PHILIPS

Data handbook

PHILIPS Electronic components and materials

Semiconductors and integrated circuits

Part 5a November 1976

Professional analogue ICs

SEMICONDUCTORS AND INTEGRATED CIRCUITS

Part 5a

November 1976

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.

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	 Diodes Triodes T-R Switches Microwave semiconductor devices Isolators – circulators	**May 1976**
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	 Thyratrons Ignitrons Industrial rectifying tubes High-voltage rectifying tubes	**August 1975**
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
Voltage regulator diodes (> 1,5 W)
Transient suppressor diodes
Rectifier stacks
Thyristors
Triacs

Part 1b **Diodes** **October 1975**

Small signal germanium diodes
Small signal silicon diodes
Special diodes
Voltage regulator diodes (< 1,5 W)
Voltage reference 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
Microwave devices
Field-effect transistors
Dual transistors
Microminiature devices for thick- and thin-film circuits

Part 4b **Devices for optoelectronics** **July 1976**

Photosensitive diodes and transistors
Light emitting diodes
Displays
Photocouplers
Infrared sensitive devices
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** **November 1975**

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

Part 2a **Resistors** **February 1976**

Fixed resistors
Variable resistors
Voltage dependent resistors (VDR)
Light dependent resistors (LDR)
Negative temperature coefficient thermistors (NTC)
Positive temperature coefficient thermistors (PTC)
Test switches

Part 2b **Capacitors** **April 1976**

Electrolytic and solid capacitors
Paper capacitors and film capacitors
Ceramic capacitors
Variable capacitors

Part 3 **Radio, Audio, Television** **February 1975**

FM tuners
Loudspeakers
Television tuners and aerial input assemblies
Components for black and white television
Components for colour television

Part 4a **Soft ferrites** **October 1976**

Ferrites for radio, audio and television
Beads and chokes
Ferroxcube potcores and square cores
Ferroxcube transformer cores

Part 4b **Piezoelectric ceramics, Permanent magnet materials** **May 1975**

Part 5 **Ferrite core memory products** **July 1975**

Ferroxcube memory cores
Matrix planes and stacks
Core memory systems

Part 6 **Electric motors and accessories** **September 1975**

Small synchronous motors
Stepper motors
Miniature direct current motors

Part 7 **Circuit blocks** **September 1971**

Circuit blocks 100 kHz-Series
Circuit blocks 1-Series
Circuit blocks 10-Series
Circuit blocks for ferrite core memory drive

Part 8 **Variable mains transformers** **July 1975**

Part 9 **Piezoelectric quartz devices** **March 1976**

Part 10 **Connectors** **November 1975**

General

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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).

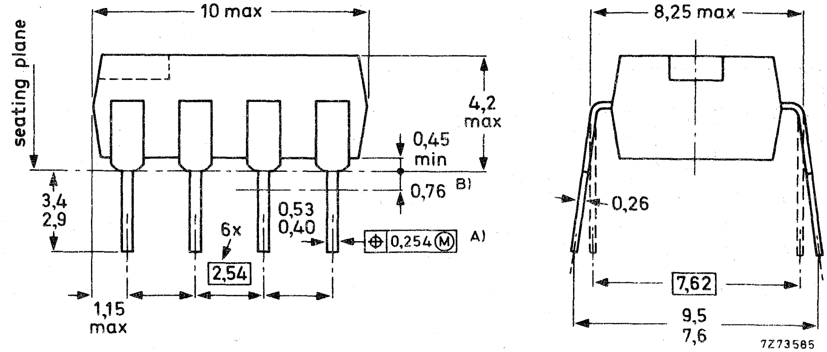
The serial number following the three letters may be either a 4-digit number or a proprietary type designation comprising a combination of letters and digits. Proprietary type designations consisting of less than 4 characters are extended to 4 by putting zeros (0) before them.

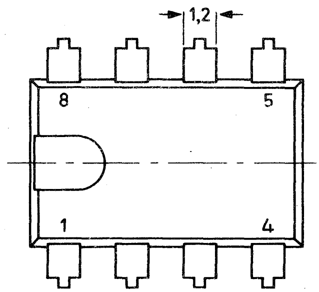
[1]) If a circuit is published for a wider temperature range, but does not qualify for another classification, the letter designating the nearest narrower temperature range is used.

Package outlines

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

Dimensions in mm





top view

⊕ Positional accuracy.

Ⓜ Maximum Material Condition.

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

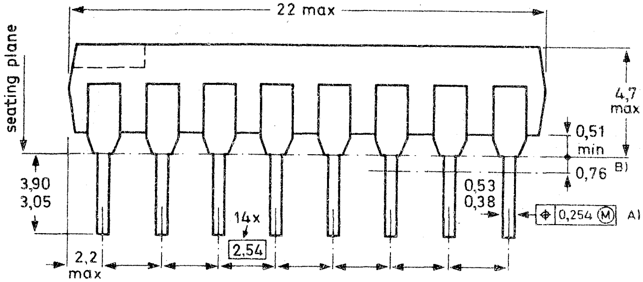
   260 °C is the maximum allowable temperature of the solder; it must not be in contact with the joint for more than 5 seconds. The total contact time of successive solder waves must not exceed 5 seconds.
   The device may be mounted up to the seating plane, but the temperature of the plastic body must 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.

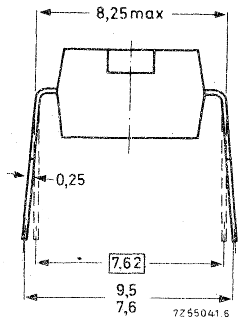
3. Repairing soldered joints

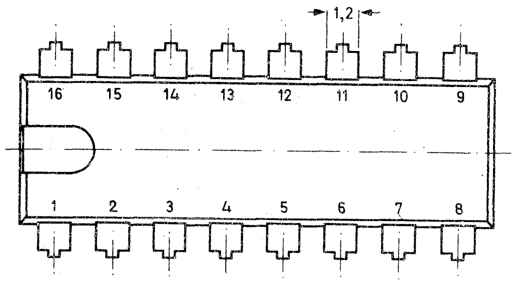
   The same precautions and limits apply as in (1) above.

PLASTIC 16-LEAD DUAL IN-LINE

Dimensions in mm







top view

⊕ Positional accuracy.

Ⓜ Maximum Material Condition.

A) Centre-lines of all leads are within ±0,127 mm of the nominal position shown; in the worst case, the spacing between any two leads may deviate from nominal by ± 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 ^{o}C it must not be in contact for more than 10 seconds; if between 300 ^{o}C and 400 ^{o}C, for not more than 5 seconds.

2. By dip or wave

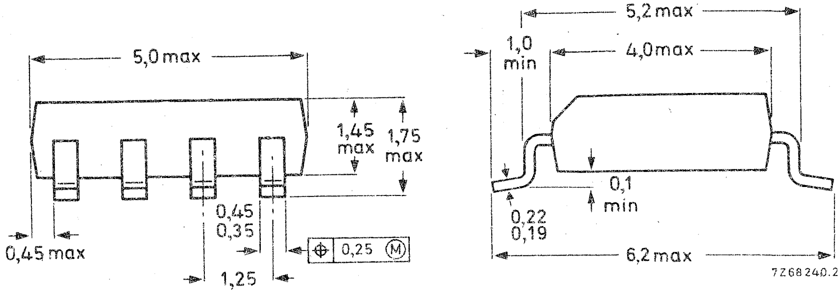
   260 ^{o}C is the maximum allowable temperature of the solder; it must not be in contact with the joint for more than 5 seconds. The total contact time of successive solder waves must not exceed 5 seconds.
   The device may be mounted up to the seating plane, but the temperature of the plastic body must 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.

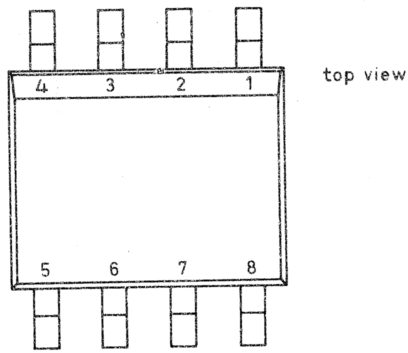
3. Repairing soldered joints

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

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

Dimensions in mm





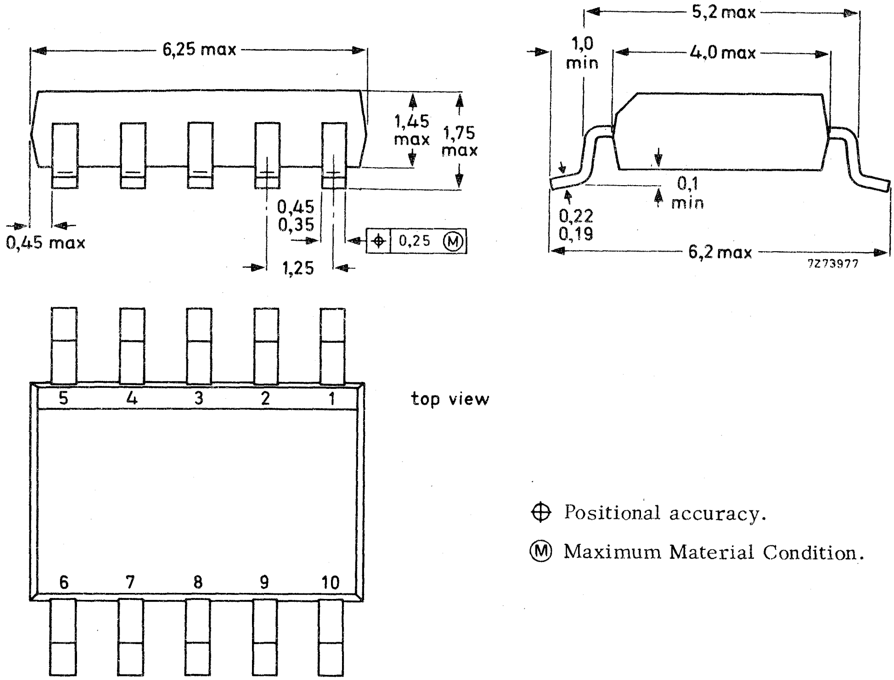
⊕ Positional accuracy.

Ⓜ Maximum Material Condition.

SOLDERING see last page of this chapter

SO-10; PLASTIC 10-LEAD FLAT PACK

Dimensions in mm



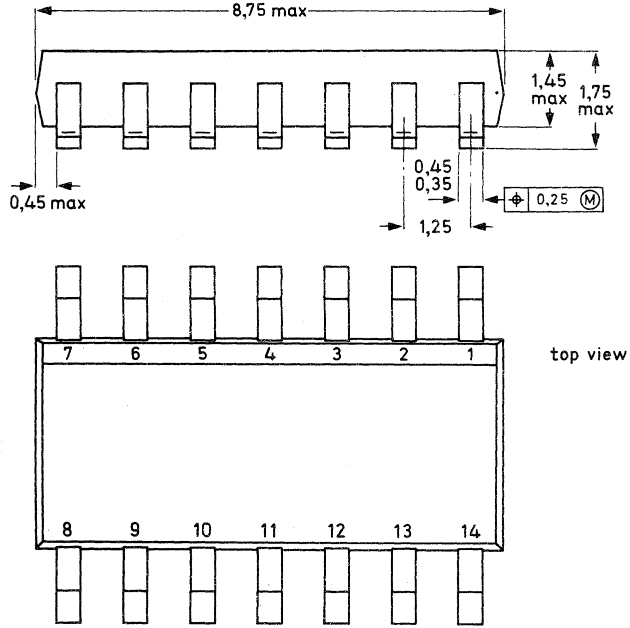
⊕ Positional accuracy.

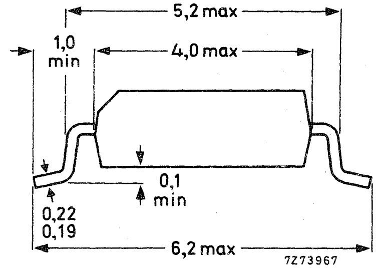
Ⓜ Maximum Material Condition.

SOLDERING see last page of this chapter

SO-14; PLASTIC 14-LEAD FLAT PACK

Dimensions in mm





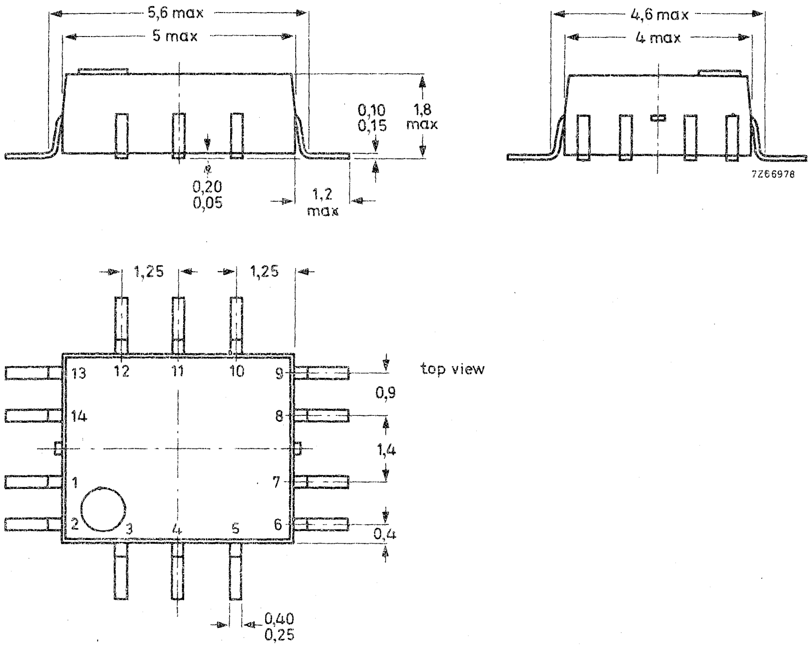
⊕ Positional accuracy.

Ⓜ Maximum Material Condition.

SOLDERING see last page of this chapter.

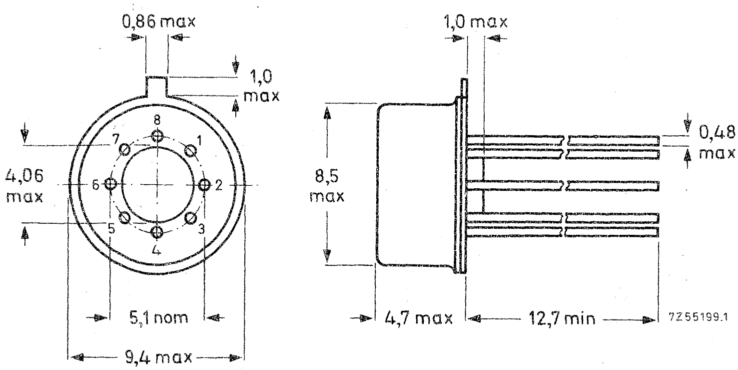
PLASTIC; 14-LEAD (SOT-43)

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
$V_{(BR)CBO}$, $V_{(BR)CEO}$, $V_{(BR)EBO}$	Breakdown voltage between the terminal of the first subscript and the reference terminal (second subscript) when the third terminal is open circuited
$V_{(BR)CS}$	Collector to substrate breakdown voltage
V_{CBO}, V_{CEO}, V_{EBO}, V_{CS}, V_{1-3}	Voltage of the terminal indicated with respect to the reference terminal (second subscript)

Letter symbol	Definition
V_i, V_o	Input, respectively output voltage of a specified circuit
V_{io}	Input offset voltage
$V_{i\ lim}$	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
φ_i, φ_f, φ_o, φ_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 μA741C, 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 kΩ; V_o = ±10 V	G_v	typ.	200 000	
Common mode rejection ratio	CMRR	typ.	90	dB
Differential input resistance	R_i	typ.	2	MΩ
Output voltage swing at R_L = 10 kΩ	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

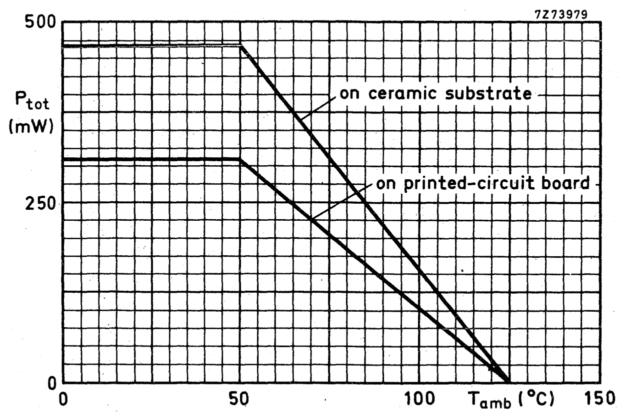
Power dissipation (see derating curve below)

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

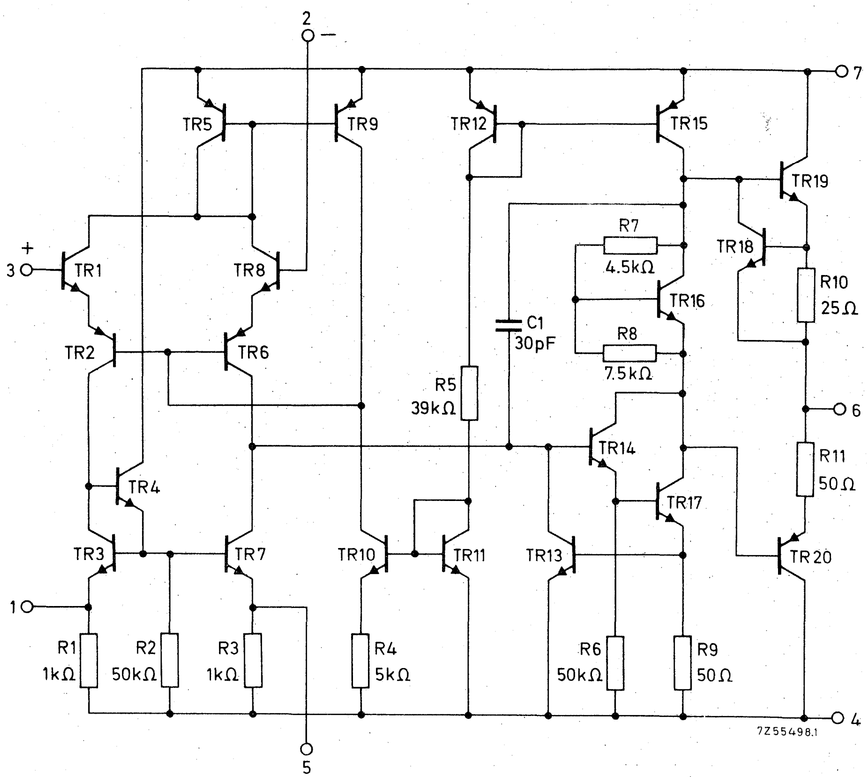
Operating ambient temperature see derating curve below	T_{amb}	−25 to +85	°C
Storage temperature	T_{stg}	−65 to +150	°C



[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

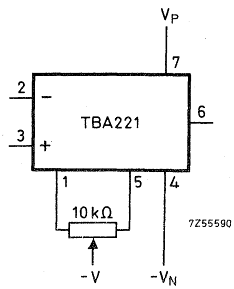


CHARACTERISTICS at V_P = 15 V; $-V_N$ = 15 V; T_{amb} = 25 °C unless otherwise specified

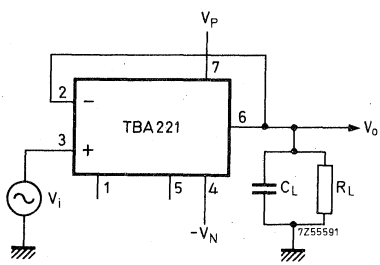
Input offset voltage	V_{io}	typ. <	1 4	mV mV
Input offset voltage at V_P = 18 V; $-V_N$ = 18 V; V_i = ±15 V	V_{io}	<	8	mV
Input offset voltage drift	ΔV_{io}	typ.	5	µV/°C
Input bias current	I_i	typ. <	50 150	nA nA
Input offset current	I_{io}	typ. <	5 50	nA nA
Input voltage range	V_i	> typ.	±12 ±13	V V
Common mode rejection ratio	CMRR	> typ.	75 90	dB dB
Differential input resistance	R_i	> typ.	0,6 2,0	MΩ MΩ
Power supply voltage rejection ratio	PSRR	typ. <	30 100	µV/V µV/V
Voltage gain at R_L = 2 kΩ; V_o = ±10 V	G_v	> typ.	30 000 200 000	
Output voltage swing at R_L = 2 kΩ	V_o	> typ.	±12 ±13	V V
Output resistance at f = 1 kHz	R_o	typ. <	60 150	Ω Ω
Output short-circuit current	I_{sc}	typ.	25	mA
Supply current at I_o = 0	$I_{P;N}$	typ. <	1,7 2,8	mA mA
A.C. gain at f = 1 kHz; R_L = 2 kΩ	G_v	typ.	1000 700 to 1500	
Transient response (unity gain; voltage follower) V_i = 20 mV; R_L = 2 kΩ; C_L = 100 pF				
Rise time		typ.	0,25	µs
Overshoot		typ.	3	%
Slew rate (unity gain) at R_L = 2 kΩ	S	typ.	0,6	V/µs
Input noise voltage at f = 1 kHz	V_n	typ.	20	nV/$\sqrt{Hz}$
at f = 30 Hz	V_n	typ.	25	nV/$\sqrt{Hz}$
Input noise current at f = 1 kHz	I_n	typ.	0,15	pA/$\sqrt{Hz}$
at f = 30 Hz	I_n	typ.	0,6	pA/$\sqrt{Hz}$

CHARACTERISTICS at V_P = 15 V; $-V_N$ = 15 V; T_{amb} = −25 to +85 °C unless otherwise specified

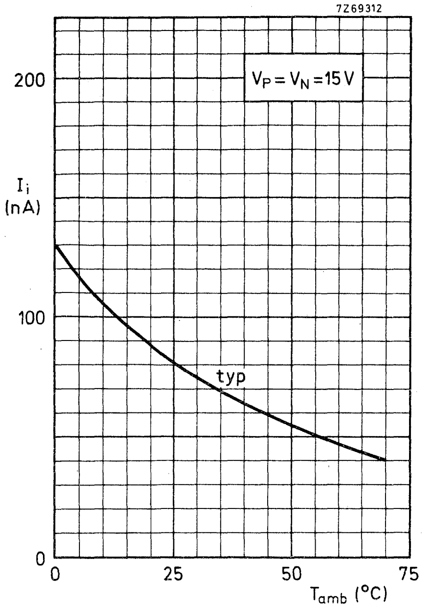
Voltage gain at R_L = 2 kΩ; V_o = ±10 V	G_v	>	20 000	
Input offset voltage	V_{io}	<	5,5	mV
Input bias current	I_i	<	0,3	μA
Input offset current	I_{io}	<	0,1	μA
Output voltage swing at R_L = 2 kΩ	V_o	>	11,5	V

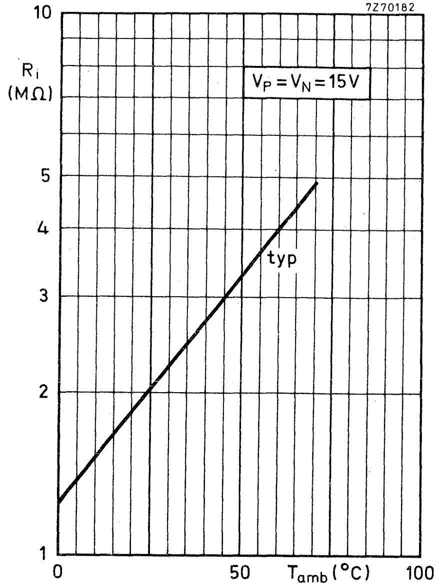


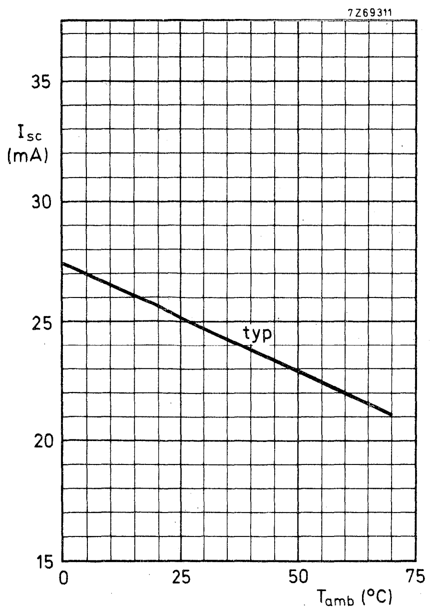
Offset voltage zeroing circuit

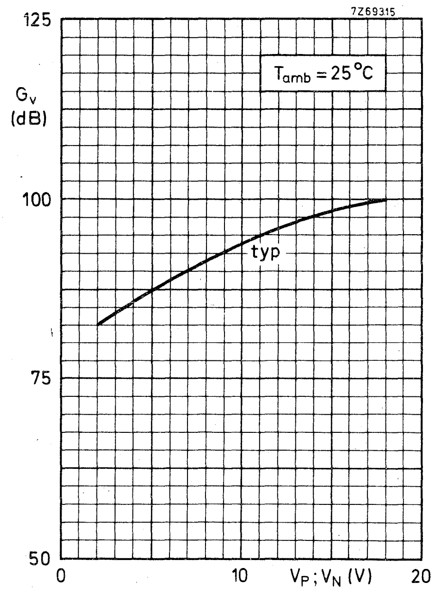


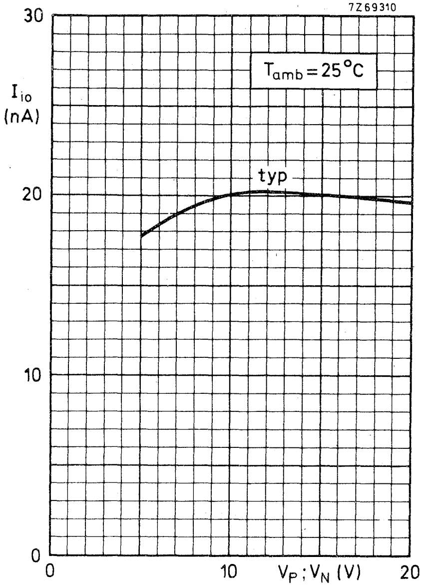
Transient response test circuit

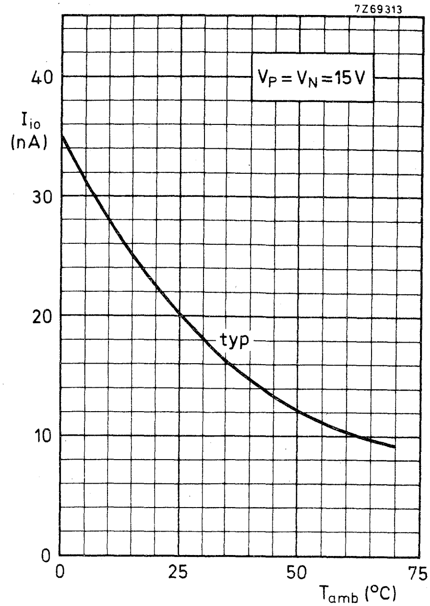

7Z69312
$V_P = V_N = 15\,V$
I_i (nA)
200
100
0
typ
0
25
50
75
T_{amb} (°C)

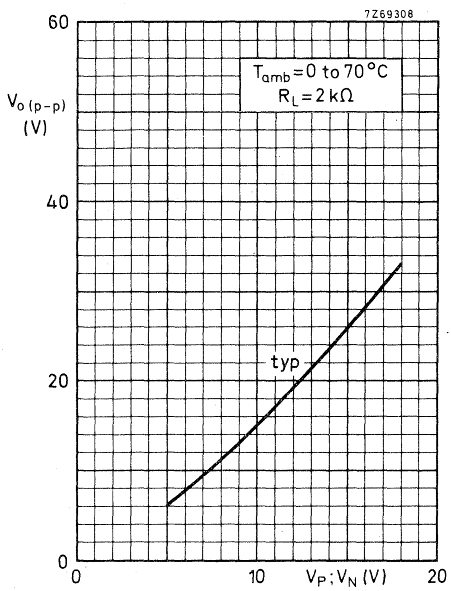

7Z70182
10
R_i (MΩ)
$V_P = V_N = 15\,V$
5
4
3
2
1
typ
0
50
T_{amb} (°C)
100

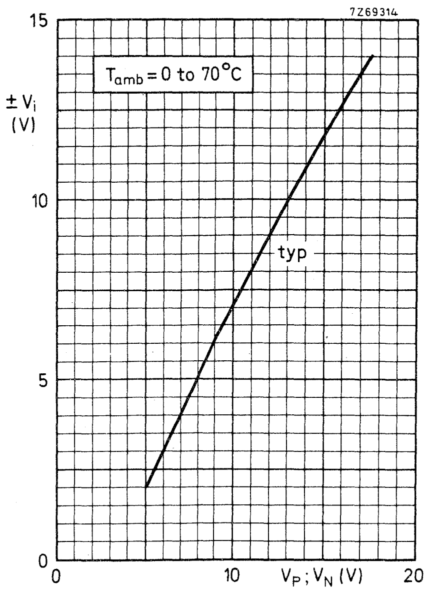

7Z69311
35
I_{sc} (mA)
30
25
20
15
typ
0
25
50
75
T_{amb} (°C)

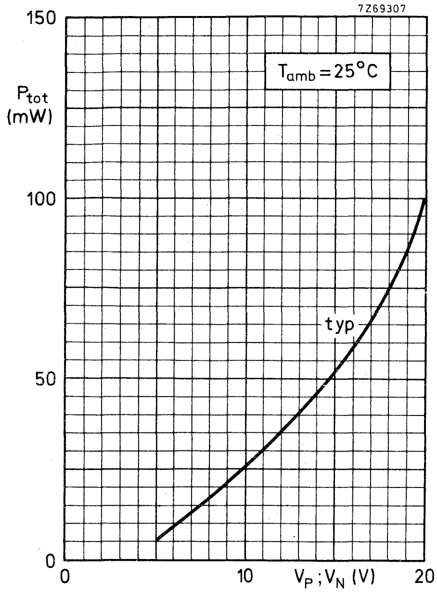

7Z69315
125
G_v (dB)
$T_{amb} = 25\,°C$
100
75
50
typ
0
10
V_P; V_N (V)
20

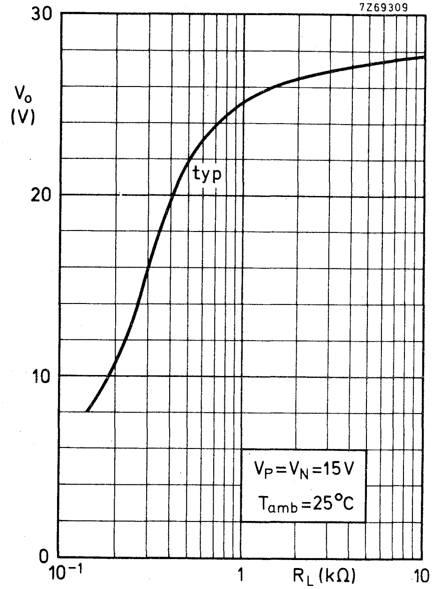

7Z69310
$T_{amb} = 25\,^{\circ}C$
I_{io} (nA)
typ
30
20
10
0
0
10
20
V_P ; V_N (V)

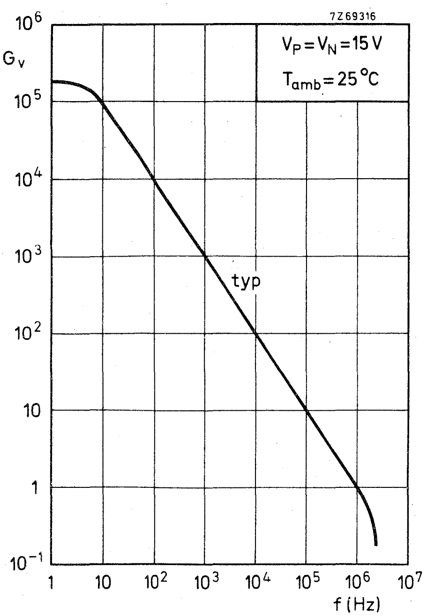

7Z69313
$V_P = V_N = 15\,V$
I_{io} (nA)
typ
40
30
20
10
0
0
25
50
75
T_{amb} (°C)

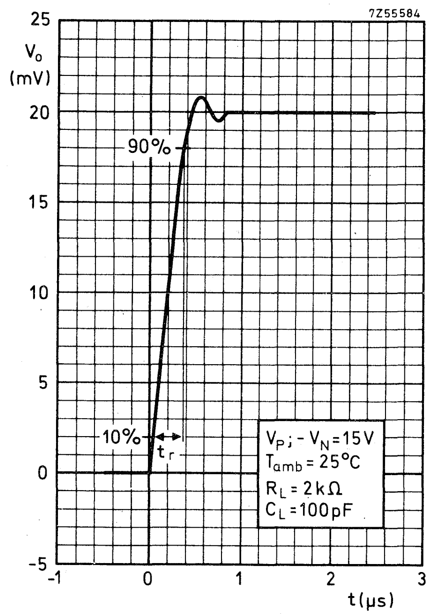

7Z69308
$T_{amb} = 0$ to $70\,^{\circ}C$
$R_L = 2\,k\Omega$
$V_{o\,(p-p)}$ (V)
typ
60
40
20
0
0
10
20
V_P ; V_N (V)

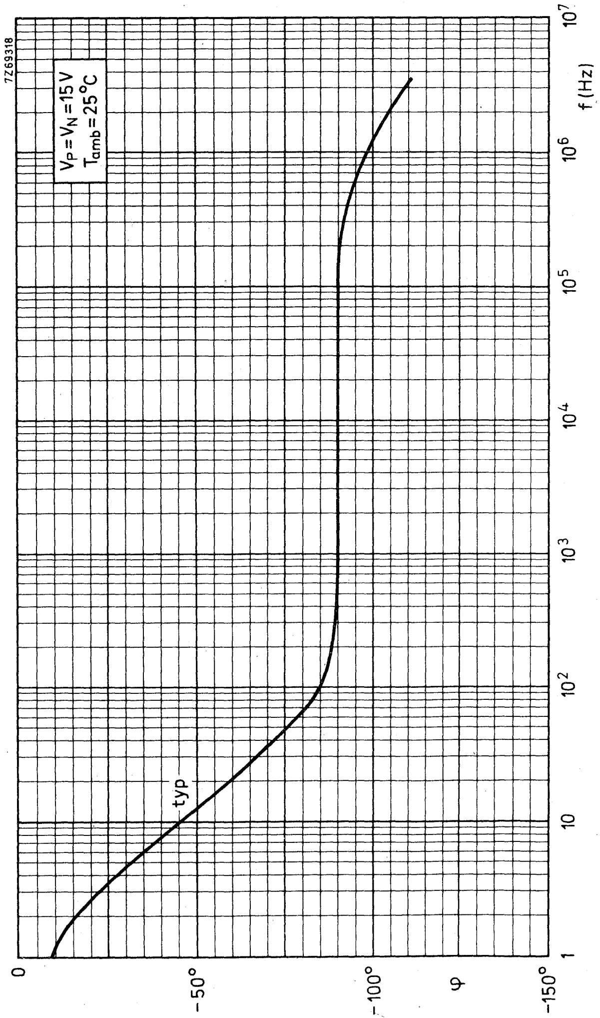

7Z69314
$T_{amb} = 0$ to $70\,^{\circ}C$
$\pm V_i$ (V)
typ
15
10
5
0
0
10
20
V_P ; V_N (V)

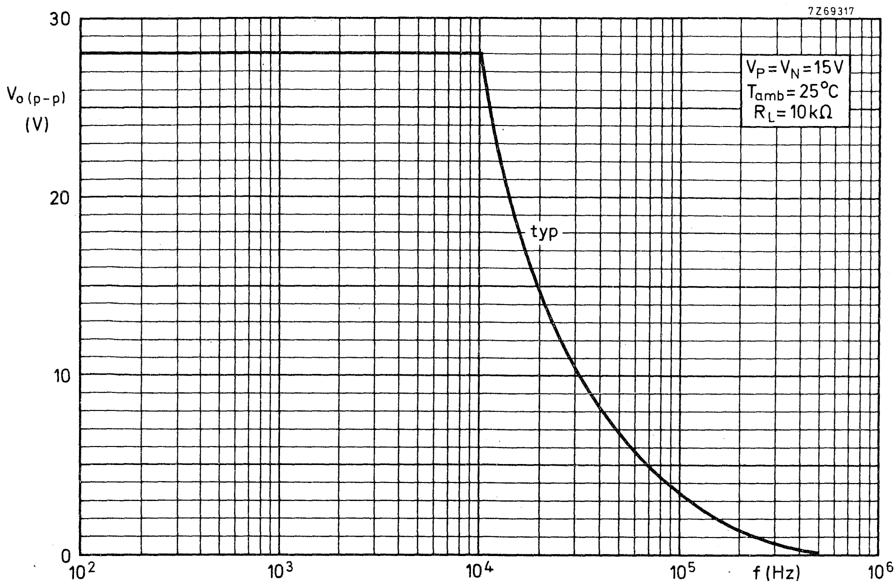

7Z69307
150
100
50
0
P_{tot} (mW)
$T_{amb} = 25°C$
typ
0
10
$V_P ; V_N$ (V)
20

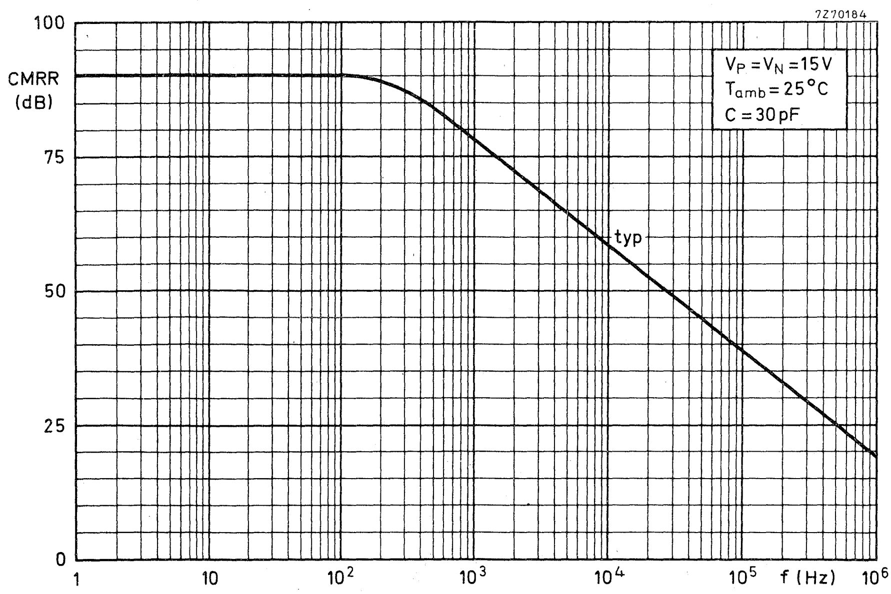

7Z69309
30
20
10
0
V_o (V)
typ
$V_P = V_N = 15 V$
$T_{amb} = 25°C$
10^{-1}
1
R_L (kΩ)
10


7Z69316
10^6
10^5
10^4
10^3
10^2
10
1
10^{-1}
G_v
$V_P = V_N = 15 V$
$T_{amb} = 25°C$
typ
1
10
10^2
10^3
10^4
10^5
10^6
10^7
f (Hz)


7Z55584
25
20
15
10
5
0
-5
V_o (mV)
90%
10%
t_r
$V_P ; -V_N = 15 V$
$T_{amb} = 25°C$
$R_L = 2 kΩ$
$C_L = 100 pF$
-1
0
1
2
3
t (μs)


7Z69318
$V_P = V_N = 15\,V$
$T_{amb} = 25\,°C$
typ
f (Hz)
φ
0
−50°
−100°
−150°
1
10
10^2
10^3
10^4
10^5
10^6
10^7


7Z69317
$V_{o(p-p)}$ (V)
30
20
10
0
10^2
10^3
10^4
10^5
f (Hz)
10^6
typ
$V_P = V_N = 15\,V$
$T_{amb} = 25\,^\circ C$
$R_L = 10\,k\Omega$


7Z70184
CMRR (dB)
100
75
50
25
0
1
10
10^2
10^3
10^4
10^5
f (Hz)
10^6
typ
$V_P = V_N = 15\,V$
$T_{amb} = 25\,^\circ C$
C = 30 pF

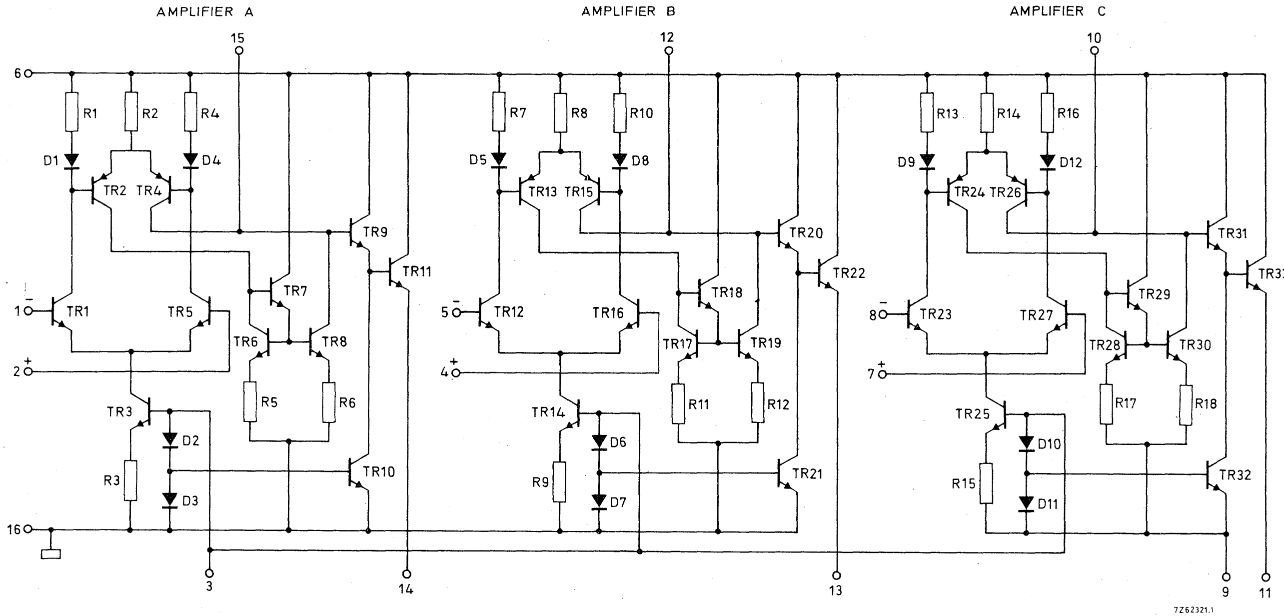
TRIPLE OPERATIONAL AMPLIFIER

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	μV/V
Input offset voltage	V_{io}	typ.	2	mV
Input offset current	I_{io}	typ.	0,2	μA

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

CIRCUIT DIAGRAM



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

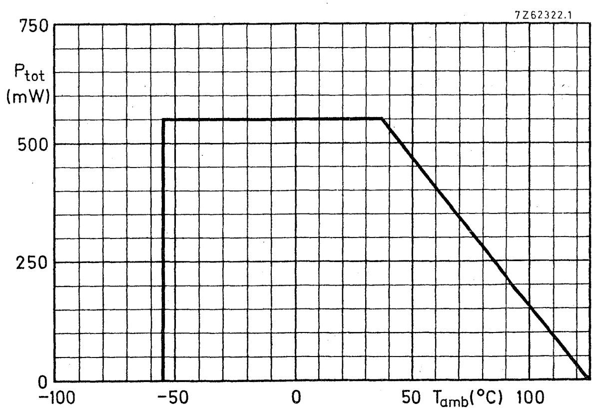
Voltages

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.

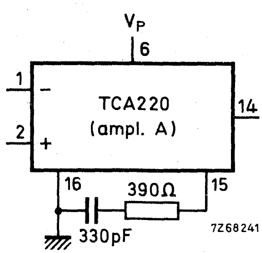
THERMAL RESISTANCE

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

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

Voltage gain at ± V_{OM} = 3,5 V	G_v	typ.	4000	
Input offset voltage at $R_S \leq$ 200 Ω	V_{io}	typ.	2	mV
		<	10	mV
Input bias current	I_i	typ.	1,0	µA
		<	2,0	µA
Input offset current	I_{io}	typ.	0,2	µA
Common mode rejection ratio at R_S = 2 kΩ	CMRR	typ.	90	dB
Input voltage range	V_i		−4,3 to +5,6	V
Differential input resistance	R_i	>	25	kΩ
Supply voltage rejection ratio at R_S = 2 kΩ	SVRR	typ.	200	µV/V
Peak output voltage swing	V_{OM}		−6 to +3,5	V
Total current at V_o = 0; R_L = 10 kΩ	I_{tot}	typ.	1,0	mA
at V_o = 0; R_L = ∞	I_{tot}	typ.	0,4	mA
Slew rate (unity-gain)		typ.	0,4	V/µs
Bias current (all three amplifiers together)	I_3	>	200	µA 1)
Channel separation 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 in 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 $\frac{V_{oA}}{V_{oB}}$ x 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)

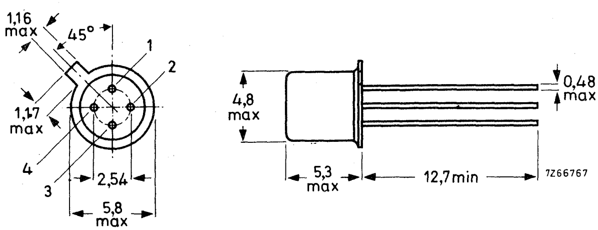
For most applications the TCA410 can be used as a direct replacement for the LM302 and LM310. The TCA410D is pin to pin compatible with the TBA221D, when the latter is connected as a voltage follower.

