

CONSUMER TRANSISTORS & ICs

DATABOOK



1975/76

INTRODUCTION

This databook contains data sheets on the SGS-ATES range of small signal transistors and integrated circuits intended for consumer applications.

To permit ease of consultation, this book has been divided into four main sections:

General Information, Germanium Transistors, Silicon Transistors, and Integrated Circuits.

The General Information section contains definitions of symbols and terms used in order to facilitate correct technical interpretation of the data sheets, as well as an alphanumerical list of types.

The information on each product has been specially presented in order that the performance of the product can be readily evaluated within any required equipment design.

An arrow (→) at left hand side of table indicates parameter which has been modified since previous data sheet issue.

OTHER SGS-ATES DATABOOKS

Data sheets on the SGS-ATES range of discrete devices and integrated circuits for professional applications, and high power devices for professional and consumer applications can be found in the following databooks:

SGS-ATES Professional Databook 1 - Small Signal Discrete Devices

SGS-ATES Professional Databook 2 - Bipolar Digital ICs

SGS-ATES Professional Databook 3 - Linear, MOS & COS/MOS ICs

SGS-ATES Power Databook - Discrete Devices

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GENERAL INFORMATION

GERMANIUM TRANSISTORS

SILICON TRANSISTORS

INTEGRATED CIRCUITS

GENERAL INFORMATION

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1. LETTER SYMBOLS FOR SEMICONDUCTOR DEVICES

(referred to diodes, transistors and linear integrated circuits)

1.1. QUANTITY SYMBOLS

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

Examples: i , v , p

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

Examples: I , V , P

1.2. SUBSCRIPTS FOR QUANTITY SYMBOLS

- a. Total values are indicated by upper case subscripts.

Examples: I_C , i_C , V_{EB} , P_C , p_C

- b. Values of varying components are indicated by lower case subscripts.

Examples: i_c , I_c , v_{eb} , p_c , P_c

- c. To distinguish between maximum (peak), average, d.c. and root-mean-square values, it is possible to represent maximum and average values adding the subscripts m or M and respectively av or AV .

Examples: I_{cm} , I_{CM} , I_{cav} , I_{CAV}

It is possible to represent R.M.S. values by adding the subscripts (rms) and (RMS)

Examples: I_c (rms), I_C (RMS)

- d. List of subscripts (for examples see figure 1 and the fundamental symbols schedule e.)

A, a = Anode terminal

K, k = Cathode terminal

- E, e = Emitter terminal
- B, b = Base terminal
- C, c = Collector terminal
- J, j = Generic terminal
- (BR) = Primary break-down
- X, x = Specified circuit
- M, m = Maximum (peak) value
- Min, min = Minimum value
- AV, av = Average value
- (RMS), (rms) = R.M.S. value
- F, f = Forward
- R, r = As first subscript: Reverse. As second subscript: Repetitive
- O, o = As third subscript: The terminal not mentioned is open circuited
- S, s = As second subscript: Non repetitive. As third subscript: Short circuit between the terminal not mentioned and the reference terminal
- Z = Zener. (Replaces R to indicate the actual zener voltage, current or power of voltage reference or voltage regulator diodes)

e. Fundamental symbols schedule (meaning of symbol with subscript)

	i	v	p	I	V	P
e b c	instantaneous value of the variable component			R.M.S. value of the variable component, or (with appropriate supplementary subscripts) the maximum or average value (direct current) of the variable component		
E B C	instantaneous total value			average value (direct current and without signal) or (with appropriate supplementary subscripts) the total average value (with signal), or the total maximum value		

f. Examples of the application of the rules:

Figure 1 represents a transistor collector current, consisting of a direct current and a variable component as a function of time.

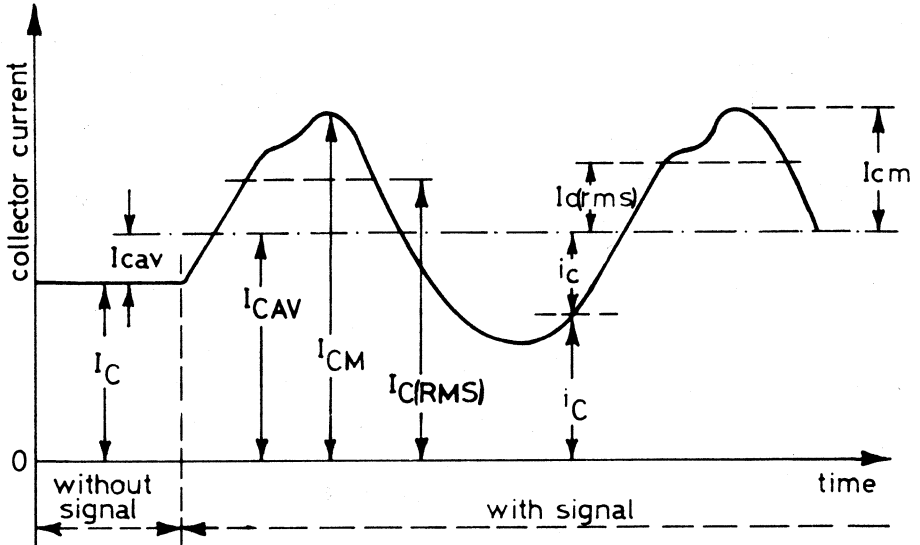


fig. 1

- I_C - DC value, no signal
- I_{CAV} - Average total value
- I_{CM} - Maximum total value
- $I_{C(RMS)}$ - R.M.S. total value
- I_{cav} - Average value of the variable component
- $I_{c(rms)}$ - R.M.S. value of the variable component
- I_{cm} - Maximum value of the variable component
- i_C - Instantaneous total value
- i_c - Instantaneous value of the variable component

1.3. CONVENTIONS FOR SUBSCRIPT SEQUENCE

a. Currents

For transistor the first subscript indicates the terminal carrying the current (conventional current flow from the external circuit into the terminal is positive).

Instead for diodes a forward current (conventional current flow into the

anode terminal) is represented by the subscript F or f; a reverse current (conventional current flow out of the anode terminal) is represented by the subscript R or r.

b. Voltages

For transistors normally, two subscripts are used to indicate the points between which the voltage is measured. The first subscript indicates one terminal point and the second the reference terminal.

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

Instead for diodes a forward voltage (anode positive with respect to cathode) is represented by the subscript F or f and a reverse voltage (anode negative with respect to cathode) by the subscript R or r.

c. Supply voltages

Supply voltages may be indicated by repeating the terminal subscript.

Examples: V_{EE} , V_{CC} , V_{BB}

The reference terminal may then be indicated by a third subscript.

Examples: V_{EEB} , V_{CCB} , V_{BBC}

d. In devices having more than one terminal of the same type, the terminal subscripts are modified by adding a number following the subscript and on the same line.

Example: V_{B_2-E} voltage between second base and emitter

In multiple unit devices, the terminal subscripts are modified by a number preceding the terminal subscripts:

Example: V_{1B-2B} voltage between the base of the first unit and that of the second one.

1.4. ELECTRICAL PARAMETER SYMBOLS

a. 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 the appropriate subscripts.

Examples: h_{ib} , Z_{fb} , Y_{oc} , h_{FE}

Note: The symbol of the capacitances that is represented by the upper case (C) is an exception to this rule.

b. The four pole matrix parameters of external circuits and of circuits in which the device forms only a part are represented by the upper case symbols with the appropriate subscripts.

Examples: H_i , Z_o , H_F , Y_R

1.5. SUBSCRIPTS FOR PARAMETER SYMBOLS

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

Examples: h_{IB} , h_{FE}

Note: The static value is the slope of the line from the origin to the operating point on the appropriate characteristic curve, i.e. the quotient of the appropriate electrical quantities at the operating point.

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

Examples: h_{ib} , Z_{ob}

- c. 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

Examples: $V_1 = h_i I_1 + h_r V_2$

$I_2 = h_f I_1 + h_o V_2$

Notes

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

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

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

- d. The second subscript identifies the circuit configuration.

e = common emitter

b = common base

c = common collector

j = common terminal, general

Examples: (common base)

$$I_1 = y_{ib} V_{1b} + y_{rb} V_{2b}$$

$$I_2 = y_{fb} V_{1b} + y_{ob} V_{2b}$$

When the common terminal is understood, the second subscript may be omitted.

- e. If it is necessary to distinguish between real and imaginary parts of the four pole parameters, the following notations may be used.

$\text{Re}(h_{ib})$ etc... for the real part

$\text{Im}(h_{ib})$ etc... for the imaginary part

2. ALPHABETICAL LIST OF SYMBOLS

AMR	Amplitude modulation rejection
B	Bandwidth
b_{fb}	Common-base, forward transfer susceptance (output short-circuited, y matrix)
b_{fe}	Common-emitter, forward transfer susceptance (output short-circuited, y matrix)
b_{ib}	Common-base, input susceptance (output short-circuited, y matrix)
b_{ie}	Common-emitter, input susceptance (output short-circuited, y matrix)
b_{ob}	Common-base, output susceptance (input short-circuited, y matrix)
b_{oe}	Common-emitter, output susceptance (input short-circuited, y matrix)
b_{rb}	Common-base, reverse transfer susceptance (input short-circuited, y matrix)
b_{re}	Common-emitter, reverse transfer susceptance (input short-circuited, y matrix)
$C_{b'c}$	Intrinsic base-collector capacitance
$C_{b'e}$	Intrinsic base-emitter capacitance
C_{CBO}	Collector-base capacitance (emitter open to a.c. and d.c.)
C_{CSS}	Collector-substrate capacitance (emitter and base open to a.c. and d.c.)
C_{EBO}	Emitter-base capacitance (collector open to a.c. and d.c.)
C_i	Input capacitance
C_{ib}	Common-base, input capacitance (output a.c. short-circuited, h and y matrix)
C_{ibo}	Common-base, input capacitance (output a.c. open-circuited)
C_{ie}	Common-emitter, input capacitance (output a.c. short-circuited, h and y matrix)
C_L	Load capacitance
CMRR	Common mode rejection ratio
C_o	Output capacitance

C_{ob}	Common-base, output capacitance (input a.c. short-circuited, y matrix)
C_{obo}	Common-base, output capacitance (input a.c. open-circuited, h matrix)
C_{oe}	Common-emitter, output capacitance (input a.c. short-circuited, y matrix)
C_{oeo}	Common-emitter, output capacitance (input a.c. open-circuited, h matrix)
C_{rb}	Common-base, reverse capacitance (input a.c. short-circuited, y matrix)
C_{re}	Common-emitter, reverse capacitance (input a.c. short-circuited, y matrix)
d	Distortion
e_N	Noise voltage
$E_{s/b}$	Second breakdown energy (with base-emitter junction reverse biased)
f	Frequency
δf	Frequency change or drift
Δf	Frequency deviation
$\frac{\delta f}{\Delta T} \left(\frac{\Delta f}{\Delta T} \right)$	Frequency drift with temperature variation
$\frac{\delta f}{\Delta V} \left(\frac{\Delta f}{\Delta V} \right)$	Frequency drift with voltage variation
f_{hfb}	Common-base, cut-off frequency
f_{hfe}	Common-emitter, cut-off frequency
f_m	Modulation frequency
f_{max}	Maximum oscillator frequency
f_T	Transition frequency
f_{yfe}	Common-emitter cut-off frequency
G_A	Available power gain
G_{AM}	Maximum available power gain
g_{fb}	Common-base, forward transconductance (input short-circuited, y matrix)

g_{fe}	Common-emitter, forward transconductance (input short-circuited, y matrix)
g_{ib}	Common-base, input conductance (output short-circuited, y matrix)
g_{ie}	Common-emitter, input conductance (output short-circuited, y matrix)
g_{ob}	Common-base, output conductance (input short-circuited, y matrix)
g_{oe}	Common-emitter, output conductance (input short-circuited, y matrix)
G_p	Power gain
G_{pb}	Common-base, power gain
G_{pe}	Common-emitter, power gain
G_{pM}	Maximum power gain
g_{rb}	Common-base, reverse transconductance (input short-circuited, y matrix)
g_{re}	Common-emitter, reverse transconductance (input short-circuited, y matrix)
G_{SM}	Maximum stable power gain
G_{tr}	Transducer power gain
G_U	Unilateralized power gain
G_{UM}	Maximum unilateralized power gain
G_v	Voltage gain
h_{fb}	Common-base, small-signal value of the short-circuit forward current transfer ratio
h_{fe}	Common-emitter, small-signal value of the short-circuit forward current transfer ratio
h_{FE}	Common-emitter, static value of the forward current transfer ratio
h_{FE1}/h_{FE2}	Common-emitter, static value of the forward current transfer matched pair ratio
h_{ib}	Common-base, small-signal value of the short-circuit input impedance
h_{ie}	Common-emitter, small-signal value of the short-circuit input impedance
h_{ob}	Common-base, small-signal value of the open-circuit output admittance
h_{oe}	Common-emitter, small-signal value of the open-circuit output admittance

h_{rb}	Common-base, small-signal value of the open-circuit reverse voltage transfer ratio
h_{re}	Common-emitter, small-signal value of the open-circuit reverse voltage transfer ratio
I_b	Bias current
I_B	Base current
I_{B1}	Turn-on current
I_{B2}	Turn-off current
$ I_{B1} - I_{B2} $	Input offset current
I_{BF}	Base forward current
I_{BFM}	Base forward peak current
I_{BM}	Base peak current
I_{BR}	Base reverse current
I_{BRM}	Base reverse peak current
I_C	Collector current
I_{CBO}	Collector cut-off current with emitter open
I_{CBV}	Collector cut-off current with specified reverse voltage between emitter and base
I_{CEO}	Collector cut-off current with base open
I_{CER}	Collector cut-off current with specified resistance between emitter and base
I_{CES}	Collector cut-off current with emitter short-circuited to base
I_{CEV}	Collector cut-off current with specified reverse voltage between emitter and base
I_{CEX}	Collector cut-off current with specified circuit between emitter and base
I_{CM}	Collector peak current
I_d	Drain current
I_E	Emitter current
I_{EBO}	Emitter cut-off current with collector open
i_N	Noise current
I_o	Output current
I_s	Supply current

