

PHILIPS

Data handbook



Electronic
components
and materials

Semiconductors and integrated circuits

Part 5a November 1976

Professional analogue ICs

SEMICONDUCTORS AND INTEGRATED CIRCUITS

Part 5a

November 1976

General

Amplifiers

Telecommunications circuits

General industrial

Special circuits

Index and maintenance type list

DATA HANDBOOK SYSTEM

Our Data Handbook System is a comprehensive source of information on electronic components, subassemblies and materials; it is made up of three series of handbooks each comprising several parts.

ELECTRON TUBES

BLUE

SEMICONDUCTORS AND INTEGRATED CIRCUITS

RED

COMPONENTS AND MATERIALS

GREEN

The several parts contain all pertinent data available at the time of publication, and each is revised and reissued periodically.

Where ratings or specifications differ from those published in the preceding edition they are pointed out by arrows. Where application information is given it is advisory and does not form part of the product specification.

If you need confirmation that the published data about any of our products are the latest available, please contact our representative. He is at your service and will be glad to answer your inquiries.

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ELECTRON TUBES (BLUE SERIES)

This series consists of the following parts, issued on the dates indicated.

Part 1a	Transmitting tubes for communication and Tubes for r.f. heating Types PE05/25 - TBW15/125	December 1975
Part 1b	Transmitting tubes for communication Tubes for r.f. heating Amplifier circuit assemblies	January 1976
Part 2	Microwave products Communication magnetrons Magnetrons for microwave heating Klystrons Travelling-wave tubes	May 1976
	Diodes Triodes T-R Switches Microwave semiconductor devices Isolators - circulators	
Part 3	Special Quality tubes; Miscellaneous devices	January 1975
Part 4	Receiving tubes	March 1975
Part 5a	Cathode-ray tubes	August 1975
Part 5b	Camera tubes; Image intensifier tubes	May 1975
Part 6	Products for nuclear technology Channel electron multipliers Geiger-Mueller tubes Neutron tubes	July 1975
Part 7	Gas-filled tubes Voltage stabilizing and reference tubes Counter, selector, and indicator tubes Trigger tubes Switching diodes	August 1975
	Thyratrons Ignitrons Industrial rectifying tubes High-voltage rectifying tubes	
Part 8	TV Picture tubes	October 1975
Part 9	Photomultiplier tubes Phototubes (diodes)	June 1976

SEMICONDUCTORS AND INTEGRATED CIRCUITS (RED SERIES)

This series consists of the following parts, issued on the dates indicated.

Part 1a	Rectifier diodes, thyristors, triacs	March 1976
	Rectifier diodes	Rectifier stacks
	Voltage regulator diodes (> 1,5 W)	Thyristors
	Transient suppressor diodes	Triacs
Part 1b	Diodes	October 1975
	Small signal germanium diodes	Voltage regulator diodes (< 1,5 W)
	Small signal silicon diodes	Voltage reference diodes
	Special diodes	Tuner diodes
Part 2	Low-frequency transistors	December 1975
Part 3	High-frequency and switching transistors	April 1976
Part 4a	Special semiconductors	June 1976
	Transmitting transistors	Dual transistors
	Microwave devices	Microminiature devices for thick- and thin-film circuits
	Field-effect transistors	
Part 4b	Devices for optoelectronics	July 1976
	Photosensitive diodes and transistors	Photocouplers
	Light emitting diodes	Infrared sensitive devices
	Displays	Photoconductive devices
Part 5a	Professional analogue integrated circuits	November 1976
	N. B. Consumer circuits will be issued in part 5b	
Part 6	Digital integrated circuits	May 1976
	LOCMOS HE family	
	GZ family	

COMPONENTS AND MATERIALS (GREEN SERIES)

This series consists of the following parts, issued on the dates indicated.

Part 1	Functional units, Input/output devices, Peripheral devices	High noise immunity logic FZ/30-Series Circuit blocks 40-Series and CSA70 Counter modules 50-Series NORbits 60-Series, 61-Series	Circuit blocks 90-Series Input/output devices Hybrid integrated circuits Peripheral devices	November 1975
Part 2a	Resistors	Fixed resistors Variable resistors Voltage dependent resistors (VDR) Light dependent resistors (LDR)	Negative temperature coefficient thermistors (NTC) Positive temperature coefficient thermistors (PTC) Test switches	February 1976
Part 2b	Capacitors	Electrolytic and solid capacitors Paper capacitors and film capacitors	Ceramic capacitors Variable capacitors	April 1976
Part 3	Radio, Audio, Television	FM tuners Loudspeakers Television tuners and aerial input assemblies	Components for black and white television Components for colour television	February 1975
Part 4a	Soft ferrites	Ferrites for radio, audio and television Beads and chokes	Ferroxcube potcores and square cores Ferroxcube transformer cores	October 1976
Part 4b	Piezoelectric ceramics, Permanent magnet materials			May 1975
Part 5	Ferrite core memory products	Ferroxcube memory cores Matrix planes and stacks	Core memory systems	July 1975
Part 6	Electric motors and accessories	Small synchronous motors Stepper motors	Miniature direct current motors	September 1975
Part 7	Circuit blocks	Circuit blocks 100 kHz-Series Circuit blocks 1-Series Circuit blocks 10-Series	Circuit blocks for ferrite core memory drive	September 1971
Part 8	Variable mains transformers			July 1975
Part 9	Piezoelectric quartz devices			March 1976
Part 10	Connectors			November 1975



General

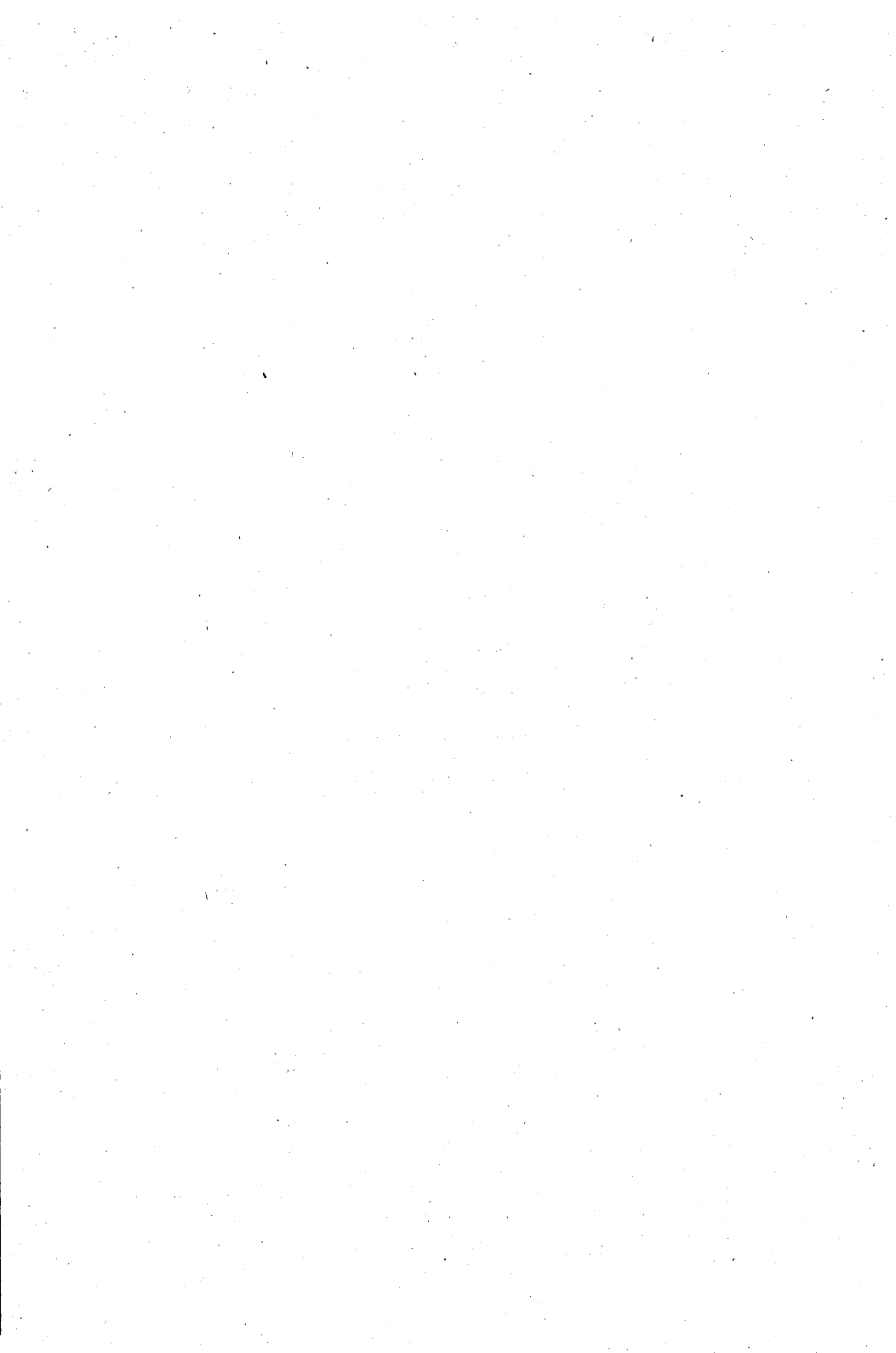
Preface

Type designation

Package outlines

Ratings

Letter symbols



PREFACE TO DATA OF INTEGRATED CIRCUITS

1. General

The published data comprise particulars needed by designers of equipment in which integrated circuits are to be incorporated, and criteria on which to base acceptance testing of such circuits. For ease of reference, the data on each circuit are grouped according to the several headings discussed below.

The limiting values quoted under the headings Characteristics and Package Outline may be taken as references for acceptance testing.

Values cited as typical are given for information only.

For an explanation of the type designation code, see the section Type Designation. For an explanation of the letter symbols used in designating terminals and performance of integrated circuits, and the electrical and logic quantities pertaining to them, see the section Letter Symbols.

2. Quick Reference Data

The main properties of the integrated circuit summarized for quick reference

3. Ratings

Ratings are limits beyond which the serviceability of the integrated circuit may be impaired. The ratings given here are in accordance with the Absolute Maximum System as defined in publication no. 134 of the International Electrical Commission; for further details see item 2 of the section Rating Systems.

If a circuit is used under the conditions set forth in the sections Characteristics and Additional System Design Data, its operation within the ratings is ensured.

4. Circuit diagram

Circuit diagrams and logic symbols are given to illustrate the circuit function. The diagrams show only essential elements, parasitic elements due to the method of manufacture normally being omitted. The manufacturer reserves the right to make minor changes to improve manufacturability.

5. System Design Data and Additional System Design Data

System Design Data normally derived from the Characteristics and based on worst-case assumptions as to temperature, loading and supply voltage, are quoted for the guidance of equipment designers. Supplementary information derived from measurements on large production samples may be given under Additional System Design Data.

6. Application information

Under this heading, practical circuit connections and the resulting performance are described. Care has been taken to ensure the accuracy and completeness of the information given, but no liability therefor is assumed, nor is licence under any patent implied.

7. Characteristics

Characteristics are measurable properties of the integrated circuit described. Under a specific set of test conditions compliance with limit values given under this heading establishes the specified performance of the circuit; this can be used as a criterion for acceptance testing.

Values cited as typical are given for information only and are not subject to any form of guarantee.

8. Logic symbols (digital circuits)

Graphical logic symbols accord with MIL standard 806B.

Supplementary drawings correlate logic functions with pin locations as a help to laying out printed circuit boards.

9. Outline drawing and pin 1 identification

Dimensional drawings indicate the pin numbering of circuit packages.

Dual in-line packages have a notch at one end to identify pin 1.

Take care not to mistake adventitious moulding marks for the pin 1 identification.

Flat packs identify pin 1 by a small projection on the pin itself and/or by a dot on the body of the package.

Metal can encapsulations identify pin 1 by a tab on the rim of the can.

PRO ELECTRON TYPE DESIGNATION CODE

The type number consists of three letters followed by a four digit serial number (sometimes augmented by a version letter).

First two letters:

Family circuits

The first two letters identify the family.

Solitary circuits

The first letter identifies the circuit as:

S-digital

T-analogue

U-mixed analogue/digital

The second letter has no special significance.

The third letter indicates the operating ambient temperature range or another significant characteristic. Letters B to F stand for the following temperature ranges: ¹⁾

B: 0 to +70 °C

C: -55 to +125 °C

D: -25 to +70 °C

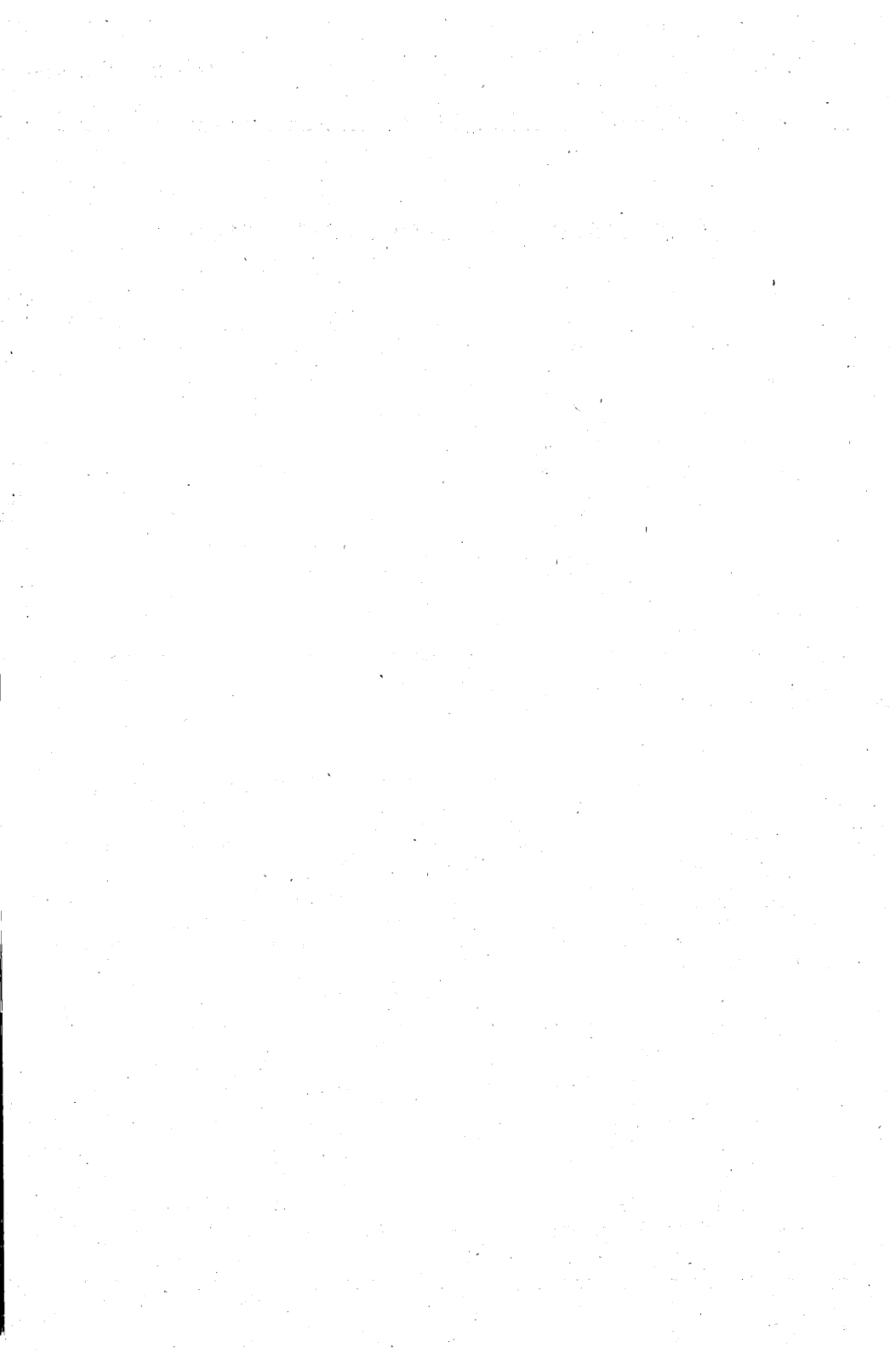
E: -25 to +85 °C

F: -40 to +85 °C

When no temperature range is specified, the third letter is A. Other third letters identify special family versions or treatments (e.g. radiation hardened).

The serial number following the three letters may be either a 4-digit number or a proprietary type designation comprising a combination of letters and digits. Proprietary type designations consisting of less than 4 characters are extended to 4 by putting zeros (0) before them.

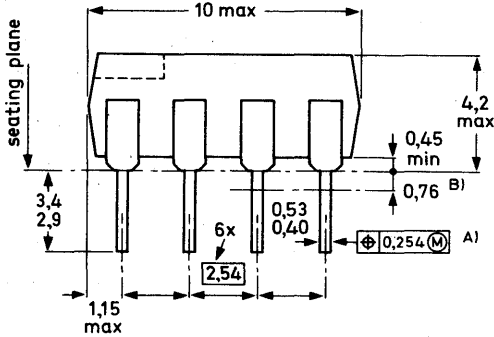
¹⁾ If a circuit is published for a wider temperature range, but does not qualify for another classification, the letter designating the nearest narrower temperature range is used.



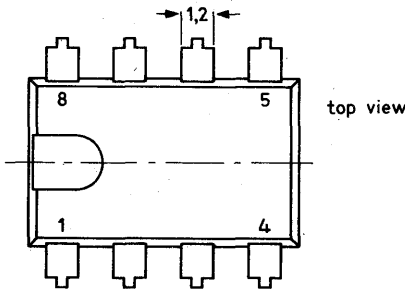
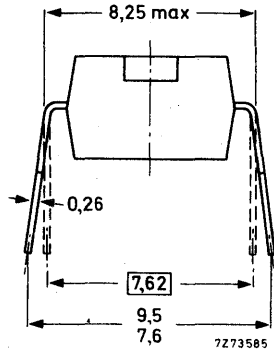
Package outlines



PLASTIC 8-LEAD DUAL IN-LINE (SOT-97)



Dimensions in mm



- ⊕ Positional accuracy.
- Ⓜ Maximum Material Condition.

- A) Centre-lines of all leads are within $\pm 0,127$ mm of the nominal position shown; in the worst case, the spacing between any two leads may deviate from nominal by $\pm 0,254$ mm.
- B) Lead spacing tolerances apply from seating plane to the line indicated.

SOLDERING

1. By hand

Apply the soldering iron below the seating plane (or not more than 2 mm above it). If its temperature is below 300 °C it must not be in contact for more than 10 seconds; if between 300 °C and 400 °C, for not more than 5 seconds.

2. By dip or wave

260 °C is the maximum allowable temperature of the solder; it must not be in contact with the joint for more than 5 seconds. The total contact time of successive solder waves must not exceed 5 seconds.

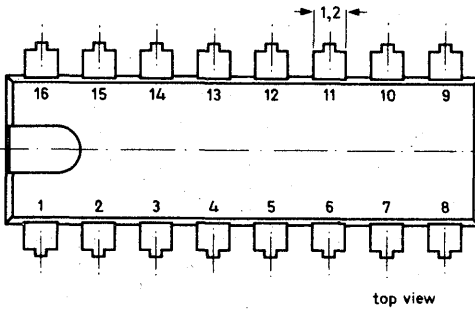
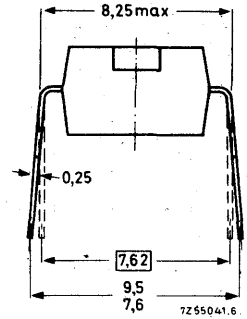
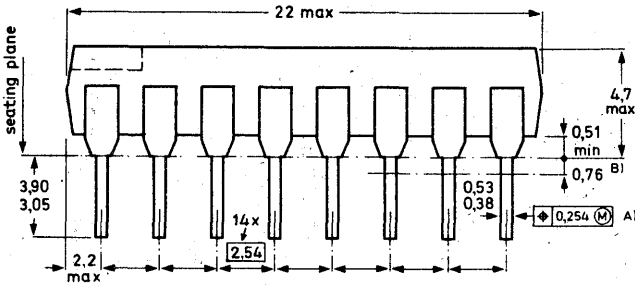
The device may be mounted up to the seating plane, but the temperature of the plastic body must not exceed the specified storage maximum. If the printed circuit board has been pre-heated, forced cooling may be necessary immediately after soldering to keep the temperature within the allowable limit.

3. Repairing soldered joints

The same precautions and limits apply as in (1) above.

PLASTIC 16-LEAD DUAL IN-LINE

Dimensions in mm



⊕ Positional accuracy.

Ⓜ Maximum Material Condition.

A) Centre-lines of all leads are within $\pm 0,127$ mm of the nominal position shown; in the worst case, the spacing between any two leads may deviate from nominal by $\pm 0,254$ mm.

B) Lead spacing tolerances apply from seating plane to the line indicated.

SOLDERING

1. By hand

Apply the soldering iron below the seating plane (or not more than 2 mm above it). If its temperature is below 300 °C it must not be in contact for more than 10 seconds; if between 300 °C and 400 °C, for not more than 5 seconds.

2. By dip or wave

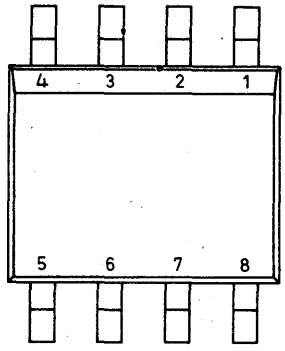
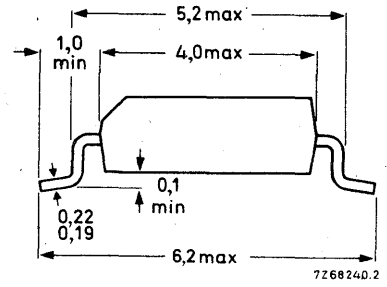
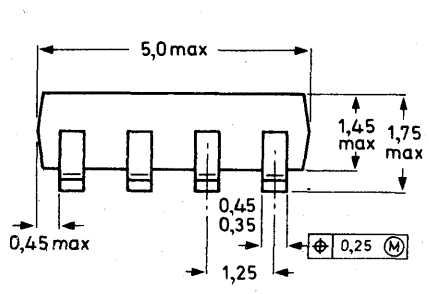
260 °C is the maximum allowable temperature of the solder; it must not be in contact with the joint for more than 5 seconds. The total contact time of successive solder waves must not exceed 5 seconds.

The device may be mounted up to the seating plane, but the temperature of the plastic body must not exceed the specified storage maximum. If the printed circuit board has been pre-heated, forced cooling may be necessary immediately after soldering to keep the temperature within the allowable limit.

3. Repairing soldered joints

The same precautions and limits apply as in (1) above.

SO-8 (SOT-96A); PLASTIC 8-LEAD FLAT PACK Dimensions in mm



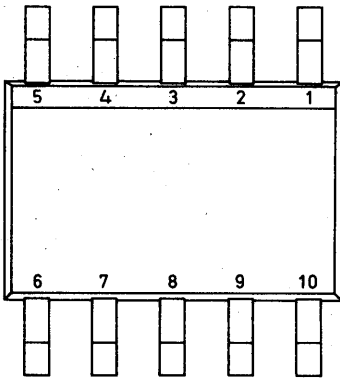
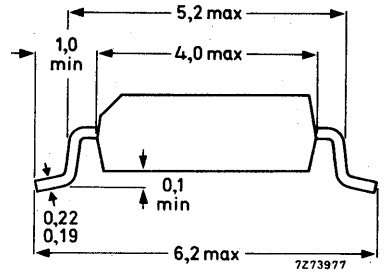
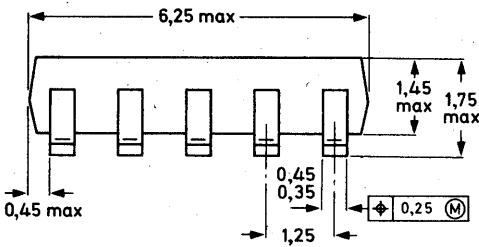
top view

- ⊕ Positional accuracy.
- Ⓜ Maximum Material Condition.

SOLDERING see last page of this chapter

SO-10; PLASTIC 10-LEAD FLAT PACK

Dimensions in mm

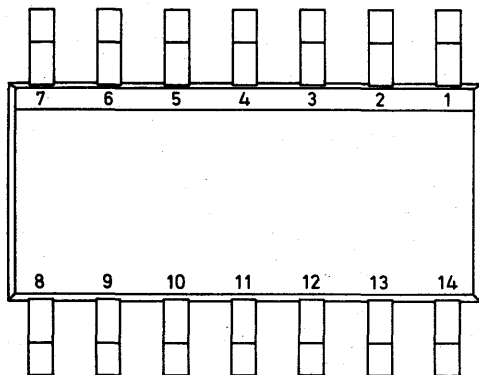
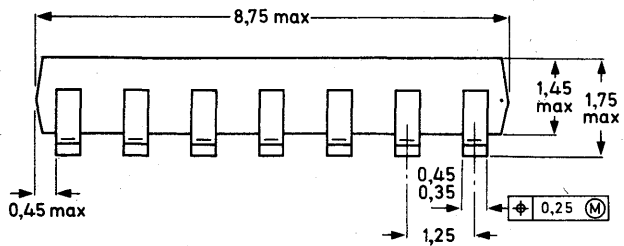


top view

- ⊕ Positional accuracy.
- (M) Maximum Material Condition.

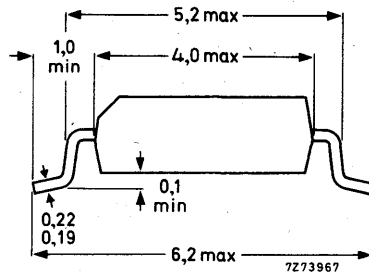
SOLDERING see last page of this chapter

SO-14; PLASTIC 14-LEAD FLAT PACK



top view

Dimensions in mm



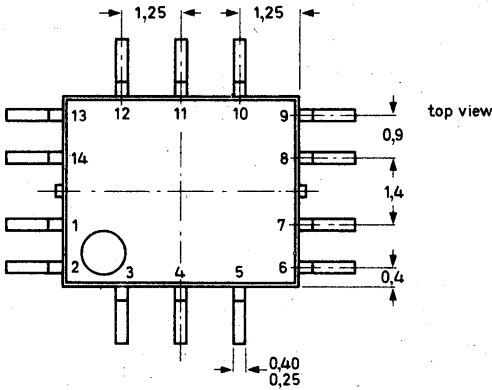
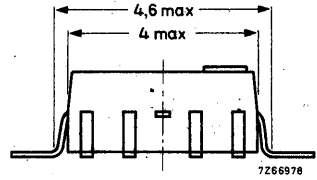
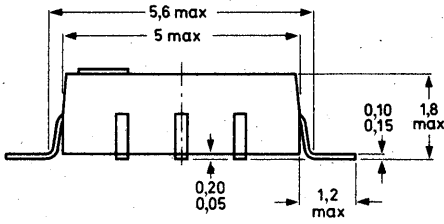
\varnothing Positional accuracy.

(M) Maximum Material Condition.

SOLDERING see last page of this chapter.

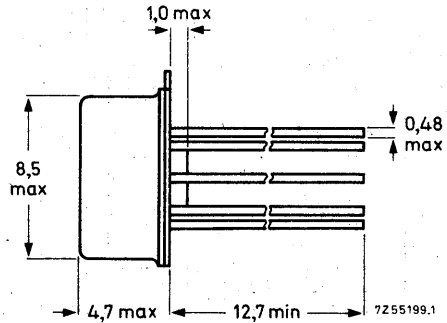
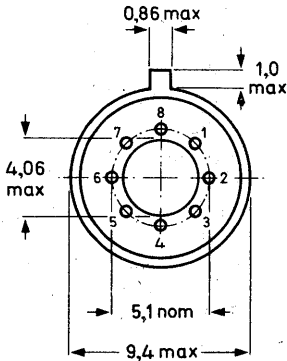
PLASTIC; 14-LEAD (SOT-43)

Dimensions in mm



8-LEAD METAL ENVELOPE (TO-99)

Dimensions in mm



SOLDERING SO-PACKAGES

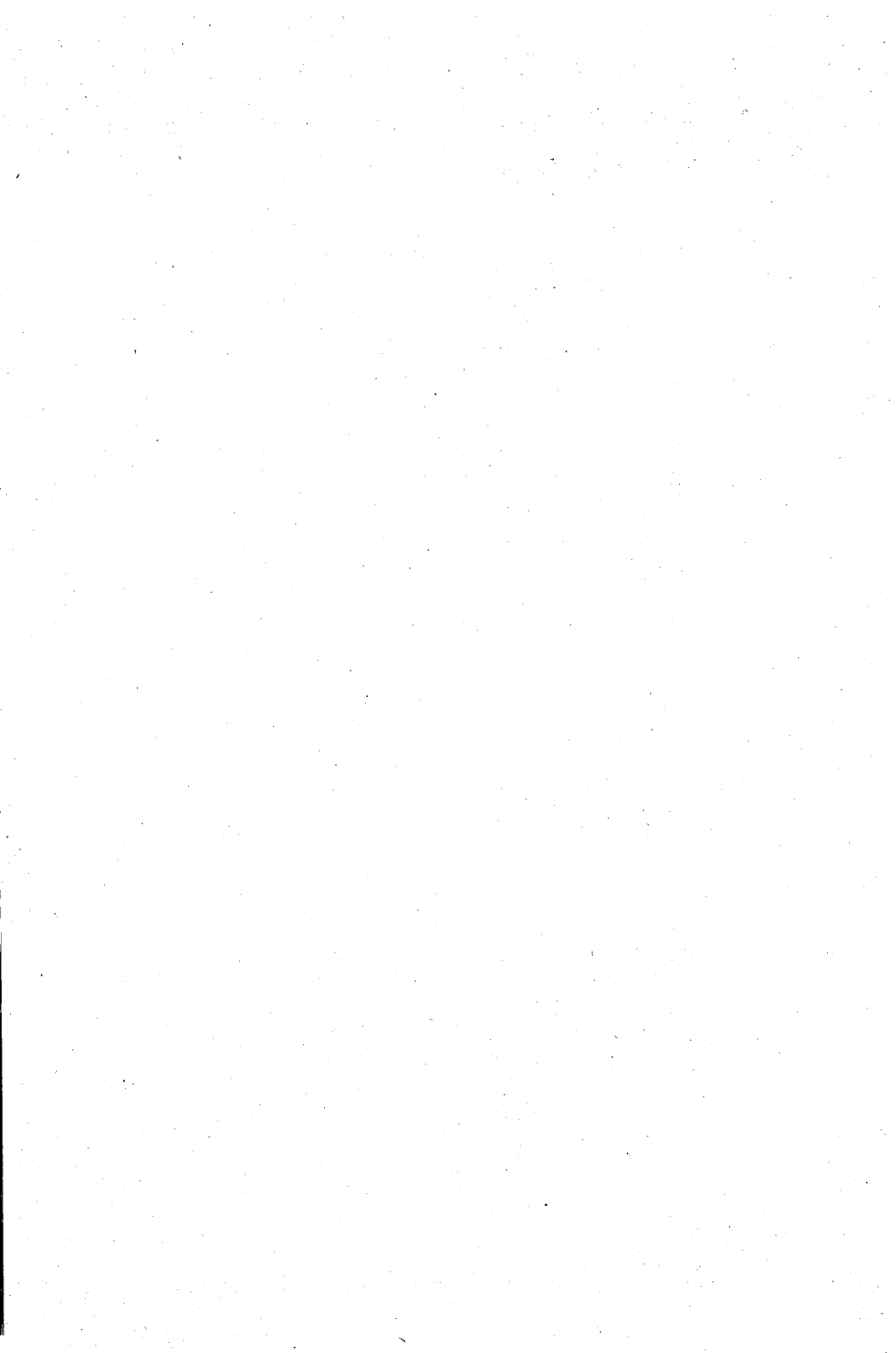
The Reflow Solder Technique

The preferred technique for mounting miniature components on hybrid thick or thin-film circuits is reflow soldering. Solder is applied to the required areas on the substrate by dipping in a solder bath or, more usually, by screen printing a solder paste. Components are put in place and the solder is reflowed by heating.

Solder pastes consist of very finely powdered solder and flux suspended in an organic liquid binder. They are available in various forms depending on the specification of the solder and the type of binder used. For hybrid circuit use, a tin-lead solder with 2 to 4% silver is recommended. The working temperature of this paste is about 220 to 230 °C when a mild flux is used.

For printing the paste onto the substrate a stainless steel screen with a mesh of 80 to 105 μm is used for which the emulsion thickness should be about 50 μm . To ensure that sufficient solder paste is applied to the substrate, the screen aperture should be slightly larger than the corresponding contact area.

The contact pins are positioned on the substrate, the slight adhesive force of the solder paste being sufficient to keep them in place. The substrate is heated to the solder working temperature preferably by means of a controlled hot plate. The soldering process should be kept as short as possible: 10 to 15 seconds is sufficient to ensure good solder joints and evaporation of the binder fluid. After soldering, the substrate must be cleaned of any remaining flux.



RATING SYSTEMS

ACCORDING TO I.E.C. PUBLICATION 134

1. DEFINITIONS OF TERMS USED

1.1 Electronic device. An electronic tube or valve, transistor or other semiconductor device.

Note: This definition excludes inductors, capacitors, resistors and similar components.

1.2 Characteristic. A characteristic is an inherent and measurable property of a device. Such a property may be electrical, mechanical, thermal, hydraulic, electro-magnetic, or nuclear, and can be expressed as a value for stated or recognized conditions. A characteristic may also be a set of related values, usually shown in graphical form.

1.3 Bogey electronic device. An electronic device whose characteristics have the published nominal values for the type. A bogey electronic device for any particular application can be obtained by considering only those characteristics which are directly related to the application.

1.4 Rating. A value which establishes either a limiting capability or a limiting condition for an electronic device. It is determined for specified values of environment and operation, and may be stated in any suitable terms.

Note: Limiting conditions may be either maxima or minima.

1.5 Rating system. The set of principles upon which ratings are established and which determine their interpretation.

Note: The rating system indicates the division of responsibility between the device manufacturer and the circuit designer, with the object of ensuring that the working conditions do not exceed the ratings.

2. ABSOLUTE MAXIMUM RATING SYSTEM

Absolute maximum ratings are limiting values of operating and environmental conditions applicable to any electronic device of a specified type as defined by its published data, which should not be exceeded under the worst probable conditions.

These values are chosen by the device manufacturer to provide acceptable serviceability of the device, taking no responsibility for equipment variations, environmental variations, and the effects of changes in operating conditions due to variations in the characteristics of the device under consideration and of all other electronic devices in the equipment.

p. t. o.

The equipment manufacturer should design so that, initially and throughout life, no absolute maximum value for the intended service is exceeded with any device under the worst probable operating conditions with respect to supply voltage variation, equipment component variation, equipment control adjustment, load variations, signal variation, environmental conditions, and variations in characteristics of the device under consideration and of all other electronic devices in the equipment.

3. DESIGN MAXIMUM RATING SYSTEM

Design maximum ratings are limiting values of operating and environmental conditions applicable to a bogey electronic device of a specified type as defined by its published data, and should not be exceeded under the worst probable conditions.

These values are chosen by the device manufacturer to provide acceptable serviceability of the device, taking responsibility for the effects of changes in operating conditions due to variations in the characteristics of the electronic device under consideration.

The equipment manufacturer should design so that, initially and throughout life, no design maximum value for the intended service is exceeded with a bogey device under the worst probable operating conditions with respect to supply voltage variation, equipment component variation, variation in characteristics of all other devices in the equipment, equipment control adjustment, load variation, signal variation and environmental conditions.

4. DESIGN CENTRE RATING SYSTEM

Design centre ratings are limiting values of operating and environmental conditions applicable to a bogey electronic device of a specified type as defined by its published data, and should not be exceeded under normal conditions.

These values are chosen by the device manufacturer to provide acceptable serviceability of the device in average applications, taking responsibility for normal changes in operating conditions due to rated supply voltage variation, equipment component variation, equipment control adjustment, load variation, signal variation, environmental conditions, and variations in the characteristics of all electronic devices.

The equipment manufacturer should design so that, initially, no design centre value for the intended service is exceeded with a bogey electronic device in equipment operating at the stated normal supply voltage.

NOTE

It is common use to apply the Absolute Maximum System in semiconductor published data.

LETTER SYMBOLS FOR LINEAR INTEGRATED CIRCUITS

General

The voltages and currents are normally related to the terminals to which they are applied or at which they appear. Each terminal is indicated by a number. In appropriate cases voltages, currents etc. pertinent to one or more of the circuit elements (transistors, diodes) are given in which case symbols are based on the recommendations as published in I.E.C. Publication 148.

Quantity symbols

1. Instantaneous values of current, voltage and power, which vary with time are represented by the appropriate lower case letter.

Examples: i , v , p

2. Maximum (peak), average, d.c. and root-mean-square values are represented by the appropriate upper case letter.

Examples: I , V , P

Polarity of current and voltage

A current is defined to be positive when its conventional direction of flow is into the device.

A voltage is measured with respect to the reference terminal, which is indicated by the subscripts. Its polarity is defined to be positive when the potential is higher than that of the reference terminal.

Subscripts

For currents the number behind the quantity symbol indicates the terminal carrying the current.

Examples: I_2 , i_{14}

For voltages normally two number subscripts are used, connected by a hyphen. The first number indicates the terminal at which the voltage is measured and the second subscript the reference terminal.

Where there is no possibility of confusion the second subscript may be omitted.

Examples: V_{2-12} , v_{14-2} , V_5 , v_8

To distinguish between maximum (peak), average, d.c. and root-mean-square values the following subscripts are added:

- For maximum (peak) values : M or m
- For average values : AV or av
- For root-mean-square values: (RMS) or (rms)
- For d.c. values : no additional subscripts

The upper case subscripts indicate total values.

The lower case subscripts indicate values of varying components:

Examples: I_2 , I_{2AV} , $I_{2(rms)}$, $I_{2(RMS)}$

If in appropriate cases quantity symbols are pertinent to single elements of a circuit (transistors or diodes), the normal subscripts for semiconductor devices can be used.

Examples: V_{CBO} , V_{be} , V_{CES} , I_C
 V_{DSS} , V_{GS} , I_D

List of subscripts:

- E, e = Emitter terminal
- B, b = Base terminal for bipolar transistors,
Substrate for MOS devices
- C, c = Collector terminal
- D, d = Drain terminal
- G, g = Gate terminal
- S, s = Source terminal for MOS devices
Substrate for bipolar transistor circuits
- (BR) = Break-down
- M, m = Maximum (peak) value
- AV, av = Average value
- (RMS), (rms) = R.M.S. value

Electrical Parameter Symbols

1. The values of four pole matrix parameters or other resistances, impedances, admittances, etc., inherent in the device, are represented by the lower case symbol with appropriate subscript.

Examples: h_i , z_f , y_o , k_r

Subscripts for Parameter Symbols

1. The static values of parameters are indicated by upper case subscripts.

Examples: h_{FE} , h_i

2. The small signal values of parameters are indicated by lower case subscripts.

Examples: h_i , z_o

3. The first subscript, in matrix notation identifies the element of the four pole matrix.

- i (for 11) = input
- o (for 22) = output
- f (for 21) = forward transfer
- r (for 12) = reverse transfer

$$\text{Examples: } V_1 = h_i I_1 + h_r V_2$$

$$I_2 = h_f I_1 + h_o V_2$$

The voltage and current symbols in matrix notation are indicated by a single digit subscript.

The subscript 1 = input; the subscript 2 = output.

The voltages and currents in these equations may be complex quantities.

4. A second subscript is used only for separate circuit elements (e.g. transistors) to identify the circuit configuration:

- e = common emitter
- b = common base
- c = common collector

5. If it is necessary to distinguish between real and imaginary parts of the four pole parameters, the following notation may be used:

- $R_e (h_i)$ etc. ... for the real part
- $I_m (h_i)$ etc. ... for the imaginary part

LIST OF LETTER SYMBOLS IN ALPHABETICAL ORDER

Letter symbol	Definition
B	Bandwidth
b_i, b_o	Input, respectively output susceptance
C_i, C_o	Input, respectively output capacitance
CMMR	Common-mode rejection ratio
d	Distortion
F	Noise figure
f	Frequency
f_c	Cut-off frequency
f_o	Centre frequency, intermediate frequency
f_m	Modulation frequency
f_T	Transition frequency
g_i, g_o	Input, respectively output conductance
G_p	Power gain
G_{tr}	Transducer gain
G_v	Voltage gain
$h_F, h_{FB}, h_{FC}, h_{FE}$	DC current gain (output voltage held constant)
$h_f, h_{fb}, h_{fc}, h_{fe}$	Small signal current gain (output short-circuited to a.c.)
$I_3, I_B, I_C, I_E, I_D, I_Q, I_S$	Total d.c. current
$i_3, i_B, i_C, i_E, i_D, i_G, i_S$	Instantaneous total value of the current
$I_{3AV}, I_{BAV}, I_{CAV}, I_{EAV}$	Total average current
$I_{3M}, I_{BM}, I_{CM}, I_{EM}$	Maximum (peak) value of the total current
$I_{3m}, I_{bm}, I_{cm}, I_{em}$	Maximum (peak) value of the varying component of the current
I_{CBO}	Collector cut-off current (open emitter)
I_{CS}	Collector-substrate leakage current
I_{DSS}	Drain cut-off current (source short-circuited to gate)

Letter symbol	Definition
I_{EBO}	Emitter cut-off current
I_I, I_i	Input current of a specified circuit
I_{io}	Input offset current
I_O, I_o	Output current of a specified circuit
I_{OM}	Peak value of output current
$I_{O(p-p)}$	Peak to peak value of output current
I_{tot}	Total supply current
K_f	Small signal voltage gain
K_o	Output impedance (see K parameters)
K_R	Reverse current transfer ratio
M	Modulation depth
P_i, P_o	Input, respectively output power of a specified circuit
P_{tot}	Total power dissipation in the device
R_i, R_o	Input, respectively output resistance of a specified circuit
R_L	Load resistance
R_S	Source resistance
R_{th}	Thermal resistance
$SVRR$	Supply voltage rejection ratio
T_{amb}	Ambient temperature
T_{case}	Case temperature
T_{stg}	Storage temperature
$V_3, V_{3-4}, V_{BE}, V_{CB}$	Total value of the voltage (d.c.)
$v_3, v_{3-4}, v_{BE}, v_{CB}$	Instantaneous value of the total voltage
V_{BEsat}, V_{CEsat}	Saturation voltage at specified bottoming conditions
$V_{(BR)CBO}, V_{(BR)CEO},$	Breakdown voltage between the terminal of the first subscript and the reference terminal (second subscript) when the third terminal is open circuited
$V_{(BR)EBO}$	
$V_{(BR)CS}$	Collector to substrate breakdown voltage
$V_{CBO}, V_{CEO}, V_{EBO}, V_{CS},$	Voltage of the terminal indicated with respect to the reference terminal (second subscript)
V_{1-3}	

LETTER SYMBOLS

Letter symbol	Definition
V_i, V_o	Input, respectively output voltage of a specified circuit
V_{io}	Input offset voltage
$V_{i \text{ lim}}$	Input voltage at which limiting starts
V_N	Negative supply voltage
V_P	Positive supply voltage
V_n	Noise voltage
Y_i, Y_f, Y_o, Y_r	Input, transfer, output and feedback admittance
Z_i, Z_o	Input, respectively output impedance
η	Efficiency
$\varphi_i, \varphi_f, \varphi_o, \varphi_r$	Phase angle of input, transfer, output and feedback admittance

AMPLIFIERS



Amplifiers

TBA221D	- op amp
TCA220	- triple op amp
TCA410A; B; D	- voltage follower
TCA520B; D	- op amp
TCA680; B; D	- high slew rate op amp
TDA0301D	- op amp
TDA0324D	- quadruple op amp
TDA0358D	- dual op amp
TDA0741D	- general purpose op amp
TDA0748D	- general purpose op amp
TDA1034; B; D	- low noise op amp
TDA1458D	- dual op amp
TDA4250B; D	- programmable op amp

OPERATIONAL AMPLIFIER

The TBA221D is a silicon monolithic integrated operational amplifier for use at temperatures from -25 to $+85$ °C. Special features are:

- no frequency compensation required
- continuous short-circuit protection
- offset voltage adjustable to zero
- large input voltage range
- low power consumption
- no latch up

TBA221D is equivalent to μ A741C, but has better specified d.c. parameters and lower noise.

QUICK REFERENCE DATA

Positive supply voltage	V_P	15	V
Negative supply voltage	$-V_N$	15	V

Characteristics at $T_{amb} = 25$ °C			
Voltage gain at $R_L = 2$ k Ω ; $V_O = \pm 10$ V	G_V	typ.	200 000
Common mode rejection ratio	CMRR	typ.	90 dB
Differential input resistance	R_i	typ.	2 M Ω
Output voltage swing at $R_L = 10$ k Ω	V_O	>	± 12 V
Input voltage range	V_i	>	± 12 V

PACKAGE OUTLINE SO-8 (SOT-96A) (plastic 8-lead flat pack) (see general section).

RATINGS Limiting values in accordance with the Absolute Maximum System (IEC 134)

Voltages

Positive supply voltage	V_P	max.	20 V
Negative supply voltage	$-V_N$	max.	20 V
Common mode input voltage ¹⁾	V_i	max.	± 15 V
Differential input voltage	V_{2-3}	max.	± 30 V

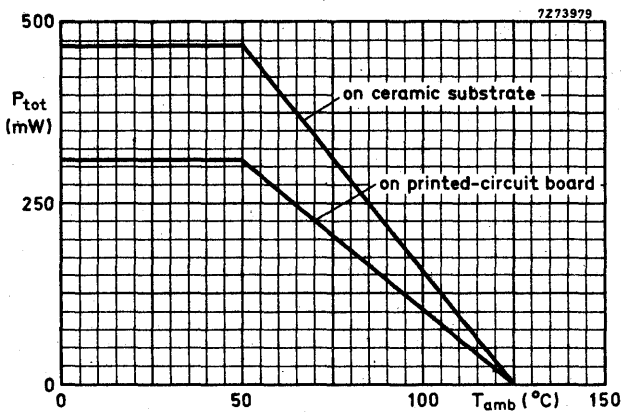
Power dissipation (see derating curve below)

Total power dissipation (free air, $T_{amb} = 50$ °C) mounted on a ceramic substrate (4 cm ²)	P_{tot}	max.	470 mW
mounted on printed-circuit board (4 cm ²)	P_{tot}	max.	310 mW

Output short-circuit duration ²⁾ indefinite

Temperatures

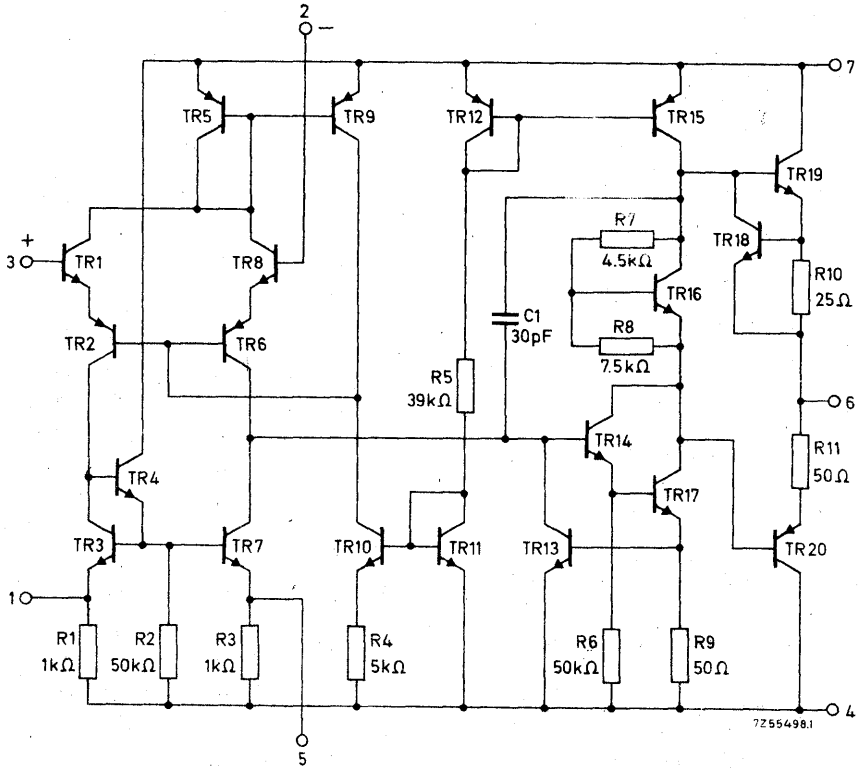
Operating ambient temperature see derating curve below	T_{amb}	-25 to +85 °C
Storage temperature	T_{stg}	-65 to +150 °C



1) For supply voltages less than ± 15 V, the absolute maximum input voltage is equal to the supply voltage.

2) Continuous short circuit is allowed to ground or either supply.

CIRCUIT DIAGRAM



CHARACTERISTICS at $V_P = 15\text{ V}$; $-V_N = 15\text{ V}$; $T_{amb} = 25\text{ }^\circ\text{C}$ unless otherwise specified

Input offset voltage	V_{io}	typ.	1	mV
		<	4	mV
Input offset voltage at $V_P = 18\text{ V}$; $-V_N = 18\text{ V}$; $V_i = \pm 15\text{ V}$	V_{io}	<	8	mV
		typ.	5	$\mu\text{V}/^\circ\text{C}$
Input offset voltage drift	ΔV_{io}	typ.	5	$\mu\text{V}/^\circ\text{C}$
Input bias current	I_i	typ.	50	nA
		<	150	nA
Input offset current	I_{io}	typ.	5	nA
		<	50	nA
Input voltage range	V_i	>	± 12	V
		typ.	± 13	V
Common mode rejection ratio	CMRR	>	75	dB
		typ.	90	dB
Differential input resistance	R_i	>	0,6	M Ω
		typ.	2,0	M Ω
Power supply voltage rejection ratio	PSRR	typ.	30	$\mu\text{V}/\text{V}$
		<	100	$\mu\text{V}/\text{V}$
Voltage gain at $R_L = 2\text{ k}\Omega$; $V_o = \pm 10\text{ V}$	G_v	>	30000	
		typ.	200000	
Output voltage swing at $R_L = 2\text{ k}\Omega$	V_o	>	± 12	V
		typ.	± 13	V
Output resistance at $f = 1\text{ kHz}$	R_o	typ.	60	Ω
		<	150	Ω
Output short-circuit current	I_{sc}	typ.	25	mA
Supply current at $I_o = 0$	$I_{P;N}$	typ.	1,7	mA
		<	2,8	mA
A. C. gain at $f = 1\text{ kHz}$; $R_L = 2\text{ k}\Omega$	G_v	typ.	1000	
			700 to 1500	
Transient response (unity gain; voltage follower)				
$V_i = 20\text{ mV}$; $R_L = 2\text{ k}\Omega$; $C_L = 100\text{ pF}$				
Rise time		typ.	0,25	μs
Overshoot		typ.	3	%
Slew rate (unity gain) at $R_L = 2\text{ k}\Omega$	S	typ.	0,6	$\text{V}/\mu\text{s}$
Input noise voltage at $f = 1\text{ kHz}$ at $f = 30\text{ Hz}$	V_n	typ.	20	$\text{nV}/\sqrt{\text{Hz}}$
		typ.	25	$\text{nV}/\sqrt{\text{Hz}}$
Input noise current at $f = 1\text{ kHz}$ at $f = 30\text{ Hz}$	I_n	typ.	0,15	$\text{pA}/\sqrt{\text{Hz}}$
		typ.	0,6	$\text{pA}/\sqrt{\text{Hz}}$

CHARACTERISTICS at $V_P = 15\text{ V}$; $-V_N = 15\text{ V}$; $T_{\text{amb}} = -25\text{ to }+85\text{ }^\circ\text{C}$ unless otherwise specified

Voltage gain at $R_L = 2\text{ k}\Omega$; $V_O = \pm 10\text{ V}$

$G_V > 20\,000$

Input offset voltage

$V_{i0} < 5,5\text{ mV}$

Input bias current

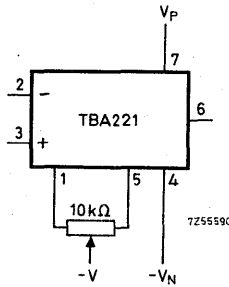
$I_i < 0,3\text{ }\mu\text{A}$

Input offset current

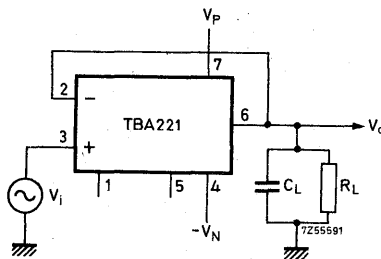
$I_{i0} < 0,1\text{ }\mu\text{A}$

Output voltage swing at $R_L = 2\text{ k}\Omega$

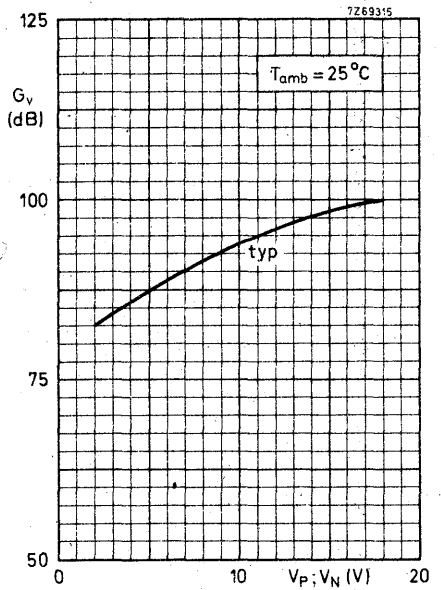
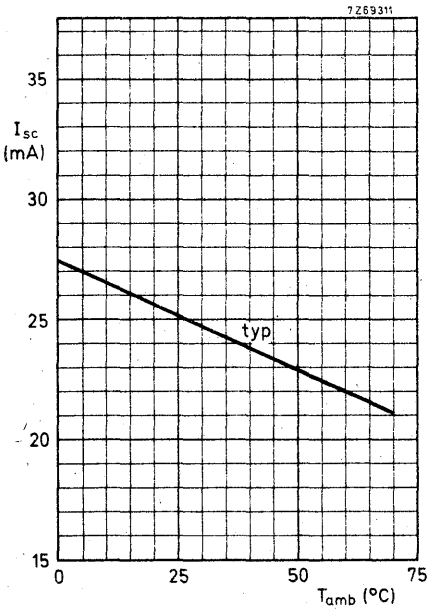
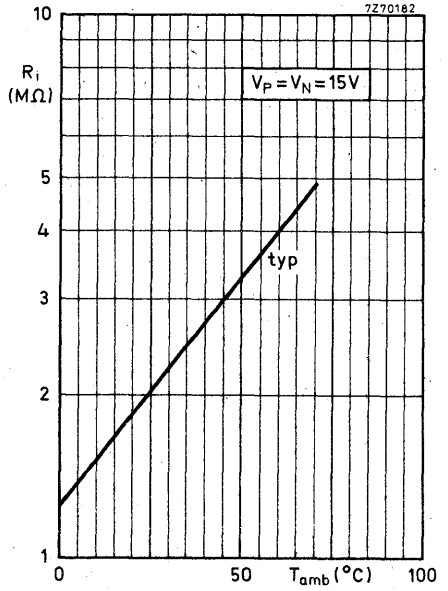
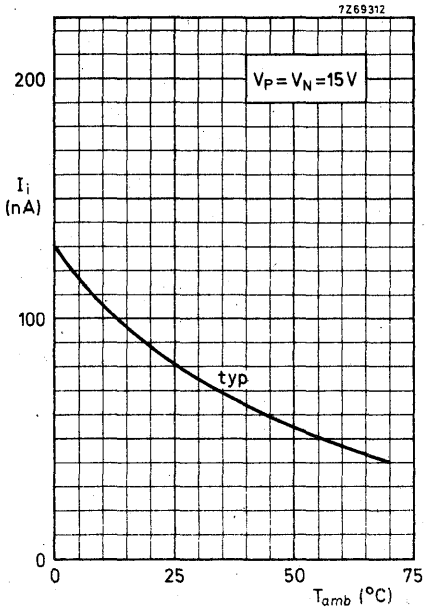
$V_O > 11,5\text{ V}$

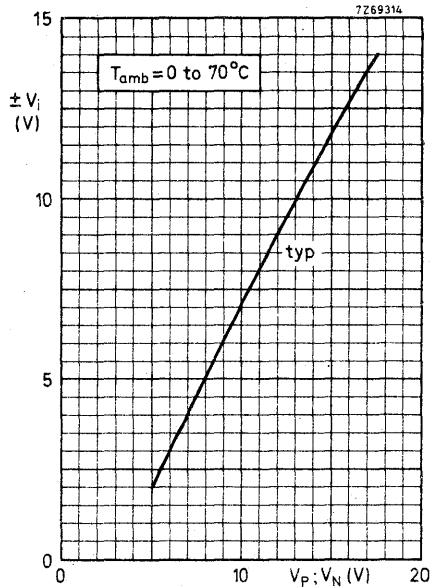
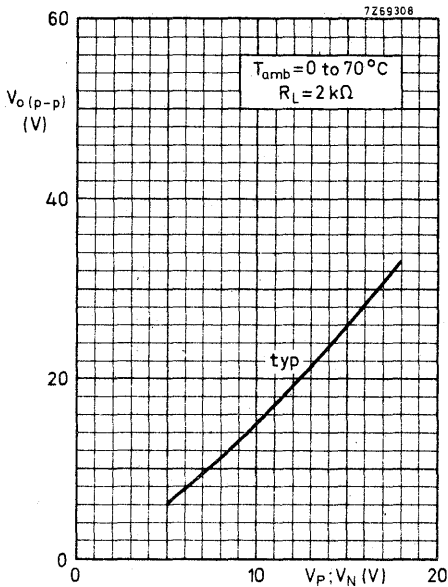
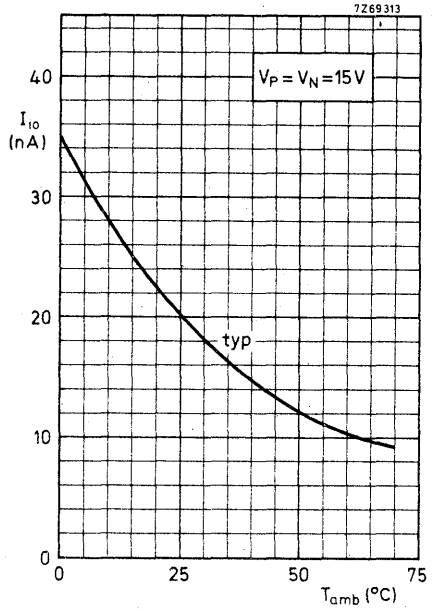
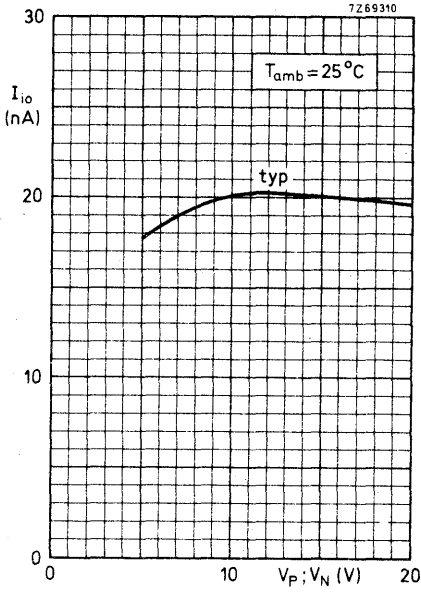


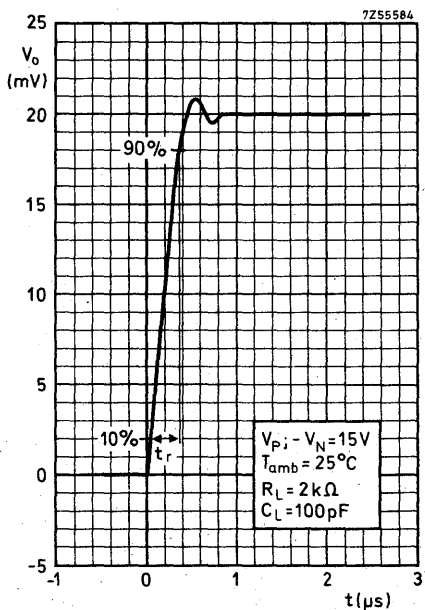
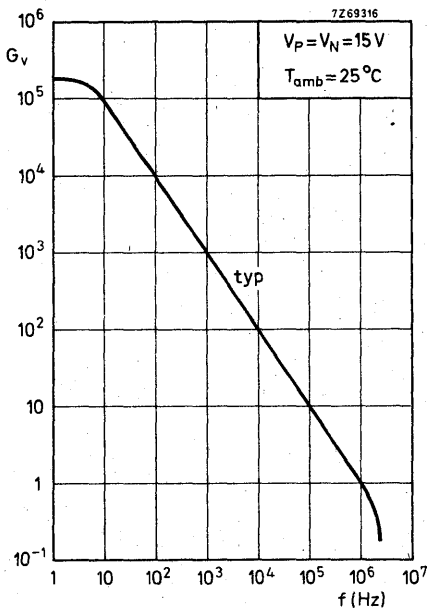
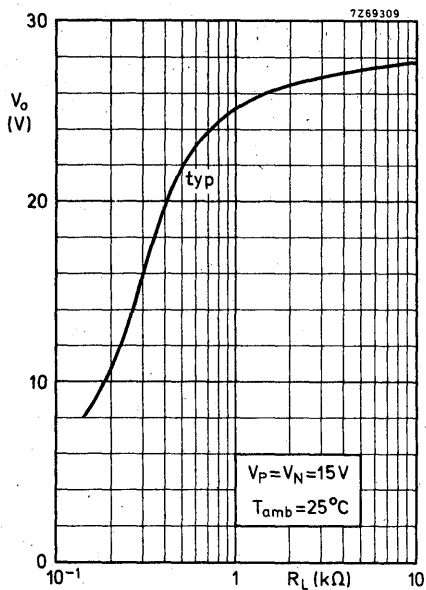
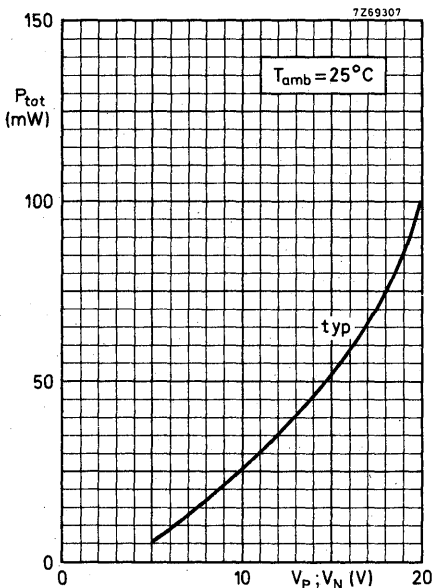
Offset voltage zeroing circuit

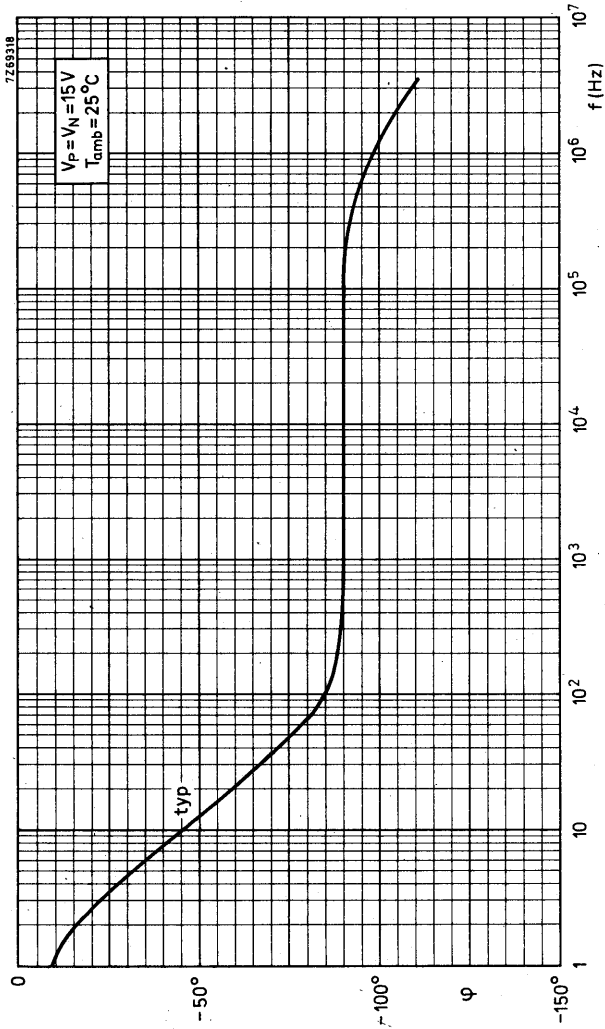


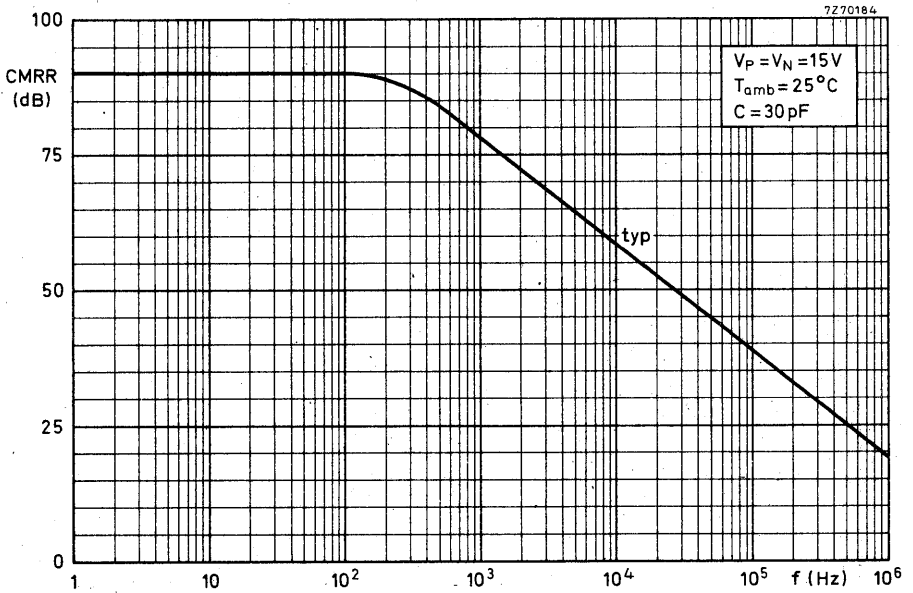
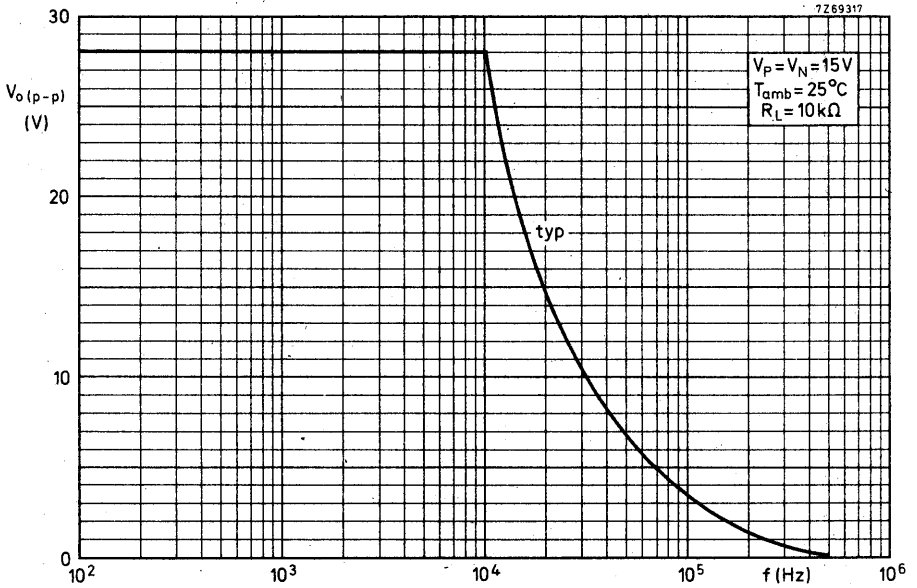
Transient response test circuit











TRIPLE OPERATIONAL AMPLIFIER

The TCA220 is a monolithic integrated circuit, consisting of three identical high-gain amplifiers.