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 kΩ	V_o	typ.	13,5	V
Slew rate	S	typ.	4	V/µs

PACKAGE OUTLINE (for TCA410D see page 2) Dimensions in mm

TCA410A; TCA410B: TO-72

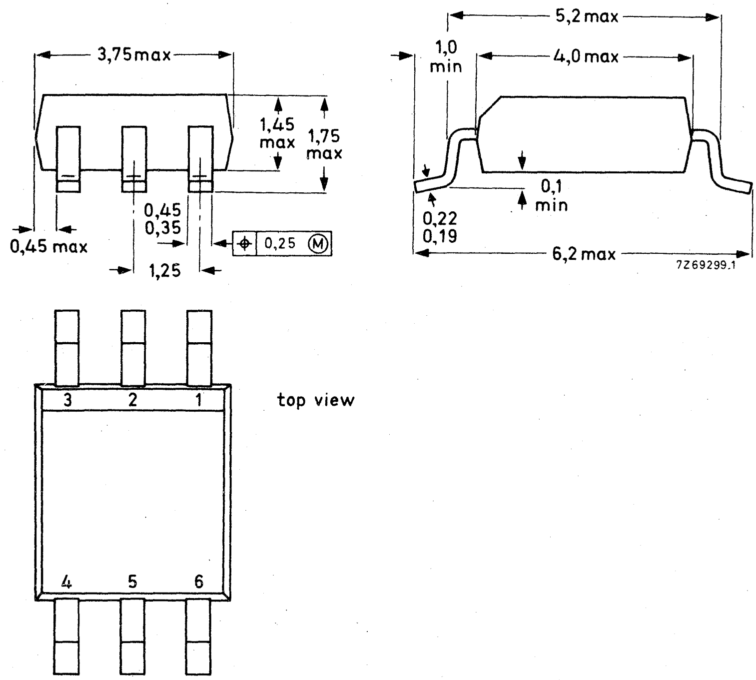


1 = V_o
2 = V_P
3 = V_i
4 = V_N

pin 4 connected to case

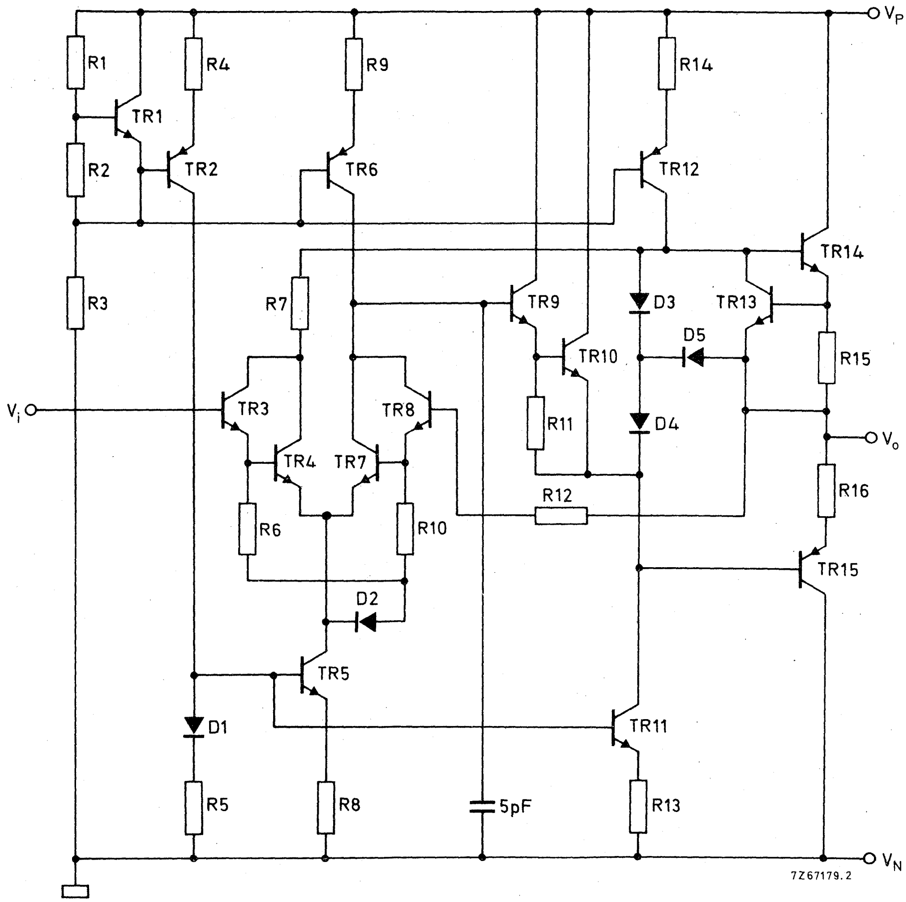
PACKAGE OUTLINE (continued) Dimensions in mm

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



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



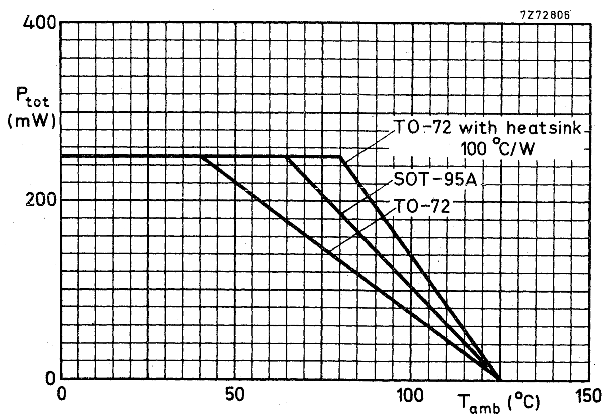
RATINGS Limiting values in accordance with the Absolute Maximum System (IEC 134)

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
Power dissipation (see derating curve)	P_{tot}	max.	250	mW

Temperatures

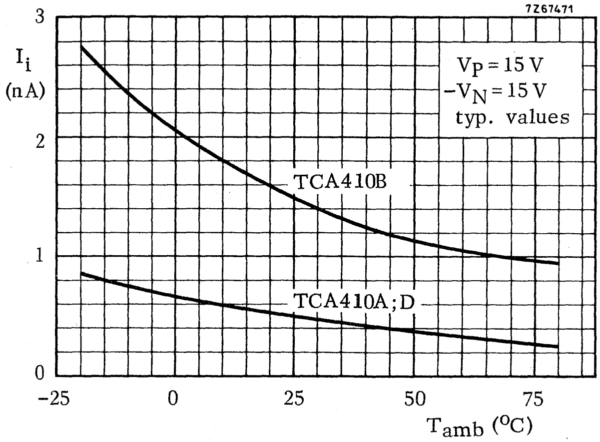
Operating ambient temperature	T_{amb}	−25 to +85	°C
Storage temperature			
metal envelope; TO-72	T_{stg}	−65 to +125	°C
plastic flat pack; SOT-95A	T_{stg}	−65 to +125	°C

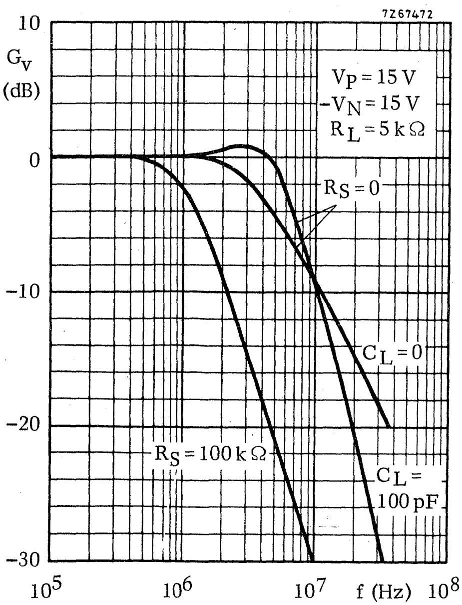


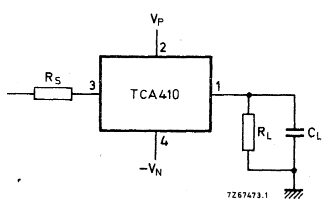
CHARACTERISTICS at V_P = 15 V; $-V_N$ = 15 V; T_{amb} = 25 °C

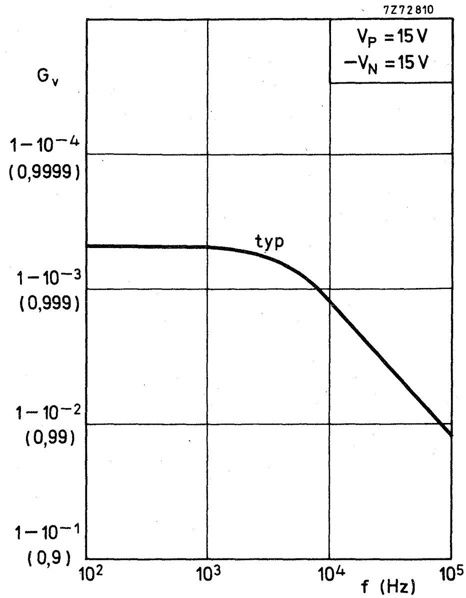
			TCA410A	B	D	
Input bias current	I_i	typ.	0,5	1,5	0,5	nA
		<	1,0	3,0	3,0	nA

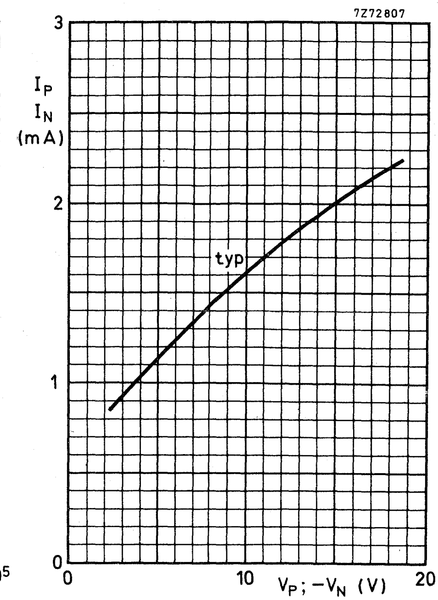
Input offset voltage	V_{io}	typ.	3	mV
		<	10	mV
Input offset voltage drift	ΔV_{io}	typ.	20	μV/°C
Voltage gain at R_L = 5 kΩ; V_i = ±12,5 V	G_v	>	0,9980	
		typ.	0,9995	
Output voltage swing at R_L = 5 kΩ	V_o	>	±12,5	V
		typ.	±13,5	V
Output resistance at I_o = ±6 mA	R_o	typ.	0,7	Ω
		<	2,0	Ω
Output short-circuit current	I_{sc}	typ.	10	mA
			6 to 14	mA
Slew rate	S	>	2,5	V/μs
		typ.	4,0	V/μs
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 kHz	V_n	typ.	80	nV/$\sqrt{Hz}$
at f = 10 Hz	V_n	typ.	200	nV/$\sqrt{Hz}$
Input noise current at f = 1 kHz: TCA410A	I_n	typ.	0,006	pA/$\sqrt{Hz}$
TCA410B	I_n	typ.	0,015	pA/$\sqrt{Hz}$
at f = 10 Hz : TCA410A	I_n	typ.	0,04	pA/$\sqrt{Hz}$
TCA410B	I_n	typ.	0,1	pA/$\sqrt{Hz}$

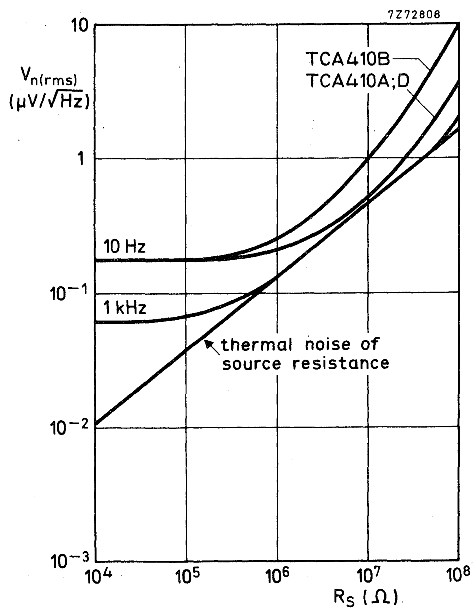

7Z67471
3
I_i
(nA)
2
1
0
$V_P = 15\ V$
$-V_N = 15\ V$
typ. values
TCA410B
TCA410A;D
−25
0
25
50
75
T_{amb} (°C)

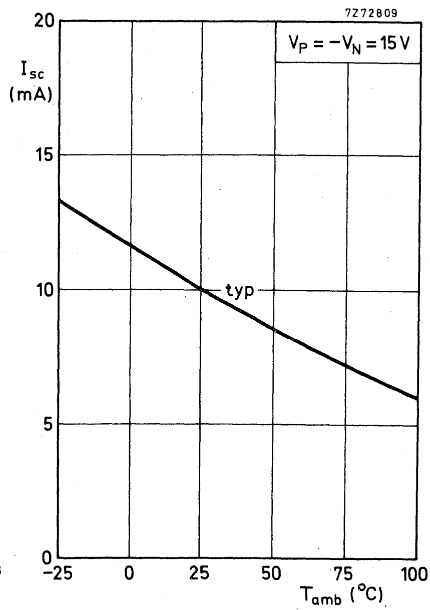

7Z67472
10
G_v
(dB)
0
−10
−20
−30
$V_P = 15\ V$
$-V_N = 15\ V$
$R_L = 5\ k\Omega$
$R_S = 0$
$C_L = 0$
$R_S = 100\ k\Omega$
$C_L =$
100 pF
10^5
10^6
10^7
f (Hz)
10^8


V_P
2
R_S
3
TCA410
1
4
$-V_N$
R_L
C_L
7Z67473.1


7Z72810
V_P = 15 V
$-V_N$ = 15 V
G_v
1 − 10^{-4}
(0,9999)
typ
1 − 10^{-3}
(0,999)
1 − 10^{-2}
(0,99)
1 − 10^{-1}
(0,9)
10^2
10^3
10^4
f (Hz)
10^5


7Z72807
I_P
I_N
(mA)
3
2
1
0
typ
0
10
V_P; $-V_N$ (V)
20


7Z72808
$V_{n(rms)}$
($\mu V/\sqrt{Hz}$)
10
1
10^{-1}
10^{-2}
10^{-3}
TCA410B
TCA410A;D
10 Hz
1 kHz
thermal noise of
source resistance
10^4
10^5
10^6
10^7
10^8
R_S (Ω)


7Z72809
$V_P = -V_N$ = 15 V
I_{sc}
(mA)
20
15
10
5
0
typ
−25
0
25
50
75
100
T_{amb} (°C)

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:

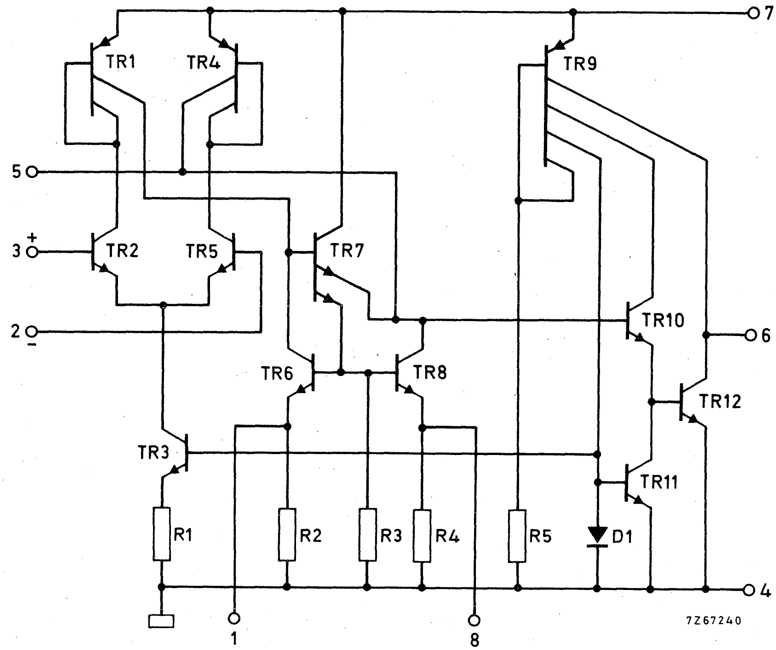
- large supply voltage range : 2 to 20 V
- offset voltage adjustable to zero
- output TTL-compatible
- low power consumption : 5 mW at 5 V
- high slew rate (comparator) : 50 V/µs
- low input bias current : 30 nA

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/µs

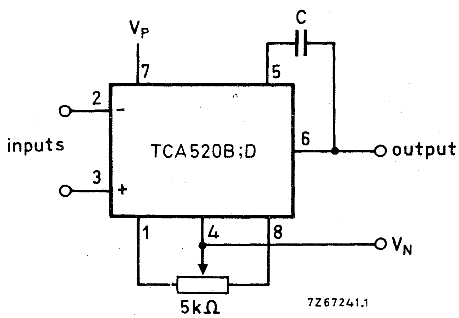
PACKAGE OUTLINES (see general section).

TCA520B : SOT-97 (plastic 8-lead dual in-line).
TCA520D : SOT-96A (plastic 8-lead flat pack).

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

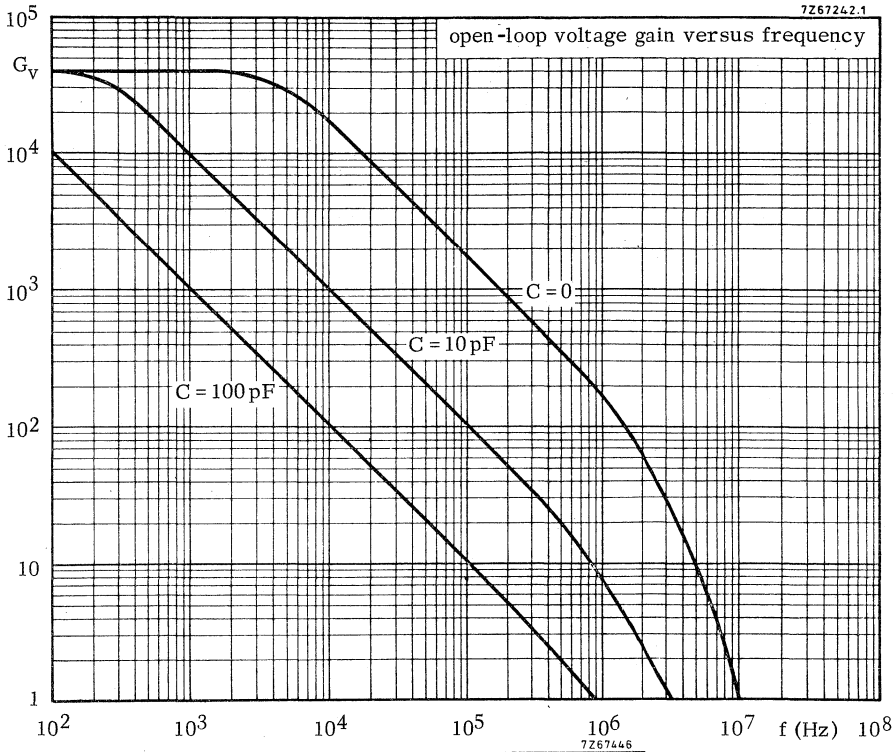
Operating ambient temperature	T_{amb}	−25 to +85	°C
Storage temperature	T_{stg}	−65 to +125	°C

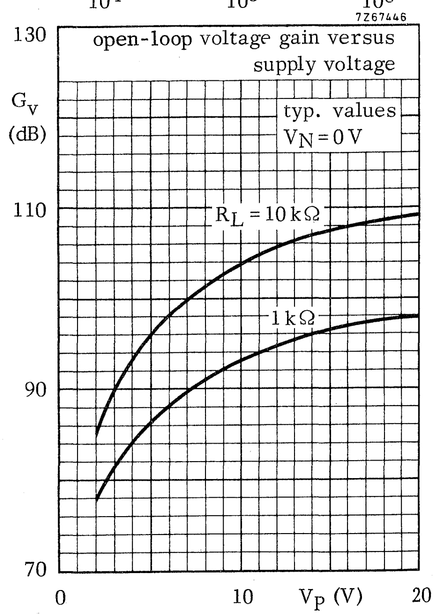
Maximum power dissipation in free air

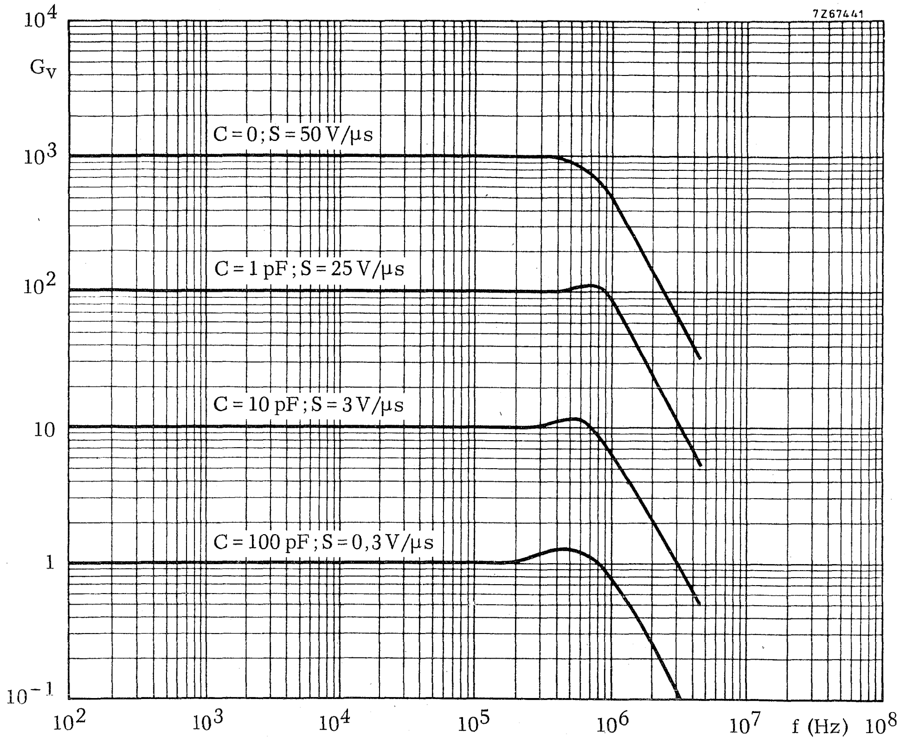
package	mounting	max. power dissipation at T_{amb} = 50 °C (mW)	derating factor for T_{amb} > 50 °C (mW/°C)	thermal resistance $R_{th\ j-a}$ (°C/W)
SOT-97	on PC board	375	5	200
SOT-96A	on ceramic substrate (4 cm^2)	440	5,8	170
SOT-96A	on PC board (4 cm^2)	300	4	250

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

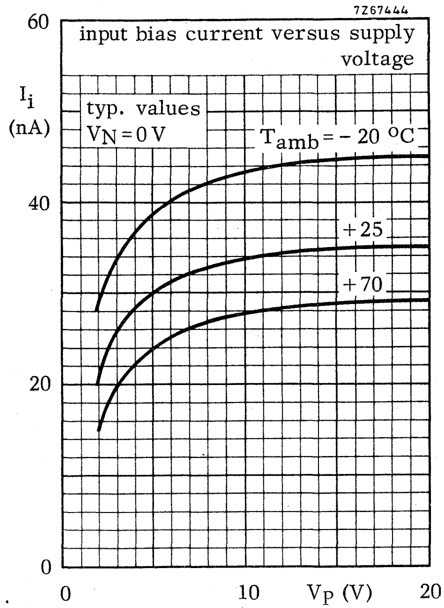
Input offset voltage	V_{io}	typ.	1	mV
		<	6	mV
Input offset voltage drift	ΔV_{io}	typ.	5	μV/°C
Input bias current	I_i	typ.	30	nA
		<	100	nA
Input offset current	I_{io}	typ.	5	nA
		<	30	nA
Input voltage range	V_i	>	$V_N + 0,9$	V
		>	$V_P - 0,5$	V
Common mode rejection ratio	CMRR	>	70	dB
		typ.	100	dB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

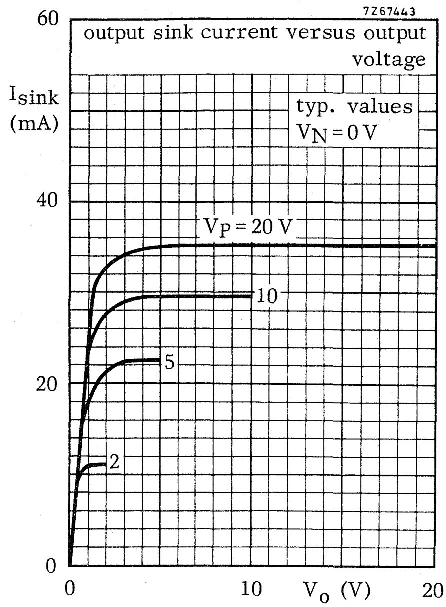

7Z67242.1
open-loop voltage gain versus frequency
G_v
10^5
10^4
10^3
10^2
10
1
C = 0
C = 10 pF
C = 100 pF
10^2
10^3
10^4
10^5
10^6
10^7
f (Hz)
10^8

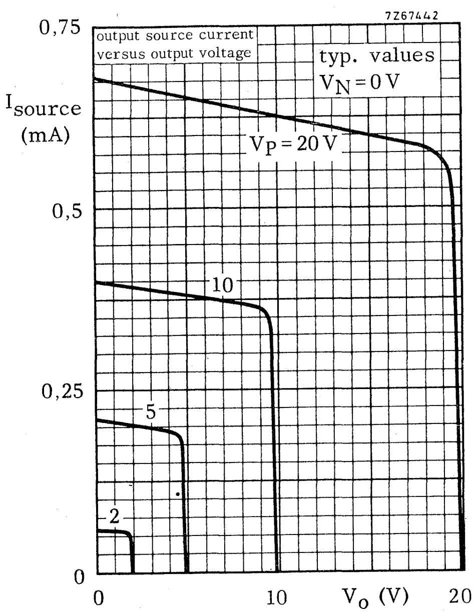

7Z67446
open-loop voltage gain versus supply voltage
G_v (dB)
130
110
90
70
typ. values
$V_N = 0$ V
$R_L = 10\,k\Omega$
$1\,k\Omega$
0
10
V_P (V)
20

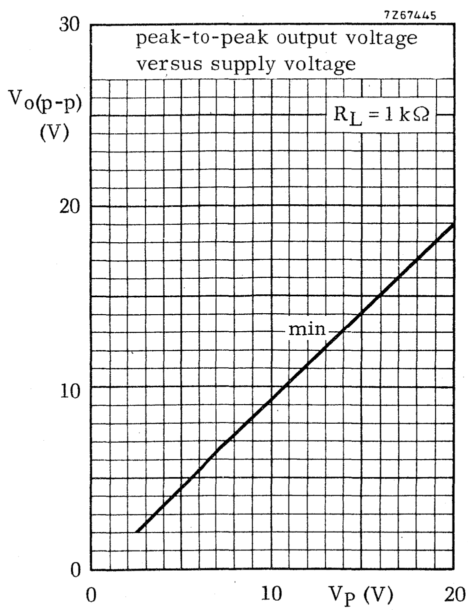


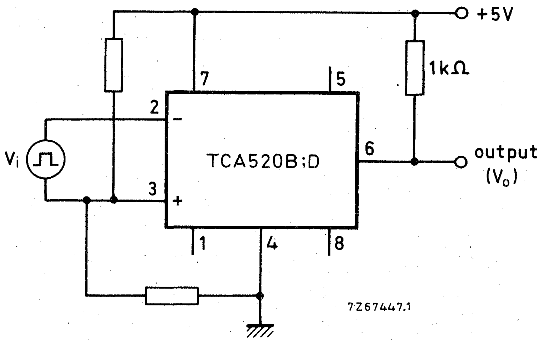
Frequency response and slew-rate for various closed-loop gains

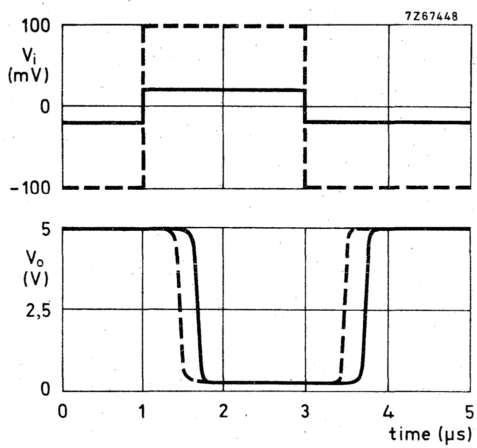

7Z67444
input bias current versus supply voltage
typ. values
$V_N = 0$ V
$T_{amb} = -20$ °C
+25
+70
I_i (nA)
60
40
20
0
0
10
V_P (V)
20


7Z67443
output sink current versus output voltage
typ. values
$V_N = 0$ V
$V_P = 20$ V
10
5
2
I_{sink} (mA)
60
40
20
0
0
10
V_o (V)
20

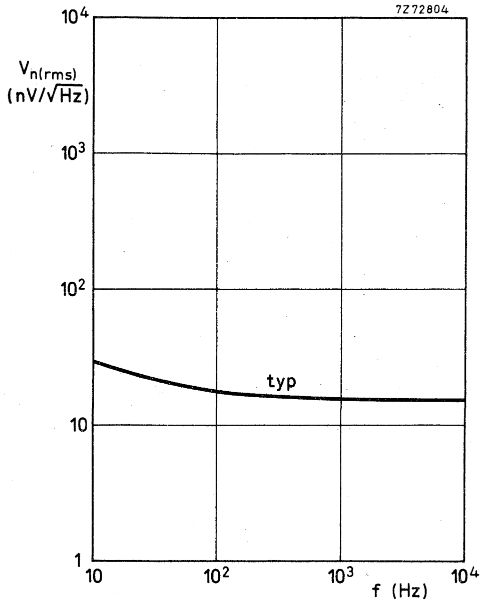

7Z67442
output source current versus output voltage
typ. values
$V_N = 0$ V
$V_P = 20$ V
10
5
2
I_{source} (mA)
0,75
0,5
0,25
0
0
10
V_o (V)
20

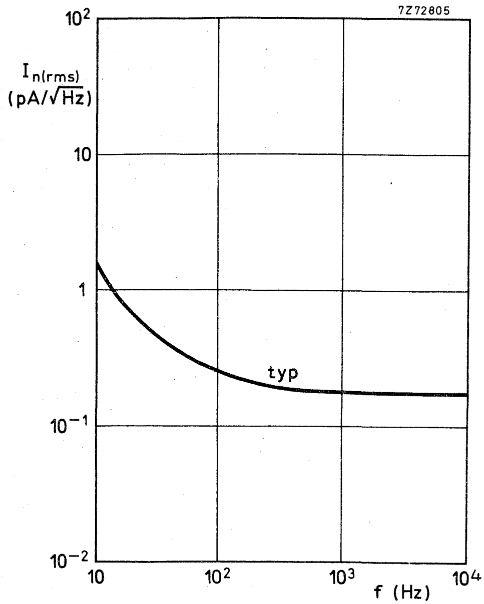

7Z67445
peak-to-peak output voltage versus supply voltage
$R_L = 1$ kΩ
min
$V_{o(p-p)}$ (V)
30
20
10
0
0
10
V_P (V)
20





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


7Z72804
$V_{n(rms)}$
$(nV/\sqrt{Hz})$
10^4
10^3
10^2
10
1
typ
10
10^2
10^3
10^4
f (Hz)


7Z72805
$I_{n(rms)}$
$(pA/\sqrt{Hz})$
10^2
10
1
10^{-1}
10^{-2}
typ
10
10^2
10^3
10^4
f (Hz)

OPERATIONAL AMPLIFIER

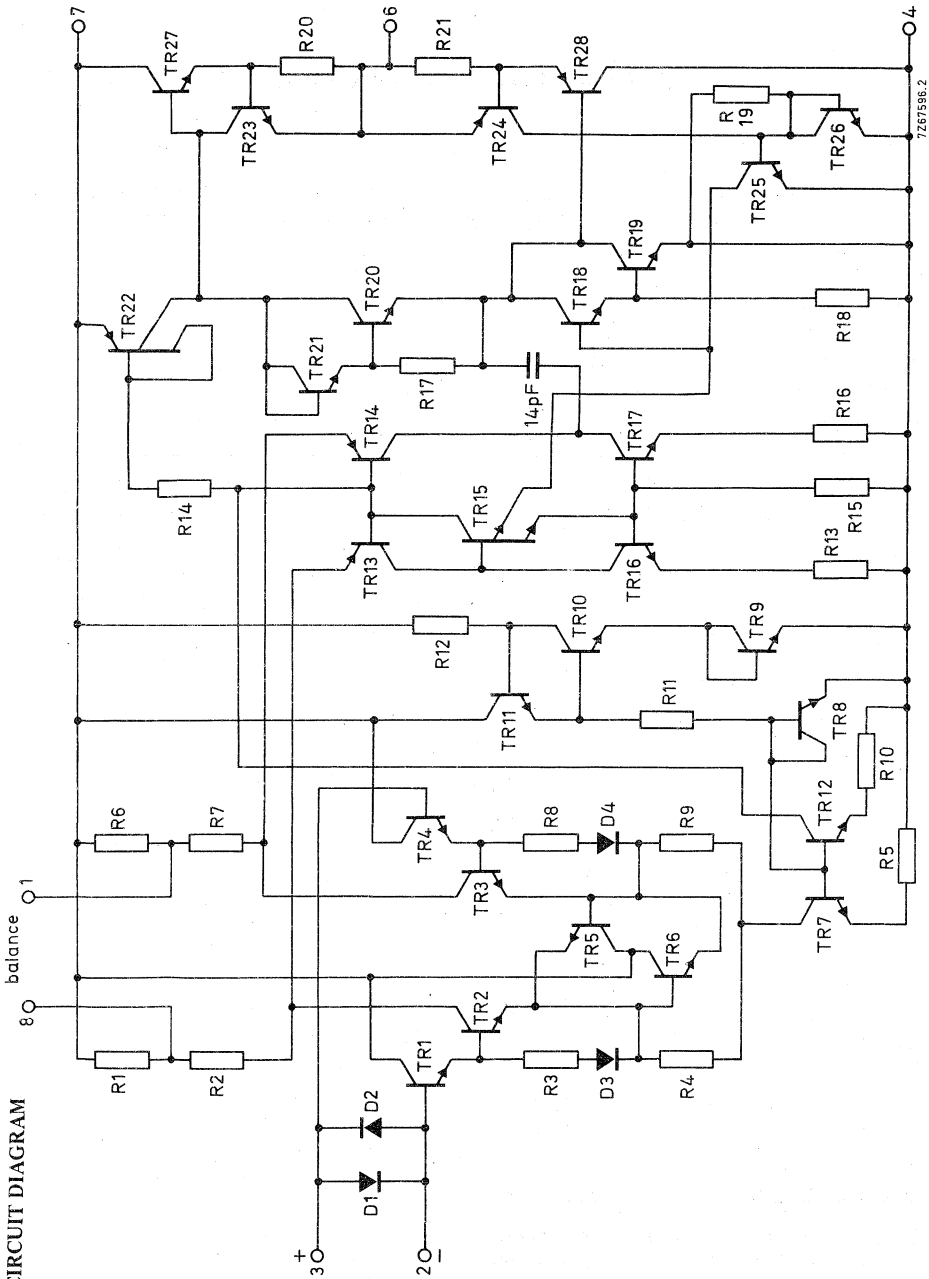
The TCA680 is a silicon monolithic integrated operational amplifier intended for general purposes, having a considerably improved slew rate and bandwidth compared to the TBA221 (μA741C).
Special features are:

- 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

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.	±0,5	V [1]

Current

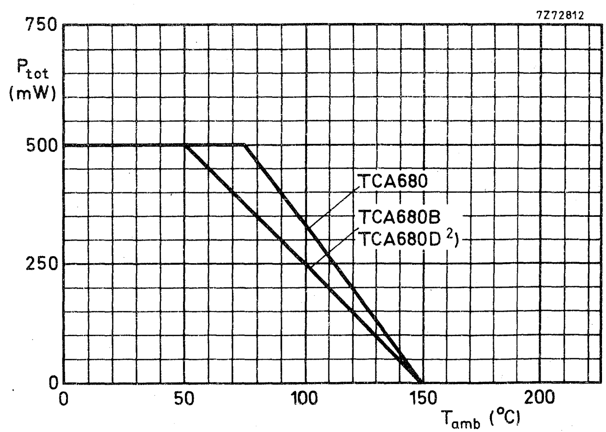
Input current	I_2; I_3	max.	±10	mA [1]

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



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 cm^2. When mounted on a PC-board the maximum power dissipation is 330 mW.

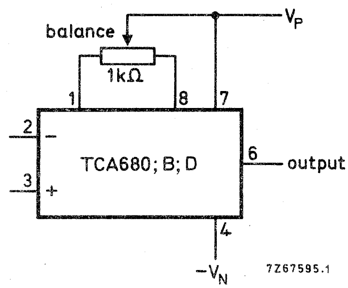
CHARACTERISTICS at V_P = 15 V; $-V_N$ = 15 V; T_{amb} = 25 °C unless otherwise specified

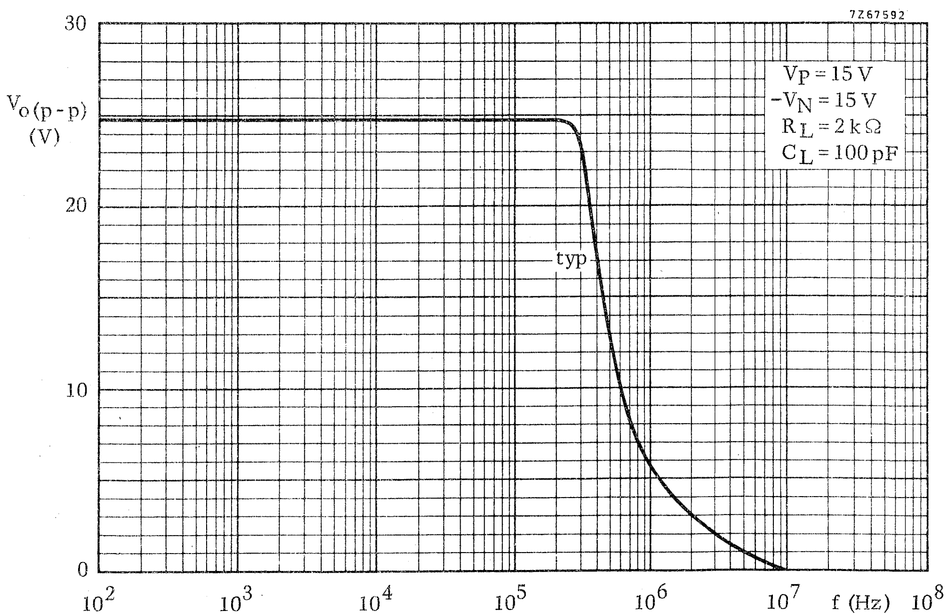
Input offset voltage	V_{io}	typ.	2	mV
		<	8	mV
Input offset voltage drift	ΔV_{io}	typ.	25	mV
Input offset current	I_{io}	typ.	5	nA
		<	30	nA
Input bias current	I_i	typ.	30	nA
		<	100	nA
Input voltage range	V_i	>	−12,5 to +13,5	V
		typ.	−13,5 to +14,5	V
Common mode rejection ratio	CMRR	>	70	dB
		typ.	100	dB
Power supply voltage rejection ratio	PSRR	typ.	10	μV/V
		<	100	μV/V
Large signal voltage gain				
$\pm V_o$ = 10 V; R_L = 1 kΩ	G_v	>	30 000	
		typ.	100 000	
Output voltage swing at R_L = 1 kΩ	V_o	>	±12	V
		typ.	±13	V
Output resistance at f = 1 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 mV; R_S = 10 kΩ; R_L = 1 kΩ				
C_L = 100 pF				
rise time		typ.	50	ns
overshoot		typ.	20	%
Settling time at V_i = 10 V; 0,1% error		typ.	750	ns
Slew rate at R_L = 1 kΩ; C_L = 100 pF	S	>	15	V/μs
		typ.	20	V/μs
A.C. gain at f = 1 kHz	G_v	typ.	6000	
			3800 to 8200	
Unity gain frequency	f	typ.	6	MHz
Power bandwidth (gain: −1)				
$V_{o(p-p)}$ = 20 V; R_L = 1 kΩ; C_L = 100 pF	B	typ.	320	kHz

CHARACTERISTICS (continued)

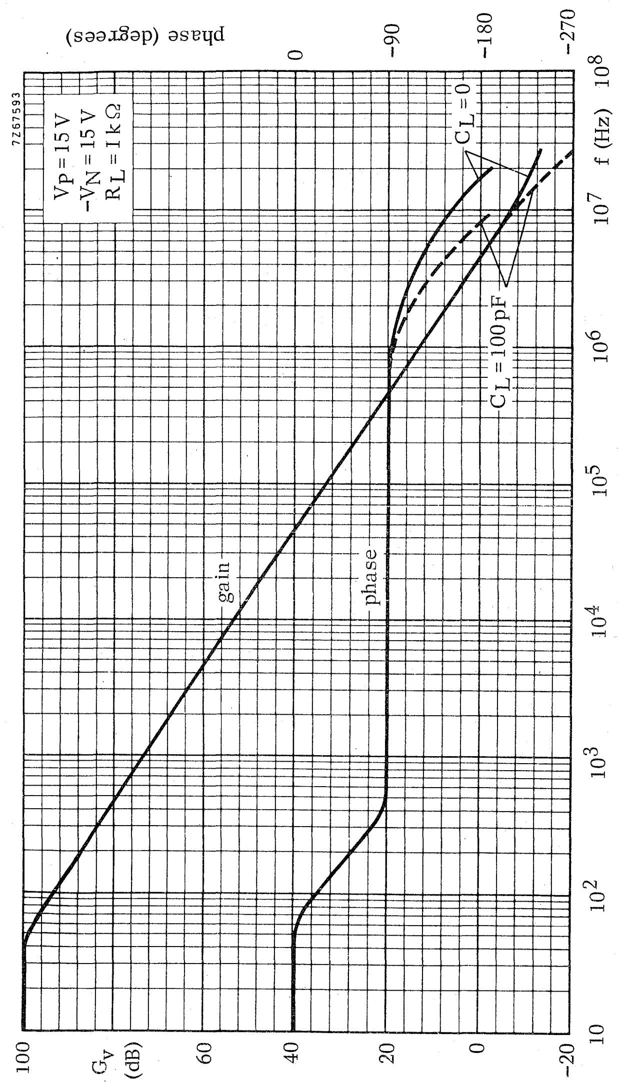
Input noise voltage at f = 1 kHz	V_n	typ.	25	$nV/\sqrt{Hz}$
at f = 80 Hz	V_n	typ.	35	$nV/\sqrt{Hz}$
Input noise current at f = 1 kHz	I_n	typ.	2	$pA/\sqrt{Hz}$
at f = 80 Hz	I_n	typ.	4	$pA/\sqrt{Hz}$

Offset voltage adjustment circuit:

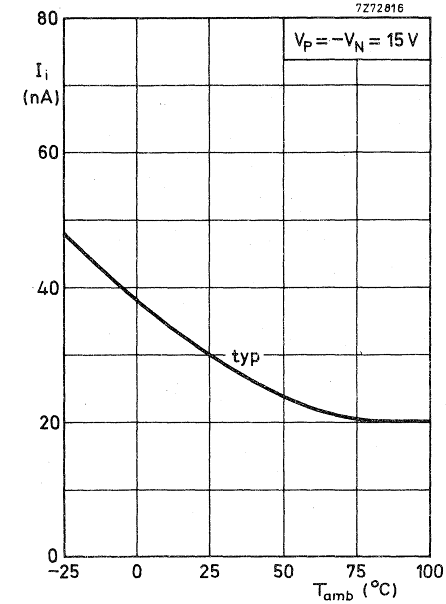




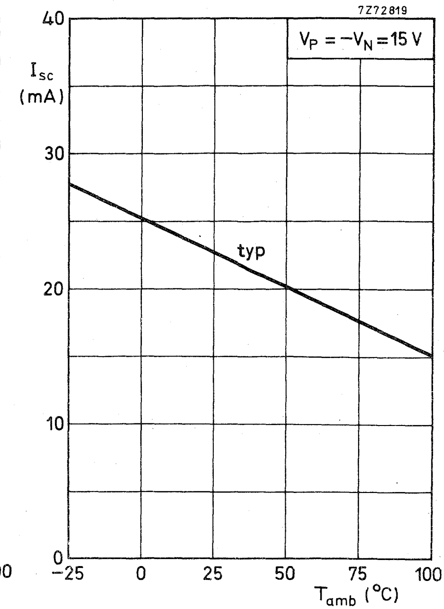
Output voltage swing versus frequency.