I_{sc}	Output current during output short-circuit
$I_{s/b}$	Second breakdown collector current (with base-emitter junction forward biased)
I_z	Zener current
m	Modulation factor
NF	Noise figure
NF _c	Conversion noise figure
P_o	Output power of a specified circuit
PRT	Power ratio test
P_{tot}	Total power dissipation
$r_{bb'}$	Base spreading resistance
$r_{bb'}C_{b'c}$	Feedback time constant
R_{BB}	Base dropping resistance
R_{BE}	Resistance between base and emitter
R_{CC}	Collector dropping resistance
R_{EE}	Emitter dropping resistance
R_g	Internal resistance of generator
R_i	Input resistance
R_L	Load resistance
R_o	Output resistance
R_{th}	Thermal resistance
$R_{th\ j-amb}$ ($R_{th\ j-a}$)	Thermal resistance junction-to-ambient
$R_{th\ j-case}$ ($R_{th\ j-c}$)	Thermal resistance junction-to-case
r_z	Dynamic zener resistance
$\frac{S+N}{N}$	Signal and noise to noise ratio
SR	Slew rate
SVR	Supply voltage rejection
t	Time
T_{amb} (T_a)	Ambient temperature
T_{case} (T_c)	Case temperature
t_d	Delay time

t_f	Fall time
T_j	Junction temperature
T_l	Lead temperature
t_{off}	Turn-off-time
t_{on}	Turn-on-time
T_{op}	Operating temperature
t_p	Pulse time
t_r	Rise time
t_s	Storage time
$T_{stg} (T_s)$	Storage temperature
$\frac{\Delta V}{\Delta T}$	Voltage drift with temperature variation
$\frac{\Delta V}{V}$	Relative voltage variation
V_{BE}	Base-emitter voltage
$V_{BE (sat)}$	Base-emitter saturation voltage
$V_{BE1} - V_{BE2}$	Base-emitter voltage difference
$ V_{BE1} - V_{BE2} $	Input offset voltage
$\frac{ V_{BE1} - V_{BE2} }{\Delta T}$	Input-offset voltage temperature coefficient
$V_{(BR) CBO}$	Collector-base breakdown voltage with emitter open
$V_{(BR) CEO}$	Collector-emitter breakdown voltage with base open
$V_{(BR) CER}$	Collector-emitter breakdown voltage with specified resistance
$V_{(BR) CES}$	Collector-emitter breakdown voltage with emitter short-circuited to base
$V_{(BR) CEV}$	Collector-emitter breakdown voltage with specified reverse voltage between emitter and base
$V_{(BR) CSSO}$	Collector-substrate voltage with base and emitter open
$V_{(BR) EBO}$	Emitter-base breakdown voltage with collector open
V_{CB}	Collector-base voltage
V_{CBO}	Collector-base voltage with emitter open
V_{CBV}	Collector-base voltage with specified reverse voltage between emitter and base
V_{CE}	Collector-emitter voltage

V_{CEK}	Knee voltage at specified condition
$V_{CEK (HF)}$	High frequency knee voltage at specified condition
V_{CEO}	Collector-emitter voltage with base open
$V_{CEO (sus)}$	Collector-emitter sustaining voltage with base open
V_{CER}	Collector-emitter voltage with specified resistance between emitter and base
$V_{CER (sus)}$	Collector-emitter sustaining voltage with specified resistance between emitter and base
$V_{CE (sat)}$	Collector-emitter saturation voltage
V_{CES}	Collector-emitter voltage with emitter short-circuited to base
$V_{CES (sus)}$	Collector-emitter sustaining voltage with emitter short-circuited to base
V_{CEV}	Collector-emitter voltage with specified reverse voltage between emitter and base
$V_{CEV (sus)}$	Collector-emitter sustaining voltage with specified reverse voltage between emitter and base
V_{CEX}	Collector-emitter voltage with specified circuit between emitter and base
$V_{CEX (sus)}$	Collector-emitter sustaining voltage with specified circuit between emitter and base
V_{CSS}	Collector-substrate voltage
V_{EB}	Emitter-base voltage
V_{EBO}	Emitter-base voltage with collector open
V_i	Input voltage of a specified circuit
$V_{i(threshold)}$	Input limiting voltage
V_{int}	Interfering voltage
V_o	Output voltage of a specified circuit
V_{pp}	Peak-to-peak voltage
V_{pt}	Punch-through voltage
V_{ref}	Reference voltage
V_s	Supply voltage
V_z	Zener voltage
y_{fb}	Common-base, small-signal value of the short-circuit forward transfer admittance

Y_{fe}	Common-emitter, small-signal value of the short-circuit forward transfer admittance
Y_{ib}	Common-base, small-signal value of the short-circuit input admittance
Y_{ie}	Common-emitter, small-signal value of the short-circuit input admittance
Y_{ob}	Common-base, small-signal value of the short-circuit output admittance
Y_{oe}	Common-emitter, small-signal value of the short-circuit output admittance
Y_{rb}	Common-base, small-signal value of the short-circuit reverse transfer admittance
Y_{re}	Common-emitter, small-signal value of the short-circuit reverse transfer admittance
Z_{BE}	Impedance between base and emitter
Z_i	Input impedance
Z_o	Output impedance
η	Efficiency
η_C	Collector efficiency
τ_s	Storage time constant
ϕ_{fb}	Common-base, phase angle of the forward transadmittance (output short-circuited, y matrix)
ϕ_{fe}	Common-emitter, phase angle of the forward transadmittance (output short-circuited, y matrix)
ϕ_{ib}	Common-base, phase angle of the input admittance (output short-circuited, y matrix)
ϕ_{ie}	Common-emitter, phase angle of the input admittance (output short-circuited, y matrix)
ϕ_{ob}	Common-base, phase angle of the output admittance (input short-circuited, y matrix)
ϕ_{oe}	Common-emitter, phase angle of the output admittance (input short-circuited, y matrix)
ϕ_{rb}	Common-base, phase angle of the reverse transadmittance (input short-circuited, y matrix)
ϕ_{re}	Common-emitter, phase angle of the reverse transadmittance (input short-circuited, y matrix)

3. RATING SYSTEMS FOR ELECTRONIC DEVICES

3.1. DEFINITIONS OF TERMS USED

- a. **Electronic device.** An electronic tube or valve, transistor or other semiconductor device.
Note: This definition excludes inductors, capacitors, resistors and similar components.
- b. **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.
- c. **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.
- d. **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.
- e. **Rating system.** The set of principles upon which ratings are established and which determines 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.

3.2. 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.

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.

3.3. 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.

3.4. 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.

The Absolute Maximum Rating System is commonly used for semiconductor devices.

4. TYPE DESIGNATION CODE

4.1. FOR DISCRETE DEVICES

The type number for "discrete" semiconductor devices consists of:
TWO LETTERS FOLLOWED BY A SERIAL NUMBER

The first letter gives information about the **material** used for the active part of the devices:

- A Material with a band gap of 0.6 to 1.0eV, such as germanium
- B Material with a band gap of 1.0 to 1.3eV, such as silicon
- C Material with a band gap of 1.3eV and more, such as gallium arsenide
- D Material with a band gap of less than 0.6eV, such as indium antimonide
- R Compound material as employed in Hall generators and photoconductive cells, such as cadmium-sulphide, lead-selenide

The second letter indicates the **function** according with the applications and the construction:

- A Detection diode, switching diode, mixer diode
- B Variable capacitance diode
- C Transistor for a.f. applications ($R_{th} j\text{-case} > 15^{\circ}\text{C/W}$)
- D Power transistor for a.f. applications ($R_{th} j\text{-case} \leq 15^{\circ}\text{C/W}$)
- E Tunnel diode
- F Transistor for h.f. applications ($R_{th} j\text{-case} > 15^{\circ}\text{C/W}$)
- G Multiple of dissimilar devices (1); Miscellaneous
- H Magnetic sensitive diode; Field probe
- K Hall generator in an open magnetic circuit, e.g. magnetogram or signal probe
- L Power transistor for h.f. applications ($R_{th} j\text{-case} \leq 15^{\circ}\text{C/W}$)
- M Hall generator in a closed electrically energised magnetic circuit, e.g. Hall modulator or multiplier
- P Radiation sensitive device
- Q Radiation generating device
- R Electrically triggered controlling and switching device having a breakdown characteristic ($R_{th} j\text{-case} > 15^{\circ}\text{C/W}$)
- S Transistor for switching applications ($R_{th} j\text{-case} > 15^{\circ}\text{C/W}$)
- T Electrically, or by means of light, triggered controlling and switching power device having a breakdown characteristic ($R_{th} j\text{-case} \leq 15^{\circ}\text{C/W}$)
- U Power transistor for switching applications ($R_{th} j\text{-case} \leq 15^{\circ}\text{C/W}$)
- X Multiplier diode, e.g. varactor, step recovery diode
- Y Rectifying diode, booster diode, efficiency diode
- Z Voltage reference or voltage regulator diode

1) A multiple device is defined as a combination of similar or dissimilar active devices, contained in a common encapsulation that cannot be dismantled, and of which all electrodes of the individual devices are accessible from the outside.

Multiples of similar devices as well as multiples consisting of a main device and an auxiliary device are designated according to the code for the discrete devices described above.

Multiples of dissimilar devices of other nature are designated by the second letter G.

The serial number is formed by:

Three figures for semiconductor devices which are primarily intended for use in domestic equipment.

Two figures and a letter (this letter starts back from z through y, x, etc. bears no signification).

Version letter

A version letter can be used, for instance, for a diode with up-rated voltage, for a sub-division of a transistor type in different gain ranges, a low noise version of an existing transistor and for a diode, transistor, or thyristor with minor mechanical differences, such as finish of the leads, length of the leads etc. The letters never have a fixed meaning, the only exception being the letter R which indicates reverse polarity.

Examples

BC 107 Silicon low power audio frequency transistor primarily intended for domestic equipment

BUY 46 Silicon power transistor for switching applications in professional equipment

4.2. FOR INTEGRATED CIRCUITS

4.2.1. Types designated by three letters and three figures

The integrated circuits are divided in four groups:

- digital types belonging to a family of circuits;
- digital solitary circuits;
- analogue circuits including linear circuits;
- mixed analogue/digital circuits.

Digital Family Types

First two letters:	family
Third letter:	circuit function
First two figures:	serial number
Third figure:	operating ambient temperature

Digital Solitary Types

First letter:	"S"
Second letter:	extension of serial number
Third letter:	circuit function
First two figures:	serial number
Third figure:	operating ambient temperature range

Analogue (Linear) Types

First letter:	"T"
Second and third letter:	extension of serial number
First two figures:	serial number
Third figure:	operating ambient temperature range

Mixed Digital/Analogue Types

First letter:	"U"
Second and third letter:	extension of serial number
First two figures:	serial number
Third figure:	operating ambient temperature range

Function

- H Combinatorial circuit
- J Bistable or multistable sequential circuit
- K Monostable sequential circuit
- L Level converter
- N Bi-metastable or multi-metastable sequential circuit
- Q Read-write memory circuit
- R Read only memory circuit
- S Sense amplifier with digital output
- Y Miscellaneous

Operating ambient temperature range

- 1 0 to + 70 °C
- 2 —55 to + 125 °C
- 3 —10 to + 85 °C
- 4 +15 to + 55 °C
- 5 —25 to + 70 °C
- 6 —40 to + 85 °C

0 It means no temperature range indicated in the type number

If a circuit is published for a wider temperature range, but does not qualify for a higher classification, the figure indicating the narrower temperature range is used.

Version letter

A version letter can be added to a type number of an existing type to indicate a different version of the same type, for instance, encapsulated

in another package, with other interconnections or showing minor differences in ratings or electrical characteristics. The letter **Z** is used to indicate a type with discretionary wiring.

4.2.2. Types designated by three letters and four figures

The serial number can be a four figure number assigned by Pro Electron or the serial number of an existing company number.

The first two letters:

A. FAMILY CIRCUITS

The **FIRST TWO LETTERS** give information about the family of circuits. These letters can be FA...FZ, GA...GZ, HA... etc.

B. SOLITARY CIRCUITS

The **FIRST LETTER** divides the solitary circuits into:

S Solitary digital circuits

T Analogue circuits

U Mixed analogue/digital circuits

The **SECOND LETTER** is a serial letter without any further significance.

The third letter indicates the operational temperature range or another significant characteristic.

The letters **B** thru **F** give information about the temperature range (note 1):

B 0 °C to + 70 °C

C -55 °C to + 125 °C

D -25 °C to + 70 °C

E -25 °C to + 85 °C

F -40 °C to + 85 °C

Other "third" letters refer to electrical or mechanical versions of a family and have no fixed meaning. If no temperature range or another characteristic is indicated, the letter **A** is used as a third letter.

