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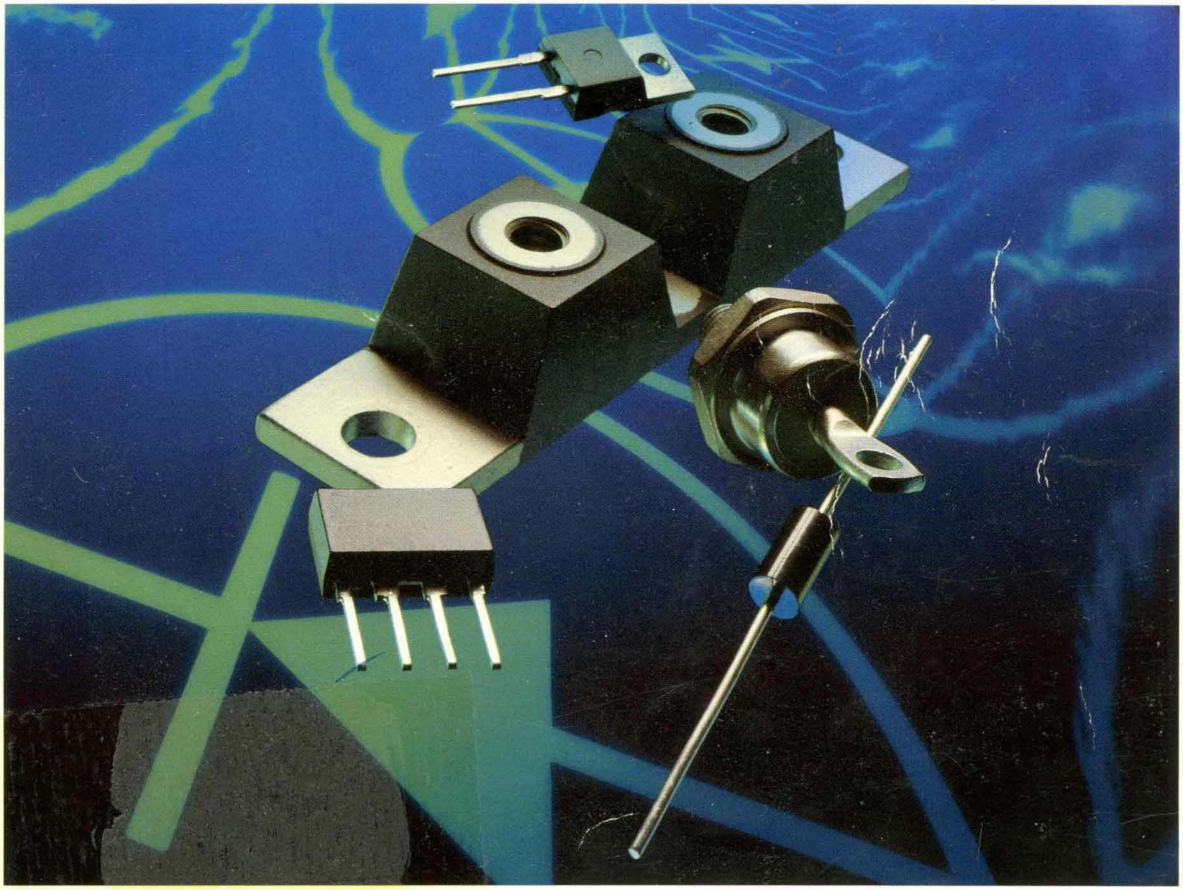

RECTIFIERS AND ZENER DIODES DATA

MOTOROLA RECTIFIERS AND ZENER DIODES DATA

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MOTOROLA

RECTIFIERS AND ZENER DIODES DATA BOOK

Prepared by
Technical Information Center

This book presents technical data for the broad line of Motorola Silicon Rectifiers and Zener Diodes. Complete specifications for the individual devices are provided in the form of data sheets. In addition, a comprehensive selector guide and industry cross-reference guide are included to simplify the task of choosing the best set of components required for a specific application.

The information in this book has been carefully checked and is believed to be accurate; however, no responsibility is assumed for inaccuracies.

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Note: Reverse polarity has an R suffix.

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*These devices are manufactured by Motorola but no data sheet available — Consult Factory.

Note: Reverse polarity has an R suffix.

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*These devices are manufactured by Motorola but no data sheet available — Consult Factory.

Note: Reverse polarity has an R suffix.

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*These devices are manufactured by Motorola but no data sheet available — Consult Factory.

Note: Reverse polarity has an R suffix.

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Note: Reverse polarity has an R suffix.

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*These devices are manufactured by Motorola but no data sheet available — Consult Factory.

Note: Reverse polarity has an R suffix.

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*These devices are manufactured by Motorola but no data sheet available — Consult Factory.

Note: Reverse polarity has an R suffix.

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*These devices are manufactured by Motorola but no data sheet available — Consult Factory.

Note: Reverse polarity has an R suffix.

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*These devices are manufactured by Motorola but no data sheet available — Consult Factory.

Note: Reverse polarity has an R suffix.

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409C		1N1202B	3-5
409D		1N1202B	3-5
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409K		1N1206B	3-5
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419A		1N1183A	3-2
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*These devices are manufactured by Motorola but no data sheet available — Consult Factory.

Note: Reverse polarity has an R suffix.

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AB1000		MR510	3-167
AC50		MR501	3-167
AC100		MR501	3-167
AC200		MR502	3-167
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Note: Reverse polarity has an R suffix.

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B600		1N4005	3-33
B800		1N4006	3-33
B1000		1N4007	3-33
BA50		1N4001	3-33
BA100		1N4002	3-33
BA200		1N4003	3-33
BA300		1N4004	3-33
BA400		1N4004	3-33
BA500		1N4005	3-33
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*These devices are manufactured by Motorola but no data sheet available — Consult Factory.

Note: Reverse polarity has an R suffix.

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*These devices are manufactured by Motorola but no data sheet available — Consult Factory.

Note: Reverse polarity has an R suffix.

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*These devices are manufactured by Motorola but no data sheet available — Consult Factory.

Note: Reverse polarity has an R suffix.

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*These devices are manufactured by Motorola but no data sheet available — Consult Factory.

Note: Reverse polarity has an R suffix.

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G1K		1N5398	3-41
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G2A		1N5391	3-41
G2B		1N5392	3-41
G2D		1N5393	3-41
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G2J		1N5397	3-41
G2K		1N5398	3-41
G2M		1N5399	3-41
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*These devices are manufactured by Motorola but no data sheet available — Consult Factory.

Note: Reverse polarity has an R suffix.

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G4D		MR502	3-167
G4G		MR504	3-167
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G8		1N4006	3-33
G10		1N4007	3-33
G100A		1N4001	3-33
G100B		1N4002	3-33
G100D		1N4003	3-33
G100F		1N4004	3-33
G100G		1N4004	3-33
G100H		1N4005	3-33
G100J		1N4005	3-33
G100K		1N4006	3-33
G100M		1N4007	3-33
GER4001		1N4001	3-33
GER4002		1N4002	3-33
GER4003		1N4003	3-33
GER4004		1N4004	3-33
GER4005		1N4005	3-33
GER4006		1N4006	3-33
GER4007		1N4007	3-33
GI500	MR500		3-167
GI501	MR501		3-167
GI502	MR502		3-167
GI504	MR504		3-167
GI506	MR506		3-167
GI508	MR508		3-167
GI510	MR510		3-167
GI750	MR750		3-173
GI751	MR751		3-173
GI752	MR752		3-173
GI754	MR754		3-173
GI756	MR756		3-173
GI758	MR758		3-173
GI810	MR810		3-177
GI811	MR811		3-177
GI812	MR812		3-177
GI814	MR814		3-177
GI816	MR816		3-177
GI817	MR817		3-177
GI818	MR818		3-177
GI820	MR820		3-183
GI821	MR821		3-183
GI822	MR822		3-183
GI824	MR824		3-183
GI826	MR826		3-183
GI850	MR850		3-192
GI851	MR851		3-192
GI852	MR852		3-192
GI854	MR854		3-192
GI856	MR856		3-192
GI910	MR910		—
GI911	MR911		—
GI912	MR912		—
GI914	MR914		—
GI916	MR916		—
GI917	MR917		—
GI918	MR918		—
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GI1103		MUR415	3-234
GI1104		MUR420	3-234
GI1301		MUR405	3-234
GI1302		MUR410	3-234
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GI1304		MUR420	3-234
GI1401	MUR805		3-241
GI1402	MUR810		3-241
GI1403	MUR815		3-241
GI1404	MUR820		3-241
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GI2403	MUR1615CT		3-252
GI2404	MUR1620CT		3-252
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GI2501	MR2501		3-217
GI2502	MR2502		3-217
GI2504	MR2504		3-217
GI2506	MR2506		3-217
GI2508	MR2508		3-217
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GIB2504		MDA2504	3-155
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GIB2508		MDA3508	3-159
GIB2510		MDA3510	3-159
GIB3500		MDA3500	3-159
GIB3501		MDA3501	3-159
GIB3502		MDA3502	3-159
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GIB3506		MDA3506	3-159
GIB3508		MDA3508	3-159
GIB3510		MDA3510	3-159
GP10A		1N4001	3-33
GP10B		1N4002	3-33
GP10D		1N4003	3-33
GP10G		1N4004	3-33
GP10J		1N4005	3-33
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Note: Reverse polarity has an R suffix.

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GP20B		1N5392	3-41
GP20D		1N5393	3-41
GP20G		1N5395	3-41
GP20J		1N5397	3-41
GP20K		1N5398	3-41
GP20M		1N5399	3-41
GP25A		MR500	3-167
GP25B		MR501	3-167
GP25D		MR502	3-167
GP25G		MR504	3-167
GP25J		MR506	3-167
GP25K		MR508	3-167
GP25M		MR510	3-167
GP30A		MR500	3-167
GP30B		MR501	3-167
GP30D		MR502	3-167
GP30G		MR504	3-167
GP30J		MR506	3-167
GP30K		MR508	3-167
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GP80B	MUR810		3-241
GP80D	MUR820		3-241
GP80G	MUR840		3-241
GP80J	MUR860		3-241
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HB400		MR504	3-167
HB500		MR506	3-167
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HER302	MUR410		3-234
HER303	MUR420		3-234
HER304	MUR430		3-234
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HER801	MUR805		3-241
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HGR-10		1N4002	3-33
HGR-20		1N4003	3-33
HGR-30		1N4004	3-33
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J4		1N5395	3-41
J6		1N5397	3-41
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KBC302		*	—
KBC304		*	—
KBC501		*	—

*These devices are manufactured by Motorola but no data sheet available — Consult Factory.

Note: Reverse polarity has an R suffix.

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KBC504		*	—
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KBC5001		*	—
KBP005	*		—
KBP01	*		—
KBP02	*		—
KBP04	*		—
KBP06	*		—
KBP08	*		—
KBP10	*		—
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KBPC10-02		MDA2502	3-155
KBPC10-04		MDA2504	3-155
KBPC10-06		MDA2506	3-155
KBPC10-08		MDA3508	3-159
KBPC10-10		MDA3510	3-159
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KBPC12-01		MDA2501	3-155
KBPC12-02		MDA2502	3-155
KBPC12-04		MDA2504	3-155
KBPC12-06		MDA2506	3-155
KBPC12-08		MDA3508	3-159
KBPC12-10		MDA3510	3-159
KBPC15-005		MDA2500	3-155
KBPC15-01		MDA2501	3-155
KBPC15-02		MDA2502	3-155
KBPC15-04		MDA2504	3-155
KBPC15-06		MDA2506	3-155
KBPC15-08		MDA3508	3-159
KBPC15-10		MDA3510	3-159
KBPC25-005		MDA2500	3-155
KBPC25-01		MDA2501	3-155
KBPC25-02		MDA2502	3-155
KBPC25-04		MDA2504	3-155
KBPC25-06		MDA2506	3-155
KBPC25-08		MDA3508	3-159
KBPC25-10		MDA3510	3-159
KBPC35-005		MDA3500	3-159
KBPC35-01		MDA3501	3-159
KBPC35-02		MDA3502	3-159
KBPC35-04		MDA3504	3-159
KBPC35-06		MDA3506	3-159
KBPC35-08		MDA3508	3-159
KBPC35-10		MDA3510	3-159
KBU4A		*	—
KBU4B		*	—
KBU4D		*	—
KBU4G		*	—
KBU6A		*	—
KBU6B		*	—
KBU6D		*	—
KBU6G		*	—
M0		1N4007	3-33
M2		1N4003	3-33
M4		1N4004	3-33
M6		1N4005	3-33
M8		1N4006	3-33
M67,A,B,C		1N4001	3-33

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M71,A,B,C		1N4005	3-33
M72,A,B,C		1N4006	3-33
M73,A,B,C		1N4007	3-33
M100A		1N4001	3-33
M100B		1N4002	3-33
M100D		1N4003	3-33
M100F		1N4004	3-33
M100G		1N4004	3-33
M100H		1N4005	3-33
M100J		1N4005	3-33
M100K		1N4006	3-33
M100M		1N4007	3-33
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MB215		1N4935	3-35
MB217		1N4936	3-35
MB218		1N4937	3-35
MB219		1N4937	3-35
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MB224		1N4936	3-35
MB225		1N4937	3-35
MB226		1N4937	3-35
MB228		MR501	3-167
MB229		MR502	3-167
MB230		MR504	3-167
MB231		MR504	3-167
MB232		MR506	3-167
MB233		MR506	3-167
MB234		MR508	3-167
MB235		MR510	3-167
MB236		1N4002	3-33
MB237		1N4003	3-33
MB238		1N4004	3-33
MB239		1N4004	3-33
MB240		1N4005	3-33
MB241		1N4005	3-33
MB242		1N4006	3-33
MB243		1N4007	3-33
MB244		1N4002	3-33
MB245		1N4003	3-33
MB246		1N4004	3-33
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MB248		1N4005	3-33
MB249		1N4005	3-33
MB250		1N4006	3-33
MB251		1N4007	3-33
MBR030	MBR030		3-81
MBR040	MBR040		3-81
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*These devices are manufactured by Motorola but no data sheet available — Consult Factory.

Note: Reverse polarity has an R suffix.

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MBR350	MBR350		3-86
MBR360	MBR360		3-86
MBR735	MBR735		3-90
MBR745	MBR745		3-90
MBR1035	MBR1035		3-92
MBR1045	MBR1045		3-92
MBR1060	MBR1060		3-96
MBR1070	MBR1070		3-96
MBR1080	MBR1080		3-96
MBR1535CT	MBR1535CT		3-98
MBR1545CT	MBR1545CT		3-98
MBR1635	MBR1635		3-100
MBR1645	MBR1645		3-100
MBR2035CT	MBR2035CT		3-102
MBR2045CT	MBR2045CT		3-102
MBR2060CT	MBR2060CT		3-106
MBR2070CT	MBR2070CT		3-106
MBR2080CT	MBR2080CT		3-106
MBR2090CT	MBR2090CT		3-106
MBR2535CT	MBR2535CT		3-108
MBR2545CT	MBR2545CT		3-108
MBR3020CT	MBR3020CT		3-110
MBR3035CT	MBR3035CT		3-110
MBR3035PT	MBR3035PT		3-114
MBR3045CT	MBR3045CT		3-114
MBR3045PT	MBR3045PT		3-114
MBR3520	MBR3520		3-116
MBR3535	MBR3535		3-116
MBR3545,H,H1	MBR3545,H,H1		3-116
MBR5825,H,H1	MBR5825,H,H1		3-55
MBR5831,H,H1	MBR5831,H,H1		3-64
MBR6035,B	MBR6035		3-124
MBR6045,B	MBR6045		3-124
MBR6045,H,H1	MBR6045,H,H1		3-124
MBR6535	MBR6535		3-128
MBR6545	MBR6545		3-128
MBR7535	MBR7535		3-132
MBR7545	MBR7545		3-132
MBR8035	MBR8035		3-134
MBR8045	MBR8045		3-134
MBR10100	MBR10100		3-96
MBR12035CT	MBR12035CT		3-138
MBR12045CT	MBR12045CT		3-138
MBR12050CT	MBR12050CT		3-138
MBR12060CT	MBR12060CT		3-138
MBR20035CT	MBR20035CT		3-142
MBR20045CT	MBR20045CT		3-142
MBR20050CT	MBR20050CT		3-142
MBR20060CT	MBR20060CT		3-142
MBR20100CT	MBR20100CT		3-106
MBR30035CT	MBR30035CT		3-144
MBR30045CT	MBR30045CT		3-144
MDA2500	MDA2500		3-155
MDA2501	MDA2501		3-155
MDA2502	MDA2502		3-155
MDA2504	MDA2504		3-155
MDA2506	MDA2506		3-155
MDA2508	MDA2508		3-155
MDA2510	MDA2510		3-155
MDA3500	MDA3500		3-159
MDA3501	MDA3501		3-159
MDA3502	MDA3502		3-159
MDA3504	MDA3504		3-159
MDA3506	MDA3506		3-159
MDA3508	MDA3508		3-159
MDA3510	MDA3510		3-159
MDA4002	MDA4002		3-163
MDA4004	MDA4004		3-163
MDA4006	MDA4006		3-163
MDA4008	MDA4008		3-163
MPR10		1N4007	3-33
MR100		1N5392	3-41
MR200		1N5393	3-41
MR400		1N5395	3-41
MR500	MR500		3-167
MR501	MR501		3-167
MR502	MR502		3-167
MR504	MR504		3-167
MR506	MR506		3-167
MR508	MR508		3-167
MR510	MR510		3-167
MR600		1N5397	3-41
MR750	MR750		3-173
MR751	MR751		3-173
MR752	MR752		3-173
MR754	MR754		3-173
MR756	MR756		3-173
MR758	MR758		3-173
MR760	MR760		3-173
MR800		1N5398	3-41
MR810	MR810		3-177
MR811	MR811		3-177
MR812	MR812		3-177
MR814	MR814		3-177
MR816	MR816		3-177
MR817	MR817		3-177
MR818	MR818		3-177
MR820	MR820		3-183
MR821	MR821		3-183
MR822	MR822		3-183
MR824	MR824		3-183
MR826	MR826		3-183
MR830	MR830		3-191
MR831	MR831		3-191
MR832	MR832		3-191
MR834	MR834		3-191
MR836	MR836		3-191
MR850	MR850		3-192
MR851	MR851		3-192
MR852	MR852		3-192
MR854	MR854		3-192
MR856	MR856		3-192
MR860		MUR5005	3-264
MR861		MUR5010	3-264
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Note: Reverse polarity has an R suffix.

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MR1121	MR1121		3-200
MR1122	MR1122		3-200
MR1123	MR1123		3-200
MR1124	MR1124		3-200
MR1125	MR1125		3-200
MR1126	MR1126		3-200
MR1128	MR1128		3-200
MR1130	MR1130		3-200
MR1366	MR1366		3-13
MR1376	MR1376		3-18
MR1386	MR1386		3-23
MR1396	MR1396		3-28
MR2000	MR2000		3-203
MR2001	MR2001		3-203
MR2002	MR2002		3-203
MR2004	MR2004		3-203
MR2006	MR2006		3-203
MR2008	MR2008		3-203
MR2010	MR2010		3-203
MR2400	MR2400		3-207
MR2400F	MR2400F		3-211
MR2401	MR2401		3-207
MR2401F	MR2401F		3-211
MR2402	MR2402		3-207
MR2402F	MR2402F		3-211
MR2404	MR2404		3-207
MR2404F	MR2404F		3-211
MR2406	MR2406		3-207
MR2406F	MR2406F		3-211
MR2500	MR2500		3-217
MR2501	MR2501		3-217
MR2502	MR2502		3-217
MR2504	MR2504		3-217
MR2506	MR2506		3-217
MR2508	MR2508		3-217
MR2510	MR2510		3-217
MR2535L	MR2535L		3-223
MR2540L	MR2540L		3-223
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Note: Reverse polarity has an R suffix.

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Note: Reverse polarity has an R suffix.

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Note: Reverse polarity has an R suffix.

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RL020		1N4935	3-35
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RL062	1N4002		3-33
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*These devices are manufactured by Motorola but no data sheet available — Consult Factory.

Note: Reverse polarity has an R suffix.

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*These devices are manufactured by Motorola but no data sheet available — Consult Factory.

Note: Reverse polarity has an R suffix.

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*These devices are manufactured by Motorola but no data sheet available — Consult Factory.

Note: Reverse polarity has an R suffix.

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*These devices are manufactured by Motorola but no data sheet available — Consult Factory.

Note: Reverse polarity has an R suffix.

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*These devices are manufactured by Motorola but no data sheet available — Consult Factory.

Note: Reverse polarity has an R suffix.

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Note: Reverse polarity has an R suffix.

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Note: Reverse polarity has an R suffix.

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Note: Reverse polarity has an R suffix.

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VSK330	MBR330		3-86
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VSK520		1N5823	3-55
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VSK1020	MBR1035		3-92
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Note: Reverse polarity has an R suffix.

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10PZ6.8B	1N3999A		4-27
10R200	1N3015A		4-15
10R200A	1N3015A		4-15
10R200B	1N3015B		4-15
10R6.8	1N3999		4-27
10R6.8A	1N3999		4-27
10R6.8B	1N3999A		4-27
10RZ200	1N3015A		4-15
10RZ200A	1N3015A		4-15
10RZ200B	1N3015B		4-15
10RZ6.8	1N3999		4-27
10RZ6.8A	1N3999		4-27
10RZ6.8B	1N3999A		4-27
10T200	1N3015A		4-15
10T200A	1N3015A		4-15
10T200B	1N3015B		4-15
10T6.8	1N3999		4-27
10T6.8A	1N3999		4-27
10T6.8B	1N3999A		4-27
10Z200	1N3015A		4-15
10Z200A	1N3015A		4-15
10Z200B	1N3015B		4-15
10Z200D(R)	1N3015RA		4-15
10Z200D(R)10	1N3015RA		4-15
10Z200D(R)5	1N3015RA		4-15
10Z3.9	1N3993		4-27
10Z3.9A	1N3993		4-27
10Z3.9B	1N3993A		4-27
1N370		1N5221B	4-40
1N371		1N5221A	4-40
1N372		1N5225A	4-40
1N373		1N5227A	4-40
1N374		1N5229A	4-40
1N375		1N5230A	4-40
1N376		1N5233A	4-40
1N377		1N5236A	4-40
1N378		1N5238A	4-40
1N379		1N5240A	4-40
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1N381		1N5246A	4-40
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1N384		1N5255A	4-40
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1N387		1N5261A	4-40
1N465		1N5223A	4-40
1N465A		1N5223B	4-40
1N466		1N5226A	4-40
1N466A		1N5226B	4-40
1N467		1N5228B	4-40
1N467A		1N5228B	4-40
1N468		1N5230A	4-40
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1N469A		1N5232B	4-40
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Note: Reverse polarity has an R suffix.

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1N668		1N5251A	4-40
1N669		1N5254A	4-40
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1N746A	1N746A		4-4
1N746A1JAN	1N746A1JAN		4-4
1N746A1JTX	1N746A1JTX		4-4
1N746A1JTXV	1N746A1JTXV		4-4
1N747	1N747		4-4
1N747A	1N747A		4-4
1N747A1JAN	1N747A1JAN		4-4
1N747A1JTX	1N747A1JTX		4-4
1N747A1JTXV	1N747A1JTXV		4-4
1N748	1N748		4-4
1N748A	1N748A		4-4
1N748A1JAN	1N748A1JAN		4-4
1N748A1JTX	1N748A1JTX		4-4
1N748A1JTXV	1N748A1JTXV		4-4
1N749	1N749		4-4
1N749A	1N749A		4-4
1N749A1JAN	1N749A1JAN		4-4
1N749A1JTX	1N749A1JTX		4-4
1N749A1JTXV	1N749A1JTXV		4-4
1N750	1N750		4-4
1N750A	1N750A		4-4
1N750A1JAN	1N750A1JAN		4-4
1N750A1JTX	1N750A1JTX		4-4
1N750A1JTXV	1N750A1JTXV		4-4
1N751	1N751A		4-4
1N751A	1N751A		4-4
1N751A1JAN	1N751A1JAN		4-4
1N751A1JTX	1N751A1JTX		4-4
1N751A1JTXV	1N751A1JTXV		4-4
1N752	1N752A		4-4
1N752A	1N752A		4-4
1N752A1JAN	1N752A1JAN		4-4
1N752A1JTX	1N752A1JTX		4-4
1N752A1JTXV	1N752A1JTXV		4-4
1N753	1N753A		4-4
1N753A	1N753A		4-4
1N753A1JAN	1N753A1JAN		4-4
1N753A1JTX	1N753A1JTX		4-4
1N753A1JTXV	1N753A1JTXV		4-4
1N754	1N754A		4-4
1N754A	1N754A		4-4
1N754A1JAN	1N754A1JAN		4-4
1N754A1JTX	1N754A1JTX		4-4
1N754A1JTXV	1N754A1JTXV		4-4
1N755	1N755A		4-4
1N755A	1N755A		4-4
1N755A1JAN	1N755A1JAN		4-4
1N755A1JTX	1N755A1JTX		4-4
1N755A1JTXV	1N755A1JTXV		4-4
1N756	1N756A		4-4
1N756A	1N756A		4-4
1N756A1JAN	1N756A1JAN		4-4
1N756A1JTX	1N756A1JTX		4-4
1N756A1JTXV	1N756A1JTXV		4-4
1N757	1N757A		4-4
1N757A	1N757A		4-4
1N757A1JAN	1N757A1JAN		4-4
1N757A1JTX	1N757A1JTX		4-4
1N757A1JTXV	1N757A1JTXV		4-4
1N758	1N758A		4-4
1N758A	1N758A		4-4
1N758A1JAN	1N758A1JAN		4-4
1N758A1JTX	1N758A1JTX		4-4
1N758A1JTXV	1N758A1JTXV		4-4
1N759	1N759A		4-4
1N759A	1N759A		4-4
1N759A1JAN	1N759A1JAN		4-4
1N759A1JTX	1N759A1JTX		4-4
1N759A1JTXV	1N759A1JTXV		4-4
1N821	1N821		4-10
1N821-1JAN	1N821-1JAN		4-10
1N821-1JTX	1N821-1JTX		4-10
1N821-1JTXV	1N821-1JTXV		4-10
1N821A	1N821A		4-10
1N821JAN	1N821JAN		4-10
1N821JTX	1N821JTX		4-10
1N821JTXV	1N821JTXV		4-10
1N823	1N823		4-10
1N823-1JAN	1N823-1JAN		4-10
1N823-1JTX	1N823-1JTX		4-10
1N823-1JTXV	1N823-1JTXV		4-10
1N823A	1N823A		4-10
1N823JAN	1N823JAN		4-10
1N823JTX	1N823JTX		4-10
1N823JTXV	1N823JTXV		4-10
1N824	1N823		4-10
1N824A	1N823A		4-10
1N825	1N825		4-10
1N825-1JAN	1N825-1JAN		4-10
1N825-1JTX	1N825-1JTX		4-10
1N825-1JTXV	1N825-1JTXV		4-10
1N825A	1N825A		4-10
1N825JAN	1N825JAN		4-10
1N825JTX	1N825JTX		4-10
1N825JTXV	1N825JTXV		4-10
1N826		1N825	4-10
1N827	1N827		4-10
1N827-1JAN	1N827-1JAN		4-10
1N827-1JTX	1N827-1JTX		4-10
1N827-1JTXV	1N827-1JTXV		4-10
1N827A	1N827A		4-10
1N827JAN	1N827JAN		4-10
1N827JTX	1N827JTX		4-10
1N827JTXV	1N827JTXV		4-10
1N828		1N827	4-10
1N829	1N829		4-10
1N829-1JAN	1N829-1JAN		4-10
1N829-1JTX	1N829-1JTX		4-10

Note: Reverse polarity has an R suffix.

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1N829JTX	1N829JTX		4-10
1N829JTXV	1N829JTXV		4-10
1N957A	1N957A		4-4
1N957B	1N957B		4-4
1N958A	1N958A		4-4
1N958B	1N958B		4-4
1N959A	1N959A		4-4
1N959B	1N959B		4-4
1N960A	1N960A		4-4
1N960B	1N960B		4-4
1N961A	1N961A		4-4
1N961B	1N961B		4-4
1N962A	1N962A		4-4
1N962B	1N962B		4-4
1N962B1JAN	1N962B1JAN		4-4
1N962B1JTX	1N962B1JTX		4-4
1N962B1JTXV	1N962B1JTXV		4-4
1N963A	1N963A		4-4
1N963B	1N963B		4-4
1N963B1JAN	1N963B1JAN		4-4
1N963B1JTX	1N963B1JTX		4-4
1N963B1JTXV	1N963B1JTXV		4-4
1N964A	1N964A		4-4
1N964B	1N964B		4-4
1N964B1JAN	1N964B1JAN		4-4
1N964B1JTX	1N964B1JTX		4-4
1N964B1JTXV	1N964B1JTXV		4-4
1N965A	1N965A		4-4
1N965B	1N965B		4-4
1N965B1JAN	1N965B1JAN		4-4
1N965B1JTX	1N965B1JTX		4-4
1N965B1JTXV	1N965B1JTXV		4-4
1N966A	1N966A		4-4
1N966B	1N966B		4-4
1N966B1JAN	1N966B1JAN		4-4
1N966B1JTX	1N966B1JTX		4-4
1N966B1JTXV	1N966B1JTXV		4-4
1N967A	1N967A		4-4
1N967B	1N967B		4-4
1N967B1JAN	1N967B1JAN		4-4
1N967B1JTX	1N967B1JTX		4-4
1N967B1JTXV	1N967B1JTXV		4-4
1N968A	1N968A		4-4
1N968B	1N968B		4-4
1N968B1JAN	1N968B1JAN		4-4
1N968B1JTX	1N968B1JTX		4-4
1N968B1JTXV	1N968B1JTXV		4-4
1N969A	1N969A		4-4
1N969B	1N969B		4-4
1N969B1JAN	1N969B1JAN		4-4
1N969B1JTX	1N969B1JTX		4-4
1N969B1JTXV	1N969B1JTXV		4-4
1N970A	1N970A		4-4
1N970B	1N970B		4-4
1N970B1JAN	1N970B1JAN		4-4
1N970B1JTX	1N970B1JTX		4-4
1N970B1JTXV	1N970B1JTXV		4-4
1N971A	1N971A		4-4
1N971B	1N971B		4-4
1N971B1JAN	1N971B1JAN		4-4
1N971B1JTX	1N971B1JTX		4-4
1N971B1JTXV	1N971B1JTXV		4-4
1N972A	1N972A		4-4
1N972B	1N972B		4-4
1N972B1JAN	1N972B1JAN		4-4
1N972B1JTX	1N972B1JTX		4-4
1N972B1JTXV	1N972B1JTXV		4-4
1N973A	1N973A		4-4
1N973B	1N973B		4-4
1N973B1JAN	1N973B1JAN		4-4
1N973B1JTX	1N973B1JTX		4-4
1N973B1JTXV	1N973B1JTXV		4-4
1N974A	1N974A		4-4
1N974B	1N974B		4-4
1N974B1JAN	1N974B1JAN		4-4
1N974B1JTX	1N974B1JTX		4-4
1N974B1JTXV	1N974B1JTXV		4-4
1N975A	1N975A		4-4
1N975B	1N975B		4-4
1N975B1JAN	1N975B1JAN		4-4
1N975B1JTX	1N975B1JTX		4-4
1N975B1JTXV	1N975B1JTXV		4-4
1N976A	1N976A		4-4
1N976B	1N976B		4-4
1N976B1JAN	1N976B1JAN		4-4
1N976B1JTX	1N976B1JTX		4-4
1N976B1JTXV	1N976B1JTXV		4-4
1N977A	1N977A		4-4
1N977B	1N977B		4-4
1N977B1JAN	1N977B1JAN		4-4
1N977B1JTX	1N977B1JTX		4-4
1N977B1JTXV	1N977B1JTXV		4-4
1N978A	1N978A		4-4
1N978B	1N978B		4-4
1N978B1JAN	1N978B1JAN		4-4
1N978B1JTX	1N978B1JTX		4-4
1N978B1JTXV	1N978B1JTXV		4-4
1N979A	1N979A		4-4
1N979B	1N979B		4-4
1N979B1JAN	1N979B1JAN		4-4
1N979B1JTX	1N979B1JTX		4-4
1N979B1JTXV	1N979B1JTXV		4-4
1N980A	1N980A		4-4
1N980B	1N980B		4-4
1N980B1JAN	1N980B1JAN		4-4
1N980B1JTX	1N980B1JTX		4-4
1N980B1JTXV	1N980B1JTXV		4-4
1N981A	1N981A		4-4
1N981B	1N981B		4-4
1N981B1JAN	1N981B1JAN		4-4
1N981B1JTX	1N981B1JTX		4-4
1N981B1JTXV	1N981B1JTXV		4-4
1N982A	1N982A		4-4
1N982B	1N982B		4-4
1N982B1JAN	1N982B1JAN		4-4
1N982B1JTX	1N982B1JTX		4-4
1N982B1JTXV	1N982B1JTXV		4-4

Note: Reverse polarity has an R suffix.

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1N983B1JTX	1N983B1JTX		4-4
1N983B1JTXV	1N983B1JTXV		4-4
1N984A	1N984A		4-4
1N984B	1N984B		4-4
1N984B1JAN	1N984B1JAN		4-4
1N984B1JTX	1N984B1JTX		4-4
1N984B1JTXV	1N984B1JTXV		4-4
1N985A	1N985A		4-4
1N985B	1N985B		4-4
1N986A	1N986A		4-4
1N986B	1N986B		4-4
1N987A	1N987A		4-13
1N987B	1N987B		4-13
1N988A	1N988A		4-13
1N988B	1N988B		4-13
1N989A	1N989A		4-13
1N989B	1N989B		4-13
1N990A	1N990A		4-13
1N990B	1N990B		4-13
1N991A	1N991A		4-13
1N991B	1N991B		4-13
1N992A	1N992A		4-13
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1N1313		1N4102	4-28
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1N1351		1N2974A	4-15
1N1351A		1N2974B	4-15
1N1352		1N2975A	4-15
1N1352A		1N2975B	4-15
1N1353		1N2976A	4-15
1N1353A		1N2976B	4-15
1N1354		1N2977A	4-15
1N1356		1N2980A	4-15
1N1356A		1N2980B	4-15
1N1357		1N2982A	4-15
1N1357A		1N2982B	4-15
1N1358		1N2984A	4-15
1N1358A		1N2984B	4-15
1N1359		1N2985A	4-15
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1N1360A		1N2986B	4-15
1N1361		1N2988A	4-15
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1N1362		1N2989A	4-15
1N1362A		1N2989B	4-15
1N1363		1N2990A	4-15
1N1363A		1N2990B	4-15
1N1364		1N2991A	4-15
1N1364A		1N2991B	4-15
1N1365		1N2992A	4-15
1N1365A		1N2992B	4-15
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1N1368		1N2997A	4-15
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1N1370A		1N3000B	4-15
1N1371		1N3001A	4-15
1N1371A		1N3001B	4-15
1N1372		1N3002A	4-15
1N1372A		1N3002B	4-15
1N1373		1N3003A	4-15
1N1373A		1N3003B	4-15
1N1374		1N3004A	4-15
1N1374A		1N3004B	4-15
1N1375		1N3005A	4-15
1N1375A		1N3005B	4-15
1N1416		1N2972B	4-15
1N1417		1N2976B	4-15
1N1418		1N2979B	4-15
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1N1422		1N3001B	4-15
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1N1430		1N4750A	4-36
1N1431		1N4760A	4-36
1N1432		1N4764A	4-36
1N1482		1N3995A	4-27
1N1483		1N3998A	4-27
1N1484		1N4732A	4-36
1N1485		1N4735A	4-36
1N1507		1N4730	4-36
1N1507A		1N4730A	4-36
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1N1518		1N4730	4-36
1N1518A		1N4730A	4-36
1N1519		1N4732	4-36

Note: Reverse polarity has an R suffix.

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1N1519A		1N4732A	4-36
1N1520		1N4734	4-36
1N1520A		1N4734A	4-36
1N1521		1N4736	4-36
1N1521A		1N4736A	4-36
1N1522		1N4738	4-36
1N1522A		1N4738A	4-36
1N1523		1N4740	4-36
1N1523A		1N4740A	4-36
1N1524		1N4742	4-36
1N1524A		1N4742A	4-36
1N1525		1N4744	4-36
1N1525A		1N4744A	4-36
1N1526		1N4746	4-36
1N1526A		1N4746A	4-36
1N1527		1N4748	4-36
1N1527A		1N4748A	4-36
1N1528		1N4750	4-36
1N1528A		1N4750A	4-36
1N1588		1N3993A	4-27
1N1588A		1N3993A	4-27
1N1589		1N3995A	4-27
1N1589A		1N3995A	4-27
1N1590		1N3997A	4-27
1N1590A		1N3997A	4-27
1N1591		1N2970RA	4-15
1N1591A		1N2970RB	4-15
1N1592		1N2972RA	4-15
1N1592A		1N2972RB	4-15
1N1593		1N2974RA	4-15
1N1593A		1N2974RB	4-15
1N1594		1N2976RA	4-15
1N1594A		1N2976RB	4-15
1N1595		1N2979RA	4-15
1N1595A		1N2979RB	4-15
1N1596		1N2982RA	4-15
1N1596A		1N2982RB	4-15
1N1597A		1N2985RB	4-15
1N1598		1N2988RA	4-15
1N1598A		1N2988RB	4-15
1N1599		1N3993A	4-27
1N1599A		1N3993A	4-27
1N1600		1N3995A	4-27
1N1600A		1N3995A	4-27
1N1601		1N3997A	4-27
1N1601A		1N3997A	4-27
1N1602		1N2970RA	4-15
1N1602A		1N2970RB	4-15
1N1603		1N2972RA	4-15
1N1603A		1N2972RB	4-15
1N1604		1N2974RA	4-15
1N1604A		1N2974RB	4-15
1N1605		1N2976RA	4-15
1N1605A		1N2976RB	4-15
1N1606		1N2979RA	4-15
1N1606A		1N2979RB	4-15
1N1607		1N2982RA	4-15
1N1607A		1N2982RB	4-15
1N1608		1N2985RA	4-15
1N1608A		1N2985RB	4-15
1N1609		1N2988RA	4-15
1N1609A		1N2988RB	4-15
1N1735		1N823	4-10
1N1743		1N2974A	4-15
1N1744		1N4740	4-36
1N1765		1N4734	4-36
1N1765A		1N4734A	4-36
1N1766		1N4735	4-36
1N1766A		1N4735A	4-36
1N1767		1N4736	4-36
1N1767A		1N4736A	4-36
1N1768		1N4737	4-36
1N1768A		1N4737A	4-36
1N1769		1N4738	4-36
1N1769A		1N4738A	4-36
1N1770		1N4739	4-36
1N1770A		1N4739A	4-36
1N1771		1N4740	4-36
1N1771A		1N4740A	4-36
1N1772		1N4741	4-36
1N1772A		1N4741A	4-36
1N1773		1N4742	4-36
1N1773A		1N4742A	4-36
1N1774		1N4743	4-36
1N1774A		1N4743A	4-36
1N1775		1N4744	4-36
1N1775A		1N4744A	4-36
1N1776		1N4745	4-36
1N1776A		1N4745A	4-36
1N1777		1N4746	4-36
1N1777A		1N4746A	4-36
1N1778		1N4747	4-36
1N1778A		1N4747A	4-36
1N1779		1N4748	4-36
1N1779A		1N4748A	4-36
1N1780		1N4749	4-36
1N1780A		1N4749A	4-36
1N1781		1N4750	4-36
1N1781A		1N4750A	4-36
1N1782		1N4751	4-36
1N1782A		1N4751A	4-36
1N1783		1N4752	4-36
1N1783A		1N4752A	4-36
1N1784		1N4753	4-36
1N1784A		1N4753A	4-36
1N1785		1N4754	4-36
1N1785A		1N4754A	4-36
1N1786		1N4755	4-36
1N1786A		1N4755A	4-36
1N1787		1N4756	4-36
1N1787A		1N4756A	4-36
1N1788		1N4757	4-36
1N1788A		1N4757A	4-36
1N1789		1N4758	4-36
1N1789A		1N4758A	4-36
1N1790		1N4759	4-36
1N1790A		1N4759A	4-36
1N1791		1N4760	4-36
1N1791A		1N4760A	4-36
1N1792		1N4761	4-36

Note: Reverse polarity has an R suffix.

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1N1793		1N4762	4-36
1N1793A		1N4762A	4-36
1N1794		1N4763	4-36
1N1794A		1N4763A	4-36
1N1795		1N4764	4-36
1N1795A		1N4764A	4-36
1N1803		1N3997RA	4-27
1N1803A		1N3997RA	4-27
1N1804		1N3998RA	4-27
1N1804A		1N3998RA	4-27
1N1805		1N2970A	4-15
1N1805A		1N2970B	4-15
1N1806		1N2971A	4-15
1N1806A		1N2971B	4-15
1N1807		1N2972A	4-15
1N1807A		1N2972B	4-15
1N1808		1N2973A	4-15
1N1808A		1N2973B	4-15
1N1809		1N3007A	4-15
1N1809A		1N3007B	4-15
1N1810		1N3008A	4-15
1N1810A		1N3008B	4-15
1N1811		1N3009A	4-15
1N1811A		1N3009B	4-15
1N1812		1N3011A	4-15
1N1812A		1N3011B	4-15
1N1813		1N3012A	4-15
1N1813A		1N3012B	4-15
1N1814		1N3014A	4-15
1N1814A		1N3014B	4-15
1N1815		1N3015A	4-15
1N1815A		1N3015B	4-15
1N1816		1N2977A	4-15
1N1816A		1N2977B	4-15
1N1817		1N2979A	4-15
1N1817A		1N2979B	4-15
1N1818		1N2980A	4-15
1N1818A		1N2980B	4-15
1N1819		1N2982A	4-15
1N1819A		1N2982B	4-15
1N1820		1N2984A	4-15
1N1820A		1N2984B	4-15
1N1821		1N2985A	4-15
1N1821A		1N2985B	4-15
1N1822		1N2986A	4-15
1N1822A		1N2986B	4-15
1N1823		1N2988A	4-15
1N1823A		1N2988B	4-15
1N1824		1N2989A	4-15
1N1824A		1N2989B	4-15
1N1825		1N2990A	4-15
1N1825A		1N2990B	4-15
1N1826		1N2991A	4-15
1N1826A		1N2991B	4-15
1N1827		1N2992A	4-15
1N1827A		1N2992B	4-15
1N1828		1N2993A	4-15
1N1828A		1N2993B	4-15
1N1829		1N2995A	4-15
1N1829A		1N2995B	4-15
1N1830		1N2997A	4-15
1N1830A		1N2997B	4-15
1N1831		1N2999A	4-15
1N1831A		1N2999B	4-15
1N1832		1N3000A	4-15
1N1832A		1N3000B	4-15
1N1833		1N3001A	4-15
1N1833A		1N3001B	4-15
1N1834		1N3002A	4-15
1N1834A		1N3002B	4-15
1N1835		1N3003A	4-15
1N1835A		1N3003B	4-15
1N1836		1N3004A	4-15
1N1836A		1N3004B	4-15
1N1876		1N4740	4-36
1N1877		1N4742	4-36
1N1878		1N4744	4-36
1N1879		1N4746	4-36
1N1880		1N4748	4-36
1N1881		1N4750	4-36
1N1882		1N4752	4-36
1N1883		1N4754	4-36
1N1884		1N4756	4-36
1N1885		1N4758	4-36
1N1886		1N4760	4-36
1N1887		1N4762	4-36
1N1888		1N4764	4-36
1N1891		1N2972A	4-15
1N1892		1N2974A	4-15
1N1893		1N2976A	4-15
1N1894		1N2979A	4-15
1N1895		1N2982A	4-15
1N1896		1N2985A	4-15
1N1897		1N2988A	4-15
1N1898		1N2990A	4-15
1N1899		1N2992A	4-15
1N1900		1N2995A	4-15
1N1901		1N2999A	4-15
1N1902		1N3001A	4-15
1N1903		1N3003A	4-15
1N1904		1N3005A	4-15
1N1905		1N3008A	4-15
1N1906		1N3011A	4-15
1N1927		1N5228A	4-40
1N1928		1N5230A	4-40
1N1929		1N5232A	4-40
1N1930		1N5235A	4-40
1N1931		1N5237A	4-40
1N1932		1N5240A	4-40
1N1933		1N5242A	4-40
1N1934		1N5245A	4-40
1N1935		1N5248A	4-40
1N1936		1N5251A	4-40
1N1937		1N5254A	4-40
1N1938		1N5257A	4-40
1N1939		1N5259A	4-40
1N1940		1N5261A	4-40
1N1941		1N5263A	4-40
1N1942		1N5266A	4-40

Note: Reverse polarity has an R suffix.

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1N1943		1N5268A	4-40
1N1944		1N5271A	4-40
1N1945		1N5273A	4-40
1N1946		1N5276A	4-40
1N1947		1N5279A	4-40
1N1954		1N5228A	4-40
1N1955		1N5230A	4-40
1N1956		1N5232A	4-40
1N1957		1N5235A	4-40
1N1958		1N5237A	4-40
1N1959		1N5240A	4-40
1N1960		1N5242A	4-40
1N1961		1N5245A	4-40
1N1962		1N5248A	4-40
1N1963		1N5251A	4-40
1N1964		1N5254A	4-40
1N1965		1N5257A	4-40
1N1966		1N5259A	4-40
1N1967		1N5261A	4-40
1N1968		1N5263A	4-40
1N1969		1N5266A	4-40
1N1970		1N5268A	4-40
1N1971		1N5271A	4-40
1N1972		1N5273A	4-40
1N1973		1N5276A	4-40
1N1974		1N5279A	4-40
1N1981		1N5228A	4-40
1N1982		1N5230A	4-40
1N1983		1N5232A	4-40
1N1984		1N5235A	4-40
1N1985		1N5237A	4-40
1N1986		1N5240A	4-40
1N1987		1N5242A	4-40
1N1988		1N5245A	4-40
1N1989		1N5248A	4-40
1N1990		1N5251A	4-40
1N1991		1N5254A	4-40
1N1992		1N5257A	4-40
1N1993		1N5259A	4-40
1N1994		1N5261A	4-40
1N1995		1N5263A	4-40
1N1996		1N5266A	4-40
1N1997		1N5268A	4-40
1N1998		1N5271A	4-40
1N1999		1N5273A	4-40
1N2000		1N5276A	4-40
1N2001		1N5279A	4-40
1N2008		1N3005A	4-15
1N2009		1N3007A	4-15
1N2010		1N3008A	4-15
1N2011		1N3009A	4-15
1N2012		1N3011A	4-15
1N2012A		1N3011B	4-15
1N2012AR		1N3011B	4-15
1N2032		1N4732	4-36
1N2033		1N4734	4-36
1N2034		1N4736	4-36
1N2035		1N4739	4-36
1N2036		1N4740	4-36
1N2037		1N4743	4-36

Industry Part Number	Motorola Direct Replacement	Motorola Similar Replacement	Page #
1N2038		1N4745	4-36
1N2039		1N4747	4-36
1N2040		1N4749	4-36
1N2041		1N3995A	4-27
1N2042		1N3997A	4-27
1N2043		1N2970RA	4-15
1N2044		1N2973RA	4-15
1N2045		1N2974RB	4-15
1N2046		1N2977RA	4-15
1N2047		1N2980RA	4-15
1N2048		1N2983RA	4-15
1N2049		1N2986RA	4-15
1N2387		1N4751	4-36
1N2498		1N2974A	4-15
1N2498A		1N2974B	4-15
1N2499		1N2975A	4-15
1N2499A		1N2975B	4-15
1N2500		1N2976A	4-15
1N2500A		1N2976B	4-15
1N2765		1N823A	4-10
1N2765A		1N825A	4-10
1N2783		1N3000A	4-15
1N2937		1N2996A	4-15
1N2970A	1N2970A		4-15
1N2970B	1N2970B		4-15
1N2970BJAN	1N2970BJAN		4-15
1N2970BJTX	1N2970BJTX		4-15
1N2970RA	1N2970RA		4-15
1N2970RB	1N2970RB		4-15
1N2971A	1N2971A		4-15
1N2971B	1N2971B		4-15
1N2971BJAN	1N2971BJAN		4-15
1N2971BJTX	1N2971BJTX		4-15
1N2971RA	1N2971RA		4-15
1N2971RB	1N2971RB		4-15
1N2972A	1N2972A		4-15
1N2972B	1N2972B		4-15
1N2972BJAN	1N2972BJAN		4-15
1N2972BJTX	1N2972BJTX		4-15
1N2972RA	1N2972RA		4-15
1N2972RB	1N2972RB		4-15
1N2973A	1N2973A		4-15
1N2973B	1N2973B		4-15
1N2973BJAN	1N2973BJAN		4-15
1N2973BJTX	1N2973BJTX		4-15
1N2973RA	1N2973RA		4-15
1N2973RB	1N2973RB		4-15
1N2974A	1N2974A		4-15
1N2974B	1N2974B		4-15
1N2974BJAN	1N2974BJAN		4-15
1N2974BJTX	1N2974BJTX		4-15
1N2974RA	1N2974RA		4-15
1N2974RB	1N2974RB		4-15
1N2975A	1N2975A		4-15
1N2975B	1N2975B		4-15
1N2975BJAN	1N2975BJAN		4-15
1N2975BJTX	1N2975BJTX		4-15
1N2975RA	1N2975RA		4-15
1N2975RB	1N2975RB		4-15
1N2976A	1N2976A		4-15

Note: Reverse polarity has an R suffix.

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Industry Part Number	Motorola Direct Replacement	Motorola Similar Replacement	Page #
1N2976B	1N2976B		4-15
1N2976BJAN	1N2976BJAN		4-15
1N2976BJTX	1N2976BJTX		4-15
1N2976RA	1N2976RA		4-15
1N2976RB	1N2976RB		4-15
1N2977A	1N2977A		4-15
1N2977B	1N2977B		4-15
1N2977BJAN	1N2977BJAN		4-15
1N2977BJTX	1N2977BJTX		4-15
1N2977RA	1N2977RA		4-15
1N2977RB	1N2977RB		4-15
1N2978A	1N2978A		4-15
1N2978B	1N2978B		4-15
1N2978RA	1N2978RA		4-15
1N2978RB	1N2978RB		4-15
1N2979A	1N2979A		4-15
1N2979B	1N2979B		4-15
1N2979BJAN	1N2979BJAN		4-15
1N2979BJTX	1N2979BJTX		4-15
1N2979RA	1N2979RA		4-15
1N2979RB	1N2979RB		4-15
1N2980A	1N2980A		4-15
1N2980B	1N2980B		4-15
1N2980BJAN	1N2980BJAN		4-15
1N2980BJTX	1N2980BJTX		4-15
1N2980RA	1N2980RA		4-15
1N2980RB	1N2980RB		4-15
1N2981A	1N2981A		4-15
1N2981B	1N2981B		4-15
1N2981RA	1N2981RA		4-15
1N2981RB	1N2981RB		4-15
1N2982A	1N2982A		4-15
1N2982B	1N2982B		4-15
1N2982BJAN	1N2982BJAN		4-15
1N2982BJTX	1N2982BJTX		4-15
1N2982RA	1N2982RA		4-15
1N2982RB	1N2982RB		4-15
1N2983A	1N2983A		4-15
1N2983B	1N2983B		4-15
1N2983BJAN	1N2983BJAN		4-15
1N2983BJTX	1N2983BJTX		4-15
1N2983RA	1N2983RA		4-15
1N2983RB	1N2983RB		4-15
1N2984A	1N2984A		4-15
1N2984B	1N2984B		4-15
1N2984BJAN	1N2984BJAN		4-15
1N2984BJTX	1N2984BJTX		4-15
1N2984RA	1N2984RA		4-15
1N2984RB	1N2984RB		4-15
1N2985A	1N2985A		4-15
1N2985B	1N2985B		4-15
1N2985BJAN	1N2985BJAN		4-15
1N2985BJTX	1N2985BJTX		4-15
1N2985RA	1N2985RA		4-15
1N2985RB	1N2985RB		4-15
1N2986A	1N2986A		4-15
1N2986B	1N2986B		4-15
1N2986BJAN	1N2986BJAN		4-15
1N2986BJTX	1N2986BJTX		4-15
1N2986RA	1N2986RA		4-15
1N2986RB	1N2986RB		4-15
1N2987A	1N2987A		4-15
1N2987B	1N2987B		4-15
1N2987RA	1N2987RA		4-15
1N2988A	1N2988A		4-15
1N2988B	1N2988B		4-15
1N2988BJAN	1N2988BJAN		4-15
1N2988BJTX	1N2988BJTX		4-15
1N2988RA	1N2988RA		4-15
1N2988RB	1N2988RB		4-15
1N2989A	1N2989A		4-15
1N2989B	1N2989B		4-15
1N2989BJAN	1N2989BJAN		4-15
1N2989BJTX	1N2989BJTX		4-15
1N2989RA	1N2989RA		4-15
1N2989RB	1N2989RB		4-15
1N2990A	1N2990A		4-15
1N2990B	1N2990B		4-15
1N2990BJAN	1N2990BJAN		4-15
1N2990BJTX	1N2990BJTX		4-15
1N2990RA	1N2990RA		4-15
1N2990RB	1N2990RB		4-15
1N2991A	1N2991A		4-15
1N2991B	1N2991B		4-15
1N2991BJAN	1N2991BJAN		4-15
1N2991BJTX	1N2991BJTX		4-15
1N2991RA	1N2991RA		4-15
1N2991RB	1N2991RB		4-15
1N2992A	1N2992A		4-15
1N2992B	1N2992B		4-15
1N2992BJAN	1N2992BJAN		4-15
1N2992BJTX	1N2992BJTX		4-15
1N2992RA	1N2992RA		4-15
1N2992RB	1N2992RB		4-15
1N2993A	1N2993A		4-15
1N2993B	1N2993B		4-15
1N2993BJAN	1N2993BJAN		4-15
1N2993BJTX	1N2993BJTX		4-15
1N2993RA	1N2993RA		4-15
1N2993RB	1N2993RB		4-15
1N2994A	1N2994A		4-15
1N2994B	1N2994B		4-15
1N2994RA	1N2994RA		4-15
1N2995A	1N2995A		4-15
1N2995B	1N2995B		4-15
1N2995RA	1N2995RA		4-15
1N2995RB	1N2995RB		4-15
1N2996A	1N2996A		4-15
1N2996B	1N2996B		4-15
1N2996BJAN	1N2996BJAN		4-15
1N2996BJTX	1N2996BJTX		4-15
1N2996RA	1N2996RA		4-15
1N2996RB	1N2996RB		4-15
1N2997A	1N2997A		4-15
1N2997B	1N2997B		4-15
1N2997BJAN	1N2997BJAN		4-15
1N2997BJTX	1N2997BJTX		4-15
1N2997RA	1N2997RA		4-15
1N2997RB	1N2997RB		4-15
1N2998A	1N2998A		4-15

Note: Reverse polarity has an R suffix.

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Industry Part Number	Motorola Direct Replacement	Motorola Similar Replacement	Page #
1N2998B	1N2998B		4-15
1N2998RA	1N2998RA		4-15
1N2998RB	1N2998RB		4-15
1N2999A	1N2999A		4-15
1N2999B	1N2999B		4-15
1N2999BJAN	1N2999BJAN		4-15
1N2999BJTX	1N2999BJTX		4-15
1N2999RA	1N2999RA		4-15
1N2999RB	1N2999RB		4-15
1N3000A	1N3000A		4-15
1N3000B	1N3000B		4-15
1N3000BJAN	1N3000BJAN		4-15
1N3000BJTX	1N3000BJTX		4-15
1N3000RA	1N3000RA		4-15
1N3000RB	1N3000RB		4-15
1N3001A	1N3001A		4-15
1N3001B	1N3001B		4-15
1N3001BJAN	1N3001BJAN		4-15
1N3001BJTX	1N3001BJTX		4-15
1N3001RA	1N3001RA		4-15
1N3001RB	1N3001RB		4-15
1N3002A	1N3002A		4-15
1N3002B	1N3002B		4-15
1N3002BJAN	1N3002BJAN		4-15
1N3002BJTX	1N3002BJTX		4-15
1N3002RA	1N3002RA		4-15
1N3002RB	1N3002RB		4-15
1N3003A	1N3003A		4-15
1N3003B	1N3003B		4-15
1N3003BJAN	1N3003BJAN		4-15
1N3003BJTX	1N3003BJTX		4-15
1N3003RA	1N3003RA		4-15
1N3003RB	1N3003RB		4-15
1N3004A	1N3004A		4-15
1N3004B	1N3004B		4-15
1N3004BJAN	1N3004BJAN		4-15
1N3004BJTX	1N3004BJTX		4-15
1N3004RA	1N3004RA		4-15
1N3004RB	1N3004RB		4-15
1N3005A	1N3005A		4-15
1N3005B	1N3005B		4-15
1N3005BJAN	1N3005BJAN		4-15
1N3005BJTX	1N3005BJTX		4-15
1N3005RA	1N3005RA		4-15
1N3005RB	1N3005RB		4-15
1N3006A	1N3006A		4-15
1N3006B	1N3006B		4-15
1N3006RA	1N3006RA		4-15
1N3006RB	1N3006RB		4-15
1N3007A	1N3007A		4-15
1N3007B	1N3007B		4-15
1N3007BJAN	1N3007BJAN		4-15
1N3007BJTX	1N3007BJTX		4-15
1N3007RA	1N3007RA		4-15
1N3007RB	1N3007RB		4-15
1N3008A	1N3008A		4-15
1N3008B	1N3008B		4-15
1N3008BJAN	1N3008BJAN		4-15
1N3008BJTX	1N3008BJTX		4-15
1N3008RA	1N3008RA		4-15
1N3008RB	1N3008RB		4-15
1N3009A	1N3009A		4-15
1N3009B	1N3009B		4-15
1N3009BJAN	1N3009BJAN		4-15
1N3009BJTX	1N3009BJTX		4-15
1N3009RA	1N3009RA		4-15
1N3009RB	1N3009RB		4-15
1N3010A	1N3010A		4-15
1N3010B	1N3010B		4-15
1N3010RA	1N3010RA		4-15
1N3010RB	1N3010RB		4-15
1N3011A	1N3011A		4-15
1N3011B	1N3011B		4-15
1N3011BJAN	1N3011BJAN		4-15
1N3011BJTX	1N3011BJTX		4-15
1N3011RA	1N3011RA		4-15
1N3011RB	1N3011RB		4-15
1N3012A	1N3012A		4-15
1N3012B	1N3012B		4-15
1N3012BJAN	1N3012BJAN		4-15
1N3012BJTX	1N3012BJTX		4-15
1N3012RA	1N3012RA		4-15
1N3012RB	1N3012RB		4-15
1N3013A	1N3013A		4-15
1N3013B	1N3013B		4-15
1N3013BJAN	1N3013BJAN		4-15
1N3013BJTX	1N3013BJTX		4-15
1N3013RA	1N3013RA		4-15
1N3013RB	1N3013RB		4-15
1N3014A	1N3014A		4-15
1N3014B	1N3014B		4-15
1N3014BJAN	1N3014BJAN		4-15
1N3014BJTX	1N3014BJTX		4-15
1N3014RA	1N3014RA		4-15
1N3014RB	1N3014RB		4-15
1N3015A	1N3015A		4-15
1N3015B	1N3015B		4-15
1N3015BJAN	1N3015BJAN		4-15
1N3015BJTX	1N3015BJTX		4-15
1N3015RA	1N3015RA		4-15
1N3015RB	1N3015RB		4-15
1N3016A	1N3016A		4-21
1N3016B	1N3016B		4-21
1N3016BJAN	1N3016BJAN		4-21
1N3016BJTX	1N3016BJTX		4-21
1N3017A	1N3017A		4-21
1N3017B	1N3017B		4-21
1N3017BJAN	1N3017BJAN		4-21
1N3017BJTX	1N3017BJTX		4-21
1N3018A	1N3018A		4-21
1N3018B	1N3018B		4-21
1N3018BJAN	1N3018BJAN		4-21
1N3018BJTX	1N3018BJTX		4-21
1N3019A	1N3019A		4-21
1N3019B	1N3019B		4-21
1N3019BJAN	1N3019BJAN		4-21
1N3019BJTX	1N3019BJTX		4-21
1N3020A	1N3020A		4-21
1N3020B	1N3020B		4-21
1N3020BJAN	1N3020BJAN		4-21

Note: Reverse polarity has an R suffix.

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Industry Part Number	Motorola Direct Replacement	Motorola Similar Replacement	Page #
1N3343B	1N3343B		4-17
1N3343BJAN	1N3343BJAN		4-17
1N3343BJTX	1N3343BJTX		4-17
1N3343RA	1N3343RA		4-17
1N3343RB	1N3343RB		4-17
1N3344A	1N3344A		4-17
1N3344B	1N3344B		4-17
1N3344BJAN	1N3344BJAN		4-17
1N3344BJTX	1N3344BJTX		4-17
1N3344RA	1N3344RA		4-17
1N3344RB	1N3344RB		4-17
1N3345A	1N3345A		4-17
1N3345B	1N3345B		4-17
1N3345BJAN	1N3345BJAN		4-17
1N3345BJTX	1N3345BJTX		4-17
1N3345RA	1N3345RA		4-17
1N3345RB	1N3345RB		4-17
1N3346A	1N3346A		4-17
1N3346B	1N3346B		4-17
1N3346BJAN	1N3346BJAN		4-17
1N3346BJTX	1N3346BJTX		4-17
1N3346RA	1N3346RA		4-17
1N3346RB	1N3346RB		4-17
1N3347A	1N3347A		4-17
1N3347B	1N3347B		4-17
1N3347BJAN	1N3347BJAN		4-17
1N3347BJTX	1N3347BJTX		4-17
1N3347RA	1N3347RA		4-17
1N3347RB	1N3347RB		4-17
1N3348A	1N3348A		4-17
1N3348B	1N3348B		4-17
1N3348BJAN	1N3348BJAN		4-17
1N3348BJTX	1N3348BJTX		4-17
1N3348RA	1N3348RA		4-17
1N3348RB	1N3348RB		4-17
1N3349A	1N3349A		4-17
1N3349B	1N3349B		4-17
1N3349BJAN	1N3349BJAN		4-17
1N3349BJTX	1N3349BJTX		4-17
1N3349RA	1N3349RA		4-17
1N3349RB	1N3349RB		4-17
1N3350A	1N3350A		4-17
1N3350B	1N3350B		4-17
1N3350BJAN	1N3350BJAN		4-17
1N3350BJTX	1N3350BJTX		4-17
1N3350RA	1N3350RA		4-17
1N3350RB	1N3350RB		4-17
1N3411		1N5234A	4-40
1N3412		1N5235A	4-40
1N3413		1N5236A	4-40
1N3414		1N5237A	4-40
1N3415		1N5240A	4-40
1N3416		1N5242A	4-40
1N3417		1N5245A	4-40
1N3418		1N5248A	4-40
1N3419		1N5251A	4-40
1N3420		1N5254A	4-40
1N3421		1N5256A	4-40
1N3422		1N5257A	4-40
1N3423		1N5259A	4-40

Industry Part Number	Motorola Direct Replacement	Motorola Similar Replacement	Page #
1N3424		1N5261A	4-40
1N3427		1N5268A	4-40
1N3428		1N5271A	4-40
1N3429		1N5273A	4-40
1N3430		1N5276A	4-40
1N3431		1N5279A	4-40
1N3432		1N5281A	4-40
1N3433		1N4738	4-36
1N3434		1N4740	4-36
1N3435		1N4742	4-36
1N3436		1N4744	4-36
1N3437		1N4746	4-36
1N3438		1N4748	4-36
1N3439		1N4750	4-36
1N3440		1N4752	4-36
1N3441		1N4754	4-36
1N3443		1N4735	4-36
1N3444		1N4736	4-36
1N3445		1N4738	4-36
1N3446		1N4740	4-36
1N3447		1N4742	4-36
1N3448		1N4744	4-36
1N3449		1N4746	4-36
1N3450		1N4748	4-36
1N3451		1N4750	4-36
1N3452		1N4751	4-36
1N3453		1N4752	4-36
1N3454		1N4754	4-36
1N3457		1N4760	4-36
1N3459		1N4764	4-36
1N3477		1N5221A	4-40
1N3477A		1N5221B	4-40
1N3496		1N823	4-10
1N3497		1N825	4-10
1N3498		1N827	4-10
1N3499		1N829	4-10
1N3500		1N821	4-10
1N3501		MZ640	4-101
1N3502		MZ620	4-101
1N3503		MZ610	4-101
1N3504		MZ605	4-101
1N3506		1N5226B	4-40
1N3507		1N5227B	4-40
1N3508		1N5228B	4-40
1N3509		1N5229B	4-40
1N3510		1N5230B	4-40
1N3511		1N5231B	4-40
1N3512		1N5232B	4-40
1N3513		1N5234B	4-40
1N3514		1N5235B	4-40
1N3515		1N5236B	4-40
1N3516		1N5237B	4-40
1N3517		1N5239B	4-40
1N3518		1N5240B	4-40
1N3519		1N5241B	4-40
1N3520		1N5242B	4-40
1N3521		1N5243B	4-40
1N3522		1N5245B	4-40
1N3523		1N5246B	4-40
1N3524		1N5248B	4-40

Note: Reverse polarity has an R suffix.

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Industry Part Number	Motorola Direct Replacement	Motorola Similar Replacement	Page #
1N3321RB	1N3321RB		4-17
1N3322A	1N3322A		4-17
1N3322B	1N3322B		4-17
1N3322RA	1N3322RA		4-17
1N3322RB	1N3322RB		4-17
1N3323A	1N3323A		4-17
1N3323B	1N3323B		4-17
1N3323BJAN	1N3323BJAN		4-17
1N3323BJTX	1N3323BJTX		4-17
1N3323RA	1N3323RA		4-17
1N3323RB	1N3323RB		4-17
1N3324A	1N3324A		4-17
1N3324B	1N3324B		4-17
1N3324BJAN	1N3324BJAN		4-17
1N3324BJTX	1N3324BJTX		4-17
1N3324RA	1N3324RA		4-17
1N3324RB	1N3324RB		4-17
1N3325A	1N3325A		4-17
1N3325B	1N3325B		4-17
1N3325BJAN	1N3325BJAN		4-17
1N3325BJTX	1N3325BJTX		4-17
1N3325RA	1N3325RA		4-17
1N3325RB	1N3325RB		4-17
1N3326A	1N3326A		4-17
1N3326B	1N3326B		4-17
1N3326BJAN	1N3326BJAN		4-17
1N3326BJTX	1N3326BJTX		4-17
1N3326RA	1N3326RA		4-17
1N3326RB	1N3326RB		4-17
1N3327A	1N3327A		4-17
1N3327B	1N3327B		4-17
1N3327BJAN	1N3327BJAN		4-17
1N3327BJTX	1N3327BJTX		4-17
1N3327RA	1N3327RA		4-17
1N3327RB	1N3327RB		4-17
1N3328A	1N3328A		4-17
1N3328B	1N3328B		4-17
1N3328BJAN	1N3328BJAN		4-17
1N3328BJTX	1N3328BJTX		4-17
1N3328RA	1N3328RA		4-17
1N3328RB	1N3328RB		4-17
1N3329A	1N3329A		4-17
1N3329B	1N3329B		4-17
1N3329RA	1N3329RA		4-17
1N3329RB	1N3329RB		4-17
1N3330A	1N3330A		4-17
1N3330B	1N3330B		4-17
1N3330BJAN	1N3330BJAN		4-17
1N3330BJTX	1N3330BJTX		4-17
1N3330RA	1N3330RA		4-17
1N3330RB	1N3330RB		4-17
1N3331A	1N3331A		4-17
1N3331B	1N3331B		4-17
1N3331RA	1N3331RA		4-17
1N3331RB	1N3331RB		4-17
1N3332A	1N3332A		4-17
1N3332B	1N3332B		4-17
1N3332BJAN	1N3332BJAN		4-17
1N3332BJTX	1N3332BJTX		4-17
1N3332RA	1N3332RA		4-17
1N3332RB	1N3332RB		4-17
1N3333A	1N3333A		4-17
1N3333B	1N3333B		4-17
1N3333RA	1N3333RA		4-17
1N3333RB	1N3333RB		4-17
1N3334A	1N3334A		4-17
1N3334B	1N3334B		4-17
1N3334BJAN	1N3334BJAN		4-17
1N3334BJTX	1N3334BJTX		4-17
1N3334RA	1N3334RA		4-17
1N3334RB	1N3334RB		4-17
1N3335A	1N3335A		4-17
1N3335B	1N3335B		4-17
1N3335BJAN	1N3335BJAN		4-17
1N3335BJTX	1N3335BJTX		4-17
1N3335RA	1N3335RA		4-17
1N3335RB	1N3335RB		4-17
1N3336A	1N3336A		4-17
1N3336B	1N3336B		4-17
1N3336BJAN	1N3336BJAN		4-17
1N3336BJTX	1N3336BJTX		4-17
1N3336RA	1N3336RA		4-17
1N3336RB	1N3336RB		4-17
1N3337A	1N3337A		4-17
1N3337B	1N3337B		4-17
1N3337BJAN	1N3337BJAN		4-17
1N3337BJTX	1N3337BJTX		4-17
1N3337RA	1N3337RA		4-17
1N3337RB	1N3337RB		4-17
1N3338A	1N3338A		4-17
1N3338B	1N3338B		4-17
1N3338BJAN	1N3338BJAN		4-17
1N3338BJTX	1N3338BJTX		4-17
1N3338RA	1N3338RA		4-17
1N3338RB	1N3338RB		4-17
1N3339A	1N3339A		4-17
1N3339B	1N3339B		4-17
1N3339BJAN	1N3339BJAN		4-17
1N3339BJTX	1N3339BJTX		4-17
1N3339RA	1N3339RA		4-17
1N3339RB	1N3339RB		4-17
1N3340A	1N3340A		4-17
1N3340B	1N3340B		4-17
1N3340BJAN	1N3340BJAN		4-17
1N3340BJTX	1N3340BJTX		4-17
1N3340RA	1N3340RA		4-17
1N3340RB	1N3340RB		4-17
1N3341A	1N3341A		4-17
1N3341B	1N3341B		4-17
1N3341BJAN	1N3341BJAN		4-17
1N3341BJTX	1N3341BJTX		4-17
1N3341RA	1N3341RA		4-17
1N3341RB	1N3341RB		4-17
1N3342A	1N3342A		4-17
1N3342B	1N3342B		4-17
1N3342BJAN	1N3342BJAN		4-17
1N3342BJTX	1N3342BJTX		4-17
1N3342RA	1N3342RA		4-17
1N3342RB	1N3342RB		4-17
1N3343A	1N3343A		4-17

Note: Reverse polarity has an R suffix.

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1N3050BJTX	1N3050BJTX		4-21
1N3051A	1N3051A		4-21
1N3051B	1N3051B		4-21
1N3051BJAN	1N3051BJAN		4-21
1N3051BJTX	1N3051BJTX		4-21
1N3098		1N3046A	4-21
1N3098A		1N3046A	4-21
1N3099		1N3048A	4-21
1N3099A		1N3048A	4-21
1N3100		1N3050A	4-21
1N3100A		1N3050A	4-21
1N3101		1N3051A	4-21
1N3101A		1N3051A	4-21
1N3102		1N3008A	4-15
1N3102A		1N3008A	4-15
1N3103		1N3011A	4-15
1N3103A		1N3011A	4-15
1N3104		1N3014A	4-15
1N3104A		1N3014A	4-15
1N3105		1N3015A	4-15
1N3105A		1N3015A	4-15
1N3112		1N4737A	4-36
1N3154A	1N2977B		4-15
1N3181		1N5237A	4-40
1N3198		1N5221B	4-40
1N3305A	1N3305A		4-17
1N3305B	1N3305B		4-17
1N3305BJAN	1N3305BJAN		4-17
1N3305BJTX	1N3305BJTX		4-17
1N3305RA	1N3305RA		4-17
1N3305RB	1N3305RB		4-17
1N3306A	1N3306A		4-17
1N3306B	1N3306B		4-17
1N3306BJAN	1N3306BJAN		4-17
1N3306BJTX	1N3306BJTX		4-17
1N3306RA	1N3306RA		4-17
1N3306RB	1N3306RB		4-17
1N3307A	1N3307A		4-17
1N3307B	1N3307B		4-17
1N3307BJAN	1N3307BJAN		4-17
1N3307BJTX	1N3307BJTX		4-17
1N3307RA	1N3307RA		4-17
1N3307RB	1N3307RB		4-17
1N3308A	1N3308A		4-17
1N3308B	1N3308B		4-17
1N3308BJAN	1N3308BJAN		4-17
1N3308BJTX	1N3308BJTX		4-17
1N3308RA	1N3308RA		4-17
1N3308RB	1N3308RB		4-17
1N3309A	1N3309A		4-17
1N3309B	1N3309B		4-17
1N3309BJAN	1N3309BJAN		4-17
1N3309BJTX	1N3309BJTX		4-17
1N3309RA	1N3309RA		4-17
1N3309RB	1N3309RB		4-17
1N3310A	1N3310A		4-17
1N3310B	1N3310B		4-17
1N3310BJAN	1N3310BJAN		4-17
1N3310BJTX	1N3310BJTX		4-17
1N3310RA	1N3310RA		4-17
1N3310RB	1N3310RB		4-17
1N3311A	1N3311A		4-17
1N3311B	1N3311B		4-17
1N3311BJAN	1N3311BJAN		4-17
1N3311BJTX	1N3311BJTX		4-17
1N3311RA	1N3311RA		4-17
1N3311RB	1N3311RB		4-17
1N3312A	1N3312A		4-17
1N3312B	1N3312B		4-17
1N3312BJAN	1N3312BJAN		4-17
1N3312BJTX	1N3312BJTX		4-17
1N3312RA	1N3312RA		4-17
1N3312RB	1N3312RB		4-17
1N3313A	1N3313A		4-17
1N3313B	1N3313B		4-17
1N3313RA	1N3313RA		4-17
1N3313RB	1N3313RB		4-17
1N3314A	1N3314A		4-17
1N3314B	1N3314B		4-17
1N3314BJAN	1N3314BJAN		4-17
1N3314BJTX	1N3314BJTX		4-17
1N3314RA	1N3314RA		4-17
1N3314RB	1N3314RB		4-17
1N3315A	1N3315A		4-17
1N3315B	1N3315B		4-17
1N3315BJAN	1N3315BJAN		4-17
1N3315BJTX	1N3315BJTX		4-17
1N3315RA	1N3315RA		4-17
1N3315RB	1N3315RB		4-17
1N3316A	1N3316A		4-17
1N3316B	1N3316B		4-17
1N3316RA	1N3316RA		4-17
1N3316RB	1N3316RB		4-17
1N3317A	1N3317A		4-17
1N3317B	1N3317B		4-17
1N3317BJAN	1N3317BJAN		4-17
1N3317BJTX	1N3317BJTX		4-17
1N3317RA	1N3317RA		4-17
1N3317RB	1N3317RB		4-17
1N3318A	1N3318A		4-17
1N3318B	1N3318B		4-17
1N3318RA	1N3318RA		4-17
1N3318RB	1N3318RB		4-17
1N3319A	1N3319A		4-17
1N3319B	1N3319B		4-17
1N3319BJAN	1N3319BJAN		4-17
1N3319BJTX	1N3319BJTX		4-17
1N3319RA	1N3319RA		4-17
1N3319RB	1N3319RB		4-17
1N3320A	1N3320A		4-17
1N3320B	1N3320B		4-17
1N3320BJAN	1N3320BJAN		4-17
1N3320BJTX	1N3320BJTX		4-17
1N3320RA	1N3320RA		4-17
1N3320RB	1N3320RB		4-17
1N3321A	1N3321A		4-17
1N3321B	1N3321B		4-17
1N3321BJAN	1N3321BJAN		4-17
1N3321BJTX	1N3321BJTX		4-17
1N3321RA	1N3321RA		4-17

Note: Reverse polarity has an R suffix.

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1N3020BJTX	1N3020BJTX		4-21
1N3021A	1N3021A		4-21
1N3021B	1N3021B		4-21
1N3021BJAN	1N3021BJAN		4-21
1N3021BJTX	1N3021BJTX		4-21
1N3022A	1N3022A		4-21
1N3022B	1N3022B		4-21
1N3022BJAN	1N3022BJAN		4-21
1N3022BJTX	1N3022BJTX		4-21
1N3023A	1N3023A		4-21
1N3023B	1N3023B		4-21
1N3023BJAN	1N3023BJAN		4-21
1N3023BJTX	1N3023BJTX		4-21
1N3024A	1N3024A		4-21
1N3024B	1N3023B		4-21
1N3024BJAN	1N3024BJAN		4-21
1N3024BJTX	1N3024BJTX		4-21
1N3025A	1N3025A		4-21
1N3025B	1N3025B		4-21
1N3025BJAN	1N3025BJAN		4-21
1N3025BJTX	1N3025BJTX		4-21
1N3026A	1N3026A		4-21
1N3026B	1N3026B		4-21
1N3026BJAN	1N3026BJAN		4-21
1N3026BJTX	1N3026BJTX		4-21
1N3027A	1N3027A		4-21
1N3027B	1N3027B		4-21
1N3027BJAN	1N3027BJAN		4-21
1N3027BJTX	1N3027BJTX		4-21
1N3028A	1N3028A		4-21
1N3028B	1N3028B		4-21
1N3028BJAN	1N3028BJAN		4-21
1N3028BJTX	1N3028BJTX		4-21
1N3029A	1N3029A		4-21
1N3029B	1N3029B		4-21
1N3029BJAN	1N3029BJAN		4-21
1N3029BJTX	1N3029BJTX		4-21
1N3030A	1N3030A		4-21
1N3030B	1N3030B		4-21
1N3030BJAN	1N3030BJAN		4-21
1N3030BJTX	1N3030BJTX		4-21
1N3031A	1N3031A		4-21
1N3031B	1N3031B		4-21
1N3031BJAN	1N3031BJAN		4-21
1N3031BJTX	1N3031BJTX		4-21
1N3032A	1N3032A		4-21
1N3032B	1N3032B		4-21
1N3032BJAN	1N3032BJAN		4-21
1N3032BJTX	1N3032BJTX		4-21
1N3033A	1N3033A		4-21
1N3033B	1N3033B		4-21
1N3033BJAN	1N3033BJAN		4-21
1N3033BJTX	1N3033BJTX		4-21
1N3034A	1N3034A		4-21
1N3034B	1N3034B		4-21
1N3034BJAN	1N3034BJAN		4-21
1N3034BJTX	1N3034BJTX		4-21
1N3035A	1N3035A		4-21
1N3035B	1N3035B		4-21
1N3035BJAN	1N3035BJAN		4-21
1N3035BJTX	1N3035BJTX		4-21
1N3036A	1N3036A		4-21
1N3036B	1N3036B		4-21
1N3036BJAN	1N3036BJAN		4-21
1N3036BJTX	1N3036BJTX		4-21
1N3037A	1N3037A		4-21
1N3037B	1N3037B		4-21
1N3037BJAN	1N3037BJAN		4-21
1N3037BJTX	1N3037BJTX		4-21
1N3038A	1N3038A		4-21
1N3038B	1N3038B		4-21
1N3038BJAN	1N3038BJAN		4-21
1N3038BJTX	1N3038BJTX		4-21
1N3039A	1N3039A		4-21
1N3039B	1N3039B		4-21
1N3039BJAN	1N3039BJAN		4-21
1N3039BJTX	1N3039BJTX		4-21
1N3040A	1N3040A		4-21
1N3040B	1N3040B		4-21
1N3040BJAN	1N3040BJAN		4-21
1N3040BJTX	1N3040BJTX		4-21
1N3041A	1N3041A		4-21
1N3041B	1N3041B		4-21
1N3041BJAN	1N3041BJAN		4-21
1N3041BJTX	1N3041BJTX		4-21
1N3042A	1N3042A		4-21
1N3042B	1N3042B		4-21
1N3042BJAN	1N3042BJAN		4-21
1N3042BJTX	1N3042BJTX		4-21
1N3043A	1N3043A		4-21
1N3043B	1N3043B		4-21
1N3043BJAN	1N3043BJAN		4-21
1N3043BJTX	1N3043BJTX		4-21
1N3044A	1N3044A		4-21
1N3044B	1N3044B		4-21
1N3044BJAN	1N3044BJAN		4-21
1N3044BJTX	1N3044BJTX		4-21
1N3045A	1N3045A		4-21
1N3045B	1N3045B		4-21
1N3045BJAN	1N3045BJAN		4-21
1N3045BJTX	1N3045BJTX		4-21
1N3046A	1N3046A		4-21
1N3046B	1N3046B		4-21
1N3046BJAN	1N3046BJAN		4-21
1N3046BJTX	1N3046BJTX		4-21
1N3047A	1N3047A		4-21
1N3047B	1N3047B		4-21
1N3047BJAN	1N3047BJAN		4-21
1N3047BJTX	1N3047BJTX		4-21
1N3048A	1N3048A		4-21
1N3048B	1N3048B		4-21
1N3048BJAN	1N3048BJAN		4-21
1N3048BJTX	1N3048BJTX		4-21
1N3049A	1N3049A		4-21
1N3049B	1N3049B		4-21
1N3049BJAN	1N3049BJAN		4-21
1N3049BJTX	1N3049BJTX		4-21
1N3050A	1N3050A		4-21
1N3050B	1N3050B		4-21
1N3050BJAN	1N3050BJAN		4-21

Note: Reverse polarity has an R suffix.

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1N3525		1N5250B	4-40
1N3526		1N5251B	4-40
1N3527		1N5252B	4-40
1N3528		1N5254B	4-40
1N3529		1N5256B	4-40
1N3530		1N5257B	4-40
1N3531		1N5258B	4-40
1N3532		1N5259B	4-40
1N3533		1N5260B	4-40
1N3534		1N5261B	4-40
1N3553		1N821	4-10
1N3675	1N4736		4-36
1N3675A	1N4736		4-36
1N3675B	1N4736A		4-36
1N3676	1N4737		4-36
1N3676A	1N4737		4-36
1N3676B	1N4737A		4-36
1N3677	1N4738		4-36
1N3677A	1N4738		4-36
1N3677B	1N4738A		4-36
1N3678	1N4739		4-36
1N3678A	1N4739		4-36
1N3678B	1N4739A		4-36
1N3679	1N4740		4-36
1N3679A	1N4740		4-36
1N3679B	1N4740A		4-36
1N3680	1N4741		4-36
1N3680A	1N4741		4-36
1N3680B	1N4741A		4-36
1N3681	1N4742		4-36
1N3681A	1N4742		4-36
1N3681B	1N4742A		4-36
1N3682	1N4743		4-36
1N3682A	1N4743		4-36
1N3682B	1N4743A		4-36
1N3683	1N4744		4-36
1N3683A	1N4744		4-36
1N3683B	1N4744A		4-36
1N3684	1N4745		4-36
1N3684A	1N4745		4-36
1N3684B	1N4745A		4-36
1N3685	1N4746		4-36
1N3685A	1N4746		4-36
1N3685B	1N4746A		4-36
1N3686	1N4747		4-36
1N3686A	1N4747		4-36
1N3686B	1N4747A		4-36
1N3687	1N4748		4-36
1N3687A	1N4748		4-36
1N3687B	1N4748A		4-36
1N3688	1N4749		4-36
1N3688A	1N4749		4-36
1N3688B	1N4749A		4-36
1N3689	1N4750		4-36
1N3689A	1N4750		4-36
1N3689B	1N4750A		4-36
1N3690	1N4751		4-36
1N3690A	1N4751		4-36
1N3690B	1N4751A		4-36
1N3691	1N4752		4-36

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1N3691A	1N4752		4-36
1N3691B	1N4752A		4-36
1N3692	1N4753		4-36
1N3692A	1N4753		4-36
1N3692B	1N4753A		4-36
1N3693	1N4754		4-36
1N3693A	1N4754		4-36
1N3693B	1N4754A		4-36
1N3694	1N4755		4-36
1N3694A	1N4755		4-36
1N3694B	1N4755A		4-36
1N3695	1N4756		4-36
1N3695A	1N4756		4-36
1N3695B	1N4756A		4-36
1N3696	1N4757		4-36
1N3696A	1N4757		4-36
1N3696B	1N4757A		4-36
1N3697	1N4758		4-36
1N3697A	1N4758		4-36
1N3697B	1N4758A		4-36
1N3698	1N4759		4-36
1N3698A	1N4759		4-36
1N3698B	1N4759A		4-36
1N3699	1N4760		4-36
1N3699A	1N4760		4-36
1N3699B	1N4760A		4-36
1N3700	1N4761		4-36
1N3700A	1N4761		4-36
1N3700B	1N4761A		4-36
1N3701	1N4762		4-36
1N3701A	1N4762		4-36
1N3701B	1N4762A		4-36
1N3702	1N4763		4-36
1N3702A	1N4763		4-36
1N3702B	1N4763A		4-36
1N3703	1N4764		4-36
1N3703A	1N4764		4-36
1N3703B	1N4764A		4-36
1N3779		1N821A	4-10
1N3780		1N821A	4-10
1N3781		1N823A	4-10
1N3782		1N825A	4-10
1N3783		1N827A	4-10
1N3784		1N829A	4-10
1N3821	1N3821		4-21
1N3821A	1N3821A		4-21
1N3821AJAN	1N3821AJAN		4-21
1N3821AJTX	1N3821AJTX		4-21
1N3822	1N3822		4-21
1N3822A	1N3822A		4-21
1N3822AJAN	1N3822AJAN		4-21
1N3822AJTX	1N3822AJTX		4-21
1N3823	1N3823		4-21
1N3823A	1N3823A		4-21
1N3823AJAN	1N3823AJAN		4-21
1N3823AJTX	1N3823AJTX		4-21
1N3824	1N3824		4-21
1N3824A	1N3824A		4-21
1N3824AJAN	1N3824AJAN		4-21
1N3824AJTX	1N3824AJTX		4-21

Note: Reverse polarity has an R suffix.

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1N3825	1N3825		4-21
1N3825A	1N3825A		4-21
1N3825AJAN	1N3825AJAN		4-21
1N3825AJTX	1N3825AJTX		4-21
1N3826	1N3826		4-21
1N3826A	1N3826A		4-21
1N3826AJAN	1N3826AJAN		4-21
1N3826AJTX	1N3826AJTX		4-21
1N3827	1N3827		4-21
1N3827A	1N3827A		4-21
1N3827AJAN	1N3827AJAN		4-21
1N3827AJTX	1N3827AJTX		4-21
1N3828	1N3828		4-21
1N3828A	1N3828A		4-21
1N3828AJAN	1N3828AJTX		4-21
1N3828AJTX	1N3828AJTX		4-21
1N3829	1N3829		4-21
1N3829A	1N3829A		4-21
1N3829AJAN	1N3829AJAN		4-21
1N3829AJTX	1N3829AJTX		4-21
1N3830	1N3830		4-21
1N3830A	1N3830A		4-21
1N3830AJAN	1N3830AJAN		4-21
1N3830AJTX	1N3830AJTX		4-21
1N3949		1N2984B	4-15
1N3951		1N5934B	4-65
1N3984		1N3997A	4-27
1N3985		1N3998A	4-27
1N3986		1N3998A	4-27
1N3993	1N3993		4-27
1N3993A	1N3993A		4-27
1N3993AJAN	1N3993AJAN		4-27
1N3993AJTX	1N3993AJTX		4-27
1N3993R	1N3993R		4-27
1N3993RA	1N3993RA		4-27
1N3993RB		1N3993RA	4-27
1N3994	1N3994		4-27
1N3994A	1N3994A		4-27
1N3994AJAN	1N3994AJAN		4-27
1N3994AJTX	1N3994AJTX		4-27
1N3994R	1N3994R		4-27
1N3994RA	1N3994RA		4-27
1N3994RB		1N3993RA	4-27
1N3995	1N3995		4-27
1N3995A	1N3995A		4-27
1N3995AJAN	1N3995AJAN		4-27
1N3995AJTX	1N3995AJTX		4-27
1N3995R	1N3995R		4-27
1N3995RA	1N3995RA		4-27
1N3995RB		1N3995RA	4-27
1N3996	1N3996		4-27
1N3996A	1N3996A		4-27
1N3996AJAN	1N3996AJAN		4-27
1N3996AJTX	1N3996AJTX		4-27
1N3996R	1N3996R		4-27
1N3996RA	1N3996RA		4-27
1N3996RB		1N3996RA	4-27
1N3997	1N3997		4-27
1N3997A	1N3997A		4-27
1N3997AJAN	1N3997AJAN		4-27

Industry Part Number	Motorola Direct Replacement	Motorola Similar Replacement	Page #
1N3997AJTX	1N3997AJTX		4-27
1N3997R	1N3997R		4-27
1N3997RA	1N3997RA		4-27
1N3997RB		1N3996RA	4-27
1N3998	1N3998		4-27
1N3998A	1N3998A		4-27
1N3998AJAN	1N3998AJAN		4-27
1N3998AJTX	1N3998AJTX		4-27
1N3998R	1N3998R		4-27
1N3998RA	1N3998RA		4-27
1N3998RB		1N3998RA	4-27
1N3999	1N3999		4-27
1N3999A	1N3999A		4-27
1N3999AJAN	1N3999AJAN		4-27
1N3999AJTX	1N3999AJTX		4-27
1N3999R	1N3999R		4-27
1N3999RA	1N3999RA		4-27
1N3999RB		1N3999RA	4-27
1N4000	1N4000		4-27
1N4000A	1N4000A		4-27
1N4000AJAN	1N4000AJAN		4-27
1N4000AJTX	1N4000AJTX		4-27
1N4000R	1N4000R		4-27
1N4000RA	1N4000RA		4-27
1N4000RB	1N4000RB		4-27
1N4010		1N821	4-10
1N4016		1N2972A	4-15
1N4016A		1N2972A	4-15
1N4016B		1N2972B	4-15
1N4017		1N2973A	4-15
1N4017A		1N2973A	4-15
1N4017B		1N2973B	4-15
1N4018		1N2974A	4-15
1N4018A		1N2974A	4-15
1N4018B		1N2974B	4-15
1N4019		1N2975A	4-15
1N4019A		1N2975A	4-15
1N4019B		1N2975B	4-15
1N4020		1N2976A	4-15
1N4020A		1N2976A	4-15
1N4020B		1N2976B	4-15
1N4021		1N2977A	4-15
1N4021A		1N2977A	4-15
1N4021B		1N2977B	4-15
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1N4023		1N2980A	4-15
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1N4024A		1N2982A	4-15
1N4024B		1N2982B	4-15
1N4025		1N2984A	4-15
1N4025A		1N2984A	4-15
1N4025B		1N2984B	4-15
1N4026		1N2985A	4-15
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Note: Reverse polarity has an R suffix.

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1N4028B		1N2988B	4-15
1N4029		1N2989A	4-15
1N4029A		1N2989A	4-15
1N4029B		1N2989B	4-15
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1N4030A		1N2990A	4-15
1N4030B		1N2990B	4-15
1N4031		1N2991A	4-15
1N4031A		1N2991A	4-15
1N4031B		1N2991B	4-15
1N4032		1N2992	4-15
1N4032A		1N2992A	4-15
1N4032B		1N2992B	4-15
1N4033		1N2993A	4-15
1N4033A		1N2993A	4-15
1N4033B		1N2993B	4-15
1N4034		1N2995A	4-15
1N4034A		1N2995A	4-15
1N4034B		1N2995B	4-15
1N4035		1N2997A	4-15
1N4035A		1N2997A	4-15
1N4035B		1N2997B	4-15
1N4036		1N2999A	4-15
1N4036A		1N2999A	4-15
1N4036B		1N2999B	4-15
1N4037		1N3000A	4-15
1N4037A		1N3000A	4-15
1N4037B		1N3000B	4-15
1N4038		1N3001A	4-15
1N4038A		1N3001A	4-15
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1N4039		1N3002A	4-15
1N4039A		1N3002A	4-15
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1N4099-1JAN	1N4099-1JAN		4-28
1N4099-1JTX	1N4099-1JTX		4-28
1N4099-1JTXV	1N4099-1JTXV		4-28
1N4100	1N4100		4-28
1N4100-1JAN	1N4100-1JAN		4-28
1N4100-1JTX	1N4100-1JTX		4-28
1N4100-1JTXV	1N4100-1JTXV		4-28
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1N4101-1JAN	1N4101-1JAN		4-28

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1N4102	1N4102		4-28
1N4102-1JAN	1N4102-1JAN		4-28
1N4102-1JTX	1N4102-1JTX		4-28
1N4102-1JTXV	1N4102-1JTXV		4-28
1N4103	1N4103		4-28
1N4103-1JAN	1N4103-1JAN		4-28
1N4103-1JTX	1N4103-1JTX		4-28
1N4103-1JTXV	1N4103-1JTXV		4-28
1N4104	1N4104		4-28
1N4104-1JAN	1N4104-1JAN		4-28
1N4104-1JTX	1N4104-1JTX		4-28
1N4104-1JTXV	1N4104-1JTXV		4-28
1N4105	1N4105		4-28
1N4106	1N4106		4-28
1N4107	1N4107		4-28
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1N4115	1N4115		4-28
1N4116	1N4116		4-28
1N4117	1N4117		4-28
1N4118	1N4118		4-28
1N4119	1N4119		4-28
1N4120	1N4120		4-28
1N4121	1N4121		4-28
1N4122	1N4122		4-28
1N4123	1N4123		4-28
1N4124	1N4124		4-28
1N4125	1N4125		4-28
1N4126	1N4126		4-28
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1N4162		1N4740	4-36
1N4162A		1N4740	4-36
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Note: Reverse polarity has an R suffix.

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1N4165		1N4743	4-36
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1N4196		1N2972A	4-15
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1N4197A		1N2973A	4-15
1N4197B		1N2973B	4-15
1N4198		1N2974A	4-15
1N4198A		1N2974A	4-15
1N4198B		1N2974B	4-15
1N4199		1N2975A	4-15
1N4199A		1N2975A	4-15
1N4199B		1N2975B	4-15
1N4200		1N2976A	4-15
1N4200A		1N2976A	4-15
1N4200B		1N2976B	4-15
1N4201		1N2977A	4-15
1N4201A		1N2977A	4-15
1N4201B		1N2977B	4-15
1N4202		1N2978A	4-15
1N4202A		1N2978A	4-15
1N4202B		1N2978B	4-15
1N4203		1N2979A	4-15
1N4203A		1N2979A	4-15
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1N4204		1N2980A	4-15
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1N4205		1N2981A	4-15
1N4205A		1N2981A	4-15
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1N4206		1N2982A	4-15
1N4206A		1N2982A	4-15
1N4206B		1N2982B	4-15
1N4207		1N2983A	4-15
1N4207A		1N2983A	4-15
1N4207B		1N2983B	4-15
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Note: Reverse polarity has an R suffix.

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1N4211		1N2987A	4-15	1N4231		1N3007A	4-15
1N4211A		1N2987A	4-15	1N4231A		1N3007A	4-15
1N4211B		1N2987B	4-15	1N4231B		1N3007B	4-15
1N4212		1N2988A	4-15	1N4232		1N3008A	4-15
1N4212A		1N2988A	4-15	1N4232A		1N3008A	4-15
1N4212B		1N2988B	4-15	1N4232B		1N3008B	4-15
1N4213		1N2989A	4-15	1N4233		1N3009A	4-15
1N4213A		1N2989A	4-15	1N4233A		1N3009A	4-15
1N4213B		1N2989B	4-15	1N4233B		1N3009B	4-15
1N4214		1N2990A	4-15	1N4234		1N3010A	4-15
1N4214A		1N2990A	4-15	1N4234A		1N3010A	4-15
1N4214B		1N2990B	4-15	1N4234B		1N3010B	4-15
1N4215		1N2991A	4-15	1N4235		1N3011A	4-15
1N4215A		1N2991A	4-15	1N4235A		1N3011A	4-15
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1N4216		1N2992A	4-15	1N4236		1N3012A	4-15
1N4216A		1N2992A	4-15	1N4236A		1N3012A	4-15
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1N4217		1N2993A	4-15	1N4237		1N3013A	4-15
1N4217A		1N2993A	4-15	1N4237A		1N3013A	4-15
1N4217B		1N2993B	4-15	1N4237B		1N3013B	4-15
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1N4218A		1N2994A	4-15	1N4238A		1N3014A	4-15
1N4218B		1N2994B	4-15	1N4238B		1N3014B	4-15
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1N4219A		1N2995A	4-15	1N4239A		1N3015A	4-15
1N4219B		1N2995B	4-15	1N4239B		1N3015B	4-15
1N4220		1N2996A	4-15	1N4258		1N2970A	4-15
1N4220A		1N2996A	4-15	1N4258A		1N2970A	4-15
1N4220B		1N2996B	4-15	1N4258B		1N2970B	4-15
1N4221		1N2997A	4-15	1N4259		1N2971A	4-15
1N4221A		1N2997A	4-15	1N4259A		1N2971A	4-15
1N4221B		1N2997B	4-15	1N4259B		1N2971B	4-15
1N4222		1N2998A	4-15	1N4260		1N2972A	4-15
1N4222A		1N2998A	4-15	1N4260A		1N2972A	4-15
1N4222B		1N2998B	4-15	1N4260B		1N2972B	4-15
1N4223		1N2999A	4-15	1N4261		1N2973A	4-15
1N4223A		1N2999A	4-15	1N4261A		1N2973A	4-15
1N4223B		1N2999B	4-15	1N4261B		1N2973B	4-15
1N4224		1N3000A	4-15	1N4262		1N2974A	4-15
1N4224A		1N3000A	4-15	1N4262A		1N2974A	4-15
1N4224B		1N3000B	4-15	1N4262B		1N2974B	4-15
1N4225		1N3001A	4-15	1N4263		1N2975A	4-15
1N4225A		1N3001A	4-15	1N4263A		1N2975A	4-15
1N4225B		1N3001B	4-15	1N4263B		1N2975B	4-15
1N4226		1N3002A	4-15	1N4264		1N2976A	4-15
1N4226A		1N3002A	4-15	1N4264A		1N2976A	4-15
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1N4227		1N3003A	4-15	1N4265		1N2977A	4-15
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1N4228		1N3004A	4-15	1N4266		1N2979A	4-15
1N4228A		1N3004A	4-15	1N4266A		1N2979A	4-15
1N4228B		1N3004B	4-15	1N4266B		1N2979B	4-15
1N4229		1N3005A	4-15	1N4267		1N2980A	4-15
1N4229A		1N3005A	4-15	1N4267A		1N2980A	4-15
1N4229B		1N3005B	4-15	1N4267B		1N2980B	4-15

Note: Reverse polarity has an R suffix.

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1N4269A		1N2984A	4-15
1N4269B		1N2984B	4-15
1N4270		1N2985A	4-15
1N4270A		1N2985A	4-15
1N4270B		1N2985B	4-15
1N4271		1N2986A	4-15
1N4272A		1N2988A	4-15
1N4272B		1N2988B	4-15
1N4273		1N2989A	4-15
1N4273A		1N2989A	4-15
1N4273B		1N2989B	4-15
1N4274		1N2990A	4-15
1N4274A		1N2990A	4-15
1N4274B		1N2990B	4-15
1N4275		1N2991A	4-15
1N4275A		1N2991A	4-15
1N4275B		1N2991B	4-15
1N4276		1N2992A	4-15
1N4276A		1N2992A	4-15
1N4276B		1N2992B	4-15
1N4277		1N2993A	4-15
1N4277A		1N2993A	4-15
1N4277B		1N2993B	4-15
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1N4278A		1N2995A	4-15
1N4278B		1N2995B	4-15
1N4279		1N2997A	4-15
1N4279A		1N2997A	4-15
1N4279B		1N2997B	4-15
1N4280		1N2999A	4-15
1N4280A		1N2999A	4-15
1N4280B		1N2999B	4-15
1N4281		1N3000A	4-15
1N4281A		1N3000A	4-15
1N4281B		1N3000B	4-15
1N4282		1N3001A	4-15
1N4282A		1N3001A	4-15
1N4282B		1N3001B	4-15
1N4283		1N3002A	4-15
1N4283A		1N3002A	4-15
1N4283B		1N3002B	4-15
1N4284		1N3003A	4-15
1N4284A		1N3003A	4-15
1N4284B		1N3003B	4-15
1N4285		1N3004A	4-15
1N4285A		1N3004A	4-15
1N4285B		1N3004B	4-15
1N4286		1N3005A	4-15
1N4286A		1N3005A	4-15
1N4286B		1N3005B	4-15
1N4287		1N3007A	4-15
1N4287A		1N3007A	4-15
1N4287B		1N3007B	4-15
1N4288		1N3008A	4-15
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1N4290A		1N3011A	4-15
1N4290B		1N3011B	4-15
1N4291		1N3012A	4-15
1N4291A		1N3012A	4-15
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1N4293A		1N3015A	4-15
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1N4323		1N4736	4-36
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1N4324B		1N4737A	4-36
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1N4326		1N4739	4-36
1N4326A		1N4739	4-36
1N4326B		1N4739A	4-36
1N4327		1N4740	4-36
1N4327A		1N4740	4-36
1N4327B		1N4740A	4-36
1N4328		1N4741	4-36
1N4328A		1N4741	4-36
1N4328B		1N4741A	4-36
1N4329		1N4742	4-36
1N4329A		1N4742	4-36
1N4329B		1N4742A	4-36
1N4330		1N4743	4-36
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1N4330B		1N4743A	4-36
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1N4333		1N4746	4-36
1N4333A		1N4746	4-36
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1N4334B		1N4747A	4-36
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Note: Reverse polarity has an R suffix.

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1N4338B		1N4751A	4-36
1N4339		1N4752	4-36
1N4339A		1N4752	4-36
1N4339B		1N4752A	4-36
1N4340		1N4753	4-36
1N4340A		1N4753	4-36
1N4340B		1N4753A	4-36
1N4341		1N4754	4-36
1N4341A		1N4754	4-36
1N4341B		1N4754A	4-36
1N4342		1N4755	4-36
1N4342A		1N4755	4-36
1N4342B		1N4755A	4-36
1N4343		1N4756	4-36
1N4343A		1N4756	4-36
1N4343B		1N4756A	4-36
1N4344		1N4757	4-36
1N4344A		1N4757	4-36
1N4344B		1N4757A	4-36
1N4345		1N4758	4-36
1N4345A		1N4758	4-36
1N4345B		1N4758A	4-36
1N4346		1N4759	4-36
1N4346A		1N4759	4-36
1N4346B		1N4759A	4-36
1N4347		1N4760	4-36
1N4347A		1N4760	4-36
1N4347B		1N4760A	4-36
1N4348		1N4761	4-36
1N4348A		1N4761	4-36
1N4348B		1N4761A	4-36
1N4349		1N4762	4-36
1N4349A		1N4762	4-36
1N4349B		1N4762A	4-36
1N4350		1N4763	4-36
1N4350A		1N4763	4-36
1N4350B		1N4763A	4-36
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1N4351A		1N4764	4-36
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1N4370	1N4370		4-4
1N4370A	1N4370A		4-4
1N4370A1JAN	1N4370A1JAN		4-4
1N4370A1JTX	1N4370A1JTX		4-4
1N4370A1JTXV	1N4370A1JTXV		4-4
1N4371	1N4371		4-4
1N4371A	1N4371A		4-4
1N4371A1JAN	1N4371A1JAN		4-4
1N4371A1JTX	1N4371A1JTX		4-4
1N4371A1JTXV	1N4371A1JTXV		4-4
1N4372	1N4372		4-4
1N4372A	1N4372A		4-4
1N4372A1JAN	1N4372A1JAN		4-4
1N4372A1JTX	1N4372A1JTX		4-4
1N4372A1JTXV	1N4372A1JTXV		4-4
1N4400		1N4736	4-36
1N4401		1N4737	4-36
1N4402		1N4738	4-36
1N4403		1N4739	4-36
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1N4406		1N4742	4-36
1N4407		1N4743	4-36
1N4408		1N4744	4-36
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1N4410		1N4746	4-36
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1N4414		1N4750	4-36
1N4415		1N4751	4-36
1N4416		1N4752	4-36
1N4417		1N4753	4-36
1N4418		1N4754	4-36
1N4419		1N4755	4-36
1N4420		1N4756	4-36
1N4421		1N4757	4-36
1N4422		1N4758	4-36
1N4423		1N4759	4-36
1N4424		1N4760	4-36
1N4425		1N4761	4-36
1N4426		1N4762	4-36
1N4427		1N4763	4-36
1N4428		1N4764	4-36
1N4460		1N4735A	4-36
1N4461		1N4736A	4-36
1N4462		1N4737A	4-36
1N4463		1N4738A	4-36
1N4464		1N4739A	4-36
1N4465		1N4740A	4-36
1N4466		1N4741A	4-36
1N4467		1N4742A	4-36
1N4468		1N4743A	4-36
1N4469		1N4744A	4-36
1N4470		1N4745A	4-36
1N4471		1N4746A	4-36
1N4472		1N4747A	4-36
1N4473		1N4748A	4-36
1N4474		1N4749A	4-36
1N4475		1N4750A	4-36
1N4476		1N4751A	4-36
1N4477		1N4752A	4-36
1N4478		1N4753A	4-36
1N4479		1N4754A	4-36
1N4480		1N4755A	4-36
1N4481		1N4756A	4-36
1N4482		1N4757A	4-36
1N4483		1N4758A	4-36
1N4484		1N4759A	4-36
1N4485		1N4760A	4-36
1N4486		1N4761A	4-36
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1N4489		1N4764A	4-36
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Note: Reverse polarity has an R suffix.

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1N4549B	1N4549B		4-17
1N4549BJAN	1N4549BJAN		4-17
1N4549BJTX	1N4549BJTX		4-17
1N4549RA	1N4549RA		4-17
1N4549RB	1N4549RB		4-17
1N4550A	1N4550A		4-17
1N4550B	1N4550B		4-17
1N4550BJAN	1N4550BJAN		4-17
1N4550BJTX	1N4550BJTX		4-17
1N4550RA	1N4550RA		4-17
1N4550RB	1N4550RB		4-17
1N4551A	1N4551A		4-17
1N4551B	1N4551B		4-17
1N4551BJAN	1N4551BJAN		4-17
1N4551BJTX	1N4551BJTX		4-17
1N4551RA	1N4551RA		4-17
1N4551RB	1N4551RB		4-17
1N4552A	1N4552A		4-17
1N4552B	1N4552B		4-17
1N4552BJAN	1N4552BJAN		4-17
1N4552BJTX	1N4552BJTX		4-17
1N4552RA	1N4552RA		4-17
1N4552RB	1N4552RB		4-17
1N4553A	1N4553A		4-17
1N4553B	1N4553B		4-17
1N4553BJAN	1N4553BJAN		4-17
1N4553BJTX	1N4553BJTX		4-17
1N4553RA	1N4553RA		4-17
1N4553RB	1N4553RB		4-17
1N4554A	1N4554A		4-17
1N4554B	1N4554B		4-17
1N4554BJAN	1N4554BJAN		4-17
1N4554BJTX	1N4554BJTX		4-17
1N4554RA	1N4554RA		4-17
1N4554RB	1N4554RB		4-17
1N4555A	1N4555A		4-17
1N4555B	1N4555B		4-17
1N4555RA	1N4555RA		4-17
1N4555RB	1N4555RB		4-17
1N4556A	1N4556A		4-17
1N4556B	1N4556B		4-17
1N4556RA	1N4556RA		4-17
1N4556RB	1N4556RB		4-17
1N4565	1N4565		4-32
1N4565A	1N4565A		4-32
1N4565AJAN	1N4565AJAN		4-32
1N4565AJTX	1N4565AJTX		4-32
1N4565AJTXV	1N4565AJTXV		4-32
1N4566	1N4566		4-32
1N4566A	1N4566A		4-32
1N4566AJAN	1N4566AJAN		4-32
1N4566AJTX	1N4566AJTX		4-32
1N4566AJTXV	1N4566AJTXV		4-32
1N4567	1N4567		4-32
1N4567A	1N4567A		4-32
1N4567AJAN	1N4567AJAN		4-32
1N4567AJTX	1N4567AJTX		4-32
1N4567AJTXV	1N4567AJTXV		4-32
1N4568	1N4568		4-32
1N4568A	1N4568A		4-32
1N4568AJAN	1N4568AJAN		4-32
1N4568AJTX	1N4568AJTX		4-32
1N4568AJTXV	1N4568AJTXV		4-32
1N4569	1N4569		4-32
1N4569A	1N4569A		4-32
1N4569AJAN	1N4569AJAN		4-32
1N4569AJTX	1N4569AJTX		4-32
1N4569AJTXV	1N4569AJTXV		4-32
1N4570	1N4570		4-32
1N4570A	1N4570A		4-32
1N4570AJAN	1N4570AJAN		4-32
1N4570AJTX	1N4570AJTX		4-32
1N4570AJTXV	1N4570AJTXV		4-32
1N4571	1N4571		4-32
1N4571A	1N4571A		4-32
1N4571AJAN	1N4571AJAN		4-32
1N4571AJTX	1N4571AJTX		4-32
1N4571AJTXV	1N4571AJTXV		4-32
1N4572	1N4572		4-32
1N4572A	1N4572A		4-32
1N4572AJAN	1N4572AJAN		4-32
1N4572AJTX	1N4572AJTX		4-32
1N4572AJTXV	1N4572AJTXV		4-32
1N4573	1N4573		4-32
1N4573A	1N4573A		4-32
1N4573AJAN	1N4573AJAN		4-32
1N4573AJTX	1N4573AJTX		4-32
1N4573AJTXV	1N4573AJTXV		4-32
1N4574	1N4574		4-32
1N4574A	1N4574A		4-32
1N4574AJAN	1N4574AJAN		4-32
1N4574AJTX	1N4574AJTX		4-32
1N4574AJTXV	1N4574AJTXV		4-32
1N4575	1N4575		4-32
1N4575A	1N4575A		4-32
1N4576	1N4576		4-32
1N4576A	1N4576A		4-32
1N4577	1N4577		4-32
1N4577A	1N4577A		4-32
1N4578	1N4578		4-32
1N4578A	1N4578A		4-32
1N4579	1N4579		4-32
1N4579A	1N4579A		4-32
1N4580	1N4580		4-32
1N4580A	1N4580A		4-32
1N4581	1N4581		4-32
1N4581A	1N4581A		4-32
1N4582	1N4582		4-32
1N4582A	1N4582A		4-32
1N4583	1N4583		4-32
1N4583A	1N4583A		4-32
1N4584	1N4584		4-32
1N4584A	1N4584A		4-32
1N4611		1N4576A	4-32
1N4611A		1N4577A	4-32
1N4611B		1N4578A	4-32
1N4611C		1N4579A	4-32
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Note: Reverse polarity has an R suffix.

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1N4613A		1N4582A	4-32
1N4613B		1N4583A	4-32
1N4613C		1N4584A	4-32
1N4614	1N4614		4-28
1N4614-1JAN	1N4614-1JAN		4-28
1N4614-1JTX	1N4614-1JTX		4-28
1N4614-1JTXV	1N4614-1JTXV		4-28
1N4615	1N4615		4-28
1N4615-1JAN	1N4615-1JAN		4-28
1N4615-1JTX	1N4615-1JTX		4-28
1N4615-1JTXV	1N4615-1JTXV		4-28
1N4616	1N4616		4-28
1N4616-1JAN	1N4616-1JAN		4-28
1N4616-1JTX	1N4616-1JTX		4-28
1N4616-1JTXV	1N4616-1JTXV		4-28
1N4617	1N4617		4-28
1N4617-1JAN	1N4617-1JAN		4-28
1N4617-1JTX	1N4617-1JTX		4-28
1N4617-1JTXV	1N4617-1JTXV		4-28
1N4618	1N4618		4-28
1N4618-1JAN	1N4618-1JAN		4-28
1N4618-1JTX	1N4618-1JTX		4-28
1N4618-1JTXV	1N4618-1JTXV		4-28
1N4619	1N4619		4-28
1N4619-1JAN	1N4619-1JAN		4-28
1N4619-1JTX	1N4619-1JTX		4-28
1N4619-1JTXV	1N4619-1JTXV		4-28
1N4620	1N4620		4-28
1N4620-1JAN	1N4620-1JAN		4-28
1N4620-1JTX	1N4620-1JTX		4-28
1N4620-1JTXV	1N4620-1JTXV		4-28
1N4621	1N4621		4-28
1N4621-1JAN	1N4621-1JAN		4-28
1N4621-1JTX	1N4621-1JTX		4-28
1N4621-1JTXV	1N4621-1JTXV		4-28
1N4622	1N4622		4-28
1N4622-1JAN	1N4622-1JAN		4-28
1N4622-1JTX	1N4622-1JTX		4-28
1N4622-1JTXV	1N4622-1JTXV		4-28
1N4623	1N4623		4-28
1N4623-1JAN	1N4623-1JAN		4-28
1N4623-1JTX	1N4623-1JTX		4-28
1N4623-1JTXV	1N4623-1JTXV		4-28
1N4624	1N4624		4-28
1N4624-1JAN	1N4624-1JAN		4-28
1N4624-1JTX	1N4624-1JTX		4-28
1N4624-1JTXV	1N4624-1JTXV		4-28
1N4625	1N4625		4-28
1N4625-1JAN	1N4625-1JAN		4-28
1N4625-1JTX	1N4625-1JTX		4-28
1N4625-1JTXV	1N4625-1JTXV		4-28
1N4626	1N4626		4-28
1N4626-1JAN	1N4626-1JAN		4-28
1N4626-1JTX	1N4626-1JTX		4-28
1N4626-1JTXV	1N4626-1JTXV		4-28
1N4627	1N4627		4-28

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1N4627-1JTX	1N4627-1JTX		4-28
1N4627-1JTXV	1N4627-1JTXV		4-28
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1N4629		1N4737A	4-36
1N4630		1N4738A	4-36
1N4631		1N4739A	4-36
1N4632		1N4740A	4-36
1N4633		1N4741A	4-36
1N4634		1N4742A	4-36
1N4635		1N4743A	4-36
1N4636		1N4744A	4-36
1N4637		1N4745A	4-36
1N4638		1N4746A	4-36
1N4639		1N4747A	4-36
1N4640		1N4748A	4-36
1N4641		1N4749A	4-36
1N4642		1N4750A	4-36
1N4643		1N4751A	4-36
1N4644		1N4752A	4-36
1N4645		1N4753A	4-36
1N4646		1N4754A	4-36
1N4647		1N4755A	4-36
1N4648		1N4756A	4-36
1N4649		1N4728A	4-36
1N4650		1N4729A	4-36
1N4651		1N4730A	4-36
1N4652		1N4731A	4-36
1N4653		1N4732A	4-36
1N4654		1N4733A	4-36
1N4655		1N4734A	4-36
1N4656		1N4735A	4-36
1N4657		1N4736A	4-36
1N4658		1N4737A	4-36
1N4659		1N4738A	4-36
1N4660		1N4739A	4-36
1N4661		1N4740A	4-36
1N4662		1N4741A	4-36
1N4663		1N4742A	4-36
1N4664		1N4743A	4-36
1N4665		1N4744A	4-36
1N4666		1N4745A	4-36
1N4667		1N4746A	4-36
1N4668		1N4747A	4-36
1N4669		1N4748A	4-36
1N4670		1N4749A	4-36
1N4671		1N4750A	4-36
1N4672		1N4751A	4-36
1N4673		1N4752A	4-36
1N4674		1N4753A	4-36
1N4675		1N4754A	4-36
1N4676		1N4755A	4-36
1N4677		1N4756A	4-36
1N4678	1N4678		4-34
1N4679	1N4679		4-34
1N4680	1N4680		4-34
1N4681	1N4681		4-34
1N4682	1N4682		4-34
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Note: Reverse polarity has an R suffix.

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1N4689	1N4689		4-34
1N4690	1N4690		4-34
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1N4692	1N4692		4-34
1N4693	1N4693		4-34
1N4694	1N4694		4-34
1N4695	1N4695		4-34
1N4696	1N4696		4-34
1N4697	1N4697		4-34
1N4698	1N4698		4-34
1N4699	1N4699		4-34
1N4700	1N4700		4-34
1N4701	1N4701		4-34
1N4702	1N4702		4-34
1N4703	1N4703		4-34
1N4704	1N4704		4-34
1N4705	1N4705		4-34
1N4706	1N4706		4-34
1N4707	1N4707		4-34
1N4708	1N4708		4-34
1N4709	1N4709		4-34
1N4710	1N4710		4-34
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Note: Reverse polarity has an R suffix.

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1N4840B		1N4748A	4-36	1N4893		MZ620	4-101
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Note: Reverse polarity has an R suffix.

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Note: Reverse polarity has an R suffix.

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1N5234A	1N5234A		4-40	1N5254A	1N5254A		4-40
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1N5241	1N5241A		4-40	1N5261	1N5261A		4-40
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Note: Reverse polarity has an R suffix.

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1N5269B	1N5269B		4-40
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1N5270A	1N5270A		4-40
1N5270B	1N5270B		4-40
1N5271	1N5271A		4-40
1N5271A	1N5271A		4-40
1N5271B	1N5271B		4-40
1N5272	1N5272A		4-40
1N5272A	1N5272A		4-40
1N5272B	1N5272B		4-40
1N5273	1N5273A		4-40
1N5273A	1N5273A		4-40
1N5273B	1N5273B		4-40
1N5274	1N5274A		4-40
1N5274A	1N5274A		4-40
1N5274B	1N5274B		4-40
1N5275	1N5275A		4-40
1N5275A	1N5275A		4-40
1N5275B	1N5275B		4-40
1N5276	1N5276A		4-40
1N5276A	1N5276A		4-40
1N5276B	1N5276B		4-40
1N5277	1N5277A		4-40
1N5277A	1N5277A		4-40
1N5277B	1N5277B		4-40
1N5278	1N5278A		4-40
1N5278A	1N5278A		4-40
1N5278B	1N5278B		4-40
1N5279	1N5279A		4-40
1N5279A	1N5279A		4-40
1N5279B	1N5279B		4-40
1N5280	1N5280A		4-40
1N5280A	1N5280A		4-40
1N5280B	1N5280B		4-40
1N5281	1N5281A		4-40
1N5281A	1N5281A		4-40
1N5281B	1N5281B		4-40
1N5283	1N5283		4-47
1N5283JAN	1N5283JAN		4-47
1N5283JTX	1N5283JTX		4-47
1N5283JTXV	1N5283JTXV		4-47
1N5284	1N5284		4-47
1N5284JAN	1N5284JAN		4-47
1N5284JTX	1N5284JTX		4-47
1N5284JTXV	1N5284JTXV		4-47
1N5285	1N5285		4-47
1N5285JAN	1N5285JAN		4-47
1N5285JTX	1N5285JTX		4-47
1N5285JTXV	1N5285JTXV		4-47
1N5286	1N5286		4-47
1N5286JAN	1N5286JAN		4-47
1N5286JTX	1N5286JTX		4-47
1N5286JTXV	1N5286JTXV		4-47
1N5287	1N5287		4-47
1N5287JAN	1N5287JAN		4-47
1N5287JTX	1N5287JTX		4-47
1N5287JTXV	1N5287JTXV		4-47
1N5288	1N5288		4-47
1N5288JAN	1N5288JAN		4-47
1N5288JTX	1N5288JTX		4-47
1N5288JTXV	1N5288JTXV		4-47
1N5289	1N5289		4-47
1N5289JAN	1N5289JAN		4-47
1N5289JTX	1N5289JTX		4-47
1N5289JTXV	1N5289JTXV		4-47
1N5290	1N5290		4-47
1N5290JAN	1N5290JAN		4-47
1N5290JTX	1N5290JTX		4-47
1N5290JTXV	1N5290JTXV		4-47
1N5291	1N5291		4-47
1N5291JAN	1N5291JAN		4-47
1N5291JTX	1N5291JTX		4-47
1N5291JTXV	1N5291JTXV		4-47
1N5292	1N5292		4-47
1N5292JAN	1N5292JAN		4-47
1N5292JTX	1N5292JTX		4-47
1N5292JTXV	1N5292JTXV		4-47
1N5293	1N5293		4-47
1N5293JAN	1N5293JAN		4-47
1N5293JTX	1N5293JTX		4-47
1N5293JTXV	1N5293JTXV		4-47
1N5294	1N5294		4-47
1N5294JAN	1N5294JAN		4-47
1N5294JTX	1N5294JTX		4-47
1N5294JTXV	1N5294JTXV		4-47
1N5295	1N5295		4-47
1N5295JAN	1N5295JAN		4-47
1N5295JTX	1N5295JTX		4-47
1N5295JTXV	1N5295JTXV		4-47
1N5296	1N5296		4-47
1N5296JAN	1N5296JAN		4-47
1N5296JTX	1N5296JTX		4-47
1N5296JTXV	1N5296JTXV		4-47
1N5297	1N5297		4-47
1N5297JAN	1N5297JAN		4-47
1N5297JTX	1N5297JTX		4-47
1N5297JTXV	1N5297JTXV		4-47
1N5298	1N5298		4-47
1N5298JAN	1N5298JAN		4-47
1N5298JTX	1N5298JTX		4-47
1N5298JTXV	1N5298JTXV		4-47
1N5299	1N5299		4-47
1N5299JAN	1N5299JAN		4-47
1N5299JTX	1N5299JTX		4-47
1N5299JTXV	1N5299JTXV		4-47
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Note: Reverse polarity has an R suffix.

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1N5301JTX	1N5301JTX		4-47	1N5334A	1N5334A		4-51
1N5301JTXV	1N5301JTXV		4-47	1N5334B	1N5334B		4-51
1N5302	1N5302		4-47	1N5334C	1N5334C		4-51
1N5302JAN	1N5302JAN		4-47	1N5334D	1N5334D		4-51
1N5302JTX	1N5302JTX		4-47	1N5335	1N5335A		4-51
1N5302JTXV	1N5302JTXV		4-47	1N5335A	1N5335A		4-51
1N5303	1N5303		4-47	1N5335B	1N5335B		4-51
1N5303JAN	1N5303JAN		4-47	1N5335C	1N5335C		4-51
1N5303JTX	1N5303JTX		4-47	1N5335D	1N5335D		4-51
1N5303JTXV	1N5303JTXV		4-47	1N5336	1N5336A		4-51
1N5304	1N5304		4-47	1N5336A	1N5336A		4-51
1N5304JAN	1N5304JAN		4-47	1N5336B	1N5336B		4-51
1N5304JTX	1N5304JTX		4-47	1N5336C	1N5336C		4-51
1N5304JTXV	1N5304JTXV		4-47	1N5336D	1N5336D		4-51
1N5305	1N5305		4-47	1N5337	1N5337A		4-51
1N5305JAN	1N5305JAN		4-47	1N5337A	1N5337A		4-51
1N5305JTX	1N5305JTX		4-47	1N5337B	1N5337B		4-51
1N5305JTXV	1N5305JTXV		4-47	1N5337C	1N5337C		4-51
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1N5306JAN	1N5306JAN		4-47	1N5338	1N5338A		4-51
1N5306JTX	1N5306JTX		4-47	1N5338A	1N5338A		4-51
1N5306JTXV	1N5306JTXV		4-47	1N5338B	1N5338B		4-51
1N5307	1N5307		4-47	1N5338C	1N5338C		4-51
1N5307JAN	1N5307JAN		4-47	1N5338D	1N5338D		4-51
1N5307JTX	1N5307JTX		4-47	1N5339	1N5339A		4-51
1N5307JTXV	1N5307JTXV		4-47	1N5339A	1N5339A		4-51
1N5308	1N5308		4-47	1N5339B	1N5339B		4-51
1N5308JAN	1N5308JAN		4-47	1N5339C	1N5339C		4-51
1N5308JTX	1N5308JTX		4-48	1N5339D	1N5339D		4-51
1N5308JTXV	1N5308JTXV		4-47	1N5340A	1N5340A		4-51
1N5309	1N5309		4-47	1N5340B	1N5340B		4-51
1N5309JAN	1N5309JAN		4-47	1N5340C	1N5340C		4-51
1N5309JTX	1N5309JTX		4-47	1N5340D	1N5340D		4-51
1N5309JTXV	1N5309JTXV		4-47	1N5341	1N5341A		4-51
1N5310	1N5310		4-47	1N5341A	1N5341A		4-51
1N5310JAN	1N5310JAN		4-47	1N5341B	1N5341B		4-51
1N5310JTX	1N5310JTX		4-47	1N5341C	1N5341C		4-51
1N5310JTXV	1N5310JTXV		4-47	1N5341D	1N5341D		4-51
1N5311	1N5311		4-47	1N5342	1N5342A		4-51
1N5311JAN	1N5311JAN		4-47	1N5342A	1N5342A		4-51
1N5311JTX	1N5311JTX		4-47	1N5342B	1N5342B		4-51
1N5311JTXV	1N5311JTXV		4-47	1N5342C	1N5342C		4-51
1N5312	1N5312		4-47	1N5342D	1N5342D		4-51
1N5312JAN	1N5312JAN		4-47	1N5343	1N5343A		4-51
1N5312JTX	1N5312JTX		4-47	1N5343A	1N5343A		4-51
1N5312JTXV	1N5312JTXV		4-47	1N5343B	1N5343B		4-51
1N5313	1N5313		4-47	1N5343C	1N5343C		4-51
1N5313JAN	1N5313JAN		4-47	1N5343D	1N5343D		4-51
1N5313JTX	1N5313JTX		4-47	1N5344	1N5344A		4-51
1N5313JTXV	1N5313JTXV		4-47	1N5344A	1N5344A		4-51
1N5314	1N5314		4-47	1N5344B	1N5344B		4-51
1N5314JAN	1N5314JAN		4-47	1N5344C	1N5344C		4-51
1N5314JTX	1N5314JTX		4-47	1N5344D	1N5344D		4-51
1N5314JTXV	1N5314JTXV		4-47	1N5345	1N5345A		4-51
1N5333	1N5333A		4-51	1N5345A	1N5345A		4-51
1N5333A	1N5333A		4-51	1N5345B	1N5345B		4-51
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Note: Reverse polarity has an R suffix.

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1N5346D	1N5346D		4-51
1N5347	1N5347A		4-51
1N5347A	1N5347A		4-51
1N5347B	1N5347B		4-51
1N5347C	1N5347C		4-51
1N5347D	1N5347D		4-51
1N5348	1N5348A		4-51
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1N5348B	1N5348B		4-51
1N5348C	1N5348C		4-51
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1N5349	1N5349A		4-51
1N5349A	1N5349A		4-51
1N5349B	1N5349B		4-51
1N5349C	1N5349C		4-51
1N5349D	1N5349D		4-51
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1N5352B	1N5352B		4-51
1N5352C	1N5352C		4-51
1N5352D	1N5352D		4-51
1N5353	1N5353A		4-51
1N5353A	1N5353A		4-51
1N5353B	1N5353B		4-51
1N5353C	1N5353C		4-51
1N5353D	1N5353D		4-51
1N5354	1N5354A		4-51
1N5354A	1N5354A		4-51
1N5354B	1N5354B		4-51
1N5354C	1N5354C		4-51
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1N5355	1N5355A		4-51
1N5355A	1N5355A		4-51
1N5355B	1N5355B		4-51
1N5355C	1N5355C		4-51
1N5355D	1N5355D		4-51
1N5356	1N5356A		4-51
1N5356A	1N5356A		4-51
1N5356B	1N5356B		4-51
1N5356C	1N5356C		4-51
1N5356D	1N5356D		4-51
1N5357	1N5357A		4-51
1N5357A	1N5357A		4-51
1N5357B	1N5357B		4-51
1N5357C	1N5357C		4-51
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1N5358	1N5358A		4-51
1N5358A	1N5358A		4-51
1N5358B	1N5358B		4-51
1N5358C	1N5358C		4-51
1N5358D	1N5358D		4-51
1N5359	1N5359A		4-51
1N5359A	1N5359A		4-51
1N5359B	1N5359B		4-51
1N5359C	1N5359C		4-51
1N5359D	1N5359D		4-51
1N5360	1N5360A		4-51
1N5360A	1N5360A		4-51
1N5360B	1N5360B		4-51
1N5360C	1N5360C		4-51
1N5360D	1N5360D		4-51
1N5361	1N5361A		4-51
1N5361A	1N5361A		4-51
1N5361B	1N5361B		4-51
1N5361C	1N5361C		4-51
1N5361D	1N5361D		4-51
1N5362	1N5362A		4-51
1N5362A	1N5362A		4-51
1N5362B	1N5362B		4-51
1N5362C	1N5362C		4-51
1N5362D	1N5362D		4-51
1N5363	1N5363A		4-51
1N5363A	1N5363A		4-51
1N5363B	1N5363B		4-51
1N5363C	1N5363C		4-51
1N5363D	1N5363D		4-51
1N5364	1N5364A		4-51
1N5364A	1N5364A		4-51
1N5364B	1N5364B		4-51
1N5364C	1N5364C		4-51
1N5364D	1N5364D		4-51
1N5365	1N5365A		4-51
1N5365A	1N5365A		4-51
1N5365B	1N5365B		4-51
1N5365C	1N5365C		4-51
1N5365D	1N5365D		4-51
1N5366	1N5366A		4-51
1N5366A	1N5366A		4-51
1N5366B	1N5366B		4-51
1N5366C	1N5366C		4-51
1N5366D	1N5366D		4-51
1N5367	1N5367A		4-51
1N5367A	1N5367A		4-51
1N5367B	1N5367B		4-51
1N5367C	1N5367C		4-51
1N5367D	1N5367D		4-51
1N5368	1N5368A		4-51
1N5368A	1N5368A		4-51
1N5368B	1N5368B		4-51
1N5368C	1N5368C		4-51
1N5368D	1N5368D		4-51
1N5369	1N5369A		4-51
1N5369A	1N5369A		4-51
1N5369B	1N5369B		4-51
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Note: Reverse polarity has an R suffix.

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1N5370D	1N5370D		4-51
1N5371	1N5371A		4-51
1N5371A	1N5371A		4-51
1N5371B	1N5371B		4-51
1N5371C	1N5371C		4-51
1N5371D	1N5371D		4-51
1N5372	1N5372A		4-51
1N5372A	1N5372A		4-51
1N5372B	1N5372B		4-51
1N5372C	1N5372C		4-51
1N5372D	1N5372D		4-51
1N5373	1N5373A		4-51
1N5373A	1N5373A		4-51
1N5373B	1N5373B		4-51
1N5373C	1N5373C		4-51
1N5373D	1N5373D		4-51
1N5374	1N5374A		4-51
1N5374A	1N5374A		4-51
1N5374B	1N5374B		4-51
1N5374C	1N5374C		4-51
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1N5375	1N5375A		4-51
1N5375A	1N5375A		4-51
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1N5376	1N5376A		4-51
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1N5377	1N5377A		4-51
1N5377A	1N5377A		4-51
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1N5377C	1N5377C		4-51
1N5377D	1N5377D		4-51
1N5378	1N5378A		4-51
1N5378A	1N5378A		4-51
1N5378B	1N5378B		4-51
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1N5379A	1N5379A		4-51
1N5379B	1N5379B		4-51
1N5379C	1N5379C		4-51
1N5379D	1N5379D		4-51
1N5380	1N5380A		4-51
1N5380A	1N5380A		4-51
1N5380B	1N5380B		4-51
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1N5381	1N5381A		4-51
1N5381A	1N5381A		4-51
1N5381B	1N5381B		4-51
1N5381C	1N5381C		4-51
1N5381D	1N5381D		4-51
1N5382	1N5382A		4-51
1N5382A	1N5382A		4-51
1N5382B	1N5382B		4-51
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1N5383	1N5383A		4-51
1N5383A	1N5383A		4-51
1N5383B	1N5383B		4-51
1N5383C	1N5383C		4-51
1N5383D	1N5383D		4-51
1N5384	1N5384A		4-51
1N5384A	1N5384A		4-51
1N5384B	1N5384B		4-51
1N5384C	1N5384C		4-51
1N5384D	1N5384D		4-51
1N5385	1N5385A		4-51
1N5385A	1N5385A		4-51
1N5385B	1N5385B		4-51
1N5385C	1N5385C		4-51
1N5385D	1N5385D		4-51
1N5386	1N5386A		4-51
1N5386A	1N5386A		4-51
1N5386B	1N5386B		4-51
1N5386C	1N5386C		4-51
1N5386D	1N5386D		4-51
1N5387	1N5387A		4-51
1N5387A	1N5387A		4-51
1N5387B	1N5387B		4-51
1N5387C	1N5387C		4-51
1N5387D	1N5387D		4-51
1N5388	1N5388A		4-51
1N5388A	1N5388A		4-51
1N5388B	1N5388B		4-51
1N5388C	1N5388C		4-51
1N5388D	1N5388D		4-51
1N5518A	1N5518A		4-55
1N5518B	1N5518B		4-55
1N5518B-1JTX	1N5518B-1JTX		4-55
1N5518B-1JTXV	1N5518B-1JTXV		4-55
1N5518B1JTX	1N5518B1JTX		4-55
1N5519A	1N5519A		4-55
1N5519B	1N5519B		4-55
1N5519B-1JTX	1N5519B-1JTX		4-55
1N5519B-1JTXV	1N5519B-1JTXV		4-55
1N5519B1JTX	1N5519B1JTX		4-55
1N5520A	1N5520A		4-55
1N5520B	1N5520B		4-55
1N5520B1JTX	1N5520B1JTX		4-55
1N5521A	1N5521A		4-55
1N5521B	1N5521B		4-55
1N5521B1JTX	1N5521B1JTX		4-55
1N5522A	1N5522A		4-55
1N5522B	1N5522B		4-55
1N5522B1JTX	1N5522B1JTX		4-55
1N5523A	1N5523A		4-55
1N5523B	1N5523B		4-55
1N5523B1JTX	1N5523B1JTX		4-55
1N5524A	1N5524A		4-55
1N5524B	1N5524B		4-55
1N5524B1JTX	1N5524B1JTX		4-55

Note: Reverse polarity has an R suffix.

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1N5525B	1N5525B		4-55
1N5525B1JTX	1N5525B1JTX		4-55
1N5526A	1N5526A		4-55
1N5526B	1N5526B		4-55
1N5526B1JTX	1N5526B1JTX		4-55
1N5527A	1N5527A		4-55
1N5527B	1N5527B		4-55
1N5527B1JTX	1N5527B1JTX		4-55
1N5528A	1N5528A		4-55
1N5528B	1N5528B		4-55
1N5528B1JTX	1N5528B1JTX		4-55
1N5529A	1N5529A		4-55
1N5529B	1N5529B		4-55
1N5529B1JTX	1N5529B1JTX		4-55
1N5530A	1N5530A		4-55
1N5530B	1N5530B		4-55
1N5530B1JTX	1N5530B1JTX		4-55
1N5531A	1N5531A		4-55
1N5531B	1N5531B		4-55
1N5531B1JTX	1N5531B1JTX		4-55
1N5532A	1N5532A		4-55
1N5532B	1N5532B		4-55
1N5532B1JTX	1N5532B1JTX		4-55
1N5533A	1N5533A		4-55
1N5533B	1N5533B		4-55
1N5533B1JTX	1N5533B1JTX		4-55
1N5534A	1N5534A		4-55
1N5534B	1N5534B		4-55
1N5534B1JTX	1N5534B1JTX		4-55
1N5535A	1N5535A		4-55
1N5535B	1N5535B		4-55
1N5535B1JTX	1N5535B1JTX		4-55
1N5536A	1N5536A		4-55
1N5536B	1N5536B		4-55
1N5536B1JTX	1N5536B1JTX		4-55
1N5537A	1N5537A		4-55
1N5537B	1N5537B		4-55
1N5537B1JTX	1N5537B1JTX		4-55
1N5538A	1N5538A		4-55
1N5538B	1N5538B		4-55
1N5538B1JTX	1N5538B1JTX		4-55
1N5539A	1N5539A		4-55
1N5539B	1N5539B		4-55
1N5539B1JTX	1N5539B1JTX		4-55
1N5540A	1N5540A		4-55
1N5540B	1N5540B		4-55
1N5540B1JTX	1N5540B1JTX		4-55
1N5541A	1N5541A		4-55
1N5541B	1N5541B		4-55
1N5541B1JTX	1N5541B1JTX		4-55
1N5542A	1N5542A		4-55
1N5542B	1N5542B		4-55
1N5542B1JTX	1N5542B1JTX		4-55
1N5543A	1N5543A		4-55
1N5543B	1N5543B		4-55
1N5543B1JTX	1N5543B1JTX		4-55
1N5544A	1N5544A		4-55
1N5544B	1N5544B		4-55
1N5544B1JTX	1N5544B1JTX		4-55

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1N5545A	1N5545A		4-55
1N5545B	1N5545B		4-55
1N5545B1JTX	1N5545B1JTX		4-55
1N5546A	1N5546A		4-55
1N5546B	1N5546B		4-55
1N5546B1JTX	1N5546B1JTX		4-55
1N5555		1N6283	4-59
1N5556		1N6283A	4-59
1N5557		1N6289A	4-59
1N5558		1N6303A	4-59
1N5629		1N6267	4-59
1N5629A		1N6267A	4-59
1N5630		1N6268	4-59
1N5630A		1N6268A	4-59
1N5631		1N6269	4-59
1N5631A		1N6269A	4-59
1N5632		1N6270	4-59
1N5632A		1N6270A	4-59
1N5633		1N6271	4-59
1N5633A		1N6271A	4-59
1N5634		1N6272	4-59
1N5634A		1N6272A	4-59
1N5635		1N6273	4-59
1N5635A		1N6273A	4-59
1N5636		1N6274	4-59
1N5636A		1N6274A	4-59
1N5637		1N6275	4-59
1N5637A		1N6275A	4-59
1N5638		1N6276	4-59
1N5638A		1N6276A	4-59
1N5639		1N6277	4-59
1N5639A		1N6277A	4-59
1N5640		1N6278	4-59
1N5640A		1N6278A	4-59
1N5641		1N6279	4-59
1N5641A		1N6279A	4-59
1N5642		1N6280	4-59
1N5642A		1N6280A	4-59
1N5643		1N6281	4-59
1N5643A		1N6281A	4-59
1N5644		1N6282	4-59
1N5644A		1N6282A	4-59
1N5645		1N6283	4-59
1N5645A		1N6283A	4-59
1N5646		1N6284	4-59
1N5646A		1N6284A	4-59
1N5651		1N6289A	4-59
1N5652		1N6290	4-59
1N5652A		1N6290A	4-59
1N5653		1N6291	4-59
1N5653A		1N6291A	4-59
1N5654		1N6292	4-59
1N5654A		1N6292A	4-59
1N5655		1N6293	4-59
1N5655A		1N6293A	4-59
1N5656		1N6294	4-59
1N5656A		1N6294A	4-59
1N5657		1N6295	4-59
1N5657A		1N6295A	4-59
1N5658		1N6296	4-59

Note: Reverse polarity has an R suffix.

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1N5659A		1N6297A	4-59
1N5660		1N6298	4-59
1N5660A		1N6298A	4-59
1N5661		1N6299	4-59
1N5661A		1N6299A	4-59
1N5662		1N6300	4-59
1N5662A		1N6300A	4-59
1N5663		1N6301	4-59
1N5663A		1N6301A	4-59
1N5664		1N6302	4-59
1N5664A		1N6302A	4-59
1N5665		1N6303	4-59
1N5665A		1N6303A	4-59
1N5728		1N5230B	4-40
1N5729		1N5231B	4-40
1N5730		1N5232B	4-40
1N5731		1N5234B	4-40
1N5732B		1N5235B	4-40
1N5733B		1N5236B	4-40
1N5734B		1N5237B	4-40
1N5735B		1N5239B	4-40
1N5736B		1N5240B	4-40
1N5738B		1N5242B	4-40
1N5739B		1N5243B	4-40
1N5740B		1N5245B	4-40
1N5741B		1N5246B	4-40
1N5742B		1N5248B	4-40
1N5743B		1N5250B	4-40
1N5744B		1N5251B	4-40
1N5745B		1N5252B	4-40
1N5746B		1N5254B	4-40
1N5747B		1N5256B	4-40
1N5748B		1N5257B	4-40
1N5749		1N5258B	4-40
1N5750		1N5259B	4-40
1N5751		1N5260B	4-40
1N5752		1N5261B	4-40
1N5753		1N5262B	4-40
1N5837		1N4370	4-4
1N5838		1N5222A	4-40
1N5839		1N4371	4-4
1N5840		1N5224A	4-40
1N5841		1N4372	4-4
1N5842		1N746	4-4
1N5843		1N747	4-4
1N5844		1N748	4-4
1N5845		1N749	4-4
1N5846		1N750	4-4
1N5847		1N751	4-4
1N5848		1N752	4-4
1N5849		1N5233A	4-40
1N5850		1N753	4-4
1N5851		1N754	4-4
1N5852		1N755	4-4
1N5853		1N756	4-4
1N5854		1N5238A	4-40
1N5855		1N757	4-4
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1N5859		1N964A	4-4
1N5860		1N5244A	4-40
1N5861		1N965A	4-4
1N5862		1N966A	4-4
1N5863		1N5247A	4-40
1N5864		1N967A	4-4
1N5865		1N5249A	4-40
1N5866		1N968A	4-4
1N5867		1N969A	4-4
1N5868		1N970A	4-4
1N5869		1N5253A	4-40
1N5870		1N971A	4-4
1N5871		1N5255A	4-40
1N5872		1N972A	4-4
1N5873		1N973A	4-4
1N5874		1N974A	4-4
1N5875		1N975A	4-4
1N5876		1N976A	4-4
1N5877		1N977A	4-4
1N5878		1N978A	4-4
1N5879		1N979A	4-4
1N5880		1N5264A	4-40
1N5881		1N980A	4-4
1N5882		1N981A	4-4
1N5883		1N982A	4-4
1N5884		1N983A	4-4
1N5885		1N5269A	4-40
1N5886		1N984A	4-4
1N5887		1N985A	4-4
1N5888		1N986A	4-4
1N5889		1N987A	4-4
1N5890		1N988A	4-4
1N5891		1N5275A	4-40
1N5892		1N989A	4-4
1N5893		1N990A	4-4
1N5894		1N5278A	4-40
1N5895		1N991A	4-4
1N5896		1N5280A	4-40
1N5897		1N992A	4-4
1N5908	1N5908		4-59
1N5913	1N5913A		4-65
1N5913A	1N5913A		4-65
1N5913B	1N5913B		4-65
1N5914	1N5914A		4-65
1N5914A	1N5914A		4-65
1N5914B	1N5914B		4-65
1N5915	1N5915A		4-65
1N5915A	1N5915A		4-65
1N5915B	1N5915B		4-65
1N5916	1N5916A		4-65
1N5916A	1N5916A		4-65
1N5916B	1N5916B		4-65
1N5917	1N5917A		4-65
1N5917A	1N5917A		4-65
1N5917B	1N5917B		4-65
1N5918	1N5918A		4-65
1N5918A	1N5918A		4-65
1N5918B	1N5918B		4-65

Note: Reverse polarity has an R suffix.

ZENER INDEX CROSS-REFERENCE (Continued)

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1N5919B	1N5919B		4-65
1N5920	1N5920A		4-65
1N5920A	1N5920A		4-65
1N5920B	1N5920B		4-65
1N5921	1N5921A		4-65
1N5921A	1N5921A		4-65
1N5921B	1N5921B		4-65
1N5922	1N5922A		4-65
1N5922A	1N5922A		4-65
1N5922B	1N5922B		4-65
1N5923	1N5923A		4-65
1N5923A	1N5923A		4-65
1N5923B	1N5923B		4-65
1N5924	1N5924A		4-65
1N5924A	1N5924A		4-65
1N5924B	1N5924B		4-65
1N5925	1N5925A		4-65
1N5925A	1N5925A		4-65
1N5925B	1N5925B		4-65
1N5926	1N5926A		4-65
1N5926A	1N5926A		4-65
1N5926B	1N5926B		4-65
1N5927	1N5927A		4-65
1N5927A	1N5927A		4-65
1N5927B	1N5927B		4-65
1N5928	1N5928A		4-65
1N5928A	1N5928A		4-65
1N5928B	1N5928B		4-65
1N5929	1N5929A		4-65
1N5929A	1N5929A		4-65
1N5929B	1N5929B		4-65
1N5930	1N5930A		4-65
1N5930A	1N5930A		4-65
1N5930B	1N5930B		4-65
1N5931	1N5931A		4-65
1N5931A	1N5931A		4-65
1N5931B	1N5931B		4-65
1N5932	1N5932A		4-65
1N5932A	1N5932A		4-65
1N5932B	1N5932B		4-65
1N5933	1N5933A		4-65
1N5933A	1N5933A		4-65
1N5933B	1N5933B		4-65
1N5934	1N5934A		4-65
1N5934A	1N5934A		4-65
1N5934B	1N5934B		4-65
1N5935	1N5935A		4-65
1N5935A	1N5935A		4-65
1N5935B	1N5935B		4-65
1N5936	1N5936A		4-65
1N5936A	1N5936A		4-65
1N5936B	1N5936B		4-65
1N5937	1N5937A		4-65
1N5937A	1N5937A		4-65
1N5937B	1N5937B		4-65
1N5938	1N5938A		4-65
1N5938A	1N5938A		4-65
1N5938B	1N5938B		4-65
1N5939	1N5939A		4-65
1N5939A	1N5939A		4-65
1N5939B	1N5939B		4-65
1N5940	1N5940A		4-65
1N5940A	1N5940A		4-65
1N5940B	1N5940B		4-65
1N5941	1N5941A		4-65
1N5941A	1N5941A		4-65
1N5941B	1N5941B		4-65
1N5942	1N5942A		4-65
1N5942A	1N5942A		4-65
1N5942B	1N5942B		4-65
1N5943	1N5943A		4-65
1N5943A	1N5943A		4-65
1N5943B	1N5943B		4-65
1N5944	1N5944A		4-65
1N5944A	1N5944A		4-65
1N5944B	1N5944B		4-65
1N5945	1N5945A		4-65
1N5945A	1N5945A		4-65
1N5945B	1N5945B		4-65
1N5946	1N5946A		4-65
1N5946A	1N5946A		4-65
1N5946B	1N5946B		4-65
1N5947	1N5947A		4-65
1N5947A	1N5947A		4-65
1N5947B	1N5947B		4-65
1N5948	1N5948A		4-65
1N5948A	1N5948A		4-65
1N5948B	1N5948B		4-65
1N5949	1N5949A		4-65
1N5949A	1N5949A		4-65
1N5949B	1N5949B		4-65
1N5950	1N5950A		4-65
1N5950A	1N5950A		4-65
1N5950B	1N5950B		4-65
1N5951	1N5951A		4-65
1N5951A	1N5951A		4-65
1N5951B	1N5951B		4-65
1N5952	1N5952A		4-65
1N5952A	1N5952A		4-65
1N5952B	1N5952B		4-65
1N5953	1N5953A		4-65
1N5953A	1N5953A		4-65
1N5953B	1N5953B		4-65
1N5954	1N5954A		4-65
1N5954A	1N5954A		4-65
1N5954B	1N5954B		4-65
1N5955	1N5955A		4-65
1N5955A	1N5955A		4-65
1N5955B	1N5955B		4-65
1N5956	1N5956A		4-65
1N5956A	1N5956A		4-65
1N5956B	1N5956B		4-65
1N5985A	1N5985A		4-68
1N5985B	1N5985B		4-68
1N5986A	1N5986A		4-68
1N5986B	1N5986B		4-68
1N5987A	1N5987A		4-68
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Note: Reverse polarity has an R suffix.

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1N5989B	1N5989B		4-68
1N5990A	1N5990A		4-68
1N5990B	1N5990B		4-68
1N5991A	1N5991A		4-68
1N5991B	1N5991B		4-68
1N5992A	1N5992A		4-68
1N5992B	1N5992B		4-68
1N5993A	1N5993A		4-68
1N5993B	1N5993B		4-68
1N5994A	1N5994A		4-68
1N5994B	1N5994B		4-68
1N5995A	1N5995A		4-68
1N5995B	1N5995B		4-68
1N5996A	1N5996A		4-68
1N5996B	1N5996B		4-68
1N5997A	1N5997A		4-68
1N5997B	1N5997B		4-68
1N5998A	1N5998A		4-68
1N5998B	1N5998B		4-68
1N5999A	1N5999A		4-68
1N5999B	1N5999B		4-68
1N6000A	1N6000A		4-68
1N6000B	1N6000B		4-68
1N6001A	1N6001A		4-68
1N6001B	1N6001B		4-68
1N6002A	1N6002A		4-68
1N6002B	1N6002B		4-68
1N6003A	1N6003A		4-68
1N6003B	1N6003B		4-68
1N6004A	1N6004A		4-68
1N6004B	1N6004B		4-68
1N6005A	1N6005A		4-68
1N6005B	1N6005B		4-68
1N6006A	1N6006A		4-68
1N6006B	1N6006B		4-68
1N6007A	1N6007A		4-68
1N6007B	1N6007B		4-68
1N6008A	1N6008A		4-68
1N6008B	1N6008B		4-68
1N6009A	1N6009A		4-68
1N6009B	1N6009B		4-68
1N6010A	1N6010A		4-68
1N6010B	1N6010B		4-68
1N6011A	1N6011A		4-68
1N6011B	1N6011B		4-68
1N6012A	1N6012A		4-68
1N6012B	1N6012B		4-68
1N6013A	1N6013A		4-68
1N6013B	1N6013B		4-68
1N6014A	1N6014A		4-68
1N6014B	1N6014B		4-68
1N6015A	1N6015A		4-68
1N6015B	1N6015B		4-68
1N6016A	1N6016A		4-68
1N6016B	1N6016B		4-68
1N6017A	1N6017A		4-68
1N6017B	1N6017B		4-68
1N6018	1N6018A		4-68
1N6018A	1N6018A		4-68
1N6018B	1N6018B		4-68
1N6019	1N6019A		4-68
1N6019A	1N6019A		4-68
1N6019B	1N6019B		4-68
1N6020	1N6020A		4-68
1N6020A	1N6020A		4-68
1N6020B	1N6020B		4-68
1N6021	1N6021A		4-68
1N6021A	1N6021A		4-68
1N6021B	1N6021B		4-68
1N6022	1N6022A		4-68
1N6022A	1N6022A		4-68
1N6022B	1N6022B		4-68
1N6023	1N6023A		4-68
1N6023A	1N6023A		4-68
1N6023B	1N6023B		4-68
1N6024	1N6024A		4-68
1N6024A	1N6024A		4-68
1N6024B	1N6024B		4-68
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1N6268A	1N6268A		4-59
1N6269	1N6269		4-59
1N6269A	1N6269A		4-59
1N6270	1N6270		4-59
1N6270A	1N6270A		4-59
1N6271	1N6271		4-59
1N6271A	1N6271A		4-59
1N6272	1N6272		4-59
1N6272A	1N6272A		4-59
1N6273	1N6273		4-59
1N6273A	1N6273A		4-59
1N6274	1N6274		4-59
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1N6278A	1N6278A		4-59
1N6279	1N6279		4-59
1N6279A	1N6279A		4-59
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1N6280A	1N6280A		4-59
1N6281	1N6281		4-59
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Note: Reverse polarity has an R suffix.

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1N6287A	1N6287A		4-59
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1N6289	1N6289		4-59
1N6289A	1N6289A		4-59
1N6290	1N6290		4-59
1N6290A	1N6290A		4-59
1N6291	1N6291		4-59
1N6291A	1N6291A		4-59
1N6292	1N6292		4-59
1N6292A	1N6292A		4-59
1N6293	1N6293		4-59
1N6293A	1N6293A		4-59
1N6294	1N6294		4-59
1N6294A	1N6294A		4-59
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1N6296	1N6296		4-59
1N6296A	1N6296A		4-59
1N6297	1N6297		4-59
1N6297A	1N6297A		4-59
1N6298	1N6298		4-59
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3EZ4.3D5	3EZ4.3D5		4-71
3EZ4.7D5	3EZ4.7D5		4-71
3EZ5.1D5	3EZ5.1D5		4-71
3EZ5.6D5	3EZ5.6D5		4-71
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Note: Reverse polarity has an R suffix.

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ICT-10		ICTE-10	4-59
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ICT-15		ICTE-15	4-59
ICT-18		ICTE-18	4-59
ICT-22		ICTE-22	4-59
ICT-36		ICTE-36	4-59
ICT-45		ICTE-45	4-59
ICTE-5	ICTE-5		4-59
ICTE-8	ICTE-8		4-59
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LVA100A		1N5530B	4-55
LVA100B		1N5530C	4-55
LVA100C		1N5530D	4-55
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LVA343B		1N5521C	4-55
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MCL1301	MCL1301		4-75
MCL1302	MCL1302		4-75
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MCT821A		1N821A	4-10
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MLL747A	MLL747A		4-76
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MLL750A	MLL750A		4-76
MLL751	MLL751		4-76
MLL751A	MLL751A		4-76
MLL752	MLL752		4-76
MLL752A	MLL752A		4-76
MLL753	MLL753		4-76
MLL753A	MLL753A		4-76
MLL754	MLL754		4-76
MLL754A	MLL754A		4-76
MLL755	MLL755		4-76
MLL755A	MLL755A		4-76
MLL756	MLL756		4-76
MLL756A	MLL756A		4-76
MLL757	MLL757		4-76
MLL757A	MLL757A		4-76
MLL758	MLL758		4-76
MLL758A	MLL758A		4-76
MLL759	MLL759		4-76
MLL759A	MLL759A		4-76
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MLL957B	MLL957B		4-76
MLL958A	MLL958A		4-76
MLL958B	MLL958B		4-76
MLL959A	MLL959A		4-76
MLL959B	MLL959B		4-76
MLL960A	MLL960A		4-76
MLL960B	MLL960B		4-76
MLL961A	MLL961A		4-76
MLL961B	MLL961B		4-76
MLL962A	MLL962A		4-76
MLL962B	MLL962B		4-76
MLL963A	MLL963A		4-76
MLL963B	MLL963B		4-76
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Note: Reverse polarity has an R suffix.

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MLL968B	MLL968B		4-76
MLL969A	MLL969A		4-76
MLL969B	MLL969B		4-76
MLL970A	MLL970A		4-76
MLL970B	MLL970B		4-76
MLL971A	MLL971A		4-76
MLL971B	MLL971B		4-76
MLL972A	MLL972A		4-76
MLL972B	MLL972B		4-76
MLL973A	MLL973A		4-76
MLL973B	MLL973B		4-76
MLL974A	MLL974A		4-76
MLL974B	MLL974B		4-76
MLL975A	MLL975A		4-76
MLL975B	MLL975B		4-76
MLL976A	MLL976A		4-76
MLL976B	MLL976B		4-76
MLL977A	MLL977A		4-76
MLL977B	MLL977B		4-76
MLL978A	MLL978A		4-76
MLL978B	MLL978B		4-76
MLL979A	MLL979A		4-76
MLL979B	MLL979B		4-76
MLL980A	MLL980A		4-76
MLL980B	MLL980B		4-76
MLL981A	MLL981A		4-76
MLL981B	MLL981B		4-76
MLL982A	MLL982A		4-76
MLL982B	MLL982B		4-76
MLL983A	MLL983A		4-76
MLL983B	MLL983B		4-76
MLL984A	MLL984A		4-76
MLL984B	MLL984B		4-76
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MLL4100	MLL4100		4-81
MLL4101	MLL4101		4-81
MLL4102	MLL4102		4-81
MLL4103	MLL4103		4-81
MLL4104	MLL4104		4-81
MLL4105	MLL4105		4-81
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MLL4114	MLL4114		4-81
MLL4115	MLL4115		4-81
MLL4116	MLL4116		4-81
MLL4117	MLL4117		4-81
MLL4118	MLL4118		4-81
MLL4119	MLL4119		4-81
MLL4120	MLL4120		4-81
MLL4121	MLL4121		4-81
MLL4122	MLL4122		4-81
MLL4123	MLL4123		4-81
MLL4124	MLL4124		4-81
MLL4125	MLL4125		4-81
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MLL4130	MLL4130		4-81
MLL4131	MLL4131		4-81
MLL4132	MLL4132		4-81
MLL4133	MLL4133		4-81
MLL4134	MLL4134		4-81
MLL4135	MLL4135		4-81
MLL4370	MLL4370A		4-76
MLL4370A	MLL4370A		4-76
MLL4371	MLL4371A		4-76
MLL4371A	MLL4371A		4-76
MLL4372	MLL4372A		4-76
MLL4372A	MLL4372A		4-76
MLL4614	MLL4614		4-81
MLL4615	MLL4615		4-81
MLL4616	MLL4616		4-81
MLL4617	MLL4617		4-81
MLL4618	MLL4618		4-81
MLL4619	MLL4619		4-81
MLL4620	MLL4620		4-81
MLL4621	MLL4621		4-81
MLL4622	MLL4622		4-81
MLL4623	MLL4623		4-81
MLL4624	MLL4624		4-81
MLL4625	MLL4625		4-81
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MLL4680	MLL4680		4-85
MLL4681	MLL4681		4-85
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MLL4683	MLL4683		4-85
MLL4684	MLL4684		4-85
MLL4685	MLL4685		4-85
MLL4686	MLL4686		4-85
MLL4687	MLL4687		4-85
MLL4688	MLL4688		4-85
MLL4689	MLL4689		4-85
MLL4690	MLL4690		4-85
MLL4691	MLL4691		4-85
MLL4692	MLL4692		4-85
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Note: Reverse polarity has an R suffix.

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MLL4703	MLL4703		4-85
MLL4704	MLL4704		4-85
MLL4705	MLL4705		4-85
MLL4706	MLL4706		4-85
MLL4707	MLL4707		4-85
MLL4708	MLL4708		4-85
MLL4709	MLL4709		4-85
MLL4710	MLL4710		4-85
MLL4711	MLL4711		4-85
MLL4712	MLL4712		4-85
MLL4713	MLL4713		4-85
MLL4714	MLL4714		4-85
MLL4715	MLL4715		4-85
MLL4716	MLL4716		4-85
MLL4717	MLL4717		4-85
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MLL4728A	MLL4728A		4-87
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MLL4729A	MLL4729A		4-87
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MLL4730A	MLL4730A		4-87
MLL4731	MLL4731		4-87
MLL4731A	MLL4731A		4-87
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MLL4732A	MLL4732A		4-87
MLL4733	MLL4733		4-87
MLL4733A	MLL4733A		4-87
MLL4734	MLL4734		4-87
MLL4734A	MLL4734A		4-87
MLL4735	MLL4735		4-87
MLL4735A	MLL4735A		4-87
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MLL4744A	MLL4744A		4-87
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MLL4746A	MLL4746A		4-87
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MLL4749	MLL4749		4-87
MLL4749A	MLL4749A		4-87
MLL4750	MLL4750		4-87
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Note: Reverse polarity has an R suffix.

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MLL5231B	MLL5231B		4-92
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MLL5232A	MLL5232A		4-92
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MLL5233A	MLL5233A		4-92
MLL5233B	MLL5233B		4-92
MLL5234	MLL5234A		4-92
MLL5234A	MLL5234A		4-92
MLL5234B	MLL5234B		4-92
MLL5235	MLL5235A		4-92
MLL5235A	MLL5235A		4-92
MLL5235B	MLL5235B		4-92
MLL5236	MLL5236A		4-92
MLL5236A	MLL5236A		4-92
MLL5236B	MLL5236B		4-92
MLL5237	MLL5237A		4-92
MLL5237A	MLL5237A		4-92
MLL5237B	MLL5237B		4-92
MLL5238	MLL5238A		4-92
MLL5238A	MLL5238A		4-92
MLL5238B	MLL5238B		4-92
MLL5239	MLL5239A		4-92
MLL5239A	MLL5239A		4-92
MLL5239B	MLL5239B		4-92
MLL5240	MLL5240A		4-92
MLL5240A	MLL5240A		4-92
MLL5240B	MLL5240B		4-92
MLL5241	MLL5241A		4-92
MLL5241A	MLL5241A		4-92
MLL5241B	MLL5241B		4-92
MLL5241	MLL5241A		4-92
MLL5241A	MLL5241A		4-92
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MLL5243	MLL5243A		4-92
MLL5243A	MLL5243A		4-92
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MLL5244	MLL5244A		4-92
MLL5244A	MLL5244A		4-92
MLL5244B	MLL5244B		4-92
MLL5245	MLL5245A		4-92
MLL5245A	MLL5245A		4-92
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MLL5246	MLL5246A		4-92
MLL5246A	MLL5246A		4-92
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MLL5251B	MLL5251B		4-92
MLL5252	MLL5252A		4-92
MLL5252A	MLL5252A		4-92
MLL5252B	MLL5252B		4-92
MLL5253	MLL5253A		4-92
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MLL5253B	MLL5253B		4-92
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MLL5254B	MLL5254B		4-92
MLL5255	MLL5255A		4-92
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MLL5255B	MLL5255B		4-92
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Note: Reverse polarity has an R suffix.

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MLV755A		1N755A	4-4
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MLV757A		1N757A	4-4
MLV758A		1N758A	4-4
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MMBZ5228	MMBZ5228B		4-98
MMBZ5228B	MMBZ5228B		4-98
MMBZ5229	MMBZ5229B		4-98
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MMBZ5230	MMBZ5230B		4-98
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MMBZ5232	MMBZ5232B		4-98
MMBZ5232B	MMBZ5232B		4-98
MMBZ5233	MMBZ5233B		4-98
MMBZ5233B	MMBZ5233B		4-98
MMBZ5234	MMBZ5234B		4-98
MMBZ5234B	MMBZ5234B		4-98
MMBZ5235	MMBZ5235B		4-98
MMBZ5235B	MMBZ5235B		4-98
MMBZ5236	MMBZ5236B		4-98
MMBZ5236B	MMBZ5236B		4-98
MMBZ5237	MMBZ5237B		4-98
MMBZ5237B	MMBZ5237B		4-98
MMBZ5238	MMBZ5238B		4-98
MMBZ5238B	MMBZ5238B		4-98
MMBZ5239	MMBZ5239B		4-98
MMBZ5239B	MMBZ5239B		4-98
MMBZ5240	MMBZ5240B		4-98
MMBZ5240B	MMBZ5240B		4-98
MMBZ5241	MMBZ5241B		4-98
MMBZ5241B	MMBZ5241B		4-98
MMBZ5242	MMBZ5242B		4-98
MMBZ5242B	MMBZ5242B		4-98
MMBZ5243	MMBZ5243B		4-98
MMBZ5243B	MMBZ5243B		4-98
MMBZ5244	MMBZ5244B		4-98
MMBZ5244B	MMBZ5244B		4-98
MMBZ5245	MMBZ5245B		4-98
MMBZ5245B	MMBZ5245B		4-98
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MMBZ5246B	MMBZ5246B		4-98
MMBZ5247	MMBZ5247B		4-98
MMBZ5247B	MMBZ5247B		4-98
MMBZ5248	MMBZ5248B		4-98
MMBZ5248B	MMBZ5248B		4-98
MMBZ5249	MMBZ5249B		4-98
MMBZ5249B	MMBZ5249B		4-98
MMBZ5250	MMBZ5250B		4-98
MMBZ5250B	MMBZ5250B		4-98
MMBZ5251	MMBZ5251B		4-98
MMBZ5251B	MMBZ5251B		4-98
MMBZ5252	MMBZ5252B		4-98
MMBZ5252B	MMBZ5252B		4-98
MMBZ5253	MMBZ5253B		4-98
MMBZ5253B	MMBZ5253B		4-98
MMBZ5254	MMBZ5254B		4-98
MMBZ5254B	MMBZ5254B		4-98
MMBZ5255	MMBZ5255B		4-98
MMBZ5255B	MMBZ5255B		4-98
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Note: Reverse polarity has an R suffix.

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Note: Reverse polarity has an R suffix.

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MZ1000-20		1N4747	4-36
MZ1000-21		1N4748	4-36
MZ1000-22		1N4749	4-36
MZ1000-23		1N4750	4-36
MZ1000-24		1N4751	4-36
MZ1000-25		1N4752	4-36
MZ1000-26		1N4753	4-36
MZ1000-27		1N4754	4-36
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MZ1000-29		1N4756	4-36
MZ1000-30		1N4757	4-36
MZ1000-31		1N4758	4-36
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MZ1000-34		1N4761	4-36
MZ1000-35		1N4763	4-36
MZ1000-36		1N4763	4-36
MZ1000-37		1N4764	4-36
MZ2360	MZ2360		4-104
MZ2361	MZ2361		4-104
MZ5555		1N6283A	4-59
MZ5556		1N6287A	4-59
MZ5557		1N6289A	4-59
MZ5558		1N6303A	4-59
P6KE6.8	P6KE6.8		4-106
P6KE6.8A	P6KE6.8A		4-106
P6KE7.5	P6KE7.5		4-106
P6KE7.5A	P6KE7.5A		4-106
P6KE8.2	P6KE8.2		4-106
P6KE8.2A	P6KE8.2A		4-106
P6KE9.1	P6KE9.1		4-106
P6KE9.1A	P6KE9.1A		4-106
P6KE10	P6KE10		4-106
P6KE10A	P6KE10A		4-106
P6KE11	P6KE11		4-106
P6KE11A	P6KE11A		4-106
P6KE12	P6KE12		4-106
P6KE12A	P6KE12A		4-106
P6KE13	P6KE13		4-106
P6KE13A	P6KE13A		4-106
P6KE15	P6KE15		4-106
P6KE15A	P6KE15A		4-106
P6KE16	P6KE16		4-106
P6KE16A	P6KE16A		4-106
P6KE18	P6KE18		4-106
P6KE18A	P6KE18A		4-106
P6KE20	P6KE20		4-106
P6KE20A	P6KE20A		4-106
P6KE22	P6KE22		4-106
P6KE22A	P6KE22A		4-106
P6KE24	P6KE24		4-106
P6KE24A	P6KE24A		4-106
P6KE27	P6KE27		4-106
P6KE27A	P6KE27A		4-106
P6KE30	P6KE30		4-106
P6KE30A	P6KE30A		4-106
P6KE33	P6KE33		4-106
P6KE33A	P6KE33A		4-106
P6KE36	P6KE36		4-106
P6KE36A	P6KE36A		4-106
P6KE39	P6KE39		4-106
P6KE39A	P6KE39A		4-106
P6KE43	P6KE43		4-106
P6KE43A	P6KE43A		4-106
P6KE47	P6KE47		4-106
P6KE47A	P6KE47A		4-106
P6KE51	P6KE51		4-106
P6KE51A	P6KE51A		4-106
P6KE56	P6KE56		4-106
P6KE56A	P6KE56A		4-106
P6KE62	P6KE62		4-106
P6KE62A	P6KE62A		4-106
P6KE68	P6KE68		4-106
P6KE68A	P6KE68A		4-106
P6KE75	P6KE75		4-106
P6KE75A	P6KE75A		4-106
P6KE82	P6KE82		4-106
P6KE82A	P6KE82A		4-106
P6KE91	P6KE91		4-106
P6KE91A	P6KE91A		4-106
P6KE100	P6KE100		4-106
P6KE100A	P6KE100A		4-106
P6KE110	P6KE110		4-106
P6KE110A	P6KE110A		4-106
P6KE120	P6KE120		4-106
P6KE120A	P6KE120A		4-106
P6KE130	P6KE130		4-106
P6KE130A	P6KE130A		4-106
P6KE150	P6KE150		4-106
P6KE150A	P6KE150A		4-106
P6KE160	P6KE160		4-106
P6KE160A	P6KE160A		4-106
P6KE170	P6KE170		4-106
P6KE170A	P6KE170A		4-106
P6KE180	P6KE180		4-106
P6KE180A	P6KE180A		4-106
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Note: Reverse polarity has an R suffix.

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PRD140	MZ640		4-101
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PS3539	1N4573A		4-32
PS3546	1N4565A		4-32
PS3549	1N4568A		4-32
SA10	SA10		4-110
SA100	SA100		4-110
SA100A	SA100A		4-110
SA10A	SA10A		4-110
SA11	SA11		4-110
SA110	SA110		4-110
SA110A	SA110A		4-110
SA11A	SA11A		4-110
SA12	SA12		4-110
SA120	SA120		4-110
SA120A	SA120A		4-110
SA12A	SA12A		4-110
SA13	SA13		4-110
SA130	SA130		4-110
SA130A	SA130A		4-110
SA13A	SA13A		4-110
SA14	SA14		4-110
SA14A	SA14A		4-110
SA15	SA15		4-110
SA150	SA150		4-110
SA150A	SA150A		4-110
SA15A	SA15A		4-110
SA16	SA16		4-110
SA160	SA160		4-110
SA160A	SA160A		4-110
SA16A	SA16A		4-110
SA17	SA17		4-110
SA170	SA170		4-110
SA170A	SA170A		4-110
SA17A	SA17A		4-110
SA18	SA18		4-110
SA18A	SA18A		4-110
SA20	SA20		4-110
SA20A	SA20A		4-110
SA22	SA22		4-110
SA22A	SA22A		4-110
SA24	SA24		4-110
SA24A	SA24A		4-110
SA26	SA26		4-110
SA26A	SA26A		4-110
SA28	SA28		4-110
SA28A	SA28A		4-110
SA30	SA30		4-110
SA30A	SA30A		4-110
SA33	SA33		4-110
SA33A	SA33A		4-110
SA36	SA36		4-110
SA36A	SA36A		4-110
SA40	SA40		4-110
SA40A	SA40A		4-110
SA43	SA43		4-110
SA43A	SA43A		4-110
SA45	SA45		4-110
SA45A	SA45A		4-110
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SA54	SA54		4-110
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SA6.0	SA6.0		4-110
SA6.0A	SA6.0A		4-110
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SA60	SA60		4-110
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SA7.0	SA7.0		4-110
SA7.0A	SA7.0A		4-110
SA7.5	SA7.5		4-110
SA7.5A	SA7.5A		4-110
SA70	SA70		4-110
SA70A	SA70A		4-110
SA75	SA75		4-110
SA75A	SA75A		4-110
SA78	SA78		4-110
SA78A	SA78A		4-110
SA8.0	SA8.0		4-110
SA8.0A	SA8.0A		4-110
SA8.5	SA8.5		4-110
SA8.5A	SA8.5A		4-110
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SA85A	SA85A		4-110
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UZ3016		1N3016	4-21
UZ3016A		1N3016A	4-21
UZ3016B		1N3016B	4-21
UZ3051		1N3051	4-21
UZ3051A		1N3051A	4-21
UZ3051B		1N3051B	4-21
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UZ3235A		1N5235A	4-40
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Note: Reverse polarity has an R suffix.

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UZ3281		1N5281	4-40
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UZ3470		1N2970	4-15
UZ3470A		1N2970A	4-15
UZ3470B		1N2970B	4-15
UZ3515		1N3015	4-15
UZ3515A		1N3015A	4-15
UZ3515B		1N3015B	4-15
UZ4116		1N5384A	4-51
UZ4116A		1N5384A	4-51
UZ4116B		1N5384B	4-51
UZ4706		1N5342A	4-51
UZ4706A		1N5342A	4-51
UZ4706B		1N5342B	4-51
UZ4736		1N4736	4-36
UZ4736A		1N4736A	4-36
UZ4737		1N4737	4-36
UZ4737A		1N4737A	4-36
UZ4738		1N4738	4-36
UZ4738A		1N4738A	4-36
UZ4739		1N4739	4-36
UZ4739A		1N4739A	4-36
UZ4740		1N4740	4-36
UZ4740A		1N4740A	4-36
UZ4741		1N4741	4-36
UZ4741A		1N4741A	4-36
UZ4742		1N4742	4-36
UZ4742A		1N4742A	4-36
UZ4743		1N4743	4-36
UZ4743A		1N4743A	4-36
UZ4744		1N4744	4-36
UZ4744A		1N4744A	4-36
UZ4745		1N4745	4-36
UZ4745A		1N4745A	4-36
UZ4746		1N4746	4-36
UZ4746A		1N4746A	4-36
UZ4747		1N4747	4-36
UZ4747A		1N4747A	4-36
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UZ4748A		1N4748A	4-36
UZ4749		1N4749	4-36
UZ4749A		1N4749A	4-36
UZ4750		1N4750	4-36
UZ4750A		1N4750A	4-36
UZ4751		1N4751	4-36
UZ4751A		1N4751A	4-36
UZ4752		1N4752	4-36
UZ4752A		1N4752A	4-36
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UZ4754A		1N4754A	4-36
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UZ4755A		1N4755A	4-36
UZ4756		1N4756	4-36
UZ4756A		1N4756A	4-36
UZ4757		1N4757	4-36
UZ4757A		1N4757A	4-36
UZ4758		1N4758	4-36
UZ4758A		1N4758A	4-36
UZ4759		1N4759	4-36
UZ4759A		1N4759A	4-36
UZ4760		1N4760	4-36
UZ4760A		1N4760A	4-36
UZ4761		1N4761	4-36
UZ4761A		1N4761A	4-36
UZ4762		1N4762	4-36
UZ4762A		1N4762A	4-36
UZ4763		1N4763	4-36
UZ4763A		1N4763A	4-36
UZ4764		1N4764	4-36
UZ4764A		1N4764A	4-36

Note: Reverse polarity has an R suffix.

1

RECTIFIERS

Motorola is the world's leading supplier of rectifiers, including those for use in switching power supplies. Wafer fabrication technology has constantly improved, leading to the product offering outlined in this selector guide. Today's Motorola rectifiers embody the same precision technology as the most advanced ICs, and are capable of passing stringent environmental testing, including under the hood of an automobile.

In addition to improved quality, rectifier product trends are toward higher operating temperature, faster switching times, plastic packages (translate lower cost) and use of dual rectifier modules.

ZENER DIODES

Motorola's standard Zeners and Avalanche Regulator diodes comprise the largest inventoried line in the industry. Continuous development of improved manufacturing techniques have resulted in computerized diffusion and test, as well as critical process controls learned from surface-sensitive MOS fabrication. Resultant high yields lower factory costs. Check the following features for application to your specific requirements:

- Wide selection of package materials and styles:
  - Plastic (Surmetic) for low cost, mechanical ruggedness
  - Glass for highest reliability, lowest cost
  - Metal for highest power
- Power ratings from 0.25 to 50 Watts
- Breakdown voltages from 1.8 to 200 V in approximately 10% steps
- Available tolerances from 10% (low cost) to as tight as 1% (critical applications) with off-the-shelf delivery
- Special selection of electrical characteristics available at low cost due to high-volume lines (check your Motorola sales representative for special quotations)
- JAN/JANTX(V) availability
- Special glass now used in DO-35 type packages is compatible with low temperature alloy processes, yielding sharper breakdown and low leakage.

Contents

Selector Guides

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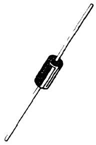
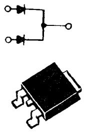
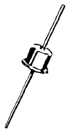
Schottky Rectifiers

SWITCHMODE Schottky Power Rectifiers with the high speed and low forward voltage drop characteristic of Schottky's metal/silicon junctions are produced with ruggedness and temperature performance comparable to silicon-junction rectifiers. Ideal for use in low voltage, high frequency power supplies and as very fast clamping diodes, these devices feature switching times less than 10 ns, and are offered in current ranges from 0.5 to 300 amperes, and reverse voltages to 60 volts.

In some current ranges, devices are available with junction temperature specifications of 125°C, 150°C, 175°C. Devices with higher T_J ratings can have significantly lower leakage currents, but higher forward-voltage specifications. These parameter tradeoffs should be considered when selecting devices for applications that can be satisfied by more than one device type number.

All devices are connected cathode to case or cathode to heatsink, where applicable. Reverse polarity may be available on some devices upon special request. Contact your Motorola representative for more information.

	I_O, AVERAGE RECTIFIED FORWARD CURRENT (Amperes)						
	0.5	**1.0**		**3.0**			**5.0**
V_{RRM} (Volts)	299-02 (DO-204AH) Glass 	59-04 Plastic 	362B-01 MLL41 Glass Leadless 	267-03 Plastic 		369A-04 Plastic 	60-01 Metal 
15		MBR115P					
20		1N5817	MBRL120	1N5820	MBR320	MBRD320	1N5823
25							
30	MBR030	1N5818	MBRL130	1N5821	MBR330	MBRD330	1N5824
35							
40	MBR040	1N5819	MBRL140	1N5822	MBR340	MBRD340	1N5825
45							
50		MBR150††			MBR350	MBRD350	
60		MBR160††			MBR360	MBRD360	
70							
80							
90							
100							
I_{FSM} (Amps)	5.0	25	20	80	80	75	500
†T_C @ Rated I_O (°C)						125	
†T_L @ Rated I_O (°C)	75	90	75	95			80
T_J (Max) (°C)	150	125	150	125	150	150	125
Max V_F @ $I_{FM} = I_O$	0.65 $T_L = 25°C$	*0.60 $T_L = 25°C$	*0.69 $T_L = 25°C$	*0.525 $T_L = 25°C$	***0.740 $T_L = 25°C$	0.45 $T_C = 125°C$	*0.38 $T_C = 25°C$

☐ TX versions available

* Values are for the 40-Volt units The lower voltage parts provide lower limits and higher voltage units provide slightly higher limits

** I_O is total device output

*** Values are for 60 volt units The lower voltages parts ≤40 volts provide lower limits

† Must be derated for reverse power dissipation See Data Sheet

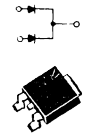
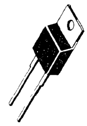
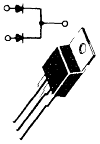
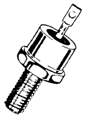
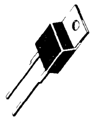
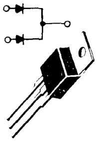
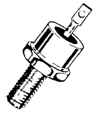
†† T_J (Max) = 150°C

There are many other standard features in Motorola Schottky rectifiers that give added performance and reliability.

1. GUARDRINGS are included in all Schottky die for reverse voltage stress protection from high rates of dv/dt to virtually eliminate the need for snubber networks. The guardring also operates like a zener and avalanches when subjected to voltage transients.

2 MOLYBDENUM DISCS on both sides of the die minimize fatigue from power cycling in all metal product. The plastic TO-220 devices have a special solder formulation for the same purpose

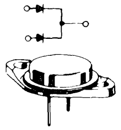
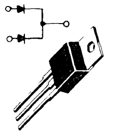
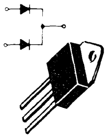
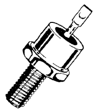
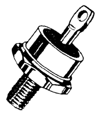
3 QUALITY CONTROL monitors all critical fabrication operations and performs selected stress tests to assure constant processes

$^{**}I_O$, AVERAGE RECTIFIED FORWARD CURRENT (Amperes)								
6.0	**7.5**	**10**	**15**		**16**	**20**	**25**	
369A-04 Plastic 	221B-01 (TO-220AC) Plastic 		221A-04 (TO-220AB) Plastic 	56-03 (DO-203AA) (DO-4) Metal 	221B-01 (TO-220AC) Plastic 	221A-04 (TO-220AB) Plastic 	56-03 (DO-203AA) (DO-4) Metal 	
MBRD620CT				1N5826			1N5829	
MBRD630CT				1N5827			1N5830	1N6095
	MBR735	MBR1035	MBR1535CT		MBR1635	MBR2035CT		
MBRD640CT				1N5828			1N5831	1N6096
	MBR745	MBR1045	MBR1545CT		MBR1645	MBR2045CT		
MBRD650CT								
MBRD660CT		MBR1060				MBR2060CT		
		MBR1070				MBR2070CT		
		MBR1080				MBR2080CT		
		MBR1090				MBR2090CT		
		MBR10100				MBR20100CT		
	150	150	150	500	150	150	800	400
	105	135	105	85	125	135	85	70
	150	150	150	125	150	150	125	125
	0.57 T_C = 125°C	0.57 T_C = 125°C	0.72 @ 15 A T_C = 125°C	*0.50 T_C = 25°C	0.57 T_C = 125°C	0.72 @ 20 A T_C = 125°C	*0.48 T_C = 25°C	0.86 @ 78.5 A T_C = 70°C

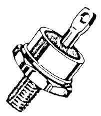
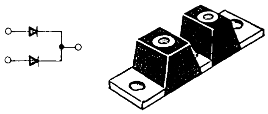
* Values are for the 40-Volt units The lower voltage parts provide lower limits

** I_O is total device output

SCHOTTKY RECTIFIERS (continued)

	**I_O, AVERAGE RECTIFIED FORWARD CURRENT (Amperes)					
	30			35	40	50
V_{RRM} (Volts)	11-03 (TO-204AA) Metal  (40 Mil Pins)	221A-04 (TO-220AB) Plastic 	340-02 (TO-218AC) Plastic 	56-03 (DO-203AA) Metal 	257-01 (DO-203AB) Metal 	
15						
20	MBR3020CT			MBR3520	1N5832	
25						
30					1N5833	1N6097
35	MBR3035CT	MBR2535CT	MBR3035PT	MBR3535		
40					1N5834	1N6098
45	SD241 MBR3045CT	MBR2545CT	MBR3045PT	SD41 MBR3545,H,H1***		
50						
60						
I_{FSM} (Amps)	400	300	400	600	800	800
†T_C @ Rated I_O (°C)	105	125	105	90	75	70
†T_L @ Rated I_O (°C)						
T_J (Max) (°C)	150	150	150	150	125	125
Max V_F @ I_{FM} = I_O	0.72 @ 30 A T_C = 125°C	0.73 @ 30 A T_C = 125°C	0.72 @ 30 A T_C = 125°C	0.55 T_C = 25°C	*0.59 T_C = 25°C	0.86 @ 157 A T_C = 70°C

* Values are for the 40-Volt units The lower voltage parts provide lower limits
** I_O is total device output
*** H & H1 versions are Hi-Rel Processed Parts (Non JAN, JTX)
† Must be derated for reverse power dissipation See Data Sheet

$^{**}I_O$, AVERAGE RECTIFIED FORWARD CURRENT (Amperes)								
60		**65**	**75**	**80**	**120**	**200**		**300**
257-01 DO-203AB Metal 					357C-01 Plastic POWER TAP 			
	MBR6015L						MBR20015CTL	
	MBR6020L						MBR20020CTL	
	MBR6025L						MBR20025CTL	
	MBR6030L						MBR20030CTL	
MBR6035		MBR6535	MBR7535	MBR8035	MBR12035CT	MBR20035CT		MBR30035CT
			MBR7540					
SD51 MBR6045,H,H1***		MBR6545	MBR7545	MBR8045	MBR12045CT	MBR20045CT		MBR30045CT
					MBR12050CT	MBR20050CT		MBR30050CT
					MBR12060CT	MBR20060CT		MBR30060CT

800	1000	800	1000	1000	1500	1500	1500	2500
90	120	120	90	120	140	140	140	140
150	150	175	150	175	175	175	175	175
*0.6 T_C = 125°C	0.38 @ T_C = 150°C	0.62 T_C = 150°C	0.60 T_C = 125°C	0.59 T_C = 150°C	0.68 T_C = 125°C	0.71 T_C = 125°C	0.48 @ T_C = 150°C	0.64 T_C = 125°C

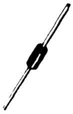
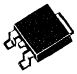
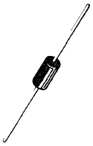
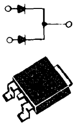
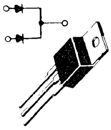
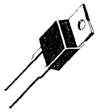
** I_O is total device output

*** H & H1 versions are Hi-Rel Processed Parts (Non JAN, JTX)

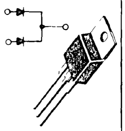
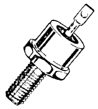
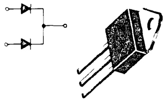
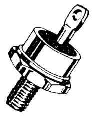
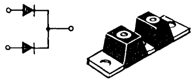
Ultrafast Recovery Rectifiers

EXPANDING the SWITCHMODE Rectifier family are these ultrafast devices with reverse recovery times of 25 to 100 nanoseconds They complement the broad Schottky offering for use in the higher voltage outputs and internal circuitry of switching power supplies as operating frequencies increase from 20 kHz to 250 kHz Additional package styles and operating current levels are planned

All devices are connected cathode to case or cathode to heatsink, where applicable. Reverse polarity may be available on some devices upon special request. Contact your Motorola representative for more information

	**I_O, AVERAGE RECTIFIED FORWARD CURRENT (Amperes)						
	1.0	**3.0**	**4.0**	**6.0**		**8.0**	**15**
V_{RRM} (Volts)	59-04 (DO-41) Plastic 	369A-04 Plastic 	267-03 Plastic 	369A-04 Plastic 	221A-04 (TO-220AB) Plastic 	221B-01 (TO-220AC) Plastic 	
50	MUR105	MURD305	MUR405	MURD605CT	MUR605CT	MUR805	MUR1505
100	MUR110	MURD310	MUR410	MURD610CT	MUR610CT	MUR810	MUR1510
150	MUR115	MURD315	MUR415	MURD615CT	MUR615CT	MUR815	MUR1515
200	MUR120	MURD320	MUR420	MURD620CT	MUR620CT	MUR820	MUR1520
300	MUR130		MUR430			MUR830	MUR1530
400	MUR140		MUR440			MUR840	MUR1540
500	MUR150		MUR450			MUR850	MUR1550
600	MUR160		MUR460			MUR860	MUR1560
700	MUR170		MUR470			MUR870	
800	MUR180		MUR480			MUR880	
900	MUR190		MUR490			MUR890	
1000	MUR1100		MUR4100			MUR8100	
I_{FSM} (Amps)	35	75	125	63	75	100	200
T_A @ Rated I_O (°C)	50		80				
T_C @ Rated I_O (°C)		158		145	130	150	150
T_J (Max) (°C)	175	175	175	175	175	175	175
t_{rr} ns	25/50/75	35	25/50/75	35	35	35/60/100	35/60

** I_O is total device output

$^{**}I_O$, AVERAGE RECTIFIED FORWARD CURRENT (Amperes)							
16	**25**	**30**		**50**	**70**	**100**	**200**
221A-04 (TO-220AB) Plastic 	56-03 (DO-203AA) 	340-02 (TO-218AC) Plastic 		257-01 (DO-203AB) Metal 		357C-01 Plastic POWER TAP 	
MUR1605CT	MUR2505	R710XPT	MUR3005PT	MUR5005	MUR7005	MUR10005CT	MUR20005CT
MUR1610CT	MUR2510	R711XPT	MUR3010PT	MUR5010	MUR7010	MUR10010CT	MUR20010CT
MUR1615CT	MUR2515		MUR3015PT	MUR5015	MUR7015	MUR10015CT	MUR20015CT
MUR1620CT	MUR2520	R712XPT	MUR3020PT	MUR5020	MUR7020	MUR10020CT	MUR20020CT
MUR1630CT			MUR3030PT				MUR20030CT
MUR1640CT		R714XPT	MUR3040PT				MUR20040CT
MUR1650CT			MUR3050PT				
MUR1660CT			MUR3060PT				
100	500	150	400	600	1000	400	800
150	145	100	150	125	125	140	95
175	175	150	175	175	175	175	175
35	50	100	35	50	50	50	50

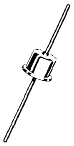
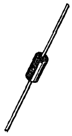
** I_O is total device output

2

Fast Recovery Rectifiers

. available for designs requiring a power rectifier having maximum switching times ranging from 200 ns to 750 ns These devices are offered in current ranges of 1.0 to 50 amperes and in voltages to 1000 volts

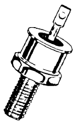
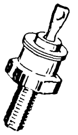
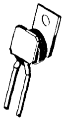
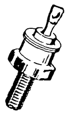
All devices are connected cathode to case or cathode to heatsink, where applicable. Reverse polarity may be available on some devices upon special request. Contact your Motorola representative for more information

	I_O, AVERAGE RECTIFIED FORWARD CURRENT (Amperes)				
	1.0			3.0	5.0
	59-04 Plastic		60-01 Metal	267-02 Plastic	194-04 Plastic
V_{RRM} (Volts)					
50	†1N4933	MR810	MR830	MR850	MR820
100	†1N4934	MR811	MR831	MR851	MR821
200	†1N4935	MR812	MR832	MR852	MR822
400	†1N4936	MR814	MR834	MR854	MR824
600	†1N4937	MR816	MR836	MR856	MR826
800		MR817			
1000		MR818			
I_{FSM} (Amps)	30	30	100	100	300
T_A @ Rated I_O (°C)	75	75		*90	*55
T_C @ Rated I_O (°C)		100	100		
T_J (Max) (°C)	150	150	150	175	175
t_{rr} (μs)	0.2	0.75	0.2	0.2	0.2

* Must be derated for reverse power dissipation See Data Sheet

† Package Size 0 120" Max Diameter by 0 260" Max Length

2

	I_O, AVERAGE RECTIFIED FORWARD CURRENT (Amperes)				
	6.0	**12**	**20**	**24**	**30**
V_{RRM} (Volts)	245A-02 (DO-203AA) Metal 		42A-01 (DO-203AB) Metal 	339-02 Plastic Note 1 	42A-01 (DO-203AB) Metal 
50	1N3879	1N3889	1N3899	MR2400F	1N3909
100	1N3880	1N3890	1N3900	MR2401F	1N3910
200	1N3881	1N3891	1N3901	MR2402F	1N3911
400	1N3883	1N3893	1N3903	MR2404F	1N3913
600	MR1366	MR1376	MR1386	MR2406F	MR1396
800					
1000					
I_{FSM} (Amps)	150	200	250	300	300
T_A @ Rated I_O (°C)					
T_C @ Rated I_O (°C)	100	100	100	125	100
T_J (max) (°C)	150	150	150	175	150
t_{rr} μs	0.2	0.2	0.2	0.2	0.2

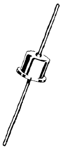
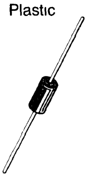
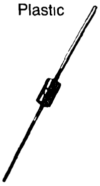
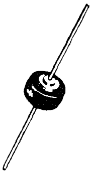
☐ TX versions available

Note 1. Meets mounting configuration of TO-220 outline

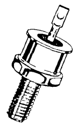
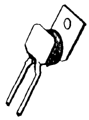
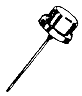
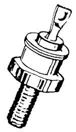
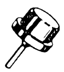
General-Purpose Rectifiers

Motorola offers a wide variety of low-cost devices, packaged to meet diverse mounting requirements Avalanche capability is available in the axial lead 1 5, 3 and 6 amp packages shown below to provide protection from transients.

All devices are connected cathode to case or cathode to heatsink, where applicable Reverse polarity may be available on some devices upon special request Contact your Motorola representative for more information

	I_O, AVERAGE RECTIFIED FORWARD CURRENT (Amperes)					
	1.0	1.5	3.0			6.0
V_{RRM} (Volts)	59-03 (DO-41) Plastic 	59-04 Plastic 	60-01 Metal 	267-03 Plastic 	267-02 Plastic 	194-04 Plastic 
50	†1N4001	**1N5391	1N4719	**MR500	1N5400	MR750
100	†1N4002	**1N5392	1N4720	**MR501	1N5401	MR751
200	†1N4003	1N5393 *MR5059	1N4721	**MR502	1N5402	MR752
400	†1N4004	1N5395 *MR5060	1N4722	**MR504	1N5404	MR754
600	†1N4005	1N5397 *MR5061	1N4723	**MR506	1N5406	MR756
800	†1N4006	1N5398	1N4724	MR508		MR758
1000	†1N4007	1N5399	1N4725	MR510		MR760
I_{FSM} (Amps)	30	50	300	100	200	400
T_A @ Rated I_O (°C)	75	T_L = 70	75	95	T_L = 105	60
T_C @ Rated I_O (°C)						
T_J (Max) (°C)	175	175	175	175	175	175

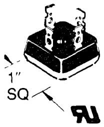
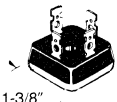
† Package Size 0 120″ Max Diameter by 0 260″ Max Length
* 1N5059 series equivalent Avalanche Rectifiers
** Avalanche versions available, consult factory

	I_O, AVERAGE RECTIFIED FORWARD CURRENT (Amperes)							
	12	20	24	25	30		40	50
	245A-02 (DO-203AA) Metal		339-02 Plastic Note 1	193-04 Plastic Note 2	43-02 (DO-21) Metal		42A-01 (DO-203AB) Metal	43-04 Metal
V_{RRM} (Volts)								
50	MR1120 1N1199,A,B	MR2000	MR2400	MR2500	1N3491	1N3659	1N1183A	MR5005
100	MR1121 1N1200,A,B	MR2001	MR2401	MR2501	1N3492	1N3660	1N1184A	MR5010
200	MR1122 1N1202,A,B	MR2002	MR2402	MR2502	1N3493	1N3661	1N1186A	MR5020
400	MR1124 1N1204,A,B	MR2004	MR2404	MR2504	1N3495	1N3663	1N1188A	MR5040
600	MR1126 1N1206,A,B	MR2006	MR2406	MR2506		Note 3	1N1190A	Note 3
800	MR1128	MR2008		MR2508		Note 3	Note 3	Note 3
1000	MR1130	MR2010		MR2510		Note 3	Note 3	Note 3
I_{FSM} (Amps)	300	400	400	400	300	400	800	600
T_A @ Rated I_O (°C)								
T_C @ Rated I_O (°C)	150	150	125	150	130	100	150	150
T_J (Max) (°C)	190	175	175	175	175	175	190	195

Note 1. Meets mounting configuration of TO-220 outline
Note 2. Request Data Sheet for Mounting Information
Note 3. Available on special order

Rectifier Bridges

Motorola SUPERBRIDGES offer cost effectiveness and reliability in single phase applications Assemblies combine pretested "button" rectifier cells for low assembly cost and high yields. Performance of four individual diodes is achieved with reliability of the whole assembly comparable to that of a single unit. Assemblies feature versatile slip-on/solder/wire wrap terminals.

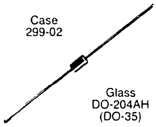
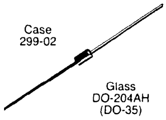
	I_O, DC OUTPUT CURRENT (Amperes)		
	25	**35**	**40**
	309A-03	309A-02	
V_{RRM} (Volts)			
50	MDA2500	MDA3500	
100	MDA2501	MDA3501	
200	MDA2502	MDA3502	MDA4002
400	MDA2504	MDA3504	MDA4004
600	MDA2506	MDA3506	MDA4006
800	MDA2508	MDA3508	MDA4008
1000	MDA2510	MDA3510	
I_{FSM} (Amps)	400	400	800
T_A @ Rated I_O (°C)			
T_C @ Rated I_O (°C)	55	55	35
T_J (Max) (°C)	175	175	175

UL RECOGNIZED E61980

Dimensions given are nominal

Zener and Avalanche Regulator Diodes

General-Purpose Regulator Diodes

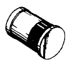
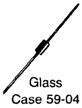
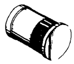
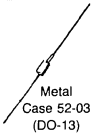
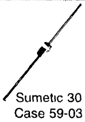
Nominal Zener Voltage	250 mW Low Level Cathode = Polarity Mark	250 mW Low Noise Cathode = Polarity Mark	250 mW Low Level Cathode = Polarity Mark	250 mW Low Noise Cathode = Polarity Mark	350 mW Cathode = Polarity Mark	400 mW Low Noise Low Leakage Cathode = Polarity Mark	500 mW Cathode = Polarity Mark		
(*Note 1)	(*Notes 2,11)		(*Note 2)	(*Note 2)	(*Notes 5 13)	(*Note 3)	(*Note 4)	(*Note 8)	(*Note 9)
	 Glass Case 362-01		 Case 299-02	Glass DO-204AH (DO-35)	 Case 318-05 Style 8 SOT-23 (TO-236AA/ AB)	 Case 299-02	Glass DO-204AH (DO-35)		
1.8	MLL4678	MLL4614	1N4678	1N4614					
2.0	MLL4679	MLL4615	1N4679	1N4615					
2 2	MLL4680	MLL4616	1N4680	1N4616					
2.4	MLL4681	MLL4617	1N4681	1N4617			1N4370	1N5221A	1N5985A
2 5									
2.7	MLL4682	MLL4618	1N4682	1N4618			1N4371	1N5223A	
2.8									1N5986A
3 0	MLL4683	MLL4619	1N4683	1N4619			1N4372	1N5225A	1N5987A
3 3	MLL4684	MLL4620	1N4684	1N4620	MMBZ5226B	1N5518A	1N746	1N5226A	1N5988A
3.6	MLL4685	MLL4621	1N4685	1N4621	MMBZ5227B	1N5519A	1N747	1N5227A	1N5989A
3.9	MLL4686	MLL4622	1N4686	1N4622	MMBZ5228B	1N5520A	1N748	1N5228A	1N5990A
4.3	MLL4687	MLL4623	1N4687	1N4623	MMBZ5229B	1N5221A	1N749	1N5229A	1N5991A
4.7	MLL4688	MLL4624	1N4688	1N4624	MMBZ5230B	1N5522A	1N750	1N5230A	1N5992A
5.1	MLL4689	MLL4625	1N4689	1N4625	MMBZ5231B	1N5523A	1N751	1N5231A	1N5993A
5.6	MLL4690	MLL4626	1N4690	1N4626	MMBZ5232B	1N5524A	1N752	1N5232A	1N5994A
6.0					MMBZ5233B				
6.2	MLL4691	MLL4627	1N4691	1N4627	MMBZ5234B	1N5525A	1N753	1N5234A	1N5995A
6.8	MLL4692	MLL4099	1N4692	1N4099	MMBZ5235B	1N5526A	1N754 1N957A	1N5235A	1N5996A
7.5	MLL4693	MLL4100	1N4693	1N4100	MMBZ5236B	1N5527A	1N755 1N958A	1N5236A	1N5997A
8.2	MLL4694	MLL4101	1N4694	1N4101	MMBZ5237B	1N5228A	1N756 1N959A	1N5237A	1N5998A
8.7	MLL4695	MLL4102	1N4695	1N4102	MMBZ5238B			1N5238A	
9.1	MLL4696	MLL4103	1N4696	1N4103	MMBZ5239B	1N5529A	1N757 1N960A	1N5239A	1N5999A
10	MLL4697	MLL4104	1N4697	1N4104	MMBZ5240B	1N5530A	1N758 1N961A	1N5240A	1N6000A
11	MLL4698	MLL4105	1N4698	1N4105	MMBZ5241B	1N5531A	1N962A	1N5241A	1N6001A
12	MLL4699	MLL4106	1N4699	1N4106	MMBZ5242B	1N5532A	1N759 1N963A	1N5242A	1N6002A
13	MLL4700	MLL4107	1N4700	1N4107	MMBZ5243B	1N5533A	1N964A	1N5243A	1N6003A
14	MLL4701	MLL4108	1N4701	1N4108	MMBZ5244B	1N5334A		1N5244A	
15	MLL4702	MLL4109	1N4702	1N4109	MMBZ5245B	1N5335A	1N965A	1N5245A	1N6004A
16	MLL4703	MLL4110	1N4703	1N4110	MMBZ5246B	1N5336A	1N966A	1N5246A	1N6005A
17	MLL4704	MLL4111	1N4704	1N4111	MMBZ5247B	1N5337A		1N5247A	
18	MLL4705	MLL4112	1N4705	1N4112	MMBZ5248B	1N5338A	1N967A	1N5248A	1N6006A
19	MLL4706	MLL4113	1N4706	1N4113	MMBZ5249B	1N5539A		1N5249A	
20	MLL4707	MLL4114	1N4707	1N4114	MMBZ5250B	1N5540A	1N968A	1N5250A	1N6007A
22	MLL4708	MLL4115	1N4708	1N4115	MMBZ5251B	1N5541A	1N969A	1N5251A	1N6008A
24	MLL4709	MLL4116	1N4709	1N4116	MMBZ5252B	1N5542A	1N970A	1N5252A	1N6009A
25	MLL4710	MLL4117	1N4710	1N4117	MMBZ5253B	1N5543A		1N5253A	
27	MLL4711	MLL4118	1N4711	1N4118	MMBZ5254B		1N971A	1N5254A	1N6010A
28	MLL4712	MLL4119	1N4712	1N4119	MMBZ5255B	1N5544A		1N5255A	
30	MLL4713	MLL4120	1N4713	1N4120	MMBZ5256B	1N5545A	1N972A	1N5256A	1N6011A
33	MLL4714	MLL4121	1N4714	1N4121	MMBZ5257B	1N5546A	1N973A	1N5257A	1N6012A
36	MLL4715	MLL4122	1N4715	1N4122			1N974A	1N5258A	1N6013A
39	MLL4716	MLL4123	1N4716	1N4123			1N975A	1N5259A	1N6014A
43	MLL4717	MLL4124	1N4717	1N4124			1N976A	1N5260A	1N6015A
47		MLL4125		1N4125			1N977A	1N5261A	1N6016A
51		MLL4126		1N4126			1N978A	1N5262A	1N6017A
56		MLL4127		1N4127			1N979A	1N5263A	1N6018A
60		MLL4128		1N4128				1N5264A	
62		MLL4129		1N4129			1N980A	1N5265A	1N6019A
68		MLL4130		1N4130			1N981A	1N5266A	1N6020A
75		MLL4131		1N4131			1N982A	1N5267A	1N6021A
82		MLL4132		1N4132			1N983A	1N5268A	1N6022A
87		MLL4133		1N4133				1N5269A	
91		MLL4134		1N4134			1N984A	1N5270A	1N6023A
100		MLL4135		1N4135			1N985A	1N5271A	1N6024A
110							1N986A	1N5272A	1N6025A
120							1N987A	†1N5273A	
130							1N988A	†1N5274A	
140								†1N5275A	
150							1N989A	†1N5276A	
160							1N990A	†1N5277A	
170								†1N5278A	
180							1N991A	†1N5279A	
200							1N992A	†1N5281A	

☐ JAN JANTX(V) available, ±5% only

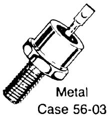
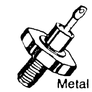
† 1N5273A–1N5281A supplied in DO-7 glass package

*See Notes — page 2-15

General-Purpose Regulator Diodes (continued)

Nominal Zener Voltage	500 mW Cathode = Polarity Mark		1 Watt Cathode = Polarity Mark		1 Watt Cathode to Case	1.5 Watt Cathode = Polarity Mark	5 Watt Cathode = Polarity Mark
(*Note 1)	(*Notes 4,11)	(*Notes 9,11)	(*Note 6)	(*Notes 6,12)	(*Note 7)	(*Note 8)	(*Note 8)
	 Glass Case 362-01		 Glass Case 59-04 (DO-41)	 Glass Case 362B-01	 Metal Case 52-03 (DO-13)	 Sumetic 30 Case 59-03 (DO-41)	 Sumetic 40 Case 17-02
1.8							
2.0							
2.2							
2.4	MLL4370	MLL5221A					
2.5		MLL5222A					
2.7	MLL4371	MLL5223A					
2.8		MLL5224A					
3.0	MLL4372	MLL4225A					
3.3	MLL746	MLL5226A	1N4728	MLL4728	1N3821	1N5913A	1N5333A
3.6	MLL747	MLL5227A	1N4729	MLL4729	1N3822	1N5914A	1N5334A
3.9	MLL748	MLL5228A	1N4730	MLL4730	1N3823	1N5915A	1N5335A
4.3	MLL749	MLL5229A	1N4731	MLL4731	1N3824	1N5916A	1N5336A
4.7	MLL750	MLL5230A	1N4732	MLL4732	1N3825	1N5917A	1N5337A
5.1	MLL751	MLL5231A	1N4733	MLL4733	1N3826	1N5918A	1N5338A
5.6	MLL752	MLL5232A	1N4734	MLL4734	1N3827	1N5919A	1N5339A
6.0		MLL5233A					
6.2	MLL753	MLL5234A	1N4735	MLL4735	1N3828	1N5920A	1N5341A
6.8	MLL754 MLL957A	MLL5235A	1N4736	MLL4736	1N3829 1N3016A	1N5921A	1N5342A
7.5	MLL755 MLL958A	MLL5236A	1N4737	MLL4737	1N3830 1N3017A	1N5922A	1N5343A
8.2	MLL756 MLL959A	MLL5237A	1N4738	MLL4738	1N3018A	1N5923A	1N5344A
8.7		MLL5238A					1N5345A
9.1	MLL757 MLL960A	MLL5239A	1N4739	MLL4739	1N3019A	1N5924A	1N5346A
10	MLL758 MLL961A	MLL5240A	1N4740	MLL4740	1N3020A	1N5925A	1N5347A
11	MLL962A	MLL5241A	1N4741	MLL4741	1N3021A	1N5926A	1N5348A
12	MLL759 MLL963A	MLL5242A	1N4742	MLL4742	1N3022A	1N5927A	1N5349A
13	MLL964A	MLL5243A	1N4743	MLL4743	1N3023A	1N5928A	1N5350A
14		MLL5244A					1N5351A
15	MLL965A	MLL5245A	1N4744	MLL4744	1N3024A	1N5929A	1N5352A
16	MLL966A	MLL5246A	1N4745	MLL4745	1N3025A	1N5930A	1N5353A
17		MLL5247A					1N5354A
18	MLL967A	MLL5248A	1N4746	MLL4746	1N3026A	1N5931A	1N5355A
19		MLL5249A					1N5356A
20	MLL968A	MLL5250A	1N4747	MLL4747	1N3027A	1N5932A	1N5357A
22	MLL969A	MLL5251A	1N4748	MLL4748	1N3028A	1N5933A	1N5358A
24	MLL970A	MLL5252A	1N4749	MLL4749	1N3029A	1N5934A	1N5359A
25		MLL5253A					1N5360A
27	MLL971A	MLL5254A	1N4750	MLL4750	1N3030A	1N5935A	1N5361A
28		MLL5255A					1N5362A
30	MLL972A	MLL5256A	1N4751	MLL4751	1N3031A	1N5936A	1N5363A
33	MLL973A	MLL5257A	1N4752	MLL4752	1N3032A	1N5937A	1N5364A
36	MLL974A	MLL5258A	1N4753	MLL4753	1N3033A	1N5938A	1N5365A
39	MLL975A	MLL5259A	1N4754	MLL4754	1N3034A	1N5939A	1N5366A
43	MLL976A	MLL5260A	1N4755	MLL4755	1N3035A	1N5940A	1N5367A
47	MLL977A	MLL5261A	1N4756	MLL4756	1N3036A	1N5941A	1N5368A
51	MLL978A	MLL5262A	1N4757	MLL4751	1N3037A	1N5942A	1N5369A
56	MLL979A	MLL5263A	1N4758	MLL4758	1N3038A	1N5943A	1N5370A
60		MLL5264A					1N5371A
62	MLL980A	MLL5265A	1N4759	MLL4759	1N3039A	1N5944A	1N5372A
68	MLL981A	MLL5266A	1N4760	MLL4760	1N3040A	1N5945A	1N5373A
75	MLL982A	MLL5267A	1N4761	MLL4761	1N3041A	1N5946A	1N5374A
82	MLL983A	MLL5268A	1N4762	MLL4762	1N3042A	1N5947A	1N5375A
87		MLL5269A					1N5376A
91	MLL984A	MLL5270A	1N4763	MLL4763	1N3043A	1N5958A	1N5377A
100	MLL985A		1N4764	MLL4764	1N3044A	1N5949A	1N5378A
110	MLL986A				1N3045A	1N5950A	1N5379A
120					1N3046A	1N5951A	1N5380A
130					1N3047A	1N5952A	1N5831A
150					1N3048A	1N5953A	1N5383A
160					1N3049A	1N5954A	1N5384A
170							1N5385A
175							
180					1N3050A	1N5955A	1N5386A
200					1N3051A	1N5956A	1N5388A

*See Notes — page 2-15

Nominal Zener Voltage	10 Watt Cathode to Case = 1N3993 & MZT2970 Series Anode to Case = 1N2970 Series	50 Watt Cathode to Case = MZT4549 Series Anode to Case = 1N4557A Series
(*Note 1)	(*Notes 9,10)	(*Notes 9,10)
	 Metal Case 56-03 DO-203AA	 Metal Case 58-01 (DO-5 Type)
1 8		
2.0		
2.2		
2.4		
2 5		
2.7		
2.8		
3.0		
3.3		
3.6		
3.9	1N3993&R	1N4549A&RA
4 3	1N3994&R	1N4550A&RA
4.7	1N3995&R	1N4551A&RA
5.1	1N3996&R	1N4552A&RA
5.6	1N3997&R	1N4553A&RA
6.0		
6 2	1N3998&R	1N4554A&RA
6.8	1N3999&R 1N2970A&RA	1N4555A&RA 1N3305A&RA
7.5	1N4000&R 1N2971A&RA	1N4556A&RA 1N3306A&RA
8.2	1N2972A&RA	1N3307A&RA
8.7		
9 1	1N2973A&RA	1N3308A&RA
10	1N2974A&RA	1N3309A&RA
11	1N2975A&RA	1N3310A&RA
12	1N2976A&RA	1N3311A&RA
13	1N2977A&RA	1N3312A&RA
14	1N2878A&RA	1N3313A&RA
15	1N2979A&RA	1N3314A&RA
16	1N2980A&RA	1N3315A&RA
17		1N3316A&RA
18	1N2982A&RA	1N3317A&RA
19	1N2983A&RA	1N3318A&RA
20	1N2984A&RA	1N3319A&RA
22	1N2985A&RA	1N3320A&RA
24	1N2986A&RA	1N3321A&RA
25		1N3322A&RA
27	1N2988A&RA	1N3323A&RA
28		
30	1N2989A&RA	1N3324A&RA
33	1N2990A&RA	1N3325A&RA
36	1N2991A&RA	1N3326A&RA
39	1N2992A&RA	1N3327A&RA
43	1N2993A&RA	1N3328A&RA
47	1N2996A&RA	1N33330A&RA
50		
51	1N2997A&RA	1N3332A&RA
52		1N3334A&RA
56	1N2999A&RA	
60		1N3335A&RA
62	1N3000A&RA	1N3336A&RA
68	1N3001A&RA	
75	1N3002A&RA	1N3337A&RA
82	1N3003A&RA	1N3338A&RA
87		
91	1N3004A&RA	1N3339A&RA
100	1N3005A&RA	1N3340A&RA
105		
110	1N3007A&RA	1N3342A&RA
120	1N3008A&RA	1N3343A&RA
130	1N3009A&RA	1N3344A&RA
140		1N3345A&RA
150	1N3011A&RA	1N3346A&RA
160	1N3012A&RA	1N3347A&RA
170		
175		
180	1N3014A&RA	1N3349A&RA
200	1N3015A&RA	1N3350A&RA

☐ JAN JANTX (V) available, ±5% only

NOTES

1 The Zener Voltage is measured at approximately 1/4 the rated power, with the following exceptions the 1N4678–4717 is measured with I_{ZT} = 50 μAdc, the 1N4614/1N4099 is measured with I_{ZT} = 250 μAdc, the 1N4370/1N746 and the 1N5221–5242 are measured with I_{ZT} = 20 mAdc, the 1N5985A–6012A is measured with I_{ZT} = 5 0 mA, 1N6013A–6023A is measured with I_{ZT} = 2 0 mA, 1N6024–6025 is measured with I_{ZT} = 1 0 mA

Tolerances

2 No suffix = ±5%
C suffix = 2%
D suffix = 1%

3 A Suffix = ±10% with guaranteed limits on V_Z, V_F, and I_R only
B suffix = ±5%
C suffix = ±2%
D suffix = ±1%

4 MLL4370/1N4370/1N746 series
No suffix = ±10%
A suffix = ±5%
C suffix = 2%
D suffix = 1%
MLL957/1N957 series
A suffix = ±10%
B suffix = ±5%
C suffix = 2%
D suffix = 1%

Military parts in 1N4370/746/962/4099/4614/5518 series supplied in DO-7 Military parts in 1N4370/746/962/4099/4614/5518 are also available in the cost effective DO-204AH (DO-35) package as the -1 version This version can be ordered by inserting a 1 between the part number and the JAN, JTX or JTXV suffix, i e 1N746A1JAN MIL-STD 19500/117 and 127 state the -1 version is a direct substitute for the non -1 version The -1 versions appear on MIL-STD 701 as the preferred parts for new designs

5 No suffix = ±10% with guaranteed limits on V_Z, V_F and I_R only
A suffix = ±10%
B suffix = ±5%

6 No suffix = ±10%
A suffix = ±5%
C suffix = 2%
D suffix = 1%

7 1N3821 series — No suffix = ±10%, A suffix = ±5%
1N3016 series — A suffix = ±10%, B suffix = ±5%

8 A suffix = ±10% C suffix = ±2%
B suffix = ±5% D suffix = ±1%

9 A suffix = ±10%
B suffix = ±5%
Exception
1N3993–1N4000 No suffix = ±10%
A suffix = ±5%

10 RA and RB = Reverse Polarity Types Available

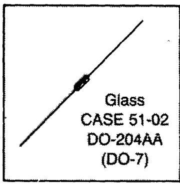
11 Available in 8 mm Tape and Reel
T1 Cathode Facing Sprocket Holes
T2 Anode Facing Sprocket Holes

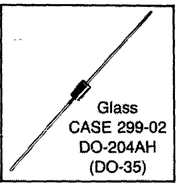
12 Available in 12 mm Tape and Reel
T1 Cathode Facing Sprocket Holes
T2 Anode Facing Sprocket Holes

13 Available in 8 mm tape and reel, both T1 and T2 options

Voltage Reference Diodes

Temperature Compensated Reference Devices





For applications where output voltage must remain within narrow limits during changes in input voltage, load resistance and temperature. Motorola guarantees all References Devices to fall within the specified maximum voltage variations, ΔV_Z, at the specifically indicated test temperatures and test current (JEDEC Standard #5). Temperature Coefficient is also specified but should be considered as a reference only — not a maximum rating.

