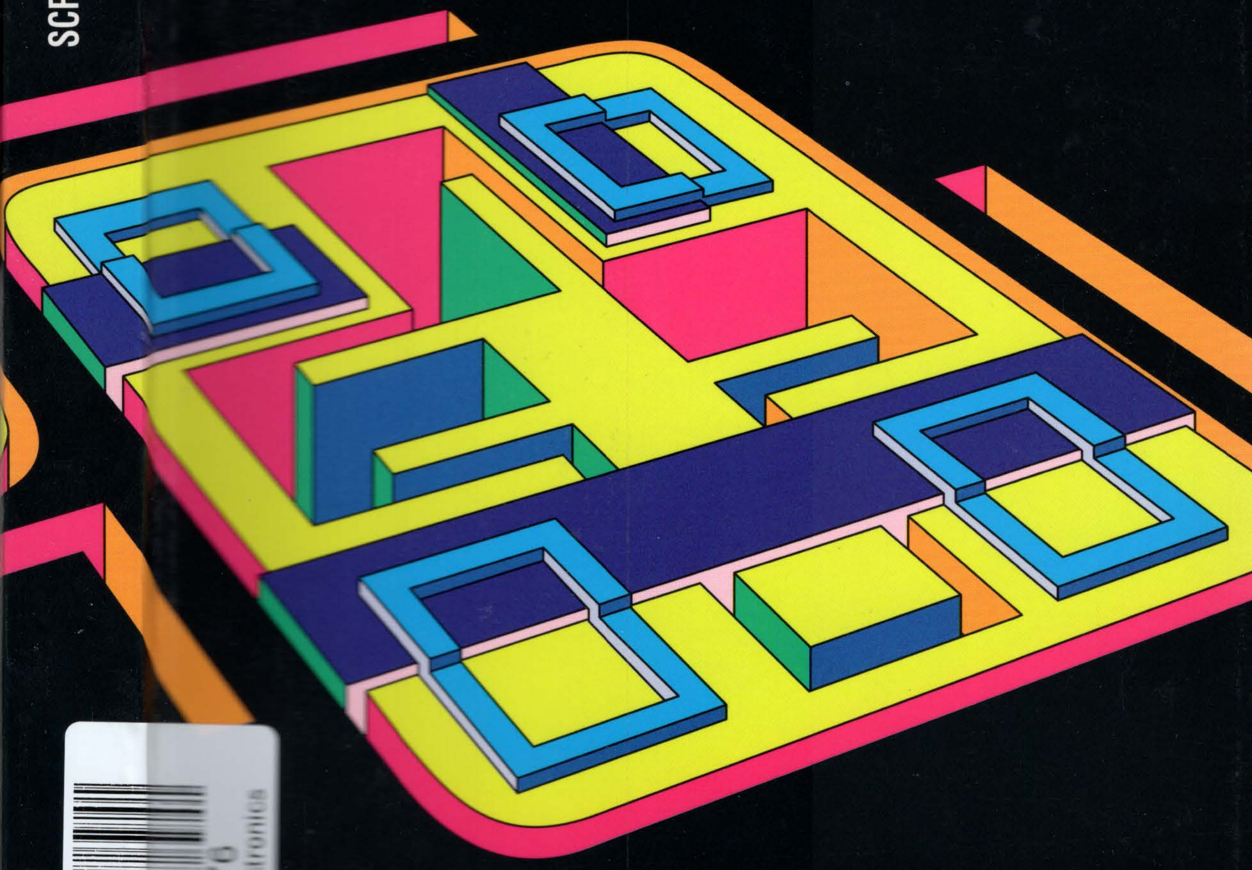
SCRs, TRIACs and AC switches

DATABOOK

4th EDITION



SCRs, TRIACs and AC switches 4th EDITION

SCRs, TRIACs and AC switches

DATABOOK

4^{th} EDITION

MARCH 2001

TABLE OF CONTENTS

ALPHANUMERICAL INDEX

ALPHANUMERICAL INDEX

LIST OF PARAMETERS

1. GENERAL COMMENTS

All datasheet parameters are rated as minimum or maximum values, corresponding to the product parameter distribution. In each datasheet, two classes of parameters are available:

- Absolute ratings, corresponding to critical parameters, not to be exceeded for safe operation. If the absolute rating is exceeded, the component may be destroyed.
- Electrical, thermal and static characteristics, defining limits on product characteristics.

2. PARAMETERS

ABSOLUTE RATINGS PARAMETERS

V_{DRM} / V_{RRM} V_{RM}	**Repetitive peak off-state voltage (50-60Hz).** This is the maximum peak voltage allowed across the device. This parameter is specified up to the maximum junction temperature and leakage currents I_{DRM} / I_{RRM} are specified under this value.
V_{DSM} / V_{RSM}	**Non-repetitive peak off-state voltage.** This is the maximum peak voltage allowed under pulse conditions across the device. It is specified for pulse duration lower or equal to 10ms.This parameter guarantees the ruggedness of the Triac in case of fast line transients exceeding the specified V_{DRM} / V_{RRM} value.
$I_{T(RMS)}$	**RMS on-state current.** This is the maximum RMS current allowed in the device for the specified case temperature (Tc) or lead temperature (Tl).
$I_{T(AV)}$	**Average on-state current (SCR only).** This is the maximum average current allowed in the SCR at the specified case temperature.
I_{TRM}	**Repetitive peak on-state current.** This is the maximum allowable repetitive peak current for a specified pulse duration at the specified case temperature and frequency.
I_{TSM} / I_{FSM}	**Non-repetitive surge peak on-state current.** This is the maximum peak current allowed in the device under pulse conditions. For Triacs, it is defined for a single full cycle sine wave of 20ms corresponding to the 50Hz mains, and 16.6ms for the 60Hz mains. If the absolute rating is exceeded, the component may be destroyed.
I^2t	**Value for fuse definition.** To protect the application, the I^2t rating of a fuse must be lower that the specified value which is equal to $\frac{I_{TSM}^2}{2} \times tp$.
dI/dt	**Critical repetitive rate of rise of on-state current.** During the turn-on operation, the maximum rate of rise of current must not exceed this maximum value. If the absolute rating is exceeded, the component may be destroyed.
I_{GM}	**Peak gate current.** This is the maximum peak current allowed between gate and cathode, defined for 20µs pulse duration.
T_{stg}, T_j	**Storage and operating junction temperature.** The storage temperature range is the range in which the device can be stored (shipping, handling, storage...), without working. The operating junction temperature range is the range in which the junction can work without damage.

ELECTRICAL CHARACTERISTICS PARAMETERS

I_{GT}	**Triggering gate current.** This is the minimum current that must be applied between gate and cathode (or gate and electrode A1 for Triac) to turn-on the device. This parameter defines the sensitivity of the component for existing quadrants.
V_{GT}	**Triggering gate voltage.** This is the minimum voltage that must be applied between gate and cathode (or gate and electrode A1 for Triac) to trigger the device.
V_{GD}	**Non-triggering gate voltage.** This is the maximum voltage which can be applied to the gate without causing undesired turn-on. This parameter is specified, for the worst case scenario, at the maximum junction temperature.
V_{RGM}	**Peak reverse gate voltage.** This parameter is only defined for SCRs. It is the maximum voltage that can be applied between gate and cathode in reverse mode without risk of destruction of the gate cathode junction.
V_{GM}	**Peak positive gate voltage (with respect to the pin «COM»).** This parameter is only defined for ACSs. It is the maximum voltage that can be applied between gate and COM without risk of destruction of the gate to the COM junction.
I_H	**Holding current.** This is the current level between Anode and Cathode (or A2 and A1 for a Triac) under which the device turns off, without a gate current.
I_L	**Latching current.** This is the minimum current level between Anode and Cathode (or A2 and A1 for a Triac) to keep the device conducting when the gate signal is removed.
dV/dt	**Critical rate of rise of off-state voltage.** This is the maximum value of the slope of the rising voltage that can be applied across a SCR or a Triac in the off-state without risking it turning on spuriously.
(dV/dt)c	**Critical rate of rise of commutating off-state voltage.** This is the maximum slope of the reapplied voltage during turn-off. Above this limit, the Triac continues conducting without a gate current.
(dI/dt)c	**Critical rate of decrease of commutating on-state current.** This is the maximum slope of the decreasing current to allow the Triac turn-off. Above this limit, the Triac remains conducting without a gate current. For standard, Logic Level Triacs and ACS™, (dI/dt)c is specified with a limited (dV/dt)c parameter. For Snubberless™ Triacs, this value is specified without it.
V_{TM}	**Peak on-state voltage drop.** This is the voltage across the device while it is on-state. It is specified at the peak current corresponding to the $I_{T(RMS)}$ current of the device.
V_{t0} / R_d	**Threshold voltage / Dynamic on-state resistance.** These two parameters are used to calculate the instantaneous voltage drop according to the relation $V_T = V_{t0} + R_d \times I_T$. This value is used to calculate the power dissipation: For SCR: $P = V_{to} \times I_{T(AV)} + R_d \times I_{T(RMS)}{}^2$ For Triac: $P = \frac{2 \cdot \sqrt{2}}{\Pi} \cdot V_{to} \cdot I_{T(RMS)} + R_d \times I_{T(RMS)}{}^2$
I_{DRM} / I_{RRM} / I_{RM}	**Maximum forward and reverse leakage current.** This is the current flowing through the device when it is in the blocking state, at the specified V_{DRM} or V_{RRM} values for Triacs or SCRs or V_R for diodes or diacs (for testing method, see appendix).

THERMAL RESISTANCE PARAMETERS

$R_{th(j\text{-}a)}$	**Junction to ambient thermal resistance.** This is the thermal resistance between junction and ambient, when the device is in use, without heatsink. For SMD packages, the copper surface under the tab is specified.
$R_{th(j\text{-}c)}$	**Junction to case thermal resistance.** This is the thermal resistance between junction and case; for Triacs, this value is specified for AC operations. For SCRs a DC value is specified.
$R_{th(j\text{-}l)}$	**Junction to lead thermal resistance.** This is the thermal resistance between junction and leads. It is given for small packages like the TO-92, with no other metallic case temperature reference.
$Z_{th(j\text{-}c)}$ / $Z_{th(j\text{-}a)}$	**Transient thermal impedance.** This is the value of the thermal resistance when the thermal equilibrium of the device is not reached. Curves provided in datasheets ($Z_{th(j\text{-}c)}$ and $Z_{th(j\text{-}a)}$) show the relative variation versus R_{th}.

OTHER PARAMETERS

t_r	**Rise time.** For a Diac, it is the time between 10 % and 90 % of the peak current generated when the component discharges a specifed capacitor into a specified load.
V_o	**Output voltage.** This is the voltage across a 20Ω resistor in series with the Diac, during the discharges of a specified capacitor.
ΔV	**Dynamic breakover voltage.** Dynamic variation of Diac voltage at triggering. It is the difference between the V_{BO} and the voltage at 10mA: $\Delta V = V_{BO} - V_{DIAC}(10mA)$
V_{CL}	**Clamping voltage:** This is the voltage level across its OUT and COM terminals, when the device enters in avalanche mode. It is defined only for ACS™ and ACST devices, which internally feature an overvoltage protection.
V_{BO}	**Breakover voltage.** This is the voltage measured between the terminals of a Diac or an ACS™ when the device switches on.
I_{BO}	**Breakover current.** This is current flowing in the breakdown mode of a Diac or an ACS™ when the device switches on.
αT	**Temperature coefficient.** This is the temperature coefficient of the breakover voltage. This parameter is generaly specified by a percentage.
V_F	**Peak forward voltage drop.** This is the voltage across a diode when the diode is conducting.

3. APPENDIX

Testing method for I_{DRM} / I_{RRM} is as follows:

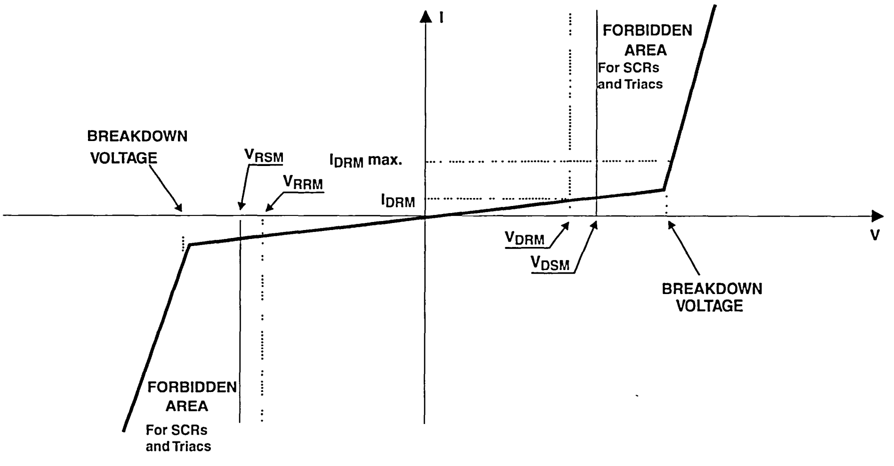
Apply the specified V_{DRM} or V_{RRM} voltage between anode and cathode

Read the leakage current :
it must be less than the maximum specification value (I_{DRM}/I_{RRM} max.).

Important: Do not use a current supply and apply the I_{DRM}/I_{RRM} max. between anode and cathode, and then measure the voltage.

In this case, the Triac or the SCR goes into breakdown voltage and may be destroyed.

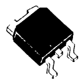
Note:
A voltage higher than the V_{DRM} / V_{RRM} rated values may be applied for less than 10 ms provided that it does not exceed the V_{DSM}/V_{RSM} specified in the datasheet.



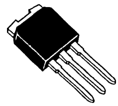
SELECTOR GUIDE

STANDARD SCRs

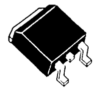
They are ideal for general purpose switching applications like battery voltage regulation, crowbar voltage protection in power supplies, speed motor control, welding equipment, ...



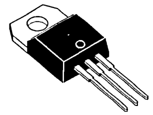
DPAK



IPAK

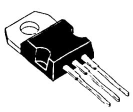


D^2PAK

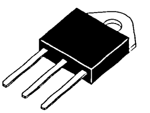


TO-220AB

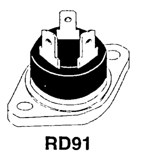
		8 Amps		12 Amps	
		DPAK / IPAK (B suffix) (H suffix)	TO-220AB	DPAK / IPAK / D PAK (B suffix) (H suffix) (G suffix)	TO-220AB
Voltage		**600 and 800 V**	**600 to 1000 V**	**600 to 1000 V**	**600 to 1000 V**
I_{GT} max	5 mA	TN805-xxxB/H			TYNx12T
	15 mA	TN815-xxxB/H	TYNx08	TN1215-xxxB/H/G	TYNx12
PAGE		77	77	83	83



TO-220AB



TOP3

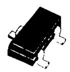


RD91

		16 Amps		25 Amps		40 Amps	
		D PAK	TO-220AB	D PAK	TO-220AB	TO-220AB	RD91 (BTW67) TOP3 Ins. (BTW69)
Voltage		**600 to 1000 V**	**600 to 1000 V**	**600 to 1000 V**	**600 to 1000 V**	**600 to 1000V**	**600 to 1200 V**
I_{GT} max	25 mA	TN1625-xxxG	TYNx16				
	35 mA					TYNx40	
	40 mA			TN2540-xxxG	TYNx25		
	80 mA						BTW67/ BTW69-xxx
PAGE		89	89	93	93	97	101

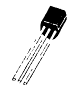
SENSITIVE SCRs

Easy to drive thanks to their very low gate current triggering, they are suitable for low power applications where low consumption is mandatory.



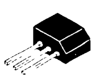
SOT-23

SOT-223

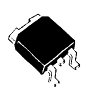


TO-92

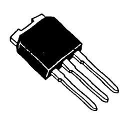
		0.2 Amp	0.8 Amp		1.25 Amp
		SOT-23	TO-92 / SOT-223 (A suffix) (N suffix)	TO-92	TO-92 / SOT-223 (A suffix) (N suffix)
Voltage		200 V	400 and 600V	600 V	600 and 800 V
I_{GT} min - max	200 μA	P0102BL	P0102xA/N	X00602MA	X0202xA/N
	0.5 - 5μA		P0118xA/N		
	4 - 25μA		P0111xA/N		
	20 - 50μA				X0205xA/N
PAGE		45	49	55	59



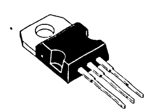
TO202-3



DPAK



IPAK

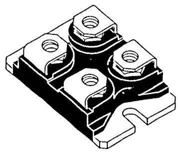


TO-220AB

		4 Amps		8 Amps	12 Amps
		TO202-3	DPAK / IPAK / TO-220AB (B suffix) (H suffix) (T suffix)	DPAK / IPAK / TO-220AB (B suffix) (H suffix) (T suffix)	DPAK / IPAK (B suffix) (H suffix)
Voltage		600 and 800 V	600 and 700 V	600 and 700 V	600 and 700 V
I_{GT} min - max	200 μA	X0402xF	TS420-xxxB/H/T	TS820-xxxB/H/T	TS1220-xxxB/H
	20 - 50μA	X0405xF			
PAGE		65	71	77	83

SCR MODULES

Specially developed for high power applications, ST SCR modules, available in half-bridge or back to back SCR configuration, provide high power drive capabilities in very compact space. Suitable for applications such as welding equipment, telecom base stations, thermal control, input bridge in power supplies, ... and general purpose industrial equipment.



ISOTOP™

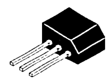
		BACK TO BACK SCR		SCR + DIODE MODULE		
		55 Amps	**70 Amps**	**50 Amps**	**70 Amps**	**85 Amps**
Voltage		**800 and 1200 V**	**800 and 1200 V**	**800 and 1200 V**	**800 and 1200 V**	**800 and 1200 V**
I_{GT} max	50 mA	MSS40-xxx	MSS50-xxx	MDS35-xxx	MDS50-xxx	
	150 mA					MDS80-xxx
PAGE		**105**	**105**	**109**	**109**	**109**

STANDARD TRIACS

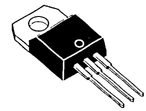
Ideal for general purpose switching applications, they are used as an ON/ OFF switch in applications such as washing machines, solid state relays, food processors, ... or as variable controllers such as light dimmers, variable speed fans, hand tools, ...

TO-92

SOT-223

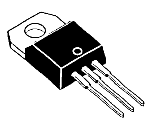


TO202-3



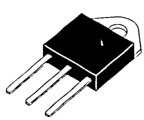
TO-220AB

		0.8 Amp	1 Amp	4 Amps	6 Amps
		TO-92	TO-92 / SOT-223 (A suffix) (N suffix)	TO202-3	TO-220AB Ins. (BTA) TO-220AB (BTB)
Voltage		600 V	600 to 800 V	600 to 800 V	600 and 800 V
I_{GT} (QI) max	3 mA		Z0103xA/N	Z0402xF	
	5 mA	Z00607MA	Z0107xA/N	Z0405xF	
	10 mA		Z0109xA/N	Z0409xF	
	25 mA		Z0110xA/N	Z0410xF	BTA/BTB06-xxxC
	50 mA				BTA/BTB06-xxxB
PAGE		117	121	127	139

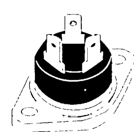


TO-220AB

		8 Amps	10 Amps	12 Amps	16 Amps
		TO-220AB Ins. (BTA) TO-220AB (BTB)	TO-220AB Ins. (BTA) TO-220AB (BTB)	TO-220AB Ins. (BTA) TO-220AB (BTB)	TO-220AB Ins. (BTA) TO-220AB (BTB)
Voltage		600 and 800V	600 and 800 V	600 and 800 V	600 and 800 V
I_{GT} (QI) max	25 mA	BTA/BTB08-xxxC	BTA/BTB10-xxxC	BTA/BTB12-xxxC	BTA/BTB16-xxxC
	50 mA	BTA/BTB08-xxxB	BTA/BTB10-xxxC	BTA/BTB12-xxxC	BTA/BTB16-xxxB
PAGE		145	151	157	169



TOP3

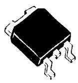


RD91

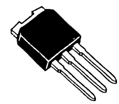
		25 Amps		40 Amps	
		RD91	TOP3	RD91	TOP3
Voltage		600 and 800 V	600 and 800 V	600 and 800 V	600 and 800 V
I_{GT} (QI) max	50 mA	BTA25-xxxB	BTA26-xxxB	BTA40-xxxB	BTA/BTB41-xxxB
PAGE		175	175	187	187

SNUBBERLESS™ & LOGIC LEVEL TRIACS (3 Quadrants)

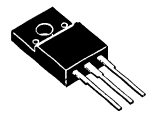
Thanks to their high switching performances while keeping low gate current drive, they are altogether recommended in highly inductive loads, like motor control, solid state relays, ... Logic level Triacs have been optimized in gate current triggering, and can be directly controlled via microprocessors.



DPAK

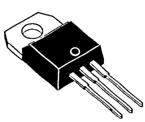


IPAK

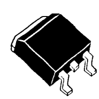


ISOWATT220AB

		4 Amps	6 Amps	8 Amps	
		DPAK / IPAK / TO-220AB (B suffix) (H suffix) (T suffix) ISOWATT220AB (W suffix)	TO-220AB Ins. (BTA) TO-220AB (BTB)	DPAK / IPAK (B suffix) (H suffix) D^2PAK (G suffix)	TO-220AB Ins. (BTA) TO-220AB (BTB)
Voltage		600 to 800V	600 and 800V	600 and 800V	600 and 800V
I_{GT} max (QI/QII/QIII)	5 mA	T405-xxxB/H/T/W	BTA/BTB06-xxxTW		BTA/BTB08-xxxTW
	10 mA	T410-xxxB/H/T/W	BTA/BTB06-xxxSW	T810-600B/H	BTA/BTB08-xxxSW
	35 mA	T435-xxxB/H/T/W	BTA/BTB06-xxxCW	T835-600B/H/G	BTA/BTB08-xxxCW
	50 mA		BTA/BTB06-xxxBW		BTA/BTB08-xxxBW
PAGE		133	139	145	145



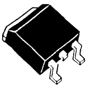
TO-220AB



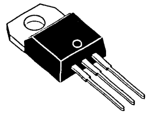
D^2PAK

		10 Amps	12 Amps	
		TO-220AB Ins. (BTA) TO-220AB (BTB)	TO-220AB Ins. (BTA) TO-220AB (BTB)	D^2PAK
Voltage		600 and 800V	600 and 800V	600 and 800V
I_{GT} max (QI/QII/QIII)	10 mA		BTA/BTB12-xxxSW	
	35 mA	BTA/BTB10-xxxCW	BTA/BTB12-xxxCW	T1235-xxxG
	50 mA	BTA/BTB10-xxxBW	BTA/BTB12-xxxBW	
PAGE		151	157	157

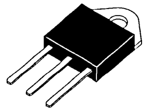
SNUBBERLESS™ & LOGIC LEVEL TRIACS (3 Quadrants) (continued)



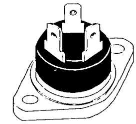
D²PAK



TO-220AB



TOP3

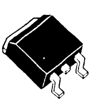


RD91

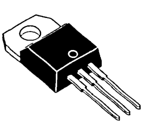
		16 Amps		25 Amps		
		TO-220AB Ins. (BTA) TO-220AB (BTB)	D²PAK	TO-220AB Ins. (BTA) TO-220AB (BTB)	RD91 (BTA25) TOP3 (BTA26)	D²PAK
Voltage		600 and 800V	600 and 800V	600 and 800V	600 and 800V	600 and 800V
I_{GT} max (QI/QII/QIII)	10 mA	BTA/BTB16-xxxSW				
	35 mA	BTA/BTB16-xxxCW	T1635-xxxG	BTA/BTB24-xxxCW	BTA25/26-xxxCW	T2535-xxxG
	50 mA	BTA/BTB16-xxxBW		BTA/BTB24-xxxBW	BTA25/26-xxxBW	
PAGE		169	169	175	175	175

HIGH TEMPERATURE TRIACS

Specially designed to work in high temperature environments (found in hot appliances such as cookers, ovens, hobs, electric heaters, coffee machines....), the "High Temperature" triacs from ST provide enhanced performances in terms of power losses and thermal dissipation. This allows optimization of the heastink dimensioning, leading to space and cost effectivness in comparison with electromechanical relays.



D²PAK



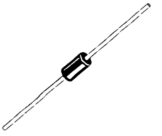
TO-220AB

		12 Amps	25 Amps
		TO-220AB / D²PAK (T suffix) (G suffix)	TO-220AB
Voltage		600 V	600 V
I_{GT} max (QI/QII/QIII)	35 mA	T1235H-600T/G	
	50 mA		T2550H-600T
PAGE		163	181

DIACS

Used as a trigger diode with a fixed voltage reference, they are mainly used in conjunction with triacs for phase control operation (light dimmers, speed motor control), or in starter circuits for fluorescent lamp ballasts.

SOT-23



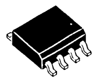
DO-35

	DO-35 / SOT-23	DO-35
Breakover voltage	**32 V**	**40 V**
28 - 36V	DB3 / SMDB3	
35 - 45V		DB4
PAGE	**195**	**195**

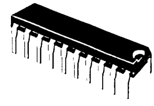
AC SWITCHES

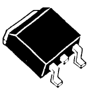
The ACS™ series is a new generation of switches specifically developed for home appliances and industrial processing applications. Thanks to their embedded overvoltage protection and integrated level shifter, they do not require external voltage protection such as MOV. They provide a high reliability level to sustain safely AC transients (like those defined in IEC61000 standards), they have superior performances in noise immunity thanks to ultra high dV/dt, and are easy to drive directly from microprocessors.

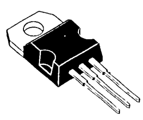

TO-92

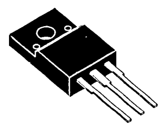

SO-8


SOT-223


DIP-20


D^{2}PAK

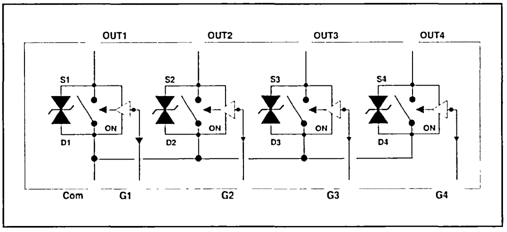

TO-220AB


TO-220FPAB

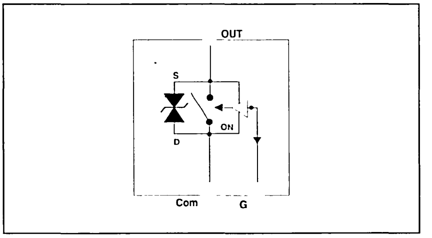
		0.2 Amp	0.8 Amp	4 x 0.2 Amps
		TO-92 / SO-8 (A suffix) (1 suffix)	TO-92 / SOT-223 (A suffix) (N suffix)	DIP-20
Stand-off voltage		**500 V**	**500 V**	**500 V**
I_{GT} max	5 mA	ACS102-5TA/1		
	10 mA		ACS108-5SA/N	ACS402-5SB4
PAGE		**201**	**209**	**217**

		6 Amps	8 Amps
		TO-220AB / D^{2}PAK / Full Pack (T suffix) (G suffix) (FP suffix)	Full Pack
Stand-off voltage		**700 V**	**800 V**
I_{GT} max	10 mA	ACST6-7ST/G/FP	
	30 mA		ACST8-8CFP
PAGE		**225**	**233**

ACS402: High voltage quad ACS™ array for low power loads in appliance systems.



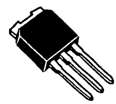
ACS108: High voltage ACS™ device for medium power loads in appliance systems.



IGNITORS: FIRE LIGHTER CIRCUITS (FLC)

Fire Lighter Circuits have been developed to fit systems based on spark generation through capacitive discharge mode. They provide high pulse and high noise immunity levels, in a fully integrated solution. Major applications are furnaces, boilers, fuel control ignition, gas ranges, ...

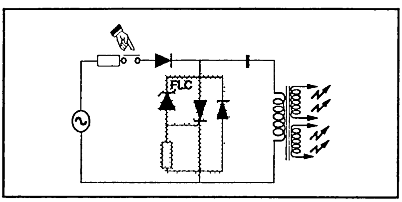
TO-92



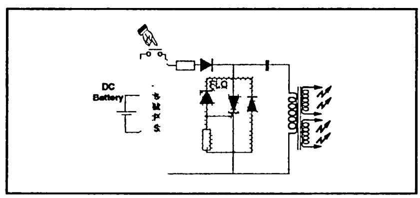
IPAK

	Low power	Medium power	High power
Breakover voltage	TO-92	IPAK	IPAK
70 - 80 V	FLC21-65A		
140 - 160 V	FLC21-135A		
206 - 233 V		FLC01-200H	FLC10-200H
PAGE			

AC Operation

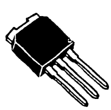


DC Battery Operation

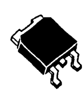


IGNITORS: STARTLIGHT (TN22)

The TN22 series has been specifically developed for use in electronic starter circuits. Use in conjunction with a sensitive SCR and a resistor, it provides high energy striking characteristics with low triggering power. Thanks to its electronic concept, this TN22 based starter offers high reliability levels and extended life time of the fluorenscent tubelamps.



IPAK

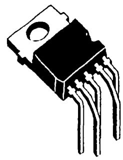


DPAK

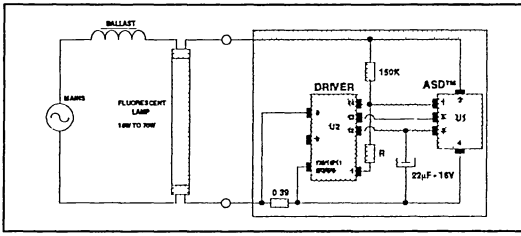
	IPAK	DPAK
Breakover voltage		
1200 - 1500 V	TN22-1500H	TN22-1500B
PAGE		

IGNITORS: ELECTRONIC FLUORESCENT STARTERS (EFS)

Consisting of a driver IC and an ASD™ power switch, the EFS kit has been developed for fluorescent tube starters. It provides, in a limited space, smooth and flicker-free starting, extended life-time for the tube lamp and automatic shutdown in case of tube failure....



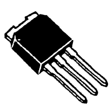
PENTAWATT HV



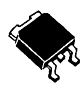
	50 Hz operation	50 / 60 Hz operation
	Pentawatt + SO-14	**Pentawatt + SO-14**
Driver	EFS2A-CD	EFS2B-CD
ASD (Power circuit)	EFS21-TL5	EFS21-TL5
PAGE		

IGNITORS: LIGHT IGNITION CIRCUITS (LIC)

Developed for high intensity discharge lamps supplied by magnetic ballasts, the LIC devices provide a high pulse current capability and a low holding current, to secure lamp ignition with multi pulse striking. Compared with conventional solutions, they offer a high reliability level and space saving, as a stand-alone circuit.

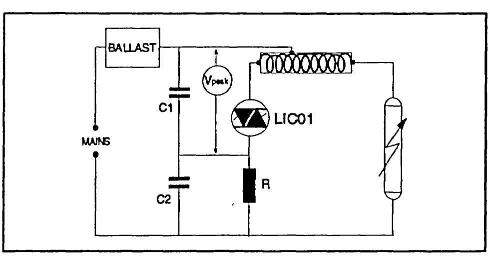


IPAK



DPAK

	IPAK	IPAK / DPAK
Breakover voltage		
195 - 230 V	LIC01-195H	
215 - 255 V		LIC01-215/H/B
PAGE		



CROSS REFERENCES

Industry Standard	ST Equivalent	ST Nearest Replacement
03P2M	X00602MA	
03P4M	X00602MA	
03P4MF	P0111DA	
03P4MG	P0111DA	
03P6MG	X0205MA	
2N5060	X00602MA	
2N5060	X00602MA	
2N5061	X00602MA	
2N5061	X00602MA	
2N5062	X00602MA	
2N5062	X00602MA	
2N5063	X00602MA	
2N5064	X00602MA	
2N5064	X00602MA	
2N5064	X00602MA	
2N6071	T435-400D	
2N6071A	T405-600H	
2N6071B	T405-600H	
2N6073	T435-400H	
2N6073A	T405-600H	
2N6073B	T405-600H	
2N6075	T435-600H	
2N6075A	T405-600H	
2N6075B		T405-600H
2N6342	BTB08-600BW	
2N6343	BTB08-600BW	
2N6344	BTB08-600BW	
2N6344A	BTB08-600B	
2N6345	BTB10-800BW	
2N6346	BTB08-600B	
2N6346A	BTB12-600B	
2N6347	BTB08-600B	
2N6347A	BTB12-600B	
2N6348	BTB08-600B	
2N6348A	BTB12-600B	
2N6349		BTB10-800B
2N6349A	BTB12-800B	
2N6394	TYN612	
2N6395	TYN612	
2N6396	TYN612	
2N6397	TYN612	
2N6398	TYN612	
2N6399	TYN812	
2N6400	TYN616	
2N6401	TYN616	
2N6402	TYN616	
2N6403	TYN616	
2N6404	TYN616	
2N6405	TYN816	
2N6504	TYN625	

Industry Standard	ST Equivalent	ST Nearest Replacement
2N6505	TYN625	
2N6506	TYN625	
2N6507	TYN625	
2N6508	TYN625	
2N6509	TYN825	
2N6564	X00602MA	
2N6565	X00602MA	
2P4M	X0402MF	
2P4M	X0402MF	
2P5M	X0402MF	
2P5M	X0402MF	
2P6M	X0402MF	
2P6M	X0402MF	
2S2M	X0402MF	
2S4M	X0402MF	
2S4M	X0402MF	
2V5P4M	X0405MF	
2V5P4M	X0405MF	
3P4J-Z	TS420-600B	
3P4MH		X0402MF
3P4MH		X0402MF
3P5MH		X0402MF
3P5MH		X0402MF
3P6MH		X0402MF
3P6MH		X0402MF
5P4J-Z	TS820-600B	
5P4M	TYN608	
5P5M	TYN608	
5P6J-Z	TS820-600B	
5P6M	TYN608	
8P2M	TYN412	
8P4J-Z	TN1215-600B	
8P4M	TYN612	
AC01DGM	Z0103MA	
AC01DJM	Z0107MN	
AC03DGM	Z0409MF	
AC03DJM	T405-700H	
AC03DJM-Z	T410-600B	
AC03DSM	T410-600W	
AC03DSMA	T410-600W	
AC03FGM	Z0409MF	
AC03FJM	T405-700H	
AC03FJM-Z	T410-600B	
AC03FSM	T410-600W	
AC03FSMA	T410-600W	
AC05DGM	BTB06-600SW	
AC05EGM	BTB06-600SW	
AC05FGM	BTB06-600SW	
AC08DGM	BTB08-600SW	
AC08EGM	BTB08-600SW	

Industry Standard	ST Equivalent	ST Nearest Replacement
AC08FGM	BTB08-600SW	
AC08FSM	T820-600W	
AC0V8DGM	Z00607MA	
AC10DGM		BTB10-600CW
AC10EGM		BTB10-600CW
AC10FGM		BTB10-600CW
AC12DGM	BTB12-600SW	
AC12EGM	BTB12-600SW	
AC12FGM	BTB12-600SW	
AC16DGM	BTB16-600CW	
AC16EGM	BTB16-600CW	
AC16FGM	BTB16-600CW	
BCR10CM-12	BTB10-600CW	
BCR10CM-8	BTB10-600CW	
BCR10CS-12	T1235-600G	
BCR10CS-8	T1235-600G	
BCR10DM-12	BTA10-600CW	
BCR10DM-8	BTA10-600CW	
BCR10UM-12	BTA10-600CW	
BCR10UM-8	BTA10-600CW	
BCR12CM-12	BTB12-600CW	
BCR12CM-8	BTB12-600CW	
BCR12CS-12	T1235-600G	
BCR12CS-8	T1235-600G	
BCR12DM-12	BTA12-600CW	
BCR12DM-8	BTA12-600CW	
BCR12UM-12	BTA12-600SW	
BCR12UM-8	BTA12-600SW	
BCR16CM-12	BTB16-600CW	
BCR16CM-8	BTB16-600CW	
BCR16CS-12	T1635-600G	
BCR16CS-8	T1635-600G	
BCR16DM-12	BTA16-600CW	
BCR16DM-8	BTA16-600CW	
BCR16UM-12	BTA16-600SW	
BCR16UM-8	BTA16-600SW	
BCR1AM-12	Z0107MA	
BCR1AM-8	Z0107MA	
BCR30AM-12		BTB41-600B
BCR30AM-8		BTB41-600B
BCR3AM-12		Z0410MF
BCR3AM-8		Z0410MF
BCR3AS12	T410-600B	
BCR3AS8	T410-600B	
BCR3KM-12	T410-600W	
BCR3KM-14	T410-700W	
BCR3KM-8	T410-600W	
BCR3PM-12	T435-600B	
BCR3PM-8	T435-600B	
BCR4AM-12	T410-600T	

Industry Standard	ST Equivalent	ST Nearest Replacement
BCR4AM-8	T410-600T	
BCR4PM-12	T410-600W	
BCR4PM-8	T410-600W	
BCR5A1S-12	T405-700H	
BCR5A1S-8	T405-700H	
BCR5AM-12	BTB06-600SW	
BCR5AM-8	BTB06-600SW	
BCR5AS-12	T410-600B	
BCR5AS-8	T410-600B	
BCR5DM-12	BTA06-600SW	
BCR5DM-8	BTA06-600SW	
BCR6AM-12	BTB06-600CW	
BCR6AM-8	BTB06-600CW	
BCR8CM-12	BTB08-600CW	
BCR8CM-8	BTB08-600CW	
BCR8CS-12	T1235-600G	
BCR8CS-8	T1235-600G	
BCR8DM-12	BTA08-600CW	
BCR8DM-8	BTA08-600CW	
BCR8UM-12	BTA08-600SW	
BCR8UM-8	BTA08-600SW	
BR100/03	DB3	
BT131-500	Z0103MA	
BT131-600	Z0103MA	
BT132-500D	Z0107MA	
BT132-600D	Z0107MA	
BT134-500		Z0410MF
BT134-500D		Z0405MF
BT134-500E		Z0409MF
BT134-500F		Z0410MF
BT134-500G		Z0410MF
BT134-600		Z0410MF
BT134-600D		Z0405MF
BT134-600E		Z0409MF
BT134-600F		Z0410MF
BT134-600G		Z0410MF
BT134-800		Z0410NF
BT134-800E		Z0409NF
BT134-800F		Z0410NF
BT134-800G		Z0410NF
BT134W-500	Z0110MN	
BT134W-500D	Z0107MN	
BT134W-500E	Z0109MN	
BT134W-500F	Z0110MN	
BT134W-500G	Z0110MN	
BT134W-600	Z0110MN	
BT134W-600D	Z0107MN	
BT134W-600E	Z0109MN	
BT134W-600F	Z0110MN	
BT134W-600G	Z0110MN	

Industry Standard	ST Equivalent	ST Nearest Replacement
BT136-500	T435-600T	
BT136-500D	T405-600T	
BT136-500E	T410-600T	
BT136-500F	T410-600T	
BT136-500G	T435-600T	
BT136-600	T435-600T	
BT136-600D	T435-600T	
BT136-600E	T405-600T	
BT136-600F	T410-600T	
BT136-600G	T435-600T	
BT136-800	T435-800T	
BT136-800E	T410-800T	
BT136-800F	T410-800T	
BT136-800G	T435-800T	
BT136B-500	T435-600B	
BT136B-500D	T405-600B	
BT136B-500E	T410-600B	
BT136B-500F	T410-600B	
BT136B-500G	T435-600B	
BT136B-600	T435-600B	
BT136B-600D	T405-600B	
BT136B-600E	T410-600B	
BT136B-600F	T410-600B	
BT136B-600G	T435-600B	
BT136B-800		T435-700B
BT136B-800E	T410-800B	
BT136B-800F	T410-800B	
BT136B-800G	T435-700B	
BT136M-500	T435-600B	
BT136M-500D	T405-600B	
BT136M-500E	T410-600B	
BT136M-500F	T410-600B	
BT136M-500G	T435-600B	
BT136M-600	T435-600B	
BT136M-600D	T405-600B	
BT136M-600E	T410-600B	
BT136M-600F	T410-600B	
BT136M-600G	T435-600B	
BT136M-800		T435-700B
BT136M-800E	T410-800B	
BT136M-800F	T410-800B	
BT136M-800G		T435-700B
BT136S-500	T435-600B	
BT136S-500D	T405-600B	
BT136S-500E	T410-600B	
BT136S-500F	T410-600B	
BT136S-500G	T435-600B	
BT136S-600	T435-600B	
BT136S-600D	T405-600B	
BT136S-600E	T410-600B	

Industry Standard	ST Equivalent	ST Nearest Replacement
BT136S-600F	T410-600B	
BT136S-600G	T435-600B	
BT136S-800		T435-700B
BT136S-800G		T435-700B
BT136X-500	T435-600W	
BT136X-500D	T405-600W	
BT136X-500E	T410-600W	
BT136X-500F	T410-600W	
BT136X-500G	T435-600W	
BT136X-600	T435-600W	
BT136X-600D	T405-600W	
BT136X-600E	T410-600W	
BT136X-600F	T410-600W	
BT136X-600G	T435-600W	
BT136X-800	T435-600W	
BT136X-800E	T410-800W	
BT136X-800F	T410-800W	
BT136X-800G	T435-600W	
BT137-500	BTB08-600C	
BT137-500D		BTB08-600SW
BT137-500E		BTB08-600SW
BT137-500F	BTB08-600C	
BT137-500G	BTB08-600B	
BT137-600	BTB08-600C	
BT137-600D		BTB08-600SW
BT137-600E		BTB08-600SW
BT137-600F	BTB08-600C	
BT137-600G	BTB08-600B	
BT137-800	BTB08-800C	
BT137-800E		BTB08-800SW
BT137-800F	BTB08-800C	
BT137-800G		BTB10-800B
BT137B-500	T835-600G	
BT137B-500E		T835-600G
BT137B-500F		T835-600G
BT137B-500G	T835-600G	
BT137B-600	T835-600G	
BT137B-600E		T835-600G
BT137B-600F		T835-600G
BT137B-600G	T835-600G	
BT137M-500		T835-600B
BT137M-500D		T810-600B
BT137M-500E		T810-600B
BT137M-500F		T810-600B
BT137M-500G		T835-600B
BT137M-600		T835-600B
BT137M-600D		T810-600B
BT137M-600E		T810-600B
BT137M-600F		T810-600B
BT137M-600G		T835-600B

Industry Standard	ST Equivalent	ST Nearest Replacement
BT137S-500	T835-600B	
BT137S-500D		T810-600B
BT137S-500E	T810-600B	
BT137S-500F	T810-600B	
BT137S-500G	T835-600B	
BT137S-600	T835-600B	
BT137S-600D		T810-600B
BT137S-600E	T810-600B	
BT137S-600F	T810-600B	
BT137S-600G	T835-600B	
BT137X-500		BTA08-600B
BT137X-500D		BTA08-600SW
BT137X-500E		BTA08-600SW
BT137X-500F		BTA08-600C
BT137X-500G		BTA08-600B
BT137X-600		BTA08-600B
BT137X-600D		BTA08-600SW
BT137X-600E		BTA08-600SW
BT137X-600F		BTA08-600C
BT137X-600G		BTA08-600B
BT137X-800		BTA08-800B
BT137X-800F		BTA08-800C
BT137X-800G		BTA08-800B
BT138-500	BTB12-600B	
BT138-500E		BTB12-600SW
BT138-500F	BTB12-600C	
BT138-500G	BTB12-600B	
BT138-600	BTB12-600B	
BT138-600E		BTB12-600SW
BT138-600F	BTB12-600C	
BT138-600G	BTB12-600B	
BT138-800	BTB12-800B	
BT138-800E		BTB12-800SW
BT138-800F		BTB12-800B
BT138-800G	BTB12-800B	
BT138B-500	T1235-600G	
BT138B-500E		T1235-600G
BT138B-500F		T1235-600G
BT138B-500G	T1235-600G	
BT138B-600	T1235-600G	
BT138B-600E		T1235-600G
BT138B-600F		T1235-600G
BT138B-600G	T1235-600G	
BT138F-500		BTA12-600BW
BT138F-500E		BTA12-600CW
BT138F-500F		BTA12-600CW
BT138F-500G		BTA12-600BW
BT138F-600		BTA12-600BW
BT138F-600E		BTA12-600CW
BT138F-600F		BTA12-600CW

Industry Standard	ST Equivalent	ST Nearest Replacement
BT138F-600G		BTA12-600BW
BT138F-700		BTA12-800BW
BT138F-700E		BTA12-800BW
BT138F-700F		BTA12-800CW
BT138F-700G		BTA12-800BW
BT138F-800		BTA12-800CW
BT138F-800E		BTA12-800CW
BT138F-800F		BTA12-800CW
BT138F-800G		BTA12-800BW
BT138X-500		BTA12-600B
BT138X-500E		BTA12-600C
BT138X-500F		BTA12-600C
BT138X-500G		BTA12-600B
BT138X-600		BTA12-600B
BT138X-600E		BTA12-600C
BT138X-600F		BTA12-600C
BT138X-600G		BTA12-600B
BT138X-800		BTA12-800B
BT138X-800E		BTA12-800B
BT138X-800F		BTA12-800B
BT138X-800G		BTA12-800B
BT139-500	BTB16-600B	
BT139-500E		BTB16-600SW
BT139-500F	BTB16-600C	
BT139-500G	BTB16-600B	
BT139-500H		BTB16-600B
BT139-600	BTB16-600B	
BT139-600E		BTB16-600SW
BT139-600F	BTB16-600C	
BT139-600G	BTB16-600B	
BT139-600H		BTB16-600B
BT139-800	BTB16-800B	
BT139-800F		BTB16-800C
BT139-800G	BTB16-800B	
BT139-800H		BTB16-800B
BT139B-500	T1635-600G	
BT139B-500E		T1635-600G
BT139B-500F		T1635-600G
BT139B-500G	T1635-600G	
BT139B-500H		T1635-600G
BT139B-600	T1635-600G	
BT139B-600E		T1635-600G
BT139B-600F		T1635-600G
BT139B-600G	T1635-600G	
BT139B-600H		T1635-600G
BT139F-500		BTA16-600BW
BT139F-500E		BTA16-600SW
BT139F-500F		BTA16-600SW
BT139F-500G		BTA16-600BW
BT139F-500H		BTA16-600BW

Industry Standard	ST Equivalent	ST Nearest Replacement
BT139F-600		BTA16-600BW
BT139F-600E		BTA16-600SW
BT139F-600F		BTA16-600SW
BT139F-600G		BTA16-600BW
BT139F-600H		BTA16-600BW
BT139F-700		BTA16-600BW
BT139F-700E		BTA16-800SW
BT139F-700F		BTA16-800SW
BT139F-700G		BTA16-800CW
BT139F-700H		BTA16-800CW
BT139F-800		BTA16-800CW
BT139F-800E		BTA16-800CW
BT139F-800F		BTA16-800CW
BT139F-800G		BTA16-800BW
BT139F-800H		BTA16-800BW
BT139X-500		BTA16-600B
BT139X-500E		BTA16-600SW
BT139X-500F		BTA16-600C
BT139X-500G		BTA16-600B
BT139X-500H		BTA16-600B
BT139X-600		BTA16-600B
BT139X-600E		BTA16-600SW
BT139X-600F		BTA16-600C
BT139X-600G		BTA16-600B
BT139X-600H		BTA16-600B
BT139X-800		BTA16-800B
BT139X-800E		BTA16-800SW
BT139X-800F		BTA16-800CW
BT139X-800G		BTA16-800B
BT139X-800H		BTA16-800B
BT145-500R	TYN625	
BT145-600R	TYN625	
BT145-800R	TYN825	
BT148-400R		X0402MF
BT148-500R		X0402MF
BT148-600R		X0402MF
BT148MZ-600R	TS420-600B	
BT148SZ-600R	TS420-600B	
BT148W-400	X0202MN	
BT148W-500	X0202MN	
BT148W-600	X0202MN	
BT149-B	X00602MA	
BT149-D	X00602MA	
BT149-E	X00602MA	
BT149-G	X00602MA	
BT150-500R	TS420-600T	
BT150-600R	TS420-600T	
BT150M-500R		TS420-600B
BT150M-600R		TS420-600B
BT150S-500R	TS420-600B	
BT150S-600R	TS420-600B	
BT151-500R	TYN612	
BT151-650R	TYN812	
BT151-800R	TYN812	
BT151B-500R	TN1215-600G	
BT151B-600R	TN1215-600B	
BT151M-500R		TN1215-600B
BT151M-600R		TN1215-600B
BT151S-500R	TN1215-600B	
BT151S-600R	TN1215-600B	
BT152-400R	TYN625	
BT152-600R	TYN625	
BT152-800R	TYN825	
BT152B-400R	TN2540-600G	
BT152B-600R	TN2540-600G	
BT168B		X0202MA
BT168BW		X0202MN
BT168D		X0202MA
BT168DW		X0202MN
BT168E		X0202MA
BT168EW		X0202MN
BT168G		X0202MA
BT168GW		X0202MN
BT169-BW	P0102DN	
BT169-EW	X0202MN	
BT169-GW	X0202MN	
BT169B	X00602MA	
BT169D	X00602MA	
BT169DW	P0102DN	
BT169E	X00602MA	
BT169G	X00602MA	
BT258-500R	TS820-600T	
BT258-600R	TS820-600T	
BT258B-500R		TS820-600B
BT258B-600R		TS820-600B
BT258M-500R		TS820-600B
BT258M-600R		TS820-600B
BT258S-500R	TS820-600B	
BT258S-600R	TS820-600B	
BT300-500R	TYN608	
BT300-600R	TYN608	
BT300-800R	TYN808	
BT300B-500R	TN815-600B	
BT300B-600R	TN815-600B	
BT300M-500R		TN815-600B
BT300M-600R		TN815-600B
BT300S-500R	TN815-600B	
BT300S-600R	TN815-600B	
BTA140-500	BTB24-600CW	
BTA140-600	BTB24-600CW	

Industry Standard	ST Equivalent	ST Nearest Replacement
BTA140B-500	T2535-600G	
BTA140B-600	T2535-600G	
BTA151-500R		TYN612T
BTA151-650R		TYN812T
BTA151-800R		TYN812T
BTA204-500B	T435-600T	
BTA204-500C	T435-600T	
BTA204-500D	T405-600T	
BTA204-500E	T410-600T	
BTA204-500F	T410-600T	
BTA204-600B	T435-600T	
BTA204-600C	T435-600T	
BTA204-600D	T405-600T	
BTA204-600E	T410-600T	
BTA204-600F	T410-600T	
BTA204-800B	T435-800T	
BTA204-800C	T435-800T	
BTA204-800E	T410-800T	
BTA204-800F	T410-800T	
BTA204M-500B		T435-600B
BTA204M-500C		T435-600B
BTA204M-500D		T405-600B
BTA204M-500E		T410-600B
BTA204M-500F		T435-600B
BTA204M-600B		T435-600B
BTA204M-600C		T435-600B
BTA204M-600D		T405-600B
BTA204M-600E		T410-600B
BTA204M-600F		T435-600B
BTA204M-800B		T435-700B
BTA204M-800C		T435-700B
BTA204M-800E		T410-800B
BTA204M-800F		T435-700B
BTA204S-500B	T435-600B	
BTA204S-500C	T435-600B	
BTA204S-500D	T405-600B	
BTA204S-500E	T410-600B	
BTA204S-500F	T435-600B	
BTA204S-600B	T435-600B	
BTA204S-600C	T435-600B	
BTA204S-600D	T405-600B	
BTA204S-600E	T410-600B	
BTA204S-600F	T435-600B	
BTA204W-500B		Z0110MN
BTA204W-500C		Z0110MN
BTA204W-500D	Z0107MN	
BTA204W-500E	Z0109MN	
BTA204W-500F	Z0110MN	
BTA204W-600B		Z0110MN
BTA204W-600C		Z0110MN

Industry Standard	ST Equivalent	ST Nearest Replacement
BTA204W-600D	Z0107MN	
BTA204W-600E	Z0109MN	
BTA204W-600F	Z0110MN	
BTA204X-500B	T435-600W	
BTA204X-500C	T435-600W	
BTA204X-500D	T405-600W	
BTA204X-500E	T410-600W	
BTA204X-500F	T410-600W	
BTA204X-600B	T435-600W	
BTA204X-600C	T435-600W	
BTA204X-600D	T405-600W	
BTA204X-600E	T410-600W	
BTA204X-600F	T410-600W	
BTA204X-800B	T435-800W	
BTA204X-800C	T435-800W	
BTA204X-800E	T410-800W	
BTA204X-800F	T410-800W	
BTA208-500B	BTB08-600BW	
BTA208-500C	BTB08-600CW	
BTA208-500D	BTB08-600TW	
BTA208-500E	BTB08-600SW	
BTA208-500F	BTB08-600SW	
BTA208-600B	BTB08-600BW	
BTA208-600C	BTB08-600CW	
BTA208-600D	BTB08-600TW	
BTA208-600E	BTB08-600SW	
BTA208-600F	BTB08-600SW	
BTA208-800B	BTB08-800BW	
BTA208-800C	BTB08-800CW	
BTA208-800E	BTB08-800SW	
BTA208-800F	BTB08-800SW	
BTA208B-500C	T835-600G	
BTA208B-500C	T835-600G	
BTA208B-500E		T835-600G
BTA208B-500F		T835-600G
BTA208B-600C	T835-600G	
BTA208B-600C	T835-600G	
BTA208B-600E		T835-600G
BTA208B-600F		T835-600G
BTA208M-500B		T835-600B
BTA208M-500C		T835-600B
BTA208M-500D		T810-600B
BTA208M-500E		T810-600B
BTA208M-500F		T810-600B
BTA208M-600B		T835-600B
BTA208M-600C		T835-600B
BTA208M-600D		T810-600B
BTA208M-600E		T810-600B
BTA208M-600F		T810-600B
BTA208S-500B	T835-600B	

Industry Standard	ST Equivalent	ST Nearest Replacement
BTA208S-500C	T835-600B	
BTA208S-500D		T810-600B
BTA208S-500E	T810-600B	
BTA208S-500F	T810-600B	
BTA208S-600B	T835-600B	
BTA208S-600C	T835-600B	
BTA208S-600D		T810-600B
BTA208S-600E	T810-600B	
BTA208S-600F	T810-600B	
BTA208X-500B		BTA08-600BW
BTA208X-500C		BTA08-600CW
BTA208X-500D		BTA08-600TW
BTA208X-500E		BTA08-600TW
BTA208X-500F		BTA08-600TW
BTA208X-600B		BTA08-600BW
BTA208X-600C		BTA08-600CW
BTA208X-600D	BTA08-600TW	
BTA208X-600E		BTA08-600TW
BTA208X-600F		BTA08-600TW
BTA208X-800B		BTA08-800BW
BTA208X-800C		BTA08-800BW
BTA208X-800E		BTA08-800TW
BTA208X-800F		BTA08-800TW
BTA212-500B	BTB12-600BW	
BTA212-500C	BTB12-600CW	
BTA212-500D		BTB12-600SW
BTA212-500E	BTB12-600SW	
BTA212-500F	BTB12-600SW	
BTA212-600B	BTB12-600BW	
BTA212-600C	BTB12-600CW	
BTA212-600D		BTB12-600SW
BTA212-600E	BTB12-600SW	
BTA212-600F	BTB12-600SW	
BTA212-800B	BTB12-800BW	
BTA212-800C	BTB12-800CW	
BTA212B-500B		T1235-600G
BTA212B-500C		T1235-600G
BTA212B-500D		T1235-600G
BTA212B-500E	T1235-600G	
BTA212B-500F	T1235-600G	
BTA212B-600B		T1235-600G
BTA212B-600C		T1235-600G
BTA212B-600D		T1235-600G
BTA212B-600E		T1235-600G
BTA212B-600F		T1235-600G
BTA212X-500B		BTA12-600BW
BTA212X-500C		BTA12-600BW
BTA212X-500D		BTA12-600SW
BTA212X-500E		BTA12-600SW
BTA212X-500F		BTA12-600CW

Industry Standard	ST Equivalent	ST Nearest Replacement
BTA212X-600B		BTA12-600BW
BTA212X-600C		BTA12-600BW
BTA212X-600D		BTA12-600SW
BTA212X-600E		BTA12-600SW
BTA212X-600F		BTA12-600CW
BTA212X-800B		BTA12-800BW
BTA212X-800C		BTA12-800CW
BTA216-500B	BTB16-600BW	
BTA216-500C	BTB16-600CW	
BTA216-500E	BTB16-600SW	
BTA216-500F	BTB16-600SW	
BTA216-600B	BTB16-600BW	
BTA216-600C	BTB16-600CW	
BTA216-600E	BTB16-600SW	
BTA216-600F	BTB16-600SW	
BTA216-800B	BTB16-800BW	
BTA216-800C	BTB16-800CW	
BTA216B-500B	T1635-600G	
BTA216B-500C	T1635-600G	
BTA216B-600B	T1635-600G	
BTA216B-600C	T1635-600G	
BTA216X-500B		BTA16-600BW
BTA216X-500C		BTA16-600CW
BTA216X-500E		BTA16-600SW
BTA216X-500F		BTA16-600SW
BTA216X-600B		BTA16-600BW
BTA216X-600C		BTA16-600CW
BTA216X-600E		BTA16-600SW
BTA216X-600F		BTA16-600SW
BTA216X-800B		BTA16-800BW
BTA216X-800C		BTA16-800CW
BTA225-500B	BTB24-600BW	
BTA225-500C	BTB24-600CW	
BTA225-600B	BTB24-600BW	
BTA225-600C	BTB24-600CW	
BTA225-800B	BTB24-800BW	
BTA225-800C	BTB24-800CW	
BTA225B-500B	T2535-600G	
BTA225B-500C	T2535-600G	
BTA225B-600B	T2535-600G	
BTA225B-600C	T2535-600G	
C106A		X0402MF
C106B		X0402MF
C106D		X0402MF
C106D1		X0402MF
C106F		X0402MF
C106M		X0402MF
C106M1		X0402MF
C122A1	TYN608	
C122B1	TYN608	

Industry Standard	ST Equivalent	ST Nearest Replacement
C122D1	TYN608	
C122F1	TYN608	
C122M1	TYN608	
C122N1	TYN808	
CR02AM-4		P0111DA
CR02AM-6		P0111DA
CR02AM-8		P0111DA
CR02AM-8A		P0111DA
CR03AM-12		X00602MA
CR03AM-8		X00602MA
CR04AM12		X00602MA
CR04AM8		X00602MA
CR05AS-4		X0205MN
CR05AS-8		X0205MN
CR08AS-12		X0205MN
CR08AS-8		X0205MN
CR12AM-12	TYN625	
CR12AM-8	TYN625	
CR2AM-12	X0405MF	
CR2AM-8	X0405MF	
CR3AM-12		X0402MF
CR3AM-8		X0402MF
CR3AS-12	TS420-600B	
CR3AS-8	TS420-600B	
CR3CM-12		X0402MF
CR3CM-8		X0402MF
CR5A1S-12		TS820-600T
CR5A1S-8		TS820-600T
CR5AS-12	TS820-600B	
CR5AS-8	TS820-600B	
CR6AM-8	TYN610	
CR6CM-12	TYN610	
CR6CM-8	TYN610	
CR8AM-12 T	YN612	
CR8AM-8	TYN612	
CR8CM-12	TYN612	
CR8CM-8	TYN612	
EC103A	X00602MA	
EC103A2		X0205MA
EC103A3	X00602MA	
EC103B	X00602MA	
EC103B2		X0205MA
EC103B3	X00602MA	
EC103C	X00602MA	
EC103C2		X0205MA
EC103C3	X00602MA	
EC103D	X00602MA	
EC103D2		X0205MA
EC103D3	X00602MA	
EC103E	X00602MA	

Industry Standard	ST Equivalent	ST Nearest Replacement
EC103E2		X0205MA
EC103E3	X00602MA	
EC103M	X00602MA	
EC103M2		X0205MA
EC103M3	X00602MA	
EC113A	X00602MA	
EC113A3	X00602MA	
EC113B	X00602MA	
EC113B3	X00602MA	
EC113C	X00602MA	
EC113C3	X00602MA	
EC113D	X00602MA	
EC113D3	X00602MA	
EC113E	X00602MA	
EC113E3	X00602MA	
EC113M	X00602MA	
EC113M3	X00602MA	
HT-32	DB3	
HT-32A		DB3
HT-32B		DB3
HT-34B		DB3
HT-35		DB3
HT-36A		DB3
HT-36B		DB3
HT-5761		DB3
HT-5761A		DB3
HT-5762		DB3
K2000E70		LIC01-195H
K2000F1		LIC01-195H
K2200E70		LIC01-195H
K2200F1		LIC01-195H
K2400E70		LIC01-215H
K2400F1		LIC01-215H
K2400S		LIC01-215B
K2401F1		LIC01-215H
L2004F32	Z0402MF	
L2004F52	Z0405MF	
L2004F62	Z0405MF	
L2004F82	Z0409MF	
L2008L6		BTA08-600SW
L201E3		Z0103MA
L201E5		Z0107MA
L201E6		Z0107MA
L201E8		Z0109MA
L2X8E3	Z0103MA	
L2X8E5	Z00607MA	
L2X8E6	Z00607MA	
L2X8E8	Z0109MA	
L4004F32	Z0402MF	
L4004F52	Z0405MF	

Industry Standard	ST Equivalent	ST Nearest Replacement
L4004F62	Z0405MF	
L4004F82	Z0409MF	
L4004L3		BTA04-600TW
L4004L5		BTA04-600TW
L4006L5		BTA04-600TW
L4008L6		BTA08-600SW
L401E3		Z0103MA
L401E5		Z0107MA
L401E6		Z0107MA
L401E8		Z0109MA
L4X8E3	Z0103MA	
L4X8E5	Z00607MA	
L4X8E6	Z00607MA	
L4X8E8	Z0109MA	
L6004F32	Z0402MF	
L6004F52	Z0405MF	
L6004F62	Z0405MF	
L6004F82	Z0409MF	
L6006L5		BTA06-600TW
L6008L6		BTA08-600SW
L601E3		Z0103MA
L601E5		Z0107MA
L601E6		Z0107MA
L601E8		Z0109MA
L6X8E3	Z0103MA	
L6X8E5	Z00607MA	
L6X8E6	Z00607MA	
L6X8E8	Z0109MA	
MAC08BT1	Z0109MN	
MAC08DT1	Z0109MN	
MAC08MT1	Z0109MN	
MAC12D	BTB12-600CW	
MAC12HCD	BTB12-600BW	
MAC12HCM	BTB12-600BW	
MAC12HCN	BTB12-800BW	
MAC12M	BTB12-600CW	
MAC12N	BTB12-800CW	
MAC137-500	BTB08-600CW	
MAC137-600	BTB08-600CW	
MAC137-700	BTB08-800CW	
MAC137-800	BTB08-800CW	
MAC137G500	BTB08-600BW	
MAC137G600	BTB08-600BW	
MAC137G700	BTB08-800BW	
MAC137G800	BTB10-800BW	
MAC15-10	BTB16-800BW	
MAC15-10FP		BTA16-800BW
MAC15-4	BTB16-600BW	
MAC15-4FP		BTA16-600BW
MAC15-6	BTB16-600BW	
MAC15-6FP		BTA16-600BW
MAC15-8	BTB16-600BW	
MAC15-8FP		BTA16-600BW
MAC15A10	BTB16-800B	
MAC15A10FP		BTA16-800B
MAC15A4	BTB16-600B	
MAC15A4FP		BTA16-600B
MAC15A6	BTB16-600B	
MAC15A6FP		BTA16-600B
MAC15A8	BTB16-600B	
MAC15A8FP		BTA16-600B
MAC15D	BTB16-600CW	
MAC15M	BTB16-600CW	
MAC15N	BTB16-800CW	
MAC15SM		BTB16-600SW
MAC15SN		BTB16-800SW
MAC16-10	BTB16-800BW	
MAC16-4	BTB16-600BW	
MAC16-6	BTB16-600BW	
MAC16-8	BTB16-600BW	
MAC16CD	BTB16-600CW	
MAC16CM	BTB16-600CW	
MAC16CN	BTB16-800CW	
MAC16D	BTB16-600BW	
MAC16M	BTB16-600BW	
MAC16N	BTB16-800BW	
MAC210-10	BTB10-800BW	
MAC210-10FP		BTA10-800BW
MAC210-4	BTB10-600BW	
MAC210-4FP		BTA10-600BW
MAC210-6	BTB10-600BW	
MAC210-6FP		BTA10-600BW
MAC210-8	BTB10-600BW	
MAC210-8FP		BTA10-600BW
MAC210A10FP		BTA10-800B
MAC210A4	BTB10-600B	
MAC210A4FP		BTA10-600B
MAC210A6	BTB10-600B	
MAC210A6FP		BTA10-600B
MAC210A8	BTB10-600B	
MAC210A8FP		BTA10-600B
MAC212-10	BTB12-800BW	
MAC212-10FP		BTA12-800BW
MAC212-4	BTB12-600BW	
MAC212-4FP		BTA12-600BW
MAC212-6	BTB12-600BW	
MAC212-6FP		BTA12-600BW
MAC212-8	BTB12-600BW	
MAC212-8FP		BTA12-600BW
MAC212A10	BTB12-800B	

Industry Standard	ST Equivalent	ST Nearest Replacement
MAC212A10FP		BTA12-800B
MAC212A4	BTB12-600B	
MAC212A4FP		BTA12-600B
MAC212A6	BTB12-600B	
MAC212A6FP		BTA12-600B
MAC212A8	BTB12-600B	
MAC212A8FP		BTA12-600B
MAC218-10	BTB10-800BW	
MAC218-10FP		BTA08-800BW
MAC218-4	BTB08-600BW	
MAC218-4FP		BTA08-600BW
MAC218-6	BTB08-600BW	
MAC218-6FP		BTA08-600BW
MAC218-8	BTB08-600BW	
MAC218-8FP		BTA08-600BW
MAC218A10		BTB10-800B
MAC218A10FP		BTA08-800C
MAC218A4	BTB08-600B	
MAC218A4FP		BTA08-600B
MAC218A6	BTB08-600B	
MAC218A6FP		BTA08-600B
MAC218A8	BTB08-600B	
MAC218A8FP		BTA08-600B
MAC223-10	BTB24-800BW	
MAC223-10FP		BTA24-800BW
MAC223-4	BTB24-600BW	
MAC223-4FP		BTA24-600BW
MAC223-6	BTB24-600BW	
MAC223-6FP		BTA24-600BW
MAC223-8		BTB24-600BW
MAC223-8FP		BTA24-600BW
MAC223A10		BTB24-800BW
MAC223A10FP		BTA24-800BW
MAC223A4		BTB24-600BW
MAC223A4FP		BTA24-600BW
MAC223A6		BTB24-600BW
MAC223A6FP		BTA24-600BW
MAC223A8		BTB24-600BW
MAC223A8FP		BTA24-600BW
MAC224-10		BTB41-800B
MAC224-4		BTB41-600B
MAC224-6		BTB41-600B
MAC224-8		BTB41-600B
MAC224A10		BTB41-800B
MAC224A4		BTB41-600B
MAC224A6		BTB41-600B
MAC224A8		BTB41-600B
MAC228-10		BTB08-800TW
MAC228-10FP	BTA08-800TW	
MAC228-4		BTB08-600TW

Industry Standard	ST Equivalent	ST Nearest Replacement
MAC228-4FP		BTA08-600TW
MAC228-6	BTB08-600TW	
MAC228-6FP		BTA08-600TW
MAC228-8	BTB08-600TW	
MAC228-8FP		BTA08-600TW
MAC228A4		BTB08-600SW
MAC228A4FP		BTA08-600SW
MAC228A6		BTB08-600SW
MAC228A6FP		BTA08-600SW
MAC228A8		BTB08-600SW
MAC228A8FP		BTA08-600SW
MAC229-10	BTB08-800TW	
MAC229-10FP		BTA08-700TW
MAC229-4	BTB08-600SW	
MAC229-4FP		BTA08-600TW
MAC229-6	BTB08-600SW	
MAC229-6FP		BTA08-600TW
MAC229-8	BTB08-600SW	
MAC229-8FP		BTA08-600TW
MAC229A4		BTB08-600SW
MAC229A4FP		BTA08-600SW
MAC229A6		BTB08-600SW
MAC229A6FP		BTA08-600SW
MAC229A8		BTB08-600SW
MAC229A8FP		BTA08-600SW
MAC310-4		BTA12-600SW
MAC310-6		BTA12-600SW
MAC310-8		BTA12-800SW
MAC310A4		BTB08-600SW
MAC310A6		BTB08-600SW
MAC320A10		BTB24-800BW
MAC320A4		BTB24-600BW
MAC320A6		BTB24-600BW
MAC320A8		BTB24-600BW
MAC321-10	BTB20-800BW	
MAC321-4	BTB20-600CW	
MAC321-6	BTB20-600CW	
MAC321-8	BTB20-600CW	
MAC4DCM	T435-600B	
MAC4DCN		T435-700B
MAC4DCN-1		T435-700H
MAC4DHM	T405-600B	
MAC4DHM-1	T405-700H	
MAC4DLM		T405-600B
MAC4DLM-1		T405-700H
MAC4DSM	T410-600B	
MAC4DSM-1	T405-700H	
MAC4DSN	T410-800B	
MAC4DSN-1		T405-700H
MAC4M	T435-600T	

Industry Standard	ST Equivalent	ST Nearest Replacement
MAC4N	T435-800T	
MAC4SM	T410-600T	
MAC4SN	T410-800T	
MAC8D	BTB08-600CW	
MAC8M	BTB08-600CW	
MAC8N	BTB08-800CW	
MAC8SD	BTB08-600TW	
MAC8SM	BTB08-600TW	
MAC8SN	BTB08-800TW	
MAC97-4	Z00607MA	
MAC97-6	Z00607MA	
MAC97-8	Z00607MA	
MAC97A4	Z00607MA	
MAC97A6	Z00607MA	
MAC97A8	Z00607MA	
MAC97B4	Z0103MA	
MAC97B6	Z0103MA	
MAC97B8	Z0103MA	
MAC9D	BTB08-600BW	
MAC9M	BTB08-600BW	
MAC9N	BTB10-800BW	
MCR08BT1	P0102DN	
MCR08DT1	P0102DN	
MCR08MT1	X0202MN	
MCR100-3	X00602MA	
MCR100-4	X00602MA	
MCR100-6	X00602MA	
MCR100-8	X00602MA	
MCR102	X00602MA	
MCR103	X00602MA	
MCR106-2	X0402MF	
MCR106-3	X0402MF	
MCR106-4	X0402MF	
MCR106-6	X0402MF	
MCR106-8	X0402MF	
MCR12D	TYN612	
MCR12DCM	TN1215-600B	
MCR12DSM	TS1220-600B	
MCR12M	TYN612	
MCR12N	TYN812	
MCR16D	TYN616	
MCR16M	TYN616	
MCR16N	TYN816	
MCR218-10	TYN808	
MCR218-2	TYN608	
MCR218-3	TYN608	
MCR218-4	TYN608	
MCR218-6	TYN608	
MCR218-8	TYN608	
MCR22-2	X0202MA	

Industry Standard	ST Equivalent	ST Nearest Replacement
MCR22-3	X0202MA	
MCR22-4	X0202MA	
MCR22-6	X0202MA	
MCR22-8	X0202MA	
MCR25D	TYN625	
MCR25M	TYN625	
MCR25N	TYN825	
MCR264-10	TYN840	
MCR264-4	TYN640	
MCR264-6	TYN640	
MCR264-8	TYN640	
MCR265-10		BTW69-800
MCR265-2		BTW69-600
MCR265-4		BTW69-600
MCR265-6		BTW69-800
MCR265-8		BTW69-800
MCR310-4		TS820-600T
MCR310-6		TS820-600T
MCR310-8		TS820-700T
MCR506-2		TS820-600T
MCR506-3		TS820-600T
MCR506-4		TS820-600T
MCR506-6		TS820-600T
MCR506-8		TS820-600T
MCR68-2	TYN612	
MCR68-3	TYN612	
MCR68-4	TYN612	
MCR68-6	TYN612	
MCR69-2	TYN616	
MCR69-3	TYN616	
MCR69-4	TYN616	
MCR69-6	TYN616	
MCR703A		TS420-600B
MCR703A1		TS420-600T
MCR72-10		TS820-700T
MCR72-2	TS820-600T	
MCR72-3	TS820-600T	
MCR72-4	TS820-600T	
MCR72-6	TS820-600T	
MCR72-8	TS820-600T	
MCR8D	TYN608	
MCR8DCM	TN815-600B	
MCR8DCN	TN815-800B	
MCR8DSM	TS820-600B	
MCR8M	TYN608	
MCR8N	TYN808	
MCR8SD	TS820-600T	
MCR8SM	TS820-600T	
Q2004L3	BTA06-600SW	
Q2004L4		BTA06-600CW

Industry Standard	ST Equivalent	ST Nearest Replacement
Q2006L4		BTA06-600CW
Q2006LH4	BTA06-600CW	
Q2006R4		BTB06-600CW
Q2006RH4	BTB06-600CW	
Q2008F41		BTB08-600CW
Q2008L4		BTA08-600CW
Q2008LH4	BTA08-600CW	
Q2008R4	BTB08-600CW	
Q2008RH4	BTB08-600CW	
Q2010L5	BTA10-600BW	
Q2010LH5	BTA10-600BW	
Q2010R5	BTB10-600BW	
Q2010RH5	BTB10-600BW	
Q2012LH5	BTA12-600BW	
Q2012RH5	BTB12-600BW	
Q2015L5	BTA16-600BW	
Q2015L5	BTA16-600BW	
Q2015L6	BTA16-600BW	
Q2015R6	BTB16-600BW	
Q201E3		Z0109MA
Q201E4		Z0110MA
Q2025J6		BTA26-600BW
Q2025K6	BTA26-600BW	
Q2025L5	BTB24-600BW	
Q2025L6	BTA24-600BW	
Q2025P		BTA25-600BW
Q2025R6	BTB24-600BW	
Q2X8E3	Z0109MA	
Q2X8E4	Z0110MA	
Q4004L3	BTA06-600SW	
Q4004L4		BTA06-600CW
Q4006L4		BTA06-600CW
Q4006LH4	BTA06-600CW	
Q4006R4		BTB06-600CW
Q4006RH4	BTB06-600CW	
Q4008L4		BTA08-600CW
Q4008LH4	BTA08-600CW	
Q4008R4	BTB08-600CW	
Q4008RH4	BTB08-600CW	
Q4010L5	BTA10-600BW	
Q4010LH5	BTA10-600BW	
Q4010R5	BTB10-600BW	
Q4010RH5	BTB10-600BW	
Q4012LH5	BTA12-600BW	
Q4012RH5	BTB12-600BW	
Q4015L5	BTA16-600BW	
Q4015L5	BTA16-600BW	
Q4015L6	BTA16-600BW	
Q4015R6	BTB16-600BW	
Q401E3		Z0109MA

Industry Standard	ST Equivalent	ST Nearest Replacement
Q401E4		Z0110MA
Q4025J6		BTA26-600BW
Q4025K6	BTA26-600BW	
Q4025L5	BTB24-600BW	
Q4025L6	BTA24-600BW	
Q4025P		BTA25-600BW
Q4025R6	BTB24-600BW	
Q4X8E3	Z0109MA	
Q4X8E4	Z0110MA	
Q5004L3	BTA06-600SW	
Q5004L4		BTA06-600CW
Q5006L4		BTA06-600CW
Q5006LH4	BTA06-600CW	
Q5006R4		BTB06-600CW
Q5006RH4	BTB06-600CW	
Q5008L4		BTA08-600CW
Q5008LH4	BTA08-600CW	
Q5008R4		BTB08-600CW
Q5008RH4	BTB08-600CW	
Q5010L5	BTA10-600BW	
Q5010LH5	BTA10-600BW	
Q5010R5	BTB10-600BW	
Q5010RH5	BTB10-600BW	
Q5012LH5	BTA12-600BW	
Q5012RH5	BTB12-600BW	
Q5015L5	BTA16-600BW	
Q5015L5	BTA16-600BW	
Q5015L6	BTA16-600BW	
Q5015R6	BTB16-600BW	
Q501E3		Z0109MA
Q501E4		Z0110MA
Q5025J6		BTA26-600BW
Q5025K6	BTA26-600BW	
Q5025L5	BTB24-600BW	
Q5025L6	BTA24-600BW	
Q5025P		BTA25-600BW
Q5025R6	BTB24-600BW	
Q5X8E3	Z0109MA	
Q5X8E4	Z0110MA	
Q6004L3	BTA06-600SW	
Q6004L4		BTA06-600CW
Q6006L5	BTA06-600BW	
Q6006LH4	BTA06-600CW	
Q6006R5	BTB06-600BW	
Q6006RH4	BTB06-600CW	
Q6008L5	BTA08-600BW	
Q6008LH4	BTA08-600CW	
Q6008R5	BTB08-600BW	
Q6008RH4	BTB08-600CW	
Q6010L5	BTA10-600BW	

Industry Standard	ST Equivalent	ST Nearest Replacement
Q6010LH5	BTA10-600BW	
Q6010R5	BTB10-600BW	
Q6010RH5	BTB10-600BW	
Q6012LH5	BTA12-600BW	
Q6012RH5	BTB12-600BW	
Q6015L5	BTB16-600BW	
Q6015L5	BTB16-600BW	
Q6015L6	BTA16-600BW	
Q6015R6	BTB16-600BW	
Q601E3		Z0109MA
Q601E4		Z0110MA
Q6025J6		BTA26-600BW
Q6025K6	BTA26-600BW	
Q6025L5	BTB24-600BW	
Q6025L6	BTA24-600BW	
Q6025P		BTA25-600BW
Q6025R6	BTB24-600BW	
Q6X8E3	Z0109MA	
Q6X8E4	Z0110MA	
Q7004L4		BTA06-800CW
Q7006L5	BTA06-800BW	
Q7006LH4		BTA06-800BW
Q7006R5	BTB06-800BW	
Q7006RH4		BTB06-800BW
Q7008L5	BTA08-800BW	
Q7008LH4	BTA08-800CW	
Q7008R5	BTB08-800BW	
Q7008RH4	BTB08-800CW	
Q7010L5	BTA10-800BW	
Q7010LH5	BTA10-800BW	
Q7010R5	BTB10-800BW	
Q7010RH5	BTB10-600BW	
Q7012LH5	BTA12-800BW	
Q7012RH5		BTB12-600BW
Q7015L5	BTB16-800BW	
Q7015L5	BTB16-800BW	
Q7015L6	BTA16-800BW	
Q7015R6	BTB16-800BW	
Q7025J6		BTA26-800BW
Q7025K6	BTA26-800BW	
Q7025L5	BTB24-800BW	
Q7025L6	BTA24-800BW	
Q7025P		BTA25-800BW
Q7025R6	BTB24-800BW	
Q8004F41		T435-800T
Q8004L4		BTA06-800CW
Q8006L5		BTA06-800BW
Q8006LH4		BTA06-800BW
Q8006R5		BTA06-800BW
Q8006RH4		BTA06-800BW

Industry Standard	ST Equivalent	ST Nearest Replacement
Q8008L5	BTA08-800BW	
Q8008LH4		BTA08-800BW
Q8008R5		BTA08-800BW
Q8008RH4		BTA08-800BW
Q8010L5	BTA10-800BW	
Q8010LH5	BTA10-800BW	
Q8010R5	BTB10-800BW	
Q8010RH5	BTB10-800BW	
Q8012LH5	BTA12-800BW	
Q8012RH5		BTA12-800BW
Q8015L5	BTB16-800BW	
Q8015L5	BTB16-800BW	
Q8015L6	BTA16-800BW	
Q8015R6	BTB16-800BW	
Q8025J6		BTA26-800BW
Q8025K6	BTA26-800BW	
Q8025L5	BTB24-800BW	
Q8025L6	BTA24-800BW	
Q8025P		BTA25-800BW
Q8025R6	BTB24-800BW	
RSF05G1-1P	X00602MA	
RSF05G1-3P	X00602MA	
RSF05G1-5P	X00602MA	
S0508R	TYN608	
S0510R	TYN612	
S0512R	TYN612	
S0516R	TYN616	
S051E		X0202MA
S0525R	TYN625	
S0535K		BTW69-600
S0555M	BTW69-600	
S0555W		BTW69-600
S1008R	TYN608	
S1010R	TYN612	
S1012R	TYN612	
S1016R	TYN616	
S101E		X0202MA
S1025R	TYN625	
S1035K		BTW69-600
S1055M	BTW69-600	
S1055W		BTW69-600
S2008R	TYN608	
S2010R	TYN612	
S2012R	TYN612	
S2016R	TYN616	
S201E		X0202MA
S2025R	TYN625	
S2035K		BTW69-600
S2055M	BTW69-600	
S2055W		BTW69-600

Industry Standard	ST Equivalent	ST Nearest Replacement
S2800A	TYN612	
S2800B	TYN612	
S2800D	TYN612	
S2800F	TYN612	
S2800M	TYN612	
S2800N	TYN812	
S4008R	TYN608	
S4010R	TYN612	
S4012R	TYN612	
S4016R	TYN616	
S401E		X0202MA
S4025R	TYN625	
S4035K		BTW69-600
S4055M	BTW69-800	
S4055W		BTW69-800
S6008R	TYN608	
S6010R	TYN612	
S6012R	TYN612	
S6016R	TYN616	
S601E		X0202MA
S6025R	TYN625	
S6035K		BTW69-600
S6055M	BTW69-800	
S6055W		BTW69-800
S6370	X00602MA	
S6744		TYN612
S6785G	TYN606	
S8008R	TYN808	
S8010R	TYN812	
S8012R	TYN812	
S8016R	TYN816	
S8025R	TYN825	
S8035K		BTW69-800
S8055M	BTW69-800	
S8055W		BTW69-800
SF0R3G42	X00602MA	
SF0R5G43	X00602MA	
SF0R5J43	X00602MA	
SF10G41A	TYN616	
SF10G48		TYN616
SF10GZ47		TYN616
SF10J41A	TYN616	
SF10J48		TYN616
SF10JZ47	TYN616	
SF16GZ51		BTW69-600
SF16JZ51		BTW69-600
SF25GZ51		BTW69-600
SF25JZ51		BTW69-600
SF3G48	TYN606	
SF3GZ47	TYN606	
SF3J48	TYN606	
SF3JZ47	TYN606	
SF5G41A	TYN608	
SF5G42	TS820-600T	
SF5G48		TYN608
SF5J41A	TYN608	
SF5J42	TS820-600T	
SF5J48		TYN608
SF8G41A	TYN612	
SF8G48		TYN612
SF8J48		TYN612
SH8G41		TYN412
SHR0R3D42	X00602MA	
SM08G43	Z0103MA	
SM12G45	BTB12-600CW	
SM12G45A	BTB12-600SW	
SM12G48		BTB12-600CW
SM12G48A		BTB12-600SW
SM12J45	BTB12-600CW	
SM12J45A	BTB12-600SW	
SM12J48		BTB12-600CW
SM12J48A		BTB12-600SW
SM16G45	BTB16-600CW	
SM16G45A	BTB16-600SW	
SM16G48		BTB16-600CW
SM16G48A		BTB16-600SW
SM16J45	BTB16-600CW	
SM16J45A	BTB16-600SW	
SM16J48		BTB16-600CW
SM16J48A		BTB16-600SW
SM1G43	Z00607MA	
SM1J43	Z00607MA	
SM1L43	Z0107NA	
SM25GZ51		BTA26-800CW
SM25JZ51		BTA26-800CW
SM2GZ47		Z0409MF
SM2GZ47A		Z0405MF
SM2JZ47		Z0409MF
SM2JZ47A		Z0405MF
SM2LZ47		Z0409NF
SM3G45	T410-600T	
SM3G48		Z0410MF
SM3GZ47	T410-600W	
SM3J45	T410-600T	
SM3J48		Z0410MF
SM3JZ47	T410-600W	
SM6G45	BTB06-600CW	
SM6G45A	BTB06-600SW	
SM6G48		BTB06-600CW
SM6G48A		BTB06-600SW

Industry Standard	ST Equivalent	ST Nearest Replacement
SM6J45	BTB06-600CW	
SM6J45A	BTB06-600SW	
SM6J48		BTB06-600CW
SM6J48A		BTB06-600SW
SM8G45	BTB08-600CW	
SM8G45A	BTB08-600SW	
SM8G48		BTB08-600CW
SM8G48A		BTB08-600SW
SM8J45	BTB08-600CW	
SM8J45A	BTB08-600SW	
SM8J48		BTB08-600CW
SM8J48A		BTB08-600SW
T106A1	X0402MF	
T106B1	X0402MF	
T106C1	X0402MF	
T106D1	X0402MF	
T106E1	X0402MF	
T106F1	X0402MF	
T106M1	X0402MF	
T107A1	X0402MF	
T107B1	X0402MF	
T107C1	X0402MF	
T107D1	X0402MF	
T107E1	X0402MF	
T107F1	X0402MF	
T107M1	X0402MF	
T2322B	T410-600H	
T2322D	T410-600H	
T2322M	T410-600H	
T2323B	T410-600H	
T2323D	T410-600H	
T2323M	T410-600H	
T2500B	BTB06-600C	
T2500BFP		BTA06-600C
T2500D	BTB06-600C	
T2500DFP		BTA06-600C
T2500M	BTB06-600C	
T2500MFP		BTA06-600C
T2800B	BTB08-600C	

Industry Standard	ST Equivalent	ST Nearest Replacement
T2800D	BTB08-600C	
T2800M	BTB08-600C	
TCR22-2		X0202MA
TCR22-3		X0202MA
TCR22-4		X0202MA
TCR22-6		X0202MA
TCR22-8		X0202MA
URSF05G49-1P	P0102DN	
URSF05G49-3P	P0102DN	
URSF05G49-5P	P0102DN	
USF05G49	P0102DN	
USF10G48		TN1625-600G
USF10J48		TN1625-600G
USF3G48		TS420-600B
USF3J48		TS420-600B
USF5G48		TN805-600B
USF5J48		TN805-600B
USF8G48	TN1215-600G	
USF8J48	TN1215-600G	
USM12G48	T1235-600G	
USM12G48A		T1235-600G
USM12J48	T1235-600G	
USM12J48A		T1235-600G
USM16G48	T1635-600G	
USM16G48A		T1635-600G
USM16J48	T1635-600G	
USM16J48A		T1635-600G
USM3G48		T410-600B
USM3J48		T410-600B
USM6G48	T835-600G	
USM6G48A		T835-600G
USM6J48	T835-600G	
USM6J48A		T835-600G
USM8G48	T835-600G	
USM8G48A		T835-600G
USM8J48	T835-600G	
USM8J48A		T835-600G

SCRS DATASHEETS

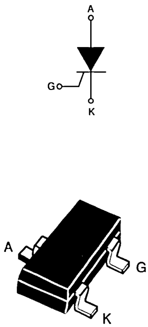
P0102BL

SENSITIVE

0.25A SCRs

MAIN FEATURES:

Symbol	Value	Unit
$I_{T(RMS)}$	0.25	A
V_{DRM}/V_{RRM}	200	V
I_{GT}	200	µA



SOT-23

DESCRIPTION

Thanks to highly sensitive triggering levels, the PO102BL SCR is suitable for all applications where the available gate current is limited such as stand-by mode power supplies, smoke and alarm detectors...
Available in SOT-23, it provides optimized space saving on high density printed circuit boards.

ABSOLUTE RATINGS (limiting values)

Symbol	Parameter			Value	Unit
$I_{T(RMS)}$	RMS on-state current (180° conduction angle)		Tamb = 30°C	0.25	A
$I_{T(AV)}$	Average on-state current (180° conduction angle)		Tamb = 30°C	0.17	A
I_{TSM}	Non repetitive surge peak on-state current	tp = 8.3 ms	Tj = 25°C	7	A
		tp = 10 ms		6	
I^2t	I^2t Value for fusing	tp = 10 ms	Tj = 25°C	0.18	A^2s
dI/dt	Critical rate of rise of on-state current $I_G = 2 \times I_{GT}$, tr ≤ 100ns	F = 60 Hz	Tj = 125°C	50	A/µs
I_{GM}	Peak gate current	tp = 20 µs	Tj = 125°C	0.5	A
$P_{G(AV)}$	Average gate power dissipation		Tj = 125°C	0.02	W
T_{stg} Tj	Storage junction temperature range Operating junction temperature range			- 40 to + 150 - 40 to + 125	°C

ELECTRICAL CHARACTERISTICS (Tj = 25°C, unless otherwise specified)

Symbol	Test Conditions			P0102BL	Unit
I_{GT}	V_D = 12 V R_L = 140 Ω		MAX.	200	µA
V_{GT}	V_D = 12 V R_L = 140 Ω		MAX.	0.8	V
V_{GD}	V_D = V_{DRM} R_L = 3.3 kΩ R_{GK} = 1 kΩ	Tj = 125°C	MIN.	0.1	V
V_{RG}	I_{RG} = 10 µA		MIN.	8	V
I_H	I_T = 50 mA R_{GK} = 1kΩ		MAX.	6	mA
I_L	I_G = 1 mA R_{GK} = 1kΩ		MAX.	7	mA
dV/dt	V_D = 67 % V_{DRM} R_{GK} = 1kΩ	Tj = 125°C	MIN.	200	V/µs
V_{TM}	I_{TM} = 0.4 A tp = 380 µs	Tj = 25°C	MAX.	1.7	V
V_{t0}	Threshold voltage	Tj = 125°C	MAX.	1.0	V
R_d	Dynamic resistance	Tj = 125°C	MAX.	1000	mΩ
I_{DRM} I_{RRM}	V_{DRM} = V_{RRM}	Tj = 25°C	MAX.	1	µA
		Tj = 125°C		100	

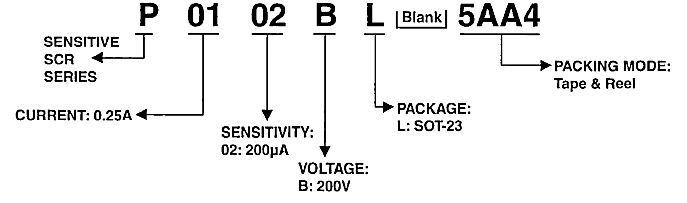
THERMAL RESISTANCES

Symbol	Parameter	Value	Unit
$R_{th(j-a)}$	Junction to ambient (mounted on FR4 with recommended pad layout)	400	°C/W

PRODUCT SELECTOR

Part Number	Voltage	Sensitivity	Package
P0102BL	200 V	200 µA	SOT-23

ORDERING INFORMATION



OTHER INFORMATION

Part Number	Marking	Weight	Base quantity	Packing mode
P0102BL	P2B	0.01 g	3000	Tape & reel

Fig. 1: Maximum average power dissipation versus average on-state current.

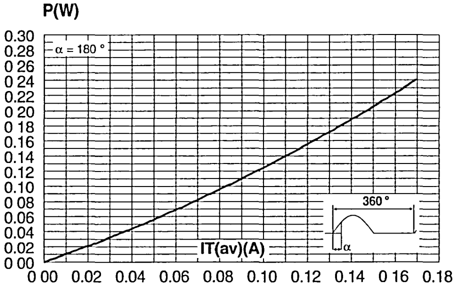


Fig. 2: Average and D.C. on-state current versus ambient temperature.

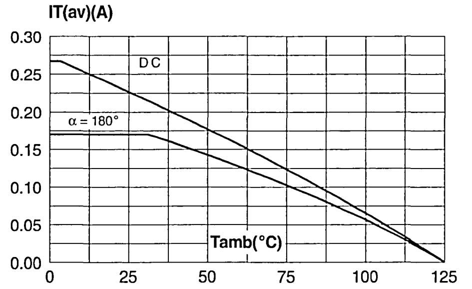


Fig. 3: Relative variation of thermal impedance junction to ambient versus pulse duration.

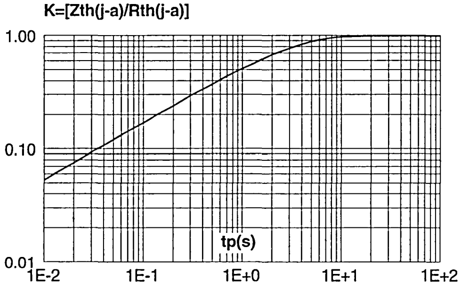


Fig. 4: Relative variation of gate trigger current, holding current and latching current versus junction temperature (typical values).

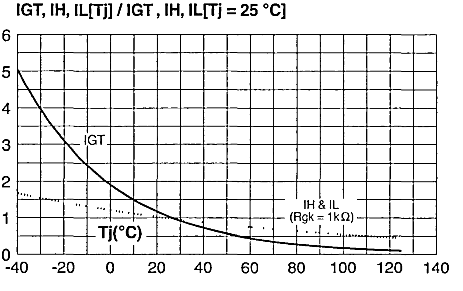


Fig. 5: Relative variation of holding current versus gate-cathode resistance (typical values).

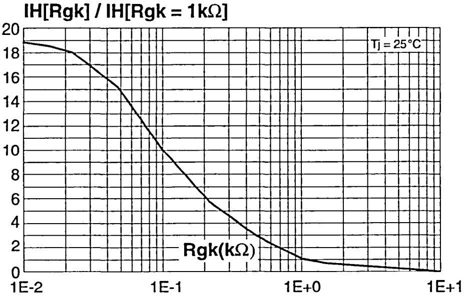


Fig. 6: Relative variation of dV/dt immunity versus gate-cathode resistance (typical values).

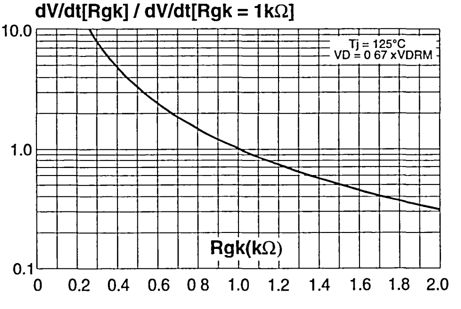


Fig. 7: Relative variation of dV/dt immunity versus gate-cathode capacitance (typical values).

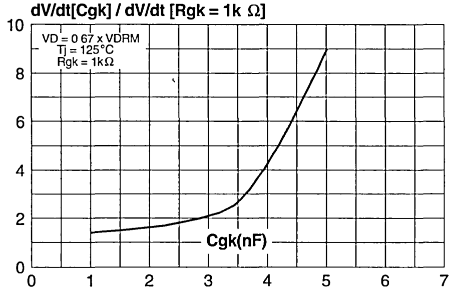


Fig. 8: Surge peak on-state current versus number of cycles.

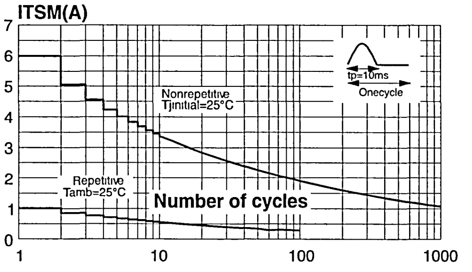


Fig. 9: Non-repetitive surge peak on-state current for a sinusoidal pulse with width tp < 10ms, and corresponding value of I^2t.

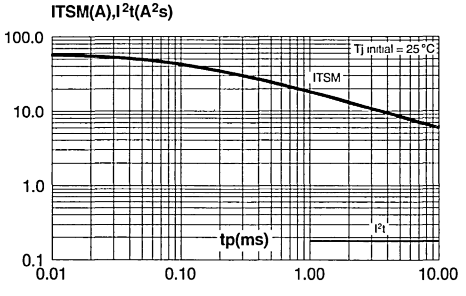


Fig. 10: On-state characteristics (maximum values).

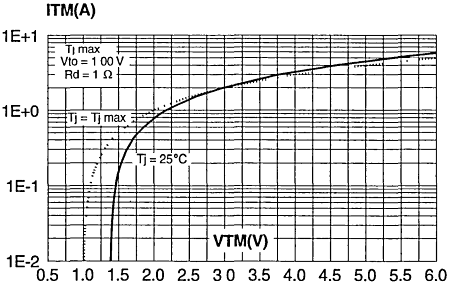
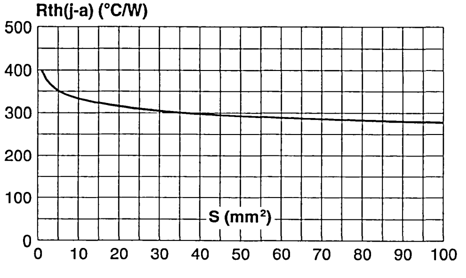


Fig. 11: Thermal resistance junction to ambient versus copper surface under tab (Epoxy printed circuit board FR4, copper thickness: 35 μm).