The serial number can be either a 4 figure number assigned by Pro Electron or the serial number (also numbers comprising letters) of an existing company type designation. Company serial numbers of less than 4 figures are completed to a 4 figure number by "0" 's in front of the number.

A version letter can be used to indicate a deviation of a single characteristic of a type, either electrically or mechanically. The letter never has a fixed meaning, the only exception being the letter **Z**, indicating "custom-wired" devices.

Note 1: If a circuit is published for a wider temperature range, but does not qualify for a higher classification, the letter indicating the narrower temperature range is used.

ALPHA-NUMERICAL LIST OF TYPES

Type	Page	Type	Page	Type	Page
AF 106	3	* BC 394	93	* M 252	217
AF 109 R	5	BC 440	95	* M 253	229
AF 139	7	BC 441	95	SAJ 210	241
AF 239	9	BC 460	99	TAA 550	247
AF 239 S	11	BC 461	99	TAA 611 A	253
BC 107	15	BC 477	103	TAA 611 B	265
BC 108	15	BC 478	103	TAA 611 C	275
BC 109	15	BC 479	103	TAA 630 S	289
BC 113	23	BF 155	111	TAA 661	295
BC 114	23	BF 158	115	TBA 231	303
BC 115	25	BF 160	117	TBA 271	247
BC 116 A	27	BF 161	119	TBA 311	309
BC 119	29	BF 166	121	TBA 331	315
BC 125	31	BF 167	123	TBA 435	323
BC 125 B	31	BF 173	129	TBA 625 A	331
BC 126	35	BF 222	135	TBA 625 B	339
BC 132	37	BF 233	137	TBA 625 C	347
BC 139	39	BF 234	137	TBA 641 A	355
BC 140	43	BF 257	139	TBA 641 B	365
BC 141	43	BF 258	139	TBA 651	375
BC 153	47	BF 259	139	TBA 780	379
BC 154	47	BF 271	143	TBA 800	387
BC 160	51	BF 272 A	147	TBA 810 S	399
BC 161	51	BF 273	153	TBA 810 AS	399
BC 177	55	BF 274	157	TBA 820	411
BC 178	55	BF 287	159	TCA 511	419
BC 179	55	BF 288	163	* TCA 830 S	427
BC 204	63	BF 316 A	167	TCA 900	439
BC 205	63	* BF 324	171	TCA 910	439
BC 206	63	BF 454	175	* TCA 940	447
BC 207	67	BF 455	179	* TCA 940 E	459
BC 208	67	* BF 457	183	* TDA 440	471
BC 209	67	* BF 458	183	* TDA 1054	481
BC 225	71	* BF 459	183	* TDA 1170	495
BC 297	73	BF 479	187	* TDA 1190	507
BC 298	73	* BF 506	191	TDA 1200	519
BC 300	77	* BF 509	195	* TDA 1270	527
BC 301	77	BF 516	199	* TDA 1405	539
BC 302	77	* BF 657	203	* TDA 1410	549
BC 303	83	* BF 658	203	* TDA 1412	563
BC 304	83	* BF 659	203	* TDA 1415	573
BC 377	87	* BF 679	207	* TDA 1420	583
BC 378	87	* BF 679 M	207	* TDA 2010	597
* BC 393	91	* BF 680	211	* TDA 2020	611

* new type

GERMANIUM TRANSISTORS

GERMANIUM MESA PNP

VHF MIXER/OSCILLATOR

The AF 106 is a germanium mesa PNP transistor in a Jedec TO-72 metal case. It is particularly designed for use as preamplifier mixer and oscillator up to 260 MHz.

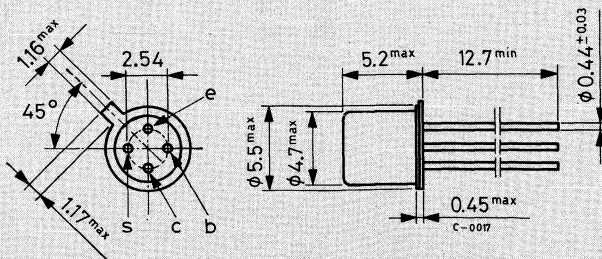
ABSOLUTE MAXIMUM RATINGS

V_{CBO}	Collector-base voltage ($I_E = 0$)	-25	V
V_{CEO}	Collector-emitter voltage ($I_B = 0$)	-18	V
V_{EBO}	Emitter-base voltage ($I_C = 0$)	-0.3	V
I_C	Collector current	-10	mA
P_{tot}	Total power dissipation at $T_{amb} \leq 45^\circ\text{C}$	60	mW
	at $T_{case} \leq 66^\circ\text{C}$	60	mW
T_{stg}	Storage temperature	-30 to 75	$^\circ\text{C}$
T_j	Junction temperature	90	$^\circ\text{C}$

MECHANICAL DATA

Dimensions in mm

Shield lead connected to case



TO-72

AF 106

THERMAL DATA

$R_{th\ j-case}$	Thermal resistance junction-case	max	400	°C/W
$R_{th\ j-amb}$	Thermal resistance junction-ambient	max	750	°C/W

ELECTRICAL CHARACTERISTICS ($T_{case} = 25\text{ °C}$ unless otherwise specified)

Parameter	Test conditions	Min.	Typ.	Max.	Unit
I_{CBO} Collector cutoff current ($I_E = 0$)	$V_{CB} = -12\text{ V}$			-10	μA
$V_{(BR)\ CBO}$ Collector-base breakdown voltage ($I_E = 0$)	$I_C = -100\ \mu\text{A}$	-25			V
$V_{(BR)\ CEO}$ Collector-emitter breakdown voltage ($I_B = 0$)	$I_C = -500\ \mu\text{A}$	-18			V
$V_{(BR)\ EBO}$ Emitter-base breakdown voltage ($I_C = 0$)	$I_E = -100\ \mu\text{A}$	-0.3			V
V_{BE} Base-emitter voltage	$I_C = -1\text{ mA}$ $V_{CE} = -12\text{ V}$ $I_C = -2\text{ mA}$ $V_{CE} = -6\text{ V}$	-0.25	-0.325	-0.38	V
h_{FE} DC current gain	$I_C = -1\text{ mA}$ $V_{CE} = -12\text{ V}$ $I_C = -2\text{ mA}$ $V_{CE} = -6\text{ V}$	20	50	70	—
f_T Transition frequency	$I_C = -1\text{ mA}$ $V_{CE} = -12\text{ V}$ $f = 100\text{ MHz}$		220		MHz
$-C_{re}$ Reverse capacitance	$I_C = -1\text{ mA}$ $V_{CE} = -12\text{ V}$ $f = 450\text{ kHz}$		0.45		pF
NF Noise figure	$I_C = -1\text{ mA}$ $V_{CE} = -12\text{ V}$ $R_g = 60\ \Omega$ $f = 200\text{ MHz}$		5.5	7.5	dB
$r_{bb}, C_{b'c}$ Feedback time constant	$I_C = -1\text{ mA}$ $V_{CE} = -12\text{ V}$ $f = 2.5\text{ MHz}$		6		ps
G_{pb} Power gain	$I_C = -3\text{ mA}$ $V_{CB} = -10\text{ V}$ $R_L = 920\ \Omega$ $f = 200\text{ MHz}$	14	17.5		dB

AF 109R

GERMANIUM MESA PNP

VHF PREAMPLIFIER

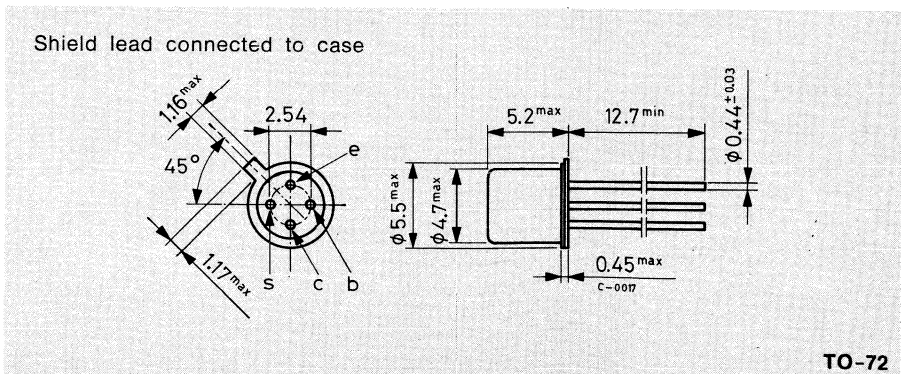
The AF 109R is a germanium mesa PNP transistor in a Jedec TO-72 metal case. It is designed for use in AGC prestages up to 260 MHz.

ABSOLUTE MAXIMUM RATINGS

V_{CBO}	Collector-base voltage ($I_E = 0$)	-20 V
V_{CEO}	Collector-emitter voltage ($I_B = 0$)	-15 V
V_{EBO}	Emitter-base voltage ($I_C = 0$)	-0.3 V
I_C	Collector current	-10 mA
P_{tot}	Total power dissipation at $T_{amb} \leq 45^\circ\text{C}$	60 mW
	at $T_{case} \leq 66^\circ\text{C}$	60 mW
T_{stg}	Storage temperature	-30 to 75 $^\circ\text{C}$
T_j	Junction temperature	90 $^\circ\text{C}$

MECHANICAL DATA

Dimensions in mm



AF 109R

THERMAL DATA

$R_{th\ j-case}$	Thermal resistance junction-case	max	400	°C/W
$R_{th\ j-amb}$	Thermal resistance junction-ambient	max	750	°C/W

ELECTRICAL CHARACTERISTICS ($T_{case} = 25\text{ °C}$ unless otherwise specified)

Parameter	Test conditions	Min.	Typ.	Max.	Unit
I_{CBO}	Collector cutoff current ($I_E = 0$) $V_{CB} = -20\text{ V}$	-0.5		-8	μA
I_{CEO}	Collector cutoff current ($I_B = 0$) $V_{CE} = -15\text{ V}$			-500	μA
I_{EBO}	Emitter cutoff current ($I_C = 0$) $V_{EB} = -0.3\text{ V}$			-100	μA
V_{BE}	Base-emitter voltage $I_C = -1.5\text{ mA}$ $V_{CE} = -12\text{ V}$ $I_C = -2\text{ mA}$ $V_{CE} = -6\text{ V}$	-320	-380	-430	mV
h_{FE}	DC current gain $I_C = -1.5\text{ mA}$ $V_{CE} = -12\text{ V}$ $I_C = -2\text{ mA}$ $V_{CE} = -6\text{ V}$	20	50	55	—
$-C_{re}$	Reverse capacitance $I_C = -1\text{ mA}$ $V_{CE} = -12\text{ V}$ $f = 450\text{ kHz}$		0.25		pF
NF	Noise figure $I_C = -2\text{ mA}$ $V_{CE} = -12\text{ V}$ $R_g = 60\ \Omega$ $f = 200\text{ MHz}$			4.8	dB
G_{db}	Power gain $I_C = -2\text{ mA}$ $V_{CE} = -12\text{ V}$ $R_L = 920\ \Omega$ $R_{EE} = 1\text{ k}\Omega$ $f = 200\text{ MHz}$	13	16.5		dB

GERMANIUM MESA PNP

UHF AMPLIFIER

The AF 139 is a germanium mesa PNP transistor in a Jedec TO-72 metal case. It is particularly designed for use in prestages as well as in mixer and oscillator stages up to 860 MHz.