Devices in this table are hermetically sealed structures. Includes JAN, JANTX and JTXV Devices.

2

V_Z Volts	Test Current mAdc	Test* Temp Points	AVERAGE TEMPERATURE COEFFICIENT OVER THE OPERATING RANGE 0.01 %/°C Device Type	0.01 %/°C ΔV_Z Max Volts	0.005 %/°C Device Type	0.005 %/°C ΔV_Z Max Volts	0.002 %/°C Device Type	0.002 %/°C ΔV_Z Max Volts	0.001 %/°C Device Type	0.001 %/°C ΔV_Z Max Volts	0.0005 %/°C Device Type	0.0005 %/°C ΔV_Z Max Volts	Case
6.2 ⚠1	7 5	A	1N821	0.096	1N823	0.048	1N825	0 019	1N827	0 009	1N829	0 005	299-02
6.2 ⚠1	7.5	A	1N821A	0 096	1N823A	0.048	1N825A	0 019	1N827A	0 009	1N829A	0 005	
6.4	0 5	B	1N4565	0 018	1N4566	0 024	1N4567	0 010	1N4568	0 005	1N4569	0 002	DO-204AH
	0.5	A	1N4565A	0 099	1N4566A	0 050	1N4567A	0 020	1N4568A	0 010	1N4569A	0 005	(DO-35)
	1.0	B	1N4570	0 048	1N4571	0 024	1N4572	0 010	1N4573	0 005	1N4574	0 002	
	1.0	A	1N4570A	0 099	1N4571A	0 050	1N4572A	0 020	1N4573A	0 010	1N4574A	0 005	
	2.0	B	1N4575	0 048	1N4576	0 024	1N4577	0 010	1N4578	0 005	1N4579	0 002	
	2 0	A	1N4575A	0.099	1N4576A	0.025	1N4577A	0 020	1N4578A	0 010	1N4579A	0.005	
	4 0	B	1N4580	0 048	1N4581	0 024	1N4582	0.010	1N4583	0 005	1N4584	0 002	
	4 0	A	1N4580A	0.099	1N4581A	0.050	1N4582A	0.020	1N4583A	0 010	1N4584A	0.005	

⚠1 Non-suffix — Z_{ZT} = 15, "A" Suffix — Z_{ZT} = 10

□ -1 and non-1 JAN/JANTX(V) available, ±5% only, Military parts in the 1N821, -1 and 1N4565, -1 series and supplied in the DO-7 package.

***Test Temperature Points °C: A** = −55, 0, +25, +75, +100 **B** = 0, +25, +75 **C** = −55, 0, +25, +75, +100, +150

Precision Reference Diodes (CASE 51-02, DO-204AA)

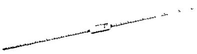
Designed, manufactured and tested for ultra-high stability of voltage with time and temperature change. Use of special measurement equipment and voltage standards provide calibration directly traceable to the National Bureau of Standards.

Reference Voltage Volts	Test Current mA	Temperature Stability ΔV_Z (mV)	Temperature Stability OP Temp Range °C	CERTIFIED VOLTAGE TIME STABILITY OVER 1000 HOURS OF OPERATION (Parts/Million Change) <5 PPM/1000 HR Device Type	<5 PPM/1000 HR Change µV Max	<10 PPM/1000 HR Device Type	<10 PPM/1000 HR Change µV Max	<20 PPM/1000 HR Device Type	<20 PPM/1000 HR Change µV Max	<40 PPM/1000 HR Device Type	<40 PPM/1000 HR Change µV Max
6.2±5%	7.5	2.5	25,75,100	MZ605	30	MZ610	60	MZ620	120	MZ640	240

Special Purpose Regulators

Field-Effect Current Regulator Diodes

High impedance diodes whose "constant current source" characteristic complements the "constant voltage" of the zener line Currents are available from 0 22 to 4 7 mA, with usable voltage range from a minimum limit of 1.0 to 2 5 V, up to a voltage compliance of 100 V, for the 1N5283 series, or 70 V, for the MCL1300 series



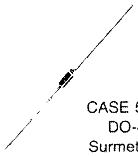
Glass
Case 51-02
DO-204AA
(DO-7)

Reg. Current Ip @VT = 25 V mA Nom	Device Type	Knee Imp ZK @ VK = 6.0 V MΩ Min	Limiting Voltage @ IL = 0.8 Ip Volts Max
0.22	1N5283	2 75	1 00
0.24	1N5284	2 35	1 00
0.27	1N5285	1 95	1 00
0.30	1N5286	1 60	1 00
0.33	1N5287	1 35	1 00
0.39	1N5288	1 00	1 05
0.43	1N5289	0 870	1 05
0.47	1N5290	0 750	1 05
0.56	1N5291	0 560	1 10
0.62	1N5292	0 470	1 13
0.68	1N5293	0 400	1 15
0.75	1N5294	0 335	1 20
0.82	1N5295	0 290	1 25
0.91	1N5296	0 240	1 29
1.00	1N5297	0 205	1 35
1.10	1N5298	0 180	1 40
1.20	1N5299	0 155	1 45
1.30	1N5300	0 135	1 50
1.40	1N5301	0 115	1 55
1.50	1N5302	0 105	1 60
1.60	1N5303	0 092	1 65
1.80	1N5304	0 074	1 75
2.00	1N5305	0 061	1 85
2.20	1N5306	0 052	1 95
2.40	1N5307	0 044	2 00
2.70	1N5308	0 035	2 15
3.00	1N5309	0 029	2 25
3.30	1N5310	0 024	3 35
3.60	1N5311	0 020	2 50
3.90	1N5312	0 017	2 60
4.30	1N5313	0 014	2 75
4.70	1N5314	0 012	2 90
0.5±.03	MCL1300	0 500	1 00
1.0±0.6	MCL1301	0 200	1 50
2.0±0.6	MCL1302	0 100	2 00
3.0±0.6	MCL1303	0 050	2 00
4.0±0.6	MCL1304	0 025	2 50

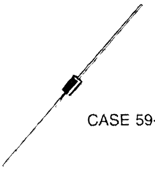
☐ JAN/JANTX (V) availability

Low-Voltage Regulators

High-conductance silicon diodes designed as stable forward-reference sources for transistor amplifier biasing and similar applications Available in high reliability glass construction or economic plastic packaging.



CASE 59-03
DO-41
Surmetic 30



CASE 59-04

ELECTRICAL CHARACTERISTICS

(T_A = 25°C unless otherwise noted)

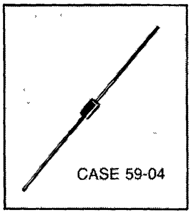
Forward Reference Voltage Min	Forward Reference Voltage Max	I_F Test Current mA	Leakage Current I_R @ V_R μA	Leakage Current Volts	Device Type	Case
0.63	0.71	10	10	5 0	MZ2360	59-04 Surmetic
1.24	1.38	10	10	5 0	MZ2361	59-03 Surmetic

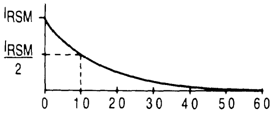
2

Transient Suppressors

General-Purpose

Transient suppressors are designed for applications requiring protection of voltage sensitive electronic devices in danger of destruction by high energy voltage transients. Select from standard factory available types or design the suppressor to meet specific needs by paralleling cells. For specific options, i.e , non-standard voltage, higher power capacity, and package configurations, consult factory.





Surge Current Characteristics

PEAK POWER DISSIPATION @ 1.0 ms = 500 WATTS — CASE 59-04

Device	V_{BR} Volts			I_{RSM} Max Reverse Surge Current Amps		V_{RSM} Max Reverse Voltage @ I_{RSM} Volts	
		Max					
	Min	Non "A"	"A"	Non "A"	"A"	Non "A"	"A"
SA5 0,A	6 4	7.3	7	52	54 3	9 6	9 2
SA6.0,A	6 67	8 15	7 37	43 9	48 5	11 4	10 3
SA6 5,A	7 22	8 82	7 98	40 7	44 7	12 3	11 2
SA7 0,A	7 78	9 51	8 6	37 8	41 7	13 3	12
SA7 5,A	8 33	10 2	9 21	35	38 8	14 3	12 9
SA8 0,A	8 89	10 9	9 3	33 3	36 7	15	13 6
SA8 5,A	9 44	11 5	10.4	31 4	34 7	15 9	14 4
SA9 0,A	10	12 2	11 1	29 5	32 5	16 9	15 4
SA10,A	11 1	13 6	12 3	26 6	29 4	18 8	17
SA11,A	12 2	14 9	13 5	24 9	27 4	20 1	18 2
SA12,A	13 3	16 3	14 7	22 7	25 1	22	19 9
SA13,A	14 4	17 6	15 9	21	23 2	23 8	21 5
SA14,A	15 6	19 1	17 2	19 4	21 5	25 8	23 2
SA15,A	16 7	20 4	18 5	18 8	20 6	26 9	24 4
SA16,A	17 8	21 8	19 7	17 6	19 2	28 8	26
SA17,A	18 9	23 1	20 9	16 4	18 1	30 5	27 6
SA18,A	20	24 4	22 1	15 5	17 2	32 2	29 2
SA20,A	22 2	27 1	24 5	13 9	15 4	35 8	32 4
SA22,A	24 4	29 8	26 9	12 7	14 1	39 4	35 5
SA24,A	26 7	32 6	29 5	11 6	12 8	43	38 9
SA26,A	28 9	35 3	31 9	10 7	11 9	26 6	42 1
SA28,A	31 1	38	34 4	9 9	11	50	45 4
SA30,A	33 3	40 7	36 8	9 3	10 3	53 5	48 4
SA33,A	36 7	44 9	40 6	8 5	9 4	59	53 3
SA36,A	40	48 9	44 2	7 8	8 6	64 3	58 1
SA40,A	44 4	54 3	49 1	7	7 8	71 4	64 5
SA43,A	47 8	58 4	52 8	6 5	7 2	76 7	69 4
SA45,A	50	61 1	55 3	6 2	6 9	80 3	72 7
SA48,A	53 3	65 1	58 9	5 8	6 5	85 5	77 4
SA51,A	56 7	69 3	62 7	5 5	6 1	91 1	82 4
SA54,A	60	73 3	66 3	5 2	5 7	96 3	87 1
SA60,A	66 7	81 5	73 7	4 7	5 2	107	96 8
SA64,A	71 1	86.9	78 6	4 4	4 9	114	103

(continued)

PEAK POWER DISSIPATION @ 1.0 ms = 500 WATTS — CASE 59-04 — continued

Device	V_{BR} Volts Min	V_{BR} Volts Max Non "A"	V_{BR} Volts Max "A"	I_{RSM} Max Reverse Surge Current Amps Non "A"	I_{RSM} "A"	V_{RSM} Max Reverse Voltage @ I_{RSM} Volts Non "A"	V_{RSM} "A"
SA70,A	77 8	95 1	86	4	4 4	125	113
SA75,A	83 3	102	92 1	3 7	4 1	134	121
SA78,A	86 7	106	95 8	3 6	4	139	126
SA85,A	94 4	115	104	3 3	3 6	151	137
SA90,A	100	122	111	3 1	3 4	160	146
SA100,A	111	136	123	2 8	3 1	179	162
SA110,A	122	149	135	2 6	2 8	196	177
SA120,A	133	163	147	2 3	2 6	214	193
SA130,A	144	176	159	2 2	2 4	231	209
SA150,A	167	204	185	1 9	2 1	268	243
SA160,A	178	218	197	1 7	1 9	287	259
SA170,A	189	231	209	1 6	1 8	304	275

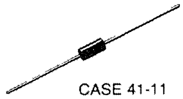
PEAK POWER DISSIPATION @ 1.0 ms = 600 WATTS

Breakdown Voltage $V_{(BR)}$ Volts Nom	@I_T mA	Device Type	I_{RSM} Maximum Reverse Surge Current Amp	V_{RSM} Maximum Reverse Voltage @ I_{RSM} Volts
6.8	10	P6KE6 8	56	10 8
7.5	10	P6KE7 5	51	11 7
8.2	10	P6KE8 2	48	12 5
9.1	1 0	P6KE9 1	44	13 8
10	1 0	P6KE10	40	15
11	1 0	P6KE11	37	16 2
12	1 0	P6KE12	35	17 3
13	1 0	P6KE13	32	19
15	1 0	P6KE15	27	22
16	1 0	P6KE16	26	23 5
18	1 0	P6KE18	23	26 5
20	1 0	P6KE20	21	29 1
22	1 0	P6KE22	19	31 9
24	1 0	P6KE24	17	34 7
27	1 0	P6KE27	15	39 1
30	1 0	P6KE30	14	43 5
33	1 0	P6KE33	12 6	47 7
36	1 0	P6KE36	11 6	52
39	1 0	P6KE39	10 6	56 4
43	1 0	P6KE43	9 6	61 9
47	1 0	P6KE47	8 9	67 8
51	1 0	P6KE51	8 2	73 5
56	1 0	P6KE56	7 4	80 5
62	1 0	P6KE62	6 8	89
68	1 0	P6KE68	6 1	98
75	1 0	P6KE75	5 5	108
82	1 0	P6KE82	5 1	118
91	1 0	P6KE91	4 8	131
100	1 0	P6KE100	4 2	144
110	1 0	P6KE110	3 8	158
120	1 0	P6KE120	3 5	173
130	1 0	P6KE130	3 2	187
150	1 0	P6KE150	2 8	215
160	1 0	P6KE160	2 6	230
170	1 0	P6KE170	2 5	244
180	1 0	P6KE180	2 3	258
200	1 0	P6KE200	2 1	287

CASE 17-02

Breakdown Voltage for Standard is ±10% Tolerance, ±5% version is available by adding "A", i e , P6KE6 8A Clipper (back to back) versions are available by ordering with a "C" or "CA" suffix, i e , P6KE6 8C or P6KE6 8CA

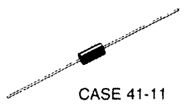
TRANSIENT SUPPRESSORS (continued)

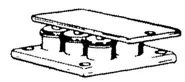

CASE 41-11

PEAK POWER DISSIPATION @ 1.0 ms = 1500 WATTS

Breakdown Voltage		Device Type		I_{RSM} Maximum Reverse Surge Current	V_{RSM} Maximum Reverse Voltage @ I_{RSM}	
$V_{(BR)}$ Volts Nom	@I_T mA			Amp	Volts	Case
6.0	1 0	1N5908		120	8 5	41-11
6.8	10	1N6267	1 5KE6 8	139	10 8	
7.5	10	1N6268	1 5KE7 5	128	11 7	
8.2	10	1N6269	1 5KE8 2	120	12 5	
9.1	1 0	1N6270	1 5KE9 1	109	13 8	
10	1 0	1N6271	1 5KE10	100	15 0	
11	1 0	1N6272	1 5KE11	93	16 2	
12	1 0	1N6273	1 5KE12	87	17 3	
13	1 0	1N6274	1 5KE13	79	19 0	
15	1 0	1N6275	1 5KE15	68	22 0	
16	1 0	1N6276	1 5KE16	64	23 5	
18	1 0	1N6277	1 5KE18	56 5	26 5	
20	1 0	1N6278	1 5KE20	51 5	29 1	
22	1 0	1N6279	1 5KE22	47 0	31 9	
24	1 0	1N6280	1 5KE24	43 0	34 7	
27	1 0	1N6281	1 5KE27	38 5	39 1	
30	1 0	1N6282	1 5KE30	34 5	43 5	
33	1 0	1N6283	1 5KE33	31 5	47 7	
36	1 0	1N6284	1 5KE36	29 0	52	
39	1 0	1N6285	1 5KE39	26 5	56 4	
43	1 0	1N6286	1 5KE43	24	61 9	
47	1 0	1N6287	1 5KE47	22 2	67 8	
51	1 0	1N6288	1 5KE51	20 4	73 5	
56	1 0	1N6289	1 5KE56	18 6	80 5	
62	1 0	1N6290	1 5KE62	16 9	89	
68	1 0	1N6291	1 5KE68	15 3	98	
75	1 0	1N6292	1 5KE75	13 9	108	
82	1 0	1N6293	1 5KE82	12 7	118	
91	1 0	1N6294	1 5KE91	11 4	131	
100	1 0	1N6295	1 5KE100	10 4	144	
110	1 0	1N6296	1 5KE110	9 5	158	
120	1 0	1N6297	1 5KE120	8 7	173	
130	1 0	1N6298	1 5KE130	8 0	187	
150	1 0	1N6299	1 5KE150	7 0	215	
160	1 0	1N6300	1 5KE160	6 5	230	
170	1 0	1N6301	1 5KE170	6 2	244	
180	1 0	1N6302	1 5KE180	5 8	258	
200	1 0	1N6303	1 5KE200	5 2	287	
220	1 0		1 5KE220	4 3	344	
250	1 0		1 5KE250	5 0	360	

Breakdown Voltage for Standard is ± 10% Tolerance, ± 5% version is available by adding "A", i e , 1N6267A, 1 5KE6 8A Clipper (back to back) versions are available by ordering the 1 5KE series with a "C" or "CA" suffix, i e , 1 5KE6 8C or 1 5KE6 8CA





PEAK POWER DISSIPATION @ 1.0 ms = 1500 WATTS

V_{RWM} Working Peak Reverse Voltage (Blocking or Stand-Off Voltage)	Device Type	Clipper (Back To Back) Version	I_{RSM} Maximum Reverse Surge Current Amp	V_{RSM} Maximum Reverse Voltage @ I_{RSM} Volts	Case
5.0	1N6373 / ICTE-5 / MPTE-5	ICTE-5C	160	9 4	41-11
8.0	1N6374 / ICTE-8 / MPTE-8	1N6382	100	15	
10	1N6375 / ICTE-10 / MPTE-10	1N6383	90	16 7	
12	1N6376 / ICTE-12 / MPTE-12	1N6384	70	21 2	
15	1N6377 / ICTE-15 / MPTE-15	1N6385	60	25	
18	1N6378 / ICTE-18 / MPTE-18	1N6386	50	30	
22	1N6379 / ICTE-22 / MPTE-22	1N6387	40	37 5	
36	1N6380 / ICTE-36 / MPTE-36	1N6388	23	65 2	
45	1N6381 / ICTE-45 / MPTE-45	1N6389	19	78 9	↓

PEAK POWER DISSIPATION @ 1.0 ms = 8000 WATTS

V_R Operating Voltage Nom Vdc	$V_{(RMS)}$	Device Type	I_R Reverse Current µA	ΔV_Z Breakdown Voltage Min Volts @	I_{ZT} mA	V_C Clamping Voltage Max Volts @	I_{PP} Amp	V_F Forward Voltage Volts @	I_F Amp	Case
14	**10**	MPZ5-16A	50	16	0 4	24	200	1 5	10	119-01
14	**10**	MPZ5-16B		16	0 4	20	200			
28	**20**	MPZ5-32A		32	0 2	50	100			
28	**20**	MPZ5-32B		32	0 2	45	100			
28	**20**	MPZ5-32C		32	0 2	40	100			
165	**117**	MPZ5-180A		180	0 03	250	20			
165	**117**	MPZ5-180B		180	0 03	225	20			
165	**117**	MPZ5-180C	↓	180	0 03	205	20	↓	↓	↓

2

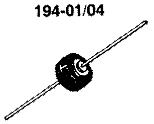
Automotive Transient Suppressors

Automotive Transient Suppressors are designed for protection against over-voltage conditions in the auto electrical system including the "LOAD DUMP" phenomenon that occurs when the battery open circuits while the car is running

AUTOMOTIVE TRANSIENT SUPPRESSOR		
	CASE 194-01 MR2535L	**CASE 194-04 MR2540L**
V_{RRM} (Volts)	20	20
I_O (Amp)	35	50
$V_{(BR)}$ (Volts)	24–32	24–32
I_{RSM}* (Amp)	110	150
T_C @ Rated I_O (°C)	150	150
T (°C)	175	175

* Time Constant = 10 ms, Duty Cycle ≤ 1 0%, T_C = 25°C

194-01/04



Lead Tape Packaging Standards for Axial-Lead Components

1.0 SCOPE — This document covers packaging requirements for the following axial-lead components' use in automatic testing and assembly equipment Motorola Case 51 (DO-7), Case 52 (DO-13), Case 59 (DO-41), Case 267, Case 299 (DO-35), Case 59-04 and Case 17 Packaging, as covered in this document, shall consist of axial-lead components mounted by their leads on pressure-sensitive tape, wound onto a reel

2.0 PURPOSE — This document establishes Motorola standard practices for lead-tape packaging of axial-lead components and meets the requirements of EIA Standard RS-296-D "Lead-taping of components on axial lead configuration for automatic insertion," level 1

3.0 REQUIREMENTS

3.1 Component Leads

3.1.1 — Component leads shall not be bent beyond dimension E from their nominal position See Figure 2

3.1.2 — The "C" dimension shall be governed by the overall length of the reel packaged component The distance between flanges shall be 0 059 inch to 0 315 inch greater than the overall component length See Figures 2 and 3

3.1.3 — Cumulative dimension "A" tolerance shall not exceed 0 059 over 5 in consecutive components

ORIENTATION — All polarized components must be oriented in one direction. The cathode lead tape shall be blue, and the anode tape shall be white See Figure 1

3.3 Reeling

3.3.1 — Components on any reel shall not represent more than two date codes when date code identification is required

3.3.2 — Components leads shall be positioned perpendicularly between pairs of 0 250 inch tape See Figure 2

3.3.3 — A minimum 1 inch leader of tape shall be provided before the first and last component on the reel

3.3.4 — 50 lb Kraft paper is wound between layers of components as far as necessary for component protection Width of paper is 0 062 inch to 0 750 inch less than "C" dimension of reel See Figure 3

3.3.5 — Components shall be centered between tapes such that the difference between D1 and D2 does not exceed 0 055

3.3.6 — Staple shall not be used for splicing No more than 4 layers of tape shall be used in any splice area and no tape shall be offset from another by more than 0 031 inch noncumulative Tape splices shall overlap at least 6 inches for butt joints and at least 3 inches for lap joints, and shall not be weaker than unspliced tape

3.3.7 — Quantity per reel shall be as indicated in Table 1 Orders for tape and reeled product will only be processed and shipped in full reel increments Scheduled orders must be in releases of full reel increments or multiples thereof High volume orders and releases may be reeled on 14 00 inch reels at Motorola's option, therefore making the quantity per reel twice that shown for the 10 50 inch reels

3.3.8 — A maximum of 0 25% of the components per reel quantity may be missing without consecutive missing per level 1 of RS-296-D

3.3.9 — The single face roll pad shall be placed around the finished reel and taped securely Each reel shall then be placed in an appropriate container

3.4 MARKING — Minimum reel and carton marking shall consist of the following See Figure 3

Part number
Purchase order number
Quantity
Date of reeling (when applicable)
Manufacturer's name
Electrical value (when applicable)
Date codes (when applicable, see note 3 3 1)
Tape (when applicable)

4.0 — Requirements differing from this Motorola standard shall be negotiated with the factory

The packages indicated in the following table are suitable for lead tape packaging The table indicates the specific devices (rectifiers and/or zeners) that can be obtained from Motorola in reel packaging, and provides the appropriate packaging specification.

TABLE 1 — PACKAGING DETAILS (ALL DIMENSIONS IN INCHES)

Case Type	Product Category	Quantity Per Reel (Item 3.3.7)	Component Spacing A	Tape Spacing B	Reel Dimensions C	D (max)	Max Off Alignment E	Item Number
Case 51-02 (DO-7)	All	3000	0 200 ± 0 020	2.062 ± 059	3 00	14.00	0 047	1
Case 299-02 (DO-35)	Zeners	3000	0 200 ± 0 020	2.062 ± 059	3 00	14.00		2
Case 17-02	Zeners	2000	0 200 ± 0 015	2.062 ± .059	3.00	14 00		3
Case 59-03 (DO-41)	Zeners	3000	0 200 ± 0 015	2.062 ± 059	3.00	14.00		4
Case 59-01 (DO-41)	Zeners	3000	0 200 ± 0 015	2.062 ± .059	3 00	14 00		5
Case 59-01 (DO-41)	Rectifiers	6000	0 200 ± 0 020	2 062 ± 059	3.00	14 00		6
Case 59-04	Rectifiers	5000	0 200 ± 0 020	2 062 ± .059	3 00	14.00		7
Case 52-03 (DO-13)	Zeners	1500	0 400 ± 0 020	2 500 ± .059	3 81	14 00		8
Case 267-02	Rectifiers	1500	0 400 ± 0 020	2 062 ± 059	3 00	14 00		9
Case 41-11	Zeners	1250	0 200 ± 0 020	2.062 ± 059	3 00	14.00		10
Case 194-01	Rectifiers	900	0 500 ± 0 020	1.875 ± .059	3 00	14 00		11
Case 194-04	Rectifiers	900	0 400 ± 0 020	1 875 ± 059	3 00	14 00		12

LEAD TAPE PACKAGING STANDARDS FOR AXIAL-LEAD COMPONENTS (continued)

FIGURE 1 — REEL PACKING

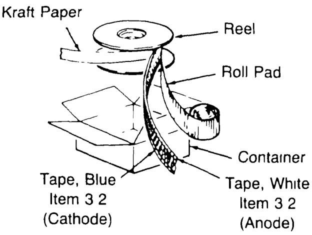
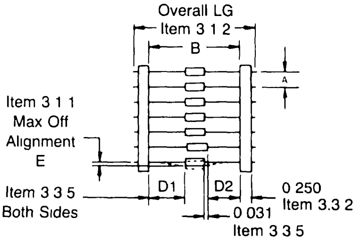
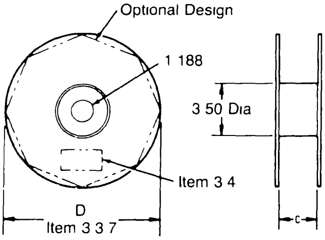


FIGURE 2 — COMPONENT SPACING



2

FIGURE 3 — REEL DIMENSIONS



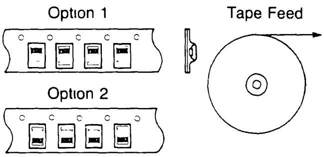
SURFACE MOUNT TAPE AND REEL

In conjunction with the industry trend to use automatic placement equipment for microminiature components, Motorola offers MLL34 and SOT-23 devices in the industry accepted 8 mm tape and reel format MLL41 devices are offered in 12 mm tape. The current packaging method is plastic tape with embossed cavities, which serve as a pocket for the individual device A sealing tape is then applied to retain the device.

- Device Orientation: Either in T1 (Option 1) or T2 (Option 2) configuration
- Quantity Per 7″ Reel: 2,000 devices for MLL34.
  1,000 devices for MLL41.
  3,000 devices for SOT-23.
- Minimum Order Quantity 1 reel.

For ordering information, please contact your local Motorola representative (See listing on back cover.)

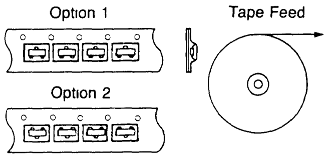
Tape & Reel Options
MLL34, MLL41



Polarity band indicates cathode

Option 1 = T1 Designator, Cathode Facing Sprocket Holes
Option 2 = T2 Designator, Anode Facing Sprocket Holes

Tape & Reel Options
SOT-23



EIA Std RS481

Option 1 = T1 Designator
Option 2 = T2 Designator

2

Rectifier Data Sheets

3

MOTOROLA
SEMICONDUCTOR
TECHNICAL DATA

1N1183A thru 1N1190A

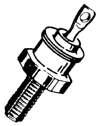
MEDIUM-CURRENT RECTIFIERS

... for applications requiring low forward voltage drop and rugged construction.

- High Surge Handling Ability
- Rugged Construction
- Reverse Polarity Available; Eliminates Need for Insulating Hardware in Many Cases
- Hermetically Sealed

20-AMP RECTIFIERS

SILICON
DIFFUSED-JUNCTION



3

***MAXIMUM RATINGS**

Rating	Symbol	1N1183A	1N1184A	1N1186A	1N1188A	1N1190A	Unit
Peak Repetitive Reverse Voltage	V_{RRM} V_{RWM} V_R	50	100	200	400	600	Volts
Average Half-Wave Rectified Forward Current With Resistive Load @ T_A = 150°C	I_O	40	40	40	40	40	Amp
Peak One Cycle Surge Current (60 Hz and 150°C Case Temperature)	I_{FSM}	800	800	800	800	800	Amp
Operating Junction Temperature	T_J	−65 to +200					°C
Storage Temperature	T_{stg}	−65 to +200					°C

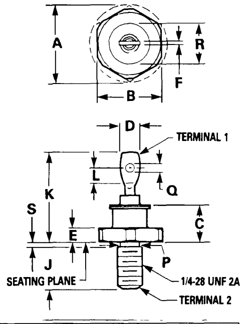
***ELECTRICAL CHARACTERISTICS** (All Types) at 25°C Case Temperature

Characteristic	Symbol	Value	Unit
Maximum Forward Voltage at 100 Amp DC Forward Current	V_F	1.1	Volts
Maximum Reverse Current at Rated DC Reverse Voltage	I_R	5.0	mAdc

THERMAL CHARACTERISTICS

Characteristic	Symbol	Typical	Unit
Thermal Resistance, Junction to Case	$R_{\theta JC}$	1.0	°C/W

*Indicates JEDEC registered data.



DIM	MILLIMETERS MIN	MILLIMETERS MAX	INCHES MIN	INCHES MAX
A	—	20 07	—	0 790
B	16 94	17 45	0 669	0 687
C	—	11 43	—	0 450
D	—	9 53	—	0 375
E	2 92	5 08	0 115	0 200
F	—	2 03	—	0 080
J	10 72	11 51	0 422	0 453
K	19 05	25 40	0 750	1 00
L	3 96	—	0 156	—
P	5 59	6 32	0 220	0 249
Q	3 56	4 45	0 140	0 175
R	—	16 94	—	0 667
S	—	2.26	—	0 089

CASE 42A-01
DO-203AB
METAL

MECHANICAL CHARACTERISTICS

CASE: Welded, hermetically sealed construction
FINISH: All external surfaces corrosion-resistant and the terminal lead is readily solderable
WEIGHT: 25 grams (approx.)
POLARITY: Cathode connected to case (reverse polarity available denoted by Suffix R, i.e.: 1N3212R)
MOUNTING POSITION: Any
MOUNTING TORQUE: 25 in-lb max

MOTOROLA
SEMICONDUCTOR
TECHNICAL DATA

1N1199 thru 1N1206

MEDIUM-CURRENT SILICON RECTIFIERS

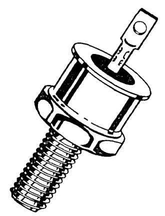
Silicon rectifiers for medium-current applications requiring

- High Current Surge —
  240 Amperes @ T_J = 190°C
- Peak Performance at Elevated Temperature —
  12 Amperes @ T_C = 150°C

MEDIUM-CURRENT SILICON RECTIFIERS

50-600 VOLTS
12 AMPERES

DIFFUSED JUNCTION



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*MAXIMUM RATINGS

Characteristic	Symbol	1N 1199	1N 1200	1N 1202	1N 1204	1N 1206	Unit
Peak Repetitive Reverse Voltage Working Peak Reverse Voltage DC Blocking Voltage	V_{RRM} V_{RWM} V_R	50	100	200	400	600	Volts
Average Rectified Forward Current (Single phase, resistive load, 60 Hz, T_C = 150°C)	I_O	← 12 →					Amp
Non-Repetitive Peak Surge Current (Surge applied at rated load conditions, half wave, single phase, 60 Hz)	I_{FSM}	← 240 (for 1 cycle) →					Amp
Operating Junction Temperature Range	T_J	← -65 to +190 →					°C

*THERMAL CHARACTERISTICS

Characteristic	Symbol	Max	Unit
Thermal Resistance, Junction to Case	$R_{\theta JC}$	2 0	°C/W

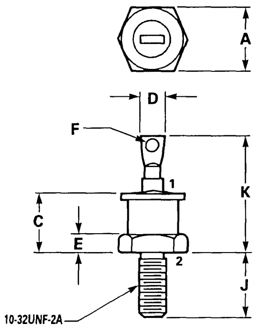
*ELECTRICAL CHARACTERISTICS

Characteristic and Conditions	Symbol	Max	Unit
Maximum Instantaneous Forward Voltage (i_F = 40 A, T_C = 25°C)	v_F	1 8	Volts
Maximum Instantaneous Reverse Current (Rated voltage, T_C = 150°C)	I_R	10	mA

*Indicates JEDEC registered data

MECHANICAL CHARACTERISTICS

CASE: Welded, hermetically sealed construction
FINISH: All external surfaces are corrosion-resistant and the terminal lead is readily solderable
POLARITY: Cathode to case (reverse polarity units are available and denoted by an "R" suffix, i.e., 1N1202R)
MOUNTING POSITION: Any
MOUNTING TORQUE: 15 in-lb max
MAXIMUM TERMINAL TEMPERATURE FOR SOLDERING PURPOSES: 275°C for 10 seconds at 3 kg tension.
WEIGHT: 6 grams (approx.)



STYLE 1
PIN 1 CATHODE
2 ANODE

STYLE 2
PIN 1 ANODE
2. CATHODE

NOTES
1 DIMENSIONING AND TOLERANCING PER ANSI Y14.5M, 1982.
2. CONTROLLING DIMENSION INCH.

DIM	MILLIMETERS MIN	MILLIMETERS MAX	INCHES MIN	INCHES MAX
A	10 75	11 12	0.423	0.438
C	—	10.28	—	0.405
D	4 07	4 69	0.160	0 185
E	1 91	4 44	0 075	0 175
F	2 29	2 41	0.090	0.095
J	10.72	11.50	0.422	0.453
K	18.80	20 32	0 740	0 800

CASE 245A-02
DO-203AA
METAL

MOTOROLA
SEMICONDUCTOR
TECHNICAL DATA

1N1199A thru 1N1206A

MEDIUM-CURRENT SILICON RECTIFIERS

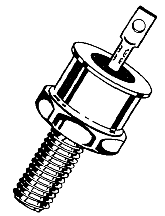
Silicon rectifiers for medium-current applications requiring:

- High Current Surge — 240 Amperes @ T_J = 200°C
- Peak Performance at Elevated Temperature — 12 Amperes @ T_C = 150°C

MEDIUM-CURRENT SILICON RECTIFIERS

50-600 VOLTS
12 AMPERES

DIFFUSED JUNCTION



*MAXIMUM RATINGS

Characteristic	Symbol	1N 1199A	1N 1200A	1N 1202A	1N 1204A	1N 1206A	Unit
Peak Repetitive Reverse Voltage Working Peak Reverse Voltage DC Blocking Voltage	V_{RRM} V_{RWM} V_R	50	100	200	400	600	Volts
Non-Repetitive Peak Reverse Voltage (Halfwave, single phase, 60 Hz peak)	V_{RSM}	100	200	350	600	800	Volts
Average Rectified Forward Current (Single phase, resistive load, 60 Hz, T_C = 150°C)	I_O	← 12 →					Amp
Non-Repetitive Peak Surge Current (Surge applied at rated load conditions, half wave, single phase, 60 Hz)	I_{FSM}	← 240 (for 1 cycle) →					Amp
Operating and Storage Junction Temperature Range	T_J, T_{stg}	← −65 to +200 →					°C

*THERMAL CHARACTERISTICS

Characteristic	Symbol	Max	Unit
Thermal Resistance, Junction to Case	$R_{\theta JC}$	2 0	°C/W

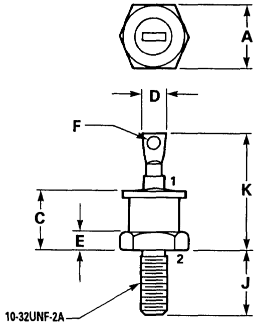
*ELECTRICAL CHARACTERISTICS

Characteristic and Conditions	Symbol	Max	Unit
Maximum Instantaneous Forward Voltage (i_F = 40 A, T_C = 25°C)	v_F	1 35	Volts
Maximum Average Reverse Current at Rated Conditions	I_{RO}		mA
1N1199A		3 0	
1N1200A		2.5	
1N1202A		2.0	
1N1204A		1.5	
1N1206A		1.0	

*Indicates JEDEC registered data

MECHANICAL CHARACTERISTICS

CASE: Welded, hermetically sealed construction
FINISH: All external surfaces are corrosion-resistant and the terminal lead is readily solderable
POLARITY: Cathode to case (reverse polarity units are available and denoted by an "R" suffix, i.e., 1N1202RA)
MOUNTING POSITION: Any
MOUNTING TORQUE: 15 in-lb max
MAXIMUM TERMINAL TEMPERATURE FOR SOLDERING PURPOSES: 275°C for 10 seconds at 3 kg tension.
WEIGHT: 6 grams (approx.)



STYLE 1:
PIN 1. CATHODE
2. ANODE

STYLE 2.
PIN 1. ANODE
2 CATHODE

NOTES:
1. DIMENSIONING AND TOLERANCING PER ANSI Y14.5M, 1982.
2. CONTROLLING DIMENSION· INCH.

DIM	MILLIMETERS MIN	MILLIMETERS MAX	INCHES MIN	INCHES MAX
A	10.75	11 12	0.423	0.438
C	—	10.28	—	0.405
D	4.07	4.69	0.160	0 185
E	1.91	4.44	0.075	0.175
F	2.29	2.41	0.090	0.095
J	10.72	11.50	0.422	0.453
K	18.80	20.32	0.740	0.800

CASE 245A-02
DO-203AA
METAL

3

MOTOROLA
SEMICONDUCTOR
TECHNICAL DATA

1N1199B thru 1N1206B

MEDIUM-CURRENT SILICON RECTIFIERS

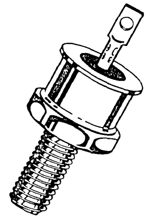
Compact, highly efficient silicon rectifiers for medium-current applications requiring:

- High Current Surge — 250 Amperes @ T_J = 200°C
- Peak Performance at Elevated Temperature — 12 Amperes @ T_C = 150°C

MEDIUM-CURRENT SILICON RECTIFIERS

50-600 VOLTS
12 AMPERES

DIFFUSED JUNCTION



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*MAXIMUM RATINGS

Characteristic	Symbol	1N 1199B	1N 1200B	1N 1202B	1N 1204B	1N 1206B	Unit
Peak Repetitive Reverse Voltage Working Peak Reverse Voltage DC Blocking Voltage	V_{RRM} V_{RWM} V_R	50	100	200	400	600	Volts
Non-Repetitive Peak Reverse Voltage (Halfwave, single phase, 60 Hz peak)	V_{RSM}	100	200	350	600	800	Volts
Average Rectified Forward Current (Single phase, resistive load, 60 Hz, T_C = 150°C)	I_O	← 12 →					Amp
Non-Repetitive Peak Surge Current (Surge applied at rated load conditions, half wave, single phase, 60 Hz)	I_{FSM}	← 250 (for 1 cycle) →					Amp
Operating and Storage Junction Temperature Range	T_J, T_{stg}	← -65 to +200 →					°C

*THERMAL CHARACTERISTICS

Characteristic	Symbol	Max	Unit
Thermal Resistance, Junction to Case	$R_{\theta JC}$	2.0	°C/W

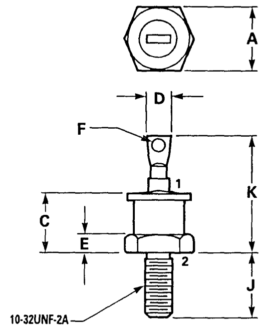
*ELECTRICAL CHARACTERISTICS

Characteristic and Conditions	Symbol	Max	Unit
Maximum Instantaneous Forward Voltage (i_F = 40 A, T_C = 25°C)	v_F	1.2	Volts
Maximum Reverse Current (Rated dc voltage, T_C = 150°C)	I_R	1.0	mA
Maximum Average Reverse Current at Rated Conditions	I_{RO}	0.9	mA
DC Forward Voltage (I_F = 12 A, T_C = 25°C)	V_F	1.1	Volts
Reverse Recovery Time (I_{FM} = 40 A, di/dt = 25 A/µs to I_{FM} = 0, $t_p \geq 4.0$ µs, 60 pulses/second, 25°C)	t_{rr}	5.0	µs

*Indicates JEDEC registered data

MECHANICAL CHARACTERISTICS

CASE: Metal, hermetically sealed construction
FINISH: All external surfaces are corrosion-resistant and the terminal lead is readily solderable
POLARITY: Cathode to case (reverse polarity units are available and denoted by an "R" suffix, i.e., 1N1202RB)
MOUNTING POSITION: Any
MOUNTING TORQUE: 15 in-lb max
MAXIMUM TERMINAL TEMPERATURE FOR SOLDERING PURPOSES: 275°C for 10 seconds at 3 kg tension.
WEIGHT: 6 grams (approx.)



STYLE 1
PIN 1. CATHODE
2. ANODE

STYLE 2:
PIN 1. ANODE
2. CATHODE

NOTES:
1. DIMENSIONING AND TOLERANCING PER ANSI Y14.5M, 1982.
2. CONTROLLING DIMENSION: INCH.

DIM	MILLIMETERS MIN	MILLIMETERS MAX	INCHES MIN	INCHES MAX
A	10.75	11.12	0.423	0.438
C	—	10.28	—	0.405
D	4.07	4.69	0.160	0.185
E	1.91	4.44	0.075	0.175
F	2.29	2.41	0.090	0.095
J	10.72	11.50	0.422	0.453
K	18.80	20.32	0.740	0.800

CASE 245A-02
DO-203AA
METAL

MOTOROLA
SEMICONDUCTOR
TECHNICAL DATA

1N3208 thru 1N3212

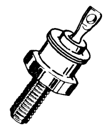
MEDIUM-CURRENT RECTIFIERS

. . . for applications requiring low forward voltage drop and rugged construction.

- High Surge Handling Ability
- Rugged Construction
- Reverse Polarity Available; Eliminates Need for Insulating Hardware in Many Cases
- Hermetically Sealed

15-AMP RECTIFIERS

SILICON DIFFUSED-JUNCTION



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***MAXIMUM RATINGS**

Rating	Symbol	1N3208 1N3208R	1N3209 1N3209R	1N3210 1N3210R	1N3211 1N3211R	1N3212 1N3212R	Unit
DC Blocking Voltage	V_R	50	100	200	300	400	Volts
RMS Reverse Voltage	$V_{R(RMS)}$	35	70	140	210	280	Volts
Average Half-Wave Rectified Forward Current With Resistive Load @ T_C = 150°C	I_O	15	15	15	15	15	Amp
Peak One Cycle Surge Current (60 Hz and 25°C Case Temperature)	I_{FSM}	250	250	250	250	250	Amp
Operating Junction Temperature	T_J	← -65 to +175 →					°C
Storage Temperature	T_{stg}	← -65 to +175 →					°C

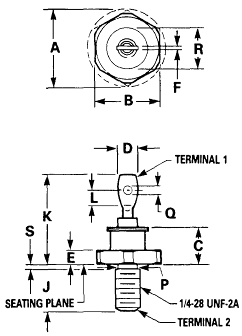
***ELECTRICAL CHARACTERISTICS** (All Types) at 25°C Case Temperature

Characteristic	Symbol	Value	Unit
Maximum Forward Voltage at 40 Amp DC Forward Current	V_F	1 5	Volts
Maximum Reverse Current at Rated DC Reverse Voltage	I_R	1 0	mAdc

THERMAL CHARACTERISTICS

Characteristic	Symbol	Typical	Unit
Thermal Resistance, Junction to Case	$R_{\theta JC}$	1 7	°C/W

*Indicates JEDEC registered data.



DIM	MILLIMETERS MIN	MILLIMETERS MAX	INCHES MIN	INCHES MAX
A	—	20 07	—	0 790
B	16 94	17 45	0 669	0 687
C	—	11 43	—	0 450
D	—	9 53	—	0 375
E	2 92	5 08	0 115	0 200
F	—	2 03	—	0 080
J	10 72	11 51	0.422	0 453
K	19 05	25 40	0 750	1 00
L	3 96	—	0 156	—
P	5 59	6 32	0 220	0.249
Q	3 56	4 45	0 140	0 175
R	—	16 94	—	0 667
S	—	2 26	—	0 089

CASE 42A-01
DO-203AB
METAL

MECHANICAL CHARACTERISTICS

CASE: Welded, hermetically sealed construction
FINISH: All external surfaces corrosion-resistant and the terminal lead is readily solderable
WEIGHT: 25 grams (approx.)
POLARITY: Cathode connected to case (reverse polarity available denoted by Suffix R, i.e.: 1N3212R)
MOUNTING POSITION: Any
MOUNTING TORQUE: 25 in-lb max

MOTOROLA
SEMICONDUCTOR
TECHNICAL DATA

1N3491 thru 1N3495

Designers Data Sheet

MEDIUM-CURRENT SILICON RECTIFIERS

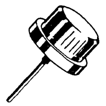
. . . compact, highly efficient silicon rectifiers.

Designer's Data for "Worst Case" Conditions

The Designers Data Sheet permits the design of most circuits entirely from the information presented Limit curves — representing device characteristics boundaries — are given to facilitate "worst case" design.

SILICON RECTIFIERS
25 AMPERE

50–400 VOLTS
DIFFUSED JUNCTION



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*MAXIMUM RATINGS

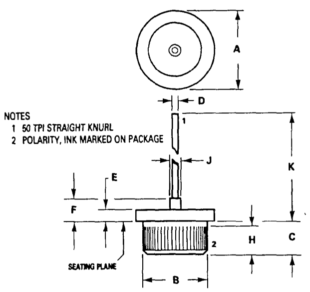
Rating	Symbol	1N3491	1N3492	1N3493	1N3494	1N3495	Unit
Peak Repetitive Reverse Voltage Working Peak Reverse Voltage DC Blocking Voltage	V_{RRM} V_{RWM} V_R	50	100	200	300	400	Volts
RMS Reverse Voltage	$V_{R(RMS)}$	35	70	140	210	280	Volts
Average Rectified Forward Current (Single phase, resistive load, 60 Hz, see Figure 3) $T_C = 100°C$	I_O	25					Amp
Nonrepetitive Peak Surge Current (surge applied at rated load conditions, see Figure 5)	I_{FSM}	300 (for 1/2 cycle)					Amp
Operating and Storage Junction Temperature Range	T_J, T_{stg}	−65 to +175					°C

THERMAL CHARACTERISTICS

Characteristic	Symbol	Max	Unit
Thermal Resistance, Junction to Case	$R_{\theta JC}$	1 2	°C/Watt

MECHANICAL CHARACTERISTICS

CASE: Welded, hermetically sealed construction
FINISH: All external surfaces corrosion-resistant and the terminal lead is readily solderable
POLARITY: CATHODE TO CASE (reverse polarity units are available upon request and are designated by an "R" suffix i e MR327R or 1N3491R)
MOUNTING POSITIONS: Any



DIM	MILLIMETERS MIN	MILLIMETERS MAX	INCHES MIN	INCHES MAX
A	15 494	16 256	0 610	0 640
B	12 725	12 827	0 501	0 505
C	5 08	6 35	0 200	0 250
D	1 193	1 346	0 047	0 053
E	2 032	4 826	0 080	0 190
F	—	10 77	—	0 424
H	4 572	6 350	0 180	0 250
J	—	3 556	—	0 140
K	12 70	—	0 500	—

CASE 43-02
DO-208AA
METAL

*Indicates JEDEC registered data for 1N3491-1N3495

1N3491 thru 1N3495

***ELECTRICAL CHARACTERISTICS**

Characteristic and Conditions	Symbol	Max	Unit
Instantaneous Forward Voltage Drop (i_F = 57 Amps, T_J = 25°C)	v_F	1 7	Volts
Full Cycle Average Reverse Current (18 Amp AV and V_r, single phase, 60 Hz, T_C = 150°C)	$I_{R(AV)}$		mA
1N3491		10	
1N3492		10	
1N3493		8 0	
1N3494		6 0	
1N3495		4 0	
DC Reverse Current (Rated V_R, T_C = 25°C)	I_R	1 0	mA

3

FIGURE 1 — MAXIMUM FORWARD VOLTAGE DROP

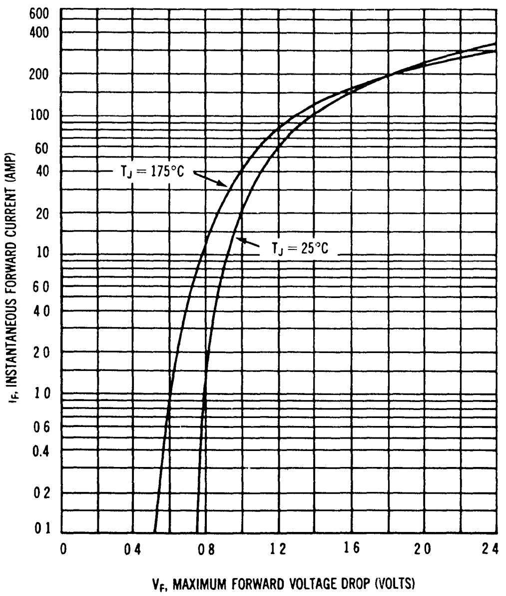


FIGURE 2 — MAXIMUM FORWARD POWER DISSIPATION

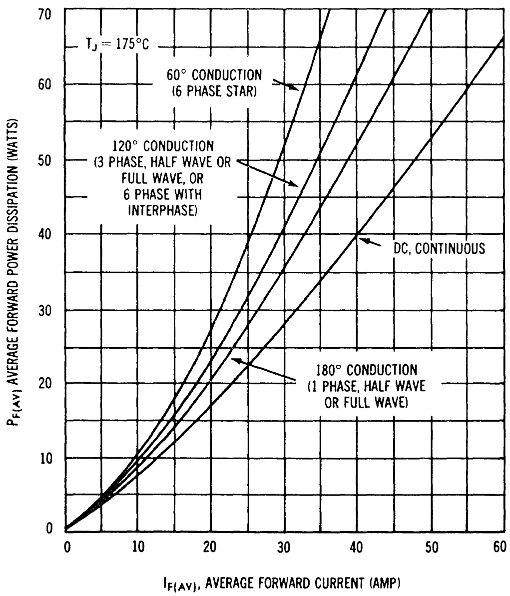


FIGURE 3 — MAXIMUM CURRENT RATINGS

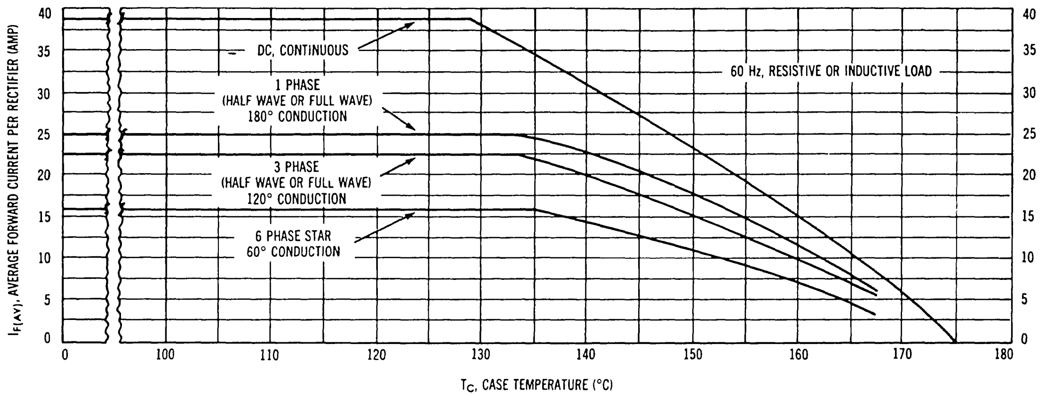


FIGURE 4 — MAXIMUM EFFECTIVE TRANSIENT THERMAL IMPEDANCE

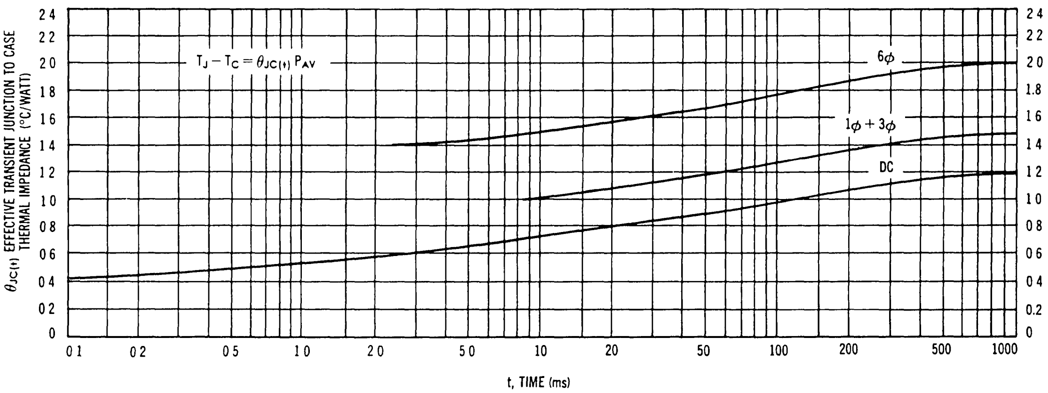
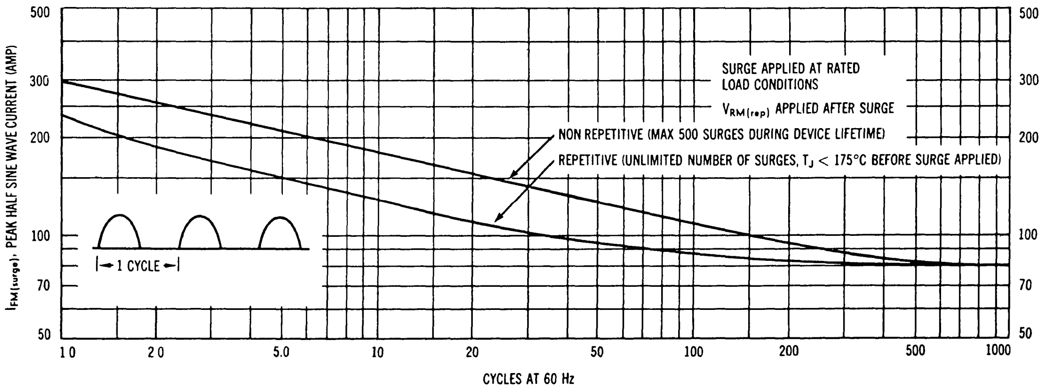


FIGURE 5 — MAXIMUM ALLOWABLE SURGE CURRENT



TYPICAL DYNAMIC CHARACTERISTICS

FIGURE 6 — RECTIFICATION EFFICIENCY

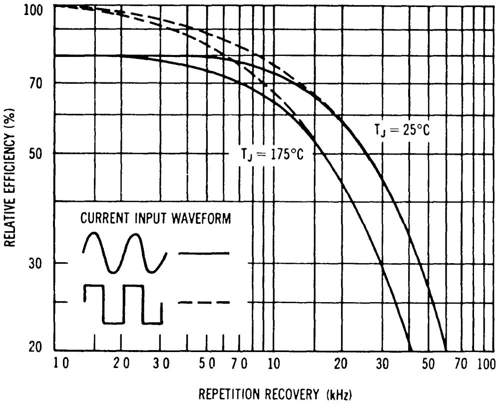


FIGURE 7 — REVERSE RECOVERY TIME

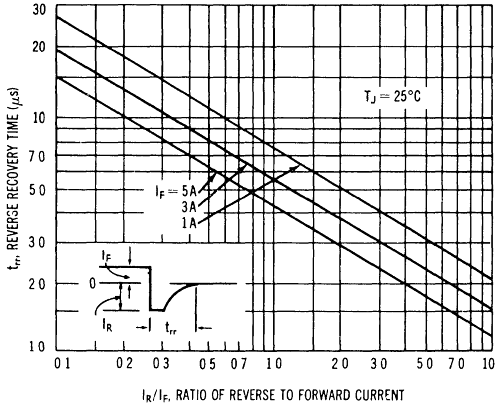


FIGURE 8 — JUNCTION CAPACITANCE

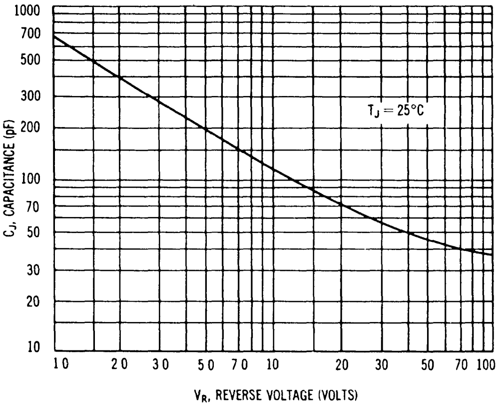
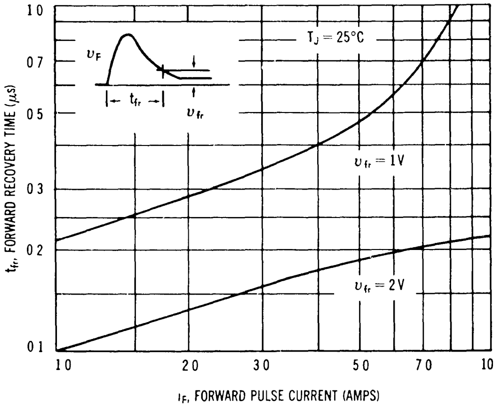
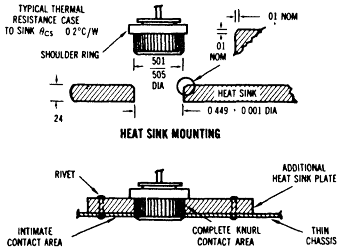


FIGURE 9 — FORWARD RECOVERY TIME





HEAT SINK MOUNTING

THIN-CHASSIS MOUNTING

MOUNTING PROCEDURES

MR327-MR331 and 1N3491-1N3495 rectifiers are designed to be press-fitted in a heat sink in order to attain full device ratings Recommended procedures for this type of mounting are as follows.

1. Drill a hole in the heat sink 0.499 ± .001 inch in diameter.
2. Break the hole edge as shown to prevent shearing off the knurled edge of the rectifier when it is pressed into the hole.
3. The depth and width of the break should be 0.010 inch maximum to retain maximum heat sink surface contact.
4. To prevent damage to the rectifier during press-in, the pressing force should be applied only on the shoulder ring of the rectifier case as shown in the figure.
5. The pressing force should be applied evenly about the shoulder ring to avoid tilting or canting of the rectifier case in the hole during the press-in operation. Also, the use of a light industrial lubricant will be of considerable aid.

MOTOROLA
SEMICONDUCTOR
TECHNICAL DATA

1N3659 thru 1N3663

LOW COST RECTIFIERS FOR MEDIUM CURRENT INDUSTRIAL AND COMMERCIAL APPLICATIONS

- High Surge Handling Ability
- Rugged Construction
- Reverse Polarity Available
- Hermetically Sealed

30-AMP RECTIFIERS

SILICON
DIFFUSED-JUNCTION

***MAXIMUM RATINGS** (T_C = 25°C unless otherwise noted)

Rating	Symbol	1N3659 1N3659R	1N3660 1N3660R	1N3661 1N3661R	1N3662 1N3662R	1N3663 1N3663R	Unit
Peak Repetitive Reverse Voltage DC Blocking Voltage	V_{RRM} V_R	50	100	200	300	400	Volts
RMS Reverse Voltage	$V_{R(RMS)}$	35	70	140	210	280	Volts
Average Half-Wave Rectified Forward Current with Resistive Load @ 100°C case @ 150°C case	I_O	← 30 → ← 25 →					Amp Amp
Peak One Cycle Surge Current (150°C case temp, 60 Hz)	I_{FSM}	← 400 →					Amp
Operating Junction Temperature	T_J	← -65 to +175 →					°C
Storage Temperature	T_{stg}	← -65 to +200 →					°C

***ELECTRICAL CHARACTERISTICS**

Characteristic	Symbol	1N3659 1N3659R	1N3660 1N3660R	1N3661 1N3661R	1N3662 1N3662R	1N3663 1N3663R	Unit
Maximum Forward Voltage at 25 Amp DC Forward Current	V_F	1 2	1 2	1 2	1 2	1 2	Volts
Instantaneous Forward Voltage Drop (i_F = 78 5 Amps, T_J = 25°C)	v_F	1 4					Volts
Maximum Full Cycle Average Reverse Current @ Rated PIV and Current (as half-wave rectifier, resistive load, 150°C)	$I_{R(AV)}$	5 0	4 5	4 0	3 5	3 0	mA

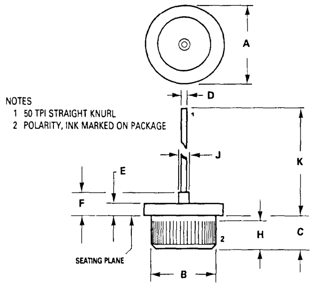
***THERMAL CHARACTERISTICS**

Characteristic	Symbol	Value	Unit
Thermal Resistance, Junction to Case	$R_{\theta JC}$	1 2	°C/W

*Indicates JEDEC registered data

MECHANICAL CHARACTERISTICS

CASE: Welded hermetically sealed construction
FINISH: All external surfaces corrosion resistant, terminals readily solderable
WEIGHT: 9 grams (approx)
POLARITY: Cathode connected to case (reverse polarity available denoted by Suffix R, i e : 1N3660R)
MOUNTING POSITION: Any

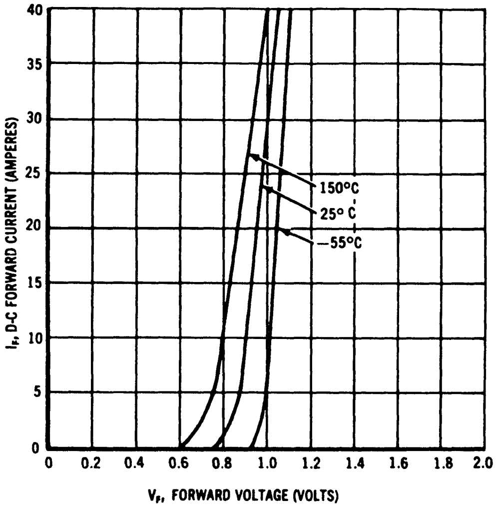


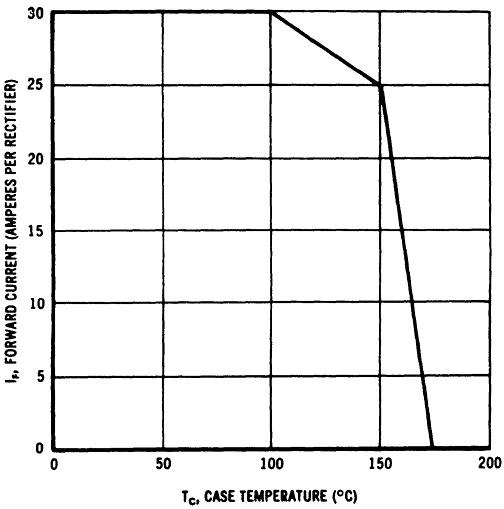
DIM	MILLIMETERS MIN	MILLIMETERS MAX	INCHES MIN	INCHES MAX
A	15 494	16 256	0 610	0 640
B	12 725	12 827	0 501	0 505
C	5 08	6 35	0 200	0 250
D	1 193	1 346	0 047	0 053
E	2 032	4 826	0 080	0 190
F	—	10 77	—	0 424
H	4 572	6 350	0 180	0 250
J	—	3 556	—	0 140
K	12 70	—	0 500	—

CASE 43-02
DO-208AA
METAL

3

3



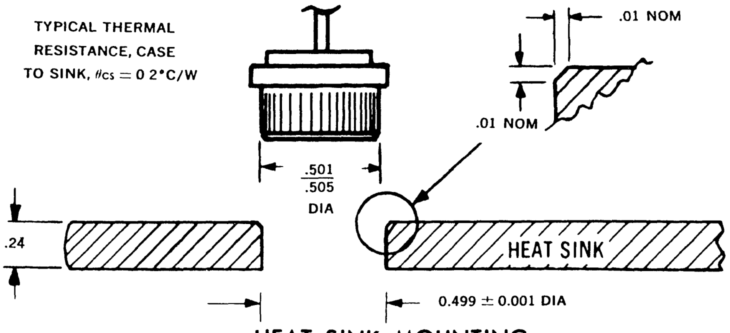


1N3659-1N3663 rectifiers are designed for press-fitted mounting in a heat sink. Recommended procedures for this type of mounting are as follows:

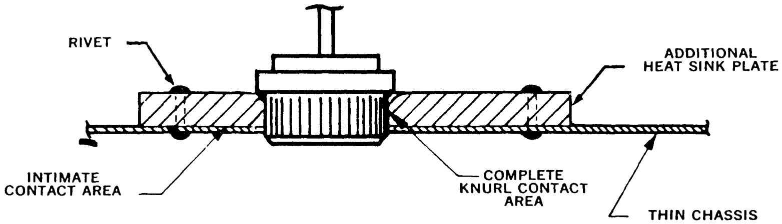
1. Drill a hole in the heat sink 0.499 ± .001 inch in diameter.
2. Break the hole edge as shown to prevent shearing off the knurled edge of the rectifier when it is pressed into the hole.
3. The depth of the break should be 0.010 inch maximum to retain maximum heat sink surface contact with the knurled rectifier surface.
4. Width of the break should be 0.010 inch as shown.

These procedures will allow proper entry of the rectifier knurled surface, provide good rectifier- heat sink surface contact, and assure reliable rectifier operation. If the break is made too deep, thereby reducing contact area for heat transfer, reliability of operation will be impaired.

These devices can be mounted in a thin chassis by inserting the rectifier through an additional heat sink plate which is mounted in intimate contact with the upper side of the chassis. This provides additional contact area for the rectifier knurled edge, as well as additional heat sink capacity.



HEAT SINK MOUNTING



THIN-CHASSIS MOUNTING

MOTOROLA
SEMICONDUCTOR
TECHNICAL DATA

1N3879 thru 1N3883
MR1366

Designers Data Sheet

STUD MOUNTED
FAST RECOVERY POWER RECTIFIERS

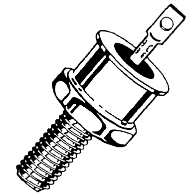
. . . designed for special applications such as dc power supplies, inverters, converters, ultrasonic systems, choppers, low RF interference, sonar power supplies and free wheeling diodes. A complete line of fast recovery rectifiers having typical recovery time of 150 nanoseconds providing high efficiency at frequencies to 250 kHz.

Designer's Data for "Worst Case" Conditions

The Designers Data sheets permit the design of most circuits entirely from the information presented. Limit curves — representing boundaries on device characteristics — are given to facilitate "worst case" design.

FAST RECOVERY POWER RECTIFIERS

50-600 VOLTS
6 AMPERES



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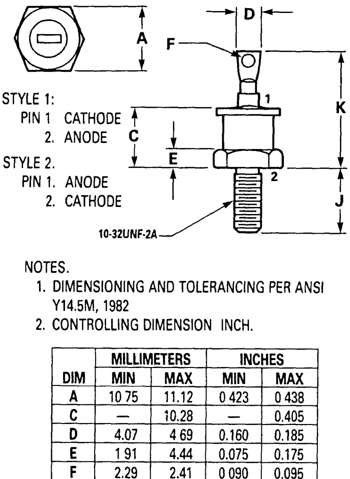


NOTES.
1. DIMENSIONING AND TOLERANCING PER ANSI Y14.5M, 1982
2. CONTROLLING DIMENSION INCH.

DIM	MILLIMETERS MIN	MILLIMETERS MAX	INCHES MIN	INCHES MAX
A	10.75	11.12	0.423	0.438
C	—	10.28	—	0.405
D	4.07	4.69	0.160	0.185
E	1.91	4.44	0.075	0.175
F	2.29	2.41	0.090	0.095
J	10.72	11.50	0.422	0.453
K	18.80	20.32	0.740	0.800

CASE 245A-02
DO-203AA
METAL

*MAXIMUM RATINGS

Rating	Symbol	1N3879	1N3880	1N3881	1N3882	1N3883	MR1366	Unit
Peak Repetitive Reverse Voltage Working Peak Reverse Voltage DC Blocking Voltage	V_{RRM} V_{RWM} V_R	50	100	200	300	400	600	Volts
Non Repetitive Peak Reverse Voltage	V_{RSM}	75	150	250	350	450	650	Volts
RMS Reverse Voltage	$V_{R(RMS)}$	35	70	140	210	280	420	Volts
Average Rectified Forward Current (Single phase, resistive load, $T_C = 100°C$)	I_O	← 6.0 →						Amps
Non-Repetitive Peak Surge Current (surge applied at rated load continuous)	I_{FSM}	← 150 → (one cycle)						Amps
Operating Junction Temperature Range	T_J	← -65 to +150 →						°C
Storage Temperature Range	T_{stg}	← -65 to +175 →						°C

THERMAL CHARACTERISTICS

Characteristic	Symbol	Max	Unit
Thermal Resistance, Junction to Case	$R_{\theta JC}$	3.0	°C/W

Motorola guarantees the listed value, although parts having higher values of thermal resistance will meet the current rating. Thermal resistance is not required by the JEDEC registration.

*ELECTRICAL CHARACTERISTICS

Characteristic	Symbol	Min	Typ	Max	Unit
Instantaneous Forward Voltage (i_F = 19 Amp, T_J = 150°C)	v_F	–	1.2	1.5	Volts
Forward Voltage (I_F = 6.0 Amp, T_C = 25°C)	V_F	–	1.0	1.4	Volts
Reverse Current (rated dc voltage) T_C = 25°C	I_R	–	10	15	μA
T_C = 100°C		–	0.5	1.0	mA

REVERSE RECOVERY CHARACTERISTICS

Characteristic	Symbol	Min	Typ	Max	Unit
Reverse Recovery Time	t_{rr}				ns
*(I_{FM} = 1.0 Amp to V_R = 30 Vdc, Figure 16)		–	150	200	
(I_{FM} = 36 Amp, di/dt = 25 A/μs, Figure 17)		–	200	400	
Reverse Recovery Current *(I_F = 1.0 Amp to V_R = 30 Vdc, Figure 16)	$I_{RM(REC)}$	–	–	2.0	Amp

*Indicates JEDEC Registered Data for 1N3879 Series

MECHANICAL CHARACTERISTICS

CASE: Welded, hermetically sealed

FINISH: All external surfaces corrosion resistant and readily solderable

POLARITY: Cathode to Case

WEIGHT: 5.6 Grams (approximately)

MOUNTING TORQUE: 15 in-lbs max.

3

FIGURE 1 — FORWARD VOLTAGE

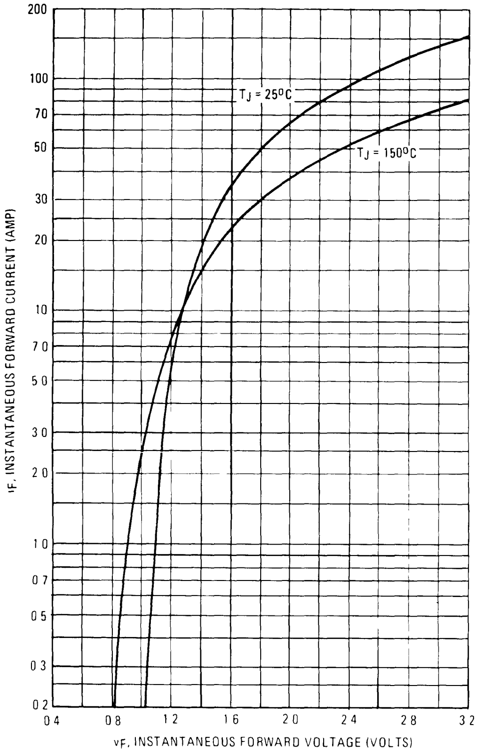
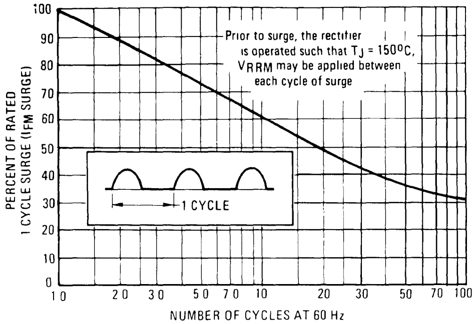
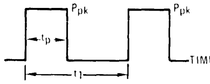


FIGURE 2 — MAXIMUM SURGE CAPABILITY



NOTE 1



DUTY CYCLE D t_p t_1
PEAK POWER P_{pk} is peak of an equivalent square power pulse

To determine maximum junction temperature of the diode in a given situation the following procedure is recommended

The temperature of the case should be measured using a thermocouple placed on the case at the temperature reference point (see Note 3) The thermal mass connected to the case is normally large enough so that it will not significantly respond to heat surges generated in the diode as a result of pulsed operation once steady state conditions are achieved Using the measured value of T_C the junction temperature may be determined by

$$T_J \; T_C + \; T_{JC}$$

where T_{JC} is the increase in junction temperature above the case temperature It may be determined by

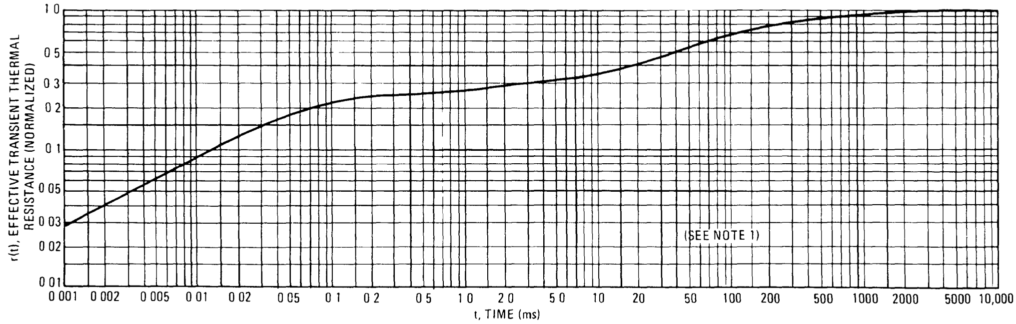
$$\Delta T_{JC} \quad P_{pk} \quad R_{\theta JC} [D + (1 - D) \quad r(t_1 + t_p) + r(t_p) \quad r(t_1)]$$

where

$r(t)$ normalized value of transient thermal resistance at time t from Figure 3 i e

$r(t_1 + t_p)$ - normalized value of transient thermal resistance at time $t_1 + t_p$

FIGURE 3 — THERMAL RESPONSE



SINE WAVE INPUT

FIGURE 4 — FORWARD POWER DISSIPATION

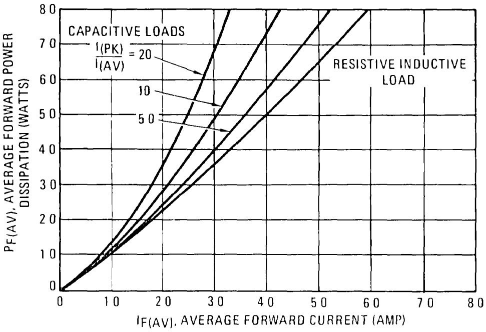


FIGURE 6 — CURRENT DERATING

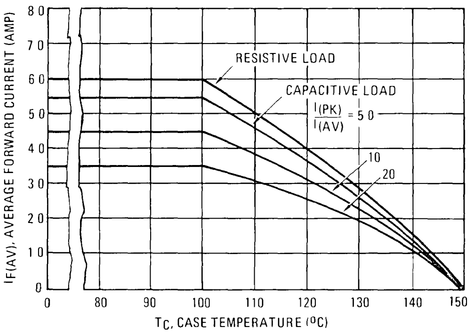
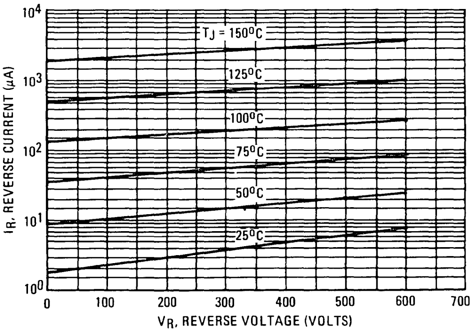


FIGURE 8 — TYPICAL REVERSE CURRENT



SQUARE WAVE INPUT

FIGURE 5 — FORWARD POWER DISSIPATION

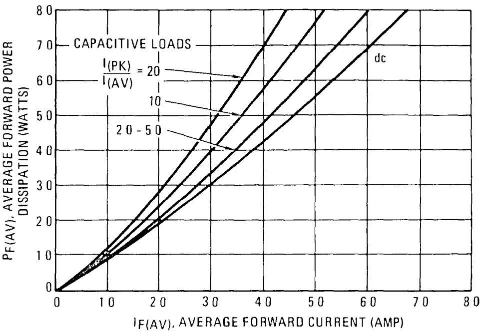


FIGURE 7 — CURRENT DERATING

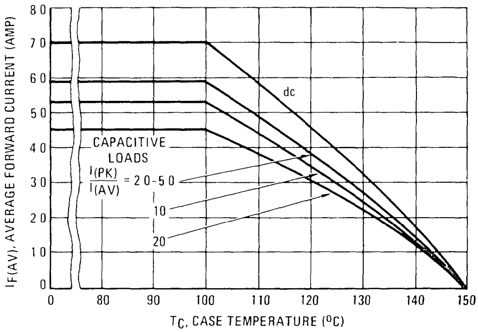
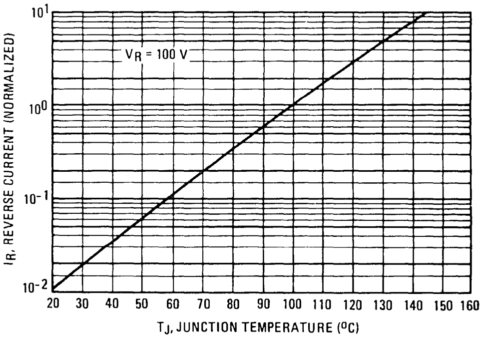


FIGURE 9 — NORMALIZED REVERSE CURRENT



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TYPICAL DYNAMIC CHARACTERISTICS

FIGURE 10 – FORWARD RECOVERY TIME

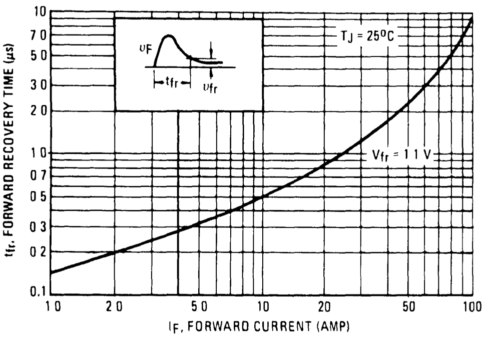
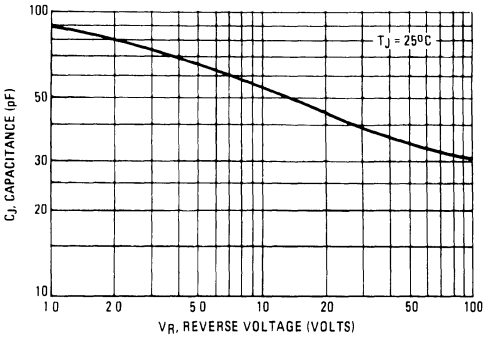


FIGURE 11 – JUNCTION CAPACITANCE



TYPICAL RECOVERED STORED CHARGE DATA

(See Note 2)

FIGURE 12 – TJ = 25°C

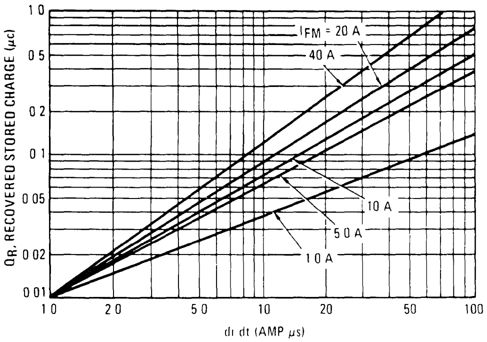


FIGURE 13 – TJ = 75°C

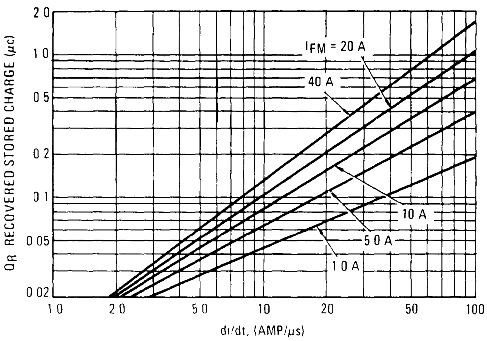


FIGURE 14 – TJ = 100°C

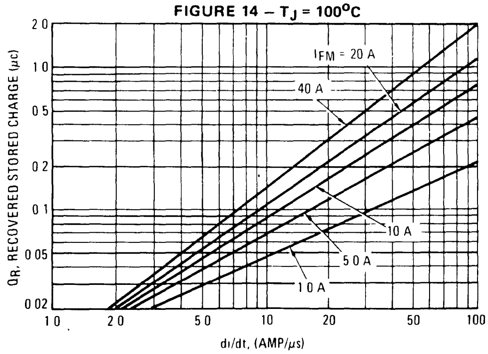


FIGURE 15 – TJ = 150°C

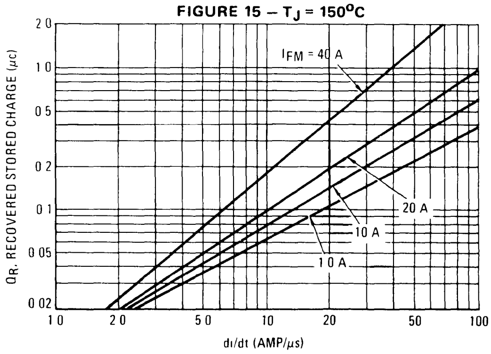
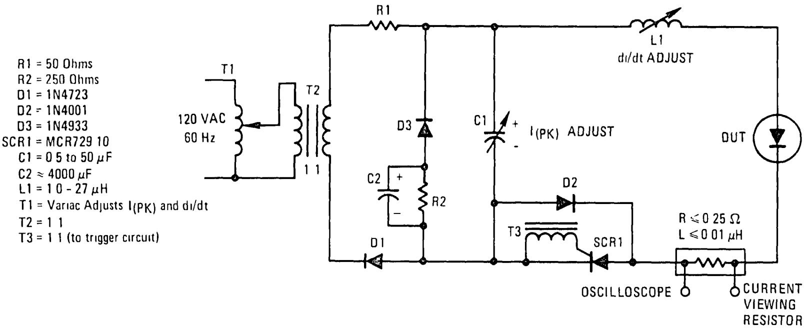


FIGURE 16 — JEDEC REVERSE RECOVERY CIRCUIT



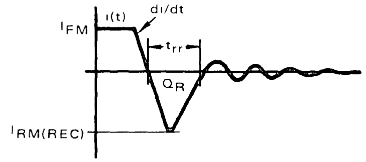
NOTE 2

Reverse recovery time is the period which elapses from the time that the current, thru a previously forward biased rectifier diode, passes thru zero going negatively until the reverse current recovers to a point which is less than 10% peak reverse current

Reverse recovery time is a direct function of the forward current prior to the application of reverse voltage

For any given rectifier, recovery time is very circuit dependent Typical and maximum recovery time of all Motorola fast recovery power rectifiers are rated under a fixed set of conditions using I_F = 1.0 A, V_R = 30 V In order to cover all circuit conditions, curves are given for typical recovered stored charge versus commutation di/dt for various levels of forward current and for junction temperatures of 25°C, 75°C, 100°C, and 150°C

To use these curves, it is necessary to know the forward current level just before commutation, the circuit commutation di/dt, and the operating junction temperature The reverse recovery test current waveform for all Motorola fast recovery rectifiers is shown



From stored charge curves versus di/dt, recovery time (t_{rr}) and peak reverse recovery current ($I_{RM(REC)}$) can be closely approximated using the following formulas

$$t_{rr} = 1.41 \times \left[\frac{Q_R}{di/dt}\right]^{1/2}$$

$$I_{RM(REC)} = 1.41 \times \left[Q_R \times di/dt\right]^{1/2}$$

3

MOTOROLA
SEMICONDUCTOR
TECHNICAL DATA

1N3889 thru 1N3893
MR1376

Designers Data Sheet

STUD MOUNTED
FAST RECOVERY POWER RECTIFIERS

. . . designed for special applications such as dc power supplies, inverters, converters, ultrasonic systems, choppers, low RF interference, sonar power supplies and free wheeling diodes. A complete line of fast recovery rectifiers having typical recovery time of 150 nanoseconds providing high efficiency at frequencies to 250 kHz.

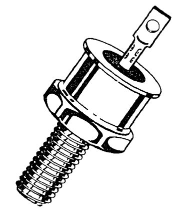
Designer's Data for "Worst Case" Conditions

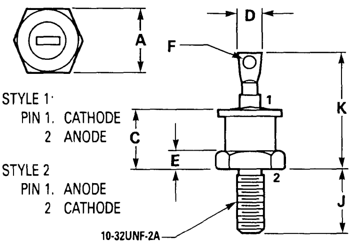
The Designers Data sheets permit the design of most circuits entirely from the information presented Limit curves — representing boundaries on device characteristics — are given to facilitate "worst case" design

3

FAST RECOVERY POWER RECTIFIERS

50-600 VOLTS
12 AMPERES





NOTES
1 DIMENSIONING AND TOLERANCING PER ANSI Y14 5M, 1982
2. CONTROLLING DIMENSION. INCH

	MILLIMETERS		INCHES	
DIM	MIN	MAX	MIN	MAX
A	10 75	11.12	0.423	0 438
C	—	10 28	—	0 405
D	4 07	4 69	0 160	0 185
E	1 91	4 44	0 075	0 175
F	2.29	2.41	0.090	0.095
J	10.72	11.50	0.422	0.453
K	18 80	20 32	0 740	0 800

CASE 245A-02
DO-203AA
METAL

*MAXIMUM RATINGS

Rating	Symbol	1N3889	1N3890	1N3891	1N3892	1N3893	MR1376	Unit
Peak Repetitive Reverse Voltage Working Peak Reverse Voltage DC Blocking Voltage	V_{RRM} V_{RWM} V_R	50	100	200	300	400	600	Volts
Non-Repetitive Peak Reverse Voltage	V_{RSM}	75	150	250	350	450	650	Volts
RMS Reverse Voltage	$V_{R(RMS)}$	35	70	140	210	280	420	Volts
Average Rectified Forward Current (Single phase, resistive load, T_C = 100°C)	I_O	← 12 →						Amps
Non-Repetitive Peak Surge Current (Surge applied at rated load conditions)	I_{FSM}	← 200 → (one cycle)						Amp
Operating Junction Temperature Range	T_J	← -65 to +150 →						°C
Storage Temperature Range	T_{stg}	← -65 to +175 →						°C

THERMAL CHARACTERISTICS

Characteristics	Symbol	Max	Unit
Thermal Resistance, Junction to Case	$R_{\theta JC}$	2 0	°C/W

Motorola guarantees the listed value, although parts having higher values of thermal resistance will meet the current rating Thermal resistance is not required by the JEDEC registration

*ELECTRICAL CHARACTERISTICS

Characteristic	Symbol	Min	Typ	Max	Unit
Instantaneous Forward Voltage (i_F = 38 Amp, T_J = 150°C)	v_F	—	1 2	1 5	Volts
Forward Voltage (I_F = 12 Amp, T_C = 25°C)	V_F	—	1 0	1 4	Volts
Reverse Current (rated dc voltage) T_C = 25°C T_C = 100°C	I_R	— —	10 0 5	25 3 0	µA mA

*REVERSE RECOVERY CHARACTERISTICS

Characteristic	Symbol	Min	Typ	Max	Unit
Reverse Recovery Time (I_F = 1 0 Amp to V_R = 30 Vdc, Figure 16) (I_{FM} = 36 Amp, di/dt = 25 A/µs, Figure 17)	t_{rr}	— —	150 200	200 400	ns
Reverse Recovery Current (I_F = 1.0 Amp to V_R = 30 Vdc, Figure 16)	$I_{RM(REC)}$	—	—	2 0	Amp

*Indicates JEDEC Registered Data for 1N3889 Series.

MECHANICAL CHARACTERISTICS
CASE: Welded, hermetically sealed
FINISH: All external surfaces corrosion resistant and readily solderable
POLARITY: Cathode to Case
WEIGHT: 5.6 grams (approximately)
MOUNTING TORQUE: 15 in-lb max

FIGURE 1 – FORWARD VOLTAGE

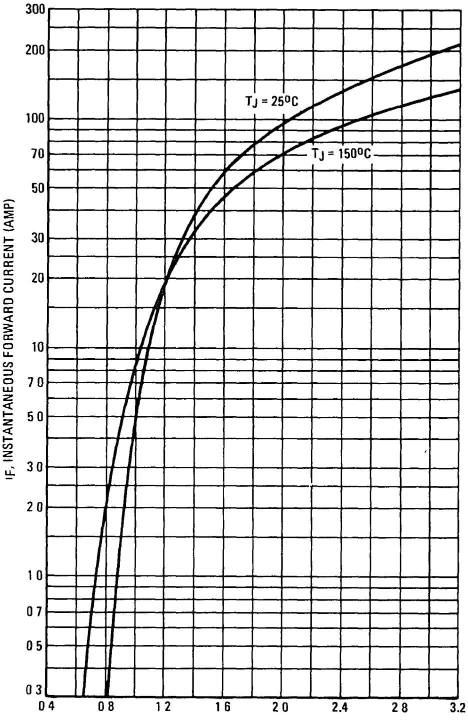
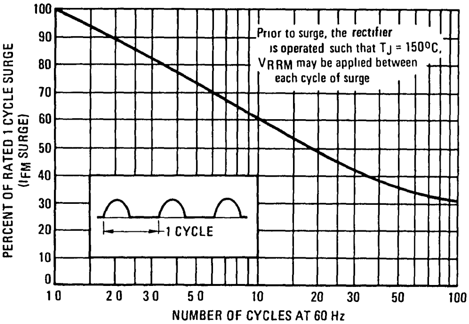
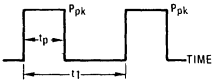


FIGURE 2 – MAXIMUM SURGE CAPABILITY



NOTE 1



DUTY CYCLE, $D = t_p/t_1$
PEAK POWER, P_{pk}, is peak of an equivalent square power pulse

To determine maximum junction temperature of the diode in a given situation, the following procedure is recommended

The temperature of the case should be measured using a thermocouple placed on the case at the temperature reference point (see Note 3) The thermal mass connected to the case is normally large enough so that it will not significantly respond to heat surges generated in the diode as a result of pulsed operation once steady state conditions are achieved Using the measured value of T_C, the junction temperature may be determined by

$$T_J = T_C + \Delta T_{JC}$$

where ΔT_{JC} is the increase in junction temperature above the case temperature It may be determined by

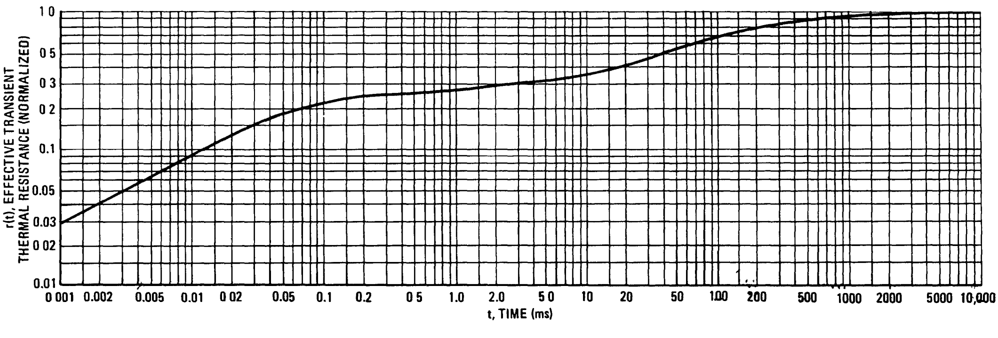
$$\Delta T_{JC} = P_{pk} \quad R_{\theta JC} [D + (1 - D) \quad r(t_1 + t_p) + r(t_p) - r(t_1)]$$

where

$r(t)$ = normalized value of transient thermal resistance at time, t, from Figure 3, i e

$r(t_1 + t_p)$ = normalized value of transient thermal resistance at time $t_1 + t_p$

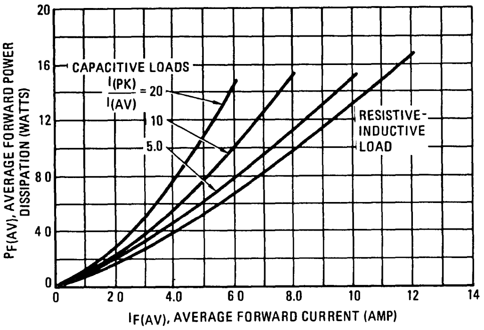
FIGURE 3 – THERMAL RESPONSE



3

SINE WAVE INPUT

FIGURE 4 – FORWARD POWER DISSIPATION



SQUARE WAVE INPUT

FIGURE 5 – FORWARD POWER DISSIPATION

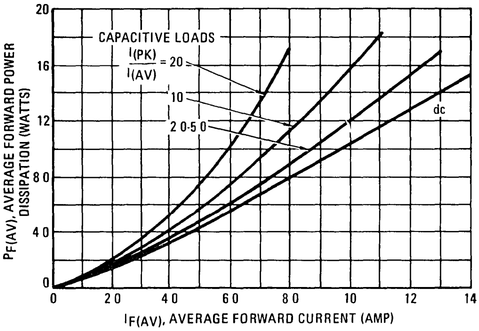


FIGURE 6 – CURRENT DERATING

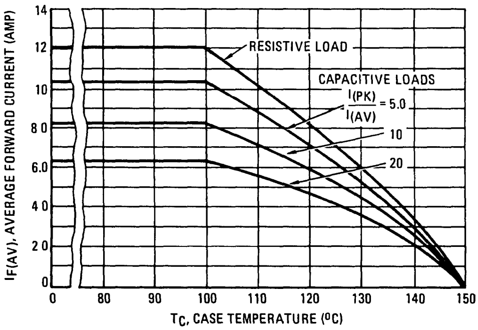


FIGURE 7 – CURRENT DERATING

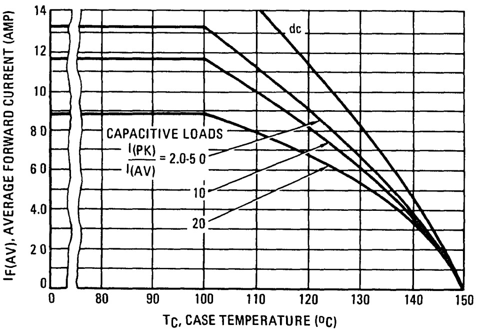


FIGURE 8 – TYPICAL REVERSE CURRENT

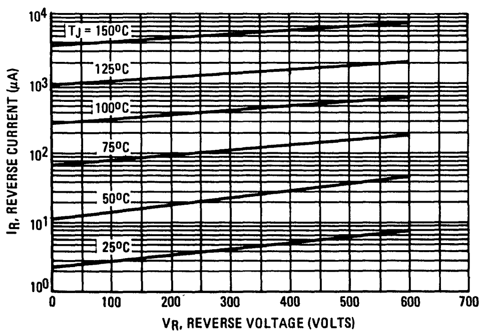
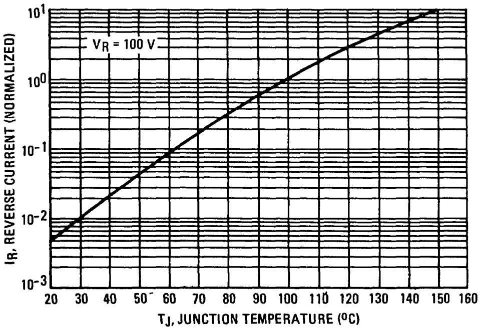


FIGURE 9 – NORMALIZED REVERSE CURRENT



TYPICAL DYNAMIC CHARACTERISTICS

FIGURE 10 – FORWARD RECOVERY TIME

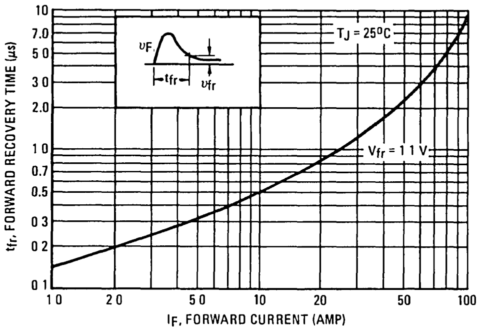
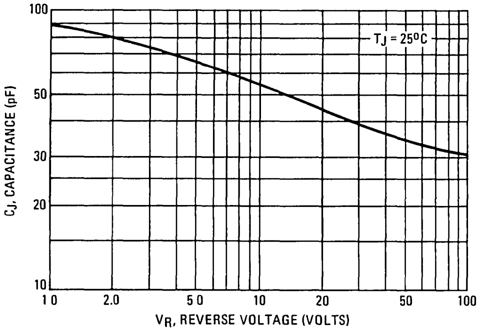


FIGURE 11 – JUNCTION CAPACITANCE



TYPICAL RECOVERED STORED CHARGE DATA

(See Note 2)

FIGURE 12 – T_J = 25°C

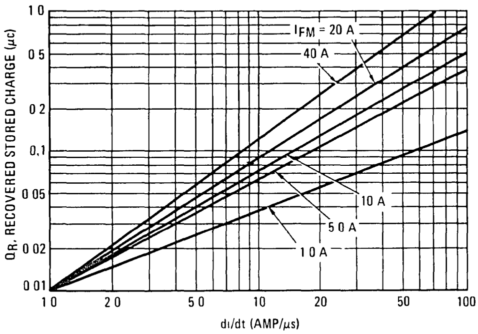


FIGURE 13 – T_J = 75°C

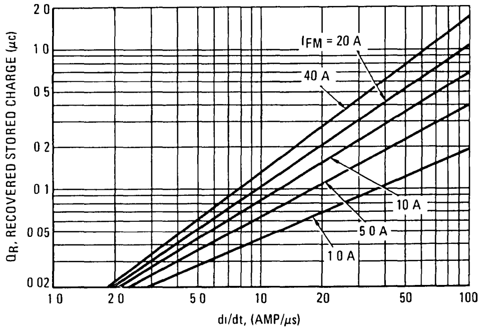


FIGURE 14 – T_J = 100°C

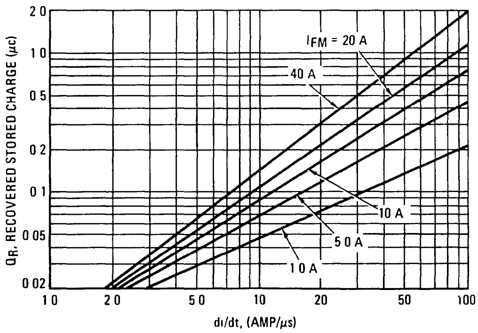


FIGURE 15 – T_J = 150°C

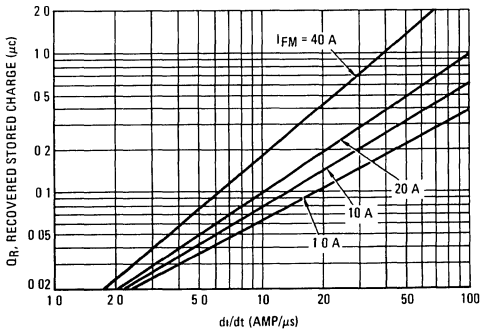
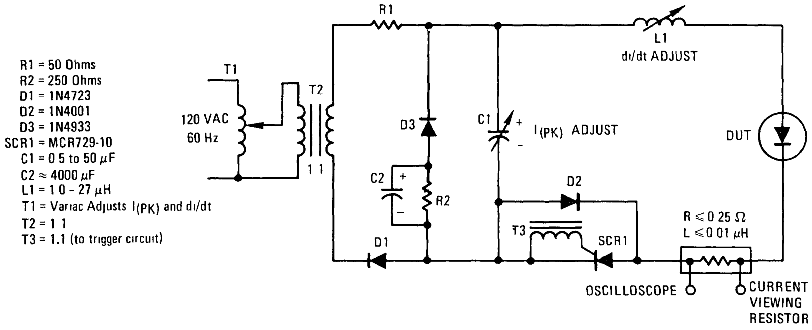


FIGURE 16 — JEDEC REVERSE RECOVERY CIRCUIT



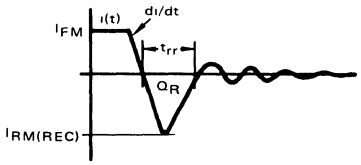
NOTE 2

Reverse recovery time is the period which elapses from the time that the current, thru a previously forward biased rectifier diode, passes thru zero going negatively until the reverse current recovers to a point which is less than 10% peak reverse current.

Reverse recovery time is a direct function of the forward current prior to the application of reverse voltage.

For any given rectifier, recovery time is very circuit dependent. Typical and maximum recovery time of all Motorola fast recovery power rectifiers are rated under a fixed set of conditions using I_F = 1.0 A, V_R = 30 V. In order to cover all circuit conditions, curves are given for typical recovered stored charge versus commutation di/dt for various levels of forward current and for junction temperatures of 25°C, 75°C, 100°C, and 150°C.

To use these curves, it is necessary to know the forward current level just before commutation, the circuit commutation di/dt, and the operating junction temperature. The reverse recovery test current waveform for all Motorola fast recovery rectifiers is shown.



From stored charge curves versus di/dt, recovery time (t_{rr}) and peak reverse recovery current ($I_{RM(REC)}$) can be closely approximated using the following formulas

$$t_{rr} = 1.41 \times \left[\frac{Q_R}{di/dt}\right]^{1/2}$$

$$I_{RM(REC)} = 1.41 \times \left[Q_R \times di/dt\right]^{1/2}$$

MOTOROLA
SEMICONDUCTOR
TECHNICAL DATA

1N3899 thru 1N3903
MR1386

Designers Data Sheet

STUD MOUNTED
FAST RECOVERY POWER RECTIFIERS

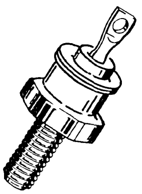
. . . designed for special applications such as dc power supplies, inverters, converters, ultrasonic systems, choppers, low RF interference, sonar power supplies and free wheeling diodes. A complete line of fast recovery rectifiers having typical recovery time of 150 nanoseconds providing high efficiency at frequencies to 250 kHz.

Designers Data for "Worst Case" Conditions

The Designers Data sheets permit the design of most circuits entirely from the information presented. Limit curves — representing boundaries on device characteristics — are given to facilitate "worst case" design.

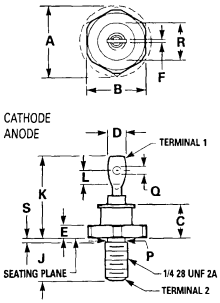
FAST RECOVERY POWER RECTIFIERS

50-600 VOLTS
20 AMPERES



3

STYLE 1
TERM 1 CATHODE
2 ANODE



DIM	MILLIMETERS MIN	MILLIMETERS MAX	INCHES MIN	INCHES MAX
A	—	20 07	—	0 790
B	16 94	17 45	0 669	0 687
C	—	11 43	—	0 450
D	—	9 53	—	0 375
E	2 92	5 08	0 115	0 200
F	—	2 03	—	0 080
J	10 72	11 51	0 422	0 453
K	19 05	25 40	0 750	1 00
L	3 96	—	0 156	—
P	5 59	6 32	0 220	0 249
Q	3 56	4 45	0 140	0 175
R	—	16 94	—	0 667
S	—	2 26	—	0 089

CASE 42A-01
DO-203AB
METAL

*MAXIMUM RATINGS

Rating	Symbol	1N3899	1N3900	1N3901	1N3902	1N3903	MR1386	Unit
Peak Repetitive Reverse Voltage Working Peak Reverse Voltage DC Blocking Voltage	V_{RRM} V_{RWM} V_R	50	100	200	300	400	600	Volts
Non-Repetitive Peak Reverse Voltage	V_{RSM}	75	150	250	350	450	650	Volts
RMS Reverse Voltage	$V_{R(RMS)}$	35	70	140	210	280	420	Volts
Average Rectified Forward Current (Single phase, resistive load, T_C = 100°C)	I_O	← 20 →						Amps
Non-Repetitive Peak Surge Current (surge applied at rated load conditions)	I_{FSM}	← 250 → (one cycle)						Amps
Operating Junction Temperature Range	T_J	← −65 to +150 →						°C
Storage Temperature Range	T_{stg}	← −65 to +175 →						°C

*THERMAL CHARACTERISTICS

Characteristic	Symbol	Max	Unit
Thermal Resistance, Junction to Case	$R_{\theta JC}$	1 8	°C/W

*ELECTRICAL CHARACTERISTICS

Characteristic	Symbol	Min	Typ	Max	Unit
Instantaneous Forward Voltage (i_F = 63 Amp, T_J = 150°C)	v_F	—	1 2	1 5	Volts
Forward Voltage (I_F = 20 Amp, T_C = 25°C)	V_F	—	1 1	1 4	Volts
Reverse Current (rated dc voltage) T_C = 25°C T_C = 100°C	I_R	— —	10 0.5	50 6 0	μA mA

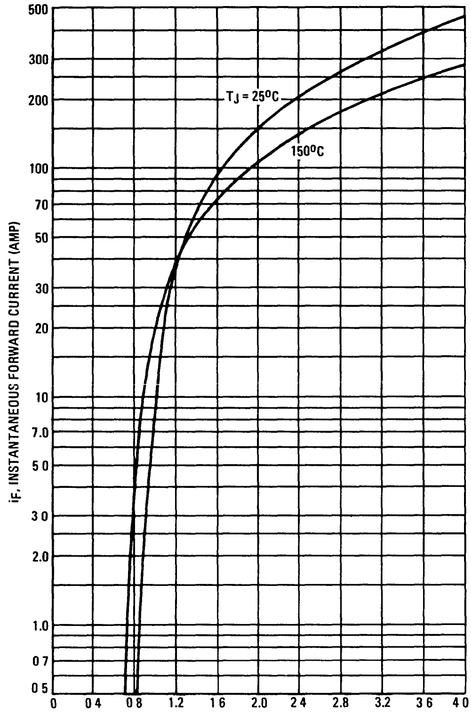
*REVERSE RECOVERY CHARACTERISTICS

Characteristic	Symbol	Min	Typ	Max	Unit
Reverse Recovery Time (I_F = 1.0 Amp to V_R = 30 Vdc, Figure 16) (I_{FM} = 36 Amp, di/dt = 25 A/μs, Figure 17)	t_{rr}	 — —	 150 200	 200 400	ns
Reverse Recovery Current (I_F = 1 0 Amp to V_R = 30 Vdc, Figure 16)	$I_{RM(REC)}$	—	—	3 0	Amp

*Indicates JEDEC Registered Data for 1N3899 Series

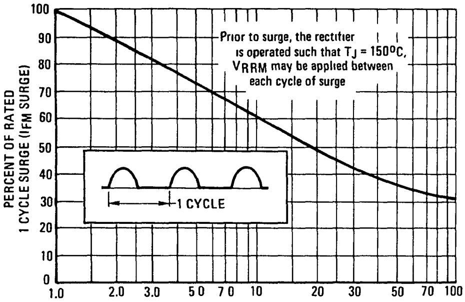
MECHANICAL CHARACTERISTICS
CASE: Welded, hermetically sealed
FINISH: All external surfaces corrosion resistant and readily solderable
POLARITY: Cathode to Case
WEIGHT: 17 grams (approximately)
MOUNTING TORQUE: 25 in-lb max

FIGURE 1 – FORWARD VOLTAGE



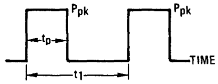
vF, INSTANTANEOUS FORWARD VOLTAGE (VOLTS)

FIGURE 2 – MAXIMUM SURGE CAPABILITY



NUMBER OF CYCLES AT 60 Hz

NOTE 1



DUTY CYCLE, $D = t_p/t_1$
PEAK POWER, P_{pk}, is peak of an equivalent square power pulse

To determine maximum junction temperature of the diode in a given situation, the following procedure is recommended

The temperature of the case should be measured using a thermocouple placed on the case at the temperature reference point (see Note 3) The thermal mass connected to the case is normally large enough so that it will not significantly respond to heat surges generated in the diode as a result of pulsed operation once steady state conditions are achieved Using the measured value of T_C, the junction temperature may be determined by

$$T_J = T_C + \Delta T_{JC}$$

where ΔT_{JC} is the increase in junction temperature above the case temperature It may be determined by

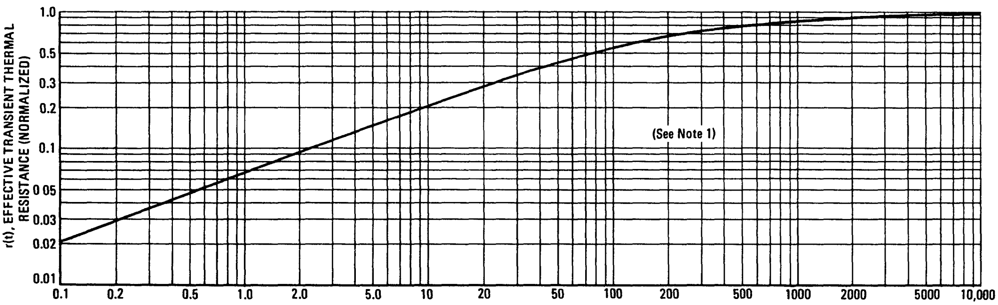
$$\Delta T_{JC} = P_{pk} \cdot R_{\theta JC} [D + (1 - D) \quad r(t_1 + t_p) + r(t_p) - r(t_1)]$$

where

$r(t)$ = normalized value of transient thermal resistance at time, t, from Figure 3, i e

$r(t_1 + t_p)$ = normalized value of transient thermal resistance at time $t_1 + t_p$

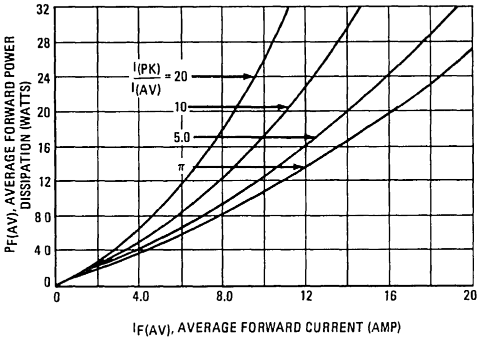
FIGURE 3 – THERMAL RESPONSE



t, TIME (ms)

SINE WAVE INPUT

FIGURE 4 — FORWARD POWER DISSIPATION



SQUARE WAVE INPUT

FIGURE 5 — FORWARD POWER DISSIPATION

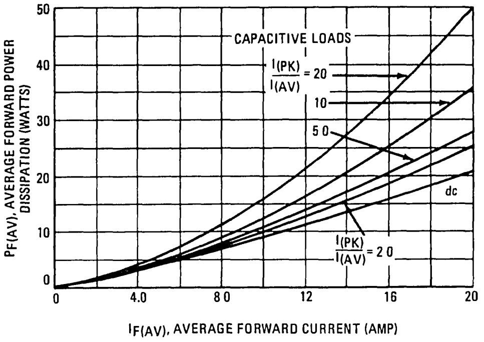


FIGURE 6 — CURRENT DERATING

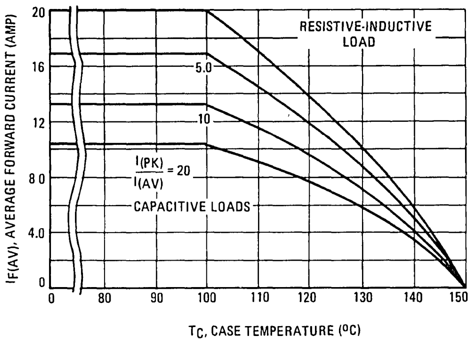


FIGURE 7 — CURRENT DERATING

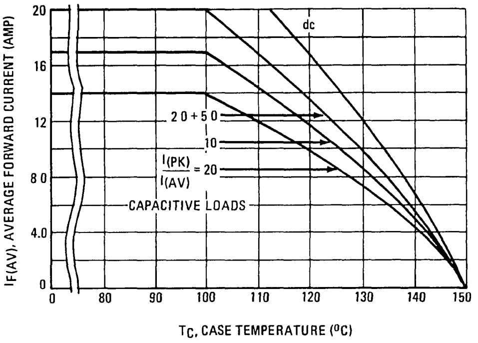


FIGURE 8 — TYPICAL REVERSE CURRENT

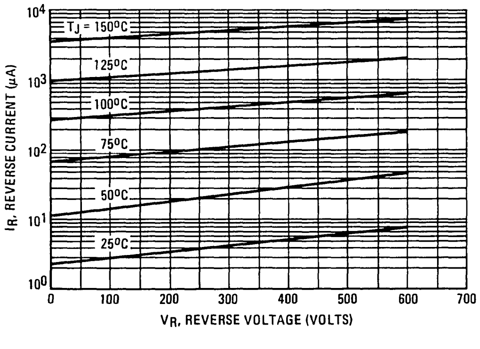
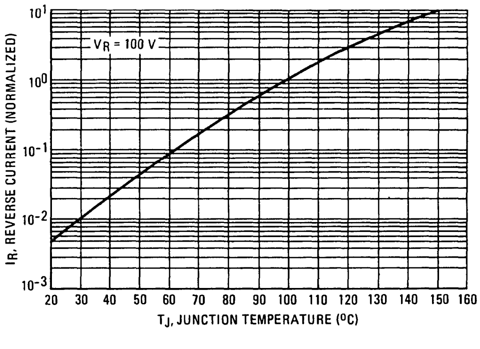


FIGURE 9 — NORMALIZED REVERSE CURRENT



3

TYPICAL DYNAMIC CHARACTERISTICS

FIGURE 10 – FORWARD RECOVERY TIME

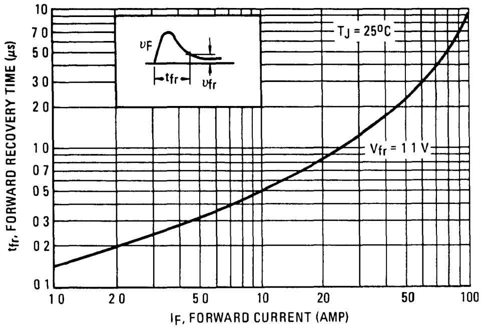
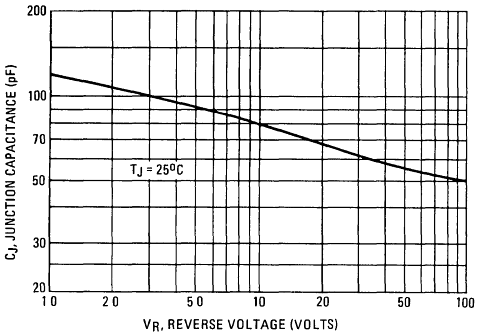


FIGURE 11 – JUNCTION CAPACITANCE



TYPICAL RECOVERED STORED CHARGE DATA

(See Note 2)

FIGURE 12 – T_J = 25°C

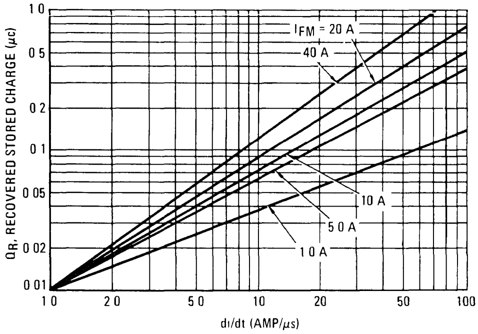
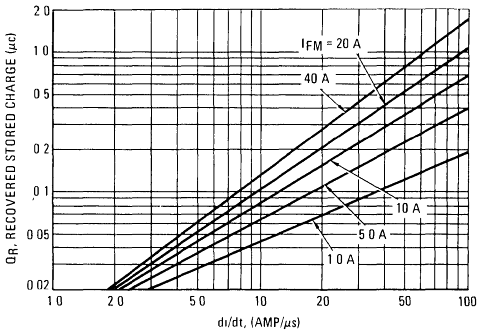


FIGURE 13 – T_J = 75°C



STORED CHARGE DATA

FIGURE 14 – T_J = 100°C

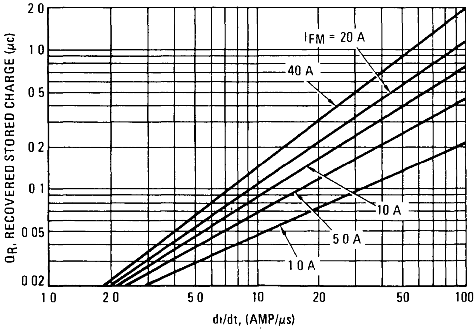


FIGURE 15 – T_J = 150°C

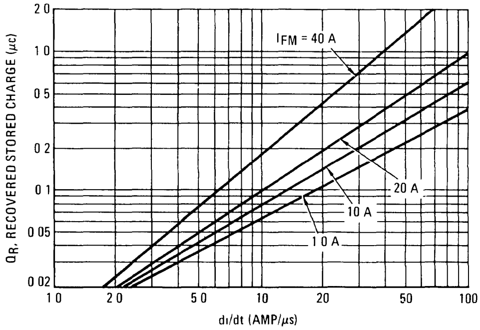
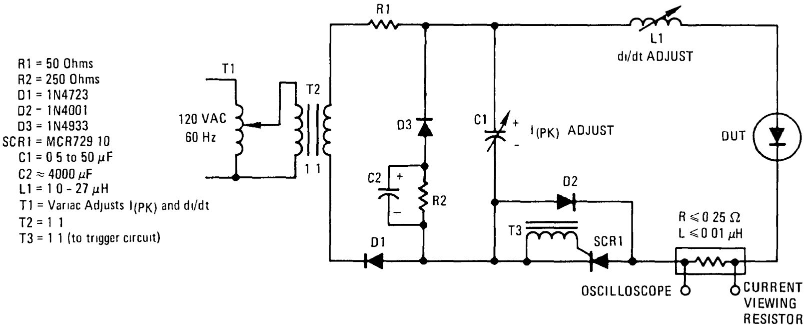


FIGURE 16 — JEDEC REVERSE RECOVERY CIRCUIT



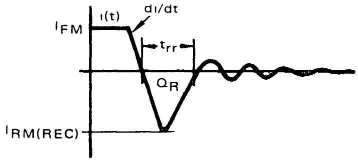
NOTE 2

Reverse recovery time is the period which elapses from the time that the current, thru a previously forward biased rectifier diode, passes thru zero going negatively until the reverse current recovers to a point which is less than 10% peak reverse current.

Reverse recovery time is a direct function of the forward current prior to the application of reverse voltage.

For any given rectifier, recovery time is very circuit dependent. Typical and maximum recovery time of all Motorola fast recovery power rectifiers are rated under a fixed set of conditions using I_F = 1.0 A, V_R = 30 V. In order to cover all circuit conditions, curves are given for typical recovered stored charge versus commutation di/dt for various levels of forward current and for junction temperatures of 25°C, 75°C, 100°C, and 150°C.

To use these curves, it is necessary to know the forward current level just before commutation, the circuit commutation di/dt, and the operating junction temperature. The reverse recovery test current waveform for all Motorola fast recovery rectifiers is shown.



From stored charge curves versus di/dt, recovery time (t_{rr}) and peak reverse recovery current ($I_{RM(REC)}$) can be closely approximated using the following formulas:

$$t_{rr} = 1.41 \times \left[\frac{Q_R}{di/dt}\right]^{1/2}$$

$$I_{RM(REC)} = 1.41 \times \left[Q_R \times di/dt\right]^{1/2}$$

3

MOTOROLA
SEMICONDUCTOR
TECHNICAL DATA

1N3909 thru 1N3913
MR1396

Designers Data Sheet

STUD MOUNTED
FAST RECOVERY POWER RECTIFIERS

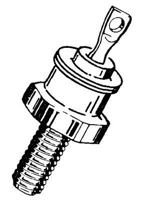
. . . designed for special applications such as dc power supplies, inverters, converters, ultrasonic systems, choppers, low RF interference, sonar power supplies and free wheeling diodes. A complete line of fast recovery rectifiers having typical recovery time of 150 nanoseconds providing high efficiency at frequencies to 250 kHz.

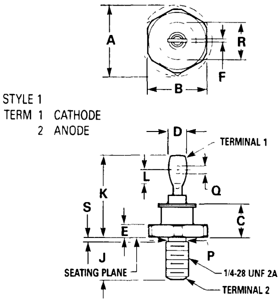
3

Designer's Data for "Worst Case" Conditions

The Designers Data sheets permit the design of most circuits entirely from the information presented Limit curves — representing boundaries on device characteristics -- are given to facilitate "worst case" design

FAST RECOVERY
POWER RECTIFIERS
50-600 VOLTS
30 AMPERES





DIM	MILLIMETERS MIN	MILLIMETERS MAX	INCHES MIN	INCHES MAX
A	—	20 07	—	0 790
B	16 94	17 45	0 669	0 687
C	—	11 43	—	0 450
D	—	9 53	—	0 375
E	2 92	5 08	0 115	0 200
F	—	2 03	—	0 080
J	10 72	11 51	0 422	0 453
K	19 05	25 40	0 750	1 00
L	3 96	—	0 156	—
P	5 59	6 32	0 220	0 249
Q	3 56	4 45	0 140	0 175
R	—	16 94	—	0 667
S	—	2 26	—	0 089

CASE 42A-01
DO-203AB
METAL

*MAXIMUM RATINGS

Rating	Symbol	1N3909	1N3910	1N3911	1N3912	1N3913	MR1396	Unit
Peak Repetitive Reverse Voltage Working Peak Reverse Voltage DC Blocking Voltage	V_{RRM} V_{RWM} V_R	50	100	200	300	400	600	Volts
Non-Repetitive Peak Reverse Voltage	V_{RSM}	75	150	250	350	450	650	Volts
RMS Reverse Voltage	$V_{R(RMS)}$	35	70	140	210	280	420	Volts
Average Rectified Forward Current (Single phase, resistive load, $T_C = 100°C$)	I_O	← 30 →						Amps
Non-Repetitive Peak Surge Current (surge applied at rated load conditions)	I_{FSM}	← 300 →						Amp
Operating Junction Temperature Range	T_J	← -65 to +150 →						°C
Storage Temperature Range	T_{stg}	← -65 to +175 →						°C

THERMAL CHARACTERISTICS

Characteristic	Symbol	Max	Unit
Thermal Resistance, Junction to Case	$R_{\theta JC}$	1 2	°C/W

*ELECTRICAL CHARACTERISTICS

Characteristic	Symbol	Min	Typ	Max	Unit
Instantaneous Forward Voltage (i_F = 93 Amp, T_J = 150°C)	v_F	—	1 2	1 5	Volts
Forward Voltage (I_F = 30 Amp, T_C = 25°C)	V_F	—	1 1	1 4	Volts
Reverse Current (rated dc voltage) T_C = 25°C T_C = 100°C	I_R	— —	10 0 5	25 1 0	μA mA

*REVERSE RECOVERY CHARACTERISTICS

Characteristic	Symbol	Min	Typ	Max	Unit
Reverse Recovery Time (I_F = 1 0 Amp to V_R = 30 Vdc, Figure 16) (I_{FM} = 36 Amp, di/dt = 25 A/μs, Figure 17)	t_{rr}	 — —	 150 200	 200 400	ns
Reverse Recovery Current (I_F = 1 0 Amp to V_R = 30 Vdc, Figure 16)	$I_{RM(REC)}$	—	1 5	2 0	Amp

*Indicates JEDEC Registered Data for 1N3909 Series

MECHANICAL CHARACTERISTICS

CASE: Welded, hermetically sealed

FINISH: All external surfaces corrosion resistant and readily solderable

POLARITY: Cathode to Case

WEIGHT: 17 Grams (Approximately)

MOUNTING TORQUE: 25 in-lbs max.

FIGURE 1 – FORWARD VOLTAGE

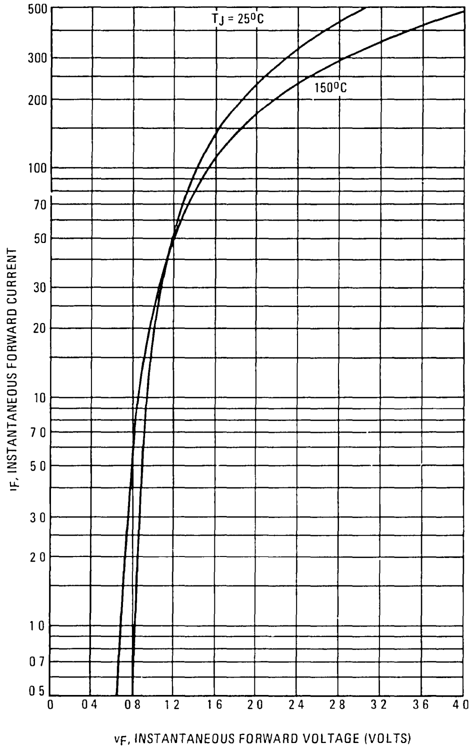
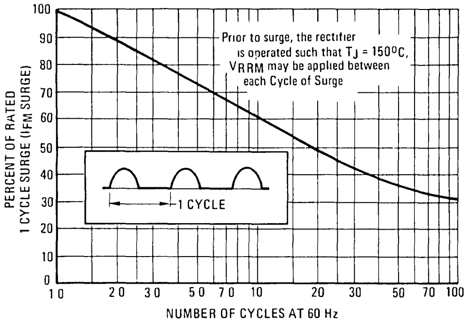
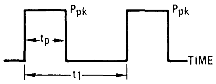


FIGURE 2 – MAXIMUM SURGE CAPABILITY



NOTE 1



DUTY CYCLE, $D = t_p/t_1$
PEAK POWER, P_{pk}, is peak of an equivalent square power pulse

To determine maximum junction temperature of the diode in a given situation, the following procedure is recommended

The temperature of the case should be measured using a thermocouple placed on the case at the temperature reference point (see Note 3) The thermal mass connected to the case is normally large enough so that it will not significantly respond to heat surges generated in the diode as a result of pulsed operation once steady state conditions are achieved Using the measured value of T_C, the junction temperature may be determined by

$$T_J = T_C + \Delta T_{JC}$$

where ΔT_{JC} is the increase in junction temperature above the case temperature It may be determined by

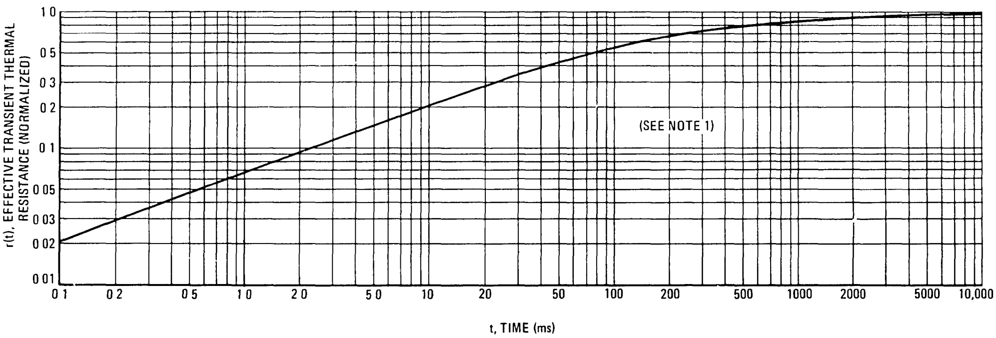
$$\Delta T_{JC} = P_{pk} \quad R_{\theta JC} [D + (1 - D) \quad r(t_1 + t_p) + r(t_p) - r(t_1)]$$

where

$r(t)$ = normalized value of transient thermal resistance at time, t, from Figure 3, i e

$r(t_1 + t_p)$ = normalized value of transient thermal resistance at time $t_1 + t_p$

FIGURE 3 – THERMAL RESPONSE



SINE WAVE INPUT

SQUARE WAVE INPUT

FIGURE 4 – FORWARD POWER DISSIPATION

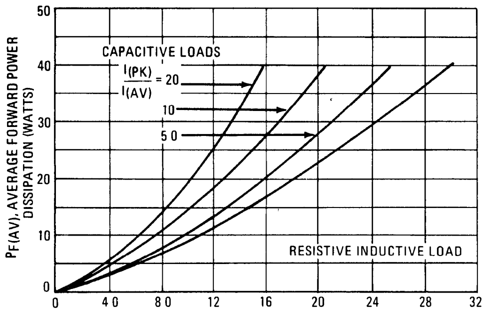


FIGURE 5 – FORWARD POWER DISSIPATION

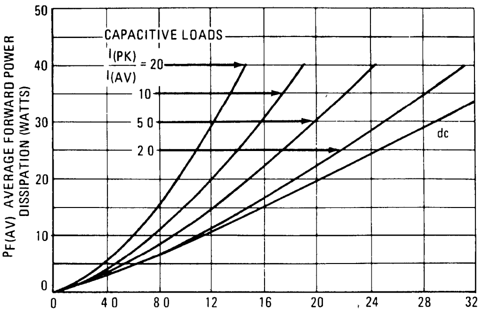


FIGURE 6 – CURRENT DERATING

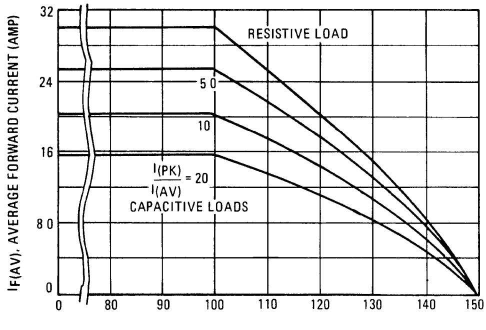


FIGURE 7 – CURRENT DERATING

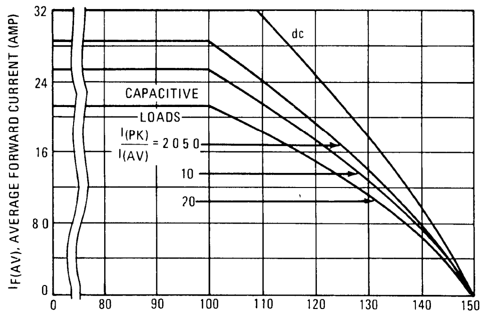


FIGURE 8 – TYPICAL REVERSE CURRENT

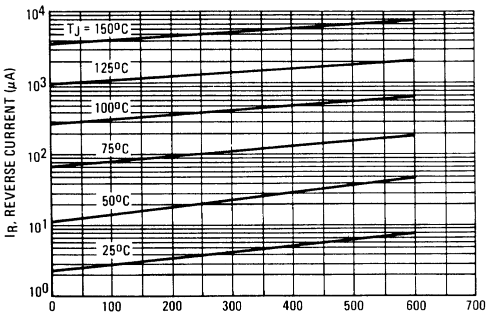
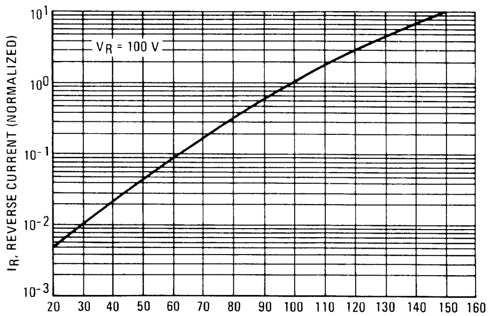


FIGURE 9 – NORMALIZED REVERSE CURRENT



TYPICAL DYNAMIC CHARACTERISTICS

FIGURE 10 – FORWARD RECOVERY TIME

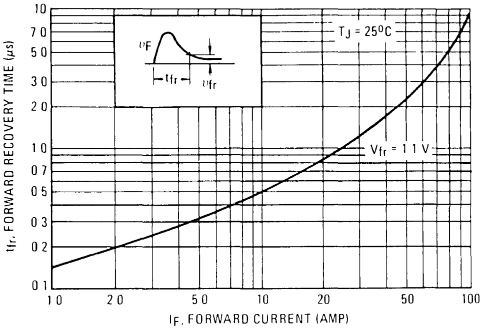
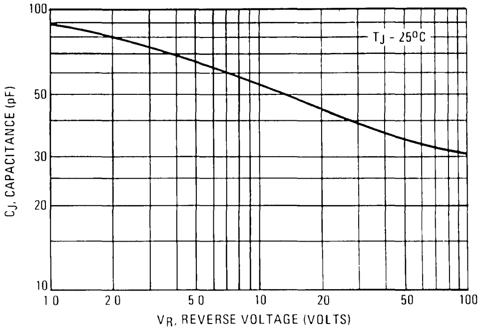


FIGURE 11 – JUNCTION CAPACITANCE



TYPICAL RECOVERED STORED CHARGE DATA

(SEE NOTE 2)

FIGURE 12 – $T_J = 25^oC$

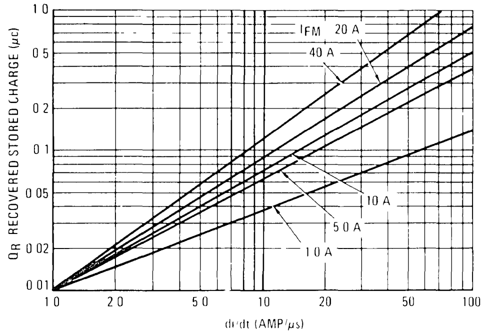


FIGURE 13 – $T_J = 75^oC$

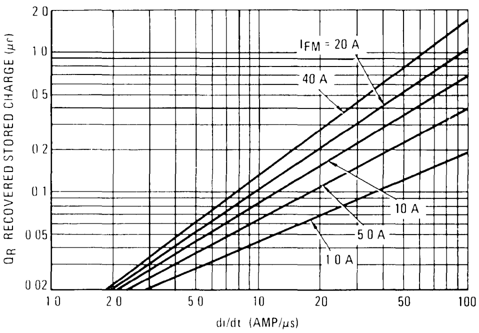


FIGURE 14 – $T_J = 100^oC$

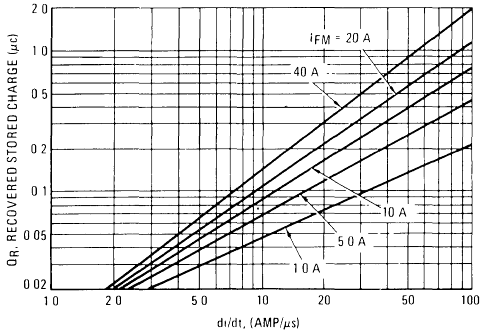


FIGURE 15 – $T_J = 150^oC$

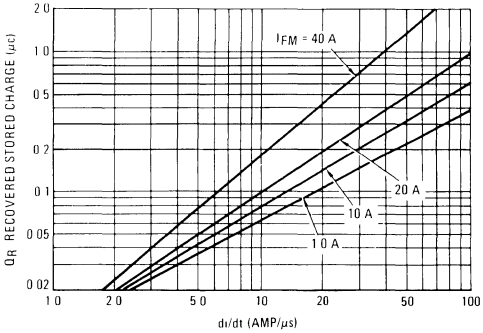


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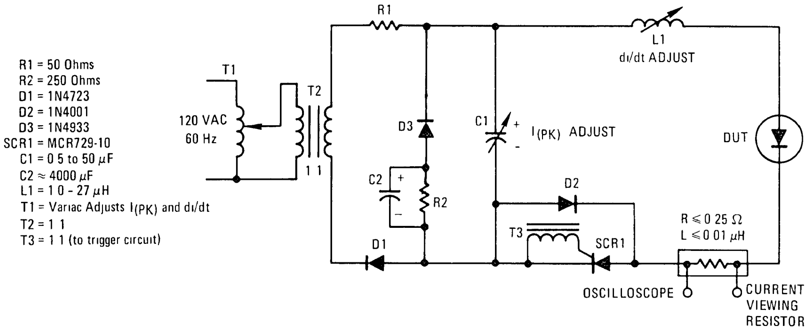
FIGURE 16 — JEDEC REVERSE RECOVERY CIRCUIT



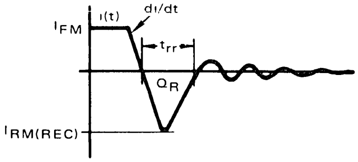
NOTE 3

Reverse recovery time is the period which elapses from the time that the current, thru a previously forward biased rectifier diode, passes thru zero going negatively until the reverse current recovers to a point which is less than 10% peak reverse current

Reverse recovery time is a direct function of the forward current prior to the application of reverse voltage

For any given rectifier, recovery time is very circuit dependent. Typical and maximum recovery time of all Motorola fast recovery power rectifiers are rated under a fixed set of conditions using I_F = 1.0 A, V_R = 30 V In order to cover all circuit conditions, curves are given for typical recovered stored charge versus commutation di/dt for various levels of forward current and for junction temperatures of 25°C, 75°C, 100°C, and 150°C.

To use these curves, it is necessary to know the forward current level just before commutation, the circuit commutation di/dt, and the operating junction temperature. The reverse recovery test current waveform for all Motorola fast recovery rectifiers is shown.



From stored charge curves versus di/dt, recovery time (t_{rr}) and peak reverse recovery current ($I_{RM(REC)}$) can be closely approximated using the following formulas

$$t_{rr} = 1.41 \times \left[\frac{Q_R}{di/dt}\right]^{1/2}$$

$$I_{RM(REC)} = 1.41 \times \left[Q_R \times di/dt\right]^{1/2}$$

MOTOROLA
SEMICONDUCTOR
TECHNICAL DATA

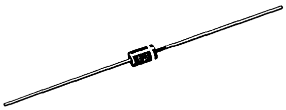
1N4001 thru 1N4007

GENERAL-PURPOSE RECTIFIERS

. . . subminiature size, axial lead mounted rectifiers for general-purpose low-power applications.

LEAD MOUNTED SILICON RECTIFIERS

50-1000 VOLTS
DIFFUSED JUNCTION



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*MAXIMUM RATINGS

Rating	Symbol	1N4001	1N4002	1N4003	1N4004	1N4005	1N4006	1N4007	Unit
Peak Repetitive Reverse Voltage Working Peak Reverse Voltage DC Blocking Voltage	V_{RRM} V_{RWM} V_R	50	100	200	400	600	800	1000	Volts
Non-Repetitive Peak Reverse Voltage (halfwave, single phase, 60 Hz)	V_{RSM}	60	120	240	480	720	1000	1200	Volts
RMS Reverse Voltage	$V_{R(RMS)}$	35	70	140	280	420	560	700	Volts
Average Rectified Forward Current (single phase, resistive load, 60 Hz, see Figure 8, T_A = 75°C)	I_O	← 1.0 →							Amp
Non-Repetitive Peak Surge Current (surge applied at rated load conditions, see Figure 2)	I_{FSM}	← 30 (for 1 cycle) →							Amp
Operating and Storage Junction Temperature Range	T_J, T_{stg}	← -65 to +175 →							°C

*ELECTRICAL CHARACTERISTICS

Characteristic and Conditions	Symbol	Typ	Max	Unit
Maximum Instantaneous Forward Voltage Drop (i_F = 1.0 Amp, T_J = 25°C) Figure 1	v_F	0.93	1.1	Volts
Maximum Full-Cycle Average Forward Voltage Drop (I_O = 1.0 Amp, T_L = 75°C, 1 inch leads)	$V_{F(AV)}$	–	0.8	Volts
Maximum Reverse Current (rated dc voltage)	I_R			μA
T_J = 25°C		0.05	10	
T_J = 100°C		1.0	50	
Maximum Full-Cycle Average Reverse Current (I_O = 1.0 Amp, T_L = 75°C, 1 inch leads	$I_{R(AV)}$	–	30	μA

*Indicates JEDEC Registered Data

MECHANICAL CHARACTERISTICS

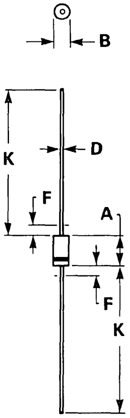
CASE: Transfer Molded Plastic

MAXIMUM LEAD TEMPERATURE FOR SOLDERING PURPOSES: 350°C, 3/8″ from case for 10 seconds at 5 lbs. tension

FINISH: All external surfaces are corrosion-resistant, leads are readily solderable

POLARITY: Cathode indicated by color band

WEIGHT: 0.40 Grams (approximately)



NOTES:
1. ALL RULES AND NOTES ASSOCIATED WITH JEDEC DO-41 OUTLINE SHALL APPLY.
2. POLARITY DENOTED BY CATHODE BAND.
3. LEAD DIAMETER NOT CONTROLLED WITHIN "F" DIMENSION

DIM	MILLIMETERS MIN	MILLIMETERS MAX	INCHES MIN	INCHES MAX
A	4.07	5.20	0.160	0.205
B	2.04	2.71	0.080	0.107
D	0.71	0.86	0.028	0.034
F	—	1.27	—	0.050
K	27.94	—	1.100	—

CASE 59-03
DO-41
PLASTIC

MOTOROLA
SEMICONDUCTOR
TECHNICAL DATA

1N4719 thru 1N4725

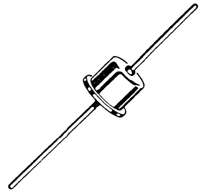
SILICON RECTIFIERS

3.0 AMPERES
50-1000 VOLTS
DIFFUSED JUNCTION

LEAD MOUNTED POWER RECTIFIERS

having low forward voltage drop and hermetic metal packages High surge current capability and good thermal characteristics provide reliable operation

- $R_{\theta JA}$ = 30°C/W



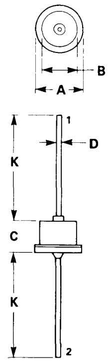
***MAXIMUM RATINGS** (Both Package Types) T_A = 25°C unless otherwise noted

Rating	Symbol	1N4719	1N4720	1N4721	1N4722	1N4723	1N4724	1N4725	Unit
Peak Repetitive Reverse Voltage Working Peak Reverse Voltage DC Blocking Voltage	V_{RRM} V_{RWM} V_R	50	100	200	400	600	800	1000	Volts
Nonrepetitive Peak Reverse Voltage (one half-wave, single phase, 60 cycle peak)	V_{RSM}	100	200	300	500	720	1000	1200	Volts
RMS Reverse Voltage	$V_{R(RMS)}$	35	70	140	280	420	560	700	Volts
Average Rectified Forward Current (single phase, resistive load, 60 Hz, T_A = 75°C)	I_O	← 3.0 →							Amp
Nonrepetitive Peak Surge Current (superimposed on rated current at rated voltage, T_A = 75°C)	I_{FSM}	← 300 (for 1/2 cycle) →							Amp
Operating and Case Temperature	T_J, T_{stg}	← -65 to +175 →							°C

ELECTRICAL CHARACTERISTICS

Characteristic	Symbol	Max Limit	Unit
*Instantaneous Forward Voltage (i_F = 3.0 A, T_J = 75°C, Half Wave Rectifier)	v_F	1.0	Volts
*Full Cycle Average Reverse Current (I_O = 3.0 Amps and Rated V_R, T_A = 75°C, Half Wave Rectifier)	$I_{R(AV)}$	1.5	mA
DC Reverse Current (Rated V_R, T_A = 25°C)	I_R	0.5	mA

*Indicates JEDEC Registered Data



DIM	MILLIMETERS MIN	MILLIMETERS MAX	INCHES MIN	INCHES MAX
A	—	11.43	—	0.450
B	—	8.89	—	0.350
C	—	7.62	—	0.300
D	1.17	1.42	0.046	0.056
K	24.89	—	0.980	—

CASE 60-01
METAL

MECHANICAL CHARACTERISTICS

CASE: Welded, hermetically sealed construction
FINISH: All external surfaces corrosion-resistant and leads readily solderable
POLARITY. CATHODE TO CASE
MOUNTING POSITIONS. Any

MOTOROLA
SEMICONDUCTOR
TECHNICAL DATA

1N4933 thru 1N4937

Designers Data Sheet

AXIAL-LEAD, FAST-RECOVERY RECTIFIERS

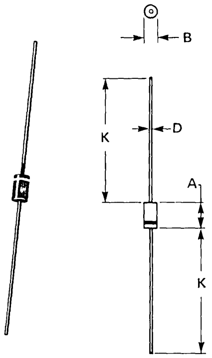
. . . designed for special applications such as dc power supplies, inverters, converters, ultrasonic systems, choppers, low RF interference and free wheeling diodes. A complete line of fast recovery rectifiers having typical recovery time of 150 nanoseconds providing high efficiency at frequencies to 250 kHz.

Designer's Data for "Worst Case" Conditions

The Designers Data Sheet permits the design of most circuits entirely from the information presented Limit curves — representing device characteristics boundaries — are given to facilitate "worst case" design

FAST RECOVERY RECTIFIERS

50—600 VOLTS
1 AMPERE



NOTES
1 ALL RULES AND NOTES ASSOCIATED WITH JEDEC DO 41 OUTLINE SHALL APPLY
2 POLARITY DENOTED BY CATHODE BAND
3 LEAD DIAMETER NOT CONTROLLED WITHIN "F" DIMENSION

DIM	MILLIMETERS MIN	MILLIMETERS MAX	INCHES MIN	INCHES MAX
A	5.97	6.60	0.235	0.260
B	2.79	3.05	0.110	0.120
D	0.76	0.86	0.030	0.034
K	27.94	—	1.100	—

CASE 59-04
DO-41
PLASTIC

*MAXIMUM RATINGS

Rating	Symbol	1N4933	1N4934	1N4935	1N4936	1N4937	Unit
Peak Repetitive Reverse Voltage Working Peak Reverse Voltage DC Blocking Voltage	V_{RRM} V_{RWM} V_R	50	100	200	400	600	Volts
Nonrepetitive Peak Reverse Voltage	V_{RSM}	75	150	250	450	650	Volts
RMS Reverse Voltage	$V_{R(RMS)}$	35	70	140	280	420	Volts
Average Rectified Forward Current (Single phase, resistive load, $T_A = 75^{\circ}C$)	I_O	← 1.0 →					Amp
Nonrepetitive Peak Surge Current (Surge applied at rated load conditions)	I_{FSM}	← 30 →					Amps
Operating Junction Temperature Range	T_J	← −65 to +150 →					°C
Storage Temperature Range	T_{stg}	← −65 to +175 →					°C

*THERMAL CHARACTERISTICS

Characteristic	Symbol	Max	Unit
Thermal Resistance, Junction to Ambient (Typical Printed Circuit-Board Mounting)	$R_{\theta JA}$	65	°C/W

*ELECTRICAL CHARACTERISTICS

Characteristic	Symbol	Min	Typ	Max	Unit
*Instantaneous Forward Voltage ($i_F = 3.14$ Amp, $T_J = 150^{\circ}C$)	v_F	—	1.0	1.2	Volts
Forward Voltage ($I_F = 1.0$ Amp, $T_A = 25^{\circ}C$)	V_F	—	1.0	1.2	Volts
*Reverse Current (Rated dc Voltage) $T_A = 25^{\circ}C$	I_R	—	1.0	5.0	µA
$T_A = 100^{\circ}C$		—	50	100	

*REVERSE RECOVERY CHARACTERISTICS

Characteristic	Symbol	Min	Typ	Max	Unit
Reverse Recovery Time ($I_F = 1.0$ Amp to $V_R = 30$ Vdc) (Figure 21)	t_{rr}	—	150	200	ns
($I_{FM} = 15$ Amp, di/dt = 10A/µs (Figure 22)		—	175	300	
Reverse Recovery Current ($I_F = 1.0$ Amp to $V_R = 30$ Vdc) (Figure 21)	$I_{RM(REC)}$	—	1.0	2.0	Amp

*Indicates JEDEC Registered Data

MECHANICAL CHARACTERISTICS

CASE: Transfer Molded Plastic
FINISH: External leads are readily solderable
POLARITY: Cathode indicated by polarity band
WEIGHT: 0.4 Gram (approximately)

3

FIGURE 1 – FORWARD VOLTAGE

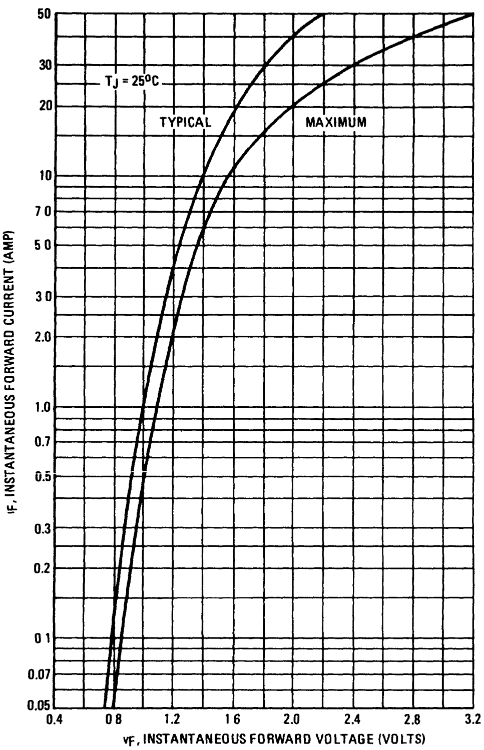


FIGURE 2 – MAXIMUM SURGE CAPABILITY

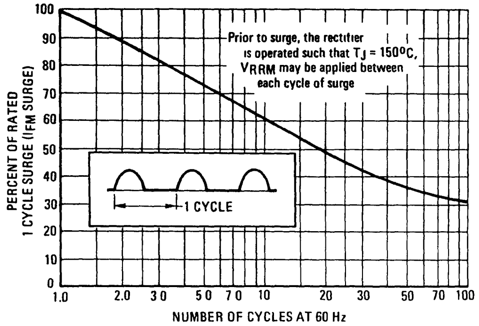
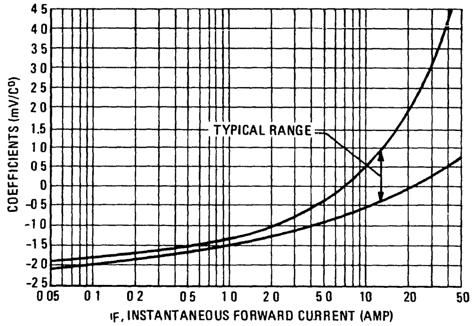
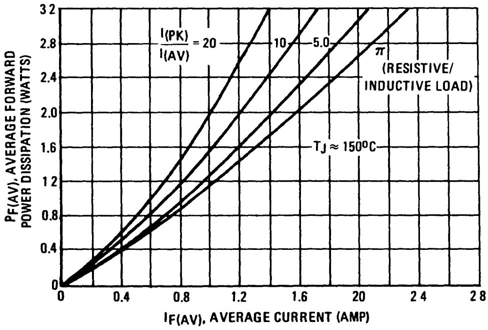


FIGURE 3 – FORWARD VOLTAGE TEMPERATURE COEFFICIENT



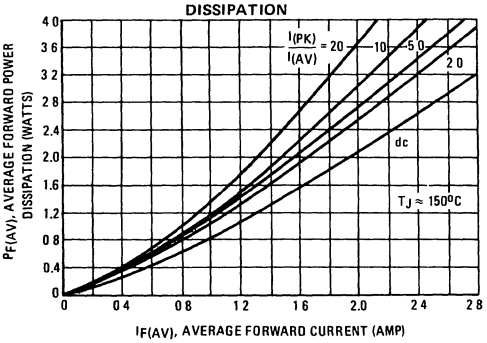
SINE WAVE INPUT

FIGURE 4 – FORWARD POWER DISSIPATION



SQUARE WAVE INPUT

FIGURE 5 – FORWARD POWER DISSIPATION

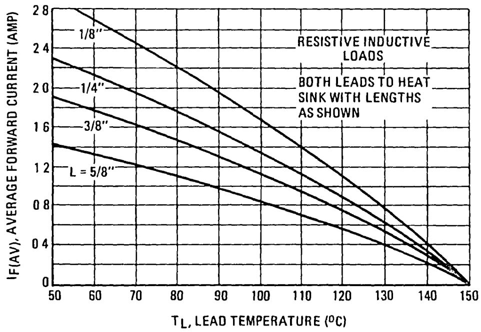


3

MAXIMUM CURRENT RATINGS

SINE WAVE INPUT

FIGURE 6 – EFFECT OF LEAD LENGTHS, RESISTIVE LOAD



SQUARE WAVE INPUT

FIGURE 7 – EFFECT OF LEAD LENGTHS, RESISTIVE LOAD

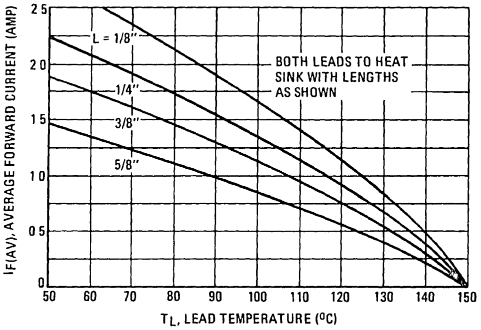


FIGURE 8 – 1/8" LEAD LENGTH, VARIOUS LOADS

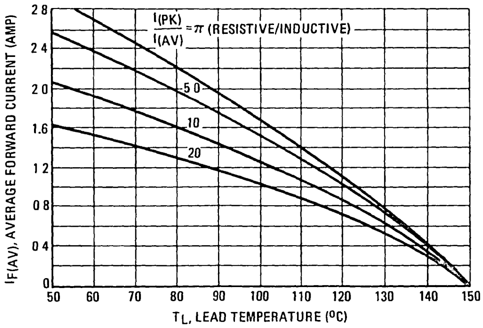


FIGURE 9 – 1/8" LEAD LENGTHS, VARIOUS LOADS

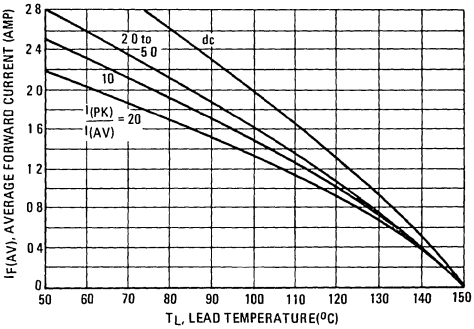


FIGURE 10 – PRINTED CIRCUIT BOARD MOUNTING, VARIOUS LOADS

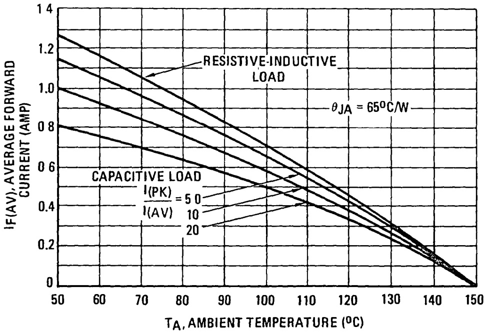
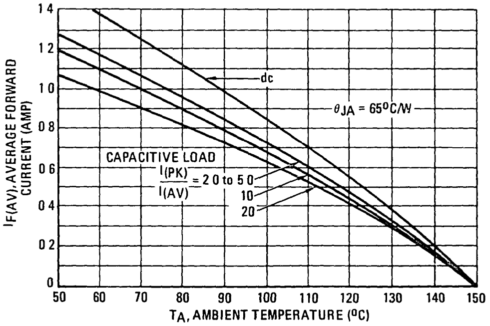


FIGURE 11 – PRINTED CIRCUIT BOARD MOUNTING, VARIOUS LOADS



3

FIGURE 12 – THERMAL RESPONSE

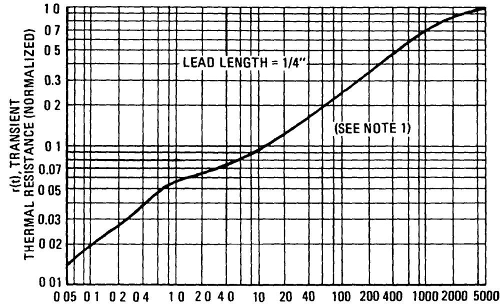
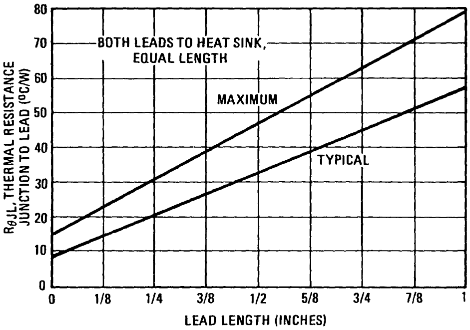
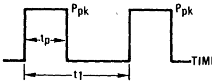


FIGURE 13 – THERMAL RESISTANCE



NOTE 1



DUTY CYCLE, $D = t_p/t_1$
PEAK POWER, P_{pk}, is peak of an equivalent square power pulse

To determine maximum junction temperature of the diode in a given situation, the following procedure is recommended

The temperature of the case should be measured using a thermocouple placed on the case at the temperature reference point (see Note 3) The thermal mass connected to the case is normally large enough so that it will not significantly respond to heat surges generated in the diode as a result of pulsed operation once steady-state conditions are achieved Using the measured value of T_C, the junction temperature may be determined by

$$T_J = T_C + \Delta T_{JC}$$

where ΔT_{JC} is the increase in junction temperature above the case temperature It may be determined by

$$\Delta T_{JC} = P_{pk} \; R_{\theta JC} \; [D + (1 - D) \quad r(t_1 + t_p) + r(t_p) - r(t_1)]$$

where
$r(t)$ = normalized value of transient thermal resistance at time, t, from Figure 3, i e
$r(t_1 + t_p)$ = normalized value of transient thermal resistance at time $t_1 + t_p$

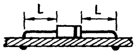
NOTE 2

Data shown for thermal resistance junction-to-ambient (θ_{JA}) for the mountings shown is to be used as typical guideline values for preliminary engineering or in case the tie point temperature cannot be measured

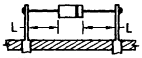
TYPICAL VALUES FOR θ_{JA} IN STILL AIR

MOUNTING METHOD	LEAD LENGTH, L (IN) 1/8	1/4	1/2	3/4	$R_{\theta JA}$
1	65	72	82	92	°C/W
2	74	81	91	101	°C/W
3	40				°C/W

MOUNTING METHOD 1



MOUNTING METHOD 2



Vector pin mounting

MOUNTING METHOD 3

P. C Board with 1-1/2" x 1-1/2" copper surface

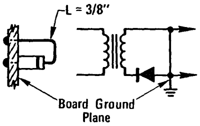
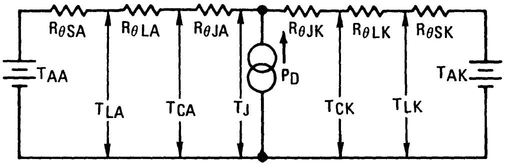


FIGURE 14 – THERMAL CIRCUIT MODEL
(For Heat Conduction Through The Leads)



Use of the above model permits junction to lead thermal resistance for any mounting configuration to be found For a given total lead length, lowest values occur when one side of the rectifier is brought as close as possible to the heat sink Terms in the model signify

T_A = Ambient Temperature
T_L = Lead Temperature
T_C = Case Temperature
T_J = Junction Temperature
$R_{\theta S}$ = Thermal Resistance, Heat Sink to Ambient
$R_{\theta L}$ = Thermal Resistance, Lead to Heat Sink
$R_{\theta J}$ = Thermal Resistance, Junction to Case
P_D = Power Dissipation

(Subscripts A and K refer to anode and cathode sides respectively)

Values for thermal resistance components are
$R_{\theta L}$ = 112°C/W/IN Typically and 128°C/W/IN Maximum
$R_{\theta J}$ = 18°C/W Typically and 30°C/W Maximum

The maximum lead temperature may be calculated as follows

$$T_L = 150^\circ - \Delta T_{JL}$$

ΔT_{JL} can be calculated as shown in NOTE 1 or it may be approximated as follows.

$\Delta T_{JL} \approx R_{\theta JL} \bullet P_F$. P_F may be formulated for sine-wave operation from Figure 3 or from Figure 4 for square-wave operation

TYPICAL DYNAMIC CHARACTERISTICS

FIGURE 15 – FORWARD RECOVERY TIME

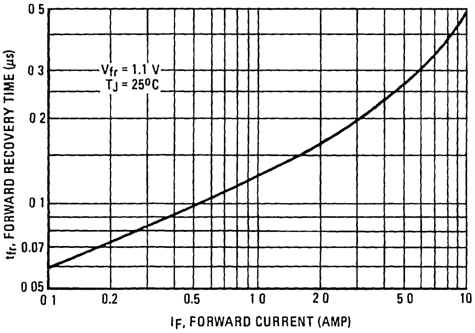
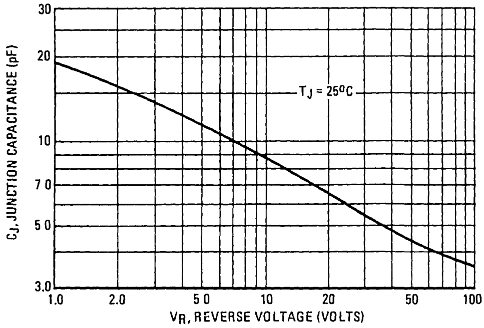


FIGURE 16 – JUNCTION CAPACITANCE



TYPICAL RECOVERED STORED CHARGED DATA

FIGURE 17 – T_J = 25°C

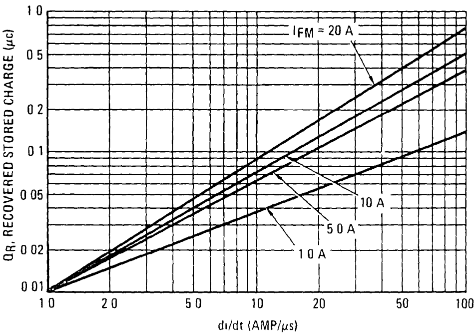


FIGURE 18 – T_J = 75°C

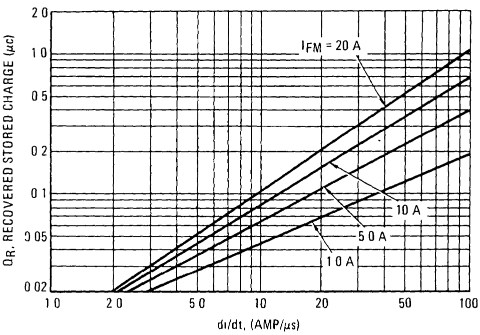


FIGURE 19 – T_J = 100°C

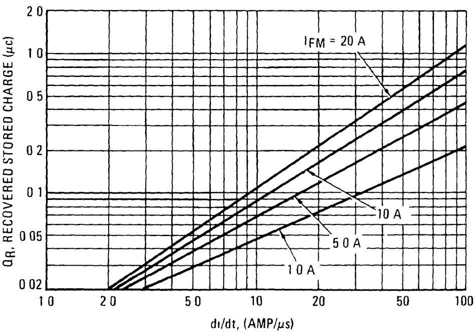


FIGURE 20 – T_J = 150°C

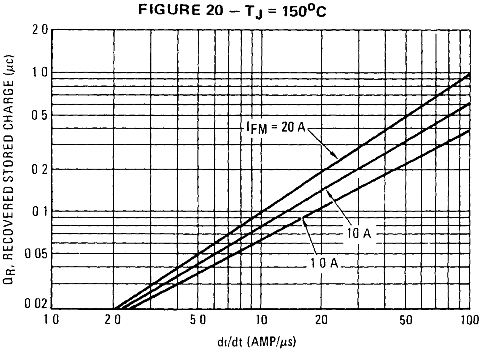
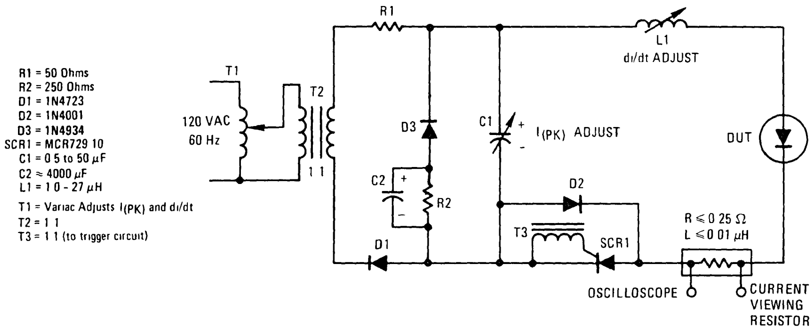


FIGURE 21 — JEDEC REVERSE RECOVERY CIRCUIT



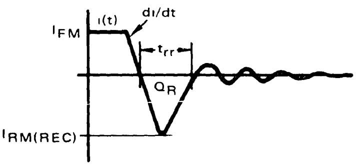
NOTE 3

Reverse recovery time is the period which elapses from the time that the current, thru a previously forward biased rectifier diode, passes thru zero going negatively until the reverse current recovers to a point which is less than 10% peak reverse current.

Reverse recovery time is a direct function of the forward current prior to the application of reverse voltage

For any given rectifier, recovery time is very circuit dependent. Typical and maximum recovery time of all Motorola fast recovery power rectifiers are rated under a fixed set of conditions using I_F = 1.0 A, V_R = 30 V. In order to cover all circuit conditions, curves are given for typical recovered stored charge versus commutation di/dt for various levels of forward current and for junction temperatures of 25°C, 75°C, 100°C, and 150°C.

To use these curves, it is necessary to know the forward current level just before commutation, the circuit commutation di/dt, and the operating junction temperature. The reverse recovery test current waveform for all Motorola fast recovery rectifiers is shown.



From stored charge curves versus di/dt, recovery time (t_{rr}) and peak reverse recovery current ($I_{RM(REC)}$) can be closely approximated using the following formulas

$$t_{rr} = 1.41 \times \left[\frac{Q_R}{di/dt}\right]^{1/2}$$

$$I_{RM(REC)} = 1.41 \times \left[Q_R \times di/dt\right]^{1/2}$$

FIGURE 22 — TYPICAL REVERSE LEAKAGE

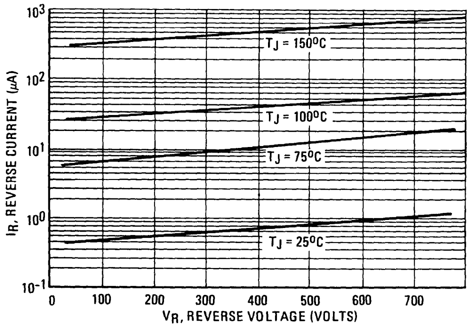
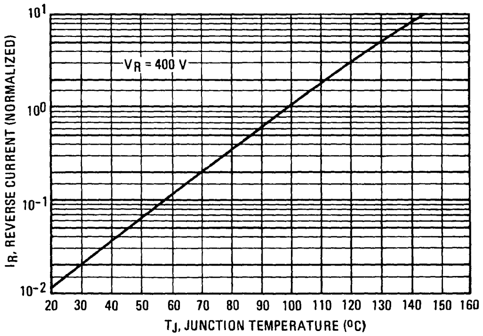


FIGURE 23 — NORMALIZED REVERSE CURRENT



MOTOROLA
SEMICONDUCTOR
TECHNICAL DATA

1N5391 thru 1N5399

Designers Data Sheet

"SURMETIC" RECTIFIERS

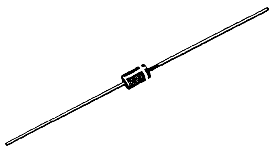
. . . subminiature size, axial lead-mounted rectifiers for general-purpose, low-power applications.

Designers Data for "Worst Case" Conditions

The Designers Data Sheets permit the design of most circuits entirely from the information presented. Limits curves—representing boundaries on device characteristics—are given to facilitate "worst-case" design.

LEAD-MOUNTED SILICON RECTIFIERS

50–1000 VOLTS
DIFFUSED JUNCTION



*MAXIMUM RATINGS

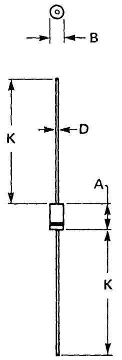
Rating	Symbol	1N5391	1N5392	1N5393	1N5395	1N5397	1N5398	1N5399	Unit
Peak Repetitive Reverse Voltage Working Peak Reverse Voltage DC Blocking Voltage	V_{RRM} V_{RWM} V_R	50	100	200	400	600	800	1000	Volts
Nonrepetitive Peak Reverse Voltage (Halfwave, Single Phase, 60 Hz)	V_{RSM}	100	200	300	525	800	1000	1200	Volts
RMS Reverse Voltage	$V_{R(RMS)}$	35	70	140	280	420	560	700	Volts
Average Rectified Forward Current (Single Phase, Resistive Load, 60 Hz, T_L = 70°C, 1/2" From Body)	I_O	← 1.5 →							Amp
Nonrepetitive Peak Surge Current (Surge Applied at Rated Load Conditions, See Figure 2)	I_{FSM}	← 50 (for 1 cycle) →							Amp
Storage Temperature Range	T_{stg}	← −65 to +175 →							°C
Operating Temperature Range	T_L	← −65 to +170 →							°C
DC Blocking Voltage Temperature	T_L	← 150 →							°C

*ELECTRICAL CHARACTERISTICS

Characteristic and Conditions	Symbol	Typ	Max	Unit
Maximum Instantaneous Forward Voltage Drop (i_F = 4.7 Amp Peak, T_L = 170°C, 1/2 Inch Leads)	v_F	–	1.4	Volts
Maximum Reverse Current (Rated dc Voltage) (T_L = 150°C)	I_R	250	300	μA
Maximum Full-Cycle Average Reverse Current (1) (I_O = 1.5 Amp, T_L = 70°C, 1/2 Inch Leads)	$I_{R(AV)}$	–	300	μA

*Indicates JEDEC Registered Data.

NOTE 1: Measured in a single-phase, halfwave circuit such as shown in Figure 6.25 of EIA RS-282, November 1963. Operated at rated load conditions I_O = 1.5 A, V_r = V_{RWM}, T_L = 70°C.



NOTES
1. ALL RULES AND NOTES ASSOCIATED WITH JEDEC DO-41 OUTLINE SHALL APPLY
2. POLARITY DENOTED BY CATHODE BAND
3. LEAD DIAMETER NOT CONTROLLED WITHIN "F" DIMENSION

DIM	MILLIMETERS MIN	MILLIMETERS MAX	INCHES MIN	INCHES MAX
A	5.97	6.60	0.235	0.260
B	2.79	3.05	0.110	0.120
D	0.76	0.86	0.030	0.034
K	27.94	—	1.100	—

CASE 59-04
PLASTIC

MECHANICAL CHARACTERISTICS

CASE: Transfer molded plastic

MAXIMUM LEAD TEMPERATURE FOR SOLDERING PURPOSES: 240°C, 1/8" from case for 10 seconds at 5 lbs. tension

FINISH: All external surfaces are corrosion-resistant, leads are readily solderable

POLARITY: Cathode indicated by color band

WEIGHT: 0.40 grams (approximately)

3

FIGURE 1 – FORWARD VOLTAGE

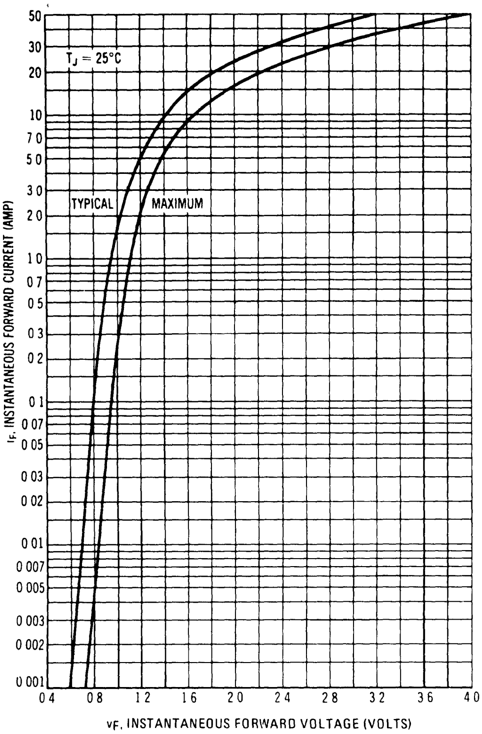


FIGURE 2 – MAXIMUM NONREPETITIVE SURGE CURRENT

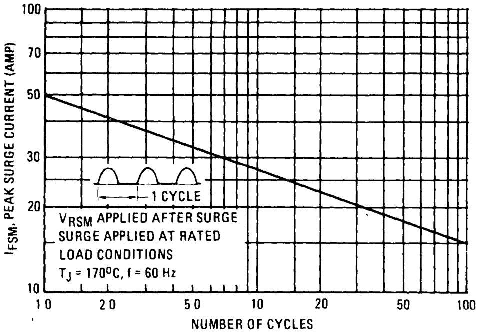


FIGURE 3 – FORWARD VOLTAGE TEMPERATURE COEFFICIENT

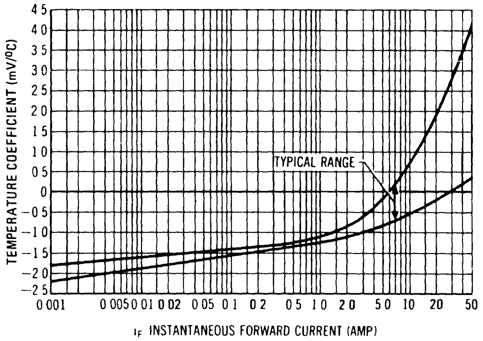
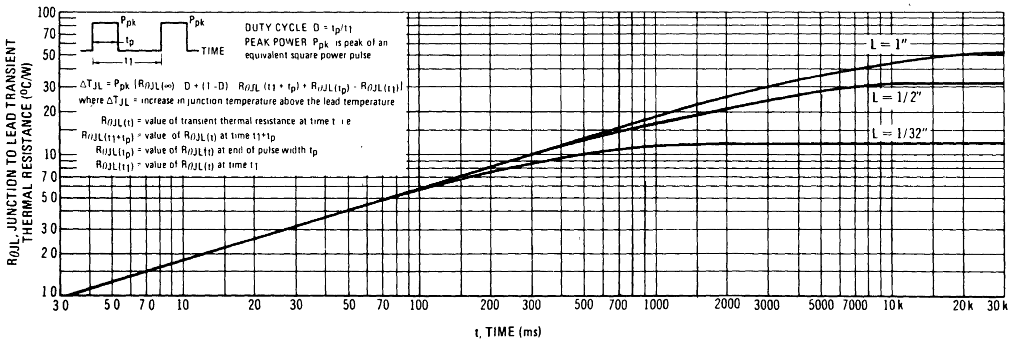


FIGURE 4 – TYPICAL TRANSIENT THERMAL RESISTANCE



The temperature of the lead should be measured using a thermocouple placed on the lead as close as possible to the tie point The thermal mass connected to the tie point is normally large enough so that it will not significantly respond to heat surges generated in the diode as a result of pulsed operation once steady-state conditions are achieved Using the measured value of T_L, the junction temperature may be determined by.

$$T_J = T_L + \Delta T_{JL}.$$

FIGURE 5 – FORWARD POWER DISSIPATION

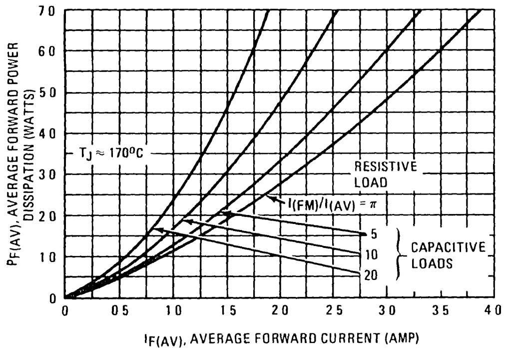


FIGURE 6 – EFFECT OF LEAD LENGTHS, RESISTIVE LOAD

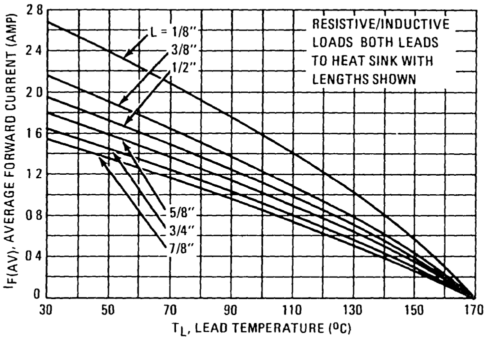


FIGURE 7 – 1/2" LEAD LENGTH, VARIOUS LOADS

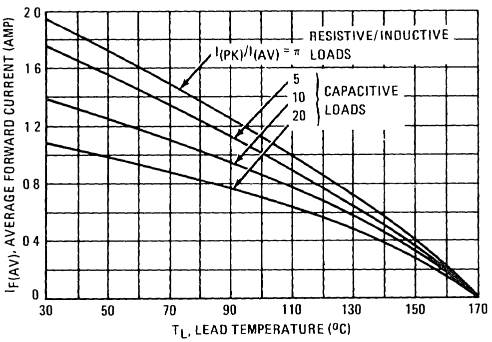


FIGURE 8 – PRINTED CIRCUIT BOARD MOUNTING, VARIOUS LOADS

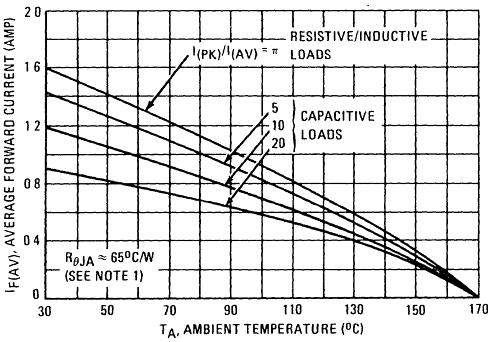
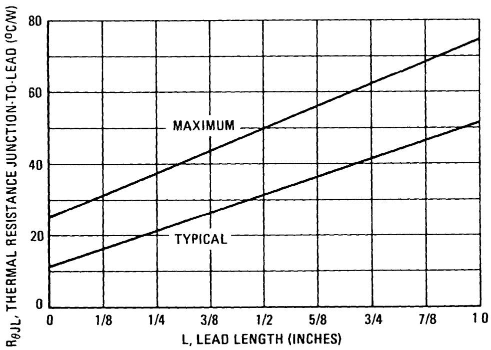


FIGURE 9 – STEADY-STATE THERMAL RESISTANCE

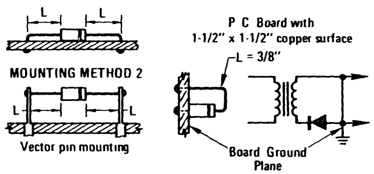


NOTE 1

Data shown for thermal resistance junction-to-ambient (θ_{JA}) for the mountings shown is to be used as typical guideline values for preliminary engineering or in case the tie point temperature cannot be measured

TYPICAL VALUES FOR θ_{JA} IN STILL AIR

MOUNTING METHOD	LEAD LENGTH, L (IN) 1/8	1/4	1/2	3/4	$R_{\theta JA}$
1	65	72	82	92	°C/W
2	74	81	91	101	°C/W
3		40			°C/W



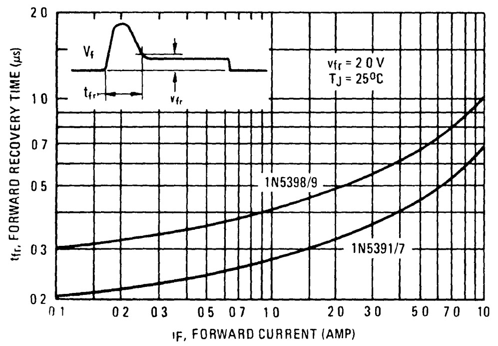


FIGURE 10 — FORWARD RECOVERY TIME

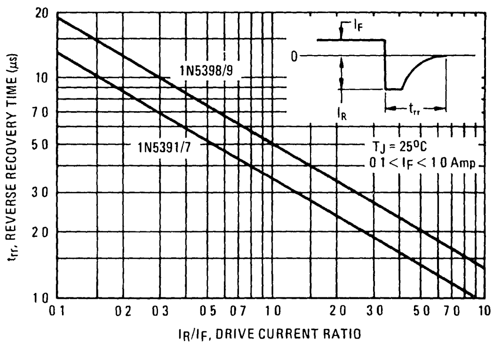


FIGURE 11 — REVERSE RECOVERY TIME

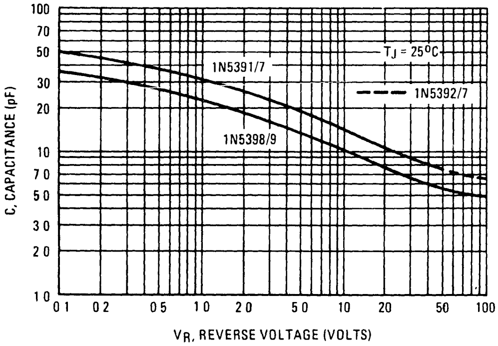


FIGURE 12 — JUNCTION CAPACITANCE

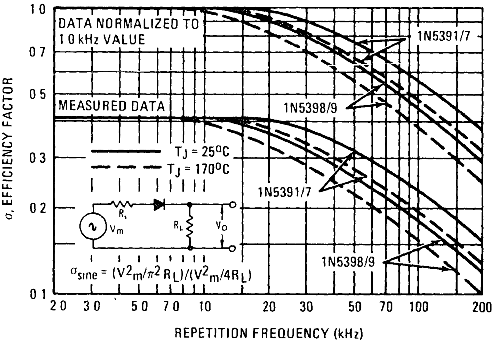


FIGURE 13 — RECTIFICATION WAVEFORM EFFICIENCY FOR SINE WAVE

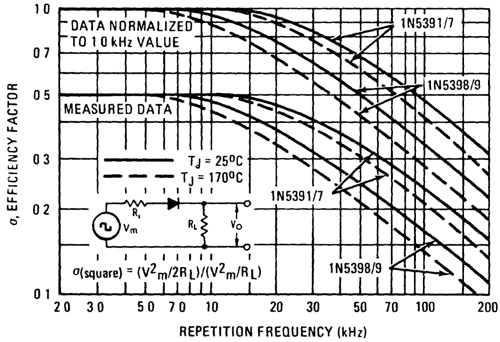


FIGURE 14 — RECTIFICATION WAVEFORM EFFICIENCY FOR SQUARE WAVE

RECTIFIER EFFICIENCY NOTE

The rectification efficiency factor σ shown in Figures 13 and 14 was calculated using the formula

$$\sigma = \frac{P_{dc}}{P_{rms}} = \frac{\frac{V^2_{O(dc)}}{R_L}}{\frac{V^2_{O(rms)}}{R_L}} \bullet 100\% = \frac{V^2_{O(dc)}}{V^2_{O(ac)} + V^2_{O(dc)}} \bullet 100\% \quad (1)$$

For a sine wave input $V_m \sin(\omega t)$ to the diode, assumed lossless, the maximum theoretical efficiency factor becomes 40%, for a square wave input of amplitude V_m, the efficiency factor becomes 50% (A full wave circuit has twice these efficiencies).

As the frequency of the input signal is increased, the reverse recovery time of the diode (Figure 11) becomes significant, resulting in an increasing ac voltage component across R_L which is opposite in polarity to the forward current thereby reducing the value of the efficiency factor σ, as shown in Figures 13 and 14.

It should be emphasized that Figures 13 and 14 show waveform efficiency only, they do not account for diode losses. Data was obtained by measuring the ac component of V_O with a true rms voltmeter and the dc component with a dc voltmeter. The data was used in Equation 1 to obtain points for the Figures.

MOTOROLA
SEMICONDUCTOR
TECHNICAL DATA

1N5400 thru 1N5406

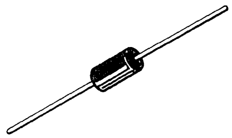
LEAD MOUNTED STANDARD RECOVERY RECTIFIERS

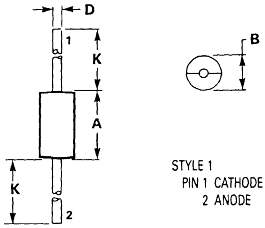
. . designed for use in power supplies and other applications having need of a device with the following features

- High Current to Small Size
- High Surge Current Capability
- Low Forward Voltage Drop
- Economical Plastic Package
- Available in Volume Quantities

STANDARD RECOVERY RECTIFIERS

50–600 VOLTS
3 AMPERE





STYLE 1
PIN 1 CATHODE
2 ANODE

NOTES
1 DIMENSIONING & TOLERANCING PER ANSI Y14.5, 1982
2 CONTROLLING DIMENSION INCH

DIM	MILLIMETERS MIN	MILLIMETERS MAX	INCHES MIN	INCHES MAX
A	—	9.39	—	0.370
B	—	6.35	—	0.250
D	1.22	1.32	0.048	0.052
K	25.40	—	1.000	—

CASE 267-02
PLASTIC

MAXIMUM RATINGS

Rating	Symbol	1N5400	1N5401	1N5402	1N5404	1N5406	Unit
Peak Repetitive Reverse Voltage Working Peak Reverse Voltage DC Blocking Voltage	V_{RRM} V_{RWM} V_R	50	100	200	400	600	Volts
Nonrepetitive Peak Reverse Voltage	V_{RSM}	100	200	300	525	800	Volts
Average Rectified Forward Current (Single Phase Resistive Load, (1/2" Leads, T_L = 105°C)	I_O	← 3.0 →					Amp
Nonrepetitive Peak Surge Current (Surge Applied at Rated Load Conditions)	I_{FSM}	← 200 (one cycle) →					Amp
Operating and Storage Junction Temperature Range	T_J, T_{stg}	← −65 to +175 →					°C

THERMAL CHARACTERISTICS

Characteristic	Symbol	Typ	Unit
Thermal Resistance, Junction to Ambient (PC Board Mount, 1/2" Leads)	$R_{\theta JA}$	53	°C/W

*ELECTRICAL CHARACTERISTICS

Characteristic	Symbol	Min	Typ	Max	Unit
Instantaneous Forward Voltage (1) (i_F = 9.4 Amp)	v_F	—	—	1.2	Volts
Average Reverse Current (1) DC Reverse Current (Rated dc Voltage, T_L = 150°C)	$I_{R(AV)}$ I_R	— —	— —	500 500	μA

*JEDEC Registered Data.

(1) Measured in a single-phase half-wave circuit such as shown in Figure 6.25 of EIA RS-282, November 1963. Operated at rated load conditions T_L=105°C, I_O=3.0 A, V_r=V_{RWM}.

MECHANICAL CHARACTERISTICS

Case: Transfer Molded Plastic
Finish: External Leads are Plated, Leads are readily Solderable
Polarity: Indicated by Cathode Band
Weight: 1.1 Grams (Approximately)
Maximum Lead Temperature for
Soldering Purposes:
240°C, 1/8" from case for 10 s at 5.0 lb tension

3

FIGURE 1 — FORWARD VOLTAGE

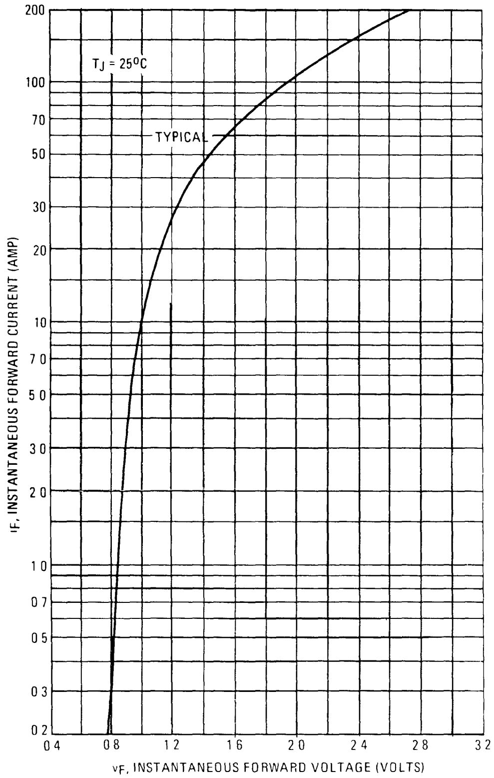


FIGURE 2 — MAXIMUM NONREPETITIVE SURGE CURRENT

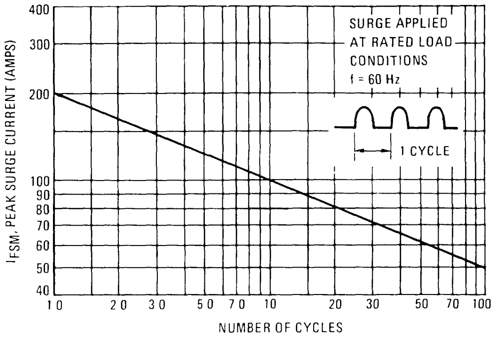
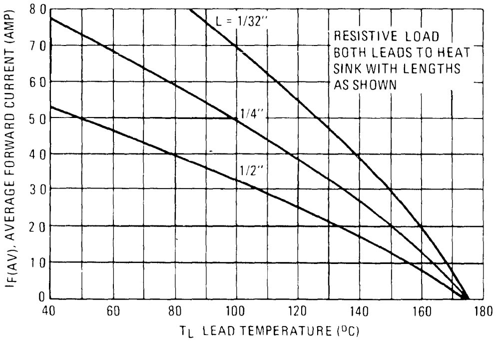


FIGURE 3 — CURRENT DERATING VARIOUS LEAD LENGTHS



NOTE 1 — AMBIENT MOUNTING DATA

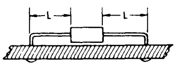
Data shown for thermal resistance junction to ambient ($R_{\theta JA}$) for the mountings shown is to be used as typical guideline values for preliminary engineering or in case the tie point temperature cannot be measured

TYPICAL VALUES FOR $R_{\theta JA}$ IN STILL AIR

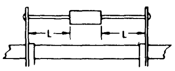
MOUNTING METHOD	LEAD LENGTH, L (IN)				$R_{\theta JA}$
	1/8	1/4	1/2	3/4	
1	50	51	53	55	°C/W
2	58	59	61	63	°C/W
3	28				°C/W

MOUNTING METHOD 1

P C Board Where Available Copper Surface area is small



MOUNTING METHOD 2
Vector Push In Terminals T 28



MOUNTING METHOD 3

P C Board with
1-1/2 x 1-1/2" Copper Surface

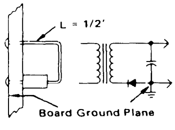
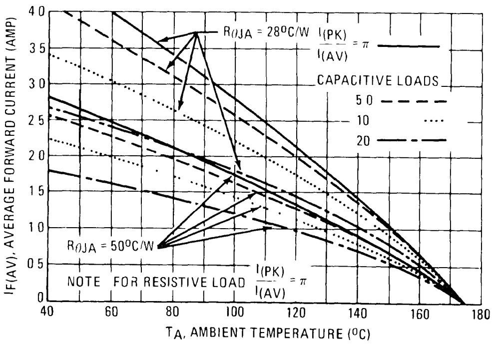


FIGURE 4 — CURRENT DERATING PC BOARD MOUNTING



MOTOROLA
SEMICONDUCTOR
TECHNICAL DATA

1N5817 MBR115P
1N5818 MBR120P
1N5819 MBR130P
MBR140P

AXIAL LEAD RECTIFIERS

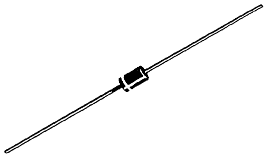
. . . employıng the Schottky Barrıer prıncıple ın a large area metal-to-sılıcon power dıode State-of-the-art geometry features epitaxial constructıon wıth oxıde passıvation and metal overlap contact. Ideally suıted for use as rectıfıers ın low-voltage, hıgh-frequency ınverters, free wheelıng dıodes, and polarıty protection dıodes.

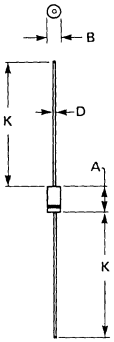
- Extremely Low v_F
- Low Stored Charge, Majorıty Carrıer Conductıon
- Low Power Loss/Hıgh Effıcıency

SCHOTTKY BARRIER RECTIFIERS

1 AMPERE
15, 20, 30, 40 VOLTS

3





DIM	MILLIMETERS MIN	MILLIMETERS MAX	INCHES MIN	INCHES MAX
A	5 97	6 60	0 235	0 260
B	2 79	3 05	0 110	0 120
D	0 76	0 86	0 030	0 034
K	27 94	—	1 100	—

CASE 59-04
PLASTIC

*MAXIMUM RATINGS

Rating	Symbol	MBR115P	1N5817 MBR120P	1N5818 MBR130P	1N5819 MBR140P	Unit
Peak Repetitive Reverse Voltage Working Peak Reverse Voltage DC Blocking Voltage	V_{RRM} V_{RWM} V_R	15	20	30	40	V
Non-Repetitive Peak Reverse Voltage	V_{RSM}	15	24	36	48	V
RMS Reverse Voltage	$V_{R(RMS)}$	10	14	21	28	V
Average Rectified Forward Current (2) ($V_{R(equiv)} \leq$ 0 2 V_R(dc), T_L = 90°C, $R_{\theta JA}$ = 80°C/W, P C Board Mounting, see Note 2, T_A = 55°C)	I_O	← 1 0 →				A
Ambient Temperature (Rated V_R(dc), $P_{F(AV)}$ = 0, $R_{\theta JA}$ = 80°C/W)	T_A	90	85	80	75	°C
Non-Repetitive Peak Surge Current (Surge applied at rated load conditions, half-wave, single phase 60 Hz, T_L = 70°C)	I_{FSM}	← 25 (for one cycle) →				A
Operating and Storage Junction Temperature Range (Reverse Voltage applied)	T_J, T_{stg}	← −65 to +125 →				°C
Peak Operating Junction Temperature (Forward Current applied)	$T_{J(pk)}$	← 150 →				°C

*THERMAL CHARACTERISTICS (Note 2)

Characteristic	Symbol	Max	Unit
Thermal Resistance, Junction to Ambient	$R_{\theta JA}$	80	°C/W

*ELECTRICAL CHARACTERISTICS (T_L = 25°C unless otherwise noted) (2)

Characteristic	Symbol	1N5817	1N5818	1N5819	MBR115P MBR120P MBR130P	MBR140P	Unit
Maximum Instantaneous Forward Forward Voltage (1)	v_F						V
(i_F = 0 1 A)		0 320	0 330	0 340	0 350	0 350	
(i_F = 1 0 A)		0 450	0 550	0 600	0 550	0 600	
(i_F = 3 0 A)		0 750	0 875	0 900	0 850	0 900	
Maximum Instantaneous Reverse Current @ Rated dc Voltage (1)	i_R						mA
(T_L = 25°C)		1 0	1 0	1 0	1 0	1 0	
(T_L = 100°C)		10	10	10	10	10	

(1) Pulse Test Pulse Width = 300 μs, Duty Cycle = 2 0%
(2) Lead Temperature reference is cathode lead 1/32" from case
*Indicates JEDEC Registered Data for 1N5817-19

MECHANICAL CHARACTERISTICS

CASE . . Transfer molded plastic
FINISH . All external surfaces corrosion-resistant and the terminal leads are readily solderable
POLARITY . . . Cathode indicated by polarity band
MOUNTING POSITIONS . Any
SOLDERING . . . 220°C 1/16" from case for ten seconds

NOTE 1 – DETERMINING MAXIMUM RATINGS

Reverse power dissipation and the possibility of thermal runaway must be considered when operating this rectifier at reverse voltages above 0.1 V_{RWM}. Proper derating may be accomplished by use of equation (1)

$$T_{A(max)} = T_{J(max)} - R_{\theta JA}P_{F(AV)} - R_{\theta JA}P_{R(AV)} \quad (1)$$

where $T_{A(max)}$ = Maximum allowable ambient temperature
$T_{J(max)}$ = Maximum allowable junction temperature (125°C or the temperature at which thermal runaway occurs, whichever is lowest)
$P_{F(AV)}$ = Average forward power dissipation
$P_{R(AV)}$ = Average reverse power dissipation
$R_{\theta JA}$ = Junction-to-ambient thermal resistance

Figures 1, 2, and 3 permit easier use of equation (1) by taking reverse power dissipation and thermal runaway into consideration. The figures solve for a reference temperature as determined by equation (2)

$$T_R = T_{J(max)} - R_{\theta JA}P_{R(AV)} \quad (2)$$

Substituting equation (2) into equation (1) yields

$$T_{A(max)} = T_R - R_{\theta JA}P_{F(AV)} \quad (3)$$

Inspection of equations (2) and (3) reveals that T_R is the ambient temperature at which thermal runaway occurs or where T_J = 125°C, when forward power is zero. The transition from one boundary condition to the other is evident on the curves of Figures 1, 2, and 3 as a difference in the rate of change of the slope in the vicinity of 115°C. The data of Figures 1, 2, and 3 is based upon dc conditions. For use in common rectifier circuits, Table 1 indicates suggested factors for an equivalent dc voltage to use for conservative design, that is

$$V_{R(equiv)} = V_{in(PK)} \times F \quad (4)$$

The factor F is derived by considering the properties of the various rectifier circuits and the reverse characteristics of Schottky diodes.

EXAMPLE Find $T_{A(max)}$ for 1N5818 operated in a 12-volt dc supply using a bridge circuit with capacitive filter such that I_{DC} = 0.4 A ($I_{F(AV)}$ = 0.5 A), $I_{(FM)}/I_{(AV)}$ = 10, Input Voltage = 10 $V_{(rms)}$, $R_{\theta JA}$ = 80°C/W.

Step 1 Find $V_{R(equiv)}$. Read F = 0.65 from Table 1,
$\therefore V_{R(equiv)} = (1.41)(10)(0.65) = 9.2$ V.

Step 2. Find T_R from Figure 2 Read T_R = 109°C
@ V_R = 9.2 V and $R_{\theta JA}$ = 80°C/W

Step 3 Find $P_{F(AV)}$ from Figure 4 **Read $P_{F(AV)}$ = 0.5 W
@ $\frac{I_{(FM)}}{I_{(AV)}}$ = 10 and $I_{F(AV)}$ = 0.5 A

Step 4. Find $T_{A(max)}$ from equation (3)
$T_{A(max)}$ = 109 – (80)(0.5) = 69°C.

**Values given are for the 1N5818. Power is slightly lower for the 1N5817 because of its lower forward voltage, and higher for the 1N5819. Variations will be similar for the MBR-prefix devices, using $P_{F(AV)}$ from Figure 7.

TABLE 1 – VALUES FOR FACTOR F

Circuit	Half Wave		Full Wave, Bridge		Full Wave, Center Tapped*†	
Load	Resistive	Capacitive*	Resistive	Capacitive	Resistive	Capacitive
Sine Wave	0.5	1.3	0.5	0.65	1.0	1.3
Square Wave	0.75	1.5	0.75	0.75	1.5	1.5

*Note that $V_{R(PK)} \approx 2.0\ V_{in(PK)}$ †Use line to center tap voltage for V_{in}

FIGURE 1 – MAXIMUM REFERENCE TEMPERATURE 1N5817/MBR115P/MBR120P

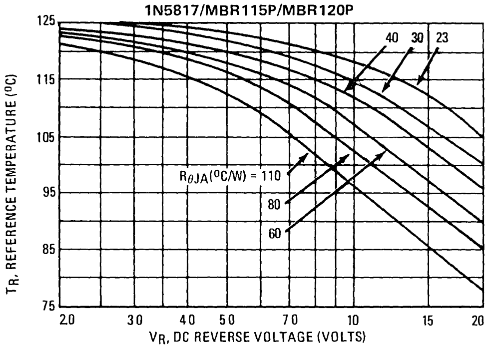


FIGURE 2 – MAXIMUM REFERENCE TEMPERATURE 1N5818/MBR130P

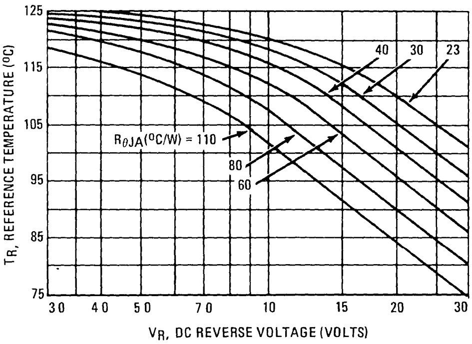


FIGURE 3 – MAXIMUM REFERENCE TEMPERATURE 1N5819/MBR140P

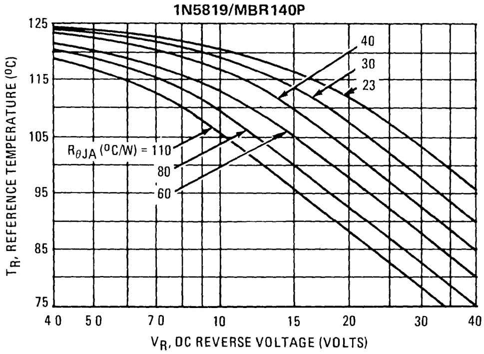
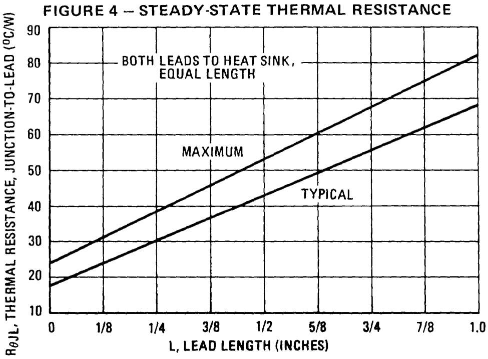


FIGURE 4 – STEADY-STATE THERMAL RESISTANCE



THERMAL CHARACTERISTICS

FIGURE 5 – THERMAL RESPONSE

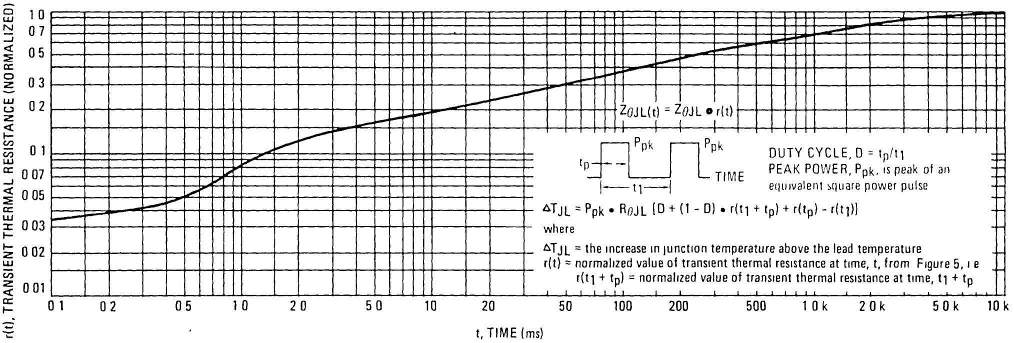


FIGURE 6 – FORWARD POWER DISSIPATION
1N5817-19

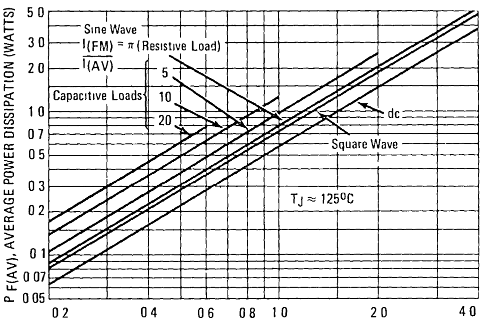
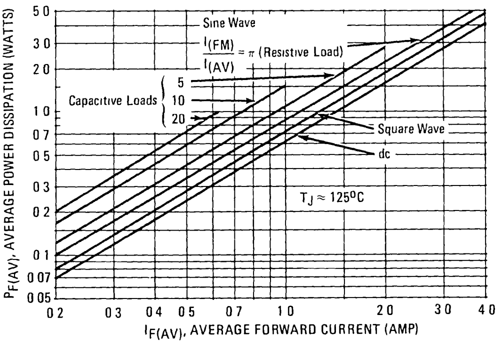


FIGURE 7 – FORWARD POWER DISSIPATION
MBR115P-140P



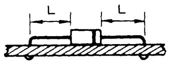
NOTE 2 – MOUNTING DATA

Data shown for thermal resistance junction-to-ambient ($R_{\theta JA}$) for the mountings shown is to be used as typical guideline values for preliminary engineering, or in case the tie point temperature cannot be measured

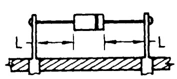
TYPICAL VALUES FOR $R_{\theta JA}$ IN STILL AIR

Mounting Method	Lead Length, L (in)				$R_{\theta JA}$
	1/8	1/4	1/2	3/4	
1	52	65	72	85	°C/W
2	67	80	87	100	°C/W
3		50			°C/W

Mounting Method 1
P C Board with
1-1/2" X 1-1/2"
copper surface

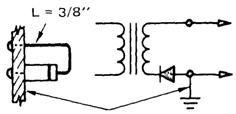


Mounting Method 2



Vector Pin Mounting

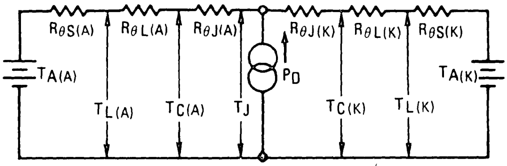
Mounting Method 3
P C Board with
1-1/2" X 1-1/2"
copper surface



Board Ground Plane

NOTE 3 – THERMAL CIRCUIT MODEL

(For heat conduction through the leads)



Use of the above model permits junction to lead thermal resistance for any mounting configuration to be found For a given total lead length, lowest values occur when one side of the rectifier is brought as close as possible to the heat sink Terms in the model signify

T_A = Ambient Temperature
T_C = Case Temperature
T_L = Lead Temperature
T_J = Junction Temperature
$R_{\theta S}$ = Thermal Resistance, Heat Sink to Ambient
$R_{\theta L}$ = Thermal Resistance, Lead to Heat Sink
$R_{\theta J}$ = Thermal Resistance, Junction to Case
P_D = Power Dissipation

(Subscripts A and K refer to anode and cathode sides, respectively.) Values for thermal resistance components are

$R_{\theta L}$ = 100°C/W/in typically and 120°C/W/in maximum
$R_{\theta J}$ = 36°C/W typically and 46°C/W maximum

3

FIGURE 8 — TYPICAL FORWARD VOLTAGE

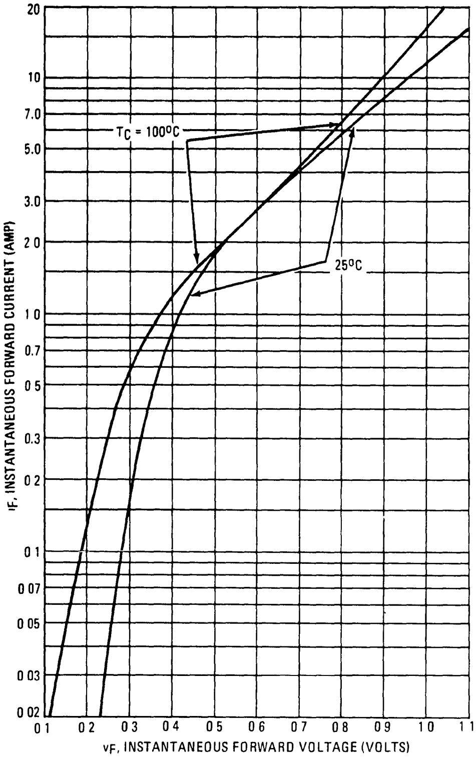


FIGURE 9 — MAXIMUM NON-REPETITIVE SURGE CURRENT

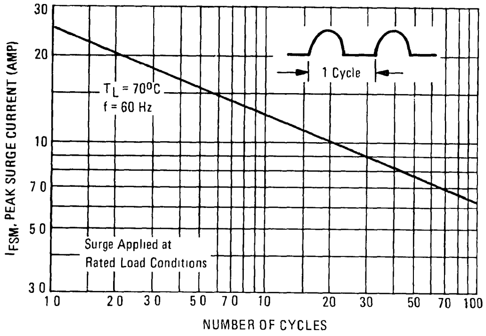


FIGURE 10 — TYPICAL REVERSE CURRENT

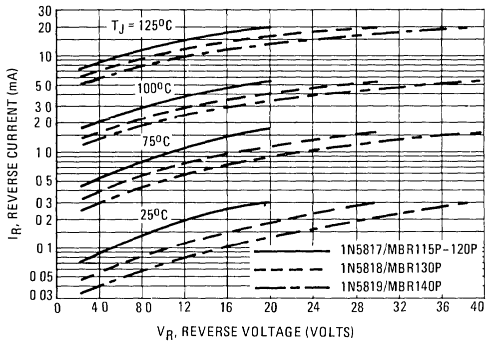
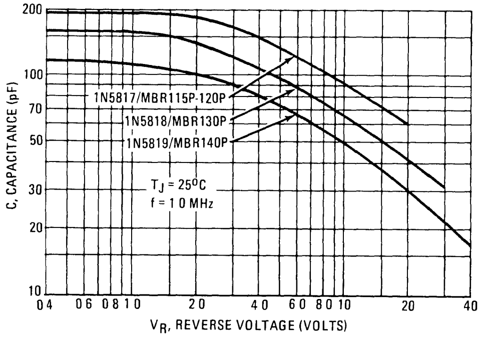


FIGURE 11 — TYPICAL CAPACITANCE



NOTE 4 — HIGH FREQUENCY OPERATION

Since current flow in a Schottky rectifier is the result of majority carrier conduction, it is not subject to junction diode forward and reverse recovery transients due to minority carrier injection and stored charge. Satisfactory circuit analysis work may be performed by using a model consisting of an ideal diode in parallel with a variable capacitance. (See Figure 11.)

Rectification efficiency measurements show that operation will be satisfactory up to several megahertz. For example, relative waveform rectification efficiency is approximately 70 per cent at 2.0 MHz, e.g., the ratio of dc power to RMS power in the load is 0.28 at this frequency, whereas perfect rectification would yield 0.406 for sine wave inputs. However, in contrast to ordinary junction diodes, the loss in waveform efficiency is not indicative of power loss: it is simply a result of reverse current flow through the diode capactiance, which lowers the dc output voltage.

(For 50 V and 60 V, see MBR150, 160 Data Sheet)

MOTOROLA
SEMICONDUCTOR
TECHNICAL DATA

1N5820 MBR320P
1N5821 MBR330P
1N5822 MBR340P

Designers Data Sheet

AXIAL LEAD RECTIFIERS

. . . employing the Schottky Barrier principle in a large area metal-to-silicon power diode. State-of-the-art geometry features epitaxial construction with oxide passivation and metal overlap contact. Ideally suited for use as rectifiers in low-voltage, high-frequency inverters, free wheeling diodes, and polarity protection diodes.