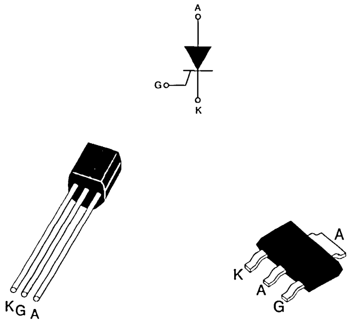


SENSITIVE

0.8A SCRs

MAIN FEATURES:

Symbol	Value	Unit
$I_{T(RMS)}$	0.8	A
V_{DRM}/V_{RRM}	400 and 600	V
I_{GT}	5 to 200	µA



TO-92 (P01xxA)

SOT-223 (P01xxN)

DESCRIPTION

Thanks to highly sensitive triggering levels, the P01 SCR series is suitable for all applications where available gate current is limited, such as ground fault circuit interrupters, pilot circuits in solid state relays, stand-by mode power supplies, smoke and alarm detectors.

Available in through-hole or surface mount packages, the voltage capability of this series has been upgrated since its introduction, to reach 600 V.

ABSOLUTE RATINGS (limiting values)

Symbol	Parameter			Value	Unit
$I_{T(RMS)}$	RMS on-state current (180° conduction angle)	TO-92	Tl = 55°C	0.8	A
		SOT-223	Tamb = 70°C		
$I_{T(AV)}$	Average on-state current (180° conduction angle)	TO-92	Tl = 55°C	0.5	A
		SOT-223	Tamb = 70°C		
I_{TSM}	Non repetitive surge peak on-state current	tp = 8.3 ms	Tj = 25°C	8	A
		tp = 10 ms		7	
I^2t	I^2t Value for fusing	tp = 10ms	Tj = 25°C	0.24	A^2s
dI/dt	Critical rate of rise of on-state current $I_G = 2 \times I_{GT}$, $tr \leq 100$ ns	F = 60 Hz	Tj = 125°C	50	A/µs
I_{GM}	Peak gate current	tp = 20 µs	Tj = 125°C	1	A
$P_{G(AV)}$	Average gate power dissipation		Tj = 125°C	0.1	W
T_{stg} Tj	Storage junction temperature range Operating junction temperature range			- 40 to + 150 - 40 to + 125	°C

ELECTRICAL CHARACTERISTICS (Tj = 25°C, unless otherwise specified)

Symbol	Test Conditions			P01xx 02	P01xx 11	P01xx 18	Unit
I_{GT}	V_D = 12 V R_L = 140 Ω		MIN.	-	4	0.5	µA
			MAX.	200	25	5	
V_{GT}			MAX.	0.8			V
V_{GD}	$V_D = V_{DRM}$ R_L = 3.3 kΩ R_{GK} = 1 kΩ	Tj = 125°C	MIN.	0.1			V
V_{RG}	I_{RG} = 10 µA		MIN.	8			V
I_H	I_T = 50 mA R_{GK} = 1 kΩ		MAX.	5			mA
I_L	I_G = 1 mA R_{GK} = 1 kΩ		MAX.	6			mA
dV/dt	V_D = 67 % V_{DRM} R_{GK} = 1 kΩ	Tj = 125°C	MIN.	75	80	75	V/µs
V_{TM}	I_{TM} = 1.6 A tp = 380 µs	Tj = 25°C	MAX.	1.95			V
V_{t0}	Threshold voltage	Tj = 125°C	MAX.	0.95			V
R_d	Dynamic resistance	Tj = 125°C	MAX.	600			mΩ
I_{DRM} I_{RRM}	$V_{DRM} = V_{RRM}$ = 400 V R_{GK} = 1 kΩ	Tj = 25°C	MAX.	1			µA
	$V_{DRM} = V_{RRM}$ = 600 V R_{GK} = 1 kΩ			10			µA
	$V_{DRM} = V_{RRM}$ R_{GK} = 1 kΩ	Tj = 125°C	MAX.	100			µA

THERMAL RESISTANCES

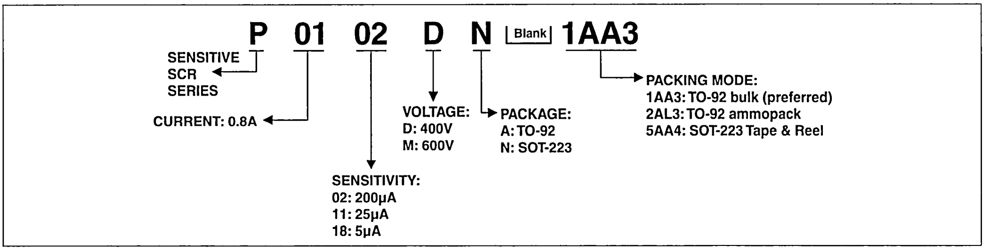
Symbol	Parameter			Value	Unit
$R_{th(j-l)}$	Junction to case (DC)		TO-92	80	°C/W
$R_{th(j-t)}$	Junction to tab (DC)		SOT-223	30	°C/W
$R_{th(j-a)}$	Junction to ambient		TO-92	150	
		S = 5 cm^2	SOT-223	60	

S = Copper surface under tab

PRODUCT SELECTOR

Part Number	Voltage 400 V	Voltage 600 V	Sensitivity	Package
P0102DA	X		200 µA	TO-92
P0102DN	X		200 µA	SOT-223
P0102MA		X	200 µA	TO-92
P0102MN		X	200 µA	SOT-223
P0111DA	X		25 µA	TO-92
P0111DN	X		25 µA	SOT-223
P0111MA		X	25 µA	TO-92
P0111MN		X	25 µA	SOT-223
P0118DA	X		5 µA	TO-92
P0118DN	X		5 µA	SOT-223
P0118MA		X	5 µA	TO-92
P0118MN		X	5 µA	SOT-223

ORDERING INFORMATION



OTHER INFORMATION

Part Number	Marking	Weight	Base Quantity	Packing mode
P01xxyA 1AA3	P01xxyA	0.2 g	2500	Bulk
P01xxyA 2AL3	P01xxyA	0.2 g	2000	Ammopack
P0102yN 5AA4	P2y	0.12 g	1000	Tape & reel
P0111yN 5AA4	P1y	0.12 g	1000	Tape & reel
P0118yN 5AA4	P8y	0.12 g	1000	Tape & reel

Note: xx = sensitivity, y = voltage

Fig. 1: Maximum average power dissipation versus average on-state current.

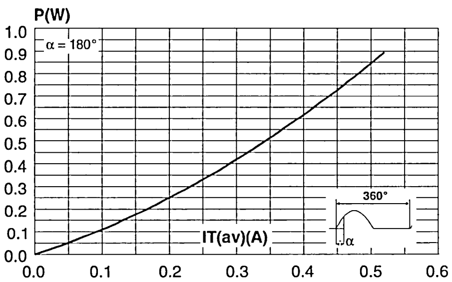


Fig. 2-1: Average and D.C. on-state current versus lead temperature.

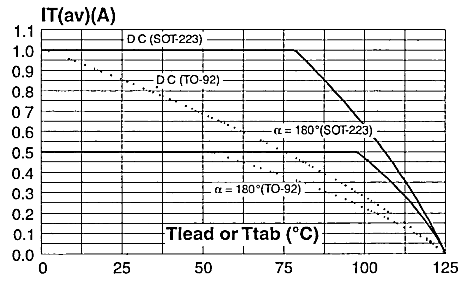


Fig. 2-2: Average and D.C. on-state current versus ambient temperature (device mounted on FR4 with recommended pad layout for SOT-223).

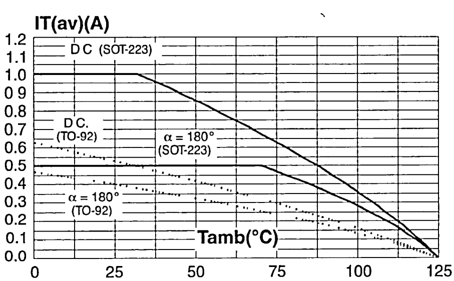


Fig. 3: Relative variation of thermal impedance junction to ambient versus pulse duration.

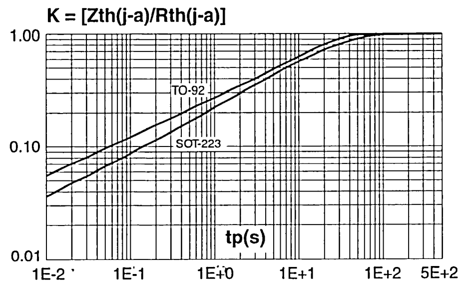


Fig. 4: Relative variation of gate trigger current, holding current and latching current versus junction temperature (typical values).

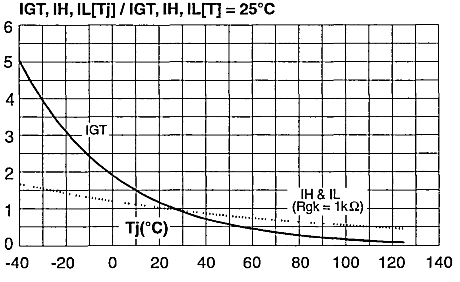


Fig. 5: Relative variation of holding current versus gate-cathode resistance (typical values).

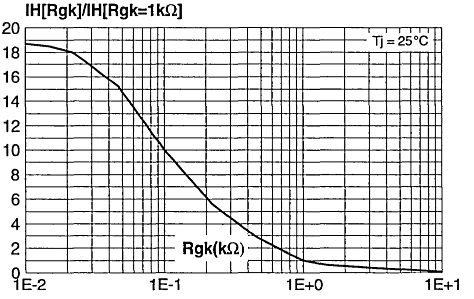


Fig. 6: Relative variation of dV/dt immunity versus gate-cathode resistance (typical values).

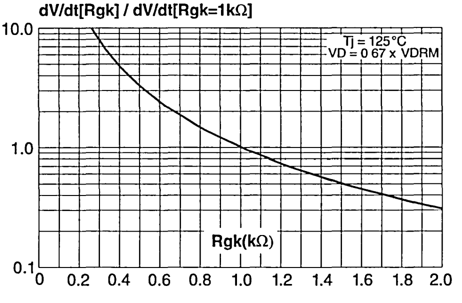


Fig. 7: Relative variation of dV/dt immunity versus gate-cathode capacitance (typical values).

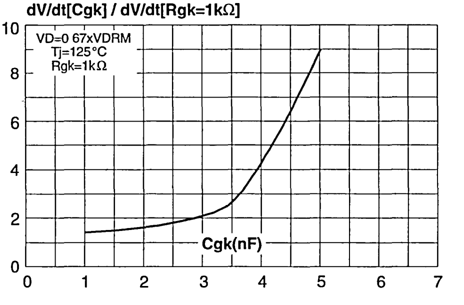


Fig. 8: Surge peak on-state current versus number of cycles.

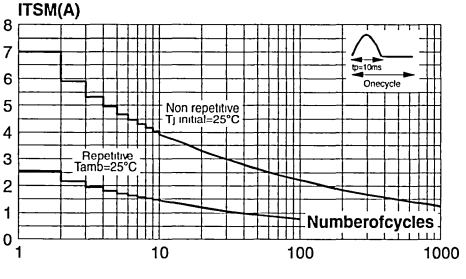


Fig. 9: Non-repetitive surge peak on-state current for a sinusoidal pulse with width tp < 10 ms, and corresponding value of I^2t.

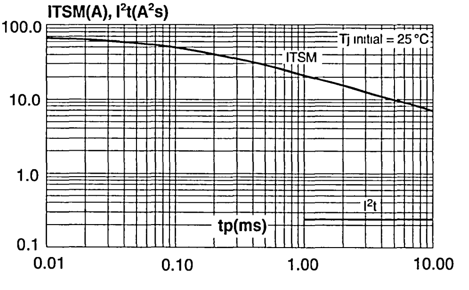


Fig. 10: On-state characteristics (maximum values).

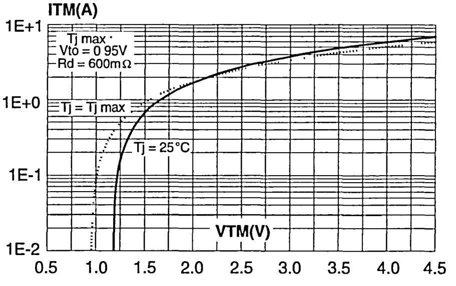
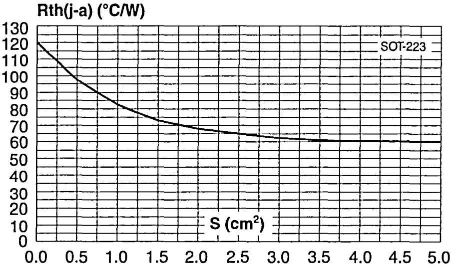


Fig. 11: SOT-223 Thermal resistance junction to ambient versus copper surface under tab (Epoxy printed circuit board FR4, copper thickness: 35 µm).

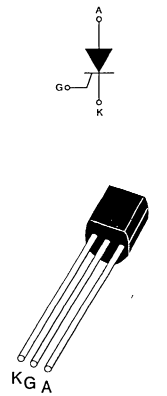


SENSITIVE

0.8A SCRs

MAIN FEATURES:

Symbol	Value	Unit
$I_{T(RMS)}$	0.8	A
V_{DRM}/V_{RRM}	600	V
I_{GT}	200	µA



TO-92

DESCRIPTION

Thanks to highly sensitive triggering levels, the X006 SCR series is suitable for all applications where the available gate current is limited, such as ground fault circuit interrupters, overvoltage crowbar protection in low power supplies, capacitive ignition circuits, ...

ABSOLUTE RATINGS (limiting values)

Symbol	Parameter			Value	Unit
$I_{T(RMS)}$	RMS on-state current (180° conduction angle)		Tl = 85°C	0.8	A
$I_{T(AV)}$	Average on-state current (180° conduction angle)		Tl = 85°C	0.5	A
I_{TSM}	Non repetitive surge peak on-state current	tp = 8.3 ms	Tj = 25°C	10	A
		tp = 10 ms		9	
I^2t	I^2t Value for fusing	tp = 10ms	Tj = 25°C	0.25	A^2s
dI/dt	Critical rate of rise of on-state current $I_G = 2 \times I_{GT}$, tr ≤ 100 ns	F = 60 Hz	Tj = 125°C	50	A/µs
I_{GM}	Peak gate current	tp = 20 µs	Tj = 125°C	1	A
$P_{G(AV)}$	Average gate power dissipation		Tj = 125°C	0.1	W
T_{stg} Tj	Storage junction temperature range Operating junction temperature range			- 40 to + 125 - 40 to + 125	°C

ELECTRICAL CHARACTERISTICS (Tj = 25°C, unless otherwise specified)

Symbol	Test Conditions			X00602MA	Unit
I_{GT}	V_D = 12 V R_L = 140 Ω		MAX.	200	µA
V_{GT}			MAX.	0.8	V
V_{GD}	V_D = V_{DRM} R_L = 3.3 kΩ R_{GK} = 1 kΩ	Tj = 125°C	MIN.	0.2	V
V_{RG}	I_{RG} = 10 µA		MIN.	5	V
I_H	I_T = 50 mA R_{GK} = 1 kΩ		MAX.	5	mA
I_L	I_G = 1 mA R_{GK} = 1 kΩ		MAX.	6	mA
dV/dt	V_D = 67 % V_{DRM} R_{GK} = 1 kΩ	Tj = 125°C	MIN.	25	V/µs
V_{TM}	I_{TM} = 1 A tp = 380 µs	Tj = 25°C	MAX.	1.35	V
V_{t0}	Threshold voltage	Tj = 125°C	MAX.	0.85	V
R_d	Dynamic resistance	Tj = 125°C	MAX.	245	mΩ
I_{DRM} I_{RRM}	V_{DRM} = V_{RRM} R_{GK} = 1 kΩ	Tj = 25°C	MAX.	1	µA
		Tj = 125°C		100	

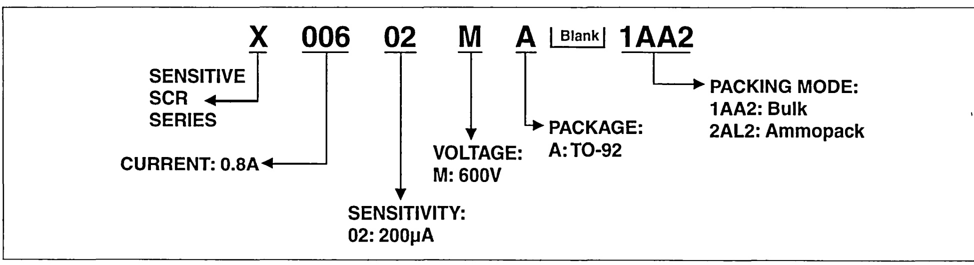
THERMAL RESISTANCES

Symbol	Parameter	Value	Unit
$R_{th(j-l)}$	Junction to lead (DC)	70	°C/W
$R_{th(j-a)}$	Junction to ambient (DC)	150	°C/W

PRODUCT SELECTOR

Part Number	Voltage	Sensitivity	Package
X00602MA	600 V	200 µA	TO-92

ORDERING INFORMATION



OTHER INFORMATION

Part Number	Marking	Weight	Base Quantity	Packing mode
X00602MA 1AA2	X0602MA	0.2 g	2500	Bulk
X00602MA 2AL2	X0602MA	0.2 g	2000	Ammopack

Fig. 1: Maximum average power dissipation versus average on-state current.

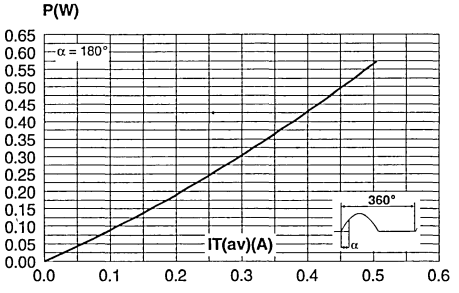


Fig. 2-1: Average and D.C. on-state current versus lead temperature.

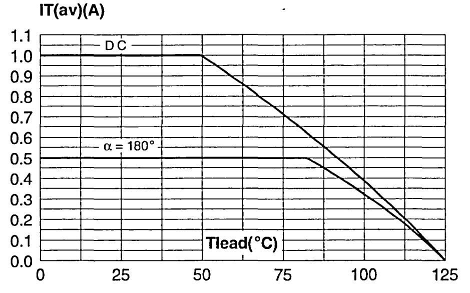


Fig. 2-2: Average and D.C. on-state current versus ambient temperature (device mounted on FR4 with recommended pad layout).

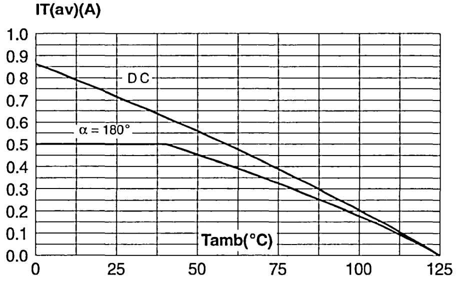


Fig. 3: Relative variation of thermal impedance junction to ambient versus pulse duration.

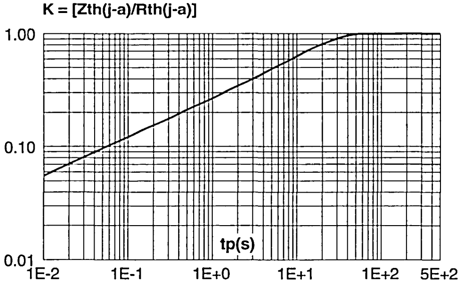


Fig. 4: Relative variation of gate trigger current, holding current and latching current versus junction temperature.

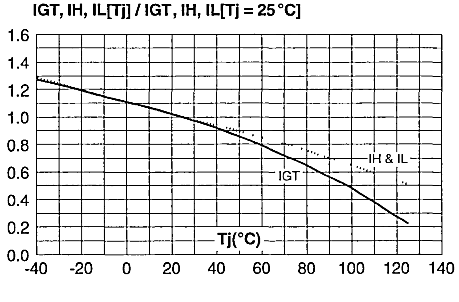


Fig. 5: Relative variation of holding current versus gate-cathode resistance (typical values).

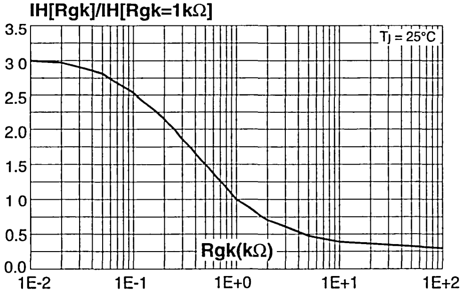


Fig. 6: Relative variation of dV/dt immunity versus gate-cathode resistance (typical values).

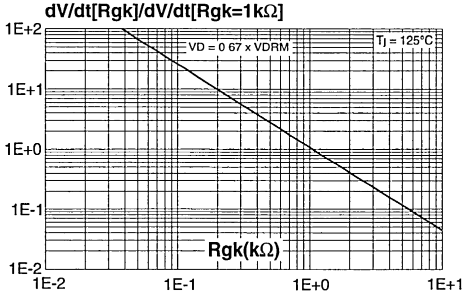


Fig. 7: Relative variation of dV/dt immunity versus gate-cathode capacitance (typical values).

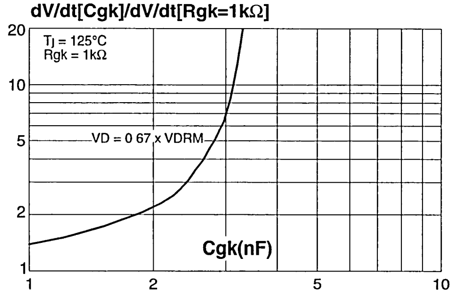


Fig. 8: Surge peak on-state current versus number of cycles.

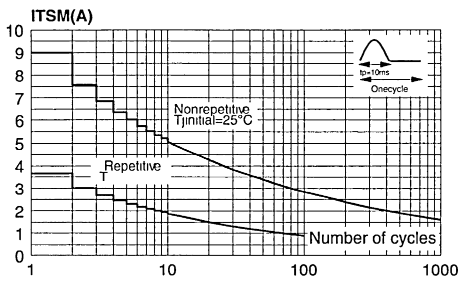


Fig. 9: Non-repetitive surge peak on-state current for a sinusoidal pulse with width tp < 10 ms, and corresponding value of I^2t.

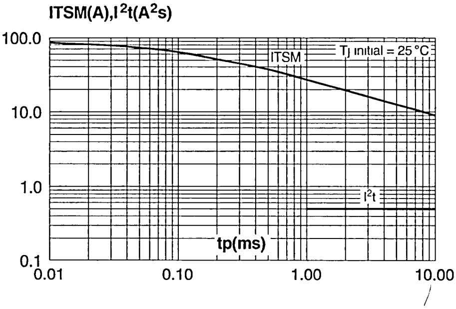
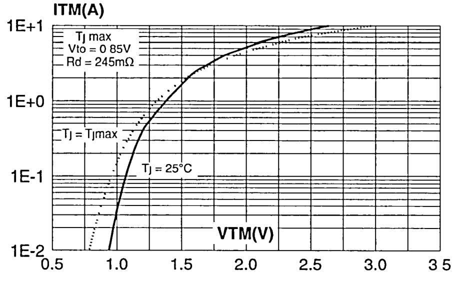


Fig. 10: On-state characteristics (maximum values).

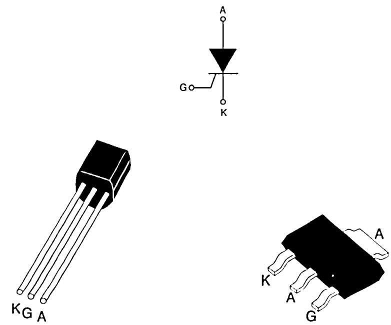


X02 Series

SENSITIVE 1.25A SCRs

MAIN FEATURES:

Symbol	Value	Unit
$I_{T(RMS)}$	1.25	A
V_{DRM}/V_{RRM}	600 and 800	V
I_{GT}	50 to 200	µA



TO-92 (X02xxA)

SOT-223 (X02xxN)

DESCRIPTION

Thanks to highly sensitive triggering levels, the X02 SCR series is suitable for all applications where the available gate current is limited, such as ground fault circuit interruptors, overvoltage crowbar protection in low power supplies, capacitive ignition circuits, ...

Available in though-hole or surface-mount packages, these devices are optimized in forward voltage drop and inrush current capabilities, for reduced power losses and high reliability in harsh environments.

ABSOLUTE RATINGS (limiting values)

Symbol	Parameter			Value	Unit
$I_{T(RMS)}$	RMS on-state current (180° conduction angle)	TO-92	Tl = 55°C	1.25	A
		SOT-223	Ttab = 95°C		
$IT_{(AV)}$	Average on-state current (180° conduction angle)	TO-92	Tl = 55°C	0.8	A
		SOT-223	Ttab = 95°C		
I_{TSM}	Non repetitive surge peak on-state current	tp = 8.3 ms	Tj = 25°C	25	A
		tp = 10 ms		22.5	
I^2t	I^2t Value for fusing	tp = 10 ms	Tj = 25°C	2.5	A^2s
dI/dt	Critical rate of rise of on-state current $I_G = 2 \times I_{GT}$, tr ≤ 100 ns	F = 60 Hz	Tj = 125°C	50	A/µs
I_{GM}	Peak gate current	tp = 20 µs	Tj = 125°C	1.2	A
$P_{G(AV)}$	Average gate power dissipation		Tj = 125°C	0.2	W
T_{stg} Tj	Storage junction temperature range Operating junction temperature range			- 40 to + 150 - 40 to + 125	°C

ELECTRICAL CHARACTERISTICS (Tj = 25°C, unless otherwise specified)

Symbol	Test Conditions			X02xx 02	X02xx 05	Unit
I_{GT}	V_D = 12 V R_L = 140 Ω		MIN.	-	20	μA
			MAX.	200	50	
V_{GT}			MAX.	0.8		V
V_{GD}	$V_D = V_{DRM}$ R_L = 3.3 kΩ R_{GK} = 1 kΩ	Tj = 125°C	MIN.	0.1		V
V_{RG}	I_{RG} = 10 μA		MIN.	8		V
I_H	I_T = 50 mA R_{GK} = 1 kΩ		MAX.	5		mA
I_L	I_G = 1 mA R_{GK} = 1 kΩ		MAX.	6		mA
dV/dt	V_D = 67 % V_{DRM} R_{GK} = 1 kΩ	Tj = 110°C	MIN.	10	15	V/μs
V_{TM}	I_{TM} = 2.5 A tp = 380 μs	Tj = 25°C	MAX.	1.45		V
V_{to}	Threshold voltage	Tj = 125°C	MAX.	0.9		V
R_d	Dynamic resistance	Tj = 125°C	MAX.	200		mΩ
I_{DRM} I_{RRM}	$V_{DRM} = V_{RRM}$ R_{GK} = 1 kΩ	Tj = 25°C	MAX.	5		μA
		Tj = 125°C		500		

THERMAL RESISTANCES

Symbol	Parameter			Value	Unit
$R_{th(j-l)}$	Junction to leads (DC)		TO-92	60	°C/W
$R_{th(j-t)}$	Junction to tab (DC)		SOT-223	25	
$R_{th(j-a)}$	Junction to ambient (DC)		TO-92	150	
		S = 5 cm^2	SOT-223	60	

S = Copper surface under tab

PRODUCT SELECTOR

Part Number	Voltage 600 V	Voltage 800 V	Sensitivity	Package
X0202MA	X		200 μA	TO-92
X0202MN	X		200 μA	SOT-223
X0202NA		X	200 μA	TO-92
X0202NN		X	200 μA	SOT-223
X0205MA	X		50 μA	TO-92
X0205MN	X		50 μA	SOT-223
X0205NA		X	50 μA	TO-92
X0205NN		X	50 μA	SOT-223

ORDERING INFORMATION

X 02 02 M A [Blank] 1BA2

- X — SENSITIVE SCR SERIES
- 02 — CURRENT: 1.25A
- 02 — SENSITIVITY: 02: 200µA, 05: 50µA
- M — VOLTAGE: M: 600V, N: 800V
- A — PACKAGE: A: TO-92, N: SOT-223
- 1BA2 — PACKING MODE: 1BA2: TO-92 Bulk, 2BL2: TO-92 Ammopack, 5BA4: SOT-223 Tape & Reel

OTHER INFORMATION

Part Number	Marking	Weight	Base Quantity	Packing mode
X02xxyA 1BA2	X02xxyA	0.2 g	2500	Bulk
X02xxyA 2BL2	X02xxyA	0.2 g	2000	Ammopack
X0202yN 5BA4	X2y	0.12 g	1000	Tape & reel
X0205yN 5BA4	X5y	0.12 g	1000	Tape & reel

Note. xx = sensitivity, y = voltage

Fig. 1: Maximum average power dissipation versus average on-state current.

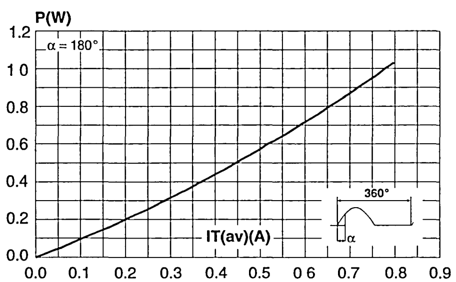


Fig. 2-1: Average and D.C. on-state current versus lead temperature (SOT-223/TO-92).

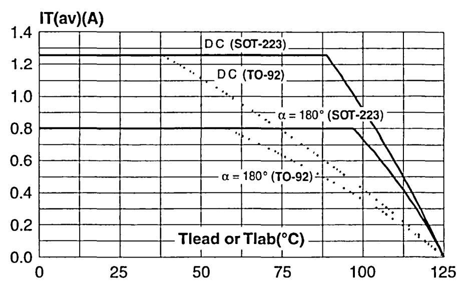


Fig. 2-2: Average and D.C. on-state current versus ambient temperature (device mounted on FR4 with recommended pad layout) (SOT-223/ TO-92).

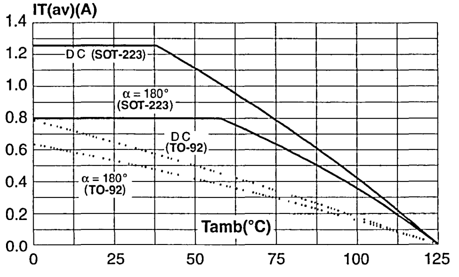


Fig. 3: Relative variation of thermal impedance junction to ambient versus pulse duration (SOT-223/TO-92).

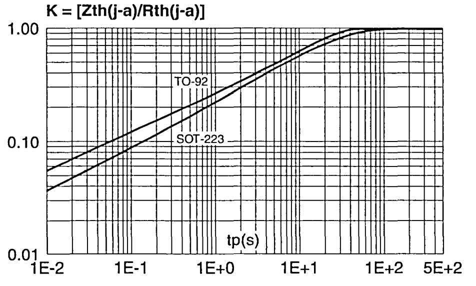


Fig. 4: Relative variation of gate trigger current, holding current and latching current versus junction temperature (typical values).

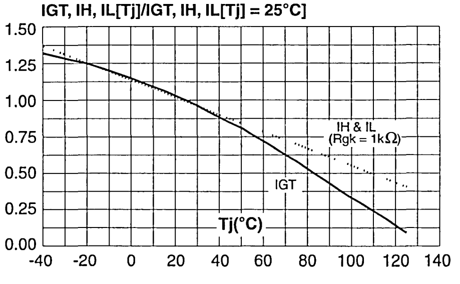


Fig. 5: Relative variation of holding current versus gate-cathode resistance (typical values).

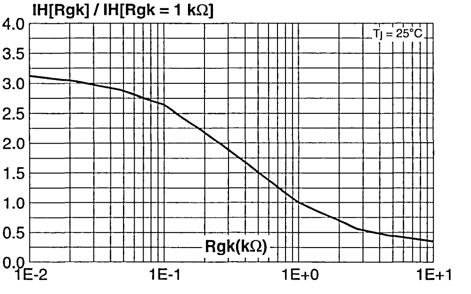


Fig. 6: Relative variation of dV/dt immunity versus gate-cathode resistance (typical values).

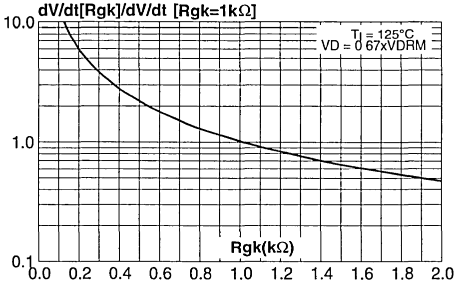


Fig. 7: Relative variation of dV/dt immunity versus gate-cathode capacitance (typical values).

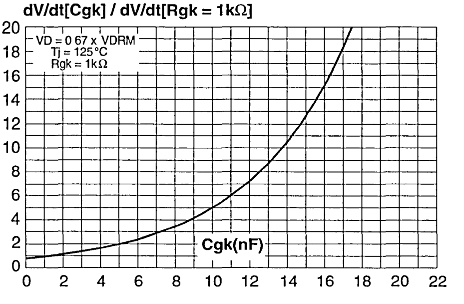


Fig. 8: Surge peak on-state current versus number of cycles.

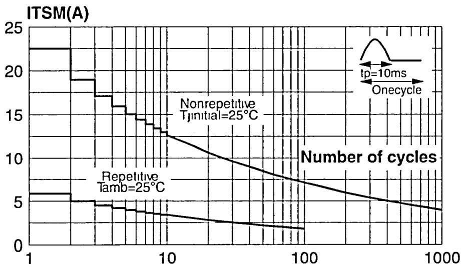


Fig. 9: Non-repetitive surge peak on-state current for a sinusoidal pulse with width tp < 10 ms, and corresponding value of I²t.

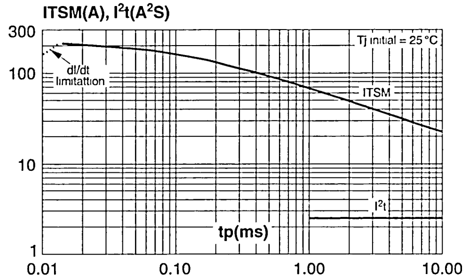


Fig. 10: On-state characteristics (maximum values).

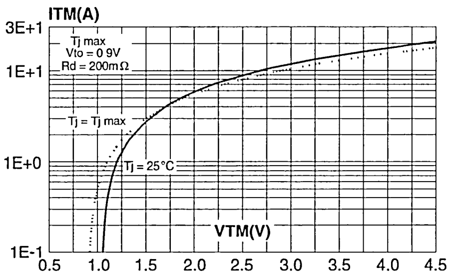
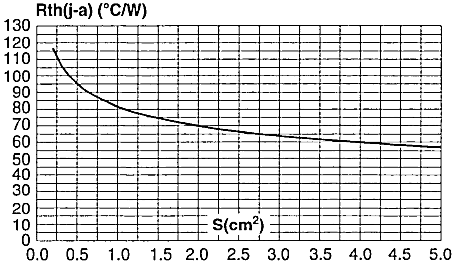


Fig. 11: Thermal resistance junction to ambient versus copper surface under tab (Epoxy printed circuit board FR4, copper thickness: 35 µm) (SOT-223).



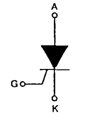
X04 Series

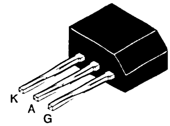
SENSITIVE

4A SCRs

MAIN FEATURES:

Symbol	Value	Unit
$I_{T(RMS)}$	4	A
V_{DRM}/V_{RRM}	600 and 800	V
I_{GT}	50 to 200	µA





TO202-3
(X04xxF)

DESCRIPTION

Thanks to highly sensitive triggering levels, the X04 SCR series is suitable for all applications where the available gate current is limited, such as capacitive discharge ignitions, motor control in kitchen aids, overvoltage crowbar protection in low power supplies...

ABSOLUTE RATINGS (limiting values)

Symbol	Parameter			Value	Unit
$I_{T(RMS)}$	RMS on-state current (180° conduction angle)		Tl = 60°C	4	A
			Tamb = 25°C	1.35	
$I_{T(AV)}$	Average on-state current (180° conduction angle)		Tl = 60°C	2.5	A
			Tamb = 25°C	0.9	
I_{TSM}	Non repetitive surge peak on-state current	tp = 8.3 ms	Tj = 25°C	33	A
		tp = 10 ms		30	
I^2t	I^2t Value for fusing	tp = 10 ms	Tj = 25°C	4.5	A^2s
dI/dt	Critical rate of rise of on-state current $I_G = 2 \times I_{GT}$, tr ≤ 100ns	F = 60 Hz	Tj = 125°C	50	A/µs
I_{GM}	Peak gate current	tp = 20 µs	Tj = 125°C	1.2	A
$P_{G(AV)}$	Average gate power dissipation		Tj = 125°C	0.2	W
T_{stg} Tj	Storage junction temperature range Operating junction temperature range			- 40 to + 150 - 40 to + 125	°C

ELECTRICAL CHARACTERISTICS (Tj = 25°C, unless otherwise specified)

Symbol	Test Conditions			X04xx 02	X04xx 05	Unit
I_{GT}	V_D = 12 V R_L = 140 Ω		MIN.	–	20	μA
			MAX.	200	50	
V_{GT}			MAX.	0.8		V
V_{GD}	$V_D = V_{DRM}$ R_L = 3.3 kΩ R_{GK} = 1 kΩ	Tj = 125°C	MIN.	0.1		V
V_{RG}	I_{RG} = 10 μA		MIN.	8		V
I_H	I_T = 50mA R_{GK} = 1kΩ		MAX.	5		mA
I_L	I_G = 1mA R_{GK} = 1kΩ		MIN.	6		mA
dV/dt	V_D = 67% V_{DRM} R_{GK} = 1kΩ	Tj = 110°C	MIN.	10	15	V/μs
V_{TM}	I_{TM} = 8 A tp = 380 μs	Tj = 25°C	MAX.	1.8		V
V_{t0}	Threshold voltage	Tj = 125°C	MAX.	0.95		V
R_d	Dynamic resistance	Tj = 125°C	MAX.	100		mΩ
I_{DRM} I_{RRM}	$V_{DRM} = V_{RRM}$ R_{GK} = 1 kΩ	Tj = 25°C	MAX.	5		μA
		Tj = 125°C		1		mA

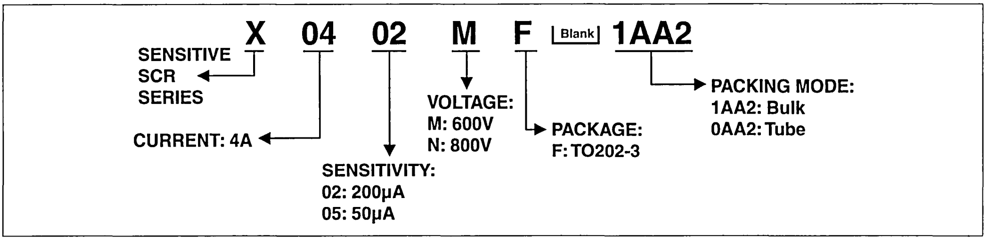
THERMAL RESISTANCES

Symbol	Parameter	Value	Unit
$R_{th(j-l)}$	Junction to leads (DC)	15	°C/W
$R_{th(j-a)}$	Junction to ambient (DC)	100	

PRODUCT SELECTOR

Part Number	Voltage 600 V	Voltage 800 V	Sensitivity	Package
X0402MF	X		200 μA	TO202-3
X0402NF		X	200 μA	TO202-3
X0405MF	X		50 μA	TO202-3
X0405NF		X	50 μA	TO202-3

ORDERING INFORMATION



OTHER INFORMATION

Part Number	Marking	Weight	Base Quantity	Packing mode
X04xxyF 1AA2	X04xxyF	0.8 g	250	Bulk
X04xxyF 0AA2	X04xxyF	0.8 g	50	Tube

Note: xx = sensitivity, y = voltage

Fig. 1: Maximum average power dissipation versus average on-state current.

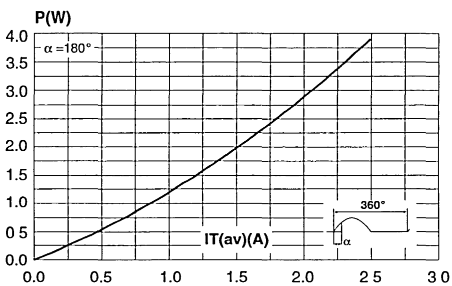


Fig. 2-1: Average and D.C. on-state current versus lead temperature.

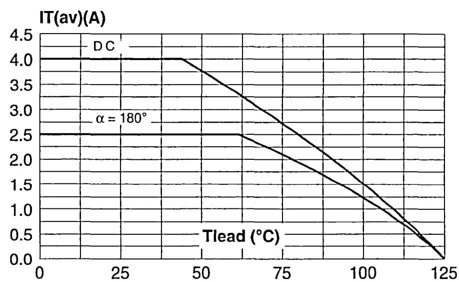


Fig. 2-2: Average and D.C. on-state current versus ambient temperature (device mounted on FR4 with recommended pad layout).

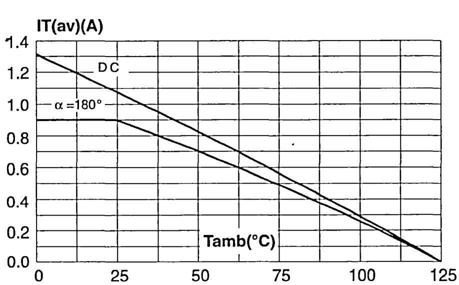


Fig. 3: Relative variation of thermal impedance junction to ambient versus pulse duration.

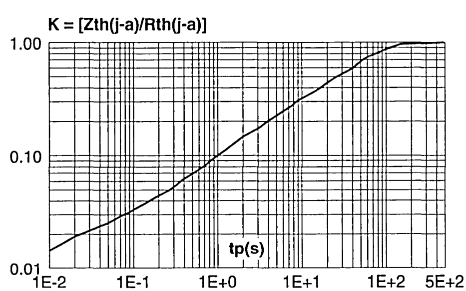


Fig. 4: Relative variation of gate trigger current, holding current and latching current versus junction temperature (typical values).

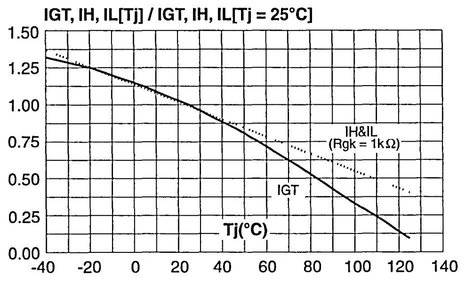


Fig. 5: Relative variation of holding current versus gate-cathode resistance (typical values).

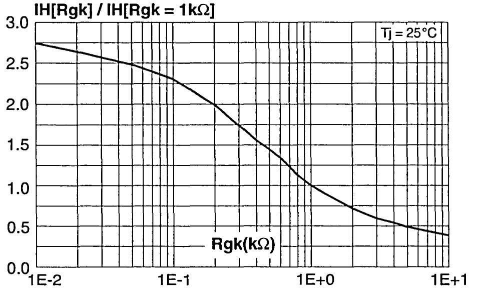


Fig. 6: Relative variation of dV/dt immunity versus gate-cathode resistance (typical values).

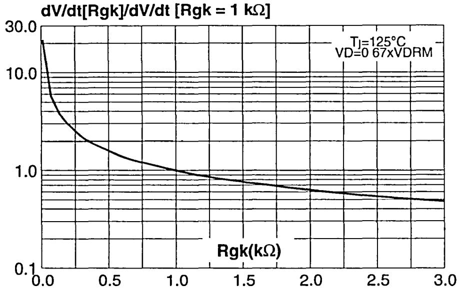


Fig. 7: Relative variation of dV/dt immunity versus gate-cathode capacitance (typical values).

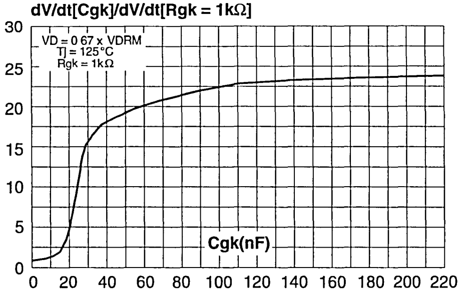


Fig. 8: Surge peak on-state current versus number of cycles.

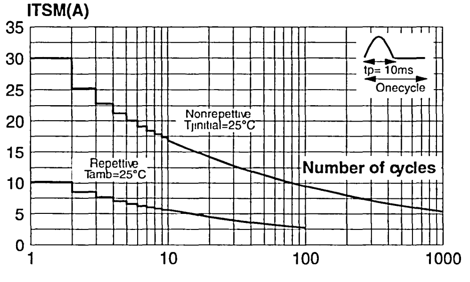


Fig. 9: Non-repetitive surge peak on-state current for a sinusoidal pulse with width tp < 10 ms, and corresponding value of I²t.

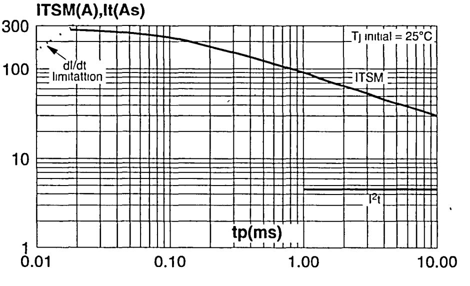
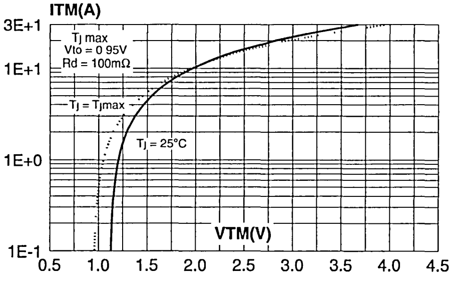


Fig. 10: On-state characteristics (maximum values).

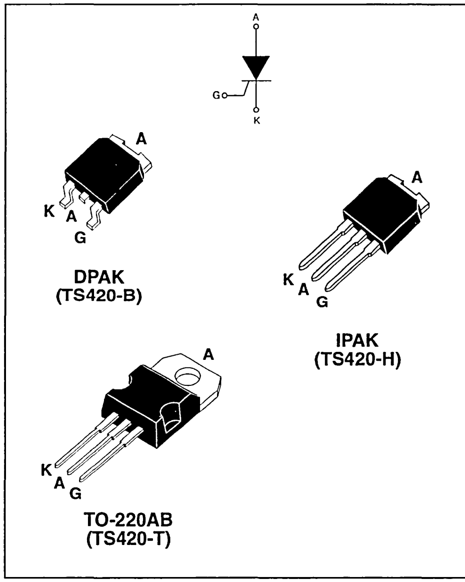


SENSITIVE

4A SCRs

MAIN FEATURES:

Symbol	Value	Unit
$I_{T(RMS)}$	4	A
V_{DRM}/V_{RRM}	600 and 700	V
I_{GT}	200	µA



DESCRIPTION

Thanks to highly sensitive triggering levels, the TS420 series is suitable for all applications where the available gate current is limited, such as motor control for hand tools, kitchen aids, overvoltage crowbar protection for low power supplies, ...
Available in through-hole or surface-mount packages, they provide an optimized performance in a limited space area.

ABSOLUTE RATINGS (limiting values)

Symbol	Parameter			Value	Unit
$I_{T(RMS)}$	RMS on-state current (180° conduction angle)		Tl = 115°C	4	A
$I_{T(AV)}$	Average on-state current (180° conduction angle)		Tl = 115°C	2.5	A
I_{TSM}	Non repetitive surge peak on-state current	tp = 8.3 ms	Tj = 25°C	33	A
		tp = 10 ms		30	
I^2t	I^2t Value for fusing	tp = 10 ms	Tj = 25°C	4.5	A^2s
dI/dt	Critical rate of rise of on-state current $I_G = 2 \times I_{GT}$, tr ≤ 100 ns	F = 60 Hz	Tj = 125°C	50	A/µs
I_{GM}	Peak gate current	tp = 20 µs	Tj = 125°C	1.2	A
$P_{G(AV)}$	Average gate power dissipation		Tj = 125°C	0.2	W
T_{stg} Tj	Storage junction temperature range Operating junction temperature range			- 40 to + 150 - 40 to + 125	°C

ELECTRICAL CHARACTERISTICS (Tj = 25°C, unless otherwise specified)

Symbol	Test Conditions			TS420	Unit
I_{GT}	V_D = 12 V R_L = 33 Ω		MAX.	200	µA
V_{GT}	V_D = 12 V R_L = 33 Ω		MAX.	0.8	V
V_{GD}	$V_D = V_{DRM}$ R_L = 3.3 kΩ R_{GK} = 220 Ω	Tj = 125°C	MIN.	0.1	V
V_{RG}	I_{RG} = 10 µA		MIN.	8	V
I_H	I_T = 50 mA R_{GK} = 1 kΩ		MAX.	5	mA
I_L	I_G = 1 mA R_{GK} = 1 kΩ		MAX.	6	mA
dV/dt	V_D = 67 % V_{DRM} R_{GK} = 220 Ω	Tj = 125°C	MIN.	5	V/µs
V_{TM}	I_{TM} = 8 A tp = 380 µs	Tj = 25°C	MAX.	1.6	V
V_{t0}	Threshold voltage	Tj = 125°C	MAX.	0.85	V
R_d	Dynamic resistance	Tj = 125°C	MAX.	90	mΩ
I_{DRM} I_{RRM}	$V_{DRM} = V_{RRM}$ R_{GK} = 220 Ω	Tj = 25°C	MAX.	5	µA
		Tj = 125°C		1	mA

THERMAL RESISTANCES

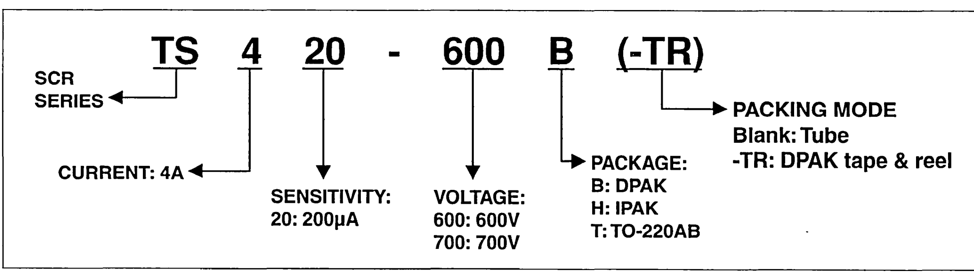
Symbol	Parameter			Value	Unit
$R_{th(j-c)}$	Junction to case (DC)			3.0	°C/W
$R_{th(j-a)}$	Junction to ambient (DC)	S = 0.5 cm^2	DPAK	70	°C/W
			IPAK	100	
			TO-220AB	60	

S = copper surface under tab

PRODUCT SELECTOR

Part Number	Voltage (xxx)		Sensitivity	Package
	600 V	700 V		
TS420-xxxB	X	X	200 µA	DPAK
TS420-xxxH	X	X	200 µA	IPAK
TS420-xxxT	X	X	200 µA	TO-220AB

ORDERING INFORMATION



OTHER INFORMATION

Part Number	Marking	Weight	Base Quantity	Packing mode
TS420-x00B	TS420x00	0.3 g	75	Tube
TS420-x00B-TR	TS420x00	0.3 g	2500	Tape & reel
TS420-x00H	TS420x00	0.4 g	75	Tube
TS420-x00T	TS420x00T	2.3 g	50	Tube

Note: x = voltage

Fig. 1: Maximum average power dissipation versus average on-state current.

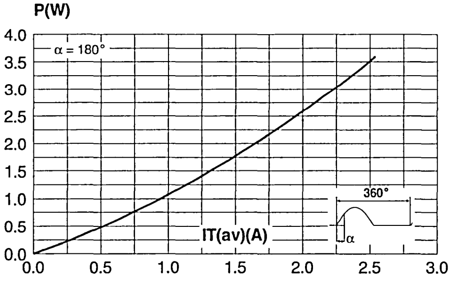


Fig. 2-1: Average and D.C. on-state current versus case temperature.

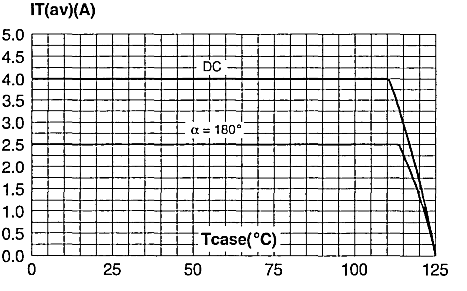


Fig. 2-2: Average and D.C. on-state current versus ambient temperature (device mounted on FR4 with recommended pad layout) (DPAK).

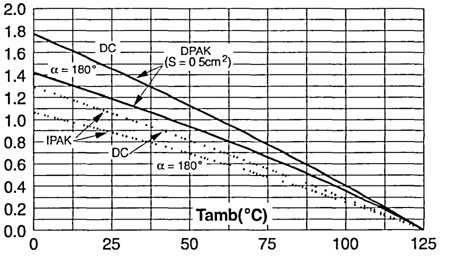


Fig. 3: Relative variation of thermal impedance junction to ambient versus pulse duration (recommended pad layout, FR4 PC board) for DPAK.

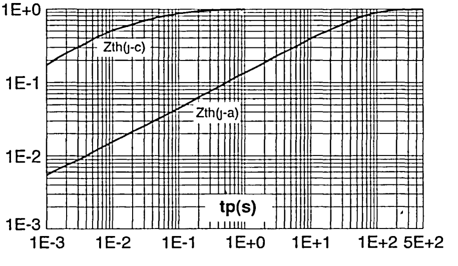


Fig. 4: Relative variation of gate trigger current and holding current versus junction temperature.

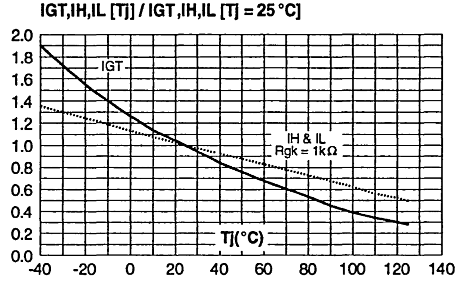


Fig. 5: Relative variation of holding current versus gate-cathode resistance (typical values).

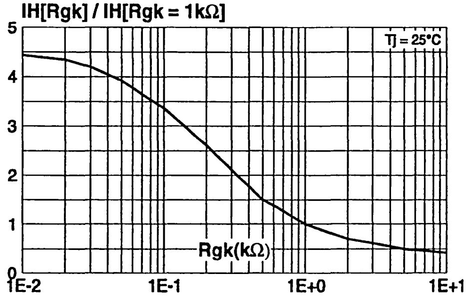


Fig. 6: Relative variation of dV/dt immunity versus gate-cathode resistance (typical values).

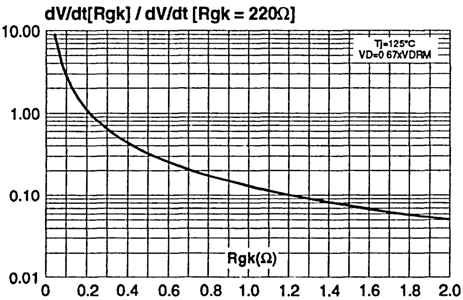


Fig. 7: Relative variation of dV/dt immunity versus gate-cathode resistance (typical values).

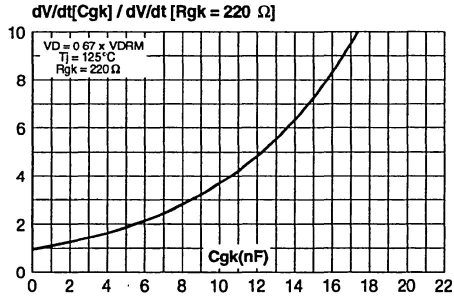


Fig. 8: Surge peak on-state current versus number of cycles.

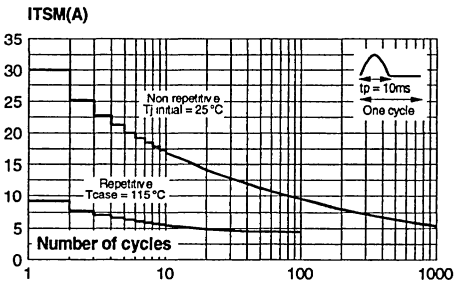


Fig. 9: Non-repetitive surge peak on-state current for a sinusoidal pulse with width tp < 10 ms, and corresponding values of I²t.

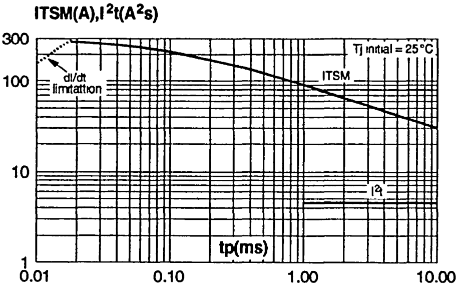


Fig. 10: On-state characteristics (maximum values).

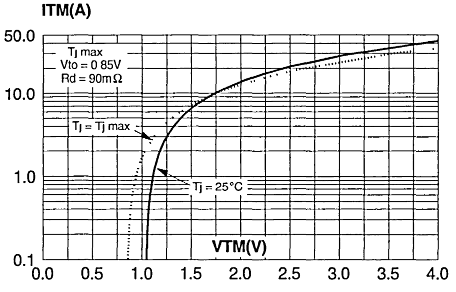
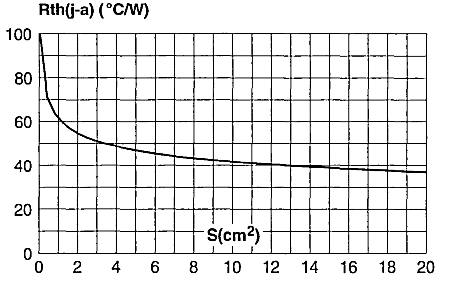


Fig. 11: Thermal resistance junction to ambient versus copper surface under tab (Epoxy printed circuit board FR4, copper thickness: 35 µm) (DPAK).

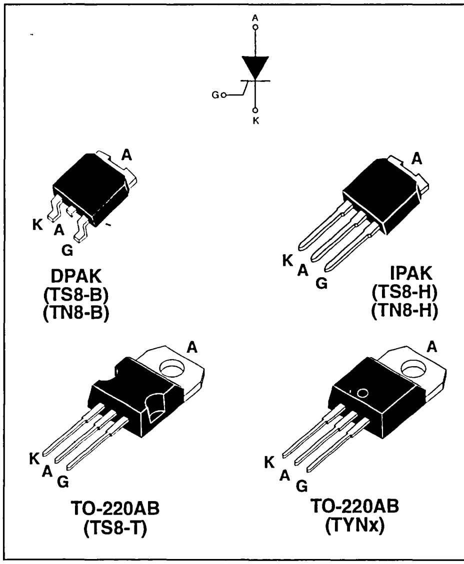


TN8, TS8 and TYNx08 Series

SENSITIVE & STANDARD — 8A SCRs

MAIN FEATURES:

Symbol	Value	Unit
$I_{T(RMS)}$	8	A
V_{DRM}/V_{RRM}	600 to 1000	V
I_{GT}	0.2 to 15	mA



DESCRIPTION

Available either in sensitive (TS8) or standard (TN8 / TYN) gate triggering levels, the 8A SCR series is suitable to fit all modes of control, found in applications such as overvoltage crowbar protection, motor control circuits in power tools and kitchen aids, inrush current limiting circuits, capacitive discharge ignition and voltage regulation circuits...
Available in through-hole or surface-mount packages, they provide an optimized performance in a limited space area.

ABSOLUTE RATINGS (limiting values)

Symbol	Parameter			Value		Unit
$I_{T(RMS)}$	RMS on-state current (180° conduction angle)		Tc = 110°C	8		A
$I_{T(AV)}$	Average on-state current (180° conduction angle)		Tc = 110°C	5		A
				TS8/TN8	TYN	
I_{TSM}	Non repetitive surge peak on-state current	tp = 8.3 ms	Tj = 25°C	73	100	A
		tp = 10 ms		70	95	
I^2t	I^2t Value for fusing	tp = 10 ms	Tj = 25°C	24.5	45	A^2s
dI/dt	Critical rate of rise of on-state current $I_G = 2 \times I_{GT}$, tr ≤ 100 ns	F = 60 Hz	Tj = 125°C	50		A/µs
I_{GM}	Peak gate current	tp = 20 µs	Tj = 125°C	4		A
$P_{G(AV)}$	Average gate power dissipation		Tj = 125°C	1		W
T_{stg} Tj	Storage junction temperature range Operating junction temperature range			- 40 to + 150 - 40 to + 125		°C
V_{RGM}	Maximum peak reverse gate voltage (for TN8 & TYN only)			5		V

ELECTRICAL CHARACTERISTICS (Tj = 25°C, unless otherwise specified)

■ SENSITIVE

Symbol	Test Conditions			TS820	Unit
I_{GT}	V_D = 12 V R_L = 140 Ω		MAX.	200	µA
V_{GT}			MAX.	0.8	V
V_{GD}	$V_D = V_{DRM}$ R_L = 3.3 kΩ R_{GK} = 220 Ω	Tj = 125°C	MIN.	0.1	V
V_{RG}	I_{RG} = 10 µA		MIN.	8	V
I_H	I_T = 50 mA R_{GK} = 1 kΩ		MAX.	5	mA
I_L	I_G = 1 mA R_{GK} = 1 kΩ		MAX.	6	mA
dV/dt	V_D = 65 % V_{DRM} R_{GK} = 220 Ω	Tj = 125°C	MIN.	5	V/µs
V_{TM}	I_{TM} = 16 A tp = 380 µs	Tj = 25°C	MAX.	1.6	V
V_{t0}	Threshold voltage	Tj = 125°C	MAX.	0.85	V
R_d	Dynamic resistance	Tj = 125°C	MAX.	46	mΩ
I_{DRM} I_{RRM}	$V_{DRM} = V_{RRM}$ R_{GK} = 220 Ω	Tj = 25°C	MAX.	5	µA
		Tj = 125°C		1	mA

■ STANDARD

Symbol	Test Conditions			TN805	TN815	TYNx08	Unit
I_{GT}	V_D = 12 V R_L = 33 Ω		MIN.	0.5	2	2	mA
			MAX.	5	15	15	
V_{GT}			MAX.	1.3			V
V_{GD}	$V_D = V_{DRM}$ R_L = 3.3 kΩ	Tj = 125°C	MIN.	0.2			V
I_H	I_T = 100 mA Gate open		MAX.	25	40	30	mA
I_L	I_G = 1.2 I_{GT}		MAX.	30	50	70	mA
dV/dt	V_D = 67 % V_{DRM} Gate open	Tj = 125°C	MIN.	50	150	150	V/µs
V_{TM}	I_{TM} = 16 A tp = 380 µs	Tj = 25°C	MAX.	1.6			V
V_{t0}	Threshold voltage	Tj = 125°C	MAX.	0.85			V
R_d	Dynamic resistance	Tj = 125°C	MAX.	46			mΩ
I_{DRM} I_{RRM}	$V_{DRM} = V_{RRM}$	Tj = 25°C	MAX.	5			µA
		Tj = 125°C		2			mA

THERMAL RESISTANCES

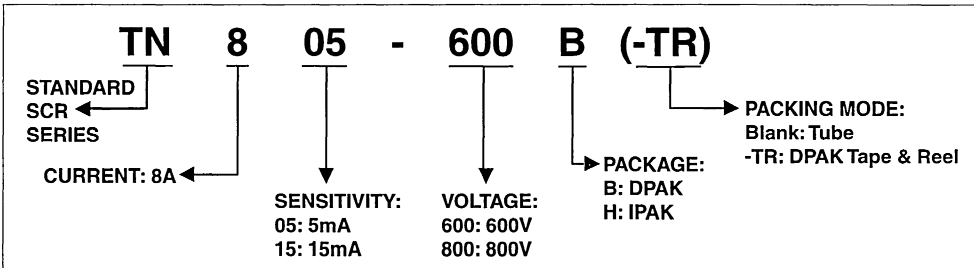
Symbol	Parameter			Value	Unit
$R_{th(j-c)}$	Junction to case (DC)			20	°C/W
$R_{th(j-a)}$	Junction to ambient (DC)		TO-220AB	60	°C/W
			IPAK	100	
		S = 0.5 cm^2	DPAK	70	

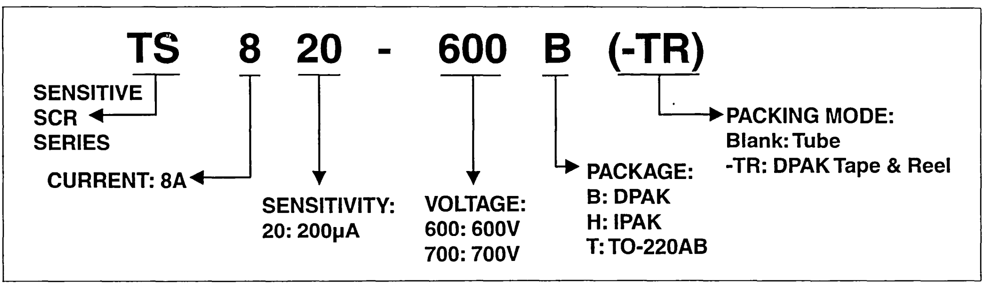
S= copper surface under tab

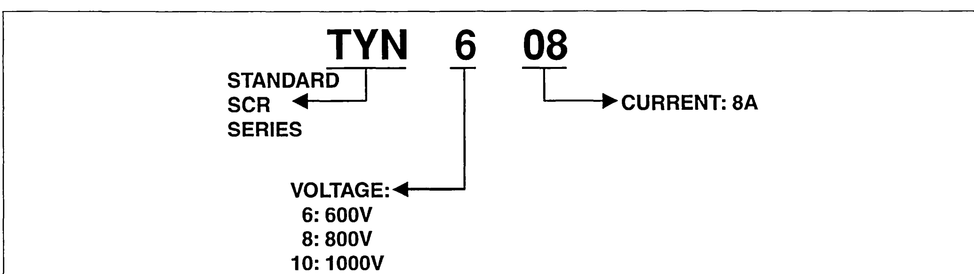
PRODUCT SELECTOR

Part Number	Voltage (xxx)				Sensitivity	Package
	600 V	700 V	800 V	1000 V		
TN805-xxxB	X		X		5 mA	DPAK
TN805-xxxH	X		X		5 mA	IPAK
TN815-xxxB	X		X		15 mA	DPAK
TN815-xxxH	X		X		15 mA	IPAK
TS820-xxxB	X	X			0.2 mA	DPAK
TS820-xxxH	X	X			0.2 mA	IPAK
TS820-xxxT	X	X			0.2 mA	TO-220AB
TYNx08	X		X	X	15 mA	TO-220AB

ORDERING INFORMATION







OTHER INFORMATION

Part Number	Marking	Weight	Base Quantity	Packing mode
TN805-x00B	TN805x00	0.3 g	75	Tube
TN805-x00B-TR	TN805x00	0.3 g	2500	Tape & reel
TN805-x00H	TN805x00	0.4 g	75	Tube
TN815-x00B	TN815x00	0.3 g	75	Tube
TN815-x00B-TR	TN815x00	0.3 g	2500	Tape & reel
TN815-x00H	TN815x00	0.4 g	75	Tube
TS820-x00B	TS820x00	0.3 g	75	Tube
TS820-x00B-TR	TS820x00	0.3 g	2500	Tape & reel
TS820-x00H	TS820x00	0.4 g	75	Tube
TS820-x00T	TS820x00T	2.3 g	50	Tube
TYNx08	TYNx08	2.3 g	250	Bulk

Note: x = voltage

Fig. 1: Maximum average power dissipation versus average on-state current.

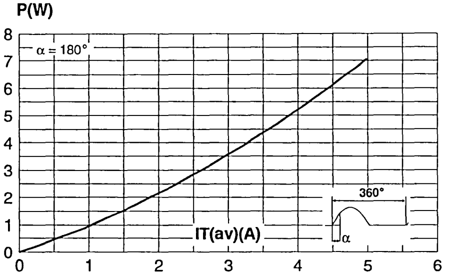


Fig. 2-1: Average and D.C. on-state current versus case temperature.

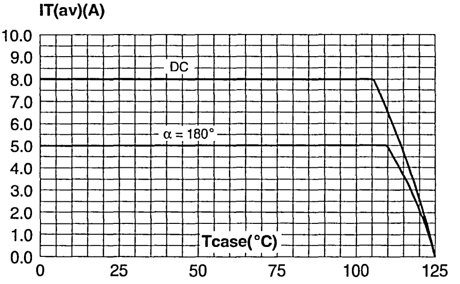


Fig. 2-2: Average and D.C. on-state current versus ambient temperature (device mounted on FR4 with recommended pad layout) (DPAK).

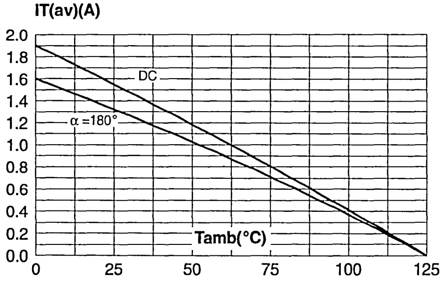


Fig. 3-1: Relative variation of thermal impedance junction to case versus pulse duration.

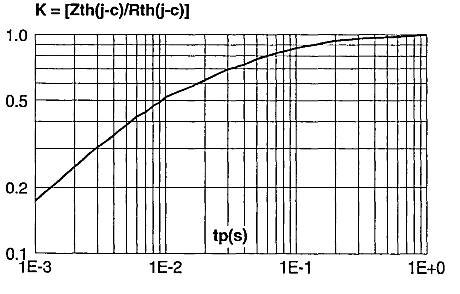


Fig. 3-2: Relative variation of thermal impedance junction to ambient versus pulse duration (recommended pad layout, FR4 PC board for DPAK).

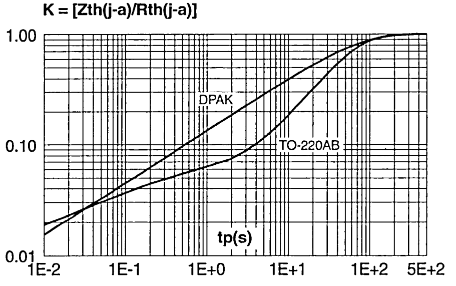


Fig. 4-1: Relative variation of gate trigger current and holding current versus junction temperature for TS8 series.

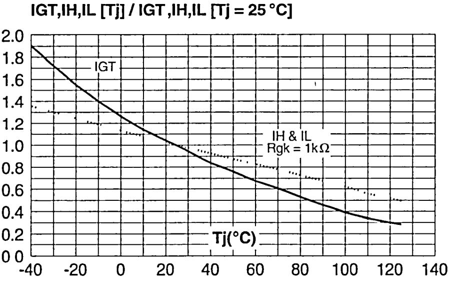


Fig. 4-2: Relative variation of gate trigger current and holding current versus junction temperature for TN8 & TYN series.

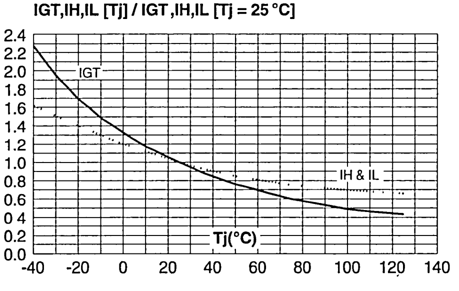


Fig. 5: Relative variation of holding current versus gate-cathode resistance (typical values) for TS8 series.

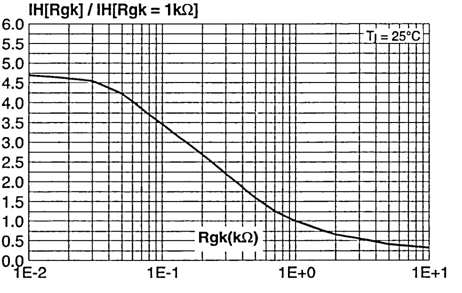


Fig. 6: Relative variation of dV/dt immunity versus gate-cathode resistance (typical values) for TS8 series.

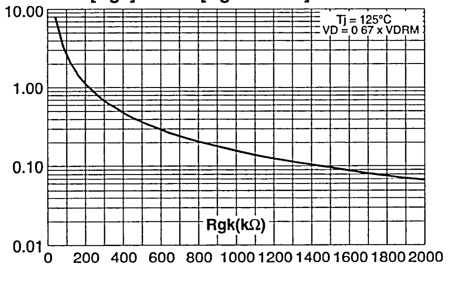


Fig. 7: Relative variation of dV/dt immunity versus gate-cathode capacitance (typical values) for TS8 series.

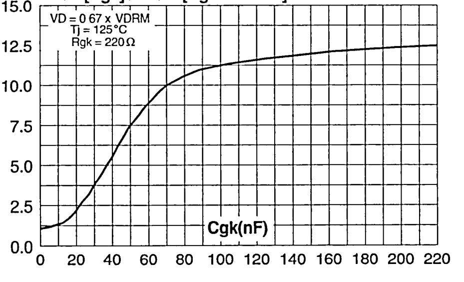


Fig. 8: Surge peak on-state current versus number of cycles. TS8/TN8/TYN.

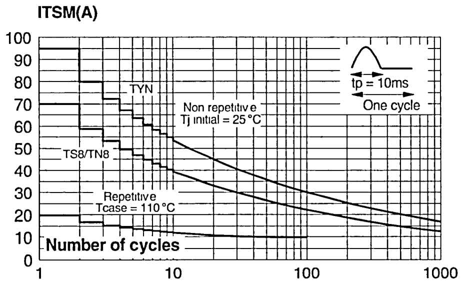


Fig. 9: Non-repetitive surge peak on-state current for a sinusoidal pulse with width tp < 10 ms, and corresponding values of I²t.

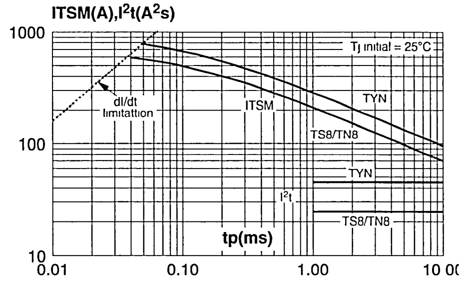


Fig. 10: On-state characteristics (maximum values).

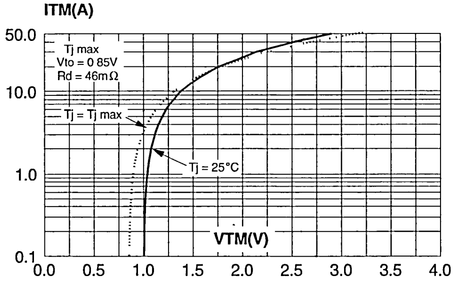
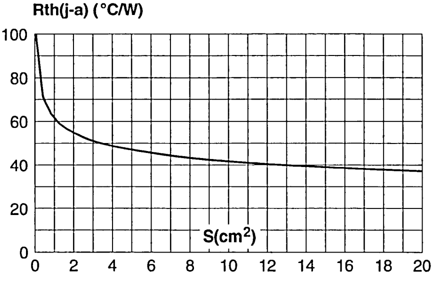


Fig. 11: Thermal resistance junction to ambient versus copper surface under tab (Epoxy printed circuit board FR4, copper thickness: 35 µm) (DPAK).



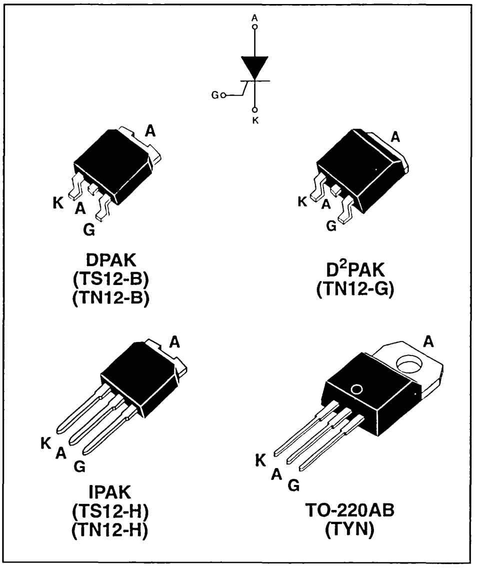
TN12, TS12 and TYNx12 Series

SENSITIVE & STANDARD

12A SCRs

MAIN FEATURES:

Symbol	Value	Unit
$I_{T(RMS)}$	12	A
V_{DRM}/V_{RRM}	600 to 1000	V
I_{GT}	0.2 to 15	mA



DESCRIPTION

Available either in sensitive (TS12) or standard (TYN, TN12...) gate triggering levels, the 12A SCR series is suitable to fit all modes of control found in applications such as overvoltage crowbar protection, motor control circuits in power tools and kitchen aids, in-rush current limiting circuits, capacitive discharge ignition, voltage regulation circuits...
Available in though-hole or surface-mount packages, they provide an optimized performance in a limited space area.

ABSOLUTE RATINGS (limiting values)

Symbol	Parameter			Value		Unit
$I_{T(RMS)}$	RMS on-state current (180° conduction angle)		Tc = 105°C	12		A
$I_{T(AV)}$	Average on-state current (180° conduction angle)		Tc = 105°C	8		A
				DPAK / IPAK	D²PAK / TO-220AB	
I_{TSM}	Non repetitive surge peak on-state current	tp = 8.3 ms	Tj = 25°C	115	146	A
		tp = 10 ms		110	140	
I^2t	I^2t Value for fusing	tp = 10 ms	Tj = 25°C	60	98	A^2s
dI/dt	Critical rate of rise of on-state current $I_G = 2 \times I_{GT}$, tr ≤ 100 ns	F = 60 Hz	Tj = 125°C	50		A/µs
I_{GM}	Peak gate current	tp = 20 µs	Tj = 125°C	4		A
$P_{G(AV)}$	Average gate power dissipation		Tj = 125°C	1		W
T_{stg} Tj	Storage junction temperature range Operating junction temperature range			- 40 to + 150 - 40 to + 125		°C
V_{RGM}	Maximum peak reverse gate voltage (for TN12 & TYN)			5		V

ELECTRICAL CHARACTERISTICS (Tj = 25°C, unless otherwise specified)

■ **SENSITIVE**

Symbol	Test Conditions			TS1220	Unit
I_{GT}	V_D = 12 V R_L = 140 Ω		MAX.	200	μA
V_{GT}			MAX.	0.8	V
V_{GD}	$V_D = V_{DRM}$ R_L = 3.3 kΩ R_{GK} = 1 kΩ	Tj = 125°C	MIN.	0.1	V
V_{RG}	I_{RG} = 10 μA		MIN.	8	V
I_H	I_T = 50 mA R_{GK} = 1 kΩ		MAX.	5	mA
I_L	I_G = 1 mA R_{GK} = 1 kΩ		MAX.	6	mA
dV/dt	V_D = 67 % V_{DRM} R_{GK} = 220 Ω	Tj = 125°C	MIN.	5	V/μs
V_{TM}	I_{TM} = 24 A tp = 380 μs	Tj = 25°C	MAX.	1.6	V
V_{t0}	Threshold voltage	Tj = 125°C	MAX.	0.85	V
R_d	Dynamic resistance	Tj = 125°C	MAX.	30	mΩ
I_{DRM} I_{RRM}	$V_{DRM} = V_{RRM}$ R_{GK} = 220 Ω	Tj = 25°C	MAX.	5	μA
		Tj = 125°C		2	mA

■ **STANDARD**

Symbol	Test Conditions			TN1215		TYN		Unit
				B/H	G	x12T	x12	
I_{GT}	V_D = 12 V R_L = 33 Ω		MIN.	2		0.5	2	mA
			MAX.	15		5	15	
V_{GT}			MAX.	1.3				V
V_{GD}	$V_D = V_{DRM}$ R_L = 3.3 kΩ	Tj = 125°C	MIN.	0.2				V
I_H	I_T = 500 mA Gate open		MAX.	40	30	15	30	mA
I_L	I_G = 1.2 I_{GT}		MAX.	80	60	30	60	mA
dV/dt	V_D = 67 % V_{DRM} Gate open	Tj = 125°C	MIN.	200		40	200	V/μs
V_{TM}	I_{TM} = 24 A tp = 380 μs	Tj = 25°C	MAX.	1.6				V
V_{t0}	Threshold voltage	Tj = 125°C	MAX.	0.85				V
R_d	Dynamic resistance	Tj = 125°C	MAX.	30				mΩ
I_{DRM} I_{RRM}	$V_{DRM} = V_{RRM}$	Tj = 25°C	MAX.	5				μA
		Tj = 125°C		2				mA

THERMAL RESISTANCES

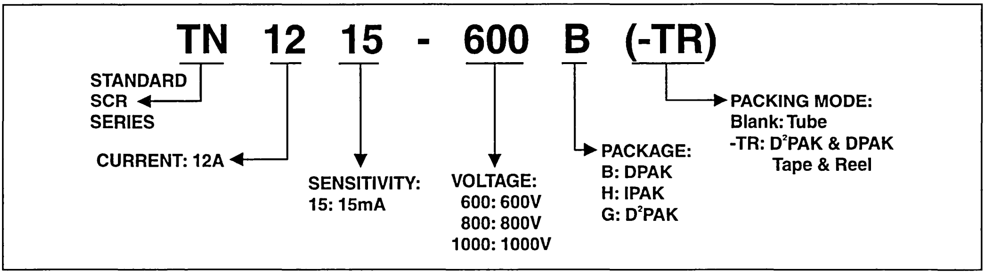
Symbol	Parameter			Value	Unit
$R_{th(j-c)}$	Junction to case (DC)			1.3	°C/W
$R_{th(j-a)}$	Junction to ambient		TO-220AB	60	°C/W
			IPAK	100	
		S = 1 cm^2	D^2PAK	45	
		S = 0.5 cm^2	DPAK	70	

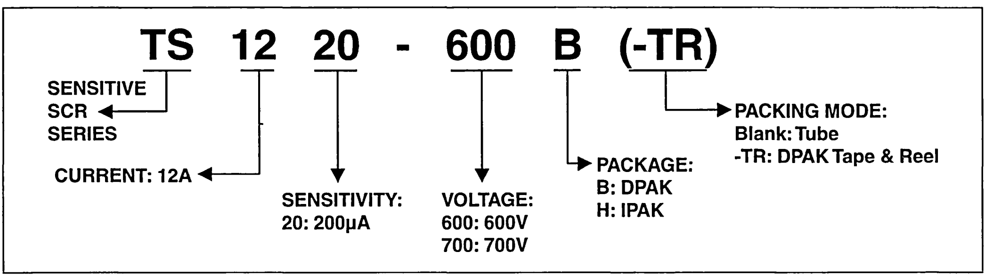
S = Copper surface under tab

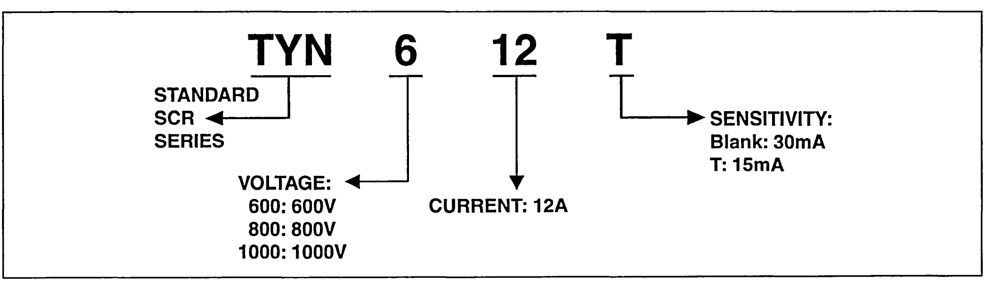
PRODUCT SELECTOR

Part Number	Voltage (xxx)				Sensitivity	Package
	600 V	700 V	800 V	1000 V		
TN1215-xxxB	X		X		15 mA	DPAK
TN1215-xxxG	X		X	X	15 mA	D^2PAK
TN1215-xxxH	X		X		15 mA	IPAK
TS1220-xxxB	X	X			0.2 mA	DPAK
TS1220-xxxH	X	X			0.2 mA	IPAK
TYNx12	X		X	X	30 mA	TO-220AB
TYNx12T	X		X	X	15 mA	TO-220AB

ORDERING INFORMATION







OTHER INFORMATION

Part Number	Marking	Weight	Base Quantity	Packing mode
TN1215-x00B	TS1215x00	0.3 g	75	Tube
TN1215-x00B-TR	TS1215x00	0.3 g	2500	Tape & reel
TN1215-x00G	TS1215x00G	1.5 g	50	Tube
TN1215-x00G-TR	TS1215x00G	1.5 g	1000	Tape & reel
TN1215-x00H	TN1215x00	0.4 g	75	Tube
TS1220-x00B	TS1220x00	0.3 g	75	Tube
TS1220-x00B-TR	TS1220x00	0.3 g	2500	Tape & reel
TS1220-x00H	TS1220x00	0.4 g	75	Tube
TYNx12	TYNx12	2.3 g	250	Bulk
TYNx12RG	TYNx12	2.3 g	50	Tube
TYNx12T	TYNx12T	2.3 g	250	Bulk
TYNx12TRG	TYNx12T	2.3 g	50	Tube

Note: x = voltage

Fig. 1: Maximum average power dissipation versus average on-state current.

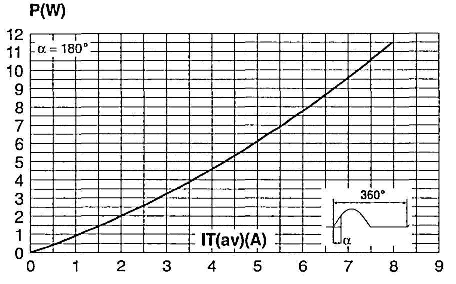


Fig. 2-1: Average and D.C. on-state current versus case temperature.

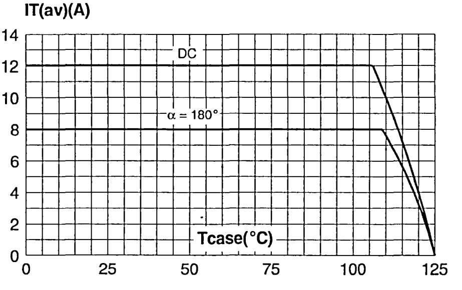


Fig. 2-2: Average and D.C. on-state current versus ambient temperature (device mounted on FR4 with recommended pad layout) (DPAK and D^{2}PAK).

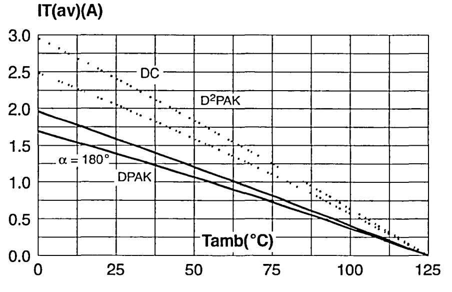


Fig. 3-1: Relative variation of thermal impedance junction to case versus pulse duration.

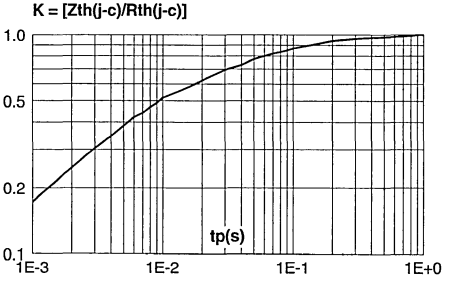


Fig. 3-2: Relative variation of thermal impedance junction to ambient versus pulse duration (recommended pad layout, FR4 PC board).

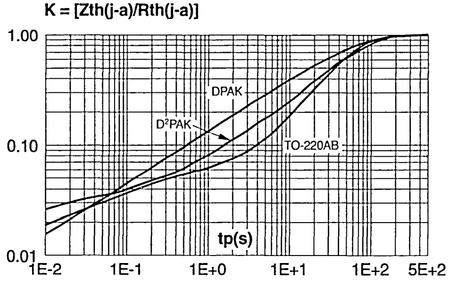


Fig. 4-1: Relative variation of gate trigger current, holding current and latching versus junction temperature for TS12 series.

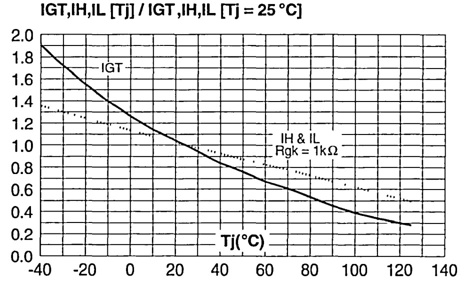


Fig. 4-2: Relative variation of gate trigger current, holding current and latching current versus junction temperature for TN12 & TYN series.

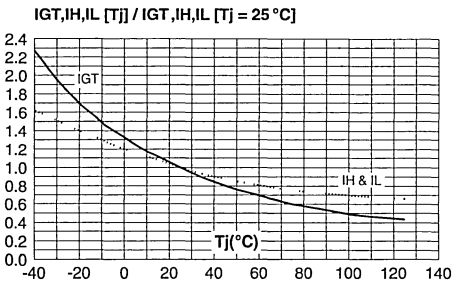


Fig. 5: Relative variation of holding current versus gate-cathode resistance (typical values) for TS12 series.

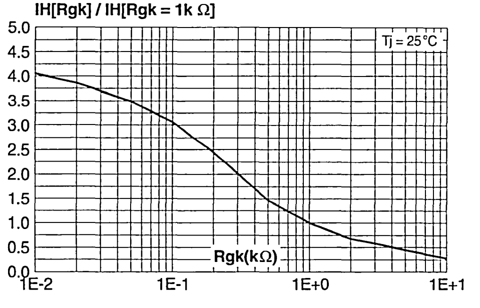


Fig. 6: Relative variation of dV/dt immunity versus gate-cathode resistance (typical values) for TS12 series.

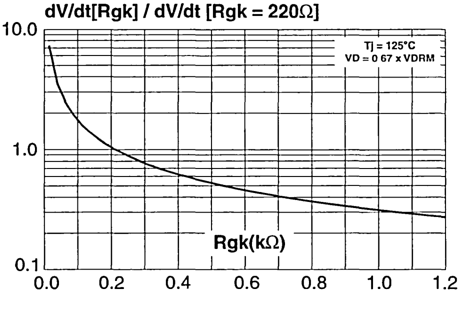


Fig. 7: Relative variation of dV/dt immunity versus gate-cathode capacitance (typical values) for TS12 series.

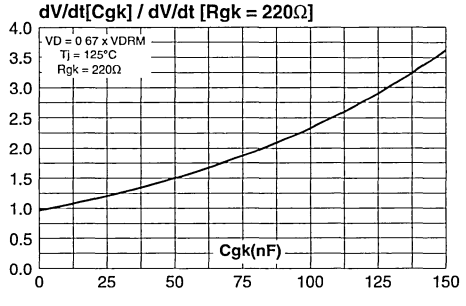


Fig. 8: Surge peak on-state current versus number of cycles (TS12/TN12/TYN).

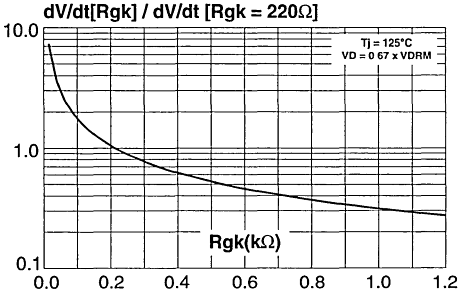


Fig. 9: Non-repetitive surge peak on-state current for a sinusoidal pulse with width tp < 10 ms, and corresponding values of I²t.

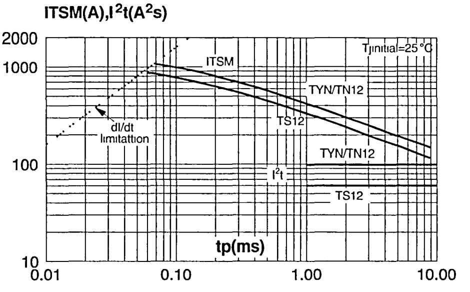


Fig. 10: On-state characteristics (maximum values).

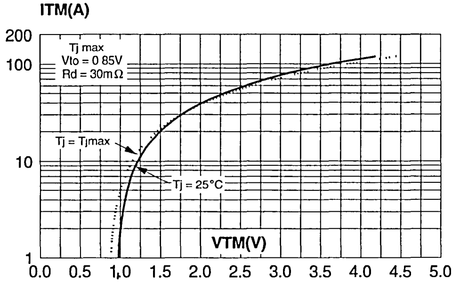
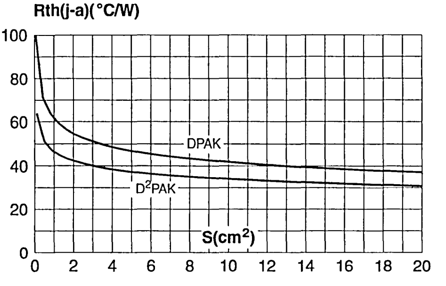


Fig. 11: Thermal resistance junction to ambient versus copper surface under tab (Epoxy printed circuit board FR4, copper thickness: 35 µm) .



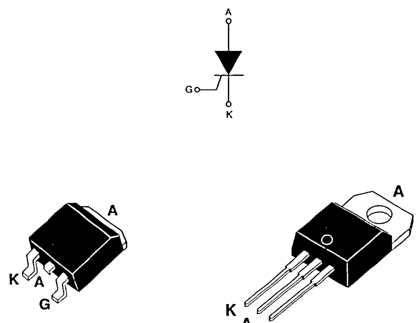
TN16 and TYNx16 Series

STANDARD

16A SCRs

MAIN FEATURES:

Symbol	Value	Unit
$I_{T(RMS)}$	16	A
V_{DRM}/V_{RRM}	600 to 1000	V
I_{GT}	25	mA



D^2PAK (TN16-G)

TO-220AB (TYN)

DESCRIPTION

The TYN / TN16 SCR Series is suitable for general purpose applications.
Using clip assembly technology, they provide a superior performance in surge current capabilities.

ABSOLUTE RATINGS (limiting values)

Symbol	Parameter			Value	Unit
$I_{T(RMS)}$	RMS on-state current (180° conduction angle)		Tc = 110°C	16	A
$T_{(AV)}$	Average on-state current (180° conduction angle)		Tc = 110°C	10	A
I_{TSM}	Non repetitive surge peak on-state current	tp = 8.3 ms	Tj = 25°C	200	A
		tp = 10 ms		190	
I^2t	I^2t Value for fusing	tp = 10 ms	Tj = 25°C	180	A^2s
dI/dt	Critical rate of rise of on-state current $I_G = 2 \times I_{GT}$, tr ≤ 100 ns	F = 60 Hz	Tj = 125°C	50	A/µs
I_{GM}	Peak gate current	tp = 20 µs	Tj = 125°C	4	A
$P_{G(AV)}$	Average gate power dissipation		Tj = 125°C	1	W
T_{stg} Tj	Storage junction temperature range Operating junction temperature range			- 40 to + 150 - 40 to + 125	°C
V_{RGM}	Maximum peak reverse gate voltage			5	V

ELECTRICAL CHARACTERISTICS (Tj = 25°C, unless otherwise specified)

Symbol	Test Conditions			Value	Unit
I_{GT}	V_D = 12 V R_L = 33 Ω		MIN.	2	mA
			MAX.	25	
V_{GT}			MAX.	1.3	V
V_{GD}	V_D = V_{DRM} R_L = 3.3 kΩ	Tj = 125°C	MIN.	0.2	V
I_H	I_T = 500 mA Gate open		MAX.	40	mA
I_L	I_G = 1.2 x I_{GT}		MAX.	60	mA
dV/dt	V_D = 67 % V_{DRM} Gate open	Tj = 125°C	MIN.	500	V/µs
V_{TM}	I_{TM} = 32 A tp = 380 µs	Tj = 25°C	MAX.	1.6	V
V_{t0}	Threshold voltage	Tj = 125°C	MAX.	0.77	V
R_d	Dynamic resistance	Tj = 125°C	MAX.	23	mΩ
I_{DRM} I_{RRM}	V_{DRM} = V_{RRM}	Tj = 25°C	MAX.	5	µA
		Tj = 125°C		2	mA

THERMAL RESISTANCES

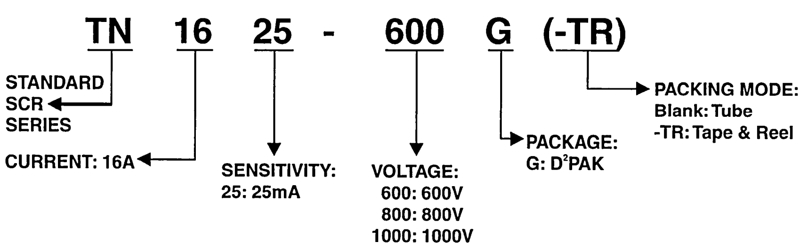
Symbol	Parameter			Value	Unit
$R_{th(j-c)}$	Junction to case (DC)			1.1	°C/W
$R_{th(j-a)}$	Junction to ambient (DC)		TO-220AB	60	°C/W
		S = 1 cm^2	D^2PAK	45	

S = Copper surface under tab

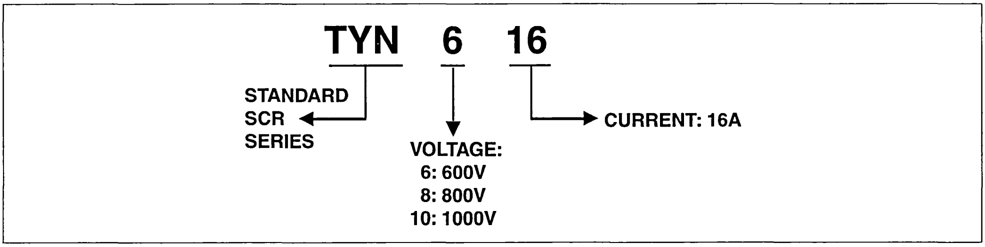
PRODUCT SELECTOR

Part Number	Voltage (xxx)			Sensitivity	Package
	600 V	800 V	1000 V		
TN1625-xxxG	X	X	X	25 mA	D^2PAK
TYNx16	X	X	X	25 mA	TO-220AB

ORDERING INFORMATION



ORDERING INFORMATION



OTHER INFORMATION

Part Number	Marking	Weight	Base Quantity	Packing mode
TN1625-x00G	TN1625x00G	1.5 g	50	Tube
TN1625-x00G-TR	TN1625x00G	1.5 g	1000	Tape & reel
TYNx16	TYNx16	2.3 g	250	Bulk

Note: x = voltage

Fig. 1: Maximum average power dissipation versus average on-state current.