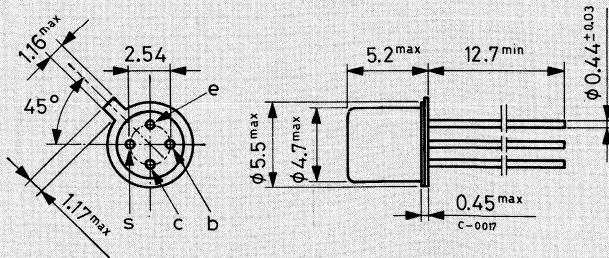
ABSOLUTE MAXIMUM RATINGS

V_{CBO}	Collector-base voltage ($I_E = 0$)	-22 V
V_{CEO}	Collector-emitter voltage ($I_B = 0$)	-15 V
V_{EBO}	Emitter-base voltage ($I_C = 0$)	-0.3 V
I_E	Emitter current	11 mA
I_C	Collector current	-10 mA
P_{tot}	Total power dissipation at $T_{amb} \leq 45^\circ\text{C}$	60 mW
	at $T_{case} \leq 66^\circ\text{C}$	60 mW
T_{stg}	Storage temperature	-30 to 75 °C
T_j	Junction temperature	90 °C

MECHANICAL DATA

Dimensions in mm

Shield lead connected to case



TO-72

AF 139

THERMAL DATA

$R_{th\ j-case}$	Thermal resistance junction-case	max	400	°C/W
$R_{th\ j-amb}$	Thermal resistance junction-ambient	max	750	°C/W

ELECTRICAL CHARACTERISTICS (T_{case} = 25 °C unless otherwise specified)

Parameter		Test conditions	Min.	Typ.	Max.	Unit
I_{CBO}	Collector cutoff current ($I_E = 0$)	$V_{CB} = -22\text{ V}$			-8	μA
I_{CEO}	Collector cutoff current ($I_B = 0$)	$V_{CE} = -15\text{ V}$			-500	μA
I_{EBO}	Emitter cutoff current ($I_C = 0$)	$V_{EB} = -0.3\text{ V}$			-100	μA
h_{FE}	DC current gain	$I_C = -1.5\text{ mA}$ $V_{CE} = -12\text{ V}$	10	50		—
f_T	Transition frequency	$I_C = -1.5\text{ mA}$ $V_{CE} = -12\text{ V}$ $f = 100\text{ MHz}$		550		MHz
$-C_{re}$	Reverse capacitance	$I_C = -1.5\text{ mA}$ $V_{CE} = -12\text{ V}$ $f = 100\text{ kHz}$		0.25		pF
NF	Noise figure	$I_C = -1.5\text{ mA}$ $V_{CE} = -12\text{ V}$ $R_g = 60\ \Omega$ $f = 800\text{ MHz}$		7	8.2	dB
$r_{bb'}$, $C_{b'c}$	Feedback time constant	$I_C = -1.5\text{ mA}$ $V_{CE} = -12\text{ V}$ $f = 2.5\text{ MHz}$		3		ps
G_{ob}	Power gain	$I_C = -1.5\text{ mA}$ $V_{CE} = -12\text{ V}$ $R_L = 1.4\text{ k}\Omega$ $f = 800\text{ MHz}$	9	11		dB

GERMANIUM MESA PNP

UHF PREAMPLIFIER

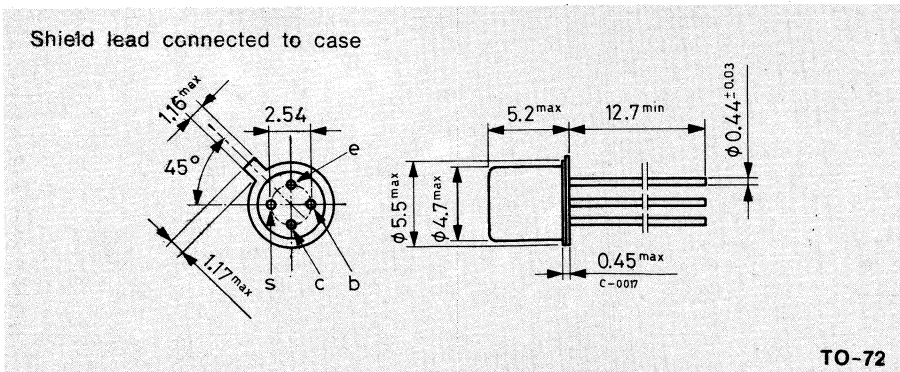
The AF 239 is a germanium mesa PNP transistor in a Jedec TO-72 metal case. It is particularly designed as preamplifier mixer and oscillator up to 900 MHz.

ABSOLUTE MAXIMUM RATINGS

V_{CES}	Collector-emitter voltage ($V_{BE} = 0$)	-20 V
V_{CEO}	Collector-emitter voltage ($I_B = 0$)	-15 V
V_{EBO}	Emitter-base voltage ($I_C = 0$)	-0.3 V
I_C	Collector current	-10 mA
P_{tot}	Total power dissipation at $T_{amb} \leq 45^\circ\text{C}$	60 mW
	at $T_{case} \leq 66^\circ\text{C}$	60 mW
T_{stg}	Storage temperature	-30 to 75 °C
T_j	Junction temperature	90 °C

MECHANICAL DATA

Dimensions in mm



AF 239

THERMAL DATA

$R_{th\ j-case}$	Thermal resistance junction-case	max	400	°C/W
$R_{th\ j-amb}$	Thermal resistance junction-ambient	max	750	°C/W

ELECTRICAL CHARACTERISTICS (T_{case} = 25 °C unless otherwise specified)

Parameter	Test conditions	Min.	Typ.	Max.	Unit
I_{CES}	Collector cutoff current ($V_{BE} = 0$)			-8	μA
I_{CEO}	Collector cutoff current ($I_B = 0$)			-500	μA
I_{EBO}	Emitter cutoff current ($I_C = 0$)			-100	μA
V_{BE}	Base-emitter voltage	$I_C = -2\text{ mA}$ $I_C = -5\text{ mA}$	$V_{CE} = -10\text{ V}$ $V_{CE} = -5\text{ V}$	-350 -400	mV mV
h_{FE}	DC current gain	$I_C = -2\text{ mA}$ $I_C = -5\text{ mA}$	$V_{CE} = -10\text{ V}$ $V_{CE} = -5\text{ V}$	10 30	— —
f_T	Transition frequency	$I_C = -2\text{ mA}$ $f = 100\text{ MHz}$	$V_{CE} = -10\text{ V}$	700	MHz
$-C_{re}$	Reverse capacitance	$I_C = -2\text{ mA}$ $f = 450\text{ kHz}$	$V_{CE} = -10\text{ V}$	0.23	pF
NF	Noise figure	$I_C = -2\text{ mA}$ $R_g = 60\ \Omega$	$V_{CE} = -10\text{ V}$ $f = 800\text{ MHz}$	5	6 dB
G_{bb}	Power gain	$I_C = -2\text{ mA}$ $R_L = 2\text{ k}\Omega$	$V_{CE} = -10\text{ V}$ $f = 800\text{ MHz}$	11	14 dB

AF 239S

GERMANIUM MESA PNP

UHF PREAMPLIFIER

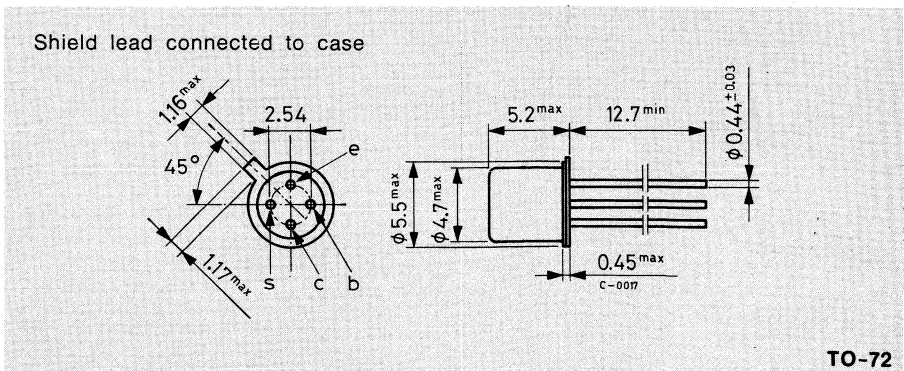
The AF 239S is a germanium mesa PNP transistor in a Jedec TO-72 metal case. It is particularly designed as preamplifier, mixer and oscillator up to 900 MHz.

ABSOLUTE MAXIMUM RATINGS

V_{CES}	Collector-emitter voltage ($V_{BE} = 0$)	-20	V
V_{CEO}	Collector-emitter voltage ($I_B = 0$)	-15	V
V_{EBO}	Emitter-base voltage ($I_C = 0$)	-0.3	V
I_C	Collector current	-10	mA
P_{tot}	Total power dissipation at $T_{amb} \leq 45^\circ\text{C}$	60	mW
	at $T_{case} \leq 66^\circ\text{C}$	60	mW
T_{stg}	Storage temperature	-30 to 75	$^\circ\text{C}$
T_j	Junction temperature	90	$^\circ\text{C}$

MECHANICAL DATA

Dimensions in mm



AF 239S

THERMAL DATA

$R_{th\ j-case}$	Thermal resistance junction-case	max	400	°C/W
$R_{th\ j-amb}$	Thermal resistance junction-ambient	max	750	°C/W

ELECTRICAL CHARACTERISTICS ($T_{case} = 25\text{ °C}$ unless otherwise specified)

Parameter	Test conditions	Min.	Typ.	Max.	Unit
I_{CES}	Collector cutoff current ($V_{BE} = 0$)			-8	μA
I_{CEO}	Collector cutoff current ($I_B = 0$)			-500	μA
I_{EBO}	Emitter cutoff current ($I_C = 0$)			-100	μA
V_{BE}	Base-emitter voltage	$I_C = -2\text{ mA}$ $I_C = -5\text{ mA}$	$V_{CE} = -10\text{ V}$ $V_{CE} = -5\text{ V}$	-350 -400	mV mV
h_{FE}	DC current gain	$I_C = -2\text{ mA}$ $I_C = -5\text{ mA}$	$V_{CE} = -10\text{ V}$ $V_{CE} = -10\text{ V}$	10 30	— —
f_T	Transition frequency	$I_C = -2\text{ mA}$ $f = 100\text{ MHz}$	$V_{CE} = -10\text{ V}$ $V_{CE} = -10\text{ V}$	780	MHz
$-C_{re}$	Reverse capacitance	$I_C = -2\text{ mA}$ $f = 450\text{ kHz}$	$V_{CE} = -10\text{ V}$	0.2	pF
NF	Noise figure	$I_C = -1\text{ mA}$ $R_g = 60\ \Omega$ $f = 800\text{ MHz}$	$V_{CE} = -10\text{ V}$	5	dB
G_{pb}	Power gain	$I_C = -2\text{ mA}$ $R_L = 2\text{ k}\Omega$ $f = 800\text{ MHz}$	$V_{CE} = -10\text{ V}$ $R_g = 60\ \Omega$	12.5 15	dB

SILICON TRANSISTORS

BC 107
BC 108
BC 109

SILICON PLANAR NPN

LOW NOISE GENERAL PURPOSE AUDIO AMPLIFIERS

The BC 107, BC 108 and BC 109 are silicon planar epitaxial NPN transistors in TO-18 metal case. They are suitable for use in driver stages, low noise input stages and signal processing circuits of television receivers.

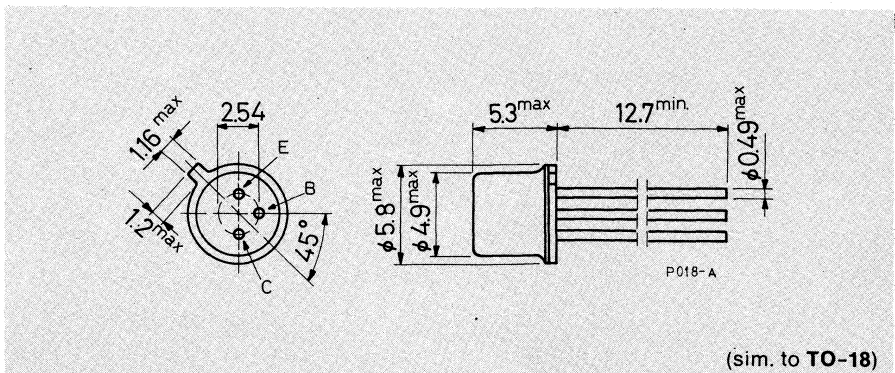
The complementary PNP types are respectively the BC 177, BC 178 and BC 179.

ABSOLUTE MAXIMUM RATINGS

		BC 107	BC 108	BC 109
V_{CBO}	Collector-base voltage ($I_E = 0$)	50 V	30 V	30 V
V_{CEO}	Collector-emitter voltage ($I_B = 0$)	45 V	20 V	20 V
V_{EBO}	Emitter-base voltage ($I_C = 0$)	6 V	5 V	5 V
I_C	Collector current	100 mA		
P_{tot}	Total power dissipation at $T_{amb} \leq 25^\circ\text{C}$ at $T_{case} \leq 25^\circ\text{C}$	0.3 W		
		0.75 W		
T_{stg}	Storage temperature	-55 to 175 °C		
T_j	Junction temperature	175 °C		

MECHANICAL DATA

Dimensions in mm



BC 107 BC 108 BC 109

THERMAL DATA

$R_{th\ j-case}$	Thermal resistance junction-case	max	200	°C/W
$R_{th\ j-amb}$	Thermal resistance junction-ambient	max	500	°C/W

ELECTRICAL CHARACTERISTICS ($T_{amb} = 25\text{°C}$ unless otherwise specified)

Parameter	Test conditions	Min.	Typ.	Max.	Unit
I_{CBO} Collector cutoff current ($I_E = 0$)	for BC 107 $V_{CB} = 40\text{ V}$ $V_{CB} = 40\text{ V}$ $T_{amb} = 150\text{°C}$ for BC 108 - BC 109 $V_{CB} = 20\text{ V}$ $V_{CB} = 20\text{ V}$ $T_{amb} = 150\text{°C}$			15 15 15 15	nA μA nA μA
$V_{(BR)CBO}$ Collector-base breakdown voltage ($I_E = 0$)	$I_C = 10\ \mu\text{A}$ for BC 107 for BC 108 for BC 109	50 30 30			V V V
$V_{(BR)CEO}$ *Collector-emitter breakdown voltage ($I_B = 0$)	$I_C = 10\text{ mA}$ for BC 107 for BC 108 for BC 109	45 20 20			V V V
$V_{(BR)EBO}$ Emitter-base breakdown voltage ($I_C = 0$)	$I_E = 10\ \mu\text{A}$ for BC 107 for BC 108 for BC 109	6 5 5			V V V
$V_{CE(sat)*}$ Collector-emitter saturation voltage	$I_C = 10\text{ mA}$ $I_B = 0.5\text{ mA}$ $I_C = 100\text{ mA}$ $I_B = 5\text{ mA}$		70 200	250 600	mV mV
V_{BE}^* Base-emitter voltage	$I_C = 2\text{ mA}$ $V_{CE} = 5\text{ V}$ $I_C = 10\text{ mA}$ $V_{CE} = 5\text{ V}$	550	650 700	700 770	mV mV
$V_{BE(sat)*}$ Base-emitter saturation voltage	$I_C = 10\text{ mA}$ $I_B = 0.5\text{ mA}$ $I_C = 100\text{ mA}$ $I_B = 5\text{ mA}$		750 900		mV mV