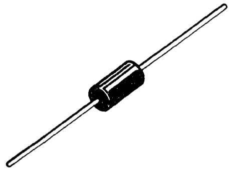
- Extremely Low v_F
- Low Power Loss/High Efficiency
- Low Stored Charge, Majority Carrier Conduction

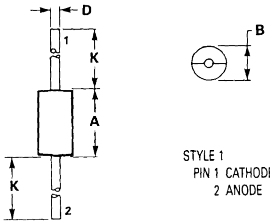
Designer's Data for Worst-Case Conditions

The Designers Data sheets permit the design of most circuits entirely from the information presented Limit curves—representing boundaries on device characteristics—are given to facilitate worst-case design

SCHOTTKY BARRIER RECTIFIERS

3.0 AMPERES
20, 30, 40 VOLTS





STYLE 1
PIN 1 CATHODE
2 ANODE

NOTES
1 DIMENSIONING & TOLERANCING PER ANSI Y14 5, 1982
2 CONTROLLING DIMENSION INCH

DIM	MILLIMETERS MIN	MILLIMETERS MAX	INCHES MIN	INCHES MAX
A	9 40	9 65	0 370	0 380
B	4 83	5 33	0 190	0 210
D	1 22	1 32	0 048	0 052
K	25 40	—	1 000	—

CASE 267-03
PLASTIC

*MAXIMUM RATINGS

Rating	Symbol	1N5820 MBR320P	1N5821 MBR330P	1N5822 MBR340P	Unit
Peak Repetitive Reverse Voltage Working Peak Reverse Voltage DC Blocking Voltage	V_{RRM} V_{RWM} V_R	20	30	40	V
Non-Repetitive Peak Reverse Voltage	V_{RSM}	24	36	48	V
RMS Reverse Voltage	$V_{R(RMS)}$	14	21	28	V
Average Rectified Forward Current (2) $V_{R(equiv)} \leq 0\ 2\ V_{R(dc)}$, $T_L = 95°C$ ($R_{\theta JA} = 28°C/W$, P C Board Mounting, see Note 2)	I_O	←	3 0	→	A
Ambient Temperature Rated $V_{R(dc)}$, $P_{F(AV)} = 0$ $R_{\theta JA} = 28°C/W$	T_A	90	85	80	°C
Non-Repetitive Peak Surge Current (Surge applied at rated load conditions, half wave, single phase 60 Hz, $T_L = 75°C$)	I_{FSM}	←	80 (for one cycle)	→	A
Operating and Storage Junction Temperature Range (Reverse Voltage applied)	T_J, T_{stg}	←	−65 to +125	→	°C
Peak Operating Junction Temperature (Forward Current Applied)	$T_{J(pk)}$	←	150	→	°C

*THERMAL CHARACTERISTICS (Note 2)

Characteristic	Symbol	Max	Unit
Thermal Resistance, Junction to Ambient	$R_{\theta JA}$	28	°C/W

*ELECTRICAL CHARACTERISTICS ($T_L = 25°C$ unless otherwise noted) (2)

Characteristic	Symbol	1N5820	1N5821	1N5822	MBR---P	Unit
Maximum Instantaneous Forward Voltage (1)	v_F					V
(i_F = 1 0 Amp)		0 370	0 380	0 390	0 400	
(i_F = 3 0 Amp)		0 475	0 500	0 525	0 550	
(i_F = 9 4 Amp)		0 850	0 900	0.950	0 950	
Maximum Instantaneous Reverse Current @ Rated dc Voltage (1)	i_R					mA
T_L = 25°C		2 0	2 0	2.0	2 0	
T_L = 100°C		20	20	20	20	

(1) Pulse Test Pulse Width = 300 μs, Duty Cycle = 2 0%
(2) Lead Temperature reference is cathode lead 1/32" from case
*Indicates JEDEC Registered Data for 1N5820-22

MECHANICAL CHARACTERISTICS

CASE . . Transfer molded plastic
FINISH. . . . . . All external surfaces corrosion-resistant and the terminal leads are readily solderable
POLARITY . . . . . Cathode indicated by polarity band
MOUNTING POSITIONS . . . . Any
SOLDERING . . .220°C 1/16" from case for ten seconds

3

3

NOTE 1 — DETERMINING MAXIMUM RATINGS

Reverse power dissipation and the possibility of thermal runaway must be considered when operating this rectifier at reverse voltages above 0.1 V_{RWM}. Proper derating may be accomplished by use of equation (1).

$$T_{A(max)} = T_{J(max)} - R_{\theta JA}P_{F(AV)} - R_{\theta JA}P_{R(AV)} \quad (1)$$

where $T_{A(max)}$ = Maximum allowable ambient temperature
$T_{J(max)}$ = Maximum allowable junction temperature (125°C or the temperature at which thermal runaway occurs, whichever is lowest)
$P_{F(AV)}$ = Average forward power dissipation
$P_{R(AV)}$ = Average reverse power dissipation
$R_{\theta JA}$ = Junction-to-ambient thermal resistance

Figures 1, 2, and 3 permit easier use of equation (1) by taking reverse power dissipation and thermal runaway into consideration. The figures solve for a reference temperature as determined by equation (2).

$$T_R = T_{J(max)} - R_{\theta JA}P_{R(AV)} \quad (2)$$

Substituting equation (2) into equation (1) yields:

$$T_{A(max)} = T_R - R_{\theta JA}P_{F(AV)} \quad (3)$$

Inspection of equations (2) and (3) reveals that T_R is the ambient temperature at which thermal runaway occurs or where T_J = 125°C, when forward power is zero. The transition from one boundary condition to the other is evident on the curves of Figures 1, 2, and 3 as a difference in the rate of change of the slope in the vicinity of 115°C. The data of Figures 1, 2, and 3 is based upon dc conditions. For use in common rectifier circuits, Table 1 indicates suggested factors for an equivalent dc voltage to use for conservative design, that is:

$$V_{R(equiv)} = V_{(FM)} \times F \quad (4)$$

The factor F is derived by considering the properties of the various rectifier circuits and the reverse characteristics of Schottky diodes.

EXAMPLE. Find $T_{A(max)}$ for 1N5821 operated in a 12-volt dc supply using a bridge circuit with capacitive filter such that I_{DC} = 2.0 A ($I_{F(AV)}$ = 1.0 A), $I_{(FM)}/I_{(AV)}$ = 10, Input Voltage = 10 $V_{(rms)}$, $R_{\theta JA}$ = 40°C/W.

Step 1. Find $V_{R(equiv)}$. Read F = 0.65 from Table 1,
$\therefore V_{R(equiv)} = (1.41)(10)(0.65) = 9.2$ V.

Step 2. Find T_R from Figure 2. Read T_R = 108°C
@ V_R = 9.2 V and $R_{\theta JA}$ = 40°C/W.

Step 3. Find $P_{F(AV)}$ from Figure 6. **Read $P_{F(AV)}$ = 0.85 W
@ $\frac{I_{(FM)}}{I_{(AV)}}$ = 10 and $I_{F(AV)}$ = 1.0 A.

Step 4. Find $T_{A(max)}$ from equation (3).
$T_{A(max)}$ = 108 − (0.85) (40) = 74°C.

**Values given are for the 1N5821. Power is slightly lower for the 1N5820 because of its lower forward voltage, and higher for the 1N5822. Variations will be similar for the MBR-prefix devices, using $P_{F(AV)}$ from Figure 7.

TABLE 1 — VALUES FOR FACTOR F

Circuit	Half Wave		Full Wave, Bridge		Full Wave, Center Tapped*†	
Load	Resistive	Capacitive*	Resistive	Capacitive	Resistive	Capacitive
Sine Wave	0.5	1.3	0.5	0.65	1.0	1.3
Square Wave	0.75	1.5	0.75	0.75	1.5	1.5

*Note that $V_{R(PK)} \approx 2.0\ V_{in(PK)}$. †Use line to center tap voltage for V_{in}.

FIGURE 1 — MAXIMUM REFERENCE TEMPERATURE 1N5820/MBR320P

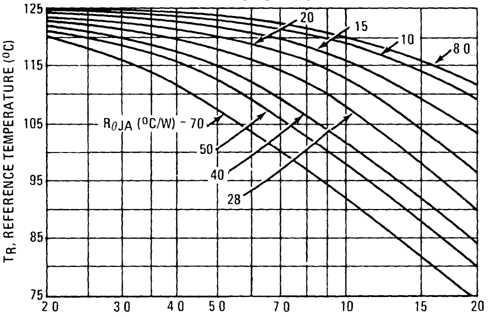


FIGURE 2 — MAXIMUM REFERENCE TEMPERATURE 1N5821/MBR330P

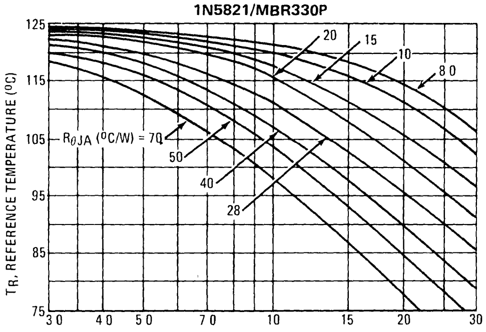


FIGURE 3 — MAXIMUM REFERENCE TEMPERATURE 1N5822/MBR340P

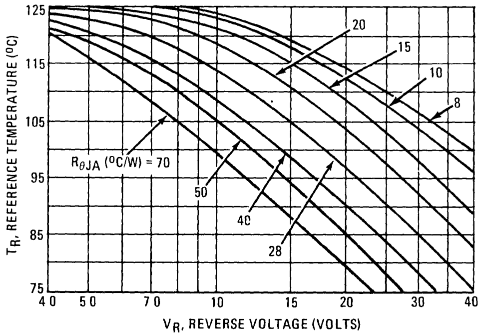


FIGURE 4 — STEADY-STATE THERMAL RESISTANCE

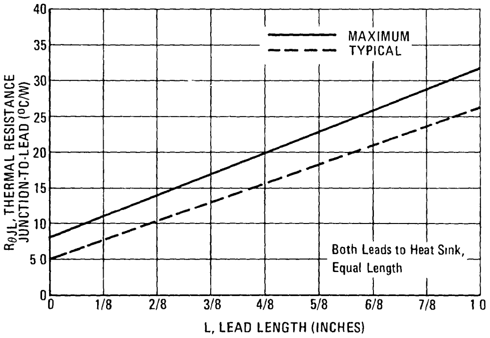


FIGURE 5 — THERMAL RESPONSE

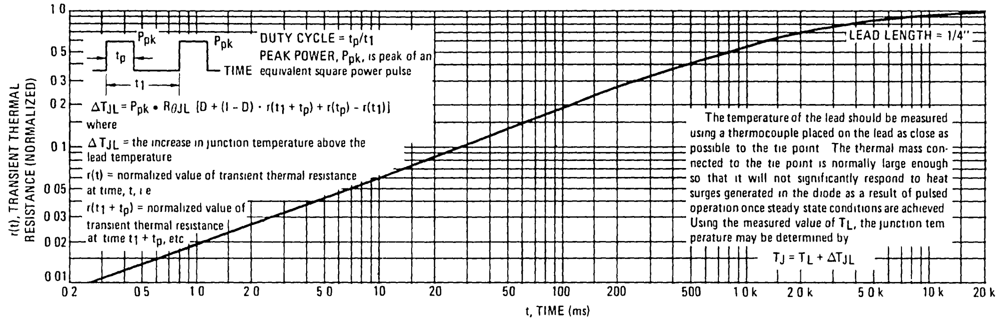


FIGURE 6 — FORWARD POWER DISSIPATION 1N5820-22

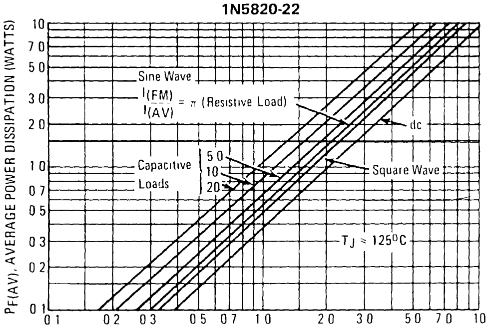
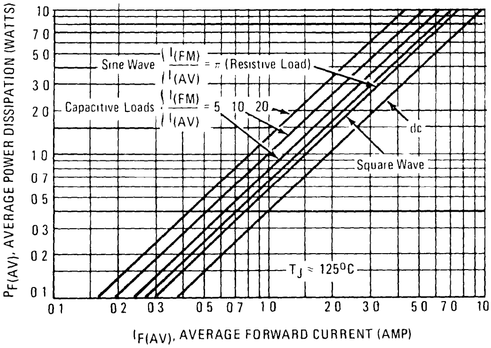
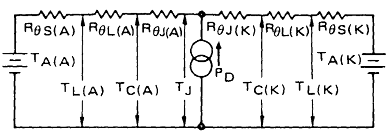


FIGURE 7 — FORWARD POWER DISSIPATION MBR320P-340P



NOTE 3 — APPROXIMATE THERMAL CIRCUIT MODEL



Use of the above model permits junction to lead thermal resistance for any mounting configuration to be found For a given total lead length, lowest values occur when one side of the rectifier is brought as close as possible to the heat sink Terms in the model signify

T_A = Ambient Temperature T_C = Case Temperature
T_L = Lead Temperature T_J = Junction Temperature
$R_{\theta S}$ = Thermal Resistance, Heat Sink to Ambient
$R_{\theta L}$ = Thermal Resistance, Lead to Heat Sink
$R_{\theta J}$ = Thermal Resistance, Junction to Case
P_D = Total Power Dissipation = $P_F + P_R$
P_F = Forward Power Dissipation
P_R = Reverse Power Dissipation
(Subscripts (A) and (K) refer to anode and cathode sides, respectively) Values for thermal resistance components are
$R_{\theta L}$ = 42°C/W/in typically and 48°C/W/in maximum
$R_{\theta J}$ = 10°C/W typically and 16°C/W maximum

The maximum lead temperature may be found as follows

$$T_L = T_{J(max)} - \Delta T_{JL}$$

where $\Delta T_{JL} \approx R_{\theta JL} \cdot P_D$

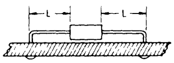
NOTE 2 — MOUNTING DATA

Data shown for thermal resistance junction-to-ambient ($R_{\theta JA}$) for the mountings shown is to be used as typical guideline values for preliminary engineering, or in case the tie point temperature cannot be measured.

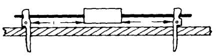
TYPICAL VALUES FOR $R_{\theta JA}$ IN STILL AIR

Mounting Method	Lead Length, L (in) 1/8	1/4	1/2	3/4	$R_{\theta JA}$
1	50	51	53	55	°C/W
2	58	59	61	63	°C/W
3	28				°C/W

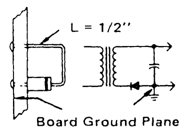
Mounting Method 1
P C Board where available copper surface is small



Mounting Method 2
Vector Push-In Terminals T-28



Mounting Method 3
P C Board with 2-1/2" X 2-1/2" copper surface



Board Ground Plane

3

FIGURE 8 — TYPICAL FORWARD VOLTAGE

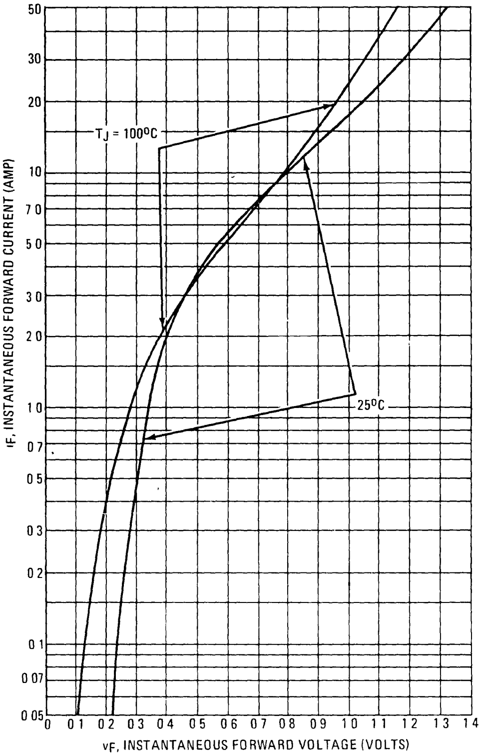


FIGURE 9 — MAXIMUM NON-REPETITIVE SURGE CURRENT

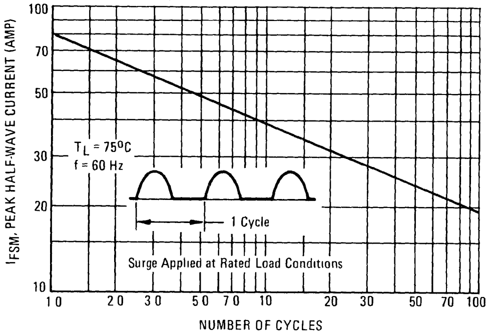


FIGURE 10 — TYPICAL REVERSE CURRENT

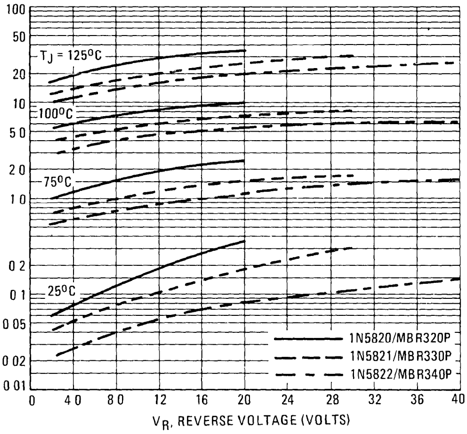
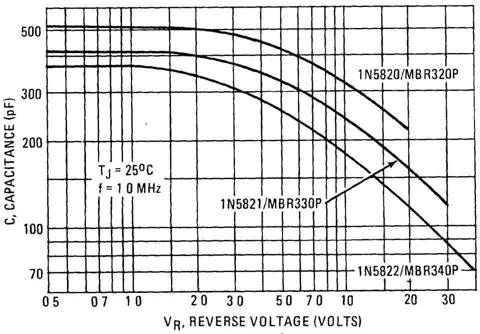


FIGURE 11 — TYPICAL CAPACITANCE



NOTE 4 — HIGH FREQUENCY OPERATION

Since current flow in a Schottky rectifier is the result of majority carrier conduction, it is not subject to junction diode forward and reverse recovery transients due to minority carrier injection and stored charge Satisfactory circuit analysis work may be performed by using a model consisting of an ideal diode in parallel with a variable capacitance (See Figure 11.)

MOTOROLA
SEMICONDUCTOR
TECHNICAL DATA

1N5823, 1N5824
1N5825
MBR5825,H,H1

Designers Data Sheet

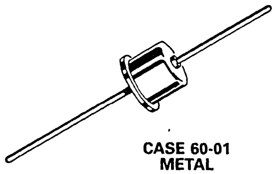
HOT CARRIER POWER RECTIFIERS

. . employing the Schottky Barrier principle in a large area metal-to-silicon power diode. State-of-the-art geometry features epitaxial construction with oxide passivation and metal overlap contact. Ideally suited for use as rectifiers in low-voltage, high-frequency inverters, free-wheeling diodes, and polarity-protection diodes.

- Extremely Low v_F
- Low Stored Charge, Majority Carrier Conduction
- Low Power Loss/ High Efficiency
- "H" & "H1" Version Available Similar to TX Processing

SCHOTTKY BARRIER RECTIFIERS

5 AMPERE
20, 30, 40 VOLTS



CASE 60-01
METAL

Designer's Data for "Worst Case" Conditions

The Designers Data sheets permit the design of most circuits entirely from the information presented Limit curves — representing boundaries on device characteristics — are given to facilitate "worst case" design

3

*MAXIMUM RATINGS

Rating	Symbol	1N5823	1N5824	1N5825 MBR5825H, H1	Unit
Peak Repetitive Reverse Voltage Working Peak Reverse Voltage DC Blocking Voltage	V_{RRM} V_{RWM} V_R	20	30	40	Volts
Non-Repetitive Peak Reverse Voltage	V_{RSM}	24	36	48	Volts
RMS Reverse Voltage	$V_{R(RMS)}$	14	21	28	Volts
Average Rectified Forward Current $V_{R(equiv)} \leq 0.2\ V_{R\ (dc)}$, $T_C = 75°C$ $V_{R(equiv)} \leq 0.2\ V_{R\ (dc)}$, $T_L = 80°C$ $R_{\theta JA} = 25°C/W$, P C Board Mounting, See Note 3)	I_O	←— 15 —→ ←— 5 0 —→			Amp
Ambient Temperature Rated $V_{R\ (dc)}$, $P_{F(AV)} = 0$ $R_{\theta JA} = 25°C/W$	T_A	65	60	55	°C
Non-Repetitive Peak Surge Current (Surge applied at rated load conditions, halfwave, single phase 60 Hz)	I_{FSM}	←— 500 (for 1 cycle) —→			Amp
Operating and Storage Junction Temperature Range (Reverse Voltage applied)	T_J, T_{stg}	←— −65 to +125 —→			°C
Peak Operating Junction Temperature (Forward Current Applied)	$T_{J(pk)}$	←— 150 —→			°C

*THERMAL CHARACTERISTICS

Characteristic	Symbol	Max	Unit
Thermal Resistance, Junction to Case	$R_{\theta JC}$	3 0	°C/W

*ELECTRICAL CHARACTERISTICS ($T_C = 25°C$ unless otherwise noted)

Characteristic	Symbol	1N5823	1N5824	1N5825 MBR5825H, H1	Unit
Maximum Instantaneous Forward Voltage (1) (i_F = 3 0 Amp) (i_F = 5 0 Amp) (i_F = 15 7 Amp)	v_F	 0 330 0 360 0.470	 0 340 0.370 0.490	 0 350 0.380 0 520	Volts
Maximum Instantaneous Reverse Current @ rated dc Voltage $T_C = 25°C$ $T_C = 100°C$	i_R	 10 100	 10 125	 10 150	mA

(1) Pulse Test Pulse Width = 300 μs, Duty Cycle = 2.0% *Indicates JEDEC Registered Data for 1N5823–1N5825

NOTE 1. DETERMINING MAXIMUM RATINGS

Reverse power dissipation and the possibility of thermal runaway must be considered when operating this rectifier at reverse voltages above 0.1 V_{RWM}. Proper derating may be accomplished by use of equation (1)

$$T_{A(max)} = T_{J(max)} - R_{\theta JA}P_{F(AV)} - R_{\theta JA}P_{R(AV)} \quad (1)$$

where

$T_{A(max)}$ = Maximum allowable ambient temperature

$T_{J(max)}$ = Maximum allowable junction temperature (125°C or the temperature at which thermal runaway occurs, whichever is lowest).

$P_{F(AV)}$ = Average forward power dissipation

$P_{R(AV)}$ = Average reverse power dissipation

$R_{\theta JA}$ = Junction-to-ambient thermal resistance

Figures 1, 2 and 3 permit easier use of equation (1) by taking reverse power dissipation and thermal runaway into consideration. The figures solve for a reference temperature as determined by equation (2)

$$T_R = T_{J(max)} - R_{\theta JA}P_{R(AV)} \quad (2)$$

Substituting equation (2) into equation (1) yields

$$T_{A(max)} = T_R - R_{\theta JA}P_{F(AV)} \quad (3)$$

Inspection of equations (2) and (3) reveals that T_R is the ambient temperature at which thermal runaway occurs or where T_J = 125°C, when forward power is zero. The transition from one boundary condition to the other is evident on the curves of Figures 1, 2 and 3 as a difference in the rate of change of the slope in the vicinity of 115°C. The data of Figures 1, 2 and 3 is based upon dc conditions. For use in common rectifier circuits, Table I indicates suggested factors for an equivalent dc voltage to use for conservative design, i.e.

$$V_{R(equiv)} = V_{IN(PK)} \times F \quad (4)$$

The Factor F is derived by considering the properties of the various rectifier circuits and the reverse characteristics of Schottky diodes.

Example: Find $T_{A(max)}$ for 1N5825 operated in a 12-Volt dc supply using a bridge circuit with capacitive filter such that I_{DC} = 10 A ($I_{F(AV)}$ = 5 A), $I_{(PK)}/I_{(AV)}$ = 10, Input Voltage = 10 V(rms), $R_{\theta JA}$ = 10°C/W

Step 1 Find $V_{R(equiv)}$. Read F = 0.65 from Table I ∴ $V_{R(equiv)}$ = (1.41)(10)(0.65) = 9.2 V

Step 2 Find T_R from Figure 3. Read T_R = 113°C @ V_R = 9.2 V & $R_{\theta JA}$ = 10°C/W.

Step 3 Find $P_{F(AV)}$ from Figure 4 **Read $P_{F(AV)}$ = 5.5 W @ $\frac{I_{(PK)}}{I_{(AV)}}$ = 10 & $I_{F(AV)}$ = 5 A

Step 4 Find $T_{A(max)}$ from equation (3) $T_{A(max)}$ = 113-(10)(5.5) = 58°C.

**Value given are for the 1N5825. Power is slightly lower for the other units because of their lower forward voltage.

3

TABLE I – VALUES FOR FACTOR F

Circuit	Half Wave		Full Wave, Bridge		Full Wave, Center Tapped *†	
Load	Resistive	Capacitive*	Resistive	Capacitive	Resistive	Capacitive
Sine Wave	0.5	1.3	0.5	0.65	1.0	1.3
Square Wave	0.75	1.5	0.75	0.75	1.5	1.5

*Note that $V_{R(PK)} \approx 2\,V_{in(PK)}$ †Use line to center tap voltage for V_{in}

FIGURE 1 – MAXIMUM REFERENCE TEMPERATURE – 1N5823

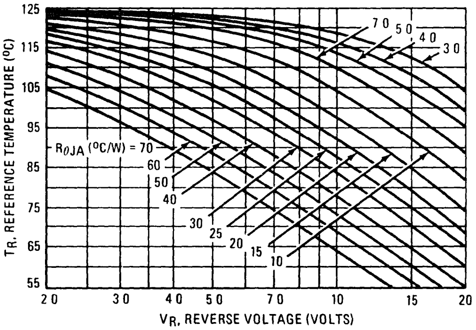


FIGURE 2 – MAXIMUM REFERENCE TEMPERATURE – 1N5824

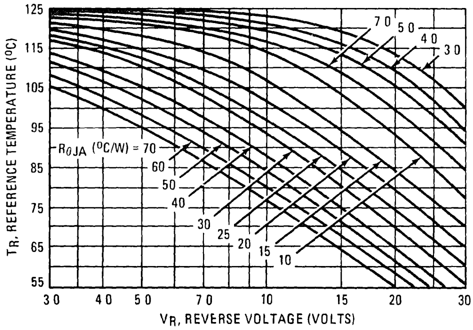


FIGURE 3 – MAXIMUM REFERENCE TEMPERATURE 1N5825 AND MBR5825H, H1

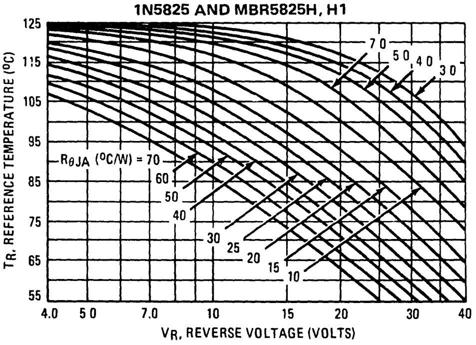
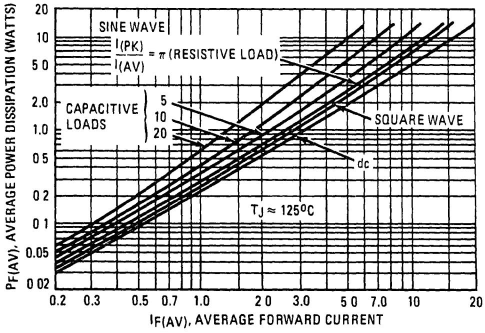
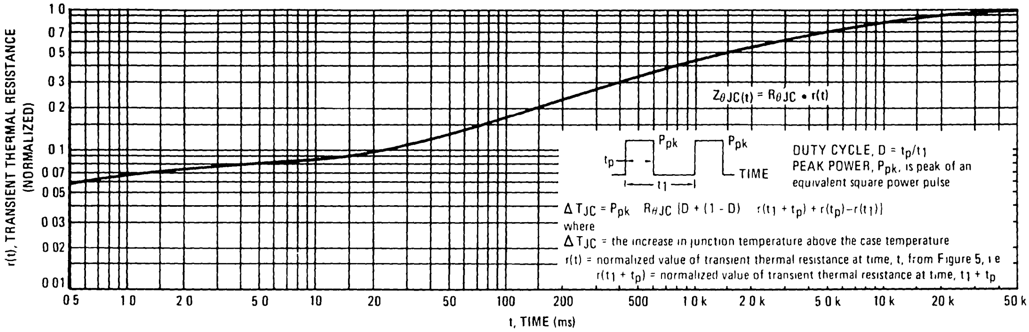


FIGURE 4 – FORWARD POWER DISSIPATION



THERMAL CHARACTERISTICS

FIGURE 5 – THERMAL RESPONSE



$Z_{\theta JC}(t) = R_{\theta JC} \cdot r(t)$

DUTY CYCLE, $D = t_p/t_1$
PEAK POWER, P_{pk}, is peak of an equivalent square power pulse

$\Delta T_{JC} = P_{pk} \cdot R_{\theta JC} [D + (1 - D) \cdot r(t_1 + t_p) + r(t_p) - r(t_1)]$

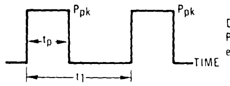
where

ΔT_{JC} = the increase in junction temperature above the case temperature

r(t) = normalized value of transient thermal resistance at time, t, from Figure 5, i.e.

$r(t_1 + t_p)$ = normalized value of transient thermal resistance at time, $t_1 + t_p$

NOTE 2 – FINDING JUNCTION TEMPERATURE



DUTY CYCLE $D = t_p/t_1$
PEAK POWER P_{pk} is peak of an equivalent square power pulse

To determine maximum junction temperature of the diode in a given situation the following procedure is recommended

The temperature of the case should be measured using a thermocouple placed on the case at the temperature reference point (see Note 3). The thermal mass connected to the case is normally large enough so that it will not significantly respond to heat surges generated in the diode as a result of pulsed operation once steady state conditions are achieved. Using the measured value of T_C the junction temperature may be determined by

$$T_J = T_C + \Delta T_{JC}$$

where ΔT_{JC} is the increase in junction temperature above the case temperature. It may be determined by

$\Delta T_{JC} = P_{pk} \cdot R_{\theta JC} [D + (1 - D) \cdot r(t_1 + t_p) + r(t_p) - r(t_1)]$

where

r(t) = normalized value of transient thermal resistance at time t from Figure 5 i.e.

$r(t_1 + t_p)$ = normalized value of transient thermal resistance at time $t_1 + t_p$

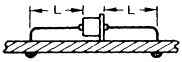
NOTE 3 – MOUNTING DATA

Data shown for thermal resistance junction-to-ambient ($R_{\theta JA}$) for the mountings shown is to be used as typical guideline values for preliminary engineering

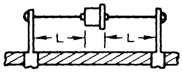
TYPICAL VALUES FOR $R_{\theta JA}$ IN STILL AIR

MOUNTING METHOD	LEAD LENGTH, L (IN) 1/4	1	$R_{\theta JA}$
1	55	60	°C/W
2	65	70	°C/W
3	25		°C/W

MOUNTING METHOD 1



MOUNTING METHOD 2



Vector pin mounting

MOUNTING METHOD 3

P C Board with 2 1/2" x 2 1/2" copper surface

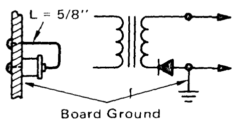
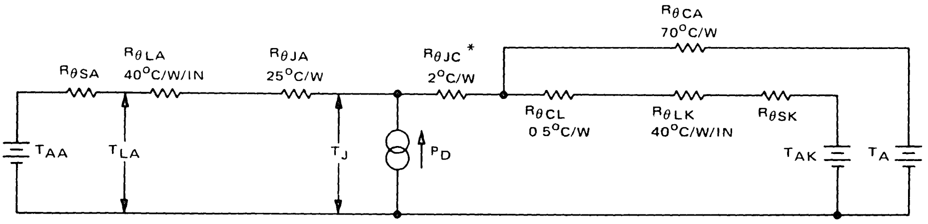


FIGURE 6 – APPROXIMATE THERMAL CIRCUIT MODEL



Use of the above model permits calculation of average junction temperature for any mounting situation. Lowest values of thermal resistance will occur when the cathode lead is brought as close as possible to a heat dissipator, as heat conduction through the anode lead is small. Terms in the model are defined as follows

***Case temperature reference is at cathode end**

TEMPERATURES

- T_A = Ambient
- T_{AA} = Anode Heat Sink Ambient
- T_{AK} = Cathode Heat Sink Ambient
- T_{LA} = Anode Lead
- T_{LK} = Cathode Lead
- T_J = Junction

THERMAL RESISTANCES

- $R_{\theta CA}$ = Case to Ambient
- $R_{\theta SA}$ = Anode Lead Heat Sink to Ambient
- $R_{\theta SK}$ = Cathode Lead Heat Sink to Ambient
- $R_{\theta LA}$ = Anode Lead
- $R_{\theta LK}$ = Cathode Lead
- $R_{\theta CL}$ = Case to Cathode Lead
- $R_{\theta JC}$ = Junction to Case
- $R_{\theta JA}$ = Junction to Anode Lead (S bend)

FIGURE 7 – TYPICAL FORWARD VOLTAGE

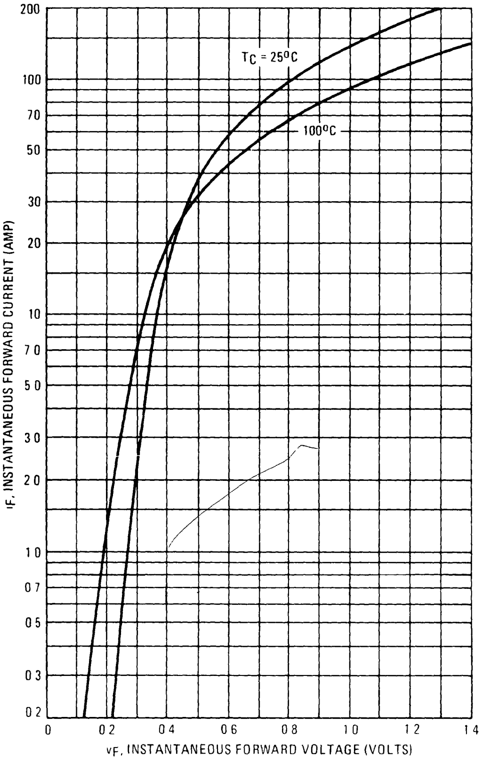


FIGURE 8 – MAXIMUM SURGE CAPABILITY

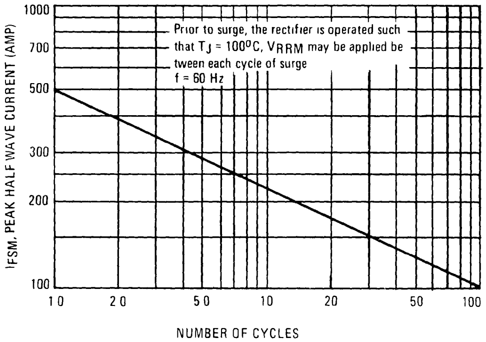


FIGURE 9 – TYPICAL REVERSE CURRENT

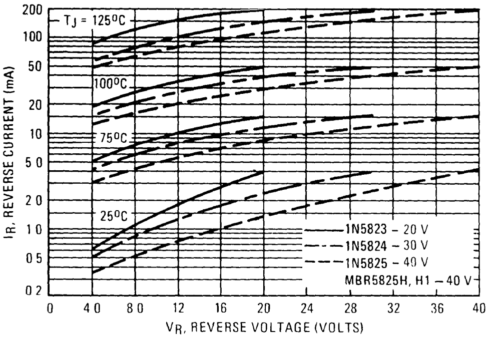
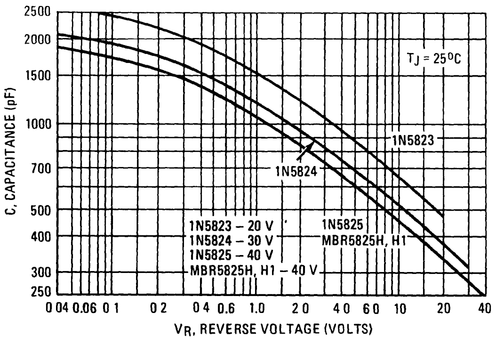


FIGURE 10 – CAPACITANCE



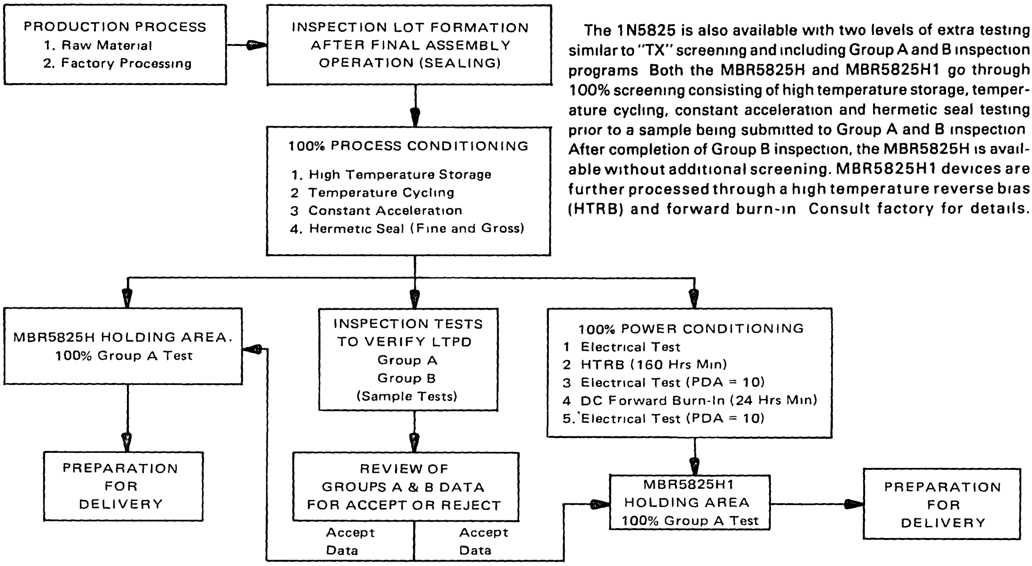
NOTE 4 – HIGH FREQUENCY OPERATION

Since current flow in a Schottky rectifier is the result of majority carrier conduction, it is not subject to junction diode forward and reverse recovery transients due to minority carrier injection and stored charge. Satisfactory circuit analysis work may be performed by using a model consisting of an ideal diode in parallel with a variable capacitance. (See Figure 10)

Rectification efficiency measurements show that operation will be satisfactory up to several megahertz. For example, relative waveform rectification efficiency is approximately 70 per cent at 2.0 MHz, e.g., the ratio of dc power to RMS power in the load is 0.28 at this frequency, whereas perfect rectification would yield 0.406 for sine wave inputs. However, in contrast to ordinary junction diodes, the loss in waveform efficiency is not indicative of power loss, it is simply a result of reverse current flow through the diode capacitance, which lowers the dc output voltage.

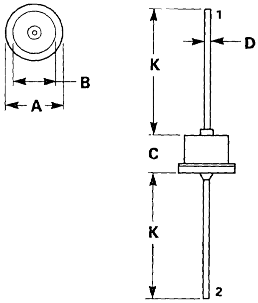
NOTE 5 – HI-REL PROGRAM OPTIONS

The 1N5825 is also available with two levels of extra testing similar to "TX" screening and including Group A and B inspection programs Both the MBR5825H and MBR5825H1 go through 100% screening consisting of high temperature storage, temperature cycling, constant acceleration and hermetic seal testing prior to a sample being submitted to Group A and B inspection After completion of Group B inspection, the MBR5825H is available without additional screening. MBR5825H1 devices are further processed through a high temperature reverse bias (HTRB) and forward burn-in Consult factory for details.



MECHANICAL CHARACTERISTICS

CASE: Welded, hermetically sealed construction.
FINISH: All external surfaces corrosion-resistant and the terminal leads are readily solderable
WEIGHT: 2 4 grams (approximately)
POLARITY: Cathode to case
MOUNTING POSITONS: Any



	MILLIMETERS		INCHES	
DIM	MIN	MAX	MIN	MAX
A	—	11.43	—	0 450
B	—	8.89	—	0 350
C	—	7.62	—	0 300
D	1.17	1.42	0.046	0.056
K	24.89	—	0.980	—

CASE 60-01
METAL

MOTOROLA
SEMICONDUCTOR
TECHNICAL DATA

1N5826
1N5827
1N5828

Designers Data Sheet

HOT CARRIER POWER RECTIFIER

employing the Schottky Barrier principle in a large area metal-to-silicon power diode. State of the art geometry features epitaxial construction with oxide passivation and metal overlap contact Ideally suited for use as rectifiers in low-voltage, high-frequency inverters, free wheeling diodes, and polarity protection diodes

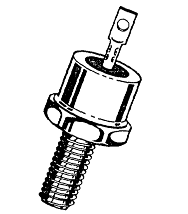
- Extremely Low v_F
- Low Stored Charge, Majority Carrier Conduction
- Low Power Loss/High Efficiency
- High Surge Capacity

Designer's Data for "Worst Case" Conditions

The Designers Data sheets permit the design of most circuits entirely from the information presented Limit curves — representing boundaries on device characteristics — are given to facilitate "worst case" design

SCHOTTKY BARRIER RECTIFIERS

15 AMPERE
20,30,40 VOLTS



3

*MAXIMUM RATINGS

Rating	Symbol	1N5826	1N5827	1N5828	Unit
Peak Repetitive Reverse Voltage Working Peak Reverse Voltage DC Blocking Voltage	V_{RRM} V_{RWM} V_R	20	30	40	Volts
Non-Repetitive Peak Reverse Voltage	V_{RSM}	24	36	48	Volts
Average Rectified Forward Current $V_{R(equiv)} \leq 0\ 2\ V_{R(dc)}$, $T_C = 85°C$	I_O	← 15 →			Amp
Ambient Temperature Rated $V_{R(dc)}$, $P_{F(AV)} = 0$, $R_{\theta JA} = 5.0°C/W$	T_A	95	90	85	°C
Non-Repetitive Peak Surge Current (surge applied at rated load conditions, halfwave, single phase, 60 Hz)	I_{FSM}	← 500 (for 1 cycle) →			Amp
Operating and Storage Junction Temperature Range (Reverse voltage applied)	T_J, T_{stg}	← -65 to +125 →			°C
Peak Operating Junction Temperature (Forward Current Applied)	$T_{J(pk)}$	← 150 →			°C

*THERMAL CHARACTERISTICS

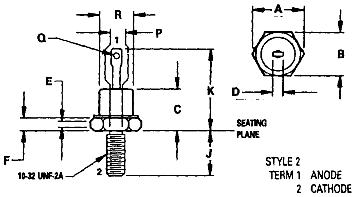
Characteristic	Symbol	Max	Unit
Thermal Resistance, Junction to Case	$R_{\theta JC}$	2.5	°C/W

*ELECTRICAL CHARACTERISTICS ($T_C = 25°C$ unless otherwise noted.)

Characteristic	Symbol	1N5826	1N5827	1N5828	Unit
Maximum Instantaneous Forward Voltage (1) ($i_F = 8\ 0$ Amp) ($i_F = 15$ Amp) ($i_F = 47\ 1$ Amp)	v_F	 0 380 0.440 0.670	 0.400 0.470 0.770	 0.420 0.500 0 870	Volts
Maximum Instantaneous Reverse Current @ rated dc Voltage (1) $T_C = 100°C$	i_R	 10 75	 10 75	 10 75	mA

*Indicates JEDEC Registered Data

(1) Pulse Test Pulse Width = 300 μs, Duty Cycle = 2 0%.



STYLE 2
TERM 1 ANODE
2 CATHODE

NOTES
1 ALL RULES AND NOTES ASSOCIATED WITH REFERENCED DO-4 OUTLINE SHALL APPLY
2 DIMENSIONING AND TOLERANCING PER ANSI Y14 5M, 1982
3 CONTROLLING DIMENSION INCH

DIM	MILLIMETERS		INCHES	
	MIN	MAX	MIN	MAX
A	—	12 82	—	0 505
B	10 77	11 09	0 424	0 437
C	—	10 28	—	0 405
D	—	6 35	—	0 250
E	1 53	—	0 060	—
F	1 91	4 44	0 075	0 175
J	10 72	11 50	0 422	0 453
K	15 24	20 32	0 600	0 800
P	4 14	4 80	0 163	0 189
Q	1 53	2 41	0 060	0 095
R	6 74	10 76	0 265	0 424

CASE 56-03
DO-203AA
METAL

MECHANICAL CHARACTERISTICS
CASE: Welded, hermetically sealed
FINISH: All external surfaces corrosion resistant and terminal leads are readily solderable
POLARITY: Cathode to Case
MOUNTING POSITION: Any
MOUNTING TORQUE: 15 in-lb max

NOTE 1: DETERMINING MAXIMUM RATINGS

Reverse power dissipation and the possibility of thermal runaway must be considered when operating this rectifier at reverse voltages above 0.2 V_{RWM}. Proper derating may be accomplished by use of equation (1):

$$T_{A(max)} = T_{J(max)} - R_{\theta JA}\, P_{F(AV)} - R_{\theta JA}\, P_{R(AV)} \quad (1)$$

where

$T_{A(max)}$ = Maximum allowable ambient temperature

$T_{J(max)}$ = Maximum allowable junction temperature (125°C or the temperature at which thermal runaway occurs, whichever is lowest).

$P_{F(AV)}$ = Average forward power dissipation

$P_{R(AV)}$ = Average reverse power dissipation

$R_{\theta JA}$ = Junction-to-ambient thermal resistance

Figures 1, 2 and 3 permit easier use of equation (1) by taking reverse power dissipation and thermal runaway into consideration. The figures solve for a reference temperature as determined by equation (2):

$$T_R = T_{J(max)} - R_{\theta JA}\, P_{R(AV)} \quad (2)$$

Substituting equation (2) into equation (1) yields:

$$T_{A(max)} = T_R - R_{\theta JA}\, P_{F(AV)} \quad (3)$$

Inspection of equations (2) and (3) reveals that T_R is the ambient temperature at which thermal runaway occurs or where T_J = 125°C, when forward power is zero. The transition from one boundary condition to the other is evident on the curves of Figures 1, 2 and 3 as a difference in the rate of change of the slope in the vicinity of 115°C. The data of Figures 1, 2 and 3 is based upon dc conditions. For use in common rectifier circuits, Table I indicates suggested factors for an equivalent dc voltage to use for conservative design; i.e.:

$$V_{R(equiv)} = V_{in(PK)} \times F \quad (4)$$

The Factor F is derived by considering the properties of the various rectifier circuits and the reverse characteristics of Schottky diodes.

Example: Find $T_{A(max)}$ for 1N5828 operated in a 12-Volt dc supply using a bridge circuit with capacitive filter such that I_{DC} = 10 A ($I_{F(AV)}$ = 5 A), $I_{(PK)}/I_{(AV)}$ = 20, Input Voltage = 10 V(rms), $R_{\theta JA}$ = 5°C/W.

Step 1: Find $V_{R(equiv)}$. Read F = 0.65 from Table I ∴
$V_{R(equiv)}$ = (1.41)(10)(0.65) = 9.18 V

Step 2: Find T_R from Figure 3. Read T_R = 121°C @ V_R = 9.18 & $R_{\theta JA}$ = 5°C/W

Step 3: Find $P_{F(AV)}$ from Figure 4.** Read $P_{F(AV)}$ = 10 W @ $\frac{I_{(PK)}}{I_{(AV)}}$ = 20 & $I_{F(AV)}$ = 5 A

Step 4: Find $T_{A(max)}$ from equation (3). $T_{A(max)}$ = 121-(5)(10) = 71°C

** Value given are for the 1N5828. Power is slightly lower for the other units because of their lower forward voltage.

TABLE I – VALUES FOR FACTOR F

Circuit	Half Wave		Full Wave, Bridge		Full Wave, Center Tapped *†	
Load	Resistive	Capacitive*	Resistive	Capacitive	Resistive	Capacitive
Sine Wave	0.5	1.3	0.5	0.65	1.0	1.3
Square Wave	0.75	1.5	0.75	0.75	1.5	1.5

*Note that $V_{R(PK)} \approx 2\, V_{in(PK)}$

*†Use line to center tap voltage for V_{in}.

FIGURE 1 – MAXIMUM REFERENCE TEMPERATURE – 1N5826

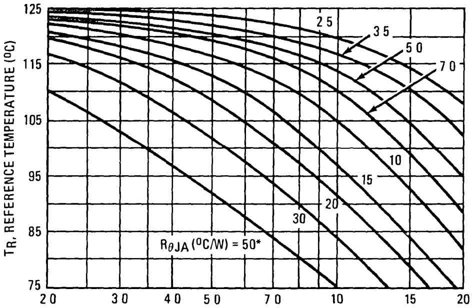


FIGURE 2 – MAXIMUM REFERENCE TEMPERATURE – 1N5827

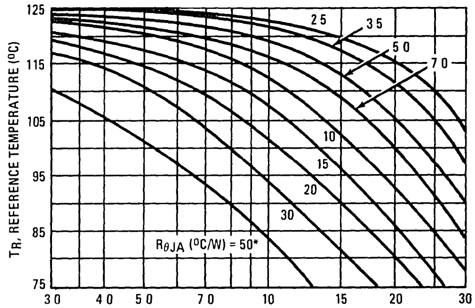


FIGURE 3 – MAXIMUM REFERENCE TEMPERATURE – 1N5828

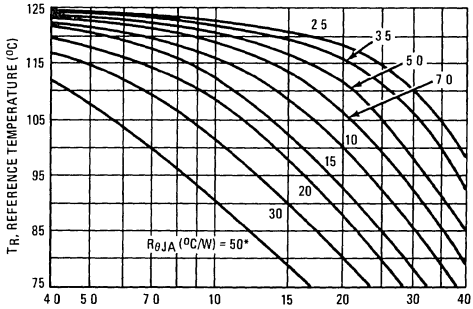
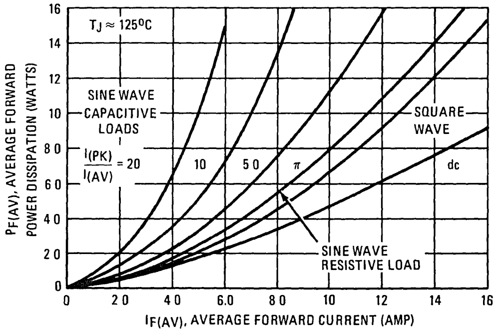


FIGURE 4 – FORWARD POWER DISSIPATION



*No external heat sink.

FIGURE 5 — TYPICAL FORWARD VOLTAGE

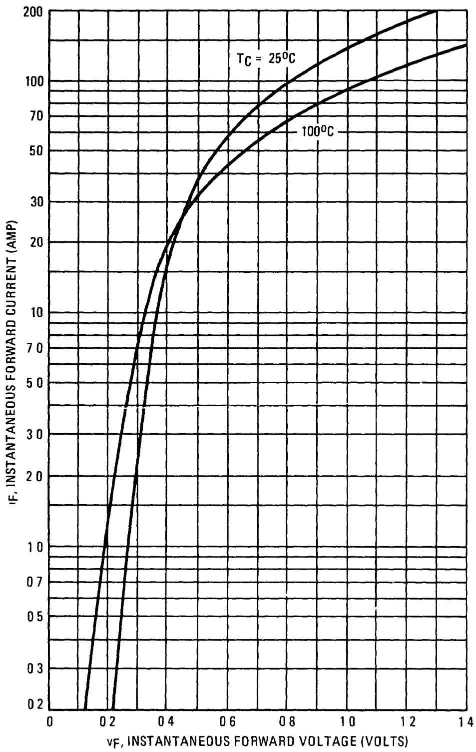


FIGURE 6 — MAXIMUM SURGE CAPABILITY

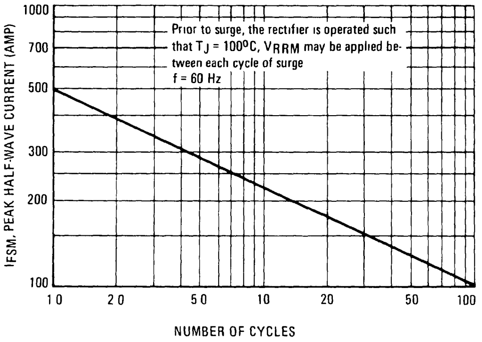


FIGURE 7 — CURRENT DERATING

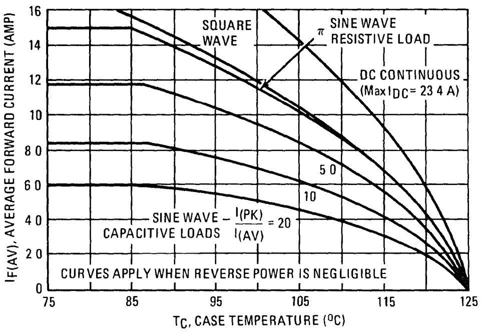


FIGURE 8 — THERMAL RESPONSE

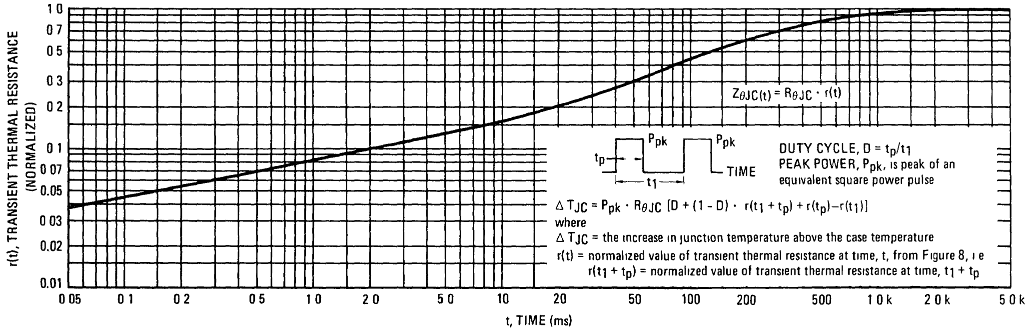


FIGURE 9 – NORMALIZED REVERSE CURRENT

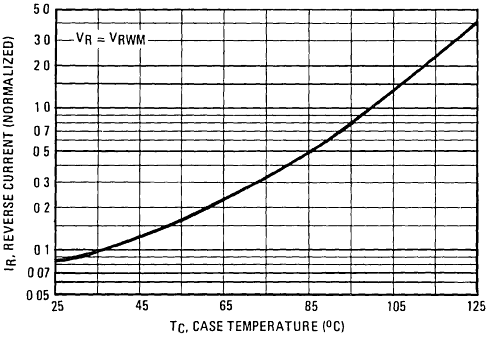


FIGURE 10 – TYPICAL REVERSE CURRENT

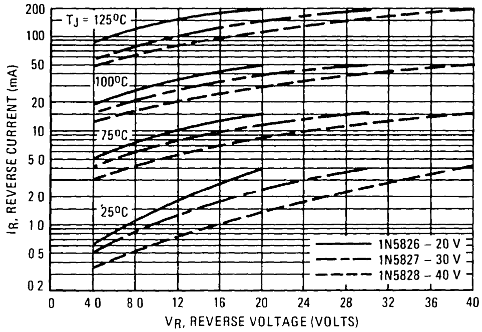
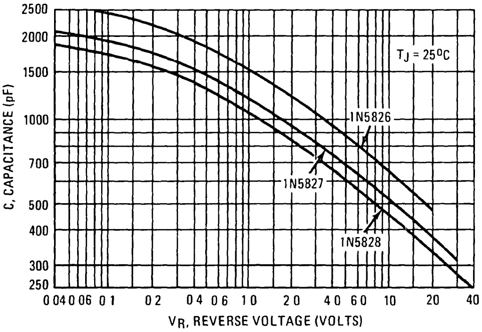


FIGURE 11 – CAPACITANCE



NOTE 2 – HIGH FREQUENCY OPERATION

Since current flow in a Schottky rectifier is the result of majority carrier conduction, it is not subject to junction diode forward and reverse recovery transients due to minority carrier injection and stored charge Satisfactory circuit analysis work may be performed by using a model consisting of an ideal diode in parallel with a variable capacitance (See Figure 11)

Rectification efficiency measurements show that operation will be satisfactory up to several megahertz For example, relative waveform rectification efficiency is approximately 70 per cent at 2 0 MHz, e g , the ratio of dc power to RMS power in the load is 0 28 at this frequency, whereas perfect rectification would yield 0 406 for sine wave inputs However, in contrast to ordinary junction diodes, the loss in waveform efficiency is not indicative of power loss, it is simply a result of reverse current flow through the diode capacitance, which lowers the dc output voltage

3

1N5829
1N5830
1N5831
MBR5831H, H1

3

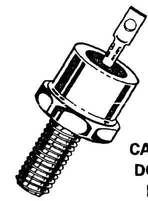
Designer's Data Sheet

Hot Carrier Power Rectifiers

. . . employing the Schottky Barrier principle in a large area metal-to-silicon power diode. State of the art geometry features epitaxial construction with oxide passivation and metal overlap contact. Ideally suited for use as rectifiers in low-voltage, high-frequency inverters, free wheeling diodes, and polarity protection diodes.

- Extremely Low v_F
- Low Stored Charge, Majority Carrier Conduction
- Low Power Loss/High Efficiency
- High Surge Capacity
- High Reliability Processing Similar to JAN,JTX Processing Available (See Note 3)

25 AMPERE
20, 30, 40 VOLTS



CASE 56-03
DO-203AA
METAL

MAXIMUM RATINGS

Rating	Symbol	*1N5829	*1N5830	*1N5831 MBR5831H,H1	Unit
Peak Repetitive Reverse Voltage Working Peak Reverse Voltage DC Blocking Voltage	V_{RRM} V_{RWM} V_R	20	30	40	Volts
Nonrepetitive Peak Reverse Voltage	V_{RSM}	24	36	48	Volts
Average Rectified Forward Current $V_{R(equiv)} \leq 0.2\ V_{R(dc)}$, $T_C = 85°C$	I_O	25			Amps
Ambient Temperature Rated $V_{R(dc)}$, $P_{F(AV)} = 0$, $R_{\theta JA} = 3.5°C/W$	T_A	90	85	80	°C
Nonrepetitive Peak Surge Current (surge applied at rated load conditions, halfwave, single phase, 60 Hz)	I_{FSM}	800 (for 1 cycle)			Amps
Operating and Storage Junction Temperature Range (Reverse voltage applied)	T_J, T_{stg}	−65 to +125			°C
Peak Operating Junction Temperature (Foward Current Applied)	$T_{J(pk)}$	150			°C

MECHANICAL CHARACTERISTICS
CASE: Welded, hermetically sealed
FINISH: All external surfaces corrosion resistant and terminal leads are readily solderable.
POLARITY: Cathode to Case
MOUNTING POSITION: Any
MOUNTING TORQUE: 15 in-lb max

THERMAL CHARACTERISTICS

Characteristic	Symbol	Max	Unit
Thermal Resistance, Junction to Case	$R_{\theta JC}$	1.75	°C/W

ELECTRICAL CHARACTERISTICS (T_C = 25°C unless otherwise noted)

Characteristic	Symbol	*1N5829	*1N5830	*1N5831 MBR5831H,H1	Unit
Maximum Instantaneous Forward Voltage(1) (i_F = 10 Amps) (i_F = 25 Amps) (i_F = 78.5 Amps)	v_F	 0.360 0.440 0.720	 0.370 0.460 0.770	 0.380 0.480 0.820	Volts
Maximum Instantaneous Reverse Current @ Rated dc Voltage(1) (T_C = 100°C)	i_R	20 150	20 150	20 150	mA

*Indicates JEDEC Registered Data.
(1) Pulse Test: Pulse Width = 300 μs, Duty Cycle = 2%.
Designer's Data for "Worst Case" Conditions — The Designer's Data Sheet permits the design of most circuits entirely from the information presented. Limit curves — representing boundaries on device characteristics — are given to facilitate "worst case" design.

NOTE 1: DETERMINING MAXIMUM RATINGS

Reverse power dissipation and the possibility of thermal runaway must be considered when operating this rectifier at reverse voltages above 0.2 V_{RWM}. Proper derating may be accomplished by use of equation (1):

$$T_{A(max)} = T_{J(max)} - R_{\theta JA}\,P_{F(AV)} - R_{\theta JA}\,P_{R(AV)} \quad (1)$$

where

$T_{A(max)}$ = Maximum allowable ambient temperature

$T_{J(max)}$ = Maximum allowable junction temperature (125°C or the temperature at which thermal runaway occurs, whichever is lowest).

$P_{F(AV)}$ = Average forward power dissipation

$P_{R(AV)}$ = Average reverse power dissipation

$R_{\theta JC}$ = Junction-to-ambient thermal resistance

Figures 1, 2 and 3 permit easier use of equation (1) by taking reverse power dissipation and thermal runaway into consideration. The figures solve for a reference temperature as determined by equation (2):

$$T_R = T_{J(max)} - R_{\theta JA}\,P_{R(AV)} \quad (2)$$

Substituting equation (2) into equation 91) yields:

$$T_{A(max)} = T_R - R_{\theta JA}\,P_{F(AV)} \quad (3)$$

Inspection of equations (2) and (3) reveals that T_R is the ambient temperature at which thermal runaway occurs or where T_J = 125°C, when forward power is zero. The transition from one boundary condition to the other is evident on the curves of Figures 1, 2 and 3 as a difference in the rate of change of the slope in the vicinity of 115°C.

The data of Figures 1, 2 and 3 is based upon dc conditions. For use in common rectifier circuits, Table 1 indicates suggested factors for an equivalent dc voltage to use for conservative design; i.e.:

$$V_{R(equiv)} = V_{in(PK)} \times F \quad (4)$$

The Factor F is derived by considering the properties of the various rectifier circuits and the reverse characteristics of Schottky diodes.

Example: Find $T_{A(max)}$ for 1N5831 operated in a 12-Volt dc supply using a bridge circuit with capacitive filter such that I_{DC} = 16 A ($I_{F(AV)}$ = 8 A), $I_{(PK)}/I_{(AV)}$ = 20, Input Voltage = 10 V(rms), $R_{\theta JA}$ = 5°C/W.

Step 1: Find $V_{R(equiv)}$. Read F = 0.65 from Table 1
$V_{R(equiv)}$ = (1.41)(10)(0.65) = 9.18 V

Step 2: Find T_R from Figure 3. Read T_R = 113°C @ V_R = 9.18 & $R_{\theta JA}$ = 5°C/W

Step 3: Find $P_{F(AV)}$ from Figure 4.** Read $P_{F(AV)}$ = 12.8 W @ $\frac{I_{(PK)}}{I_{(AV)}}$ = 20 & $I_{F(AV)}$ = 8 A

Step 4: Find $T_{A(max)}$ from equation (3). $T_{A(max)}$ = 113-(5) (12.8) = 49°C

**Value given are for the 1N5828. Power is slightly lower for the other units because of their lower forward voltage.

Table 1. Values for Factor F

Circuit Load	Half Wave		Full Wave, Bridge		Full Wave Center Tapped††	
	Resistive	Capacitive†	Resistive	Capacitive	Resistive	Capacitive
Sine Wave	0.5	1.3	0.5	0.65	1	1.3
Square Wave	0.75	1.5	0.75	0.75	1.5	1.5

†Note that $V_{R(PK)} \approx 2\,V_{in(PK)}$

††Use line to center tape voltage for V_{in}.

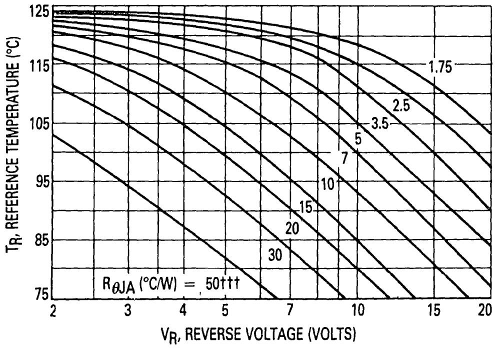


Figure 1. Maximum Reference Temperature — 1N5829

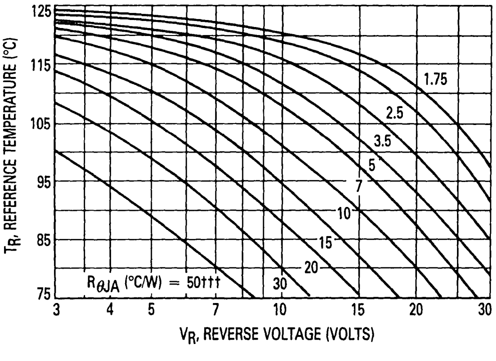


Figure 2. Maximum Reference Temperature — 1N5830

†††NO EXTERNAL HEAT SINK

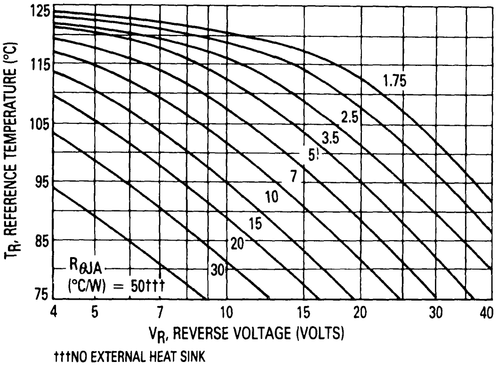


Figure 3. Maximum Reference Temperature — 1N5831

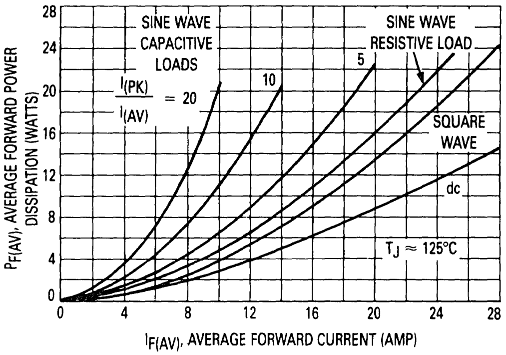


Figure 4. Forward Power Dissipation

3

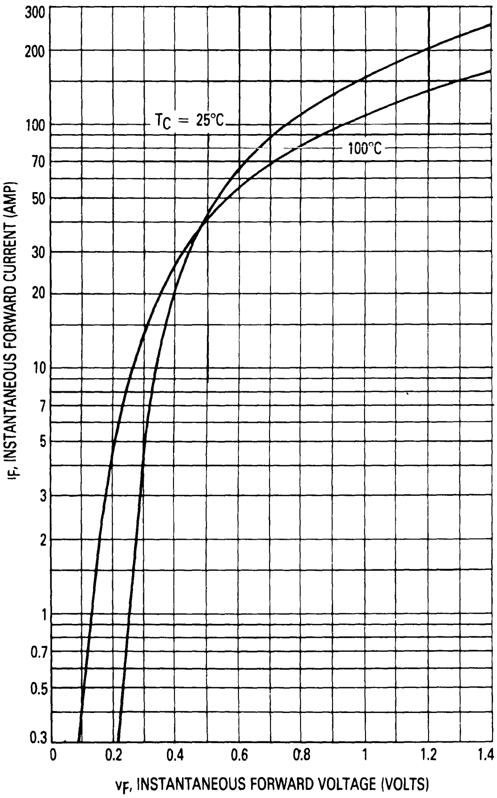


Figure 5. Typical Forward Voltage

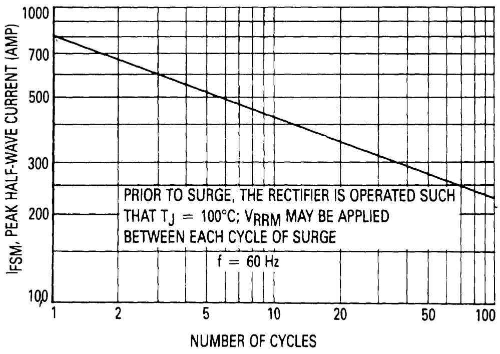


Figure 6. Maximum Surge Capability

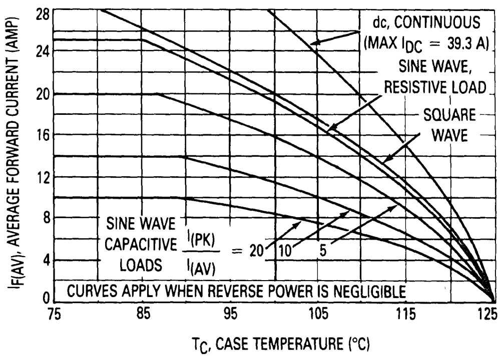


Figure 7. Current Derating

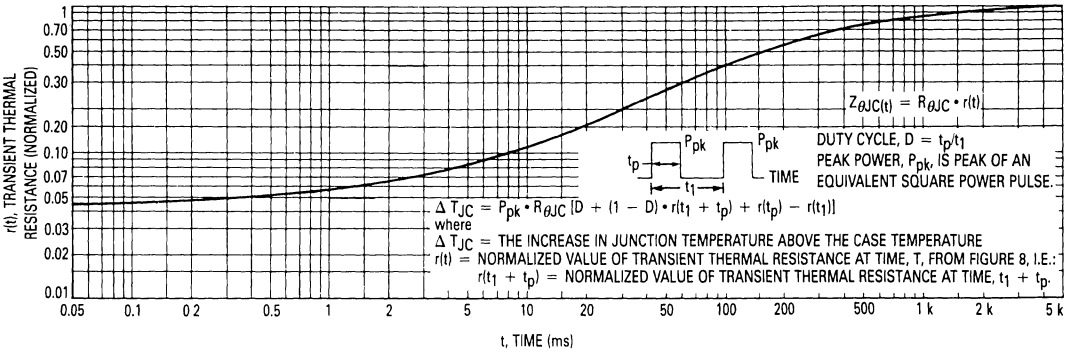


Figure 8. Thermal Response

3

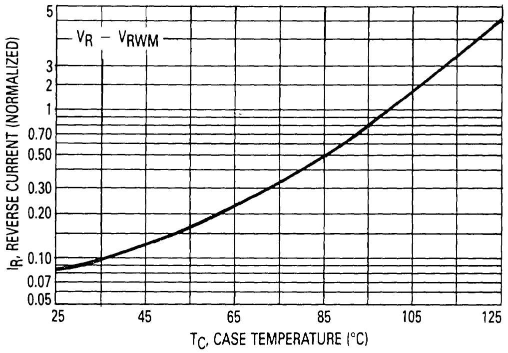


Figure 9. Normalized Reverse Current

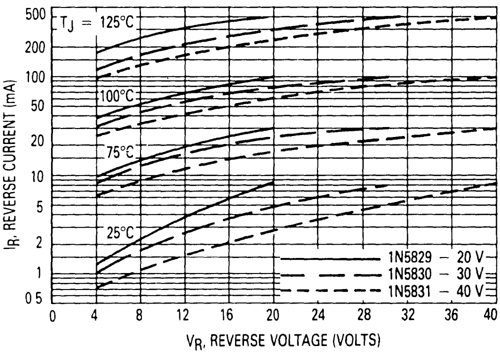


Figure 10. Typical Reverse Current

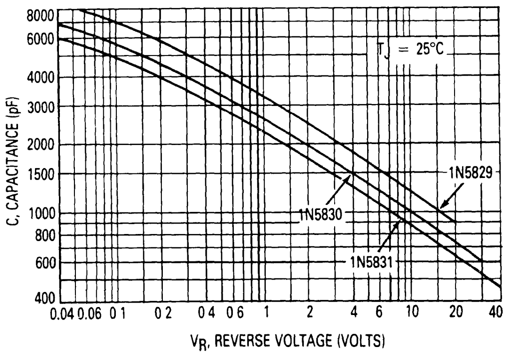


Figure 11. Capacitance

NOTE 2 — HIGH FREQUENCY OPERATION

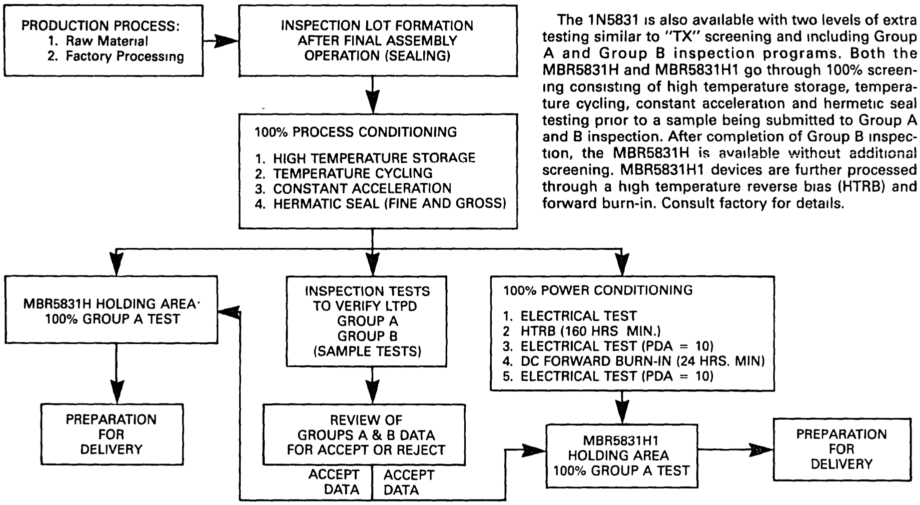
Since current flow in a Schottky rectifier is the result of majority carrier conduction, it is not subject to junction diode forward and reverse recovery transients due to minority carrier injection and stored charge. Satisfactory circuit analysis work may be performed by using a model consisting of an ideal diode in parallel with a variable capacitance. (See Figure 11.)

Rectification efficiency measurements show that operation will be satisfactory up to several megahertz. For example, relative waveform rectification efficiency is approximately 70 percent at 2 MHz, e.g., the ratio of dc power to RMS power in the load is 0.28 at this frequency, whereas perfect rectification would yield 0.406 for sine wave inputs. However, in contrast to ordinary junction diodes, the loss in waveform efficiency is not indicate of power loss; it is simply a result of reverse current flow through the diode capacitance, which lowers the dc output voltage.

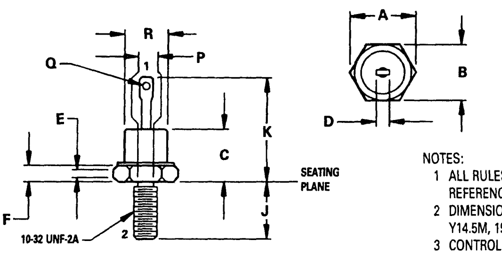
3

NOTE 3 — HI-REL PROGRAM OPTIONS

The 1N5831 is also available with two levels of extra testing similar to "TX" screening and including Group A and Group B inspection programs. Both the MBR5831H and MBR5831H1 go through 100% screening consisting of high temperature storage, temperature cycling, constant acceleration and hermetic seal testing prior to a sample being submitted to Group A and B inspection. After completion of Group B inspection, the MBR5831H is available without additional screening. MBR5831H1 devices are further processed through a high temperature reverse bias (HTRB) and forward burn-in. Consult factory for details.



OUTLINE DIMENSIONS



CASE 56-03
DO-203AA
METAL

STYLE 2:
TERM 1. ANODE
2. CATHODE

NOTES:
1 ALL RULES AND NOTES ASSOCIATED WITH REFERENCED DO-4 OUTLINE SHALL APPLY.
2 DIMENSIONING AND TOLERANCING PER ANSI Y14.5M, 1982.
3 CONTROLLING DIMENSION. INCH.

DIM	MILLIMETERS		INCHES	
	MIN	MAX	MIN	MAX
A	—	12 82	—	0 505
B	10 77	11.09	0 424	0 437
C	—	10 28	—	0 405
D	—	6 35	—	0 250
E	1.53	—	0.060	—
F	1 91	4 44	0 075	0 175
J	10.72	11 50	0 422	0.453
K	15 24	20.32	0 600	0 800
P	4 14	4 80	0 163	0 189
Q	1.53	2 41	0.060	0.095
R	6 74	10 76	0 265	0 424

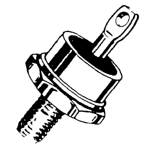
MOTOROLA
SEMICONDUCTOR
TECHNICAL DATA

1N5832
1N5833
1N5834

Designers Data Sheet

SCHOTTKY BARRIER RECTIFIERS

40 AMPERE
20,30,40 VOLTS



HOT CARRIER POWER RECTIFIER

. . employing the Schottky Barrier principle in a large area metal-to-silicon power diode State of the art geometry features epitaxial construction with oxide passivation and metal overlap contact Ideally suited for use as rectifiers in low-voltage, high-frequency inverters, free wheeling diodes, and polarity protection diodes

- Extremely Low v_F
- Low Stored Charge, Majority Carrier Conduction
- Low Power Loss/High Efficiency
- High Surge Capacity

Designer's Data for "Worst Case" Conditions

The Designers Data sheets permit the design of most circuits entirely from the information presented Limit curves — representing boundaries on device characteristics — are given to facilitate "worst case" design

*MAXIMUM RATINGS

Rating	Symbol	1N5832	1N5833	1N5834	Unit
Peak Repetitive Reverse Voltage Working Peak Reverse Voltage DC Blocking Voltage	V_{RRM} V_{RWM} V_R	20	30	40	Volts
Non-Repetitive Peak Reverse Voltage	V_{RSM}	24	36	48	Volts
Average Rectified Forward Current $V_{R(equiv)} \leq 0\ 2\ V_{R(dc)}, T_C = 75^oC$	I_O	← 40 →			Amp
Ambient Temperature Rated $V_{R(dc)}$, $P_{F(AV)} = 0$, $R_{\theta JA} = 2.0^oC/W$	T_A	100	95	90	^oC
Non-Repetitive Peak Surge Current (surge applied at rated load conditions halfwave, single phase, 60 Hz)	I_{FSM}	← 800 (for 1 cycle) →			Amp
Operating and Storage Junction Temperature Range (Reverse voltage applied)	T_J, T_{stg}	← -65 to +125 →			^oC
Peak Operating Junction Temperature (Forward Current Applied)	$T_{J(pk)}$	← 150 →			^oC

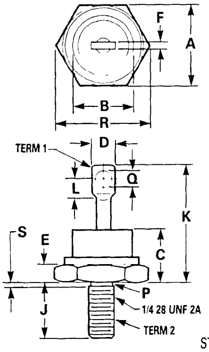
*THERMAL CHARACTERISTICS

Characteristic	Symbol	Max	Unit
Thermal Resistance, Junction to Case	$R_{\theta JC}$	1 0	$^oC/W$

*ELECTRICAL CHARACTERISTICS ($T_C = 25^oC$ unless otherwise noted)

Characteristic	Symbol	1N5832	1N5833	1N5834	Unit
Maximum Instantaneous Forward Voltage(1)	v_F				Volts
(i_F = 10 Amp)		0.360	0 370	0 380	
(i_F = 40 Amp)		0.520	0 550	0.590	
(i_F = 125 Amp)		0.980	1.080	1 180	
Maximum Instantaneous Reverse Current @ rated dc Voltage (1)	i_R	20	20	20	mA
$T_C = 100^oC$		150	150	150	

*Indicates JEDEC Registered Data.
(1) Pulse Test. Pulse Width = 300 μs, Duty Cycle = 2.0%



STYLE 1
TERM 1 CATHODE
2 ANODE (CASE)

NOTES
1 DIM "P" IS DIA
2 CHAMFER OR UNDERCUT ON ONE OR BOTH ENDS OF HEXAGONAL BASE IS OPTIONAL
3 ANGULAR ORIENTATION AND CONTOUR OF TERMINAL ONE IS OPTIONAL
4 THREADS ARE PLATED
5 DIMENSIONING AND TOLERANCING PER ANSI Y14 5, 1973

DIM	MILLIMETERS MIN	MILLIMETERS MAX	INCHES MIN	INCHES MAX
A	16 94	17 45	0 669	0 687
B	—	16 94	—	0 667
C	—	11 43	—	0 450
D	—	9 53	—	0 375
E	2 92	5 08	0 115	0 200
F	—	2 03	—	0 080
J	10 72	11 51	0 422	0 453
K	—	25 40	—	1 000
L	3 86	—	0 156	—
P	5 59	6 32	0 220	0 249
Q	3 56	4 45	0 140	0 175
R	—	20 16	—	0 794
S	—	2 26	—	0 089

CASE 257-01
DO-203AB
METAL

3

3

NOTE 1: DETERMINING MAXIMUM RATINGS

Reverse power dissipation and the possibility of thermal runaway must be considered when operating this rectifier at reverse voltages above 0.2 V_{RWM}. Proper derating may be accomplished by use of equation (1):

$$T_{A(max)} = T_{J(max)} - R_{\theta JA}\,P_{F(AV)} - R_{\theta JA}\,P_{R(AV)} \quad (1)$$

where

$T_{A(max)}$ = Maximum allowable ambient temperature

$T_{J(max)}$ = Maximum allowable junction temperature (125°C or the temperature at which thermal runaway occurs, whichever is lowest).

$P_{F(AV)}$ = Average forward power dissipation

$P_{R(AV)}$ = Average reverse power dissipation

$R_{\theta JC}$ = Junction-to-ambient thermal resistance

Figures 1, 2 and 3 permit easier use of equation (1) by taking reverse power dissipation and thermal runaway into consideration. The figures solve for a reference temperature as determined by equation (2).

$$T_R = T_{J(max)} - R_{\theta JA}\,P_{R(AV)} \quad (2)$$

Substituting equation (2) into equation (1) yields

$$T_{A(max)} = T_R - R_{\theta JA}\,P_{F(AV)} \quad (3)$$

Inspection of equations (2) and (3) reveals that T_R is the ambient temperature at which thermal runaway occurs or where T_J = 125°C, when forward power is zero. The transition from one boundary condition to the other is evident on the curves of Figures 1, 2 and 3 as a difference in the rate of change of the slope in the vicinity of 115°C. The data of Figures 1, 2 and 3 is based upon dc conditions. For use in common rectifier circuits, Table I indicates suggested factors for an equivalent dc voltage to use for conservative design; i.e.:

$$V_{R(equiv)} = V_{in(PK)} \times F \quad (4)$$

The Factor F is derived by considering the properties of the various rectifier circuits and the reverse characteristics of Schottky diodes.

Example: Find $T_{A(max)}$ for 1N5834 operated in a 12-Volt dc supply using a bridge circuit with capacitive filter such that I_{DC} = 30 A ($I_{F(AV)}$ = 15 A), $I_{(PK)}/I_{(AV)}$ = 10, Input Voltage = 10 V(rms), $R_{\theta JA}$ = 3°C/W.

Step 1: Find $V_{R(equiv)}$. Read F = 0.65 from Table I ∴ $V_{R(equiv)}$ = (10)(1.41)(0.65) = 9.18 V

Step 2: Find T_R from Figure 3. Read T_R = 118°C @ V_R = 9.18 V & $R_{\theta JA}$ = 3°C/W

Step 3: Find $P_{F(AV)}$ from Figure 4 †Read $P_{F(AV)}$ = 20 W @ $\frac{I_{(PK)}}{I_{(AV)}}$ = 10 & $I_{F(AV)}$ = 15 A

Step 4: Find $T_{A(max)}$ from equation (3). $T_{A(max)}$ = 118-(3)(20) = 58°C

†Values given are for the 1N5834. Power is slightly lower for the other units because of their lower forward voltage.

TABLE I – VALUES FOR FACTOR F

Circuit	Half Wave		Full Wave, Bridge		Full Wave, Center Tapped (1),(2)	
Load	Resistive	Capacitive (1)	Resistive	Capacitive	Resistive	Capacitive
Sine Wave	0.5	1.3	0.5	0.65	1.0	1.3
Square Wave	0.75	1.5	0.75	0.75	1.5	1.5

(1) Note that $V_{R(PK)} \approx 2\,V_{in(PK)}$

(2) Use line to center tap voltage for V_{in}

FIGURE 1 – MAXIMUM REFERENCE TEMPERATURE – 1N5832

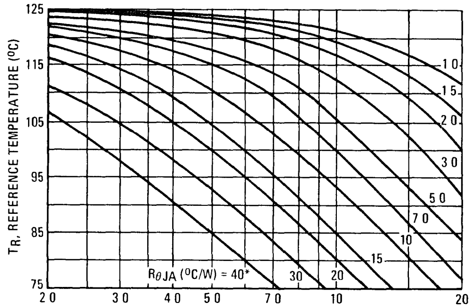


FIGURE 2 – MAXIMUM REFERENCE TEMPERATURE – 1N5833

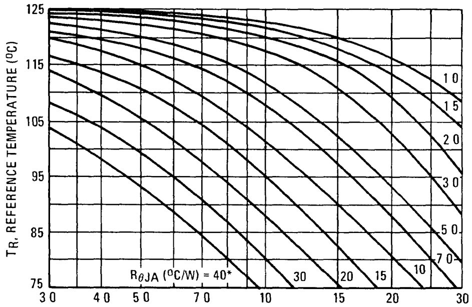


FIGURE 3 – MAXIMUM REFERENCE TEMPERATURE – 1N5834

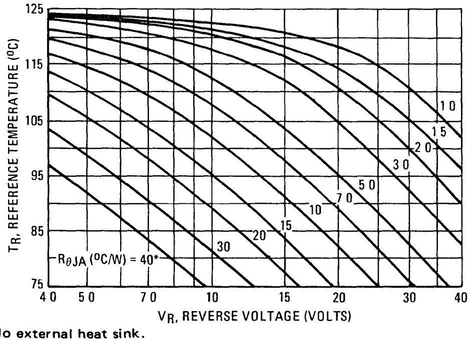
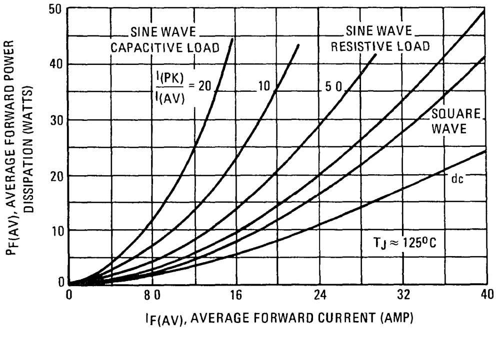


FIGURE 4 – FORWARD POWER DISSIPATION



*No external heat sink.

FIGURE 5 – TYPICAL FORWARD VOLTAGE

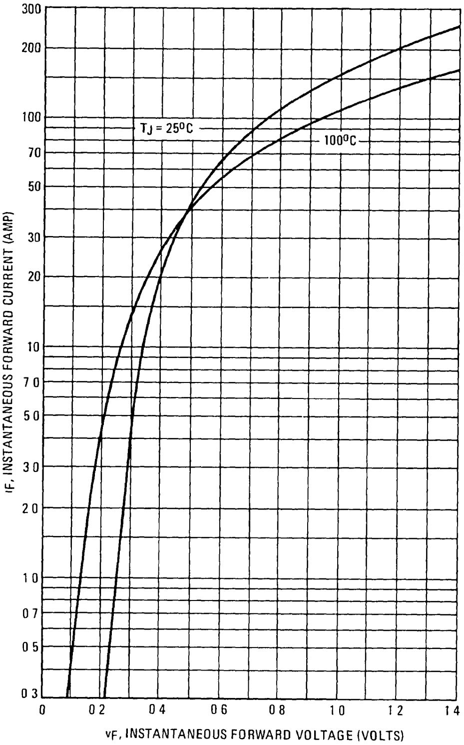


FIGURE 6 – MAXIMUM SURGE CAPABILITY

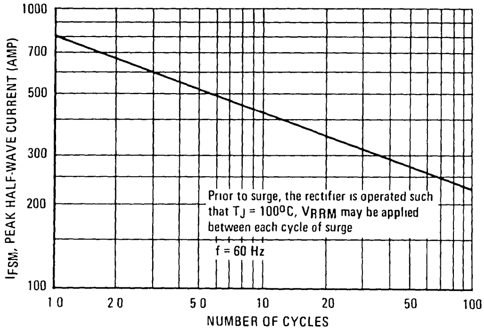


FIGURE 7 – CURRENT DERATING

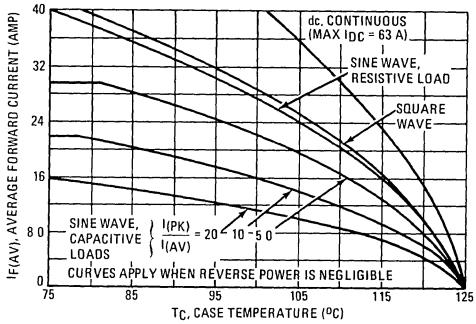


FIGURE 8 – THERMAL RESPONSE

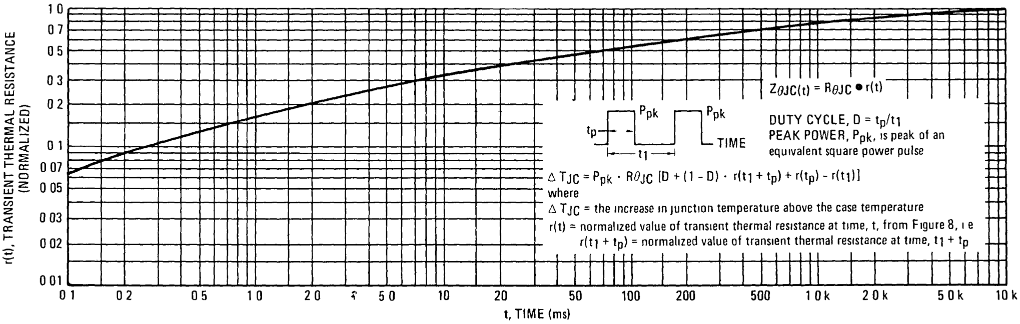


FIGURE 9 – NORMALIZED REVERSE CURRENT

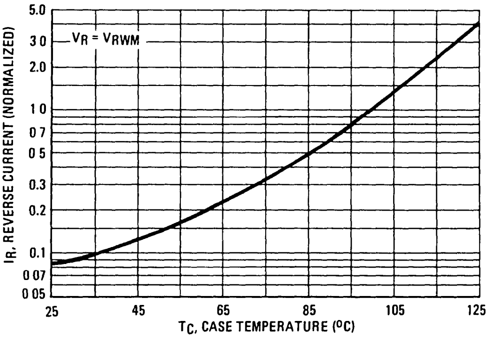


FIGURE 10 – TYPICAL REVERSE CURRENT

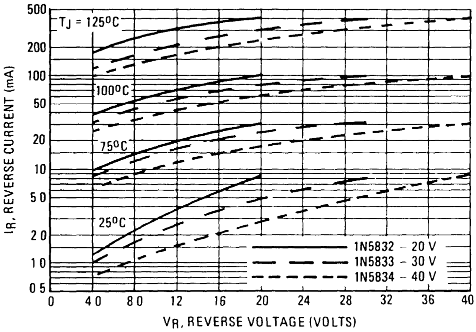
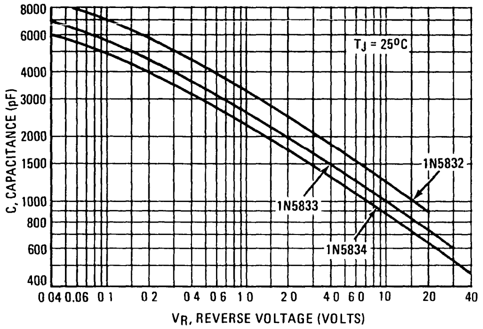


FIGURE 11 – CAPACITANCE



NOTE 2: HIGH FREQUENCY OPERATION

Since current flow in a Schottky rectifier is the result of majority carrier conduction, it is not subject to junction diode forward and reverse recovery transients due to minority carrier injection and stored charge. Satisfactory circuit analysis work may be performed by using a model consisting of an ideal diode in parallel with a variable capacitance. (See Figure 11).

Rectification efficiency measurements show that operation will be satisfactory up to several megahertz. For example, relative waveform rectification efficiency is approximately 70 per cent at 2.0 MHz, e g , the ratio of dc power to RMS power in the load is 0 28 at this frequency, whereas perfect rectification would yield 0 406 for sine wave inputs. However, in contrast to ordinary junction diodes, the loss in waveform efficiency is not indicative of power loss, it is simply a result of reverse current flow through the diode capacitance, which lowers the dc output voltage.

MECHANICAL CHARACTERISTICS
CASE: Welded, hermetically sealed
FINISH: All external surfaces corrosion resistant and terminal lead is readily solderable.
POLARITY: Cathode to Case
MOUNTING POSITION: Any
MOUNTING TORQUE: 25 in-lb max
SOLDER HEAT: See Note 3

NOTE 3: SOLDER HEAT

The excellent heat transfer property of the heavy duty copper anode terminal which transmits heat away from the die requires that caution be used when attaching wires. Motorola suggests a heat sink be clamped between the eyelet and the body during any soldering operation.

MOTOROLA
SEMICONDUCTOR
TECHNICAL DATA

1N6095
1N6096
SD41

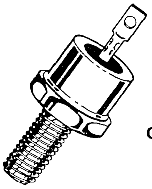
SWITCHMODE POWER RECTIFIERS

using the Schottky Barrier principle with a platinum barrier metal
These state-of-the-art devices have the following features

- Guardring for Stress Protection
- Low Forward Voltage
- 150°C Operating Junction Temperature Capability
- Guaranteed Reverse Avalanche

SCHOTTKY BARRIER RECTIFIERS

25 and 30 AMPERES
30 to 45 VOLTS



CASE 56-03
DO-203AA
METAL

3

MAXIMUM RATINGS

Rating	Symbol	1N6095*	1N6096*	SD41	Unit
Peak Repetitive Reverse Voltage Working Peak Reverse Voltage DC Blocking Voltage	V_{RRM} V_{RWM} V_R	30	40	45 35 45	Volts
Average Rectified Forward Current (Rated V_R)	I_O	25 $T_C = 70°C$	25 $T_C = 70°C$	30 $T_C = 105°C$	Amps
Case Temperature (Rated V_R)	T_C	105	105	—	°C
Nonrepetitive Peak Surge Current (Surge applied at rated load conditions halfwave, single phase, 60 Hz)	I_{FSM}	400	400	600	Amp
Peak Repetitive Reverse Surge Current (2 0 μs, 1 0 kHz) See Figure 10 (1)	I_{RRM}	2 0	2 0	2 0	Amps
Operating and Storage Junction Temperature Range	T_J, T_{stg}	-65 to + 125	-65 to + 125	-55 to + 150°C	°C
Peak Operating Junction Temperature (Forward Current Applied)	$T_{J(pk)}$	150	150	150	°C
Voltage Rate of Change (Rated V_R)	dv/dt	—	—	700	V/μs

THERMAL CHARACTERISTICS

Characteristic	Symbol	1N6095*	1N6096*	SD41	Unit
Maximum Thermal Resistance, Junction to Case	$R_{\theta JC}$	←	2 0	→	°C/W

ELECTRICAL CHARACTERISTICS

Characteristic	Symbol	1N6095*	1N6096*	SD41	Unit
Maximum Instantaneous Forward Voltage (2) (i_F = 30 Amp, T_C = 125°C) (i_F = 78 5 Amp, T_C = 70°C)	v_F	 — 0 86	 — 0 86	 0 55 —	Volts
Maximum Instantaneous Reverse Current (2) (Rated dc Voltage, T_C = 125°C)	i_R	250	250	125 @ V_R = 35 V	mA
Capacitance (100 kHz ≥ f ≥ 1 0 MHz)	C_t	6000 V_R = 1 0 V	6000 V_R = 1 0 V	2000 V_R = 5 0 V	pF

*Indicates JEDEC Registered Data
(1) Not JEDEC requirement, but a Motorola product capability
(2) Pulse Test Pulse Width = 300 μs, Duty Cycle ≤ 2 0%

3

FIGURE 1 — TYPICAL FORWARD VOLTAGE

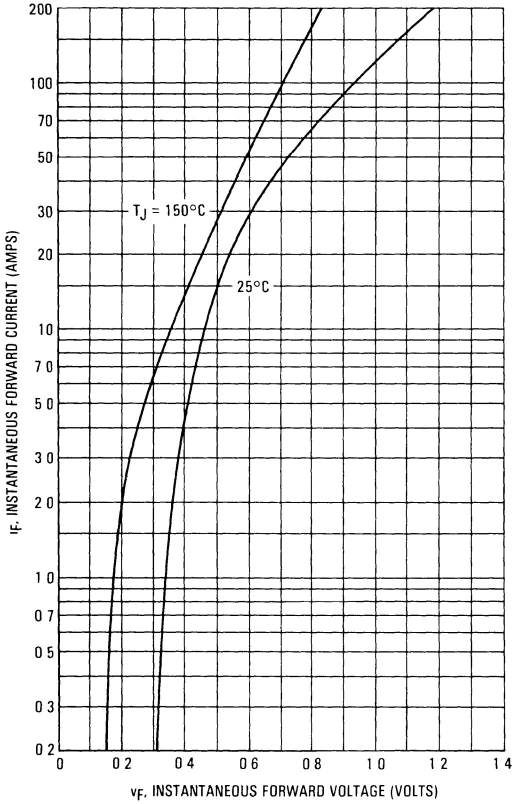


FIGURE 2 — TYPICAL REVERSE CURRENT

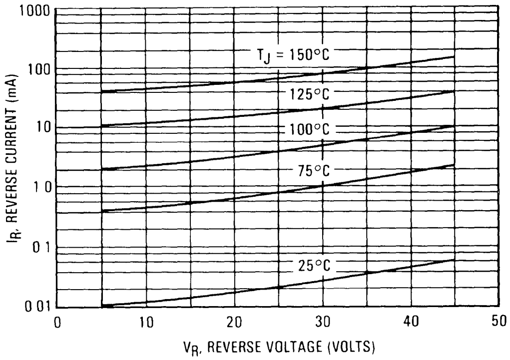
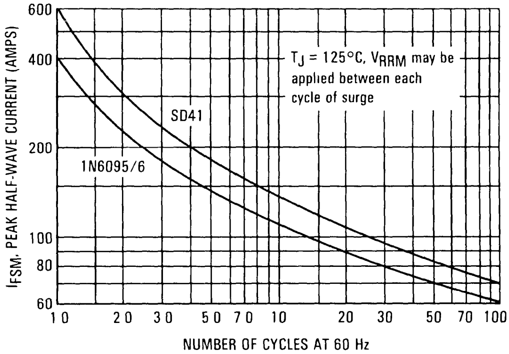


FIGURE 3 — MAXIMUM SURGE CAPABILITY



HIGH FREQUENCY OPERATION

Since current flow in a Schottky rectifier is the result of majority carrier conduction, it is not subject to junction diode forward and reverse recovery transients due to minority carrier injection and stored charge Satisfactory circuit analysis work may be performed by using a model consisting of an ideal diode in parallel with a variable capacitance (See Figure 4)

Rectification efficiency measurements show that operation will be satisfactory up to several megahertz For example, relative waveform rectification efficiency is approximately 70 per cent at 2 0 MHz, e g., the ratio of dc power to RMS power in the load is 0 28 at this frequency, whereas perfect rectification would yield 0.406 for sine wave inputs However, in contrast to ordinary junction diodes, the loss in waveform efficieny is not indicative of power loss, it is simply a result of reverse current flow through the diode capacitance, which lowers the dc output voltage

FIGURE 4 — CAPACITANCE

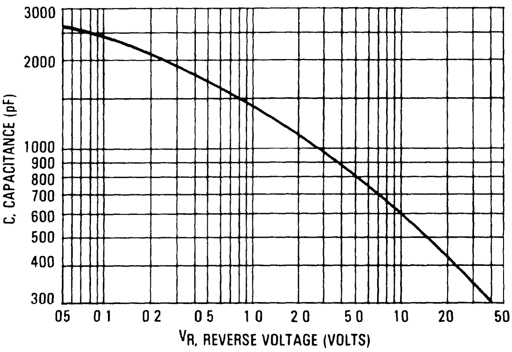


FIGURE 5 — SD41 CURRENT DERATING

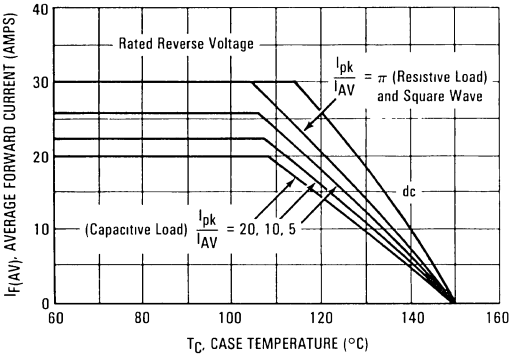


FIGURE 6 — 1N6095/6 CURRENT DERATING

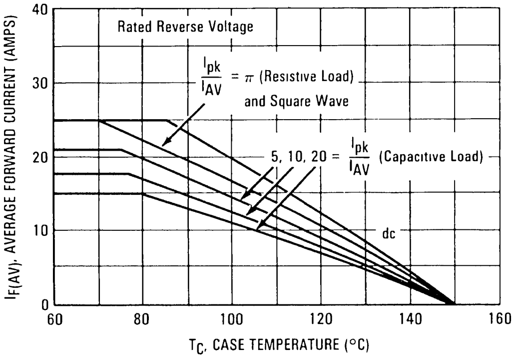


FIGURE 7 — FORWARD POWER DISSIPATION

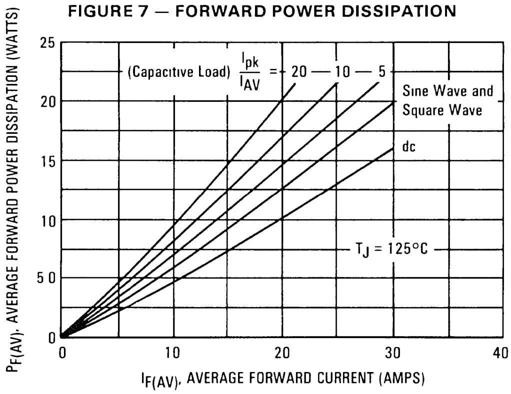


FIGURE 8 — THERMAL RESPONSE

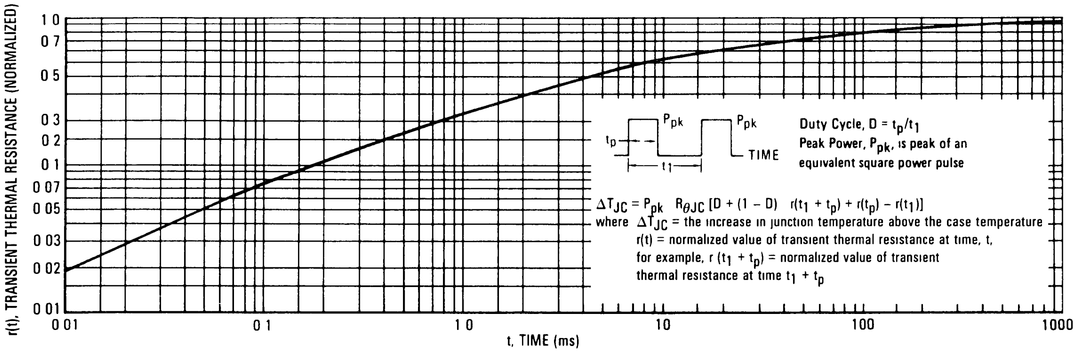
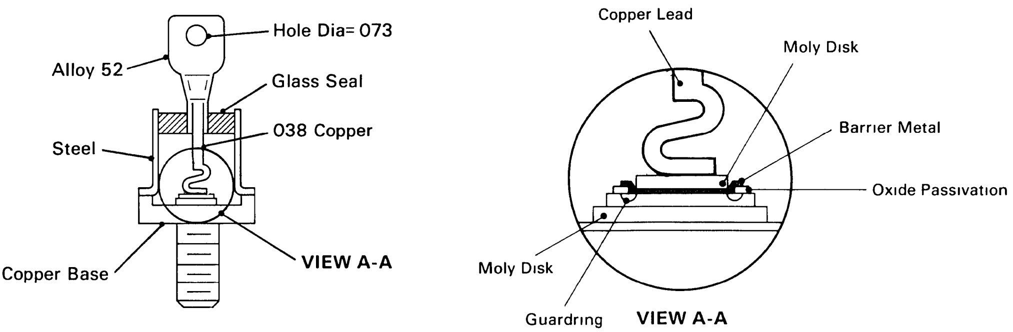


FIGURE 9 — SCHOTTKY RECTIFIER



3

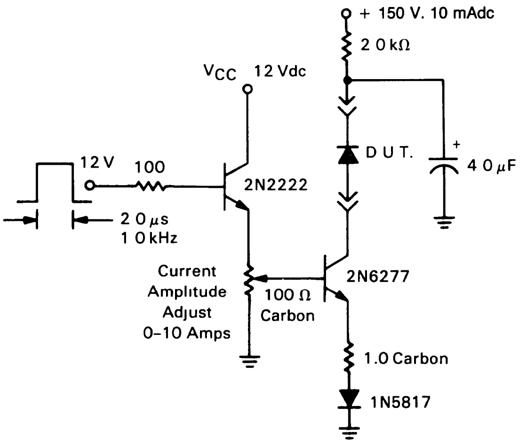
Motorola builds quality and reliability into its Schottky Rectifiers

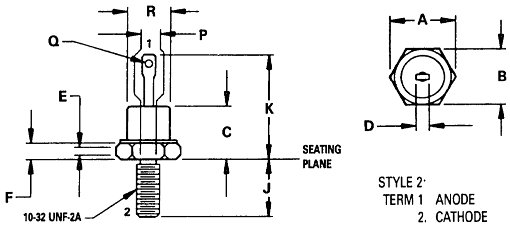
First is the chip, which has an interface metal between the platinum-barrier metal and nickel-gold ohmic-contact metal to eliminate any possible interaction with the barrier The indicated guardring prevents dv/dt problems, so snubbers are not required The guardring also operates like a zener to absorb over-voltage transients

Second is the package There are molybdenum disks which closely match the thermal coefficient of expansion of silicon on each side of the chip The top copper lead is also stress-relieved These two features give the unit the capability of passing stringent thermal fatigue tests for 5,000 cycles The top copper lead provides a low resistance to current and therefore does not contribute to device heating, a heat sink should be used when attaching wires

Third is the redundant electrical testing The device is tested before assembly in "sandwich" form, with the chip between the moly disks It is tested again after assembly As part of the final electrical test, devices are 100% tested for dv/dt at 1,600 V/μs and reverse avalanche

FIGURE 10 — TEST CIRCUIT FOR dv/dt AND REVERSE SURGE CURRENT





MOUNTING TORQUE: 15 in-lb max

NOTES.
1 ALL RULES AND NOTES ASSOCIATED WITH REFERENCED DO-4 OUTLINE SHALL APPLY
2 DIMENSIONING AND TOLERANCING PER ANSI Y14.5M, 1982.
3 CONTROLLING DIMENSION INCH

DIM	MILLIMETERS		INCHES	
	MIN	MAX	MIN	MAX
A	—	12 82	—	0 505
B	10 77	11 09	0 424	0 437
C	—	10 28	—	0 405
D	—	6 35	—	0 250
E	1.53	—	0 060	—
F	1 91	4 44	0.075	0 175
J	10 72	11 50	0 422	0 453
K	15 24	20.32	0.600	0 800
P	4 14	4 80	0 163	0 189
Q	1 53	2 41	0 060	0 095
R	6 74	10 76	0 265	0 424

CASE 56-03
DO-203AA
METAL

MOTOROLA
SEMICONDUCTOR
TECHNICAL DATA

1N6097
1N6098
SD51

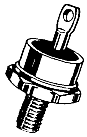
SWITCHMODE POWER RECTIFIERS

. . using a platinum barrier metal in a large area metal-to-silicon power diode State-of-the-art geometry features epitaxial construction with oxide passivation and metal overlap contact Ideally suited for use as rectifiers in low-voltage, high-frequency inverters, free-wheeling diodes, and polarity-protection diodes

- Guaranteed Reverse Avalanche
- Extremely Low v_F
- Low Stored Charge, Majority Carrier Conduction
- Guardring for Stress Protection
- Low Power Loss/High Efficiency
- 150°C Operating Junction Temperature Capability
- High Surge Capacity

SCHOTTKY BARRIER RECTIFIERS

60 AMPERES
20 to 45 VOLTS



CASE 257-01
DO-203AB
METAL

3

MAXIMUM RATINGS

Rating	Symbol	1N6097*	1N6098*	SD51	Unit
Peak Repetitive Reverse Voltage Working Peak Reverse Voltage DC Blocking Voltage	V_{RRM} V_{RWM} V_R	30	40	45 35 45	Volts
Peak Repetitive Forward Current (Rated V_R, Square Wave, 20 kHz)	I_{FRM}	—	—	120 T_C = 90°C	Amps
Average Rectified Forward Current (Rated V_R)	I_O	50 T_C = 70°C	50 T_C = 70°C	—	Amps
Case Temperature (Rated V_R)	T_C	115	115	—	°C
Nonrepetitive Peak Surge Current (Surge applied at rated load conditions halfwave, single phase, 60 Hz)	I_{FSM}	← 800 →			Amps
Peak Repetitive Reverse Surge Current [2] (2 0 μs, 1 0 kHz) See Figure 10	I_{RRM}	← 2 0 →			Amps
Operating Junction Temperature Range (Reverse Voltage Applied)	T_J	-65 to +125	-65 to +125	-65 to +150	°C
Storage Temperature Range	T_{stg}	-65 to +125	-65 to +125	-65 to +165	°C
Voltage Rate of Change (Rated V_R)	dv/dt	—	—	700	V/μs

THERMAL CHARACTERISTICS

Characteristic	Symbol	1N6097*	1N6098*	SD51	Unit
Thermal Resistance, Junction-to-Case	$R_{\theta JC}$	← 1 0 →			°C/W

ELECTRICAL CHARACTERISTICS (T_C = 25°C unless otherwise noted)

Characteristic	Symbol	1N6097*	1N6098*	SD51	Unit
Maximum Instantaneous Forward Voltage (2) (i_F = 157 Amp, T_C = 70°C) (i_F = 60 Amp) (i_F = 60 Amp, T_C = 125°C) (i_F = 120 Amp, T_C = 125°C)	v_F	 0 86 — — —	 0 86 — — —	 — 0 70 0 60 0 84	Volts
Maximum Instantaneous Reverse Current (2) (Rated Voltage, T_C = 125°C) (Rated Voltage, T_C = 25°C)	i_R	 250 —	 250 —	200 50 @ V_R = 35 V	mA
DC Reverse Current (Rated Voltage, T_C = 115°C)	I_R	250	250	—	mA
Maximum Capacitance (100 kHz ≤ f ≤ 1 0 MHz)	C_t	7000 V_R = 1.0 Vdc	7000 V_R = 1 0 Vdc	4000 V_R = 5 0 Vdc	pF

*Indicates JEDEC Registered Data
(1) Not a JEDEC requirement, but of Motorola product capability.
(2) Pulse Test Pulse Width = 300 μs, Duty Cycle = 2 0%

FIGURE 1 — TYPICAL FORWARD VOLTAGE

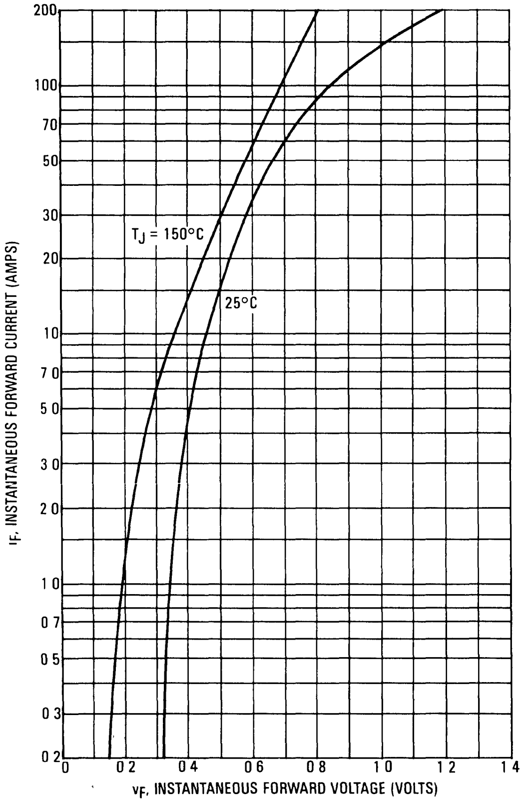


FIGURE 2 — TYPICAL REVERSE CURRENT

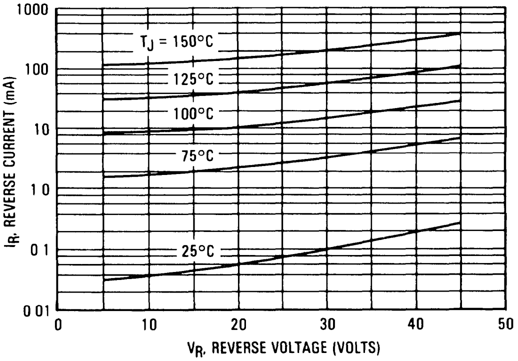


FIGURE 3 — TYPICAL SURGE CAPABILITY

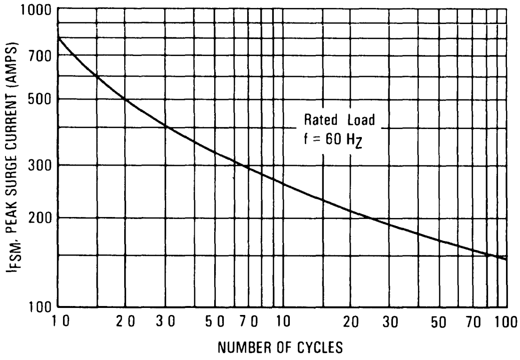
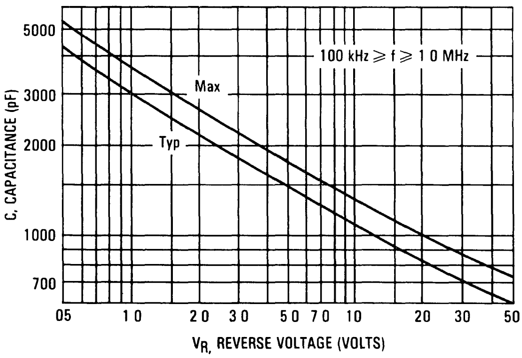


FIGURE 4 — CAPACITANCE



NOTE 1
HIGH FREQUENCY OPERATION

Since current flow in a Schottky rectifier is the result of majority carrier conduction, it is not subject to junction diode forward and reverse recovery transients due to minority carrier injection and stored charge Satisfactory circuit analysis work may be performed by using a model consisting of an ideal diode in parallel with a variable capacitance (See Figure 4)

Rectification efficiency measurements show that operation will be satisfactory up to several megahertz For example, relative waveform rectification efficiency is approximately 70 per cent at 2 0 MHz, e g , the ratio of dc power to RMS power in the load is 0 28 at this frequency, whereas perfect rectification would yield 0 406 for sine wave inputs. However, in contrast to ordinary junction diodes, the loss in waveform efficiency is not indicative of power loss, it is simply a result of reverse current flow through the diode capacitance, which lowers the dc output voltage.

FIGURE 5 — CURRENT DERATING (SD51)

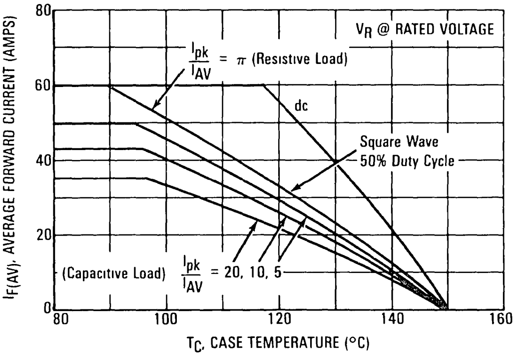


FIGURE 6 — CURRENT DERATING (1N6097/1N6098)

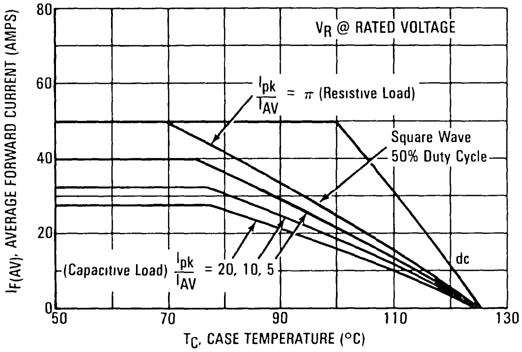
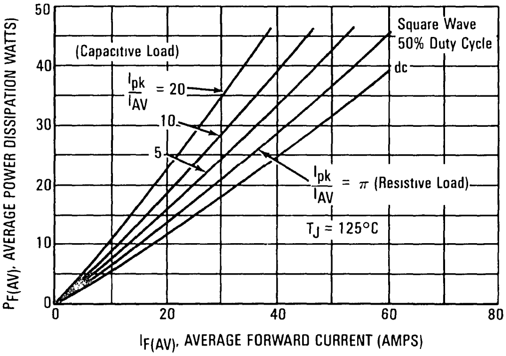
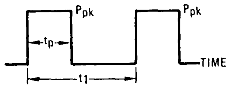


FIGURE 7 — POWER DISSIPATION



NOTE 2



DUTY CYCLE, $D = t_p/t_1$
PEAK POWER, P_{pk}, is peak of an equivalent square power pulse

To determine maximum junction temperature of the diode in a given situation, the following procedure is recommended

The temperature of the case should be measured using a thermocouple placed on the case The thermal mass connected to the case is normally large enough so that it will not significantly respond to heat surges generated in the diode as a result of pulsed operation once steady-state conditions are achieved Using the measured value of T_C, the junction temperature may be determined by

$$T_J = T_C + \Delta T_{JC}$$

where ΔT_C is the increase in junction temperature above the case temperature It may be determined by

$\Delta T_{JC} = P_{pk} \cdot R_{\theta JC}[D + (1 - D) \cdot r(t_1 + t_p) + r(t_p) - r(t_1)]$ where

$r(t)$ = normalized value of transient thermal resistance at time, t, from Figure 8, i e

$r(t_1 + t_p)$ = normalized value of transient thermal resistance at time $t_1 + t_p$

FIGURE 8 — THERMAL RESPONSE

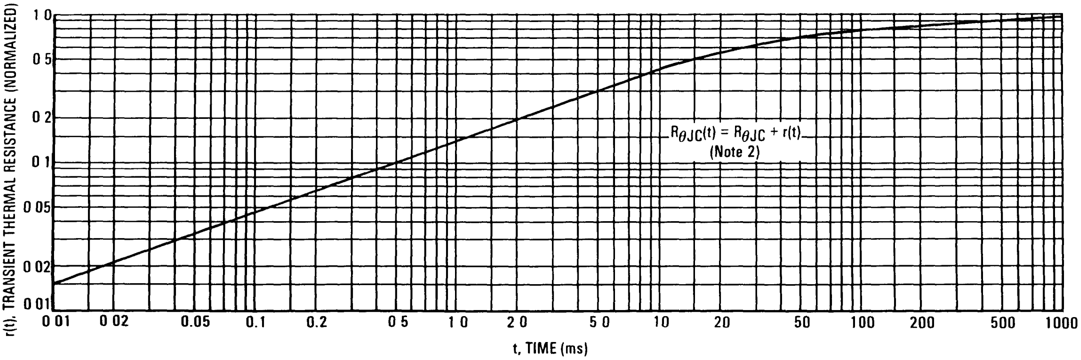
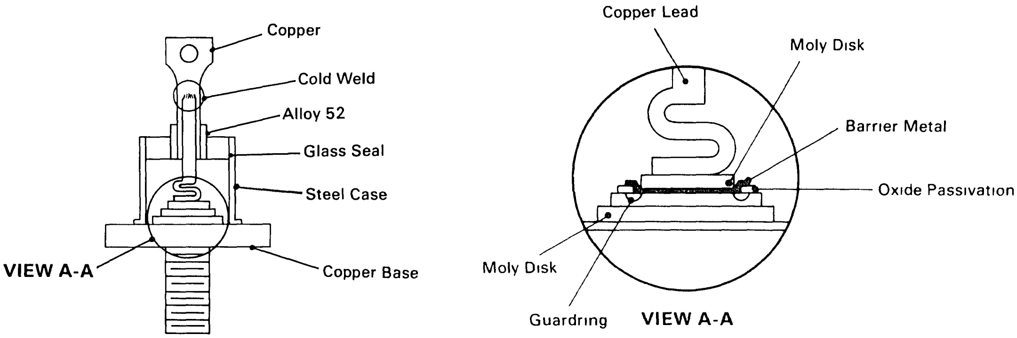


FIGURE 9 — SCHOTTKY RECTIFIER



3

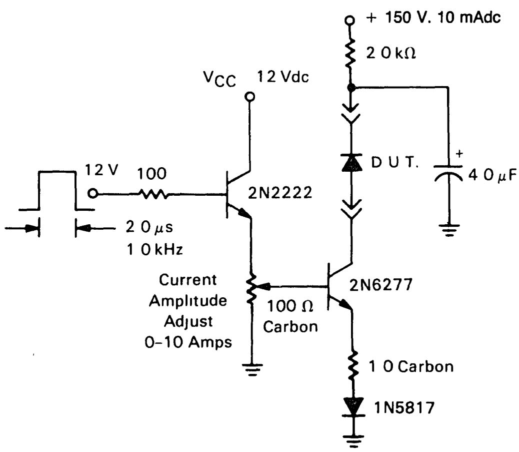
Motorola builds quality and reliability into its Schottky Rectifiers

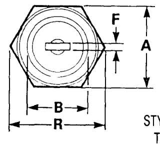
First is the chip, which has an interface metal between the platinum-barrier metal and nickel-gold ohmic-contact metal to eliminate any possible interaction with the barrier The indicated guardring prevents dv/dt problems, so snubbers are not mandatory The guardring also operates like a zener to absorb overvoltage transients

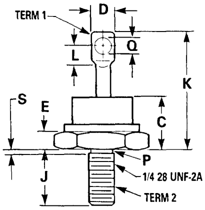
Second is the package. There are molybdenum disks which closely match the thermal coefficient of expansion of silicon on each side of the chip. The top copper lead has a stress relief feature which protects the die during assembly These two features give the unit the capability of passing stringent thermal fatigue tests for 5,000 cycles The top copper lead provides a low resistance to current and therefore does not contribute to device heating, a heat sink should be used when attaching wires

Third is the redundant electrical testing The device is tested before assembly in "sandwich" form, with the chip between the moly disks It is tested again after assembly As part of the final electrical test, devices are 100% tested for dv/dt at 1,600 V/μs and reverse avalanche

FIGURE 10 — TEST CIRCUIT FOR dv/dt AND REVERSE SURGE CURRENT







STYLE 1
TERM 1 CATHODE
2 ANODE (CASE)

NOTES
1 DIM "P" IS DIA
2 CHAMFER OR UNDERCUT ON ONE OR BOTH ENDS OF HEXAGONAL BASE IS OPTIONAL
3 ANGULAR ORIENTATION AND CONTOUR OF TERMINAL ONE IS OPTIONAL
4 THREADS ARE PLATED
5 DIMENSIONING AND TOLERANCING PER ANSI Y14.5, 1973

	MILLIMETERS		INCHES	
DIM	MIN	MAX	MIN	MAX
A	16.94	17.45	0.669	0.687
B	—	16.94	—	0.667
C	—	11.43	—	0.450
D	—	9.53	—	0.375
E	2.92	5.08	0.115	0.200
F	—	2.03	—	0.080
J	10.72	11.51	0.422	0.453
K	—	25.40	—	1.000
L	3.86	—	0.156	—
P	5.59	6.32	0.220	0.249
Q	3.56	4.45	0.140	0.175
R	—	20.16	—	0.794
S	—	2.26	—	0.089

CASE 257-01
DO-203AB
METAL

MECHANICAL CHARACTERISTICS
CASE: Welded, hermetically sealed
FINISH: All external surfaces corrosion resistant and terminal lead is readily solderable.
POLARITY: Cathode to Case
MOUNTING POSITION: Any
MOUNTING TORQUE: 25 in-lb max
SOLDER HEAT: The excellent heat transfer property of the heavy duty copper anode terminal which transmits heat away from the die requires that caution be used when attaching wires. Motorola suggests a heat sink be clamped between the eyelet and the body during any soldering operation

MOTOROLA
SEMICONDUCTOR
TECHNICAL DATA

MBR030
MBR040

Advance Information

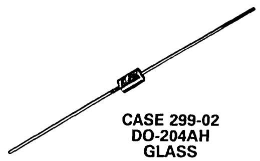
SWITCHMODE RECTIFIERS

. . . designed for use in switching power supplies, inverters, and as free wheeling diodes, these devices have the following features:

- Low Forward Voltage
- Low Leakage Current
- DO-204AH (DO-35) Glass Package

SCHOTTKY RECTIFIERS

0.5 AMPERE
30–40 VOLTS



CASE 299-02
DO-204AH
GLASS

MAXIMUM RATINGS

Rating	Symbol	MBR030	MBR040	Unit
Peak Repetitive Reverse Voltage Working Peak Reverse Voltage DC Blocking Voltage	V_{RRM} V_{RWM} V_R	30	40	Volts
Average Rectified Forward Current (Rated V_R) T_L = 90°C, L = 3/8″ T_A = 60°C, L = 3/8″, (Mt. Method #1)	$I_{F(AV)}$	← 0.5 → ← 0.5 →		Amps
Nonrepetitive Peak Surge Current (Surge applied at rated load conditions halfwave, single phase, 60 Hz)	I_{FSM}	← 15.0 →		Amps
Operating Junction and Storage Temperature	T_J, T_{stg}	−65 to +150		

THERMAL CHARACTERISTICS

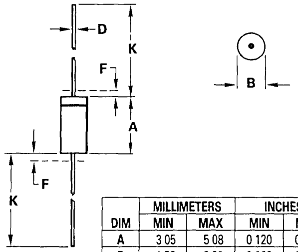
Characteristic	Symbol	Typ	Max	Unit
Thermal Resistance, Junction to Lead = 3/8″	$R_{\theta JL}$	180	190	°C/W

ELECTRICAL CHARACTERISTICS

Characteristic	Symbol	Typ	Max	Unit
Instantaneous Foward Voltage (1) (i_F = 0.1 A, T_J = 25°C) (i_F = 0.5 A, T_J = 25°C)	v_F	 0.460 0.610	 0.500 0.750	Volts
Reverse Current (Rated dc Voltage, T_J = 150°C) (Rated dc Voltage, T_J = 25°C)	i_R	 0.6 0.003	 1.0 0.001	mA

(1) Pulse Test: Pulse Width = 300 μs, Duty Cycle ≤ 2.0%.

This document contains information on a new product. Specifications and information herein are subject to change without notice.



DIM	MILLIMETERS MIN	MILLIMETERS MAX	INCHES MIN	INCHES MAX
A	3.05	5.08	0.120	0.200
B	1.52	2.29	0.060	0.090
D	0.46	0.56	0.018	0.022
F	—	1.27	—	0.050
K	25.40	38.10	1.000	1.500

All JEDEC dimensions and notes apply

NOTES
1. PACKAGE CONTOUR OPTIONAL WITHIN A AND B HEAT SLUGS, IF ANY, SHALL BE INCLUDED WITHIN THIS CYLINDER, BUT NOT SUBJECT TO THE MINIMUM LIMIT OF B
2. LEAD DIAMETER NOT CONTROLLED IN ZONE F TO ALLOW FOR FLASH, LEAD FINISH BUILDUP AND MINOR IRREGULARITIES OTHER THAN HEAT SLUGS
3. POLARITY DENOTED BY CATHODE BAND
4. DIMENSIONING AND TOLERANCING PER ANSI Y14.5, 1973

MECHANICAL CHARACTERISTICS

CASE: Glass

FINISH: External leads are plated and are readily solderable

POLARITY: Cathod indicated by polarity band.

WEIGHT: 0.2 Gram (approximately).

MAXIMUM LEAD TEMPERATURE FOR SOLDERING PURPOSES: 230°C, 1/8″ from case for 10 seconds.

3

FIGURE 1 — TYPICAL FORWARD VOLTAGE

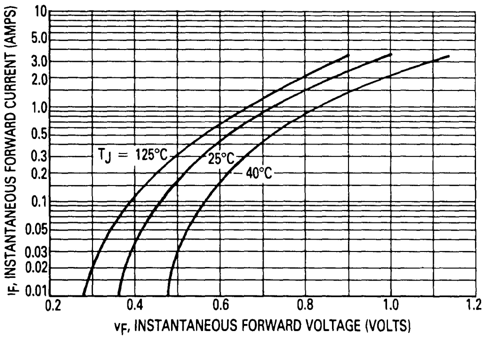


FIGURE 2 — CURRENT DERATING, PRINTED CIRCUIT BOARD MOUNTING

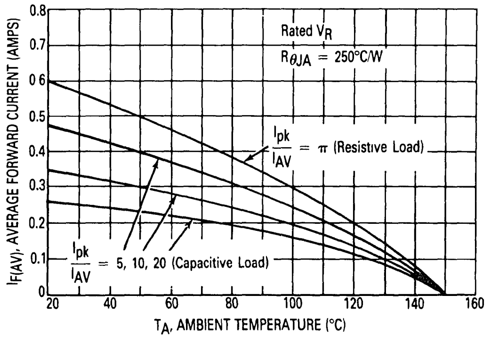


FIGURE 3 — TYPICAL CAPACITANCE

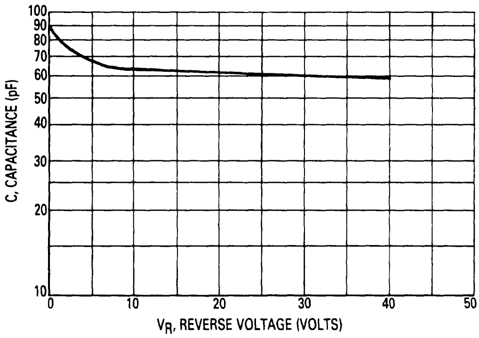


FIGURE 4 — CURRENT DERATING, LEAD TEMPERATURE

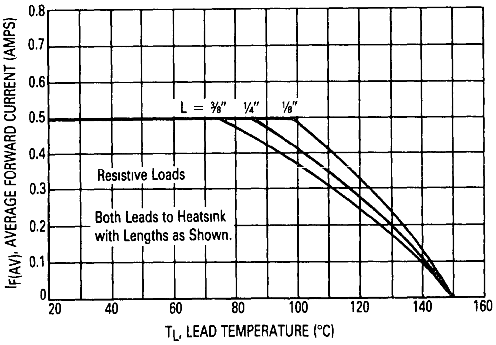
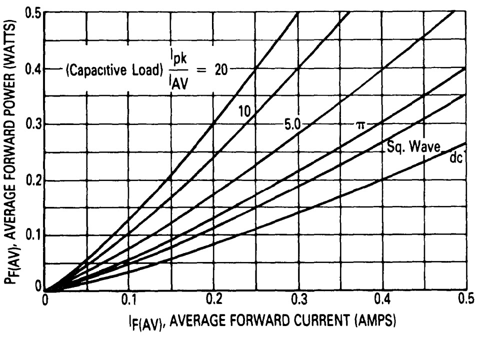


FIGURE 5 — FORWARD POWER DISSIPATION



NOTE 1

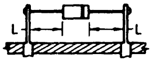
Data shown for thermal resistance junction to ambient (θ_{JA}) for the mountings shown is to be used as typical guideline values for preliminary engineering or in case the tie point temperature cannot be measured

TYPICAL VALUES FOR θ_{JA} IN STILL AIR

MOUNTING METHOD	1/8	1/4	3/8	$R_{\theta JA}$
1	200	225	250	°C/W
2	210	235	260	°C/W
3		150		°C/W

MOUNTING METHOD 1

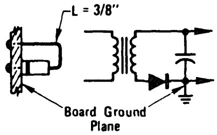
MOUNTING METHOD 2



Vector pin mounting

MOUNTING METHOD 3

P. C. Board with 1-1/2" x 1 1/2" copper surface



MOTOROLA
SEMICONDUCTOR
TECHNICAL DATA

MBR115P MBR120P
MBR130P MBR140P
See Page 3-47

MBR150
MBR160

Axial Lead Rectifiers

. . . employing the Schottky Barrier principle in a large area metal-to-silicon power diode. State-of-the-art geometry features epitaxial construction with oxide passivation and metal overlap contact. Ideally suited for use as rectifiers in low-voltage, high-frequency inverters, free wheeling diodes, and polarity protection diodes.

- Low Reverse Current
- Low Stored Charge, Majority Carrier Conduction
- Low Power Loss/High Efficiency
- Highly Stable Oxide Passivated Junction

Mechanical Characteristics:

Case: Void free, transfer molded
Finish: All external surfaces corrosion-resistant and the terminal leads are readily solderable
Polarity: Cathode indicated by polarity band
Mounting Positions: Any
Soldering: 220°C 1/16″ from case for ten seconds

SCHOTTKY BARRIER RECTIFIERS
1 AMPERE
50, 60 VOLTS

CASE 59-04
PLASTIC

MAXIMUM RATINGS

Rating	Symbol	MBR150	MBR160	Unit
Peak Repetitive Reverse Voltage Working Peak Reverse Voltage DC Blocking Voltage	V_{RRM} V_{RWM} V_R	50	60	Volts
RMS Reverse Voltage	$V_{R(RMS)}$	35	42	Volts
Average Rectified Forward Current (2) ($V_{R(equiv)} \leq 0.2\ V_R(dc)$, $T_L = 90°C$, $R_{\theta JA} = 80°C/W$, P.C. Board Mounting, see Note 3, $T_A = 55°C$)	I_O	1		Amp
Nonrepetitive Peak Surge Current (Surge applied at rated load conditions, half-wave, single phase, 60 Hz, $T_L = 70°C$)	I_{FSM}	25 (for one cycle)		Amps
Operating and Storage Junction Temperature Range (Reverse Voltage applied)	T_J, T_{stg}	−65 to +150		°C
Peak Operating Junction Temperature (Forward Current applied)	$T_{J(pk)}$	150		°C

THERMAL CHARACTERISTICS (Notes 3 and 4)

Characteristic	Symbol	Max	Unit
Thermal Resistance, Junction to Ambient	$R_{\theta JA}$	80	°C/W

ELECTRICAL CHARACTERISTICS (T_L = 25°C unless otherwise noted) (2)

Characteristic	Symbol	Max	Unit
Maximum Instantaneous Forward Voltage (1) (i_F = 0.1 A) (i_F = 1 A) (i_F = 3 A)	v_F	 0.550 0.750 1.000	Volt
Maximum Instantaneous Reverse Current @ Rated dc Voltage (1) (T_L = 25°C) (T_L = 100°C)	I_R	 0.5 5	mA

(1) Pulse Test Pulse Width = 300 μs, Duty Cycle ≤ 2%
(2) Lead Temperature reference is cathode lead 1/32″ from case.

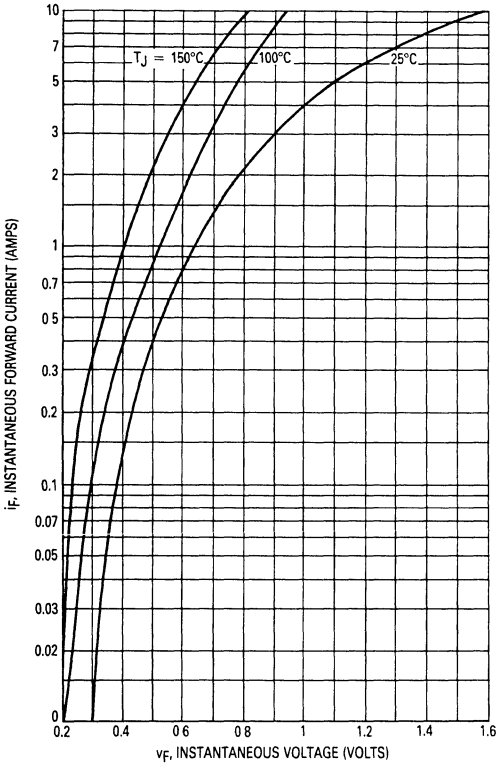


Figure 1. Typical Forward Voltage

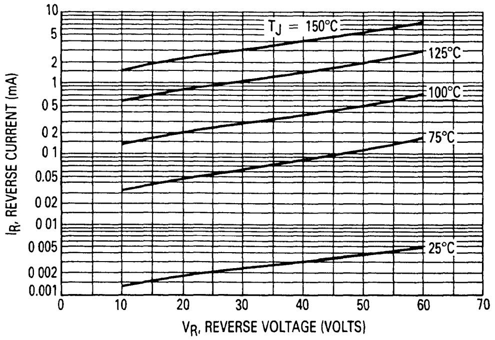


Figure 2. Typical Reverse Current*

*The curves shown are typical for the highest voltage device in the voltage grouping. Typical reverse current for lower voltage selections can be estimated from these same curves if V_R is sufficiently below rated V_R.

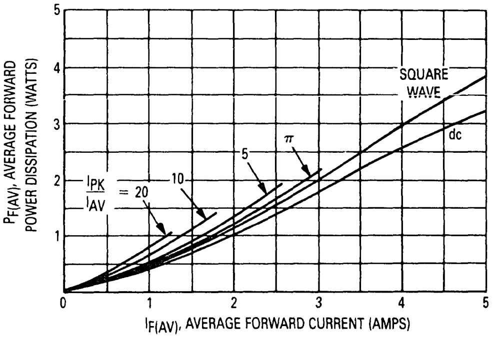


Figure 3. Forward Power Dissipation

THERMAL CHARACTERISTICS

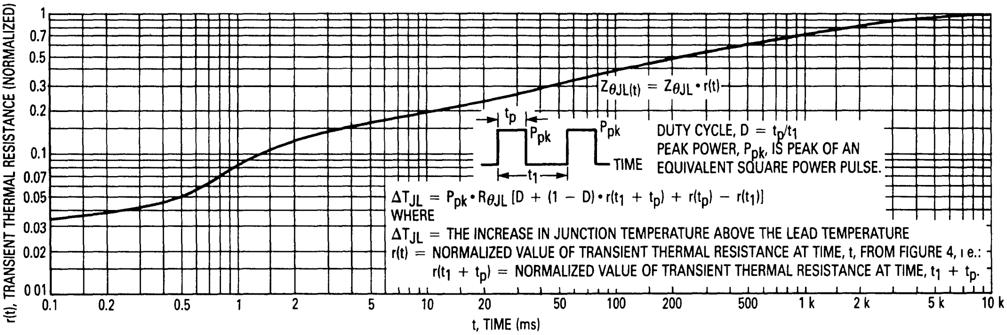


Figure 4. Thermal Response

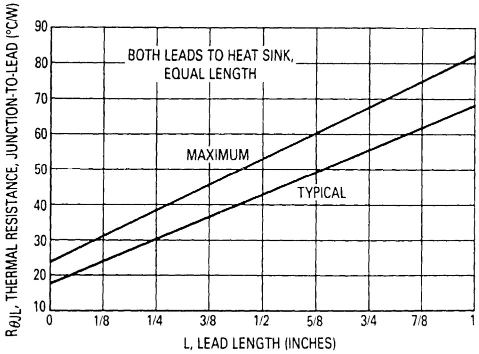


Figure 5. Steady-State Thermal Resistance

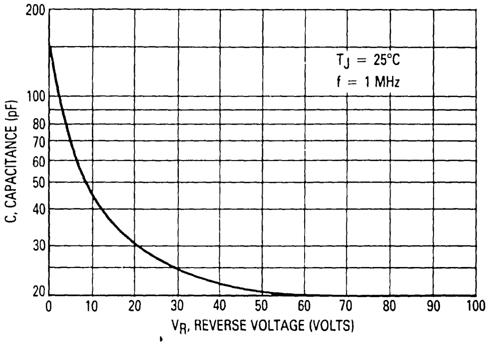


Figure 6. Typical Capacitance

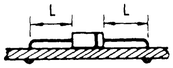
NOTE 3 — MOUNTING DATA:

Data shown for thermal resistance junction-to-ambient ($R_{\theta JA}$) for the mounting shown is to be used as a typical guideline values for preliminary engineering or in case the tie point temperature cannot be measured.

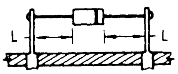
Typical Values for $R_{\theta JA}$ in Still Air

Mounting Method	Lead Length, L (in)				$R_{\theta JA}$
	1/8	1/4	1/2	3/4	
1	52	65	72	85	°C/W
2	67	80	87	100	°C/W
3			50		°C/W

Mounting Method 1
P.C. Board with 1-1/2" x 1-1/2" copper surface.

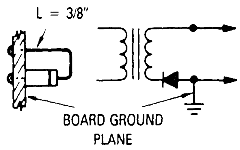


Mounting Method 2



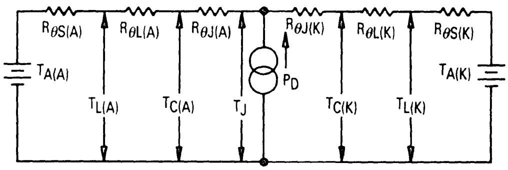
VECTOR PIN MOUNTING

Mounting Method 3
P.C. Board with 1-1/2" x 1-1/2" copper surface



3

NOTE 4 — THERMAL CIRCUIT MODEL:
(For heat conduction through the leads)



Use of the above model permits junction to lead thermal resistance for any mounting configuration to be found. For a given total lead length, lowest values occur when one side of the rectifier is brought as close as possible to the heat sink. Terms in the model signify:

T_A = Ambient Temperature T_C = Case Temperature
T_L = Lead Temperature T_J = Junction Temperature
$R_{\theta S}$ = Thermal Resistance, Heat Sink to Ambient
$R_{\theta L}$ = Thermal Resistance, Lead to Heat Sink
$R_{\theta J}$ = Thermal Resistance, Junction to Case
P_D = Power Dissipation

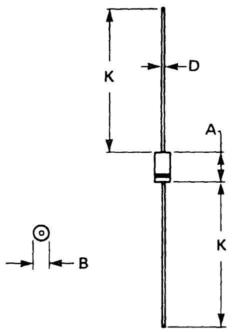
(Subscripts A and K refer to anode and cathode sides, respectively.) Values for thermal resistance components are
$R_{\theta L}$ = 100°C/W/in typically and 120°C/W/in maximum.
$R_{\theta J}$ = 36°C/W typically and 46°C/W maximum.

NOTE 5 — HIGH FREQUENCY OPERATION:

Since current flow in a Schottky rectifier is the result of majority carrier conduction, it is not subject to junction diode forward and reverse recovery transients due to minority carrier injection and stored charge. Satisfactory circuit analysis work may be performed by using a model consisting of an ideal diode in parallel with a variable capacitance. (See Figure 6.)

Rectification efficiency measurements show that operation will be satisfactory up to several megahertz. For example, relative waveform rectification efficiency is approximatley 70 percent at 2 MHz, e.g., the ratio of dc power to RMS power in the load is 0.28 at this frequency, whereas perfect rectification would yield 0.406 for sine wave inputs. However, in contrast to ordinary junction diodes, the loss in waveform efficiency is not indicative of power loss: it is simply a result of reverse current flow through the diode capacitance, which lowers the dc output voltage.

OUTLINE DIMENSIONS



NOTES
1. ALL RULES AND NOTES ASSOCIATED WITH JEDEC DO-41 OUTLINE SHALL APPLY
2. POLARITY DENOTED BY CATHODE BAND
3. LEAD DIAMETER NOT CONTROLLED WITHIN "F" DIMENSION

DIM	MILLIMETERS MIN	MILLIMETERS MAX	INCHES MIN	INCHES MAX
A	5.97	6.60	0.235	0.260
B	2.79	3.05	0.110	0.120
D	0.76	0.86	0.030	0.034
K	27.94	—	1.100	—

CASE 59-04
PLASTIC

MOTOROLA
SEMICONDUCTOR
TECHNICAL DATA

MBR320 MBR340 MBR330 MBR350 MBR360

AXIAL LEAD RECTIFIERS

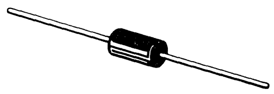
. . . employing the Schottky Barrier principle in a large area metal-to-silicon power diode. State-of-the-art geometry features epitaxial construction with oxide passivation and metal overlap contact. Ideally suited for use as rectifiers in low-voltage, high-frequency inverters, free wheeling diodes, and polarity protection diodes.

- Extremely Low v_F
- Low Power Loss/High Efficiency
- Highly Stable Oxide Passivated Junction
- Low Stored Charge, Majority Carrier Conduction

3

SCHOTTKY BARRIER RECTIFIERS

3.0 AMPERES
20, 30, 40, 50, 60 VOLTS



CASE 267-03
PLASTIC

MAXIMUM RATINGS

Rating	Symbol	MBR320	MBR330	MBR340	MBR350	MBR360	Unit
Peak Repetitive Reverse Voltage Working Peak Reverse Voltage DC Blocking Voltage	V_{RRM} V_{RWM} V_R	20	30	40	50	60	V
Average Rectified Forward Current T_A = 65°C ($R_{\theta JA}$ = 28°C/W, P.C. Board Mounting, see Note 3)	I_O	3.0					A
Nonrepetitive Peak Surge Current (2) (Surge applied at rated load conditions, half wave, single phase 60 Hz, T_L = 75°C)	I_{FSM}	80					A
Operating and Storage Junction Temperature Range (Reverse Voltage applied)	T_J, T_{stg}	−65 to 150°C					°C
Peak Operating Junction Temperature (Forward Current Applied)	$T_{J(pk)}$	150					°C

THERMAL CHARACTERISTICS

Characteristic	Symbol	Max	Unit
Thermal Resistance, Junction to Ambient, (see Note 3, Mounting Method 3)	$R_{\theta JA}$	28	°C/W

ELECTRICAL CHARACTERISTICS (T_L = 25°C unless otherwise noted)(2)

Characteristic	Symbol	MBR320	MBR330	MBR340	MBR350	MBR360	Unit
Maximum Instantaneous Forward Voltage (1) (i_F = 1.0 Amp) (i_F = 3.0 Amp) (i_F = 9.4 Amp)	v_F	0.500 0.600 0.850			0.600 0.740 1.080		V
Maximum Instantaneous Reverse Current @ Rated dc Voltage (1) T_L = 25°C T_L = 100°C	i_R	0.60 20					mA

(1) Pulse Test. Pulse Width = 300 μs, Duty Cycle = 2.0%
(2) Lead Temperature reference is cathode lead 1/32″ from case

MBR320, 330 AND 340

FIGURE 1 — TYPICAL FORWARD VOLTAGE

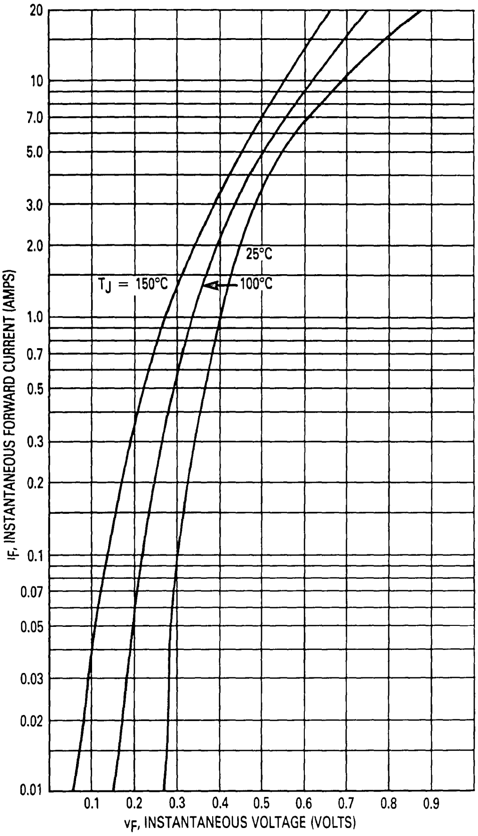
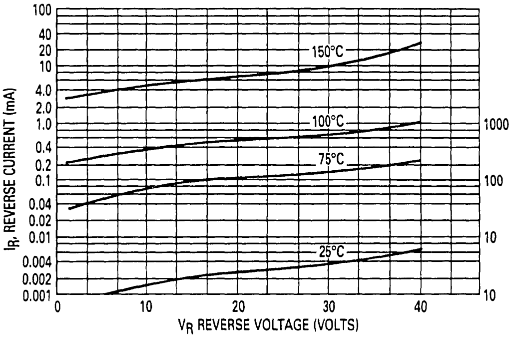


FIGURE 2 — TYPICAL REVERSE CURRENT*



*The curves shown are typical for the highest voltage device in the voltage grouping. Typical reverse current for lower voltage selections can be estimated from these same curves if V_R is sufficiently below rated V_R.

FIGURE 3 — CURRENT DERATING (MOUNTING METHOD #3 PER NOTE 3)

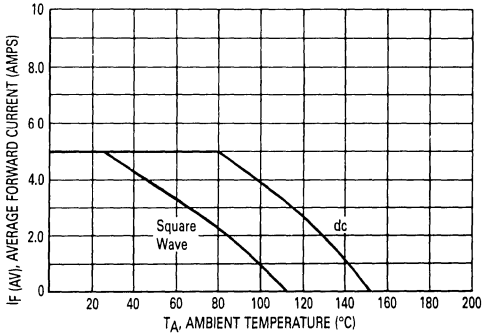


FIGURE 4 — POWER DISSIPATION

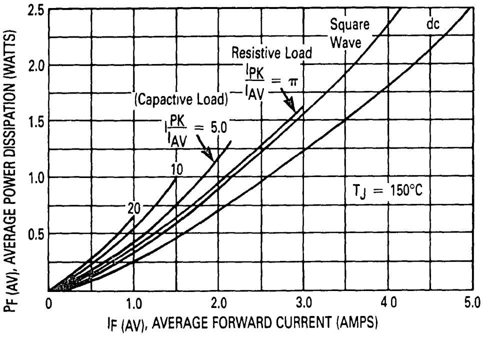
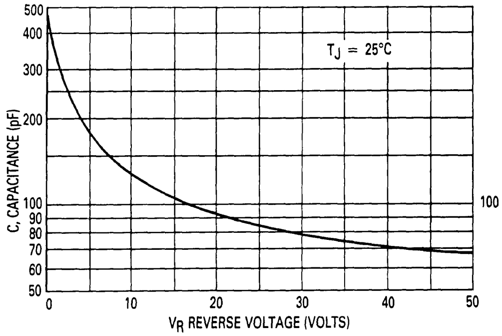


FIGURE 5 — TYPICAL CAPACITANCE



3

3

MBR350 AND 360

FIGURE 6 — TYPICAL FORWARD VOLTAGE

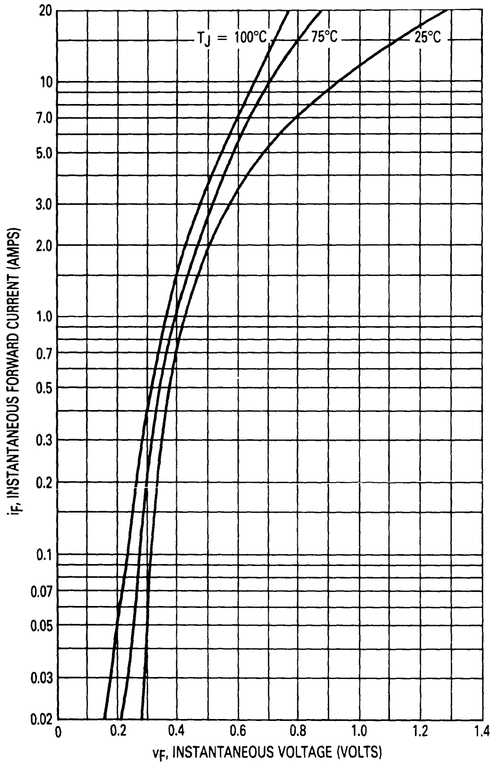


FIGURE 7 — TYPICAL REVERSE CURRENT*

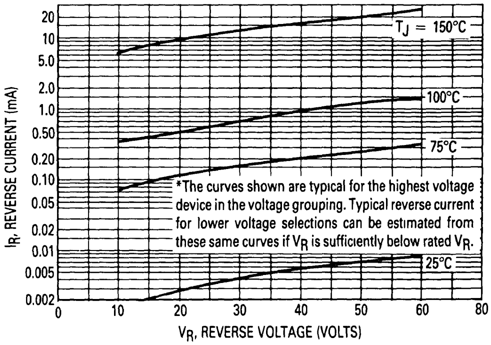


FIGURE 8 — CURRENT DERATING AMBIENT (MOUNTING METHOD #3 PER NOTE 3)

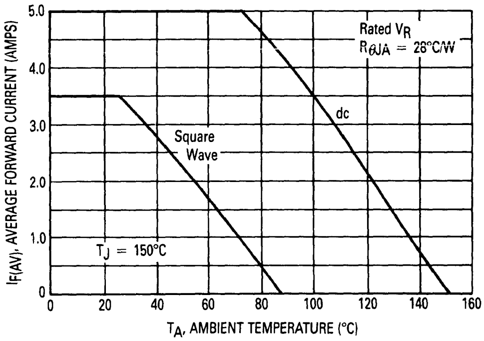


FIGURE 9 — POWER DISSIPATION

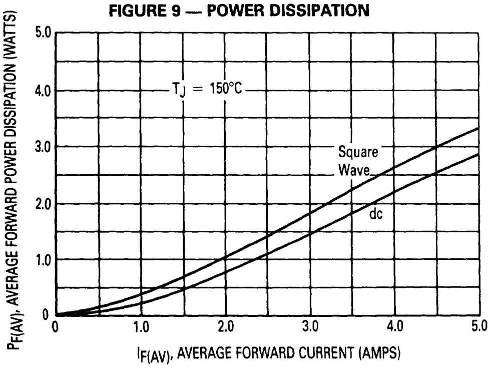
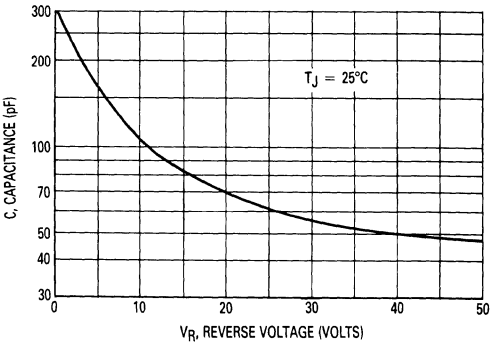


FIGURE 10 — TYPICAL CAPACITANCE



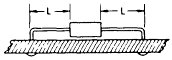
NOTE 3 — MOUNTING DATA

Data shown for thermal resistance junction-to-ambient ($R_{\theta JA}$) for the mountings shown is to be used as typical guideline values for preliminary engineering, or in case the tie point temperature cannot be measured.

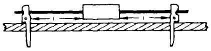
TYPICAL VALUES FOR $R_{\theta JA}$ IN STILL AIR

Mounting Method	Lead Length, L (in)				$R_{\theta JA}$
	1/8	1/4	1/2	3/4	
1	50	51	53	55	°C/W
2	58	59	61	63	°C/W
3	28				°C/W

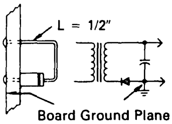
Mounting Method 1
P.C Board where available copper surface is small.



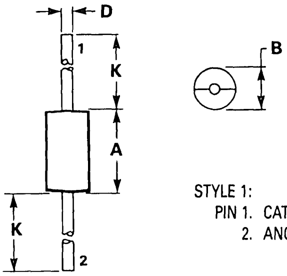
Mounting Method 2
Vector Push-In Terminals T-28



Mounting Method 3
P.C. Board with 2-1/2″ × 2-1/2″ copper surface



OUTLINE DIMENSIONS



STYLE 1:
PIN 1. CATHODE
2. ANODE

NOTES:
1. DIMENSIONING AND TOLERANCING PER ANSI Y14.5M, 1982.
2. CONTROLLING DIMENSION: INCH.

DIM	MILLIMETERS MIN	MILLIMETERS MAX	INCHES MIN	INCHES MAX
A	9.40	9.65	0.370	0.380
B	4.83	5.33	0.190	0.210
D	1.22	1.32	0.048	0.052
K	25.40	—	1.000	—

CASE 267-03
PLASTIC

MECHANICAL CHARACTERISTICS

CASE . . . . Void free, transfer molded
FINISH . . . . All external surfaces corrosion-resistant and the terminal leads are readily solderable
POLARITY . . . . Cathode indicated by polarity band
MOUNTING POSITIONS . . . . Any
SOLDERING . . . . . . 220°C 1/16″ from case for ten seconds

3

MOTOROLA
SEMICONDUCTOR
TECHNICAL DATA

MBR320P MBR330P
MBR340P
See Page 3-51

MBR735
MBR745

SWITCHMODE POWER RECTIFIERS

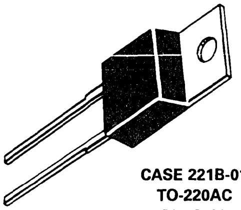
using the Schottky Barrier principle with a platinum barrier metal These state-of-the-art devices have the following features

- Guardring for Stress Protection
- Low Forward Voltage
- 150°C Operating Junction Temperature
- Guaranteed Reverse Avalanche
- Epoxy Meets UL94, VO at 1/8″

SCHOTTKY BARRIER RECTIFIERS

7.5 AMPERES
35 and 45 VOLTS

3



CASE 221B-01
TO-220AC
PLASTIC

MAXIMUM RATINGS

Rating	Symbol	MBR735	MBR745	Unit
Peak Repetitive Reverse Voltage Working Peak Reverse Voltage DC Blocking Voltage	V_{RRM} V_{RWM} V_R	35	45	Volts
Average Rectified Forward Current (Rated V_R) T_C = 105°C	$I_{F(AV)}$	7 5	7 5	Amps
Peak Repetitive Forward Current (Rated V_R, Square Wave, 20 kHz) T_C = 105°C	I_{FRM}	15	15	Amps
Nonrepetitive Peak Surge Current (Surge applied at rated load conditions halfwave, single phase, 60 Hz)	I_{FSM}	150	150	Amps
Peak Repetitive Reverse Surge Current (2 0 μs, 1 0 kHz)	I_{RRM}	1 0	1 0	Amps
Operating Junction Temperature	T_J	-65 to +150	-65 to +150	°C
Storage Temperature	T_{stg}	-65 to +175	-65 to +175	°C
Voltage Rate of Change (Rated V_R)	dv/dt	1000	1000	V/μs

THERMAL CHARACTERISTICS

Maximum Thermal Resistance, Junction to Case	$R_{\theta JC}$	3 0	3 0	°C/W
Maximum Thermal Resistance, Junction to Ambient	$R_{\theta JA}$	60	60	°C/W

ELECTRICAL CHARACTERISTICS

Maximum Instantaneous Forward Voltage (1) (i_F = 7 5 Amp, T_C = 125°C) (i_F = 15 Amp, T_C = 125°C) (i_F = 15 Amp, T_C = 25°C)	v_F	 0 57 0 72 0 84	 0 57 0 72 0 84	Volts
Maximum Instantaneous Reverse Current (1) (Rated dc Voltage, T_C = 125°C) (Rated dc Voltage, T_C = 25°C)	i_R	 15 0 1	 15 0 1	mA

(1) Pulse Test Pulse Width = 300 μs, Duty Cycle ≤ 2 0%

FIGURE 1 — TYPICAL FORWARD VOLTAGE

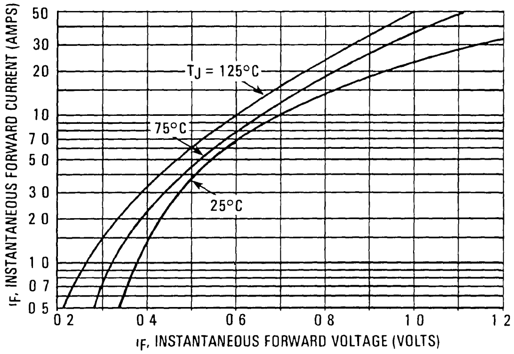


FIGURE 2 — TYPICAL REVERSE CURRENT

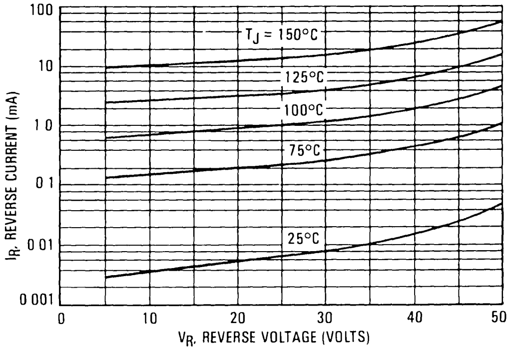


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FIGURE 3 — CURRENT DERATING, CASE

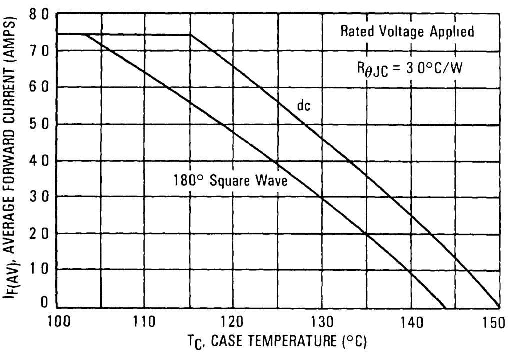


FIGURE 4 — CURRENT DERATING, AMBIENT

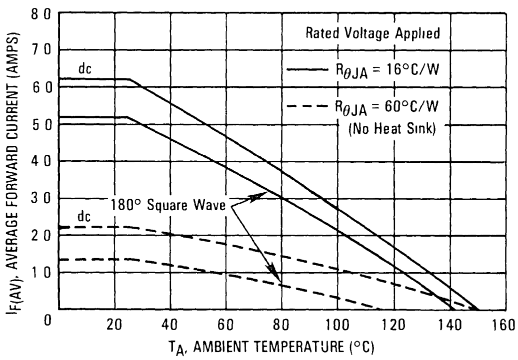
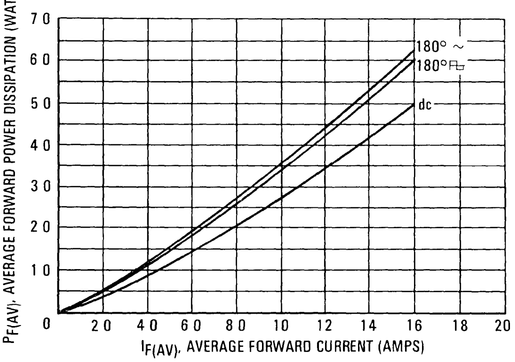
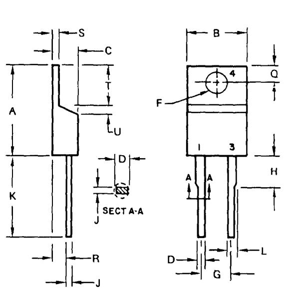


FIGURE 5 — POWER DISSIPATION





STYLE 1
PIN 1 CATHODE
2 N/A
3 ANODE
4 CATHODE

DIM	MILLIMETERS MIN	MILLIMETERS MAX	INCHES MIN	INCHES MAX
A	15 11	15 75	0 595	0 620
B	9 65	10 29	0 380	0 405
C	4 06	4 82	0 160	0 190
D	0 64	0 89	0 025	0 035
F	3 61	3 73	0 142	0 147
G	4 83	5 33	0 190	0 210
H	2 79	3 30	0 110	0 130
J	0 36	0 56	0 014	0 022
K	12 70	14 27	0 500	0 562
L	1 14	1 27	0 045	0 050
Q	2 54	3 04	0 100	0 120
R	2 04	2 79	0 080	0 110
S	1 14	1 39	0 045	0 055
T	5 97	6 48	0 235	0 255
U	0 76	1 27	0 030	0 050

POLARITY: CATHODE-TO-CASE

CASE 221B-01

MBR1035
MBR1045

3

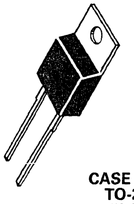
SWITCHMODE POWER RECTIFIERS

using the Schottky Barrier principle with a platinum barrier metal These state-of-the-art devices have the following features.

- Guardring for Stress Protection
- Low Forward Voltage
- 150°C Operating Junction Temperature
- Guaranteed Reverse Avalanche
- Epoxy Meets UL94, V0 at 1/8″

SCHOTTKY BARRIER RECTIFIERS

10 AMPERES
20 to 45 VOLTS



CASE 221B-01
TO-220AC
PLASTIC

MAXIMUM RATINGS

Rating	Symbol	MBR1035	MBR1045	Unit
Peak Repetitive Reverse Voltage Working Peak Reverse Voltage DC Blocking Voltage	V_{RRM} V_{RWM} V_R	35	45	Volts
Average Rectified Forward Current (Rated V_R) T_C = 135°C	$I_{F(AV)}$	10	10	Amps
Peak Repetitive Forward Current (Rated V_R, Square Wave, 20 kHz) T_C = 135°C	I_{FRM}	20	20	Amps
Nonrepetitive Peak Surge Current (Surge applied at rated load conditions halfwave, single phase, 60 Hz)	I_{FSM}	150	150	Amps
Peak Repetitive Reverse Surge Current (2 0 μs, 1 0 kHz) See Figure 12	I_{RRM}	1 0	1 0	Amps
Operating Junction Temperature	T_J	-65 to + 150	-65 to + 150	°C
Storage Temperature	T_{stg}	-65 to +175	-65 to +175	°C
Voltage Rate of Change (Rated V_R)	dv/dt	1000	1000	V/μs

THERMAL CHARACTERISTICS

Characteristic	Symbol	MBR1035	MBR1045	Unit
Maximum Thermal Resistance, Junction to Case	$R_{\theta JC}$	2 0	2 0	°C/W

ELECTRICAL CHARACTERISTICS

Characteristic	Symbol	MBR1035	MBR1045	Unit
Maximum Instantaneous Forward Voltage (1) (i_F = 10 A, T_C = 125°C) (i_F = 20 A, T_C = 125°C) (i_F = 20 A, T_C = 25°C)	v_F	 0 57 0 72 0 84	 0 57 0 72 0 84	Volts
Maximum Instantaneous Reverse Current (1) (Rated dc Voltage, T_C = 125°C) (Rated dc Voltage, T_C = 25°C)	i_R	 15 0 1	 15 0 1	mA

(1) Pulse Test Pulse Width = 300 μs, Duty Cycle ≤ 2 0%

FIGURE 1 —MAXIMUM FORWARD VOLTAGE

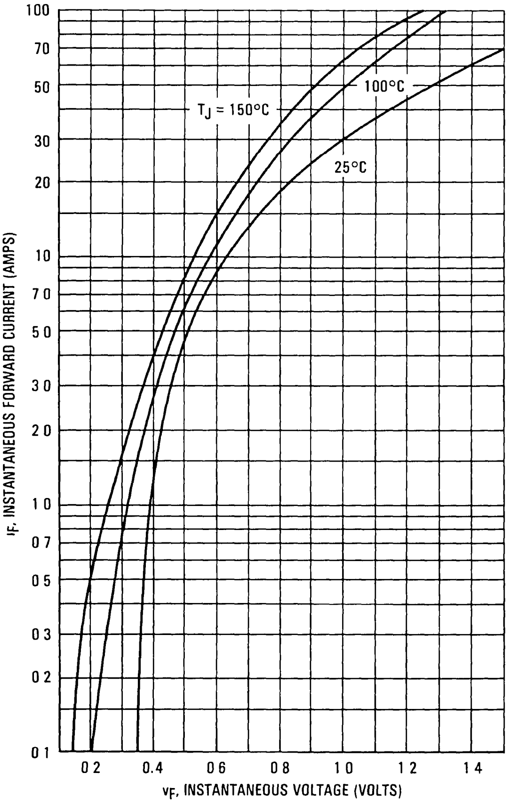


FIGURE 2 —TYPICAL FORWARD VOLTAGE

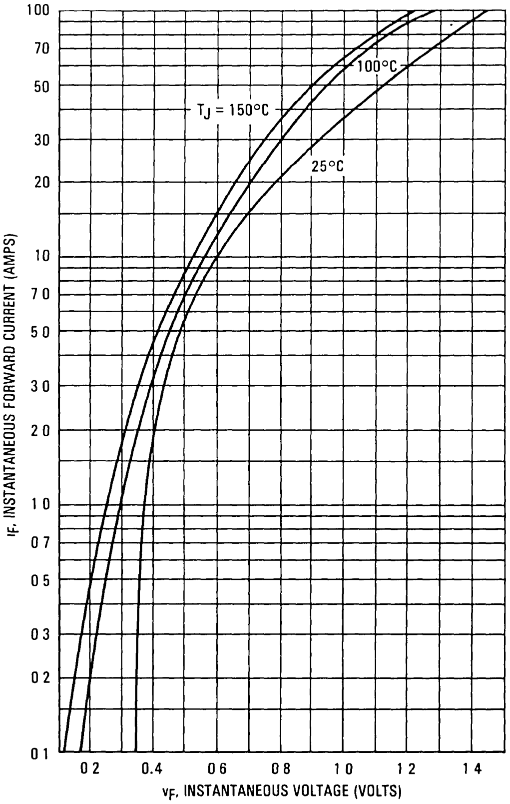


FIGURE 3 — MAXIMUM REVERSE CURRENT

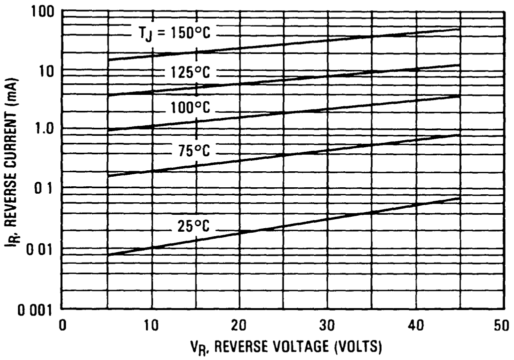


FIGURE 4 — MAXIMUM SURGE CAPABILITY

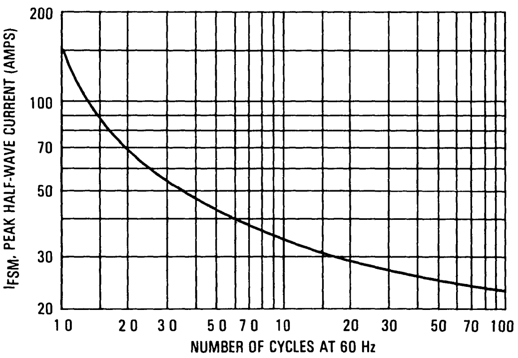


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FIGURE 5 — CURRENT DERATING, INFINITE HEATSINK

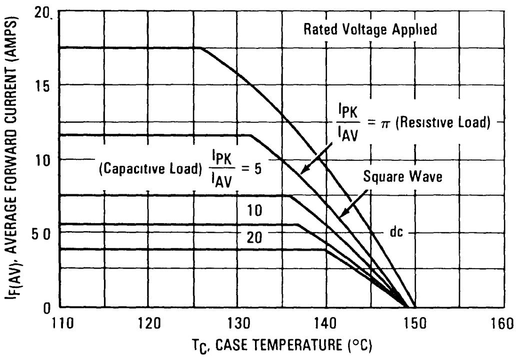


FIGURE 6 — CURRENT DERATING, $R_{\theta JA}$ = 16° C/W

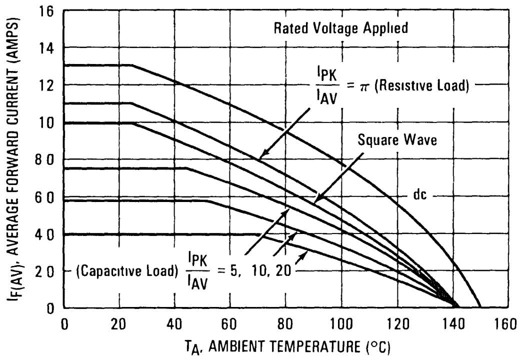


FIGURE 7 — FORWARD POWER DISSIPATION

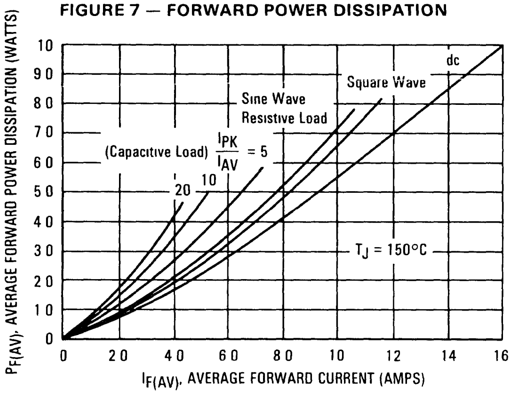


FIGURE 8 — CURRENT DERATING, FREE AIR

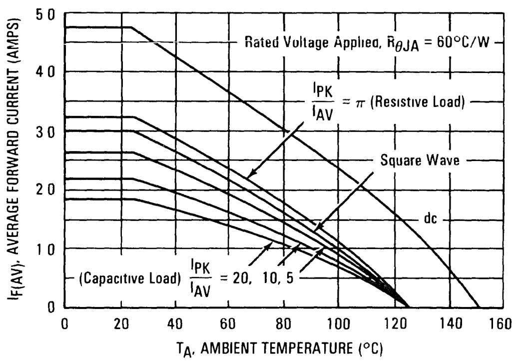
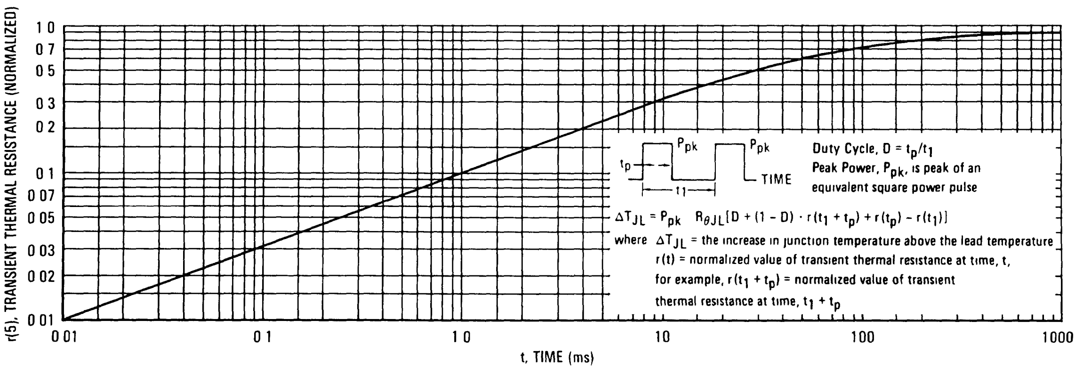


FIGURE 9 — THERMAL RESPONSE



HIGH FREQUENCY OPERATION

Since current flow in a Schottky rectifier is the result of majority carrier conduction, it is not subject to junction diode forward and reverse recovery transients due to minority carrier injection and stored charge. Satisfactory circuit analysis work may be performed by using a model consisting of an ideal diode in parallel with a variable capacitance. (See Figure 10.)

Rectification efficiency measurements show that operation will be satisfactory up to several megahertz. For example, relative waveform rectification efficiency is approximately 70 per cent at 2.0 MHz, e.g., the ratio of dc power to RMS power in the load is 0.28 at this frequency, whereas perfect rectification would yield 0.406 for sine wave inputs. However, in contrast to ordinary junction diodes, the loss in waveform efficieny is not indicative of power loss, it is simply a result of reverse current flow through the diode capacitance, which lowers the dc output voltage.

FIGURE 10 — CAPACITANCE

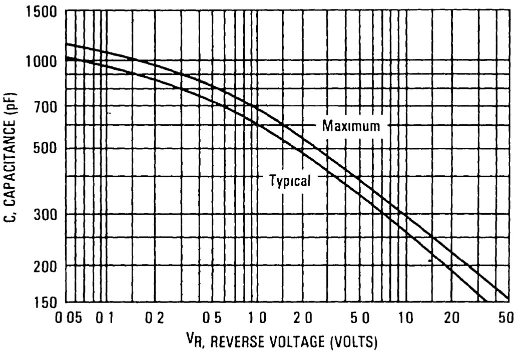
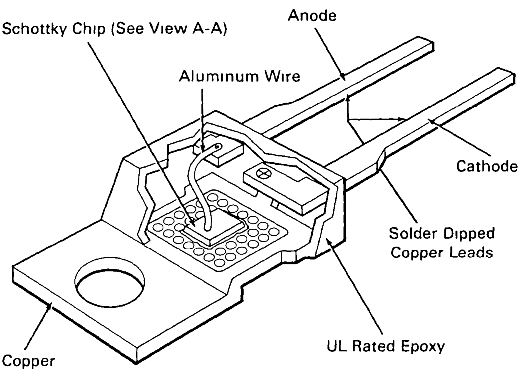
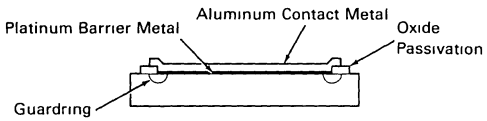


FIGURE 11 — SCHOTTKY RECTIFIER



Schottky Chip — View A-A



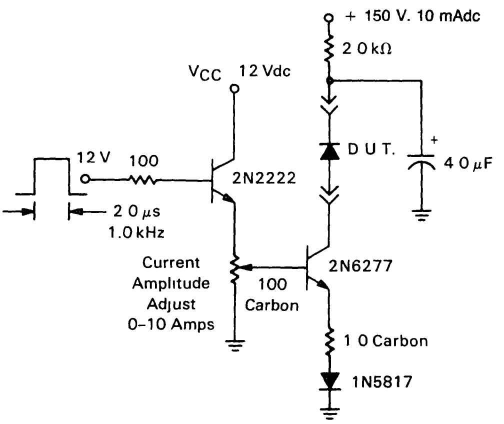
Motorola builds quality and reliability into its Schottky Rectifiers.

First is the chip, which has an interface metal between the barrier metal and aluminum-contact metal to eliminate any possible interaction between the two. The indicated guardring prevents dv/dt problems, so snubbers are not mandatory. The guardring also operates like a zener to absorb over-voltage transients.

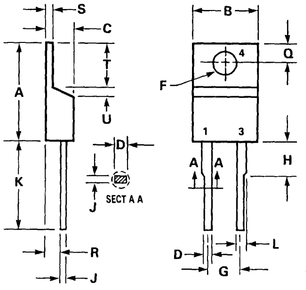
Second is the package. The Schottky chip is bonded to the copper heat sink using a specially formulated solder. This gives the unit the capability of passing 10,000 operating thermal-fatigue cycles having a ΔT_J of 100°C. The epoxy molding compound is rated per UL 94, V0 @ 1/8". Wire bonds are 100% tested in assembly as they are made.

Third is the electrical testing, which includes 100% dv/dt at 1600 V/μs and reverse avalanche as part of device characterization.

FIGURE 12 — TEST CIRCUIT FOR dv/dt AND REVERSE SURGE CURRENT



OUTLINE DIMENSIONS



STYLE 1
PIN 1 CATHODE
2 N/A
3 ANODE
4 CATHODE

DIM	MILLIMETERS		INCHES	
	MIN	MAX	MIN	MAX
A	15.11	15.75	0.595	0.620
B	9.65	10.29	0.380	0.405
C	4.06	4.82	0.160	0.190
D	0.64	0.89	0.025	0.035
F	3.61	3.73	0.142	0.147
G	4.83	5.33	0.190	0.210
H	2.79	3.30	0.110	0.130
J	0.36	0.56	0.014	0.022
K	12.70	14.27	0.500	0.562
L	1.14	1.27	0.045	0.050
Q	2.54	3.04	0.100	0.120
R	2.04	2.79	0.080	0.110
S	1.14	1.39	0.045	0.055
T	5.97	6.48	0.235	0.255
U	0.76	1.27	0.030	0.050

CASE 221B-01
TO-220AC
PLASTIC

3

MBR1060
MBR1070
MBR1080
MBR1090
MBR10100

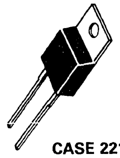
Switchmode Power Rectifiers

. . . using the Schottky Barrier principle with a platinum barrier metal. These state-of-the-art devices have the following features:

- Guard-Ring for Stress Protection
- Low Forward Voltage
- 150°C Operating Junction Temperature
- Guaranteed Reverse Avalanche
- Epoxy Meets UL94, VO at 1/8″
- Low Power Loss/High Efficiency
- High Surge Capacity
- Low Stored Charge Majority Carrier Conduction

3

SCHOTTKY BARRIER RECTIFIERS
10 AMPERES
60–100 VOLTS



CASE 221B-01
TO-220AC
PLASTIC

MAXIMUM RATINGS

Rating	Symbol	MBR					Unit
		1060	1070	1080	1090	10100	
Peak Repetitive Reverse Voltage Working Peak Reverse Voltage DC Blocking Voltage	V_{RRM} V_{RWM} V_R	60	70	80	90	100	Volts
Average Rectified Forward Current (Rated V_R) T_C = 133°C	$I_{F(AV)}$			10			Amps
Peak Repetitive Forward Current (Rated V_R, Square Wave, 20 kHz) T_C = 133°C	I_{FRM}			20			Amps
Nonrepetitive Peak Surge Current (Surge applied at rated load conditions halfwave, single phase, 60 Hz)	I_{FSM}			150			Amps
Peak Repetitive Reverse Surge Current (2 μs, 1 kHz)	I_{RRM}			0.5			Amp
Operating Junction Temperature	T_J			−65 to +150			°C
Storage Temperature	T_{stg}			−65 to +175			°C
Voltage Rate of Change (Rated V_R)	dv/dt			1000			V/μs

THERMAL CHARACTERISTICS

Maximum Thermal Resistance — Junction to Case — Junction to Ambient	$R_{\theta JC}$ $R_{\theta JA}$	2 60	°C/W

ELECTRICAL CHARACTERISTICS

Maximum Instantaneous Forward Voltage (1) (i_F = 10 Amp, T_C = 125°C) (i_F = 10 Amp, T_C = 25°C) (i_F = 20 Amp, T_C = 125°C) (i_F = 20 Amp, T_C = 25°C)	v_F	 0.7 0.8 0.85 0.95	Volts
Maximum Instantaneous Reverse Current (1) (Rated dc Voltage, T_C = 125°C) (Rated dc Voltage, T_C = 25°C)	i_R	 150 0.15	mA

(1) Pulse Test: Pulse Width = 300 μs, Duty Cycle ≤ 2%.

MBR1060, MBR1070, MBR1080, MBR1090, MBR10100

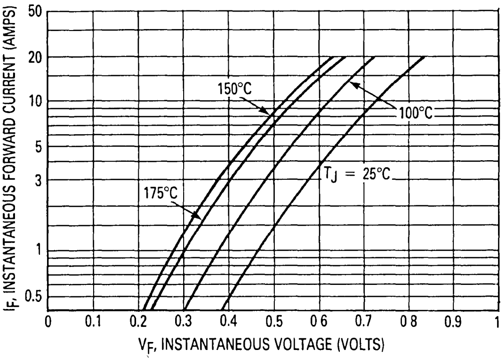


Figure 1. Typical Forward Voltage

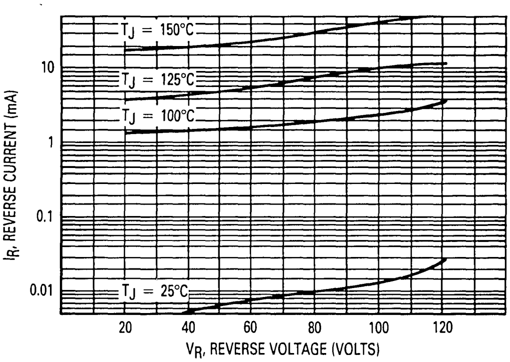


Figure 2. Typical Reverse Current

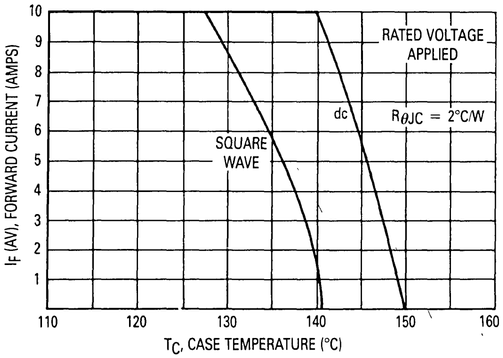


Figure 3. Current Derating, Case

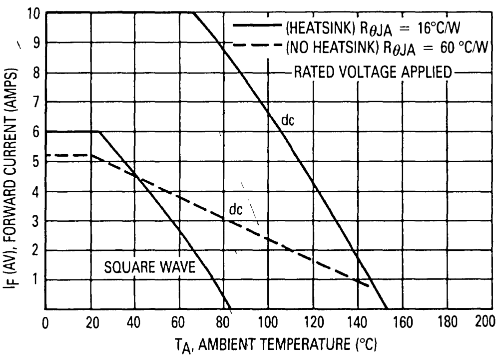


Figure 4. Current Derating, Ambient

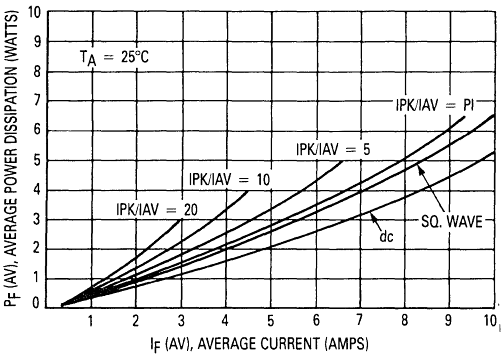
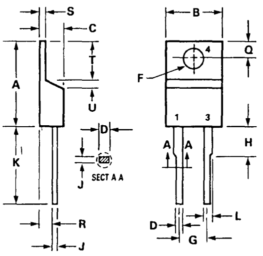


Figure 5. Forward Power Dissipation



Polarity: Cathode-To-Case

CASE 221B-01
TO-220AC
PLASTIC

STYLE 1
PIN 1 CATHODE
2 N A
3 ANODE
4 CATHODE

DIM	MILLIMETERS		INCHES	
	MIN	MAX	MIN	MAX
A	15 11	15 75	0 595	0 620
B	9 65	10 29	0 380	0 405
C	4 06	4 82	0 160	0 190
D	0 64	0 89	0 025	0 035
F	3 61	3 73	0 142	0 147
G	4 83	5 33	0 190	0 210
H	2 79	3 30	0 110	0 130
J	0 36	0 56	0 014	0 022
K	12 70	14 27	0 500	0 562
L	1 14	1 27	0 045	0 050
Q	2 54	3 04	0 100	0 120
R	2 04	2 79	0 080	0 110
S	1 14	1 39	0 045	0 055
T	5 97	6 48	0 235	0 255
U	0 76	1 27	0 030	0 050

3

MBR1535CT
MBR1545CT

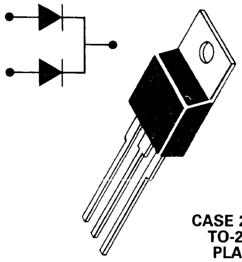
SWITCHMODE POWER RECTIFIERS

using the Schottky Barrier principle with a platinum barrier metal These state-of-the-art devices have the following features

- Center-Tap Configuration
- Guardring for Stress Protection
- Low Forward Voltage
- 150°C Operating Junction Temperature
- Guaranteed Reverse Avalanche
- Epoxy Meets UL94, VO at 1/8″

SCHOTTKY BARRIER RECTIFIERS

15 AMPERES
35 and 45 VOLTS



CASE 221A-04
TO-220AB
PLASTIC

MAXIMUM RATINGS

Rating		Symbol	MBR1535CT	MBR1545CT	Unit
Peak Repetitive Reverse Voltage Working Peak Reverse Voltage DC Blocking Voltage		V_{RRM} V_{RWM} V_R	35	45	Volts
Average Rectified Forward Current T_C = 105°C (Rated V_R)	Per Diode Per Device	$I_{F(AV)}$	7 5 15	7 5 15	Amps
Peak Repetitive Forward Current, T_C = 105°C (Rated V_R, Square Wave, 20 kHz) Per Diode		I_{FRM}	15	15	Amps
Nonrepetitive Peak Surge Current (Surge applied at rated load conditions halfwave, single phase, 60 Hz)		I_{FSM}	150	150	Amps
Peak Repetitive Reverse Surge Current (2 0 μs, 1 0 kHz)		I_{RRM}	1 0	1 0	Amps
Operating Junction Temperature		T_J	-65 to +150	-65 to +150	°C
Storage Temperature		T_{stg}	-65 to +175	-65 to +175	°C
Voltage Rate of Change (Rated V_R)		dv/dt	1000	1000	V/μs

THERMAL CHARACTERISTICS PER DIODE

Maximum Thermal Resistance, Junction to Case	$R_{\theta JC}$	3 0	3 0	°C/W
Maximum Thermal Resistance, Junction to Ambient	$R_{\theta JA}$	60	60	°C/W

ELECTRICAL CHARACTERISTICS PER DIODE

Maximum Instantaneous Forward Voltage (1) (i_F = 7 5 Amp, T_C = 125°C) (i_F = 15 Amp, T_C = 125°C) (i_F = 15 Amp, T_C = 25°C)	v_F	0 57 0 72 0 84	0 57 0 72 0 84	Volts
Maximum Instantaneous Reverse Current (1) (Rated dc Voltage, T_C = 125°C) (Rated dc Voltage, T_C = 25°C)	i_R	15 0 1	15 0 1	mA

(1) Pulse Test Pulse Width = 300 μs, Duty Cycle ≤ 2 0%

FIGURE 1 — TYPICAL FORWARD VOLTAGE

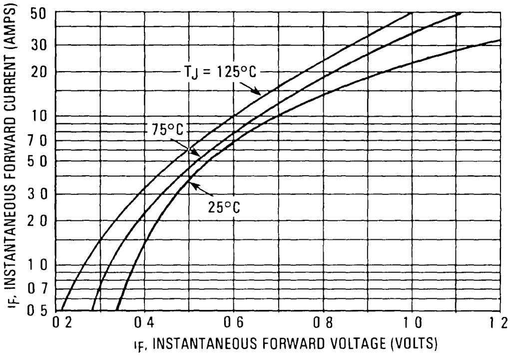


FIGURE 2 — TYPICAL REVERSE CURRENT

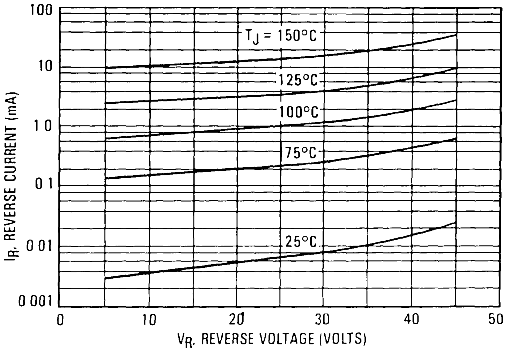


FIGURE 3 — CURRENT DERATING, CASE

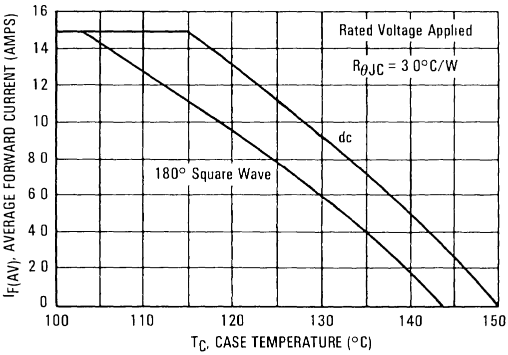


FIGURE 4 — CURRENT DERATING, AMBIENT

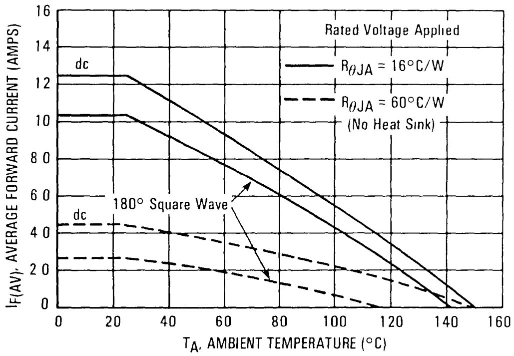
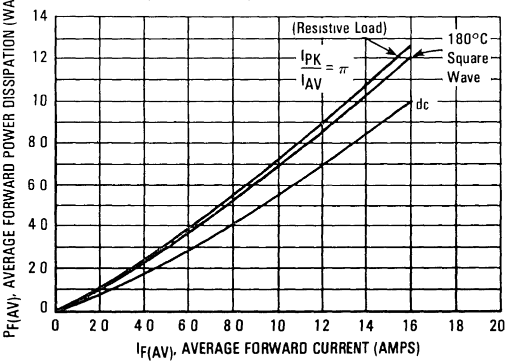
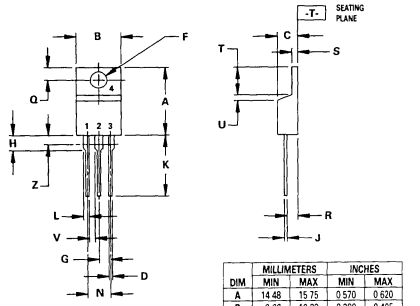


FIGURE 5 — POWER DISSIPATION





STYLE 6
PIN 1 ANODE
2 CATHODE
3 ANODE
4 CATHODE

NOTES
1 DIMENSIONING AND TOLERANCING PER ANSI Y14 5M, 1982
2 CONTROLLING DIMENSION INCH
3 DIM Z DEFINES A ZONE WHERE ALL BODY AND LEAD IRREGULARITIES ARE ALLOWED

DIM	MILLIMETERS		INCHES	
	MIN	MAX	MIN	MAX
A	14 48	15 75	0 570	0 620
B	9 66	10 28	0 380	0 405
C	4 07	4 82	0 160	0 190
D	0 64	0 88	0 025	0 035
F	3 61	3 73	0 142	0 147
G	2 42	2 66	0 095	0 105
H	2 80	3 93	0 110	0 155
J	0 36	0 55	0 014	0 022
K	12 70	14 27	0 500	0 562
L	1 15	1 39	0 045	0 055
N	4 83	5 33	0 190	0 210
Q	2 54	3 04	0 100	0 120
R	2 04	2 79	0 080	0 110
S	1 15	1 39	0 045	0 055
T	5 97	6 47	0 235	0 255
U	0 00	1 27	0 000	0 050
V	1 15	—	0 045	—
Z	—	2 04	—	0 080

CASE 221A-04
TO-220AB
PLASTIC

MOTOROLA
SEMICONDUCTOR
TECHNICAL DATA

MBR1635
MBR1645

SWITCHMODE POWER RECTIFIERS

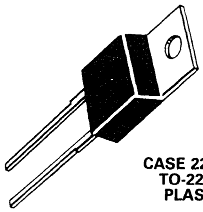
using the Schottky Barrier principle with a platinum barrier metal These state-of-the-art devices have the following features

- Guardring for Stress Protection
- Low Forward Voltage
- 150°C Operating Junction Temperature
- Guaranteed Reverse Avalanche

SCHOTTKY BARRIER RECTIFIERS

16 AMPERES
35 and 45 VOLTS

3



CASE 221B-01
TO-220AC
PLASTIC

MAXIMUM RATINGS

Rating	Symbol	MBR1635	MBR1645	Unit
Peak Repetitive Reverse Voltage Working Peak Reverse Voltage DC Blocking Voltage	V_{RRM} V_{RWM} V_R	35	45	Volts
Average Rectified Forward Current (Rated V_R) T_C = 125°C	$I_{F(AV)}$	16	16	Amps
Peak Repetitive Forward Current (Rated V_R, Square Wave, 20 kHz) T_C = 125°C	I_{FRM}	32	32	Amps
Nonrepetitive Peak Surge Current (Surge applied at rated load conditions halfwave, single phase, 60 Hz)	I_{FSM}	150	150	Amps
Peak Repetitive Reverse Surge Current (2 0 μs, 1 0 kHz)	I_{RRM}	1 0	1 0	Amps
Operating Junction Temperature	T_J	-65 to +150	-65 to +150	°C
Storage Temperature	T_{stg}	-65 to +175	-65 to +175	°C
Voltage Rate of Change (Rated V_R)	dv/dt	1000	1000	V/μs

THERMAL CHARACTERISTICS

Maximum Thermal Resistance, Junction to Case	$R_{\theta JC}$	1 5	1 5	°C/W

ELECTRICAL CHARACTERISTICS

Maximum Instantaneous Forward Voltage (1) (i_F = 16 Amp, T_C = 125°C) (i_F = 16 Amp, T_C = 25°C)	v_F	 0 57 0 63	 0 57 0 63	Volts
Maximum Instantaneous Reverse Current (1) (Rated dc Voltage, T_C = 125°C) (Rated dc Voltage, T_C = 25°C)	i_R	 40 0 2	 40 0 2	mA

(1) Pulse Test Pulse Width = 300 μs, Duty Cycle ≤ 2 0%

MBR1635, MBR1645

FIGURE 1 — TYPICAL FORWARD VOLTAGE

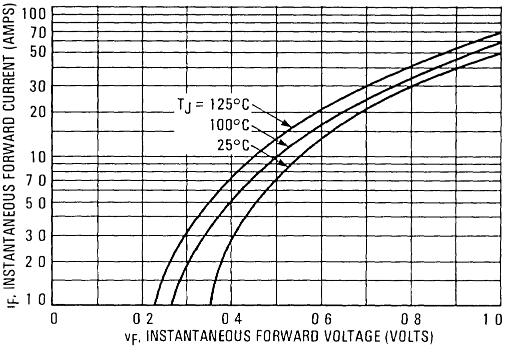


FIGURE 2 — TYPICAL REVERSE CURRENT

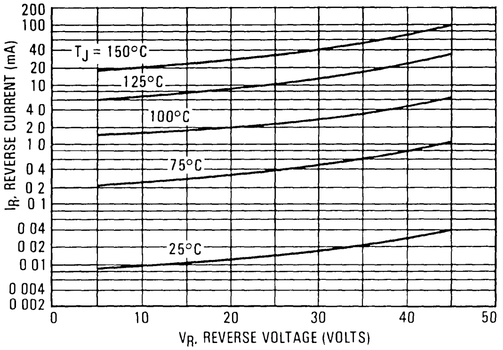


FIGURE 3 — CURRENT DERATING, CASE

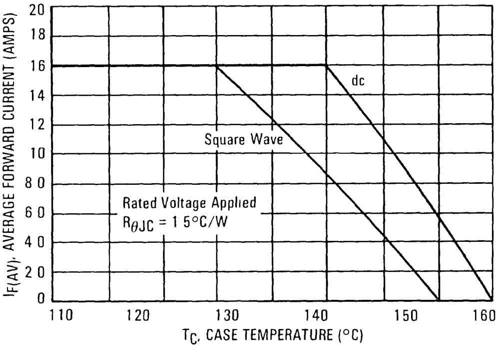


FIGURE 4 — CURRENT DERATING, AMBIENT

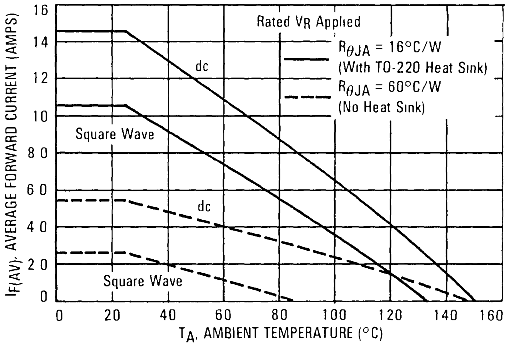
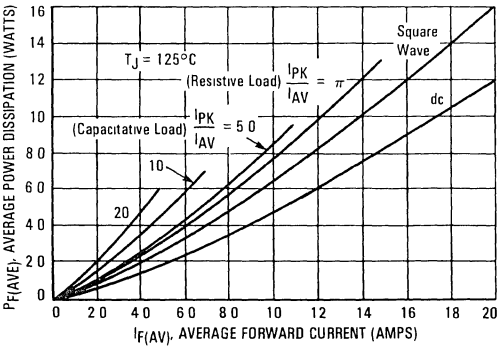
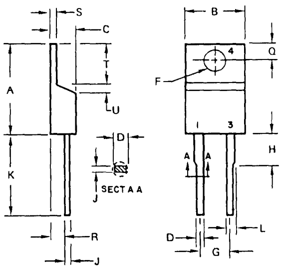


FIGURE 5 — FORWARD POWER DISSIPATION





STYLE 1
PIN 1 CATHODE
2 N/A
3 ANODE
4 CATHODE

DIM	MILLIMETERS MIN	MILLIMETERS MAX	INCHES MIN	INCHES MAX
A	15 11	15 75	0 595	0 620
B	9 65	10 29	0 380	0 405
C	4 06	4 82	0 160	0 190
D	0 64	0 89	0 025	0 035
F	3 61	3 73	0 142	0 147
G	4 83	5 33	0 190	0 210
H	2 79	3 30	0 110	0 130
J	0 36	0 56	0 014	0 022
K	12 70	14 27	0 500	0 562
L	1 14	1 27	0 045	0 050
Q	2 54	3 04	0 100	0 120
R	2 04	2 79	0 080	0 110
S	1 14	1 39	0 045	0 055
T	5 97	6 48	0 235	0 255
U	0 76	1 27	0 030	0 050

CATHODE COMMON TO TAB

CASE 221B-01
TO-220AC
PLASTIC

MOTOROLA
SEMICONDUCTOR
TECHNICAL DATA

MBR2035CT
MBR2045CT

3

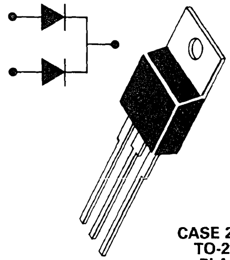
SCHOTTKY BARRIER RECTIFIERS

20 AMPERES
35 and 45 VOLTS

SWITCHMODE POWER RECTIFIERS

using the Schottky Barrier principle with a platinum barrier metal These state-of-the-art devices have the following features

- Guardring for Stress Protection
- Low Forward Voltage
- 150°C Operating Junction Temperature
- Guaranteed Reverse Avalanche
- Epoxy Meets UL94, V0 at 1/8″



CASE 221A-04
TO-220AB
PLASTIC

MAXIMUM RATINGS

Rating	Symbol	MBR2035CT	MBR2045CT	Unit
Peak Repetitive Reverse Voltage Working Peak Reverse Voltage DC Blocking Voltage	V_{RRM} V_{RWM} V_R	35	45	Volts
Average Rectified Forward Current (Rated V_R) T_C = 135°C	$I_{F(AV)}$	20	20	Amps
Peak Repetitive Forward Current Per Diode Leg (Rated V_R, Square Wave, 20 kHz) T_C = 135°C	I_{FRM}	20	20	Amps
Nonrepetitive Peak Surge Current (Surge applied at rated load conditions halfwave, single phase, 60 Hz)	I_{FSM}	150	150	Amps
Peak Repetitive Reverse Surge Current (2 0 μs, 1 0 kHz) See Figure 11	I_{RRM}	1 0	1 0	Amps
Operating Junction Temperature	T_J	-65 to +150	-65 to +150	°C
Storage Temperature	T_{stg}	-65 to +175	-65 to +175	°C
Voltage Rate of Change (Rated V_R)	dv/dt	1000	1000	V/μs

THERMAL CHARACTERISTICS

Maximum Thermal Resistance, Junction to Case	$R_{\theta JC}$	2 0	2 0	°C/W

ELECTRICAL CHARACTERISTICS

Maximum Instantaneous Forward Voltage (1) (i_F = 10 Amp, T_C = 125°C) (i_F = 20 Amp, T_C = 125°C) (i_F = 20 Amp, T_C = 25°C)	v_F	 0 57 0 72 0 84	 0 57 0 72 0 84	Volts
Maximum Instantaneous Reverse Current (1) (Rated dc Voltage, T_C = 125°C) (Rated dc Voltage, T_C = 25°C)	i_R	 15 0 1	 15 0 1	mA

(1) Pulse Test Pulse Width = 300 μs, Duty Cycle ≤ 2 0%

FIGURE 1 —MAXIMUM FORWARD VOLTAGE

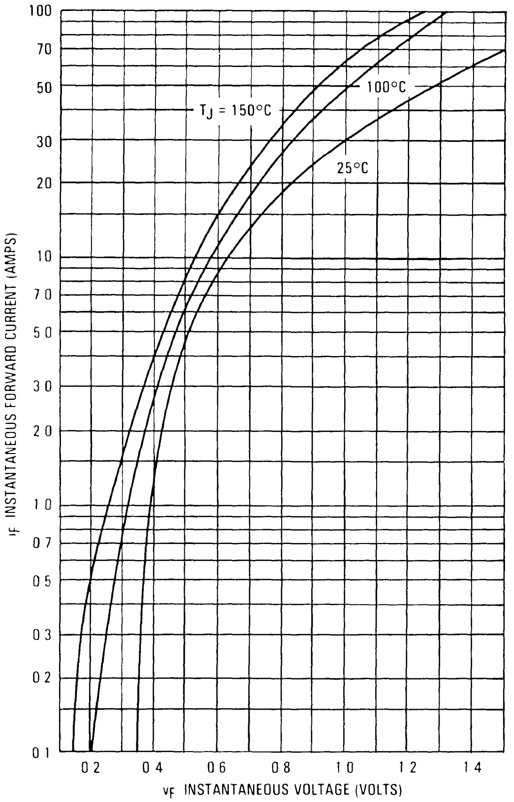


FIGURE 2 —TYPICAL FORWARD VOLTAGE

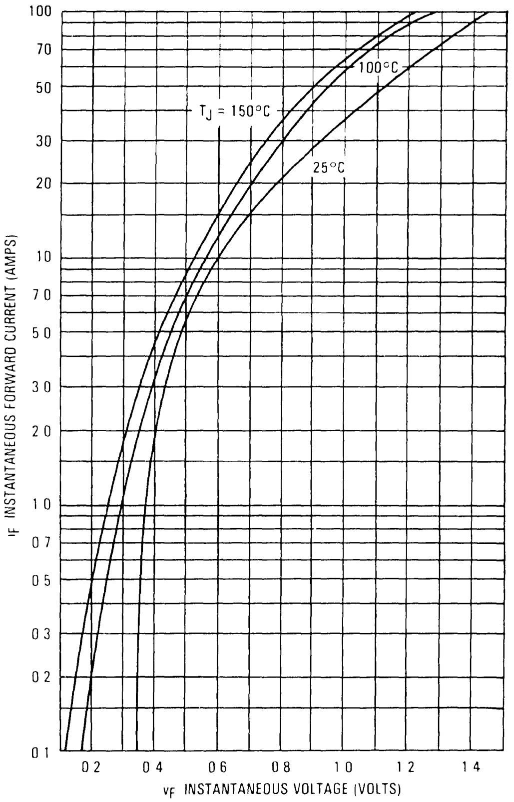


FIGURE 3 — MAXIMUM REVERSE CURRENT

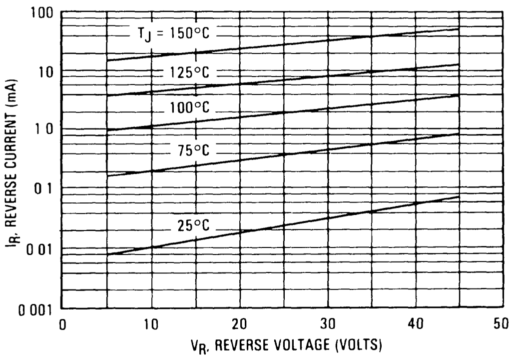


FIGURE 4 — MAXIMUM SURGE CAPABILITY

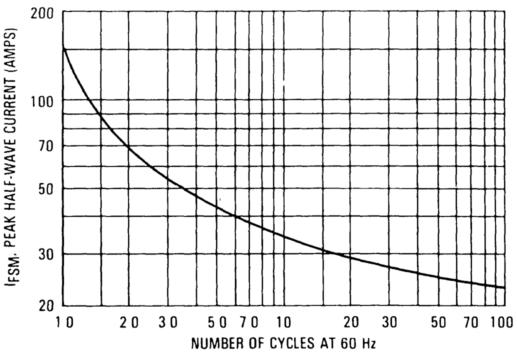


FIGURE 5 — CURRENT DERATING, INFINITE HEATSINK

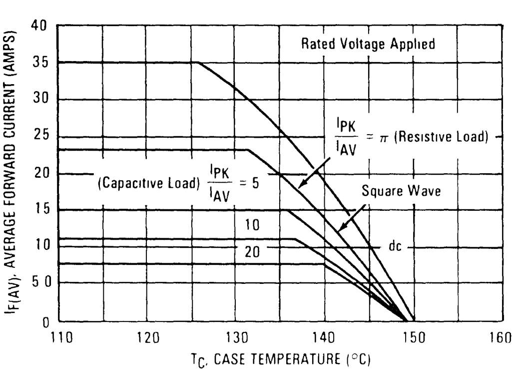


FIGURE 6 — CURRENT DERATING, $R_{\theta JA}$ = 16° C/W

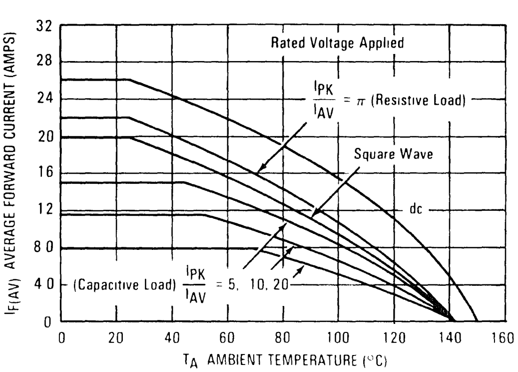


FIGURE 7 — FORWARD POWER DISSIPATION

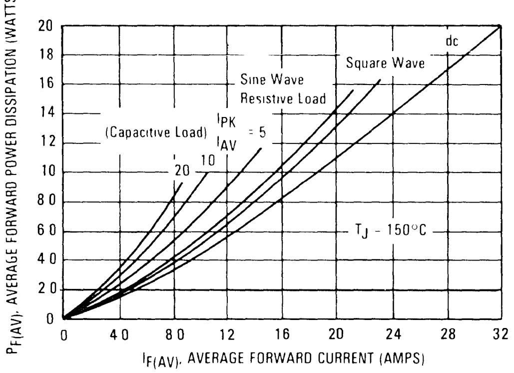


FIGURE 8 — CURRENT DERATING, FREE AIR

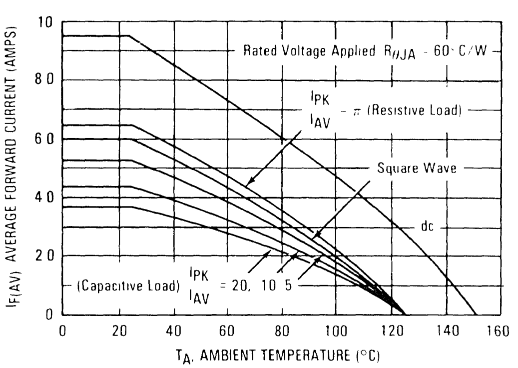
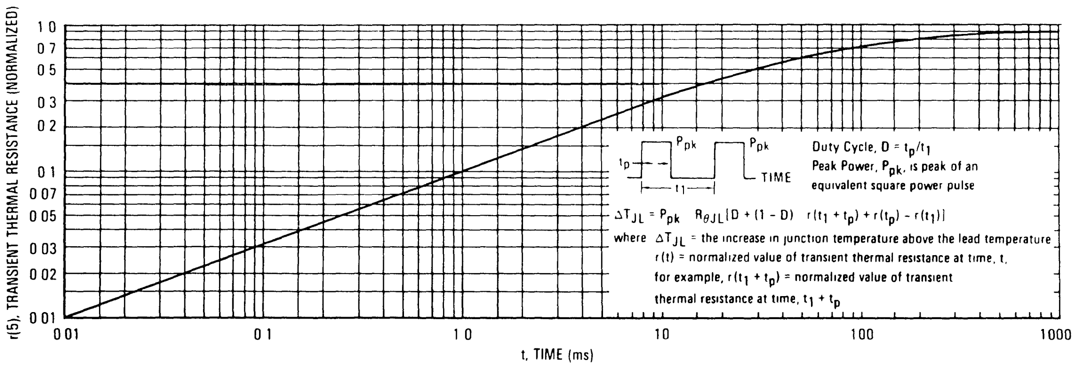


FIGURE 9 — THERMAL RESPONSE

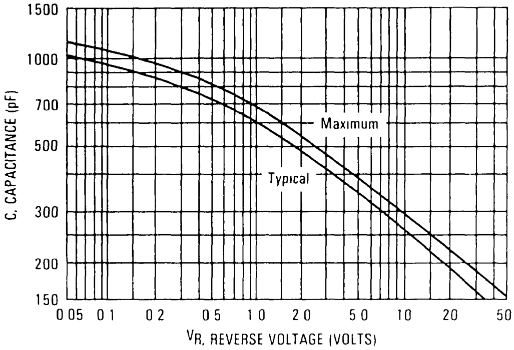


HIGH FREQUENCY OPERATION

Since current flow in a Schottky rectifier is the result of majority carrier conduction, it is not subject to junction diode forward and reverse recovery transients due to minority carrier injection and stored charge Satisfactory circuit analysis work may be performed by using a model consisting of an ideal diode in parallel with a variable capacitance (See Figure 10)

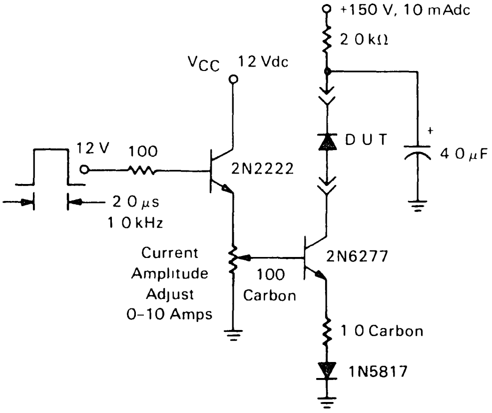
Rectification efficiency measurements show that operation will be satisfactory up to several megahertz For example, relative waveform rectification efficiency is approximately 70 per cent at 2 0 MHz, e g , the ratio of dc power to RMS power in the load is 0 28 at this frequency, whereas perfect rectification would yield 0 406 for sine wave inputs However, in contrast to ordinary junction diodes, the loss in waveform efficieny is not indicative of power loss, it is simply a result of reverse current flow through the diode capacitance, which lowers the dc output voltage

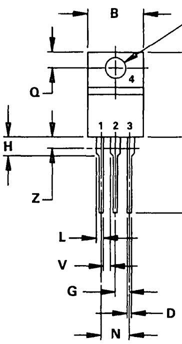
FIGURE 10 — CAPACITANCE

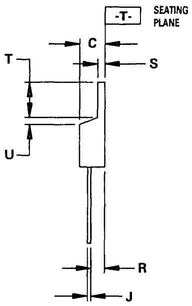


3

FIGURE 11 — TEST CIRCUIT FOR dv/dt AND REVERSE SURGE CURRENT







NOTES
1 DIMENSIONING AND TOLERANCING PER ANSI Y14 5M, 1982.
2 CONTROLLING DIMENSION INCH
3 DIM Z DEFINES A ZONE WHERE ALL BODY AND LEAD IRREGULARITIES ARE ALLOWED

DIM	MILLIMETERS		INCHES	
	MIN	MAX	MIN	MAX
A	14 48	15 75	0 570	0 620
B	9 66	10 28	0 380	0 405
C	4 07	4 82	0 160	0 190
D	0 64	0 88	0 025	0 035
F	3 61	3 73	0 142	0 147
G	2 42	2 66	0 095	0 105
H	2 80	3 93	0 110	0 155
J	0 36	0 55	0 014	0 022
K	12 70	14 27	0 500	0 562
L	1 15	1 39	0 045	0 055
N	4 83	5 33	0 190	0 210
Q	2 54	3 04	0 100	0 120
R	2 04	2 79	0 080	0 110
S	1 15	1 39	0 045	0 055
T	5 97	6 47	0 235	0 255
U	0 00	1 27	0 000	0 050
V	1 15	—	0 045	—
Z	—	2 04	—	0 080

STYLE 6
PIN 1 ANODE
2 CATHODE
3 ANODE
4 CATHODE

CASE 221A-04
TO-220AB
PLASTIC

MOTOROLA
SEMICONDUCTOR
TECHNICAL DATA

Switchmode Power Rectifiers

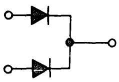
MBR2060CT
MBR2070CT
MBR2080CT
MBR2090CT
MBR20100CT

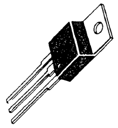
. . . using the Schottky Barrier principle with a platinum barrier metal. These state-of-the-art devices have the following features:

- 20 Amps Total (10 Amps Per Diode Leg)
- Guard-Ring for Stress Protection
- Low Forward Voltage
- 150°C Operating Junction Temperature
- Guaranteed Reverse Avalanche
- Epoxy Meets UL94, VO at 1/8″
- Low Power Loss/High Efficiency
- High Surge Capacity
- Low Stored Charge Majority Carrier Conduction

3

SCHOTTKY BARRIER RECTIFIERS
20 AMPERES
60–100 VOLTS





CASE 221A-04
TO-220AB
PLASTIC

MAXIMUM RATINGS PER DIODE LEG

Rating	Symbol	MBR					Unit
		2060CT	2070CT	2080CT	2090CT	20100CT	
Peak Repetitive Reverse Voltage Working Peak Reverse Voltage DC Blocking Voltage	V_{RRM} V_{RWM} V_R	60	70	80	90	100	Volts
Average Rectified Forward Current (Rated V_R) T_C = 133°C	$I_{F(AV)}$	10					Amps
Peak Repetitive Forward Current (Rated V_R, Square Wave, 20 kHz) T_C = 133°C	I_{FRM}	20					Amps
Nonrepetitive Peak Surge Current (Surge applied at rated load conditions halfwave, single phase, 60 Hz)	I_{FSM}	150					Amps
Peak Repetitive Reverse Surge Current (2 μs, 1 kHz)	I_{RRM}	0.5					Amp
Operating Junction Temperature	T_J	−65 to +150					°C
Storage Temperature	T_{stg}	−65 to +175					°C
Voltage Rate of Change (Rated V_R)	dv/dt	1000					V/μs

THERMAL CHARACTERISTICS

Maximum Thermal Resistance — Junction to Case — Junction to Ambient	$R_{\theta JC}$ $R_{\theta JA}$	2 60	°C/W

ELECTRICAL CHARACTERISTICS PER DIODE LEG

Maximum Instantaneous Forward Voltage (1) (i_F = 10 Amp, T_C = 125°C) (i_F = 10 Amp, T_C = 25°C) (i_F = 20 Amp, T_C = 125°C) (i_F = 20 Amp, T_C = 25°C)	v_F	 0.7 0.8 0.85 0.95	Volts
Maximum Instantaneous Reverse Current (1) (Rated dc Voltage, T_C = 125°C) (Rated dc Voltage, T_C = 25°C)	i_R	 150 0.15	mA

(1) Pulse Test Pulse Width = 300 μs, Duty Cycle ≤ 2%

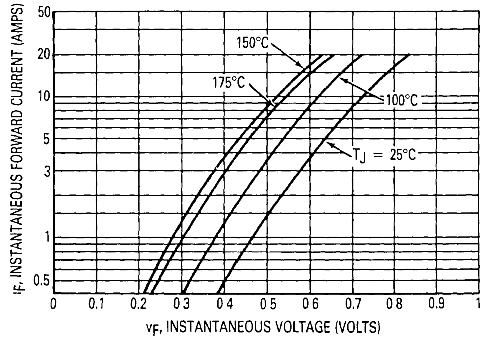


Figure 1. Typical Forward Voltage Per Diode

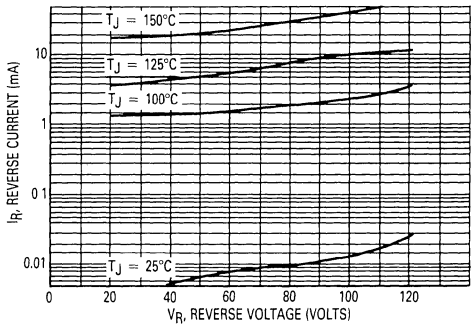


Figure 2. Typical Reverse Current Per Diode

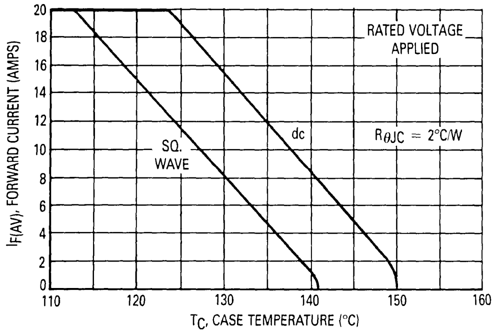


Figure 3. Current Derating, Case

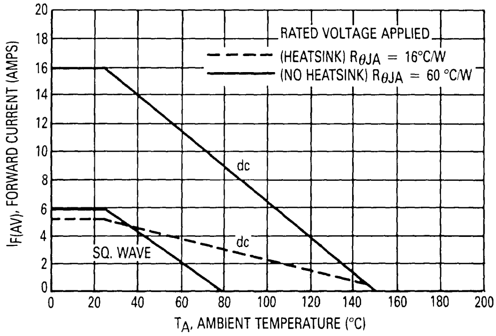


Figure 4. Current Derating, Ambient

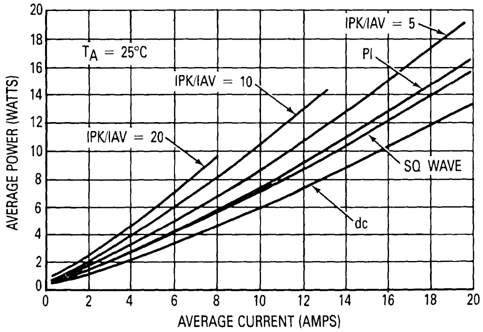
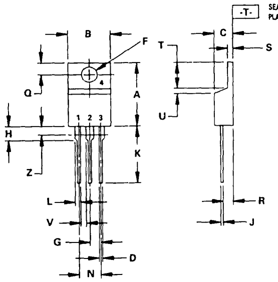


Figure 5. Average Power Dissipation and Average Current



Polarity: Cathode-To-Case

STYLE 6
PIN 1 ANODE
2 CATHODE
3 ANODE
4 CATHODE

DIM	MILLIMETERS MIN	MILLIMETERS MAX	INCHES MIN	INCHES MAX
A	14 48	15 75	0 570	0 620
B	9 66	10 28	0 380	0 405
C	4 07	4 82	0 160	0 190
D	0 64	0 88	0 025	0 035
F	3 61	3 73	0 142	0 147
G	2 42	2 66	0 095	0 105
H	2 80	3 93	0 110	0 155
J	0 36	0 55	0 014	0 022
K	12 70	14 27	0 500	0 562
L	1 15	1 39	0 045	0 055
N	4 83	5 33	0 190	0 210
Q	2 54	3 04	0 100	0 120
R	2 04	2 79	0 080	0 110
S	1 15	1 39	0 045	0 055
T	5 97	6 47	0 235	0 255
U	0 00	1 27	0 000	0 050
V	1 15	—	0 045	—
Z	—	2 04	—	0 080

NOTES
1 DIMENSIONING AND TOLERANCING PER ANSI Y14 5M, 1982
2 CONTROLLING DIMENSION INCH
3 DIM Z DEFINES A ZONE WHERE ALL BODY AND LEAD IRREGULARITIES ARE ALLOWED

CASE 221A-04
TO-220AB
PLASTIC

3

MOTOROLA
SEMICONDUCTOR
TECHNICAL DATA

MBR2535CT
MBR2545CT

3

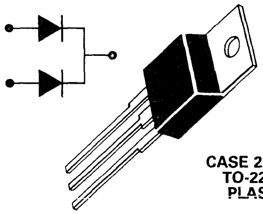
SWITCHMODE POWER RECTIFIERS

using the Schottky Barrier principle with a platinum barrier metal These state-of-the-art devices have the following features

- Guardring for Stress Protection
- Low Forward Voltage
- 150°C Operating Junction Temperature
- Guaranteed Reverse Avalanche

SCHOTTKY BARRIER RECTIFIERS

30 AMPERES
35 and 45 VOLTS



CASE 221A-04
TO-220AB
PLASTIC

MAXIMUM RATINGS

Rating	Symbol	MBR2535CT	MBR2545CT	Unit
Peak Repetitive Reverse Voltage Working Peak Reverse Voltage DC Blocking Voltage	V_{RRM} V_{RWM} V_R	35	45	Volts
Average Rectified Forward Current (Rated V_R) T_C = 130°C	$I_{F(AV)}$	30	30	Amps
Peak Repetitive Forward Current Per Diode Leg (Rated V_R, Square Wave, 20 kHz) T_C = 130°C	I_{FRM}	30	30	Amps
Nonrepetitive Peak Surge Current per Diode Leg (Surge applied at rated load conditions halfwave, single phase, 60 Hz)	I_{FSM}	150	150	Amps
Peak Repetitive Reverse Surge Current (2 0 μs, 1 0 kHz)	I_{RRM}	1 0	1 0	Amps
Operating Junction Temperature	T_J	-65 to + 150	-65 to + 150	°C
Storage Temperature	T_{stg}	-65 to +175	-65 to +175	°C
Voltage Rate of Change (Rated V_R)	dv/dt	1000	1000	V/μs

THERMAL CHARACTERISTICS PER DIODE LEG

Rating	Symbol	MBR2535CT	MBR2545CT	Unit
Maximum Thermal Resistance, Junction to Case	$R_{\theta JC}$	1 5	1 5	°C/W

ELECTRICAL CHARACTERISTICS PER DIODE LEG

Rating	Symbol	MBR2535CT	MBR2545CT	Unit
Maximum Instantaneous Forward Voltage (1) (i_F = 30 Amp, T_C = 125°C) (i_F = 30 Amp, T_C = 25°C)	v_F	 0 73 0 82	 0 73 0 82	Volts
Maximum Instantaneous Reverse Current (1) (Rated dc Voltage, T_C = 125°C) (Rated dc Voltage, T_C = 25°C)	i_R	 40 0 2	 40 0 2	mA

(1) Pulse Test Pulse Width = 300 μs, Duty Cycle ≤ 2 0%

FIGURE 1 — TYPICAL FORWARD VOLTAGE

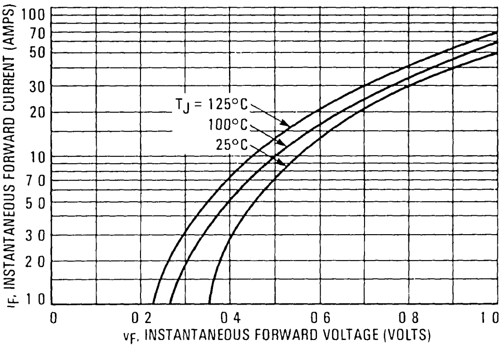


FIGURE 2 — TYPICAL REVERSE CURRENT

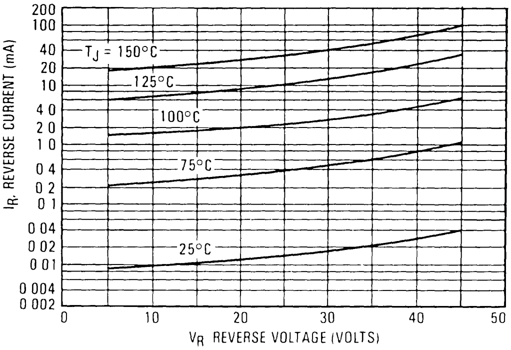


FIGURE 3 — CURRENT DERATING, CASE

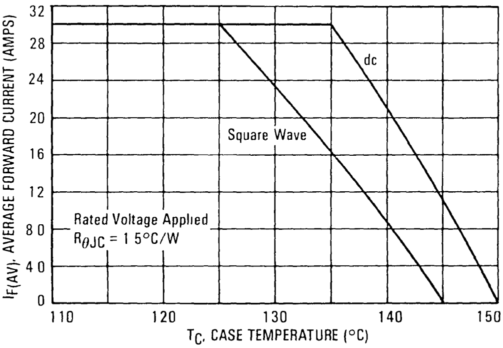


FIGURE 4 — CURRENT DERATING, AMBIENT

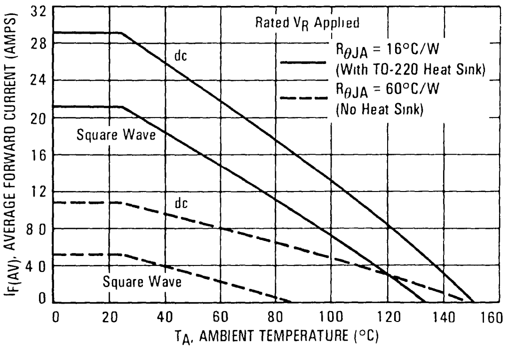
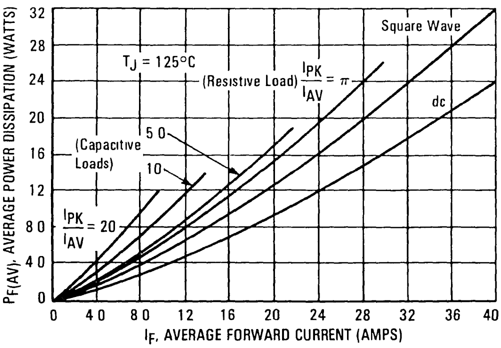
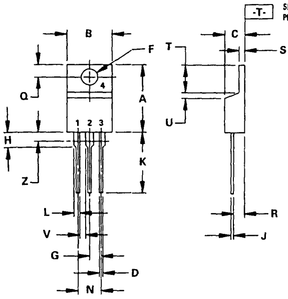


FIGURE 5 — FORWARD POWER DISSIPATION





STYLE 6
PIN 1 ANODE
2 CATHODE
3 ANODE
4 CATHODE

DIM	MILLIMETERS MIN	MILLIMETERS MAX	INCHES MIN	INCHES MAX
A	14 48	15 75	0 570	0 620
B	9 66	10 28	0 380	0 405
C	4 07	4 82	0 160	0 190
D	0 64	0 88	0 025	0 035
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H	2 80	3 93	0 110	0 155
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K	12 70	14 27	0 500	0 562
L	1 15	1 39	0 045	0 055
N	4 83	5 33	0 190	0 210
Q	2 54	3 04	0 100	0 120
R	2 04	2 79	0 080	0 110
S	1 15	1 39	0 045	0 055
T	5 97	6 47	0 235	0 255
U	0 00	1 27	0 000	0 050
V	1 15	—	0 045	—
Z	—	2 04	—	0 080

NOTES
1 DIMENSIONING AND TOLERANCING PER ANSI Y14 5M, 1982
2 CONTROLLING DIMENSION INCH
3 DIM Z DEFINES A ZONE WHERE ALL BODY AND LEAD IRREGULARITIES ARE ALLOWED

CASE 221A-04
TO-220AB
PLASTIC

MOTOROLA
SEMICONDUCTOR
TECHNICAL DATA

MBR3020CT
MBR3035CT
MBR3045CT
SD241

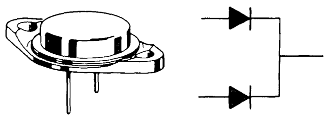
SWITCHMODE POWER RECTIFIERS

using the Schottky Barrier principle with a platinum barrier metal These state-of-the-art devices have the following features

- Dual Diode Construction
- Guardring for Stress Protection
- Low Forward Voltage
- 150°C Operating Junction Temperature
- Guaranteed Reverse Avalanche

SCHOTTKY BARRIER RECTIFIERS

30 AMPERES
20 to 45 VOLTS



CASE 11-03
TO-204AA
METAL

3

MAXIMUM RATINGS

Rating	Symbol	MBR3020CT	MBR3035CT	MBR3045CT	SD241	Unit
Peak Repetitive Reverse Voltage Working Peak Reverse Voltage DC Blocking Voltage	V_{RRM} V_{RWM} V_R	20	35	45	45	Volts
Average Rectified Forward Current Per Device (Rated V_R) T_C = 105°C Per Diode	I_O	30 15	30 15	30 15	30 15	Amps
Peak Repetitive Forward Current, Per Diode (Rated V_R, Square Wave, 20 kHz)	I_{FRM}	30	30	30	30	Amps
Nonrepetitive Peak Surge Current (Surge applied at rated load conditions halfwave, single phase, 60 Hz)	I_{FSM}	400	400	400	400	Amps
Peak Repetitive Reverse Current, Per Diode (2 0 μs, 1 0 kHz) See Figure 8	I_{RRM}	2 0	2 0	2 0	2 0	Amps
Operating Junction Temperature	T_J	-65 to + 150	-65 to + 150	-65 to + 150	-65 to +150	°C
Storage Temperature	T_{stg}	-65 to +175	-65 to +175	-65 to +175	-65 to +175	°C
Peak Surge Junction Temperature (Forward Current Applied)	$T_J(pk)$	175	175	175	175	°C
Voltage Rate of Change (Rated V_R)	dv/dt	1000	1000	1000	1000	V/μs

THERMAL CHARACTERISTICS PER DIODE

Maximum Thermal Resistance, Junction to Case	$R_{\theta JC}$	1 4	1 4	1 4	1 4	°C/W

ELECTRICAL CHARACTERISTICS PER DIODE

Maximum Instantaneous Forward Voltage (1) (i_F = 10 Amp, T_C = 125°C) (i_F = 20 Amp, T_C = 125°C) (i_F = 30 Amp, T_C = 125°C) (i_F = 30 Amp, T_C = 25°C)	v_F	 — 0 60 0 72 0 76	 — 0 60 0 72 0 76	 — 0 60 0 72 0 76	 0 47 0 60 — —	Volts
Maximum Instantaneous Reverse Current (1) (Rated dc Voltage, T_C = 125°C) (Rated dc Voltage, T_C = 25°C)	i_R	 60 1 0	 60 1 0	 60 1 0	 100 V_R = 35 V	mA
Capacitance	C_t	2000	2000	2000	2000	pF

(1) Pulse Test Pulse Width = 300 μs, Duty Cycle ≤ 2 0%

FIGURE 1 — TYPICAL FORWARD VOLTAGE

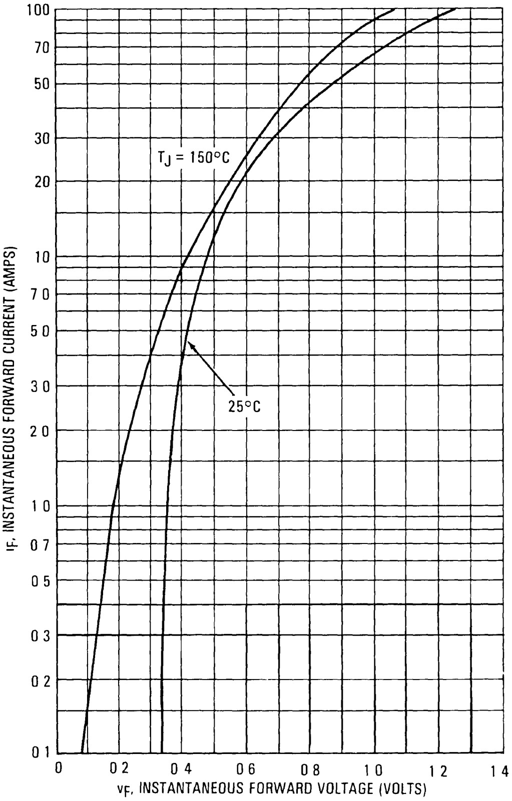


FIGURE 2 — TYPICAL REVERSE CURRENT

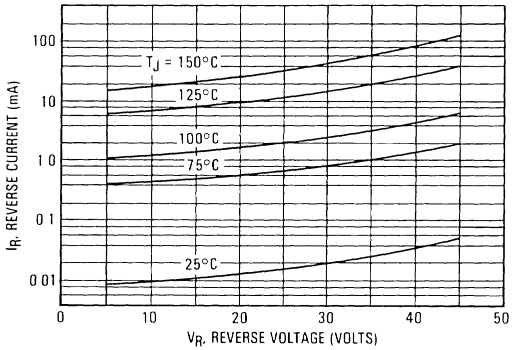


FIGURE 3 — MAXIMUM SURGE CAPABILITY

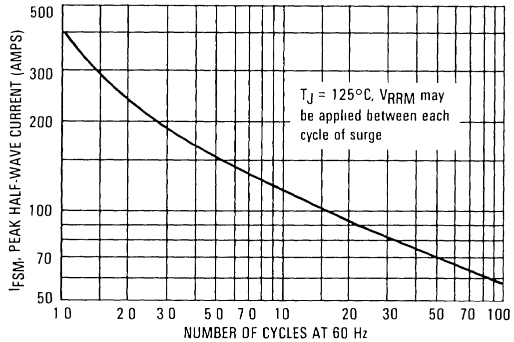


FIGURE 4 — CURRENT DERATING

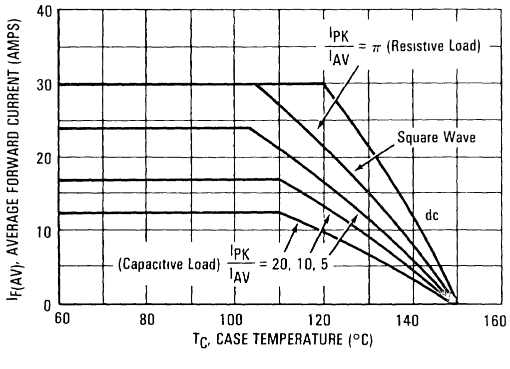


FIGURE 5 — FORWARD POWER DISSIPATION

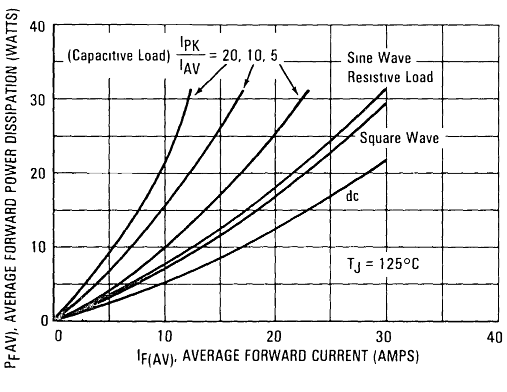
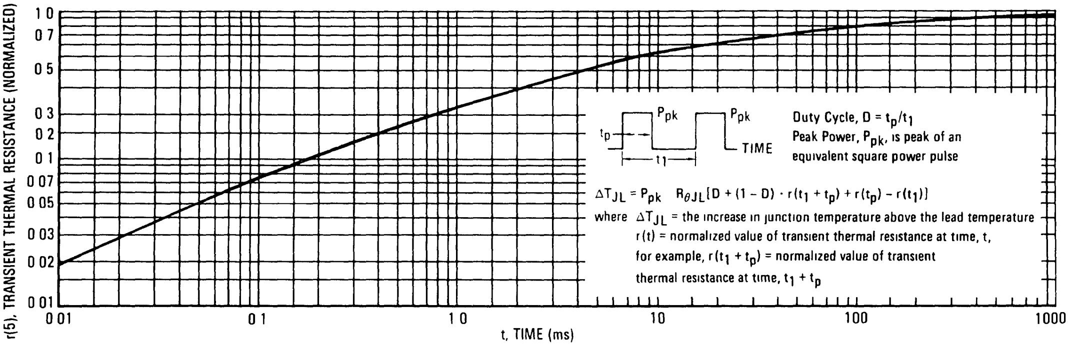


FIGURE 6 — THERMAL RESPONSE PER DIODE LEG



HIGH FREQUENCY OPERATION

Since current flow in a Schottky rectifier is the result of majority carrier conduction, it is not subject to junction diode forward and reverse recovery transients due to minority carrier injection and stored charge Satisfactory circuit analysis work may be performed by using a model consisting of an ideal diode in parallel with a variable capacitance (See Figure 7)

Rectification efficiency measurements show that operation will be satisfactory up to several megahertz For example, relative waveform rectification efficiency is approximately 70 per cent at 2 0 MHz, e g , the ratio of dc power to RMS power in the load is 0 28 at this frequency, whereas perfect rectification would yield 0 406 for sine wave inputs However, in contrast to ordinary junction diodes, the loss in waveform efficieny is not indicative of power loss, it is simply a result of reverse current flow through the diode capacitance, which lowers the dc output voltage

FIGURE 7 — CAPACITANCE

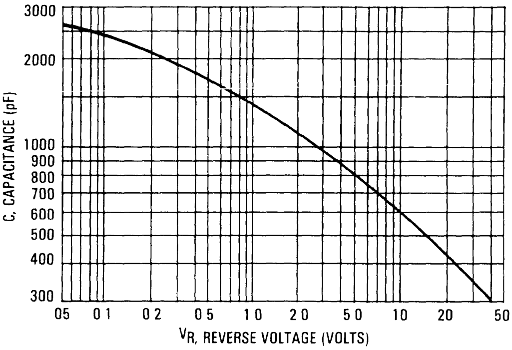


FIGURE 8 — TEST CIRCUIT FOR REPETITIVE REVERSE CURRENT

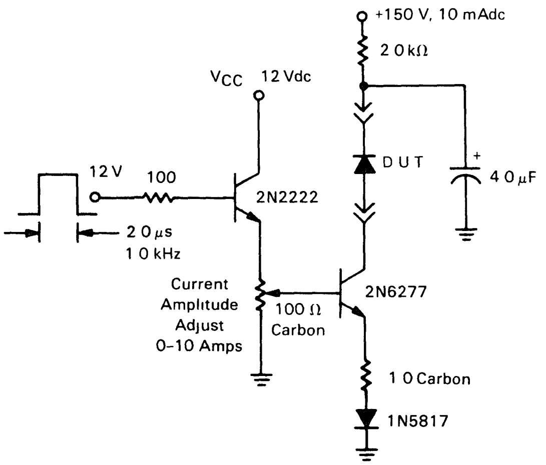
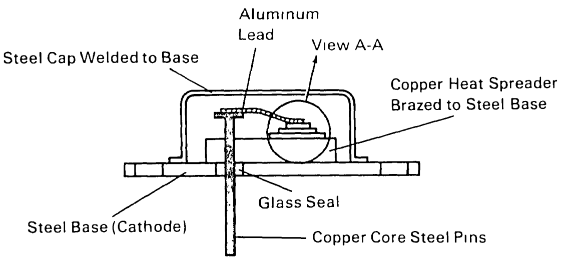
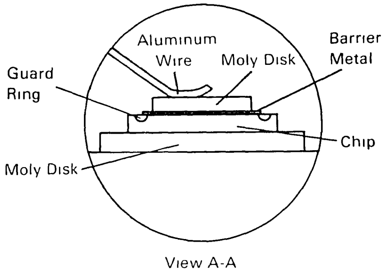


FIGURE 9 — SCHOTTKY RECTIFIER



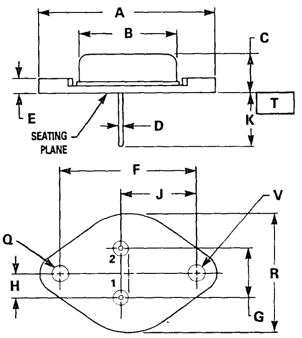


Motorola builds quality and reliability into its Schottky Rectifiers

First is the chip, which has an interface metal between the platinum-barrier metal and nickel-gold ohmic-contact metal to eliminate any possible interaction with the barrier The indicated guardring prevents dv/dt problems, so snubbers are not required The guardring also operates like a zener to absorb over-voltage transients

Second is the package There are molybdenum disks which closely match the thermal coefficient of expansion of silicon on each side of the chip The pin-to-chip aluminum leadwire provides stress relief These two features give the unit the capability of passing stringent thermal fatigue tests for 5,000 cycles Copper-core steel pins match the expansion coefficient of the glass and are long enough (0 440 in min) to reach through a heat sink to a printed circuit board

Third is the redundant electrical testing The device is tested before assembly in "sandwich" form, with the chip between the moly disks It is tested again after assembly As part of the final electrical test, devices are 100% tested for dv/dt at 1,600 V/μs and reverse avalanche



MECHANICAL CHARACTERISTICS

CASE Welded, hermetically sealed

FINISH: All external surfaces corrosion resistant and terminal lead is readily solderable

POLARITY: Cathode to Case

MOUNTING POSITION. Any

	MILLIMETERS		INCHES	
DIM	MIN	MAX	MIN	MAX
A	–	39 37	–	1 550
B	–	22.23	–	0 875
C	6 35	11 43	0 250	0 450
D	0 97	1 09	0 038	0 043
E	–	3 43	–	0 135
F	30 15 BSC		1 187 BSC	
G	10 92 BSC		0 430 BSC	
H	5 46 BSC		0 215 BSC	
J	16 89 BSC		0.665 BSC	
K	11 18	12 19	0 440	0.480
Q	3 84	4 09	0.151	0 161
R	–	26 67	–	1 050
V	3.84	4 09	0 151	0 161

NOTES
1 DIAMETERS Q, V AND SURFACE T ARE DATUMS
2 POSITIONAL TOLERANCE FOR HOLE Q
⊕ | ∅ 0 25 (0 010) Ⓜ | T | V Ⓜ
3 POSITIONAL TOLERANCE FOR LEADS
⊕ | ∅ 0 30 (0 012) Ⓜ | T | V Ⓜ | Q Ⓜ
4 DIMENSIONING AND TOLERANCING PER ANSI Y14 5, 1973

STYLE 4
PIN 1 ANODE 1
2 ANODE 2
CASE COMMON CATHODE

CASE 11-03
TO-204AA
METAL

MOTOROLA
SEMICONDUCTOR
TECHNICAL DATA

MBR3035PT
MBR3045PT

3

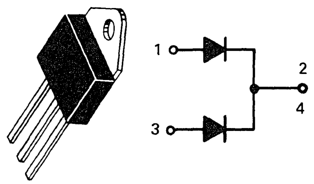
SWITCHMODE POWER RECTIFIERS

. . using the Schottky Barrier principle with a platinum barrier metal These state-of-the-art devices have the following features.