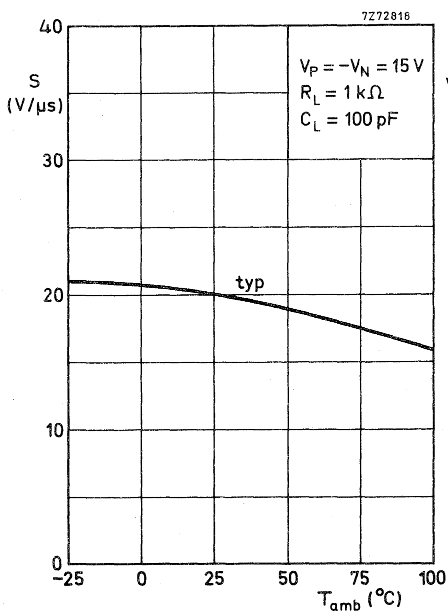
Open-loop voltage gain and phase response versus frequency



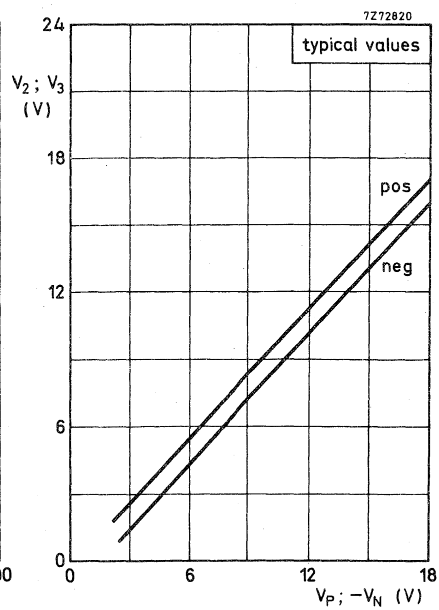
Input bias current.



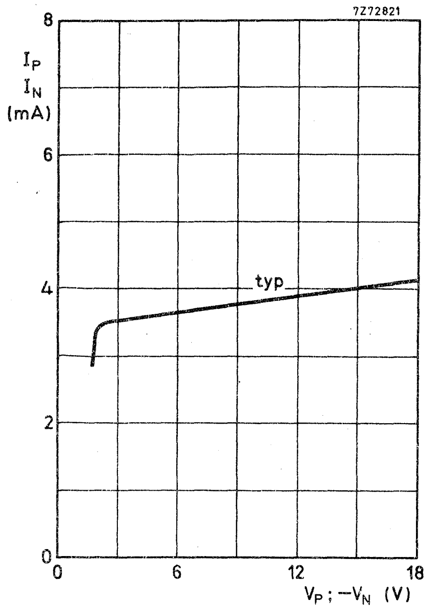
Output short-circuit current.



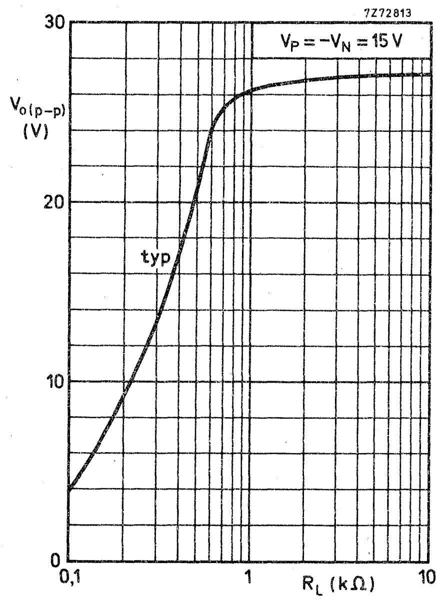
Slew rate.



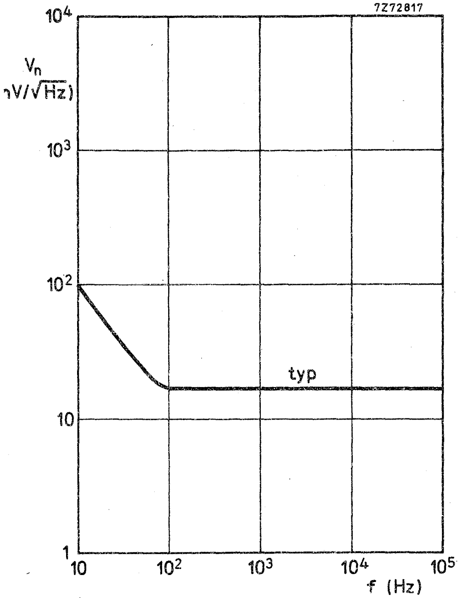
Input common mode voltage range.



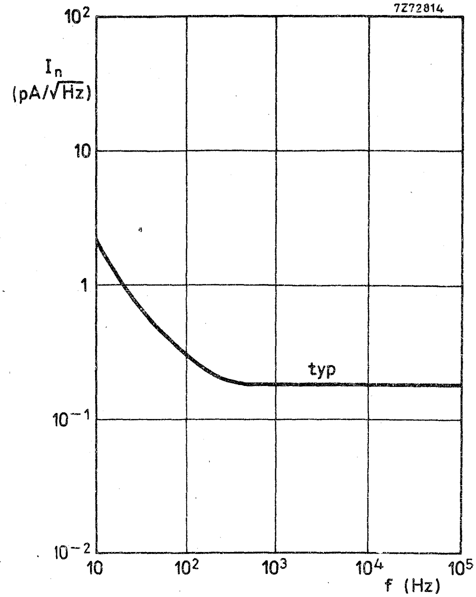
Supply current.



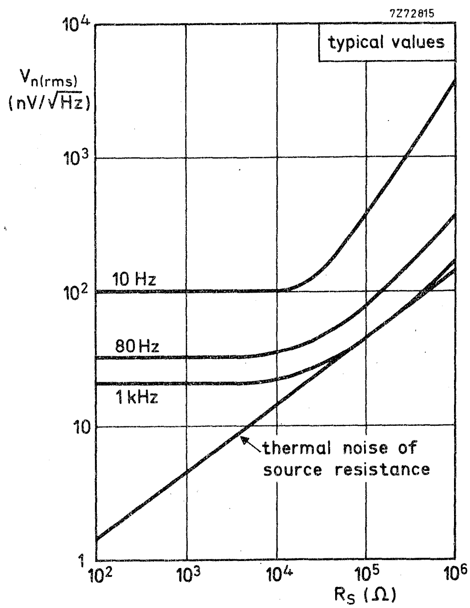
Output voltage swing.



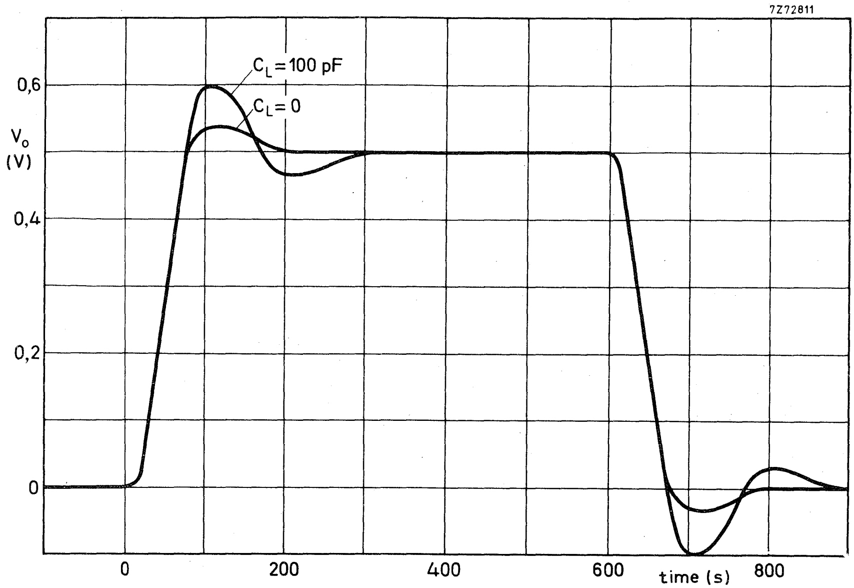
Input noise voltage density.

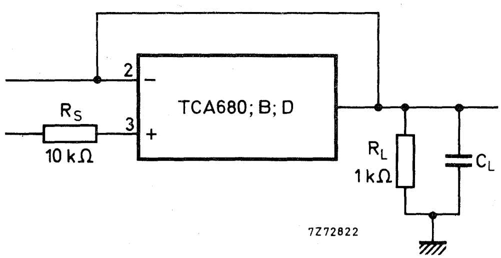


Input noise current density.



Total input noise voltage density.





Transient response curves and test circuit.

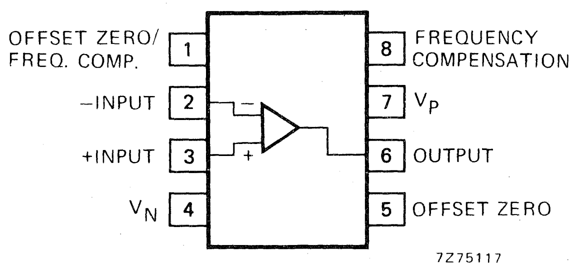
OPERATIONAL AMPLIFIER

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

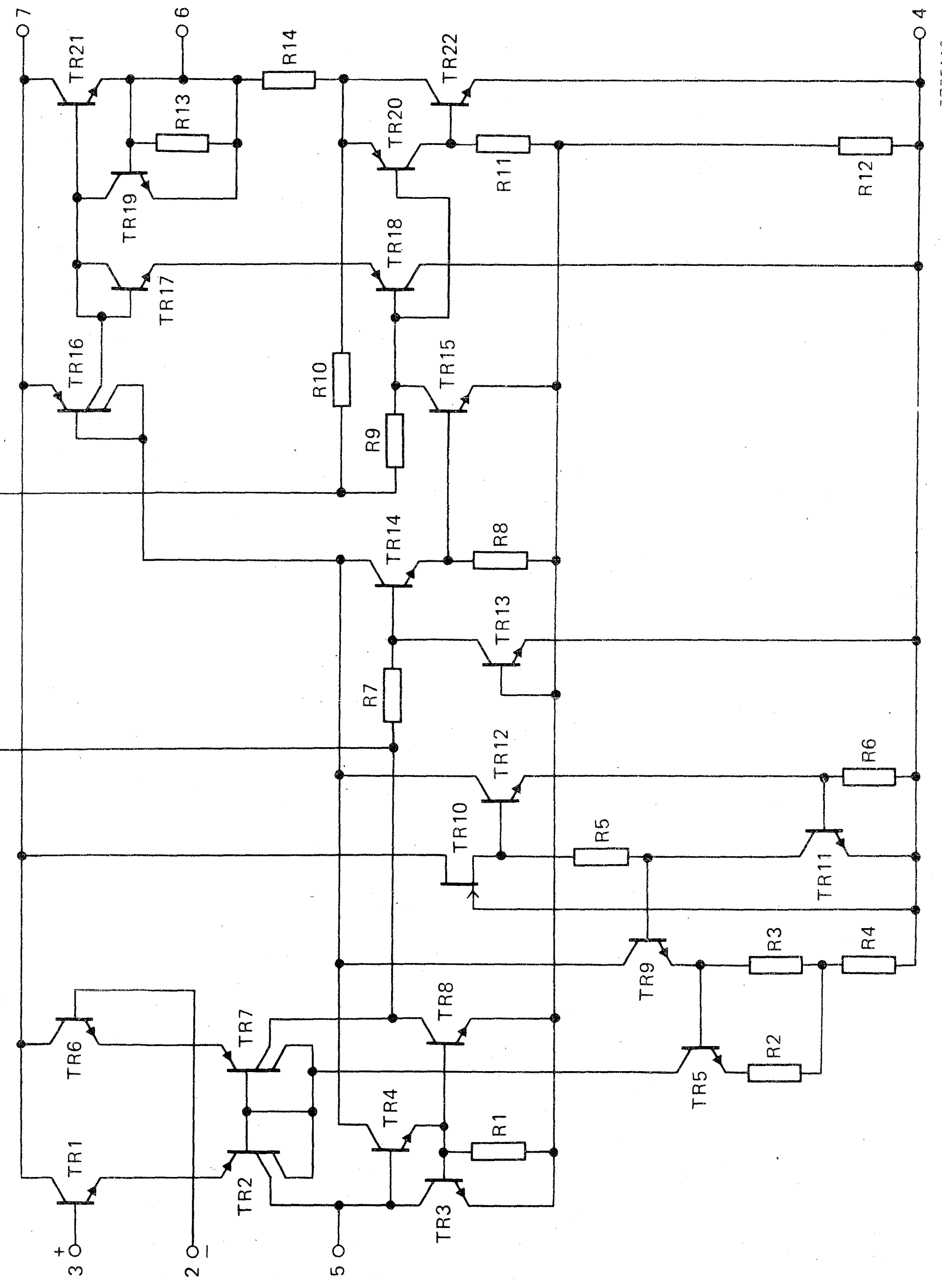
CONNECTION DIAGRAM



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 (IEC 134)

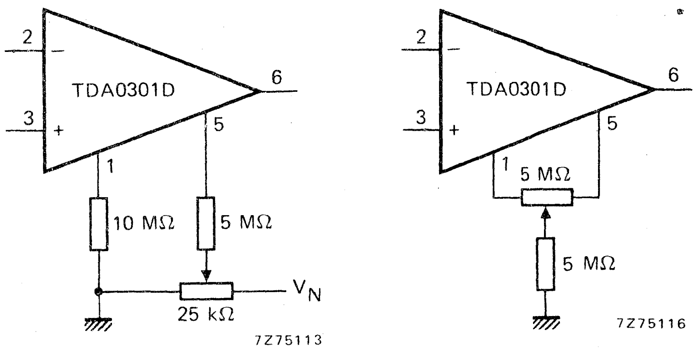
Supply voltage	$V_P - V_N$	max.	36	V
Differential input voltage	$V_{I+} - V_{I-}$	max.	±30	V
Common mode input voltage	$V_{I+}; V_{I-}$	V_N to V_P		

<u>Temperatures</u>

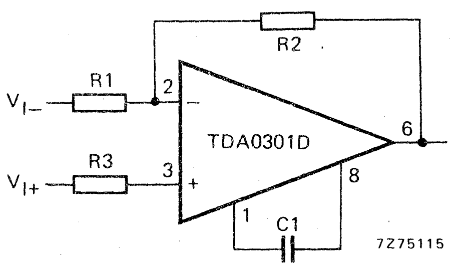
Operating ambient temperature	T_{amb}		-25 to +85	^oC
Storage temperature	T_{stg}		-65 to +125	^oC
Junction temperature	T_j	max.	125	^oC

<u>Power dissipation</u> in free air; $T_{amb} = 50\ ^oC$

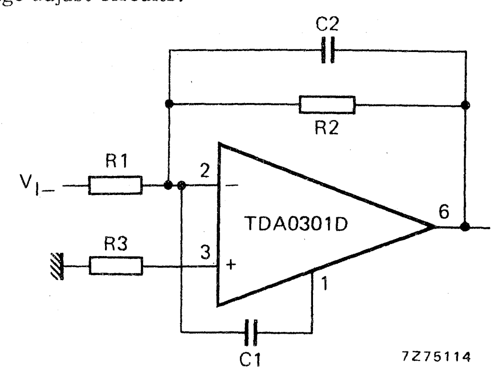
Mounted on a ceramic substrate of 4 cm^2	P_{tot}	max.	470	mW
derating factor for $T_{amb} > 50\ ^oC$	$1/R_{th}$	=	6,3	mW/^oC
Mounted on PC board of 4 cm^2	P_{tot}	max.	310	mW
derating factor for $T_{amb} > 50\ ^oC$	$1/R_{th}$	=	4,2	mW/^oC



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	–	MΩ
Large signal voltage gain	$V_P = -V_N$ = 15 V; V_o = ±10 V; $R_L \geqslant$ 2 kΩ	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	µV/°C
Average temperature coefficient of I_{io}	T_{amb} = 25 to 70 °C		–	0,01	0,3	nA/°C
	T_{amb} = 0 to 125 °C		–	0,02	0,6	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 = ±10 V; $R_L \geqslant$ 2 kΩ	G_v	15	–	–	V/mV
Output voltage range	$V_P = -V_N$ = 15 V; R_L = 10 kΩ	V_o	±12	±14	–	V
	R_L = 2 kΩ	V_o	±10	±13	–	V

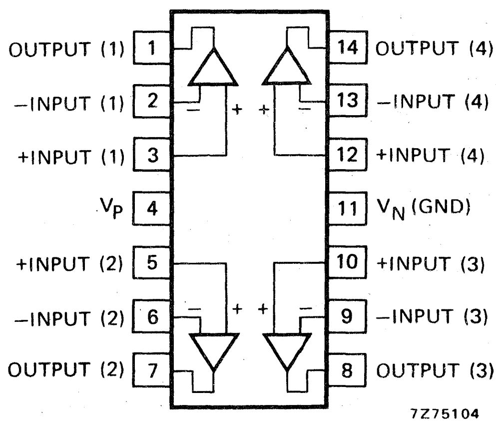
QUADRUPLE OPERATIONAL AMPLIFIER

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

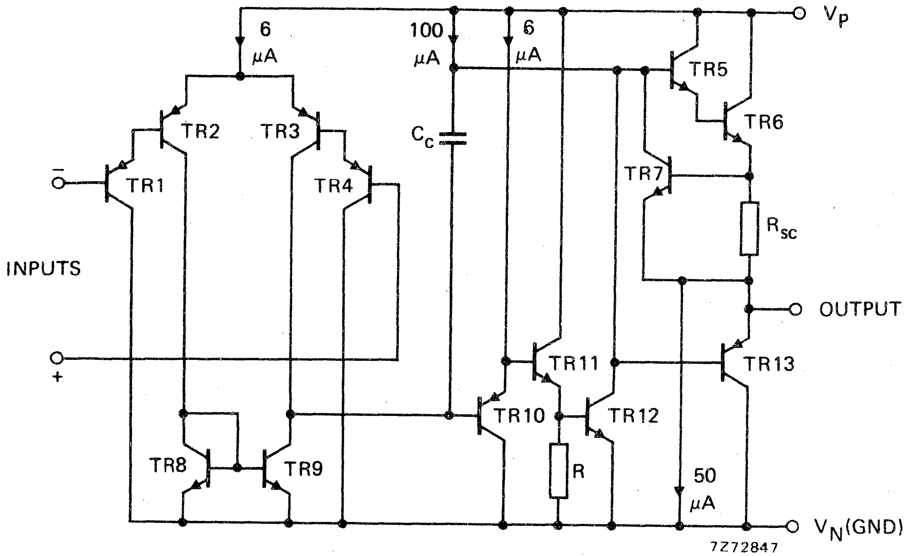
CONNECTION DIAGRAM



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 V; V_N = 0; T_{amb} = 25 °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	$V_P \leq 30$ 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 kHz to 20 kHz (input referred)		–	-120	–	dB
Large signal voltage gain	$R_L > 2$ kΩ	G_v	–	100	–	V/mV
Output voltage range	$R_L > 2$ kΩ	V_o	0	–	V_P-1,5	V
Output current source	V_{I+} = 1 V; V_{I-} = 0 V	I_o	20	40	–	mA
Output current sink	V_{I+} = 0 V; V_{I-} = 1 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 V, but either or both inputs can go to +30 V without damage.

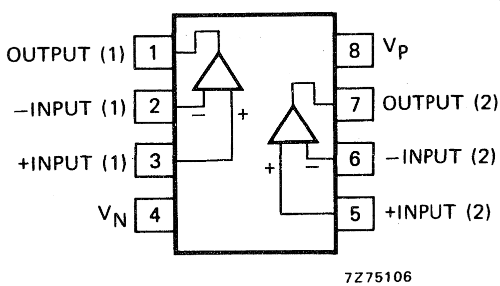
DUAL OPERATIONAL AMPLIFIER

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

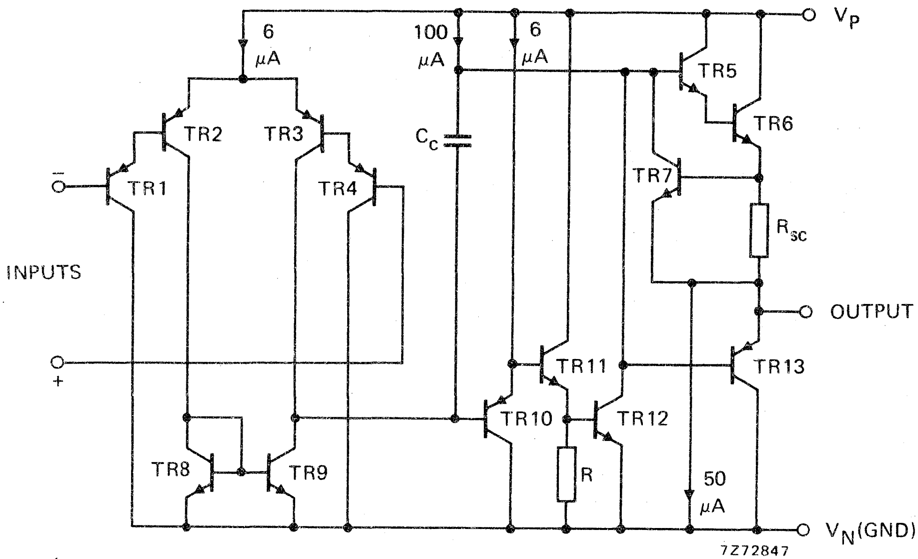
CONNECTION DIAGRAM



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 °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.	450	mW
derating factor for T_{amb} > 50 °C	$1/R_{th}$	=	6	mW/°C
Mounted on PC board of 4 cm^2	P_{tot}	max.	310	mW
derating factor for T_{amb} > 50 °C	$1/R_{th}$	=	4,2	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 $V_P = +5$ V; $V_N = 0$; $T_{amb} = 25$ °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	$V_P \leq 30$ 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 kHz to 20 kHz (input referred)		–	-120	–	dB
Large signal voltage gain	$R_L > 2$ kΩ	G_v	–	100	–	V/mV
Output voltage range	$R_L > 2$ kΩ	V_o	0	–	$V_P - 1,5$	V
Output current source	$V_{I+} = 1$ V; $V_{I-} = 0$ V	I_o	20	40	–	mA
Output current sink	$V_{I+} = 0$ V; $V_{I-} = 1$ 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 $V_P - 1,5$ 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 °C				
Voltage gain at R_L = 2 kΩ; V_o = ±10 V	G_v	typ.	200 000	
Common mode rejection ratio	CMRR	typ.	90	dB
Differential input resistance	R_i	typ.	2	MΩ
Output voltage swing at R_L = 10 kΩ	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

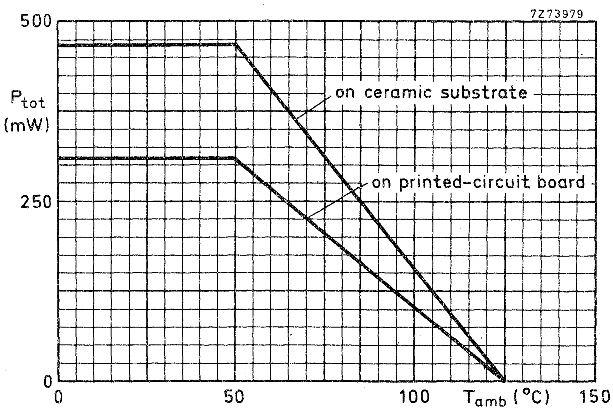
Power dissipation (see derating curve below)

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

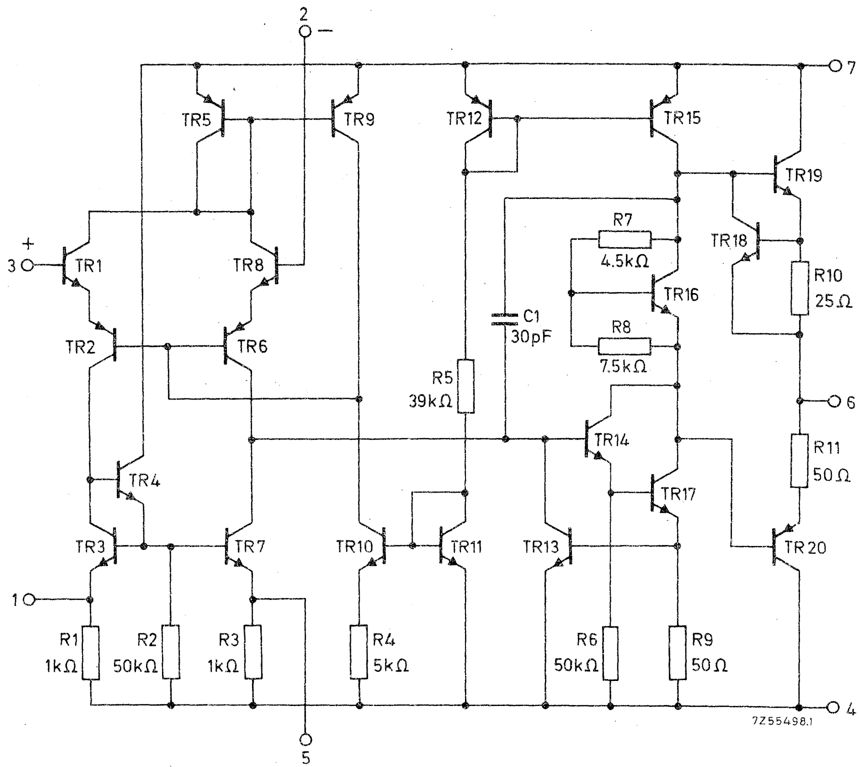
Operating ambient temperature see derating curve below	T_{amb}	−25 to +85	°C
Storage temperature	T_{stg}	−65 to +125	°C



[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

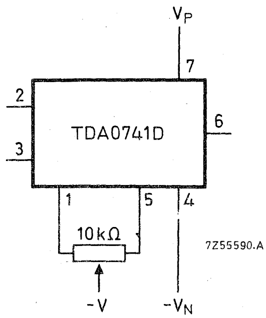


CHARACTERISTICS at V_P = 15 V; $-V_N$ = 15 V; T_{amb} = 25 °C unless otherwise specified

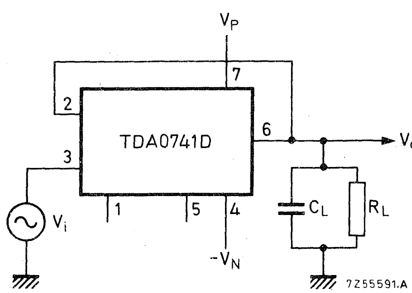
Input offset voltage	V_{io}	typ.	2	mV
		<	6	mV
Input bias current	I_i	typ.	80	nA
		<	500	nA
Input offset current	I_{io}	typ.	20	nA
		<	200	nA
Input voltage range	V_i	>	±12	V
		typ.	±13	V
Common mode rejection ratio	CMRR	>	70	dB
		typ.	90	dB
Differential input resistance	R_i	>	0,3	MΩ
		typ.	2,0	MΩ
Power supply voltage rejection ratio	PSRR	typ.	30	μV/V
		<	150	μV/V
Voltage gain at R_L = 2 kΩ; V_o = ±10 V	G_v	>	20 000	
		typ.	200 000	
Output voltage swing at R_L = 2 kΩ	V_o	>	±10	V
		typ.	±13	V
at R_L = 10 kΩ	V_o	>	±12	V
		typ.	±13	V
Output resistance at f = 1 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 mV; R_L = 2 kΩ; C_L = 100 pF				
Rise time		typ.	0,3	μs
Overshoot		typ.	5	%
Slew rate (unity gain) at R_L = 2 kΩ	S	typ.	0,5	V/μs

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

Voltage gain at R_L = 2 kΩ; V_o = ±10V	G_v	>	15 000	
Input offset voltage	V_{io}	<	7,5	mV
Input bias current	I_i	<	0,8	μA
Input offset current	I_{io}	<	0,3	μA
Output voltage swing at R_L = 2 kΩ	V_o	>	±10	V
		typ.	±13	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 μA748. It is similar to TBA221D, which has internal frequency compensation.

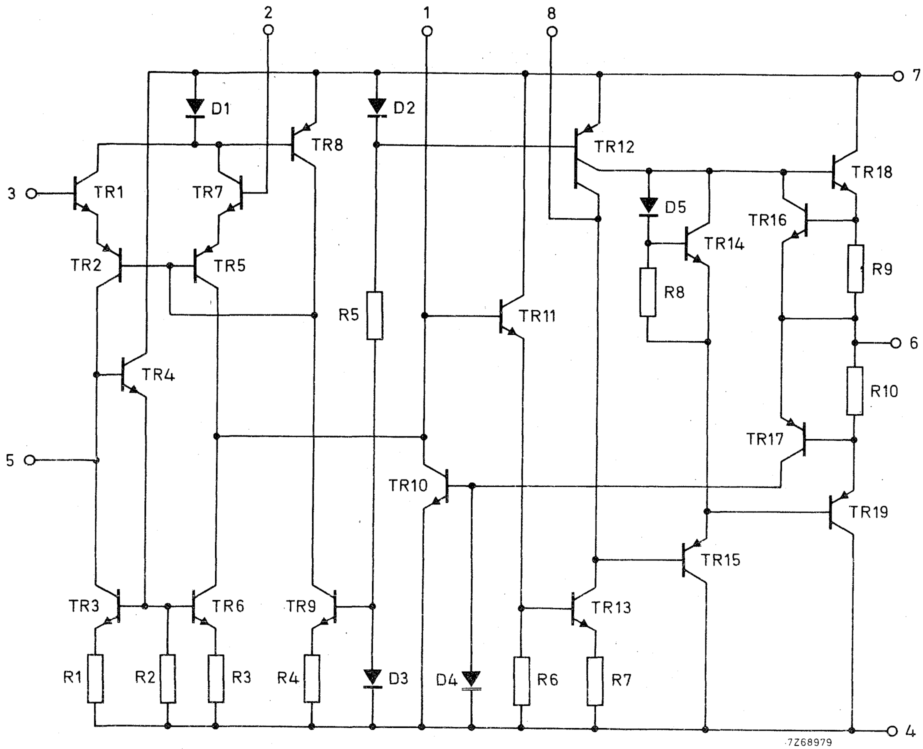
QUICK REFERENCE DATA

Positive supply voltage	V_P	typ.	15	V
Negative supply voltage	V_N	typ.	15	V
Characteristics at T_{amb} = 25 °C				
Voltage gain at $R_L \geq 2$ kΩ; $V_o = \pm$ 10 V	G_v	typ.	150 000	
Common mode rejection ratio at $R_S \leq 10$ kΩ	CMRR	typ.	90	dB
Input resistance	R_i	typ.	2	MΩ
Output voltage swing at $R_L \geq 10$ kΩ	$\pm V_o$	>	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 °C	P_{tot}	max.	470	mW	[2]
Output short-circuit duration	t	max.	60	s	[3]

[1]) For supply voltage less than ± 15 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

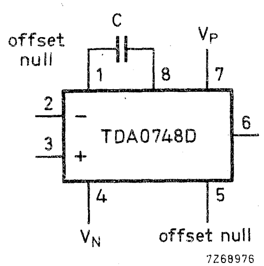
Storage temperature	T_{stg}		−55 to +125	°C
Operating ambient temperature	T_{amb}		0 to +85	°C
Lead temperature (soldering time < 60 s)	T_{lead}	max.	260	°C

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

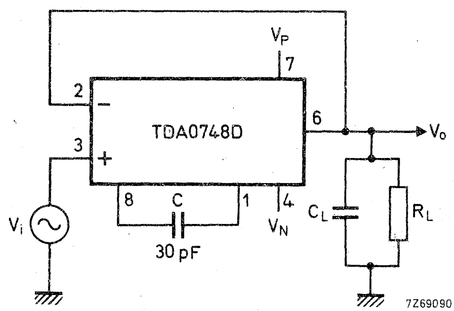
Input offset voltage at $R_S \leq 10$ kΩ	V_{io}	typ. <	2, 0 6, 0	mV mV
Input offset current	I_{io}	typ. <	20 200	nA nA
Input bias current	I_i	typ. <	80 500	nA nA
Input resistance	R_i	> typ.	0, 3 2, 0	MΩ MΩ
Input capacitance	C_i	typ.	2, 0	pF
Offset voltage adjustment range	$\pm V_{io}$	typ.	15	mV
Large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

CHARACTERISTICS V_P = 15 V; V_N = 15 V; T_{amb} = 0 to +70 °C; C = 30 pF unless otherwise specified

Input offset voltage at $R_S \leq 10$ kΩ	V_{io}	<	7,5	mV
Input offset current	I_{io}	<	300	nA
Input bias current	I_i	<	800	nA
Input voltage range	$\pm V_i$	>	12	V
		typ.	13	V
Common mode rejection ratio at $R_S \leq 10$ kΩ	CMRR	>	70	dB
		typ.	90	dB
Supply voltage rejection ratio at $R_S \leq 10$ kΩ	SVRR	typ.	30	μV/V
		<	150	μV/V
Large signal voltage gain at $R_L \geq 2$ kΩ; $\pm V_o$ = 10 V	G_v	>	15 000	
Output voltage swing at $R_L \geq 10$ kΩ	$\pm V_o$	>	12	V
		typ.	14	V
at $R_L \geq 2$ kΩ	$\pm V_o$	>	10	V
		typ.	13	V
Total power consumption	P_{tot}	typ.	60	mW
		<	100	mW

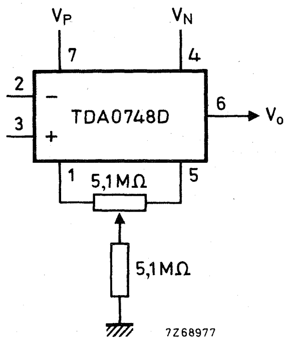


Basic circuit

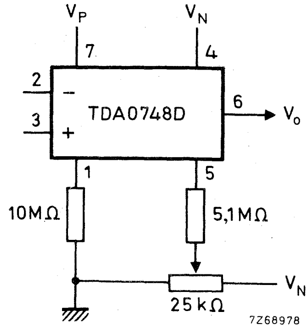


Transient response test circuit

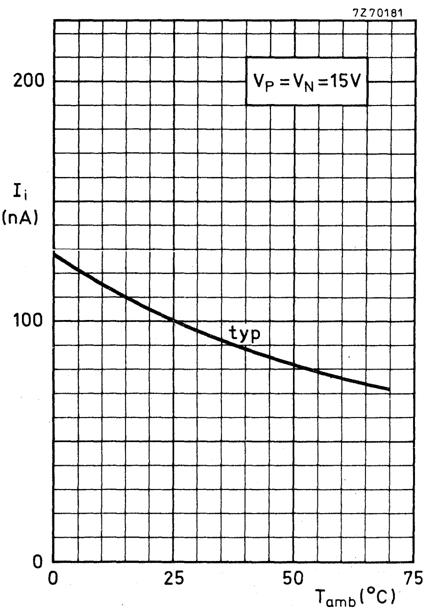
Offset voltage null circuit

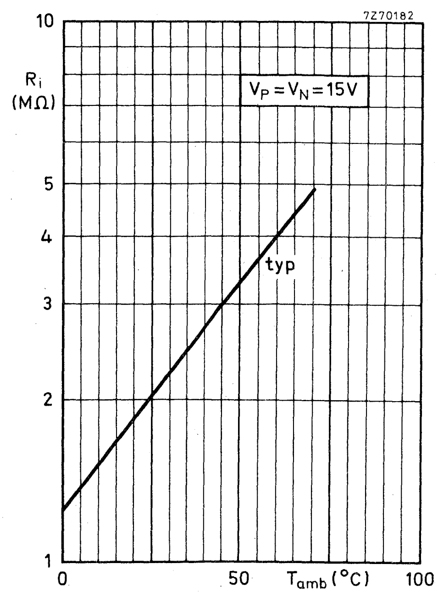


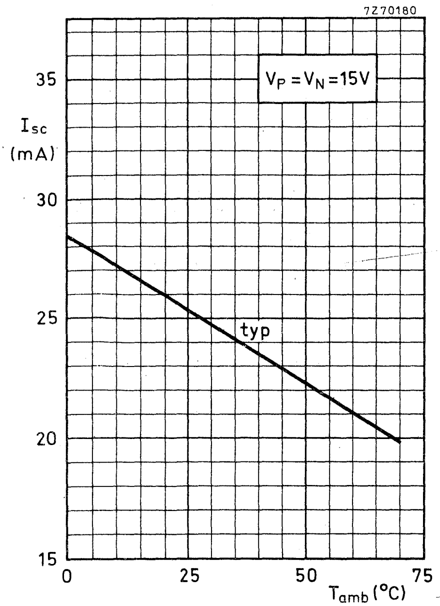
Recommended circuit

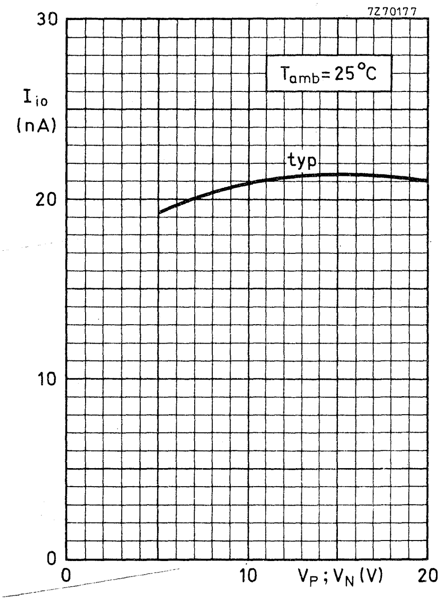


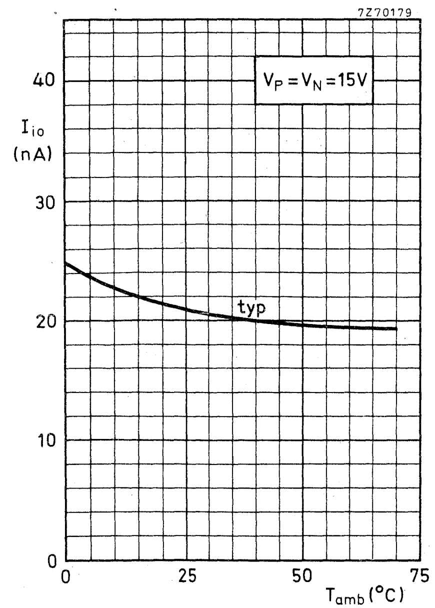
Alternate circuit

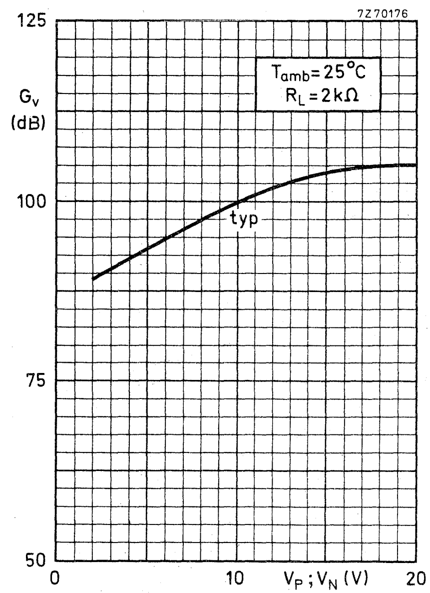


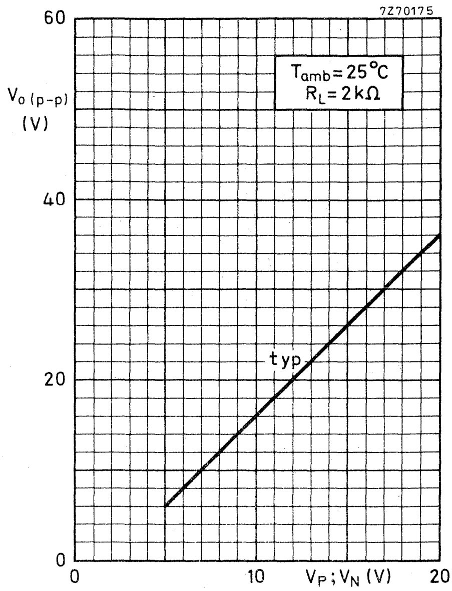


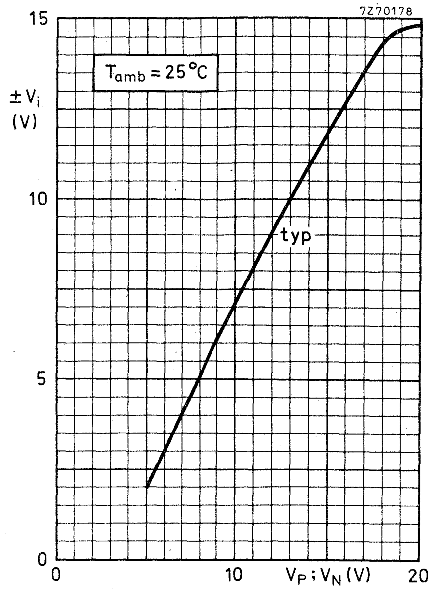

7Z70180
$V_P = V_N = 15V$
I_{sc} (mA)
35
30
25
20
15
typ
0
25
50
75
T_{amb} (°C)

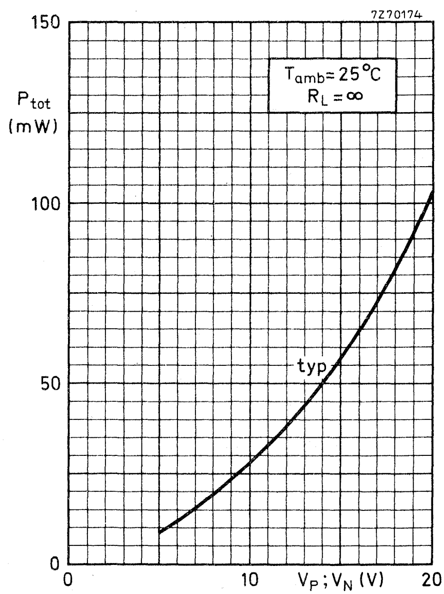

7Z70177
$T_{amb} = 25°C$
I_{io} (nA)
30
20
10
0
typ
10
V_P; V_N (V)
20

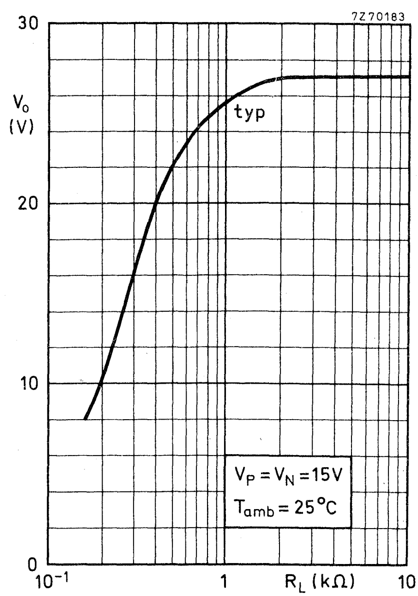

7Z70179
$V_P = V_N = 15V$
I_{io} (nA)
40
30
20
10
0
typ
25
50
75
T_{amb} (°C)

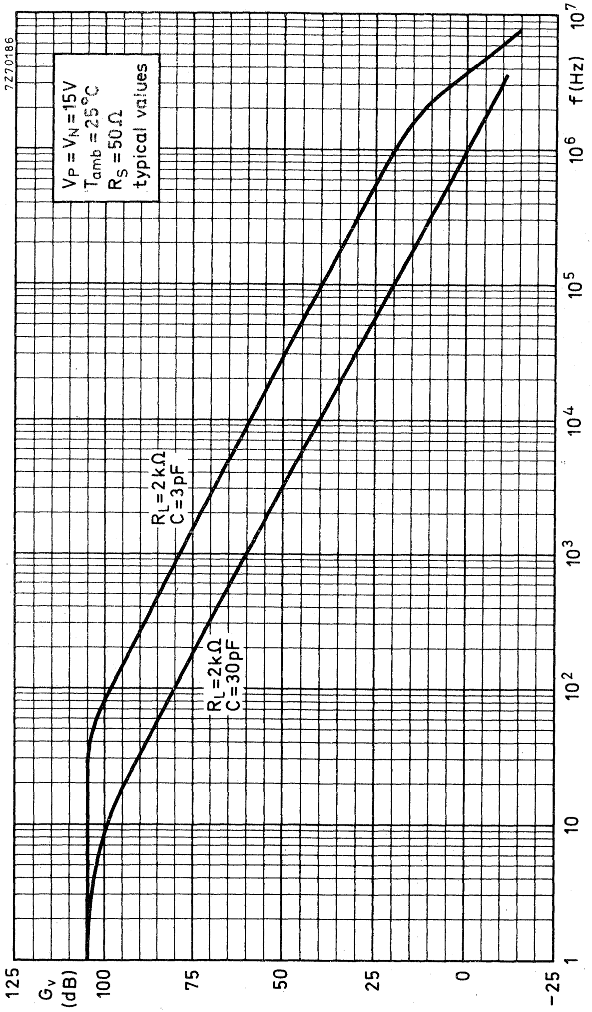

7Z70176
$T_{amb} = 25°C$
$R_L = 2k\Omega$
G_v (dB)
125
100
75
50
typ
0
10
V_P; V_N (V)
20

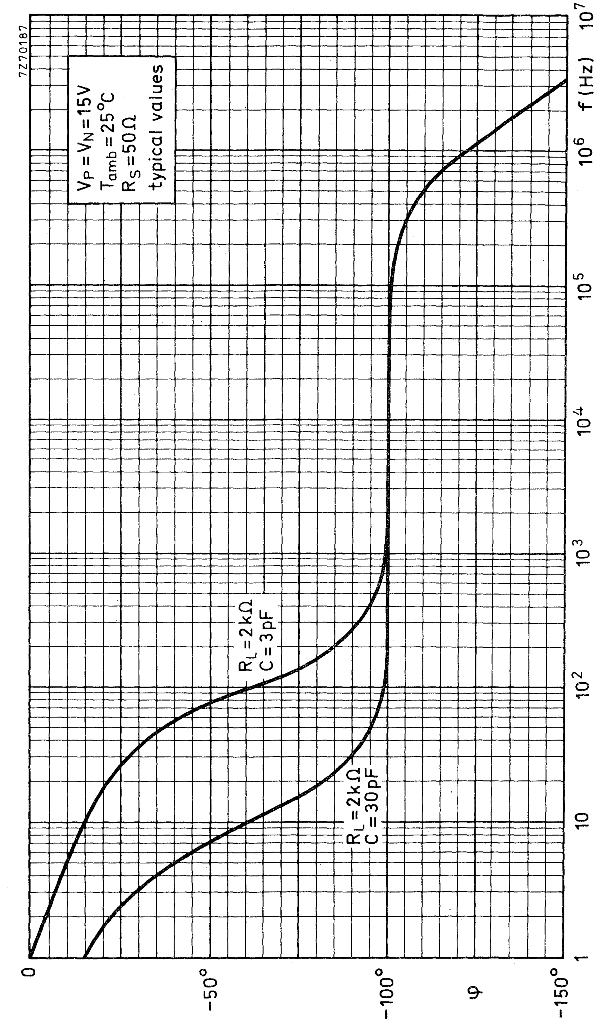

7Z70175
Tamb = 25 °C
RL = 2 kΩ
Vo (p-p) (V)
typ
VP; VN (V)
0
20
40
60
0
10
20

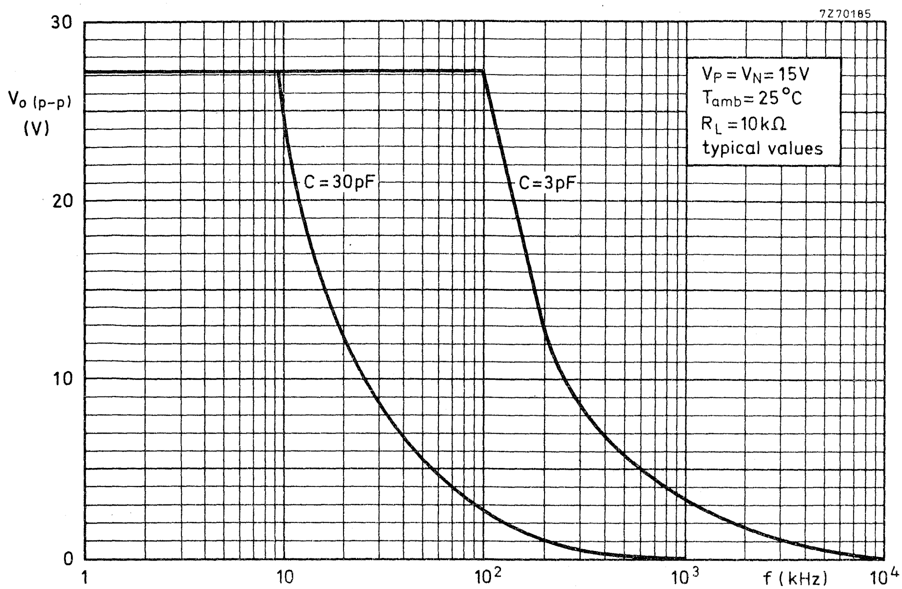

7Z70178
Tamb = 25 °C
±Vi (V)
typ
VP; VN (V)
0
5
10
15
0
10
20

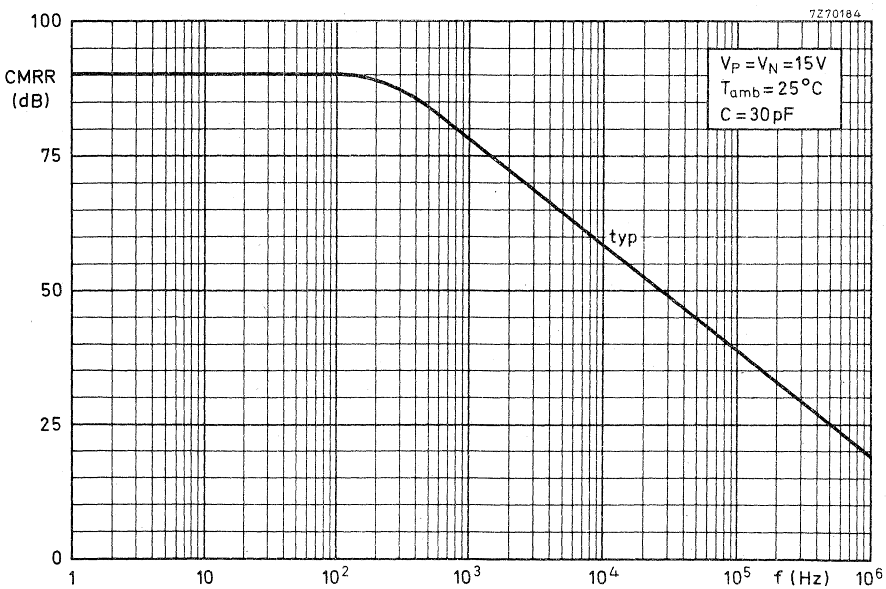

7Z70174
Tamb = 25 °C
RL = ∞
Ptot (mW)
typ
VP; VN (V)
0
50
100
150
0
10
20


7Z70183
Vo (V)
typ
VP = VN = 15 V
Tamb = 25 °C
RL (kΩ)
0
10
20
30
10−1
1
10


7Z70186
VP = VN = 15V
Tamb = 25 °C
RS = 50 Ω
typical values
RL = 2 kΩ
C = 3 pF
RL = 2 kΩ
C = 30 pF
Gv
(dB)
125
100
75
50
25
0
−25
1
10
10²
10³
10⁴
10⁵
10⁶
10⁷
f (Hz)


7Z70187
V_P = V_N = 15V
T_amb = 25°C
R_S = 50Ω
typical values
R_L = 2 kΩ
C = 3pF
R_L = 2 kΩ
C = 30pF
0
−50°
−100°
φ
−150°
1
10
10²
10³
10⁴
10⁵
10⁶
10⁷
f (Hz)


7Z70185
30
20
10
0
Vo (p-p)
(V)
VP = VN = 15 V
Tamb = 25 °C
RL = 10 kΩ
typical values
C = 30 pF
C = 3 pF
1
10
10²
10³
f (kHz)
10⁴


7Z70184
100
75
50
25
0
CMRR
(dB)
VP = VN = 15 V
Tamb = 25 °C
C = 30 pF
typ
1
10
10²
10³
10⁴
10⁵
f (Hz)
10⁶

OPERATIONAL AMPLIFIER

The TDA1034 is a high-performance general purpose operational amplifier. Compared to most of the standard operational amplifiers (e.g. μA741, 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.