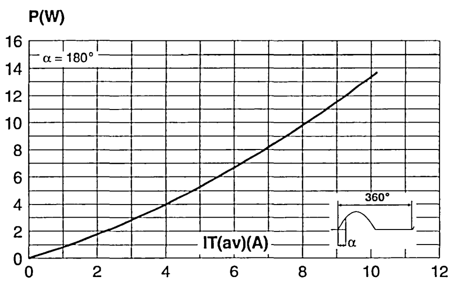


Fig. 2-1: Average and D.C. on-state current versus case temperature.

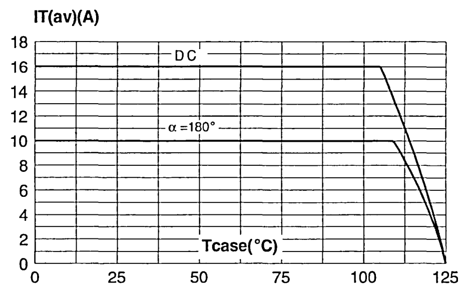


Fig. 2-2: Average and D.C. on-state current versus ambient temperature (copper surface under tab: S = 1 cm² (for D²PAK).

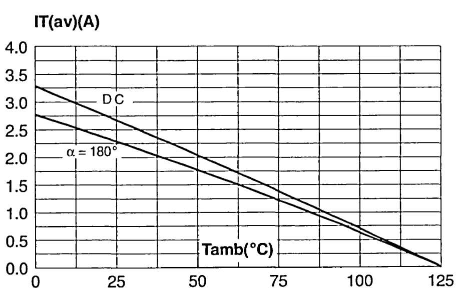


Fig. 3: Relative variation of thermal impedance versus pulse duration.

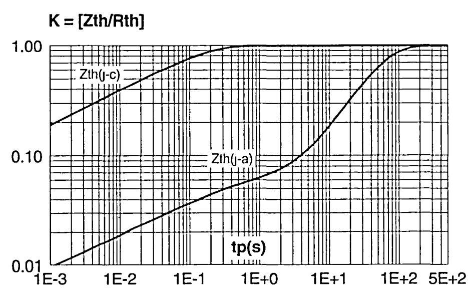


Fig. 4: Relative variation of gate trigger current, holding current and latching current versus junction temperature.

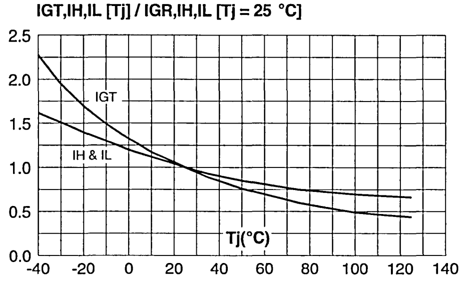


Fig. 5: Surge peak on-state current versus number of cycles.

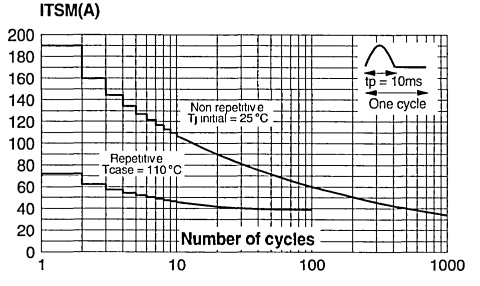


Fig. 6: Non-repetitive surge peak on-state current for a sinusoidal pulse with width tp < 10 ms, and corresponding value of I²t.

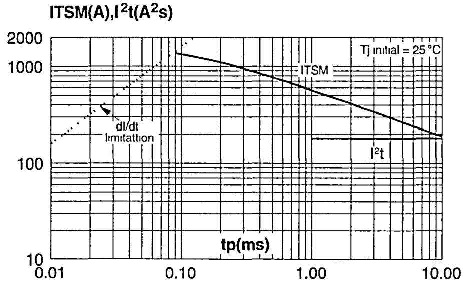


Fig. 7: On-state characteristics (maximum values).

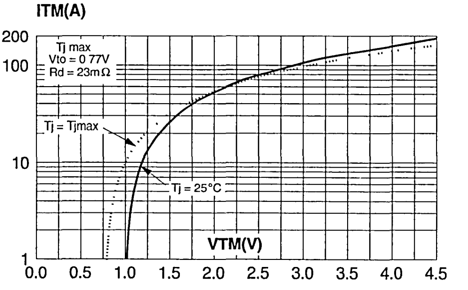
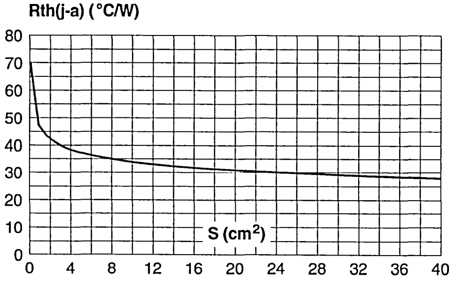


Fig. 8: Thermal resistance junction to ambient versus copper surface under tab (Epoxy printed circuit board FR4, copper thickness: 35 µm) (for D²PAK).



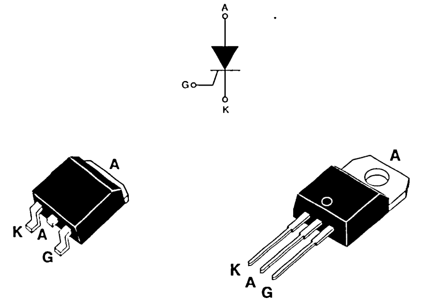
TN25 and TYNx25 Series

STANDARD

25A SCRs

MAIN FEATURES:

Symbol	Value	Unit
$I_{T(RMS)}$	25	A
V_{DRM}/V_{RRM}	600 to 1000	V
I_{GT}	40	mA



D²PAK (TN25-G) — **TO-220AB (TYN)**

DESCRIPTION

The TYN / TN25 SCR Series is suitable for general purpose applications.
Using clip assembly technology, they provide a superior performance in surge current capabilities.

ABSOLUTE RATINGS (limiting values)

Symbol	Parameter			Value	Unit
$I_{T(RMS)}$	RMS on-state current (180° conduction angle)		Tc = 100°C	25	A
$T_{(AV)}$	Average on-state current (180° conduction angle)		Tc = 100°C	16	A
I_{TSM}	Non repetitive surge peak on-state current	tp = 8.3 ms	Tj = 25°C	314	A
		tp = 10 ms		300	
I^2t	I^2t Value for fusing	tp = 10 ms	Tj = 25°C	450	A^2s
dI/dt	Critical rate of rise of on-state current $I_G = 2 \times I_{GT}$, tr ≤ 100 ns	F = 60 Hz	Tj = 125°C	50	A/µs
I_{GM}	Peak gate current	tp = 20 µs	Tj = 125°C	4	A
$P_{G(AV)}$	Average gate power dissipation		Tj = 125°C	1	W
T_{stg} Tj	Storage junction temperature range Operating junction temperature range			- 40 to + 150 - 40 to + 125	°C
V_{RGM}	Maximum peak reverse gate voltage			5	V

ELECTRICAL CHARACTERISTICS (Tj = 25°C, unless otherwise specified)

Symbol	Test Conditions			Value	Unit
I_{GT}	V_D = 12 V R_L = 33 Ω		MIN.	4	mA
			MAX.	40	
V_{GT}			MAX.	1.3	V
V_{GD}	$V_D = V_{DRM}$ R_L = 3.3 kΩ	Tj = 125°C	MIN.	0.2	V
I_H	I_T = 500 mA Gate open		MAX.	50	mA
I_L	$I_G = 1.2\ I_{GT}$		MAX.	90	mA
dV/dt	V_D = 67 % V_{DRM} Gate open	Tj = 125°C	MIN.	1000	V/µs
V_{TM}	I_{TM} = 50 A tp = 380 µs	Tj = 25°C	MAX.	1.6	V
V_{t0}	Threshold voltage	Tj = 125°C	MAX.	0.77	V
R_d	Dynamic resistance	Tj = 125°C	MAX.	14	mΩ
I_{DRM} I_{RRM}	$V_{DRM} = V_{RRM}$	Tj = 25°C	MAX.	5	µA
		Tj = 125°C		4	mA

THERMAL RESISTANCES

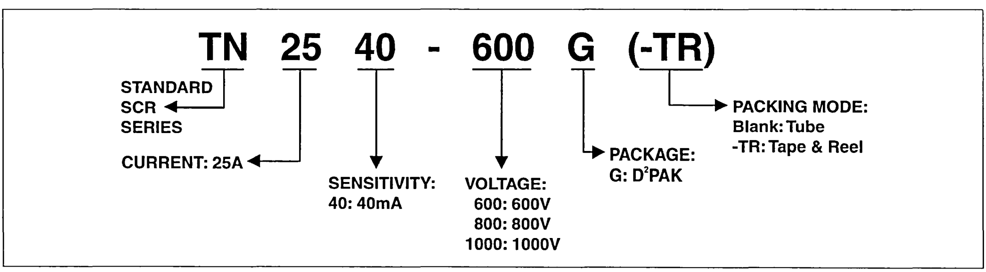
Symbol	Parameter			Value	Unit
$R_{th(j-c)}$	Junction to case (DC)			1.0	°C/W
$R_{th(j-a)}$	Junction to ambient (DC)		TO-220AB	60	°C/W
		S = 1 cm^2	D^2PAK	45	

S = Copper surface under tab

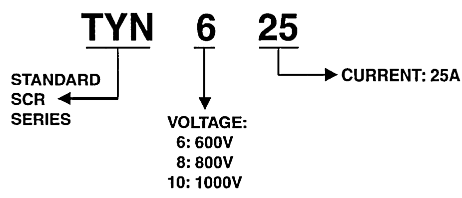
PRODUCT SELECTOR

Part Number	Voltage (xxx)			Sensitivity	Package
	600 V	800 V	1000 V		
TN2540-xxxG	X	X	X	40 mA	D^2PAK
TYNx25	X	X	X	40 mA	TO-220AB

ORDERING INFORMATION



ORDERING INFORMATION



OTHER INFORMATION

Part Number	Marking	Weight	Base Quantity	Packing mode
TN2540-x00G	TN2540x00G	1.5 g	50	Tube
TN2540-x00G-TR	TN2540x00G	1.5 g	1000	Tape & reel
TYNx25	TYNx25	2.3 g	250	Bulk

Note: x = voltage

Fig. 1: Maximum average power dissipation versus average on-state current.

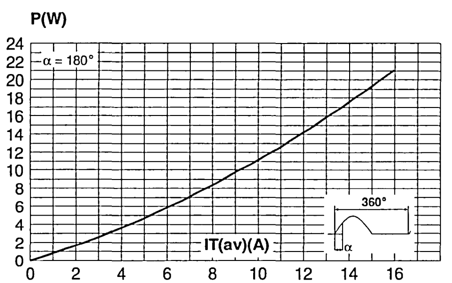


Fig. 2-1: Average and D.C. on-state current versus case temperature.

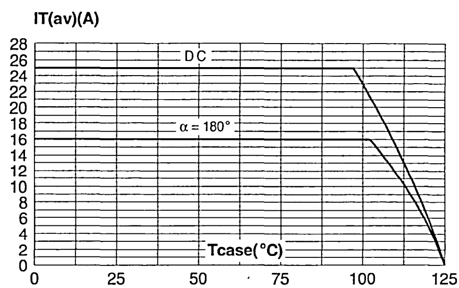


Fig. 2-2: Average and D.C. on-state current versus ambient temperature (copper surface under tab: S = 1 cm² (for D²PAK).

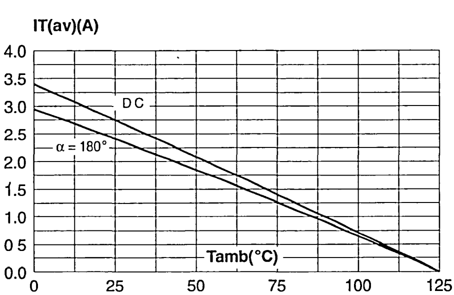


Fig. 3: Relative variation of thermal impedance versus pulse duration.

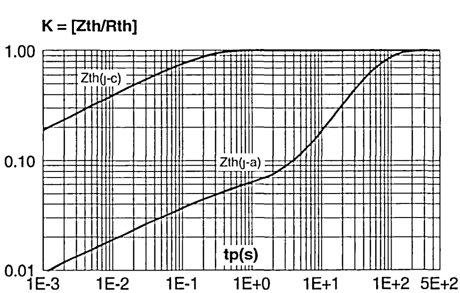


Fig. 4: Relative variation of gate trigger current, holding current and latching current versus junction temperature.

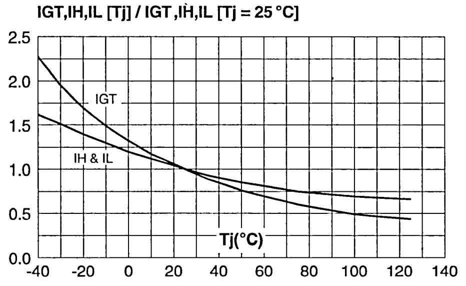


Fig. 5: Surge peak on-state current versus number of cycles.

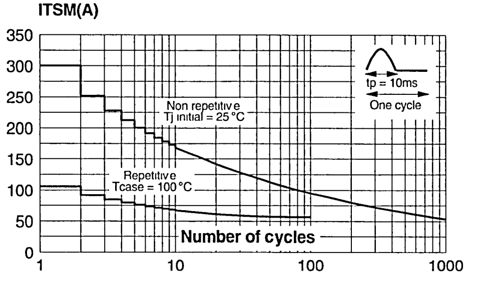


Fig. 6: Non-repetitive surge peak on-state current for a sinusoidal pulse with width tp < 10 ms, and corresponding values of I²t.

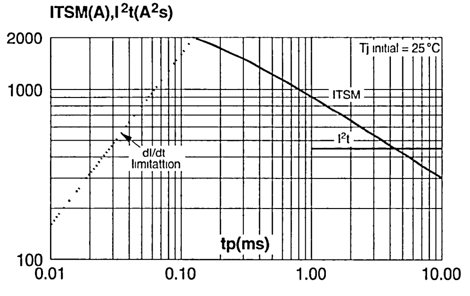


Fig. 7: On-state characteristics (maximum values).

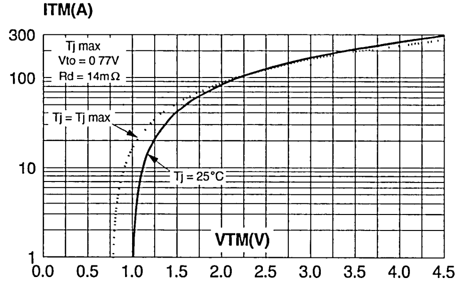
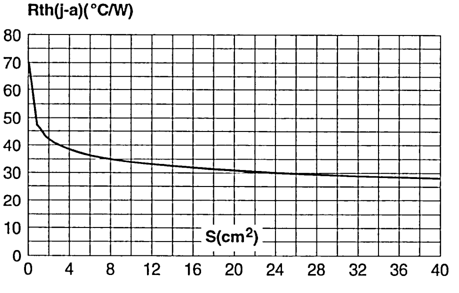


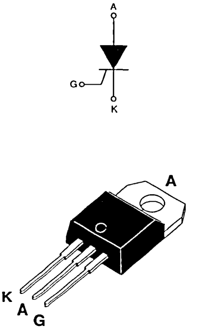
Fig. 8: Thermal resistance junction to ambient versus copper surface under tab (Epoxy printed circuit board FR4, copper thickness: 35 µm) (D^2PAK).



STANDARD 40A SCRs

MAIN FEATURES:

Symbol	Value	Unit
$I_{T(RMS)}$	40	A
V_{DRM}/V_{RRM}	600 to 1000	V
I_{GT}	35	mA



TO-220AB
(TYNx40)

DESCRIPTION

The TYNx40 series is suitable for applications where in-rush current conditions are critical, such as overvoltage crowbar protection circuits in power supplies, in-rush current limiting circuits, solid state relays (in back to back configuration), welding equipment, high power motor control circuits.
Using clip assembly technology, they provide a superior performance in high surge current capabilites.

ABSOLUTE RATINGS (limiting values)

Symbol	Parameter			Value	Unit
$I_{T(RMS)}$	RMS on-state current (180° conduction angle)		Tc = 95°C	40	A
$I_{T(AV)}$	Average on-state current (180° conduction angle)		Tc = 95°C	25	A
I_{TSM}	Non repetitive surge peak on-state current	tp = 8.3 ms	Tj = 25°C	480	A
		tp = 10 ms		460	
I^2t	I^2t Value for fusing		Tj = 25°C	1060	A^2s
dI/dt	Critical rate of rise of on-state current $I_G = 2 \times I_{GT}$, tr ≤ 100 ns	F = 60 Hz	Tj = 125°C	50	A/µs
I_{GM}	Peak gate current	tp = 20 µs	Tj = 125°C	4	A
$P_{G(AV)}$	Average gate power dissipation		Tj = 125°C	1	W
T_{stg} Tj	Storage junction temperature range Operating junction temperature range			- 40 to + 150 - 40 to + 125	°C
V_{RGM}	Maximum peak reverse gate voltage			5	V

ELECTRICAL CHARACTERISTICS (Tj = 25°C, unless otherwise specified)

Symbol	Test Conditions			Value	Unit
I_{GT}	V_D = 12 V R_L = 33 Ω		MIN.	3.5	mA
			MAX.	35	
V_{GT}			MAX.	1.3	V
V_{GD}	V_D = V_{DRM} R_L = 3.3 kΩ	Tj = 125°C	MIN.	0.2	V
I_H	I_T = 500 mA Gate open		MAX.	75	mA
I_L	I_G = 1.2 I_{GT}		MAX.	150	mA
dV/dt	V_D = 67 % V_{DRM} Gate open	Tj = 125°C	MIN.	1000	V/µs
V_{TM}	I_{TM} = 80 A tp = 380 µs	Tj = 25°C	MAX.	1.6	V
V_{t0}	Threshold voltage	Tj = 125°C	MAX.	0.85	V
R_d	Dynamic resistance	Tj = 125°C	MAX.	10	mΩ
I_{DRM} I_{RRM}	V_{DRM} = V_{RRM}	Tj = 25°C	MAX.	5	µA
		Tj = 125°C		4	mA

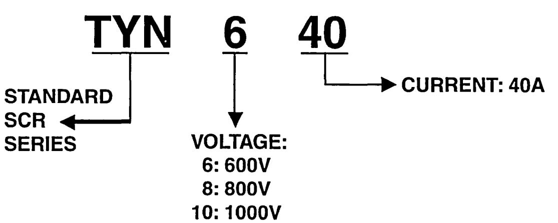
THERMAL RESISTANCES

Symbol	Parameter	Value	Unit
$R_{th(j-c)}$	Junction to case (DC)	0.8	°C/W
$R_{th(j-a)}$	Junction to ambient (DC)	60	°C/W

PRODUCT SELECTOR

Part Number	Voltage			Sensitivity	Package
	600 V	800 V	1000 V		
TYNx40	X	X	X	35 mA	TO-220AB

ORDERING INFORMATION



OTHER INFORMATION

Part Number	Marking	Weight	Base Quantity	Packing mode
TYNx40	TYNx40	2.3 g	250	Bulk

Note: x = voltage

Fig. 1: Maximum average power dissipation versus average on-state current.

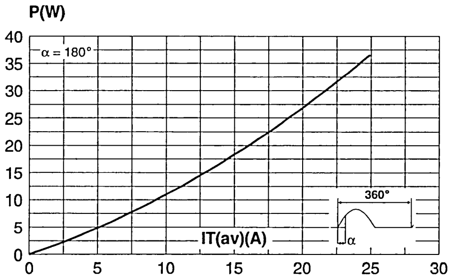


Fig. 2: Average and DC on-state current versus case temperature.

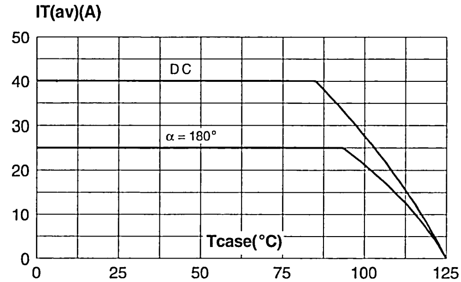


Fig. 3: Relative variation of thermal impedance versus pulse duration.

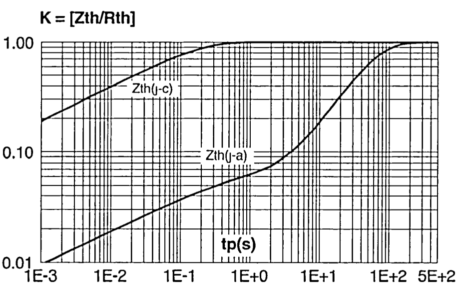


Fig. 4: Relative variation of gate trigger current, holding current and latching current versus junction temperature.

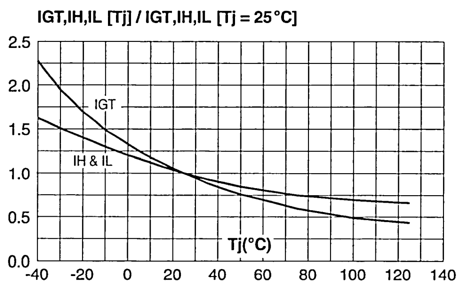


Fig. 5: Surge peak on-state current versus number of cycles.

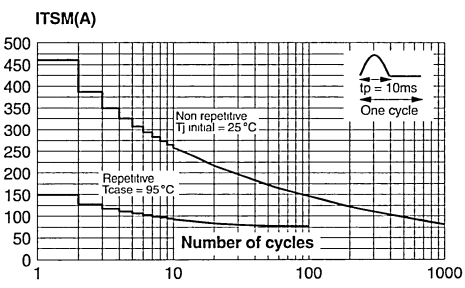


Fig. 6: Non-repetitive surge peak on-state current for a sinusoidal pulse with width tp < 10 ms, and corresponding value of I^2t.

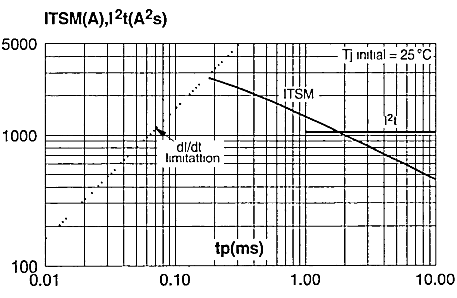
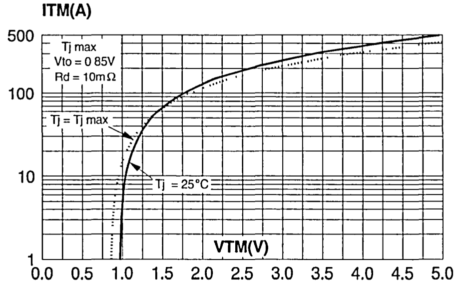


Fig. 7: On-state characteristics (maximum values).

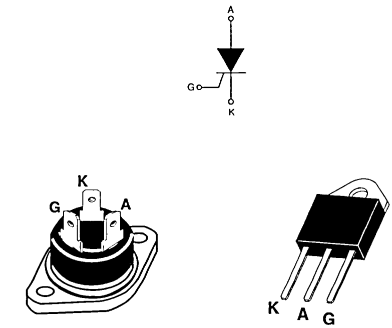


BTW67 and BTW69 Series

STANDARD 50A SCRs

MAIN FEATURES:

Symbol	Value	Unit
$I_{T(RMS)}$	50	A
V_{DRM}/V_{RRM}	600 to 1200	V
I_{GT}	80	mA



RD91 (BTW67)

TOP3 (BTW69)

DESCRIPTION

Available in high power packages, the BTW67 / BTW69 Series is suitable in applications where power handling and power dissipation are critical, such as solid state relays, welding equipment, high power motor control.
Based on a clip assembly technology, they offer a superior performance in surge current handling capabilities.
Thanks to their internal ceramic pad, they provide high voltage insulation (2500V RMS), complying with UL standards (file ref: E81734).

ABSOLUTE RATINGS (limiting values)

Symbol	Parameter			Value	Unit
$I_{T(RMS)}$	RMS on-state current (180° conduction angle)	RD91	Tc = 70°C	50	A
		TOP3 Ins.	Tc = 75°C		
$I_{T(AV)}$	Average on-state current (180° conduction angle)	RD91	Tc = 70°C	32	A
		TOP3 Ins.	Tc = 75°C		
I_{TSM}	Non repetitive surge peak on-state current	tp = 8.3 ms	Tj = 25°C	610	A
		tp = 10 ms		580	
I^2t	I^2t Value for fusing		Tj = 25°C	1680	A^2s
dI/dt	Critical rate of rise of on-state current I_G = 2 x I_{GT} , tr ≤ 100 ns	F = 60 Hz	Tj = 125°C	50	A/µs
I_{GM}	Peak gate current	tp = 20 µs	Tj = 125°C	8	A
$P_{G(AV)}$	Average gate power dissipation		Tj = 125°C	1	W
T_{stg} Tj	Storage junction temperature range Operating junction temperature range			- 40 to + 150 - 40 to + 125	°C
V_{RGM}	Maximum peak reverse gate voltage			5	V

ELECTRICAL CHARACTERISTICS (Tj = 25°C, unless otherwise specified)

Symbol	Test Conditions			Value	Unit
I_{GT}	V_D = 12 V R_L = 33 Ω		MIN.	8	mA
			MAX.	80	
V_{GT}			MAX.	1	V
V_{GD}	V_D = V_{DRM} R_L = 3.3 kΩ	Tj = 125°C	MIN.	0.2	V
I_H	I_T = 500 mA Gate open		MAX.	150	mA
I_L	I_G = 1.2 I_{GT}		MAX.	200	mA
dV/dt	V_D = 67 % V_{DRM} Gate open	Tj = 125°C	MIN.	1000	V/µs
V_{TM}	I_{TM} = 100 A tp = 380 µs	Tj = 25°C	MAX.	1.9	V
V_{t0}	Threshold voltage	Tj = 125°C	MAX.	1.0	V
R_d	Dynamic resistance	Tj = 125°C	MAX.	8.5	mΩ
I_{DRM} I_{RRM}	V_{DRM} = V_{RRM}	Tj = 25°C	MAX.	10	µA
		Tj = 125°C		5	mA

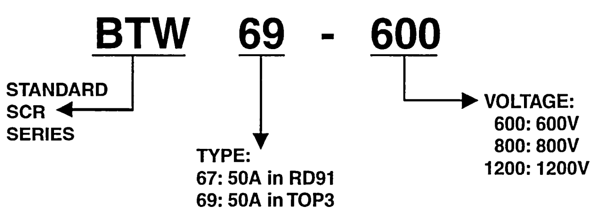
THERMAL RESISTANCES

Symbol	Parameter		Value	Unit
$R_{th(j\text{-}c)}$	Junction to case (DC)	RD91 (Insulated)	1.0	°C/W
		TOP3 Insulated	0.9	
$R_{th(j\text{-}a)}$	Junction to ambient	TOP3 Insulated	50	°C/W

PRODUCT SELECTOR

Part Number	Voltage (xxx)			Sensitivity	Package
	600 V	800 V	1200 V		
BTW67-xxx	X	X	X	80 mA	RD91
BTW69-xxx	X	X	X	80 mA	TOP3 Ins.

ORDERING INFORMATION



OTHER INFORMATION

Part Number	Marking	Weight	Base Quantity	Packing mode
BTW67-xxx	BTW67xxx	20.0 g	25	Bulk
BTW69-xxx	BTW69xxx	4.5 g	120	Bulk

Note: xxx = voltage

Fig. 1: Maximum average power dissipation versus average on-state current.

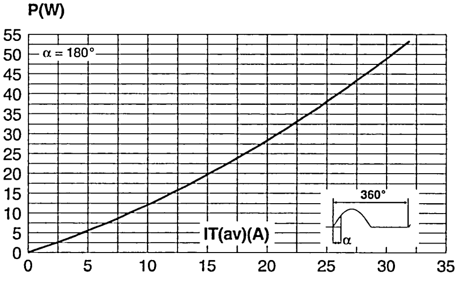


Fig. 2: Average and D.C. on-state current versus case temperature.

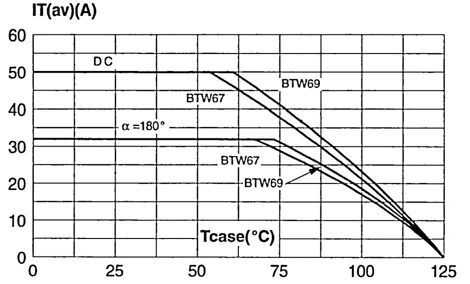


Fig. 3: Relative variation of thermal impedance versus pulse duration.

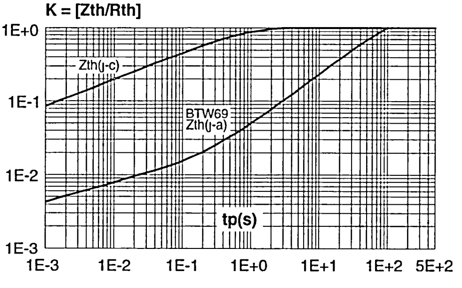


Fig. 4: Relative variation of gate trigger current, holding current and latching current versus junction temperature.

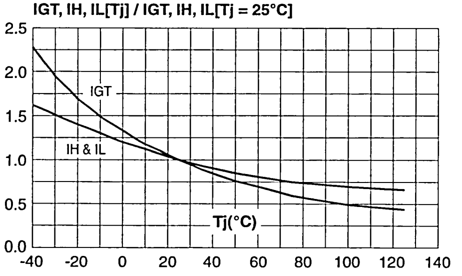


Fig. 5: Surge peak on-state current versus number of cycles.

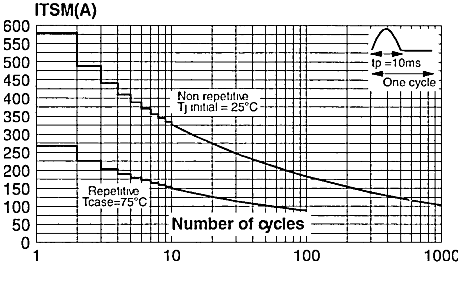


Fig. 6: Non-repetitive surge peak on-state current for a sinusoidal pulse with width tp < 10ms, and corresponding value of I²t.

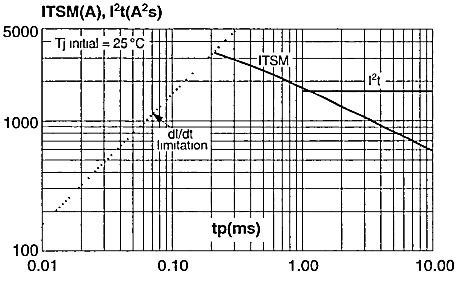
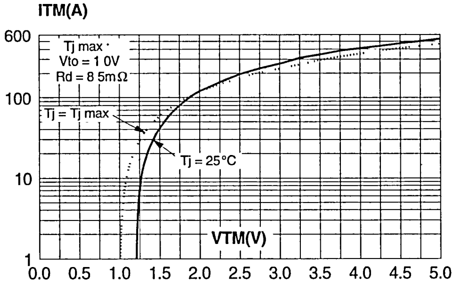


Fig. 7: On-state characteristics (maximum values).

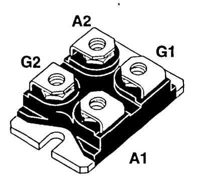


MSS40 / 50 Series

BACK TO BACK SCR MODULE

MAIN FEATURES:

Symbol	Value	Unit
$I_{T(RMS)}$	55 and 70	A
V_{DRM}/V_{RRM}	800 and 1200	V
I_{GT}	50	mA



ISOTOP®

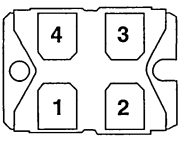
DESCRIPTION

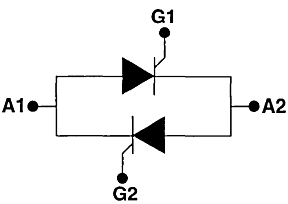
Packaged in ISOTOP modules, the MSS40 / MSS50 Series is based on two back-to-back SCR configurations, providing high noise immunity. They are suitable for high power applications such as solid state relays, heating control systems, welding equipment, motor control circuits...

The compactness of the ISOTOP package allows high power density and optimized power bus connections. Thanks to their internal ceramic pad, they provide high voltage insulation (2500V RMS), complying with UL standards (File ref: E81734).

PIN CONNECTIONS

1 Thyristor 2 Anode (A2)
2 Thyristor 2 Gate (G2)
3 Thyristor 1 Anode (A1)
4 Thyristor 1 Gate (G1)





ABSOLUTE RATINGS (limiting values)

Symbol	Parameter			Value MSS40	Value MSS50	Unit
$I_{T(RMS)}$	RMS on-state current	Tc = 80 °C		55		A
		Tc = 85 °C			70	
I_{TSM}	Non repetitive surge peak on-state current	tp = 16.7 ms	Tj = 25°C	420	630	A
		tp = 20 ms		400	600	
I^2t	I^2t Value for fusing	tp = 10 ms	Tj = 25°C	800	1800	A^2s
dI/dt	Critical rate of rise of on-state current $I_G = 2 \times I_{GT}$, tr ≤ 100 ns	F = 120 Hz	Tj = 125°C	50		A/µs
I_{GM}	Peak gate current	tp = 20 µs	Tj = 125°C	4		A
$P_{G(AV)}$	Average gate power dissipation		Tj = 125°C	1		W
T_{stg} T_j	Storage junction temperature range Operating junction temperature range			- 40 to + 150 - 40 to + 125		°C
V_{RGM}	Maximum peak reverse gate voltage			5		V

ISOTOP is a registred trademark of STMicroelectronics

ELECTRICAL CHARACTERISTICS (Tj = 25°C, unless otherwise specified)

Symbol	Test Conditions			Value MSS40	Value MSS50	Unit
I_{GT}	V_D = 12 V R_L = 33 Ω		MIN.	5		mA
			MAX.	50		
V_{GT}			MAX.	1.3		V
V_{GD}	V_D = V_{DRM} R_L = 3.3 kΩ	Tj = 125°C	MIN.	0.2		V
I_H	I_T = 500 mA Gate open		MAX.	80		mA
I_L	I_G = 1.2 I_{GT}		MAX.	120		mA
dV/dt	V_D = 67 % V_{DRM} Gate open	Tj = 125°C	MIN.	1000		V/µs
V_{TM}	I_{TM} = 80 A tp = 380 µs	Tj = 25°C	MAX.	1.7	-	V
	I_{TM} = 100 A tp = 380 µs			-	1.7	
V_{t0}	Threshold voltage	Tj = 125°C	MAX.	0.85		V
R_d	Dynamic resistance	Tj = 125°C	MAX.	11	7	mΩ
I_{DRM} I_{RRM}	V_{DRM} / V_{RRM} RATED	Tj = 25°C	MAX.	20		µA
		Tj = 125°C		10		mA

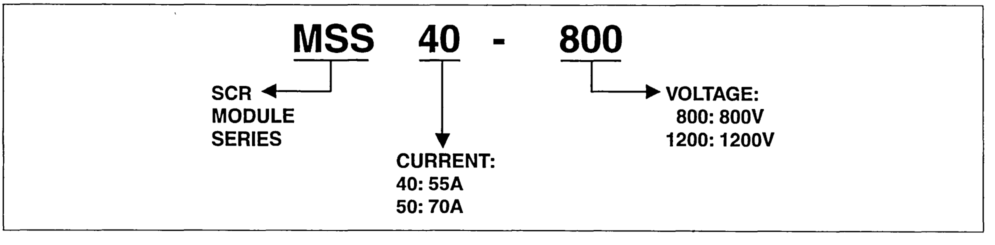
THERMAL RESISTANCES

Symbol	Parameter		Value	Unit
$R_{th(j-c)}$	Junction to case (AC)	MSS40	0.6	°C/W
		MSS50	0.45	

PRODUCT SELECTOR

Part Number	Voltage (xxx) 800 V	Voltage (xxx) 1200 V	Sensitivity	Package
MSS40-xxx	X	X	50 mA	ISOTOP™
MSS50-xxx	X	X	50 mA	ISOTOP™

ORDERING INFORMATION



OTHER INFORMATION

Part Number	Marking	Weight	Base Quantity	Packing mode
MSS40-xxx	MSS40-xxx	27.0 g	10	Tube
MSS50-xxx	MSS50-xxx	27.0 g	10	Tube

Note: xxx = voltage

Fig. 1: Maximum power dissipation versus RMS on-state current.

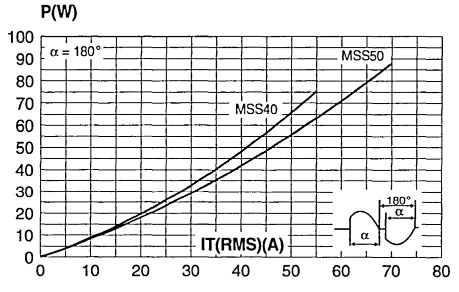


Fig. 2: RMS on-state current versus case temperature.

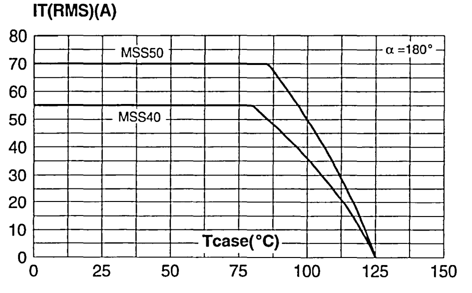


Fig. 3: Relative variation of thermal impedance junction to case versus pulse duration.

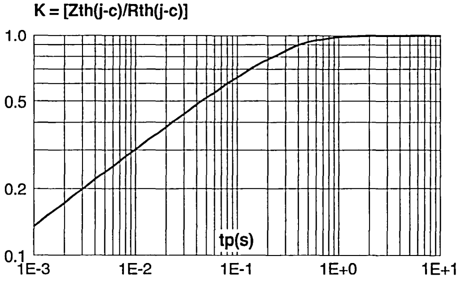


Fig. 4: Relative variation of gate trigger current, holding current and latching current versus junction temperature (typical values).

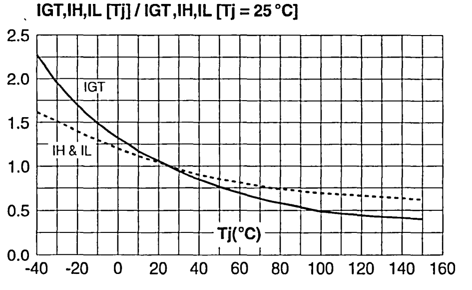


Fig. 5: Surge peak on-state current versus number of cycles.

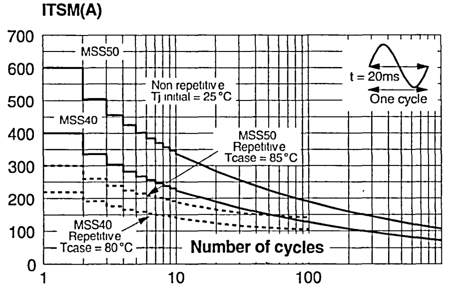


Fig. 6: Non-repetitive surge peak on-state current for a sinusoidal pulse with width tp < 10 ms, and corresponding value of I²t.

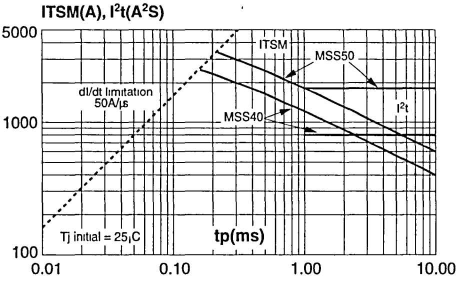


Fig. 7-1: On-state characteristics (maximum values) (MSS40).

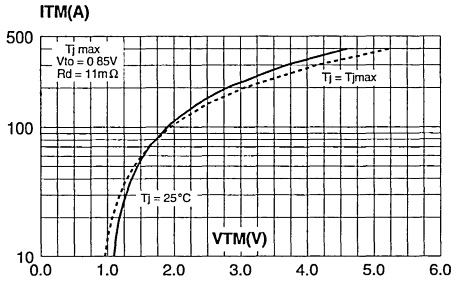
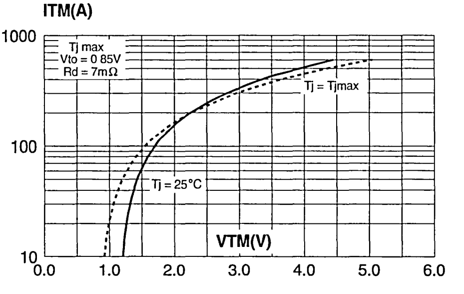


Fig. 7-2: On state characteristics (maximum values) (MSS50).

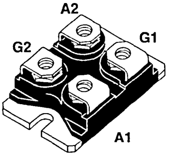


MDS35 / 50 / 80 Series

DIODE / SCR MODULE

MAIN FEATURES:

Symbol	Value	Unit
$I_{T(RMS)}$	50-70-85	A
V_{DRM}/V_{RRM}	800 and 1200	V
I_{GT}	50 and 150	mA



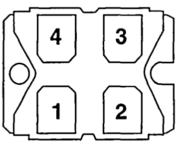
ISOTOP®

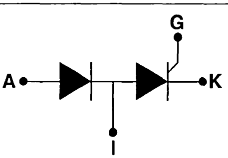
DESCRIPTION

Packaged in ISOTOP modules, the MDS Series is based on the half-bridge SCR-diode configuration. They are suitable for high power applications, using phase controlled bridges, such as soft-start circuits, welding equipment, motor speed controller. The compactness of the ISOTOP package allows high power density and optimized power bus connections. Thanks to their internal ceramic pad, they provide high voltage insulation (2500V RMS), complying with UL standards (File ref: E81734).

PIN CONNECTIONS

1: Thyristor Gate (G)
2: Thyristor Cathode (K)
3: Thyristor Anode/Diode Cathode (I)
4: Diode Anode (A)





ABSOLUTE RATINGS (limiting values)

Symbol	Parameter			Value 35	Value 50	Value 80	Unit
$I_{T(RMS)}$	RMS on-state current			50	70	85	A
$I_{T(AV)}$	Average on-state current (Single phase-circuit, 180° conduction angle per device)		Tc = 85°C	25	35	55	A
I_{TSM}	Non repetitive surge peak on-state current (Tj initial = 25°C)	tp = 8.3 ms	Tj = 25°C	420	630	730	A
I_{FSM}		tp = 10 ms		400	600	700	
I^2t	I^2t Value for fusing	tp = 10 ms	Tj = 25°C	800	1800	2450	A^2s
dI/dt	Critical rate of rise of on-state current I_G = 2 x I_{GT} , tr ≤ 100 ns	F = 60 Hz	Tj = 125°C	50			A/µs
I_{GM}	Peak gate current	tp = 20 µs	Tj = 125°C	4			A
$P_{G(AV)}$	Average gate power dissipation		Tj = 125°C	1			W
T_{stg} T_j	Storage junction temperature range Operating junction temperature range			- 40 to + 150 - 40 to + 125			°C
V_{RGM}	Maximum peak reverse SCR gate voltage			5			V

ISOTOP is a registred trademark of STMicroelectronics

Fig. 1-1: Maximum average power dissipation versus average on-state current (thyristor or diode, sinusoïdal waveform).

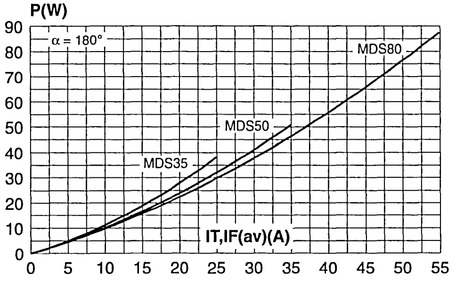


Fig. 1-2: Maximum average power dissipation versus average on-state current (thyristor or diode, rectangular waveform).

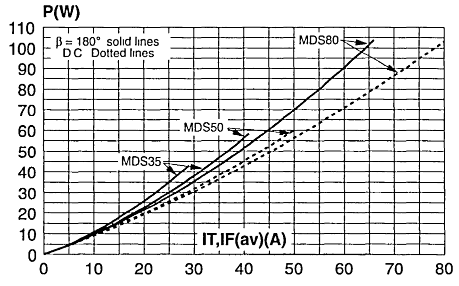


Fig. 1-3: Maximum total power dissipation versus output current on resistive or inductive load (Single phase bridge rectifier, two packages).

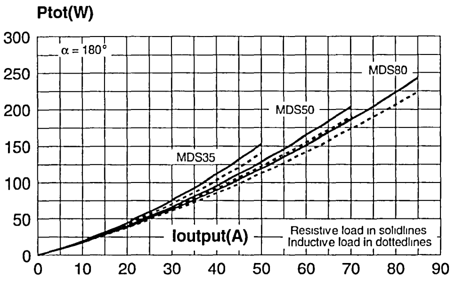


Fig. 1-4: Maximum total power dissipation versus output current (Three phase bridge rectifier, three packages).

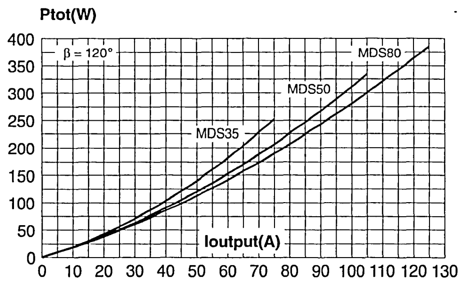


Fig. 2-1: Average on-state current versus case temperature (thyristor or diode, sinusoïdal waveform).

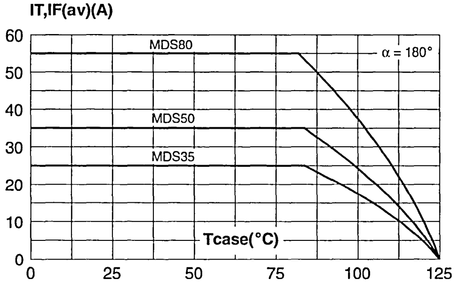
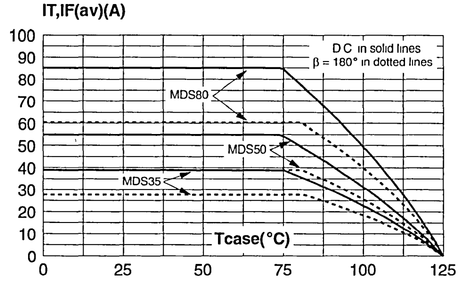


Fig. 2-2: Average on-state current versus case temperature (thyristor or diode, rectangular waveform).



THERMAL RESISTANCES

Symbol	Parameter		Value	Unit
$R_{th(j-c)}$	Junction to case (DC)	MDS35	1.00	°C/W
		MDS50	0.75	
		MDS80	0.45	

PRODUCT SELECTOR

Part Number	Voltage (xxx)		Sensitivity	Package
	800 V	1200 V		
MDS35-xxx	X	X	50 mA	ISOTOP™
MDS50-xxx	X	X	50 mA	
MDS80-xxx	X	X	150 mA	

ORDERING INFORMATION

MDS 35 - 800

- MDS → SCR MODULE SERIES
- 35 → CURRENT:
  - 35: 50A
  - 50: 70A
  - 80: 85A
- 800 → VOLTAGE:
  - 800: 800V
  - 1200: 1200V

OTHER INFORMATION

Part Number	Marking	Weight	Base Quantity	Packing mode
MDS35-xxx	MDS35-xxx	27.0 g	10	Tube
MSDS50-xxx	MDS50-xxx	27.0 g	10	Tube
MDS80-xxx	MDS80-xxx	27.0 g	10	Tube

Note: xxx = voltage

ELECTRICAL CHARACTERISTICS (Tj = 25°C, unless otherwise specified)

SCR

Symbol	Test Conditions			MDS 35	MDS 50	MDS 80	Unit
I_{GT}	V_D = 12 V R_L = 30 Ω		MIN.	5		15	mA
			MAX.	50		150	
V_{GT}			MAX.	1.3			V
V_{GD}	$V_D = V_{DRM}$ R_L = 3.3 kΩ	Tj = 125°C	MIN.	0.2			V
I_H	I_T = 500 mA Gate open		MAX.	80			mA
I_L	$I_G = 1.2\ I_{GT}$		MAX.	120			mA
dV/dt	V_D = 67% V_{DRM} Gate open	Tj = 125°C	MIN.	1000			V/µs
V_{TM}	I_{TM} = 80 A tp = 380 µs	Tj = 25°C	MAX.	1.7	-	-	V
	I_{TM} = 110 A tp = 380 µs			-	1.75	-	
	I_{TM} = 170 A tp = 380 µs			-	-	1.75	
V_{t0}	Threshold voltage	Tj = 125°C	MAX.	0.85			V
R_d	Dynamic resistance	Tj = 125°C	MAX.	11	7.0	5.5	mΩ
I_{DRM} I_{RRM}	V_{DRM} / V_{RRM} RATED	Tj = 125°C	MAX.	20			µA
		Tj = 125°C		10			mA

DIODE

Symbol	Test Conditions			MDS 35	MDS 50	MDS 80	Unit
V_F	I_F = 80 A	Tj = 25°C	MAX.	1.7	-	-	V
	I_F = 110 A			-	1.7	-	
	I_F = 170 A			-	-	1.7	
V_{t0}	Threshold voltage	Tj = 125°C	MAX.	0.85			V
R_d	Dynamic resistance	Tj = 125°C	MAX.	11	7.0	5.5	mΩ
I_R	$V_R = V_{RRM}$	Tj = 25°C	MAX.	20			µA
		Tj = 125°C		10			mA

Fig. 3: Relative variation of thermal impedance junction to case versus pulse duration.

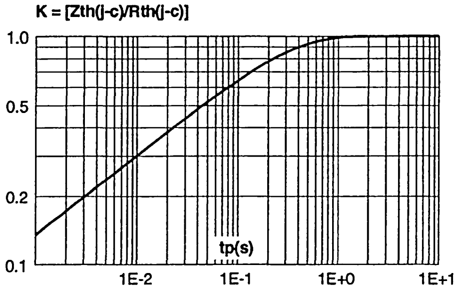


Fig. 4: Relative variation of gate trigger current, holding current and latching current versus junction temperature (typical values).

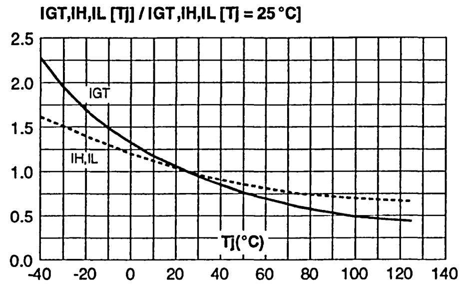


Fig. 5-1: Surge peak on-state current versus number of cycles (MDS35 and MDS50).

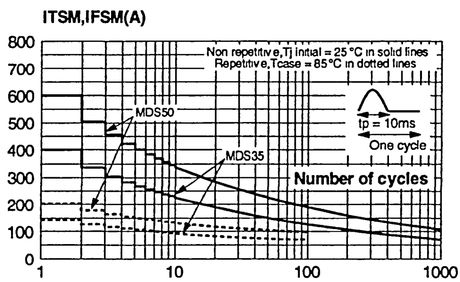


Fig. 5-2: Surge peak on-state current versus number of cycles (MDS80).

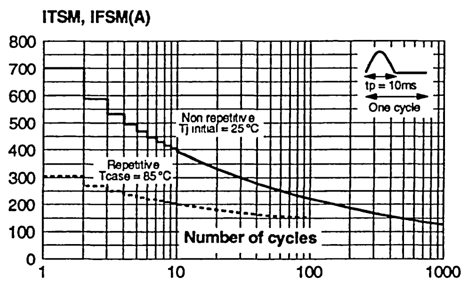


Fig. 6-1: Non-repetitive surge peak on-state current for a sinusoidal pulse with width tp < 10 ms, and corresponding value of I^2t (MDS35 and MDS50).

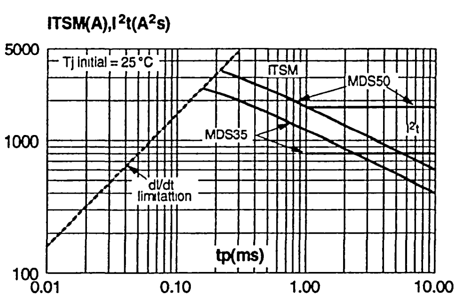


Fig. 6-2: Non repetitive surge peak on-state current for a sinusoidal pulse with width tp < 10 ms, and corresponding value of I^2t (MDS80).

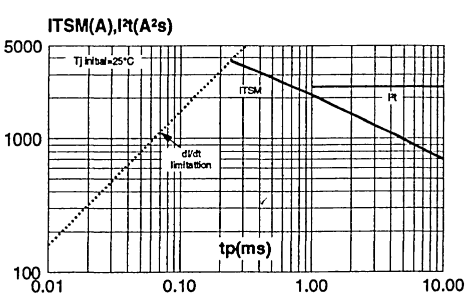


Fig. 7-1: On-state characteristics (thyristor or diode, maximum values) (MDS35).

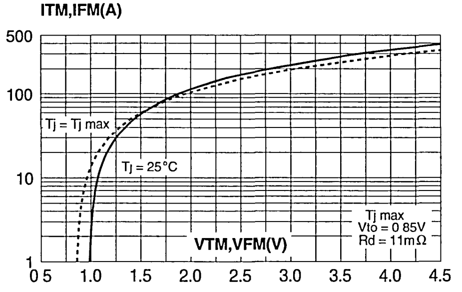


Fig. 7-2: On-state characteristics (thyristor or diode, maximum values) (MDS50).

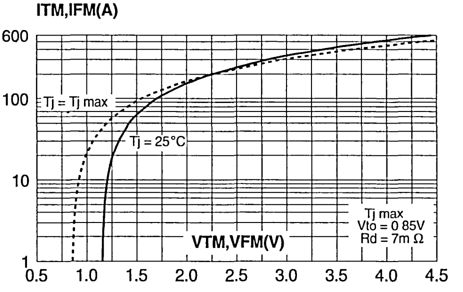
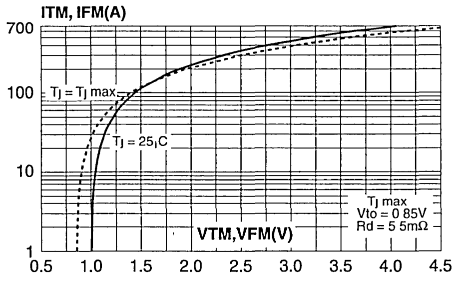


Fig. 7-3: On-state characteristics (thyristor or diode, maximum values) (MDS80).



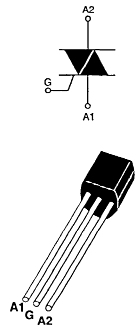
TRIACs DATASHEETS

Z00607MA

STANDARD — **0.8A TRIACs**

MAIN FEATURES:

Symbol	Value	Unit
$I_{T(RMS)}$	0.8	A
V_{DRM}/V_{RRM}	600	V
$I_{GT\ (Q_1)}$	5	mA



TO-92

DESCRIPTION

The Z00607MA is suitable for low power AC switching applications, such as fan speed, small light controllers...
Thanks to low gate triggering current, it can be directly driven by microcontrollers.

ABSOLUTE MAXIMUM RATINGS

Symbol	Parameter			Value	Unit
$I_{T(RMS)}$	RMS on-state current (full sine wave)		Tl = 50°C	0.8	A
I_{TSM}	Non repetitive surge peak on-state current (full cycle, Tj initial = 25°C)	F = 50 Hz	t = 20 ms	9	A
		F = 60 Hz	t = 16.7 ms	9.5	
I^2t	I^2t Value for fusing	tp = 10 ms		0.55	A^2s
dI/dt	Critical rate of rise of on-state current $I_G = 2 \times I_{GT}$, tr ≤ 100 ns	F = 120 Hz	Tj = 110°C	20	A/µs
I_{GM}	Peak gate current	tp = 20 µs	Tj = 110°C	1	A
$P_{G(AV)}$	Average gate power dissipation		Tj = 110°C	0.1	W
T_{stg} T_j	Storage junction temperature range Operating junction temperature range			- 40 to + 150 - 40 to + 110	°C

ELECTRICAL CHARACTERISTICS (Tj = 25°C, unless otherwise specified)

Symbol	Test Conditions	Quadrant		Value	Unit
I_G (1)	V_D = 12 V R_L = 30 Ω	I - II - III IV	MAX.	5 7	mA
V_{GT}		ALL	MAX.	1.3	V
V_{GD}	$V_D = V_{DRM}$ R_L = 3.3 kΩ Tj = 110°C	ALL	MIN.	0.2	V
I_H (2)	I_T = 200 mA		MAX.	5	mA
I_L	I_G = 1.2 I_{GT}	I - III - IV	MAX.	10	mA
		II		20	
dV/dt (2)	V_D = 67 %V_{DRM} gate open Tj = 110°C		MIN.	10	V/µs
(dV/dt)c (2)	(dI/dt)c = 0.35 A/ms Tj = 110°C		MIN.	1.5	V/µs

STATIC CHARACTERISTICS

Symbol	Test Conditions			Value	Unit
V_{TM} (2)	I_{TM} = 1.1 A tp = 380 µs	Tj = 25°C	MAX.	1.5	V
V_{to} (2)	Threshold voltage	Tj = 110°C	MAX.	0.95	V
R_d (2)	Dynamic resistance	Tj = 110°C	MAX.	420	mΩ
I_{DRM} I_{RRM}	$V_{DRM} = V_{RRM}$ = 600 V	Tj = 25°C	MAX.	5	µA
		Tj = 110°C		0.1	mA

Note 1: minimum IGT is guaranteed at 5% of IGT max.

Note 2: for both polarities of A2 referenced to A1

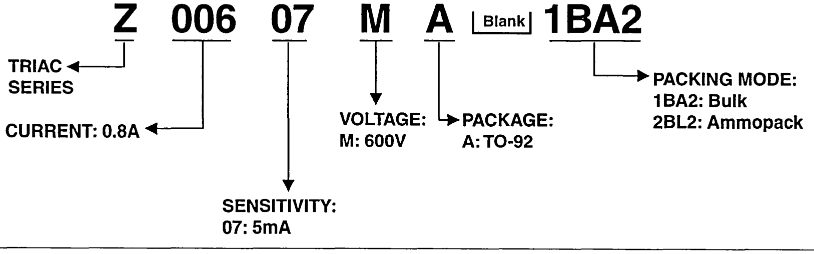
THERMAL RESISTANCES

Symbol	Parameter	Value	Unit
$R_{th(j-l)}$	Junction to lead (AC)	60	°C/W
$R_{th(j-a)}$	Junction to ambient	150	°C/W

PRODUCT SELECTOR

Part Number	Voltage	Sensitivity	Type	Package
Z00607MA	600 V	5 mA	Standard	TO-92

ORDERING INFORMATION



OTHER INFORMATION

Part Number	Marking	Weight	Base quantity	Packing mode
Z00607MA 1BA2	Z00607MA	0.2 g	2500	Bulk
Z00607MA 2BL2	Z00607MA	0.2 g	2500	Ammopack

Fig. 1: Maximum power dissipation versus RMS on-state current (full cycle).

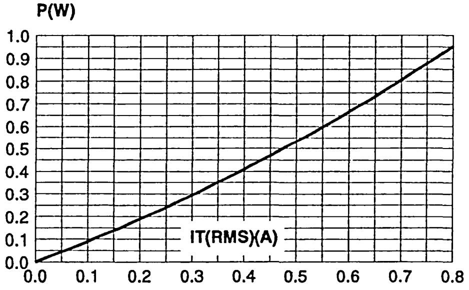


Fig. 2: RMS on-state current versus ambient temperature (full cycle).

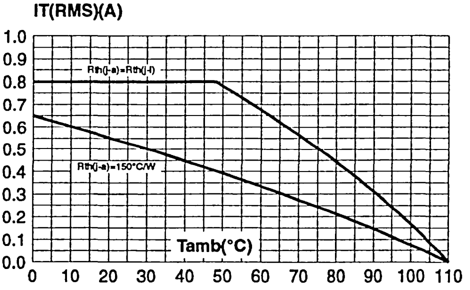


Fig. 3: Relative variation of thermal impedance junction to ambient versus pulse duration.

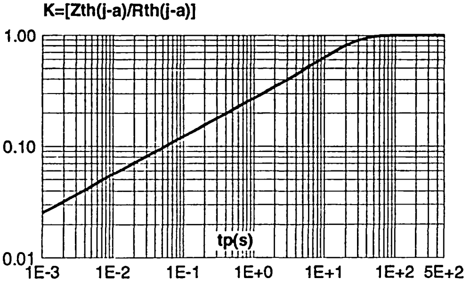


Fig. 4: Relative variation of gate trigger current, holding current and latching current versus junction temperature (typical values).

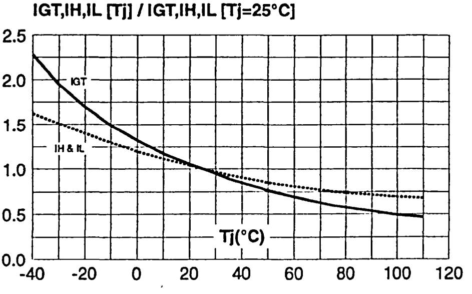


Fig. 5: Surge peak on-state current versus number of cycles.

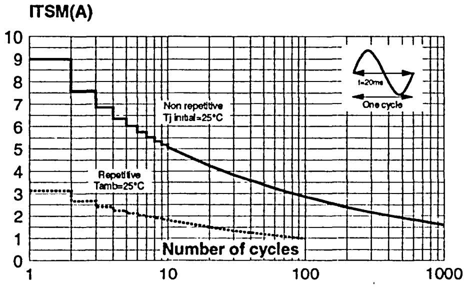


Fig. 6: Non-repetitive surge peak on-state current for a sinusoidal pulse with width tp < 10ms, and corresponding value of I^2t.

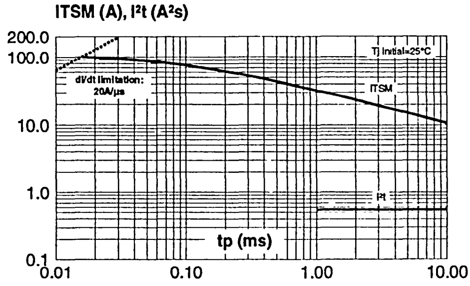


Fig. 7: On-state characteristics (maximum values).

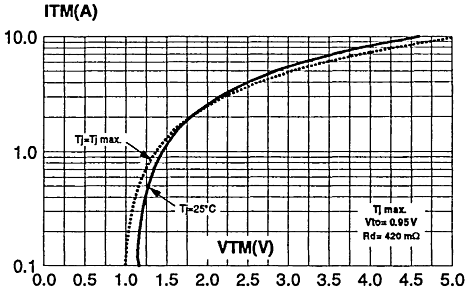


Fig. 8: Relative variation of critical rate of decrease of main current versus (dV/dt)c (typical values).

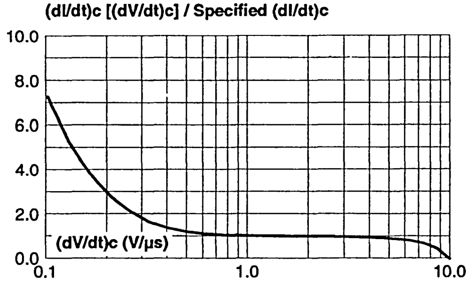
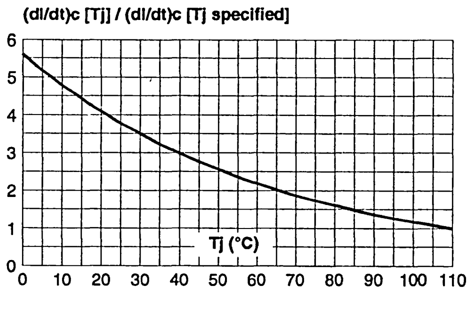


Fig. 9: Relative variation of critical rate of decrease of main current versus junction temperature.



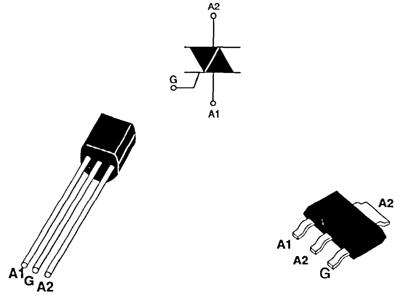
Z01 Series

STANDARD

1A TRIACs

MAIN FEATURES:

Symbol	Value	Unit
$I_{T(RMS)}$	1	A
V_{DRM}/V_{RRM}	600 to 800	V
I_{GT} (Q_1)	3 to 25	mA



TO-92 (Z01xxA) **SOT-223 (Z01xxN)**

DESCRIPTION

The Z01 series is suitable for general purpose AC switching applications. They can be found in applications such as home appliances (electrovalve, pump, door lock, small lamp control), fan speed controllers,...
Different gate current sensitivities are available, allowing optimized performances when controlled directly from microcontrollers.

ABSOLUTE MAXIMUM RATINGS

Symbol	Parameter			Value	Unit
$I_{T(RMS)}$	RMS on-state current (full sine wave)	SOT-223	Ttab = 90°C	1	A
		TO-92	Tl = 50°C		
I_{TSM}	Non repetitive surge peak on-state current (full cycle, Tj initial = 25°C)	F = 50 Hz	t = 20 ms	8	A
		F = 60 Hz	t = 16.7 ms	8.5	
I^2t	I^2t Value for fusing	tp = 10 ms		0.45	A^2s
dI/dt	Critical rate of rise of on-state current $I_G = 2 \times I_{GT}$, tr ≤ 100 ns	F = 120 Hz	Tj = 125°C	20	A/µs
I_{GM}	Peak gate current	tp = 20 µs	Tj = 125°C	1	A
$P_{G(AV)}$	Average gate power dissipation		Tj = 125°C	0.1	W
T_{stg} T_j	Storage junction temperature range Operating junction temperature range			- 40 to + 150 - 40 to + 125	°C

ELECTRICAL CHARACTERISTICS (Tj = 25°C, unless otherwise specified)

Symbol	Test Conditions	Quadrant		Z01xx				Unit
				03	07	09	10	
I_{GT} (1)	V_D = 12 V R_L = 30 Ω	I - II - III IV	MAX.	3 5	5 7	10 10	25 25	mA
V_{GT}		ALL	MAX.	1.3				V
V_{GD}	V_D = V_{DRM} R_L = 3.3 kΩ Tj = 125°C	ALL	MIN.	0.2				V
I_H (2)	I_T = 50 mA		MAX.	7	10	10	25	mA
I_L	I_G = 1.2 I_{GT}	I - III - IV	MAX.	7	10	15	25	mA
		II		15	20	25	50	
dV/dt (2)	V_D = 67 %V_{DRM} gate open Tj = 110°C		MIN.	10	20	50	100	V/µs
(dV/dt)c (2)	(dI/dt)c = 0.44 A/ms Tj = 110°C		MIN.	0.5	1	2	5	V/µs

STATIC CHARACTERISTICS

Symbol	Test Conditions			Value	Unit
V_{TM} (2)	I_{TM} = 1.4 A tp = 380 µs	Tj = 25°C	MAX.	1.6	V
V_{to} (2)	Threshold voltage	Tj = 125°C	MAX.	0.95	V
R_d (2)	Dynamic resistance	Tj = 125°C	MAX.	400	mΩ
I_{DRM} I_{RRM}	V_{DRM} = V_{RRM}	Tj = 25°C	MAX.	5	µA
		Tj = 125°C		0.5	mA

Note 1: minimum IGT is guaranted at 5% of IGT max

Note 2: for both polarities of A2 referenced to A1

THERMAL RESISTANCES

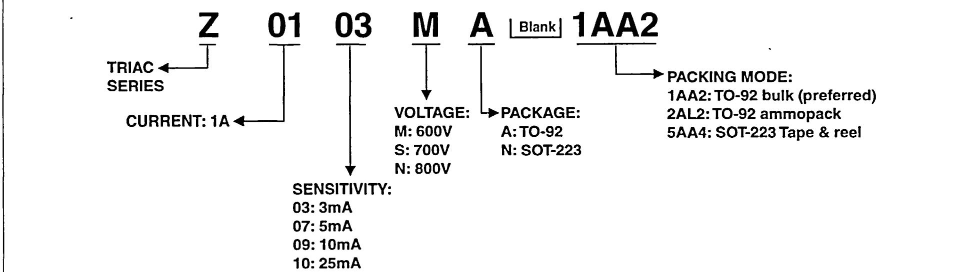
Symbol	Parameter			Value	Unit
R_{th}	Junction to tab (AC)		SOT-223	25	°C/W
$R_{th(j-l)}$	Junction to lead (AC)		TO-92	60	
$R_{th(j-a)}$	Junction to ambient	S = 5 cm^2	SOT-223	60	°C/W
			TO-92	150	

S = Copper surface under tab

PRODUCT SELECTOR

Part Number	Voltage			Sensitivity	Type	Package
	600 V	700 V	800 V			
Z0103MA	X			3 mA	Standard	TO-92
Z0103MN	X			3 mA	Standard	SOT-223
Z0103SA		X		3 mA	Standard	TO-92
Z0103SN		X		3 mA	Standard	SOT-223
Z0103NA			X	3 mA	Standard	TO-92
Z0103NN			X	3 mA	Standard	SOT-223
Z0107MA	X			5 mA	Standard	TO-92
Z0107MN	X			5 mA	Standard	SOT-223
Z0107SA		X		5 mA	Standard	TO-92
Z0107SN		X		5 mA	Standard	SOT-223
Z0107NA			X	5 mA	Standard	TO-92
Z0107NN			X	5 mA	Standard	SOT-223
Z0109MA	X			10 mA	Standard	TO-92
Z0109MN	X			10 mA	Standard	SOT-223
Z0109SA		X		10 mA	Standard	TO-92
Z0109SN		X		10 mA	Standard	SOT-223
Z0109NA			X	10 mA	Standard	TO-92
Z0109NN			X	10 mA	Standard	SOT-223
Z0110MA	X			25 mA	Standard	TO-92
Z0110MN	X			25 mA	Standard	SOT-223
Z0110SA		X		25 mA	Standard	TO-92
Z0110SN		X		25 mA	Standard	SOT-223
Z0110NA			X	25 mA	Standard	TO-92
Z0110NN			X	25 mA	Standard	SOT-223

ORDERING INFORMATION



OTHER INFORMATION

Part Number	Marking	Weight	Base quantity	Packing mode
Z01xxyA 1AA2	Z01xxyA	0.2 g	2500	Bulk
Z01xxyA 2AL2	Z01xxyA	0.2 g	2000	Ammopack
Z0103yN 5AA4	Z3y	0.12 g	1000	Tape & reel
Z0107yN 5AA4	Z7y	0.12 g	1000	Tape & reel
Z0109yN 5AA4	Z9y	0.12 g	1000	Tape & reel
Z0110yN 5AA4	Z0y	0.12 g	1000	Tape & reel

Note: xx = sensitivity, y = voltage

Fig. 1: Maximum power dissipation versus RMS on-state current (full cycle).

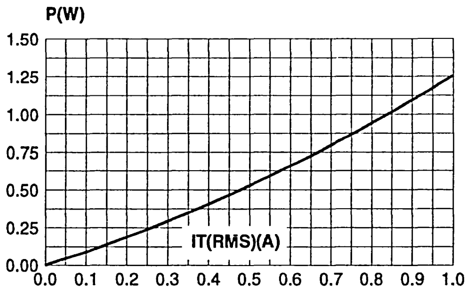


Fig. 2-1: RMS on-state current versus ambient temperature (full cycle).

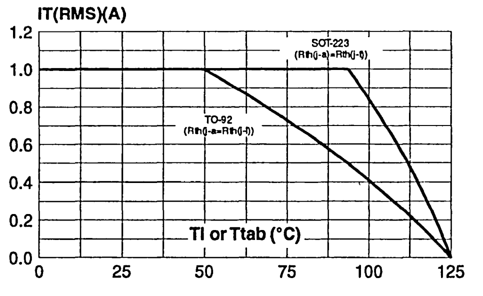


Fig. 2-2: RMS on-state current versus ambient temperature (full cycle).

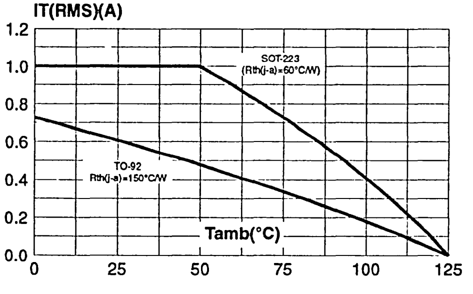


Fig. 3: Relative variation of thermal impedance junction to ambient versus pulse duration.

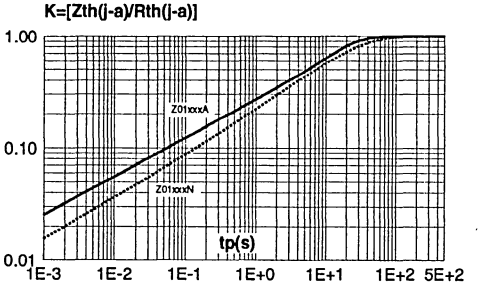


Fig. 4: Relative variation of gate trigger current, holding current and latching current versus junction temperature (typical values).

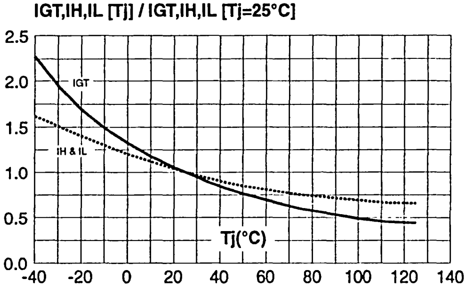


Fig. 5: Surge peak on-state current versus number of cycles.

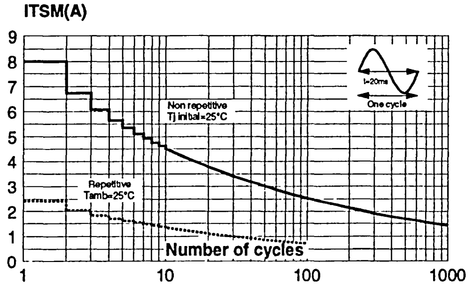


Fig. 6: Non-repetitive surge peak on-state current for a sinusoidal pulse with width tp < 10ms, and corresponding value of I²t.

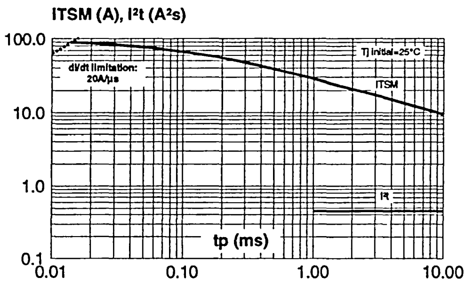


Fig. 7: On-state characteristics (maximum values).

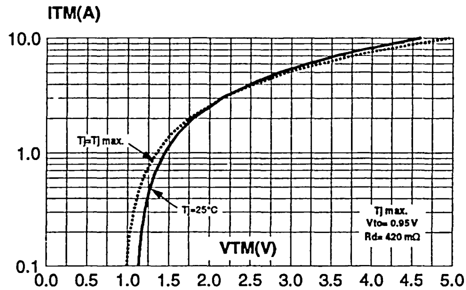


Fig. 8: Relative variation of critical rate of decrease of main current versus (dV/dt)c (typical values).

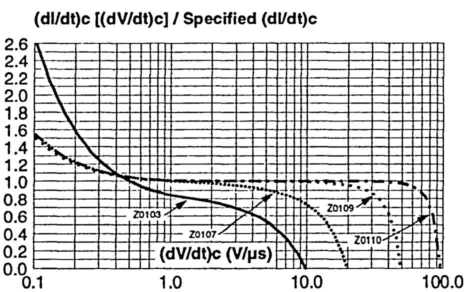


Fig. 9: Relative variation of critical rate of decrease of main current versus junction temperature.

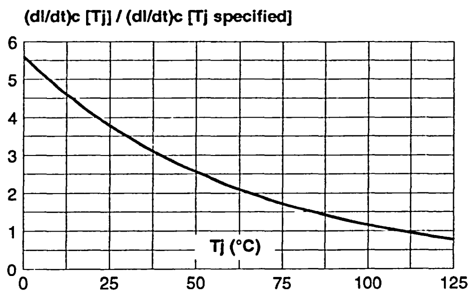
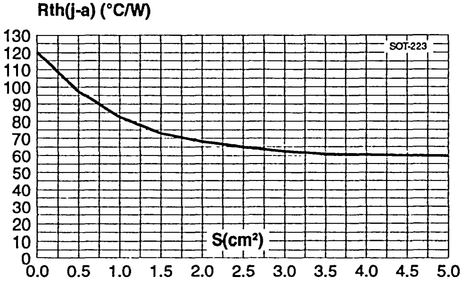


Fig. 10: SOT-223 Thermal resistance junction to ambient versus copper surface under tab (printed circuit board FR4, copper thickness: 35µm).



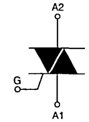
Z04 Series

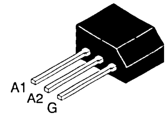
STANDARD

4A TRIACs

MAIN FEATURES:

Symbol	Value	Unit
$I_{T(RMS)}$	4	A
V_{DRM}/V_{RRM}	600 to 800	V
$I_{GT\ (Q_1)}$	3 to 25	mA





TO202-3
(Z04xxF)

DESCRIPTION

The Z04 series is suitable for general purpose AC switching applications. They can be found in applications such as touch light dimmers, fan controllers, HID lamp ignitors,...
Different gate current sensitivities are available, allowing optimized performances when controlled directly from microcontrollers.

ABSOLUTE MAXIMUM RATINGS

Symbol	Parameter			Value	Unit
$I_{T(RMS)}$	RMS on-state current (full sine wave)		Tl = 30°C	4	A
			Tamb = 25°C	1	
I_{TSM}	Non repetitive surge peak on-state current (full cycle, Tj initial = 25°C)	F = 50 Hz	t = 20 ms	20	A
		F = 60 Hz	t = 16.7 ms	21	
I^2t	I^2t Value for fusing	tp = 10 ms		2.8	A^2s
dI/dt	Critical rate of rise of on-state current $I_G = 2 \times I_{GT}$, tr ≤ 100 ns	F = 120 Hz	Tj = 125°C	20	A/µs
I_{GM}	Peak gate current	tp = 20 µs	Tj = 125°C	1.2	A
$P_{G(AV)}$	Average gate power dissipation		Tj = 125°C	0.2	W
T_{stg} T_j	Storage junction temperature range Operating junction temperature range			- 40 to + 150 - 40 to + 125	°C

ELECTRICAL CHARACTERISTICS (Tj = 25°C, unless otherwise specified)

Symbol	Test Conditions	Quadrant		Z04xx 02	Z04xx 05	Z04xx 09	Z04xx 10	Unit
I_{GT} (1)	V_D = 12 V R_L = 30 Ω	ALL	MAX.	3	5	10	25	mA
V_{GT}		ALL	MAX.	1.3				V
V_{GD}	$V_D = V_{DRM}$ R_L = 3.3 kΩ Tj = 125°C	ALL	MIN.	0.2				V
I_H (2)	I_T = 50 mA		MAX.	3	5	10	25	mA
I_L	I_G = 1.2 I_{GT}	I - III - IV	MAX.	6	10	15	25	mA
		II		12	15	25	50	
dV/dt (2)	V_D = 67 %V_{DRM} gate open Tj = 110°C		MIN.	10	20	100	200	V/µs
(dV/dt)c (2)	(dI/dt)c = 1.8 A/ms Tj = 110°C		MIN.	0.5	1	2	5	V/µs

STATIC CHARACTERISTICS

Symbol	Test Conditions			Value	Unit
V_{TM} (2)	I_{TM} = 5.5 A tp = 380 µs	Tj = 25°C	MAX.	2.0	V
V_{to} (2)	Threshold voltage	Tj = 125°C	MAX.	0.95	V
R_d (2)	Dynamic resistance	Tj = 125°C	MAX.	180	mΩ
I_{DRM} I_{RRM}	$V_{DRM} = V_{RRM}$	Tj = 25°C	MAX.	5	µA
		Tj = 125°C		0.5	mA

Note 1: minimum IGT is guaranted at 5% of IGT max

Note 2: for both polarities of A2 referenced to A1

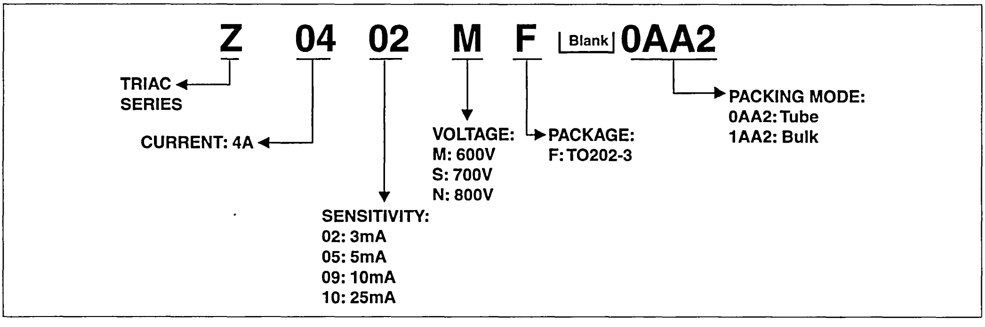
THERMAL RESISTANCES

Symbol	Parameter	Value	Unit
$R_{th(j-l)}$	Junction to lead (AC)	15	°C/W
$R_{th(j-a)}$	Junction to ambient	100	°C/W

PRODUCT SELECTOR

Part Number	Voltage			Sensitivity	Type	Package
	600 V	700 V	800 V			
Z0402MF	X			3 mA	Standard	TO202-3
Z0402SF		X		3 mA	Standard	TO202-3
Z0402NF			X	3 mA	Standard	TO202-3
Z0405MF	X			5 mA	Standard	TO202-3
Z0405SF		X		5 mA	Standard	TO202-3
Z0405NF			X	5 mA	Standard	TO202-3
Z0409MF	X			10 mA	Standard	TO202-3
Z0409SF		X		10 mA	Standard	TO202-3
Z0409NF			X	10 mA	Standard	TO202-3
Z0410MF	X			25 mA	Standard	TO202-3
Z0410SF		X		25 mA	Standard	TO202-3
Z0410NF			X	25 mA	Standard	TO202-3

ORDERING INFORMATION



OTHER INFORMATION

Part Number	Marking	Weight	Base quantity	Packing mode
Z04xxyF 0AA2	Z04xxyF	0.8 g	50	Tube
Z04xxyF 1AA2	Z04xxyF	0.8 g	250	Bulk

Note: xx = sensitivity, y = voltage

Fig. 1: Maximum power dissipation versus RMS on-state current (full cycle).

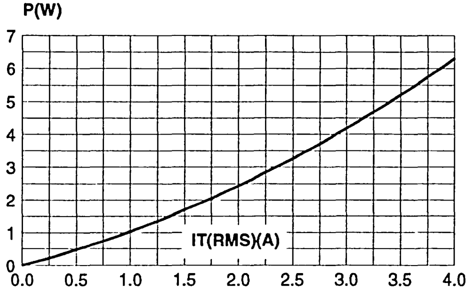


Fig. 2: RMS on-state current versus ambient temperature (full cycle).

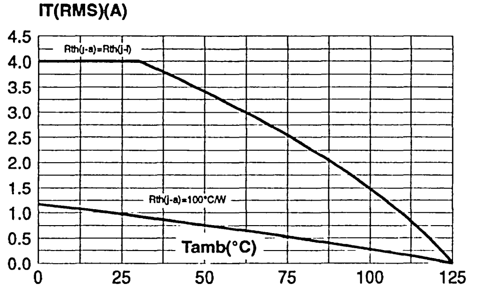


Fig. 3: Relative variation of thermal impedance junction to ambient versus pulse duration.

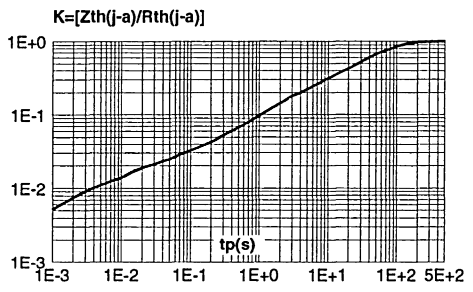


Fig. 4: Relative variation of gate trigger current, holding current and latching current versus junction temperature (typical values).

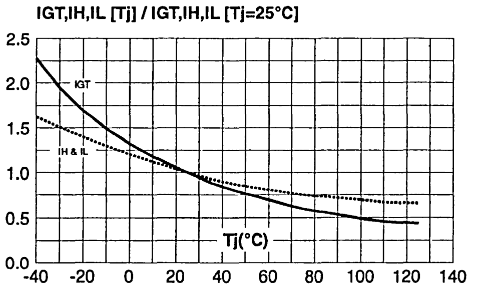


Fig. 5: Surge peak on-state current versus number of cycles.

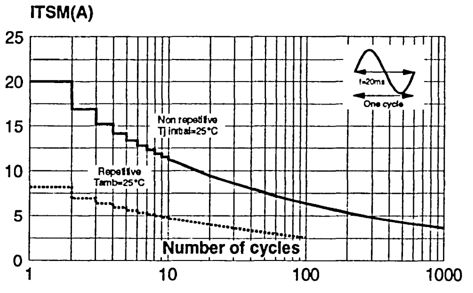


Fig. 6: Non-repetitive surge peak on-state current for a sinusoidal pulse with width tp < 10ms, and corresponding value of I^2t.

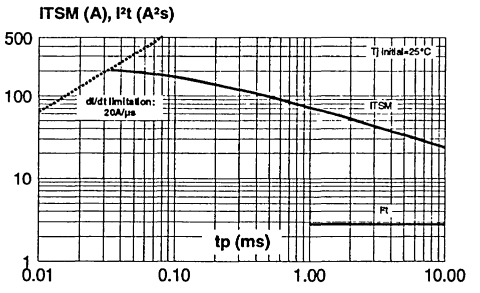


Fig. 7: On-state characteristics (maximum values).

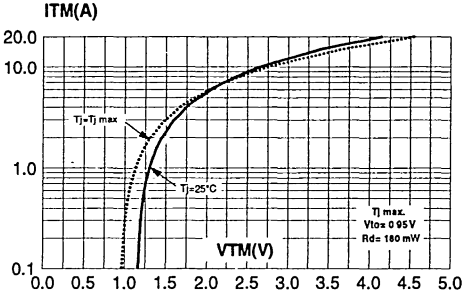


Fig. 8: Relative variation of critical rate of decrease of main current versus (dV/dt)c (typical values).

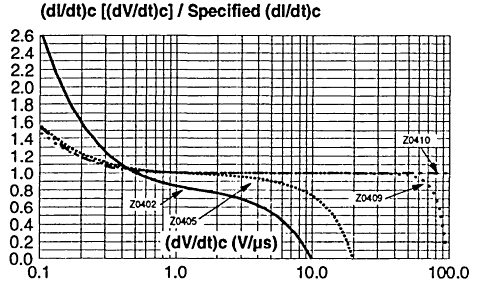
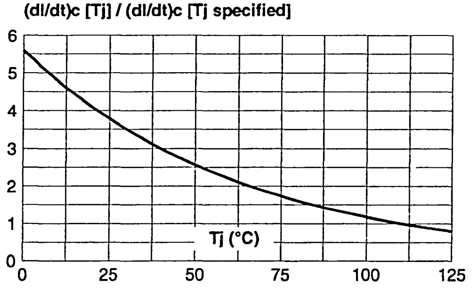


Fig. 9: Relative variation of critical rate of decrease of main current versus junction temperature.

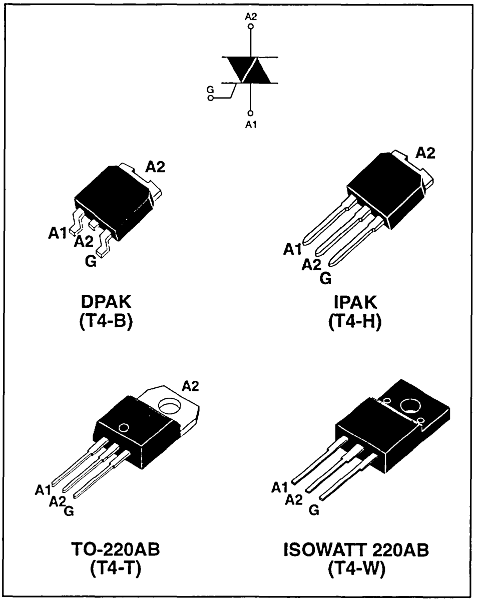


T4 Series

SNUBBERLESS™ & LOGIC LEVEL — 4A TRIACs

MAIN FEATURES:

Symbol	Value	Unit
$I_{T(RMS)}$	4	A
V_{DRM}/V_{RRM}	600 to 800	V
I_{GT} (Q_1)	5 to 35	mA



DESCRIPTION

Based on ST's Snubberless / Logic level technology providing high commutation performances, the T4 series is suitable for use on AC inductive loads. They are recommended for applications using universal motors, electrovalves.... such as kitchen aid equipments, power tools, dishwashers,... Available in a fully insulated package, the T4...-...W version complies with UL standards (ref. E81734).

ABSOLUTE MAXIMUM RATINGS

Symbol	Parameter			Value	Unit
$I_{T(RMS)}$	RMS on-state current (full sine wave)	DPAK / IPAK TO-220AB	Tc = 110°C	4	A
		ISOWATT 220AB	Tc = 105°C		
I_{TSM}	Non repetitive surge peak on-state current (full cycle, Tj initial = 25°C)	F = 50 Hz	t = 20 ms	30	A
		F = 60 Hz	t = 16.7 ms	31	
I^2t	I^2t Value for fusing	tp = 10 ms		6.5	A^2s
dI/dt	Critical rate of rise of on-state current $I_G = 2 \times I_{GT}$, tr ≤ 100 ns	F = 120 Hz	Tj = 125°C	50	A/µs
I_{GM}	Peak gate current	tp = 20 µs	Tj = 125°C	4	A
$P_{G(AV)}$	Average gate power dissipation		Tj = 125°C	1	W
T_{stg} T_j	Storage junction temperature range Operating junction temperature range			- 40 to + 150 - 40 to + 125	°C

ELECTRICAL CHARACTERISTICS (Tj = 25°C, unless otherwise specified)

Symbol	Test Conditions	Quadrant		T4			Unit
				T405	T410	T435	
I_{GT} (1)	V_D = 12 V R_L = 30 Ω	I - II - III	MAX.	5	10	35	mA
V_{GT}		I - II - III	MAX.	1.3			V
V_{GD}	V_D = V_{DRM} R_L = 33 kΩ Tj = 125°C	I - II - III	MIN.	0.2			V
I_H (2)	I_T = 100 mA		MAX.	10	15	35	mA
I_L	I_G = 1.2 I_{GT}	I - III	MAX.	10	25	50	mA
		II		15	30	60	
dV/dt (2)	V_D = 67 %V_{DRM} gate open Tj = 125°C		MIN.	20	40	400	V/µs
(dI/dt)c (2)	(dV/dt)c = 0.1 V/µs Tj = 125°C		MIN.	1.8	2.7	-	A/ms
	(dV/dt)c = 10 V/µs Tj = 125°C			0.9	2.0	-	
	Without snubber Tj = 125°C			-	-	2.5	

STATIC CHARACTERISTICS

Symbol	Test Conditions			Value	Unit
V_{TM} (2)	I_{TM} = 5.5 A tp = 380 µs	Tj = 25°C	MAX.	1.6	V
V_{to} (2)	Threshold voltage	Tj = 125°C	MAX.	0.9	V
R_d (2)	Dynamic resistance	Tj = 125°C	MAX.	120	mΩ
I_{DRM} I_{RRM}	V_{DRM} = V_{RRM}	Tj = 25°C	MAX.	5	µA
		Tj = 125°C		1	mA

Note 1: minimum IGT is guaranted at 5% of IGT max

Note 2: for both polarities of A2 referenced to A1

THERMAL RESISTANCES

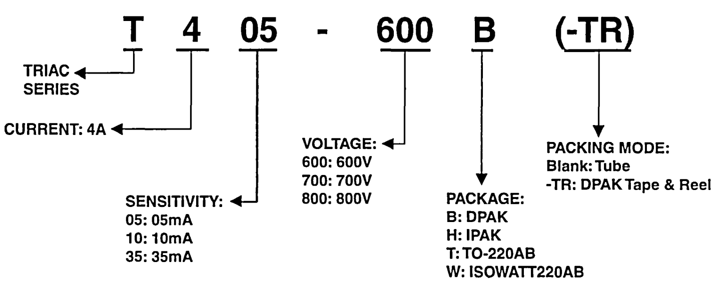
Symbol	Parameter			Value	Unit
$R_{th(j-c)}$	Junction to case (AC)		DPAK IPAK TO-220AB	2.6	°C/W
			ISOWATT220AB	4.0	
$R_{th(j-a)}$	Junction to ambient	S = 0.5 cm^2	DPAK	70	°C/W
			TO-220AB ISOWATT220AB	60	
			IPAK	100	

S = Copper surface under tab

PRODUCT SELECTOR

Part Number	Voltage (xxx)			Sensitivity	Type	Package
	600 V	700 V	800 V			
T405-xxxB	X	X	X	5 mA	Logic level	DPAK
T405-xxxH	X	X	X	5 mA	Logic level	IPAK
T405-xxxT	X	X	X	5 mA	Logic level	TO-220AB
T405-xxxW	X	X	X	5 mA	Logic level	ISOWATT220AB
T410-xxxB	X	X	X	10 mA	Logic level	DPAK
T410-xxxH	X	X	X	10 mA	Logic level	IPAK
T410-xxxT	X	X	X	10 mA	Logic level	TO-220AB
T410-xxxW	X	X	X	10 mA	Logic level	ISOWATT220AB
T435-xxxB	X	X	X	35 mA	Snubberless	DPAK
T435-xxxH	X	X	X	35 mA	Snubberless	IPAK
T435-xxxT	X	X	X	35 mA	Snubberless	TO-220AB
T435-xxxW	X	X	X	35 mA	Snubberless	ISOWATT220AB

ORDERING INFORMATION



OTHER INFORMATION

Part Number	Marking	Weight	Base quantity	Packing mode
T4xx-yyyB	T4xxyyyB	0.3 g	75	Tube
T4xx-yyyB-TR	T4xxyyyB	0.3 g	2500	Tape & reel
T4xx-yyyH	T4xxyyyH	0.4 g	75	Tube
T4xx-yyyT	T4xxyyyT	2.3 g	50	Tube
T4xx-yyyW	T4xxyyyW	2.1 g	50	Tube

Note: xx = sensitivity, yyy = voltage

Fig. 1: Maximum power dissipation versus RMS on-state current (full cycle).

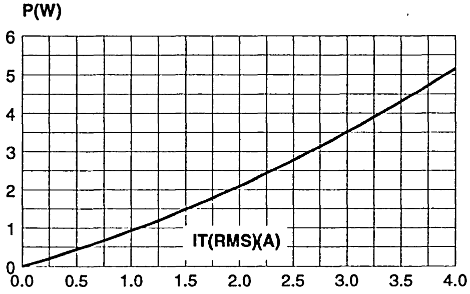


Fig. 2-1: RMS on-state current case versus temperature (full cycle).

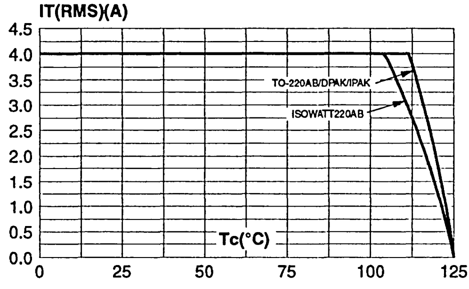


Fig. 2-2: RMS on-state current versus ambient temperature (printed circuit FR4, copper thickness: 35µm),full cycle.