- Dual Diode Construction — Terminals 1 and 3 May Be Connected For Parallel Operation At Full Rating
- Guardring For Stress Protection
- Low Forward Voltage
- 150°C Operating Junction Temperature
- Guaranteed Reverse Avalanche

SCHOTTKY BARRIER RECTIFIERS

30 AMPERES
35 to 45 VOLTS



RATINGS

Rating		Symbol	Maximum	Unit
Peak Repetitive Reverse Voltage Working Peak Reverse Voltage DC Blocking Voltage	MBR3035PT MBR3045PT	V_{RRM} V_{RWM} V_R	35 45	Volts
Average Rectified Forward Current (Rated V_R) T_C = 105°C	Per Device Per Diode	$I_{F(AV)}$	30 15	Amps
Peak Repetitive Forward Current, Per Diode (Rated V_R, Square Wave, 20 kHz)		I_{FRM}	30	Amps
Nonrepetitive Peak Surge Current (Surge Applied at rated load conditions halfwave, single phase, 60 Hz)		I_{FSM}	200	Amps
Peak Repetitive Reverse Current, Per Diode (2 0 μs, 1 0 kHz) See Figure 6		I_{RRM}	2 0	Amps
Operating Junction Temperature		T_J	-65 to +150	°C
Storage Temperature		T_{stg}	-65 to +175	°C
Peak Surge Junction Temperature (Forward Current Applied)		$T_{J(pk)}$	175	°C
Voltage Rate of Change (Rated V_R)		dv/dt	1000	V/μs

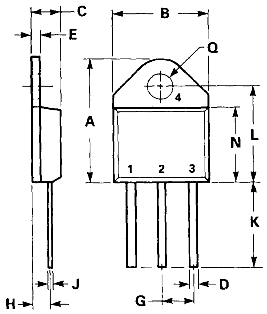
THERMAL CHARACTERISTICS PER DIODE

Thermal Resistance, Junction to Case	$R_{\theta JC}$	1 4	°C/W
Thermal Resistance, Junction to Ambient	$R_{\theta JA}$	40	°C/W

ELECTRICAL CHARACTERISTICS PER DIODE

Instantaneous Forward Voltage (1) (i_F = 20 Amp, T_C = 125°C) (i_F = 30 Amp, T_C = 125°C) (i_F = 30 Amp, T_C = 25°C)	v_F	 0 60 0 72 0 76	Volts
Instantaneous Reverse Current (1) (Rated dc Voltage, T_C = 125°C) (Rated dc Voltage, T_C = 25°C)	i_R	 100 1.0	mA

(1) Pulse Test Pulse Width = 300 μs, Duty Cycle ≤ 2 0%



NOTES
1. DIMENSIONING AND TOLERANCING PER ANSI Y14 5M, 1982
2. CONTROLLING DIMENSION INCH

	MILLIMETERS		INCHES	
DIM	MIN	MAX	MIN	MAX
A	20 32	21 08	0 800	0 830
B	15 49	15 90	0 610	0 626
C	4 19	5 08	0 165	0 200
D	1 02	1 65	0 040	0 065
E	1 35	1 65	0 053	0 065
G	5 21	5 72	0 205	0 225
H	2 65	2 94	0 104	0 116
J	0 38	0 64	0 015	0 025
K	12 70	15 49	0 500	0 610
L	15 88	16 51	0 625	0 650
N	12 19	12 70	0 480	0 500
Q	4 04	4 22	0 159	0 166

CASE 340-02
TO-218AC
PLASTIC

FIGURE 1 — TYPICAL FORWARD VOLTAGE

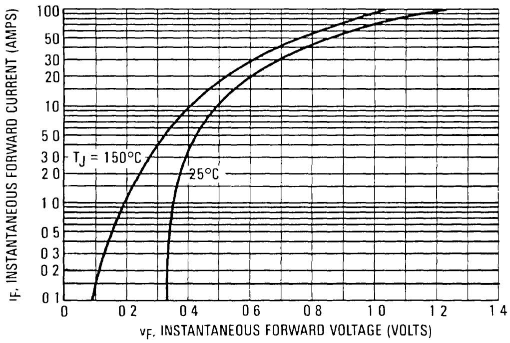
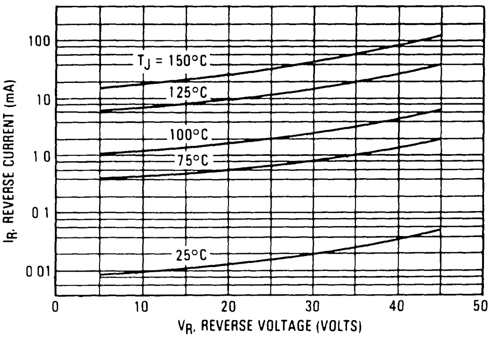


FIGURE 2 — TYPICAL REVERSE CURRENT



3

FIGURE 3 — CURRENT DERATING PER LEG

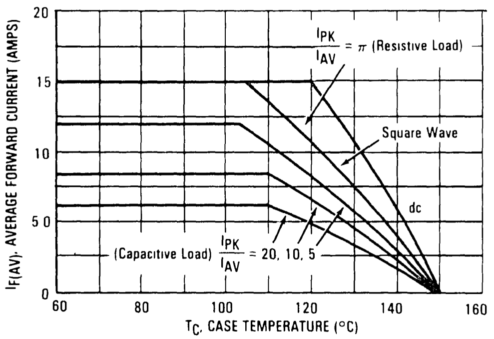


FIGURE 4 — FORWARD POWER DISSIPATION PER LEG

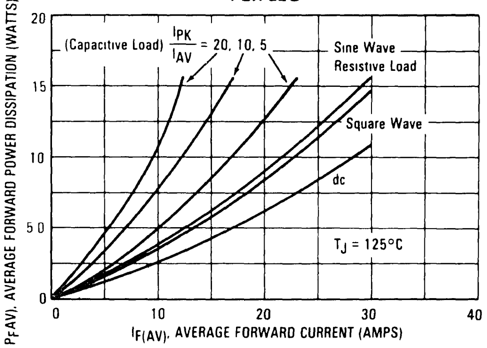


FIGURE 5 — CAPACITANCE

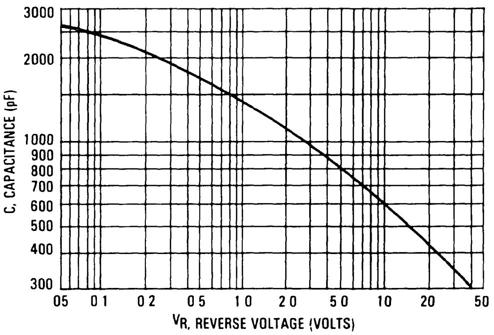
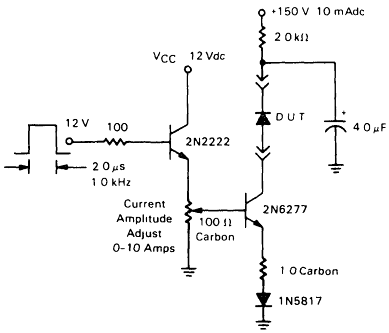


FIGURE 6 — TEST CIRCUIT FOR REPETITIVE REVERSE CURRENT



MOTOROLA
SEMICONDUCTOR
TECHNICAL DATA

MBR3520
MBR3535
MBR3545, H, H1

SWITCHMODE POWER RECTIFIERS

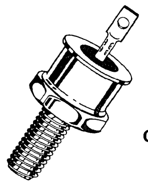
using a platinum barrier metal in a large area metal-to-silicon power diode State-of-the-art geometry features epitaxial construction with oxide passivation and metal overlap contact Ideally suited for use as rectifiers in low-voltage, high-frequency inverters, free-wheeling diodes, and polarity-protection diodes

- Guardring for dv/dt Stress Protection
- Guaranteed Reverse Surge Current/Avalanche
- 150°C Operating Junction Temperature

3

SCHOTTKY BARRIER RECTIFIERS

35 AMPERES
20 to 45 VOLTS



CASE 56-03
DO-203AA
METAL

MAXIMUM RATINGS

Rating	Symbol	MBR3520	MBR3535	MBR3545, H, H1*	Unit
Peak Repetitive Reverse Voltage Working Peak Reverse Voltage DC Blocking Voltage	V_{RRM} V_{RWM} V_R	20	35	45	Volts
Peak Repetitive Forward Current (Rated V_R, Square Wave, 20 kHz, T_C = 110°C)	I_{FRM}	← 70 →			Amps
Average Rectified Forward Current (Rated V_R, T_C = 110°C)	$I_{F(AV)}$	← 35 →			Amps
Peak Repetitive Reverse Surge Current (2 0 μs, 1 0 kHz) See Figure 8	I_{RRM}	← 2 0 →			Amps
Nonrepetitive Peak Surge Current (Surge applied at rated load conditions halfwave, single phase, 60 Hz)	I_{FSM}	← 600 →			Amps
Operating Junction Temperature	T_J	← -65 to + 150 →			°C
Storage Temperature	T_{stg}	← -65 to +175 →			°C
Voltage Rate of Change (Rated V_R)	dv/dt	← 1000 →			V/μs

THERMAL CHARACTERISTICS

Characteristic	Symbol	Typ	Max	Unit
Thermal Resistance, Junction-to-Case	$R_{\theta JC}$	1 3	1 5	°C/W

ELECTRICAL CHARACTERISTICS PER DIODE

Characteristic	Symbol	Typ	Max	Unit
Instantaneous Forward Voltage (1) (i_F = 35 Amp, T_C = 125°C) (i_F = 35 Amp, T_C = 25°C) (i_F = 70 Amp, T_C = 125°C)	v_F	 0 49 0 55 0 60	 0 55 0 63 0 69	Volts
Instantaneous Reverse Current (1) (Rated Voltage, T_C = 125°C) (Rated Voltage, T_C = 25°C)	i_R	 60 0 1	 100 0 3	mA
Capacitance (V_R = 1 0 Vdc, 100 kHz > f > 1.0 MHz, T_C = 25°C)	C_t	3000	3700	pF

*H and H1 devices include extra testing See Figure 10
(1) Pulse Test Pulse Width = 300 μs, Duty Cycle = 2 0%

FIGURE 1 — MAXIMUM FORWARD VOLTAGE

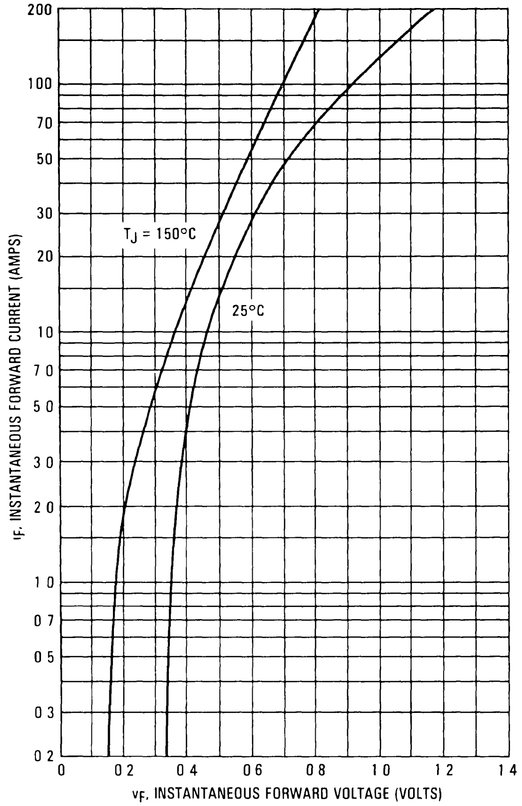


FIGURE 2 — MAXIMUM REVERSE CURRENT

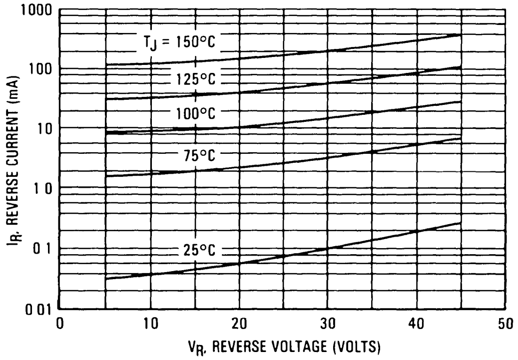


FIGURE 3 — MAXIMUM SURGE CAPABILITY

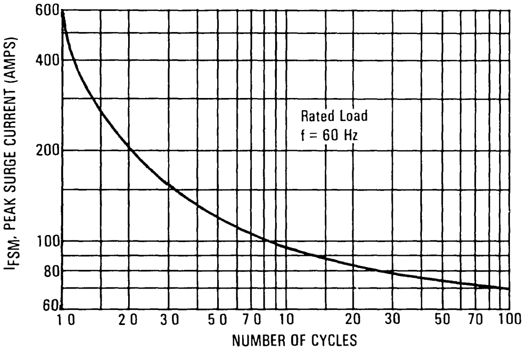


FIGURE 4 — CURRENT DERATING

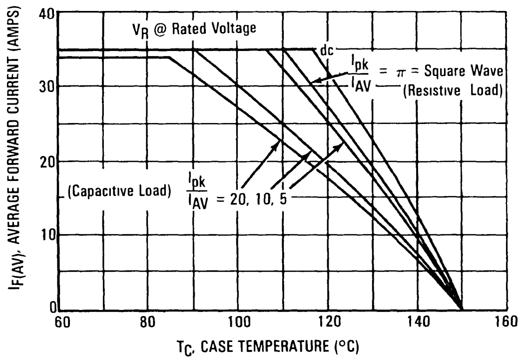


FIGURE 5 — POWER DISSIPATION

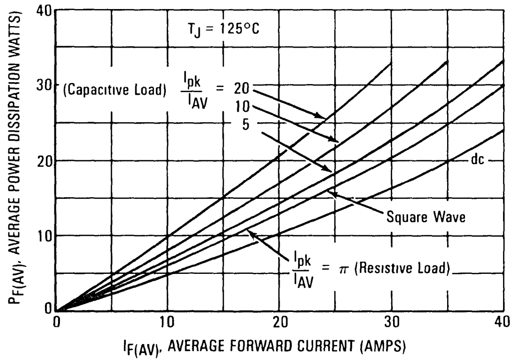
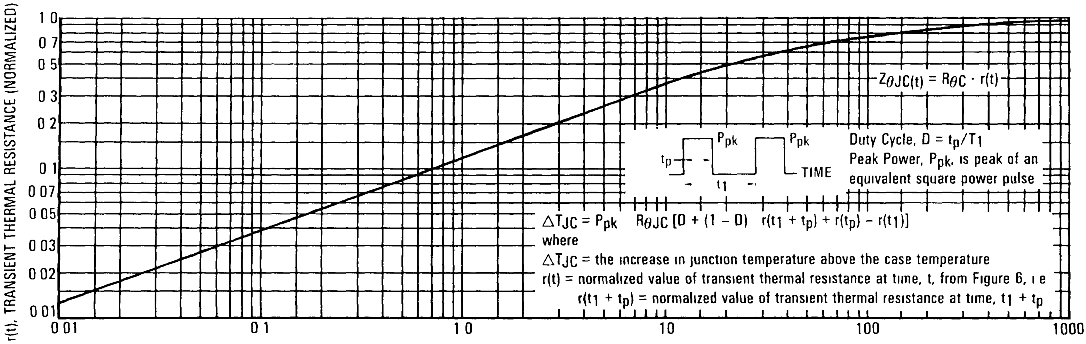


FIGURE 6 — THERMAL RESPONSE



HIGH FREQUENCY OPERATION

Since current flow in a Schottky rectifier is the result of majority carrier conduction, it is not subject to junction diode forward and reverse recovery transients due to minority carrier injection and stored charge Satisfactory circuit analysis work may be performed by using a model consisting of an ideal diode in parallel with a variable capacitance (See Figure 7)

Rectification efficiency measurements show that operation will be satisfactory up to several megahertz For example, relative waveform rectification efficiency is approximately 70 per cent at 2 0 MHz, e g , the ratio of dc power to RMS power in the load is 0 28 at this frequency, whereas perfect rectification would yield 0 406 for sine wave inputs However, in contrast to ordinary junction diodes, the loss in waveform efficiency is not indicative of power loss, it is simply a result of reverse current flow through the diode capacitance, which lowers the dc output voltage

FIGURE 7 — CAPACITANCE

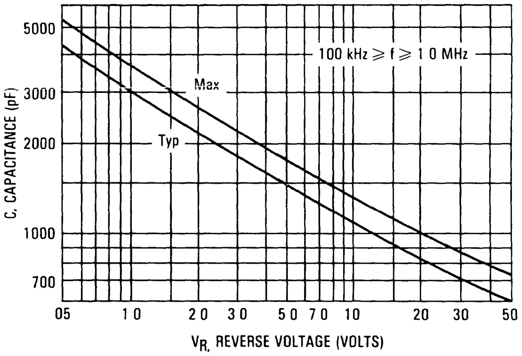
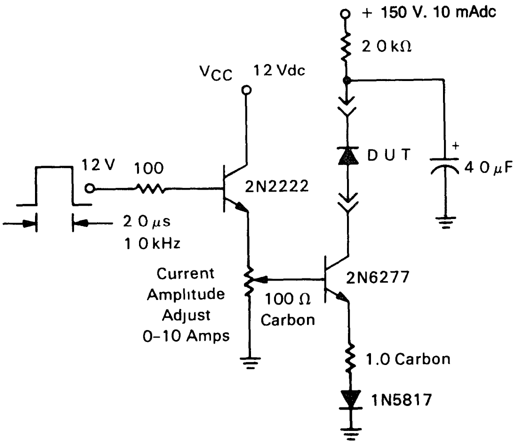
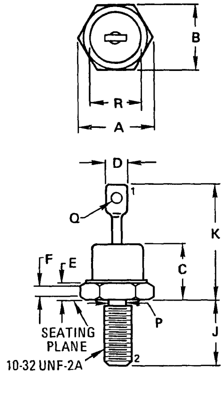


FIGURE 8 — TEST CIRCUIT FOR dv/dt AND REVERSE SURGE CURRENT





DIM	MILLIMETERS		INCHES	
	MIN	MAX	MIN	MAX
A	11.94	12 83	0 470	0 505
B	10.77	11 10	0 424	0 437
C	–	10.29	–	0.405
D	–	6.35	–	0.250
E	1 91	4.45	0.075	0.175
F	1.52	–	0.060	–
J	10.72	11.51	0 422	0.453
K	–	20.32	–	0.800
P	4.14	4.80	0.163	0.189
Q	1.52	–	0.060	–
R	–	10.77	–	0.424

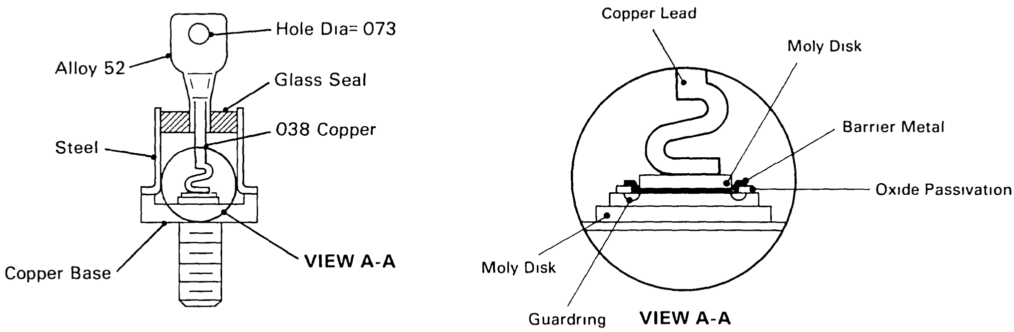
All JEDEC dimensions and notes apply

STYLE 2
TERM 1 ANODE
2 CATHODE

CASE 56-03
DO-203AA
METAL

MOUNTING TORQUE: 15 in-lb max

FIGURE 9 — SCHOTTKY RECTIFIER



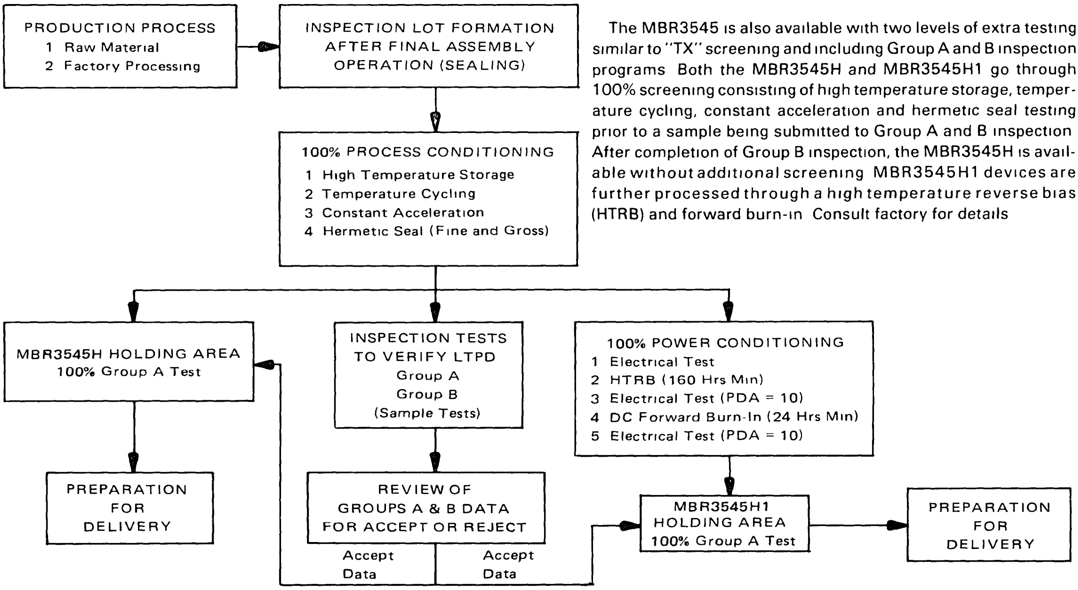
Motorola builds quality and reliability into its Schottky Rectifiers First is the chip, which has an interface metal between the platinum-barrier metal and nickel-gold ohmic-contact metal to eliminate any possible interaction with the barrier The indicated guardring prevents dv/dt problems, so snubbers are not mandatory The guardring also operates like a zener to absorb overvoltage transients

Second is the package There are molybdenum disks which closely match the thermal coefficient of expansion of silicon on each side of the chip The top copper lead is also stress-relieted to prevent damage during assembly These two features give the unit the capability of passing powered thermal fatigue tests for 5,000 cycles The top copper lead provides a low resistance to current and therefore does not contribute to device heating, a heat sink should be used when attaching wires

Third is the redundant electrical testing The device is tested before assembly in "sandwich" form, with the chip between the moly disks It is tested again after assembly As part of the final electrical test, devices are 100% tested for dv/dt at 1,600 V/μs and reverse avalanche Devices are also 100% reverse scope tested for trace anomalies

FIGURE 10 — HI-REL PROGRAM OPTIONS

The MBR3545 is also available with two levels of extra testing similar to "TX" screening and including Group A and B inspection programs Both the MBR3545H and MBR3545H1 go through 100% screening consisting of high temperature storage, temperature cycling, constant acceleration and hermetic seal testing prior to a sample being submitted to Group A and B inspection After completion of Group B inspection, the MBR3545H is available without additional screening MBR3545H1 devices are further processed through a high temperature reverse bias (HTRB) and forward burn-in Consult factory for details



3

MOTOROLA
SEMICONDUCTOR
TECHNICAL DATA

MBR5825, H, H1
See Page 3-55
MBR5831, H, H1
See Page 3-64

MBR6015L
MBR6020L
MBR6025L
MBR6030L

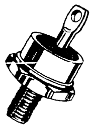
Switchmode Power Rectifiers

. . . using a platinum barrier metal in a large area metal-to-silicon power diode. State-of-the-art geometry features epitaxial construction with oxide passivation and metal overlap contact. Ideally suited for use as rectifiers in low-voltage, high frequency inverters, free-wheeling diodes, and polarity-protection diodes.

- Guaranteed Reverse Avalanche
- Guardring for dv/dt Stress Protection
- 175°C Operating Junction Temperature
- Extremely Low Forward Voltage

3

SCHOTTKY RECTIFIERS
60 AMPERES
15 TO 30 VOLTS



CASE 257-01
DO-203AB
METAL

MAXIMUM RATINGS

Rating		Symbol	Value	Unit
Peak Repetitive Reverse Voltage Working Peak Reverse Voltage DC Blocking Voltage	MBR6015L MBR6020L MBR6025L MBR6030L	V_{RRM} V_{RWM} V_R	15 20 25 30	Volts
Peak Repetitive Forward Current (Rated V_R, Square Wave, 20 kHz) T_C = 90°C		I_{FRM}	150	Amps
Average Rectified Forward Current (Rated V_R) T_C = 120°C		I_O	60	Amps
Peak Repetitive Reverse Surge Current (2 μs, 1 kHz) See Figure 7		I_{RRM}	2	Amps
Nonrepetitive Peak Surge Current (Surge applied at rated load conditions halfwave, single phase, 60 Hz)		I_{FSM}	1000	Amps
Operating Junction Temperature		T_J	−65 to +150	°C
Storage Temperature Range		T_{stg}	−65 to +175	°C
Voltage Rate of Change (Rated V_R)		dv/dt	1000	V/μs

THERMAL CHARACTERISTICS

Maximum Thermal Resistance, Junction to Case	$R_{\theta JC}$	0.8	°C/W

ELECTRICAL CHARACTERISTICS

Maximum Instantaneous Forward Voltage (1) (i_F = 30 Amps, T_C = 25°C) (i_F = 60 Amps, T_C = 25°C) (i_F = 30 Amps, T_C = 150°C) (i_F = 60 Amps, T_C = 150°C)	v_F	 0.42 0.48 0.30 0.38	Volts
Maximum Instantaneous Reverse Current (1) (Rated Voltage, T_C = 25°C) (Rated Voltage, T_C = 125°C)	i_R	 50 280	mA
Capacitance (V_R = 1 Vdc, 100 kHz ≤ f ≤ 1 MHz)	C_t	6000	pF

(1) Pulse Test: Pulse Width ≤ 300 μs, Duty Cycle ≤ 2%.

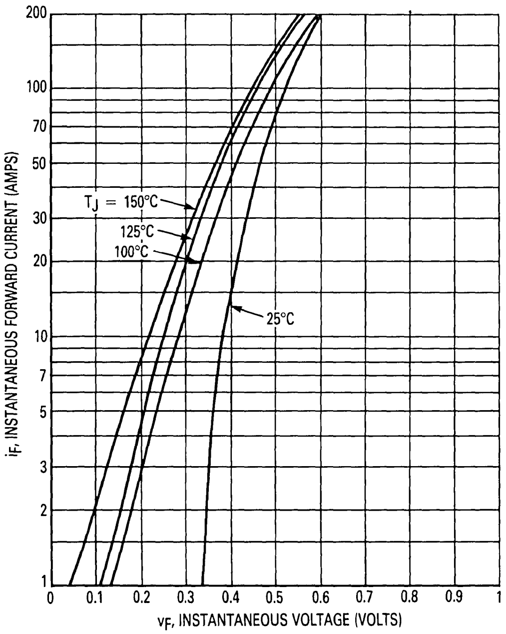


Figure 1. Typical Forward Voltage

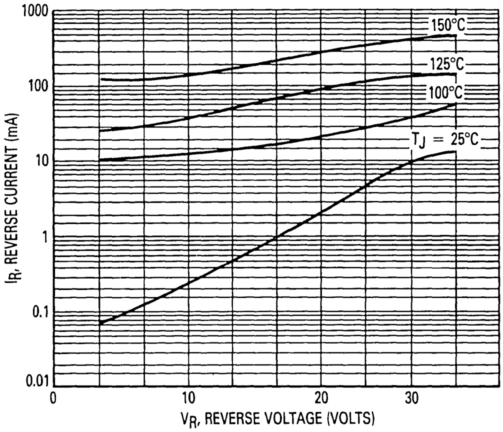


Figure 2. Typical Reverse Current*

*The curves shown are typical for the highest voltage device in the voltage grouping. Typical reverse current for lower voltage selections can be estimated from these same curves if V_R is sufficiently below rated V_R.

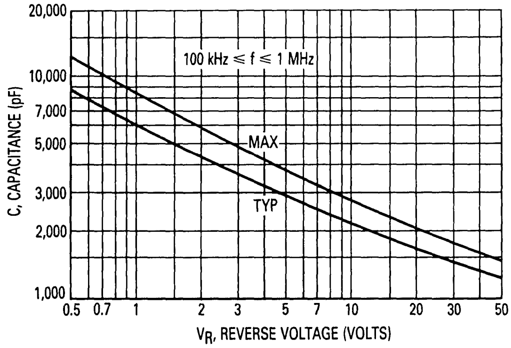


Figure 3. Capacitance

NOTE 1

HIGH FREQUENCY OPERATION

Since current flow in a Schottky rectifier is the result of majority carrier conduction, it is not subject to junction diode forward and reverse recovery transients due to minority carrier injection and stored charge. Satisfactory circuit analysis work may be performed by using a model consisting of an ideal diode in parallel with a variable capacitance. (See Figure 4.)

Rectification efficiency measurements show that operation will be satisfactory up to several megahertz. For example, relative waveform rectification efficiency is approximately 70 percent at 2 MHz, e.g., the ratio of dc power to RMS power in the load is 0.28 at this frequency, whereas perfect rectification would yield 0.406 for sine wave inputs. However, in contrast to ordinary junction diodes, the loss in waveform efficiency is not indicative of power loss; it is simply a result of reverse current flow through the diode capacitance, which lowers the dc output voltage.

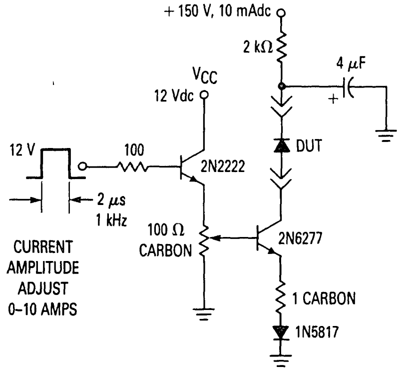


Figure 4. Test Circuit for dv/dt and Reverse Surge Current

3

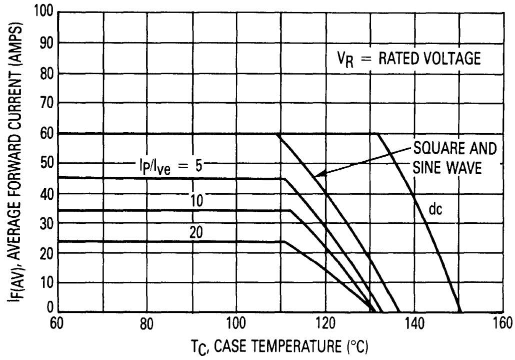


Figure 5. Forward Current Derating

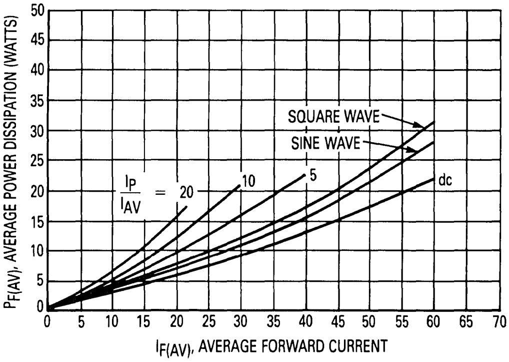
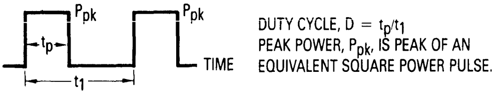


Figure 6. Power Dissipation

NOTE 2



To determine maximum junction temperature of the diode in a given situation, the following procedure is recommended:

The temperature of the case should be measured using a thermocouple placed on the case. The thermal mass connected to the case is normally large enough so that it will not significantly respond to heat surges generated in the diode as a result of pulsed operation once steady-state conditions are achieved. Using the measured value of T_C, the junction temperature may be determined by:

$$T_J = T_C + \Delta T_{JC}$$

where ΔT_C is the increase in junction temperature above the case temperature. It may be determined by:

$$\Delta T_{JC} = P_{pk} \cdot R_{\theta JC}[D + (1 - D) \cdot r(t_1 + t_p) + r(t_p) - r(t_1)]$$

where

$r(t)$ = normalized value of transient thermal resistance at time, t, from Figure 7, i.e.:

$r(t_1 - t_p)$ = normalized value of transient thermal resistance at time $t_1 + t_p$.

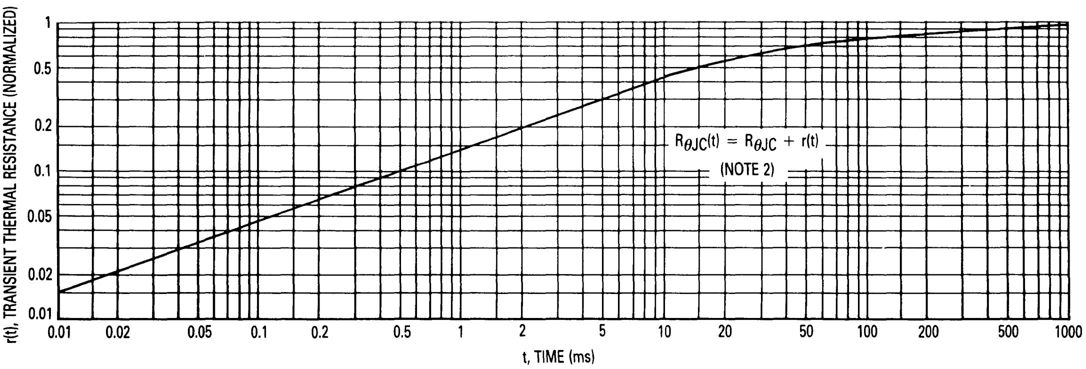
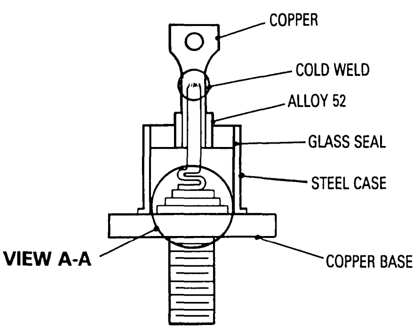
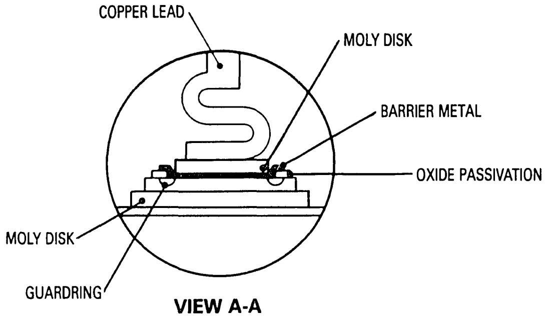


Figure 7. Thermal Response





Motorola builds quality and reliability into its Schottky Rectifiers.

First is the chip, which has an interface metal between the platinum-barrier metal and nickel-gold ohmic-contact metal to eliminate any possible interaction with the barrier. The indicated guardring prevents dv/dt problems, so snubbers are not mandatory. The guardring also operates like a zener to absorb overvoltage transients.

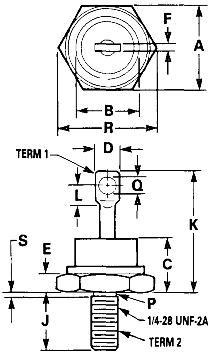
Second is the package. There are molybdenum disks which closely match the thermal coefficient of expansion of silicon on each side of the chip. The top copper lead has a stress relief feature which protects the die during assembly. These two features give the unit the capability of passing stringent thermal fatique tests for 5,000 cycles. The top copper lead provides a low resistance to current and therefore does not contribute to device heating; a heat sink should be used when attaching wires.

Third is the redundant electrical testing. The device is tested before assembly in "sandwich" form, with the chip between the moly disks. It is tested again after assembly. As part of the final electrical test, devices are 100% tested for dv/dt at 1,600 V/μs and reverse avalanche.

Figure 8. Schottky Rectifier

3

OUTLINE DIMENSIONS



	MILLIMETERS		INCHES	
DIM	MIN	MAX	MIN	MAX
A	16.94	17.45	0.669	0.687
B	—	16.94	—	0.667
C	—	11.43	—	0.450
D	—	9.53	—	0.375
E	2.92	5.08	0.115	0.200
F	—	2.03	—	0.080
J	10.72	11.51	0.422	0.453
K	—	25.40	—	1.000
L	3.86	—	0.156	—
P	5.59	6.32	0.220	0.249
Q	3.56	4.45	0.140	0.175
R	—	20.16	—	0.794
S	—	2.26	—	0.089

STYLE 2.
TERM.1. ANODE
2. CATHODE (CASE)

CASE 257-01
DO-203AB
METAL

NOTES.
1. DIM "P" IS DIA.
2. CHAMFER OR UNDERCUT ON ONE OR BOTH ENDS OF HEXAGONAL BASE IS OPTIONAL
3. ANGULAR ORIENTATION AND CONTOUR OF TERMINAL ONE IS OPTIONAL
4. THREADS ARE PLATED
5. DIMENSIONING AND TOLERANCING PER ANSI Y14.5, 1973

MECHANICAL CHARACTERISTICS

CASE: Welded, hermetically sealed
FINISH: All external surfaces corrosion resistant and terminal lead is readily solderable
POLARITY: Cathode-to-Case
MOUNTING POSITION: Any
MOUNTING TORQUE: 25 in-lb max
SOLDER HEAT: The excellent heat transfer property of the heavy duty copper anode terminal which transmits heat away from the die requires that caution be used when attaching wires. Motorola suggests a heat sink be clamped between the eyelet and the body during any soldering operation.

MOTOROLA
SEMICONDUCTOR
TECHNICAL DATA

MBR6035
MBR6045, H, H1

SWITCHMODE POWER RECTIFIERS

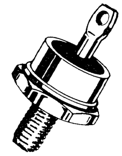
using a platinum barrier metal in a large area metal-to-silicon power diode State-of-the-art geometry features epitaxial construction with oxide passivation and metal overlap contact Ideally suited for use as rectifiers in low-voltage, high-frequency inverters, free-wheeling diodes, and polarity-protection diodes

- Guaranteed Reverse Avalanche
- Guardring for dv/dt Stress Protection
- 150°C Operating Junction Temperature
- Low Forward Voltage

3

SCHOTTKY RECTIFIERS

60 AMPERES
35 AND 45 VOLTS



CASE 257-01
DO-203AB
METAL

MAXIMUM RATINGS

Rating	Symbol	MBR6035 MBR6035B	MBR6045, H, H1* MBR6045B	Unit
Peak Repetitive Reverse Voltage Working Peak Reverse Voltage DC Blocking Voltage	V_{RRM} V_{RWM} V_R	35	45	Volts
Peak Repetitive Forward Current (Rated V_R, Square Wave, 20 kHz) T_C = 100°C	I_{FRM}	← 120 →		Amps
Average Rectified Forward Current (Rated V_R) T_C = 100°C	I_O	← 60 →		Amps
Peak Repetitive Reverse Surge Current (2 0 μs, 1 0 kHz) See Figure 7	I_{RRM}	← 2 0 →		Amps
Nonrepetitive Peak Surge Current (Surge applied at rated load conditions halfwave, single phase, 60 Hz)	I_{FSM}	← 800 →		Amps
Operating Junction Temperature	T_J	← -65 to + 150 →		°C
Storage Temperature	T_{stg}	← -65 to +175 →		°C
Voltage Rate of Change (Rated V_R)	dv/dt	← 1000 →		V/μs

THERMAL CHARACTERISTICS

Characteristic	Symbol	Typ	Max	Unit
Thermal Resistance, Junction-to-Case	$R_{\theta JC}$	0 85	1 0	°C/W

ELECTRICAL CHARACTERISTICS

Characteristic	Symbol	Typ	Max	Unit
Instantaneous Forward Voltage (1) (i_F = 60 Amp, T_C = 25°C) (i_F = 60 Amp, T_C = 125°C) (i_F = 120 Amp, T_C = 125°C)	v_F	 0 65 0 57 0.70	 0 70 0 60 0 76	Volts
Instantaneous Reverse Current (1) (Rated Voltage, T_C = 25°C) (Rated Voltage, T_C = 125°C)	i_R	 0 1 55	 0 3 100	mA
Capacitance (V_R = 1 0 Vdc, 100 kHz ≤ 1 0 MHz)	C_t	3000	3700	pF

*H and H1 devices include extra testing
(1) Pulse Test Pulse Width = 300 μs, Duty Cycle = 2 0%

FIGURE 1 — TYPICAL FORWARD VOLTAGE

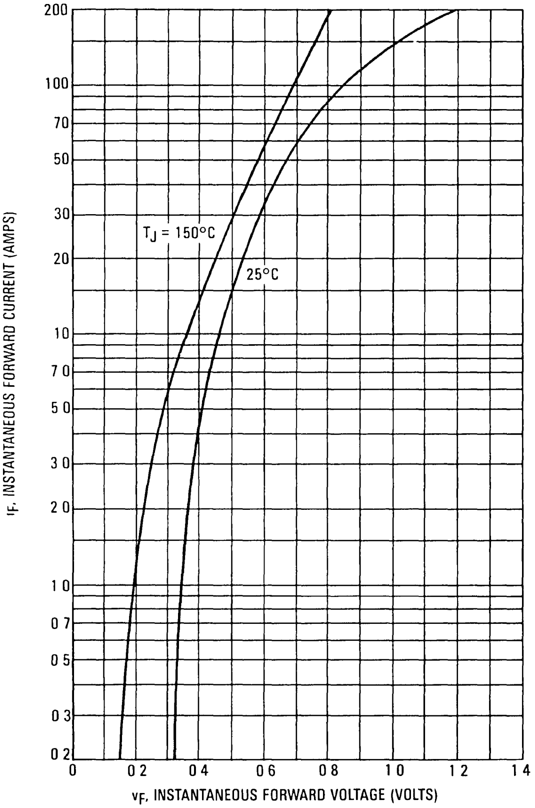


FIGURE 2 — TYPICAL REVERSE CURRENT

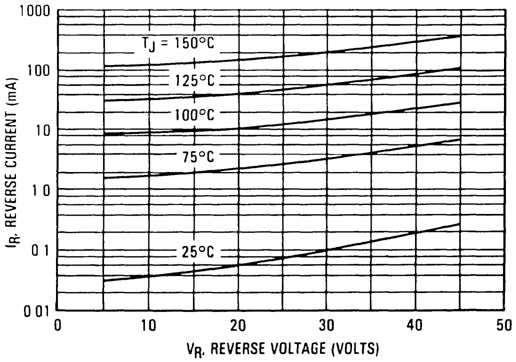
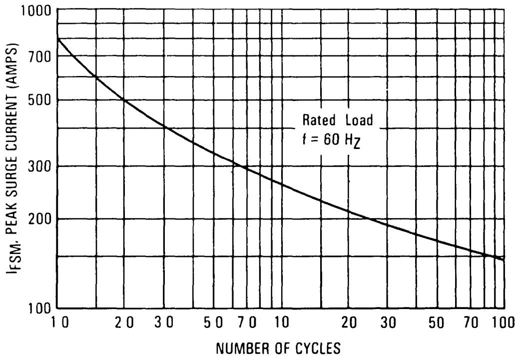


FIGURE 3 — MAXIMUM SURGE CAPABILITY



NOTE 1
HIGH FREQUENCY OPERATION

Since current flow in a Schottky rectifier is the result of majority carrier conduction, it is not subject to junction diode forward and reverse recovery transients due to minority carrier injection and stored charge Satisfactory circuit analysis work may be performed by using a model consisting of an ideal diode in parallel with a variable capacitance (See Figure 4)

Rectification efficiency measurements show that operation will be satisfactory up to several megahertz For example, relative waveform rectification efficiency is approximately 70 per cent at 2 0 MHz, e g , the ratio of dc power to RMS power in the load is 0 28 at this frequency, whereas perfect rectification would yield 0 406 for sine wave inputs However, in contrast to ordinary junction diodes, the loss in waveform efficiency is not indicative of power loss; it is simply a result of reverse current flow through the diode capacitance, which lowers the dc output voltage.

FIGURE 4 — CAPACITANCE

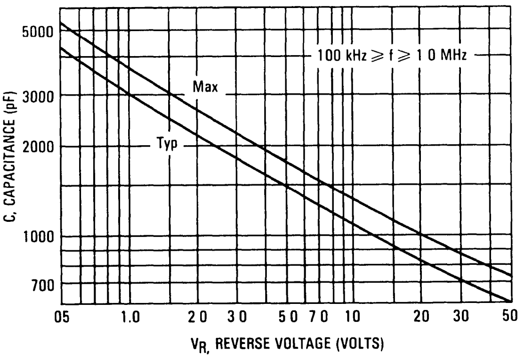


FIGURE 5 — FORWARD CURRENT DERATING

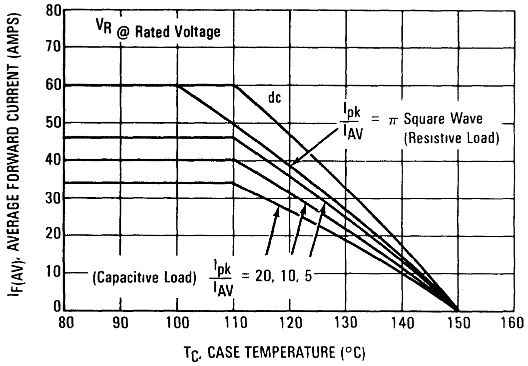
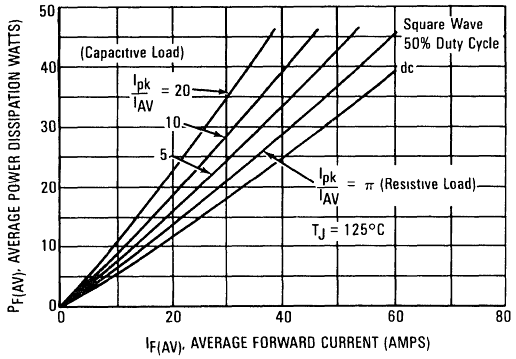
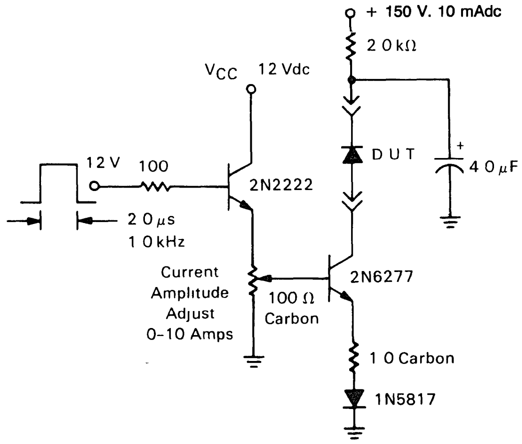


FIGURE 6 — POWER DISSIPATION

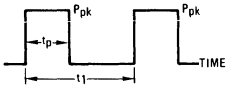


3

FIGURE 7 — TEST CIRCUIT FOR dv/dt AND REVERSE SURGE CURRENT



NOTE 2



DUTY CYCLE, $D = t_p/t_1$
PEAK POWER, P_{pk}, is peak of an equivalent square power pulse

To determine maximum junction temperature of the diode in a given situation, the following procedure is recommended

The temperature of the case should be measured using a thermocouple placed on the case The thermal mass connected to the case is normally large enough so that it will not significantly respond to heat surges generated in the diode as a result of pulsed operation once steady-state conditions are achieved Using the measured value of T_C, the junction temperature may be determined by

$$T_J = T_C + \Delta T_{JC}$$

where ΔT_C is the increase in junction temperature above the case temperature It may be determined by

$\Delta T_{JC} = P_{pk} \cdot R_{\theta JC}[D + (1 - D) \cdot r(t_1 + t_p) + r(t_p) - r(t_1)]$ where

$r(t)$ = normalized value of transient thermal resistance at time, t, from Figure 8, i e

$r(t_1 + t_p)$ = normalized value of transient thermal resistance at time $t_1 + t_p$

FIGURE 8 — THERMAL RESPONSE

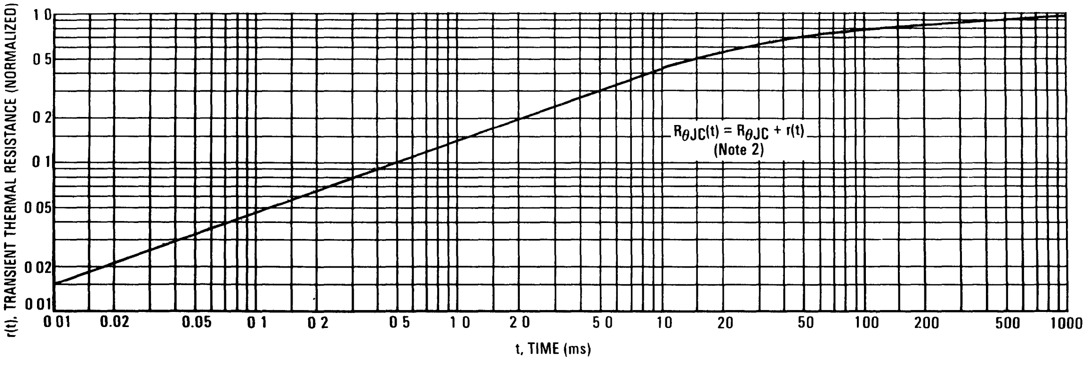
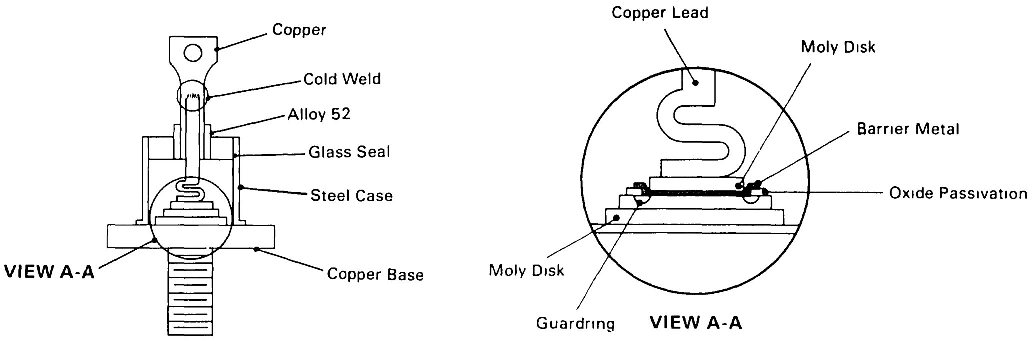


FIGURE 9 — SCHOTTKY RECTIFIER



Motorola builds quality and reliability into its Schottky Rectifiers First is the chip, which has an interface metal between the platinum-barrier metal and nickel-gold ohmic-contact metal to eliminate any possible interaction with the barrier The indicated guardring prevents dv/dt problems, so snubbers are not mandatory The guardring also operates like a zener to absorb overvoltage transients

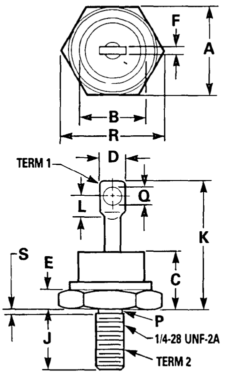
Second is the package There are molybdenum disks which closely match the thermal coefficient of expansion of silicon on each side of the chip The top copper lead has a stress relief feature which protects the die during assembly These two features give the unit the capability of passing stringent thermal fatigue tests for 5,000 cycles The top copper lead provides a low resistance to current and therefore does not contribute to device heating, a heat sink should be used when attaching wires

Third is the redundant electrical testing The device is tested before assembly in "sandwich" form, with the chip between the moly disks It is tested again after assembly As part of the final electrical test, devices are 100% tested for dv/dt at 1,600 V/μs and reverse avalanche

3

HI-REL PROGRAM OPTIONS

The MBR6045 is also available with two levels of extra testing similar to "TX" screening and including Group A and B inspection programs Both the MBR6045H and MBR6045H1 go through 100% screening consisting of high temperature storage, temperature cycling, constant acceleration and hermetic seal testing prior to a sample being submitted to Group A and B inspection After completion of Group B inspection, the MBR6045H is available without additional screening MBR6045H1 devices are further processed through a high temperature reverse bias (HTRB) and forward burn-in Consult factory for details



NOTES.
1. DIM "P" IS DIA.
2. CHAMFER OR UNDERCUT ON ONE OR BOTH ENDS OF HEXAGONAL BASE IS OPTIONAL.
3. ANGULAR ORIENTATION AND CONTOUR OF TERMINAL ONE IS OPTIONAL.
4. THREADS ARE PLATED.
5. DIMENSIONING AND TOLERANCING PER ANSI Y14.5, 1973

	MILLIMETERS		INCHES	
DIM	MIN	MAX	MIN	MAX
A	16.94	17.45	0.669	0.687
B	—	16 94	—	0.667
C	—	11.43	—	0.450
D	—	9.53	—	0.375
E	2.92	5.08	0.115	0 200
F	—	2.03	—	0.080
J	10 72	11 51	0 422	0 453
K	—	25.40	—	1.000
L	3.86	—	0.156	—
P	5.59	6.32	0.220	0.249
Q	3.56	4.45	0.140	0.175
R	—	20.16	—	0.794
S	—	2.26	—	0.089

MECHANICAL CHARACTERISTICS

CASE: Welded, hermetically sealed

FINISH All external surfaces corrosion resistant and terminal lead is readily solderable

POLARITY· Cathode-to-Case

MOUNTING POSITION: Any

MOUNTING TORQUE: 25 in-lb max

SOLDER HEAT The excellent heat transfer property of the heavy duty copper anode terminal which transmits heat away from the die requires that caution be used when attaching wires Motorola suggests a heat sink be clamped between eyelet and the body during any soldering operation.

CASE 257-01
DO-203AB
METAL

MOTOROLA
SEMICONDUCTOR
TECHNICAL DATA

MBR6535
MBR6545

3

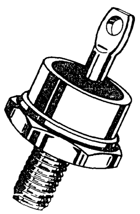
SWITCHMODE POWER RECTIFIERS

. using a platinum barrier metal in a large area metal-to-silicon power diode State-of-the-art geometry features epitaxial construction with oxide passivation and metal overlap contact. Ideally suited for use as rectifiers in low-voltage, high frequency inverters, free-wheeling diodes, and polarity-protection diodes

- Guaranteed Reverse Avalanche
- Guardring for dv/dt Stress Protection
- 175°C Operating Junction Temperature
- Low Forward Voltage

HIGH TEMPERATURE SCHOTTKY RECTIFIERS

65 AMPERES
35 and 45 VOLTS



CASE 257-01
DO-203AB
METAL

MAXIMUM RATINGS

Rating	Symbol	MBR6535	MBR6545	Unit
Peak Repetitive Reverse Voltage Working Peak Reverse Voltage DC Blocking Voltage	V_{RRM} V_{RWM} V_R	35	45	Volts
Peak Repetitive Forward Current (Rated V_R, Square Wave, 20 kHz) T_C = 120°C	I_{FRM}	130	130	Amps
Average Rectified Forward Current (Rated V_R) T_C = 120°C	I_O	65	65	Amps
Peak Repetitive Reverse Surge Current (2 0 μs, 1 0 kHz) See Figure 7	I_{RRM}	2 0	2 0	Amps
Nonrepetitive Peak Surge Current (Surge applied at rated load conditions halfwave, single phase, 60 Hz)	I_{FSM}	800	800	Amps
Operating Junction Temperature and Storage Temperature	T_J, T_{stg}	-65 to +175	-65 to +175	°C
Voltage Rate of Change (Rated V_R)	dv/dt	1000	1000	V/μs

THERMAL CHARACTERISTICS

Characteristic	Symbol	MBR6535	MBR6545	Unit
Maximum Thermal Resistance, Junction to Case	$R_{\theta JC}$	1 0	1 0	°C/W

ELECTRICAL CHARACTERISTICS

Characteristic	Symbol	MBR6535	MBR6545	Unit
Maximum Instantaneous Forward Voltage (1) (i_F = 65 Amp, T_C = 25°C) (i_F = 65 Amp, T_C = 150°C) (i_f = 130 Amp, T_C = 150°C)	v_F	 0 78 0 62 0 73	 0 78 0 62 0 73	Volts
Maximum Instantaneous Reverse Current (1) (Rated Voltage, T_C = 25°C) (Rated Voltage, T_C = 150°C)	I_R	 0 07 125	 0 07 125	mA
Capacitance (V_R = 1 0 Vdc, 100 kHz ≤ f ≤ 1 0 MHz)	C_t	3700	3700	pF

(1) Pulse Test Pulse Width = 300 μs, Duty Cycle ≤ 2 0%

FIGURE 1 — TYPICAL FORWARD VOLTAGE

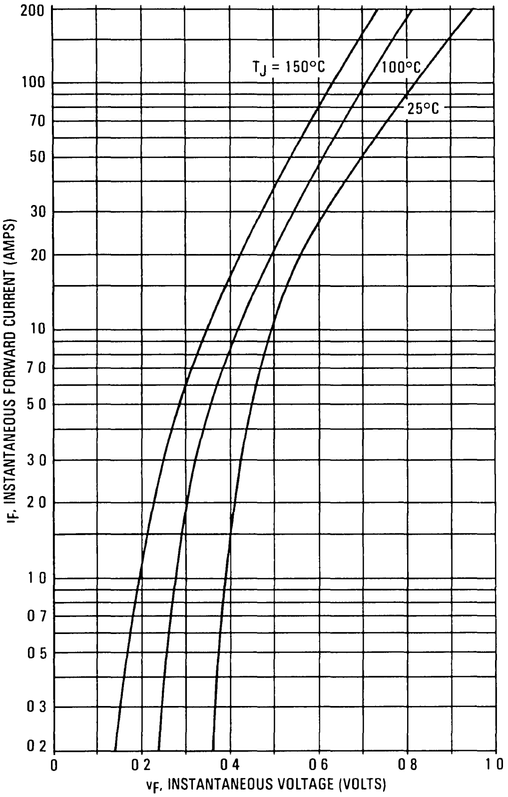


FIGURE 2 — TYPICAL REVERSE CURRENT

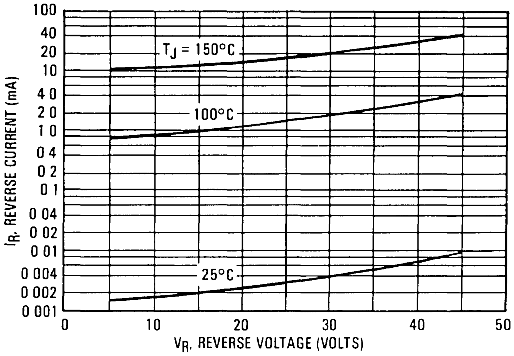


FIGURE 3 — MAXIMUM SURGE CAPABILITY

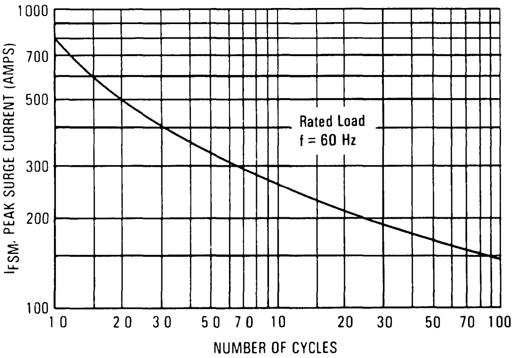


FIGURE 4 — CAPACITANCE

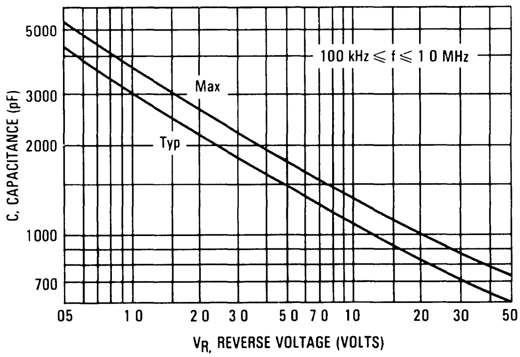


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FIGURE 5 — FORWARD CURRENT DERATING

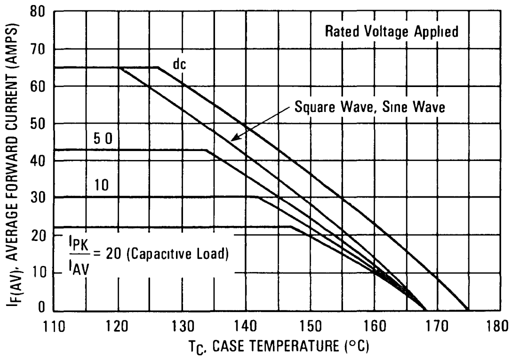


FIGURE 6 — POWER DISSIPATION

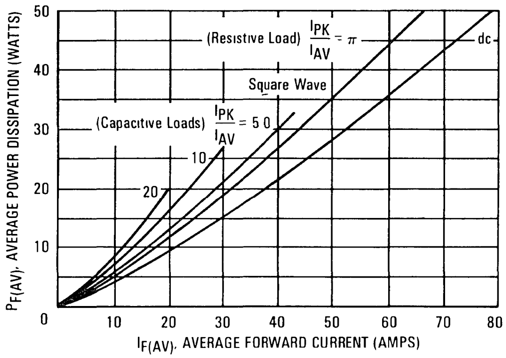
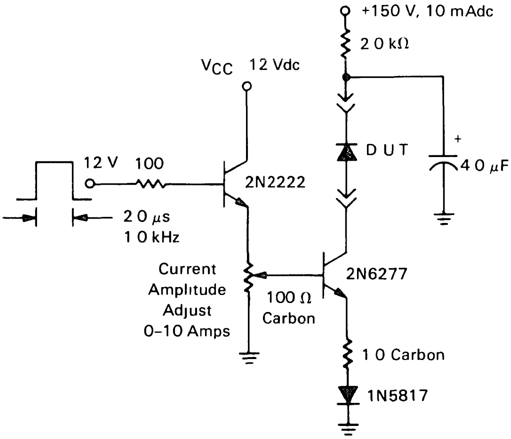
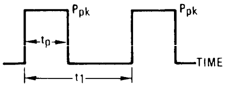


FIGURE 7 — TEST CIRCUIT FOR dv/dt AND REVERSE SURGE CURRENT



NOTE 2



DUTY CYCLE, $D = t_p/t_1$
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$$T_J = T_C + \Delta T_{JC}$$

where ΔT_C is the increase in junction temperature above the case temperature It may be determined by

$\Delta T_{JC} = P_{pk} \cdot R_{\theta JC}[D + (1 - D) \cdot r(t_1 + t_p) + r(t_p) - r(t_1)]$ where

r(t) = normalized value of transient thermal resistance at time, t, from Figure 8, i e

$r(t_1 + t_p)$ = normalized value of transient thermal resistance at time $t_1 + t_p$

FIGURE 8 — THERMAL RESPONSE

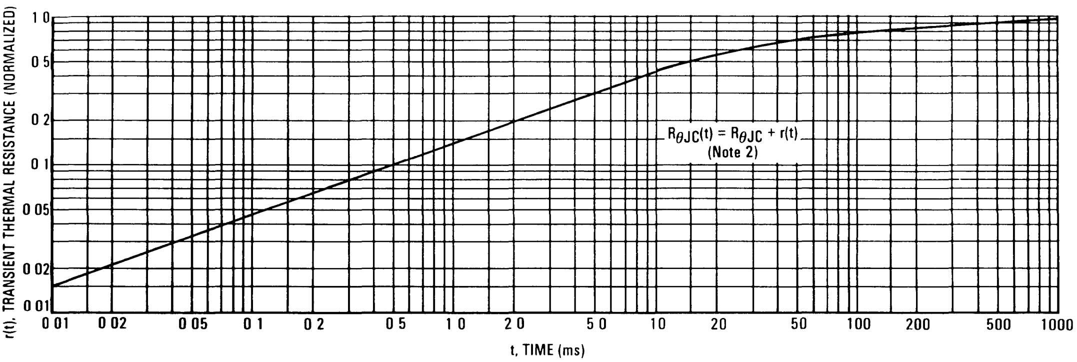
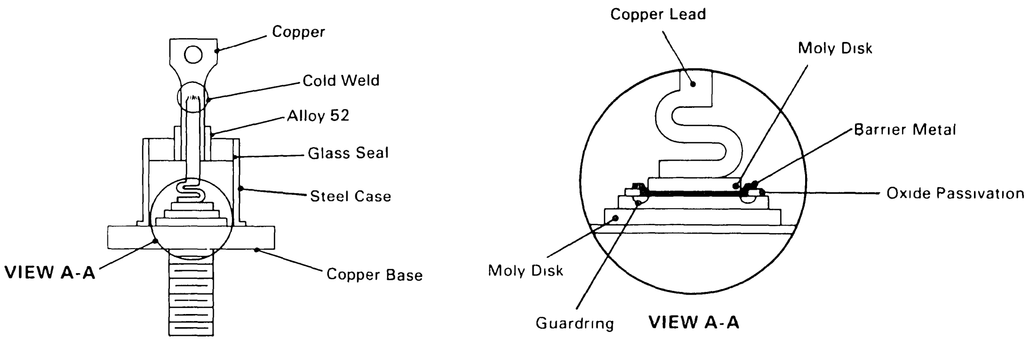


FIGURE 9 — SCHOTTKY RECTIFIER



Motorola builds quality and reliability into its Schottky Rectifiers

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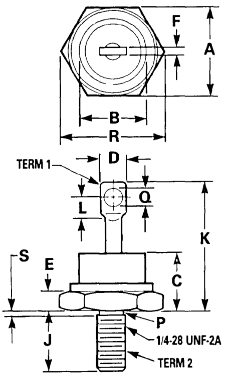


NOTES
1. DIM "P" IS DIA.
2. CHAMFER OR UNDERCUT ON ONE OR BOTH ENDS OF HEXAGONAL BASE IS OPTIONAL
3. ANGULAR ORIENTATION AND CONTOUR OF TERMINAL ONE IS OPTIONAL
4. THREADS ARE PLATED.
5. DIMENSIONING AND TOLERANCING PER ANSI Y14.5, 1973

DIM	MILLIMETERS MIN	MILLIMETERS MAX	INCHES MIN	INCHES MAX
A	16.94	17.45	0 669	0.687
B	—	16.94	—	0 667
C	—	11.43	—	0 450
D	—	9.53	—	0.375
E	2 92	5.08	0.115	0 200
F	—	2.03	—	0.080
J	10 72	11 51	0 422	0.453
K	—	25.40	—	1.000
L	3.86	—	0.156	—
P	5 59	6.32	0 220	0.249
Q	3.56	4 45	0.140	0.175
R	—	20 16	—	0 794
S	—	2.26	—	0.089

STYLE 2:
TERM 1. ANODE
2. CATHODE (CASE)

CASE 257-01
DO-203AB
METAL

MECHANICAL CHARACTERISTICS

CASE: Welded, hermetically sealed

FINISH: All external surfaces corrosion resistant and terminal lead is readily solderable.

POLARITY: Cathode-to-Case

MOUNTING POSITION: Any

MOUNTING TORQUE: 25 in-lb max

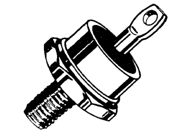
SOLDER HEAT: The excellent heat transfer property of the heavy duty copper anode terminal which transmits heat away from the die requires that caution be used when attaching wires. Motorola suggests a heat sink be clamped between the eyelet and the body during any soldering operation.

3

MBR7535 MBR7540 MBR7545

SCHOTTKY BARRIER RECTIFIERS

75 AMPERES
20 to 45 VOLTS



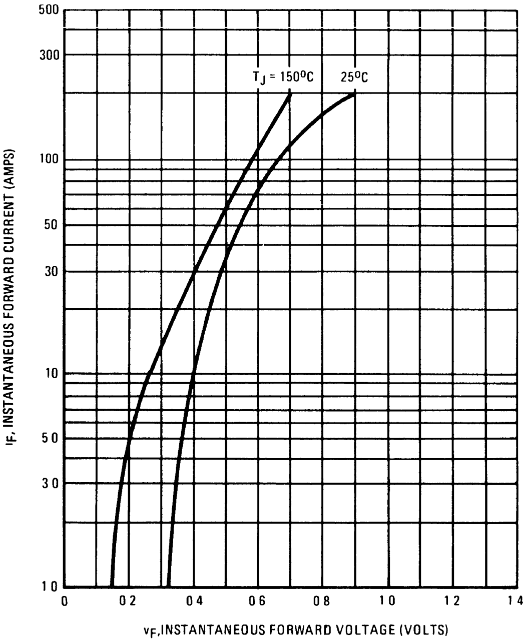
SWITCHMODE POWER RECTIFIERS

. . . employing the Schottky Barrier principle in a large area metal-to-silicon power diode. State-of-the-art geometry features epitaxial construction with oxide passivation and metal overlap contact. Ideally suited for use as rectifiers in low-voltage, high-frequency inverters, free-wheeling diodes, and polarity-protection diodes.

- Extremely Low v_F
- Low Stored Charge, Majority Carrier Conduction
- Low Power Loss/ High Efficiency
- High Surge Capacity

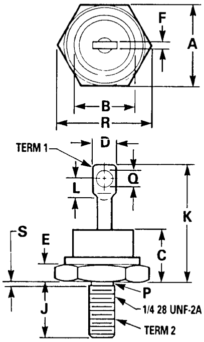
3

FIGURE 1 — TYPICAL FORWARD VOLTAGE



MECHANICAL CHARACTERISTICS

CASE: Welded, hermetically sealed
FINISH: All external surfaces corrosion-resistant and terminal lead is readily solderable.
POLARITY: Cathode to Case
MOUNTING POSITIONS: Any
MOUNTING TORQUE: 25 in-lb max



STYLE 2
TERM 1 ANODE
2 CATHODE (CASE)

NOTES
1 DIM "P" IS DIA
2 CHAMFER OR UNDERCUT ON ONE OR BOTH ENDS OF HEXAGONAL BASE IS OPTIONAL.
3 ANGULAR ORIENTATION AND CONTOUR OF TERMINAL ONE IS OPTIONAL
4 THREADS ARE PLATED
5 DIMENSIONING AND TOLERANCING PER ANSI Y14 5, 1973

	MILLIMETERS		INCHES	
DIM	MIN	MAX	MIN	MAX
A	16 94	17 45	0 669	0 687
B	—	16 94	—	0 667
C	—	11 43	—	0 450
D	—	9 53	—	0 375
E	2 92	5 08	0 115	0 200
F	—	2.03	—	0 080
J	10 72	11 51	0 422	0 453
K	—	25 40	—	1 000
L	3 86	—	0 156	—
P	5 59	6 32	0 220	0 249
Q	3 56	4 45	0 140	0 175
R	—	20 16	—	0 794
S	—	2 26	—	0 089

CASE 257-01
DO-203AB
METAL

MAXIMUM RATINGS

Rating	Symbol	MBR7535	MBR7540	MBR7545	Unit
Peak Repetitive Reverse Voltage Working Peak Reverse Voltage DC Blocking Voltage	V_{RRM} V_{RWM} V_R	35	40	45	Volts
Peak Repetitive Forward Current (Rated V_R, Square Wave, 20 kHz)	I_{FRM}		150 $T_C = 90°C$		Amp
Average Rectified Forward Current (Rated V_R)	I_O		70 $T_C = 90°C$		Amp
Non-repetitive Peak Surge Current (Surge applied at rated load conditions, halfwave, single phase, 60 Hz)	I_{FSM}		1000		Amp
Operating and Storage Junction Temperature Range	T_J, T_{stg}		−65 to +150		°C
Peak Operating Junction Temperature (Forward Current Applied)	$T_{J(pk)}$		175		°C
Voltage Rate of Change (Rated V_R)	dv/dt		1000		v/μs

3

THERMAL CHARACTERISTICS

Characteristic	Symbol	MBR7535	MBR7540	MBR7545	Unit
Thermal Resistance, Junction to Case	$R_{\theta JC}$		0.8		°C/W

ELECTRICAL CHARACTERISTICS (T_C = 25°C unless otherwise noted)

Characteristic	Symbol	MBR7535	MBR7540	MBR7545	Unit
Maximum Instantaneous Forward Voltage (1) (i_F = 60 Amp, T_C = 125°C) (i_F = 220 Amp, T_C = 125°C)	v_F		 0.60 0.90		Volts
Maximum Instantaneous Reverse Current (1) (Rated dc Voltage, T_C = 125°C)	i_R	150	200	250	mA
Capacitance (V_R = 5.0 Vdc, 100 kHz ≤ f ≤ 1.0 MHz)	C_t		4000		pF

(1) Pulse Test: Pulse Width = 300 μs, Duty Cycle = 2 0%

FIGURE 2 – CURRENT DERATING

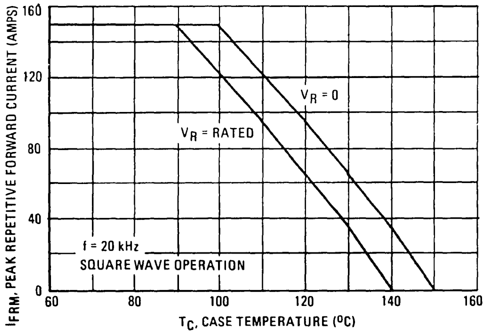
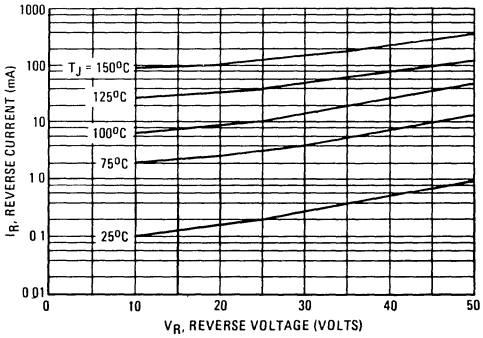


FIGURE 3 – TYPICAL REVERSE OPERATION



MOTOROLA
SEMICONDUCTOR
TECHNICAL DATA

MBR8035
MBR8045

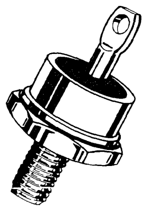
SCHOTTKY RECTIFIERS

80 AMPERES
35 and 45 VOLTS

SWITCHMODE POWER RECTIFIERS

using a platinum barrier metal in a large area metal-to-silicon power diode State-of-the-art geometry features epitaxial construction with oxide passivation and metal overlap contact Ideally suited for use as rectifiers in low-voltage, high frequency inverters, free-wheeling diodes, and polarity-protection diodes

- Guaranteed Reverse Avalanche
- Guardring for dv/dt Stress Protection
- 175°C Operating Junction Temperature
- Low Forward Voltage



CASE 257-01
DO-203AB
METAL

3

MAXIMUM RATINGS

Rating	Symbol	MBR8035	MBR8045	Unit
Peak Repetitive Reverse Voltage Working Peak Reverse Voltage DC Blocking Voltage	V_{RRM} V_{RWM} V_R	35	45	Volts
Peak Repetitive Forward Current (Rated V_R, Square Wave, 20 kHz) T_C = 120°C	I_{FRM}	160	160	Amps
Average Rectified Forward Current (Rated V_R) T_C = 120°C	I_O	80	80	Amps
Peak Repetitive Reverse Surge Current (2 0 μs, 1 0 kHz) See Figure 7	I_{RRM}	2 0	2 0	Amps
Nonrepetitive Peak Surge Current (Surge applied at rated load conditions halfwave, single phase, 60 Hz)	I_{FSM}	1000	1000	Amps
Operating Junction Temperature and Storage Temperature	T_J, T_{stg}	−65 to +175	−65 to +175	°C
Voltage Rate of Change (Rated V_R)	dv/dt	1000	1000	V/μs

THERMAL CHARACTERISTICS

Rating	Symbol	MBR8035	MBR8045	Unit
Maximum Thermal Resistance, Junction to Case	$R_{\theta JC}$	0 80	0 80	°C/W

ELECTRICAL CHARACTERISTICS

Rating	Symbol	MBR8035	MBR8045	Unit
Maximum Instantaneous Forward Voltage (1) (i_F = 80 Amp, T_C = 25°C) (i_F = 80 Amp, T_C = 150°C) (i_F = 160 Amp, T_C = 150°C)	v_F	 0 72 0 59 0 67	 0 72 0 59 0 67	Volts
Maximum Instantaneous Reverse Current (1) (Rated Voltage, T_C = 25°C) (Rated Voltage, T_C = 150°C)	i_R	 1 0 150	 1 0 150	mA
Capacitance (V_R = 1 0 Vdc, 100 kHz ≤ f ≤ 1 0 MHz)	C_t	5000	5000	pF

(1) Pulse Test Pulse Width = 300 μs, Duty Cycle ≤ 2 0%

FIGURE 1 — TYPICAL FORWARD VOLTAGE

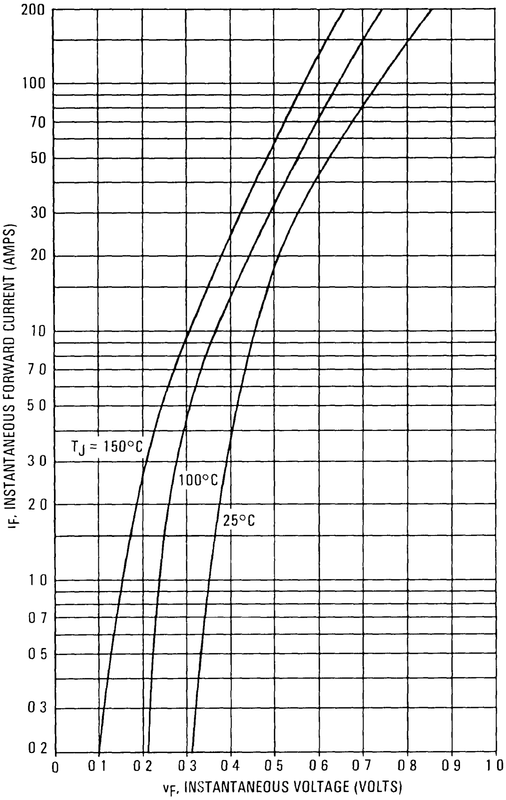
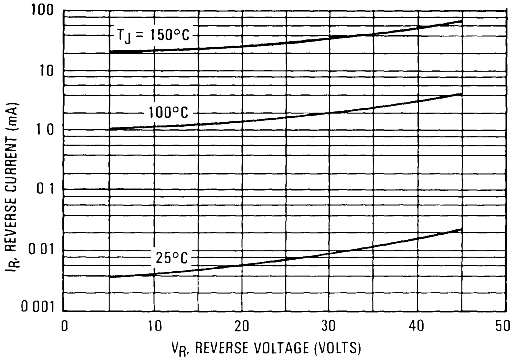
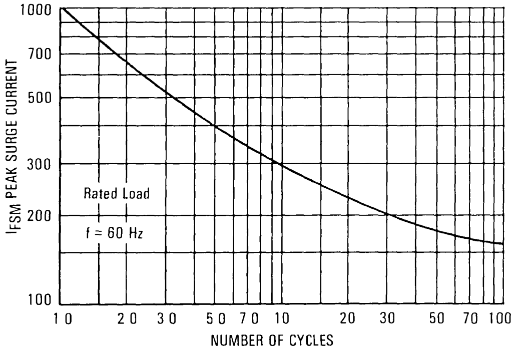


FIGURE 2 — TYPICAL REVERSE CURRENT



3

FIGURE 3 — MAXIMUM SURGE CAPABILITY



NOTE 1
HIGH FREQUENCY OPERATION

Since current flow in a Schottky rectifier is the result of majority carrier conduction, it is not subject to junction diode forward and reverse recovery transients due to minority carrier injection and stored charge Satisfactory circuit analysis work may be performed by using a model consisting of an ideal diode in parallel with a variable capacitance (See Figure 4)

Rectification efficiency measurements show that operation will be satisfactory up to several megahertz For example, relative waveform rectification efficiency is approximately 70 per cent at 2 0 MHz, e g , the ratio of dc power to RMS power in the load is 0 28 at this frequency, whereas perfect rectification would yield 0 406 for sine wave inputs However, in contrast to ordinary junction diodes, the loss in waveform efficiency is not indicative of power loss, it is simply a result of reverse current flow through the diode capacitance, which lowers the dc output voltage

FIGURE 4 — CAPACITANCE

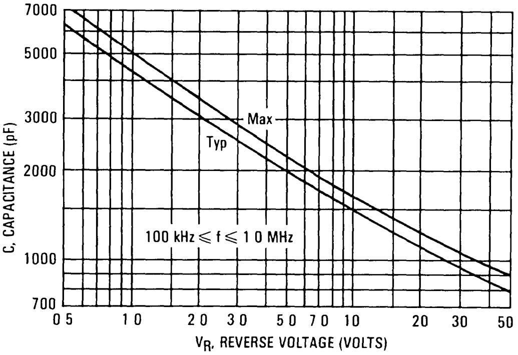


FIGURE 5 — FORWARD CURRENT DERATING

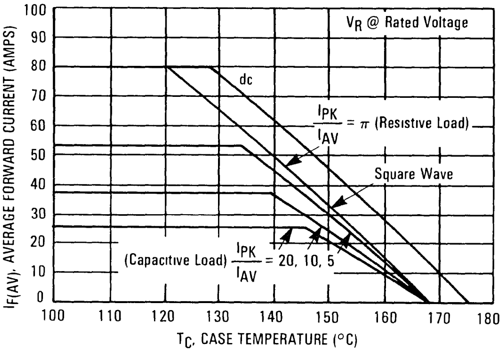


FIGURE 6 — POWER DISSIPATION

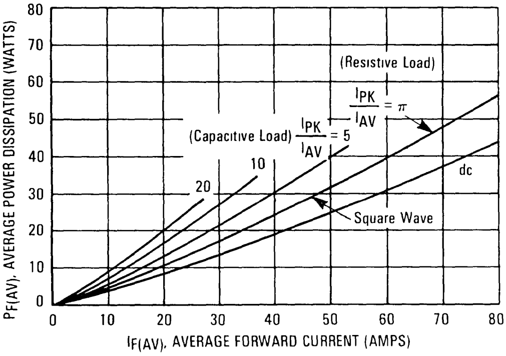
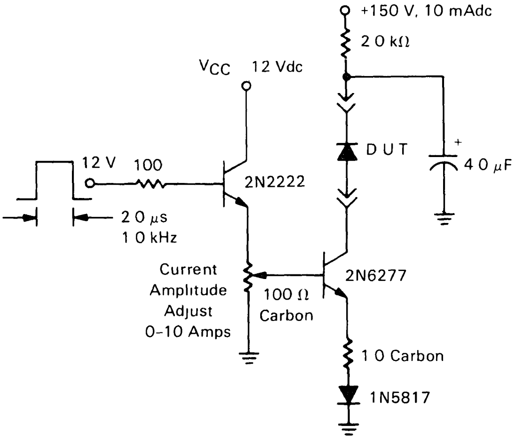
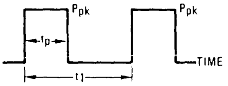


FIGURE 7 — TEST CIRCUIT FOR dv/dt AND REVERSE SURGE CURRENT



NOTE 2



DUTY CYCLE, $D = t_p/t_1$
PEAK POWER, P_{pk}, is peak of an equivalent square power pulse

To determine maximum junction temperature of the diode in a given situation, the following procedure is recommended

The temperature of the case should be measured using a thermocouple placed on the case. The thermal mass connected to the case is normally large enough so that it will not significantly respond to heat surges generated in the diode as a result of pulsed operation once steady state conditions are achieved. Using the measured value of T_C, the junction temperature may be determined by

$$T_J = T_C + \Delta T_{JC}$$

where ΔT_C is the increase in junction temperature above the case temperature. It may be determined by

$$\Delta T_{JC} = P_{pk} \cdot R_{\theta JC}[D + (1 - D) \cdot r(t_1 + t_p) + r(t_p) - r(t_1)]$$ where

$r(t)$ = normalized value of transient thermal resistance at time, t, from Figure 8, i.e.

$r(t_1 + t_p)$ = normalized value of transient thermal resistance at time $t_1 + t_p$

FIGURE 8 — THERMAL RESPONSE

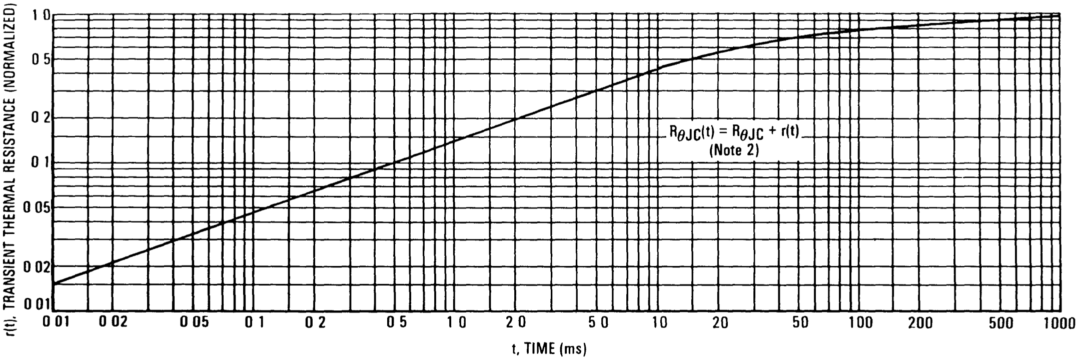
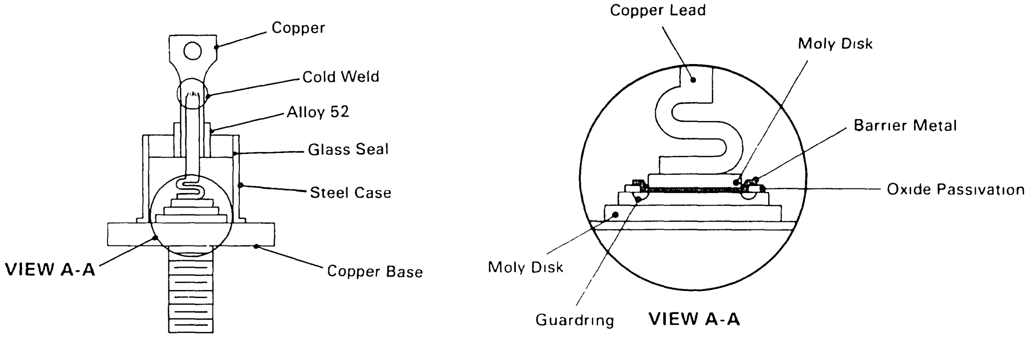


FIGURE 9 — SCHOTTKY RECTIFIER

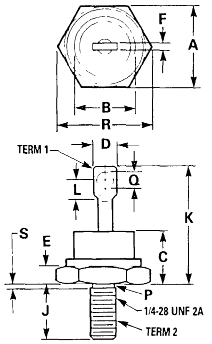


Motorola builds quality and reliability into its Schottky Rectifiers First is the chip, which has an interface metal between the platinum-barrier metal and nickel-gold ohmic-contact metal to eliminate any possible interaction with the barrier The indicated guardring prevents dv/dt problems, so snubbers are not mandatory The guardring also operates like a zener to absorb overvoltage transients

Second is the package There are molybdenum disks which closely match the thermal coefficient of expansion of silicon on each side of the chip The top copper lead has a stress relief feature which protects the die during assembly These two features give the unit the capability of passing stringent thermal fatigue tests for 5,000 cycles The top copper lead provides a low resistance to current and therefore does not contribute to device heating, a heat sink should be used when attaching wires

Third is the redundant electrical testing The device is tested before assembly in "sandwich" form, with the chip between the moly disks It is tested again after assembly As part of the final electrical test, devices are 100% tested for dv/dt at 1,600 V/μs and reverse avalanche

3



NOTES
1 DIM "P" IS DIA
2 CHAMFER OR UNDERCUT ON ONE OR BOTH ENDS OF HEXAGONAL BASE IS OPTIONAL
3 ANGULAR ORIENTATION AND CONTOUR OF TERMINAL ONE IS OPTIONAL
4 THREADS ARE PLATED
5 DIMENSIONING AND TOLERANCING PER ANSI Y14 5, 1973

	MILLIMETERS		INCHES	
DIM	MIN	MAX	MIN	MAX
A	16 94	17 45	0 669	0 687
B	—	16 94	—	0 667
C	—	11 43	—	0 450
D	—	9 53	—	0 375
E	2 92	5 08	0 115	0 200
F	—	2 03	—	0 080
J	10 72	11 51	0 422	0 453
K	—	25 40	—	1 000
L	3 86	—	0 156	—
P	5 59	6 32	0 220	0 249
Q	3 56	4 45	0 140	0 175
R	—	20 16	—	0 794
S	—	2 26	—	0 089

STYLE 2
TERM 1 ANODE
2 CATHODE (CASE)

CASE 257-01
DO-203AB
METAL

MECHANICAL CHARACTERISTICS

CASE: Welded, hermetically sealed

FINISH: All external surfaces corrosion resistant and terminal lead is readily solderable

POLARITY: Cathode-to-Case

MOUNTING POSITION: Any

MOUNTING TORQUE: 25 in-lb max

SOLDER HEAT: The excellent heat transfer property of the heavy duty copper anode terminal which transmits heat away from the die requires that caution be used when attaching wires. Motorola suggests a heat sink be clamped between the eyelet and the body during any soldering operation.

MOTOROLA
SEMICONDUCTOR
TECHNICAL DATA

MBR12035CT
MBR12045CT
MBR12050CT
MBR12060CT

3

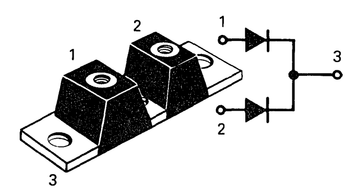
SWITCHMODE POWER RECTIFIERS

. . . using the Schottky Barrier principle with a platinum barrier metal. These state-of-the-art devices have the following features:

- Dual Diode Construction — May Be Paralleled For Higher Current Output
- Guardring For Stress Protection
- Low Forward Voltage
- 175°C Operating Junction Temperature
- Guaranteed Reverse Avalanche

SCHOTTKY BARRIER RECTIFIERS

120 AMPERES
35 to 60 VOLTS



MAXIMUM RATINGS

Rating		Symbol	Max	Unit
Peak Repetitive Reverse Voltage	MBR12035CT	V_{RRM}	35	Volts
	MBR12045CT		45	
Working Peak Reverse Voltage	MBR12050CT	V_{RWM}	50	
DC Blocking Voltage	MBR12060CT	V_R	60	
Average Rectified Forward Current	Per Device	$I_{F(AV)}$	120	Amps
(Rated V_R) T_C = 140°C	Per Leg		60	
Peak Repetitive Forward Current, Per Leg (Rated V_R, Square Wave, 20 kHz), T_C = 140°C		I_{FRM}	120	Amps
Nonrepetitive Peak Surge Current (Surge applied at rated load conditions halfwave, single phase, 60 Hz)		I_{FSM}	800	Amps
Peak Repetitive Reverse Current, Per Leg (2.0 μs, 1.0 kHz) See Figure 6		I_{RRM}	2.0	Amps
Operating Junction and Storage Temperature		T_J, T_{stg}	−65 to +175	°C
Voltage Rate of Change (Rated V_R)		dv/dt	1000	V/μs

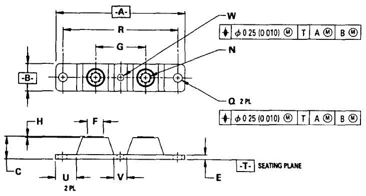
THERMAL CHARACTERISTICS PER LEG

Thermal Resistance, Junction to Case	$R_{\theta JC}$	0.85	°C/W

ELECTRICAL CHARACTERISTICS PER LEG

Instantaneous Forward Voltage (1)	v_F		Volts
(i_F = 60 Amp, T_J = 125°C)		0.590	
(i_F = 120 Amp, T_J = 175°C)		0.620	
(i_F = 120 Amp, T_J = 125°C)		0.680	
(i_F = 120 Amp, T_J = 25°C)		0.830	
Instantaneous Reverse Current (1)	i_R		mA
(Rated dc Voltage, T_J = 125°C)		25	
(Rated dc Voltage, T_J = 25°C)		0.25	

(1) Pulse Test. Pulse Width = 300 μs, Duty Cycle ≤ 2.0%



NOTES.
1. DIMENSIONING AND TOLERANCING PER ANSI Y14 5M, 1982.
2. CONTROLLING DIMENSION INCH.

DIM	MILLIMETERS MIN	MILLIMETERS MAX	INCHES MIN	INCHES MAX
A	87.63	92.20	3.450	3.630
B	17.78	20.57	0.700	0.810
C	15.63	16.00	0.615	0.630
E	3.05	3.30	0.120	0.130
F	11.05	11.30	0.435	0.445
G	34.80	35.05	1.370	1.380
H	0.18	0.68	0.007	0.027
N	1/4-20UNC-2B		1/4-20UNC-2B	
Q	6.86	7.23	0.270	0.285
R	80.01 BSC		3.150 BSC	
U	15.24	16.00	0.600	0.630
V	8.39	9.52	0.330	0.375
W	4.32	4.82	0.170	0.190

CASE 357C-01
POWER TAP

Terminal Penetration:	0.280 max
Terminal Torque:	25–40 in-lb max
Mounting Torque — Outside Holes:*	30–40 in-lb max
*Center Hole Must be Torqued First:	8–10 in-lb max

FIGURE 1 — TYPICAL FORWARD VOLTAGE PER LEG

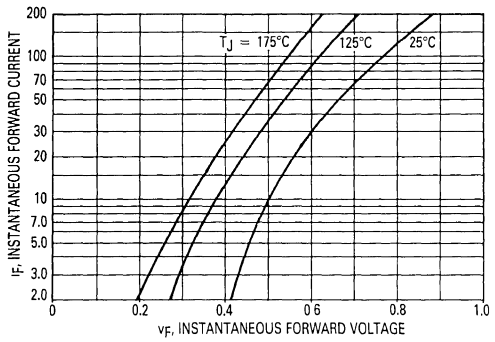


FIGURE 2 — TYPICAL REVERSE CURRENT, PER LEG*

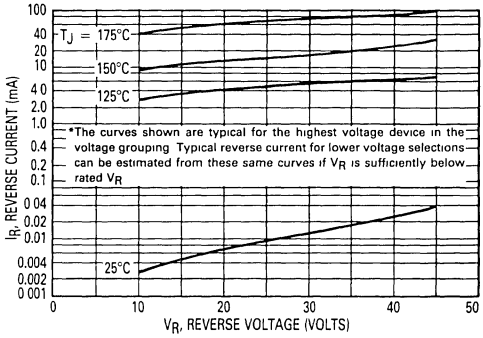


FIGURE 3 — FORWARD CURRENT DERATING, PER LEG

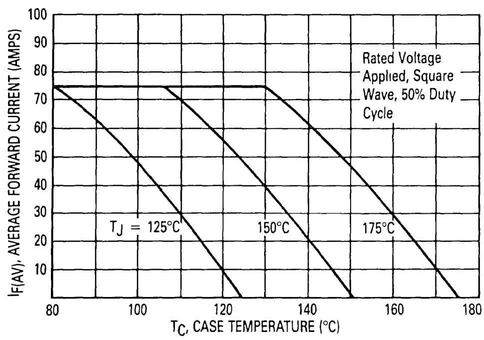


FIGURE 4 — POWER DISSIPATION PER LEG

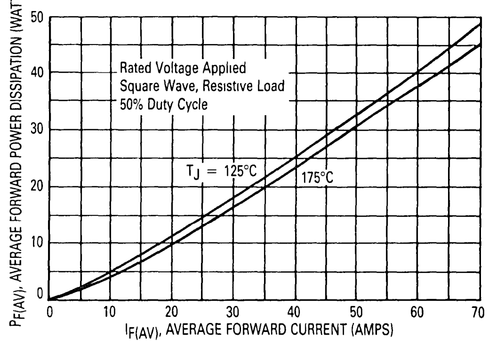


FIGURE 5 — TYPICAL CAPACITANCE, PER LEG

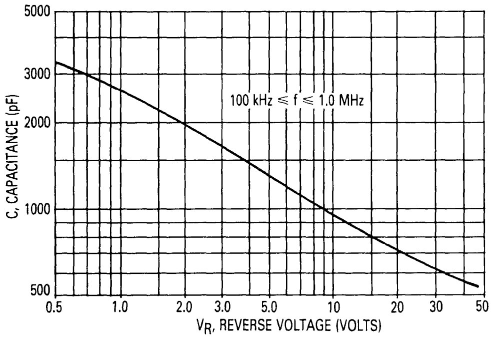
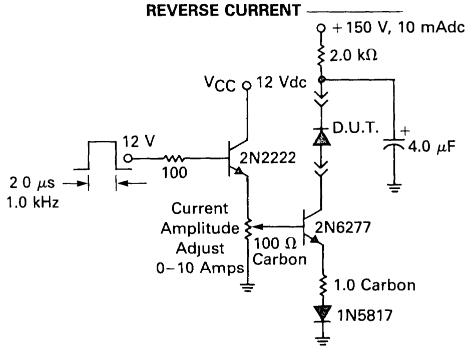


FIGURE 6 — TEST CIRCUIT FOR REPETITIVE REVERSE CURRENT

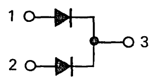


POWERTAP
Switchmode Power Rectifiers

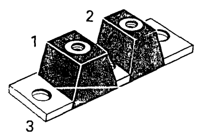
MBR20015CTL
MBR20020CTL
MBR20025CTL
MBR20030CTL

. . . using the Schottky Barrier principle with a platinum barrier metal. These state-of-the-art devices have the following features:

- Dual Diode Construction — May Be Paralleled For Higher Current Output
- Guardring For Stress Protection
- Low Forward Voltage
- 150°C Operating Junction Temperature
- Guaranteed Reverse Avalanche



LOW V_F
SCHOTTKY BARRIER
RECTIFIERS
200 AMPERES
15 to 30 VOLTS



3

MAXIMUM RATINGS

Rating		Symbol	Max	Unit
Peak Repetitive Reverse Voltage Working Peak Reverse Voltage DC Blocking Voltage	MBR20015CTL MBR20020CTL MBR20025CTL MBR20030CTL	V_{RRM} V_{RWM} V_R	15 20 25 30	Volts
Average Rectified Forward Current Per Device (Rated V_R) T_C = 140°C Per Leg		$I_{F(AV)}$	200 100	Amps
Peak Repetitive Forward Current, Per Leg (Rated V_R, Square Wave, 20 kHz), T_C = 140°C		I_{FRM}	200	Amps
Nonrepetitive Peak Surge Current Per Leg (Surge applied at rated load conditions halfwave, single phase, 60 Hz)		I_{FSM}	1500	Amps
Peak Repetitive Reverse Current, Per Leg (2 μs, 1.0 kHz) See Figure 6		I_{RRM}	2	Amps
Storage Temperature		T_{stg}	−65 to +175	°C
Operating Junction and Storage Temperature		T_J, T_{stg}	−65 to +150	°C
Voltage Rate of Change (Rated V_R)		dv/dt	1000	V/μs

THERMAL CHARACTERISTICS PER LEG

Thermal Resistance, Junction to Case	$R_{\theta JC}$	0.4	°C/W

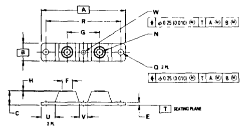
ELECTRICAL CHARACTERISTICS PER LEG

Instantaneous Forward Voltage (1) (i_F = 100 Amp, T_J = 150°C) (i_F = 200 Amp, T_J = 150°C) (i_F = 100 Amp, T_J = 25°C) (i_F = 200 Amp, T_J = 25°C)	v_F	 0.39 0.48 0.46 0.55	Volts
Instantaneous Reverse Current (1) (Rated dc Voltage, T_J = 100°C) (Rated dc Voltage, T_J = 25°C)	i_R	 500 5	mA

(1) Pulse Test: Pulse Width = 300 μs, Duty Cycle ≤ 2.0%.

Terminal Penetration:	0.280 max
Terminal Torque:	25–40 in-lb max
Mounting Torque — Outside Holes:*	30–40 in-lb max
*Center Hole Must be Torqued First:	8–10 in-lb max

OUTLINE DIMENSIONS



NOTES
1 DIMENSIONING AND TOLERANCING PER ANSI Y14 5M, 1982
2 CONTROLLING DIMENSION INCH

DIM	MILLIMETERS MIN	MILLIMETERS MAX	INCHES MIN	INCHES MAX
A	87 63	92 20	3 450	3 630
B	17 78	20 57	0 700	0 810
C	15 63	16 00	0 615	0 630
E	3 05	3 30	0 120	0 130
F	11 05	11 30	0 435	0 445
G	34 80	35 05	1 370	1 380
H	0 18	0 68	0 007	0 027
N	1/4-20UNC-2B		1/4-20UNC-2B	
Q	6 86	7 23	0 270	0 285
R	80 01 BSC		3 150 BSC	
U	15 24	16 00	0 600	0 630
V	8 39	9 52	0 330	0 375
W	4 32	4 82	0 170	0 190

CASE 357C-01
POWERTAP

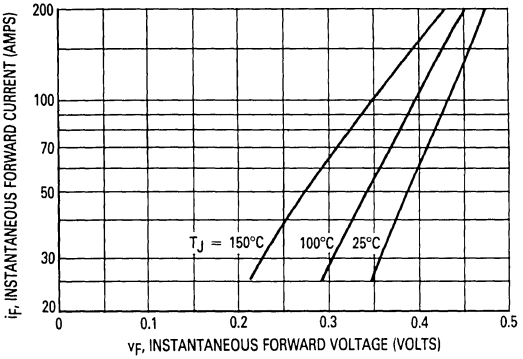
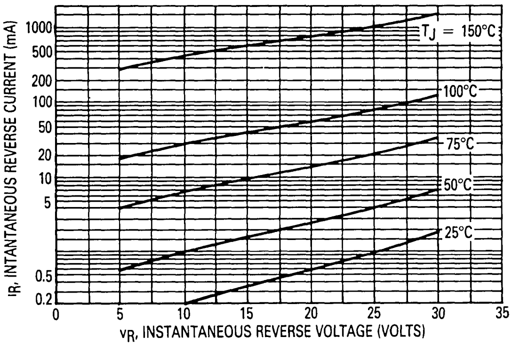


Figure 1. Typical Forward Voltage



*The curves shown are typical for the highest voltage device in the voltage grouping. Typical reverse current for lower voltage selections can be estimated from these same curves if V_R is sufficiently below rated V_R.

Figure 2. Typical Instantaneous Reverse Current, Per Leg*

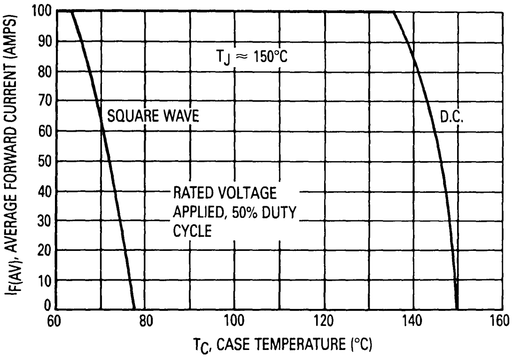


Figure 3. Forward Current Derating, Per Leg

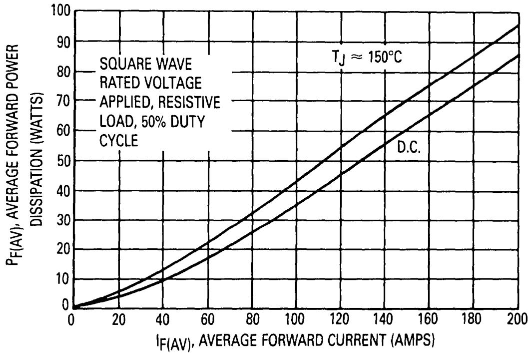


Figure 4. Power Dissipation Per Leg

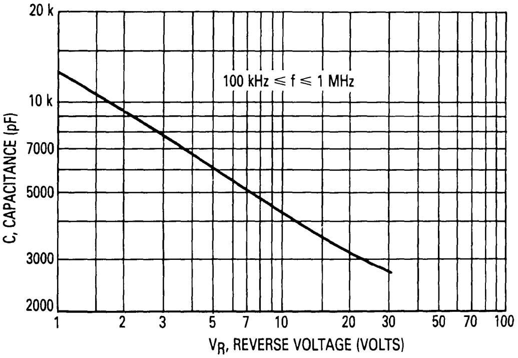


Figure 5. Typical Capacitance, Per Leg

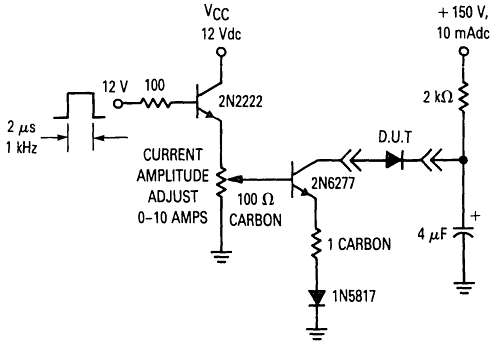


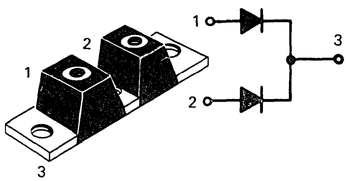
Figure 6. Test Circuit For Repetitive Reverse Current

MOTOROLA
SEMICONDUCTOR
TECHNICAL DATA

MBR20035CT
MBR20045CT
MBR20050CT
MBR20060CT

SCHOTTKY BARRIER RECTIFIERS

200 AMPERES
35 to 60 VOLTS



SWITCHMODE POWER RECTIFIERS

. . . using the Schottky Barrier principle with a platinum barrier metal. These state-of-the-art devices have the following features:

- Dual Diode Construction — May Be Paralleled For Higher Current Output
- Guardring For Stress Protection
- Low Forward Voltage
- 175°C Operating Junction Temperature
- Guaranteed Reverse Avalanche

3

MAXIMUM RATINGS

Rating		Symbol	Max	Unit
Peak Repetitive Reverse Voltage Working Peak Reverse Voltage DC Blocking Voltage	MBR20035CT MBR20045CT MBR20050CT MBR20060CT	V_{RRM} V_{RWM} V_R	35 45 50 60	Volts
Average Rectified Forward Current (Rated V_R) T_C = 140°C	Per Device Per Leg	$I_{F(AV)}$	200 100	Amps
Peak Repetitive Forward Current, Per Leg (Rated V_R, Square Wave, 20 kHz), T_C = 140°C		I_{FRM}	200	Amps
Nonrepetitive Peak Surge Current Per Leg (Surge applied at rated load conditions halfwave, single phase, 60 Hz)		I_{FSM}	1500	Amps
Peak Repetitive Reverse Current, Per Leg (2.0 μs, 1.0 kHz) See Figure 6		I_{RRM}	2.0	Amps
Operating Junction and Storage Temperature		T_J, T_{stg}	−65 to +175	°C
Voltage Rate of Change (Rated V_R)		dv/dt	1000	V/μs

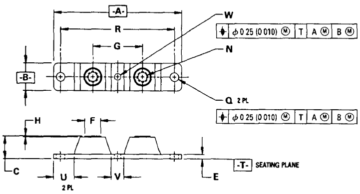
THERMAL CHARACTERISTICS PER LEG

Thermal Resistance, Junction to Case	$R_{\theta JC}$	0.5	°C/W

ELECTRICAL CHARACTERISTICS PER LEG

Instantaneous Forward Voltage (1) (i_F = 200 Amp, T_J = 175°C) (i_F = 200 Amp, T_J = 125°C) (i_F = 100 Amp, T_J = 125°C) (i_F = 100 Amp, T_J = 25°C)	V_F	 0.650 0.825 0.710 0.800	Volts
Instantaneous Reverse Current (1) (Rated dc Voltage, T_J = 125°C) (Rated dc Voltage, T_J = 25°C)	i_R	 50 0.5	mA

(1) Pulse Test: Pulse Width = 300 μs, Duty Cycle ≤ 2.0%.



NOTES:
1. DIMENSIONING AND TOLERANCING PER ANSI Y14.5M, 1982.
2. CONTROLLING DIMENSION: INCH.

DIM	MILLIMETERS MIN	MILLIMETERS MAX	INCHES MIN	INCHES MAX
A	87.63	92.20	3.450	3.630
B	17.78	20.57	0.700	0.810
C	15.63	16.00	0.615	0.630
E	3.05	3.30	0.120	0.130
F	11.05	11.30	0.435	0.445
G	34.80	35.05	1.370	1.380
H	0.18	0.68	0.007	0.027
N	1/4-20UNC-2B		1/4-20UNC-2B	
Q	6.86	7.23	0.270	0.285
R	80.01 BSC		3.150 BSC	
U	15.24	16.00	0.600	0.630
V	8.39	9.52	0.330	0.375
W	4.32	4.82	0.170	0.190

CASE 357C-01
POWER TAP

Terminal Penetration:	0.280 mx
Terminal Torque:	25–40 in-lb max
Mounting Torque — Outside Holes:*	30–40 in-lb max
*Center Hole Must be Torqued First:	8–10 in-lb max

FIGURE 1 — TYPICAL FORWARD VOLTAGE, PER LEG

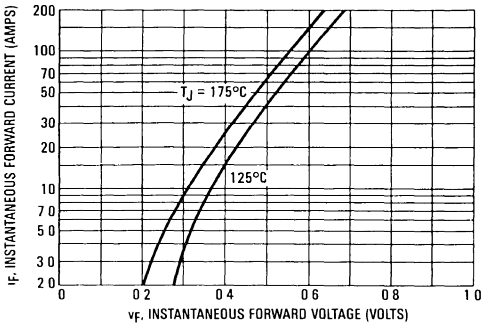


FIGURE 2 — TYPICAL REVERSE CURRENT, PER LEG

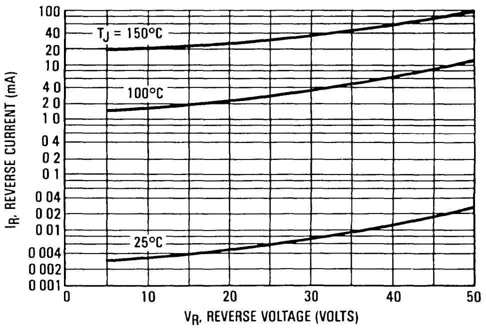


FIGURE 3 — FORWARD CURRENT DERATING, PER LEG

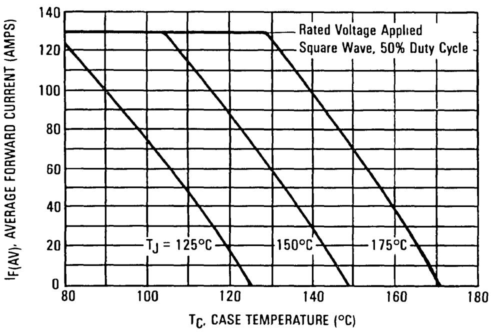


FIGURE 4 — POWER DISSIPATION, PER LEG

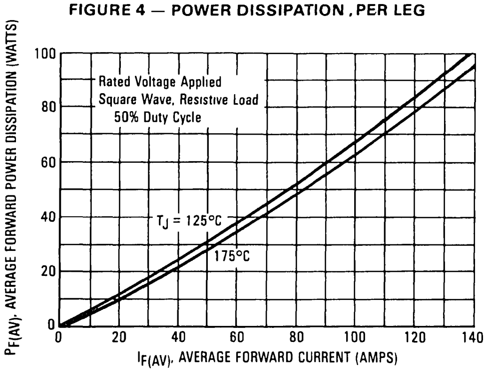


FIGURE 5 — CAPACITANCE, PER LEG

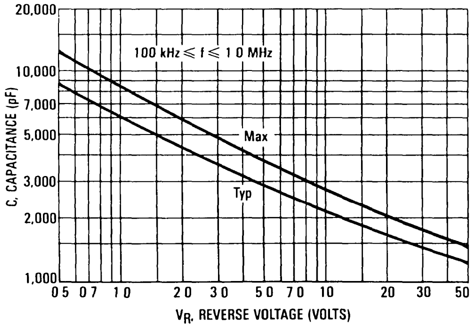
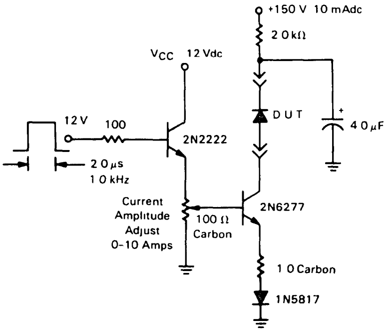


FIGURE 6 — TEST CIRCUIT FOR REPETITIVE REVERSE CURRENT



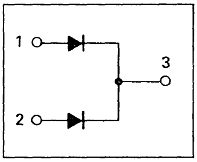
MBR30035CT
MBR30045CT
MBR30050CT
MBR30060CT

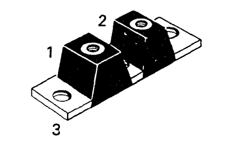
POWER TAP
Switchmode Power Rectifiers

. . . using the Schottky Barrier principle with a platinum barrier metal. These state-of-the-art devices have the following features:

- Dual Diode Construction — May Be Paralleled For Higher Current Output
- Guardring For Stress Protection
- Low Forward Voltage
- 175°C Operating Junction Temperature
- Guaranteed Reverse Avalanche

SCHOTTKY BARRIER RECTIFIERS
300 AMPERES
35 TO 60 VOLTS





MAXIMUM RATINGS

Rating		Symbol	Max	Unit
Peak Repetitive Reverse Voltage Working Peak Reverse Voltage DC Blocking Voltage	MBR30035CT MBR30045CT MBR30050CT MBR30060CT	V_{RRM} V_{RWM} V_R	35 45 50 60	Volts
Average Rectified Forward Current (Rated V_R) T_C = 140°C	Per Device Per Leg	$I_{F(AV)}$	300 150	Amps
Peak Repetitive Forward Current, Peg Leg (Rated V_R, Square Wave, 20 kHz), T_C = 140°C		I_{FRM}	300	Amps
Nonrepetitive Peak Surge Current Per Leg (Surge applied at rated load conditions halfwave, single phase, 60 Hz)		I_{FSM}	2500	Amps
Peak Repetitive Reverse Current, Per Leg (2 μs, 1 kHz) See Figure 6		I_{RRM}	2	Amps
Operating Junction and Storage Temperature		T_J, T_{stg}	−65 to +175	°C
Voltage Rate of Change (Rated V_R)		dv/dt	1000	V/μs

THERMAL CHARACTERISTICS PER LEG

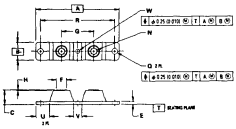
Thermal Resistance, Junction to Case	$R_{\theta JC}$	0.4	°C/W

ELECTRICAL CHARACTERISTICS PER LEG

Instantaneous Forward Voltage (1) (i_F = 150 Amps, T_C = 175°C) (i_F = 150 Amps, T_C = 125°C) (i_F = 150 Amps, T_C = 25°C) (i_F = 300 Amps, T_C = 125°C) (i_F = 300 Amps, T_C = 25°C)	v_F	 0 57 0.64 0.74 0.78 0 82	Volts
Instantaneous Reverse Current (1) (Rated dc Voltage, T_C = 125°C) (Rated dc Voltage, T_C = 25°C)	i_R	 75 0.8	mA

(1) Pulse Test. Pulse Width = 300 μs, Duty Cycle ≤ 2%

OUTLINE DIMENSIONS



NOTES
1 DIMENSIONING AND TOLERANCING PER ANSI Y14 5M, 1982
2 CONTROLLING DIMENSION INCH

DIM	MILLIMETERS MIN	MILLIMETERS MAX	INCHES MIN	INCHES MAX
A	87 63	92 20	3 450	3 630
B	17 78	20 57	0 700	0 810
C	15 63	16 00	0 615	0 630
E	3 05	3 30	0 120	0 130
F	11 05	11.30	0 435	0 445
G	34 80	35 05	1 370	1.380
H	0 18	0 68	0 007	0 027
N	1/4-20UNC-2B		1/4-20UNC-2B	
Q	6 86	7 23	0 270	0 285
R	80 01 BSC		3 150 BSC	
U	15 24	16 00	0 600	0 630
V	8 39	9 52	0 330	0 375
W	4 32	4 82	0 170	0 190

CASE 357C-01
POWERTAP

Terminal Penetration:	0.280 max
Terminal Torque:	25–40 in-lb max
Mounting Torque — Outside Holes:*	30–40 in-lb max
*Center Hole Must be Torqued First:	8–10 in-lb max

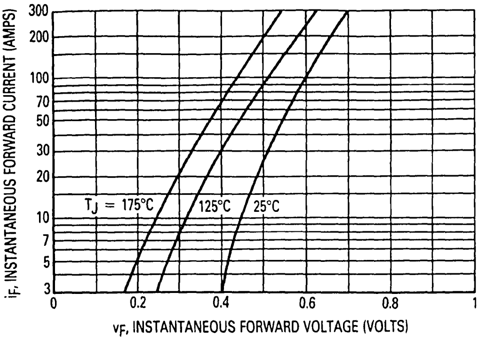


Figure 1. Typical Forward Voltage (Per Leg)

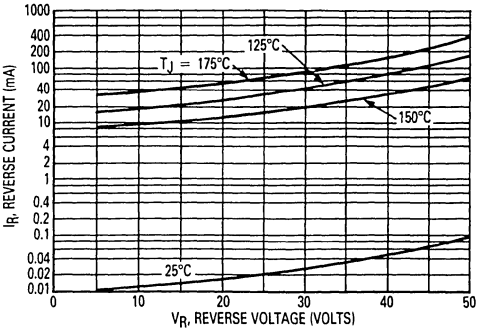


Figure 2. Typical Reverse Current (Per Leg)*

*The curves shown are typical for the highest voltage device in the voltage grouping. Typical reverse current for lower voltage selections can be estimated from these same curves if V_R is sufficiently below rated V_R.

3

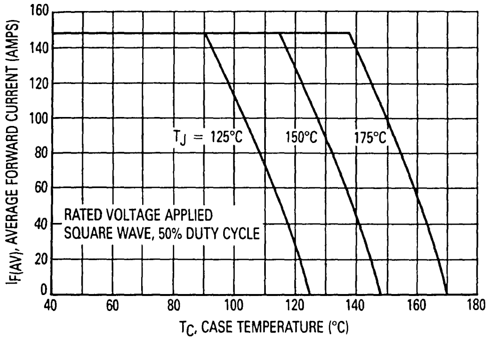


Figure 3. Current Derating (Per Leg)

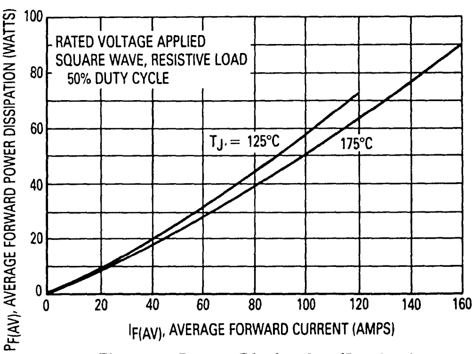


Figure 4. Power Dissipation (Per Leg)

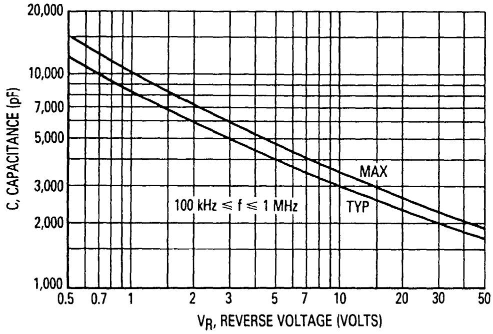


Figure 5. Capacitance (Per Leg)

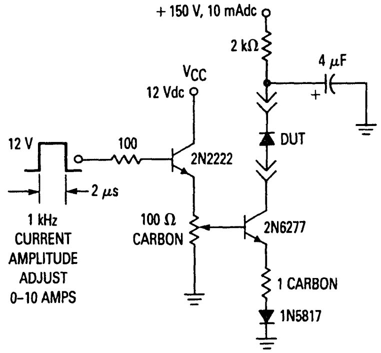


Figure 6. Test Circuit For Repetitive Reverse Current

MBRD320 MBRD330 MBRD340 MBRD350 MBRD360

Switchmode Power Rectifiers
DPAK Surface Mount Package

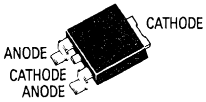
. . . designed for use as output rectifiers, free wheeling, protection and steering diodes in switching power supplies, inverters and other inductive switching circuits. These state-of-the-art devices have the following features:

- Extremely Fast Switching
- Extremely Low Forward Drop
- Platinum Barrier with Avalanche Guardrings
- Guaranteed Reverse Avalanche

Mechanical Characteristics

- Case: Epoxy, Molded
- Finish: All External Surface Corrosion Resistance and Terminal Leads are Readily Solderable
- Lead Formed for Surface Mount
- Available in 16 mm Tape and Reel or Plastic Rails
- Compact Size
- Lead and Mounting Surface Temperature for Soldering Purposes 260°C Max. for 10 Seconds

SCHOTTKY BARRIER RECTIFIERS
3 AMPERES
20 TO 60 VOLTS



CASE 369A-04
PLASTIC

3

MAXIMUM RATINGS

Rating	Symbol	MBRD 320	MBRD 330	MBRD 340	MBRD 350	MBRD 360	Unit
Peak Repetitive Reverse Voltage Working Peak Reverse Voltage DC Blocking Voltage	V_{RRM} V_{RWM} V_R	20	30	40	50	60	Volts
Average Rectified Forward Current (T_C = +125°C, Rated V_R)	$I_{F(AV)}$	3					Amps
Peak Repetitive Forward Current, T_C = +125°C (Rated V_R, Square Wave, 20 kHz)	I_{FRM}	6					Amps
Nonrepetitive Peak Surge Current (Surge applied at rated load conditions halfwave, single phase, 60 Hz)	I_{FSM}	75					Amps
Peak Repetitive Reverse Surge Current (2 μs, 1 kHz)	I_{RRM}	1					Amp
Operating Junction Temperature	T_J	−65 to +150					°C
Storage Temperature	T_{stg}	−65 to +175					°C
Voltage Rate of Change (Rated V_R)	dv/dt	1000					V/μs

THERMAL CHARACTERISTICS

Maximum Thermal Resistance, Junction to Case	$R_{\theta JC}$	6	°C/W
Maximum Thermal Resistance, Junction to Ambient (1)	$R_{\theta JA}$	80	°C/W

ELECTRICAL CHARACTERISTICS

Maximum Instantaneous Forward Voltage (2) i_F = 3 Amps, T_C = +25°C i_F = 3 Amps, T_C = +125°C i_F = 6 Amps, T_C = +25°C i_F = 6 Amps, T_C = +125°C	v_F	 0.6 0.45 0.7 0.625	Volts
Maximum Instantaneous Reverse Current (2) (Rated dc Voltage, T_C = +25°C) (Rated dc Voltage, T_C = +125°C)	i_R	 0.2 20	mA

(1) Rating applies when surface mounted on the minimum pad size recommended.
(2) Pulse Test: Pulse Width = 300 μs, Duty Cycle ≤ 2%.

TYPICAL CHARACTERISTICS

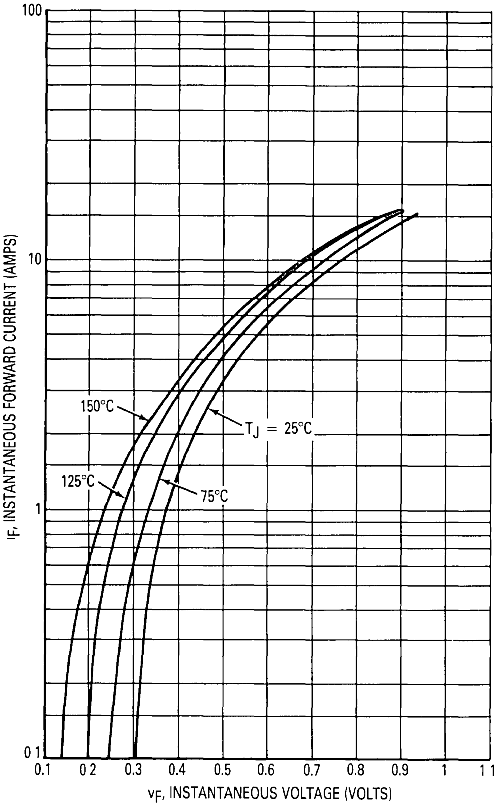
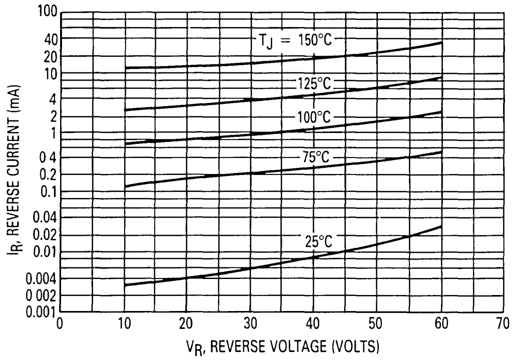


Figure 1. Typical Forward Voltage



*The curves shown are typical for the highest voltage device in the voltage grouping Typical reverse current for lower voltage selections can be estimated from these curves if V_R is sufficient below rated V_R

Figure 2. Typical Reverse Current

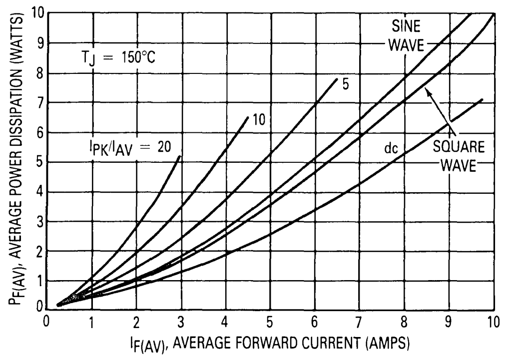


Figure 3. Average Power Dissipation

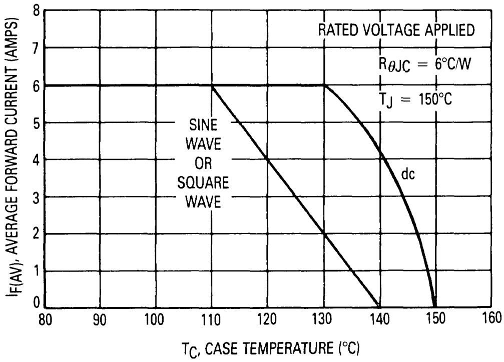


Figure 4. Current Derating, Case

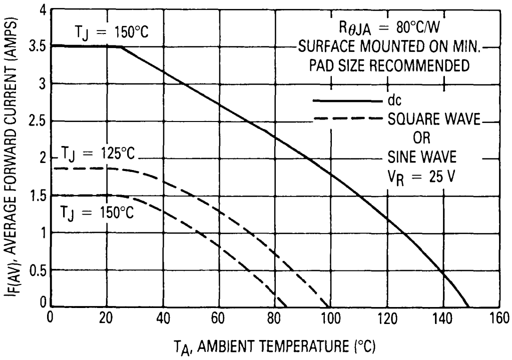


Figure 5. Current Derating, Ambient

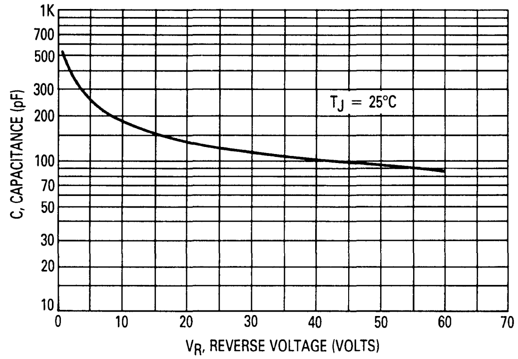
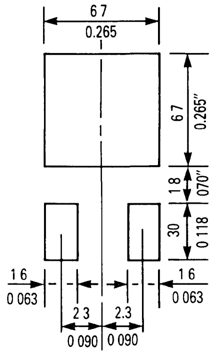


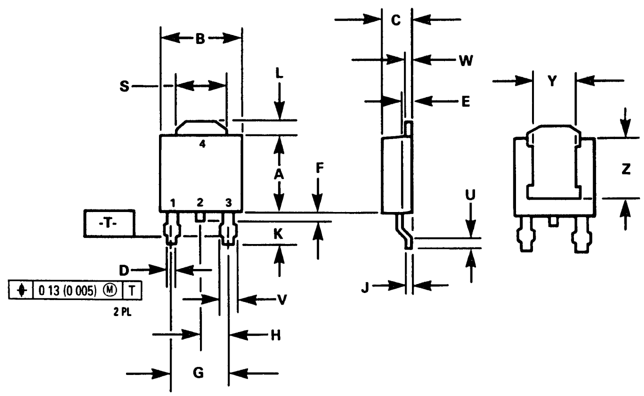
Figure 6. Typical Capacitance

MINIMUM PAD SIZES RECOMMENDED FOR SURFACE MOUNTED APPLICATIONS



3

OUTLINE DIMENSIONS



DIM	MILLIMETERS MIN	MILLIMETERS MAX	INCHES MIN	INCHES MAX
A	5 97	6 22	0.235	0.245
B	6 35	6.73	0.250	0.265
C	2.19	2.38	0.086	0.094
D	0 69	0 88	0.027	0.035
E	0.97	1.06	0 038	0.042
F	0 64	0.88	0.025	0 035
G	4.58 BSC		0 180 BSC	
H	2 29 BSC		0.090 BSC	
J	6.46	0.58	0 018	0.023
K	2.59	2.89	0.102	0.114
L	0 89	1.27	0.035	0.050
S	5.21	5.46	0.205	0.215
U	0.51	—	0.020	—
V	0 77	1.14	0.030	0 045
W	0.84	0.94	0.033	0 037
Y	4.32	—	0.170	—
Z	3.69	—	0.145	—

STYLE 3
PIN 1. ANODE
2 CATHODE
3 ANODE
4. CATHODE

CASE 369A-04
PLASTIC

NOTES
1. SURFACE "T" IS BOTH A DATUM AND A MOUNTING SURFACE.
2. DIMENSIONING AND TOLERANCING PER ANSI Y14.5M, 1982.
3 CONTROLLING DIMENSION· INCH

MBRD620CT MBRD630CT MBRD640CT MBRD650CT MBRD660CT

Switchmode Power Rectifiers

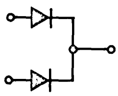
DPAK Surface Mount Package

. . . in switching power supplies, inverters and as free wheeling diodes, these state-of-the-art devices have the following features:

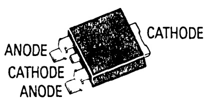
- Extremely Fast Switching
- Extremely Low Forward Drop
- Platinum Barrier with Avalanche Guardrings
- Guaranteed Reverse Avalanche

Mechanical Characteristics

- Case: Epoxy, Molded
- Finish: All External Surface Corrosion Resistance and Terminal Leads are Readily Solderable
- Lead Formed for Surface Mount
- Available in 16 mm Tape and Reel or Plastic Rails
- Compact Size
- Lead and Mounting Surface Temperature for Soldering Purposes 260°C Max. for 10 Seconds



SCHOTTKY BARRIER RECTIFIERS
6 AMPERES
20 TO 60 VOLTS



CASE 369A-04
PLASTIC

MAXIMUM RATINGS

Rating	Symbol	MBRD					Unit
		620CT	630CT	640CT	650CT	660CT	
Peak Repetitive Reverse Voltage Working Peak Reverse Voltage DC Blocking Voltage	V_{RRM} V_{RWM} V_R	20	30	40	50	60	Volts
Average Rectified Forward Current Per Diode T_C = 130°C (Rated V_R) Per Device	$I_{F(AV)}$			3 6			Amps
Peak Repetitive Forward Current, T_C = 130°C (Rated V_R, Square Wave, 20 kHz) Per Diode	I_{FRM}			6			Amps
Nonrepetitive Peak Surge Current (Surge applied at rated load conditions halfwave, single phase, 60 Hz)	I_{FSM}			75			Amps
Peak Repetitive Reverse Surge Current (2 μs, 1 kHz)	I_{RRM}			1			Amp
Operating Junction Temperature	T_J			−65 to +150			°C
Storage Temperature	T_{stg}			−65 to +175			°C
Voltage Rate of Change (Rated V_R)	dv/dt			1000			V/μs

THERMAL CHARACTERISTICS PER DIODE

Maximum Thermal Resistance, Junction to Case	$R_{\theta JC}$	6	°C/W
Maximum Thermal Resistance, Junction to Ambient (1)	$R_{\theta JA}$	80	°C/W

ELECTRICAL CHARACTERISTICS PER DIODE

Maximum Instantaneous Forward Voltage (2) i_F = 3 Amps, T_C = 25°C i_F = 3 Amps, T_C = 125°C i_F = 6 Amps, T_C = 25°C i_F = 6 Amps, T_C = 125°C	v_F	 0.7 0.65 0.9 0.85	Volts
Maximum Instantaneous Reverse Current (2) (Rated dc Voltage, T_C = 25°C) (Rated dc Voltage, T_C = 125°C)	i_R	 0.1 15	mA

(1) Rating applies when surface mounted on the minimum pad size recommended.
(2) Pulse Test: Pulse Width = 300 μs, Duty Cycle ≤ 2%

TYPICAL CHARACTERISTICS

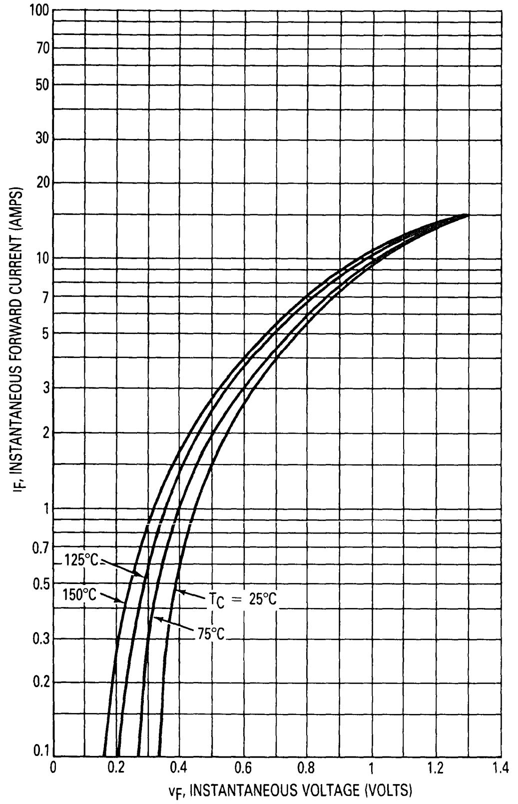
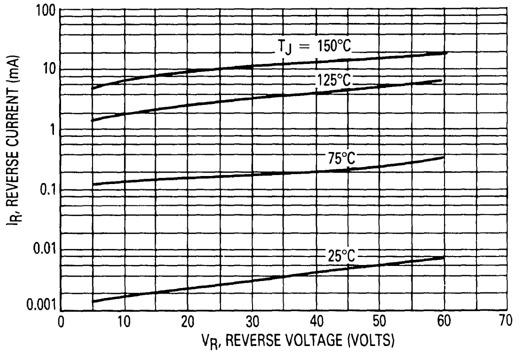


Figure 1. Typical Forward Voltage, Per Leg



*The curves shown are typical for the highest voltage device in the voltage grouping. Typical reverse current for lower voltage selections can be estimated from these curves if V_R is sufficient below rated V_R

Figure 2. Typical Reverse Current,* Per Leg

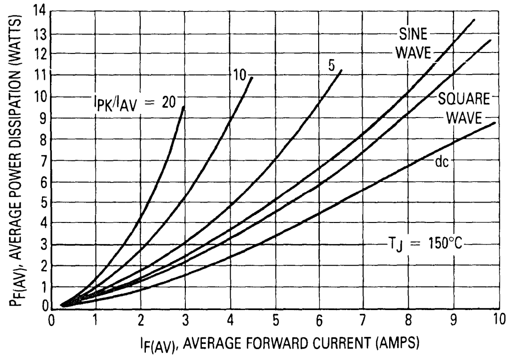


Figure 3. Average Power Dissipation, Per Leg

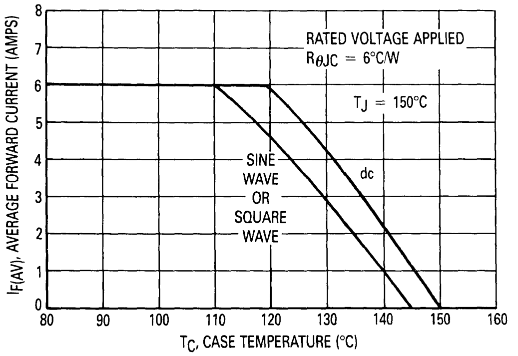


Figure 4. Current Derating, Case, Per Leg

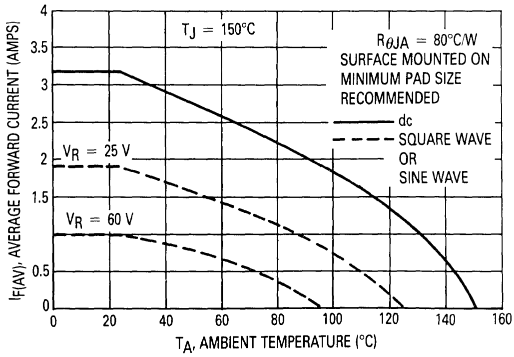


Figure 5. Current Derating, Ambient, Per Leg

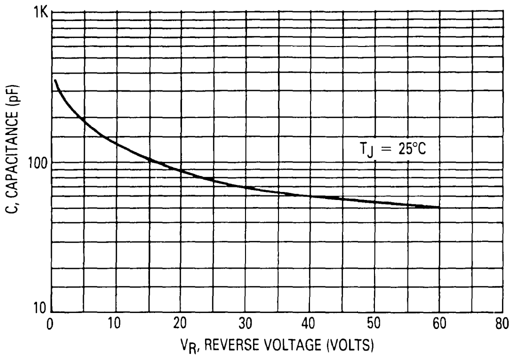
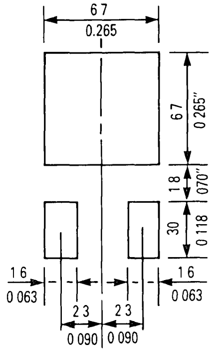


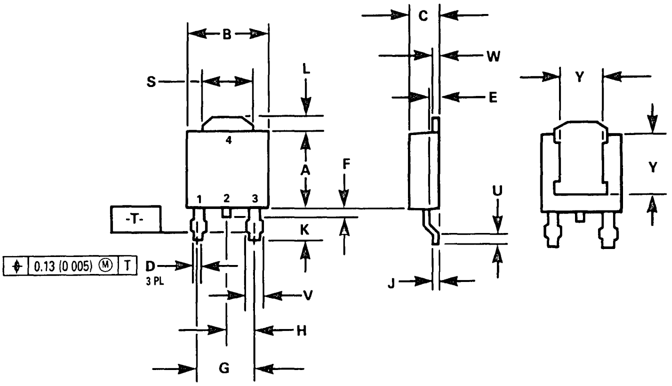
Figure 6. Typical Capacitance, Per Leg

MINIMUM PAD SIZES RECOMMENDED FOR SURFACE MOUNTED APPLICATIONS



3

OUTLINE DIMENSIONS



DIM	MILLIMETERS		INCHES	
	MIN	MAX	MIN	MAX
A	5 97	6 22	0 235	0 245
B	6 35	6 73	0 250	0 265
C	2 19	2 38	0 086	0 094
D	0 69	0 88	0 027	0 035
E	0 97	1 06	0 038	0 042
F	0 64	0 88	0 025	0 035
G	4 58 BSC		0 180 BSC	
H	2 29 BSC		0 090 BSC	
J	6 46	0 58	0 018	0 023
K	2 59	2 89	0 102	0 114
L	0 89	1 27	0 035	0 050
S	5 21	5 46	0 205	0 215
U	0.51	—	0 020	—
V	0 77	1 14	0 030	0 045
W	0 84	0 94	0 033	0 037
Y	4 32	—	0 170	—

NOTES
1 SURFACE "T" IS BOTH A DATUM AND A MOUNTING SURFACE.
2 DIMENSIONING AND TOLERANCING PER ANSI Y14 5M, 1982
3 CONTROLLING DIMENSION INCH

STYLE 3
PIN 1 ANODE
2 CATHODE
3 ANODE
4 CATHODE

CASE 369A-04
PLASTIC

MBRL120
MBRL130
MBRL140

Switchmode Rectifiers

. . . designed for use in switching power supplies, inverters, and as free wheeling diodes, these devices have the following features:

- Low Forward Voltage
- Low Leakage Current
- Leadless Package for Surface Mount Technology

Mechanical Characteristics:

Case: Glass

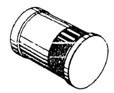
Finish: End caps are plated and are readily solderable

Polarity: Cathode indicated by polarity band

Maximum Lead Temperature For Soldering Purposes:

230°C, @ end cap for 10 seconds.

LEADLESS SCHOTTKY RECTIFIERS
1 AMPERE
20–40 VOLTS



CASE 362B-01

MAXIMUM RATINGS

Rating	Symbol	MBRL 120	MBRL 130	MBRL 140	Unit
Peak Repetitive Reverse Voltage Working Peak Reverse Voltage DC Blocking Voltage	V_{RRM} V_{RWM} V_R	20	30	40	Volts
Average Rectified Forward Current (Rated V_R) T_C = 75°C, T_A = 50°C, Mounting Per Note 1	$I_{F(AV)}$	1			Amp
Nonrepetitive Peak Surge Current (Surge applied at rated load conditions halfwave, single phase, 60 Hz)	I_{FSM}	20			Amps
Operating Junction and Storage Temperature	T_J, T_{stg}	−65 to +150			°C

THERMAL CHARACTERISTICS

Characteristic	Symbol	Typ	Max	Unit
Thermal Resistance, Junction to End Cap	$R_{\theta JC}$	40	65	°C/W

ELECTRICAL CHARACTERISTICS

Characteristic	Symbol	Max	Unit
Instantaneous Forward Voltage (1) (i_F = 1 A, T_J = 25°C) (i_F = 1 A, T_J = 125°C)	v_F	 0.690 0.650	Volts
Reverse Current (Rated dc Voltage, T_J = 125°C) (Rated dc Voltage, T_J = 25°C)	I_R	 10 0.1	mA

(1) Pulse Test: Pulse Width = 300 μs, Duty Cycle ≤ 2%.

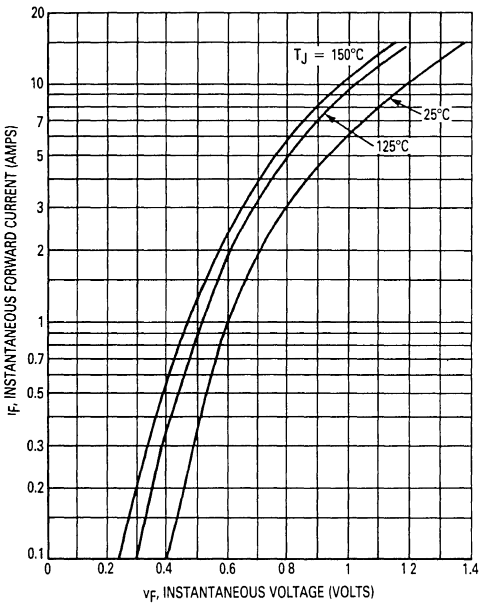
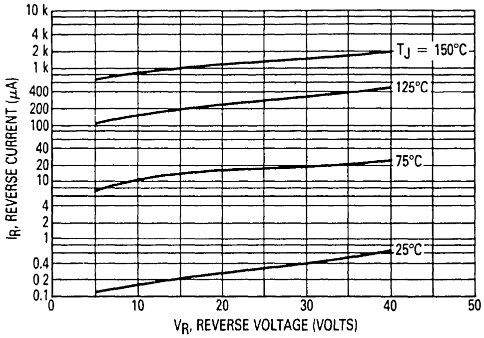


Figure 1. Typical Forward Voltage



*The curves shown are typical for the highest voltage device in the voltage grouping. Typical reverse current for lower voltage selections can be estimated from these same curves if V_R is sufficiently below rated V_R.

Figure 2. Typical Reverse Current*

3

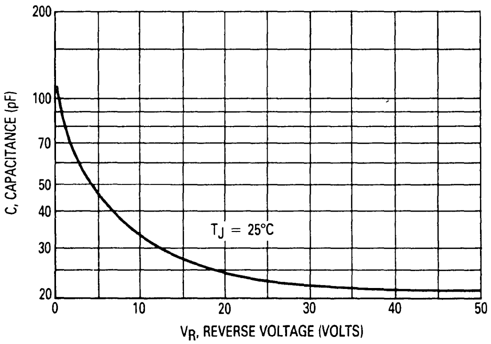


Figure 3. Typical Capacitance

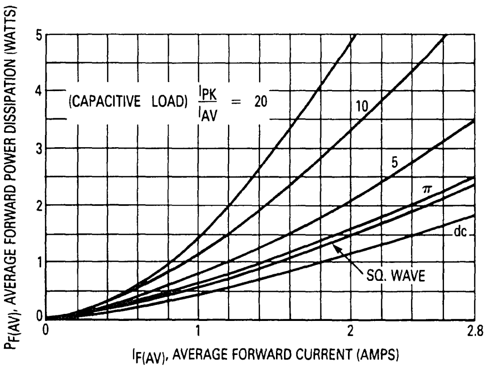


Figure 4. Forward Power Dissipation

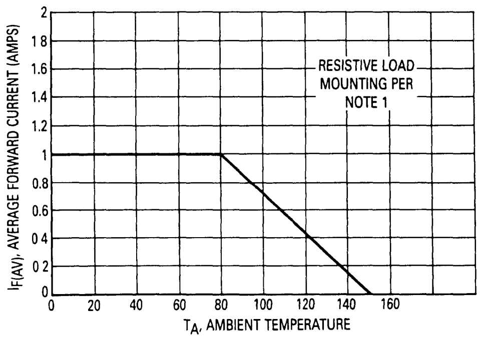
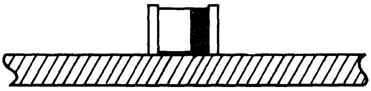


Figure 5. Current Derating, Printed Circuit Board Mounting

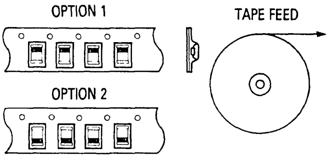
Note 1: Data shown for thermal resistance junction-to-ambient (θ_{JA}) for the mounting shown is to be used as a typical guideline values for preliminary engineering or in case the tie point temperature cannot be measured

Typical Values for θ_{JA} in Still Air = 118°C/W

PC Board with 1/4″ x 1/4″ Copper Mounting Pads



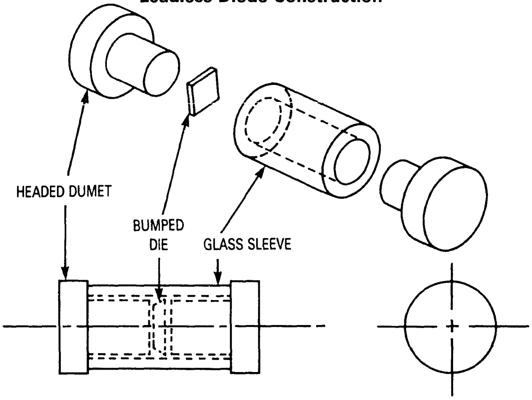
Tape & Reel Options
12 mm Tape
MLL41



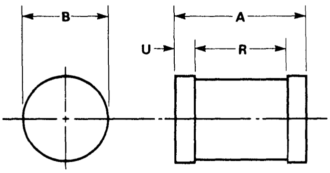
POLARITY BAND INDICATES CATHODE.

OPTION 1 = T1 DESIGNATOR
OPTION 2 = T2 DESIGNATOR

Leadless Diode Construction



OUTLINE DIMENSIONS



DIM	MILLIMETERS		INCHES	
	MIN	MAX	MIN	MAX
A	4.80	5.20	0.189	0.205
B	2.39	2.59	0.094	0.102
R	3.68	4.54	0.145	0.179
U	0.30	0.55	0.012	0.022

MLL41
CASE 362B-01

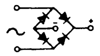
MOTOROLA
SEMICONDUCTOR
TECHNICAL DATA

MDA2500 Series

RECTIFIER ASSEMBLY

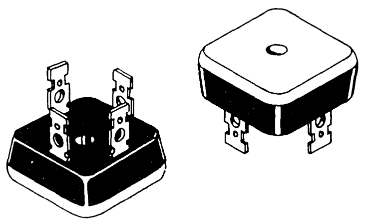
utilizing individual void-free molded rectifiers, interconnected and mounted on an electrically isolated aluminum heat sink by a high thermal-conductive epoxy resin.

- 400 Ampere Surge Capability
- Electrically Isolated Base
- UL Recognized
- 1800 Volt Heat Sink Isolation



SINGLE-PHASE
FULL-WAVE BRIDGE

25 AMPERES
50-600 VOLTS



3

MAXIMUM RATINGS

Rating (Per Diode)	Symbol	MDA 2500	2501	2502	2504	2506	2508	2510	Unit
Peak Repetitive Reverse Voltage Working Peak Reverse Voltage DC Blocking Voltage	V_{RRM} V_{RWM} V_R	50	100	200	400	600	800	1000	Volts
DC Output Voltage Resistive Load Capacitive Load	Vdc	 30 50	 62 100	 124 200	 250 400	 380 600	 500 600	 620 1000	Volts
Sine Wave RMS Input Voltage	$V_{R(RMS)}$	35	70	140	280	420	560	700	Volts
Average Rectified Forward Current (Single phase bridge resistive load, 60 Hz, T_C = 55°C)	I_O	25							Amp
Nonrepetitive Peak Surge Current (Surge applied at rated load conditions)	I_{FSM}	400							Amp
Operating and Storage Junction Temperature Range	T_J, T_{stg}	−65 to +175							°C

THERMAL CHARACTERISTICS

Characteristic	Symbol	Typ	Max	Unit
Thermal Resistance, Junction to Case Each Die Total Bridge	$R_{\theta JC}$	 4.5 2.0	 6 0 2.8	°C/W

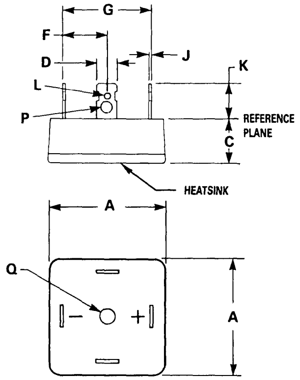
ELECTRICAL CHARACTERISTICS (T_C = 25°C unless otherwise noted)

Characteristic	Symbol	Min	Typ	Max	Unit
Instantaneous Forward Voltage (Per Diode) (i_F = 40 A)*	v_F	–	0 95	1 05	Volts
Reverse Current (Per Diode) (Rated V_R)	I_R	–	–	10	μA

MECHANICAL CHARACTERISTICS

CASE: Plastic case with an electrically isolated aluminum base.
POLARITY: Terminal designation embossed on case:
+DC output
−DC output
AC not marked
MOUNTING POSITION: Bolt down. Highest heat transfer efficiency accomplished through the surface opposite the terminals. Use silicone heat sink compound on mounting surface for maximum heat transfer.
WEIGHT: 25 grams (approx.)
TERMINALS: Suitable for fast-on connections. Readily solderable, corrosion resistant. Soldering recommended for applications greater than 15 amperes.
MOUNTING TORQUE: 20 in-lb max

*Pulse Width = 100 ms, Duty Cycle ≤ 2%



NOTES
1 DIMENSION "Q" SHALL BE MEASURED ON HEATSINK SIDE OF PACKAGE
2 DIMENSIONS "F" AND "G" SHALL BE MEASURED AT THE REFERENCE PLANE.

DIM	MILLIMETERS MIN	MAX	INCHES MIN	MAX
A	25 65	26 16	1 010	1 030
C	12 44	13 97	0 490	0 550
D	6 10	6 60	0 240	0 260
F	10 01	10 49	0 394	0 413
G	19 99	21 01	0 787	0 827
J	0 71	0 86	0 028	0 034
K	9 52	11 43	0 375	0 450
L	1 52	2 06	0 060	0 081
P	2 79	2 92	0 110	0 115
Q	4 42	4 67	0 174	0 184

CASE 309A-03

3

FIGURE 1 — FORWARD VOLTAGE

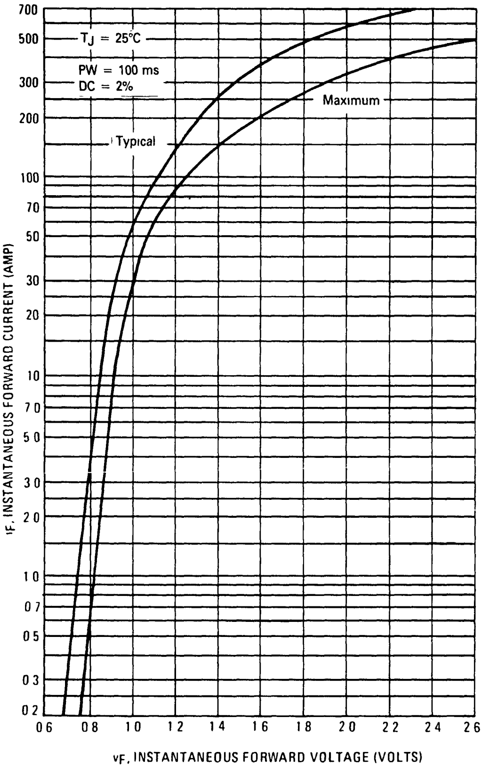


FIGURE 2 — NON REPETITIVE SURGE CURRENT

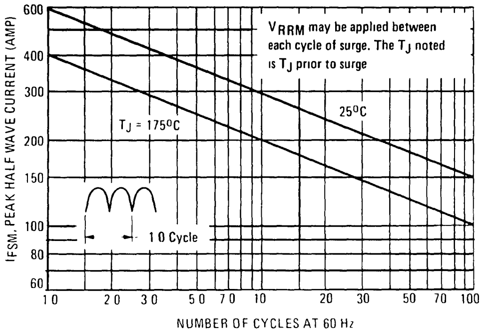


FIGURE 3 — FORWARD VOLTAGE TEMPERATURE COEFFICIENT

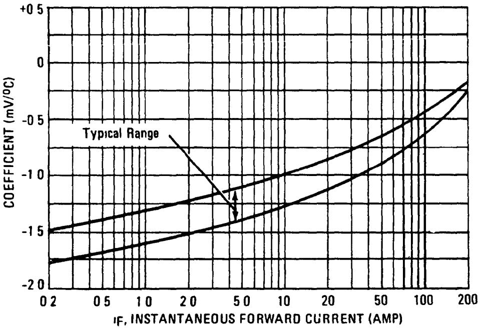


FIGURE 4 — CURRENT DERATING

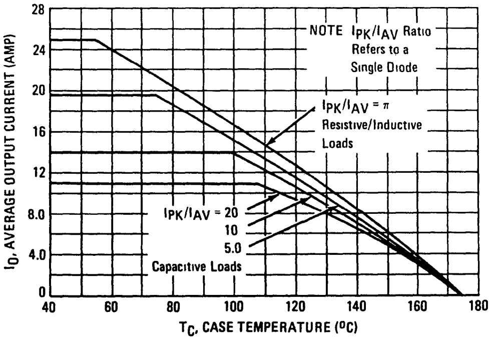


FIGURE 5 — FORWARD POWER DISSIPATION

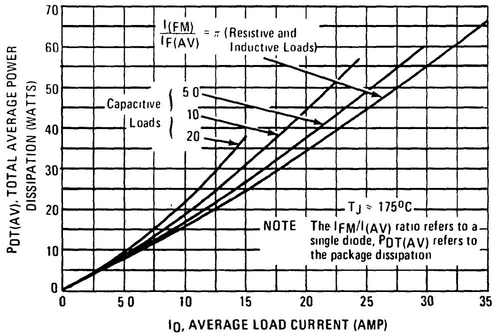
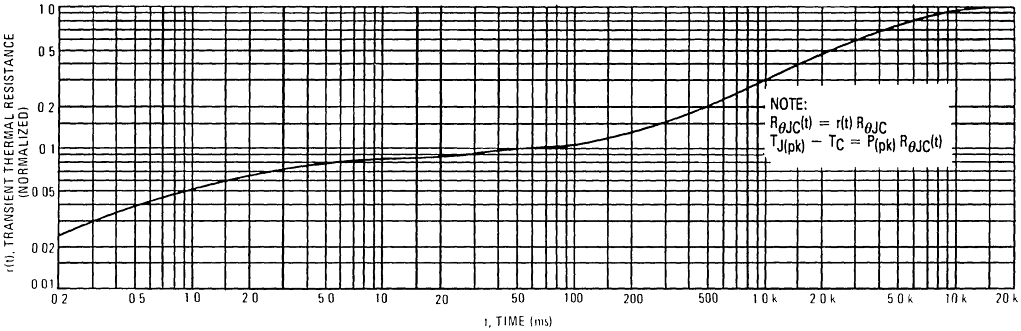
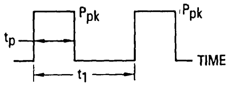


FIGURE 6 — TYPICAL THERMAL RESPONSE



NOTE 1



DUTY CYCLE, $D = t_p/t_1$
PEAK POWER, P_{pk}, is peak of an equivalent square power pulse.

To determine maximum junction temperature of the diode in a given situation, the following procedure is recommended.

The temperature of the case should be measured using a thermocouple placed on the case at the temperature reference point (see the outline drawing on page 1). The thermal mass connected to the case is normally large enough so that it will not significantly respond to heat surges generated in the diode as a result of pulsed operation once steady state conditions are achieved. Using the measured value of T_C, the junction temperature may be determined by

$$T_J = T_C + \Delta T_{JC}$$

where ΔT_{JC} is the increase in junction temperature above the case temperature. It may be determined by:

$$\Delta T_{JC} = P_{pk} \bullet R_{\theta JC} [D + (1 - D) \bullet r(t_1 + t_p) + r(t_p) - r(t_1)]$$

where

$r(t)$ = normalized value of transient thermal resistance at time, t, from Figure 6, i.e.,
$r(t_1 + t_p)$ = normalized value of transient thermal resistance at time $t_1 + t_p$

FIGURE 7 — CAPACITANCE

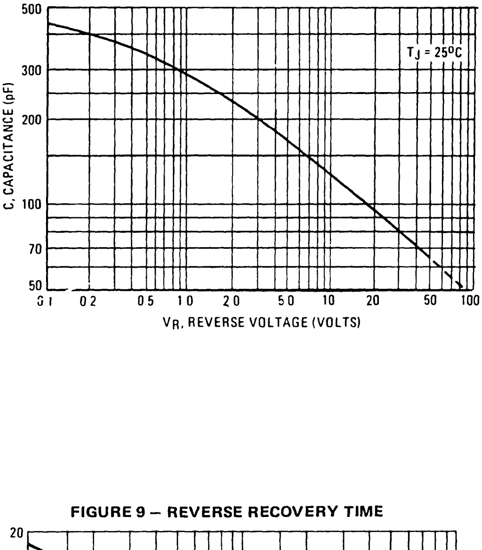


FIGURE 8 — FORWARD RECOVERY TIME

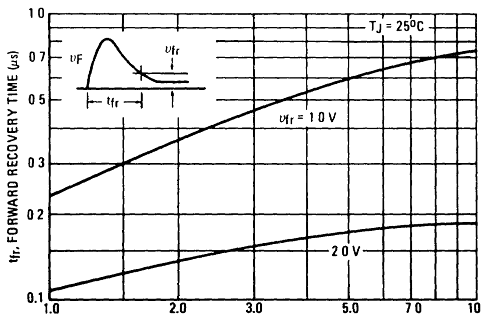
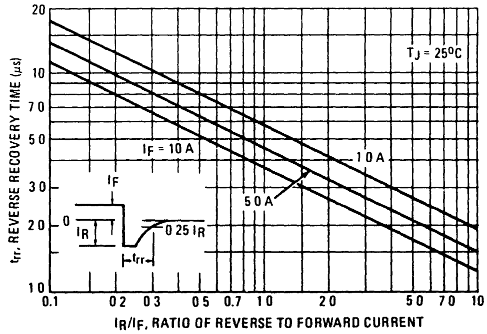


FIGURE 9 — REVERSE RECOVERY TIME



AMBIENT TEMPERATURE DERATING INFORMATION

FIGURE 10A – THERMALLOY HEAT SINK 6005B

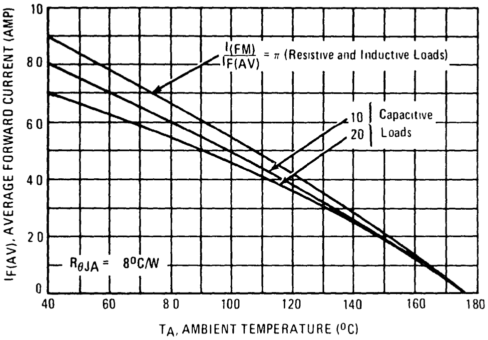
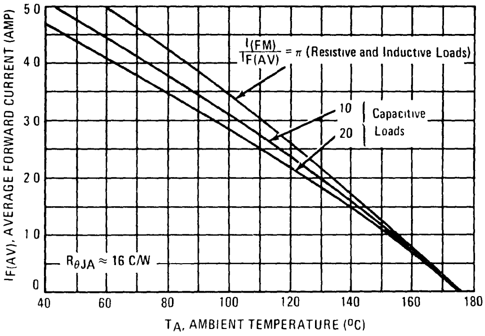


FIGURE 10B – IERC HEAT SINK UP3



NOTE 2: THERMAL COUPLING AND EFFECTIVE THERMAL RESISTANCE

In multiple chip devices where there is coupling of heat between die, the junction temperature can be calculated as follows

(1) $\Delta T_{J1} = R_{\theta 1}P_{D1} + R_{\theta 2}K_{\theta 2}P_{D2} + R_{\theta 3}K_{\theta 3}P_{D3} + R_{\theta 4}K_{\theta 4}P_{D4}$

where ΔT_{J1} is the change in junction temperature of diode 1, $R_{\theta 1}$ through 4 is the thermal resistance of diodes 1 through 4, P_{D1} through 4 is the power dissipated in diodes 1 through 4, $K_{\theta 2}$ through 4 is the thermal coupling between diode 1, and diodes 2 through 4

An effective package thermal resistance can be defined as follows.

$$(2)\ R_{\theta(EFF)} = \Delta T_{J1}/P_{DT}$$

where P_{DT} is the total package power dissipation

Assuming equal thermal resistance for each die, equation (1) simplifies to

$$(3)\ \Delta T_{J1} = R_{\theta 1}(P_{D1} + K_{\theta 2}P_{D2} + K_{\theta 3}P_{D3} + K_{\theta 4}P_{D4})$$

For the conditions where $P_{D1} = P_{D2} = P_{D3} = P_{D4}$, $P_{DT} = 4\ P_{D1}$, equation (3) can be further simplified and by substituting into equation (2) results in

$$(4)\ R_{\theta(EFF)} = R_{\theta 1}(1 + K_{\theta 2} + K_{\theta 3} + K_{\theta 4})/4$$

When the case is used as a reference point, coupling between opposite die is negligible for the MDA2500, and coupling between adjacent die is approximately 6%.

NOTE 3: SPLIT LOAD DERATING INFORMATION

Bridge rectifiers are used in two basic configurations as shown by circuits A and B of Figure 11 The current derating data of Figure 4 applies to the standard bridge circuit (A) where $I_A = I_B$. For circuit B where $I_A = I_B$, derating information can be calculated as follows

$$(6)\ T_{R(max)} = T_{J(max)} - \Delta T_{J1}$$

Where $T_{R(max)}$ is the reference temperature (either case or ambient), ΔT_{J1} can be calculated using equation (3) in Note 2

For example, to determine $T_{C(max)}$ for the MDA2500 with the following capacitive load conditions·

I_A = 20 A average with a peak of 60 A,
I_B = 10 A average with a peak of 70 A,

first calculate the peak to average ratio for I_A $I_{(PK)}/I_{(AV)}$ = 60/10 = 6 0 (Note that the peak to average ratio is on a per diode basis and each diode provides 10 A average.)

From Figure 5, for an average current of 20 A and an $I_{(PK)}/I_{(AV)}$ = 6 0, read $P_{DT(AV)}$ = 40 watts or 10 watts/diode Thus $P_{D1} = P_{D3}$ = 10 watts

Similarly, for a load current I_B of 10 A, diode #2 and diode #4 each see 5 0 A average resulting in an $I_{(PK)}/I_{(AV)}$ = 14

Thus, the package power dissipation for 10 A is 20 watts or 5 0 watts/diode Therefore, $P_{D2} = P_{D4}$ = 5 0 watts

The maximum junction temperature occurs in diodes #1 and #3. From equation (3) for diode #1,

$$\Delta T_{J1} = 10[10 + 0(5) + 0.06(10) + 0\ 06(5)]$$

$$\Delta T_{J1} \approx 109^{\circ}C.$$

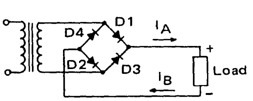
Thus, $T_{C(max)}$ = 175 – 109 = 66°C

The total package dissipation in this example is

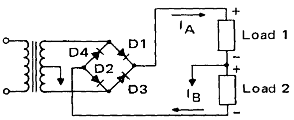
$$P_{DT(AV)} = 2 \times 10 + 2 \times 5\ 0 = 30 \text{ watts},$$

which must be considered when selecting a heat sink.

FIGURE 11 – BASIC CIRCUIT USES FOR BRIDGE RECTIFIERS



Circuit A



Circuit B

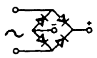
MOTOROLA SEMICONDUCTOR TECHNICAL DATA

MDA3500 Series

RECTIFIER ASSEMBLY

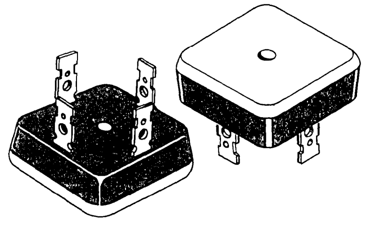
. . . utilizing individual void-free molded MR2500 Series rectifiers, interconnected and mounted on an electrically isolated aluminum heat sink by a high thermal-conductive epoxy resin.

- 400 Ampere Surge Capability
- Electrically Isolated Base —1800 Volts
- UL Recognized
- Cost Effective in Lower Current Applications



SINGLE-PHASE FULL-WAVE BRIDGE

35 AMPERES 50-1000 VOLTS



MAXIMUM RATINGS

Rating (Per Diode)	Symbol	MDA 3500	3501	3502	3504	3506	3508	3510	Unit
Peak Repetitive Reverse Voltage Working Peak Reverse Voltage DC Blocking Voltage	V_{RRM} V_{RWM} V_R	50	100	200	400	600	800	1000	Volts
DC Output Voltage Resistive Load Capacitive Load	 Vdc Vdc	 30 50	 62 100	 124 200	 250 400	 380 600	 500 800	 630 1000	 Volts Volts
Sine Wave RMS Input Voltage	$V_{R(RMS)}$	35	70	140	280	420	560	700	Volts
Average Rectified Forward Current (Single phase bridge resistive load, 60 Hz, $T_C = 55°C$)	I_O	← 35 →							Amp
Non-Repetitive Peak Surge Current (Surge applied at rated load conditions)	I_{FSM}	← 400 →							Amp
Operating and Storage Junction Temperature Range	T_J, T_{stg}	← −65 to +175 →							°C

THERMAL CHARACTERISTICS (Total Bridge)

Characteristic	Symbol	Typ	Max	Unit
Thermal Resistance, Junction to Case	$R_{\theta JC}$	1.4	1.87	°C/W

ELECTRICAL CHARACTERISTICS ($T_C = 25°C$ unless otherwise noted)

Characteristic	Symbol	Min	Typ	Max	Unit
Instantaneous Forward Voltage (Per Diode) ($i_F = 55$ A)*	v_F	—	1.0	1.1	Volts
Reverse Current (Per Diode) (Rated V_R)	I_R	—	—	10	µA

MECHANICAL CHARACTERISTICS

CASE: Plastic case with an electrically isolated aluminum base.

POLARITY: Terminal designation embossed on case:
+DC output
−DC output
AC not marked

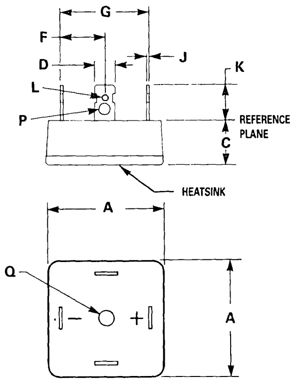
MOUNTING POSITION: Bolt down. Highest heat transfer efficiency accomplished through the surface opposite the terminals. Use silicone grease on mounting surface for maximum heat transfer.

WEIGHT: 40 grams (approx.)

TERMINALS: Suitable for fast-on connections. Readily solderable, corrosion resistant. Soldering recommended for applications greater than 15 amperes.

MOUNTING TORQUE: 20 in-lb max

*Pulse Width = 100 ms, Duty Cycle ≤ 2%



NOTES
1 DIMENSION "Q" SHALL BE MEASURED ON HEATSINK SIDE OF PACKAGE
2 DIMENSIONS F AND G SHALL BE MEASURED AT THE REFERENCE PLANE

DIM	MILLIMETERS MIN	MAX	INCHES MIN	MAX
A	34.80	35.18	1.370	1.385
C	12.44	13.97	0.490	0.550
D	6.10	6.60	0.240	0.260
F	13.97	14.50	0.550	0.571
G	28.00	29.00	1.100	1.142
J	0.71	0.86	0.028	0.034
K	9.52	11.43	0.375	0.450
L	1.52	2.06	0.060	0.081
P	2.79	2.92	0.110	0.115
Q	4.32	4.83	0.170	0.190

CASE 309A-02

3

3

FIGURE 1 — FORWARD VOLTAGE

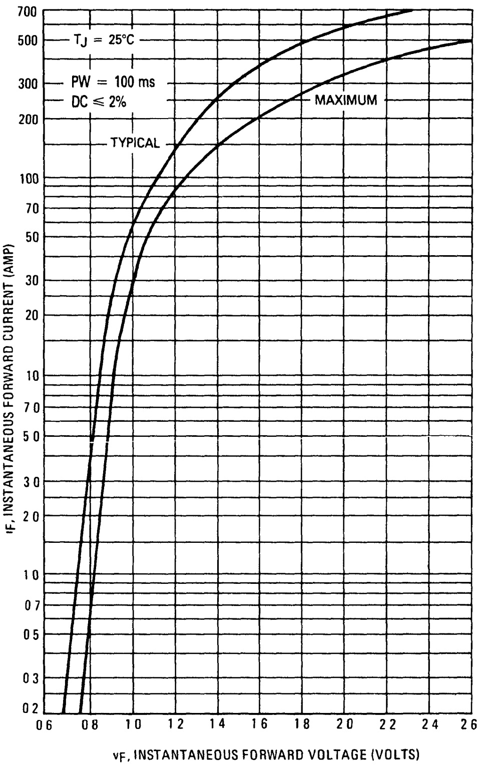


FIGURE 2 — NON REPETITIVE SURGE CURRENT

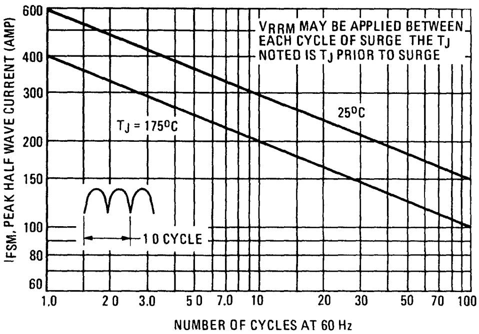


FIGURE 3 — FORWARD VOLTAGE TEMPERATURE COEFFICIENT

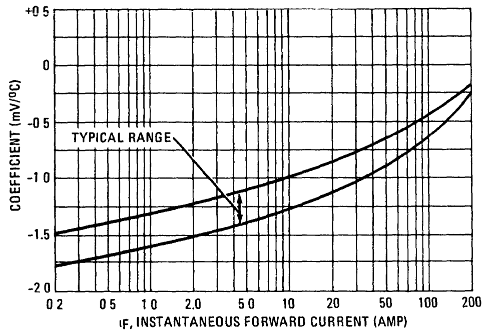


FIGURE 4 — CURRENT DERATING

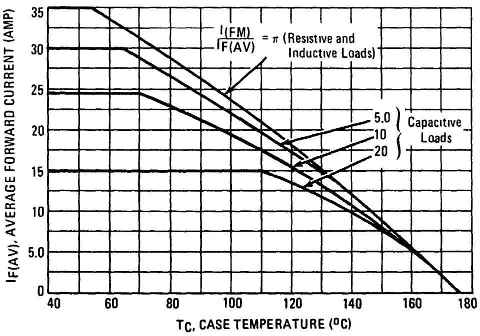


FIGURE 5 — FORWARD POWER DISSIPATION

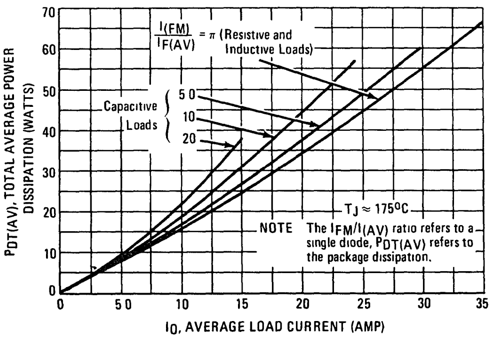
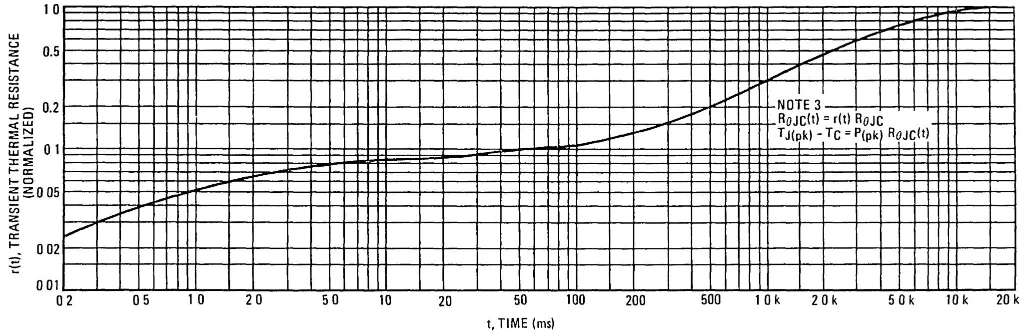
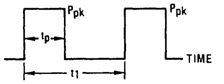


FIGURE 6 — TYPICAL THERMAL RESPONSE



NOTE 1



DUTY CYCLE, $D = t_p/t_1$
PEAK POWER, P_{pk}, is peak of an equivalent square power pulse

To determine maximum junction temperature of the diode in a given situation, the following procedure is recommended

The temperature of the case should be measured using a thermocouple placed on the case at the temperature reference point (see the outline drawing on page 1) The thermal mass connected to the case is normally large enough so that it will not significantly respond to heat surges generated in the diode as a result of pulsed operation once steady state conditions are achieved Using the measured value of T_C, the junction temperature may be determined by

$$T_J = T_C + \Delta T_{JC}$$

where ΔT_{JC} is the increase in junction temperature above the case temperature It may be determined by

$$\Delta T_{JC} = P_{pk} \bullet R_{\theta JC} [D + (1 - D) \bullet r(t_1 + t_p) + r(t_p) - r(t_1)]$$

where

$r(t)$ = normalized value of transient thermal resistance at time, t, from Figure 6, i e ,

$r(t_1 + t_p)$ = normalized value of transient thermal resistance at time $t_1 + t_p$

FIGURE 7 — CAPACITANCE

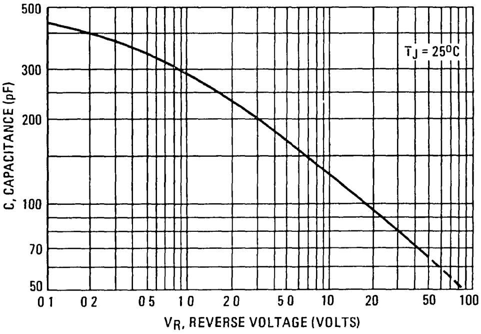


FIGURE 8 — FORWARD RECOVERY TIME

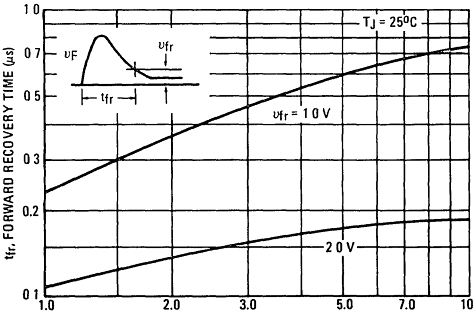
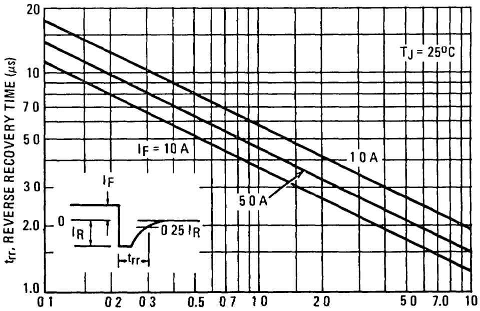


FIGURE 9 — REVERSE RECOVERY TIME



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AMBIENT TEMPERATURE DERATING INFORMATION

FIGURE 10A – THERMALLOY HEATSINK 6005B

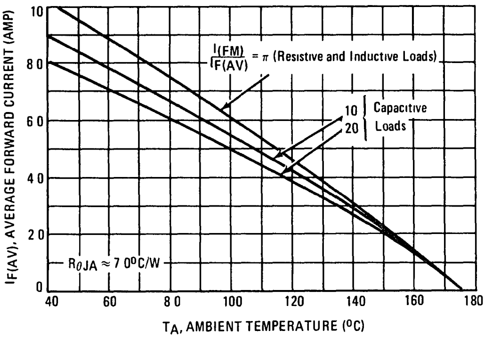
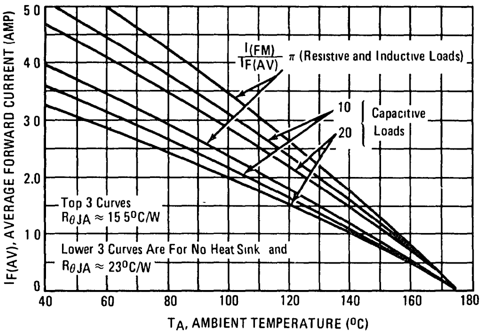


FIGURE 10B – IERC HEATSINK UP3 AND NO HEATSINK



NOTE 2: THERMAL COUPLING AND EFFECTIVE THERMAL RESISTANCE

In multiple chip devices where there is coupling of heat between die, the junction temperature can be calculated as follows:

(1) $\Delta T_{J1} = R_{\theta 1} P_{D1} + R_{\theta 2} K_{\theta 2} P_{D2} + R_{\theta 3} K_{\theta 3} P_{D3} + R_{\theta 4} K_{\theta 4} P_{D4}$

Where ΔT_{J1} is the change in junction temperature of diode 1
$R_{\theta 1}$ thru 4 is the thermal resistance of diodes 1 through 4
P_{D1} thru 4 is the power dissipated in diodes 1 through 4
$K_{\theta 2}$ thru 4 is the thermal coupling between diode 1 and diodes 2 through 4.

An effective package thermal resistance can be defined as follows:

(2) $R_{\theta(EFF)} = \Delta T_{J1}/P_{DT}$

Where P_{DT} is the total package power dissipation

Assuming equal thermal resistance for each die, equation (1) simplifies to

(3) $\Delta T_{J1} = R_{\theta 1} (P_{D1} + K_{\theta 2}P_{D2} + K_{\theta 3}P_{D3} + K_{\theta 4}P_{D4})$

For the conditions where $P_{D1} = P_{D2} = P_{D3} = P_{D4}$, $P_{DT} = 4 P_{D1}$, equation (3) can be further simplified and by substituting into equation (2) results in

(4) $R_{\theta(EFF)} = R_{\theta 1} (1 + K_{\theta 2} + K_{\theta 3} + K_{\theta 4})/4$

When the case is used as a reference point, coupling between die is neglegible for the MDA3500. When the bridge is used without a heatsink, coupling between die is approximately 70% and $R_{\theta 1}$ is 30°C/W,

$\therefore R_{\theta(EFF)} = 30\ [1 + (3)\ (.7)]\ /4 = 23$°C/W

NOTE 3: SPLIT LOAD DERATING INFORMATION

Bridge rectifiers are used in two basic configurations as shown by circuits A and B of Figure 11. The current derating data of Figure 4 applies to the standard bridge circuit (A) where $I_A = I_B$. For circuit B where $I_A \neq I_B$, derating information can be calculated as follows:

(6) $T_{R(Max)} = T_{J(Max)} - \Delta T_{J1}$

Where $T_{R(Max)}$ is the reference temperature (either case or ambient)

ΔT_{J1} can be calculated using equation (3) in Note 2.

For example, to determine $T_{C(Max)}$ for the MDA3500 with the following capacitive load conditons.

I_A = 20 A average with a peak of 60 A
I_B = 10 A average with a peak of 70 A

First calculate the peak to average ratio for I_A. $I_{(PK)}/I_{(AV)}$ = 60/10 = 6.0. (Note that the peak to average ratio is on a per diode basis and each diode provides 10 A average).