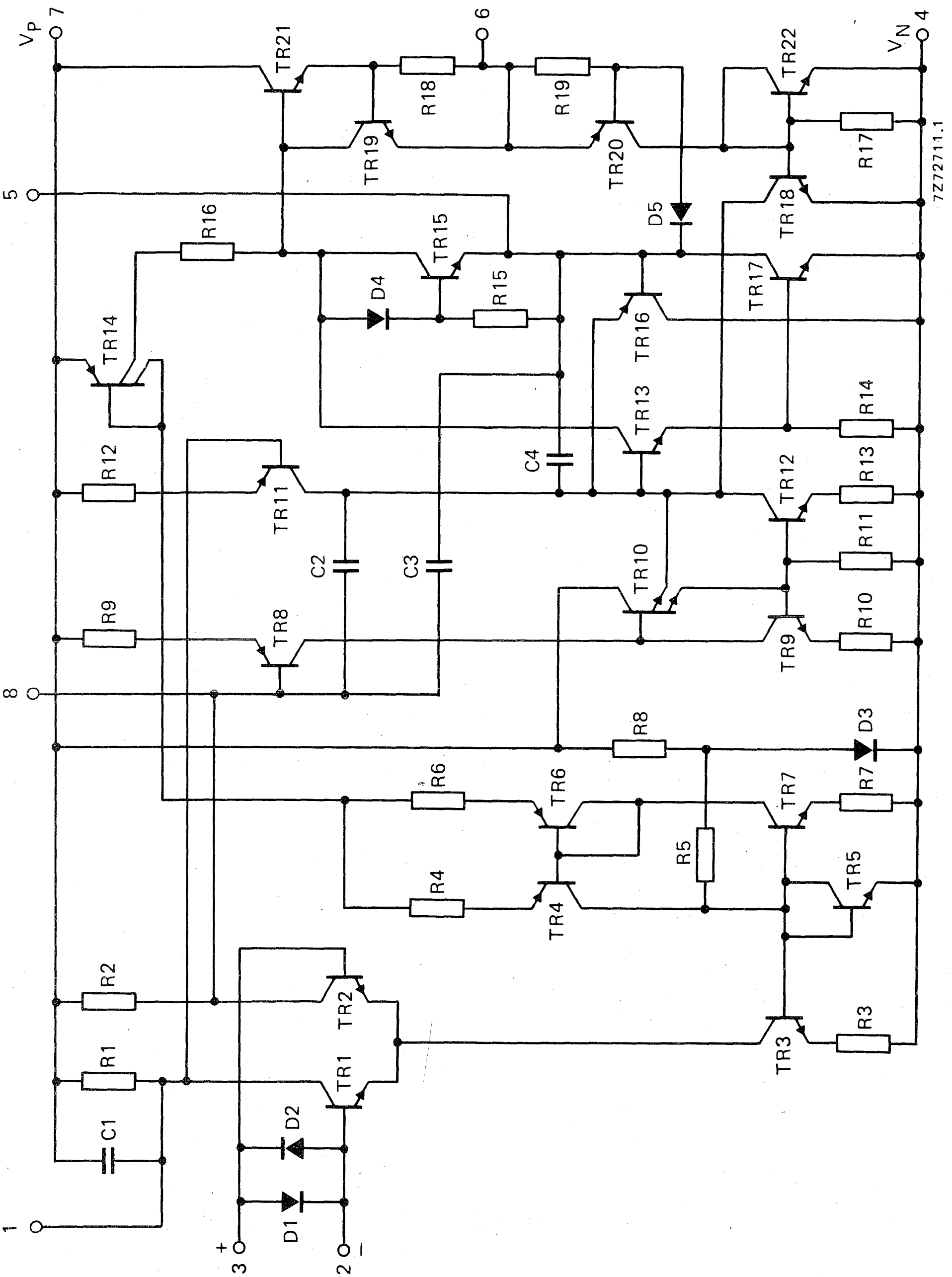
Features

- 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/$\sqrt{Hz}$
- D.C. voltage gain : 100 000
- A.C. voltage gain : 6000 at 10 kHz
- Power bandwidth : 200 kHz
- Slew-rate : 13 V/μs
- 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).

CIRCUIT DIAGRAM



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.	± 0,5	V [1]

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

Maximum power dissipation in free air

package	mounting	max. power dissipation at T_{amb} = 50 °C (mW)	derating factor for T_{amb} > 50 °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 $V_P = 15$ V; $-V_N = 15$ V; $T_{amb} = 25$ °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	kΩ
		typ.	100	kΩ
Common mode rejection ratio	CMRR	>	80	dB
		typ.	100	dB
Power supply voltage rejection ratio	PSRR	typ.	10	μV/V
		<	50	μV/V
Large-signal voltage gain				
$R_L = 600\ \Omega$; $V_o = \pm 10$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				
$G_v = 30$ dB; $f = 10$ kHz; $R_L = 600\ \Omega$; $C_C = 22$ 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)				
$V_i = 50$ mV; $R_L = 600\ \Omega$; $C_C = 22$ pF; $C_L = 100$ pF				
rise time	t_r	typ.	20	ns
overshoot		typ.	20	%
$V_i = 50$ mV; $R_L = 600\ \Omega$; $C_C = 47$ pF; $C_L = 500$ pF				
rise time	t_r	typ.	50	ns
overshoot		typ.	35	%
A.C. gain at $f = 10$ kHz; $C_C = 0$	G_v	typ.	6000	
at $f = 10$ kHz; $C_C = 22$ pF	G_v	typ.	2200	
Unity gain frequency at $C_C = 22$ pF; $C_L = 100$ pF	f	typ.	10	MHz
Slew-rate at $C_C = 0$	S	typ.	13	V/μs
at $C_C = 22$ pF	S	typ.	6	V/μs
Power bandwidth at $V_{o(p-p)} = 20$ V				
$C_C = 0$	B	typ.	200	kHz
$C_C = 22$ pF	B	typ.	95	kHz

CHARACTERISTICS (continued)

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

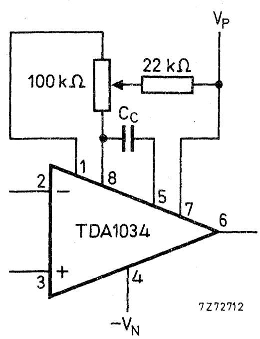
CHARACTERISTICS at V_P = 18 V; $-V_N$ = 18 V; T_{amb} = 25 °C unless otherwise specified

Output voltage swing at R_L = 600 Ω	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 $V_{o(p-p)}$ = 28 V; R_L = 600 Ω; C_C = 22 pF	B	typ.	70	kHz

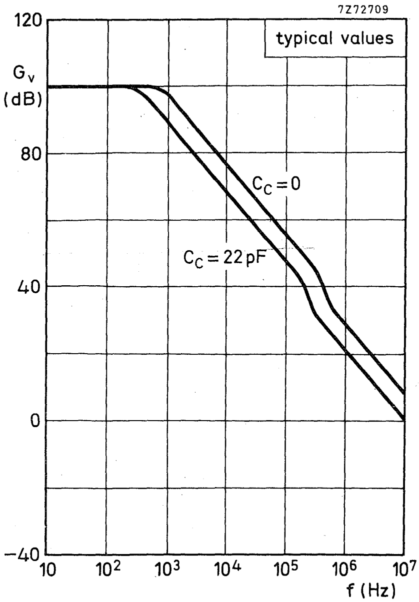
TDA1034N version

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

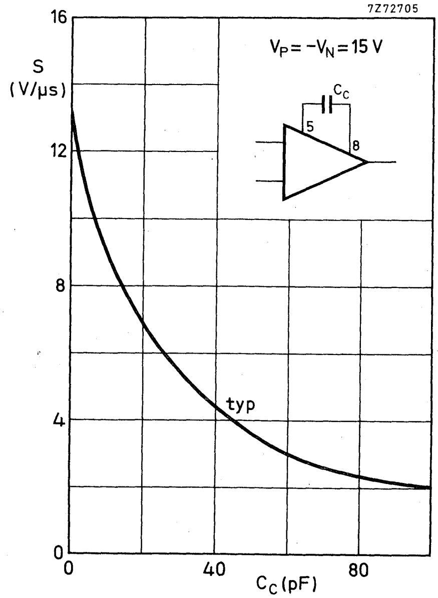
Input bias current	I_i	typ.	0,4	μA
		<	0,8	μA
Input offset current	I_{io}	typ.	0,01	μA
		<	0,2	μA
Input noise voltage at f = 30 Hz	V_n	typ.	5,5	$nV/\sqrt{Hz}$
		<	7	$nV/\sqrt{Hz}$
at f = 1 kHz	V_n	typ.	3,5	$nV/\sqrt{Hz}$
		<	4,5	$nV/\sqrt{Hz}$
Input noise current at f = 30 Hz	I_n	typ.	1,5	$pA/\sqrt{Hz}$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



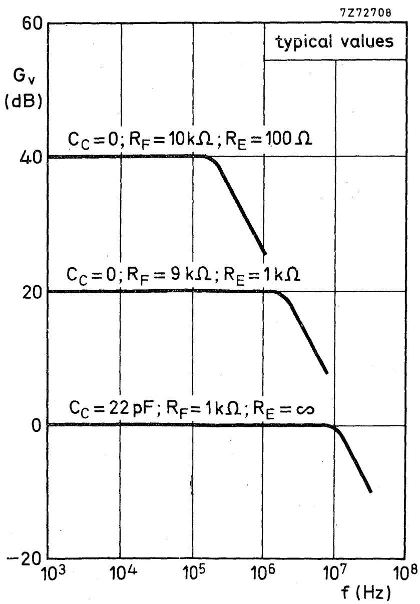
Frequency compensation and offset voltage adjustment circuit.

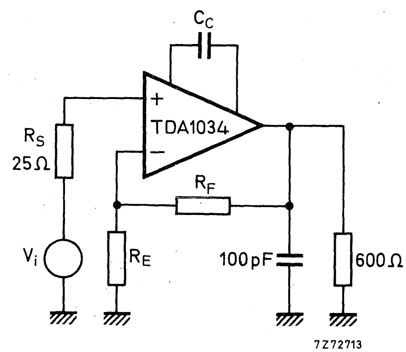


Open loop frequency response.

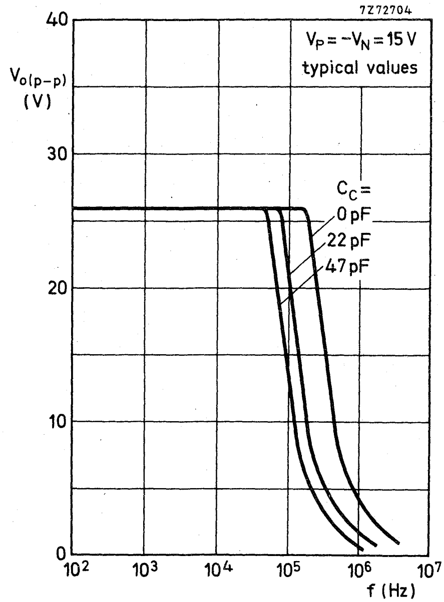


Slew-rate as a function of compensation capacitance.

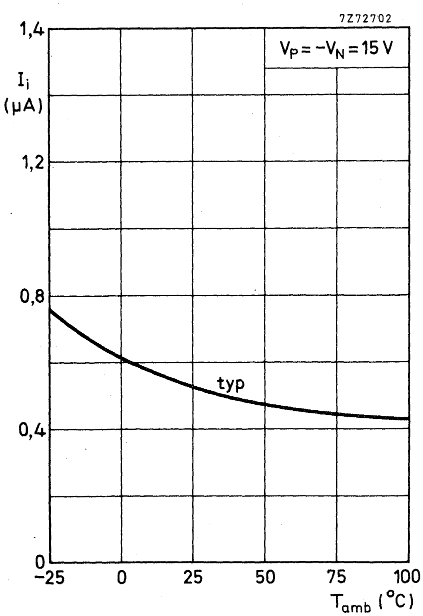




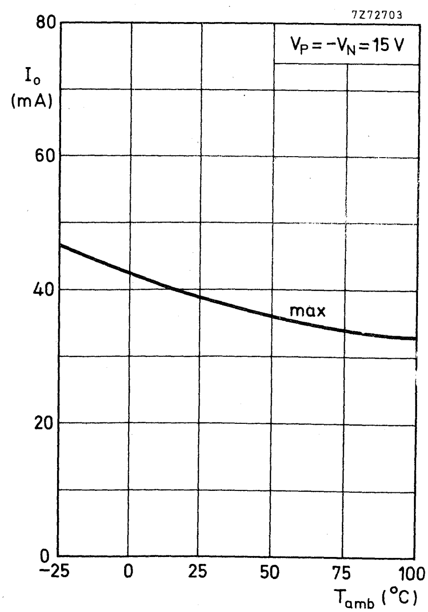
Closed loop frequency response.



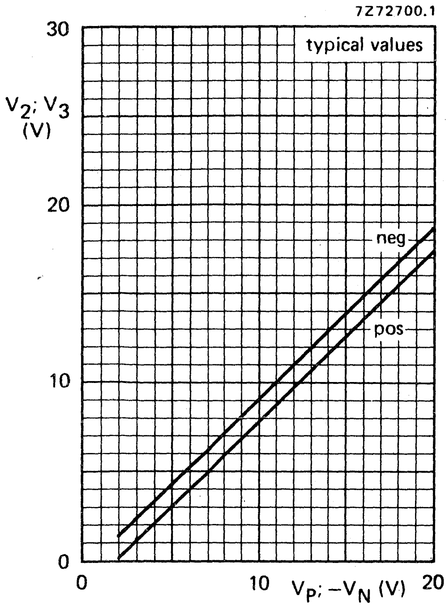
Large-signal frequency response.



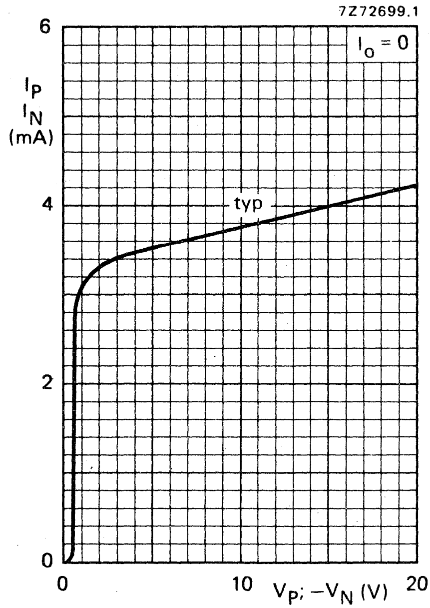
Input bias current.



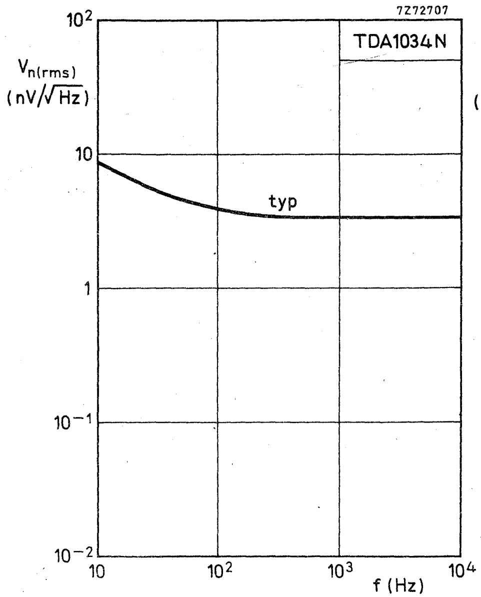
Output short-circuit current.



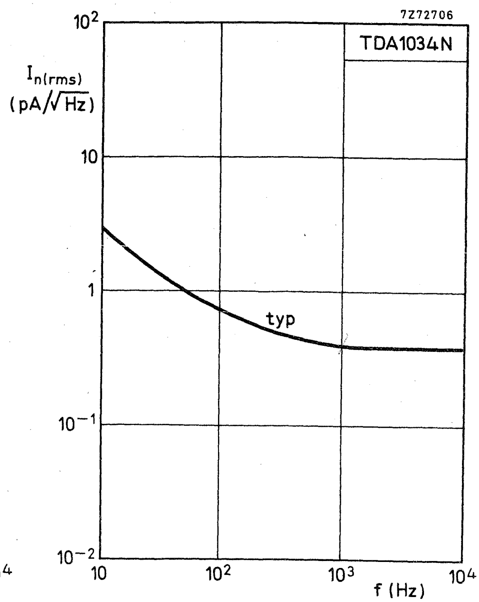
Input common mode voltage range.



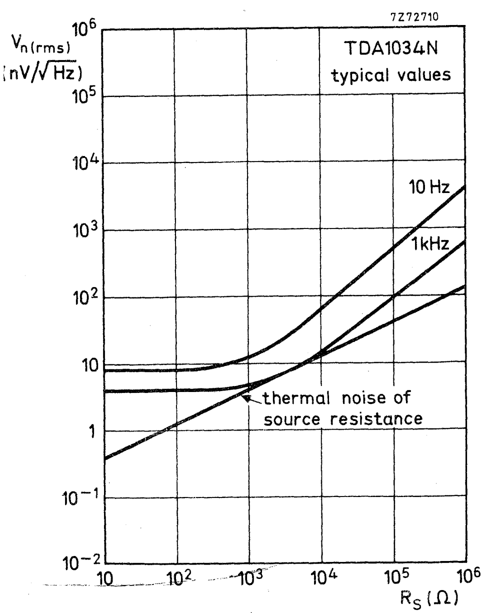
Supply current.



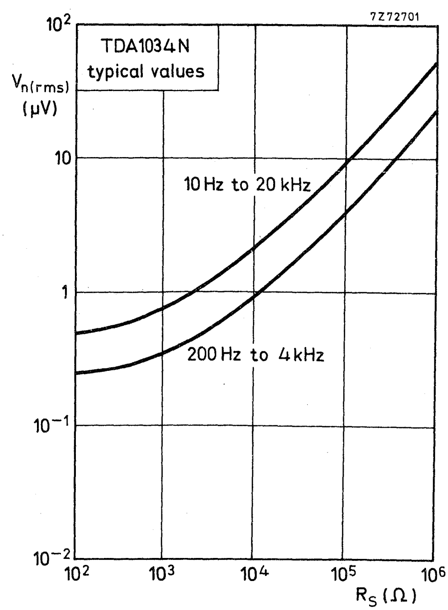
Input noise voltage density.



Input noise current density.



Total input noise density.



Broadband input noise voltage.

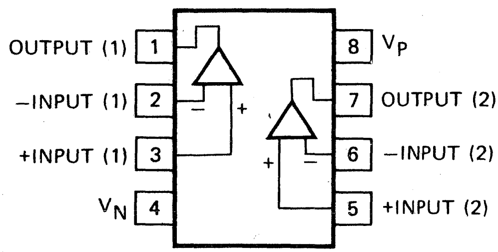
DUAL OPERATIONAL AMPLIFIER

The TDA1458D consists of two independent, internally frequency compensated operational amplifiers. The circuit is the equivalent of two standard μA741 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

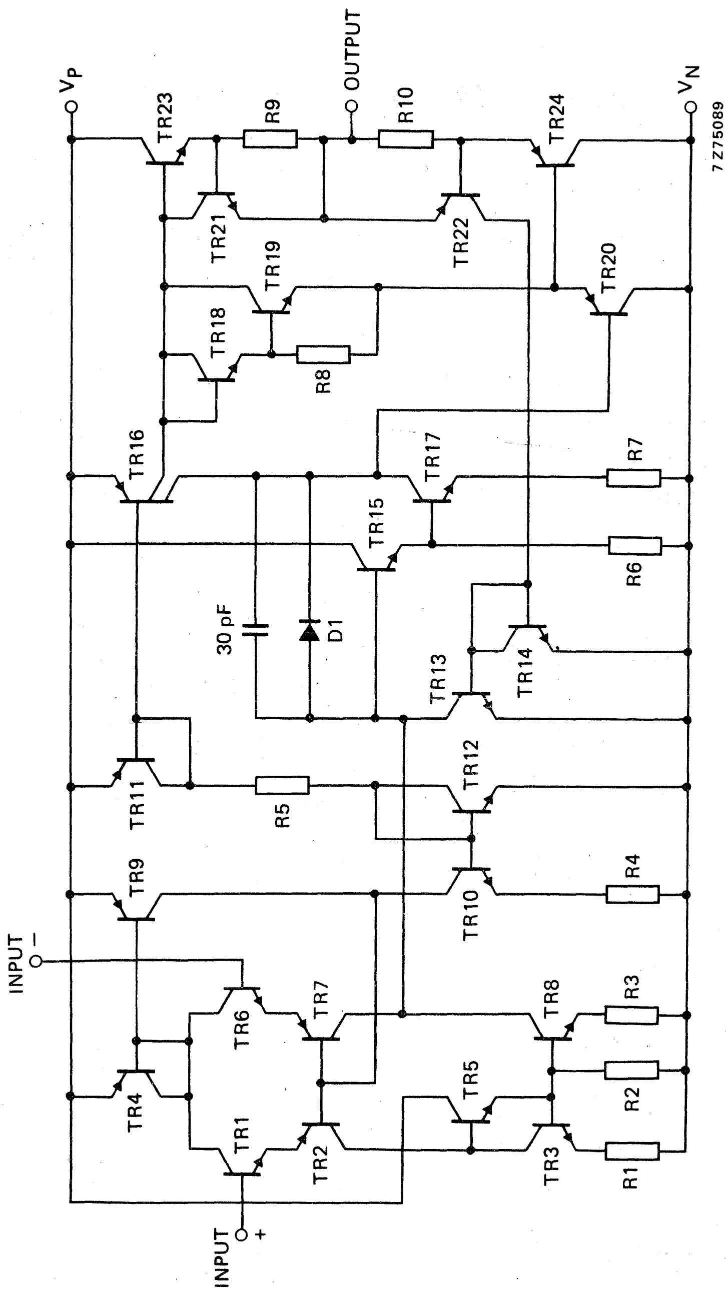


7Z75106

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

CHARACTERISTICS at V_P = 15 V; $-V_N$ = 15 V; T_{amb} = 25 °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	-	MΩ
Power supply rejection ratio		PSRR	-	30	150	μV/V
Large signal voltage gain	R_L = 2 kΩ; V_o = ± 10 V	G_v	20	100	-	V/mV
Output voltage swing	R_L = 10 kΩ R_L = 2 kΩ	V_o V_o	±12 ±10	±14 ±13	- -	V V
Output resistance	f = 20 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 kΩ; THD < 5%; $V_{o(p-p)}$ = 20 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 kΩ	S	-	0,8	-	V/μs
Channel separation			-	120	-	dB

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

Parameter	Conditions	Symbol	min.	typ.	max.	Unit
Large signal voltage gain	R_L = 2 kΩ; V_o = ±10 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 kΩ	V_o	±10	±13	-	V

[1]) THD = total harmonic distortion.

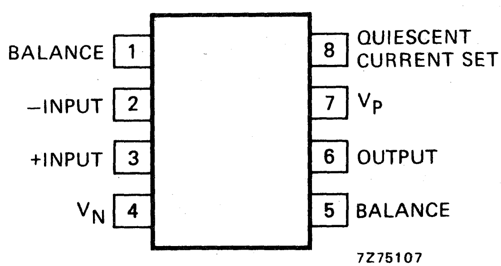
PROGRAMMABLE OPERATIONAL AMPLIFIER

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 μA776; 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

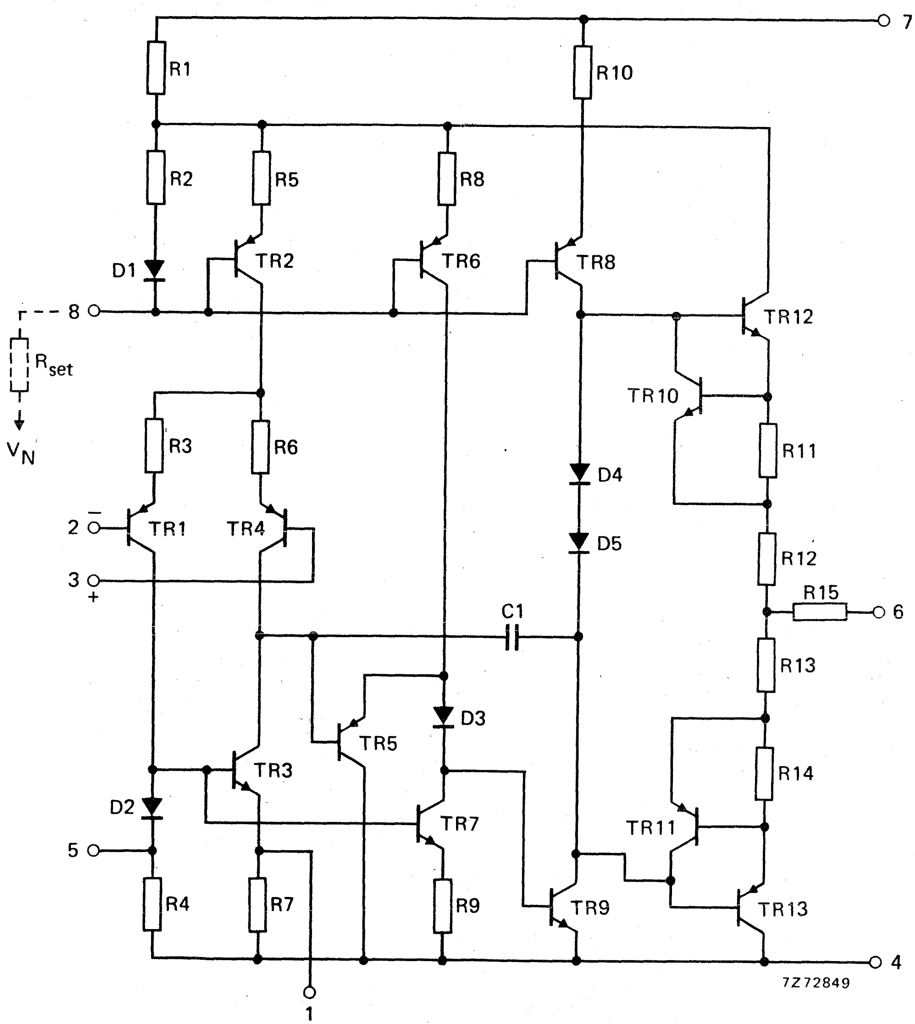
CONNECTION DIAGRAM



PACKAGE OUTLINE (see general section)

TDA4250B : plastic 8-lead dual in-line.
TDA4250D : SO-8 (SOT-96A); plastic 8-lead flat pack.

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		^oC
Storage temperature	T_{stg}	−65 to +125		^oC
Junction temperature	T_j	max.	125	^oC

Power dissipation in free air; T_{amb} = 50 ^oC

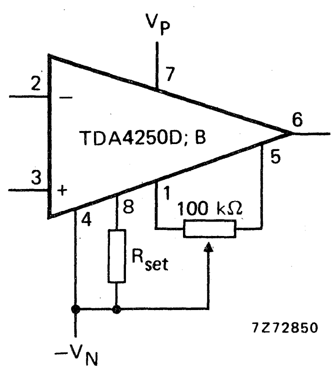
TDA4250B

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

TDA4250D

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

CHARACTERISTICS



Offset voltage adjustment circuit.

CHARACTERISTICS at I_{set} = 10 µA; V_P = 6 V; $-V_N$ = 6 V; T_{amb} = −25 to +85 °C unless otherwise specified

Parameter	Conditions	Symbol	min.	typ.	max.	Unit
Input offset voltage		V_{io}	–	–	7,5	mV
	T_{amb} = 25 °C	V_{io}	–	2	6	mV
Input offset current		I_{io}	–	–	25	nA
	T_{amb} = 25 °C	I_{io}	–	–	20	nA
Input bias current		I_i	–	–	85	nA
	T_{amb} = 25 °C	I_i	–	–	80	nA
Input voltage range	V_P = 15 V; $-V_N$ = 15 V	V_i	±13,5	±14	–	V
Output voltage swing	V_P = 15 V; $-V_N$ = 15 V; R_L = 10 kΩ	V_o	±12,5	±13,5	–	V
Supply current	I_{set} included	$I_{P;N}$	–	60	100	µA
D.C. voltage gain	R_L = 10 kΩ; V_o = ±3 V	G_v	50	200	–	V/mV
A.C. voltage gain	f = 1 kHz; R_L = 10 kΩ	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 µA

Parameter	Conditions	Symbol	min.	typ.	max.	Unit
Input offset voltage		V_{io}	–	–	6,5	mV
	T_{amb} = 25 °C	V_{io}	–	2	5	mV
Input offset current		I_{io}	–	–	6	nA
	T_{amb} = 25 °C	I_{io}	–	–	4	nA
Input bias current		I_i	–	–	12	nA
	T_{amb} = 25 °C	I_i	–	–	10	nA
Input voltage range	V_P = 15 V; $-V_N$ = 15 V	V_i	±13,5	±14	–	V
Output voltage swing	V_P = 15 V; $-V_N$ = 15 V; R_L = 100 kΩ	V_o	±13	±14	–	V
Supply current	I_{set} included	$I_{P;N}$	–	7	11	µA
D.C. voltage gain	R_L = 100 kΩ; V_o = ±3 V	G_v	50	200	–	V/mV
A.C. voltage gain	f = 1 kHz; R_L = 100 kΩ	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
TDA1022	– bucket brigade delay line

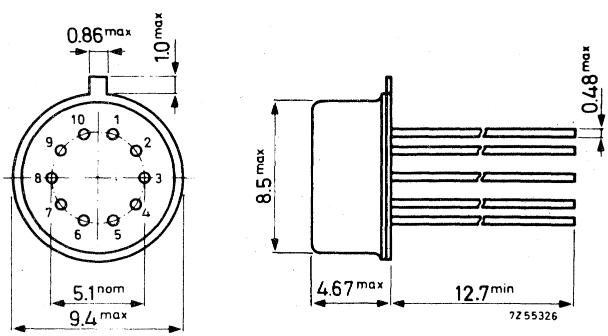
TRIPLE AMPLIFIER FOR ACTIVE FILTERS

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)	$\lvert y_{fs} \rvert$	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	kΩ
Output resistance (on pins 2, 5 and 6)	R_o	typ.	9	kΩ
(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



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

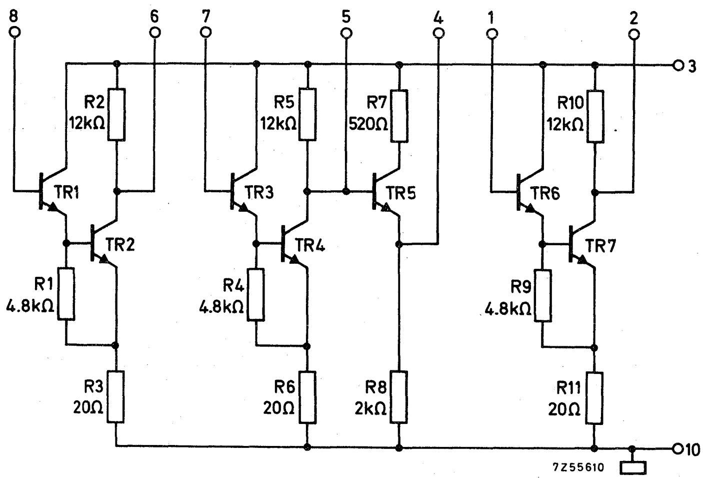
Input current	I_8, I_7, I_1	max.	50	μA

Total power dissipation	P_{tot}	max.	250	mW

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 V; T_{amb} = 25 °C unless otherwise specified.

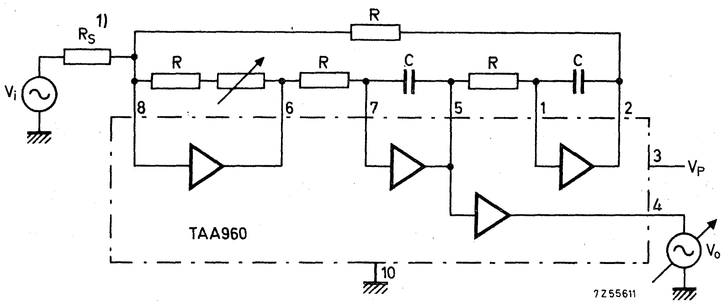
Supply current [1]	I_3		1.5 to 2.5	mA
		typ.	2.0	mA
Supply current [1] at V_3 = 10 V	I_3		1.5 to 3.8	mA
		typ.	2.6	mA
Voltage gain (each amplifier)	G_v		60 to 150	
		typ.	90	
Input resistance (each amplifier)	R_i	>	25	kΩ
Output resistance on terminals 2, 5 and 6	R_o	>	8	kΩ
		typ.	9	kΩ
on terminals 4	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 kΩ

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

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

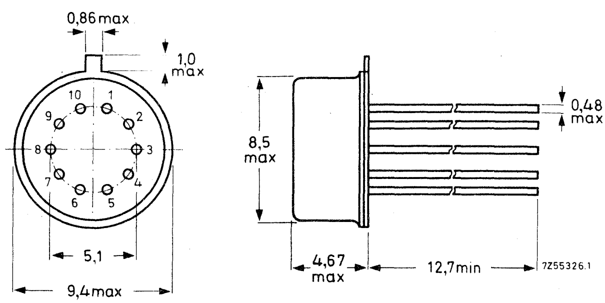
MICROPHONE AMPLIFIER

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

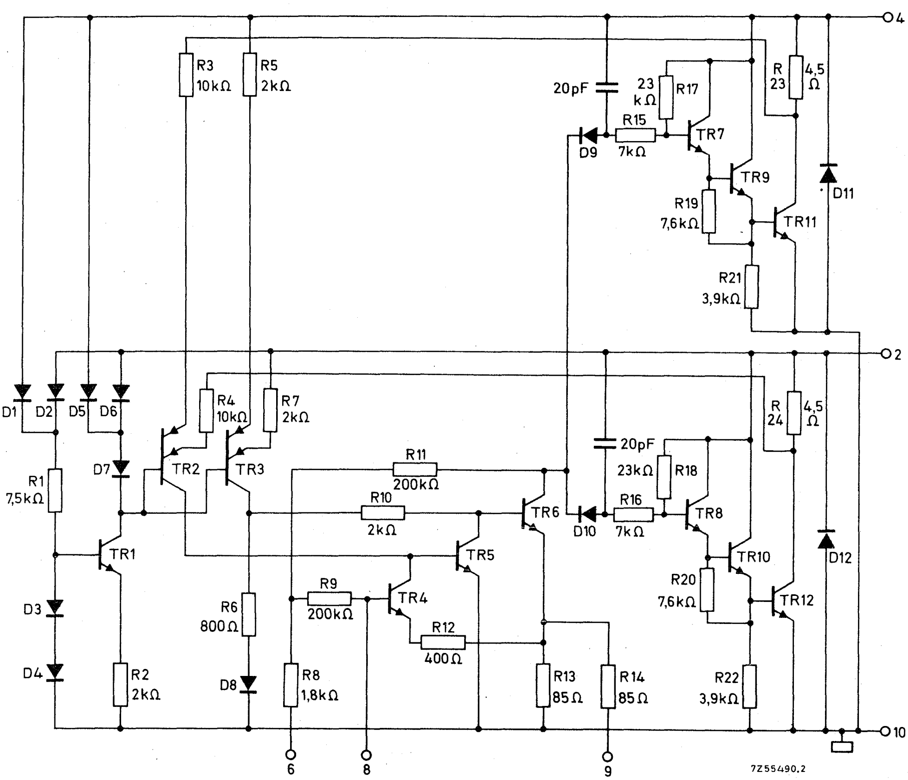
QUICK REFERENCE DATA				
Supply current	$\pm I_2$		10 to 100	mA
Supply voltage drop at $\pm I_2$ = 50 mA	$\pm V_{2-4}$	typ.	4,8	V
Voltage gain				
pin 9 not connected	G_v	typ.	150	
pin 9 connected to pin 10	G_v	typ.	210	
Output impedance				
pin 9 not connected	R_o	typ.	60	Ω
pin 9 connected to pin 10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

PACKAGE OUTLINE

TO-74 (reduced height) Dimensions in mm



CIRCUIT DIAGRAM



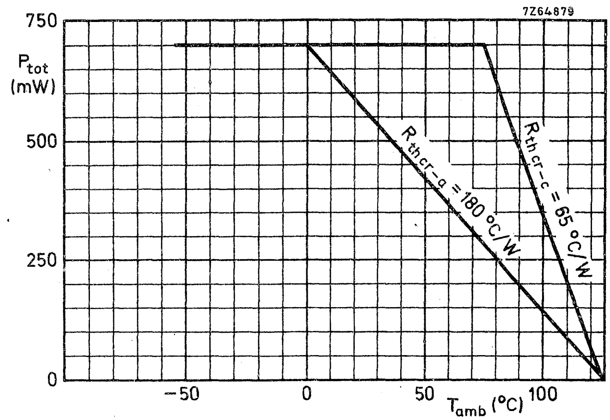
RATINGS Limiting values in accordance with the Absolute Maximum System (IEC 134)

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	μA
Pin No. 8 current	I_8	max.	100	μA

Power dissipation

Total power dissipation	P_{tot}	max.	700	mW



Temperatures

Storage temperature	T_{stg}	−55 to +125	°C
Operating ambient temperature	T_{amb}	−35 to +75	°C

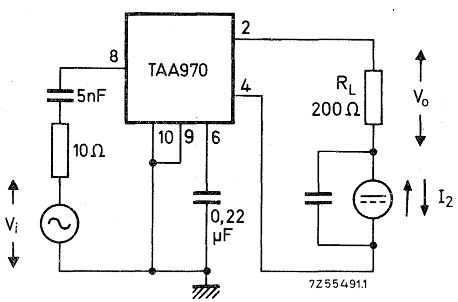
THERMAL RESISTANCE

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

CHARACTERISTICS at R_L = 200 Ω; f = 2 kHz; T_{amb} = 25 °C unless otherwise specified. (see test circuit below).

Supply voltage drop at $R_{th\ j\text{-}a}$ = 100 °C/W				
± I_2 = 10 mA		± V_{2-4}	3,4 to 5,4	V
± I_2 = 50 mA		± V_{2-4}	3,8 to 5,8	V
± I_2 = 100 mA		± V_{2-4}	4,3 to 6,0	V
Voltage gain				
pin 9 not connected	± I_2 = 10 mA	G_v	typ. 140 105 to 165	
	± I_2 = 50 mA	G_v	typ. 150 125 to 165	
pin 9 connected to pin 10	± I_2 = 10 mA	G_v	typ. 200 150 to 230	
	± I_2 = 50 mA	G_v	typ. 210 180 to 230	
Change of voltage gain				
when changing T_{amb} from −20 °C to +55 °C		ΔG_v	< 10	%
Gain reduction at f = 300 Hz				
(with respect to f = 2 kHz)		ΔG_v	typ. 1 < 3	dB dB
Output impedance at ± I_2 = 50 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 kHz to 4 kHz				
pin 9 not connected		$V_{n(rms)}$	< 1	mV
pin 9 connected to pin 10		$V_{n(rms)}$	< 1,3	mV
Output voltage				
I_2 = 25 mA; d_{tot} = 5%		V_o	> 0,85 typ. 1,0	V V

Test circuit:



RING (DE)MODULATOR FOR TELEPHONY AND INDUSTRIAL EQUIPMENT

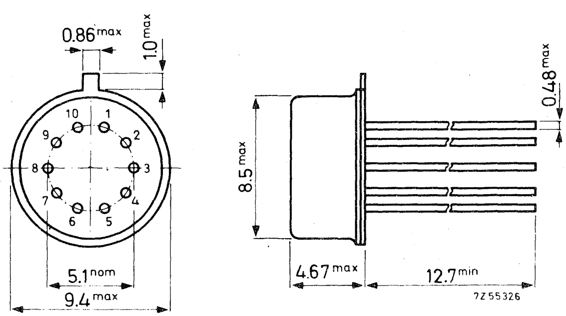
The TBA673 is a monolithic integrated circuit comprising a 4-transistor modulator and demodulator circuit.
The four transistors must be as identical as possible; the lay-out has been designed to achieve this and the best possible tracking of the transistor parameters with temperature.