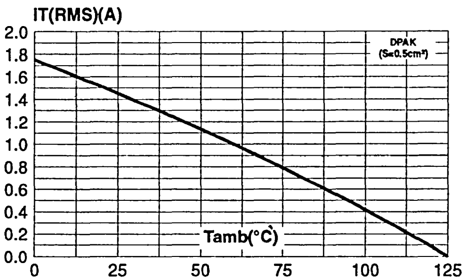


Fig. 3: Relative variation of thermal impedance versus pulse duration.

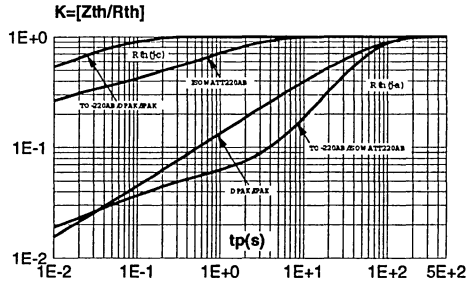


Fig. 4: Relative variation of gate trigger current, holding current and latching current versus junction temperature (typical values).

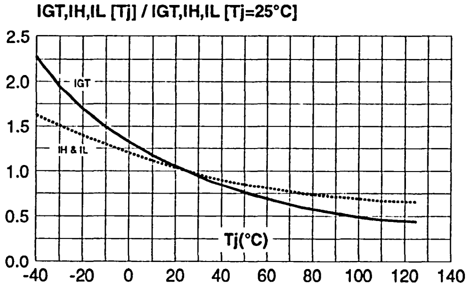


Fig. 5: Surge peak on-state current versus number of cycles.

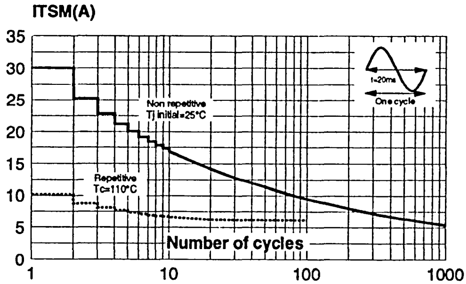


Fig. 6: Non-repetitive surge peak on-state current for a sinusoidal pulse with width tp < 10ms, and corresponding value of I²t.

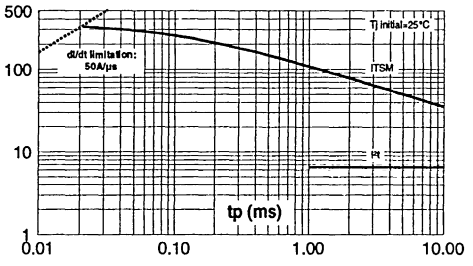


Fig. 7: On-state characteristics (maximum values).

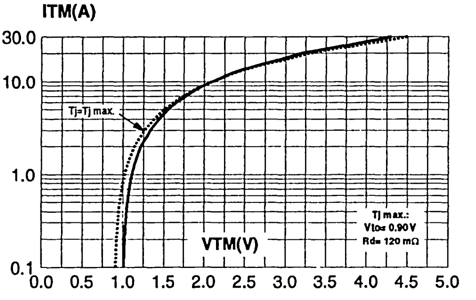


Fig. 8: Relative variation of critical rate of decrease of main current versus (dV/dt)c (typical values).

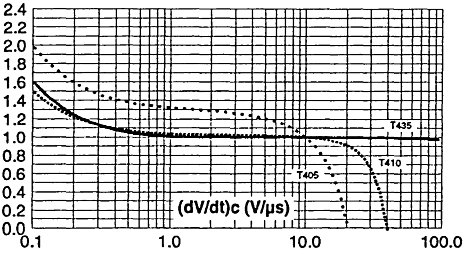


Fig. 9: Relative variation of critical rate of decrease of main current versus junction temperature.

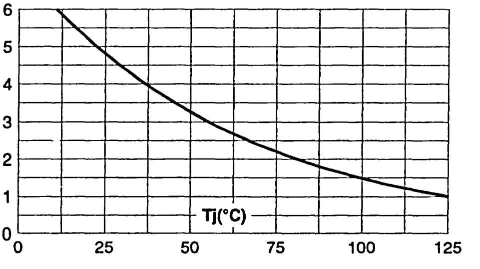
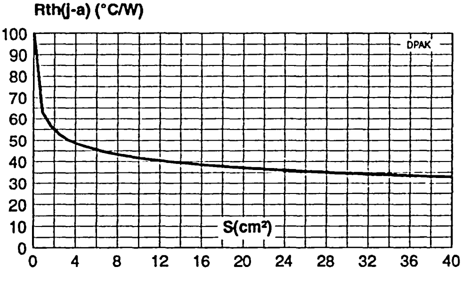


Fig. 10: DPAK thermal resistance junction to ambient versus copper surface under tab (printed circuit board FR4, copper thickness: 35µm).

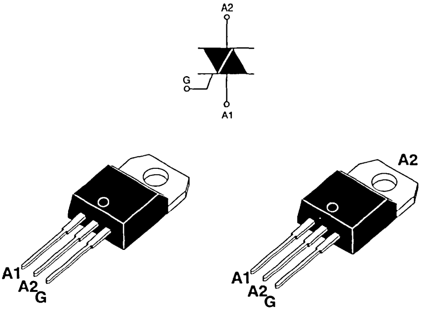


SNUBBERLESS™, LOGIC LEVEL & STANDARD

6A TRIACs

MAIN FEATURES:

Symbol	Value	Unit
$I_{T(RMS)}$	6	A
V_{DRM}/V_{RRM}	600 and 800	V
$I_{G\ (Q_1)}$	5 to 50	mA



TO-220AB Insulated (BTA06)

TO-220AB (BTB06)

DESCRIPTION

Suitable for AC switching operations, the BTA/BTB06 series can be used as an ON/OFF function in applications such as static relays, heating regulation, induction motor starting circuits... or for phase control in light dimmers, motor speed controllers,...

The snubberless and logic level versions (BTA/BTB...W) are specially recommended for use on inductive loads, thanks to their high commutation performances. By using an internal ceramic pad, the BTA series provides voltage insulated tab (rated at 2500V RMS) complying with UL standards (File ref.: E81734)

ABSOLUTE MAXIMUM RATINGS

Symbol	Parameter			Value	Unit
$I_{T(RMS)}$	RMS on-state current (full sine wave)	TO-220AB	Tc = 110°C	6	A
		TO-220AB Ins.	Tc = 105°C		
I_{TSM}	Non repetitive surge peak on-state current (full cycle, Tj initial = 25°C)	F = 50 Hz	t = 20 ms	60	A
		F = 60 Hz	t = 16.7 ms	63	
I^2t	I^2t Value for fusing	tp = 10 ms		25	A^2s
dI/dt	Critical rate of rise of on-state current $I_G = 2 \times I_{GT}$, tr ≤ 100 ns	F = 120 Hz	Tj = 125°C	50	A/µs
I_{GM}	Peak gate current	tp = 20 µs	Tj = 125°C	4	A
$P_{G(AV)}$	Average gate power dissipation		Tj = 125°C	1	W
T_{stg} T_j	Storage junction temperature range Operating junction temperature range			- 40 to + 150 - 40 to + 125	°C

ELECTRICAL CHARACTERISTICS (Tj = 25°C, unless otherwise specified)

■ SNUBBERLESS™ and LOGIC LEVEL (3 Quadrants)

Symbol	Test Conditions	Quadrant		BTA/BTB06				Unit
				TW	SW	CW	BW	
I_{GT} (1)	V_D = 12 V R_L = 30 Ω	I - II - III	MAX.	5	10	35	50	mA
V_{GT}		I - II - III	MAX.	1.3				V
V_{GD}	$V_D = V_{DRM}$ R_L = 3.3 kΩ Tj = 125°C	I - II - III	MIN.	0.2				V
I_H (2)	I_T = 100 mA		MAX.	10	15	35	50	mA
I_L	I_G = 1.2 I_{GT}	I - III	MAX.	10	25	50	70	mA
		II		15	30	60	80	
dV/dt (2)	V_D = 67 %V_{DRM} gate open Tj = 125°C		MIN.	20	40	400	1000	V/µs
(dI/dt)c (2)	(dV/dt)c = 0.1 V/µs Tj = 125°C		MIN.	2.7	3.5	-	-	A/ms
	(dV/dt)c = 10 V/µs Tj = 125°C			1.2	2.4	-	-	
	Without snubber Tj = 125°C			-	-	3.5	5.3	

■ STANDARD (4 Quadrants)

Symbol	Test Conditions	Quadrant		BTA/BTB06		Unit
				C	B	
I_G (1)	V_D = 12 V R_L = 30 Ω	I - II - III IV	MAX.	25 50	50 100	mA
V_{GT}		ALL	MAX.	1.3		V
V_{GD}	$V_D = V_{DRM}$ R_L = 3.3 kΩ Tj = 125°C	ALL	MIN.	0.2		V
I_H (2)	I_T = 500 mA		MAX.	25	50	mA
I_L	I_G = 1.2 I_{GT}	I - III - IV	MAX.	40	50	mA
		II		80	100	
dV/dt (2)	V_D = 67 %V_{DRM} gate open Tj = 125°C		MIN.	200	400	V/µs
(dV/dt)c (2)	(dI/dt)c = 2.7 A/ms Tj = 125°C		MIN.	5	10	V/µs

STATIC CHARACTERISTICS

Symbol	Test Conditions			Value	Unit
V_T (2)	I_{TM} = 11 A tp = 380 µs	Tj = 25°C	MAX.	1.55	V
V_{to} (2)	Threshold voltage	Tj = 125°C	MAX.	0.85	V
R_d (2)	Dynamic resistance	Tj = 125°C	MAX.	60	mΩ
I_{DRM} I_{RRM}	$V_{DRM} = V_{RRM}$	Tj = 25°C	MAX.	5	µA
		Tj = 125°C		1	mA

Note 1: minimum IGT is guaranteed at 5% of IGT max.

Note 2: for both polarities of A2 referenced to A1

THERMAL RESISTANCES

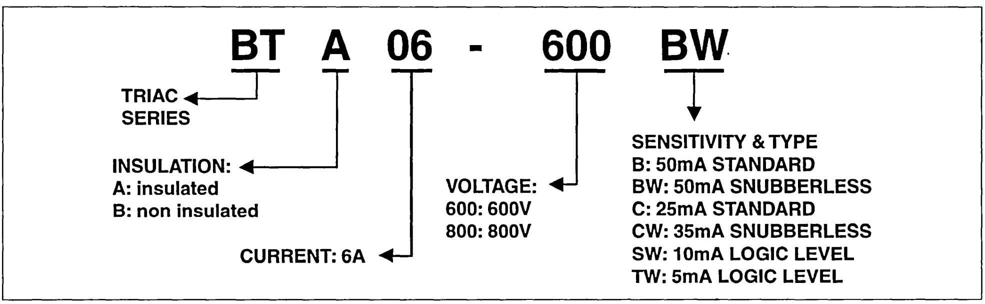
Symbol	Parameter		Value	Unit
$R_{th(j-c)}$	Junction to case (AC)	TO-220AB	1.8	°C/W
		TO-220AB Insulated	2.7	
$R_{th(j-a)}$	Junction to ambient	TO-220AB TO-220AB Insulated	60	°C/W

PRODUCT SELECTOR

Part Number	Voltage (xxx)		Sensitivity	Type	Package
	600 V	800 V			
BTA/BTB06-xxxB	X	X	50 mA	Standard	TO-220AB
BTA/BTB06-xxxBW	X	X	50 mA	Snubberless	TO-220AB
BTA/BTB06-xxxC	X	X	25 mA	Standard	TO-220AB
BTA/BTB06-xxxCW	X	X	35 mA	Snubberless	TO-220AB
BTA/BTB06-xxxSW	X	X	10 mA	Logic level	TO-220AB
BTA/BTB06-xxxTW	X	X	5 mA	Logic level	TO-220AB

BTB non insulated TO-220AB package

ORDERING INFORMATION



OTHER INFORMATION

Part Number	Marking	Weight	Base quantity	Packing mode
BTA/BTB06-xxxyz	BTA/BTB06-xxxyz	2.3 g	250	Bulk

Note: xxx = voltage, y = sensitivity, z = type

Fig. 1: Maximum power dissipation versus RMS on-state current (full cycle).

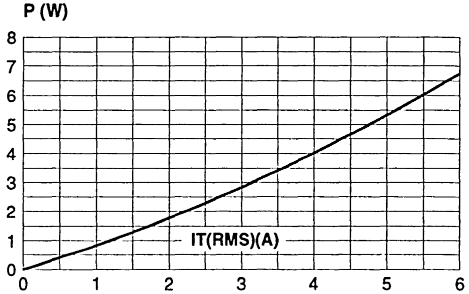


Fig. 2: RMS on-state current versus case temperature (full cycle).

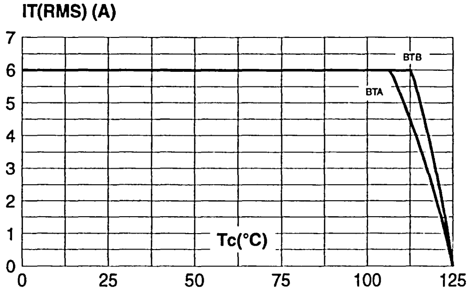


Fig. 3: Relative variation of thermal impedance versus pulse duration.

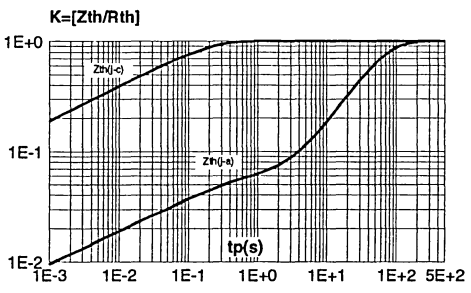


Fig. 4: On-state characteristics (maximum values).

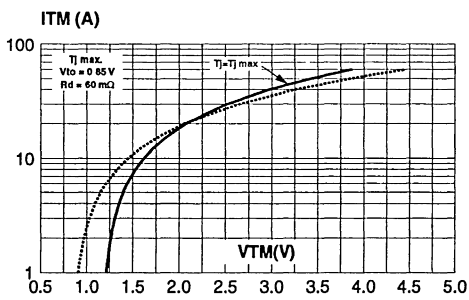


Fig. 5: Surge peak on-state current versus number of cycles.

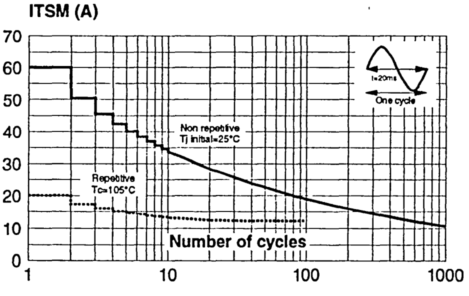


Fig. 6: Non-repetitive surge peak on-state current for a sinusoidal pulse with width tp < 10ms, and corresponding value of I²t.

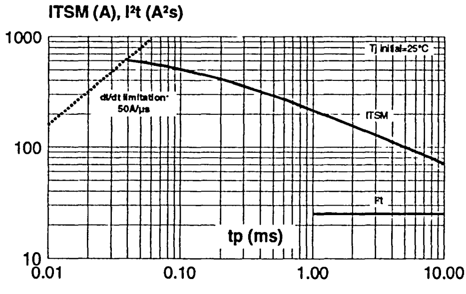


Fig. 7: Relative variation of gate trigger current, holding current and latching current versus junction temperature (typical values).

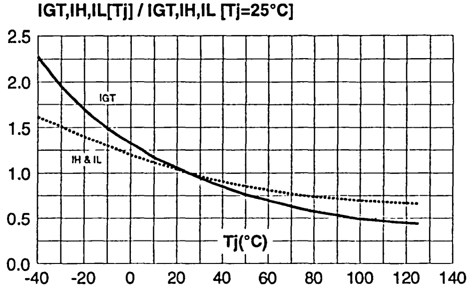


Fig. 8-1: Relative variation of critical rate of decrease of main current versus (dV/dt)c (typical values). Snubberless & Logic Level Types

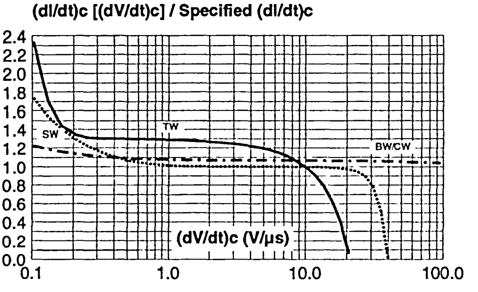


Fig. 8-2: Relative variation of critical rate of decrease of main current versus (dV/dt)c (typical values). Standard Types

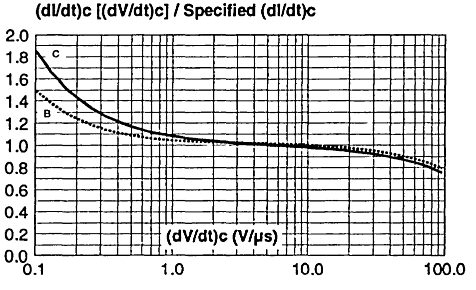
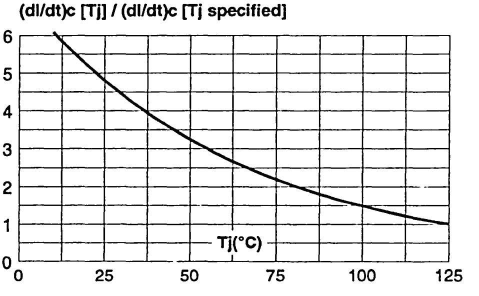


Fig. 9: Relative variation of critical rate of decrease of main current versus junction temperature.

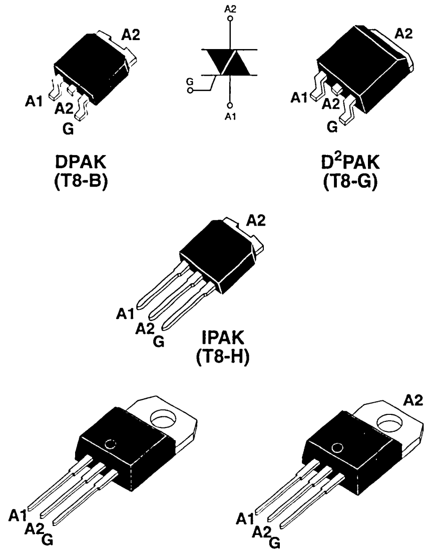


SNUBBERLESS™, LOGIC LEVEL & STANDARD

8A TRIACs

MAIN FEATURES:

Symbol	Value	Unit
$I_{T(RMS)}$	8	A
V_{DRM}/V_{RRM}	600 and 800	V
$I_{GT\ (Q_1)}$	5 to 50	mA



DPAK (T8-B) · D²PAK (T8-G) · IPAK (T8-H) · TO-220AB Insulated (BTA08) · TO-220AB (BTB08)

DESCRIPTION

Available either in through-hole or surface-mount packages, the BTA/BTB08 and T8 triac series is suitable for general purpose AC switching. They can be used as an ON/OFF function in applications such as static relays, heating regulation, induction motor starting circuits... or for phase control operation in light dimmers, motor speed controllers,...

The snubberless versions (BTA/BTB...W and T8 series) are specially recommended for use on inductive loads, thanks to their high commutation performances. By using an internal ceramic pad, the BTA series provides voltage insulated tab (rated at 2500V RMS) complying with UL standards (File ref.: E81734)

ABSOLUTE MAXIMUM RATINGS

Symbol	Parameter			Value	Unit
$I_{T(RMS)}$	RMS on-state current (full sine wave)	DPAK / D²PAK IPAK / TO-220AB	Tc = 110°C	8	A
		TO-220AB Ins.	Tc = 100°C		
I_{TSM}	Non repetitive surge peak on-state current (full cycle, Tj initial = 25°C)	F = 50 Hz	t = 20 ms	80	A
		F = 60 Hz	t = 16.7 ms	84	
I^2t	I^2t Value for fusing	tp = 10 ms		45	A^2s
dI/dt	Critical rate of rise of on-state current $I_G = 2 \times I_{GT}$, tr ≤ 100 ns	F = 120 Hz	Tj = 125°C	50	A/µs
I_{GM}	Peak gate current	tp = 20 µs	Tj = 125°C	4	A
$P_{G(AV)}$	Average gate power dissipation		Tj = 125°C	1	W
T_{stg} T_j	Storage junction temperature range Operating junction temperature range			- 40 to + 150 - 40 to + 125	°C

ELECTRICAL CHARACTERISTICS (Tj = 25°C, unless otherwise specified)

■ SNUBBERLESS™ and LOGIC LEVEL (3 Quadrants)

Symbol	Test Conditions	Quadrant		T8		BTA/BTB08				Unit
				T810	T835	TW	SW	CW	BW	
I_{GT} (1)	V_D = 12 V R_L = 30 Ω	I - II - III	MAX.	10	35	5	10	35	50	mA
V_{GT}		I - II - III	MAX.	1.3						V
V_{GD}	$V_D = V_{DRM}$ R_L = 3.3 kΩ Tj = 125°C	I - II - III	MIN.	0.2						V
I_H (2)	I_T = 100 mA		MAX.	15	35	10	15	35	50	mA
I_L	I_G = 1.2 I_{GT}	I - III	MAX.	25	50	10	25	50	70	mA
		II		30	60	15	30	60	80	
dV/dt (2)	V_D = 67 %V_{DRM} gate open Tj = 125°C		MIN.	40	400	20	40	400	1000	V/µs
(dI/dt)c (2)	(dV/dt)c = 0.1 V/µs Tj = 125°C		MIN.	5.4	-	3.5	5.4	-	-	A/ms
	(dV/dt)c = 10 V/µs Tj = 125°C			2.8	-	1.5	2.8	-	-	
	Without snubber Tj = 125°C			-	4.5	-	-	4.5	7	

■ STANDARD (4 Quadrants)

Symbol	Test Conditions	Quadrant		BTA/BTB08		Unit
				C	B	
I_{GT} (1)	V_D = 12 V R_L = 30 Ω	I - II - III IV	MAX.	25 50	50 100	mA
V_{GT}		ALL	MAX.	1.3		V
V_{GD}	$V_D = V_{DRM}$ R_L = 3.3 kΩ Tj = 125°C	ALL	MIN.	0.2		V
I_H (2)	I_T = 500 mA		MAX.	25	50	mA
I_L	I_G = 1.2 I_{GT}	I - III - IV	MAX.	40	50	mA
		II		80	100	
dV/dt (2)	V_D = 67 %V_{DRM} gate open Tj = 125°C		MIN.	200	400	V/µs
(dV/dt)c (2)	(dI/dt)c = 3.5 A/ms Tj = 125°C		MIN.	5	10	V/µs

STATIC CHARACTERISTICS

Symbol	Test Conditions			Value	Unit
V_{TM} (2)	I_{TM} = 11 A tp = 380 µs	Tj = 25°C	MAX.	1.55	V
V_{to} (2)	Threshold voltage	Tj = 125°C	MAX.	0.85	V
R_d (2)	Dynamic resistance	Tj = 125°C	MAX.	50	mΩ
I_{DRM}	$V_{DRM} = V_{RRM}$	Tj = 25°C	MAX.	5	µA
I_{RRM}		Tj = 125°C		1	mA

Note 1: minimum IGT is guaranted at 5% of IGT max

Note 2: for both polarities of A2 referenced to A1

THERMAL RESISTANCES

Symbol	Parameter			Value	Unit
$R_{th(j-c)}$	Junction to case (AC)		DPAK / D^2PAK IPAK / TO-220AB	1.6	°C/W
			TO-220AB Insulated	2.5	
$R_{th(j-a)}$	Junction to ambient	S = 1 cm^2	D^2PAK	45	°C/W
		S = 0.5 cm^2	DPAK	70	
			TO-220AB TO-220AB Insulated	60	
			IPAK	100	

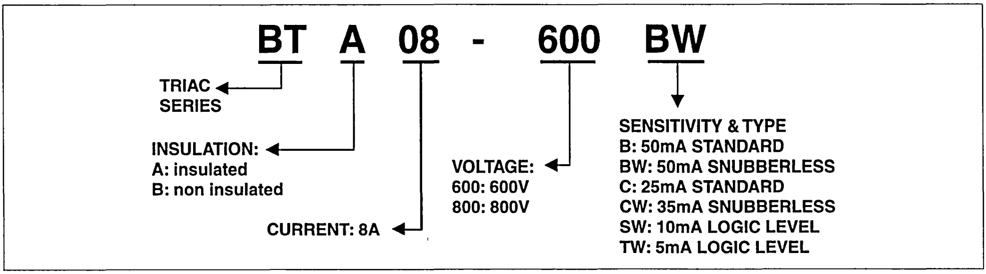
S = Copper surface under tab

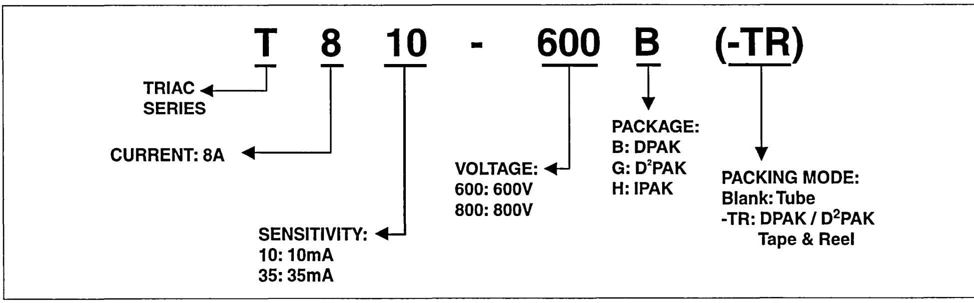
PRODUCT SELECTOR

Part Number	Voltage (xxx)		Sensitivity	Type	Package
	600 V	800 V			
BTA/BTB08-xxxB	X	X	50 mA	Standard	TO-220AB
BTA/BTB108-xxxBW	X	X	50 mA	Snubberless	TO-220AB
BTA/BTB08-xxxC	X	X	25 mA	Standard	TO-220AB
BTA/BTB08-xxxCW	X	X	35 mA	Snubberless	TO-220AB
BTA/BTB08-xxxSW	X	X	10 mA	Logic level	TO-220AB
BTA/BTB08-xxxTW	X	X	5 mA	Logic level	TO-220AB
T810-xxxB	X	X	10 mA	Logic level	DPAK
T810-xxxH	X	X	10 mA	Logic level	IPAK
T835-xxxB	X	X	35mA	Snubberless	DPAK
T835-xxxG	X	X	35 mA	Snubberless	D^2PAK
T835-xxxH	X	X	35 mA	Snubberless	IPAK

BTB: non insulated TO-220AB package

ORDERING INFORMATION





OTHER INFORMATION

Part Number	Marking	Weight	Base quantity	Packing mode
BTA/BTB08-xxxyz	BTA/BTB08xxxyz	2.3 g	250	Bulk
T8yy-xxxB	T8yyxxx	0.3 g	75	Tube
T8yy-xxxB-TR	T8yyxxx	0.3 g	2500	Tape & reel
T8yy-xxxH	T8yyxxx	0.4 g	75	Tube
T8yy-xxxG	T8yyxxx	1.5 g	50	Tube
T8yy-xxxG-TR	T8yyxxx	1.5 g	1000	Tape & reel

Note: xxx = voltage, yy = sensitivity, z = type

Fig. 1: Maximum power dissipation versus RMS on-state current (full cycle).

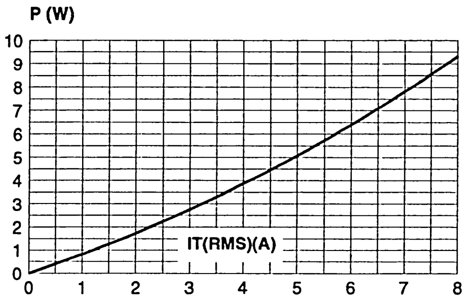


Fig. 2-1: RMS on-state current versus case temperature (full cycle).

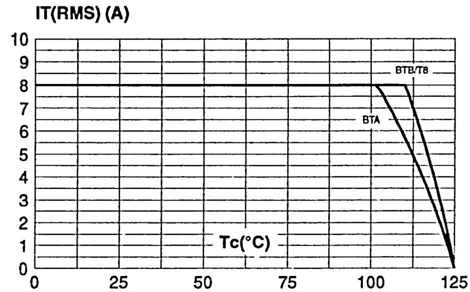


Fig. 2-2: RMS on-state current versus ambient temperature (printed circuit board FR4, copper thickness: 35µm),full cycle.

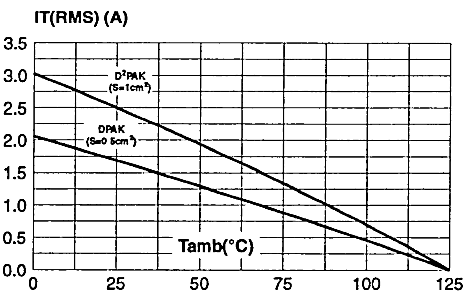


Fig. 3: Relative variation of thermal impedance versus pulse duration.

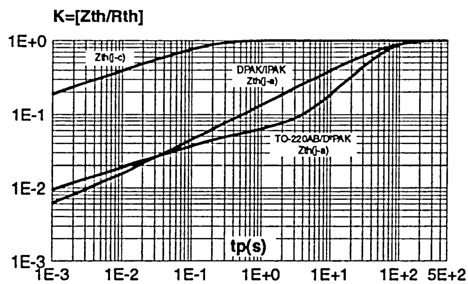


Fig. 4: On-state characteristics (maximum values).

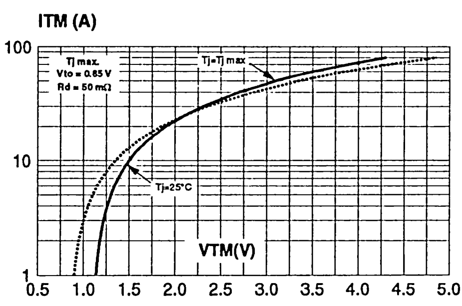


Fig. 5: Surge peak on-state current versus number of cycles.

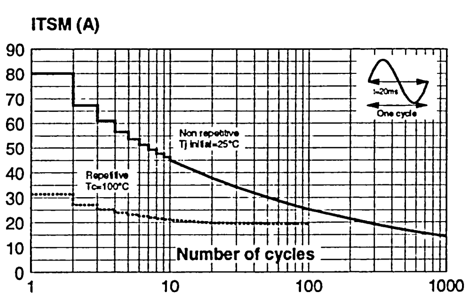


Fig. 6: Non-repetitive surge peak on-state current for a sinusoidal pulse with width tp < 10ms, and corresponding value of I²t.

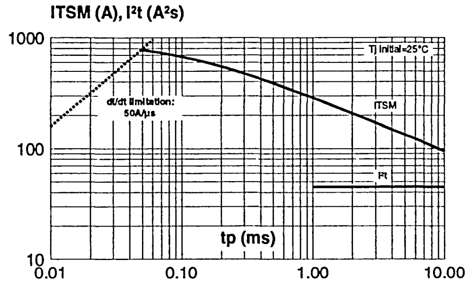


Fig. 7: Relative variation of gate trigger current, holding current and latching current versus junction temperature (typical values).

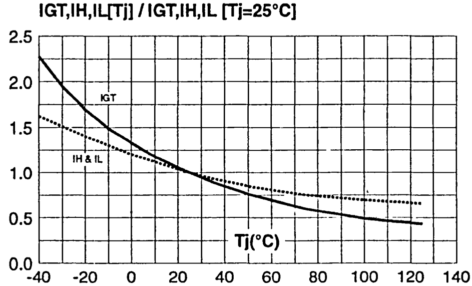


Fig. 8-1: Relative variation of critical rate of decrease of main current versus (dV/dt)c (typical values). Snubberless & Logic Level Types

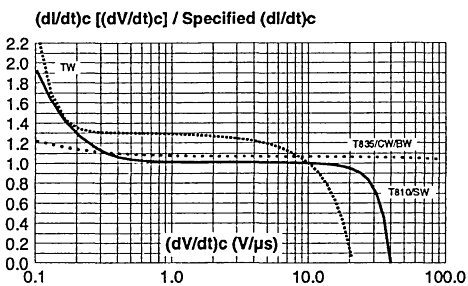


Fig. 8-2: Relative variation of critical rate of decrease of main current versus (dV/dt)c (typical values). Standard Types

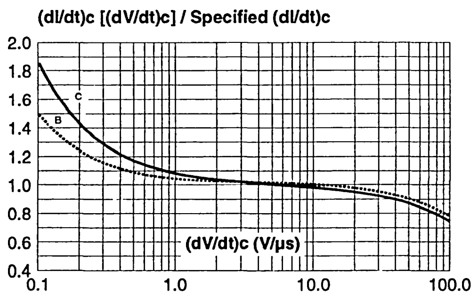


Fig. 9: Relative variation of critical rate of decrease of main current versus junction temperature.

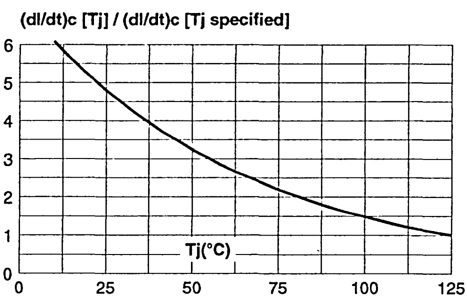
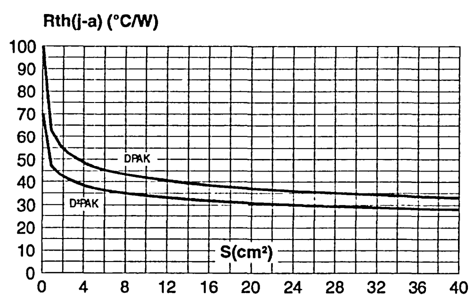


Fig. 10: DPAK and D²PAK Thermal resistance junction to ambient versus copper surface under tab (printed circuit board FR4, copper thickness: 35 µm).



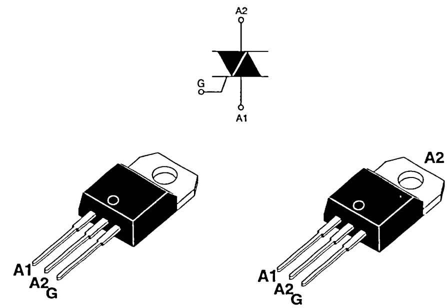
BTA/BTB10 Series

SNUBBERLESS™ & STANDARD

10A TRIACs

MAIN FEATURES:

Symbol	Value	Unit
$I_{T(RMS)}$	10	A
V_{DRM}/V_{RRM}	600 and 800	V
I_{GT} (Q_1)	25 to 50	mA



TO-220AB Insulated (BTA10) **TO-220AB (BTB10)**

DESCRIPTION

Available either in standard or snubberless version, the BTA/BTB10 triac series is suitable for general purpose AC switching. They can be used as an ON/OFF function in applications such as static relays, heating regulation, induction motor starting circuits... or for phase control operation in light dimmers, motor speed controllers, ...

The snubberless version (W suffix) is specially recommended for use on inductive loads, thanks to their high commutation performances.

By using an internal ceramic pad, the BTA series provides voltage insulated tab (rated at 2500 V RMS) complying with UL standards (File ref.: E81734).

ABSOLUTE MAXIMUM RATINGS

Symbol	Parameter			Value	Unit
$I_{T(RMS)}$	RMS on-state current (full sine wave)	TO-220AB	Tc = 105°C	10	A
		TO-220AB Ins.	Tc = 95°C		
I_{TSM}	Non repetitive surge peak on-state current (full cycle, Tj initial = 25°C)	F = 60 Hz	t = 16.7 ms	105	A
		F = 50 Hz	t = 20 ms	100	
I^2t	I^2t Value for fusing	tp = 10 ms		72	A^2s
dI/dt	Critical rate of rise of on-state current $I_G = 2 \times I_{GT}$, tr ≤ 100 ns	F = 120 Hz	Tj = 125°C	50	A/µs
V_{DSM}/V_{RSM}	Non repetitive surge peak off-state voltage	tp = 10 ms	Tj = 25°C	V_{DRM}/V_{RRM} + 100	V
I_{GM}	Peak gate current	tp = 20 µs	Tj = 125°C	4	A
$P_{G(AV)}$	Average gate power dissipation		Tj = 125°C	1	W
T_{stg} T_j	Storage junction temperature range Operating junction temperature range			- 40 to + 150 - 40 to + 125	°C

ELECTRICAL CHARACTERISTICS (Tj = 25°C, unless otherwise specified)

■ SNUBBERLESS™ (3 Quadrants)

Symbol	Test Conditions	Quadrant		BTA/BTB10		Unit
				CW	BW	
I_{GT} (1)	V_D = 12 V R_L = 33 Ω	I - II - III	MAX.	35	50	mA
V_{GT}		I - II - III	MAX.	1.3		V
V_{GD}	V_D = V_{DRM} R_L = 3.3 kΩ Tj = 125°C	I - II - III	MIN.	0.2		V
I_H (2)	I_T = 500 mA		MAX.	35	50	mA
I_L	I_G = 1.2 I_{GT}	I - III	MAX.	50	70	mA
		II		60	80	
dV/dt (2)	V_D = 67 % V_{DRM} gate open Tj = 125°C		MIN.	500	1000	V/µs
(dI/dt)c (2)	Without snubber Tj = 125°C		MIN.	5.5	9.0	A/ms

■ STANDARD (4 Quadrants)

Symbol	Test Conditions	Quadrant		BTA/BTB10		Unit
				C	B	
I_{GT} (1)	V_D = 12 V R_L = 33 Ω	I - II - III IV	MAX.	25 50	50 100	mA
V_{GT}		ALL	MAX.	1.3		V
V_{GD}	V_D = V_{DRM} R_L = 3.3 kΩ Tj = 125°C	ALL	MIN.	0.2		V
I_H (2)	I_T = 500 mA		MAX.	25	50	mA
I_L	I_G = 1.2 I_{GT}	I - III - IV	MAX.	40	50	mA
		II		80	100	
dV/dt (2)	V_D = 67 %V_{DRM} gate open Tj = 125°C		MIN.	200	400	V/µs
(dV/dt)c (2)	(dI/dt)c = 4.4 A/ms Tj = 125°C		MIN.	5	10	V/µs

STATIC CHARACTERISTICS

Symbol	Test Conditions			Value	Unit
V_{TM} (2)	I_{TM} = 14 A tp = 380 µs	Tj = 25°C	MAX.	1.55	V
V_{to} (2)	Threshold voltage	Tj = 125°C	MAX.	0.85	V
R_d (2)	Dynamic resistance	Tj = 125°C	MAX.	40	mΩ
I_{DRM}	V_{DRM} = V_{RRM}	Tj = 25°C	MAX.	5	µA
I_{RRM}		Tj = 125°C		1	mA

Note 1: minimum IGT is guaranteed at 5% of IGT max.

Note 2: for both polarities of A2 referenced to A1

THERMAL RESISTANCES

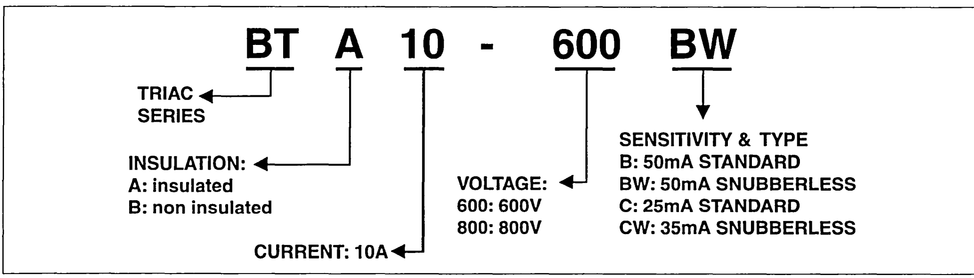
Symbol	Parameter		Value	Unit
$R_{th(j-c)}$	Junction to case (AC)	TO-220AB	1.5	°C/W
		TO-220AB Insulated	2.4	
$R_{th(j-a)}$	Junction to ambient	TO-220AB	60	°C/W
		TO-220AB Insulated		

PRODUCT SELECTOR

Part Number	Voltage (xxx)		Sensitivity	Type	Package
	600 V	800 V			
BTA/BTB10-xxxB	X	X	50 mA	Standard	TO-220AB
BTA/BTB10-xxxBW	X	X	50 mA	Snubberless	TO-220AB
BTA/BTB10-xxxC	X	X	25 mA	Standard	TO-220AB
BTA/BTB10-xxxCW	X	X	35 mA	Snubberless	TO-220AB

BTB: Non insulated TO-220AB package

ORDERING INFORMATION



OTHER INFORMATION

Part Number	Marking	Weight	Base quantity	Packing mode
BTA/BTB10-xxxyz	BTA/BTB10xxxyz	2.3 g	250	Bulk

Note: xxx = voltage, y = sensitivity, z = type

Fig. 1: Maximum power dissipation versus RMS on-state current (full cycle).

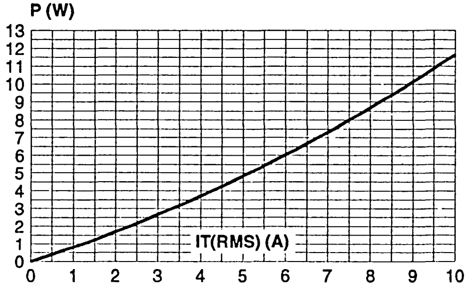


Fig. 2: RMS on-state current versus case temperature (full cycle).

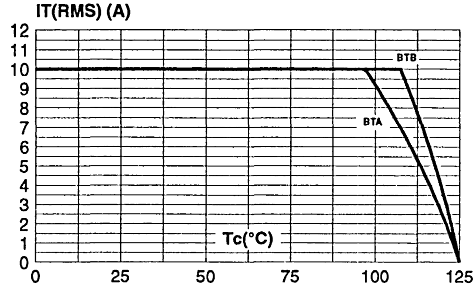


Fig. 3: Relative variation of thermal impedance versus pulse duration.

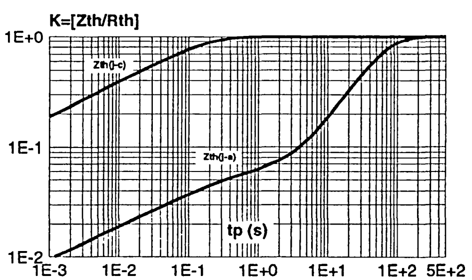


Fig. 4: On-state characteristics (maximum values).

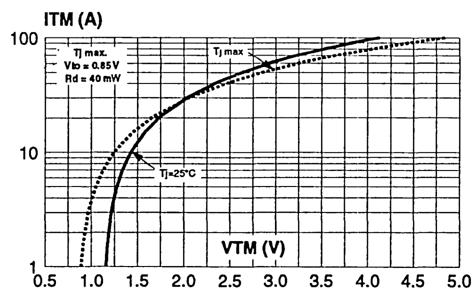


Fig. 5: Surge peak on-state current versus number of cycles.

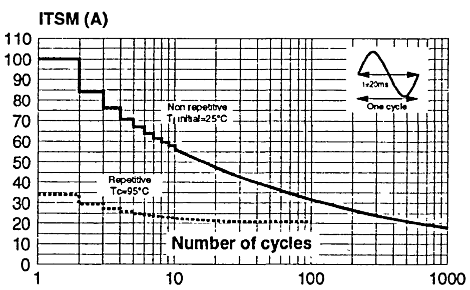


Fig. 6: Non-repetitive surge peak on-state current for a sinusoidal pulse with width tp < 10ms, and corresponding value of I²t.

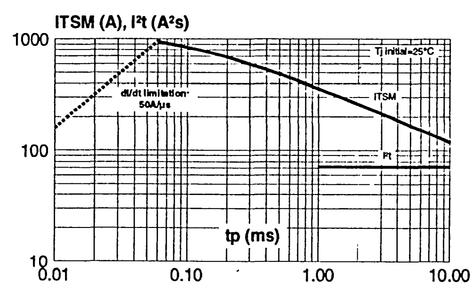


Fig. 7: Relative variation of gate trigger current, holding current and latching current versus junction temperature (typical values).

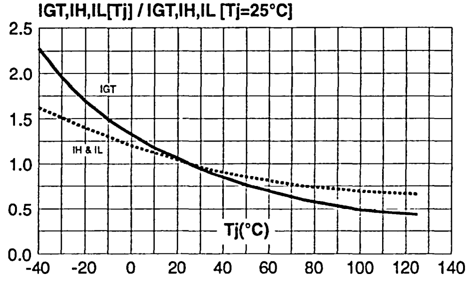


Fig. 8: Relative variation of critical rate of decrease of main current versus (dV/dt)c (typical values).

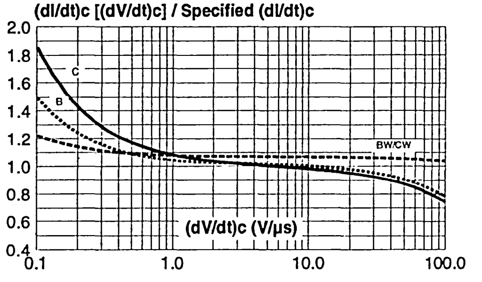
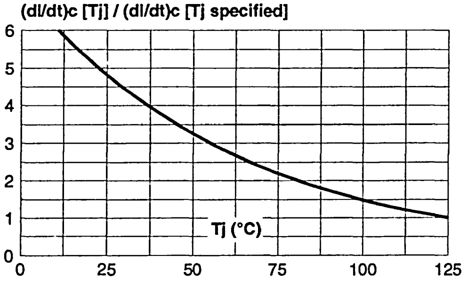


Fig. 9: Relative variation of critical rate of decrease of main current versus junction temperature.



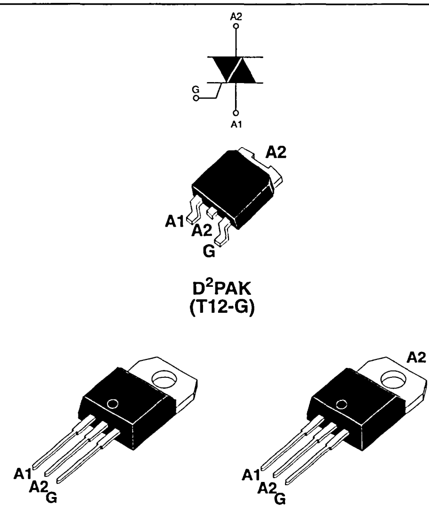
BTA/BTB12 and T12 Series

SNUBBERLESS™, LOGIC LEVEL & STANDARD

12A TRIACs

MAIN FEATURES:

Symbol	Value	Unit
$I_{T(RMS)}$	12	A
V_{DRM}/V_{RRM}	600 and 800	V
$I_{GT\ (Q_1)}$	10 to 50	mA



D²PAK (T12-G)

TO-220AB Insulated (BTA12)

TO-220AB (BTB12)

DESCRIPTION

Available either in through-hole or surface-mount packages, the BTA/BTB12 and T12 triac series is suitable for general purpose AC switching. They can be used as an ON/OFF function in applications such as static relays, heating regulation, induction motor starting circuits... or for phase control operation in light dimmers, motor speed controllers,...

The snubberless versions (BTA/BTB...W and T12 series) are specially recommended for use on inductive loads, thanks to their high commutation performances. By using an internal ceramic pad, the BTA series provides voltage insulated tab (rated at 2500V RMS) complying with UL standards (File ref.: E81734)

ABSOLUTE MAXIMUM RATINGS

Symbol	Parameter			Value	Unit
$I_{T(RMS)}$	RMS on-state current (full sine wave)	D²PAK/TO-220AB	Tc = 105°C	12	A
		TO-220AB Ins.	Tc = 90°C		
I_{TSM}	Non repetitive surge peak on-state current (full cycle, Tj initial = 25°C)	F = 50 Hz	t = 20 ms	120	A
		F = 60 Hz	t = 16.7 ms	126	
I^2t	I^2t Value for fusing	tp = 10 ms		100	A^2s
dI/dt	Critical rate of rise of on-state current $I_G = 2 \times I_{GT}$, tr ≤ 100 ns	F = 120 Hz	Tj = 125°C	50	A/µs
V_{DSM}/V_{RSM}	Non repetitive surge peak off-state voltage	tp = 10 ms	Tj = 25°C	V_{DRM}/V_{RRM} + 100	V
I_{GM}	Peak gate current	tp = 20 µs	Tj = 125°C	4	A
$P_{G(AV)}$	Average gate power dissipation		Tj = 125°C	1	W
T_{stg} T_j	Storage junction temperature range Operating junction temperature range			- 40 to + 150 - 40 to + 125	°C

ELECTRICAL CHARACTERISTICS (Tj = 25°C, unless otherwise specified)

■ SNUBBERLESS™ and LOGIC LEVEL (3 Quadrants)

Symbol	Test Conditions		Quadrant		T12	BTA/BTB12			Unit
					T1235	SW	CW	BW	
I_{GT} (1)	V_D = 12 V	R_L = 30 Ω	I - II - III	MAX.	35	10	35	50	mA
V_{GT}			I - II - III	MAX.	1.3				V
V_{GD}	$V_D = V_{DRM}$ R_L = 3.3 kΩ Tj = 125°C		I - II - III	MIN.	0.2				V
I_H (2)	I_T = 100 mA			MAX.	35	15	35	50	mA
I_L	$I_G = 1.2\ I_{GT}$		I - III	MAX.	50	25	50	70	mA
			II		60	30	60	80	
dV/dt (2)	V_D = 67 %V_{DRM} gate open Tj = 125°C			MIN.	500	40	500	1000	V/µs
(dI/dt)c (2)	(dV/dt)c = 0.1 V/µs	Tj = 125°C		MIN.	-	6.5	-	-	A/ms
	(dV/dt)c = 10 V/µs	Tj = 125°C			-	2.9	-	-	
	Without snubber	Tj = 125°C			6.5	-	6.5	12	

■ STANDARD (4 Quadrants)

Symbol	Test Conditions	Quadrant		BTA/BTB06		Unit
				C	B	
I_{GT} (1)	V_D = 12 V R_L = 30 Ω	I - II - III IV	MAX.	25 50	50 100	mA
V_{GT}		ALL	MAX.	1.3		V
V_{GD}	$V_D = V_{DRM}$ R_L = 3.3 kΩ Tj = 125°C	ALL	MIN.	0.2		V
I_H (2)	I_T = 500 mA		MAX.	25	50	mA
I_L	$I_G = 1.2\ I_{GT}$	I - III - IV	MAX.	40	50	mA
		II		80	100	
dV/dt (2)	V_D = 67 %V_{DRM} gate open Tj = 125°C		MIN.	200	400	V/µs
(dV/dt)c (2)	(dI/dt)c = 5.3 A/ms Tj = 125°C		MIN.	5	10	V/µs

STATIC CHARACTERISTICS

Symbol	Test Conditions			Value	Unit
V_T (2)	I_{TM} = 17 A tp = 380 µs	Tj = 25°C	MAX.	1.55	V
V_{to} (2)	Threshold voltage	Tj = 125°C	MAX.	0.85	V
R_d (2)	Dynamic resistance	Tj = 125°C	MAX.	35	mΩ
I_{DRM} I_{RRM}	$V_{DRM} = V_{RRM}$	Tj = 25°C	MAX.	5	µA
		Tj = 125°C		1	mA

Note 1: minimum IGT is guaranteed at 5% of IGT max

Note 2: for both polarities of A2 referenced to A1

THERMAL RESISTANCES

Symbol	Parameter			Value	Unit
$R_{th(j-c)}$	Junction to case (AC)		D^2PAK/TO-220AB	1.4	°C/W
			TO-220AB Insulated	2.3	
$R_{th(j-a)}$	Junction to ambient	$S = 1\ cm^2$	D^2PAK	45	°C/W
			TO-220AB TO-220AB Insulated	60	

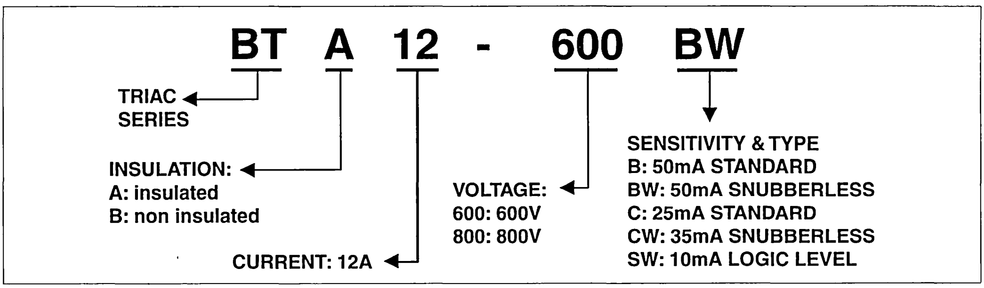
S = Copper surface under tab

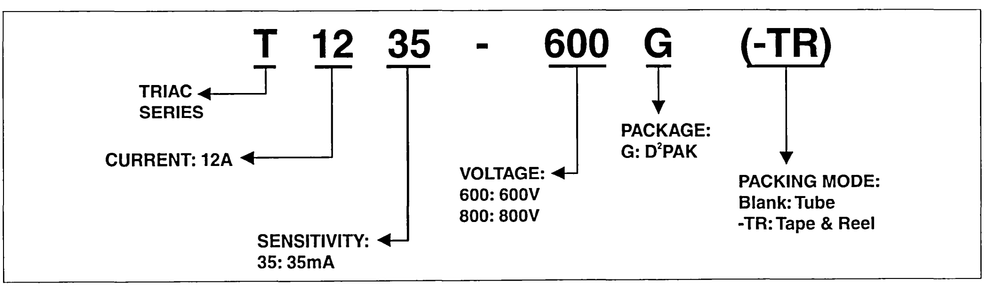
PRODUCT SELECTOR

Part Number	Voltage (xxx)		Sensitivity	Type	Package
	600 V	800 V			
BTA/BTB12-xxxB	X	X	50 mA	Standard	TO-220AB
BTA/BTB12-xxxBW	X	X	50 mA	Snubberless	TO-220AB
BTA/BTB12-xxxC	X	X	25 mA	Standard	TO-220AB
BTA/BTB12-xxxCW	X	X	35 mA	Snubberless	TO-220AB
BTA/BTB12-xxxSW	X	X	10 mA	Logic level	TO-220AB
T1235-xxxG	X	X	35 mA	Snubberless	D^2PAK

BTB: non insulated TO-220AB package

ORDERING INFORMATION





OTHER INFORMATION

Part Number	Marking	Weight	Base quantity	Packing mode
BTA/BTB12-xxxyz	BTA/BTB12-xxxyz	2.3 g	250	Bulk
T1235-xxxG	T1235xxxG	1.5 g	50	Tube
T1235-xxxG-TR	T1235xxxG	1.5 g	1000	Tape & reel

Note: xxx = voltage, yy = sensitivity, z = type

Fig. 1: Maximum power dissipation versus RMS on-state current (full cycle).

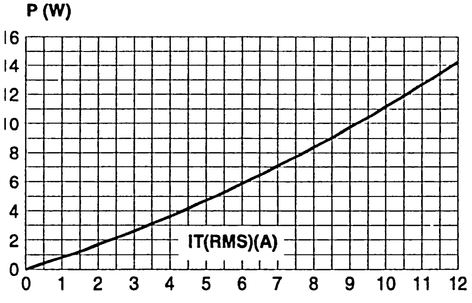


Fig. 2-1: RMS on-state current versus case temperature (full cycle).

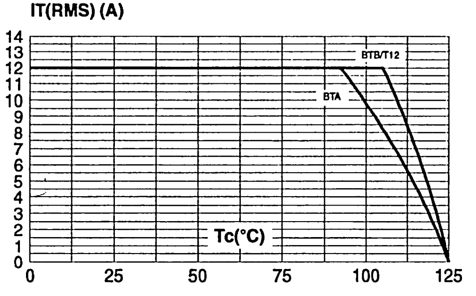


Fig. 2-2: RMS on-state current versus ambient temperature (printed circuit board FR4, copper thickness: 35µm),full cycle.

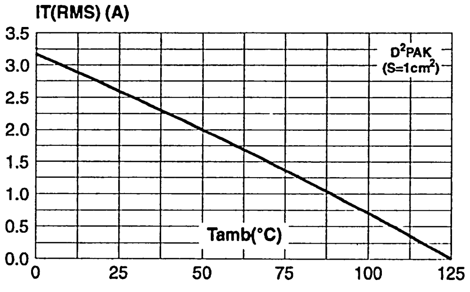


Fig. 3: Relative variation of thermal impedance versus pulse duration.

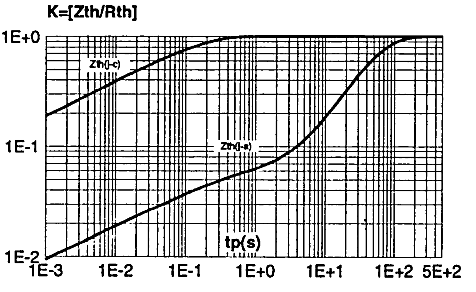


Fig. 4: On-state characteristics (maximum values).

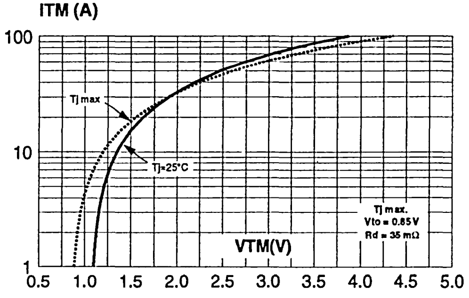


Fig. 5: Surge peak on-state current versus number of cycles.

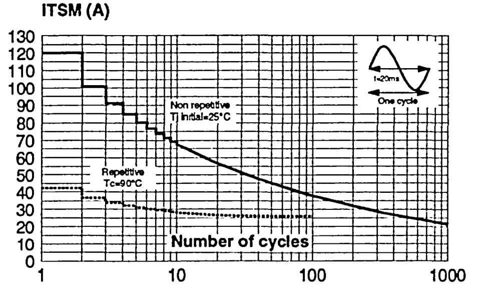


Fig. 6: Non-repetitive surge peak on-state current for a sinusoidal pulse with width tp < 10ms, and corresponding value of I²t.

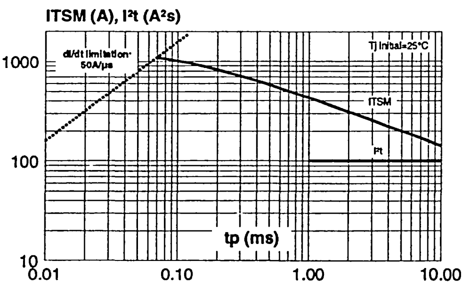


Fig. 7: Relative variation of gate trigger current, holding current and latching current versus junction temperature (typical values).

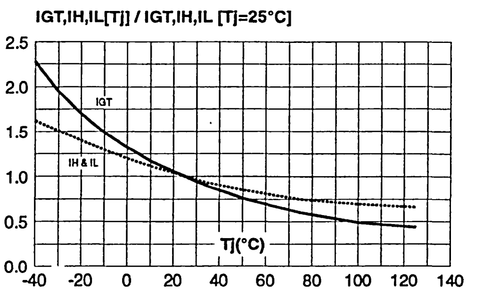


Fig. 8: Relative variation of critical rate of decrease of main current versus (dV/dt)c (typical values).

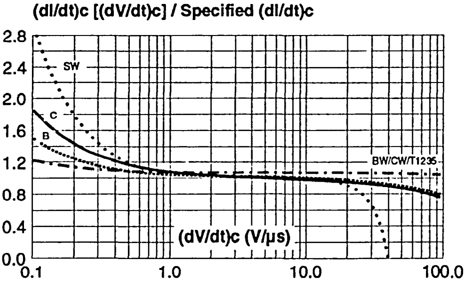


Fig. 9: Relative variation of critical rate of decrease of main current versus junction temperature.

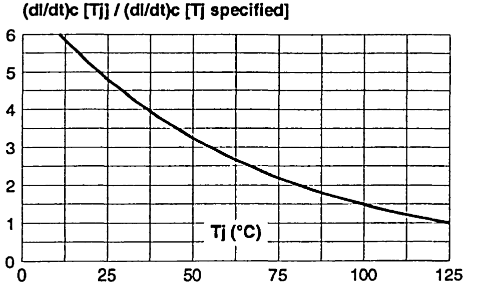
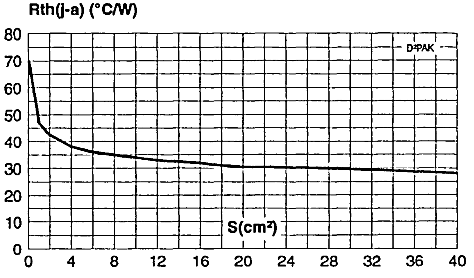


Fig. 10: D²PAK Thermal resistance junction to ambient versus copper surface under tab (printed circuit board FR4, copper thickness: 35 µm).

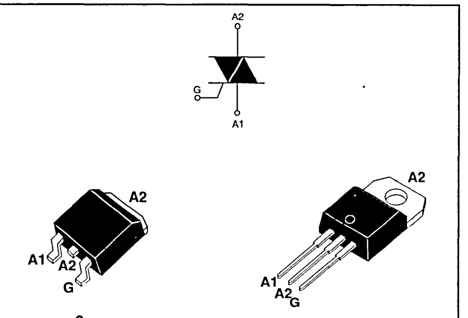


T1235H Series

SNUBBERLESS™ HIGH TEMPERATURE — 12A TRIACs

MAIN FEATURES:

Symbol	Value	Unit
$I_{T(RMS)}$	12	A
V_{DRM}/V_{RRM}	600	V
$I_{GT\ (Q_1)}$	35	mA



D²PAK (T1235-G)

TO-220AB (T1235-T)

DESCRIPTION

Specifically designed for use in high temperature environment (found in hot appliances such as cookers, ovens, hobs, electric heaters, coffee machines...), the new 12 Amps T1235H triacs provide an enhanced performance in terms of power loss and thermal dissipation. This allows for optimization of the heatsinking dimensioning, leading to space and cost effectivness when compared to electro-mechanical solutions.

Based on ST snubberless technology, they offer high commutation switching capabilities and high noise immunity levels. And, thanks to their clip assembly technique, they provide a superior performance in surge current handling.

ABSOLUTE MAXIMUM RATINGS

Symbol	Parameter			Value	Unit
$I_{T(RMS)}$	RMS on-state current (full sine wave)		Tc = 135°C	12	A
I_{TSM}	Non repetitive surge peak on-state current (full cycle, Tj initial = 25°C)	F = 60 Hz	t = 16.7 ms	145	A
		F = 50 Hz	t = 20 ms	140	
I^2t	I^2t Value for fusing	tp = 10 ms		138	A^2s
dI/dt	Critical rate of rise of on-state current $I_G = 2 \times I_{GT}$, tr ≤ 100 ns	F = 120 Hz	Tj = 150°C	50	A/µs
V_{DSM}/V_{RSM}	Non repetitive surge peak off-state voltage	tp = 10 ms	Tj = 25°C	700	V
I_{GM}	Peak gate current	tp = 20 µs	Tj = 150°C	4	A
$P_{G(AV)}$	Average gate power dissipation		Tj = 150°C	1	W
T_{stg} T_j	Storage junction temperature range Operating junction temperature range			- 40 to + 150 - 40 to + 150	°C

ELECTRICAL CHARACTERISTICS (Tj = 25°C, unless otherwise specified)

Symbol	Test Conditions	Quadrant		Value	Unit
I_{GT} (1)	V_D = 12 V R_L = 33 Ω	I - II - III	MAX.	35	mA
V_{GT}		I - II - III	MAX.	1.3	V
V_{GD}	$V_D = V_{DRM}$ R_L = 3.3 kΩ Tj = 150°C	I - II - III	MIN.	0.15	V
I_H (2)	I_T = 100 mA		MAX.	35	mA
I_L	I_G = 1.2 I_{GT}	I - III	MAX.	50	mA
		II		80	
dV/dt (2)	V_D = 67 % V_{DRM} gate open Tj = 150°C		MIN.	300	V/µs
(dI/dt)c (2)	Without snubber Tj = 150°C		MIN.	5.3	A/ms

STATIC CHARACTERISTICS

Symbol	Test Conditions			Value	Unit
V_{TM} (2)	I_{TM} = 17 A tp = 380 µs	Tj = 25°C	MAX.	1.5	V
V_{to} (2)	Threshold voltage	Tj = 150°C	MAX.	0.80	V
R_d (2)	Dynamic resistance	Tj = 150°C	MAX.	25	mΩ
I_{DRM} I_{RRM}	$V_{DRM} = V_{RRM}$	Tj = 25°C	MAX.	5	µA
		Tj = 150°C		5.5	mA
	V_D/V_R = 400 V (at mains peak voltage)	Tj = 150°C		3.5	

Note 1: minimum IGT is guaranted at 10% of IGT max

Note 2: for both polarities of A2 referenced to A1

THERMAL RESISTANCES

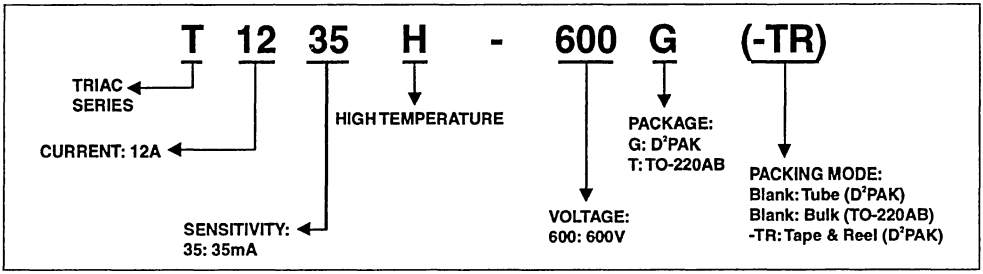
Symbol	Parameter			Value	Unit
$R_{th(j-c)}$	Junction to case (AC)		D^2PAK TO-220AB	1.2	°C/W
$R_{th(j-a)}$	Junction to ambient	S = 1 cm^2	D^2PAK	45	°C/W
			TO-220AB	60	

S Copper surface under tab

PRODUCT SELECTOR

Part Number	Voltage	Sensitivity	Type	Package
T1235H-600G	600 V	35 mA	Snubberless	D^2PAK
T1235H-600T	600 V	35 mA	Snubberless	TO-220AB

ORDERING INFORMATION



OTHER INFORMATION

Part Number	Marking	Weight	Base quantity	Packing mode
T1235H-600G	T1235H600G	1.5 g	50	Tube
T1235H-600G-TR	T1235H600G	1.5 g	1000	Tape & reel
T1235H-600T	T1235H600T	2.3 g	250	Bulk

Fig. 1: Maximum power dissipation versus RMS on-state current (full cycle).

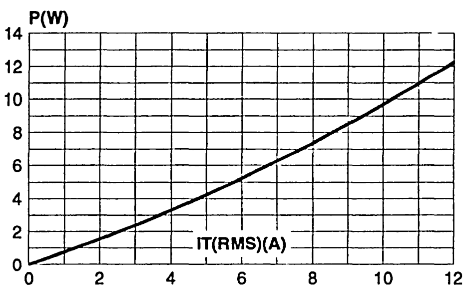


Fig. 2-1: RMS on-state current versus case temperature (full cycle).

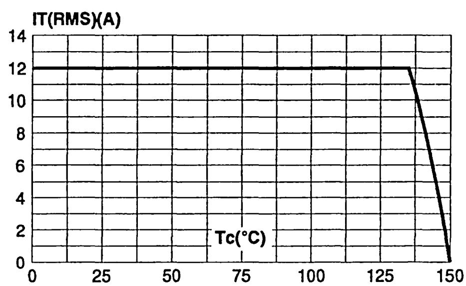


Fig. 2-2: RMS on-state current versus ambient temperature (printed circuit board FR4, copper thickness: 35 µm), full cycle.

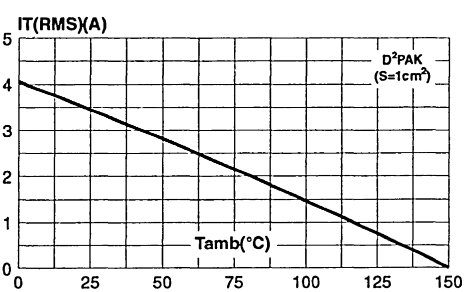


Fig. 3: Relative variation of thermal impedance versus pulse duration.

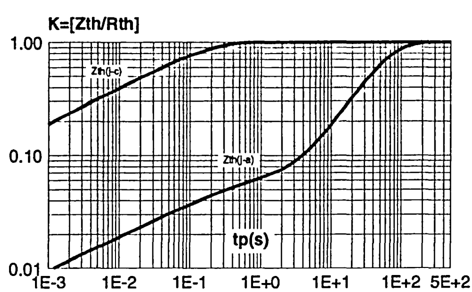


Fig. 4: Relative variation of gate trigger current, holding current and latching current versus junction temperature (typical values).

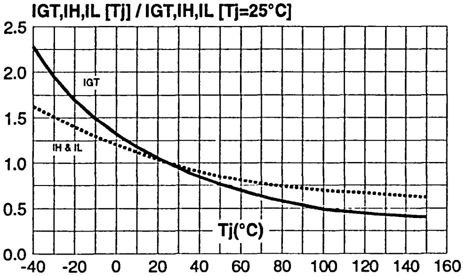


Fig. 5: Surge peak on-state current versus number of cycles.

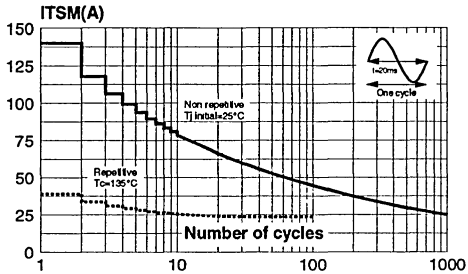


Fig. 6: Non-repetitive surge peak on-state current for a sinusoidal pulse with width tp < 10ms, and corresponding value of I²t.

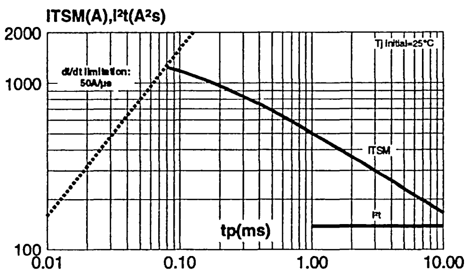


Fig. 7: On-state characteristics (maximum values).

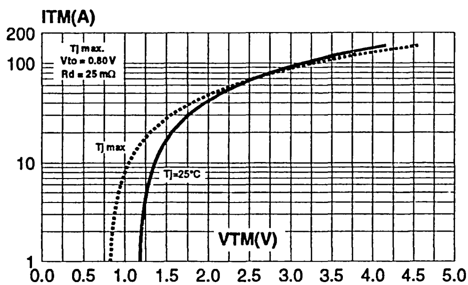


Fig. 8: Relative variation of critical rate of decrease of main current versus junction temperature (typical values).

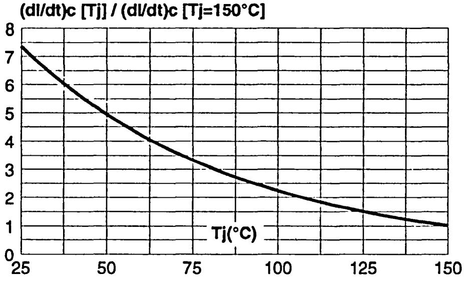


Fig. 9: Relative variation of critical rate of decrease of main current versus (dV/dt)c (typical values).

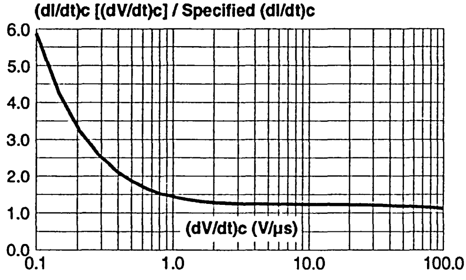


Fig. 10: Leakage current versus junction temperature for different values of blocking voltage (typical values).

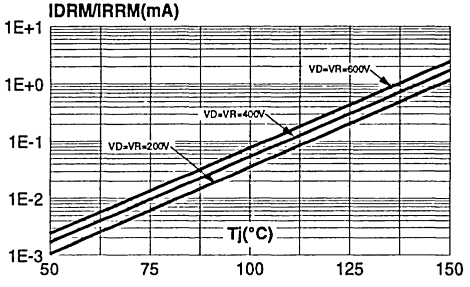


Fig. 11: Acceptable repetitive peak off-state voltage versus case-ambient thermal resistance.

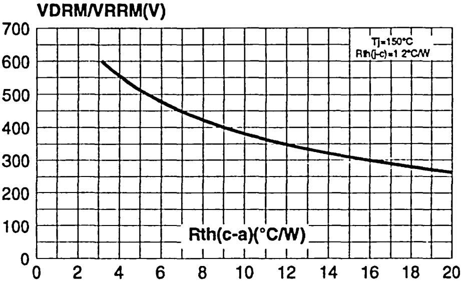
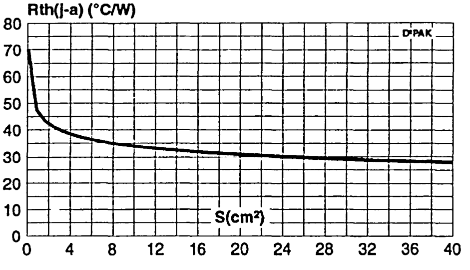


Fig. 12: D²PAK Thermal resistance junction to ambient versus copper surface under tab (printed circuit board FR4, copper thickness: 35 µm).



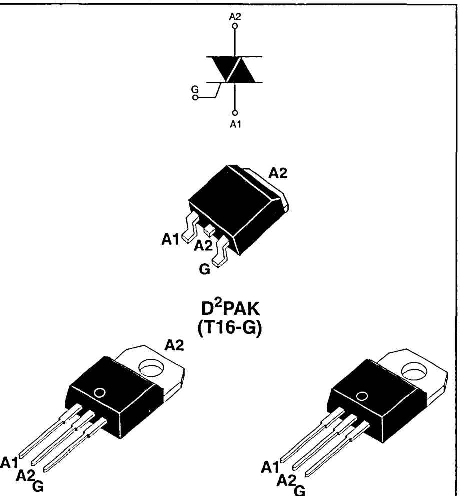
BTA/BTB16 and T16 Series

SNUBBERLESS™ , LOGIC LEVEL & STANDARD

16A TRIACs

MAIN FEATURES:

Symbol	Value	Unit
$I_{T(RMS)}$	16	A
V_{DRM}/V_{RRM}	600 and 800	V
$I_{GT\ (Q_1)}$	10 to 50	mA



D²PAK (T16-G)

TO-220AB (BTB16)

TO-220AB Insulated (BTA16)

DESCRIPTION

Available either in through-hole or surface-mount packages, the BTA/BTB16 and T16 triac series is suitable for general purpose AC switching. They can be used as an ON/OFF function in applications such as static relays, heating regulation, induction motor starting circuits... or for phase control operation in light dimmers, motor speed controllers, ...

The snubberless versions (BTA/BTB...W and T16 series) are specially recommended for use on inductive loads, thanks to their high commutation performances. By using an internal ceramic pad, the BTA series provides voltage insulated tab (rated at 2500V RMS) complying with UL standards (File ref.: E81734).

ABSOLUTE MAXIMUM RATINGS

Symbol	Parameter			Value	Unit
$I_{T(RMS)}$	RMS on-state current (full sine wave)	D2²PAK	Tc = 100°C	16	A
		TO-220AB			
		TO-220AB Ins.	Tc = 85°C		
I_{TSM}	Non repetitive surge peak on-state current (full cycle, Tj initial = 25°C)	F = 60 Hz	t = 16.7 ms	168	A
		F = 50 Hz	t = 20 ms	160	
I^2t	I^2t Value for fusing	tp = 10 ms		180	A^2s
dI/dt	Critical rate of rise of on-state current $I_G = 2 \times I_{GT}$, tr ≤ 100 ns	F = 120 Hz	Tj = 125°C	50	A/µs
V_{DSM}/V_{RSM}	Non repetitive surge peak off-state voltage	tp = 10 ms	Tj = 25°C	V_{DRM}/V_{RRM} + 100	V
I_{GM}	Peak gate current	tp = 20 µs	Tj = 125°C	4	A
$P_{G(AV)}$	Average gate power dissipation		Tj = 125°C	1	W
T_{stg} T_j	Storage junction temperature range Operating junction temperature range			- 40 to + 150 - 40 to + 125	°C

ELECTRICAL CHARACTERISTICS (Tj = 25°C, unless otherwise specified)

■ SNUBBERLESS™ and LOGIC LEVEL (3 Quadrants)

Symbol	Test Conditions	Quadrant		T16	BTA/BTB16			Unit
				T1635	SW	CW	BW	
I_{GT} (1)	V_D = 12 V R_L = 33 Ω	I - II - III	MAX.	35	10	35	50	mA
V_{GT}		I - II - III	MAX.	1.3				V
V_{GD}	$V_D = V_{DRM}$ R_L = 3.3 kΩ Tj = 125°C	I - II - III	MIN.	0.2				V
I_H (2)	I_T = 500 mA		MAX.	35	15	35	50	mA
I_L	I_G = 1.2 I_{GT}	I - III	MAX.	50	25	50	70	mA
		II		60	30	60	80	
dV/dt (2)	V_D = 67 % V_{DRM} gate open Tj = 125°C		MIN.	500	40	500	1000	V/µs
(dI/dt)c (2)	(dV/dt)c = 0.1 V/µs Tj = 125°C		MIN.	-	8.5	-	-	A/ms
	(dV/dt)c = 10 V/µs Tj = 125°C			-	3.0	-	-	
	Without snubber Tj = 125°C			8.5	-	8.5	14	

■ STANDARD (4 Quadrants)

Symbol	Test Conditions	Quadrant		BTA/BTB16		Unit
				C	B	
I_{GT} (1)	V_D = 12 V R_L = 33 Ω	I - II - III IV	MAX.	25 50	50 100	mA
V_{GT}		ALL	MAX.	1.3		V
V_{GD}	$V_D = V_{DRM}$ R_L = 3.3 kΩ Tj = 125°C	ALL	MIN.	0.2		V
I_H (2)	I_T = 500 mA		MAX.	25	50	mA
I_L	I_G = 1.2 I_{GT}	I - III - IV	MAX.	40	60	mA
		II		80	120	
dV/dt (2)	V_D = 67 % V_{DRM} gate open Tj = 125°C		MIN.	200	400	V/µs
(dV/dt)c (2)	(dI/dt)c = 7 A/ms Tj = 125°C		MIN.	5	10	V/µs

STATIC CHARACTERISTICS

Symbol	Test Conditions			Value	Unit
V_{TM} (2)	I_{TM} = 22.5 A tp = 380 µs	Tj = 25°C	MAX.	1.55	V
V_{to} (2)	Threshold voltage	Tj = 125°C	MAX.	0.85	V
R_d (2)	Dynamic resistance	Tj = 125°C	MAX.	25	mΩ
I_{DRM}	$V_{DRM} = V_{RRM}$	Tj = 25°C	MAX.	5	µA
I_{RRM}		Tj = 125°C		2	mA

Note 1: minimum IGT is guaranted at 5% of IGT max

Note 2: for both polarities of A2 referenced to A1

THERMAL RESISTANCES

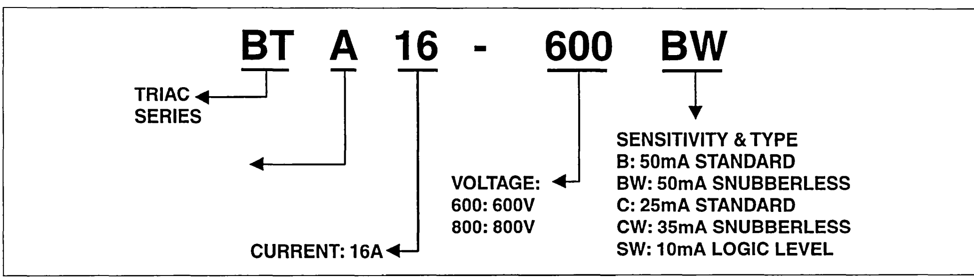
Symbol	Parameter			Value	Unit
$R_{th(j-c)}$	Junction to case (AC)		D^2PAK TO-220AB	1.2	°C/W
			TO-220AB Insulated	2.1	
$R_{th(j-a)}$	Junction to ambient	S = 1 cm^2	D^2PAK	45	°C/W
			TO-220AB	60	
			TO-220AB Insulated		

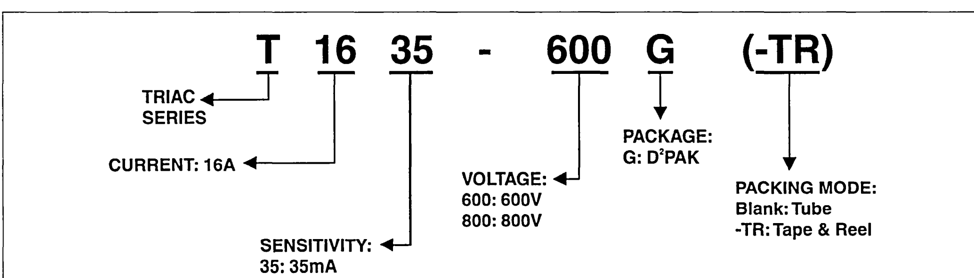
S. Copper surface under tab

PRODUCT SELECTOR

Part Number	Voltage(xxx)		Sensitivity	Type	Package
	600 V	800 V			
BTA/BTB16-xxxB	X	X	50 mA	Standard	TO-220AB
BTA/BTB16-xxxBW	X	X	50 mA	Snubberless	TO-220AB
BTA/BTB16-xxxC	X	X	25 mA	Standard	TO-220AB
BTA/BTB16-xxxCW	X	X	35 mA	Snubberless	TO-220AB
BTA/BTB16-xxxSW	X	X	10 mA	Logic level	TO-220AB
T1635-xxxG	X	X	35 mA	Snubberless	D^2PAK

ORDERING INFORMATION





OTHER INFORMATION

Part Number	Marking	Weight	Base quantity	Packing mode
BTA/BTB16-xxxyz	BTA/BTB16xxxyz	2.3 g	250	Bulk
T1635-xxxG	T1635xxxG	1.5 g	50	Tube
T1635-xxxG-TR	T1635xxxG	1.5 g	1000	Tape & reel

Note: xxx = voltage, y = sensitivity, z = type

Fig. 1: Maximum power dissipation versus RMS on-state current (full cycle).

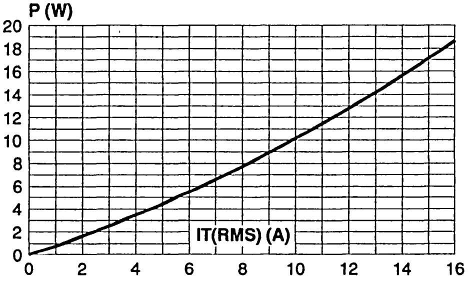


Fig. 2-1: RMS on-state current versus case temperature (full cycle).

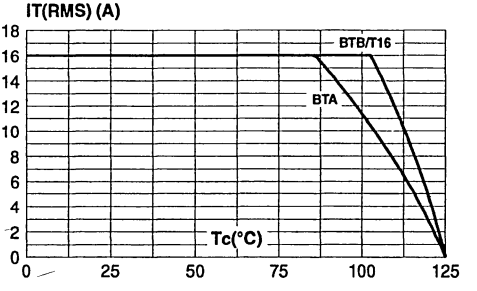


Fig. 2-2: D²PAK RMS on-state current versus ambient temperature (printed circuit board FR4, copper thickness: 35 µm), full cycle.

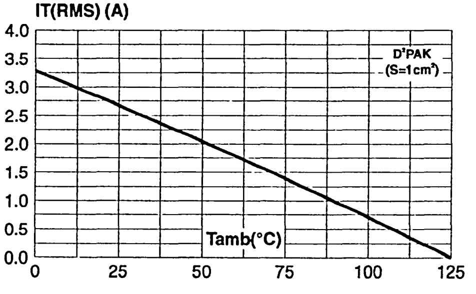


Fig. 3: Relative variation of thermal impedance versus pulse duration.

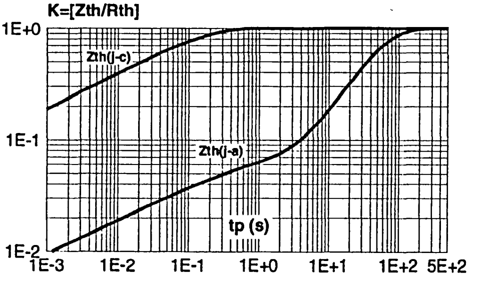


Fig. 4: On-state characteristics (maximum values)

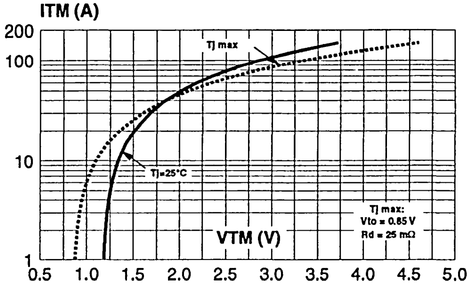


Fig. 5: Surge peak on-state current versus number of cycles.

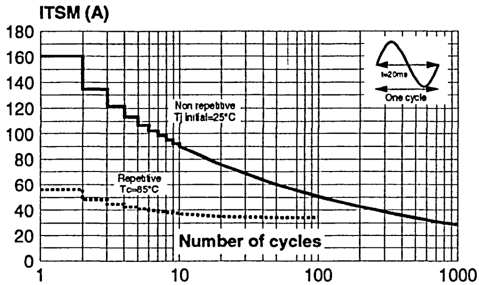


Fig. 6: Non-repetitive surge peak on-state current for a sinusoidal pulse with width tp < 10ms, and corresponding value of I²t.

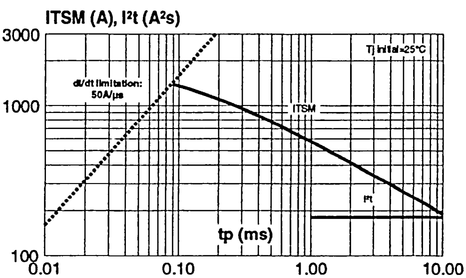


Fig. 7: Relative variation of gate trigger current, holding current and latching current versus junction temperature (typical values).

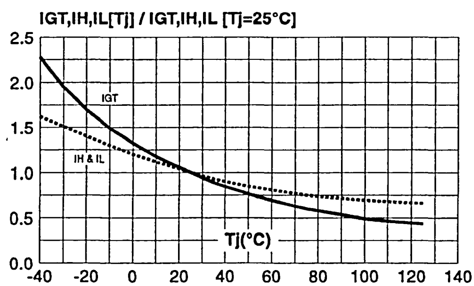


Fig. 8: Relative variation of critical rate of decrease of main current versus (dV/dt)c (typical values).

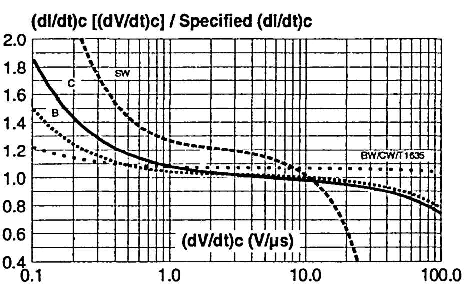


Fig. 9: Relative variation of critical rate of decrease of main current versus junction temperature.

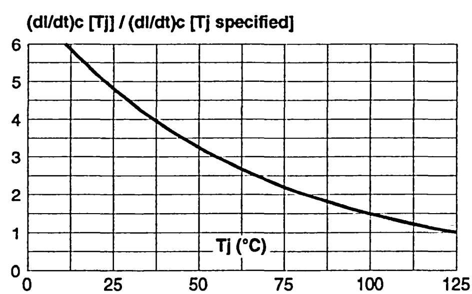
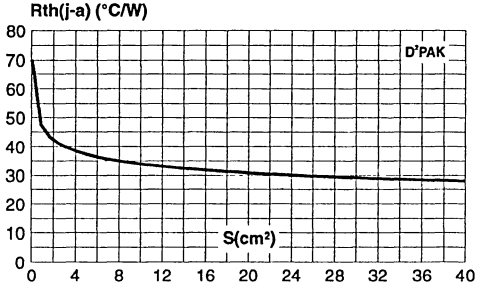


Fig. 10: D^2PAK Thermal resistance junction to ambient versus copper surface under tab (printed circuit board FR4, copper thickness: 35 µm).



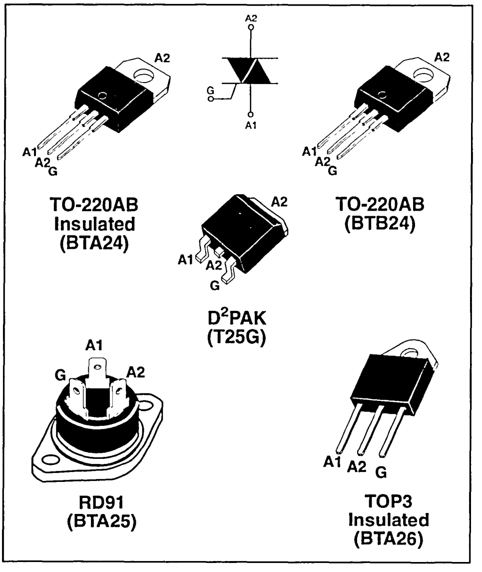
BTA/BTB24, BTA25, BTA26 and T25 Series

SNUBBERLESS™ & STANDARD

25A TRIACs

MAIN FEATURES:

Symbol	Value	Unit
$I_{T(RMS)}$	25	A
V_{DRM}/V_{RRM}	600 and 800	V
$I_{GT\ (Q_1)}$	35 to 50	mA



DESCRIPTION

Available either in through-hole of surface and T25 mount packages, the BTA/BTB24-25-26 triac series is suitable for general purpose AC power switching. They can be used as an ON/OFF function in applications such as static relays, heating regulation, water heaters, induction motor starting circuits...or for phase control operation in high power motor speed controllers, soft start circuits...The snubberless versions (BTA/BTB...W and T25 series) are specially recommended for use on inductive loads, thanks to their high commutation performances.
By using an internal ceramic pad, the BTA series provides voltage insulated tab (rated at 2500V RMS) complying with UL standards (File ref.: E81734).

ABSOLUTE MAXIMUM RATINGS

Symbol	Parameter			Value	Unit
$I_{T(RMS)}$	RMS on-state current (full sine wave)	D²PAK TO-220AB	Tc = 100°C	25	A
		RD91 TOP3 Ins.	Tc = 90°C		
		TO-220AB Ins.	Tc = 75°C		
I_{TSM}	Non repetitive surge peak on-state current (full cycle, Tj initial = 25°C)	F = 60 Hz	t = 16.7 ms	260	A
		F = 50 Hz	t = 20 ms	250	
I^2t	I^2t Value for fusing	tp = 10 ms		450	A^2s
dI/dt	Critical rate of rise of on-state current $I_G = 2 \times I_{GT}$, tr ≤ 100 ns	F = 120 Hz	Tj = 125°C	50	A/µs
V_{DSM}/V_{RSM}	Non repetitive surge peak off-state voltage	tp = 10 ms	Tj = 25°C	V_{DRM}/V_{RRM} + 100	V
I_{GM}	Peak gate current	tp = 20 µs	Tj = 125°C	4	A
$P_{G(AV)}$	Average gate power dissipation		Tj = 125°C	1	W
T_{stg} T_j	Storage junction temperature range Operating junction temperature range			- 40 to + 150 - 40 to + 125	°C

ELECTRICAL CHARACTERISTICS (Tj = 25°C, unless otherwise specified)

■ SNUBBERLESS™ (3 Quadrants) T25-G, BTA/BTB24...W, BTA25...W, BTA26...W

Symbol	Test Conditions	Quadrant		T25	BTA/BTB		Unit
				T2535	CW	BW	
I_{GT} (1)	V_D = 12 V R_L = 33 Ω	I - II - III	MAX.	35	35	50	mA
V_{GT}		I - II - III	MAX.	1.3			V
V_{GD}	$V_D = V_{DRM}$ R_L = 3.3 kΩ Tj = 125°C	I - II - III	MIN.	0.2			V
I_H (2)	I_T = 500 mA		MAX.	50	50	75	mA
I_L	I_G = 1.2 I_{GT}	I - III	MAX.	70	70	80	mA
		II		80	80	100	
dV/dt (2)	V_D = 67 % V_{DRM} gate open Tj = 125°C		MIN.	500	500	1000	V/µs
(dI/dt)c (2)	Without snubber Tj = 125°C		MIN.	13	13	22	A/ms

■ STANDARD (4 Quadrants): BTA25...B, BTA26...B

Symbol	Test Conditions	Quadrant		Value	Unit
I_{GT} (1)	V_D = 12 V R_L = 33 Ω	I - II - III IV	MAX.	50 100	mA
V_{GT}		ALL	MAX.	1.3	V
V_{GD}	$V_D = V_{DRM}$ R_L = 3.3 kΩ Tj = 125°C	ALL	MIN.	0.2	V
I_H (2)	I_T = 500 mA		MAX.	80	mA
I_L	I_G = 1.2 I_{GT}	I - III - IV	MAX.	70	mA
		II		160	
dV/dt (2)	V_D = 67 % V_{DRM} gate open Tj = 125°C		MIN.	500	V/µs
(dV/dt)c (2)	(dI/dt)c = 13.3 A/ms Tj = 125°C		MIN.	10	V/µs

STATIC CHARACTERISTICS

Symbol	Test Conditions			Value	Unit
V_{TM} (2)	I_{TM} = 35 A tp = 380 µs	Tj = 25°C	MAX.	1.55	V
V_{to} (2)	Threshold voltage	Tj = 125°C	MAX.	0.85	V
R_d (2)	Dynamic resistance	Tj = 125°C	MAX.	16	mΩ
I_{DRM}	$V_{DRM} = V_{RRM}$	Tj = 25°C	MAX.	5	µA
I_{RRM}		Tj = 125°C		3	mA

Note 1: minimum IGT is guaranted at 5% of IGT max

Note 2: for both polarities of A2 referenced to A1

THERMAL RESISTANCES

Symbol	Parameter			Value	Unit
$R_{th(j-c)}$	Junction to case (AC)		D^2PAK TO-220AB	0.8	°C/W
			RD91 (Insulated) TOP3 Insulated	1.1	
			TO-220AB Insulated	1.7	
$R_{th(j-a)}$	Junction to ambient	S = 1 cm^2	D^2PAK	45	°C/W
			TOP3 Insulated	50	
			TO-220AB	60	
			TO-220AB Insulated		

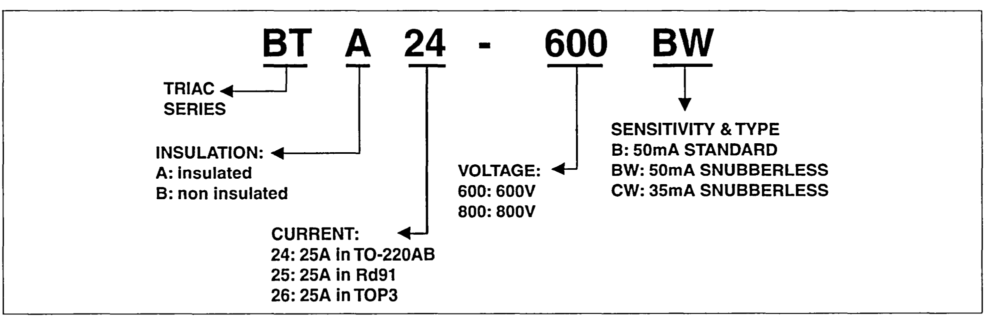
S Copper surface under tab

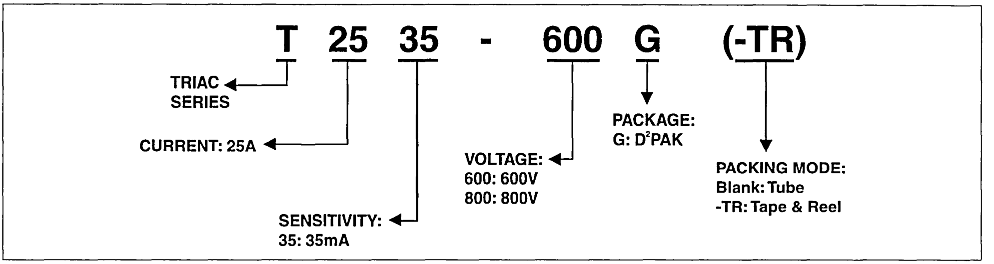
PRODUCT SELECTOR

Part Number	Voltage (xxx)		Sensitivity	Type	Package
	600 V	800 V			
BTB24-xxxB	X	X	50 mA	Standard	TO-220AB
BTA/BTB24-xxxBW	X	X	50 mA	Snubberless	TO-220AB
BTA/BTB24-xxxCW	X	X	35 mA	Snubberless	TO-220AB
BTA25-xxxB	X	X	50 mA	Standard	RD-91
BTA25-xxxBW	X	X	50 mA	Snubberless	RD-91
BTA25-xxxCW	X	X	35 mA	Snubberless	RD-91
BTA26-xxxB	X	X	50 mA	Standard	TOP3 Ins.
BTA26-xxxBW	X	X	50 mA	Snubberless	TOP3 Ins.
BTA26-xxxCW	X	X	35 mA	Snubberless	TOP3 Ins.
T2535-xxxG	X	X	35 mA	Snubberless	D^2PAK

BTB: Non insulated TO-220AB package

ORDERING INFORMATION





OTHER INFORMATION

Part Number	Marking	Weight	Base quantity	Packing mode
BTA/BTB24-xxxyz	BTA/BTB24xxxyz	2.3 g	250	Bulk
BTA25-xxxyz	BTA25xxxyz	20 g	25	Bulk
BTA26-xxxyz	BTA26xxxyz	4.5 g	120	Bulk
T2535-xxxG	T2535xxxG	1.5 g	50	Tube
T2535-xxxG-TR	T2535xxxG	1.5 g	1000	Tape & reel

Note: xxx= voltage, y = sensitivity, z = type

Fig. 1: Maximum power dissipation versus RMS on-state current (full cycle).