The amplifiers have a differential input stage and an emitter-follower output stage, which can supply a current up to 100 mA.

The unity-gain frequency with 6 dB/octave compensation is 5 MHz minimum. No latch-up occurs if the input voltage range is exceeded.

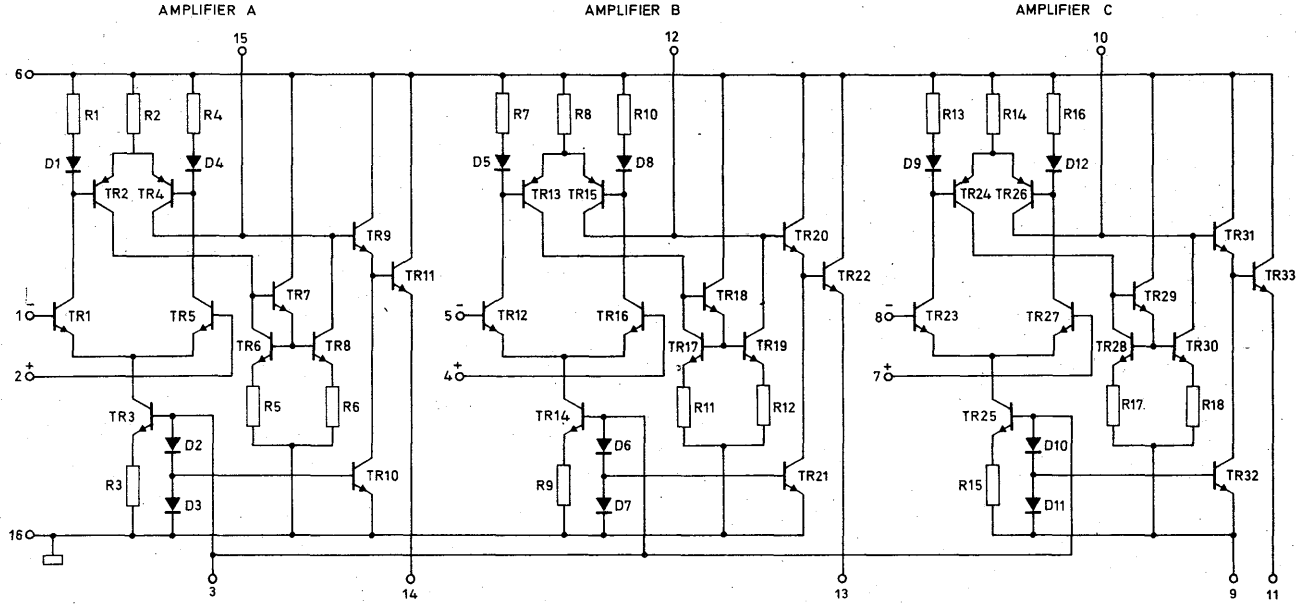
QUICK REFERENCE DATA

Positive supply voltage	V_P	nom.	6	V
Negative supply voltage	V_N	nom.	6	V

Voltage gain	G_V	typ.	4000	
Common mode rejection ratio	CMRR	typ.	90	dB
Supply voltage rejection ratio	SVRR	typ.	200	$\mu\text{V}/\text{V}$
Input offset voltage	V_{i0}	typ.	2	mV
Input offset current	I_{i0}	typ.	0,2	μA

PACKAGE OUTLINE plastic 16-lead dual in-line (see general section).

CIRCUIT DIAGRAM



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RATINGS Limiting values in accordance with the Absolute Maximum System (IEC134)

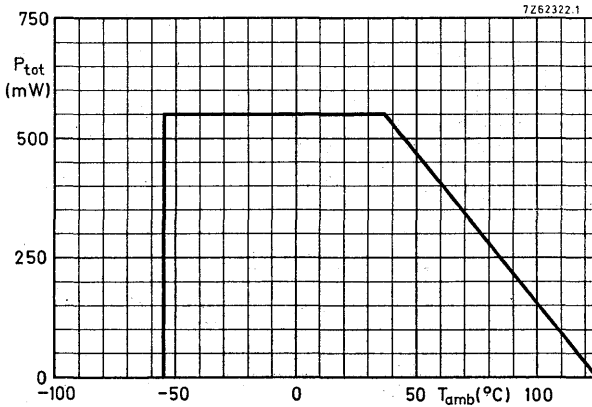
Voltages

Supply voltage	V_{6-16}	max.	18	V			
Common mode input voltage	V_i	max.	18	V ¹⁾			
Differential input voltages	$\pm V_{1-2}$ $\pm V_{5-4}$ $\pm V_{8-7}$	}	max.	5,0 V			
Pin No. 9 voltage	V_{9-16}				max.	0	V ²⁾

Currents

Input currents (pins, 1, 2, 4, 5, 7, 8)	$I_1; I_2$ $I_4; I_5$ $I_7; I_8$	}	max.	0,5	mA			
Output currents (pins 14, 13, 11)	$-I_{14}; -I_{13}; -I_{11}$					max.	100	mA
Bias current (pin 3)	I_3					max.	5,0	mA

Total power dissipation



Temperatures

Storage temperature	T_{stg}	-55 to +125	°C
Junction temperature	T_j	max. 125	°C

1) For a total supply voltage less than 18 V, the absolute maximum input voltage is equal to the supply voltage.

2) If amplifier C is used, pin 9 must be connected to pin 16.

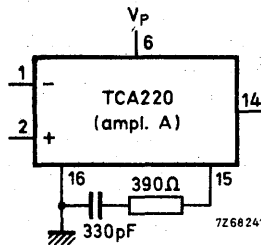
THERMAL RESISTANCE

From junction to ambient R_{th} max. 160 °C/W

CHARACTERISTICS (each amplifier) at $V_P = 6\text{ V}$; $-V_N = 6\text{ V}$; $T_{amb} = 25\text{ °C}$
 $R_L = 10\text{ k}\Omega$ (unless otherwise specified)

<u>Voltage gain</u> at $\pm V_{OM} = 3,5\text{ V}$	G_V	typ.	4000	
<u>Input offset voltage</u> at $R_S \leq 200\ \Omega$	V_{io}	typ.	2	mV
		<	10	mV
<u>Input bias current</u>	I_i	typ.	1,0	μA
		<	2,0	μA
<u>Input offset current</u>	I_{io}	typ.	0,2	μA
<u>Common mode rejection ratio</u> at $R_S = 2\text{ k}\Omega$	CMRR	typ.	90	dB
<u>Input voltage range</u>	V_i		-4,3 to +5,6	V
<u>Differential input resistance</u>	R_i	>	25	k Ω
<u>Supply voltage rejection ratio</u> at $R_S = 2\text{ k}\Omega$	SVRR	typ.	200	$\mu\text{V/V}$
<u>Peak output voltage swing</u>	V_{OM}		-6 to +3,5	V
<u>Total current</u> at $V_o = 0$; $R_L = 10\text{ k}\Omega$	I_{tot}	typ.	1,0	mA
		at $V_o = 0$; $R_L = \infty$	typ.	0,4
<u>Slew rate</u> (unity-gain)		typ.	0,4	V/ μs
<u>Bias current</u> (all three amplifiers together)	I_3	>	200	μA^1
<u>Channel separation</u> between amplifiers A and B		typ.	94	dB ²⁾
	between amplifiers A and C	typ.	130	dB ²⁾
	between amplifiers B and C	typ.	110	dB ²⁾

Frequency compensation circuit



1) The voltage at pin 3 is always 2 diode voltages (approx. 1,5 V) above the negative supply voltage; if the bias current is obtained from the positive supply voltage a dropping resistor $R_p \leq \frac{V_P - V_N - 1,5}{200 \cdot 10^{-6}}$

gives minimum power consumption.

2) Channel separation defined as $20 \log \frac{V_{oA}}{V_{oB}} \times G_B$, if G_B is the closed loop gain of amplifier B.

VOLTAGE FOLLOWER

The TCA410 is a silicon monolithic integrated operational amplifier internally connected as a voltage follower.

Special features are:

- very low input current;
- continuous short-circuit protection;
- no frequency compensation required
- small package (TO-72 or SOT-95A)

For most applications the TCA410 can be used as a direct replacement for the LM302 and LM310. The TCA410D is pin to pin compatible with the TBA221D, when the latter is connected as a voltage follower.

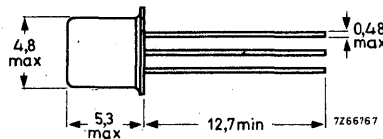
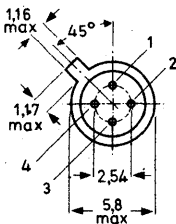
QUICK REFERENCE DATA

Supply voltage range	$V_P = -V_N$		5 to 18 V	
	TCA410A TCA410D	TCA410B		
Input bias current	I_i	typ. 0,5	1,5	nA
Input offset voltage	V_{io}	typ.	3	mV
Output short-circuit current	I_{sc}	typ.	10	mA
Output voltage swing at $R_L = 5 \text{ k}\Omega$	V_o	typ.	13,5	V
Slew rate	S	typ.	4	V/ μ s

PACKAGE OUTLINE (for TCA410D see page 2)

Dimensions in mm

TCA410A; TCA410B: TO-72



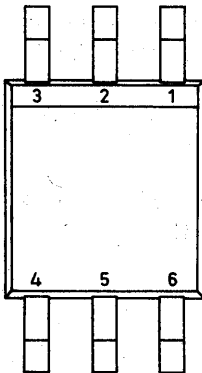
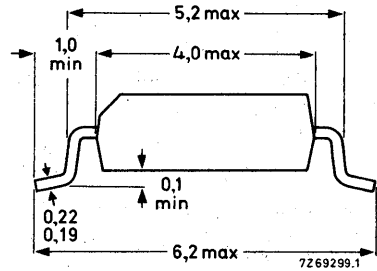
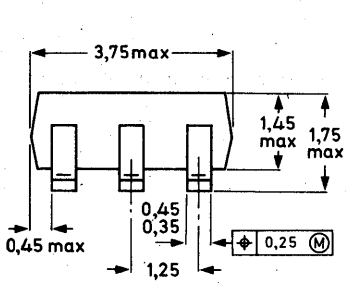
- 1 = V_o
- 2 = V_P
- 3 = V_i
- 4 = V_N

pin 4 connected to case

PACKAGE OUTLINE (continued)

Dimensions in mm

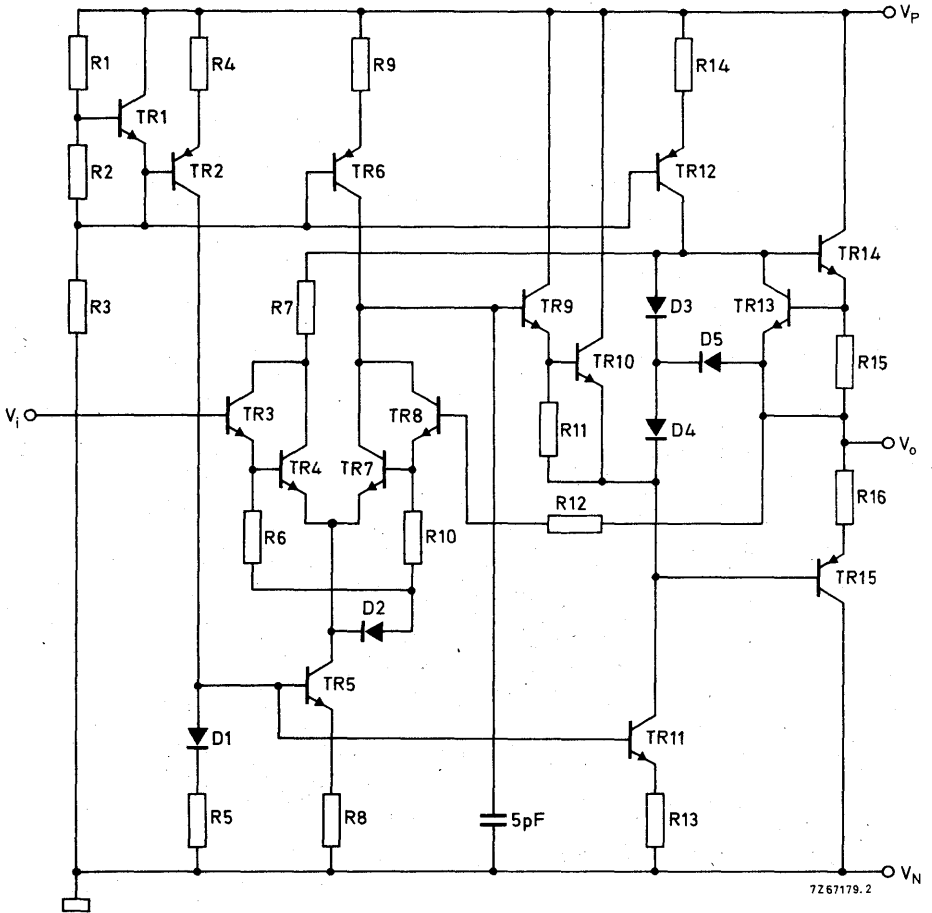
TCA410D; SOT-95A (plastic 6-lead flat pack)



top view

1. Not connected
2. Input (V_i)
3. Negative supply (V_N)
4. Not connected
5. Output (V_o)
6. Positive supply (V_P)

CIRCUIT DIAGRAM



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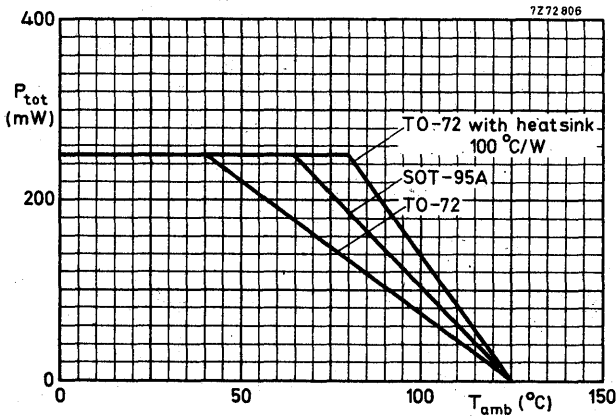
RATINGS Limiting values in accordance with the Absolute Maximum System (IEC 134)

Voltages

Positive supply voltage	V_P	max.	18	V
Negative supply voltage	$-V_N$	max.	18	V
Common mode input voltage			V_N to V_P	
Differential input/output voltage		max.	± 6	V
<u>Power dissipation</u> (see derating curve)	P_{tot}	max.	250	mW

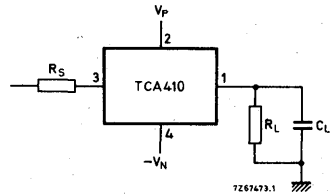
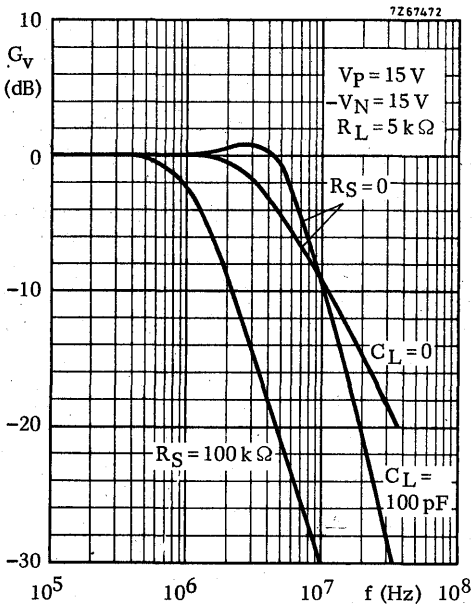
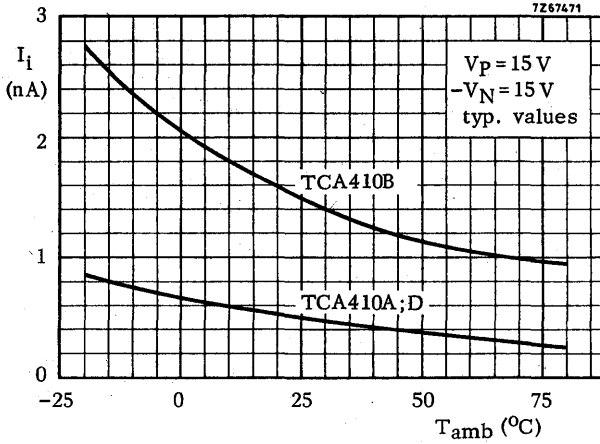
Temperatures

Operating ambient temperature	T_{amb}	-25 to +85	$^{\circ}C$
Storage temperature			
metal envelope; TO-72	T_{stg}	-65 to +125	$^{\circ}C$
plastic flat pack; SOT-95A	T_{stg}	-65 to +125	$^{\circ}C$

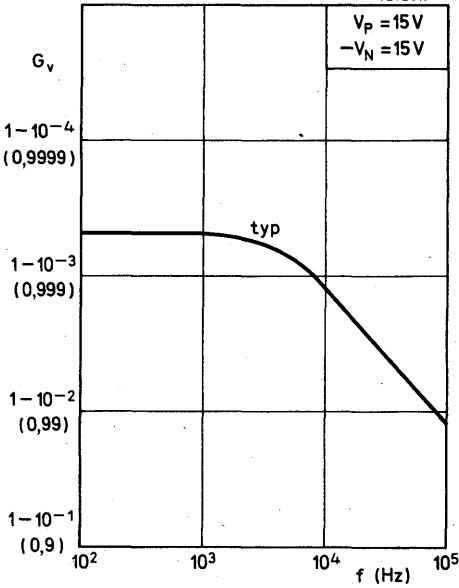


CHARACTERISTICS at $V_P = 15\text{ V}$; $-V_N = 15\text{ V}$; $T_{amb} = 25\text{ }^\circ\text{C}$

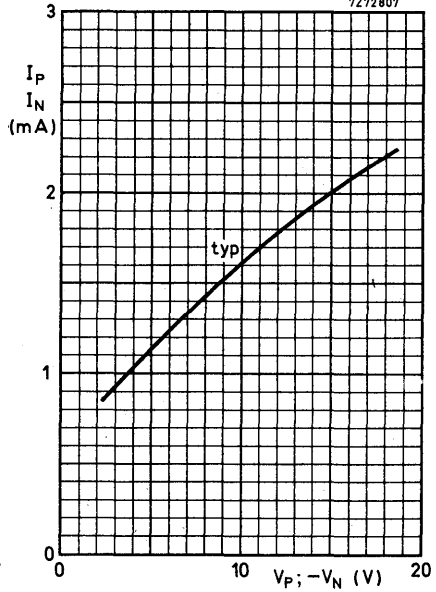
		TCA410A			B	D	
		typ.	0,5	1,5			
Input bias current	I_i		0,5	1,5	0,5	nA	
		<	1,0	3,0	3,0	nA	
Input offset voltage	V_{io}	typ.			3	mV	
		<			10	mV	
Input offset voltage drift	ΔV_{io}	typ.			20	$\mu\text{V}/^\circ\text{C}$	
Voltage gain at $R_L = 5\text{ k}\Omega$; $V_i = \pm 12,5\text{ V}$	G_v	>			0,9980		
		typ.			0,9995		
Output voltage swing at $R_L = 5\text{ k}\Omega$	V_o	>			$\pm 12,5$	V	
		typ.			$\pm 13,5$	V	
Output resistance at $I_o = \pm 6\text{ mA}$	R_o	typ.			0,7	Ω	
		<			2,0	Ω	
Output short-circuit current	I_{sc}	typ.			10	mA	
					6 to 14	mA	
Slew rate	S	>			2,5	$\text{V}/\mu\text{s}$	
		typ.			4,0	$\text{V}/\mu\text{s}$	
Supply current	$I_P; N$	typ.			2	mA	
		<			3	mA	
Power supply voltage rejection ratio	PSRR	>			65	dB	
		typ.			75	dB	
Supply voltage range	$V_P = -V_N$				5 to 18	V	
Input capacitance	C_i	typ.			2,5	pF	
Input noise voltage at $f = 1\text{ kHz}$ at $f = 10\text{ Hz}$	V_n	typ.			80	$\text{nV}/\sqrt{\text{Hz}}$	
		typ.			200	$\text{nV}/\sqrt{\text{Hz}}$	
Input noise current at $f = 1\text{ kHz}$: TCA410A TCA410B	I_n	typ.			0,006	$\text{pA}/\sqrt{\text{Hz}}$	
		typ.			0,015	$\text{pA}/\sqrt{\text{Hz}}$	
at $f = 10\text{ Hz}$: TCA410A TCA410B	I_n	typ.			0,04	$\text{pA}/\sqrt{\text{Hz}}$	
		typ.			0,1	$\text{pA}/\sqrt{\text{Hz}}$	



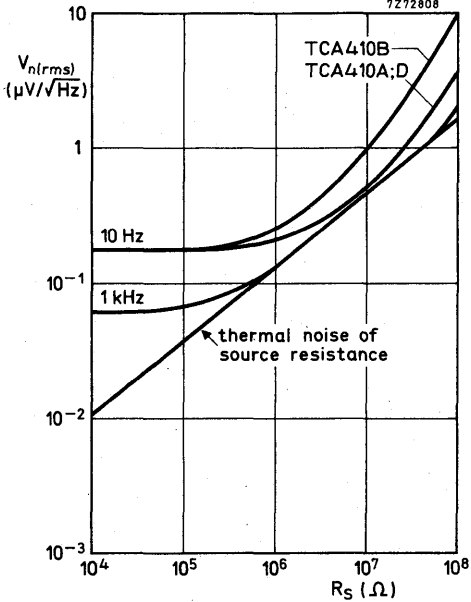
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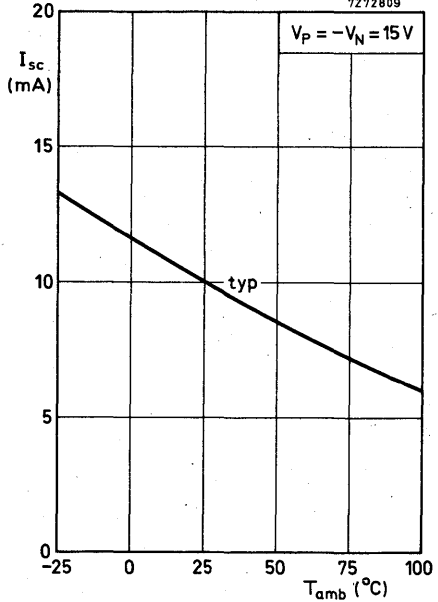
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7272808



7272809



OPERATIONAL AMPLIFIER

The TCA520 is a silicon monolithic integrated circuit primarily intended for use in low power, low voltage applications and as comparator in digital systems.

Special features are:

- large supply voltage range : 2 to 20 V
- offset voltage adjustable to zero
- output TTL-compatible
- low power consumption : 5 mW at 5 V
- high slew rate (comparator) : 50 V/ μ s
- low input bias current : 30 nA

QUICK REFERENCE DATA

Supply voltage	V_P	nom.	5	V
Output sink current	I_{SINK}	typ.	12	mA
Input current	I_i	typ.	30	nA
Slew rate (comparator)	S	typ.	50	V/ μ s

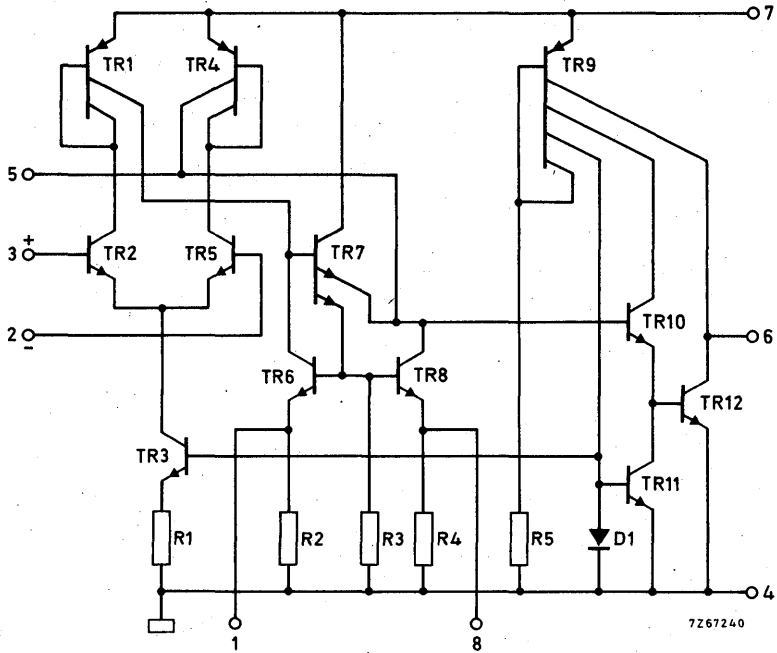
PACKAGE OUTLINES (see general section).

TCA520B : SOT-97 (plastic 8-lead dual in-line).

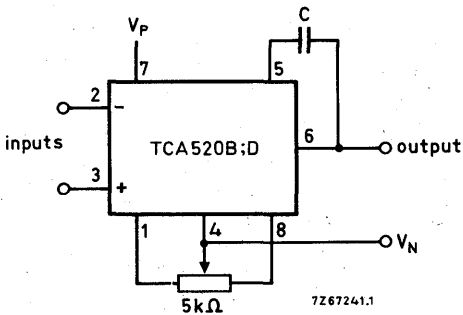
TCA520D : SOT-96A (plastic 8-lead flat pack).

**TCA520B
TCA520D**

CIRCUIT DIAGRAM



CONNECTION DIAGRAM AND PINNING



1. Balance
2. Inverting input
3. Non-inverting input
4. Negative supply (V_N)
5. Frequency compensation
6. Output
7. Positive supply (V_P)
8. Balance

RATINGS Limiting values in accordance with the Absolute Maximum System (IEC 134)

Voltages

Positive supply voltage	V_P	max.	11 V
Negative supply voltage	$-V_N$	max.	11 V
Differential input voltage	$\pm V_{2-3}$	max.	6 V

Temperatures

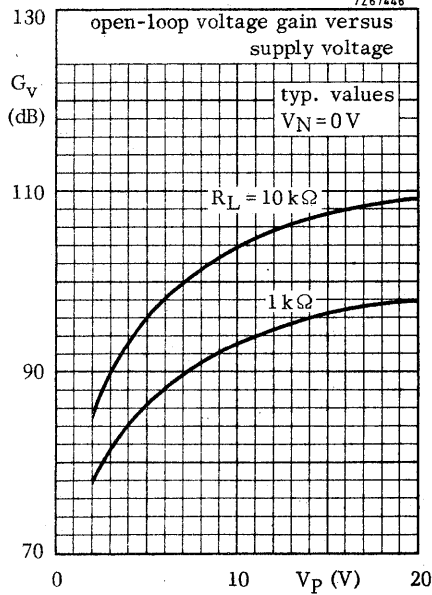
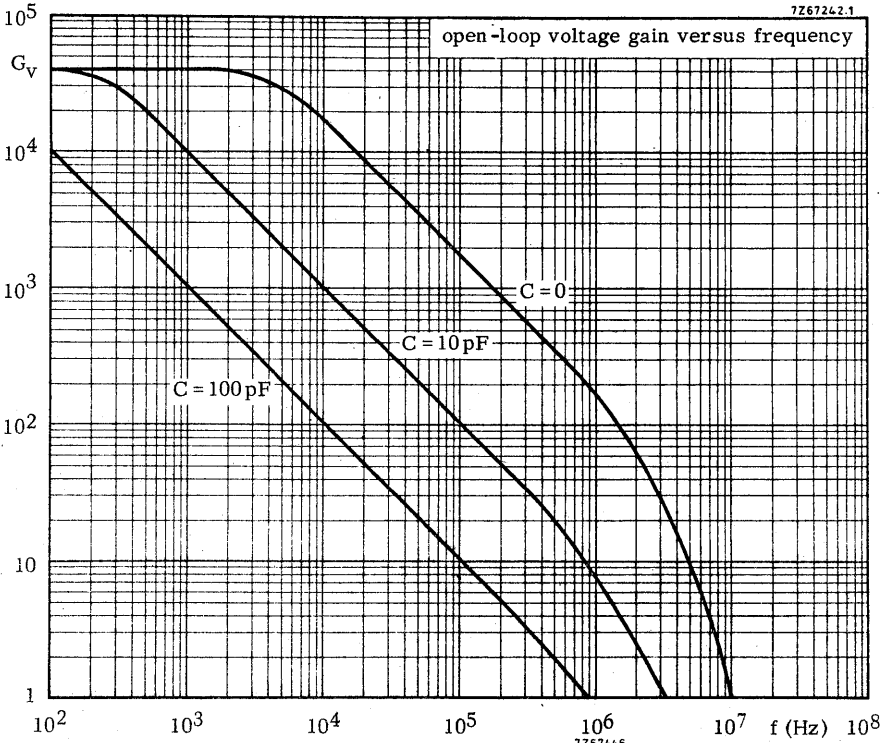
Operating ambient temperature	T_{amb}	-25 to +85 °C
Storage temperature	T_{stg}	-65 to +125 °C

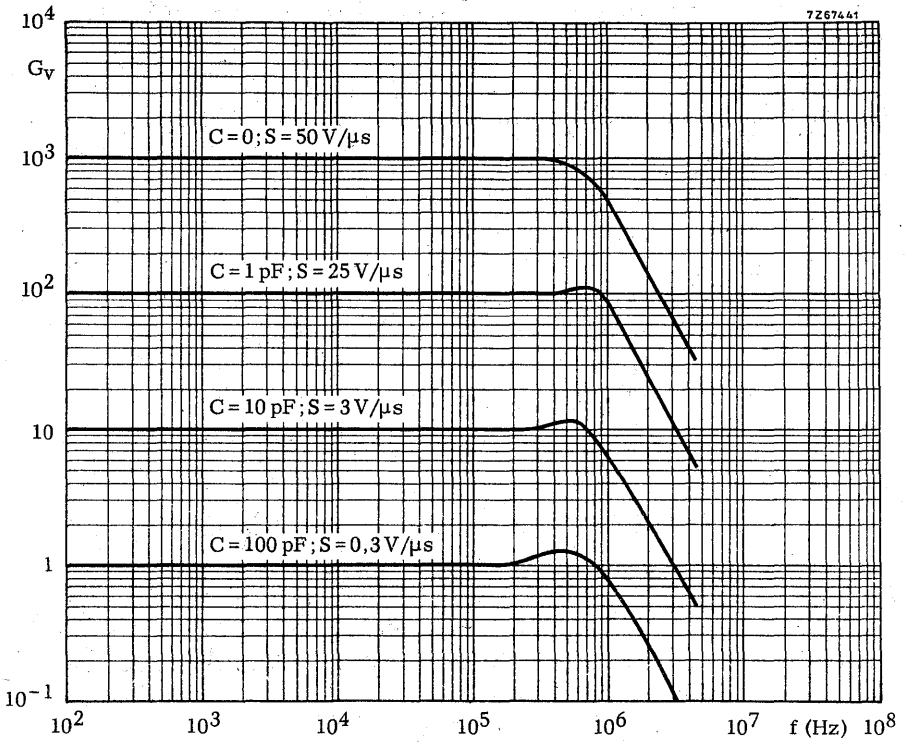
Maximum power dissipation in free air

package	mounting	max. power dissipation at $T_{amb} = 50\text{ °C}$ (mW)	derating factor for $T_{amb} > 50\text{ °C}$ (mW/°C)	thermal resistance $R_{th\ j-a}$ (°C/W)
SOT-97	on PC board	375	5	200
SOT-96A	on ceramic substrate (4 cm ²)	440	5, 8	170
SOT-96A	on PC board (4 cm ²)	300	4	250

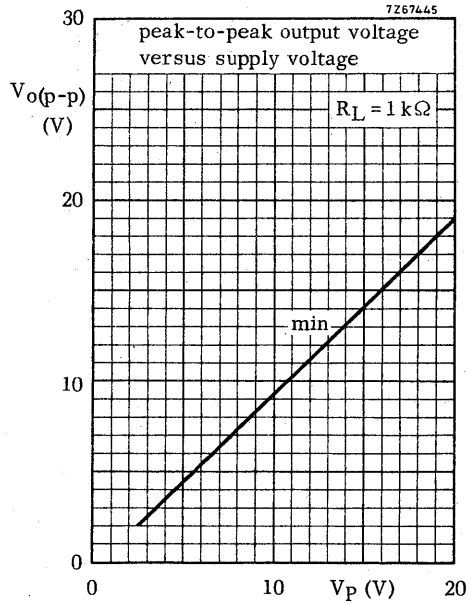
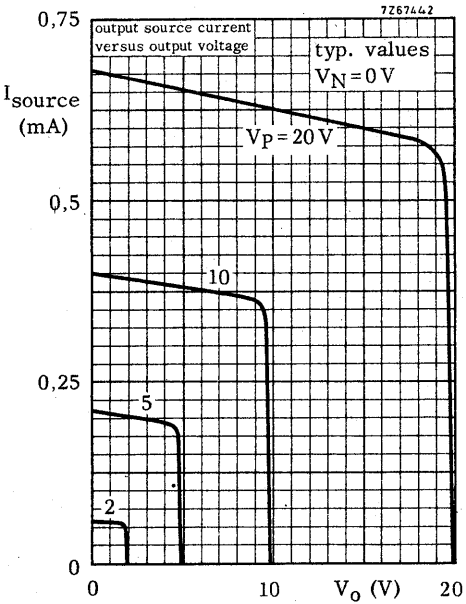
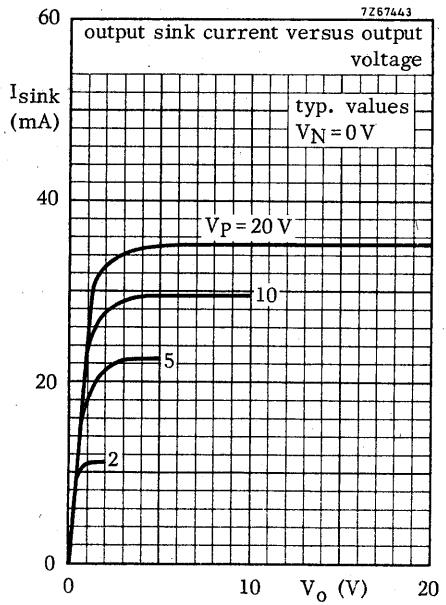
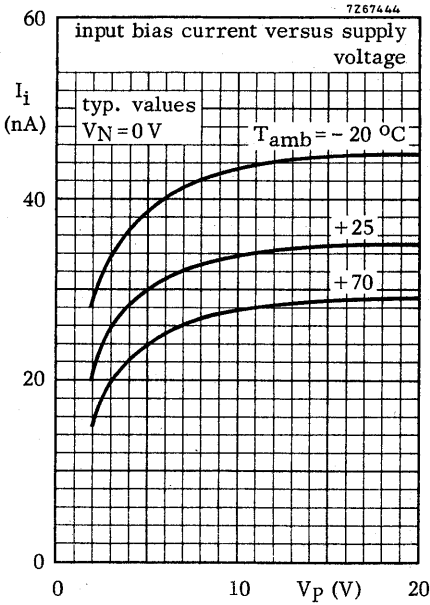
CHARACTERISTICS $V_P = 5\text{ V}$; $V_N = 0\text{ V}$; $T_{\text{amb}} = 25\text{ }^\circ\text{C}$; R_L connected between output (pin 6) and positive supply (pin 7)

Input offset voltage	V_{io}	typ. <	1 mV 6 mV
Input offset voltage drift	ΔV_{io}	typ.	5 $\mu\text{V}/^\circ\text{C}$
Input bias current	I_i	typ. <	30 nA 100 nA
Input offset current	I_{io}	typ. <	5 nA 30 nA
Input voltage range	V_i	> >	$V_N + 0,9\text{ V}$ $V_P - 0,5\text{ V}$
Common mode rejection ratio	CMRR	> typ.	70 dB 100 dB
D. C. voltage gain at $R_L = 5\text{ k}\Omega$	G_v	> typ.	25 000 50 000
A. C. voltage gain at $f = 1\text{ kHz}$; $C = 100\text{ pF}$	G_v	typ.	600 to 1800 1000
Output voltage range at $R_L = 5\text{ k}\Omega$	V_o	> >	$V_N + 0,1\text{ V}$ $V_P - 0,1\text{ V}$
Output sink current at $V_o = V_N + 0,4\text{ V}$	I_{sink}	> typ.	8 mA 12 mA
Output source current at $V_o \leq V_P - 0,4\text{ V}$	I_{source}	> typ.	0,13 mA 0,20 mA
Supply current at $I_o = 0$	$I_{P,N}$	typ. <	1 mA 1,5 mA
Slew rate at $C = 100\text{ pF}$; $R_L = 1\text{ k}\Omega$ at $C = 0$; $R_L = 1\text{ k}\Omega$	S S	typ. typ.	0,3 V/ μs 50 V/ μs
Input noise voltage at $f = 1\text{ kHz}$	V_n	typ.	15 nV/ $\sqrt{\text{Hz}}$
Input noise current at $f = 1\text{ kHz}$	I_n	typ.	0,2 pA/ $\sqrt{\text{Hz}}$

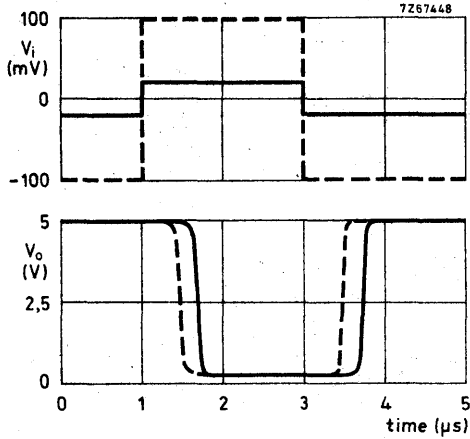
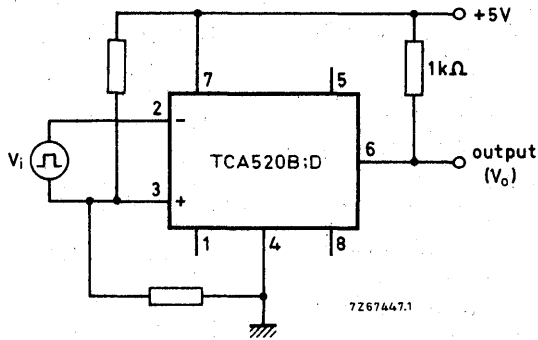




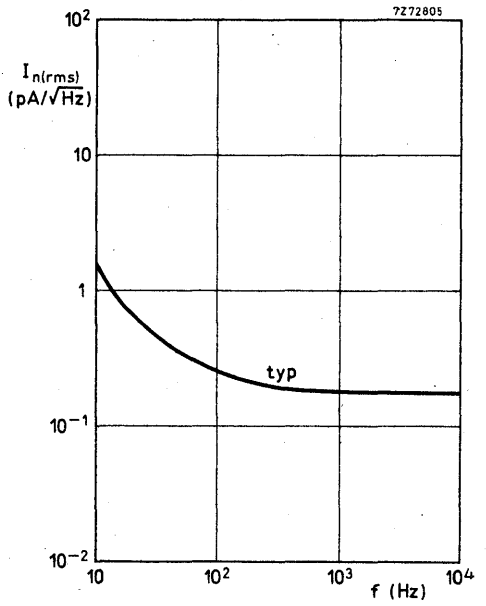
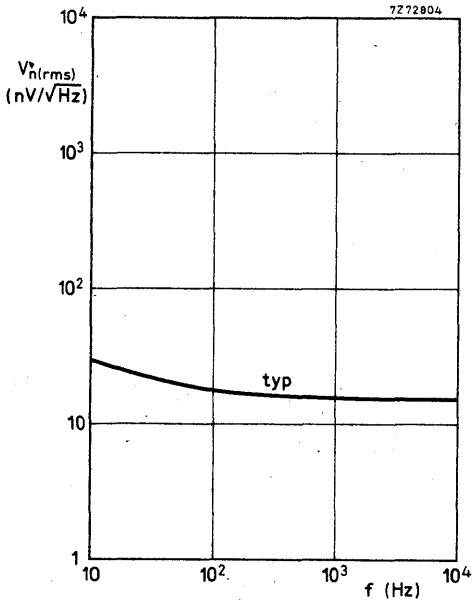
Frequency response and slew-rate for various closed-loop gains



TCA520B
TCA520D



The TCA520B;D used as a comparator; pulse delays when the circuit is 20 or 100 mV overdriven.



OPERATIONAL AMPLIFIER

The TCA680 is a silicon monolithic integrated operational amplifier intended for general purposes, having a considerably improved slew rate and bandwidth compared to the TBA221 ($\mu\text{A}741\text{C}$).

Special features are:

- internal frequency compensation;
- output short-circuit protection;
- pin compatible with general purpose operational amplifiers;
- offset voltage adjustable to zero.

QUICK REFERENCE DATA

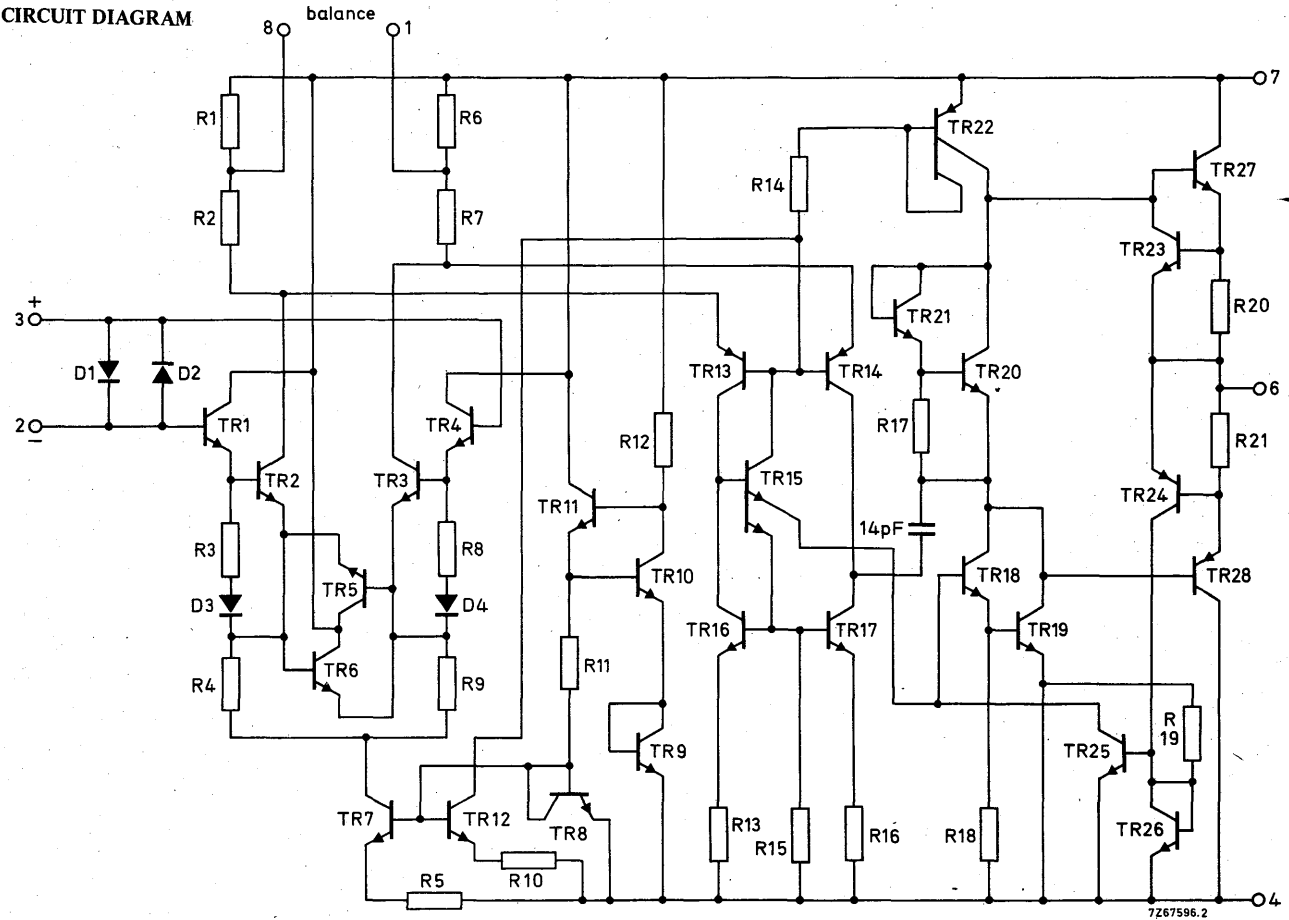
Slew rate	S	typ.	20	V/ μs
Unity gain frequency	f	typ.	6	MHz
Input bias current	I_i	typ.	30	nA
Voltage gain	G_v	typ.	100 000	
Supply voltage range	$V_p; -V_N$		3 to 15	V



PACKAGE OUTLINES (see general section)

- TCA680 : TO-99 (8-lead metal envelope).
 TCA680B : SOT-97 (plastic 8-lead dual in-line).
 TCA680D : SOT-96A (plastic 8-lead flat pack).

CIRCUIT DIAGRAM



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RATINGS Limiting values in accordance with the Absolute Maximum System (IEC 134)

Voltages

Positive supply voltage	V_P	max.	18 V
Negative supply voltage	$-V_N$	max.	18 V
Common mode input voltage (pins 2 and 3)		V_P to $-V_N$	
Differential input voltage	V_{2-3}	max.	$\pm 0,5$ V ¹⁾

Current

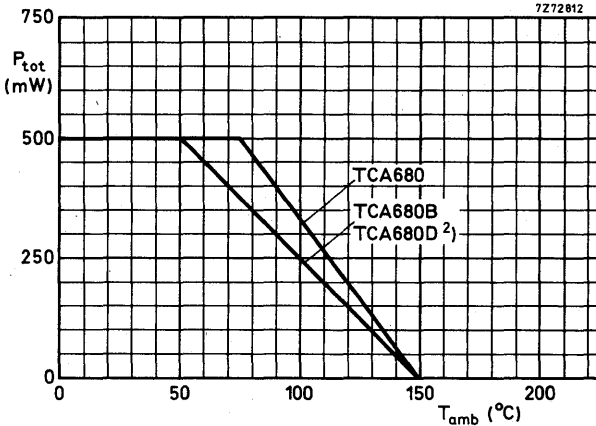
Input current	$I_2; I_3$	max.	± 10 mA ¹⁾
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Temperatures

Operating ambient temperature	T_{amb}	-25 to +85 °C
Storage temperature; metal envelope	T_{stg}	-65 to +150 °C
plastic envelope	T_{stg}	-65 to +125 °C

Power dissipation

Total power dissipation (see derating graph)	P_{tot}	max.	500 mW
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¹⁾ Diodes protect the inputs against over-voltage. Therefore, unless current-limiting resistors are used, large currents will flow if the differential input voltage exceeds 0,6 V.

²⁾ TCA680D mounted on a ceramic substrate of 5 cm². When mounted on a PC-board the maximum power dissipation is 330 mW.

CHARACTERISTICS at $V_P = 15\text{ V}$; $-V_N = 15\text{ V}$; $T_{\text{amb}} = 25\text{ }^\circ\text{C}$ unless otherwise specified

Input offset voltage	V_{io}	typ.	2	mV
		<	8	mV
Input offset voltage drift	ΔV_{io}	typ.	25	mV
Input offset current	I_{io}	typ.	5	nA
		<	30	nA
Input bias current	I_i	typ.	30	nA
		<	100	nA
Input voltage range	V_i	>	-12,5 to +13,5	V
		typ.	-13,5 to +14,5	V
Common mode rejection ratio	CMRR	>	70	dB
		typ.	100	dB
Power supply voltage rejection ratio	PSRR	typ.	10	$\mu\text{V}/\text{V}$
		<	100	$\mu\text{V}/\text{V}$
Large signal voltage gain $\pm V_o = 10\text{ V}$; $R_L = 1\text{ k}\Omega$	G_v	>	30000	
		typ.	100000	
Output voltage swing at $R_L = 1\text{ k}\Omega$	V_o	>	± 12	V
		typ.	± 13	V
Output resistance at $f = 1\text{ kHz}$	R_o	typ.	50	Ω
		<	100	Ω
Output short-circuit current	I_{sc}	typ.	22	mA
Supply current	$I_{P;N}$	typ.	4	mA
		<	6	mA
Transient response (voltage follower)				
$V_i = 500\text{ mV}$; $R_S = 10\text{ k}\Omega$; $R_L = 1\text{ k}\Omega$				
$C_L = 100\text{ pF}$				
rise time		typ.	50	ns
overshoot		typ.	20	%
Settling time at $V_i = 10\text{ V}$; 0, 1% error		typ.	750	ns
Slew rate at $R_L = 1\text{ k}\Omega$; $C_L = 100\text{ pF}$	S	>	15	$\text{V}/\mu\text{s}$
		typ.	20	$\text{V}/\mu\text{s}$
A.C. gain at $f = 1\text{ kHz}$	G_v	typ.	6000	
			3800 to 8200	
Unity gain frequency	f	typ.	6	MHz
Power bandwidth (gain: -1) $V_{o(p-p)} = 20\text{ V}$; $R_L = 1\text{ k}\Omega$; $C_L = 100\text{ pF}$	B	typ.	320	kHz

CHARACTERISTICS (continued)

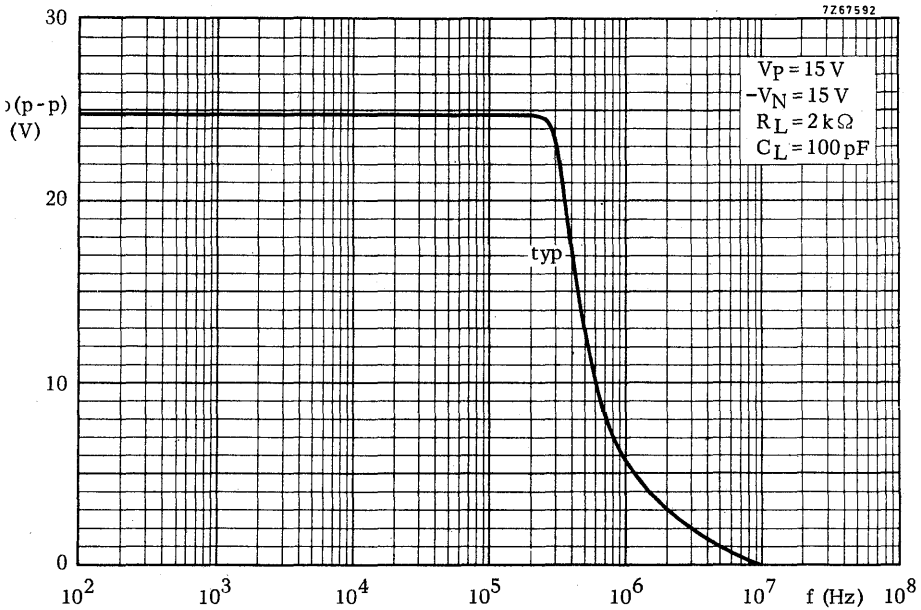
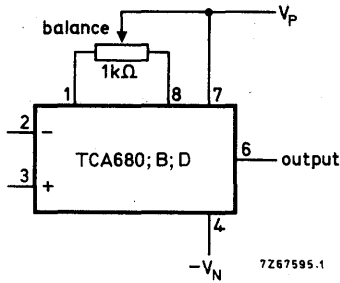
Input noise voltage at $f = 1 \text{ kHz}$
at $f = 80 \text{ Hz}$

V_n	typ.	25	$\text{nV}/\sqrt{\text{Hz}}$
V_n	typ.	35	$\text{nV}/\sqrt{\text{Hz}}$

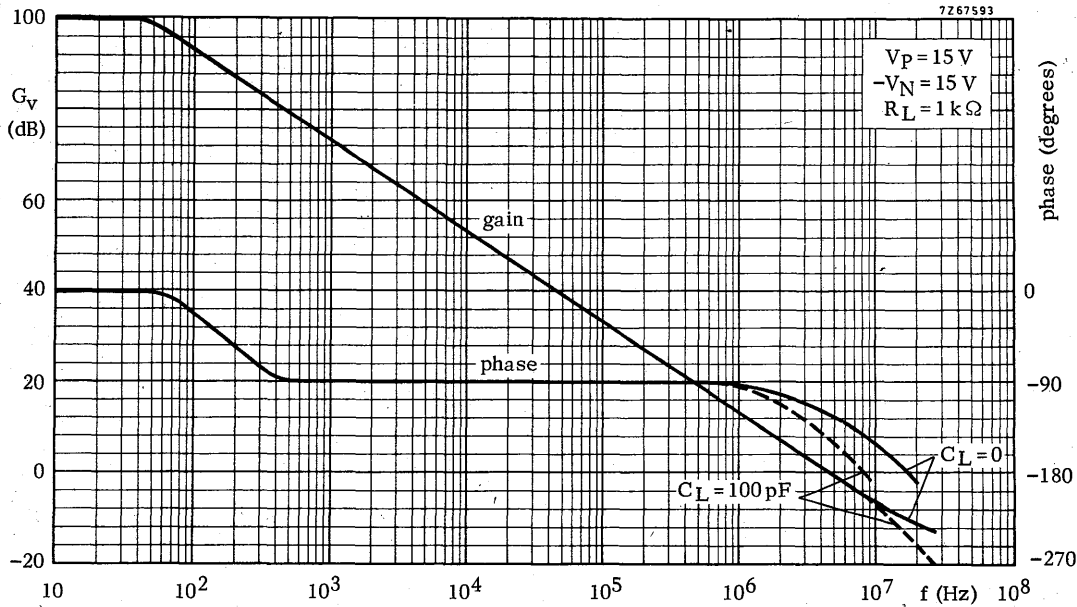
Input noise current at $f = 1 \text{ kHz}$
at $f = 80 \text{ Hz}$

I_n	typ.	2	$\text{pA}/\sqrt{\text{Hz}}$
I_n	typ.	4	$\text{pA}/\sqrt{\text{Hz}}$

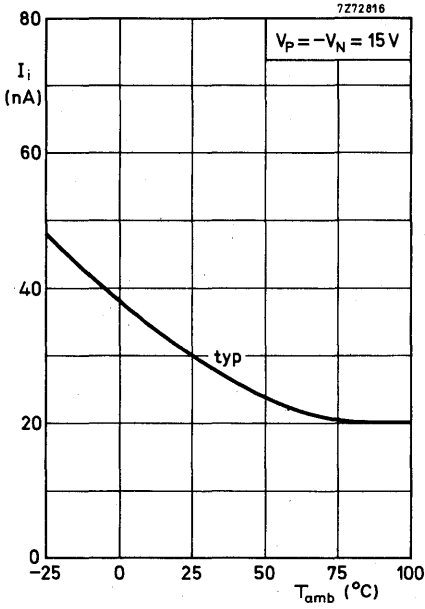
Offset voltage adjustment circuit:



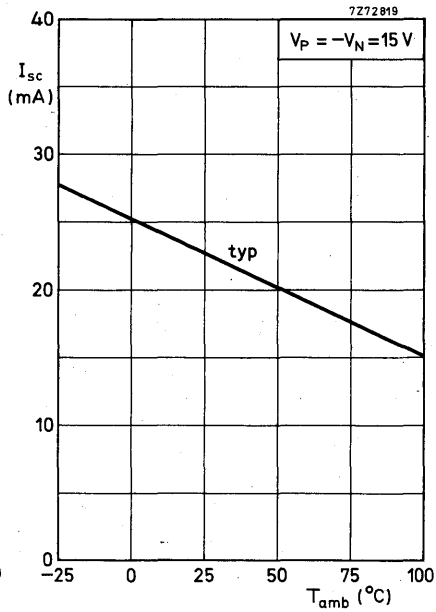
Output voltage swing versus frequency.



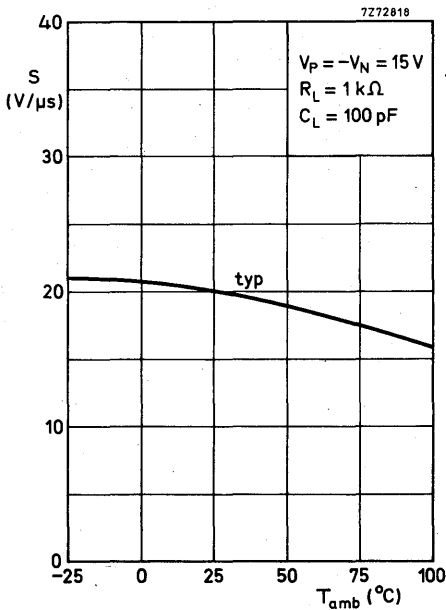
Open-loop voltage gain and phase response versus frequency



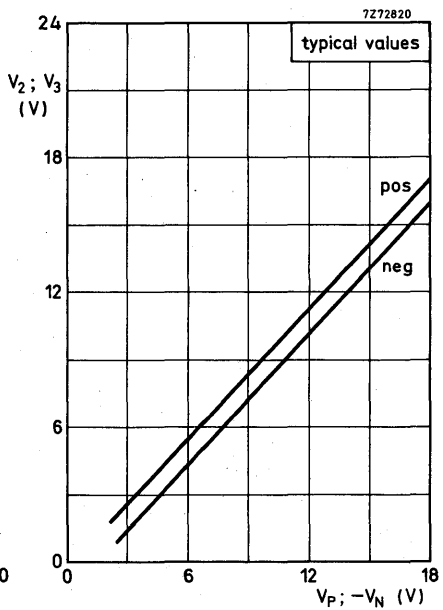
Input bias current.



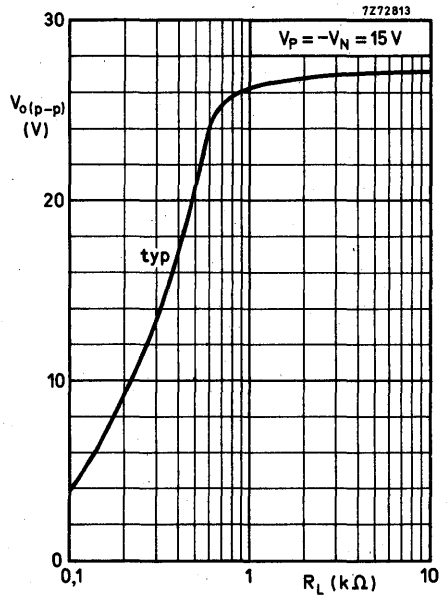
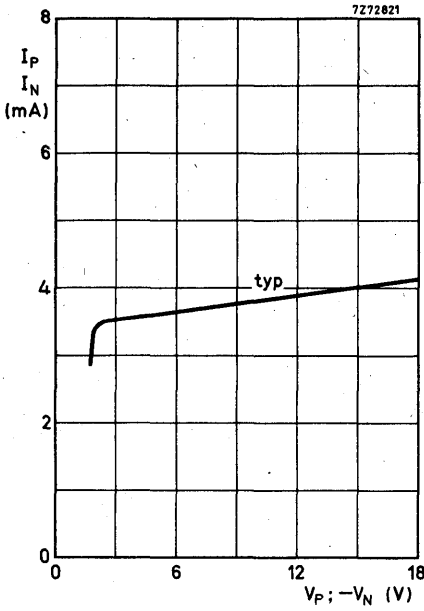
Output short-circuit current.

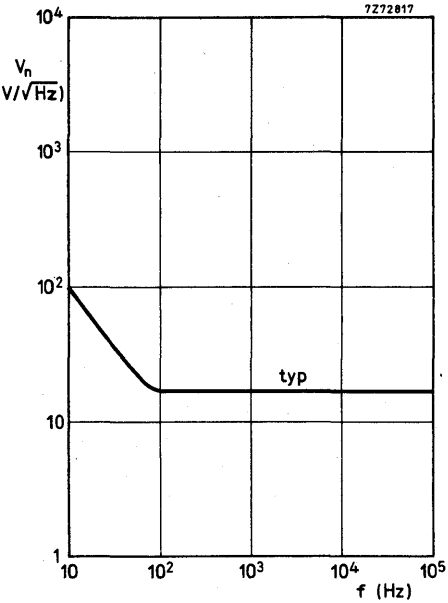


Slew rate.

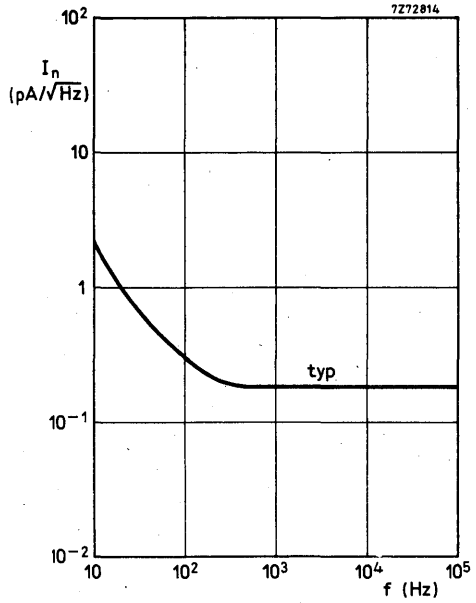


Input common mode voltage range.

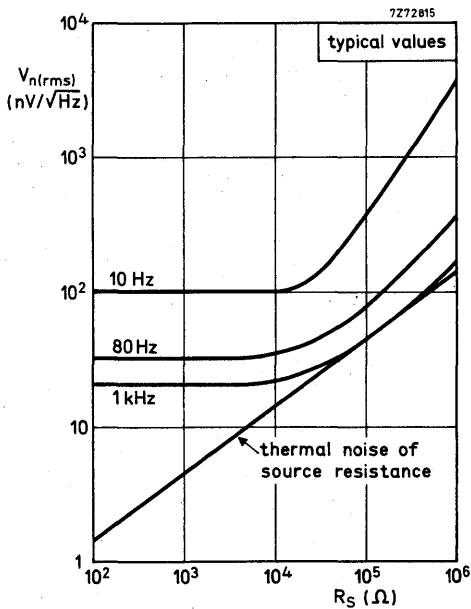




Input noise voltage density.



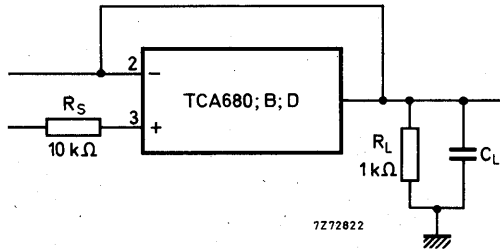
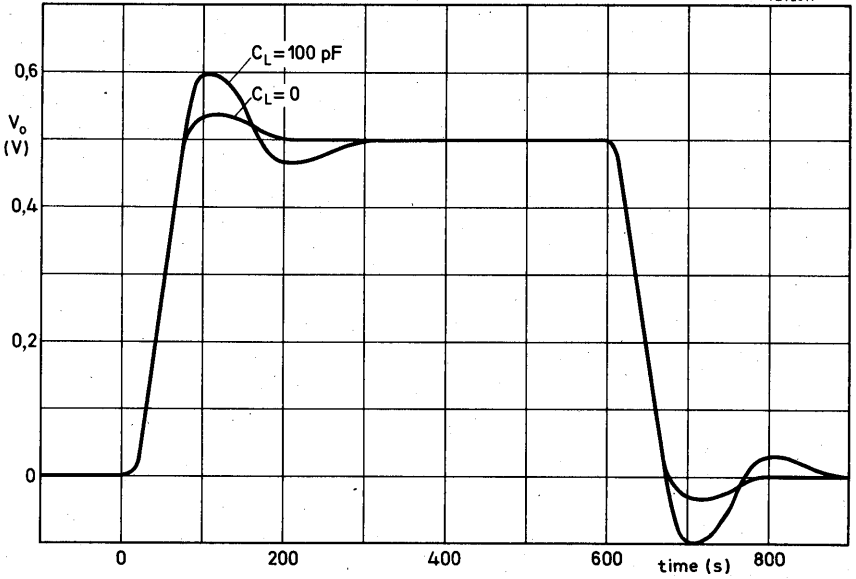
Input noise current density.



Total input noise voltage density.



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Transient response curves and test circuit.

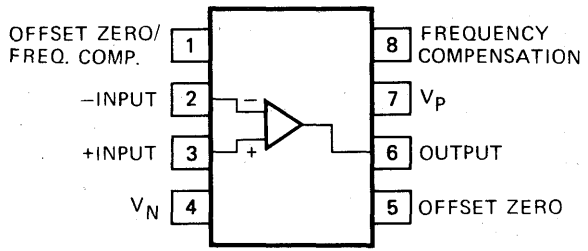
OPERATIONAL AMPLIFIER

The TDA0301D is a general purpose operational amplifier. It is equivalent to the LM301A, however, it is mounted in a miniature plastic package. The device is intended for a wide range of applications where adaption of the frequency characteristics is desirable. Feed forward compensation can be applied.