QUICK REFERENCE DATA				
Collector cut-off current $I_E = 0$; $V_{CB} = 5$ V; $T_{amb} = 25\ ^oC$	I_{CBO}	<	100	nA
Base-emitter voltage differences between transistors 1, 2, 3, 4	$\lvert V_{BE1} - V_{BE2} \rvert$	<	5	mV
$V_{CB} = 5$ V; $-I_E = 150\ \mu A$	$\lvert V_{BE3} - V_{BE4} \rvert$	<	5	mV
D.C. current gain differences between transistors 1, 2, 3, 4	$\lvert h_{FB1} - h_{FB2} \rvert$	<	0,008	
$V_{CB} = 5$ V; $-I_E = 150\ \mu A$	$\lvert h_{FB3} - h_{FB4} \rvert$	<	0,008	

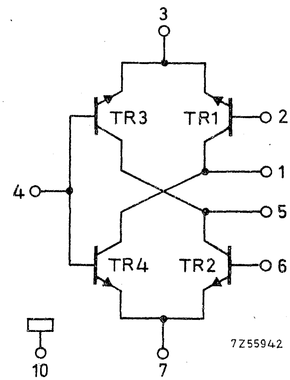
PACKAGE OUTLINE

Dimensions in mm

TO-74 (reduced height)



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)

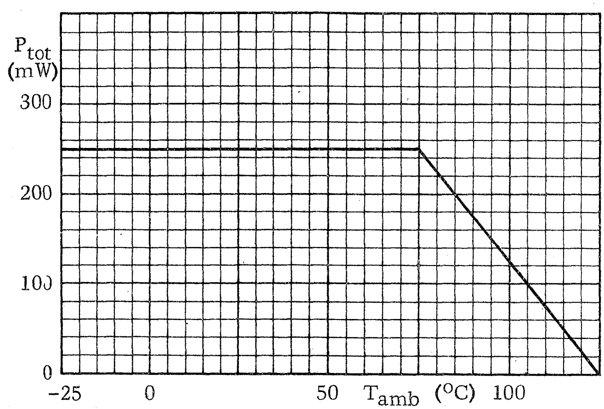
Collector current	I_C	max.	20	mA
→ Emitter cut-off current	I_{EBO}	max.	10	μA

Power dissipation (4 transistors)

Total power dissipation	See curve below

Temperatures

Storage temperature	T_{stg}	−55 to + 125	°C
Operating ambient temperature	See curve below		

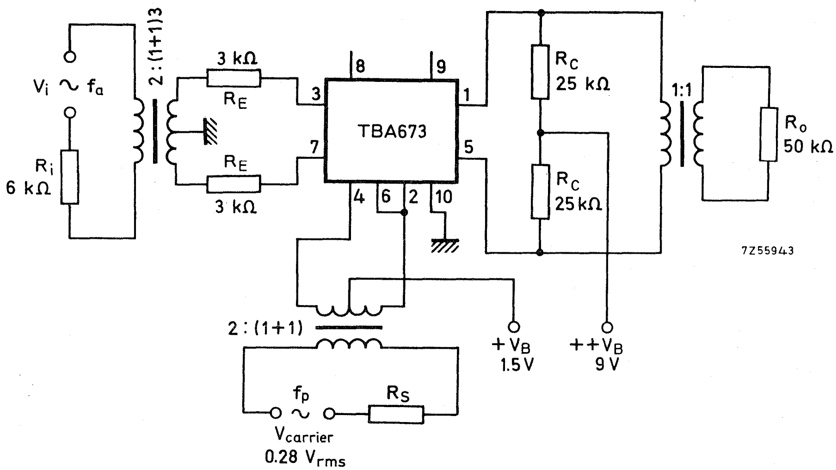


CHARACTERISTICS T_{amb} = 25 °C unless otherwise specified

Parameter	Symbol		Value	Unit
Collector cut-off current				
$I_E = 0$; $V_{CB} = 5$ V	I_{CBO}	typ.	5	nA
		<	100	nA
Collector-substrate leakage current				
$V_{CS} = 5$ V	I_{CS}	typ.	5	nA
		<	100	nA
Emitter cut-off current				
$I_C = 0$; $V_{EB} = 1$ V	I_{EBO}	typ.	5	nA
		<	100	nA
Breakdown voltages				
$I_E = 0$; $I_C = 50$ µA	$V_{(BR)CBO}$	>	45	V
$I_B = 0$; $I_C = 200$ µA	$V_{(BR)CEO}$	>	17,5	V
$-I_S = 50$ µA	$V_{(BR)CS}$	>	65	V
$I_C = 0$; $I_E = 10$ µA	$V_{(BR)EBO}$	>	6,2	V
D.C. current gain				
$I_C = 150$ µA; $V_{CB} = 5$ V	h_{FE}	>	35	
		typ.	90	
$I_C = 10$ mA; $V_{CB} = 5$ V	h_{FE}	>	35	
		typ.	75	
Transition frequency at f = 35 MHz				
$I_C = 150$ µA ; $V_{CB} = 5$ V	f_T	typ.	140	MHz ←
$I_C = 1$ mA ; $V_{CB} = 5$ V	f_T	typ.	320	MHz ←
Collector-base capacitance				
$V_{CB} = 5$ V; $I_E = 0$	C_{cb}	typ.	0,4	pF
Collector-substrate capacitance				
$V_{CS} = 5$ V; $I_E = 0$	C_{cs}	typ.	2,8	pF
Base-emitter voltage difference				
between transistors TR1 and TR2 at $-I_{E1} = -I_{E2} = 150$ µA; $V_{CB1} = V_{CB2} = 5$ V	$\|V_{BE1} - V_{BE2}\|$	typ.	2	mV
		<	5	mV
between transistors TR3 and TR4 at $-I_{E3} = -I_{E4} = 150$ µA; $V_{CB3} = V_{CB4} = 5$ V	$\|V_{BE3} - V_{BE4}\|$	typ.	2	mV
		<	5	mV
D.C. current gain differences				
between transistors TR1 and TR2 at $-I_{E1} = -I_{E2} = 150$ µA; $V_{CB1} = V_{CB2} = 5$ V	$\|h_{FB1} - h_{FB2}\|$	typ.	0,002	
		<	0,008	
between transistors TR3 and TR4 at $-I_{E3} = -I_{E4} = 150$ µA; $V_{CB3} = V_{CB4} = 5$ V	$\|h_{FB3} - h_{FB4}\|$	typ.	0,002	
		<	0,008	

APPLICATION INFORMATION

Telephony carriers ring modulator



Performance at T_{amb} = 25 ^{o}C

Conversion gain at f_a = 1 kHz V_i = 0, 4 V; f_p = 34 kHz	G_c	typ.	-0, 75	dB
Carrier leakage power in R_o at f_p = 34 kHz	P_{oc}	typ.	3	nW

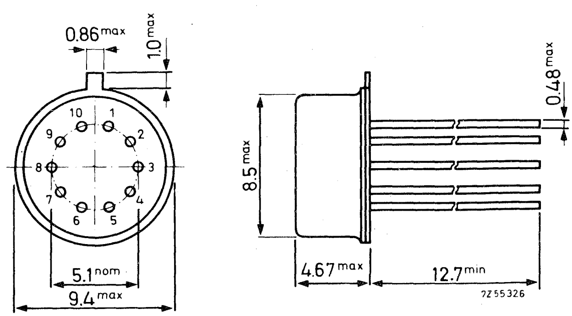
AUDIO AMPLIFIER

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.

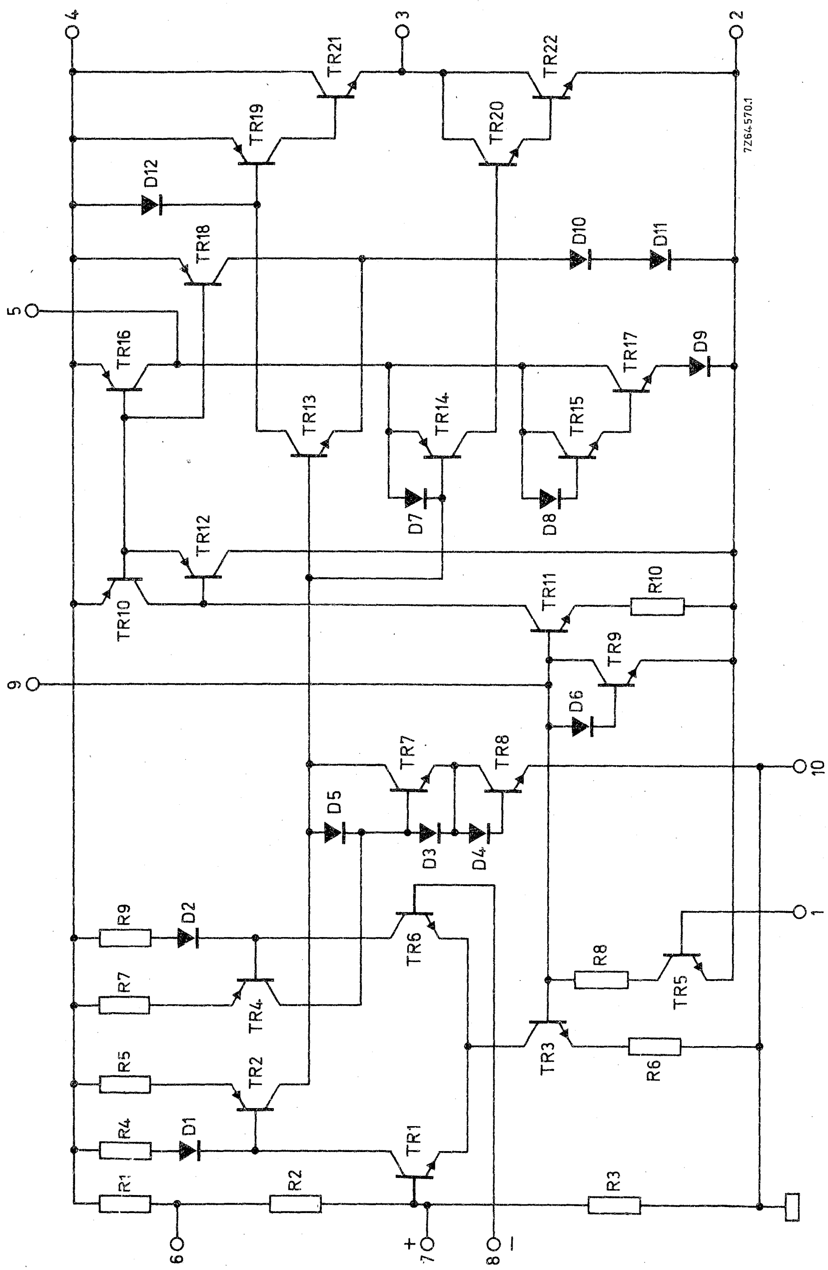
QUICK REFERENCE DATA				
Supply voltage	V_P	nom.	12	V
Output power at R_L = 20 Ω	P_o	typ.	500	mW
Input signal for P_o = 500 mW	V_i	typ.	10	mV
Input impedance	R_i	typ.	9	kΩ
Total current (no signal)	I_{tot}	typ.	2	mA
(squelched)	I_{tot}	typ.	0,4	mA

PACKAGE OUTLINE Dimensions in mm

TO-74 (reduced height)



CIRCUIT DIAGRAM



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

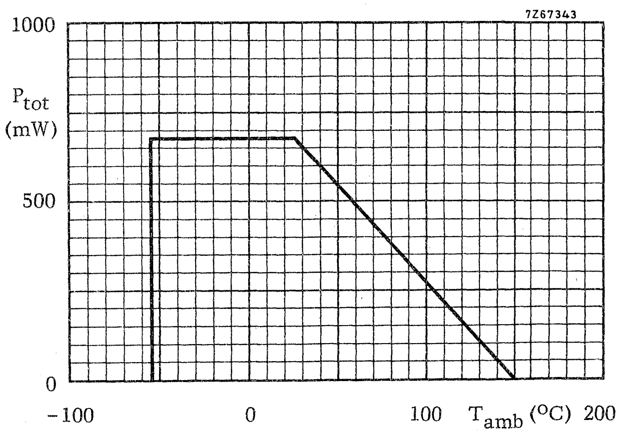
Voltages (pin 2 must be externally connected to pin 10)

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	$+I_1$	max.	1	mA
	$-I_1$	max.	10	μA

Total power dissipation



Temperatures

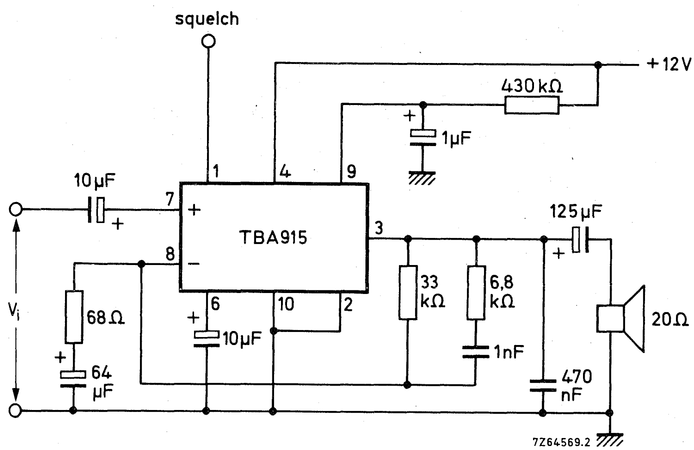
Storage temperature	T_{stg}	-55 to +125	°C
Operating ambient temperature see derating curve above	T_{amb}	-55 to +125	°C

CHARACTERISTICS at T_{amb} = 25 °C; V_P = 12 V

Measured in the test circuit below

Output power at d_{tot} = 5%	P_o	typ.	500	mW
Bandwidth (−3 dB)	B	>	6	kHz
Total current (d.c.)				
no signal	I_{tot}	typ. <	2 3,7	mA mA
no signal with squelch	I_{tot}	typ.	0,4	mA
with signal at P_o = 500 mW	I_{tot}	typ.	72	mA
Total distortion at P_o = 500 mW	d_{tot}	typ. <	2,5 5	% %
Input signal at P_o = 500 mW	V_i	typ. <	10 15	mV mV
Input impedance	$\|Z_i\|$	typ.	9	kΩ
Signal-to-noise ratio				
related to P_o = 500 mW R_S = 600 Ω; B = 300 Hz to 6 kHz	$\frac{S}{N}$	typ.	72	dB
Bias current	I_9	>	25	μA

Test circuit



SQUELCH REQUIREMENTS at I_9 = 25 μA

Squelch "on"	V_1 I_1	> >	800 10	mV μA
Squelch "off"	V_1	<	400	mV

AUDIO AMPLIFIER AND PRE-AMPLIFIER

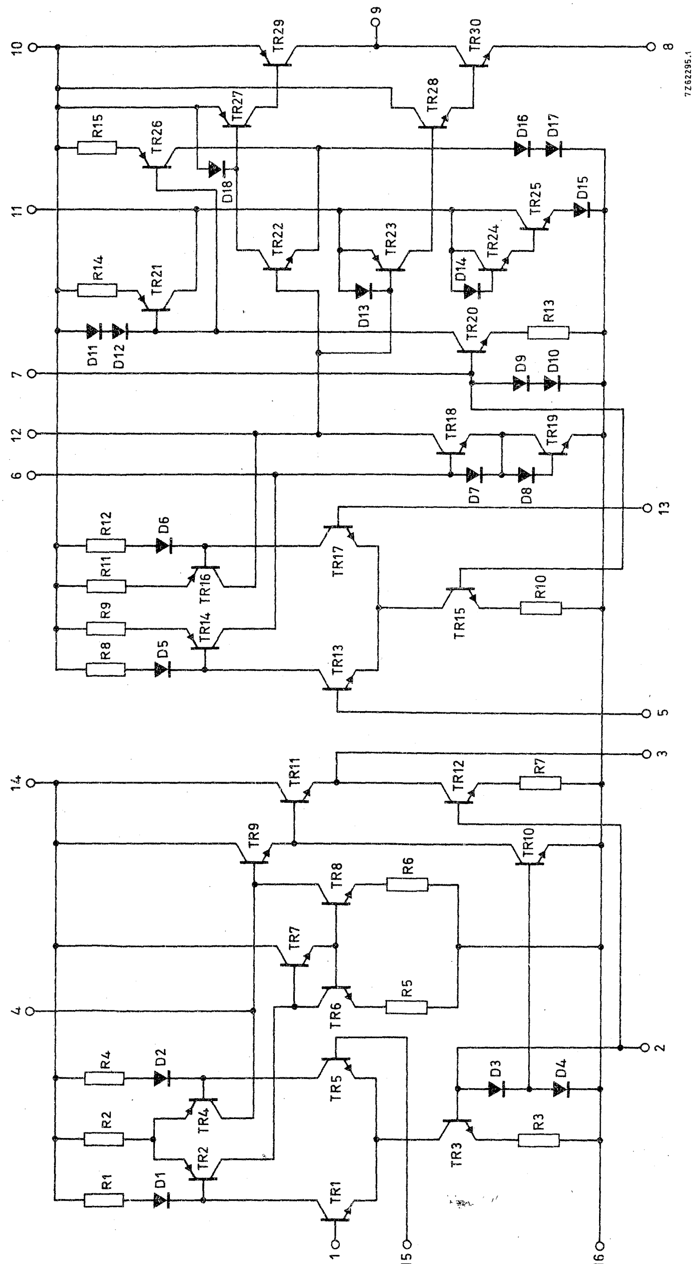
The TCA210 is a monolithic integrated circuit comprising two amplifiers for use in intercoms and other audio systems. The first is a high-gain pre-amplifier with differential input and a class-A output stage which can deliver 2,5 mW into an 800 Ω load. The second is a power amplifier with a class-B output 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
Pre-amplifier				
Open loop voltage gain	G_v	typ.	10 000	
Output power at R_L = 800 Ω	P_o	typ.	2,5	mW
Noise figure (B = 300 to 4000 Hz) R_S = 500 Ω	F	<	6	dB
Unity-gain bandwidth (compensated)	B	>	10	MHz
Output amplifier				
Open loop voltage gain	G_v	typ.	500	
Output power at R_L = 25 Ω; d_{tot} = 5%	P_o	typ.	500	mW
at R_L = 15 Ω; d_{tot} = 5%	P_o	typ.	800	mW

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

CIRCUIT DIAGRAM



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

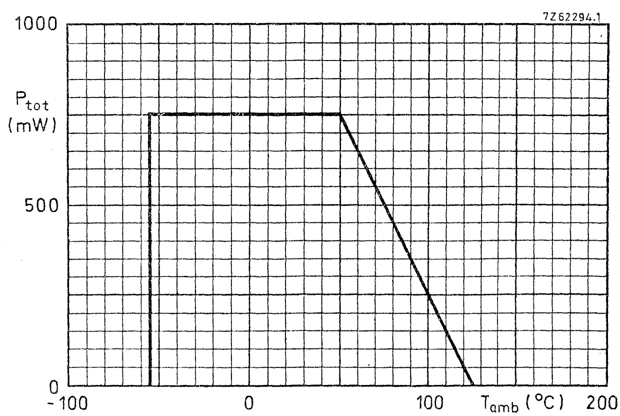
Voltages; pin 8 must be externally connected to pin 16

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 °C; V_P = 12 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

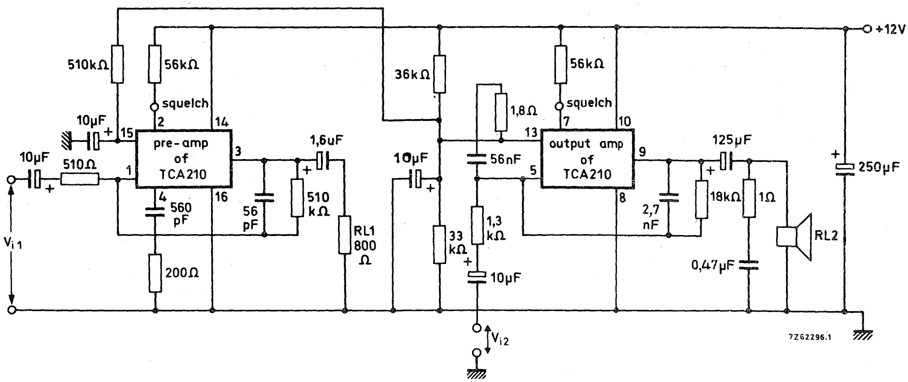
Open loop voltage gain	G_v	>	65	dB
		typ.	80	dB
Noise figure at R_S = 5 kΩ; B = 300 to 4000 Hz	F	typ.	4	dB
Current in the output transistor	I_C	>	2,5	mA
Unity gain bandwidth with 6 dB/oct compensation	B	typ.	10	MHz

Output amplifier

Open loop voltage gain	G_v	typ.	54	dB
Total distortion at f = 1 kHz; P_o = 50 mW; R_L = 25Ω	d_{tot}	typ.	1,5	%
Maximum output power at d_{tot} = 5%; R_L = 25Ω	P_o	typ.	450	mW

APPLICATION INFORMATION

Pre-amplifier and output amplifier for intercom systems



Performance T_{amb} = 25 °C; V_P = 12 V

Pre-amplifier

Output power at R_{L1} = 800 Ω	P_o	typ.	2,5	mW
Bandwidth (−3 dB)	B	typ.	4	kHz
Total current	I_{14}	typ.	4,0	mA
Input signal	V_{i1}	typ.	1,5	mV
Input impedance	$\|Z_i\|$	typ.	500	Ω

Output amplifier

Output power at R_{L2} = 25 Ω; d_{tot} = 5%	P_o	typ.	500	mW
at R_{L2} = 15 Ω; d_{tot} = 5%	P_o	typ.	800	mW
Bandwidth (−3 dB)	B	typ.	4	kHz
Total distortion at P_o = 50 mW	d_{tot}	typ.	1,5	%
Input signal	V_{i2}	typ.	260	mV
Input impedance	$\|Z_i\|$	typ.	1,3	kΩ
Total current (d.c.; no signal; pin 10)	I_{10}	typ.	4	mA

DOUBLE BALANCED MODULATOR/DEMODULATOR

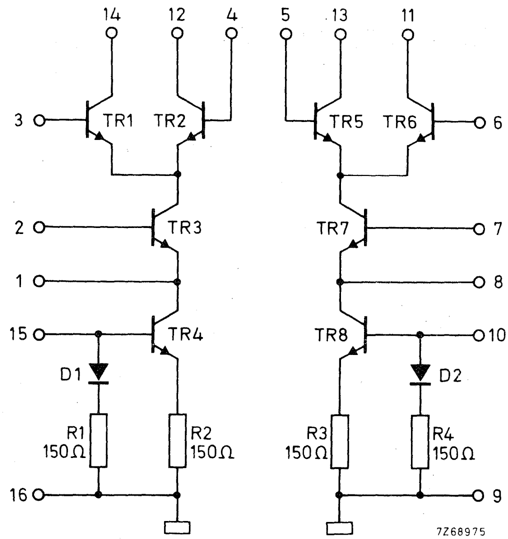
The TCA240 is a monolithic integrated circuit used for general purpose applications, such as:

- 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)

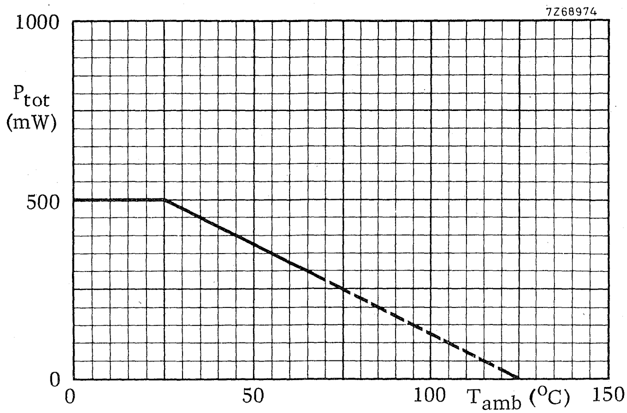
Collector-substrate voltage (open base and emitter)	V_{CSO}	max.	16	V
Collector-base voltage (open emitter)	V_{CBO}	max.	16	V
Collector-emitter voltage (open base)	V_{CEO}	max.	12	V
Emitter-base voltage (open collector)	V_{EBO}	max.	5	V

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	^{o}C
Operating ambient temperature	T_{amb}	−20 to +70	^{o}C
Crystal temperature	T_{c}	max. 125	^{o}C

THERMAL RESISTANCE

From crystal to ambient	$R_{th\ j\text{-}a}$	= 200	^{o}C/W

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

Collector current difference				
between transistors TR4 and TR8 $I_{10} = I_{15} = 1,5$ mA	$\lvert I_{C4} - I_{C8} \rvert$	$<$	0,07	mA
Base-emitter voltage				
of transistors TR3 and TR7 $I_1 = I_8 = -1$ mA	$V_{BE3}; V_{BE7}$		690 to 770	mV
Base-emitter voltage difference				
between transistors TR1 and TR2 $V_{12-16} = V_{14-16} = 10$ V; $I_{15} = 1,5$ mA	$\lvert V_{BE1} - V_{BE2} \rvert$	$<$	2,5	mV
between transistors TR5 and TR6 $V_{11-9} = V_{13-9} = 10$ V; $I_{10} = 1,5$ mA	$\lvert V_{BE5} - V_{BE6} \rvert$	$<$	2,5	mV
between the parallel connection of TR1, TR5 and TR2, TR6 $V_{11-9} = V_{13-9} = V_{12-16} = V_{14-16} = 8$ V $I_1 + I_8 = -3$ mA	$\lvert V_{BE1;5} - V_{BE2;6} \rvert$	$<$	2,1	mV
D.C. current gain				
of transistors TR3 and TR7 $I_1 + I_8 = -3$ mA	h_{FE3}, h_{FE7}		23 to 190	
D.C. current gain ratio				
of transistors TR3 and TR7 $I_1 + I_8 = -3$ mA	$\left\lvert \frac{h_{FE3} - h_{FE7}}{h_{FE3} + h_{FE7}} \right\rvert \times 200$		0 to 60	%
D.C. current gain				
of transistors TR1, TR2, TR5 and TR6 $I_E = 750$ µA	$h_{FE1}, h_{FE2}, h_{FE5}, h_{FE6}$		23 to 190	
D.C. current gain ratio				
of transistors TR1 and TR2 $I_1 = -1,5$ mA	$\left\lvert \frac{h_{FE1} - h_{FE2}}{h_{FE1} + h_{FE2}} \right\rvert \times 200$		0 to 60	%
of transistors TR5 and TR6 $I_8 = -1,5$ mA	$\left\lvert \frac{h_{FE5} - h_{FE6}}{h_{FE5} + h_{FE6}} \right\rvert \times 200$		0 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)

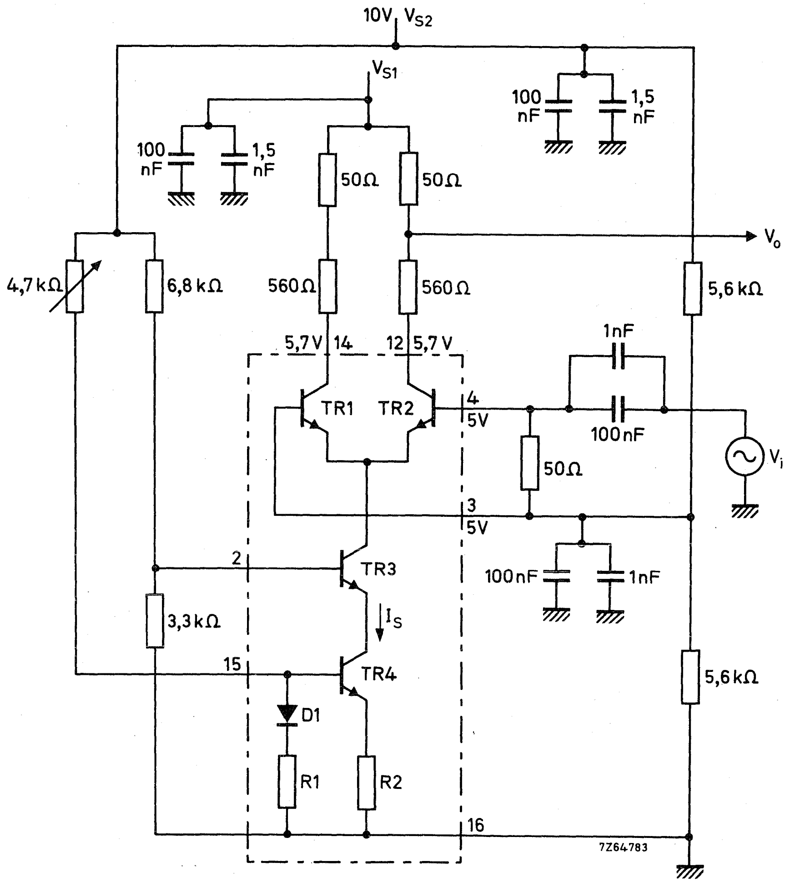
I_S = 5 mA; R_C = 600 Ω; f = −3 dB f typ. 34 MHz

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

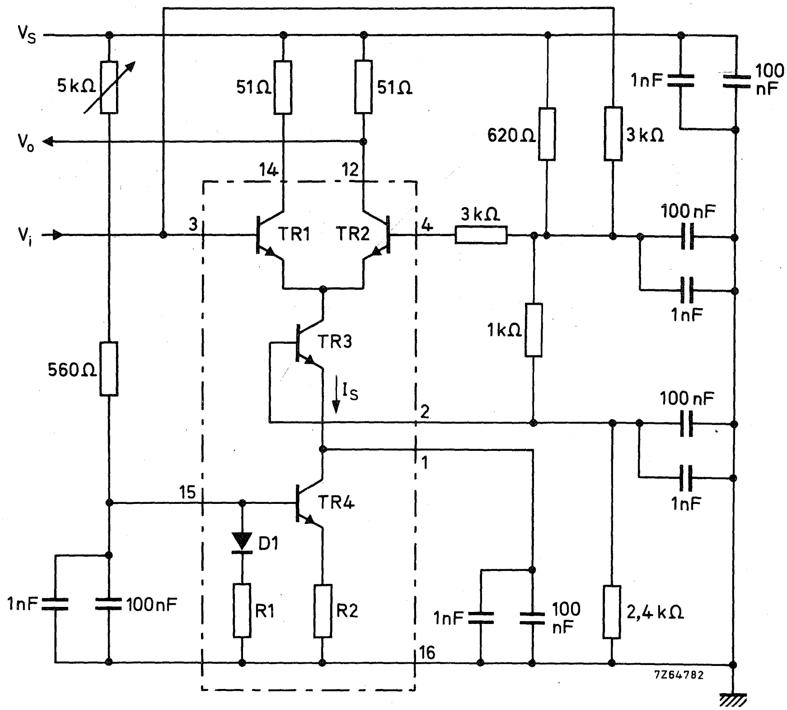
[1]) Reference level 50 %.

DYNAMIC DESIGN DATA (continued)



Circuit for measuring the frequency response

DYNAMIC DESIGN DATA (continued)



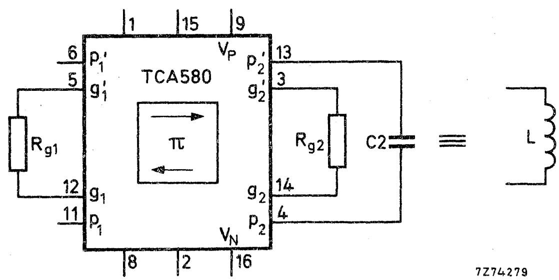
Circuit for measuring t_r, t_f, t_{pdr} and t_{pdf}

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 MH ± 2% can be achieved.

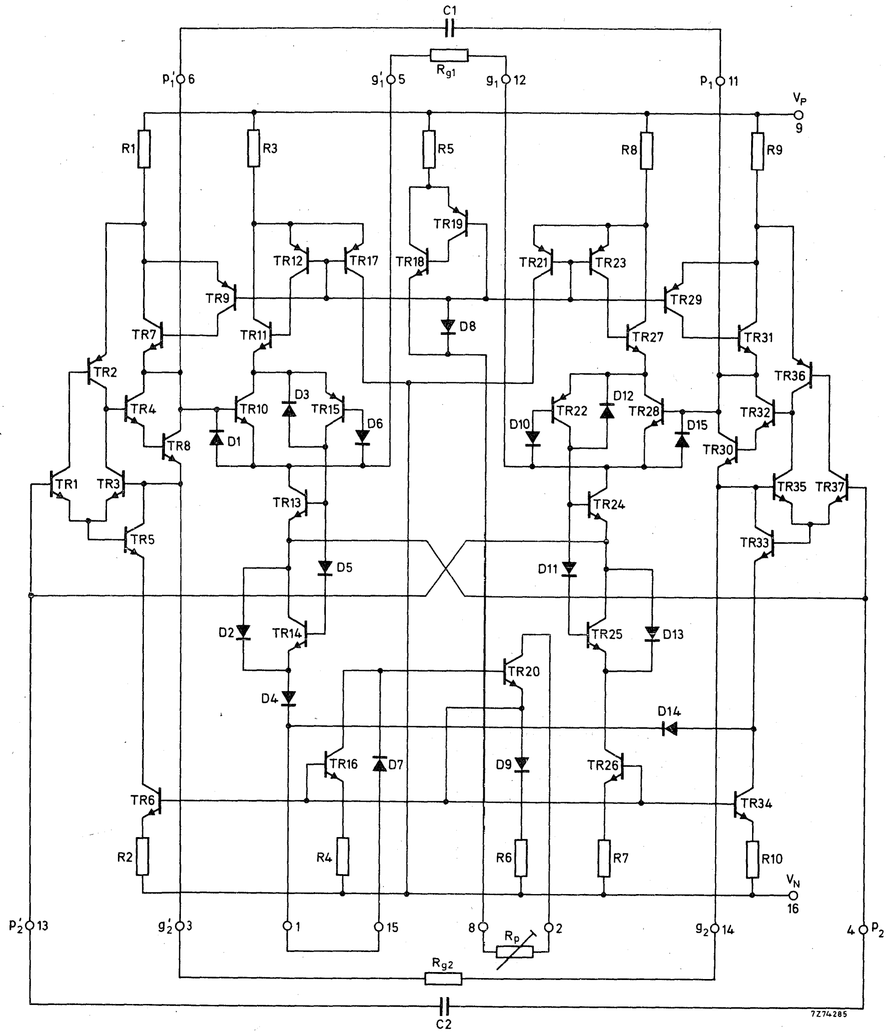
QUICK REFERENCE DATA				
Supply voltages	V_P	typ.	4,4	V
	V_N	typ.	7,6	V
Supply current	I_P	typ.	0,8	mA
Frequency range	f		d.c. to 10	kHz
Quality factor at f = 200 Hz	Q		500 to 5000	
Efficiency	η	typ.	1,4	%
Operating ambient temperature	T_{amb}		−20 to +70	°C

BASIC CIRCUIT

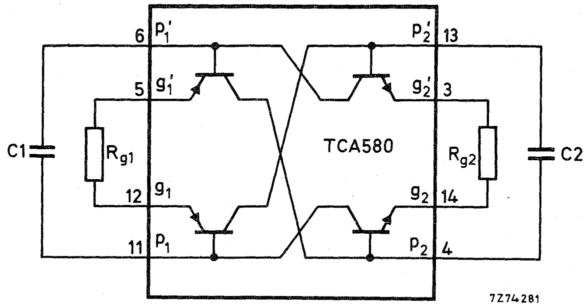


PACKAGE OUTLINE plastic 16-lead dual in-line (see general section).

CIRCUIT DIAGRAM



SIMPLIFIED CIRCUIT DIAGRAM



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

Voltages

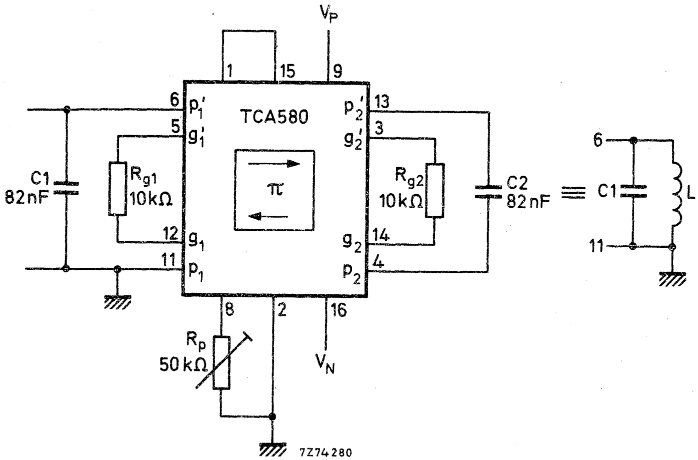
Supply voltages	V_P to V_N	max.	14	V
Common mode input voltage	$\pm V_{IC}$	max.	14	V
Differential input voltage	$\pm V_{ID}$	max.	14	V

Temperatures

Storage temperature	T_{stg}	−55 to +125	^oC
Operating ambient temperature	T_{amb}	−20 to +70	^oC

CHARACTERISTICS at $V_P = 4,4$ V; $V_N = 7,6$ V; $T_{amb} = 25$ °C

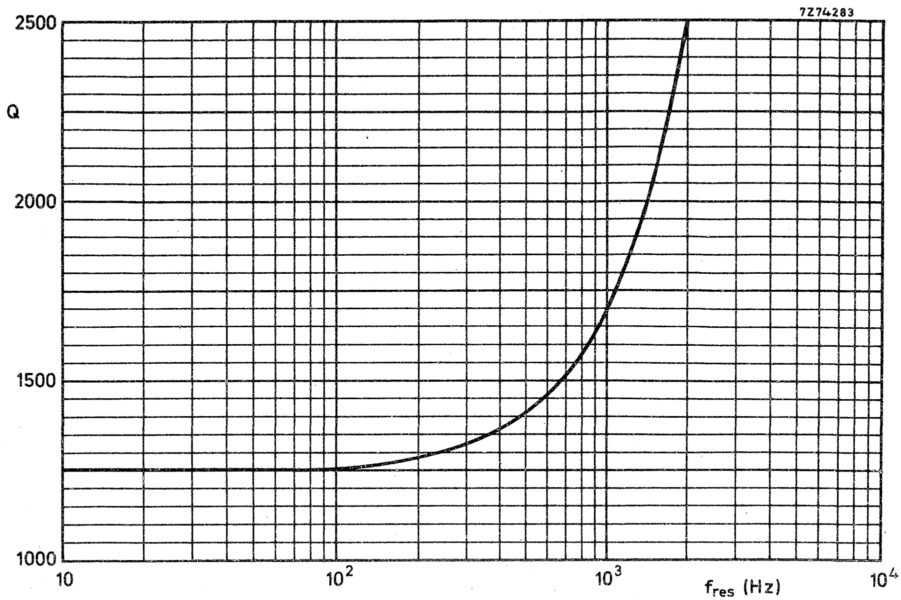
Supply current (adjust with $R_p = 50$ kΩ)	I_P	typ.	0,8	mA
Efficiency: $\frac{\text{signal power}}{\text{supply power}}$	η	typ.	1,4	%
Tolerance of inductance	ΔL	≈	±0,2	%
Quality factor at f = 200 Hz; $R_{g1} = R_{g2} = 10$ kΩ; pin 11 earthed	Q	500 to 5000		
Output voltage (peak value)	V_{om}	<	1,6	V
Input offset voltage	V_{io}	<	25	mV
Input offset current	I_{io}	<	9	µA



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

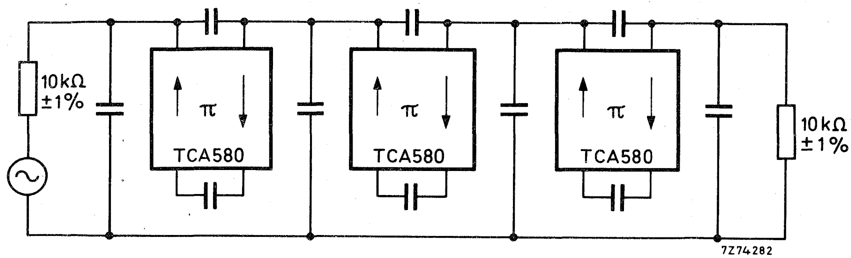
$$L = R_{g1} R_{g2} C2 = 8,2 \text{ H}$$

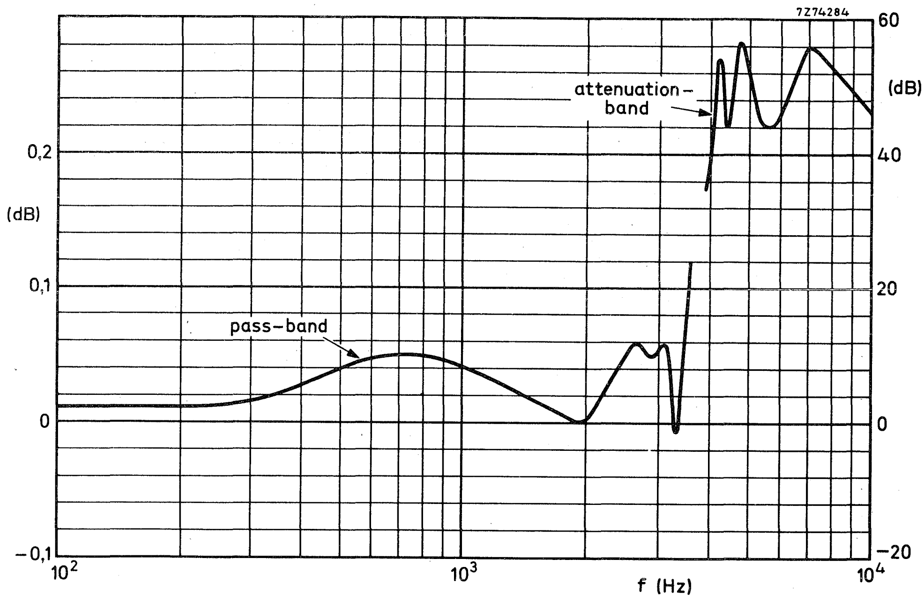
$$f_{res} = \frac{1}{2\pi \sqrt{R_{g1} R_{g2} C1\, C2}} = 194 \text{ Hz}$$



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.

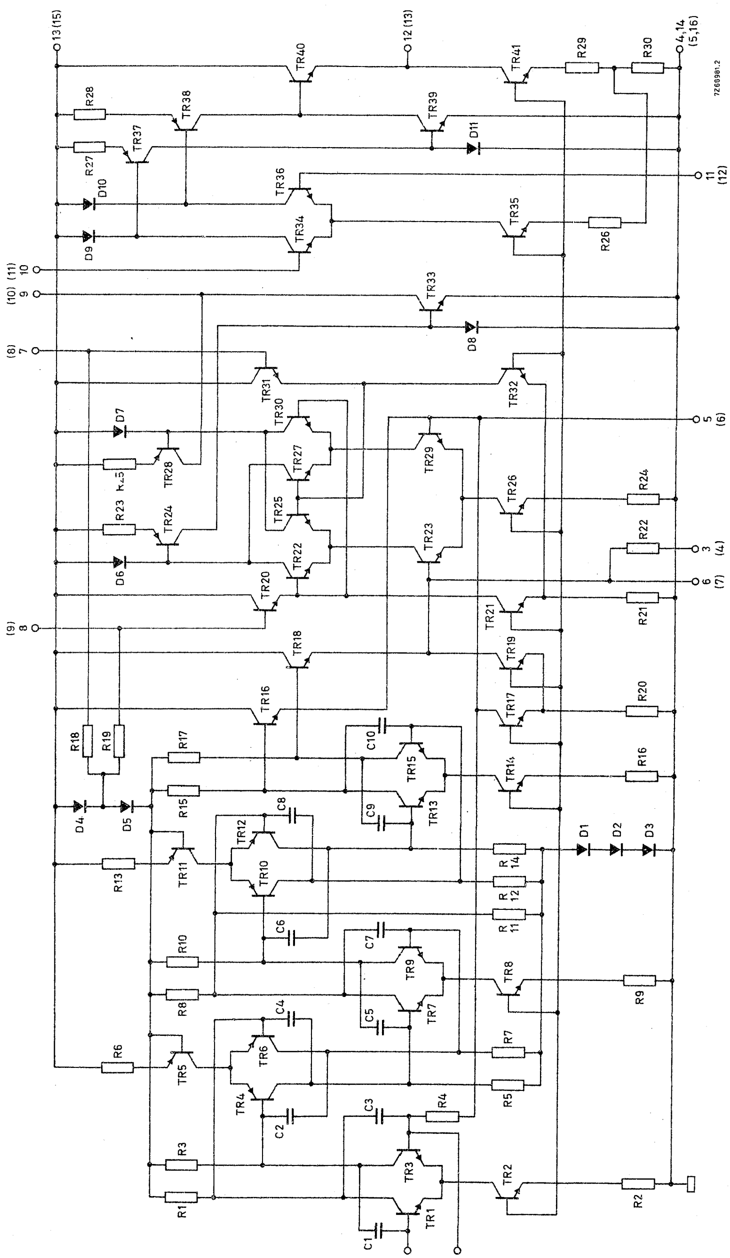
QUICK REFERENCE DATA

Supply voltage	V_P	typ.	7,5	V
Ambient temperature	T_{amb}	typ.	25	^oC
Frequency	f_o	typ.	100	kHz
Total current consumption	I_{tot}	typ.	450	μA
Input limiting voltage (-3 dB)	$V_{i\,lim}$	typ.	30	μV
A.F. output voltage at $\Delta f = \pm 3,5$ kHz (r.m.s. value)	$V_{o(rms)}$	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

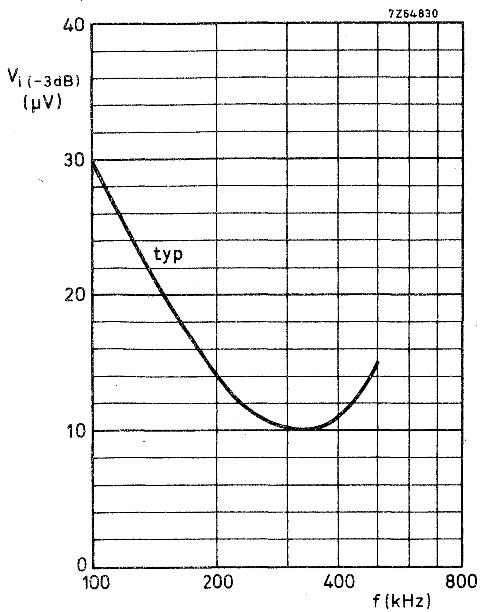
CHARACTERISTICS at V_P = 7,5 V; T_{amb} = 25 °C; f_o = 100 kHz; measured in circuit on page 4. The pin numbers between brackets for TCA770A only.