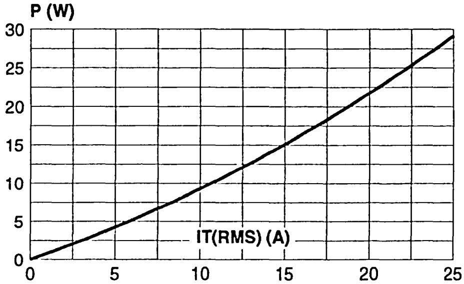


Fig. 2-1: RMS on-state current versus case temperature (full cycle).

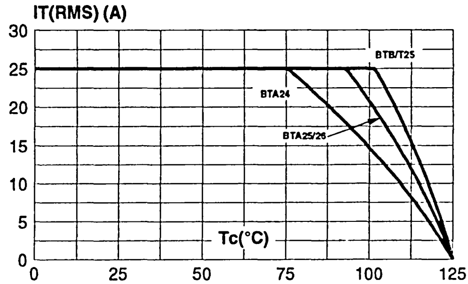


Fig. 2-2: D²PAK RMS on-state current versus ambient temperature (printed circuit board FR4, copper thickness: 35 µm), full cycle.

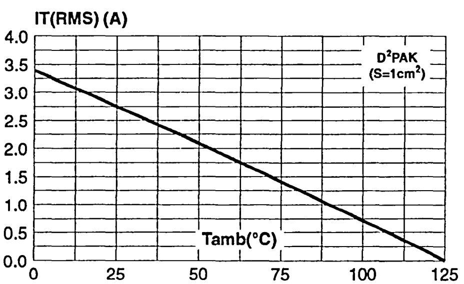


Fig. 3: Relative variation of thermal impedance versus pulse duration.

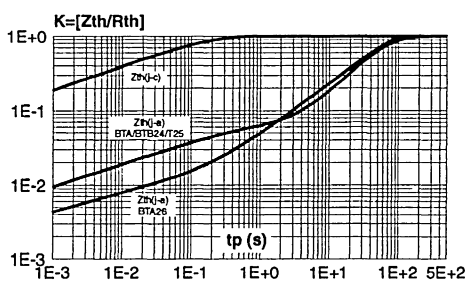


Fig. 4: On-state characteristics (maximum values).

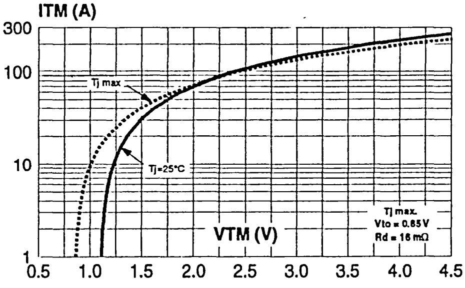


Fig. 5: Surge peak on-state current versus number of cycles.

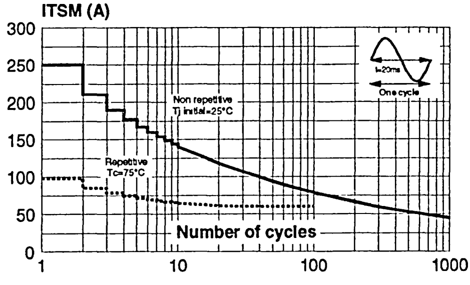


Fig. 6: Non-repetitive surge peak on-state current for a sinusoidal pulse with width tp < 10ms, and corresponding value of I^2t.

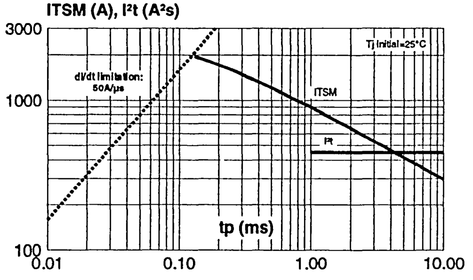


Fig. 7: Relative variation of gate trigger current, holding current and latching current versus junction temperature (typical values).

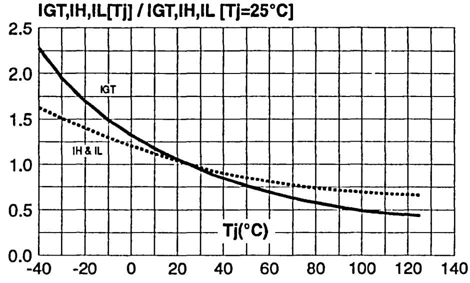


Fig. 8: Relative variation of critical rate of decrease of main current versus (dV/dt)c (typical values).

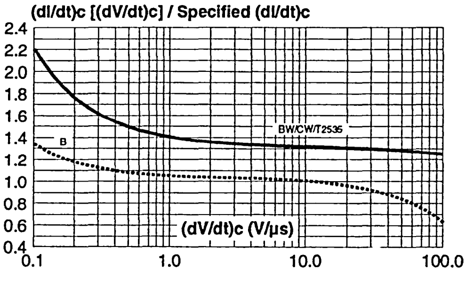


Fig. 9: Relative variation of critical rate of decrease of main current versus junction temperature.

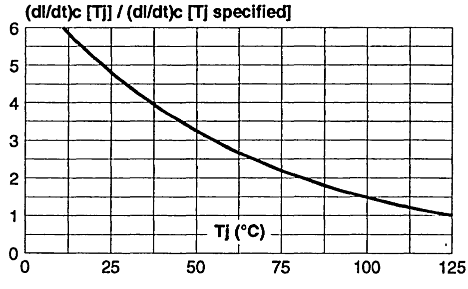
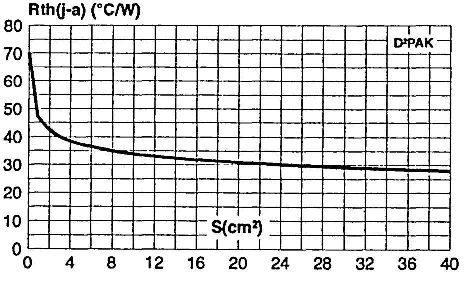


Fig. 10: D^2PAK Thermal resistance junction to ambient versus copper surface under tab (printed circuit board FR4, copper thickness: 35 µm).



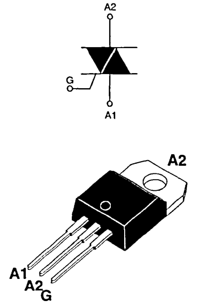
T2550H-600T

SNUBBERLESS™ HIGH TEMPERATURE

25A TRIACs

MAIN FEATURES:

Symbol	Value	Unit
$I_{T(RMS)}$	25	A
V_{DRM}/V_{RRM}	600	V
$I_{GT\ (Q_1)}$	50	mA



TO-220AB

DESCRIPTION

Specifically designed for use in high temperature environment (found in hot appliances such as cookers, ovens, hobs, electric heaters, coffee machines...), the new 25 Amps T25500H triacs provide an enhanced performance in terms of power loss and thermal dissipation. This allows optimization of the heatsinking dimensioning, leading to space and cost effectivness when compared to electro-mechnical solutions.

Based on ST snubberless technology, they offer high commutation switching capabilities and high noise immunity levels. And, thanks to their clip assembly technique, they provide a superior performance in surge current handling.

ABSOLUTE MAXIMUM RATINGS

Symbol	Parameter			Value	Unit
$I_{T(RMS)}$	RMS on-state current (full sine wave)		Tc = 125°C	25	A
I_{TSM}	Non repetitive surge peak on-state current (full cycle, Tj initial = 25°C)	F = 60 Hz	t = 16.7 ms	260	A
		F = 50 Hz	t = 20 ms	250	
I^2t	I^2t Value for fusing	tp = 10 ms		450	A^2s
dI/dt	Critical rate of rise of on-state current $I_G = 2 \times I_{GT}$, tr ≤ 100 ns	F = 120 Hz	Tj = 150°C	50	A/µs
V_{DSM}/V_{RSM}	Non repetitive surge peak off-state voltage	tp = 10 ms	Tj = 25°C	700	V
I_{GM}	Peak gate current	tp = 20 µs	Tj = 150°C	4	A
$P_{G(AV)}$	Average gate power dissipation		Tj = 150°C	1	W
T_{stg} T_j	Storage junction temperature range Operating junction temperature range			- 40 to + 150 - 40 to + 150	°C

ELECTRICAL CHARACTERISTICS (Tj = 25°C, unless otherwise specified)

Symbol	Test Conditions	Quadrant		Value	Unit
I_{GT} (1)	V_D = 12 V R_L = 33 Ω	I - II - III	MAX.	50	mA
V_{GT}		I - II - III	MAX.	1.3	V
V_{GD}	$V_D = V_{DRM}$ R_L = 3.3 kΩ Tj = 150°C	I - II - III	MIN.	0.15	V
I_H (2)	I_T = 500 mA		MAX.	75	mA
I_L	$I_G = 1.2\ I_{GT}$	I - II - III	MAX.	90	mA
dV/dt (2)	V_D = 67 % V_{DRM} gate open Tj = 150°C		MIN.	500	V/µs
(dI/dt)c (2)	Without snubber Tj = 150°C		MIN.	11.1	A/ms

STATIC CHARACTERISTICS

Symbol	Test Conditions			Value	Unit
V_{TM} (2)	I_{TM} = 35 A tp = 380 µs	Tj = 25°C	MAX.	1.5	V
V_{to} (2)	Threshold voltage	Tj = 150°C	MAX.	0.80	V
R_d (2)	Dynamic resistance	Tj = 150°C	MAX.	19	mΩ
I_{DRM} I_{RRM}	$V_{DRM} = V_{RRM}$	Tj = 25°C	MAX.	5	µA
		Tj = 150°C		8.5	mA
	V_{DRM} / V_{RRM} = 400 V (at mains peak voltage)	Tj = 150°C		5.5	

Note 1: minimum IGT is guaranted at 10% of IGT max.

Note 2: for both polarities of A2 referenced to A1

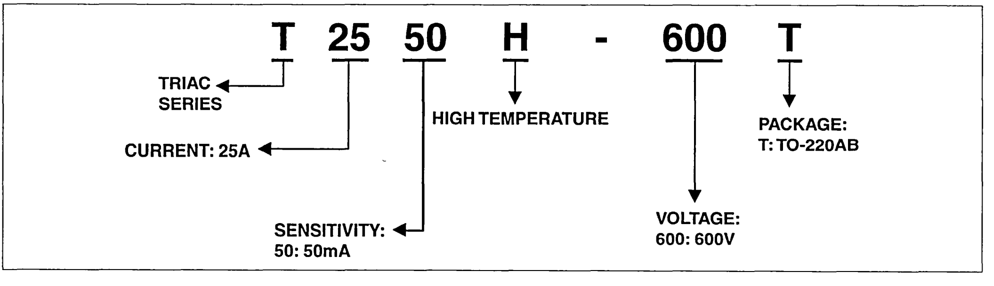
THERMAL RESISTANCE

Symbol	Parameter	Value	Unit
$R_{th(j-c)}$	Junction to case (AC)	0.8	°C/W

PRODUCT SELECTOR

Part Number	Voltage	Sensitivity	Type	Package
T2550H-600T	600 V	50 mA	Snubberless	TO-220AB

ORDERING INFORMATION



OTHER INFORMATION

Part Number	Marking	Weight	Base quantity	Packing mode
T2550H-600T	T2550H600T	2.3 g	250	Bulk

Fig. 1: Maximum power dissipation versus RMS on-state current (full cycle).

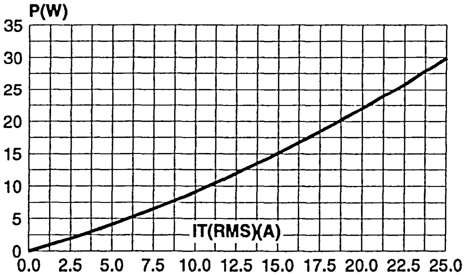


Fig. 2: RMS on-state current versus case temperature (full cycle).

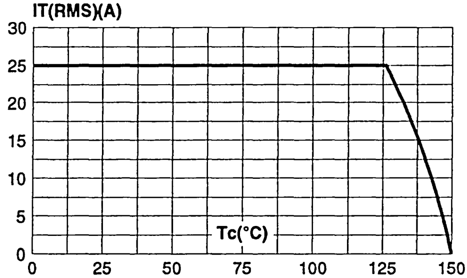


Fig. 3: Relative variation of thermal impedance versus pulse duration.

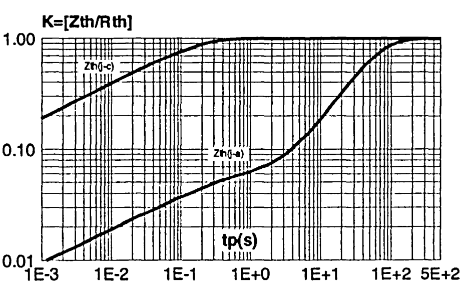


Fig. 4: Relative variation of gate trigger current, holding current and latching current versus junction temperature (typical values).

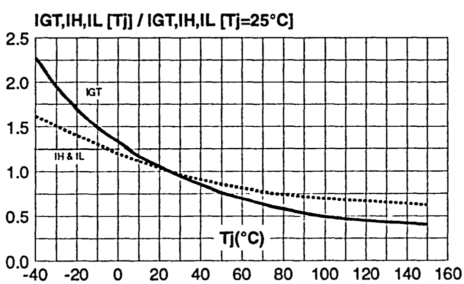


Fig. 5: Surge peak on-state current versus number of cycles.

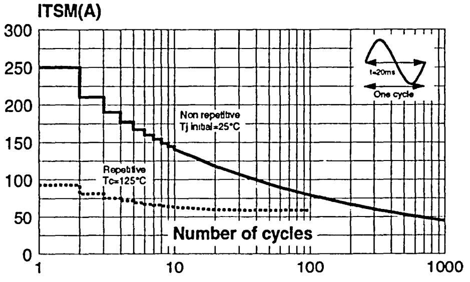


Fig. 6: Non-repetitive surge peak on-state current for a sinusoidal pulse with width tp < 10ms, and corresponding value of I^2t.

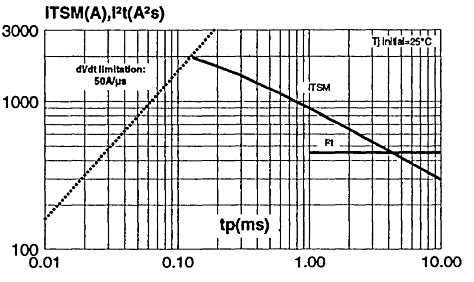


Fig. 7: On-state characteristics (maximum values).

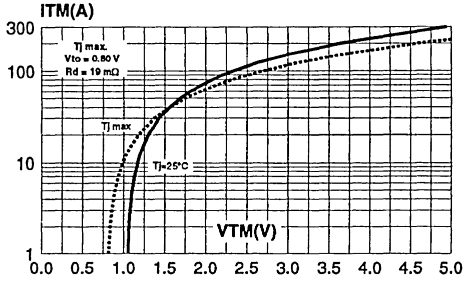


Fig. 8: Relative variation of critical rate of decrease of main current versus junction temperature (typical values).

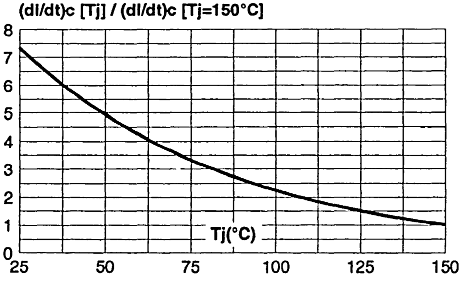


Fig. 9: Relative variation of critical rate of decrease of main current versus (dV/dt)c (typical values).

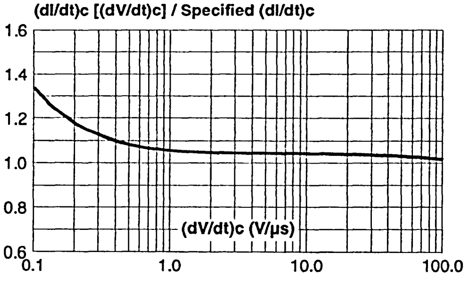


Fig. 10: Leakage current versus junction temperature for different values of blocking voltage (typical values).

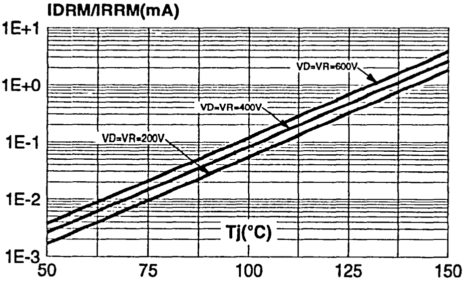
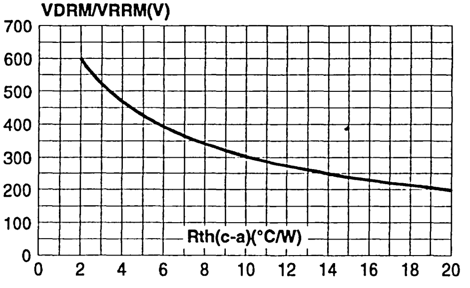


Fig. 11: Acceptable repetitive peak off-state voltage versus case-ambient thermal resistance.

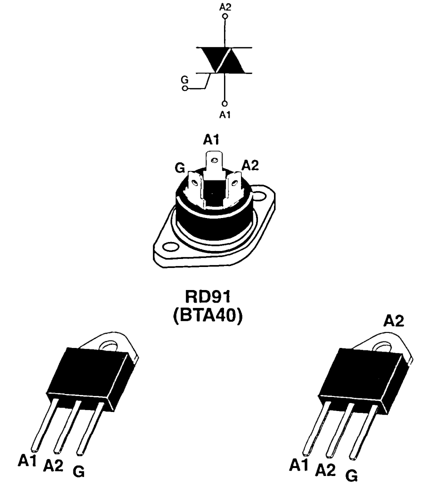


BTA40 and BTA/BTB41 Series

STANDARD | 40A TRIACs

MAIN FEATURES:

Symbol	Value	Unit
$I_{T(RMS)}$	40	A
V_{DRM}/V_{RRM}	600 and 800	V
$I_{GT\ (Q_1)}$	50	mA



RD91 (BTA40)
TOP3 Insulated (BTA41)
TOP3 (BTB41)

DESCRIPTION

Available in high power packages, the BTA/BTB40-41 series is suitable for general purpose AC power switching. They can be used as an ON/OFF function in applications such as static relays, heating regulation, water heaters, induction motor starting circuits, welding equipment... or for phase control operation in high power motor speed controllers, soft start circuits...

Thanks to their clip assembly technique, they provide a superior performance in surge current handling capabilities.

By using an internal ceramic pad, the BTA series provides voltage insulated tab (rated at 2500 V RMS) complying with UL standards (File ref.: E81734).

ABSOLUTE MAXIMUM RATINGS

Symbol	Parameter			Value	Unit
$I_{T(RMS)}$	RMS on-state current (full sine wave)	RD91	Tc = 80°C	40	A
		TOP3			
		TOP3 Ins.	Tc = 70°C		
I_{TSM}	Non repetitive surge peak on-state current (full cycle, Tj initial = 25°C)	F = 60 Hz	t = 16.7 ms	420	A
		F = 50 Hz	t = 20 ms	400	
I^2t	I^2t Value for fusing	tp = 10 ms		1120	A^2s
dI/dt	Critical rate of rise of on-state current $I_G = 2 \times I_{GT}$, tr ≤ 100 ns	F = 120 Hz	Tj = 125°C	50	A/µs
V_{DSM}/V_{RSM}	Non repetitive surge peak off-state voltage	tp = 10 ms	Tj = 25°C	V_{DRM}/V_{RRM} + 100	V
I_{GM}	Peak gate current	tp = 20 µs	Tj = 125°C	8	A
$P_{G(AV)}$	Average gate power dissipation		Tj = 125°C	1	W
T_{stg} T_j	Storage junction temperature range Operating junction temperature range			- 40 to + 150 - 40 to + 125	°C

ELECTRICAL CHARACTERISTICS (Tj = 25°C, unless otherwise specified)

Symbol	Test Conditions	Quadrant		Value	Unit
I_{GT} (1)	V_D = 12 V R_L = 33 Ω	I - II - III IV	MAX.	50 100	mA
V_{GT}		ALL	MAX.	1.3	V
V_{GD}	$V_D = V_{DRM}$ R_L = 3.3 kΩ Tj = 125°C	ALL	MIN.	0.2	V
I_H (2)	I_T = 500 mA		MAX.	80	mA
I_L	I_G = 1.2 I_{GT}	I - III - IV	MAX.	70	mA
		II		160	
dV/dt (2)	V_D = 67 % V_{DRM} gate open Tj = 125°C		MIN.	500	V/µs
(dV/dt)c (2)	(dI/dt)c = 20 A/ms Tj = 125°C		MIN.	10	V/µs

STATIC CHARACTERISTICS

Symbol	Test Conditions			Value	Unit
V_{TM} (2)	I_{TM} = 60 A tp = 380 µs	Tj = 25°C	MAX.	1.55	V
V_{to} (2)	Threshold voltage	Tj = 125°C	MAX.	0.85	V
R_d (2)	Dynamic resistance	Tj = 125°C	MAX.	10	mΩ
I_{DRM} I_{RRM}	$V_{DRM} = V_{RRM}$	Tj = 25°C	MAX.	5	µA
		Tj = 125°C		5	mA

Note 1: minimum IGT is guaranted at 5% of IGT max

Note 2: for both polarities of A2 referenced to A1

THERMAL RESISTANCES

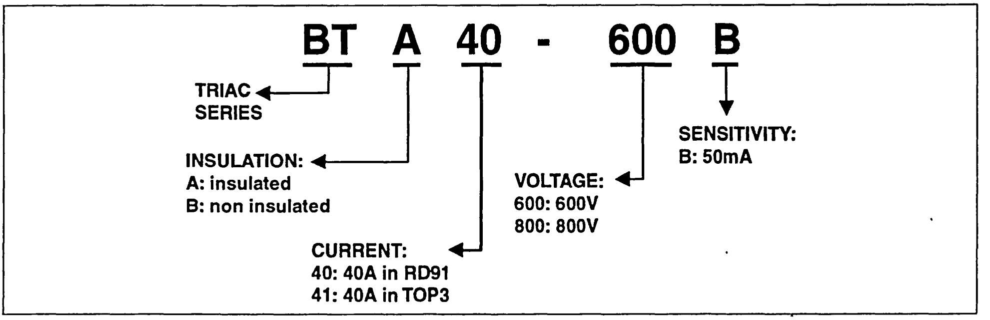
Symbol	Parameter		Value	Unit
$R_{th(j-c)}$	Junction to case (AC)	RD91 (Insulated) TOP3	0.9	°C/W
		TOP3 Insulated	1.2	
$R_{th(j-a)}$	Junction to ambient	TOP3	50	°C/W
		TOP3 Insulated		

PRODUCT SELECTOR

Part Number	Voltage (xxx)		Sensitivity	Type	Package
	600 V	800 V			
BTA40-xxxB	X	X	50 mA	Standard	RD91
BTA/BTB41-xxxB	X	X	50 mA	Standard	TOP3

BTB: Non insulated TOP3 package

ORDERING INFORMATION



OTHER INFORMATION

Part Number	Marking	Weight	Base quantity	Packing mode
BTA40-xxxB	BTA40xxxB	20.0 g	25	Bulk
BTA/BTB41-xxxB	BTA/BTB41xxxB	4.5 g	120	Bulk

Note: xxx= voltage

Fig. 1: Maximum power dissipation versus RMS on-state current (full cycle).

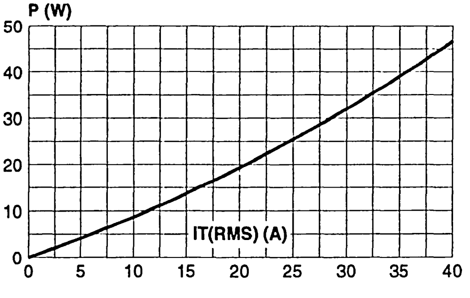


Fig. 2: RMS on-state current versus case temperature (full cycle).

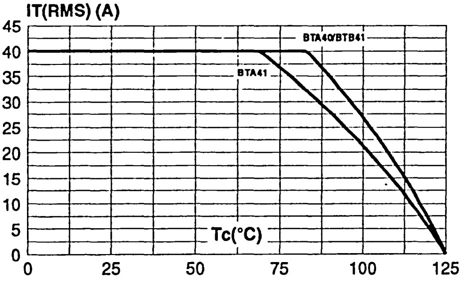


Fig. 3: Relative variation of thermal impedance versus pulse duration.

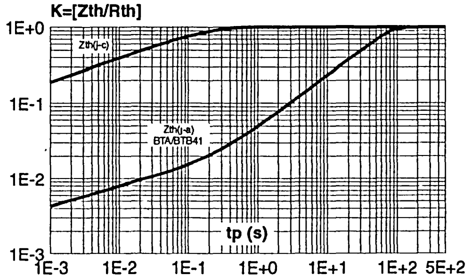


Fig. 4: On-state characteristics (maximum values).

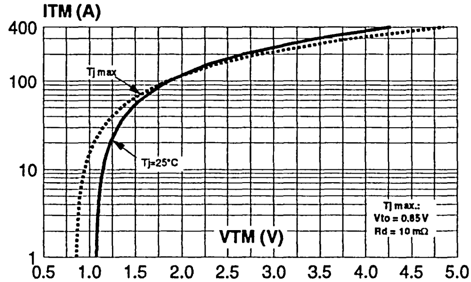


Fig. 5: Surge peak on-state current versus number of cycles.

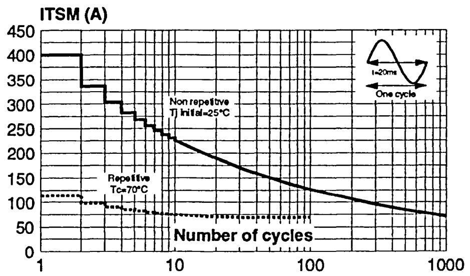


Fig. 6: Non-repetitive surge peak on-state current for a sinusoidal pulse with width tp < 10 ms, and corresponding value of I^2t.

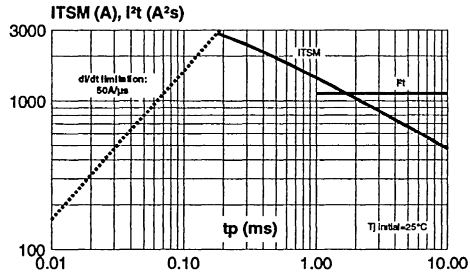


Fig. 7: Relative variation of gate trigger current, holding current and latching current versus junction temperature (typical values).

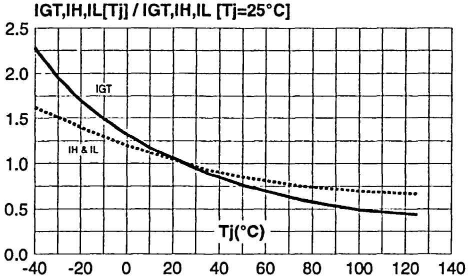


Fig. 8: Relative variation of critical rate of decrease of main current versus (dV/dt)c (typical values).

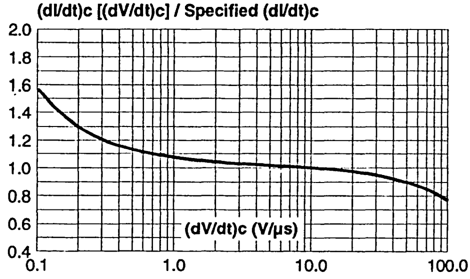
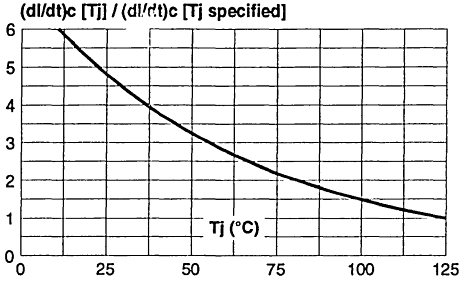


Fig. 9: Relative variation of critical rate of decrease of main current versus junction temperature.



DIACs DATASHEETS

DIAC

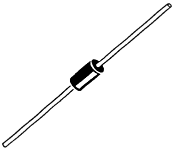
FEATURES

- V_{BO} : 32V and 40V
- LOW BREAKOVER CURRENT

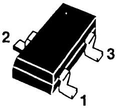
DESCRIPTION

Functioning as a trigger diode with a fixed voltage reference, the DB3/DB4 series can be used in conjunction with triacs for simplified gate control circuits or as a starting element in fluorenscent lamp ballasts.

A new surface mount version is now available in SOT-23 package, providing reduced space and compatibility with automatic pick and place equipment.



DO-35
(DB3 and DB4)



SOT-23
(SMDB3)*
Pin 1 and 3 must be shorted together

ABSOLUTE MAXIMUM RATINGS (limiting values)

Symbol	Parameter		Value	Unit
I_{TRM}	Repetitive peak on-state current tp = 20 µs F= 120 Hz	SMDB3	0.50	A
		DB3 / DB4	2.00	
Tstg Tj	Storage temperature range Operating junction temperature range		- 40 to + 125	°C

Note: * SMDB3 indicated as Preliminary spec as product is still in development stage.

ELECTRICAL CHARACTERISTICS (Tj = 25°C unless otherwise specified)

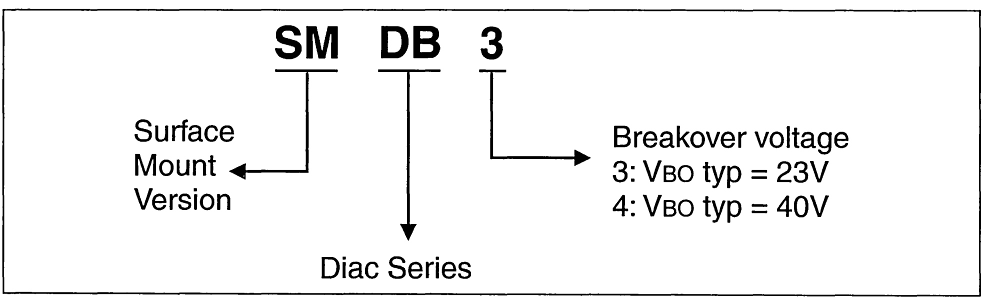
Symbol	Parameter	Test Conditions		SMDB3	DB3	DB4	Unit
V_{BO}	Breakover voltage *	C = 22nF **	MIN.	28	28	35	V
			TYP.	32	32	40	
			MAX.	36	36	45	
$\mid V_{BO1} - V_{BO2} \mid$	Breakover voltage symmetry	C = 22nF **	MAX.	3			V
ΔV	Dynamic breakover voltage *	V_{BO} and V_F at 10mA	MIN.	10	5		V
V_O	Output voltage *	see diagram 2 (R=20Ω)	MIN.	10	5		V
I_{BO}	Breakover current *	C = 22nF **	MAX.	10	50		µA
tr	Rise time *	see diagram 3	MAX.	0.50	2		µs
I_R	Leakage current *	$V_R = 0.5\ V_{BO}$ max	MAX.	1	10		µA
I_P	Peak current *	see diagram 2 (Gate)	MIN.	0.50	0.30		A

* Applicable to both forward and reverse directions.
** Connected in parallel to the device.

PRODUCT SELECTOR

Part Number	V_{BO}	Package
SMDB3	28 - 36	SOT-23
DB3	28 - 36	DO-35
DB4	35 - 45	DO-35

ORDERING INFORMATION



OTHER INFORMATION

Part Number	Marking	Weight	Base Quantity	Packing Mode
SMDB3	DB3	0.01 g	3000	Tape & Reel
DB3	DB3 (Blue Body Coat)	0.15 g	5000	Tape & Reel
DB4	DB4 (Blue Body Coat)	0.15 g	5000	Tape & Reel

Diagram 1: Voltage - current characteristic curve.

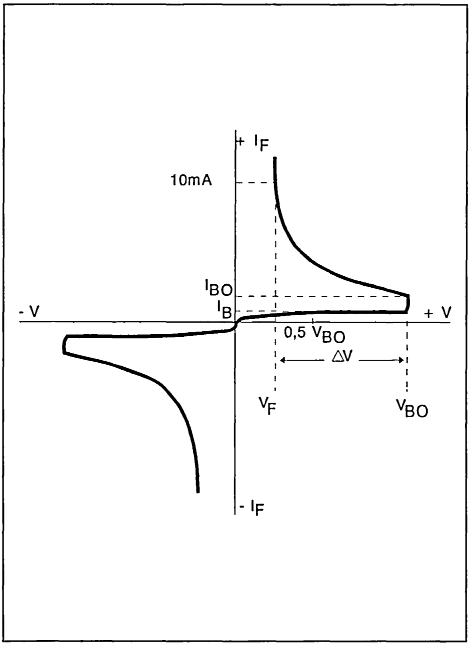


Diagram 2: Test circuit.

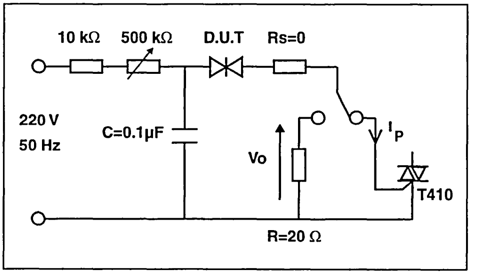


Diagram 3: Rise time measurement.

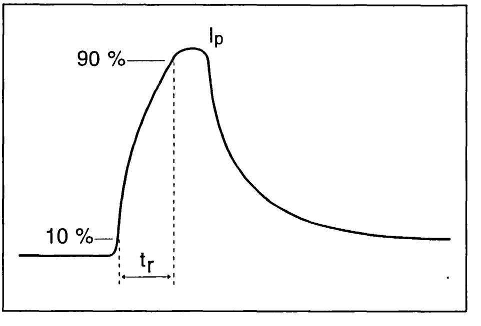


Fig. 1: Relative variation of VBO versus junction temperature (typical values).

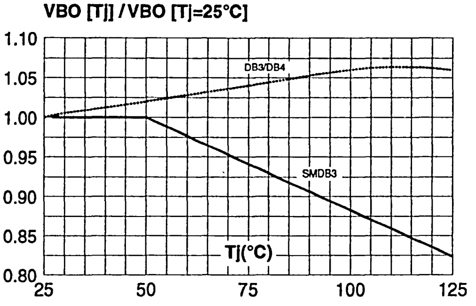


Fig. 2: Repetitive peak pulse current versus pulse duration (maximum values).

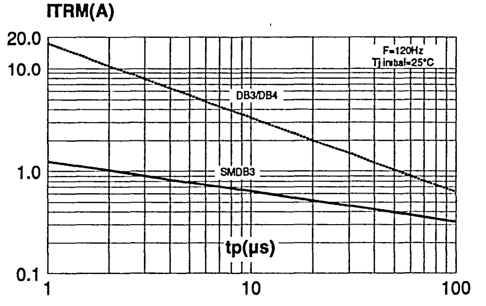
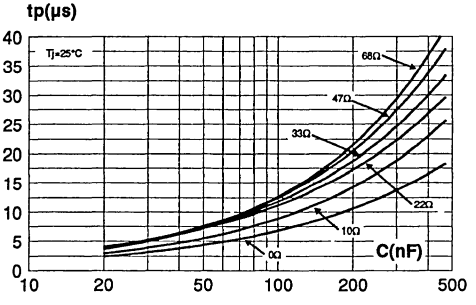


Fig. 3: Time duration while current pulse is higher 50mA versus C and Rs (typical values).



AC SWITCHES DATASHEETS

ACS102-5Tx

ASD™ AC Switch Family

AC LINE SWITCH

MAIN APPLICATIONS

- AC on-off static switching in appliance & industrial control systems
- Drive of low power high inductive or resistive loads like
  - relay, valve, solenoid, dispenser
  - pump, fan, micro-motor
  - low power lamp bulb, door lock

FEATURES

- Blocking voltage : V_{DRM} / V_{RRM} = 500V
- Clamping voltage : V_{CL} = 600 V
- Nominal current : $I_{T(RMS)}$ = 0.2 A
- Gate triggering current : $I_{GT} < 5$ mA
- Switch integrated driver
- Triggering current is sourced by the gate
- SO-8 package:
  - drive reference COM connected to 2 cooling pins
  - 3.5 mm creepage distance from pin OUT to other pins

BENEFITS

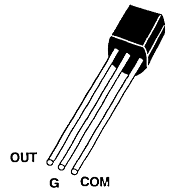
- Needs no external overvoltage protection
- Enables equipment to meet IEC61000-4-5 & IEC 335-1
- Reduces component count by up to 80 %
- Interfaces directly with a microcontroller
- Eliminates any stressing gate kick back on microcontroller
- Allows straightforward connection of several ACS™ on same cooling pad.

DESCRIPTION

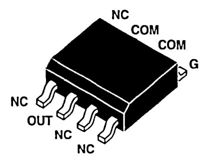
The ACS102 belongs to the AC line switch family built around the ASD™ concept. This high performance device is able to control an up to 0.3 A load device.

The ACS™ switch embeds a high voltage clamping structure to absorb the inductive turn off energy and a gate level shifter driver to separate the digital controller from the main switch. It is triggered with a negative gate current flowing out of the gate pin.

For further technical information, please refer to AN1172 application note.



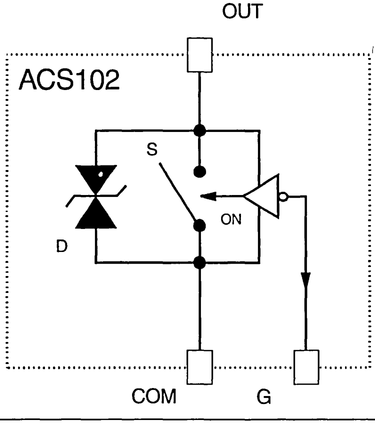
TO-92
ACS102-5TA



SO-8
ACS102-5T1

NC: Not Connected

FUNCTIONAL DIAGRAM



ASD and ACS are a trademarks of STMicroelectronics.

ABSOLUTE RATINGS (limiting values)

Symbol	Parameter			Value	Unit
V_{DRM} / V_{RRM}	Repetitive peak off-state voltage		Tj = 125 °C	500	V
$I_{T(RMS)}$	RMS on-state current full cycle sine wave 50 to 60 Hz	TO-92	Tamb = 100 °C	0.2	A
		SO-8	Tamb = 100 °C	0.2	A
I_{TSM}	Non repetitive surge peak on-state current Tj initial = 25°C, full cycle sine wave		F =50 Hz	7.3	A
			F =60 Hz	8	A
dI/dt	Critical rate of repetitive rise of on-state current I_G = 10mA with tr = 100ns		F =120 Hz	20	A/µs
V_{PP}	Non repetitive line peak pulse voltage		note 1	2	kV
Tstg	Storage temperature range			- 40 to + 150	°C
Tj	Operating junction temperature range			- 30 to + 125	°C
Tl	Maximum lead temperature for soldering during 10s			260	°C

Note 1: according to test described by IEC61000-4-5 standard & Figure 3.

SWITCH GATE CHARACTERISTICS (maximum values)

Symbol	Parameter	Value	Unit
$P_{G\,(AV)}$	Average gate power dissipation	0.1	W
I_{GM}	Peak gate current (tp = 20µs)	1	A
V_{GM}	Peak positive gate voltage (respect to the pin COM)	5	V

THERMAL RESISTANCES

Symbol	Parameter		Value	Unit
Rth (j-a)	Junction to ambient	TO-92	150	°C/W
		SO-8 *	150	°C/W
Rth (j-l)	Junction to leads for full AC line cycle conduction	TO-92	60	°C/W

* with 40mm^2 copper (ex: 35µm) surface under "com" pins

ELECTRICAL CHARACTERISTICS

For either positive or negative polarity of pin OUT voltage respect to pin COM voltage excepted note 3*.

Symbol	Test Conditions			Values	Unit
I_{GT}	V_{OUT}=12V R_L=140Ω	Tj=25°C	MAX	5	mA
V_{GT}	V_{OUT}=12V R_L=140Ω	Tj=25°C	MAX	0.9	V
V_{GD}	V_{OUT}=V_{DRM} R_L=3.3kΩ	Tj=125°C	MIN	0.15	V
I_H	I_{OUT}= 100mA gate open	Tj=25°C	TYP	20	mA
			MAX	tbd	
I_L	I_G= 20mA	Tj=25°C	TYP	25	mA
			MAX	tbd	
V_{TM}	I_{OUT} = 0.3A tp=380µs	Tj=25°C	MAX	1.2	V
I_{DRM} I_{RRM}	V_{OUT} = V_{DRM} V_{OUT} = V_{RRM}	Tj=25°C	MAX	2	µA
		Tj=125°C	MAX	200	
dV/dt	V_{OUT}=400V gate open	Tj=110°C	MIN	300	V/µs
(dI/dt)c *(Note 3)	(dV/dt)c = 5V/µs I_{OUT} > 0	Tj=110°C	MIN	0.1	A/ms
	(dV/dt)c = 10V/µs I_{OUT} < 0			0.15	
V_{CL}	I_{CL} = 1mA tp=1ms	Tj=25°C	TYP	600	V

tbd = to be defined

AC LINE SWITCH BASIC APPLICATION

The ACS102 device is well adapted to washing machines, dish washers, tumble driers, refrigerators, water heaters, and cookware. It has been designed especially to switch on & off low power loads such as solenoids, valves, relays, dispensers, micro-motors, pumps, fans, door locks, and low power lamps bulbs.

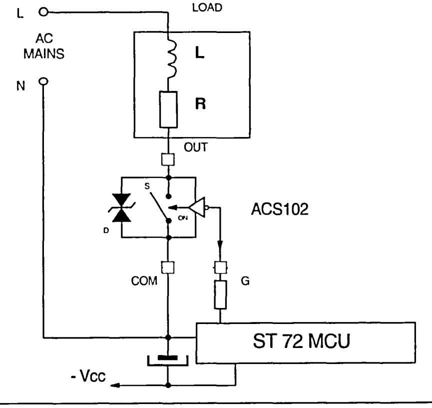
Pin COM : Common drive reference, to connect to the power line neutral
Pin G : Switch Gate input to connect to the digital controller through a resistor
Pin OUT : Switch Output, to connect to the load

This ACS™ switch is triggered with a negative gate current flowing out of the gate pin G. It can be driven directly by the digital controller through a resistor as shown on the typical application diagram. No protection device are required between the gate and COM terminals.
The SO-8 version allows to connect several ACS102 devices on the same cooling PCB pad which is the COM pin.
In appliance systems, the ACS102 switch intends to drive low power loads in full cycle ON / OFF mode. The turn off commutation characteristics of these loads are described in Table 1.
Thanks to its thermal and turn-off commutation characteristics, the ACS102 switch drives a load, such as door lock, lamp, relay, valve and micro motor, up to 0.2A without any turn-off aid circuit. Switching off the ACS within one full AC line cycle will extend its current up to 0.3 A.

Table 1: Low power load turn off commutation requirement (230V AC applications).

LOAD	Load IRMS current (A)	POWER FACTOR	(dI/dt)c (A/ms)	(dV/dt)c (V/µs)	TURN-OFF DELAY (ms)
Door lock, lamp	< 0.2	1	< 0.1	< 0.15	< 10
Relay Valve Dispenser Micro-motor	< 0.2	> 0.7	< 0.1	< 5	< 10
Pump Fan	< 0.3	> 0.2	< 0.15	< 10	< 20

TYPICAL APPLICATION DIAGRAM



HIGH INDUCTIVE SWITCH-OFF OPERATION

At the end of the last conduction half-cycle, the load current reaches the holding current level I_H, and the ACS™ switch turns off. Because of the inductance L of the load, the current flows through the avalanche diode D and decreases linearly to zero. During this time, the voltage across the switch is limited to the clamping voltage V_{CL}.

The energy stored in the inductance of the load depends on the holding current I_H and the inductance (up to 10 H); it can reach about 20 mJ and is dissipated in the clamping diode section. The ACS™ switch sustains the turn off energy, because its clamping section is designed for that purpose.

Fig. 1: Turn-off operation of the ACS102 switch with an electro valve: waveform of the gate current I_G, pin OUT current I_{OUT} & voltage V_{OUT}.

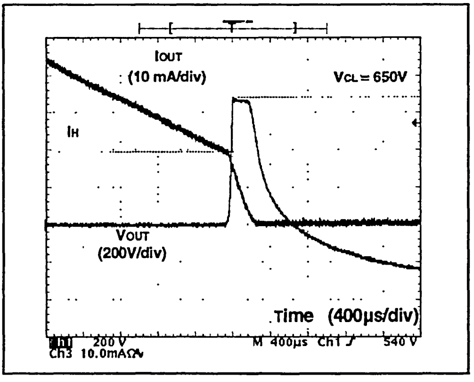
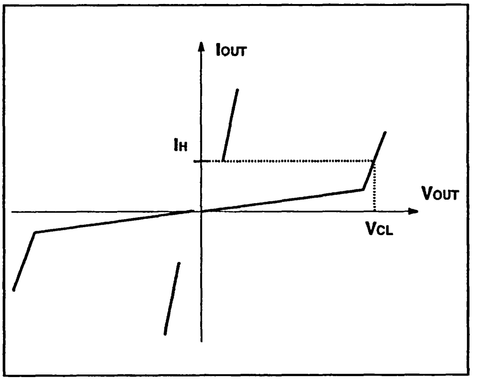


Fig. 2: ACS102 switch static characteristic.



AC LINE TRANSIENT VOLTAGE RUGGEDNESS

The ACS102 switch is able to withstand safely the AC line transient voltages either by clamping the low energy spikes or by breaking over under high energy shocks.

The test circuit of the figure 3 is representative of the final ACS™ application and is also used to stress the ACS™ switch according to the IEC61000-4-5 standard conditions. Thanks to the load, the ACS™ switch withstands the voltage spikes up to 2 kV above the peak line voltage. It will break over safely even on resistive load where the turn on current rate of increase is high as shown on figure 4. Such non repetitive test can be done 10 times on each AC line voltage polarity.

Fig. 3: Overvoltage ruggedness test circuit for resistive and inductive loads according to IEC61000-4-5 standard.
R = 150Ω, L = 5µH, V_{PP} = 2kV.

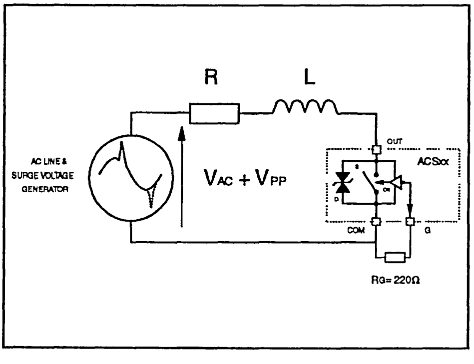


Fig. 4: Current and Voltage of the ACS™ during IEC61000-4-5 standard test with R = 150Ω, L = 5µH & V_{PP} = 2kV.

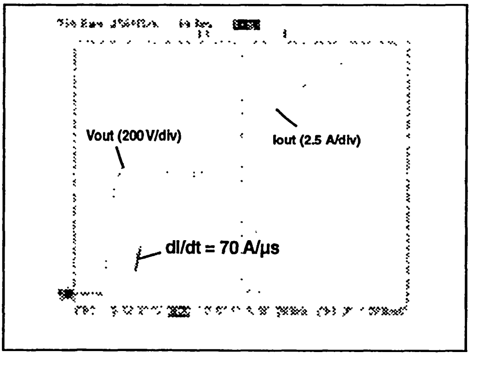


Fig. 5: Maximum power dissipation versus RMS on-state current.

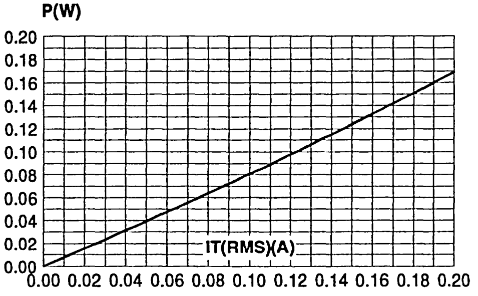


Fig. 6: RMS on-state current versus ambient temperature.

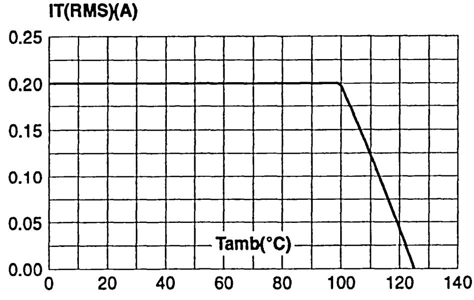


Fig. 7-1: Relative variation of thermal impedance junction to ambient versus pulse duration (ACS102-5TA) (TO-92).

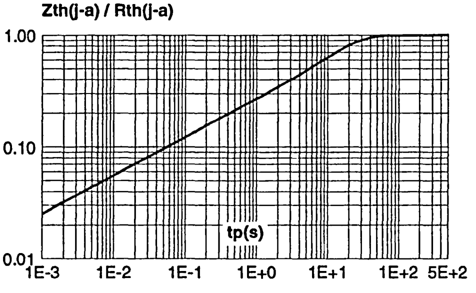


Fig. 7-2: Relative variation of thermal impedance junction to ambient versus pulse duration (printed circuit board FR4, e(Cu) = 35µm, S(Cu) = 40mm^2 under "com" pins) (ACS102-5T1) (SO-8).

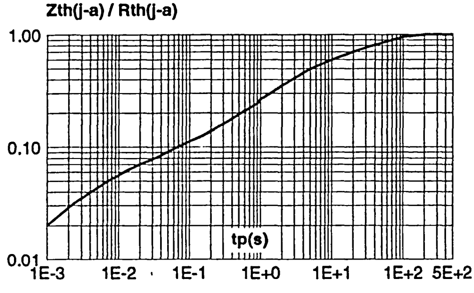


Fig. 8: Relative variation of gate trigger current versus junction temperature.

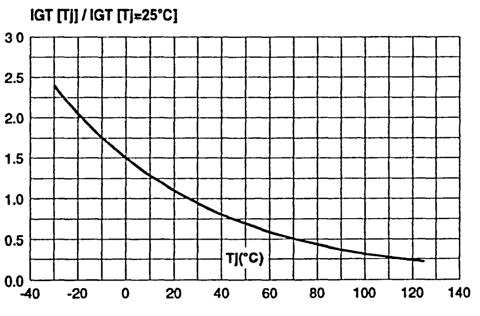


Fig. 9: Relative variation of holding and latching current versus junction temperature.

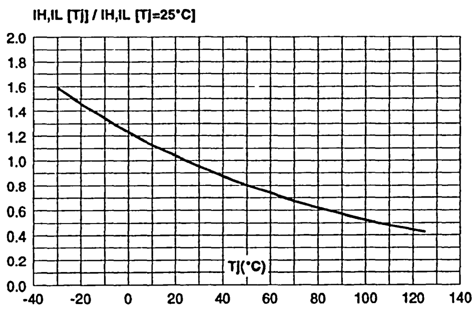


Fig. 10: Surge peak on-state current versus number of cycles.

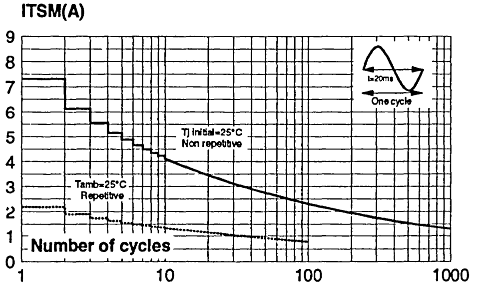


Fig. 11: Non-repetitive surge peak on-state current for a sinusoidal pulse with width tp<10ms, and corresponding value of I^2t..

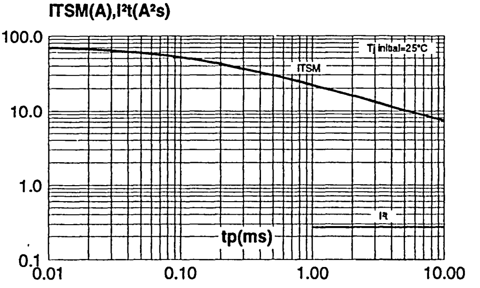


Fig. 12: On-state characteristics (maximum values).

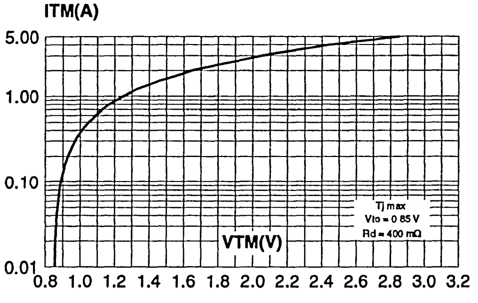


Fig. 13: Thermal resistance junction to ambient versus copper surface under tab (Epoxy printed circuit board FR4, copper thickness under "com" pins: 35µm) (ACS102-5T1).

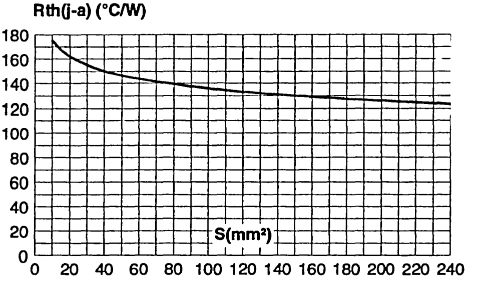
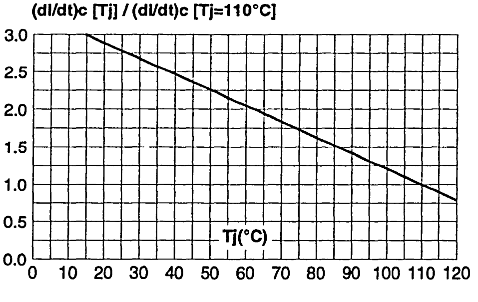
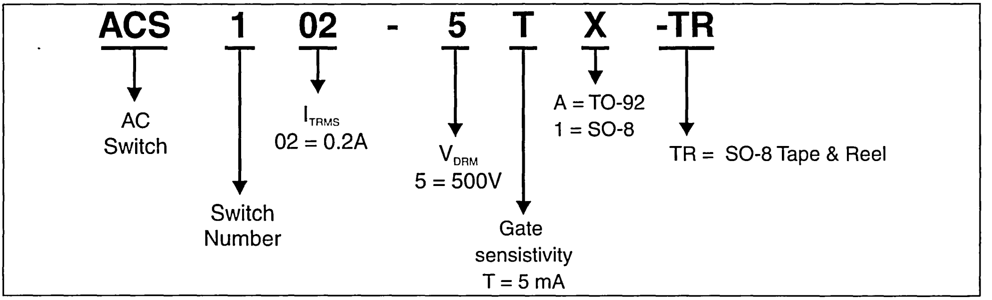


Fig. 14: Relative variation of critical (dI/dt)c versus junction temperature (ACS102-5T1).



ORDERING INFORMATION



OTHER INFORMATION

Ordering type	Marking	Package	Weight	Base qty	Delivery mode
ACS102-5TA	ACS102	TO-92	0.2g	2500	Bulk
ACS102-5TA-TR	ACS102	TO-92	0.2g	2000	Tape & reel
ACS102-5T1	ACS102	SO-8	0.11g	100	Tube
ACS102-5T1-TR	ACS102	SO-8	0.11g	2500	Tape & reel

ASD and ACS are a trademarks of STMicroelectronics.

ACS108-5Sx

ASD™
AC Switch Family

AC LINE SWITCH

MAIN APPLICATIONS

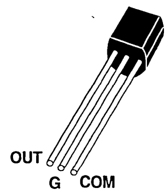
- AC on-off static switching in appliance & industrial control systems
- Drive of low power high inductive or resistive loads like:
  - relay, valve, solenoid, dispenser
  - pump, fan, micro-motor
  - low power lamp bulb, door lock

FEATURES

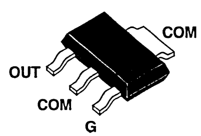
- Blocking voltage: V_{DRM} / V_{RRM} = 500V
- Clamping voltage: V_{CL} = 600V
- Nominal current: $I_{T(RMS)}$ = 0.8 A
- Gate triggering current : I_{GT} < 10 mA
- Triggering current is sourced by the gate
- Switch integrated driver
- Drive reference COM connected to the SOT-223 tab

BENEFITS

- Needs no external overvoltage protection.
- Enables the equipment to meet IEC61000-4-5 standard.
- Allows straightforward connection of several SOT-223 devices on the same cooling pad.
- Reduces the switch component count by up to 80%.
- Interfaces directly with the microcontroller.
- Eliminates any stressing gate kick back on the microcontroller.



TO-92
ACS108-5SA



SOT-223
ACS108-5SN

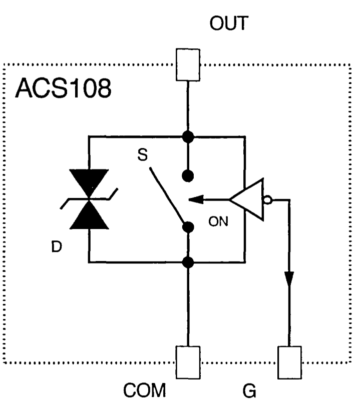
DESCRIPTION

The ACS108 belongs to the AC line switches built around the ASD™ concept. This high performance device is able to control an 0.8 A load device.

The ACS™ switch embeds a high voltage clamping structure to absorb the inductive turn-off energy and a gate level shifter driver to separate the digital controller from the main switch. It is triggered with a negative gate current flowing out of the gate pin.

For further technical information, please refer to AN1172 the Application note.

FUNCTIONAL DIAGRAM



ASD and ACS are a trademarks of STMicroelectronics.

ABSOLUTE RATINGS (limiting values)

Symbol	Parameter			Value	Unit
V_{DRM} / V_{RRM}	Repetitive peak off-state voltage		Tj = 125 °C	500	V
$I_{T(RMS)}$	RMS on-state current full cycle sine wave 50 to 60 Hz	TO-92	Tlead = 75 °C	0.8	A
		TO-92	Tamb = 60 °C	0.3	A
		SOT-223	Tamb = 75 °C	0.8	A
I_{TSM}	Non repetitive surge peak on-state current Tj initial = 25°C, full cycle sine wave		F =50 Hz	7.3	A
			F =60 Hz	8	A
dI/dt	Critical rate of repetitive rise of on-state current I_G = 20mA with tr = 100ns		F =120 Hz	100	A/µs
V_{PP}	Non repetitive line peak pulse voltage		note 1	2	kV
Tstg	Storage temperature range			- 40 to + 150	°C
Tj	Operating junction temperature range			- 30 to + 125	°C
Tl	Maximum lead temperature for soldering during 10s			260	°C

Note 1: according to test described by IEC61000-4-5 standard & Figure 3.

SWITCH GATE CHARACTERISTICS (maximum values)

Symbol	Parameter	Value	Unit
$P_{G\ (AV)}$	Average gate power dissipation	0.1	W
I_{GM}	Peak gate current (tp = 20µs)	1	A
V_{GM}	Peak positive gate voltage (respect to the pin COM)	5	V

THERMAL RESISTANCES

Symbol	Parameter		Value	Unit
Rth (j-a)	Junction to ambient	TO-92	150	°C/W
		SOT-223 (*)	60	°C/W
Rth (j-l)	Junction to lead for full AC line cycle conduction	TO-92	60	°C/W
Rth (j-t)	Junction to tab for full AC line cycle conduction	SOT-223	25	°C/W

(*) : with 5cm^2 copper (e=35µm) surface under tab

ELECTRICAL CHARACTERISTICS

For either positive or negative polarity of pin OUT voltage respect to pin COM voltage excepted note 3

Symbol	Test Conditions			Values	Unit
I_{GT}	V_{OUT}=12V R_L=140Ω	Tj=25°C	MAX.	10	mA
V_{GT}	V_{OUT}=12V R_L=140Ω	Tj=25°C	MAX.	1	V
V_{GD}	V_{OUT}=V_{DRM} R_L=3.3kΩ	Tj=125°C	MIN.	0.15	V
I_H	I_{OUT}= 100mA gate open	Tj=25°C	TYP.	25	mA
			MAX.	60	mA
I_L	I_G= 20mA	Tj=25°C	TYP.	30	mA
			MAX.	65	mA
V_{TM}	IOUT = 1.1A tp=500µs	Tj=25°C	MAX.	1.3	V
I_{DRM} I_{RRM}	V_{OUT} = V_{DRM} V_{OUT} = V_{RRM}	Tj=25°C	MAX.	2	µA
		Tj=125°C	MAX.	200	µA
dV/dt	V_{OUT}=400V gate open	Tj=110°C	MIN.	500	V/µs
(dI/dt)c	(dV/dt)c=10V/µs	Tj=110°C	MIN.	0.1	A/ms
(dI/dt)c*	(dV/dt)c = 15V/µs Iout < 0 (note 3)	Tj=110°C	MIN.	0.3	A/ms
V_{CL}	ICL = 1mA tp=1ms	Tj=25°C	TYP.	600	V

AC LINE SWITCH BASIC APPLICATION

The ACS108 device is well adapted to washing machines, dishwashers, tumble driers, refrigerators, water heaters and cookware. It has been especially designed to switch ON and OFF low power loads such as solenoids, valves, relays, dispensers, micro-motors, fans, pumps, door locks and low power lamp bulbs.

Pin COM: Common drive reference to connect to the power line neutral

Pin G: Switch Gate input to connect to the digital controller through the resistor

Pin OUT: Switch Output to connect to the Load

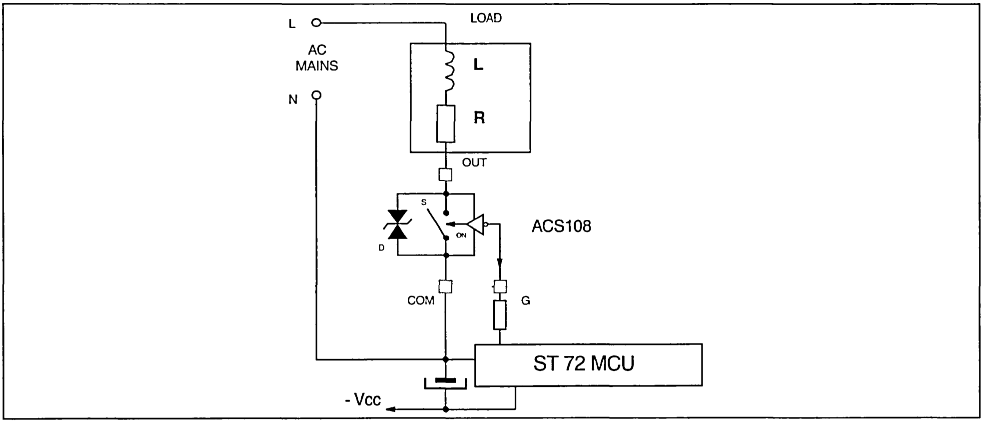
The ACS™ switch is triggered with a negative gate current flowing out of the gate pin G. It can be driven directly by the digital controller through a resistor as shown on the typical application diagram. No protection devices are required between the gates and common terminals.
The SOT-223 version allows several ACS108 devices to be connected on the same cooling PCB pad which is the COM pin : this cooling pad can be then reduced, and the printed circuit layout is simplified.
In appliance systems, the ACS108 switch intends to drive low power load in full cycle ON / OFF mode. The turn off commutation characteristics of these loads can be classified in 3 groups as shown in Table 1.

Thanks to its thermal and turn-off commutation characteristics, the ACS108 switch drives a load, such as door lock, lamp, relay, valve and micro motor, up to 0.2 A without any turn-off aid circuit. Switching off the ACS within one full AC line cycle will extend its current up to 0.8 A on resistive load.

Table 1: Load grouping versus their turn off commutation requirement (230V AC applications).

LOAD	Load IRMS Current (A)	POWER FACTOR	(dI/dt)c (A/ms)	(dV/dt)c (V/µs)	TURN-FF DELAY (ms)
Door Lock Lamp	< 0.3	1	0.15	0.15	<10
	< 0.8	1	0.4	0.15	< 20
Relay Valve Dispenser Micro-motor	< 0.1	> 0.7	< 0.05	< 5	< 10
Pump Fan	< 0.2	> 0.2	< 0.1	< 10	< 10
	< 0.6	> 0.2	< 0.3	< 10	< 20

TYPICAL APPLICATION DIAGRAM



HIGH INDUCTIVE SWITCH-OFF OPERATION

At the end of the last conduction half-cycle, the load current reaches the holding current level I_H, and the ACS™ switch turns off. Because of the inductance L of the load, the current flows through the avalanche diode D and decreases linearly to zero. During this time, the voltage across the switch is limited to the clamping voltage V_{CL}.

The energy stored in the inductance of the load depends on the holding current I_H and the inductance (up to 10 H); it can reach about 20 mJ and is dissipated in the clamping section that is especially designed for that purpose.

Fig. 1: Turn-off operation of the ACS108 switch with an electro valve: waveform of the gate current I_G, pin OUT current I_{OUT} & voltage V_{OUT}.

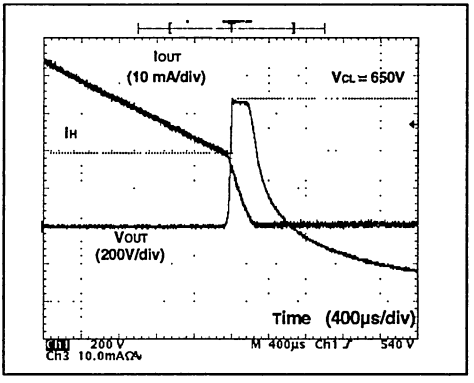
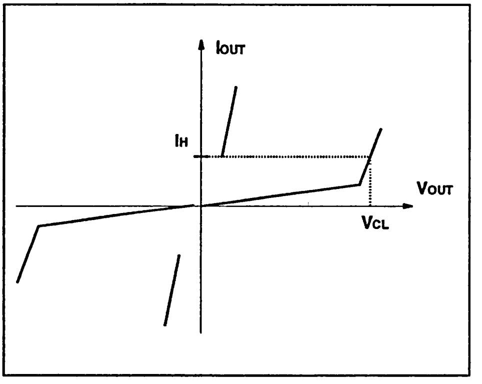


Fig. 2: ACS108 switch static characteristic.



AC LINE TRANSIENT VOLTAGE RUGGEDNESS

The ACS108 switch is able to safely withstand the AC line transient voltages either by clamping the low energy spikes or by breaking over under high energy shocks.

The test circuit in Figure 4 is representative of the final ACS™ application and is also used to stress the ACS™ switch according to the IEC61000-4-5 standard conditions. Thanks to the load, the ACS™ switch withstands the voltage spikes up to 2 kV above the peak line voltage. It will break over safely even on resistive load where the turn-on current rise is high as shown in Figure 4. Such non-repetitive testing can be done 10 times on each AC line voltage polarity.

Fig. 3: Overvoltage ruggedness test circuit for resistive and inductive loads according to IEC61000-4-5 standard.
R = 150Ω, L = 5µH, V_{PP} = 2kV.

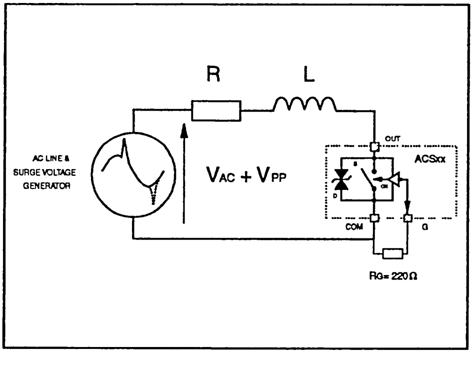


Fig. 4: Current and voltage of the ACS™ during IEC61000-4-5 standard test with a 150Ω - 10µH load & V_{PP} = 2kV.

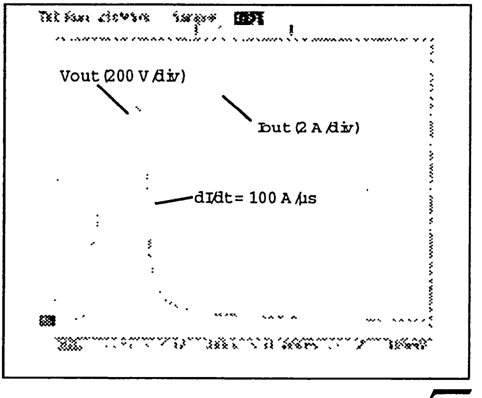


Fig. 5: Maximum power dissipation versus RMS on-state current.

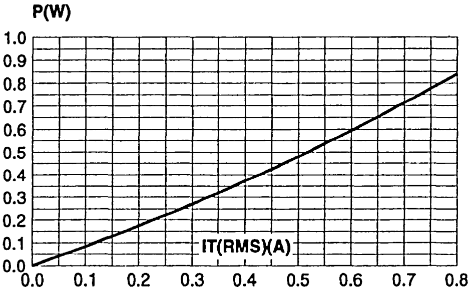


Fig. 6: RMS on-state current versus ambient temperature.

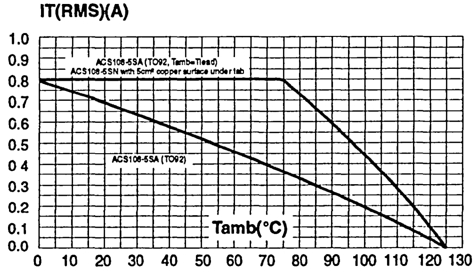


Fig. 7-1: Relative variation of thermal impedance junction to ambient versus pulse duration (ACS108-5SA) (TO-92).

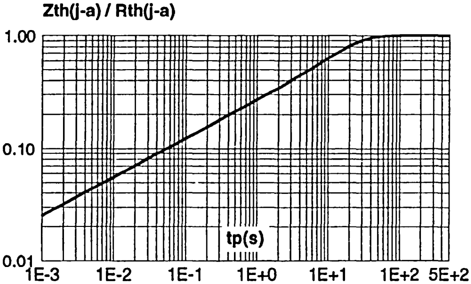


Fig. 7-2: Relative variation of thermal impedance junction to ambient versus pulse duration (ACS108-5SN) (SOT-223).

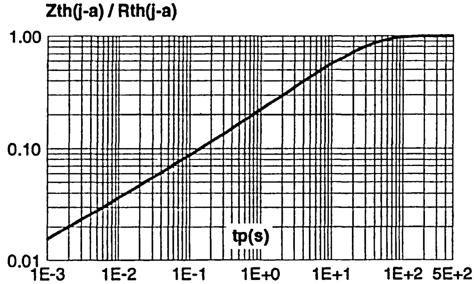


Fig. 8: Relative variation of gate trigger current versus junction temperature.

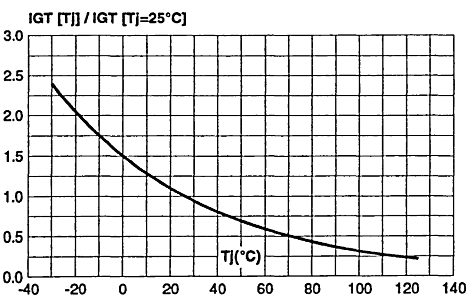


Fig. 9: Relative variation of holding and latching current versus junction temperature.

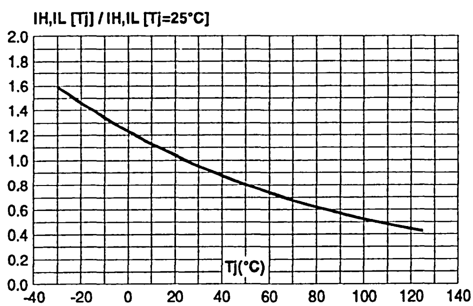


Fig. 10: Non repetitive surge peak on-state current versus number of cycles.

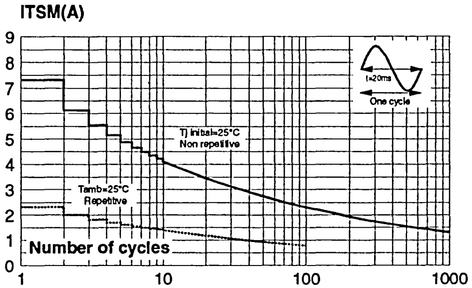


Fig. 11: Non-repetitive surge peak on-state current for a sinusoidal pulse with width tp<10ms, and corresponding value of I^2t.

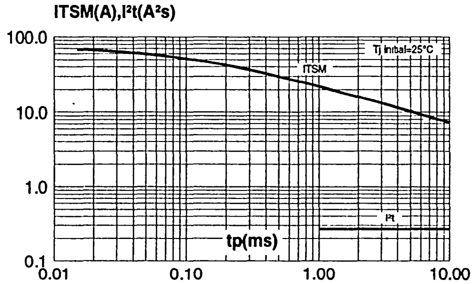


Fig. 12: On-state characteristics (maximum values).

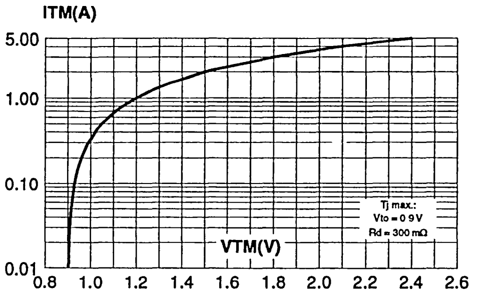


Fig. 13: Thermal resistance junction to ambient versus copper surface under tab (Epoxy printed circuit board FR4, copper thickness: 35µm).

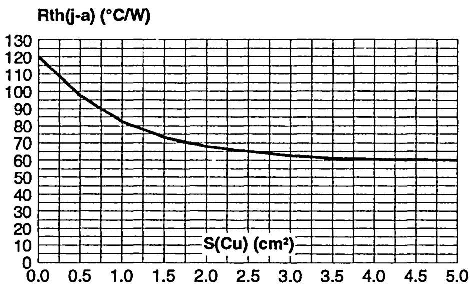
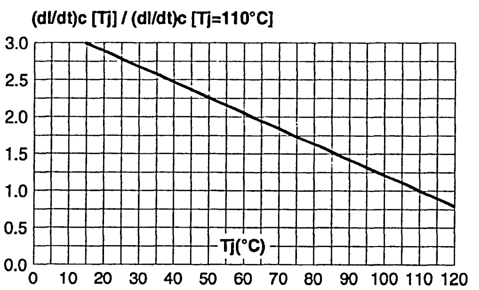
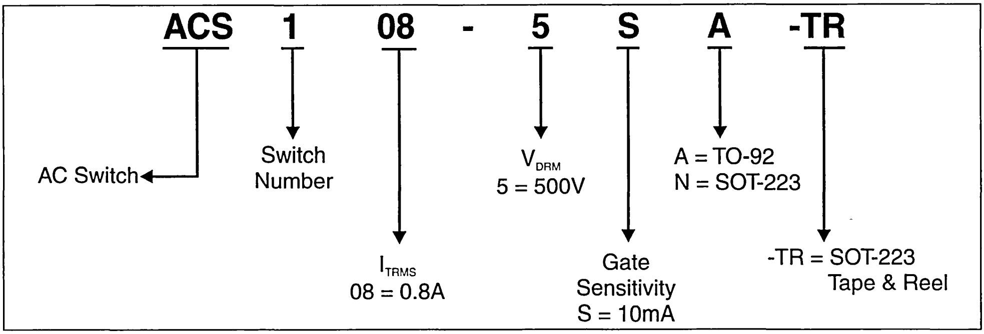


Fig. 14: Relative variation of critical (dI/dt)c versus junction temperature.



ORDERING INFORMATION



OTHER INFORMATION

Ordering type	Marking	Package	Weight	Base qty	Delivery mode
ACS108-5SA	ACS08/5S	TO-92	0.2 g	2500	Bulk
ACS108-5SA-TR	ACS08/5S	TO-92	0.2 g	2000	Tape & reel
ACS108-5SN	ACS/085S	SOT-223	0.12 g	1000	Tape & reel

ACS402-5SB4

ASD™ AC Switch Family

QUAD AC LINE SWITCH ARRAY

MAIN APPLICATIONS

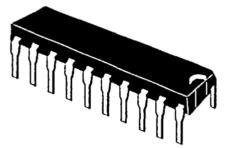
- AC on-off static switching in appliance & industrial control systems
- Drive of low power high inductive or resistive loads like:
  - relay, valve, solenoid, dispenser
  - pump, fan, micro-motor
  - low power lamp bulb, door lock

FEATURES

- 4 high voltage AC switch array
- Blocking voltage: V_{DRM} / V_{RRM} = 500V
- Clamping voltage: V_{CL} = 600V
- Nominal current: $I_{T(RMS)}$ = 0.2 A per switch
- Nominal current: $I_{T(RMS)}$ = 0.4 A for the total array
- Switch integrated driver
- Triggering current is sourced by the gate
- Gate triggering current : I_{GT} < 10 mA

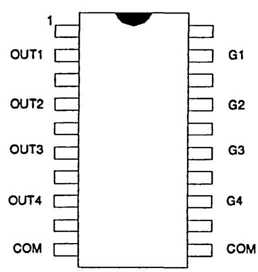
BENEFITS

- Needs no external overvoltage protection.
- Enables the equipment to meet IEC61000-4-5 standard.
- Miniaturizes 4 switches in 1 package.
- Reduces the switch component count by up to 80%.
- Interfaces directly with the microcontroller.
- Eliminates any stressing gate kick back on the microcontroller.



DIP-20

PIN OUT CONNECTION



note : pins 1, 3, 5, 7, 9, 12, 14, 16, 18, 20 not connected.

DESCRIPTION

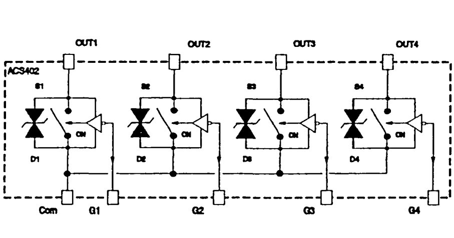
The ACS402 belongs to the AC line switches array family built around the ASD™ concept. This high performance device includes 4 bi-directional a.c. switches able to control an 0.2 A resistive or inductive load device.

Each ACS™ switch integrates a high voltage clamping structure to absorb the inductive turn off energy and a gate level shifter driver to separate the digital controller from each main switch. It is triggered with a negative gate current flowing out of the gate pin.

For further technical information, please refer to AN1172 the Application note.

ASD and ACS are a trademarks of STMicroelectronics .

FUNCTIONAL DIAGRAM



ABSOLUTE RATINGS (limiting values)

Symbol	Parameter			Value	Unit
V_{DRM} / V_{RRM}	Repetitive peak off-state voltage		Tj = 125 °C	500	V
$I_{T(RMS)}$	RMS on-state current full cycle sine wave 50 to 60 Hz	per switch	Tamb = 110 °C	0.2	A
		total array	Tamb = 90 °C	0.4	A
I_{TSM}	Non repetitive surge peak on-state current Tj initial = 25°C, full cycle sine wave		F =50 Hz	5	A
			F =60 Hz	5.5	A
dI/dt	Critical rate of repetitive rise of on-state current I_G = 20mA (tr = 100ns)		F =120 Hz	20	A/µs
V_{PP}	Non repetitive line peak pulse voltage		note 1	2	kV
Tstg	Storage temperature range			- 40 to + 150	°C
Tj	Operating junction temperature range			- 30 to + 125	°C
Tl	Maximum lead temperature for soldering during 10s			260	°C

Note 1: according to test described by IEC61000-4-5 standard & Figure 3.

SWITCH GATE CHARACTERISTICS (maximum values)

Symbol	Parameter	Value	Unit
$P_{G(AV)}$	Average gate power dissipation	0.1	W
I_{GM}	Peak gate current (tp = 20µs)	1	A
V_{GM}	Peak positive gate voltage (respect to the pin COM)	5	V

THERMAL RESISTANCE

Symbol	Parameter	Value	Unit
Rth (j-a)	Junction to ambient	90	°C/W

ELECTRICAL CHARACTERISTICS PER SWITCH

For either positive or negative polarity of pin OUT1, OUT2, OUT3, OUT4 voltage respect to pin COM voltage.

Symbol	Test conditions			Values	Unit
I_{GT}	V_D = 12V R_L = 140Ω	Tj=25°C	MAX.	10	mA
V_{GT}	V_D = 12V R_L = 140Ω	Tj=25°C	MAX.	1	V
V_{GD}	V_{OUT} = V_{DRM} R_L = 3.3kΩ	Tj=125°C	MIN.	0.15	V
I_H	I_{OUT} = 100mA gate open	Tj=25°C	TYP.	25	mA
			MAX.	60	mA
I_L	I_G = 20mA	Tj=25°C	TYP.	30	mA
			MAX.	65	mA
V_{TM}	I_{OUT} = 0.3A tp = 500µs	Tj=25°C	MAX.	1.1	V
I_{DRM} I_{RRM}	V_{OUT} = V_{DRM} V_{OUT} = V_{RRM}	Tj=25°C	MAX.	2	µA
		Tj=125°C	MAX.	200	µA
dV/dt	V_{OUT} = 400V gate open	Tj=110°C	MIN.	500	V/µs
(dI/dt)c	(dV/dt)c = 10V/µs	Tj=110°C	MIN.	0.1	A/ms
V_{CL}	I_{CL} = 1mA tp = 1ms	Tj=25°C	TYP.	600	V

AC LINE SWITCH BASIC APPLICATION

The ACS402 device is well adapted to washing machines, dishwashers, tumble driers, refrigerators, water heaters and cookware. It has been designed especially to switch ON and OFF low power loads such as solenoids, valves, relays, micro-motors, pumps, fans, door locks and low power lamp bulbs.

Pin COM: Common drive reference to connect to the power line neutral

Pin G: Switch Gate input to connect to the digital controller through the resistor

Pin OUT: Switch Output to connect to the load

Each ACS™ switch is triggered with a negative gate current flowing out of the gate pin G. It can be driven directly by the digital controller through a resistor as shown on the typical application diagram. No protection device are required between the gates and common terminals.

In appliance systems, this ACS™ switch intends to drive low power load in full cycle ON / OFF mode. The turn off commutation characteristics of these loads can be classified in 3 groups as shown in Table 1.

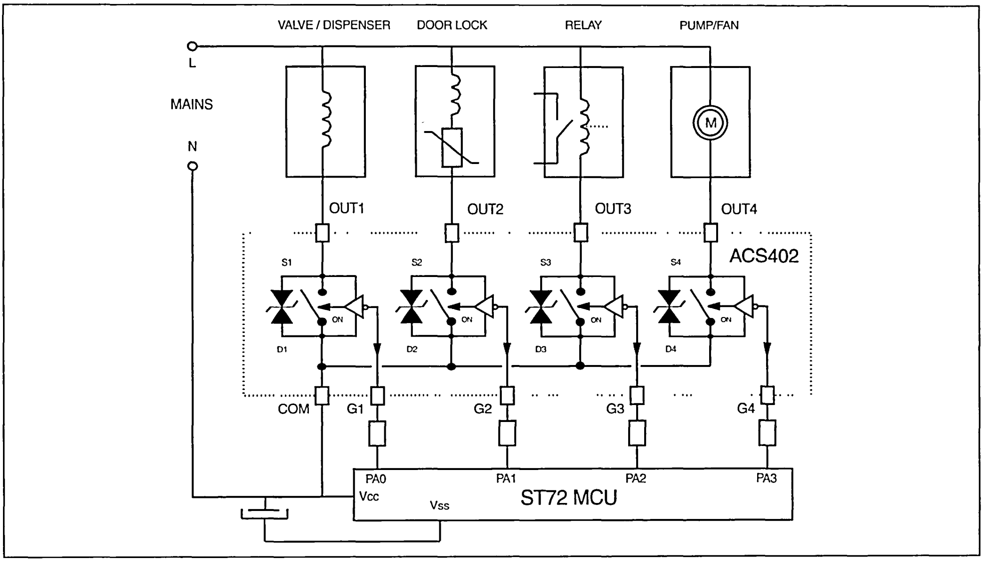
Thanks to its thermal and turn-off commutation performance, each switch of the ACS402 is able to drive an inductive or resistive load up to 0.2 A with no additional turn-off snubber.

Table 1: Load grouping versus their turn off commutation requirement (230V AC applications).

LOAD	POWER (VA)	POWER FACTOR	RMS LOAD CURRENT (A)	$(dI_{OUT}/dt)c$ (A/ms)	$(dV_{OUT}/dt)c$ (V/µs)
Door lock Bulb Lamp	< 40	1	< 0.2	< 0.1	< 0.15
Relay Valve Dispenser Micro-motor Solenoid	< 20	> 0.7	< 0.1	< 0.05	< 2
Pump Fan	< 40	> 0.2	< 0.2	< 0.1	< 10

(*): Measured with an ACS402 switch

TYPICAL APPLICATION DIAGRAM



HIGH INDUCTIVE SWITCH-OFF OPERATION

At the end of the last conduction half-cycle, the load current reaches the holding current level I_H , and the ACS™ switch turns off. Because of the inductance L of the load, the current flows through the avalanche diode D and decreases linearly to zero. During this time, the voltage across the switch is limited to the clamping voltage V_{CL}.

The energy stored in the inductance of the load depends on the holding current I_H and the inductance (up to 10 H); it can reach about 20 mJ and is dissipated in the clamping section that is especially designed for that purpose.

Fig 1: Turn-off operation of the ACS402 switch with an electro valve: waveform of the gate current I_G, pin OUT current I_{OUT} & voltage V_{OUT}.

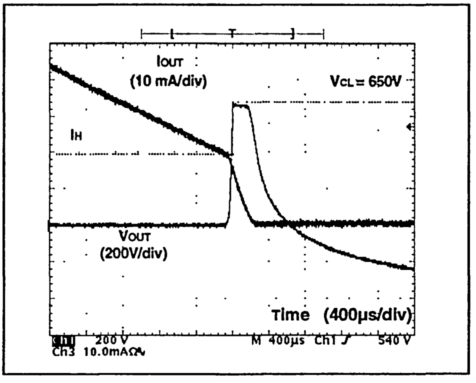
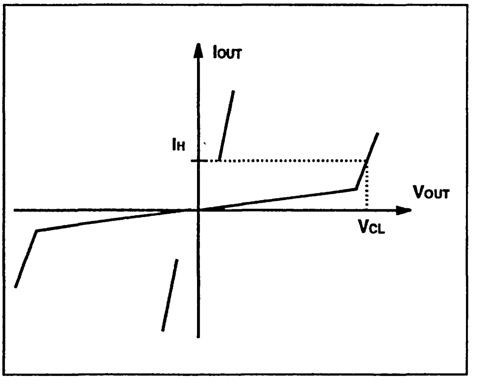


Fig 2: ACS402 switch static characteristic.



AC LINE TRANSIENT VOLTAGE RUGGEDNESS

Each ACS402 switch is able to safely withstand the AC line transient voltages either by clamping the low energy spikes or by breaking over under high energy shocks.

The test circuit in Figure 3 is representative of the final ACS™ application and is also used to stress the ACS™ switch according to the IEC61000-4-5 standard conditions. Thanks to the load, the ACS™ switch withstands the voltage spikes up to 2 kV above the peak line voltage. It will break over safely even on resistive load where the turn-on current rise is high as shown in Figure 4. Such non repetitive test can be done 10 times on each AC line voltage polarity.

Fig 3: Overvoltage ruggedness test circuit for resistive and inductive loads according to IEC61000-4-5 standard.
R = 150Ω, L = 5µH, VPP = 2kV.

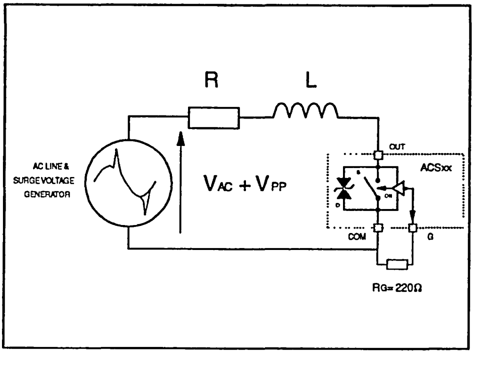


Fig 4: Current and voltage of the ACS™ during IEC61000-4-5 standard test with a 150Ω - 10µH load & VPP = 2kV.

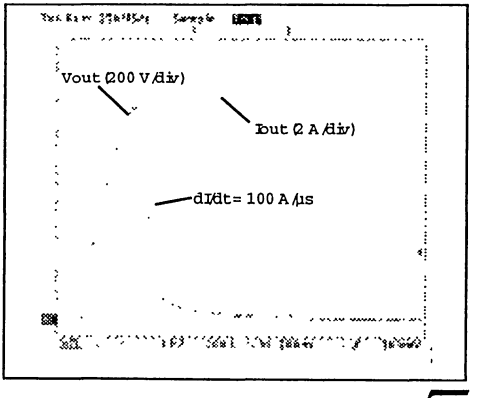


Fig. 5: Maximum power dissipation versus RMS on-state current (per switch).

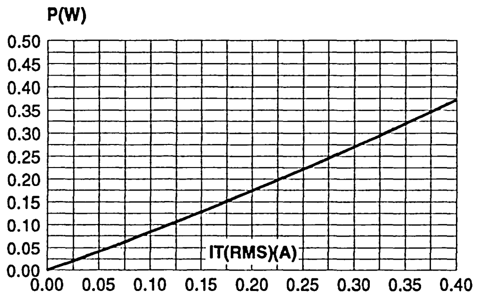


Fig. 6: RMS on-state current versus ambient temperature.

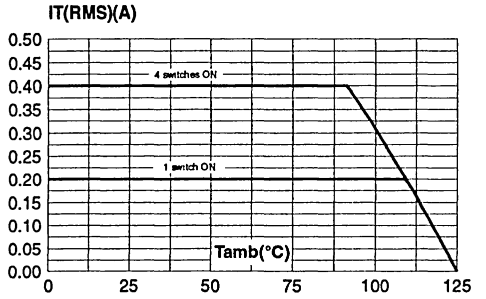


Fig. 7: Relative variation of thermal impedance junction to ambient versus pulse duration (device mounted on printed circuit board FR4, e(Cu) = 35µm)

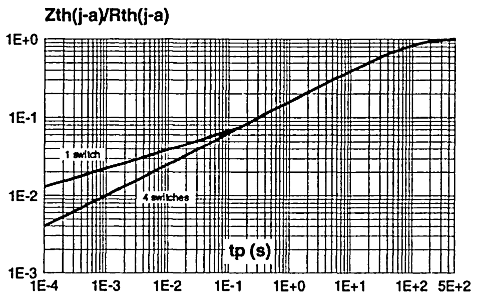


Fig. 8: Relative variation of gate trigger current versus junction temperature.

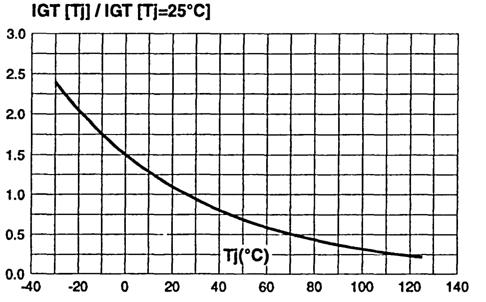


Fig. 9: Relative variation of holding and latching current versus junction temperature.

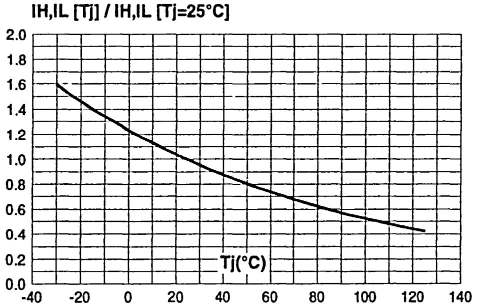


Fig. 10: Surge peak on-state current versus number of cycles.

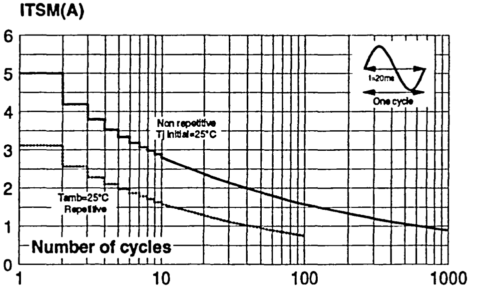


Fig. 11: Non-repetitive surge peak on-state current for a sinusoidal pulse with width tp < 10ms, and corresponding value of I^2t.

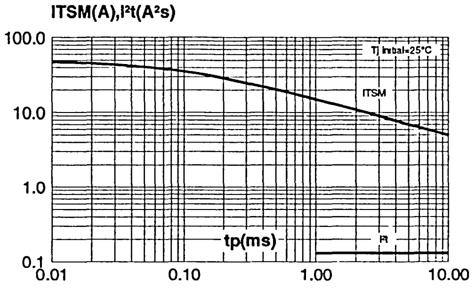


Fig. 12: On-state characteristics (maximum values).

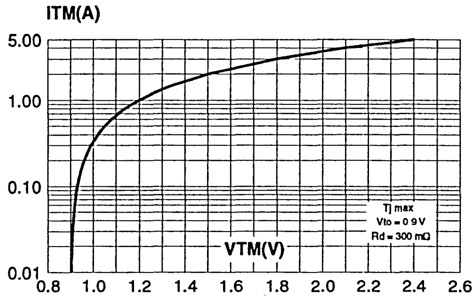
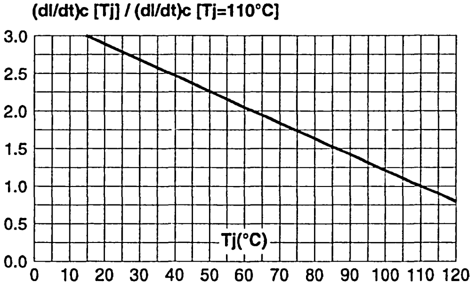
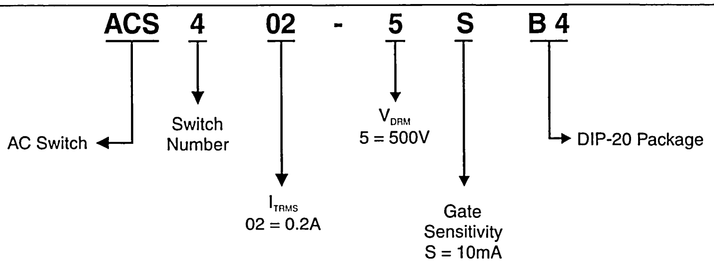


Fig. 13: Relative variation of critical (dI/dt)c versus junction temperature.



ORDERING INFORMATION



OTHER INFORMATION

Ordering type	Marking	Package	Weight	Base qty	Delivery mode
ACS402-5SB4	ACS4025	DIP-20	1.4 g.	19	Tube

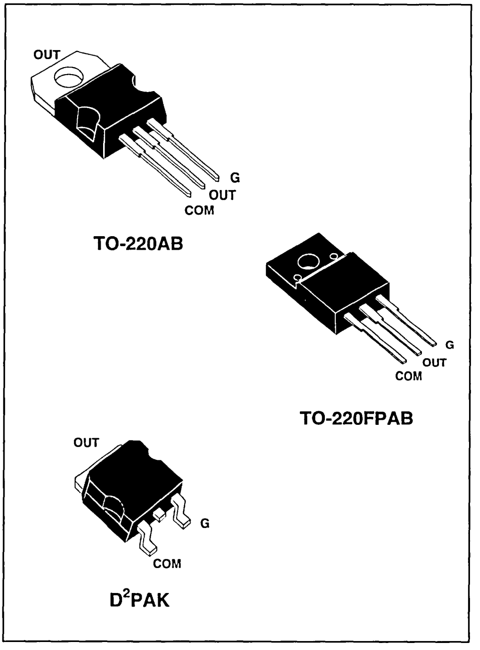
- Epoxy meets UL94,V0

ASD and ACS are a trademarks of STMicroelectronics .