Features

- Frequency characteristics adjustable with external capacitor
- Short-circuit protection
- Large input and output voltage range
- Offset voltage adjustable to zero
- Miniature plastic encapsulation

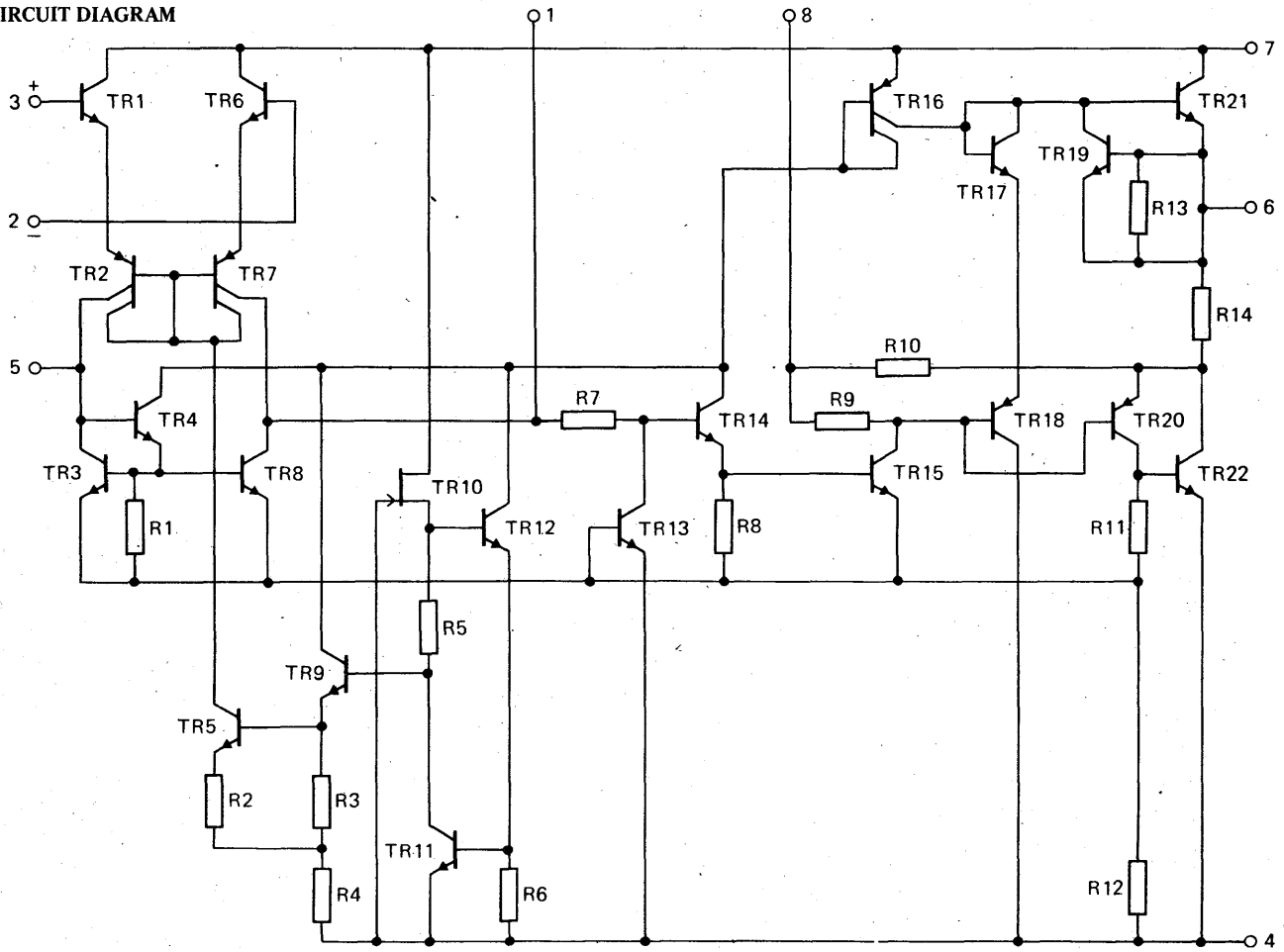
CONNECTION DIAGRAM



PACKAGE OUTLINE (see general section)

SO-8 (SOT-96A); plastic 8-lead flat pack.

CIRCUIT DIAGRAM



RATINGS Limiting values in accordance with the Absolute Maximum System (IEC134)

Supply voltage	$V_P - V_N$	max.	36 V
Differential input voltage	$V_{I+} - V_{I-}$	max.	± 30 V
Common mode input voltage	$V_{I+}; V_{I-}$		V_N to V_P
<u>Temperatures</u>			
Operating ambient temperature	T_{amb}		-25 to +85 °C
Storage temperature	T_{stg}		-65 to +125 °C
Junction temperature	T_j	max.	125 °C

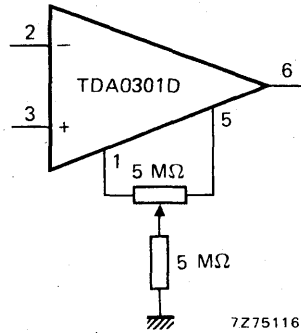
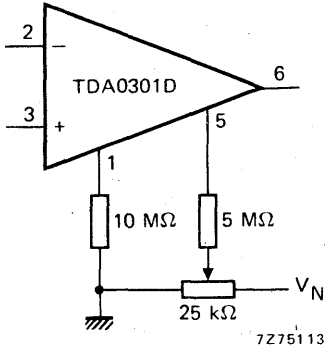
Power dissipation in free air; $T_{amb} = 50$ °C

Mounted on a ceramic substrate of 4 cm²
derating factor for $T_{amb} > 50$ °C

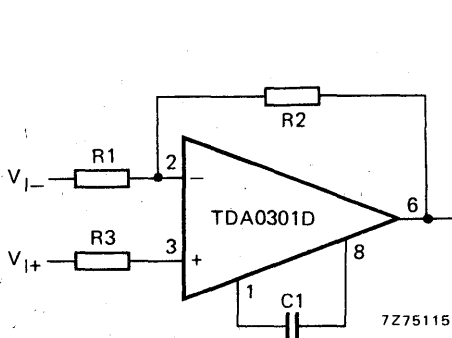
P_{tot}	max.	470 mW
I/R_{th}	=	6,3 mW/°C

Mounted on PC board of 4 cm²
derating factor for $T_{amb} > 50$ °C

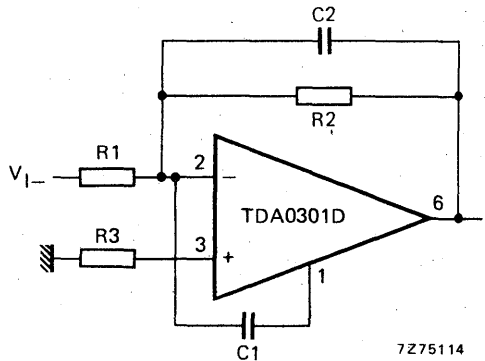
P_{tot}	max.	310 mW
I/R_{th}	=	4,2 mW/°C



Offset voltage adjust circuits.



Single pole compensation.



Feed forward compensation.

CHARACTERISTICS at $V_P = -V_N = 5$ to 15 V; $T_{amb} = 25$ °C unless otherwise specified

Parameter	Conditions	Symbol	min.	typ.	max.	Unit
Input offset voltage		V_{io}	-	2	7,5	mV
Input offset current		I_{io}	-	3	50	nA
Input bias current		I_i	-	70	250	nA
Input resistance		R_i	0,5	2	-	M Ω
Large signal voltage gain	$V_P = -V_N = 15$ V; $V_o = \pm 10$ V; $R_L \geq 2$ k Ω	G_V	25	160	-	V/mV
Supply current	$V_P = -V_N = 15$ V	$I_{P,N}$	-	1,8	3	mA

CHARACTERISTICS at $V_P = -V_N = 5$ to 15 V; $T_{amb} = 0$ to $+70$ °C

Parameter	Conditions	Symbol	min.	typ.	max.	Unit
Input offset voltage		V_{io}	-	-	10	mV
Input offset current		I_{io}	-	-	70	nA
Input bias current		I_i	-	-	300	nA
Average temperature coefficient of V_{io}			-	6	30	μ V/°C
Average temperature coefficient of I_{io}	$T_{amb} = 25$ to 70 °C $T_{amb} = 0$ to 125 °C		-	0,01	0,3	nA/°C
Input voltage range	$V_P = -V_N = 15$ V	V_i	± 12	-	-	V
Common mode rejection ratio		CMRR	70	90	-	dB
Power supply rejection ratio		PSRR	70	96	-	dB
Large signal voltage gain	$V_P = -V_N = 15$ V; $V_o = \pm 10$ V; $R_L \geq 2$ k Ω	G_V	15	-	-	V/mV
Output voltage range	$V_P = -V_N = 15$ V; $R_L = 10$ k Ω $R_L = 2$ k Ω	V_o V_o	± 12 ± 10	± 14 ± 13	- -	V V

QUADRUPLE OPERATIONAL AMPLIFIER

The TDA0324D consists of four independent, high gain, internally frequency compensated operational amplifiers. It is especially designed to operate from a single power supply over a wide range of voltages.

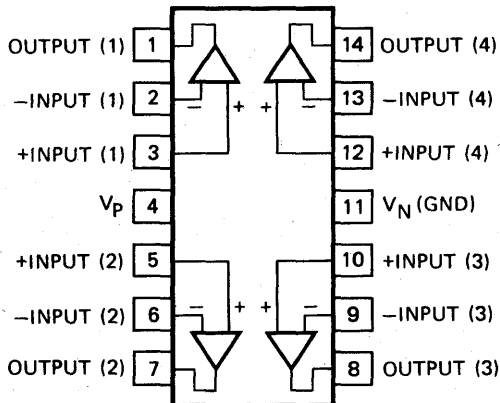
The circuit is equivalent to the LM324, however it is mounted in a miniature plastic package.

The device can be directly operated from the standard +5 V supply voltage which is used in digital systems and will easily provide the required interface electronics without requiring the additional ± 15 V supplies.

Features

- Internally frequency compensated for unity gain
- Large d. c. voltage gain: 100 dB
- Unity gain bandwidth: 1 MHz
- Wide supply voltage range: 3 to 30 V
- Low supply current drain: 1 mW per op amp at $V_p - V_N = 5$ V
- Differential input voltage range equal to supply voltage
- Input common mode range includes ground
- Large output voltage range: 0 to $V_p - 1,5$ V
- Operating temperature: -25 to $+85$ °C

CONNECTION DIAGRAM

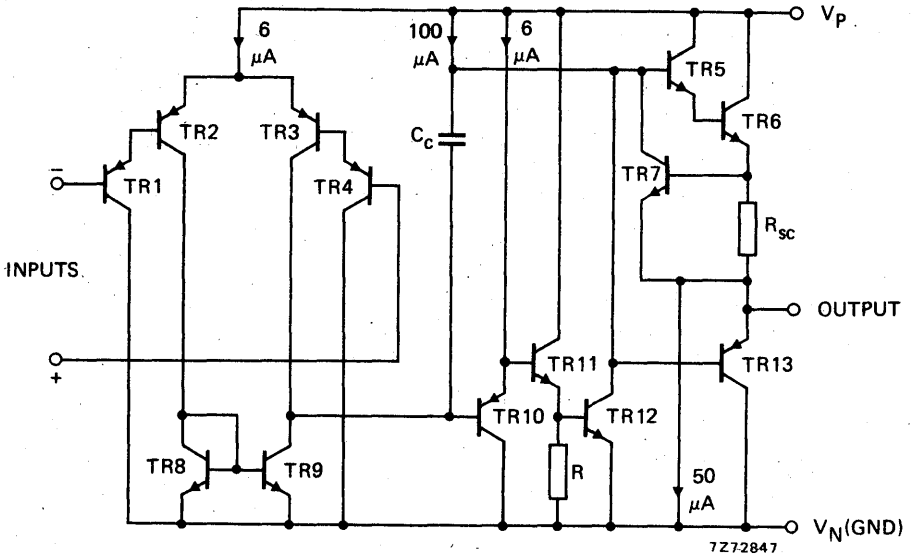


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PACKAGE OUTLINE (see general section)

SO-14; plastic 14-lead flat pack.

CIRCUIT DIAGRAM (one amplifier)



RATINGS Limiting values in accordance with the Absolute Maximum System (IEC 134)

Supply voltage	$V_P - V_N$	max.	32 V
Differential input voltage	$V_{I+} - V_{I-}$	max.	± 32 V
Common mode input voltage	$V_{I+}; V_{I-}$	max.	-0,3 to +32 V
Output short-circuit to V_N (see note)		continuous at $T_{amb} = 25$ °C;	$V_P < 15$ V, only one amplifier

Temperatures

Operating ambient temperature	T_{amb}	-25 to +85 °C
Storage temperature	T_{stg}	-65 to +125 °C
Junction temperature	T_j	max. 125 °C

Power dissipation in free air; $T_{amb} = 50$ °C (see note)

Mounted on a ceramic substrate of 4 cm ²	P_{tot}	max.	500 mW
derating factor for $T_{amb} > 50$ °C	$1/R_{th}$	=	6,7 mW/°C
Mounted on PC board of 4 cm ²	P_{tot}	max.	360 mW
derating factor for $T_{amb} > 50$ °C	$1/R_{th}$	=	4,8 mW/°C

Note: Short-circuits from the output to V_P can cause excessive heating and eventual destruction. I_o max. is about 40 mA independent of the magnitude of V_P . At values of V_P in excess of +15 V, continuous short-circuits can exceed the power dissipation ratings and cause eventual destruction.

CHARACTERISTICS at $V_P = +5\text{ V}$; $V_N = 0$; $T_{\text{amb}} = 25\text{ }^\circ\text{C}$ unless otherwise specified

Parameter	Conditions	Symbol	min.	typ.	max.	Unit
Input offset voltage		V_{io}	-	2	7	mV
Input offset current		I_{io}	-	5	50	nA
Input bias current	1)	I_i	-	45	500	nA
Common mode input voltage	$V_P \leq 30\text{ V}$ 2)	V_i	0	-	$V_P - 1,5$	V
Common mode rejection ratio	d. c.	CMRR	-	85	-	dB
Power supply rejection ratio	d. c.	PSRR	-	100	-	dB
Amplifier to amplifier coupling	$f = 1\text{ kHz to } 20\text{ kHz}$ (input referred)		-	-120	-	dB
Large signal voltage gain	$R_L > 2\text{ k}\Omega$	G_V	-	100	-	V/mV
Output voltage range	$R_L > 2\text{ k}\Omega$	V_o	0	-	$V_P - 1,5$	V
Output current source	$V_{I+} = 1\text{ V}; V_{I-} = 0\text{ V}$	I_o	20	40	-	mA
Output current sink	$V_{I+} = 0\text{ V}; V_{I-} = 1\text{ V}$	I_o	10	20	-	mA
Supply current	$R_L = \infty$ (all op amps)	I_P	-	0,8	2	mA

1) The direction of the input current is out of the IC due to the p-n-p input stage.

2) Either input signal voltage should not be allowed to go negative by more than 0,3 V. The upper end of the common mode voltage range is $V_P - 1,5\text{ V}$, but either or both inputs can go to +30 V without damage.

DUAL OPERATIONAL AMPLIFIER

The TDA0358D consists of two independent, high gain, internally frequency compensated operational amplifiers. It is especially designed to operate from a single power supply over a wide range of voltages.

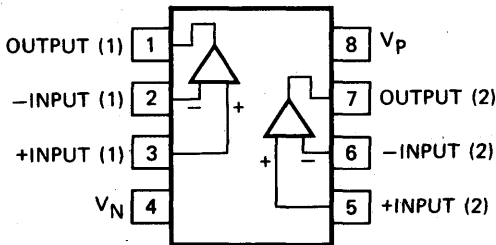
The circuit is equivalent to the LM358, however it is mounted in a miniature plastic package.

The device can be directly operated from the standard +5 V supply voltage which is used in digital systems and will easily provide the required interface electronics without requiring the additional ± 15 V supplies.

Features

- Internally frequency compensated for unity gain
- Large d. c. voltage gain : 100 dB
- Unity gain bandwidth : 1 MHz
- Wide supply voltage range : 3 to 30 V
- Low supply current drain : 1 mW per op amp at $V_P - V_N = 5$ V
- Differential input voltage range equal to supply voltage
- Input common mode range includes ground
- Large output voltage range : 0 to $V_P - 1,5$ V
- Operating ambient temperature : -25 to $+85$ °C

CONNECTION DIAGRAM

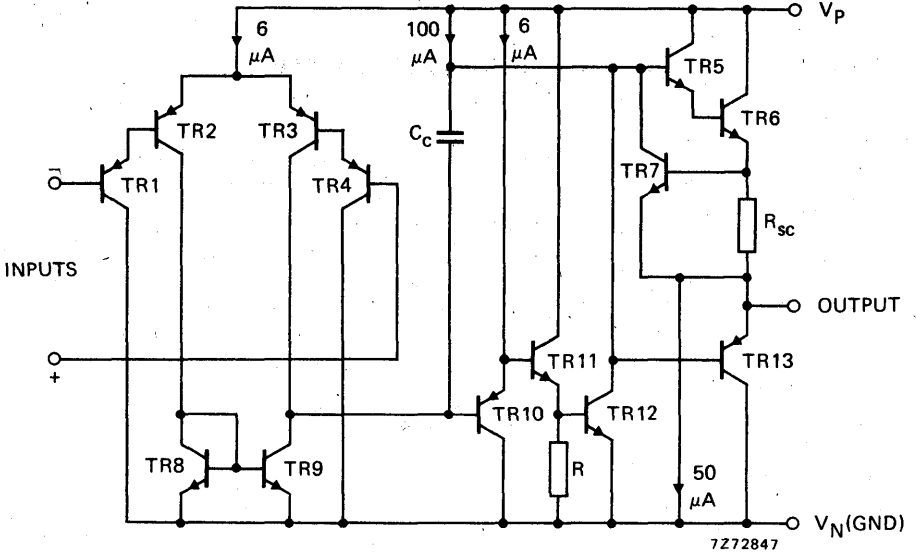


7275106

PACKAGE OUTLINE (see general section)

SO-8 (SOT-96A); plastic 8-lead flat pack.

CIRCUIT DIAGRAM (one amplifier)



RATINGS Limiting values in accordance with the Absolute Maximum System (IEC 134)

Supply voltage	$V_P - V_N$	max.	32	V
Differential input voltage	$V_{I+} - V_{I-}$	max.	± 32	V
Common mode input voltage	$V_{I+}; V_{I-}$		-0,3 to +32	V
Output short-circuit to V_N (see note)			continuous at $T_{amb} = 25^\circ\text{C}$ $V_P < 15\text{ V}$, only one amplifier	

Temperatures

Operating ambient temperature	T_{amb}		-25 to +85	$^\circ\text{C}$
Storage temperature	T_{stg}		-65 to +125	$^\circ\text{C}$
Junction temperature	T_j	max.	125	$^\circ\text{C}$

Power dissipation in free air; $T_{amb} = 50^\circ\text{C}$ (see note)

Mounted on a ceramic substrate of 4 cm^2 derating factor for $T_{amb} > 50^\circ\text{C}$	P_{tot}	max.	450	mW
	$1/R_{th}$	=	6	mW/ $^\circ\text{C}$
Mounted on PC board of 4 cm^2 derating factor for $T_{amb} > 50^\circ\text{C}$	P_{tot}	max.	310	mW
	$1/R_{th}$	=	4,2	mW/ $^\circ\text{C}$

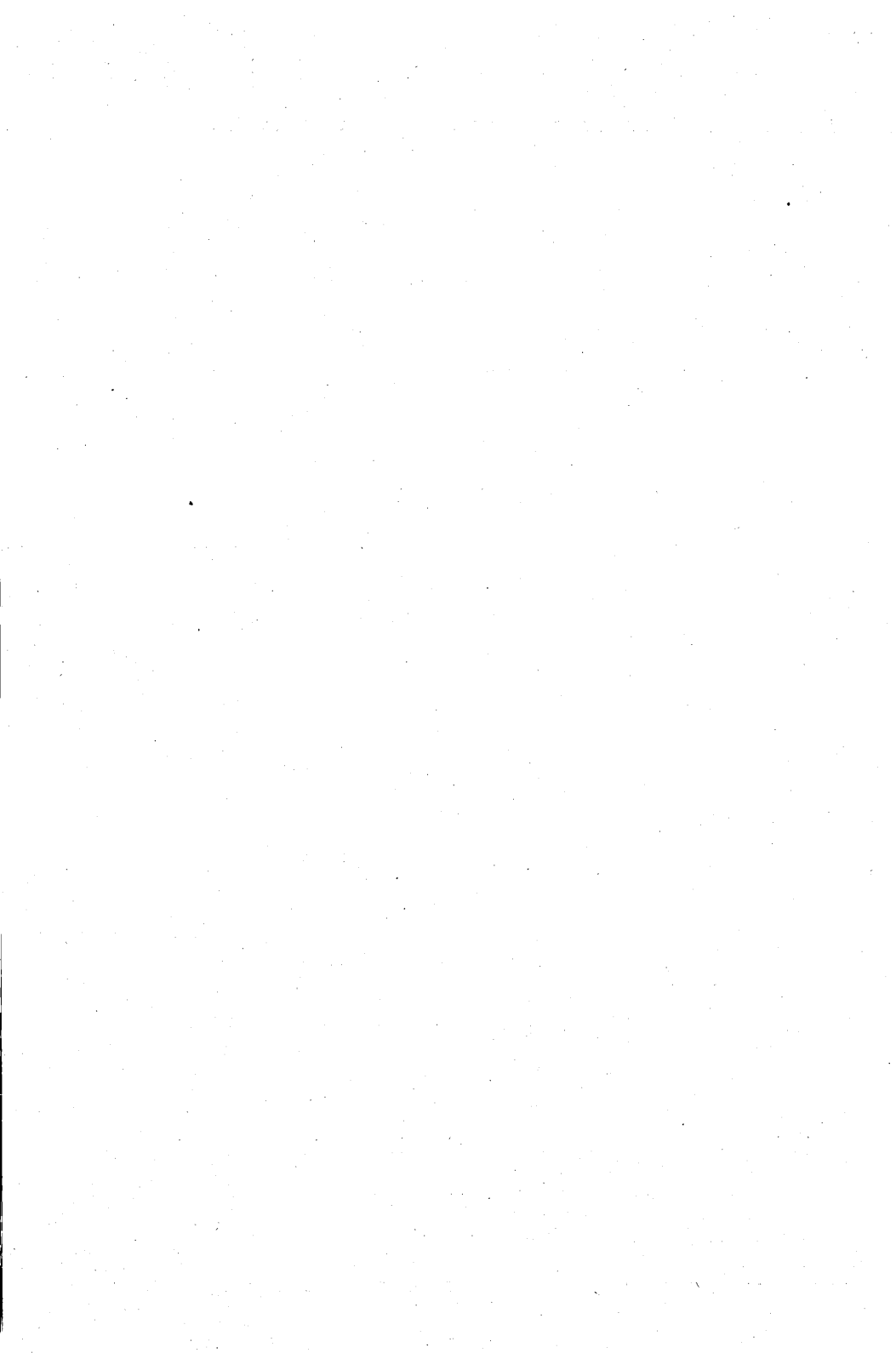
Note : Short-circuits from the output to V_P can cause excessive heating and eventual destruction. I_O max. is about 40 mA independent of the magnitude of V_P . At values of V_P in excess of +15 V, continuous short-circuits can exceed the power dissipation ratings and cause eventual destruction.

CHARACTERISTICS at $V_P = +5\text{ V}$; $V_N = 0$; $T_{\text{amb}} = 25\text{ }^\circ\text{C}$ unless otherwise specified

Parameter	Conditions	Symbol	min.	typ.	max.	Unit
Input offset voltage		V_{io}	-	2	7	mV
Input offset current		I_{io}	-	5	50	nA
Input bias current	1)	I_i	-	45	500	nA
Common mode input voltage	$V_P \leq 30\text{ V }^2)$	V_i	0	-	$V_P - 1,5$	V
Common mode rejection ratio	d. c.	CMRR	-	85	-	dB
Power supply rejection ratio	d. c.	PSRR	-	100	-	dB
Amplifier to amplifier coupling	$f = 1\text{ kHz to } 20\text{ kHz}$ (input referred)		-	-120	-	dB
Large signal voltage gain	$R_L > 2\text{ k}\Omega$	G_V	-	100	-	V/mV
Output voltage range	$R_L > 2\text{ k}\Omega$	V_o	0	-	$V_P - 1,5$	V
Output current source	$V_{I+} = 1\text{ V}; V_{I-} = 0\text{ V}$	I_o	20	40	-	mA
Output current sink	$V_{I+} = 0\text{ V}; V_{I-} = 1\text{ V}$	I_o	10	20	-	mA
Supply current	$R_L = \infty$ (all op amps)	I_P	-	0,5	1,2	mA

1) The direction of the input current is out of the IC due to the p-n-p input stage.

2) Either input signal voltage should not be allowed to go negative by more than 0,3 V. The upper end of the common mode voltage range is $V_P - 1,5\text{ V}$, but either or both inputs can go to +30 V without damage.



OPERATIONAL AMPLIFIER

The TDA0741D is a silicon monolithic integrated operational amplifier intended for use in hybrid modules and applications where small outline dimensions are important.

Features :

- no frequency compensation required
- short-circuit protection
- large input and output voltage range
- offset voltage adjustable to zero

QUICK REFERENCE DATA

Positive supply voltage	V_P	15	V
Negative supply voltage	$-V_N$	15	V
Characteristics at $T_{amb} = 25\text{ }^\circ\text{C}$			
Voltage gain at $R_L = 2\text{ k}\Omega$; $V_O = \pm 10\text{ V}$	G_V	typ. 200 000	
Common mode rejection ratio	CMRR	typ. 90	dB
Differential input resistance	R_i	typ. 2	$M\Omega$
Output voltage swing at $R_L = 10\text{ k}\Omega$	V_O	> ± 12	V
Input voltage range	V_i	> ± 12	V

PACKAGE OUTLINE SOT-96A (plastic 8-lead flat pack) (see general section).

RATINGS Limiting values in accordance with the Absolute Maximum System (IEC 134)

Voltages

Positive supply voltage	V_P	max.	18 V
Negative supply voltage	$-V_N$	max.	18 V
Common mode input voltage ¹⁾	V_i	max.	± 15 V
Differential input voltage	V_{2-3}	max.	± 30 V

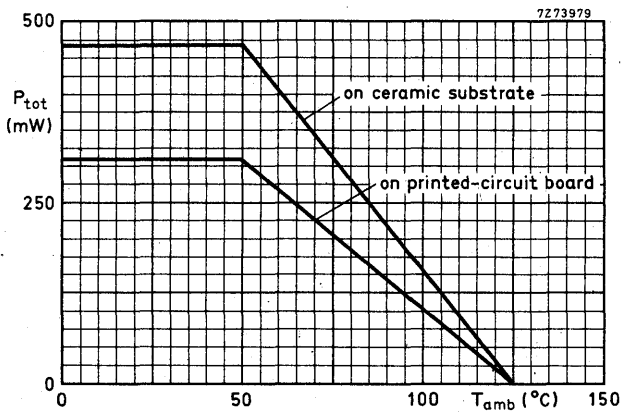
Power dissipation (see derating curve below)

Total power dissipation (free air, $T_{amb} = 50$ °C) mounted on a ceramic substrate (4 cm ²)	P_{tot}	max.	470 mW
mounted on printed-circuit board (4 cm ²)	P_{tot}	max.	310 mW

Output short-circuit duration ²⁾ indefinite

Temperatures

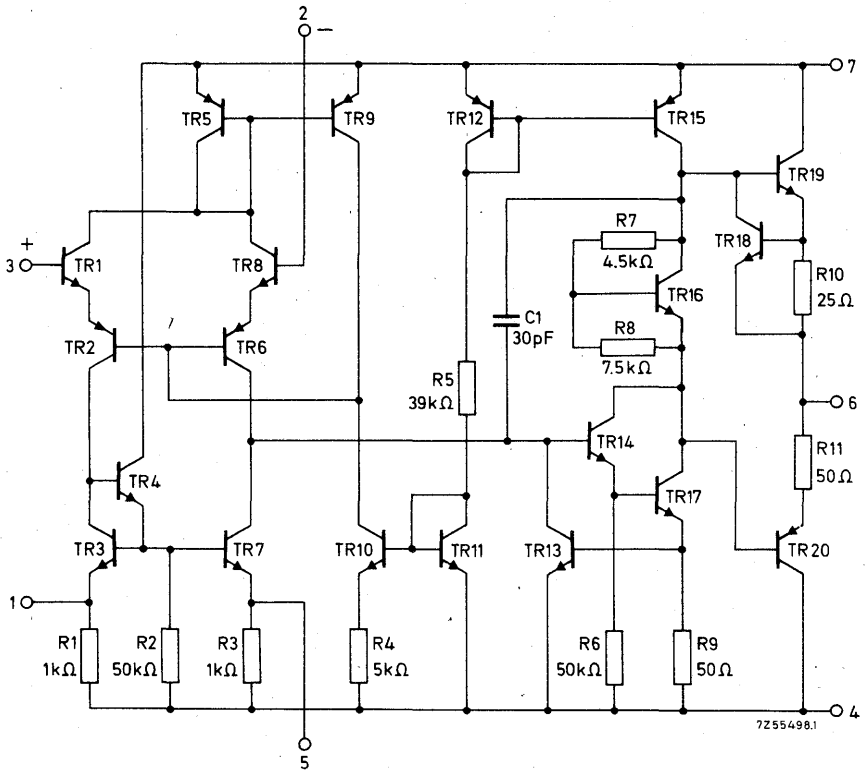
Operating ambient temperature see derating curve below	T_{amb}	-25 to +85 °C
Storage temperature	T_{stg}	-65 to +125 °C



¹⁾ For supply voltage less than ± 15 V, the absolute maximum input voltage is equal to the supply voltage.

²⁾ Continuous short circuit is allowed to ground or either supply.

CIRCUIT DIAGRAM



CHARACTERISTICS at $V_P = 15\text{ V}$; $-V_N = 15\text{ V}$; $T_{\text{amb}} = 25\text{ }^\circ\text{C}$ unless otherwise specified

Input offset voltage	V_{io}	typ.	2	mV
		<	6	mV
Input bias current	I_i	typ.	80	nA
		<	500	nA
Input offset current	I_{io}	typ.	20	nA
		<	200	nA
Input voltage range	V_i	>	± 12	V
		typ.	± 13	V
Common mode rejection ratio	CMRR	>	70	dB
		typ.	90	dB
Differential input resistance	R_i	>	0,3	M Ω
		typ.	2,0	M Ω
Power supply voltage rejection ratio	PSRR	typ.	30	$\mu\text{V/V}$
		<	150	$\mu\text{V/V}$
Voltage gain at $R_L = 2\text{ k}\Omega$; $V_o = \pm 10\text{ V}$	G_v	>	20 000	
		typ.	200 000	
Output voltage swing at $R_L = 2\text{ k}\Omega$	V_o	>	± 10	V
		typ.	± 13	V
at $R_L = 10\text{ k}\Omega$	V_o	>	± 12	V
		typ.	± 13	V
Output resistance at $f = 1\text{ kHz}$	R_o	typ.	60	Ω
Output short-circuit current	I_{sc}	typ.	25	mA
Supply current at $I_o = 0$	$I_{P;N}$	typ.	1,7	mA
		<	2,8	mA
Transient response (unity gain; voltage follower)				
$V_i = 20\text{ mV}$; $R_L = 2\text{ k}\Omega$; $C_L = 100\text{ pF}$				
Rise time		typ.	0,3	μs
Overshoot		typ.	5	%
Slew rate (unity gain) at $R_L = 2\text{ k}\Omega$	S	typ.	0,5	V/ μs

CHARACTERISTICS at $V_P = 15\text{ V}$; $-V_N = 15\text{ V}$; $T_{amb} = 0\text{ to }70\text{ }^\circ\text{C}$ unless otherwise specified

Voltage gain at $R_L = 2\text{ k}\Omega$; $V_O = \pm 10\text{ V}$

$G_V > 15\,000$

Input offset voltage

$V_{io} < 7,5\text{ mV}$

Input bias current

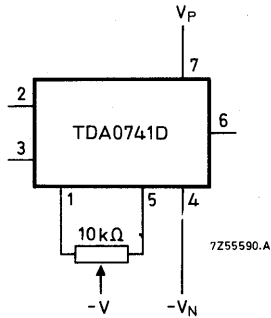
$I_i < 0,8\text{ }\mu\text{A}$

Input offset current

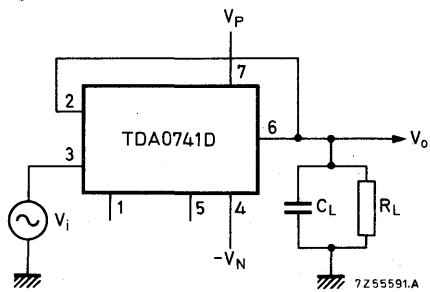
$I_{io} < 0,3\text{ }\mu\text{A}$

Output voltage swing at $R_L = 2\text{ k}\Omega$

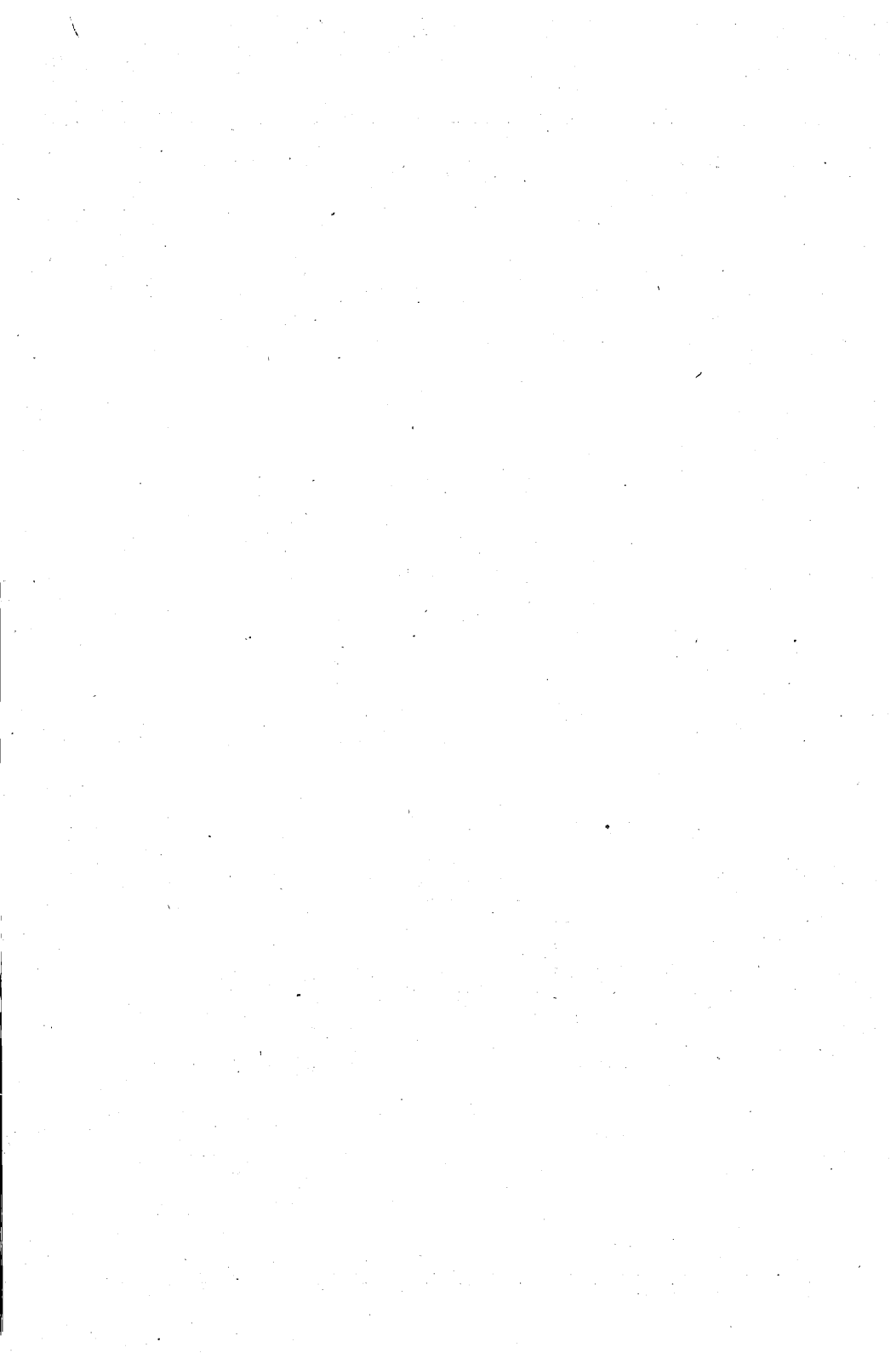
$V_O > \pm 10\text{ V}$
typ. $\pm 13\text{ V}$



Offset voltage zeroing circuit



Transient response test circuit



OPERATIONAL AMPLIFIER

The TDA0748D is a high-performance, silicon, monolithic, operational amplifier for use in a wide range of analogue applications. The device is mounted in a microminiature envelope, especially designed for use in thick and thin-film circuits.

Ability to accept a large common mode voltage, together with freedom from latch-up, makes it an ideal voltage follower.

Owing to its high gain and wide operating voltage range, it also offers superior performance in integration, summing, and general feedback applications.

Features :

- suitable for use in thick and thin-film hybrid circuits
- short-circuit protection
- offset voltage null capability
- large common-mode and differential voltage ranges
- low power consumption
- no latch-up

The TDA0748D is equivalent to μ A748. It is similar to TBA221D, which has internal frequency compensation.

QUICK REFERENCE DATA

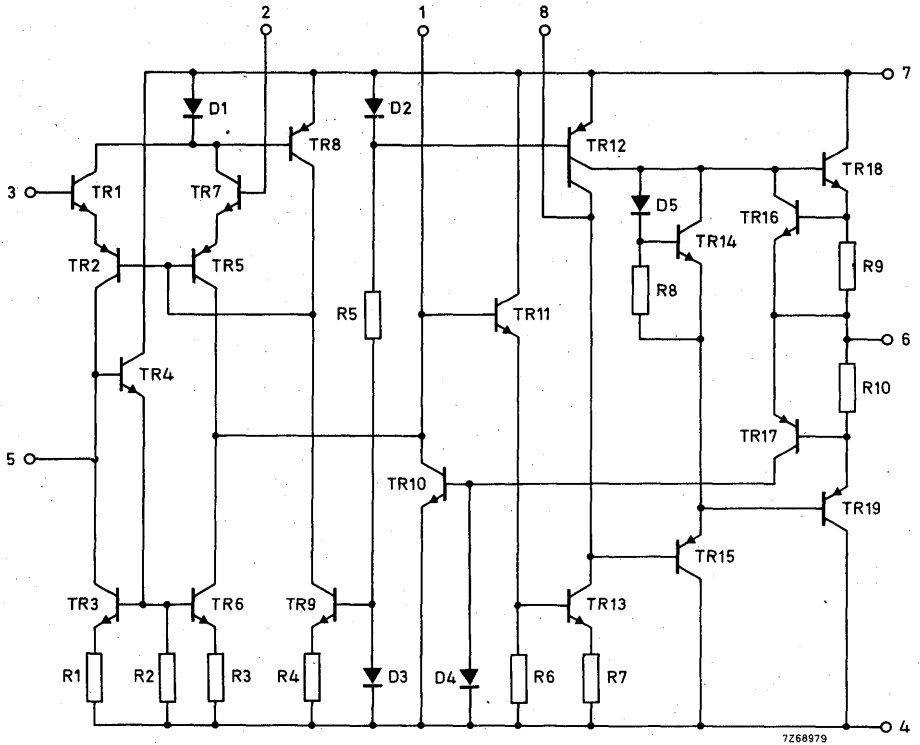
Positive supply voltage	V_P	typ.	15 V
Negative supply voltage	V_N	typ.	15 V

Characteristics at $T_{amb} = 25\text{ }^\circ\text{C}$			
Voltage gain at $R_L \geq 2\text{ k}\Omega$; $V_O = \pm 10\text{ V}$	G_V	typ.	150 000
Common mode rejection ratio at $R_S \leq 10\text{ k}\Omega$	CMRR	typ.	90 dB
Input resistance	R_i	typ.	2 M Ω
Output voltage swing at $R_L \geq 10\text{ k}\Omega$	$\pm V_O$	>	12 V
Input voltage range	$\pm V_i$	>	12 V
Total power consumption	P_{tot}	typ.	60 mW

PACKAGE OUTLINE

SOT-96A (plastic 8-lead flat pack) (see general section).

CIRCUIT DIAGRAM



RATINGS Limiting values in accordance with the Absolute Maximum System (IEC134)

Voltages

Positive supply voltage	V_P	max.	18 V
Negative supply voltage	V_N	max.	18 V
Common mode input voltage	$\pm V_i$	max.	15 V ¹⁾
Differential input voltage	$\pm V_{2-3}$	max.	30 V

→ Total power dissipation up to $T_{amb} = 50\text{ }^\circ\text{C}$ P_{tot} max. 470 mW ²⁾

Output short-circuit duration t max. 60 s ³⁾

- 1) For supply voltage less than $\pm 15\text{ V}$, the absolute maximum input voltage is equal to the supply voltage.
- 2) When soldered on a ceramic substrate. In free air the maximum dissipation is 310 mW.
- 3) Short circuit is allowed to ground or either supply during this period.

RATINGS (continued)

Temperatures

Storage temperature	T_{stg}	-55 to +125	°C
Operating ambient temperature	T_{amb}	0 to +85	°C ←
Lead temperature (soldering time < 60 s)	T_{lead}	max. 260	°C

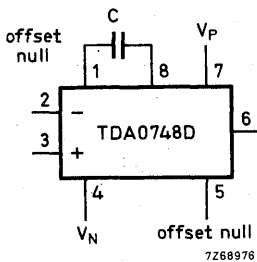
CHARACTERISTICS $V_p = 15\text{ V}$; $V_N = 15\text{ V}$; $T_{amb} = 25\text{ °C}$; $C = 30\text{ pF}$ unless otherwise specified

<u>Input offset voltage</u> at $R_S \leq 10\text{ k}\Omega$	V_{io}	typ. 2,0 mV < 6,0 mV	
<u>Input offset current</u>	I_{io}	typ. 20 nA < 200 nA	
<u>Input bias current</u>	I_i	typ. 80 nA < 500 nA	
<u>Input resistance</u>	R_i	> 0,3 M Ω typ. 2,0 M Ω	
<u>Input capacitance</u>	C_i	typ. 2,0 pF	
<u>Offset voltage adjustment range</u>	$\pm V_{io}$	typ. 15 mV	
<u>Large signal voltage gain</u> at $R_L \geq 2\text{ k}\Omega$; $\pm V_o = 10\text{ V}$	G_v	> 20 000 typ. 150 000	
<u>Output resistance</u>	R_o	typ. 75 Ω	
<u>Output short-circuit current</u>	I_{sc}	typ. 25 mA	
<u>Supply current</u>	$I_{P,N}$	typ. 1,9 mA < 2,8 mA	
<u>Total power consumption</u>	P_{tot}	typ. 60 mW < 85 mW	
<u>Transient response</u> at $G_v = 1$ (voltage follower)			
$V_i = 20\text{ mV}$; $C = 30\text{ pF}$; $R_L = 2\text{ k}\Omega$			
$C_L \leq 100\text{ pF}$			
rise time	t_r	typ. 0,3 μs	
overshoot		typ. 5,0 %	
<u>Slew rate</u> at $G_v = 1$ (voltage follower); $R_L \geq 2\text{ k}\Omega$	S	typ. 0,5 V/ μs	
<u>Transient response</u> at $G_v = 10$ (voltage follower)			
$V_i = 20\text{ mV}$; $C = 3,5\text{ pF}$; $R_L = 2\text{ k}\Omega$			
$C_L \leq 100\text{ pF}$			
rise time	t_r	typ. 0,3 μs ←	
overshoot		typ. 5,0 %	
<u>Slew rate</u> at $G_v = 10\text{ V}$ (voltage follower); $R_L \geq 2\text{ k}\Omega$	S	typ. 5,5 V/ μs	

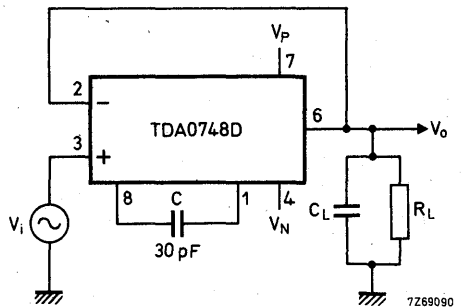
TDA0748D

CHARACTERISTICS $V_P = 15\text{ V}$; $V_N = 15\text{ V}$; $T_{\text{amb}} = 0\text{ to }+70\text{ }^\circ\text{C}$; $C = 30\text{ pF}$ unless otherwise specified

<u>Input offset voltage</u> at $R_S \leq 10\text{ k}\Omega$	V_{io}	<	7.5	mV
<u>Input offset current</u>	I_{io}	<	300	nA
<u>Input bias current</u>	I_i	<	800	nA
<u>Input voltage range</u>	$\pm V_i$	>	12	V
		typ.	13	V
<u>Common mode rejection ratio</u> at $R_S \leq 10\text{ k}\Omega$	CMRR	>	70	dB
		typ.	90	dB
<u>Supply voltage rejection ratio</u> at $R_S \leq 10\text{ k}\Omega$	SVRR	typ.	30	$\mu\text{V/V}$
		<	150	$\mu\text{V/V}$
<u>Large signal voltage gain</u> at $R_L \geq 2\text{ k}\Omega$; $\pm V_o = 10\text{ V}$	G_v	>	15000	
<u>Output voltage swing</u> at $R_L \geq 10\text{ k}\Omega$	$\pm V_o$	>	12	V
		typ.	14	V
at $R_L \geq 2\text{ k}\Omega$	$\pm V_o$	>	10	V
		typ.	13	V
<u>Total power consumption</u>	P_{tot}	typ.	60	mW
		<	100	mW

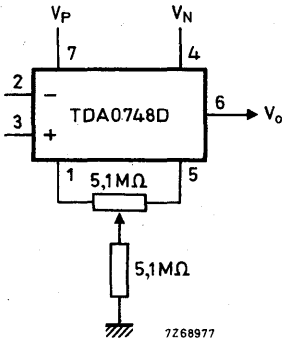


Basic circuit

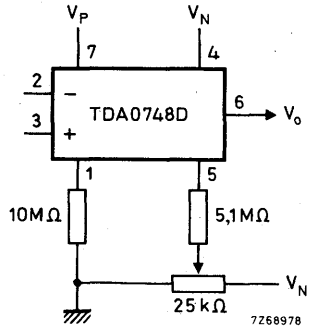


Transient response test circuit

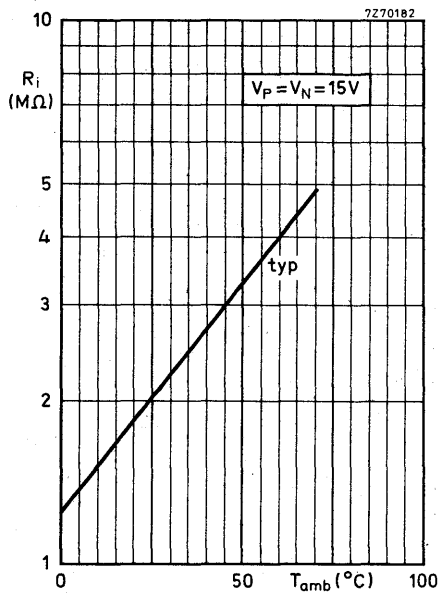
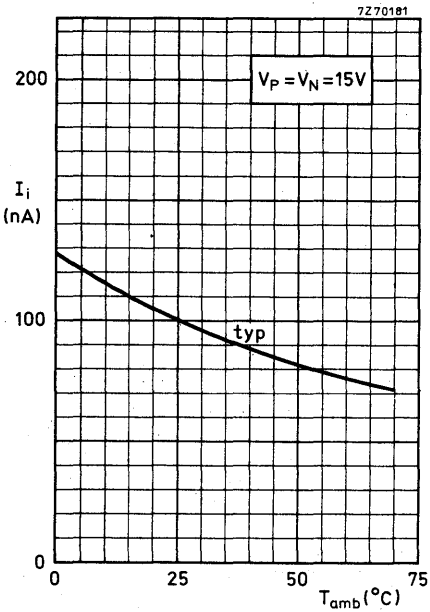
Offset voltage null circuit

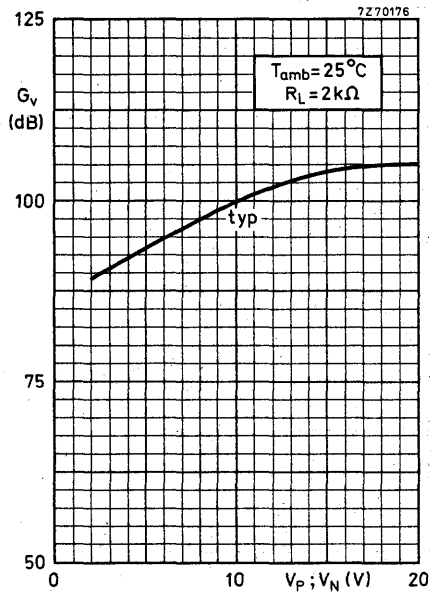
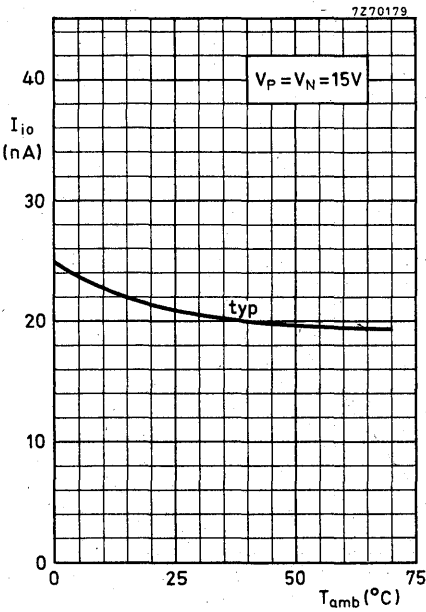
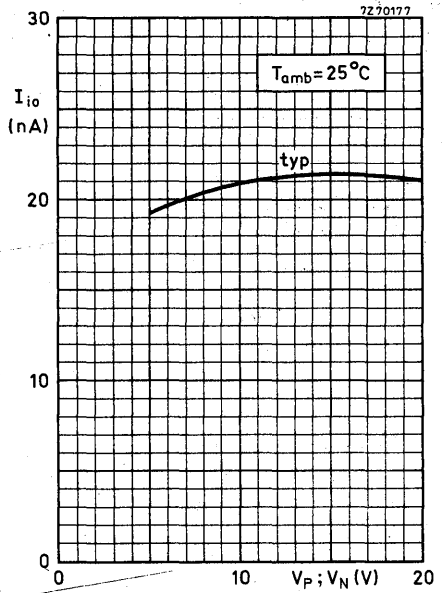
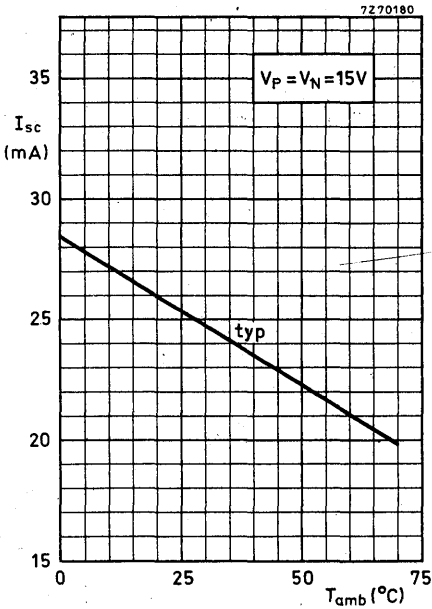


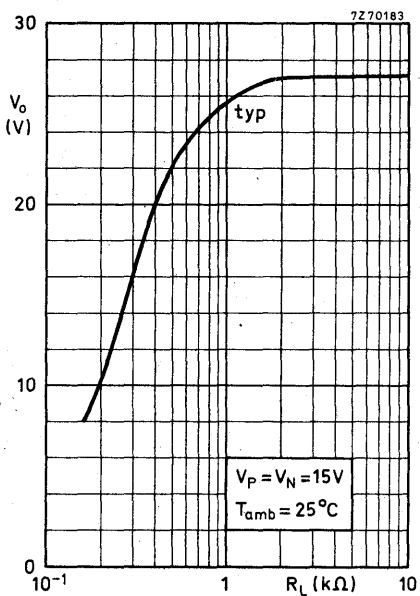
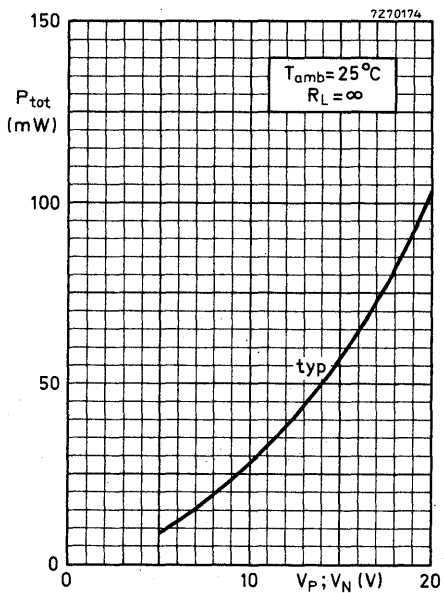
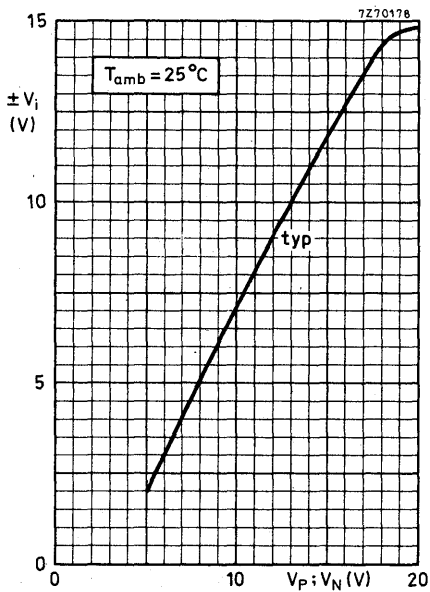
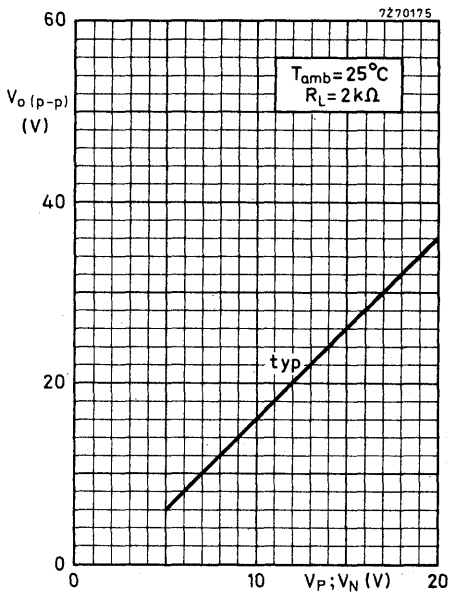
Recommended circuit

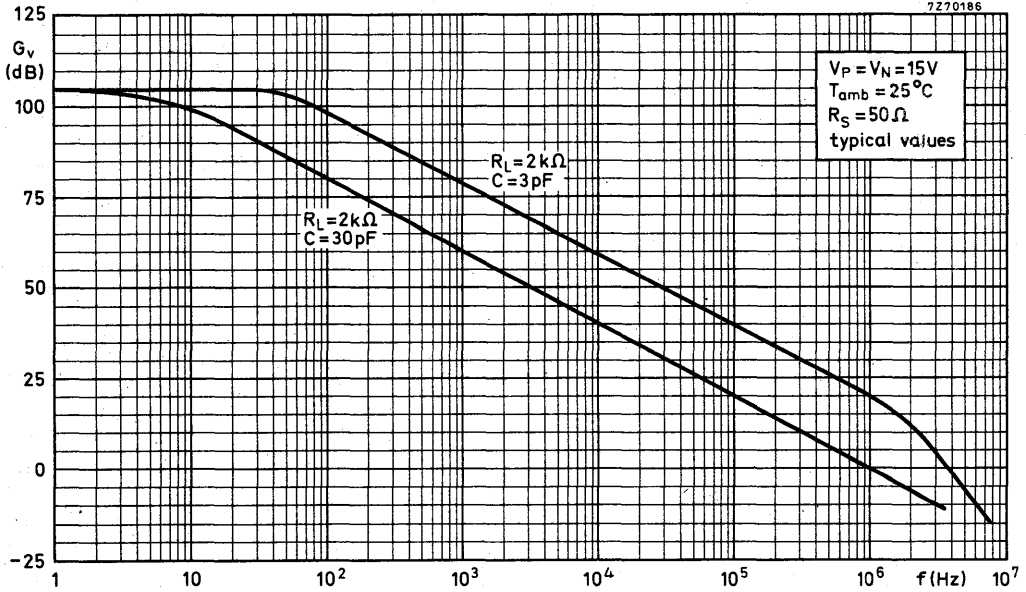


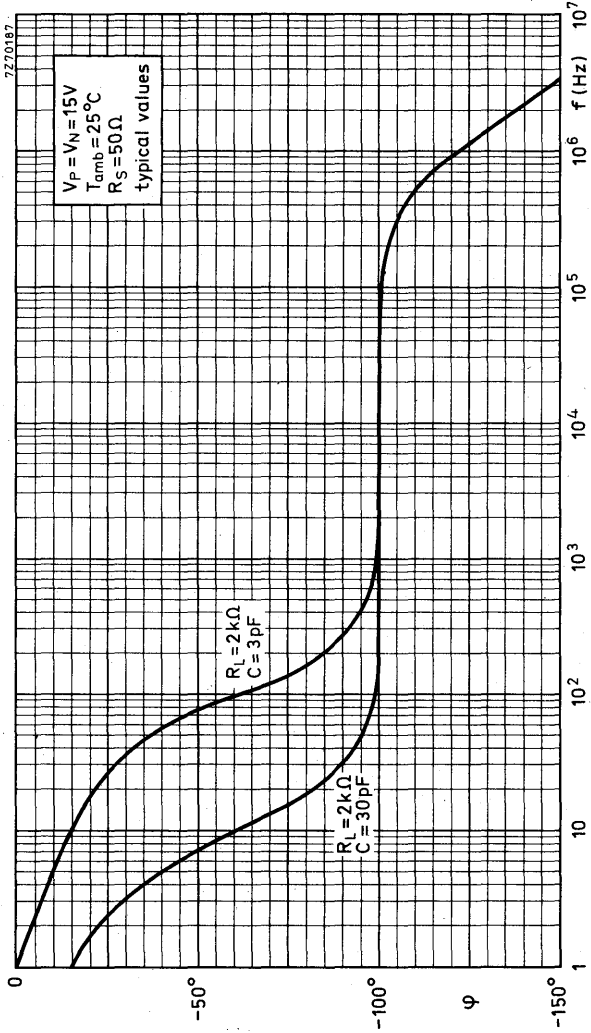
Alternate circuit



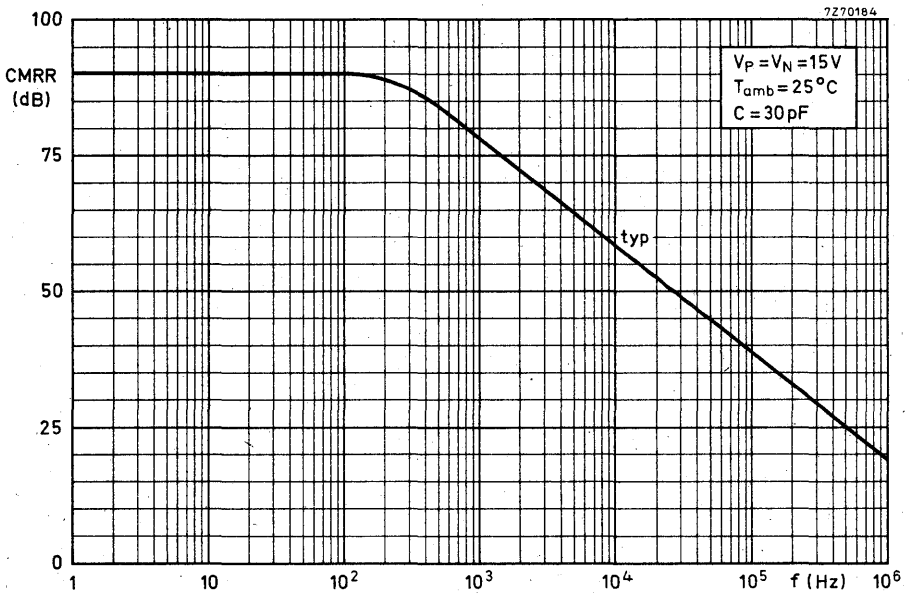
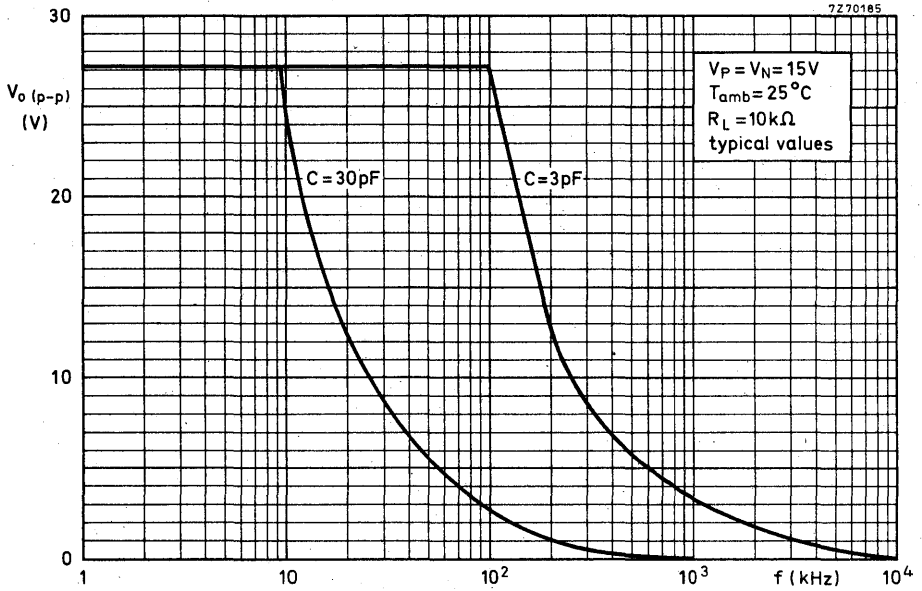








TDA0748D



OPERATIONAL AMPLIFIER

The TDA1034 is a high-performance general purpose operational amplifier. Compared to most of the standard operational amplifiers (e.g. μ A741, TBA221, LM301A and LM307), it shows better noise performance, improved output drive capability and considerably higher small-signal and power bandwidth.

This makes the device especially suitable for application in high quality and professional audio equipment, in instrumentation and control circuits and telephone channel amplifiers. The op amp is internally compensated for gain equal to, or higher than, three.

The frequency response can be optimized with an external compensation capacitor for various applications (unity gain amplifier, capacitive load, slew-rate, low overshoot, etc.). If very low noise is of prime importance, it is recommended that the TDA1034N version be used which has guaranteed noise specifications and somewhat lower input current.

Features

- Small-signal bandwidth : 10 MHz
- Output drive capability : 600 Ω , 10 V (r.m.s.) at $V_P = -V_N = 18$ V
- Input noise voltage : 4 nV/ $\sqrt{\text{Hz}}$
- D.C. voltage gain : 100 000
- A.C. voltage gain : 6000 at 10 kHz
- Power bandwidth : 200 kHz
- Slew-rate : 13 V/ μ s
- Large supply voltage range : ± 3 to ± 20 V

PACKAGE OUTLINES (see general section).

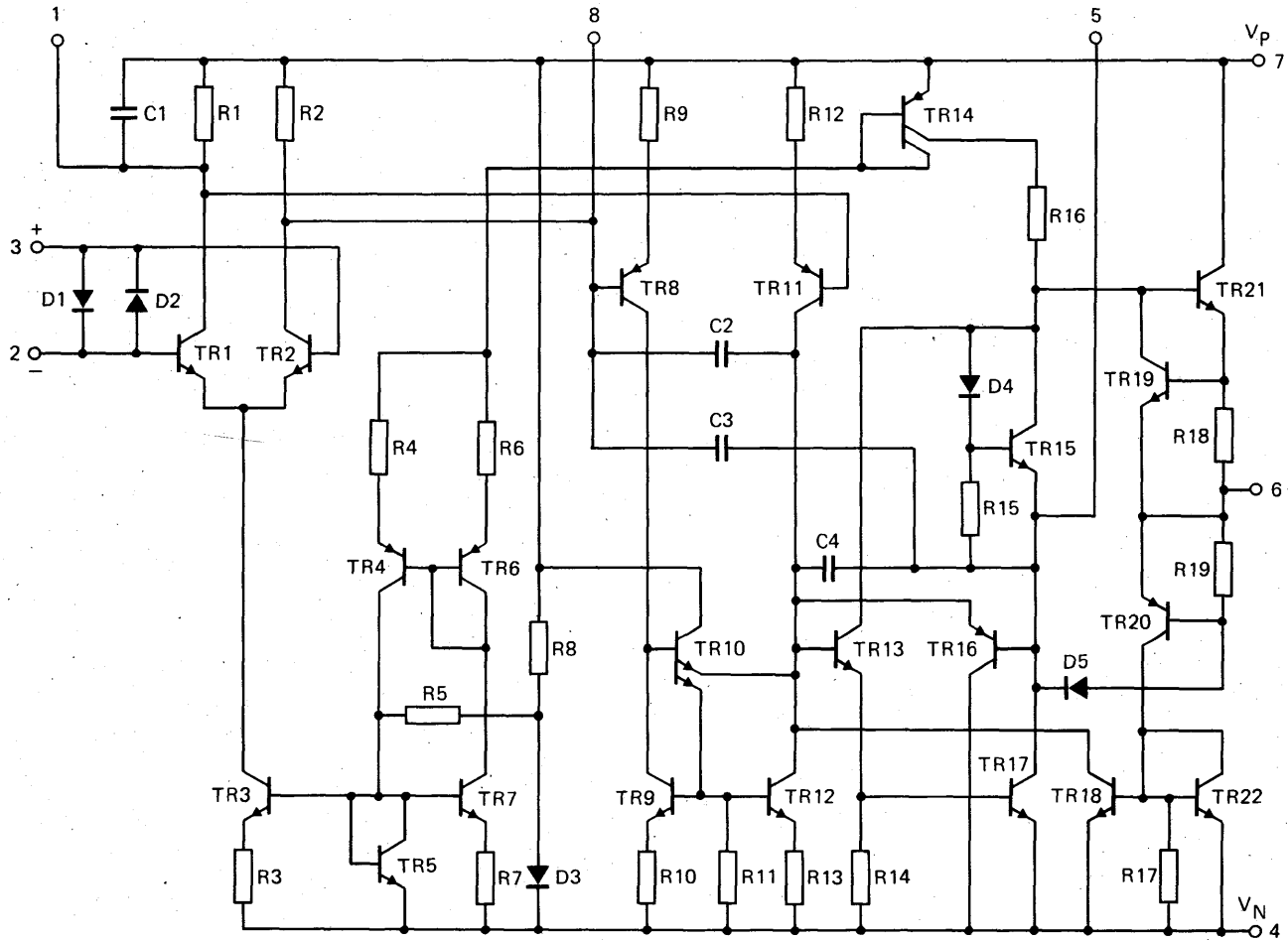
TDA1034; N : TO-99 (8-lead metal envelope).