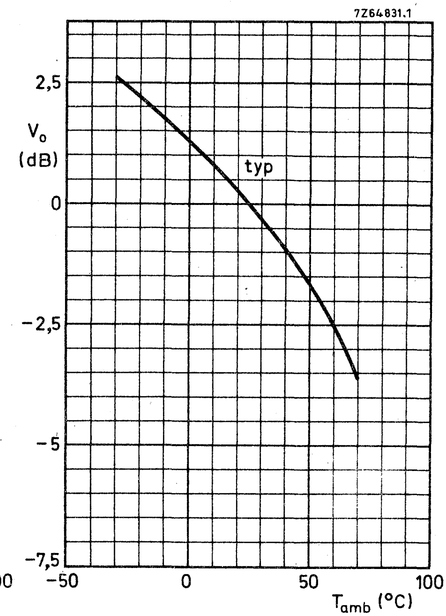
Total current consumption	I_{tot}	typ.	450	μA	
			300 to 600	μA	
Supply voltage range	V_{13-14}		5 to 10	V	
Power dissipation	P_{tot}	typ.	3,4	mW	
			2,5 to 4,5	mW	
I.F. limiter-amplifier and f.m. detector					
Input limiting voltage (-3 dB)	$V_{i\,lim}$	typ.	30	μV	1)
A.M. rejection					
f.m. signal: Δf = ±3,5 kHz; f_m = 70 Hz					
a.m. signal: m = 0,3; f_m = 1 kHz					
at V_i = 300 μV	α	typ.	40	dB	
at V_i = 1 mV	α	typ.	50	dB	
at V_i = 10 mV	α	typ.	60	dB	
Input impedance; pin 1	$\|Z_i\|$	>	10	kΩ	
A.F. output voltage; pin 9 (10) load = 100 kΩ; Δf = ±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 Δf = ±5 kHz; f_m = 1 kHz		typ.	2	%	
		<	3	%	
A.F. amplifier 3)					
Open loop voltage gain (R_{load} = ∞)	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.

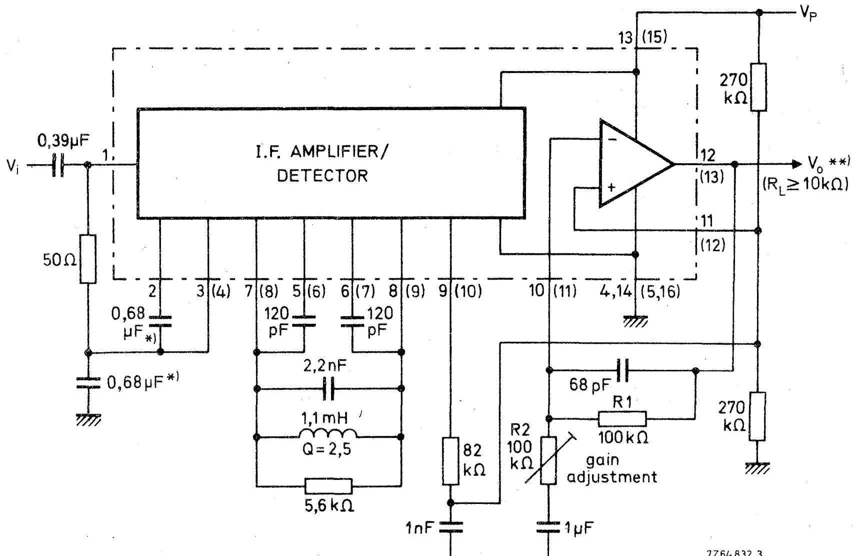
2) See also right-hand graph on page 4.

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





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/μbar when used with a microphone having an impedance of 200 Ω and a sensitivity of 100 μV/μbar.
A capsule assembly containing the TCA980, a low-impedance microphone and a 0,22 μF capacitor can directly replace a carbon microphone.
The d.c. supply to the device may be of either polarity.

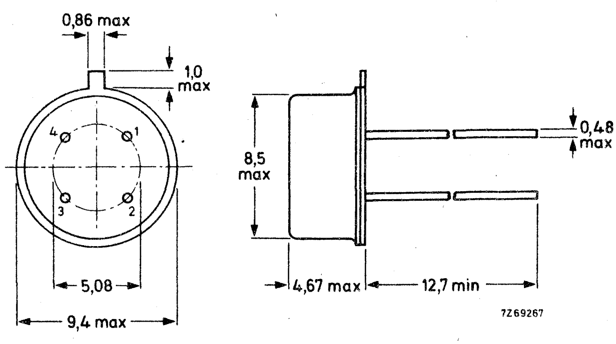
QUICK REFERENCE DATA

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	G_v	typ.	220	
at $\pm I_2$ = 10 mA	G_v	<	260	
Output impedance at $\pm I_2$ = 30 mA	$\lvert Z_o \rvert$	typ.	150	Ω

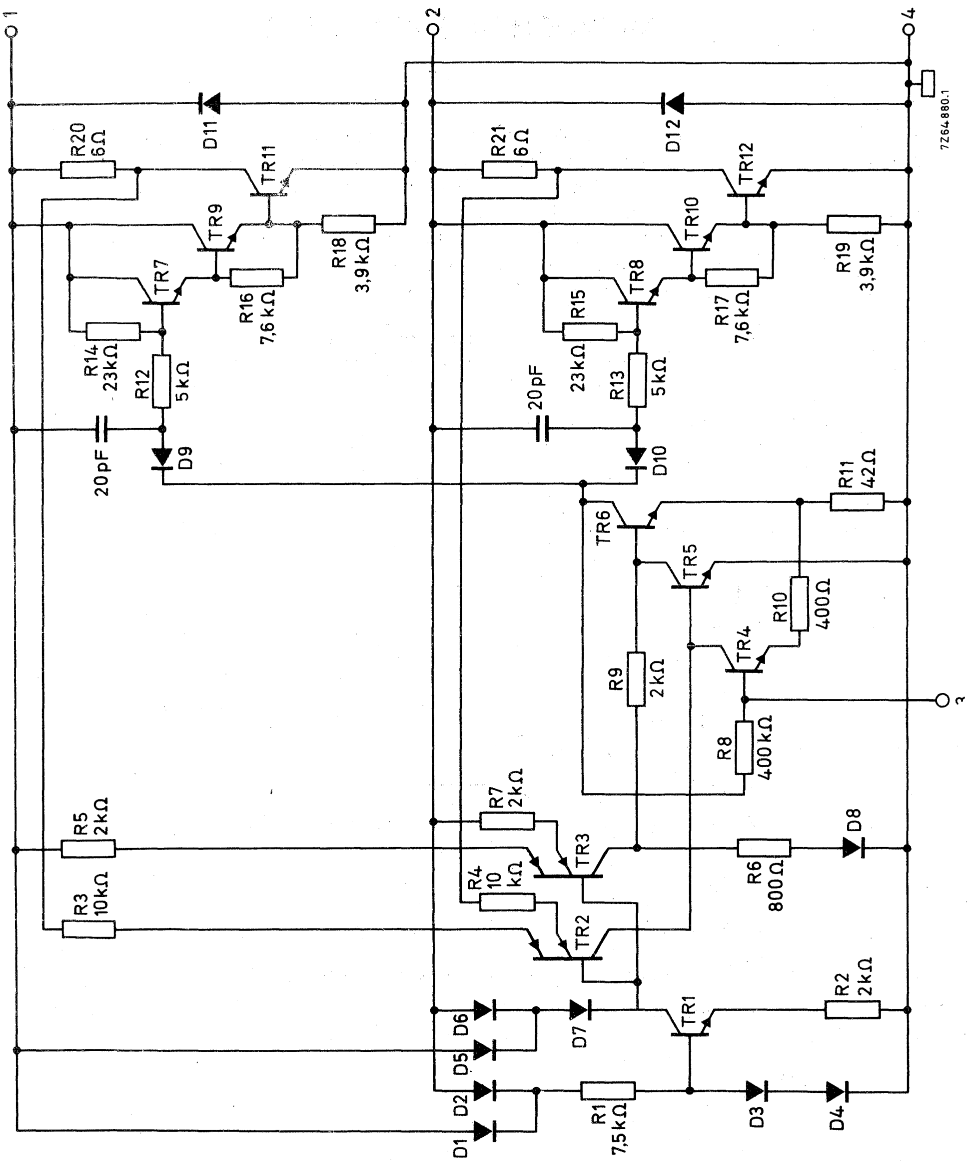
PACKAGE OUTLINE

Dimensions in mm

TO-12 (reduced height)



CIRCUIT DIAGRAM



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	μA

Power dissipation

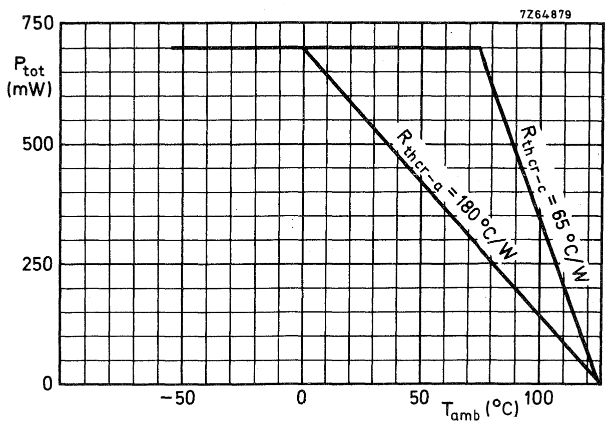
Total power dissipation — See derating curve below

Temperatures

Storage temperature	T_{stg}	−55 to + 125	°C
Ambient temperature	T_{amb}	−55 to + 125	°C
Crystal temperature	T_{cr}	max. 125	°C

THERMAL RESISTANCE

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



D.C. CHARACTERISTICS [1]) at T_{case} = 25 °C; measured in circuit below)

Supply voltage drop

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

A.C. CHARACTERISTICS

Voltage gain (measured in circuit below)

f = 2 kHz; $\pm I_2$ = 30 mA	G_v	typ.	220	
			190 to 260	
f = 2 kHz; $\pm I_2$ = 10 mA	G_v		160 to 260	

Change of voltage gain

when changing T_{amb} from −20 to +55 °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 kHz; d_{tot} < 5% (r.m.s. value)

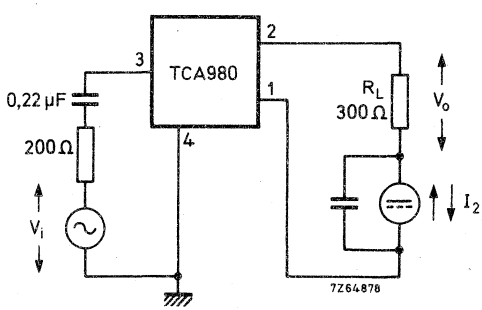
$\pm I_2$ = 10 mA	$V_{o(rms)}$	>	1	V
$\pm I_2$ = 30 mA	$V_{o(rms)}$	>	1,35	V
$\pm I_2$ = 60 mA	$V_{o(rms)}$	>	1	V
		typ.	1,5	V

Noise output voltage

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

Output impedance

f = 2 kHz; $\pm I_2$ = 30 mA	$\lvert Z_o \rvert$	typ.	150	Ω



BUCKET BRIGADE DELAY LINE FOR ANALOGUE SIGNALS

The TDA1022 is a MOS monolithic integrated circuit, generally intended to delay analogue signals (e.g. delay time = 512/2 f_ϕ).
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.

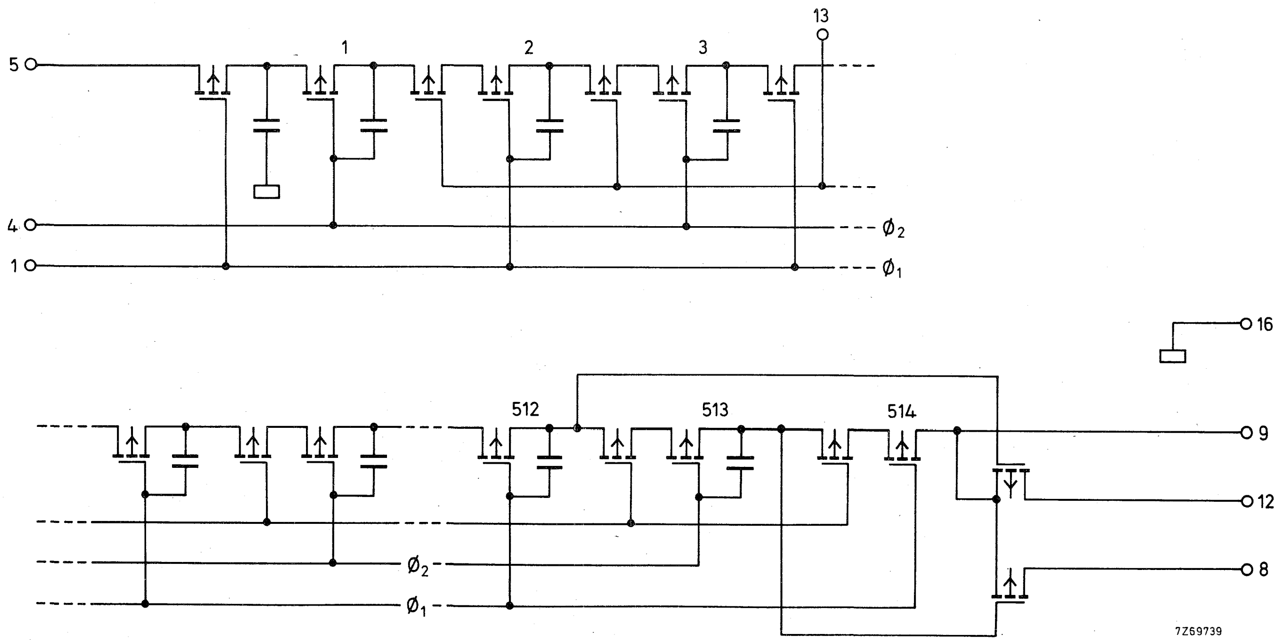
QUICK REFERENCE DATA

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



PINNING

1. Clock input 1 (V_{CL1})
2. Not connected
3. Not connected
4. Clock input 2 (V_{CL2})
5. Signal input
6. Not connected
7. Not connected
8. Output 513
9. Negative supply (V_{DD})
10. Not connected
11. Not connected
12. Output 512
13. Tetrode gate (V_{13-16})
14. Not connected
15. Not connected
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 kΩ (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	$t_{\phi 1}$; $t_{\phi 2}$	≤	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	1)
			−10 to −18	V	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	

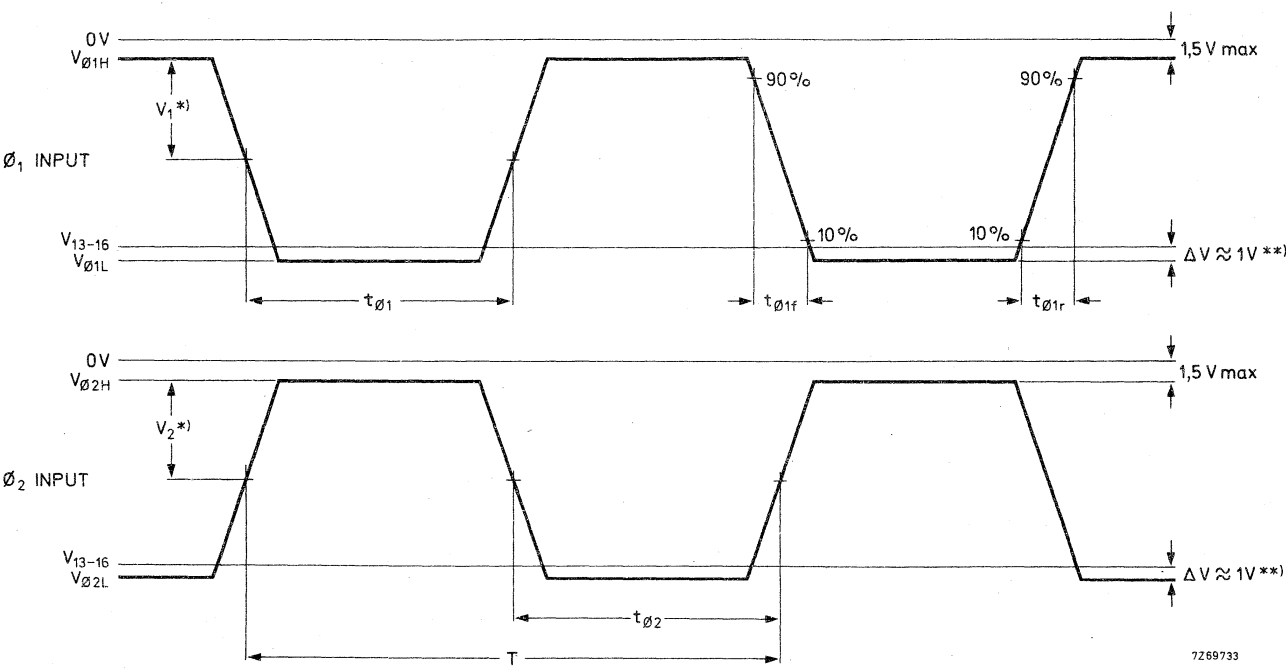
1) It is recommended that $V_{13-16} = V_{\phi 1L} + 1\ V = V_{\phi 2L} + 1\ V$; V_{DD} more negative than $V_{\phi L}$.
2) In theory the clock frequency must be higher than twice the highest signal frequency; in practice $f_s \leq 0,3\ f_\phi$ to $0,5\ f_\phi$ is recommended, depending on the characteristics 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 $f_\phi = 40$ kHz; $f_s = 1$ kHz		typ.	4	dB	1)
		<	7	dB	
Change in output at $f_s = 1$ kHz; $V_{s(rms)} = 1$ 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) $f_\phi = 100$ kHz (weighted by "A" curve)	$V_{N(rms)}$	typ.	0,25	mV	
Signal-to-noise ratio at max. output voltage	S/N	typ.	74	dB	
Load resistance	R_L	>	10	kΩ	1)
		typ.	47	kΩ	

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

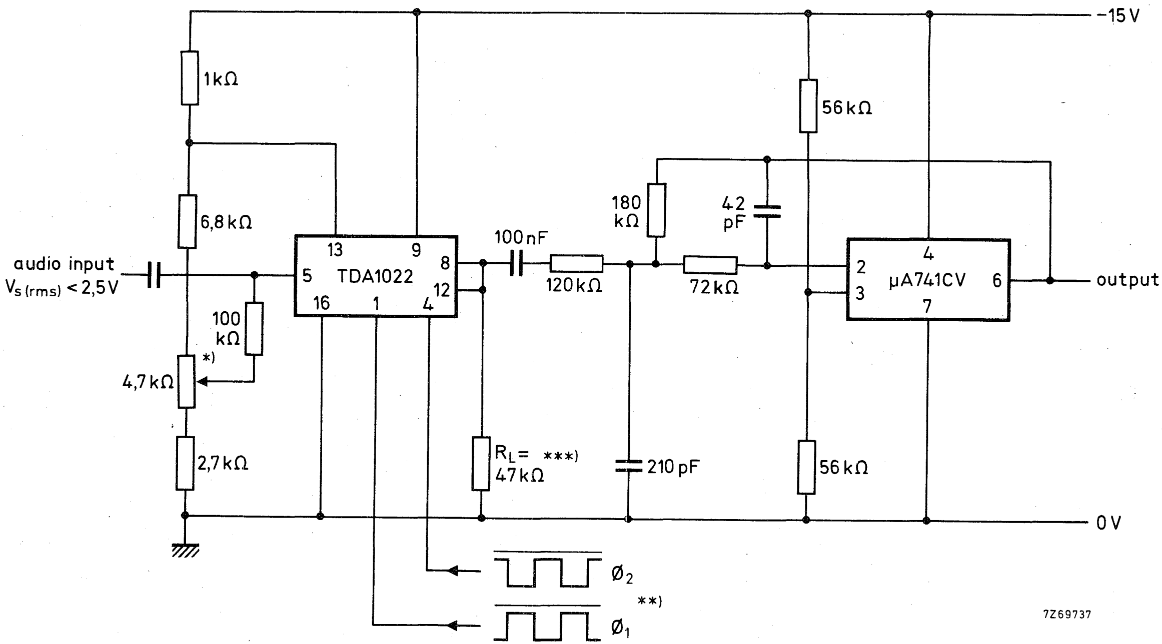
TIMING DIAGRAM



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

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

APPLICATION INFORMATION



Single delay line connection

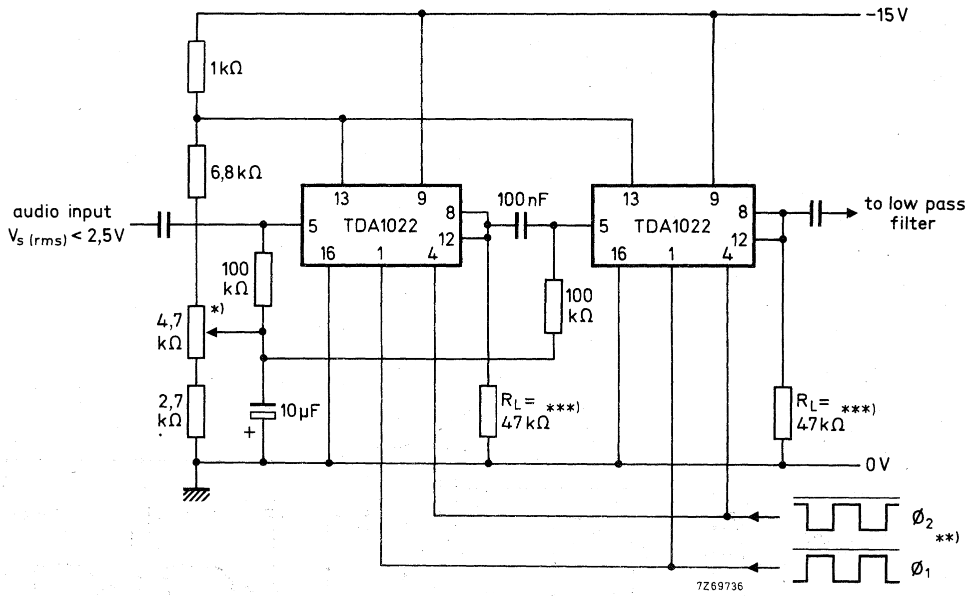
*) Adjust d.c. voltage for class-A operation (≈ 5 V).

Conditions: low pass filter μA741CV (12 dB per octave);
gain = +3,5 dB (compensation for line attenuation);
f_ϕ = 50 kHz (min.);
cut-off frequency = 15 kHz.

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

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

APPLICATION INFORMATION (continued)



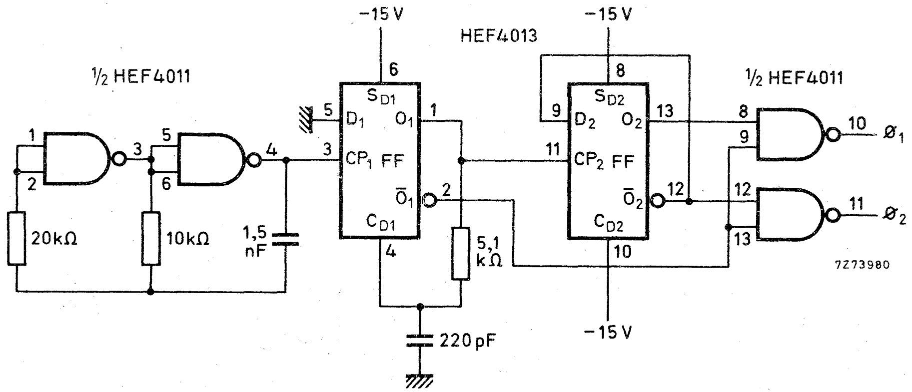
Series connection of two lines TDA1022

*) Adjust d.c. voltage for class-A operation (≈ 5 V).

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

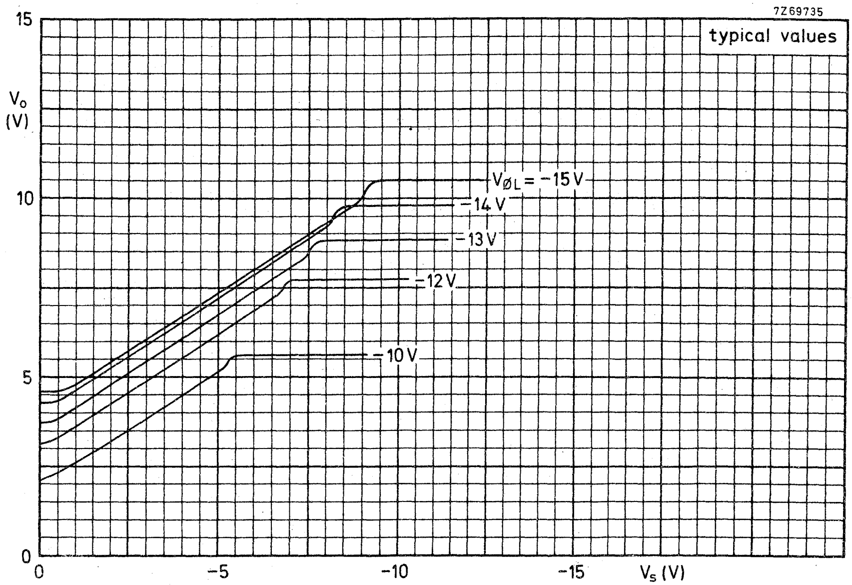
***) Can be replaced by a current source of 100 to 400 µA (see also note 1 on page 4).

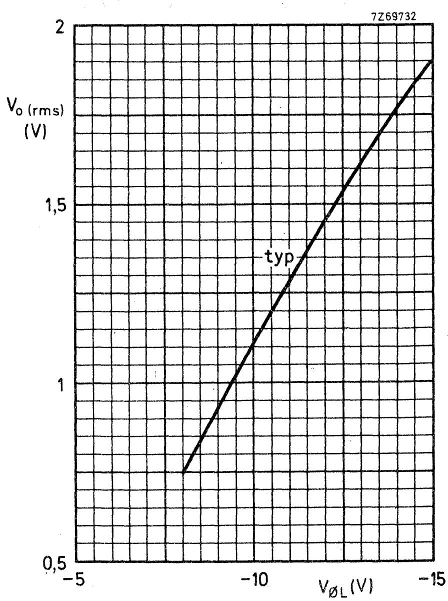
APPLICATION INFORMATION (continued)



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

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



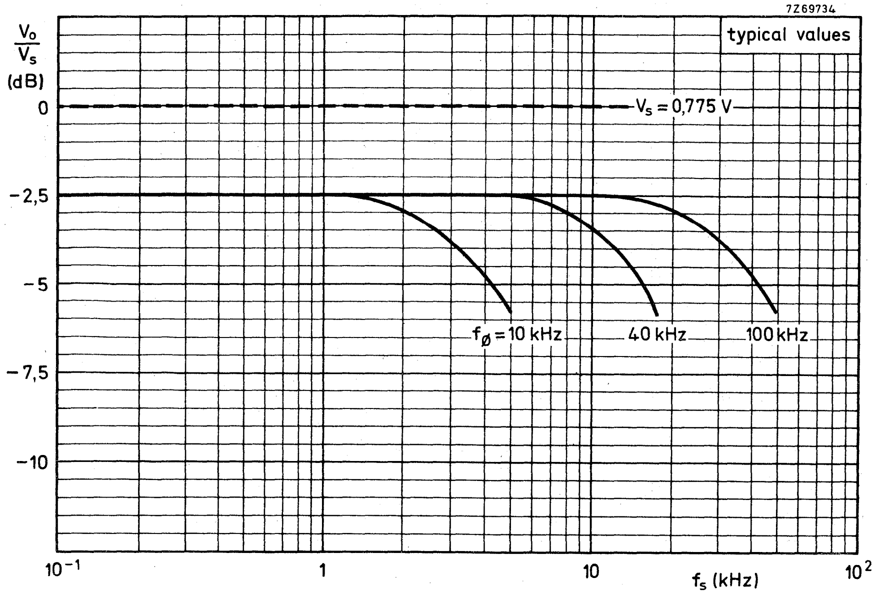


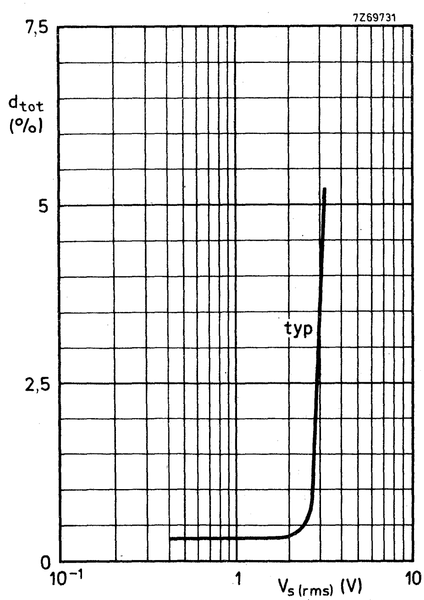
Conditions for the graph above:

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

Conditions for the left-hand graph:

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





Conditions for the graph above:

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

Conditions for the left-hand graph:

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

GENERAL INDUSTRIAL

General industrial

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

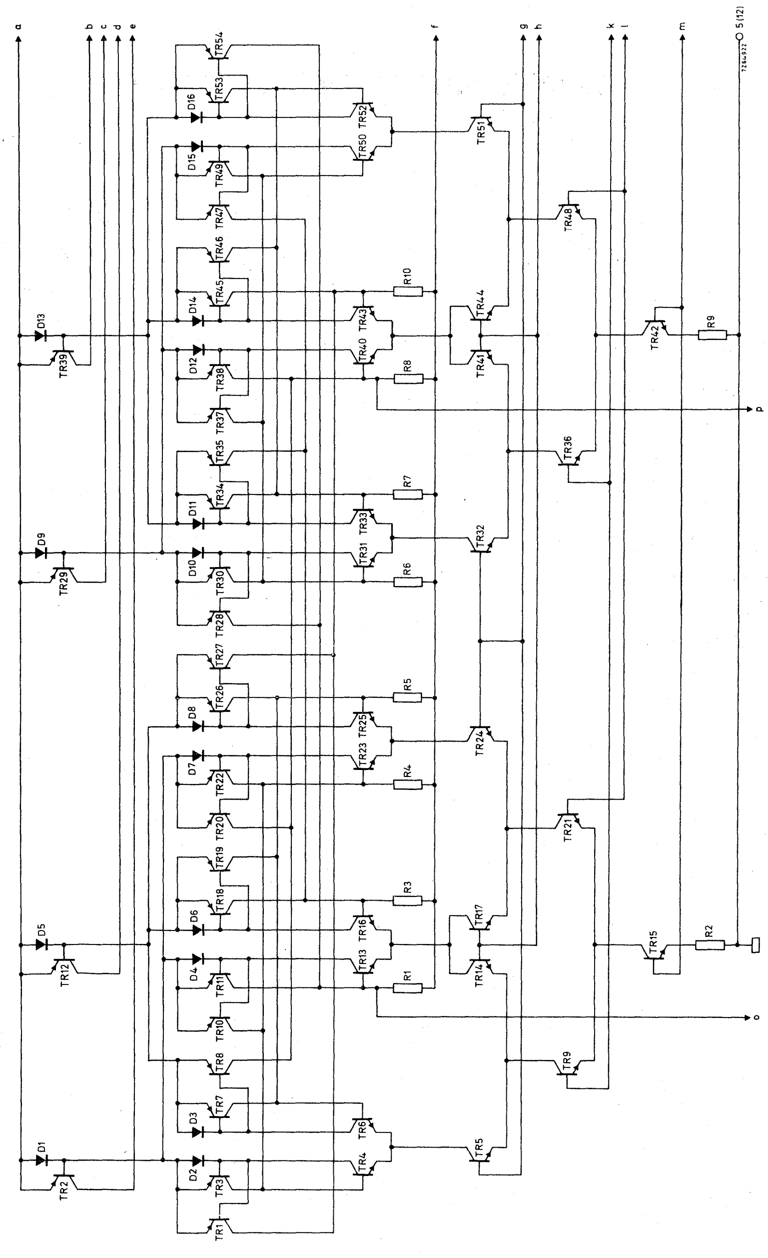
STEPPER MOTOR DRIVE CIRCUIT

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.

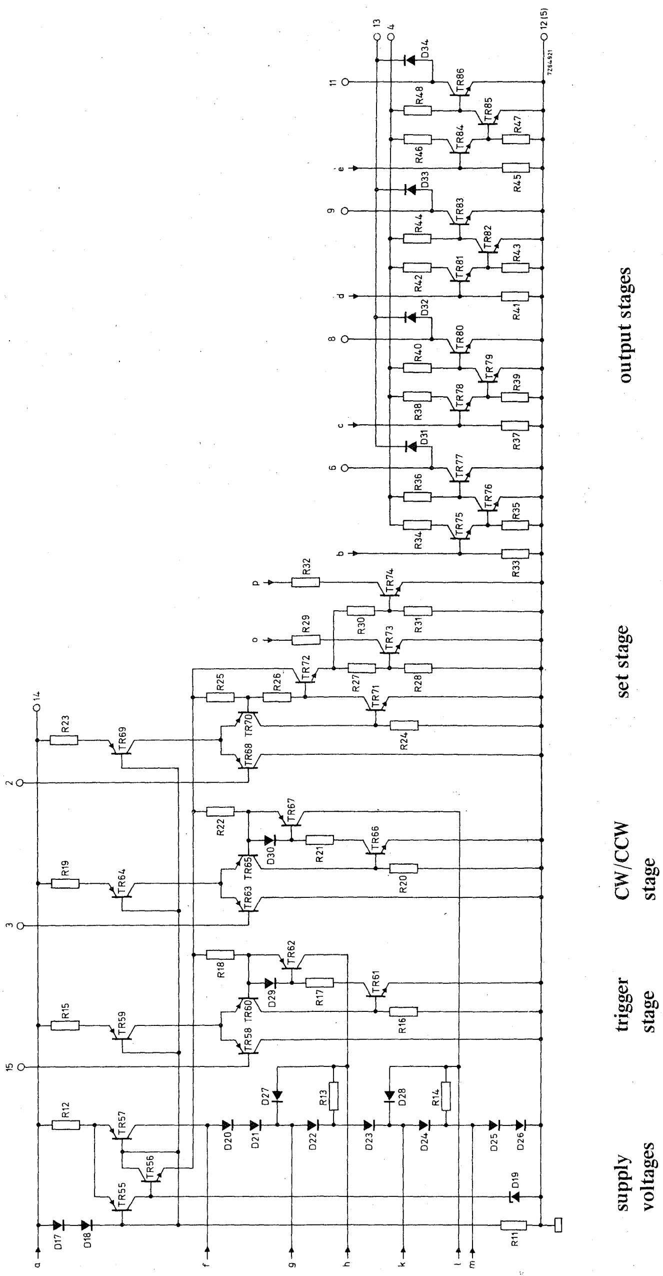
QUICK REFERENCE DATA				
Supply voltage	V_P		9,5 to 18	V
Load current (each output)	I_Q	max.	350	mA
Logic for CW and CCW operation				

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

CIRCUIT DIAGRAM



bi-directional, 4 position, synchronous counter


output stages
set stage
CW/CCW stage
trigger stage
supply voltages

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[illegible]	I_Q	max.	500 mA

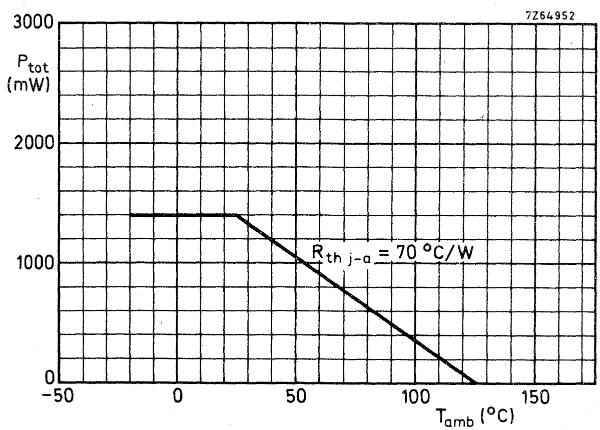
Power dissipation — see derating curve below[1])

Temperatures

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

THERMAL RESISTANCE

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

Direction 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 µA
LOW	V_{IL}	<	4,5 V
	I_{IL}	typ.	30 µA
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

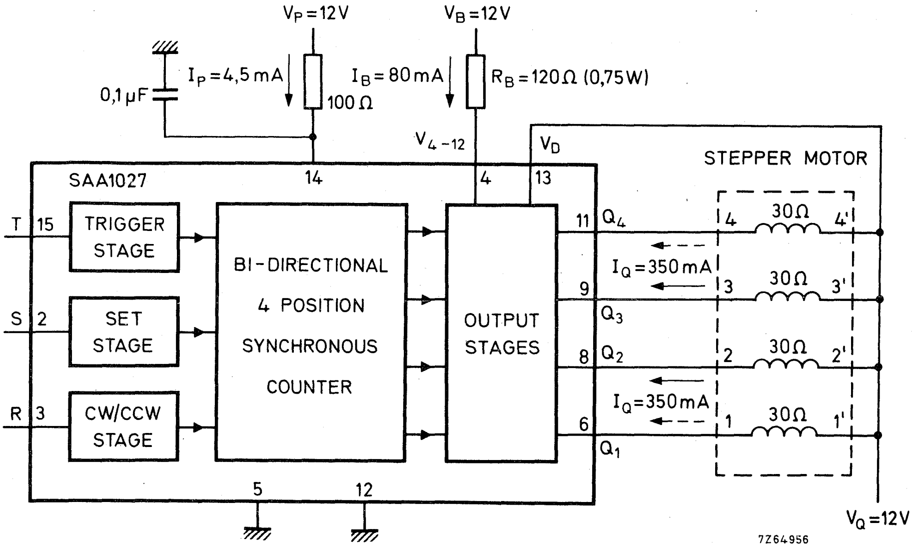
Bias voltage and current (max. values; pin 4) — See top graph on page 7

Bias resistor — See bottom graph on page 7

Power dissipation in bias resistor — See top graph on page 8

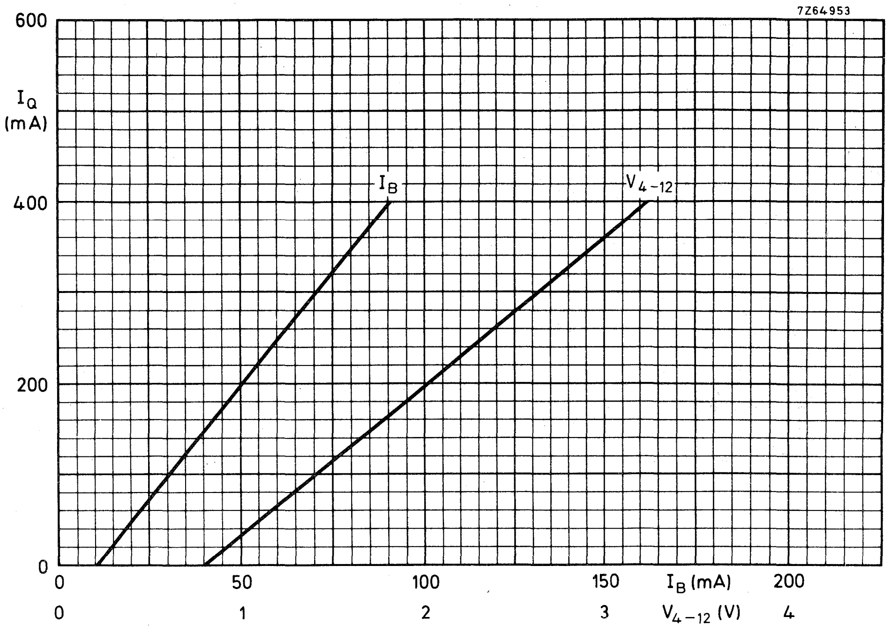
Total device power dissipation — See bottom graph on page 8

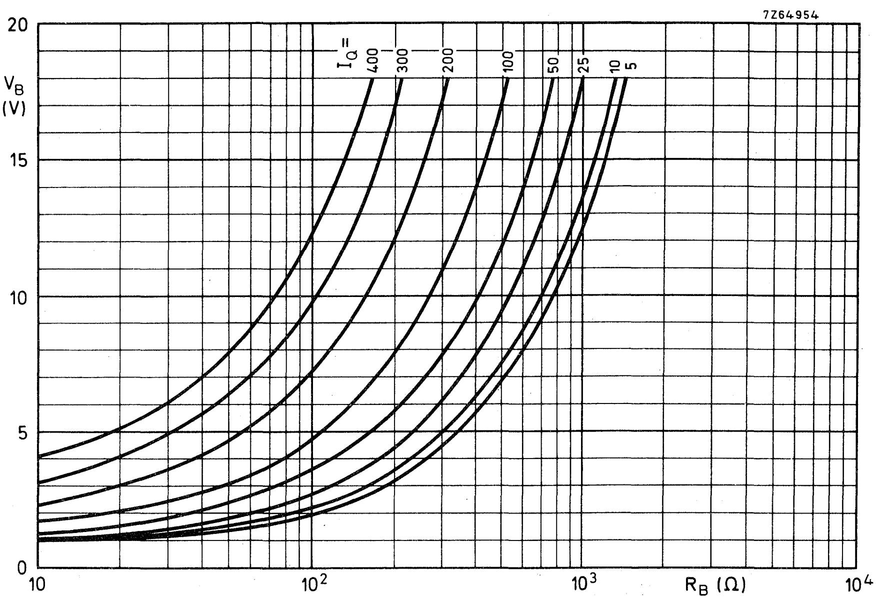
APPLICATION INFORMATION

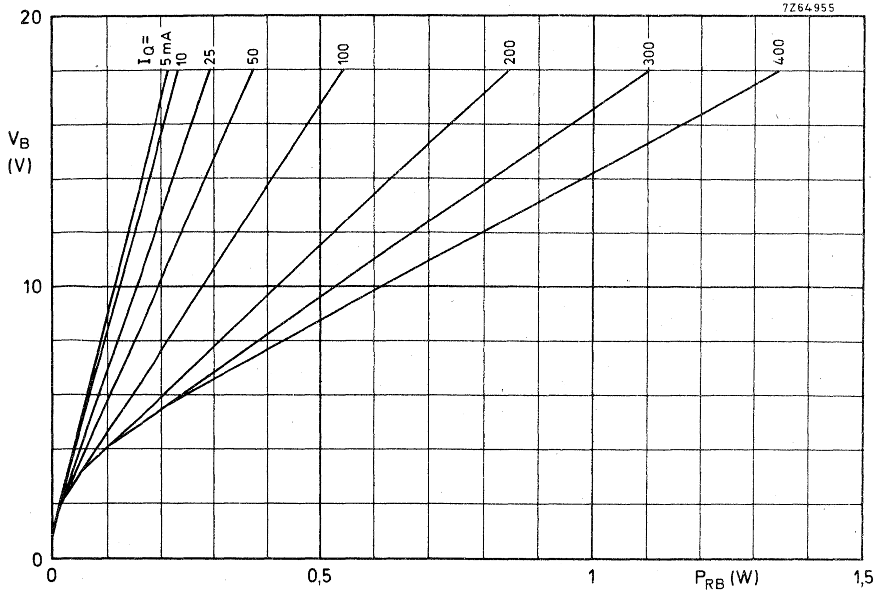


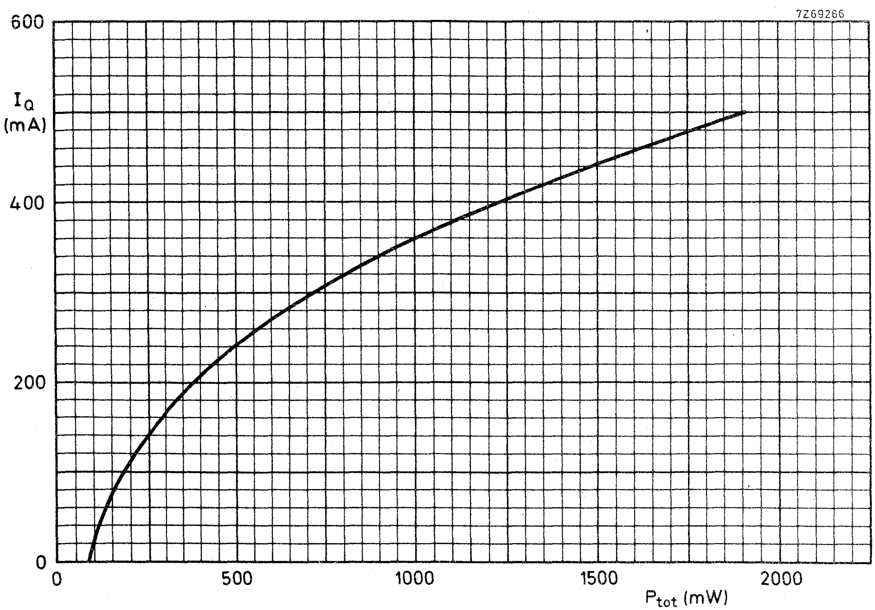
PINNING

1. not connected
2. S (set input)
3. R (CW/CCW input)
4. V_B (positive supply)
5. Earth (negative supply)
6. Q_1 (output)
7. not connected
8. Q_2 (output)
9. Q_3 (output)
10. not connected
11. Q_4 (output)
12. Earth (negative supply)
13. V_D (positive supply)
14. V_P (positive supply)
15. T (trigger input)
16. not connected