ACST6-7S

ASD™
AC Switch Family

OVER VOLTAGE PROTECTED AC POWER SWITCH



MAIN APPLICATIONS

- AC static switching in appliance & industrial control systems
- Induction motor drive actuator for:
  - Refrigerator / Freezer compressor
  - Dishwasher spray pump
  - Clothes drier tumble
- Actuator for the thermostat of a refrigerator or freezer

FEATURES

- V_{DRM} / V_{RRM} = +/- 700V
- Avalanche controlled device
- $I_{T(RMS)}$=1.5 A with no heat sink and T_{amb} = 40°C
- $I_{T(RMS)}$ = 6A with T_{CASE} = 105 °C
- High noise immunity: static dV/dt > 200 V/µs
- Gate triggering current : I_{GT} < 10 mA
- Snubberless turn off commutation: (dI/dt)c > 3.5A/ms
- D²PAK, TO-220FPAB or TO-220 package

BENEFITS

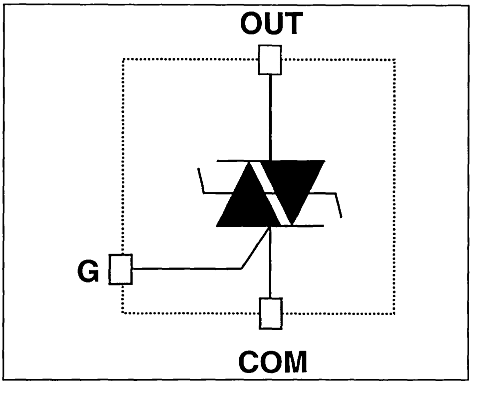
- Enables equipment to meet EN61000-4-5 standards
- High off-state reliability with planar technology
- Needs no external overvoltage protection
- Direct interface with the microcontroller
- Reduces the power component count

DESCRIPTION

The ACST6-7Sx belongs to the AC power switch family built around the ASD technology. This high performance device is adapted to home appliances or industrial systems and drives an induction motor up to 6A.

This ACST switch embeds a triac structure with a high voltage clamping device to absorb the inductive turn-off energy and sustain line transients such as those described in the IEC61000-4-5 standards.

FUNCTIONAL DIAGRAM:



ABSOLUTE RATINGS (limiting values)

Symbol	Parameter		Value	Unit
V_{DRM} / V_{RRM}	Repetitive peak off-state voltage	Tj = 125 °C	700	V
$I_{T(RMS)}$	RMS on-state current full cycle sine wave 50 to 60 Hz, no heat sink	Tamb = 40 °C	1.5	A
	RMS on-state current full cycle sine wave 50 to 60 Hz, TO-220AB package	Tcase= 105 °C	6	A
I_{TSM}	Non repetitive surge peak on-state current Tj initial = 25°C, full cycle sine wave	tp = 20ms	45	A
		tp = 16.7ms	50	A
I^2t	Thermal constraint for fuse selection	tp = 10ms	14	A^2s
dI/dt	Non repetitive on-state current critical rate of rise I_G = 10mA (t_R < 100ns)	Rate period > 1mn	100	A/µs
V_{PP}	Non repetitive line peak pulse voltage	note 1	2	kV
Tstg	Storage temperature range		- 40 to + 150	°C
Tj	Operating junction temperature range		- 30 to + 125	°C
Tl	Maximum lead soldering temperature during 10s		260	°C

Note 1: according to test described by IEC61000-4-5 standard & Figure A.

GATE CHARACTERISTICS (maximum values)

Symbol	Parameter	Value	Unit
$P_{G\ (AV)}$	Average gate power dissipation	0.1	W
P_{GM}	Peak gate power dissipation (tp = 20µs)	10	W
I_{GM}	Peak gate current (tp = 20µs)	1	A

THERMAL RESISTANCE

Symbol	Parameter	Value	Unit
Rth (j-a)	Junction to ambient TO-220AB / TO-220FPAB	60	°C/W
Rth (j-a)	Junction to ambient D^2PAK soldered on 1cm^2 copper pad	45	°C/W
Rth (j-c)	Junction to case for full cycle sine wave conduction (TO-220AB)	2.5	°C/W
Rth (j-c)	Junction to case for full cycle sine wave conduction (TO-220FPAB)	3.5	°C/W

PARAMETER DESCRIPTION

Parameter Symbol	Parameter description
I_{GT}	Gate triggering current
V_{GT}	Gate triggering voltage
V_{GD}	Non triggering voltage
I_H	Holding current
I_L	Latching current
V_{TM}	On state voltage
V_{TO}	On state characteristic threshold voltage
R_D	On state characteristic dynamic resistance
I_{DRM} / I_{RRM}	Forward or reverse leakage current
dV/dt	Static pin OUT voltage rise
(dI/dt)c	Turn off current rate of decay
V_{CL}	Avalanche voltage at turn off

ELECTRICAL CHARACTERISTICS PER SWITCH

For either positive or negative polary of pin OUT voltage in respect to pin COM voltage

Symbol	Test conditions			Values	Unit
I_{GT}	Vout = 12V (DC) $R_L = 33\Omega$	Tj = 25°C	MAX.	10	mA
V_{GT}	Vout = 12V (DC) $R_L = 33\Omega$	Tj = 25°C	MAX.	1.5	V
V_{GD}	$V_{OUT} = V_{DRM}$ $R_L = 3.3k\Omega$	Tj =125°C	MIN.	0.2	V
I_H	I_{OUT} = 100mA Gate open	Tj = 25°C	MAX.	25	mA
I_L	I_G = 20mA	Tj = 25°C	MAX.	50	mA
V_{TM}	I_{OUT} = 2.1A tp = 380µs	Tj = 25°C	MAX.	1.4	V
V_{TM}	I_{OUT} = 8.5A tp = 380µs	Tj = 25°C	MAX.	1.7	V
V_{to}		Tj = 125°C	MAX.	0.9	V
R_D		Tj = 125°C	MAX.	80	mΩ
I_{DRM} I_{RRM}	$V_{OUT} = V_{DRM}$ $V_{OUT} = V_{RRM}$	Tj = 25°C	MAX.	20	µA
		Tj = 125°C	MAX.	500	µA
dV/dt	V_{OUT} = 600V gate open	Tj = 125°C	MIN.	200	V/µs
(dI/dt)c	(dV/dt)c = 15V/µs	Tj = 125°C	MIN.	3	A/ms
(dI/dt)c	(dV/dt)c = 15V/µs Iout < 0 Rgk = 150Ω	Tj = 125°C	MIN.	3.5	A/ms
V_{CL}	I_{CL} = 1mA tp = 1ms	Tj = 25°C	TYP.	1100	V

AC LINE SWITCH BASIC APPLICATION

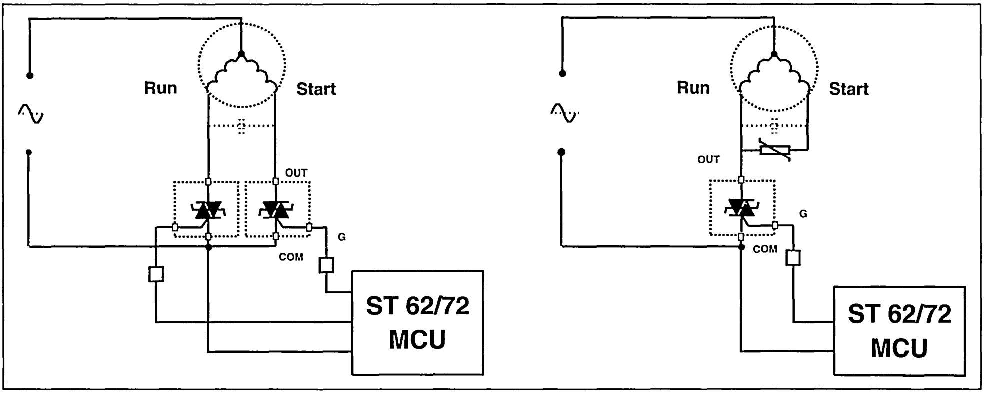
The ACST6-7S device is especially designed to drive medium power induction motors in refrigerators, dish washers, and tumble dryers.

Pin COM : Common drive reference, to be connected to the power line neutral
Pin G : Switch Gate input to be connected to the controller
Pin OUT : Switch Output to be connected to the load

When driven from a low voltage controller, the ACST switch is triggered with a negative gate current flowing out of the gate pin G. It can be directly driven by the controller through a resistor as shown on the typical application diagram. In appliance systems, the ACST6-7S switch intends to drive medium power load in ON / OFF full cycle or phase angle control mode.

Thanks to its thermal and turn-off commutation characteristics, the ACST6-7S switch is able to drive an inductive load up to 6A without a turn-off aid snubber circuit.

TYPICAL APPLICATION DIAGRAM



AC LINE TRANSIENT VOLTAGE RUGGEDNESS

The ACST6-7S switch is able to safely withstand the AC line transient voltages either by clamping the low energy spikes or by breaking over under high energy shocks.

The test circuit in Figure A is representative of the ACST application and is used to test the ACST switch according to the IEC61000-4-5 standard conditions. Thanks to the load impedance, the ACST switch withstands voltage spikes up to 2 kV above the peak line voltage by breaking over safely. Such non-repetitive testing can be done 10 times on each AC line voltage polarity.

Fig. A: Overvoltage ruggedness test circuit for resistive and inductive loads according to IEC61000-4-5 standard R = 10Ω, L = 5µH & V_{PP} = 2kV

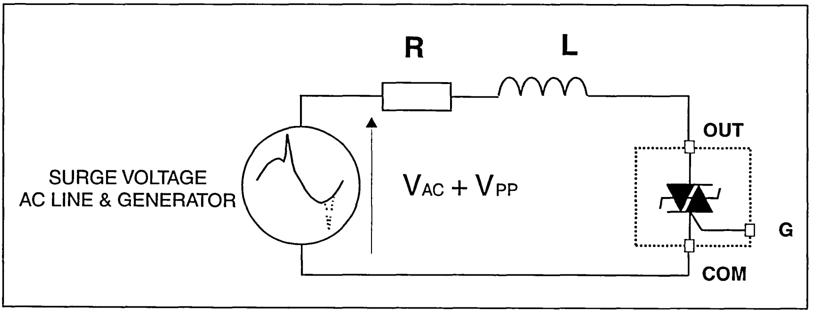


Fig. 1: Maximum power dissipation versus RMS on-state current.

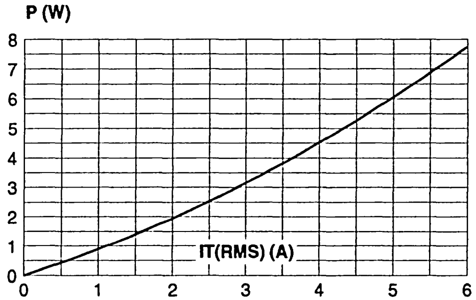


Fig. 2-1: RMS on-state current versus case temperature.

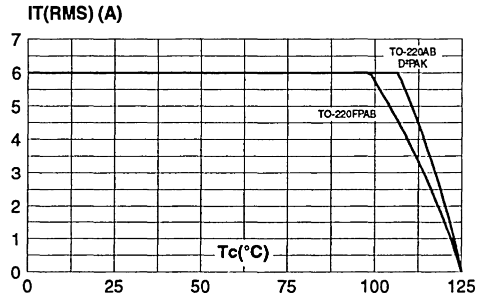


Fig. 2-2: RMS on-state current versus ambient temperature.

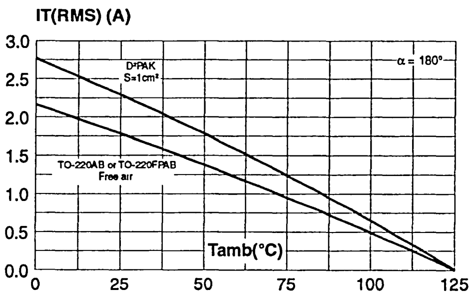


Fig. 3: Relative variation of thermal impedance versus pulse duration.

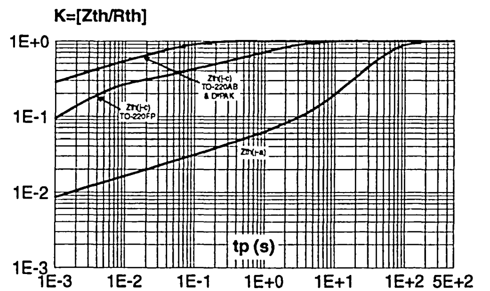


Fig. 4: On-state characteristics (maximum values).

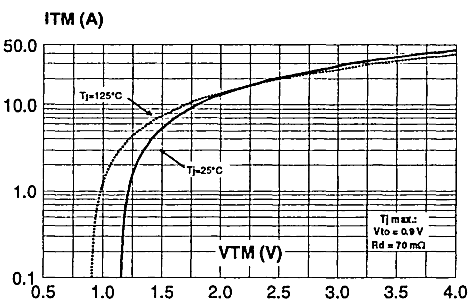


Fig. 5: Surge peak on-state current versus number of cycles.

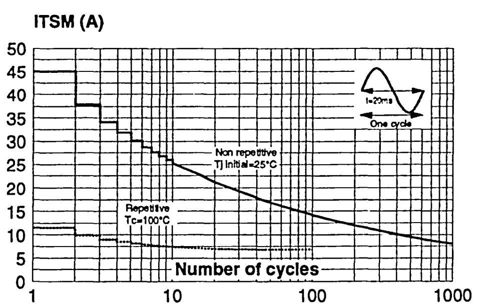


Fig. 6: Non repetitive surge pea on-state current for a sinusoidal pulse with width tp<10ms, and corresponding value of I^2t.

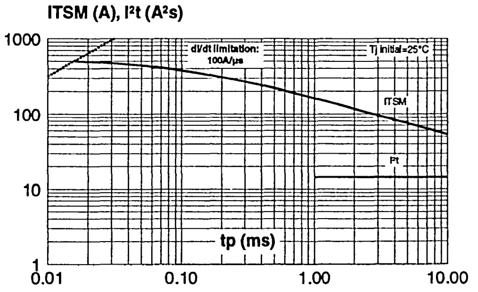


Fig. 7: Relative variation of gate trigger current, holding current and latching current versus junction temperature (typical values).

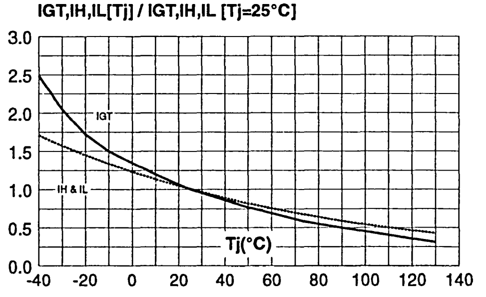


Fig. 8: Relative variation of critical rate of decrease of main current versus reapplied dV/dt (typical values).

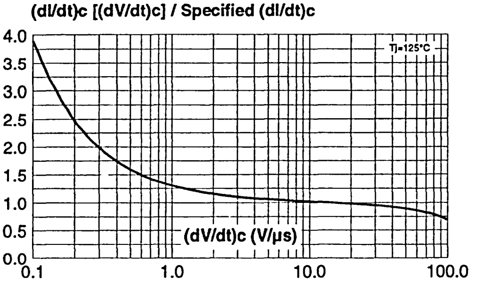


Fig. 9: Relative variation of critical rate of decrease of main current versus junction teperature.

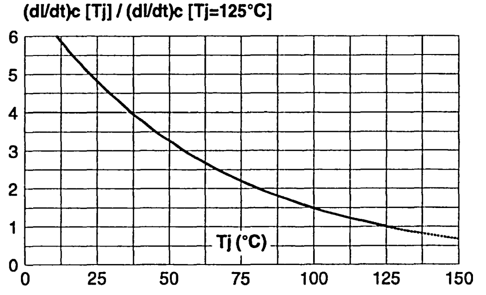


Fig. 10: Relative variation of dV/dt immunity versus junction temperature for different values of gate to com resistance.

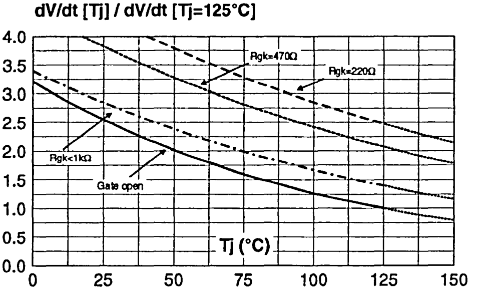
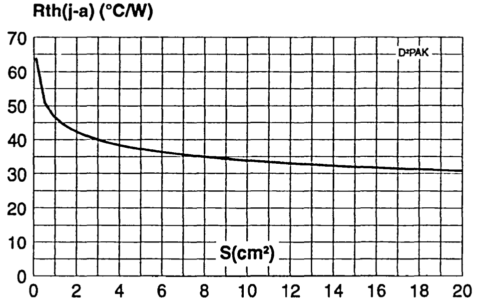
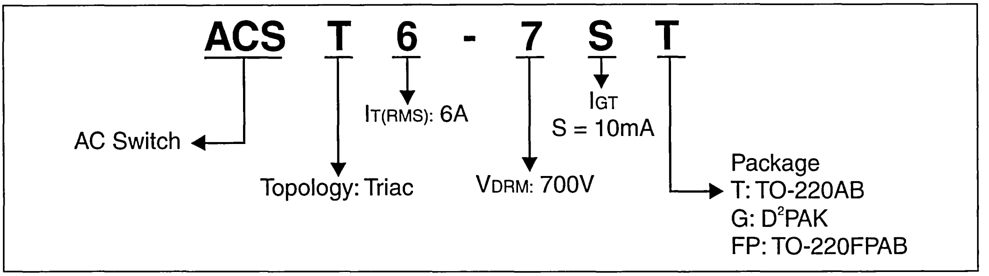


Fig. 11: Thermal resistance junction to ambient versus copper surface under tab (Epoxy printed circuit board FR4, copper thickness: 35µm).



ORDERING INFORMATION



OTHER INFORMATION

Ordering type	Marking	Package	Weight	Base qty	Delivery mode
ACST6-7ST	ACST67S	TO-220AB	2.3 g	50	Tube
ACST6-7SG	ACST67S	D^2PAK	1.5 g	50	Tube
ACST6-7SFP	ACST67S	TO-220FPAB	2.4 g	50	Tube

- Epoxy meets UL94,V0

ACST8-8C

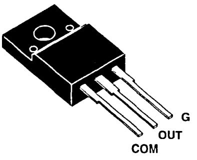
ASD™
AC Switch Family

OVER VOLTAGE PROTECTED AC POWER SWITCH

PRELIMINARY DATASHEET

MAIN APPLICATIONS

- AC static switching in appliance & industrial control systems
- Washing machine with bi-rotational induction motor drive
- Induction motor drive for:
  - refrigerator / freezer compressor
  - air conditioning compressor

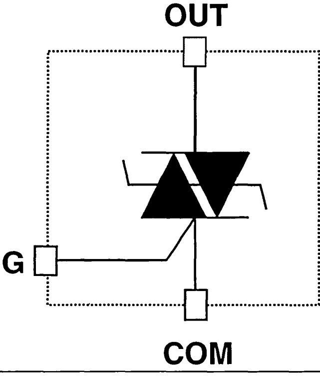


TO-220FPAB

FEATURES

- V_{DRM} / V_{RRM} = +/- 800V
- Avalanche controlled device
- $I_{T(RMS)}$ = 8A with T_{CASE} = 90 °C
- High noise immunity: static dV/dt > 500 V/µs
- Gate triggering current : I_{GT} < 30 mA
- Snubberless turn off commutation: (dI/dt)c > 4.5A/ms
- TO-220FPAB package

FUNCTIONAL DIAGRAM:



BENEFITS

- Enables equipment to meet EN61000-4-5 standard
- High off-state reliability with planar technology
- Need no external overvoltage protection
- Reduces the power component count

DESCRIPTION

The ACST8-8C belongs to the AC power switch family built around the ASD technology. This high performance device is adapted to home appliances or industrial systems and drives an induction motor up to 8A.

This ACST switch embeds a triac structure with a high voltage clamping device to absorb the inductive turn off energy and sustain line transients such as those described in the IEC61000-4-5 standards.

ABSOLUTE RATINGS (limiting values)

Symbol	Parameter		Value	Unit
V_{DRM} / V_{RRM}	Repetitive peak off-state voltage	Tj = 125 °C	800	V
$I_{T(RMS)}$	RMS on-state current full cycle sine wave 50 to 60 Hz	Tcase = 90°C	8	A
I_{TSM}	Non repetitive surge peak on-state current Tj initial = 25°C, full cycle sine wave	tp = 20ms	80	A
		tp = 16.7ms	85	A
I^2t	Thermal constraint for fuse selection	tp = 10ms	40	A^2s
dI/dt	Non repetitive on-state current critical rate of rise I_G = 10mA (tr < 100ns)	Rate period > 1mn	100	A/µs
V_{PP}	Non repetitive line peak pulse voltage	note 1	2	kV
Tstg	Storage temperature range		- 40 to + 150	°C
Tj	Operating junction temperature range		- 40 to + 125	°C
Tl	Maximum lead soldering temperature during 10s		260	°C

Note 1: according to test described by IEC61000-4-5 standard & Figure A.

GATE CHARACTERISTICS (maximum values)

Symbol	Parameter	Value	Unit
$P_{G(AV)}$	Average gate power dissipation	0.1	W
P_{GM}	Peak gate power dissipation (tp = 20µs)	10	W
I_{GM}	Peak gate current (tp = 20µs)	1	A

THERMAL RESISTANCE

Symbol	Parameter	Value	Unit
Rth (j-a)	Junction to ambient	60	°C/W
Rth (j-c)	Junction to case for full cycle sine wave conduction	3.5	°C/W

PARAMETER DESCRIPTION

Parameter Symbol	Parameter description
I_{GT}	Gate triggering current
V_{GT}	Gate triggering voltage
V_{GD}	Non triggering voltage
I_H	Holding current
I_L	Latching current
V_{TM}	On state voltage
V_{TO}	On state characteristic threshold voltage
R_D	On state characteristic dynamic resistance
I_{DRM} / I_{RRM}	Forward or reverse leakage current
dV/dt	Static pin OUT voltage rise
(dI/dt)c	Turn off current rate of decay
V_{CL}	Avalanche voltage at turn off

ELECTRICAL CHARACTERISTICS PER SWITCH

For either positive or negative polary of pin OUT voltage respect to pin COM voltage

Symbol	Test conditions			Values	Unit
I_{GT}	Vout = 12V (DC) $R_L = 33\Omega$	Tj = 25°C	MAX.	30	mA
V_{GT}	Vout = 12V (DC) $R_L = 33\Omega$	Tj = 25°C	MAX.	1.5	V
V_{GD}	$V_{OUT} = V_{DRM}$ $R_L = 3.3k\Omega$	Tj =125°C	MIN.	0.2	V
I_H	I_{OUT} = 100mA Gate open	Tj = 25°C	MAX.	40	mA
I_L	I_G = 20mA	Tj = 25°C	MAX.	70	mA
V_{TM}	I_{OUT} = 11A tp = 380µs	Tj = 25°C	MAX.	1.5	V
V_{to}		Tj = 125°C	MAX.	0.95	V
R_D		Tj = 125°C	MAX.	60	mΩ
I_{DRM} I_{RRM}	$V_{OUT} = V_{DRM}$ $V_{OUT} = V_{RRM}$	Tj = 25°C	MAX.	20	µA
		Tj = 125°C	MAX.	1	mA
dV/dt	V_{OUT} = 550V gate open	Tj = 125°C	MIN.	500	V/µs
(dI/dt)c	Without snubber	Tj = 125°C	MIN.	4.5	A/ms
V_{CL}	I_{CL} = 1mA tp = 1ms	Tj = 25°C	TYP.	1100	V

AC LINE SWITCH BASIC APPLICATION

The ACST8-8C device is especially designed to drive medium power induction motors in washing machines, refrigerators, dish washers, and tumble dryers.

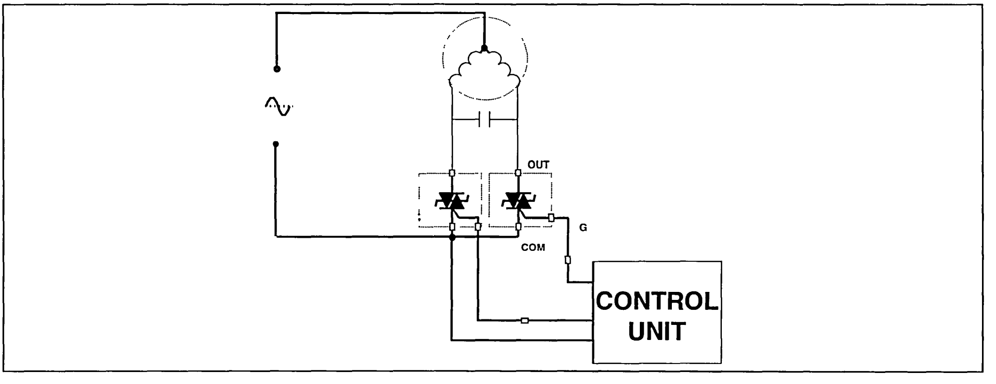
Pin COM : Common drive reference, to be connected to the power line neutral
Pin G : Switch Gate input to be connected to the controller
Pin OUT : Switch Output to be connected to the load

When driven from a low voltage controller, the ACST switch is triggered with a negative gate current flowing out of the gate pin G. It can be driven by the controller through a resistor as shown on the typical application diagram. In appliance systems, the ACST8-8C switch intends to drive medium power load in ON / OFF full cycle or phase angle control mode.

Thanks to its thermal and turn-off commutation characteristics, the ACST8-8C switch is able to drive an inductive load up to 8A without a turn-off aid snubber circuit.

In washing machine or drier appliances, the tumble rotates in both directions. When using bidirectional phase shift induction motor, two switches are connected on each side of the phase shift capacitor: in steady-state operation, one switch only conducts energising the coils and defining the tumble direction.

TYPICAL APPLICATION DIAGRAM



ROBUSTNESS AGAINST FAST CAPACITOR DISCHARGE

When parasitic transients or controller mis-operation occur, the blocked switch may turn on by spurious switch firing. Since the phase shift capacitor is charged, its energy is instantaneously dissipated through the two ACSTs which can be destroyed. To prevent such a failure, a resistive inductive circuit R-L is added in series with the phase shift capacitor.

The dI/dt depends on the maximal voltage V_{max} of the phase shift capacitor (700V on 240V mains applications), and on the inductance L:

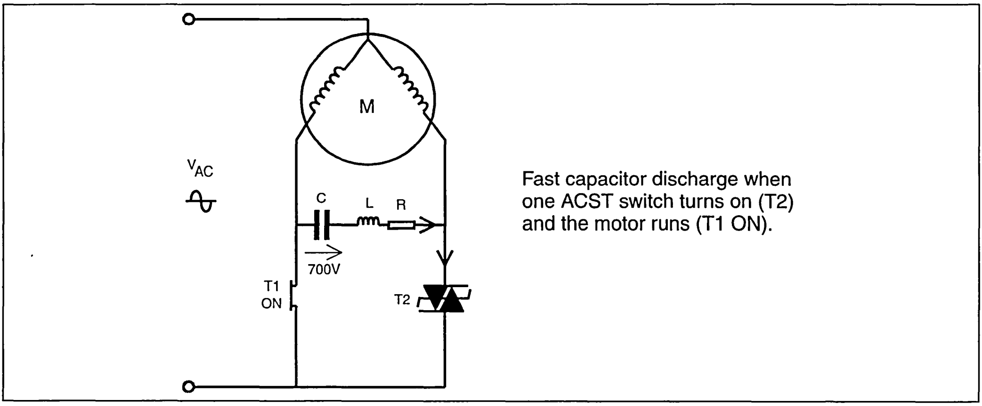
$$\frac{dI}{dt} = \frac{V\max}{L}$$

The total switch turn on di/dt is the sum of the di/dt created by any RC noise suppressor discharge and the dI/dt created by the motor capacitor discharge.

Since the maximal di/dt capability at turn-on of the ACST8 is 100A/µs, the motor capacitor di/dt is assumed to be less than 50A/µs; therefore, the inductance should be 14µH.

The resistor R limits the surge current through the ACST8 during the capacitor discharge according to the specified curve I_{TSM} = f (tp) as shown in Figure 6 *(to be issued)*, and 1.2 Ω is low enough to limit the resistor dissipation (usually less than 1 W).

Finally both the 14µH inductance and the 1.2Ω resistance provide a safety margin of two on the surge current I_{TSM} described in Figure 6.

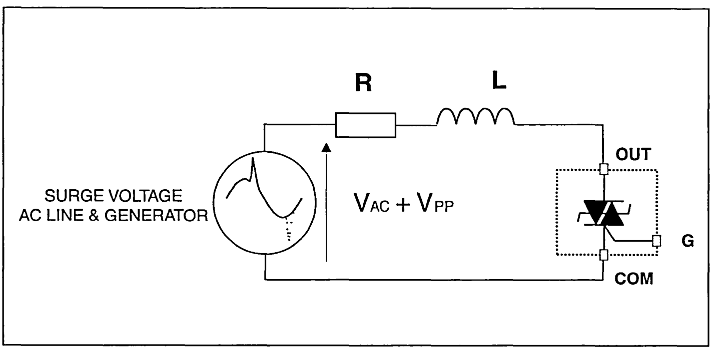


AC LINE TRANSIENT VOLTAGE RUGGEDNESS

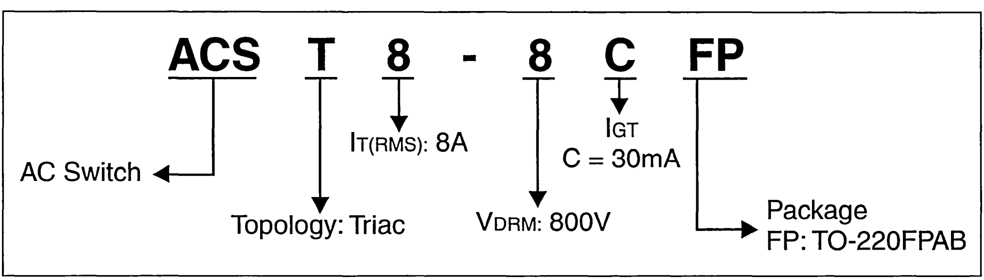
The ACST8-8C switch is able to safely withstand the AC line transient voltages either by clamping the low energy spikes or by breaking over under high energy shocks.

The test circuit in Figure A is representative of the ACST application and is used to test the ACST switch according to the IEC61000-4-5 standard conditions. Thanks to the load impedance, the ACST switch withstands voltage spikes up to 2 kV above the peak line voltage by breaking over safely. Such non repetitive testing can be done 10 times on each AC line voltage polarity.

Fig. A: Overvoltage ruggedness test circuit for resistive and inductive loads according to IEC61000-4-5 standard R = 47Ω, L = 100mH & V_{PP} = 2kV



ORDERING INFORMATION



OTHER INFORMATION

Ordering type	Marking	Package	Weight	Base qty	Delivery mode
ACST8-8CFP	ACST88C	TO-220FPAB	2.4 g	50	Tube

- Epoxy meets UL94,V0

IGNITORS DATASHEETS

FLC21 Series

Application Specific Discretes
A.S.D.™

LOW POWER
FIRE LIGHTER CIRCUIT

FEATURES

- DEDICATED THYRISTOR STRUCTURE FOR CAPACITIVE DISCHARGE IGNITION OPERATION
- HIGH PULSE CURRENT CAPABILITY $I_{FRM} = 90A$ @ $tp = 10\mu S$
- AC OR DC OPERATION CAPABILITY WITH SUPPLY FROM THE AC MAINS OR A DC BATTERY
- FAST TURN-ON OPERATION
- DESIGNED FOR HIGH AMBIENT TEMPERATURE (up to 120°C)

BENEFITS

- SPACE SAVING THANKS TO MONOLITHIC FUNCTION INTEGRATION
- HIGH RELIABILITY WITH PLANAR TECHNOLOGY

DESCRIPTION

The FLC21 series has been especially developed for capacitance discharge operation. The main applications are: fuel ignitors, fuel or gas heaters, gas ranges, cooker tops, barbecues, water heaters, HVACs, portable ignitors, insect killers.

Based on ST's ASD™ technology, it provides a fully integrated function, with high performance and reliability levels, adapted to severe and hot temperature environment.

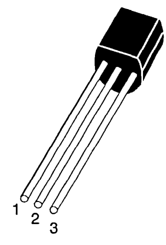
The typical supply of the FLC21 fire lighter circuit is a DC battery or the AC mains.

Th: Thyristor for the switching operation.

Z: Zener diode to set the igniting threshold voltage.

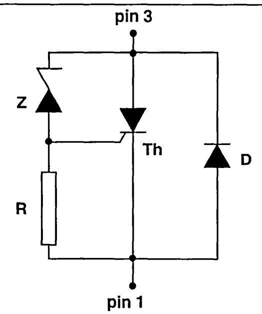
D: Diode for the reverse conduction.

R: 2 kΩ resistor.



TO-92
(Plastic)

FUNCTIONAL DIAGRAM



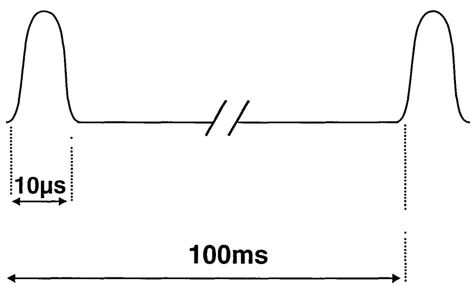
pin 2 not connected

DEVICE TYPE	APPLICATION	MODE
FLC21-135A	BATTERY OPERATION	Ignition
FLC21-65A	100V Mains	Ignition

ABSOLUTE RATINGS (limiting values)

Symbol	Parameter		Value	Unit
I_{TRM}	Repetitive surge peak on state current for thyristor -30°C ≤ Tamb ≤ 120°C	tp = 10μs (note 1)	90	A
I_{FRM}	Repetitive surge peak on state current for diode -30°C ≤ Tamb ≤ 120°C			
dI/dt	Critical rate of rise on state current -30°C ≤ Tamb ≤ 120°C		50	A/μs
Tstg Tj	Storage junction temperature range Maximum junction temperature		- 40 to + 150 125	°C
Tamb	Operating temperature range		- 30 to + 120	°C
T_L	Maximum lead temperature for soldering during 10s		260	°C

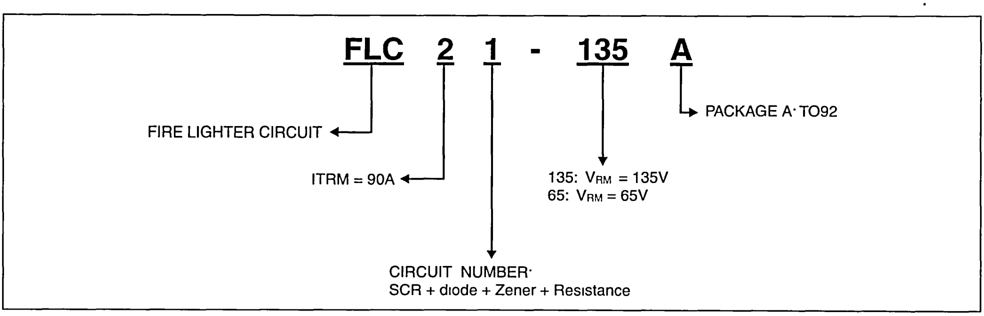
Note 1 : Test current waveform



THERMAL RESISTANCE

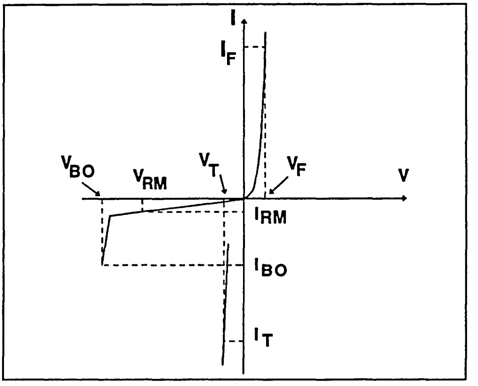
Symbol	Parameter	Value	Unit
Rth(j-a)	Junction to ambient	150	°C/W

ORDERING INFORMATION



ELECTRICAL CHARACTERISTICS

Symbol	Parameters
V_{RM}	Stand-off voltage
V_{BO}	Breakover voltage
V_T	On-state voltage
V_F	Diode forward voltage drop
I_{BO}	Breakover current
I_{RM}	Leakage current
αT	Temperature coefficient for V_{BO}



DIODE (D) PARAMETER

Symbol	Test Conditions			Value	Unit
V_F	$I_F = 1A$ tp ≤ 500µs	Tj = 25°C	Max.	1.7	V

THYRISTOR (Th) and ZENER (Z) PARAMETERS

Symbol	Test conditions		Value						Unit
			FLC21-65A			FLC21-135A			
			Min.	Typ.	Max.	Min.	Typ.	Max.	
I_{RM}	V_{RM} = 65V for FLC21-65A	Tj = 25°C			1			1	µA
	V_{RM} = 135V for FLC21-135A	Tj = 125°C			10			10	µA
V_{BO}	at I_{BO}	Tj = 25°C	70		80	140		160	V
I_{BO}	at V_{BO}	Tj = 25°C			500			500	µA
V_T	I_T = 2A tp ≤ 500µs	Tj = 25°C			1.7			1.7	V
αT				0.07			0.16		V/°C

Fig. 1: Relative variation of breakover current versus junction temperature.

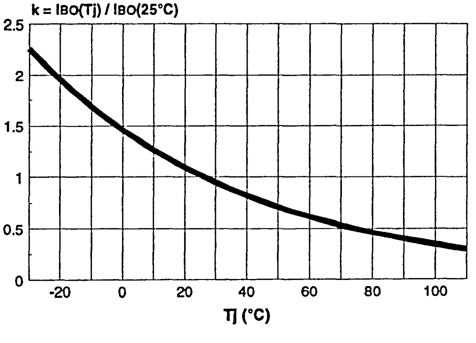


Fig. 2: BASIC AC MAINS APPLICATION.

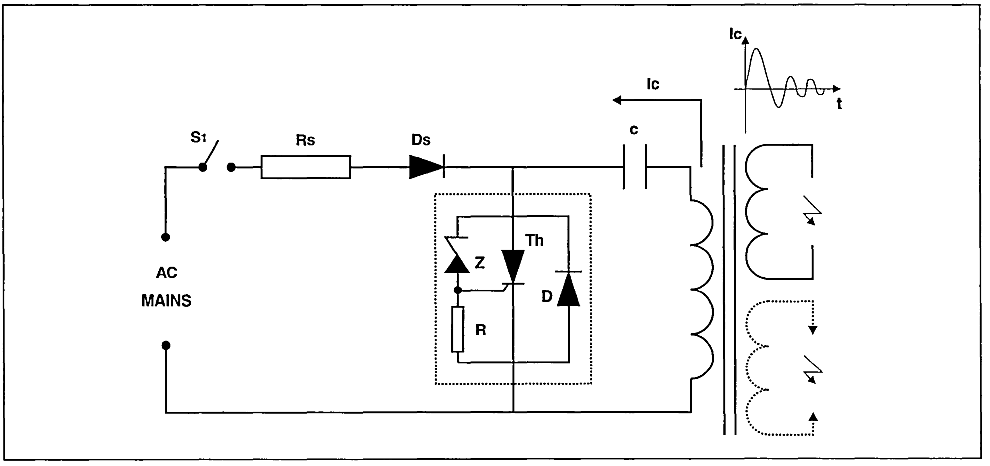
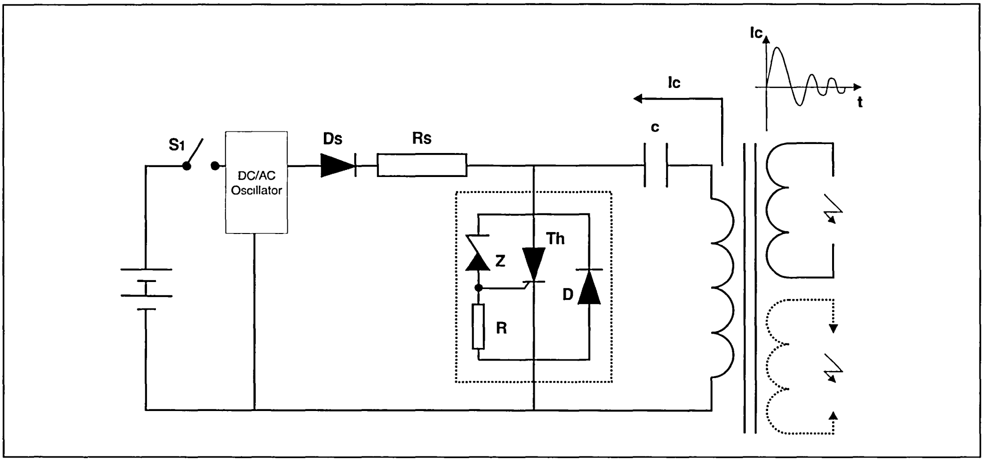


Fig. 3: BASIC DC APPLICATION.



1/ IGNITION MODE

PHASE 1

The AC voltage is rectified by the diode Ds. The ignition energy is supplied by the mains and stored into the capacitor C.

PHASE 2

At the end of the phase 1, the voltage across the capacitor C reaches the avalanche threshold of the Zener diode Z. Then, a current flows through this Zener diode into the gate of the thyristor Th which is triggered.

The thyristor turn-on generates an alternating current through the capacitor C. Its positive parts flow through the capacitor C, the primary of the HV transformer and the thyristor Th. Its negative parts of the current flow through C, D and the primary of the H.V transformer.

RS RESISTANCE CALCULATION

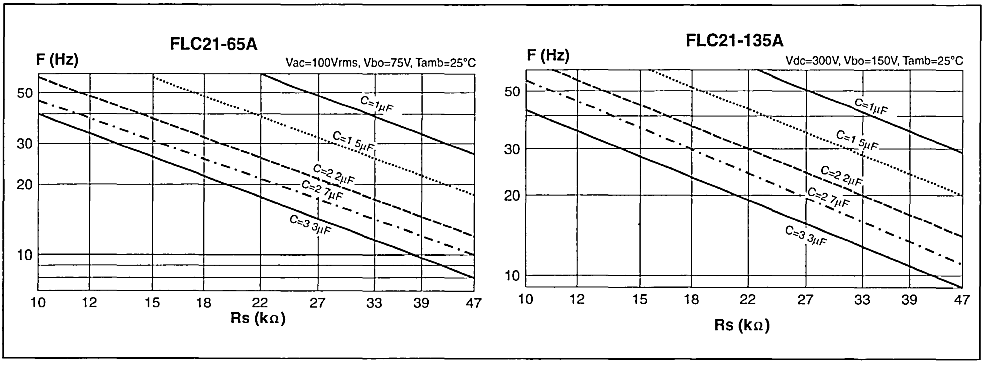
The Rs resistance allows, in addition with the capacitance C, the spark frequency to be adjusted and the current supplied by the mains to be limited. This resistance allows the thyristor triggering in any requested cases. In the worst case scenario, the system must fire when the a.c. line voltage is minimum while the breakdown voltage V_{BO} and the current I_{BO} of the FLC are maximum.

The maximum Rs value is equal to:

$$Rs\max = \frac{(V_{AC}\ \min.\sqrt{2}\ ) - [V_{BO}\ \max.(1 + \alpha\ T.(\ T_{amb} - 25\ ))]}{k\ .\ I_{BO}\ ^{*}}$$

* : see fig 1

Fig. 4: Spark frequency versus Rs and C.



The couple Rs/C can be chosen with the previous curve. Keep in mind the Rs maximum limit for which the system would not work when the AC mains is minimum.

OTHER INFORMATION

Type	Marking	Package	Weight	Base qty	Delivery mode
FLC21- 65A	FLC21-65A	TO-92	0.20 g	2500	Bulk
FLC21-135A	FLC21-135A	TO-92	0.20 g	2500	Bulk

- Epoxy meets UL94, VO at 1/8"

FLC01-200H

Application Specific Discretes
A.S.D.™

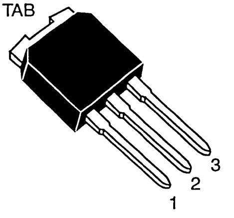
FIRE LIGHTER CIRCUIT

FEATURES

- DEDICATED THYRISTOR STRUCTURE FOR CAPACITANCE DISCHARGE IGNITION OPERATION
- HIGH PULSE CURRENT CAPABILITY 190A @ tp = 10µs
- FAST TURN-ON OPERATION
- DESIGNED FOR HIGH AMBIENT TEMPERATURE (up to 120°C)

BENEFITS

- SPACE SAVING THANKS TO MONOLITHIC FUNCTION INTEGRATION
- HIGH RELIABILITY WITH PLANAR TECHNOLOGY



IPAK

DESCRIPTION

The FLC01 series has been especially developed for capacitance discharge operation. The main applications are gas lighters or ignitors such as cookers / gas boilers / gas hobs...

Based on ST's ASD™ technology, it provides a fully integrated function, with high performance and reliability levels, adapted to severe and hot temperature environment.

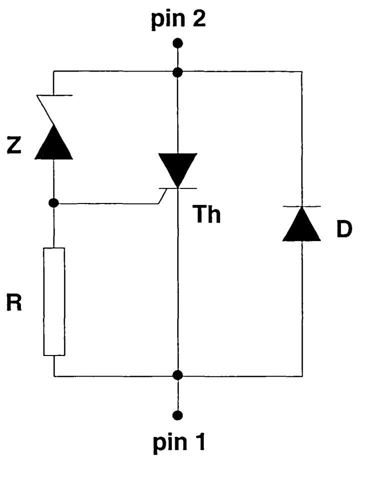
Th: Thyristor for switching operation.

Z: Zener diode to set the threshold voltage.

D: Diode for reverse conduction.

R: 2 kΩ resistor.

FUNCTIONAL DIAGRAM

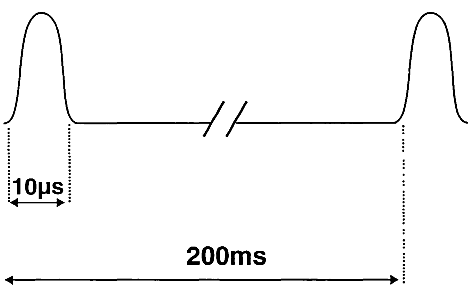


* pin 3 non connected

ABSOLUTE RATINGS (limiting values)

Symbol	Parameter		Value	Unit
I_{TRM}	Repetitive surge peak on state current for thyristor -30°C ≤ T_{amb} ≤ 120°C	tp = 10µs (note 1)	190	A
I_{FRM}	Repetitive surge peak on state current for diode -30°C ≤ T_{amb} ≤ 120°C			
dI/dt	Critical rate of rise time on state current -30°C ≤ T_{amb} ≤ 120°C		120	A/µs
Tstg Tj	Storage junction temperature range Maximum junction temperature		- 40 to + 150 + 125	°C
Toper	Operating temperature range		-30 + 120	°C
T_L	Maximum lead temperature for soldering during 10s		260	°C

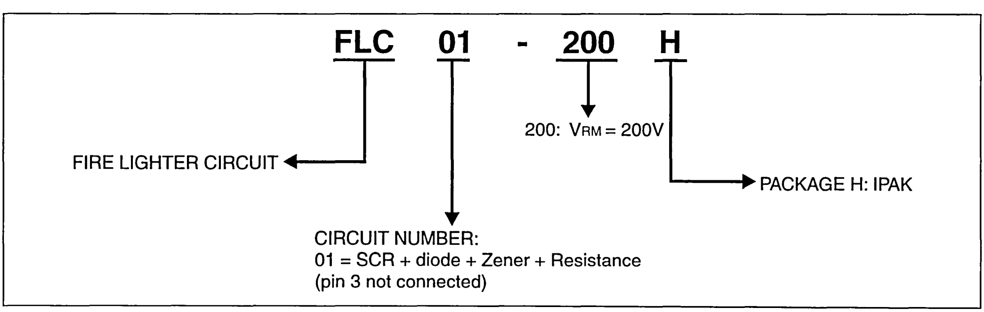
Note 1 : Test current waveform



THERMAL RESISTANCE

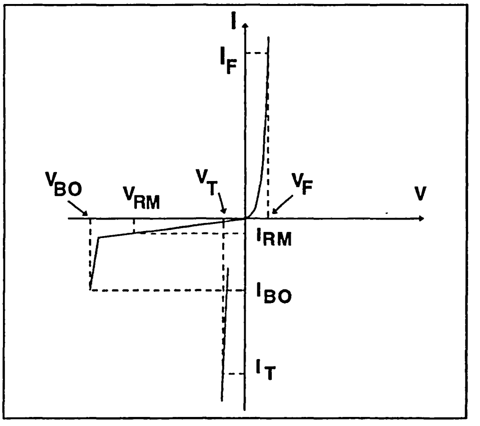
Symbol	Parameter	Value	Unit
Rth(j-a)	Thermal resistance junction to ambient	100	°C/W

ORDERING INFORMATION



ELECTRICAL CHARACTERISTICS

Symbol	Parameters
V_{RM}	Stand-off voltage
V_{BO}	Breakover voltage
V_T	On-state voltage
V_F	Diode forward voltage drop
I_{BO}	Breakover current
I_{RM}	Leakage current
αT	Temperature coefficient for V_{BO}



DIODE (D) PARAMETER

Symbol	Test Conditions			Value	Unit
V_F	$I_F = 2A$ tp ≤ 500µs	Tj = 25°C	Max.	1.7	V

THYRISTOR (Th) and ZENER (Z) PARAMETERS

Symbol	Test conditions		Min.	Typ.	Max.	Unit
I_{RM}	$V_{RM} = 200$ V	Tj = 25°C			1	µA
		Tj = 125°C			10	µA
V_{BO}	at I_{BO}	Tj = 25°C	206	220	233	V
I_{BO}	at V_{BO}	Tj = 25°C			0.5	mA
V_T	$I_T = 2A$ tp ≤ 500µs	Tj = 25°C			1.7	V
αT				0.27		V/°C

Fig. 1: Relative variation of breakover current versus junction temperature.

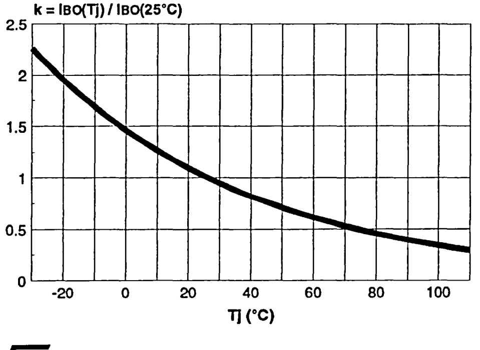
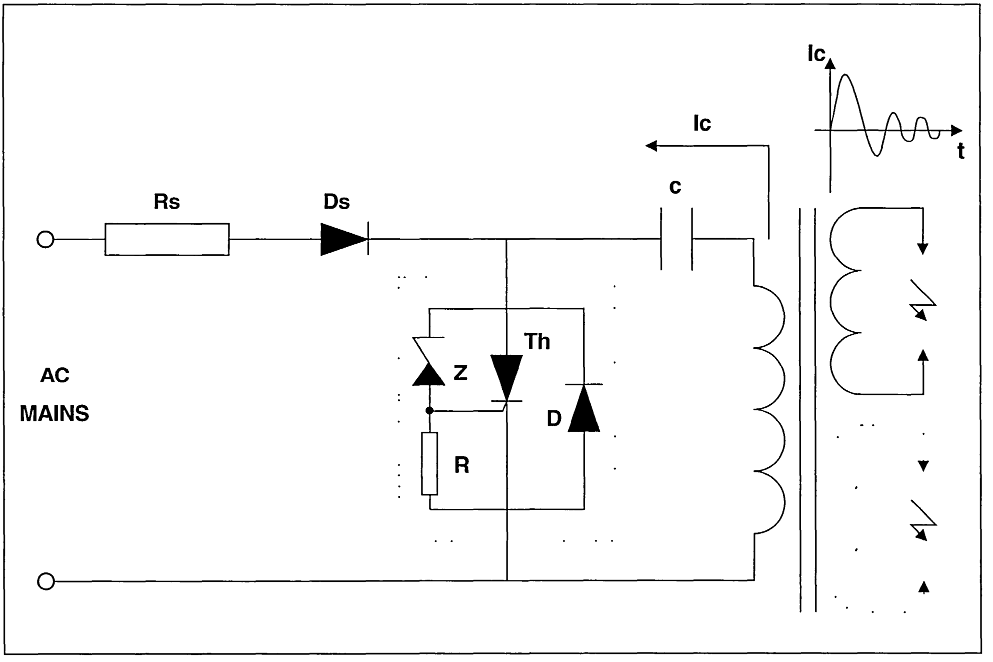


Fig. 2: BASIC APPLICATION



The applications of the lighter using the capacitance discharge topology operate in 2 phases :

PHASE 1

The energy coming from the mains is stored into the capacitor C. For that, the AC voltage is rectified by the diode Ds.

PHASE 2

At the end of the phase 1, the voltage across the capacitor C reaches the avalanche threshold of the zener. Then a current flows through the gate of the thyristor Th which fires.
The firing of the thyristor causes an alternating current to flow through the capacitor C.
The positive parts of this current flow through C, Th and the primary of the HV transformer.
The negative parts of the current flow through C, D and the primaty of the HV transformer.

RS RESISTOR CALCULATION

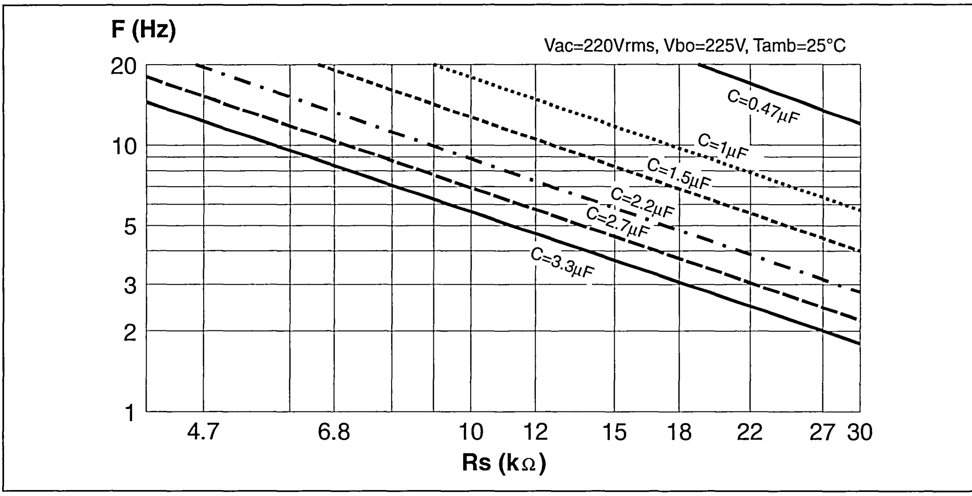
The Rs resistor allows, in addition with the capacitor C, the spark frequency to be adjusted and the current from the mains to be limited. Its value shall allow the thyristor Th to fire even in the worst case. In this case the system must fire with the lower RMS mains voltage value while the breakdown voltage and current of the FLC are at the maximum.

The maximum Rs value is equal to :

$$Rs\max = \frac{(V_{AC}\ \text{min}.\sqrt{2}\ ) - [V_{BO}\ \text{max}\ .(1 + \alpha\ T.(\ T_{amb} - 25\ ))]}{k\ .\ I_{BO}\ ^{*}}$$

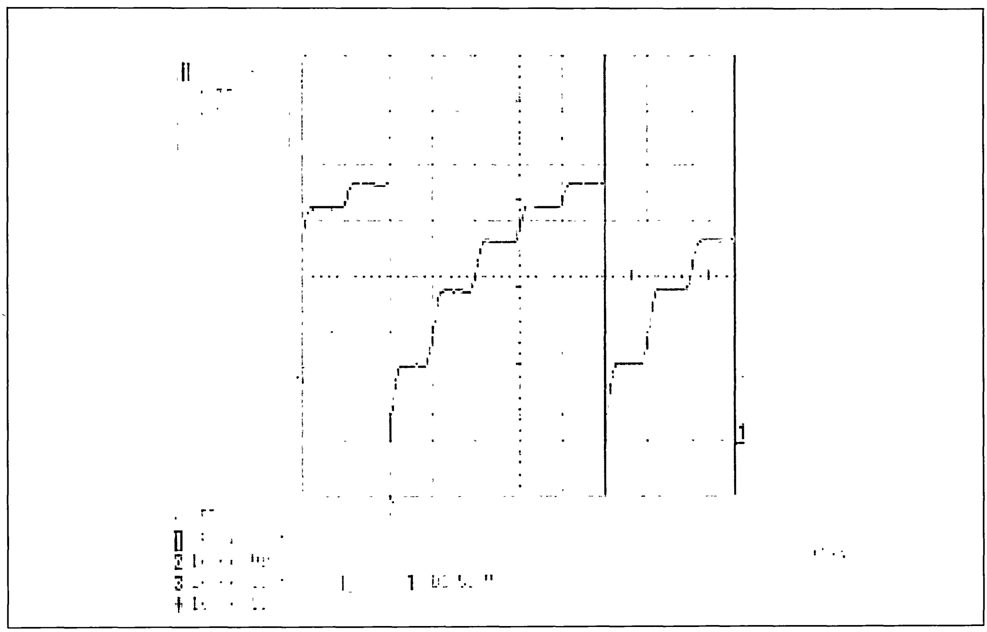
* : see fig 1

Fig. 3: Spark frequency versus Rs and C



The couple Rs/C can be chosen with the previous curve. Keep in mind the Rs maximum limit for which the system would not work when the AC mains is minimum. The next curve shows the behavior with Rs=15kΩ and C=1µF.

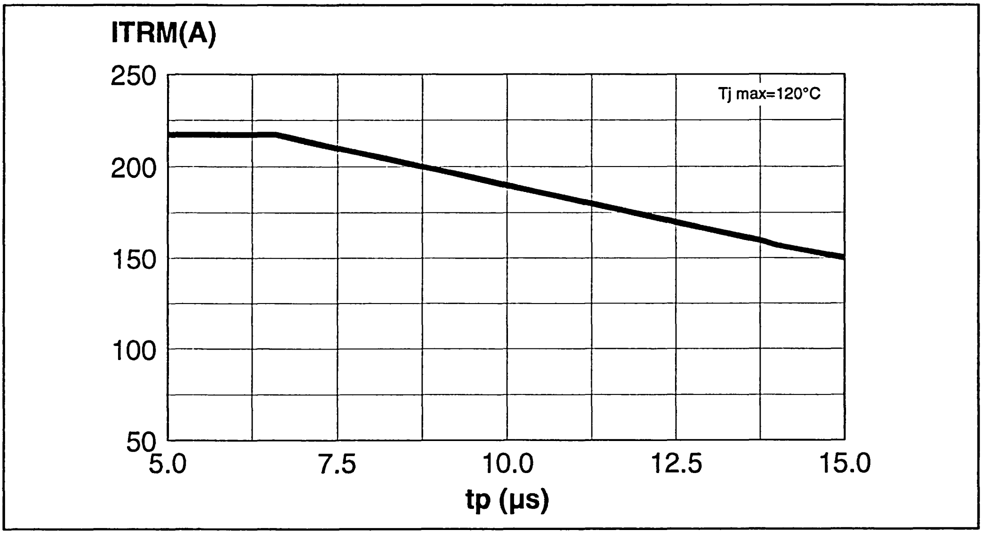
Fig. 4: Voltage across the capacitance with Rs = 15kΩ, C = 1µF and V_{BO} = 225V.



PEAK CURRENT LIMIT

This component is designed to withstand I_{TRM} = 190A for a pulse duration of 10µs for an ambient temperature of 120°C in repetitive surge. The curve of peak current versus the pulse duration allows us to verify if the application is within the FLC operating limit.

Fig. 5: Peak current limit



POWER LOSSES (For 10µs, see note 1)

To evaluate the power losses, please use the following equations :

For the thyristor : $P = 1.18 \times I_{T(AV)} + 0.035\ I^2_{T(RMS)}$

For the diode : $P = 0.67 \times I_{F(AV)} + 0.106\ I^2_{F(RMS)}$

OTHER INFORMATION

Type	Marking	Package	Weight	Base qty	Delivery mode
FLC01-200H	FLC01-200H	IPAK	0.40 g	75	Tube

FLC10-200H

Application Specific Discretes
A.S.D.™

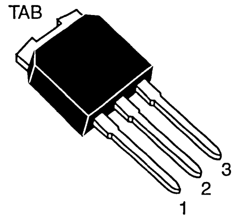
FIRE LIGHTER CIRCUIT

FEATURES

- DEDICATED THYRISTOR STRUCTURE FOR CAPACITANCE DISCHARGE IGNITION OPERATION
- HIGH PULSE CURRENT CAPABILITY 240A @ tp= 10µs
- FAST TURN-ON OPERATION
- DESIGNED FOR HIGH AMBIENT TEMPERATURE (up to 120°C)

BENEFITS

- SPACE SAVING THANKS TO MONOLITHIC FUNCTION INTEGRATION
- HIGH RELIABILITY WITH PLANAR TECHNOLOGY



IPAK

DESCRIPTION

The FLC10 series has been especially developed for high power capacitance discharge operation. The main applications are gas lighters or ignitors such as :
cookers / gas boilers / gas hobs...

Based on ST's ASD™ technology, it provides a fully integrated function, with high performance and reliability levels, adapted to severe and hot temperature environment.

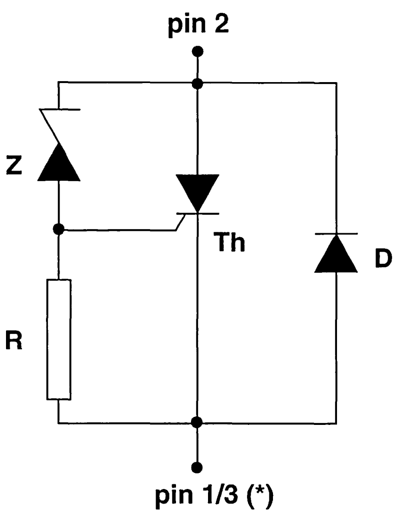
Th: Thyristor for switching operation.

Z: Zener diode to set the threshold voltage.

D: Diode for reverse conduction.

R: 2 kΩ resistor.

FUNCTIONAL DIAGRAM

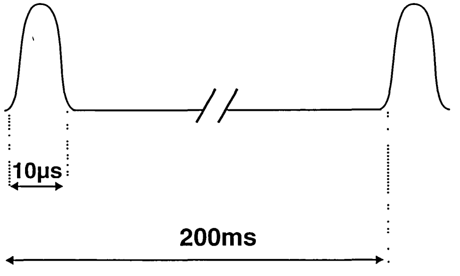


(*) Pin1 and Pin3 must be shorted together in the application circuit layout.

ABSOLUTE RATINGS (limiting values)

Symbol	Parameter		Value	Unit
I_{TRM}	Repetitive surge peak on state current for thyristor -30°C ≤ T_{amb} ≤ 120°C	tp = 10µs (note 1)	240	A
I_{FRM}	Repetitive surge peak on state current for diode -30°C ≤ T_{amb} ≤ 120°C			
dI/dt	Critical rate of rise time on state current -30°C ≤ T_{amb} ≤ 120°C		200	A/µs
Tstg Tj	Storage junction temperature range Maximum junction temperature		- 40 to + 150 + 125	°C
Toper	Operating temperature range		-30 + 120	°C
T_L	Maximum lead temperature for soldering during 10s		260	°C

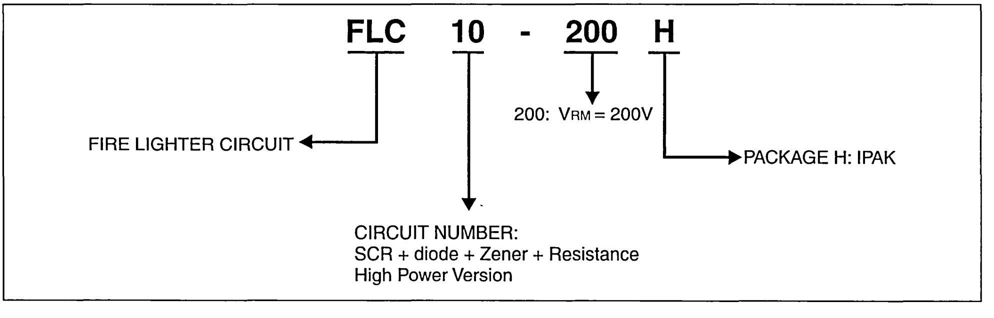
Note 1 : Test current waveform



THERMAL RESISTANCE

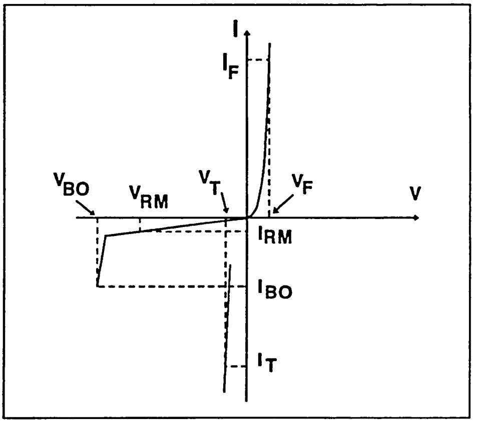
Symbol	Parameter	Value	Unit
Rth(j-a)	Thermal resistance junction to ambient	100	°C/W

ORDERING INFORMATION



ELECTRICAL CHARACTERISTICS

Symbol	Parameters
V_{RM}	Stand-off voltage
V_{BO}	Breakover voltage
V_T	On-state voltage
V_F	Diode forward voltage drop
I_{BO}	Breakover current
I_{RM}	Leakage current
αT	Temperature coefficient for V_{BO}



DIODE (D) PARAMETER

Symbol	Test Conditions			Value	Unit
V_F	$I_F = 2A$ tp ≤ 500µs	Tj = 25°C	Max.	1.7	V

THYRISTOR (Th) and ZENER (Z) PARAMETERS

Symbol	Test conditions		Min	Typ	Max	Unit
I_{RM}	V_{RM} = 200 V	Tj = 25°C			10	µA
		Tj = 125°C			100	µA
V_{BO}	at I_{BO}	Tj = 25°C	200	225	250	V
I_{BO}	at V_{BO}	Tj = 25°C			0.5	mA
V_T	$I_T = 2A$ tp ≤ 500µs	Tj = 25°C			1.7	V
αT				0.3		V/°C

Fig. 1: Relative variation of breakover current versus junction temperature.

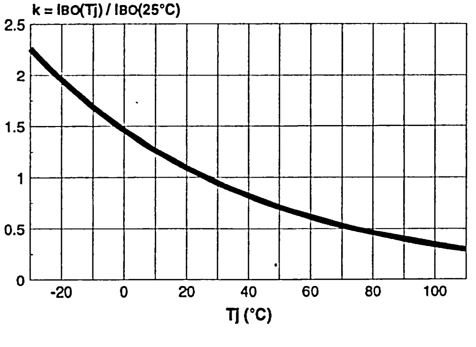
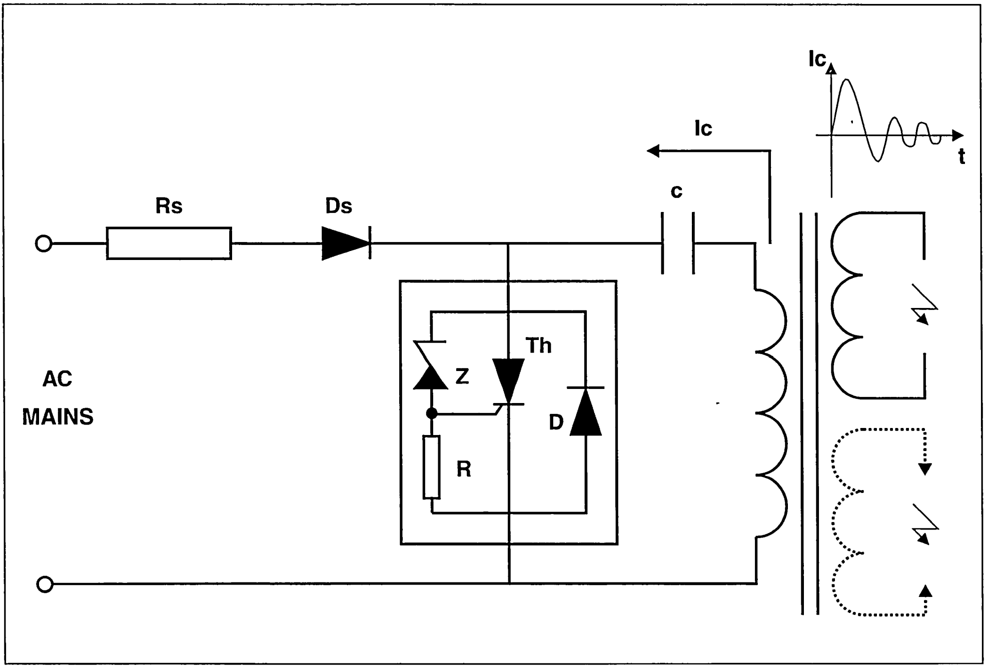


Fig. 2: BASIC APPLICATION



The applications of the lighter using the capacitance discharge topology operate in 2 phases :

PHASE 1

The energy coming from the mains is stored into the capacitor C. For that, the AC voltage is rectified by the diode Ds.

PHASE 2

At the end of the phase 1, the voltage across the capacitor C reaches the avalanche threshold of the zener. Then a current flows through the gate of the thyristor Th which fires.
The firing of the thyristor causes an alternating current to flow through the capacitor C.
The positive parts of this current flow through C, Th and the primary of the HV transformer.
The negative parts of the current flow through C, D and the primaty of the HV transformer.

COMPONENT CHOICE

RS RESISTOR CALCULATION

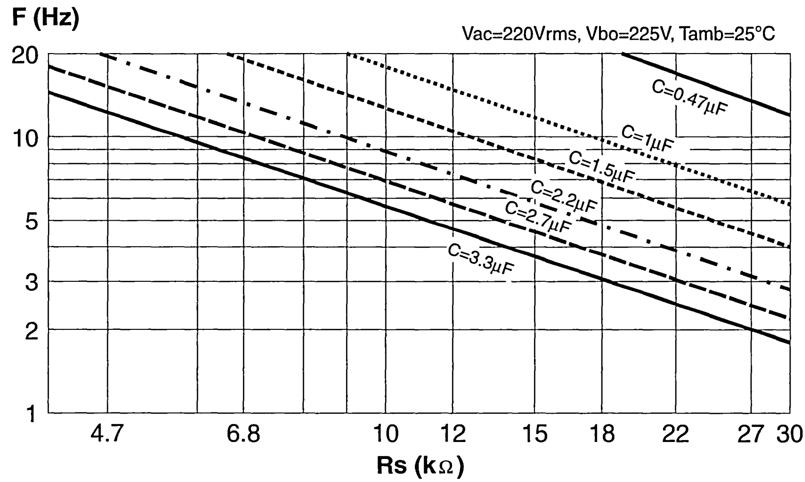
The Rs resistor allows, in addition with the capacitor C, the spark frequency to be adjusted and the current from the mains to be limited. Its value shall allow the thyristor Th to fire even in worst case conditions. In this borderline case, the system must fire with the lowest value of RMS mains voltage while the breakdown voltage and current of the FLC are at the maximum.

The maximum Rs value is equal to :

$$Rs\max = \frac{(V_{AC}\ \min.\sqrt{2}\ ) - [V_{BO}\ \max.(1 + \alpha\, T.(\ T_{amb} - 25\ ))]}{k\ .\ I_{BO}\ \ ^{*}}$$

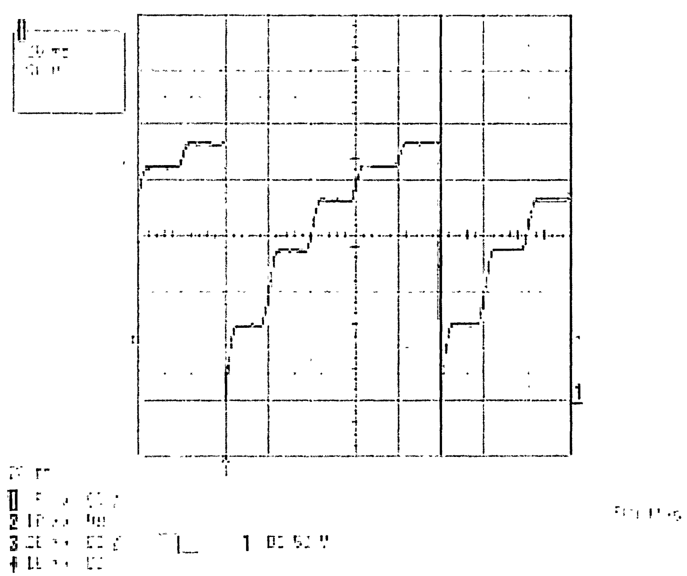
* : see fig 1

Fig. 3: Spark frequency versus Rs and C



The couple Rs/C can be chosen with the previous curve. Keep in mind the Rs maximum limit for which the system would not work when the AC mains is minimum. The next curve shows the behavior with Rs=15kΩ and C=1µF.

Fig. 4: Voltage across the capacitance with Rs = 15kΩ, C = 1µF and V_{BO} = 225V.

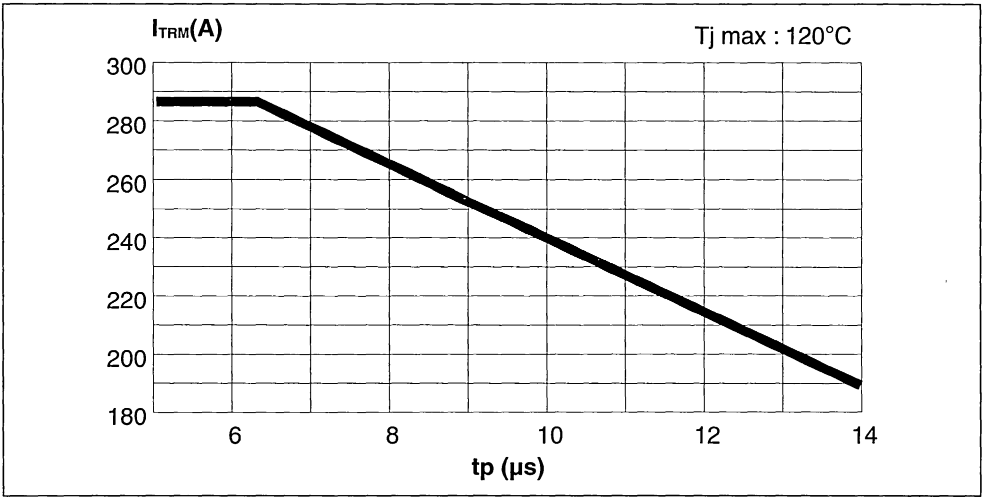


PEAK CURRENT LIMIT

This component is designed to withstand I_{TRM} = 240A for a pulse duration of 10µs for an ambient temperature of 120°C in repetitive surge (see note 1, page 2).

The curve of peak current versus the pulse duration allows us to verify if the application is within the FLC operating limit.

Fig. 5: Peak current limit versus pulse duration.



POWER LOSSES (For 10µs, see note 1)

To evaluate the power losses, please use the following equations :

For the thyristor : $P = 1.18 \times I_{T(AV)} + 0.035\ I^2_{T(RMS)}$

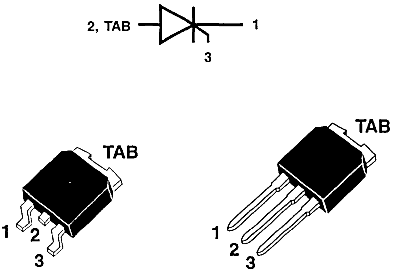
For the diode : $P = 0.67 \times I_{F(AV)} + 0.106\ I^2_{F(RMS)}$

OTHER INFORMATION

Type	Marking	Package	Weight	Base qty	Delivery mode
FLC10-200H	FLC10-200H	IPAK	0.40 g	75	Tube

Application Specific Discretes
A.S.D.™

STARTLIGHT



DPAK
(TN22-B)

IPAK
(TN22-H)

FEATURES

- High clamping voltage structure (1200 - 1500V)
- Low gate triggering current for direct drive from line (< 1.5mA)
- High holding current (> 175mA), ensuring high striking energy.

DESCRIPTION

The TN22 has been specifically developed for use in electronic starter circuits. Use in conjunction with a sensitive SCR and a resistor, it provides high energy striking characteristics with low triggering power. Thanks to its electronic concept, this TN22 based starter offers high reliability levels and extended life time of the fluorescent tubelamps.

ABSOLUTE RATINGS (limiting values)

Symbol	Parameter		Value	Unit
V_{DRM}	Repetitive peak off-state voltage	T_j = 110°C	400	V
$I_{T(RMS)}$	RMS on-state current Full sine ware (180° conduction angle)	Tc= 95°C	2	A
$I_{T(AV)}$	Mean on-state current Full sine ware (180° conduction angle)	Tc= 95°C	1.8	A
I_{TSM}	Non repetitive surge peak on-state current (T_j initial = 25°C)	tp = 8.3ms	22	A
		tp = 10ms	20	
I^2t	I^2t Value for fusing	tp = 10ms	2	A^2s
dI/dt	Critical rate of rise of on-state current I_G = 5 mA dI_G/dt = 70 mA/µs.		50	A/µs
T_{stg} T_j	Storage and operating junction temperature range		- 40 to + 150 - 40 to + 110	°C
Tl	Maximum lead temperature for soldering during 10s at 4.5mm from case		260	°C

THERMAL RESISTANCES

Symbol	Parameters	Value	Unit
Rth(j-a)	Junction to ambient	100	°C/W
Rth(j-c)	Junction to case	3	°C/W

GATE CHARACTERISTICS (maximum values)

$P_{G\ (AV)}$= 300 mW P_{GM} = 2 W (tp = 20 µs) I_{FGM} = 1 A (tp = 20 µs) V_{RGM} = 6V

ELECTRICAL CHARACTERISTICS

Symbol	Test conditions		Type	Value	Unit
I_{GT}	V_D=12V (DC) R_L=33Ω	Tj= 25°C	MAX	1.5	mA
V_{GT}	V_D=12V (DC) R_L=33Ω R_{GK} = 1 KΩ	Tj= 25°C	MAX	3	V
I_H	V_{GK} = 0V	Tj= 25°C	MIN	175	mA
V_{TM}	I_{TM}= 2A tp= 380µs	Tj= 25°C	MAX	3.1	V
I_{DRM}	V_{DRM} Rated	Tj= 25°C	MAX	0.1	mA
dV/dt	Linear slope up to V_D=67%V_{DRM} V_{GK} = 0V	Tj= 110°C	MIN	500	V/µs

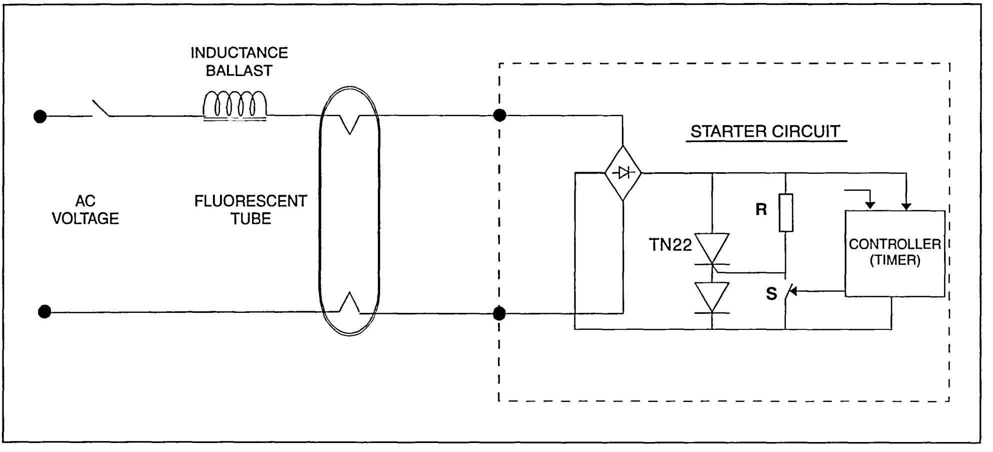
Symbol	Test conditions	Type	Value	Unit
			TN22-1500	
V_{BR}	I_D= 5mA V_{GK} = 0V Tj = 25°C	MIN	1200	V
		MAX	1500	V

This thyristor has been designed for use as a fluorescent tube starter switch.

An electronic starter circuit provides :

- A pre-heating period during which a heating current is applied to the cathode heaters.
- One or several high voltage striking pulses across the lamp.

BASIC APPLICATION DIAGRAM



PRINCIPLE OF OPERATION

1/ Pre-heating

At rest the switch S is opened and when the mains voltage is applied across the circuit a full wave rectified current flows through the resistor R and the TN22 gate : at every half-cycle when this current reaches the gate triggering current (I_{GT}) the thyristor turns on.

When the device is turned on the heating current, limited by the ballast choke, flows through the tube heaters.
The pre-heating time is typically 2 or 3 seconds.

2/ Pulsing

At the end of the pre-heating phase the switch S is turned on. At this moment :
If the current through the devices is higher than the holding current (I_H) the thyristor remains on until the current falls below I_H. Then the thyristor turns off.
If the current is equal or lower than the holding current the thyristor turns off instantaneously.

When the thyristor turns off the current flowing through the ballast choke generates a high voltage pulse. This overvoltage is clamped by the thyristor avalanche characteristic (V_{BR}).

If the lamp is not struck after the first pulse, the system starts a new ignition sequence again.

3/ Steady state

When the lamp is on the running voltage is about 150V and the starter switch is in the off-state.

IMPLEMENTATION

The resistor R must be chosen to ensure a proper triggering in the worst case (minimum operating temperature) according to the specified gate triggering current and the peak line voltage.

Switch S : This function can be realized with a gate sensitive SCR type : P0130AA 1EA3
This component is a low voltage device (< 50V) and the maximum current sunk through this switch can reach the level of the thyristor holding current.

The pre-heating period can be determined by the time constant of a capacitor-resistor circuit charged by the voltage drop of diodes used in series in the thyristor cathode.

Fig.1 : Maximum average power dissipation versus average on-state current (rectified full sine wave).

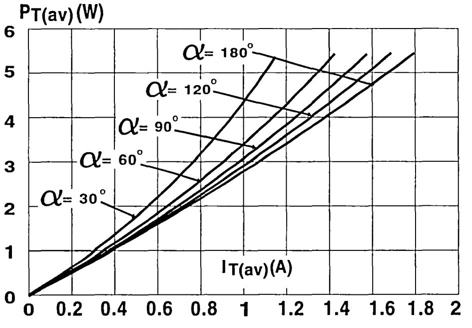


Fig.2 : Correlation between maximum average power dissipation and maximum allowable temperature (Tamb and Tcase) for different thermal resistances heatsink + contact.

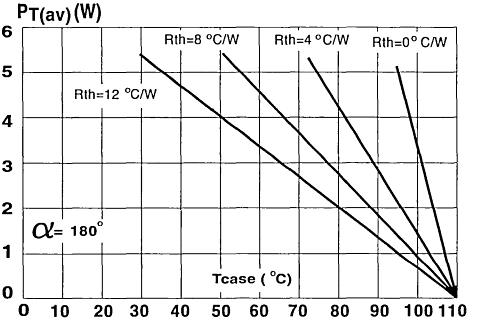


Fig.3 : Average on-state current versus case temperature (rectified full sine wave).

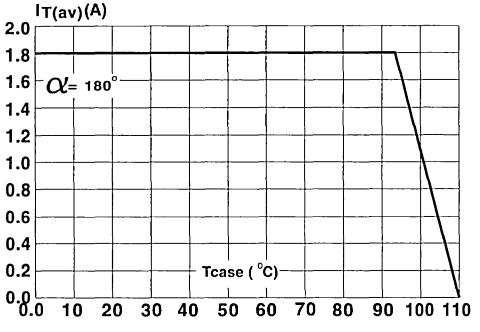


Fig.4 : Thermal transient impedance junction to ambient versus pulse duration.

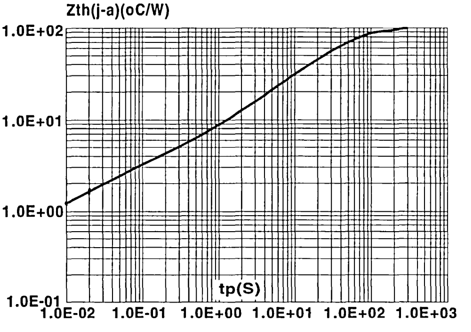


Fig.5 : Relative variation of gate trigger current and holding current versus junction temperature.

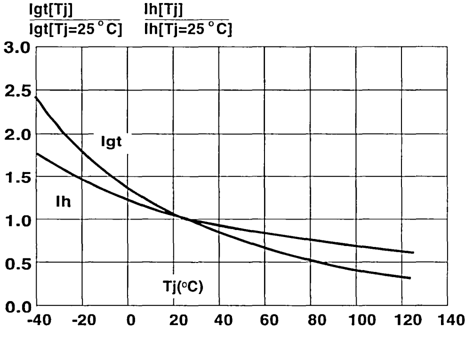


Fig.6 : Non repetitive surge peak on-state current versus number of cycles.

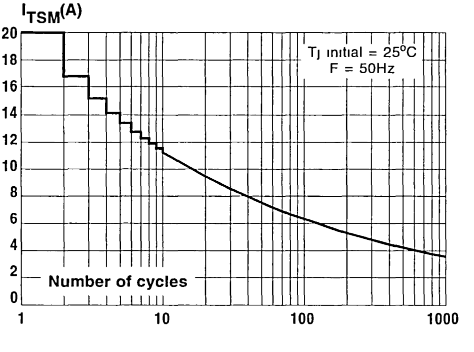


Fig.7 : Non repetitive surge peak on-state current for a sinusoidal pulse with width : tp = 10ms, and corresponding value of I^2t.

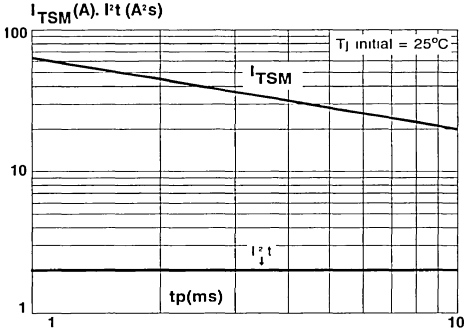


Fig.8 : On-state characteristics (maximum values).

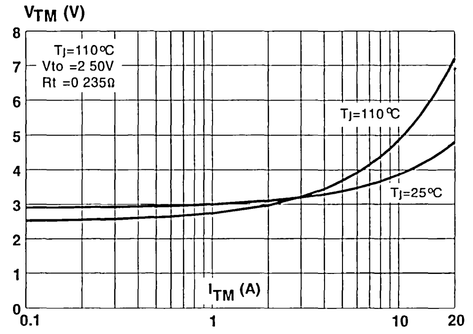


Fig.9 : Relative variation of holding current versus gate-cathode resistance (typical values).

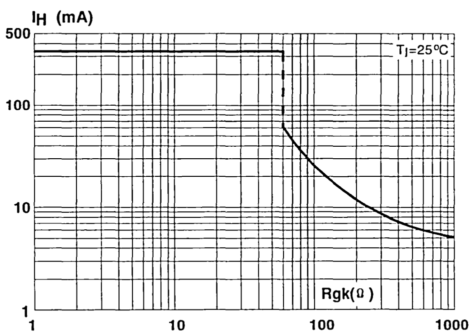
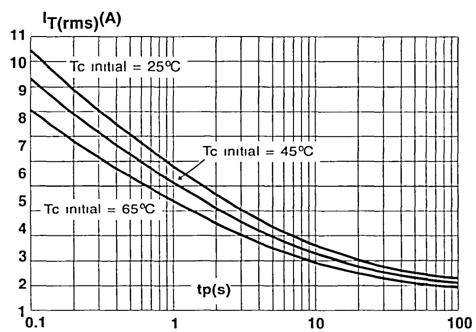
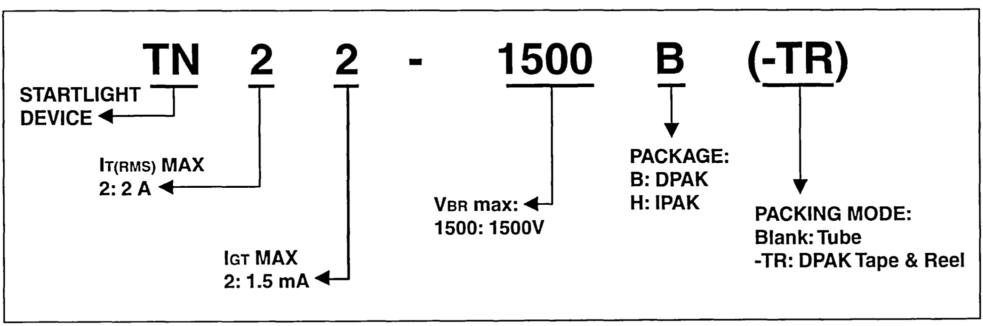


Fig.10 : Maximum allowable RMS current versus time conduction and initial case temperature.
Note : Calculation made fot Tj max = 135°C (the failure mode will be short circuit)



ORDERING INFORMATION



OTHER INFORMATION

Type	Marking	Package	Weight	Base Qty	Delivery mode
TN22-1500B	TN221500	DPAK	0.3 g	75	Tube
TN22-1500B-TR	TN221500	DPAK	0.3 g	2500	Tape & Reel
TN22-1500H	TN221500	IPAK	0.4 g	75	Tube

Application Specific Discretes
A.S.D.™

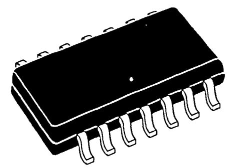
STARLIGHT-KIT 2-CHIPS SET FOR FLUORESCENT LAMP STARTER

FEATURES

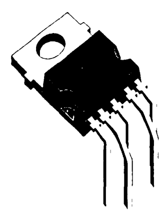
- VERY WIDE TEMPERATURE RANGE: tube ignition from **- 30 to + 85 °C**
- SINGLE SHOT IGNITION FROM -30 to 0°C : **350mA, 1350V** striking pulse
- VERY WIDE POWER RANGE: Fluorescent tube lamp ignition from **18 to 70W**
- EFS2B driver compatible with **50/60Hz** operation
- SELECTABLE PREHEAT TIME:
  EFS2A driver: **1.5s or 2.56s** (50Hz)
  EFS2B driver: **0.74s or 1.24s** (50Hz)
  EFS2B driver: **0.62s or 1.03s** (60Hz)
- 8 STRIKING PULSES CAPABILITY: for very cold environment or ageing lamp
- STARTER SHUTDOWN WITH FAILED LAMP

BENEFITS

- Very low component count: **2 chips** + 7 passive components
- Meets EN55015 standards WITHOUT EMI capacitor
- Extended life time of the fluorescent lamp due to smooth and single shot ignition
- High inherent **reliability** and **extended life time** of the starter



SO-14
EFS2A-CD
EFS2B-CD



PENTAWATT HV
EFS21-TL5

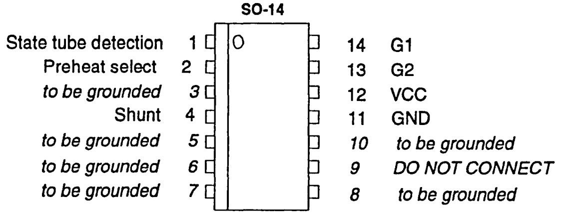
DESCRIPTION

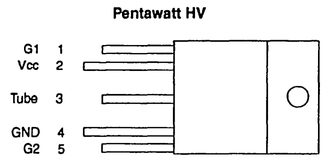
The EFS Kit is a 2 chips set used with 7 additional passive components, for Glow switch Starter.

The ASD™ (Application Specific Discretes) includes a bi-directional Power Switch and a Power Supply for the driver.

The driver provides a program to ensure a fully optimised linear fluorescent lamp ignition.

PIN CONNECTION (top view)





DRIVER: EFS2A-CD
and : EFS2B-CD

ASD™: EFS21-TL5

EFS STARLIGHT-KIT PARTS SELECTION:

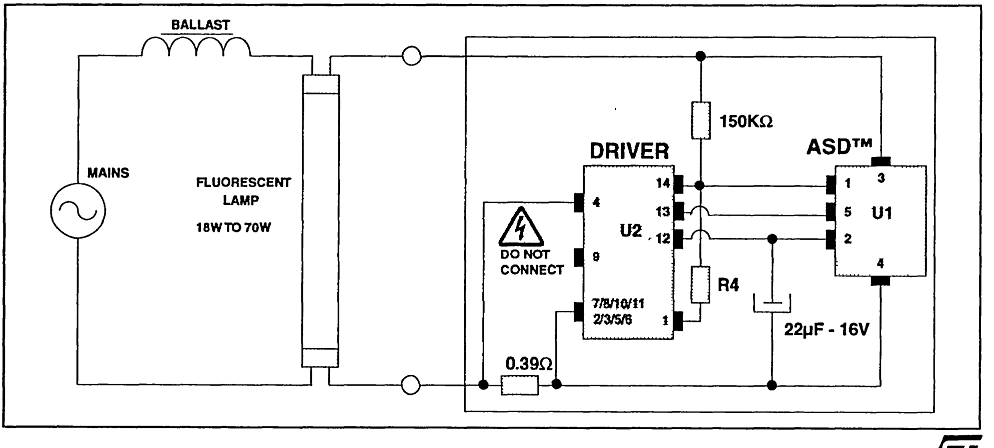
The EFS STARLIGHT-KIT answers effectively to linear fluorescent lamp ignition needs:

	MAINS FREQUENCY					
	50Hz				60Hz	
DRIVER VERSION	**EFS2A**		**EFS2B**			
Pin 2 connection	GND	VCC	GND	VCC	GND	VCC
PREHEAT DURATION	1.5s	2.56s	0.74s	1.24s	0.62s	1.03s
ASD™	**EFS21**					
LAMP POWER RANGE	18 to 70W (note 2)					
AMBIENT TEMPERATURE RANGE	-30 to 85°C (note1, note 2)					

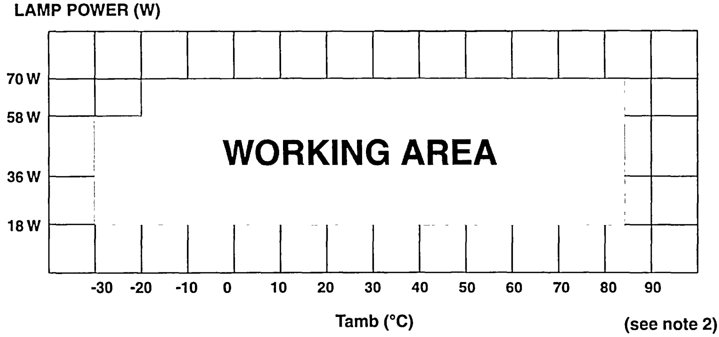
Note 1: below -20°C, it is recommended to limit the lamp power range to 58W.

Note 2: the ignition temperature range is given with starting aid, as required in the IEC 81 and IEC 926 (§6.3.1) standards.

BASIC APPLICATION DIAGRAM



RECOMMENDED LAMP POWER RANGE APPLICATION



Note 2: the ignition temperature range is given with starting aid, as required in the IEC 81 and IEC 926 (§6.3.1) standards.