TDA1034B; NB : SOT-97 (plastic 8-lead dual in-line).

TDA1034D; ND : SO-8 (SOT-96A) (plastic 8-lead flat pack).

TDA1034A; N
TDA1034B; NB
TDA1034D; ND

CIRCUIT DIAGRAM



7272711.1

RATINGS Limiting values in accordance with the Absolute Maximum System (IEC 134)

Voltages

Positive supply voltage	V_P	max.	20	V
Negative supply voltage	V_N	max.	20	V
Common mode input voltage (pins 2 and 3)			V_P to $-V_N$	
Differential input voltage	V_{2-3}	max.	$\pm 0,5$	V ¹⁾

Temperatures

Operating ambient temperature	T_{amb}	-25 to +85	°C
Storage temperature; metal envelope plastic envelope	T_{stg}	-65 to +150	°C
	T_{stg}	-65 to +125	°C

Maximum power dissipation in free air

package	mounting	max. power dissipation at $T_{amb} = 50,0^{\circ}C$ (mW)	derating factor for $T_{amb} > 50^{\circ}C$ (mW/°C)	max. junction temperature (°C)	thermal resistance $R_{th j-a}$ (°C/W)
TO-99	on PC board	625	6,25	150	160
	with 33 °C/W cooling fin; on PC board	1100	11	150	90
SOT-97	on PC board	450	6	125	165
SOT-96A	on ceramic substrate of 4 cm ²	500	6,7	125	150
	on PC board of 4 cm ²	325	4,3	125	230

¹⁾ Diodes protect the inputs against over-voltage. Therefore, unless current-limiting resistors are used, large currents will flow if the differential input voltage exceeds 0,6 V.

CHARACTERISTICS at $V_P = 15\text{ V}$; $-V_N = 15\text{ V}$; $T_{\text{amb}} = 25\text{ }^\circ\text{C}$ unless otherwise specified

Input offset voltage	V_{io}	typ.	0,5	mV
		<	4,0	mV
Input bias current	I_i	typ.	0,5	μA
		<	1,5	μA
Input offset current	I_{io}	typ.	0,02	μA
		<	0,3	μA
Input voltage range	V_i	>	+12; -13	V
		typ.	+13; -14	V
Differential input resistance	R_i	>	30	$\text{k}\Omega$
		typ.	100	$\text{k}\Omega$
Common mode rejection ratio	CMRR	>	80	dB
		typ.	100	dB
Power supply voltage rejection ratio	PSRR	typ.	10	$\mu\text{V}/\text{V}$
		<	50	$\mu\text{V}/\text{V}$
Large-signal voltage gain $R_L = 600\ \Omega$; $V_o = \pm 10\text{ V}$	G_v	>	30 000	
		typ.	100 000	
Output voltage swing at $R_L = 600\ \Omega$	V_o	>	± 12	V
		typ.	± 13	V
Output resistance; closed loop $G_v = 30\ \text{dB}$; $f = 10\ \text{kHz}$; $R_L = 600\ \Omega$; $C_C = 22\ \text{pF}$	R_o	typ.	0,3	Ω
Output short-circuit current	I_{sc}	typ.	38	mA
Supply current at $I_o = 0$	I_P ; N	typ.	4	mA
		<	6,5	mA
Transient response (voltage follower)				
$V_i = 50\ \text{mV}$; $R_L = 600\ \Omega$; $C_C = 22\ \text{pF}$; $C_L = 100\ \text{pF}$				
rise time	t_r	typ.	20	ns
overshoot		typ.	20	%
$V_i = 50\ \text{mV}$; $R_L = 600\ \Omega$; $C_C = 47\ \text{pF}$; $C_L = 500\ \text{pF}$				
rise time	t_r	typ.	50	ns
overshoot		typ.	35	%
A.C. gain at $f = 10\ \text{kHz}$; $C_C = 0$	G_v	typ.	6000	
at $f = 10\ \text{kHz}$; $C_C = 22\ \text{pF}$	G_v	typ.	2200	
Unity gain frequency at $C_C = 22\ \text{pF}$; $C_L = 100\ \text{pF}$	f	typ.	10	MHz
Slew-rate at $C_C = 0$	S	typ.	13	$\text{V}/\mu\text{s}$
at $C_C = 22\ \text{pF}$	S	typ.	6	$\text{V}/\mu\text{s}$
Power bandwidth at $V_{o(p-p)} = 20\ \text{V}$	B	typ.	200	kHz
$C_C = 0$	B	typ.	95	kHz
$C_C = 22\ \text{pF}$	B	typ.		

CHARACTERISTICS (continued)

Input noise voltage at $f = 30 \text{ Hz}$	V_n	typ.	7	$\text{nV}/\sqrt{\text{Hz}}$
at $f = 1 \text{ kHz}$	V_n	typ.	4	$\text{nV}/\sqrt{\text{Hz}}$
Input noise current at $f = 30 \text{ Hz}$	I_n	typ.	2,5	$\text{pA}/\sqrt{\text{Hz}}$
at $f = 1 \text{ kHz}$	I_n	typ.	0,6	$\text{pA}/\sqrt{\text{Hz}}$

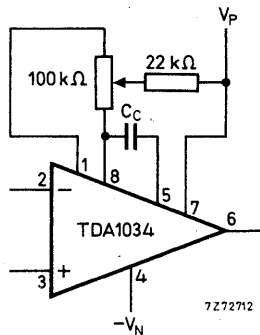
CHARACTERISTICS at $V_p = 18 \text{ V}$; $-V_N = 18 \text{ V}$; $T_{\text{amb}} = 25 \text{ }^\circ\text{C}$ unless otherwise specified

Output voltage swing at $R_L = 600 \Omega$	V_o	>	± 15	V
		typ.	± 16	V
Supply current at $I_o = 0$	$I_{P;N}$	typ.	4,2	mA
		<	7	mA
Power bandwidth at $V_o(\text{p-p}) = 28 \text{ V}$ $R_L = 600 \Omega$; $C_C = 22 \text{ pF}$	B	typ.	70	kHz

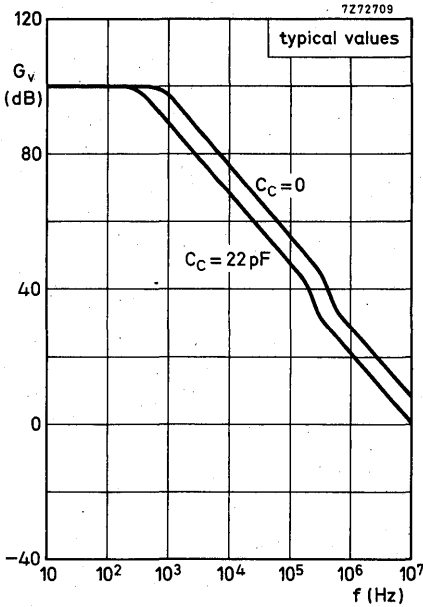
TDA1034N version

The TDA1034N version has the same electrical specifications as the TDA1034, with the following exceptions:

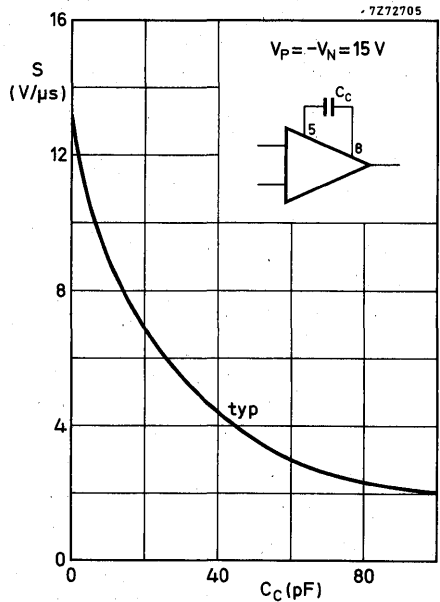
Input bias current	I_i	typ.	0,4	μA
		<	0,8	μA
Input offset current	I_{io}	typ.	0,01	μA
		<	0,2	μA
Input noise voltage at $f = 30 \text{ Hz}$	V_n	typ.	5,5	$\text{nV}/\sqrt{\text{Hz}}$
		<	7	$\text{nV}/\sqrt{\text{Hz}}$
at $f = 1 \text{ kHz}$	V_n	typ.	3,5	$\text{nV}/\sqrt{\text{Hz}}$
		<	4,5	$\text{nV}/\sqrt{\text{Hz}}$
Input noise current at $f = 30 \text{ Hz}$	I_n	typ.	1,5	$\text{pA}/\sqrt{\text{Hz}}$
at $f = 1 \text{ kHz}$	I_n	typ.	0,4	$\text{pA}/\sqrt{\text{Hz}}$
Broadband noise figure $f = 10 \text{ Hz to } 20 \text{ kHz}$; $R_S = 5 \text{ k}\Omega$	F	typ.	0,9	dB



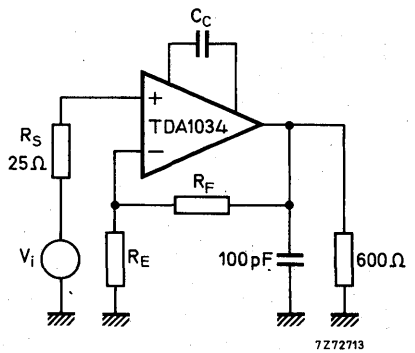
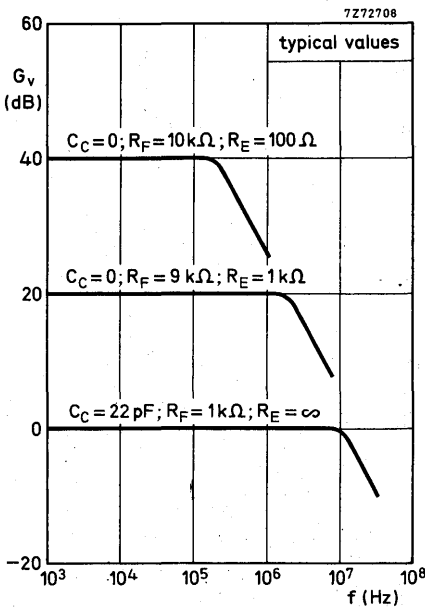
Frequency compensation and offset voltage adjustment circuit.



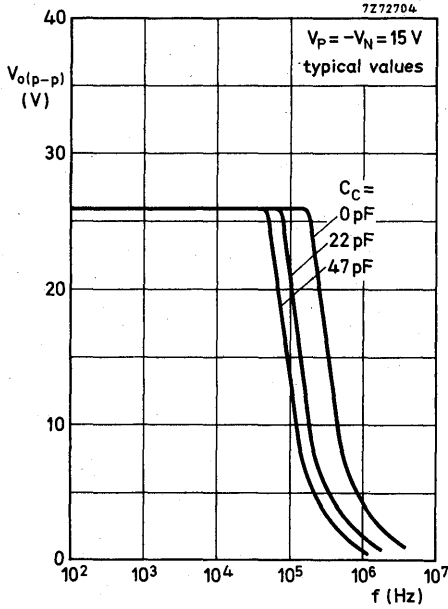
Open loop frequency response.



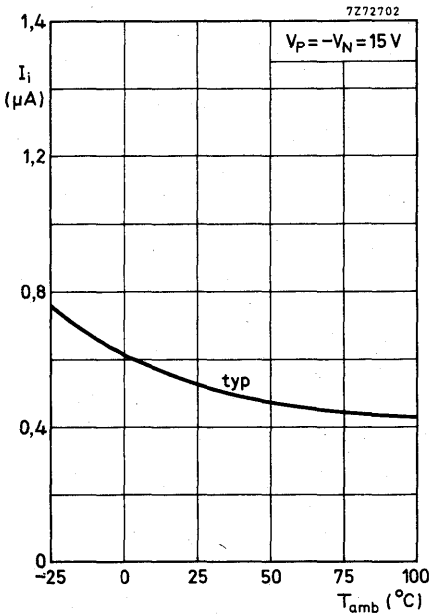
Slew-rate as a function of compensation capacitance.



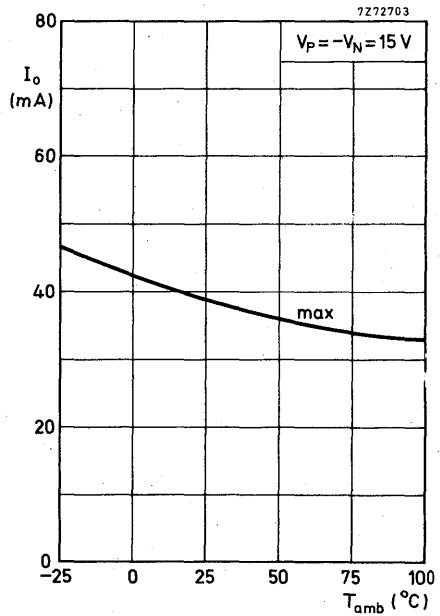
Closed loop frequency response.



Large-signal frequency response.

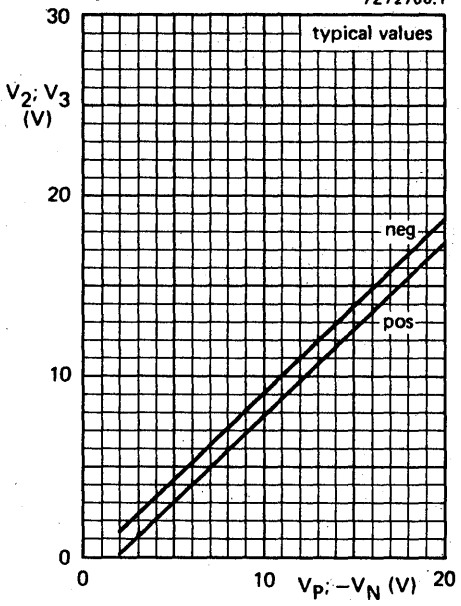


Input bias current.



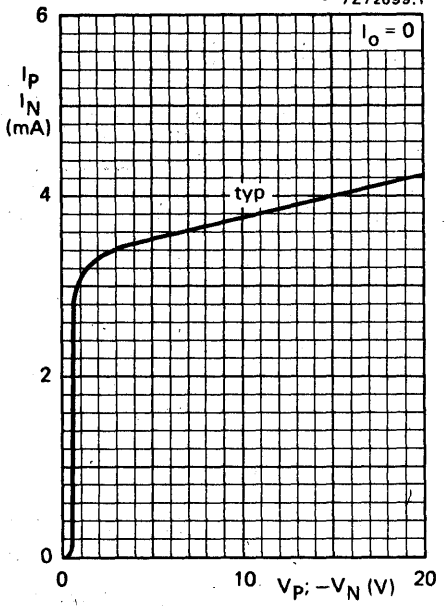
Output short-circuit current.

7Z72700.1

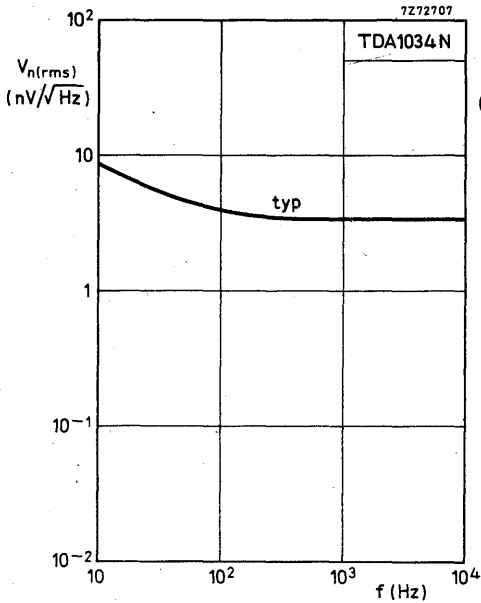


Input common mode voltage range.

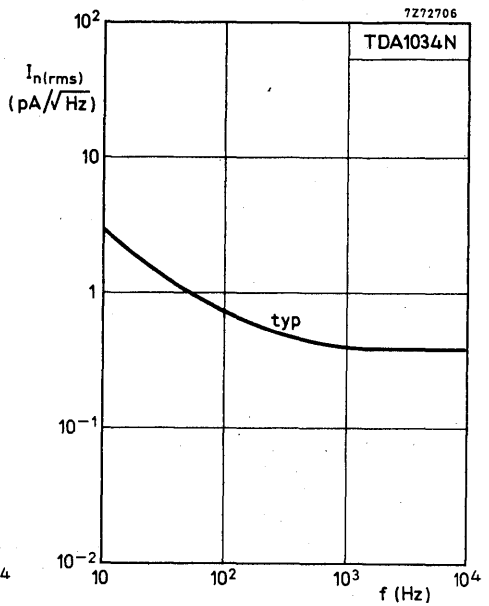
7Z72699.1



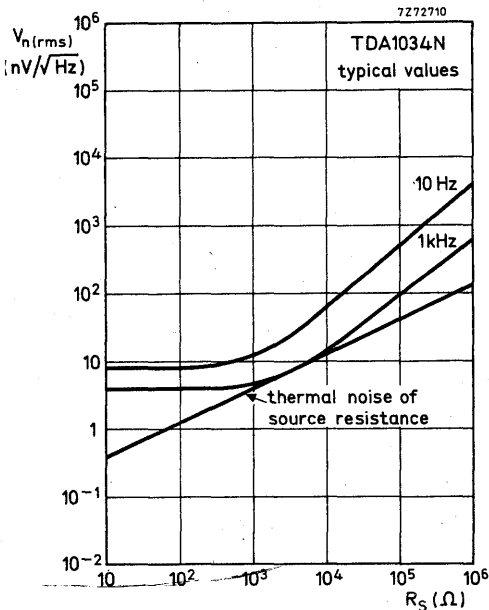
Supply current.



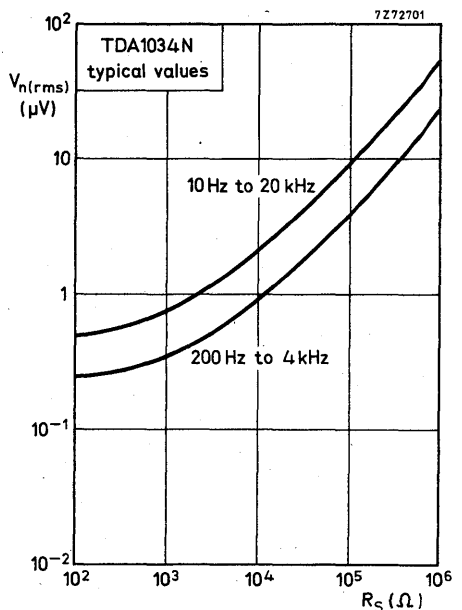
Input noise voltage density.



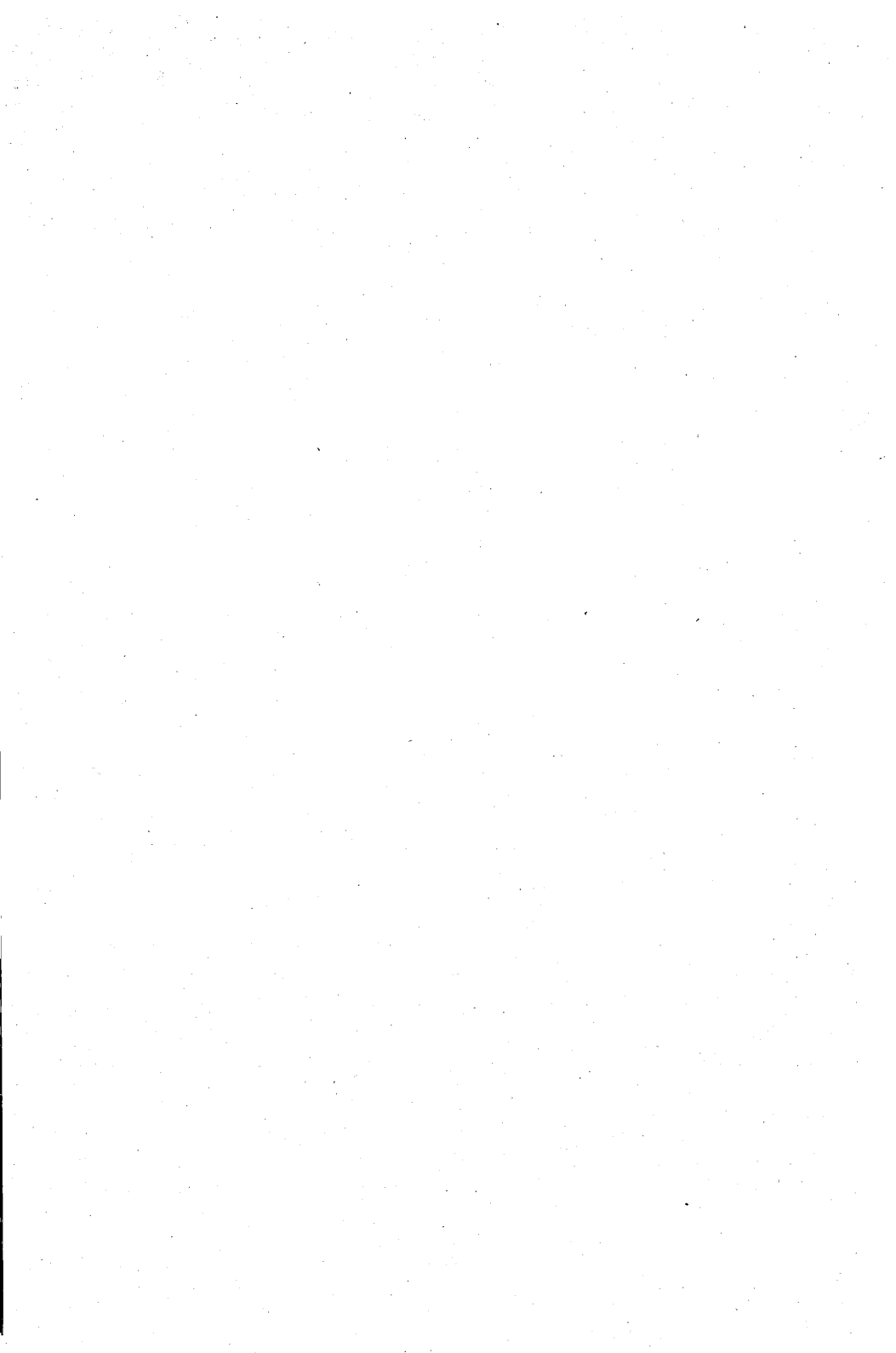
Input noise current density.



Total input noise density.



Broadband input noise voltage.



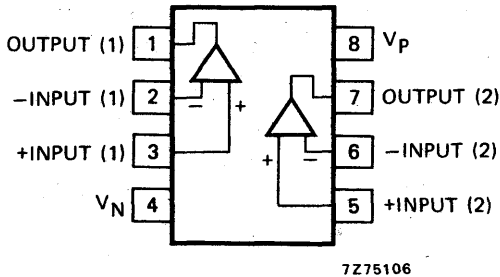
DUAL OPERATIONAL AMPLIFIER

The TDA1458D consists of two independent, internally frequency compensated operational amplifiers. The circuit is the equivalent of two standard μ A741 circuits. It is mounted in a miniature plastic package suitable for hybrid modules and for applications where small dimensions are important.

Features

- No frequency compensation required
- Short-circuit protection
- Large input and output voltage range
- Miniature plastic encapsulation

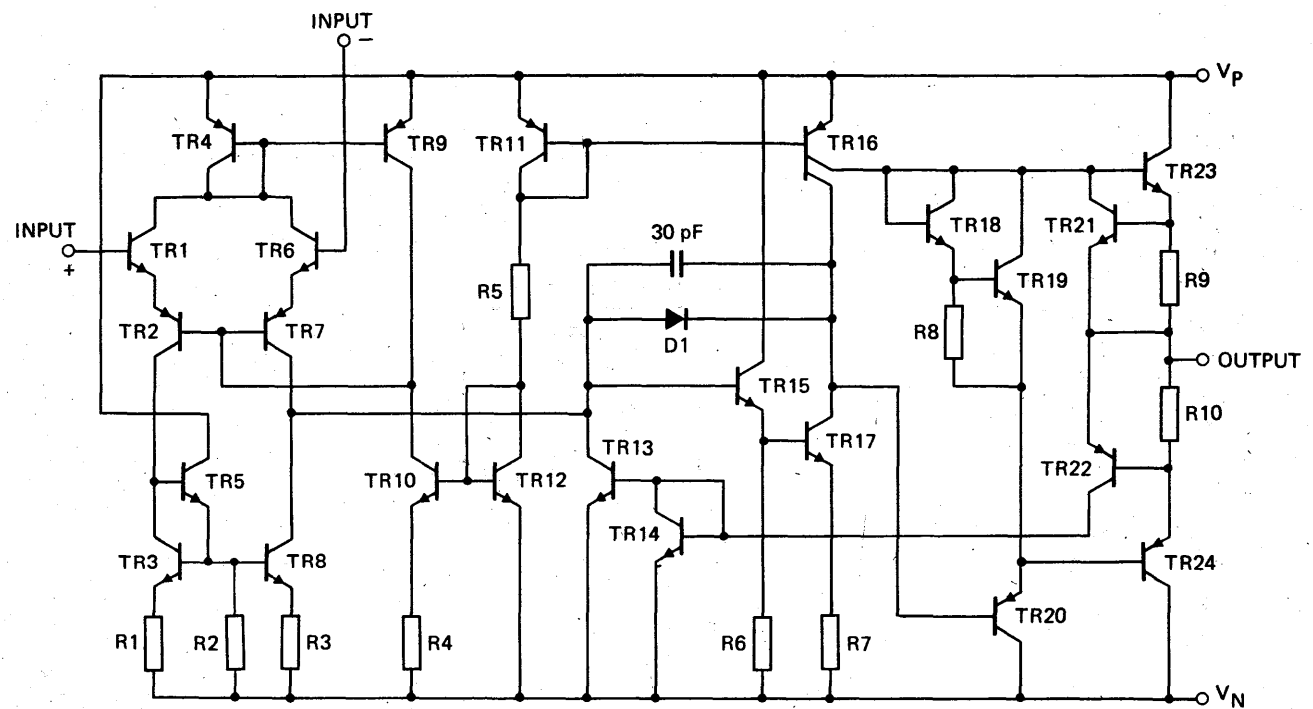
CONNECTION DIAGRAM



PACKAGE OUTLINE (see general section)

SO-8 (SOT-96A); plastic 8-lead flat pack.

CIRCUIT DIAGRAM (one amplifier)



7 Z75089

RATINGS Limiting values in accordance with the Absolute Maximum System (IEC 134)

Supply voltage	$V_P - V_N$	max.	36	V
Differential input voltage	$V_{I+} - V_{I-}$	max.	± 30	V
Common mode input voltage	$V_{I+}; V_{I-}$		V_N to V_P	

Temperatures

Operating ambient temperature	T_{amb}	-25 to +85	$^{\circ}C$
Storage temperature	T_{stg}	-65 to +125	$^{\circ}C$
Junction temperature	T_j	max. 125	$^{\circ}C$

Power dissipation in free air; $T_{amb} = 50^{\circ}C$

Mounted on a ceramic substrate of 4 cm^2 derating factor for $T_{amb} > 50^{\circ}C$	P_{tot}	max.	480	mW
	$1/R_{th}$	=	6,4	mW/ $^{\circ}C$
Mounted on PC board of 4 cm^2 derating factor for $T_{amb} > 50^{\circ}C$	P_{tot}	max.	325	mW
	$1/R_{th}$	=	4,3	mW/ $^{\circ}C$



CHARACTERISTICS at $V_P = 15\text{ V}$; $-V_N = 15\text{ V}$; $T_{\text{amb}} = 25\text{ }^\circ\text{C}$ unless otherwise specified

Parameter	Conditions	Symbol	min.	typ.	max.	Unit
Input offset voltage		V_{io}	-	2	6	mV
Input offset current		I_{io}	-	20	200	nA
Input bias current		I_i	-	80	500	nA
Input voltage range		V_i	± 12	± 13	-	V
Common mode rejection ratio		CMRR	70	90	-	dB
Differential input resistance		R_i	0,3	1	-	M Ω
Power supply rejection ratio		PSRR	-	30	150	$\mu\text{V/V}$
Large signal voltage gain	$R_L = 2\text{ k}\Omega$; $V_o = \pm 10\text{ V}$	G_V	20	100	-	V/mV
Output voltage swing	$R_L = 10\text{ k}\Omega$	V_o	± 12	± 14	-	V
	$R_L = 2\text{ k}\Omega$	V_o	± 10	± 13	-	V
Output resistance	$f = 20\text{ Hz}$	R_o	-	300	-	Ω
Output short-circuit current		I_{sc}	-	20	-	mA
Supply current	$I_o = 0$	I_p ; I_N	-	2,3	5,6	mA
Power bandwidth	gain = 1; $R_L = 2\text{ k}\Omega$; THD < 5%; $V_o(p-p) = 20\text{ V}$	B	-	14	-	kHz ¹⁾
Unity gain cross-over frequency	open loop		-	1,1	-	MHz
Phase margin			-	65	-	degree
Gain margin			-	11	-	dB
Slew rate	$R_L = 2\text{ k}\Omega$	S	-	0,8	-	V/ μs
Channel separation			-	120	-	dB

CHARACTERISTICS at $V_P = 15\text{ V}$; $-V_N = 15\text{ V}$; $T_{\text{amb}} = 0\text{ to }+70\text{ }^\circ\text{C}$

Parameter	Conditions	Symbol	min.	typ.	max.	Unit
Large signal voltage gain	$R_L = 2\text{ k}\Omega$; $V_o = \pm 10\text{ V}$	G_V	15	-	-	V/mV
Input offset voltage		V_{io}	-	-	7,5	mV
Input offset current		I_{io}	-	-	300	nA
Input bias current		I_i	-	-	800	nA
Output voltage swing	$R_L = 2\text{ k}\Omega$	V_o	± 10	± 13	-	V

¹⁾ THD = total harmonic distortion.

PROGRAMMABLE OPERATIONAL AMPLIFIER

The TDA4250B; D is a versatile, programmable monolithic operational amplifier, especially designed for applications requiring very low stand-by power consumption over a wide range of supply voltages.

The quiescent current of the amplifier can be set by a single external resistor or current source. With this programming, the power consumption, input current, slew rate and gain-bandwidth product can be adapted to a particular application.

The TDA4250B is mounted in a standard plastic 8-lead dual in-line.

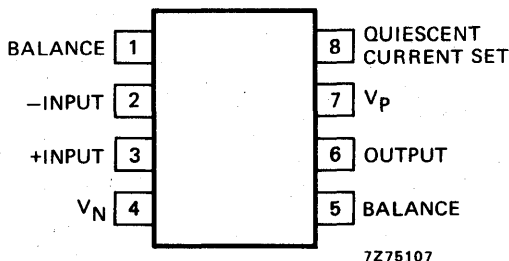
The TDA4250D is mounted in a miniature plastic encapsulation, mainly intended for use in hybrid circuits.

The circuit is equivalent to the LM4250; C, SG4250; C, ICL8021 and similar to the μ A776; C.

Features

- Programmable electrical parameters
- Very low stand-by power consumption
- No frequency compensation required
- ± 1 to ± 18 V power supply operation
- Short-circuit protection
- Offset voltage adjustable to zero
- Operating ambient temperature: -25 to $+85$ °C

CONNECTION DIAGRAM



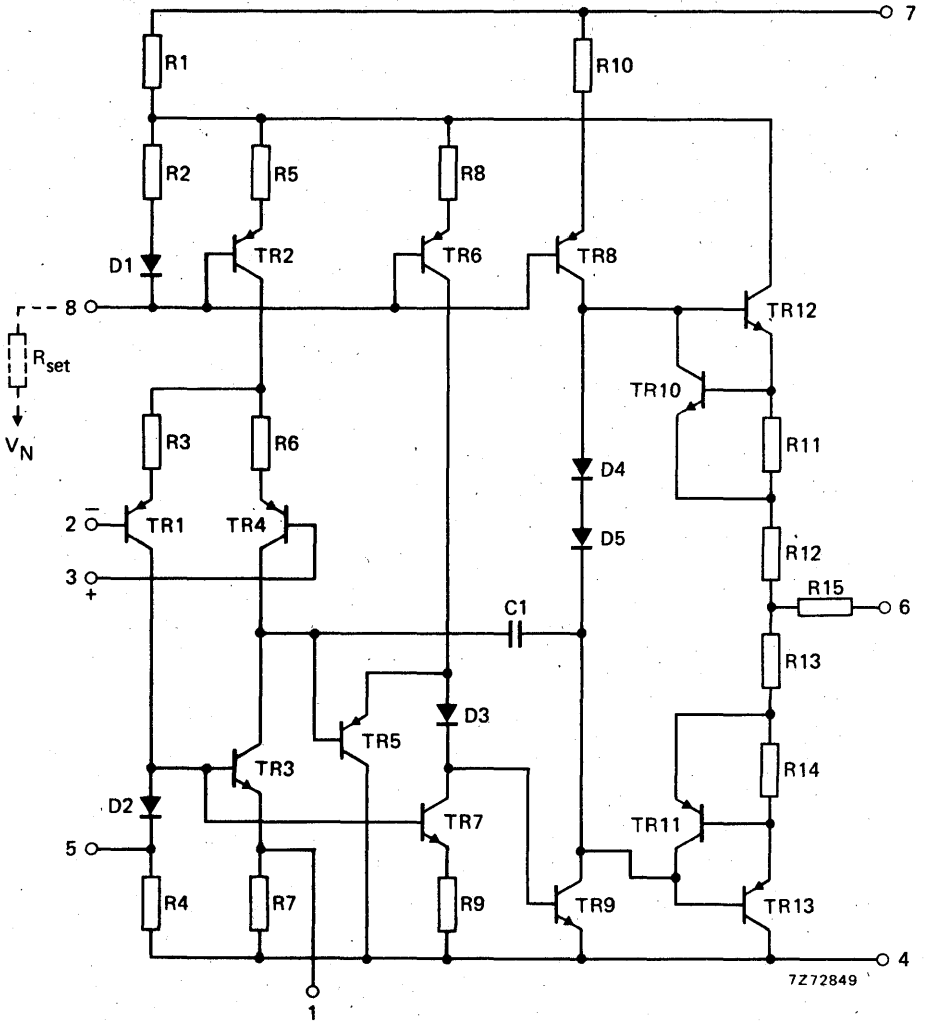
PACKAGE OUTLINE (see general section)

TDA4250B : plastic 8-lead dual in-line.

TDA4250D : SO-8 (SOT-96A); plastic 8-lead flat pack.

TDA4250B
TDA4250D

CIRCUIT DIAGRAM



RATINGS Limiting values in accordance with the Absolute Maximum System (IEC 134)

Supply voltage	$V_P; -V_N$	max.	18	V
Common mode input voltage (pins 2 and 3)	$V_{I+}; V_{I-}$		V_P to $-V_N$	
Differential input voltage	$V_{I+} - V_{I-}$	max.	± 30	V
Output short-circuit duration			indefinite	

Temperatures

Operating ambient temperature	T_{amb}	-25 to +85	$^{\circ}C$
Storage temperature	T_{stg}	-65 to +125	$^{\circ}C$
Junction temperature	T_j	max. 125	$^{\circ}C$

Power dissipation in free air; $T_{amb} = 50^{\circ}C$

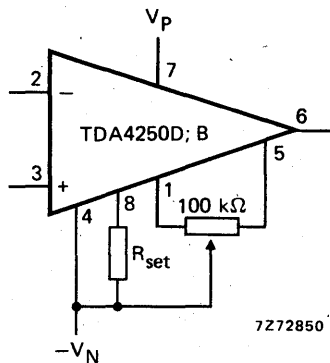
TDA4250B

Mounted on PC board	P_{tot}	max.	440	mW
derating factor for $T_{amb} > 50^{\circ}C$	$1/R_{th}$	=	5,8	mW/ $^{\circ}C$

TDA4250D

Mounted on a ceramic substrate of 4 cm ²	P_{tot}	max.	470	mW
derating factor for $T_{amb} > 50^{\circ}C$	$1/R_{th}$	=	6,3	mW/ $^{\circ}C$
Mounted on PC board of 4 cm ²	P_{tot}	max.	310	mW
derating factor for $T_{amb} > 50^{\circ}C$	$1/R_{th}$	=	4,2	mW/ $^{\circ}C$

CHARACTERISTICS



Offset voltage adjustment circuit.

TDA4250B

TDA4250D

CHARACTERISTICS at $I_{set} = 10 \mu A$; $V_P = 6 V$; $-V_N = 6 V$; $T_{amb} = -25$ to $+85 \text{ }^\circ C$ unless otherwise specified

Parameter	Conditions	Symbol	min.	typ.	max.	Unit
Input offset voltage	$T_{amb} = 25 \text{ }^\circ C$	V_{io}	-	-	7,5	mV
		V_{io}	-	2	6	mV
Input offset current	$T_{amb} = 25 \text{ }^\circ C$	I_{io}	-	-	25	nA
		I_{io}	-	-	20	nA
Input bias current	$T_{amb} = 25 \text{ }^\circ C$	I_i	-	-	85	nA
		I_i	-	-	80	nA
Input voltage range	$V_P = 15 V$; $-V_N = 15 V$	V_i	$\pm 13,5$	± 14	-	V
Output voltage swing	$V_P = 15 V$; $-V_N = 15 V$; $R_L = 10 k\Omega$	V_o	$\pm 12,5$	$\pm 13,5$	-	V
Supply current	I_{set} included	$I_{P; N}$	-	60	100	μA
D.C. voltage gain	$R_L = 10 k\Omega$; $V_o = \pm 3 V$	G_v	50	200	-	V/mV
A.C. voltage gain	$f = 1 \text{ kHz}$; $R_L = 10 k\Omega$	G_v	-	300	-	
Slew rate		S	-	0,25	-	V/ μs
Common mode rejection ratio		CMRR	70	-	-	dB
Power supply rejection ratio		PSRR	76	-	-	dB

At $I_{set} = 1 \mu A$

Parameter	Conditions	Symbol	min.	typ.	max.	Unit
Input offset voltage	$T_{amb} = 25 \text{ }^\circ C$	V_{io}	-	-	6,5	mV
		V_{io}	-	2	5	mV
Input offset current	$T_{amb} = 25 \text{ }^\circ C$	I_{io}	-	-	6	nA
		I_{io}	-	-	4	nA
Input bias current	$T_{amb} = 25 \text{ }^\circ C$	I_i	-	-	12	nA
		I_i	-	-	10	nA
Input voltage range	$V_P = 15 V$; $-V_N = 15 V$	V_i	$\pm 13,5$	± 14	-	V
Output voltage swing	$V_P = 15 V$; $-V_N = 15 V$; $R_L = 100 k\Omega$	V_o	± 13	± 14	-	V
Supply current	I_{set} included	$I_{P; N}$	-	7	11	μA
D.C. voltage gain	$R_L = 100 k\Omega$; $V_o = \pm 3 V$	G_v	50	200	-	V/mV
A.C. voltage gain	$f = 1 \text{ kHz}$; $R_L = 100 k\Omega$	G_v	-	75	-	
Slew rate		S	-	0,025	-	V/ μs
Common mode rejection ratio		CMRR	70	-	-	dB
Power supply rejection ratio		PSRR	76	-	-	dB

TELECOMMUNICATIONS CIRCUITS



Telecommunications circuits

TAA960	- triple amp
TAA970	- microphone amp
TBA673	- balanced modulator
TBA915	- audio amp
TCA210	- audio amp
TCA240	- balanced modulator
TCA580	- gyrator
TCA770; A; D	- i. f. amp/f. m. discriminator
TCA980	- microphone amp
TDA 1022	- bucket brigade delay line

TRIPLE AMPLIFIER FOR ACTIVE FILTERS

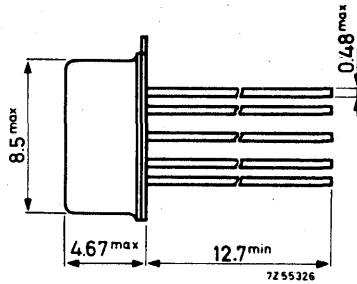
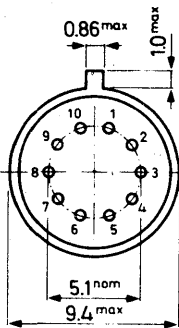
The TAA960 consists of three identical general-purpose amplifiers integrated in a single silicon chip. The amplifiers can be used separately or can be cascaded to give a voltage gain of 117 dB. One of the amplifiers has an additional emitter-follower stage. The TAA960 is very suitable for use in an active RC band-pass filter with Q up to 60.

QUICK REFERENCE DATA

Supply voltage	V_{3-10}	nom.	6	V
Supply current	I_3	typ.	2	mA
Transfer admittance (each amplifier)	$ y_{fs} $	typ.	9.5	$m\Omega^{-1}$
Voltage gain (each amplifier)	G_V	typ.	39	dB
Input resistance (on pins 1, 7 and 8)	R_i	>	25	$k\Omega$
Output resistance (on pins 2, 5 and 6)	R_o	typ.	9	$k\Omega$
	(on pin 4)	R_o	typ.	500 Ω
Q factor (in typical RC filter)	Q	typ.	45	

PACKAGE OUTLINE TO-74; reduced height

Dimensions in mm



TAA960

RATINGS Limiting values in accordance with the Absolute Maximum System (IEC 134)

Voltages with respect to pin 10

Supply voltage ¹⁾	V ₃	max.	10	V
Input voltage	V ₈ , V ₇ , V ₁	max.	4	V
Output voltage	V ₆ , V ₅ , V ₄ , V ₂	max.	10	V

Currents

Input current	I ₈ , I ₇ , I ₁	max.	50	μA
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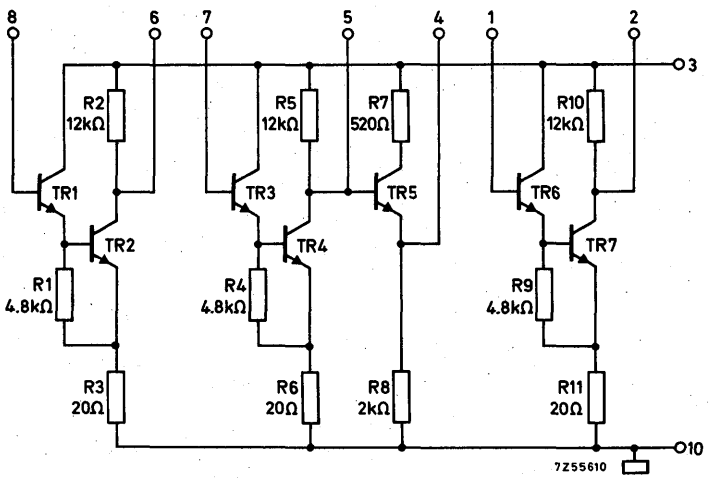
Total power dissipation

P _{tot}	max.	250	mW
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Temperatures

Storage temperature	T _{stg}	-65 to +125	°C
Operating ambient temperature	T _{amb}	-55 to + 65	°C

CIRCUIT DIAGRAM



¹⁾ With lower d. c. potential on all other terminals.

CHARACTERISTICS at $V_3 = 6\text{ V}$; $T_{\text{amb}} = 25\text{ }^\circ\text{C}$ unless otherwise specified.

<u>Supply current</u> ¹⁾	I_3		1.5 to 2.5	mA
		typ.	2.0	mA
<u>Supply current</u> ¹⁾ at $V_3 = 10\text{ V}$	I_3		1.5 to 3.8	mA
		typ.	2.6	mA
<u>Voltage gain</u> (each amplifier)	G_v		60 to 150	
		typ.	90	
<u>Input resistance</u> (each amplifier)	R_i	>	25	$\text{k}\Omega$
<u>Output resistance</u> on terminals 2, 5 and 6	R_o	>	8	$\text{k}\Omega$
		typ.	9	$\text{k}\Omega$
on terminals 4	R_o		135 to 750	Ω

¹⁾ Terminal 8 connected to terminal 6

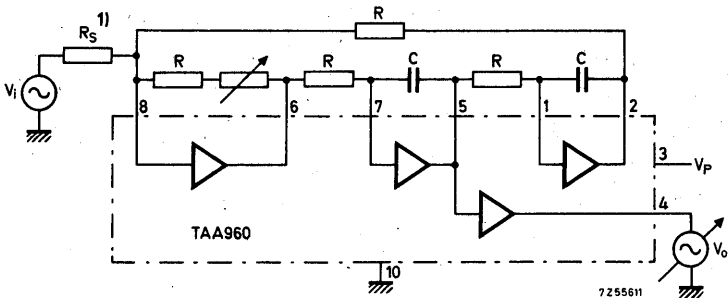
"	7	"	"	"	5
"	1	"	"	"	2



APPLICATION INFORMATION

Active RC filter for frequencies up to 150 kHz

- This frequency range can be extended to 200 kHz if a feed forward capacitor is connected between pin 5 and 8.



$$R = 10 \text{ k}\Omega$$

<u>Frequency</u>	f	typ.	$\frac{1}{2\pi RC}$	
<u>Supply voltage</u>	V_P	typ.	6	V
<u>Filter performance</u> at $T_{amb} = 25 \text{ }^\circ\text{C}$	Q	typ.	40 to 55	
at $T_{amb} = -30 \text{ to } +65 \text{ }^\circ\text{C}$	Q	typ.	45	
			35 to 55	
<u>Input voltage</u>	V_i	typ.	400	mV
<u>Output voltage</u>	V_o	typ.	400	mV
<u>Distortion at $V_o = 350 \text{ mV}$</u>	d_{tot}	typ.	2	%
<u>S/N ratio at $V_o = 400 \text{ mV}$</u>	S/N	>	50	dB
<u>Input resistor 1)</u>	R_S	typ.	470	k Ω

1) Value of input resistor to be determined for $\frac{V_o}{V_i} = 0,90 \text{ to } 1,1$.

MICROPHONE AMPLIFIER

The TAA970 is a monolithic integrated microphone amplifier for use in telephone systems. It is compatible with both piezo-electric and dynamic microphones of suitable impedance and sensitivity.

Special features are:

- almost constant voltage gain and d. c. voltage drop with supply current variations of 10 to 100 mA.
- output voltage before limiting: 1 V (r. m. s. value)
- operation is independent of supply voltage polarity
- gain can be set to either of two values
- only one external capacitor required
- output impedance determined by internal feed back

QUICK REFERENCE DATA

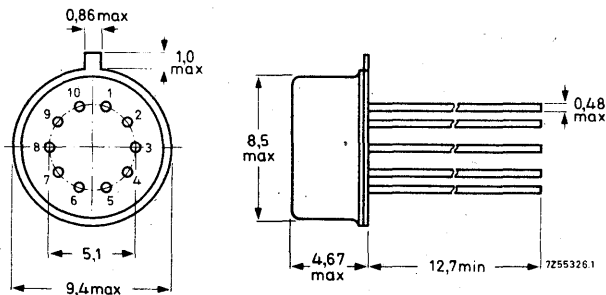
Supply current	$\pm I_2$	10 to 100	mA

Supply voltage drop at $\pm I_2 = 50$ mA	$\pm V_{2-4}$	typ. 4,8	V
Voltage gain			
pin 9 not connected	G_V	typ. 150	
pin 9 connected to pin 10	G_V	typ. 210	
Output impedance			
pin 9 not connected	R_O	typ. 60	Ω
pin 9 connected to pin 10	R_O	typ. 100	Ω

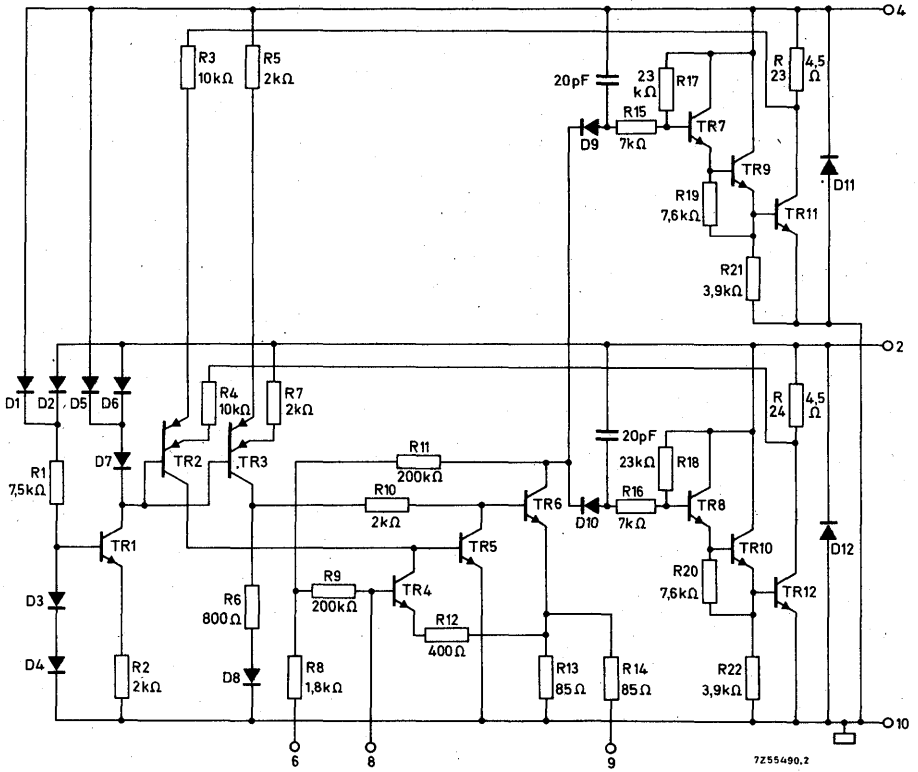
PACKAGE OUTLINE

TO-74 (reduced height)

Dimensions in mm



CIRCUIT DIAGRAM



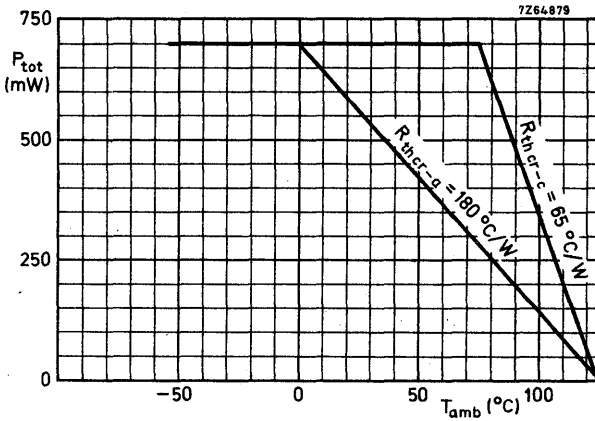
RATINGS Limiting values in accordance with the Absolute Maximum System (IEC 134)

Currents

Supply current (d. c.)	I_2	-100 to +100	mA
A. C. component of supply current (peak value)	I_{2m}	max. 100	mA
Pin No. 6 current	I_6	max. 100	μ A
Pin No. 8 current	I_8	max. 100	μ A

Power dissipation

Total power dissipation	P_{tot}	max. 700	mW
-------------------------	-----------	----------	----



Temperatures

Storage temperature	T_{stg}	-55 to +125	$^{\circ}$ C
Operating ambient temperature	T_{amb}	-35 to +75	$^{\circ}$ C

THERMAL RESISTANCE

From crystal to case	$R_{th\ cr-c}$	=	65	$^{\circ}$ C/W
From crystal to ambient	$R_{th\ cr-a}$	=	180	$^{\circ}$ C/W

TAA970

CHARACTERISTICS at $R_L = 200 \Omega$; $f = 2 \text{ kHz}$; $T_{amb} = 25 \text{ }^\circ\text{C}$ unless otherwise specified.
(see test circuit below).

Supply voltage drop at $R_{th \text{ j-a}} = 100 \text{ }^\circ\text{C/W}$

$\pm I_2 = 10 \text{ mA}$	$\pm V_{2-4}$	3,4 to 5,4	V
$\pm I_2 = 50 \text{ mA}$	$\pm V_{2-4}$	3,8 to 5,8	V
$\pm I_2 = 100 \text{ mA}$	$\pm V_{2-4}$	4,3 to 6,0	V

Voltage gain

pin 9 not connected	$\left\{ \begin{array}{l} \pm I_2 = 10 \text{ mA} \\ \pm I_2 = 50 \text{ mA} \end{array} \right.$	G_V	$\left\{ \begin{array}{l} \text{typ. } 140 \\ 105 \text{ to } 165 \end{array} \right.$
		G_V	$\left\{ \begin{array}{l} \text{typ. } 150 \\ 125 \text{ to } 165 \end{array} \right.$
pin 9 connected to pin 10	$\left\{ \begin{array}{l} \pm I_2 = 10 \text{ mA} \\ \pm I_2 = 50 \text{ mA} \end{array} \right.$	G_V	$\left\{ \begin{array}{l} \text{typ. } 200 \\ 150 \text{ to } 230 \end{array} \right.$
		G_V	$\left\{ \begin{array}{l} \text{typ. } 210 \\ 180 \text{ to } 230 \end{array} \right.$

Change of voltage gain

when changing T_{amb} from $-20 \text{ }^\circ\text{C}$ to $+55 \text{ }^\circ\text{C}$	ΔG_V	<	10	%
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Gain reduction at $f = 300 \text{ Hz}$

(with respect to $f = 2 \text{ kHz}$)	ΔG_V	typ.	1	dB
		<	3	dB

Output impedance at $\pm I_2 = 50 \text{ mA}$

pin 9 not connected	R_O	typ.	60	Ω
pin 9 connected to pin 10	R_O	typ.	100	Ω

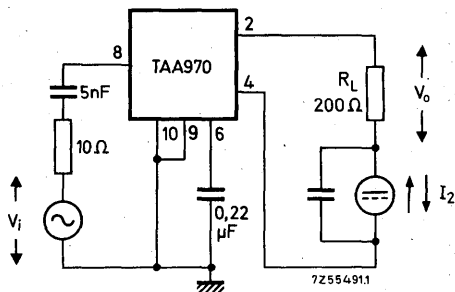
Noise output voltage at $B = 0,3 \text{ kHz to } 4 \text{ kHz}$

pin 9 not connected	$V_{n(\text{rms})}$	<	1	mV
pin 9 connected to pin 10	$V_{n(\text{rms})}$	<	1,3	mV

Output voltage

$I_2 = 25 \text{ mA}$; $d_{tot} = 5\%$	V_O	>	0,85	V
		typ.	1,0	V

Test circuit:



RING (DE)MODULATOR FOR TELEPHONY AND INDUSTRIAL EQUIPMENT

The TBA673 is a monolithic integrated circuit comprising a 4-transistor modulator and demodulator circuit.

The four transistors must be as identical as possible; the lay-out has been designed to achieve this and the best possible tracking of the transistor parameters with temperature.

QUICK REFERENCE DATA

Collector cut-off current

$$I_E = 0; V_{CB} = 5 \text{ V}; T_{amb} = 25 \text{ }^\circ\text{C}$$

$$I_{CBO} < 100 \text{ nA}$$

Base-emitter voltage differences
between transistors 1, 2, 3, 4

$$|V_{BE1} - V_{BE2}| < 5 \text{ mV}$$

$$V_{CB} = 5 \text{ V}; -I_E = 150 \text{ } \mu\text{A}$$

$$|V_{BE3} - V_{BE4}| < 5 \text{ mV}$$

D. C. current gain differences
between transistors 1, 2, 3, 4

$$|h_{FB1} - h_{FB2}| < 0,008$$

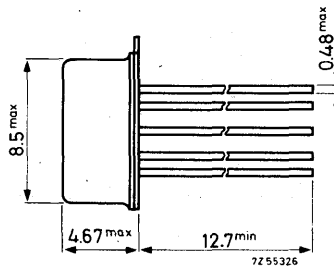
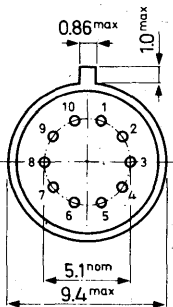
$$V_{CB} = 5 \text{ V}; -I_E = 150 \text{ } \mu\text{A}$$

$$|h_{FB3} - h_{FB4}| < 0,008$$

PACKAGE OUTLINE

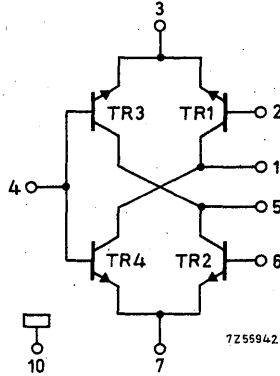
Dimensions in mm

TO-74 (reduced height)



TBA673

CIRCUIT DIAGRAM



RATINGS Limiting values in accordance with the Absolute Maximum System (IEC 134)

Voltages (each transistor)

Collector-emitter voltage (open base)	V_{CEO}	max.	17,5	V
Emitter-base voltage (open collector)	V_{EBO}	max.	6,2	V
Collector-substrate voltage	V_{CS}	max.	65	V

Currents (each transistor)

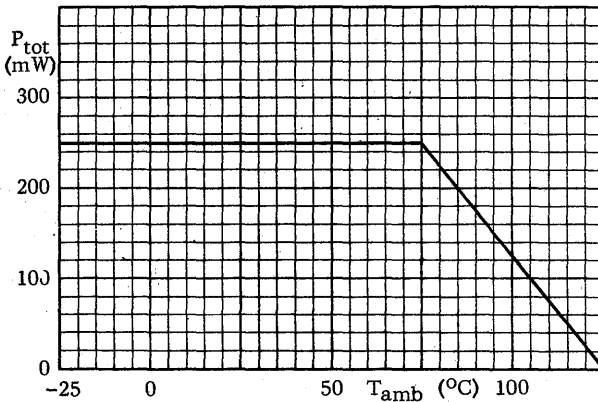
Collector current	I_C	max.	20	mA
→ Emitter cut-off current	I_{EBO}	max.	10	μ A

Power dissipation (4 transistors)

Total power dissipation See curve below

Temperatures

Storage temperature	T_{stg}	-55 to +125	$^{\circ}$ C
Operating ambient temperature		See curve below	



$T_{amb} = 25\text{ }^{\circ}\text{C}$ unless otherwise specified

CHARACTERISTICS

Collector cut-off current

$I_E = 0; V_{CB} = 5\text{ V}$

I_{CBO}	typ.	5	nA
	<	100	nA

Collector-substrate leakage current

$V_{CS} = 5\text{ V}$

I_{CS}	typ.	5	nA
	<	100	nA

Emitter cut-off current

$I_C = 0; V_{EB} = 1\text{ V}$

I_{EBO}	typ.	5	nA
	<	100	nA

Breakdown voltages

$I_E = 0; I_C = 50\text{ }\mu\text{A}$

$V_{(BR)CBO}$	>	45	V
---------------	---	----	---

$I_B = 0; I_C = 200\text{ }\mu\text{A}$

$V_{(BR)CEO}$	>	17,5	V
---------------	---	------	---

$-I_S = 50\text{ }\mu\text{A}$

$V_{(BR)CS}$	>	65	V
--------------	---	----	---

$I_C = 0; I_E = 10\text{ }\mu\text{A}$

$V_{(BR)EBO}$	>	6,2	V
---------------	---	-----	---

D.C. current gain

$I_C = 150\text{ }\mu\text{A}; V_{CB} = 5\text{ V}$

h_{FE}	>	35	
	typ.	90	

$I_C = 10\text{ mA}; V_{CB} = 5\text{ V}$

h_{FE}	>	35	
	typ.	75	

Transition frequency at $f = 35\text{ MHz}$

$I_C = 150\text{ }\mu\text{A}; V_{CB} = 5\text{ V}$

f_T	typ.	140	MHz ←
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$I_C = 1\text{ mA}; V_{CB} = 5\text{ V}$

f_T	typ.	320	MHz ←
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Collector-base capacitance

$V_{CB} = 5\text{ V}; I_E = 0$

C_{cb}	typ.	0,4	pF
----------	------	-----	----

Collector-substrate capacitance

$V_{CS} = 5\text{ V}; I_E = 0$

C_{cs}	typ.	2,8	pF
----------	------	-----	----

Base-emitter voltage difference

between transistors TR1 and TR2 at

$-I_{E1} = -I_{E2} = 150\text{ }\mu\text{A}; V_{CB1} = V_{CB2} = 5\text{ V}$

$ V_{BE1} - V_{BE2} $	typ.	2	mV
	<	5	mV

between transistors TR3 and TR4 at

$-I_{E3} = -I_{E4} = 150\text{ }\mu\text{A}; V_{CB3} = V_{CB4} = 5\text{ V}$

$ V_{BE3} - V_{BE4} $	typ.	2	mV
	<	5	mV

D.C. current gain differences

between transistors TR1 and TR2 at

$-I_{E1} = -I_{E2} = 150\text{ }\mu\text{A}; V_{CB1} = V_{CB2} = 5\text{ V}$

$ h_{FB1} - h_{FB2} $	typ.	0,002	
	<	0,008	

between transistors TR3 and TR4 at

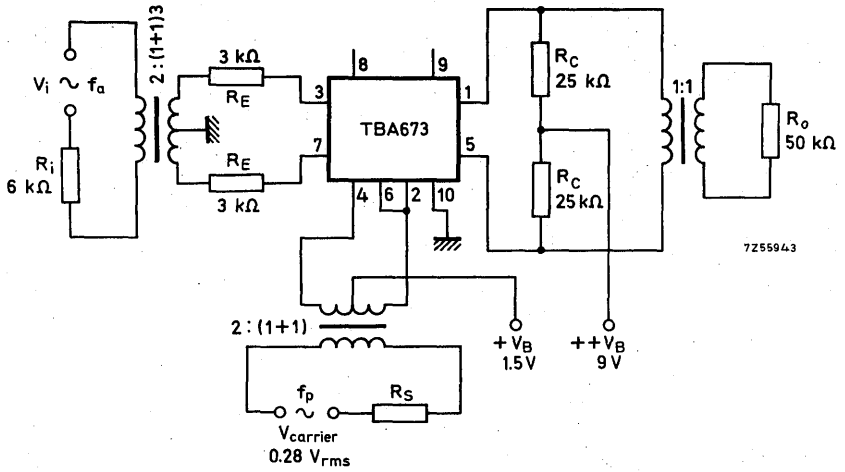
$-I_{E3} = -I_{E4} = 150\text{ }\mu\text{A}; V_{CB3} = V_{CB4} = 5\text{ V}$

$ h_{FB3} - h_{FB4} $	typ.	0,002	
	<	0,008	

TBA673

APPLICATION INFORMATION

Telephony carriers ring modulator



Performance at $T_{amb} = 25^{\circ}C$

Conversion gain at $f_a = 1$ kHz

$V_i = 0,4$ V; $f_p = 34$ kHz

Carrier leakage power in R_o at $f_p = 34$ kHz

G_c typ. $-0,75$ dB

P_{oc} typ. 3 nW

AUDIO AMPLIFIER

The TBA915 is a monolithic integrated a. f. amplifier designed for use in small communication receivers, where low battery drain is of paramount importance. The output power of the device is 500 mW and the zero-signal current is only 2 mA (typ.). The circuit can be squelched to a stand-by current of 0,4 mA.

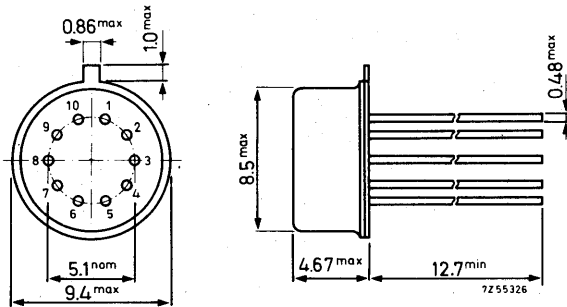
QUICK REFERENCE DATA

Supply voltage	V_P	nom.	12	V
Output power at $R_L = 20 \Omega$	P_O	typ.	500	mW
Input signal for $P_O = 500 \text{ mW}$	V_i	typ.	10	mV
Input impedance	R_i	typ.	9	k Ω
Total current (no signal) (squelched)	I_{tot}	typ.	2	mA
	I_{tot}	typ.	0,4	mA

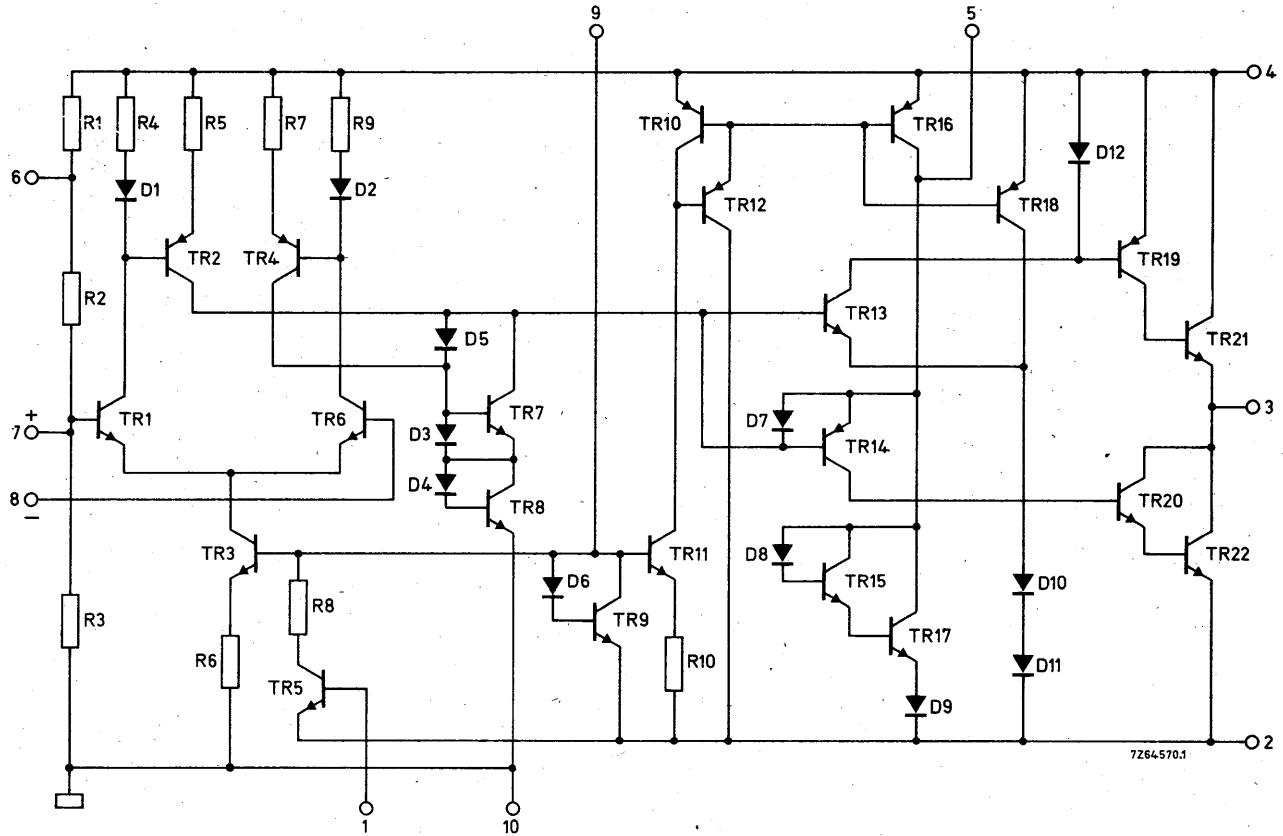
PACKAGE OUTLINE

Dimensions in mm

TO-74 (reduced height)



CIRCUIT DIAGRAM



7284570.1

RATINGS Limiting values in accordance with the Absolute Maximum System (IEC 134).