7Z64953
600
I_Q
(mA)
400
200
0
I_B
V_{4-12}
0
50
100
150
200
I_B (mA)
0
1
2
3
4
V_{4-12} (V)

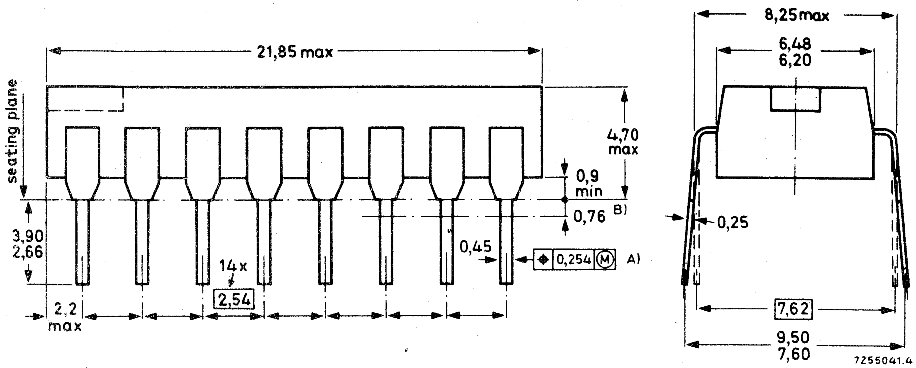

7Z64954
20
V_B
(V)
15
10
5
0
I_Q=
400
300
200
100
50
25
10
5
10
10^2
10^3
10^4
R_B (Ω)

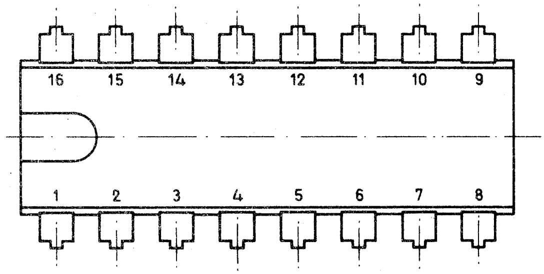

7Z64955
20
10
0
V_B
(V)
$I_Q =$ 5 mA
10
25
50
100
200
300
400
0
0,5
1
1,5
P_{RB} (W)


7Z69266
600
400
200
0
I_Q
(mA)
0
500
1000
1500
2000
P_{tot} (mW)

16 LEAD PLASTIC POWER DUAL IN-LINE

Dimensions in mm





top view

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

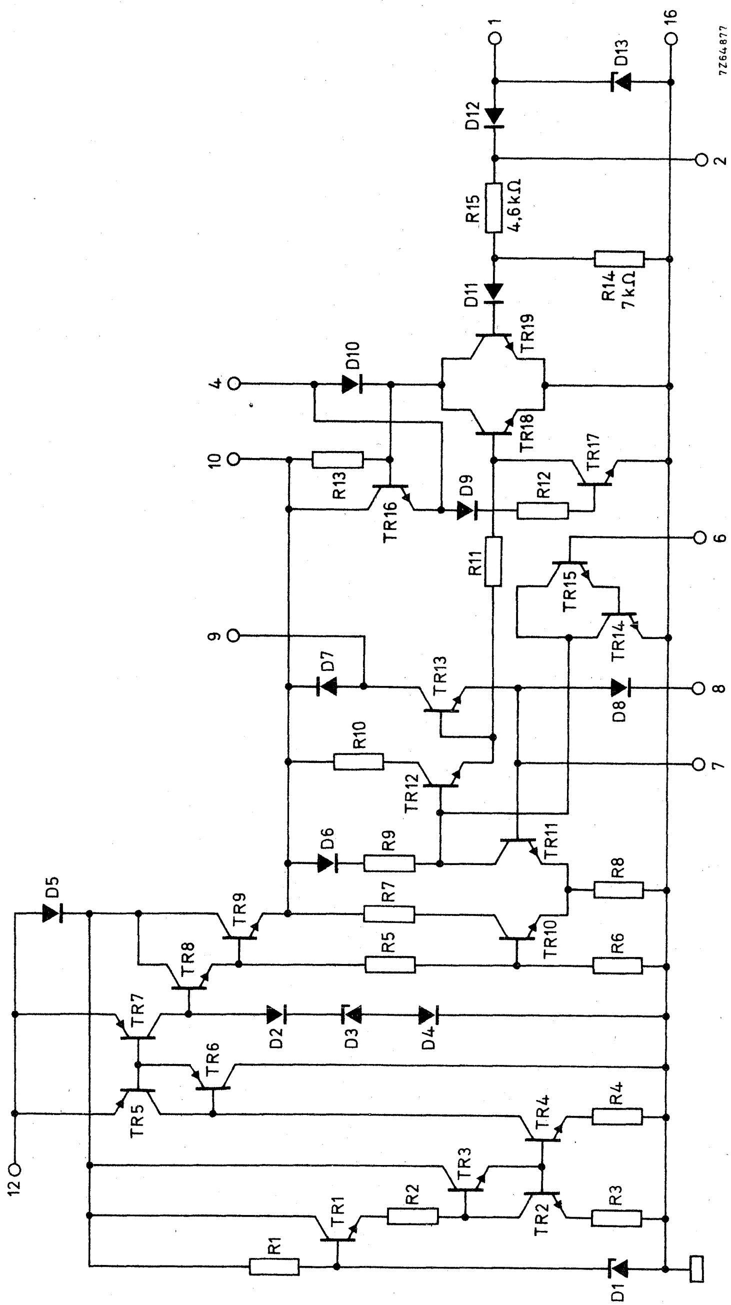
REVOLUTION COUNTER

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



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

Voltage

Supply voltage (pin 12)	V_P	max.	18 V

Currents

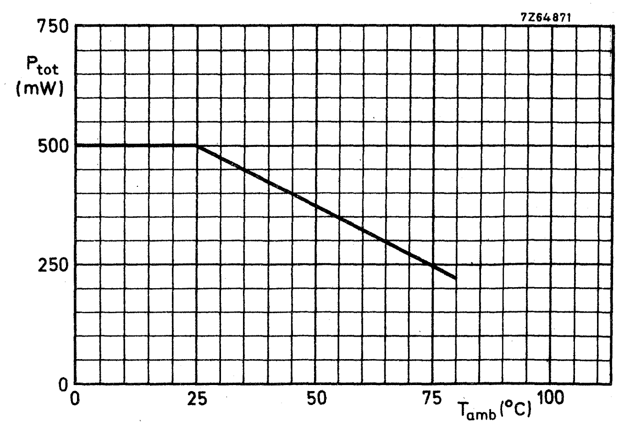
Current at pin 9 (peak value)	$-I_{9M}$	max.	50 mA
at pin 7 (peak value)	$-I_{7M}$	max.	50 mA
at pin 8 (peak value)	$-I_{8M}$	max.	50 mA
at pin 1	$\pm I_1$	max.	10 mA

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



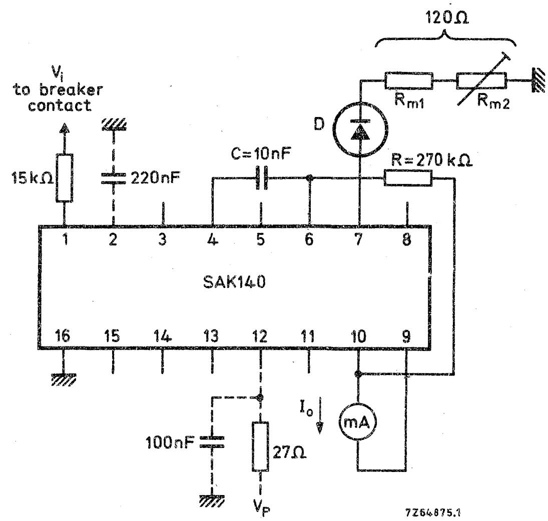
CHARACTERISTICS

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

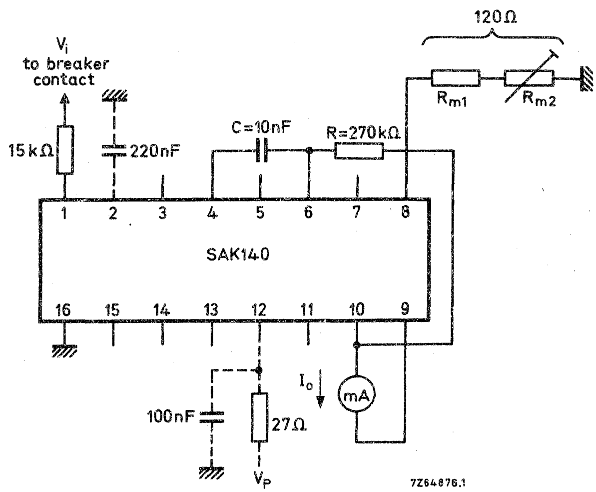
[1]) The circuit is internally protected against reverse connected supply voltage.

[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



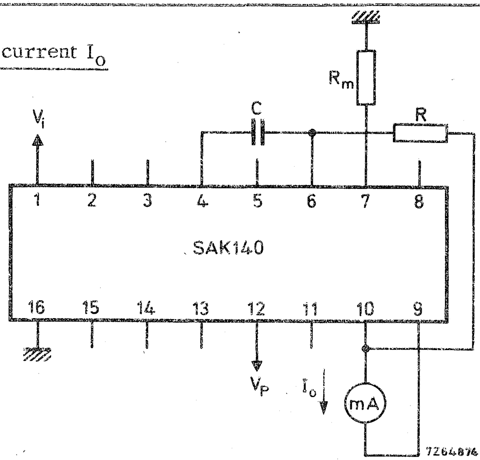
Temperature coefficient of I_o is 800 ppm/°C determined by diode D. [1])



Temperature coefficient of I_o 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.

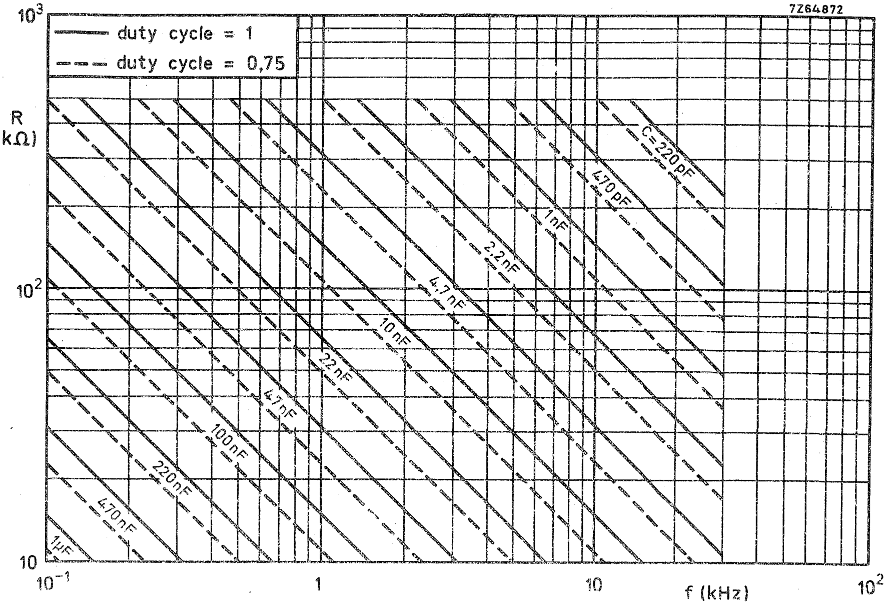
Temperature coefficient of output current I_o



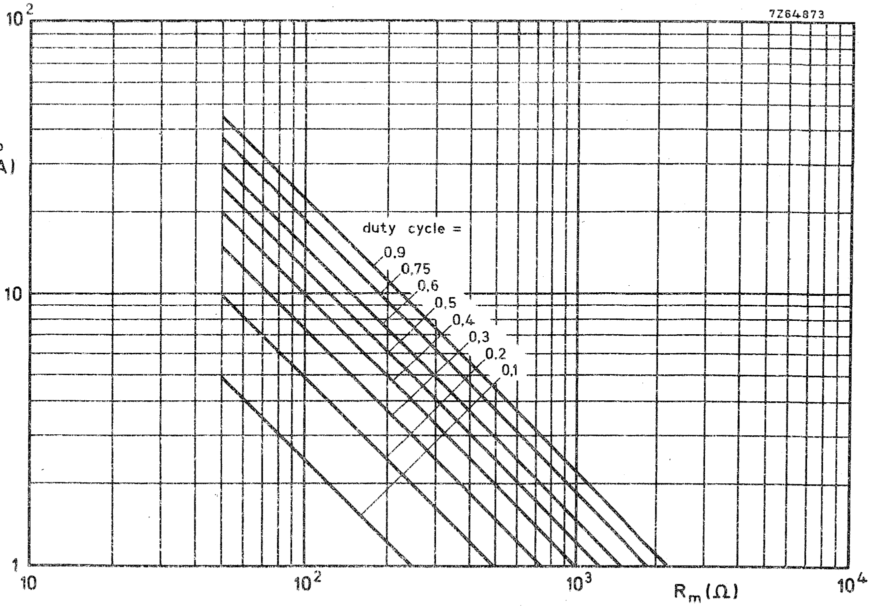
The temperature coefficient of I_o depends on the temperature coefficients of R, C, R_m and the voltage on pin 7.
The temperature coefficient of R = 270 kΩ (carbon resistor, catalogue number 2322 101 33274) is −330 ppm/°C and of V_{7-16} is 200 ppm/°C.
The temperature coefficients of R_m and C depend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

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

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



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**

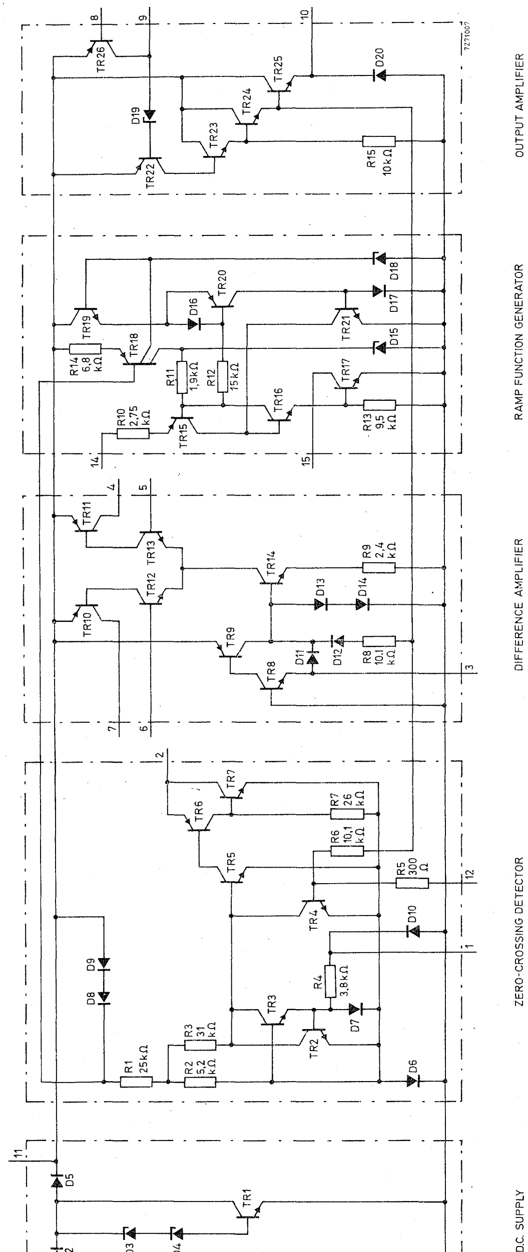
— **synchronous on/off switching** (static switch)

— **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



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

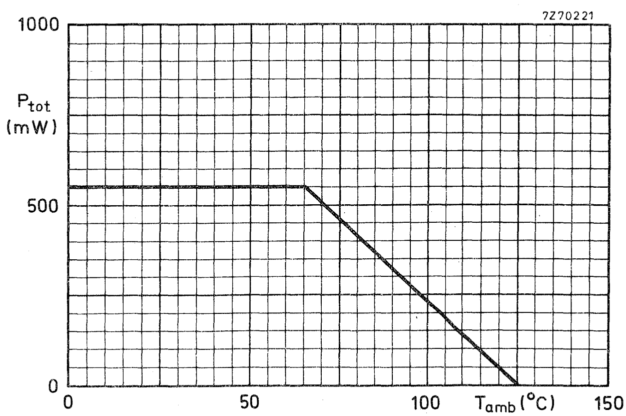
Voltages

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] $t \leq 300\ \mu s$

CHARACTERISTICS at T_{amb} = 25 °C

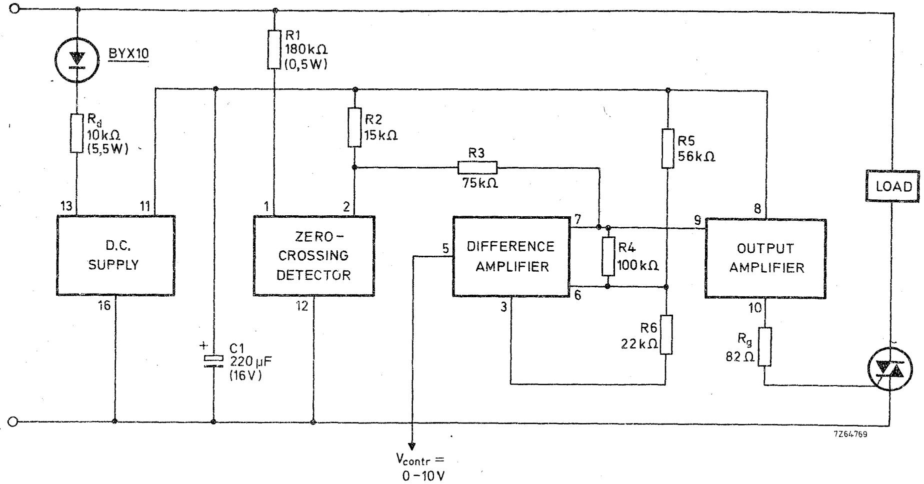
Power supply

Supply voltage at I_{13} = 5 mA; I_{10} = 0	V_{11-16}	typ.	14,4	V
			13 to 15	V
Supply voltage range for external supply	V_{11-16}		11 to 17	V
Zero-crossing detector				
Input current at V_{11-16} = 13 V; I_2 = 0,5 mA	$\pm I_1$		30 to 50	μA
Input voltage at I_2 = 0,1 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 V; $+I_3$ = 10 μA or $-I_3$ = 30 μA	I_5	typ.	5	μA
		<	10	μA
$-V_{6-11}$ = 3 V; $+I_3$ = 10 μA or $-I_3$ = 30 μA	I_6	typ.	5	μA
		<	10	μA
Output currents				
$-V_{5-11}$ = 3 V; $+I_3$ = 10 μA or $-I_3$ = 30 μA	$-I_4$		0,3 to 1,2	mA
$-V_{6-11}$ = 3 V; $+I_3$ = 10 μA or $-I_3$ = 30 μA	$-I_7$		0,3 to 1,2	mA
Ramp function generator				
Trigger current	I_{14T}	<	3	μA
Holding current	I_{14H}		95 to 210	μA
Trigger voltage at $I_{14} < I_{14T}$	V_{14-16}		7,0 to 8,3	V
On-state voltage at $I_{14} > I_{14T}$	V_{14-16}		1,8 to 2,8	V
Output amplifier				
Input currents at $-I_9$ = 100 μA	$-I_8$		19 to 53	μA
at $-I_{10}$ = 200 mA	$-I_9$	<	15	μA
Output current (off-state)				
I_9 = 0; V_{10-16} = 0	$-I_{10}$	<	1	μA
Output voltage drop				
$-I_{10}$ = 200 mA; $-I_9$ = 50 μA; V_{11-16} = 13 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)



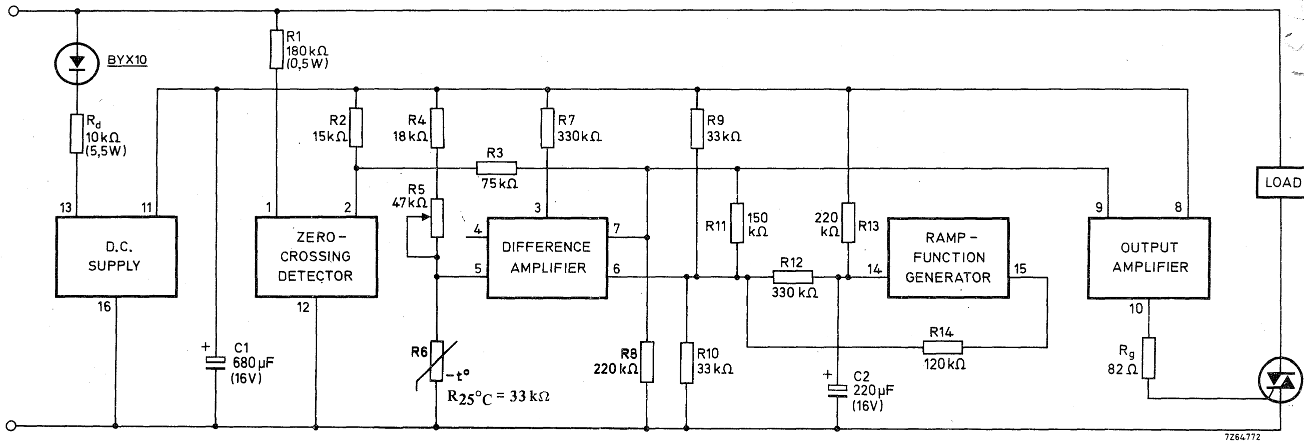
The synchronous switch gives triggering around the zero crossings of the mains voltage with a typical pulse duration of 160 µs.

Note

Values of R_d, R_g, and C1 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



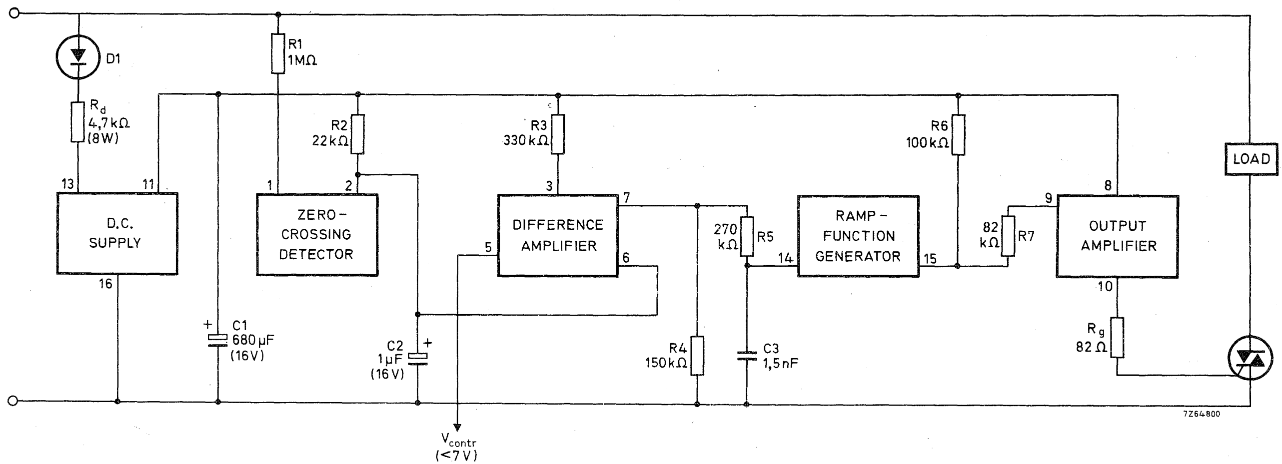
Triggering is as in the circuit described on page 5 (synchronous on/off switching; resistive load), as triggering coincides with the zero crossings of the mains voltage. However, no triggering can occur if the voltage at pin 5 of the difference amplifier, supplied by the temperature-conscious bridge formed by R4, R5 and the NTC thermistor R6 in one branch, and R9 and R 10 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 R 12.

Note

See note on page 5.

APPLICATION INFORMATION (continued)

3. Single phase control circuit using trigger pulse bursts.

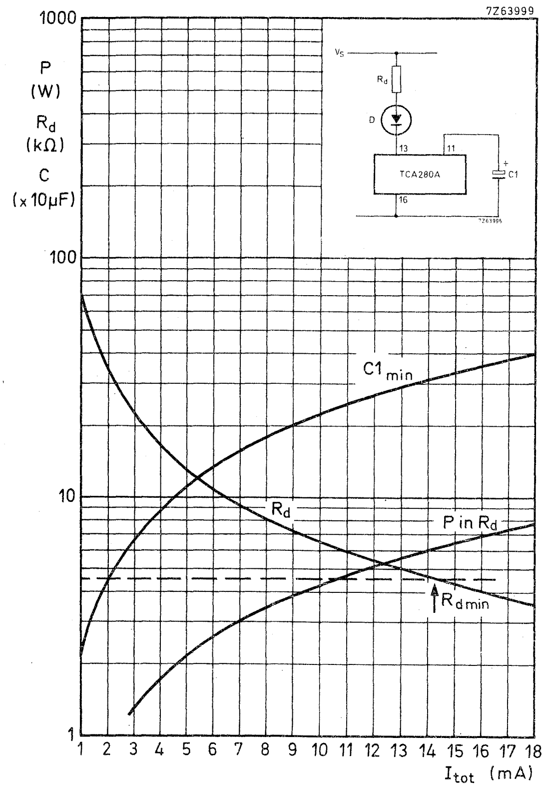


This circuit used in conjunction with a triac, provides a full-wave a.c. controller, and if used in conjunction with a thyristor, a controlled half-wave rectifier.

Note

See note on page 5.

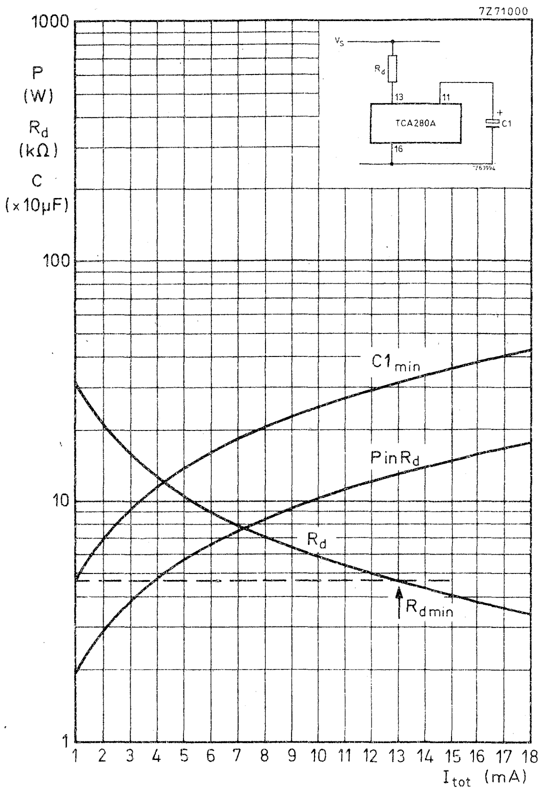
APPLICATION INFORMATION (continued)



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 D5, 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)

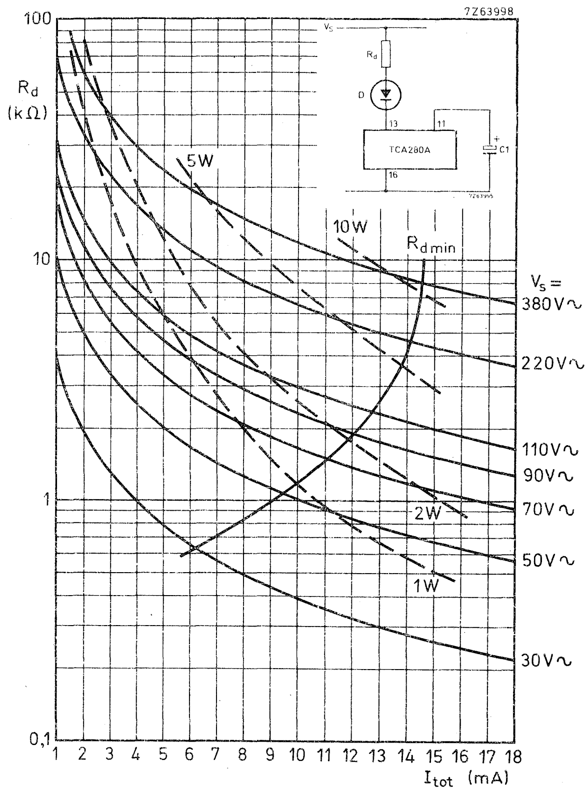


Without diode

Note

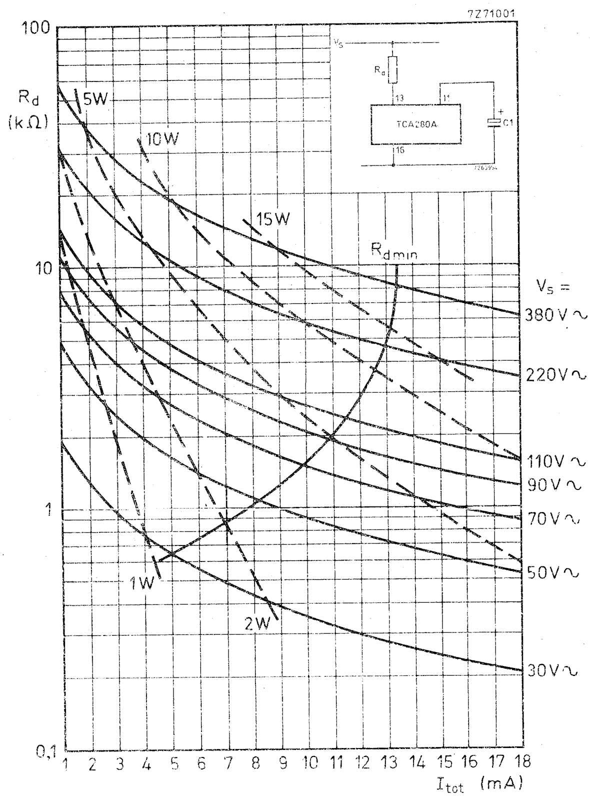
This graph is not suitable for phase control applications; use the graph on page 8.

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)

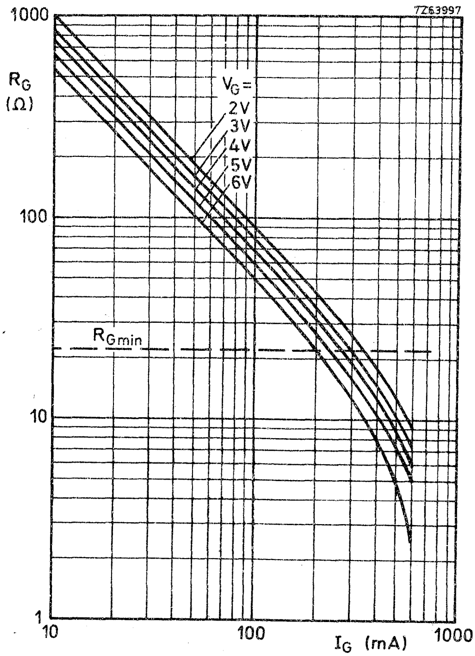


Without diode.

Note

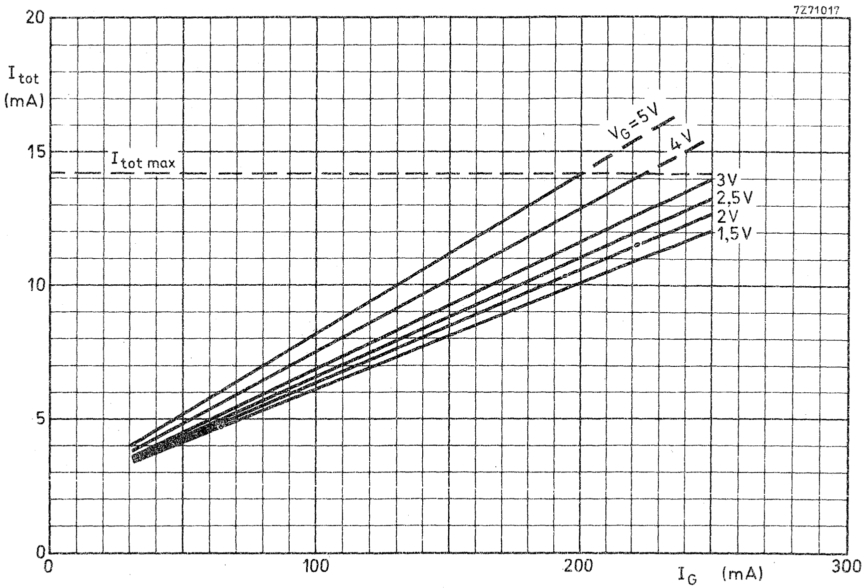
This graph is not suitable for phase control applications; use the graph on page 10.

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_{10} 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 uesd only if the highest possible R_G is used.

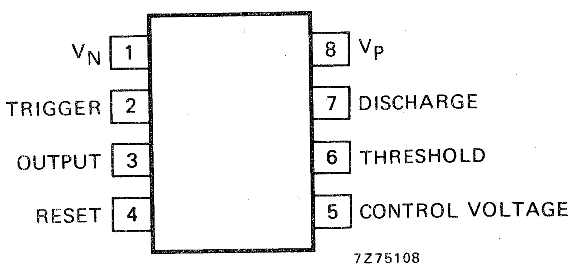
TIMER

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%/^{o}C
- Normally-on and normally-off output
- Operating ambient temperature: −25 to +85 ^{o}C
- Miniature plastic encapsulation

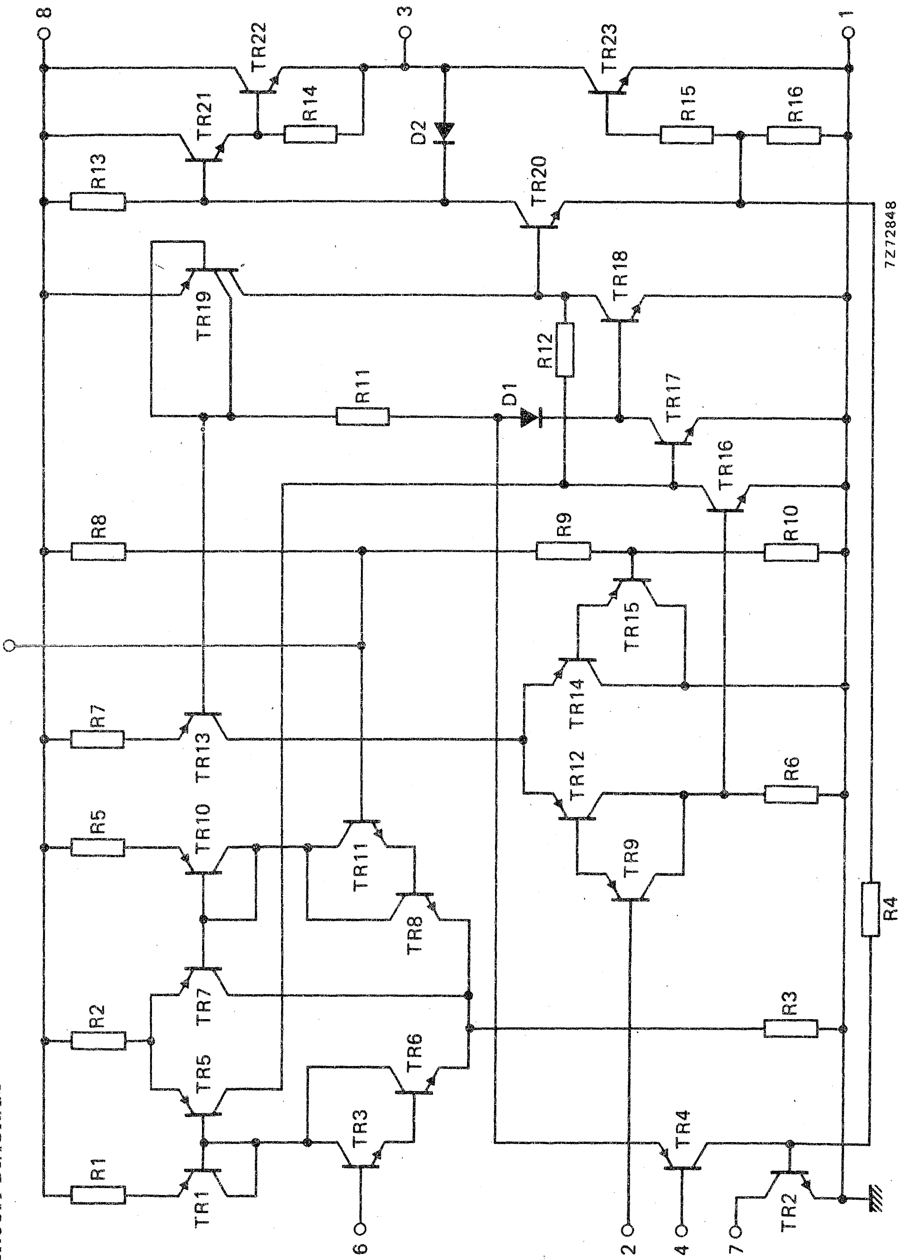
CONNECTION DIAGRAM



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

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 kΩ					
initial accuracy	C = 0,1 µF		–	1	–	%
drift with temperature			–	50	–	ppm/°C
drift with supply voltage			–	0,1	–	%/V
Timing error (astable)	R_A; R_B = 2 to 100 kΩ					
initial accuracy	C = 0,1 µF		–	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	–	µA
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:

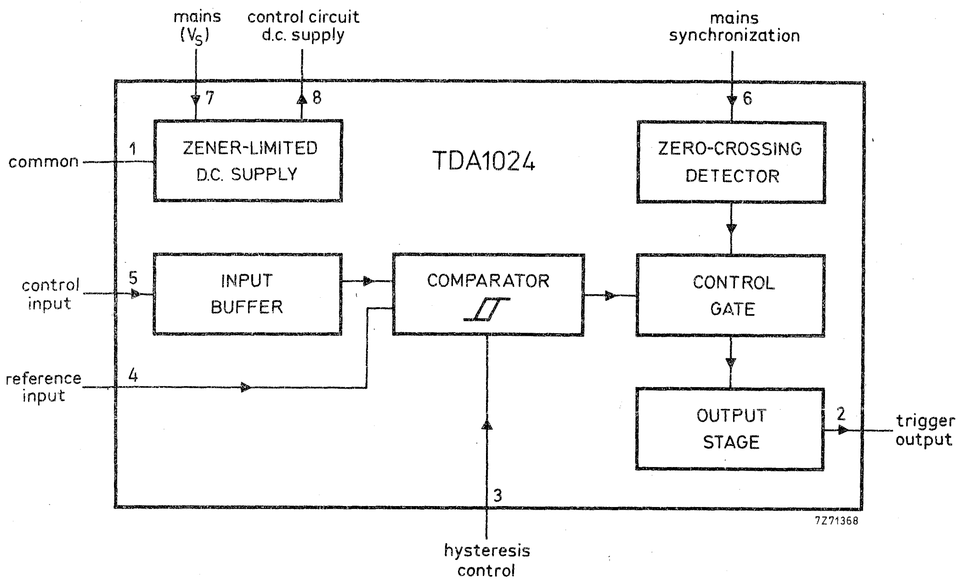
- central heating installations,
- washing machine heaters,
- water heaters,
- smoothing irons.

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	μs
Max. trigger current capability	I_{2max}	>	100	mA

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

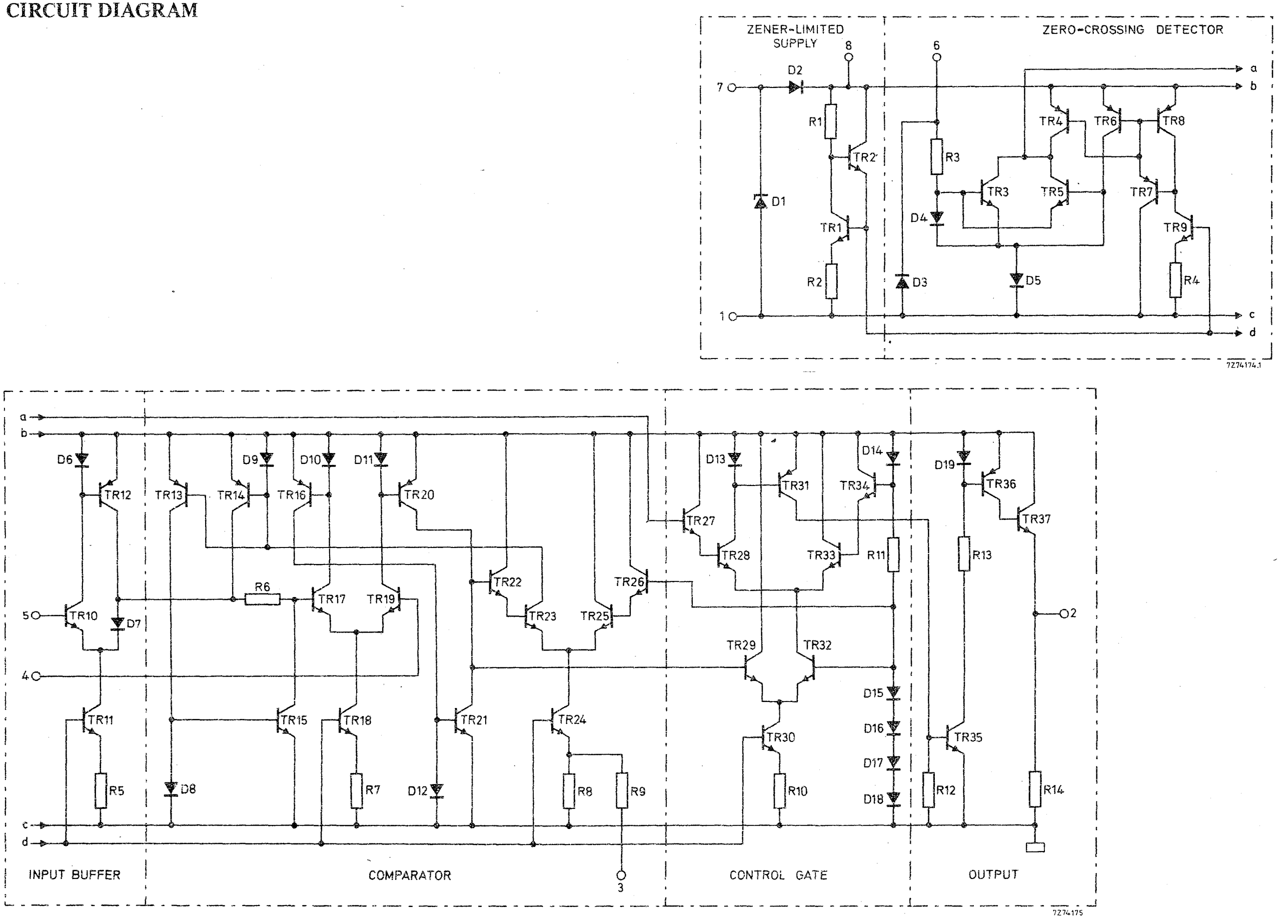
BLOCK DIAGRAM



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 betweenpin 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

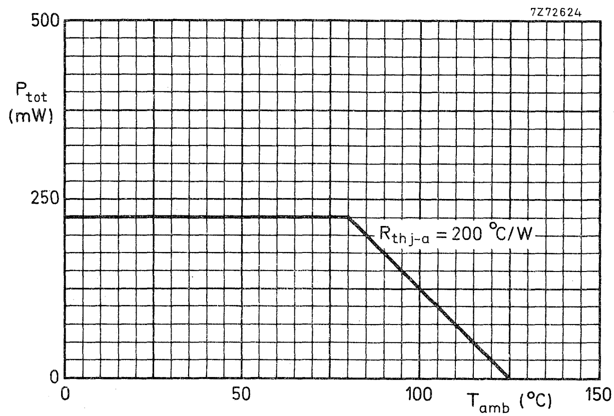
Supply current (pin 7); average value	$\pm I_{7(av)}$	max.	30	mA
peak value	$\pm I_{7M}$	max.	80	mA
Current at pins 4, 5, and 6	I_4; I_5; $\pm I_6$	max.	10	mA
Non-repetitive peak current at pin 7 (t_p<50μs)	$\pm I_{7SM}$	max.	2	A
Output current (pin 2); average value	$I_{2(av)}$	max.	30	mA
peak value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

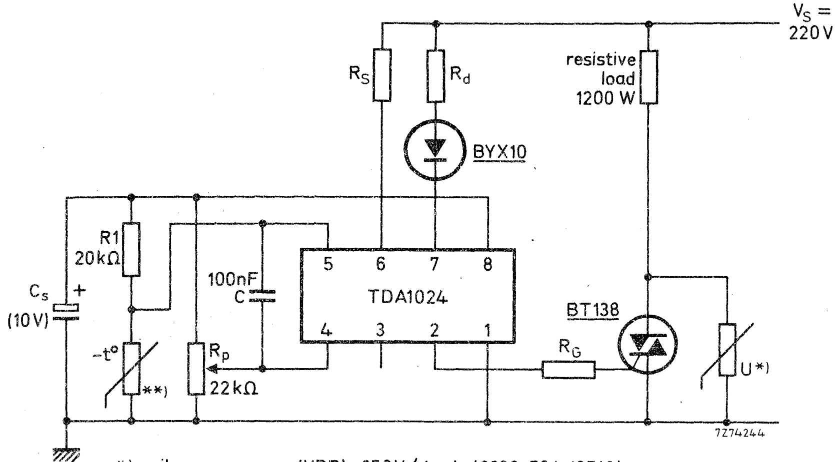


CHARACTERISTICS at T_{amb} = 25 °C; f = 50 Hz

Zero-crossing detector				
Trigger pulse width at $I_{6(rms)}$ = 1 mA;		typ.	195	μs
V_{8-1} = 5,5 V	t_p		130 to 265	μs
Synchronization resistor	see Fig. 3			
Trigger output (pin 2)				
Max. current capability at V_{8-1} = 5,5 V	$-I_{2\,max}$	>	100	mA
Trigger current capability	see Figures 5, 6, 7 and 8			
Max. trigger voltage at $-I_2$ = 100 mA	V_{2-1}	>	4	V
Gate resistor	see Fig. 4			
Comparator at V_{8-1} = 6,5 V				
Hysteresis; pin 3 not connected; I_3 = 0	ΔV_{5-4}		10 to 30	mV
Hysteresis; pin 3 connected to common; V_3 = 0	ΔV_{5-4}	typ.	300	mV
Input 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 mA		typ.	6,5	V
	V_{8-1}		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 V	I_{IC}	<	1,8	mA
IC 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 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

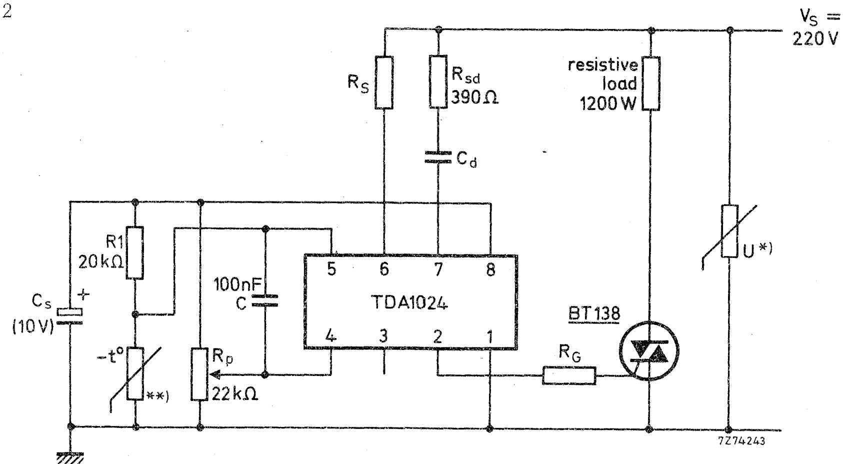
Fig. 1



*) spike suppressor (VDR): 350 V / 1 mA (2322 594 13512)
**) R_{25} = 22 kΩ

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



*) spike suppressor (VDR): 350 V / 1 mA (2322 594 13512)
**) R_{25} = 22 kΩ

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):

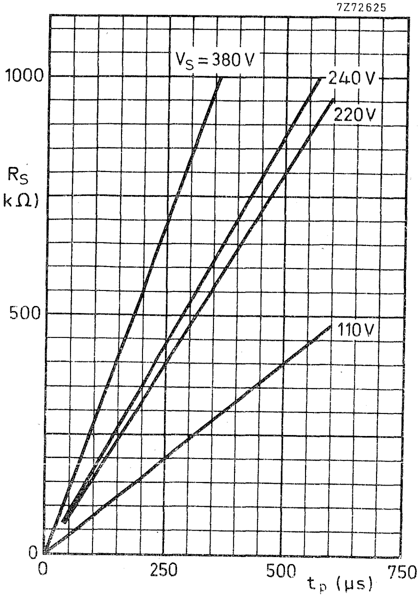
BT138 triac with: V_{GT} = 1,6V at 0 °C
I_{GT} = 72 mA at 0 °C
I_L < 60 mA

Mains voltage: V_S = 220 V
Triac load: 1200 W

Component values and circuit parameters:

parameter		Value Fig. 1	Value Fig. 2	Figure
trigger pulse width	: t_p (μs)	105	105	*)
sync. resistor	: R_S (kΩ)	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 (kΩ)	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.