BC 107
BC 108
BC 109

ELECTRICAL CHARACTERISTICS (continued)

Parameter	Test conditions	Min.	Typ.	Max.	Unit		
h_{FE}^* DC current gain	$I_C = 2 \text{ mA}$ $V_{CE} = 5 \text{ V}$ for BC 107 for BC 107 Gr. A for BC 107 Gr. B for BC 108 for BC 108 Gr. A for BC 108 Gr. B for BC 108 Gr. C for BC 109 for BC 109 Gr. B for BC 109 Gr. C $I_C = 10 \mu\text{A}$ $V_{CE} = 5 \text{ V}$ for BC 107 for BC 107 Gr. A for BC 107 Gr. B for BC 108 for BC 108 Gr. A for BC 108 Gr. B for BC 108 Gr. C for BC 109 for BC 109 Gr. B for BC 109 Gr. C	110	230	450	—		
		110	180	220	—		
		200	290	450	—		
		110	350	800	—		
		110	180	220	—		
		200	290	450	—		
		420	520	800	—		
		200	350	800	—		
		200	290	450	—		
		420	520	800	—		
					120	—	
					90	—	
				40	150	—	
					120	—	
					90	—	
				40	150	—	
				100	270	—	
			70	210	—		
			40	150	—		
			100	270	—		
h_{fe} Small signal current gain	$I_C = 2 \text{ mA}$ $V_{CE} = 5 \text{ V}$ $f = 1 \text{ kHz}$ for BC 107 for BC 107 Gr. A for BC 107 Gr. B for BC 108 for BC 108 Gr. A for BC 108 Gr. B for BC 108 Gr. C for BC 109 for BC 109 Gr. B for BC 109 Gr. C $I_C = 10 \text{ mA}$ $V_{CE} = 10 \text{ V}$ $f = 100 \text{ MHz}$			250	—		
				190	—		
				300	—		
				370	—		
				190	—		
				300	—		
				500	—		
				370	—		
				300	—		
				550	—		
					2	—	
		C_{CBO} Collector-base capacitance	$I_E = 0$ $V_{CB} = 10 \text{ V}$ $f = 1 \text{ MHz}$		4	6	pF

* Pulsed: pulse duration = 300 μs , duty factor = 1%

BC 107
BC 108
BC 109

ELECTRICAL CHARACTERISTICS (continued)

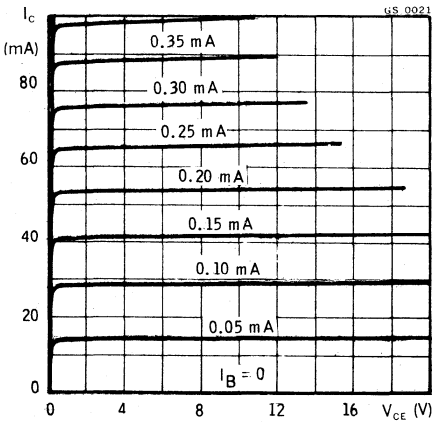
Parameter		Test conditions	Min.	Typ.	Max.	Unit
C_{EBO}	Emitter-base capacitance	$I_C = 0$ $V_{EB} = 0.5 V$ $f = 1 \text{ MHz}$		11.5		pF
NF	Noise figure	$I_C = 0.2 \text{ mA}$ $V_{CE} = 5 V$ $R_g = 2 \text{ k}\Omega$ $f = 1 \text{ kHz}$ $B = 200 \text{ Hz}$ for BC 107 for BC 108 for BC 109 $I_C = 0.2 \text{ mA}$ $V_{CE} = 5 V$ $R_g = 2 \text{ k}\Omega$ $f = 10 \text{ Hz to } 10 \text{ kHz}$ $B = 15.7 \text{ kHz}$ for BC 109		2 2 1.5 1.5	10 10 4 4	dB dB dB dB
h_{ie}	Input impedance	$I_C = 2 \text{ mA}$ $V_{CE} = 5 V$ $f = 1 \text{ kHz}$ for BC 107 for BC 107 Gr. A for BC 107 Gr. B for BC 108 for BC 108 Gr. A for BC 108 Gr. B for BC 108 Gr. C for BC 109 for BC 109 Gr. B for BC 109 Gr. C		4 3 4.8 5.5 3 4.8 7 5.5 4.8 7		k Ω k Ω k Ω k Ω k Ω k Ω k Ω k Ω k Ω k Ω
h_{re}	Reverse voltage ratio	$I_C = 2 \text{ mA}$ $V_{CE} = 5 V$ $f = 1 \text{ kHz}$ for BC 107 for BC 107 Gr. A for BC 107 Gr. B for BC 108 for BC 108 Gr. A for BC 108 Gr. B for BC 108 Gr. C for BC 109 for BC 109 Gr. B for BC 109 Gr. C		2.2×10^{-4} 1.7×10^{-4} 2.7×10^{-4} 3.1×10^{-4} 1.7×10^{-4} 2.7×10^{-4} 3.8×10^{-4} 3.1×10^{-4} 2.7×10^{-4} 3.8×10^{-4}		— — — — — — — — — —

BC 107
BC 108
BC 109

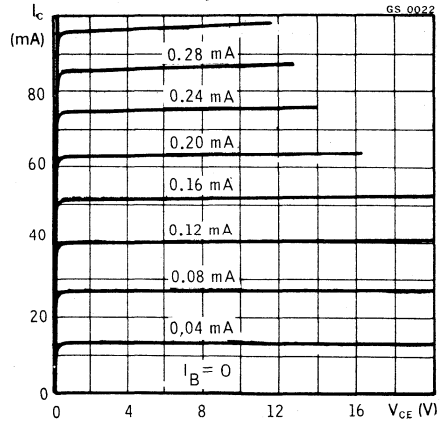
ELECTRICAL CHARACTERISTICS (continued)

Parameter	Test conditions	Min.	Typ.	Max.	Unit
h_{oe} Output admittance	$I_C = 2 \text{ mA}$ $V_{CE} = 5 \text{ V}$ $f = 1 \text{ kHz}$				
	for BC 107		20		μS
	for BC 107 Gr. A		13		μS
	for BC 107 Gr. B		26		μS
	for BC 108		30		μS
	for BC 108 Gr. A		13		μS
	for BC 108 Gr. B		26		μS
	for BC 108 Gr. C		34		μS
	for BC 109		30		μS
	for BC 109 Gr. B		26		μS
for BC 109 Gr. C		34		μS	

Typical output characteristics
(for **BC 107** only)

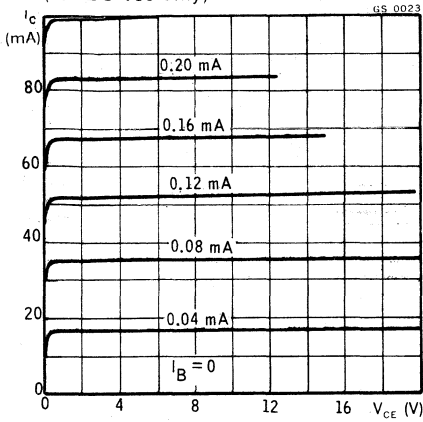


Typical output characteristics
(for **BC 108** only)

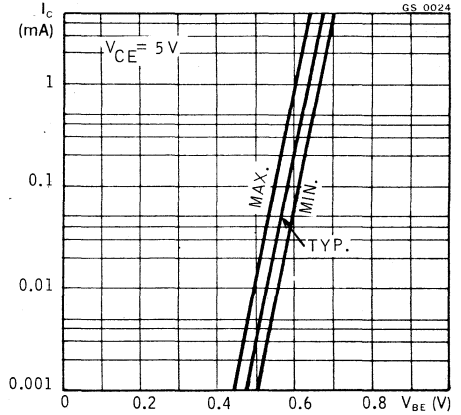


BC 107 BC 108 BC 109

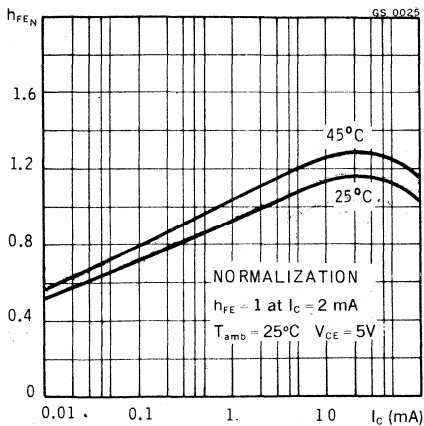
Typical output characteristics
(for BC 109 only)



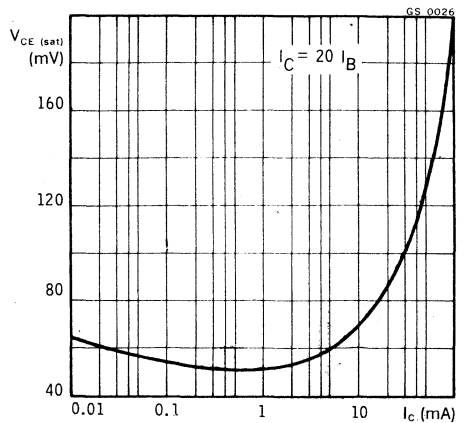
DC transconductance



DC normalized current gain

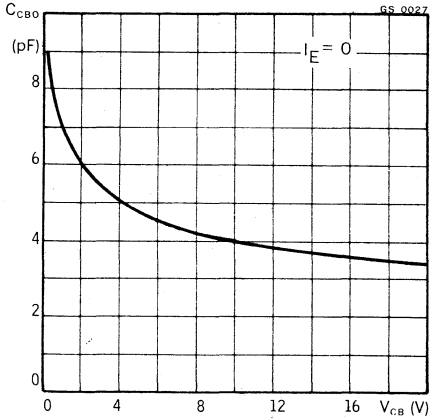


Collector-emitter saturation voltage

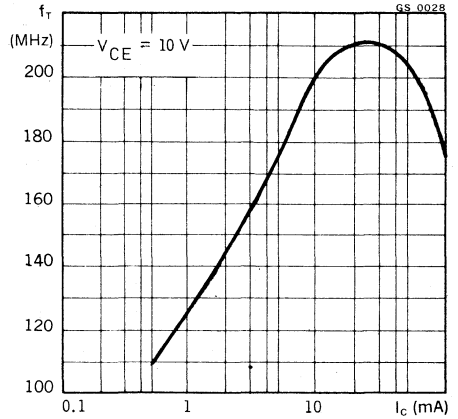


BC 107
BC 108
BC 109

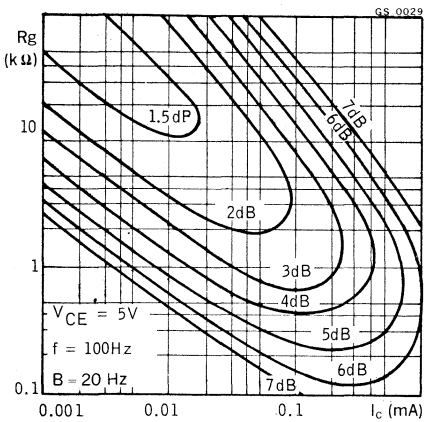
Collector-base capacitance



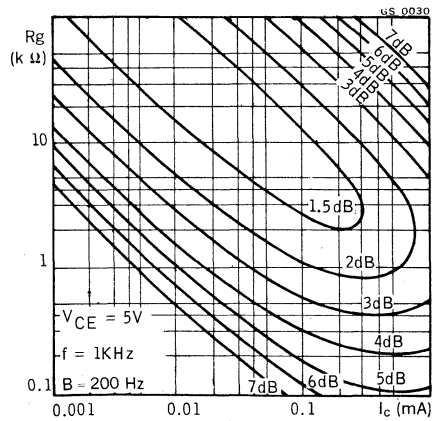
Transition frequency



Noise figure (for BC 109 only)

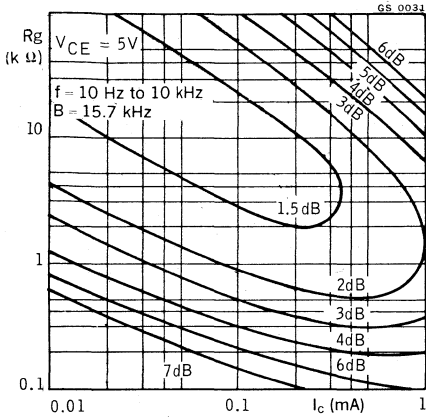


Noise figure (for BC 109 only)

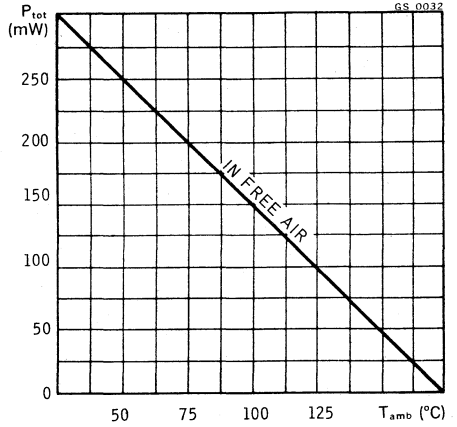


BC 107
BC 108
BC 109

Noise figure (for BC 109 only)



Power rating chart



BC 113
BC 114

SILICON PLANAR NPN

HIGH GAIN, LOW NOISE AUDIO AMPLIFIERS

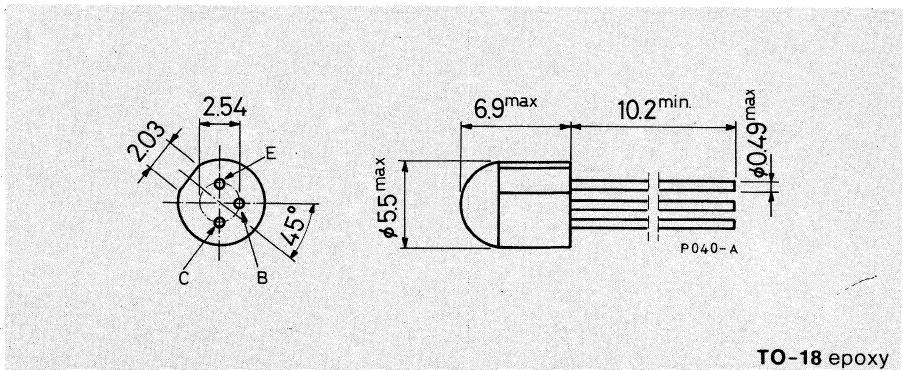
The BC 113 and BC 114 are silicon planar NPN transistors in TO-18 epoxy package. They are specifically designed for use in low-noise audio preamplifiers.