From Figure 5, for an average current of 20 A and an $I_{(PK)}/I_{(AV)}$ = 6.0 read $P_{DT(AV)}$ = 40 watts or 10 watts/diode. Thus $P_{D1} = P_{D3}$ = 10 watts.

Similarly, for a load current I_B of 10 A, diode #2 and diode #4 each see 5.0 A average resulting in an $I_{(PK)}/I_{(AV)}$ = 14.

Thus, the package power dissipation for 10 A is 20 watts or 5.0 watts/diode $\therefore P_{D2} = P_{D4}$ = 5.0 watts.

The maximum junction temperature occurs in diode #1 and #3. From equation (3) for diode #1 ΔT_{J1} = (7.5) (10), since coupling is negligible.

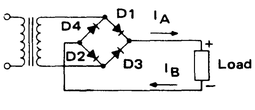
$\Delta T_{J1} \approx 75$°C

Thus $T_{C(Max)}$ = 175 – 75 = 100°C

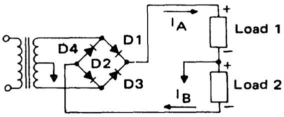
The total package dissipation in this example is:

$P_{DT(AV)}$ = 2 x 10 + 2 x 5.0 = 30 watts, which must be considered when selecting a heat sink.

FIGURE 11– BASIC CIRCUIT USES FOR BRIDGE RECTIFIERS



Circuit A



Circuit B

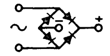
MOTOROLA
SEMICONDUCTOR
TECHNICAL DATA

MDA4002
MDA4004
MDA4006
MDA4008

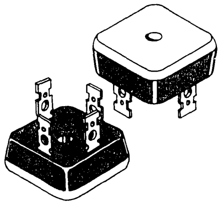
Rectifier Assembly

. . . utilizing individual void-free molded rectifiers, interconnected and mounted on an electrically isolated aluminum heat sink by a high thermal-conductive epoxy resin.

- Surge and Overload Capability of 525 A
- Electrically Isolated Base
- High Current, Low v_F
- 2500 V Isolation



SINGLE-PHASE FULL-WAVE BRIDGE
40 AMPERES
200–800 VOLTS



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Mechanical Characteristics

CASE: Plastic case with an electrically isolated aluminum base.
POLARITY: Terminal-designation embossed on case
+DC output
−DC output
AC not marked
MOUNTING POSITION: Bolt down. Highest heat transfer efficiency accomplished through the surface opposite the terminals. Use silicon grease on mounting surface for maximum heat transfer.
WEIGHT: 40 grams (approx.)
TERMINALS: Suitable for fast-on connections. Readily solderable, corrosion resistant. Soldering recommended for applications greater than 15 Amperes.
MOUNTING TORQUE: 20 in-lb max

MAXIMUM RATINGS

Rating (Per Diode)	Symbol	MDA 4002	4004	4006	4008	Unit
Peak Repetitive Reverse Voltage Working Peak Reverse Voltage DC Blocking Voltage	V_{RRM} V_{RWM} V_R	200	400	600	800	Volts
DC Output Voltage — Resistive Load — Capacitive Load	Vdc	124 200	250 400	375 600	500 800	Volts
Sine Wave RMS Input Voltage	V_R (RMS)	140	280	420	560	Volts
Average Rectified Forward Current (Single phase bridge resistive load, 60 Hz, T_C = 35°C)	I_O	40				Amps
Non-Repetitive Peak Surge Current (Surge applied at rated load conditions)	I_{FSM}	525				Amps
Operating and Storage Junction Temperature Range	T_J, T_{stg}	−65 to +175				°C

THERMAL CHARACTERISTICS (Total Bridge)

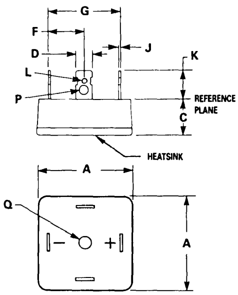
Characteristic	Symbol	Typ	Max	Unit
Thermal Resistance, Junction to Case	$R_{\theta JC}$	1.4	1.87	°C/W

ELECTRICAL CHARACTERISTICS (T_C = 25°C unless otherwise noted).

Characteristic	Symbol	Min	Typ	Max	Unit
Instantaneous Forward Voltage (i_F = 40 A)*	v_F	—	0.95	1.05	Volts
Reverse Current (Per Diode) (Rated V_R)	I_R	—	—	10	μA

*300 μs < 2% DC

OUTLINE DIMENSIONS



NOTES
1 DIMENSION "Q" SHALL BE MEASURED ON HEATSINK SIDE OF PACKAGE
2 DIMENSIONS F AND G SHALL BE MEASURED AT THE REFERENCE PLANE

DIM	MILLIMETERS MIN	MILLIMETERS MAX	INCHES MIN	INCHES MAX
A	34 80	35 18	1 370	1 385
C	12 44	13 97	0 490	0 550
D	6 10	6 60	0 240	0 260
F	13 97	14 50	0 550	0 571
G	28 00	29 00	1 100	1 142
J	0 71	0 86	0 028	0 034
K	9 52	11 43	0 375	0 450
L	1 52	2 06	0 060	0 081
P	2 79	2 92	0 110	0 115
Q	4 32	4 83	0 170	0 190

CASE 309A-02

3

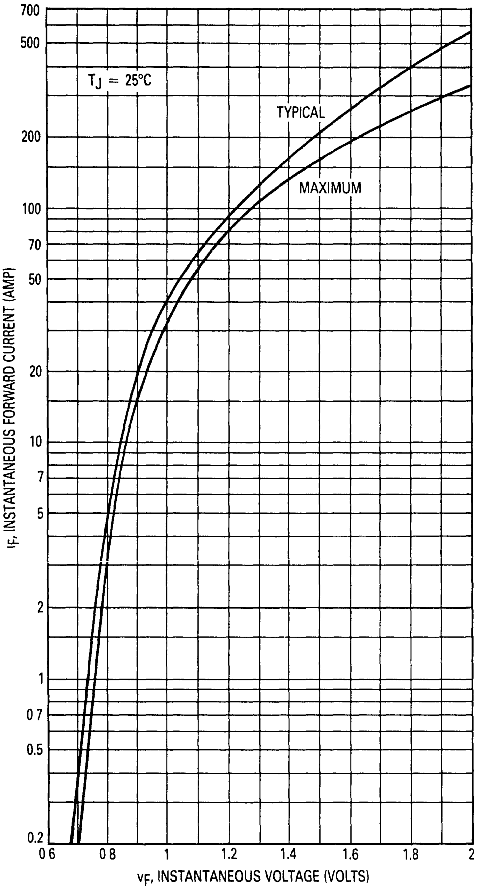


Figure 1. Forward Voltage

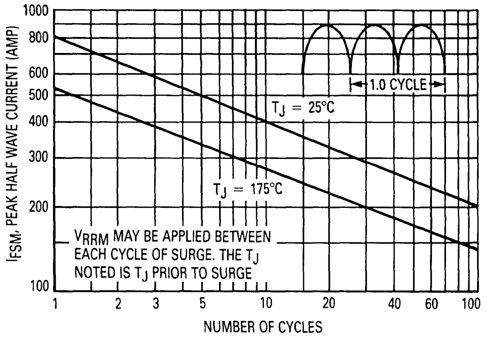


Figure 2. Non-Repetitive Surge Current

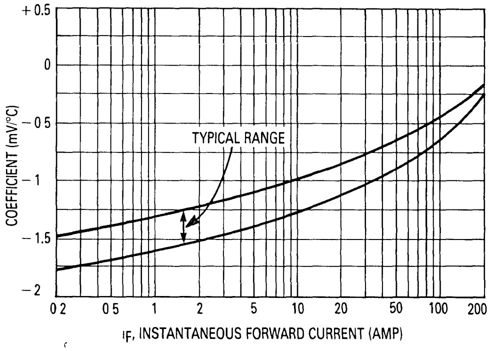


Figure 3. Forward Voltage Temperature Coefficient

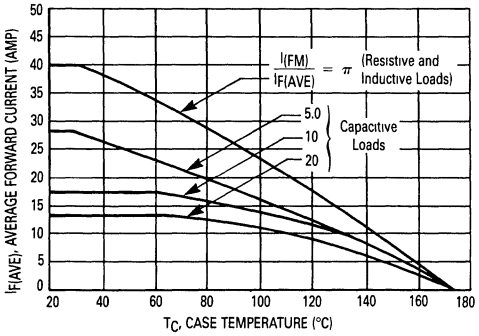


Figure 4. Current Derating

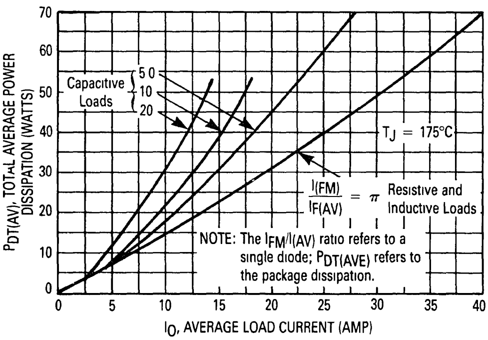


Figure 5. Forward Power Dissipation

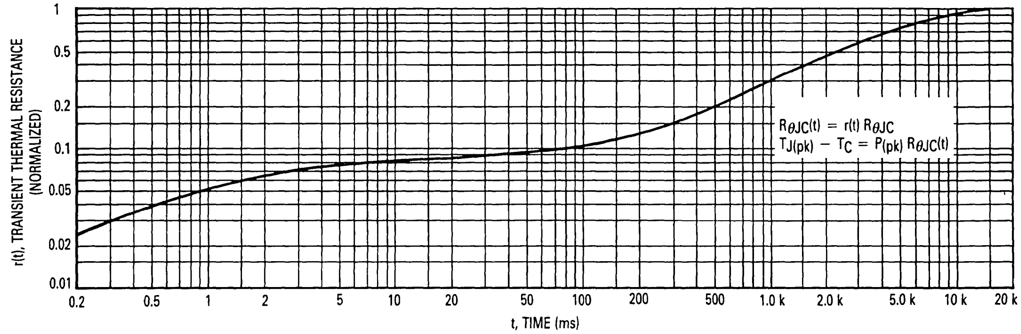
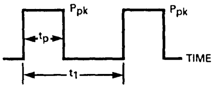


Figure 6. Typical Thermal Response

Note 1



DUTY CYCLE, $D = t_p/t_1$
PEAK POWER, P_{pk}, is peak of an equivalent square power pulse

To determine maximum junction temperature of the diode in a given situation, the following procedure is recommended

The temperature of the case should be measured using a thermocouple placed on the case at the temperature reference point (see the outline drawing on page 1) The thermal mass connected to the case is normally large enough so that it will not significantly respond to heat surges generated in the diode as a result of pulsed operation once steady state conditions are achieved Using the measured value of T_C, the junction temperature may be determined by

$$T_J = T_C + \Delta T_{JC}$$

where ΔT_{JC} is the increase in junction temperature above the case temperature It may be determined by

$$\Delta T_{JC} = P_{pk} \bullet R_{\theta JC} [D + (1 - D) \bullet r(t_1 + t_p) + r(t_p) - r(t_1)]$$

where

$r(t)$ = normalized value of transient thermal resistance at time, t, from Figure 8, i e ,
$r(t_1 + t_p)$ = normalized value of transient thermal resistance at time $t_1 + t_p$

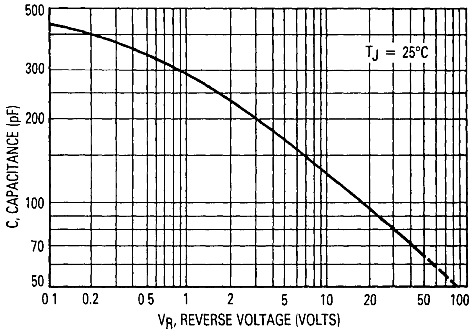


Figure 7. Capacitance

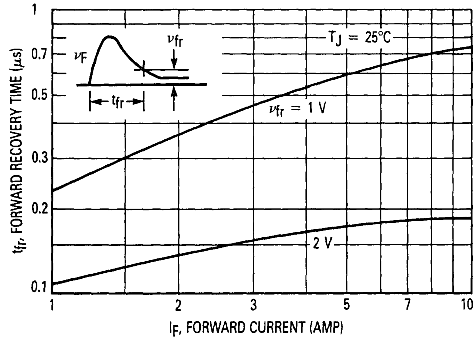


Figure 8. Forward Recovery Time

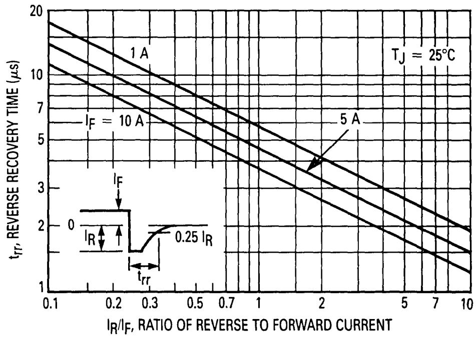


Figure 9. Reverse Recovery Time

AMBIENT TEMPERATURE DERATING INFORMATION

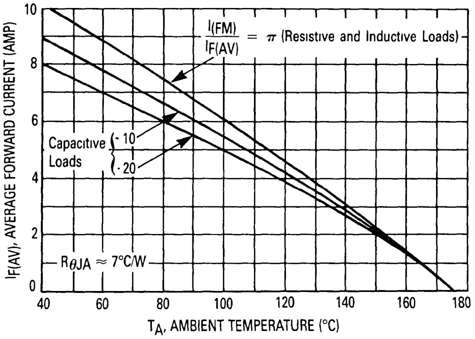


Figure 10A. Thermalloy Heatsink 6005B

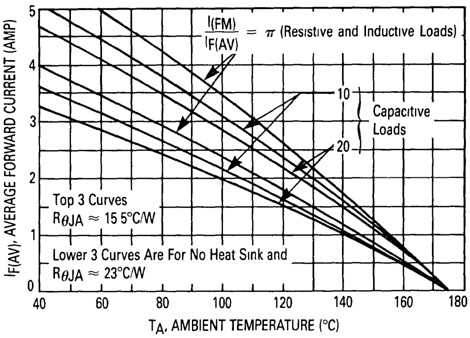


Figure 10B. IERC Heatsink UP3 and No Heatsink

Note 2: Thermal Coupling and Effective Thermal Resistance

In multiple chip devices where there is coupling of heat between die, the junction temperature can be calculated as follows

(1) $\Delta T_{J1} = R_{\theta 1} P_{D1} + R_{\theta 2} K_{\theta 2} P_{D2} + R_{\theta 3} K_{\theta 3} P_{D3} + R_{\theta 4} K_{\theta 4} P_{D4}$

Where ΔT_{J1} is the change in junction temperature of diode 1

$R_{\theta 1}$ thru 4 is the the thermal resistance of diodes 1 through 4

P_{D1} thru 4 is the power dissipated in diodes 1 through 4

$K_{\theta 2}$ thru 4 is the thermal coupling between diode 1 and diodes 2 through 4.

An effective package thermal resistance can be defined as follows:

(2) $R_{\theta(EFF)} = \Delta T_{J1}/P_{DT}$

Where P_{DT} is the total package power dissipation

Assuming equal thermal resistance for each die, equation (1) simplifies to

(3) $\Delta T_{J1} = R_{\theta 1} (P_{D1} + K_{\theta 2} P_{D2} + K_{\theta 3} P_{D3} + K_{\theta 4} P_{D4})$

For the conditions where $P_{D1} = P_{D2} = P_{D3} = P_{D4}$, $P_{DT} = 4\ P_{D1}$, equation (3) can be further simplified and by substituting into equation (2) results in

(4) $R_{\theta(EFF)} = R_{\theta 1} (1 + K_{\theta 2} + K_{\theta 3} + K_{\theta 4})/4$

When the case is used as a reference point, coupling between die is negligible for the MDA3500 When the bridge is used without a heatsink, coupling between die is approximately 70% and $R_{\theta 1}$ is 30°C/W,

$R_{\theta(EFF)} = 30\ [1 + (3)\ (\ 7)]/4 = 23°C/W$

Note 3: Split Load Derating Information

Bridge rectifiers are used in two basic configurations as shown by circuits A and B of Figure 11. The current derating data of Figure 4 applies to the standard bridge circuit (A) where $I_A = I_B$. For circuit B where $I_A = I_B$, derating information can be calculated as follows:

(6) $T_{R(Max)} = T_{J(Max)} - \Delta T_{J1}$

Where $T_{R(Max)}$ is the reference temperature (either case or ambient)

ΔT_{J1} can be calculated using equation (3) in Note 2

For example, to determine $T_{C(Max)}$ for the MDA3500 with the following capacitive load conditions.

I_A = 20 A average with a peak of 60 A

I_B = 10 A average with a peak of 70 A

First calculate the peak to average ratio for I_A $I_{(PK)}/I_{(AV)} = 60/10 = 6\ 0$. (Note that the peak to average ratio is on a per diode basis and each diode provides 10 A average)

From Figure 5, for an average current of 20 A and an $I_{(PK)}/I_{(AV)} = 6.0$ read $P_{DT(AV)}$ = 40 watts or 10 watts/diode Thus $P_{D1} = P_{D3} = 10$ watts.

Similarly, for a load current I_B of 10 A, diode #2 and diode #4 each see 5.0 A average resulting in an $I_{(PK)}/I_{(AV)} = 14$.

Thus, the package power dissipation for 10 A is 20 watts or 5 0 watts/diode . $P_{D2} = P_{D4}$ = 5.0 watts.

The maximum junction temperature occurs in diode #1 and #3 From equation (3) for diode #1 ΔT_{J1} = (7.5) (10), since coupling is negligible

$\Delta T_{J1} \approx 75°C$

Thus $T_{C(Max)} = 175 - 75 = 100°C$

The total package dissipation in this example is

$P_{DT(AV)} = 2 \times 10 + 2 \times 5\ 0 = 30$ watts, which must be considered when selecting a heat sink

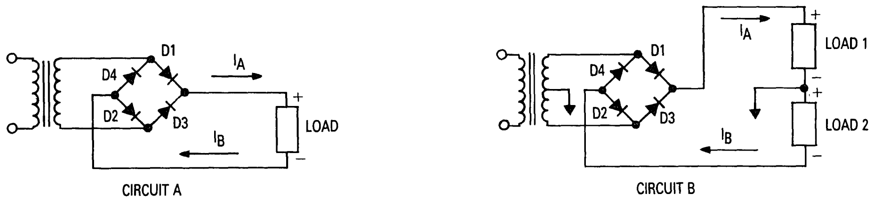


Figure 11. Basic Circuit Uses for Bridge Rectifiers

MOTOROLA
SEMICONDUCTOR
TECHNICAL DATA

MR500 MR501 MR502 MR504 MR506 MR508 MR510

Designer's Data Sheet

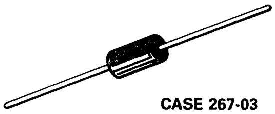
MINIATURE SIZE, AXIAL LEAD MOUNTED STANDARD RECOVERY POWER RECTIFIERS

. . . designed for use in power supplies and other applications having need of a device with the following features:

- High Current to Small Size
- High Surge Current Capability
- Low Forward Voltage Drop
- Economical Plastic Package
- Available in Volume Quantities

STANDARD RECOVERY POWER RECTIFIERS

50-1000 VOLTS
3 AMPERE



CASE 267-03
PLASTIC

3

Designer's Data for "Worst Case" Conditions

The Designers Data sheets permit the design of most circuits entirely from the information presented Limit curves — representing boundaries on device characteristics — are given to facilitate "worst case" design

MAXIMUM RATINGS

Rating	Symbol	MR500	MR501	MR502	MR504	MR506	MR508	MR510	Unit
Peak Repetitive Reverse Voltage Working Peak Reverse Voltage DC Blocking Voltage	V_{RRM} V_{RWM} V_R	50	100	200	400	600	800	1000	Volts
Non-Repetitive Peak Reverse Voltage	V_{RSM}	75	150	250	450	650	850	1050	Volts
Average Rectified Forward Current (Single phase resistive load, T_Z = 95°C, PC Board Mounting) (1) (EIA Standard Conditions L = 1/32", T_L = 85°C)	I_O	← 3.0 → ← 8.0 →							Amp
Non-Repetitive Peak Surge Current (surge applied at rated load conditions)	I_{FSM}	← 100 → (one cycle)							Amp
Operating and Storage Junction Temperature Range (2)	T_J, T_{stg}	← -65 to +175 →							°C

THERMAL CHARACTERISTICS

Characteristic	Symbol	Max	Unit
Thermal Resistance, Junction to Ambient (Recommended Printed Circuit Board Mounting, See Note 2).	$R_{\theta JA}$	28	°C/W

ELECTRICAL CHARACTERISTICS

Characteristic	Symbol	Min	Typ	Max	Unit
Instantaneous Forward Voltage (3)	v_F				Volts
(i_F = 9.4 Amp, T_J = 175°C)		—	0.9	1.0	
(i_F = 9.4 Amp, T_J = 25°C)		—	1.04	1.1	
Reverse Current (rated dc voltage) (3)	I_R				μA
T_J = 25°C		—	0.1	5.0	
T_J = 100°C		—	2.8	25	

(1) Derate for reverse power dissipation.
(2) Derate as shown in Figure 1.
(3) Pulse Test. Pulse Width = 300 μs, Duty Cycle = 2.0%

MECHANICAL CHARACTERISTICS

Case: Transfer Molded Plastic
Finish: External Leads are Plated, Leads are readily Solderable
Polarity: Indicated by Cathode Band
Weight: 1.1 Grams (Approximately)
Maximum Lead Temperature for Soldering Purposes: 300°C, 1/8" from case for 10 s at 5.0 lb. tension

3

NOTE 1: DETERMINING MAXIMUM RATINGS

Reverse power dissipation and the possibility of thermal runaway must be considered when operating this rectifier at reverse voltages above 200 volts. Proper derating may be accomplished by use of equation (1):

$$T_{A(max)} = T_{J(max)} - R_{\theta JA}P_{F(AV)} - R_{\theta JA}P_{R(AV)} \quad (1)$$

where

$T_{A(max)}$ = Maximum allowable ambient temperature

$T_{J(max)}$ = Maximum allowable junction temperature (175°C or the temperature at which thermal runaway occurs, whichever is lowest.)

$P_{F(AV)}$ = Average forward power dissipation

$P_{R(AV)}$ = Average reverse power dissipation

$R_{\theta JA}$ = Junction-to-ambient thermal resistance

Figure 1 permits easier use of equation (1) by taking reverse power dissipation and thermal runaway into consideration. The figure solves for a reference temperature as determined by equation (2):

$$T_R = T_{J(max)} - R_{\theta JA}P_{R(AV)} \quad (2)$$

Substituting equation (2) into equation (1) yields:

$$T_{A(max)} = T_R - R_{\theta JA}P_{F(AV)} \quad (3)$$

Inspection of equations (2) and (3) reveals that T_R is the ambient temperature at which thermal runaway occurs or where T_J = 175°C, when forward power is zero. The transition from one boundary condition to the other is evident on the curves of Figure 1 as a difference in the rate of change of the slope in the vicinity of 165°C. The data of Figure 1 is based upon dc conditions. For use in common rectifier circuits, Table 1 indicates suggested factors for an equivalent dc voltage to use for conservative design; i.e.:

$$V_{R(equiv)} = V_{in(PK)} \times F \quad (4)$$

The Factor F is derived by considering the properties of the various rectifier circuits and the rectifiers reverse characteristics.

Example: Find $T_{A(max)}$ for MR510 operated in a 400 Volt dc supply using a full wave center-tapped circuit with capacitive filter such that I_{DC} = 6.0 A, ($I_{F(AV)}$ = 3.0 A), $I_{(PK)}/I_{(AV)}$ = 10, Input Voltage = 283 V(rms) (line to center tap), $R_{\theta JA}$ = 28°C/W.

Step 1: Find $V_{R(equiv)}$. Read F = 1.11 from Table 1 ∴ $V_{R(equiv)}$ = 1.41)(283)(1.11) = 444 V

Step 2: Find T_R from Figure 1. Read T_R = 167°C @ V_R = 444 V & $R_{\theta JA}$ = 28°C/W.

Step 3: Find $P_{F(AV)}$ from Figure 8. Read $P_{F(AV)}$ = 4 W @ $\frac{I_{PK}}{I_{AV}}$ = 10 & $I_{F(AV)}$ = 3.0 A

Step 4: Find $T_{A(max)}$ from equation (3). $T_{A(max)}$ = 167-(28)(4) = 55°C.

TABLE I — VALUES FOR FACTOR F

Circuit	Half Wave		Full Wave, Bridge		Full Wave Center-Tapped*†	
Load	Resistive	Capacitive*	Resistive	Capacitive	Resistive	Capacitive
Sine Wave	0.45	1.11	0.45	0.55	0.90	1.11
Square Wave	0.61	1.22	0.61	0.61	1.22	1.22

*Note that $V_{R(PK)} \approx 2\ V_{in(PK)}$ †Use line to center tap voltage for V_{in}.

FIGURE 1 — MAXIMUM REFERENCE TEMPERATURE

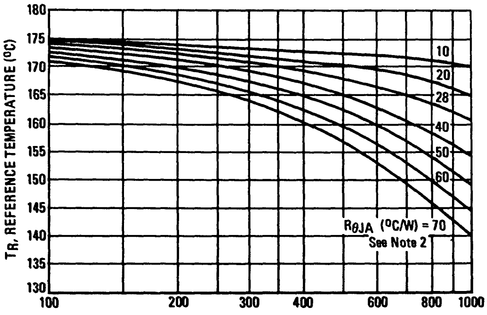
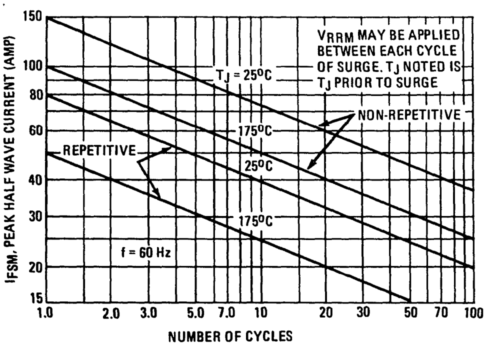


FIGURE 2 — MAXIMUM SURGE CAPABILITY



CURRENT DERATING
(Reverse Power Loss Neglected)

FIGURE 3 – PC BOARD MOUNTING

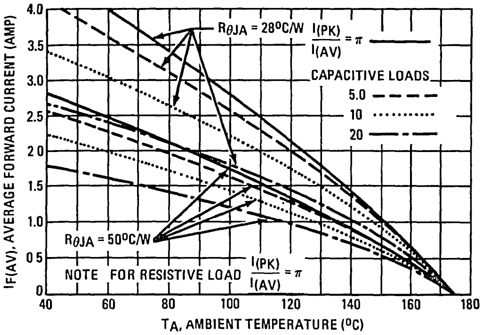


FIGURE 4 – SEVERAL LEAD LENGTHS

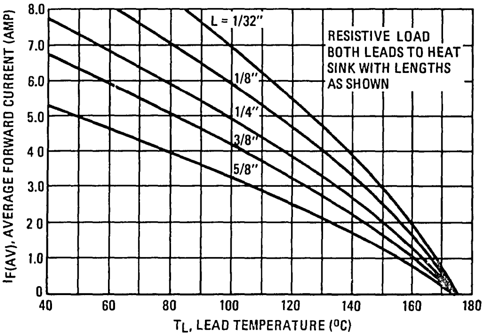


FIGURE 5 – 1/8" LEAD LENGTH

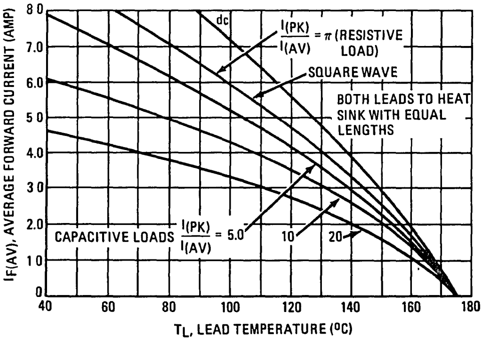


FIGURE 6 – MAXIMUM FORWARD VOLTAGE

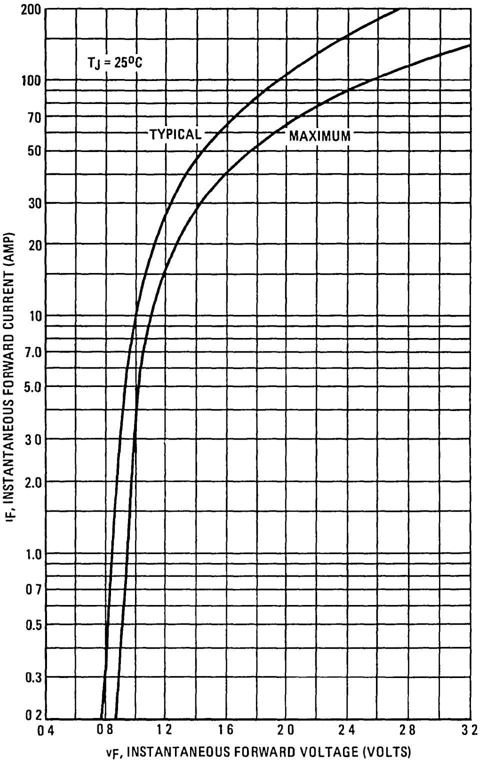
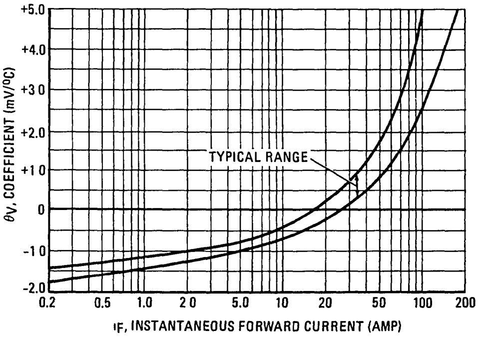


FIGURE 7 – FORWARD VOLTAGE TEMPERATURE COEFFICIENT



3

3

FIGURE 8 — FORWARD POWER DISSIPATION

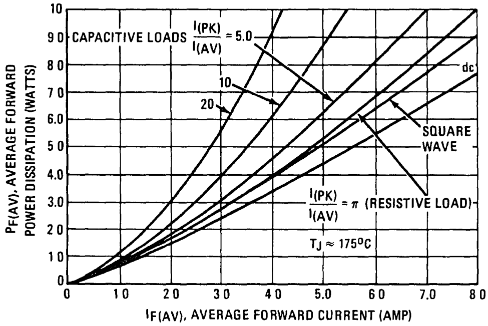
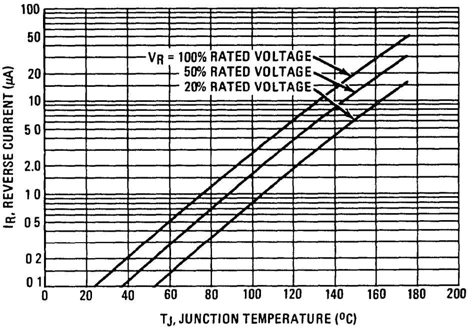


FIGURE 9 — TYPICAL REVERSE CURRENT



THERMAL CHARACTERISTICS

FIGURE 10 — THERMAL RESPONSE

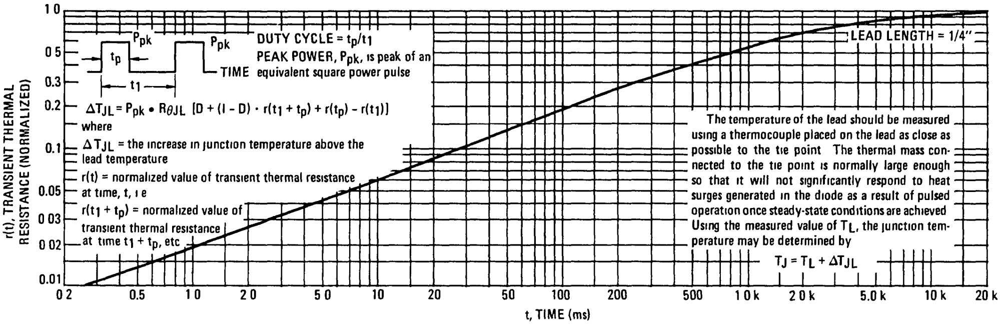
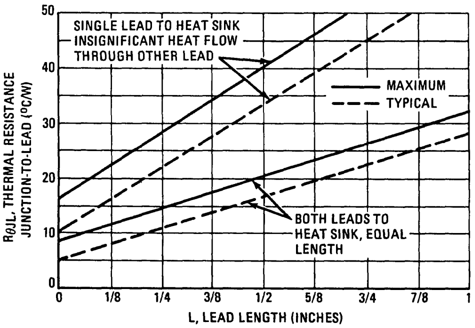


FIGURE 11 — STEADY-STATE THERMAL RESISTANCE



NOTE 2 — AMBIENT MOUNTING DATA

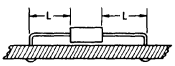
Data shown for thermal resistance junction-to-ambient ($R_{\theta JA}$) for the mountings shown is to be used as typical guideline values for preliminary engineering or in case the tie point temperature cannot be measured

TYPICAL VALUES FOR $R_{\theta JA}$ IN STILL AIR

MOUNTING METHOD	LEAD LENGTH, L (IN)				$R_{\theta JA}$
	1/8	1/4	1/2	3/4	
1	50	51	53	55	°C/W
2	58	59	61	63	°C/W
3		28			°C/W

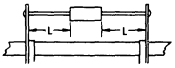
MOUNTING METHOD 1

P C Board Where Available Copper Surface area is small



MOUNTING METHOD 2

Vector Push-In Terminals T-28



MOUNTING METHOD 3

P C Board with 1-1/2" x 1-1/2" Copper Surface

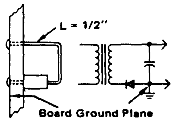
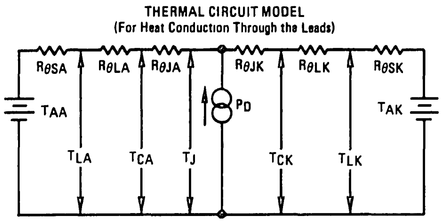


FIGURE 12 — APPROXIMATE THERMAL CIRCUIT MODEL



Use of the above model permits junction to lead thermal resistance for any mounting configuration to be found. For a given total lead length, lowest values occur when one side of the rectifier is brought as close as possible to the heat sink. Terms in the model signify:

T_A = Ambient Temperature
T_L = Lead Temperature
T_C = Case Temperature
T_J = Junction Temperature
$R_{\theta S}$ = Thermal Resistance, Heat Sink to Ambient
$R_{\theta L}$ = Thermal Resistance, Lead to Heat Sink
$R_{\theta J}$ = Thermal Resistance, Junction to Case
P_D = Total Power Dissipation = $P_F + P_R$
P_F = Forward Power Dissipation
P_R = Reverse Power Dissipation

(Subscripts A and K refer to anode and cathode sides respectively.)
Values for thermal resistance components are:

$R_{\theta L}$ = 46°C/W/IN Typically and 48°C/W/IN Maximum
$R_{\theta J}$ = 10°C/W Typically and 16°C/W Maximum

The maximum lead temperature may be found as follows:

$$T_L = T_{J(max)} - \Delta T_{JL}$$

where $\Delta T_{JL} \approx R_{\theta JL}$

3

TYPICAL DYNAMIC CHARACTERISTICS
($T_J = 25°C$)

FIGURE 13 — FORWARD RECOVERY TIME

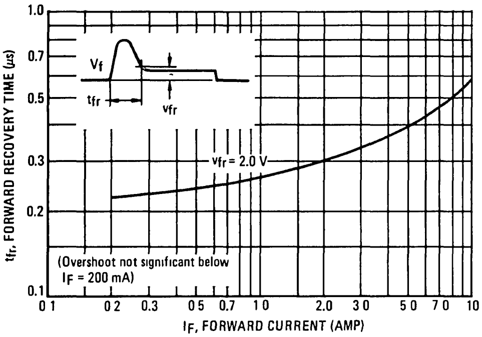


FIGURE 14 — REVERSE RECOVERY TIME

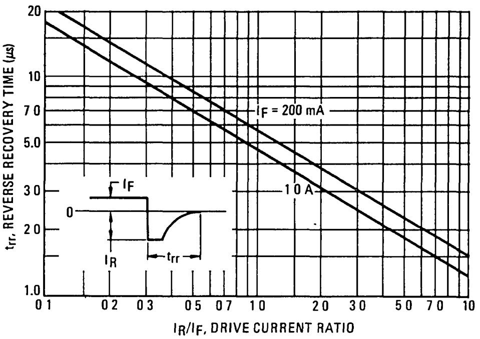


FIGURE 15 — RECTIFICATION WAVEFORM EFFICIENCY

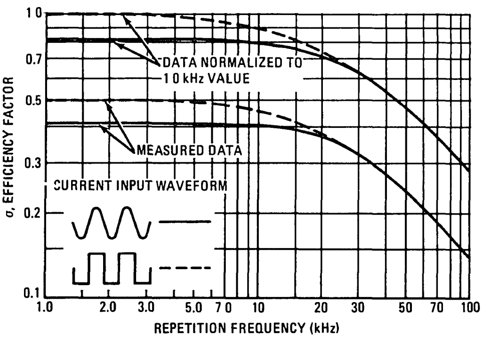
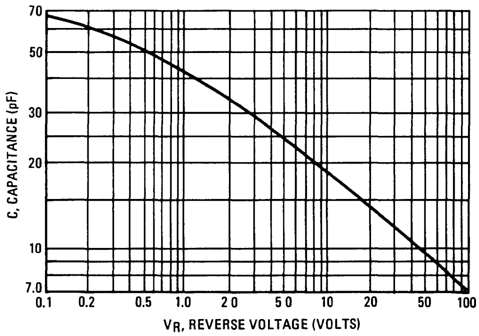
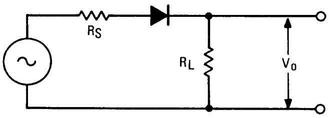


FIGURE 16 — JUNCTION CAPACITANCE



RECTIFIER EFFICIENCY NOTE

FIGURE 17 — SINGLE-PHASE HALF-WAVE RECTIFIER CIRCUIT



The rectification efficiency factor σ shown in Figure 15 was calculated using the formula

$$\sigma = \frac{P_{(dc)}}{P_{(rms)}} = \frac{\dfrac{V^2{}_{o(dc)}}{R_L}}{\dfrac{V^2{}_{o(rms)}}{R_L}} \cdot 100\% = \frac{V^2{}_{o(dc)}}{V^2{}_{o(ac)} + V^2{}_{o(dc)}} \cdot 100\% \quad (1)$$

For a sine wave input $V_m \sin(\omega t)$ to the diode, assumed lossless, the maximum theoretical efficiency factor becomes:

$$\sigma_{(sine)} = \frac{\dfrac{V^2{}_m}{\pi^2 R_L}}{\dfrac{V^2{}_m}{4R_L}} \cdot 100\% = \frac{4}{\pi^2} \cdot 100\% = 40.6\% \quad (2)$$

For a square wave input of amplitude V_m, the efficiency factor becomes.

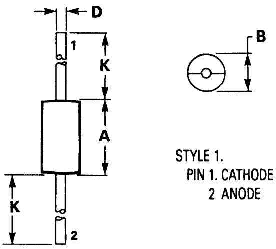
$$\sigma_{(square)} = \frac{\dfrac{V^2{}_m}{2R_L}}{\dfrac{V^2{}_m}{R_L}} \cdot 100\% = 50\% \quad (3)$$

(A full wave circuit has twice these efficiencies)

As the frequency of the input signal is increased, the reverse recovery time of the diode (Figure 14) becomes significant, resulting in an increasing ac voltage component across R_L which is opposite in polarity to the forward current, thereby reducing the value of the efficiency factor σ, as shown on Figure 15.

It should be emphasized that Figure 15 shows waveform efficiency only; it does not provide a measure of diode losses Data was obtained by measuring the ac component of V_o with a true rms ac voltmeter and the dc component with a dc voltmeter. The data was used in Equation 1 to obtain points for the figure.

OUTLINE DIMENSIONS



STYLE 1.
PIN 1. CATHODE
2 ANODE

NOTES:
1. DIMENSIONING & TOLERANCING PER ANSI Y14.5, 1982.
2. CONTROLLING DIMENSION: INCH

DIM	MILLIMETERS MIN	MILLIMETERS MAX	INCHES MIN	INCHES MAX
A	9.40	9.65	0.370	0.380
B	4.83	5.33	0.190	0.210
D	1.22	1.32	0.048	0.052
K	25.40	—	1.000	—

CASE 267-03
PLASTIC

MOTOROLA
SEMICONDUCTOR
TECHNICAL DATA

MR750
MR751 MR752
MR754 MR756
MR758 MR760

Designers Data Sheet

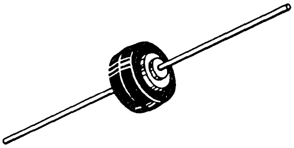
HIGH CURRENT LEAD MOUNTED RECTIFIERS

- Current Capacity Comparable To Chassis Mounted Rectifiers
- Very High Surge Capacity
- Insulated Case

Designer's Data for "Worst Case" Conditions

The Designers Data sheets permit the design of most circuits entirely from the information presented Limit curves — representing boundaries on device characteristics — are given to facilitate "worst case" design

HIGH CURRENT LEAD MOUNTED SILICON RECTIFIERS 50–1000 VOLTS DIFFUSED JUNCTION



3

***MAXIMUM RATINGS**

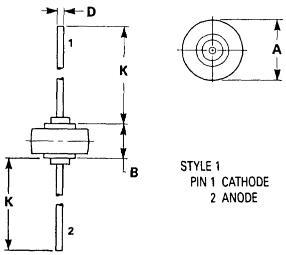
Characteristic	Symbol	MR750	MR751	MR752	MR754	MR756	MR758	MR760	Unit
Peak Repetitive Reverse Voltage Working Peak Reverse Voltage DC Blocking Voltage	V_{RRM} V_{RWM} V_R	50	100	200	400	600	800	1000	Volts
Non-Repetitive Peak Reverse Voltage (halfwave, single phase, 60 Hz peak)	V_{RSM}	60	120	240	480	720	960	1200	Volts
RMS Reverse Voltage	$V_{R(RMS)}$	35	70	140	280	420	560	700	Volts
Average Rectified Forward Current (single phase, resistive load, 60 Hz) See Figures 5 and 6	I_O	22 (T_L = 60°C, 1/8" Lead Lengths) 6.0 (T_A = 60°C, P.C. Board mounting)							Amp
Non-Repetitive Peak Surge Current (surge applied at rated load conditions)	I_{FSM}	400 (for 1 cycle)							Amp
Operating and Storage Junction Temperature Range	T_J, T_{stg}	−65 to +175							°C

ELECTRICAL CHARACTERISTICS

Characteristic and Conditions	Symbol	Max	Unit
Maximum Instantaneous Forward Voltage Drop (i_F = 100 Amp, T_J = 25°C)	v_F	1.25	Volts
Maximum Forward Voltage Drop (I_F = 6.0 Amp, T_A = 25°C, 3/8" leads)	V_F	0.90	Volts
Maximum Reverse Current T_J = 25°C (rated dc voltage) T_J = 100°C	I_R	25 1.0	μA mA

MECHANICAL CHARACTERISTICS

CASE: Transfer Molded Plastic
MAXIMUM LEAD TEMPERATURE FOR SOLDERING PURPOSES: 350°C 3/8" from case for 10 seconds at 5.0 lbs. tension
FINISH: All external surfaces are corrosion-resistant, leads are readily solderable
POLARITY: Indicated by diode symbol
WEIGHT: 2.5 Grams (approx.)



STYLE 1
PIN 1 CATHODE
2 ANODE

NOTE
1 CATHODE SYMBOL ON PKG

DIM	MILLIMETERS MIN	MILLIMETERS MAX	INCHES MIN	INCHES MAX
A	8.43	8.69	0.332	0.342
B	5.94	6.25	0.234	0.246
D	1.27	1.35	0.050	0.053
K	25.15	25.65	0.990	1.010

CASE 194-04
PLASTIC

FIGURE 1 – FORWARD VOLTAGE

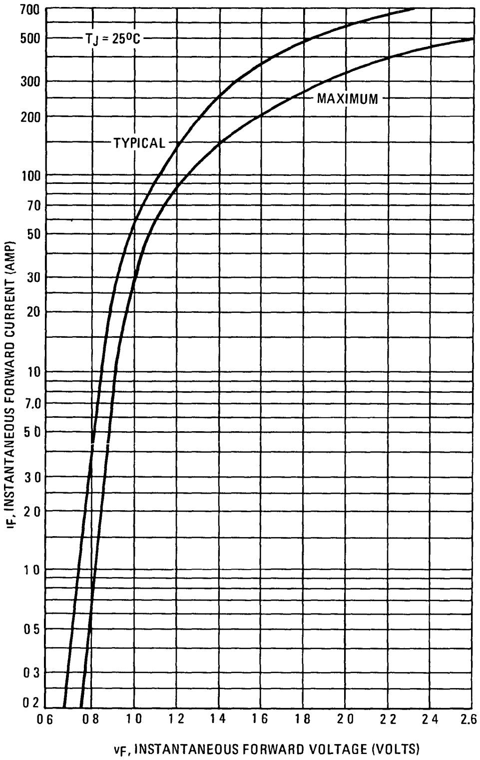


FIGURE 2 – MAXIMUM SURGE CAPABILITY

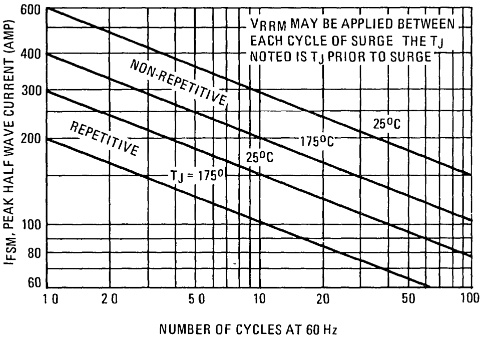


FIGURE 3 – FORWARD VOLTAGE TEMPERATURE COEFFICIENT

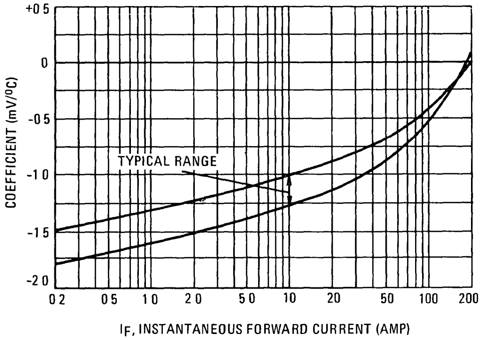


FIGURE 4 – TYPICAL TRANSIENT THERMAL RESISTANCE

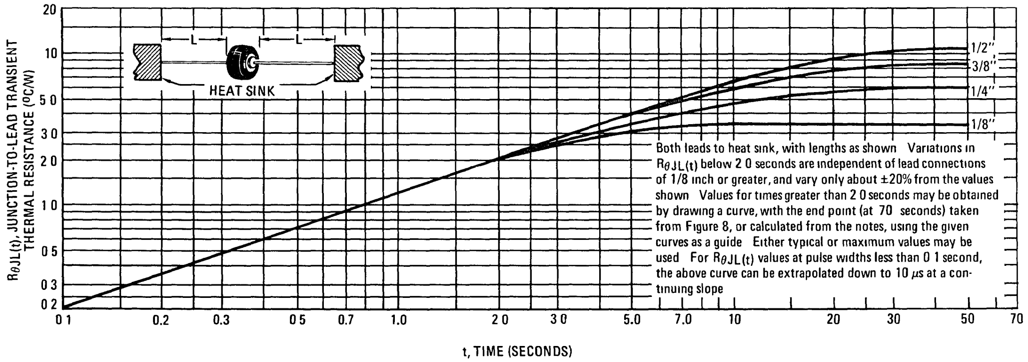


FIGURE 5 — MAXIMUM CURRENT RATINGS

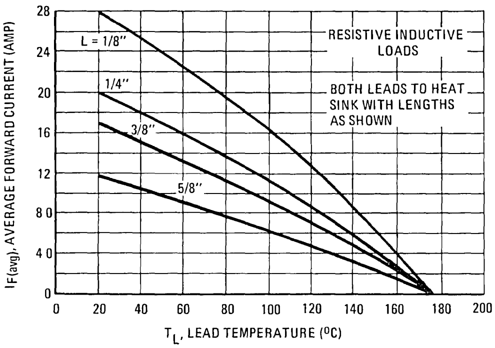


FIGURE 6 — MAXIMUM CURRENT RATINGS

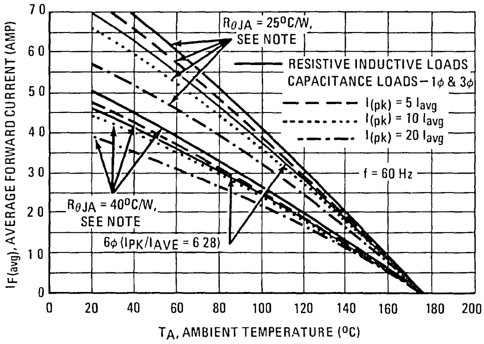


FIGURE 7 — POWER DISSIPATION

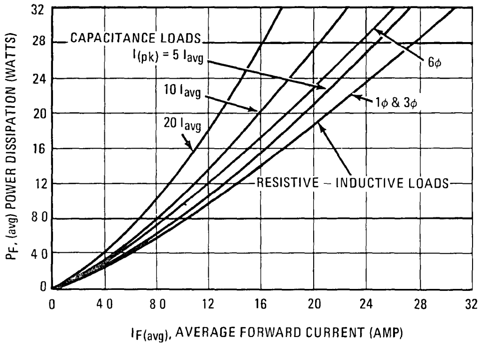
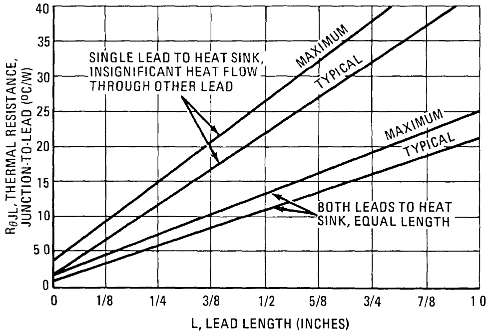


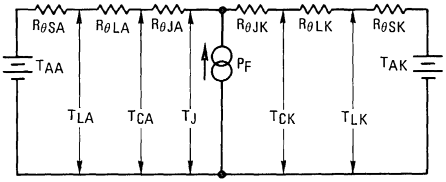
FIGURE 8 — STEADY STATE THERMAL RESISTANCE



NOTES

THERMAL CIRCUIT MODEL

(For Heat Conduction Through The Leads)



Use of the above model permits junction to lead thermal resistance for any mounting configuration to be found Lowest values occur when one side of the rectifier is brought as close as possible to the heat sink as shown below Terms in the model signify

T_A = Ambient Temperature — $R_{\theta S}$ = Thermal Resistance, Heat Sink to Ambient
T_L = Lead Temperature — $R_{\theta L}$ = Thermal Resistance, Lead to Heat Sink
T_C = Case Temperature — $R_{\theta J}$ = Thermal Resistance, Junction to Case
T_J = Junction Temperature — P_F = Power Dissipation

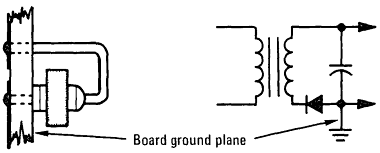
(Subscripts A and K refer to anode and cathode sides respectively)

Values for thermal resistance components are

$R_{\theta L}$ = 40°C/W/IN Typically and 44°C/W/IN Maximum
$R_{\theta J}$ = 2°C/W Typically and 4°C/W Maximum

Since $R_{\theta J}$ is so low, measurements of the case temperature, T_C, will be approximately equal to junction temperature in practical lead mounted applications When used as a 60 Hz rectifier, the slow thermal response holds $T_{J(PK)}$ close to $T_{J(AVG)}$ Therefore maximum lead temperature may be found from $T_L = 175° - R_{\theta JL} P_F$ P_F may be found from Figure 7

The recommended method of mounting to a P C board is shown on the sketch, where $R_{\theta JA}$ is approximately 25°C/W for a 1-1/2" x 1-1/2" copper surface area Values of 40°C/W are typical for mounting to terminal strips or P C boards where available surface area is small



Recommended mounting for half wave circuit

3

TYPICAL DYNAMIC CHARACTERISTICS

FIGURE 9 — RECTIFICATION EFFICIENCY

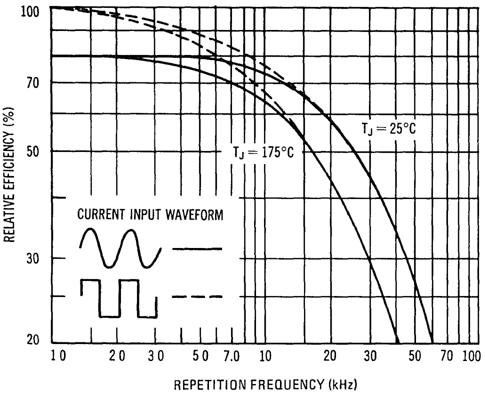


FIGURE 10 — REVERSE RECOVERY TIME

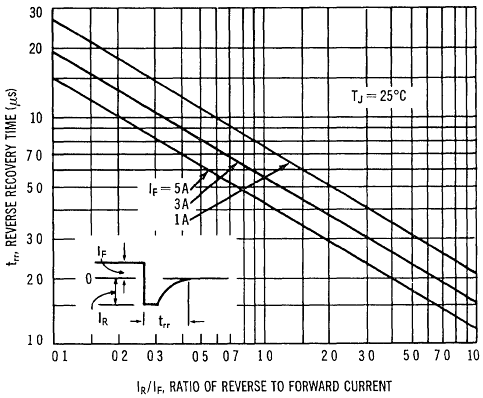


FIGURE 11 — JUNCTION CAPACITANCE

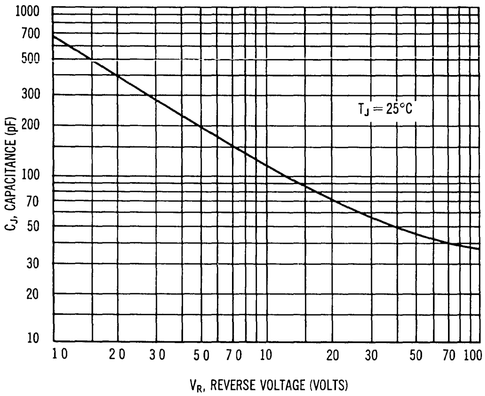


FIGURE 12 — FORWARD RECOVERY TIME

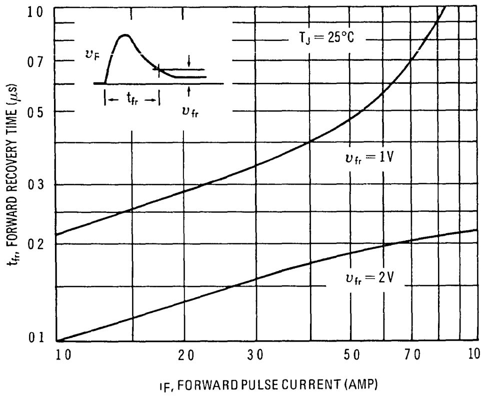
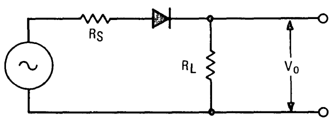


FIGURE 13 — SINGLE-PHASE HALF-WAVE RECTIFIER CIRCUIT



The rectification efficiency factor σ shown in Figure 9 was calculated using the formula:

$$\sigma = \frac{P_{(dc)}}{P_{(rms)}} = \frac{\frac{V^2{}_o(dc)}{R_L}}{\frac{V^2{}_o(rms)}{R_L}} \cdot 100\% = \frac{V^2{}_o(dc)}{V^2{}_o(ac) + V^2{}_o(dc)} \cdot 100\% \quad (1)$$

For a sine wave input $V_m \sin(\omega t)$ to the diode, assumed lossless, the maximum theoretical efficiency factor becomes:

$$\sigma_{(sine)} = \frac{\frac{V^2{}_m}{\pi^2 R_L}}{\frac{V^2{}_m}{4R_L}} \cdot 100\% = \frac{4}{\pi^2} \; 100\% = 40.6\% \quad (2)$$

For a square wave input of amplitude V_m, the efficiency factor becomes:

$$\sigma_{(square)} = \frac{\frac{V^2{}_m}{2R_L}}{\frac{V^2{}_m}{R_L}} \cdot 100\% = 50\% \quad (3)$$

(A full wave circuit has twice these efficiencies)

As the frequency of the input signal is increased, the reverse recovery time of the diode (Figure 10) becomes significant, resulting in an increasing ac voltage component across R_L which is opposite in polarity to the forward current, thereby reducing the value of the efficiency factor σ, as shown on Figure 9

It should be emphasized that Figure 9 shows waveform efficiency only; it does not provide a measure of diode losses Data was obtained by measuring the ac component of V_o with a true rms ac voltmeter and the dc component with a dc voltmeter. The data was used in Equation 1 to obtain points for Figure 9.

MOTOROLA
SEMICONDUCTOR
TECHNICAL DATA

MR810 thru MR814
MR816 thru MR818

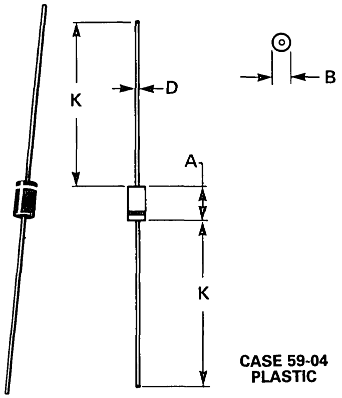
Designers Data Sheet

SUBMINIATURE SIZE, AXIAL LEAD MOUNTED FAST RECOVERY POWER RECTIFIERS

. . . designed for special applications such as dc power supplies, inverters, converters, ultrasonic systems, choppers, low RF interference and free-wheeling diodes. A complete line of fast recovery rectifiers having typical recovery time of 350 nanoseconds providing high efficiency at frequencies to 100 kHz.

FAST RECOVERY POWER RECTIFIERS

50-1000 VOLTS
1 AMPERE



CASE 59-04
PLASTIC

NOTES:
1. ALL RULES AND NOTES ASSOCIATED WITH JEDEC DO-41 OUTLINE SHALL APPLY.
2. POLARITY DENOTED BY CATHODE BAND.
3. LEAD DIAMETER NOT CONTROLLED WITHIN "F" DIMENSION.

DIM	MILLIMETERS MIN	MILLIMETERS MAX	INCHES MIN	INCHES MAX
A	5.97	6.60	0.235	0.260
B	2.79	3.05	0.110	0.120
D	0.76	0.86	0.030	0.034
K	27.94	—	1.100	—

DESIGNER'S DATA FOR "WORST CASE" CONDITIONS

The Designers Data Sheet permits the design of most circuits entirely from the information presented. Limit curves — representing device characteristic boundaries — are given to facilitate "worst case" design.

MAXIMUM RATINGS

Rating	Symbol	MR810	MR811	MR812	MR813	MR814	MR816	MR817	MR818	Unit
Peak Repetitive Reverse Voltage Working Peak Reverse Voltage DC Blocking Voltage	V_{RRM} V_{RWM} V_R	50	100	200	300	400	600	800	1000	Volts
Non-Repetitive Peak Reverse Voltage	V_{RSM}	100	200	300	400	500	800	1000	1200	Volts
RMS Reverse Voltage	$V_{R(RMS)}$	35	70	140	210	280	420	560	700	Volts
Average Rectified Forward Current (Single phase, resistive load, $T_A = 75°C$)	I_O	← 1.0 →								Amp
Non-Repetitive Peak Surge Current (surge applied at rated load conditions) ($T_A = 75°C$)	I_{FSM}	← 30 →								Amps
Operating Junction Temperature Range	T_J	← −65 to +150 →								°C
Storage Temperature Range	T_{stg}	← −65 to +175 →								°C

THERMAL CHARACTERISTICS

Characteristic	Symbol	Max	Unit
Thermal Resistance, Junction to Ambient (Typical Printed Circuit Board Mounting)	$R_{\theta JA}$	65	°C/W

ELECTRICAL CHARACTERISTICS

Characteristic	Symbol	Min	Typ	Max	Unit
Instantaneous Forward Voltage ($I_F = 3.14$ Amp, $T_J = 150°C$)	v_F	–	1.1	1.2	Volts
Forward Voltage ($I_F = 1.0$ Amp, $T_A = 25°C$)	V_F	–	1.0	1.2	Volts
Reverse Current (rated dc voltage) $T_A = 25°C$ $T_A = 100°C$	I_R	– –	1.0 50	10 100	µA

REVERSE RECOVERY CHARACTERISTICS

Characteristic	Symbol	Min	Typ	Max	Unit
Reverse Recovery Time ($I_F = 1.0$ Amp to $V_R = 30$ Vdc) (Figure 21) ($I_F = 20$ mA, $I_R = 2.0$ mA, Tektronix S-Plug-In) (Figure 22)	t_{rr}	– –	350 1.5	750 3.0	ns µs
Reverse Recovery Current ($I_F = 1.0$ Amp to $V_R = 30$ Vdc) (Figure 21)	$I_{RM(REC)}$	–	–	3.0	Amp

MECHANICAL CHARACTERISTICS

CASE: Transfer Molded Plastic

FINISH: External leads are plated and are readily solderable

POLARITY: Cathode indicated by Polarity band

WEIGHT: 0.4 Grams (Approximately)

3

FIGURE 1 — FORWARD VOLTAGE

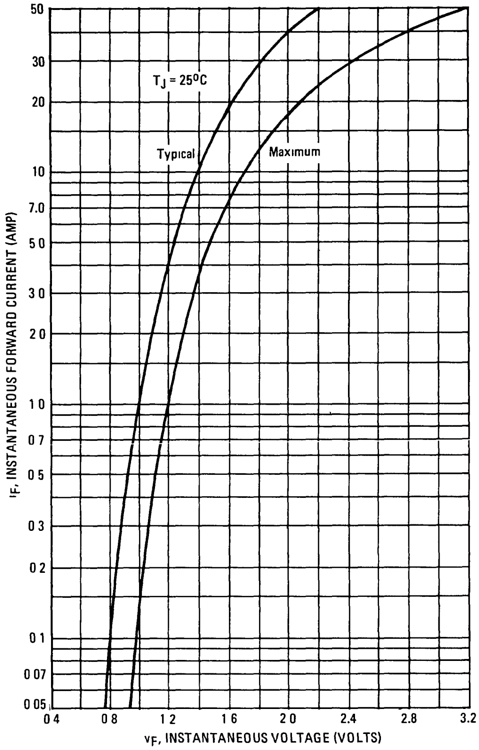


FIGURE 2 — MAXIMUM SURGE CAPABILITY

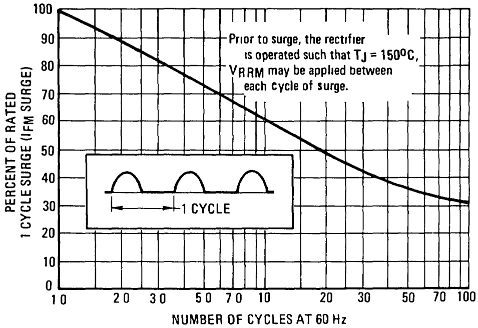


FIGURE 3 — TEMPERATURE COEFFICIENT

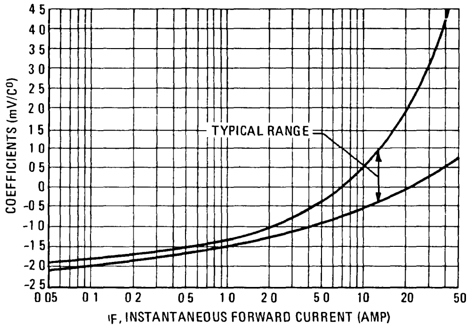


FIGURE 4 — FORWARD POWER DISSIPATION

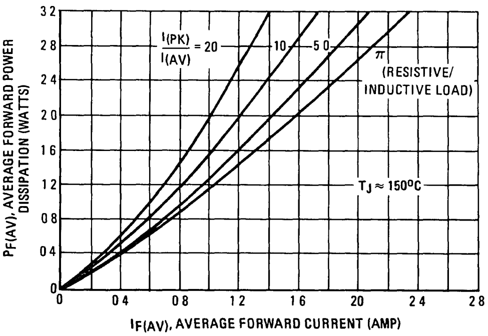
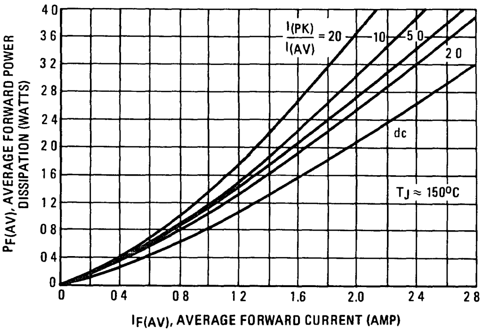


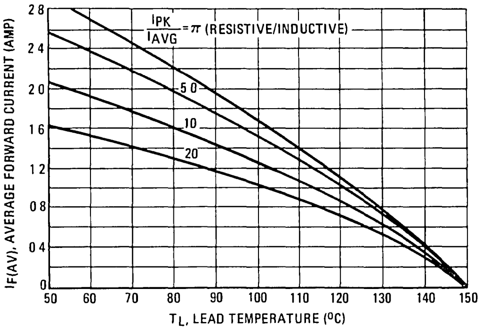
FIGURE 5 — FORWARD POWER DISSIPATION



MAXIMUM CURRENT RATINGS
(SEE NOTES 1 and 2)

SINE WAVE INPUT

FIGURE 6 — EFFECT OF LEAD LENGTHS, RESISTIVE LOAD



SQUARE WAVE INPUT

FIGURE 7 — EFFECT OF LEAD LENGTHS, RESISTIVE LOAD

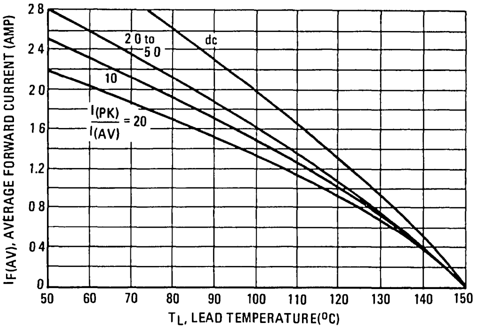


FIGURE 8 — 1/8" LEAD LENGTH, VARIOUS LOADS

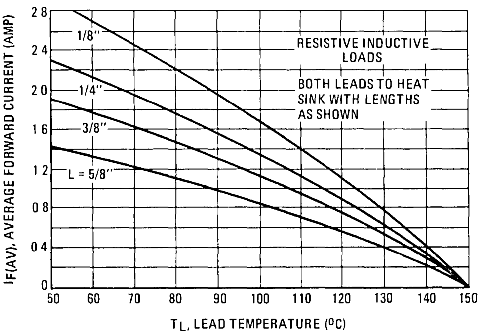


FIGURE 9 — 1/8" LEAD LENGTH, VARIOUS LOADS

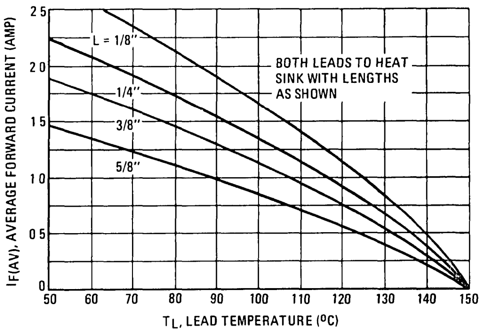


FIGURE 10 — PRINTED CIRCUIT BOARD MOUNTING, VARIOUS LOADS

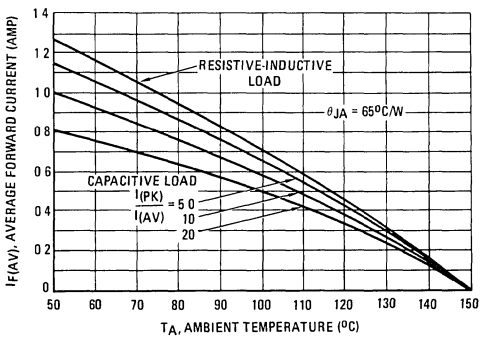


FIGURE 11 — PRINTED CIRCUIT BOARD MOUNTING, VARIOUS LOADS

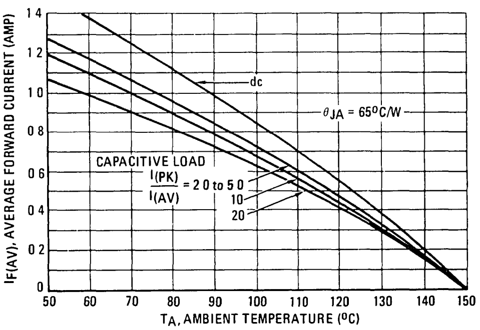


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FIGURE 12 – THERMAL RESPONSE

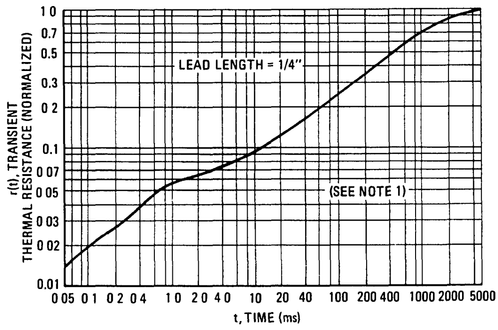
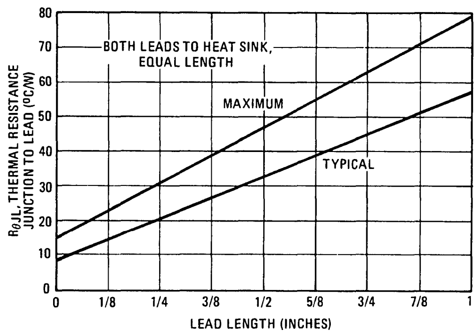
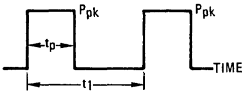


FIGURE 13 – THERMAL RESISTANCE



NOTE 1



DUTY CYCLE, $D = t_p/t_1$
PEAK POWER, P_{pk}, is peak of an equivalent square power pulse

To determine maximum junction temperature of the diode in a given situation, the following procedure is recommended

The temperature of the case should be measured using a thermocouple placed on the case as close as possible to the tie point. The thermal mass connected to the tie point is normally large enough so that it will not significantly respond to heat surges generated in the diode as a result of pulsed operation once steady-state conditions are achieved. Using the measured value of T_C, the junction temperature may be determined by

$$T_J = T_C + \Delta T_{JC}$$

where ΔT_{JC} is the increase in junction temperature above the case temperature It may be determined by

$$\Delta T_{JC} = P_{pk} \cdot R_{\theta JC} \left[D + (1 - D) \cdot r(t_1 + t_p) + r(t_p) - r(t_1) \right]$$

where

$r(t)$ = normalized value of transient thermal resistance at time, t, from Figure 12, i.e..
$r(t_1 + t_p)$ = normalized value of transient thermal resistance at time $t_1 + t_p$

NOTE 2

Data shown for thermal resistance junction to-ambient (θ_{JA}) for the mountings shown is to be used as typical guideline values for preliminary engineering or in case the tie point temperature cannot be measured

TYPICAL VALUES FOR θ_{JA} IN STILL AIR

MOUNTING METHOD	LEAD LENGTH, L (IN) 1/8	1/4	1/2	3/4	$R_{\theta JA}$
1	65	72	82	92	°C/W
2	74	81	91	101	°C/W
3		40			°C/W

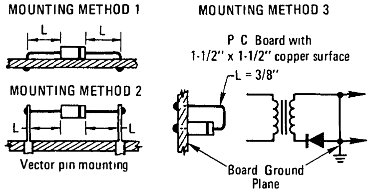
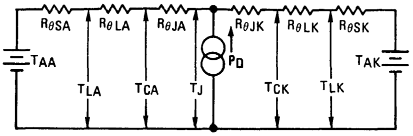


FIGURE 14 – THERMAL CIRCUIT MODEL



Use of the above model permits junction to lead thermal resistance for any mounting configuration to be found. For a given total lead length, lowest values occur when one side of the rectifier is brought as close as possible to the heat sink. Terms in the model signify

T_A = Ambient Temperature $R_{\theta S}$ = Thermal Resistance, Heat Sink to Ambient
T_L = Lead Temperature $R_{\theta L}$ = Thermal Resistance, Lead to Heat Sink
T_C = Case Temperature $R_{\theta J}$ = Thermal Resistance, Junction to Case
T_J = Junction Temperature P_D = Power Dissipation
(Subscripts A and K refer to anode and cathode sides respectively)
Values for thermal resistance components are
$R_{\theta L}$ = 112°C/W/IN Typically and 128°C/W/IN Maximum
$R_{\theta J}$ = 18°C/W Typically and 30°C/W Maximum
The maximum lead temperature may be calculated as follows·

$$T_L = 150^\circ - \Delta T_{JL}$$

ΔT_{JL} can be calculated as shown in NOTE 1 or it may be approximated as follows

$\Delta T_{JL} \approx R_{\theta JL} \bullet P_F$. P_F may be formulated for sine-wave operation from Figure 3 or from Figure 4 for square-wave operation

TYPICAL DYNAMIC CHARACTERISTICS

FIGURE 15 – FORWARD RECOVERY TIME

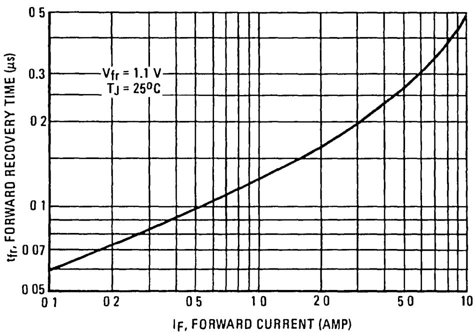
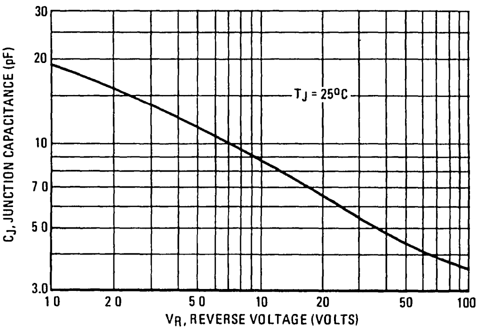


FIGURE 16 – JUNCTION CAPACITANCE



TYPICAL RECOVERED STORED CHARGE DATA (SEE NOTE 3)

FIGURE 17 – T_J = 25°C

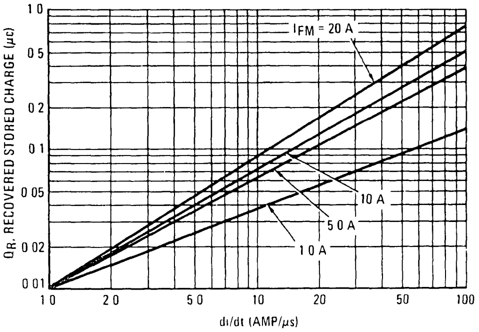


FIGURE 18 – T_J = 75°C

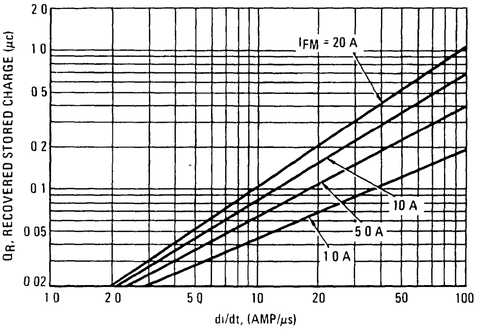


FIGURE 19 – T_J = 100°C

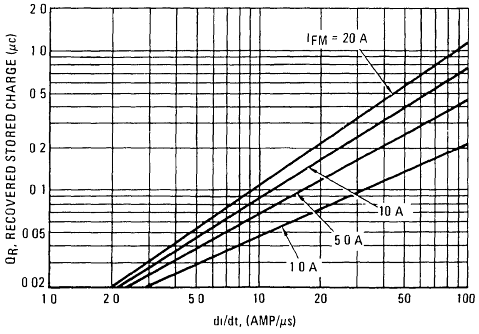


FIGURE 20 – T_J = 150°C

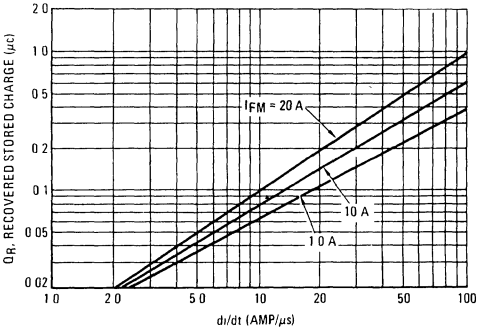


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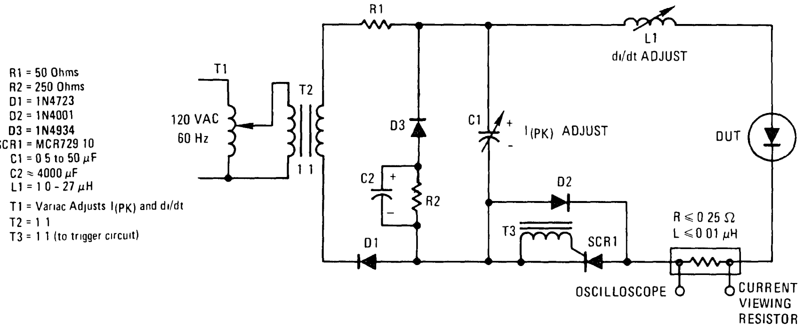
FIGURE 21 — JEDEC REVERSE RECOVERY CIRCUIT



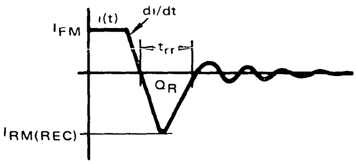
NOTE 3

Reverse recovery time is the period which elapses from the time that the current, thru a previously forward biased rectifier diode, passes thru zero going negatively until the reverse current recovers to a point which is less than 10% peak reverse current.

Reverse recovery time is a direct function of the forward current prior to the application of reverse voltage

For any given rectifier, recovery time is very circuit dependent. Typical and maximum recovery time of all Motorola fast recovery power rectifiers are rated under a fixed set of conditions using I_F = 1.0 A, V_R = 30 V. In order to cover all circuit conditions, curves are given for typical recovered stored charge versus commutation di/dt for various levels of forward current and for junction temperatures of 25°C, 75°C, 100°C, and 150°C.

To use these curves, it is necessary to know the forward current level just before commutation, the circuit commutation di/dt, and the operating junction temperature. The reverse recovery test current waveform for all Motorola fast recovery rectifiers is shown.



From stored charge curves versus di/dt, recovery time (t_{rr}) and peak reverse recovery current ($I_{RM(REC)}$) can be closely approximated using the following formulas

$$t_{rr} = 1.41 \times \left[\frac{Q_R}{di/dt}\right]^{1/2}$$

$$I_{RM(REC)} = 1.41 \times \left[Q_R \times di/dt\right]^{1/2}$$

FIGURE 22 — TYPICAL REVERSE LEAKAGE

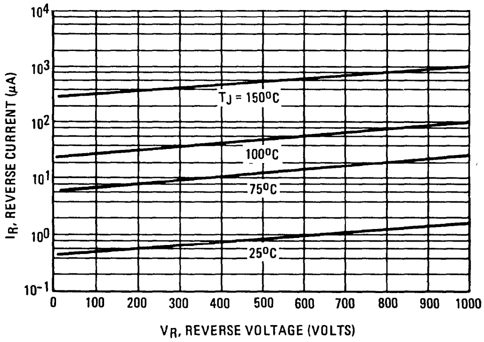
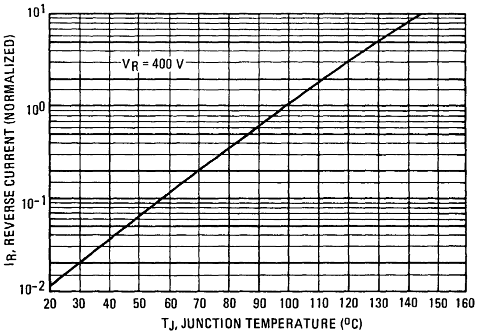


FIGURE 23 — TYPICAL REVERSE LEAKAGE



MOTOROLA
SEMICONDUCTOR
TECHNICAL DATA

MR820
MR821 MR822
MR824 MR826

Designers Data Sheet

SUBMINIATURE SIZE, AXIAL LEAD MOUNTED FAST RECOVERY POWER RECTIFIERS

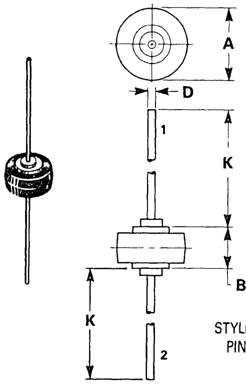
. . . designed for special applications such as dc power supplies, inverters, converters, ultrasonic systems, choppers, low RF interference and free wheeling diodes. A complete line of fast recovery rectifiers having typical recovery time of 150 nanoseconds providing high efficiency at frequencies to 250 kHz.

FAST RECOVERY POWER RECTIFIERS

50-600 VOLTS
5.0 AMPERES

Designer's Data for "Worst Case" Conditions

The Designers Data sheets permit the design of most circuits entirely from the information presented Limit curves — representing boundaries on device characteristics — are given to facilitate "worst case" design



STYLE 1
PIN 1 CATHODE
2. ANODE

NOTE.
1. CATHODE SYMBOL ON PKG

	MILLIMETERS		INCHES	
DIM	MIN	MAX	MIN	MAX
A	8 43	8 69	0 332	0 342
B	5 94	6.25	0.234	0 246
D	1 27	1.35	0 050	0 053
K	25.15	25 65	0 990	1 010

CASE 194-04
PLASTIC

MAXIMUM RATINGS

Rating	Symbol	MR820	MR821	MR822	MR824	MR826	Unit
Peak Repetitive Reverse Voltage Working Peak Reverse Voltage DC Blocking Voltage	V_{RRM} V_{RWM} V_R	50	100	200	400	600	Volts
Non-Repetitive Peak Reverse Voltage	V_{RSM}	75	150	250	450	650	Volts
RMS Reverse Voltage	$V_{R(RMS)}$	35	70	140	280	420	Volts
Average Rectified Forward Current (Single phase, resistive load, $T_A = 55^oC$) (1)	I_O	← 5 0 →					Amp
Non-Repetitive Peak Surge Current (Surge applied at rated load conditions)	I_{FSM}	← 300 →					Amp
Operating and Storage Junction Temperature Range (2)	T_J,T_{stg}	← -65 to +175 →					^oC

THERMAL CHARACTERISTICS

Characteristic	Symbol	Max	Unit
Thermal Resistance, Junction to Ambient (Recommended Printed Circuit Board Mounting, See Note 6)	$R_{\theta JA}$	25	$^oC/W$

ELECTRICAL CHARACTERISTICS

Characteristic	Symbol	Min	Typ	Max	Unit
Instantaneous Forward Voltage (i_F = 15 7 Amp, $T_J = 150^oC$)	v_F	–	0 75	1 05	Volts
Forward Voltage (I_F = 5 0 Amp, $T_J = 25^oC$)	V_F	–	0.9	1.1	Volts
Maximum Reverse Current, (rated dc voltage) $T_J = 25^oC$	I_R	–	5 0	25	μA
$T_J = 100^oC$		–	0 4	1 0	mA

REVERSE RECOVERY CHARACTERISTICS

Characteristic	Symbol	Min	Typ	Max	Unit
Reverse Recovery Time	t_{rr}				ns
(I_F = 1 0 Amp to V_R = 30 Vdc, Figure 25)		–	150	200	
(I_{FM} = 15 Amp, di/dt = 25 A/μs, Figure 26)		–	150	300	
Reverse Recovery Current (I_F = 1 0 Amp to V_R = 30 Vdc, Figure 25)	$I_{RM(REC)}$	–	–	2 0	Amp

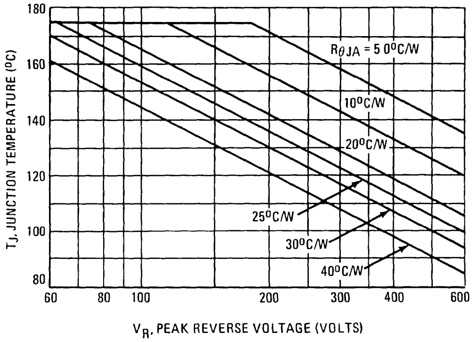
(1) Must be derated for reverse power dissipation See Note 3
(2) Derate as shown in Figure 1

MECHANICAL CHARACTERISTICS

CASE: Transfer Molded Plastic
FINISH: External Surfaces are Corrosion Resistant
POLARITY: Indicated by Diode Symbol
WEIGHT: 2.5 Grams (Approximately)
MAXIMUM LEAD TEMPERATURE FOR SOLDERING PURPOSES: 350^oC, 3/8" from case for 10 s at 5.0 lb. tension.

MAXIMUM CURRENT AND TEMPERATURE RATINGS

FIGURE 1 – MAXIMUM ALLOWABLE JUNCTION TEMPERATURE



NOTE 1

MAXIMUM JUNCTION TEMPERATURE DERATING

When operating this rectifier at junction temperatures over approximately 85°C, reverse power dissipation and the possibility of thermal runaway must be considered. The data of Figure 1 is based upon worst case reverse power and should be used to derate $T_{J(max)}$ from its maximum value of 175°C. See Note 3 for additional information on derating for reverse power dissipation.

When current ratings are computed from $T_{J(max)}$ and reverse power dissipation is also included, ratings vary with reverse voltage as shown on Figures 2 thru 5.

RESISTIVE LOAD RATINGS

PRINTED CIRCUIT BOARD MOUNTING – SEE NOTE 6

FIGURE 2 – SINE WAVE INPUT

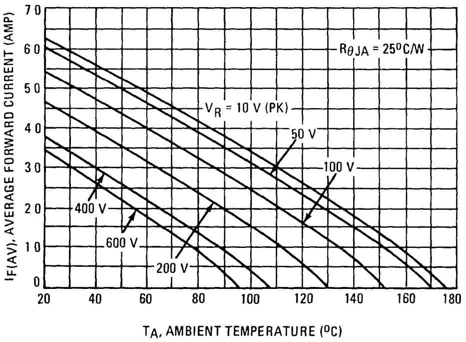


FIGURE 3 – SQUARE WAVE INPUT

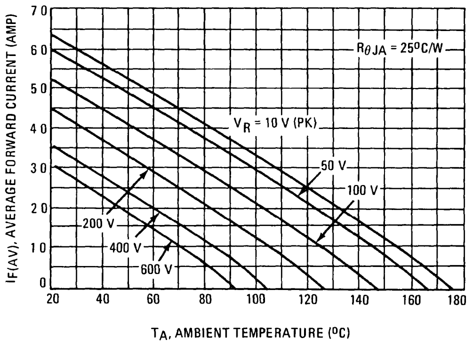


FIGURE 4 – SINE WAVE INPUT

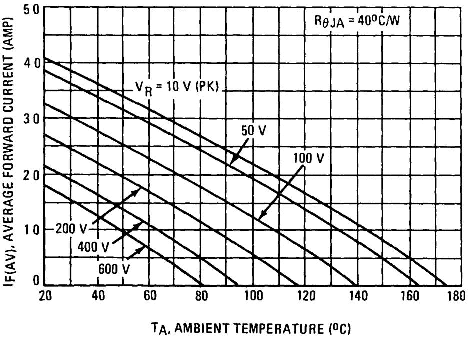
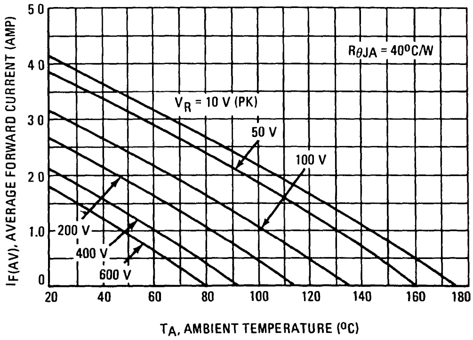


FIGURE 5 – SQUARE WAVE INPUT



MAXIMUM CURRENT RATINGS

NOTE 2

Current derating data is based upon the thermal response data of Figure 29 and the forward power dissipation data of Figures 19 and 20. Since reverse power dissipation is not considered in Figures 6 thru 11, additional derating for reverse voltage and for junction to ambient thermal resistance must be applied. See Note 3

SINE WAVE INPUT

FIGURE 6 – EFFECT OF LEAD LENGTHS, RESISTIVE LOAD

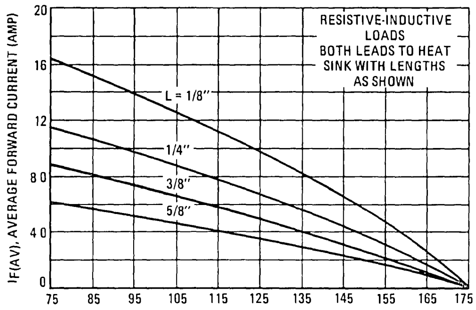


FIGURE 8 – 1/8" LEAD LENGTH, VARIOUS LOADS

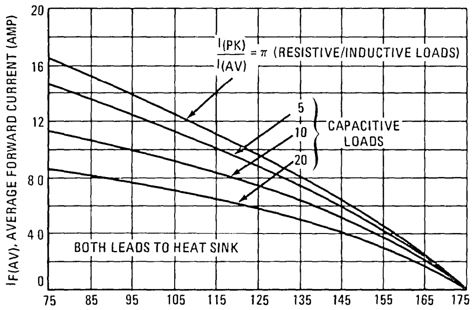
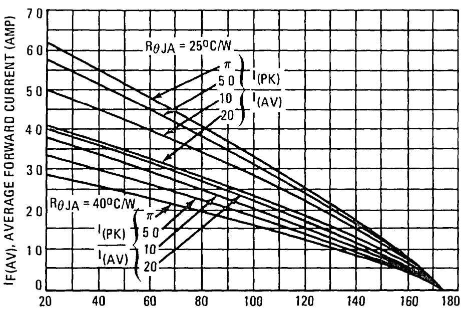


FIGURE 10 – PRINTED CIRCUIT BOARD MOUNTING, VARIOUS LOADS



SQUARE WAVE INPUT

FIGURE 7 – EFFECT OF LEAD LENGTHS, RESISTIVE LOAD

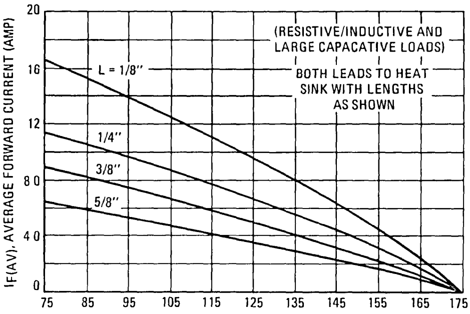


FIGURE 9 – 1/8" LEAD LENGTH, VARIOUS LOADS

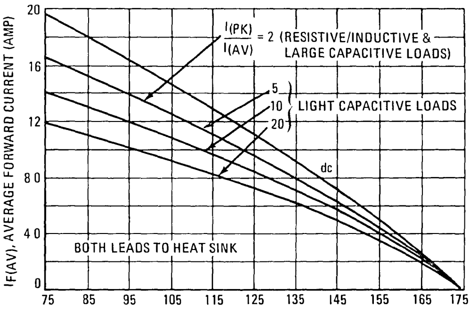
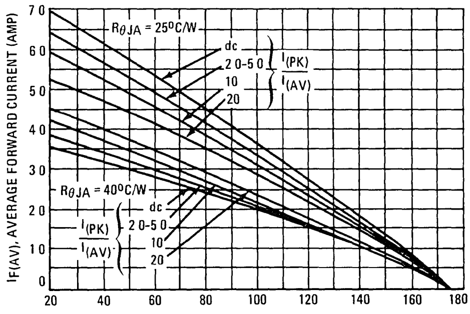


FIGURE 11 – PRINTED CIRCUIT BOARD MOUNTING, VARIOUS LOADS



3

3

REVERSE POWER DISSIPATION AND CURRENT

NOTE 3
DERATING FOR REVERSE POWER DISSIPATION

In this rectifier, power loss due to reverse current is generally not negligible For reliable circuit design, the maximum junction temperature must be limited to either 175°C or the temperature which results in thermal runaway Proper derating may be accomplished by use of equation 1 or equation 2

Equation 1 $T_A = T_1 - (175 - T_{J(max)}) - P_R\ R_{\theta JA}$

Where T_1 = Maximum Allowable Ambient Temperature neglecting reverse power dissipation (from Figures 10 or 11)

$T_{J(max)}$ = Maximum Allowable Junction Temperature to prevent thermal runaway or 175°C, whichever is lower (See Figure 1)

P_R = Reverse Power Dissipation (From Figure 12 or 13, adjusted for $T_{J(max)}$ as shown below)

$R_{\theta JA}$ = Thermal Resistance, Junction to Ambient

When thermal resistance, junction to ambient, is over 20°C/W, the effect of thermal response is negligible Satisfactory derating may be found by using

Equation 2 $T_A = T_{J(max)} - (P_R + P_F)\ R_{\theta JA}$

P_F = Forward Power Dissipation (See Figures 19 & 20)

Other terms defined above

The reverse power given on Figures 12 and 13 is calculated for T_J = 150°C When T_J is lower, P_R will decrease, its value can be found by multiplying P_R by the normalized reverse current from Figure 14 at the temperature of interest

The reverse power data is calculated for half wave rectification circuits For full wave rectification using either a bridge or a center tapped transformer, the data for resistive loads is equivalent when V_P is the line to line voltage across the rectifiers For capacitive loads, it is recommended that the dc case on Figure 13 be used, regardless of input waveform, for bridge circuits For capacitively loaded full wave center-tapped circuits, the 20 1 data of Figure 12 should be used for sine wave inputs and the capacitive load data of Figure 13 should be used for square wave inputs regardless of $I_{(pk)}/I_{(av)}$ For these two cases, V_P is the voltage across one leg of the transformer

EXAMPLE

Find Maximum Ambient Temperature for I_{AV} = 2 A, Capacitive Load of I_{PK}/I_{AV} = 20, Input Voltage = 120 V (rms) Sine Wave, $R_{\theta JA}$ = 25°C/W, Half Wave Circuit

Solution 1

Step 1 Find V_P, $V_P = \sqrt{2}\ V_{in}$ = 169 V $V_{R(pk)}$ = 338 V
Step 2 Find $T_{J(max)}$ from Figure 1 Read $T_{J(max)}$ = 119°C
Step 3 Find $P_{R(max)}$ from Figure 12 Read P_R = 770 mW @ 140°C
Step 4 Find I_R normalized from Figure 14 Read $I_{R(norm)}$ = 0 4
Step 5 Correct P_R to $T_{J(max)}$ $P_R = I_{R(norm)} \times P_R$ (Figure 12)
P_R = 0 4 x 770 = 310 mW
Step 6 Find P_F from Figure 19 Read P_F = 2 4 W
Step 7 Compute T_A from $T_A = T_{J(max)} - (P_R + P_F)\ R_{\theta JA}$
T_A = 119 - (0 31 + 2 4)(25)
T_A = 51°C

Solution 2

Steps 1 thru 5 are as above
Step 6 Find $T_A = T_1$ from Figure 10 Read T_A = 115°C
Step 7 Compute T_A from $T_A = T_1 - (175 - (T_{J(max)})\ P_R\ R_{\theta JA}$
T_A = 115 - (175 - 119) - (0 31)(25)
T_A = 51°C

At times, a discrepancy between methods will occur because thermal response is factored into Solution 2

FIGURE 12 – SINE WAVE INPUT DISSIPATION

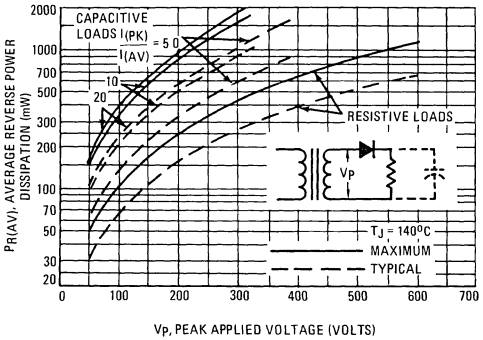


FIGURE 13 – SQUARE WAVE INPUT DISSIPATION

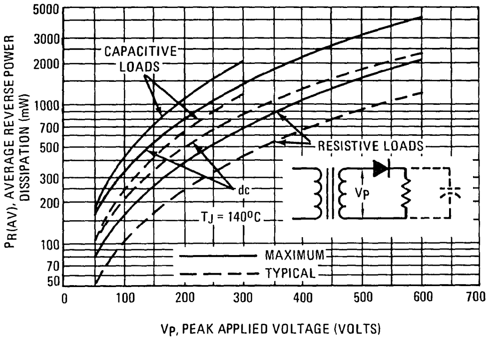


FIGURE 14 – NORMALIZED REVERSE CURRENT

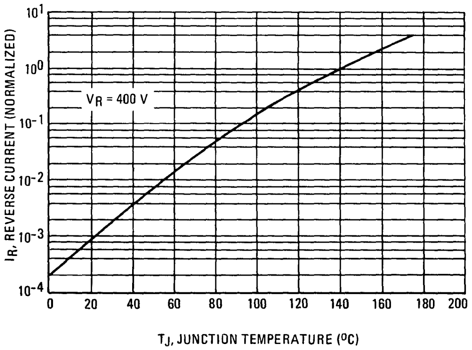
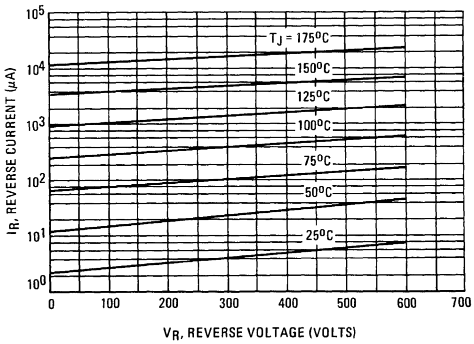


FIGURE 15 – TYPICAL REVERSE CURRENT



STATIC CHARACTERISTICS

FIGURE 16 – FORWARD VOLTAGE

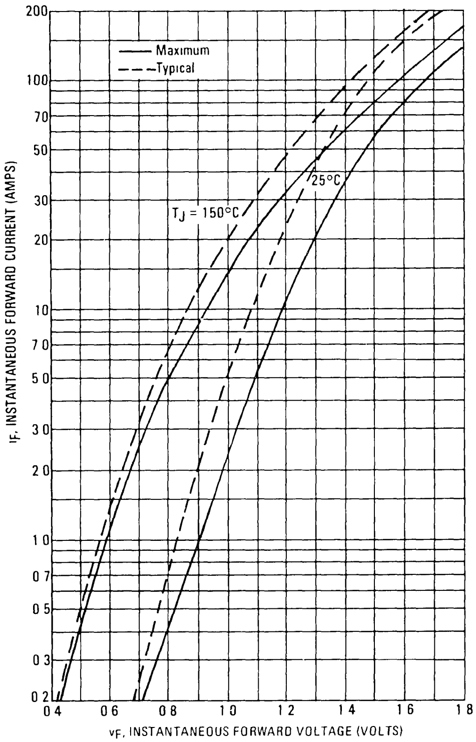


FIGURE 17 – MAXIMUM SURGE CAPABILITY

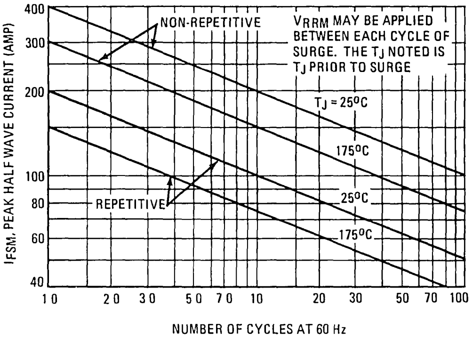
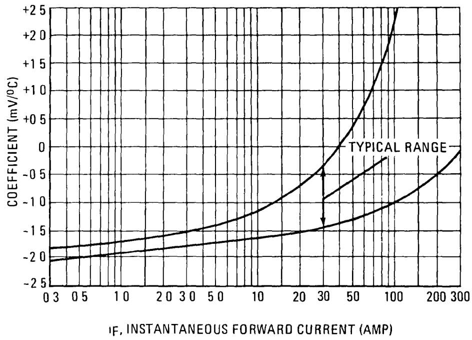


FIGURE 18 – FORWARD VOLTAGE TEMPERATURE COEFFICIENT



MAXIMUM FORWARD POWER DISSIPATION

FIGURE 19 – SINE WAVE INPUT

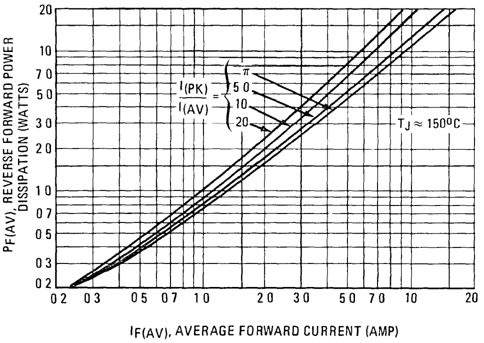
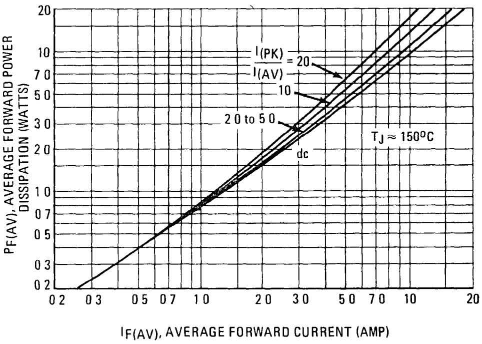


FIGURE 20 – SQUARE WAVE INPUT



TYPICAL RECOVERED STORED CHARGE DATA

(See Note 4)

FIGURE 21 – $T_J = 25°C$

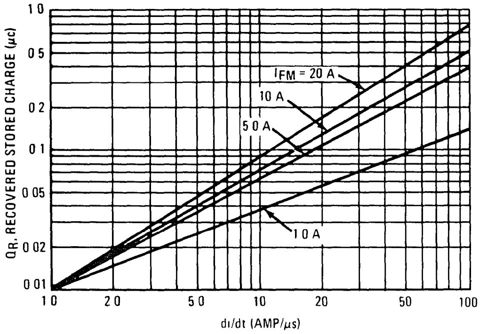


FIGURE 22 – $T_J = 75°C$

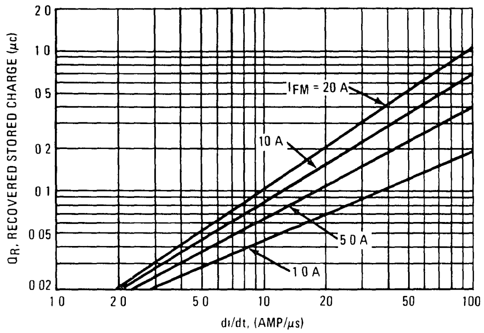


FIGURE 23 – $T_J = 100°C$

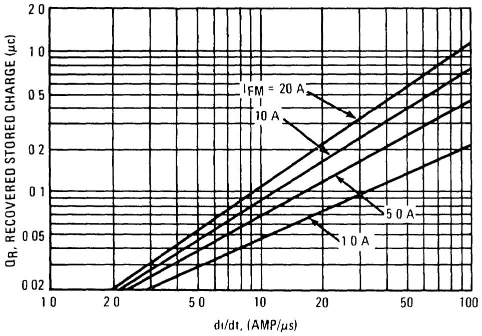
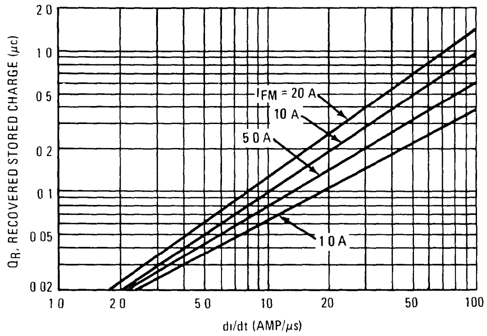


FIGURE 24 – $T_J = 150°C$



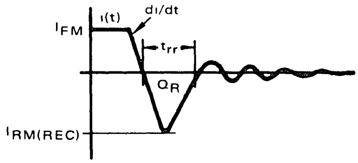
NOTE 4

Reverse recovery time is the period which elapses from the time that the current, thru a previously forward biased rectifier diode, passes thru zero going negatively until the reverse current recovers to a point which is less than 10% peak reverse current

Reverse recovery time is a direct function of the forward current prior to the application of reverse voltage

For any given rectifier, recovery time is very circuit dependent. Typical and maximum recovery time of all Motorola fast recovery power rectifiers are rated under a fixed set of conditions using $I_F \doteq 1.0$ A, $V_R = 30$ V. In order to cover all circuit conditions, curves are given for typical recovered stored charge versus commutation di/dt for various levels of forward current and for junction temperatures of 25°C, 75°C, 100°C, and 150°C.

To use these curves, it is necessary to know the forward current level just before commutation, the circuit commutation di/dt, and the operating junction temperature. The reverse recovery test current waveform for all Motorola fast recovery rectifiers is shown.



From stored charge curves versus di/dt, recovery time (t_{rr}) and peak reverse recovery current ($I_{RM(REC)}$) can be closely approximated using the following formulas:

$$t_{rr} = 1.41 \times \left[\frac{Q_R}{di/dt}\right]^{1/2}$$

$$I_{RM(REC)} = 1.41 \times \left[Q_R \times di/dt\right]^{1/2}$$

DYNAMIC CHARACTERISTICS

FIGURE 25 — JEDEC REVERSE RECOVERY CIRCUIT

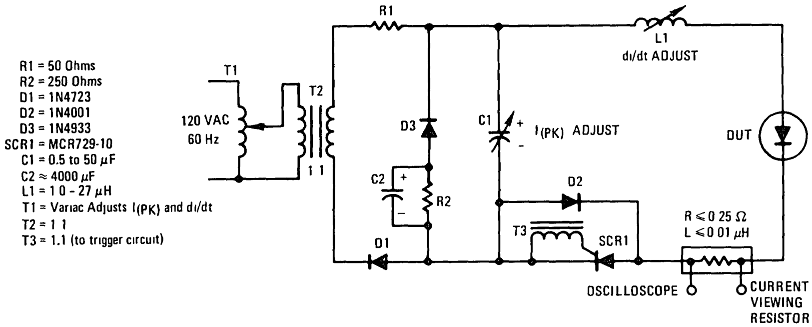


FIGURE 26 — FORWARD RECOVERY TIME

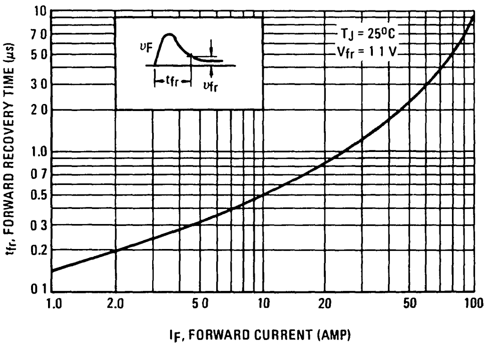
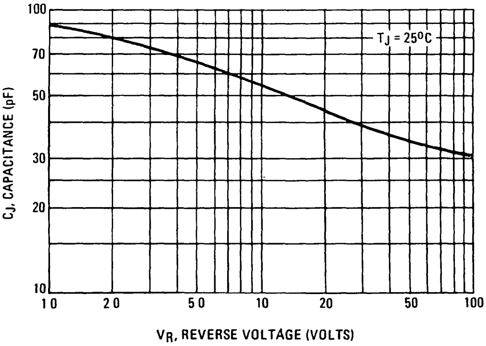
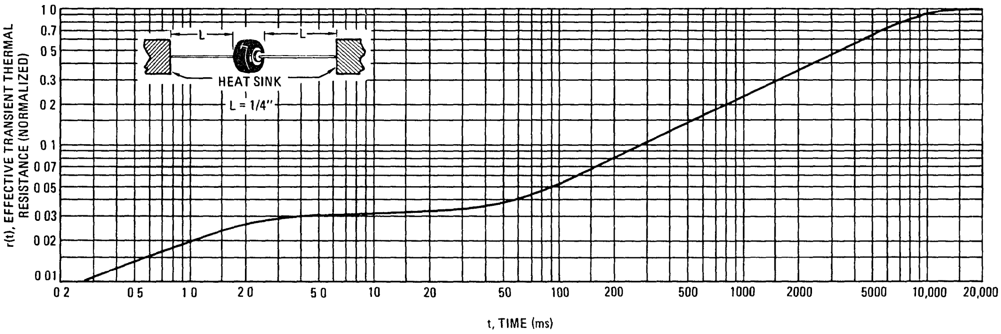


FIGURE 27 — JUNCTION CAPACITANCE



THERMAL CHARACTERISTICS

FIGURE 28 — THERMAL RESPONSE



NOTE 5

To determine maximum junction temperature of the diode in a given situation, the following procedure is recommended

The temperature of the lead should be measured using a thermocouple placed on the lead as close as possible to the tie point. The thermal mass connected to the tie point is normally large enough so that it will not significantly respond to heat surges generated in the diode as a result of pulsed operation once steady-state conditions are achieved. Using the measured value of T_L, the junction temperature may be determined by

$$T_J = T_L + \Delta T_{JL}$$

where ΔT_{JL} is the increase in junction temperature above the lead temperature. It may be determined by

$$\Delta T_{JL} = P_{pk} \cdot R_{\theta JL} \, [D + (1 - D) \cdot r(t_1 + t_p) + r(t_p) - r(t_1)]$$

where r(t) = normalized value of transient thermal resistance at time t from Figure 29, i.e.:

$r(t_1 + t_p)$ = normalized value of transient thermal resistance at time $t_1 + t_p$.

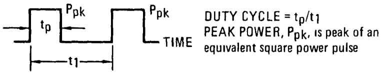
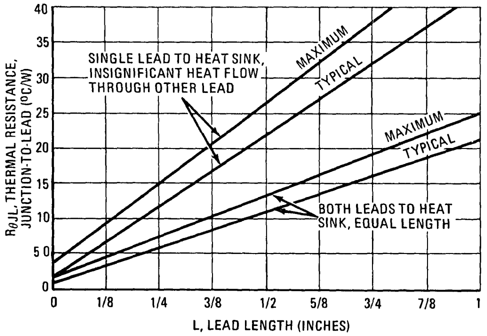
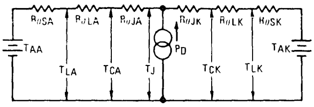


FIGURE 29 — STEADY-STATE THERMAL RESISTANCE



NOTE 6



Use of the above model permits junction to lead thermal resistance for any mounting configuration to be found. Lowest values occur when one side of the rectifier is brought as close as possible to the heat sink as shown below. Terms in the model signify:

T_A = Ambient Temperature	$R_{\theta S}$ = Thermal Resistance, Heat sink to Ambient
T_L = Lead Temperature	$R_{\theta L}$ = Thermal Resistance, Lead to Heat Sink
T_C = Case Temperature	$R_{\theta J}$ = Thermal Resistance, Junction to Case
T_J = Junction Temperature	P_D = Power Dissipation = $P_F + P_R$
	P_F = Forward Power Dissipation
	P_R = Reverse Power Dissipation

(Subscripts A and K refer to anode and cathode sides respectively) Values for thermal resistance components are.

$R_{\theta L}$ = 40°C/W/IN. Typically and 44°C/W/IN Maximum.
$R_{\theta J}$ = 2°C/W Typically and 4°C/W Maximum.

Since $R_{\theta J}$ is so low, measurements of the case temperature, T_C, will be approximately equal to junction temperature in practical lead mounted applications. When used as a 60 Hz rectifier, the slow thermal response holds $T_{J(PK)}$ close to $T_{J(AV)}$. Therefore maximum lead temperature may be found as follows:

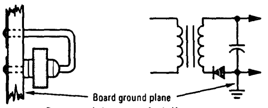
$$T_L = T_{J(max)} - \Delta T_{JL}$$

where

ΔT_{JL} can be approximated as follows:

$\Delta T_{JL} \approx R_{\theta JL} \cdot P_D$, P_D is the sum of forward and reverse power dissipation shown in Figures 12 & 19 for sine wave operation and Figures 13 & 20 for square wave operation

The recommended method of mounting to a P.C. board is shown on the sketch, where $R_{\theta JA}$ is approximately 25°C/W for a 1-1/2" x 1-1/2" copper surface area. Values of 40°C/W are typical for mounting to terminal strips or P.C. boards where available surface area is small.



Recommended mounting for half wave circuit

MOTOROLA
SEMICONDUCTOR
TECHNICAL DATA

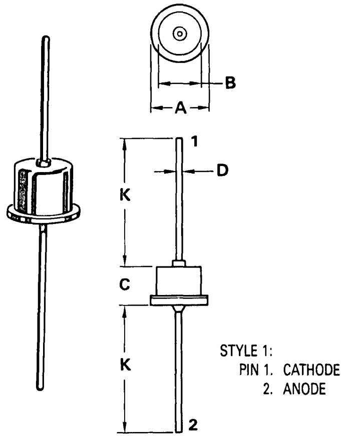
MR830 MR831 MR832 MR834 MR836

HERMETICALLY SEALED, AXIAL LEAD MOUNTED FAST RECOVERY POWER RECTIFIERS

. . . designed for special applications such as dc power supplies, inverters, converters, ultrasonic systems, choppers, low RF interference and free wheeling diodes. A complete line of fast recovery rectifiers having typical recovery time of 150 nanoseconds providing high efficiency at frequencies to 250 kHz.

FAST RECOVERY POWER RECTIFIERS

50-600 VOLTS
3 AMPERES



DIM	MILLIMETERS MIN	MILLIMETERS MAX	INCHES MIN	INCHES MAX
A	—	11 43	—	0.450
B	—	8.89	—	0 350
C	—	7.62	—	0.300
D	1.17	1 42	0 046	0.056
K	24.89	—	0 980	—

CASE 60-01
METAL

MAXIMUM RATINGS

Rating	Symbol	MR830	MR831	MR832	MR834	MR836	Unit
Peak Repetitive Reverse Voltage Working Peak Reverse Voltage DC Blocking Voltage	V_{RRM} V_{RWM} V_R	50	100	200	400	600	Volts
Average Rectified Forward Current (Single phase, resistive load, $T_C = 100°C$)	I_O	← 3 0 →					Amps
Non-Repetitive Peak Surge Current (surge applied at rated load conditions)	I_{FSM}	← 100 →					Amps
Operating Junction Temperature Range	T_J	← -65 to +150 →					°C
Storage Temperature Range	T_{stg}	← -65 to +175 →					°C

ELECTRICAL CHARACTERISTICS

Characteristic	Symbol	Min	Max	Unit
Forward Voltage ($I_F = 3\ 0$ Adc, $T_A = 25°C$)	V_F	–	1.1	Volts
Reverse Current (rated DC Voltage) $T_A = 25°C$	I_R	–	0.5	mA
$T_A = 100°C$		–	1.5	

REVERSE RECOVERY CHARACTERISTICS

Characteristic	Symbol	Min	Typ	Max	Unit
Reverse Recovery Time ($I_F = 1.0$ Amp to $V_R = 30$ Vdc)	t_{rr}	–	150	200	ns
($I_{FM} = 15$ Amp, di/dt = 25 A/μs)		–	150	300	ns
Reverse Recovery Current ($I_F = 1\ 0$ Amp to $V_R = 30$ Vdc)	$I_{RM(REC)}$	–	–	2.0	Amp

MECHANICAL CHARACTERISTICS

CASE: Welded, hermetically sealed
FINISH: All external surfaces corrosion resistant and leads readily solderable
POLARITY: Cathode to Case
WEIGHT: 2.4 Grams (Approximately)

3

MOTOROLA
SEMICONDUCTOR
TECHNICAL DATA

MR850 MR851 MR852 MR854 MR856

Designers Data Sheet

SUBMINIATURE SIZE, AXIAL LEAD MOUNTED FAST RECOVERY POWER RECTIFIERS

. . . designed for special applications such as dc power supplies, inverters, converters, ultrasonic systems, choppers, low RF interference and free wheeling diodes. A complete line of fast recovery rectifiers having typical recovery time of 150 nanoseconds providing high efficiency at frequencies to 250 kHz.

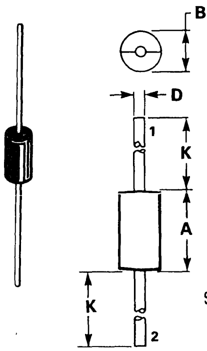
Designer's Data for "Worst Case" Conditions

The Designers Data sheets permit the design of most circuits entirely from the information presented Limit curves — representing boundaries on device characteristics — are given to facilitate "worst case" design.

FAST RECOVERY POWER RECTIFIERS

50-600 VOLTS
3 AMPERE

3



STYLE 1:
PIN 1. CATHODE
2. ANODE

NOTES:
1. DIMENSIONING & TOLERANCING PER ANSI Y14.5, 1982.
2. CONTROLLING DIMENSION: INCH.

DIM	MILLIMETERS MIN	MILLIMETERS MAX	INCHES MIN	INCHES MAX
A	—	9.39	—	0.370
B	—	6 35	—	0 250
D	1 22	1.32	0 048	0.052
K	25 40	—	1.000	—

CASE 267-02
PLASTIC

MAXIMUM RATINGS

Rating	Symbol	MR850	MR851	MR852	MR854	MR856	Unit
Peak Repetitive Reverse Voltage Working Peak Reverse Voltage DC Blocking Voltage	V_{RRM} V_{RWM} V_R	50	100	200	400	600	Volts
Non-Repetitive Peak Reverse Voltage	V_{RSM}	75	150	250	450	650	Volts
RMS Reverse Voltage	$V_{R(RMS)}$	35	70	140	280	420	Volts
Average Rectified Forward Current (Single phase resistive load, $T_A = 90°C$) (1)	I_O	← 3 0 →					Amp
Non-Repetitive Peak Surge Current (surge applied at rated load conditions)	I_{FSM}	← 100 → (one cycle)					Amp
Operating and Storage Junction Temperature Range (2)	T_J, T_{stg}	← -65 to +175 →					°C

THERMAL CHARACTERISTICS

Characteristic	Symbol	Max	Unit
Thermal Resistance, Junction to Ambient (Recommended Printed Circuit Board Mouting, See Note 6, Page 8)	$R_{\theta JA}$	28	°C/W

ELECTRICAL CHARACTERISTICS

Characteristic	Symbol	Min	Typ	Max	Unit
Instantaneous Forward Voltage ($i_F = 9.4$ Amp, $T_J = 175°C$)	v_F	–	0.9	1 1	Volts
Forward Voltage ($I_F = 3.0$ Amp, $T_J = 25°C$)	V_F	–	1.04	1.25	Volts
Reverse Current (rated dc voltage) $T_J = 25°C$	I_R	–	2.0	10	μA
$T_J = 100°C$ MR850		–	–	150	
MR851		–	60	150	
MR852		–	–	200	
MR854		–	–	250	
MR856		–	100	300	

REVERSE RECOVERY CHARACTERISTICS

Characteristic	Symbol	Min	Typ	Max	Unit
Reverse Recovery Time	t_{rr}				ns
($I_F = 1.0$ Amp to $V_R = 30$ Vdc, Figure 25)		–	150	200	
($I_F = 15$ Amp, di/dt = 10 A/μs, Figure 26)		–	200	300	
Reverse Recovery Current ($I_F = 1.0$ Amp to $V_R = 30$ Vdc, Figure 25)	$I_{RM(REC)}$	–	–	2 0	Amp

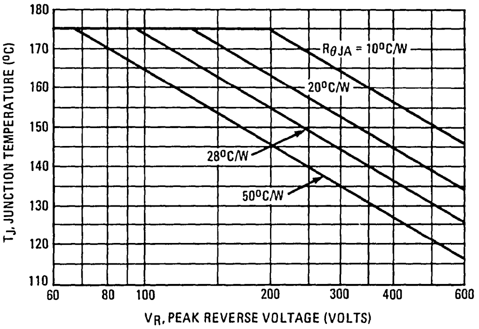
(1) Must be derated for reverse power dissipation. See Note 2, Page 4
(2) Derate as shown in Figure 1

MECHANICAL CHARACTERISTICS

Case: Transfer Molded Plastic
Finish: External Leads are Plated, Leads are readily Solderable
Polarity: Cathode Indicated by Polarity Band
Weight: 1.1 Grams (Approximately)
Maximum Lead Temperature for Soldering Purposes:
300°C, 1/8" from case for 10 s at 5.0 lb. tension

MAXIMUM CURRENT AND TEMPERATURE RATINGS

FIGURE 1 — MAXIMUM ALLOWABLE JUNCTION TEMPERATURE



NOTE 1
MAXIMUM JUNCTION TEMPERATURE DERATING

When operating this rectifier at junction temperatures over 120°C, reverse power dissipation and the possibility of thermal runaway must be considered. The data of Figure 1 is based upon worst case reverse power and should be used to derate $T_{J(max)}$ from its maximum value of 175°C. See Note 2 for additional information on derating for reverse power dissipation.

When current ratings are computed from $T_{J(max)}$ and reverse power dissipation is also included, ratings vary with reverse voltage as shown on Figures 2 thru 5.

3

RESISTIVE LOAD RATINGS

Printed Circuit Board Mounting — See Note 6, Page 8

FIGURE 2 — SINE WAVE INPUT

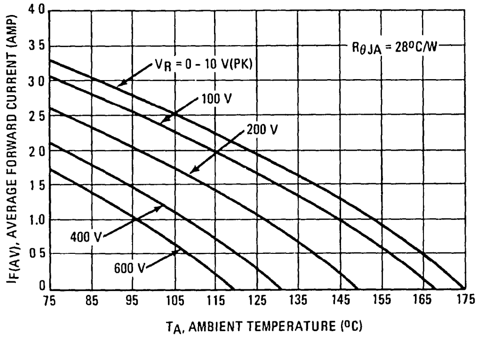


FIGURE 3 — SQUARE WAVE INPUT

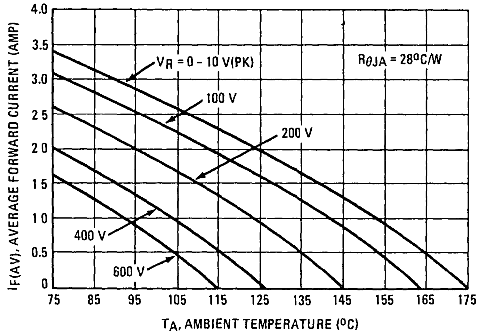


FIGURE 4 — SINE WAVE INPUT

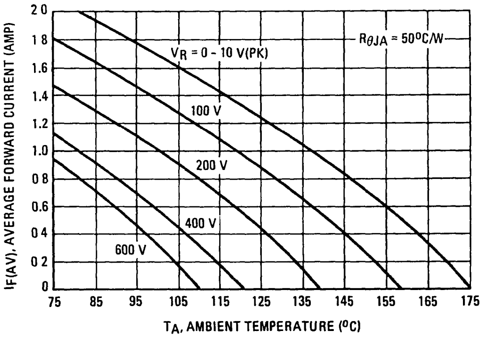
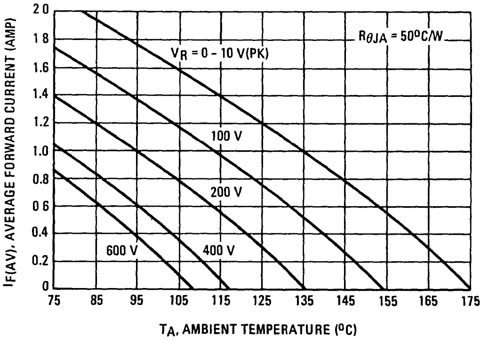


FIGURE 5 — SQUARE WAVE INPUT



3

MAXIMUM CURRENT RATINGS

Current derating data is based upon the thermal response data of Figure 29 and the forward power dissipation data of Figures 19 and 20. Since reverse power dissipation is not considered in Figures 6 thru 11, additional derating for reverse voltage and for junction to ambient thermal resistance must be applied. See Note 2

SINE WAVE INPUTS

FIGURE 6 — EFFECT OF LEAD LENGTHS, RESISTIVE LOAD

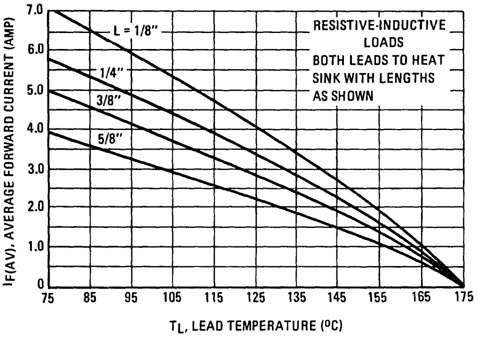


FIGURE 8 — 1/8" LEAD LENGTH, VARIOUS LOADS

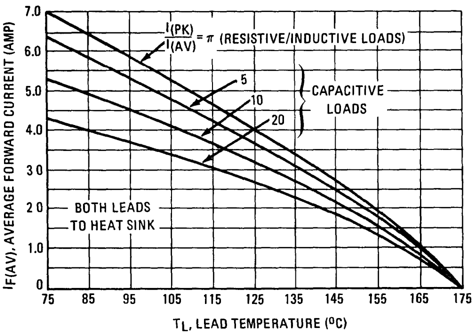
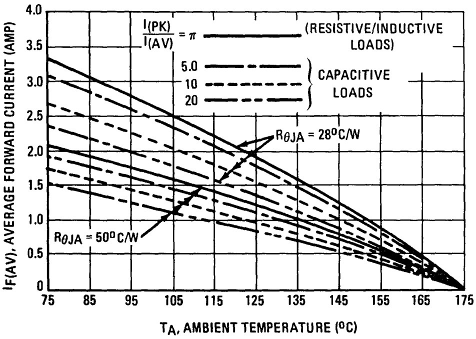


FIGURE 10 — PRINTED CIRCUIT BOARD MOUNTING, VARIOUS LOADS



SQUARE WAVE INPUTS

FIGURE 7 — EFFECT OF LEAD LENGTHS, RESISTIVE LOAD

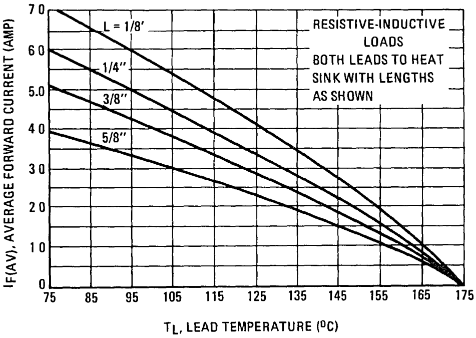


FIGURE 9 — 1/8" LEAD LENGTH, VARIOUS LOADS

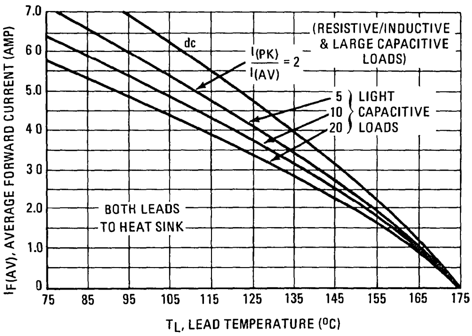
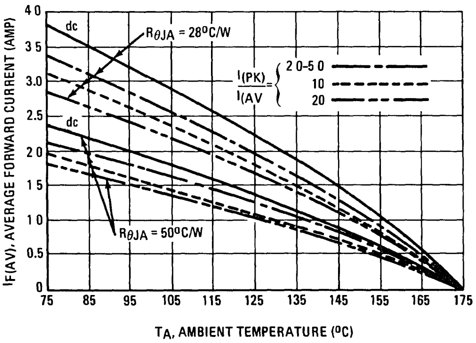


FIGURE 11 — PRINTED CIRCUIT BOARD MOUNTING, VARIOUS LOADS



REVERSE POWER DISSIPATION AND CURRENT

NOTE 2
DERATING FOR REVERSE POWER DISSIPATION

In this rectifier, power loss due to reverse current is generally not negligible For reliable circuit design, the maximum junction temperature must be limited to either 175°C or the temperature which results in thermal runaway Proper derating may be accomplished by use of equation 1 or equation 2

Equation 1 $T_A = T_1 - (175 - T_{J(max)}) - P_R R_{\theta JA}$

Where T_1 = Maximum Allowable Ambient Temperature neglecting reverse power dissipation (from Figures 10 or 11)

$T_{J(max)}$ = Maximum Allowable Junction Temperature to prevent thermal runaway or 175°C, which ever is lower. (See Figure 1)

P_R = Reverse Power Dissipation (From Figure 12 or 13, adjusted for $T_{J(max)}$ as shown below)

$R_{\theta JA}$ = Thermal Resistance, Junction to Ambient

When thermal resistance, junction to ambient, is over 20°C/W, the effect of thermal response is negligible Satisfactory derating may be found by using

Equation 2 $T_A = T_{J(max)} - (P_R + P_F) R_{\theta JA}$

P_F = Forward Power Dissipation (See Figures 19 & 20)

Other terms defined above.

The reverse power given on Figures 12 and 13 is calculated for T_J = 150°C When T_J is lower, P_R will decrease, its value can be found by multiplying P_R by the normalized reverse current from Figure 14 at the temperature of interest

The reverse power data is calculated for half wave rectification circuits For full wave rectification using either a bridge or a center-tapped transformer, the data for resistive loads is equivalent when V_P is the line to line voltage across the rectifiers For capacitive loads, it is recommended that the dc case on Figure 13 be used, regardless of input waveform, for bridge circuits For capacitively loaded full wave center-tapped circuits, the 20 1 data of Figure 12 should be used for sine wave inputs and the capacitive load data of Figure 13 should be used for square wave inputs regardless of $I_{(pk)}/I_{(av)}$ For these two cases, V_P is the voltage across one leg of the transformer

Example 1 Find maximum ambient temperature for I_{AV} = 2 A, capacitive load of I_{PK}/I_{AV} = 20, Input Voltage = 60 V (rms), sine wave, $R_{\theta JA}$ = 28°C/W, half wave circuit

Solution 1 (using Equation 1)

Step 1 Find V_P, $V_P = \sqrt{2}\, V_{in}$ = 85 V, $V_{R(pk)}$ = 170

Step 2 Find $T_{J(max)}$ from Figure 1 Read $T_{J(max)}$ = 157°C

Step 3 Find $P_{R(max)}$ from Figure 12 Read P_R = 360 mW @ 150°C

Step 4 Find I_R normalized from Figure 14 Read $I_{R(norm)}$ = 1 5

Step 5 Correct P_R to $T_{J(max)}$, $P_R = I_{R(norm)} \times P_R$ (Figure 12) P_R = 1 5 x 360 = 540 mW

Step 6 Find $T_A = T_1$ from Figure 10 Read T_1 = 94°C

Step 7 Compute T_A from $T_A = T_1 - (175 - T_{J(max)}) - P_R R_{\theta JA}$
T_A = 94 - (175 - 157) - (0 54) (28)
T_A = 61°C

Solution 2 (using Equation 2)

Steps 1 thru 5 are as Solution 1

Step 6 Find P_F from Figure 19 Read P_F = 3 0 W

Step 7 Compute T_A from $T_A = T_{J(max)} - (P_R + P_F) R_{\theta JA}$
T_A = 157 - (0 54 + 3)28
T_A = 58°C

The discrepancy occurs because thermal response is factored into solution 1, and advantage is taken of the cooling time after the power pulse and before reverse voltage achieves its maximum 61°C is a satisfactory ambient temperature

FIGURE 12 — REVERSE POWER DISSIPATION, SINE WAVE

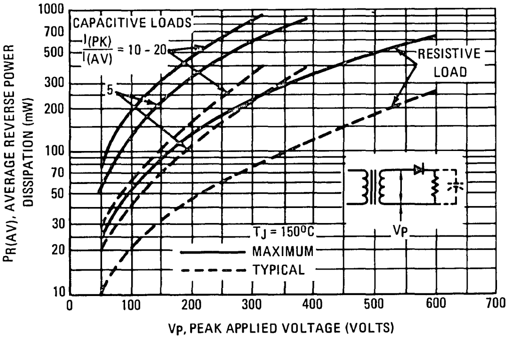


FIGURE 13 — REVERSE POWER DISSIPATION, SQUARE WAVE

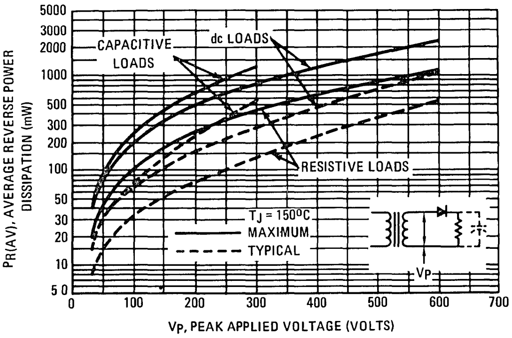


FIGURE 14 — NORMALIZED REVERSE CURRENT

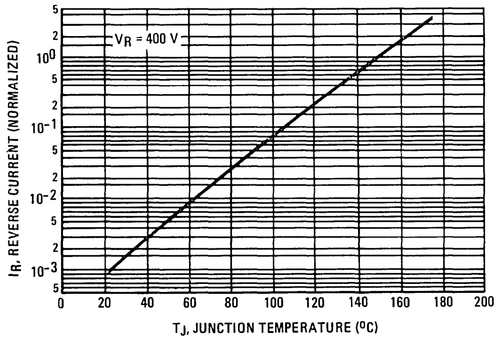
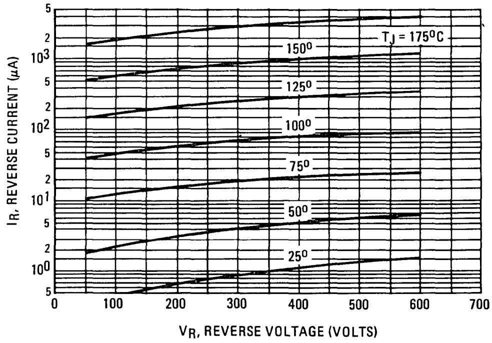


FIGURE 15 — TYPICAL REVERSE CURRENT



3

3

STATIC CHARACTERISTICS

FIGURE 16 – FORWARD VOLTAGE

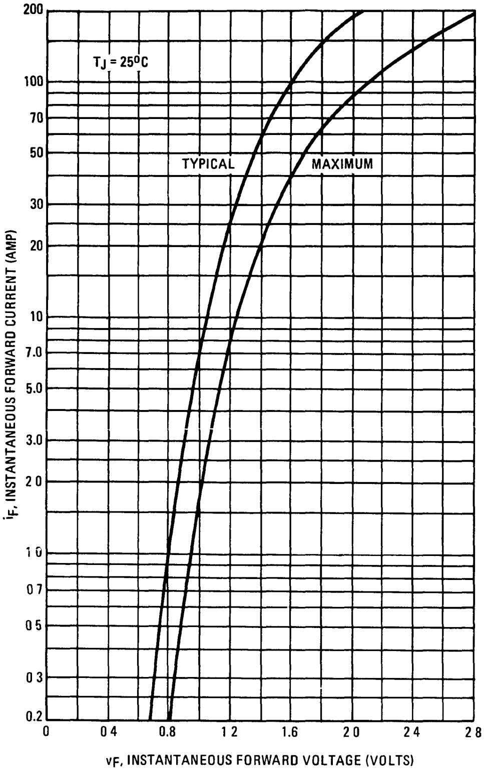


FIGURE 17 – MAXIMUM SURGE CAPABILITY

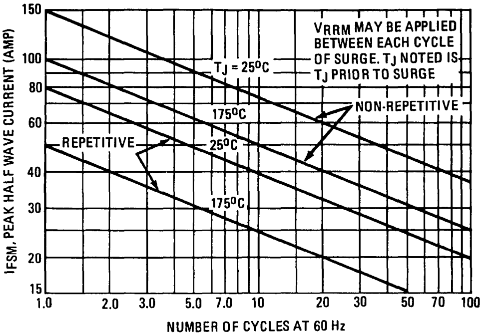
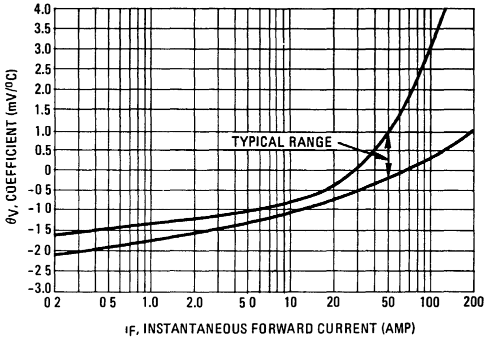
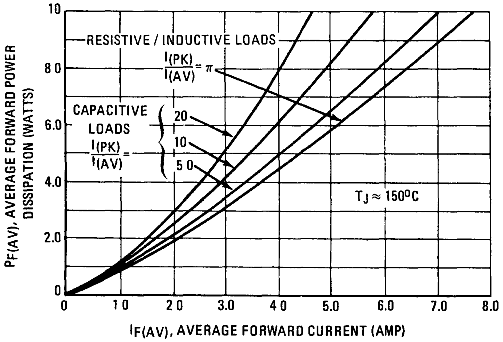


FIGURE 18 – FORWARD VOLTAGE TEMPERATURE COEFFICIENT



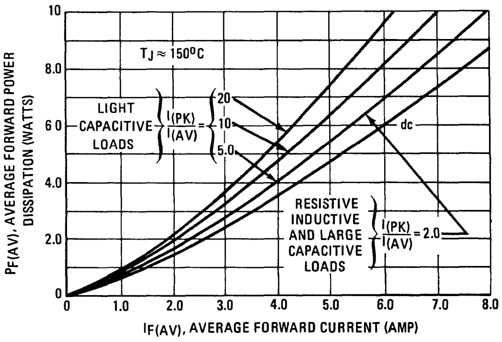
SINE WAVE INPUT

FIGURE 19 – FORWARD POWER DISSIPATION



SQUARE WAVE INPUT

FIGURE 20 – FORWARD POWER DISSIPATION



TYPICAL RECOVERED STORED CHARGE DATA

(See Note 3)

FIGURE 21 — $T_J = 25^oC$

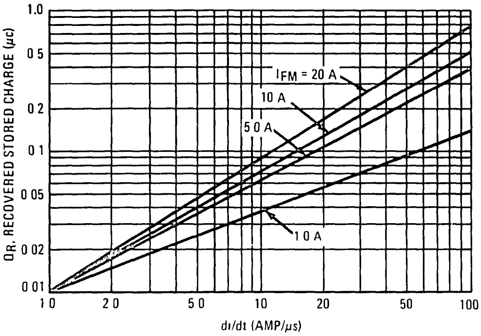


FIGURE 22 — $T_J = 75^oC$

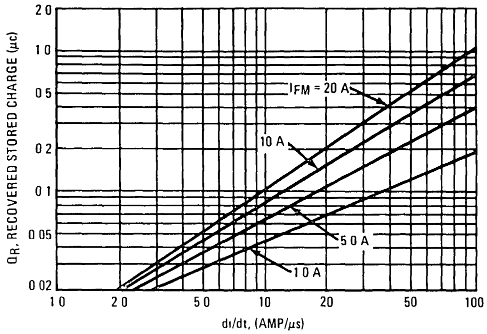


FIGURE 23 — $T_J = 100^oC$

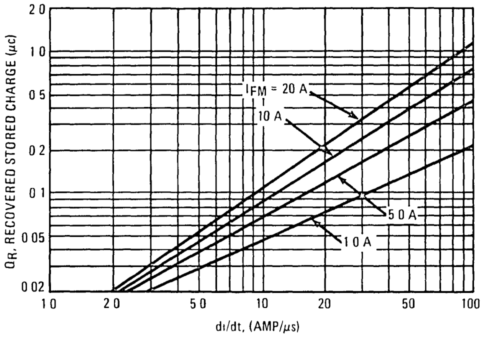
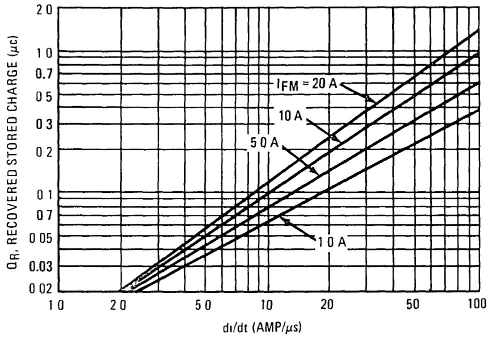


FIGURE 24 — $T_J = 150^oC$



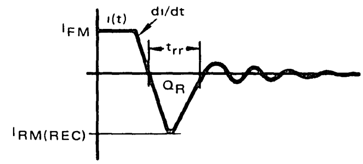
NOTE 3

Reverse recovery time is the period which elapses from the time that the current, thru a previously forward biased rectifier diode, passes thru zero going negatively until the reverse current recovers to a point which is less than 10% peak reverse current.

Reverse recovery time is a direct function of the forward current prior to the application of reverse voltage

For any given rectifier, recovery time is very circuit dependent. Typical and maximum recovery time of all Motorola fast recovery power rectifiers are rated under a fixed set of conditions using I_F = 1.0 A, V_R = 30 V. In order to cover all circuit conditions, curves are given for typical recovered stored charge versus commutation di/dt for various levels of forward current and for junction temperatures of 25°C, 75°C, 100°C, and 150°C.

To use these curves, it is necessary to know the forward current level just before commutation, the circuit commutation di/dt, and the operating junction temperature. The reverse recovery test current waveform for all Motorola fast recovery rectifiers is shown.



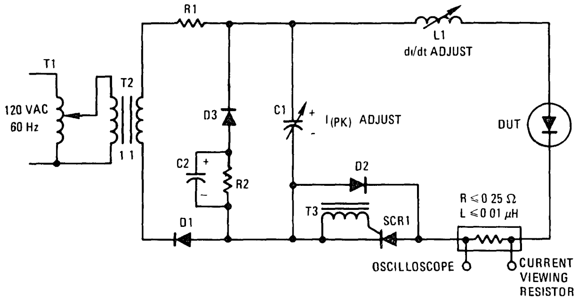
From stored charge curves versus di/dt, recovery time (t_{rr}) and peak reverse recovery current ($I_{RM(REC)}$) can be closely approximated using the following formulas:

$$t_{rr} = 1.41 \times \left[\frac{Q_R}{di/dt}\right]^{1/2}$$

$$I_{RM(REC)} = 1.41 \times \left[Q_R \times di/dt\right]^{1/2}$$

DYNAMIC CHARACTERISTICS

FIGURE 25 — JEDEC REVERSE RECOVERY CIRCUIT



R1 = 50 Ohms
R2 = 250 Ohms
D1 = 1N4723
D2 = 1N4001
D3 = 1N4934
SCR1 = MCR729 10
C1 = 0.5 to 50 µF
C2 ≈ 4000 µF
L1 = 1.0 - 27 µH
T1 = Variac Adjusts $I_{(PK)}$ and di/dt
T2 = 1:1
T3 = 1:1 (to trigger circuit)

FIGURE 26 — FORWARD RECOVERY TIME

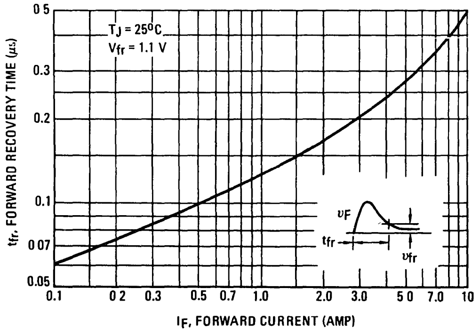


FIGURE 27 — JUNCTION CAPACITANCE

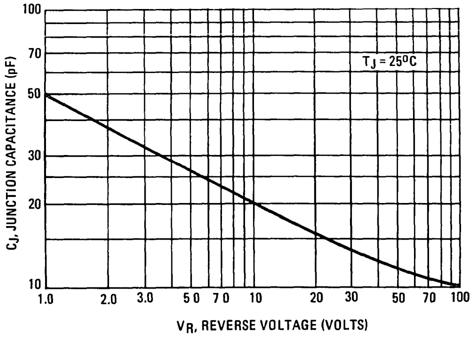


FIGURE 28 — THERMAL RESPONSE

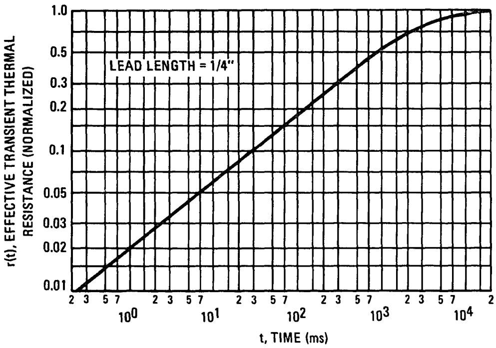
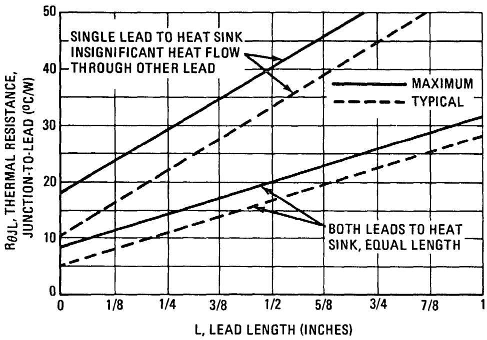


FIGURE 29 — STEADY-STATE THERMAL RESISTANCE



NOTE 4

To determine maximum junction temperature of the diode in a given situation, the following procedure is recommended

The temperature of the lead should be measured using a thermocouple placed on the lead as close as possible to the tie point The thermal mass connected to the tie point is normally large enough so that it will not significantly respond to heat surges generated in the diode as a result of pulsed operation once steady-state conditions are achieved Using the measured value of T_L, the junction temperature may be determined by

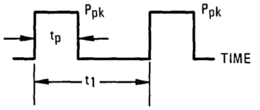
$$T_J = T_L + \Delta T_{JL}$$

where ΔT_{JL} is the increase in junction temperature above the lead temperature It may be determined by

$$\Delta T_{JL} = P_{pk} \cdot R_{\theta JL} [D + (1 - D) \cdot r(t_1 + t_p) + r(t_p) - r(t_1)]$$

where $r(t)$ = normalized value of transient thermal resistance at time t from Figure 29, i e

$r(t_1 + t_p)$ = normalized value of transient thermal resistance at time $t_1 + t_p$



DUTY CYCLE = t_p/t_1
PEAK POWER, P_{pk}, is peak of an equivalent square power pulse

NOTE 5

Use of the above model permits junction to lead thermal resistance for any mounting configuration to be found For a given total lead length, lowest values occur when one side of the rectifier is brought as close as possible to the heat sink Terms in the model signify

T_A = Ambient Temperature
T_L = Lead Temperature
T_C = Case Temperature
T_J = Junction Temperature
$R_{\theta S}$ = Thermal Resistance, Heat Sink to Ambient
$R_{\theta L}$ = Thermal Resistance, Lead to Heat Sink
$R_{\theta J}$ = Thermal Resistance, Junction to Case
P_D = Total Power Dissipation = $P_F + P_R$
P_F = Forward Power Dissipation
P_R = Reverse Power Dissipation

(Subscripts A and K refer to anode and cathode sides respectively) Values for thermal resistance components are

$R_{\theta L}$ = 46°C/W/IN Typically and 48°C/W/IN Maximum
$R_{\theta J}$ = 10°C/W Typically and 16°C/W Maximum

The maximum lead temperature may be found as follows

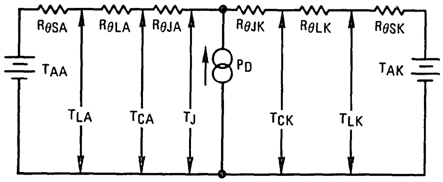
$$T_L = T_{J(max)} - \Delta T_{JL}$$

where

ΔT_{JL} can be approximated as follows

$\Delta T_{JL} \approx R_{\theta JL} \cdot P_D$, P_D is the sum of forward and reverse power dissipation shown in Figures 2 and 4 for sine wave operation and Figures 3 and 5 for square wave operation

THERMAL CIRCUIT MODEL
(For Heat Conduction Through the Leads)



NOTE 6

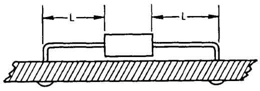
Data shown for thermal resistance junction-to-ambient ($R_{\theta JA}$) for the mountings shown is to be used as typical guideline values for preliminary engineering or in case the tie point temperature cannot be measured

TYPICAL VALUES FOR $R_{\theta JA}$ IN STILL AIR

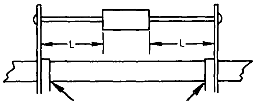
MOUNTING METHOD	LEAD LENGTH, L (IN) 1/8	1/4	1/2	3/4	$R_{\theta JA}$
1	50	51	53	55	°C/W
2	58	59	61	63	°C/W
3	28				°C/W

MOUNTING METHOD 1

P C Board Where Available Copper Surface area is small



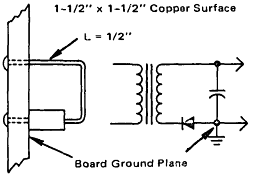
MOUNTING METHOD 2
Vector Pin Mounting



Vector Push-In Terminals T-28

MOUNTING METHOD 3

P C Board with
1-1/2" x 1-1/2" Copper Surface



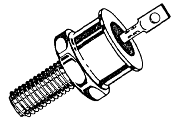
3

MOTOROLA
SEMICONDUCTOR
TECHNICAL DATA

MR1120 thru MR1126 MR1128 MR1130

MEDIUM-CURRENT SILICON RECTIFIERS

50-1000 VOLTS
12 AMPERES



MEDIUM-CURRENT SILICON RECTIFIER

Medium-current silicon rectifiers feature high surge current capacity, and low forward voltage drop.

3

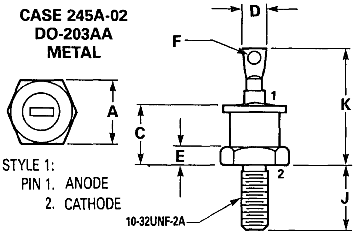
MAXIMUM RATINGS

Rating	Symbol	MR 1120	MR 1121	MR 1122	MR 1123	MR 1124	MR 1125	MR 1126	MR 1128	MR 1130	Unit
Peak Repetitive Reverse Voltage Working Peak Reverse Voltage DC Blocking Voltage	V_{RRM} V_{RWM} V_R	50	100	200	300	400	500	600	800	1000	Volts
Non-Repetitive Peak Reverse Voltage (one half-wave, single phase, 60 cycle peak)	V_{RSM}	100	200	300	400	500	600	720	100	1200	Volts
RMS Reverse Voltage	$V_{R(RMS)}$	35	70	140	210	280	350	420	560	700	Volts
Average Rectified Forward Current (single phase, resistive load, 60 Hz, T_C = 150°C)	I_O	← 12 →									Amp
Peak Repetitive Forward Current (T_C = 150°C)	I_{FRM}	← 75 →									Amp
Non-Repetitive Peak Surge Current (superimposed on rated current at rated voltage, T_C = 150°C)	I_{FSM}	← 300 (for 1/2 cycle) →									Amp
I^2t Rating (non-repetitive, 1 ms < t < 8 3 ms)	I^2t	← 375 →									$A_{(rms)}^2s$
Maximum Junction Operating and Storage Temperature Range	T_J, T_{stg}	← -65 to +190 →									°C

ELECTRICAL CHARACTERISTICS (All Types)

Characteristic	Symbol	Max	Unit
Full Cycle Average Forward Voltage Drop (I_O = 12 Amps and Rated V_r, T_C = 150°C, Half Wave Rectifier)	$V_{F(AV)}$	0 55	Volts
DC Forward Voltage Drop (I_F = 12 Adc, T_C = 25°C)	V_F	1 0	Volts
Full Cycle Average Reverse Current (I_O = 12 Amps and Rated V_r, T_C = 150°C, Half Wave Rectifier)	$I_{R(AV)}$	1 5	mA
DC Reverse Current (Rated V_R, T_C = 25°C)	I_R	0.5	mA

CASE 245A-02
DO-203AA
METAL



STYLE 1:
PIN 1. ANODE
2. CATHODE

MOUNTING TORQUE: 15 in-lb max

NOTES:
1. DIMENSIONING AND TOLERANCING PER ANSI Y14.5M, 1982.
2. CONTROLLING DIMENSION: INCH.

DIM	MILLIMETERS MIN	MILLIMETERS MAX	INCHES MIN	INCHES MAX
A	10.75	11.12	0.423	0.438
C	—	10.28	—	0 405
D	4.07	4.69	0 160	0.185
E	1.91	4.44	0.075	0 175
F	2.29	2.41	0.090	0.095
J	10.72	11.50	0.422	0 453
K	18.80	20.32	0.740	0.800

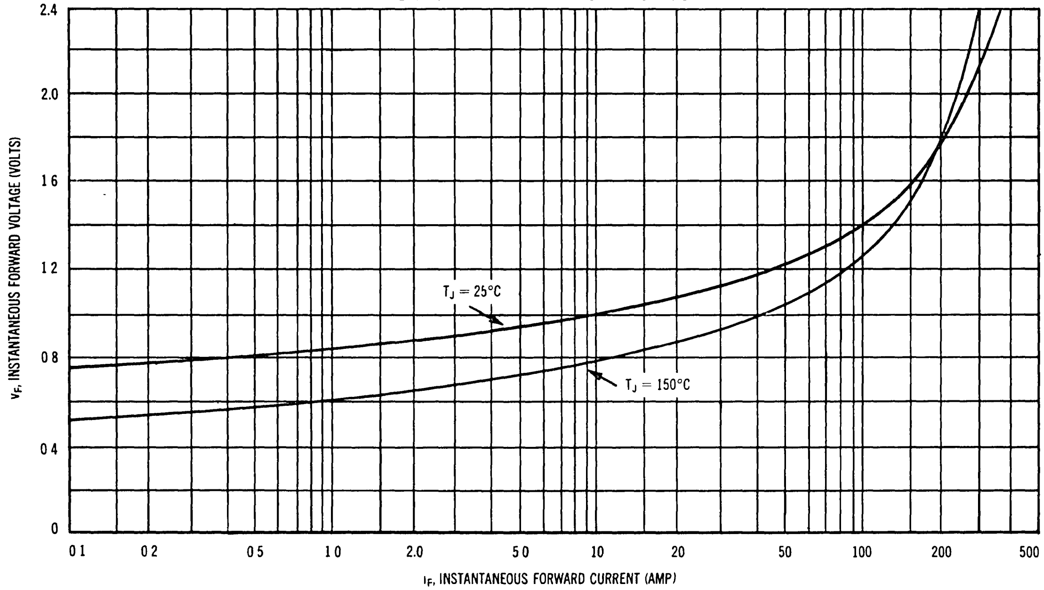
THERMAL CHARACTERISTICS

Maximum Steady State DC Thermal Resistance, $R_{\theta JC}$: 2.5°C/Watt

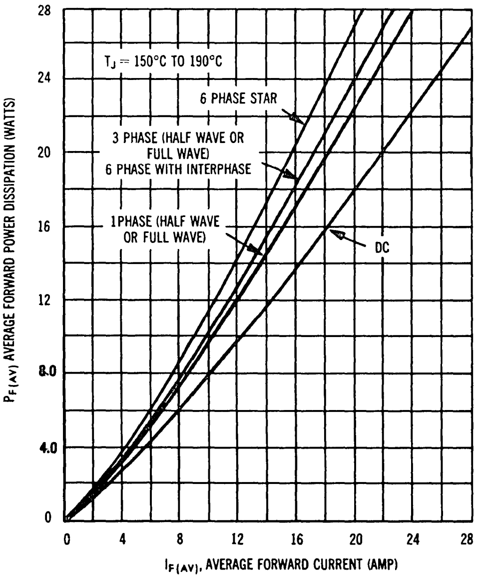
MECHANICAL CHARACTERISTICS

CASE: Welded, hermetically sealed construction.
FINISH: All external surfaces corrosion-resistant and the terminal lug is readily solderable.
POLARITY: CATHODE-TO-CASE (reverse polarity units are available upon request and are designated by an "R" suffix i.e. MR1120R).
MOUNTING POSITIONS: Any
STUD TORQUE: 15 in-lbs maximum.

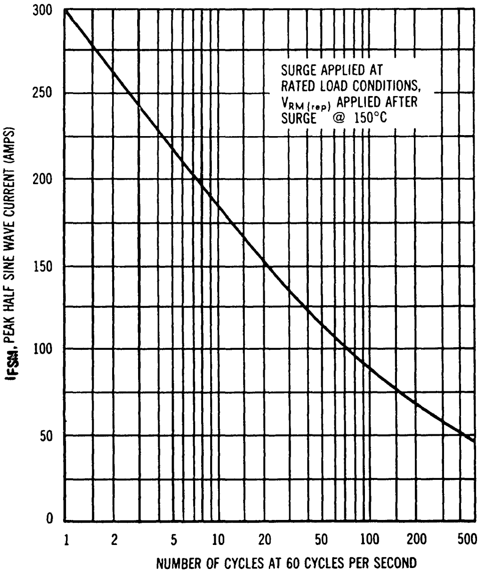
TYPICAL FORWARD CHARACTERISTICS



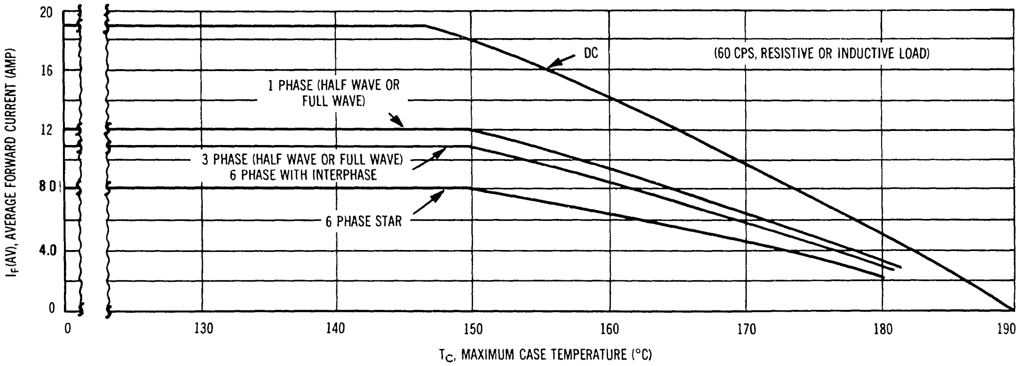
FORWARD POWER DISSIPATION



MAXIMUM ALLOWABLE SURGE CURRENT



MAXIMUM CURRENT RATINGS



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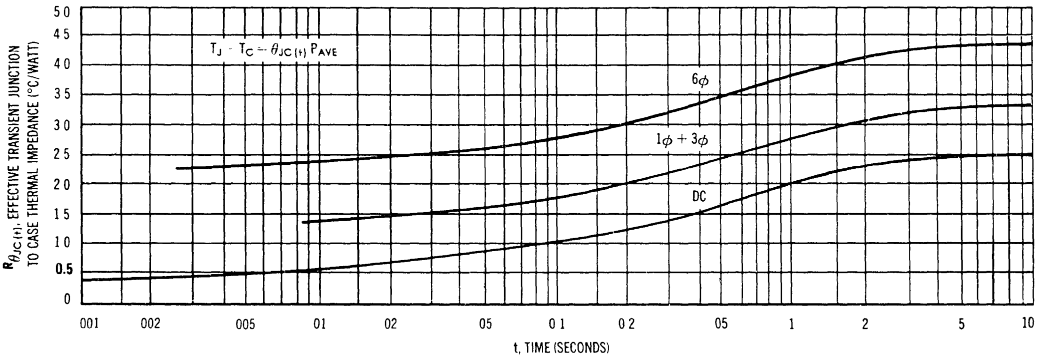
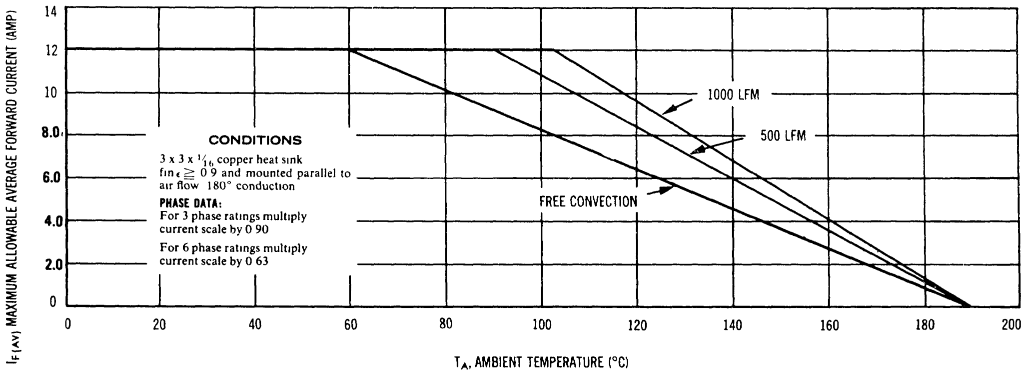
EFFECTIVE TRANSIENT THERMAL IMPEDANCE



CURRENT DERATING DATA



MOTOROLA
SEMICONDUCTOR
TECHNICAL DATA

MR1366 See Page 3-13
MR1376 See Page 3-18
MR1386 See Page 3-23
MR1396 See Page 3-28

MR2000 Series

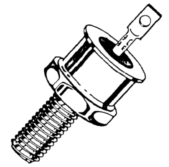
MEDIUM-CURRENT SILICON RECTIFIERS

. . . compact, highly efficient silicon rectifiers for medium-current applications requiring:

- High Current Surge — 400 Amperes @ T_J = 175°C
- Peak Performance @ Elevated Temperature — 20 Amperes @ T_C = 150°C
- Low Cost
- Compact, Molded Package — For Optimum Efficiency in a Small Case Configuration

MEDIUM-CURRENT SILICON RECTIFIERS
50-1000 VOLTS
20 AMPERES
DIFFUSED JUNCTION

3



MAXIMUM RATINGS

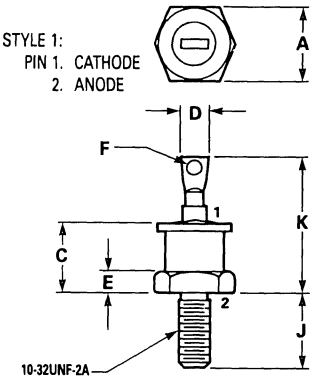
Characteristic	Symbol	MR 2000	MR 2001	MR 2002	MR 2004	MR 2006	MR 2008	MR 2010	Unit
Peak Repetitive Reverse Voltage Working Peak Reverse Voltage DC Blocking Voltage	V_{RRM} V_{RWM} V_R	50	100	200	400	600	800	1000	Volts
Non-Repetitive Peak Reverse Voltage (halfwave, single phase, 60 Hz peak)	V_{RSM}	60	120	240	480	720	960	1200	Volts
RMS Forward Current	$I_{(RMS)}$	← 40 →							Amp
Average Rectified Forward Current (Single phase, resistive load, 60 Hz, T_C = 150°C)	I_O	← 20 →							Amp
Non-Repetitive Peak Surge Current (surge applied @ rated load conditions, half wave, single phase, 60 Hz)	I_{FSM}	← 400 (for 1 cycle) →							Amp
Operating and Storage Junction Temperature Range	T_J, T_{stg}	← -65 to +175 →							°C

THERMAL CHARACTERISTICS

Characteristic	Symbol	Max	Unit
Thermal Resistance, Junction to Case	$R_{\theta JC}$	1 3	°C/W

ELECTRICAL CHARACTERISTICS

Characteristic and Conditions	Symbol	Max	Unit
Maximum Instantaneous Forward Voltage (i_F = 63 Amp, T_C = 25°C)	v_F	1 1	Volts
Maximum Reverse Current (rated dc voltage) T_C = 25°C T_C = 100°C	I_R	100 500	μA



NOTES:
1. DIMENSIONING AND TOLERANCING PER ANSI Y14.5M, 1982.
2. CONTROLLING DIMENSION: INCH.

DIM	MILLIMETERS MIN	MILLIMETERS MAX	INCHES MIN	INCHES MAX
A	10.75	11.12	0.423	0.438
C	—	10.28	—	0.405
D	4.07	4.69	0.160	0.185
E	1.91	4.44	0 075	0.175
F	2.29	2.41	0.090	0.095
J	10.72	11.50	0.422	0.453
K	18.80	20.32	0.740	0.800

CASE 245A-02
DO-203AA
METAL

MECHANICAL CHARACTERISTICS

CASE: Void Free, Transfer Molded.
FINISH: All External Surfaces are Corrosion-Resistant and the Terminal Lead is Readily Solderable.
POLARITY: Cathode to Case (Reverse Polarity Units are Available and Designated by an "R" Suffix i.e., MR2000SR).
MOUNTING POSITIONS: Any
MOUNTING TORQUE: 15 in-lb max
MAXIMUM TERMINAL TEMPERATURE FOR SOLDERING PURPOSES: 275°C for 10 Seconds @ 3 Kg Tension.
WEIGHT: 6 Grams (Approximately).

3

FIGURE 1 — FORWARD VOLTAGE

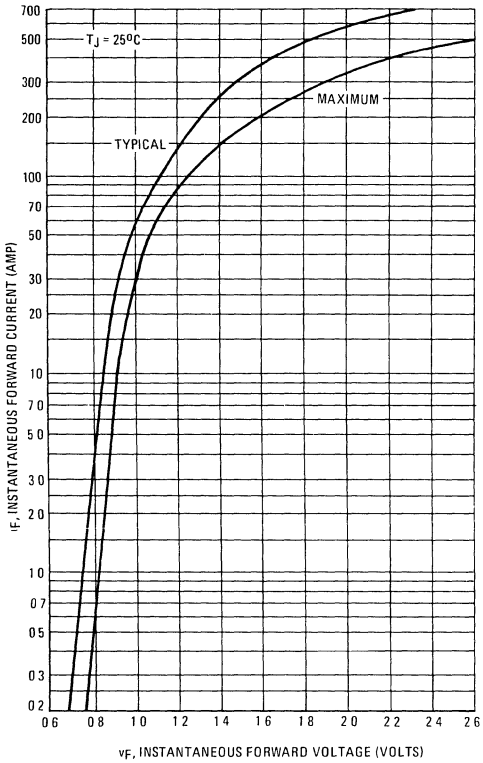


FIGURE 2 — NON-REPETITIVE SURGE CURRENT

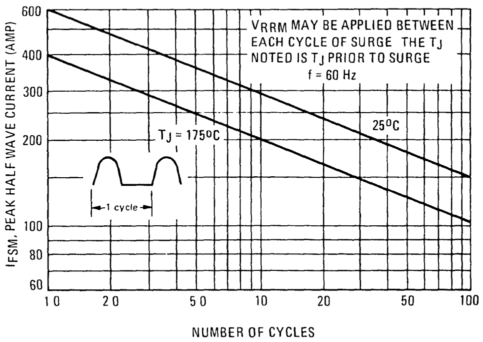


FIGURE 3 — FORWARD VOLTAGE TEMPERATURE COEFFICIENT

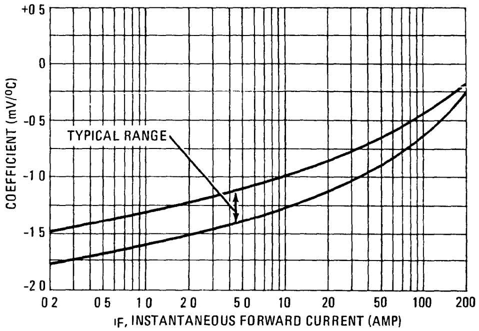


FIGURE 4 — CURRENT DERATING

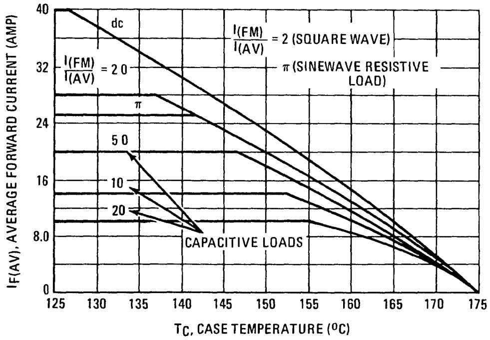


FIGURE 5 — FORWARD POWER DISSIPATION

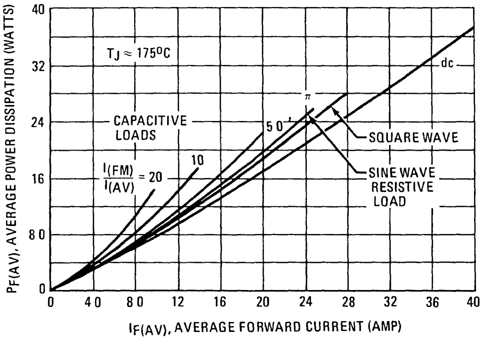
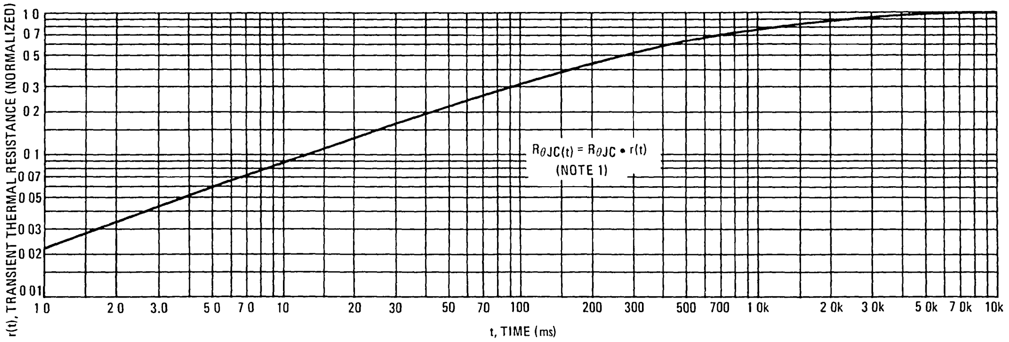
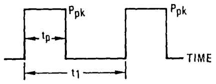


FIGURE 6 – THERMAL RESPONSE



NOTE 1



DUTY CYCLE, $D = t_p/t_1$
PEAK POWER, P_{pk}, is peak of an equivalent square power pulse

To determine maximum junction temperature of the diode in a given situation, the following procedure is recommended

The temperature of the case should be measured using a thermocouple placed on the case at the temperature reference point (see the outline drawing on page 1) The thermal mass connected to the case is normally large enough so that it will not significantly respond to heat surges generated in the diode as a result of pulsed operation once steady state conditions are achieved Using the measured value of T_C, the junction temperature may be determined by

$$T_J = T_C + \Delta T_{JC}$$

where ΔT_{JC} is the increase in junction temperature above the case temperature It may be determined by

$$\Delta T_{JC} = P_{pk} \bullet R_{\theta JC} [D + (1 - D) \bullet r(t_1 + t_p) + r(t_p) - r(t_1)]$$

where

$r(t)$ = normalized value of transient thermal resistance at time, t, from Figure 6, i e ,

$r(t_1 + t_p)$ = normalized value of transient thermal resistance at time $t_1 + t_p$

FIGURE 7 – CAPACITANCE

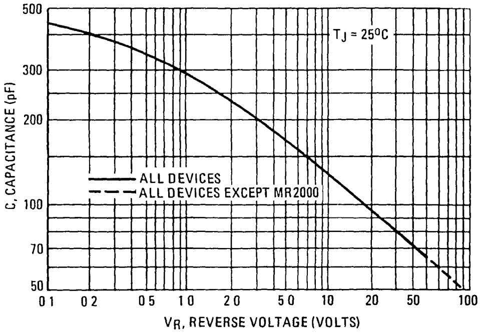


FIGURE 8 – FORWARD RECOVERY TIME

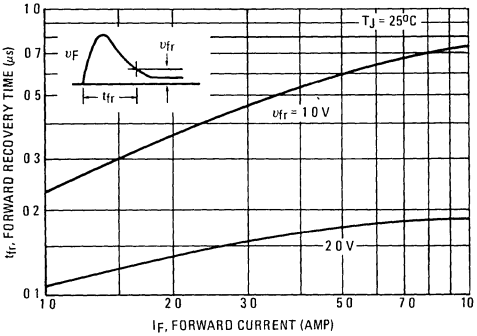


FIGURE 9 – REVERSE RECOVERY TIME

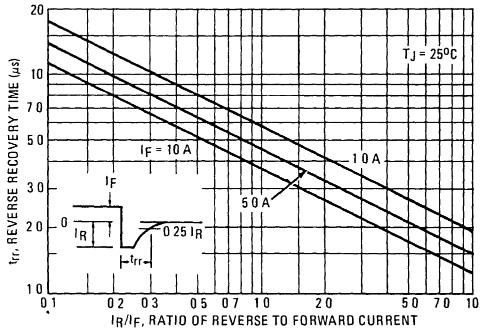
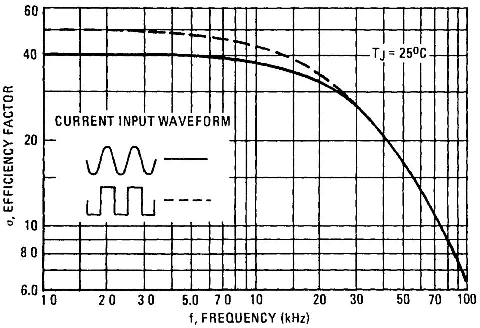
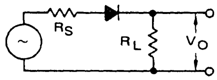


FIGURE 10 – RECTIFICATION WAVEFORM EFFICIENCY



RECTIFICATION EFFICIENCY NOTE

FIGURE 11 – SINGLE-PHASE HALF-WAVE RECTIFIER CIRCUIT



The rectification efficiency factor σ shown in Figure 10 was calculated using the formula

$$\sigma = \frac{P_{dc}}{P_{rms}} = \frac{\frac{V^2_{O(dc)}}{R_L}}{\frac{V^2_{O(rms)}}{R_L}} \bullet 100\% = \frac{V^2_{O(dc)}}{V^2_{O(ac)} + V^2_{O(dc)}} \bullet 100\% \qquad (1)$$

For a sine wave input $V_m \sin(\omega t)$ to the diode, assume lossless, the maximum theoretical efficiency factor becomes

$$\sigma_{(sine)} = \frac{\frac{V^2_m}{\pi^2 R_L}}{\frac{V^2_m}{4R_L}} \bullet 100\% = \frac{4}{\pi^2} \bullet 100\% = 40.6\% \qquad (2)$$

For a square wave input of amplitude V_m, the efficiency factor becomes:

$$\sigma_{(square)} = \frac{\frac{V^2_m}{2R_L}}{\frac{V^2_m}{R_L}} \bullet 100\% = 50\% \qquad (3)$$

(A full wave circuit has twice these efficiencies)

As the frequency of the input signal is increased, the reverse recovery time of the diode (Figure 9) becomes significant, resulting in an increasing ac voltage component across R_L which is opposite in polarity to the forward current, thereby reducing the value of the efficiency factor σ, as shown on Figure 10.

It should be emphasized that Figure 10 shows waveform efficiency only; it does not provide a measure of diode losses. Data was obtained by measuring the ac component of V_O with a true rms ac voltmeter and the dc component with a dc voltmeter. The data was used in Equation 1 to obtain points for Figure 10.

3

MOTOROLA
SEMICONDUCTOR
TECHNICAL DATA

MR2400 thru MR2406

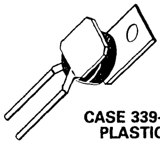
TAB-MOUNTED MEDIUM-CURRENT SILICON RECTIFIERS

. . . compact, highly efficient silicon rectifiers for medium current applications requiring:

- High Current Surge — 400 Amperes @ T_J = 175°C
- Peak Performance @ Elevated Temperature — 24 Amperes @ T_C = 150°C
- Low Cost
- Same Mounting as a TO-220AB

MEDIUM-CURRENT SILICON RECTIFIERS

50-600 VOLTS
24 AMPERES



CASE 339-02
PLASTIC

3

MAXIMUM RATINGS

Rating	Symbol	MR2400	MR2401	MR2402	MR2404	MR2406	Unit
Peak Repetitive Reverse Voltage Working Peak Reverse Voltage DC Blocking Voltage	V_{RRM} V_{RWM} V_R	50	100	200	400	600	Volts
Nonrepetitive Peak Reverse Voltage (half wave, single phase, 60 Hz peak)	V_{RSM}	60	120	240	480	720	Volts
Average Rectified Forward Current (Single phase, resistive load, 60 Hz, T_C = 150°C)	I_O	← 24 →					Amp
Nonrepetitive Peak Surge Current (surge applied @ rated load conditions, half wave, single phase, 60 Hz)	I_{FSM}	← 400 (for 1 cycle) →					Amp
Operating and Storage Junction Temperature Range	T_J, T_{stg}	← -65 to +175 →					°C

THERMAL CHARACTERISTICS

Characteristic	Symbol	Max	Unit
Thermal Resistance, Junction to Case	$R_{\theta JC}$	0 8	°C/W
Thermal Resistance, Junction to Air PC Board Mount, Perpendicular to Surface	$R_{\theta JA}$	55	°C/W

ELECTRICAL CHARACTERISTICS

Characteristics and Conditions	Symbol	Max	Unit
Maximum Instantaneous Forward Voltage (i_F = 75 4 Amp, T_C = 25°C)	v_F	1 18	Volts
Maximum Reverse Current (rated dc voltage) T_C = 25°C T_C = 100°C	I_R	 25 1.0	 μA mA

MECHANICAL CHARACTERISTICS

CASE: Plastic encapsulated, metal tabs.

FINISH: All external surfaces are corrosion resistant and the leads are readily solderable.

POLARITY: Cathode to tab with hole, Reverse polarity available by adding "R" Suffix, MR2402R

MOUNTING TORQUE: 8 in-lb max

MAXIMUM TEMPERATURE FOR SOLDERING PURPOSES: 350°C, 3/8" from case for 10 seconds.

WEIGHT: 3 6 Grams (Approximately).

3

FIGURE 1 – FORWARD VOLTAGE

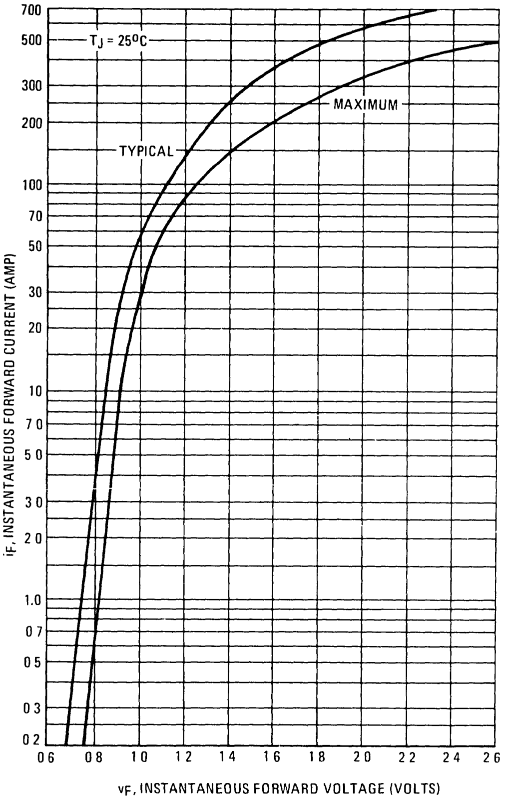


FIGURE 2 – NONREPETITIVE SURGE CURRENT

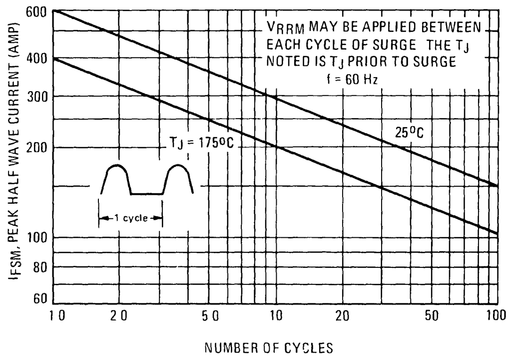


FIGURE 3 – FORWARD VOLTAGE TEMPERATURE COEFFICIENT

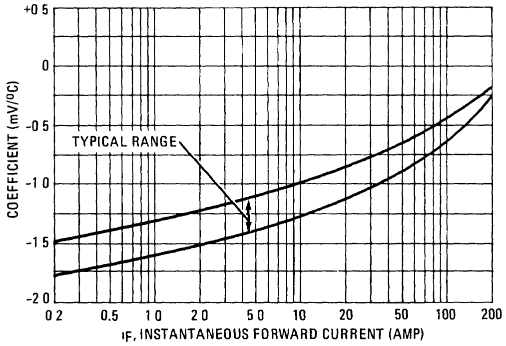


FIGURE 4 – CURRENT DERATING

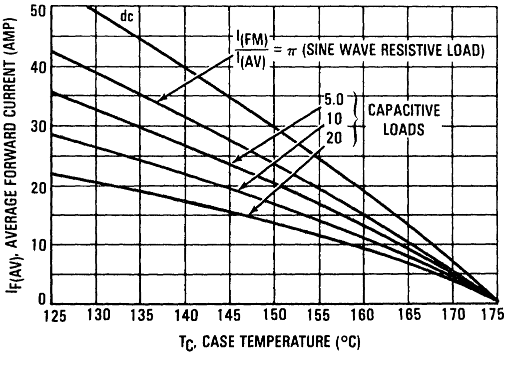


FIGURE 5 – FORWARD POWER DISSIPATION

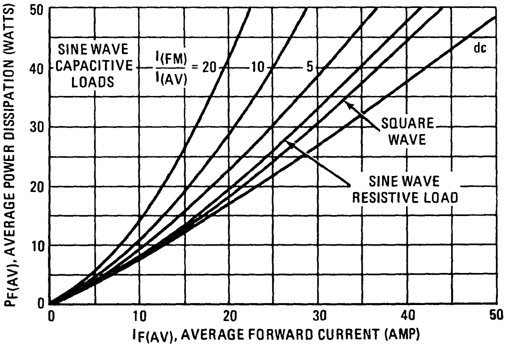
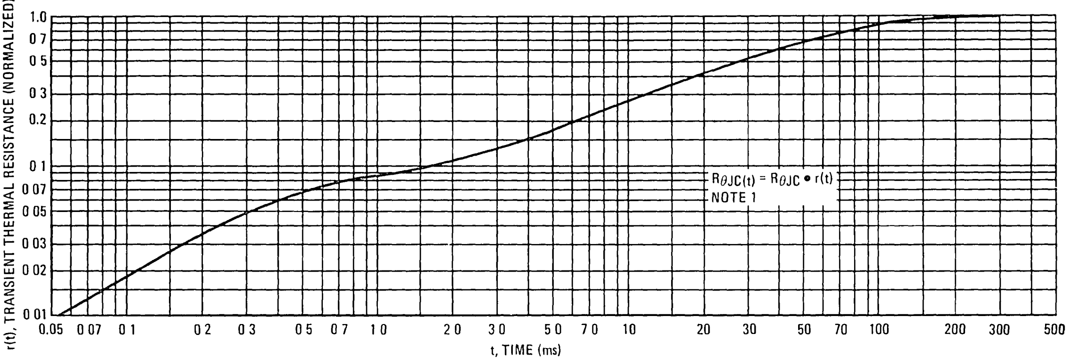


FIGURE 6 – THERMAL RESPONSE



NOTE 1

DUTY CYCLE, $D = t_p/t1$
PEAK POWER, P_{pk}, is peak of an equivalent square power pulse

To determine maximum junction temperature of the diode in a given situation, the following procedure is recommended

The temperature of the case should be measureed using a thermocouple placed on the case at the temperature reference point The thermal mass connected to the case is normally large enough so that it will not significantly respond to heat surges generated in the diode as a result of pulsed operation once steady-state conditions are achieved Using the measured value of T_C, the junction temperature may be determined by

$$T_J = T_C + \Delta T_{JC}$$

where ΔT_{JC} is the increase in junction temperature above the case temperature It may be determined by

$$\Delta T_{JC} = P_{pk} \circ R_{\theta JC} [D + (1 - D) \circ r(t1 + t_p) + r(t_p) - r(t1)]$$

where

$r(t)$ = normalized value of transient thermal resistance at time, t, from Figure 3, i e

$r(t1 + t_p)$ = normalized value of transient thermal resistance at time $t1 + t_p$

3

FIGURE 7 – CAPACITANCE

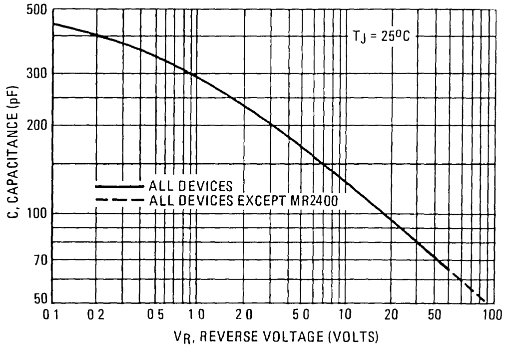


FIGURE 8 – FORWARD RECOVERY TIME

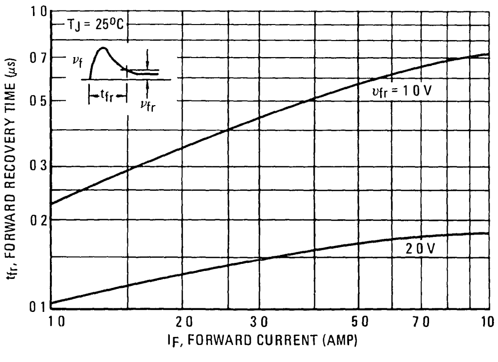


FIGURE 9 – REVERSE RECOVERY TIME

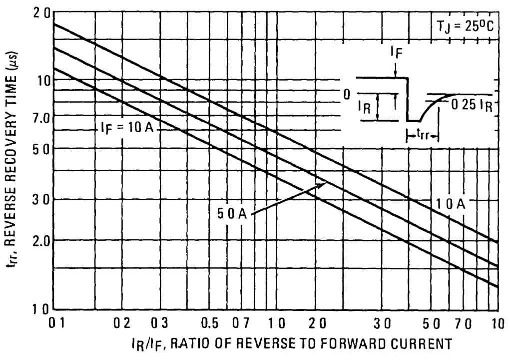
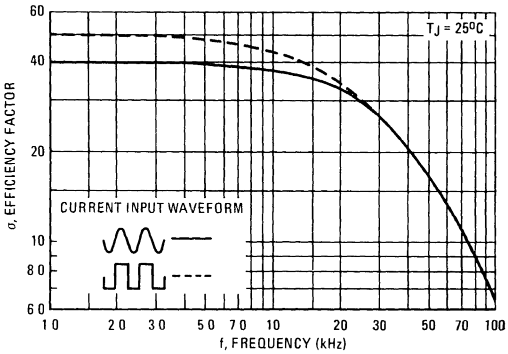


FIGURE 10 – RECTIFICATION WAVEFORM EFFICIENCY



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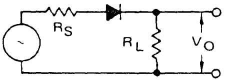
RECTIFICATION EFFICIENCY NOTE



The rectification efficiency factor σ shown in Figure 10 was calculated using the formula

$$\sigma = \frac{P_{dc}}{P_{rms}} = \frac{\frac{V^2_{O(dc)}}{R_L}}{\frac{V^2_{O(rms)}}{R_L}} \bullet 100\% = \frac{V^2_{O(dc)}}{V^2_{O(ac)} + V^2_{O(dc)}} \bullet 100\% \quad (1)$$

For a sine wave input $V_m \sin(\omega t)$ to the diode, assume lossless, the maximum theoretical efficiency factor becomes

$$\sigma_{(sine)} = \frac{\frac{V^2_m}{\pi^2 R_L}}{\frac{V^2_m}{4R_L}} \bullet 100\% = \frac{4}{\pi^2} \bullet 100\% = 40.6\% \quad (2)$$

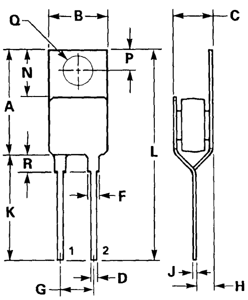
For a square wave input of amplitude V_m, the efficiency factor becomes

$$\sigma_{(square)} = \frac{\frac{V^2_m}{2R_L}}{\frac{V^2_m}{R_L}} \bullet 100\% = 50\% \quad (3)$$

(A full wave circuit has twice these efficiencies)

As the frequency of the input signal is increased, the reverse recovery time of the diode (Figure 9) becomes significant, resulting in an increasing ac voltage component across R_L which is opposite in polarity to the forward current, thereby reducing the value of the efficiency factor σ, as shown on Figure 10

It should be emphasized that Figure 10 shows waveform efficiency only, it does not provide a measure of diode losses Data was obtained by measuring the ac component of V_O with a true rms ac voltmeter and the dc component with a dc voltmeter The data was used in Equation 1 to obtain points for Figure 10



STYLE 1
1 CATHODE
2 ANODE

DIM	MILLIMETERS MIN	MILLIMETERS MAX	INCHES MIN	INCHES MAX
A	14.22	15.88	0.560	0.625
B	9.65	10.67	0.380	0.420
C	7.21	7.87	0.284	0.310
D	0.64	1.14	0.025	0.045
F	1.52	2.29	0.060	0.090
G	4.32	5.33	0.170	0.210
H	2.03	2.92	0.080	0.115
J	0.58	0.74	0.023	0.029
K	—	14.27	—	0.562
L	—	30.15	—	1.187
N	5.84	6.86	0.230	0.270
P	2.54	3.05	0.100	0.120
Q	3.53	3.73	0.139	0.147
R	—	5.08	—	0.200

CASE 339-02
PLASTIC
(Meets TO-220AB except dimension "C")

MOTOROLA
SEMICONDUCTOR
TECHNICAL DATA

MR2400F thru MR2406F

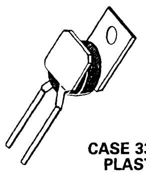
TAB-MOUNTED FAST RECOVERY POWER RECTIFIERS

designed for special applications such as dc power supplies, inverters, converters, ultrasonic systems, choppers, low RF interference, sonar power supplies and free wheeling diodes A complete line of fast recovery rectifiers having typical recovery time of 150 nanoseconds providing high efficiency at frequencies to 250 kHz

- Same Mounting as a TO-220AB
- Cost Effective in Low Current Applications
- Lead or Chassis Mounted
- High Surge Current Capability

FAST RECOVERY POWER RECTIFIERS

50-600 VOLTS
24 AMPERES



CASE 339-02
PLASTIC

3

MAXIMUM RATINGS

Rating	Symbol	MR2400F	MR2401F	MR2402F	MR2404F	MR2406F	Unit
Peak Repetitive Reverse Voltage Working Peak Reverse Voltage DC Blocking Voltage	V_{RRM} V_{RWM} V_R	50	100	200	400	600	Volts
Nonrepetitive Peak Reverse Voltage	V_{RSM}	75	150	250	450	650	Volts
RMS Reverse Voltage	$V_{R(RMS)}$	35	70	140	280	420	Volts
Average Rectified Forward Current (Single phase, resistive load, T_C = 125°C)	I_O	← 24 →					Amp
Nonrepetitive Peak Surge Current (surge applied @ rated load conditions)	I_{FSM}	← 300 (for 1 cycle) →					Amp
Operating Junction Temperature Range	T_J	← −65 to +150 →					°C
Storage Temperature Range	T_{stg}	← −65 to +175 →					°C

THERMAL CHARACTERISTICS

Characteristic	Symbol	Max	Unit
Thermal Resistance, Junction to Case	$R_{\theta JC}$	0.8	°C/W
Thermal Resistance, Junction to Air, PC Board Mount, Perpendicular to Surface	$R_{\theta JA}$	55	°C/W

ELECTRICAL CHARACTERISTICS

Characteristic	Symbol	Min	Typ	Max	Unit
Instantaneous Forward Voltage (I_F = 75 Amp, T_J = 150°C)	v_F	—	1.15	1.29	Volts
Forward Voltage (I_F = 24 Amp, T_C = 25°C)	V_F	—	1.00	1.15	Volts
Reverse Current (rated dc voltage) T_C = 25°C T_C = 100°C T_C = 150°C	I_R	— — —	10 0.5 7.0	25 1.0 10	μA mA mA

REVERSE RECOVERY CHARACTERISTICS

Characteristic	Symbol	Min	Typ	Max	Unit
Reverse Recover Time — Soft Recovery (I_F = 1.0 Amp to V_R = 30 Vdc, Figure 19) (I_{FM} = 36 Amp, di/dt = 25 A/μs, Figure 20)	t_{rr}	 — —	 150 200	 200 300	ns
Reverse Recovery Current (I_F = 1.0 Amp to V_R = 30 Vdc, Figure 19)	$I_{RM(REC)}$	—	—	4.0	Amp

FIGURE 1 — MAXIMUM FORWARD VOLTAGE

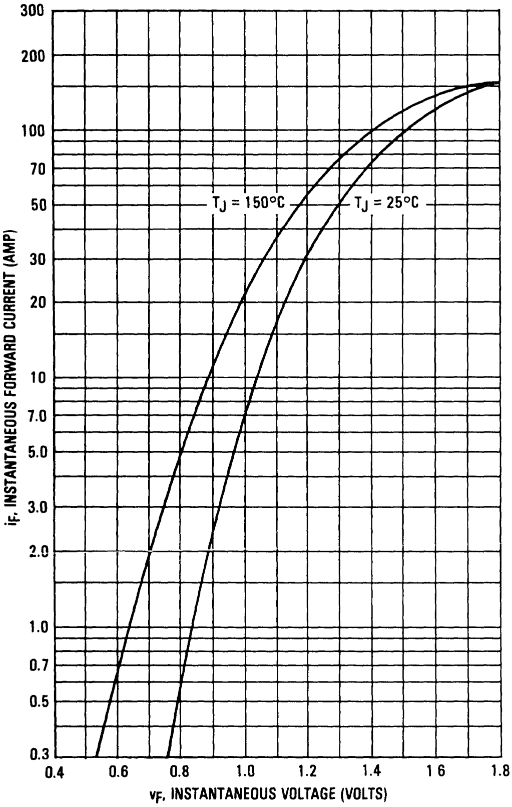
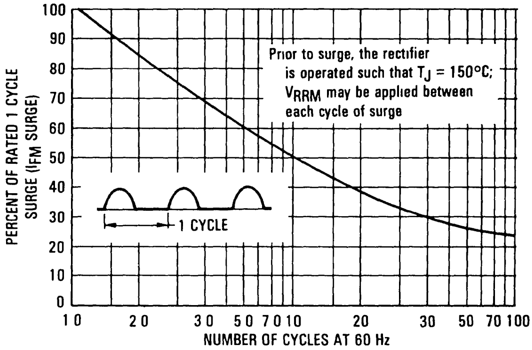
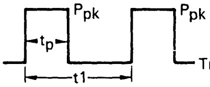


FIGURE 2 — MAXIMUM SURGE CAPABILITY



NOTE 1



DUTY CYCLE, $D = t_p/t1$
PEAK POWER, P_{pk}, is peak of an equivalent square power pulse

To determine maximum junction temperature of the diode in a given situation, the following procedure is recommended

The temperature of the case should be measureed using a thermocouple placed on the case at the temperature reference point The thermal mass connected to the case is normally large enough so that it will not significantly respond to heat surges generated in the diode as a result of pulsed operation once steady-state conditions are achieved Using the measured value of T_C, the junction temperature may be determined by

$$T_J = T_C + \Delta T_{JC}$$

where ΔT_{JC} is the increase in junction temperature above the case temperature It may be determined by

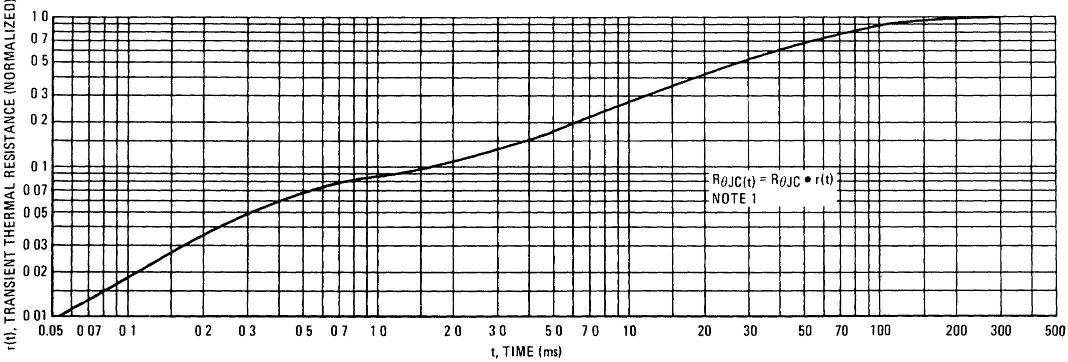
$$\Delta T_{JC} = P_{pk} \bullet R_{\theta JC} [D + (1 - D) \bullet r(t1 + t_p) + r(t_p) - r(t1)]$$

where

$r(t)$ = normalized value of transient thermal resistance at time, t, from Figure 3, i e

$r(t1 + t_p)$ = normalized value of transient thermal resistance at time $t1 + t_p$

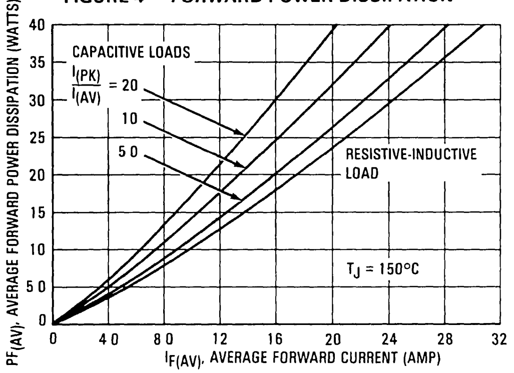
FIGURE 3 — THERMAL RESPONSE, CHASSIS MOUNTED



CHASSIS MOUNT RATING DATA

Sine Wave Input

FIGURE 4 — FORWARD POWER DISSIPATION



Square Wave Input

FIGURE 5 — FORWARD POWER DISSIPATION

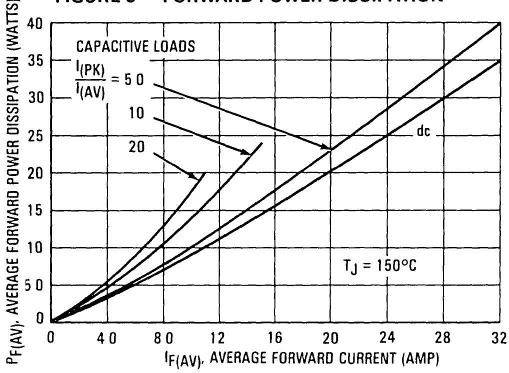


FIGURE 6 — CURRENT DERATING

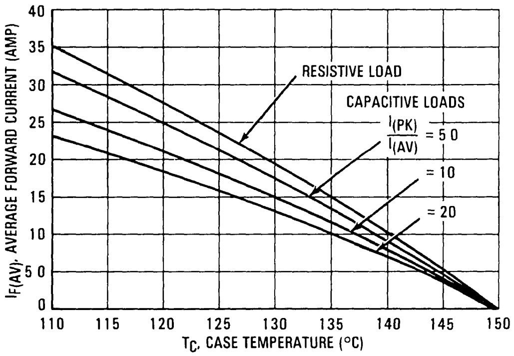
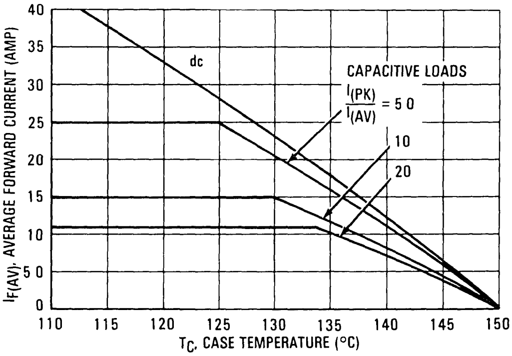


FIGURE 7 — CURRENT DERATING



PRINTED CIRCUIT BOARD RATING DATA

FIGURE 8 — FORWARD POWER DISSIPATION

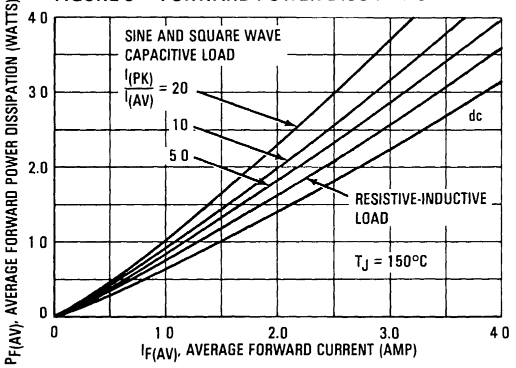
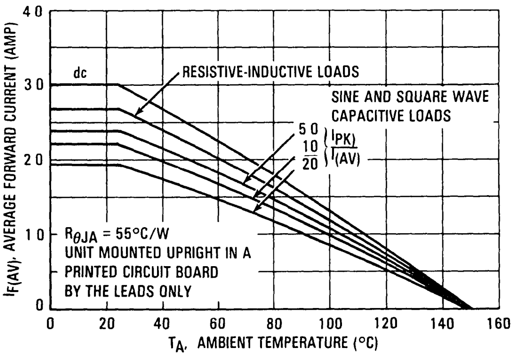


FIGURE 9 — CURRENT DERATING



3

TYPICAL DYNAMIC CHARACTERISTICS

FIGURE 10 — FORWARD RECOVERY TIME

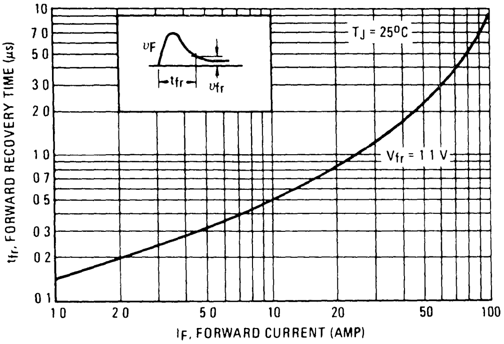


FIGURE 11 — JUNCTION CAPACITANCE

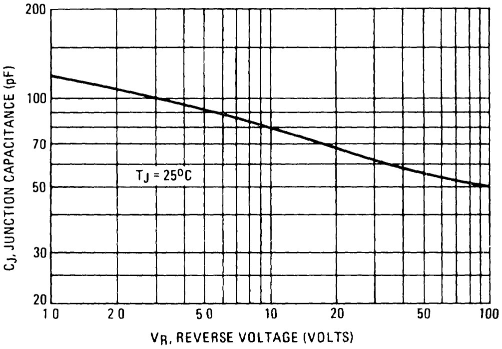


FIGURE 12 — TYPICAL REVERSE CURRENT

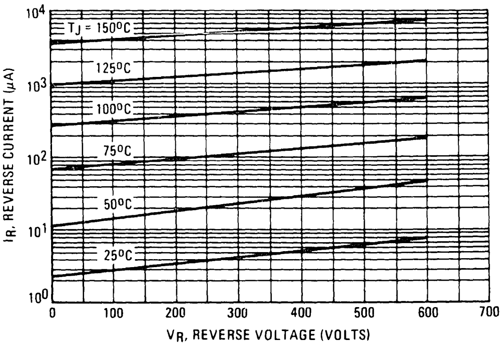
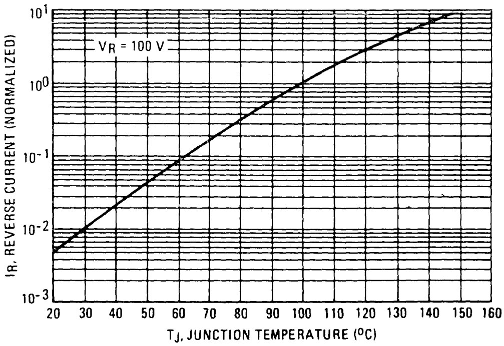
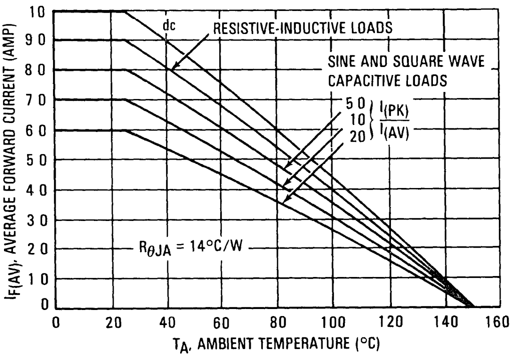


FIGURE 13 — NORMALIZED REVERSE CURRENT



TYPICAL MOUNTING DATA

FIGURE 14 — CURRENT DERATING



NOTE 2

Figure 14 shows the current carrying capability of a device mounted on a printed circuit board with a typical TO-220 type heatsink having a sink-to-air thermal resistance of 12°C/W. Allowing another 2°C/W for $R_{\theta JC}$ plus $R_{\theta CS}$ (case-to-sink) puts the total at 14°C/W as indicated. The unit and heatsink were mounted perpendicular to the printed circuit board for this data.

TYPICAL RECOVERED STORED CHARGE DATA
(See Note 3)

FIGURE 15 — T_J = 25°C

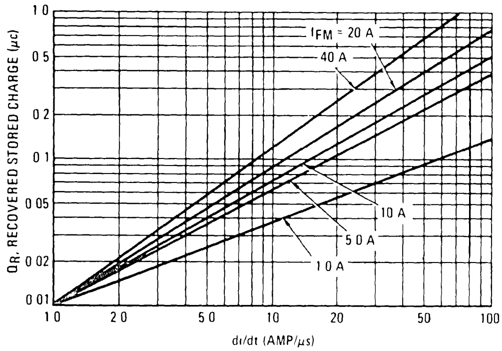
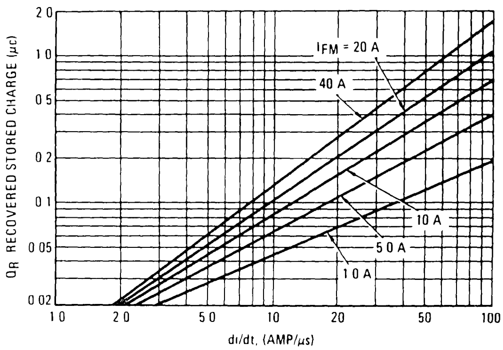


FIGURE 16 — T_J = 75°C



3

FIGURE 17 — T_J = 100°C

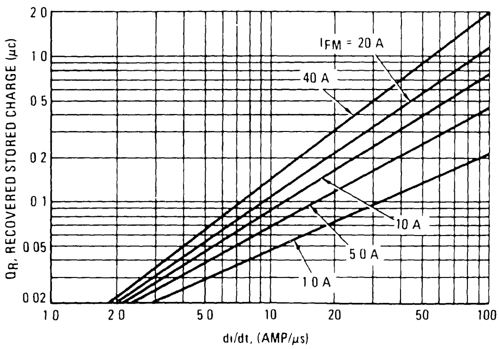
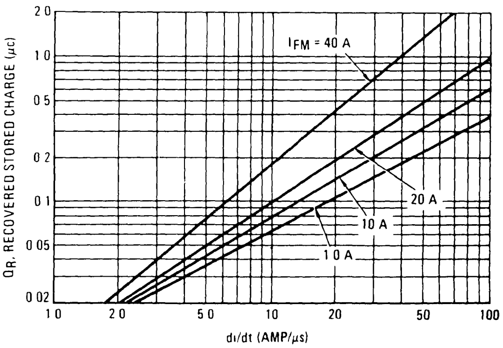


FIGURE 18 — T_J = 150°C



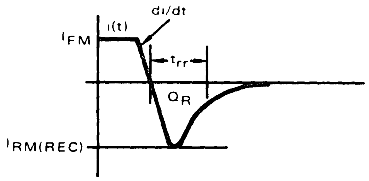
NOTE 3

Reverse recovery time is the period which elapses from the time that the current, thru a previously forward biased rectifier diode, passes thru zero going negatively until the reverse current recovers to a point which is less than 10% peak reverse current.

Reverse recovery time is a direct function of the forward current prior to the application of reverse voltage.

For any given rectifier, recovery time is very circuit dependent. Typical and maximum recovery time of all Motorola fast recovery power rectifiers are rated under a fixed set of conditions using I_F = 1.0 A, V_R = 30 V. In order to cover all circuit conditions, curves are given for typical recovered stored charge versus commutation di/dt for various levels of forward current and for junction temperatures of 25°C, 75°C, 100°C, and 150°C.

To use these curves, it is necessary to know the forward current level just before commutation, the circuit commutation di/dt, and the operating junction temperature. The reverse recovery test current waveform for all Motorola fast recovery rectifiers is shown.

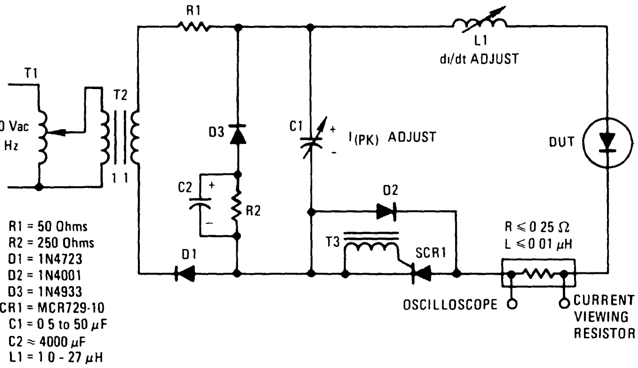


From stored charge curves versus di/dt, recovery time (t_{rr}) and peak reverse recovery current ($I_{RM(REC)}$) can be closely approximated using the following formulas:

$$t_{rr} = 1.41 \times \left[\frac{Q_R}{di/dt}\right]^{1/2}$$

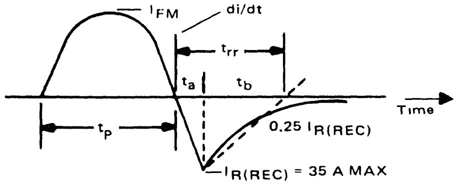
$$I_{RM(REC)} = 1.41 \times \left[Q_R \times di/dt\right]^{1/2}$$

FIGURE 19 — JEDEC REVERSE RECOVERY CIRCUIT

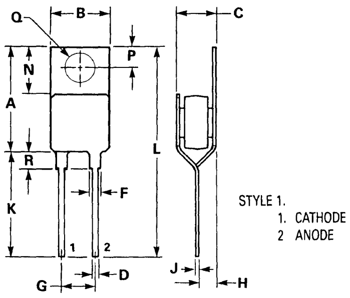


R1 = 50 Ohms
R2 = 250 Ohms
D1 = 1N4723
D2 = 1N4001
D3 = 1N4933
SCR1 = MCR729-10
C1 = 0.5 to 50 μF
C2 ≈ 4000 μF
L1 = 1.0 - 27 μH
T1 = Variac Adjusts $I_{(PK)}$ and di/dt
T2 = 1:1
T3 = 1:1 (to trigger circuit)

FIGURE 20 — REVERSE RECOVERY CHARACTERISTIC



SOFT RECOVERY



DIM	MILLIMETERS		INCHES	
	MIN	MAX	MIN	MAX
A	14.22	15.88	0.560	0.625
B	9.65	10.67	0.380	0.420
C	7.21	7.87	0.284	0.310
D	0.64	1.14	0.025	0.045
F	1.52	2.29	0.060	0.090
G	4.32	5.33	0.170	0.210
H	2.03	2.92	0.080	0.115
J	0.58	0.74	0.023	0.029
K	—	14.27	—	0.562
L	—	30.15	—	1.187
N	5.84	6.86	0.230	0.270
P	2.54	3.05	0.100	0.120
Q	3.53	3.73	0.139	0.147
R	—	5.08	—	0.200

CASE 339-02
PLASTIC
(Meets TO-220AB except dimension "C")

3

MECHANICAL CHARACTERISTICS

CASE: Plastic Encapsulated, Metal Tabs.

FINISH: All external surfaces are corrosion resistant and are readily solderable.

POLARITY: Cathode to Tab with hole; Reverse polarity available by adding "R" Suffix, MR2402FR.

WEIGHT: 3.6 Grams (Approximately).

MOUNTING TORQUE: 8 in-lbs max.

MAXIMUM TEMPERATURE FOR SOLDERING PURPOSES: 350°C, 3/8" from case for 10 seconds.