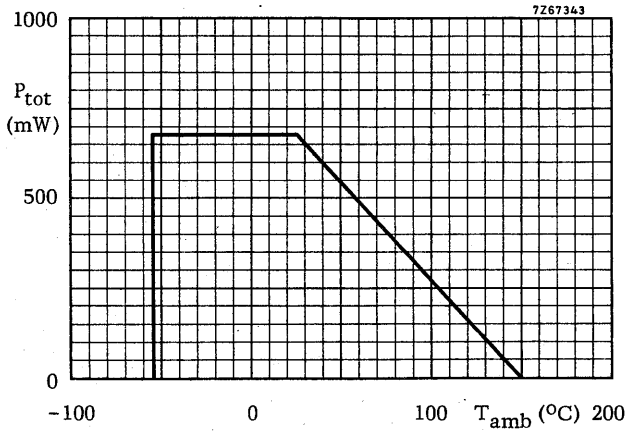
Voltages (pin 2 must be externally connected to pin 10)

Pin No. 4 voltage	V_{4-2}	max.	17	V
Pin No. 8 voltage	$\pm V_{8-7}$	max.	5	V
Pin No. 3 voltage	V_{3-2}	max.	17	V

Currents

Pin No. 4 current	I_4	max.	350	mA
Pin No. 3 current	$\pm I_3$	max.	350	mA
Pin No. 7 current	I_7	max.	0,5	mA
Pin No. 8 current	I_8	max.	0,5	mA
Pin No. 5 current	I_5	max.	5	mA
Pin No. 9 current	I_9	max.	5	mA
Pin No. 1 current	$\left\{ \begin{array}{l} +I_1 \\ -I_1 \end{array} \right.$	max.	1	mA
		max.	10	μA

Total power dissipation



Temperatures

Storage temperature	T_{stg}	-55 to +125	°C
Operating ambient temperature see derating curve above	T_{amb}	-55 to +125	°C

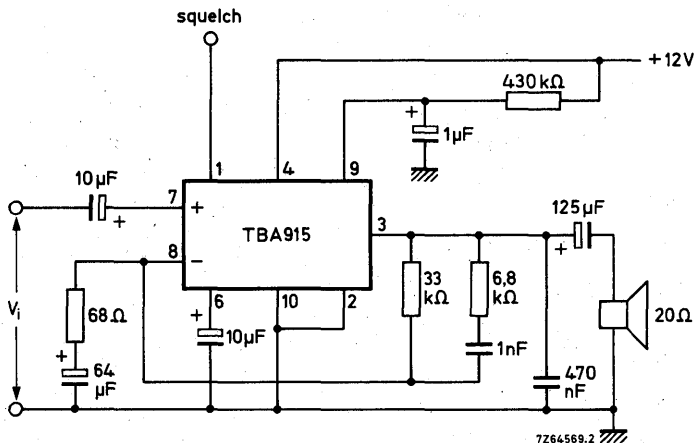
TBA915

CHARACTERISTICS at $T_{amb} = 25\text{ }^{\circ}\text{C}$; $V_P = 12\text{ V}$

Measured in the test circuit below

<u>Output power</u> at $d_{tot} = 5\%$	P_O	typ.	500	mW
<u>Bandwidth</u> (-3 dB)	B	>	6	kHz
<u>Total current</u> (d.c.)				
→ no signal	I_{tot}	typ.	2	mA
		<	3,7	mA
no signal with squelch	I_{tot}	typ.	0,4	mA
with signal at $P_O = 500\text{ mW}$	I_{tot}	typ.	72	mA
<u>Total distortion</u> at $P_O = 500\text{ mW}$	d_{tot}	typ.	2,5	%
		<	5	%
<u>Input signal</u> at $P_O = 500\text{ mW}$	V_i	typ.	10	mV
		<	15	mV
<u>Input impedance</u>	$ Z_i $	typ.	9	k Ω
<u>Signal-to-noise ratio</u>				
related to $P_O = 500\text{ mW}$				
$R_S = 600\text{ }\Omega$; B = 300 Hz to 6 kHz	$\frac{S}{N}$	typ.	72	dB
<u>Bias current</u>	I_Q	>	25	μA

Test circuit



→ SQUELCH REQUIREMENTS at $I_Q = 25\text{ }\mu\text{A}$

Squelch "on"	$\left\{ \begin{array}{l} V_1 \\ I_1 \end{array} \right.$	>	800	mV
		>	10	μA
Squelch "off"	V_1	<	400	mV

AUDIO AMPLIFIER AND PRE-AMPLIFIER

The TCA210 is a monolithic integrated circuit comprising two amplifiers for use in intercoms and other audio systems. The first is a high-gain pre-amplifier with differential input and a class-A output stage which can deliver 2,5 mW into an 800 Ω load. The second is a power amplifier with a class-B output stage capable of delivering 500 mW into a 25 Ω load.

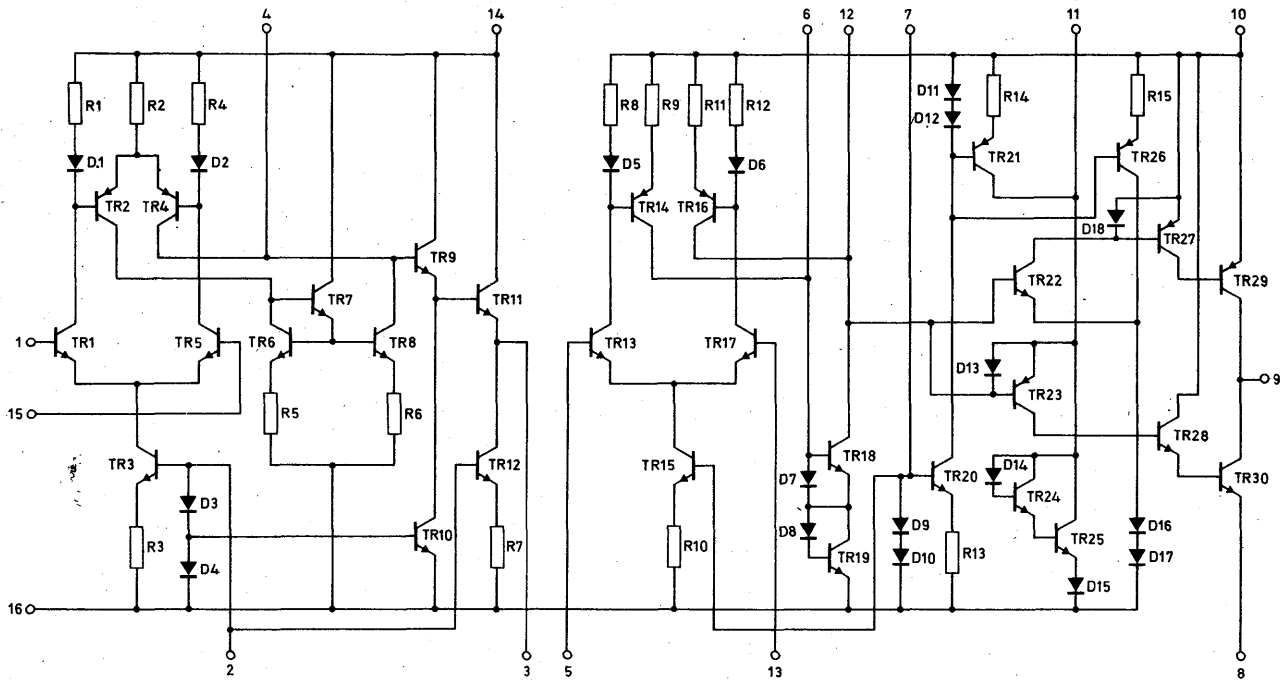
Speech rating: up to 800 mW can be delivered into a 15 Ω load for short periods. When there is no signal, the current consumption is 8 mA (typ.). Squelch provision incorporated in both amplifiers can be used to ensure maximum battery life.

QUICK REFERENCE DATA

Supply voltage	V_p	nom.	12	V
Total current drain	I_{tot}	typ.	8	mA
<u>Pre-amplifier</u>				
Open loop voltage gain	G_v	typ.	10 000	
Output power at $R_L = 800 \Omega$	P_o	typ.	2,5	mW
Noise figure (B = 300 to 4000 Hz) $R_S = 500 \Omega$	F	<	6	dB
Unity-gain bandwidth (compensated)	B	>	10	MHz
<u>Output amplifier</u>				
Open loop voltage gain	G_v	typ.	500	
Output power at $R_L = 25 \Omega$; $d_{tot} = 5\%$	P_o	typ.	500	mW
at $R_L = 15 \Omega$; $d_{tot} = 5\%$	P_o	typ.	800	mW

PACKAGE OUTLINE plastic 16-lead dual in-line (see general section).

CIRCUIT DIAGRAM



7262295.1

RATINGS Limiting values in accordance with the Absolute Maximum System (IEC 134)

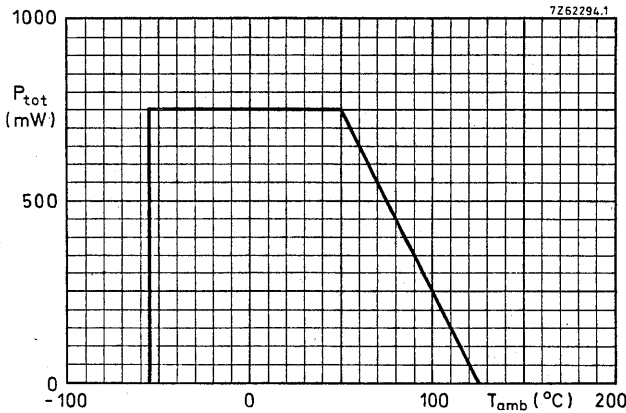
Voltages; pin 8 must be externally connected to pin 16

Pins 3, 9, 10, 14 with respect to pin 16	max.	17 V
Pins 1, 15, 5, 13 with respect to pin 16	max.	17 V ¹⁾
Pin 1 with respect to pin 15	max.	±5 V
Pin 5 with respect to pin 13	max.	±5 V

Currents

Pin 10	max.	550 mA
Pin 9	max.	±550 mA
Pin 8	max.	550 mA
Pin 14	max.	20 mA
Pin 3	max.	±20 mA
Pins 2, 4, 6, 7, 11, 12	max.	5 mA
Pins 1, 15, 5, 13	max.	0,5 mA

Total power dissipation



Temperatures

Storage temperature	T_{stg}	-55 to +125 °C
Operating ambient temperature (see also graph)	T_{amb}	-55 to +125 °C

¹⁾ For a supply voltage less than 14 V, the maximum input voltage is equal to the supply voltage.

CHARACTERISTICS at $T_{amb} = 25^{\circ}\text{C}$; $V_P = 12\text{ V}$

Input bias current; pins 1 and 15	$\frac{1}{2} (I_1 + I_{15})$	typ.	2,5	μA
Total current; pin 14	I_{14}	typ.	4	mA
Bias current; pin 2	I_2	typ.	200	μA
Input current; pins 5 and 13	$\frac{1}{2} (I_5 + I_{13})$	typ.	2	μA
Total current; d. c. ; no signal; pin 10	I_{10}	typ.	4	mA
Bias current; pin 7	I_7	typ.	150	μA

Pre-amplifier

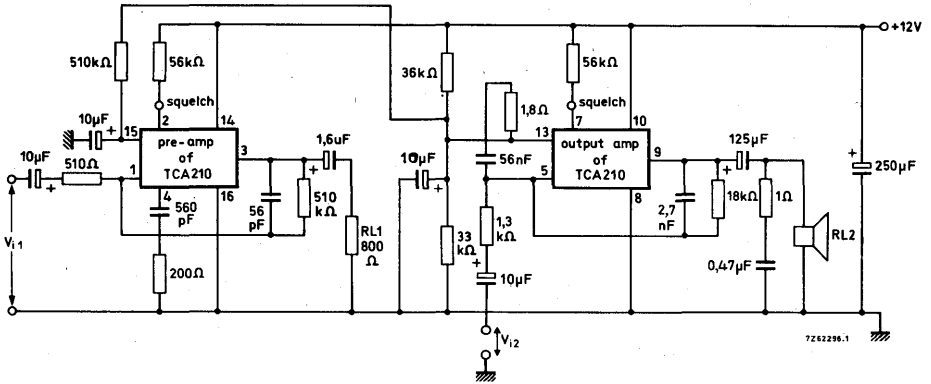
Open-loop voltage gain	G_V	>	65	dB
		typ.	80	dB
Noise figure at $R_S = 5\text{ k}\Omega$; $B = 300$ to 4000 Hz	F	typ.	4	dB
Current in the output transistor	I_C	>	2,5	mA
Unity gain bandwidth with 6 dB/oct compensation	B	typ.	10	MHz

Output amplifier

Open loop voltage gain	G_V	typ.	54	dB
Total distortion at $f = 1\text{ kHz}$; $P_O = 50\text{ mW}$; $R_L = 25\Omega$	d_{tot}	typ.	1,5	%
Maximum output power at $d_{tot} = 5\%$; $R_L = 25\Omega$	P_O	typ.	450	mW

APPLICATION INFORMATION

Pre-amplifier and output amplifier for intercom systems



Performance $T_{amb} = 25\text{ }^{\circ}\text{C}$; $V_P = 12\text{ V}$

Pre-amplifier

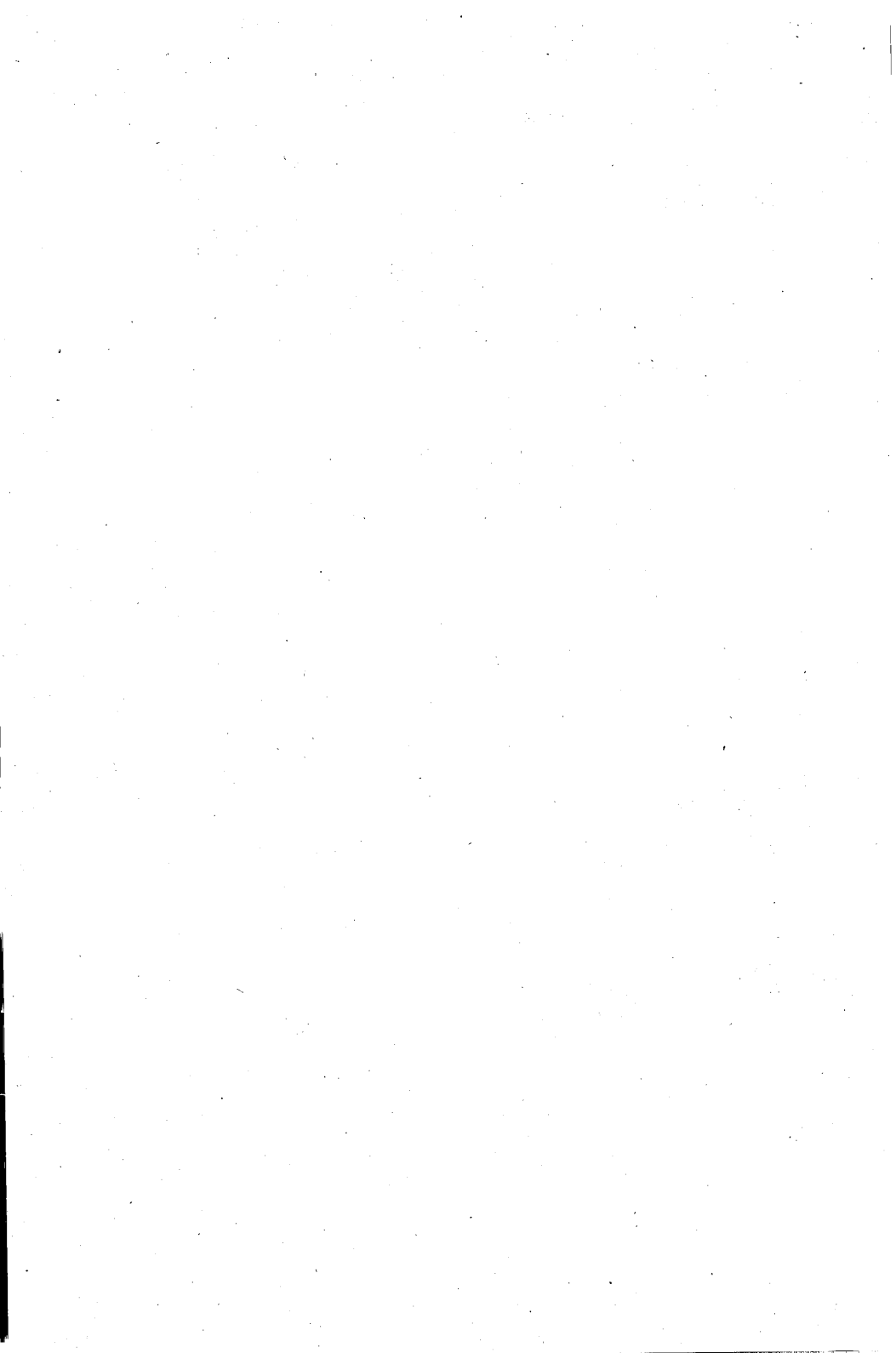
Output power at $R_{L1} = 800\text{ }\Omega$
 Bandwidth (-3 dB)
 Total current
 Input signal
 Input impedance

P_O	typ.	2,5	mW
B	typ.	4	kHz
I_{14}	typ.	4,0	mA
V_{i1}	typ.	1,5	mV
$ Z_i $	typ.	500	Ω

Output amplifier

Output power at $R_{L2} = 25\text{ }\Omega$; $d_{tot} = 5\%$
 at $R_{L2} = 15\text{ }\Omega$; $d_{tot} = 5\%$
 Bandwidth (-3 dB)
 Total distortion at $P_O = 50\text{ mW}$
 Input signal
 Input impedance
 Total current (d. c. ; no signal; pin 10)

P_O	typ.	500	mW
P_O	typ.	800	mW
B	typ.	4	kHz
d_{tot}	typ.	1,5	%
V_{i2}	typ.	260	mV
$ Z_i $	typ.	1,3	$k\Omega$
I_{10}	typ.	4	mA



DOUBLE BALANCED MODULATOR/DEMODULATOR

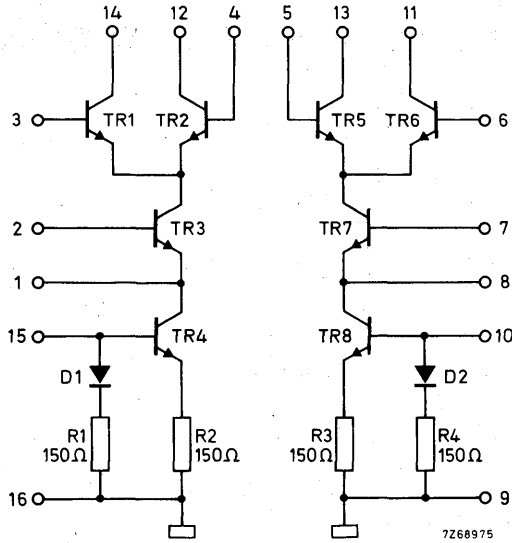
The TCA240 is a monolithic integrated circuit used for general purpose applications, such as:

- modulator
- mixer
- switch/chopper
- a.m. synchronous demodulator
- f.m. quadrature demodulator
- phase comparator
- differential amplifier

The circuit is arranged to offer very flexible circuit design possibilities. The excellent matching and temperature tracking of the transistors in the circuit allows the use of circuit techniques which are not available when using discrete devices.

PACKAGE OUTLINE plastic 16-lead dual in-line (see general section).

CIRCUIT DIAGRAM



Note

Pins 16 and 9 are connected to the substrate.
 When both long tailed pairs are used connect pin 9 with pin 16 externally.

RATINGS Limiting values in accordance with the Absolute Maximum System (IEC 134)

Voltages (each transistor)

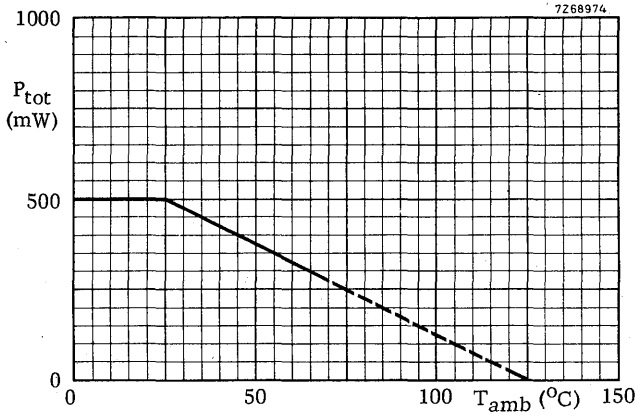
Collector-substrate voltage (open base and emitter)	V_{CSO}	max.	16	V
Collector-base voltage (open emitter)	V_{CBO}	max.	16	V
Collector-emitter voltage (open base)	V_{CEO}	max.	12	V
Emitter-base voltage (open collector)	V_{EBO}	max.	5	V

Currents (each transistor)

Emitter current	I_E	max.	10	mA
Base current	I_B	max.	10	mA

RATINGS (continued)

Total power dissipation (mounted on a printed-wiring board)



Temperatures

Storage temperature

T_{stg} -55 to +125 $^{\circ}C$

Operating ambient temperature

T_{amb} -20 to +70 $^{\circ}C$

Crystal temperature

T_c max. 125 $^{\circ}C$

THERMAL RESISTANCE

From crystal to ambient

$R_{th\ j-a}$ = 200 $^{\circ}C/W$



CHARACTERISTICS at $V_{11-9} = V_{13-9} = V_{12-16} = V_{14-16} = 12 \text{ V}$;
 $V_{3-16} = V_{4-16} = V_{5-9} = V_{6-9} = 6 \text{ V}$; $V_{2-16} = V_{7-9} = 4 \text{ V}$;
 $T_{\text{amb}} = 25 \text{ }^\circ\text{C}$; unless otherwise specified

Collector current difference

between transistors TR4 and TR8
 $I_{10} = I_{15} = 1.5 \text{ mA}$

$$|I_{C4} - I_{C8}| < 0.07 \text{ mA}$$

Base-emitter voltage

of transistors TR3 and TR7
 $I_1 = I_8 = -1 \text{ mA}$

$$V_{BE3}; V_{BE7} \quad 690 \text{ to } 770 \text{ mV}$$

Base-emitter voltage difference

between transistors TR1 and TR2
 $V_{12-16} = V_{14-16} = 10 \text{ V}$; $I_{15} = 1.5 \text{ mA}$

$$|V_{BE1} - V_{BE2}| < 2.5 \text{ mV}$$

between transistors TR5 and TR6

$$|V_{BE5} - V_{BE6}| < 2.5 \text{ mV}$$

$V_{11-9} = V_{13-9} = 10 \text{ V}$; $I_{10} = 1.5 \text{ mA}$

between the parallel connection of
 TR1, TR5 and TR2, TR6

$V_{11-9} = V_{13-9} = V_{12-16} = V_{14-16} = 8 \text{ V}$
 $I_1 + I_8 = -3 \text{ mA}$

$$|V_{BE1;5} - V_{BE2;6}| < 2.1 \text{ mV}$$

D. C. current gain

of transistors TR3 and TR7
 $I_1 + I_8 = -3 \text{ mA}$

$$h_{FE3}, h_{FE7} \quad 23 \text{ to } 190$$

D. C. current gain ratio

of transistors TR3 and TR7
 $I_1 + I_8 = -3 \text{ mA}$

$$\left| \frac{h_{FE3} - h_{FE7}}{h_{FE3} + h_{FE7}} \right| \times 200 \quad 0 \text{ to } 60 \%$$

D. C. current gain

of transistors TR1, TR2, TR5 and TR6
 $I_E = 750 \text{ } \mu\text{A}$

$$h_{FE1}, h_{FE2}, h_{FE5}, h_{FE6} \quad 23 \text{ to } 190$$

D. C. current gain ratio

of transistors TR1 and TR2
 $I_1 = -1.5 \text{ mA}$

$$\left| \frac{h_{FE1} - h_{FE2}}{h_{FE1} + h_{FE2}} \right| \times 200 \quad 0 \text{ to } 60 \%$$

of transistors TR5 and TR6
 $I_8 = -1.5 \text{ mA}$

$$\left| \frac{h_{FE5} - h_{FE6}}{h_{FE5} + h_{FE6}} \right| \times 200 \quad 0 \text{ to } 60 \%$$

CHARACTERISTICS (continued)

D. C. current gain

of the parallel connection of TR1 and TR6 at $I_1 + I_8 = -3$ mA	h_{FE1}, h_{FE6}	23 to 190
of the parallel connection of TR2 and TR5 at $I_1 + I_8 = -3$ mA	h_{FE2}, h_{FE5}	23 to 190

D. C. current gain ratio

of the parallel connection of TR1, TR6 and TR2, TR5 $I_1 + I_8 = -3$ mA	$\left \frac{h_{FE1;6} - h_{FE2;5}}{h_{FE1;6} + h_{FE2;5}} \right \times 200$	0 to 60 %
---	---	-----------

DYNAMIC DESIGN DATA

Noise figure at $f = 100$ MHz

$I_C = 1$ mA; $V_{CB} = 5$ V; $G_S = 3,7$ mA/V; $B_S = -2,5$ mA/V	F	<	3,7	dB
$I_E = 2,5$ mA; $V_{CB} = 5$ V; $G_S = 6,5$ mA/V; $B_S = -2,5$ mA/V	F	<	4,2	dB

y parameters

$V_{CE} = 5$ V; $f = 100$ MHz

			$I_E = 1$ mA	$I_E = 5$ mA
Input conductance	g_{ie}	typ.	4,4	13,6 mA/V
Input susceptance	b_{ie}	typ.	7,6	9 mA/V
Feedback admittance	$ y_{re} $	typ.	0,4	0,4 mA/V
Phase angle of feedback admittance	$-\varphi_{re}$	typ.	100°	100°
Transfer admittance	$ y_{fe} $	typ.	22	55 mA/V
Phase angle of feedback admittance	$-\varphi_{fe}$	typ.	45°	96°
Output conductance	g_{oe}	typ.	0,4	0,5 mA/V
Output susceptance	b_{oe}	typ.	1,8	1,8 mA/V

Frequency response (see circuit on page 6)

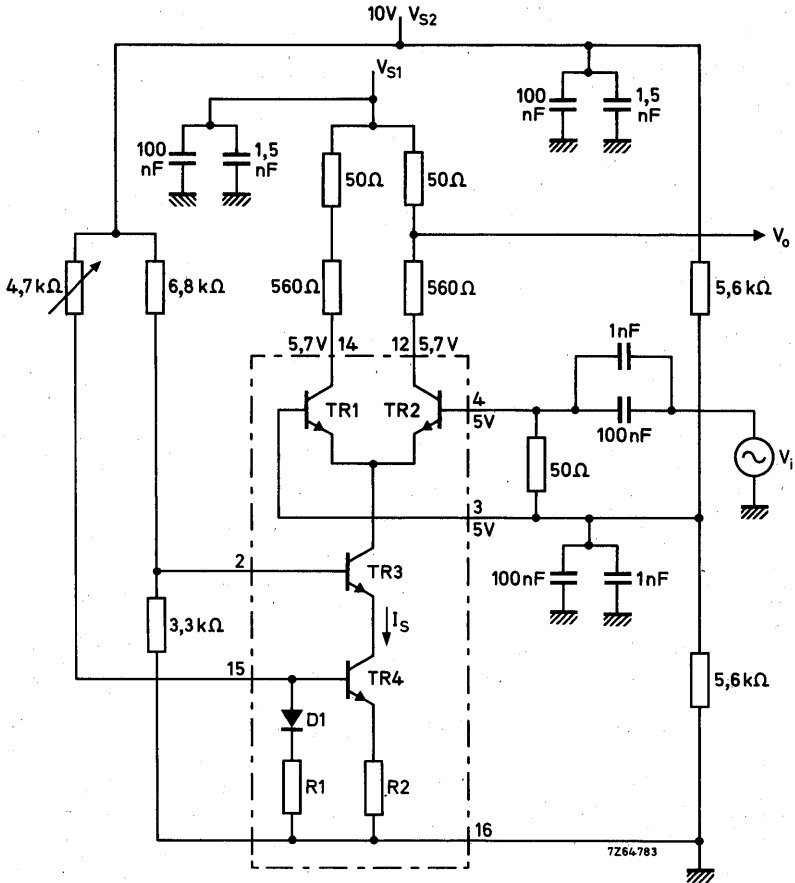
$I_S = 5$ mA; $R_C = 600 \Omega$; $f = -3$ dB	f	typ.	34	MHz
--	---	------	----	-----

Switching times (see circuit on page 7)

	$I_S =$	0,5	1	2	4	mA
Rise time	t_r	typ.	2,9	2,7	2,7	3,1 ns
Fall time	t_f	typ.	1,4	1,3	1,6	2,3 ns
Rise propagation delay time 1)	t_{pdr}	typ.	1,1	1,2	1,4	1,7 ns
Fall propagation delay time 1)	t_{pdf}	typ.	1,1	1,2	1,4	1,7 ns

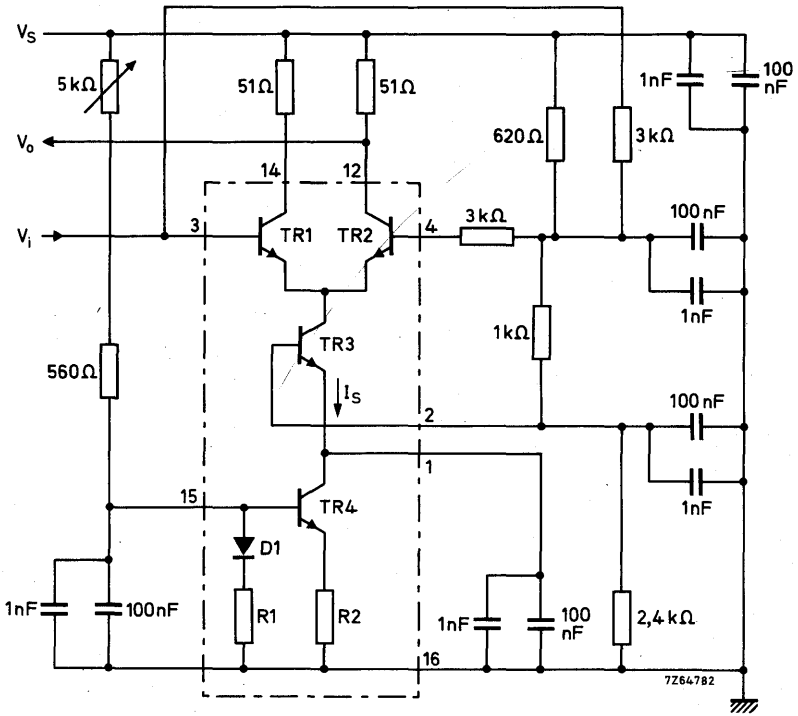
1) Reference level 50 %.

DYNAMIC DESIGN DATA (continued)

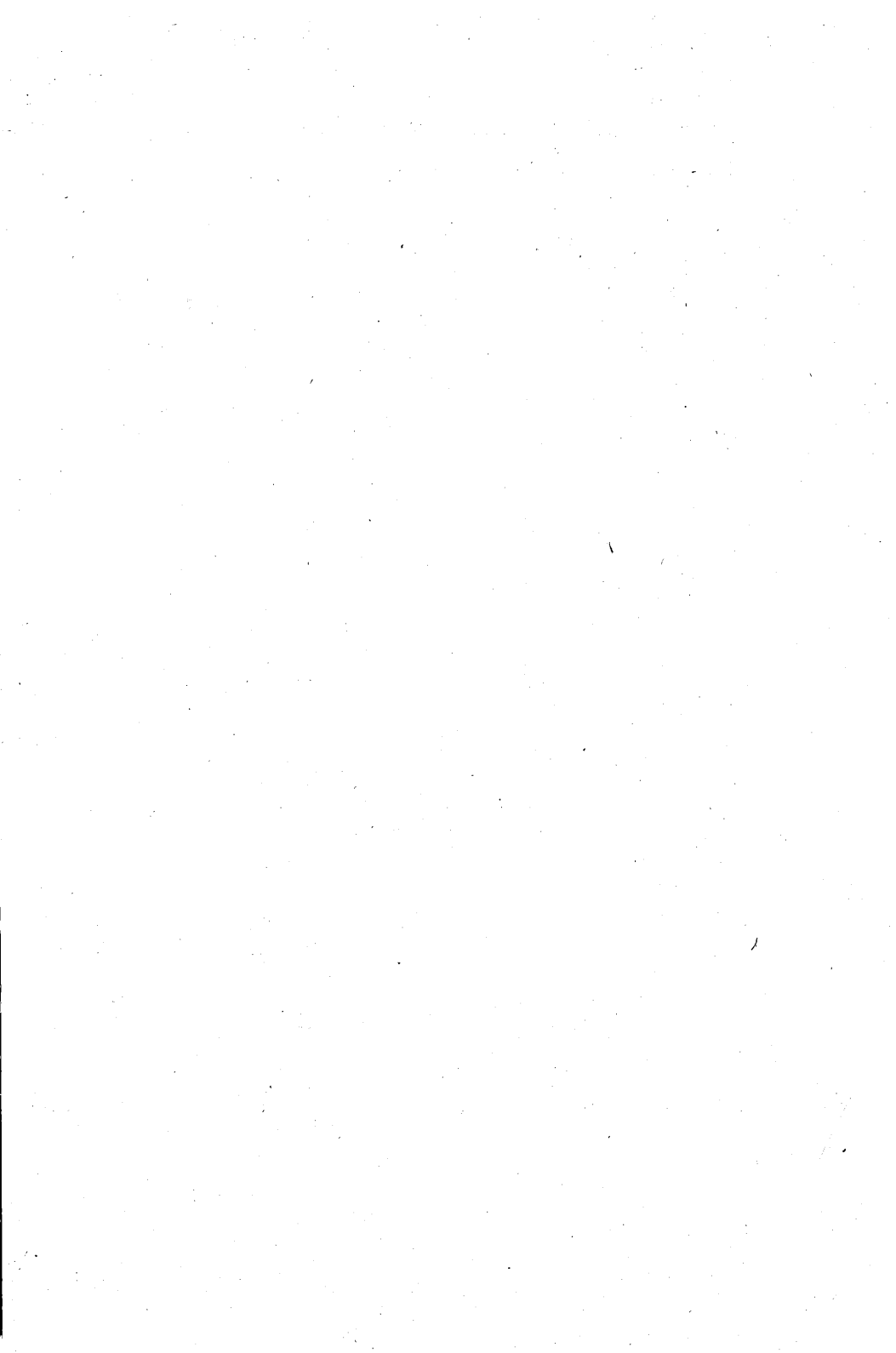


Circuit for measuring the frequency response

DYNAMIC DESIGN DATA (continued)



Circuit for measuring t_r , t_f , t_{pdr} and t_{pdf}



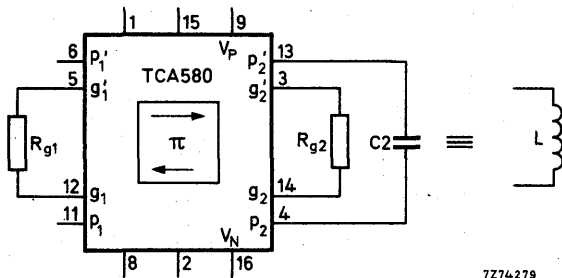
INTEGRATED GYRATOR CIRCUIT

The TCA580 is a monolithic integrated gyrator circuit with floating inputs. It is intended mainly to replace the coils in telephony low-pass filters. The simulated inductance consists of the IC, two resistors R_{g1} and R_{g2} and a capacitor $C2$. With this configuration, inductances of up to $1 \text{ MH} \pm 2\%$ can be achieved.

QUICK REFERENCE DATA

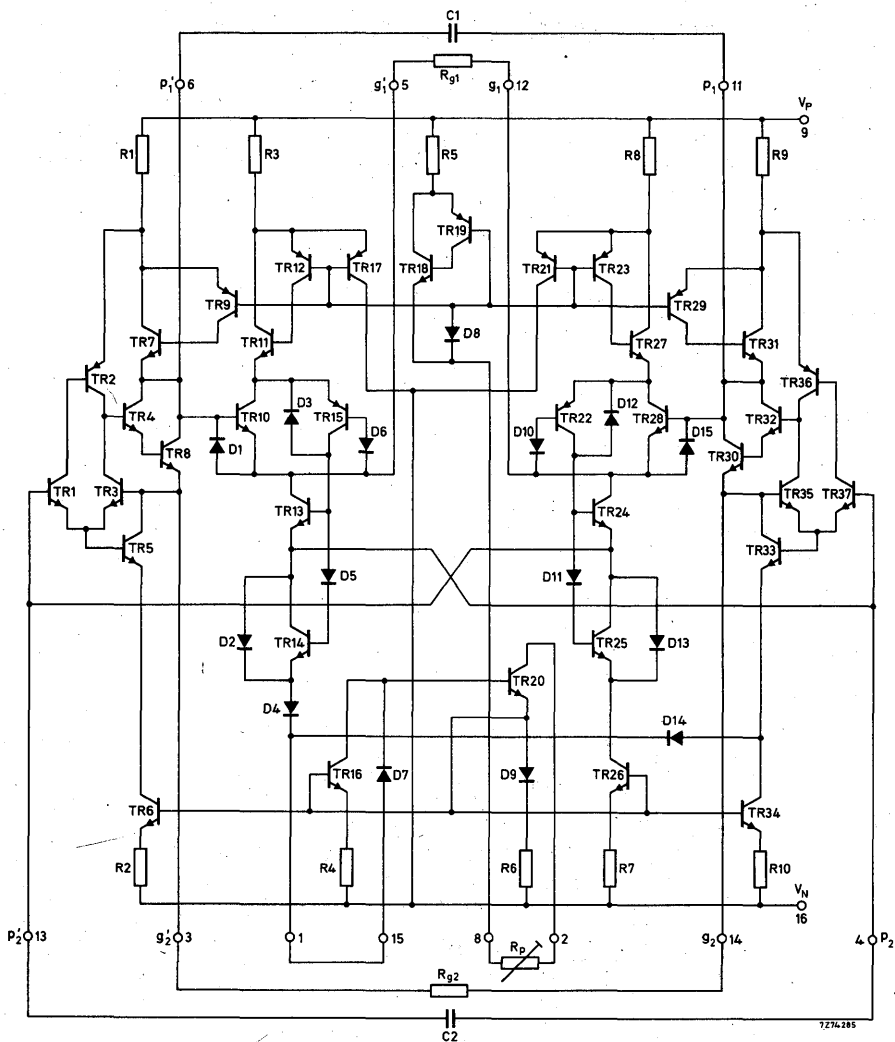
Supply voltages	V_P	typ.	4,4	V
	V_N	typ.	7,6	V
Supply current	I_P	typ.	0,8	mA
Frequency range	f		d. c. to 10	kHz
Quality factor at $f = 200 \text{ Hz}$	Q		500 to 5000	
Efficiency	η	typ.	1,4	%
Operating ambient temperature	T_{amb}		-20 to +70	$^{\circ}\text{C}$

BASIC CIRCUIT

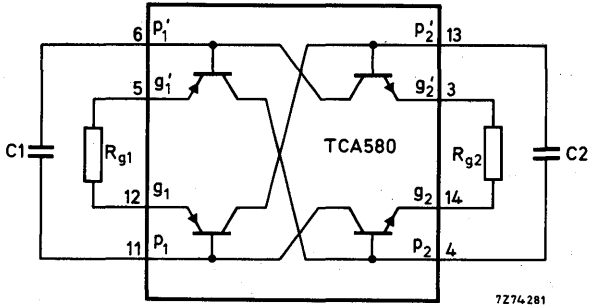


PACKAGE OUTLINE plastic 16-lead dual in-line (see general section).

CIRCUIT DIAGRAM



SIMPLIFIED CIRCUIT DIAGRAM



RATINGS Limiting values in accordance with the Absolute Maximum System (IEC 134)

Voltages

Supply voltages	V_p to V_N	max.	14	V
Common mode input voltage	$\pm V_{IC}$	max.	14	V
Differential input voltage	$\pm V_{ID}$	max.	14	V

Temperatures

Storage temperature	T_{stg}	-55 to +125	°C
Operating ambient temperature	T_{amb}	-20 to +70	°C

CHARACTERISTICS at $V_P = 4,4 \text{ V}$; $V_N = 7,6 \text{ V}$; $T_{\text{amb}} = 25 \text{ }^\circ\text{C}$

Supply current (adjust with $R_P = 50 \text{ k}\Omega$)

I_P typ. 0,8 mA

Efficiency: $\frac{\text{signal power}}{\text{supply power}}$

η typ. 1,4 %

Tolerance of inductance

$\Delta L \approx \pm 0,2 \text{ %}$

Quality factor at $f = 200 \text{ Hz}$;

$R_{g1} = R_{g2} = 10 \text{ k}\Omega$; pin 11 earthed

Q 500 to 5000

Output voltage (peak value)

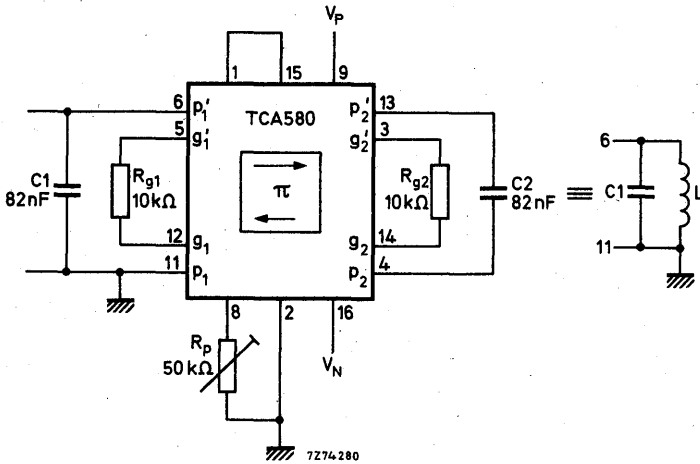
$V_{om} < 1,6 \text{ V}$

Input offset voltage

$V_{io} < 25 \text{ mV}$

Input offset current

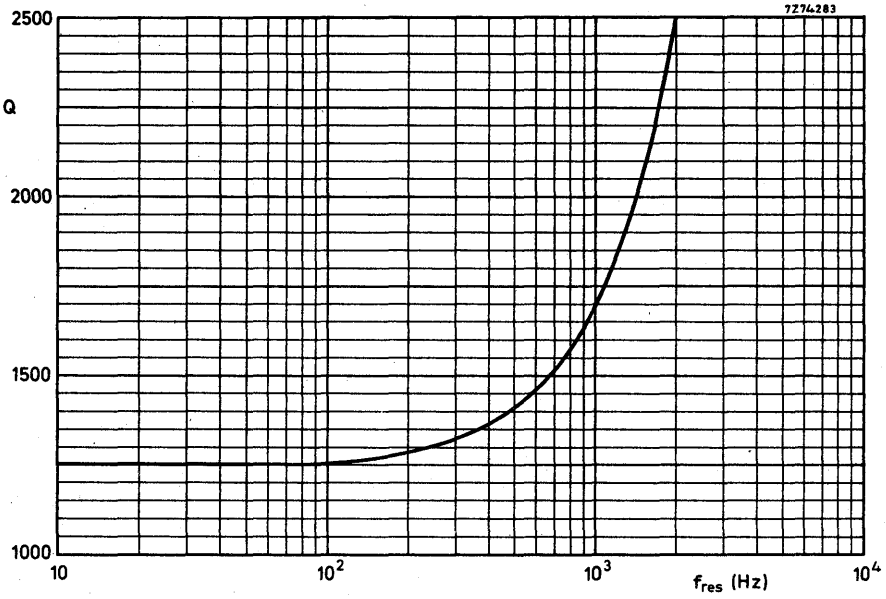
$I_{io} < 9 \text{ }\mu\text{A}$



The values for L and f_{res} in the circuit above are:

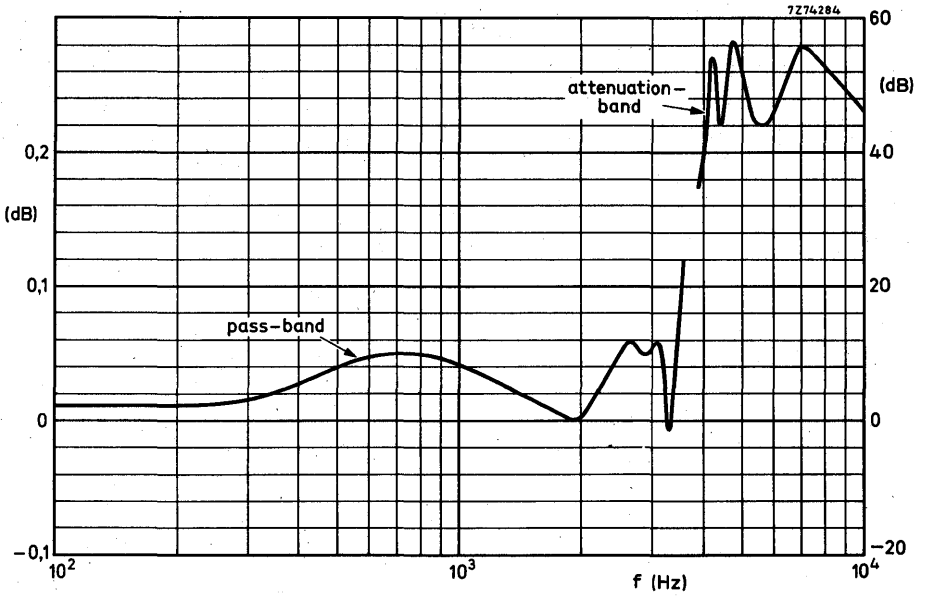
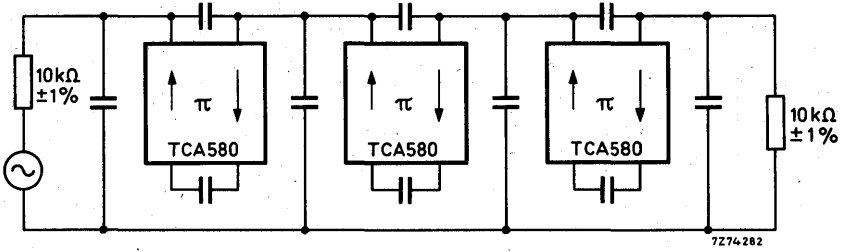
$$L = R_{g1} R_{g2} C_2 = 8,2 \text{ H}$$

$$f_{res} = \frac{1}{2\pi \sqrt{R_{g1} R_{g2} C_1 C_2}} = 194 \text{ Hz}$$



Quality factor as a function of frequency at pin 11 connected to earth.

Circuit and response of a low-pass filter with three TCA580 gyrators.



I.F. LIMITER-AMPLIFIER with very low current consumption

The TCA770 is a limiter-amplifier with a balanced f. m. detector and an audio pre-amplifier intended for a frequency range of 100 kHz to 500 kHz with narrow band f. m. The circuit is especially intended for use in portophone sets, where low current consumption and high sensitivity are important.

QUICK REFERENCE DATA

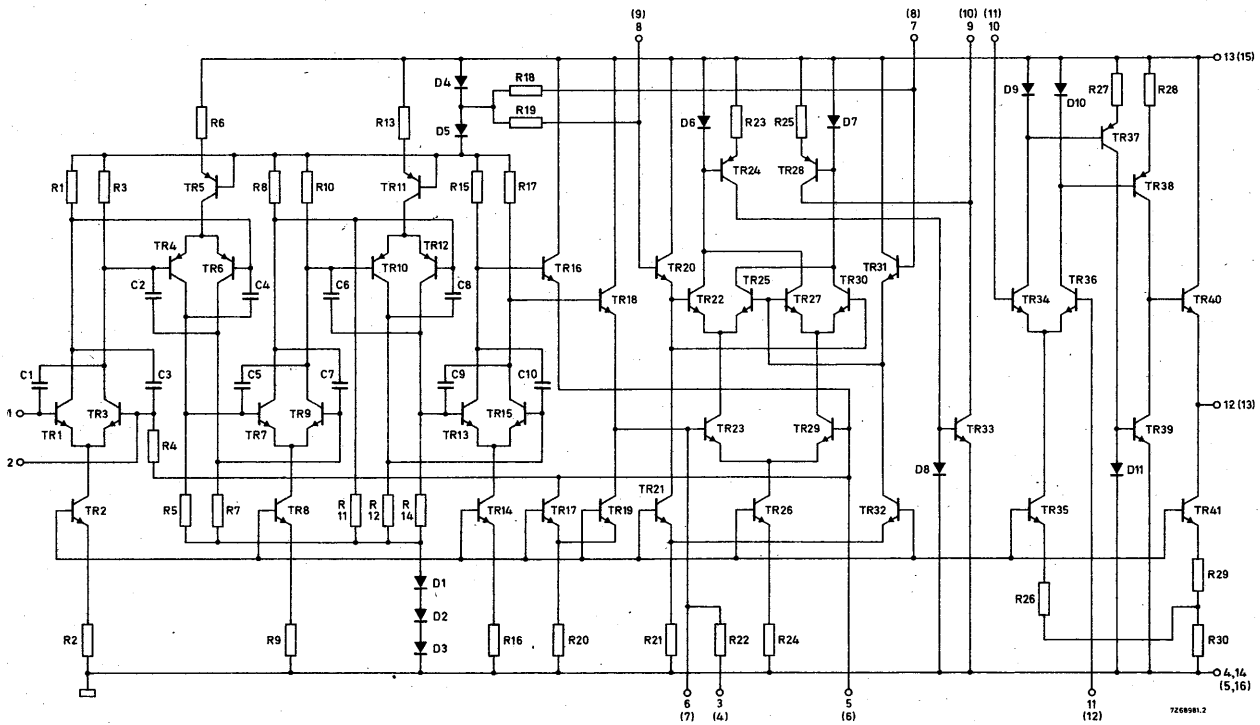
Supply voltage	V_p	typ.	7,5	V
Ambient temperature	T_{amb}	typ.	25	°C
Frequency	f_o	typ.	100	kHz

Total current consumption	I_{tot}	typ.	450	μA
Input limiting voltage (-3 dB)	$V_i \text{ lim}$	typ.	30	μV
A. F. output voltage at $\Delta f = \pm 3,5$ kHz (r. m. s. value)	$V_o(\text{rms})$	typ.	90	mV
A. M. rejection at $\Delta f = \pm 3,5$ kHz; $m = 0,3$; $f_m = 1$ kHz $V_i = 1$ mV	α	typ.	50	dB
Open loop voltage gain	G_V	typ.	600	

PACKAGE OUTLINES (see general section).

TCA770 : SOT-43 (plastic; 14-lead).
TCA770A : plastic 16-lead dual in-line.
TCA770D : SO-14 (plastic 14-lead flat pack).

CIRCUIT DIAGRAM (pin numbers between brackets for TCA770A only).



RATINGS Limiting values in accordance with the Absolute Maximum System (IEC 134)

Supply voltage (pin 13 or 15)	V_P	max.	15	V
Storage temperature	T_{stg}		-55 to +125	°C
Operating ambient temperature	T_{amb}		-30 to +70	°C

CHARACTERISTICS at $V_P = 7,5$ V; $T_{amb} = 25$ °C; $f_o = 100$ kHz; measured in circuit on page 4. The pin numbers between brackets for TCA770A only.

Total current consumption	I_{tot}	typ.	450	µA
			300 to 600	µA
Supply voltage range	V_{13-14}		5 to 10	V
Power dissipation	P_{tot}	typ.	3,4	mW
			2,5 to 4,5	mW

I.F. limiter-amplifier and f.m. detector

Input limiting voltage (-3 dB)	$V_{i\lim}$	typ.	30	µV ¹⁾
--------------------------------	-------------	------	----	------------------

A.M. rejection

f. m. signal: $\Delta f = \pm 3,5$ kHz; $f_m = 70$ Hz

a. m. signal: $m = 0,3$; $f_m = 1$ kHz

at $V_i = 300$ µV

at $V_i = 1$ mV

at $V_i = 10$ mV

α	typ.	40	dB
α	typ.	50	dB
α	typ.	60	dB

Input impedance; pin 1	$ Z_i $	>	10	kΩ
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A.F. output voltage; pin 9 (10)

load = 100 kΩ; $\Delta f = \pm 3,5$ kHz;

$f_m = 1$ kHz; $V_i = 10$ mV (r. m. s. value)

$V_{o(rms)}$	typ.	90	mV
--------------	------	----	----

Influence of ambient temperature on output voltage		typ.	6,2	dB/100 °C ²⁾
--	--	------	-----	-------------------------

Distortion at $\Delta f = \pm 5$ kHz; $f_m = 1$ kHz		typ.	2	%
		<	3	%

A.F. amplifier ³⁾

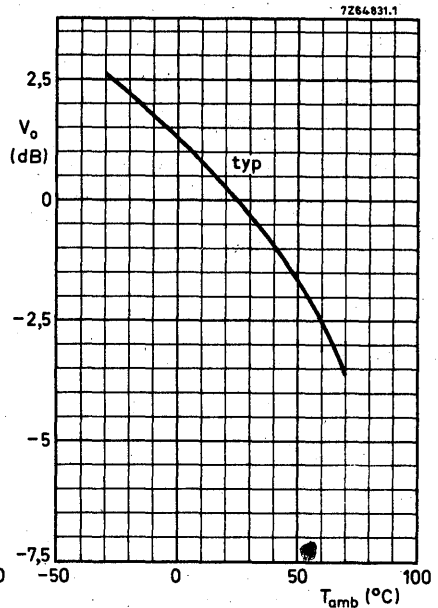
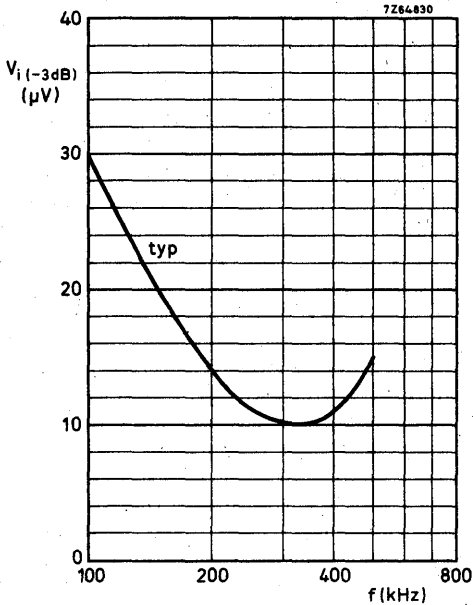
Open loop voltage gain ($R_{load} = \infty$)	G_V	typ.	600	
Input bias current; pins 10 and 11 (11 and 12)	I_i	typ.	270	nA
Current of current sink in output stage	I_C	typ.	56	µA

¹⁾ See also left-hand graph on page 4.

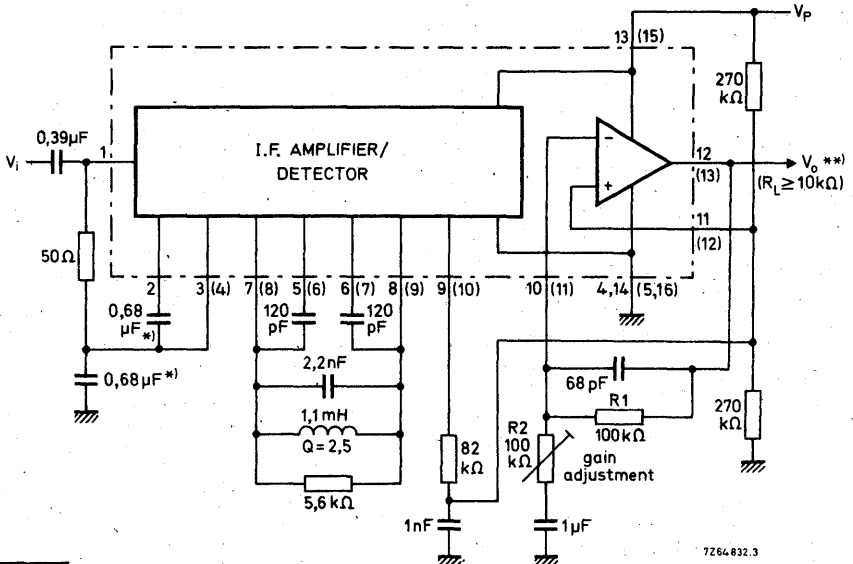
²⁾ See also right-hand graph on page 4.

³⁾ If the a. f. amplifier is not used, pin 11 (12) must be connected to V_P .

TCA770
TCA770A
TCA770D



TEST CIRCUIT (pin numbers between brackets for TCA770A only).



*) The input limiting voltage depends on capacitor values. (Suggested type: solid aluminium capacitor, 2222 122 56687; 0,68 μF /25 V).

***) $V_o = (R_1 + R_2)/R_2 \times V_{11-4}$.

MICROPHONE AMPLIFIER

The TCA980 is a monolithic integrated microphone amplifier. It is primarily intended for use with low-impedance microphones in telephone systems.

The output of the amplifier is 22 mV/ μ bar when used with a microphone having an impedance of 200 Ω and a sensitivity of 100 μ V/ μ bar.

A capsule assembly containing the TCA980, a low-impedance microphone and a 0,22 μ F capacitor can directly replace a carbon microphone.

The d. c. supply to the device may be of either polarity.

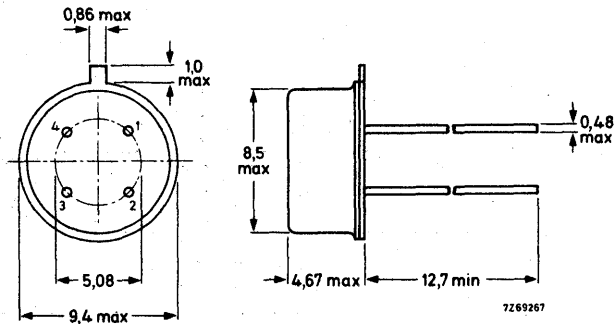
QUICK REFERENCE DATA

Supply current	$\pm I_2$	10 to 100	mA
Supply voltage drop at $\pm I_2 = 10$ mA	$\pm V_{1-2}$	typ. 4,5	V
Voltage gain at $\pm I_2 = 30$ mA at $\pm I_2 = 10$ mA	G_V	typ. 220	
	G_V	< 260	
Output impedance at $\pm I_2 = 30$ mA	$ Z_0 $	typ. 150	Ω

PACKAGE OUTLINE

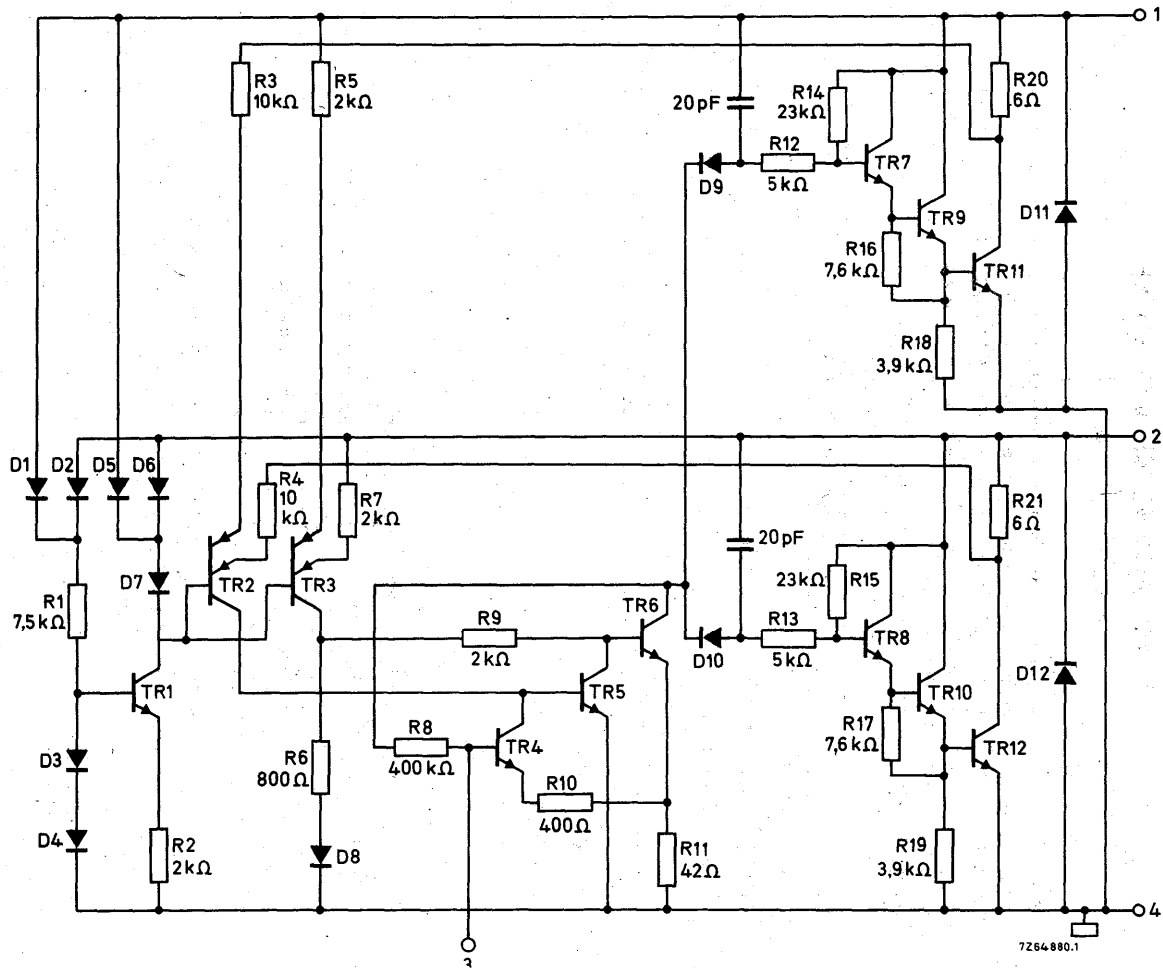
Dimensions in mm

TO-12 (reduced height)



CIRCUIT DIAGRAM

TCA980



RATINGS Limiting values in accordance with the Absolute Maximum System (IEC 134)

Currents

Supply current (d. c.)	$\pm I_2$	max. 100 mA
Non-repetitive peak current	100 mA (a. c.)	superimposed on 100 mA (d. c.)
Current into pin 3 (d. c.)	$+I_3$	max. 100 μ A

Power dissipation

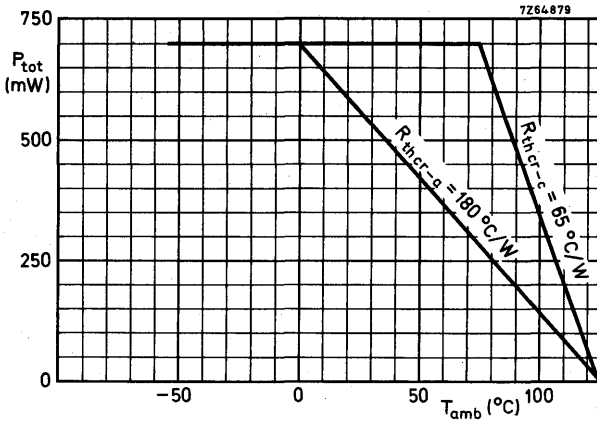
Total power dissipation See derating curve below

Temperatures

Storage temperature	T_{stg}	-55 to +125 $^{\circ}$ C
Ambient temperature	T_{amb}	-55 to +125 $^{\circ}$ C
Crystal temperature	T_{cr}	max. 125 $^{\circ}$ C

THERMAL RESISTANCE

From crystal to case	$R_{th\ cr-c}$	=	65 $^{\circ}$ C/W
From crystal to ambient	$R_{th\ cr-a}$	=	180 $^{\circ}$ C/W



TCA980

D.C. CHARACTERISTICS ¹⁾ at $T_{case} = 25\text{ }^{\circ}\text{C}$; measured in circuit below)

Supply voltage drop

$\pm I_2 = 10\text{ mA}$	$\pm V_{1-2}$	3,50 to 5,75	V
$\pm I_2 = 30\text{ mA}$	$\pm V_{1-2}$	4,45 to 6,75	V
$\pm I_2 = 60\text{ mA}$	$\pm V_{1-2}$	5,00 to 7,80	V

A.C. CHARACTERISTICS

Voltage gain (measured in circuit below)

$f = 2\text{ kHz}; \pm I_2 = 30\text{ mA}$	G_V	typ. 220 190 to 260
$f = 2\text{ kHz}; \pm I_2 = 10\text{ mA}$	G_V	160 to 260

Change of voltage gain

when changing T_{amb} from -20 to $+55\text{ }^{\circ}\text{C}$	ΔG_V	< 10 %
---	--------------	--------

Gain reduction

between $f = 0,3$ and 2 kHz	ΔG_V	typ. 1 dB < 3 dB
--------------------------------------	--------------	---------------------

Output voltage at $f = 2\text{ kHz}; d_{tot} < 5\%$ (r. m. s. value)

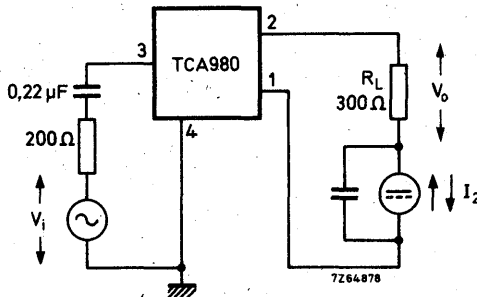
$\pm I_2 = 10\text{ mA}$	$V_{o(rms)}$	> 1	V
$\pm I_2 = 30\text{ mA}$	$V_{o(rms)}$	> 1,35	V
$\pm I_2 = 60\text{ mA}$	$V_{o(rms)}$	> 1	V
	$V_{o(rms)}$	typ. 1,5	V

Noise output voltage

$B = 0,3\text{ kHz to }4\text{ kHz}$ (r. m. s. value)	$V_{n(rms)}$	< 1,3	mV
---	--------------	-------	----

Output impedance

$f = 2\text{ kHz}; \pm I_2 = 30\text{ mA}$	$ Z_o $	typ. 150	Ω
--	---------	----------	----------



BUCKET BRIGADE DELAY LINE FOR ANALOGUE SIGNALS

The TDA 1022 is a MOS monolithic integrated circuit, generally intended to delay analogue signals (e. g. delay time = $512/2 f_{\phi}$).