ABSOLUTE RATINGS (limiting values)

Symbol	Parameter	Value	Unit
Top	Operating Junction temperature range	-30 to +125	°C
Tstg	Storage temperature range	-55 to +150	°C

DRIVER: EFS2 A & EFS2B

Symbol	Parameter	Value	Unit
Vcc	Maximum supply voltage	14	V
Ptot	Power dissipation	500	mW
ESD	Electrostatic discharge between any pins Standard: MIL STD 883C Human Body Model	1	kV
V_{SENSE}	Input operating range	±10	V

ASD™: EFS21

Symbol	Parameter	Value	Unit
$I_{T(RMS)}$	RMS on-state current Tcase = 90°C	1	A
Tcase	$I_{T(RMS)}$ = 1A t_{OFF} = 0.16s t_{ON} = 0.75s	+ 120	°C
I_{TSM}	Surge peak on-state current T_j initial = 25°C, tp = 10ms Minimum repetitive rate periode : 1min.	15	A
V_{DRM} V_{RRM}	Repetitive peak off-state voltage	600	V

ELECTRICAL CHARACTERISTICS (T_j = 25°C, unless otherwise specified)

DRIVER

Symbol	Parameter	Min.	Typ.	Max.	Unit
V_{CC}	Supply voltage in preheat mode	7		12	V
V_{UVLO}	Under voltage lock-out threshold			5	V
V_{CCH}	Supply limitation high in standby mode	6.8	7.7	8.7	V
V_{CCL}	Supply limitation low in standby mode	6.77	7.57	8.41	V
I_{CC}	Supply current in standby mode	440	450	475	µA
I_{SO}	Ignition current level Rsense = 0.39Ω	280	350	420	mA
LAMP OFF STATE DETECTION					
tc	Checking delay after zero crossing lamp voltage				
	EFS2A version	2.9		5.9	ms
	EFS2B version	2.5		7.5	ms
V_{REF}	Internal reference voltage	1.12		1.26	V

ASD

Symbol	Parameter	Min.	Typ.	Max.	Unit
VT +	Positive on-state voltage I_T = 1.5A tp = 500µs		2.1	3.15	V
VT -	Negative on-state voltage I_T = 1.5A tp = 500µs		0.89	1.2	V
V_{BR}	Breakdown positive voltage I_{DRM} = 5mA t_p = 10ms	1200	1350	1500	V
V_{DCM} V_{RCM}	Non repetitive peak off-state voltage Pin 1 = Pin 2 = Pin 4 = Pin 5 Repetitive rate : 3Hz	800			V
I_{DRM} I_{RRM}	Leakage current, at V_{DRM}/V_{RRM} rated Pin 1 = Pin 2 = Pin 4 = Pin 5			20	µA
I_H	Holding current dI/dt = 9 A/ms Pin1 = Pin 2 = Pin4 = Pin5	350			mA

ORDERING INFORMATION

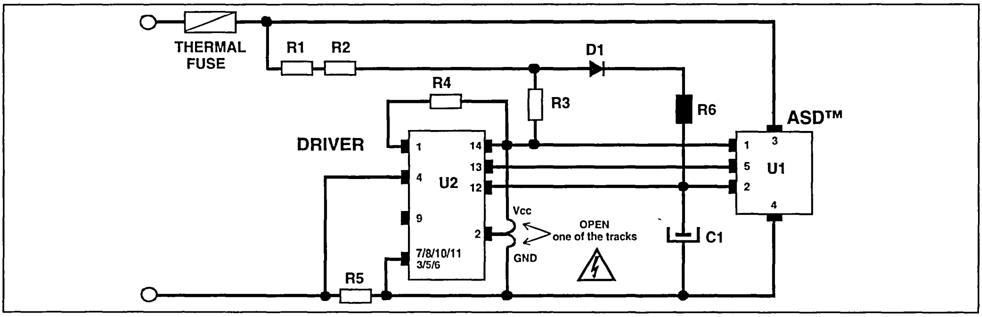
DRIVER

EFS	2	A/B	-	CD
Electronic Fluorescent Switch	Kit	Version Digit A: 50Hz B: 50/60Hz		SO-14 Package

ASD™

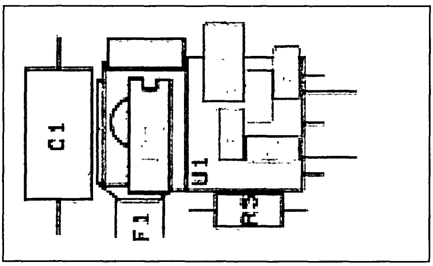
EFS	2	1	-	TL5
Electronic Fluorescent Switch	Kit	Version Digit		TL5: Pentawatt HV Package with lead forming

DEMONSTRATION BOARD DIAGRAM

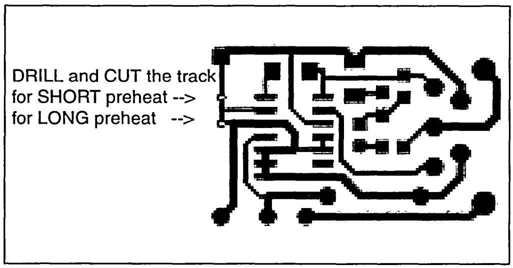


When the starter has to be protected against over-temperature, over-current or short circuit, it is recommended to implement a thermal fuse in series with the starter.
To meet (IEC 926) standards, a capacitor (f.i. 5nF) can be connected between pin 3 and pin 4 of the ASD™.

BOARD ASSEMBLY



PCB with Pentawatt HV and SO14



Pin 2 is the preheat time select pin. To select a short preheat time, drill to cut the Vcc to pin 2 track at the metallic hole. To select a long preheat time, drill to cut the GND to pin 2 track. The layout must be configured for either choice to avoid **supply short circuit**.

RECOMMENDED COMPONENTS ACCORDING TO APPLICATION CONDITIONS

Application Conditions			
AC mains	Single 230V - 50Hz	Single 120V - 60Hz	Twin series 230V / 50Hz or single 115V / 50Hz
Lamp Power Range	18 to 70W		18 to 36W
Ambient Temperature Range	-30 to + 85°C (note 3)		
Recommended Components			
ASD™ version	**EFS21**		
Driver version	**EFS2A or EFS2B**	**EFS2B**	**EFS2A or EFS2B**
R1, R2	30kΩ - 0.125W - 5%	15kΩ - 0.125W - 5%	
R3	130kΩ - 0.125W - 5%		
R4	2.2kΩ - 0.25W - 5%	3.3kΩ - 0.25W - 5%	
R5	0.39Ω - 0.25W - 5% (note 4)		
R6	39kΩ - 0.25W - 5%		
C1	22µF - 16V - 20%		
D1	BYD17K (800V)		

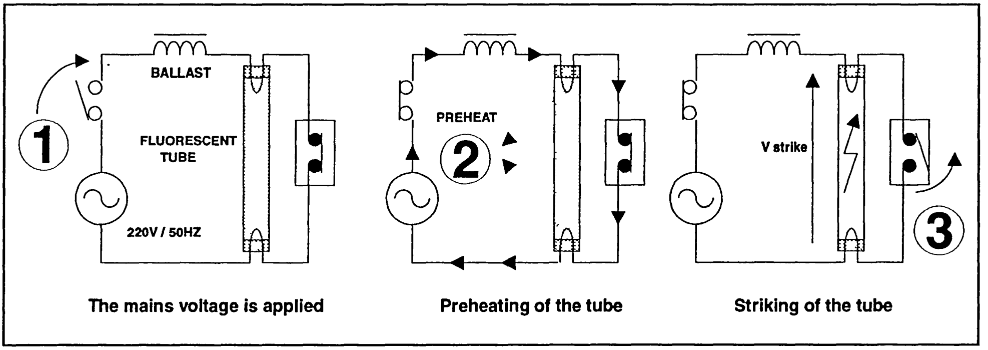
Note 3: below -20°C, it is recommended to limit the lamp power range to 58W.
Note 4: R5(Rsense) should have a 8 A, 10 ms surge capability.

EFS STARLIGHT-KIT APPLICATION NOTE

1/ THE AC POWER SWITCH: FUNCTIONAL DESCRIPTION

The Starter is a bi-directional switch which performs two functions:

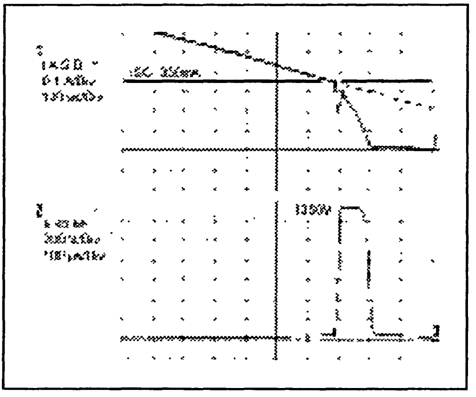
- to preheat of the tube,
- to ignition of the tube.



During the preheat period, the ASD™ is conducting fully. The tube lamp is short circuited by the starter, and the current flows through its filaments. In these conditions, the lamp can not light up, but the temperature of the lamp electrodes increases.

At the end of the preheat period, lamp filaments are warm enough to emit electrons in the gas and to permit the lamp ignition in good conditions. The ASD™ switches off the preheating current . At this moment, the ballast is equivalent to a current generator ($I=I_{SO}$, I_{SO} = Switched Off current). As the ASD™ switches off, the starter voltage increases. The amplitude of this high voltage spike is then clamped by the ASD™ (V_{BR}'1350 V). As the starter and the lamp are in parallel, the striking pulse is directly applied to the lamp. The electromagnetic energy of the ballast is then

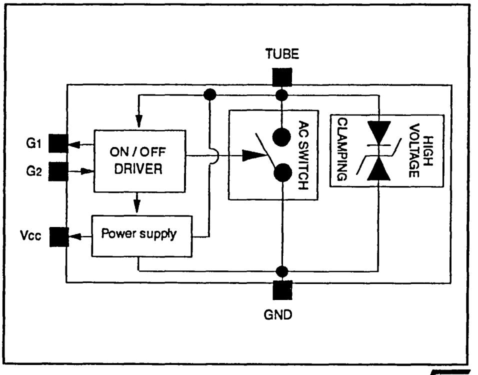
Striking pulse



2/ WHAT'S NEW IN THIS SWITCH?

The AC SWITCH merges an auxiliary power supply for the driver, a power clamping device (1350V) and a bi-directional switch with his execution pilot block.

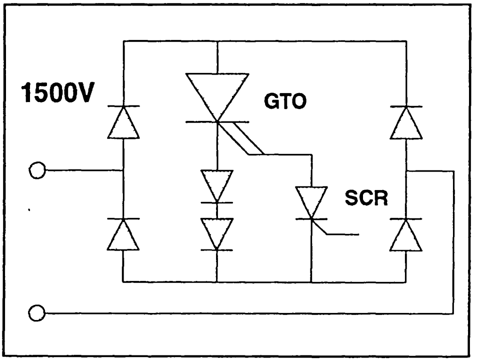
NEW EFS ASD



Present solutions work with a unidirectional switch, like MOS transistors or GTO (Gate Turn Off thyristor). As a starter is a bi-directional switch, it is necessary to use a rectifier bridge (4 diodes of 1500V). More, 2 or 3 diodes in series with the GTO are required to get the necessary switch off effect, and the whole is controlled with an analog timer built around a small SCR.

The advantages of a bi-directional switch are as follows: a drastic reduction of the number of components, and of course, a reduction of power losses (only 1 forward voltage instead of 5).

Conventional discrete circuit (minimal version)



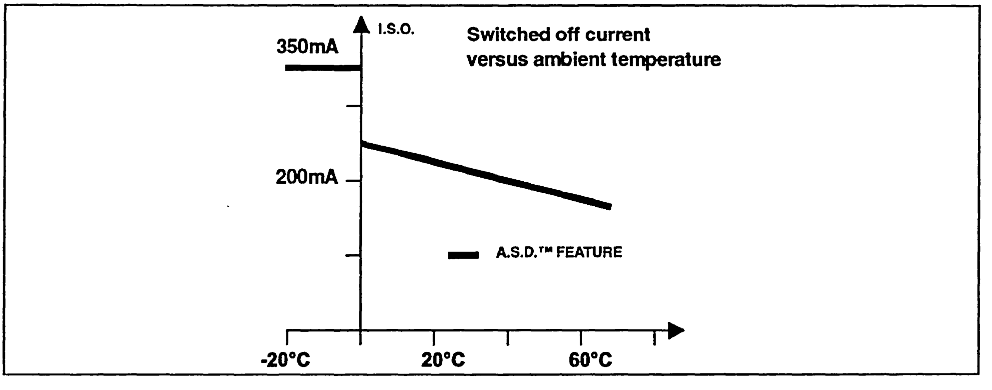
3/ LAMP IGNITION FEATURE:

A lamp requires a minimum energy level to be ignited, but this energy depends especially on the lamp temperature. The lower the temperature, the more energetic the lamp strike.

This energy stored in the ballast is directly proportional to the Switched Off current I_{SO} ($E = \frac{L.I_{SO}^2}{2}$).

In other words, the energy required and of course the I_{SO} level, are maximum for the minimum temperature. Results based on experiments show that it is necessary to switch off a current of 350 mA to strike a 58W tube at -30°C (with a voltage amplitude clamped at 1200V and starting aid).

Therefore, the best way to strike a tube, independent of the temperature, is to keep the maximum I_{SO} level for all the temperature range. Unfortunately, the solution is not so simple to implement because the energy level at ambient or warm temperature would be much important: the lamp would be ignited, but the lamp lifetime would be shortened. This is why one of the innovations of the ASD™ is to modulate the striking energy versus temperature (see feature hereafter).

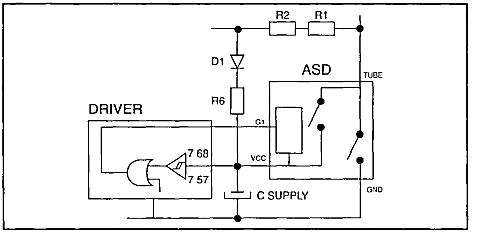


For freezing temperatures, the I_{SO} level is maintained at 350 mA, and for positive temperatures, the I_{SO} level decreases slowly.

4/ AUXILIARY POWER SUPPLY:

In order to reduce the number of components, an auxiliary power supply is integrated in the ASD™. This active power supply works directly on the mains and requires only a low voltage capacitor 16V - 22µF. The operating mode of this supply varies with the starter operating phase:

POWER SUPPLY SCHEMATIC



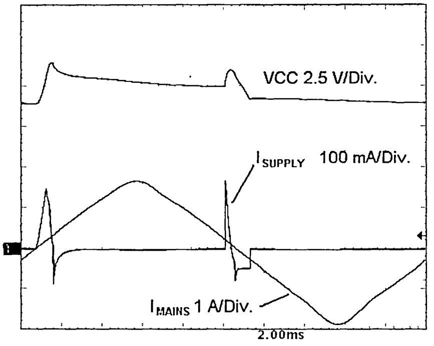
Supply operation during preheat phase:

During preheat phase, the driver solely manages the supply function (neither the driver nor D1 and R6 are involved). A part of the current flowing through the ASD™ is used, at the beginning and at the end of each positive mains half cycle, to charge the output capacitor.

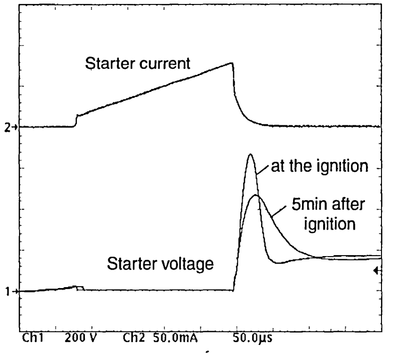
Supply operation during standby phase:

When the lamp is lit, the driver monitors its supply voltage (Vcc). At the beginning of each positive mains half cycle, when Vcc is lower than 7.57V, the driver closes the ASD™ supply switch. The capacitor is charged to provide the standby current of the driver. During this phase the tube lamp is short circuited by the ASD™. When the supply voltage reaches 7.68V, the driver opens the ASD™ supply switch. Since this current is also flowing in the ballast, the supply turn off provides across the lamp an additional voltage spike. After it has been running for a few minutes the lamp becomes warm and this spike voltage naturally decreases.

SUPPLY DURING PREHEAT PHASE



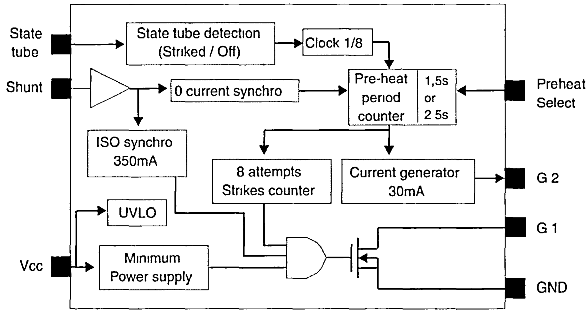
SUPPLY DURING STANDBY PHASE
(Without E.M.I. Capacitor nor R6 nor D1)



To dramatically reduce this repetitive voltage spikes across the lamp, the R6 resistor with the diode D1 provide a part of the supply current. Thus, the ripple voltage of the supply voltage is reduced, as well as the level of the switched-off current. On the other hand, this increases the safety margin of the RF noise (versus the IEC 55015 limits)

5/ THE DRIVER: FUNCTIONAL DESCRIPTION

EFS2A DRIVER Internal block diagram (50Hz operation)



ALGORITHM

1. At switch on:

At switch on, an integrated Under Voltage Lock Out function (UVLO) resets the driver as long as the supply voltage stays below a safety level.

2. Preheat:

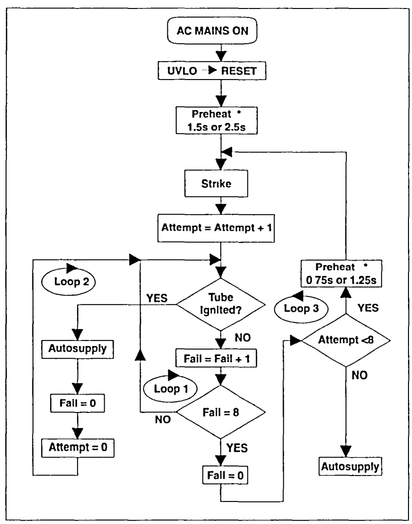
The ignition sequence begins with the preheat phase. Two different durations can be selected with PIN 2 (see table EFS STARLIGHT-KIT PARTS SELECTION page 2).
During this phase, the driver maintains the ASD™ in a full ON-state making the starter equivalent to a bi-directional conducting switch.

3. Ignition of the fluorescent tube:

At the end of the preheat period, the starter strikes the fluorescent lamp.
For this, the driver continuously reads the current through the starter. When the current reaches the Switch Off level (I_{SO} = 350mA), the driver turns off the ASD™. This induces a high voltage pulse across the lamp. This pulse amplitude is limited by the ASD™ (≈1350V).

4. If the lamp fails to strike:

The driver detects the state of the tube (lit or off). If it stays off during 8 mains cycles (loop 1), a new preheat period, shorter than the first one, starts again (loop 3), followed by a new ignition attempt. The driver will try to fire the tube 8 times. If none of the 8 attempts succeeds in striking the lamp, the driver turns in standby mode, and the whole starter is fully stopped until the next mains removal and power supply reset.



* see the preheat duration table § 6

5. If the lamp is ignited:

If the lamp is ignited, the driver stays in standby mode while monitoring the state of the lamp (loop 2).
During normal operation of the tube, this short pulse is masked by the lamp conduction. If the mains interruption is really long enough to turn off completely the lamp, a new ignition sequence starts again (loop 3) with 8 other possible attempts.

6/ PREHEAT PHASE DURATION 50-60Hz:

The driver determines the preheat duration by counting mains cycles. This numeric solution naturally brings a good precision depending only on the mains frequency tolerance.

With the 2 driver versions, the EFS startlight-kit provides a choice of 4 preheat durations. The following table gives the preheat duration before the first ignition attempt. The next seven preheat durations, in the case of an unsuccessful ignition attempt, will last half of the duration of the first one

	PREHEAT DURATION					
MAINS FREQUENCY	50Hz				60Hz	
DRIVER VERSION	EFS2A		EFS2B		EFS2B	
Pin 2 connection	GND	VCC	GND	VCC	GND	VCC
	1.5s	2.56s	0.74s	1.24s	0.62s	1.03s

7/ TUBE STATE DETECTION:

During the ignition sequence or once the lamp is lit, the starter checks the state of the lamp (lit or off). To determine this state, the driver reads the lamp voltage through the resistor bridge (R1+R2+R3, R4).

- If the lamp is off, its voltage is equal to the mains voltage.
- If the lamp is lit, its voltage is only 80 V (for a 58W lamp).

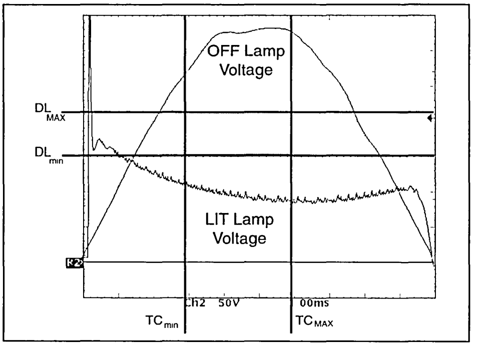
Thus the lamp state is determined by detecting the lamp voltage.

Tolerance effects:

Tolerances on resistors (R1, R2, R3 and R4) as well as on the integrated comparator bring a tolerance on the set detection level. Thus the detection level is included in a range defined by the maximum and the minimum detection levels (DL_{MAX} DL_{min}).

The driver checks the state of the lamp when mains voltage is maximum, that is to say 5 ms after the zero crossing mains voltage (50Hz). Here again internal tolerances bring a tolerance on the real checking moment (TC_{min} TC_{MAX}).

CORRECT SETTING = NO WAVEFORM ACROSS THE GREY AREA



How to set the detection level?

Only the R4 resistor value can be set to adjust the detection level. Values of resitors R1 to R3 must match values of the table RECOMMENDED COMPONENTS ACCORDING TO APPLICATION CONDITIONS of the page 5. In practice, the R4 resistor value has to be set so that neither the OFF lamp voltage nor the LIT lamp voltage cross the grey area.

The DL_{MAX} and DL_{min} limits can be calculated as follows:

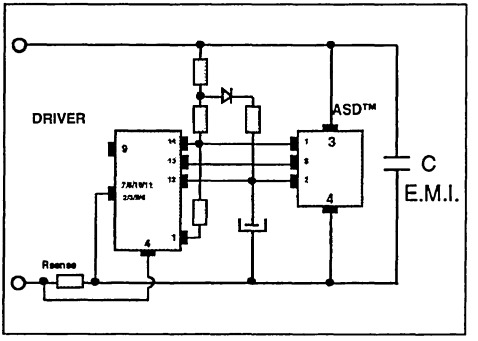
$$DL_{MAX} = \frac{1.265 \ x \ (R4_{min} + R1_{MAX} + R2_{MAX} + R3_{MAX})}{R4_{min}} \text{ and } DL_{min} = \frac{1.122 \ x \ (R4_{MAX} + R1_{min} + R2_{min} + R3_{min})}{R4_{MAX}}$$

8/ E.M.I. CAPACITOR:

As required in the IEC 926 standard (§11.5), "starters which are interchangeable with glow starters in accordance with IEC 155 shall contain means for radio interference suppression, the effect of which is equivalent to that of the radio interference suppression capacitor prescribed in 7.12 of IEC 155".

The EFS starlight-kit is compatible with this 5nF E.M.I. Capacitor which must be directly connected across the ASD™ (between pin 3 "TUBE" and pin 4 "GND").

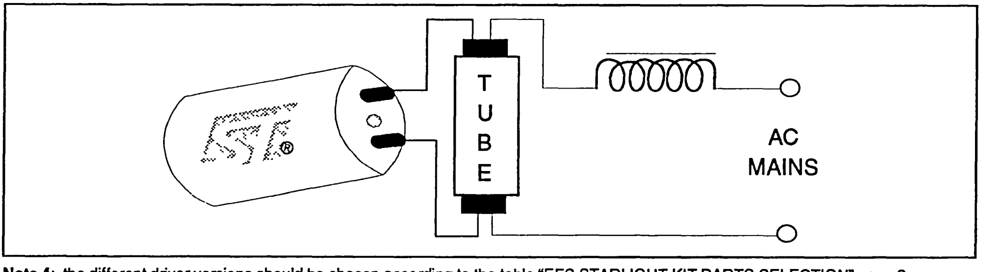
On the other hand, this E.M.I. capacitor increases the striking pulse width of about 55% on positive temperatures.



8.1. Operation in single lamp configuration

The EFS STARLIGHT-KIT is ideal in the following configurations:

- Single Starter / 230V / 50Hz - Single Starter / 230V / 60Hz - Single Starter / 120V / 60Hz



Note 4: the different driver versions should be chosen according to the table "EFS STARLIGHT KIT PARTS SELECTION" page 2.

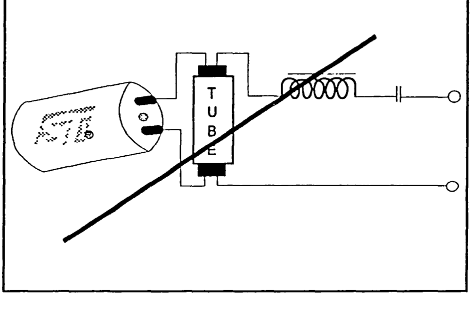
Note 5: Components to choose are listed in the table "RECOMMENDED COMPONENTS ACCORDING TO APPLICATION CONDITIONS" page 5.

8.2. Operation with capacitor for power factor correction:

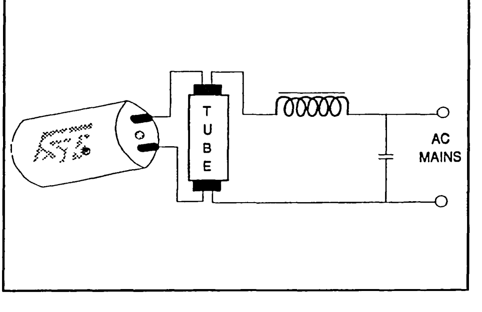
The EFS STARLIGHT-KIT is also suitable for magnetic ballast including front end parallel capacitor.

The EFS STARLIGHT-KIT is NOT suitable for magnetic ballast including front end serial capacitor.

LEADING MAGNETIC BALLAST WITH SERIAL CAPACITOR



MAGNETIC BALLAST WITH SHUNT PARALLEL CAPACITOR

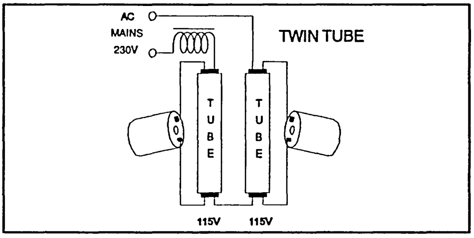


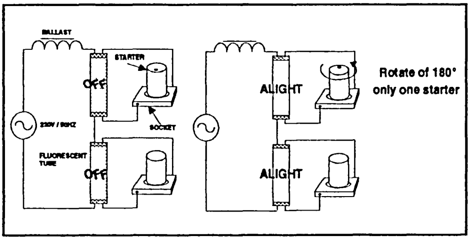
8.3. Operation on the 230V/50Hz AC mains in twin tubes configuration

The EFS STARLIGHT-KIT is also suitable for the configurations Twin tubes Starter

Note 5: Components to choose are listed in the table "RECOMMENDED COMPONENTS ACCORDING TO APPLICATION CONDITIONS" page 5.

The only electrical diagram difference consists of the R4 resistor which needs to be changed from 2.2kΩ to 3.3kΩ. Without this modification, the starter will generate only one ignition attempt instead of 8 in case of defective lamp; loop 3 is removed from the algorithm described in page 9.





In the Twin Series 230V/50Hz configuration, the polarity of the two starters must be respected:

In the case of no operation of starters, rotate one of the starters of 180° on its socket.

OTHER INFORMATION

Type	Marking	Package	Weight	Base Qty	Delivery mode
EFS2A-CD	EFS2A	SO-14	0.13 g	50	Tube
EFS2B-CD	EFS2B	SO-14	0.13 g	50	Tube
EFS21-TL5	EFS21	Pentawatt HV	1.9 g	50	Tube

LIC01 Series

Application Specific Discretes
A.S.D.™

LIGHT IGNITION CIRCUIT

FEATURES

- HIGH VOLTAGE BREAKOVER DIODE: $V_{BO\ MIN}$ = 195 or 215 V
- HIGH HOLDING CURRENT STRUCTURE : I_H > 50 mA
- HIGH PEAK CURRENT PULSE CAPABILITY : I_{TRM} = 50 A
- DIRECT OPERATION ON 220/240 VAC MAINS CIRCUITS

BENEFITS

- SPACE SAVING THANKS TO MONOLOTHIC FUNCTION INTEGRATION
- HIGH RELIABILITY WITH PLANAR TECHNOLOGY

DESCRIPTION

The LIC01 has been especially designed for high voltage pulse generation circuits such as light ignitors for :

. High pressure sodium lamp

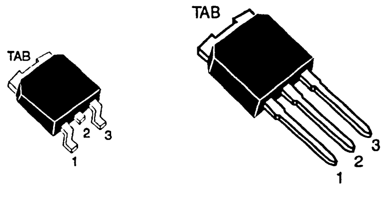
. Lamp flashing circuit

. Metal Halid lamp

It uses a high performance planar diffused technology device suitable for high surge current operation in rugged environmental conditions.

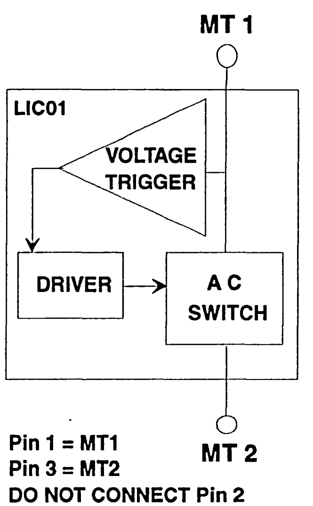
When the voltage across the device reaches the breakover voltage, it decreases from an off-state to low voltage on-state condition. When the current through the circuit drops below the holding current I_H , the device comes back to the off-state.

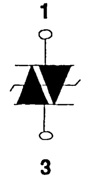
DEVICE TYPE	BREAKDOWN VOLTAGE RANGE
LIC01-195	V_{BO} min: 195V V_{BO} max: 230V
LIC01-215	V_{BO} min: 215V V_{BO} max: 255V



DPAK IPAK

FUNCTIONAL DIAGRAM





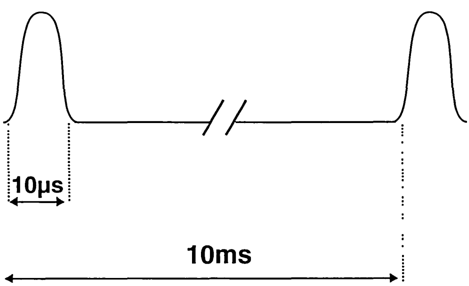
SYMBOL

Pin 1 = MT1
Pin 3 = MT2
DO NOT CONNECT Pin 2
DO NOT CONNECT TAB

ABSOLUTE RATINGS (limiting values)

Symbol	Parameter		Value	Unit
I_{TRM}	Repetitive surge peak on state current	tp = 10µs (note 1)	±50	A
$I_{T(RMS)}$	RMS on state current	T_{amb} = 90°C	1.2	A
di/dt	Critical rate of rise on state current		80	A/µs
V_{DRM} / V_{RRM}	Repetitive peak off state voltage	Tj = 125°C	180	V
Tstg	Storage junction temperature range		- 40 to + 125	°C
Tj	Operating junction temperature range		-20 to 125	°C
T_L	Maximum lead temperature for soldering during 10s		260	°C

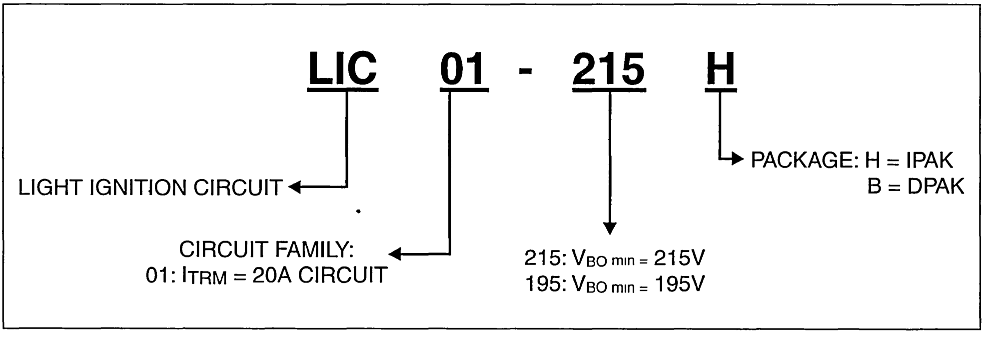
Note 1 : Test current waveform



THERMAL RESISTANCE

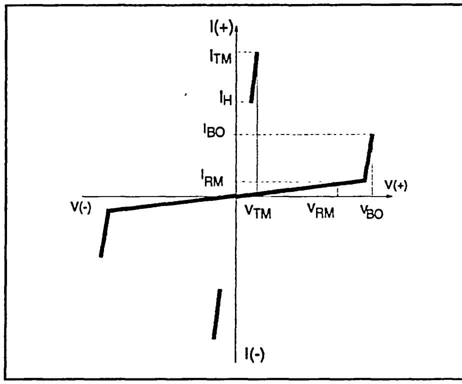
Symbol	Parameter	Value	Unit
Rth(j-a)	Junction to ambient	100	°C/W
Rth(j-c)	Junction to case	3.5	°C/W

ORDERING INFORMATION



ELECTRICAL CHARACTERISTICS

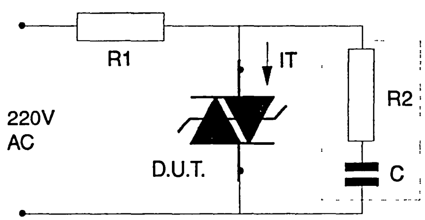
Symbol	Parameters
V_{RM}	Stand-off voltage
V_{TM}	On-state voltage
V_{BO}	Breakover voltage
I_{TM}	On-state current
I_H	Holding current
I_{BO}	Breakover current
I_{RM}	Leakage current

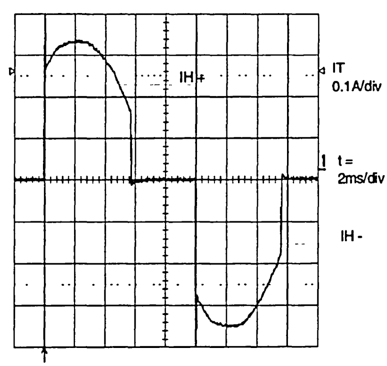


ELECTRICAL PARAMETERS

Symbol	Test conditions				Value	Unit
I_{RM}	$V_D = V_{RM}$ 180V		Tj = 25°C	MAX	5	µA
			Tj = 125°C	MAX	50	µA
V_{BO}	I_{BO}	LIC01-195	Tj = 25°C	MIN	195	V
				MAX	230	
		LIC01-215	Tj = 25°C	MIN	215	V
				MAX	255	
I_{BO}	V_{BO} max.		Tj = 25°C	TYP	200	µA
				MAX	500	
I_H	I_T = 350mA		Tj = 25°C	MIN	50	mA
V_{TM}	I_{TM} = 1A		Tj = 25°C	MAX	5	V

HOLDING CURRENT TEST CIRCUIT

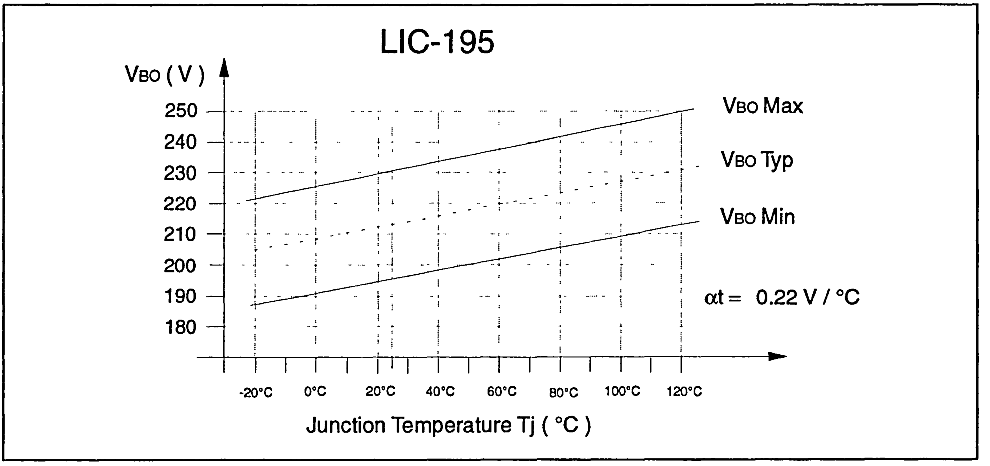




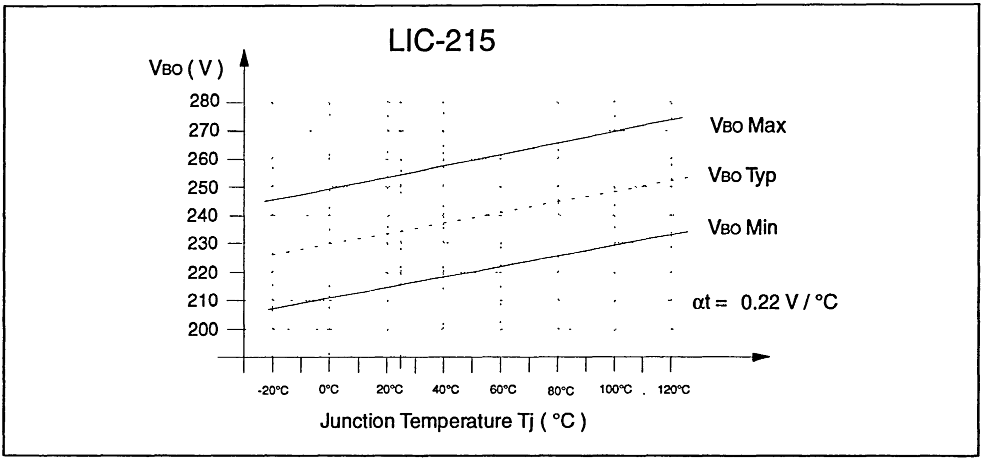
R1 = 1kΩ / 50W (a 220V / 60W bulb can be used)

R2 = 22Ω } Auxiliary network providing the complete
C2 = 220nF } firing of the LIC01 under test

VARIATION OF V_{BO} VERSUS JUNCTION TEMPERATURE

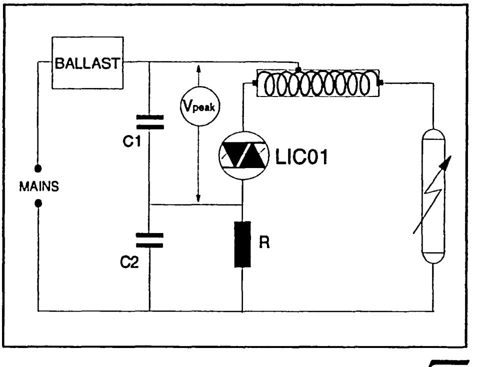


VARIATION OF V_{BO} VERSUS JUNCTION TEMPERATURE



TYPICAL APPLICATION

When the peak voltage across C1 reaches the break over voltage VBO of the LIC01, this device turns on and produces a pulse of current through the primary of the transformer. In turn, the transformer generates high voltage pulses across the lamp.



OTHER INFORMATION

Type	Marking	Package	Weight	Base qty	Delivery mode
LIC01-xxxH	LIC01-xxxH	IPAK	0.4 g	75	Tube
LIC01-xxxB	LIC01-xxxB	DPAK	0.3 g	75	Tube

THE ASD™ TECHNOLOGY

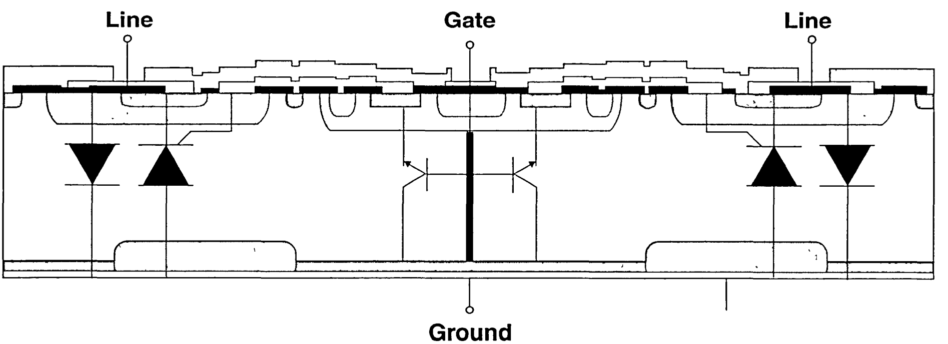
ASD™ TECHNOLOGY

ASD™ TECHNOLOGY OPENS A NEW AREA FOR POWER PROCESSING INTEGRATION

1. ASD™ TECHNOLOGY overview

The ASD™ technology is a unique vertical integrated power technology designed in a full planar process. Its masking process is applied on both sides of the chip offering new design possibilities that are not available with epitaxial base or horizontal architecture.

Fig. 1: Full planar bi-face vertical technology.



A high potential technology

With the ability to combine major power devices for Power Processing in a single architecture, ASD technology offers outstanding global characteristics:

- High bi-directional current up to 100 A/mm² in pulse mode
- High symmetric voltage up to 800V in repetitive AC or DC mode
- High inherent ruggedness especially thanks to its clamping mode with a voltage of up to 1400V or its transient noise immunity of up to 1 kV/µs
- Micro triggering level down to 10 µA.

System oriented circuits

The ASD™ circuits combine several power and signal cells to achieve a power function that has bi-directional current and symmetric voltage capabilities. Using Application Specific Discretes integration skills, an ASD™ circuit is designed to fit the requirements of an application and cut the component count of the whole system. This dedication to the application highlights the ASD™ circuit as a system oriented solution.

2. ASD™ APPLICATIONS

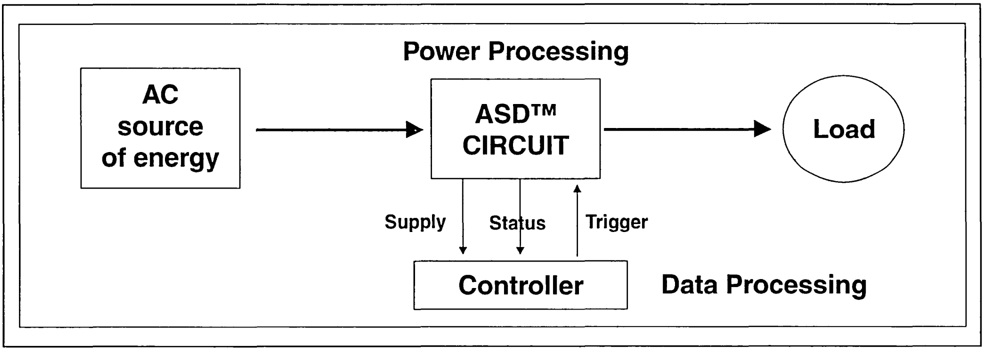
ASD™ technology is the natural way of achieving solid state AC Switching circuits in systems that are directly powered by the mains. Motor drives, solid state relays, electronic starters, and home appliance actuators are examples of some power processing fields illustrating the importance of the ASD™ technology.

New integration possibilities

Because the transient surge disturbances can be bi-directional and very energetic, the ASD™ is also ideal to achieve EMI filters or electrical protections in telecom switchboards, mobile phones, modems, and data bus applications.

Furthermore, the ASD™ is well adapted to fast turn-on applications such as capacitive discharge ignition circuitry where the turn-on current rise is high (50 A/µs). The two-stroke thermic engine ignition for motorcycles, saws, gas ignitors for heaters or cookware, and HID lamp ignitions are a significant applications for this technology.

Fig. 2: Power processing with an ASD™ circuit.

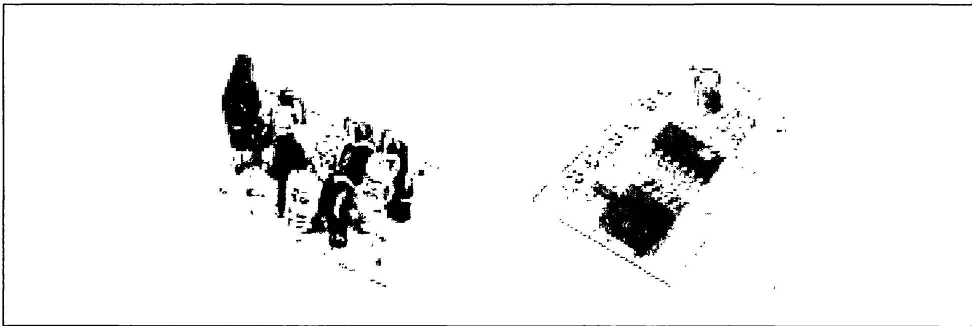


3. Global ASD™ TECHNOLOGY benefits

The ASD™ technology brings significant advantages to the medium power area inherent in integration :

- Improved reliability thanks to a full planar technology that provides outstanding ruggedness to the device.
- Enhanced performance that results from a design dedicated to the application. For instance, filtering skills are greater in the EMI range than discrete circuitry.
- Component count reduction in a ratio of 2 to 6 that is directly produced by integration.
- PCB space and assembly cost reduction which can be achieved without sacrificing the benefits of high voltage and high current density capability associated with discrete components.

Fig. 3: Two PCBs, one using discrete compnents and the other using ASD™ circuit.



Because it is designed specifically for an application, an ASD™ circuit includes not only the required functional features, but also added values that benefit the complete system. Therefore, the ASD™ circuit largely simplifies the system design and shortens the time to bring it on to market.

4. Examples in the AC Power management

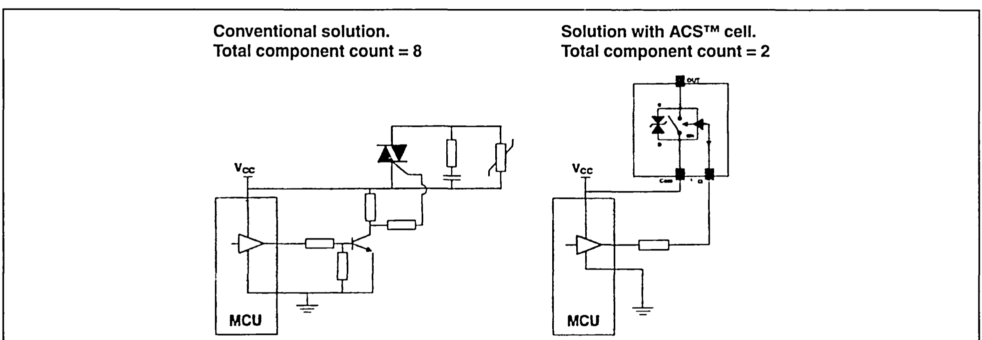
The ACS™, a new AC switching solution

Developed for driving low power AC load in home appliances, the ACS108 device is a 0.8A-500V ASD circuit achieving the functional integration in a monolithic structure of the 3 basic parts of a conventional AC switch function :

- A bi-directional switch of 0.8 A
- A 600V clamping device to protect the switch at turn-off by absorbing the inductive energy of the load (from 2 to 20 mJ)
- A level shifter to separate the micro-controller output and the power switch. It amplifies the MCU output current and filters the stressing transients transmitted through the switch.

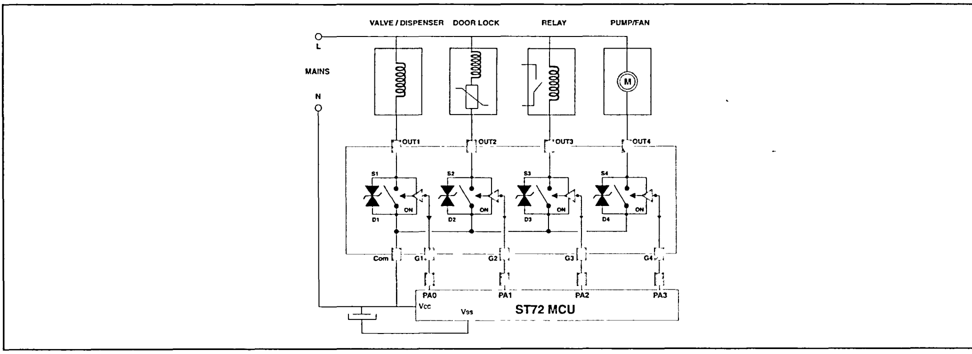
While contributing to the miniaturization of the electronic controller in a household appliance such as washing machines, refrigerators or dishwashers, ACS™ circuits provide more over-voltage ruggedness and thereby enhancing the system's reliability.

Fig. 4: ACS™ drastically reduces PCB size and component count.



Also proposed in an array configuration with the ACS402, this version embeds four 0.2A-500V ACSs, minimizes the component count of the controller and reduces the assembly cycle time of the controller.

Fig. 5: ACS™ drastically reduces PCB size and component count.



The EFS, a starter chip set which increases the life time of fluorescent tube lamps

The EFS02 chip set, called *STARLIGHT-KIT,* is an electronic starter for fluorescent tube lamps, comprising a driver and an ASD™ circuit.

The driver controls the lamp power-up process and drives the ASD™ circuit. It drastically reduces the lamp filament degradation by monitoring accurately the pre-heat time.

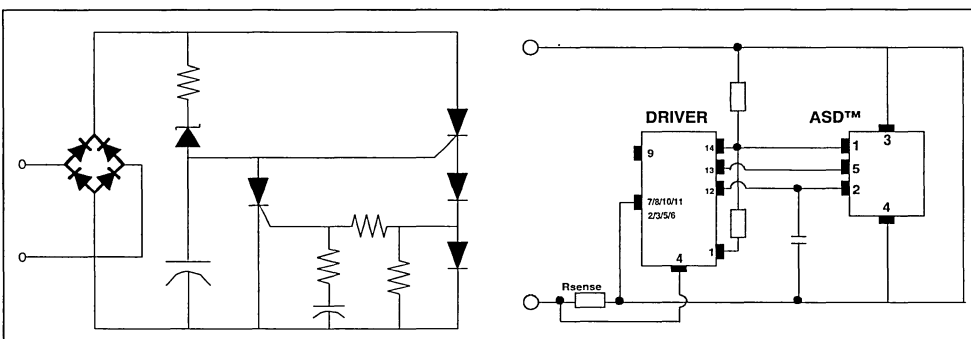
The ASD™ circuit includes, all the power circuits for the starter, in a monolithic device :

- a 1A-800V bi-directional switch
- a 1400V lamp ignitor
- a AC-DC 12V-5mA supply.

During the power-up phase, it drives the pre-heat of the lamp filaments. And, at the end of the pre-heat phase, it ignites the lamp with a 1400V striking voltage, the duration of which is set in function of the temperature to minimize the filament stress.

The *STARLIGHT-KIT* achieves an "off-the-shelf" electronic starter system; it minimizes the board space and the component count (6 in total on the board) of the starter while including all the required functions into the canister.

Fig. 6: The STARLIGHT-KIT offers a component count reduced by 2.



The main advantages offered to the user are the significantly increased lamp life time and the visual comfort provided by the single striking pulse for ignition.

5. Conclusion

ASD™ technology gives designers new possibilities of innovation in AC Power management.

Their high level of integration capability means that ASD™ circuits embed system-on-board solutions with added functions, improved performance and comparatively higher reliability.

Significant production demand for ASD™ technology is now emerging in the fields of household automation and mecatronic AC switching, where new features will be required such as over-current or over-temperature protection.

DESIGN NOTE

DESIGN RULES FOR RELIABLE TRIAC OPERATION

1/ CORRECT TRIGGERING:

To turn a triac ON, the gate drive circuit must supply an "energetic" gate current to ensure fast and efficient firing.

Gate current amplitude:

The gate current (I_G) must be much higher than the specified maximum gate triggering current **(IGTmax)**. This parameter is given at Tj = 25°C.

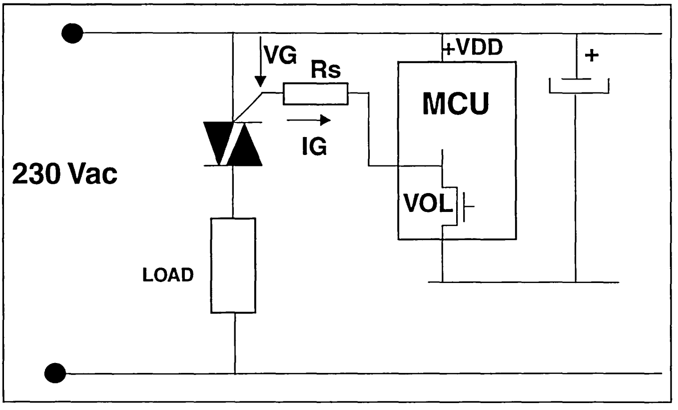
For lower temperatures, use the curve which presents the relative variation of the gate triggering current versus junction temperature. Design the gate driver for the lowest expected operating temperature. A high I_G value provides an efficient firing (see §2).

As a practical rule we recommend:

$$I_G > 2 \cdot I_{GTMAX}$$

Gate circuit design:

Fig. 1: Example of gate drive circuit.



$$Rs = \frac{V_{DD}(\min) - V_{OL} - V_G}{I_G}$$

With : V_{DD} (min) = minimum value of the power supply
V_{OL} = output voltage of the microcontroller (at 0 logic level)
V_G = voltage across the gate of the triac. Take the specified VGT.
I_G = required gate current (IG > 2. IGT max)

Gate current duration:

(For ON-OFF switching)

Pulse operation allows the power consumption of the gate drive to be significantly reduced.

Apply the gate current IG until the load current reaches the latching current (I_L) .

Continuous DC gate current is recommended for low load current (I_T < 50 or 100 mA) to avoid current discontinuity through the load due to the holding and latching currents.

Quadrants:

In new projects, avoid operation in the 4th quadrant in order to use high switching performance triacs (**Snubberless™** and **Logic Level™** series) which are specified in quadrants I, II, and III only.

2/ SMOOTH TURN-ON

When the triac is being turned on, make sure that the rate of increase of the on-state current (dI/ dt) does not exceed the specified maximum value.

It is particularly important to check this point in case of capacitor discharge for example when a **SNUBBER** network is used across the triac.

If the **dI/dt** exceeds the specified value, then the current density around the gate area is too high and generates hot spots. High **repetitive dI/dt** may cause progressive degradation of the silicon die, provoking gate current increasing and loss of blocking capability.

Zero voltage switching drastically reduces the **dI/dt** at turn on and also, in most cases, the **inrush current**.

Reminder:

- A powerful gate current improves the di/dt capability of the triac and provides a reliable turn on commutation: $I_G >> I_{GT}$ (at least 2 or 3 times IGT max).

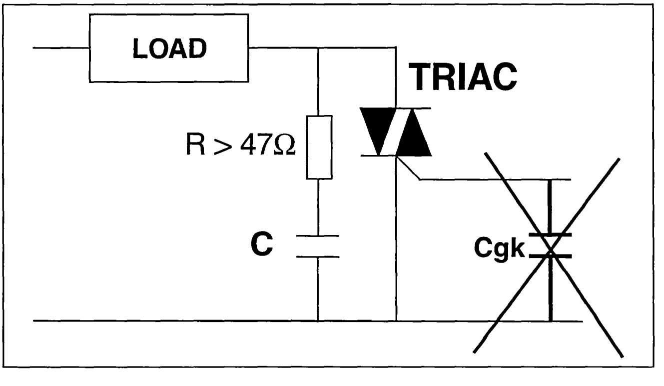
- **In the case of RC** network across the triac, the value of the series resistor R must be sufficient to limit the peak current and the dI/dt through the triac. We recommend:

$$R > 47 Ohms$$

- **Do not use** a capacitor across the gate (Cgk).

This capacitor markedly reduces the dI/dt capability. Moreover this capacitor does not improve the static dV/dt behavior.

Fig. 2: To minimize the dI/dt stress at turn on:
- R must be higher than 47Ω
- No capacitor across the gate (Cgk)



3/ RELIABLE ON-STATE OPERATION.

Continuously control the junction temperature:

$$Tj < Tj \text{ max specified}$$

At every moment, it is crucial to know the current flowing through the device, and therefore the power dissipation.

Evaluation of the power dissipation (P):

- By using the curve P = f(IT_{RMS}) given in the data sheet.
- By calculation of the max power dissipation with the following equation :

$$P = \frac{2 \cdot \sqrt{2} \cdot IT_{RMS} \cdot Vto}{\Pi} + IT^2{}_{RMS} \cdot Rd$$

With: **Vt_o** = threshold voltage of on-state V (refer to the datasheet) characteristic
Rd = dynamic on-state resistance (refer to the datasheet)
IT_{RMS} = current through the triac

Operation without heatsink:

The triac is mounted directly on the printed board without any cooling device.

$$Tj = Tamb + Rth(j - a) \cdot P$$

With : Tamb = maximum ambient temperature
Rth(j-a) = specified thermal resistance junction to ambient (refer to the datasheet)
P = power dissipation of the triac in conduction.

The controllable load current in these conditions is generally **lower than 2 Amps**.

Operation with heatsink:

$$Tj = Tamb + [Rth(j - c) + Rth(c - hs) + Rth(hs)] \cdot P$$

With : Tamb = maximum ambient temperature.
Rth(j-c) = thermal resistance junction to case (refer to the datasheet)
Rth(c-hs) = contact thermal resistance between case and heatsink
Ex: For TO-220 package Rth(c-hs) $\leq$ 0.5°C/W (with thermal grease)
Rth(hs) = thermal resistance of the heat sink .
P = power dissipation of the triac in conduction.

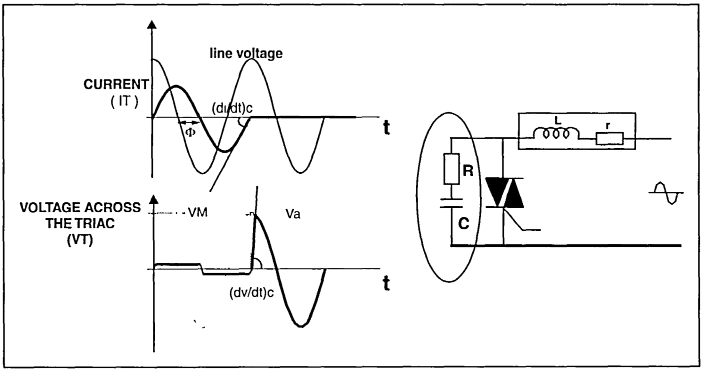
4/ SAFE TURNING-OFF

To guarantee a safe turn-off operation (without risk of re-firing), the component choice is firstly driven by the maximum (dI/dt)c through the application circuit.

1- Case of standard and sensitive triacs.

The monitoring of (di/dt)c is not sufficent. In the case of inductive load, the reapplied **(dV/dt)c** must be limited to the specified value with a RC network (see fig.3).

Fig. 3: (dV/dt)c limitation with a snubber



The maximum permitted value generally ranges from 1 to 20 V/µs (refer to the datasheet).
Practical relations for RC calculation:

$$C > \frac{Va^2}{L \cdot (dV/dt)_C^2} \quad \text{and} \quad R = 0.5\sqrt{L/C}$$

With: Va = line voltage when the triac turns off (Va = V_M . sinϕ).
L = inductance of the load
(dV/dt)c = minimum specified value

2- Case of Snubberless™ triacs.

Check only the max (dI/dt)c specified. The commutation capability is given without **(dV/dt)c** limitation.
No RC network is needed.

Reminder:

When the current is a sine wave (it is generally the case) the (dI/dt)c is:

$$(dI/dt)c = IT_{RMS} \cdot \sqrt{2} \cdot 2\Pi F$$

With: IT_{RMS} = RMS current through the load.
F= mains frequency.

At 50 Hz, the (dI/dt)c is :

$$(dI/dt)c = 0.444 \cdot IT_{RMS} \ (in\ A/ms\ with\ IT_{RMS}\ in\ Amp.)$$

Example: For a 8 A RMS sine current through the load, the rate of decrease of the current at turn off is:

$$(dI/dt)c = 3.5\ A/ms$$

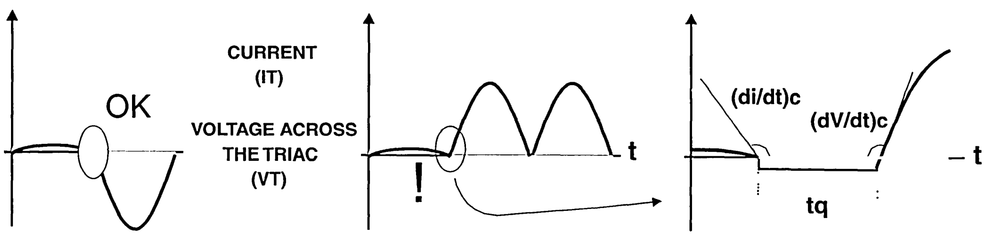
Notice :

In case of non-sinusoidal current waveform, the (dI/dt)c must be carefully measured in the application circuit in order to choose the suitable triac.

Pay particular attention to the case of specific applications such as **universal motor or inductive** load driven through a bridge rectifier.

3- Case of Thyristors.

After the conduction of a thyristor, a delay (tq) has to be kept before a direct voltage be reapplyed across the thyristor (i.e. In the case of a SCR behind a rectifier bridge). Of course if the reapplied voltage is negative, the SCR is naturally turnedd-off in safe condictions. On the other hand, if the voltage is positive, and is reapplied too early or too quickly (dV/dt)c, the thyristor may reconduct spontaneously. Generally this delay is around 50µs for standard thyristors and can reach 200µs for very sensitive SCRs.



If the delay tq can not be lenghtened, the voltage slope (dV/dt)c can be reduced with a snubber network. Note that the tq delay depends also of the decreasing slope of the current at turn off (dI/dt)c, higher is the (dI/dt)c longer is the tq.

5/ KEEPING THE BLOCKING STATE UNDER CONTROL

1- Maximum off-state voltage

The voltage across the triac must always be lower than the specified maximum blocking voltage: V_{DRM} /V_{RRM} in normal operation and V_{DSM} / V_{RSM} for transient overvoltage.

The technology of triacs is optimized for a reliable operation at the maximum voltage rating (V_{DRM} / V_{RRM}). Beyond this value, irreversible degradations of the blocking capability are possible .

Moreover, if the voltage across the triac reaches the breakover voltage (VBO), the device goes into conduction. In most applications, switch-on by overvoltage could have hazardous results on the triac. In fact, this way of firing is uncontrolled, and hot points can occur because of the high instantaneous power dissipation non uniformly distributed over the junction area. In some extreme cases due to the high dI/dt, **the triac failed in short circuit.**

__a- Protection against external transients.__

Triacs must be protected against overvoltages superimposed on the mains.
Use clamping devices (**Transil** diodes or varistor) across the triac to provide additional protection to the **power clamping and filtering stage** generally implemented at the line input of the equipment.

__b- Protection against overvoltage at turn-off.__

Small loads such as relay coils or valves are highly inductive. When the triac turns off, the load is equivalent to a current generator, supplying the holding current (I_H). The interruption of this current generates overvoltage which may reach a dangerous level across the triac.

We recommend these spikes to be limited, below the V_{RSM} / V_{DSM}, by a **VDR** (Varistor) or a **RC network**.

2- Elimination of the risk of unwanted firing.

Spurious triggering can only occur for the following reasons:

- **a- high dV/dt apply across the triac.**
- **b- Noise on the gate.**
- **c- Loss of blocking capability.**
- **d- Overvoltage.**

__a- dV/dt across the triac.__

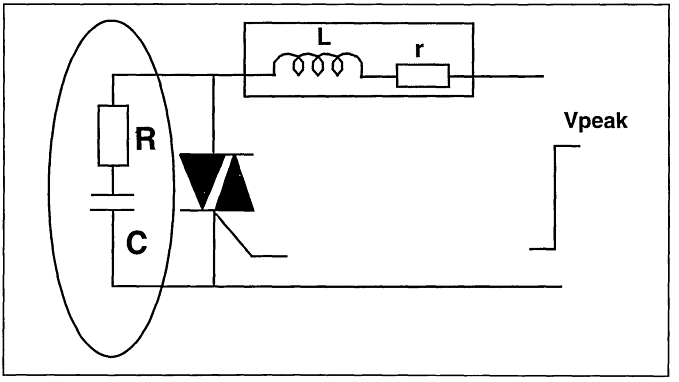
A triac can be turned on by applying a dV/dt higher than the specified value (static dV/dt).
In case of fast transients due to either commutations inside the equipment (specially mechanical switches) or spikes coming from the mains, it is necessary to implement a RC network (snubber):

Practical relations for RC values calculation:

$$C > \frac{V^2 peak}{L \cdot (dV/dt)^2} \quad and \quad R + r = \sqrt{L/C}$$

(dV/dt = max specified value)

Fig. 4: Protection against static dV/dt



Note:

- For a pure resistive load, a small additional inductance is required.
- The existing clamping devices are used to avoid overvoltages, but they do not limit the dV/dt.
- For a triac, a resistor connected in parallel across the gate (RGK) does not greatly improve the dV/dt behavior.

b- Noise across the gate.

The triac remains in blocked state if the voltage across the gate is kept lower than the specified V_{GD} (refer to the datasheet).

On the other hand, a minimum triggering current (**I_{GT} min**) is generally specified. Below this level, it is not possible to turn the triac on.

The gate terminal is a low impedance circuit (< 1 kΩ for sensitive devices and around 100 Ω for others), so these values (VGD and IGTmin) are easy to respect by using the usual rules of decoupling and filtering when implementing the driver circuit.

Avoid connecting a filtering capacitor directly across the gate (see §2)

c- Loss of the blocking capability.

The triac can switch-on spontaneously:

- At off-state, if the junction temperature is too high and exceeds the specified max value.

In this case the leakage current reaches several milliamp and there is a risk of **thermal runaway** and failure of the triac: set up proper cooling (see §3).

- After conduction, if the conditions of commutation from on-state to off-state are not fulfilled: the limits of (dI/dt)c and / or (dV/dt)c are exceeded, or the junction temperature is too high (see §4).

d- Overvoltage.

If the voltage across the triac exceeds the V_{DSM} or V_{RSM} value - even transiently - the device goes into conduction: efficient clamping circuit is required (see §5.1).

CONCLUSION

To take advantage of the performance and the reliability of today's triacs, designers must apply some simple rules, as described in this paper, when developing a new circuit.

The risk of catastrophic failures can be eliminated by turning the triac on under a low rate increase in current (dI/dt) and by implementing an efficient overvoltage protection to avoid breakover firing.

A long life time will be ensured thanks to strict monitoring of the junction temperature achieved by choosing the suitable triac in terms of current rating (expecting the worst case), and by designing an efficient cooling.

Unwanted firings will be avoided by using the right triac offering commutation parameters compatible with the load to be controlled and by designing properly the gate drive circuit to reduce noise across the gate terminal .

In case of transient overvoltages in the circuit, optimized RC network and/or suitable voltage suppressor must be implemented .

ASSEMBLY RULES

ASSEMBLY RULES

SCRs, TRIACs and AC switches: Thermal Management Precautions for Handling and Mounting

INTRODUCTION

The behaviour of a semiconductor device depends on the temperature of its silicon chip. This is why electrical parameters are given at a specified temperature.

To sustain the performance of a component and to avoid failure, the temperature has to be limited by managing the heat transfer between the chip and the ambient atmosphere. The aim of this note is to show how to calculate a suitable heatsink for a semiconductor device and the precautions needed for handling and mounting techniques.

THROUGH - HOLE PACKAGES

I - THERMAL RESISTANCE

1- Review

The thermal resistance of semiconductor assembly is the parameter which characterizes its resistance to the heatflow generated by the junction during operation. A temperature exceeding the maximum junction temperature curtails the electrical performance and may damage the device.

The maximum dissipated power capability is :

$$P_{max} = \frac{Tj_{max} - Ta}{Rth_{(j-a)}}$$

Where:

- Tj_{max} is the maximum junction temperature of the semiconductor in degrees (°C)
- Ta is the ambient air temperature in degrees (°C)
- $Rth_{(j-a)}$ is the thermal resistance between junction and ambient air in°C/W

The Rth(j-a) takes into account all materials between the junction and ambient air.

2- Dissipated power in a thyristor

The maximum mean power dissipation versus the average on-state current curve is given in the datasheet. However, a more accurate result is obtained by using the Vto and Rd values with the following calculation:

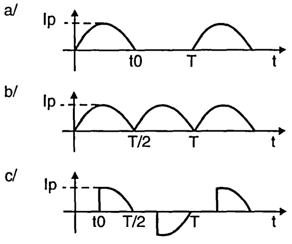
$$P = V_{to} \cdot I_{T(AV)} + R_d \cdot I^2{}_{T(RMS)}$$

Where:

- V_{to} is the threshold voltage specified in the datasheet
- Rd is the dynamic on-state resistance specified Rd in the datasheet
- $I_{T(AV)}$ is the average on-state current
- $I_{T(RMS)}$ is the R_{MS} on-state current

Figure 1 shows the R_{MS} and average values for different waveforms of current.

Fig. 1: RMS and average current.



a/ $I_{T(AV)} = \frac{2.I_p.t_0}{\pi.T}$ $\qquad I_{T(RMS)}^2 = \frac{I_p^2.t_0}{2.T}$

b/ $I_{T(AV)} = \frac{2.I_p}{\pi}$ $\qquad I_{T(RMS)} = \frac{I_p}{\sqrt{2}}$

c/ $I_{T(RMS)}^2 = \frac{I_p^2}{2}\left(1 - \frac{2.t_0}{T} + \frac{1}{2.\pi}\sin\left(\frac{4.\pi.t_0}{T}\right)\right)$

$$I_{T(AV)} = \frac{1}{T}\int_0^T i(t)dt \qquad I_{T(RMS)}^2 = \frac{1}{T}\int_0^T i^2(t)dt$$

3- Dissipated power in a triac

A triac is made up of two thyristors connected back to back. This means we consider the sum of the dissipated power of both thyristors.

The following formula gives the total dissipated power versus $I_{T(RMS)}$ current though the triac :

$$P = \frac{2.\sqrt{2}}{\pi}.I_{T(RMS)}.Vto + Rd.I^2{}_{T(RMS)}$$

For a phase angle conduction the R_{MS} current is shown in figure I c.

Depending on the dissipated power in the component, two types of assembly are possible:

- In the air without external heatsink
- With heatsink

4- Triac without external heatsink

Figure 2 shows the thermal equivalent diagram for a triac without external heatsink.

In practice the imposed parameters are:

- **Ta:** ambient air temperature where the triac is located
- **Rth(j-a):** thermal resistance between junction and ambient air given in the datasheet
- **P :** dissipated power in the triac depending on the used triac and on the load

The following equation defines the junction temperature depending on these parameters:

$$Tj = P\,.\,Rth_{(j-a)} + Ta$$

If this temperature is higher than the maximum junction temperature specified in the datasheet, a heatsink has to be used.

Recommendation: this calculation has to be made in the worst case scenario i.e with the maximum dissipated power, load and line voltage dispersions. We have to consider the maximum ambient temperature around the component i.e. inside the box where the triac is located. The most rigorous way is to determine the thermal resistance between ambient air and the triac location.

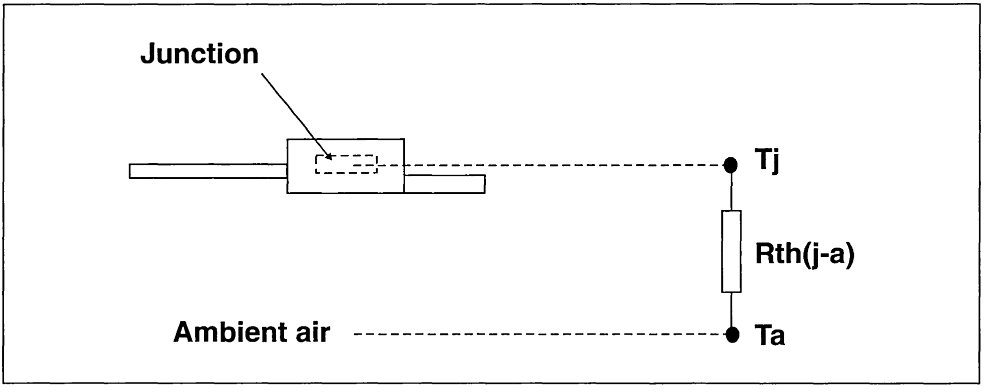
In most cases, the ambient temperature is considered as the temperature around the triac which is the box temperature. This has been done in this paper.

An analogy between Ohm's law and the thermal equivalent circuit can be made:

- Electrical resistance corresponds to thermal resistance
- Current corresponds to dissipated power
- Voltage corresponds to temperature

Thus: U = R.I corresponds to T = Rth.P

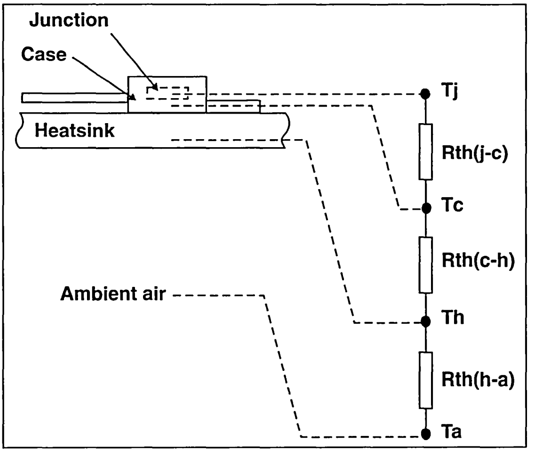
Fig. 2: Thermal equivalent diagram.



5- Triac with external heatsink.

The same approach allows a suitable heatsink to be defined. Figure 3 shows the thermal diagram.

Fig. 3: Thermal equivalent diagram with external heatsink.



The formula to calculate the thermal resistance between heatsink and ambient air is the following :

$$Rth_{(h-a)} = (Tj - Ta) / P - Rth_{(j-c)} - Rth_{(c-h)}$$

Where:

- T_j is the junction temperature in °C
- P is the maximum dissipated power in W
- $R_{th(j-c)}$ is the thermal resistance between junction and case in °C/W
- $R_{th(c-h)}$ is the thermal resistance between case and heatsink in °C/W, depending on the contact case/heatsink.

Since the current alternates in a triac, we have to consider the Rth(j-c) in AC which is different to the Rth(j-c) in DC.

This difference is due to the die of the triac. The first half of the silicon die works when the current is positive, the second when the current is negative. Because of the thermal coupling between these two parts, we use the following equation.

$$Rth_{(j-c)}\ AC = 0.75\ x\ Rth_{(j-c)}\ DC$$

6 - Choice of heatsink

Choosing of a heatsink depends on several parameters: the thermal characteristic, the shape and the cost.

However, in some applications a flat heatsink can be sufficient. Figure 4 on the following page shows the curve Rth(h-a) versus the length of a flat square heatsink for different materials and thickness.

Some applications need heatsinks with a very optimised shape where the thermal resistances are not known.

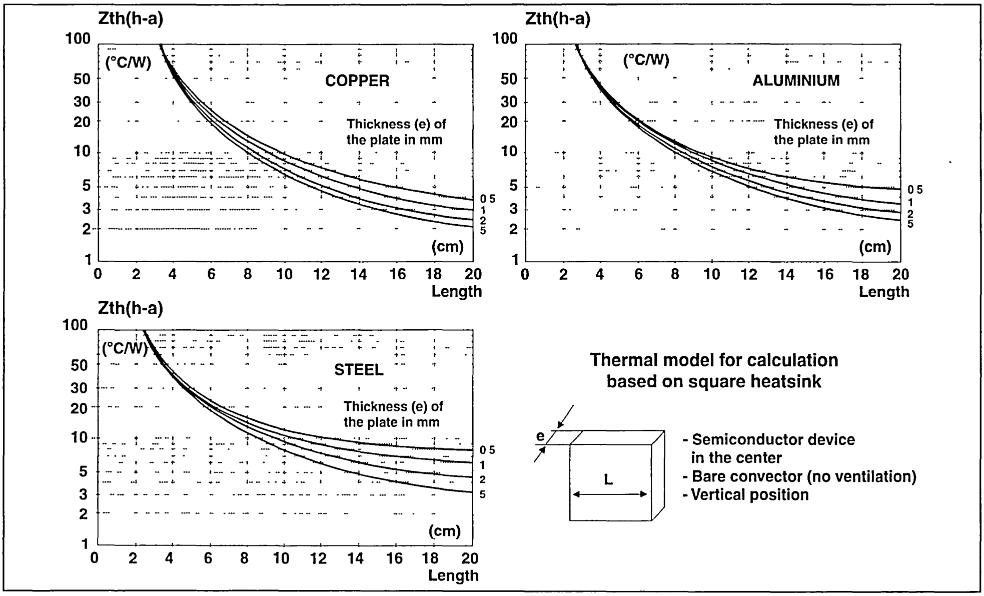
For this, the best solution involves measuring the case temperature of the component in the worst case scenario and keeping to the following formula:

$$Tc < Tj_{max} - P\ .\ Rth_{(j-c)}$$

Where:

- Tc is the case temperature
- Tjmax is the maximum junction temperature
- P is the dissipated power in the component
- Rth(j-c) is the thermal resistance between junction and case.

Fig. 4: Rth(h-a) versus the length of a flat square heatsink.



7- Forced cooling

For high power or very high power, an air-forced or liquid cooling may be needed. Heatsink manufacturers give a coefficient depending on the air or liquid flow.

However in some applications like vacuum cleaners, dissipated power is only a few watts and there is air flow. This allows a very small heatsink to be used, very often a flat aluminium heatsink. In this case it is necessary to measure the case temperature in the worst case scenario and to check the following formula:

$$Tc < Tj_{\max} - P \,.\, Rth_{(j-c)}$$

II - THERMAL IMPEDANCE

In steady state, a thermal equivalent circuit can be made only with thermal resistances. However, for pulse operation it can be useful to consider the thermal capacitance, especially when the component is on during a time lower than the time to reach the thermal resistance. The thermal impedance value versus duration is given in the datasheet (see an example on fig.5), in relation with Zth/Rth relation variation.

For example, BTA08-600SW is able to dissipate 21 W without heating during 1s :

$$P = \frac{Tj_{\max} - Ta_{\max}}{Zth_{(j-a)}}$$

$$P = \frac{125 - 25}{60 x 0.06}$$

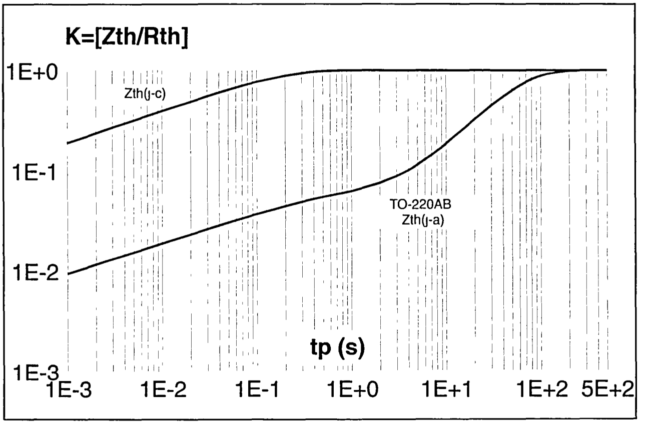
$$P = 27.5\ W$$

In steady state, with the same ambient temperature, the same triac is able to dissipate :

$$P = \frac{125 - 25}{60}$$

$$P = 1.7\ W$$

Fig. 5: Thermal transient impedance of a BTA08-600SW.



III - INSULATING MATERIALS

We can classify them in 3 types as follows :

a - Mica insulators

This has been the most commonly used insulator for many years. Its insulating quality is good, but due to its rigidity the thermal interface is not very good, and needs contact grease on both sides. Because of its rigidity it can be easily broken.

b - Ceramic insulators

More expensive than mica, their thermal resistances are lower. Due to their rigidity, they also need contact grease. However, they can be easily broken, as they are less fragile than mica.

c - Silicon insulators

These materials are not rigid and therefore do not need contact grease. They assume the shape of the component and of the heatsink if sufficient pressure is applied. The problems previously explained disappear. According to manufacturers, the stability in time is much better than with contact grease. However the thermal resistance is higher than the combination of the mica + grease.

Fig. 6: Rth(c-h) for different materials for TO-220AB package.

	CONTACT GREASE	MICA + GREASE e=80µm	MICA DRY e=80µm	SILICONE INSULATOR
Rth(c-h) °C/W	0.5	1.7	4	2.6

Figure 6 shows the thermal resistance for different TO-220AB insulators and for a given pressure (F = 30N).

IV - INSULATED COMPONENTS

Most of the thyristors and triacs manufactured by STMicroelectronics are available in insulated and non-insulated packages. For insulated packages, insulation can be achieved in two different ways, either with a ceramic between the die pad and the heatsink of the component (TO-220AB/TOP3/RD91/ISOTOP packages), or by the resin used for encapsulation (ISOWATT220AB). All insulated packages delivered by STMicroelectronics are in accordance with UL1557 recognition applicable for "electrically isolated semiconductors". The added material increases the thermal resistance between the junction and the case, but the total thermal resistance (Rthj-a) is lower than the one when using a non insulated component with an external insulating material. In addition, it simplifies assembly and reduces the cost.

For two 16 Amps triacs in TO-220AB package, Rth(j-c) AC are the following (in °C/W):

BTA16-600C (insulated version)	BTB16-600C (non insulated version)
2.1 device + 0.5 grease --------- 2.6	1.2 device + 1.7 mica + grease ---------- 2.9

The use of an insulated component results in low thermal resistance between junction and heatsink and reduced assembly costs.

V - HANDLING AND MOUNTING TECHNIQUES:

The use of inappropriate techniques or unsuitable tools during handling and mounting can affect the long term reliability of the device, or even damage it.

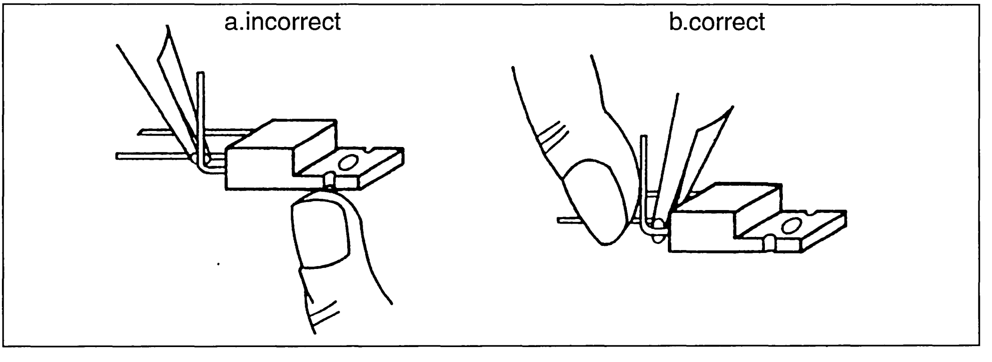
1- Bending and cutting leads.

Lead bending must be done carefully. The lead must be firmly held between the plastic package and the bending point during lead operation. If the package / lead interface is strained, the resistance to humidity is impaired and in addition mechanical stress is inflicted on the die. This damage can affect the long term reliability of the devices.

There are six basic rules to bear in mind :

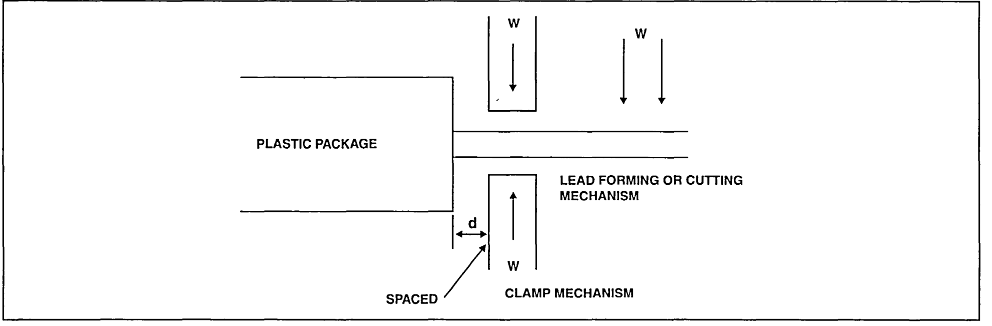
a. Never clamp the plastic package (figure 7a - 7b)

Figure 7a - 7b



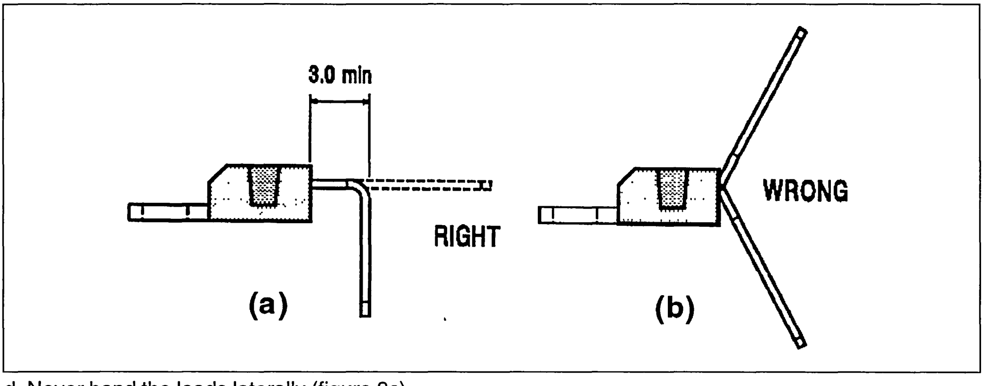
b. Clamp the leads firmly between the plastic package and the bend / cut point (figure 7c).

Figure 7c:



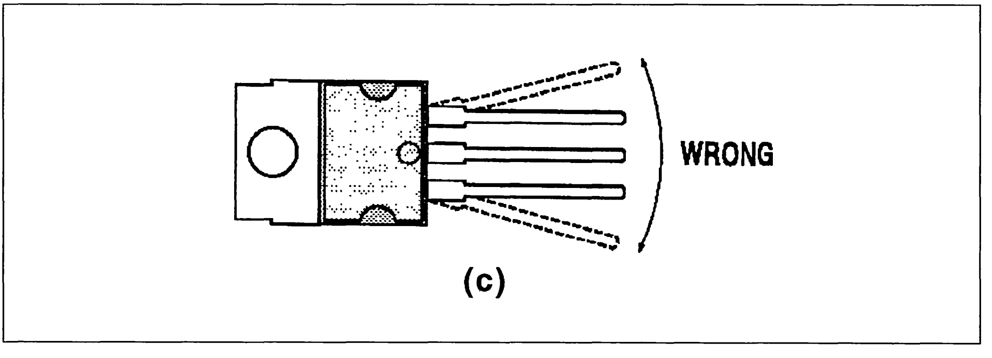
c. Bend the leads at least 3mm from the plastic package (figure 8a -8b).

Figure 8a - 8b



d. Never bend the leads laterally (figure 8c).

Figure 8c



e. Never bend the leads more than 90° and never bend more than once

f. Make sure that the bending / cutting tool does not damage the leads.

2- Using a heatsink

Mounting surface preparation:

- The mounting surface should be flat, clean and free of burrs and scratches.

- The use of a thin layer of thermal silicon grease ensures a very low contact thermal resistance between the component and the heatsink. An excessively thick layer or an execessively viscous silicon grease may have the opposite effect and cause the deformation of the tab.

- The planarity of the contact surface between device and heatsink must be more than 50µm for TO-220AB.

Insertion:

If the heatsink is mounted on the PC board, it should be attached to the component before the soldering process of the leads.

Mounting techniques:

Mounting must be done carefully. Excessive stress may induce distortion of the tab and as a consequence mechanical damage on the die.

Soldering: It is not recommended for through-hole packages.

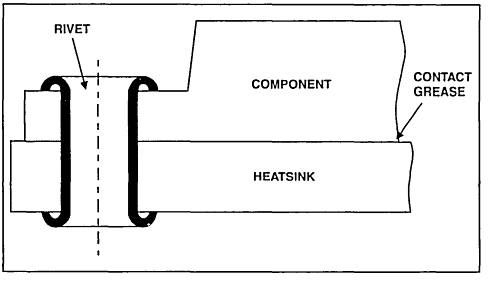
With rivets: Pop rivets should never be used for the following reasons:

- A too rigorous expansion of the metal can lead to a distortion of the heatsink hole and induce mechanical stresses on the die.

- High crimping shock can dammage the die.

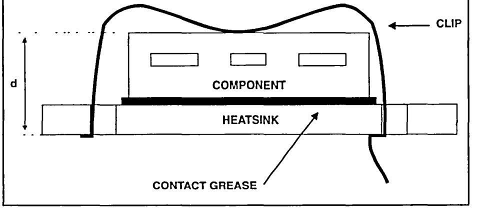
Press rivets can be used with caution provided they are of a soft metal like aluminium. The crimping force must be applied slowly and carefully in order to avoid shock and deformation of the heatsink.

Fig. 9: Assembly with rivet.



With clips: Care shoud be taken with the contact area between the plastic case and the clip: the maximum pressure allowed on plastic is 150N/mm2. Over this value, cracks may be induced in the package. Therefore, the clips have to be round or smooth in the contact area to avoid concentrate loads on the plastic body. The force applied on the component depends on the heatsink and the component thickness, so they must be specially designed to take this value in to account:

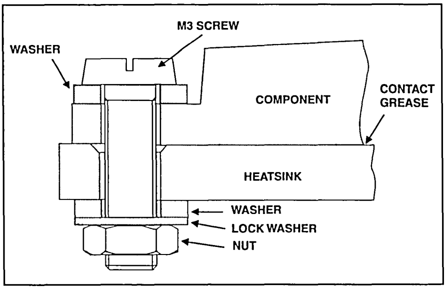
Fig. 10: Clip assembly.



With screws: The following precautionary measures should be taken:

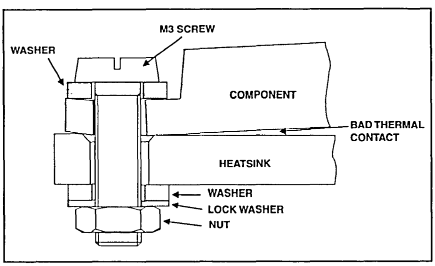
- In order to avoid tab distortion, a rectangular washer must be put between the screw head and the tab, and a compression washer must be put between the tab and the nut.

Fig. 11: Correct assembly.



- Take care to avoid mechanical shock during screwing
- Keep the screw straight
- Appropriate screwing torque should be used, execessive screwing torque may cause the distortion of the tab and induce bad thermal contact. In addition it can generate cracks in the die:

Fig. 12: Incorrect assembly.



The thermal contact resistance depends on the force generated by the applied torque on the screw:

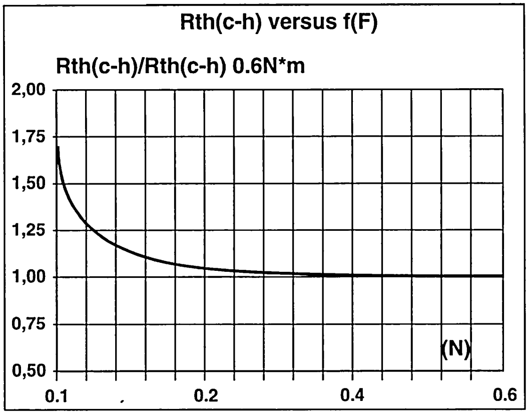
$$F = \frac{2 . T . \pi}{P + r . D . \pi}$$

Where:

- **T:** applied torque on the screw in N.m
- **P:** pitch in m
- **D:** screw diameter in m
- **r:** rubbing factor: # 0.12 for steel-steel with grease and # 0.2 for steel-aluminium

The relative variation of the Rth(j-c) versus the torque for M3 screw used for the TO220AB is:

Fig. 13: Relative variation of Rth(c-h) versus pressure force for TO-220AB.



The table below gives the recommended torque and the thermal contact resistance:

Package	Torque (N*m)	Thermal Contact Resistance (°C/W)
TO202-3	0.5 to 0.7	0.5
TO-220AB	0.4 to 0.6 (*)	0.5
ISOWATT220	0.4 to 0.6	0.5
TOP3	0.9 to 1.2	0.1
RD91	0.9 to 1.2	0.1
ISOTOP™	0.9 to 1.2	0.05

Note (*): For BTB20-xxx, BTB24-xxx and TYNxx40, the maximum torque is 0.5N*m.

VI - SUMMARY

To sustain the performance of a component, the temperature has to be limited by applying simple rules.

1- Dissipated power:

Thyristor : $P = I_{T(AV)} \cdot Vto + R_d \cdot I^2{}_{T(RMS)}$

Triac : $P = \frac{2 \cdot \sqrt{2}}{\pi} \cdot I_{T(RMS)} \cdot Vto + R_d \cdot I^2{}_{T(RMS)}$

2- Junction temperature:

$Tj = P \cdot Rth(j - a) + Ta$

3- External heatsink:

needed if : $Tj > Tj_{max}$

4- Thermal resistance between case and heatsink:

This thermal contact resistance has to be as small as possible. This is done by adding contact grease between the case and heatsink.

5- Insulation:

If insulation is needed, we recommend an insulated component instead of external insulation.

6- Heatsink thermal resistance:

$$Rth_{(h-a)} = \frac{Tj - Ta}{P} - Rth_{(j-c)} - Rth_{(c-h)}$$

7- Handling:

The use of inappropriate techniques or unsuitable tools during handling and mounting can affect the long term reliability of the device or even damage it.

8- Mounting with a screw, rivet or clip:

Screw :

- Advantages:
  - Possibility to insulate and easy and fast to disassemble
- Disadvantages:
  - Slow assembly for mass production, high cost
  - Master control the tightening torque

Rivet :

- Advantages:
  - Fast assembly for mass production
- Disadvantages:
  - Difficult to disassemble
  - Difficult to control the force applied to the rivet

Clip :

- Advantages:
  - Fast assembly and disassembly
  - Easy to control the applied pressure
- Disadvantages:
  - Difficult to place the component

SURFACE MOUNT PACKAGES

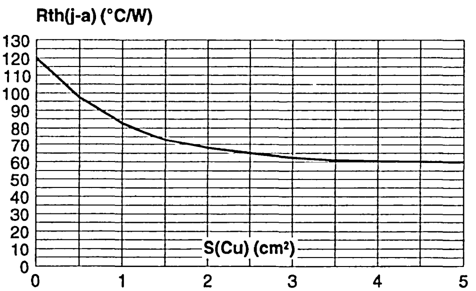
I - THERMAL CHARACTERISTICS

1- Thermal resistance

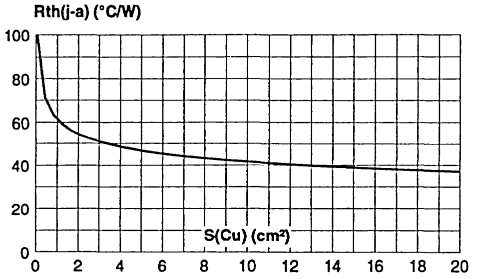
The thermal resistance of a semiconductor device characterizes the device capability to dissipate the heat generated by the chip during operation. This parameter allows us to calculate the junction temperature, taking into account the device environment (load current, ambient temperature, mounting conditions etc...).

For SMDs, the thermal resistance between junction and ambient, called Rth(j-a), depends on the copper surface used under the tab. Below, are the curves giving the relation between Rth(j-a) and the copper surface under the tab for a FR4 board - 35µm copper thickness:

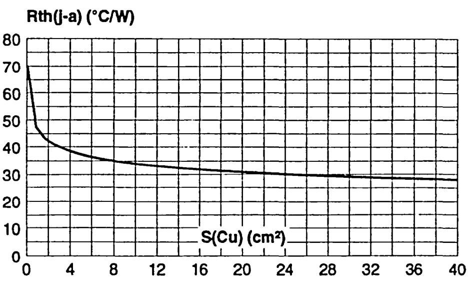
SOT-223



DPAK



D²PAK



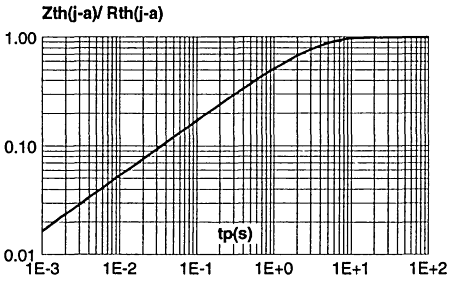
2- Thermal impedance

When dealing with short duration pulses, the thermal impedance must be considered to calculate the junction temperature. Depending on the time scale, the following elements are thermally prevalent:

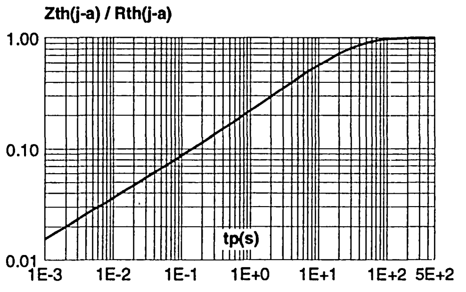
- tp < 500ms : die influence
- tp < 0.1s : package influence
- tp < 10s : PCB influence
- above 10s : thermal exchange board-air (example: with / without force cooling)

The figures on next page show the Zth / Rth ratio for SMD packages

Relative variation of thermal impedance junction to ambient versus pulse duration

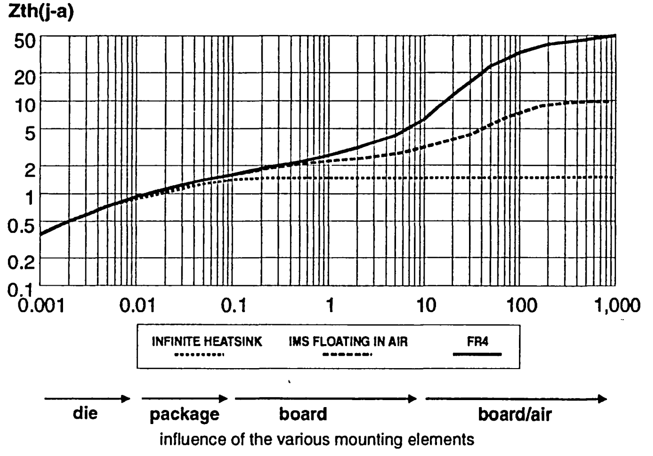


SOT-23



SOT-223

Typical Zth(j-a) for DPAK and D^2PAK

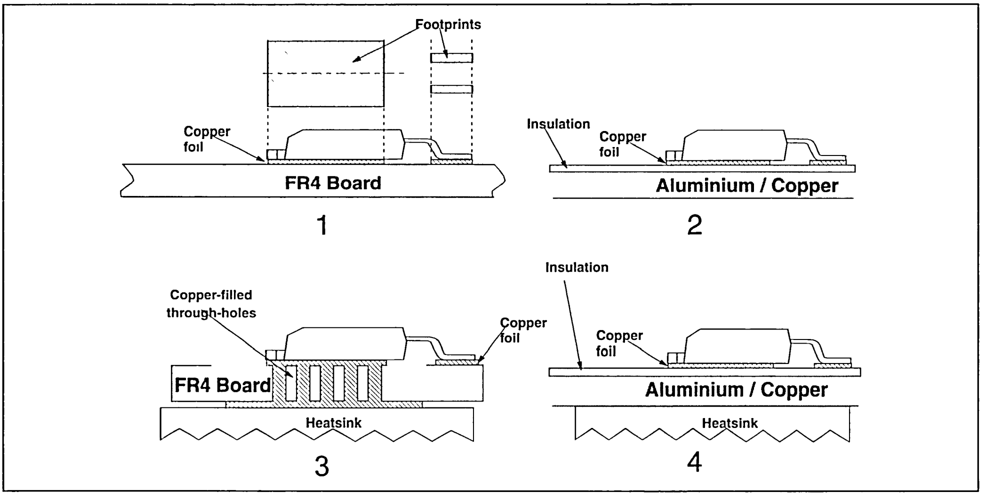


3- Mounting Techniques and Rth(j-a)

Rth(j-a) varies with the mounting technique. Several can be used depending on the performance required in the design. Four techniques are commonly used:

- FR4 - Copper
- IMS (Insulated Metal Substrate)
- Aluminum
- FR4 board with copper filled through holes + HEATSINK
- IMS + HEATSINK.