MOTOROLA
SEMICONDUCTOR
TECHNICAL DATA

MR2500 Series

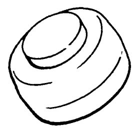
MEDIUM-CURRENT SILICON RECTIFIERS

. . . compact, highly efficient silicon rectifiers for medium-current applications requiring:

- High Current Surge — 400 Amperes @ T_J = 175°C
- Peak Performance @ Elevated Temperature — 25 Amperes @ T_C = 150°C
- Low Cost
- Compact, Molded Package — For Optimum Efficiency in a Small Case Configuration
- Available With a Single Lead Attached

MEDIUM-CURRENT SILICON RECTIFIERS

50 — 1000 VOLTS
25 AMPERES
DIFFUSED JUNCTION



MAXIMUM RATINGS

Characteristic	Symbol	MR 2500	MR 2501	MR 2502	MR 2504	MR 2506	MR 2508	MR 2510	Unit
Peak Repetitive Reverse Voltage Working Peak Reverse Voltage DC Blocking Voltage	V_{RRM} V_{RWM} V_R	50	100	200	400	600	800	1000	Volts
Non-Repetitive Peak Reverse Voltage (halfwave, single phase, 60 Hz peak)	V_{RSM}	60	120	240	480	720	960	1200	Volts
Average Rectified Forward Current (Single phase, resistive load, 60 Hz, T_C = 150°C)	I_O	← 25 →							Amp
Non-Repetitive Peak Surge Current (surge applied @ rated load conditions, half wave, single phase, 60 Hz)	I_{FSM}	← 400 (for 1 cycle) →							Amp
Operating and Storage Junction Temperature Range	T_J, T_{stg}	← -65 to +175 →							°C

THERMAL CHARACTERISTICS

Characteristic	Symbol	Max	Unit
Thermal Resistance, Junction to Case (Single Side Cooled)	$R_{\theta JC}$	1 0	°C/W

ELECTRICAL CHARACTERISTICS

Characteristics and Conditions	Symbol	Max	Unit
Maximum Instantaneous Forward Voltage (i_F = 78 5 Amp, T_C = 25°C)	v_F	1 18	Volts
Maximum Reverse Current (rated dc voltage) T_C = 25°C T_C = 100°C	I_R	 100 500	μA

MECHANICAL CHARACTERISTICS

CASE: Transfer Molded Plastic

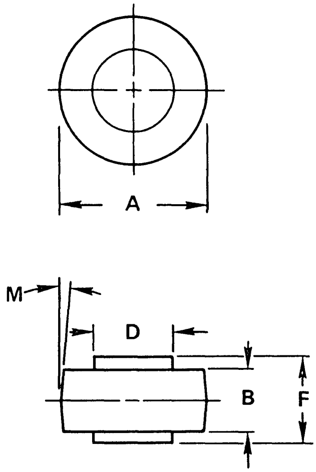
FINISH: All External Surfaces are Corrosion Resistant and the Contact Areas Readily Solderable.

POLARITY: Indicated by dot on Cathode Side

MOUNTING POSITIONS: Any

MAXIMUM TEMPERATURE FOR SOLDERING PURPOSES: 250°C

WEIGHT: 1.8 Grams (Approximately)



DIM	MILLIMETERS MIN	MILLIMETERS MAX	INCHES MIN	INCHES MAX
A	8.43	8.69	0.332	0.342
B	4.19	4.45	0.165	0.175
D	5.54	5.64	0.218	0.222
F	5.94	6.25	0.234	0.246
M	5° NOM		5° NOM	

CASE 193-04
PLASTIC

3

FIGURE 1 — FORWARD VOLTAGE

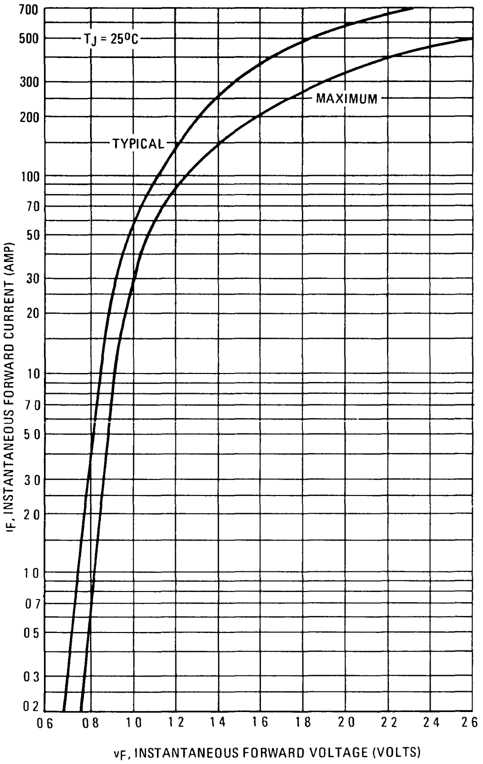


FIGURE 2 — NON-REPETITIVE SURGE CURRENT

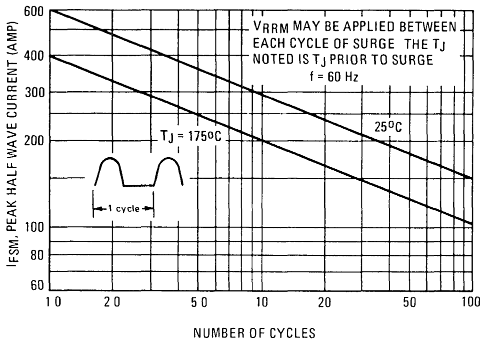


FIGURE 3 — FORWARD VOLTAGE TEMPERATURE COEFFICIENT

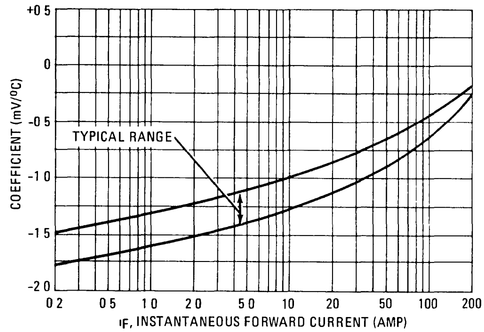


FIGURE 4 — CURRENT DERATING

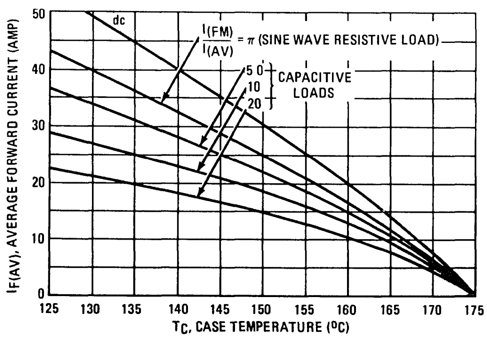


FIGURE 5 — FORWARD POWER DISSIPATION

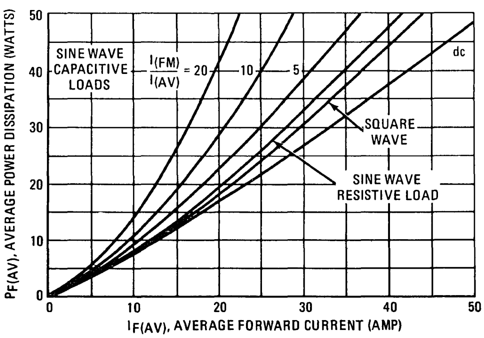
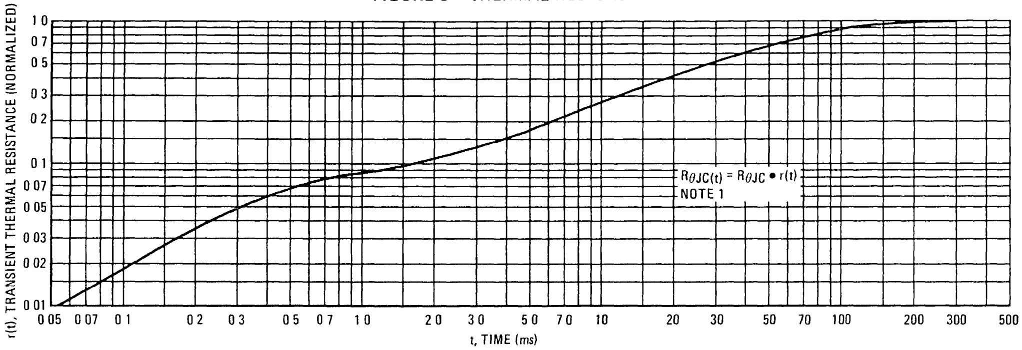


FIGURE 6 – THERMAL RESPONSE



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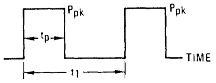


DUTY CYCLE, $D = t_p/t_1$
PEAK POWER P_{pk}, is peak of an equivalent square power pulse

To determine maximum junction temperature of the diode in a given situation, the following procedure is recommended

The temperature of the case should be measured using a thermocouple placed on the case at the temperature reference point (see the outline drawing on page 1) The thermal mass connected to the case is normally large enough so that it will not significantly respond to heat surges generated in the diode as a result of pulsed operation once steady state conditions are achieved Using the measured value of T_C the junction temperature may be determined by

$$T_J \quad T_C + \Delta T_{JC}$$

where ΔT_{JC} is the increase in junction temperature above the case temperature It may be determined by

$$\Delta T_{JC} = P_{pk} \bullet R_{\theta JC} [D + (1 \quad D) \bullet r(t_1 + t_p) + r(t_p) \quad r(t_1)]$$

where

$r(t)$ = normalized value of transient thermal resistance at time t from Figure 6 i e ,
$r(t_1 + t_p)$ – normalized value of transient thermal resistance at time $t_1 + t_p$

FIGURE 7 – CAPACITANCE

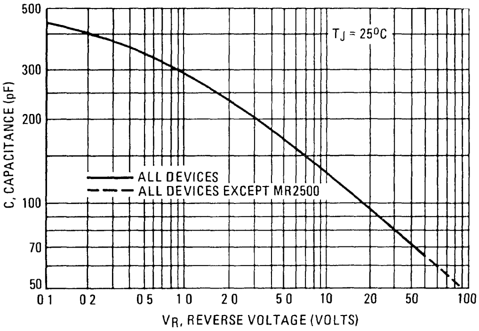


FIGURE 8 – FORWARD RECOVERY TIME

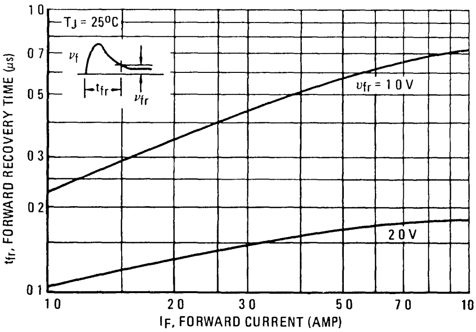


FIGURE 9 – REVERSE RECOVERY TIME

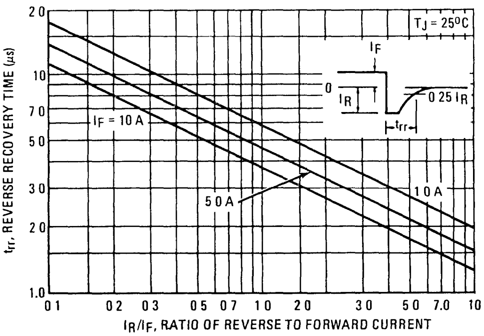
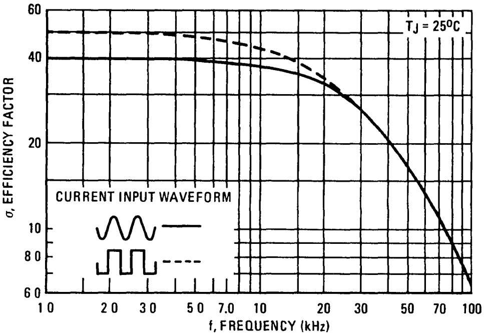


FIGURE 10 — RECTIFICATION WAVEFORM EFFICIENCY



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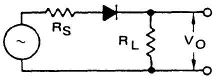
RECTIFICATION EFFICIENCY NOTE

FIGURE 11 — SINGLE-PHASE HALF-WAVE RECTIFIER CIRCUIT



The rectification efficiency factor σ shown in Figure 10 was calculated using the formula

$$\sigma = \frac{P_{dc}}{P_{rms}} = \frac{\frac{V^2_{O(dc)}}{R_L}}{\frac{V^2_{O(rms)}}{R_L}} \bullet 100\% = \frac{V^2_{O(dc)}}{V^2_{O(ac)} + V^2_{O(dc)}} \bullet 100\% \quad (1)$$

For a sine wave input $V_m \sin(\omega t)$ to the diode, assume lossless, the maximum theoretical efficiency factor becomes

$$\sigma_{(sine)} = \frac{\frac{V^2_m}{\pi^2 R_L}}{\frac{V^2_m}{4R_L}} \bullet 100\% = \frac{4}{\pi^2} \bullet 100\% = 40.6\% \quad (2)$$

For a square wave input of amplitude V_m, the efficiency factor becomes

$$\sigma_{(square)} = \frac{\frac{V^2_m}{2R_L}}{\frac{V^2_m}{R_L}} \bullet 100\% = 50\% \quad (3)$$

(A full wave circuit has twice these efficiencies)

As the frequency of the input signal is increased, the reverse recovery time of the diode (Figure 9) becomes significant, resulting in an increasing ac voltage component across R_L which is opposite in polarity to the forward current, thereby reducing the value of the efficiency factor σ, as shown on Figure 10

It should be emphasized that Figure 10 shows waveform efficiency only; it does not provide a measure of diode losses Data was obtained by measuring the ac component of V_O with a true rms ac voltmeter and the dc component with a dc voltmeter The data was used in Equation 1 to obtain points for Figure 10

ASSEMBLY AND SOLDERING INFORMATION

There are *two basic areas* of consideration for successful implementation of button rectifiers:

1. Mounting and Handling
2. Soldering

each should be carefully examined before attempting a finished assembly or mounting operation.

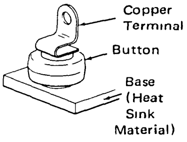
MOUNTING AND HANDLING

The button rectifier lends itself to a multitude of assembly arrangements but one key consideration must *always* be included:

One Side of the Connections to the Button Must Be Flexible!

This stress relief to the button should also be chosen for maximum contact area to afford the best heat transfer — but not at the expense of flexibility. For an annealed copper terminal a thickness of 0.015" is suggested.

Strain Relief Terminal for Button Rectifier



The base heat sink may be of various materials whose shape and size are a function of the individual application and the heat transfer requirements.

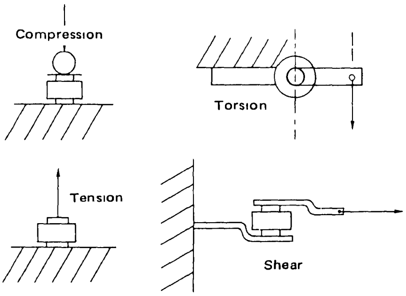
Common Materials	Advantages and Disadvantages
Steel	Low Cost; relatively low heat conductivity
Copper	High Cost; high heat conductivity
Aluminum	Medium Cost; medium heat conductivity Relatively expensive to plate and not all platers can process aluminum.

Handling of the button during assembly must be relatively gentle to minimize sharp impact shocks and avoid nicking of the plastic. Improperly designed automatic handling equipment is the worst source of unnecessary shocks. Techniques for vacuum handling and spring loading should be investigated.

The mechanical stress limits for the button diode are as follows:

Compression	32 lbs.	142 3 Newton
Tension	32 lbs.	142.3 Newton
Torsion	6-inch lbs.	0.68 Newton-meters
Shear	55 lbs.	244.7 Newton

MECHANICAL STRESS



Exceeding these recommended maximums can result in electrical degradation of the device.

SOLDERING

The button rectifier is basically a semiconductor chip bonded between two nickel-plated copper heat sinks with an encapsulating material of thermal-setting silicone. The exposed metal areas are also tin plated to enhance solderability.

In the soldering process it is important that the temperature not exceed 250°C if device damage is to be avoided. Various solder alloys can be used for this operation but two types are recommended for best results:

1. 96.5% tin, 3.5% silver; Melting point is 221°C (this particular eutetic is used by Motorola for its button rectifier assemblies).
2. 63% tin, 37% lead; Melting point 183°C (eutetic).

Solder is available as preforms or paste. The paste contains both the metal and flux and can be dispensed rapidly. The solder preform requires the application of a flux to assure good wetting of the solder. The type of flux used depends upon the degree of cleaning to be accomplished and is a function of the metals involved. These fluxes range from a mild rosin to a strong acid; e.g., Nickel plating oxides are best removed by an acid base flux while an activated rosin flux may be sufficient for tin plated parts.

Since the button is relatively light-weight, there is a tendency for it to float when the solder becomes liquid. To prevent bad joints and misalignment it is suggested that a weighting or spring loaded fixture be employed. It is also important that severe thermal shock (either heating or cooling) be avoided as it may lead to damage of the die or encapsulant of the part.

Button holding fixtures for use during soldering may be of various materials. Stainless steel has a longer use life while black anodized aluminum is less expensive and will limit heat reflection and enhance absorption. The assembly volume will influence the choice of materials. Fixture dimension tolerances for locating the button must allow for expansion during soldering as well as allowing for button clearance.

HEATING TECHNIQUES

The following four heating methods have their advantages and disadvantages depending on volume of buttons to be soldered.

1. **Belt Furnaces** readily handle large or small volumes and are adaptable to establishment of "on-line" assembly since a variable belt speed sets the run rate. Individual furnace zone controls make excellent temperature control possible.

2. **Flame Soldering** involves the directing of natural gas flame jets at the base of a heatsink as the heatsink is indexed to various loading-heating-cooling-unloading positions. This is the most economical labor method of soldering large volumes. Flame soldering offers good temperature control but requires sophisticated temperature monitoring systems such as infrared.

ASSEMBLY AND SOLDERING INFORMATION (continued)

3. **Ovens** are good for batch soldering and are production limited. There are handling problems because of slow cooling. Response time is load dependent, being a function of the watt rating of the oven and the mass of parts. Large ovens may not give an acceptable temperature gradient. Capital cost is low compared to belt furnaces and flame soldering.
4. **Hot Plates** are good for soldering small quantities of prototype devices. Temperature control is fair with overshoot common because of the exposed heating surface. Solder flow and positioning can be corrected during soldering since the assembly is exposed. Investment cost is very low.

Regardless of the heating method used, a soldering profile giving the time-temperature relationship of the particular method must be determined to assure proper soldering. Profiling must be performed on a scheduled basis to minimize poor soldering. The time-temperature relationship will change depending on the heating method used.

SOLDER PROCESS EVALUATION

Characteristics to look for when setting up the soldering process:

I **Overtemperature** is indicated by any one or all three of the following observations.
1. Remelting of the solder inside the button rectifier shows the temperature has exceeded 285°C and is noted by "islands" of shiny solder and solder dewetting when a unit is broken apart.
2. Cracked die inside the button may be observed by a moving reverse oscilloscope trace when pressure is applied to the unit.
3. Cracked plastic may be caused by thermal shock as well as overtemperature so cooling rate should also be checked.

II **Cold soldering** gives a grainy appearance and solder build-up without a smooth continuous solder fillet. The temperature must be adjusted until the proper solder fillet is obtained within the maximum temperature limits.

III **Incomplete solder fillets** result from insufficient solder or parts not making proper contact.

IV **Tilted buttons** can cause a void in the solder between the heatsink and button rectifier which will result in poor heat transfer during operation. An eight degree tilt is a suggested maximum value.

V **Plating problems** require a knowledge of plating operations for complete understanding of observed deficiencies.
1. Peeling or plating separation is generally seen when a button is broken away for solder inspection. If heatsink or terminal base metal is present the plating is poor and must be corrected.
2. Thin plating allows the solder to penetrate through to the base metal and can give a poor connection. A suggested minimum plating thickness is 300 microinches.
3. Contaminated soldering surfaces may out-gas and cause non-wetting resulting in voids in the solder connection. The exact cause is not always readily apparent and can be because of
   (a) improper plating
   (b) mishandling of parts
   (c) improper and/or excessive storage time

SOLDER PROCESS MONITORING

Continuous monitoring of the soldering process must be established to minimize potential problems All parts used in the soldering operation should be sampled on a lot by lot basis by assembly of a controlled sample. Evaluate the control sample by break-apart tests to view the solder connections, by physical strength tests and by dimensional characteristics for part mating

A shear test is a suggested way of testing the solder bond strength.

POST SOLDERING OPERATION CONSIDERATIONS

After soldering, the completed assembly must be unloaded, washed and inspected.

Unloading must be done carefully to avoid unnecessary stress. Assembly fixtures should be cooled to room temperature so solder profiles are not affected.

Washing is mandatory if an acid flux is used because of its ionic and corrosive nature. Wash the assemblies in agitated hot water and detergent for three to five minutes. After washing; rinse, blow off excessive water and bake 30 minutes at 150°C to remove trapped moisture.

Inspection should be both electrical and physical. Any rejects can be reworked as required.

SUMMARY

The Button Rectifier is an excellent building block for specialized applications. The prime example of its use is the output bridge of the automative alternator where millions are used each year. Although the material presented here is not all inclusive, primary considerations for use are presented. For further information, contact the nearest Motorola Sales Office or franchised distributor.

MR2535L
MR2540L

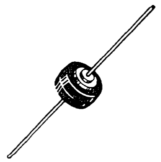
Advance Information

Overvoltage Transient Suppressors

MEDIUM CURRENT OVERVOLTAGE TRANSIENT SUPPRESSORS

. . . designed for applications requiring a low voltage rectifier with reverse avalanche characteristics for use as reverse power transient suppressors. Developed to suppress transients in the automotive system, these devices operate in the forward mode as standard rectifiers or reverse mode as power avalanche rectifier and will protect electronic equipment from overvoltage conditions.

- Avalanche Voltage 24 to 32 Volts
- High Power Capability
- Economical
- Increased Capacity by Parallel Operation
- Replaces MR2520L/2525L



CASE 194-01
MR2540L

CASE 194-04
MR2535L

MECHANICAL CHARACTERISTICS:
CASE: Transfer Molded Plastic
MAXIMUM LEAD TEMPERATURE FOR SOLDERING PURPOSES: 350°C 3/8″ from case for 10 seconds at 5 lbs. tension
FINISH: All external surfaces are corrosion-resistant, leads are readily solderable
POLARITY: Indicated by diode symbol or cathode band
WEIGHT: 2.5 Grams (approx.)

MAXIMUM RATINGS

Rating	Symbol	Value	Unit
DC Peak Repetitive Reverse Voltage Working Peak Reverse Voltage DC Blocking Voltage	V_{RRM} V_{RWM} V_R	20	Volts
Repetitive Peak Reverse Surge Current MR2535L MR2540L (Time Constant = 10 ms, Duty Cycle ≤ 1%, T_C = 25°C) (See Figure 1)	I_{RSM}	 110 150	Amps
Average Rectified Forward Current (Single Phase, Resistive Load, 60 Hz, T_C = 150°C) MR2535L MR2540L	I_O	 35 50	Amps
Non-Repetitive Peak Surge Current Surge Supplied at Rated Load Conditions Halfwave, Single Phase MR2535L MR2540L	I_{FSM}	 600 800	Amps
Operating and Storage Junction Temperature Range	T_J, T_{stg}	−65 to +175	°C

THERMAL CHARACTERISTICS

Characteristic	Lead Length	Symbol	Max	Unit
Thermal Resistance, Junction to Lead @ Both Leads to Heat Sink, Equal Length	1/4″ 3/8″ 1/2″	$R_{\theta JL}$	7.5 10 13	°C/W
Thermal Resistance Junction to Case		$R_{\theta JC}$	0.8*	°C/W

*Typical

This document contains information on a new product Specifications and information herein are subject to change without notice

ELECTRICAL CHARACTERISTICS

Characteristic	Symbol	Min	Max	Unit
Instantaneous Forward Voltage (1) (I_F = 100 Amps, T_C = 25°C)	v_F	—	1.1	Volts
Reverse Current (V_R = 20 Vdc, T_C = 25°C)	I_R	—	200	nAdc
Breakdown Voltage (1) (I_R = 100 mAdc, T_C = 25°C)	$V_{(BR)}$	24	32	Volts
Breakdown Voltage (1) MR2535L only (I_R = 90 Amp, T_C = 150°C, PW = 80 μs)	$V_{(BR)}$	—	40	Volts
Breakdown Voltage Temperature Coefficient	$V_{(BR)TC}$	—	0.096*	%/°C
Forward Voltage Temperature Coefficient @ I_F = 10 mA	V_{FTC}	—	2*	mV/°C

(1) Pulse Test: Pulse Width ≤ 300 μs, Duty Cycle ≤ 2%
* Typical

3

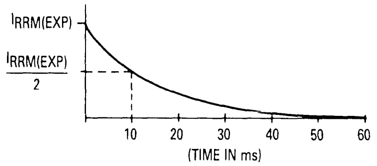
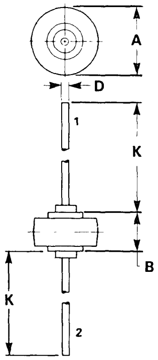


Figure 1. Surge Current Characteristics

OUTLINE DIMENSIONS



DIM	MILLIMETERS MIN	MILLIMETERS MAX	INCHES MIN	INCHES MAX
A	10.03	10.29	0.395	0.405
B	5.94	6.25	0.234	0.246
D	1.27	1.35	0.050	0.053
K	25.15	25.65	0.990	1.010

CASE 194-01
MR2540L

STYLE 1
PIN 1. CATHODE
2. ANODE

NOTE
1. CATHODE SYMBOL ON PKG

DIM	MILLIMETERS MIN	MILLIMETERS MAX	INCHES MIN	INCHES MAX
A	8.43	8.69	0.332	0.342
B	5.94	6.25	0.234	0.246
D	1.27	1.35	0.050	0.053
K	25.15	25.65	0.990	1.010

CASE 194-04
MR2535L

MOTOROLA
SEMICONDUCTOR
TECHNICAL DATA

MR5005 MR5010 MR5020 MR5030 MR5040

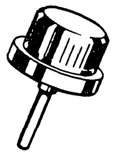
INDUSTRIAL PRESSFIT SILICON POWER RECTIFIERS

designed for use in all medium-current applications or for higher current industrial alternators and chassis mounted power supply rectifiers.

- 50 Amp @ T_C = 150°C
- 600 Amp Surge Capability
- Reverse Polarity Available
- Rugged Construction

SILICON POWER RECTIFIERS

50-400 VOLTS
50 AMPERE



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MAXIMUM RATINGS

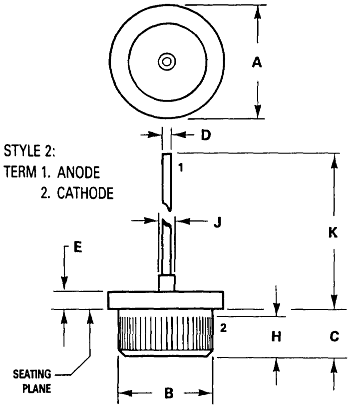
Rating	Symbol	MR5005	MR5010	MR5020	MR5030	MR5040	Unit
Peak Repetitive Reverse Voltage Working Peak Reverse Voltage DC Blocking Voltage	V_{RRM} V_{RWM} V_R	50	100	200	300	400	Volts
Non Repetitive Peak Reverse Voltage	V_{RSM}	75	150	250	400	450	Volts
RMS Reverse Voltage	$V_{R(RMS)}$	35	70	140	210	280	Volts
Average Rectified Forward Current (Single phase, resistive load, T_C = 150°C	I_O	← 50 →					Amp
Non-Repetitive Peak Surge Current (Surge applied at rated load conditions)	I_{FSM}	← 600 →					Amp
Operating and Storage Junction Temperature Range	T_J,T_{stg}	← -65 to +195 →					°C

THERMAL CHARACTERISTICS

Characteristic	Symbol	Max	Unit
Thermal Resistance, Junction to Case	$R_{\theta JC}$	0 8	°C/W

ELECTRICAL CHARACTERISTICS

Characteristic	Symbol	Min	Typ	Max	Unit
Instantaneous Forward Voltage (i_F = 157 Amp, T_J = 25°C) (i_F = 50 Amp, T_J = 25°C)	v_F	 – –	 1 10 0 95	 1.18 1 00	Volts
Reverse Current (rated dc voltage) (T_C = 25°C) (T_C = 150°C)	I_R	 – –	 0 05 1 0	 0 2 2.0	mA



NOTES
1 50 TPI STRAIGHT KNURL
2 POLARITY, INK MARKED ON PACKAGE.

	MILLIMETERS		INCHES	
DIM	MIN	MAX	MIN	MAX
A	15 49	16 26	0 610	0 640
B	12 73	12 83	0 501	0 505
C	5 08	6.35	0 200	0 250
D	2 46	2 62	0 097	0 103
E	2 03	4 83	0.080	0 190
H	5 08	6 35	0 200	0 250
J	—	3.56	—	0 140
K	—	15 24	—	0 600

CASE 43-04
METAL

MECHANICAL CHARACTERISTICS

CASE Welded hermetically sealed construction

FINISH: All external surfaces corrosion resistant, terminals readily solerable

WEIGHT: 9 grams (approx.)

POLARITY: Cathode connected to case (reverse polarity available denoted by Suffix R, i.e MR5030R)

MOUNTING POSITION: Any

3

FIGURE 1 – CURRENT DERATING

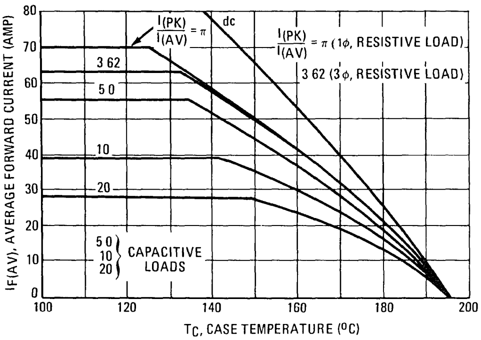


FIGURE 2 – FORWARD POWER DISSIPATION

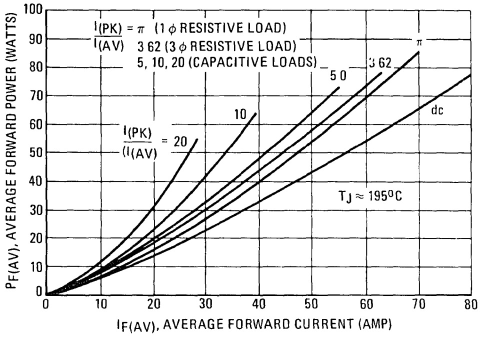


FIGURE 3 – MAXIMUM FORWARD VOLTAGE

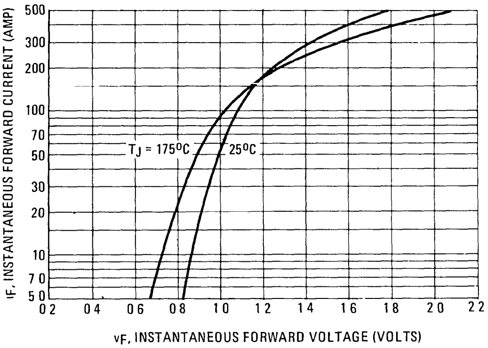


FIGURE 4 – MAXIMUM NON-REPETITIVE SURGE CAPABILITY

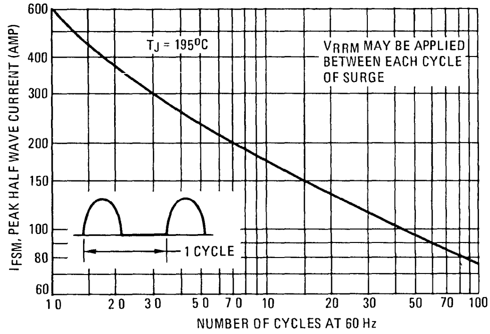
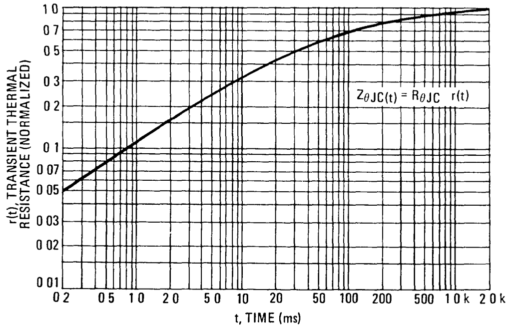
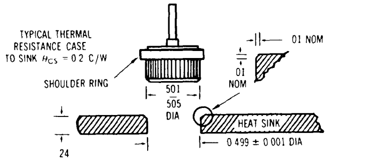


FIGURE 5 – THERMAL RESPONSE

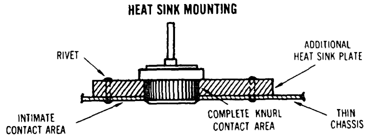


Recommended procedures for mounting are as follows

1. Drill a hole in the heat sink 0 499 ± 0 001 inch in diameter
2. Break the hole edge as shown to provide a guide into the hole and prevent shearing off the knurled side of the rectifier
3. The depth and width of the break should be 0 010 inch maximum to retain maximum heat sink surface contact
4. To prevent damage to the rectifier during press in, the pressing force should be applied only on the shoulder ring of the rectifier case as shown
5. The pressing force should be applied evenly about the shoulder ring to avoid tilting or canting of the rectifier case in the hole during the press in operation. Also, the use of a thermal lubricant such as D C 340 will be of considerable aid



HEAT SINK MOUNTING



THIN-CHASSIS MOUNTING

MOTOROLA
SEMICONDUCTOR
TECHNICAL DATA

MR5060
MR5061

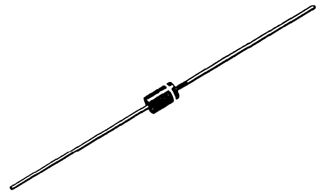
AVALANCHE RECTIFIERS

subminiature size, axial lead-mounted rectifiers for general-purpose, low-power applications requiring avalanche protection

- Avalanche power capability
  - — 1000 Watts at 20 μs
  - — 450 Watts at 100 μs
- Low Forward Voltage
- Low Cost

LEAD-MOUNTED AVALANCHE RECTIFIERS

200-400-600 VOLTS
1.5 AMPS



3

MAXIMUM RATINGS

Rating	Symbol	MR5060	MR5061	Unit
Peak Repetitive Reverse Voltage Working Peak Reverse Voltage DC Blocking Voltage	V_{RRM} V_{RWM} V_R	400	600	Volts
Nonrepetitive Peak Reverse Voltage (Halfwave, Single Phase, 60 Hz)	V_{RSM}	525	800	Volts
RMS Reverse Voltage	$V_{R(RMS)}$	280	420	Volts
Average Rectified Forward Current (Single Phase, Resistive Load, 60 Hz, T_L = 70°C, 1/2″ From Body)	I_O	1 5 Amp		
Nonrepetitive Peak Surge Current (Surge Applied at Rated Load Conditions)	I_{FSM}	50 (for 1 cycle)		Amp
Junction & Storage Temperature Range	T_J, T_{stg}	-65 to +175		°C
Nonrepetitive Peak Reverse Surge Power (t = 20 μs)	P_{RM}	1000		Watts

ELECTRICAL CHARACTERISTICS

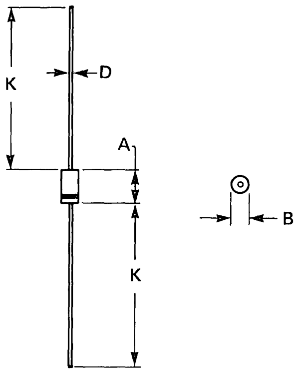
Characteristic and Conditions	Symbol	Typ	Max	Unit
Instantaneous Forward Voltage (i_f = 1 5 Amp, T_J = 25°C)	v_F	0 93	1 04	Volts
Reverse Current (Rated dc Voltage) T_J = 150°C	I_R	250	300	μA
T_J = 25°C		3 0	5 0	

THERMAL CHARACTERISTICS

Characteristic	Symbol	Typ	Max	Unit
Thermal Resistance, Junction to Lead	$R_{\theta JL}$			°C/W
1/4″		21	38	
1/2″		31	50	

MECHANICAL CHARACTERISTICS

CASE: Void free, transfer molded plastic
MAXIMUM LEAD TEMPERATURE FOR SOLDERING PURPOSES. 240°C, 1/8″ from case for 10 seconds at 5 lbs tension
FINISH. All external surfaces are corrosion-resistant, leads are readily solderable
POLARITY Cathode indicated by color band
WEIGHT. 0 40 grams (approximately)



NOTES:
1. ALL RULES AND NOTES ASSOCIATED WITH JEDEC DO-41 OUTLINE SHALL APPLY.
2. POLARITY DENOTED BY CATHODE BAND.
3. LEAD DIAMETER NOT CONTROLLED WITHIN "F" DIMENSION.

DIM	MILLIMETERS MIN	MILLIMETERS MAX	INCHES MIN	INCHES MAX
A	5.97	6 60	0.235	0.260
B	2.79	3 05	0.110	0.120
D	0.76	0.86	0 030	0.034
K	27.94	—	1.100	—

CASE 59-04
PLASTIC
Dimensions Within JEDEC DO-15 Outline

3

FIGURE 1 — FORWARD VOLTAGE

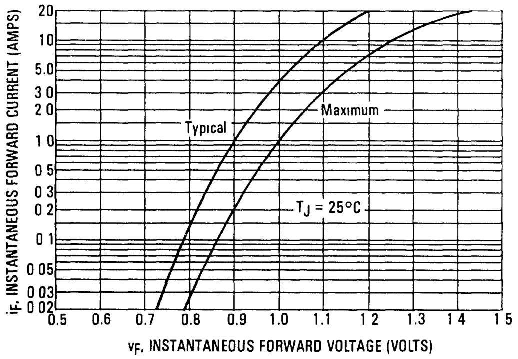


FIGURE 2 — MAXIMUM NON-REPETITIVE AVALANCHE SURGE POWER

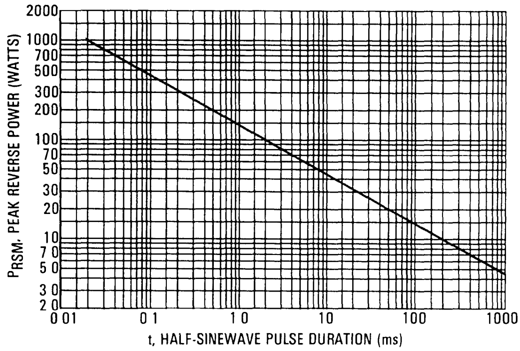


FIGURE 3 — POWER DISSIPATION

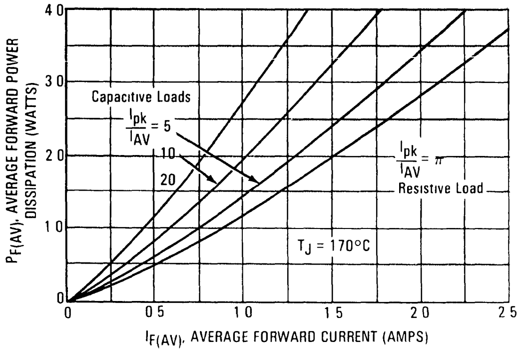


FIGURE 4 — EFFECT OF LEAD LENGTHS, RESISTIVE LOAD

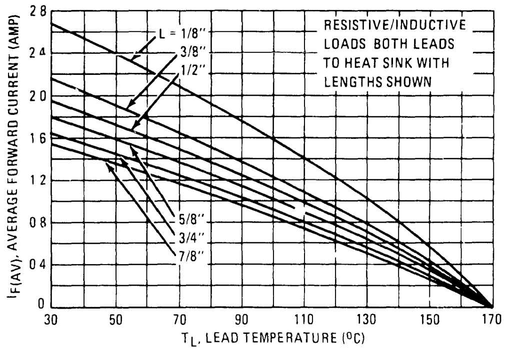
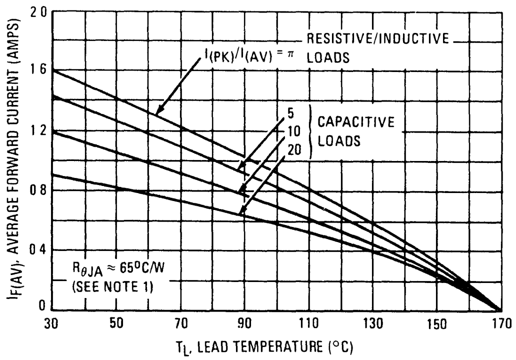


FIGURE 5 — PRINTED CIRCUIT BOARD MOUNTING, VARIOUS LOADS

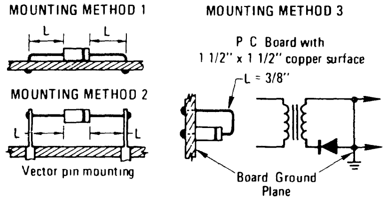


NOTE 1

Data shown for thermal resistance junction to ambient (θ_{JA}) for the mountings shown is to be used as typical guideline values for preliminary engineering or in case the tie point temperature cannot be measured

TYPICAL VALUES FOR θ_{JA} IN STILL AIR

MOUNTING METHOD	LEAD LENGTH L (IN) 1/8	1/4	1/2	3/4	$R_{\theta JA}$
1	65	72	82	92	°C/W
2	74	81	91	101	°C/W
3	40				°C/W



MOTOROLA
SEMICONDUCTOR
TECHNICAL DATA

MUR105 MUR110 MUR115 MUR120 MUR130 MUR140 MUR150 MUR160 MUR170 MUR180 MUR190 MUR1100

SWITCHMODE POWER RECTIFIERS

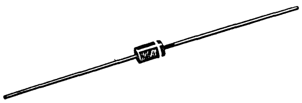
. . . designed for use in switching power supplies, inverters and as free wheeling diodes, these state-of-the-art devices have the following features:

- Ultrafast 25, 50 and 75 Nanosecond Recovery Times
- 175°C Operating Junction Temperature
- Low Forward Voltage
- Low Leakage Current
- High Temperature Glass Passivated Junction
- Reverse Voltage to 1000 Volts

ULTRAFAST RECTIFIERS

1.0 AMPERE
50–1000 VOLTS

3



CASE 59-04
PLASTIC

MAXIMUM RATINGS

Rating	Symbol	MUR 105	110	115	120	130	140	150	160	170	180	190	1100	Unit
Peak Repetitive Reverse Voltage Working Peak Reverse Voltage DC Blocking Voltage	V_{RRM} V_{RWM} V_R	50	100	150	200	300	400	500	600	700	800	900	1000	Volts
Average Rectified Forward Current (Square Wave Mounting Method #3 Per Note 1)	$I_{F(AV)}$	1.0 @ T_A = 130°C			1.0 @ T_A = 120°C					1.0 @ T_A = 95°C				Amps
Nonrepetitive Peak Surge Current (Surge applied at rated load conditions, halfwave, single phase, 60 Hz)	I_{FSM}	35												Amps
Operating Junction Temperature and Storage Temperature	T_J, T_{stg}	−65 to +175												°C
THERMAL CHARACTERISTICS														
Maximum Thermal Resistance, Junction to Ambient	$R_{\theta JA}$	See Note 1												°C/W
ELECTRICAL CHARACTERISTICS														
Maximum Instantaneous Forward Voltage (1) (i_F = 1.0 Amp, T_J = 150°C) (i_F = 1.0 Amp, T_J = 25°C)	v_F	 0.710 0.875			 1.05 1.25					 1.50 1.75				Volts
Maximum Instantaneous Reverse Current (1) (Rated dc Voltage, T_J = 150°C) (Rated dc Voltage, T_J = 25°C)	i_R	 50 2.0			 150 5.0					 600 10				μA
Maximum Reverse Recovery Time (I_F = 1.0 Amp, di/dt = 50 Amp/μs) (I_F = 0.5 Amp, i_R = 1.0 Amp, I_{REC} = 0.25 A)	t_{rr}	 35 25			 75 50					 100 75				ns
Maximum Forward Recovery Time (I_F = 1.0 A, di/dt = 100 A/μs, I_{REC} to 1.0 V)	t_{fr}	25			50					75				ns

(1)Pulse Test: Pulse Width = 300 μs, Duty Cycle ≤2.0%

3

MUR105, 110 AND 115

FIGURE 1 — TYPICAL FORWARD VOLTAGE

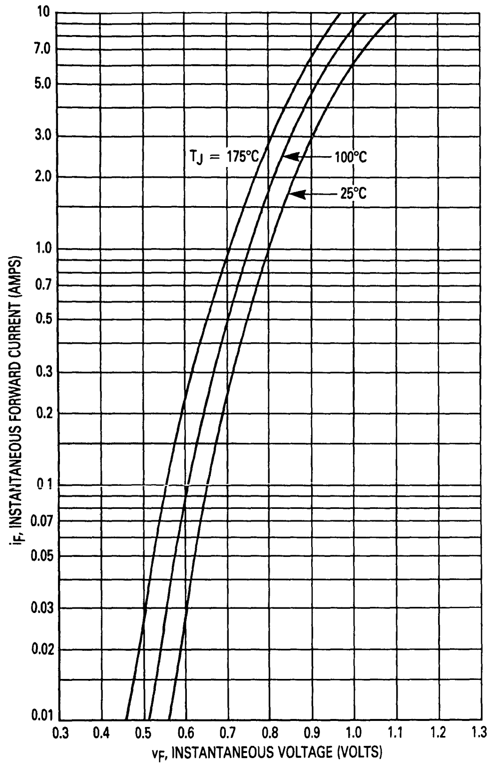


FIGURE 2 — TYPICAL REVERSE CURRENT*

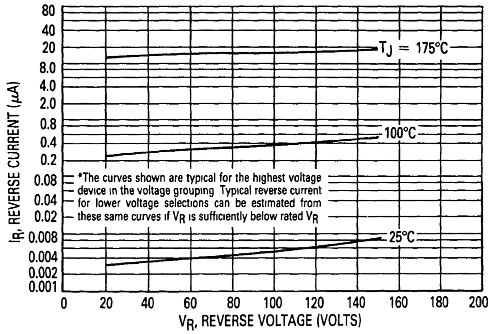


FIGURE 3 — CURRENT DERATING (MOUNTING METHOD #3 PER NOTE 1)

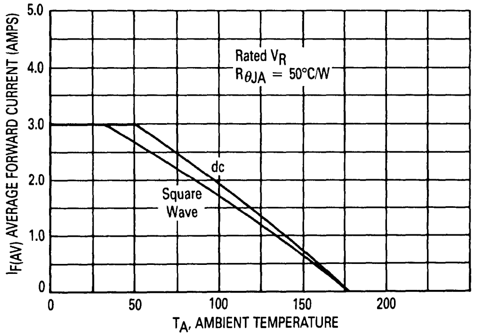


FIGURE 4 — POWER DISSIPATION

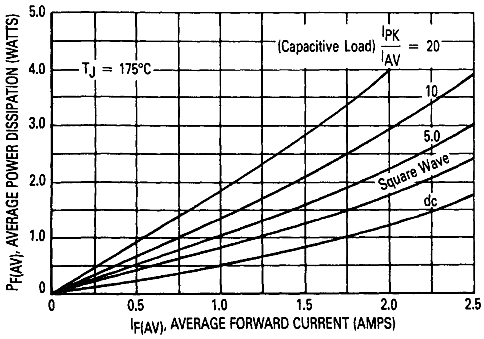
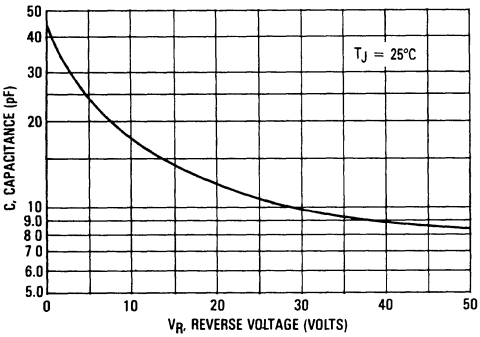


FIGURE 5 — TYPICAL CAPACITANCE



MUR120, 130, 140, 150, 160

FIGURE 6 — TYPICAL FORWARD VOLTAGE

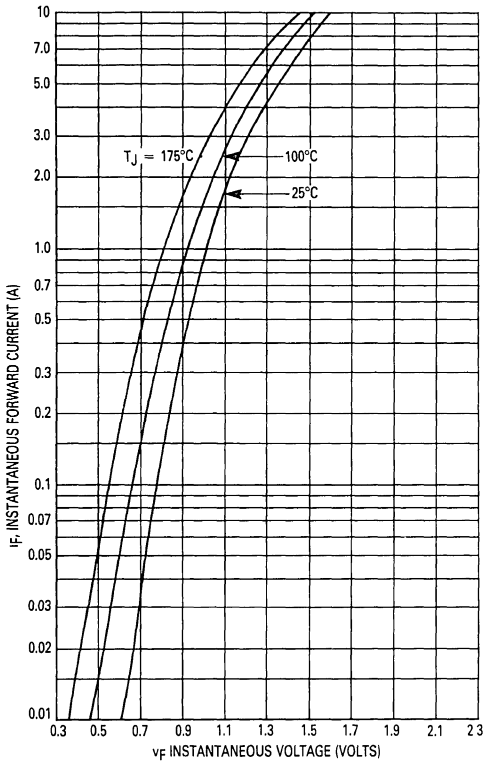


FIGURE 7 — TYPICAL REVERSE CURRENT*

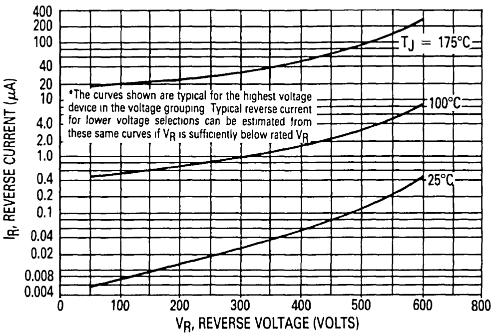


FIGURE 8 — CURRENT DERATING (MOUNTING METHOD #3 PER NOTE 1)

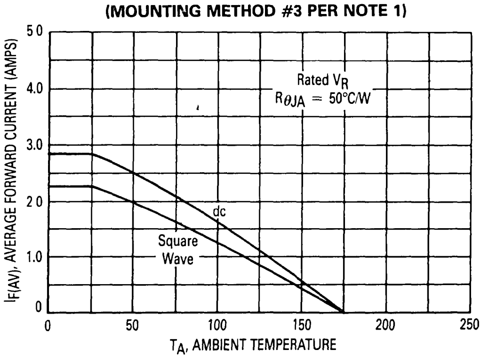


FIGURE 9 — POWER DISSIPATION

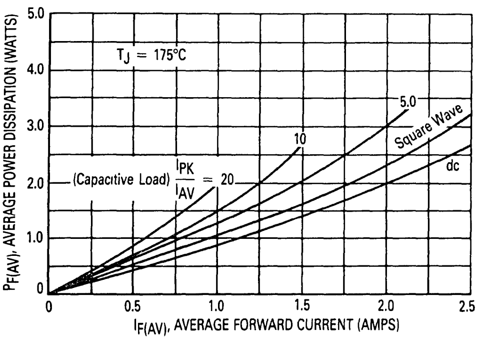
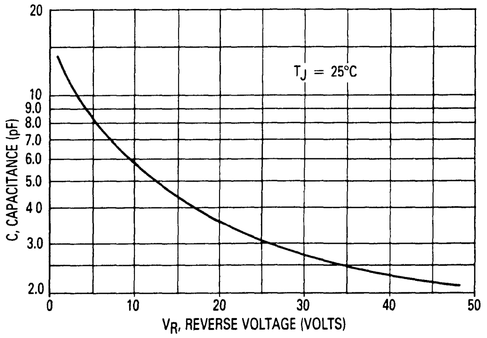


FIGURE 10 — TYPICAL CAPACITANCE



3

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FIGURE 11 — TYPICAL FORWARD VOLTAGE

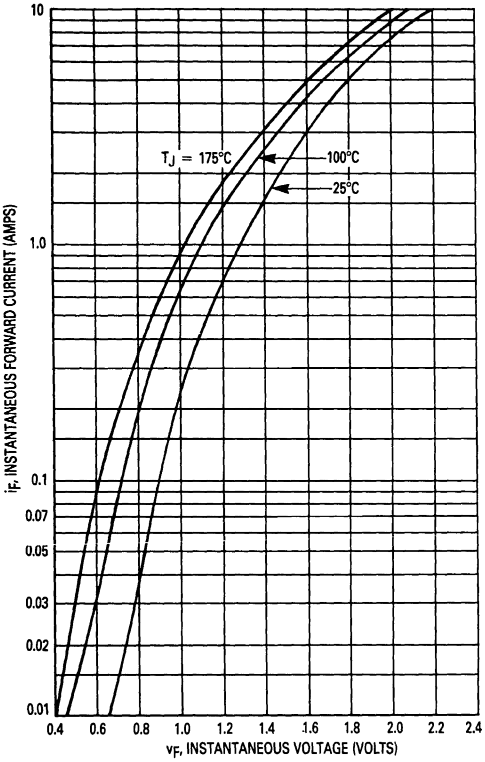


FIGURE 12 — TYPICAL REVERSE CURRENT*

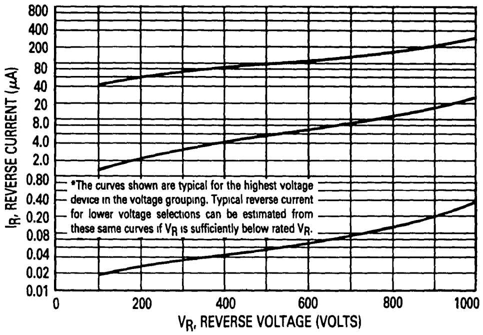


FIGURE 13 — CURRENT DERATING (MOUNTING METHOD #3 PER NOTE 1)

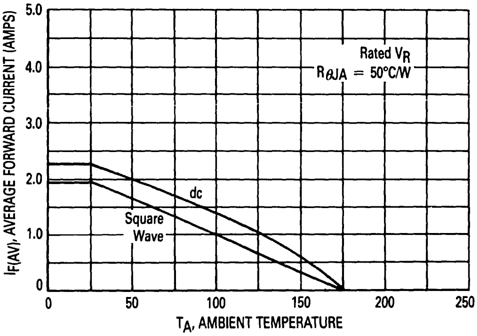


FIGURE 14 — POWER DISSIPATION

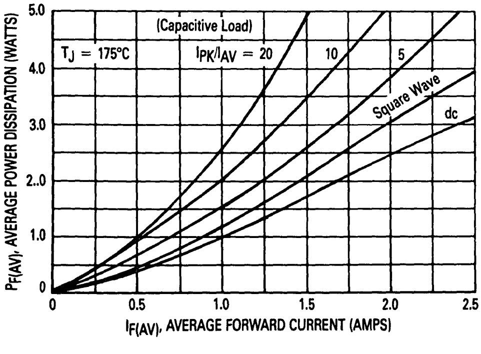
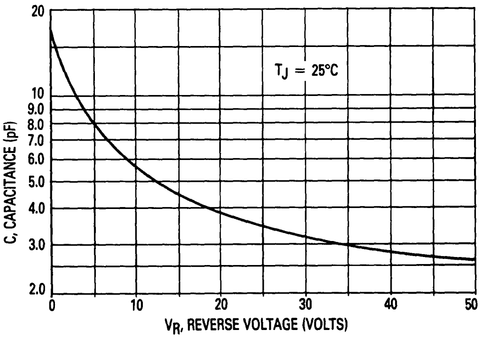


FIGURE 15 — TYPICAL CAPACITANCE



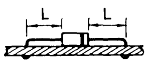
NOTE 1 — AMBIENT MOUNTING DATA

Data shown for thermal resistance junction-to-ambient ($R_{\theta JA}$) for the mountings shown is to be used as typical guideline values for preliminary engineering or in case the tie point temperature cannot be measured.

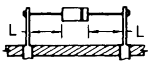
TYPICAL VALUES FOR $R_{\theta JA}$ IN STILL AIR

MOUNTING METHOD		LEAD LENGTH, L			UNITS
		1/8	1/4	1/2	
1	$R_{\theta JA}$	52	65	72	°C/W
2	$R_{\theta JA}$	67	80	87	°C/W
3	$R_{\theta JA}$		50		°C/W

MOUNTING METHOD 1

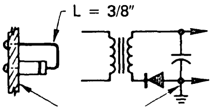


MOUNTING METHOD 2



Vector Pin Mounting

MOUNTING METHOD 3



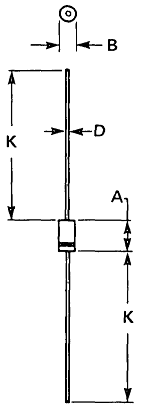
Board Ground Plane

P.C. Board with
1-1/2″ x 1-1/2″ Copper Surface

MECHANICAL CHARACTERISTICS

Case: Transfer Molded Plastic
Finish: External Leads are Plated, Leads are readily Solderable
Polarity: Indicated by Cathode Band
Weight: 1.1 Grams (Approximately)
Maximum Lead Temperature for Soldering Purposes: 240°C, 1/8″ from case for 10 seconds at 5.0 lbs. tension.

OUTLINE DIMENSIONS



NOTES:
1. ALL RULES AND NOTES ASSOCIATED WITH JEDEC DO-41 OUTLINE SHALL APPLY.
2. POLARITY DENOTED BY CATHODE BAND.
3. LEAD DIAMETER NOT CONTROLLED WITHIN "F" DIMENSION.

DIM	MILLIMETERS		INCHES	
	MIN	MAX	MIN	MAX
A	5.97	6.60	0.235	0.260
B	2.79	3.05	0.110	0.120
D	0.76	0.86	0.030	0.034
K	27.94	—	1.100	—

CASE 59-04
PLASTIC

MOTOROLA
SEMICONDUCTOR
TECHNICAL DATA

MUR405 MUR410 MUR415 MUR420 MUR430 MUR440 MUR450 MUR460 MUR470 MUR480 MUR490 MUR4100

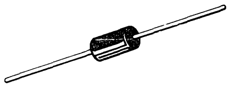
SWITCHMODE POWER RECTIFIERS

. . . designed for use in switching power supplies, inverters and as free wheeling diodes, these state-of-the-art devices have the following features:

- Ultrafast 25, 50 and 75 Nanosecond Recovery Times
- 175°C Operating Junction Temperature
- Low Forward Voltage
- Low Leakage Current
- High Temperature Glass Passivated Junction
- Reverse Voltage to 1000 Volts

ULTRAFAST RECTIFIERS

4.0 AMPERES
50–1000 VOLTS



CASE 267-03
PLASTIC

MAXIMUM RATINGS

Rating	Symbol	MUR												Unit
		405	410	415	420	430	440	450	460	470	480	490	4100	
Peak Repetitive Reverse Voltage Working Peak Reverse Voltage DC Blocking Voltage	V_{RRM} V_{RWM} V_R	50	100	150	200	300	400	500	600	700	800	900	1000	Volts
Average Rectified Forward Current (Square Wave) (Mounting Method #3 Per Note 1)	$I_{F(AV)}$	4.0 @ T_A = 80°C			4.0 @ T_A = 40°C					4.0 @ T_A = 35°C				Amps
Nonrepetitive Peak Surge Current (Surge applied at rated load conditions halfwave, single phase, 60 Hz)	I_{FSM}	125			70									Amps
Operating Junction Temperature and Storage Temperature	T_J, T_{stg}	−65 to +175												°C
THERMAL CHARACTERISTICS														
Maximum Thermal Resistance, Junction to Ambient	$R_{\theta JA}$	See Note 1												°C/W
ELECTRICAL CHARACTERISTICS														
Maximum Instantaneous Forward Voltage (1) (i_F=3.0 Amp, T_J=150°C) (i_F=3.0 Amp, T_J=25°C) (i_F=4.0 Amp, T_J=25°C)	v_F	 0.710 0.875 0.890			 1.05 1.25 1.28					 1.53 1.75 1.85				Volts
Maximum Instantaneous Reverse Current (1) (Rated dc Voltage, T_J=150°C) (Rated dc Voltage, T_J=25°C)	i_R	 150 5.0			 250 10					 900 25				μA
Maximum Reverse Recovery Time (I_F=1.0 Amp, di/dt=50 Amp/μs) (I_F=0.5 Amp, i_R=1.0 Amp, I_{REC}=0.25 Amp)	t_{rr}	 35 25			 75 50					 100 75				ns
Maximum Forward Recovery Time (I_F=1.0 A, di/dt = 100 A/μs, Recovery to 1.0 V)	t_{fr}	25			50					75				ns

(1)Pulse Test: Pulse Width = 300 μs, Duty Cycle ≤2.0%

MUR405, 410 AND 415

FIGURE 1 — TYPICAL FORWARD VOLTAGE

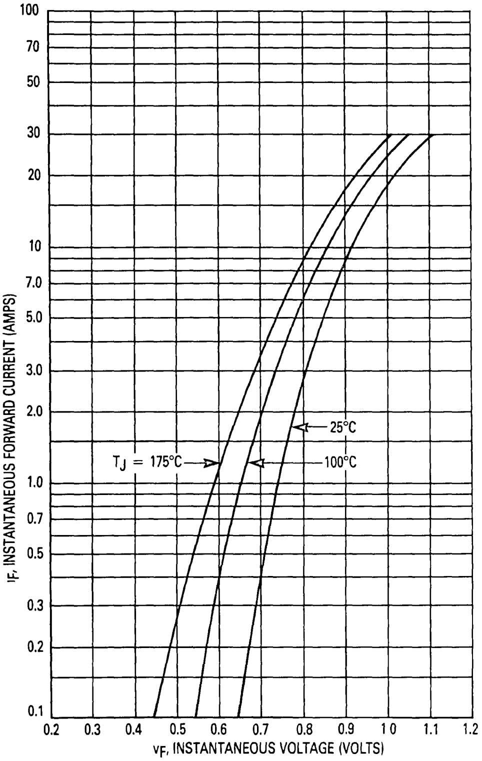


FIGURE 2 — TYPICAL REVERSE CURRENT*

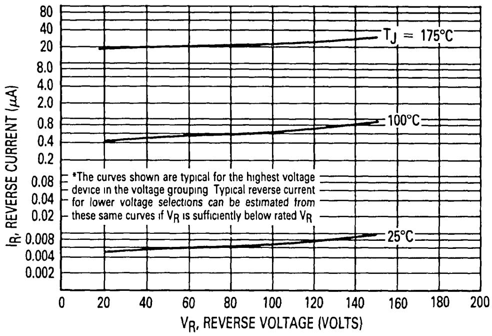


FIGURE 3 — CURRENT DERATING (MOUNTING METHOD #3 PER NOTE 1)

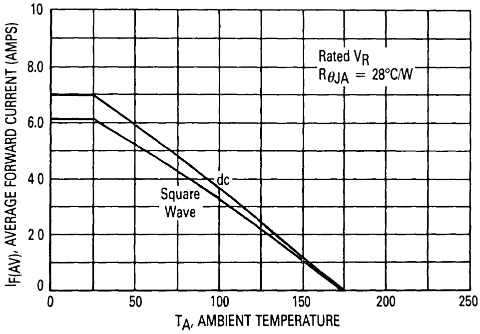


FIGURE 4 — POWER DISSIPATION

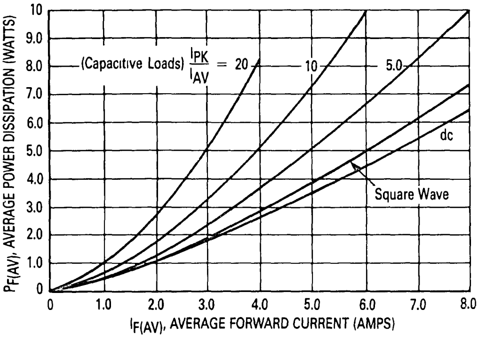
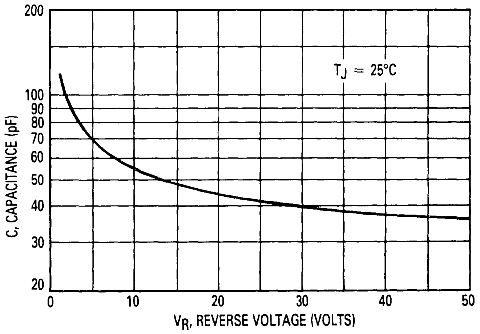


FIGURE 5 — TYPICAL CAPACITANCE



3

MUR420, 430, 440, 450 AND 460

FIGURE 6 — TYPICAL FORWARD VOLTAGE

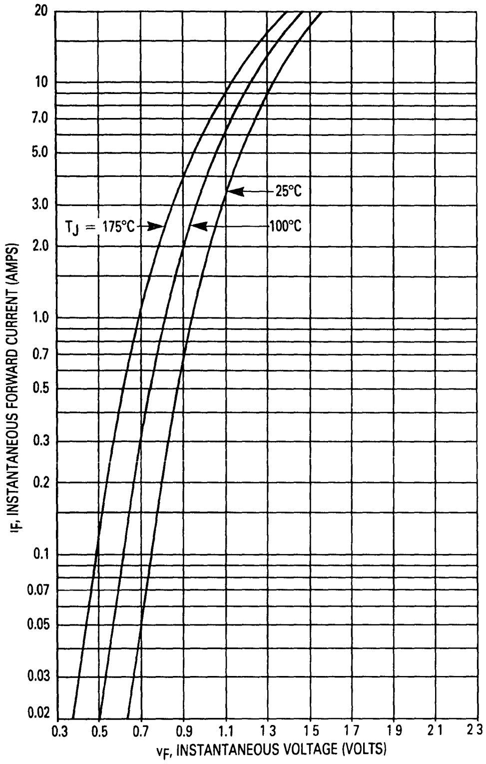


FIGURE 7 — TYPICAL REVERSE CURRENT*

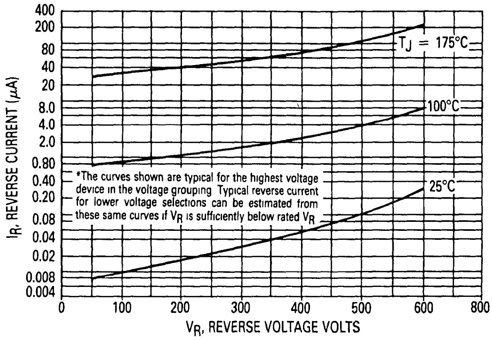


FIGURE 8 — CURRENT DERATING (MOUNTING METHOD #3 PER NOTE 1)

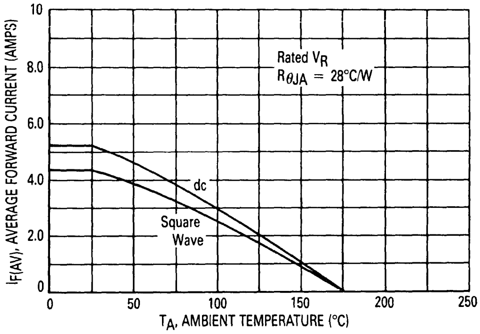


FIGURE 9 — POWER DISSIPATION

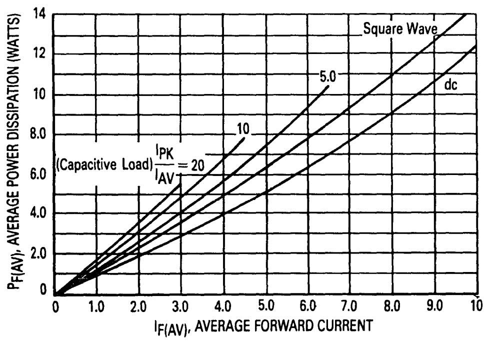
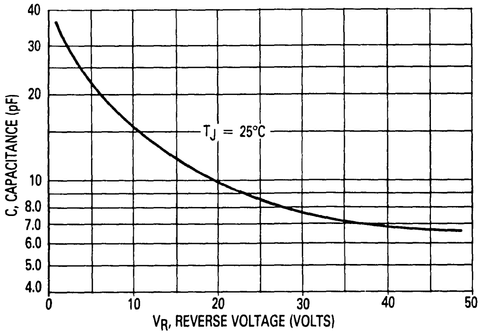


FIGURE 10 — TYPICAL CAPACITANCE



MUR470, 480, 490, 4100

FIGURE 11 — TYPICAL FORWARD VOLTAGE

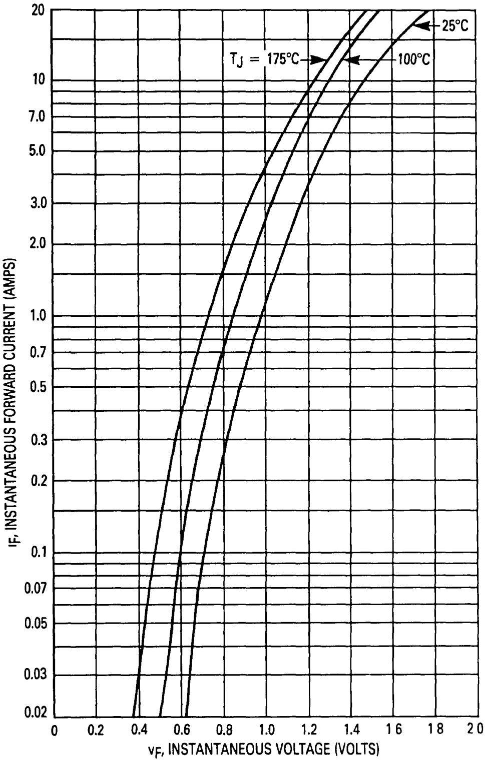


FIGURE 12 — TYPICAL REVERSE CURRENT*

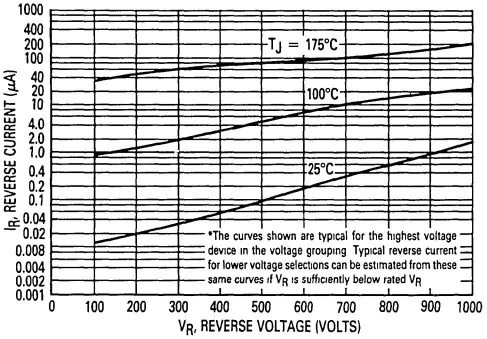


FIGURE 13 — CURRENT DERATING
(MOUNTING METHOD #3 PER NOTE 1)

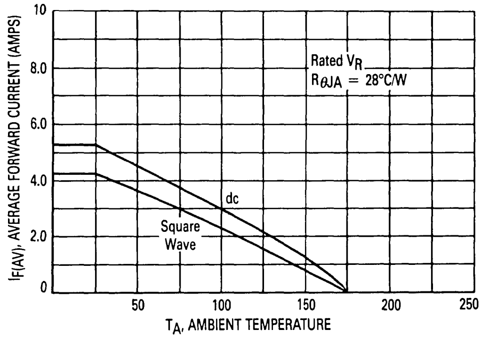


FIGURE 14 — POWER DISSIPATION

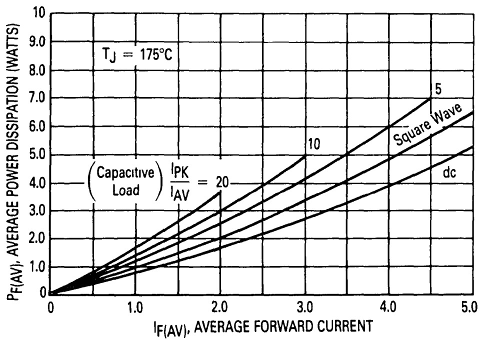
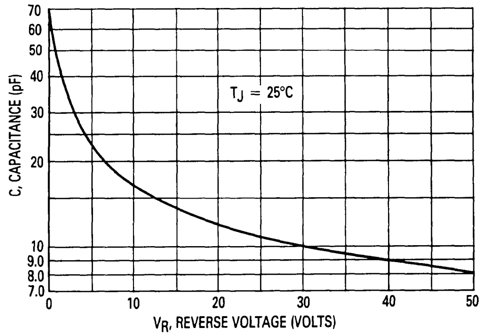


FIGURE 15 — TYPICAL CAPACITANCE



3

3

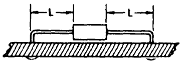
NOTE 1 — AMBIENT MOUNTING DATA

Data shown for thermal resistance junction-to-ambient ($R_{\theta JA}$) for the mountings shown is to be used as typical guideline values for preliminary engineering or in case the tie point temperature cannot be measured.

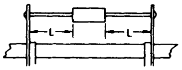
TYPICAL VALUES FOR $R_{\theta JA}$ IN STILL AIR

MOUNTING METHOD		LEAD LENGTH, L (IN)				UNITS
		1/8	1/4	1/2	3/4	
1	$R_{\theta JA}$	50	51	53	55	°C/W
2	$R_{\theta JA}$	58	59	61	63	°C/W
3	$R_{\theta JA}$	28				°C/W

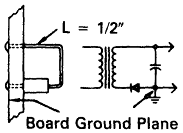
MOUNTING METHOD 1
P.C. Board Where Available Copper Surface area is small.



MOUNTING METHOD 2
Vector Push-In Terminals T-28



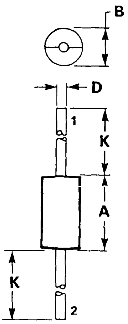
MOUNTING METHOD 3
P.C. Board with
1-1/2" x 1-1/2" Copper Surface



MECHANICAL CHARACTERISTICS

Case: Transfer Molded Plastic
Finish: External Leads are Plated, Leads are readily Solderable
Polarity: Indicated by Cathode Band
Weight: 1.1 Grams (Approximately)
Maximum Lead Temperature for Soldering Purposes:
300°C, 1/8" from case for 10 s

OUTLINE DIMENSIONS



STYLE 1
PIN 1 CATHODE
2 ANODE

NOTES.
1 DIMENSIONING & TOLERANCING PER ANSI Y14.5, 1982
2 CONTROLLING DIMENSION. INCH

DIM	MILLIMETERS		INCHES	
	MIN	MAX	MIN	MAX
A	9.40	9.65	0.370	0.380
B	4.83	5.33	0.190	0.210
D	1.22	1.32	0.048	0.052
K	25.40	—	1.000	—

CASE 267-03
PLASTIC

MOTOROLA
SEMICONDUCTOR
TECHNICAL DATA

MUR605CT
MUR610CT
MUR615CT
MUR620CT

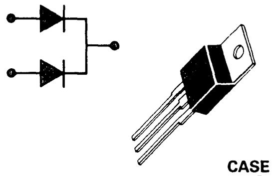
SWITCHMODE POWER RECTIFIERS

. . . designed for use in switching power supplies, inverters and as free wheeling diodes, these state-of-the-art devices have the following features:

- Ultrafast 35 Nanosecond Recovery Time
- 175°C Operating Junction Temperature
- Popular TO-220 Package

ULTRAFAST RECTIFIERS

6 AMPERES
50–200 VOLTS



CASE 221A-04
TO-220AB
PLASTIC

3

MAXIMUM RATINGS

Rating	Symbol	MUR605CT	MUR610CT	MUR615CT	MUR620CT	Unit
Peak Repetitive Reverse Voltage Working Peak Reverse Voltage DC Blocking Voltage	V_{RRM} V_{RWM} V_R	50	100	150	200	Volts
Average Rectified Forward Current (Rated V_R) T_C = 130°C — Per Diode Total Device	$I_{F(AV)}$	← 3.0 → ← 6.0 →				Amps
Peak Repetitive Forward Current Per Diode Leg (Rated V_R, Square Wave, 20 kHz) T_C = 130°C	I_{FRM}	← 6.0 →				Amps
Nonrepetitive Peak Surge Current (Surge applied at rated load conditions halfwave, single phase, 60 Hz)	I_{FSM}	← 75 →				Amps
Operating Junction Temperature and Storage Temperature	T_J, T_{stg}	← −65 to +175 →				°C

THERMAL CHARACTERISTICS PER DIODE LEG

Rating	Symbol	Typical	Maximum	Unit
Thermal Resistance, Junction to Case	$R_{\theta JC}$	5.0–6.0	7.0	°C/W

ELECTRICAL CHARACTERISTICS PER DIODE LEG

Characteristic	Symbol	Typical	Maximum	Unit
Instantaneous Forward Voltage (1) (i_F = 3.0 Amp, T_C = 150°C) (i_F = 3.0 Amp, T_C = 25°C)	v_F	 0.80 0.94	 0.895 0.975	Volts
Instantaneous Reverse Current (1) (Rated dc Voltage, T_C = 150°C) (Rated dc Voltage, T_C = 25°C)	i_R	 2.0–10 0.01–3.0	 250 5.0	μA
Reverse Recovery Time (I_F = 1.0 Amp, di/dt = 50 Amp/μs)	t_{rr}	20–30	35	ns

(1) Pulse Test Pulse Width = 300 μs, Duty Cycle ≤ 2.0%.

FIGURE 1 — TYPICAL FORWARD VOLTAGE

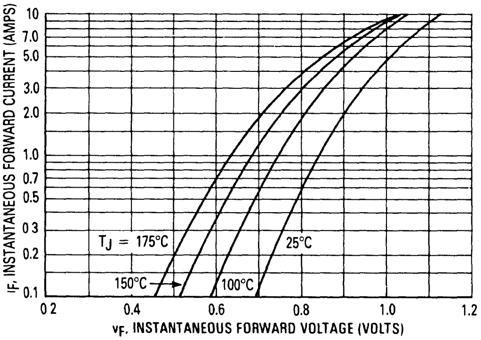


FIGURE 2 — TYPICAL REVERSE CURRENT

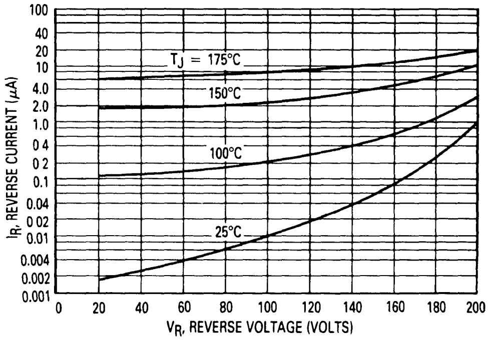


FIGURE 3 — TOTAL DEVICE CURRENT DERATING, CASE

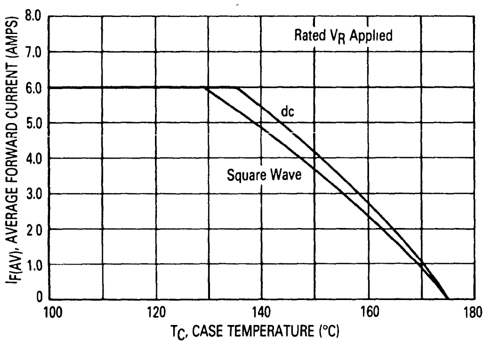


FIGURE 4 — TOTAL DEVICE CURRENT DERATING, AMBIENT

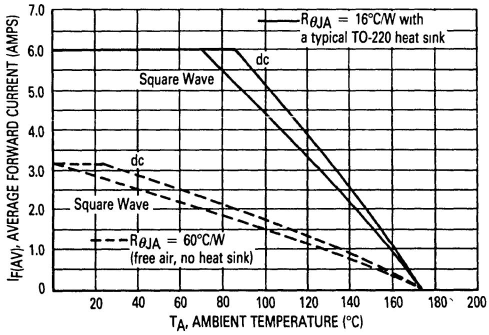
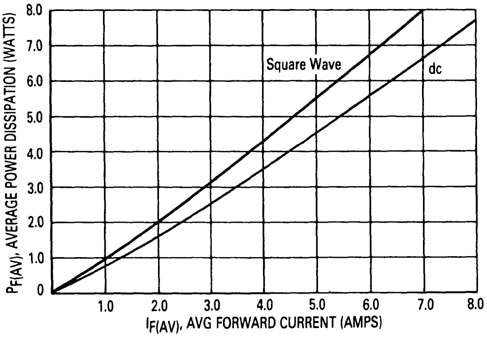
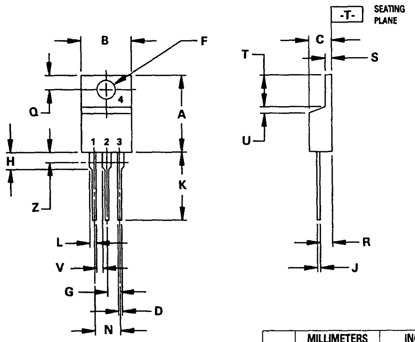


FIGURE 5 — POWER DISSIPATION





STYLE 6,
PIN 1 ANODE
2 CATHODE
3 ANODE
4 CATHODE

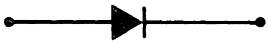
NOTES
1 DIMENSIONING AND TOLERANCING PER ANSI Y14 5M, 1982
2 CONTROLLING DIMENSION INCH
3 DIM Z DEFINES A ZONE WHERE ALL BODY AND LEAD IRREGULARITIES ARE ALLOWED

DIM	MILLIMETERS		INCHES	
	MIN	MAX	MIN	MAX
A	14 48	15 75	0 570	0 620
B	9 66	10 28	0 380	0 405
C	4 07	4 82	0 160	0 190
D	0 64	0 88	0 025	0 035
F	3 61	3 73	0 142	0 147
G	2 42	2 66	0 095	0 105
H	2 80	3 93	0 110	0 155
J	0 36	0 55	0 014	0 022
K	12 70	14 27	0 500	0 562
L	1 15	1 39	0 045	0 055
N	4 83	5 33	0 190	0 210
Q	2 54	3 04	0 100	0 120
R	2 04	2 79	0 080	0 110
S	1 15	1 39	0 045	0 055
T	5 97	6 47	0 235	0 255
U	0 00	1 27	0 000	0 050
V	1 15	—	0 045	—
Z	—	2 04	—	0 080

CASE 221A-04
TO-220AB
PLASTIC

MOTOROLA
SEMICONDUCTOR
TECHNICAL DATA

MUR805 MUR810 MUR815 MUR820 MUR830 MUR840 MUR850 MUR860 MUR870 MUR880 MUR890 MUR8100



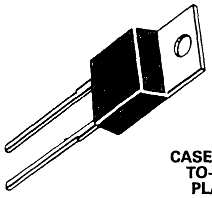
SWITCHMODE POWER RECTIFIERS

. . . designed for use in switching power supplies, inverters and as free wheeling diodes, these state-of-the-art devices have the following features:

- Ultrafast 25, 50 and 75 Nanosecond Recovery Time
- 175°C Operating Junction Temperature
- Popular TO-220 Package
- Epoxy meets UL94, V_O @ ⅛″
- Low Forward Voltage
- Low Leakage Current
- High Temperature Glass Passivated Junction
- Reverse Voltage to 1000 Volts

ULTRAFAST RECTIFIERS

8 AMPERES
50–1000 VOLTS



CASE 221B-01
TO-220AC
PLASTIC

3

MAXIMUM RATINGS

Rating	Symbol	MUR 805	810	815	820	830	840	850	860	870	880	890	8100	Unit
Peak Repetitive Reverse Voltage Working Peak Reverse Voltage DC Blocking Voltage	V_{RRM} V_{RWM} V_R	50	100	150	200	300	400	500	600	700	800	900	1000	Volts
Average Rectified Forward Current Total Device, (Rated V_R), T_C = 150°C	$I_{F(AV)}$	8.0												Amps
Peak Repetitive Forward Current (Rated V_R, Square Wave, 20 kHz), T_C = 150°C	I_{FM}	16												Amps
Nonrepetitive Peak Surge Current (Surge applied at rated load conditions halfwave, single phase, 60 Hz)	I_{FSM}	100												Amps
Operating Junction Temperature and Storage Temperature	T_J, T_{stg}	−65 to +175												°C

THERMAL CHARACTERISTICS

Rating	Symbol	805	810	815	820	830	840	850	860	870	880	890	8100	Unit
Maximum Thermal Resistance, Junction to Case	$R_{\theta JC}$	3.0				2.0								°C/W

ELECTRICAL CHARACTERISTICS

Rating	Symbol	805	810	815	820	830	840	850	860	870	880	890	8100	Unit
Maximum Instantaneous Forward Voltage (1) (i_F = 8.0 Amp, T_C = 150°C) (i_F = 8.0 Amp, T_C = 25°C)	v_F	0.895 0.975				1.00 1.30		1.20 1.50		1.5 1.8				Volts
Maximum Instantaneous Reverse Current (1) (Rated dc Voltage, T_C = 150°C) (Rated dc Voltage, T_C = 25°C)	i_R	250 5.0				500 10		500 10		500 25				μA
Maximum Reverse Recovery Time (I_F = 1.0 Amp, di/dt = 50 Amp/μs) (I_F = 0.5 Amp, i_R = 1.0 Amp, I_{REC} = 0.25 Amp)	t_{rr}	35 25				60 50				100 75				ns

(1) Pulse Test Pulse Width = 300 μs, Duty Cycle ≤ 2.0%

3

MUR805, 810 AND 815

FIGURE 1 — TYPICAL FORWARD VOLTAGE

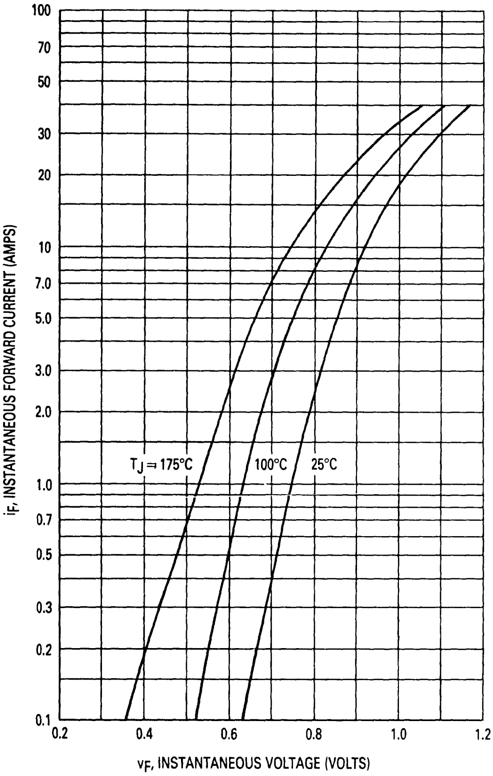


FIGURE 2 — TYPICAL REVERSE CURRENT*

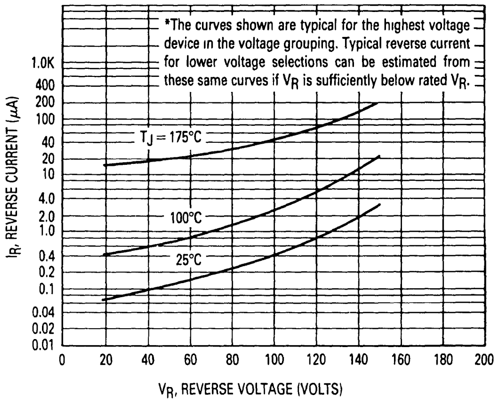


FIGURE 3 — CURRENT DERATING, CASE

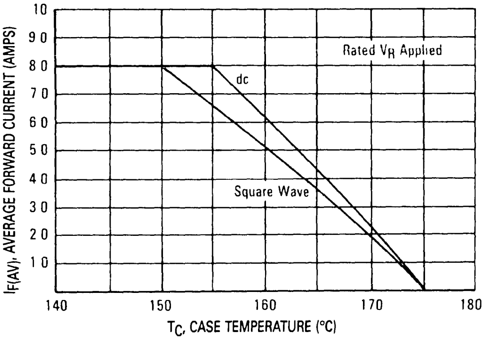


FIGURE 4 — CURRENT DERATING, AMBIENT

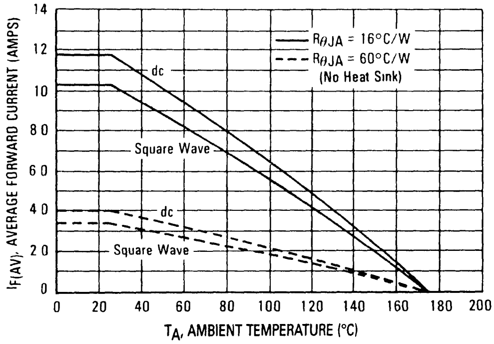
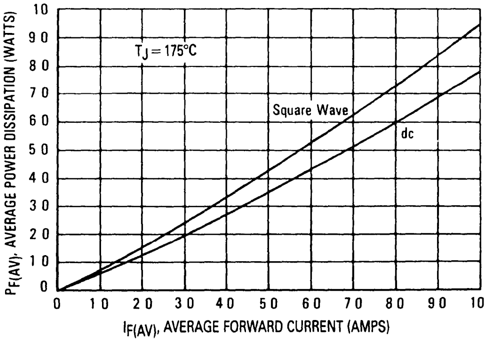


FIGURE 5 — POWER DISSIPATION



MUR820, 830 AND 840

FIGURE 6 — TYPICAL FORWARD VOLTAGE

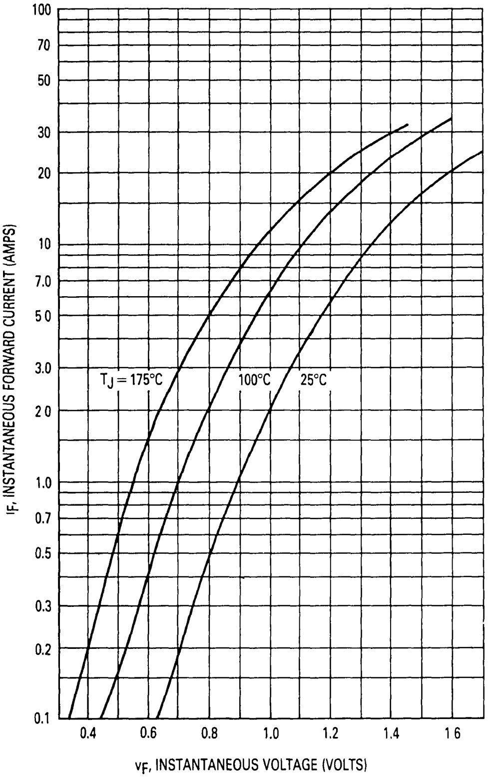


FIGURE 7 — TYPICAL REVERSE CURRENT*

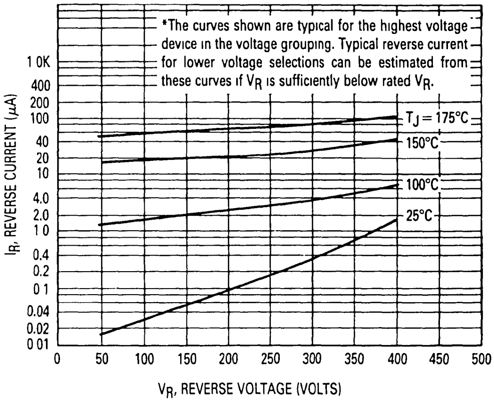


FIGURE 8 — CURRENT DERATING, CASE

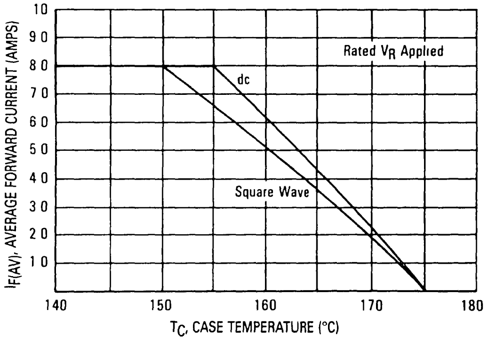


FIGURE 9 — CURRENT DERATING, AMBIENT

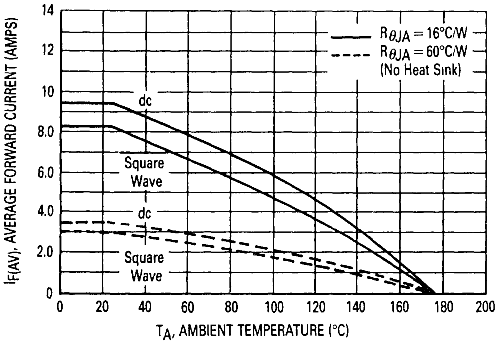
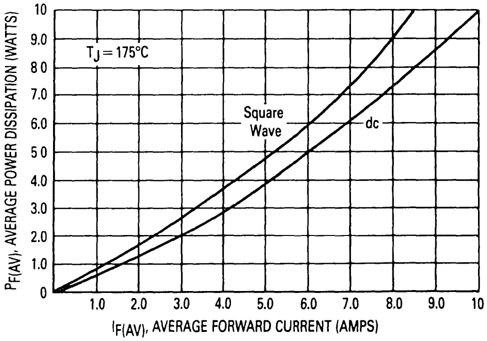


FIGURE 10 — POWER DISSIPATION



MUR850 AND 860

FIGURE 11 — TYPICAL FORWARD VOLTAGE

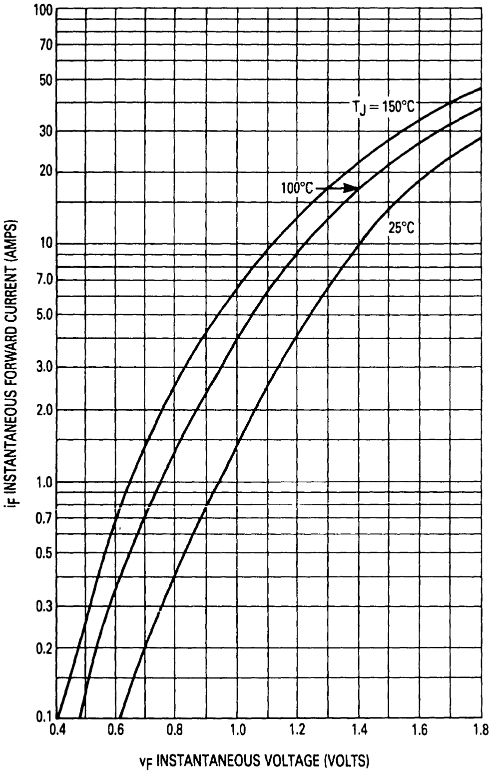


FIGURE 12 — TYPICAL REVERSE CURRENT*

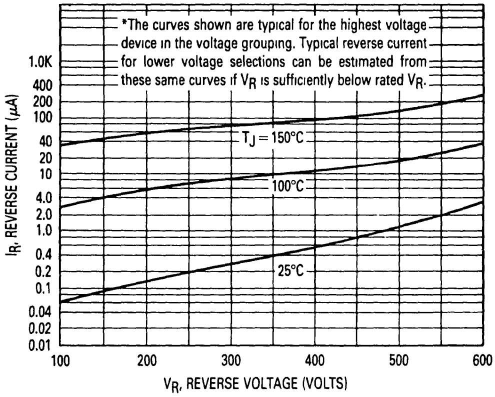


FIGURE 13 — CURRENT DERATING, CASE

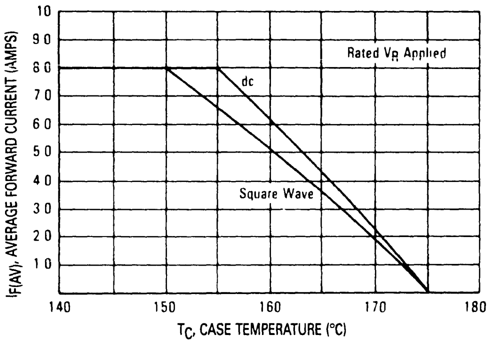


FIGURE 14 — CURRENT DERATING, AMBIENT

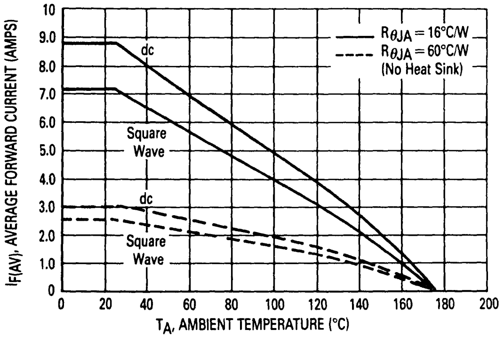
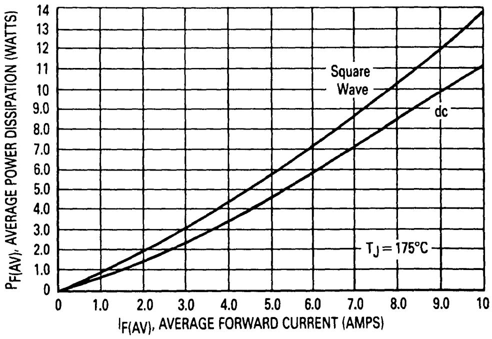


FIGURE 15 — POWER DISSIPATION



3

MUR870, 880, 890 AND 8100

FIGURE 16 — TYPICAL FORWARD VOLTAGE

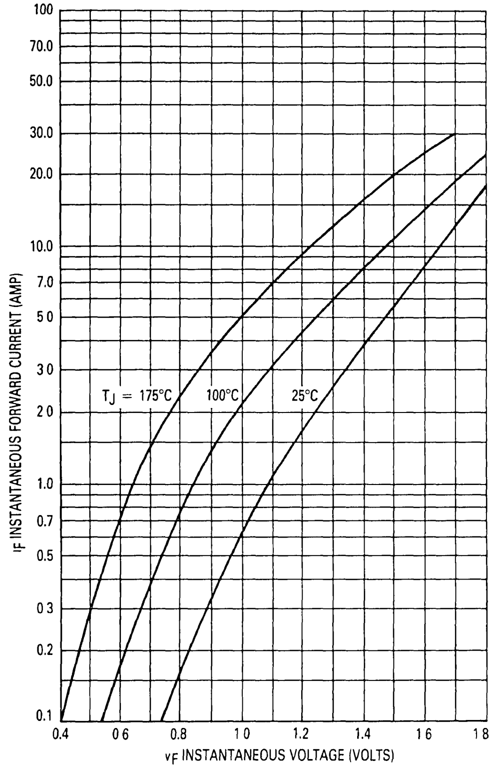


FIGURE 17 — TYPICAL REVERSE CURRENT*

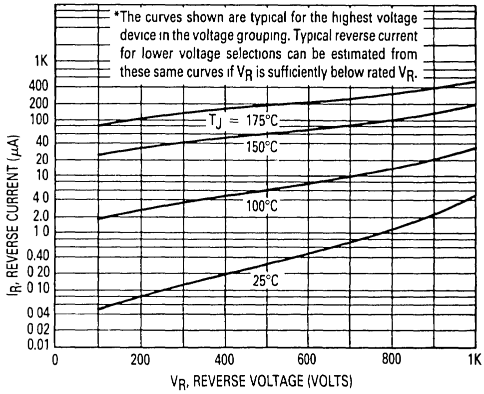


FIGURE 18 — CURRENT DERATING, CASE

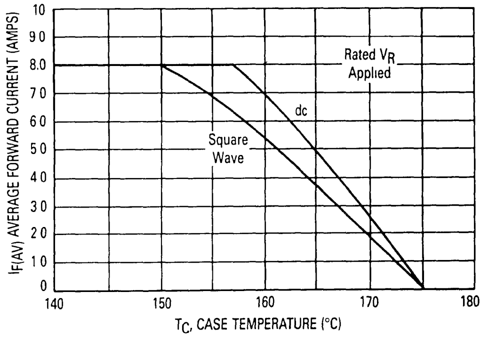


FIGURE 19 — CURRENT DERATING, AMBIENT

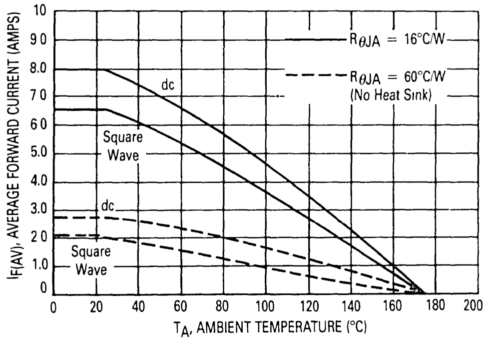


FIGURE 20 — POWER DISSIPATION

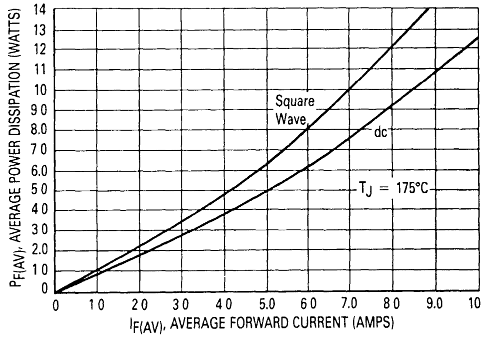


FIGURE 21 — THERMAL RESPONSE

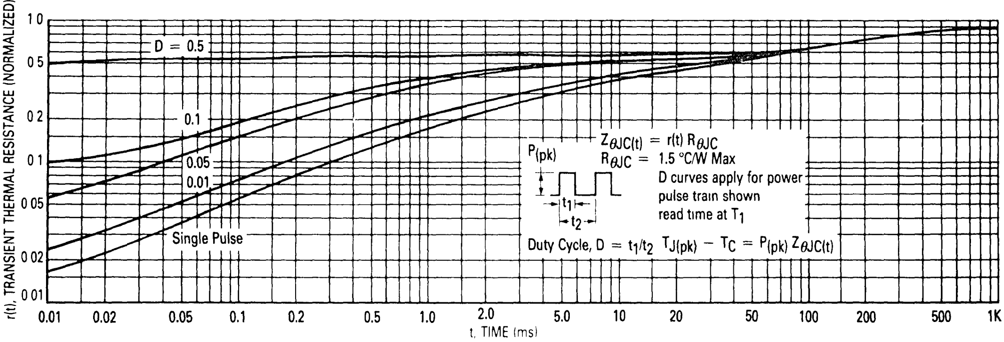


FIGURE 22 — TYPICAL CAPACITANCE

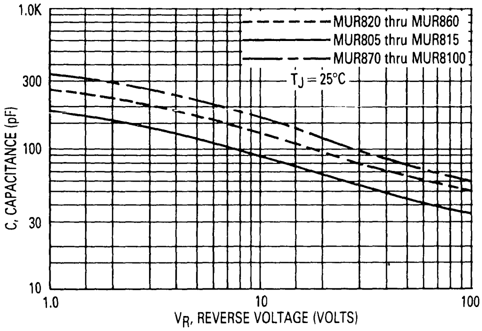
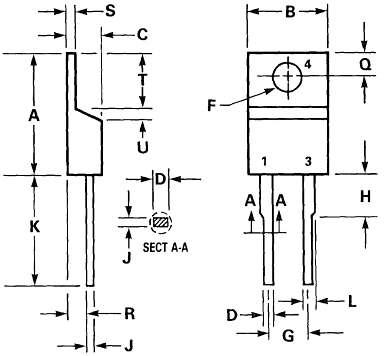


FIGURE 23 — OUTLINE DIMENSIONS



STYLE 1
PIN 1. CATHODE
2. N/A
3 ANODE
4 CATHODE

CASE 221B-01
TO-220AC
PLASTIC

DIM	MILLIMETERS		INCHES	
	MIN	MAX	MIN	MAX
A	15 11	15 75	0 595	0 620
B	9 65	10 29	0 380	0.405
C	4.06	4 82	0 160	0.190
D	0.64	0 89	0 025	0 035
F	3 61	3 73	0 142	0.147
G	4 83	5 33	0.190	0 210
H	2 79	3 30	0 110	0 130
J	0 36	0.56	0 014	0 022
K	12 70	14 27	0.500	0 562
L	1.14	1 27	0 045	0 050
Q	2.54	3 04	0 100	0 120
R	2.04	2 79	0 080	0 110
S	1 14	1 39	0 045	0.055
T	5 97	6.48	0.235	0 255
U	0.76	1 27	0 030	0.050

MOTOROLA
SEMICONDUCTOR
TECHNICAL DATA

MUR1505 MUR1530
MUR1510 MUR1540
MUR1515 MUR1550
MUR1520 MUR1560

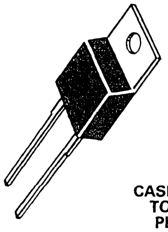
SWITCHMODE POWER RECTIFIERS

. . . designed for use in switching power supplies, inverters and as free wheeling diodes, these state-of-the-art devices have the following features:

- Ultrafast 35 and 60 Nanosecond Recovery Time
- 175°C Operating Junction Temperature
- Popular TO-220 Package
- High Voltage Capability to 600 Volts
- Low Forward Drop
- Low Leakage Specified @ 150°C Case Temperature
- Current Derating Specified @ Both Case and Ambient Temperatures

ULTRAFAST RECTIFIERS

15 AMPERES
50–600 VOLTS



CASE 221B-01
TO-220AC
PLASTIC

3

MAXIMUM RATINGS

Rating	Symbol	MUR 1505	1510	1515	1520	1530	1540	1550	1560	Unit
Peak Repetitive Reverse Voltage Working Peak Reverse Voltage DC Blocking Voltage	V_{RRM} V_{RWM} V_R	50	100	150	200	300	400	500	600	Volts
Average Rectified Forward Current (Rated V_R)	$I_{F(AV)}$	15 @ T_C = 150°C						15 @ T_C = 145°C		Amps
Peak Repetitive Forward Current (Rated V_R, Square Wave, 20 kHz)	I_{FRM}	30 @ T_C = 150°C						30 @ T_C = 145°C		Amps
Nonrepetitive Peak Surge Current (Surge applied at rated load conditions halfwave, single phase, 60 Hz)	I_{FSM}	200				150				Amps
Operating Junction Temperature and Storage Temperature	T_J, T_{stg}	−65 to +175								°C

THERMAL CHARACTERISTICS

Rating	Symbol	MUR 1505	1510	1515	1520	1530	1540	1550	1560	Unit
Maximum Thermal Resistance, Junction to Case	$R_{\theta JC}$	1.5								°C/W

ELECTRICAL CHARACTERISTICS

Rating	Symbol	MUR 1505	1510	1515	1520	1530	1540	1550	1560	Unit
Maximum Instantaneous Forward Voltage (1) (i_F = 15 Amp, T_C = 150°C) (i_F = 15 Amp, T_C = 25°C)	v_F	 0.85 1 05				 1.12 1.25		 1.20 1.50		Volts
Maximum Instantaneous Reverse Current (1) (Rated dc Voltage, T_C = 150°C) (Rated dc Voltage, T_C = 25°C)	i_R	 500 10						 1000 10		μA
Maximum Reverse Recovery Time (I_F = 1.0 Amp, di/dt = 50 Amp/μs)	t_{rr}	35				60				ns

(1) Pulse Test Pulse Width = 300 μs, Duty Cycle ≤ 2 0%

3

MUR1505, 1510, and 1515

FIGURE 1 — TYPICAL FORWARD VOLTAGE

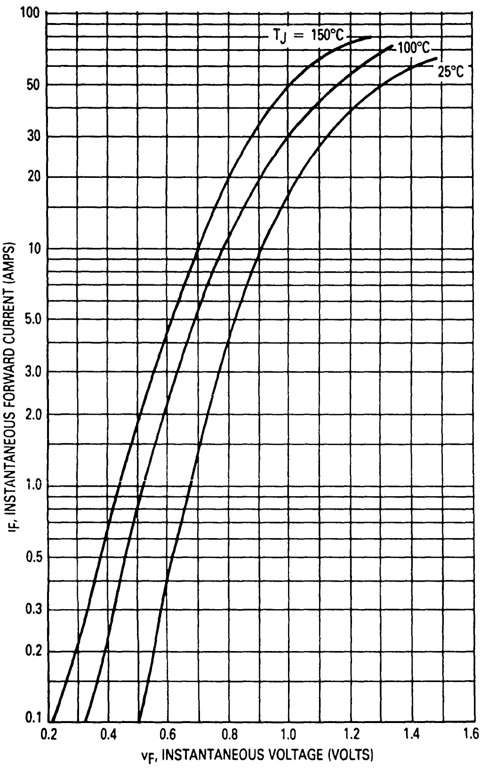
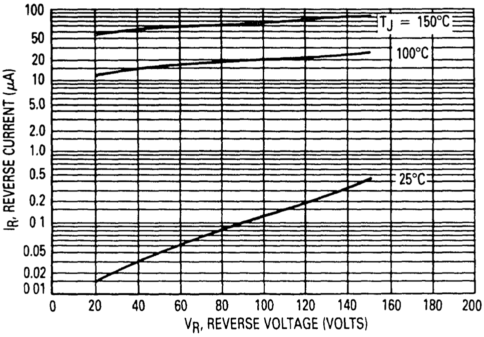


FIGURE 2 — TYPICAL REVERSE CURRENT*



*The curves shown are typical for the highest voltage device in the voltage grouping. Typical reverse current for lower voltage selections can be estimated from these same curves if V_R is sufficiently below rated V_R

FIGURE 3 — CURRENT DERATING, CASE

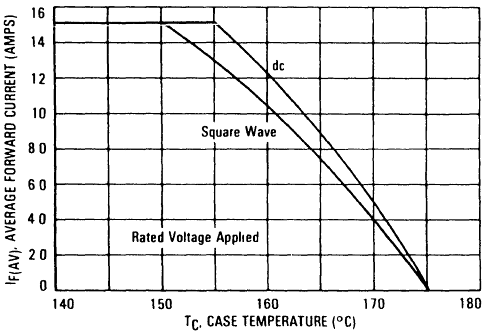


FIGURE 4 — CURRENT DERATING, AMBIENT

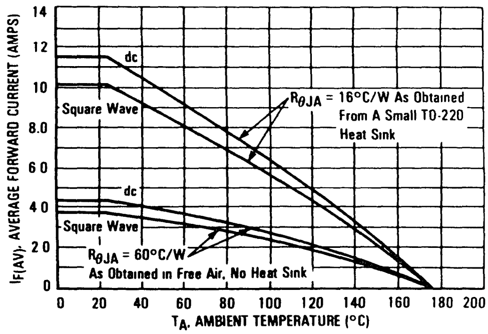
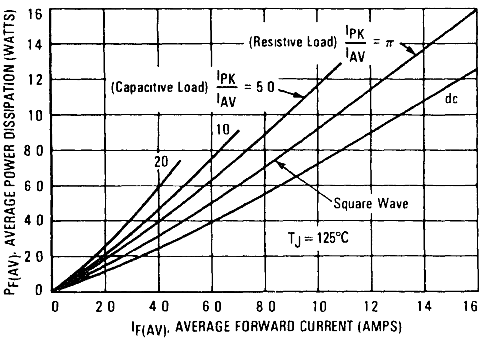


FIGURE 5 — POWER DISSIPATION



MUR1520, 1530, 1540

FIGURE 6 — TYPICAL FORWARD VOLTAGE

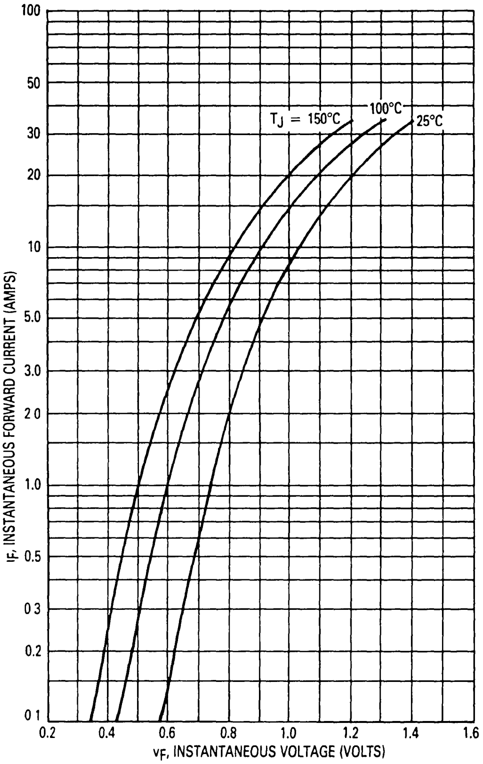
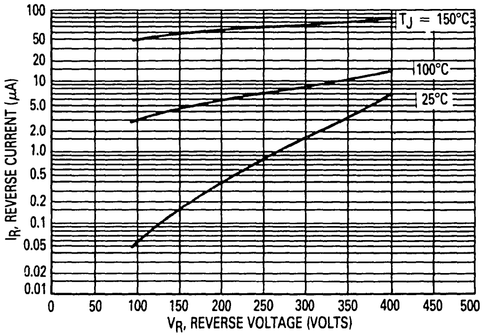


FIGURE 7 — TYPICAL REVERSE CURRENT*



*The curves shown are typical for the highest voltage device in the voltage grouping. Typical reverse current for lower voltage selections can be estimated from these same curves if V_R is sufficiently below rated V_R.

FIGURE 8 — CURRENT DERATING, CASE

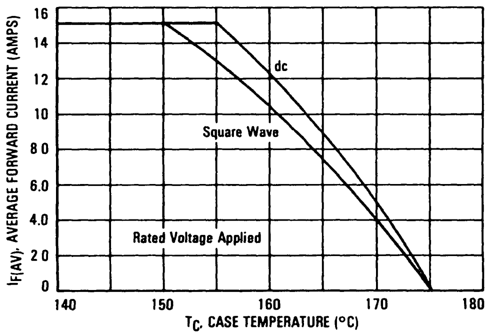


FIGURE 9 — CURRENT DERATING, AMBIENT

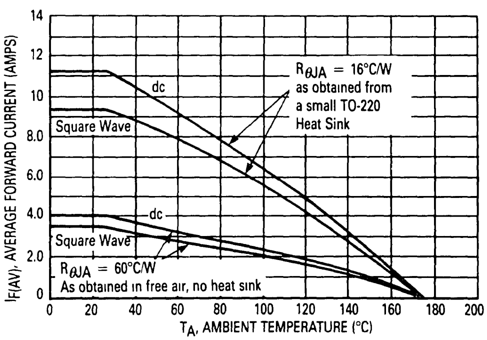
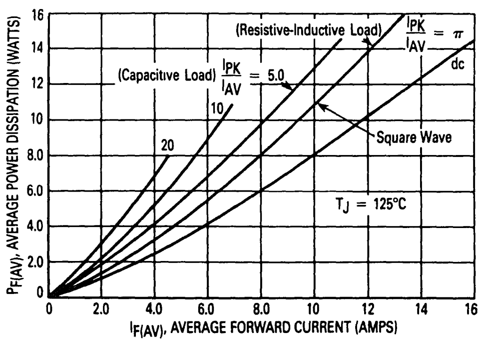


FIGURE 10 — POWER DISSIPATION



3

3

MUR1550, 1560

FIGURE 11 — TYPICAL FORWARD VOLTAGE

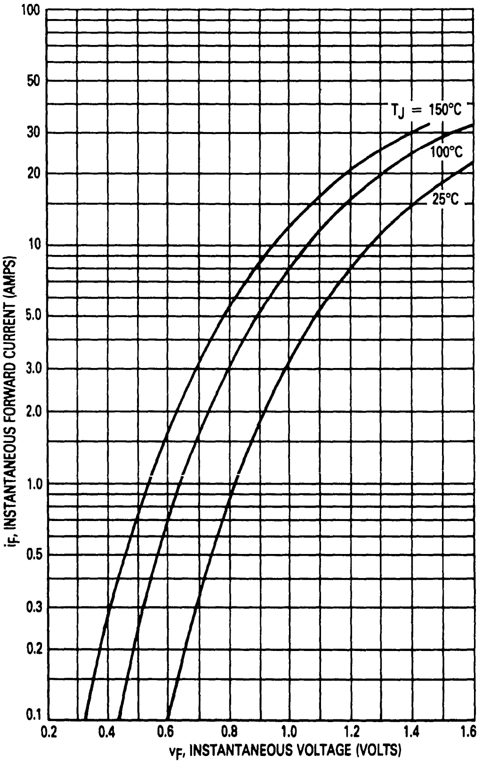
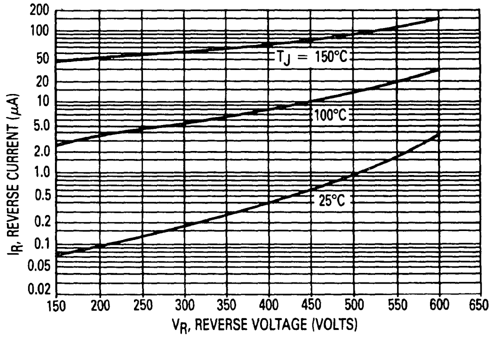


FIGURE 12 — TYPICAL REVERSE CURRENT*



*The curves shown are typical for the highest voltage device in the voltage grouping. Typical reverse current for lower voltage selections can be estimated from these same curves if V_R is sufficiently below rated V_R.

FIGURE 13 — CURRENT DERATING, CASE

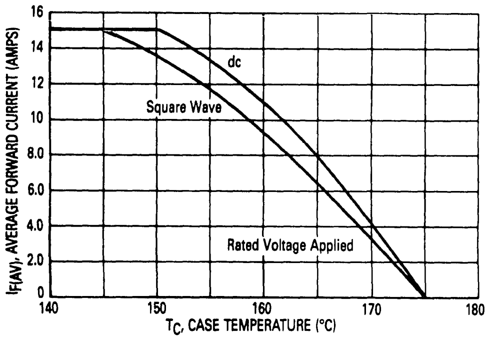


FIGURE 14 — CURRENT DERATING, AMBIENT

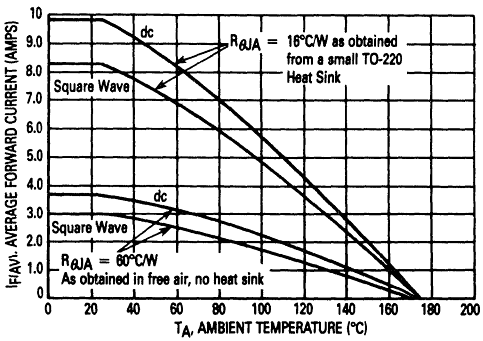


FIGURE 15 — POWER DISSIPATION

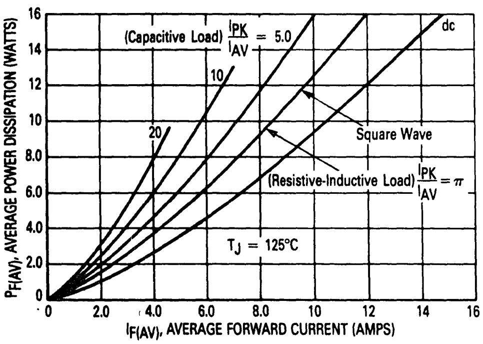


FIGURE 16 — THERMAL RESPONSE

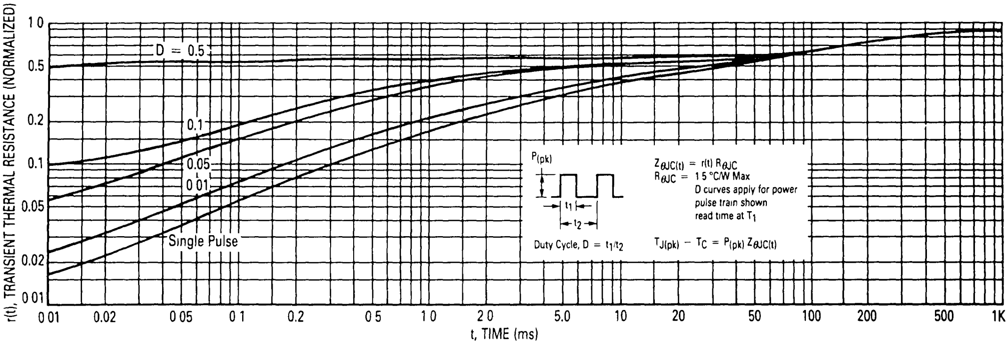


FIGURE 17 — TYPICAL CAPACITANCE

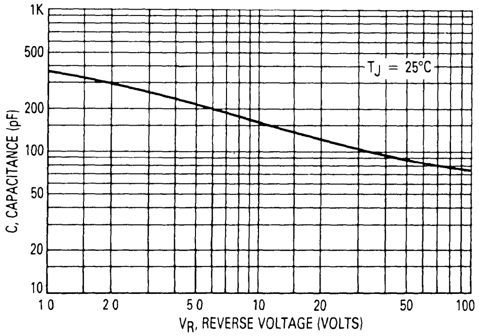
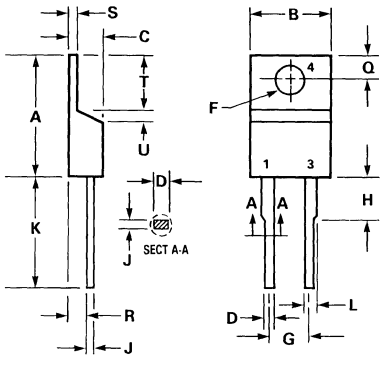


FIGURE 18 — OUTLINE DIMENSIONS



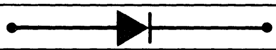
STYLE 1
PIN 1 CATHODE
2 N/A
3 ANODE
4 CATHODE

CASE 221B-01
TO-220AC
PLASTIC

DIM	MILLIMETERS		INCHES	
	MIN	MAX	MIN	MAX
A	15.11	15.75	0.595	0.620
B	9.65	10.29	0.380	0.405
C	4.06	4.82	0.160	0.190
D	0.64	0.89	0.025	0.035
F	3.61	3.73	0.142	0.147
G	4.83	5.33	0.190	0.210
H	2.79	3.30	0.110	0.130
J	0.36	0.56	0.014	0.022
K	12.70	14.27	0.500	0.562
L	1.14	1.27	0.045	0.050
Q	2.54	3.04	0.100	0.120
R	2.04	2.79	0.080	0.110
S	1.14	1.39	0.045	0.055
T	5.97	6.48	0.235	0.255
U	0.76	1.27	0.030	0.050

MOTOROLA
SEMICONDUCTOR
TECHNICAL DATA

MUR1605CT MUR1630CT
MUR1610CT MUR1640CT
MUR1615CT MUR1650CT
MUR1620CT MUR1660CT



SWITCHMODE POWER RECTIFIERS

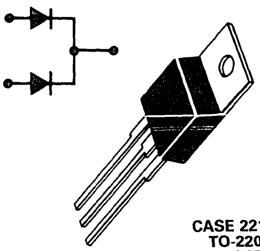
. . . designed for use in switching power supplies, inverters and as free wheeling diodes, these state-of-the-art devices have the following features:

- Ultrafast 35 and 60 Nanosecond Recovery Times
- 175°C Operating Junction Temperature
- Popular TO-220 Package
- Epoxy meets UL94, V_O @ ⅛″
- High Temperature Glass Passivated Junction
- High Voltage Capability to 600 Volts
- Low Leakage Specified @ 150°C Case Temperature
- Current Derating @ Both Case and Ambient Temperatures

ULTRAFAST RECTIFIERS

8 AMPERES
50–600 VOLTS

3



CASE 221A-04
TO-220AB
PLASTIC

MAXIMUM RATINGS

Rating	Symbol	MUR 1605CT	1610CT	1615CT	1620CT	1630CT	1640CT	1650CT	1660CT	Unit
Peak Repetitive Reverse Voltage Working Peak Reverse Voltage DC Blocking Voltage	V_{RRM} V_{RWM} V_R	50	100	150	200	300	400	500	600	Volts
Average Rectified Forward Current Per Leg Total Device, (Rated V_R), T_C = 150°C Total Device	$I_{F(AV)}$	8.0 16								Amps
Peak Repetitive Forward Current Per Diode Leg (Rated V_R, Square Wave, 20 kHz), T_C = 150°C	I_{FM}	16								Amps
Nonrepetitive Peak Surge Current (Surge applied at rated load conditions halfwave, single phase, 60 Hz)	I_{FSM}	100								Amps
Operating Junction Temperature and Storage Temperature	T_J, T_{stg}	−65 to +175								°C

THERMAL CHARACTERISTICS, PER DIODE LEG

Characteristic	Symbol	1605CT	1610CT	1615CT	1620CT	1630CT	1640CT	1650CT	1660CT	Unit
Maximum Thermal Resistance, Junction to Case	$R_{\theta JC}$	3.0				2.0				°C/W

ELECTRICAL CHARACTERISTICS, PER DIODE LEG

Characteristic	Symbol	1605CT	1610CT	1615CT	1620CT	1630CT	1640CT	1650CT	1660CT	Unit
Maximum Instantaneous Forward Voltage (1) (i_F = 8.0 Amp, T_C = 150°C) (i_F = 8.0 Amp, T_C = 25°C)	v_F	0.895 0.975				1.00 1.30		1.20 1.50		Volts
Maximum Instantaneous Reverse Current (1) (Rated dc Voltage, T_C = 150°C) (Rated dc Voltage, T_C = 25°C)	i_R	250 5.0				500 10		500 10		μA
Maximum Reverse Recovery Time (I_F = 1.0 Amp, di/dt = 50 Amp/μs) (I_F = 0.5 Amp, i_R = 1.0 Amp, I_{REC} = 0.25 Amp)	t_{rr}	35 25				60 50				ns

(1)Pulse Test: Pulse Width = 300 μs, Duty Cycle ≤2.0%

MUR1605CT, 1610CT AND 1615CT

FIGURE 1 — TYPICAL FORWARD VOLTAGE, PER LEG

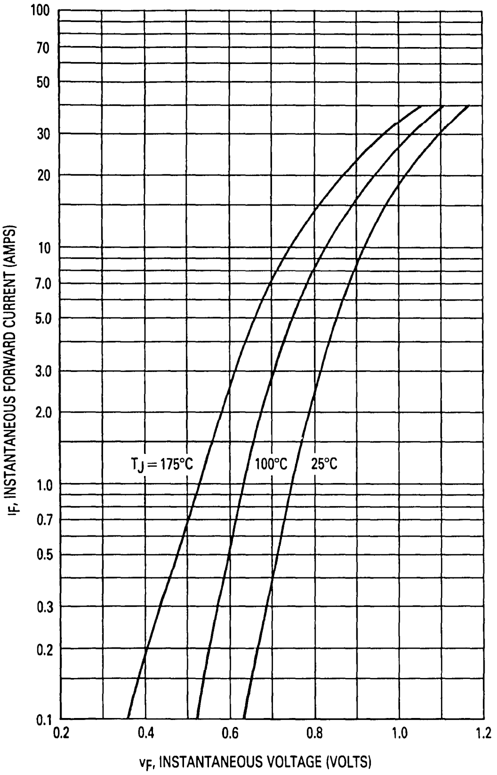


FIGURE 2 — TYPICAL REVERSE CURRENT, PER LEG*

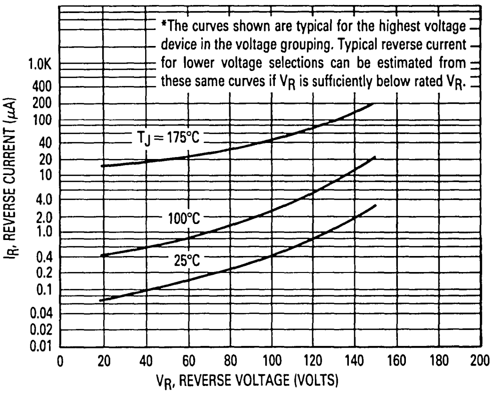


FIGURE 3 — CURRENT DERATING CASE, PER LEG

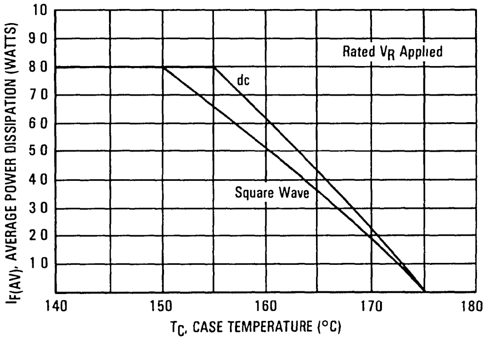


FIGURE 4 — CURRENT DERATING, AMBIENT, PER LEG

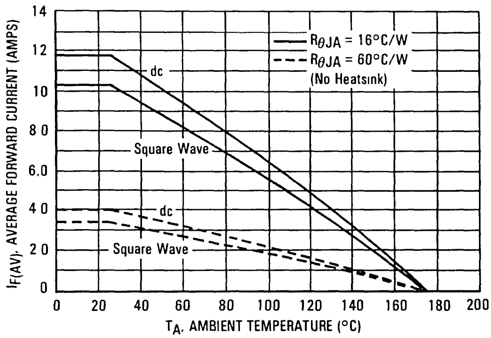
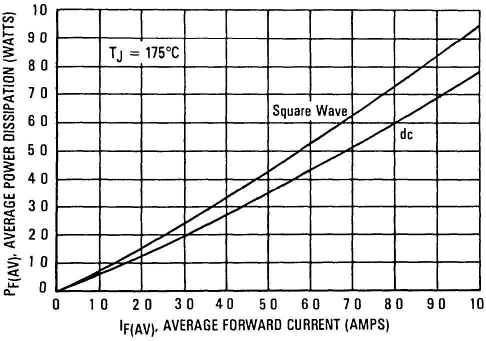


FIGURE 5 — POWER DISSIPATION, PER LEG



3

MUR1620CT, 1630CT AND 1640CT

FIGURE 6 — TYPICAL FORWARD VOLTAGE, PER LEG

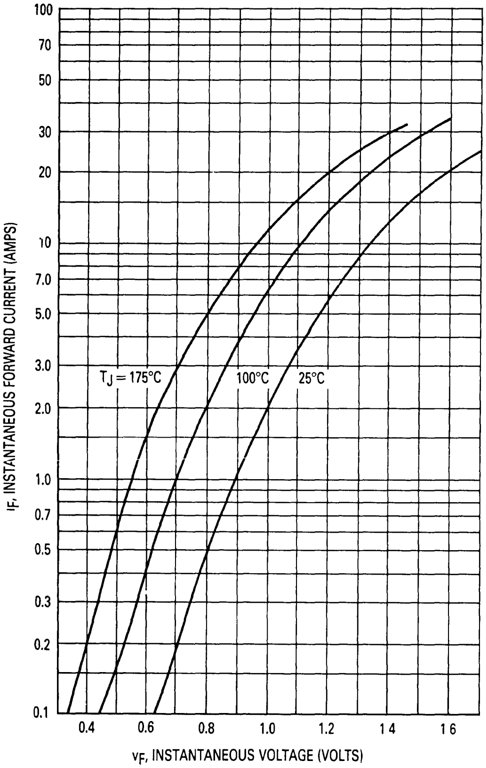


FIGURE 7 — TYPICAL REVERSE CURRENT, PER LEG*

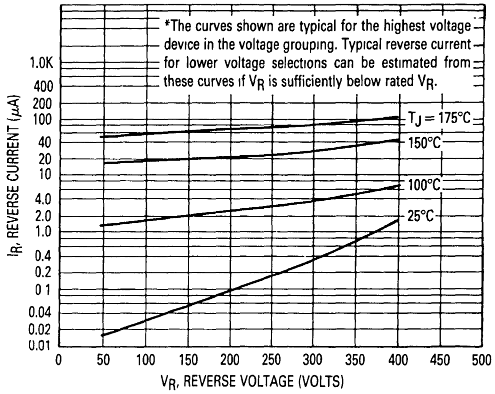


FIGURE 8 — CURRENT DERATING, CASE, PER LEG

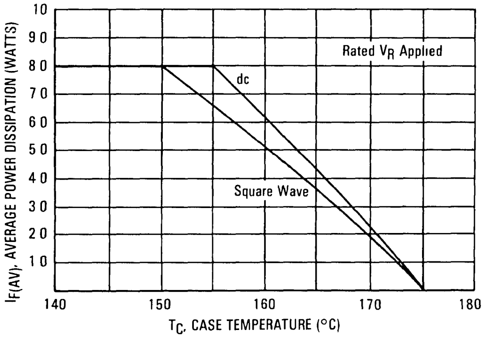


FIGURE 9 — CURRENT DERATING, AMBIENT, PER LEG

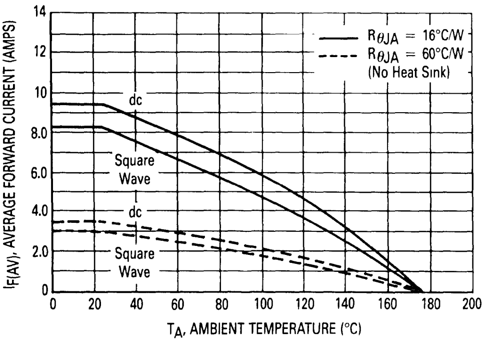
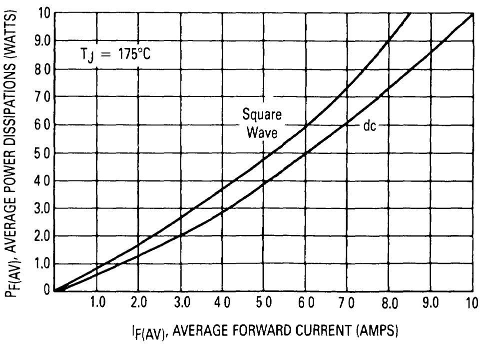


FIGURE 10 — POWER DISSIPATION, PER LEG



MUR1650CT AND 1660CT

FIGURE 11 — TYPICAL FORWARD VOLTAGE, PER LEG

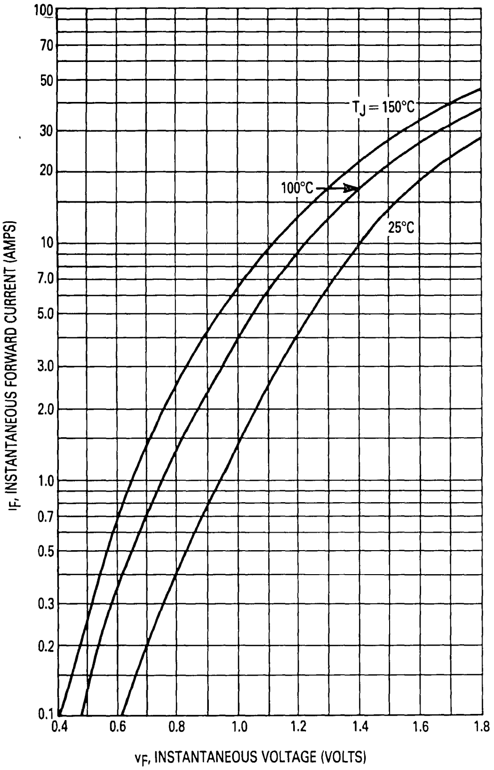


FIGURE 12 — TYPICAL REVERSE CURRENT, PER LEG*

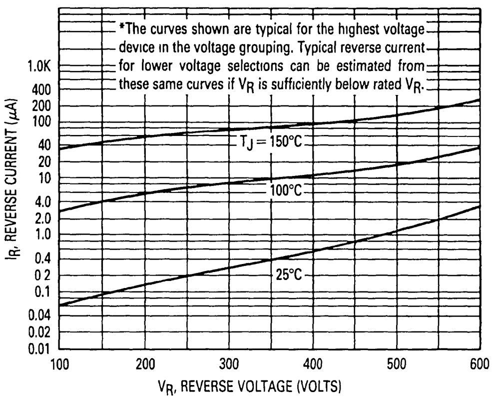


FIGURE 13 — CURRENT DERATING, CASE, PER LEG

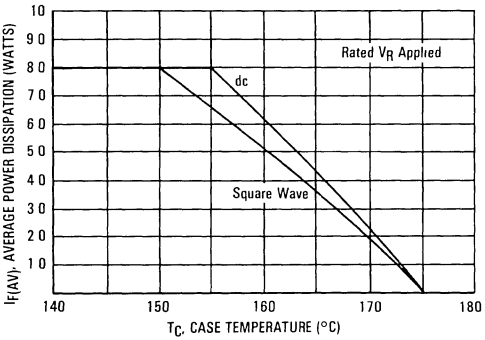


FIGURE 14 — CURRENT DERATING, AMBIENT, PER LEG

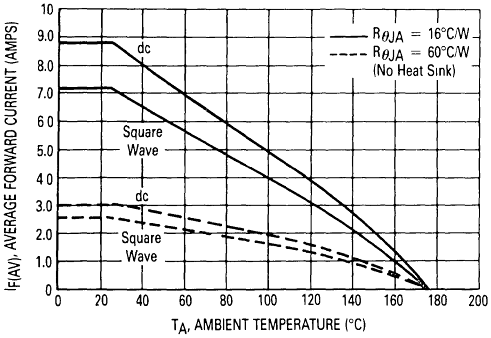


FIGURE 15 — POWER DISSIPATION, PER LEG

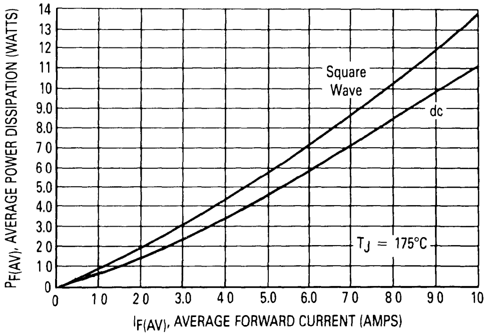


FIGURE 16 — THERMAL RESPONSE

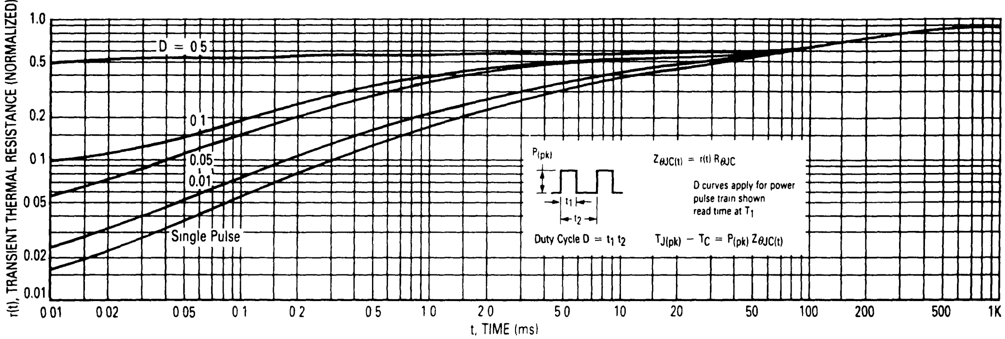
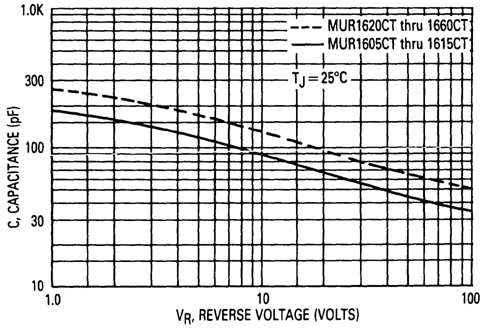
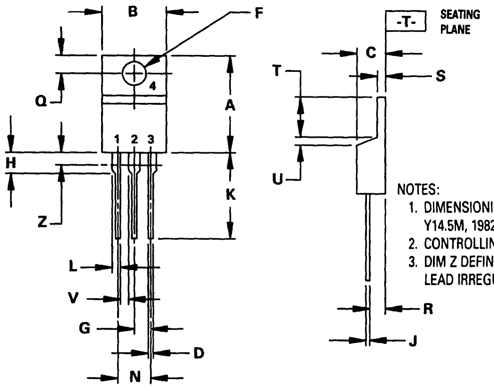


FIGURE 17 — TYPICAL CAPACITANCE, PER LEG



OUTLINE DIMENSIONS



STYLE 6:
PIN 1. ANODE
2. CATHODE
3. ANODE
4. CATHODE

NOTES:
1. DIMENSIONING AND TOLERANCING PER ANSI Y14.5M, 1982.
2. CONTROLLING DIMENSION: INCH.
3. DIM Z DEFINES A ZONE WHERE ALL BODY AND LEAD IRREGULARITIES ARE ALLOWED.

CASE 221A-04
TO-220AB
PLASTIC

DIM	MILLIMETERS		INCHES	
	MIN	MAX	MIN	MAX
A	14.48	15.75	0 570	0 620
B	9 66	10.28	0.380	0.405
C	4.07	4 82	0 160	0 190
D	0.64	0.88	0.025	0 035
F	3 61	3.73	0.142	0 147
G	2.42	2.66	0.095	0 105
H	2 80	3.93	0.110	0 155
J	0.36	0.55	0 014	0.022
K	12.70	14 27	0 500	0.562
L	1.15	1.39	0.045	0 055
N	4 83	5.33	0.190	0.210
Q	2.54	3 04	0.100	0.120
R	2.04	2 79	0.080	0.110
S	1.15	1.39	0.045	0.055
T	5.97	6 47	0 235	0.255
U	0.00	1.27	0 000	0.050
V	1.15	—	0.045	—
Z	—	2.04	—	0 080

MOTOROLA
SEMICONDUCTOR
TECHNICAL DATA

MUR2505
MUR2510
MUR2515
MUR2520

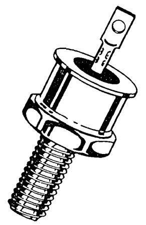
SWITCHMODE POWER RECTIFIERS

designed for use in switching power supplies, inverters and as free wheeling diodes, these state-of-the-art devices have the following features

- Ultrafast 50 Nanosecond Recovery Time
- Low Forward Voltage Drop
- Hermetically Sealed Metal DO-203AA (DO-4) Package

ULTRAFAST RECTIFIERS

25 AMPERES
50 to 200 VOLTS



3

MAXIMUM RATINGS

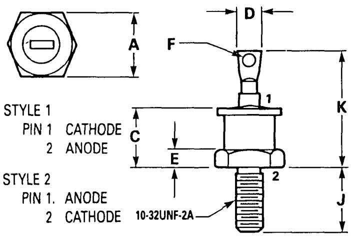
Rating	Symbol	MUR 2505	MUR 2510	MUR 2515	MUR 2520	Unit
Peak Repetitive Reverse Voltage Working Peak Reverse Voltage DC Blocking Voltage	V_{RRM} V_{RWM} V_R	50	100	150	200	Volts
Nonrepetitive Peak Reverse Voltage	V_{RSM}	55	110	165	220	Volts
Average Forward Current $T_C = 145°C$	$I_{F(AV)}$	25				Amps
Nonrepetitive Peak Surge Forward Current (half cycle, 60 Hz, Sinusoidal Waveform)	I_{FSM}	500				Amps
Operating Junction and Storage Temperature	T_J, T_{stg}	-65 to +175				°C

THERMAL CHARACTERISTICS

Rating	Symbol	All Devices	Unit
Thermal Resistance, Junction to Case	$R_{\theta JC}$	1 3	°C/W

ELECTRICAL CHARACTERISTICS

Maximum Instantaneous Forward Voltage Drop (i_F = 25 Amp, T_J = 25°C) (i_F = 25 Amp, T_J = 125°C) (i_F = 50 Amp, T_J = 125°C)	v_F	 0 95 0 80 0 88	Volts
Maximum Reverse Current @ DC Voltage (T_J = 25°C) (T_J = 125°C)	I_R	 10 1 0	 μA mA
Maximum Reverse Recovery Time (I_F = 1 0 Amp, di/dt = 50 Amp/μs, V_R = 30 V, T_J = 25°C)	t_{rr}	50	ns



NOTES
1 DIMENSIONING AND TOLERANCING PER ANSI Y14.5M, 1982.
2. CONTROLLING DIMENSION: INCH

DIM	MILLIMETERS MIN	MILLIMETERS MAX	INCHES MIN	INCHES MAX
A	10 75	11 12	0.423	0.438
C	—	10.28	—	0 405
D	4 07	4 69	0.160	0.185
E	1 91	4 44	0.075	0.175
F	2.29	2.41	0 090	0 095
J	10 72	11 50	0.422	0.453
K	18.80	20.32	0.740	0.800

CASE 245A-02
DO-203AA
METAL

MECHANICAL CHARACTERISTICS
CASE: Welded, hermetically sealed
FINISH: All external surface corrosion resistant and terminal leads are readily solderable
POLARITY: Cathode to Case
MOUNTING POSITIONS: Any
MOUNTING TORQUE: 15 in-lb max

3

FIGURE 1 — TYPICAL FORWARD VOLTAGE

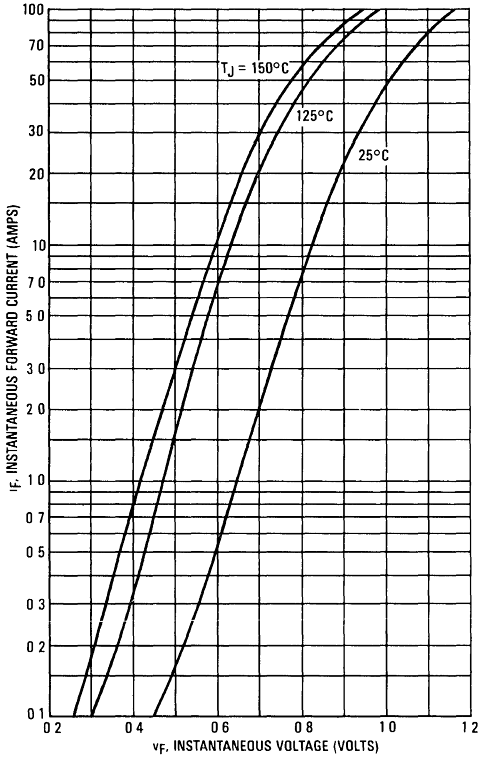
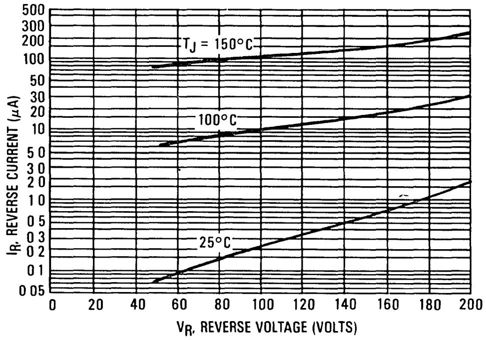


FIGURE 2 — TYPICAL REVERSE CURRENT*



*The curves shown are typical for the highest voltage device in the voltage grouping Typical reverse current for lower voltage selections can be estimated from these same curves if V_R is sufficiently below rated V_R

FIGURE 3 — CURRENT DERATING, CASE

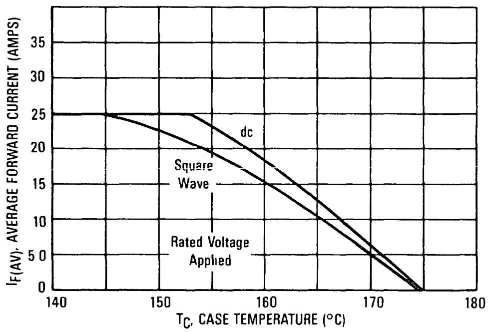


FIGURE 4 — POWER DISSIPATION

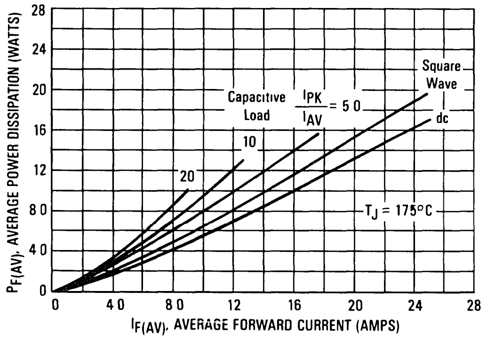


FIGURE 5 — TYPICAL CAPACITANCE

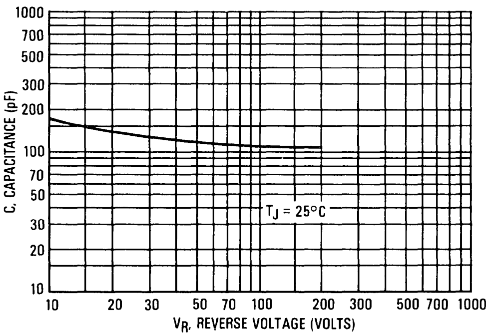
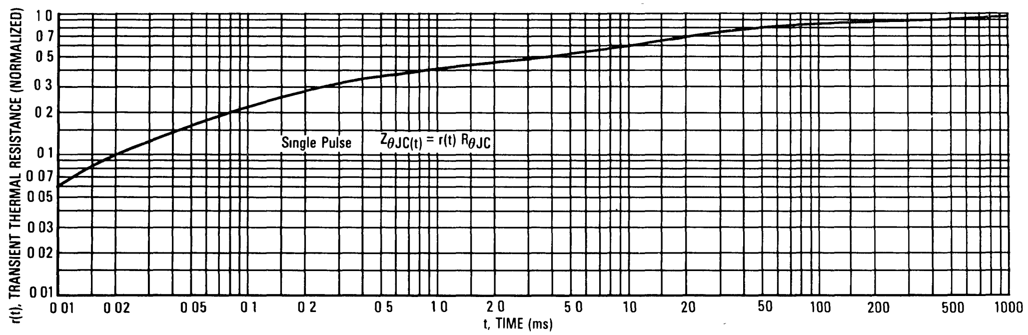


FIGURE 6 — THERMAL RESPONSE



MOTOROLA
SEMICONDUCTOR
TECHNICAL DATA

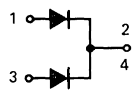
MUR3005PT thru MUR3060PT

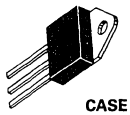
Switchmode Power Rectifiers

. . . designed for use in switching power supplies, inverters and as free wheeling diodes, these state-of-the-art devices have the following features:

- Ultrafast 35 and 60 Nanosecond Recovery Time
- 175°C Operating Junction Temperature
- Popular TO-218 Package
- High Voltage Capability to 600 Volts
- Low Forward Drop
- Low Leakage Specified @ 150°C Case Temperature
- Current Derating Specified @ Both Case and Ambient Temperatures
- Epoxy Meets UL94, V_O @ 1/8″
- High Temperature Glass Passivated Junction

ULTRAFAST RECTIFIERS
30 AMPERES
50–600 VOLTS





CASE 340-02
TO-218AC
PLASTIC

3

MAXIMUM RATINGS

Rating	Symbol	MUR 3005PT	3010PT	3015PT	3020PT	3030PT	3040PT	3050PT	3060PT	Unit
Peak Repetitive Reverse Voltage Working Peak Reverse Voltage DC Blocking Voltage	V_{RRM} V_{RWM} V_R	50	100	150	200	300	400	500	600	Volts
Average Rectified Forward Current (Rated V_R) Per Leg Per Device	$I_{F(AV)}$	15 30 T_C = 150°C						15 30 T_C = 145°C		Amps
Peak Repetitive Forward Current, Per Leg (Rated V_R, Square Wave, 20 kHz), T_C = 150°C	I_{FRM}	30 @ T_C = 150°C						30 @ T_C = 145°C		Amps
Nonrepetitive Peak Surge Current (Surge applied at rated load conditions halfwave, single phase, 60 Hz) Per Leg	I_{FSM}	200				150				Amps
Operating Junction Temperature and Storage Temperature	T_J, T_{stg}	−65 to +175								°C

THERMAL CHARACTERISTICS PER DIODE LEG

Characteristic	Symbol	Value	Unit
Maximum Thermal Resistance, Junction to Case	$R_{\theta JC}$	1.5	°C/W
Junction to Ambient	$R_{\theta JA}$	40	°C/W

ELECTRICAL CHARACTERISTICS PER DIODE LEG

Characteristic	Symbol	3005PT	3010PT	3015PT	3020PT	3030PT	3040PT	3050PT	3060PT	Unit
Maximum Instantaneous Forward Voltage (1) (i_F = 15 Amps, T_C = 150°C) (i_F = 15 Amps, T_C = 25°C)	v_F	0.85 1.05				1.12 1.25		1.2 1.5		Volts
Maximum Instantaneous Reverse Current (1) (Rated dc Voltage, T_C = 150°C) (Rated dc Voltage, T_C = 25°C)	i_R	500 10						1000 10		μA
Maximum Reverse Recovery Time (I_F = 1 Amp, di/dt = 50 Amps/μs)	t_{rr}	35				60				ns

(1) Pulse Test: Pulse Width = 300 μs, Duty Cycle ≤ 2%.

MUR3005PT, 3010PT, and 3015PT

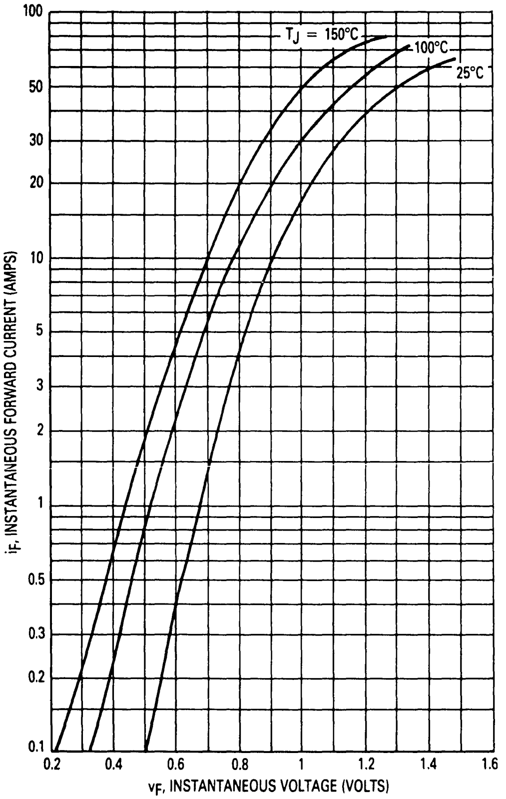
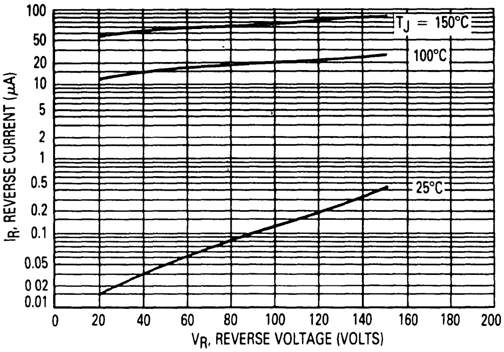


Figure 1. Typical Forward Voltage (Per Leg)



*The curves shown are typical for the highest voltage device in the voltage grouping Typical reverse current for lower voltage selections can be estimated from these same curves if V_R is sufficiently below rated V_R.

Figure 2. Typical Reverse Current (Per Leg)*

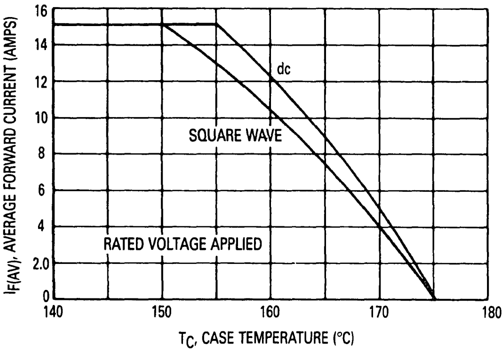


Figure 3. Current Derating, Case (Per Leg)

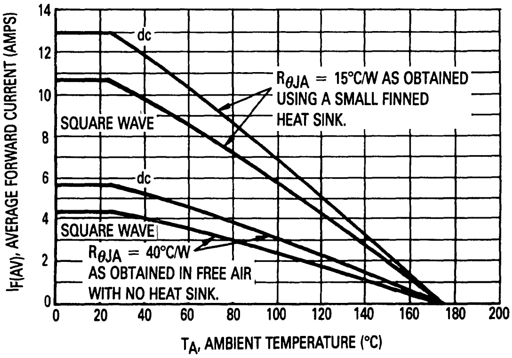


Figure 4. Current Derating, Ambient (Per Leg)

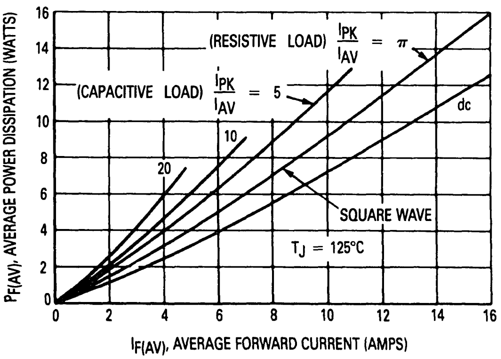


Figure 5. Power Dissipation (Per Leg)

MUR3020PT,3030PT, and 3040PT

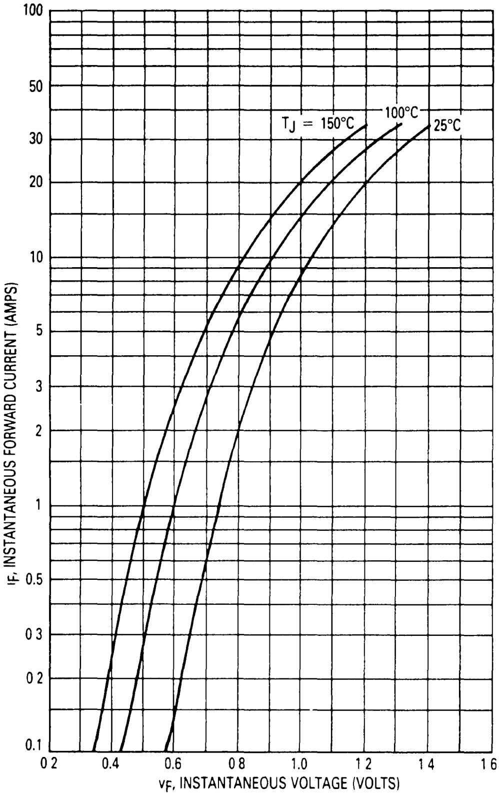
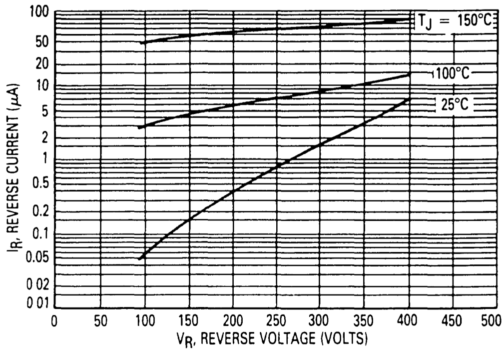


Figure 6. Typical Forward Voltage (Per Leg)



*The curves shown are typical for the highest voltage device in the voltage grouping Typical reverse current for lower voltage selections can be estimated from these same curves if V_R is sufficiently below rated V_R

Figure 7. Typical Reverse Current (Per Leg)*

3

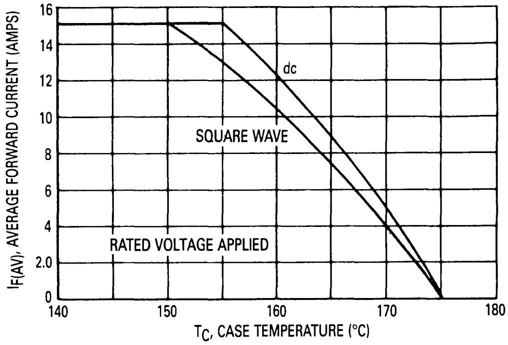


Figure 8. Current Derating, Case (Per Leg)

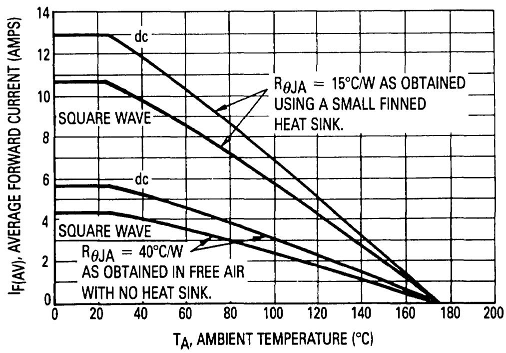


Figure 9. Current Derating, Ambient (Per Leg)

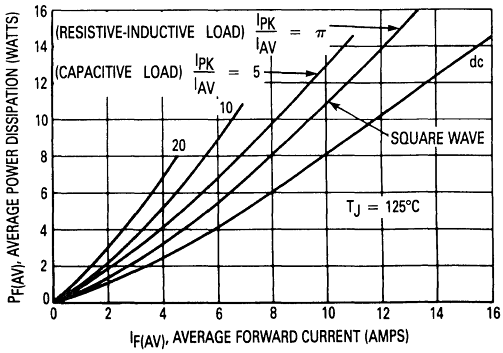


Figure 10. Power Dissipation (Per Leg)

MUR3050PT and MUR3060PT

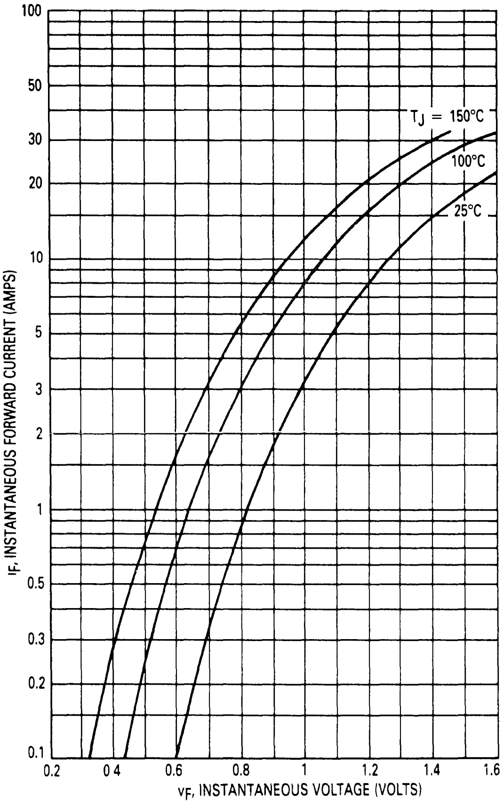
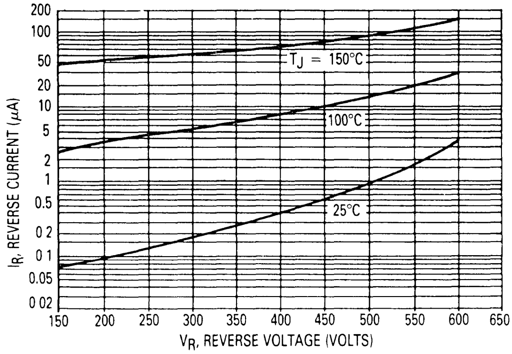


Figure 11. Typical Forward Voltage



*The curves shown are typical for the highest voltage device in the voltage grouping Typical reverse current for lower voltage selections can be estimated from these same curves if V_R is sufficiently below rated V_R

Figure 12. Typical Reverse Current*

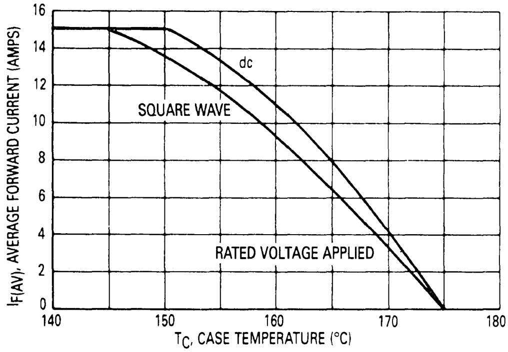


Figure 13. Current Derating, Case

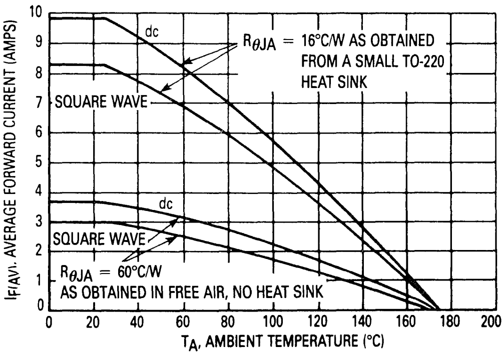


Figure 14. Current Derating, Ambient

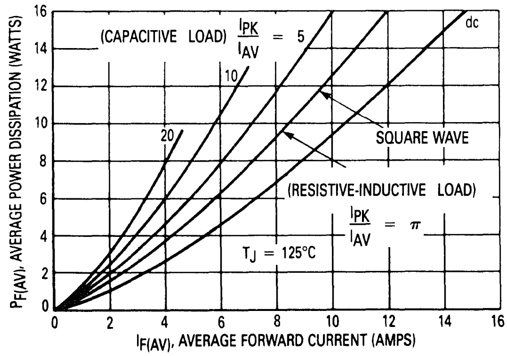


Figure 15. Power Dissipation

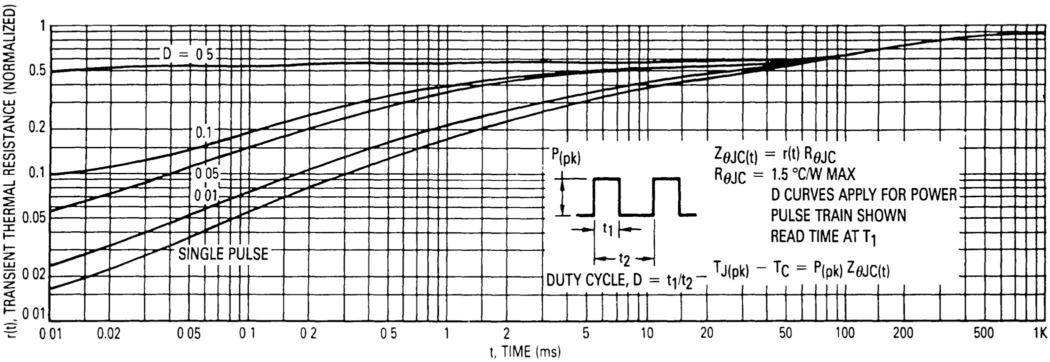


Figure 16. Thermal Response

3

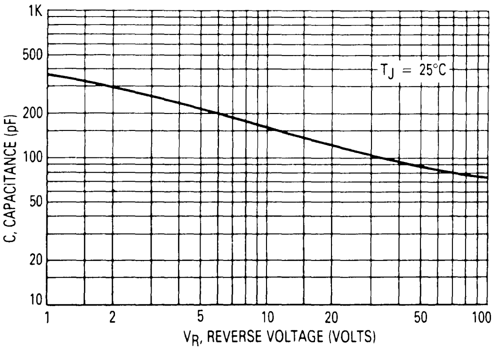
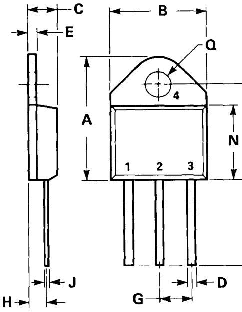


Figure 17. Typical Capacitance (Per Leg)

OUTLINE DIMENSIONS



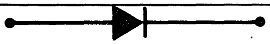
CASE 340-02
TO-218AC
PLASTIC

NOTES
1 DIMENSIONING AND TOLERANCING PER ANSI Y14.5M, 1982
2 CONTROLLING DIMENSION INCH

DIM	MILLIMETERS MIN	MILLIMETERS MAX	INCHES MIN	INCHES MAX
A	20.32	21.08	0.800	0.830
B	15.49	15.90	0.610	0.626
C	4.19	5.08	0.165	0.200
D	1.02	1.65	0.040	0.065
E	1.35	1.65	0.053	0.065
G	5.21	5.72	0.205	0.225
H	2.65	2.94	0.104	0.116
J	0.38	0.64	0.015	0.025
K	12.70	15.49	0.500	0.610
L	15.88	16.51	0.625	0.650
N	12.19	12.70	0.480	0.500
Q	4.04	4.22	0.159	0.166

MOTOROLA
SEMICONDUCTOR
TECHNICAL DATA

MUR5005
MUR5010
MUR5015
MUR5020



ULTRAFAST RECTIFIERS

50 AMPERES
50 to 200 VOLTS

SWITCHMODE POWER RECTIFIERS

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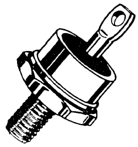
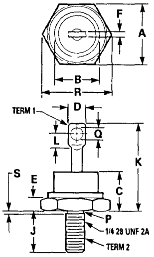
- Low Forward Voltage Drop
- Hermetically Sealed Metal DO-203AB Package





NOTES
1 DIM "P" IS DIA
2 CHAMFER OR UNDERCUT ON ONE OR BOTH ENDS OF HEXAGONAL BASE IS OPTIONAL
3 ANGULAR ORIENTATION AND CONTOUR OF TERMINAL ONE IS OPTIONAL
4 THREADS ARE PLATED
5 DIMENSIONING AND TOLERANCING PER ANSI Y14 5, 1973

DIM	MILLIMETERS MIN	MILLIMETERS MAX	INCHES MIN	INCHES MAX
A	16 94	17 45	0 669	0 687
B	—	16 94	—	0 667
C	—	11 43	—	0 450
D	—	9 53	—	0 375
E	2 92	5 08	0 115	0 200
F	—	2 03	—	0 080
J	10 72	11 51	0 422	0 453
K	—	25 40	—	1 000
L	3 86	—	0 156	—
P	5 59	6 32	0 220	0 249
Q	3 56	4 45	0 140	0 175
R	—	20 16	—	0 794
S	—	2 26	—	0 089

CASE 257-01
DO-203AB
METAL

MAXIMUM RATINGS

Rating	Symbol	MUR 5005	5010	5015	5020	Unit
Peak Repetitive Reverse Voltage Working Peak Reverse Voltage DC Blocking Voltage	V_{RRM} V_{RWM} V_R	50	100	150	200	Volts
Nonrepetitive Peak Reverse Voltage	V_{RSM}	55	110	165	220	Volts
Average Forward Current T_C = 125°C	$I_{F(AV)}$	50				Amps
Nonrepetitive Peak Surge Forward Current (half cycle, 60 Hz, Sinusoidal Waveform)	I_{FSM}	600				Amps
Operating Junction and Storage Temperature	T_J, T_{stg}	-55 to +175				°C

THERMAL CHARACTERISTICS

Rating	Symbol	All Devices	Unit
Thermal Resistance, Junction to Case	$R_{\theta JC}$	1 0	°C/W

ELECTRICAL CHARACTERISTICS

Maximum Instantaneous Forward Voltage Drop (i_F = 50 Amp, T_J = 25°C) (i_F = 50 Amp, T_J = 125°C) (i_F = 100 Amp, T_J = 125°C)	v_F	 1 15 0 95 1 10	Volts
Maximum Reverse Current @ DC Voltage (T_J = 25°C) (T_J = 125°C)	I_R	 10 1 0	 μA mA
Maximum Reverse Recovery Time (I_F = 1 0 Amp, di/dt = 50 Amp/μs, V_R = 30 V, T_J = 25°C)	t_{rr}	50	ns

MECHANICAL CHARACTERISTICS
CASE: Welded, hermetically sealed
FINISH: All external surface corrosion resistant and terminal leads are readily solderable
POLARITY: Cathode to Case
MOUNTING POSITIONS: Any
MOUNTING TORQUE: 25 in-lb max

FIGURE 1 — TYPICAL FORWARD VOLTAGE

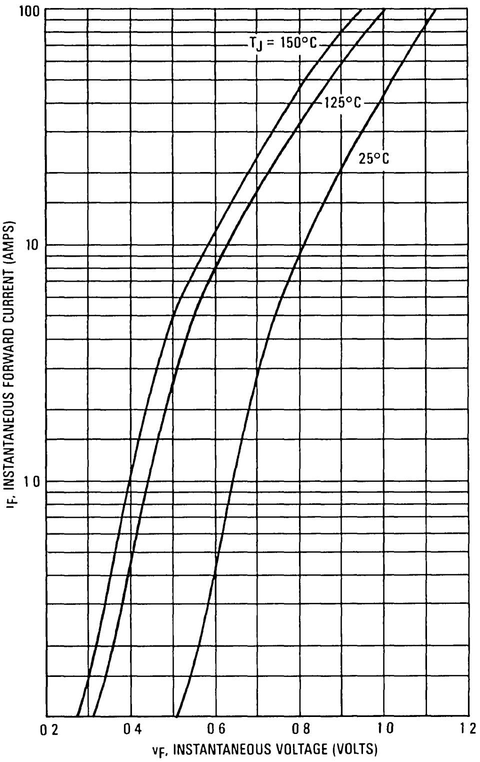
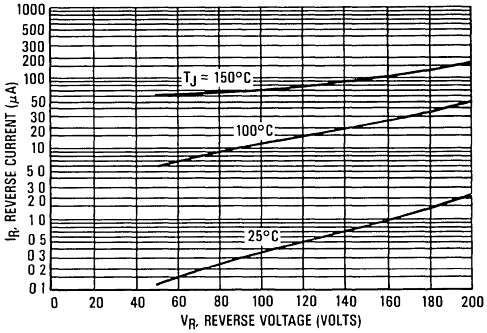


FIGURE 2 — TYPICAL REVERSE CURRENT*



*The curves shown are typical for the highest voltage device in the voltage grouping. Typical reverse current for lower voltage selections can be estimated from these same curves if V_R is sufficiently below rated V_R

FIGURE 3 — CURRENT DERATING, CASE

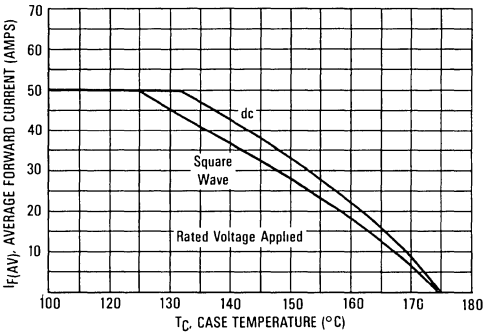


FIGURE 4 — POWER DISSIPATION

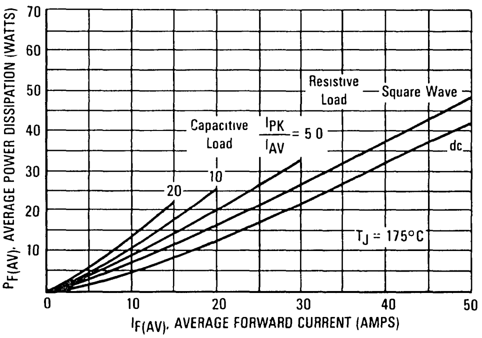


FIGURE 5 — TYPICAL CAPACITANCE

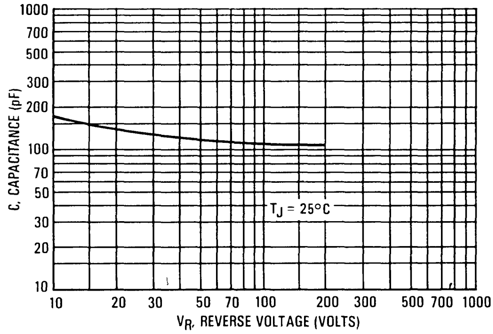
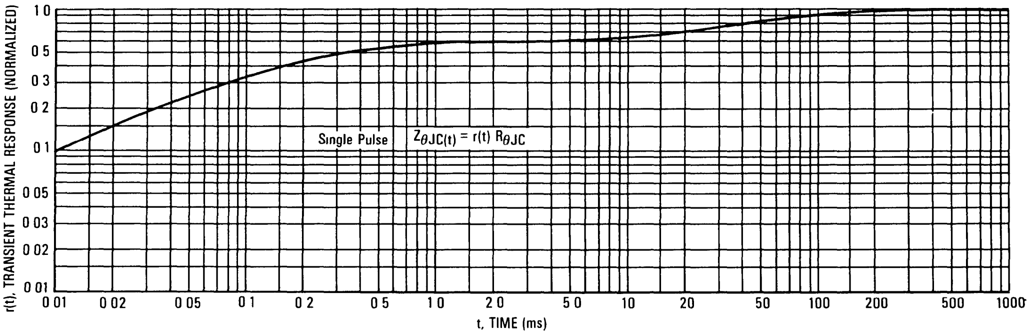


FIGURE 6 — THERMAL RESPONSE



MOTOROLA
SEMICONDUCTOR
TECHNICAL DATA

MUR7005
MUR7010
MUR7015
MUR7020

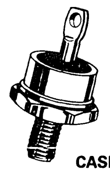
Switchmode Power Rectifiers

. . . designed for use in switching power supplies, inverters and as free wheeling diodes, these state-of-the-art devices have the following features:

- Ultrafast 50 Nanosecond Recovery Time
- Low Forward Voltage Drop
- Hermetically Sealed Metal DO-203AB (DO-5) Package

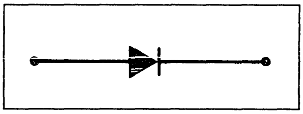
Mechanical Characteristics
Case: Welded, hermetically sealed
Finish: All external surface corrosion resistant and terminal leads are readily solderable
Polarity: Cathode to Case
Mounting Positions: Any
Mounting Torque: 25 in-lb max

ULTRAFAST RECTIFIERS
70 AMPERES
50 TO 200 VOLTS



CASE 257-01
DO-203AB

3



MAXIMUM RATINGS

Rating	Symbol	MUR 7005	MUR 7010	MUR 7015	MUR 7020	Unit
Peak Repetitive Reverse Voltage Working Peak Reverse Voltage DC Blocking Voltage	V_{RRM} V_{RWM} V_R	50	100	150	200	Volts
Nonrepetitive Peak Reverse Voltage	V_{RSM}	55	110	165	220	Volts
Average Forward Current $T_C = 125°C$	$I_{F(AV)}$	70				Amps
Nonrepetitive Peak Surge Forward Current (half cycle, 60 Hz, Sinusoidal Waveform)	I_{FSM}	1000				Amps
Operating Junction and Storage Temperature	T_J, T_{stg}	−55 to +175				°C

THERMAL CHARACTERISTICS

Rating	Symbol	All Devices	Unit
Thermal Resistance, Junction to Case	$R_{\theta JC}$	0.8	°C/W

ELECTRICAL CHARACTERISTICS

Maximum Instantaneous Forward Voltage Drop (i_F = 70 Amps, T_J = 25°C) (i_F = 70 Amps, T_J = 150°C)	v_F	 0.975 0.840	Volts
Maximum Reverse Current @ DC Voltage (T_J = 25°C) (T_J = 150°C)	I_R	 25 30	 μA mA
Maximum Reverse Recovery Time (I_F = 1 Amp, di/dt = 50 Amps/μs, V_R = 30 V, T_J = 25°C) (I_F = 0.5 Amp, i_R = 1 Amp, I_{REC} = 0.25 A, V_R = 30 V, T_J = 25°C)	t_{rr}	 60 50	ns

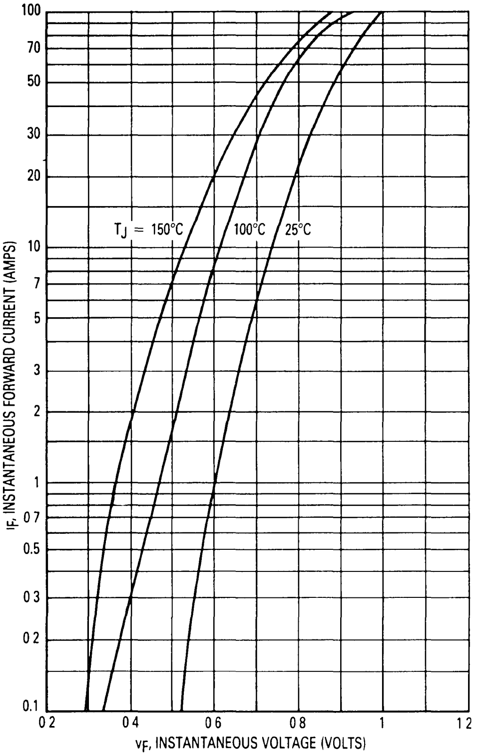


Figure 1. Typical Forward Voltage

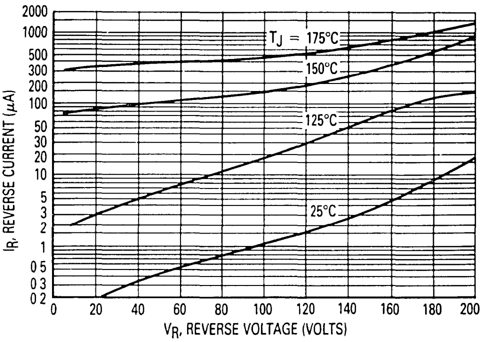


Figure 2. Typical Reverse Current*

*The curves shown are typical for the highest voltage device in the voltage grouping Typical reverse current for lower voltage selections can be estimated from these same curves if V_R is sufficiently below rated V_R

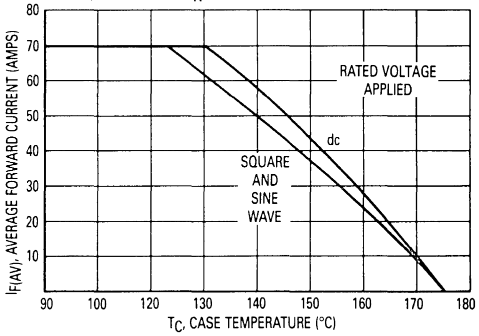


Figure 3. Current Derating, Case

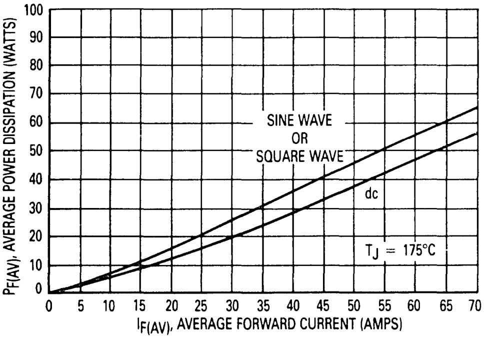


Figure 4. Average Power Dissipation

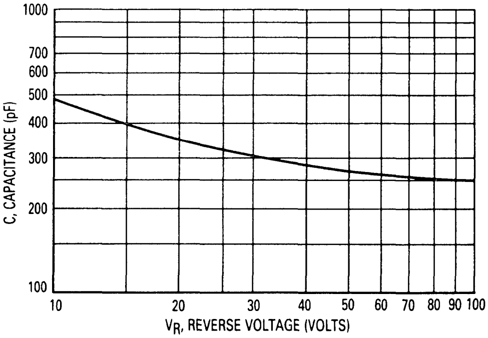


Figure 5. Typical Capacitance

3

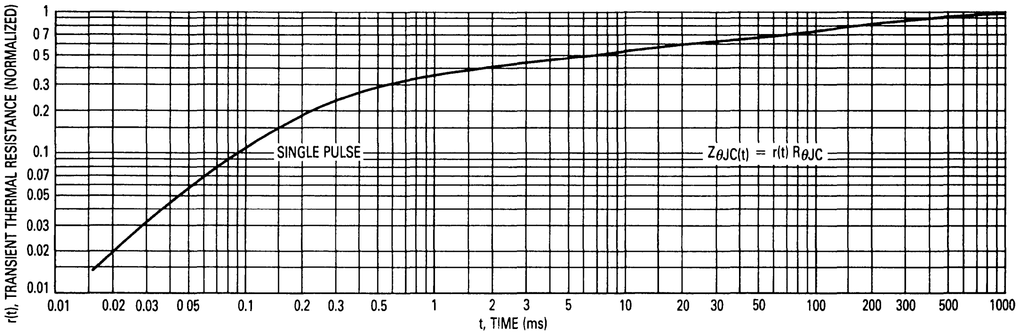
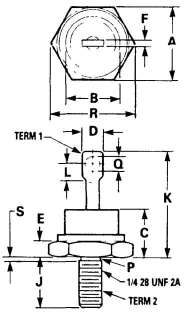


Figure 6. Thermal Response

OUTLINE DIMENSIONS



CASE 257-01
DO-203AB
(DO-5)

NOTES
1 DIM "P" IS DIA
2 CHAMFER OR UNDERCUT ON ONE OR BOTH ENDS OF HEXAGONAL BASE IS OPTIONAL
3 ANGULAR ORIENTATION AND CONTOUR OF TERMINAL ONE IS OPTIONAL
4 THREADS ARE PLATED
5 DIMENSIONING AND TOLERANCING PER ANSI Y14.5, 1973

DIM	MILLIMETERS		INCHES	
	MIN	MAX	MIN	MAX
A	16.94	17.45	0.669	0.687
B	—	16.94	—	0.667
C	—	11.43	—	0.450
D	—	9.53	—	0.375
E	2.92	5.08	0.115	0.200
F	—	2.03	—	0.080
J	10.72	11.51	0.422	0.453
K	—	25.40	—	1.000
L	3.86	—	0.156	—
P	5.59	6.32	0.220	0.249
Q	3.56	4.45	0.140	0.175
R	—	20.16	—	0.794
S	—	2.26	—	0.089

MOTOROLA
SEMICONDUCTOR
TECHNICAL DATA

MUR10005CT
MUR10010CT
MUR10015CT
MUR10020CT

Advance Information

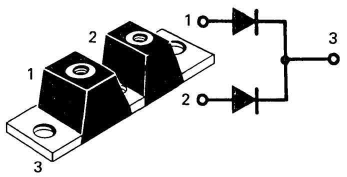
ULTRAFAST SWITCHMODE POWER RECTIFIERS

. . . designed for use in switching power supplies, inverters, and as free wheeling diodes. These state-of-the-art devices have the following features:

- Dual Diode Construction
- Low Leakage Current
- Low Forward Voltage
- 175°C Operating Junction Temperature
- Labor Saving POWERTAP® Package

ULTRAFAST RECTIFIERS

100 AMPERES
50 TO 200 VOLTS



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MAXIMUM RATINGS

Rating	Symbol	MUR 10005CT	MUR 10010CT	MUR 10015CT	MUR 10020CT	Unit
Peak Repetitive Reverse Voltage Working Peak Reverse Voltage DC Blocking Voltage	V_{RRM} V_{RWM} V_R	50	100	150	200	Volts
Average Rectified Forward Current, (Rated V_R), $T_C = 140°C$ Per Device Per Leg	$I_{F(AV)}$		100 50			Amps
Peak Repetitive Forward Current, Per Leg, (Rated V_R, Square Wave, 20 kHz), $T_C = 140°C$	I_{FRM}		100			Amps
Nonrepetitive Peak Surge Current Per Leg (Surge applied at rated load conditions halfwave, single phase, 60 Hz)	I_{FSM}		400			Amps
Operating Junction and Storage Temperature	T_J, T_{stg}		−65 to +175			°C

THERMAL CHARACTERISTICS PER LEG

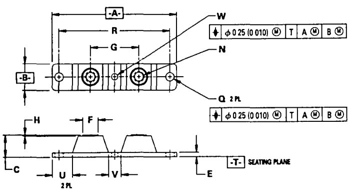
Rating	Symbol	Max	Unit
Thermal Resistance, Junction to Case	$R_{\theta JC}$	1.0	°C/W

ELECTRICAL CHARACTERISTICS PER LEG

Characteristic	Symbol	Max	Unit
Instantaneous Forward Voltage (1) (i_F = 50 Amp, T_C = 25°C)	v_F	1.10	Volts
Instantaneous Reverse Current (1) (Rated dc Voltage, T_C = 125°C) (Rated dc Voltage, T_C = 25°C)	i_R	 250 25	μA
Maximum Reverse Recovery Time (I_F = 1.0 Amps, di/dt = 50 Amps/μs)	t_{rr}	50	ns

(1) Pulse Test: Pulse Width = 300 μs, Duty Cycle ≤ 2.0%.

This document contains information on a new product Specifications and information herein are subject to change without notice



NOTES
1. DIMENSIONING AND TOLERANCING PER ANSI Y14.5M, 1982
2. CONTROLLING DIMENSION. INCH

	MILLIMETERS		INCHES	
DIM	MIN	MAX	MIN	MAX
A	87 63	92 20	3 450	3 630
B	17 78	20 57	0 700	0 810
C	15 63	16 00	0 615	0 630
E	3 05	3 30	0 120	0 130
F	11 05	11 30	0 435	0 445
G	34 80	35 05	1 370	1 380
H	0 18	0 68	0 007	0.027
N	1/4-20UNC-2B		1/4-20UNC-2B	
Q	6 86	7 23	0 270	0 285
R	80 01 BSC		3 150 BSC	
U	15 24	16 00	0 600	0 630
V	8 39	9 52	0 330	0 375
W	4 32	4 82	0 170	0 190

CASE 357C-01
POWER TAP

Terminal Penetration:	0.280 max
Terminal Torque:	25–40 in-lb max
Mounting Torque — Outside Holes:*	30–40 in-lb max
*Center Hole Must be Torqued First:	8–10 in-lb max

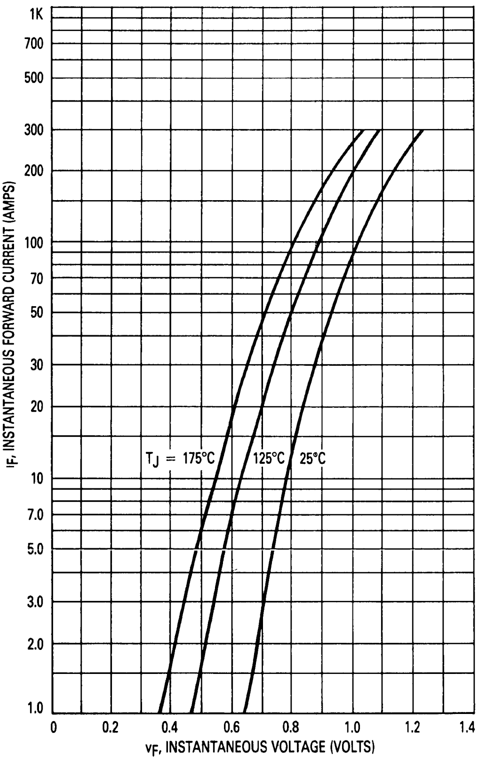


FIGURE 1 — FORWARD VOLTAGE

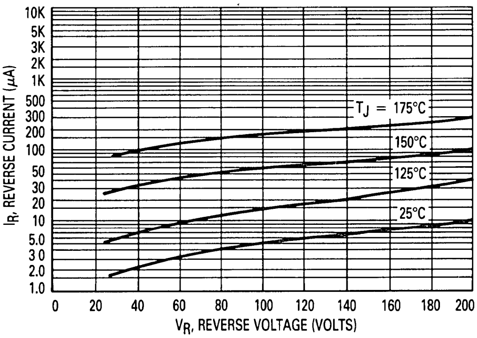


FIGURE 2 — TYPICAL REVERSE CURRENT*

*The curves shown are typical for the highest voltage device in the voltage grouping. Typical reverse current for lower voltage selections can be estimated from these same curves, if V_R is sufficiently below rated V_R.

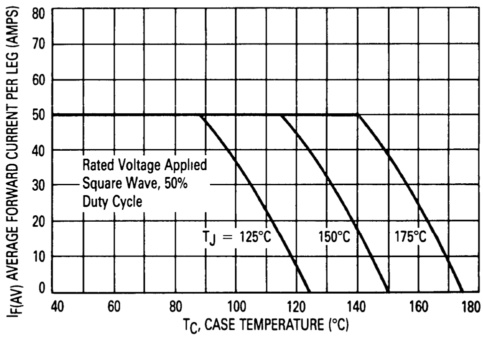


FIGURE 3 — CURRENT DERATING (PER LEG)

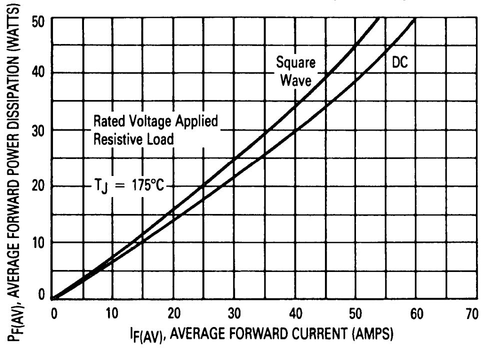


FIGURE 4 — POWER DISSIPATION (PER LEG)

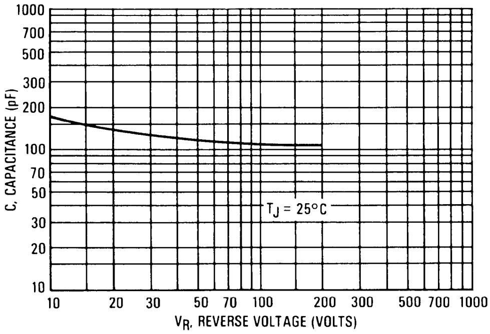


FIGURE 5 — CAPACITANCE (PER LEG)

MOTOROLA
SEMICONDUCTOR
TECHNICAL DATA

MUR20005CT
MUR20010CT
MUR20015CT
MUR20020CT

Advance Information

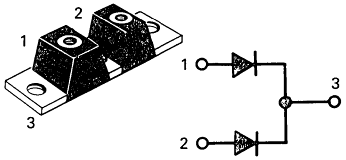
ULTRAFAST SWITCHMODE POWER RECTIFIERS

. . . designed for use in switching power supplies, inverters, and as free wheeling diodes. These state-of-the-art devices have the following features:

- Dual Diode Construction
- Low Leakage Current
- Low Forward Voltage
- 175°C Operating Junction Temperature
- Labor Saving PowerTap® Package

ULTRAFAST RECTIFIERS

200 AMPERES
50 TO 200 VOLTS



MAXIMUM RATINGS

Rating	Symbol	MUR 20005CT	MUR 20010CT	MUR 20015CT	MUR 20020CT	Unit
Peak Repetitive Reverse Voltage Working Peak Reverse Voltage DC Blocking Voltage	V_{RRM} V_{RWM} V_R	50	100	150	200	Volts
Average Rectified Forward Current, (Rated V_R), $T_C = 95°C$ Per Device Per Leg	$I_{F(AV)}$	200 100				Amps
Peak Repetitive Forward Current, Per Leg, (Rated V_R, Square Wave, 20 kHz), $T_C = 95°C$	I_{FRM}	200				Amps
Nonrepetitive Peak Surge Current Per Leg (Surge applied at rated load conditions halfwave, single phase, 60 Hz)	I_{FSM}	800				Amps
Operating Junction and Storage Temperature	T_J, T_{stg}	−65 to +175				°C

THERMAL CHARACTERISTICS PER LEG

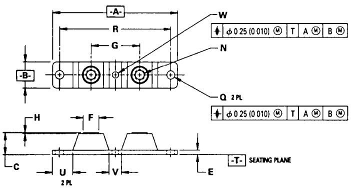
Rating	Symbol	Max	Unit
Thermal Resistance, Junction to Case	$R_{\theta JC}$	0.70	°C/W

ELECTRICAL CHARACTERISTICS PER LEG

Characteristic	Symbol	Max	Unit
Instantaneous Forward Voltage (1) (i_F = 100 Amp, T_C = 25°C)	v_F	1.25	Volts
Instantaneous Reverse Current (1) (Rated dc Voltage, T_C = 125°C) (Rated dc Voltage, T_C = 25°C)	i_R	 500 50	µA
Maximum Reverse Recovery Time (I_F = 1.0 Amps, di/dt = 50 Amps/µs)	t_{rr}	50	ns

(1) Pulse Test. Pulse Width = 300 µs, Duty Cycle ≤ 2 0%

This document contains information on a new product Specifications and information herein are subject to change without notice



NOTES
1 DIMENSIONING AND TOLERANCING PER ANSI Y14 5M, 1982
2 CONTROLLING DIMENSION INCH

DIM	MILLIMETERS MIN	MILLIMETERS MAX	INCHES MIN	INCHES MAX
A	87 63	92 20	3 450	3 630
B	17 78	20 57	0 700	0 810
C	15 63	16 00	0 615	0 630
E	3 05	3 30	0 120	0 130
F	11 05	11 30	0 435	0 445
G	34 80	35 05	1 370	1 380
H	0 18	0 68	0 007	0 027
N	1/4-20UNC-2B		1/4-20UNC-2B	
Q	6 86	7 23	0 270	0 285
R	80 01 BSC		3 150 BSC	
U	15 24	16 00	0 600	0 630
V	8 39	9 52	0 330	0 375
W	4 32	4 82	0 170	0 190

CASE 357C-01
POWER TAP

Terminal Penetration:	0.280 max
Terminal Torque:	25–40 in-lb max
Mounting Torque — Outside Holes:*	30–40 in-lb max
*Center Hole Must be Torqued First:	8–10 in-lb max

3

3

FIGURE 1 — TYPICAL FORWARD VOLTAGE (PER LEG)

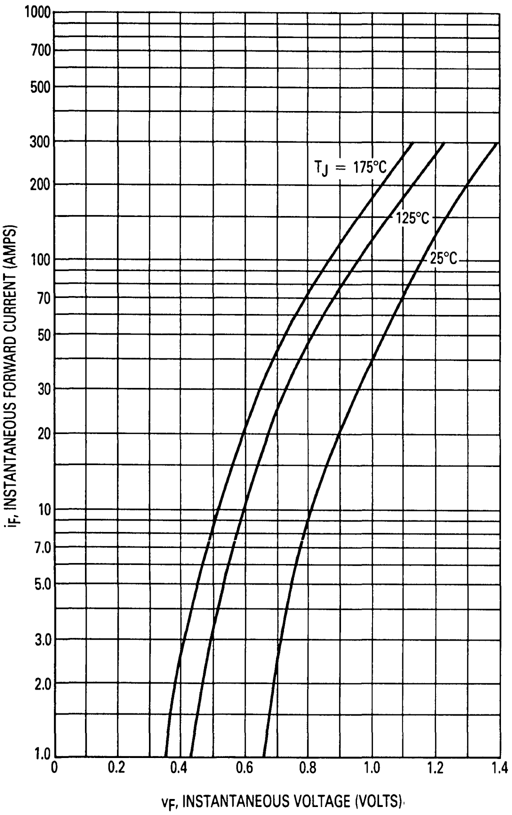
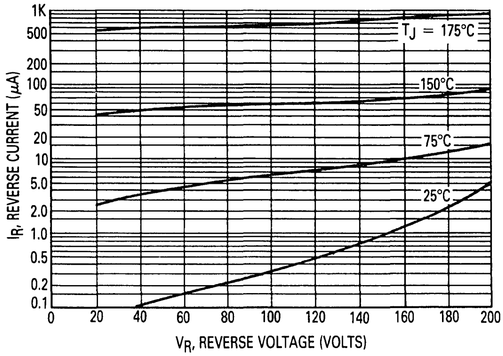


FIGURE 2 — TYPICAL REVERSE CURRENT*



*The curves shown are typical for the highest voltage device in the voltage grouping. Typical reverse current for lower voltage selections can be estimated from these curves, if V_R is sufficiently below rated V_R.

FIGURE 3 — CURRENT DERATING (PER LEG)

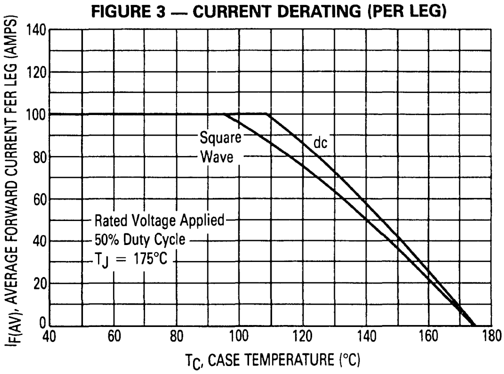


FIGURE 4 — POWER DISSIPATION (PER LEG)

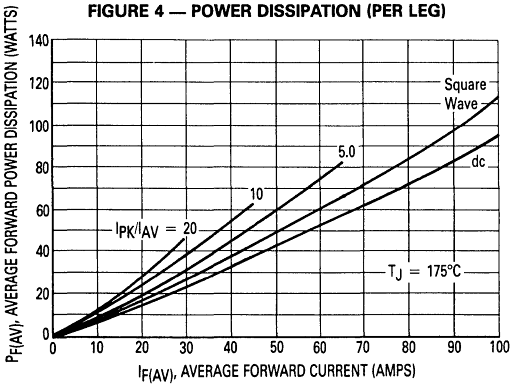
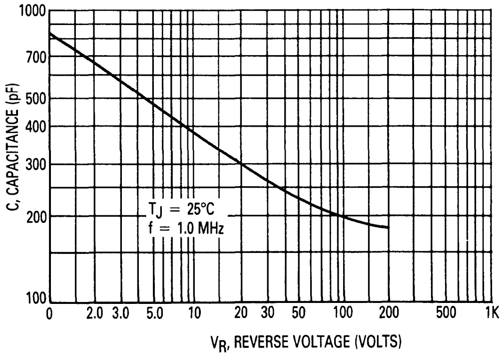


FIGURE 5 — CAPACITANCE (PER LEG)



MOTOROLA
SEMICONDUCTOR
TECHNICAL DATA

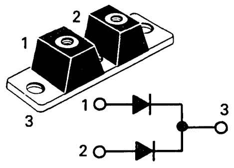
Ultrafast Switchmode Power Rectifiers

MUR20030CT
MUR20040CT

... designed for use in switching power supplies, inverters, and as freewheeling diodes. These state-of-the-art devices have the following features:

- Dual Diode Construction — May Be Paralleled For Higher Current Output
- Low Leakage Current
- Low Forward Voltage
- 175°C Operating Junction Temperature
- Labor Saving POWERTAP Package

ULTRAFAST RECTIFIERS
200 AMPERES
300 and 400 VOLTS



CASE 357C-01
POWERTAP

3

MAXIMUM RATINGS

Rating	Symbol	MUR20030CT	MUR20040CT	Unit
Peak Repetitive Reverse Voltage Working Peak Reverse Voltage DC Blocking Voltage	V_{RRM} V_{RWM} V_R	300	400	Volts
Average Rectified Forward Current, (Rated V_R), T_C = 95°C Per Device Per Leg	$I_{F(AV)}$	 200 100		Amps
Peak Repetitive Forward Current, Per Leg, (Rated V_R, Square Wave, 20 kHz), T_C = 95°C	I_{FRM}	200		Amps
Nonrepetitive Peak Surge Current Per Leg (Surge applied at rated load conditions halfwave, single phase, 60 Hz)	I_{FSM}	800		Amps
Operating Junction and Storage Temperature	T_J, T_{stg}	−65 to +175		°C

THERMAL CHARACTERISTICS PER LEG

Rating	Symbol	Max	Unit
Thermal Resistance, Junction to Case	$R_{\theta JC}$	0.75	°C/W

ELECTRICAL CHARACTERISTICS PER LEG

Rating	Symbol	Max	Unit
Instantaneous Forward Voltage (1) (i_F = 100 Amp, T_C = 25°C) (i_F = 100 Amp, T_C = 125°C)	v_F	 1.35 1.25	Volts
Instantaneous Reverse Current (1) (Rated dc Voltage, T_C = 125°C) (Rated dc Voltage, T_C = 25°C)	i_R	 500 50	μA
Maximum Reverse Recovery Time (I_F = 1 Amp, di/dt = 50 Amps/μs)	t_{rr}	75	ns

(1) Pulse Test. Pulse Width = 300 μs, Duty Cycle ≤ 2%.

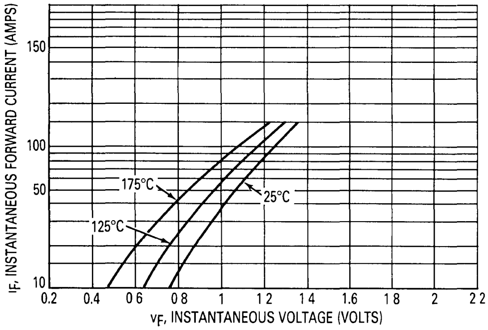


Figure 1. Typical Forward Voltage

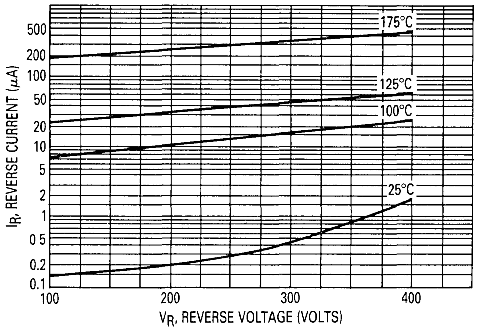


Figure 2. Typical Reverse Current

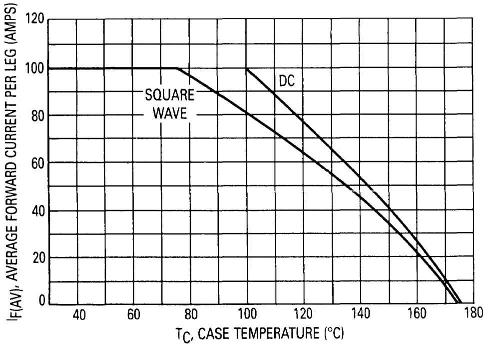


Figure 3. Current Derating (Per Leg)

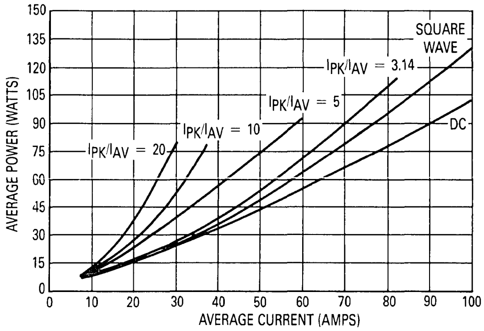


Figure 4. Average Power Dissipation and Average Current

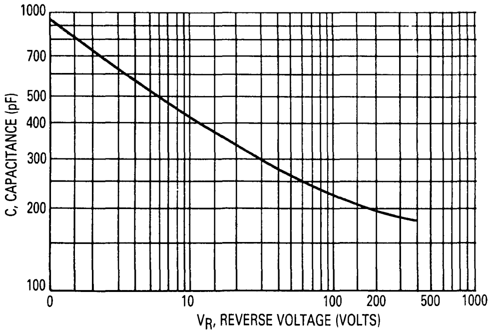
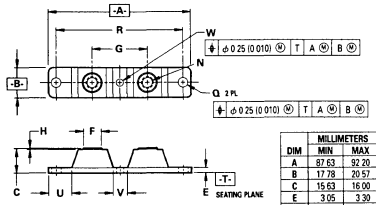


Figure 5. Capacitance (Per Leg)

OUTLINE DIMENSIONS



NOTES
1 DIMENSIONING AND TOLERANCING PER ANSI Y14 5M, 1982
2 CONTROLLING DIMENSION INCH

DIM	MILLIMETERS		INCHES	
	MIN	MAX	MIN	MAX
A	87 63	92 20	3 450	3 630
B	17 78	20 57	0 700	0 810
C	15 63	16 00	0 615	0 630
E	3 05	3 30	0 120	0 130
F	11 05	11 30	0 435	0 445
G	34 80	35 05	1 370	1 380
H	0 18	0 68	0 007	0 027
N	1/4 20UNC 2B		1/4-20UNC 2B	
Q	6 86	7 23	0 270	0 285
R	80 01 BSC		3 150 BSC	
U	15 24	16 00	0 600	0 630
V	8 39	9 52	0 330	0 375
W	4 32	4 82	0 170	0 190

CASE 357C-01
POWERTAP

Terminal Penetration:	0.280 max
Terminal Torque	25–40 in-lb max
Mounting Torque — Outside Holes:*	30–40 in-lb max
*Center Hole Must be Torqued First·	8–10 in-lb max

MOTOROLA
SEMICONDUCTOR
TECHNICAL DATA

MURD305
MURD310
MURD315
MURD320

Switchmode Power Rectifiers
DPAK Surface Mount Package

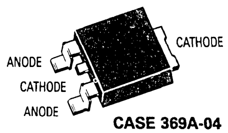
ULTRAFAST RECTIFIERS
3 AMPERES
50 TO 200 VOLTS

... designed for use in switching power supplies, inverters and as free wheeling diodes, these state-of-the-art devices have the following features:

- Ultrafast 35 Nanosecond Recovery Time
- Low Forward Voltage Drop
- Low Leakage

Mechanical Characteristics

- Case: Epoxy, Molded
- Finish: All External Surface Corrosion Resistance and Terminal Leads are Readily Solderable
- Lead Formed for Surface Mount
- Available in 16 mm Tape and Reel or Plastic Rails
- Compact Size
- Lead and Mounting Surface Temperature for Soldering Purpose 260°C Max. for 10 Seconds



CASE 369A-04
PLASTIC

MAXIMUM RATINGS

Rating	Symbol	MURD 305	MURD 310	MURD 315	MURD 320	Unit
Peak Repetitive Reverse Voltage Working Peak Reverse Voltage DC Blocking Voltage	V_{RRM} V_{RWM} V_R	50	100	150	200	Volts
Average Rectified Forward Current (T_C = 158°C, Rated V_R)	$I_{F(AV)}$	3				Amps
Peak Repetitive Forward Current (Rated V_R, Square Wave, 20 kHz, T_C = 158°C)	I_{FRM}	6				Amps
Nonrepetitive Peak Surge Current (Surge applied at rated load conditions, halfwave, 60 Hz)	I_{FSM}	75				Amps
Operating Junction and Storage Temperature	T_J, T_{stg}	−65 to +175				°C

THERMAL CHARACTERISTICS

Thermal Resistance, Junction to Case Junction to Ambient (1)	$R_{\theta JC}$ $R_{\theta JA}$	6 80	°C/W

ELECTRICAL CHARACTERISTICS

Maximum Instantaneous Forward Voltage Drop (2) (i_F = 3 Amps, T_J = 25°C) (i_F = 3 Amps, T_J = 125°C)	v_F	 0.95 0.75	Volts
Maximum Instantaneous Reverse Current (2) (T_J = 25°C, Rated dc Voltage) (T_J = 125°C, Rated dc Voltage)	i_R	 5 500	μA
Maximum Reverse Recovery Time (I_F = 1 Amp, di/dt = 50 Amps/μs, V_R = 30 V, T_J = 25°C) (I_F = 0.5 Amp, i_R = 1 Amp, I_{REC} = 0.25 A, V_R = 30 V, T_J = 25°C)	t_{rr}	 35 25	ns

(1) Rating applies when surface mounted on the minimum pad sizes recommended.
(2) Pulse Test Pulse Width = 300 μs, Duty Cycle ≤ 2%

3

TYPICAL CHARACTERISTICS

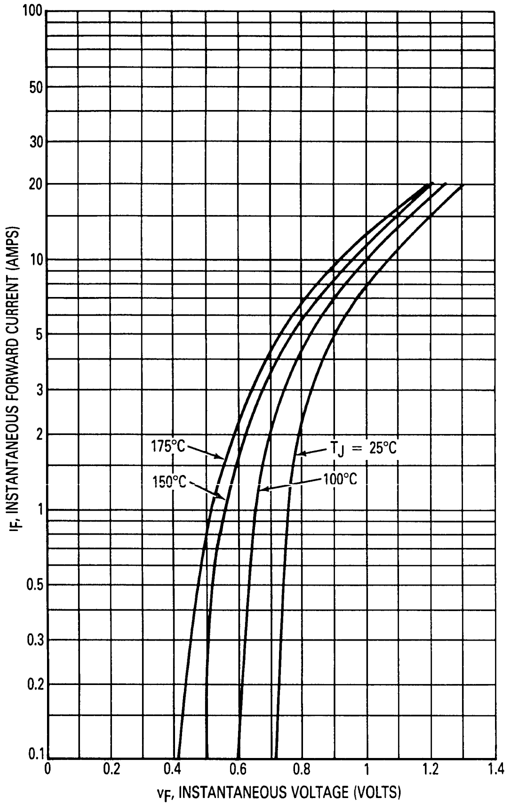
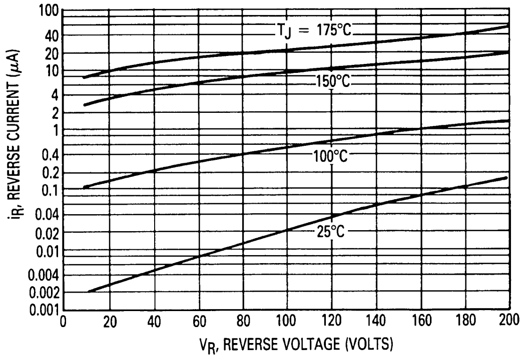


Figure 1. Typical Forward Voltage



*The curves shown are typical for the highest voltage device in the voltage grouping. Typical reverse current for lower voltage selections can be estimated from these curves if V_R is sufficient below rated V_R.