It can be used with clock frequencies in the range 5 kHz to 500 kHz.

The device contains 512 stages, so the input signal can be delayed from 51,2 ms to 0,512 ms.

Applications in which the device can be used:

- variation of fixed delays of analogue signals, vox control, equalizing speech delay in public address systems;
- in electronic organs and other musical instruments for vibrato and chorus effects;
- reverberation effects;
- variable compression and expansion of speech in tape-recorders;
- in communication systems for speech scrambling and time scale conversion.

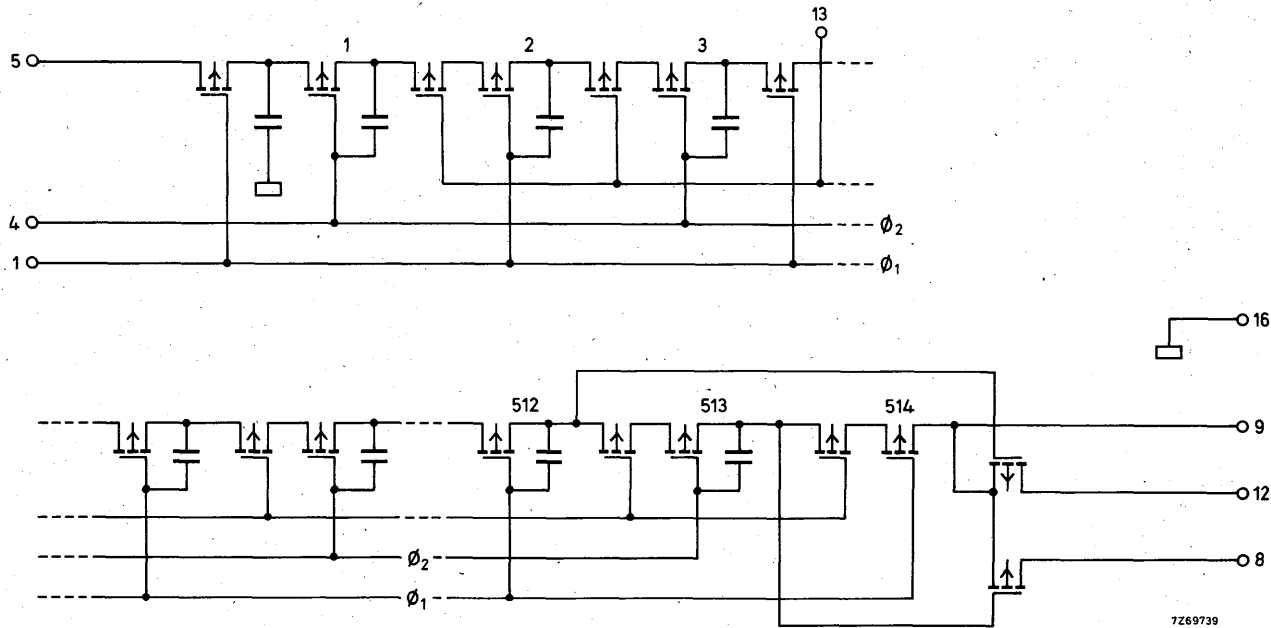
QUICK REFERENCE DATA

Supply voltage (pin 9)	V_{DD}	nom.	-15 V
Clock frequency	f_{ϕ}		5 to 500 kHz
Number of stages			512
Signal delay range	t_d		51,2 to 0,512 ms
Signal frequency range	f_s		0 (d. c.) to 45 kHz
Input voltage at pin 5 (peak-to-peak value)	$V_{5-16(p-p)}$	typ.	7 V
Line attenuation		typ.	4 dB ¹⁾

PACKAGE OUTLINE plastic 16-lead dual in-line (see general section).

¹⁾ See note 1 on page 4.

CIRCUIT DIAGRAM



7269739

PINNING

- | | | | |
|--------------------------------|------------------|---------------------------------|----------------------------------|
| 1. Clock input 1 (V_{CL1}) | 5. Signal input | 9. Negative supply (V_{DD}) | 13. Tetrode gate (V_{13-16}) |
| 2. Not connected | 6. Not connected | 10. Not connected | 14. Not connected |
| 3. Not connected | 7. Not connected | 11. Not connected | 15. Not connected |
| 4. Clock input 2 (V_{CL2}) | 8. Output 513 | 12. Output 512 | 16. Ground (substrate) |

RATINGS Limiting values in accordance with the Absolute Maximum System (IEC 134)

Voltages (see note)

Supply voltage	V_{9-16}	0 to -20 V
Clock input, data input, output voltage and V_{13-16}		0 to -18 V

Current

Output current	$I_8; I_{12}$	0 to 5 mA
----------------	---------------	-----------

Temperatures

Storage temperature	T_{stg}	-40 to +150 °C
Operating ambient temperature	T_{amb}	-20 to +85 °C

Note

Though MOS integrated circuits incorporate protection against electrostatic discharge, they can nevertheless be damaged by accidental over-voltages.

To be totally safe, it is desirable to take handling precautions into account.

CHARACTERISTICS at $T_{amb} = -20$ to $+55$ °C; $V_{DD} = -15$ V; $V_{\phi 1} = V_{\phi 2} = -15$ V;
 $V_{13-16} = -14$ V; $R_L = 47$ k Ω (unless otherwise specified)

Supply voltage range	V_{DD}	-10 to -18 V	1)
Supply current	I_9	typ. 0,3 mA	
Clock frequency	$f_{\phi 1}; f_{\phi 2}$	5 to 500 kHz	2)
Clock pulse width	$t_{\phi 1}; t_{\phi 2}$	$\leq 0,5T$	3)
Clock pulse rise time	$t_{\phi 1r}; t_{\phi 2r}$	typ. 0,05T	3)
fall time	$t_{\phi 1f}; t_{\phi 2f}$	typ. 0,05T	3)
Clock pulse voltage levels; HIGH	$V_{\phi 1H}; V_{\phi 2H}$	0 to -1,5 V	
LOW	$V_{\phi 1L}; V_{\phi 2L}$	typ. -15 V -10 to -18 V	1) 1)
Signal input voltage at 1% output voltage distortion (r. m. s. value)	$V_{s(rms)}$	typ. 2,5 V	
Signal frequency	f_s	0 (d. c.) to 45 kHz	

1) It is recommended that $V_{13-16} = V_{\phi 1L} + 1$ V = $V_{\phi 2L} + 1$ V; V_{DD} more negative than $V_{\phi L}$.

2) In theory the clock frequency must be higher than twice the highest signal frequency; in practice $f_s \leq 0,3 f_{\phi}$ to $0,5 f_{\phi}$ is recommended, depending on the characteristics of the output filter.

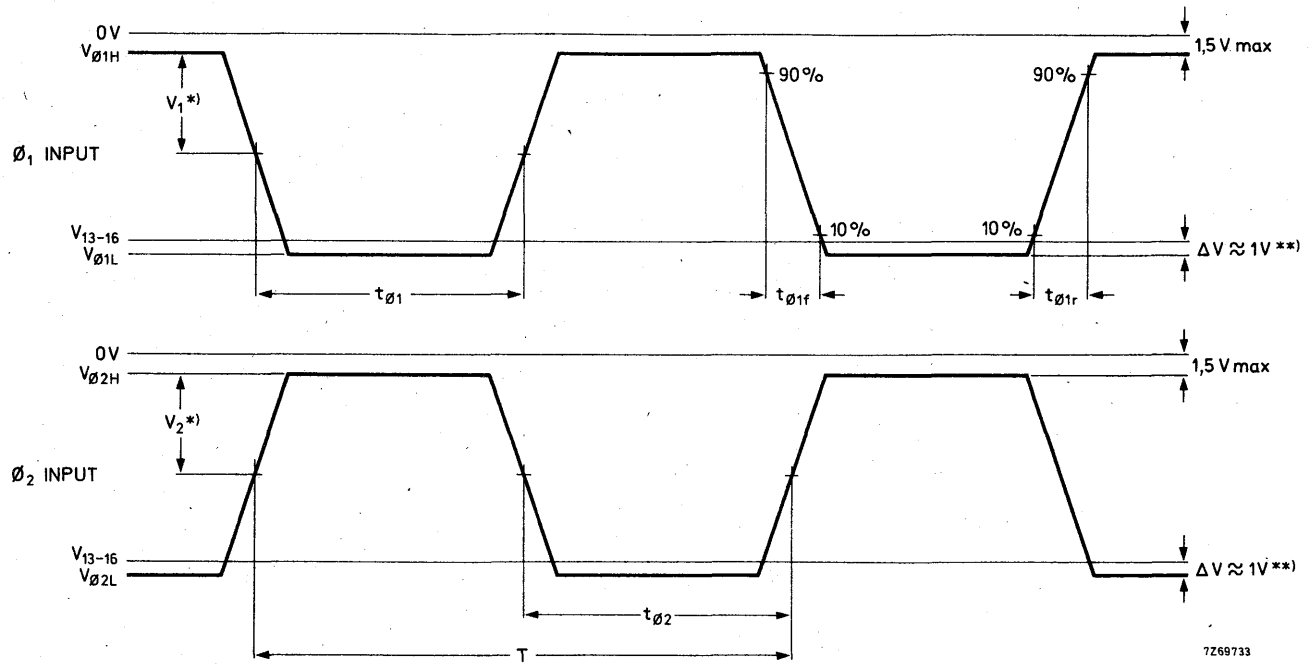
3) T = period time = $1/f_{\phi}$. The data on fall and rise times are given to eliminate overlap between the two clock pulses. To be independent of these rise and fall times a clock generator with simple gating can be used. See also pages 5 and 8.

CHARACTERISTICS (continued)

Attenuation from input to output $f_{\phi} = 40 \text{ kHz}; f_s = 1 \text{ kHz}$	typ.	4 dB	1)
	<	7 dB	
Change in output at $f_s = 1 \text{ kHz}; V_s(\text{rms}) = 1 \text{ V}$ when f_{ϕ} varies from 5 to 100 kHz	typ.	0,5 dB	
	<	1 dB	
when f_{ϕ} varies from 100 to 300 kHz	typ.	0,5 dB	
	<	1 dB	
D.C. voltage shift when f_{ϕ} varies from 5 to 300 kHz	<	0,5 V	
Noise output voltage (r. m. s. value) $f_{\phi} = 100 \text{ kHz}$ (weighted by "A" curve)	$V_N(\text{rms})$ typ.	0,25 mV	
Signal-to-noise ratio at max. output voltage	S/N typ.	74 dB	
Load resistance	R_L >	10 k Ω	1)
	typ.	47 k Ω	

1) Attenuation can be reduced to typ. 2,5 dB if load resistor is replaced by a current source of 100 to 400 μA .

TIMING DIAGRAM



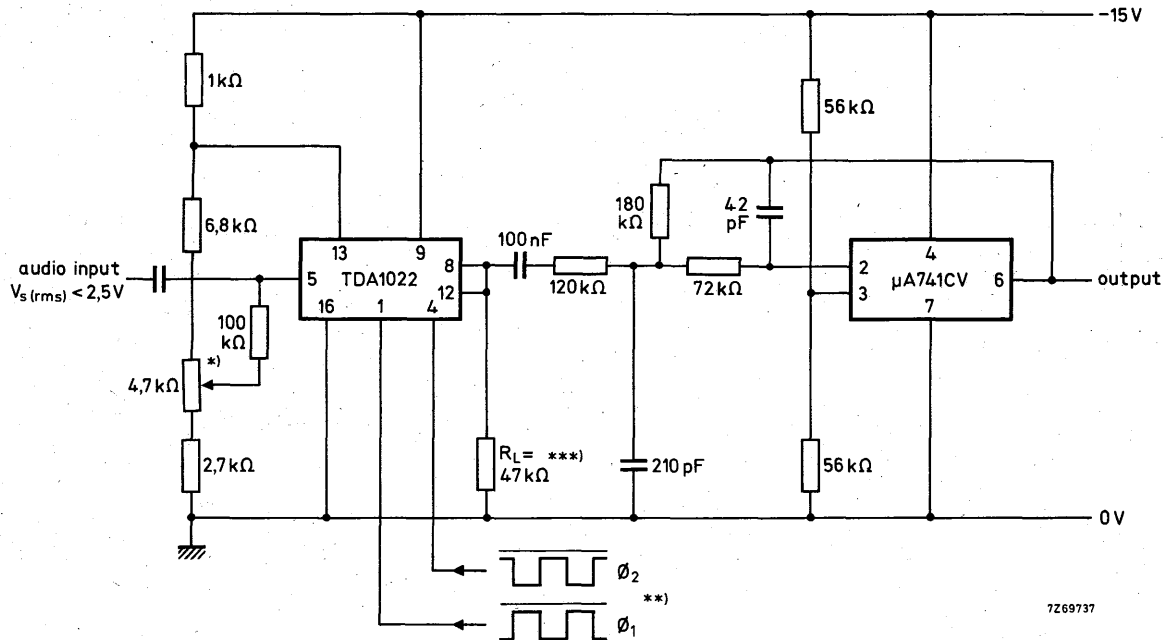
7269733

*) $|V_1 + V_2| \leq |V_{\phi 1L}|$; $V_{\phi 1L} = V_{\phi 2L}$.

***) For maximum dynamic range adjust V_{13-16} so that $\Delta V = V_{13-16} - V_{\phi L} \approx 1V$.



APPLICATION INFORMATION



Single delay line connection

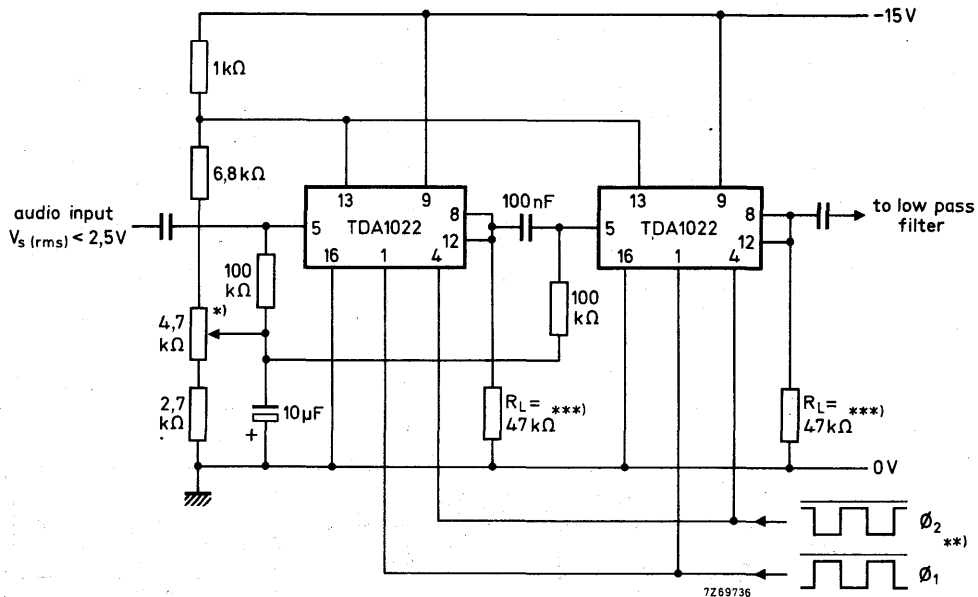
*) Adjust d. c. voltage for class-A operation ($\approx 5V$).

**) Clock input voltage amplitude: $V_{CL} = -15V$.

Conditions: low pass filter $\mu A741CV$ (12 dB per octave);
gain = +3,5 dB (compensation for line attenuation);
 $f_\phi = 50$ kHz (min.);
cut-off frequency = 15 kHz;

***) Can be replaced by a current source of
100 to 400 μA (see also note 1 on page 4).

APPLICATION INFORMATION (continued)



Series connection of two lines TDA1022

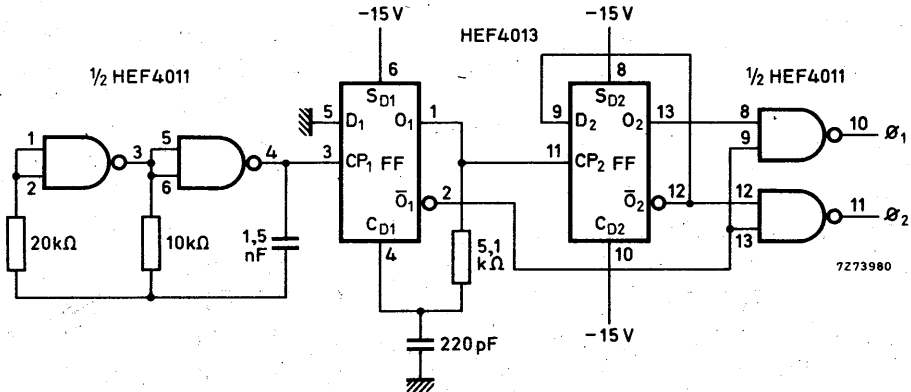
*) Adjust d. c. voltage for class-A operation ($\approx 5 \text{ V}$).

***) Clock input voltage amplitude: $V_{CL} = -15 \text{ V}$.

****) Can be replaced by a current source of 100 to 400 μA (see also note 1 on page 4).



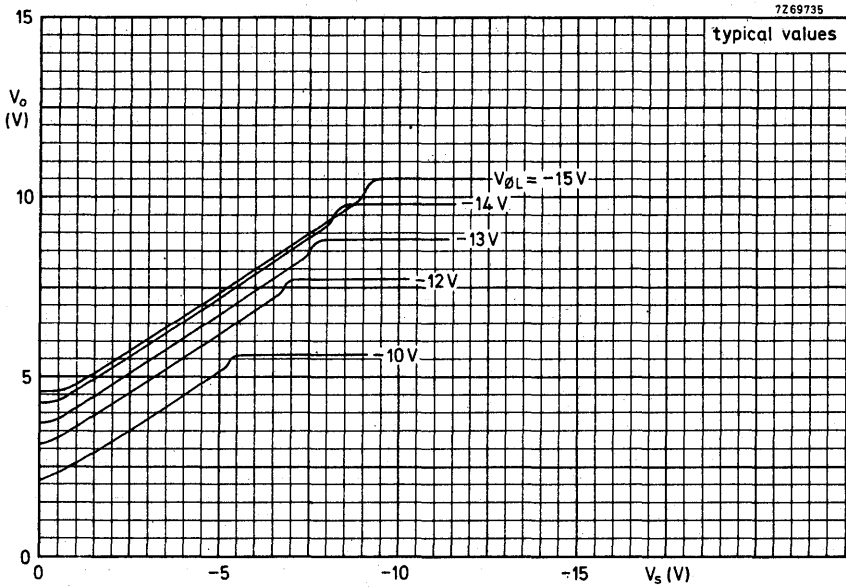
APPLICATION INFORMATION (continued)



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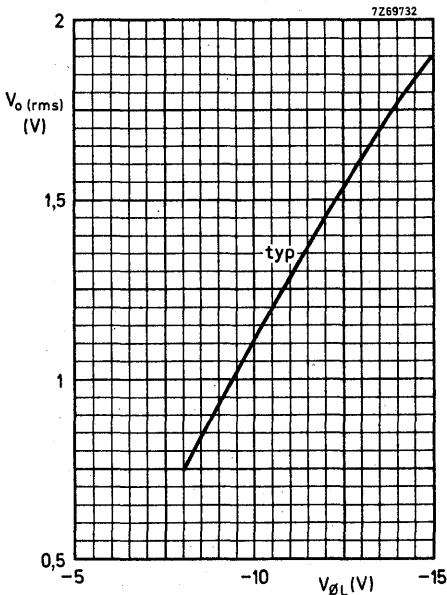
$V_{DD} = 0$
 $V_{SS} = -15 \text{ V}$
 $f_{\phi} = 15 \text{ kHz}$

Clock oscillator and driver circuit with elimination of overlap (for max. 6 x TDA1022)



Conditions for the graph above:

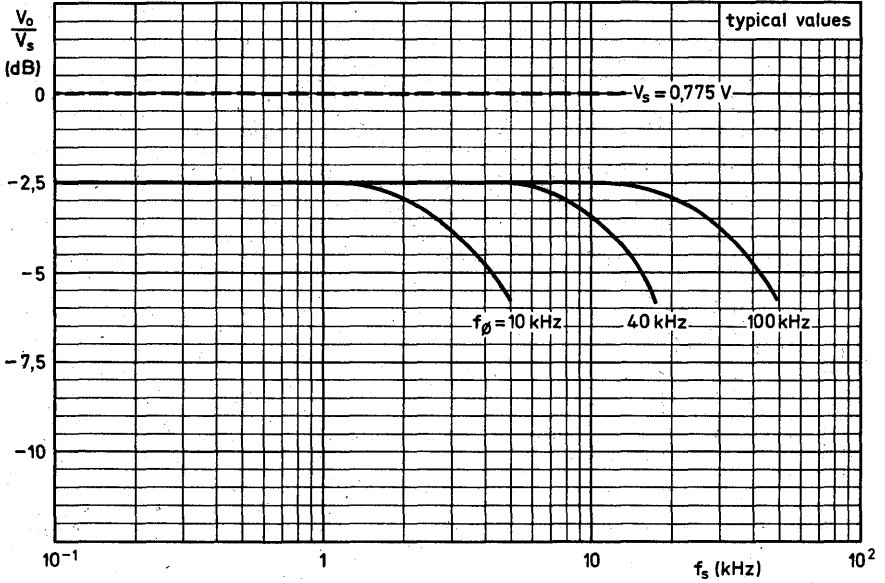
$V_{DD} = -15V$
 $V_{13-16} = -14V$
 $V_{\phi H} = 0V$
 $f_{\phi} = 40kHz$
 $R_L = 47k\Omega$



Conditions for the left-hand graph:

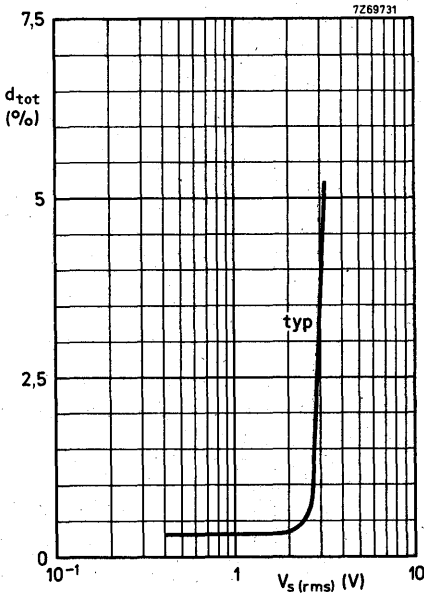
$V_{DD} = -15V$
 $V_{13-16} = -14V$
 $V_{\phi H} = 0V$
 $f_{\phi} = 40kHz$
 $f_s = 1kHz$
 $R_L = 47k\Omega$

7269734



Conditions for the graph above :

- $V_{DD} = -15 V$
- $V_{13-16} = -14 V$
- $V_\phi = 0 \text{ to } -15 V$



Conditions for the left-hand graph :

- $f_s = 1 \text{ kHz}$
- $V_s = -5,2 V$
- $V_{DD} = -15 V$
- $V_{13-16} = -14 V$
- $V_\phi = 0 \text{ to } -15 V$
- $f_\phi = 40 \text{ kHz}$

GENERAL INDUSTRIAL



TYPE SELECTION

General industrial

- SAA1027 - stepper motor driver
- SAK140 - revolution counter
- TCA280A - universal triac control (trigger module)
- TDA0555D - timer
- TDA1024 - a mains-zero triac-triggering circuit

STEPPER MOTOR DRIVE CIRCUIT

The SAA1027 is intended for driving a four phase two stator stepper motor. The circuit consists of four output stages, a logic part and three input stages. The logic part is driven by three input stages; a trigger input stage, an input stage which can change the switching sequence of the logic part so that the motor can rotate clock wise (CW) or counter clock wise (CCW) and a set input stage to set the four output stages. The three inputs are compatible with high noise immunity logic to ensure proper operation, even in noisy environments. The output can deliver 350 mA in each phase. The right switching sequence of the four phases is obtained from the logic part of the circuit. Integrated diodes protect the outputs against transient spikes.

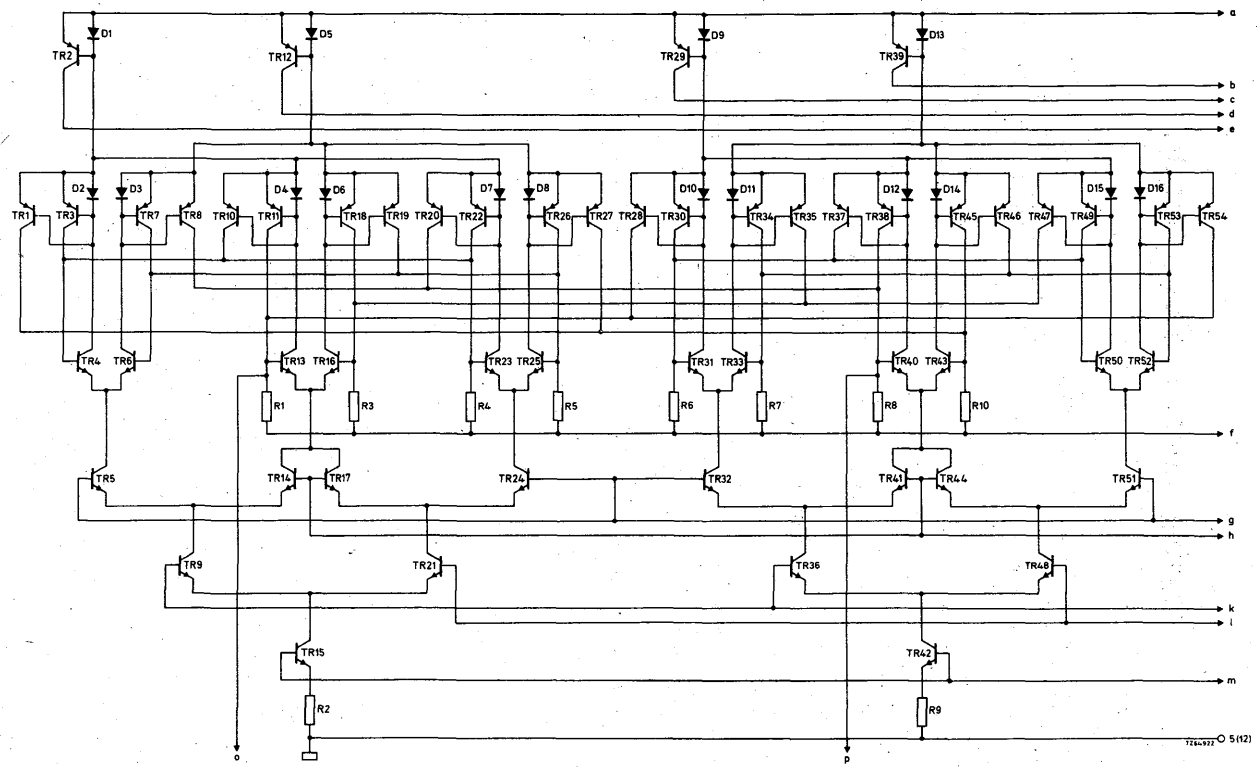
QUICK REFERENCE DATA

Supply voltage	V_P	9, 5 to 18	V
Load current (each output)	I_Q	max.	350 mA
Logic for CW and CCW operation			

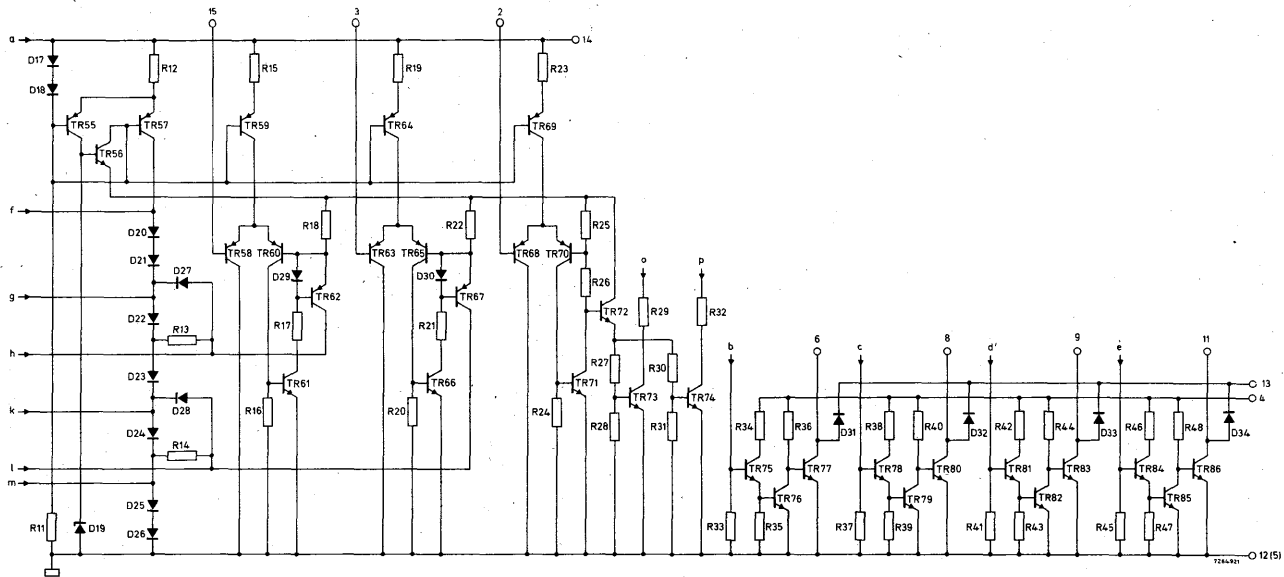
PACKAGE OUTLINE 16 lead plastic power dual in-line (see page 9)



CIRCUIT DIAGRAM



bi-directional, 4 position, synchronous counter



supply voltages

trigger stage

CW/CCW stage

set stage

output stages



RATINGS Limiting values in accordance with the Absolute Maximum System (IEC 134)

Voltages

Supply voltage (pins 4, 13, 14)	V_P	max.	20 V
Input voltage; R (pin 3), S (pin 2), T (pin 15)	V_I	max.	20 V

Current

Output current; Q_1 (pin 6), Q_2 (pin 8), Q_3	I_Q	max.	500 mA
---	-------	------	--------

Power dissipation

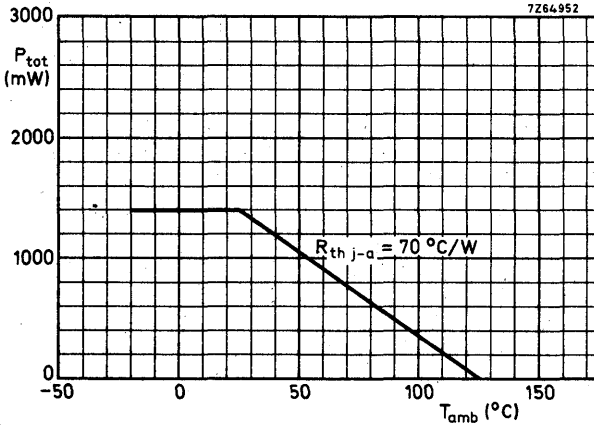
see derating curve below 1)

Temperatures

Storage temperature	T_{stg}	-40 to +125 °C
Operating ambient temperature	T_{amb}	-20 to + 70 °C

THERMAL RESISTANCE

From junction to ambient $R_{th\ j-a} = 70\text{ °C/W}$



1) Additional power caused by the self-inductance of the motor-coils will be dissipated in the diodes (D31 to D34). This extra dissipation has not been considered in the bottom graph on page 8. If necessary external diodes must be used.

FUNCTION TABLEDirection conditions (R)

The direction of rotation can be changed at any moment independent of the state of the T and S inputs.

Set conditions (S)

When T is HIGH and S LOW then the outputs are set: $Q_1 = L$, $Q_2 = H$, $Q_3 = L$, $Q_4 = H$.

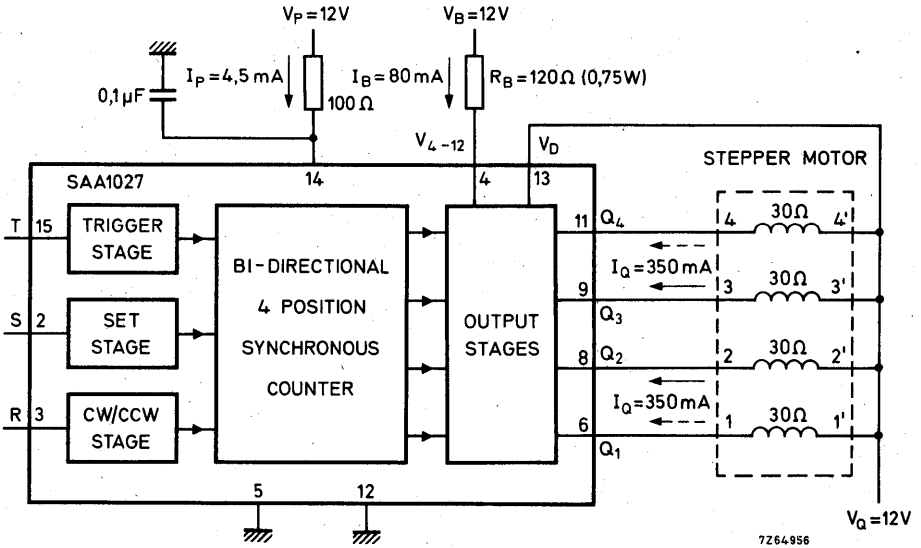
Trigger conditions (T)

S = H									
R = H					R = L				
T	Q ₁	Q ₂	Q ₃	Q ₄	T	Q ₁	Q ₂	Q ₃	Q ₄
0	L	H	L	H	0	L	H	L	H
1	H	L	L	H	1	L	H	H	L
2	H	L	H	L	2	H	L	H	L
3	L	H	H	L	3	H	L	L	H
4	L	H	L	H	4	L	H	L	H

CHARACTERISTICS at $T_{amb} = -20$ to $+65$ °C; $V_P = 12$ V

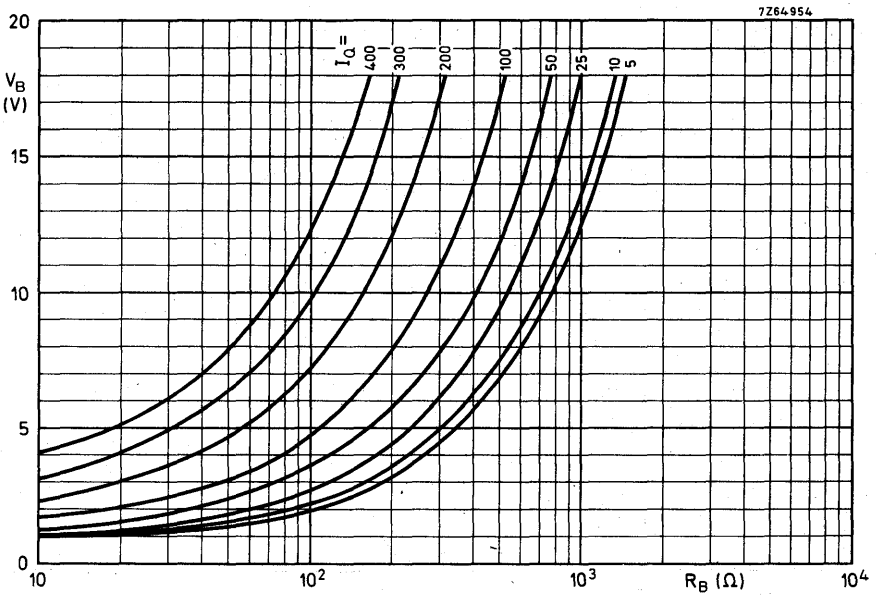
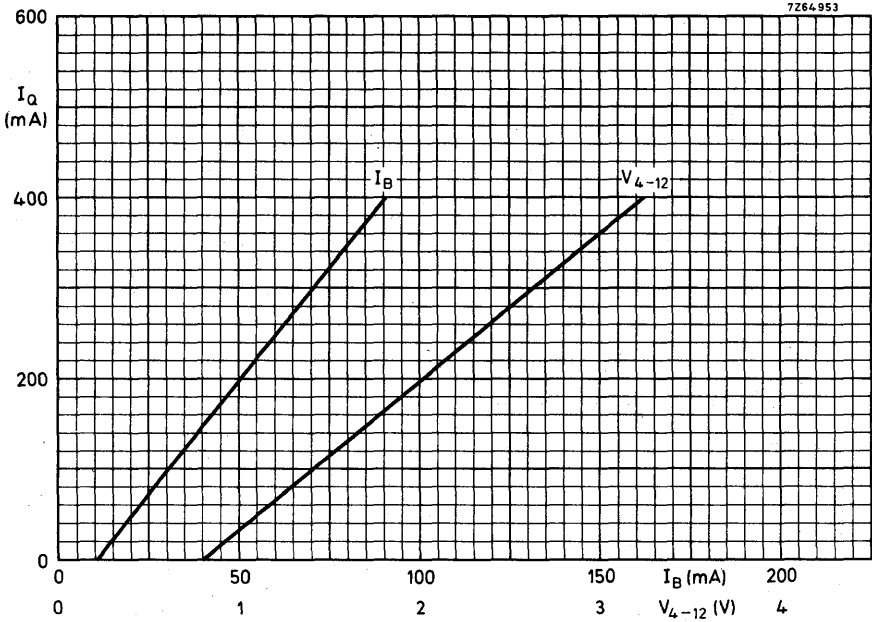
Supply voltage (pin 14)	V_P	typ. 12 V 9,5 to 18 V
Supply current (without load, all inputs HIGH, pin 4 open)	I_P	typ. 4,5 mA 2,0 to 6,5 mA
Input logic voltage levels and currents for R, S and T HIGH	V_{IH}	> 7,5 V
	I_{IH}	typ. 1 μ A
LOW	V_{IL}	< 4,5 V
	I_{IL}	typ. 30 μ A
Supply voltage (each output stage)	V_Q	typ. 12 V 1,5 to 18 V
Supply current (each output stage)	I_Q	< 350 mA
Saturation voltage of output transistors at $I_Q = 350$ mA (pins 6, 8, 9, 11)	V_{sat}	< 1,0 V
Bias voltage and current (max. values; pin 4)		See top graph on page 7
Bias resistor		See bottom graph on page 7
Power dissipation in bias resistor		See top graph on page 8
Total device power dissipation		See bottom graph on page 8

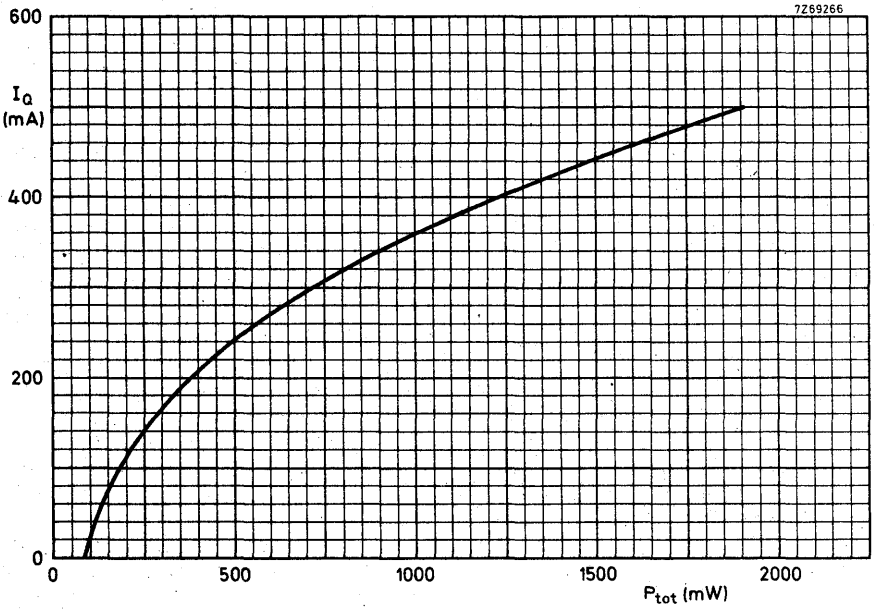
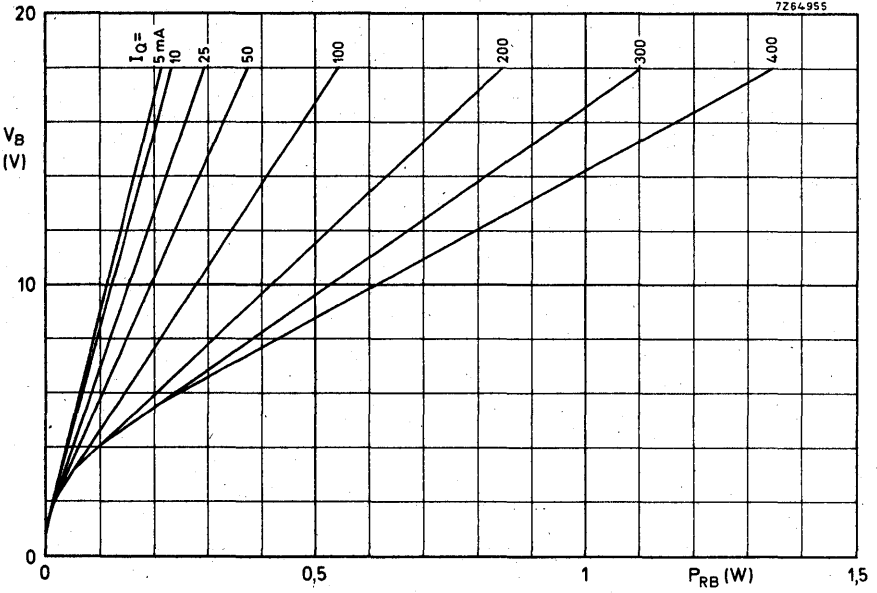
APPLICATION INFORMATION



PINNING

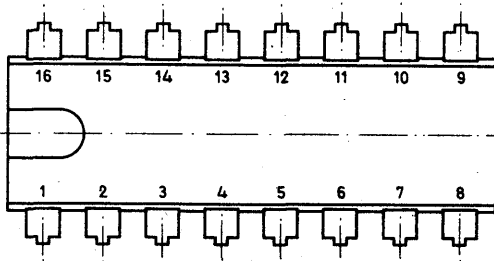
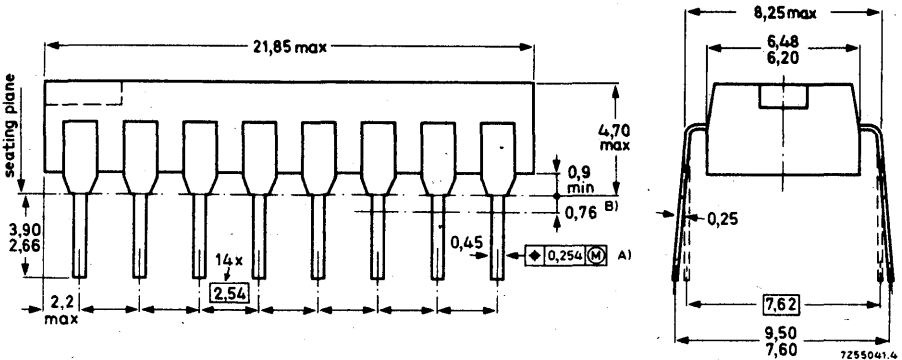
- | | |
|-------------------------------------|--------------------------------------|
| 1. not connected | 9. Q ₃ (output) |
| 2. S (set input) | 10. not connected |
| 3. R (CW/CCW input) | 11. Q ₄ (output) |
| 4. V _B (positive supply) | 12. Earth (negative supply) |
| 5. Earth (negative supply) | 13. V _D (positive supply) |
| 6. Q ₁ (output) | 14. V _P (positive supply) |
| 7. not connected | 15. T (trigger input) |
| 8. Q ₂ (output) | 16. not connected |





16 LEAD PLASTIC POWER DUAL IN-LINE

Dimensions in mm



top view

A) Centre-lines of all leads are within $\pm 0,127$ mm of the nominal positions shown; in the worst case, the spacing between any two leads may deviate from nominal by $\pm 0,254$ mm.

B) Lead spacing tolerances apply from seating plane to the line indicated

SOLDERING

1. By hand

Apply the soldering iron below the seating plane (or not more than 2 mm above it). If its temperature is below 300 °C it must not be in contact for more than 10 seconds; if between 300 °C and 400 °C, for not more than 5 seconds.

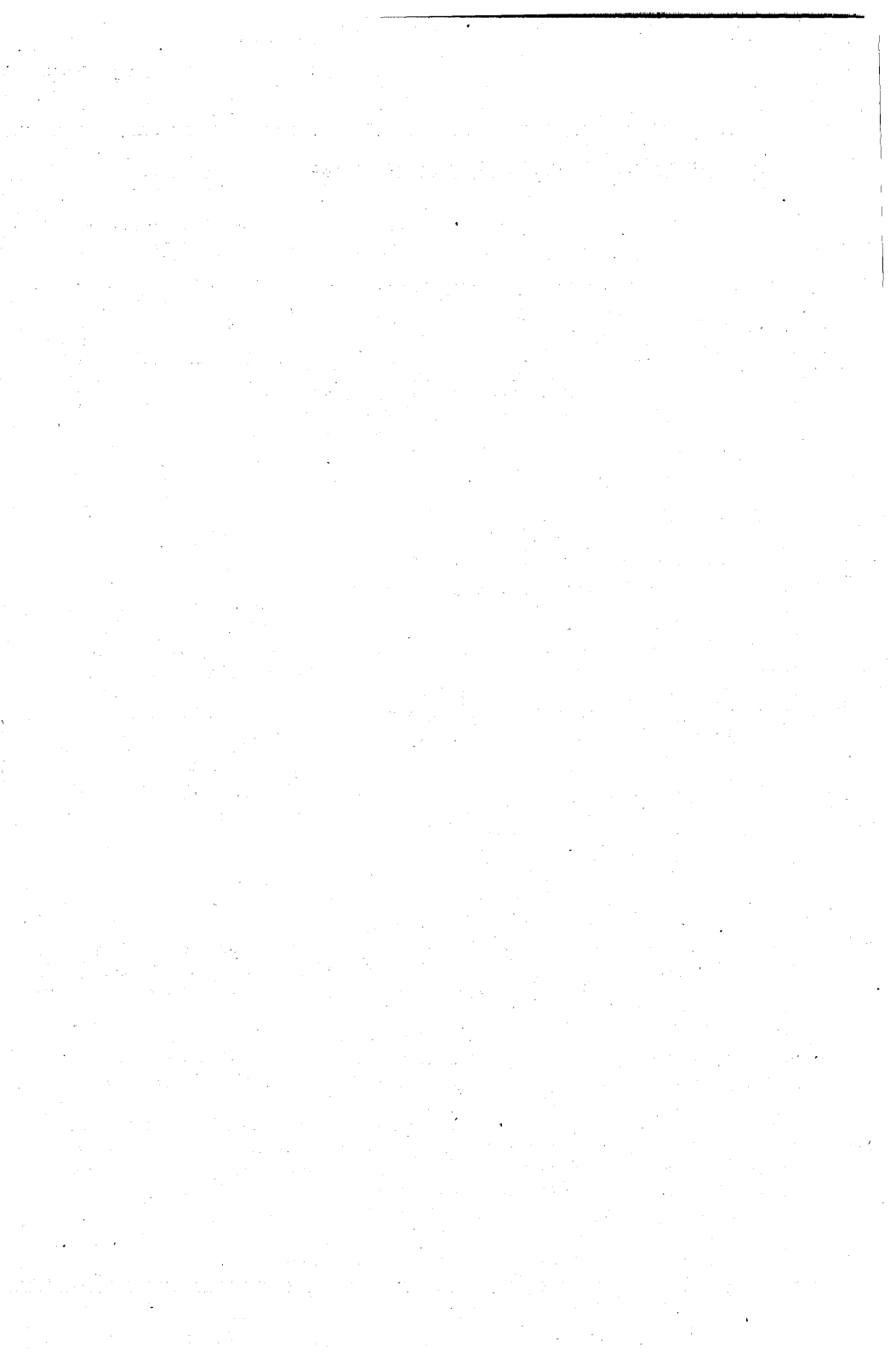
2. By dip or wave

260 °C is the maximum allowable temperature of the solder; it must not be in contact with the joint for more than 5 seconds. The total contact time of successive solder waves must not exceed 5 seconds.

The device may be mounted up to the seating plane, but the temperature of the plastic body must not exceed the specified storage maximum. If the printed circuit board has been pre-heated, forced cooling may be necessary immediately after soldering to keep the temperature within the allowable limit.

3. Repairing soldered joints

The same precautions and limits apply as in (1) above.



REVOLUTION COUNTER

The SAK140 is a monolithic integrated circuit intended for use as a revolution counter in motor cars.

It contains a stabilization circuit and a monostable multivibrator which converts the circuit input pulses into output current pulses of constant duration and amplitude.

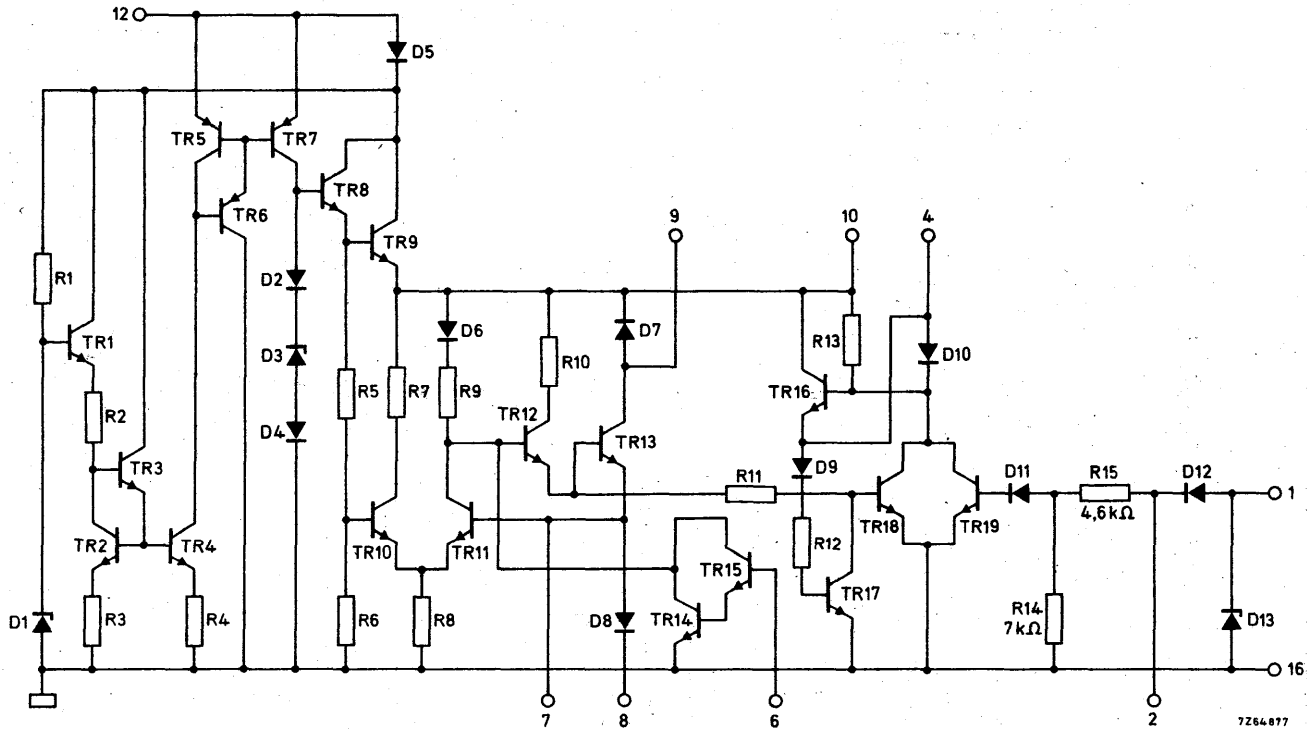
This pulse duration is determined by an external R-C network; by proper choice of R and C, the circuit can be easily adapted to any milliammeter. Together with the internal stabilization circuitry this makes the indication almost independent of temperature changes and supply voltage variations.

QUICK REFERENCE DATA

Supply voltage	V_p	10 to 18 V
Power dissipation at $n = 6000$ rpm; $I_o = 12$ mA; $V_p = 12$ V	P_{tot}	typ. 130 mW
Input pulse amplitude (pin 1)	V_i	> 3,5 V
Output current (pin 9)	I_o	< 50 mA

PACKAGE OUTLINE plastic 16-lead dual in-line (see general section).

CIRCUIT DIAGRAM



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RATINGS Limiting values in accordance with the Absolute Maximum System (IEC 134)

Voltage

Supply voltage (pin 12) V_p max. 18 V

Currents

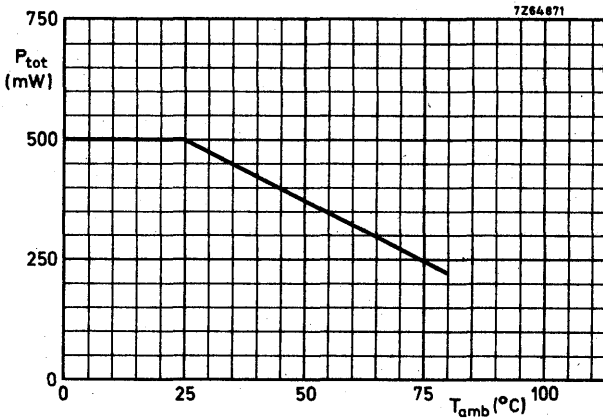
Current at pin 9 (peak value)	$-I_{9M}$	max. 50 mA
at pin 7 (peak value)	$-I_{7M}$	max. 50 mA
at pin 8 (peak value)	$-I_{8M}$	max. 50 mA
at pin 1	$\pm I_1$	max. 10 mA

Dissipation

Total power dissipation see derating curve below

Temperatures

Storage temperature	T_{stg}	-40 to +80 °C
Ambient temperature	T_{amb}	-40 to +80 °C



CHARACTERISTICS

<u>Supply voltage range</u> (pin 12)	V_p	10 to 18 V ¹⁾
<u>Supply current</u> (on-state) at $V_p = 12$ V	I_{12}	typ. 5 mA
<u>Power dissipation</u> at $n = 6000$ rpm; $I_o = 12$ mA; $V_p = 12$ V	P_{tot}	typ. 130 mW
<u>Voltage at pin 7</u> (on-state)	V_{7-16}	typ. 2,5 V
<u>Temperature coefficient</u> of output pulse (pin 9)		typ. 200 ppm/°C
<u>Adjustable output current</u> resistor between pins 7 and 16 or 8 and 16		< 50 mA
<u>Resistor for peak output current adjustment</u>	R_m	> 50 Ω
<u>Resistor for output pulse duration adjustment</u>	R	{ typ. 270 k Ω 0,01 to 500 k Ω
<u>Capacitor for output pulse duration adjustment</u>	C	{ > 220 pF typ. 10 nF < 30 μ F
<u>Input pulse frequency</u> (for circuits on page 5)	f	< 400 Hz
<u>Input pulse frequency</u> (pin 2 not connected)	f	< 30 kHz
<u>Influence of supply voltage on output amplitude</u> V_p from 10 to 16 V; top circuit on page 5 bottom circuit on page 5		typ. 0,6 % typ. 1,6 %
<u>Input triggering voltage</u> at which level good triggering is achieved	V_{1-16}	> 3,5 V ²⁾
<u>Duty cycle of output pulse</u>	δ	typ. 0,75 < 0,90

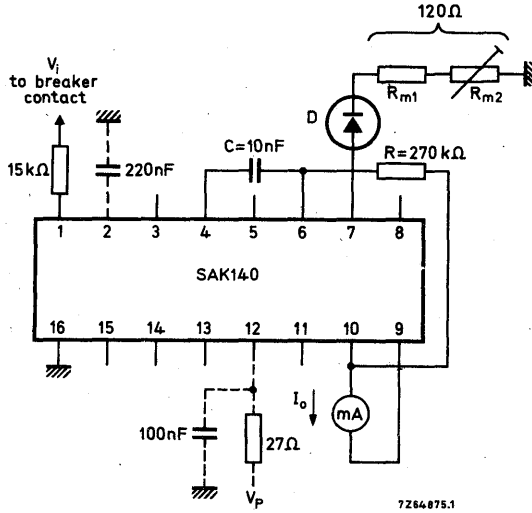
1) The circuit is internally protected against reverse connected supply voltage.

2) To prevent the input circuit from overloading by large input pulses a voltage regulator diode (D13) has been connected at the input terminal.

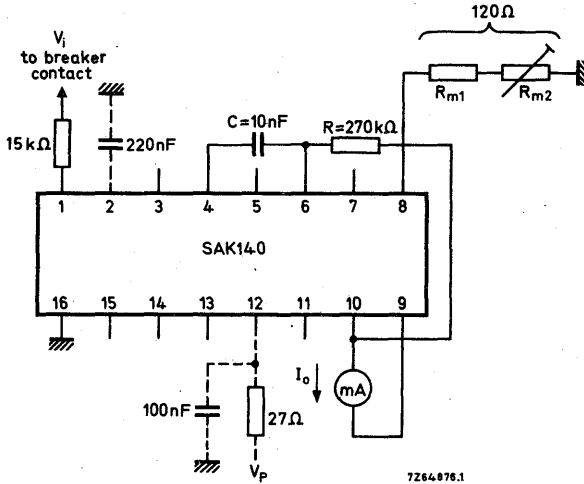
This diode also functions as a protection against negative trigger pulses.

A resistor has to be connected in series with the input terminal, having such a value that the input current does not exceed 10 mA.

APPLICATION INFORMATION



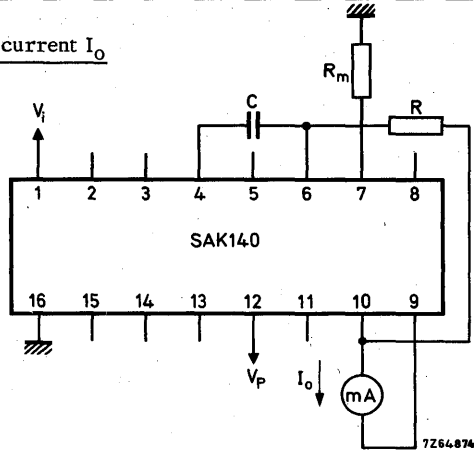
Temperature coefficient of I_0 is 800 ppm/°C determined by diode D. ¹⁾



Temperature coefficient of I_0 is 800 ppm/°C determined by an internal diode between pins 7 and 8. ¹⁾

¹⁾ The influence of supply voltage variations is very small when using the top circuit. When using the bottom circuit the influence will be greater. The influence of the temperature coefficients of R, C and R_m are in this case negligible.

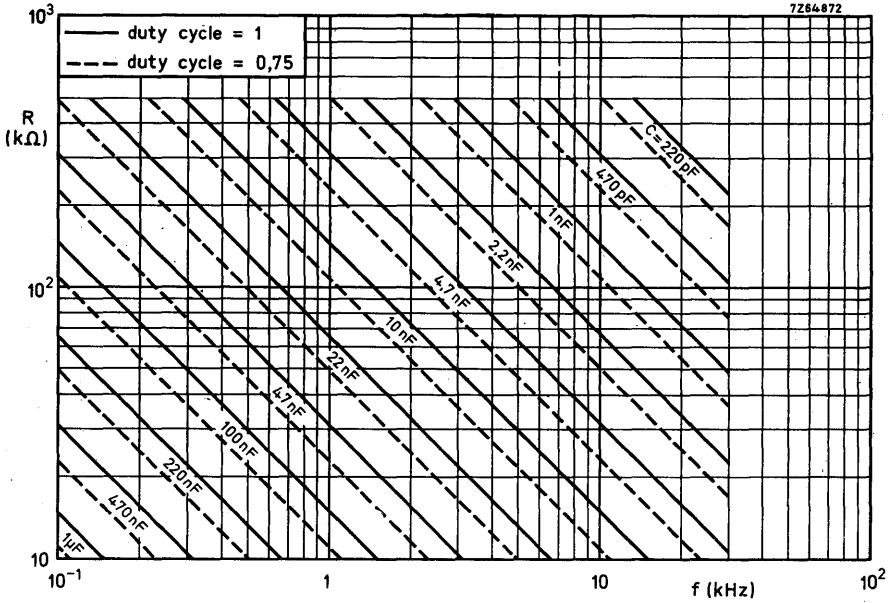
Temperature coefficient of output current I_o



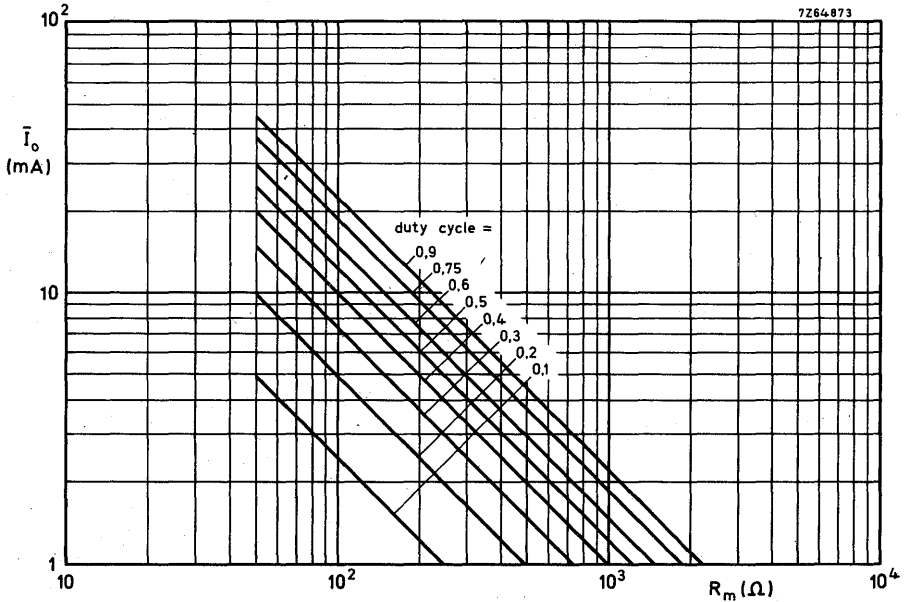
The temperature coefficient of I_o depends on the temperature coefficients of R , C , R_m and the voltage on pin 7.
 The temperature coefficient of $R = 270 \text{ k}\Omega$ (carbon resistor, catalogue number 2322 101 33274) is $-330 \text{ ppm}/^\circ\text{C}$ and of V_{7-16} is $200 \text{ ppm}/^\circ\text{C}$.
 The temperature coefficients of R_m and C depend on the kind of components chosen. Their influence on the temperature coefficient of I_o are given below.

$C = 10 \text{ nF}$	$R_m = 160 \Omega$	t. c. $I_o = 12 \text{ mA}$
metallized polyester capacitor (flat film type) t. c. = $350 \text{ ppm}/^\circ\text{C}$ catalogue number: 2222 342 25103	carbon resistor t. c. = $-220 \text{ ppm}/^\circ\text{C}$ catalogue number: 2322 101 33161	440 $\text{ppm}/^\circ\text{C}$
	moulded metal film resistor t. c. = $25 \text{ ppm}/^\circ\text{C}$ catalogue number: 2322 163 11601	190 $\text{ppm}/^\circ\text{C}$
tubular moulded polystyrene capacitor t. c. = $-100 \text{ ppm}/^\circ\text{C}$ catalogue number: 2222 435 21003	carbon resistor t. c. = $-220 \text{ ppm}/^\circ\text{C}$ catalogue number: 2322 101 33161	$-10 \text{ ppm}/^\circ\text{C}$
	moulded metal film resistor t. c. = $25 \text{ ppm}/^\circ\text{C}$ catalogue number: 2322 163 11601	$-250 \text{ ppm}/^\circ\text{C}$

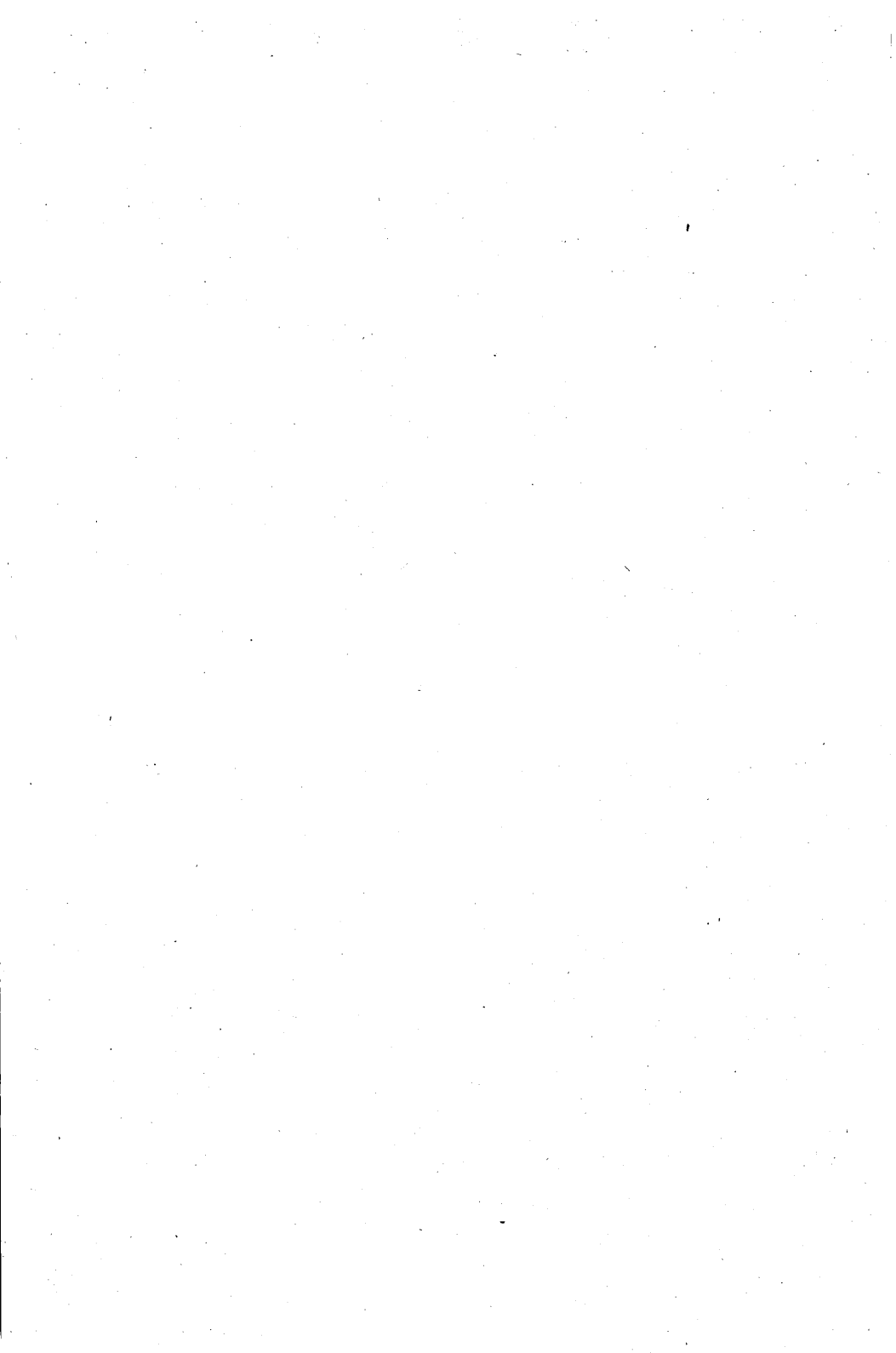
$$\text{In general: t. c.} = \frac{\Delta I_o}{I_o} = \frac{1 + \frac{\Delta C}{C} + \frac{\Delta R}{R} + \frac{\Delta V_{7-16}}{V_{7-16}}}{1 + \frac{\Delta R_m}{R_m}} - 1$$



For other duty cycles at f. s. d. than 0,75, the value of R or C derived from the graph at a duty cycle of 1 must be multiplied by the duty cycle required.