Mounting techniques for power SMDs



As the FR4 board is commonly used in surface mounting techniques, there are several ways of overcoming its low thermal performance:

- The use of large heat spreader areas (heat sink) at the copper layer of the PCB.
- The use of copper-filled through holes in addition to an external heatsink for an even better thermal management.

However, due to its power dissipation limitation, using the FR4 board with these techniques is only advisable for currents up to 8 Amps max.

A new technology available today is IMS - an Insulated Metallic Substrate. This offers greatly enhanced thermal characteristics for surface mount components. IMS is a substrate consisting of three different layers :

- (I) the base material which is available as an aluminum or a copper plate
- (II) a thermal conductive dielectric layer
- (III) a copper foil, which can be etched as a circuit layer.

Even if a higher power is to be dissipated, an external heatsink can be applied leading to an Rth(j-a) of 4.5°C/W (see table 1 below) assuming that Rth (heatsink-air) is equal to Rth (junction-heatsink). This is commonly applied in practice, leading to reasonable heatsink dimensions. Often power devices are defined by considering the maximum junction temperature of the device. In practice, however, this is far from being exploited.

The designer should then carefully examine the appropriate mounting method (see table 1) to be used according to the dissipated power. The type of board wil influence the thermal performance of the system. Table 1 shows the Rth(j-a) depending on the mounting techniques for DPAK and D²PAK.

TABLE 1: Rth(j-a) for DPAK and D²PAK

MOUNTING METHOD	Rth (j-a)	
	DPAK	D²PAK
FR4	70°C/W	50°C/W
FR4 with 10cm2 heatsink on board	40°C/W	35°C/W
FR4 with copper filled holes & external heatsink	13°C/W	12°C/W
IMS (40cm2) floating in air	9°C/W	8°C/W
IMS with external heatsink	4.5°C/W	3.5°C/W

II - SOLDERING INFORMATION

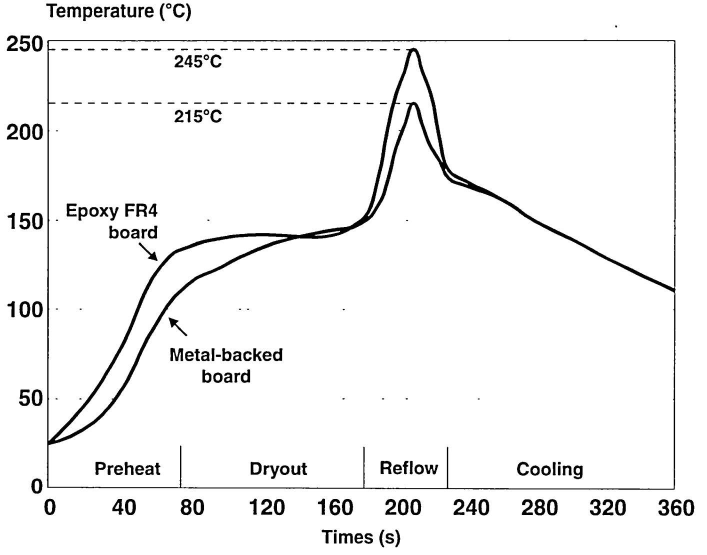
The Surface Mount assembly is a 4-step process :

- solder paste printing
- component placement on the board
- reflow soldering
- cleaning (optional)

The soldering process causes considerable thermal stress to a semiconductor component. This has to be minimized to assure a reliable and extended lifetime of the device. SOT-23, SOT-223, SO-8, DPAK and D²PAK packages can be exposed to a maximum temperature of *260°C for 10 seconds* . Overheating during the reflow soldering process may damage the device, therefore any solder temperature profile should be within these limits. As reflow techniques are most common in surface mounting, typical heating profiles are given in Figure 14 for SOT-23, SOT-223, DPAK and D²PAK package family, either for mounting on a FR4 or on metal-backed boards (IMS).

Wave soldering **is not advisable for DPAK and D²PAK because it is almost impossible to contact the whole package slug during the process.**

Fig. 14: Reflow soldering heat profile temperature



For each individual board, the appropriate heat profile has to be adjusted experimentally. The current proposal is just a starting point. In every case, the following precautions have to be considered :

- Always preheat the device. The purpose of this step is to minimize the rate of temperature rise to less than 2°C per second in order to minimize thermal shock on the component.

- Dryout sections ensure that the solder paste is fully dried before starting reflow step. Also, this step allows the temperature gradient on the board to be evened out.

- Peak temperature should be at least 30°C higher than the melting point of the solder alloy chosen to ensure the quality reflow. In any case the peak temperature should not exceed 260°C.

Voids pose a difficult reliability problem for large surface mount devices. Such voids under the package result in poor thermal contact and the high thermal resistance leads to component failures.

Coplanarity between the substrate and the package can be easily verified. The quality of the solder joints is very important for two reasons :

(I) poor quality solder joints directly result in poor reliability

(II) solder thickness affects the thermal resistance significantly. Thus, tight control of this parameter results in thermally efficient and reliable solder joints.

QUALITY AND RELIABILITY

QUALITY AND RELIABILITY

1. INTRODUCTION

To offer strategic independence to our partners worldwide as a profitable and viable broad range semiconductor supplier, **STMicroelectronics** has committed to produce and provide products and services of the highest quality, while ensuring total customer satisfaction.

This strategy is supported by **Total Quality Management (TQM)**:

- **TQM** is a way of managing all aspects of a business to achieve the best results for the shareholders by providing customer satisfaction and employee motivation at the lowest achievable cost, through the practice of continuous improvement and defect prevention, involving all employees in the corporation.
- **TQM** is a practical way of working and is implemented as part of the day to day managerial process. It is not an addition to the normal management load, but a better way of coping with the load.
- **TQM** is owned and implemented by all line management. It is not delegated.
- **TQM** is the Top Management providing the guidance and leadership, mobilizing all its determination and intelligence to effectively involve every level of the organization in quality management practices.
- **TQM** leadership provides visible hands-on commitment and involvement, and must be demonstrated in daily conduct and decisions. Words will not be effective. Actions will be.
- **TQM** is market driven and people oriented. It is dynamic, flexible and innovative. It is systematic and also encourages entrepreneurship.

THE FIVE KEY PRINCIPLES OF OUR TQM INITIATIVE

MANAGEMENT COMMITMENT	1	PLAN (DIRECT DRIVE)
	2	DO (DEPLOY, SUPPORT, PARTICIPATE)
	3	CHECK (REVIEW)
	4	ACT (RECOGNIZE, COMMUNICATE, REVIEW)
EMPLOYEE EMPOWERMENT	1	TRAINING
	2	SUGGESTION SCHEME
	3	MEASUREMENT AND RECOGNITION
	4	EXCELLENCE TEAMS
FACT-BASE DECISION MAKING	1	SPC (STATISTICAL PROCESS CONTROL)
	2	DOE (DESIGN OF EXPERIMENT), FMEA (FAILURE MODES AND EFFECTS ANALYSIS)
	3	THE SEVEN STATISTICAL TOOLS
	4	TOPS (FORD 8D - TEAM ORIENTED PROBLEM SOLVING)
CONTINUOUS IMPROVEMENT	1	SYSTEMATIC MEASUREMENT AND FOCUS ON CONQ (COST OF NON QUALITY)
	2	EXCELLENCE TEAMS
	3	CROSS-FUNCTIONAL PROCESS MANAGEMENT
	4	ATTAIN, MAINTAIN, IMPROVE STANDARDS
CUSTOMER FOCUS	1	SUPPLIER PARTNERSHIP
	2	SERVICE RELATIONSHIP WITH INTERNAL CUSTOMERS
	3	NEVER COMPROMISE QUALITY
	4	CUSTOMER DRIVEN STANDARDS

2.QUALITY POLICY

To meet this quality target, a company quality policy has been implemented by the Top Management, creating an environment for the continuous improvement of quality to achieve **zero defects** in our products and services.

The main points of our policy are:

- Customers' needs and requirements must be met through a market driven approach to business.
- Quality must be incorporated in and built-in to be prevention driven instead of correction driven.
- Processes must be kept under strict control, using **SPC** (Statistical Process Control) as the basic tool.
- Quality systems must meet **ISO9000 / QS9000** requirements.
- Training on quality is a basic motivation and improvement tool.

3. QUALITY IN DESIGN

Manufacturing and reliability are considered at the Design level in order to manufacture reliable products which meet customers expectation.

The flow chart followed by each new product includes three main reviews:

- **NPR:** New Product Review
- **DR:** Design Review
- **QR:** Qualification Review

Each new product begins with the preparation of a target specification, and a document called a **New Product Review** (NPR) which contains business and technical details.

Once the NPR is approved, the designers start the development of the new product. When the design is complete and the first working samples are available, evaluations are carried out (electrical characterization / construction analysis) to make sure the design is robust.

The next step, the **Design Review** (DR), includes:

- Feedback from the customers regarding the engineering samples in the application.
- Evaluation results on the first working samples.
- A **Design Failure Mode Effect Analysis** (DFMEA) in order to evaluate potential failure modes and define preventive actions.

The last step before production commences is the **Qualification Review** (QR) which includes :

- Characterization reports
- Reliability reports
- The results of the Process FMEA and Equipement FMEA if required
- Flow chart and operating procedures for the full production.

At this step, the **Qualification Package** is available for customers to ensure the ability of the new product to meet the market requirements.

During the first months of production, specific attention is paid to the in-process control through a **Pre-Launch Control Plan** which includes tightened controls.

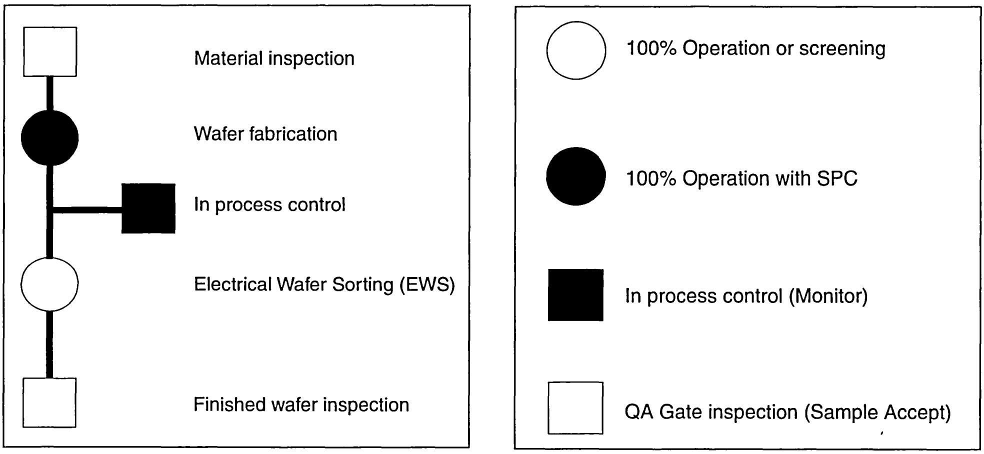
4. QUALITY IN PROCUREMENT

All internal STsuppliers must be certified or in the process of being certified **ISO9000**.

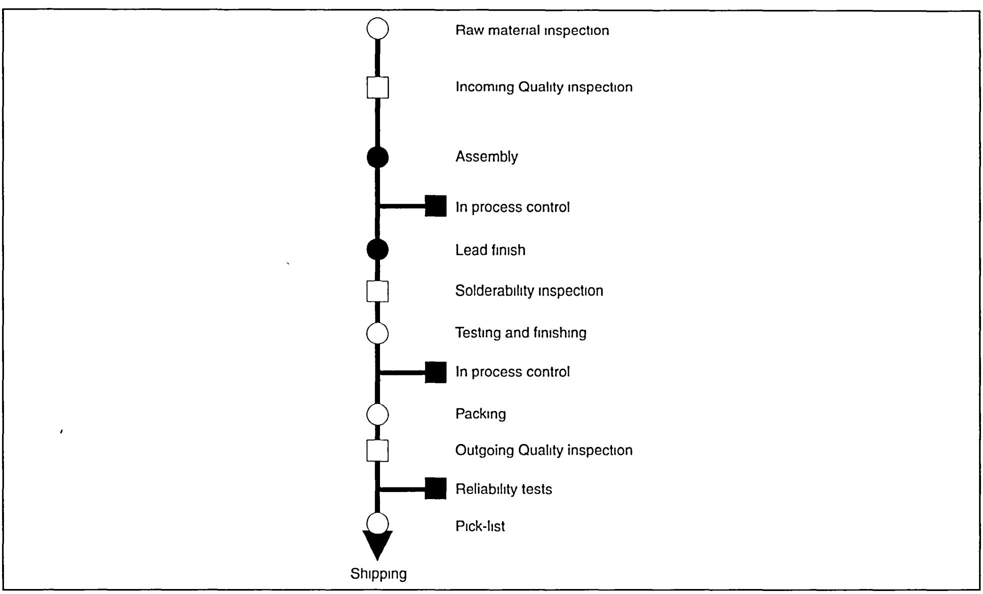
All strategic suppliers are requested to follow a continuous improvement program with STMicroelectronics. Such programs are periodically reviewed using the Corporate Certified Materials Supplier Quality.

5. QUALITY IN PRODUCTION

5.1. WAFER FAB TYPICAL FLOW-CHART



5.2: TYPICAL ASSEMBLY PROCESS FLOW-CHART



A great deal of attention is paid to automation which, being more than a productivity improvement tool, is a major contributor to the yield and as a consequence of the quality breakthrough.

To keep this process under strict control, STMicroelectronics uses **Statistical Process Control** (SPC) techniques supported by a computer system for data collection and analysis.

Fact based problem-solving process are used in resolving process and product problems.

All operating procedures and appropriate control procedures are in a documented control system which is described in the chapter “Documentation”.

A **Total Productive Maintenance** (TPM) is the basis for achieving capacity optimization, cycle time, yield and low variability in the manufacturing. This TPM empowers the operators to repair and maintain the equipment on which they are working.

All operators are formally trained and must be recertified at least every 12 months.

Assembly level reliability is performed after assembly and electrical testing. It is done every week on a small sample, to monitor the reliability of any product and to detect any drift in the production which could induce early failure at the customer.
The tests are described in chapter 11 “Reliability”

5.3.OUTGOING QUALITY INSPECTION:

All products are submitted to the outgoing **Quality Control inspection** (QC) according to the acceptance levels below:

Parameters	Minimum sample size	Acceptance number
Visual and mechanical	315	0
Electrical	200	0

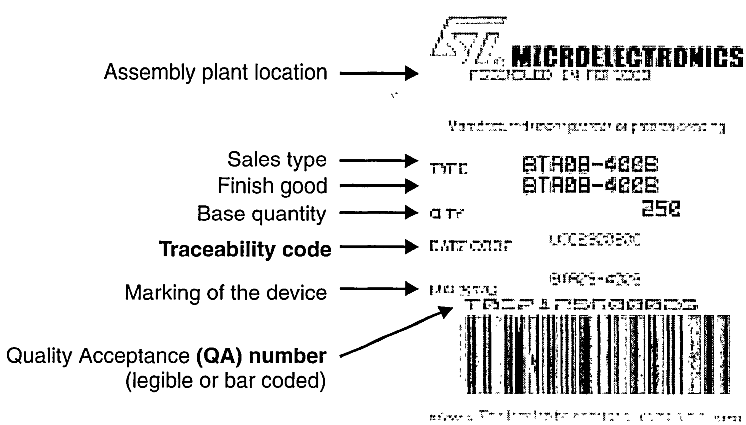
6. TRACEABILITY / LABELLING

The ability to access to historical records of a manufacturing process is needed to identify causes of defects, in order to monitor corrective actions for problems and implement continuous improvement.

This traceability is available for each production lot and each shipment lot through the labelling.

The **QA number** and the **tracability code** printed on the packing labels ensure backward traceability from the lot sent to the customer at each step of the process: In/Out dates and quantity at diffusion, assembly, test and final store.

Likewise, forward traceability is able to trace a lot history from the wafer fab to the final customers.



The **traceability code** printed on the label is designed to be short enough to be marked, except in case of limited area on the devices.

It consist of: **W A T N N Y Y W W C**

Where:

W = Wafer fab site
A = Assembly site
T = Test site
N N = Lot sequential number, linked to the EWS lot number
Y Y W W = Date of constitution of the assy lot
C = Country of assembly

The **QA number** or bar code consist of 12 digits:

1 = Product level or subcontractor code
2 = Last digit of the year
3 = Site code
4, 5 = Week of labelling
6, 7, 8 = Sequential number for the lot
9 - 12 = Sequential number for boxes

7. PROCESS CHANGES

To support market requests, process and product improvement is required.

It is STMicroelectronics' responsability to ensure that any change does not affect the customers, and to keep them informed of all major changes.

In this way, a **Process Change Notification** (PCN) is sent to the customers at least three months before the change (6 months for Automotive customers).

It includes the description and the reason of the change, the provided advantages, the internal qualification plan timing for the effective date of change, and the lot of affected products.

A qualification report is available for customers to verify with confidence the ability of the new process to meet the market requirements.

8. DOCUMENTATION

Standard Operating Procedures (SOP) define the way in which corporate policies are implemented. In conjunction with the Quality manual, they give instructions for all users.

All STMicroelectronics' documents are managed in computerized system which is call **Advanced Document Control System** (ADCS).

Thanks to the private network **ST-NET**, the system provides a means of approving specifications to all sites in real time. At the release of a new SOP, the users are informed by Electronic mail and the document is available worldwide to any user possessing the security authorization.

9. ENVIRONMENTAL POLICY

STMicroelectronics' "Ecological vision" is to become a corporation that approaches environmental neutrality.

With this in mind, we will meet all the local ecological / environmental requirements of those communities in which we operate.

To achieve this, each site has a specific environmental policy. This policy uses the Corporate environmental policy as a guideline.

All class 1 **Ozone Depleting Substances** (ODS) have been eliminated.

All ST Microelectronics' sites are in accordance with the **EMAS** standards and **ISO14001** environmental standard.

Remark: *see environmental protection information on ST's web site at http://www.st.com*

10. CUSTOMER SUPPORT

Meetings with customers allow quality results and trends to be reviewed, the promotion of corrective actions, and the presentation of new quality goals.

The increasingly severe requirements of the market have made **accurate analysis** and **prompt feedback** to the customers a very high priority .

To achieve this, each site has a **failure analysis laboratory** which identifies if detected failures are induced by manufacturing defects or by operating devices outside the maximum rating limits.

In the first case, feedback to the customer is given using the **"problem solving method"** including containment actions, the root cause and corrective and preventive actions.

This analysis helps STMicroelectronics to improve its manufacturing process.

In the second case, feedback is given to the customer with the support of the **Application and System Engineering department** which helps the customer to modify the application board and to improve the quality of its products.

11. RELIABILITY

In a customer's application, semiconductor devices must work properly under the given operationnal conditions throughout the specified life of the product.

In this way, ST Microelectronics exercises meticulous care in the design level and during the manufacturing stages, and studies the various factors that affect the reliability of the device such as operational and environmental conditions.

11.1. RELIABILITY TEST PROCEDURES

- **Assembly Level Reliability / Real Time Control Test (R.T.C tests):**

It is performed after assembly and electrical testing on a small sample in order to monitor the reliability of any product. The main objective is to detect any device which would fail in the early stages of use. These failures, called "infant mortality", are usually related to assembly defects. It is done on a **weekly basis,** and allows us to react in the case of abnormal situations.

- **Long term reliability tests:**

They are usually performed on a small sample for long periods under highly accelerated conditions. The purpose is to cumulate data. Duration is aligned on internationnal standards: 1000 cycles, 1000 hours etc.. On some dedicated products, this duration is increased in order to investigate wearout failures and define the limit of the products.

These tests are selected according to the knowledge of the application conditions and the failure mode effect analysis performed at the design/ development.

Every reject is subjected to a failure analysis to determine the root cause, and the results are used for process and product improvement.

The tests are divided into three main families called the **"die-oriented test"**, **"die and package oriented test"** and **"package oriented test"**.

For **surface mount devices**, a **preconditioning** of the device is performed before all reliability tests in order to simulate the assembly conditions at the customer.

The following chapter, "Reliability test description", provides the relevant information on usual terms for reliability, acceleration factors, and describes the most widely used tests for SCR's TRIACS and ASD's.

11.2. RELIABILITY TEST DEFINITIONS

- **Failure point:** Physical localisation of failure.
- **Failure process:** Physical or chemical or other mechanism resulting in failure.
- **F I T:** Failure unit ; 1 fit = 1 failure in 10^9 devices - Hours.
- **Failure rate:** Also called "Lambda - λ" ; it is the incremental change in the number of failures per associated incremental change in time. Failure rate is expressed in fits.
- **Accelerating factor:** the physical or chemical factor increasing the failure rate.
- **Confidence level:** a 60% confidence level means there is a 60% probability that the failure rate of a sampling does not exceed the given failure rate of the population.
- **Arrhenius law:** Temperature is one of the main factors affecting reliability. The failure rate increases rapidly with the junction temperature following the Arrhenius law:

with: $\lambda = \lambda o\ e - ^{Ea/K(Tj-To)}$

λ = failure rate at Tj

λo = failure rate at To

K = Boltzmann's constant = 8.62 10-5 ev/K

Ea = activation energy

The typical activation energy for SCR's and Triacs is 1 eV.

- **FIT calculation:** Suppose we have one failure out of 7000 devices tested for 10000 hours, the result is:

$$\lambda = \frac{1\,failure}{7000\,devices \times 10000\,hours} \times 10^9 = 14\,FIT\ or\ 14\,failures\ per\ 10^9\ device\ hours$$

With this example, it is quickly apparent that test conditions are required to accelerate the failure mechanism. It is the basis for accelerated stress used for the reliability tests.

These tests are performed in more severe conditions than the ones of the customer application.
It is possible to correlate the results of the accelerated-stress tests with the estimated failure rate in the customer application by using the confidence level and the accelerating factors:

The formula giving the estimation of failure rate is:

$$\lambda = X_B^2(2P + 2) / 2NtQ$$

With: P = Number of defect

$X_B^2(2P + 2)$ = X 2 value for a confidence level "B"

N = Number of components tested

t = Duration

Q = Accelerating factor

Example of calculation:

- Tests conditions and results

N = 100

P = 1

t = 2000 hours

Tj = 125°C

- Customer conditions:

Tj = 55°C

The accelerating factor (Q) between 125°C and 55°C is given by the Arrhenius law.
If Ea = 1ev, we have Q = 500 with a confidence level of 90%, $X_B^2(2P+2) = 7.8$
In these conditions, the failure rate at Tj = 55°C established with a confidence level of 90% is lower than:

$$\lambda \leq \frac{7.8}{2.100.2000.500} \times 10^9 = 39\,FITS$$

11.3. RELIABILITY TEST DESCRIPTION

DIE ORIENTED TESTS:

Test description	Failure point	Failure process	Acceleration factors
High Temperature Storage (HST) 1000Hrs - Ta=150°C MIL STD 750C.1032	Metallization	Contact degradation Corrosion	Temperature
High Temperature Reverse Bias (HTRB) 1000Hrs - Tj=125°C V=VDRM rated MIL STD 750C.1027	Passivation layers and silicon interfaces	Surface charge accumulation	Temperature Electrical field

DIE AND PACKAGE TESTS:

Test description	Failure point	Failure process	Acceleration factors
Thermal fatigue $\Delta t_C = 55°C \pm 5°C$ Tj = Tj max 10000 cycles MIL STD 750C. 1037	Die attach	Contact degradation	Case temperature variation
Thermal cycling-55°C + 150° 1000 cycles MIL STD 750C.1051-2	Die passivation Die attach Insulating voltage	Thermal mismatch between die and package	Temperature variation

PACKAGE ORIENTED TESTS:

Test description	Failure point	Failure process	Acceleration factors
Temp. Humidity bias 80°C 85% RH (THB) 1000Hrs V= 100VDC CECC 90000 4.6.3 Cond.1	Die periphery Metallization	Poor hermeticity Contamination Corrosion	Humidity, Temperature
Pressure cooker test (PCT) 135°C 100% RH 67Hrs 3atm	Die periphery Metallization	Poor hermeticity Contamination Corrosion	Temperature, Pressure
Solderability 245°C 5s 1H steam aging MIL STD 750C.2026	Lead surface	Plating or dipping process material	Aging humidity, Temperature

Notes:

1/ For **surface mount** devices, the **preconditioning** is done before all reliability tests:

- Bake at 125°C / 24Hrs
- Moisture soak 85°C / 85% / 168Hrs accordingly to sensibility level 1, JEDEC A112-A
- Dipping in oil bath at 230°C / 40 secondes - 3 times

2/ For **ASD's**, in addition to those standard reliability tests, **functional tests** are performed **to simulate device operating conditions** in the specific customer application.

11.4. EFFICIENCY OF RELIABILITY TESTS:

Since the high cost and availability of test equipments are major factors, it is necessary to optimise reliability tests mainly for the qualification of a new product and changes in technology.

Efficiency of the tests is summarized in the table below:

RELIABILITY TEST	PROCESS STEP				
	DIFFUSION	PASSIVATION	DIE SEPARATION	METALLIZATION DIE & ATTACH	MOLDING
Thermal fatigue	0	0	0	++	0
High temp.Reverse bias	+	++	++	0	+
Thermal cycling	0	+	++	++	+
Storage	+	+	0	+	+
Humidity test	0	+	+	+	++
Thermal shocks	0	+	+	0	++
Pressure cooker test	0	+	0	+	++

Key: ++ High probability to detect a fault
\+ Medium probability to detect a fault
0 Low probability to detect a fault

11.5. RESULTS:

Annual results are given, on request, for each SCR and Triacs family.

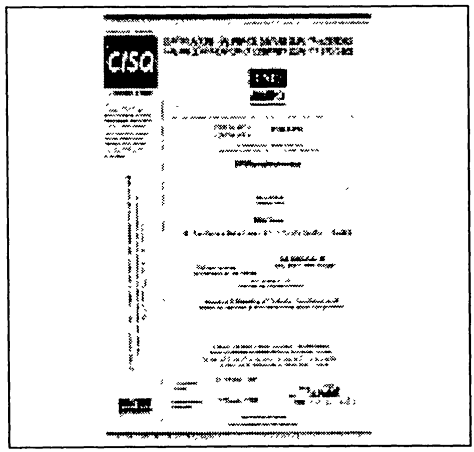
12. CERTIFICATION AND RECOGNITION

As a result of the Quality and Environment Management System, STMicroelectronics' business sites are **ISO9001 / QS9000** and **ISO14001** certified.

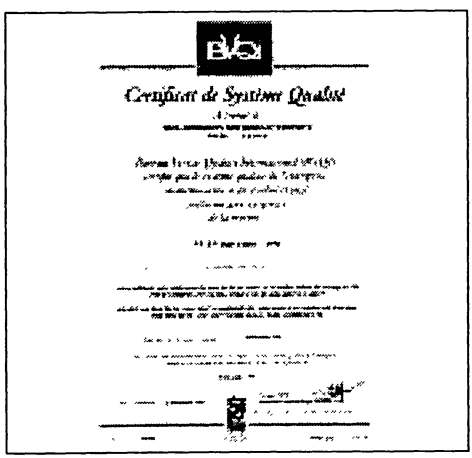
In addition, our product quality has gained **wide range of recognition from our customers**. During recent years, many important customers have officially recognized **STMicroelectronics as a high quality supplier.**

ISO9001 CERTIFICATION

QS9000 CERTIFICATION



ISO14001 CERTIFICATION

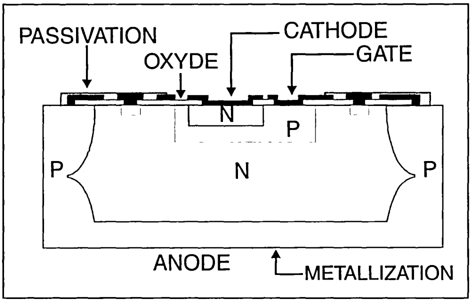


13. DEVICES TECHNOLOGY:

Three different technologies are used by STMicroelectronics to manufacture SCR, Triacs and ASD™: Thanks to Design, R&D and Process Engineering departments, the introduction of process for innovative products is daily supported on site.

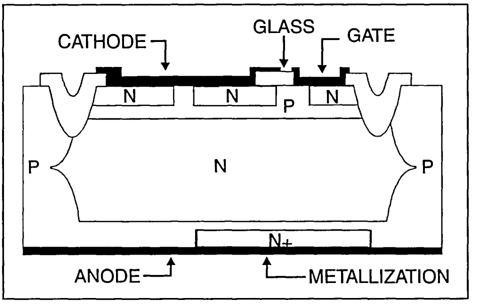
- Planar technology for: ASD™ product
  : Low current and sensitive thyristor
- Topglass technology for low and medium power thyristors and triacs.
- Mesa technology for medium and high power thyristors and triacs

PLANAR SCR



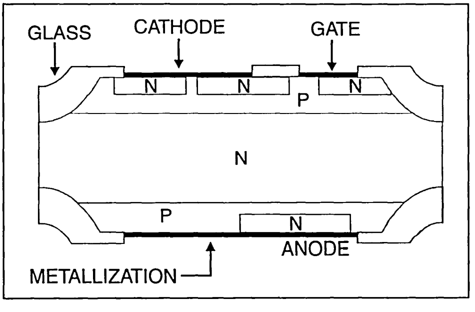
- Low power
- High sensitivity
- Wire assy

TOPGLASS TRIAC



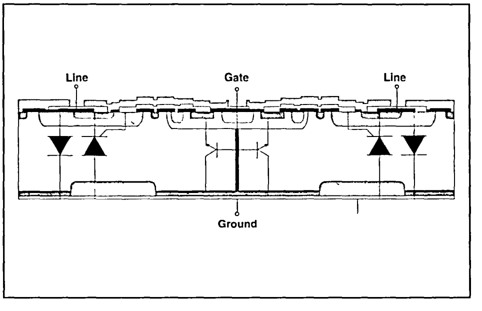
- Med. power
- Wire assy

MESA GLASS TRIAC



- High power
- Clip assy
- I_{TSM} performance

PLANAR ASD™

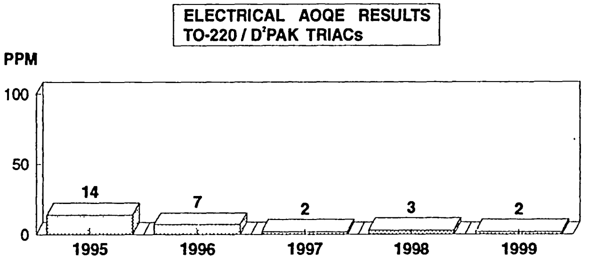


- Power & logic integration
- Innovative solution
- Wire assy
- High bidirectional current
- High symetric voltage up to 800 volts
- High inherent ruggedness thanks to its clamping mode and its transient noise immunities.

14. MANUFACTURING PROCESS

The newest manufacturing tools are used to attain the best performances and quality standards:

- **Wafer fab:**
  Clean room class 10/100 with automatic equipments as ionic implantation / furnaces / aligners / metallization for better reproductibility. Robots are used for wafer handling.
- **Assy and Test:**
  For both wire and clip assembly process, fully automatic equipment is used at each step of the process to ensure a quality level below 3ppm as a target.



On top of this, the use of fully automated lines allows the ever growing market demand to be supported in order to ensure a "gold standard" delivery performance.

- **UL Certification:**
  - All plastic packages use resins which are UL94V0 approved. The UL94 is the specification for: "Test for flammability of plastic materials for parts in devices and appliances".

  - All insulated packages are UL approved according to the UL1557. This is the specification for "Electrically isolated semiconductor devices". The registration number is E81734.
- **ESD triacs level:**
  The ESD triacs level is tested in accordance with the MIL STD 885D, method 3015-6 (Human Body Model), the ESD threshold classification is:

  Class 1: 0 to 1999 volts

  Class 2: 2000 to 3999 volts

  Class 3: 4000 volts and above

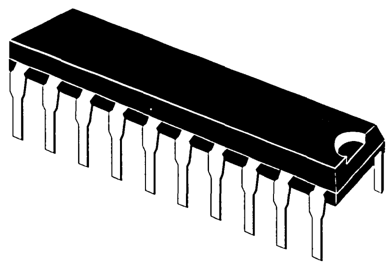
All thyristors and triacs are classified in Class 3.

PACKAGES

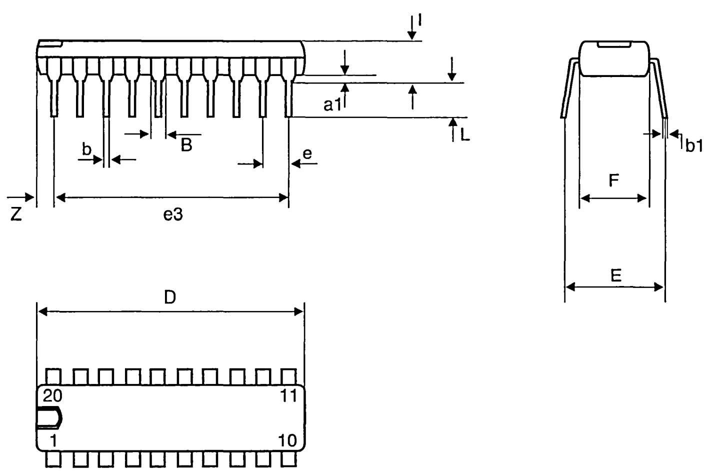
REF.	DIMENSIONS					
	Millimetres			Inches		
	Min.	Typ.	Max.	Min.	Typ.	Max.
a1	0.508			0.020		
B	1.39		1.65	0.055		0.065
b		0.45			0.018	
b1		0.25			0.010	
D			25.4			1.000
E		8.5			0.335	
e		2.54			0.100	
e3		22.86			0.900	
F			7.1			0.279
I			3.93			0.155
L		3.3			0.130	
Z			1.34			0.053

Weight: 1.4 g

OUTLINE AND MECHANICAL DATA



DIP-20

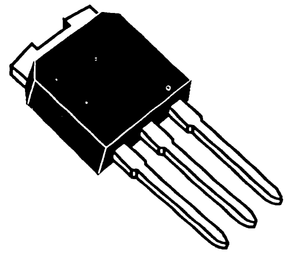


September 2000

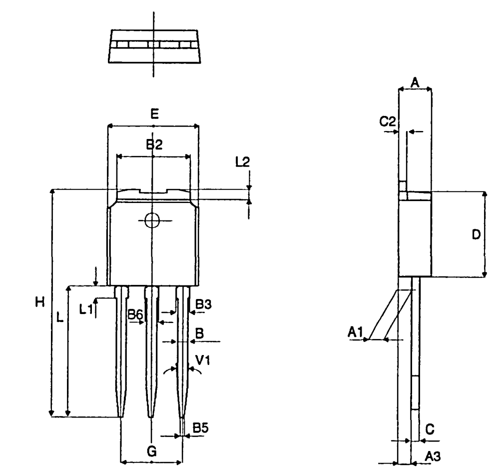
REF.	DIMENSIONS					
	Millimeters			Inches		
	Min.	Typ.	Max.	Min.	Typ.	Max.
A	2.2		2.4	0.086		0.094
A1	0.9		1.1	0.035		0.043
A3	0.7		1.3	0.027		0.051
B	0.64		0.9	0.025		0.035
B2	5.2		5.4	0.204		0.212
B3			0.85			0.033
B5		0.3			0.035	
B6			0.95			0.037
C	0.45		0.6	0.017		0.023
C2	0.48		0.6	0.019		0.023
D	6		6.2	0.236		0.244
E	6.4		6.6	0.252		0.260
G	4.4		4.6	0.173		0.181
H	15.9		16.3	0.626		0.641
L	9		9.4	0.354		0.370
L1	0.8		1.2	0.031		0.047
L2		0.8	1		0.031	0.039
V1		10°			10°	

Weight: 0.4 g

OUTLINE AND MECHANICAL DATA



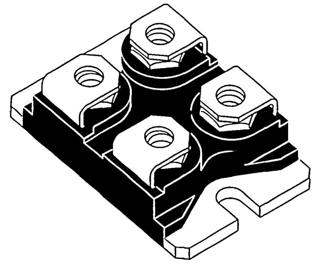
IPAK



REF.	DIMENSIONS			
	Millimeters		Inches	
	Min.	Max.	Min.	Max.
A	11.80	12.20	0.465	0.480
A1	8.90	9.10	0.350	0.358
B	7.8	8.20	0.307	0.323
C	0.75	0.85	0.030	0.033
C2	1.95	2.05	0.077	0.081
D	37.80	38.20	1.488	1.504
D1	31.50	31.70	1.240	1.248
E	25.15	25.50	0.990	1.004
E1	23.85	24.15	0.939	0.951
E2	24.80 typ.		0.976 typ.	
G	14.90	15.10	0.587	0.594
G1	12.60	12.80	0.496	0.504
G2	3.50	4.30	0.138	0.169
F	4.10	4.30	0.161	0.169
F1	4.60	5.00	0.181	0.197
P	4.00	4.30	0.157	0.69
P1	4.00	4.40	0.157	0.173
S	30.10	30.30	1.185	1.193

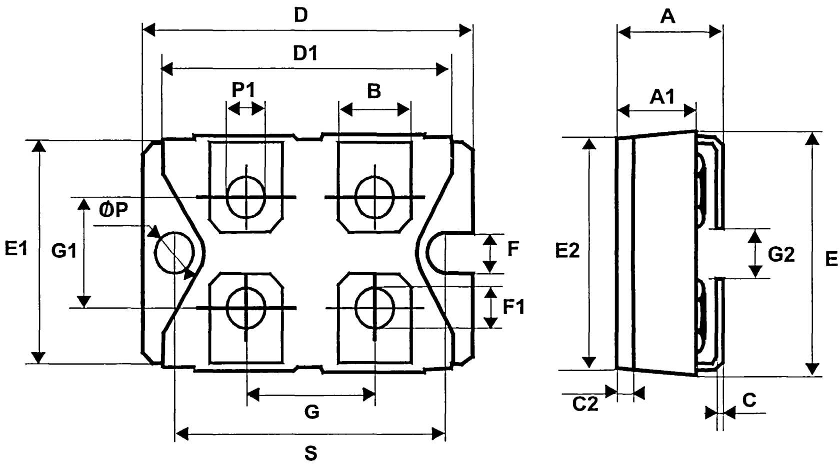
Weight: 27.0 g

OUTLINE AND MECHANICAL DATA



ISOTOP®

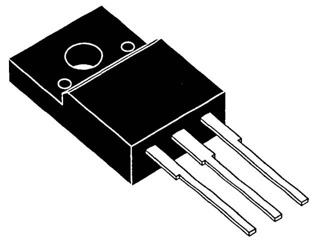
- Recommended torque value: 1.3 Nm (max. 1.5 Nm) for the 6 x M4 screws (2 x M4 screws recommended for mounting the package on the heatsink and the 4 provided screws.
- The screws supplied with the package are adapted for mounting on a board (or other types of terminals) with a thickness of 0.6 mm min. and 2.2 mm max.



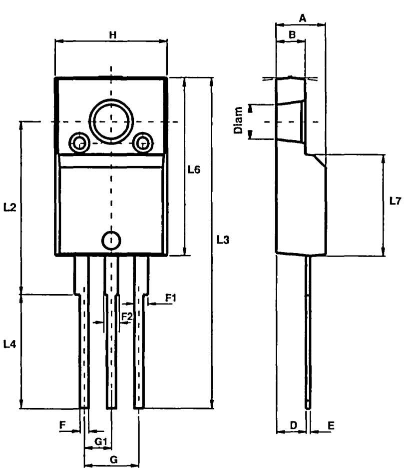
REF.	DIMENSIONS			
	Millimeters		Inches	
	Min.	Max.	Min.	Max.
A	4.40	4.60	0.173	0.181
B	2.50	2.70	0.098	0.106
D	2.50	2.75	0.098	0.108
E	0.40	0.70	0.016	0.028
F	0.75	1.00	0.030	0.039
F1	1.15	1.70	0.045	0.067
F2	1.15	1.70	0.045	0.067
G	4.95	5.20	0.195	0.205
G1	2.40	2.70	0.094	0.106
H	10.00	10.40	0.394	0.409
L2	16.00 typ.		0.630 typ.	
L3	28.60	30.60	1.125	1.205
L4	9.80	10.60	0.386	0.417
L6	15.90	16.40	0.626	0.646
L7	9.00	9.30	0.354	0.366
Diam	3.00	3.20	0.118	0.126

Weight: 2.1 g

OUTLINE AND MECHANICAL DATA



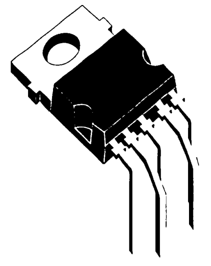
ISOWATT220AB



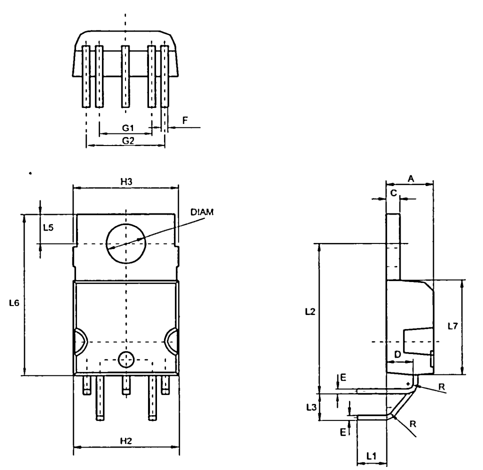
OUTLINE AND MECHANICAL DATA

REF.	DIMENSIONS			
	Millimeters		Inches	
	Min.	Max.	Min.	Max.
A	4.3	4.8	0.169	0.188
C	1.22	1.42	0.048	0.056
D	2.4	2.8	0.094	0.110
DIAM	3.65	3.85	0.144	0.152
E	0.35	0.45	0.014	0.018
F	0.65	0.75	0.026	0.030
G1	4.88	5.28	0.192	0.208
G2	7.42	7.82	0.292	0.308
H2		10.4		0.409
H3	10.05	10.4	0.396	0.409
L1	3.3 Typ.		0.130 Typ.	
L2	14.24	14.64	0.560	0.576
L3	2.34	2.74	0.092	0.108
L5	2.6	3	0.102	0.118
L6	15.1	15.8	0.594	0.622
L7	6	6.6	0.236	0.260
R	0.5 Typ.		0.020 Typ.	

Weight: 1.9 g



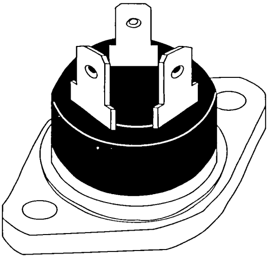
PENTAWATT HV



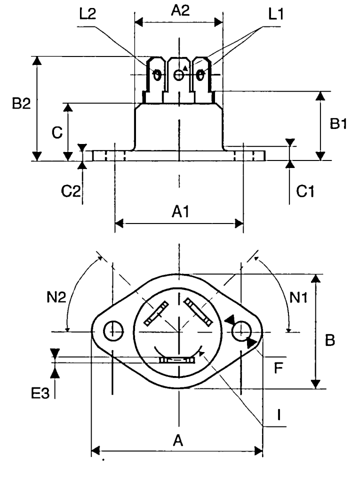
REF.	DIMENSIONS			
	Millimeters		Inches	
	Min.	Max.	Min.	Max.
A		40.00		1.575
A1	29.90	30.30	1.177	1.193
A2		22.00		0.867
B		27.00		1.063
B1	13.50	16.50	0.531	0.650
B2		24.00		0.945
C		14.00		0.551
C1		3.50		0.138
C2	1.95	3.00	0.077	0.118
E3	0.70	0.90	0.027	0.035
F	4.00	4.50	0.157	0.177
I	11.20	13.60	0.441	0.535
L1	3.10	3.50	0.122	0.138
L2	1.70	1.90	0.067	0.075
N1	33°	43°	33°	43°
N2	28°	38°	28°	38°

Weight: 20.0 g

OUTLINE AND MECHANICAL DATA



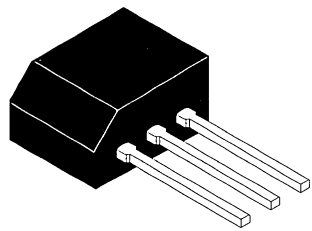
RD91



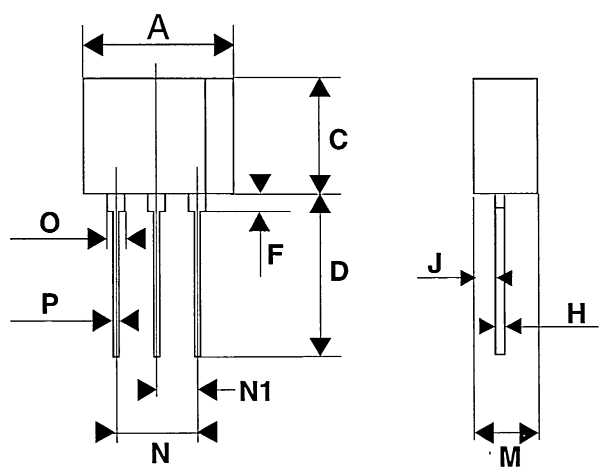
REF.	DIMENSIONS					
	Millimeters			Inches		
	Min.	Typ.	Max.	Min.	Typ.	Max.
A			10.1			0.398
C		7.3			0.287	
D		10.5			0.413	
F			1.5			0.059
H		0.51			0.020	
J		1.5			0.059	
M		4.5			0.177	
N			5.3			0.209
N1		2.54			0.100	
O			1.4			0.055
P			0.7			0.028

Weight: 0.8 g

OUTLINE AND MECHANICAL DATA



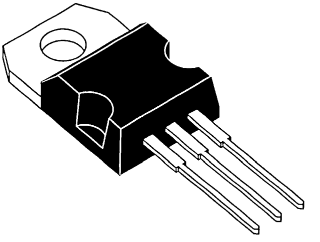
TO202-3



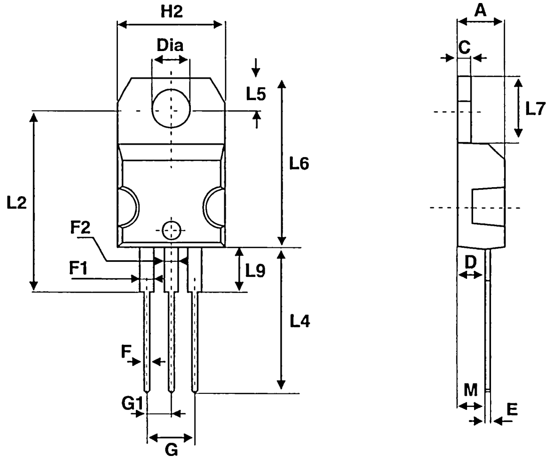
REF.	DIMENSIONS			
	Millimeters		Inches	
	Min.	Max.	Min.	Max.
A	4.40	4.60	0.173	0.181
C	1.23	1.32	0.048	0.051
D	2.40	2.72	0.094	0.107
E	0.49	0.70	0.019	0.027
F	0.61	0.88	0.024	0.034
F1	1.14	1.70	0.044	0.066
F2	1.14	1.70	0.044	0.066
G	4.95	5.15	0.194	0.202
G1	2.40	2.70	0.094	0.106
H2	10	10.40	0.393	0.409
L2	16.4 typ.		0.645 typ.	
L4	13	14	0.511	0.551
L5	2.65	2.95	0.104	0.116
L6	15.25	15.75	0.600	0.620
L7	6.20	6.60	0.244	0.259
L9	3.50	3.93	0.137	0.154
M	2.6 typ.		0.102 typ.	
Diam.	3.75	3.85	0.147	0.151

Weight: 2.3 g

OUTLINE AND MECHANICAL DATA



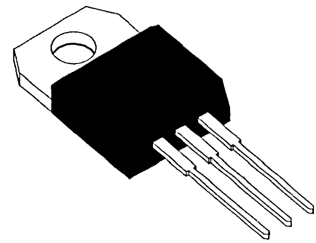
TO-220AB (with notches)



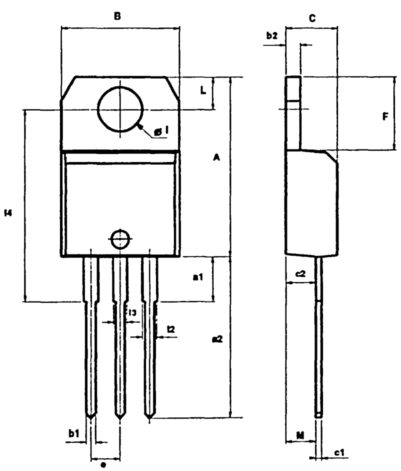
REF.	DIMENSIONS					
	Millimeters			Inches		
	Min.	Typ.	Max.	Min.	Typ.	Max.
A	15.20		15.90	0.598		0.625
a1		3.75			0.147	
a2	13.00		14.00	0.511		0.551
B	10.00		10.40	0.393		0.409
b1	0.61		0.88	0.024		0.034
b2	1.23		1.32	0.048		0.051
C	4.40		4.60	0.173		0.181
c1	0.49		0.70	0.019		0.027
c2	2.40		2.72	0.094		0.107
e	2.40		2.70	0.094		0.106
F	6.20		6.60	0.244		0.259
I	3.75		3.85	0.147		0.151
l4	15.80	16.40	16.80	0.622	0.646	0.661
L	2.65		2.95	0.104		0.116
l2	1.14		1.70	0.044		0.066
l3	1.14		1.70	0.044		0.066
M		2.60			0.102	

Weight: 2.3 g

OUTLINE AND MECHANICAL DATA



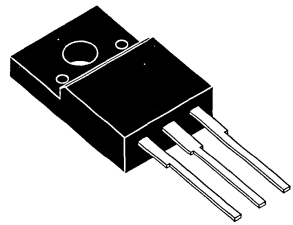
TO-220AB (no notches)



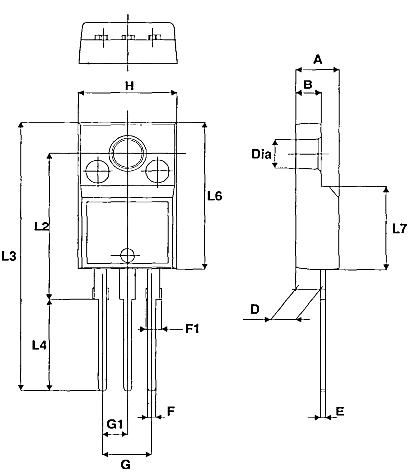
REF.	DIMENSIONS			
	Millimeters		Inches	
	Min.	Max.	Min.	Max.
A	4.4	4.6	0.173	0.181
B	2.5	2.7	0.098	0.106
D	2.5	2.75	0.098	0.108
E	0.45	0.70	0.017	0.027
F	0.75	1	0.030	0.039
F1	1.15	1.70	0.045	0.067
F2	1.15	1.70	0.045	0.067
G	4.95	5.20	0.195	0.204
G1	2.40	2.70	0.094	0.106
H	10	10.4	0.393	0.409
L2	16 Typ.		0.63 Typ.	
L3	28.6	30.6	1.126	1.204
L4	9.8	10.6	0.385	0.417
L6	15.9	16.4	0.626	0.645
L7	9.00	9.30	0.354	0.366
Dia.	3	3.20	0.118	0.126

Weight: 1.7 g

OUTLINE AND MECHANICAL DATA



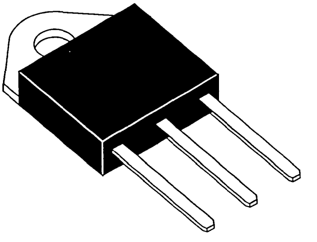
TO-220FPAB



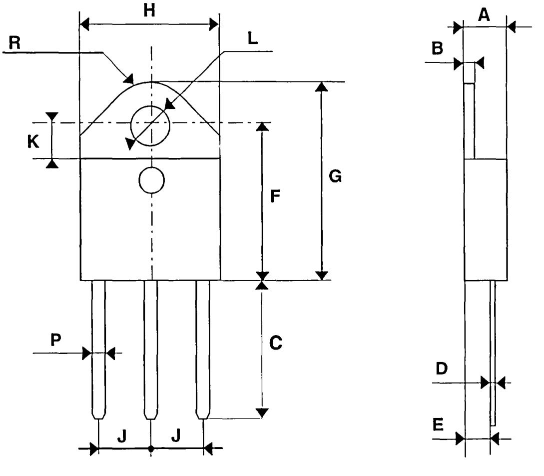
REF.	DIMENSIONS					
	Millimeters			Inches		
	Min.	Typ.	Max.	Min.	Typ.	Max.
A	4.4		4.6	0.173		0.181
B	1.45		1.55	0.057		0.061
C	14.35		15.60	0.565		0.614
D	0.5		0.7	0.020		0.028
E	2.7		2.9	0.106		0.114
F	15.8		16.5	0.622		0.650
G	20.4		21.1	0.815		0.831
H	15.1		15.5	0.594		0.610
J	5.4		5.65	0.213		0.222
K	3.4		3.65	0.134		0.144
L	4.08		4.17	0.161		0.164
P	1.20		1.40	0.047		0.055
R		4.60			0.181	

Weight: 4.5 g

OUTLINE AND MECHANICAL DATA



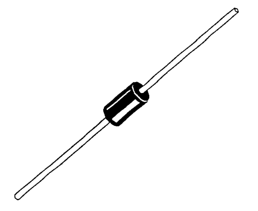
TOP3



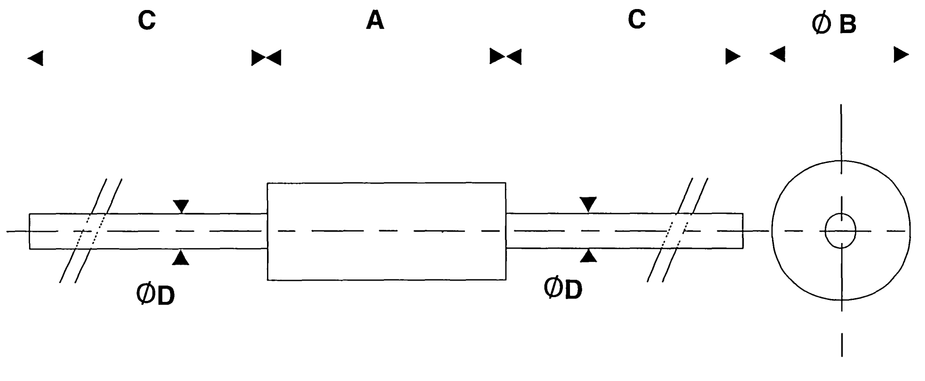
REF.	DIMENSIONS			
	Millimeters		Inches	
	Min.	Max.	Min.	Max.
A	3.05	4.50	0.120	0.177
B	1.53	2.00	0.060	0.079
C	12.70		0.500	
D	0.458	0.558	0.018	0.022

Weight: 0.15 g

OUTLINE AND MECHANICAL DATA



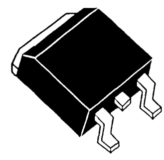
DO-35



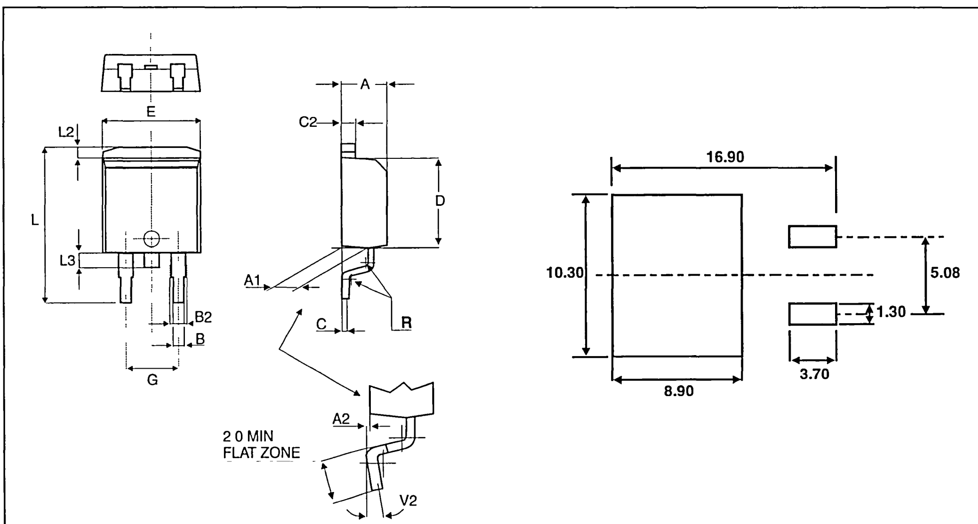
REF.	DIMENSIONS					
	Millimeters			Inches		
	Min.	Typ.	Max.	Min.	Typ.	Max.
A	4.30		4.60	0.169		0.181
A1	2.49		2.69	0.098		0.106
A2	0.03		0.23	0.001		0.009
B	0.70		0.93	0.027		0.037
B2	1.25	1.40		0.048	0.055	
C	0.45		0.60	0.017		0.024
C2	1.21		1.36	0.047		0.054
D	8.95		9.35	0.352		0.368
E	10.00		10.28	0.393		0.405
G	4.88		5.28	0.192		0.208
L	15.00		15.85	0.590		0.624
L2	1.27		1.40	0.050		0.055
L3	1.40		1.75	0.055		0.069
R		0.40			0.016	
V2	0°		8°	0°		8°

Weight: 1.5 g

OUTLINE AND MECHANICAL DATA



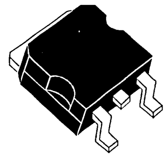
D²PAK



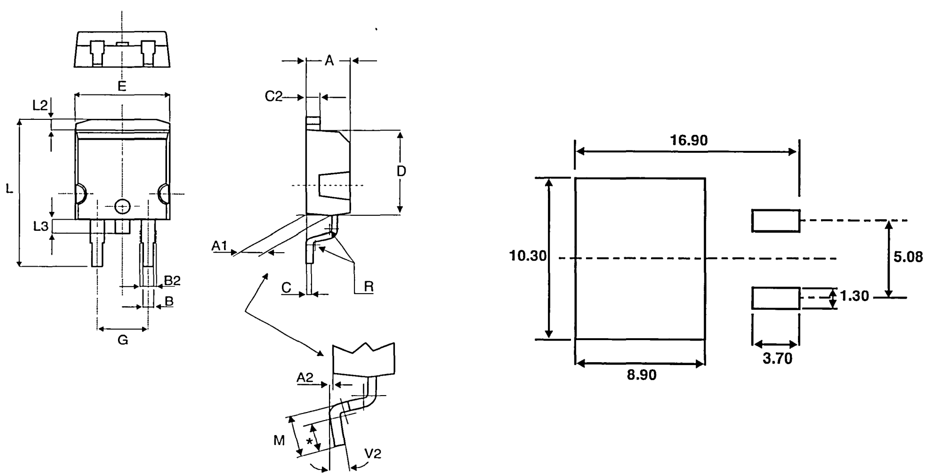
OUTLINE AND MECHANICAL DATA

REF.	DIMENSIONS			
	Millimeters		Inches	
	Min.	Max.	Min.	Max.
A	4.40	4.60	0.173	0.181
A1	2.49	2.69	0.098	0.106
A2	0.03	0.23	0.001	0.009
B	0.70	0.93	0.027	0.037
B2	1.14	1.70	0.045	0.067
C	0.45	0.60	0.017	0.024
C2	1.23	1.36	0.048	0.054
D	8.95	9.35	0.352	0.368
E	10.00	10.40	0.393	0.409
G	4.88	5.28	0.192	0.208
L	15.00	15.85	0.590	0.624
L2	1.27	1.40	0.050	0.055
L3	1.40	1.75	0.055	0.069
M	2.40	3.20	0.094	0.126
R	0.40 typ.		0.016 typ.	
V2	0°	8°	0°	8°

Weight: 1.5 g



D²PAK

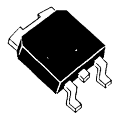


* FLAT ZONE NO LESSTHAN 2mm

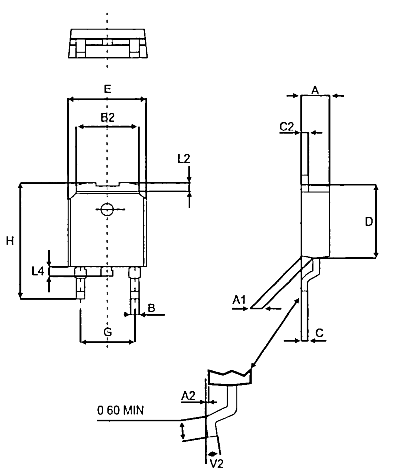
REF.	DIMENSIONS			
	Millimeters		Inches	
	Min.	Max	Min.	Max.
A	2.20	2.40	0.086	0.094
A1	0.90	1.10	0.035	0.043
A2	0.03	0.23	0.001	0.009
B	0.64	0.90	0.025	0.035
B2	5.20	5.40	0.204	0.212
C	0.45	0.60	0.017	0.023
C2	0.48	0.60	0.018	0.023
D	6.00	6.20	0.236	0.244
E	6.40	6.60	0.251	0.259
G	4.40	4.60	0.173	0.181
H	9.35	10.10	0.368	0.397
L2	0.80 typ.		0.031 typ.	
L4	0.60	1.00	0.023	0.039
V2	0°	8°	0°	8°

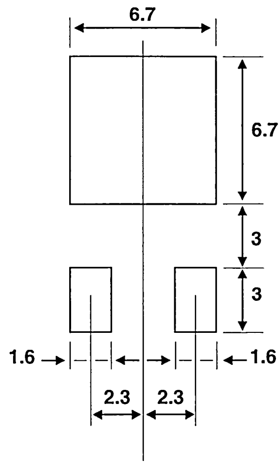
Weight: 0.3 g

OUTLINE AND MECHANICAL DATA



DPAK

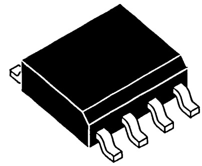




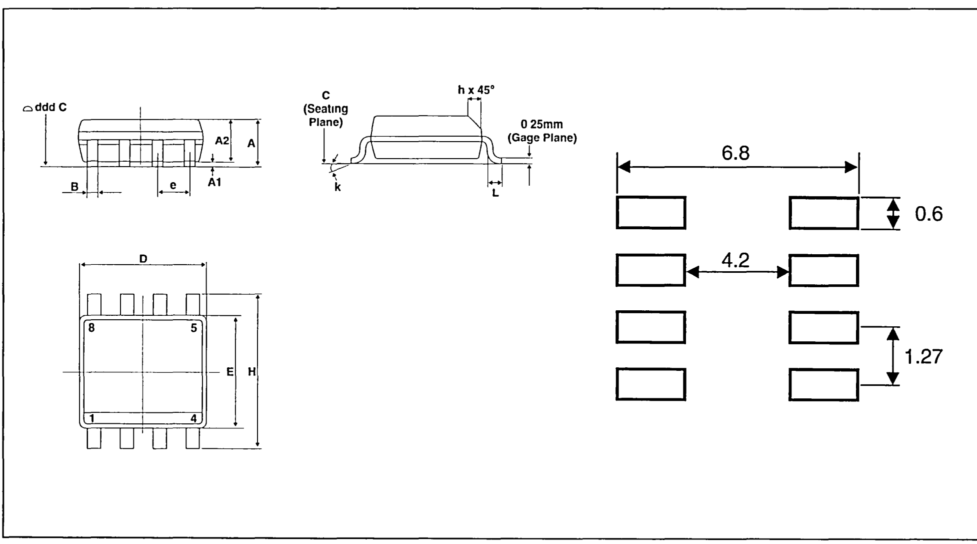
REF.	DIMENSIONS			
	Millimetres		Inches	
	Min.	Max.	Min.	Max.
A	1.35	1.75	0.053	0.069
A1	0.1	0.25	0.004	0.010
A2	1.10	1.65	0.043	0.065
B	0.33	0.51	0.013	0.020
C	0.19	0.25	0.007	0.010
D	4.80	5.00	0.189	0.197
E	3.80	4.00	0.150	0.157
e	1.27 Typ.		0.05 Typ.	
H	5.80	6.20	0.228	0.244
h	0.25	0.50	0.010	0.019
L	0.4	1.27	0.016	0.050
k	8° (max)			
ddd	0.100		0.004	

Weight: 0.1 g

OUTLINE AND MECHANICAL DATA



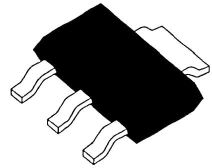
SO-8



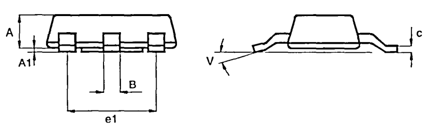
REF.	DIMENSIONS					
	Millimeters			Inches		
	Min.	Typ.	Max.	Min.	Typ.	Max.
A			1.80			0.071
A1	0.02		0.10	0.001		0.004
B	0.60	0.70	0.85	0.024	0.027	0.033
B1	2.90	3.00	3.15	0.114	0.118	0.124
c	0.24	0.26	0.35	0.009	0.010	0.014
D	6.30	6.50	6.70	0.248	0.256	0.264
e		2.3			0.090	
e1		4.6			0.181	
E	3.30	3.50	3.70	0.130	0.138	0.146
H	6.70	7.00	7.30	0.264	0.276	0.287
V	10° max					

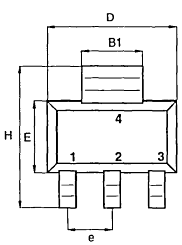
Weight: 0.12 g

OUTLINE AND MECHANICAL DATA

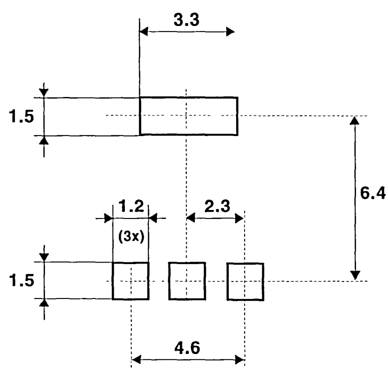


SOT-223





PIN	DESCRIPTION	
1	GATE	BASE
2	DRAIN	COLLECTOR
3	SOURCE	EMITTER
4	DRAIN	COLLECTOR

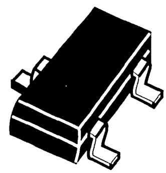


Recommended soldering pattern SOT223

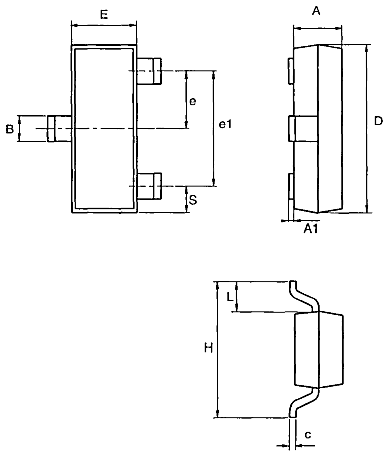
REF.	DIMENSIONS			
	Millimeters		Inches	
	Min.	Max.	Min.	Max.
A	0.89	1.4	0.035	0.055
A1	0	0.1	0	0.004
B	0.3	0.51	0.012	0.02
c	0.085	0.18	0.003	0.007
D	2.75	3.04	0.108	0.12
e	0.85	1.05	0.033	0.041
e1	1.7	2.1	0.067	0.083
E	1.2	1.6	0.047	0.063
H	2.1	2.75	0.083	0.108
L	0.6 typ.		0.024 typ.	
S	0.35	0.65	0.014	0.026

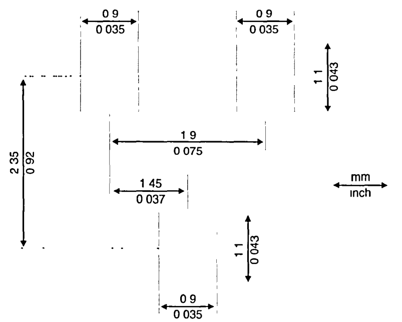
Weight: 0.01 g

OUTLINE AND MECHANICAL DATA



SOT-23

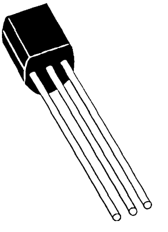




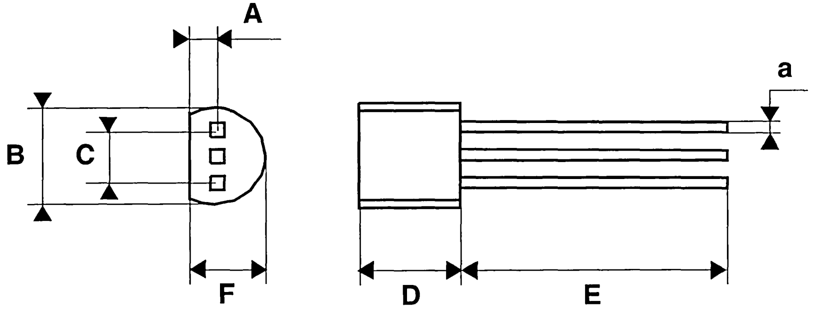
REF.	DIMENSIONS					
	Millimeters			Inches		
	Min.	Typ.	Max.	Min.	Typ.	Max.
A		1.35			0.053	
B			4.70			0.185
C		2.54			0.100	
D	4.40			0.173		
E	12.70			0.500		
F			3.70			0.146
a			0.50			0.019

Weight: 0.2 g

OUTLINE AND MECHANICAL DATA



TO-92



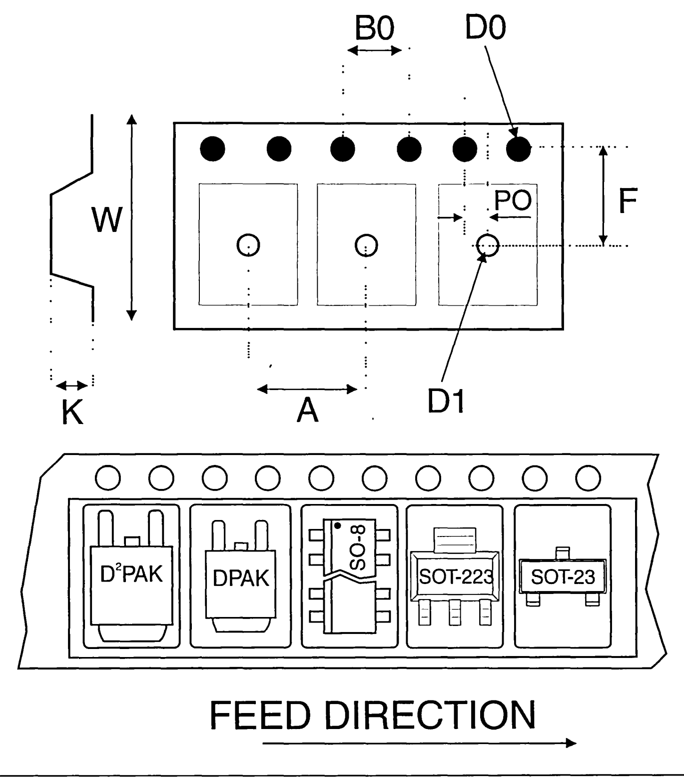
PACKING INFORMATION

PACKING INFORMATION

SURFACE MOUNT DEVICES TAPE DIMENSIONS

PACKAGE	HOLES SPACING B0	COMPONENT SPACING A	HOLE DIAMATER D0	HOLE DIAMETER D1	HOLES POSITION F	COMPARTMENT DEPTH K	TAPE WIDTH W	PO
D^2PAK	4.0 ± 0.1	12.0 ± 0.1	1.55 ± 0.05	1.6 ± 0.1	11.5 ± 0.1	4.9 ± 0.1	24.0 ± 0.3	2 ± 0.1
DPAK	4.0 ± 0.1	8.0 ± 0.1	1.55 ± 0.05	1.6 ± 0.1	7.5 ± 0.1	2.65 ± 0.1	16.0 ± 0.3	2 ± 0.1
SO-8	12 ± 0.3	6.4 ± 0.1	1.55 ± 0.05	1.6 ± 0.1	5.5 ± 0.1	2.13 ± 0.1	12 ± 0.3	2 ± 0.1
SOT-223	4.0 ± 0.1	8.0 ± 0.1	1.55 ± 0.05	1.5 ± 0.25	5.5 ± 0.05	1.88 ± 0.1	12.0 ± 0.3	2 ± 0.05
SOT-23	4.0 ± 0.1	4.0 ± 0.1	1.50 ± 0.1	1.0 ± 0.15	3.5 ± 0.05	1.2 ± 0.1	8.0 ± 0.3	2 ± 0.05

All dimensions are in millimeters.

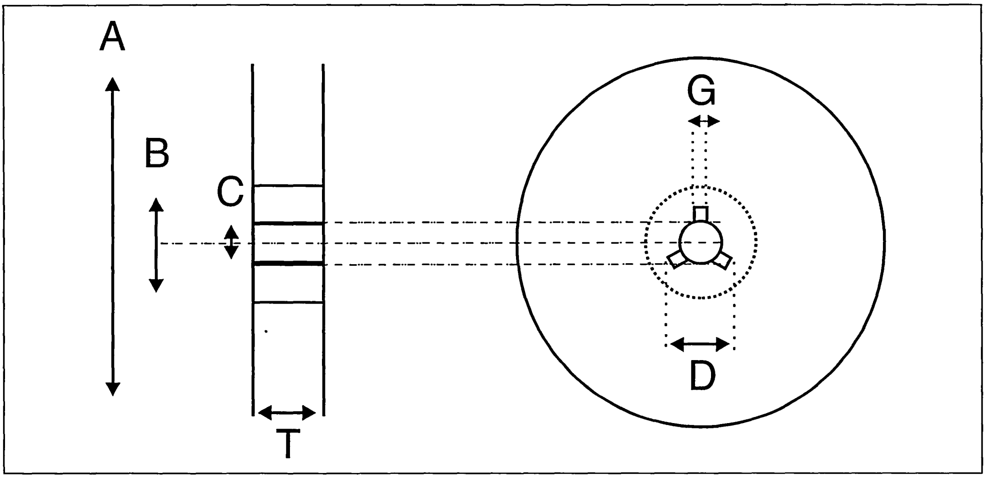


In compliance with IEC286-3 and EIA481-1 standards.

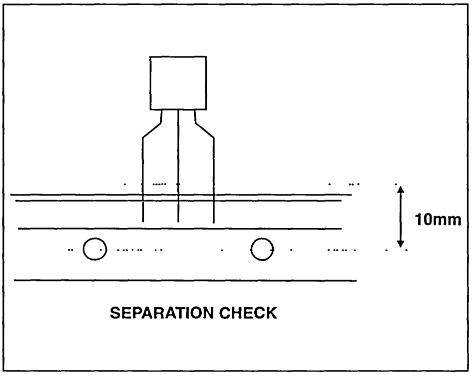
REEL DIMENSIONS (all devices are delivered in reels)

PACKAGE	BASE QTY	REEL DIAMETER A (max.)	TUBE DIAMATER B (min.)	C	D	G (min.)	REEL WIDTH (-0/+2)
D^2PAK	1000	330	100	13	20.2	1.5	24.4
DO-35	5000	262	47.5	20	20.2	-	72 (-1/+3)
DPAK	2500	330	100	13	20.2	1.5	16.4
SO-8	2500	330	50	13	20.2	1.5	12.4
SOT-223	1000	185	60	13	20.2	1.5	11
SOT-23	3000	185	60	13	20.2	1.5	8.4
TO-92	2000	359	77	30.5	20.2	-	42

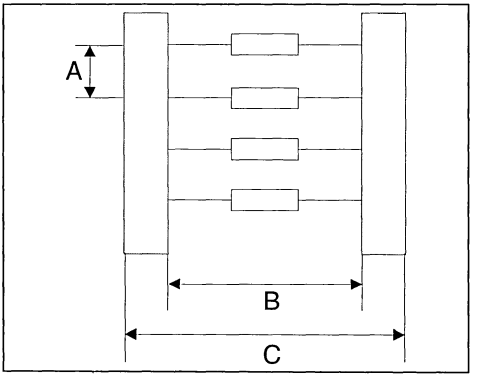
All dimensions are in millimeters.



TO-92 PACKING MODE



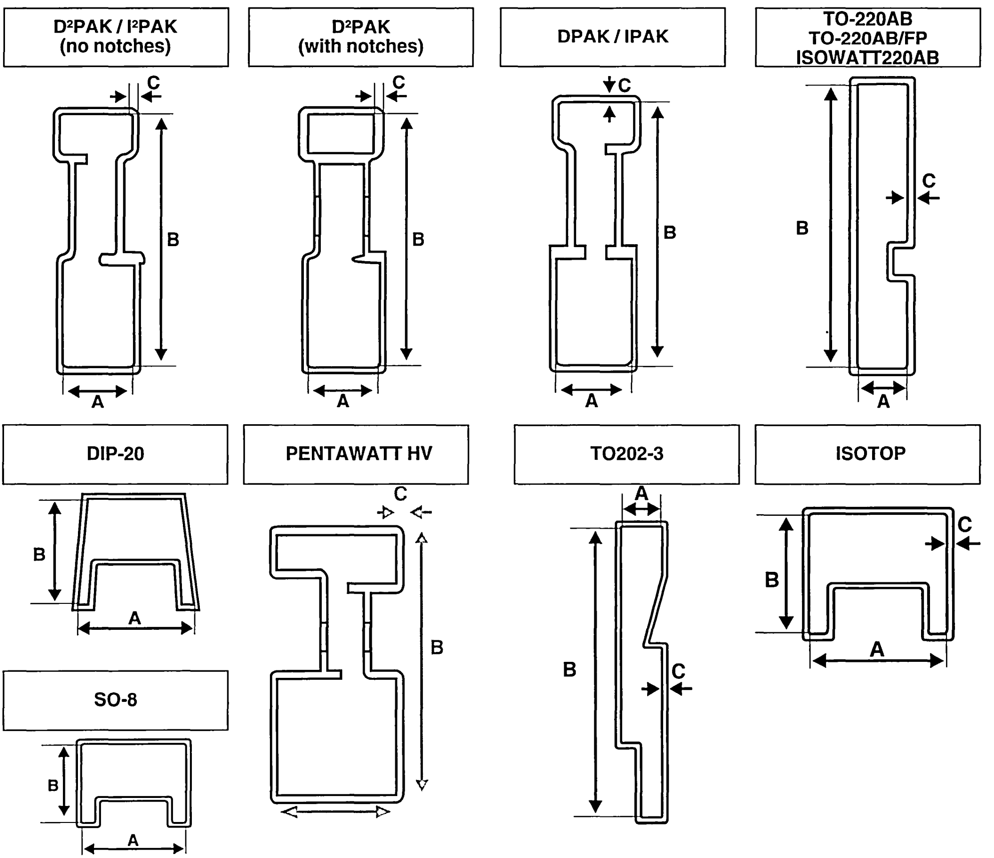
DO-35 PACKING MODE



TUBE DIMENSIONS

Package	Base QTY	Tube length ± 0.5	Tube dimensions		
			A	B(±0.2)	C
D^2PAK	50	532	9.5 (± 0.2)	32.4	0.75 (± 0.1)
DIP-20	20	532	15.2 (± 0.25)	11.2 (± 0.25)	-
DPAK	75	532	6 (± 0.1)	21.3	0.6 (± 0.1)
I^2PAK	50	532	9.5 (± 0.2)	32.4	0.75 (± 0.1)
IPAK	75	532	6 (± 0.1)	21.3	0.6 (± 0.1)
ISOTOP	10	532	26.5 (± 0.15)	23	1.25 max.
ISOWATT220AB	50	532	5.5 (± 0.2)	31.4	0.75 (± 0.1)
PENTAWATT HV	50	532	17 (± 0.2)	32.1	1 (± 0.1)
SO-8	100	532	7.8 (± 0.1)	3.8 (± 0.1)	-
TO202-3	50	532	6.5 (± 0.5)	38.5 (± 1)	0.75 (± 0.1)
TO-220AB	50	532	5.5 (± 0.2)	31.4	0.75 (± 0.1)
TO-220AB/FP	50	532	5.5 (± 0.2)	31.4	0.75 (± 0.1)

All dimensions are in millimeters.



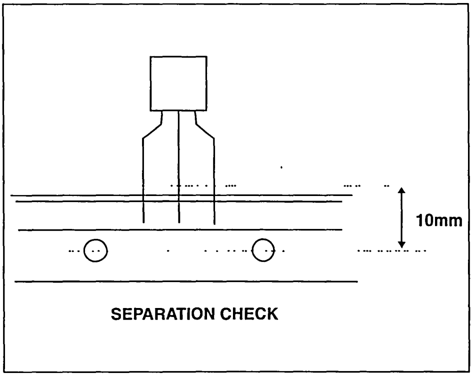
PACKING INFORMATION

FAN FOLD BOX (AMMOPACK)

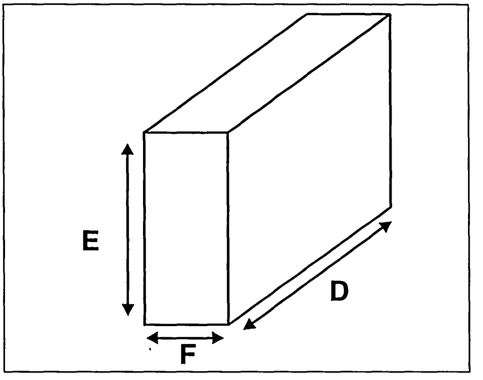
Package	Base QTY	Box dimensions		
		E	F	D
TO-92	2000	180	37	326

All dimensions are in millimeters.

TO-92 PACKING MODE



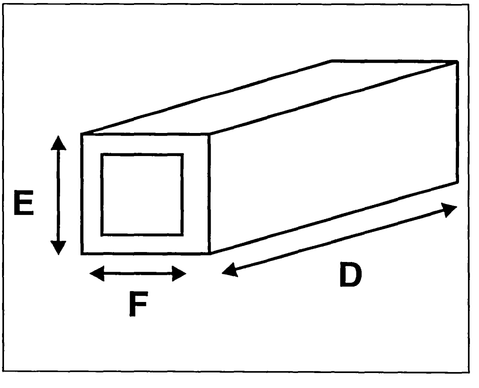
FAN FOLD BOX



MATCHBOX (BULK)

Package	Base QTY	Box dimensions		
		E	F	D
RD91	25	62	80	148
TO202-3	250	62	80	148
TO-220AB	250	62	80	148
TO-92	2500	77	77	252
TOP-3	120	62	80	140
All dimensions are in millimeters.				

MATCHBOX



LIST OF APPLICATION NOTES

Ref.	Title
AN301	The TRIAC (1)
AN533	SCRs and TRIACs: Thermal Management - Precautions for Handling and Mounting (2)
AN302	THYRISTORS and TRIACS, an important parameter: The holding current (1) (2)
AN303	THYRISTORS and TRIACS, an important parameter: Latching current (1) (2)
AN437	New TRIACS: Is the snubber circuit necessary ? (1) (2)
AN439	Improvement in the TRIAC commutation (1) (2)
AN328	Protect your TRIACS (1) (2)
AN308	Control by a TRIAC for an inductive load - How to select a suitable circuit (1) (2)
AN440	TRIAC drive circuit for operation in quadrants I and III (1) (2)
AN441	TRIAC for microwave ovens (1) (2)
AN306	Design of a static relay (1)
AN389	An automatic line voltage switching circuit (2)
AN390	How to use the AVS kit (2)
AN391	How to use the AVS08 (2)
AN442	TRIACS and microcontrollers - The easy connection (1) (2)
AN392	Microcontroller and TRIACS on the 110/240V mains (2)
AN416	Sensorless motor drive with the ST62 MCU + TRIAC (2)
AN422	Improved universal motor drive (2)
AN863	Improved sensorless control with the ST62 MCU for universal motor (2)
AN1114	Burst mode TRIACS control by using ST52x301(2)
AN1172	The new ACS™ series: a breakthrough in ruggedness & drive for home appliance (2)
AN1296	Ring wave tests with ACS402 / ACS108 driving valves & pumps

Note:

1) These application notes can be found in the "DISCRETE POWER SEMICONDUCTOR HANDBOOK" or in the "DESIGNER'S GUIDE TO POWER PRODUCTS".

2) These application notes can be found on the Internet **"http://www.st.com"**

EUROPE

FINLAND
LOHJA SF-08100
Laurinkaty 48A
Tel. (358-19) 3282 1
Telefax. (358-19) 3155 66

FRANCE
75669 PARIS Cedex 14
29, bd Romain Rolland
Tel.: (33-1) 58077575
Telefax. (33-1) 55489569

67000 STRASBOURG
20, Place des Halles
Tel. (33-3) 88755066
Telefax: (33-3) 88222932

GERMANY
D-85630 GRASBRUNN
Bretonischer Ring 4
Postfach 1122
Tel.: (49-89) 460060
Telefax. (49-89) 4605454

D-90449 NÜRNBERG
Südwestpark 92
Tel.: (49-911) 670408 0
Telefax: (49-911) 670408 99

D-70499 STUTTGART 31
Mittlerer Pfad 2-4
Tel. (49-711) 13968 0
Telefax: (49-711) 8661427

HUNGARY
(Representative Office)

1139 BUDAPEST
Vaci UT 99
Tel. (36-1) 350 5280
Telefax: (36-1) 350 5281

ITALY
20090 ASSAGO (MI)
V.le Milanofiori - Strada 4
Palazzo E/5
Tel. (39) 0257546.1
Telefax: (39) 028250449

40033 CASALECCHIO DI RENO (BO)
Via R. Fucini, 12
Tel. (39) 051591914
Telefax: (39) 051591305

00161 ROMA
Via A. Torlonia, 15
Tel. (39) 0644251142
Telefax: (39) 0685354438

MOROCCO (and North Africa)
20180 Casablanca
RP 3013 - Km 17 Bouskoura - BP 97
Tel.: (212) 22936002
Telefax: (212) 22936055

THE NETHERLANDS
5503 LL Velhoven
De Run 4222
Tel.: (31-40) 2509600
Telefax: (31-40) 2528835

POLAND
Oddziai w Warszawie
ul. Nowogrodzka 11
PL-00-513 Warszawa
Tel.: (48-22) 225290529
Telefax: (48-22) 5290520

SPAIN
E-08004 BARCELONA
Calle Gran Via Cortes Catalanas, 322
6th Floor, 2nd Door
Tel. (34) 93 4251800
Telefax: (34) 93 4253674

E-28027 MADRID
Calle Albacete, 5
Tel. (34) 91 4051615
Telefax: (34) 91 4031134

SWEDEN
SE-16425 KISTA
Borgarfjordsgatan, 13 - Box 1094
Tel.: (46-8) 58774400
Telefax: (46-8) 58774411

SWITZERLAND
CH-1215 Geneva 15
Route de Pré-Bois, 20
Tel. (41-22) 9292929
Telefax: (41-22) 9292900

TURKEY
34630 FLORYA INSTANBUL
Besyol Mah. Florya Kavsagi
Eski Londra Asfalti No. 26B/10
Tel. (90) 212 624 32 64
Telefax: (90) 212 624 9626

35030 BORNOVA IZMIR
295 SK. No:1 K:8 D:6
Tel. (90) 232 486 03 51
Telefax. (90) 232 486 05 28

UNITED KINGDOM and EIRE
MARLOW, BUCKS, SL71Y
Planar House, Parkway
Globe Park
Tel.: (44-1628) 890800
Telefax. (44-1628) 890391

Internet Address http://www.st.com

AMERICAS

BRAZIL

05413 SÃO PAULO
R. Henrique Schaumann 286-CJ33
Tel.: (55-11) 883-5455
Telefax : (55-11) 282-2367

69050-002 Manaus/AM
Costantino Nery Street, 2789
80 Stair - 806 Room (Chapada)
Tel.: (55-92) 657 0017
Telefax: (55-92) 657 0157

CANADA

NEPEAN ONTARIO K2H 8R6
16 Fitzerald Rd, Suite 300
Tel.: (613) 768-9000
Telefax: (613) 768-9001

MISSISAUGA, Ontario L4V 1R9
5945 Airport Rd., Suite 362
Tel : (905) 678-9800
Telefax: (905) 678-1799

MEXICO

01070 MEXICO City
Col. Chimalistac, San Angel
Insurgentes Sur 2376 604
Tel.: (52-5) 616 4801
Telefax: (52-5) 616 4872

44550 Guadalajara
2347 Av. Mariano Otero
Piso 5, of. "B"
Col. Verde Valle
Tel.: (52-3) 647 6081
Telefax: (52-3) 647 5231

U.S.A.

NORTH & SOUTH AMERICAN
MARKETING HEADQUARTERS
Lexington Corporate Center
10 Maguire Road
Building 1, 3rd Floor
Lexington, MA 02421
Tel.: (781) 861-2650
Telefax: (781) 861-2678

ALABAMA
Huntsville - Tel.: (256) 837-3754
Fax: (256) 937-8246

ARIZONA
Phoenix - Tel.: (602) 485-6100
Fax: (602) 485-6102

CALIFORNIA
Agoura Hills - Tel.: (818) 865-6850
Fax: (818) 865-6861
Laguna Niguel - Tel.: (949) 347-0717
Fax: (949) 347-1224
San Jose - Tel.: (408) 452-8585
Fax: (408) 452-1549

COLORADO
Longmont - Tel.: (303) 772-9729
Fax: (303) 381-3680

CONNECTICUT
Woodstock - Tel.: (860) 928-7700
Fax: (860) 928-2722

FLORIDA
Boca Raton - Tel.: (561) 997-7233
Fax: (561) 997-7554

IDAHO
Boise - Tel.: (208) 376-9151
Fax: (208) 376-9109

ILLINOIS
Schaumburg - Tel.: (847) 585-3000
Fax: (847) 517-1899

INDIANA
Indianapolis - Tel.: (317) 575-5520
Fax: (317) 575-8271
Kokomo - Tel.: (765) 455-3500
Fax: (765) 455-3400

MICHIGAN
Livonia - Tel.: (734) 953-1700
Fax: (734) 462-4071

MINNESOTA
Edina - Tel.: (612) 835-3500
Fax: (612) 835-3555

MISSOURI
Kansas City - Tel.: (816) 468-6868
Fax: (816) 468-6561

NEW JERSEY
Basking Ridge - Tel.: (908) 766-7401
Fax: (908) 766-7738
Voorhees - Tel.: (609) 772-6222
Fax: (609) 772-6037

NEW YORK
Manhattan - Tel.: (212) 850-5650

NORTH CAROLINA
Cary - Tel.: (919) 469-1311
Fax: (919) 469-4515

OREGON
Beaverton - Tel.: (503) 690 8604
Corvalis - Tel.: (541) 754 8192
Fax: (541) 754 8262
Portland - Tel.: (503) 282-4941
Fax: (503) 282-4963

PENSYLVANIA
Bensalem - Tel.: (215) 638 2958
Fax. (215) 638 2986

TEXAS
Carrollton - Tel.: (972) 466-6000
Fax: (972) 466-8130
Houston - Tel.: (281) 376-9939
Fax: (281) 376-9948

UTAH
Midvale - Tel.: (801) 256 3571
Fax: (801) 256 3578

ASIA / PACIFIC

AUSTRALIA

SYDNEY
Suite 3, Level 7, Otis House
43 Bridge Street
N.S.W. 2220 Hurtsville
Tel. (61-2) 9580 3811
Telefax: (61-2) 9580 6440

MELBOURNE
Suite 305, Level 3
3 Chester Street
Oakleigh Vic 3166
Tel. (61-3) 9568 1222
Telefax: (61-3) 9568 1999

CHINA (Liaison Offices)

BEIJING 100080
East Unit, 1/F, SIGMA Building,
No. 49 Zhichun Road, Haidian District,
Tel.: (86-10) 8809 7398
Telefax: (86-10) 8809 7171

SHANGHAI 200021
Unit 1801, 18/F
Shui On Plaza
333 Huai Hai Zhong Road
Tel. (86-21) 5306 0898
Telefax: (86-21) 5306 0890

SHENZHEN 518048
3/F., Block 205
Shangbu Industrial Park
Huaqiang Road North,
Tel. (86-755) 322 5991
Telefax: (86-755) 320 6039

HONG KONG

Special Administrative Region
Tsim Sha Tsui, Kowloon
16/F, Tower I, The Gateway I
25 Canton Road
Tel. (852) 2861 5700
Telefax: (852) 2861 5044

INDIA (Liaison Offices)

BANGALORE 560052
Diners Business Service
26 Cunningham Road
Tel. (91-80) 226 7272
Telefax: (91-80) 225 1133

NOIDA 201301
Liaison Office
Plot N. 2 & 3, Sector 16A
Institutional Area
Distt. Ghaziabad UP
Tel. (91-11) 8 4515262-4515285
Telefax: (91-11) 8 4515304

MALAYSIA

SELANGOR, PJ 46050
Suite 5-01A, 5th Floor, Menara Amcorp,
Amcorp Trade Centre,
No 18, Jalan Persiaran Barat
Tel.: (60-3) 7958 1189
Telefax: (60-3) 7958 1179

PENANG 11900
Unit 13A, Lower Level 5
Hotel Equatorial
1 Jalan Bukit Jambul
Tel. (60-4) 642 8291
Telefax: (60-4) 642 8284

KOREA

SEOUL
19th Fl Kang Nam Building,
1321-1 Seocho-dong, Seocho-Ku
Tel. (82-2) 3489-0114
Telefax: (82-2) 588-9030

TAEGU 701-023
18th Floor Youngnam Tower
111 Shinchun-3 Dong, Dong-Ku
Tel. (82-53) 756-9583
Telefax: (82-53) 756-4463

SINGAPORE

SINGAPORE 569508
28 Ang Mo Kio - Industrial Park 2
Tel. (65) 482 1411
Telefax: (65) 482 0240

TAIWAN

TAIPEI 106
#20th Floor, #207
Tun Hua South Road, Section 2
Tel. (886-2) 2378 8088
Telefax: (886-2) 2378 9188

THAILAND

BANGKOK 10110
Unit # 1315
54 Asoke Road
Sukhumvit 21
Tel.: (66-2) 260 7870
Telefax: (66-2) 260 7871

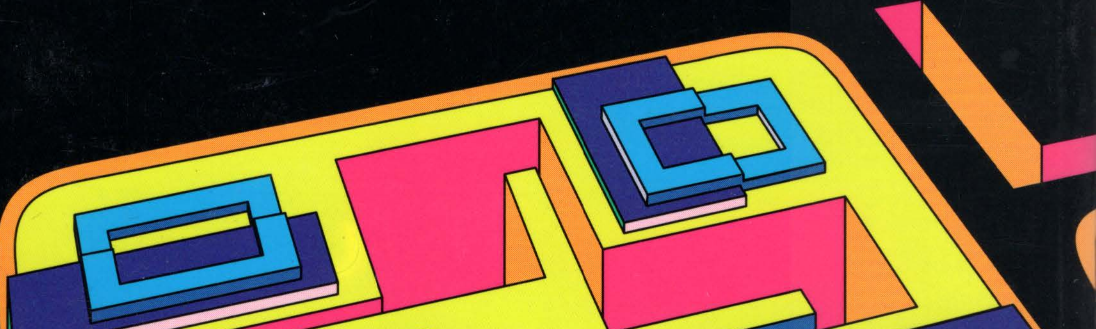
JAPAN

TOKYO 108-6010
Shinagawa INTERCITY Tower A
2-15-1, Konan, Minato-Ku
Tel. (81-3) 5783 8200
Telefax: (81-3) 5783 8216

OSAKA 532-0003
14 F Shin-Osaka Second Mori Bldg.
3-5-36 Miyahara Yodogawa-Ku
Tel. (81-6) 6397-4130
Telefax: (81-6) 6397-4131

Internet Address http://www.st.com

Recycled and chlorine free paper



ORDER CODE: DBSCRTRIST/4