ABSOLUTE MAXIMUM RATINGS

V_{CB0}	Collector-base voltage ($I_E = 0$)	30 V
V_{CEO}	Collector-emitter voltage ($I_B = 0$)	30 V
V_{EBO}	Emitter-base voltage ($I_C = 0$)	6 V
I_C	Collector current	50 mA
P_{tot}	Total power dissipation at $T_{amb} \leq 25^\circ\text{C}$ at $T_{case} \leq 25^\circ\text{C}$	200 mW 500 mW
T_{stg}	Storage temperature	-55 to 125 °C
T_j	Junction temperature	125 °C

MECHANICAL DATA

Dimensions in mm



BC 113 BC 114

THERMAL DATA

$R_{th\ j-case}$	Thermal resistance junction-case	max	200	°C/W
$R_{th\ j-amb}$	Thermal resistance junction-ambient	max	500	°C/W

ELECTRICAL CHARACTERISTICS ($T_{amb} = 25\text{ °C}$ unless otherwise specified)

Parameter	Test conditions	Min.	Typ.	Max.	Unit
I_{CES} Collector cutoff current ($V_{BE} = 0$)	$V_{CE} = 20\text{ V}$ $V_{CE} = 20\text{ V}$ $T_{amb} = 65\text{ °C}$			50 5	nA μA
$V_{(BR)CEO}$ *Collector-emitter breakdown voltage ($I_B = 0$)	$I_C = 10\text{ mA}$	30			V
$V_{(BR)CBO}$ Collector-base breakdown voltage ($I_E = 0$)	$I_C = 10\text{ }\mu\text{A}$	30			V
$V_{(BR)EBO}$ Emitter-base breakdown voltage ($I_C = 0$)	$I_E = 10\text{ }\mu\text{A}$	6			V
V_{BE} Base-emitter voltage	$I_C = 1\text{ mA}$ $V_{CE} = 5\text{ V}$	0.64	0.7		V
h_{FE} DC current gain	$I_C = 10\text{ }\mu\text{A}$ $V_{CE} = 5\text{ V}$ $I_C = 100\text{ }\mu\text{A}$ $V_{CE} = 5\text{ V}$ $I_C = 1\text{ mA}$ $V_{CE} = 5\text{ V}$ $I_C = 10\text{ mA}$ $V_{CE} = 5\text{ V}$ for BC 113 for BC 114	120 200	170 250 1000		— — — — —
f_T Transition frequency	$I_C = 1\text{ mA}$ $V_{CE} = 5\text{ V}$ for BC 113 for BC 114	60 70	100 100		MHz MHz
C_{CBO} Collector-base capacitance	$I_E = 0$ $V_{CB} = 5\text{ V}$	2.7	4		pF
NF Noise figure	$I_C = 10\text{ }\mu\text{A}$ $V_{CE} = 5\text{ V}$ $R_g = 10\text{ k}\Omega$ $f = 1\text{ kHz}$ $B = 200\text{ Hz}$ for BC 113 for BC 114		2.5 1.5	3	dB dB

* Pulsed: pulse duration = 300 μs , duty factor = 1%

SILICON PLANAR NPN**AUDIO DRIVER**

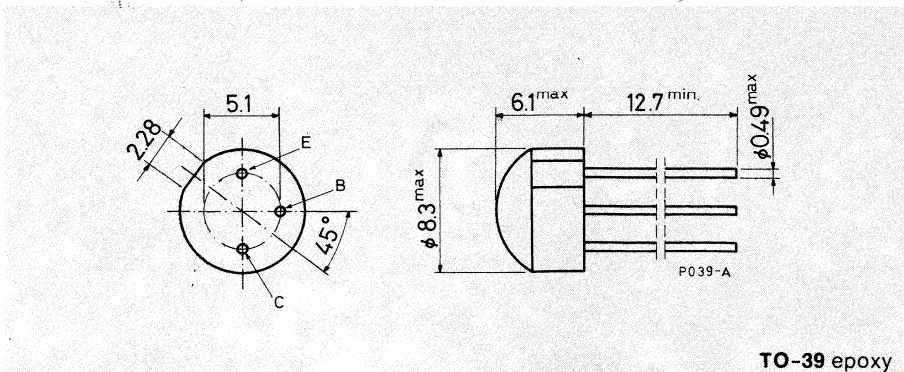
The BC 115 is a silicon planar epitaxial NPN transistor in a TO-39 epoxy package. It is particularly suited for use in audio driver circuits.

ABSOLUTE MAXIMUM RATINGS

V_{CB0}	Collector-base voltage ($I_E = 0$)	40	V
V_{CE0}	Collector-emitter voltage ($I_B = 0$)	30	V
V_{EB0}	Emitter-base voltage ($I_C = 0$)	5	V
I_C	Collector current	200	mA
P_{tot}	Total power dissipation at $T_{amb} \leq 25^\circ\text{C}$	0.3	W
	at $T_{case} \leq 25^\circ\text{C}$	0.8	W
T_{stg}	Storage temperature	-55 to 125	$^\circ\text{C}$
T_j	Junction temperature	125	$^\circ\text{C}$

MECHANICAL DATA

Dimensions in mm



BC 115

THERMAL DATA

$R_{th\ j-case}$	Thermal resistance junction-case	max	125	°C/W
$R_{th\ j-amb}$	Thermal resistance junction-ambient	max	330	°C/W

ELECTRICAL CHARACTERISTICS ($T_{amb} = 25\text{ °C}$ unless otherwise specified)

Parameter	Test conditions	Min.	Typ.	Max.	Unit
I_{CBO} Collector cutoff current ($I_E = 0$)	$V_{CB} = 20\text{ V}$ $V_{CB} = 20\text{ V}$ $T_{amb} = 65\text{ °C}$			100 5	nA μA
$V_{(BR)\ CBO}$ Collector-base breakdown voltage ($I_E = 0$)	$I_C = 100\ \mu\text{A}$	40			V
$V_{(BR)\ CEO}$ *Collector-emitter breakdown voltage ($I_B = 0$)	$I_C = 30\text{ mA}$	30			V
$V_{(BR)\ EBO}$ Emitter-base breakdown voltage ($I_C = 0$)	$I_C = 10\ \mu\text{A}$	5			V
$V_{CE(sat)}$ * Collector-emitter saturation voltage	$I_C = 100\text{ mA}$ $I_B = 10\text{ mA}$		0.4	1	V
V_{BE} Base-emitter voltage	$I_C = 10\text{ mA}$ $V_{CE} = 10\text{ V}$ $I_C = 100\text{ mA}$ $V_{CE} = 10\text{ V}$		0.65 0.75		V V
$V_{BE(sat)}$ * Base-emitter saturation voltage	$I_C = 100\text{ mA}$ $I_B = 10\text{ mA}$		0.8	0.9	V
h_{FE} * DC current gain	$I_C = 100\ \mu\text{A}$ $V_{CE} = 10\text{ V}$ $I_C = 1\text{ mA}$ $V_{CE} = 10\text{ V}$ $I_C = 10\text{ mA}$ $V_{CE} = 10\text{ V}$ $I_C = 100\text{ mA}$ $V_{CE} = 10\text{ V}$		95 50 145 100 170 400 50 150		— — — —
f_T Transition frequency	$I_C = 10\text{ mA}$ $V_{CE} = 10\text{ V}$		80		MHz
C_{CBO} Collector-base capacitance	$I_E = 0$ $V_{CB} = 10\text{ V}$ $f = 1\text{ MHz}$		12	25	pF

* Pulsed: pulse duration = 300 μs , duty factor = 1%

BC 116A

SILICON PLANAR PNP

GENERAL PURPOSE TRANSISTOR

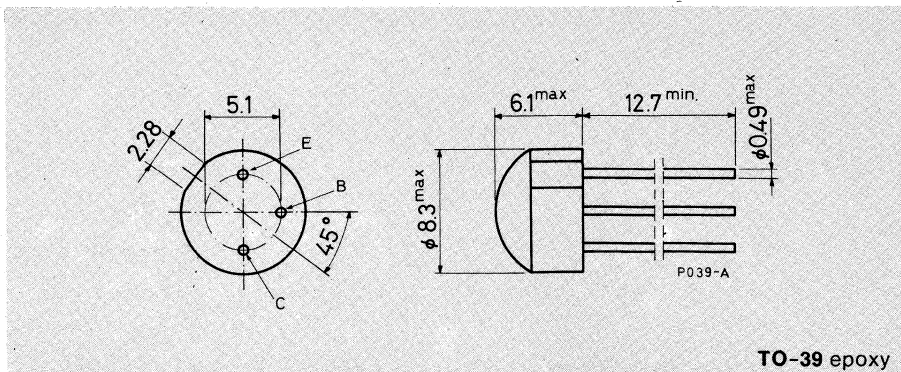
The BC 116A is a silicon planar epitaxial PNP transistor in a TO-39 epoxy package. It is designed as general purpose device for application over a wide range of collector current.

ABSOLUTE MAXIMUM RATINGS

V_{CBO}	Collector-base voltage ($I_E = 0$)	-45	V
V_{CEO}	Collector-emitter voltage ($I_B = 0$)	-40	V
V_{EBO}	Emitter-base voltage ($I_C = 0$)	-5	V
I_C	Collector current	-500	mA
P_{tot}	Total power dissipation at $T_{amb} \leq 25^\circ\text{C}$	0.3	W
	at $T_{case} \leq 25^\circ\text{C}$	0.8	W

MECHANICAL DATA

Dimensions in mm



BC 116A

THERMAL DATA

$R_{th\ j-case}$	Thermal resistance junction-case	max	125	°C/W
$R_{th\ j-amb}$	Thermal resistance junction-ambient	max	330	°C/W

ELECTRICAL CHARACTERISTICS ($T_{amb} = 25\text{ °C}$ unless otherwise specified)

Parameter	Test conditions	Min.	Typ.	Max.	Unit
I_{CBO} Collector cutoff current ($I_E = 0$)	$V_{CB} = -20\text{ V}$ $V_{CB} = -20\text{ V}$ $T_{amb} = 75\text{ °C}$			-100 -10	nA μA
$V_{(BR)\ CBO}$ Collector-base breakdown voltage ($I_E = 0$)	$I_C = -10\ \mu\text{A}$	-45			V
$V_{(BR)\ CEO}^*$ Collector-emitter breakdown voltage ($I_B = 0$)	$I_C = -10\text{ mA}$	-40			V
$V_{(BR)\ EBO}$ Emitter-base breakdown voltage ($I_C = 0$)	$I_C = -10\ \mu\text{A}$	-5			V
$V_{CE\ (sat)}^*$ Collector-emitter saturation voltage	$I_C = -50\text{ mA}$ $I_B = -5\text{ mA}$ $I_C = -150\text{ mA}$ $I_B = -15\text{ mA}$			-0.25 -0.40	V V
V_{BE}^* Base-emitter voltage	$I_C = -10\text{ mA}$ $V_{CE} = -10\text{ V}$ $I_C = -50\text{ mA}$ $V_{CE} = -1\text{ V}$		-0.70 -0.75		V V
$V_{BE\ (sat)}^*$ Base-emitter saturation voltage	$I_C = -50\text{ mA}$ $I_B = -5\text{ mA}$ $I_C = -150\text{ mA}$ $I_B = -15\text{ mA}$		-0.80 -1		V V
h_{FE} DC current gain	$I_C = -100\ \mu\text{A}$ $V_{CE} = -10\text{ V}$ $I_C = -10\text{ mA}$ $V_{CE} = -1\text{ V}$ $I_C = -50\text{ mA}$ $V_{CE} = -1\text{ V}$ $I_C = -150\text{ mA}$ $V_{CE} = -10\text{ V}$	30	90		— — — —
f_T Transition frequency	$I_C = -30\text{ mA}$ $V_{CE} = -10\text{ V}$	130	200		MHz
C_{CBO} Collector-base capacitance	$I_E = 0$ $V_{CB} = -10\text{ V}$ $f = 1\text{ MHz}$			5	10 pF

* Pulsed: pulse duration = 300 μs , duty factor = 1%

BC 119

SILICON PLANAR NPN

AUDIO OUTPUT AMPLIFIER

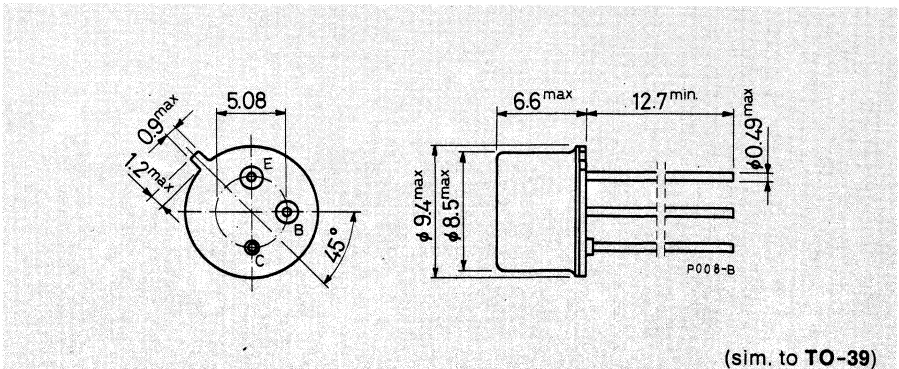
The BC 119 is a silicon planar epitaxial NPN transistor in a TO-39 metal case. It is suitable for 1 W class "A" and up to 6 W class "B" audio output stages and is available as a pair 2 BC 119.