If a diode is connected in series with R_m , the value of R_m derived from the graph must be lowered with 25 %.



TRIGGER MODULE

The TCA280A is a monolithic integrated circuit designed for thyristor and triac control. It contains the following circuit sections:

- d.c. power supply (intended for direct a. c. supply)
- zero-crossing detector (for synchronization of the trigger circuit)
- difference amplifier (used as a sensing amplifier)
- ramp function generator (operating as the sawtooth oscillator in time-proportional control)
- output amplifier (amplifying the trigger pulses and feeding the thyristor or triac gate)

Various control modes possible when using the TCA280A are:

- phase control
- synchronous on/off switching (static switch)
- time proportional control

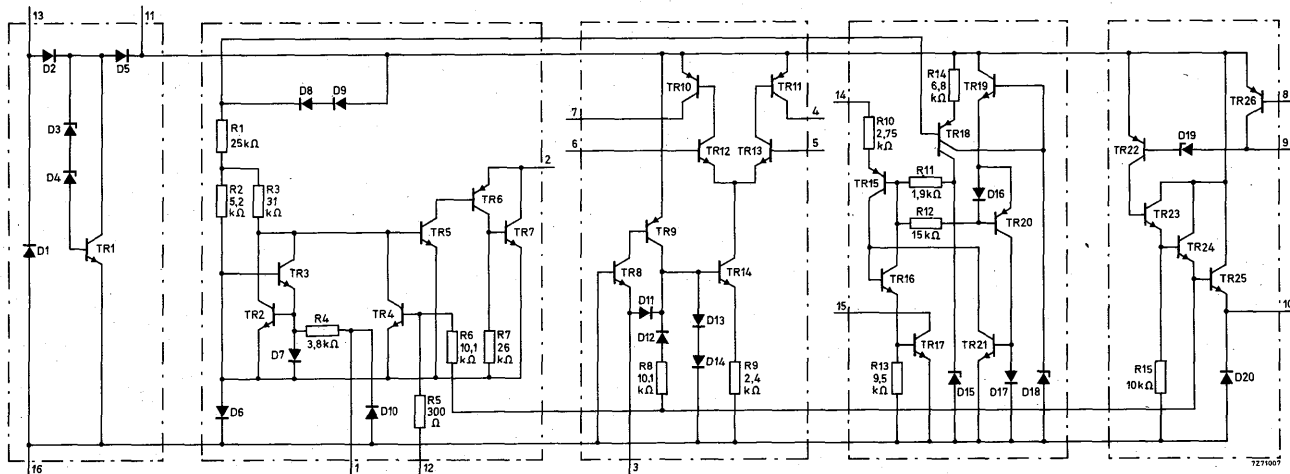
The device is designed to be supplied directly from the a. c. mains through a dropping resistor, alternatively, supply can be obtained from a 14,5 V(d. c.) source connected between pins 11 and 16.

The output current capability permits triggering of large thyristors and triacs.

PACKAGE OUTLINE plastic 16-lead dual in-line (see general section.)

CIRCUIT DIAGRAM

TCA280A



D.C. SUPPLY

ZERO-CROSSING DETECTOR

DIFFERENCE AMPLIFIER

RAMP FUNCTION GENERATOR

OUTPUT AMPLIFIER

RATINGS Limiting values in accordance with the Absolute Maximum System (IEC 134)

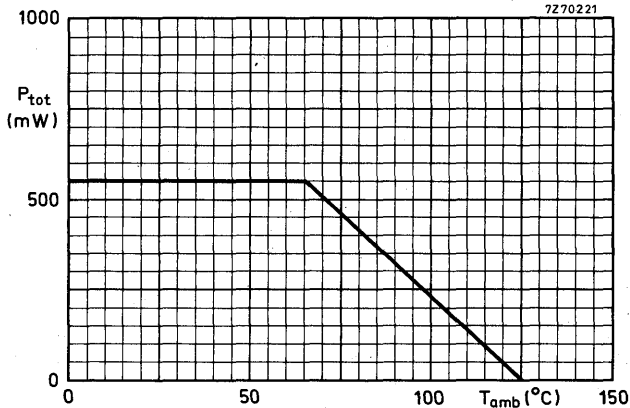
Voltages

V_{11-16}	max.	17	V
V_{11-7}	max.	17	V
V_{11-4}	max.	17	V
V_{8-16}	max.	17	V
V_{8-11}	max.	17	V
V_{9-16}	max.	17	V
V_{5-16}	max.	17	V
V_{6-16}	max.	17	V
$\pm V_{5-6}$	max.	7	V
V_{15-16}	max.	17	V

Currents

$\pm I_{13(AV)}$	max.	30	mA
$\pm I_{13M}$	max.	80	mA
$\pm I_{13SM}$	max.	2	A ¹⁾
$-I_{10(AV)}$	max.	30	mA
$-I_{10M}$	max.	600	mA ²⁾
$\pm I_{1M}$	max.	10	mA
I_2	max.	200	mA
$\pm I_3$	max.	10	mA
$I_5; I_6$	max.	10	mA
$-I_8; -I_9$	max.	10	mA
I_{12}	max.	10	mA
I_{15}	max.	10	mA

Total power dissipation



Temperatures

Storage temperature	T_{stg}	-55 to +125	°C
Operating ambient temperature	T_{amb}	-20 to +80	°C

1) $t \leq 10 \mu s$

2) $t \leq 300 \mu s$

TCA280A

CHARACTERISTICS at $T_{amb} = 25\text{ }^{\circ}\text{C}$

Power supply

<u>Supply voltage</u> at $I_{13} = 5\text{ mA}$; $I_{10} = 0$	V_{11-16}	typ.	14,4	V
			13 to 15	V
<u>Supply voltage range</u> for external supply	V_{11-16}		11 to 17	V

Zero-crossing detector

<u>Input current</u> at $V_{11-16} = 13\text{ V}$; $I_2 = 0,5\text{ mA}$	$\pm I_1$		30 to 50	μA	
<u>Input voltage</u> at $I_2 = 0,1\text{ mA}$					
	$-I_1$	$-V_{1-16}$	<	0,25	V
	$+I_1$	$+V_{1-16}$	<	1,9	V

Difference amplifier

Input currents

$-V_{5-11} = 3\text{ V}$; $+I_3 = 10\text{ }\mu\text{A}$ or $-I_3 = 30\text{ }\mu\text{A}$	I_5	typ.	5	μA
		<	10	μA
$-V_{6-11} = 3\text{ V}$; $+I_3 = 10\text{ }\mu\text{A}$ or $-I_3 = 30\text{ }\mu\text{A}$	I_6	typ.	5	μA
		<	10	μA

Output currents

$-V_{5-11} = 3\text{ V}$; $+I_3 = 10\text{ }\mu\text{A}$ or $-I_3 = 30\text{ }\mu\text{A}$	$-I_4$		0,3 to 1,2	mA
$-V_{6-11} = 3\text{ V}$; $+I_3 = 10\text{ }\mu\text{A}$ or $-I_3 = 30\text{ }\mu\text{A}$	$-I_7$		0,3 to 1,2	mA

Ramp function generator

<u>Trigger current</u>	I_{14T}	<	3	μA
<u>Holding current</u>	I_{14H}		95 to 210	μA
<u>Trigger voltage</u> at $I_{14} < I_{14T}$	V_{14-16}		7,0 to 8,3	V
<u>On-state voltage</u> at $I_{14} > I_{14T}$	V_{14-16}		1,8 to 2,8	V

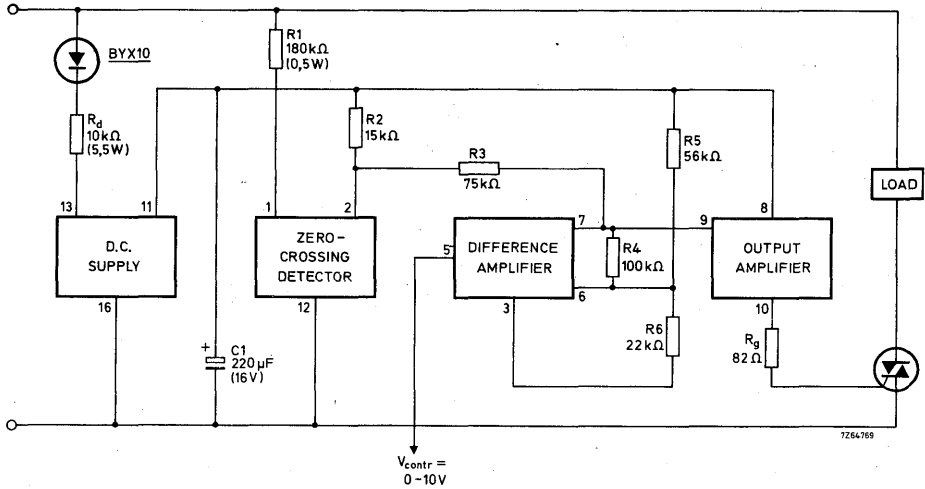
Output amplifier

<u>Input currents</u> at $-I_9 = 100\text{ }\mu\text{A}$	$-I_8$		19 to 53	μA
at $-I_{10} = 200\text{ mA}$	$-I_9$	<	15	μA
<u>Output current</u> (off-state)				
$I_9 = 0$; $V_{10-16} = 0$	$-I_{10}$	<	1	μA
<u>Output voltage drop</u>				
$-I_{10} = 200\text{ mA}$; $-I_9 = 50\text{ }\mu\text{A}$; $V_{11-16} = 13\text{ V}$	V_{11-10}	<	2,8	V

APPLICATION INFORMATION

The following are a few examples of the various control circuits possible with the TCA280A.

1. Synchronous on/off switching (static switch-resistive load)



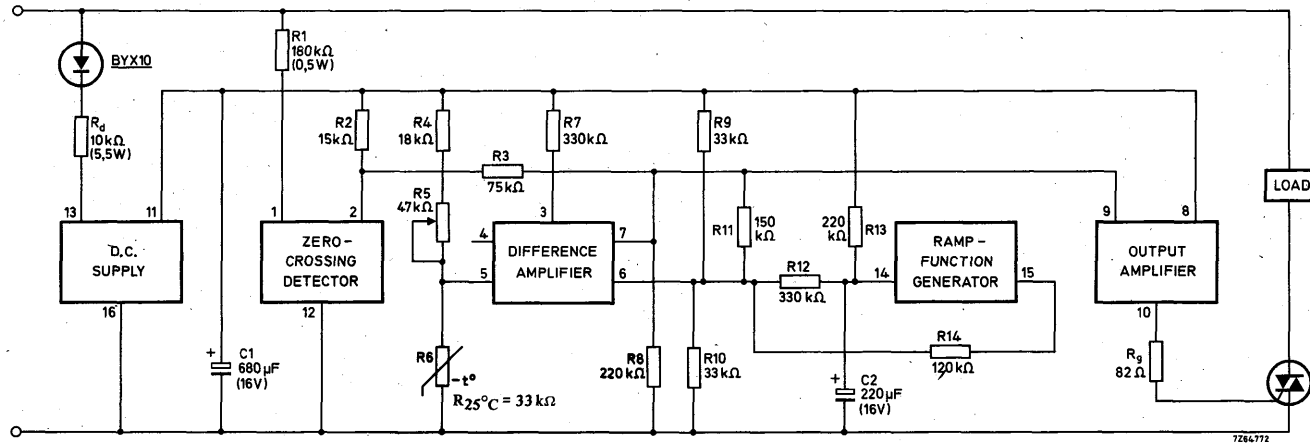
The synchronous switch gives triggering around the zero crossings of the mains voltage with a typical pulse duration of 160 μ s.

Note

Values of R_d , R_g , and C_1 are chosen for triacs requiring a gate current I_G typ. 100 mA at V_G typ. 2.5 V. For other conditions see graphs on pages 8, 9, 10 and 11.

APPLICATION INFORMATION (continued)

2. Time proportional temperature controller



Triggering is as in the circuit described on page 5 (synchronous on/off switching; resistive load), as triggering coincides with the zero crossings of the mains voltage. However, no triggering can occur if the voltage at pin 5 of the difference amplifier, supplied by the temperature-conscious bridge formed by R4, R5 and the NTC thermistor R6 in one branch, and R9 and R10 in the other, drops below the voltage at pin 6.

The voltage at pin 6 (V_{6-16}) is a sawtooth, produced by the ramp-function generator (pin 14), superimposed on a d.c. reference voltage.

Its repetition time is about 30 s and can be adjusted by varying C2.

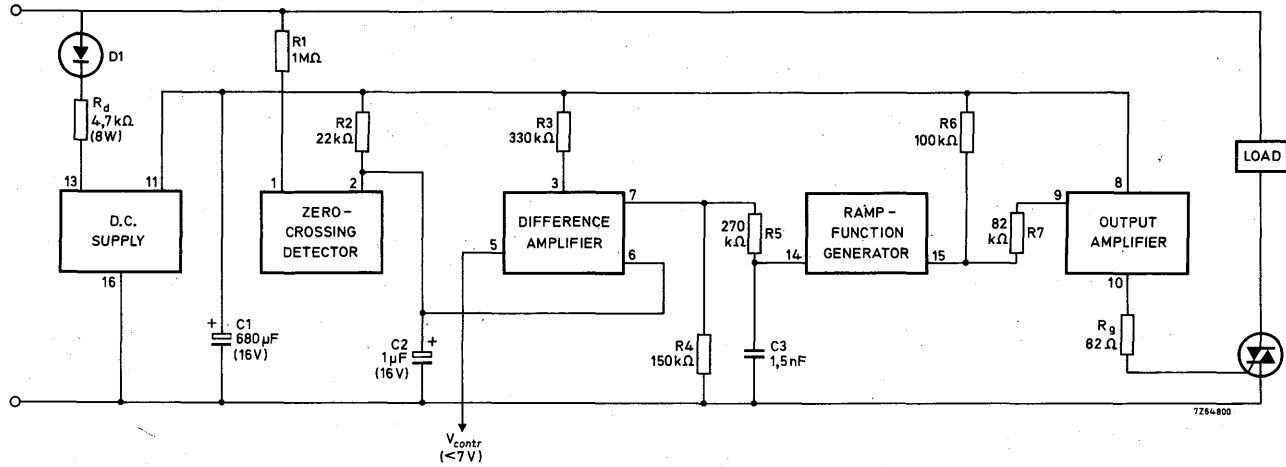
The amplitude of V_{6-16} determines the proportional band and can be adjusted by varying R12.

Note

See note on page 5.

APPLICATION INFORMATION (continued)

3. Single phase control circuit using trigger pulse bursts.



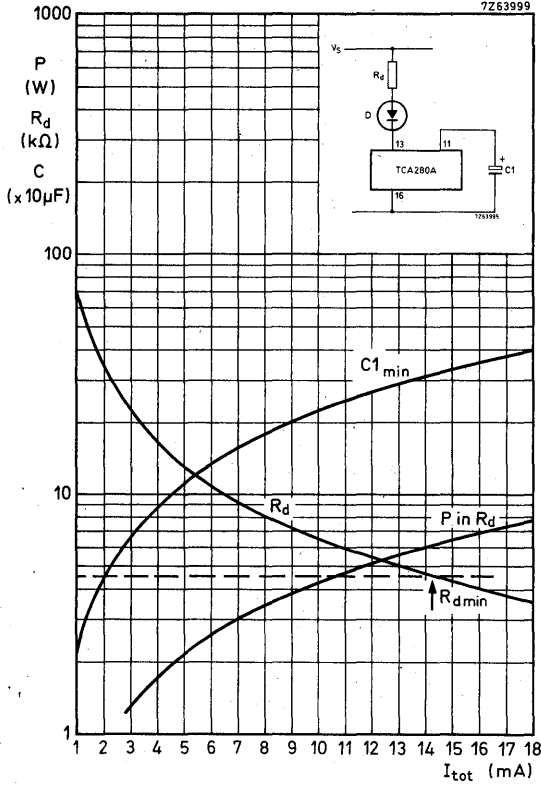
This circuit used in conjunction with a triac, provides a full-wave a.c. controller, and if used in conjunction with a thyristor, a controlled half-wave rectifier.

Note

See note on page 5.



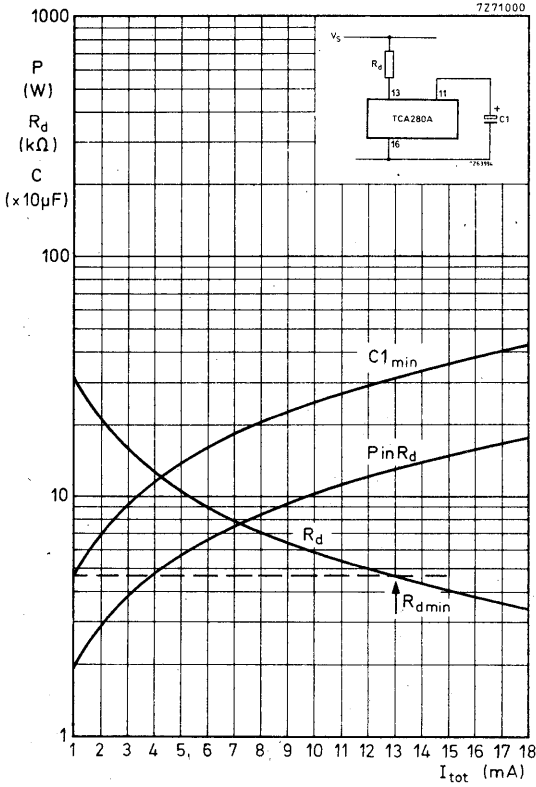
APPLICATION INFORMATION (continued)



Graph for determining the values of R_d , dissipation P in R_d , and minimum recommended value of $C1$ as functions of I_{tot} for the circuit conditions shown (with diode D). I_{tot} is the maximum average current through D , and is the total of the current consumed by the IC and by the external components.

It should be noted that certain applications like the time proportional controller require an up to three times higher value of $C1$.

APPLICATION INFORMATION (continued)

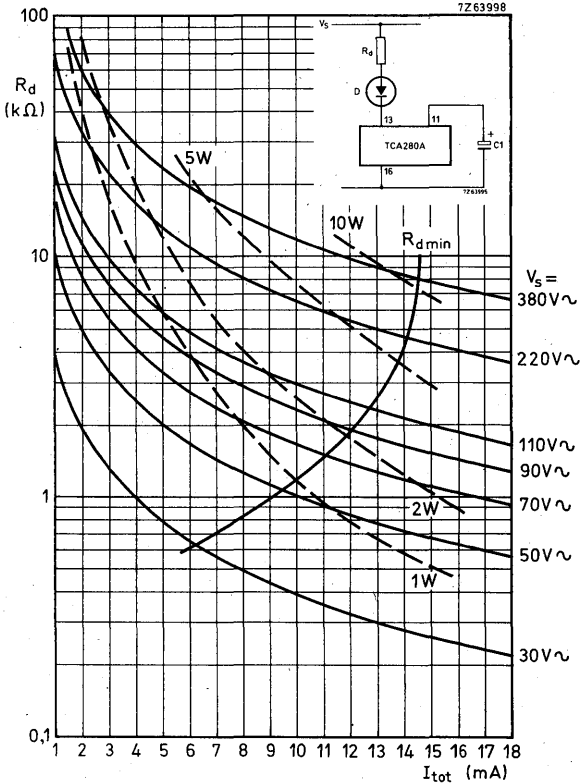


Without diode

Note

This graph is not suitable for phase control applications; use the graph on page 8.

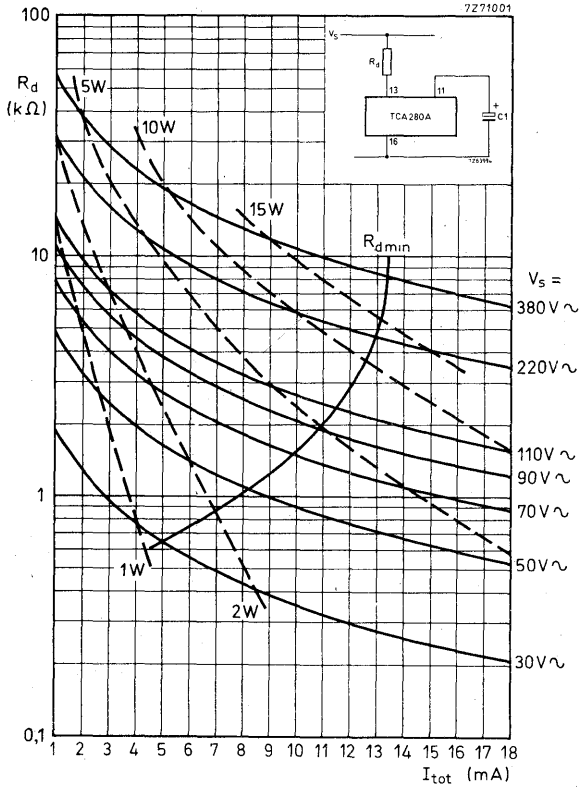
APPLICATION INFORMATION (continued)



Graph for determining the value of R_d and corresponding dissipation at different mains voltages for the circuit conditions shown (with diode D)

I_{tot} is the maximum average current through D5, and is the sum total of the current consumed by the IC and by the external components.

APPLICATION INFORMATION (continued)

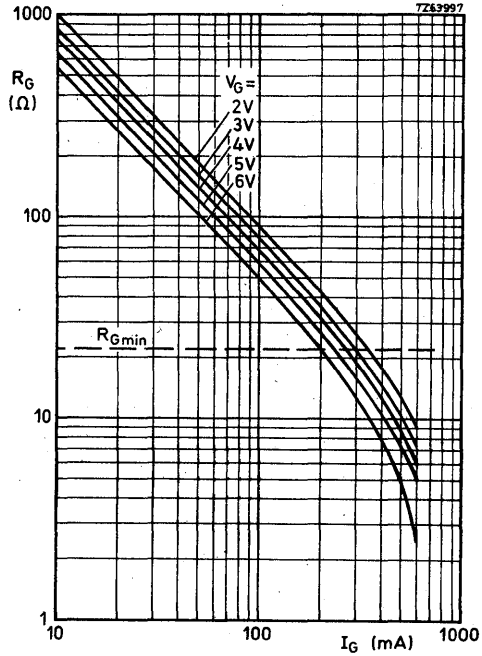


Without diode

Note

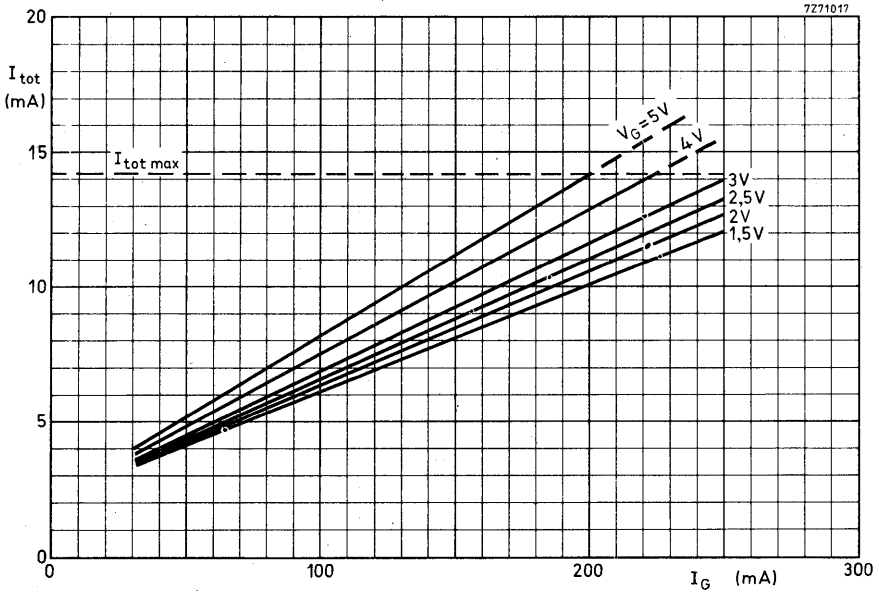
This graph is not suitable for phase control applications; use the graph on page 10,

APPLICATION INFORMATION (continued)



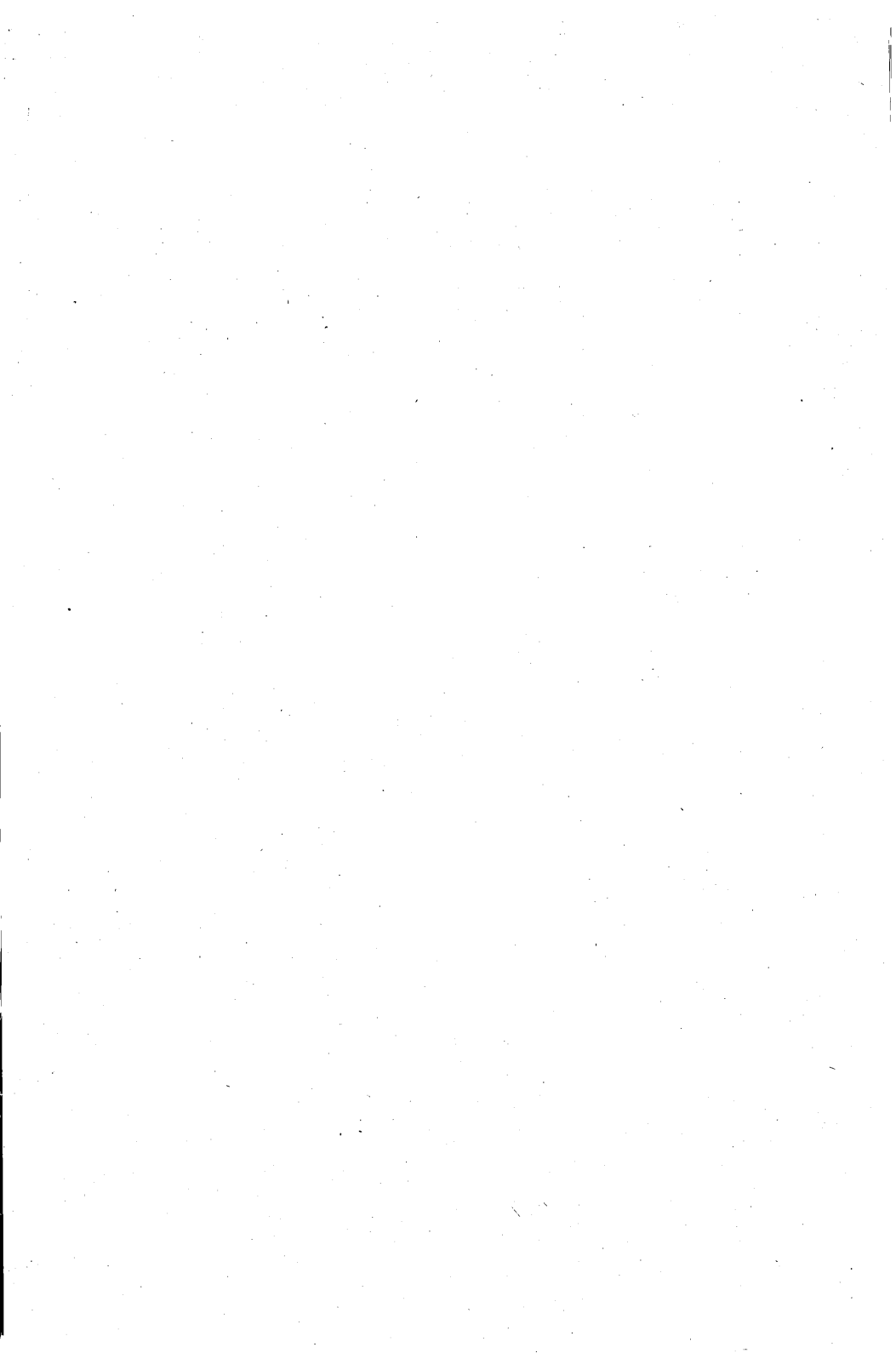
Graph showing R_G as a function of I_G of the TCA280A for various values of V_G . The minimum value of R_G at which the current I_{I0} is kept within the specified limits is 22 Ω .

APPLICATION INFORMATION (continued)



Graph for determining I_{tot} corresponding to a given I_G with V_G as a parameter. Once I_{tot} is known, the required values of R_d , R_G and $C1$ can be found from the graphs on pages 8, 9, 10, 11 and 12.

Note that this graph can be used only if the highest possible R_G is used.



TIMER

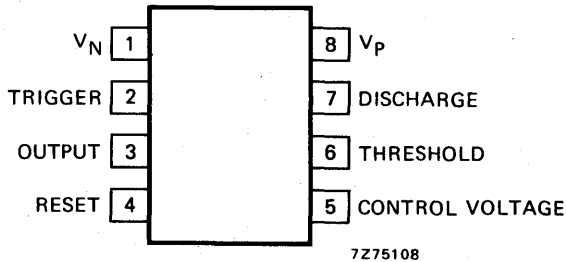
The TDA0555D is a monolithic timer, equivalent to the NE555, however it is mounted in a miniature plastic package.

It is a highly stable controller capable of producing accurate time delays or oscillations. In the time delay mode of operation the timer is controlled by one external resistor and capacitor. For operation as an oscillator the frequency and the duty factor are both accurately controlled by two external resistors and one capacitor. Additional terminals are provided for triggering or resetting. The circuit may be triggered and reset on the falling-edge of a waveform.

Features

- Timing from microseconds to hours
- Operates in both astable and monostable modes
- Adjustable duty factor
- Output can source or sink 200 mA
- Output and supply TTL compatible
- Temperature stability 0,005%/°C
- Normally-on and normally-off output
- Operating ambient temperature : -25 to +85 °C
- Miniature plastic encapsulation

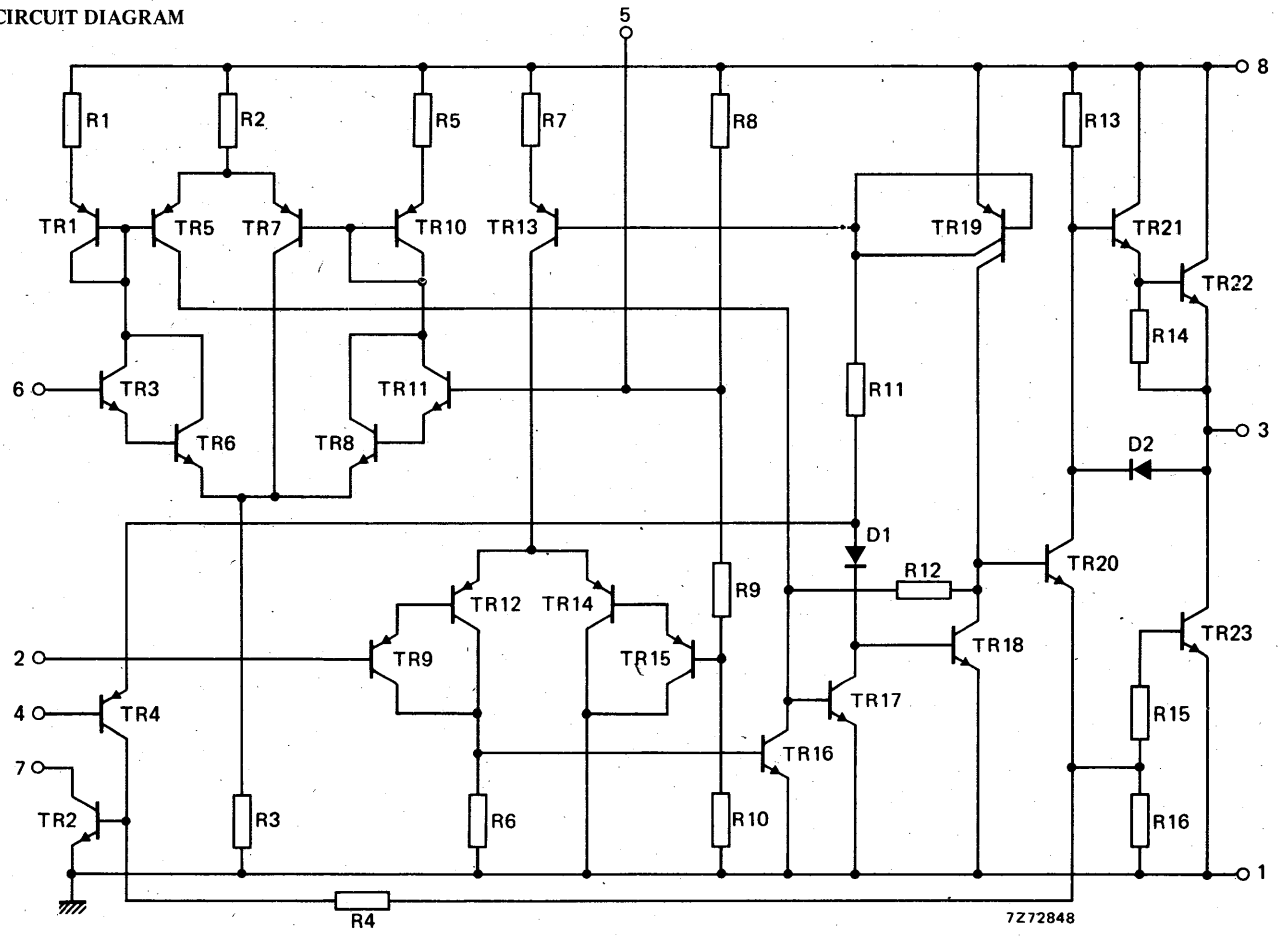
CONNECTION DIAGRAM



PACKAGE OUTLINE (see general section)

SO-8 (SOT-96A); plastic 8-lead flat pack.

CIRCUIT DIAGRAM



RATINGS Limiting values in accordance with the Absolute Maximum System (IEC 134)

Supply voltage	$V_P - V_N$	max.	18	V
<u>Temperatures</u>				
Operating ambient temperature	T_{amb}	-25 to +85	°C	
Storage temperature	T_{stg}	-65 to +125	°C	
Junction temperature	T_j	max.	125	°C
<u>Power dissipation in free air; $T_{amb} = 50$ °C</u>				
Mounted on a ceramic substrate of 4 cm^2 derating factor for $T_{amb} > 50$ °C	P_{tot} $1/R_{th}$	max. =	470 6,3	mW mW/°C
Mounted on PC board of 4 cm^2 derating factor for $T_{amb} > 50$ °C	P_{tot} $1/R_{th}$	max. =	310 4,2	mW mW/°C

CHARACTERISTICS at $V_P = 5$ to 15 V; $V_N = 0$ V; $T_{amb} = 25$ °C unless otherwise specified

Parameter	Conditions	Symbol	min.	typ.	max.	Unit
Supply voltage		V_P	4,5	-	16	V
Supply current ¹⁾	$V_P = 5$ V; $R_L = \infty$	I_P	-	3	6	mA
	$V_P = 15$ V; $R_L = \infty$	I_P	-	10	15	mA
Timing error (monostable)	$R_A = 2$ to 100 k Ω					
initial accuracy	$C = 0, 1$ μ F		-	1	-	%
drift with temperature			-	50	-	ppm/°C
drift with supply voltage			-	0,1	-	%/V
Timing error (astable)	$R_A; R_B = 2$ to 100 k Ω					
initial accuracy	$C = 0, 1$ μ F		-	2,25	-	%
drift with temperature			-	150	-	ppm/°C
drift with supply voltage			-	0,3	-	%/V
Threshold voltage			-	$2/3 V_P$	-	V
Threshold current			-	100	250	nA
Trigger voltage	$V_P = 15$ V		-	5	-	V
	$V_P = 5$ V		-	1,67	-	V
Trigger current			-	2	-	μ A
Reset voltage			0,4	0,7	1,0	V
Reset current			-	0,1	-	mA
Control voltage level	$V_P = 15$ V		9	10	11	V
	$V_P = 5$ V		2,6	3,33	4	V
Output voltage; LOW	$V_P = 15$ V; $I_{sink} = 10$ mA	V_{OL}	-	0,1	0,25	V
	$V_P = 15$ V; $I_{sink} = 50$ mA	V_{OL}	-	0,4	0,75	V
	$V_P = 15$ V; $I_{sink} = 100$ mA	V_{OL}	-	2,0	2,5	V
	$V_P = 15$ V; $I_{sink} = 200$ mA	V_{OL}	-	2,5	-	V
	$V_P = 5$ V; $I_{sink} = 5$ mA	V_{OL}	-	0,25	0,35	V
Output voltage; HIGH	$V_P = 15$ V; $I_{source} = 200$ mA	V_{OH}	-	12,5	-	V
	$V_P = 15$ V; $I_{source} = 100$ mA	V_{OH}	12,75	13,3	-	V
	$V_P = 5$ V; $I_{source} = 100$ mA	V_{OH}	2,75	3,3	-	V
Output rise time		t_r	-	100	-	ns
Output fall time		t_f	-	100	-	ns
Discharge leakage current			-	20	100	nA

¹⁾ Supply current when output HIGH : typ. 1 mA less.

A MAINS-ZERO TRIAC-TRIGGERING CIRCUIT

The TDA1024 is a monolithic integrated circuit intended for use in ON/OFF control of triacs in static switching applications. It incorporates zero voltage point triggering to minimize radio interference.

The TDA1024 is mainly intended for applications such as switching resistive loads and replacing mechanical thermostats in, for example:

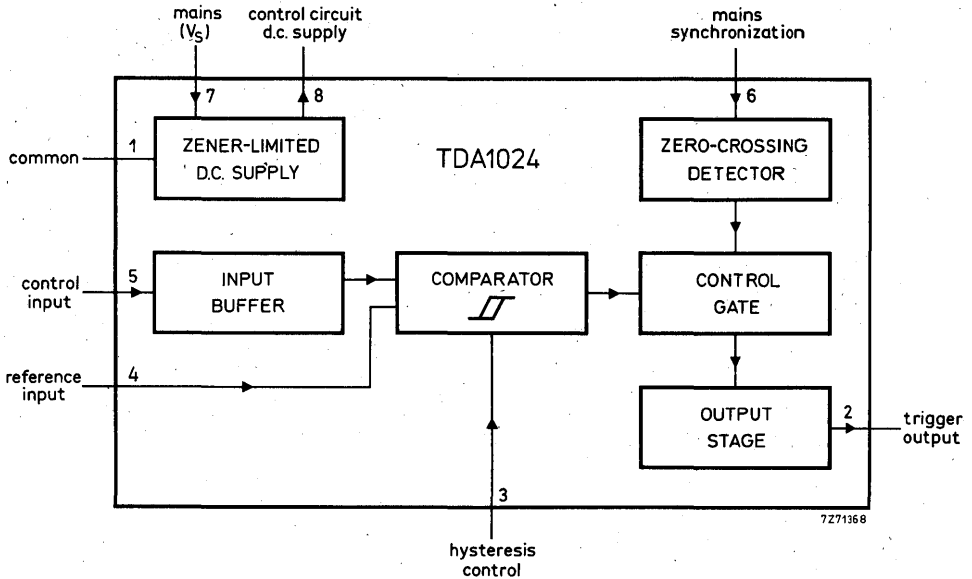
- central heating installations,
- washing machine heaters,
- water heaters,
- smoothing irons.

QUICK REFERENCE DATA

Supply voltage (via dropping resistor)	V_S	mains voltage	
Average supply current	$I_{7(av)}$	typ.	10 mA
Trigger pulse width	t_p	typ.	195 μ s
Max. trigger current capability	I_{2max}	>	100 mA

PACKAGE OUTLINE plastic 8 lead dual in-line (see general section).

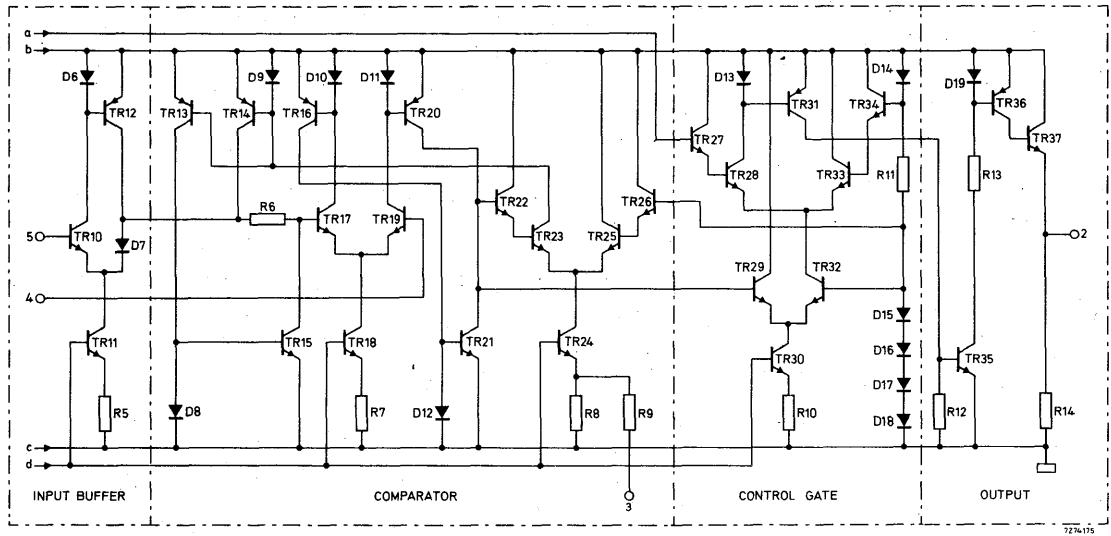
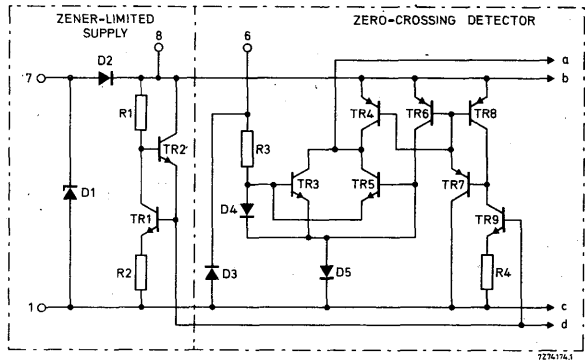
BLOCK DIAGRAM



Functions of the TDA1024 are :

- a comparator with Schmitt-trigger action.
This circuit compares the control voltage at pin 5 with the reference voltage at pin 4 and switches on when the control voltage exceeds the reference voltage. The hysteresis of the circuit is adjustable between 20 mV and 300 mV by selection of the value of a resistor connected between pin 3 and pin 1.
- an input buffer circuit with high input impedance and low output impedance. This circuit presents a low impedance to the comparator input so that the hysteresis of the circuit is independent of variations of the input voltage.
- a control circuit d. c. supply which provides a zener-limited nominal 6,5 V supply, at a current of up to 30 mA, for application to the input bridge.
- a zero-crossing detector which produces an output when the sinusoidal voltage applied to pin 6 passes through zero; advantage of this mode is minimum radio interference.
- a control gate which inhibits the output trigger pulse from the TDA1024 unless there are outputs from both zero-crossing detector and comparator.
- an output stage which delivers a positive-going, mains-synchronized triac trigger pulse whenever the control gate is activated. The output from this stage is current-limited and protected against short-circuit. Since the current and voltage in the load must be in phase for mains-synchronized switching, the applications of the TDA1024 are restricted to the switching of resistive loads.

CIRCUIT DIAGRAM



RATINGS Limiting values in accordance with the Absolute Maximum System (IEC 134)

Voltages

Supply voltage (pin 7)	V_S	max.	8 V
Voltage on pins 2, 3, 4, 5 and 8	$V_{2-1}; V_{3-1}; V_{4-1};$ $V_{5-1}; V_{8-1}$	max.	8 V

Currents

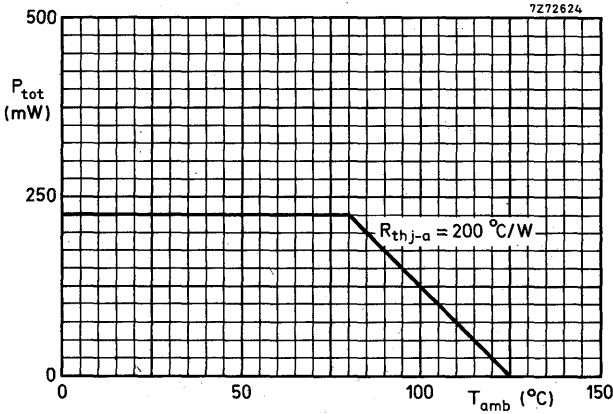
Supply current (pin 7); average value	$\pm I_{7(av)}$	max.	30 mA
	peak value $\pm I_{7M}$	max.	80 mA
Current at pins 4, 5, and 6	$I_4; I_5; \pm I_6$	max.	10 mA
Non-repetitive peak current at pin 7 ($t_p < 50\mu s$)	$\pm I_{7SM}$	max.	2 A
Output current (pin 2); average value	$I_{2(av)}$	max.	30 mA
	peak value ($t_p < 300\mu s$) I_{2M}	max.	400 mA

Temperatures

Storage temperature	T_{stg}	-55 to +125 °C
Operating ambient temperature	T_{amb}	-20 to +80 °C

Power dissipation

Total power dissipation see derating curve below



CHARACTERISTICS at $T_{amb} = 25\text{ }^{\circ}\text{C}$; $f = 50\text{ Hz}$ Zero-crossing detectorTrigger pulse width at $I_6(rms) = 1\text{ mA}$;

$V_{8-1} = 5,5\text{ V}$

t_p	typ.	195	μs
		130 to 265	μs

Synchronization resistor

see Fig. 3

Trigger output (pin 2)Max. current capability at $V_{8-1} = 5,5\text{ V}$ $-I_2\text{ max} >$ 100 mA

Trigger current capability

see Figures 5, 6, 7 and 8

Max. trigger voltage at $-I_2 = 100\text{ mA}$ $V_{2-1} >$ 4 V

Gate resistor

see Fig. 4

Comparator at $V_{8-1} = 6,5\text{ V}$ Hysteresis; pin 3 not connected; $I_3 = 0$ ΔV_{5-4} 10 to 30 mVHysteresis; pin 3 connected to common; $V_3 = 0$ ΔV_{5-4} typ. 300 mVInput current at $V_{4-1} > V_{5-1}$ (pin 4) $I_4 <$ 5 μA

Input current (pin 5)

 $I_5 <$ 5 μA Control circuit d. c. supply (pin 8)Voltage on pin 8 at $I_{7(av)} = 10\text{ mA}$

V_{8-1}	typ.	6,5	V
		5,5 to 7,5	V

IC current consumption (with min. hysteresis)
pins 2 and 3 not connected;

$V_{5-1} > V_{4-1}; V_{8-1} = 5,5\text{ V}$

 $I_{IC} <$ 1,8 mAIC current consumption (with max. hysteresis)
pin 2 not connected; pin 3 connected to common;

$V_{5-1} > V_{4-1}; V_{8-1} = 5,5\text{ V}$

 $I_{IC} <$ 3 mA

Total average current consumption (pin 7)

see Fig. 9

Mains dropping resistor

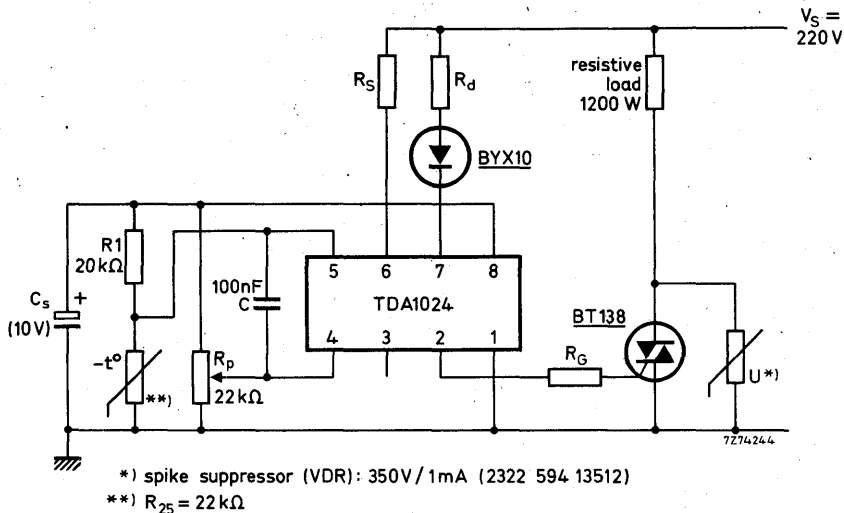
see Figures 10 and 11

Mains dropping capacitor

see Fig. 12

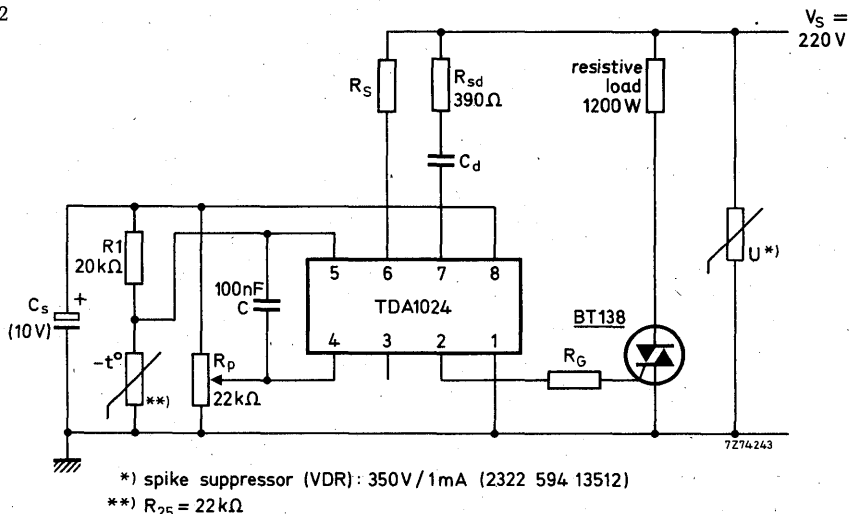
APPLICATION INFORMATION

Fig. 1



The TDA1024 used in a 1200 W thermostat covering the temperature range 5°C to 30°C and designed to minimize the power dissipated by mains dropping resistor R_d by using a rectifier diode.

Fig. 2



The TDA1024 used in a 1200W thermostat covering the temperature range 5°C to 30°C and designed to minimize the dissipation in the mains voltage reduction circuit by using capacitor C_d .

APPLICATION INFORMATION (continued)

Design data for the two previous circuits (for other circuits the same sequence of component value selection must be used):

BT138 triac with: $V_{GT} = 1,6V$ at $0^{\circ}C$ Mains voltage: $V_S = 220 V$
 $I_{GT} = 72 \text{ mA}$ at $0^{\circ}C$ Triac load: 1200 W
 $I_L < 60 \text{ mA}$

Component values and circuit parameters:

parameter		Value		Figure
		Fig. 1	Fig. 2	
trigger pulse width	: t_p (μs)	105	105	*)
sync. resistor	: R_S ($k\Omega$)	180	180	3
gate resistor	: R_G (Ω)	33	33	4
average gate current	: $I_{2(av)}$ (mA)	3,7	3,7	6
min. required supply current	: I_7 (mA)	6,5	6,5	9
mains dropping resistor	: R_d ($k\Omega$)	10	—	10
smoothing capacitor	: C_S (μF)	470	470	10
power dissipated by R_d	: P_{Rd} (W)	3,2	—	11
mains dropping capacitor	: C_d (nF)	—	270	12
power dissipated by R_{sd}	: P_{Rsd} (mW)	—	190	12

*) See BT138 data sheet.

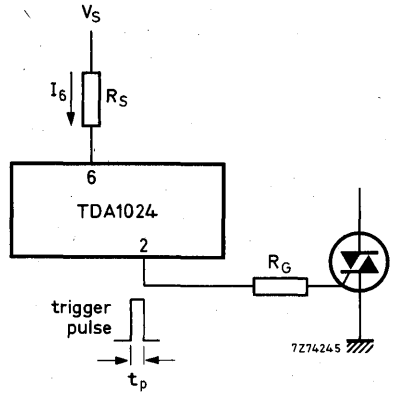
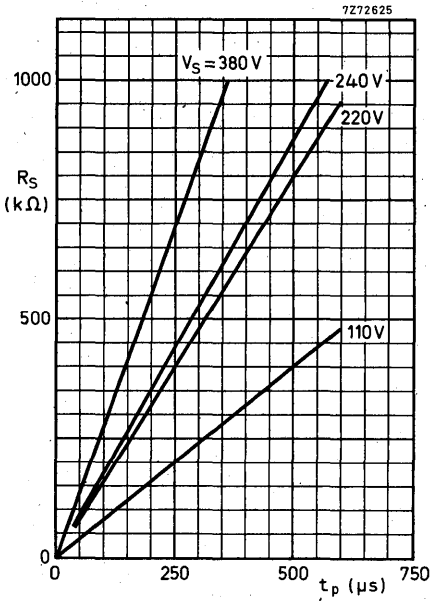


Fig. 3. Synchronization resistor (R_S) value as a function of required trigger pulse width (t_p) with applied mains voltage (V_S) as a parameter. Tolerance for R_S : $\pm 5\%$ for V_S : $\pm 10\%$

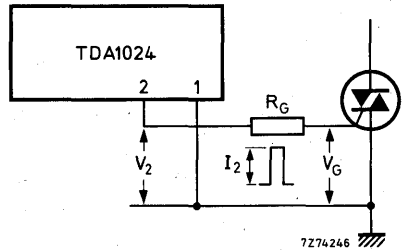
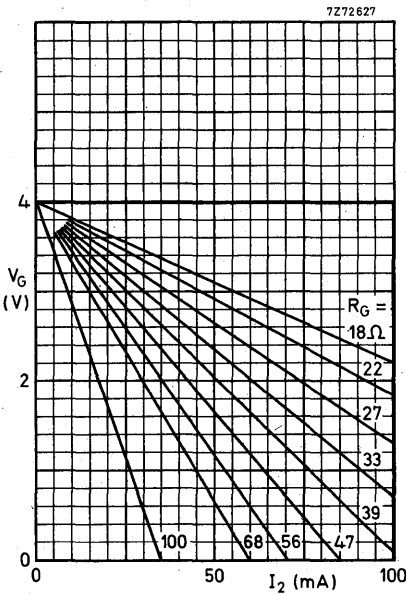
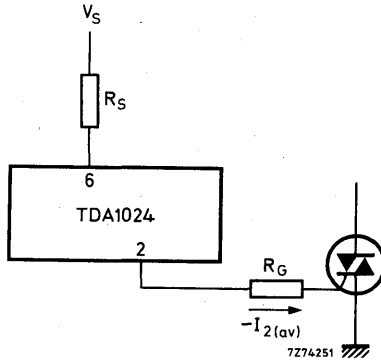


Fig. 4. Gate voltage (V_G) as a function of trigger current (I_2) with gate resistor (R_G) load lines.

Figures 5, 6, 7 and 8, on the next two pages, have to be used with the circuit below. They show the maximum average trigger current $I_{2(av)}$ as a function of the value of R_G with the value of R_S as a parameter for $V_S = 110V; 220 V; 240 V; 380 V$ respectively.



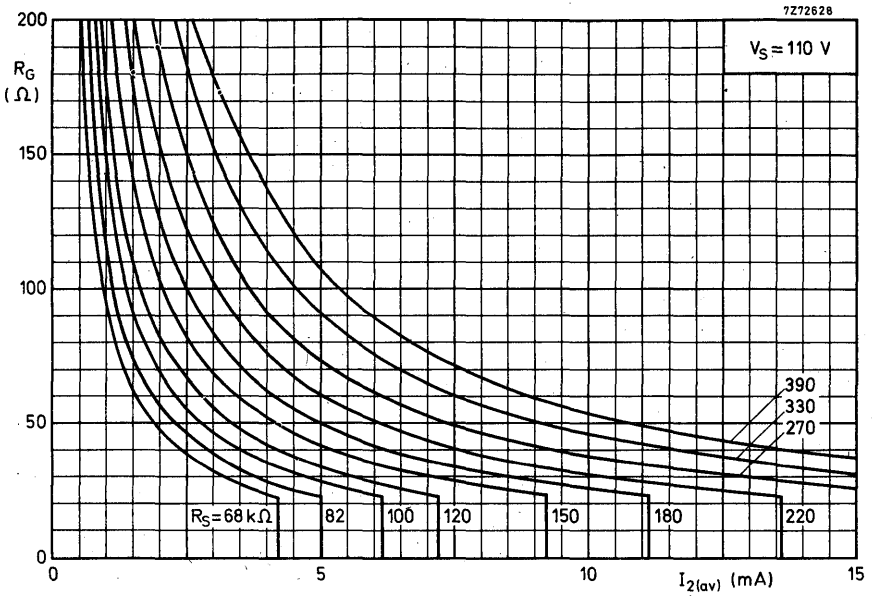


Fig. 5

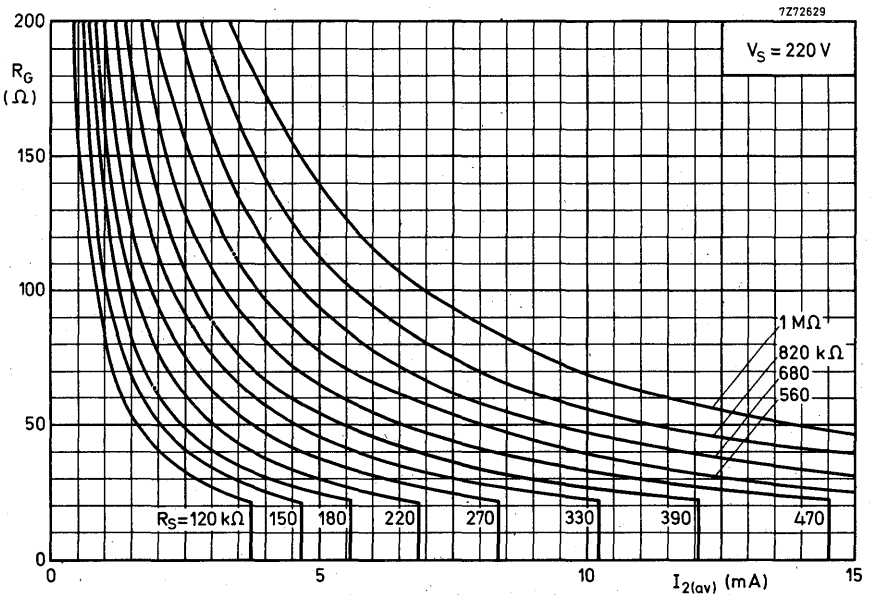


Fig. 6

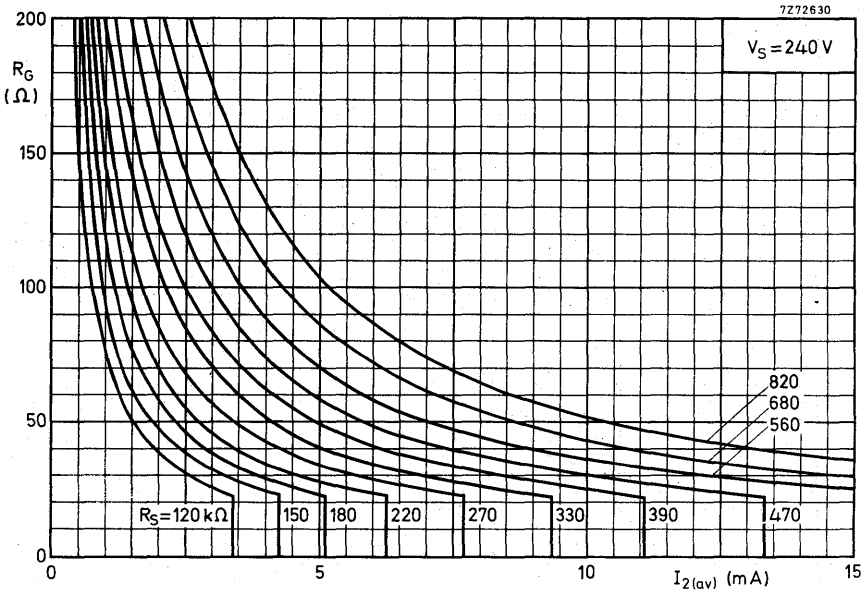


Fig. 7

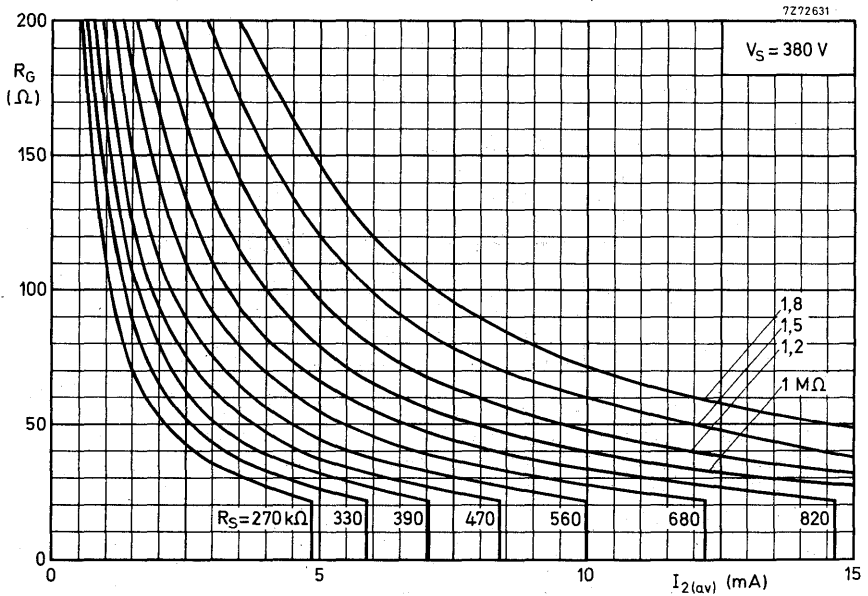


Fig. 8

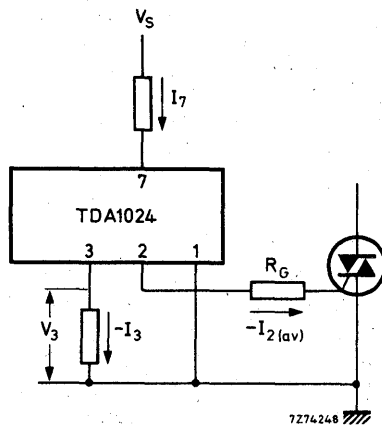
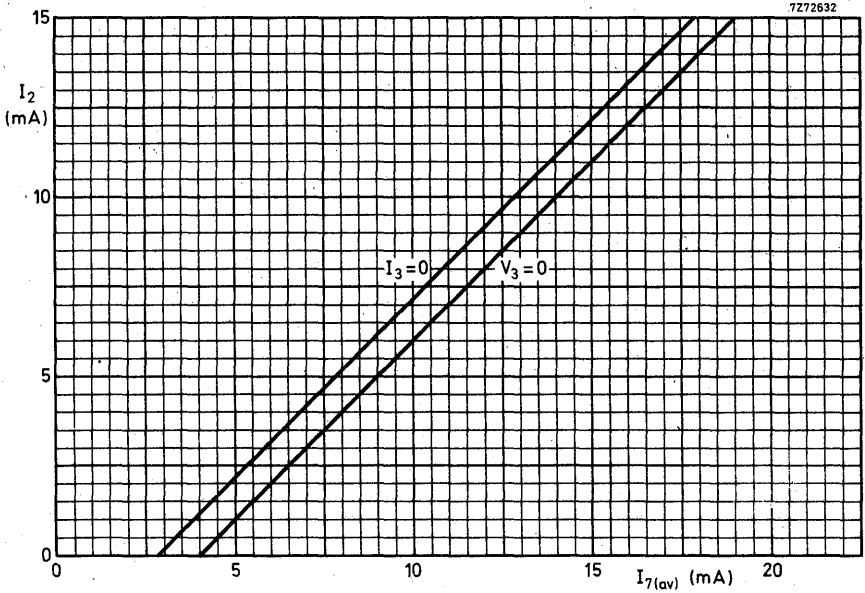


Fig. 9. Minimum required supply current (I_7) as a function of maximum average trigger current ($I_{2(av)}$), with hysteresis setting as a parameter.
 $I_3 = 0$; min. hysteresis.
 $V_3 = 0$; max. hysteresis.