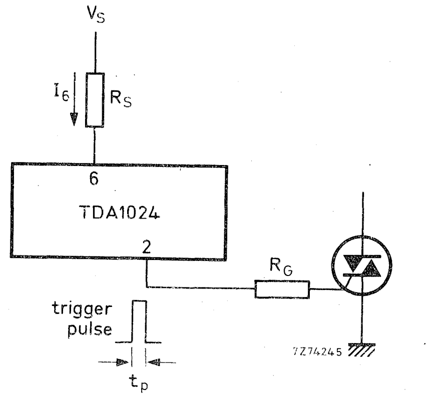
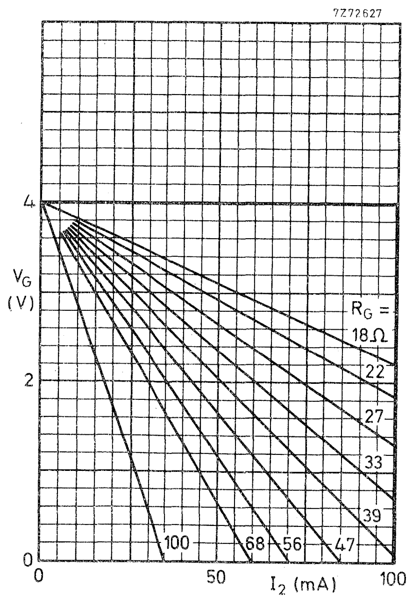


Fig. 3. Synchronization resistor (R_S) value as a function of required trigger pulse width (t_p) with applied mains voltage (V_S) as a parameter.
Tolerance for R_S : ± 5%
for V_S : ± 10%



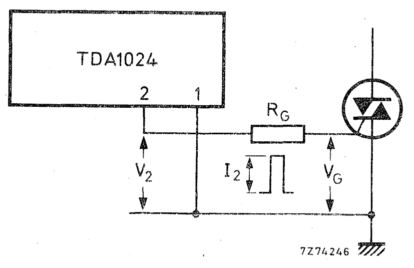
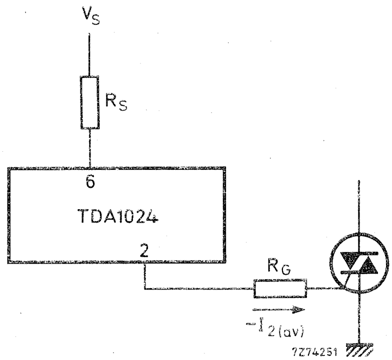


Fig. 4. Gate voltage (V_G) as a function of trigger current (I_2) with gate resistor (R_G) load lines.

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.



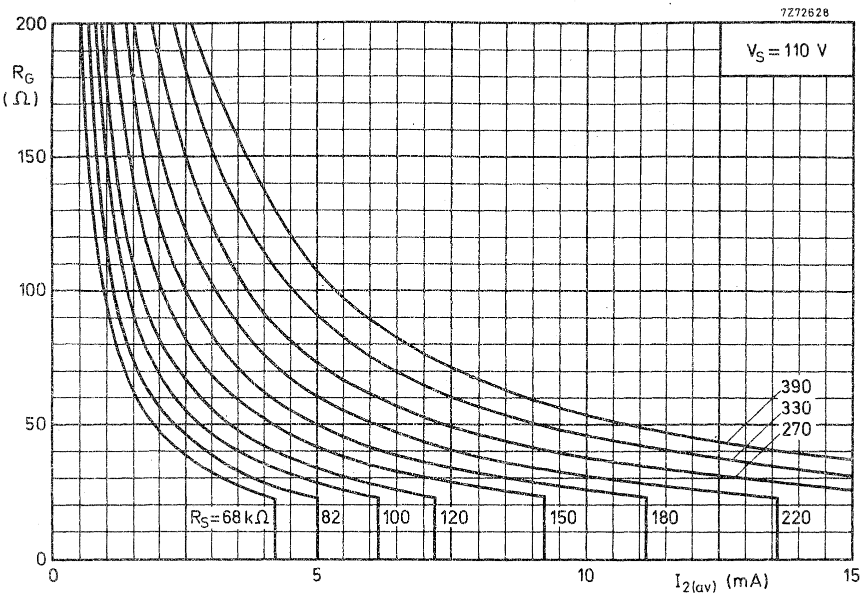

7Z72628
V_S = 110 V
R_G (Ω)
200
150
100
50
0
0
5
10
15
I_2(av) (mA)
390
330
270
R_S = 68 kΩ
82
100
120
150
180
220

Fig. 5

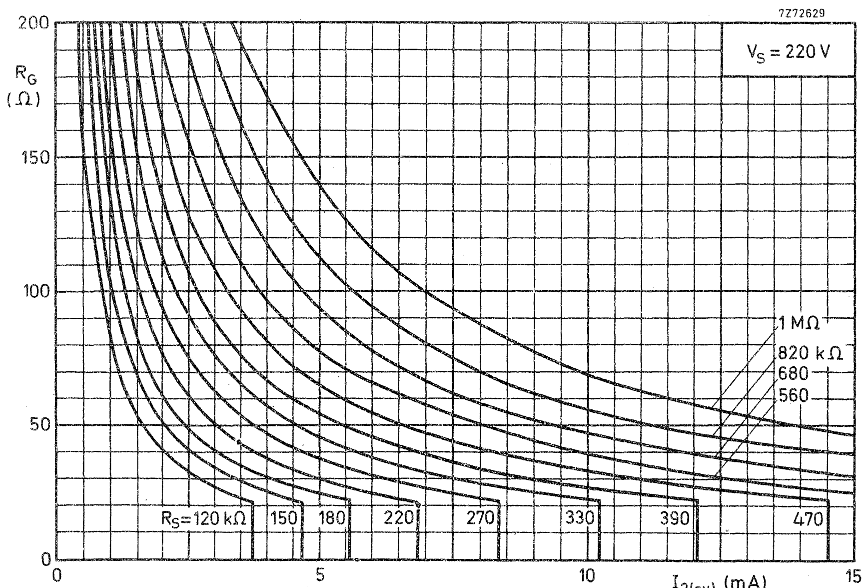

7Z72629
V_S = 220 V
R_G (Ω)
200
150
100
50
0
0
5
10
15
I_2(av) (mA)
1 MΩ
820 kΩ
680
560
R_S = 120 kΩ
150
180
220
270
330
390
470

Fig. 6

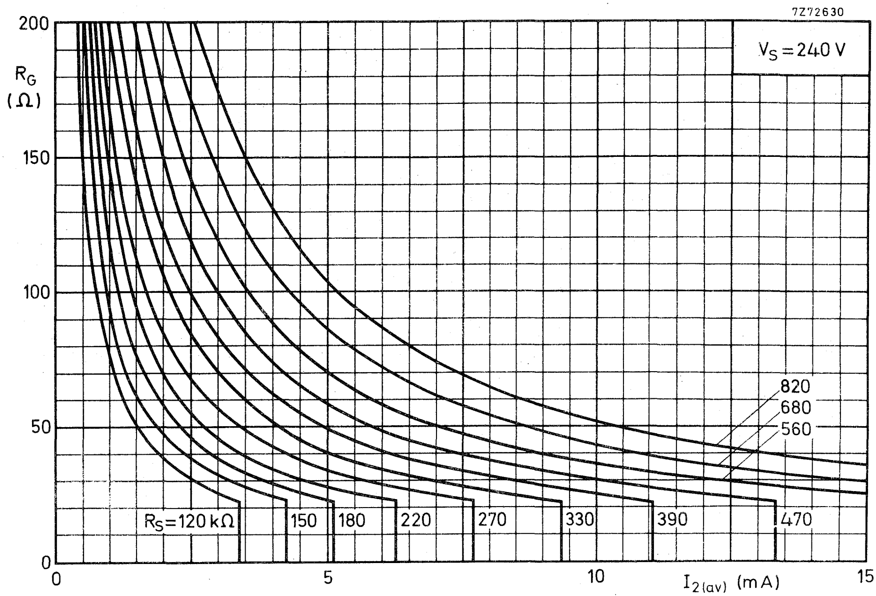

7Z72630
$V_S = 240$ V
R_G (Ω)
200
150
100
50
0
820
680
560
R_S=120 kΩ
150
180
220
270
330
390
470
0
5
10
15
$I_{2(av)}$ (mA)

Fig. 7

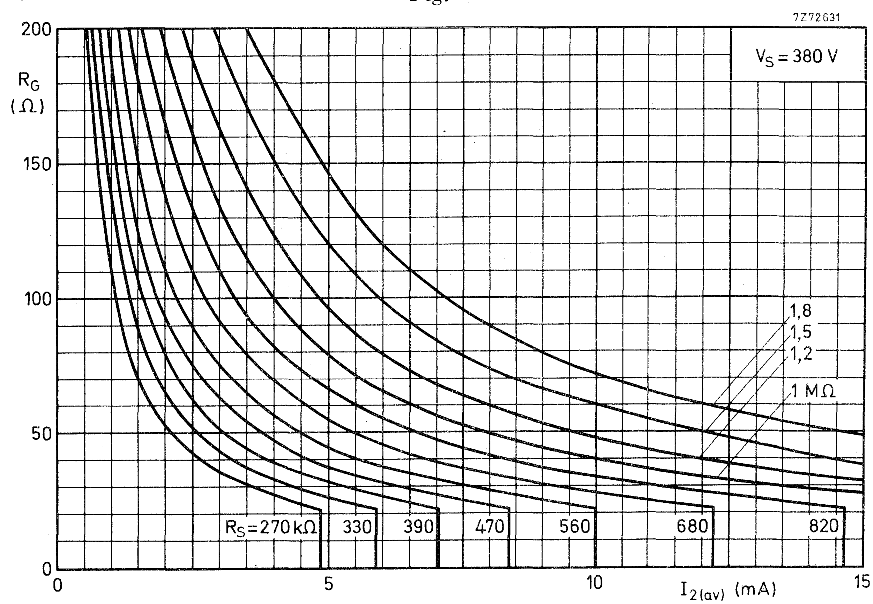
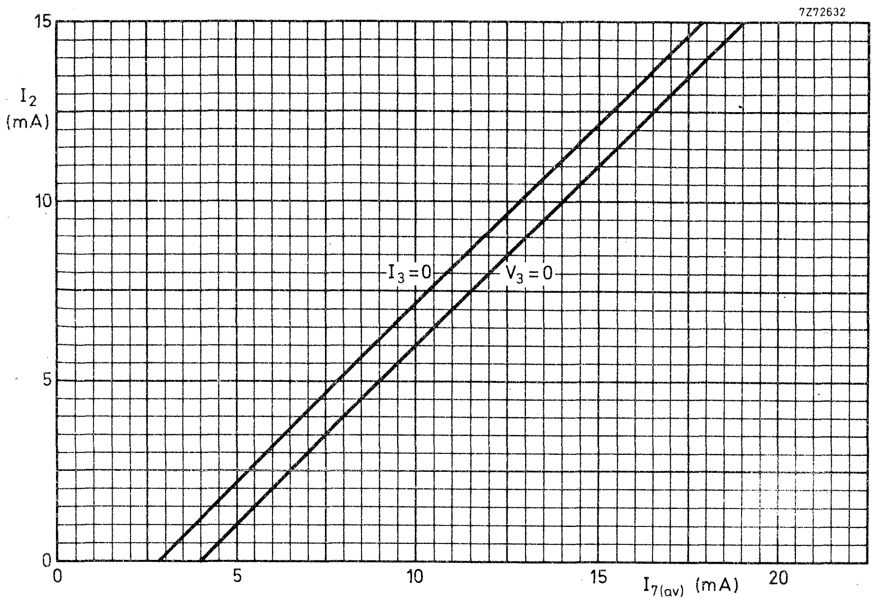

7Z72631
$V_S = 380$ V
R_G (Ω)
200
150
100
50
0
1,8
1,5
1,2
1 MΩ
R_S=270 kΩ
330
390
470
560
680
820
0
5
10
15
$I_{2(av)}$ (mA)

Fig. 8



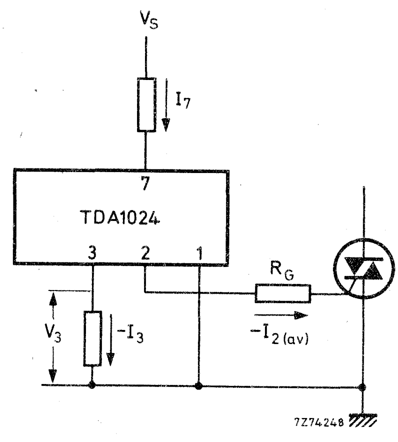
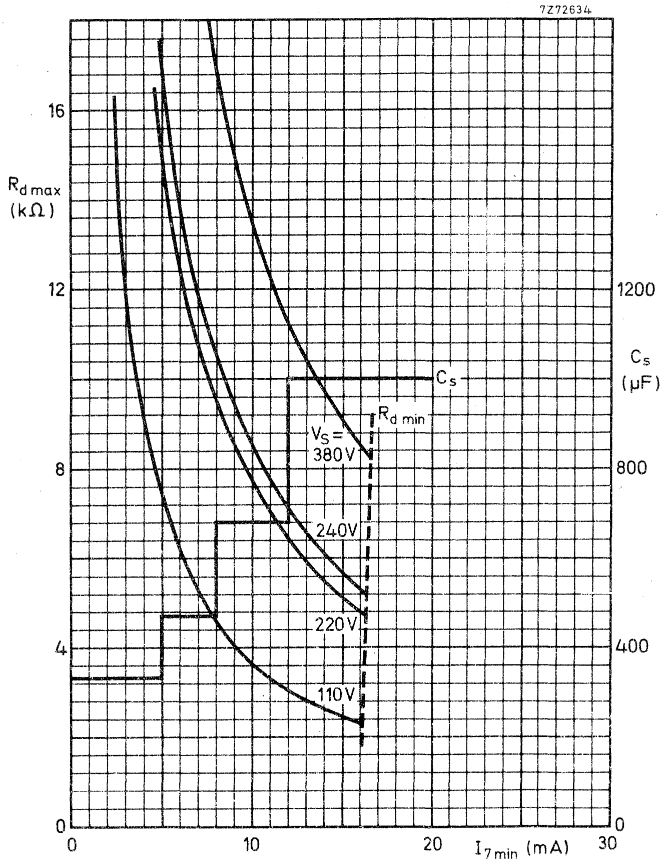


Fig. 9. Minimum required supply current (I_7) as a function of maximum average trigger current ($I_{2(av)}$), with hysteresis setting as a parameter.
$I_3 = 0$; min. hysteresis.
$V_3 = 0$; max. hysteresis.



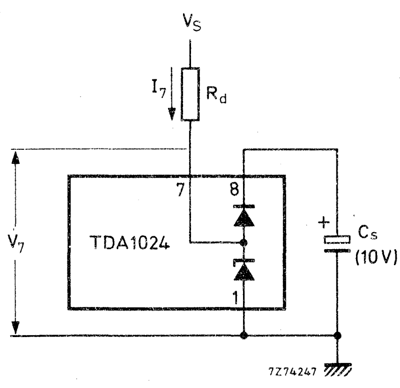
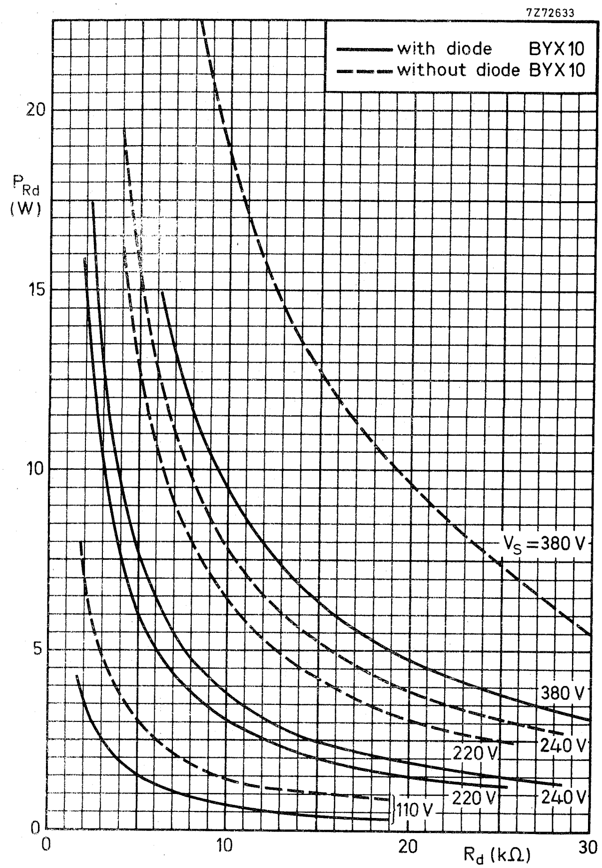


Fig. 10. Value of $R_{d\,max}$ as a function of I_{7min} with supply voltage (V_S) as a parameter.
Also shown is the value of the smoothing capacitor (C_S) as a function of I_{7min}.



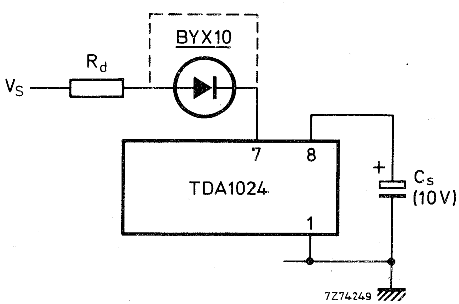
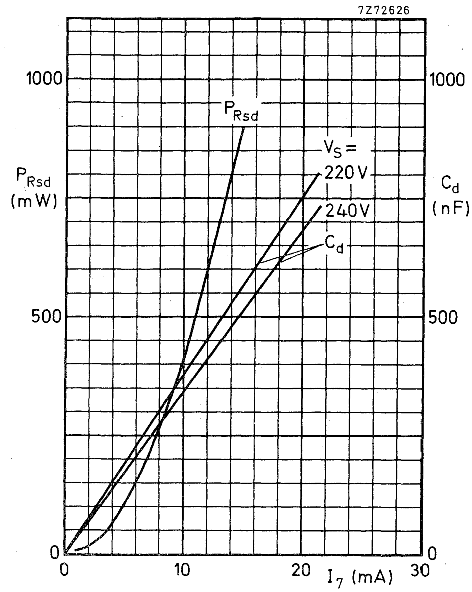


Fig. 11. The power dissipated by mains dropping resistor R_d (P_{Rd}) as a function of its value with the supply voltage (V_S) as a parameter.



Using a capacitor for mains supply voltage dropping.

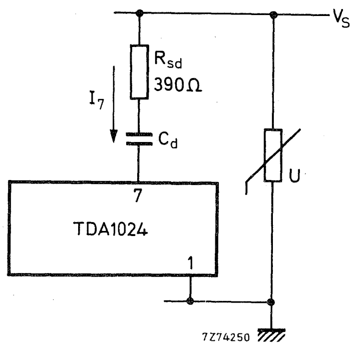


Fig. 12. Power dissipated by the dropping resistor (P_{Rsd}) and the dropping capacitor value (C_d) as a function of the current into pin 7 (I_7) with the mains supply voltage (V_S) as a parameter.

SPECIAL CIRCUITS

Special circuits

SAA1114; Z – 4-MHz clock circuit

TDA0319D – dual voltage comparator

TDA0723D – precision voltage regulator

TDA3081; TDA3082 – seven-transistor array

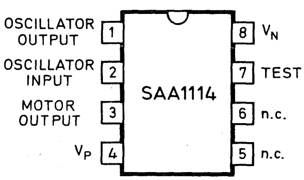
4 MHz CLOCK CIRCUITS

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.

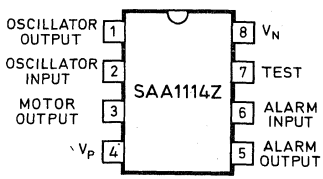
Features

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

CONNECTION DIAGRAMS



7Z76024



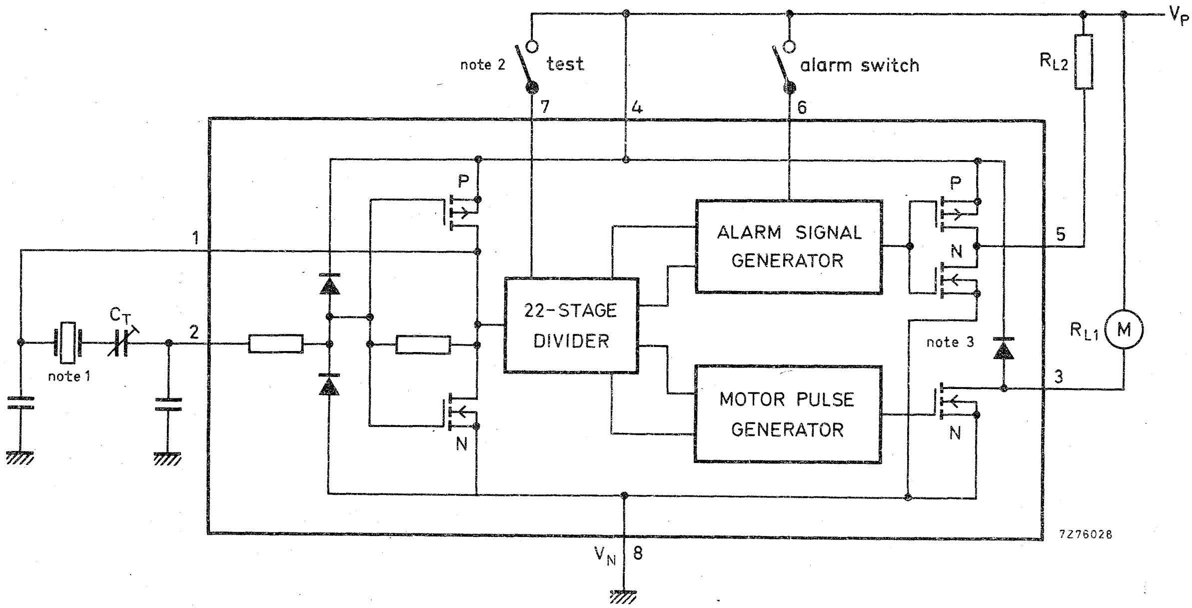
7Z76023

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

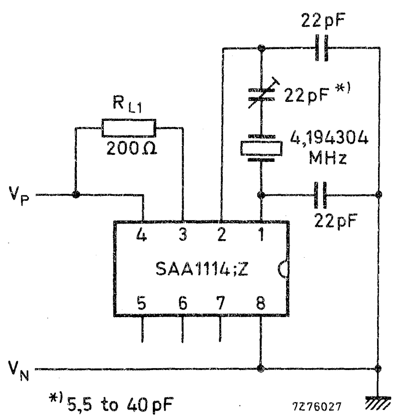
CHARACTERISTICS at $V_P = 1,5$ V; $V_N = 0$; $f_o = 4,194$ MHz; $T_{amb} = 25$ °C unless otherwise specified

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	μA
		<	120	μA
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.	$0,2 \times 10^{-6}$	

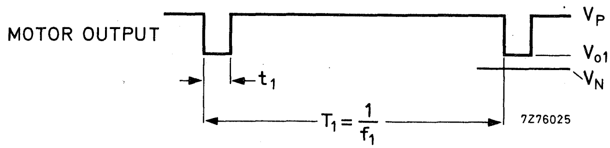
The following characteristics apply to the SAA1114Z only (with additional alarm output).

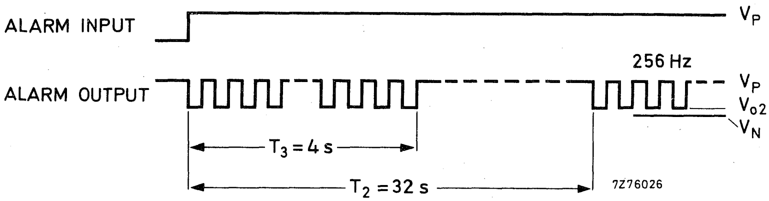
Duration of alarm signal; pin 6 at V_P	T_3	typ.	4	s
Repetition of alarm signal; pin 6 at V_P	T_2	typ.	32	s
Frequency of alarm signal (50% duty cycle)	f_2	typ.	256	Hz
Voltage drop across alarm output at $R_{L2} = 1$ kΩ	V_{o2}	typ.	100	mV
		<	250	mV

Test circuit



TIMING DIAGRAMS





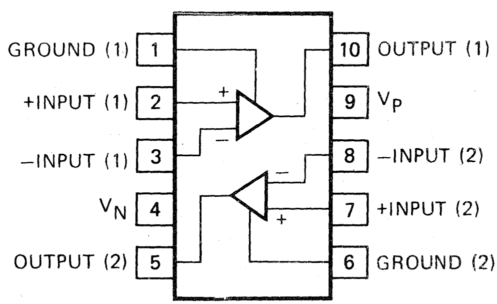
DUAL VOLTAGE COMPARATOR

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 μA
- Inputs and outputs can be insulated from system ground
- High common mode slew rate.

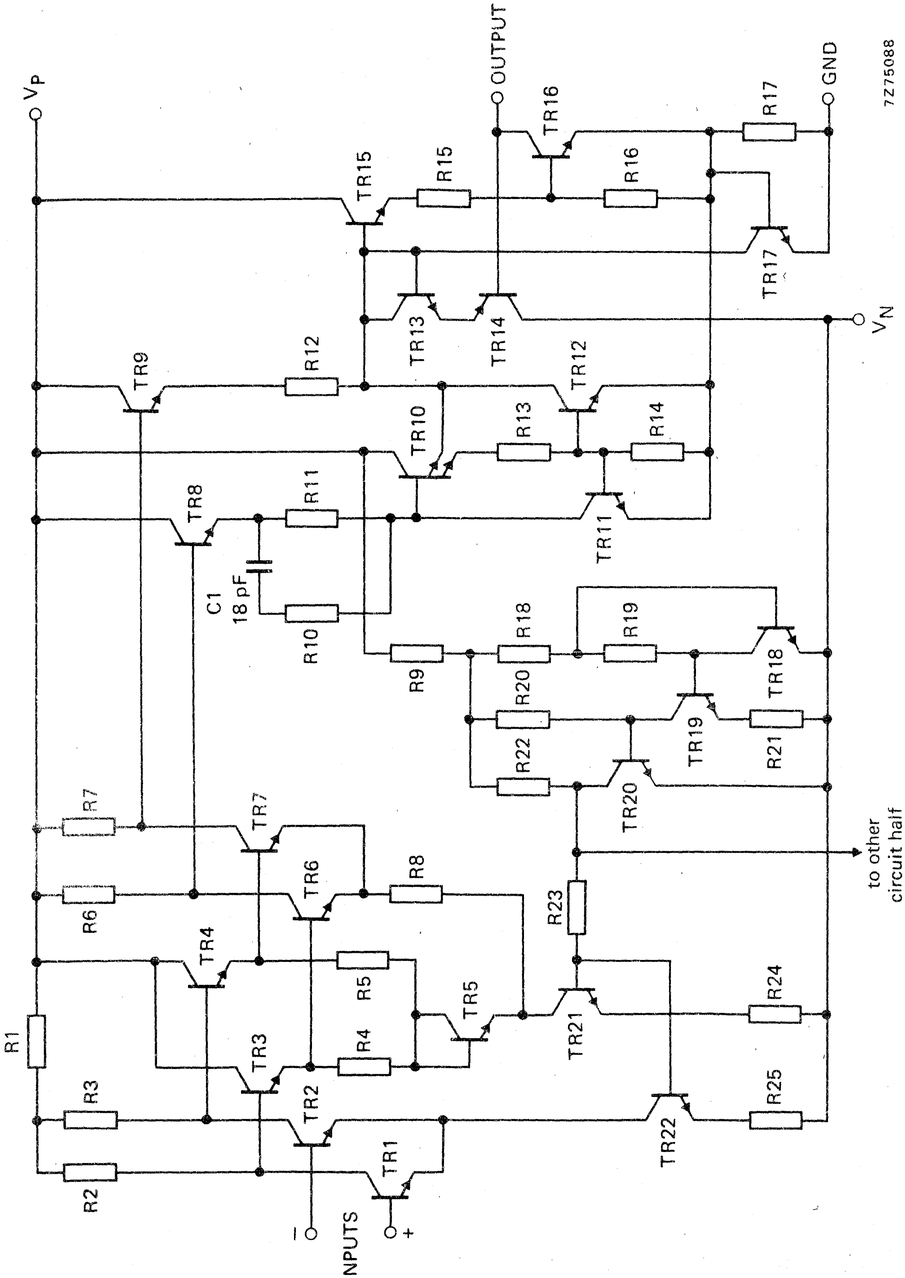
CONNECTION DIAGRAM



7Z75101

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

CIRCUIT DIAGRAM (one comparator)



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 cm²	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 cm²	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 V; $-V_N$ = 15 V; T_{amb} = 25 °C unless otherwise specified

Parameter	Conditions	Symbol	min.	typ.	max.	Unit
Input offset voltage	$R_S < 5$ kΩ [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	$-V_i < 10$mV; I_o=25mA	V_{sat}	–	0,75	1,5	V
Output leakage current	$V_i > 10$mV; V_o=35V	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 V; $-V_N$ = 0	I_P	–	4,3	–	mA

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

Parameter	Conditions	Symbol	min.	typ.	max.	Unit
Input offset voltage	$R_S < 5$ kΩ [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 V	V_{io}	–	±13	–	V
	V_P = 5 V; $-V_N$ = 0	V_{io}	1	–	3	V
Saturation voltage	$V_P > 4,5$ V; $-V_N$ = 0 $V_i < -10$ mV; $I_{sink} < 3,2$ 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 ±15 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.

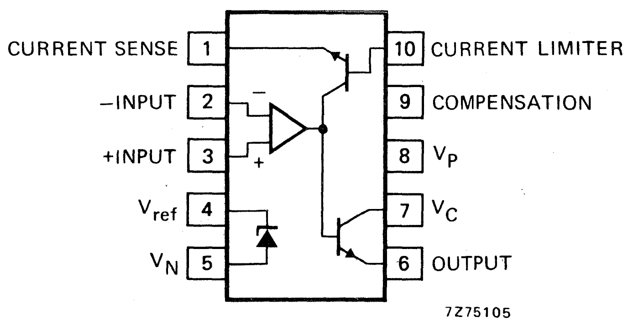
PRECISION VOLTAGE REGULATOR

The TDA0723D is a monolithic precision voltage regulator. The circuit is equivalent to the µA723C, 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 ^{o}C
- Input voltage range: 9,5 to 40 V
- Output voltage range: 2 to 37 V
- Operating ambient temperature: −25 to +85 ^{o}C
- Miniature plastic encapsulation.

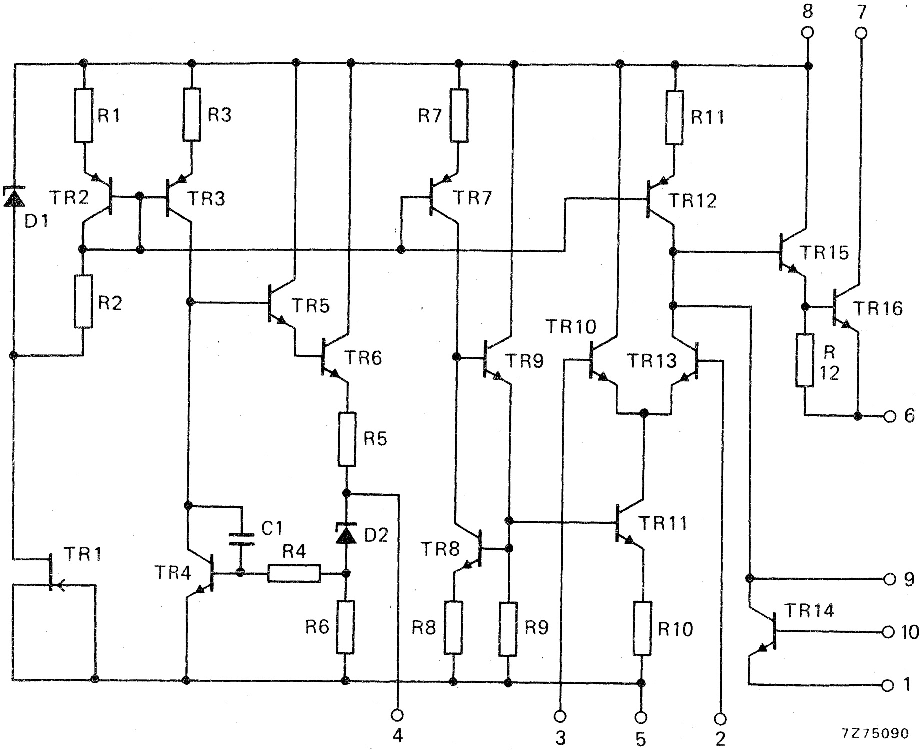
CONNECTION DIAGRAM



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 °C

Mounted on a ceramic substrate of 4 cm^2	P_{tot}	max.	485 mW
derating factor for T_{amb} > 50 °C	$1/R_{th}$	=	6, 5 mW/°C
Mounted on PC board of 4 cm^2	P_{tot}	max.	335 mW
derating factor for T_{amb} > 50 °C	$1/R_{th}$	=	4, 5 mW/°C

CHARACTERISTICS at $V_i = V_P = V_C$ = 12 V; $-V_N$ = 0 V; I_L = 5 mA; R_{sc} = 0; C = 100 pF; C_{ref} = 0; Tamb = 25 °C unless otherwise specified

Parameter	Conditions	Symbol	min.	typ.	max.	Unit
Line regulation [1]	V_i = 12 to 15 V		–	0, 01	0, 1	$\%V_o$
	V_i = 12 to 40 V		–	0, 1	0, 5	$\%V_o$
Load regulation [1]	I_L = 1 to 50 mA		–	0, 03	0, 2	$\%V_o$
Ripple rejection	f = 50 Hz to 10 kHz					
	C_{ref} = 0		–	74	–	dB
	C_{ref} = 5 μF		–	86	–	dB
Short-circuit current limit	R_{sc} = 10 Ω; V_o = 0		–	65	–	mA
Reference voltage		V_{ref}	6, 80	7, 15	7, 50	V
Output noise voltage	B = 100 Hz to 10 kHz					
	C_{ref} = 0	$V_{n(rms)}$	–	20	–	μV
	C_{ref} = 5 μF	$V_{n(rms)}$	–	2, 5	–	μV
Long term stability	over 1000 hours		–	0, 1	–	%
Stand-by current drain	I_L = 0; V_i = 30 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

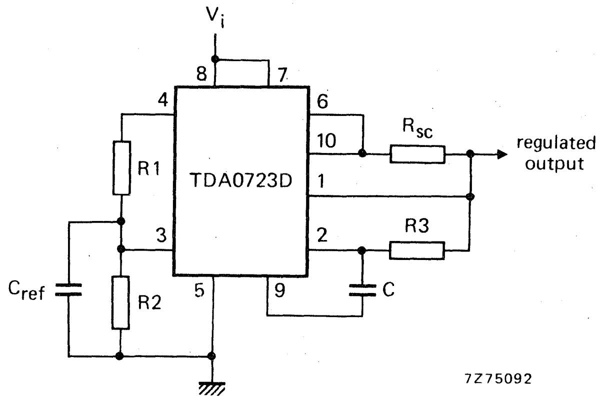
The following characteristics are at T_{amb} = 0 to +70 °C

Parameter	Conditions	Symbol	min.	typ.	max.	Unit
Line regulation	V_i = 12 to 15 V		–	–	0, 3	$\%V_o$
Load regulation	I_L = 1 to 50 mA		–	–	0, 6	$\%V_o$
Average temperature coefficient of output voltage			–	0,003	0,015	%/°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.

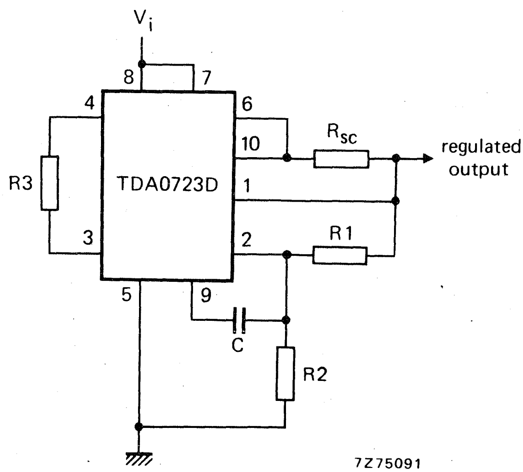
Low voltage regulator (V_O = 2 to 7 V)



$$V_O = V_{ref} \times \frac{R2}{R1+R2}$$

$$R3 = \frac{R1 \cdot R2}{R1+R2}$$ for minimum temperature drift.

High voltage regulator (V_O = 7 to 37 V)



$$V_O = V_{ref} \times \frac{R1+R2}{R2}$$

$$R3 = \frac{R1 \cdot R2}{R1+R2}$$ for minimum temperature drift

R3 may be eliminated for minimum component count.

SEVEN-TRANSISTOR ARRAYS

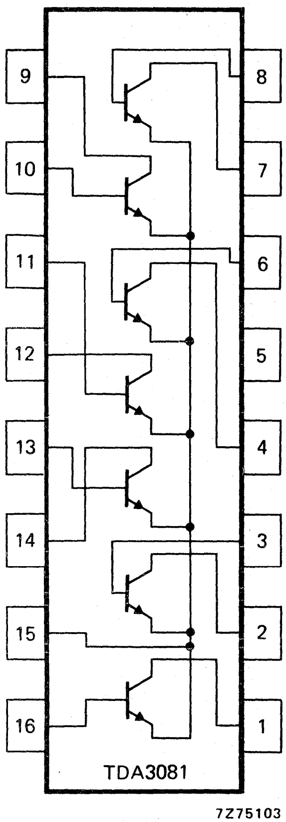
The TDA3081 and TDA3082 are monolithic integrated circuits each consisting of seven separate n-p-n transistors on a common substrate.
The transistors are capable of driving loads up to 100 mA. At the same time the transistor geometry used gives maximum current gain at quite low currents, making the devices 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.

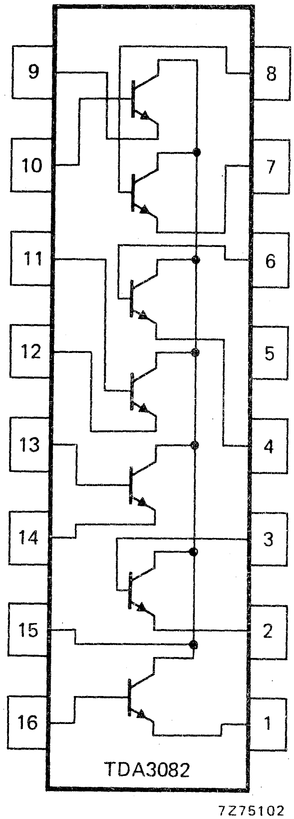
QUICK REFERENCE DATA				
Collector-base voltage (open emitter)	V_{CBO}	max.	50	V
Collector-emitter voltage (open base)	V_{CEO}	max.	35	V
Collector current (d.c.)	I_C	max.	100	mA
Power dissipation : any one transistor	P	max.	500	mW
total package	P_{tot}	max.	750	mW

CONNECTION DIAGRAMS (see page 2)

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

CONNECTION DIAGRAMS





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_{CBO}	max.	50	V
Collector-substrate voltage (open base and emitter)	V_{CSO}	max.	50	V
Emitter-base voltage (open collector)	V_{EBO}	max.	6	V

Currents

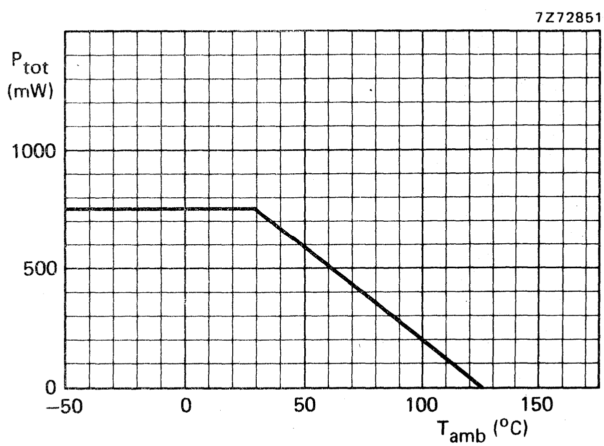
Collector current (d.c.)	I_C	max.	100	mA
Base current (d.c.)	I_B	max.	20	mA

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 °C unless otherwise specified

Collector-emitter breakdown voltage				
I_C = 1 mA; I_B = 0	$V_{(BR)CEO}$	>	35	V
Collector-substrate breakdown voltage				
I_C = 1 mA; I_B = 0; I_E = 0	$V_{(BR)CSO}$	>	50	V
Collector-base breakdown voltage				
I_C = 10 μA; I_E = 0	$V_{(BR)CBO}$	>	50	V
Emitter-base breakdown voltage				
I_E = 10 μA; I_C = 0	$V_{(BR)EBO}$	typ.	7,0	V
			6,5 to 7,5	V
D.C. current gain				
I_E = 10 μA ; V_{CE} = 5 V	h_{FE}		50 to 300	
I_E = 1 mA; V_{CE} = 5 V	h_{FE}		50 to 300	
I_E = 20 mA; V_{CE} = 5 V	h_{FE}		30 to 200	
Saturation voltage				
I_C = 5 mA; I_B = 0,5 mA	V_{CEsat}	typ.	0,2	V
		<	0,4	V
I_C = 50 mA; I_B = 5 mA	V_{CEsat}	typ.	0,4	V
		<	0,8	V

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
GI = General industrial
SpC = Special circuits
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

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