Figure 2. Typical Reverse Current*

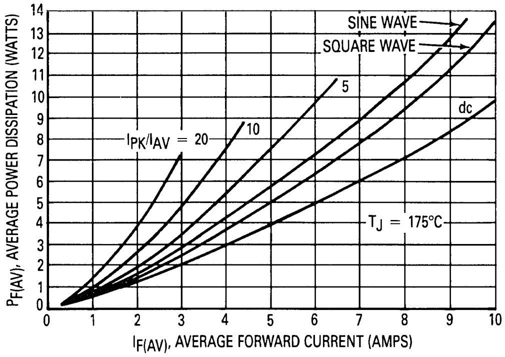


Figure 3. Average Power Dissipation

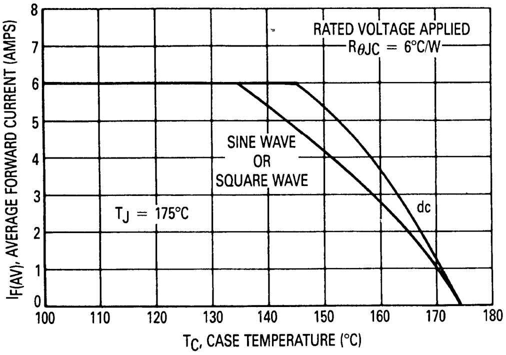


Figure 4. Current Derating, Case

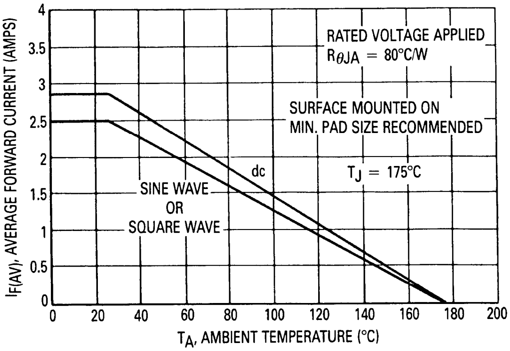


Figure 5. Current Derating, Ambient

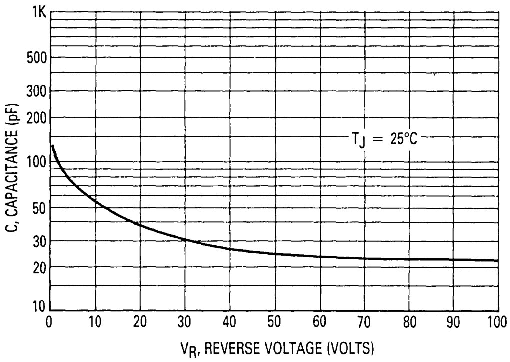
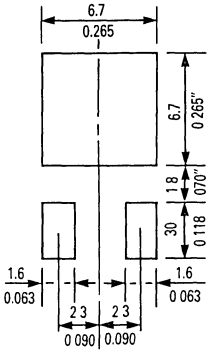
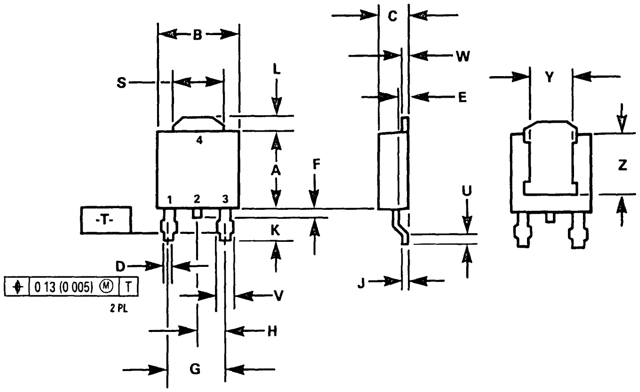


Figure 6. Typical Capacitance

MINIMUM PAD SIZES RECOMMENDED FOR SURFACE MOUNTED APPLICATIONS



OUTLINE DIMENSIONS



STYLE 3
PIN 1 ANODE
2 CATHODE
3 ANODE
4 CATHODE

DIM	MILLIMETERS MIN	MILLIMETERS MAX	INCHES MIN	INCHES MAX
A	5 97	6 22	0 235	0 245
B	6.35	6.73	0 250	0 265
C	2.19	2 38	0 086	0 094
D	0 69	0 88	0.027	0 035
E	0.97	1 06	0 038	0 042
F	0 64	0.88	0.025	0 035
G	4.58 BSC		0.180 BSC	
H	2.29 BSC		0.090 BSC	
J	6.46	0.58	0.018	0.023
K	2.59	2.89	0.102	0.114
L	0.89	1 27	0 035	0 050
S	5.21	5 46	0 205	0 215
U	0.51	—	0.020	—
V	0.77	1.14	0 030	0 045
W	0 84	0 94	0 033	0 037
Y	4.32	—	0.170	—
Z	3.69	—	0.145	—

NOTES.
1. SURFACE "T" IS BOTH A DATUM AND A MOUNTING SURFACE
2. DIMENSIONING AND TOLERANCING PER ANSI Y14 5M, 1982.
3 CONTROLLING DIMENSION· INCH

CASE 369A-04
PLASTIC

MOTOROLA
SEMICONDUCTOR
TECHNICAL DATA

MURD605CT
MURD610CT
MURD615CT
MURD620CT

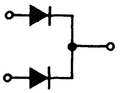
Switchmode Power Rectifiers
DPAK Surface Mount Package

. . . designed for use in switching power supplies, inverters and as free wheeling diodes, these state-of-the-art devices have the following features:

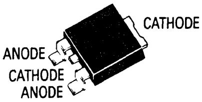
- Ultrafast 35 Nanosecond Recovery Time
- Low Forward Voltage Drop
- Low Leakage

Mechanical Characteristics

- Case: Epoxy, Molded
- Finish: All External Surface Corrosion Resistance and Terminal Leads are Readily Solderable
- Lead Formed for Surface Mount
- Available in 16 mm Tape and Reel or Plastic Rails
- Compact Size
- Dual Rectifier Single Chip Construction
- Lead Temperature for Soldering Purpose: 260°C for 10 Seconds



ULTRAFAST RECTIFIERS
6 AMPERES
50 TO 200 VOLTS



CASE 369A-04
PLASTIC

3

MAXIMUM RATINGS

Rating	Symbol	MURD 605CT	MURD 610CT	MURD 615CT	MURD 620CT	Unit
Peak Repetitive Reverse Voltage Working Peak Reverse Voltage DC Blocking Voltage	V_{RRM} V_{RWM} V_R	50	100	150	200	Volts
Average Rectified Forward Voltage (T_C = 145°C, Rated V_R) Per Diode Per Device	$I_{F(AV)}$	3 6				Amps
Peak Repetitive Forward Current (Rated V_R, Square Wave, 20 kHz, T_C = 145°C) Per Diode	I_F	6				Amps
Nonrepetitive Peak Surge Current (Surge applied at rated load conditions, halfwave, 60 Hz)	I_{FSM}	63				Amps
Operating Junction and Storage Temperature	T_J, T_{stg}	−65 to +175				°C

THERMAL CHARACTERISTICS PER DIODE

Thermal Resistance, Junction to Case Junction to Ambient (1)	$R_{\theta JC}$ $R_{\theta JA}$	9 80	°C/W

ELECTRICAL CHARACTERISTICS PER DIODE

Maximum Instantaneous Forward Voltage Drop (2) i_F = 3 Amps, T_C = 25°C i_F = 3 Amps, T_C = 125°C i_F = 6 Amps, T_C = 25°C i_F = 6 Amps, T_C = 125°C	v_F	 1 0.95 1.2 1.1	Volts
Maximum Instantaneous Reverse Current (2) (T_J = 25°C, Rated dc Voltage) (T_J = 125°C, Rated dc Voltage)	i_R	 5 250	µA
Maximum Reverse Recovery Time (I_F = 1 Amp, di/dt = 50 Amps/µs, V_R = 30 V, T_J = 25°C) (I_F = 0.5 Amp, i_R = 1 Amp, I_{REC} = 0.25 A, V_R = 30 V, T_J = 25°C)	t_{rr}	 35 25	ns

(1) Rating applies when surface mounted on the minimum pad size recommended.
(2) Pulse Test: Pulse Width = 300 µs, Duty Cycle ≤ 2%.

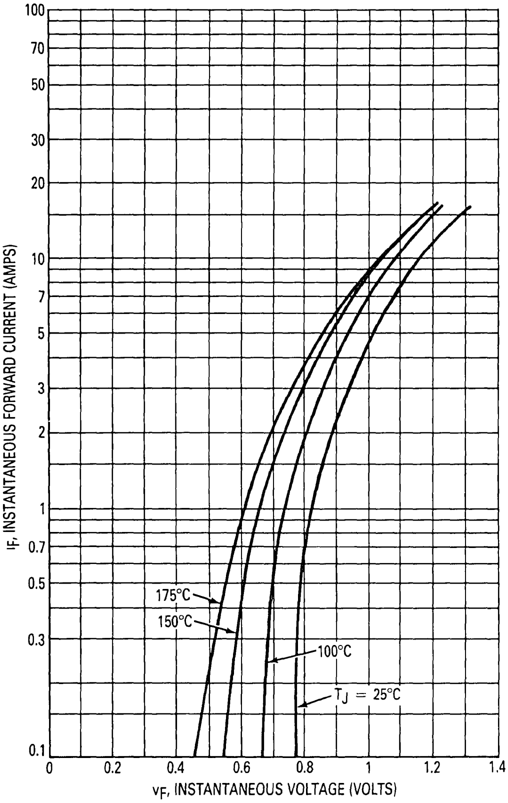
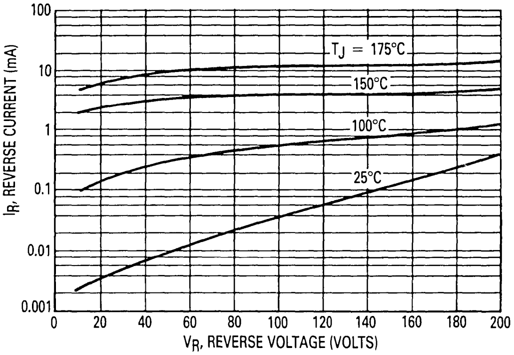


Figure 1. Typical Forward Voltage (Per Leg)



*The curves shown are typical for the highest voltage device in the voltage grouping. Typical reverse current for lower voltage selections can be estimated from these curves if V_R is sufficient below rated V_R.

Figure 2. Typical Leakage Current* (Per Leg)

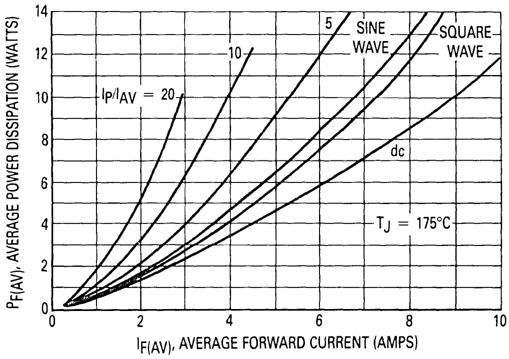


Figure 3. Average Power Dissipation (Per Leg)

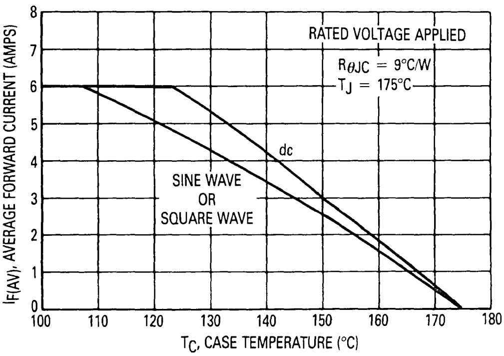


Figure 4. Current Derating, Case (Per Leg)

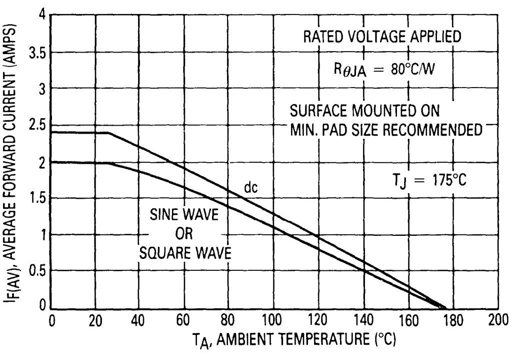


Figure 5. Current Derating, Ambient (Per Leg)

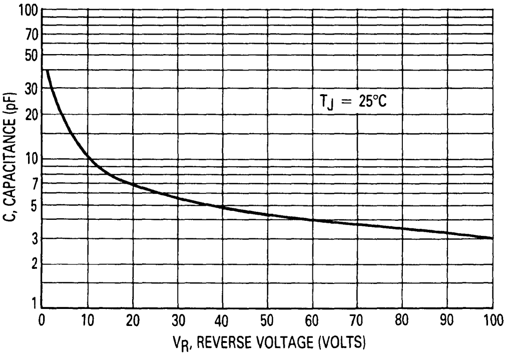
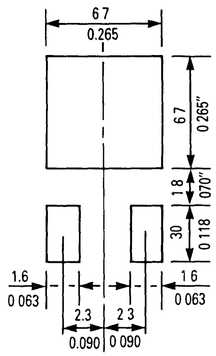


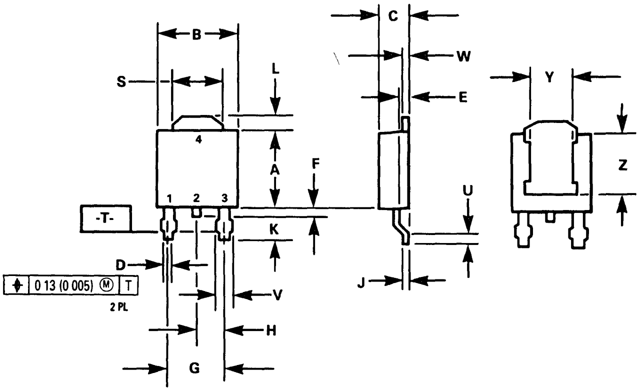
Figure 6. Typical Capacitance (Per Leg)

MINIMUM PAD SIZES RECOMMENDED FOR SURFACE MOUNTED APPLICATIONS



3

OUTLINE DIMENSIONS



STYLE 3
PIN 1 ANODE
2 CATHODE
3 ANODE
4 CATHODE

DIM	MILLIMETERS		INCHES	
	MIN	MAX	MIN	MAX
A	5.97	6.22	0 235	0 245
B	6 35	6.73	0.250	0.265
C	2.19	2 38	0 086	0.094
D	0 69	0 88	0.027	0 035
E	0.97	1 06	0 038	0 042
F	0 64	0.88	0.025	0.035
G	4.58 BSC		0.180 BSC	
H	2 29 BSC		0 090 BSC	
J	6.46	0 58	0 018	0 023
K	2 59	2.89	0 102	0.114
L	0 89	1.27	0 035	0.050
S	5 21	5.46	0 205	0 215
U	0.51	—	0 020	—
V	0.77	1.14	0.030	0.045
W	0.84	0.94	0.033	0.037
Y	4.32	—	0 170	—
Z	3 69	—	0.145	—

NOTES
1. SURFACE "T" IS BOTH A DATUM AND A MOUNTING SURFACE
2 DIMENSIONING AND TOLERANCING PER ANSI Y14 5M, 1982
3 CONTROLLING DIMENSION. INCH

CASE 369A-04
PLASTIC

MOTOROLA
SEMICONDUCTOR
TECHNICAL DATA

SD41 See Page 3-73
SD51 See Page 3-77
SD241 See Page 3-110

R710XPT R712XPT R711XPT R714XPT

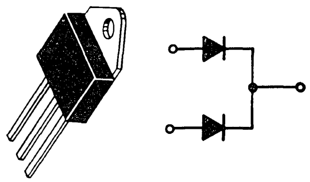
SWITCHMODE POWER RECTIFIERS

. . . designed for special applications such as dc power supplies, inverters, converters, ultrasonic systems, choppers, low RF interference, sonar power supplies and free wheeling diodes. A complete line of fast recovery rectifiers having typical recovery time of 150 nanoseconds providing high efficiency at frequencies to 50 kHz.

- Dual Diode Construction
- 150°C Operating Junction Temperature

ULTRAFAST RECOVERY RECTIFIERS

30 AMPERES
50 to 400 VOLTS



3

MAXIMUM RATINGS

Rating		Symbol	Maximum	Unit
Peak Repetitive Reverse Voltage Working Peak Reverse Voltage DC Blocking Voltage	R710XPT R711XPT R712XPT R714XPT	V_{RRM} V_{RWM} V_R	50 100 200 400	Volts
Average Rectified Forward Current (Rated V_R) T_C = 100°C	Per Device Per Diode	I_O	30 15	Amps
Peak Repetitive Forward Current, Per Diode (1 Second at 60 Hz, T_C = 100°C)		I_{FRM}	50	Amps
Nonrepetitive Peak Surge Current Per Diode (Surge applied at rated load conditions halfwave, single phase, 60 Hz)		I_{FSM}	150	Amps
Operating Junction and Storage Temperature		T_J, T_{stg}	-65 to +150	°C

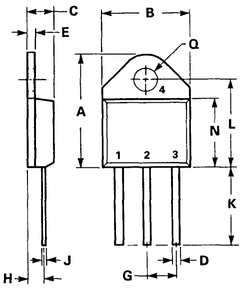
THERMAL CHARACTERISTICS PER DIODE

Characteristic	Symbol	Maximum	Unit
Thermal Resistance, Junction to Case	$R_{\theta JC}$	1 5	°C/W
Thermal Resistance, Junction to Ambient	$R_{\theta JA}$	40	°C/W

ELECTRICAL CHARACTERISTICS PER DIODE

Characteristic	Symbol	Maximum	Unit
Instantaneous Forward Voltage (1) (i_F = 15 Amp, T_C = 25°C)	v_F	1 30	Volts
Instantaneous Reverse Current (1) (Rated dc Voltage, T_C = 100°C) (Rated dc Voltage, T_C = 25°C)	i_R	 1 0 0 015	mA
Reverse Recovery Time (I_F = 1 0 Ampere to V_R = 30 Vdc)	t_{rr}	100	ns

(1) Pulse Test Pulse Width = 300 μs, Duty Cycle ≤ 2 0%



STYLE 1:
PIN 1. ANODE
2. CATHODE
3. ANODE
4. CATHODE

NOTES
1 DIMENSIONING AND TOLERANCING PER ANSI Y14 5M, 1982
2. CONTROLLING DIMENSION INCH

DIM	MILLIMETERS		INCHES	
	MIN	MAX	MIN	MAX
A	20 32	21 08	0 800	0 830
B	15 49	15 90	0 610	0 626
C	4 19	5 08	0 165	0 200
D	1 02	1 65	0 040	0 065
E	1 35	1 65	0 053	0 065
G	5 21	5 72	0 205	0 225
H	2 65	2 94	0 104	0 116
J	0 38	0 64	0 015	0 025
K	12 70	15 49	0 500	0 610
L	15 88	16 51	0 625	0 650
N	12 19	12 70	0 480	0 500
Q	4 04	4 22	0 159	0 166

CASE 340-02
TO-218AC
PLASTIC

FIGURE 1 — TYPICAL FORWARD VOLTAGE

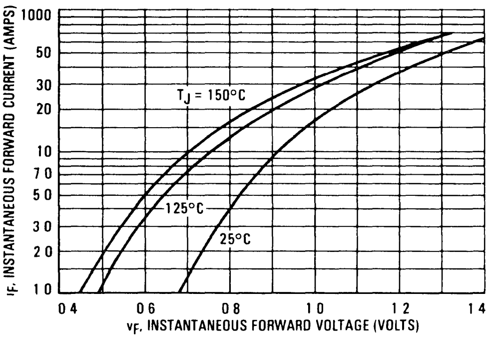


FIGURE 2 — TYPICAL REVERSE CURRENT

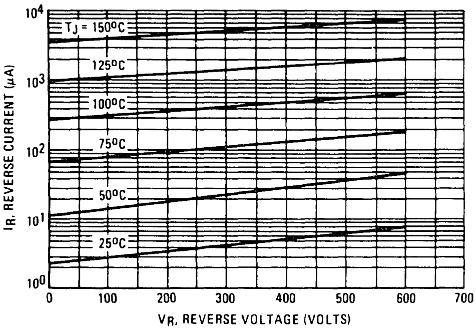


FIGURE 3 — CURRENT DERATING — TOTAL UNIT

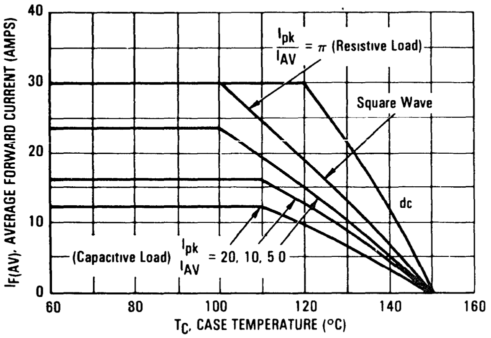


FIGURE 4 — TYPICAL CAPACITANCE

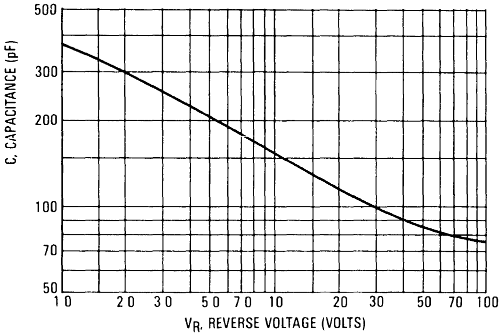


FIGURE 5 — POWER DISSIPATION — TOTAL UNIT

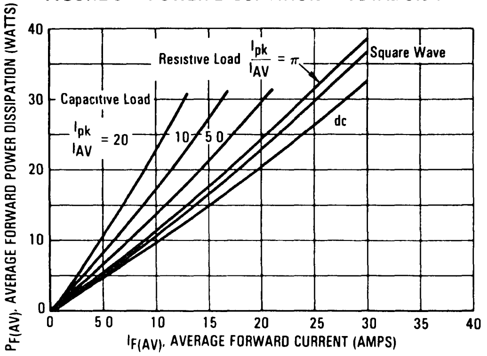
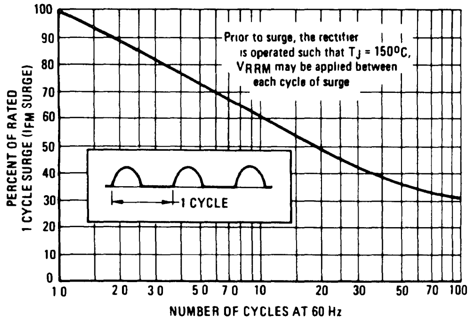


FIGURE 6 — MAXIMUM SURGE CAPABILITY



Zener Diode Data Sheets

4

MOTOROLA
SEMICONDUCTOR
TECHNICAL DATA

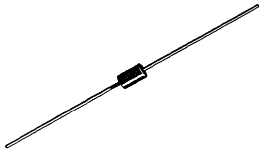
1/4M2.4AZ10 thru 1/4M105Z10

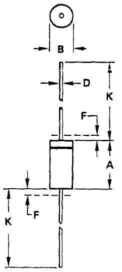
4

1/4 WATT SILICON ZENER DIODES

Hermetically sealed, all-glass case with all external surfaces corrosion resistant. Cathode end, indicated by color band, will be positive with respect to anode end when operated in the zener region. These devices are in the same 400 mW glass package as the 1N746 and 1N957 Series, but designated 1/4 Watt to allow characterization at a different test current level

1/4 WATT
SILICON ZENER DIODES
2.4-105 VOLTS





NOTES
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2 LEAD DIAMETER NOT CONTROLLED IN ZONE F TO ALLOW FOR FLASH, LEAD FINISH BUILDUP AND MINOR IRREGU LARITIES OTHER THAN HEAT SLUGS
3 POLARITY DENOTED BY CATHODE BAND
4 DIMENSIONING AND TOLERANCING PER ANSI Y14 5, 1973

	MILLIMETERS		INCHES	
DIM	MIN	MAX	MIN	MAX
A	3 05	5 08	0 120	0 200
B	1 52	2 29	0 060	0 090
D	0 46	0 56	0 018	0 022
F	–	1 27	–	0 050
K	25 40	38 10	1 000	1 500

All JEDEC dimensions and notes apply

CASE 299-02
DO-204AH
GLASS

MAXIMUM RATINGS

Junction and Storage Temperature −65°C to +175°C
DC Power Dissipation 1/4 Watt (Derate 1 67 mW/°C Above 25°C)

The type numbers specified have a standard voltage (V_Z) tolerance of ±10% For closer tolerances, add suffix "5" for ±5%, (3%, 2%, 1% tolerances also available)

ELECTRICAL CHARACTERISTICS (T_A = 25°C, V_F = 1 5 V max @ 100 mA)

Type No.	Nominal Zener Voltage @ I_{ZT} (V_Z) Volts	Test Current (I_{ZT}) mA	Maximum Zener Impedance (Z_{ZT}) @ I_{ZT} Ohms	Maximum DC Zener Current (I_{ZM}) mA	Reverse Leakage Current I_R Max (μA)	Test Voltage Vdc* V_{R1}	Test Voltage Vdc* V_{R2}
1/4M2.4AZ10	2.4	10	60	70	75	1	1
1/4M2.7AZ10	2.7	10	60	65	75	1	1
1/4M3.0AZ10	3 0	10	55	60	50	1	1
1/4M3.3AZ10	3 3	10	55	55	50	1	1
1/4M3.6AZ10	3.6	10	50	52	50	1	1

*V_{R1} — Test Voltage for 5% Tolerance Device
V_{R2} — Test Voltage for 10% Tolerance Device

1/4M2.4AZ10 thru 1/4M105Z10

ELECTRICAL CHARACTERISTICS (T_A = 25°C, V_F = 1.5 V max @ 100 mA)

Type No.	Nominal Zener Voltage @ I_{ZT} (V_Z) Volts	Test Current (I_{ZT}) mA	Maximum Zener Impedance (Z_{ZT}) @ I_{ZT} Ohms	Maximum DC Zener Current (I_{ZM}) mA	Reverse Leakage Current		
					I_R Max (μA)	Test Voltage Vdc*	
						V_{R1}	V_{R2}
1/4M3.9AZ10	3.9	10	50	49	25	1	1
1/4M4.3AZ10	4.3	10	45	46	25	1.5	1 5
1/4M4.7AZ10	4 7	10	35	42	10	1 5	1 5
1/4M5.1AZ10	5.1	10	25	39	5	1.5	1 5
1/4M5.6AZ10	5 6	10	20	36	5	1.5	1 5
1/4M6.2AZ10	6 2	10	15	33	5	3.5	3.5
1/4M6 8Z10	6 8	9 2	7 0	33	150	5 2	4.9
1/4M7 5Z10	7.5	8 3	8.0	30	75	5 7	5 4
1/4M8 2Z10	8.2	7.6	9 0	26	50	6 2	5 9
1/4M9.1Z10	9 1	6 9	10	24	25	6.9	6 6
1/4M10Z10	10	6 3	11	21	10	7 6	7 2
1/4M11Z10	11	5 7	13	19	5	8 4	8 0
1/4M12Z10	12	5 2	15	18	5	9.1	8.6
1/4M13Z10	13	4 8	18	16	5	9 9	9 4
1/4M14Z10	14	4 5	20	15	5	10.6	10 1
1/4M15Z10	15	4.2	22	14	5	11 4	10 8
1/4M16Z10	16	3.9	24	13	5	12 2	11 5
1/4M17Z10	17	3 7	26	12 5	5	13 0	12 2
1/4M18Z10	18	3 5	28	11 5	5	13.7	13 0
1/4M19Z10	19	3 3	30	11.0	5	14 4	13 7
1/4M20Z10	20	3 1	33	10 5	5	15 2	14 4
1/4M22Z10	22	2 8	40	9 5	5	16 7	15 8
1/4M24Z10	24	2 6	46	9 0	5	18 2	17 3
1/4M25Z10	25	2 5	50	8 0	5	19 0	18 0
1/4M27Z10	27	2 3	58	7.5	5	20 6	19 4
1/4M30Z10	30	2 1	70	7 0	5	22 8	21 6
1/4M33Z10	33	1 9	85	6 5	5	25 1	23 8
1/4M36Z10	36	1 7	100	6 0	5	27 4	25 9
1/4M39Z10	39	1 6	120	5 0	5	29 7	28 1
1/4M43Z10	43	1 5	140	4 8	5	32.7	31 0
1/4M45Z10	45	1 4	150	4 5	5	34 2	32 4
1/4M47Z10	47	1 3	160	4.3	5	35 8	33.8
1/4M50Z10	50	1 2	180	4 1	5	38 0	36 0
1/4M52Z10	52	1 2	200	4 0	5	39 5	37 4
1/4M56Z10	56	1 1	230	3 8	5	42 6	40 3
1/4M62Z10	62	1 0	290	3 3	5	47 1	44 6
1/4M68Z10	68	0 92	350	3.0	5	51.7	49 0
1/4M75Z10	75	0 83	450	2 8	5	56.0	54.0
1/4M82Z10	82	0.76	550	2 5	5	62.2	59 0
1/4M91Z10	91	0.69	700	2.3	5	69 2	65.5
1/4M100Z10	100	0 63	900	2 0	5	76.0	72 0
1/4M105Z10	105	0 60	1000	1.9	5	79.8	75 6

*V_{R1} — Test Voltage for 5% Tolerance Device

V_{R2} — Test Voltage for 10% Tolerance Device

SPECIAL SELECTIONS AVAILABLE INCLUDE

1 — Nominal zener voltages between those shown

2 — Matches sets (Standard Tolerances are ±5 0%, ±3 0%, ±2 0%, ±1 0%) depending on voltage per device.

a Two or more units for series connection with specified tolerance on total voltage. Series matched sets make possible higher zener voltages and provide lower temperature coefficients, lower dynamic impedance and greater power handling ability

b Two or more units matched to one another with any specified tolerance

3 — Tight voltage tolerances 1 0%, 2 0%, 3 0%.

MOTOROLA
SEMICONDUCTOR
TECHNICAL DATA

1.5KE6.8, A thru 1.5KE250, A
See Page 4-59

Designers Data Sheet

500-MILLIWATT HERMETICALLY SEALED GLASS SILICON ZENER DIODES

- Complete Voltage Range — 2.4 to 110 Volts
- DO-35 Package — Smaller than Conventional DO-7 Package
- Double Slug Type Construction
- Metallurgically Bonded Construction
- Oxide Passivated Die

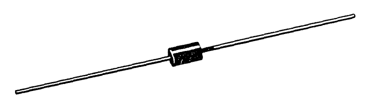
Designer's Data for "Worst Case" Conditions

The Designer's Data sheets permit the design of most circuits entirely from the information presented. Limit curves – representing boundaries on device characteristics – are given to facilitate "worst case" design.

1N746 thru 1N759
1N957A thru 1N986A
1N4370 thru 1N4372

GLASS ZENER DIODES
500 MILLIWATTS
2.4-110 VOLTS

4



MAXIMUM RATINGS

Rating	Symbol	Value	Unit
DC Power Dissipation @ $T_L \leq 50^oC$, Lead Length = 3/8"	P_D		
*JEDEC Registration		400	mW
*Derate above $T_L = 50^oC$		3.2	$mW/^oC$
Motorola Device Ratings		500	mW
Derate above $T_L = 50^oC$		3 33	$mW/^oC$
Operating and Storage Junction Temperature Range	T_J, T_{stg}		^oC
*JEDEC Registration		-65 to +175	
Motorola Device Ratings		-65 to +200	

*Indicates JEDEC Registered Data.

MECHANICAL CHARACTERISTICS

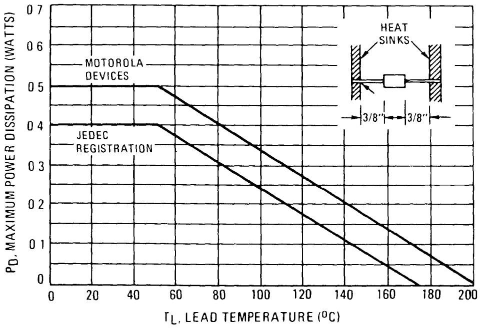
MAXIMUM LEAD TEMPERATURE FOR SOLDERING PURPOSES: 230°C, 1/16" from case for 10 seconds

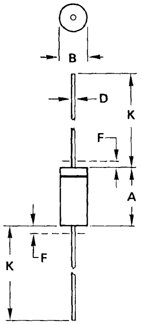
FINISH: All external surfaces are corrosion resistant with readily solderable leads.

POLARITY: Cathode indicated by color band. When operated in zener mode, cathode will be positive with respect to anode.

MOUNTING POSITION: Any

STEADY STATE POWER DERATING





NOTES
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4 DIMENSIONING AND TOLERANCING PER ANSI Y14 5, 1973

DIM	MILLIMETERS		INCHES	
	MIN	MAX	MIN	MAX
A	3 05	5 08	0 120	0 200
B	1 52	2 29	0 060	0 090
D	0 46	0 56	0 018	0 022
F	–	1 27	–	0 050
K	25 40	38 10	1 000	1 500

All JEDEC dimensions and notes apply

CASE 299-02
DO-204AH
GLASS

1N746 thru 1N759, 1N957A thru 1N986A, 1N4370 thru 1N4372

ELECTRICAL CHARACTERISTICS ($T_A = 25°C$, V_F = 1 5 V max at 200 mA for all types)

Type Number (Note 1)	Nominal Zener Voltage V_Z @ I_{ZT} (Note 2) Volts	Test Current I_{ZT} mA	Maximum Zener Impedance Z_{ZT} @ I_{ZT} (Note 3) Ohms	*Maximum DC Zener Current I_{ZM} (Note 4) mA		Maximum Reverse Leakage Current $T_A = 25°C$ I_R @ V_R = 1 V µA	$T_A = 150°C$ I_R @ V_R = 1 V µA
1N4370	2.4	20	30	150	190	100	200
1N4371	2 7	20	30	135	165	75	150
1N4372	3 0	20	29	120	150	50	100
1N746	3 3	20	28	110	135	10	30
1N747	3 6	20	24	100	125	10	30
1N748	3.9	20	23	95	115	10	30
1N749	4 3	20	22	85	105	2	30
1N750	4 7	20	19	75	95	2	30
1N751	5 1	20	17	70	85	1	20
1N752	5 6	20	11	65	80	1	20
1N753	6 2	20	7	60	70	0 1	20
1N754	6 8	20	5	55	65	0 1	20
1N755	7 5	20	6	50	60	0.1	20
1N756	8 2	20	8	45	55	0 1	20
1N757	9 1	20	10	40	50	0 1	20
1N758	10	20	17	35	45	0 1	20
1N759	12	20	30	30	35	0 1	20

Type Number (Note 1)	Nominal Zener Voltage V_Z (Note 2) Volts	Test Current I_{ZT} mA	Maximum Zener Impedance (Note 3) Z_{ZT} @ I_{ZT} Ohms	Z_{ZK} @ I_{ZK} Ohms	I_{ZK} mA	*Maximum DC Zener Current I_{ZM} (Note 4) mA		Maximum Reverse Current I_R Maximum µA	Test Voltage Vdc V_R 5%	10%
1N957A	6 8	18 5	4 5	700	1 0	47	61	150	5 2	4 9
1N958A	7 5	16 5	5 5	700	0 5	42	55	75	5 7	5 4
1N959A	8 2	15	6 5	700	0 5	38	50	50	6 2	5 9
1N960A	9 1	14	7 5	700	0 5	35	45	25	6 9	6 6
1N961A	10	12 5	8 5	700	0 25	32	41	10	7 6	7 2
1N962A	11	11 5	9 5	700	0 25	28	37	5	8 4	8 0
1N963A	12	10 5	11 5	700	0 25	26	34	5	9.1	8 6
1N964A	13	9 5	13	700	0 25	24	32	5	9 9	9 4
1N965A	15	8 5	16	700	0 25	21	27	5	11 4	10 8
1N966A	16	7 8	17	700	0 25	19	37	5	12 2	11 5
1N967A	18	7 0	21	750	0 25	17	23	5	13 7	13 0
1N968A	20	6 2	25	750	0 25	15	20	5	15 2	14 4
1N969A	22	5 6	29	750	0 25	14	18	5	16 7	15 8
1N970A	24	5 2	33	750	0 25	13	17	5	18 2	17 3
1N971A	27	4 6	41	750	0 25	11	15	5	20 6	19 4
1N972A	30	4 2	49	1000	0 25	10	13	5	22 8	21 6
1N973A	33	3 8	58	1000	0 25	9 2	12	5	25 1	23 8
1N974A	36	3 4	70	1000	0 25	8 5	11	5	27 4	25 9
1N975A	39	3 2	80	1000	0 25	7 8	10	5	29 7	28 1
1N976A	43	3 0	93	1500	0 25	7 0	9 6	5	32 7	31 0
1N977A	47	2 7	105	1500	0 25	6 4	8 8	5	35 8	33 8
1N978A	51	2 5	125	1500	0 25	5 9	8 1	5	38 8	36 7
1N979A	56	2 2	150	2000	0 25	5 4	7 4	5	42 6	40 3
1N980A	62	2 0	185	2000	0 25	4 9	6 7	5	47 1	44 6
1N981A	68	1 8	230	2000	0 25	4 5	6 1	5	51 7	49 0
1N982A	75	1 7	270	2000	0 25	1 0	5 5	5	56 0	54 0
1N983A	82	1 5	330	3000	0 25	3 7	5 0	5	62 2	59.0
1N984A	91	1 4	400	3000	0 25	3 3	4 5	5	69 2	65 5
1N985A	100	1 3	500	3000	0 25	3.0	4.5	5	76	72
1N986A	110	1 1	750	4000	0.25	2 7	4 1	5	83 6	79.2

NOTE 1. TOLERANCE AND VOLTAGE DESIGNATION

Tolerance Designation

The type numbers shown have tolerance designations as follows:

1N4370 series: ±10%, suffix A for ±5% units,
C for ±2%, D for ±1%.

1N746 series: ±10%, suffix A for ±5% units,
C for ±2%, D for ±1%.

1N957 series: ±10%, suffix A for ±10% units,
C for ±2%, D for ±1%,
suffix B for ±5% units,
C for ±2%, D for ±1%.

NOTE 2. ZENER VOLTAGE (V_Z) MEASUREMENT

Nominal zener voltage is measured with the device junction in thermal equilibrium at the lead temperature of 30°C ±1°C and 3/8" lead length.

NOTE 3. ZENER IMPEDANCE (Z_Z) DERIVATION

Z_{ZT} and Z_{ZK} are measured by dividing the ac voltage drop across the device by the ac current applied. The specified limits are for $I_Z(ac) = 0.1\ I_Z(dc)$ with the ac frequency = 60 Hz.

NOTE 4. MAXIMUM ZENER CURRENT RATINGS (I_{ZM})

Maximum zener current ratings are based on the maximum voltage of a 10% 1N746 type unit or a 20% 1N957 type unit. For closer tolerance units (10% or 5%) or units where the actual zener voltage (V_Z) is known at the operating point, the maximum zener current may be increased and is limited by the derating curve.

APPLICATION NOTE

Since the actual voltage available from a given zener diode is temperature dependent, it is necessary to determine junction temperature under any set of operating conditions in order to calculate its value. The following procedure is recommended:

Lead Temperature, T_L, should be determined from:

$$T_L = \theta_{LA} P_D + T_A$$

θ_{LA} is the lead-to-ambient thermal resistance (°C/W) and P_D is the power dissipation. The value for θ_{LA} will vary and depends on the device mounting method. θ_{LA} is generally 30-40°C/W for the various clips and tie points in common use and for printed circuit board wiring.

The temperature of the lead can also be measured using a thermocouple placed on the lead as close as possible to the tie point. The thermal mass connected to the tie point is normally large enough so that it will not significantly respond to heat surges generated in the diode as a result of pulsed operation once steady-state conditions are achieved. Using the measured value of T_L, the junction temperature may be determined by.

$$T_J = T_L + \Delta T_{JL}$$

ΔT_{JL} is the increase in junction temperature above the lead temperature and may be found from Figure 1 for dc power.

$$\Delta T_{JL} = \theta_{JL} P_D$$

For worst-case design, using expected limits of I_Z, limits of P_D and the extremes of $T_J(\Delta T_J)$ may be estimated. Changes in voltage, V_Z, can then be found from:

$$\Delta V = \theta_{VZ} \Delta T_J$$

θ_{VZ}, the zener voltage temperature coefficient, is found from Figures 3 and 4.

Under high power-pulse operation, the zener voltage will vary with time and may also be affected significantly by the zener resistance. For best regulation, keep current excursions as low as possible.

Surge limitations are given in Figure 6. They are lower than would be expected by considering only junction temperature, as current crowding effects cause temperatures to be extremely high in small spots, resulting in device degradation should the limits of Figure 6 be exceeded.

FIGURE 1 – TYPICAL THERMAL RESISTANCE

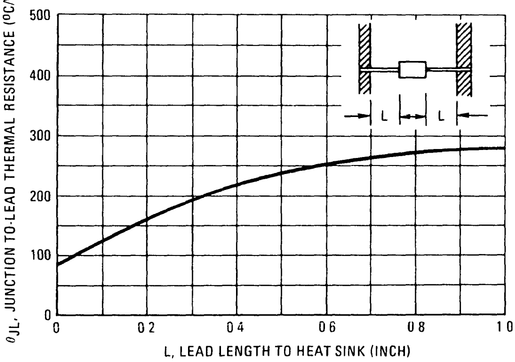


FIGURE 2 – TYPICAL LEAKAGE CURRENT

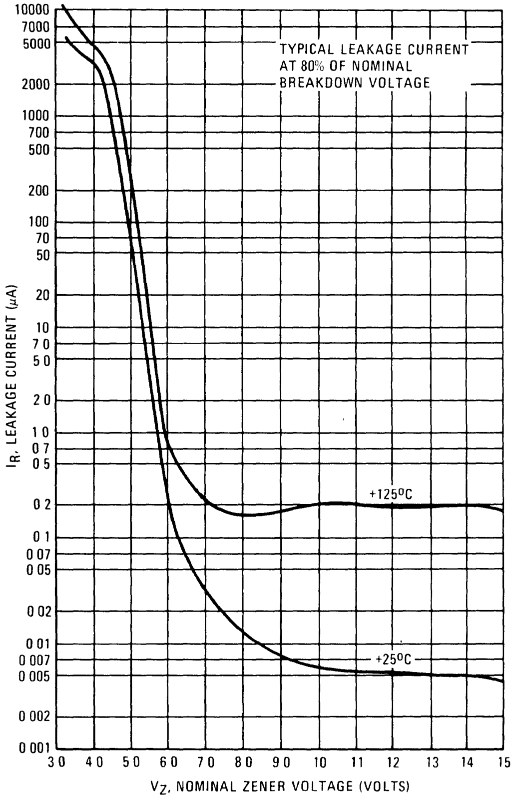
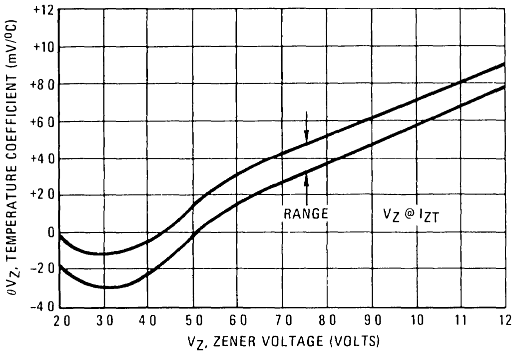


FIGURE 3 — TEMPERATURE COEFFICIENTS
(-55°C to +150°C temperature range; 90% of the units are in the ranges indicated.)

a — RANGE FOR UNITS TO 12 VOLTS



b — RANGE FOR UNITS 12 TO 100 VOLTS

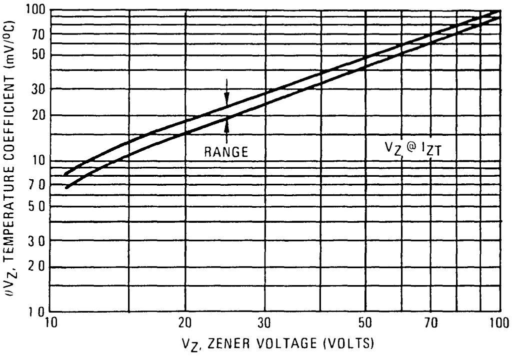


FIGURE 4 — EFFECT OF ZENER CURRENT

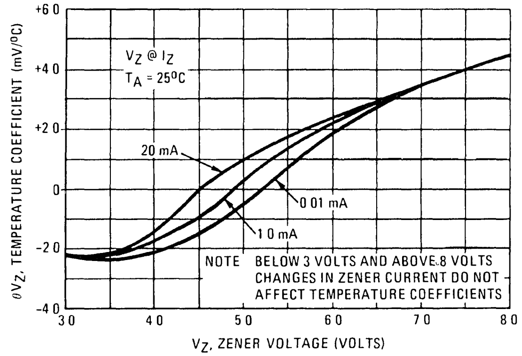


FIGURE 5 — TYPICAL CAPACITANCE

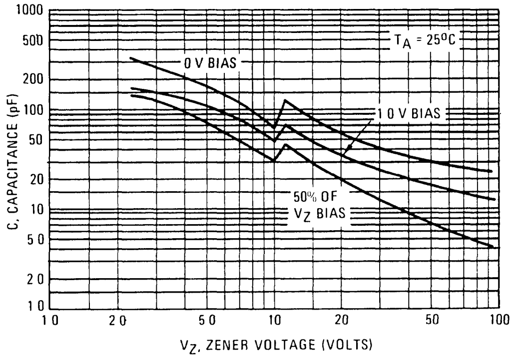
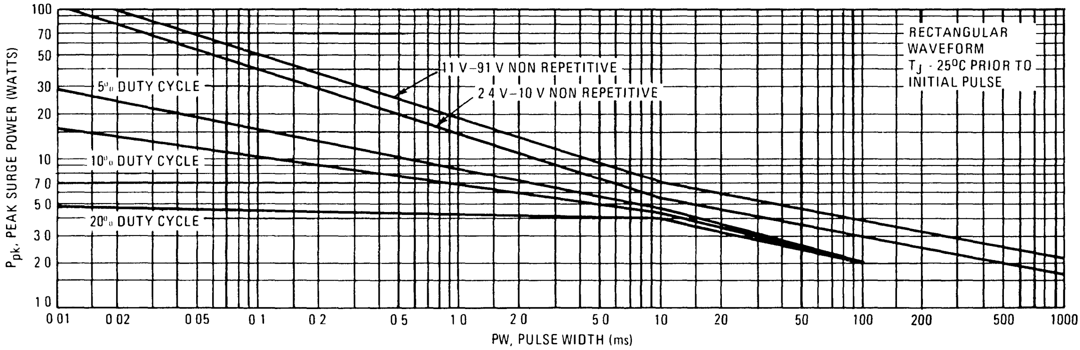


FIGURE 6 — MAXIMUM SURGE POWER



This graph represents 90 percentil data points
For worst case design characteristics, multiply surge power by 2/3

FIGURE 7 – EFFECT OF ZENER CURRENT ON ZENER IMPEDANCE

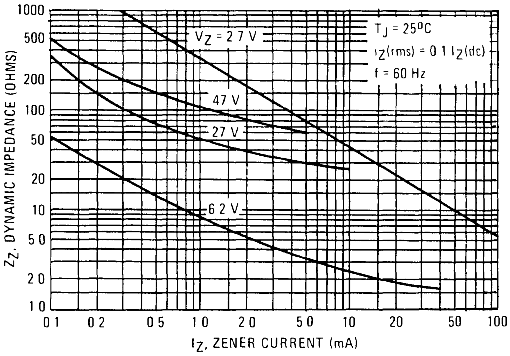


FIGURE 8 – EFFECT OF ZENER VOLTAGE ON ZENER IMPEDANCE

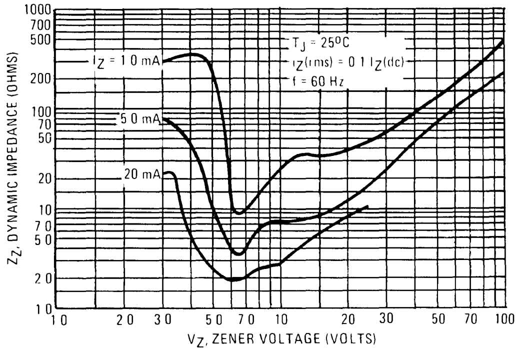


FIGURE 9 – TYPICAL NOISE DENSITY

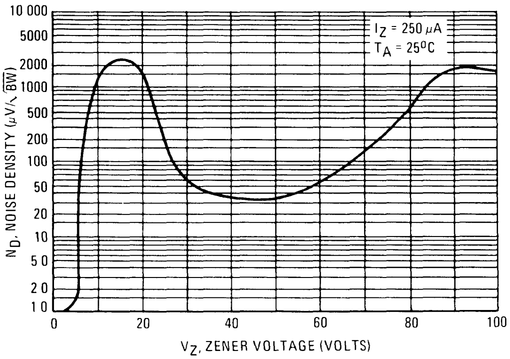
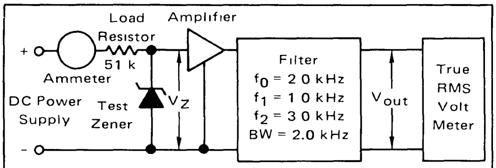


FIGURE 10 – NOISE DENSITY MEASUREMENT METHOD



Noise Density (Volts Per Square Root Bandwidth) $= \dfrac{V_{out}}{\text{Overall Gain}\ \sqrt{BW}}$

Where BW = Filter Bandwidth (Hz)

V_{out} = Output Noise (Volts RMS)

The input voltage and load resistance are high so that the zener diode is driven from a constant current source The amplifier is low noise so that the amplifier noise is negligible compared to that of the test zener The filter bandpass is known so that the noise density can be calculated from the formula shown

FIGURE 11 – TYPICAL FORWARD CHARACTERISTICS

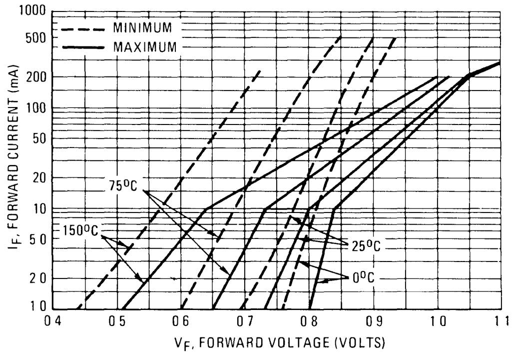


FIGURE 12 – ZENER VOLTAGE versus ZENER CURRENT – V_Z = 1 THRU 16 VOLTS

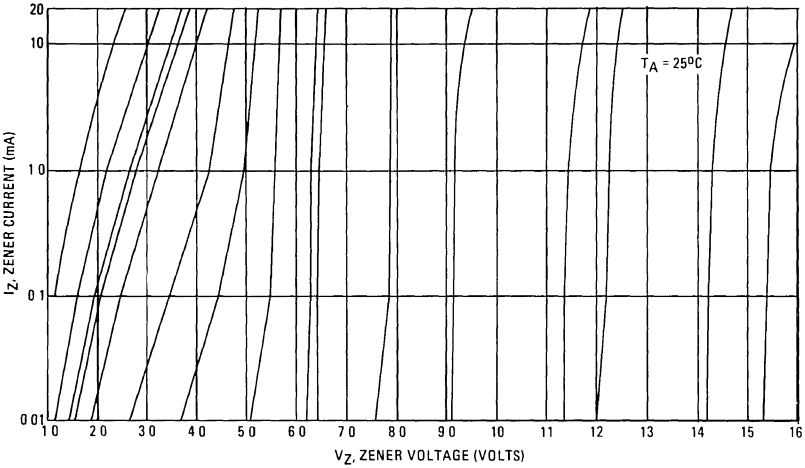


FIGURE 13 – ZENER VOLTAGE versus ZENER CURRENT – V_Z = 15 THRU 30 VOLTS

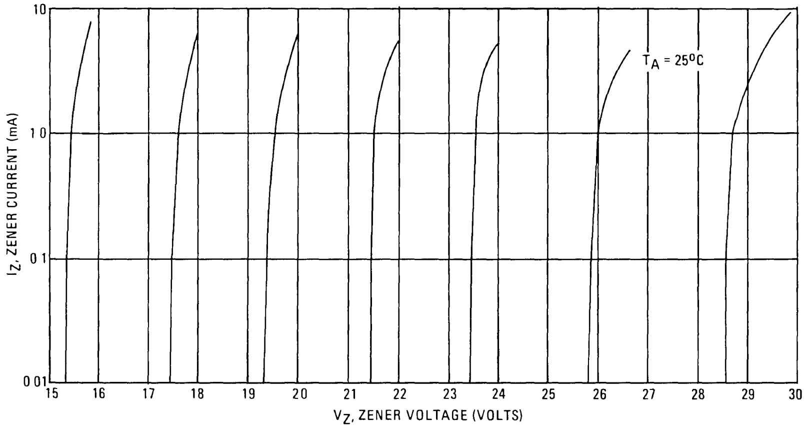
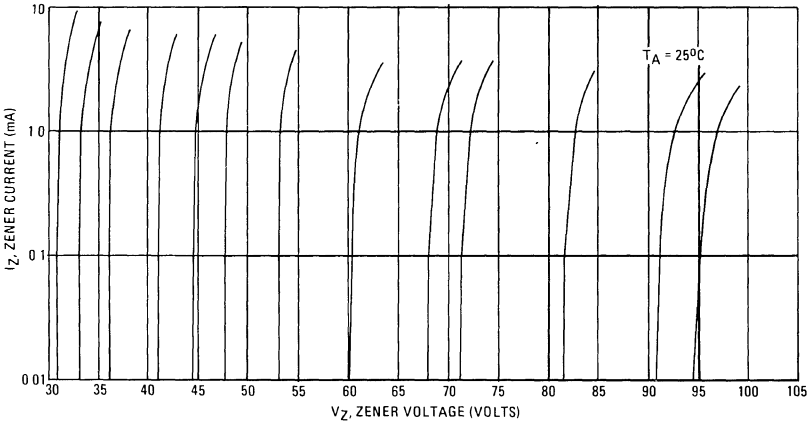


FIGURE 14 – ZENER VOLTAGE versus ZENER CURRENT – V_Z = 30 THRU 105 VOLTS



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MOTOROLA
SEMICONDUCTOR
TECHNICAL DATA

1N821, A 1N823, A 1N825, A 1N827, A 1N829, A

Designers Data Sheet

TEMPERATURE-COMPENSATED ZENER REFERENCE DIODES

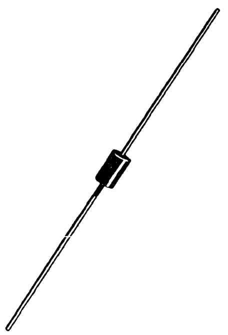
Temperature-compensated zener reference diodes utilizing a nitride passivated junction for long-term voltage stability A rugged, glass-enclosed, hermetically sealed structure

Designer's Data for "Worst-Case" Conditions

The Designers Data Sheet permits the design of most circuits entirely from the information presented. Limit data — representing device characteristic boundaries — are given to facilitate "worst-case" design.

TEMPERATURE-COMPENSATED SILICON ZENER REFERENCE DIODES

6.2 V, 400 mW



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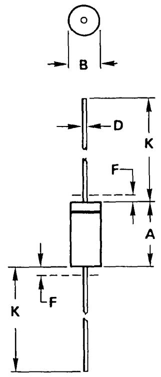
MAXIMUM RATINGS

Junction Temperature -55 to +175°C
Storage Temperature -65 to +175°C
DC Power Dissipation 400 mW @ T_A = 50°C

MECHANICAL CHARACTERISTICS

CASE: Hermetically sealed, all-glass
DIMENSIONS: See outline drawing
FINISH: All external surfaces are corrosion resistant and leads are readily solderable and weldable.
POLARITY: Cathode indicated by polarity band
WEIGHT: 0 2 Gram (approx)
MOUNTING POSITION: Any



DIM	MILLIMETERS MIN	MILLIMETERS MAX	INCHES MIN	INCHES MAX
A	3 05	5 08	0 120	0 200
B	1 52	2 29	0 060	0 090
D	0 46	0 56	0 018	0 022
F	–	1 27	–	0 050
K	25 40	38 10	1 000	1 500

All JEDEC dimensions and notes apply

CASE 299-02
DO-204AH
GLASS

ELECTRICAL CHARACTERISTICS (T_A = 25°C unless otherwise noted. V_Z = 6.2 V ± 5.0%* @ I_{ZT} = 7.5 mA)

JEDEC Type No.	Maximum Voltage Change ΔV_Z (Volts) (Note 1)	Ambient Test Temperature °C ±1°C	Temperature Coefficient %/°C (Note 1)	Maximum Dynamic Impedance Z_{ZT} Ohms (Note 2)
1N821	0 096	-55, 0, +25, +75, +100	0 01	15
1N823	0.048	↓	0.005	↓
1N825	0.019	↓	0.002	↓
1N827	0 009	↓	0.001	↓
1N829	0 005	↓	0 0005	↓
1N821A	0 096	↓	0 01	10
1N823A	0 048	↓	0 005	↓
1N825A	0.019	↓	0.002	↓
1N827A	0 009	↓	0 001	↓
1N829A	0.005	↓	0.0005	↓

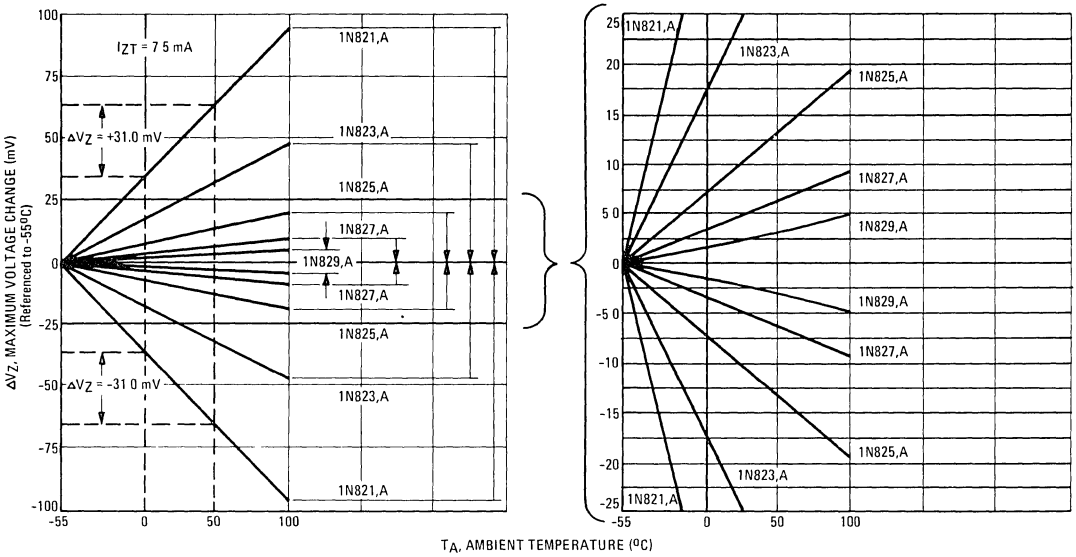
*Tighter-tolerance units available on special request.

MAXIMUM VOLTAGE CHANGE versus AMBIENT TEMPERATURE

(with I_{ZT} = 7.5 mA ±0.01 mA) (See Note 3)

1N821 thru 1N829

FIGURE 1a — FIGURE 1b



ZENER CURRENT versus MAXIMUM VOLTAGE CHANGE

(At Specified Temperatures)
(See Note 4)

MORE THAN 95% OF THE UNITS ARE IN THE RANGES INDICATED BY THE CURVES

FIGURE 2 — 1N821 SERIES

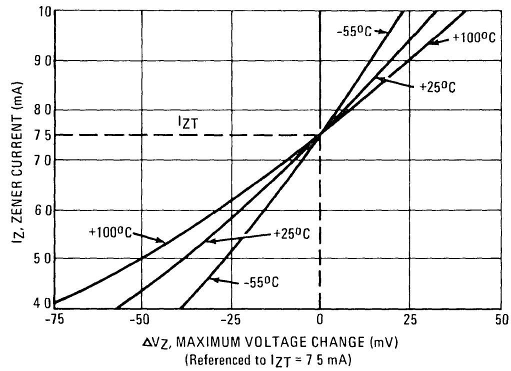
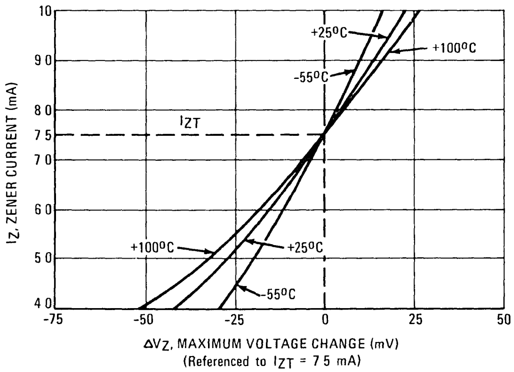


FIGURE 3 — 1N821A SERIES



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MAXIMUM ZENER IMPEDANCE versus ZENER CURRENT

(See Note 2)

MORE THAN 95% OF THE UNITS ARE IN THE RANGES INDICATED BY THE CURVES.

FIGURE 4 – 1N821 SERIES

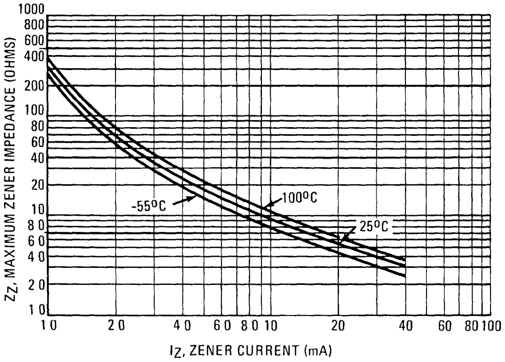
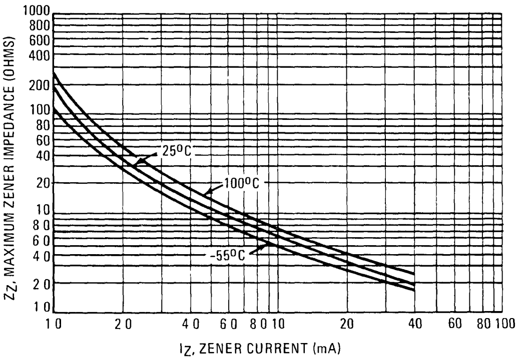


FIGURE 5 – 1N821A SERIES



NOTE 1.

Voltage Variation (ΔV_Z) and Temperature Coefficient

All reference diodes are characterized by the "box method" This guarantees a maximum voltage variation (ΔV_Z) over the specified temperature range, at the specified test current (I_{ZT}), verified by tests at indicated temperature points within the range. V_Z is measured and recorded at each temperature specified The ΔV_Z between the highest and lowest values must not exceed the maximum ΔV_Z given This method of indicating voltage stability is now used for JEDEC registration as well as for military qualification. The former method of indicating voltage stability – by means of temperature coefficient – accurately reflects the voltage deviation at the temperature extremes, but is not necessarily accurate within the temperature range because reference diodes have a nonlinear temperature relationship The temperature coefficient, therefore, is given only as a reference.

NOTE 2.

The dynamic zener impedance, Z_{ZT}, is derived from the 60-Hz ac voltage drop which results when an ac current with an rms value equal to 10% of the dc zener current, I_{ZT}, is superimposed on I_{ZT} Curves showing the variation of zener impedance with zener current for each series are given in Figures 4 and 5.

NOTE 3

These graphs can be used to determine the maximum voltage change of any device in the series over any specific temperature range For example, a temperature change from 0 to +50°C will cause a voltage change no greater than +31 mV or -31 mV for 1N821 or 1N821A, as illustrated by the dashed lines in Figure 1. The boundaries given are maximum values. For greater resolution, an expanded view of the shaded area in Figure 1a is shown in Figure 1b

NOTE 4

The maximum voltage change, ΔV_Z, Figures 2 and 3 is due entirely to the impedance of the device. If both temperature and I_{ZT} are varied, then the total voltage change may be obtained by graphically adding ΔV_Z in Figure 2 or 3 to the ΔV_Z in Figure 1 for the device under consideration. If the device is to be operated at some stable current other than the specified test current, a new set of characteristics may be plotted by superimposing the data in Figure 2 or 3 on Figure 1 For a more detailed explanation see AN-437 (Application Note)

MOTOROLA
SEMICONDUCTOR
TECHNICAL DATA

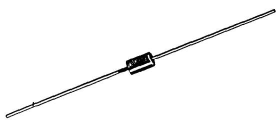
1N957A thru 1N986A
See Page 4-4

1N987A thru 1N992A

Advance Information

400-MILLIWATT

SILICON ZENER DIODES



CONSTANT -VOLTAGE REFERENCES FOR 120 thru 200-VOLT APPLICATIONS

- 400-Milliwatt
- Guaranteed Low Zener Impedance
- Guaranteed Low Leakage Current
- Controlled Forward Characteristics
- Temperature Range. −65 to +175°C
- No Heat Sink Required

4

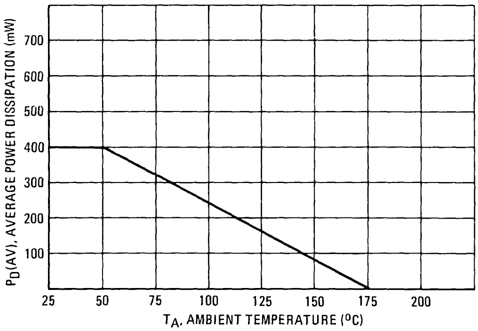
MAXIMUM RATINGS

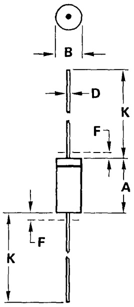
Rating	Symbol	Value	Unit
DC Power Dissipation @ T_L = 50°C Derate above T_L = 50°C	P_D	400 3.2	mW mW/°C
Operating and Storage Junction Temperature Range	T_J, T_{stg}	−65 to +175	°C

MECHANICAL CHARACTERISTICS

CASE: Hermetically sealed all glass case
DIMENSIONS: See outline drawing
FINISH: All external surfaces are corrosion resistant with readily solderable leads
POLARITY: Cathode end indicated by color band When operated in zener region, the cathode end will be positive with respect to anode end
WEIGHT: 0.2 grams (approx.)
MOUNTING POSITION: Any

FIGURE 1 — POWER DISSIPATION





NOTES
1 PACKAGE CONTOUR OPTIONAL WITHIN A AND B HEAT SLUGS, IF ANY, SHALL BE INCLUDED WITHIN THIS CYLINDER, BUT NOT SUBJECT TO THE MINIMUM LIMIT OF B
2 LEAD DIAMETER NOT CONTROLLED IN ZONE F TO ALLOW FOR FLASH, LEAD FINISH BUILDUP AND MINOR IRREGULARITIES OTHER THAN HEAT SLUGS
3 POLARITY DENOTED BY CATHODE BAND
4 DIMENSIONING AND TOLERANCING PER ANSI Y14.5, 1973

	MILLIMETERS		INCHES	
DIM	MIN	MAX	MIN	MAX
A	3.05	5.08	0.120	0.200
B	1.52	2.29	0.060	0.090
D	0.46	0.56	0.018	0.022
F	—	1.27	—	0.050
K	25.40	38.10	1.000	1.500

All JEDEC dimensions and notes apply

CASE 299-02
DO-204AH
GLASS

This document contains information on a new product Specifications and information herein are subject to change without notice

ELECTRICAL CHARACTERISTICS (T_A = 25°C, V_F = 1.5 V max at 200 mA for all types)

Type Number (Note 1)	Nominal Zener Voltage V_Z (Note 2) Volts	Test Current I_{ZT} mA	Maximum Zener Impedance (Note 3)			Maximum DC Zener Current I_{ZM} (Note 4) mA	Maximum Reverse Current (Note 5)		
			Z_{ZT} @ I_{ZT} Ohms	Z_{ZK} @ I_{ZK} Ohms	I_{ZK} mA		I_R Maximum μA	Test Voltage Vdc V_R 5%	10%
1N987A	120	1.0	900	4500	0.25	2 5	5.0	91.2	86 4
1N988A	130	0.95	1100	5000	0.25	2.3	5.0	98 8	93.6
1N989A	150	0 85	1500	6000	0 25	2 0	5 0	114	108
1N990A	160	0 80	1700	6500	0.25	1 9	5.0	121 6	115.2
1N991A	180	0 68	2200	7100	0.25	1 7	5 0	136 8	129 6
1N992A	200	0.65	2500	8000	0.25	1 5	5.0	152	144

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NOTE 1 – TOLERANCE AND VOLTAGE DESIGNATION

Tolerance Designation

The tolerance designations are as follows.

Suffix A: ±10%
Suffix B: ±5%
Suffix C: ±2%
Suffix D: ±1%

NOTE 2 – ZENER VOLTAGE (V_Z) MEASUREMENT

Nominal zener voltage is measured with the device junction in thermal equilibrium with ambient temperature of 25°C

NOTE 3 – ZENER IMPEDANCE (Z_Z) DERIVATION

The zener impedance is derived from the 60 cycle ac voltage, which results when an ac current having an rms value equal to 10% of the dc zener current (I_{ZT}) is superimposed on I_{ZT}

A cathode ray oscilloscope curve test is used to insure that each zener diode breakdown region begins at a low current level and that zener voltage remains nearly constant to a current level in excess of I_{ZM}.

NOTE 4 – MAXIMUM ZENER CURRENT RATINGS (I_{ZM})

Maximum zener current ratings are based on the maximum voltage of a 20% unit. For closer tolerance units (10% or 5%) or units where the actual zener voltage (V_Z) is known at the operating point, the maximum zener current may be increased and is limited by the derating curve.

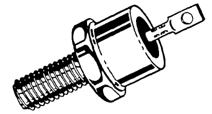
NOTE 5 – REVERSE LEAKAGE CURRENT I_R

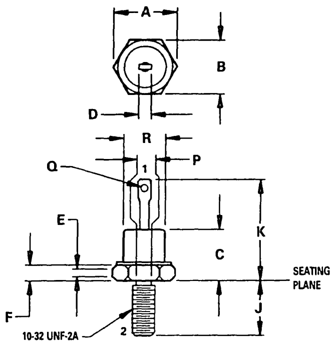
Reverse leakage currents are guaranteed only for 5% and 10% 400 mW silicon zener diodes and are measured at V_R as shown on the table.

MOTOROLA
SEMICONDUCTOR
TECHNICAL DATA

1N2970A thru 1N3015A

10 WATTS ZENER DIODES





DIM	MILLIMETERS MIN	MILLIMETERS MAX	INCHES MIN	INCHES MAX
A	—	12 82	—	0 505
B	10 77	11 09	0 424	0 437
C	—	10 28	—	0 405
D	—	6 35	—	0 250
E	1 53	—	0 060	—
F	1.91	4 44	0 075	0 175
J	10 72	11 50	0 422	0 453
K	15 24	20 32	0 600	0 800
P	4 14	4 80	0 163	0 189
Q	1.53	2 41	0 060	0 095
R	6 74	10 76	0 265	0 424

STYLE 1·
TERM 1 CATHODE
2 ANODE

STYLE 2
TERM 1 ANODE
2. CATHODE

CASE 56-03
DO-203AA
METAL

ZENER DIODES

Diffused-junction zener diodes for both military and high-reliability industrial applications. Available with anode-to-case and cathode-to-case connections (standard and reverse polarity), i.e., 1N2970 and 1N2970R. Supplied with mounting hardware.

The type numbers shown have a standard tolerance of ±10% on the nominal zener voltage. Add suffix "B" for ±5% units. (2% and 1% tolerance also available.)

MAXIMUM RATINGS

Junction and Storage Temperature: -65°C to +175°C.

DC Power Dissipation: 10 Watts. (Derate 83.3 mW/°C above 55°C).

ELECTRICAL CHARACTERISTICS ($T_C = 25°C$ unless otherwise noted, $V_F = 1.5$ V max @ $I_F = 2$ amp on all types.)

Type No.	Nominal Zener Voltage V_Z @ I_{ZT} Volts	Test Current I_{ZT} mA	Max Zener Impedance Z_{ZT} @ I_{ZT} Ohms	Max Zener Impedance Z_{ZK} @ I_{ZK} Ohms	Max Zener Impedance I_{ZK} mA	Max DC Zener Current I_{ZM} mA	Max. Reverse Current* I_R Max (μA)	Max. Reverse Current* V_{R1}	Max. Reverse Current* V_{R2}
1N2970A	6.8	370	1.2	500	1 0	1,320	150	5 2	4.9
1N2971A	7.5	335	1.3	250	1 0	1,180	75	5.7	5.4
1N2972A	8.2	305	1.5	250	1.0	1,040	50	6.2	5 9
1N2973A	9.1	275	2.0	250	1.0	960	25	6.9	6 6
1N2974A	10	250	3	250	1 0	860	10	7.6	7.2
1N2975A	11	230	3	250	1 0	780	5	8.4	8.0
1N2976A	12	210	3	250	1.0	720	5	9 1	8.6
1N2977A	13	190	3	250	1.0	660	5	9.9	9.4
1N2978A	14	180	3	250	1.0	600	5	10.6	10.1
1N2979A	15	170	3	250	1.0	560	5	11.4	10.8

*V_{R1} — Test Voltage for 5% Tolerance Device. V_{R2} — Test Voltage for 10 % Tolerance Device. No Leakage Specified as 20% Tolerance Device.

ELECTRICAL CHARACTERISTICS (T_C = 25 °C unless otherwise noted, V_F = 1.5 V max @ I_F = 2 amp on all types.)

Type No.	Nominal Zener Voltage V_Z @ I_{ZT} Volts	Test Current I_{ZT} mA	Max Zener Impedance Z_{ZT} @ I_{ZT} Ohms	Z_{ZK} @ I_{ZK} Ohms	I_{ZK} mA	Max DC Zener Current I_{ZM} mA	Max. Reverse Current* I_R Max (μA)	V_{R1}	V_{R2}
1N2980A	16	155	4	250	1 0	530	5	12 2	11 5
1N2982A	18	140	4	250	1 0	460	5	13 7	13 0
1N2983A	19	130	4	250	1 0	440	5	14 4	13 7
1N2984A	20	125	4	250	1 0	420	5	15 2	14 4
1N2985A	22	115	5	250	1 0	380	5	16 7	15 8
1N2986A	24	105	5	250	1 0	350	5	18 2	17 3
1N2988A	27	95	7	250	1 0	300	5	20 6	19 4
1N2989A	30	85	8	300	1 0	280	5	22 8	21 6
1N2990A	33	75	9	300	1 0	260	5	25 1	23 8
1N2991A	36	70	10	300	1 0	230	5	27 4	25 9
1N2992A	39	65	11	300	1 0	210	5	29 7	28 1
1N2993A	43	60	12	400	1 0	195	5	32 7	31 0
1N2995A	47	55	14	400	1 0	175	5	35 8	33 8
1N2996A	50	50	15	500	1 0	165	5	38 0	36 0
1N2997A	51	50	15	500	1 0	163	5	38 8	36 7
1N2998A	52	50	15	500	1 0	160	5	39 5	37 4
1N2999A	56	45	16	500	1 0	150	5	42 6	40 3
1N3000A	62	40	17	600	1 0	130	5	47 1	44 6
1N3001A	68	37	18	600	1 0	120	5	51 7	49 0
1N3002A	75	33	22	600	1 0	110	5	56 0	54 0
1N3003A	82	30	25	700	1 0	100	5	62 2	59 0
1N3004A	91	28	35	800	1 0	85	5	69 2	65 5
1N3005A	100	25	40	900	1 0	80	5	76 0	72 0
1N3006A	105	25	45	1,000	1 0	75	5	79 8	75 6
1N3007A	110	23	55	1,100	1 0	72	5	83 6	79 2
1N3008A	120	20	75	1,200	1 0	67	5	91 2	86 4
1N3009A	130	19	100	1,300	1 0	62	5	98 8	93 6
1N3010A	140	18	125	1,400	1 0	58	5	106 4	100 8
1N3011A	150	17	175	1,500	1 0	54	5	114 0	108 0
1N3012A	160	16	200	1,600	1 0	50	5	121 6	115 2
1N3014A	180	14	260	1,850	1 0	45	5	136 8	129 6
1N3015A	200	12	300	2,000	1 0	40	5	152 0	144 0

*V_{R1} — Test Voltage for 5% Tolerance Device V_{R2} — Test Voltage for 10 % Tolerance Device No Leakage Specified as 20% Tolerance Device

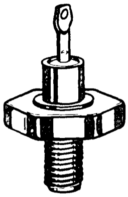
MOTOROLA
SEMICONDUCTOR
TECHNICAL DATA

1N3016A thru 1N3051A
See Page 4-21

1N3305A thru 1N3350A
6.8V thru 200V

1N4549A thru 1N4556A
3.9V thru 7.5V

50 WATTS
ZENER DIODES



CASE 58-01
(stud package)
METAL

4

ZENER DIODES

Units are available with anode-to-case and cathode-to-case connections (standard and reverse polarity). For reverse polarity, add suffix "R" to type number.

MAXIMUM RATINGS
Junction and Storage Temperature: −65°C to +175°C.
DC Power Dissipation: 50 Watts. (Derate 0.5 W/°C above 75°C).
TOLERANCE DESIGNATION: The type numbers shown have a standard tolerance of ±10% on the nominal zener voltage. Add suffix "B" for ±5% units. (2% and 1% tolerance also available.)

ELECTRICAL CHARACTERISTICS (T_C = 30°C unless otherwise specified, V_F = 1.5 V max @ 10 A on all types.)

50 Watt Case 58	Nominal Zener Voltage @ I_{ZT} (V_Z) Volts	Test Current (I_{ZT}) mA	Max Zener Impedance		Max DC Zener Current 75°C Case Temp (I_{ZM})mA	Reverse* Leakage Current			Typical Zener Voltage Temp. Coeff. %/°C
			Z_{ZT} @ I_{ZT} ohms	Z_{ZK} @ I_{ZK} = 5mA ohms		I_RMax (μA)	V_{R1}	V_{R2}	
1N4549A	3 9	3200	0 16	400	11900	150	0.5	0 5	- 025
1N4550A	4.3	2900	0 16	500	10650	150	0.5	0 5	- 025
1N4551A	4 7	2650	0.12	600	9700	100	1.0	1 0	.010
1N4552A	5.1	2450	0 12	650	8900	20	1.0	1.0	015
1N4553A	5 6	2250	0.12	900	8100	20	1.0	1 0	.030
1N4554A	6 2	2000	0 14	1000	7300	20	2.0	2.0	040
1N3305A	6 8	1850	0 2	70	6600	150	4 5	4.3	040
1N4555A	6 8	1850	0 16	200	6650	10	2.0	2 0	045
1N3306A	7 5	1700	0 3	70	5900	75	5.0	4 7	045
1N4556A	7 5	1650	0 24	100	6050	10	3.0	3 0	.053
1N3307A	8 2	1500	0 4	70	5200	50	5 4	5.2	.048
1N3308A	9 1	1370	0 5	70	4800	25	6.1	5 7	051
1N3309A	10	1200	0 6	80	4300	10	6 7	6 3	055
1N3310A	11	1100	0 8	80	3900	5	8 4	8 0	060
1N3311A	12	1000	1 0	80	3600	5	9 1	8 6	065
1N3312A	13	960	1 1	80	3300	5	9 9	9 4	065
1N3313A	14	890	1 2	80	3000	5	10 6	10.1	.070
1N3314A	15	830	1 4	80	2800	5	11 4	10 8	070
1N3315A	16	780	1 6	80	2650	5	12 2	11 5	070
1N3316A	17	740	1 8	80	2500	5	13 0	12 2	075
1N3317A	18	700	2 0	80	2300	5	13 7	13 0	075
1N3318A	19	660	2 2	80	2200	5	14 4	13.7	.075
1N3319A	20	630	2 4	80	2100	5	15 2	14.4	075
1N3320A	22	570	2 5	80	1900	5	16 7	15 8	080
1N3321A	24	520	2 6	80	1750	5	18 2	17 3	.080
1N3322A	25	500	2 7	90	1550	5	19 0	18 0	.080
1N3323A	27	460	2 8	90	1500	5	20 6	19 4	085
1N3324A	30	420	3 0	90	1400	5	22.8	21 6	085
1N3325A	33	380	3 2	90	1300	5	25.1	23.8	085
1N3326A	36	350	3 5	90	1150	5	27.4	25 9	085
1N3327A	39	320	4 0	90	1050	5	29 7	28 1	090
1N3328A	43	290	4 5	90	975	5	32.7	31 0	090
1N3329A	45	280	4 5	100	930	5	34 2	32 4	.090
1N3330A	47	270	5 0	100	880	5	35.8	33 8	.090
1N3331A	50	250	5.0	100	830	5	38 0	36.0	.090
1N3332A	51	245	5 2	100	810	5	38.8	36 7	090
1N3333A	52	240	5 5	100	790	5	39 5	37 4	090
1N3334A	56	220	6	110	740	5	42.6	40 3	.090
1N3335A	62	200	7	120	660	5	47.1	44.6	.090
1N3336A	68	180	8	140	600	5	51.7	49 0	.090
1N3337A	75	170	9	150	540	5	56.0	54.0	.090
1N3338A	82	150	11	160	490	5	62 2	59.0	090
1N3339A	91	140	15	180	420	5	69 2	65.5	090
1N3340A	100	120	20	200	400	5	76.0	72.0	.090
1N3341A	105	120	25	210	380	5	79.8	75.6	.095
1N3342A	110	110	30	220	365	5	83.6	79 2	.095
1N3343A	120	100	40	240	335	5	91.2	86 4	.095
1N3344A	130	95	50	275	310	5	98 8	93 6	.095
1N3345A	140	90	60	325	290	5	106.4	100 8	.095
1N3346A	150	85	75	400	270	5	114.0	108.0	.095
1N3347A	160	80	80	450	250	5	121.6	115.2	.095
1N3348A	175	70	85	500	230	5	133.0	126.0	.095
1N3349A	180	68	90	525	220	5	136 8	129.6	.095
1N3350A	200	65	100	600	200	5	152.0	144 0	.100

SPECIAL SELECTIONS AVAILABLE INCLUDE: (See Selector Guide for details)

*V_{R1} — Test Voltage for 5% Tolerance Device
V_{R2} — Test Voltage for 10% Tolerance Device
No Leakage Specified as 20% Tolerance Device

4

1N3305A thru 1N3350A, 1N4549A thru 1N4556A

FIGURE 1 — TEMPERATURE CHARACTERISTICS

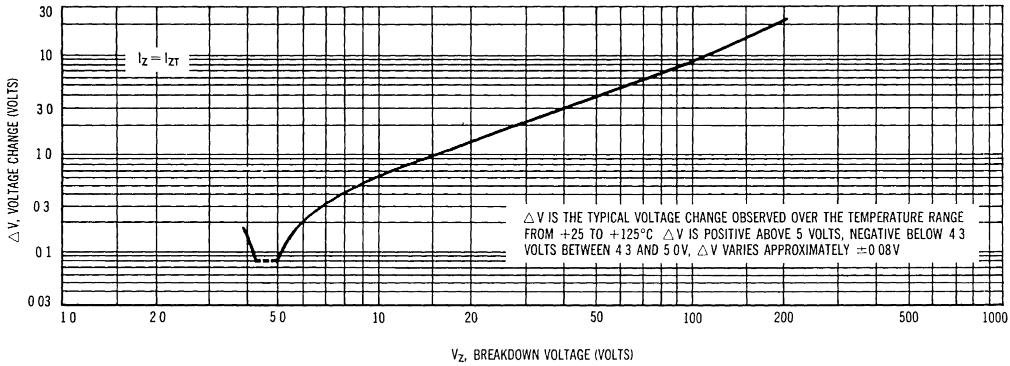


FIGURE 2 — POWER-TEMPERATURE DERATING CURVE

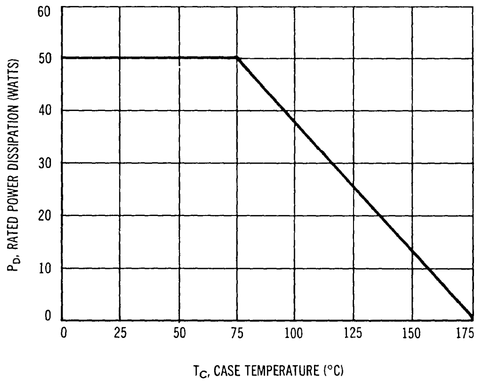


FIGURE 3 — LEAKAGE CURRENT

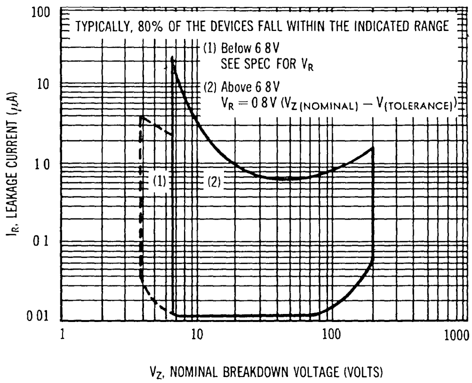
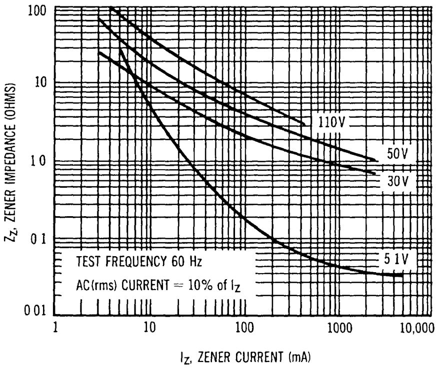


FIGURE 4 — ZENER IMPEDANCE versus ZENER CURRENT



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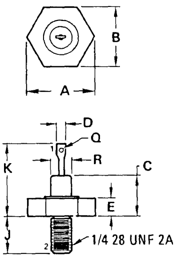


STYLE 1
TERM 1 CATHODE
2 ANODE
STYLE 2
TERM 1 ANODE
2 CATHODE

DIM	MILLIMETERS		INCHES	
	MIN	MAX	MIN	MAX
A	18 92	19 18	0 745	0 755
B	16 94	17 45	0 667	0 687
C	–	11 94	-	0 470
D	3 18	NOM	0 125	NOM
E	2 92	5 08	0 115	0 200
J	10 72	11 51	0 422	0 453
K	–	21 34	–	0 840
Q	1 78	NOM	0 070	NOM
R	–	7 11	–	0 280

CASE 58-01
(stud package)
METAL

MOTOROLA
SEMICONDUCTOR
TECHNICAL DATA

1N3821 thru 1N3830 SERIES

1N3016A thru 1N3051A SERIES

Designers Data Sheet

1.0 WATT METAL SILICON ZENER DIODES

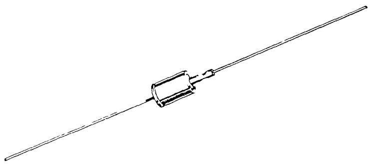
. . a complete series of 1.0 Watt Zener Diodes with limits and operating characteristics that reflect the superior capabilities of silicon-oxide-passivated junctions. All this in an axial-lead, metal package offering protection in all common environmental conditions

- To 100 Watts Surge Rating @ 10 ms
- Maximum Limits Guaranteed on Five Electrical Parameters
- Power Capability to MIL-S-19500 Specifications

Designer's Data for "Worst Case" Conditions

The Designers Data sheets permit the design of most circuits entirely from the information presented Limit curves — representing boundaries on device characteristics — are given to facilitate "worst case" design

1.0 WATT
ZENER REGULATOR DIODES
3.3–200 VOLTS



*MAXIMUM RATINGS

Rating	Symbol	Value	Unit
DC Power Dissipation @ $T_A = 25^oC$ Derate above 25°C (See Figure 1)	P_D	1 0 6 67	Watt mW/°C
Operating and Storage Junction Temperature Range	T_J, T_{stg}	-65 to +175	°C
Lead Temperature 230°C at a distance not less than 1/16" from the case for 10 seconds			

MECHANICAL CHARACTERISTICS

CASE: Welded, hermetically sealed metal and glass

DIMENSIONS: See outline drawing

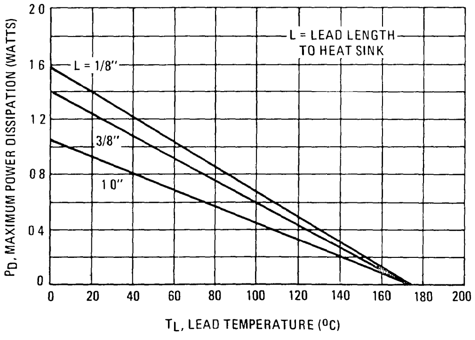
FINISH: All external surfaces are corrosion-resistant and leads are readily solderable and weldable

POLARITY: Cathode connected to the case When operated in zener mode, cathode will be positive with respect to anode

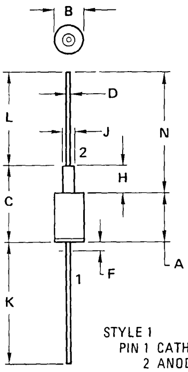
WEIGHT: 1 4 Grams (approx)

MOUNTING POSITION: Any

FIGURE 1 — POWER-TEMPERATURE DERATING CURVE



*Indicates JEDEC Registered Data



STYLE 1
PIN 1 CATHODE
2 ANODE

DIM	MILLIMETERS MIN	MILLIMETERS MAX	INCHES MIN	INCHES MAX
A	7 44	9 07	0 293	0 357
B	5 46	5 97	0 215	0 235
C	–	14 48	–	0 570
D	0 64	0 89	0 025	0 035
F	–	4 78	–	0 188
J	1 14	2 54	0 045	0 100
K	25 40	41 28	1 000	1 625
L	25 40	41 28	1 000	1 625

All JEDEC dimensions and notes apply

CASE 52-03
DO-13
METAL

NOTE
1. ALL RULES AND NOTES ASSOCIATED WITH DO-13 OUTLINE SHALL APPLY

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ELECTRICAL CHARACTERISTICS (T_C = 25°C unless otherwise noted)
V_F = 1.5 V max @ I_F = 200 mA for all types

JEDEC Type No. (Flangeless) (Note 1)	*Nominal Zener Voltage V_Z @ I_{ZT} Volts (Note 1)	*Test Current I_{ZT} mA	*Max Zener Impedance (Note 4)			Max Reverse Current (Note 5)			*Max DC Zener Current I_{ZM} mA (Note 4)
			Z_{ZT} @ I_{ZT} Ohms	Z_{ZK} @ I_{ZK} Ohms	I_{ZK} mA	I_R Max (μA)	V_{R1} 5%	V_{R2} 10%	
1N3821	3 3	76	10	400	1 0	•100	•1 0	1 0	276
1N3822	3 6	69	10	400	1 0	•100	•1 0	1 0	252
1N3823	3 9	64	9 0	400	1 0	•50	•1 0	1.0	238
1N3824	4.3	58	9 0	400	1 0	•10	•1 0	1 0	213
1N3825	4 7	53	8 0	500	1 0	•10	•1 0	1 0	194
1N3826	5 1	49	7 0	550	1 0	•10	•1 0	1 0	178
1N3827	5 6	45	5 0	600	1 0	•10	•2 0	2 0	162
1N3828	6 2	41	2 0	700	1 0	•10	•3 0	3 0	146
1N3829	6 8	37	1 5	500	1 0	•10	•3 0	3 0	133
1N3830	7 5	34	1 5	250	1 0	•10	•3 0	3 0	121
1N3016A	6 8	37	3 5	700	1 0	10	5 2	4 9	140
1N3017A	7 5	34	4 0	700	0 5	10	5 7	5 4	125
1N3018A	8 2	31	4 5	700	0 5	10	6 2	5 9	115
1N3019A	9 1	28	5 0	700	0 5	7 5	6 9	6 6	105
1N3020A	10	25	7 0	700	0 25	5 0	7 6	7 2	95
1N3021A	11	23	8 0	700	0 25	5 0	8 4	8 0	85
1N3022A	12	21	9 0	700	0 25	2 0	9 1	8 6	80
1N3023A	13	19	10	700	0 25	1 0	9 9	9 4	74
1N3024A	15	17	14	700	0 25	1 0	11.4	10 8	63
1N3025A	16	15 5	16	700	0 25	1 0	12 2	11 5	60
1N3026A	18	14	20	750	0 25	0 5	13 7	13 0	52
1N3027A	20	12 5	22	750	0 25	0 5	15 2	14 4	47
1N3028A	22	11 5	23	750	0 25	0 5	16 7	15 8	43
1N3029A	24	10 5	25	750	0 25	0 5	18 2	17 3	40
1N3030A	27	9 5	35	750	0 25	0 5	20 6	19 4	34
1N3031A	30	8 5	40	1000	0 25	0 5	22 8	21 6	31
1N3032A	33	7 5	45	1000	0 25	0 5	25 1	23 8	28
1N3033A	36	7.0	50	1000	0 25	0 5	27 4	25 9	26
1N3034A	39	6 5	60	1000	0 25	0 5	29 7	28 1	23
1N3035A	43	6.0	70	1500	0 25	0 5	32 7	31 0	21
1N3036A	47	5 5	80	1500	0 25	0 5	35 8	33 8	19
1N3037A	51	5 0	95	1500	0 25	0 5	38 8	36 7	18
1N3038A	56	4 5	110	2000	0 25	0 5	42 6	40 3	17
1N3039A	62	4 0	125	2000	0 25	0 5	47 1	44 6	15
1N3040A	68	3 7	150	2000	0 25	0 5	51 7	49 0	14
1N3041A	75	3 3	175	2000	0 25	0 5	56 0	54 0	12
1N3042A	82	3 0	200	3000	0 25	0 5	62 2	59 0	11
1N3043A	91	2 8	250	3000	0 25	0 5	69 2	65 5	10
1N3044A	100	2 5	350	3000	0 25	0 5	76 0	72 0	9 0
1N3045A	110	2 3	450	4000	0 25	0 5	83 6	79 2	8 3
1N3046A	120	2 0	550	4500	0 25	0 5	91 2	86 4	8 0
1N3047A	130	1 9	700	5000	0 25	0 5	98 8	93 6	6 9
1N3048A	150	1.7	1000	6000	0 25	0 5	114 0	108 0	5 7
1N3049A	160	1 6	1100	6500	0 25	0 5	121 6	115 2	5 4
1N3050A	180	1 4	1200	7000	0 25	0 5	136 8	129 6	4 9
1N3051A	200	1 2	1500	8000	0 25	0 5	152 0	144 0	4 6

*JEDEC Registered Data on 1N3821 thru 1N3830 and 1N3016A thru 1N3051A
(*See Notes — page 4-23)

NOTE 1 – ZENER VOLTAGE (V_Z) MEASUREMENT

Motorola guarantees the zener voltage when measured at 90 seconds while maintaining the lead temperature (T_L) at $30^oC \pm 1^oC$, 3/8" from the diode body

Devices shown in table have a standard tolerance of ±10% on the nominal zener voltage ±5% are as follows 1N3821A, 1N3830A, 1N3016B–1N3051B

NOTE 2 – ZENER IMPEDANCE (Z_Z) DERIVATION

The zener impedance is derived from the 60 cycle ac voltage, which results when an ac current having an rms value equal to 10% of the dc zener current (I_{ZT} or I_{ZK}) is superimposed on I_{ZT} or I_{ZK}

NOTE 3 – REVERSE LEAKAGE CURRENT I_R

Reverse leakage currents are guaranteed only for 5% and 10% zener diodes and are measured at V_R as shown in the Electrical Characteristics Table

NOTE 4 – MAXIMUM ZENER CURRENT RATINGS (I_{ZM})

1N3821 thru 1N3830 – Maximum zener current ratings are based on maximum voltage of 10% tolerance units

1N3016 thru 1N3051 – Maximum zener current ratings are based on maximum voltage of 5% tolerance units

NOTE 5 – SURGE CURRENT (i_r)

Surge current is specified as the maximum allowable peak, non-recurrent square-wave current with a specified pulse width, PW The data presented in Figures 8 and 9 may be used to find the maximum surge current for a square wave of any pulse width between 0 01 ms and 1000 ms.

APPLICATION NOTE

Since the actual voltage available from a given zener diode is temperature dependent, it is necessary to determine junction temperature under any set of operating conditions in order to calculate its value The following procedure is recommended

Lead Temperature, T_L, should be determined from

$$T_L = \theta_{LA} P_D + T_A$$

θ_{LA} is the lead-to-ambient thermal resistance ($^oC/W$) and P_D is the power dissipation The value for θ_{LA} will vary and depends on the device mounting method θ_{LA} is generally 30 $40^oC/W$ for the various clips and tie points in common use and for printed circuit board wiring

The temperature of the lead can also be measured using a thermocouple placed on the lead as close as possible to the tie point The thermal mass connected to the tie point is normally large enough so that it will not significantly respond to heat surges generated in the diode as a result of pulsed operation once steady-state conditions are achieved Using the measured value of T_L, the junction temperature may be determined by

$$T_J = T_L + \Delta T_{JL}$$

ΔT_{JL} is the increase in junction temperature above the lead temperature and may be found from Figure 6 for a train of power pulses (L = 3/8 inch) or from Figure 7 for dc power

$$\Delta T_{JL} = \theta_{JL} P_D$$

For worst-case design, using expected limits of I_Z, limits of P_D and the extremes of $T_J(\Delta T_J)$ may be estimated Changes in voltage, V_Z, can then be found from

$$\Delta V = \theta_{VZ} \Delta T_J$$

θ_{VZ}, the zener voltage temperature coefficient, is found from Figures 2 and 3

Under high power-pulse operation, the zener voltage will vary with time and may also be affected significantly by the zener resistance For best regulation, keep current excursions as low as possible.

Data of Figure 6 should not be used to compute surge capability Surge limitations are given in Figure 8 They are lower than would be expected by considering only junction temperature, as current crowding effects cause temperatures to be extremely high in small spots resulting in device degradation should the limits of Figure 8 be exceeded

TEMPERATURE COEFFICIENTS AND VOLTAGE REGULATION

(90% OF THE UNITS ARE IN THE RANGES INDICATED)

FIGURE 2 – TEMPERATURE COEFFICIENT-RANGE FOR UNITS TO 12 VOLTS

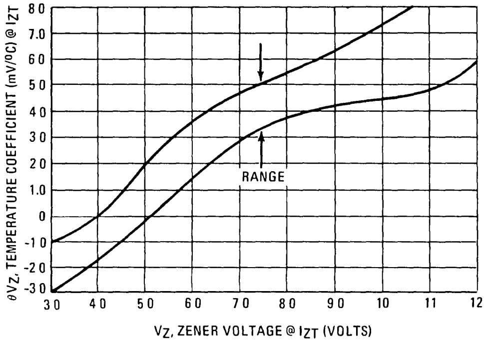

FIGURE 3 – TEMPERATURE COEFFICIENT-RANGE FOR UNITS 10 TO 220 VOLTS

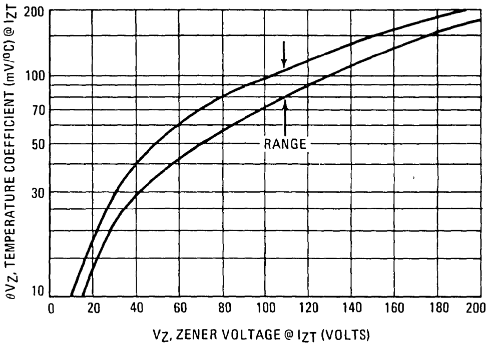

FIGURE 4 – TYPICAL VOLTAGE REGULATION

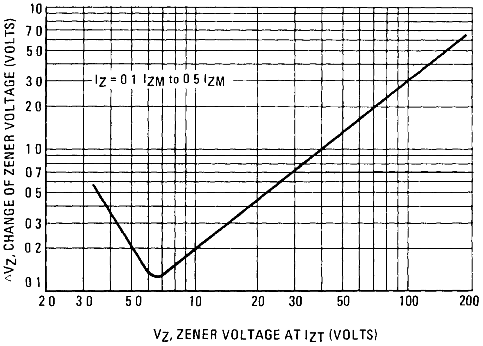

FIGURE 5 – MAXIMUM REVERSE LEAKAGE (95% OF THE UNITS ARE BELOW THE VALUES SHOWN)

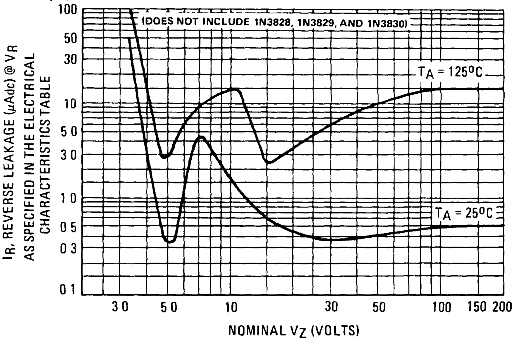

FIGURE 6 – TYPICAL THERMAL RESPONSE L, LEAD LENGTH = 3/8 INCH

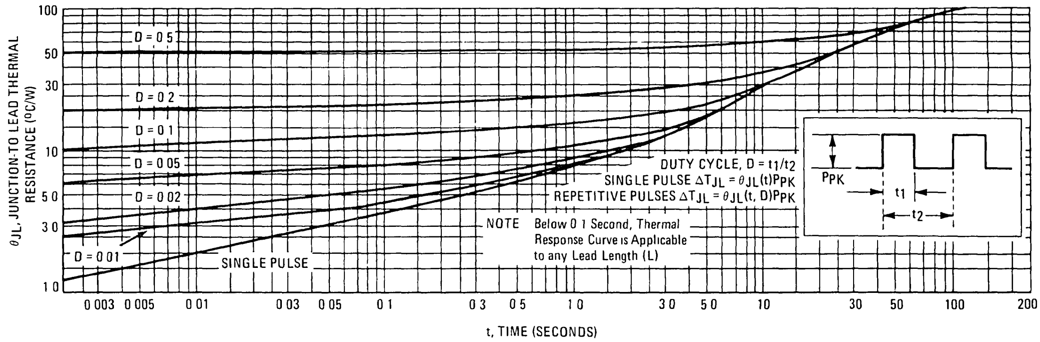

FIGURE 7 – TYPICAL THERMAL RESISTANCE

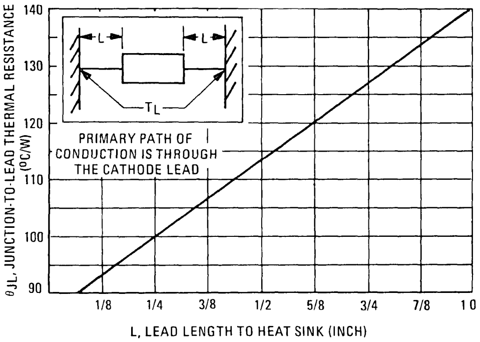

FIGURE 8 – MAXIMUM NON-REPETITIVE SURGE CURRENT

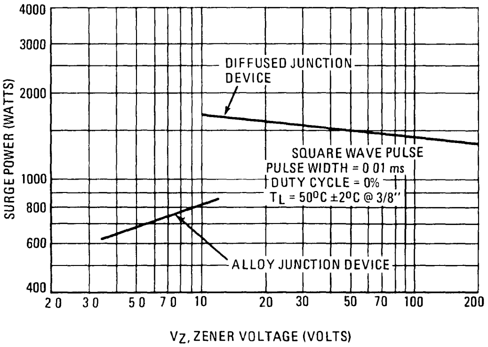

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FIGURE 9 – SURGE POWER FACTOR

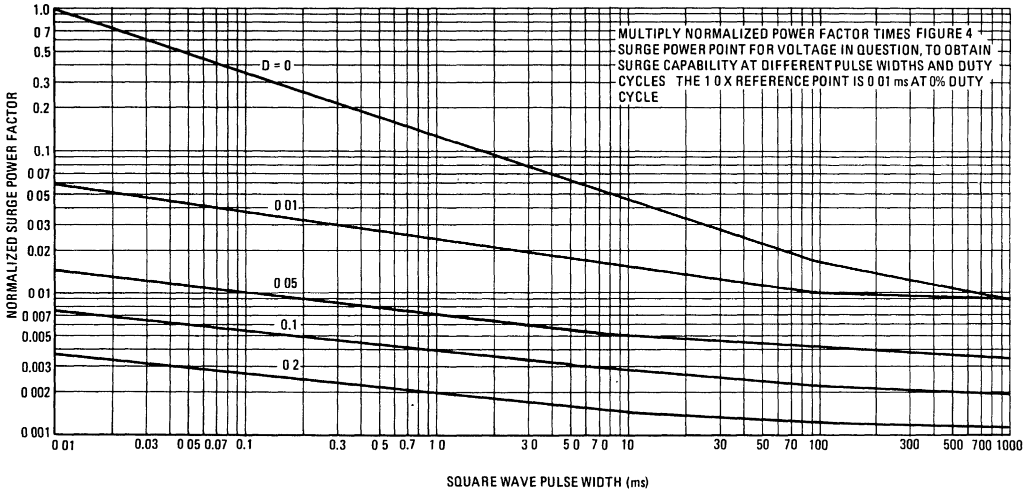
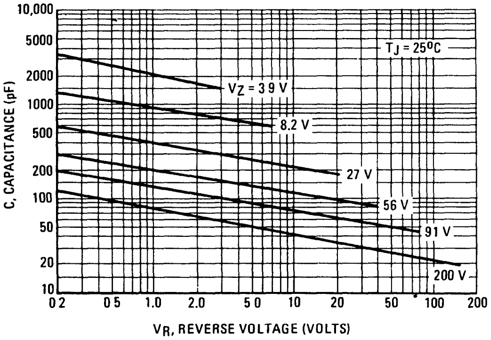


FIGURE 10 – TYPICAL CAPACITANCE



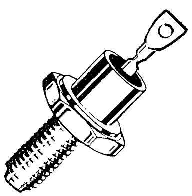
MOTOROLA
SEMICONDUCTOR
TECHNICAL DATA

1N3993 THRU 1N4000

ZENER DIODES

Low-voltage, alloy-junction zener diodes in hermetically sealed package with cathode connected to case. Supplied with mounting hardware.

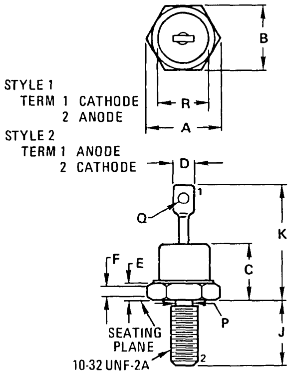
10 WATTS ZENER DIODES



MAXIMUM RATINGS

Junction and Storage Temperature: −65 °C to +175 °C.
DC Power Dissipation: 10 Watts. (Derate 83.3 mW/°C above 55 °C).

The type numbers shown in the table have a standard tolerance on the nominal zener voltage of ±10%. A standard tolerance of ±5% on individual units is also available and is indicated by suffixing "A" to the standard type number.



DIM	MILLIMETERS MIN	MILLIMETERS MAX	INCHES MIN	INCHES MAX
A	11 94	12 83	0 470	0 505
B	10 77	11.10	0 424	0 437
C	–	10 29	–	0 405
D	–	6 35	–	0 250
E	1 91	4 45	0 075	0 175
F	1 52	–	0 060	–
J	10 72	11 51	0 422	0 453
K	–	20.32	–	0 800
P	4.14	4 80	0 163	0 189
Q	1 52	–	0.060	–
R	–	10 77	–	0 424

All JEDEC dimensions and notes apply

CASE 56-02
DO-203AA
METAL

ELECTRICAL CHARACTERISTICS ($T_B = 30\,°C \pm 3$, $V_F = 1.5$ max @ $I_F = 2$ amp for all units)

Type No.	Nominal Zener Voltage V_Z @ I_{ZT} Volts	Test Current I_{ZT} mA	Max Zener Impedance Z_{ZT} @ I_{ZT} Ohms	Max Zener Impedance Z_{ZK} @ $I_{ZK} = 1.0$ mA Ohms	Max DC Zener Current I_{ZM} mA	Reverse Leakage Current I_R µA	Reverse Leakage Current V_R Volts
1N3993	3.9	640	2 0	400	2380	100	0.5
1N3994	4 3	580	1 5	400	2130	100	0.5
1N3995	4 7	530	1 2	500	1940	50	1.0
1N3996	5.1	490	1 1	550	1780	10	1.0
1N3997	5 6	445	1 0	600	1620	10	1.0
1N3998	6.2	405	1.1	750	1460	10	2.0
1N3999	6.8	370	1.2	500	1330	10	2 0
1N4000	7.5	335	1.3	250	1210	10	3 0

SPECIAL SELECTIONS AVAILABLE INCLUDE: (See Selector Guide for details)

MOTOROLA
SEMICONDUCTOR
TECHNICAL DATA

1N4099 thru 1N4135
1N4614 thru 1N4627

LOW-LEVEL SILICON PASSIVATED ZENER DIODES

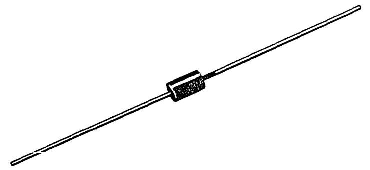
designed for 250 mW applications requiring low leakage, low impedance, and low noise.

- Voltage Range from 1 8 to 100 Volts
- First Zener Diode Series to Specify Noise — 50% Lower than Conventional Diffused Zeners
- Zener Impedance and Zener Voltage Specified for Low-Level Operation at I_{ZT} = 250 μA
- Low Leakage Current — I_R from 0 01 to 10 μA over Voltage Range

SILICON ZENER DIODES
(±5.0% TOLERANCE)

250 MILLIWATTS
1.8-100 VOLTS

SILICON OXIDE PASSIVATED JUNCTION



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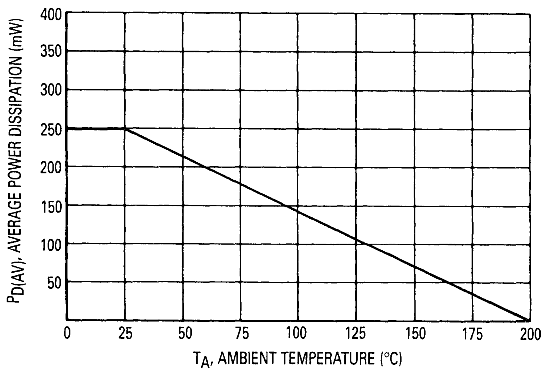
MAXIMUM RATINGS

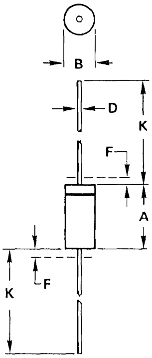
Rating	Symbol	Value	Unit
DC Power Dissipation @ T_A = 25°C Derate above 25°C	P_D	250 1 43	mW mW/°C
Junction and Storage Temperature Range	T_J, T_{stg}	-65 to +200	°C

MECHANICAL CHARACTERISTICS

CASE: Hermetically sealed, all-glass
DIMENSIONS See outline drawing
FINISH All external surfaces are corrosion resistant and leads are readily solderable and weldable
POLARITY: Cathode indicated by polarity band
WEIGHT. 0 2 gram (approx)
MOUNTING POSITION. Any

POWER TEMPERATURE DERATING CURVE





NOTES
1 PACKAGE CONTOUR OPTIONAL WITHIN A AND B HEAT SLUGS, IF ANY, SHALL BE INCLUDED WITHIN THIS CYLINDER, BUT NOT SUBJECT TO THE MINIMUM LIMIT OF B
2 LEAD DIAMETER NOT CONTROLLED IN ZONE F TO ALLOW FOR FLASH, LEAD FINISH BUILDUP AND MINOR IRREGULARITIES OTHER THAN HEAT SLUGS
3 POLARITY DENOTED BY CATHODE BAND
4 DIMENSIONING AND TOLERANCING PER ANSI Y14 5, 1973

	MILLIMETERS		INCHES	
DIM	MIN	MAX	MIN	MAX
A	3 05	5 08	0 120	0 200
B	1 52	2 29	0 060	0 090
D	0 46	0 56	0 018	0 022
F	–	1 27	–	0 050
K	25 40	38 10	1 000	1 500

All JEDEC dimensions and notes apply

CASE 299-02
DO-204AH
GLASS

ELECTRICAL CHARACTERISTICS

(At 25°C Ambient temperature unless otherwise specified) I_{ZT} = 250 μA and V_F = 1.0 V max @ I_F = 200 mA on all Types

Type Number (Note 1)	Nominal Zener Voltage V_Z (Note 1) (Volts)	Max Zener Impedance Z_{ZT} (Note 2) (Ohms)	Max Reverse Current I_R (μA)	@ (Note 4)	Test Voltage V_R (Volts)	Max Noise Density At I_{ZT} = 250 μA N_D (Fig 1) (micro-volts per Square Root Cycle)	Max Zener Current I_{ZM} (Note 3) (mA)
1N4614	1.8	1200	7.5		1.0	1.0	120
1N4615	2.0	1250	5.0		1.0	1.0	110
1N4616	2.2	1300	4.0		1.0	1.0	100
1N4617	2.4	1400	2.0		1.0	1.0	95
1N4618	2.7	1500	1.0		1.0	1.0	90
1N4619	3.0	1600	0.8		1 0	1.0	85
1N4620	3.3	1650	7.5		1.5	1.0	80
1N4621	3.6	1700	7 5		2.0	1.0	75
1N4622	3.9	1650	5.0		2.0	1.0	70
1N4623	4.3	1600	4.0		2 0	1.0	65
1N4624	4.7	1550	10		3 0	1.0	60
1N4625	5.1	1500	10		3.0	2.0	55
1N4626	5.6	1400	10		4.0	4.0	50
1N4627	6.2	1200	10		5.0	5.0	45
1N4099	6.8	200	10		5.2	40	35
1N4100	7.5	200	10		5.7	40	31.8
1N4101	8.2	200	1.0		6.3	40	29.0
1N4102	8.7	200	1.0		6.7	40	27.4
1N4103	9.1	200	1.0		7.0	40	26 2
1N4104	10	200	1.0		7.6	40	24.8
1N4105	11	200	0.05		8.5	40	21 6
1N4106	12	200	0.05		9.2	40	20.4
1N4107	13	200	0.05		9.9	40	19.0
1N4108	14	200	0.05		10.7	40	17.5
1N4109	15	100	0.05		11.4	40	16.3
1N4110	16	100	0.05		12.2	40	15.4
1N4111	17	100	0.05		13.0	40	14.5
1N4112	18	100	0 05		13.7	40	13.2
1N4113	19	150	0.05		14.5	40	12.5
1N4114	20	150	0.01		15.2	40	11.9
1N4115	22	150	0 01		16.8	40	10.8
1N4116	24	150	0.01		18.3	40	9.9
1N4117	25	150	0.01		19.0	40	9.5
1N4118	27	150	0.01		20 5	40	8.8
1N4119	28	200	0.01		21.3	40	8.5
1N4120	30	200	0.01		22.8	40	7.9
1N4121	33	200	0.01		25.1	40	7.2
1N4122	36	200	0.01		27.4	40	6.6
1N4123	39	200	0.01		29.7	40	6.1
1N4124	43	250	0.01		32.7	40	5.5
1N4125	47	250	0.01		35.8	40	5.1
1N4126	51	300	0.01		38.8	40	4.6
1N4127	56	300	0.01		42.6	40	4.2
1N4128	60	400	0.01		45.6	40	4.0
1N4129	62	500	0.01		47.1	40	3.8
1N4130	68	700	0.01		51.7	40	3.5
1N4131	75	700	0.01		57.0	40	3.1
1N4132	82	800	0.01		62.4	40	2.9
1N4133	87	1000	0.01		66.2	40	2.7
1N4134	91	1200	0.01		69.2	40	2.6
1N4135	100	1500	0.01		76.0	40	2.3

NOTE 1: TOLERANCE AND VOLTAGE DESIGNATION

The type numbers shown have a standard tolerance of ±5.0% on the nominal zener voltage. C for ±2.0%, D for ±1%.

NOTE 2: ZENER IMPEDANCE (Z_{ZT}) DERIVATION

The zener impedance is derived from the 60 cycle ac voltage, which results when an ac current having an rms value equal to 10% of the dc zener current (I_{ZT}) is superimposed on I_{ZT}.

NOTE 3: MAXIMUM ZENER CURRENT RATINGS (I_{ZM})

Maximum zener current ratings are based on maximum zener voltage of the individual units.

NOTE 4: REVERSE LEAKAGE CURRENT I_R

Reverse leakage currents are guaranteed and are measured at V_R as shown on the table.

ZENER NOISE DENSITY

A zener diode generates noise when it is biased in the zener direction. A small part of this noise is due to the internal resistance associated with the device. A larger part of zener noise is a result of the zener breakdown phenomenon and is called microplasma noise. This microplasma noise is generally considered "white" noise with equal amplitude for all frequencies from about zero cycles to approximately 200,000 cycles. To eliminate the higher frequency components of noise a small shunting capacitor can be used. The lower frequency noise generally must be tolerated since a capacitor required to eliminate the lower frequencies would degrade the regulation properties of the zener in many applications.

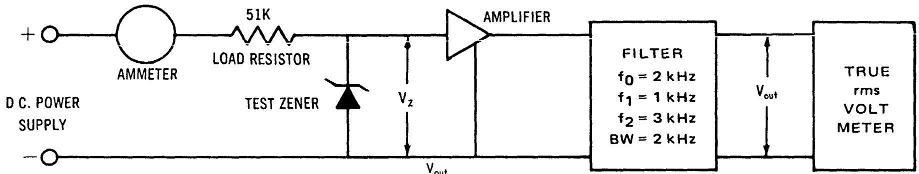
Motorola is rating this series with a maximum noise density at 250 microamperes. The rating of microvolts RMS per square root cycle enables calculation of the maximum RMS noise for any bandwidth.

Noise density decreases as zener current increases. This can be seen by the graph in Figure 2 where a typical noise density is plotted as a function of zener current.

The junction temperature will also change the zener noise levels. Thus the noise rating must indicate bandwidth, current level and temperature.

The block diagram given in Figure 1 shows the method used to measure noise density. The input voltage and load resistance is high so that the zener is driven from a constant current source. The amplifier must be low noise so that the amplifier noise is negligible compared to the test zener. The filter bandpass is known so that the noise density in volts RMS per square root cycle can be calculated.

FIGURE 1 — NOISE DENSITY MEASUREMENT METHOD



$$\text{NOISE DENSITY (VOLTS PER SQUARE ROOT CYCLE)} = \frac{V_{out}}{\text{OVERALL GAIN}\sqrt{BW}}$$

WHERE BW = FILTER BANDWIDTH (CYCLES)

V_{out} = OUTPUT NOISE (VOLTS RMS)

FIGURE 2 — TYPICAL NOISE DENSITY versus ZENER CURRENT

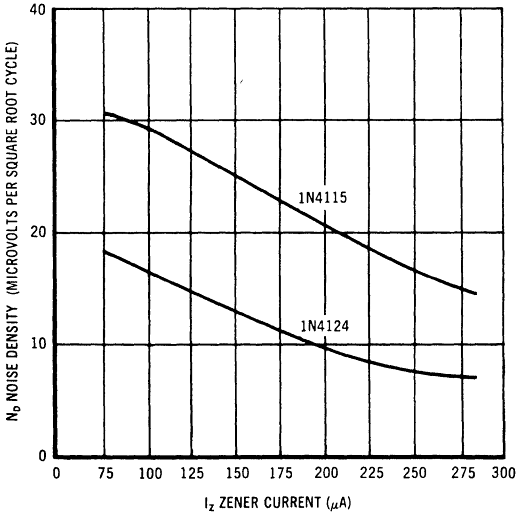


FIGURE 3 – TYPICAL CAPACITANCE

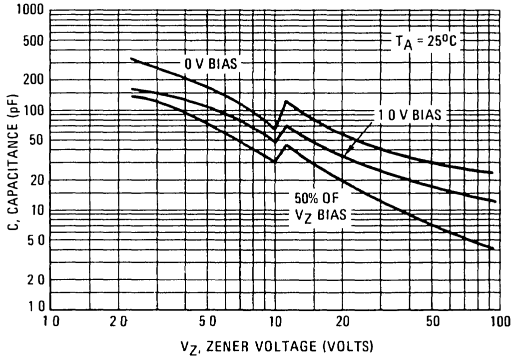
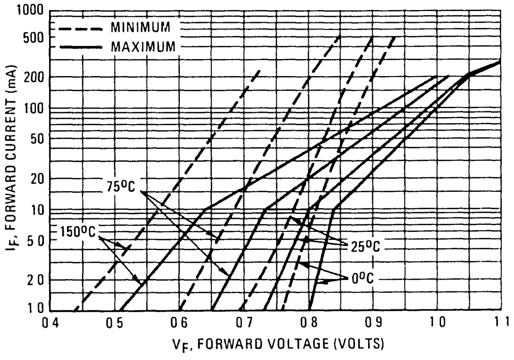


FIGURE 4 – TYPICAL FORWARD CHARACTERISTICS



4

MOTOROLA
SEMICONDUCTOR
TECHNICAL DATA

1N4370 thru 1N4372
See Page 4-4

1N4549A thru 1N4556A
See Page 4-17

1N4565 thru 1N4584

REFERENCE DIODES

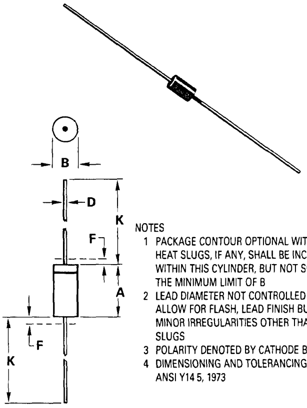
LOW LEVEL TEMPERATURE-COMPENSATED ZENER

LOW-LEVEL TEMPERATURE-COMPENSATED ZENER REFERENCE DIODES

Highly reliable reference sources utilizing a passivated junction for long-term voltage stability. Glass construction provides a rugged, hermetically sealed structure.

- Low Power Drain Devices Specified @ 0.5 mA, 1.0 mA, 2.0 mA, and 4.0 mA
- Maximum Voltage Change Specified over Test Temperature Range
- Temperature Compensation Guaranteed over Two Standard Operating Temperature Ranges·
  0 to 75°C
  -55 to 100°C

1N4565 thru 1N4584



NOTES
1 PACKAGE CONTOUR OPTIONAL WITHIN A AND B HEAT SLUGS, IF ANY, SHALL BE INCLUDED WITHIN THIS CYLINDER, BUT NOT SUBJECT TO THE MINIMUM LIMIT OF B
2 LEAD DIAMETER NOT CONTROLLED IN ZONE F TO ALLOW FOR FLASH, LEAD FINISH BUILDUP AND MINOR IRREGULARITIES OTHER THAN HEAT SLUGS
3 POLARITY DENOTED BY CATHODE BAND
4 DIMENSIONING AND TOLERANCING PER ANSI Y14 5, 1973

DIM	MILLIMETERS MIN	MILLIMETERS MAX	INCHES MIN	INCHES MAX
A	3 05	5 08	0 120	0 200
B	1 52	2 29	0 060	0 090
D	0 46	0 56	0 018	0 022
F	—	1 27	—	0 050
K	25 40	38 10	1 000	1 500

All JEDEC dimensions and notes apply

CASE 299-02
DO-204AH
GLASS

MAXIMUM RATINGS

Rating	Symbol	Value	Unit
DC Power Dissipation @ T_A = 50°C Derate above 50°C	P_D	400 3 2	mW mW/°C
Junction and Storage Temperature Range	T_J, T_{stg}	-65 to +175	°C

MECHANICAL CHARACTERISTICS

CASE. Hermetically sealed, all-glass

DIMENSIONS: See outline drawing

FINISH: All external surfaces are corrosion resistant and leads are readily solderable and weldable

POLARITY: Cathode indicated by polarity band

WEIGHT: 0 2 gram (approx)

MOUNTING POSITION: Any

1N4565 thru 1N4584

TYPE	ΔV_Z (Note 1) Volts Max	@ Test Temperature °C	Temperature Coefficient for Reference %/°C (Note 1)	Dynamic Imped. Ohms Max (Note 2)
$V_Z = 6.4$ Volts ±5% ($I_{ZT} = 0.5$ mA)				
1N4565	0.048		0.01	
1N4566	0.024		0.005	
1N4567	0.010	0, +25,	0.002	200
1N4568	0.005	+75	0.001	
1N4569	0.002		0.0005	
1N4565A	0.099		0.01	
1N4566A	0.050	−55, 0,	0.005	
1N4567A	0.020	+25, +75,	0.002	200
1N4568A	0.010	+100	0.001	
1N4569A	0.005		0.005	
$V_Z = 6.4$ Volts ±5% ($I_{ZT} = 1.0$ mA)				
1N4570	0.048		0.01	
1N4571	0 024		0.005	
1N4572	0 010	0, +25,	0.002	100
1N4573	0.005	+75	0.001	
1N4574	0.002		0 0005	
1N4570A	0.099		0.01	
1N4571A	0.050	−55, 0,	0.005	
1N4572A	0.020	+25, +75,	0.002	100
1N4573A	0.010	+100	0 001	
1N4574A	0.005		0.0005	
$V_Z = 6.4$ Volts ±5% ($I_{ZT} = 2.0$ mA)				
1N4575	0.048		0 01	
1N4576	0.024		0.005	
1N4577	0.010	0, +25,	0.002	50
1N4578	0 005	+75	0.001	
1N4579	0.002		0.0005	
1N4575A	0.099		0.01	
1N4576A	0.050	−55, 0,	0.005	
1N4577A	0.020	+25, +75,	0.002	50
1N4578A	0.010	+100	0.001	
1N4579A	0.005		0.0005	
$V_Z = 6.4$ Volts ±5% ($I_{ZT} = 4.0$ mA)				
1N4580	0.048		0.01	
1N4581	0.024		0.005	
1N4582	0.010	0, +25,	0.002	25
1N4583	0.005	+75	0.001	
1N4584	0.002		0.0005	
1N4580A	0.099		0.01	
1N4581A	0.050	−55, 0,	0.005	
1N4582A	0.020	+25, +75,	0.002	25
1N4583A	0.010	+100	0.001	
1N4584A	0.005		0.0005	

NOTE 1: Voltage Variation (ΔV_Z) and Temperature Coefficient.
All reference diodes are characterized by the "box method" This guarantees a maximum voltage variation (ΔV_Z) over the specified temperature range, at the specified test current (I_{ZT}), verified by tests at indicated temperature points within the range This method of indicating voltage stability is now used for JEDEC registration as well as for military qualification The former method of indicating voltage stability—by means of temperature coefficient—accurately reflects the voltage deviation at the temperature extremes, but is not necessarily accurate within the temperature range because reference diodes have a nonlinear temperature relationship The temperature coefficient, therefore, is given only as a reference.

NOTE 2:
The dynamic zener impedance, Z_{ZT}, is derived from the 60 Hz ac voltage drop which results when an ac current with an rms value equal to 10% of the dc zener current, I_{ZT} is superimposed on I_{ZT}. A cathode-ray tube curve-trace test on a sample basis is used to ensure that the zener has a sharp and stable knee region.

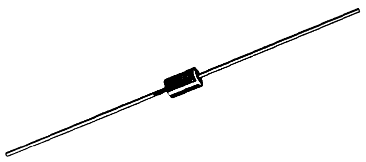
MOTOROLA
SEMICONDUCTOR
TECHNICAL DATA

1N4614 thru 1N4627
See Page 4-28

1N4678 thru 1N4717

ZENER REGULATOR DIODES

250 MILLIWATTS



ZENER REGULATOR DIODES

Low level oxide passivated zener diodes for applications requiring extremely low operating currents, low leakage, and sharp breakdown voltage.

- Zener Voltage Specified @ I_{ZT} = 50 μA
- Maximum Delta V_Z Given from 10 to 100 μA

ABSOLUTE MAXIMUM RATINGS

Rating	Symbol	Value	Unit
DC Power Dissipation @ T_A = 50°C Derate above T_A = 50°C	P_D	250 1 67	mW mW/°C
Operating and Storage Junction Temperature Range	T_J, T_{stg}	−65 to +175	°C

MECHANICAL CHARACTERISTICS

CASE: Hermetically sealed all glass case.

DIMENSIONS: See outline drawing

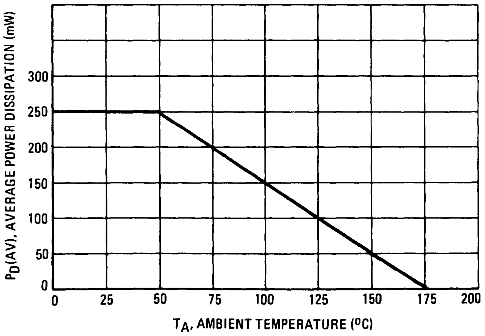
FINISH: All external surfaces are corrosion resistant with readily solerable leads

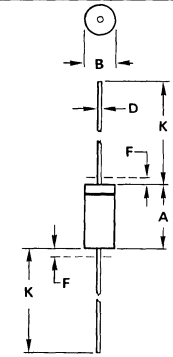
POLARITY: Cathode end indicated by color band. When operated in zener region, the cathode end will be positive with respect to anode end

WEIGHT: 0.2 grams (approx)

MOUNTING POSITION: Any.

FIGURE 1 — POWER TEMPERATURE DERATING CURVE





NOTES
1 PACKAGE CONTOUR OPTIONAL WITHIN A AND B HEAT SLUGS, IF ANY, SHALL BE INCLUDED WITHIN THIS CYLINDER, BUT NOT SUBJECT TO THE MINIMUM LIMIT OF B
2 LEAD DIAMETER NOT CONTROLLED IN ZONE F TO ALLOW FOR FLASH, LEAD FINISH BUILDUP AND MINOR IRREGULARITIES OTHER THAN HEAT SLUGS
3 POLARITY DENOTED BY CATHODE BAND
4 DIMENSIONING AND TOLERANCING PER ANSI Y14 5, 1973

	MILLIMETERS		INCHES	
DIM	MIN	MAX	MIN	MAX
A	3 05	5 08	0 120	0 200
B	1 52	2.29	0 060	0 090
D	0 46	0.56	0 018	0 022
F	–	1 27	–	0 050
K	25 40	38 10	1.000	1 500

All JEDEC dimensions and notes apply

CASE 299-02
DO-204AH
GLASS

4

1N4678 thru 1N4717

ELECTRICAL CHARACTERISTICS (T_A = 25°C, V_F = 1.5 V max at I_F = 100 mA for all types)

Type Number (Note 1)	Zener Voltage V_Z @ I_{ZT} = 50 µA Volts			Maximum Reverse Current I_R µA (Note 3)	Test Voltage V_R Volts	Maximum Zener Current I_{ZM} mA (Note 2)	Maximum Voltage Change ΔV_Z Volts (Note 4)
	Nom (Note 1)	Min	Max				
1N4678	1 8	1.710	1.890	7.5	1.0	120	0.70
1N4679	2.0	1.900	2.100	5.0	1.0	110	0.70
1N4680	2.2	2.090	2.310	4.0	1.0	100	0.75
1N4681	2.4	2.280	2.520	2.0	1.0	95	0.80
1N4682	2.7	2.565	2.835	1.0	1.0	90	0.85
1N4683	3.0	2.850	3.150	0.8	1.0	85	0.90
1N4684	3.3	3.135	3.465	7.5	1.5	80	0.95
1N4685	3.6	3.420	3.780	7.5	2.0	75	0.95
1N4686	3.9	3 705	4.095	5.0	2.0	70	0.97
1N4687	4.3	4.085	4.515	4.0	2.0	65	0.99
1N4688	4.7	4.465	4.935	10	3.0	60	0.99
1N4689	5.1	4.845	5.355	10	3.0	55	0.97
1N4690	5.6	5.320	5.880	10	4.0	50	0.96
1N4691	6.2	5.890	6.510	10	5.0	45	0.95
1N4692	6.8	6 460	7.140	10	5.1	35	0.90
1N4693	7.5	7.125	7.875	10	5.7	31.8	0.75
1N4694	8.2	7.790	8.610	1.0	6 2	29.0	0.50
1N4695	8.7	8.265	9.135	1.0	6.6	27.4	0.10
1N4696	9 1	8.645	9.555	1.0	6.9	26.2	0.08
1N4697	10	9.500	10.50	1.0	7.6	24.8	0.10
1N4698	11	10.45	11.55	0.05	8.4	21.6	0.11
1N4699	12	11.40	12.60	0.05	9.1	20.4	0 12
1N4700	13	12.35	13.65	0.05	9.8	19.0	0.13
1N4701	14	13.30	14.70	0.05	10.6	17.5	0.14
1N4702	15	14.25	15.75	0.05	11.4	16.3	0.15
1N4703	16	15.20	16.80	0.05	12.1	15.4	0.16
1N4704	17	16.15	17.85	0.05	12.9	14.5	0.17
1N4705	18	17.10	18.90	0.05	13.6	13.2	0.18
1N4706	19	18.05	19.95	0.05	14.4	12.5	0.19
1N4707	20	19.00	21.00	0.01	15.2	11 9	0.20
1N4708	22	20.90	23.10	0.01	16.7	10.8	0.22
1N4709	24	22.80	25.20	0.01	18.2	9.9	0.24
1N4710	25	23.75	26.25	0.01	19.0	9.5	0.25
1N4711	27	25.65	28.35	0.01	20.4	8.8	0.27
1N4712	28	26.60	29.40	0.01	21.2	8.5	0.28
1N4713	30	28.50	31.50	0.01	22.8	7.9	0.30
1N4714	33	31.35	34.65	0.01	25.0	7 2	0.33
1N4715	36	34.20	37.80	0.01	27.3	6.6	0.36
1N4716	39	37.05	40.95	0.01	29.6	6.1	0.39
1N4717	43	40.85	45.15	0.01	32.6	5.5	0.43

NOTES: 1. TOLERANCING AND VOLTAGE DESIGNATION (V_Z)
The type numbers shown have a standard tolerance of ±5% on the nominal Zener voltage, C for ±2%, D for ±1%.

2. MAXIMUM ZENER CURRENT RATINGS (I_{ZM})
Maximum Zener current ratings are based on maximum Zener voltage of the individual units.

3. REVERSE LEAKAGE CURRENT (I_R)
Reverse leakage currents are guaranteed and measured at V_R as shown on the table.

4. MAXIMUM VOLTAGE CHANGE (ΔV_Z)
Voltage change is equal to the difference between V_Z at 100 µA and V_Z at 10 µA.

MOTOROLA
SEMICONDUCTOR
TECHNICAL DATA

1N4728, A thru 1N4764, A

Designers Data Sheet

ONE WATT HERMETICALLY SEALED GLASS SILICON ZENER DIODES

- Complete Voltage Range — 3.3 to 100 Volts
- DO-41 Package
- Double Slug Type Construction
- Metallurgically Bonded Construction
- Oxide Passivated Die

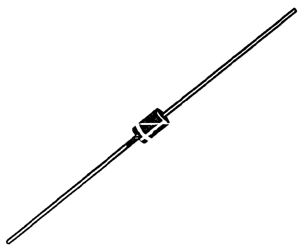
Designer's Data for "Worst Case" Conditions

The Designers Data sheets permit the design of most circuits entirely from the information presented. Limit curves — representing boundaries on device characteristics — are given to facilitate "worst case" design.

1.0 WATT

ZENER REGULATOR DIODES

3.3–100 VOLTS



4

*MAXIMUM RATINGS

Rating	Symbol	Value	Unit
DC Power Dissipation @ $T_A = 50^oC$ Derate above 50^oC	P_D	1.0 6.67	Watt $mW/^oC$
Operating and Storage Junction Temperature Range	T_J, T_{stg}	-65 to +200	^oC

MECHANICAL CHARACTERISTICS

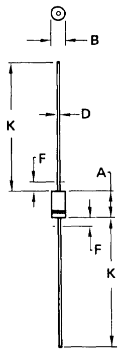
CASE. Double slug type, hermetically sealed glass

MAXIMUM LEAD TEMPERATURE FOR SOLDERING PURPOSES: 230°C, 1/16" from case for 10 seconds

FINISH: All external surfaces are corrosion resistant with readily solderable leads

POLARITY: Cathode indicated by color band When operated in zener mode, cathode will be positive with respect to anode

MOUNTING POSITION. Any

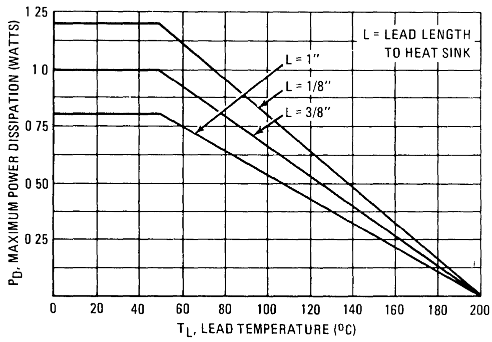


DIM	MILLIMETERS MIN	MILLIMETERS MAX	INCHES MIN	INCHES MAX
A	4.07	5.20	0.160	0.205
B	2.04	2.71	0.080	0.107
D	0.71	0.86	0.028	0.034
F	–	1.27	–	0.050
K	27.94	–	1.100	–

CASE 59-03
DO-41
GLASS

NOTES
1 ALL RULES AND NOTES ASSOCIATED WITH JEDEC DO 41 OUTLINE SHALL APPLY
2 POLARITY DENOTED BY CATHODE BAND
3 LEAD DIAMETER NOT CONTROLLED WITHIN "F" DIMENSION

FIGURE 1 – POWER TEMPERATURE DERATING CURVE



*Indicates JEDEC Registered Data

*ELECTRICAL CHARACTERISTICS (T_A = 25°C unless otherwise noted) V_F = 1.2 V max, I_F = 200 mA for all types.

JEDEC Type No. (Note 1)	Nominal Zener Voltage V_Z @ I_{ZT} Volts (Notes 2 and 3)	Test Current I_{ZT} mA	Maximum Zener Impedance (Note 4) Z_{ZT} @ I_{ZT} Ohms	Z_{ZK} @ I_{ZK} Ohms	I_{ZK} mA	Leakage Current I_R µA Max	V_R Volts	Surge Current @ T_A = 25°C i_r – mA (Note 5)
1N4728	3.3	76	10	400	1.0	100	1.0	1380
1N4729	3.6	69	10	400	1.0	100	1.0	1260
1N4730	3.9	64	9.0	400	1.0	50	1.0	1190
1N4731	4.3	58	9.0	400	1.0	10	1.0	1070
1N4732	4.7	53	8.0	500	1.0	10	1.0	970
1N4733	5.1	49	7.0	550	1.0	10	1.0	890
1N4734	5.6	45	5.0	600	1.0	10	2.0	810
1N4735	6.2	41	2.0	700	1.0	10	3.0	730
1N4736	6.8	37	3.5	700	1.0	10	4.0	660
1N4737	7.5	34	4.0	700	0.5	10	5.0	605
1N4738	8.2	31	4.5	700	0.5	10	6.0	550
1N4739	9.1	28	5.0	700	0.5	10	7.0	500
1N4740	10	25	7.0	700	0.25	10	7.6	454
1N4741	11	23	8.0	700	0.25	5.0	8.4	414
1N4742	12	21	9.0	700	0.25	5.0	9.1	380
1N4743	13	19	10	700	0.25	5.0	9.9	344
1N4744	15	17	14	700	0.25	5.0	11.4	304
1N4745	16	15.5	16	700	0.25	5.0	12.2	285
1N4746	18	14	20	750	0.25	5.0	13.7	250
1N4747	20	12.5	22	750	0.25	5.0	15.2	225
1N4748	22	11.5	23	750	0.25	5.0	16.7	205
1N4749	24	10.5	25	750	0.25	5.0	18.2	190
1N4750	27	9.5	35	750	0.25	5.0	20.6	170
1N4751	30	8.5	40	1000	0.25	5.0	22.8	150
1N4752	33	7.5	45	1000	0.25	5.0	25.1	135
1N4753	36	7.0	50	1000	0.25	5.0	27.4	125
1N4754	39	6.5	60	1000	0.25	5.0	29.7	115
1N4755	43	6.0	70	1500	0.25	5.0	32.7	110
1N4756	47	5.5	80	1500	0.25	5.0	35.8	95
1N4757	51	5.0	95	1500	0.25	5.0	38.8	90
1N4758	56	4.5	110	2000	0.25	5.0	42.6	80
1N4759	62	4.0	125	2000	0.25	5.0	47.1	70
1N4760	68	3.7	150	2000	0.25	5.0	51.7	65
1N4761	75	3.3	175	2000	0.25	5.0	56.0	60
1N4762	82	3.0	200	3000	0.25	5.0	62.2	55
1N4763	91	2.8	250	3000	0.25	5.0	69.2	50
1N4764	100	2.5	350	3000	0.25	5.0	76.0	45

*Indicates JEDEC Registered Data

NOTE 1 — Tolerance and Type Number Designation. The JEDEC type numbers listed have a standard tolerance on the nominal zener voltage of ±10%. A standard tolerance of ±5% on individual units is also available and is indicated by suffixing "A" to the standard type number. C for ±2.0%, D for ±1.0%.

NOTE 2 — Specials Available Include:

A Nominal zener voltages between the voltages shown and tighter voltage tolerances,

B Matched sets

For detailed information on price, availability, and delivery, contact your nearest Motorola representative

NOTE 3 — Zener Voltage (V_Z) Measurement. Motorola guarantees the zener voltage when measured at 90 seconds while maintaining the lead temperature (T_L) at 30°C ± 1°C, 3/8" from the diode body.

NOTE 4 — Zener Impedance (Z_Z) Derivation. The zener impedance is derived from the 60 cycle ac voltage, which results when an ac current having an rms value equal to 10% of the dc zener current (I_{ZT} or I_{ZK}) is superimposed on I_{ZT} or I_{ZK}

NOTE 5 — Surge Current (i_r) Non-Repetitive. The rating listed in the electrical characteristics table is maximum peak, non-repetitive, reverse surge current of 1/2 square wave or equivalent sine wave pulse of 1/120 second duration superimposed on the test current, I_{ZT}, per JEDEC registration, however, actual device capability is as described in Figure 5

APPLICATION NOTE

Since the actual voltage available from a given zener diode is temperature dependent, it is necessary to determine junction temperature under any set of operating conditions in order to calculate its value. The following procedure is recommended.

Lead Temperature, T_L, should be determined from

$$T_L = \theta_{LA} P_D + T_A$$

θ_{LA} is the lead-to-ambient thermal resistance (°C/W) and P_D is the power dissipation. The value for θ_{LA} will vary and depends on the device mounting method. θ_{LA} is generally 30 to 40°C/W for the various clips and tie points in common use and for printed circuit board wiring.

The temperature of the lead can also be measured using a thermocouple placed on the lead as close as possible to the tie point. The thermal mass connected to the tie point is normally large enough so that it will not significantly respond to heat surges generated in the diode as a result of pulsed operation once steady-state conditions are achieved. Using the measured value of T_L, the junction temperature may be determined by:

$$T_J = T_L + \Delta T_{JL}.$$

ΔT_{JL} is the increase in junction temperature above the lead temperature and may be found as follows

$$\Delta T_{JL} = \theta_{JL} P_D$$

θ_{JL} may be determined from Figure 3 for dc power conditions For worst-case design, using expected limits of I_Z, limits of P_D and the extremes of $T_J(\Delta T_J)$ may be estimated. Changes in voltage, V_Z, can then be found from

$$\Delta V = \theta_{VZ} \Delta T_J$$

θ_{VZ}, the zener voltage temperature coefficient, is found from Figure 2

Under high power-pulse operation, the zener voltage will vary with time and may also be affected significantly by the zener resistance. For best regulation, keep current excursions as low as possible.

Surge limitations are given in Figure 5. They are lower than would be expected by considering only junction temperature, as current crowding effects cause temperatures to be extremely high in small spots resulting in device degradation should the limits of Figure 5 be exceeded.

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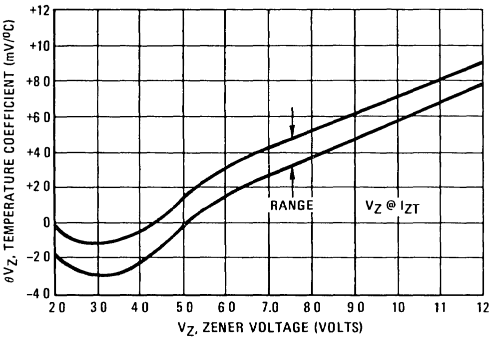
FIGURE 2 – TEMPERATURE COEFFICIENTS

(−55°C to +150°C temperature range; 90% of the units are in the ranges indicated)

a – RANGE FOR UNITS TO 12 VOLTS



b – RANGE FOR UNITS 12 TO 100 VOLTS

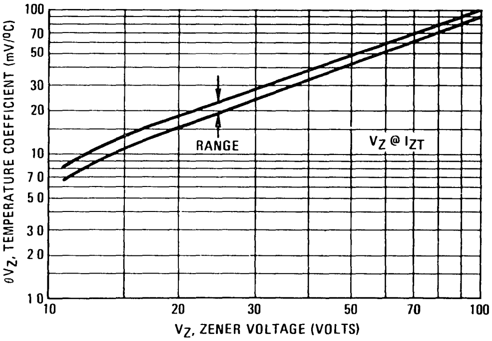


FIGURE 3 – TYPICAL THERMAL RESISTANCE versus LEAD LENGTH

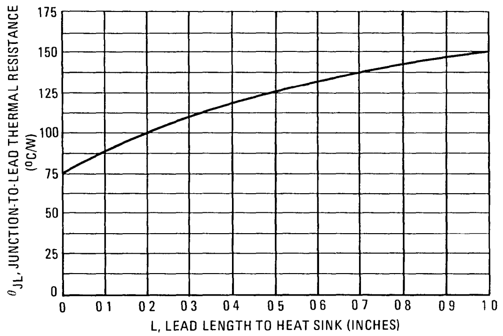


FIGURE 4 – EFFECT OF ZENER CURRENT

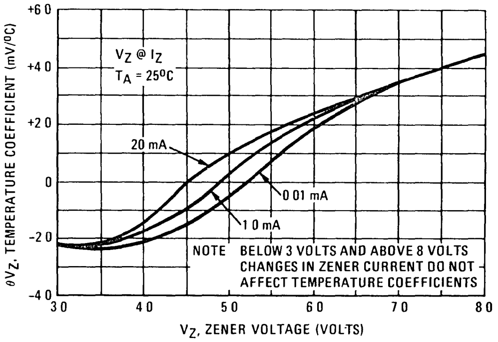
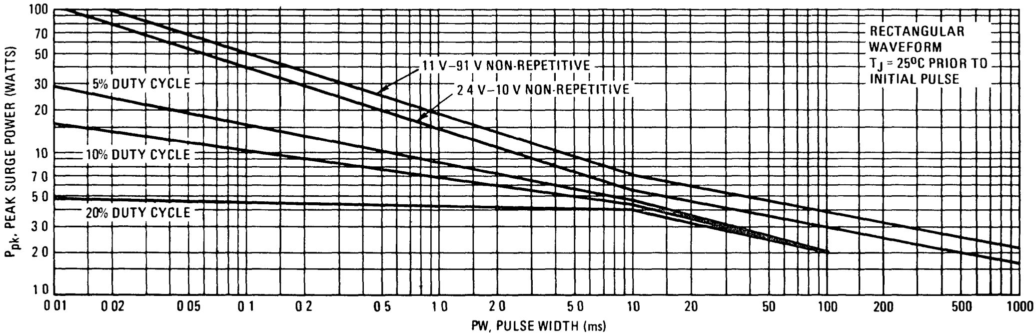


FIGURE 5 – MAXIMUM SURGE POWER



This graph represents 90 percentile data points

For worst-case design characteristics, multiply surge power by 2/3

FIGURE 6 — EFFECT OF ZENER CURRENT ON ZENER IMPEDANCE

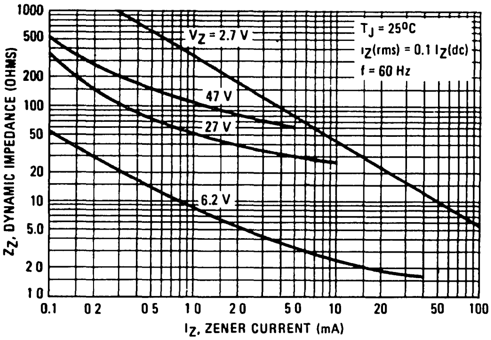


FIGURE 7 — EFFECT OF ZENER VOLTAGE ON ZENER IMPEDANCE

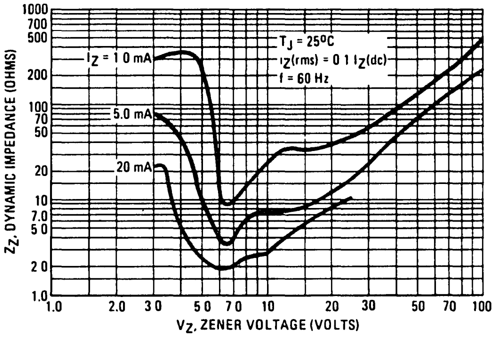


FIGURE 8 — TYPICAL LEAKAGE CURRENT

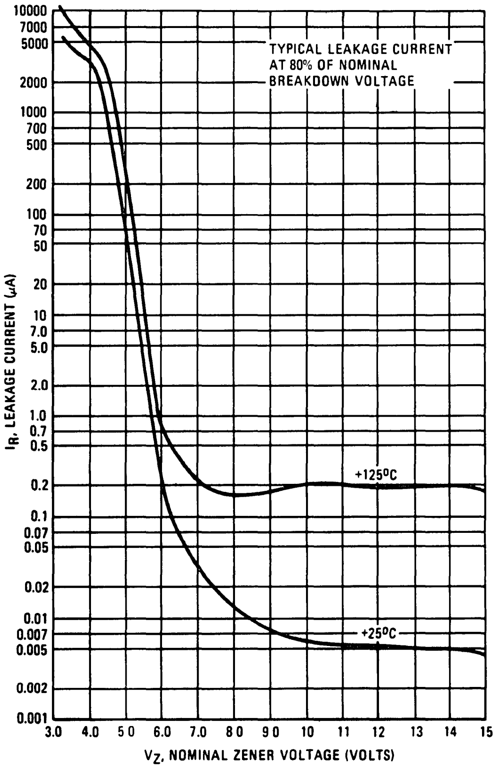


FIGURE 9 — TYPICAL CAPACITANCE versus VZ

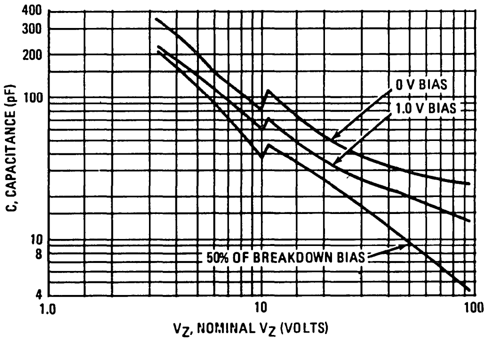
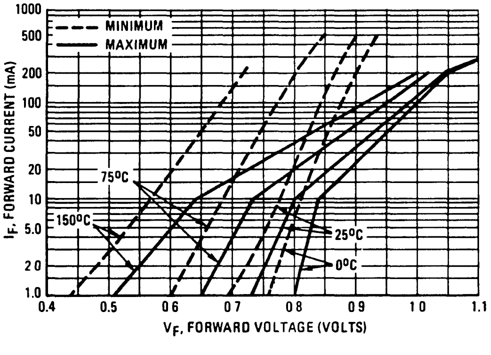


FIGURE 10 — TYPICAL FORWARD CHARACTERISTICS



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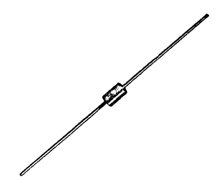
MOTOROLA
SEMICONDUCTOR
TECHNICAL DATA

1N5221A, B thru 1N5281A, B

Designer's Data Sheet

500 Milliwatt Hermetically Sealed Glass Silicon Zener Diodes

GLASS ZENER DIODES
500 MILLIWATTS
2.4–200 VOLTS



- Complete Voltage Range — 2.4 to 200 Volts
- DO-204AH Package — Smaller than Conventional DO-204AA Package
- Double Slug Type Construction
- Metallurgically Bonded Construction

Mechanical Characteristics:
CASE: Double slug type, hermetically sealed glass
MAXIMUM LEAD TEMPERATURE FOR SOLDERING PURPOSES: 230°C, 1/16″ from case for 10 seconds
FINISH: All external surfaces are corrosion resistant with readily solderable leads
POLARITY: Cathode indicated by color band. When operated in zener mode, cathode will be positive with respect to anode
MOUNTING POSITION: Any

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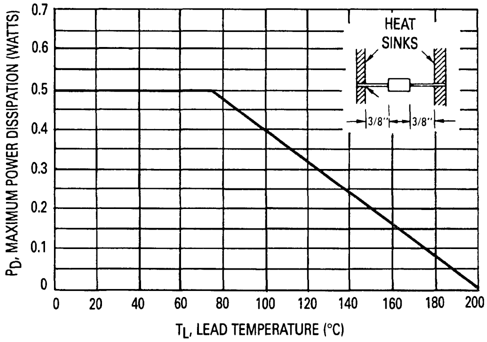


Figure 1. Steady State Power Derating

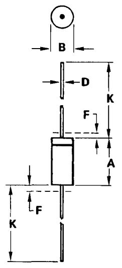
*MAXIMUM RATINGS

Rating	Symbol	Value	Unit
DC Power Dissipation @ $T_L \leq 75°C$ Lead Length = 3/8″ Derate above T_L = 75°C	P_D	 500 4	 mW mW/°C
Operating and Storage Junction Temperature Range	T_J, T_{stg}	−65 to +200	°C

*Indicates JEDEC Registered Data

Designer's Data for "Worst Case" Conditions — The Designer's Data Sheet permits the design of most circuits entirely from the information presented. Limit curves — representing boundaries on device characteristics — are give to facilitate "worst case" design.

OUTLINE DIMENSIONS



NOTES
1 PACKAGE CONTOUR OPTIONAL WITHIN A AND B HEAT SLUGS, IF ANY, SHALL BE INCLUDED WITHIN THIS CYLINDER, BUT NOT SUBJECT TO THE MINIMUM LIMIT OF B
2 LEAD DIAMETER NOT CONTROLLED IN ZONE F TO ALLOW FOR FLASH, LEAD FINISH BUILDUP AND MINOR IRREGULARITIES OTHER THAN HEAT SLUGS
3 POLARITY DENOTED BY CATHODE BAND
4 DIMENSIONING AND TOLERANCING PER ANSI Y14 5, 1973

DIM	MILLIMETERS		INCHES	
	MIN	MAX	MIN	MAX
A	3 05	5 08	0 120	0 200
B	1 52	2 29	0 060	0 090
D	0 46	0 56	0 018	0 022
F	—	1 27	—	0 050
K	25 40	38 10	1 000	1 500

CASE 299-02
DO-204AH

ELECTRICAL CHARACTERISTICS (T_A = 25°C unless otherwise noted. Based on dc measurements at thermal equilibrium; lead length = 3/8″; thermal resistance of heat sink = 30°C/W) V_F = 1.1 max @ I_F = 200 mA for all types.

JEDEC Type No. (Note 1)	Nominal Zener Voltage V_Z @ I_{ZT} Volts (Note 2)	Test Current I_{ZT} mA	Max Zener Impedance A and B Suffix only: Z_{ZT} @ I_{ZT} Ohms	Z_{ZK} @ I_{ZK} = 0.25 mA Ohms	Max Reverse Leakage Current A and B Suffix only: I_R µA	V_R Volts A	V_R Volts B	Non-Suffix: I_R @ V_R Used for Suffix A µA	Max Zener Voltage Temperature Coeff. (A and B Suffix only) θ_{VZ} (%/°C) (Note 3)
1N5221	2.4	20	30	1200	100	0.95	1	200	−0.085
1N5222	2.5	20	30	1250	100	0.95	1	200	−0.085
1N5223	2.7	20	30	1300	75	0.95	1	150	−0.080
1N5224	2.8	20	30	1400	75	0.95	1	150	−0.080
1N5225	3	20	29	1600	50	0.95	1	100	−0.075
1N5226	3.3	20	28	1600	25	0.95	1	100	−0.070
1N5227	3.6	20	24	1700	15	0.95	1	100	−0.065
1N5228	3.9	20	23	1900	10	0.95	1	75	−0.060
1N5229	4.3	20	22	2000	5	0.95	1	50	±0.055
1N5230	4.7	20	19	1900	5	1.9	2	50	±0.030
1N5231	5.1	20	17	1600	5	1.9	2	50	±0.030
1N5232	5.6	20	11	1600	5	2.9	3	50	+0.038
1N5233	6	20	7	1600	5	3.3	3.5	50	+0.038
1N5234	6.2	20	7	1000	5	3.8	4	50	+0.045
1N5235	6.8	20	5	750	3	4.8	5	30	+0.050
1N5236	7.5	20	6	500	3	5.7	6	30	+0.058
1N5237	8.2	20	8	500	3	6.2	6.5	30	+0.062
1N5238	8.7	20	8	600	3	6.2	6.5	30	+0.065
1N5239	9.1	20	10	600	3	6.7	7	30	+0.068
1N5240	10	20	17	600	3	7.6	8	30	+0.075
1N5241	11	20	22	600	2	8	8.4	30	+0.076
1N5242	12	20	30	600	1	8.7	9.1	10	+0.077
1N5243	13	9.5	13	600	0.5	9.4	9.9	10	+0.079
1N5244	14	9	15	600	0.1	9.5	10	10	+0.082
1N5245	15	8.5	16	600	0.1	10.5	11	10	+0.082
1N5246	16	7.8	17	600	0.1	11.4	12	10	+0.083
1N5247	17	7.4	19	600	0.1	12.4	13	10	+0.084
1N5248	18	7	21	600	0.1	13.3	14	10	+0.085
1N5249	19	6.6	23	600	0.1	13.3	14	10	+0.086
1N5250	20	6.2	25	600	0.1	14.3	15	10	+0.086
1N5251	22	5.6	29	600	0.1	16.2	17	10	+0.087
1N5252	24	5.2	33	600	0.1	17.1	18	10	+0.088
1N5253	25	5	35	600	0.1	18.1	19	10	+0.089
1N5254	27	4.6	41	600	0.1	20	21	10	+0.090
1N5255	28	4.5	44	600	0.1	20	21	10	+0.091
1N5256	30	4.2	49	600	0.1	22	23	10	+0.091
1N5257	33	3.8	58	700	0.1	24	25	10	+0.092
1N5258	36	3.4	70	700	0.1	26	27	10	+0.093
1N5259	39	3.2	80	800	0.1	29	30	10	+0.094
1N5260	43	3	93	900	0.1	31	33	10	+0.095
1N5261	47	2.7	105	1000	0.1	34	36	10	+0.095
1N5262	51	2.5	125	1100	0.1	37	39	10	+0.096
1N5263	56	2.2	150	1300	0.1	41	43	10	+0.096
1N5264	60	2.1	170	1400	0.1	44	46	10	+0.097
1N5265	62	2	185	1400	0.1	45	47	10	+0.097
1N5266	68	1.8	230	1600	0.1	49	52	10	+0.097
1N5267	75	1.7	270	1700	0.1	53	56	10	+0.098
1N5268	82	1.5	330	2000	0.1	59	62	10	+0.098
1N5269	87	1.4	370	2200	0.1	65	68	10	+0.099
1N5270	91	1.4	400	2300	0.1	66	69	10	+0.099
1N5271	100	1.3	500	2600	0.1	72	76	10	+0.110
1N5272	110	1.1	750	3000	0.1	80	84	10	+0.110
1N5273	120	1	900	4000	0.1	86	91	10	+0.110
1N5274	130	0.95	1100	4500	0.1	94	99	10	+0.110
1N5275	140	0.9	1300	4500	0.1	101	106	10	+0.110
1N5276	150	0.85	1500	5000	0.1	108	114	10	+0.110
1N5277	160	0.8	1700	5500	0.1	116	122	10	+0.110
1N5278	170	0.74	1900	5500	0.1	116	129	10	+0.110
1N5279	180	0.68	2200	6000	0.1	130	137	10	+0.110
1N5280	190	0.66	2400	6500	0.1	137	144	10	+0.110
1N5281	200	0.65	2500	7000	0.1	144	152	10	+0.110

NOTE 1. Tolerance — The JEDEC type numbers shown indicate a tolerance of ±10% with guaranteed limits on only V_Z, I_R and V_F as shown in the electrical characteristics table. Units with guaranteed limits on all six parameters are indicated by suffix "A" for ±10% tolerance, suffix "B" for ±5%, "C" for ±2% and "D" for ±1%.

NOTE 2. Special Selections† Available Include:
1. Nominal zener voltages between those shown.
2. Two or more units for series connection with specified tolerance on total voltage. Series matched sets make zener voltages in excess of 200 volts possible as well as providing lower temperature coefficients, lower dynamic impedance and greater power handling ability.
3. Nominal voltages at non-standard test currents.

NOTE 3. Temperature Coefficient (θ_{VZ}) — Test conditions for temperature coefficient are as follows:
a. I_{ZT} = 7.5 mA, T_1 = 25°C,
T_2 = 125°C (1N5221A,B through 1N5242A,B).
b. I_{ZT} = Rated I_{ZT}, T_1 = 25°C,
T_2 = 125°C (1N5243A,B through 1N5272A,B).
Device to be temperature stabilized with current applied prior to reading breakdown voltage at the specified ambient temperature.

NOTE 4. Zener Voltage (V_Z) Measurement — Nominal zener voltage is measured with the device junction in thermal equilibrium at the lead temperature of 30°C ±1°C and 3/8" lead length.

NOTE 5. Zener Impedance (Z_Z) Derivation — Z_{ZT} and Z_{ZK} are measured by dividing the ac voltage drop across the device by the ac current applied. The specified limits are for $I_Z(ac) = I_Z(dc)$ with the ac frequency = 60 Hz.

†For more information on special selections contact your nearest Motorola representative.

APPLICATION NOTE

Since the actual voltage available from a given zener diode is temperature dependent, it is necessary to determine junction temperature under any set of operating conditions in order to calculate its value. The following procedure is recommended:

Lead Temperature, T_L, should be determined from:

$$T_L = \theta_{LA} P_D + T_A.$$

θ_{LA} is the lead-to-ambient thermal resistance (°C/W) and P_D is the power dissipation. The value for θ_{LA} will vary and depends on the device mounting method. θ_{LA} is generally 30 to 40°C/W for the various clips and tie points in common use and for printed circuit board wiring.

The temperature of the lead can also be measured using a thermocouple placed on the lead as close as possible to the tie point. The thermal mass connected to the tie point is normally large enough so that it will not significantly respond to heat surges generated in the diode as a result of pulsed operation once steady-state conditions are achieved. Using the measured value of T_L, the junction temperature may be determined by:

$$T_J = T_L + \Delta T_{JL}.$$

ΔT_{JL} is the increase in junction temperature above the lead temperature and may be found from Figure 2 for dc power:

$$\Delta T_{JL} = \theta_{JL} P_D.$$

For worst-case design, using expected limits of I_Z, limits of P_D and the extremes of $T_J(\Delta T_J)$ may be estimated. Changes in voltage, V_Z, can then be found from:

$$\Delta V = \theta_{VZ} \Delta T_J.$$

θ_{VZ}, the zener voltage temperature coefficient, is found from Figures 4 and 5.

Under high power-pulse operation, the zener voltage will vary with time and may also be affected significantly by the zener resistance. For best regulation, keep current excursions as low as possible.

Surge limitations are given in Figure 7. They are lower than would be expected by considering only junction temperature, as current crowding effects cause temperatures to be extremely high in small spots, resulting in device degradation should the limits of Figure 7 be exceeded.

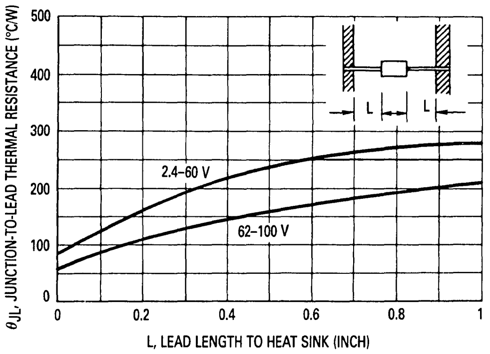


Figure 2. Typical Thermal Resistance

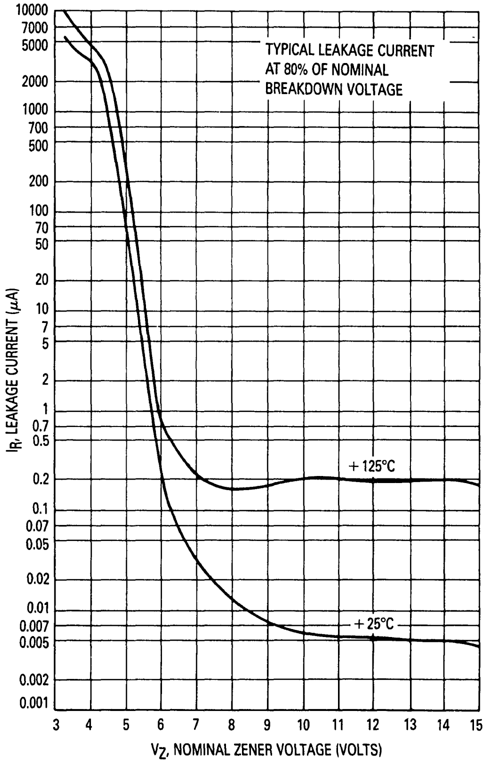


Figure 3. Typical Leakage Current

4

TEMPERATURE COEFFICIENTS
(−55°C to +150°C temperature range; 90% of the units are in the ranges indicated.)

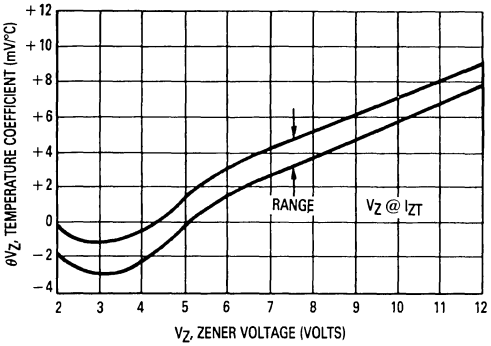


Figure 4a. Range for Units to 12 Volts

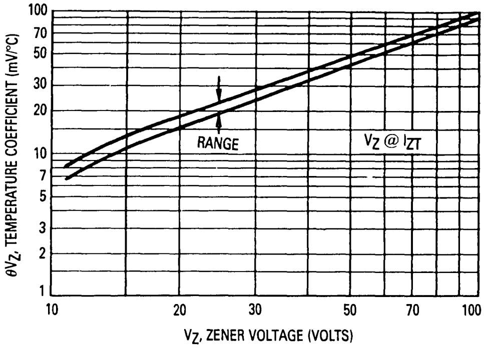


Figure 4b. Range for Units 12 to 100 Volts

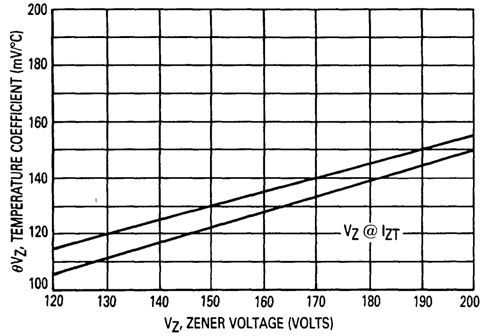


Figure 4c. Range for Units 120 to 200 Volts

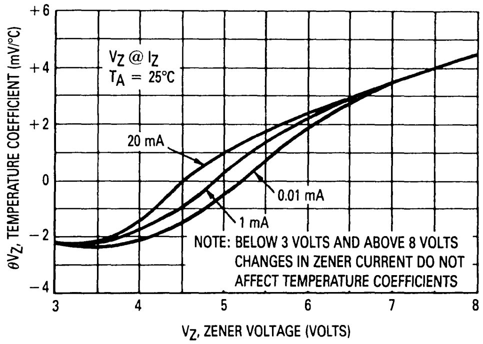


Figure 5. Effect of Zener Current

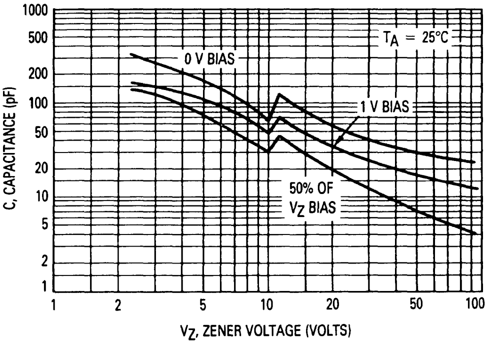


Figure 6a. Typical Capacitance 1–100 Volts

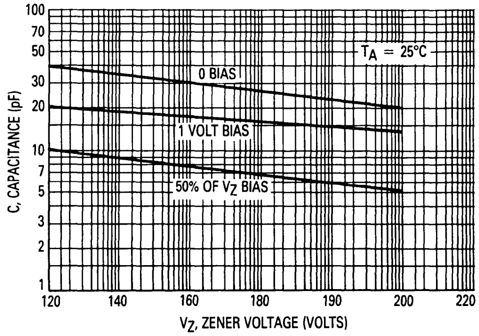


Figure 6b. Typical Capacitance 120–220 Volts

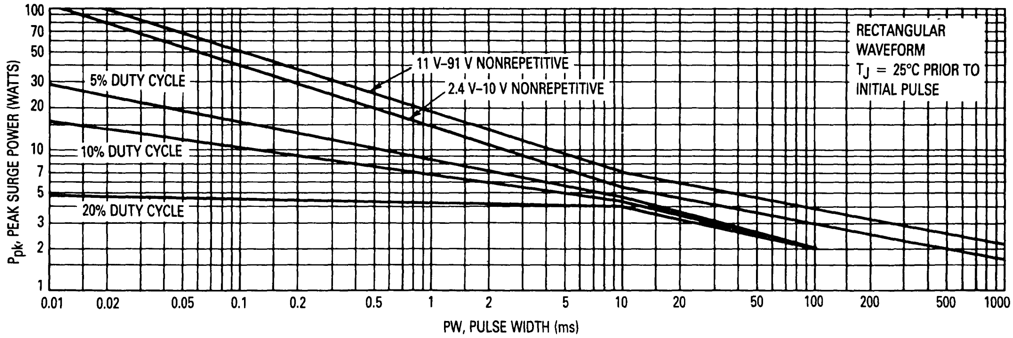


Figure 7a. Maximum Surge Power 2.4–9 Volts

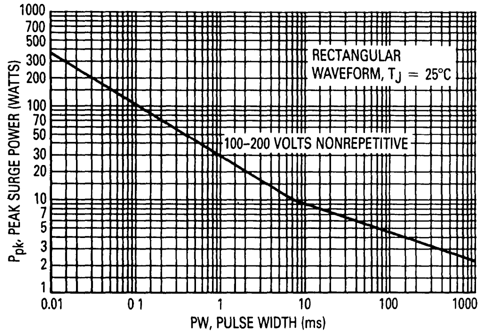


Figure 7b. Maximum Surge Power DO-204AH 100–200 Volts

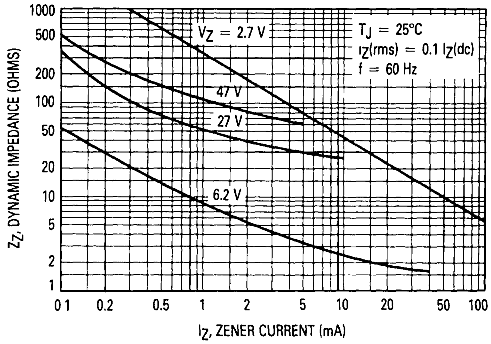


Figure 8. Effect of Zener Current on Zener Impedance

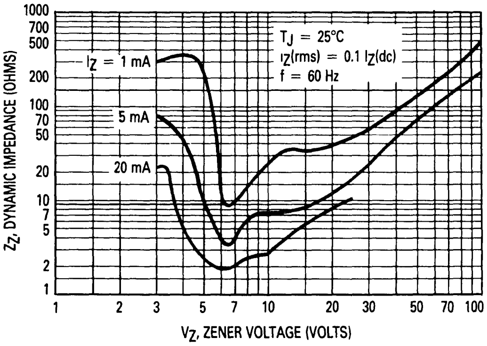


Figure 9. Effect of Zener Voltage on Zener Impedance

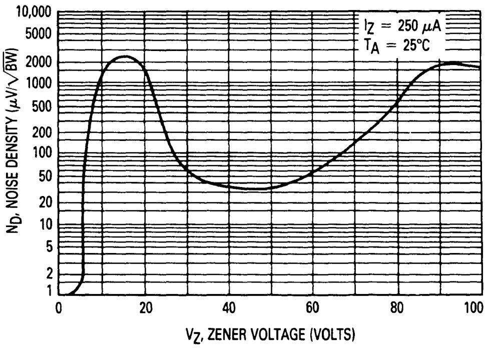
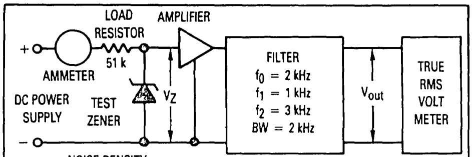


Figure 10. Typical Noise Density



$$\text{NOISE DENSITY (VOLTS PER SQUARE ROOT BANDWIDTH)} = \frac{V_{out}}{\text{OVERALL GAIN } \sqrt{BW}}$$

WHERE BW = FILTER BANDWIDTH (Hz)

V_{out} = OUTPUT NOISE (VOLTS RMS)

The input voltage and load resistance are high so that the zener diode is driven from a constant current source. The amplifier is low noise so that the amplifier noise is negligible compared to that of the test zener. The filter bandpass is known so that the noise density can be calculated from the formula shown.

Figure 11. Noise Density Measurement Method

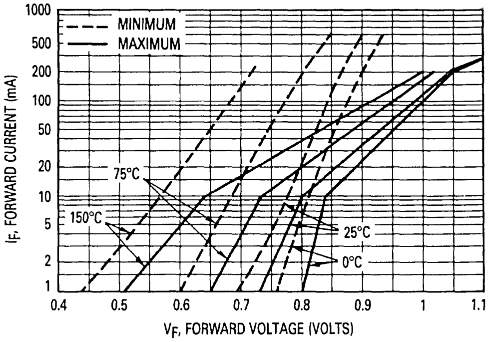


Figure 12. Typical Forward Characteristics

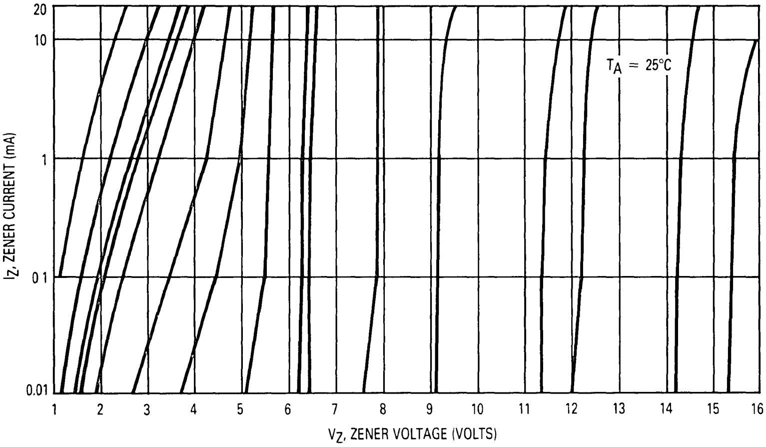


Figure 13. Zener Voltage versus Zener Current — V_Z = 1 thru 16 Volts

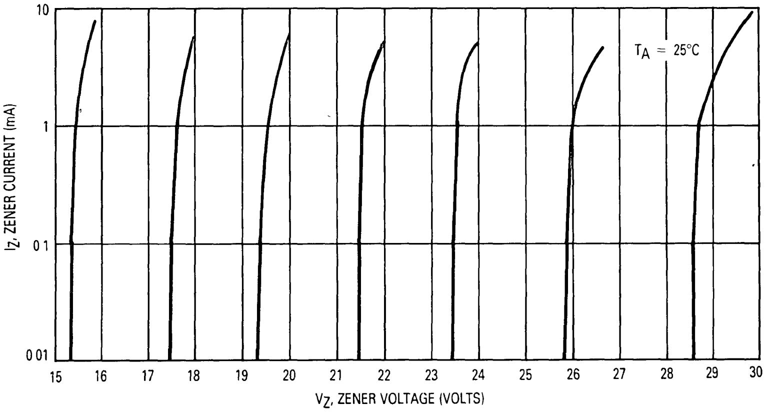


Figure 14. Zener Voltage versus Zener Current — V_Z = 15 thru 30 Volts

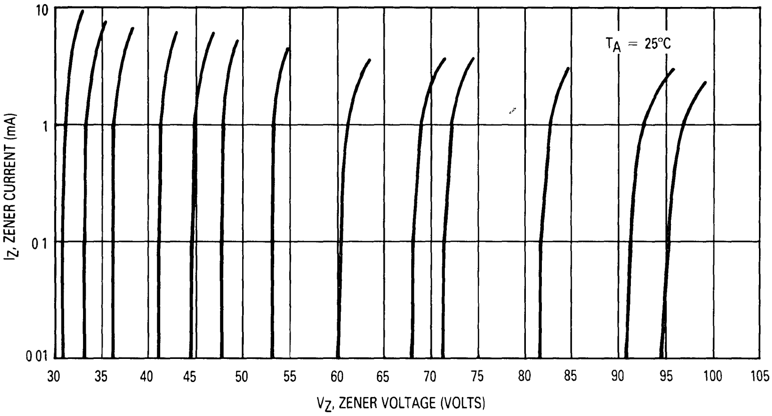


Figure 15. Zener Voltage versus Zener Current — V_Z = 30 thru 105 Volts

4

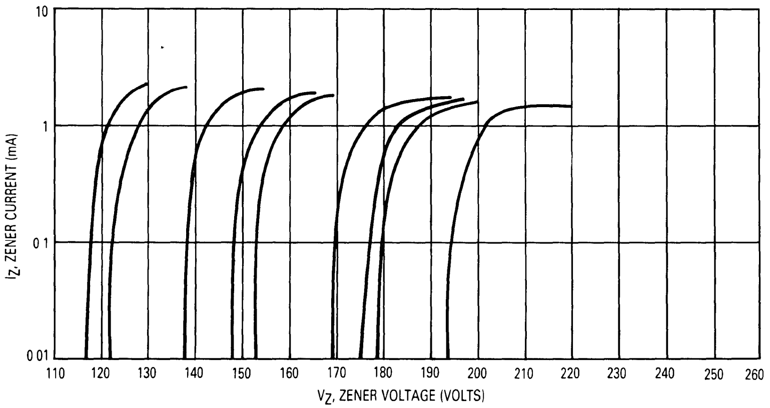


Figure 16. Zener Voltage versus Zener Current — V_Z = 110–220 Volts

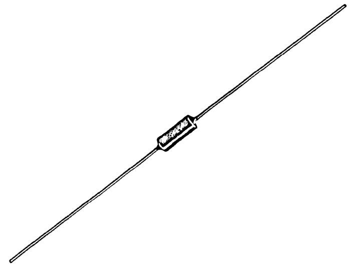
MOTOROLA
SEMICONDUCTOR
TECHNICAL DATA

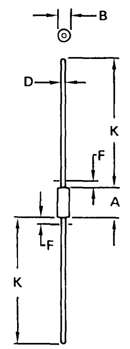
1N5283 thru 1N5314

CURRENT REGULATOR DIODES

CURRENT REGULATOR DIODES

Field-effect current regulator diodes are circuit elements that provide a current essentially independent of voltage. These diodes are especially designed for maximum impedance over the operating range. These devices may be used in parallel to obtain higher currents.





DIM	MILLIMETERS MIN	MILLIMETERS MAX	INCHES MIN	INCHES MAX
A	5 84	7 62	0 230	0 300
B	2 16	2 72	0 085	0 107
D	0 46	0 56	0 018	0 022
F	–	1 27	–	0 050
K	25 40	38 10	1 000	1 500

All JEDEC dimensions and notes apply

CASE 51-02
DO-204AA
GLASS

NOTES
1 PACKAGE CONTOUR OPTIONAL WITHIN DIA B AND LENGTH A HEAT SLUGS, IF ANY, SHALL BE INCLUDED WITHIN THIS CYLINDER, BUT SHALL NOT BE SUBJECT TO THE MIN LIMIT OF DIA B
2 LEAD DIA NOT CONTROLLED IN ZONES F, TO ALLOW FOR FLASH, LEAD FINISH BUILDUP, AND MINOR IRREGULARITIES OTHER THAN HEAT SLUGS

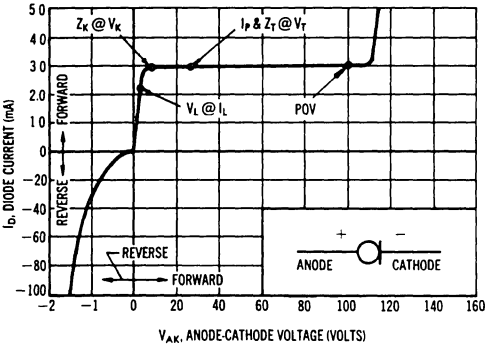
MAXIMUM RATINGS

Rating	Symbol	Value	Unit
Peak Operating Voltage ($T_J = -55°C$ to $+200°C$)	POV	100	Volts
Steady State Power Dissipation @ $T_L = 75°C$	P_D	600	mW
Derate above $T_L = 75°C$		4 8	mW/°C
Lead Length = 3/8″ (Forward or Reverse Bias)			
Operating and Storage Junction Temperature Range	T_J, T_{stg}	−55 to +200	°C

ELECTRICAL CHARACTERISTICS ($T_A = 25\,°C$ unless otherwise noted)

Type No.	Regulator Current I_P (mA) @ $V_T = 25$ V nom	min	max	Minimum Dynamic Impedance @ $V_T = 25$ V Z_T (MΩ)	Minimum Knee Impedance @ $V_K = 6.0$ V Z_K (MΩ)	Maximum Limiting Voltage @ $I_L = 0.8\ I_P$ (min) V_L (Volts)
1N5283	0.22	0.198	0.242	25.0	2.75	1.00
1N5284	0.24	0.216	0.264	19.0	2.35	1.00
1N5285	0.27	0.243	0.297	14.0	1.95	1.00
1N5286	0.30	0.270	0.330	9.0	1.60	1.00
1N5287	0.33	0.297	0.363	6.6	1.35	1.00
1N5288	0.39	0.351	0.429	4.10	1.00	1.05
1N5289	0.43	0.387	0.473	3.30	0.870	1.05
1N5290	0.47	0.423	0.517	2.70	0.750	1.05
1N5291	0.56	0.504	0.616	1.90	0.560	1.10
1N5292	0.62	0.558	0.682	1.55	0.470	1.13
1N5293	0.68	0.612	0.748	1.35	0.400	1.15
1N5294	0.75	0.675	0.825	1.15	0.335	1.20
1N5295	0.82	0.738	0.902	1.00	0.290	1.25
1N5296	0.91	0.819	1.001	0.880	0.240	1.29
1N5297	1.00	0.900	1.100	0.800	0.205	1.35
1N5298	1.10	0.990	1.210	0.700	0.180	1.40
1N5299	1.20	1.08	1.32	0.640	0.155	1.45
1N5300	1.30	1.17	1.43	0.580	0.135	1.50
1N5301	1.40	1.26	1.54	0.540	0.115	1.55
1N5302	1.50	1.35	1.65	0.510	0.105	1.60
1N5303	1.60	1.44	1.76	0.475	0.092	1.65
1N5304	1.80	1.62	1.98	0.420	0.074	1.75
1N5305	2.00	1.80	2.20	0.395	0.061	1.85
1N5306	2.20	1.98	2.42	0.370	0.052	1.95
1N5307	2.40	2.16	2.64	0.345	0.044	2.00
1N5308	2.70	2.43	2.97	0.320	0.035	2.15
1N5309	3.00	2.70	3.30	0.300	0.029	2.25
1N5310	3.30	2.97	3.63	0.280	0.024	2.35
1N5311	3.60	3.24	3.96	0.265	0.020	2.50
1N5312	3.90	3.51	4.29	0.255	0.017	2.60
1N5313	4.30	3.87	4.73	0.245	0.014	2.75
1N5314	4.70	4.23	5.17	0.235	0.012	2.90

FIGURE 1 — TYPICAL CURRENT REGULATOR CHARACTERISTICS



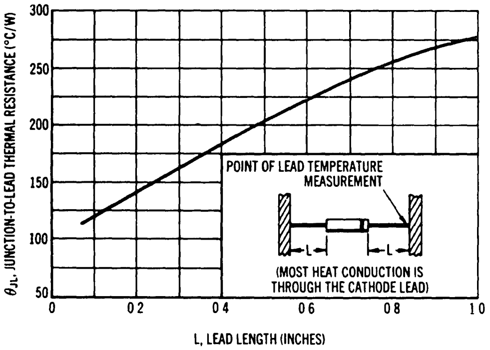
SYMBOLS AND DEFINITIONS

I_D — Diode Current
I_L — Limiting Current: 80% of I_P minimum used to determine Limiting voltage, V_L
I_P — Pinch-off Current: Regulator current at specified Test Voltage, V_T
POV — Peak Operating Voltage Maximum voltage to be applied to device
θ_I — Current Temperature Coefficient
V_{AK} — Anode to cathode Voltage
V_K — Knee Impedance Test Voltage Specified voltage used to establish Knee Impedance, Z_K
V_L — Limiting Voltage: Measured at I_L V_L, together with Knee AC Impedance, Z_K, indicates the Knee characteristics of the device
V_T — Test Voltage: Voltage at which I_P and Z_T are specified
Z_K — Knee AC Impedance at Test Voltage To test for Z_K, a 90 Hz signal v_K with RMS value equal to 10% of test voltage, V_K, is superimposed on V_K:

$$Z_K = v_K/i_K$$

where i_K is the resultant ac current due to v_K
To provide the most constant current from the diode, Z_K should be as high as possible, therefore, a minimum value of Z_K is specified
Z_T — AC Impedance at Test Voltage Specified as a minimum value To test for Z_T, a 90 Hz signal with RMS value equal to 10% of Test Voltage, V_T, is superimposed on V_T

FIGURE 2 — TYPICAL THERMAL RESISTANCE



APPLICATION NOTE

As the current available from the diode is temperature dependent, it is necessary to determine junction temperature, T_J, under specific operating conditions to calculate the value of the diode current The following procedure is recommended

Lead Temperature, T_L, shall be determined from.

$$T_L = \theta_{LA} P_D + T_A$$

where θ_{LA} is lead-to ambient thermal resistance
and P_D is power dissipation
θ_{LA} is generally 30-40°C/W for the various clips and tie points in common use, and for printed circuit-board wiring

Junction Temperature, T_J, shall be calculated from·

$$T_J = T_L + \theta_{JL} P_D$$

where θ_{JL} is taken from Figure 2

For circuit design limits of V_{AK}, limits of P_D may be estimated and extremes of T_J may be computed Using the information on Figures 4 and 5, changes in current may be found To improve current regulation, keep V_{AK} low to reduce P_D and keep the leads short, especially the cathode lead, to reduce θ_{JL}

4

FIGURE 3 — TYPICAL FORWARD CHARACTERISTICS

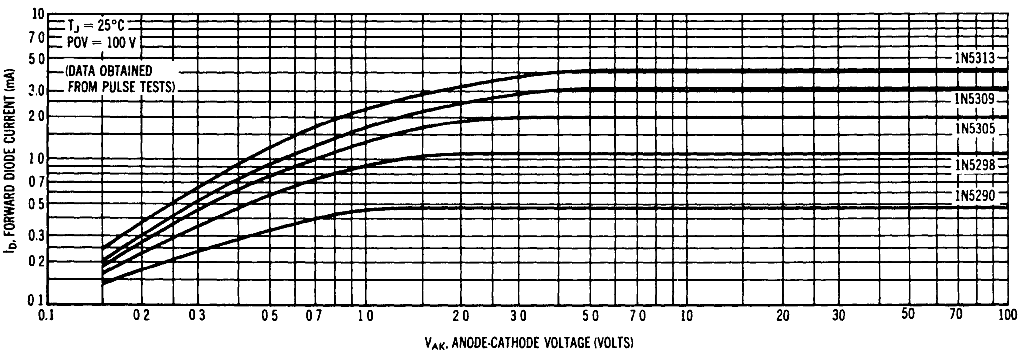


FIGURE 4 — TEMPERATURE COEFFICIENT

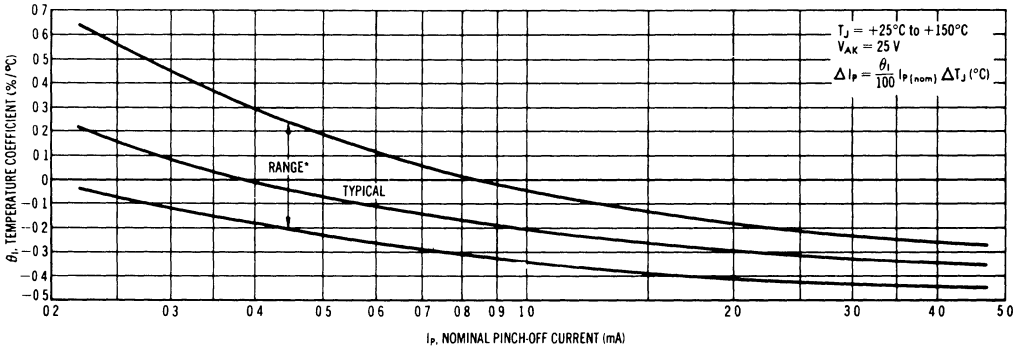


FIGURE 5 — TEMPERATURE COEFFICIENT

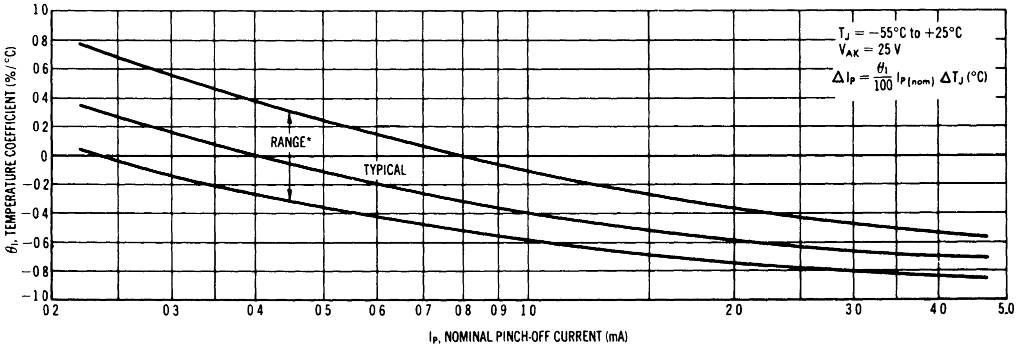
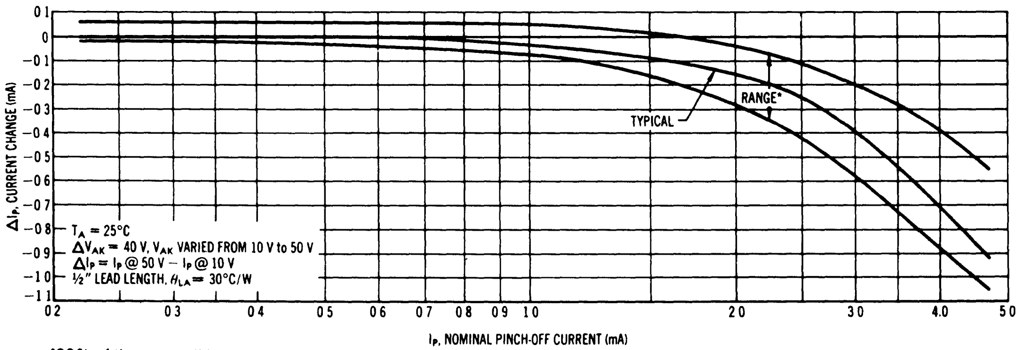


FIGURE 6 — CURRENT REGULATION FACTOR



*90% of the units will be in the ranges shown.

MOTOROLA
SEMICONDUCTOR
TECHNICAL DATA

1N5333A, B, C, D thru 1N5388A, B, C, D

Designer's Data Sheet

5-Watt Surmetic 40 Silicon Zener Diodes

5-WATT ZENER REGULATOR DIODES 3.3–200 VOLTS

. . . a complete series of 5 Watt Zener Diodes with tight limits and better operating characteristics that reflect the superior capabilities of silicon-oxide-passivated junctions. All this in an axial-lead, transfer-molded plastic package offering protection in all common environmental conditions.

- Up to 180 Watt Surge Rating @ 8.3 ms
- Maximum Limits Guaranteed on Seven Electrical Parameters
- Offered in 10%, 5%, 2% and 1% V_Z Tolerance

Mechanical Characteristics:

CASE: Void-free, transfer-molded, thermosetting plastic
FINISH: All external surfaces are corrosion resistant and leads are readily solderable
POLARITY: Cathode indicated by color band. When operated in zener mode, cathode will be positive with respect to anode
MOUNTING POSITION: Any
WEIGHT: 0.7 gram (approx)

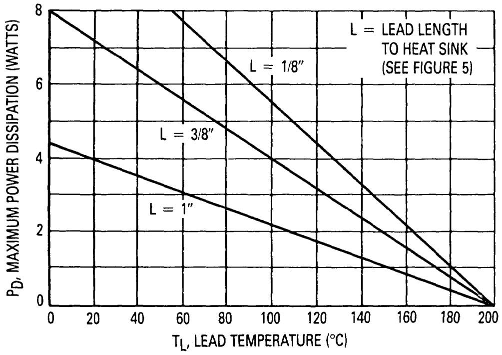
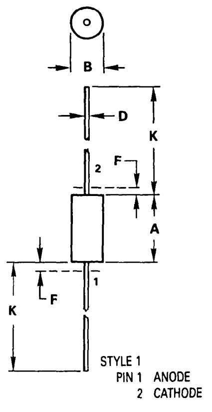


Figure 1. Power-Temperature Derating Curve

4

OUTLINE DIMENSIONS



NOTE
1 LEAD DIAMETER & FINISH NOT CONTROLLED WITHIN DIM "F"

DIM	MILLIMETERS MIN	MILLIMETERS MAX	INCHES MIN	INCHES MAX
A	8.38	8.89	0.330	0.350
B	3.30	3.68	0.130	0.145
D	0.94	1.09	0.037	0.043
F	—	1.27	—	0.050
K	25.40	31.75	1.000	1.250

CASE 17-02 GLASS

MAXIMUM RATINGS

Rating	Symbol	Value	Unit
DC Power Dissipation @ T_L = 75°C Lead Length = 3/8" Derate above 75°C	P_D	5 40	Watts mW/°C
Operating and Storage Junction Temperature Range	T_J, T_{stg}	−65 to +200	°C

Designer's Data for "Worst Case" Conditions — The Designer's Data Sheet permits the design of most circuits entirely from the information presented. Limit curves — representing boundaries on device characteristics — are given to facilitate "worst case" design.

ELECTRICAL CHARACTERISTICS (T_A = 25°C unless otherwise noted, V_F = 1.2 Max @ I_F = 1 A for all types)

JEDEC Type No. (Note 1)	Nominal Zener Voltage V_Z @ I_{ZT} Volts (Note 2)	Test Current I_{ZT} mA	Max Zener Impedance A & B Suffix Only: Z_{ZT} @ I_{ZT} Ohms (Note 2)	Max Zener Impedance A & B Suffix Only: Z_{ZK} @ I_{ZK} = 1 mA Ohms (Note 2)	Max Reverse Leakage Current: I_R µA	Max Reverse Leakage Current: @ V_R Volts, Non & A Suffix	Max Reverse Leakage Current: @ V_R Volts, B-Suffix	Applies to all Suffix: Max Surge Current i_r, Amps (Note 3)	A & B Suffix Only: Max Voltage Regulation ΔV_Z, Volts (Note 4)	Maximum Regulator Current I_{ZM} mA (Note 5)
1N5333A	3.3	380	3	400	300	1	1	20	0.85	1440
1N5334A	3.6	350	2.5	500	150	1	1	18.7	0.8	1320
1N5335A	3.9	320	2	500	50	1	1	17.6	0.54	1220
1N5336A	4.3	290	2	500	10	1	1	16.4	0.49	1100
1N5337A	4.7	260	2	450	5	1	1	15.3	0.44	1010
1N5338A	5.1	240	1.5	400	1	1	1	14.4	0.39	930
1N5339A	5.6	220	1	400	1	2	2	13.4	0.25	865
1N5340A	6	200	1	300	1	3	3	12.7	0.19	790
1N5341A	6.2	200	1	200	1	4	3	12.4	0.1	765
1N5342A	6.8	175	1	200	10	4.9	5.2	11.5	0.15	700
1N5343A	7.5	175	1.5	200	10	5.4	5.7	10.7	0.15	630
1N5344A	8.2	150	1.5	200	10	5.9	6.2	10	0.2	580
1N5345A	8.7	150	2	200	10	6.3	6.6	9.5	0.2	545
1N5346A	9.1	150	2	150	7.5	6.6	6.9	9.2	0.22	520
1N5347A	10	125	2	125	5	7.2	7.6	8.6	0.22	475
1N5348A	11	125	2.5	125	5	8	8.4	8	0.25	430
1N5349A	12	100	2.5	125	2	8.6	9.1	7.5	0.25	395
1N5350A	13	100	2.5	100	1	9.4	9.9	7	0.25	365
1N5351A	14	100	2.5	75	1	10.1	10.6	6.7	0.25	340
1N5352A	15	75	2.5	75	1	10.8	11.5	6.3	0.25	315
1N5353A	16	75	2.5	75	1	11.5	12.2	6	0.3	295
1N5354A	17	70	2.5	75	0.5	12.2	12.9	5.8	0.35	280
1N5355A	18	65	2.5	75	0.5	13	13.7	5.5	0.4	265
1N5356A	19	65	3	75	0.5	13.7	14.4	5.3	0.4	250
1N5357A	20	65	3	75	0.5	14.4	15.2	5.1	0.4	237
1N5358A	22	50	3.5	75	0.5	15.8	16.7	4.7	0.45	216
1N5359A	24	50	3.5	100	0.5	17.3	18.2	4.4	0.55	198
1N5360A	25	50	4	110	0.5	18	19	4.3	0.55	190
1N5361A	27	50	5	120	0.5	19.4	20.6	4.1	0.6	176
1N5362A	28	50	6	130	0.5	20.1	21.2	3.9	0.6	170
1N5363A	30	40	8	140	0.5	21.6	22.8	3.7	0.6	158
1N5364A	33	40	10	150	0.5	23.8	25.1	3.5	0.6	144
1N5365A	36	30	11	160	0.5	25.9	27.4	3.3	0.65	132
1N5366A	39	30	14	170	0.5	28.1	29.7	3.1	0.65	122
1N5367A	43	30	20	190	0.5	31	32.7	2.8	0.7	110
1N5368A	47	25	25	210	0.5	33.8	35.8	2.7	0.8	100
1N5369A	51	25	27	230	0.5	36.7	38.8	2.5	0.9	93
1N5370A	56	20	35	280	0.5	40.3	42.6	2.3	1	86
1N5371A	60	20	40	350	0.5	43	42.5	2.2	1.2	79
1N5372A	62	20	42	400	0.5	44.6	47.1	2.1	1.35	76
1N5373A	68	20	44	500	0.5	49	51.7	2	1.5	70
1N5374A	75	20	45	620	0.5	54	56	1.9	1.6	63
1N5375A	82	15	65	720	0.5	59	62.2	1.8	1.8	58
1N5376A	87	15	75	760	0.5	63	66	1.7	2	54.5
1N5377A	91	15	75	760	0.5	65.5	69.2	1.6	2.2	52.5
1N5378A	100	12	90	800	0.5	72	76	1.5	2.5	47.5
1N5379A	110	12	125	1000	0.5	79.2	83.6	1.4	2.5	43
1N5380A	120	10	170	1150	0.5	86.4	91.2	1.3	2.5	39.5
1N5381A	130	10	190	1250	0.5	93.6	98.8	1.2	2.5	36.6
1N5382A	140	8	230	1500	0.5	101	106	1.2	2.5	34
1N5383A	150	8	330	1500	0.5	108	114	1.1	3	31.6
1N5384A	160	8	350	1650	0.5	115	122	1.1	3	29.4
1N5385A	170	8	380	1750	0.5	122	129	1	3	28
1N5386A	180	5	430	1750	0.5	130	137	1	4	26.4
1N5387A	190	5	450	1850	0.5	137	144	0.9	5	25
1N5388A	200	5	480	1850	0.5	144	152	0.9	5	23.6

NOTES:

(1) TOLERANCE AND VOLTAGE DESIGNATION — The JEDEC type numbers shown indicate a tolerance of ±10% with guaranteed limits on only V_Z, I_R, I_r, and V_F as shown in the electrical characteristics table. Units with guaranteed limits on all seven parameters are indicated by suffix "A" for ±10% tolerance and suffix "B" for ±5%, C for ±2% and D for ±1%.

(2) ZENER VOLTAGE (V_Z) AND IMPEDANCE (Z_{ZT} & Z_{ZK}) — Test conditions for Zener voltage and impedance are as follows I_Z is applied 40 ± 10 ms prior to reading. Mounting contacts are located 3/8" to 1/2" from the inside edge of mounting clips to the body of the diode. (T_A = 25°C $^{+8}_{-2}$°C)

(3) SURGE CURRENT (i_r) — Surge current is specified as the maximum allowable peak, non-recurrent square-wave current with a pulse width, PW, of 8.3 ms. The data given in Figure 6 may be used to find the maximum surge current for a square wave of any pulse width between 1 ms and 1000 ms by plotting the applicable points on logarithmic paper. Examples of this, using the 3.3 V and 200 V zeners, are shown in Figure 7. Mounting contact located as specified in Note 3 (T_A = 25°C $^{+8}_{-2}$°C)

(4) VOLTAGE REGULATION (ΔV_Z) — Test conditions for voltage regulation are as follows: V_Z measurements are made at 10% and then at 50% of the I_Z max value listed in the electrical characteristics table. The test currents are the same for the 5% and 10% tolerance devices. The test current time duration for each V_Z measurement is 40 ± 10 ms. (T_A = 25°C $^{+8}_{-2}$°C). Mounting contact located as specified in Note 2.

(5) MAXIMUM REGULATOR CURRENT (I_{ZM}) — The maximum current shown is based on the maximum voltage of a 5% type unit, therefore, it applies only to the B-suffix device The actual I_{ZM} for any device may not exceed the value of 5 watts divided by the actual V_Z of the device. T_L = 75°C at 3/8" maximum from the device body.

TEMPERATURE COEFFICIENTS

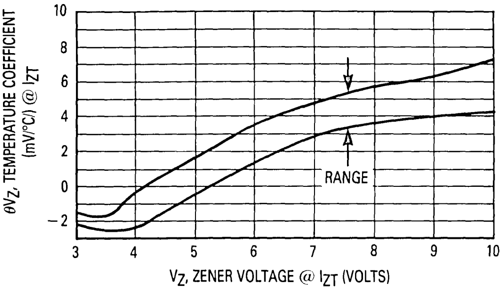


Figure 2. Temperature Coefficient-Range for Units 3 to 10 Volts

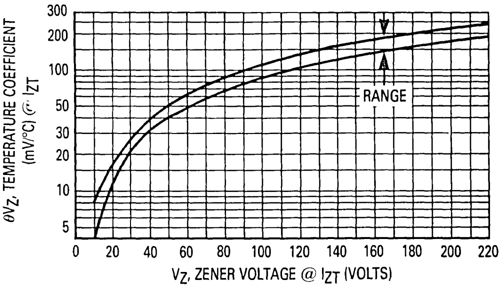


Figure 3. Temperature Coefficient-Range for Units 10 to 220 Volts

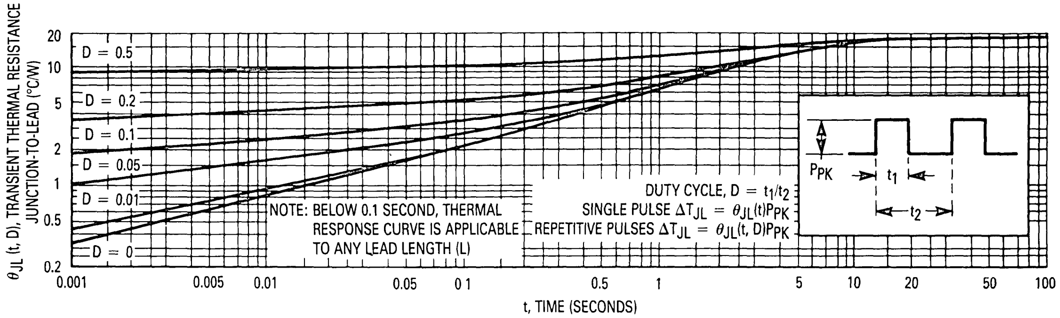


Figure 4. Typical Thermal Response
L, Lead Length = 3.8 Inch

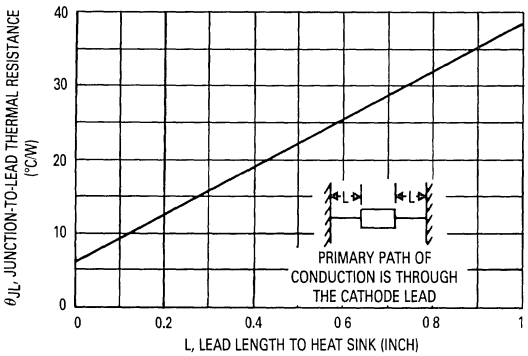


Figure 5. Typical Thermal Resistance

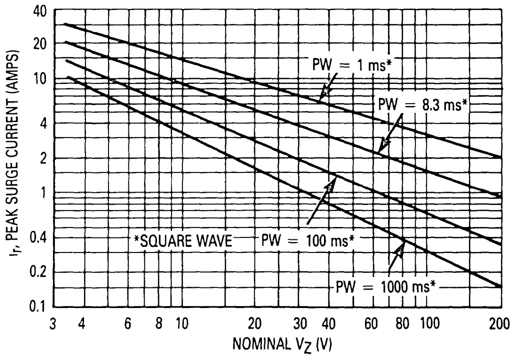


Figure 6. Maximum Non-Repetitive Surge Current versus Nominal Zener Voltage (See Note 3)

Data of Figure 4 should not be used to compute surge capability. Surge limitations are given in Figure 6. They are lower than would be expected by considering only junction temperature, as current crowding effects cause temperatures to be extremely high in small spots resulting in device degradation should the limits of Figure 6 be exceeded.

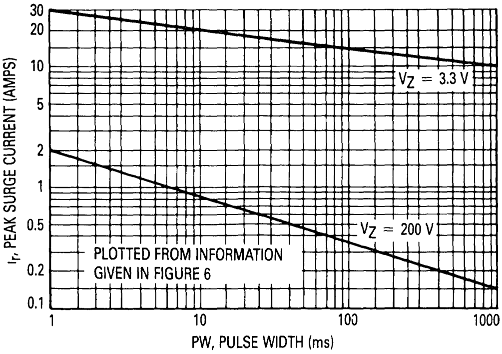


Figure 7. Peak Surge Current versus Pulse Width (See Note 3)

ZENER VOLTAGE versus ZENER CURRENT

(Figures 8, 9 and 10)

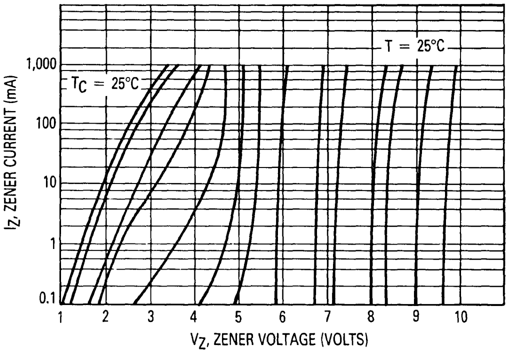


Figure 8. Zener Voltage versus Zener Current V_Z = 3.3 thru 10 Volts

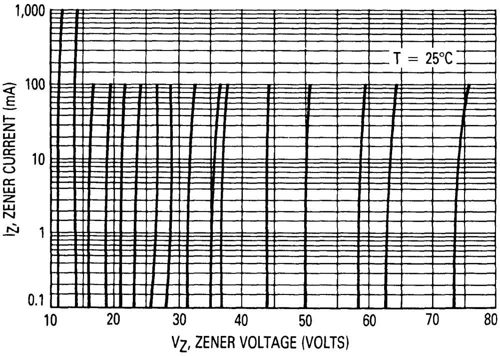


Figure 9. Zener Voltage versus Zener Current V_Z = 11 thru 75 Volts

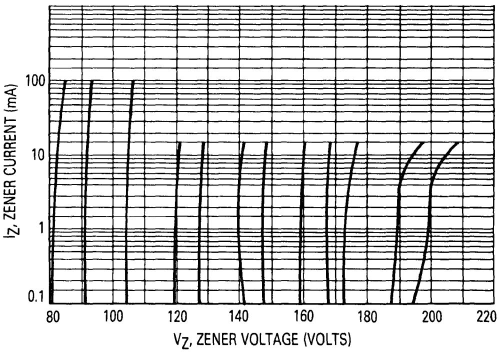


Figure 10. Zener Voltage versus Zener Current V_Z = 82 thru 200 Volts

APPLICATION NOTE

Since the actual voltage available from a given zener diode is temperature dependent, it is necessary to determine junction temperature under any set of operating conditions, in order to calculate its value. The following procedure is recommended:

Lead Temperature, T_L, should be determined from:

$$T_L = \theta_{LA} P_D + T_A$$

θ_{LA} is the lead-to-ambient thermal resistance and P_D is the power dissipation.

Junction Temperature, T_J, may be found from:

$$T_J = T_L + \Delta T_{JL}$$

ΔT_{JL} is the increase in junction temperature above the lead temperature and may be found from Figure 4 for a train of power pulses or from Figure 5 for dc power.

$$\Delta T_{JL} = \theta_{JL} P_D$$

For worst-case design, using expected limits of I_Z, limits of P_D and the extremes of T_J (ΔT_J) may be estimated. Changes in voltage, V_Z, can then be found from:

$$\Delta V = \theta_{VZ} \Delta T_J$$

θ_{VZ}, the zener voltage temperature coefficient, is found from Figures 2 and 3.

Under high power-pulse operation, the zener voltage will vary with time and may also be affected significantly by the zener resistance. For best regulation, keep current excursions as low as possible.

MOTOROLA
SEMICONDUCTOR
TECHNICAL DATA

1N5518A, B thru 1N5546A, B

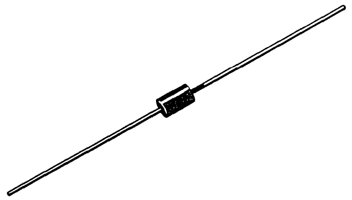
LOW VOLTAGE AVALANCHE SILICON OXIDE PASSIVATED ZENER REGULATOR DIODES

Highly reliable silicon regulators utilizing an oxide-passivated junction for long-term voltage stability. Double slug construction provides a rugged, glass-enclosed, hermetically sealed structure.

- Low Zener Noise Specified
- Low Maximum Regulation Factor
- Low Zener Impedance
- Low Leakage Current
- Controlled Forward Characteristics
- Temperature Range: -65 to +200°C

LOW VOLTAGE AVALANCHE ZENER DIODES

400 MILLIWATTS
3.3 THRU 33 VOLTS



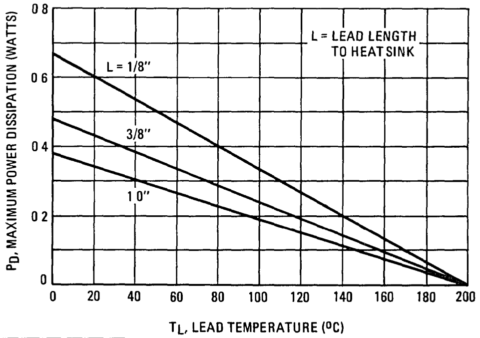
MAXIMUM RATINGS

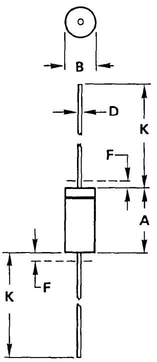
Rating	Symbol	Value	Unit
DC Power Dissipation @ $T_A = 50°C$ Derate above 50°C	P_D	400 3.2	mW mW/°C
DC Power Dissipation @ $T_L = 50°C$ Lead Length = 1/8" Derate above 50°C (Figure 1)	P_D	500 3.3	mW mW/°C
Operating and Storage Junction Temperature Range	T_J, T_{stg}	-65 to +200	°C

MECHANICAL CHARACTERISTICS

CASE: Hermetically sealed, all-glass
DIMENSIONS: See outline drawing.
FINISH: All external surfaces are corrosion resistant and leads are readily solderable and weldable.
POLARITY: Cathode indicated by polarity band.
WEIGHT: 0.2 Gram (approx)
MOUNTING POSITION: Any

FIGURE 1 — POWER-TEMPERATURE DERATING CURVE





NOTES
1. PACKAGE CONTOUR OPTIONAL WITHIN A AND B HEAT SLUGS, IF ANY, SHALL BE INCLUDED WITHIN THIS CYLINDER, BUT NOT SUBJECT TO THE MINIMUM LIMIT OF B
2. LEAD DIAMETER NOT CONTROLLED IN ZONE F TO ALLOW FOR FLASH, LEAD FINISH BUILDUP AND MINOR IRREGULARITIES OTHER THAN HEAT SLUGS
3. POLARITY DENOTED BY CATHODE BAND
4. DIMENSIONING AND TOLERANCING PER ANSI Y14.5, 1973

DIM	MILLIMETERS MIN	MILLIMETERS MAX	INCHES MIN	INCHES MAX
A	3.05	5.08	0.120	0.200
B	1.52	2.29	0.060	0.090
D	0.46	0.56	0.018	0.022
F	–	1.27	–	0.050
K	25.40	38.10	1.000	1.500

All JEDEC dimensions and notes apply.