ABSOLUTE MAXIMUM RATINGS

V_{CBO}	Collector-base voltage ($I_E = 0$)	60	V
V_{CEO}	Collector-emitter voltage ($I_B = 0$)	30	V
V_{EBO}	Emitter-base voltage ($I_C = 0$)	5	V
P_{tot}	Total power dissipation at $T_{amb} \leq 25^\circ\text{C}$	0.8	W
	at $T_{case} \leq 25^\circ\text{C}$	5	W
	at $T_{case} \leq 100^\circ\text{C}$	2.8	W
T_{stg}	Storage temperature	-55 to 200	$^\circ\text{C}$
T_j	Junction temperature	200	$^\circ\text{C}$

MECHANICAL DATA

Dimensions in mm



BC 119

THERMAL DATA

$R_{th\ j-case}$	Thermal resistance junction-case	max	35	°C/W
$R_{th\ j-amb}$	Thermal resistance junction-ambient	max	220	°C/W

ELECTRICAL CHARACTERISTICS ($T_{amb} = 25\text{ °C}$ unless otherwise specified)

Parameter	Test conditions	Min.	Typ.	Max.	Unit
I_{CBO} Collector cutoff current ($I_E = 0$)	$V_{CB} = 40\text{ V}$ $V_{CB} = 40\text{ V}$ $T_{amb} = 150\text{ °C}$			100 20	nA μA
$V_{(BR)\ CBO}$ Collector-base breakdown voltage ($I_E = 0$)	$I_C = 100\ \mu\text{A}$	60			V
$V_{CEO(sus)}$ * Collector-emitter sustaining voltage ($I_B = 0$)	$I_C = 30\text{ mA}$	30			V
$V_{(BR)\ EBO}$ Emitter-base breakdown voltage ($I_C = 0$)	$I_E = 100\ \mu\text{A}$	5			V
$V_{CE(sat)}$ * Collector-emitter saturation voltage	$I_C = 150\text{ mA}$ $I_B = 15\text{ mA}$ $I_C = 500\text{ mA}$ $I_B = 50\text{ mA}$ $I_C = 1\text{ A}$ $I_B = 100\text{ mA}$		0.15 0.4 0.8	0.35 1.1 1.5	V V V
V_{BE} * Base-emitter voltage	$I_C = 500\text{ mA}$ $V_{CE} = 10\text{ V}$ $I_C = 150\text{ mA}$ $V_{CE} = 1\text{ V}$		1 0.85	1.8 1	V V
$V_{BE(sat)}$ * Base-emitter saturation voltage	$I_C = 150\text{ mA}$ $I_B = 15\text{ mA}$ $I_C = 1\text{ A}$ $I_B = 0.1\text{ A}$		0.9 1.4	1.2 2	V V
h_{FE} * DC current gain	$I_C = 50\text{ mA}$ $V_{CE} = 1\text{ V}$ $I_C = 150\text{ mA}$ $V_{CE} = 1\text{ V}$ $I_C = 500\text{ mA}$ $V_{CE} = 10\text{ V}$	40 40 25	100 90 60		— — —
h_{FE1}/h_{FE2} Matched pair	$I_C = 300\text{ mA}$ $V_{CE} = 5\text{ V}$			1.4	—
f_T Transition frequency	$I_C = 50\text{ mA}$ $V_{CE} = 10\text{ V}$	40			MHz
C_{CBO} Collector-base capacitance	$I_E = 0$ $V_{CB} = 10\text{ V}$		12	25	pF

* Pulsed: pulse duration = 300 μs , duty factor = 1%

BC 125
BC 125B

SILICON PLANAR NPN

AUDIO DRIVERS

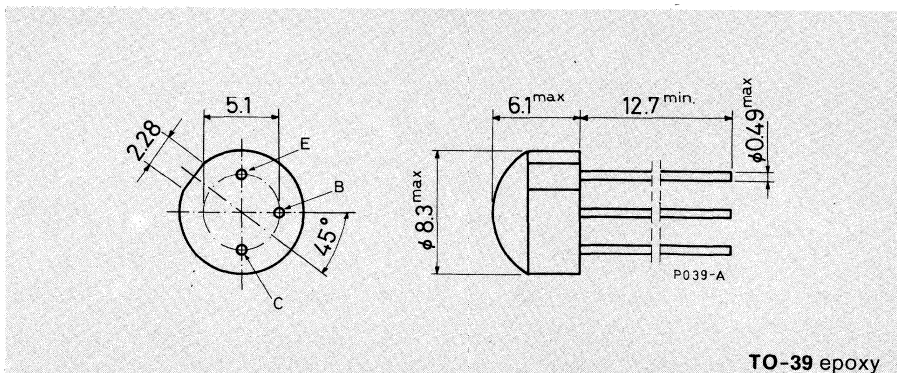
The BC 125 and BC 125 B are silicon planar epitaxial NPN transistors in TO-39 epoxy package. They are designed for use as audio drivers.

ABSOLUTE MAXIMUM RATINGS

		BC 125	BC 125 B
V_{CBO}	Collector-base voltage ($I_E = 0$)	50 V	60 V
V_{EBO}	Emitter-base voltage ($I_C = 0$)	5 V	6 V
V_{CEO}	Collector-emitter voltage ($I_B = 0$)	30 V	
I_C	Collector current	0.5 A	
P_{tot}	Total power dissipation at $T_{amb} \leq 25^\circ\text{C}$ at $T_{case} \leq 25^\circ\text{C}$	0.3 W	
		0.8 W	
T_{stg}	Storage temperature	-55 to 125 °C	
T_j	Junction temperature	125 °C	

MECHANICAL DATA

Dimensions in mm



BC 125 BC 125B

THERMAL DATA

$R_{th\ j-case}$	Thermal resistance junction-case	max	125	°C/W
$R_{th\ j-amb}$	Thermal resistance junction-ambient	max	330	°C/W

ELECTRICAL CHARACTERISTICS ($T_{amb} = 25\text{ °C}$ unless otherwise specified)

Parameter	Test conditions	Min.	Typ.	Max.	Unit
I_{CBO} Collector cutoff current ($I_E = 0$)	for BC 125 $V_{CB} = 20\text{ V}$ $V_{CB} = 20\text{ V}$ $T_{amb} = 75\text{ °C}$ for BC 125 B $V_{CB} = 40\text{ V}$ $V_{CB} = 40\text{ V}$ $T_{amb} = 75\text{ °C}$		0.5	100	nA μA nA μA
$V_{(BR)\ CBO}$ Collector-base breakdown voltage ($I_E = 0$)	$I_C = 10\ \mu\text{A}$ for BC 125 for BC 125 B	50		60	V V
$V_{CEO(sus)}$ * Collector-emitter sustaining voltage ($I_B = 0$)	$I_C = 30\text{ mA}$	30			V
$V_{(BR)\ EBO}$ Emitter-base breakdown voltage ($I_C = 0$)	$I_C = 10\ \mu\text{A}$ for BC 125 for BC 125 B	5		6	V V
$V_{CE(sat)}$ * Collector-emitter saturation voltage	for BC 125 $I_C = 150\text{ mA}$ $I_B = 15\text{ mA}$ for BC 125 B $I_C = 150\text{ mA}$ $I_B = 15\text{ mA}$ $I_C = 500\text{ mA}$ $I_B = 50\text{ mA}$		0.2	2.5	V V V
			0.15	0.25	V
			0.4	0.8	V

* Pulsed: pulse duration = 300 μs , duty factor = 1%

BC 125 BC 125B

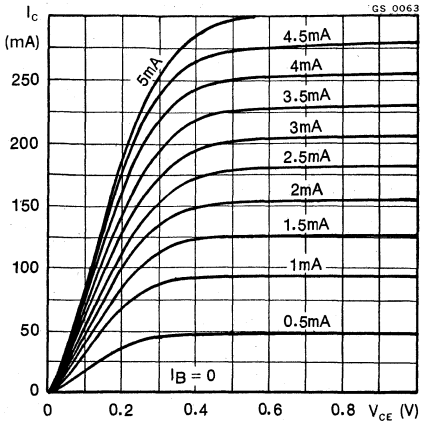
ELECTRICAL CHARACTERISTICS (continued)

Parameter	Test conditions	Min.	Typ.	Max.	Unit
V_{BE}^* Base-emitter voltage	$I_C = 50 \text{ mA}$ $V_{CE} = 1 \text{ V}$	0.72			V
$V_{BE(sat)}^*$ Base-emitter saturation voltage	for BC 125 $I_C = 150 \text{ mA}$ $I_B = 15 \text{ mA}$	1 1.3			V
	for BC 125 B $I_C = 150 \text{ mA}$ $I_B = 15 \text{ mA}$	0.87 1			V
	$I_C = 500 \text{ mA}$ $I_B = 50 \text{ mA}$	1.1 1.3			V
h_{FE}^* DC current gain	for BC 125 $I_C = 1 \text{ mA}$ $V_{CE} = 1 \text{ V}$	50			—
	$I_C = 10 \text{ mA}$ $V_{CE} = 1 \text{ V}$	70			—
	$I_C = 50 \text{ mA}$ $V_{CE} = 1 \text{ V}$	30	75		—
	$I_C = 150 \text{ mA}$ $V_{CE} = 1 \text{ V}$	30	60		—
	$I_C = 1 \text{ mA}$ $V_{CE} = 10 \text{ V}$	25	55		—
	$I_C = 10 \text{ mA}$ $V_{CE} = 10 \text{ V}$	30	75		—
	for BC 125 B $I_C = 1 \text{ mA}$ $V_{CE} = 1 \text{ V}$	85			—
	$I_C = 10 \text{ mA}$ $V_{CE} = 1 \text{ V}$	45	100		—
	$I_C = 50 \text{ mA}$ $V_{CE} = 1 \text{ V}$	95			—
	$I_C = 150 \text{ mA}$ $V_{CE} = 1 \text{ V}$	40	80	120	—
$I_C = 500 \text{ mA}$ $V_{CE} = 10 \text{ V}$	70			—	
f_T Transition frequency	$I_C = 50 \text{ mA}$ $V_{CE} = 10 \text{ V}$	200	350		MHz
C_{CBO} Collector-base capacitance	$I_E = 0$ $V_{CB} = 10 \text{ V}$ $f = 1 \text{ MHz}$				
		for BC 125 for BC 125 B			6 12 5 8

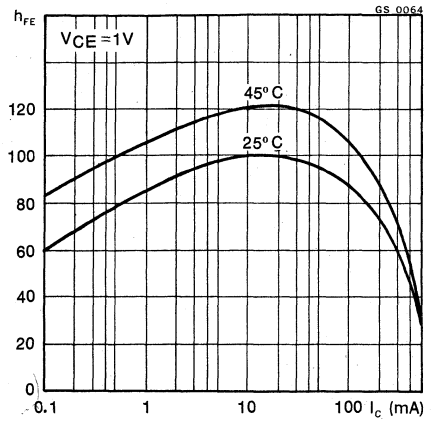
* Pulsed: pulse duration = 300 μs , duty factor = 1%

BC 125 BC 125B

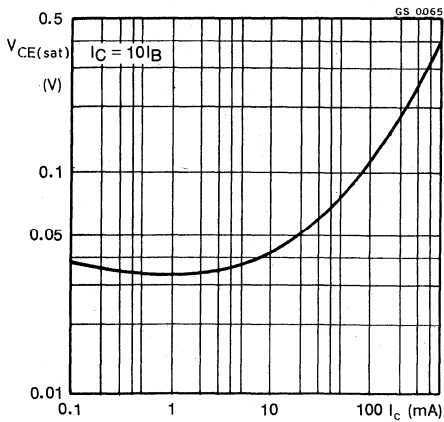
Typical output characteristics
(for BC 125 B only)