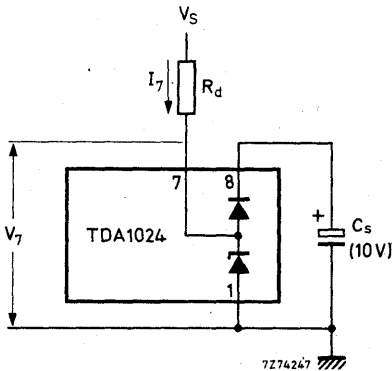
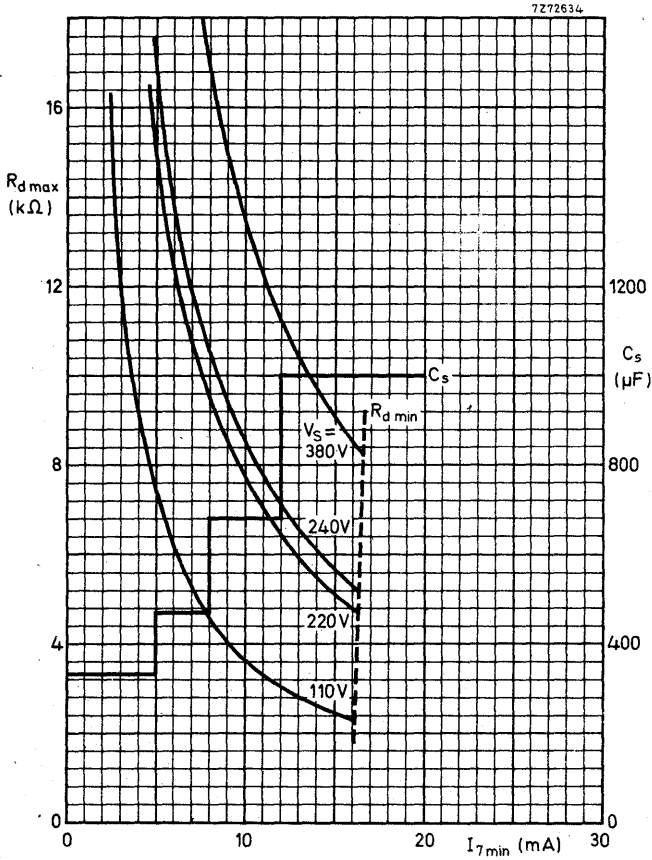


Fig. 10. Value of $R_d \text{ max}$ as a function of $I_{7 \text{ min}}$ with supply voltage (V_s) as a parameter. Also shown is the value of the smoothing capacitor (C_s) as a function of $I_{7 \text{ min}}$.

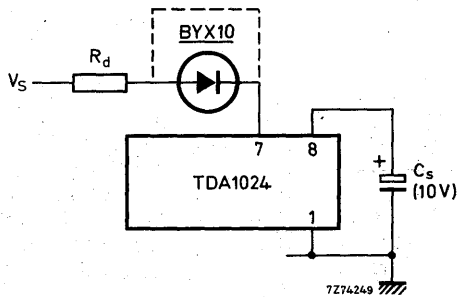
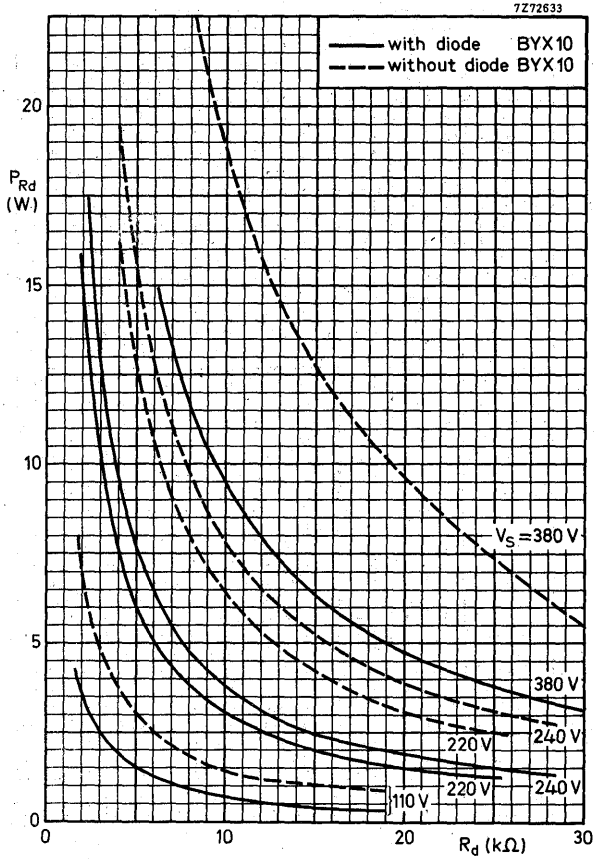
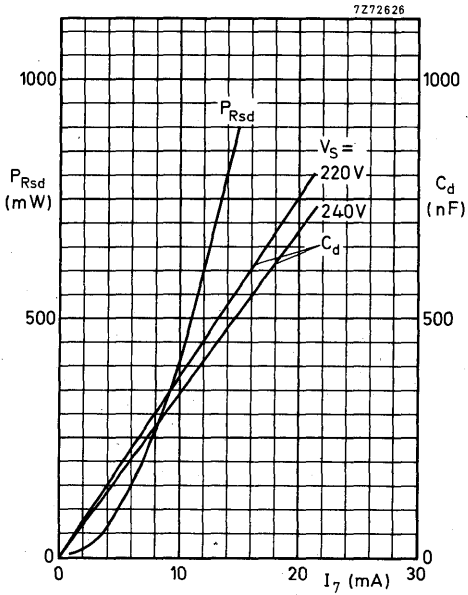


Fig. 11. The power dissipated by mains dropping resistor R_d (P_{R_d}) as a function of its value with the supply voltage (V_s) as a parameter.



Using a capacitor for mains supply voltage dropping.

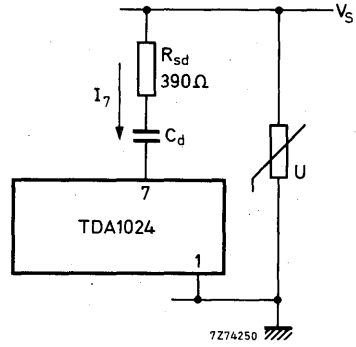
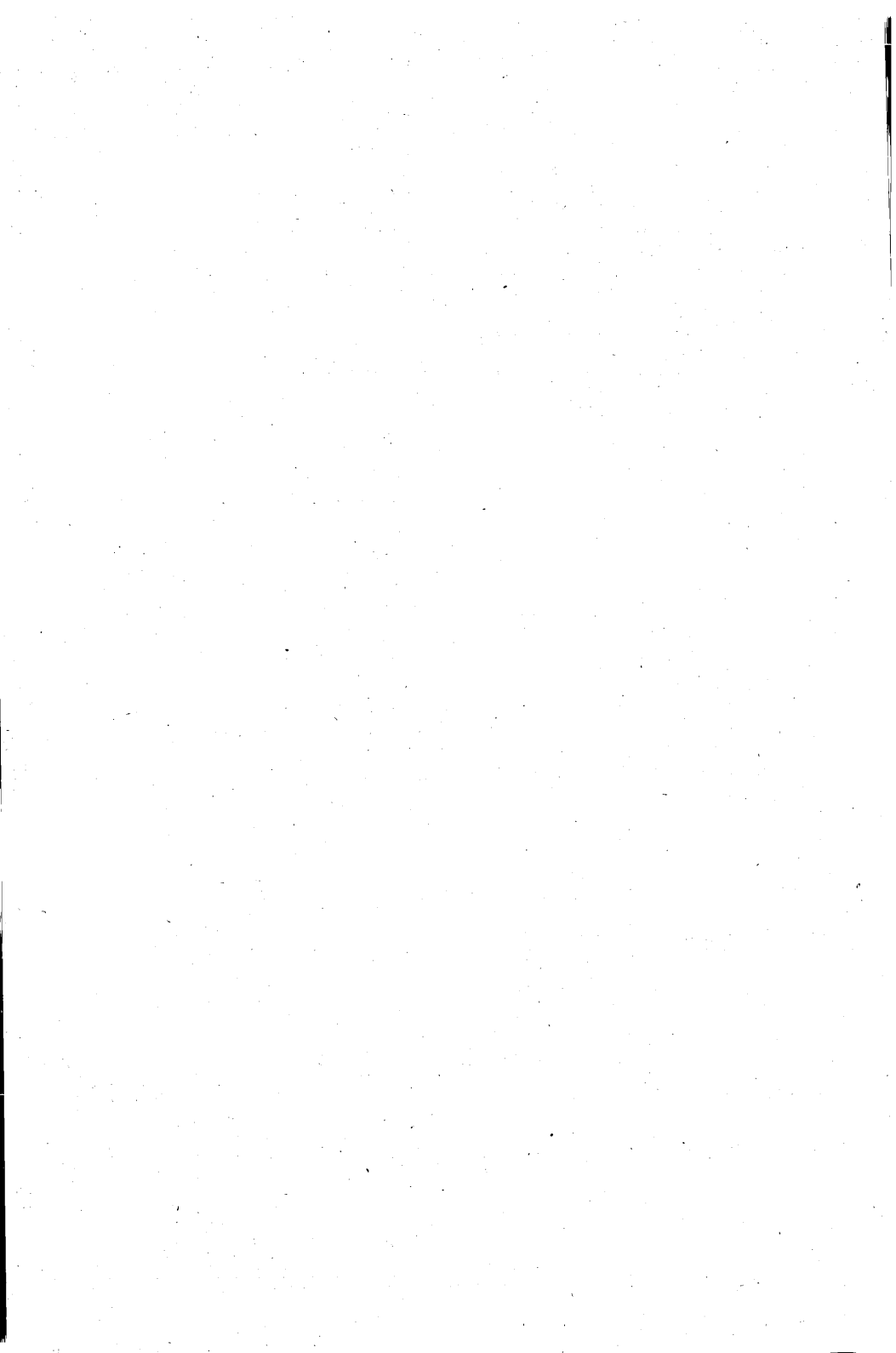


Fig. 12. Power dissipated by the dropping resistor (P_{Rsd}) and the dropping capacitor value (C_d) as a function of the current into pin 7 (I_7) with the mains supply voltage (V_S) as a parameter.



SPECIAL CIRCUITS



TYPE SELECTION

Special circuits

- SAA1114; Z - 4-MHz clock circuit
- TDA0319D - dual voltage comparator
- TDA0723D - precision voltage regulator
- TDA3081; TDA3082 - seven-transistor array

4 MHz CLOCK CIRCUITS

The SAA1114 is a C-MOS integrated circuit, particularly suited for crystal controlled clocks powered by a single battery.

It contains an oscillator, a 22-stage frequency divider and a driver for a unipolar stepper motor.

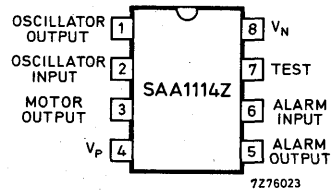
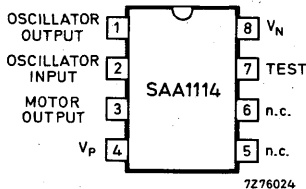
With an oscillator frequency of 4,1943 MHz, the output is a 1 Hz pulse of 31,25 ms duration with a current sinking capability of minimum 6 mA.

The SAA1114Z is the same circuit, but has, in addition an alarm output signal.

Features

- Oscillator frequency: 4 MHz
- Output for unipolar stepper motor
- Single battery power supply
- Current consumption: typ. 50 μ A
- Output signal for alarm (SAA1114Z only)

CONNECTION DIAGRAMS

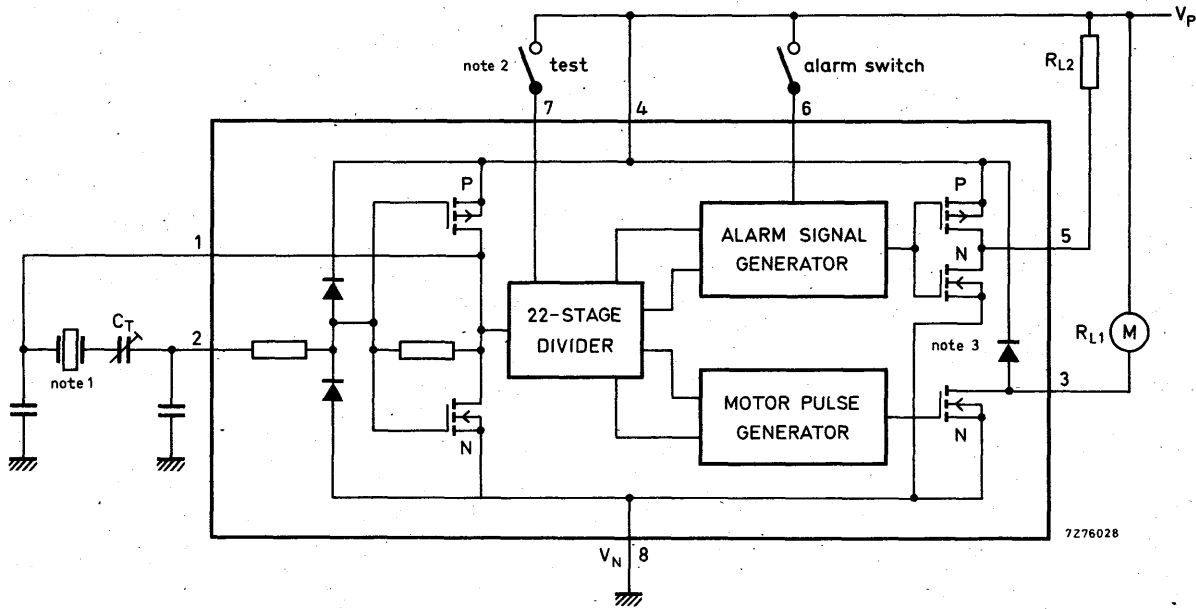


Note

The SAA1114 is internally protected against electrostatic damage. However, to be totally safe, it is desirable to take handling precautions into account.

PACKAGE OUTLINE plastic 8-lead dual in-line (see general section).

BLOCK DIAGRAM



Notes

1. Recommended crystal: 4322 143 03111; trimmer: 2222 808 32409.
2. Connecting the test terminal (pin 7) to V_P speeds up the output by a factor 128 for rapid testing. No connection is necessary for normal operation, due to an internal pull-down.
3. A built-in clamping diode between the motor output and V_P acts as a current by-pass if the induced voltage of the stepper motor exceeds 0,6 V.

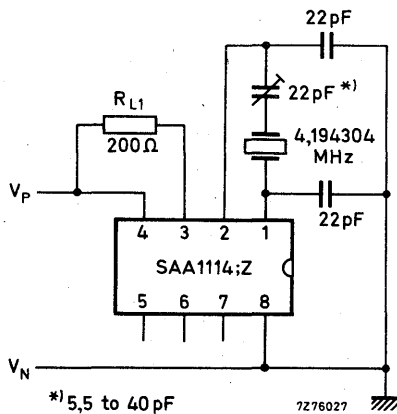
RATINGS Limiting values in accordance with the Absolute Maximum System (IEC 134)

Supply voltage ($V_N = 0$)	V_P	max.	3	V
Input voltage (all inputs)			V_N to V_P	
Motor output current (pin 3)	$\pm I_3$	max.	50	mA
Operating ambient temperature	T_{amb}		-20 to +70	°C
Storage temperature	T_{stg}		-30 to +100	°C

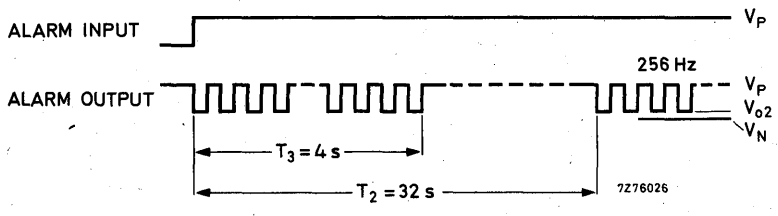
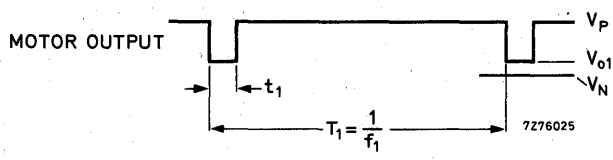
CHARACTERISTICS at $V_P = 1,5$ V; $V_N = 0$; $f_o = 4,194$ MHz; $T_{amb} = 25$ °C unless otherwise specified

Supply voltage range	V_P	>	1,2 to 1,7	V
		typ.	1,0 to 3,0	V
Supply current at $R_{L1} = \infty$	I_P	typ.	50	μ A
		<	120	μ A
Motor output frequency (see timing diagram)	f_1	typ.	1	Hz
Pulse width of motor output	t_1	typ.	31,25	ms
Voltage drop across output transistor at $R_{L1} = 200\Omega$	V_{o1}	typ.	80	mV
		<	200	mV
Stability of oscillator at $\Delta V_P = 100$ mV	$\Delta f/f_o$	typ.	$0,2 \times 10^{-6}$	
The following characteristics apply to the SAA1114Z only (with additional alarm output).				
Duration of alarm signal; pin 6 at V_P	T_3	typ.	4	s
Repetition of alarm signal; pin 6 at V_P	T_2	typ.	32	s
Frequency of alarm signal (50% duty cycle)	f_2	typ.	256	Hz
Voltage drop across alarm output at $R_{L2} = 1$ k Ω	V_{o2}	typ.	100	mV
		<	250	mV

Test circuit



TIMING DIAGRAMS



DUAL VOLTAGE COMPARATOR

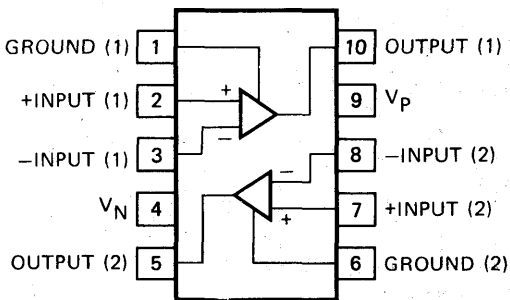
The TDA0319D consists of two independent precision high-speed comparators. It is designed to operate over a wide range of supply voltages down to a single 5 V logic supply and ground.

The uncommitted collector of the output stage makes the device compatible with DTL, TTL and C-MOS as well as capable of driving lamps and relays at currents up to 25 mA. The circuit is equivalent to the LM319, however it is mounted in a miniature plastic package suitable for hybrid modules and for applications where small dimensions are important.

Features

- Two independent comparators
- Operates from a single 5 V supply
- Typically 80 ns response time at ± 15 V
- Minimum fan-out of 2 TTL gates (each side)
- Maximum input current: 1 μ A
- Inputs and outputs can be insulated from system ground
- High common mode slew rate.

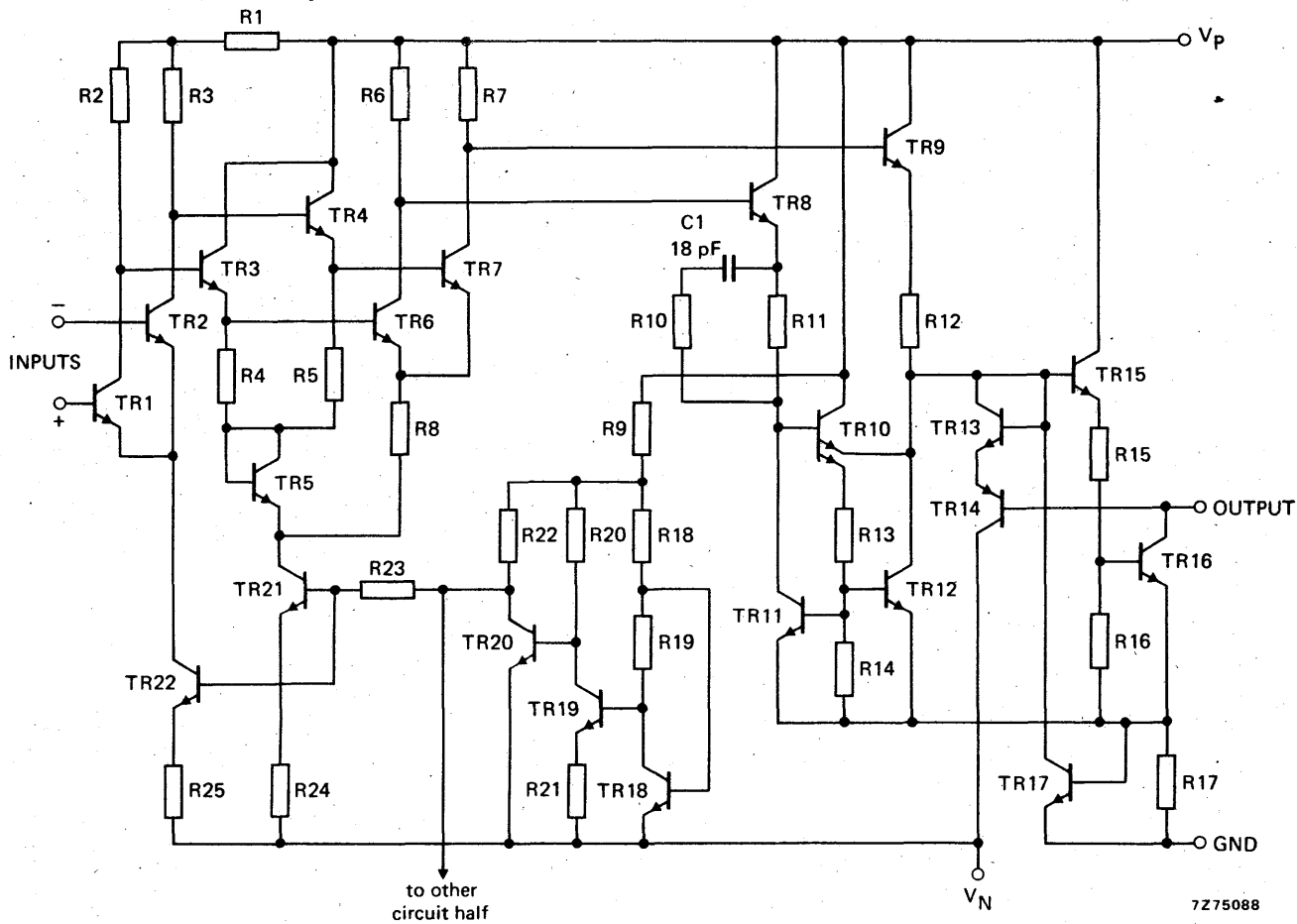
CONNECTION DIAGRAM



7275101

PACKAGE OUTLINE SO-10 (plastic 10-lead flat pack) (see general section).

CIRCUIT DIAGRAM (one comparator)



7Z75088

RATINGS Limiting values in accordance with the Absolute Maximum System (IEC 134)

Supply voltage	$V_P - V_N$	max.	36	V
Output to negative supply voltage	$V_O - V_N$	max.	36	V
Ground to negative supply voltage	$V_{GND} - V_N$	max.	25	V
Ground to positive supply voltage	$V_P - V_{GND}$	max.	18	V
Differential input voltage	$V_{I+} - V_{I-}$	max.	± 5	V
Common mode input voltage	$V_{I+}; V_{I-}$	max.	± 15	V ¹⁾
Output short-circuit duration	t_{sc}	max.	10	s

Temperatures

Operating ambient temperature	T_{amb}	-25 to +85	°C
Storage temperature	T_{stg}	-65 to +125	°C
Junction temperature	T_j	max. 125	°C

Power dissipation in free air; $T_{amb} = 50$ °C

Mounted on a ceramic substrate of 4 cm ²	P_{tot}	max.	500	mW
derating factor for $T_{amb} > 50$ °C	$1/R_{th}$	=	6,7	mW/°C
Mounted on PC board of 4 cm ²	P_{tot}	max.	350	mW
derating factor for $T_{amb} > 50$ °C	$1/R_{th}$	=	4,7	mW/°C

¹⁾ For supply voltages less than ± 15 V, the absolute maximum input voltage is equal to the supply voltage.

CHARACTERISTICS at $V_P = 15\text{ V}$; $-V_N = 15\text{ V}$; $T_{\text{amb}} = 25\text{ }^\circ\text{C}$ unless otherwise specified

Parameter	Conditions	Symbol	min.	typ.	max.	Unit
Input offset voltage	$R_S < 5\text{ k}\Omega$ 1) 2)	V_{io}	-	2,0	8,0	mV
Input offset current	1) 2)	I_{io}	-	80	200	nA
Input bias current	1)	I_i	-	250	1000	nA
Voltage gain		G_V	8	40	-	V/mV
Response time	3)		-	80	-	ns
Saturation voltage	$-V_i < 10\text{mV}$; $I_o = 25\text{mA}$	V_{sat}	-	0,75	1,5	V
Output leakage current	$V_i > 10\text{mV}$; $V_o = 35\text{V}$	I_o	-	0,2	10	μA
Positive supply current		I_P	-	8	12,5	mA
Negative supply current		I_N	-	3	5	mA
Positive supply current	$V_P = 5\text{V}$; $-V_N = 0$	I_P	-	4,3	-	mA

CHARACTERISTICS at $V_P = 15\text{ V}$; $-V_N = 15\text{ V}$; $T_{\text{amb}} = 0\text{ to }+70\text{ }^\circ\text{C}$

Parameter	Conditions	Symbol	min.	typ.	max.	Unit
Input offset voltage	$R_S < 5\text{ k}\Omega$ 1) 2)	V_{io}	-	-	10	V
Input offset current	1) 2)	I_{io}	-	-	300	nA
Input bias current	1)	I_i	-	-	1200	nA
Offset voltage range	$V_P = -V_N = 15\text{ V}$	V_{io}	-	± 13	-	V
	$V_P = 5\text{ V}$; $-V_N = 0$	V_{io}	1	-	3	V
Saturation voltage	$V_P > 4,5\text{ V}$; $-V_N = 0$					
	$V_i < -10\text{mV}$; $I_{\text{sink}} < 3,2\text{ mA}$	V_{sat}	-	0,3	0,4	V
Differential input voltage		V_i	-	± 5	-	V

- 1) The offset voltage, offset current and bias current specifications apply for any supply voltage from a single 5 V supply up to $\pm 15\text{ V}$ supplies.
- 2) The offset voltages and offset currents given are the maximum values required to drive the output within 1 V of either supply with a 1 mA load. Thus these parameters define an error band and take into account the worst case effects of voltage gain and input impedance.
- 3) The response time specified is for a 100 mV input step with 5 mV overdrive.

PRECISION VOLTAGE REGULATOR

The TDA0723D is a monolithic precision voltage regulator. The circuit is equivalent to the μ A723C, however it is mounted in a miniature plastic package suitable for hybrid circuits or other miniaturized applications.

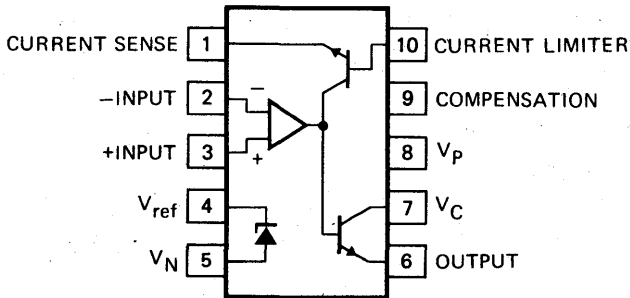
The circuit contains a temperature compensated reference amplifier, an error amplifier, a power series pass transistor and a current limiting circuit with access to remote shut down.

The device can be used with positive or negative supply voltages as a series, shunt, switching or floating regulator.

Features

- Positive and negative supply operation.
- Line and load regulation
- Temperature coefficient of the output voltage: typ. 0,003 % per $^{\circ}\text{C}$
- Input voltage range: 9,5 to 40 V
- Output voltage range: 2 to 37 V
- Operating ambient temperature: -25 to $+85$ $^{\circ}\text{C}$
- Miniature plastic encapsulation.

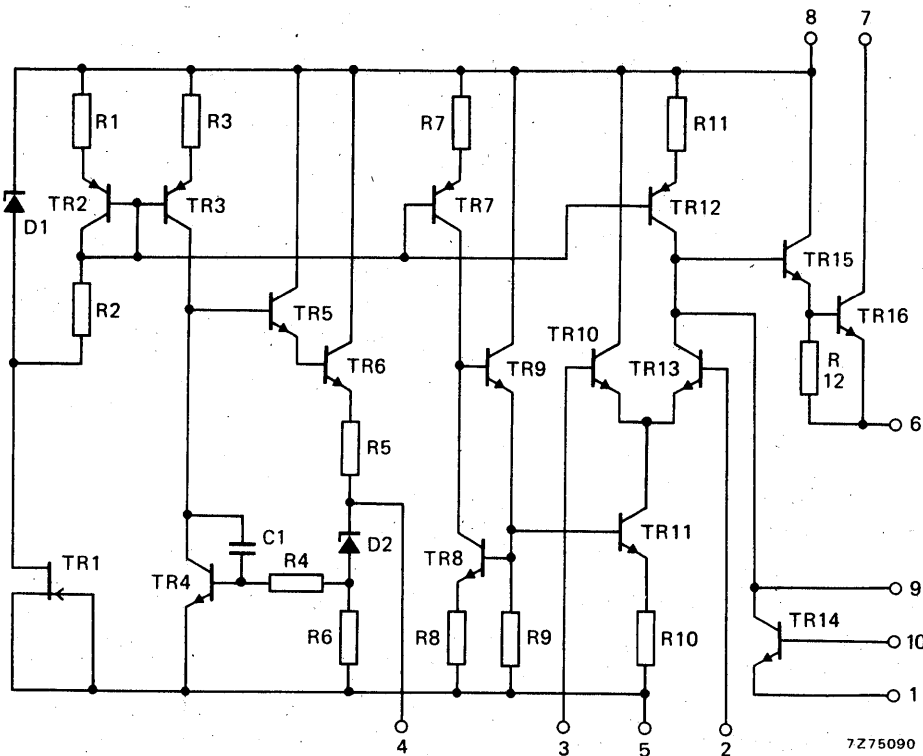
CONNECTION DIAGRAM



PACKAGE OUTLINE (see general section)

SO-10; plastic 10-lead flat pack.

CIRCUIT DIAGRAM



RATINGS Limiting values in accordance with the Absolute Maximum System (IEC134)

Input collector voltage (pin 7)	V_C	max.	40 V
Supply voltage	V_P	max.	40 V
Input-output voltage difference	V_{7-6}	max.	40 V
Output current	I_6	max.	150 mA
Current from reference output	I_4	max.	15 mA

Temperatures

Operating ambient temperature	T_{amb}	-25 to +85 °C
Storage temperature	T_{stg}	-65 to +125 °C
Junction temperature	T_j	max. 125 °C

RATINGS (continued)Power dissipation in free air; $T_{amb} = 50\text{ }^{\circ}\text{C}$ Mounted on a ceramic substrate of 4 cm^2
derating factor for $T_{amb} > 50\text{ }^{\circ}\text{C}$

P_{tot}	max.	485 mW
$1/R_{th}$	=	6,5 mW/ $^{\circ}\text{C}$

Mounted on PC board of 4 cm^2
derating factor for $T_{amb} > 50\text{ }^{\circ}\text{C}$

P_{tot}	max.	335 mW
$1/R_{th}$	=	4,5 mW/ $^{\circ}\text{C}$

CHARACTERISTICS at $V_i = V_P = V_C = 12\text{ V}$; $-V_N = 0\text{ V}$; $I_L = 5\text{ mA}$; $R_{sc} = 0$;
 $C = 100\text{ pF}$; $C_{ref} = 0$; $T_{amb} = 25\text{ }^{\circ}\text{C}$ unless otherwise specified

Parameter	Conditions	Symbol	min.	typ.	max.	Unit
Line regulation ¹⁾	$V_i = 12\text{ to }15\text{ V}$		-	0,01	0,1	% V_O
	$V_i = 12\text{ to }40\text{ V}$		-	0,1	0,5	% V_O
Load regulation ¹⁾	$I_L = 1\text{ to }50\text{ mA}$		-	0,03	0,2	% V_O
Ripple rejection	$f = 50\text{ Hz to }10\text{ kHz}$					
	$C_{ref} = 0$		-	74	-	dB
	$C_{ref} = 5\text{ }\mu\text{F}$		-	86	-	dB
Short-circuit current limit	$R_{sc} = 10\text{ }\Omega$; $V_O = 0$		-	65	-	mA
Reference voltage		V_{ref}	6,80	7,15	7,50	V
Output noise voltage	$B = 100\text{ Hz to }10\text{ kHz}$					
	$C_{ref} = 0$	$V_n(\text{rms})$	-	20	-	μV
	$C_{ref} = 5\text{ }\mu\text{F}$	$V_n(\text{rms})$	-	2,5	-	μV
Long term stability	over 1000 hours		-	0,1	-	%
Stand-by current drain	$I_L = 0$; $V_i = 30\text{ V}$		-	2,3	4,0	mA
Input voltage range		V_i	9,5	-	40	V
Output voltage range		V_O	2	-	37	V
Input-output voltage difference		$V_i - V_O$	3	-	38	V

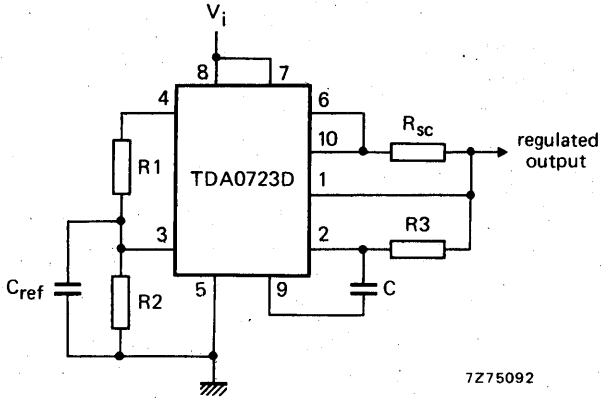
The following characteristics are at $T_{amb} = 0\text{ to }+70\text{ }^{\circ}\text{C}$

Parameter	Conditions	Symbol	min.	typ.	max.	Unit
Line regulation	$V_i = 12\text{ to }15\text{ V}$		-	-	0,3	% V_O
Load regulation	$I_L = 1\text{ to }50\text{ mA}$		-	-	0,6	% V_O
Average temperature coefficient of output voltage			-	0,003	0,015	%/ $^{\circ}\text{C}$

¹⁾ The load and line regulation specifications are for a constant junction temperature. Temperature drift effects must be taken into account separately when the unit is operating under high dissipation conditions.

N.B.: For R_{sc} , C , C_{ref} see circuits on page 4.

Low voltage regulator ($V_o = 2$ to 7 V)

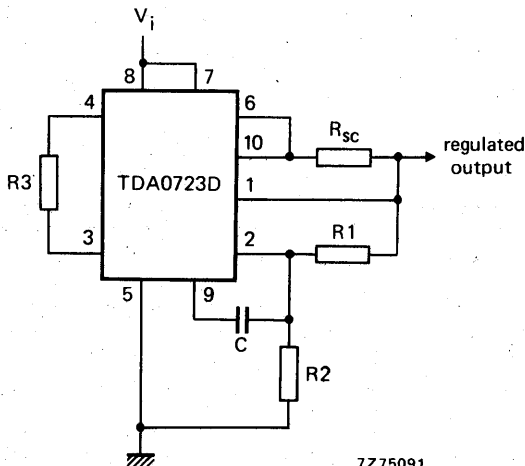


7Z75092

$$V_o = V_{ref} \times \frac{R_2}{R_1 + R_2}$$

$$R_3 = \frac{R_1 \cdot R_2}{R_1 + R_2} \text{ for minimum temperature drift.}$$

High voltage regulator ($V_o = 7$ to 37 V)



7Z75091

$$V_o = V_{ref} \times \frac{R_1 + R_2}{R_2}$$

$$R_3 = \frac{R_1 \cdot R_2}{R_1 + R_2} \text{ for minimum temperature drift}$$

R3 may be eliminated for minimum component count.

DEVELOPMENT SAMPLE DATA

This information is derived from development samples made available for evaluation. It does not form part of our data handbook system and does not necessarily imply that the device will go into production

TDA3081
TDA3082

SEVEN-TRANSISTOR ARRAYS

The TDA3081 and TDA3082 are monolithic integrated circuits each consisting of seven separate n-p-n transistors on a common substrate.

The transistors are capable of driving loads up to 100 mA. At the same time the transistor geometry used gives maximum current gain at quite low currents, making the devices also suitable for small signal applications.

In the TDA3081 the transistors are connected in common emitter configuration whilst in the TDA3082 the collectors are common.

The transistor arrays are particularly suitable for driving light-emitting diodes and seven-segment displays as well as for general purpose applications.

QUICK REFERENCE DATA

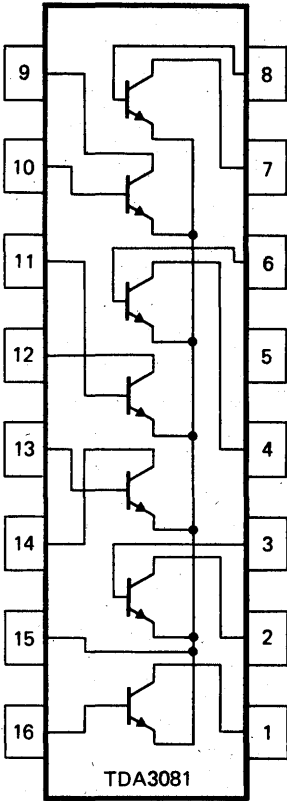
Collector-base voltage (open emitter)	V_{CBO}	max.	50	V
Collector-emitter voltage (open base)	V_{CEO}	max.	35	V
Collector current (d. c.)	I_C	max.	100	mA
Power dissipation : any one transistor	P	max.	500	mW
total package	P_{tot}	max.	750	mW

CONNECTION DIAGRAMS (see page 2)

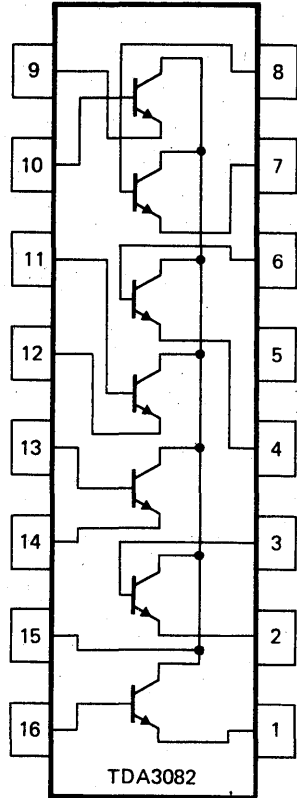
PACKAGE OUTLINE plastic 16-lead dual in-line (see general section).

TDA3081
TDA3082

CONNECTION DIAGRAMS



7275103



7275102

Note : pins 5 are substrate.

RATINGS Limiting values in accordance with the Absolute Maximum System (IEC 134)

Each transistor

Voltages

Collector-emitter voltage (open base)	V_{CEO}	max.	35	V
Collector-base voltage (open emitter)	V_{CB0}	max.	50	V
Collector-substrate voltage (open base and emitter)	V_{CS0}	max.	50	V
Emitter-base voltage (open collector)	V_{EBO}	max.	6	V

Currents

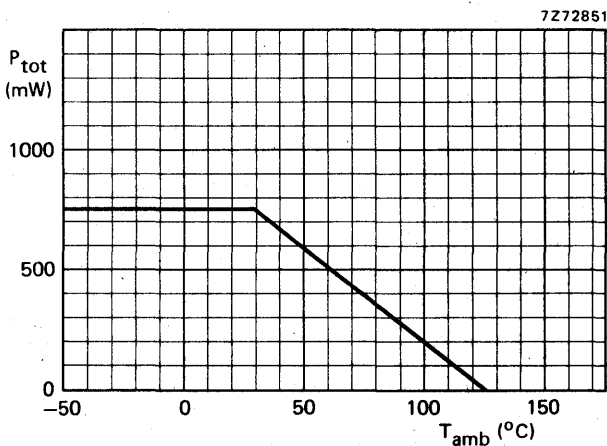
Collector current (d.c.)	I_C	max.	100	mA
Base current (d.c.)	I_B	max.	20	mA

Power dissipation

Power dissipation: any one transistor	P	max.	500	mW
total package (see derating curve)	P_{tot}	max.	750	mW

Temperatures

Operating ambient temperature	T_{amb}	-40 to +125	°C
Storage temperature	T_{stg}	-50 to +125	°C
Junction temperature	T_j	max. 125	°C



CHARACTERISTICS at $T_{amb} = 25\text{ }^{\circ}\text{C}$ unless otherwise specified

Collector-emitter breakdown voltage

$$I_C = 1\text{ mA}; I_B = 0$$

$$V_{(BR)CEO} > 35\text{ V}$$

Collector-substrate breakdown voltage

$$I_C = 1\text{ mA}; I_B = 0; I_E = 0$$

$$V_{(BR)CSO} > 50\text{ V}$$

Collector-base breakdown voltage

$$I_C = 10\text{ }\mu\text{A}; I_E = 0$$

$$V_{(BR)CBO} > 50\text{ V}$$

Emitter-base breakdown voltage

$$I_E = 10\text{ }\mu\text{A}; I_C = 0$$

$$V_{(BR)EBO} \begin{matrix} \text{typ. } 7,0\text{ V} \\ 6,5\text{ to } 7,5\text{ V} \end{matrix}$$

D. C. current gain

$$I_E = 10\text{ }\mu\text{A}; V_{CE} = 5\text{ V}$$

$$h_{FE} \quad 50\text{ to } 300$$

$$I_E = 1\text{ mA}; V_{CE} = 5\text{ V}$$

$$h_{FE} \quad 50\text{ to } 300$$

$$I_E = 20\text{ mA}; V_{CE} = 5\text{ V}$$

$$h_{FE} \quad 30\text{ to } 200$$

Saturation voltage

$$I_C = 5\text{ mA}; I_B = 0,5\text{ mA}$$

$$V_{CEsat} \begin{matrix} \text{typ. } 0,2\text{ V} \\ < 0,4\text{ V} \end{matrix}$$

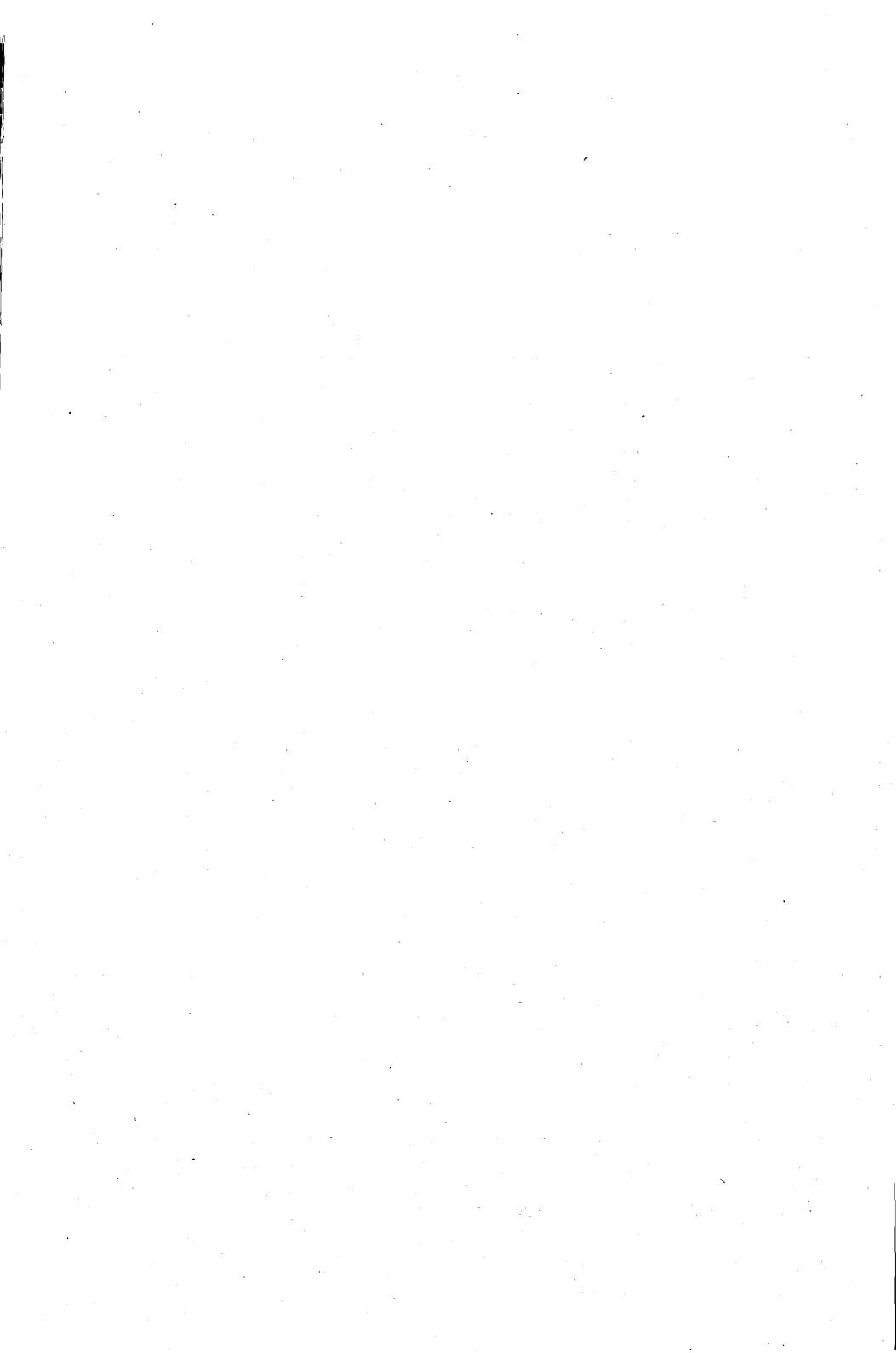
$$I_C = 50\text{ mA}; I_B = 5\text{ mA}$$

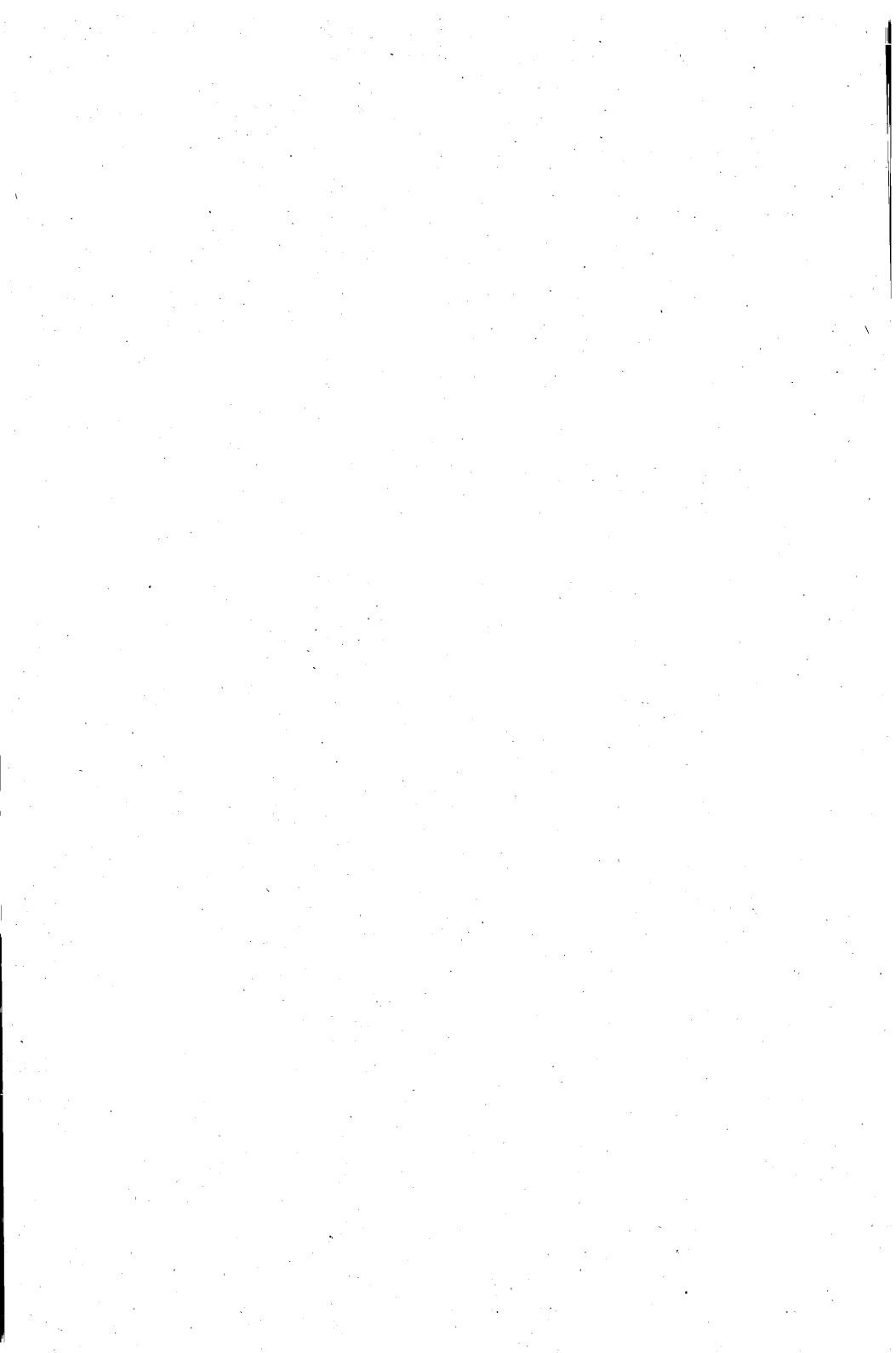
$$V_{CEsat} \begin{matrix} \text{typ. } 0,4\text{ V} \\ < 0,8\text{ V} \end{matrix}$$

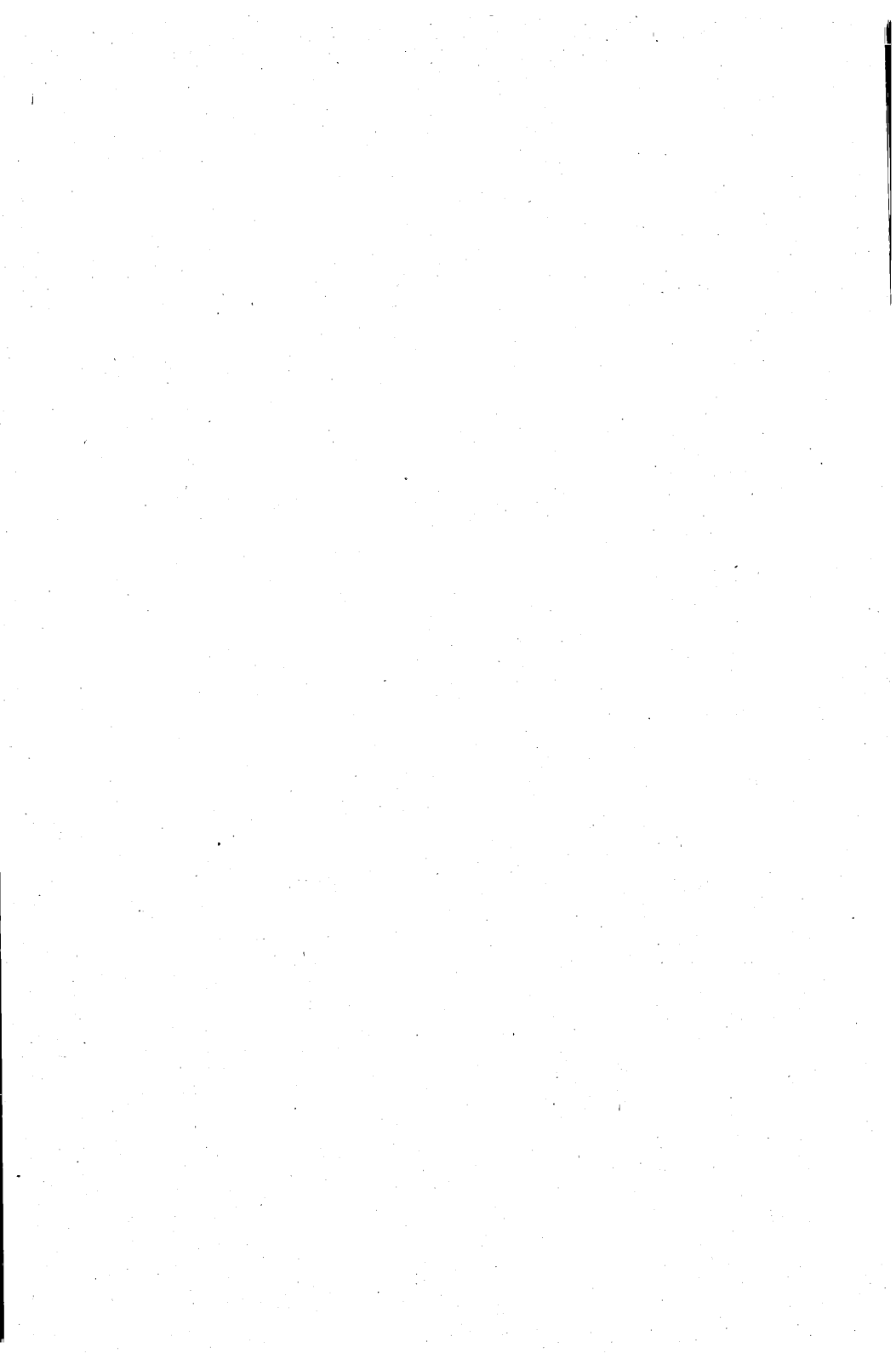
OPERATING NOTE

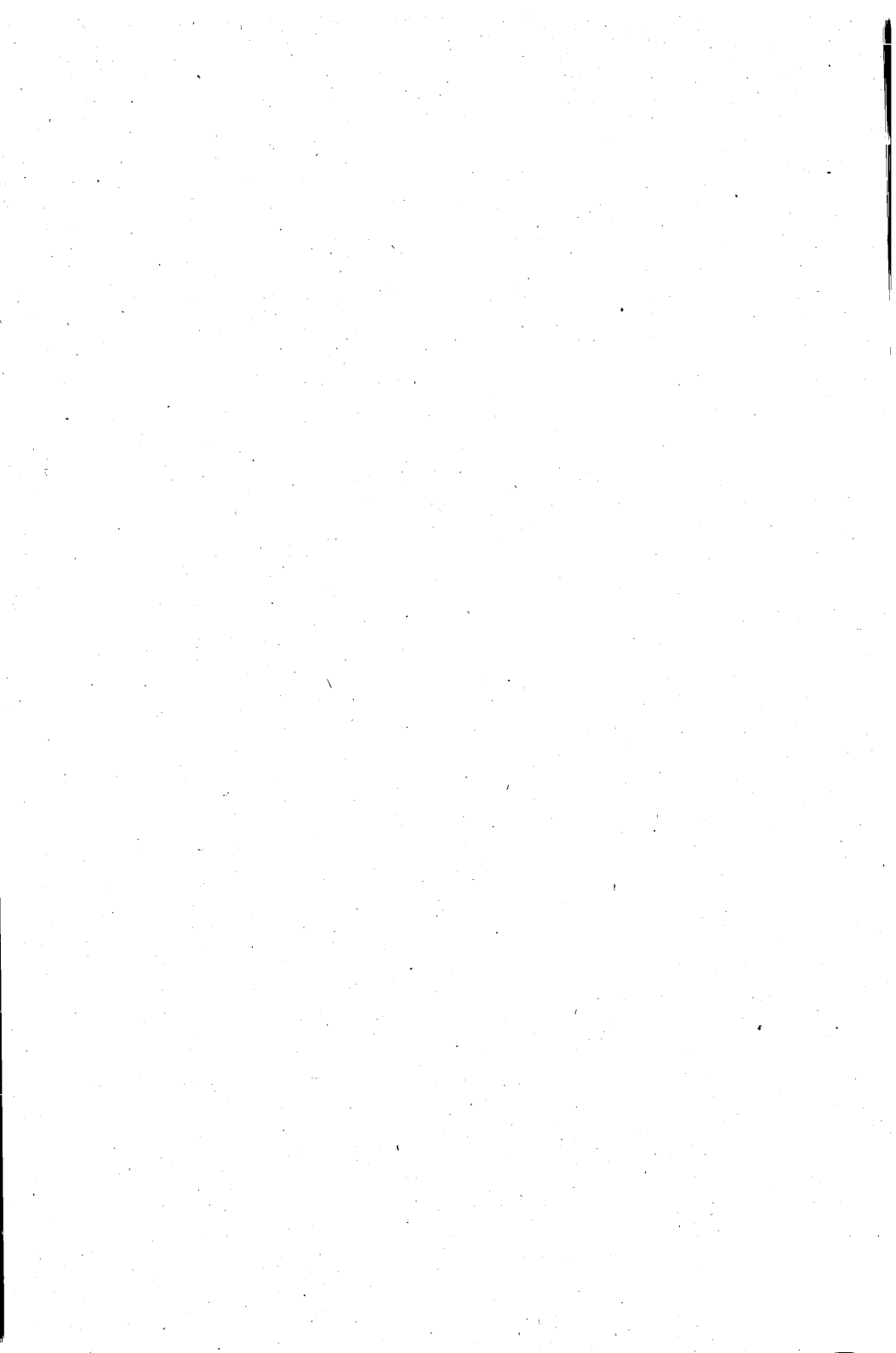
As each collector forms a parasitic diode with the substrate, the substrate has to be connected to a voltage which is lower than the lowest collector voltage.

To avoid parasitic coupling between the transistors, the substrate (pin 5) should be connected to signal ground.









INDEX OF TYPE NUMBERS

The inclusion of a type number in this publication does not necessarily imply its availability.

Type No.	Section	Type No.	Section	Type No.	Section	Type No.	Section
SAA1027	GI	TCA410D	A	TDA0723D	SpC	TDA4250D	A
SAA1114	SpC	TCA520B	A	TDA0741D	A		
SAA1114Z	SpC	TCA520D	A	TDA0748D	A		
SAK140	GI	TCA580	TC	TDA1022	TC		
TAA960	TC	TCA680B	A	TDA1024	GI		
TAA970	TC	TCA680D	A	TDA1034	A		
TBA221D	A	TCA770	TC	TDA1034B	A		
TBA673	TC	TCA770A	TC	TDA1034D	A		
TBA915	TC	TCA770D	TC	TDA1034N	A		
TCA210	TC	TCA980	TC	TDA1034NB	A		
TCA220	A	TDA0301D	A	TDA1034ND	A		
TCA240	TC	TDA0319D	SpC	TDA1458D	A		
TCA280A	GI	TDA0324D	A	TDA3081	SpC		
TCA410A	A	TDA0358D	A	TDA3082	SpC		
TCA410B	A	TDA0555D	GI	TDA4250B	A		

A = Amplifiers SpC = Special circuits
 GI = General industrial TC = Telecommunications circuits

MAINTENANCE TYPE LIST

The type numbers listed below are not included in this handbook.
 Detailed information will be supplied on request.

SAA1028
 TCA490



General

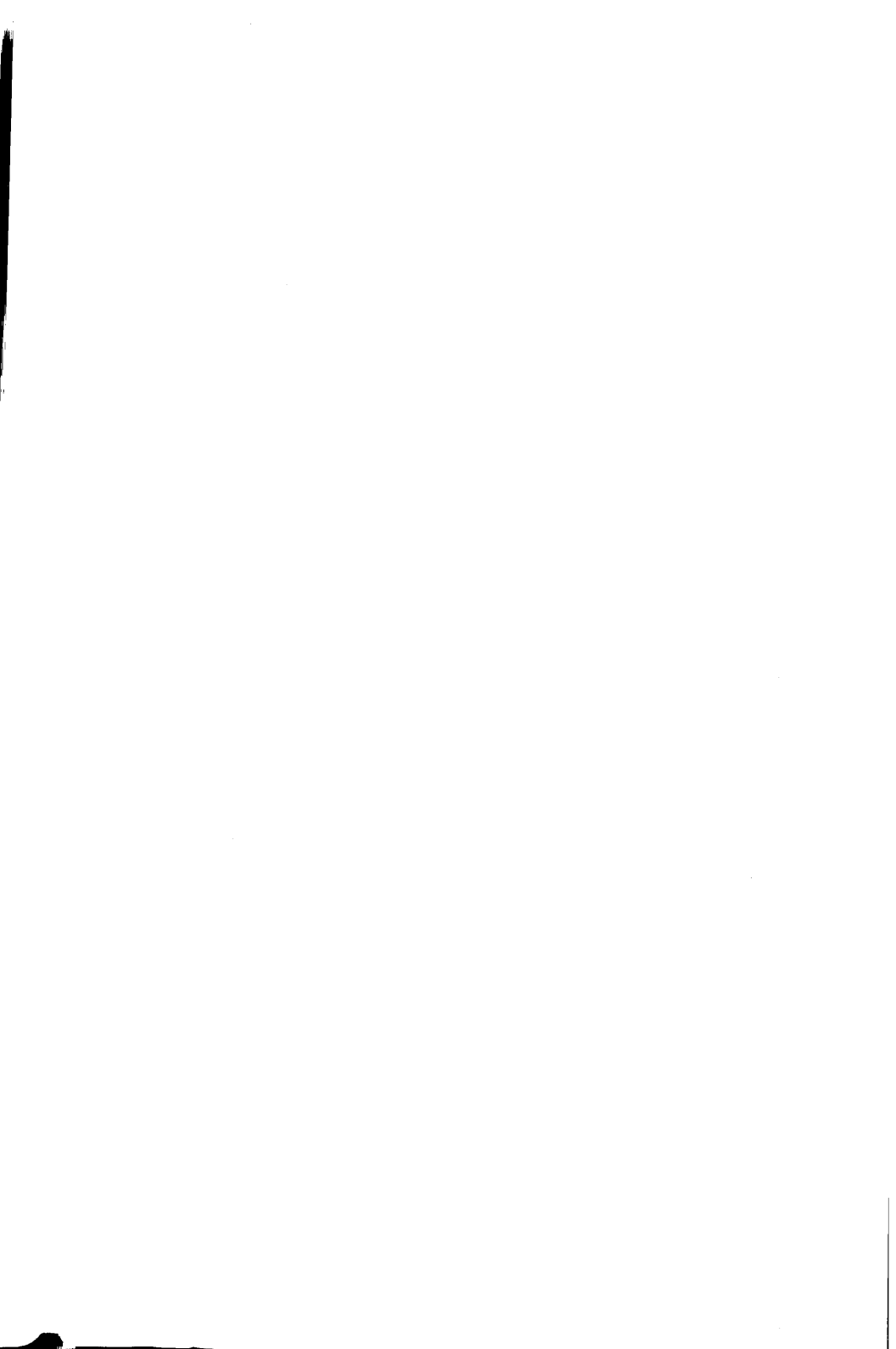
Amplifiers

Telecommunications circuits

General industrial

Special circuits

Index and maintenance type list



Argentina: FAPESA I.y.C., Av. Crovara 2550, Tablada, Prov. de BUENOS AIRES, Tel. 652-7438/7478.

Australia: PHILIPS INDUSTRIES HOLDINGS LTD., Elcoma Division, 67 Mars Road, LANE COVE, 2066, N.S.W., Tel. 42 1261.

Austria: ÖSTERREICHISCHE PHILIPS BAUELEMENTE Industrie G.m.b.H., Triester Str. 64, A-1101 WIEN, Tel. 62 91 11.

Belgium: M.B.L.E., 80, rue des Deux Gares, B-1070 BRUXELLES, Tel 523 00 00.

Brazil: IBRAPE, Caixa Postal 7383, Av. Paulista 2073-S/Loja, SAO PAULO, SP, Tel. 287-7144.

Canada: PHILIPS ELECTRONICS LTD., Electron Devices Div., 601 Milner Ave., SCARBOROUGH, Ontario, M1B 1M8, Tel. 292-5161.

Chile: PHILIPS CHILENA S.A., Av. Santa Maria 0760, SANTIAGO, Tel. 39-40 01.

Colombia: SADAPE S.A., P.O. Box 9805 Calle 13, No. 51 + 39, BOGOTA D.E. 1., Tel. 600 600.

Denmark: MINIWATT A/S, Emdrupvej 115A, DK-2400 KØBENHAVN NV., Tel. (01) 69 16 22.

Finland: OY PHILIPS AB, Elcoma Division, Kaivokatu 8, SF-00100 HELSINKI 10, Tel. 1 72 71.

France: R.T.C. LA RADIOTECHNIQUE-COMPELEC, 130 Avenue Ledru Rollin, F-75540 PARIS 11, Tel. 355-44-99.

Germany: VALVO, UB Bauelemente der Philips G.m.b.H., Valvo Haus, Burchardstrasse 19, D-2 HAMBURG 1, Tel. (040) 3296-1.

Greece: PHILIPS S.A. HELLENIQUE, Elcoma Division, 52, Av. Syngrou, ATHENS, Tel. 915 311.

Hong Kong: PHILIPS HONG KONG LTD., Comp. Dept., Philips Ind. Bldg., Kung Yip St., K.C.T.L. 289, KWAI SHUNG, N.T. Tel. 12-24 51

India: PHILIPS INDIA LTD., Elcoma Div., Band Box House, 254-D, Dr. Annie Besant Rd., Prabhadevi, BOMBAY-25-DD, Tel. 457 311-5.

Indonesia: P.T. PHILIPS-RALIN ELECTRONICS, Elcoma Division, 'Timah' Building, Jl. Jen. Gatot Subroto, JAKARTA, Tel. 44 163.

Ireland: PHILIPS ELECTRICAL (IRELAND) LTD., Newstead, Clonskeagh, DUBLIN 14, Tel. 69 33 55.

Italy: PHILIPS S.P.A., Sezione Elcoma, Piazza IV Novembre 3, I-20124 MILANO, Tel. 2-6994.

Japan: NIHON PHILIPS CORP., Shuwa Shinagawa Bldg., 26-33 Takanawa 3-chome, Minato-ku, TOKYO (108), Tel. 448-5611.
(IC Products) SIGNETICS JAPAN, LTD., TOKYO, Tel. (03) 230-1521.

Korea: PHILIPS ELECTRONICS (KOREA) LTD., Philips House, 260-199 Itaewon-dong, Yongsan-ku, C.P.O. Box 3680, SEOUL, Tel. 44-4202.

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Norway: ELECTRONICA A/S., Vitaminveien 11, P.O. Box 29, Grefsen, OSLO 4, Tel. (02) 15 05 90.

Peru: CADESA, Jr. Ilo, No. 216, Apartado 10132, LIMA, Tel. 27 73 17.

Philippines: ELDAC, Philips Industrial Dev. Inc., 2246 Pasong Tamo, MAKATI-RIZAL, Tel. 86-89-51 to 59.

Portugal: PHILIPS PORTUGESA S.A.R.L., Av. Eng. Duharte Pacheco 6, LISBOA 1, Tel. 68 31 21.

Singapore: PHILIPS SINGAPORE PTE LTD., Elcoma Div., POB 340, Toa Payoh CPO, Lorong 1, Toa Payoh, SINGAPORE 12, Tel. 53 88 11.

South Africa: EDAC (Pty.) Ltd., South Park Lane, New Doornfontein, JOHANNESBURG 2001, Tel. 24/6701.

Spain: COPRESA S.A., Balmes 22, BARCELONA 7, Tel. 301 63 12.

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