CASE 299-02
DO-204AH
GLASS

4

ELECTRICAL CHARACTERISTICS (T_A = 25°C unless otherwise noted. Based on dc measurements at thermal equilibrium, V_F = 1.1 Max @ I_F = 200 mA for all types)

JEDEC Type No. (Note 1)	Nominal Zener Voltage V_Z @ I_{ZT} Volts (Note 2)	Test Current I_{ZT} mAdc	Max Zener Impedance B-C-D Suffix Z_{ZT} @ I_{ZT} Ohms (Note 3)	Max Reverse Leakage Current I_R µAdc (Note 4)			B-C-D Suffix Maximum DC Zener Current I_{ZM} mAdc (Note 5)	B-C-D Suffix Max Noise Density at I_Z = 250 µA N_D (Figure 1) (micro-volts per square root cycle)	Regulation Factor ΔV_Z Volts (Note 6)	Low V_Z Current I_{ZL} mAdc
					V_R – Volts Non & A-Suffix	V_R – Volts B-C-D Suffix				
1N5518A	3.3	20	26	5 0	0 90	1 0	115	0 5	0.90	2.0
1N5519A	3 6	20	24	3 0	0.90	1 0	105	0 5	0.90	2.0
1N5520A	3.9	20	22	1 0	0.90	1.0	98	0 5	0.85	2.0
1N5521A	4.3	20	18	3 0	1.0	1.5	88	0 5	0 75	2.0
1N5522A	4.7	10	22	2 0	1.5	2 0	81	0.5	0 60	1 0
1N5523A	5.1	5 0	26	2 0	2.0	2.5	75	0 5	0 65	0 25
1N5524A	5.6	3.0	30	2 0	3 0	3.5	68	1.0	0.30	0.25
1N5525A	6.2	1 0	30	1 0	4 5	5.0	61	1.0	0 20	0 01
1N5526A	6 8	1.0	30	1 0	5 5	6.2	56	1.0	0.10	0 01
1N5527A	7.5	1.0	35	0.5	6.0	6 8	51	2 0	0 05	0 01
1N5528A	8 2	1.0	40	0.5	6.5	7.5	46	4 0	0 05	0 01
1N5529A	9 1	1.0	45	0 1	7.0	8 2	42	4 0	0 05	0.01
1N5530A	10 0	1.0	60	0.05	8 0	9 1	38	4.0	0.10	0 01
1N5531A	11.0	1.0	80	0.05	9.0	9.9	35	5.0	0 20	0 01
1N5532A	12.0	1.0	90	0 05	9 5	10.8	32	10	0.20	0 01
1N5533A	13.0	1.0	90	0 01	10 5	11.7	29	15	0.20	0.01
1N5534A	14 0	1 0	100	0 01	11 5	12.6	27	20	0 20	0 01
1N5535A	15.0	1 0	100	0 01	12.5	13.5	25	20	0 20	0.01
1N5536A	16.0	1 0	100	0.01	13 0	14 4	24	20	0.20	0 01
1N5537A	17.0	1.0	100	0.01	14.0	15.3	22	20	0 20	0 01
1N5538A	18.0	1.0	100	0.01	15.0	16.2	21	20	0.20	0 01
1N5539A	19.0	1 0	100	0.01	16 0	17.1	20	20	0 20	0 01
1N5540A	20.0	1 0	100	0.01	17.0	18.0	19	20	0 20	0 01
1N5541A	22 0	1 0	100	0 01	18 0	19.8	17	20	0 25	0 01
1N5542A	24 0	1.0	100	0 01	20.0	21.6	16	20	0 30	0 01
1N5543A	25.0	1.0	100	0 01	21.0	22 4	15	20	0 35	0 01
1N5544A	28 0	1.0	100	0.01	23.0	25 2	14	20	0 40	0.01
1N5545A	30.0	1.0	100	0 01	24.0	27.0	13	20	0 45	0 01
1N5546A	33 0	1.0	100	0.01	28 0	29 7	12	20	0.50	0 01

4

NOTE 1 – TOLERANCE AND VOLTAGE DESIGNATION

The JEDEC type numbers shown are ±10% with guaranteed limits for V_Z, I_R, and V_F. Units with guaranteed limits for all six parameters are indicated by a "B" suffix for ±5.0% units, "C" suffix for ±2.0% and "D" suffix for ±1.0%.

NOTE 2 – ZENER VOLTAGE (V_Z) MEASUREMENT

Nominal zener voltage is measured with the device junction in thermal equilibrium with ambient temperature of 25°C.

NOTE 3 – ZENER IMPEDANCE (Z_Z) DERIVATION

The zener impedance is derived from the 60 Hz ac voltage, which results when an ac current having an rms value equal to 10% of the dc zener current (I_{ZT}) is superimposed on I_{ZT}.

NOTE 4 – REVERSE LEAKAGE CURRENT (I_R)

Reverse leakage currents are guaranteed and are measured at V_R as shown on the table.

NOTE 5 – MAXIMUM REGULATOR CURRENT (I_{ZM})

The maximum current shown is based on the maximum voltage of a 5.0% type unit, therefore, it applies only to the "B" suffix device. The actual I_{ZM} for any device may not exceed the value of 400 milliwatts divided by the actual V_Z of the device.

NOTE 6 – MAXIMUM REGULATION FACTOR (ΔV_Z)

ΔV_Z is the maximum difference between V_Z at I_{ZT} and V_Z at I_{ZL} measured with the device junction in thermal equilibrium.

ZENER NOISE DENSITY

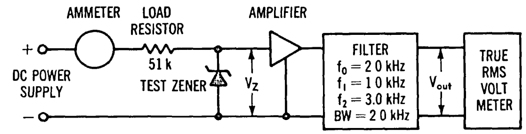
A zener diode generates noise when it is biased in the zener direction. A small part of this noise is due to the internal resistance associated with the device. A larger part of zener noise is a result of the zener breakdown phenomenon and is called microplasma noise. To eliminate the higher frequency components of noise a small shunting capacitor can be used. The lower frequency noise generally must be tolerated since a capacitor required to eliminate the lower frequencies would degrade the regulation properties of the zener in many applications.

Motorola is rating this series with a maximum noise density at 250 microamperes, a bandwidth of 2.0 kHz and a center frequency of 2.0 kHz.

Noise density decreases as zener current increases. The junction temperature will also change the zener noise levels, thus the noise rating must indicate frequency, bandwidth, current level and temperature.

The block diagram shown in Figure 2 represents the method used to measure noise density. The input voltage and load resistance is high so that the zener is driven from a constant current source. The amplifier must be low noise so that the amplifier noise is negligible compared to the test zener. The filter frequency and bandpass is known so that the noise density in volts RMS per square root cycle can be calculated.

FIGURE 2 – NOISE DENSITY MEASUREMENT METHOD



$$\text{NOISE DENSITY (VOLTS PER SQUARE ROOT BANDWIDTH)} = \frac{V_{out}}{\text{OVERALL GAIN}\sqrt{BW}}$$

WHERE. BW = FILTER BANDWIDTH (Hz)
V_{out} = OUTPUT NOISE (VOLTS RMS)

FIGURE 3 – TYPICAL CAPACITANCE

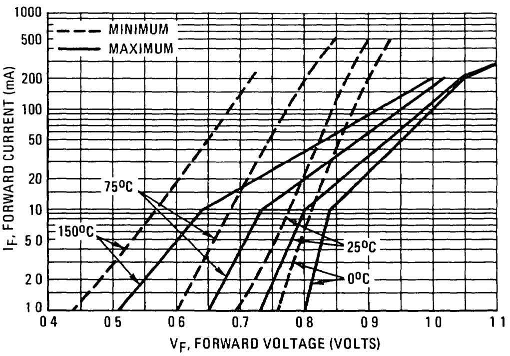
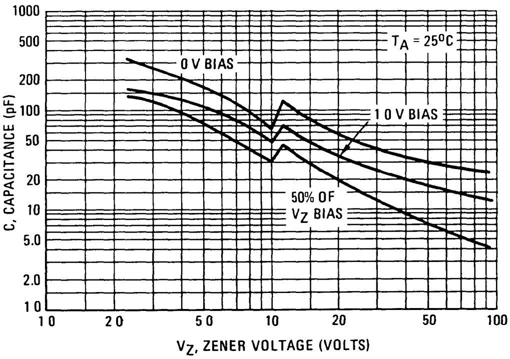
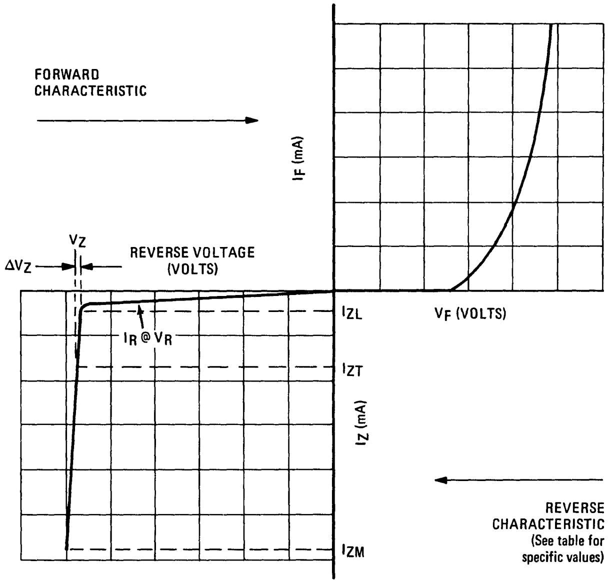


FIGURE 4 – TYPICAL FORWARD CHARACTERISTICS



4

FIGURE 5 – ZENER DIODE CHARACTERISTICS AND SYMBOL IDENTIFICATION



MOTOROLA
SEMICONDUCTOR
TECHNICAL DATA

1N5908
1N6373/ICTE-5, C MPTE-5, C thru 1N6389/ICTE-45, C MPTE-45, C
1N6267, A/1.5KE6.8, A thru 1N6303, A/1.5KE250, A

ZENER OVERVOLTAGE TRANSIENT SUPPRESSOR

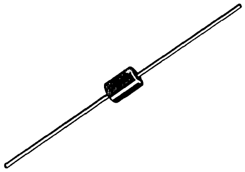
Mosorb devices are designed to protect voltage sensitive components from high voltage, high energy transients. They have excellent clamping capability, high surge capability, low zener impedance and fast response time. These devices are Motorola's exclusive, cost-effective, highly reliable Surmetic axial leaded package and are ideally-suited for use in communication systems, numerical controls, process controls, medical equipment, business machines, power supplies and many other industrial/consumer applications, to protect CMOS, MOS and Bipolar integrated circuits.

SPECIFICATION FEATURES

- Standard Voltage Range — 5.0 to 200 V
- Peak Power — 1500 Watts @ 1.0 ms
- Maximum Clamp Voltage @ Peak Pulse Current
- Low Leakage < 5.0 μA above 10 V
- Standard Back to Back Versions Available

MOSORBS ZENER OVERVOLTAGE TRANSIENT SUPPRESSORS

5.0-200 VOLT
1500 WATT PEAK POWER
5.0 WATTS STEADY STATE



MAXIMUM RATINGS

Rating	Symbol	Value	Units
Peak Power Dissipation (1) @ $T_L \leq 25^{\circ}C$	P_{PK}	1500	Watts
Steady State Power Dissipation @ $T_L \leq 75^{\circ}C$, Lead Length = 3/8"	P_D	5.0	Watts
Derated above $T_L = 75^{\circ}C$		50	mW/°C
Forward Surge Current (2) @ $T_A = 25^{\circ}C$	I_{FSM}	200	Amps
Operating and Storage Temperature Range	T_J, T_{stg}	-65 to +175	°C

Lead Temperature not less than 1/16" from the case for 10 seconds: 230°C

MECHANICAL CHARACTERISTICS

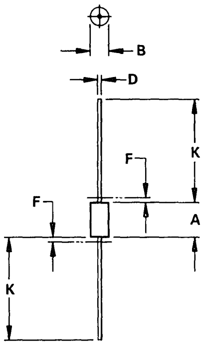
CASE: Void-free, transfer-molded, thermosetting plastic

FINISH: All external surfaces are corrosion resistant and leads are readily solderable and weldable

POLARITY: Cathode indicated by polarity band. When operated in zener mode, will be positive with respect to anode

MOUNTING POSITION: Any

NOTES: 1. Nonrepetitive Current Pulse per Figure 4 and Derated above $T_A = 25^{\circ}C$ per Figure 2
2. 1/2 Square Wave (or equivalent), PW = 8.3 ms, Duty Cycle = 4 Pulses per minute maximum



NOTES
1. DIMENSIONING AND TOLERANCING PER ANSI Y14.5M, 1982
2. CONTROLLING DIMENSION: INCH
3. LEAD FINISH AND DIAMETER UNCONTROLLED IN DIM F

DIM	MILLIMETERS MIN	MILLIMETERS MAX	INCHES MIN	INCHES MAX
A	9.14	9.52	0.360	0.375
B	4.83	5.21	0.190	0.205
D	0.97	1.07	0.038	0.042
F	—	1.27	—	0.050
K	27.94	—	1.100	—

CASE 41-11
PLASTIC

4

***ELECTRICAL CHARACTERISTICS** (T_A = 25°C unless otherwise noted) V_F# = 3.5 V max, I_F** = 100 A

Device	Breakdown Voltage V_{BR} (Volts) Min	Breakdown Voltage @ I_T (mA)	Maximum Reverse Stand-Off Voltage V_{RWM}*** (Volts)	Maximum Reverse Leakage @ V_{RWM} I_R (μA)	Maximum Reverse Voltage @ I_{RSM}† = 120 A (Clamping Voltage) V_{RSM} (Volts)	Clamping Voltage: Peak Pulse Current @ I_{pp1}† = 30 A V_{C1} (Volts max)	Clamping Voltage: Peak Pulse Current @ I_{pp2}† = 60 A V_{C2} (Volts max)
1N5908	6.0	1.0	5.0	300	8 5	7.6	8.0

ELECTRICAL CHARACTERISTIC (T_A = 25°C unless otherwise noted) V_F# = 3.5 V max, I_F** = 100 A) (C suffix denotes standard back to back versions. Test both polarities)

JEDEC Device	Device	Breakdown Voltage V_{BR} Volts Min	Breakdown Voltage @ I_T (mA)	Maximum Reverse Stand-Off Voltage V_{RWM}*** (Volts)	Maximum Reverse Leakage @ V_{RWM} I_R (μA)	Maximum Reverse Surge Current I_{RSM}† (Amps)	Maximum Reverse Voltage @ I_{RSM}† (Clamping Voltage) V_{RSM} (Volts)	Clamping Voltage: Peak Pulse Current @ I_{pp1}† = 1.0 A V_{C1} (Volts max)	Clamping Voltage: Peak Pulse Current @ I_{pp2}† = 10 A V_{C2} (Volts max)
1N6373	ICTE-5/MPTE-5	6 0	1 0	5 0	300	160	9 4	7 1	7 5
—	ICTE-5C/MPTE-5C	6 0	1 0	5 0	300	160	9 4	8 1	8 3
1N6374	ICTE-8/MPTE-8	9 4	1 0	8 0	25	100	15 0	11 3	11 5
1N6382	ICTE-8C/MPTE-8C	9 4	1 0	8 0	25	100	15 0	11 4	11 6
1N6375	ICTE-10/MPTE-10	11 7	1 0	10	2 0	90	16 7	13 7	14 1
1N6383	ICTE-10C/MPTE-10C	11 7	1 0	10	2 0	90	16 7	14 1	14 5
1N6376	ICTE-12/MPTE-12	14 1	1 0	12	2 0	70	21 2	16 1	16 5
1N6384	ICTE-12C/MPTE-12C	14 1	1 0	12	2 0	70	21 2	16 7	17 1
1N6377	ICTE-15/MPTE-15	17 6	1 0	15	2 0	60	25 0	20 1	20 6
1N6385	ICTE-15C/MPTE-15C	17 6	1 0	15	2 0	60	25 0	20 8	21 4
1N6378	ICTE-18/MPTE-18	21 2	1 0	18	2 0	50	30 0	24 2	25 2
1N6386	ICTE-18C/MPTE-18C	21 2	1 0	18	2 0	50	30 0	24 8	25 5
1N6379	ICTE-22/MPTE-22	25 9	1 0	22	2 0	40	37 5	29 8	32 0
1N6387	ICTE-22C/MPTE-22C	25 9	1 0	22	2 0	40	37 5	30 8	32 0
1N6380	ICTE-36/MPTE-36	42 4	1 0	36	2 0	23	65 2	50 6	54 3
1N6388	ICTE-36C/MPTE-36C	42 4	1 0	36	2 0	23	65 2	50 6	54 3
1N6381	ICTE-45/MPTE-45	52 9	1 0	45	2 0	19	78 9	63 3	70 0
1N6389	ICTE-45C/MPTE-45C	52 9	1 0	45	2 0	19	78 9	63 3	70 0

JEDEC Device	Device	Breakdown Voltage V_{BR} Volts Min	Breakdown Voltage V_{BR} Volts Nom	Breakdown Voltage V_{BR} Volts Max	@ I_T (mA)	Working Peak Reverse Voltage V_{RWM} (Volts)	Maximum Reverse Leakage @ V_{RWM} I_R (μA)	Maximum Reverse Surge Current I_{RSM}† (Amps)	Maximum Reverse Voltage @ I_{RSM} (Clamping Voltage) V_{RSM} (Volts)	Maximum Temperature Coefficient of V_{BR} (%/°C)
1N6267	1 5KE6 8	6 12	6.8	7.48	10	5 50	1000	139	10 8	0 057
1N6267A	1 5KE6 8A	6.45	6.8	7 14	10	5.80	1000	143	10 5	0 057
1N6268	1 5KE7 5	6 75	7.5	8 25	10	6 05	500	128	11 7	0 061
1N6268A	1 5KE7 5A	7 13	7.5	7.88	10	6 40	500	132	11 3	0 061
1N6269	1 5KE8 2	7.38	8.2	9 02	10	6 63	200	120	12 5	0 065
1N6269A	1 5KE8 2A	7.79	8 2	8 61	10	7 02	200	124	12 1	0 065
1N6270	1.5KE9 1	8 19	9.1	10 0	1 0	7 37	50	109	13 8	0 068
1N6270A	1 5KE9 1A	8 65	9 1	9.55	1.0	7.78	50	112	13.4	0 068
1N6271	1 5KE10	9 00	10	11	1.0	8 10	10	100	15 0	0 073
1N6271A	1 5KE10A	9.50	10	10 5	1 0	8.55	10	103	14 5	0 073
1N6272	1.5KE11	9.90	11	12.1	1.0	8 92	5 0	93.0	16 2	0 075
1N6272A	1.5KE11A	10.5	11	11 6	1 0	9 40	5.0	96 0	15 6	0 075

*ELECTRICAL CHARACTERISTICS (Continued)

JEDEC Device	Device	Breakdown Voltage V_{BR} Volts Min	Nom	Max	@ I_T (mA)	Working Peak Reverse Voltage V_{RWM} (Volts)	Maximum Reverse Leakage @ V_{RWM} I_R (μA)	Maximum Reverse Surge Current I_{RSM}† (Amps)	Maximum Reverse Voltage @ I_{RSM} (Clamping Voltage) V_{RSM} (Volts)	Maximum Temperature Coefficient of V_{BR} (%/°C)
1N6273	1 5KE12	10 8	12	13 2	1 0	9 72	5 0	87 0	17 3	0 078
1N6273A	1 5KE12A	11 4	12	12 6	1 0	10 2	5 0	90 0	16 7	0 078
1N6274	1 5KE13	11 7	13	14 3	1 0	10 5	5 0	79 0	19 0	0 081
1N6274A	1.5KE13A	12.4	13	13.7	1.0	11.1	5.0	82.0	18.2	0.081
1N6275	1 5KE15	13 5	15	16 5	1 0	12 1	5 0	68 0	22 0	0 084
1N6275A	1 5KE15A	14 3	15	15 8	1 0	12 8	5 0	71 0	21 2	0 084
1N6276	1 5KE16	14 4	16	17 6	1 0	12 9	5 0	64 0	23 5	0 086
1N6276A	1 5KE16A	15 2	16	16 8	1 0	13 6	5 0	67 0	22 5	0 086
1N6277	1 5KE18	16 2	18	19 8	1 0	14 5	5 0	56 5	26 5	0 088
1N6277A	1 5KE18A	17 1	18	18 9	1 0	15 3	5 0	59 5	25 2	0 088
1N6278	1 5KE20	18 0	20	22 0	1 0	16 2	5 0	51 5	29 1	0 090
1N6278A	1 5KE20A	19 0	20	21 0	1 0	17 1	5 0	54 0	27 7	0 090
1N6279	1 5KE22	19 8	22	24 2	1 0	17 8	5 0	47 0	31 9	0 092
1N6279A	1 5KE22A	20 9	22	23 1	1 0	18 8	5 0	49 0	30 6	0 092
1N6280	1 5KE24	21 6	24	26 4	1 0	19 4	5 0	43 0	34 7	0 094
1N6280A	1 5KE24A	22 8	24	25 2	1 0	20 5	5 0	45 0	33 2	0 094
1N6281	1 5KE27	24 3	27	29 7	1 0	21 8	5 0	38 5	39 1	0 096
1N6281A	1 5KE27A	25 7	27	28 4	1 0	23 1	5 0	40 0	37 5	0 096
1N6282	1 5KE30	27 0	30	33 0	1 0	24 3	5 0	34 5	43 5	0 097
1N6282A	1 5KE30A	28 5	30	31 5	1 0	25 6	5 0	36 0	41 4	0 097
1N6283	1 5KE33	29 7	33	36 3	1 0	26 8	5 0	31 5	47 7	0 098
1N6283A	1 5KE33A	31 4	33	34 7	1 0	28 2	5 0	33 0	45 7	0 098
1N6284	1 5KE36	32 4	36	39 6	1 0	29 1	5 0	29 0	52 0	0 099
1N6284A	1 5KE36A	34 2	36	37 8	1 0	30 8	5 0	30 0	49 9	0 099
1N6285	1 5KE39	35 1	39	42 9	1 0	31 6	5 0	26 5	56 4	0 100
1N6285A	1 5KE39A	37 1	39	41 0	1 0	33 3	5 0	28 0	53 9	0 100
1N6286	1 5KE43	38 7	43	47 3	1 0	34 8	5 0	24 0	61 9	0 101
1N6286A	1 5KE43A	40 9	43	45 2	1 0	36 8	5 0	25 3	59 3	0 101
1N6287	1 5KE47	42 3	47	51 7	1 0	38 1	5 0	22 2	67 8	0 101
1N6287A	1 5KE47A	44 7	47	49 4	1 0	40 2	5 0	23 2	64 8	0 101
1N6288	1 5KE51	45 9	51	56 1	1 0	41 3	5 0	20 4	73 5	0 102
1N6288A	1 5KE51A	48 5	51	53 6	1 0	43 6	5 0	21 4	70 1	0 102
1N6289	1 5KE56	50 4	56	61 6	1 0	45 4	5 0	18 6	80 5	0 103
1N6289A	1 5KE56	53 2	56	58 8	1 0	47 8	5 0	19 5	77 0	0 103
1N6290	1 5KE62	55 8	62	68 2	1 0	50 2	5 0	16 9	89 0	0 104
1N6290A	1 5KE62A	58 9	62	65 1	1 0	53 0	5 0	17 7	85 0	0 104
1N6291	1 5KE68	61 2	68	74 8	1 0	55 1	5 0	15 3	98 0	0 104
1N6291A	1 5KE68A	64 6	68	71 4	1 0	58 1	5 0	16 3	92 0	0 104
1N6292	1 5KE75	67 5	75	82 5	1 0	60 7	5 0	13 9	108 0	0 105
1N6292A	1 5KE75A	71 3	75	78 8	1 0	64 1	5 0	14 6	103 0	0 105
1N6293	1 5KE82	73 8	82	90 2	1 0	66 4	5 0	12 7	118 0	0 105
1N6293A	1 5KE82A	77 9	82	86 1	1 0	70 1	5 0	13 3	113 0	0 105
1N6294	1 5KE91	81 9	91	100 0	1 0	73 7	5 0	11 4	131 0	0 106
1N6294A	1 5KE91A	86 5	91	95 50	1 0	77 8	5 0	12 0	125 0	0 106
1N6295	1 5KE100	90 0	100	110 0	1 0	81 0	5 0	10 4	144 0	0 106
1N6295A	1 5KE100A	95 0	100	105 0	1 0	85 5	5 0	11 0	137 0	0 106
1N6296	1 5KE110	99 0	110	121 0	1 0	89 2	5 0	9 5	158 0	0 107
1N6296A	1 5KE110A	105 0	110	116 0	1 0	94 0	5 0	9 9	152 0	0 107
1N6297	1 5KE120	108 0	120	132 0	1 0	97 2	5 0	8 7	173 0	0 107
1N6297A	1 5KE120A	114 0	120	126 0	1 0	102 0	5 0	9 1	165 0	0 107
1N6298	1 5KE130	117 0	130	143 0	1 0	105 0	5 0	8 0	187 0	0 107
1N6298A	1 5KE130A	124 0	130	137 0	1 0	111 0	5 0	8 4	179 0	0 107
1N6299	1 5KE150	135 0	150	165 0	1 0	121 0	5 0	7 0	215 0	0 108
1N6299A	1 5KE150A	143 0	150	158 0	1 0	128 0	5 0	7 2	207 0	0 108
1N6300	1 5KE160	144 0	160	176 0	1 0	130 0	5 0	6 5	230 0	0 108
1N6300A	1 5KE160A	152 0	160	168 0	1 0	136 0	5 0	6 8	219 0	0 108

***ELECTRICAL CHARACTERISTICS** (Continued)

JEDEC Device	Device	Breakdown Voltage V_{BR} Volts Min	Nom	Max	@ I_T (mA)	Working Peak Reverse Voltage V_{RWM} (Volts)	Maximum Reverse Leakage @ V_{RWM} I_R (μA)	Maximum Reverse Surge Current I_{RSM}† (Amps)	Maximum Reverse Voltage @ I_{RSM} (Clamping Voltage) V_{RSM} (Volts)	Maximum Temperature Coefficient of V_{BR} (%/°C)
1N6301	1 5KE170	153	170	187	1 0	138	5 0	6 2	244	0 108
1N6301A	1.5KE170A	162	170	179	1 0	145	5 0	6 4	234	0.108
1N6302	1 5KE180	162	180	198	1 0	146	5 0	5 8	258	0 108
1N6302A	1.5KE180A	171	180	189	1 0	154	5.0	6 1	246	0 108
1N6303	1 5KE200	180	200	220	1 0	162	5 0	5 2	287	0 108
1N6303A	1 5KE200A	190	200	210	1 0	171	5 0	5 5	274	0 108
	1 5KE220	198	220	242	1 0	175	5 0	4 3	344	0 109
	1 5KE220A	209	220	231	1 0	185	5 0	4 6	328	0 109
	1.5KE250	225	250	275	1 0	202	5 0	5 0	360	0 109
	1 5KE250A	237	250	263	1 0	214	5 0	5 0	344	0 109

†Surge Current Waveform per Figure 4 and Derate per Figure 2
*Indicates JEDEC Registered Data
**1/2 Square Equivalent Sine Wave, PW = 8 3 ms, Duty Cycle = 4 Pulses per Minute maximum
***A Transient Suppressor is normally selected according to the maximum reverse stand-off voltage (V_{RWM}), which should be equal to or greater than the dc or continuous peak operating voltage level
#V_F applies to Non-C suffix devices only
C suffix denotes standard back-to-back versions Test both polarities

To order clipper-bidirectional device in 1N6267 series, add a "C" suffix to 1 5KE device title, i e , 1 5KE7 5C or 1 5KE7 5CA

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FIGURE 1 — PULSE RATING CURVE

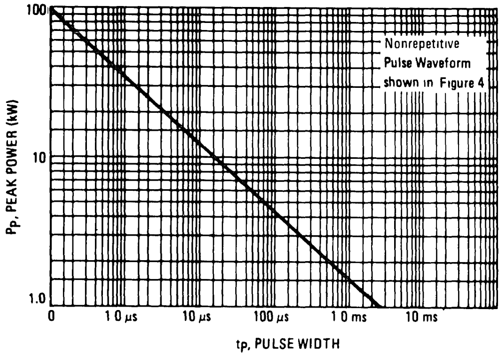


FIGURE 2 — PULSE DERATING CURVE

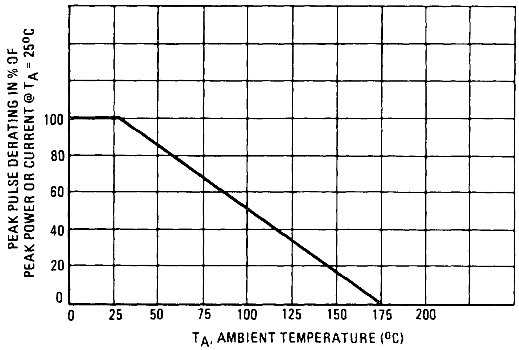
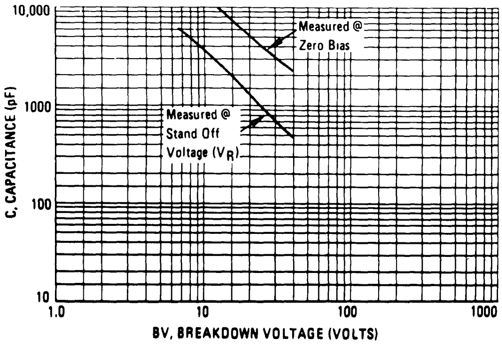


FIGURE 3 — CAPACITANCE versus BREAKDOWN VOLTAGE

1N6373, ICTE-5, C, MPTE-5, C
thru
1N6389, ICTE-45, C, MPTE-45, C



1N6267, A/1.5KE6.8, A
thru
1N6303, A/1.5KE200, A

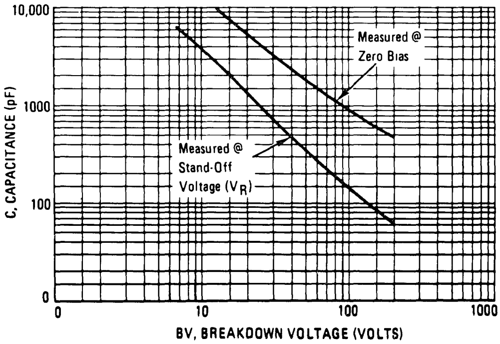


FIGURE 4 — STEADY STATE POWER DERATING

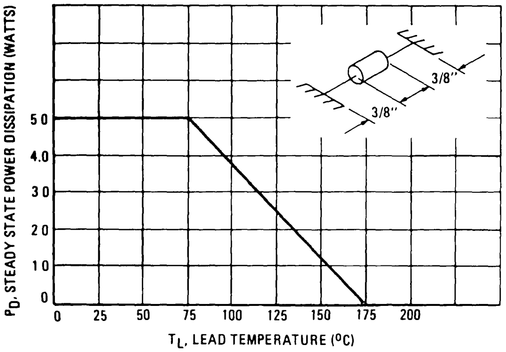


FIGURE 5 — PULSE WAVEFORM

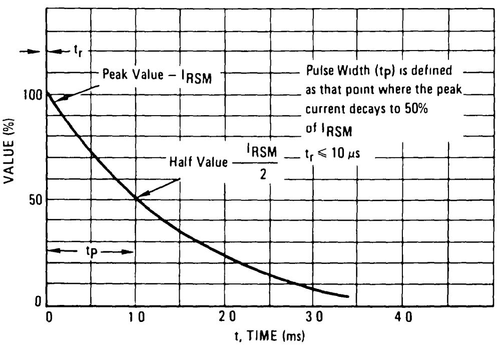
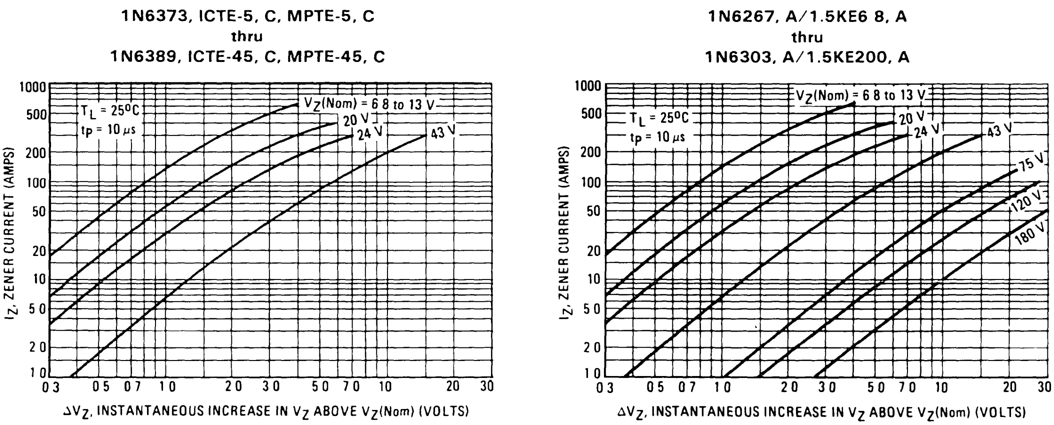


FIGURE 6 — DYNAMIC IMPEDANCE



APPLICATION NOTES

SPECIAL DEVICES

Matched sets and back-to-back configurations for bidirectional applications can be ordered upon special request Contact your nearest Motorola representative

RESPONSE TIME

In most applications, the transient suppressor device is placed in parallel with the equipment or component to be protected. In this situation, there is a time delay associated with the capacitance of the device and an overshoot condition associated with the inductance of the device and the inductance of the connection method The capacitive effect is of minor importance in the parallel protection scheme because it only produces a time delay in the transition from the operating voltage to the clamp voltage as shown in Figure A

The inductive effects in the device are due to actual turn-on time (time required for the device to go from zero current to full current) and lead inductance This inductive effect produces an overshoot in the voltage across the equipment or component being protected as shown in Figure B Minimizing this overshoot is very important in the application, since the main purpose for adding a transient suppressor is to clamp voltage spikes These devices have excellent response time, typically in the picosecond range and negligible inductance However, external inductive effects could produce unacceptable overshoot. Proper circuit layout, minimum lead lengths and placing the suppressor device as close as possible to the equipment or components to be protected will minimize this overshoot

Some input impedance represented by Z_{in} is essential to prevent overstress of the protection device This impedance should be as high as possible, without restricting the circuit operation

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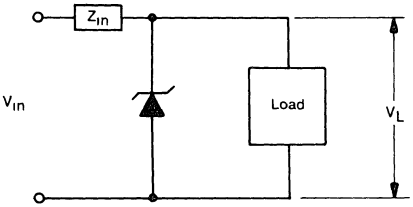
TYPICAL PROTECTION CIRCUIT



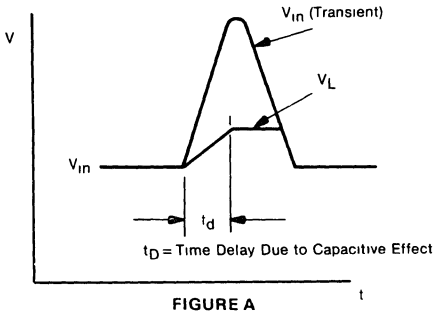


FIGURE A

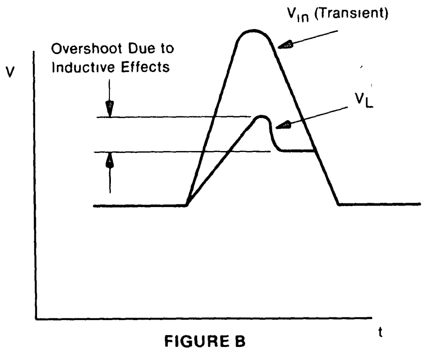


FIGURE B

MOTOROLA
SEMICONDUCTOR
TECHNICAL DATA

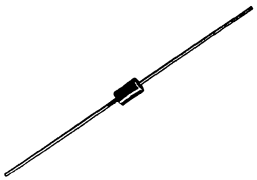
1N5913A thru 1N5956A

1.5 WATT SURMETIC 30 SILICON ZENER DIODES

. . . A complete line of 1.5-Watt Zener Diodes offering the following advantages:

- Complete Voltage Range — 3.3 to 200 Volts
- DO-41 Package — Smaller than Conventional Metal Devices
- Metallurgically Bonded Construction
- JEDEC Registered Parameters
- Oxide Passivated Diode
- Molded Package

1.5 WATTS
ZENER DIODES
3.3 – 200 VOLTS



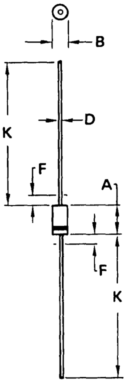
*MAXIMUM RATINGS

Rating	Symbol	Value	Unit
DC Power Dissipation @ T_L = 75°C, Lead Length = 3/8"	P_D	1.5	Watts
Derate above 75°C		12	mW/°C
Operating and Storage Junction Temperature Range	T_J, T_{stg}	-55 to +200	°C

*Indicates JEDEC Registered Data

MECHANICAL CHARACTERISTICS

CASE: Surmetic 30 void-free, transfer-molded, thermosetting-plastic
MAXIMUM LEAD TEMPERATURE FOR SOLDERING PURPOSES: 230°C, 1/16" from case for 10 seconds
FINISH: All external surfaces are corrosion resistant with readily solderable leads
POLARITY: Cathode indicated by color band. When operated in zener mode, cathode will be positive with respect to anode.
MOUNTING POSITION: Any



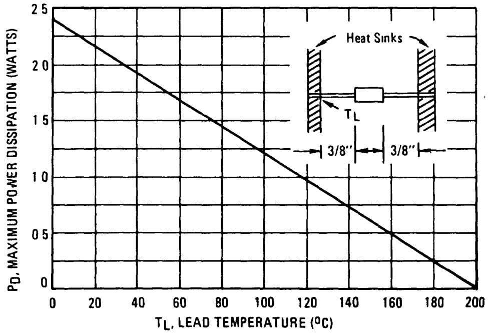
DIM	MILLIMETERS MIN	MILLIMETERS MAX	INCHES MIN	INCHES MAX
A	4.07	5.20	0.160	0.205
B	2.04	2.71	0.080	0.107
D	0.71	0.86	0.028	0.034
F	–	1.27	–	0.050
K	27.94	–	1.100	–

All JEDEC dimensions and notes apply

CASE 59-03
DO-41
PLASTIC

NOTES
1. ALL RULES AND NOTES ASSOCIATED WITH JEDEC DO-41 OUTLINE SHALL APPLY
2. POLARITY DENOTED BY CATHODE BAND
3. LEAD DIAMETER NOT CONTROLLED WITHIN "F" DIMENSION.

FIGURE 1 – STEADY STATE POWER DERATING



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1N5913A thru 1N5956A

***ELECTRICAL CHARACTERISTICS** (T_L = 30°C unless otherwise noted. V_F= 1.5 Volts Max @ I_F = 200 mAdc for all types.)

Motorola Type Number (Note 1)	Nominal Zener Voltage V_Z @ I_{ZT} Volts (Note 2)	Test Current I_{ZT} mA	Max. Zener Impedance Z_{ZT} @ I_{ZT} Ohms	Z_{ZK} @ Ohms	I_{ZK} mA	Max. Reverse Leakage Current I_R @ µA	V_R Volts	Maximum DC Zener Current I_{ZM} mAdc
1N5913A	3 3	113 6	10	500	1 0	100	1 0	454
1N5914A	3 6	104 2	9 0	500	1 0	75	1 0	416
1N5915A	3 9	96 1	7 5	500	1 0	25	1 0	384
1N5916A	4 3	87 2	6 0	500	1 0	5 0	1 0	348
1N5917A	4 7	79 8	5.0	500	1 0	5 0	1 5	319
1N5918A	5 1	73 5	4 0	350	1 0	5.0	2 0	294
1N5919A	5 6	66 9	2 0	250	1 0	5 0	3 0	267
1N5920A	6 2	60 5	2.0	200	1 0	5.0	4 0	241
1N5921A	6 8	55 1	2 5	200	1 0	5 0	5 2	220
1N5922A	7 5	50 0	3.0	400	0 5	5 0	6 8	200
1N5923A	8 2	45 7	3 5	400	0 5	5 0	6 5	182
1N5924A	9 1	41 2	4 0	500	0 5	5 0	7 0	164
1N5925A	10	37 5	4 5	500	0 25	5 0	8 0	150
1N5926A	11	34 1	5 5	550	0 25	1 0	8 4	136
1N5927A	12	31 2	6 5	550	0 25	1 0	9 1	125
1N5928A	13	28 8	7 0	550	0 25	1 0	9 9	115
1N5929A	15	25 0	9 0	600	0 25	1 0	11 4	100
1N5930A	16	23 4	10	600	0 25	1 0	12 2	93
1N5931A	18	20 8	12	650	0 25	1 0	13 7	83
1N5932A	20	18 7	14	650	0 25	1 0	15 2	75
1N5933A	22	17 0	17 5	650	0 25	1 0	16 7	68
1N5934A	24	15 6	19	700	0 25	1 8	18 2	62
1N5935A	27	13 9	23	700	0 25	1 0	20 6	55
1N5936A	30	12 5	26	750	0 25	1 0	22 8	50
1N5937A	33	11 4	33	800	0 25	1 0	25 1	45
1N5938A	36	10 4	38	850	0 25	1 0	27 4	41
1N5939A	39	9 6	45	900	0 25	1 0	29 7	38
1N5940A	43	8 7	53	950	0 25	1 0	32 7	34
1N5941A	47	8 0	67	1000	0 25	1 0	35 8	31
1N5942A	51	7 3	70	1100	0 25	1 0	38 8	29
1N5943A	56	6 7	86	1300	0 25	1 0	42 6	26
1N5944A	62	6 0	100	1500	0 25	1 0	47 1	24
1N5945A	68	5 5	120	1700	0 25	1 0	51 7	22
1N5946A	75	5 0	140	2000	0 25	1 0	56 0	20
1N5947A	82	4 6	160	2500	0 25	1 0	62 2	18
1N5948A	91	4 1	200	3000	0 25	1 0	69 2	16
1N5949A	100	3 7	250	3100	0 25	1 0	76 0	15
1N5950A	110	3.4	300	4000	0 25	1.0	83 6	13
1N5951A	120	3 1	380	4500	0 25	1 0	91 2	12
1N5952A	130	2 9	450	5000	0 25	1 0	98 8	11
1N5953A	150	2.5	600	6000	0 25	1 0	114	10
1N5954A	160	2.3	700	6500	0 25	1.0	121 6	9 0
1N5955A	180	2.1	900	7000	0 25	1 0	136 8	8 0
1N5956A	200	1.9	1200	8000	0 25	1.0	152	7 0

*Indicates JEDEC Registered Data.

NOTE 1 – TOLERANCE AND VOLTAGE DESIGNATION

Tolerance designation — Device tolerances of ±10% are indicated by an "A" suffix, ±5% by a "B" suffix, ±2% by a "C" suffix, ±1% by a "D" suffix.

NOTE 2 – SPECIAL SELECTIONS AVAILABLE INCLUDE

Nominal zener voltages between those shown

TYPICAL CHARACTERISTICS

TEMPERATURE COEFFICIENTS (-55°C to +150°C temperature range)

FIGURE 2 – ZENER VOLTAGE – TO 12 VOLTS

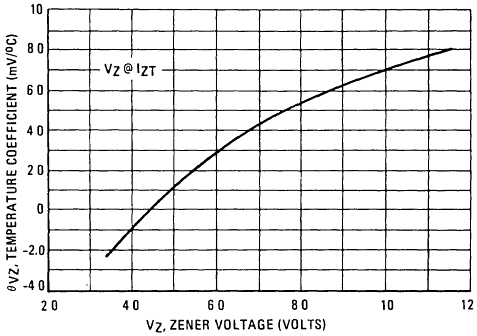
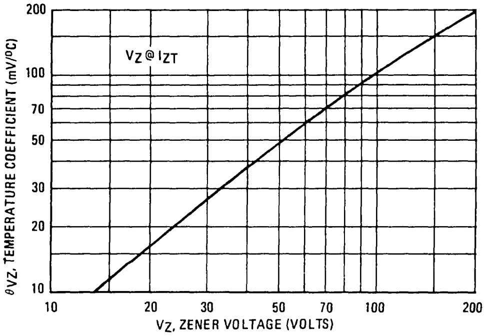


FIGURE 3 – ZENER VOLTAGE – 14 TO 200 VOLTS



ZENER IMPEDANCE

FIGURE 4 – EFFECT OF ZENER CURRENT

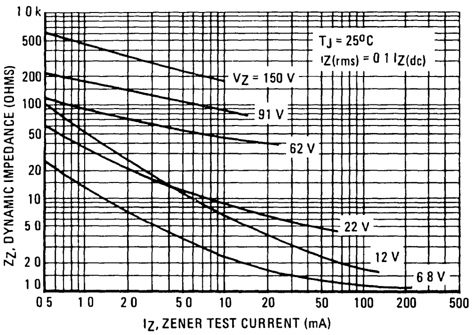
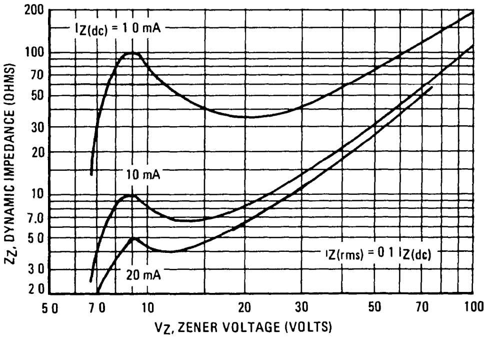


FIGURE 5 – EFFECT OF ZENER VOLTAGE



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MOTOROLA
SEMICONDUCTOR
TECHNICAL DATA

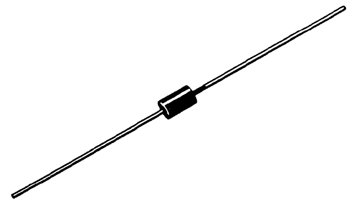
1N5985A thru 1N6025A

500 MILLIWATT HERMETICALLY SEALED GLASS SILICON ZENER DIODES

. . . A complete line of 500 mW Zener Diodes offering the following advantages:

- Complete Voltage Range – 2.4 to 110 Volts
- DO-35 Package – Smaller than Conventional DO-7 Package
- Double Slug Type Construction
- Metallurgically Bonded Construction
- JEDEC Registered
- Oxide Passivated Die

500 MILLIWATT
GLASS ZENER DIODES
2.4-110 VOLTS



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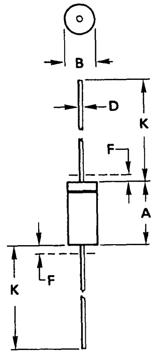
*MAXIMUM RATINGS

Rating	Symbol	Value	Unit
DC Power Dissipation @ $T_L \leq 50^\circ C$, Lead Length = 3/8″	P_D	500	mW
Derate above $50^\circ C$		3.33	$mW/^\circ C$
Operating and Storage Junction Temperature Range	T_J, T_{stg}	-55 to +200	$^\circ C$

*Indicates JEDEC Registered Data.

MECHANICAL CHARACTERISTICS

CASE: Double slug type, hermetically sealed glass
MAXIMUM LEAD TEMPERATURE FOR SOLDERING PURPOSES: 230°C, 1/16″ from case for 10 seconds
FINISH: All external surfaces are corrosion resistant with readily solderable leads.
POLARITY: Cathode indicated by color band. When operated in zener mode, cathode will be positive with respect to anode.
MOUNTING POSITION: Any



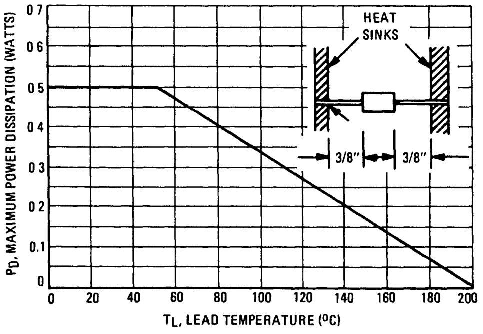
NOTES
1. PACKAGE CONTOUR OPTIONAL WITHIN A AND B HEAT SLUGS, IF ANY, SHALL BE INCLUDED WITHIN THIS CYLINDER, BUT NOT SUBJECT TO THE MINIMUM LIMIT OF B
2. LEAD DIAMETER NOT CONTROLLED IN ZONE F TO ALLOW FOR FLASH, LEAD FINISH BUILDUP AND MINOR IRREGULARITIES OTHER THAN HEAT SLUGS.
3. POLARITY DENOTED BY CATHODE BAND
4. DIMENSIONING AND TOLERANCING PER ANSI Y14.5, 1973

DIM	MILLIMETERS		INCHES	
	MIN	MAX	MIN	MAX
A	3 05	5 08	0 120	0 200
B	1.52	2 29	0 060	0 090
D	0 46	0 56	0 018	0 022
F	–	1 27	–	0 050
K	25 40	38 10	1.000	1 500

All JEDEC dimensions and notes apply.

CASE 299-02
DO-204AH
GLASS

FIGURE 1 – STEADY STATE POWER DERATING



***ELECTRICAL CHARACTERISTICS** (T_L = 30°C unless otherwise noted.) (V_F = 1.5 Volts Max @ I_F = 100 mAdc for all types.)

Motorola Type Number (Note 1)	Nominal Zener Voltage V_Z @ I_{ZT} Volts (Note 2)	Test Current I_{ZT} mA	Max. Zener Impedance (Note 4) Z_{ZT} @ I_{ZT} Ohms		Z_{ZK} @ I_{ZK} = 0.25 mA Ohms		Max. Reverse Leakage Current I_R µA		@ V_R volts		Max. DC Zener Current I_{ZM} (Note 3)
			B Suffix	A, Non-Suffix	B Suffix	A, Non-Suffix	B Suffix	A, Non-Suffix	B Suffix	A, Non-Suffix	
1N5985A	2.4	5.0	100	110	1800	2000	100	100	1.0	0.5	208
1N5986A	2.7	5.0	100	110	1900	2200	75	100	1.0	0.5	185
1N5987A	3.0	5.0	95	100	2000	2300	50	100	1.0	0.5	167
1N5988A	3.3	5.0	95	100	2200	2400	25	75	1.0	0.5	152
1N5989A	3.6	5.0	90	95	2300	2500	15	50	1.0	0.5	139
1N5990A	3.9	5.0	90	95	2400	2500	10	25	1.0	1.0	128
1N5991A	4.3	5.0	88	90	2500	2500	5.0	15	1.0	1.0	116
1N5992A	4.7	5.0	70	90	2200	2500	3.0	10	1.5	1.0	106
1N5993A	5.1	5 0	50	88	2050	2500	2.0	5.0	2.0	1.0	98
1N5994A	5.6	5.0	25	70	1800	2200	2.0	3.0	3.0	1.5	89
1N5995A	6.2	5.0	10	50	1300	2050	1.0	2.0	4.0	2.0	81
1N5996A	6.8	5.0	8.0	25	750	1800	1.0	2.0	5.2	3.0	74
1N5997A	7.5	5.0	7.0	10	600	1300	0.5	1.0	6.0	4.0	67
1N5998A	8.2	5.0	7.0	15	600	750	0.5	1.0	6.5	5.2	61
1N5999A	9.1	5.0	10	18	600	600	0.1	0.5	7.0	6.0	55
1N6000A	10	5.0	15	22	600	600	0.1	0.5	8.0	6.5	50
1N6001A	11	5.0	18	25	600	600	0.1	0 1	8.4	7.0	45
1N6002A	12	5.0	22	32	600	600	0.1	0.1	9.1	8.0	42
1N6003A	13	5.0	25	36	600	600	0.1	0.1	9.9	8.4	38
1N6004A	15	5.0	32	42	600	600	0.1	0.1	11	9.1	33
1N6005A	16	5.0	36	48	600	600	0.1	0.1	12	9.9	31
1N6006A	18	5.0	42	55	600	600	0.1	0.1	14	11	28
1N6007A	20	5.0	48	62	600	600	0.1	0.1	15	12	25
1N6008A	22	5.0	55	70	600	600	0.1	0.1	17	14	23
1N6009A	24	5.0	62	78	600	600	0.1	0.1	18	15	21
1N6010A	27	5.0	70	88	600	700	0.1	0.1	21	17	19
1N6011A	30	5.0	78	95	600	700	0.1	0.1	23	18	17
1N6012A	33	5.0	88	110	700	800	0.1	0.1	25	21	15
1N6013A	36	5.0	95	130	700	900	0.1	0.1	27	23	14
1N6014A	39	2.0	130	170	800	1000	0.1	0.1	30	25	13
1N6015A	43	2.0	150	180	900	1100	0.1	0.1	33	27	12
1N6016A	47	2 0	170	200	1000	1300	0.1	0.1	36	30	11
1N6017A	51	2.0	180	225	1300	1400	0.1	0.1	39	33	9 8
1N6018A	56	2.0	200	240	1400	1600	0.1	0.1	43	36	8.9
1N6019A	62	2.0	225	265	1400	1700	0 1	0.1	47	39	8.0
1N6020A	68	2.0	240	280	1600	2000	0.1	0.1	52	43	7 4
1N6021A	75	2.0	265	300	1700	2300	0 1	0.1	56	47	6 7
1N6022A	82	2.0	280	350	2000	2600	0.1	0.1	62	52	6.1
1N6023A	91	2.0	300	400	2300	3000	0 1	0.1	69	56	5 5
1N6024A	100	1 0	500	800	2600	4000	0.1	0 1	76	62	5.0
1N6025A	110	1 0	650	950	3000	4500	0 1	0 1	84	69	4 5

*Indicates JEDEC Registered Data

4

NOTE 1 – TOLERANCE AND VOLTAGE DESIGNATION

Tolerance designation – Device tolerances of ±10% are indicated by an "A" suffix, ±5% by a "B" suffix, ±2% by a "C" suffix, ±1% by a "D" suffix

NOTE 2 – SPECIAL SELECTIONS AVAILABLE INCLUDE:

(a) Nominal Zener voltages between those shown.

(b) Matched sets· (Standard Tolerances are ±5.0%, ±2 0%, ±1 0%)

a. Two or more units for series connection with specified tolerance on total voltage Series matched sets make zener voltages in excess of 200 volts possible as well as providing lower temperature coefficients, lower dynamic impedance and greater power handling ability

b Two or more units matched to one another with any specified tolerance

NOTE 3:

This data was calculated using nominal voltages. In order to determine the maximum current handling capability on a worst case basis the following formula must be used:

$$I_{zm}(\text{worst case}) = \frac{500\text{ mW}}{V_z(\text{nom}) + \text{tolerance}}$$

NOTE 4:

Z_{ZT} and Z_{ZK} are measured by dividing the ac voltage drop across the device by the ac current applied. The specified limits are for $I_Z(ac) = 0.1\ I_Z(dc)$ with the ac frequency = 1 0 kHz.

TYPICAL CHARACTERISTICS

TEMPERATURE COEFFICIENTS (-55°C to +150°C temperature range)

FIGURE 2A – ZENER VOLTAGE 2.4 to 12 VOLTS

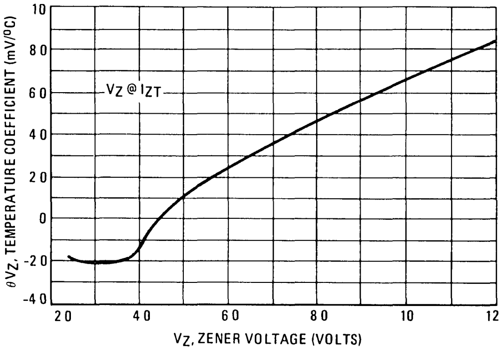


FIGURE 2B – ZENER VOLTAGE 12 to 200 VOLTS

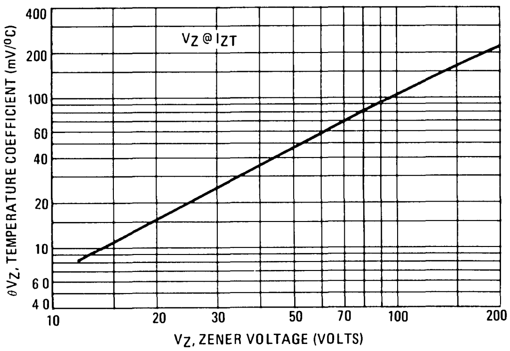


FIGURE 3 – EFFECT OF ZENER CURRENT ON ZENER IMPEDANCE

FIGURE 3A

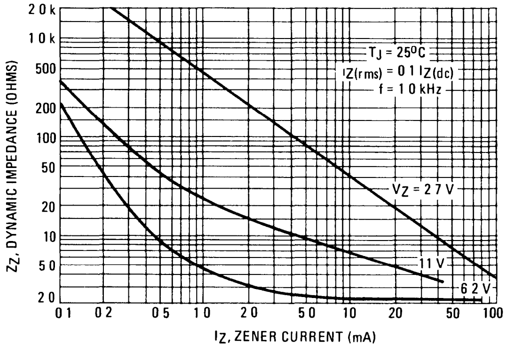


FIGURE 3B

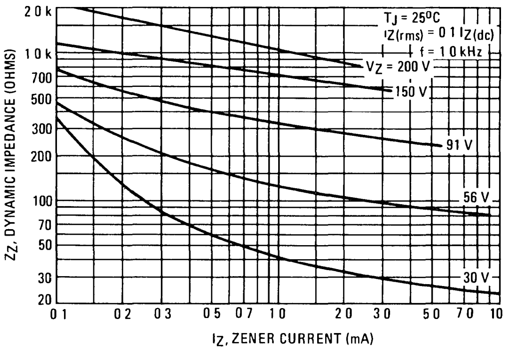
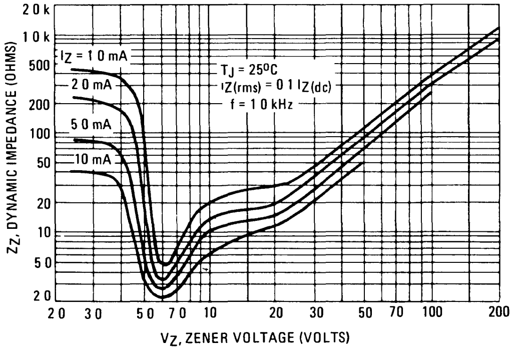


FIGURE 4 – EFFECT OF ZENER VOLTAGE ON ZENER IMPEDANCE



MOTOROLA
SEMICONDUCTOR
TECHNICAL DATA

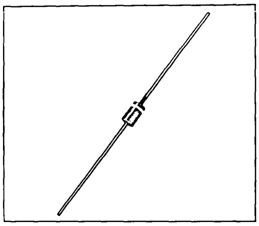
1N6267, A thru 1N6303, A
1N6373 thru 1N6389

See Page 4-59

Designer's Data Sheet
3-Watt Surmetic 30 Silicon Zener Diodes

3EZ3.9D5 thru 3EZ200D5

3-WATT ZENER REGULATOR DIODES 3.9–200 VOLTS



. . . a complete series of 3 Watt Zener Diodes with limits and operating characteristics that reflect the superior capabilities of silicon-oxide-passivated junctions. All this in an axial-lead, transfer-molded plastic package offering protection in all common environmental conditions.

- Surge Rating of 98 Watts @ 1 ms
- Maximum Limits Guaranteed on Six Electrical Parameters
- Package No Larger Than the Conventional 1 W Package

Mechanical Characteristics:

CASE: Void-free, transfer-molded, thermosetting plastic
FINISH: All external surfaces are corrosion resistant and leads are readily solderable and weldable
POLARITY: Cathode indicated by polarity band. When operated in zener mode, cathode will be positive with respect to anode
MOUNTING POSITION: Any
WEIGHT: 0.4 gram (approx)

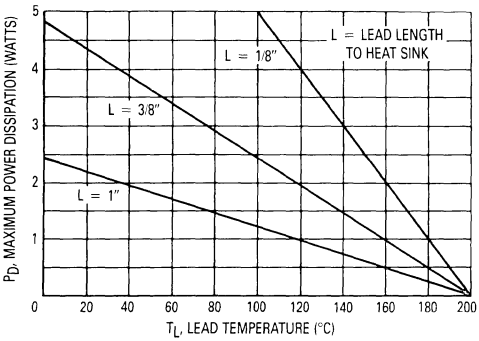
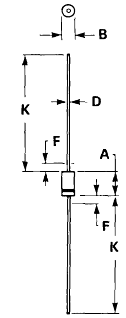


Figure 1. Power-Temperature Derating Curve

OUTLINE DIMENSIONS



NOTES
1 ALL RULES AND NOTES ASSOCIATED WITH JEDEC DO-41 OUTLINE SHALL APPLY
2 POLARITY DENOTED BY CATHODE BAND
3 LEAD DIAMETER NOT CONTROLLED WITHIN "F" DIMENSION

	MILLIMETERS		INCHES	
DIM	MIN	MAX	MIN	MAX
A	4 07	5 20	0 160	0 205
B	2 04	2 71	0 080	0 107
D	0 71	0 86	0 028	0 034
F	—	1 27	—	0 050
K	27 94	—	1 100	—

CASE 59-03 (DO-41)

MAXIMUM RATINGS

Rating	Symbol	Value	Unit
DC Power Dissipation @ T_L = 75°C Lead Length = 3/8" Derate above 75°C	P_D	3 24	Watts mW/°C
DC Power Dissipation @ T_A = 50°C Derate above 50°C	P_D	1 6.67	Watt mW/°C
Operating and Storage Junction Temperature Range	T_J, T_{stg}	−65 to +200	°C

Designer's Data for "Worst Case" Conditions — The Designer's Data Sheet permits the design of most circuits entirely from the information presented Limit curves — representing boundaries on device characteristics — are given to facilitate "worst case" design

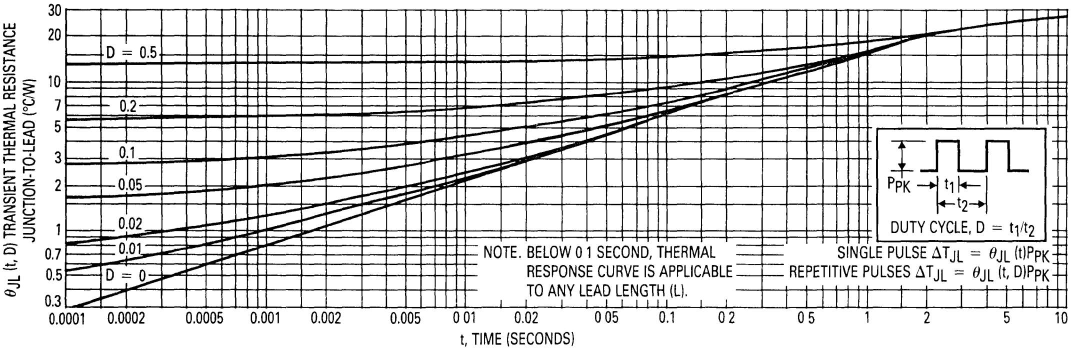


Figure 2. Typical Thermal Response L, Lead Length = 3/8 Inch

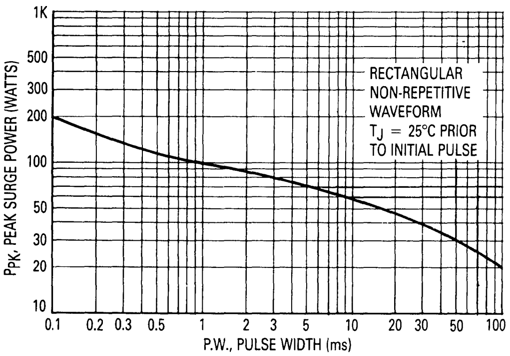


Figure 3. Maximum Surge Power

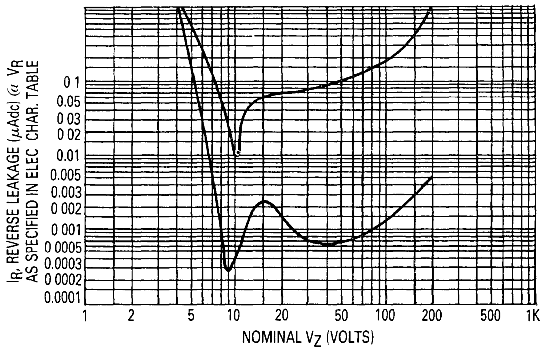


Figure 4. Typical Reverse Leakage

APPLICATION NOTE:

Since the actual voltage available from a given zener diode is temperature dependent, it is necessary to determine junction temperature under any set of operating conditions in order to calculate its value. The following procedure is recommended:

Lead Temperature, T_L, should be determined from:

$$T_L = \theta_{LA} P_D + T_A$$

θ_{LA} is the lead-to-ambient thermal resistance (°C/W) and P_D is the power dissipation. The value for θ_{LA} will vary and depends on the device mounting method. θ_{LA} is generally 30–40°C/W for the various clips and tie points in common use and for printed circuit board wiring.

The temperature of the lead can also be measured using a thermocouple placed on the lead as close as possible to the tie point. The thermal mass connected to the tie point is normally large enough so that it will not significantly respond to heat surges generated in the diode as a result of pulsed operation once steady-state conditions are achieved. Using the measured value of T_L, the junction temperature may be determined by:

$$T_J = T_L + \Delta T_{JL}$$

ΔT_{JL} is the increase in junction temperature above the lead temperature and may be found from Figure 2 for a train of power pulses (L = 3/8 inch) or from Figure 10 for dc power.

$$\Delta T_{JL} = \theta_{JL} P_D$$

For worst-case design, using expected limits of I_Z, limits of P_D and the extremes of T_J (ΔT_J) may be estimated. Changes in voltage, V_Z, can then be found from:

$$\Delta V = \theta_{VZ} \Delta T_J$$

θ_{VZ}, the zener voltage temperature coefficient, is found from Figures 5 and 6.

Under high power-pulse operation, the zener voltage will vary with time and may also be affected significantly by the zener resistance. For best regulation, keep current excursions as low as possible.

Data of Figure 2 should not be used to compute surge capability. Surge limitations are given in Figure 3. They are lower than would be expected by considering only junction temperature, as current crowding effects cause temperatures to be extremely high in small spots resulting in device degradation should the limits of Figure 3 be exceeded.

TEMPERATURE COEFFICIENT RANGES

(90% of the Units are in the Ranges Indicated)

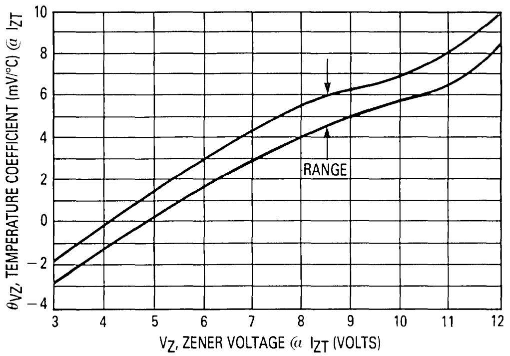


Figure 5. Units To 12 Volts

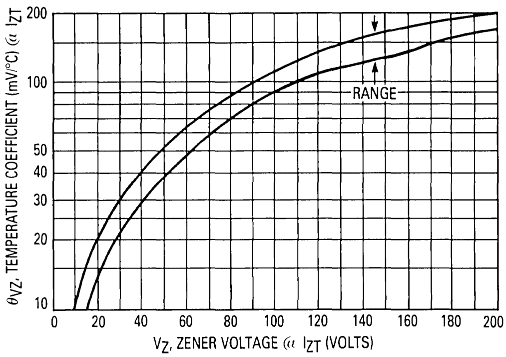


Figure 6. Units 10 To 200 Volts

ZENER VOLTAGE versus ZENER CURRENT

(Figures 7, 8 and 9)

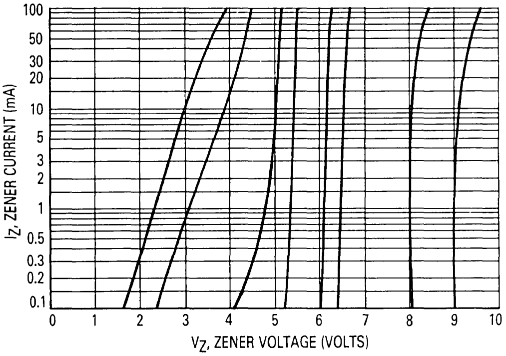


Figure 7. V_Z = 3.9 thru 10 Volts

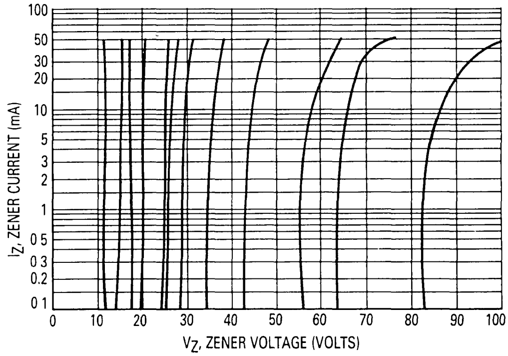


Figure 8. V_Z = 12 thru 82 Volts

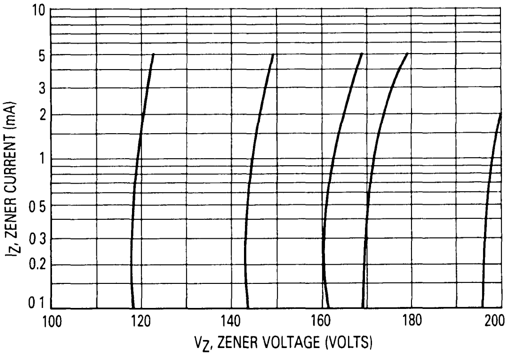


Figure 9. V_Z = 100 thru 200 Volts

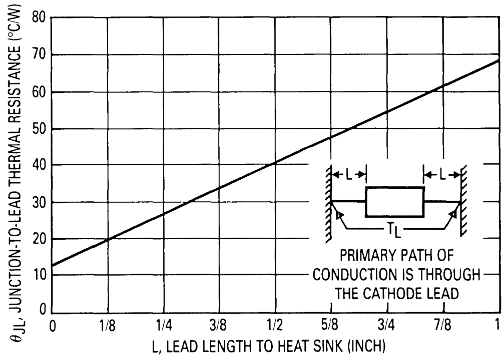


Figure 10. Typical Thermal Resistance

ELECTRICAL CHARACTERISTICS (T_A = 25°C unless otherwise noted) V_F = 1.5 V max, I_F = 200 mA for all types)

Motorola Type No. (Note 1)	Nominal Zener Voltage V_Z @ I_{ZT} Volts (Note 2)	Test Current I_{ZT} mA	Max Zener Impedance (Note 3)			Leakage Current		Maximum Zener Current I_{ZM} mA	Surge Current @ T_A = 25°C i_r – mA (Note 4)
			Z_{ZT} @ I_{ZT} Ohms	Z_{ZK} @ I_{ZK} Ohms	I_{ZK} mA	I_R µA Max @	V_R Volts		
3EZ3.9D5	3.9	192	4.5	400	1	80	1	630	4.4
3EZ4.3D5	4.3	174	4.5	400	1	30	1	590	4.1
3EZ4.7D5	4.7	160	4	500	1	20	1	550	3.8
3EZ5.1D5	5.1	147	3.5	550	1	5	1	520	3.5
3EZ5.6D5	5.6	134	2.5	600	1	5	2	480	3.3
3EZ6.2D5	6.2	121	1.5	700	1	5	3	435	3.1
3EZ6.8D5	6.8	110	2	700	1	5	4	393	2.9
3EZ7.5D5	7.5	100	2	700	0.5	5	5	360	2.66
3EZ8.2D5	8.2	91	2.3	700	0.5	5	6	330	2.44
3EZ9.1D5	9.1	82	2.5	700	0.5	3	7	297	2.2
3EZ10D5	10	75	3.5	700	0.25	3	7.6	270	2
3EZ11D5	11	68	4	700	0.25	1	8.4	225	1.82
3EZ12D5	12	63	4.5	700	0.25	1	9.1	246	1.66
3EZ13D5	13	58	4.5	700	0.25	0.5	9.9	208	1.54
3EZ14D5	14	53	5	700	0.25	0.5	10.6	193	1.43
3EZ15D5	15	50	5.5	700	0.25	0.5	11.4	180	1.33
3EZ16D5	16	47	5.5	700	0.25	0.5	12.2	169	1.25
3EZ17D5	17	44	6	750	0.25	0.5	13	150	1.18
3EZ18D5	18	42	6	750	0.25	0.5	13.7	159	1.11
3EZ19D5	19	40	7	750	0.25	0.5	14.4	142	1.05
3EZ20D5	20	37	7	750	0.25	0.5	15.2	135	1
3EZ22D5	22	34	8	750	0.25	0.5	16.7	123	0.91
3EZ24D5	24	31	9	750	0.25	0.5	18.2	112	0.83
3EZ27D5	27	28	10	750	0.25	0.5	20.6	100	0.74
3EZ28D5	28	27	12	750	0.25	0.5	21	96	0.71
3EZ30D5	30	25	16	1000	0.25	0.5	22.5	90	0.67
3EZ33D5	33	23	20	1000	0.25	0.5	25.1	82	0.61
3EZ36D5	36	21	22	1000	0.25	0.5	27.4	75	0.56
3EZ39D5	39	19	28	1000	0.25	0.5	29.7	69	0.51
3EZ43D5	43	17	33	1500	0.25	0.5	32.7	63	0.45
3EZ47D5	47	16	38	1500	0.25	0.5	35.6	57	0.42
3EZ51D5	51	15	45	1500	0.25	0.5	38.8	53	0.39
3EZ56D5	56	13	50	2000	0.25	0.5	42.6	48	0.36
3EZ62D5	62	12	55	2000	0.25	0.5	47.1	44	0.32
3EZ68D5	68	11	70	2000	0.25	0.5	51.7	40	0.29
3EZ75D5	75	10	85	2000	0.25	0.5	56	36	0.27
3EZ82D5	82	9.1	95	3000	0.25	0.5	62.2	33	0.24
3EZ91D5	91	8.2	115	3000	0.25	0.5	69.2	30	0.22
3EZ100D5	100	7.5	160	3000	0.25	0.5	76	27	0.2
3EZ110D5	110	6.8	225	4000	0.25	0.5	83.6	25	0.18
3EZ120D5	120	6.3	300	4500	0.25	0.5	91.2	22	0.16
3EZ130D5	130	5.8	375	5000	0.25	0.5	98.8	21	0.15
3EZ140D5	140	5.3	475	5000	0.25	0.5	106.4	19	0.14
3EZ150D5	150	5	550	6000	0.25	0.5	114	18	0.13
3EZ160D5	160	4.7	625	6500	0.25	0.5	121.6	17	0.12
3EZ170D5	170	4.4	650	7000	0.25	0.5	130.4	16	0.12
3EZ180D5	180	4.2	700	7000	0.25	0.5	136.8	15	0.11
3EZ190D5	190	4	800	8000	0.25	0.5	144.8	14	0.1
3EZ200D5	200	3.7	875	8000	0.25	0.5	152	13	0.1

NOTES:

(1) TOLERANCES — Suffix 1 indicates 1% tolerance, suffix 2 indicates 2% tolerance, suffix 5 indicates 5% tolerance and suffix 10 indicates 10% tolerance, any other tolerance will be considered as a special device.

(2) ZENER VOLTAGE (V_Z) MEASUREMENT — Motorola guarantees the zener voltage when measured at 40 ms ± 10 ms 3/8″ from the diode body, and an ambient temperature of 25°C (+8°C, −2°C).

(3) ZENER IMPEDANCE (Z_Z) DERIVATION — The zener impedance is derived from the 60 cycle ac voltage, which results when an ac current having an rms value equal to 10% of the dc zener current (I_{ZT} or I_{ZK}) is superimposed on I_{ZT} or I_{ZK}.

(4) SURGE CURRENT (i_r) NON-REPETITIVE — The rating listed in the electrical characteristics table is maximum peak, non-repetitive, reverse surge current of 1/2 square wave or equivalent sine wave pulse of 1/120 second duration superimposed on the test current, I_{ZT}, per JEDEC standards, however, actual device capability is as described in Figure 3.

MOTOROLA
SEMICONDUCTOR
TECHNICAL DATA

ICTE-5, C thru ICTE-45, C
See Page 4-59

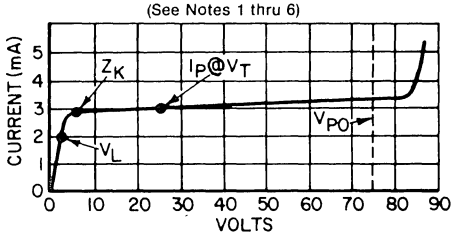
MCL1300 thru MCL1304

CURRENT LIMITING DIODES

CURRENT LIMITING DIODES

Field-effect current limiting diodes designed for applications requiring a current reference or a constant current over a specified voltage range.

CURRENT-LIMITER CHARACTERISTICS AND SYMBOL IDENTIFICATION
(See Notes 1 thru 6)



MAXIMUM RATINGS ($T_A = 25°C$ unless otherwise noted)

Junction and Storage Temperature: −65°C to +200°C
Peak Operating Voltage: See Table

ELECTRICAL CHARACTERISTICS ($T_A = 25°C$ unless otherwise noted)

Type Number	Nominal Pinch-Off Current Note 1 I_P (mA)	Tol. (mA)	Test Volt. Note 2 V_T (Volts)	Limiter Imped. Note 3 Z_T (min) (Megohms)	Knee Imped. at 6 V Note 4 Z_K (min) (Megohms)	Limiting Voltage Note 5 V_L (max) (Volts)	Peak Operating Voltage Note 6 V_{PO} (Volts)
MCL1300	0 5	±0 3	25	4 000	0 500	1 0	75
MCL1301	1 0	±0 6	25	0 800	0 200	1 5	75
MCL1302	2 0	±0 6	25	0 400	0 100	2 0	75
MCL1303	3 0	±0 6	25	0 300	0 050	2 0	75
MCL1304	4 0	±0 6	25	0 250	0 025	2 5	75

These specifications are preliminary Selections may be made to obtain nominal currents between those shown, as well as tighter tolerance units

SYMBOL DEFINITIONS:

NOTE 1 I_P - The pinch-off current is the guaranteed current at a specified V_T I_P is specified as a nominal with a tolerance

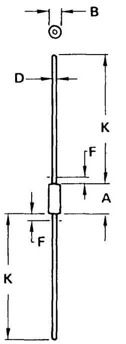
NOTE 2 V_T - The test voltage for measurement of I_P.

NOTE 3 Z_T - The impedance at the test voltage, V_T, specified. To provide the most constant current Z_T should be as high as possible; thus a minimum Z_T is specified. Z_T is derived from the 90 cycle per second current which results when an AC voltage having an RMS value equal to 10% of the test voltage (V_T) is superimposed on V_T.

NOTE 4 Z_K - Knee impedance is specified as a minimum also since again the highest value is desired V_K is established as 6.0 V for convenience.

NOTE 5 V_L - Limiting Voltage. This specification is provided with Z_K to indicate the sharp knee of the device. The specification is analogous to I_R and Z_K of a zener diode. V_L a maximum specification is measured at 80% on I_P tolerance.

NOTE 6 V_{PO} - The peak-operating voltage is provided and indicates the maximum voltage to be applied to the device. The specification is necessary since the device is either power limited or breakdown limited beyond this specified voltage.



DIM	MILLIMETERS MIN	MILLIMETERS MAX	INCHES MIN	INCHES MAX
A	5 84	7 62	0 230	0 300
B	2 16	2 72	0 085	0 107
D	0 46	0 56	0 018	0 022
F	–	1 27	–	0 050
K	25 40	38 10	1 000	1 500

All JEDEC dimensions and notes apply

CASE 51-02
DO-204AA
GLASS

NOTES
1 PACKAGE CONTOUR OPTIONAL WITHIN DIA B AND LENGTH A HEAT SLUGS, IF ANY, SHALL BE INCLUDED WITHIN THIS CYLINDER, BUT SHALL NOT BE SUBJECT TO THE MIN LIMIT OF DIA B
2 LEAD DIA NOT CONTROLLED IN ZONES F, TO ALLOW FOR FLASH, LEAD FINISH BUILDUP, AND MINOR IRREGULARITIES OTHER THAN HEAT SLUGS

4

MOTOROLA
SEMICONDUCTOR
TECHNICAL DATA

MLL746 thru MLL759
MLL957A thru MLL986A
MLL4370 thru MLL4372

500 MILLIWATT HERMETICALLY SEALED GLASS SILICON ZENER DIODES

- Complete Voltage Range — 2.4 to 110 Volts
- Leadless Package for Surface Mount Technology
- Double Slug Type Construction
- Metallurgically Bonded Construction
- Nitride Passivated Die
- Available in 8 mm Tape and Reel
  T1 Cathode Facing Sprocket Holes
  T2 Anode Facing Sprocket Holes

LEADLESS GLASS ZENER DIODES

500 MILLIWATTS
2.4–110 VOLTS

MAXIMUM RATINGS

Rating	Symbol	Value	Unit
DC Power Dissipation @ $T_A \leq 50°C$ Derate above $T_A = 50°C$	P_D	500 3.3	mW mW/°C
Operating and Storage Junction Temperature Range	T_J, T_{stg}	−65 to +200	°C

MECHANICAL CHARACTERISTICS

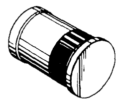
CASE: Double slug type, hermetically sealed glass

MAXIMUM LEAD TEMPERATURE FOR SOLDERING PURPOSES: 230°C, for 10 seconds

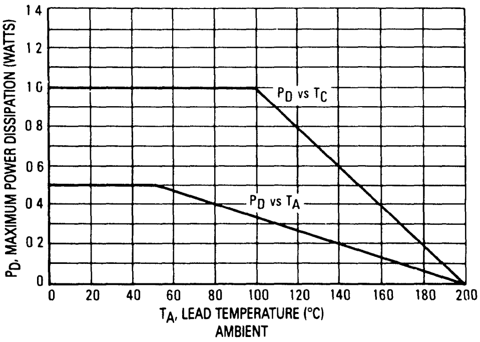
FINISH: All external surfaces are corrosion resistant and readily solderable

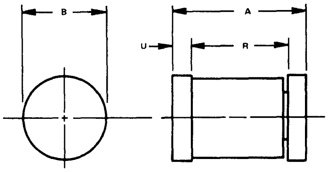
POLARITY: Cathode indicated by color band. When operated in zener mode, cathode will be positive with respect to anode

MOUNTING POSITION: Any



STEADY STATE POWER DERATING





DIM	MILLIMETERS MIN	MILLIMETERS MAX	INCHES MIN	INCHES MAX
A	3.30	3.70	0.130	0.146
B	1.60	1.70	0.063	0.067
R	2.49	2.59	0.098	0.102
U	0.41	0.55	0.016	0.022

CASE 362-01
GLASS

4

ELECTRICAL CHARACTERISTICS (T_A = 25°C, V_F = 1.5 V Max @ 200 mA for all types)

Type Number (Note 1)	Nominal Zener Voltage V_Z @ I_{ZT} (Notes 1,2,3) Volts	Test Current I_{ZT} (Note 2) mA	Maximum Zener Impedance Z_{ZT} @ I_{ZT} (Note 4) Ohms	Maximum DC Zener Current I_{ZM} mA		Maximum Reverse Leakage Current T_A = 25°C I_R @ V_R = 1 V μA	Maximum Reverse Leakage Current T_A = 150°C I_R @ V_R = 1 V μA
MLL4370	2.4	20	30	150	190	100	200
MLL4371	2.7	20	30	135	165	75	150
MLL4372	3.0	20	29	120	150	50	100
MLL746	3.3	20	28	110	135	10	30
MLL747	3.6	20	24	100	125	10	30
MLL748	3.9	20	23	95	115	10	30
MLL749	4.3	20	22	85	105	2	30
MLL750	4.7	20	19	75	95	2	30
MLL751	5.1	20	17	70	85	1	20
MLL752	5.6	20	11	65	80	1	20
MLL753	6.2	20	7	60	70	0.1	20
MLL754	6.8	20	5	55	65	0.1	20
MLL755	7.5	20	6	50	60	0.1	20
MLL756	8.2	20	8	45	55	0.1	20
MLL757	9.1	20	10	40	50	0.1	20
MLL758	10	20	17	35	45	0.1	20
MLL759	12	20	30	30	35	0.1	20

Type Number (Note 1)	Nominal Zener Voltage V_Z (Notes 1,2,3) Volts	Test Current I_{ZT} (Note 2) mA	Maximum Zener Impedance (Note 4) Z_{ZT} @ I_{ZT} Ohms	Maximum Zener Impedance (Note 4) Z_{ZK} @ I_{ZK} Ohms	I_{ZK} mA	Maximum DC Zener Current I_{ZM} mA		Maximum Reverse Current I_R Maximum μA	Test Voltage Vdc V_R 5%	Test Voltage Vdc V_R 10%
MLL957A	6.8	18.5	4.5	700	1.0	47	61	150	5.2	4.9
MLL958A	7.5	16.5	5.5	700	0.5	42	55	75	5.7	5.4
MLL959A	8.2	15	6.5	700	05	38	50	50	6.2	5.9
MLL960A	9.1	14	7.5	700	0.5	35	45	25	6.9	6.6
MLL961A	10	12.5	8.5	700	0.25	32	41	10	7.6	7 2
MLL962A	11	11.5	9.5	700	0.25	28	37	5	8.4	8.0
MLL963A	12	10.5	11.5	700	0.25	26	34	5	9.1	8.6
MLL964A	13	9.5	13	700	0.25	24	32	5	9.9	9.4
MLL965A	15	8.5	16	700	0.25	21	27	5	11.4	10.8
MLL966A	16	7.8	17	700	0.25	19	37	5	12.2	11.5
MLL967A	18	7.0	21	750	0.25	17	23	5	13.7	13.0
MLL968A	20	6.2	25	750	0.25	15	20	5	15.2	14.4
MLL969A	22	5.6	29	750	0.25	14	18	5	16.7	15.8
MLL970A	24	5.2	33	750	0.25	13	17	5	18.2	17.3
MLL971A	27	4.6	41	750	0.25	11	15	5	20.6	19.4
MLL972A	30	4.2	49	1000	0.25	10	13	5	22.8	21.6
MLL973A	33	3.8	58	1000	0.25	9.2	12	5	25.1	23.8
MLL974A	36	3.4	70	1000	0.25	8.5	11	5	27.4	25.9
MLL975A	39	3.2	80	1000	0.25	7.8	10	5	29.7	28.1
MLL976A	43	3.0	93	1500	0.25	7.0	9.6	5	32.7	31.0
MLL977A	47	2.7	105	1500	0.25	6.4	8.8	5	35.8	33.8
MLL978A	51	2.5	125	1500	0.25	5.9	8.1	5	38.8	36.7
MLL979A	56	2.2	150	2000	0.25	5.4	7.4	5	42.6	40.3
MLL980A	62	2.0	185	2000	0.25	4.9	6.7	5	47.1	44.6
MLL981A	68	1.8	230	2000	0.25	4.5	6.1	5	51.7	49.0
MLL982A	75	1.7	270	2000	0.25	1.0	5.5	5	56.0	54.0
MLL983A	82	1.5	330	3000	0.25	3.7	5.0	5	62.2	59.0
MLL984A	91	1.4	400	3000	0.25	3.3	4.5	5	69.2	65.5
MLL985A	100	1.3	500	3000	0.25	3.0	4.5	5	76	72
MLL986A	110	1.1	750	4000	0.25	2.7	4.1	5	83.6	79.2

NOTE 1. Tolerance Designation — The type numbers shown have tolerance designations as follows:

MLL4370 series: ±10%, suffix A for ±5% units.
MLL746 series: ±10%, suffix A for ±5% units.
MLL957 series: suffix A for ±10% units, suffix B for ±5% units.

NOTE 2. Special Selections† Available Include:

1. Nominal zener voltages between those shown.
2. Two or more units for series connection with specified tolerance on total voltage. Series matched sets make zener voltages in excess of 200 volts possible as well as providing lower temperature coefficients, lower dynamic impedance and greater power handling ability.
3. Nominal voltages at non-standard test currents.

NOTE 3. Zener Voltage (V_Z) Measurement — Nominal zener voltage is measured with the device junction in thermal equilibrium at the case temperature of 30°C ±1°C.

NOTE 4. Zener Impedance (Z_Z) Derivation — Z_{ZT} is measured by dividing the ac voltage drop across the device by the ac current applied. The specified limits are for $I_Z(ac) = 0.1 \times I_Z(dc)$ with the ac frequency = 1.0 kHz.

†For more information on special selections contact your nearest Motorola representative.

APPLICATION NOTE

Since the actual voltage available from a given zener diode is temperature dependent, it is necessary to determine junction temperature under any set of operating conditions in order to calculate its value. The following procedure is recommended:

Case Temperature, T_C, should be determined from:

$$T_C = \theta_{CA} P_D + T_A.$$

θ_{CA} is the case-to-ambient thermal resisstance (°C/W) and P_D is the power dissipation. The value for θ_{CA} will vary and depends on the device mounting method. θ_{CA} is generally 200°C/W for the various clips and tie points in common use and for printed circuit board wiring.

The temperature of the case can also be measured using a thermocouple placed at the case end as close as possible to the tie point. The thermal mass connected to the tie point is normally large enough so that it will not significantly respond to heat surges generated in the diode as a result of pulsed operation once steady-state conditions are achieved. Using the measured value of T_C, the junction temperature may be determined by:

$$T_J = T_C + \Delta T_{JC}.$$

ΔT_{JC} is the increase in junction temperature above the case temperature and may be found by using:

$$\Delta T_{JC} = \theta_{JC} P_D.$$

For worst-case design, using expected limits of I_Z, limits of P_D and the extremes of $T_J(\Delta T_J)$ may be estimated. Changes in voltage, V_Z, can then be found from:

$$\Delta V = \theta_{VZ} \Delta T_J.$$

θ_{VZ}, the zener voltage temperature coefficient, is found from Figures 2 and 3.

Under high power-pulse operation, the zener voltage will vary with time and may also be affected significantly by the zener resistance. For best regulation, keep current excursions as low as possible.

Surge limitations are given in Figure 6. They are lower than would be expected by considering only junction temperature, as current crowding effects cause temperatures to be extremely high in small spots, resulting in device degradation should the limits of Figure 6 be exceeded.

FIGURE 1 — TYPICAL LEAKAGE CURRENT

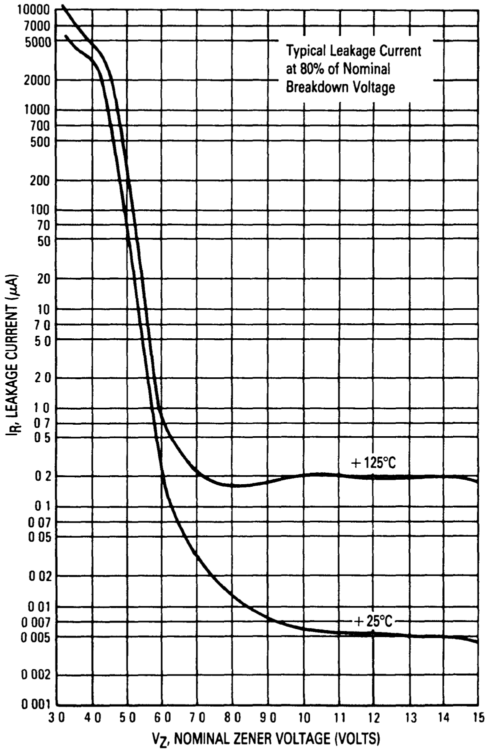
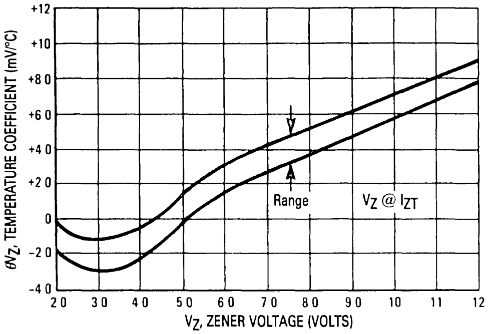


FIGURE 2 — TEMPERATURE COEFFICIENTS
(−55°C to +150°C temperature range; 90% of the units are in the ranges indicated.)

a — RANGE FOR UNITS TO 12 VOLTS



b — RANGE FOR UNITS 12 TO 100 VOLTS

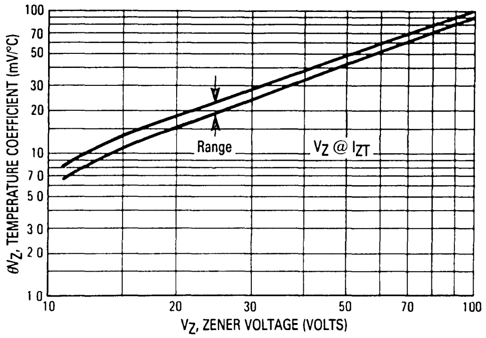


FIGURE 3 — EFFECT OF ZENER CURRENT

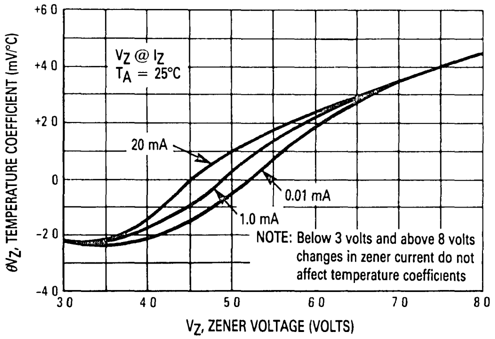


FIGURE 4 — TYPICAL CAPACITANCE

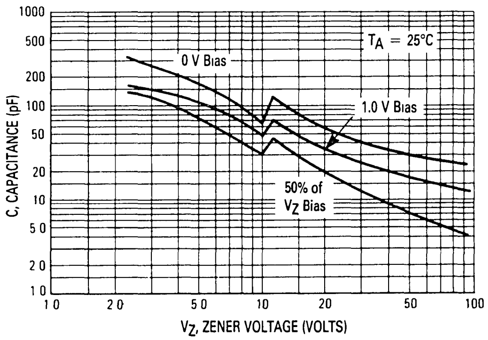
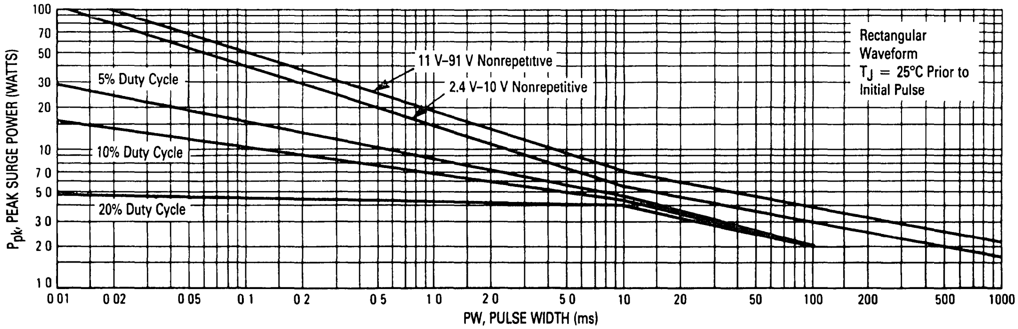


FIGURE 5 — MAXIMUM SURGE POWER



This graph represents 90 percentil data points
For worst-case design characteristics, multiply surge power by 2/3

FIGURE 6 — EFFECT OF ZENER CURRENT ON ZENER IMPEDANCE

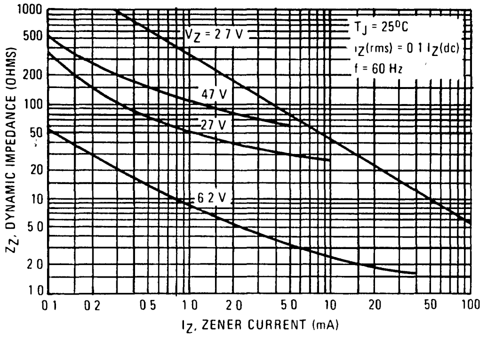


FIGURE 7 — EFFECT OF ZENER VOLTAGE ON ZENER IMPEDANCE

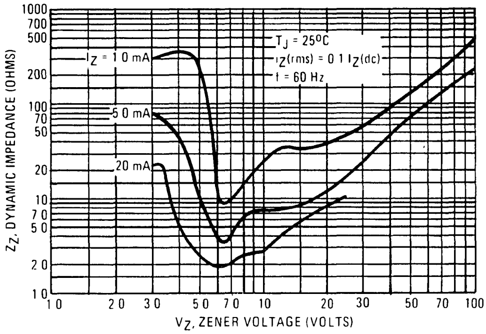


FIGURE 8 — TYPICAL NOISE DENSITY

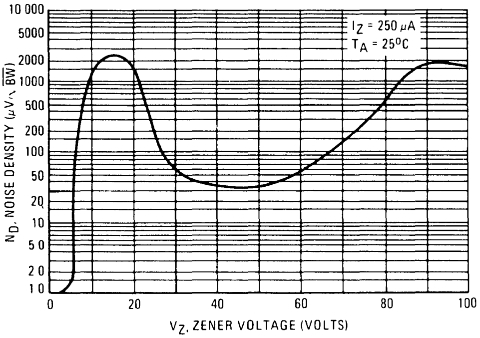
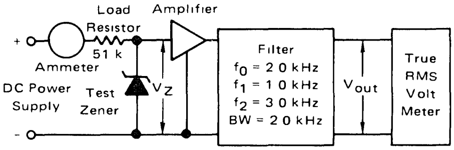


FIGURE 9 — NOISE DENSITY MEASUREMENT METHOD

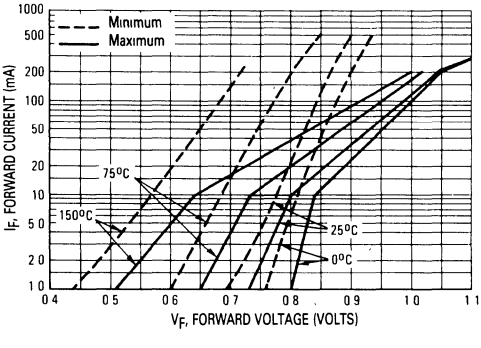


Noise Density (Volts Per Square Root Bandwidth) $= \frac{V_{out}}{\text{Overall Gain } \sqrt{BW}}$

Where BW = Filter Bandwidth (Hz)
V_{out} = Output Noise (Volts RMS)

The input voltage and load resistance are high so that the zener diode is driven from a constant current source The amplifier is low noise so that the amplifier noise is negligible compared to that of the test zener The filter bandpass is known so that the noise density can be calculated from the formula shown

FIGURE 10 — TYPICAL FORWARD CHARACTERISTICS



MOTOROLA
SEMICONDUCTOR
TECHNICAL DATA

MLL4099–MLL4135
MLL4614–MLL4627

LOW NOISE LEVEL SILICON PASSIVATED ZENER DIODES

. . . designed for 250 mW applications requiring low leakage, low impedance, and low noise.

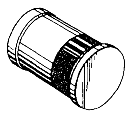
- Leadless Package for Surface Mount Technology
- Voltage Range from 1.8 to 100 Volts
- First Leadless Zener Diode Series to Specify Noise — 50% Lower than Conventional Diffused Zeners
- Zener Impedance and Zener Voltage Specified for Low-Level Operation at I_{ZT} = 250 μA
- Low Leakage Current — I_R from 0.01 to 10 μA over Voltage Range
- Available in 8mm Tape and Reel
  T1 Cathode Facing Sprocket Holes
  T2 Anode Facing Sprocket Holes

SILICON LEADLESS GLASS ZENER DIODES

(±5.0% TOLERANCE)

250 MILLIWATTS
1.8–100 VOLTS

SILICON NITRIDE PASSIVATED JUNCTION

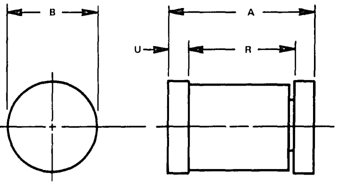


MAXIMUM RATINGS

Rating	Symbol	Value	Unit
DC Power Dissipation @ T_A = 25°C Derate above 25°C	P_D	250 1.43	mW mW/°C
Junction and Storage Temperature Range	T_J, T_{stg}	−65 to +200	°C

MECHANICAL CHARACTERISTICS

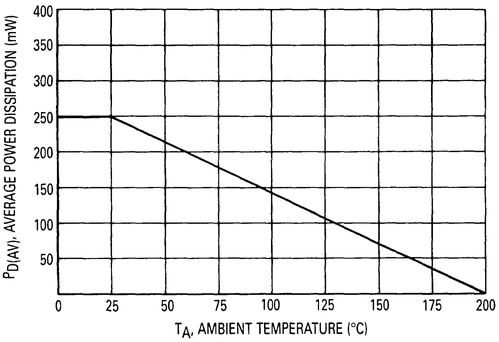
CASE: Double slug, hermetically sealed glass
MAXIMUM LEAD TEMPERATURE FOR SOLDERING PURPOSES: 230°C for 10 seconds
FINISH: All external surfaces are corrosion resistant and readily solderable
POLARITY: Cathode indicated by color band. When operated in the zener mode, cathode will be positive with respect to anode
MOUNTING POSITION: Any



DIM	MILLIMETERS MIN	MILLIMETERS MAX	INCHES MIN	INCHES MAX
A	3 30	3 70	0 130	0 146
B	1 60	1 70	0 063	0 067
R	2 49	2 59	0 098	0 102
U	0 41	0 55	0 016	0 022

CASE 362-01
GLASS

POWER TEMPERATURE DERATING CURVE



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ELECTRICAL CHARACTERISTICS

(At 25°C Ambient temperature unless otherwise specified) I_{ZT} = 250 μA and V_F = 1.0 V max @ I_F = 200 mA on all Types

Type Number (Note 1)	Nominal Zener Voltage V_Z (Note 1) (Volts)	Max Zener Impedance Z_{ZT} (Note 2) (Ohms)	Max Reverse Current I_R (μA) (Note 3)	Test Voltage V_R (Volts)	Max Noise Density At I_{ZT} = 250 μA N_D (Fig 1) (micro-volts per Square Root Cycle)	Max Zener Current I_{ZM} (Note 4) (mA)
MLL4614	1.8	1200	7.5	1.0	1.0	120
MLL4615	2.0	1250	5.0	1.0	1.0	110
MLL4616	2.2	1300	4.0	1.0	1.0	100
MLL4617	2.4	1400	2.0	1.0	1.0	95
MLL4618	2.7	1500	1.0	1.0	1.0	90
MLL4619	3.0	1600	0.8	1.0	1.0	85
MLL4620	3.3	1650	7.5	1.5	1.0	80
MLL4621	3.6	1700	7.5	2.0	1.0	75
MLL4622	3.9	1650	5.0	2.0	1.0	70
MLL4623	4.3	1600	4.0	2.0	1.0	65
MLL4624	4.7	1550	10	3.0	1.0	60
MLL4625	5.1	1500	10	3.0	2.0	55
MLL4626	5.6	1400	10	4.0	4.0	50
MLL4627	6.2	1200	10	5.0	5.0	45
MLL4099	6.8	200	10	5.2	40	35
MLL4100	7.5	200	10	5.7	40	31.8
MLL4101	8.2	200	1.0	6.3	40	29.0
MLL4102	8.7	200	1.0	6.7	40	27.4
MLL4103	9.1	200	1.0	7.0	40	26.2
MLL4104	10	200	1.0	7.6	40	24.8
MLL4105	11	200	0.05	8.5	40	21.6
MLL4106	12	200	0.05	9.2	40	20.4
MLL4107	13	200	0.05	9.9	40	19.0
MLL4108	14	200	0.05	10.7	40	17.5
MLL4109	15	100	0.05	11.4	40	16.3
MLL4110	16	100	0.05	12.2	40	15.4
MLL4111	17	100	0.05	13.0	40	14.5
MLL4112	18	100	0.05	13.7	40	13.2
MLL4113	19	150	0.05	14.5	40	12.5
MLL4114	20	150	0.01	15.2	40	11.9
MLL4115	22	150	0.01	16.8	40	10.8
MLL4116	24	150	0.01	18.3	40	9.9
MLL4117	25	150	0.01	19.0	40	9.5
MLL4118	27	150	0.01	20.5	40	8.8
MLL4119	28	200	0.01	21.3	40	8.5
MLL4120	30	200	0.01	22.8	40	7.9
MLL4121	33	200	0.01	25.1	40	7.2
MLL4122	36	200	0.01	27.4	40	6.6
MLL4123	39	200	0.01	29.7	40	6.1
MLL4124	43	250	0.01	32.7	40	5.5
MLL4125	47	250	0.01	35.8	40	5.1
MLL4126	51	300	0.01	38.8	40	4.6
MLL4127	56	300	0.01	42.6	40	4.2
MLL4128	60	400	0.01	45.6	40	4.0
MLL4129	62	500	0.01	47.1	40	3.8
MLL4130	68	700	0.01	51.7	40	3.5
MLL4131	75	700	0.01	57.0	40	3.1
MLL4132	82	800	0.01	62.4	40	2.9
MLL4133	87	1000	0.01	66.2	40	2.7
MLL4134	91	1200	0.01	69.2	40	2.6
MLL4135	100	1500	0.01	76.0	40	2.3

NOTE 1: TOLERANCE AND VOLTAGE DESIGNATION

The type numbers shown have a standard tolerance of ±5.0% on the nominal zener voltage.

NOTE 2: ZENER IMPEDANCE (Z_{ZT}) DERIVATION

The zener impedance is derived from the 1000 cycle ac voltage, which results when an ac current having an rms value equal to 10% of the dc zener current (I_{ZT}) is superimposed on I_{ZT}.

NOTE 3: REVERSE LEAKAGE CURRENT I_R

Reverse leakage currents are guaranteed and are measured at V_R as shown on the table.

NOTE 4: MAXIMUM ZENER CURRENT RATINGS (I_{ZM})

Maximum zener current ratings are based on maximum zener voltage of the individual units.

4

ZENER NOISE DENSITY

A zener diode generates noise when it is biased in the zener direction. A small part of this noise is due to the internal resistance associated with the device. A larger part of zener noise is a result of the zener breakdown phenomenon and is called microplasma noise. This microplasma noise is generally considered "white" noise with equal amplitude for all frequencies from about zero cycles to approximately 200,000 cycles. To eliminate the higher frequency components of noise a small shunting capacitor can be used. The lower frequency noise generally must be tolerated since a capacitor required to eliminate the lower frequencies would degrade the regulation properties of the zener in many applications.

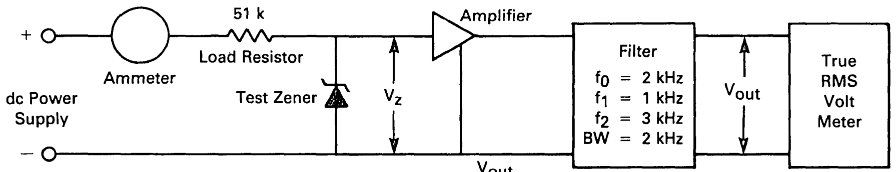
Motorola is rating this series with a maximum noise density at 250 microamperes. The rating of microvolts RMS per square root cycle enables calculation of the maximum RMS noise for any bandwidth.

Noise density decreases as zener current increases. This can be seen by the graph in Figure 2 where a typical noise density is plotted as a function of zener current.

The junction temperature will also change the zener noise levels. Thus the noise rating must indicate bandwidth, current level and temperature.

The block diagram given in Figure 1 shows the method used to measure noise density. The input voltage and load resistance is high so that the zener is driven from a constant current source. The amplifier must be low noise so that the amplifier noise is negligible compared to the test zener. The filter bandpass is known so that the noise density in volts RMS per square root cycle can be calculated.

FIGURE 1 — NOISE DENSITY MEASUREMENT METHOD



$$\text{Noise Density (volts per square root cycle)} = \frac{V_{out}}{\text{Overall Gain}\ \sqrt{BW}}$$

Where: BW = Filter Bandwidth (Cycles)

V_{out} = Output Noise (Volts RMS)

FIGURE 2 — TYPICAL NOISE DENSITY versus ZENER CURRENT

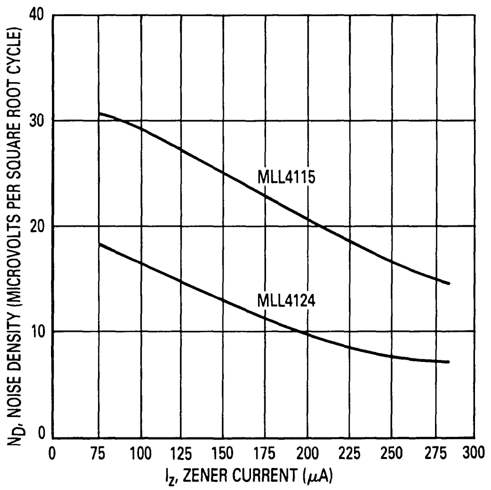


FIGURE 3 — TYPICAL CAPACITANCE

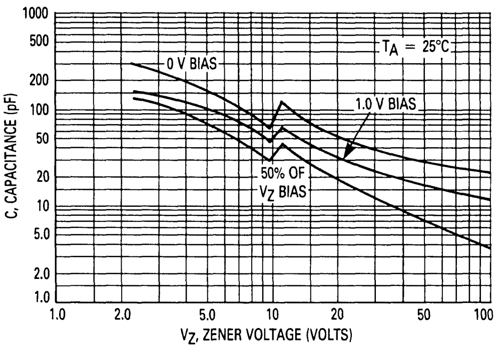
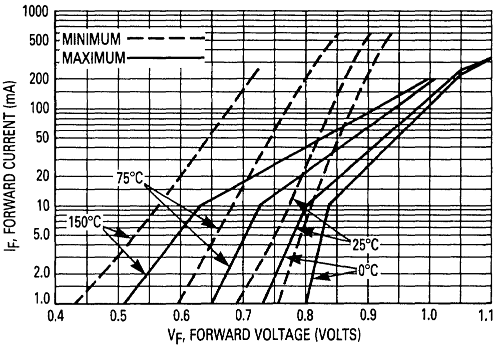


FIGURE 4 — TYPICAL FORWARD CHARACTERISTICS



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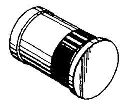
MOTOROLA
SEMICONDUCTOR
TECHNICAL DATA

MLL4370 thru MLL4372
See Page 4-76

MLL4678 thru MLL4717

LEADLESS GLASS ZENER DIODES

250 MILLIWATTS



250 MILLIWATT HERMETICALLY SEALED GLASS SILICON ZENER DIODES

Low level nitride passivated zener diodes for applications requiring extremely low operating currents, low leakage, and sharp breakdown voltage.

- Complete Voltage Range — 1.8 to 43 Volts
- Zener Voltage Specified @ I_{ZT} = 50 μA
- Leadless Package for Surface Mount Technology
- Maximum Delta V_Z Given from 10 to 100 μA
- Available in 8 mm Tape and Reel
  T1 Cathode Facing Sprocket Holes
  T2 Anode Facing Sprocket Holes

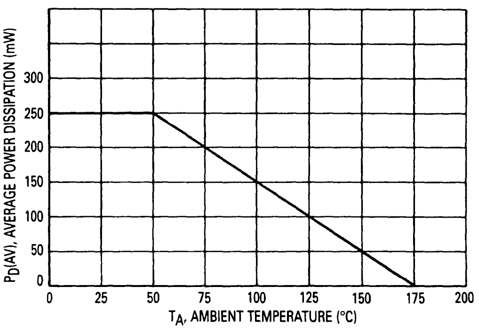
ABSOLUTE MAXIMUM RATINGS

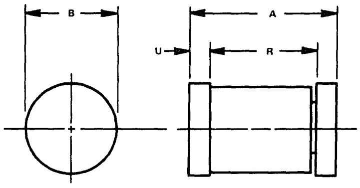
Rating	Symbol	Value	Unit
DC Power Dissipation @ T_A = 50°C Derate above T_A = 50°C	P_D	250 1.67	mW mW/°C
Operating and Storage Junction Temperature Range	T_J, T_{stg}	−65 to +175	°C

MECHANICAL CHARACTERISTICS

CASE: Double slug, hermetically sealed glass
MAXIMUM LEAD TEMPERATURE FOR SOLDERING PURPOSES: 230°C for 10 seconds
FINISH: All external surfaces are corrosion resistant and readily solderable
POLARITY: Cathode end indicated by color band. When operated in zener mode, the cathode will be positive with respect to anode
MOUNTING POSITION: Any

FIGURE 1 — POWER TEMPERATURE DERATING CURVE





DIM	MILLIMETERS MIN	MILLIMETERS MAX	INCHES MIN	INCHES MAX
A	3 30	3 70	0 130	0 146
B	1 60	1 70	0 063	0 067
R	2 49	2 59	0 098	0 102
U	0 41	0 55	0 016	0 022

CASE 362-01
GLASS

4

ELECTRICAL CHARACTERISTICS (T_A = 25°C, V_F = 1.5 V max at I_F = 100 mA for all types)

Type Number (Note 1)	Zener Voltage V_Z @ I_{ZT} = 50 μA Volts			Maximum Reverse Current I_R μA (Note 3)	Test Voltage V_R Volts	Maximum Zener Current I_{ZM} mA (Note 2)	Maximum Voltage Change ΔV_Z Volts (Note 4)
	Nom (Note 1)	Min	Max				
MLL4678	1.8	1.710	1.890	7.5	1.0	120	0.70
MLL4679	2.0	1.900	2.100	5.0	1.0	110	0.70
MLL4680	2.2	2.090	2.310	4.0	1.0	100	0.75
MLL4681	2.4	2.280	2.520	2.0	1.0	95	0.80
MLL4682	2.7	2.565	2.835	1.0	1.0	90	0.85
MLL4683	3.0	2.850	3.150	0.8	1.0	85	0.90
MLL4684	3.3	3.135	3.465	7.5	1.5	80	0.95
MLL4685	3.6	3.420	3.780	7.5	2.0	75	0.95
MLL4686	3.9	3.705	4.095	5.0	2.0	70	0.97
MLL4687	4.3	4.085	4.515	4.0	2.0	65	0.99
MLL4688	4.7	4.465	4.935	10	3.0	60	0.99
MLL4689	5.1	4.845	5.355	10	3.0	55	0.97
MLL4690	5.6	5.320	5.880	10	4.0	50	0.96
MLL4691	6.2	5.890	6.510	10	5.0	45	0.95
MLL4692	6.8	6.460	7.140	10	5.1	35	0.90
MLL4693	7.5	7.125	7.875	10	5.7	31.8	0.75
MLL4694	8.2	7.790	8.610	1.0	6.2	29.0	0.50
MLL4695	8.7	8.265	9.135	1.0	6.6	27.4	0.10
MLL4696	9.1	8.645	9.555	1.0	6.9	26.2	0.08
MLL4697	10	9.500	10.50	1.0	7.6	24.8	0.10
MLL4698	11	10.45	11.55	0.05	8.4	21.6	0.11
MLL4699	12	11.40	12.60	0.05	9.1	20.4	0.12
MLL4700	13	12.35	13.65	0.05	9.8	19.0	0.13
MLL4701	14	13.30	14.70	0.05	10.6	17.5	0.14
MLL4702	15	14.25	15.75	0.05	11.4	16.3	0.15
MLL4703	16	15.20	16.80	0.05	12.1	15.4	0.16
MLL4704	17	16.15	17.85	0.05	12.9	14.5	0.17
MLL4705	18	17.10	18.90	0.05	13.6	13.2	0.18
MLL4706	19	18.05	19.95	0.05	14.4	12.5	0.19
MLL4707	20	19.00	21.00	0.01	15.2	11.9	0.20
MLL4708	22	20.90	23.10	0.01	16.7	10.8	0.22
MLL4709	24	22.80	25.20	0.01	18.2	9.9	0.24
MLL4710	25	23.75	26.25	0.01	19.0	9.5	0.25
MLL4711	27	25.65	28.35	0.01	20.4	8.8	0.27
MLL4712	28	26.60	29.40	0.01	21.2	8.5	0.28
MLL4713	30	28.50	31.50	0.01	22.8	7.9	0.30
MLL4714	33	31.35	34.65	0.01	25.0	7.2	0.33
MLL4715	36	34.20	37.80	0.01	27.3	6.6	0.36
MLL4716	39	37.05	40.95	0.01	29.6	6.1	0.39
MLL4717	43	40.85	45.15	0.01	32.6	5.5	0.43

NOTES:
1. **TOLERANCE AND VOLTAGE DESIGNATION (V_Z)**
   The type numbers shown have a standard tolerance of ±5% on the nominal zener voltage.
2. **MAXIMUM ZENER CURRENT RATINGS (I_{ZM})**
   Maximum Zener current ratings are based on maximum Zener voltage of the individual units.
3. **REVERSE LEAKAGE CURRENT (I_R)**
   Reverse leakage currents are guaranteed and are measured at V_R as shown on the table.
4. **MAXIMUM VOLTAGE CHANGE (ΔV_Z)**
   Voltage change is equal to the difference between V_Z at 100 μA and V_Z at 10 μA.

MOTOROLA
SEMICONDUCTOR
TECHNICAL DATA

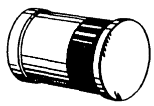
MLL4728 thru MLL4764

1.0 WATT HERMETICALLY SEALED GLASS SILICON ZENER DIODES

- Complete Voltage Range — 3.3 to 100 Volts
- Leadless Package for Surface Mount Technology
- Double Slug Type Construction
- Metallurgically Bonded Construction
- Oxide Passivated Die
- Available in 12 mm Tape and Reel
  T1 Cathode Facing Sprocket Holes
  T2 Anode Facing Sprocket Holes

LEADLESS GLASS ZENER DIODES

1.0 WATT
3.3–100 VOLTS



MAXIMUM RATINGS

Rating	Symbol	Value	Unit
DC Power Dissipation @ $T_A \leq 50°C$ Derate above $T_A = 50°C$	P_D	1.0 6.67	W mW/°C
Operating and Storage Junction Temperature Range	T_J, T_{stg}	−65 to +200	°C

MECHANICAL CHARACTERISTICS

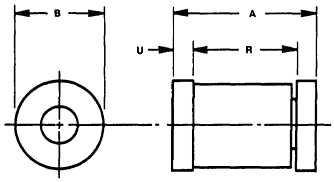
CASE: Double slug type, hermetically sealed glass

MAXIMUM TEMPERATURE FOR SOLDERING PURPOSES: 230°C, for 10 seconds

FINISH: All external surfaces are corrosion resistant and readily solderable

POLARITY: Cathode indicated by color band. When operated in zener mode, cathode will be positive with respect to anode

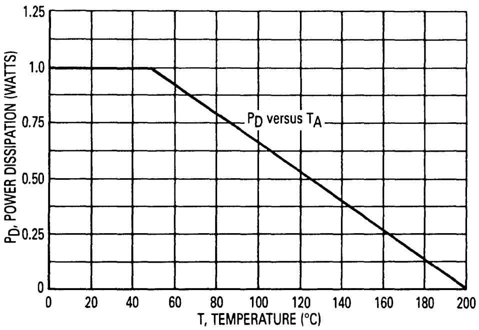
MOUNTING POSITION: Any



DIM	MILLIMETERS MIN	MILLIMETERS MAX	INCHES MIN	INCHES MAX
A	4.80	5.20	0.189	0.205
B	2.39	2.59	0.094	0.102
R	3.68	4.54	0.145	0.179
U	0.30	0.55	0.012	0.022

CASE 362B-01
GLASS

STEADY STATE POWER DERATING



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ELECTRICAL CHARACTERISTICS
(T_A = 25°C unless otherwise noted. Based on dc measurements at thermal equilibrium; case temperature maintained at 30±2°C. V_F = 1.2 V max @ I_F = 200 mA for all types.)

Type No. (Note 1)	Nominal Zener Voltage V_Z @ I_{ZT} Volts (Notes 2 and 3)	Test Current I_{ZT} mA	Maximum Zener Impedance (Note 4) Z_{ZT} @ I_{ZT} Ohms	Z_{ZK} @ I_{ZK} Ohms	I_{ZK} mA	Leakage Current I_R µA Max	V_R Volts	Surge Current @ T_A = 25°C i_r – mA (Note 5)
MLL4728	3.3	76	10	400	1.0	100	1.0	1380
MLL4729	3.6	69	10	400	1.0	100	1.0	1260
MLL4730	3.9	64	9.0	400	1.0	50	1.0	1190
MLL4731	4.3	58	9.0	400	1.0	10	1.0	1070
MLL4732	4.7	53	8.0	500	1.0	10	1.0	970
MLL4733	5.1	49	7.0	550	1.0	10	1.0	890
MLL4734	5.6	45	5.0	600	1.0	10	2.0	810
MLL4735	6.2	41	2.0	700	1.0	10	3.0	730
MLL4736	6.8	37	3.5	700	1.0	10	4.0	660
MLL4737	7.5	34	4.0	700	0.5	10	5.0	605
MLL4738	8.2	31	4.5	700	0.5	10	6.0	550
MLL4739	9.1	28	5.0	700	0.5	10	7.0	500
MLL4740	10	25	7.0	700	0.25	10	7.6	454
MLL4741	11	23	8.0	700	0.25	5.0	8.4	414
MLL4742	12	21	9.0	700	0.25	5.0	9.1	380
MLL4743	13	19	10	700	0.25	5.0	9.9	344
MLL4744	15	17	14	700	0.25	5.0	11.4	304
MLL4745	16	15.5	16	700	0.25	5.0	12.2	285
MLL4746	18	14	20	750	0.25	5.0	13.7	250
MLL4747	20	12.5	22	750	0.25	5.0	15.2	225
MLL4748	22	11.5	23	750	0.25	5.0	16.7	205
MLL4749	24	10.5	25	750	0.25	5.0	18.2	190
MLL4750	27	9.5	35	750	0.25	5.0	20.6	170
MLL4751	30	8.5	40	1000	0.25	5.0	22.8	150
MLL4752	33	7.5	45	1000	0.25	5.0	25.1	135
MLL4753	36	7.0	50	1000	0.25	5.0	27.4	125
MLL4754	39	6.5	60	1000	0.25	5.0	29.7	115
MLL4755	43	6.0	70	1500	0.25	5.0	32.7	110
MLL4756	47	5.5	80	1500	0.25	5.0	35.8	95
MLL4757	51	5.0	95	1500	0.25	5.0	38.8	90
MLL4758	56	4.5	110	2000	0.25	5.0	42.6	80
MLL4759	62	4.0	125	2000	0.25	5.0	47.1	70
MLL4760	68	3.7	150	2000	0.25	5.0	51.7	65
MLL4761	75	3.3	175	2000	0.25	5.0	56.0	60
MLL4762	82	3.0	200	3000	0.25	5.0	62.2	55
MLL4763	91	2.8	250	3000	0.25	5.0	69.2	50
MLL4764	100	2.5	350	3000	0.25	5.0	76.0	45

NOTE 1. Tolerance and Type Number Designation — The type numbers listed have a standard tolerance on the nominal zener voltage of ±10%. A standard tolerance of ±5% on individual units is also available and is indicated by suffixing "A" to the standard type number.

NOTE 2. Special Selections† Available Include:

1. Nominal zener voltages between those shown.
2. Two or more units for series connection with specified tolerance on total voltage. Series matched sets make zener voltages in excess of 200 volts possible as well as providing lower temperature coefficients, lower dynamic impedance and greater power handling ability.
3. Nominal voltages at non-standard test currents

NOTE 3. Zener Voltage (V_Z) Measurement — Nominal zener voltage is measured with the device junction in thermal equilibrium at the case temperature of 30°C ±2°C.

NOTE 4. Zener Impedance (Z_Z) Derivation — Z_{ZT} and Z_{ZK} are measured by dividing the ac voltage drop across the device by the ac current applied. The specified limits are for $I_Z(ac) = 0.1 \times I_Z(dc)$ with the ac frequency = 1.0 kHz.

†For more information on special selections contact your nearest Motorola representative.

APPLICATION NOTE

Since the actual voltage available from a given zener diode is temperature dependent, it is necessary to determine junction temperature under any set of operating conditions in order to calculate its value The following procedure is recommended·

Case Temperature, T_C, should be determined from:

$$T_C = \theta_{CA}P_D + T_A.$$

θ_{CA} is the case-to-ambient thermal resistance (°C/W) and P_D is the power dissipation. The value for θ_{CA} will vary and depends on the device mounting method. θ_{CA} is generally 200°C/W for the various clips and tie points in common use and for printed circuit board wiring.

The temperature of the case can also be measured using a thermocouple placed at the case end as close as possible to the tie point. The thermal mass connected to the tie point is normally large enough so that it will not significantly respond to heat surges generated in the diode as a result of pulsed operation once steady-state conditions are achieved. Using the measured value of T_C, the junction temperature may be determined by·

$$T_J = T_C + \Delta T_{JC}.$$

ΔT_{JC} is the increase in junction temperature above the case temperature and may be found by using:

$$\Delta T_{JC} = \theta_{JC}P_D.$$

For worst-case design, using expected limits of I_Z, limits of P_D and the extremes of $T_J(\Delta T_J)$ may be estimated. Changes in voltage, V_Z, can then be found from:

$$\Delta V = \theta_{VZ}\Delta T_J.$$

θ_{VZ}, the zener voltage temperature coefficient, is found from Figures 3 and 4.

Under high power-pulse operation, the zener voltage will vary with time and may also be affected significantly by the zener resistance. For best regulation, keep current excursions as low as possible.

NOTE 5. Surge Current (i_r) Nonrepetitive — The rating listed in the electrical characteristics table is maximum peak, non-repetitive, reverse surge current of 1/2 square wave or equivalent sine wave pulse of 1/120 second duration superimposed on the test current, I_{ZT}, per JEDEC registration; however, actual device capability is as described in Figures 4 and 6.

Surge limitations are given in Figure 6. They are lower than would be expected by considering only junction temperature, as current crowding effects cause temperatures to be extremely high in small spots, resulting in device degradation should the limits of Figure 6 be exceeded.

4

FIGURE 1 — TYPICAL LEAKAGE CURRENT

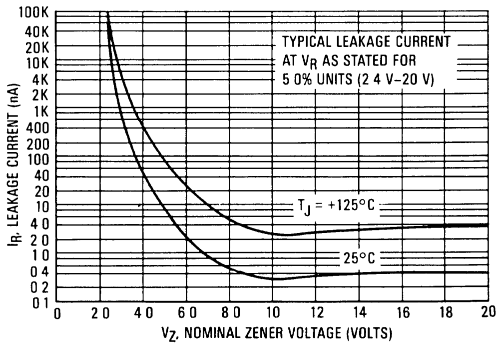

FIGURE 2 — TYPICAL LEAKAGE CURRENT

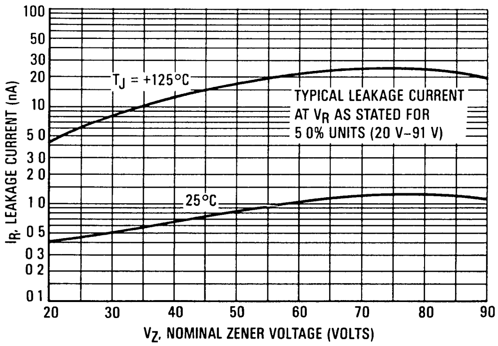

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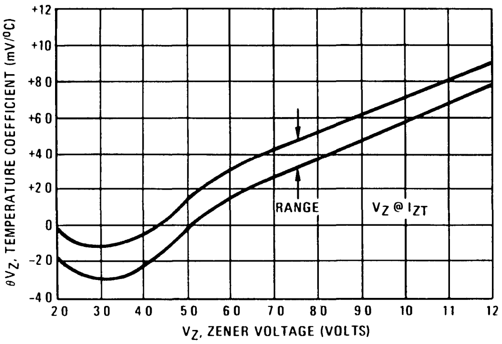
FIGURE 3 — TEMPERATURE COEFFICIENTS @ I_{ZT}

(−55°C to +150°C temperature range; 90% of the units are in the ranges indicated.)

a — RANGE FOR UNITS TO 12 VOLTS



b — RANGE FOR UNITS 12 TO 100 VOLTS

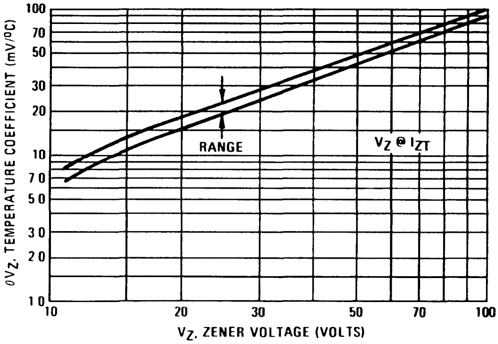


FIGURE 4 — EFFECT OF ZENER CURRENT

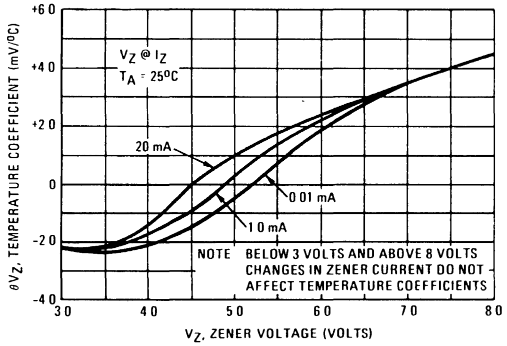


FIGURE 5 — TYPICAL CAPACITANCE

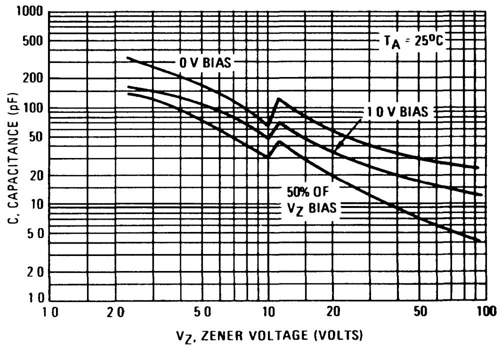
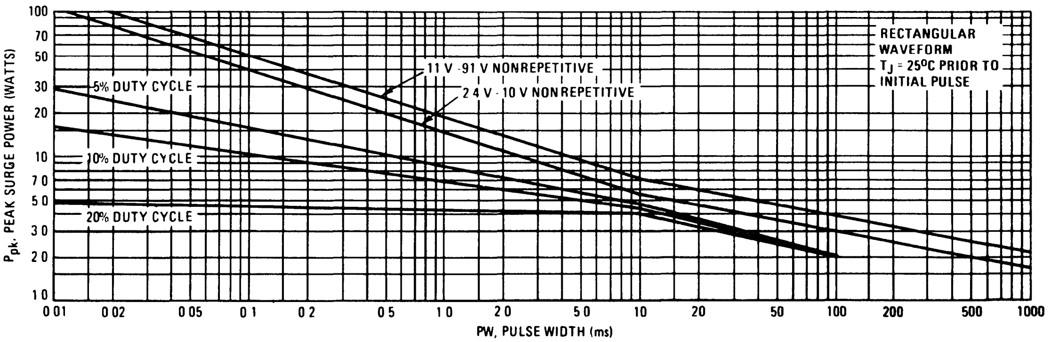


FIGURE 6 — MAXIMUM SURGE POWER



This graph represents 90 percentil data points.
For worst-case design characteristics, multiply surge power by 2/3.

FIGURE 7 — EFFECT OF ZENER CURRENT ON ZENER IMPEDANCE

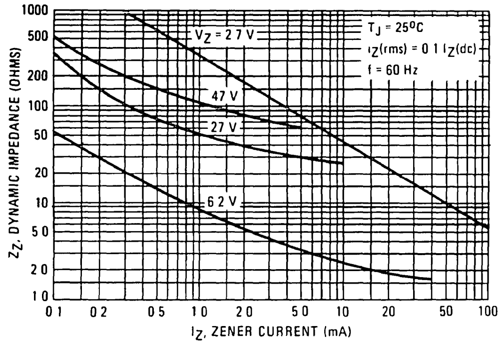


FIGURE 8 — EFFECT OF ZENER VOLTAGE ON ZENER IMPEDANCE

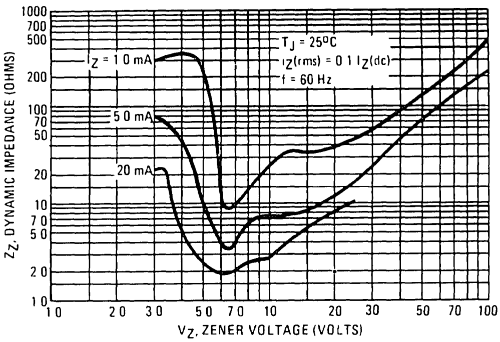


FIGURE 9 — TYPICAL NOISE DENSITY

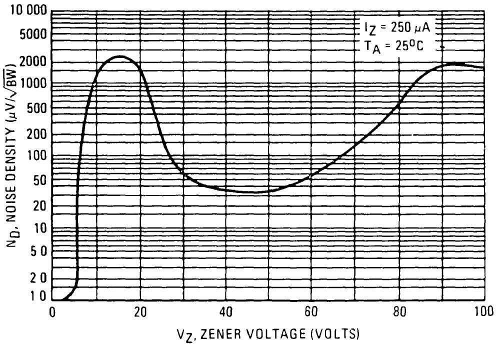
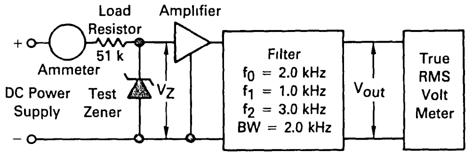


FIGURE 10 — NOISE DENSITY MEASUREMENT METHOD



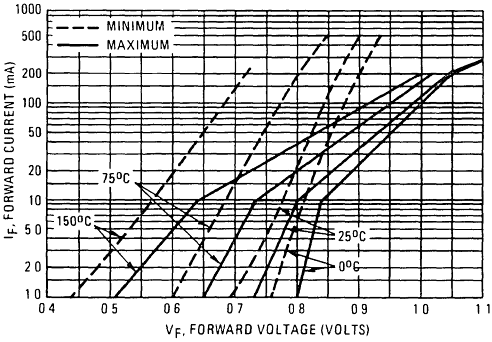
Noise Density (Volts Per Square Root Bandwidth) $= \frac{V_{out}}{\text{Overall Gain} \sqrt{BW}}$

Where: BW = Filter Bandwidth (Hz)

V_{out} = Output Noise (Volts RMS)

The input voltage and load resistance are high so that the zener diode is driven from a constant current source. The amplifier is low noise so that the amplifier noise is negligible compared to that of the test zener. The filter bandpass is known so that the noise density can be calculated from the formula shown.

FIGURE 11 — TYPICAL FORWARD CHARACTERISTICS



MOTOROLA
SEMICONDUCTOR
TECHNICAL DATA

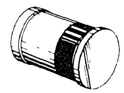
MLL5221A thru MLL5270A

500 MILLIWATT HERMETICALLY SEALED GLASS SILICON ZENER DIODES

- Complete Voltage Range — 2.4 to 91 Volts
- Leadless Package for Surface Mount Technology
- Double Slug Type Construction
- Metallurgically Bonded Construction
- Oxide Passivated Die

LEADLESS GLASS ZENER DIODES

500 MILLIWATTS
2.4-110 VOLTS



4

MAXIMUM RATINGS

Rating	Symbol	Value	Unit
DC Power Dissipation @ $T_A \leqslant 50°C$ Derate above $T_A = 50°C$	P_D	500 3 3	mW mW/°C
Operating and Storage Junction Temperature Range	T_J, T_{stg}	-65 to +200	°C

MECHANICAL CHARACTERISTICS

CASE: Double slug type, hermetically sealed glass

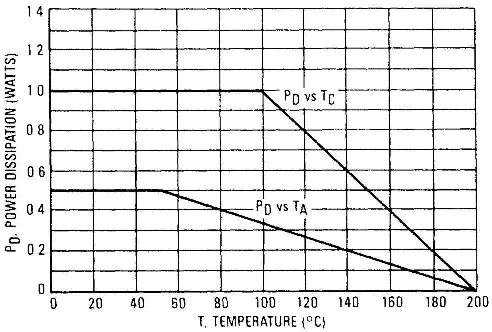
MAXIMUM LEAD TEMPERATURE FOR SOLDERING PURPOSES 230°C, for 10 seconds

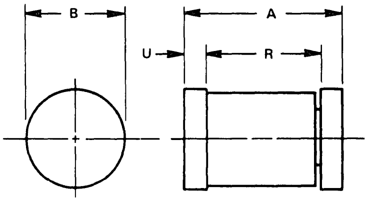
FINISH: All external surfaces are corrosion resistant and readily solderable

POLARITY. Cathode indicated by color band When operated in zener mode, cathode will be positive with respect to anode

MOUNTING POSITION Any

STEADY STATE POWER DERATING





DIM	MILLIMETERS MIN	MILLIMETERS MAX	INCHES MIN	INCHES MAX
A	3 30	3 70	0 130	0 146
B	1 60	1 70	0 063	0 067
R	2 49	2 59	0 098	0 102
U	0 41	0 55	0 016	0 022

CASE 362-01
GLASS

ELECTRICAL CHARACTERISTICS

(T_A = 25°C unless otherwise noted Based on dc measurements at thermal equilibrium, case temperature maintained at 30±2°C V_F = 1 1 max @ I_F = 200 mA for all types)

Type No. (Note 1)	Nominal Zener Voltage V_Z @ I_{ZT} Volts (Note 2)	Test Current I_{ZT} mA	Max Zener Impedance A and B Suffix only		Max Reverse Leakage Current A and B Suffix only			Max Reverse Leakage Current Non-Suffix	Max Zener Voltage Temperature Coeff. (A and B Suffix only) θ_{VZ} (%/°C) (Note 3)
			Z_{ZT} @ I_{ZT} Ohms	Z_{ZK} @ I_{ZK} = 0.25 mA Ohms	I_R µA	@ V_R Volts A	@ V_R Volts B	I_R @ V_R Used for Suffix A µA	
MLL5221A	2 4	20	30	1200	100	0 95	1 0	200	-0 085
MLL5222A	2 5	20	30	1250	100	0 95	1 0	200	-0 085
MLL5223A	2 7	20	30	1300	75	0 95	1 0	150	-0 080
MLL5224A	2 8	20	30	1400	75	0 95	1 0	150	-0 080
MLL5225A	3 0	20	29	1600	50	0 95	1 0	100	-0 075
MLL5226A	3 3	20	28	1600	25	0 95	1 0	100	-0 070
MLL5227A	3 6	20	24	1700	15	0 95	1 0	100	-0 065
MLL5228A	3 9	20	23	1900	10	0 95	1 0	75	-0 060
MLL5229A	4 3	20	22	2000	5 0	0 95	1 0	50	±0 055
MLL5230A	4 7	20	19	1900	5 0	1 9	2 0	50	±0 030
MLL5231A	5 1	20	17	1600	5 0	1 9	2 0	50	±0 030
MLL5232A	5 6	20	11	1600	5 0	2 9	3 0	50	+0 038
MLL5233A	6 0	20	7 0	1600	5 0	3 3	3 5	50	+0 038
MLL5234A	6 2	20	7 0	1000	5 0	3 8	4 0	50	+0 045
MLL5235A	6 8	20	5 0	750	3 0	4 8	5 0	30	+0 050
MLL5236A	7 5	20	6 0	500	3 0	5 7	6 0	30	+0 058
MLL5237A	8 2	20	8 0	500	3 0	6 2	6 5	30	+0 062
MLL5238A	8 7	20	8 0	600	3 0	6 2	6 5	30	+0 065
MLL5239A	9 1	20	10	600	3 0	6 7	7 0	30	+0 068
MLL5240A	10	20	17	600	3 0	7 6	8 0	30	+0 075
MLL5241A	11	20	22	600	2 0	8 0	8 4	30	+0 076
MLL5242A	12	20	30	600	1 0	8 7	9 1	10	+0 077
MLL5243A	13	9 5	13	600	0 5	9 4	9 9	10	+0 079
MLL5244A	14	9 0	15	600	0 1	9 5	10	10	+0 082
MLL5245A	15	8 5	16	600	0 1	10 5	11	10	+0 082
MLL5246A	16	7 8	17	600	0 1	11 4	12	10	+0 083
MLL5247A	17	7 4	19	600	0 1	12 4	13	10	+0 084
MLL5248A	18	7 0	21	600	0 1	13 3	14	10	+0 085
MLL5249A	19	6 6	23	600	0 1	13 3	14	10	+0 086
MLL5250A	20	6 2	25	600	0 1	14 3	15	10	+0 086
MLL5251A	22	5 6	29	600	0 1	16 2	17	10	+0 087
MLL5252A	24	5 2	33	600	0 1	17 1	18	10	+0 088
MLL5253A	25	5 0	35	600	0 1	18 1	19	10	+0 089
MLL5254A	27	4 6	41	600	0 1	20	21	10	+0 090
MLL5255A	28	4 5	44	600	0 1	20	21	10	+0 091
MLL5256A	30	4 2	49	600	0 1	22	23	10	+0 091
MLL5257A	33	3 8	58	700	0 1	24	25	10	+0 092
MLL5258A	36	3 4	70	700	0 1	26	27	10	+0 093
MLL5259A	39	3 2	80	800	0 1	29	30	10	+0 094
MLL5260A	43	3 0	93	900	0 1	31	33	10	+0 095
MLL5261A	47	2 7	105	1000	0 1	34	36	10	+0 095
MLL5262A	51	2 5	125	1100	0 1	37	39	10	+0 096
MLL5263A	56	2 2	150	1300	0 1	41	43	10	+0 096
MLL5264A	60	2 1	170	1400	0 1	44	46	10	+0 097
MLL5265A	62	2 0	185	1400	0 1	45	47	10	+0 097
MLL5266A	68	1 8	230	1600	0 1	49	52	10	+0 097
MLL5267A	75	1 7	270	1700	0 1	53	56	10	+0 098
MLL5268A	82	1 5	330	2000	0 1	59	62	10	+0 098
MLL5269A	87	1 4	370	2200	0 1	65	68	10	+0 099
MLL5270A	91	1 4	400	2300	0 1	66	69	10	+0 099

NOTE 1. Tolerance — Units with guaranteed limits on all six parameters are indicated by suffix "A" for ±10% tolerance and suffix "B" for ±5.0% units.

NOTE 2. Special Selections† Available Include.
1 Nominal zener voltages between those shown
2 Two or more units for series connection with specified tolerance on total voltage Series matched sets make zener voltages in excess of 200 volts possible as well as providing lower temperature coefficients, lower dynamic impedance and greater power handling ability
3 Nominal voltages at non-standard test currents

NOTE 3 Temperature Coefficient (θ_{VZ}) — Test conditions for temperature coefficient are as follows
a I_{ZT} = 7 5 mA, T_1 = 25°C,
T_2 = 125°C (MLL5221A,B through MLL5242A,B)
b I_{ZT} = Rated I_{ZT}, T_1 = 25°C,
T_2 = 125°C (MLL5243A, B through MLL5270A,B)
Device to be temperature stabilized with current applied prior to reading breakdown voltage at the specified ambient temperature

NOTE 4 Zener Voltage (V_Z) Measurement — Nominal zener voltage is measured with the device junction in thermal equilibrium at the case temperature of 30°C ±1°C

NOTE 5 Zener Impedance (Z_Z) Derivation — Z_{ZT} and Z_{ZK} are measured by dividing the ac voltage drop across the device by the ac current applied The specified limits are for $I_Z(ac)$ = 0 1 × $I_Z(dc)$ with the ac frequency = 1 0 kHz

4

† For more information on special selections contact your nearest Motorola representative

APPLICATION NOTE

Since the actual voltage available from a given zener diode is temperature dependent, it is necessary to determine junction temperature under any set of operating conditions in order to calculate its value The following procedure is recommended

Case Temperature, T_C, should be determined from

$$T_C = \theta_{CA} P_D + T_A$$

θ_{CA} is the case-to-ambient thermal resistance (°C/W) and P_D is the power dissipation The value for θ_{CA} will vary and depends on the device mounting method θ_{CA} is generally 200°C/W for the various clips and tie points in common use and for printed circuit board wiring

The temperature of the case can also be measured using a thermocouple placed at the case end as close as possible to the tie point The thermal mass connected to the tie point is normally large enough so that it will not significantly respond to heat surges generated in the diode as a result of pulsed operation once steady-state conditions are achieved Using the measured value of T_C, the junction temperature may be determined by

$$T_J = T_C + \Delta T_{JC}$$

ΔT_{JC} is the increase in junction temperature above the case temperature and may be found by using

$$\Delta T_{JC} = \theta_{JC} P_D$$

For worst-case design, using expected limits of I_Z, limits of P_D and the extremes of $T_J(\Delta T_J)$ may be estimated Changes in voltage, V_Z, can then be found from

$$\Delta V = \theta_{VZ} \Delta T_J$$

θ_{VZ}, the zener voltage temperature coefficient, is found from Figures 3 and 4

Under high power-pulse operation, the zener voltage will vary with time and may also be affected significantly by the zener resistance For best regulation, keep current excursions as low as possible

Surge limitations are given in Figure 6 They are lower than would be expected by considering only junction temperature, as current crowding effects cause temperatures to be extremely high in small spots, resulting in device degradation should the limits of Figure 6 be exceeded

FIGURE 1 — TYPICAL LEAKAGE CURRENT

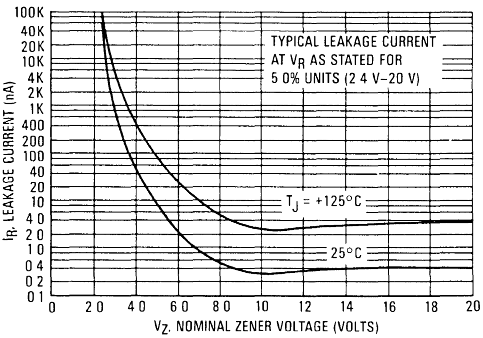


FIGURE 2 — TYPICAL LEAKAGE CURRENT

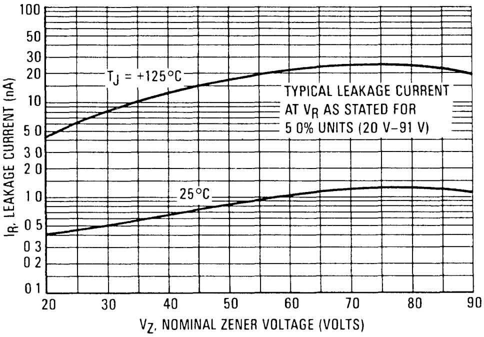


FIGURE 3 — TEMPERATURE COEFFICIENTS

(-55°C to +150°C temperature range; 90% of the units are in the ranges indicated.)

a – RANGE FOR UNITS TO 12 VOLTS

b – RANGE FOR UNITS 12 TO 100 VOLTS

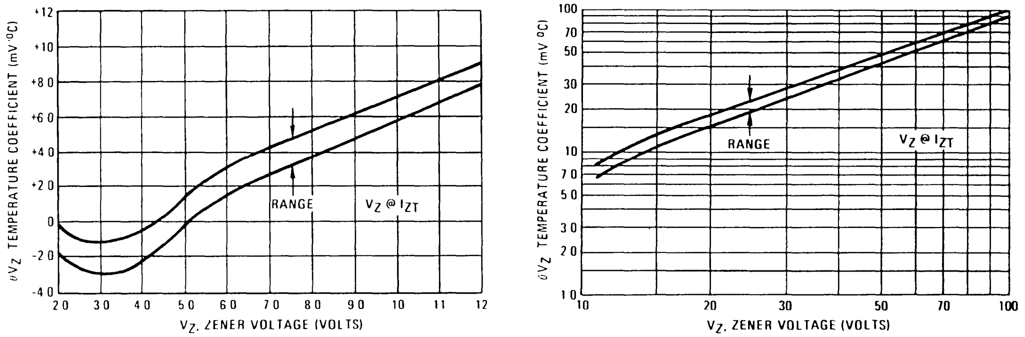


FIGURE 4 — EFFECT OF ZENER CURRENT

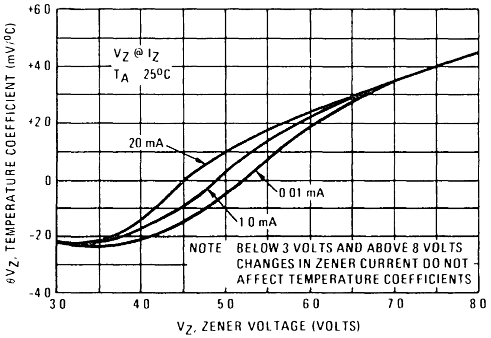


FIGURE 5 — TYPICAL CAPACITANCE

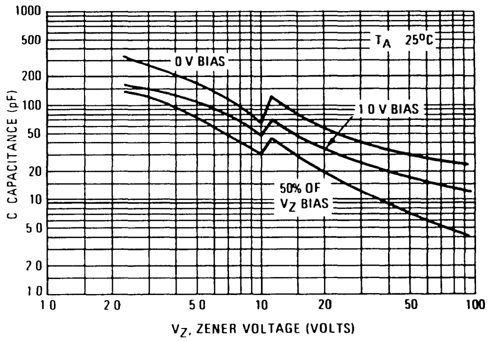
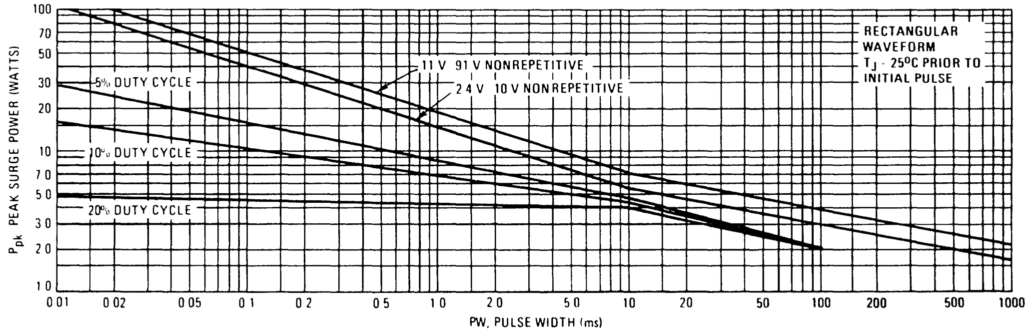


FIGURE 6 — MAXIMUM SURGE POWER



This graph represents 90 percentil data points
For worst case design characteristics multiply surge power by 2/3

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FIGURE 7 — EFFECT OF ZENER CURRENT ON ZENER IMPEDANCE

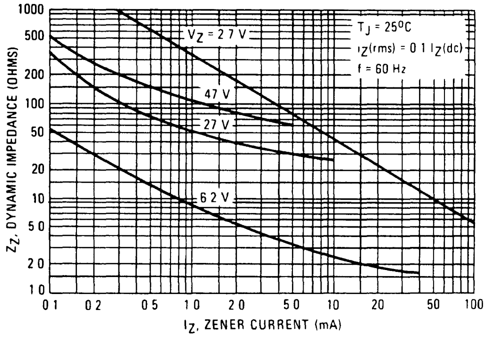


FIGURE 8 — EFFECT OF ZENER VOLTAGE ON ZENER IMPEDANCE

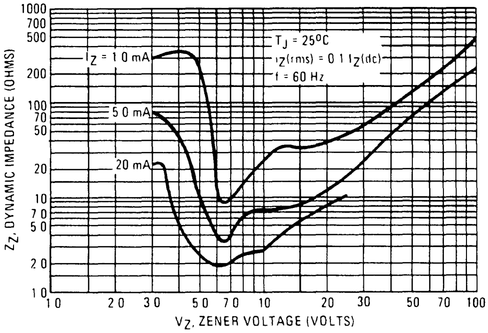


FIGURE 9 — TYPICAL NOISE DENSITY

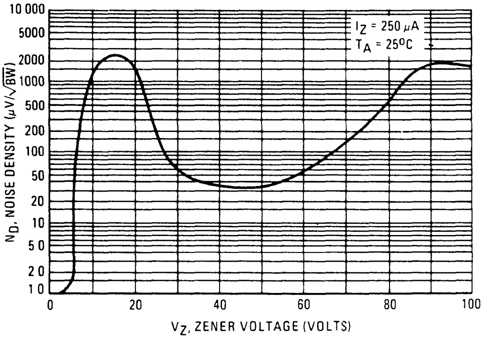
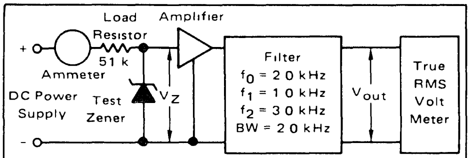


FIGURE 10 — NOISE DENSITY MEASUREMENT METHOD



$$\text{Noise Density (Volts Per Square Root Bandwidth)} = \frac{V_{out}}{\text{Overall Gain } \sqrt{BW}}$$

Where BW = Filter Bandwidth (Hz)
V_{out} = Output Noise (Volts RMS)

The input voltage and load resistance are high so that the zener diode is driven from a constant current source The amplifier is low noise so that the amplifier noise is negligible compared to that of the test zener The filter bandpass is known so that the noise density can be calculated from the formula shown

FIGURE 11 — TYPICAL FORWARD CHARACTERISTICS

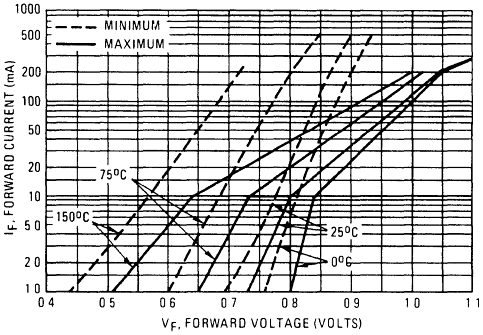


FIGURE 12 — ZENER VOLTAGE versus ZENER CURRENT — V_Z = 1 THRU 16 VOLTS

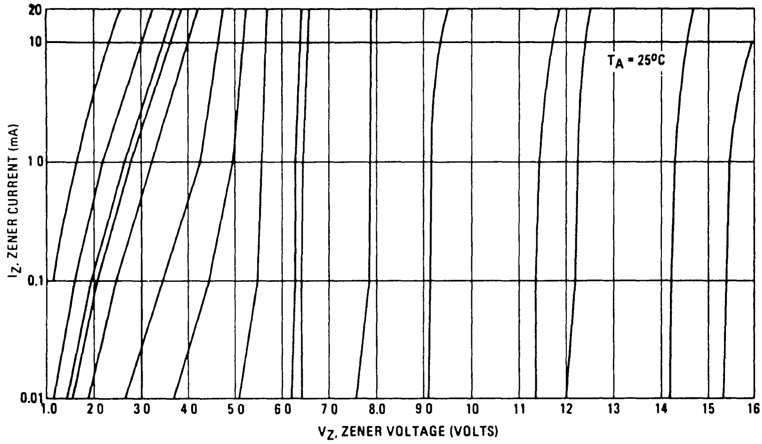


FIGURE 13 — ZENER VOLTAGE versus ZENER CURRENT — V_Z = 15 THRU 30 VOLTS

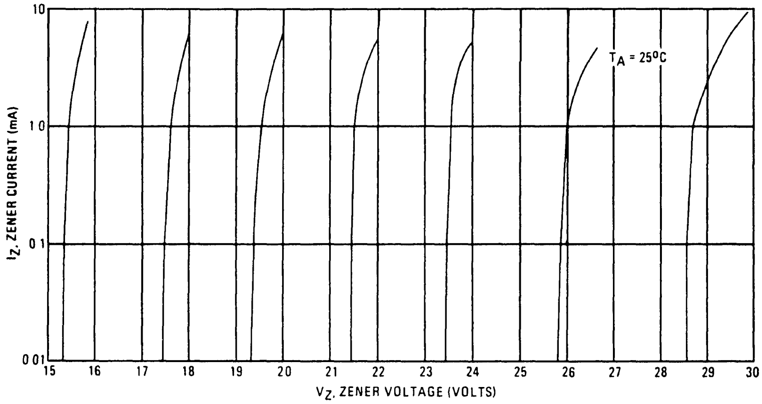
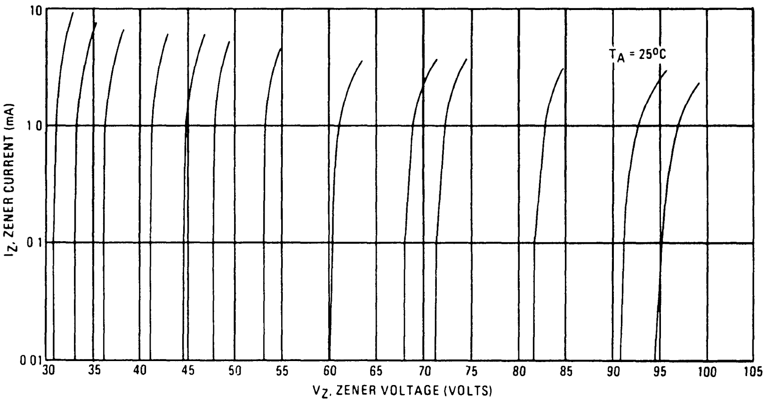


FIGURE 14 — ZENER VOLTAGE versus ZENER CURRENT — V_Z = 30 THRU 105 VOLTS



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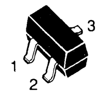
MOTOROLA
SEMICONDUCTOR
TECHNICAL DATA

MMBZ5226B thru MMBZ5257B

CASE 318-05, STYLE 8
SOT-23 (TO-236AA/AB)



ZENER DIODES

THERMAL CHARACTERISTICS

Characteristic	Symbol	Max	Unit
Total Device Dissipation FR-5 Board,* T_A = 25°C Derate above 25°C	P_D	225 1.8	mW mW/°C
Thermal Resistance Junction to Ambient	$R_{\theta JA}$	556	°C/mW
Total Device Dissipation Alumina Substrate,** T_A = 25°C Derate above 25°C	P_D	300 2.4	mW mW/°C
Thermal Resistance Junction to Ambient	$R_{\theta JA}$	417	°C/mW
Junction and Storage Temperature	T_J, T_{stg}	150	°C

*FR-5 = 1.0 x 0.75 x 0.62 in.
**Alumina = 0.4 x 0.3 x 0.024 in. 99.5% alumina.

Pinout: 1-Anode, 2-NC, 3-Cathode (V_F = 0.9 V Max @ I_F = 10 mA for all types.)

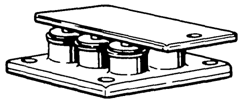
Device	Marking	Test Current I_{ZT} mA	Zener Voltage V_Z (±5%) Nominal	Z_{ZK} I_Z = 0.25 mA Ω Max	Z_{ZT} I_Z = I_{ZT} @ 10% Mod Ω Max	Max I_R µA	@ V_R V
MMBZ5226B	8A	20	3.3	1600	28	25	1.0
MMBZ5227B	8B	20	3.6	1700	24	15	1.0
MMBZ5228B	8C	20	3.9	1900	23	10	1.0
MMBZ5229B	8D	20	4.3	2000	22	5.0	1.0
MMBZ5230B	8E	20	4.7	1900	19	5.0	2.0
MMBZ5231B	8F	20	5.1	1600	17	5.0	2.0
MMBZ5232B	8G	20	5.6	1600	11	5.0	3.0
MMBZ5233B	8H	20	6.0	1600	7.0	5.0	3.5
MMBZ5234B	8J	20	6.2	1000	7.0	5.0	4.0
MMBZ5235B	8K	20	6.8	750	5.0	3.0	5.0
MMBZ5236B	8L	20	7.5	500	6.0	3.0	6.0
MMBZ5237B	8M	20	8.2	500	8.0	3.0	6.5
MMBZ5238B	8N	20	8.7	600	8.0	3.0	6.5
MMBZ5239B	8P	20	9.1	600	10	3.0	7.0
MMBZ5240B	8Q	20	10	600	17	3.0	8.0
MMBZ5241B	8R	20	11	600	22	2.0	8.4
MMBZ5242B	8S	20	12	600	30	1.0	9.1
MMBZ5243B	8T	9.5	13	600	13	0.5	9.9
MMBZ5244B	8U	9.0	14	600	15	0.1	10
MMBZ5245B	8V	8.5	15	600	16	0.1	11
MMBZ5246B	8W	7.8	16	600	17	0.1	12
MMBZ5247B	8X	7.4	17	600	19	0.1	13
MMBZ5248B	8Y	7.0	18	600	21	0.1	14
MMBZ5249B	8Z	6.6	19	600	23	0.1	14
MMBZ5250B	81A	6.2	20	600	25	0.1	15
MMBZ5251B	81B	5.6	22	600	29	0.1	17
MMBZ5252B	81C	5.2	24	600	33	0.1	18
MMBZ5253B	81D	5.0	25	600	35	0.1	19
MMBZ5254B	81E	4.6	27	600	41	0.1	21
MMBZ5255B	81F	4.5	28	600	44	0.1	21
MMBZ5256B	81G	4.2	30	600	49	0.1	23
MMBZ5257B	81H	3.8	33	700	58	0.1	25

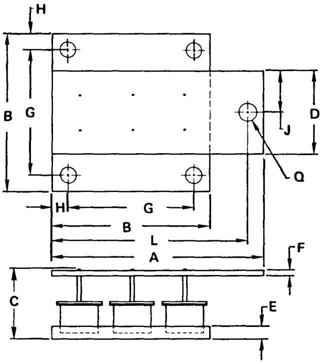
MPTE-5, C thru MPTE-45, C
See Page 4-59

MOTOROLA
SEMICONDUCTOR
TECHNICAL DATA

MPZ5-16 Series
MPZ5-32 Series
MPZ5-180 Series

SILICON POWER TRANSIENT SUPPRESSOR





DIM	MILLIMETERS MIN	MILLIMETERS MAX	INCHES MIN	INCHES MAX
A	50 29	51 31	1 980	2.020
B	37 59	38 61	1.480	1 520
C	–	16 51	–	0.650
D	20.24	21 01	0.797	0 827
E	2 92	3 43	0 115	0 135
F	1.32	1 83	0 052	0.072
G	29.97	30 99	1 180	1 220
H	3.56	4.06	0.140	0 160
J	10.06	10.57	0 396	0 416
L	46.74	47 74	1 840	1 860
Q	3.30	3 81	0 130	0.150

CASE 119-01

NOTE DIA "Q" 5 PLACES

SILICON POWER TRANSIENT SUPPRESSOR

. . . designed for applications requiring protection of voltage sensitive electronic devices in danger of destruction by high energy voltage transients. Individual cells are matched to insure current-sharing under high current pulse conditions.

- Peak Surge Power Capacity Given From 0.1 ms To 10 Seconds
- Low Clamping Factor Assures Low Voltage Overshoot
- Negligible Power Loss
- Small Size and Weight
- Following Variations are Available:
  - Non-Standard Voltages
  - Higher Power Capacity
  - Other Package Configurations

MAXIMUM RATINGS

Transient Power Dissipation: 40 kW

Pulse Width: 0.1ms, (See Figure 1)

DC Power Dissipation: 350 Watts @ $T_C = 25°C$
(Derate 2.33 W/°C above 25°C)

Operating Junction & Storage Temperature Range.
−65°C to +175°C

MECHANICAL CHARACTERISTICS

POLARITY: Anode-to-Case is Standard. Cathode-to-Case Available Upon Request.

ELECTRICAL CHARACTERISTICS ($T_A = 25°C$, $V_F = 1.5$ V max @ 10 A for all types)

Type	Nominal Operating Voltage (Note 1) $V_{OP(PK)}$ Vdc	Nominal Operating Voltage (Note 1) $V_{OP(RMS)}$ V rms	Maximum Device Clamping Factor $CF = \frac{V_Z @ I_{Z(pulse)}}{V_Z @ I_{ZT}}$ (Note 2)	Minimum Zener Voltage $V_{Z(min)}$ Vdc	@ I_{ZT} Adc	Maximum Zener Voltage Pulse Width = 1.0 ms $V_{Z(max)}$ Vdc	@ $I_{Z(pulse)}$ Adc	Maximum Reverse Current $I_{R(max)}$ @ $V_R = V_{OP(PK)}$ µAdc	Typical Capacitance C (typ) @ $V_R = V_{OP(PK)}$ µF
MPZ5-16A	14	10	1 25	16	0 4	24	200	50	0 025
-16B	14	10	1 25	16	0 4	20	200	↑	0 025
-32A	28	20	1 25	32	0 2	50	100	|	0 011
-32B	28	20	1 25	32	0 2	45	100	|	0 011
-32C	28	20	1 25	32	0 2	40	100	|	0 011
-180A	165	117	1 14	180	0 03	250	20	|	0 0012
-180B	165	117	1 14	180	0 03	225	20	↓	0 0012
-180C	165	117	1 14	180	0 03	205	20	50	0 0012

FIGURE 1 – MAXIMUM NON-REPETITIVE SURGE POWER
(RECTANGULAR WAVEFORM)

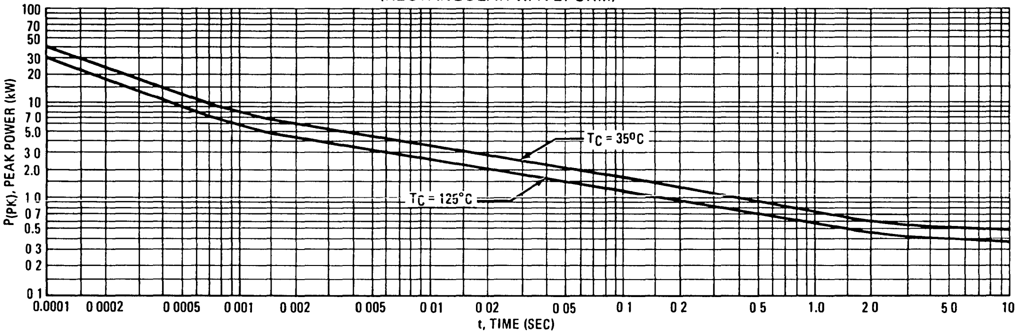
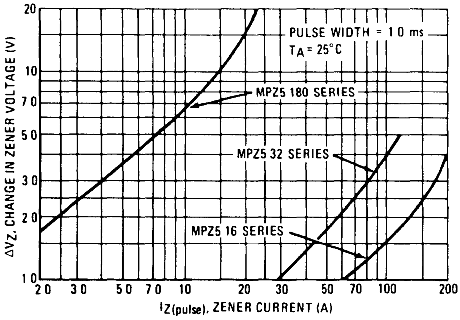


FIGURE 2 – TYPICAL DYNAMIC ZENER VOLTAGE CHARACTERISTICS (Note 2)



NOTE 1. Nominal operating voltage is defined as normal input voltage to device for non-operating condition. If non-sinusoidal wave or dc input is present, peak voltage input values $V_{OP(PK)}$ should be used to select device type.

NOTE 2. The maximum device clamping factor C_F is a ratio of V_Z measured at I_Z (pulse) given in the Electrical Characteristics Table divided by V_Z measured at I_{ZT} under steady state conditions. This value guarantees the sharpness of the voltage breakdown of individual devices. Figure 2 demonstrates the typical sharpness of the breakdown, and indicates the voltage regulation over a wide range of currents.

$$\Delta V_Z = V_Z \text{ @ } I_{Z(pulse)} - V_Z \text{ @ } I_{ZT}$$

MOTOROLA
SEMICONDUCTOR
TECHNICAL DATA

MZ600 Series

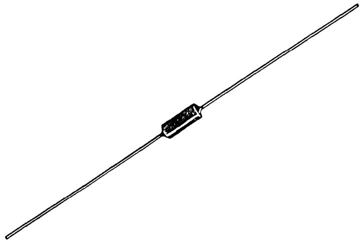
6.2 VOLTS

PRECISION REFERENCE DIODES

... designed, manufactured and tested for applications requiring a precision voltage reference with ultra-high stability of voltage with time and temperature change.

Special test laboratory uses precision measurement equipment, four-terminal (separate contacts for current and voltage) measurement techniques and voltage standards to provide calibration directly traceable to the National Bureau of Standards.

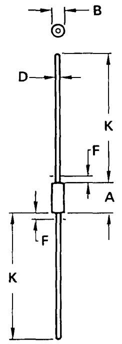
PRECISION REFERENCE DIODES with CERTIFIED ZENER VOLTAGE-TIME STABILITY



Certified TEST DATA

Every Precision Reference Diode is individually serialized and its test data recorded on a Certificate of Precision that accompanies the device when shipped. This data shows:

- Actual device voltage at 168 hour intervals during verification test
- Voltage stability throughout the entire 1000 hour test period
- Certification of Precision
- All diodes are marked with the device type number and polarity band



NOTES
1 PACKAGE CONTOUR OPTIONAL WITHIN DIA B AND LENGTH A HEAT SLUGS, IF ANY, SHALL BE INCLUDED WITHIN THIS CYLINDER, BUT SHALL NOT BE SUBJECT TO THE MIN LIMIT OF DIA B
2 LEAD DIA NOT CONTROLLED IN ZONES F, TO ALLOW FOR FLASH, LEAD FINISH BUILDUP, AND MINOR IRREGULARITIES OTHER THAN HEAT SLUGS

DIM	MILLIMETERS		INCHES	
	MIN	MAX	MIN	MAX
A	5 84	7 62	0 230	0 300
B	2 16	2 72	0 085	0 107
D	0 46	0 56	0 018	0 022
F	–	1 27	–	0 050
K	25 40	38 10	1 000	1 500

All JEDEC dimensions and notes apply

CASE 51-02
DO-204AA
GLASS

4

OPERATING TEMPERATURE RANGE:* 25 to 100°C.

MZ600 SERIES (Voltage 6.2V ±5%, I_{ZT} = 7.5 mAdc†, ΔV_Z = 2.5 mVdc**)

Type No.	Voltage-Time Stability (µV/1000 Hours)	Parts Per Million Change (ppm/1000 Hours)
MZ605	31 Maximum	< 5
MZ610	62 Maximum	<10
MC620	124 Maximum	<20
MZ640	248 Maximum	<40

DYNAMIC IMPEDANCE: 10 Ohms at I_{ZT} = 7.5 mAdc, I_{ac} = 0.75 mA.

4

NOTES

†TEST CURRENT

For certification testing of time stability, Motorola maintains I_{ZT} constant and repeatable to ±0.05 µA tolerance. For voltage tolerance, impedance and voltage temperature stability I_{ZT} needs to be held to 0.01 tolerance only.

*Maximum limits for use as a precision reference device. Limits are well below the maximum thermal limits.

**VOLTAGE-TEMPERATURE STABILITY: Maximum allowable voltage change between voltages recorded at 25, 75 and 100°C ambient.

VOLTAGE-TIME STABILITY

(ΔV_Z/1000 Hours).

The device voltage is read and recorded initially and at 168 hour intervals through 1000 hours. The maximum change of voltage between readings, taken at any of the seven points, must be less than the maximum voltage change per 1000 hour specified as Voltage-Time Stability.

TURN-ON CHARACTERISTICS

Precision Reference Diodes have been tested to determine the behavior of the device under interrupted power operation. To insure specified performance, adequate time must be allowed for the device and its environment to reach thermal equilibrium. "Warm-up" time may range from 8 to 24 hours. Thermal equilibrium is reached when the chamber is cycling at the required temperature with the device energized.

After this '"warm-up" period, the device voltage will be between the minimum and the maximum voltage of those recorded at the seven points of the Voltage-Time Stability certification.

MOUNTING

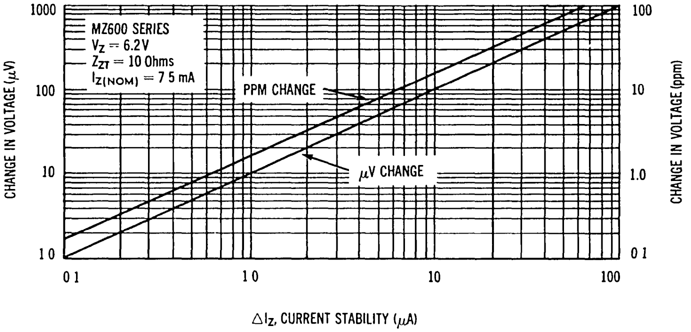
Excellent results have been obtained by using a mechanical mounting. If necessary, the device may be soldered into a circuit using a heat sink between the heat source and the body of the diode. A low thermal EMF solder is recommended.

SPECIAL NOTE

Voltage tolerance less than 5 0% is available upon special request.

Precision Reference Diodes capable of meeting special requirements for standard voltages regardless of required test current, temperature range, or test temperatures are available. Custom requirements of particular devices for specific applications are also available.

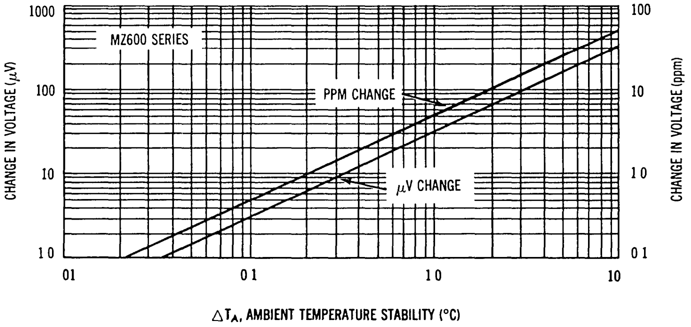
FIGURE 1 — MAXIMUM VOLTAGE CHANGE, IN μV AND PPM, DUE TO CURRENT SUPPLY STABILITY



VOLTAGE-CURRENT STABILITY CHARACTERISTICS

For verification of time stability, and for repeatable operation, I_{ZT} should be maintained with a tolerance of ±0.1 μA Figure 1 will assist in design where the supply current stability cannot be maintained to better than 0.2 μA deviation.

FIGURE 2 — TYPICAL VOLTAGE CHANGE, IN μV AND PPM, DUE TO AMBIENT TEMPERATURE STABILITY



VOLTAGE-TEMPERATURE CHARACTERISTICS

CHOICE OF OPERATING TEMPERATURE

The stability certification is performed at 65°C ±0.02°C. The operating temperature can be selected within the operating temperature range. If the desired temperature is not 65°C, the precise voltage of the device will be different but the certified stability will still be observed.

VOLTAGE TEMPERATURE STABILITY

For verification of time stability and/or repeatable operation, the ambient temperature should be controlled to ±0.1°C.

Figure 2 will assist in designs where ambient temperature cannot be controlled to better than 0.2°C deviation.

MOTOROLA
SEMICONDUCTOR
TECHNICAL DATA

MZ2360
MZ2361

FORWARD REFERENCE DIODES

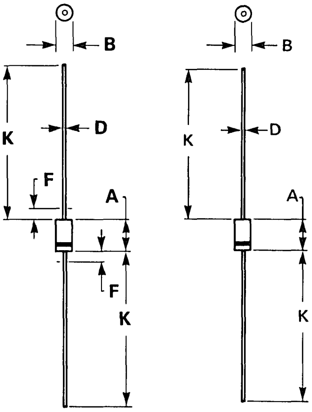
STABISTORS

CONSTANT-VOLTAGE REFERENCE DIODES FOR LOW-VOLTAGE APPLICATIONS

. . . high-conductance silicon diodes designed as a stable forward reference source for biasing transistor amplifiers and similar applications.

- Guaranteed Forward Voltage Range
- Temperature Effects Provided

4



CASE 59-03 CASE 59-04

NOTES:
1. ALL RULES AND NOTES ASSOCIATED WITH JEDEC DO-41 OUTLINE SHALL APPLY.
2. POLARITY DENOTED BY CATHODE BAND.
3. LEAD DIAMETER NOT CONTROLLED WITHIN "F" DIMENSION.

	MILLIMETERS		INCHES	
DIM	MIN	MAX	MIN	MAX
A	4 07	5 20	0.160	0 205
B	2 04	2 71	0 080	0.107
D	0.71	0.86	0.028	0.034
F	—	1.27	—	0 050
K	27.94	—	1.100	—

CASE 59-03
DO-41

	MILLIMETERS		INCHES	
DIM	MIN	MAX	MIN	MAX
A	5.97	6.60	0 235	0 260
B	2.79	3 05	0 110	0.120
D	0.76	0.86	0.030	0.034
K	27 94	—	1.100	—

CASE 59-04
DO-41

MAXIMUM RATINGS

Rating	Symbol	Value	Unit
DC Power Dissipation @ $T_L = 30°C \pm 3°C$, Lead Length = 3/8″	P_D	1.5	W
Operating and Storage Junction Temperature Range	T_J, T_{stg}	− 65 to + 175	°C

MECHANICAL CHARACTERISTICS

CASE: Surmetic

DIMENSIONS: See outline drawing

FINISH: All external surfaces are corrosion resistant and leads are readily solderable and weldable

POLARITY: Cathode indicated by polarity band. Cathode negative for forward reference application

MOUNTING POSITIONS: Any

ELECTRICAL CHARACTERISTICS (T_A = 25°C unless otherwise noted)

Type Number	Forward Reference Voltage (1) @ V_F Volts Min/Max	I_F mA	Reverse Leakage Current (Max) @ I_R µA	V_R Volts	Package	Case
MZ2360	0.63/0.71	10	10	5.0	Surmetic	59-04
MZ2361	1.24/1.38	10	10	5.0	Surmetic	59-03

(1) Motorola guarantees the forward reference voltage when measured at 90 seconds while maintaining the lead temperature (T_L) at 30°C ± 1°C, 3/8″ from the diode body.

TYPICAL FORWARD VOLTAGE CHARACTERISTICS

FIGURE 1 — MZ2360

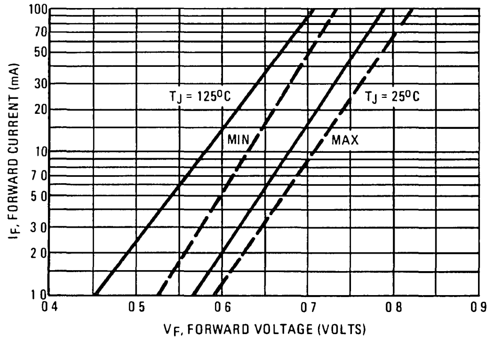
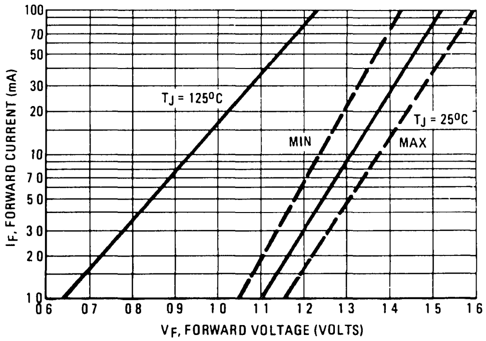


FIGURE 2 — MZ2361



TYPICAL TEMPERATURE COEFICIENT

FIGURE 3 — MZ2360

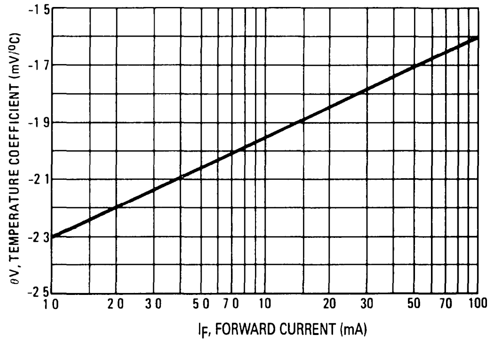
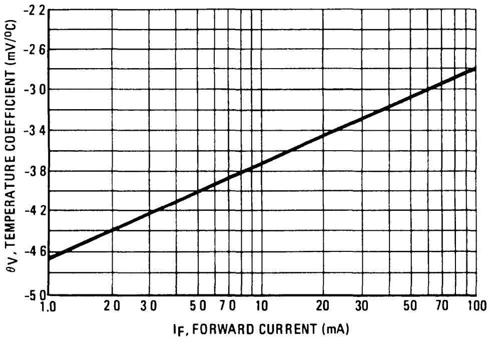


FIGURE 4 — MZ2361



4

P6KE6.8, A thru P6KE200, A

ZENER OVERVOLTAGE TRANSIENT SUPPRESSOR

The P6KE6 8 series is designed to protect voltage sensitive components from high voltage, high energy transients They have excellent clamping capability, high surge capability, low zener impedance and fast response time The P6KE6 8 series is supplied in Motorola's exclusive, cost-effective, highly reliable surmetic axial leaded package and is ideally-suited for use in communication systems, numerical controls, process controls, medical equipment, business machines, power supplies and many other industrial/consumer applications

SPECIFICATION FEATURES

- Standard Zener Voltage Range — 6 8 to 200 V
- Peak Power — 600 Watts @ 1 0 ms
- Maximum Clamp Voltage @ Peak Pulse Current
- Low Leakage < 5 0 μA above 10 V
- Maximum Temperature Coefficient Specified

4

MAXIMUM RATINGS

Rating	Symbol	Value	Units
Peak Power Dissipation (1) @ $T_L \leq 25^oC$	P_{PK}	600	Watts
Steady State Power Dissipation @ $T_L \leq 75^oC$, Lead Length = 3/8"	P_D	5 0	Watts
Derated above T_L = 75°C		50	mW/°C
Forward Surge Current (2) @ T_A = 25°C	I_{FSM}	100	Amps
Operating and Storage Temperature Range	T_J, T_{stg}	-65 to +175	°C

Lead Temperature not less than 1/16" from the case for 10 seconds 230°C

MECHANICAL CHARACTERISTICS

CASE· Void-free, transfer-molded, thermosetting plastic

FINISH: All external surfaces are corrosion resistant and leads are readily solderable and weldable

POLARITY. Cathode indicated by polarity band When operated in zener mode, will be positive with respect to anode

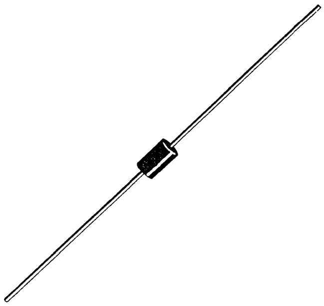
MOUNTING POSITION: Any

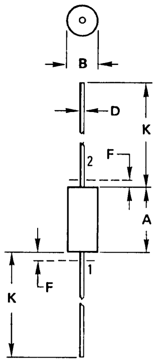
NOTES 1 Non-Repetitive Current Pulse per Figure 4 and Derated above T_A = 25°C per Figure 2

2 1/2 Square Wave (or equivalent), PW = 8 3 ms, Duty Cycle = 4 Pulses per Minute maximum

ZENER OVERVOLTAGE TRANSIENT SUPPRESSORS

6.8-200 VOLT
600 WATT PEAK POWER
5 0 WATTS STEADY STATE





NOTE
1 LEAD DIAMETER & FINISH NOT CONTROLLED WITHIN DIM "F"

STYLE 1.
PIN 1. ANODE
2. CATHODE

DIM	MILLIMETERS MIN	MILLIMETERS MAX	INCHES MIN	INCHES MAX
A	8 38	8 89	0.330	0 350
B	3 30	3.68	0 130	0 145
D	0 94	1.09	0.037	0 043
F	–	1 27	–	0.050
K	25.40	31 75	1 000	1.250

CASE 17-02
PLASTIC

P6KE6.8, A thru P6KE200, A

ELECTRICAL CHARACTERISTIC (T_A = 25°C unless otherwise noted) V_F = 3.5 V max, I_F** = 50 A for all types

Device	Breakdown Voltage * V_{BR} (Volts) Min	Nom	Max	@ I_T (mA)	Working Peak Reverse Voltage V_{RWM} (Volts)	Maximum Reverse Leakage @ V_{RWM} I_R (μA)	Maximum Reverse Surge Current I_{RSM}† (Amps)	Maximum Reverse Voltage @ I_{RSM} (Clamping Voltage) V_{RSM} (Volts)	Maximum Temperature Coefficient of V_{BR} (%/°C)
P6KE6 8	6 12	6 8	7 48	10	5.50	1000	56	10.8	0.057
P6KE6 8A	6.45	6 8	7.14	10	5 80	1000	57	10.5	0 057
P6KE7 5	6.75	7 5	8 25	10	6.05	500	51	11 7	0 061
P6KE7 5A	7 13	7 5	7 88	10	6.40	500	53	11.3	0 061
P6KE8 2	7.38	8 2	9.02	10	6.63	200	48	12 5	0.065
P6KE8 2A	7.79	8 2	8.61	10	7 02	200	50	12 1	0 065
P6KE9 1	8.19	9 1	10 0	1 0	7 37	50	44	13.8	0 068
P6KE9 1A	8.65	9.1	9 55	1 0	7 78	50	45	13.4	0 068
P6KE10	9 00	10	11.0	1 0	8.10	10	40	15.0	0.073
P6KE10A	9.50	10	10 5	1 0	8 55	10	41	14.5	0 073
P6KE11	9 90	11	12 1	1 0	8.92	5 0	37	16 2	0 075
P6KE11A	10 5	11	11 6	1 0	9 40	5 0	38	15 6	0 075
P6KE12	10.8	12	13 2	1 0	9 72	5 0	35	17.3	0.078
P6KE12A	11.4	12	12 6	1 0	10 2	5 0	36	16 7	0 078
P6KE13	11.7	13	14 3	1 0	10 5	5 0	32	19 0	0 081
P6KE13A	12 4	13	13 7	1 0	11 1	5.0	33	18 2	0 081
P6KE15	13 5	15	16.5	1 0	12.1	5 0	27	22.0	0 084
P6KE15A	14 3	15	15 8	1 0	12.8	5 0	28	21 2	0 084
P6KE16	14 4	16	17 6	1 0	12 9	5 0	26	23 5	0 086
P6KE16A	15 2	16	16 8	1 0	13 6	5 0	27	22 5	0 086
P6KE18	16.2	18	19 8	1.0	14.5	5 0	23	26 5	0 088
P6KE18A	17 1	18	18.9	1 0	15 3	5 0	24	25 2	0 088
P6KE20	18 0	20	22 0	1 0	16 2	5 0	21	29 1	0 090
P6KE20A	19.0	20	21 0	1 0	17 1	5 0	22	27 7	0 090
P6KE22	19 8	22	24 2	1 0	17 8	5 0	19	31 9	0 092
P6KE22A	20 9	22	23 1	1 0	18 8	5 0	20	30 6	0 092
P6KE24	21 6	24	26 4	1 0	19 4	5 0	17	34 7	0 094
P6KE24A	22 8	24	25 2	1 0	20 5	5 0	18	33 2	0 094
P6KE27	24 3	27	29 7	1 0	21 8	5 0	15	39 1	0 096
P6KE27A	25 7	27	28 4	1 0	23 1	5 0	16	37 5	0 096
P6KE30	27 0	30	33 0	1 0	24 3	5 0	14	43 5	0 097
P6KE30A	28.5	30	31 5	1 0	25 6	5 0	14 4	41 4	0 097
P6KE33	29.7	33	36 3	1 0	26 8	5 0	12 6	47 7	0 098
P6KE33A	31 4	33	34 7	1 0	28 2	5 0	13 2	45 7	0 098
P6KE36	32 4	36	39 6	1 0	29 1	5 0	11 6	52 0	0 099
P6KE36A	34.2	36	37 8	1 0	30 8	5 0	12	49 9	0 099
P6KE39	35 1	39	42 9	1 0	31 6	5 0	10 6	56 4	0 100
P6KE39A	37 1	39	41 0	1 0	33 3	5 0	11 2	53 9	0 100
P6KE43	38 7	43	47 3	1 0	34 8	5 0	9 6	61 9	0 101
P6KE43A	40 9	43	45 2	1 0	36 8	5 0	10 1	59 3	0 101
P6KE47	42 3	47	51 7	1 0	38 1	5 0	8 9	67 8	0 101
P6KE47A	44 7	47	49 4	1 0	40.2	5 0	9 3	64.8	0 101
P6KE51	45.9	51	56 1	1 0	41 3	5 0	8 2	73 5	0 102
P6KE51A	48 5	51	53.6	1 0	43 6	5 0	8 6	70 1	0 102
P6KE56	50.4	56	61 6	1 0	45 4	5 0	7 4	80 5	0.103
P6KE56A	53 2	56	58 8	1.0	47.8	5.0	7 8	77.0	0 103
P6KE62	55 8	62	68.2	1 0	50 2	5.0	6 8	89 0	0 104
P6KE62A	58 9	62	65.1	1 0	53 0	5.0	7 1	85 0	0 104
P6KE68	61.2	68	74.8	1 0	55.1	5 0	6 1	98.0	0 104
P6KE68A	64 6	68	71.4	1.0	58.1	5 0	6 5	92.0	0.104
P6KE75	67.5	75	82.5	1 0	60.7	5 0	5 5	108 0	0 105
P6KE75A	71 3	75	78.8	1.0	64.1	5.0	5 8	103 0	0.105
P6KE82	73.8	82	90.2	1.0	66.4	5.0	5 1	118.0	0 105
P6KE82A	77.9	82	86.1	1.0	70.1	5.0	5 3	113 0	0.105
P6KE91	81.9	91	100.0	1.0	73.7	5.0	4 8	131.0	0.106
P6KE91A	86.5	91	95.50	1.0	77.8	5.0	4 8	125.0	0 106

ELECTRICAL CHARACTERISTICS (continued)

Device	Breakdown Voltage V_{BR} (Volts) Min	Nom	Max	@ I_T (mA)	Working Peak Reverse Voltage V_{RWM} (Volts)	Maximum Reverse Leakage @ V_{RWM} I_R (μA)	Maximum Reverse Surge Current I_{RSM}† (Amps)	Maximum Reverse Voltage @ I_{RSM} (Clamping Voltage) V_{RSM} (Volts)	Maximum Temperature Coefficient of V_{BR} (%/°C)
P6KE100	90.0	100	110 0	1 0	81 0	5 0	4 2	144.0	0.106
P6KE100A	95 0	100	105 0	1.0	85.5	5 0	4 4	137 0	0 106
P6KE110	99 0	110	121 0	1 0	89.2	5 0	3 8	158 0	0 107
P6KE110A	105.0	110	116.0	1 0	94.0	5 0	4 0	152 0	0 107
P6KE120	108 0	120	132 0	1 0	97 2	5 0	3 5	173 0	0 107
P6KE120A	114.0	120	126 0	1 0	102.0	5 0	3 6	165 0	0 107
P6KE130	117 0	130	143 0	1 0	105 0	5 0	3 2	187 0	0 107
P6KE130A	124 0	130	137 0	1 0	111.0	5 0	3 3	179 0	0 107
P6KE150	135 0	150	165 0	1 0	121 0	5 0	2 8	215 0	0 108
P6KE150A	143 0	150	158 0	1 0	128 0	5 0	2 9	207 0	0 108
P6KE160	144 0	160	176 0	1 0	130 0	5 0	2 6	230 0	0 108
P6KE160A	152 0	160	168 0	1 0	136 0	5 0	2 7	219 0	0 108
P6KE170	153.0	170	187 0	1 0	138 0	5 0	2 5	244 0	0 108
P6KE170A	162.0	170	179 0	1 0	145 0	5 0	2 6	234 0	0 108
P6KE180	162.0	180	198 0	1 0	146 0	5 0	2 3	258 0	0 108
P6KE180A	171 0	180	189 0	1 0	154 0	5 0	2 4	246 0	0 108
P6KE200	180 0	200	220 0	1 0	162 0	5 0	2 1	287 0	0 108
P6KE200A	190 0	200	210 0	1 0	171 0	5 0	2 2	274 0	0 108

†Surge Current Waveform per Figure 4 and Derate per Figure 2
**1/2 Square or Equivalent Sine Wave, PW = 8 3 ms, Duty Cycle = 4 Pulses per Minute maximum
*V_{BR} measured after I_T applied for 300 μs, I_T = Square Wave Pulse or equivalent.

FIGURE 1 – PULSE RATING CURVE

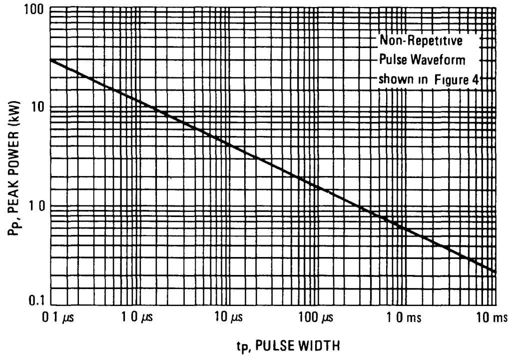


FIGURE 2 – PULSE DERATING CURVE

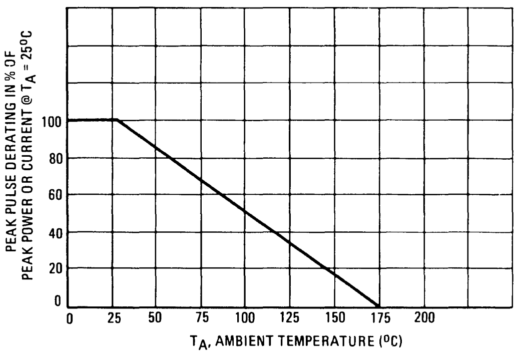


FIGURE 3 – CAPACITANCE versus BREAKDOWN VOLTAGE

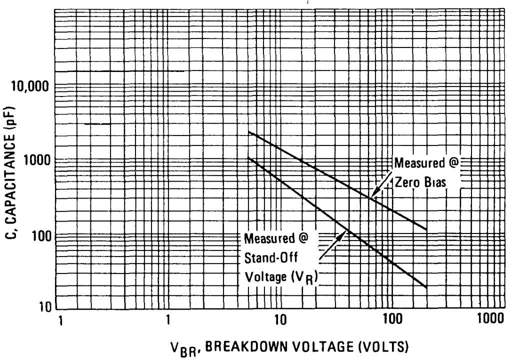


FIGURE 4 – PULSE WAVEFORM

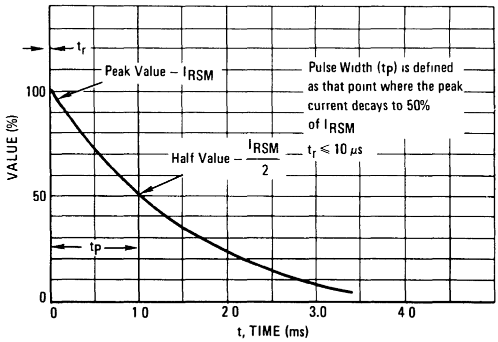
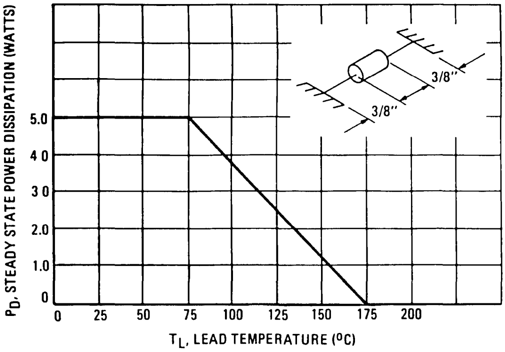


FIGURE 5 — STEADY STATE POWER DERATING



APPLICATION NOTES

SPECIAL DEVICES

Matched sets and back-to-back configurations for bidirectional applications can be ordered upon special request. Contact your nearest Motorola representative.

For a bidirectional device use a C or CA suffix (i.e. P6KE10CA). Electrical characteristics apply in both directions except for V_F. Available for all P/N's except P6KE6.8,A.

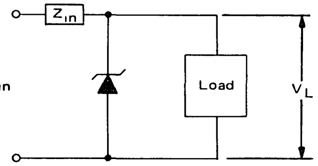
RESPONSE TIME

In most applications, the transient suppressor device is placed in parallel with the equipment or component to be protected. In this situation, there is a time delay associated with the capacitance of the device and an overshoot condition associated with the inductance of the device and the inductance of the connection method. The capactive affect is of minor importance in the parallel protection scheme because it only produces a time delay in the transition from the operating voltage to the clamp voltage as shown in Figure A.

The inductive affects in the device are due to actual turn-on time (time required for the device to go from zero current to full current) and lead inductance. This inductive affect produces an overshoot in the voltage across the equipment or component being protected as shown in Figure B. Minimizing this overshoot is very important in the application, since the main purpose for adding a transient suppressor is to clamp voltage spikes. The P6KE6.8 series has very good response time, typically < 1.0 ns and negligible inductance. However, external inductive affects could produce unacceptable overshoot. Proper circuit layout, minimum lead lengths and placing the suppressor device as close as possible to the equipment or components to be protected will minimize this overshoot.

Some input impedance represented by Z_{in} is essential to prevent overstress of the protection device. This impedance should be as high as possible, without restricting the circuit operation.

TYPICAL PROTECTION CIRCUIT



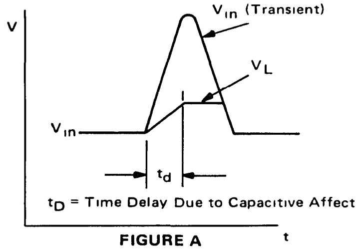


FIGURE A

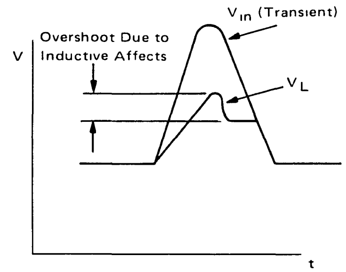


FIGURE B

4

Zener Overvoltage Transient Suppressor

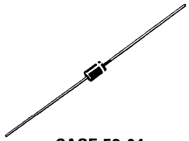
SA5.0 thru SA170A

MOSORB
ZENER OVERVOLTAGE TRANSIENT SUPPRESSORS
5–170 VOLT
500 WATT PEAK POWER
3 WATT STEADY STATE

The SA5.0 series is designed to protect voltage sensitive components from high voltage, high energy transients. They have excellent clamping capability, high surge capability, low zener impedance and fast response time. The SA5.0 series is supplied in Motorola's exclusive, cost-effective, highly reliable surmetic axial leaded package and is ideally-suited for use in communication systems, numerical controls, process controls, medical equipment, business machines, power supplies and many other industrial/consumer applications.

Specification Features

- Standard Zener Voltage Range — 5 to 170 V
- Peak Power — 500 Watts @ 1 ms
- Maximum Clamp Voltage @ Peak Pulse Current
- Low Leakage < 1 μA Above 8.5 Volts
- Maximum Temperature Coefficient Specified



CASE 59-04
PLASTIC

MAXIMUM RATINGS

Rating	Symbol	Value	Units
Peak Power Dissipation (1) @ $T_L \leq 25°C$	P_{PK}	500	Watts
Steady State Power Dissipation @ $T_L \leq 75°C$, Lead Length = 3/8" Derated above T_L = 75°C	P_D	3 30	Watts mW/°C
Forward Surge Current (2) @ T_A = 25°C	I_{FSM}	70	Amps
Operating and Storage Temperature Range	T_J, T_{stg}	−55 to +175	°C

Lead Temperature not less than 1/16" from the case for 10 seconds. 203°C

MECHANICAL CHARACTERISTICS

CASE: Void-free, transfer-molded, thermosetting plastic

FINISH: All external surfaces are corrosion resistant and leads are readily solderable and weldable

POLARITY: Cathode indicated by polarity band When operated in zener mode, will be positive with respect to anode

MOUNTING POSITION: Any

NOTES 1 Nonrepetitive Current Pulse per Figure 4 and Derated above T_A = 25°C per Figure 2
2 1/2 Square Wave (or equivalent), PW = 8 3 ms, Duty Cycle = 4 Pulses per Minute maximum

SA5.0 thru SA170A

ELECTRICAL CHARACTERISTICS (T_A = 25°C unless otherwise noted) V_F* = 3.5 V Max, I_F** = 35 A

Device	Breakdown Voltage V_{BR} (Volts) Min	Max	@ I_T (mA)	Working Peak Reverse Voltage V_{RWM}*** (Volts)	Maximum Reverse Leakage @ V_{RWM} I_R (μA)	Maximum Reverse Surge Current I_{RSM}† (Amps)	Maximum Reverse Voltage @ I_{RSM} (Clamping Voltage) V_{RSM} (Volts)	Maximum Voltage Temperature Variation of V_{BR} mV/°C
SA5.0	6.4	7.3	10	5	600	52	9.6	5
SA5.0A	6.4	7	10	5	600	54.3	9.2	5
SA6.0	6.67	8.15	10	6	600	43.9	11 4	5
SA6.0A	6.67	7.37	10	6	600	48 5	10.3	5
SA6.5	7.22	8.82	10	6.5	400	40.7	12.3	5
SA6.5A	7.22	7 98	10	6.5	400	44.7	11.2	5
SA7.0	7.78	9.51	10	7	150	37 8	13.3	6
SA7.0A	7.78	8.6	10	7	150	41.7	12	6
SA7.5	8.33	10.2	1	7.5	50	35	14.3	7
SA7.5A	8.33	9.21	1	7.5	50	38.8	12.9	7
SA8.0	8.89	10.9	1	8	25	33 3	15	7
SA8.0A	8.89	9.3	1	8	25	36 7	13.6	7
SA8.5	9.44	11.5	1	8.5	5	31 4	15.9	8
SA8.5A	9.44	10.4	1	8.5	5	34 7	14 4	8
SA9.0	10	12.2	1	9	1	29.5	16.9	9
SA9.0A	10	11.1	1	9	1	32.5	15.4	9
SA10	11.1	13.6	1	10	1	26.6	18.8	10
SA10A	11.1	12.3	1	10	1	29.4	17	10
SA11	12.2	14.9	1	11	1	24.9	20.1	11
SA11A	12.2	13.5	1	11	1	27 4	18.2	11
SA12	13.3	16 3	1	12	1	22.7	22	12
SA12A	13.3	14.7	1	12	1	25 1	19.9	12
SA13	14.4	17.6	1	13	1	21	23.8	13
SA13A	14.4	15.9	1	13	1	23.2	21.5	13
SA14	15.6	19.1	1	14	1	19.4	25 8	14
SA14A	15.6	17.2	1	14	1	21.5	23 2	14
SA15	16.7	20 4	1	15	1	18 8	26.9	16
SA15A	16.7	18.5	1	15	1	20 6	24.4	16
SA16	17 8	21.8	1	16	1	17.6	28.8	19
SA16A	17 8	19.7	1	16	1	19.2	26	17
SA17	18.9	23 1	1	17	1	16 4	30.5	20
SA17A	18.9	20.9	1	17	1	18 1	27.6	19
SA18	20	24.4	1	18	1	15 5	32.2	21
SA18A	20	22.1	1	18	1	17.2	29.2	20
SA20	22.2	27.1	1	20	1	13 9	35.8	25
SA20A	22.2	24.5	1	20	1	15 4	32.4	23
SA22	24.4	29.8	1	22	1	12.7	39 4	28
SA22A	24.4	26.9	1	22	1	14.1	35 5	25
SA24	26.7	32.6	1	24	1	11.6	43	31
SA24A	26.7	29 5	1	24	1	12 8	38.9	28
SA26	28 9	35.3	1	26	1	10.7	46 6	31
SA26A	28.9	31.9	1	26	1	11.9	42 1	30
SA28	31 1	38	1	28	1	9.9	50	35
SA28A	31 1	34.4	1	28	1	11	45 4	31
SA30	33.3	40.7	1	30	1	9.3	53.5	39
SA30A	33.3	36.8	1	30	1	10 3	48.4	36
SA33	36.7	44.9	1	33	1	8.5	59	42
SA33A	36.7	40.6	1	33	1	9 4	53 3	39
SA36	40	48.9	1	36	1	7 8	64.3	46
SA36A	40	44.2	1	36	1	8.6	58.1	41
SA40	44.4	54.3	1	40	1	7	71.4	51
SA40A	44.4	49.1	1	40	1	7 8	64.5	46

(continued)

ELECTRICAL CHARACTERISTICS (T_A = 25°C unless otherwise noted) V_F* = 3.5 V Max, I_F** = 35 A

Device	Breakdown Voltage V_{BR} (Volts) Min	Max	@ I_T (mA)	Working Peak Reverse Voltage V_{RWM}*** (Volts)	Maximum Reverse Leakage @ V_{RWM} I_R (μA)	Maximum Reverse Surge Current I_{RSM}† (Amps)	Maximum Reverse Voltage @ I_{RSM} (Clamping Voltage) V_{RSM} (Volts)	Maximum Voltage Temperature Variation of V_{BR} mV/°C
SA43	47.8	58.4	1	43	1	6.5	76.7	55
SA43A	47.8	52.8	1	43	1	7.2	69.4	50
SA45	50	61.1	1	45	1	6.2	80.3	58
SA45A	50	55.3	1	45	1	6.9	72.7	52
SA48	53.3	65.1	1	48	1	5.8	85.5	63
SA48A	53.3	58.9	1	48	1	6.5	77 4	56
SA51	56.7	69.3	1	51	1	5.5	91.1	66
SA51A	56.7	62.7	1	51	1	6.1	82.4	61
SA54	60	73.3	1	54	1	5.2	96.3	71
SA54A	60	66.3	1	54	1	5.7	87.1	65
SA58	64.4	78.7	1	58	1	4.9	103	78
SA58A	64.4	71.2	1	58	1	5.3	93.6	70
SA60	66.7	81.5	1	60	1	4.7	107	80
SA60A	66.7	73.7	1	60	1	5.2	96 8	71
SA64	71.1	86.9	1	64	1	4.4	114	86
SA64A	71.1	78.6	1	64	1	4.9	103	76
SA70	77.8	95.1	1	70	1	4	125	94
SA70A	77.8	86	1	70	1	4 4	113	85
SA75	83.3	102	1	75	1	3 7	134	101
SA75A	83.3	92.1	1	75	1	4.1	121	91
SA78	86.7	106	1	78	1	3 6	139	105
SA78A	86.7	95.8	1	78	1	4	126	95
SA85	94.4	115	1	85	1	3.3	151	114
SA85A	94.4	104	1	85	1	3.6	137	103
SA90	100	122	1	90	1	3.1	160	121
SA90A	100	111	1	90	1	3 4	146	110
SA100	111	136	1	100	1	2.8	179	135
SA100A	111	123	1	100	1	3.1	162	123
SA110	122	149	1	110	1	2.6	196	148
SA110A	122	135	1	110	1	2.8	177	133
SA120	133	163	1	120	1	2.3	214	162
SA120A	133	147	1	120	1	2	193	146
SA130	144	176	1	130	1	2 2	231	175
SA130A	144	159	1	130	1	2.4	209	158
SA150	167	204	1	150	1	1 9	268	203
SA150A	167	185	1	150	1	2.1	243	184
SA160	178	218	1	160	1	1.7	287	217
SA160A	178	197	1	160	1	1.9	259	196
SA170	189	231	1	170	1	1.6	304	230
SA170A	189	209	1	170	1	1 8	275	208

* V_F applies to non-C suffix devices only. C suffix denotes standard back-to-back versions. Test both polarities.
** 1/2 square or equivalent sine wave PW = 8 3 ms, duty cycle = 4 pulses per minute maximum.
*** MOSORB transient suppressors are normally selected according to the maximum reverse stand-off voltage (V_{RWM}), which should be equal to or greater than the dc or continuous peak operating voltage level.
† Surge current waveform per Figure 4 and derate per Figure 2.

To order clipper bidirectional device, add a "C" suffix to device title; i.e. SA7.5C or SA7.5CA.

4

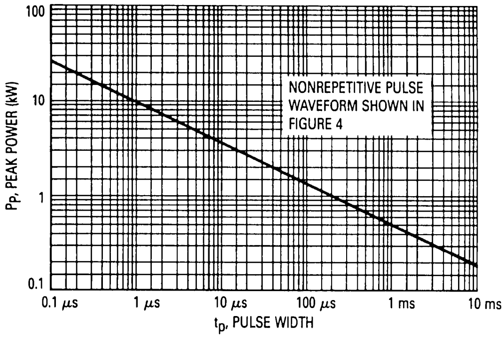


Figure 1. Pulse Rating Curve

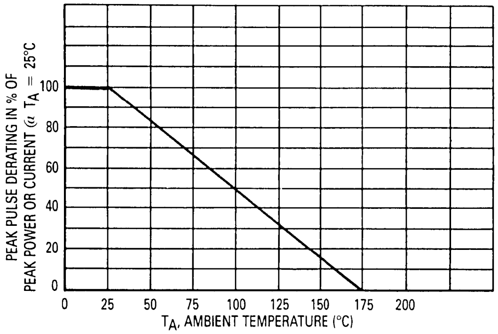


Figure 2. Pulse Derating Curve

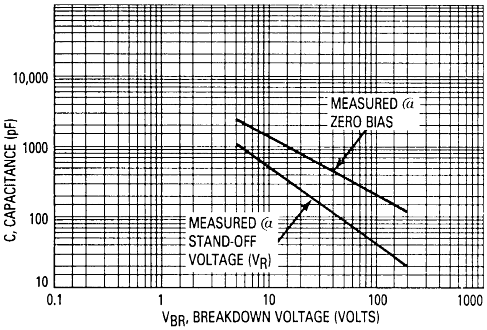


Figure 3. Capacitance versus Breakdown Voltage

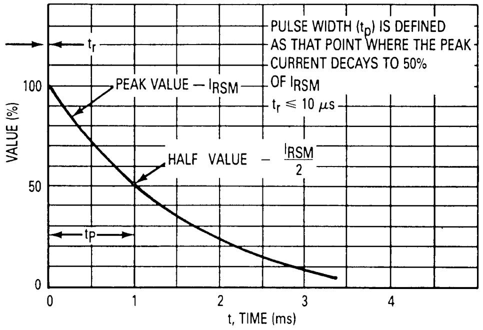


Figure 4. Pulse Waveform

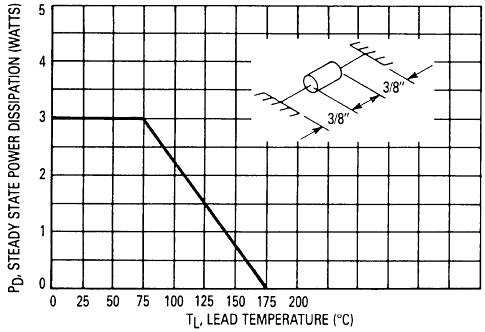


Figure 5. Steady State Power Derating

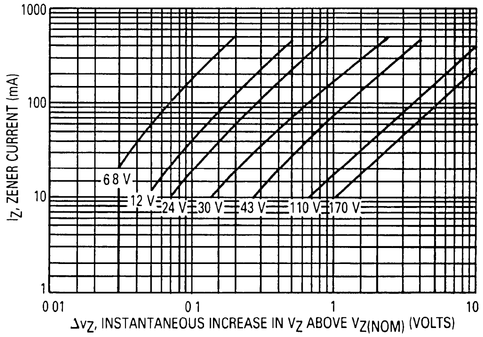


Figure 6. Dynamic Impedance

4

APPLICATION NOTES

SPECIAL DEVICES

Matched sets and back-to-back configurations for bidirectional applications can be ordered upon special request. Contact your nearest Motorola representative.

For a bidirectional device use a C or CA suffix. Electrical characteristics apply in both directions except for V_F.

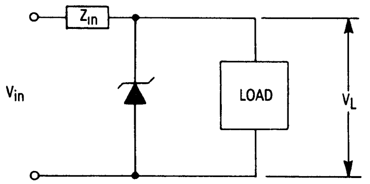
RESPONSE TIME

In most applications, the transient suppressor device is placed in parallel with the equipment or component to be protected. In this situation, there is a time delay associated with the capacitance of the device and an overshoot condition associated with the inductance of the device and the inductance of the connection method. The capacitive affect is of minor importance in the parallel protection scheme because it only produces a time delay in the transition from the operating voltage to the clamp voltage as shown in Figure 7.

The inductive affects in the device are due to actual turn-on time (time required for the device to go from zero current to full current) and lead inductance. This inductive affect produces an overshoot in the voltage across the equipment or component being protected as shown in Figure 8. Minimizing this overshoot is very important in the application, since the main purpose for adding a transient suppressor is to clamp voltage spikes. The SA5.0 series has very good response time, typically < 1 ns and negligible inductance. However, external inductive affects could produce unacceptable overshoot. Proper circuit layout, minimum lead lengths and placing the suppressor device as close as possible to the equipment or components to be protected will minimize this overshoot.

Some input impedance represented by Z_{in} is essential to prevent overstress of the protection device. This impedance should be as high as possible, without restricting the circuit operation.

TYPICAL PROTECTION CIRCUIT



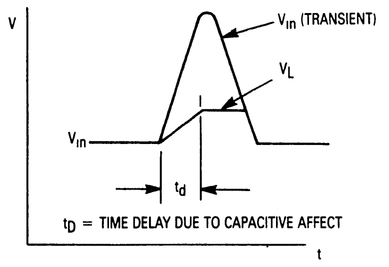


Figure 7

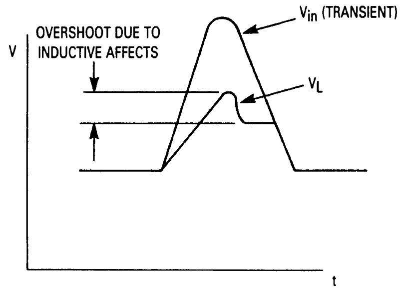


Figure 8

NOTES

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MOTOROLA

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