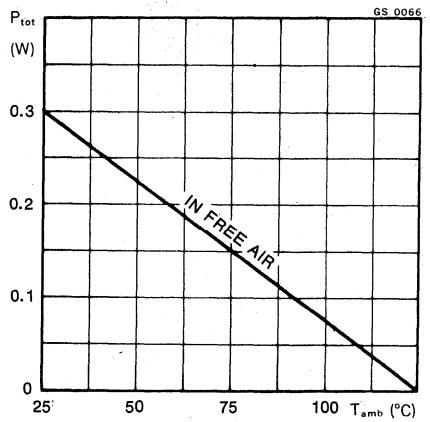
DC current gain (for BC 125 B only)



Collector-emitter saturation voltage



Power rating chart



BC 126

SILICON PLANAR PNP

AUDIO DRIVER

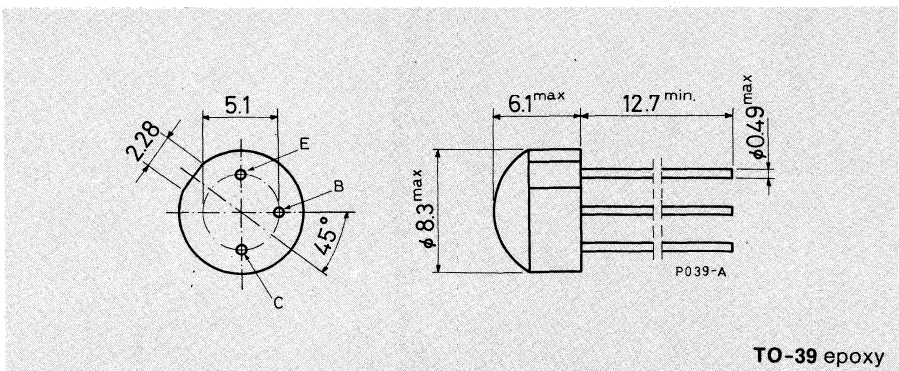
The BC 126 is a silicon planar epitaxial PNP transistor in a TO-39 epoxy package. It is designed for audio driver applications. The complementary NPN type is the BC 125.

ABSOLUTE MAXIMUM RATINGS

V_{CBO}	Collector-base voltage ($I_E = 0$)	-35	V
V_{CEO}	Collector-emitter voltage ($I_B = 0$)	-30	V
V_{EBO}	Emitter-base voltage ($I_C = 0$)	-5	V
I_C	Collector current	-0.5	A
P_{tot}	Total power dissipation at $T_{amb} \leq 25^\circ\text{C}$	0.3	W
	at $T_{case} \leq 25^\circ\text{C}$	0.8	W
T_{stg}	Storage temperature	-55 to 125	$^\circ\text{C}$
T_j	Junction temperature	125	$^\circ\text{C}$

MECHANICAL DATA

Dimensions in mm



BC 126

THERMAL DATA

$R_{th\ j-case}$	Thermal resistance junction-case	max	125	°C/W
$R_{th\ j-amb}$	Thermal resistance junction-ambient	max	330	°C/W

ELECTRICAL CHARACTERISTICS ($T_{amb} = 25\text{ °C}$ unless otherwise specified)

Parameter	Test conditions	Min.	Typ.	Max.	Unit	
I_{CBO} Collector cutoff current ($I_E = 0$)	$V_{CB} = -20\text{ V}$ $V_{CB} = -20\text{ V}$ $T_{amb} = 75\text{ °C}$			-100 -20	nA μA	
$V_{(BR)\ CBO}$ Collector-base breakdown voltage ($I_E = 0$)	$I_C = -10\ \mu\text{A}$	-35			V	
$V_{(BR)\ CEO}$ Collector-emitter breakdown voltage ($I_B = 0$)	$I_C = -10\text{ mA}$	-30			V	
$V_{(BR)\ EBO}$ Emitter-base breakdown voltage ($I_C = 0$)	$I_E = -10\ \mu\text{A}$	-5			V	
$V_{CE(sat)}$ Collector-emitter saturation voltage	$I_C = -50\text{ mA}$ $I_B = -5\text{ mA}$			-0.25	V	
	$I_C = -150\text{ mA}$ $I_B = -15\text{ mA}$			-0.50	V	
V_{BE} Base-emitter voltage	$I_C = -50\text{ mA}$ $V_{CE} = -1\text{ V}$	-0.75		-1	V	
$V_{BE(sat)}$ Base-emitter saturation voltage	$I_C = -150\text{ mA}$ $I_B = -15\text{ mA}$			-1	-1.3	V
	$I_C = -50\text{ mA}$ $I_B = -5\text{ mA}$			-0.8		V
h_{FE} DC current gain	$I_C = -50\text{ mA}$ $V_{CE} = -1\text{ V}$	30	80		—	
	$I_C = -150\text{ mA}$ $V_{CE} = -1\text{ V}$	30	60	120	—	
f_T Transition frequency	$I_C = -50\text{ mA}$ $V_{CE} = -20\text{ V}$		200		MHz	
C_{CBO} Collector-base capacitance	$I_E = 0$ $V_{CB} = -10\text{ V}$ $f = 1\text{ MHz}$		5		pF	

SILICON PLANAR NPN**AUDIO AMPLIFIER**

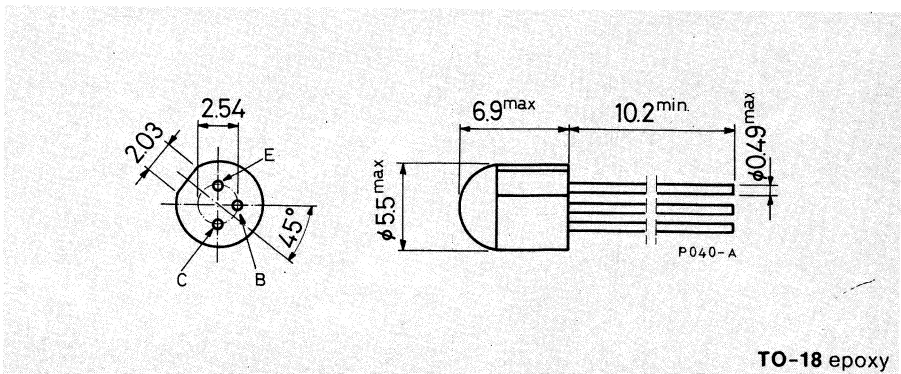
The BC 132 is a silicon planar NPN transistor in a TO-18 epoxy package. It is suitable for low level audio stages and direct coupled circuits.

ABSOLUTE MAXIMUM RATINGS

V_{CBO}	Collector-base voltage ($I_E = 0$)	30 V
V_{CEO}	Collector-emitter voltage ($I_B = 0$)	25 V
V_{EBO}	Emitter-base voltage ($I_C = 0$)	6 V
I_C	Collector current	20 mA
P_{tot}	Total power dissipation at $T_{amb} \leq 25^\circ\text{C}$ at $T_{case} \leq 25^\circ\text{C}$	0.2 W 0.5 W
T_{stg}	Storage temperature	-55 to 125 °C
T_j	Junction temperature	125 °C

MECHANICAL DATA

Dimensions in mm



BC 132

THERMAL DATA

$R_{th\ j-case}$	Thermal resistance junction-case	max	200	°C/W
$R_{th\ j-amb}$	Thermal resistance junction-ambient	max	500	°C/W

ELECTRICAL CHARACTERISTICS ($T_{amb} = 25\text{°C}$ unless otherwise specified)

Parameter	Test conditions	Min.	Typ.	Max.	Unit
I_{CBO} Collector cutoff current ($I_E = 0$)	$V_{CB} = 5\text{ V}$ $V_{CB} = 5\text{ V}$ $T_{amb} = 65\text{°C}$			100 3	nA μA
$V_{(BR)\ CBO}$ Collector-base breakdown voltage ($I_E = 0$)	$I_C = 100\ \mu\text{A}$	30			V
$V_{(BR)\ CEO}$ Collector-emitter breakdown voltage ($I_B = 0$)	$I_C = 10\text{ mA}$	25			V
$V_{(BR)\ EBO}$ Emitter-base breakdown voltage ($I_C = 0$)	$I_E = 100\ \mu\text{A}$	6			V
$V_{CE(sat)}$ Collector-emitter saturation voltage	$I_C = 1\text{ mA}$ $I_B = 0.1\text{ mA}$			0.35	V
h_{FE} DC current gain	$I_C = 50\ \mu\text{A}$ $V_{CE} = 10\text{ V}$ $I_C = 1\text{ mA}$ $V_{CE} = 10\text{ V}$	60	50	300	— —
C_{CBO} Collector-base capacitance	$I_E = 0$ $V_{CB} = 5\text{ V}$	2.2		4	pF

SILICON PLANAR PNP

AUDIO OUTPUT AMPLIFIER

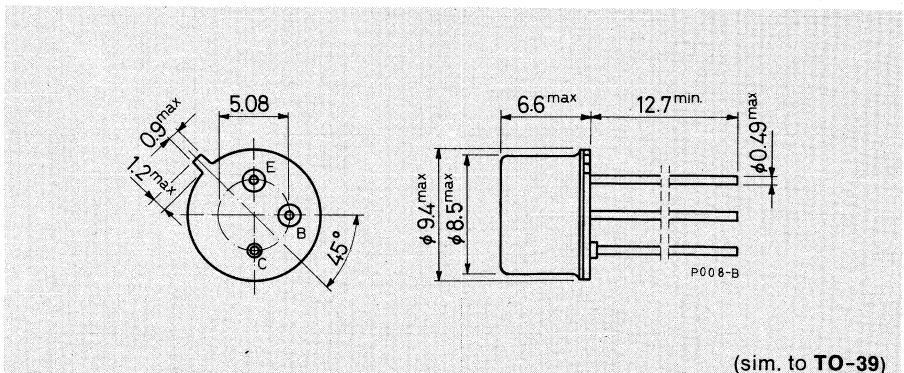
The BC 139 is a silicon planar epitaxial PNP transistor in a TO-39 metal case. It is particularly designed for use in audio output and driver stages. The complementary NPN type is the BC 119.

ABSOLUTE MAXIMUM RATINGS

V_{CBO}	Collector-base voltage ($I_E = 0$)	-40	V
V_{CEO}	Collector-emitter voltage ($I_B = 0$)	-40	V
V_{EBO}	Emitter-base voltage ($I_C = 0$)	-5	V
I_C	Collector current	-0.5	A
P_{tot}	Total power dissipation at $T_{amb} \leq 25^\circ\text{C}$	0.7	W
	at $T_{case} \leq 25^\circ\text{C}$	3	W
T_{stg}	Storage temperature	-55 to 200	$^\circ\text{C}$
T_j	Junction temperature	200	$^\circ\text{C}$

MECHANICAL DATA

Dimensions in mm



BC 139

THERMAL DATA

$R_{th\ j-case}$	Thermal resistance junction-case	max	58	°C/W
$R_{th\ j-amb}$	Thermal resistance junction-ambient	max	250	°C/W

ELECTRICAL CHARACTERISTICS ($T_{amb} = 25\text{ °C}$ unless otherwise specified)

Parameter		Test conditions	Min.	Typ.	Max.	Unit
I_{CBO}	Collector cutoff current ($I_E = 0$)	$V_{CB} = -30\text{ V}$ $V_{CB} = -30\text{ V } T_{amb} = 75\text{ °C}$			-100 -50	nA μA
$V_{(BR)\ CBO}$	Collector-base breakdown voltage ($I_E = 0$)	$I_C = -10\ \mu\text{A}$	-40			V
$V_{(BR)\ CEO}$	*Collector-emitter breakdown voltage ($I_B = 0$)	$I_C = -10\text{ mA}$	-40			V
$V_{(BR)\ EBO}$	Emitter-base breakdown voltage ($I_C = 0$)	$I_E = -10\ \mu\text{A}$	-5			V
$V_{CE(sat)}$	Collector-emitter saturation voltage	$I_C = -300\text{ mA}$ $I_B = -30\text{ mA}$ $I_C = -500\text{ mA}$ $I_B = -50\text{ mA}$		-0.45	-0.8	V
V_{BE}	Base-emitter voltage	$I_C = -10\text{ mA}$ $V_{CE} = -10\text{ V}$ $I_C = -100\text{ mA}$ $V_{CE} = -10\text{ V}$ $I_C = -300\text{ mA}$ $V_{CE} = -1\text{ V}$		-0.7	-0.77 -0.97	V

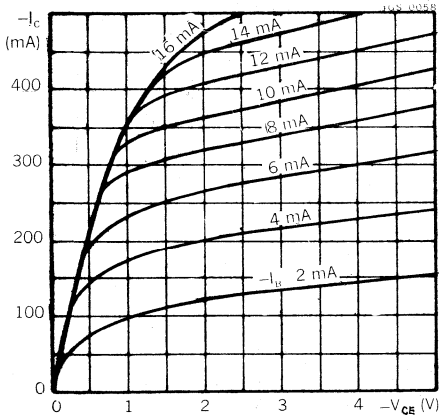
* Pulsed: pulse duration = 300 μs , duty factor = 1%

ELECTRICAL CHARACTERISTICS (continued)

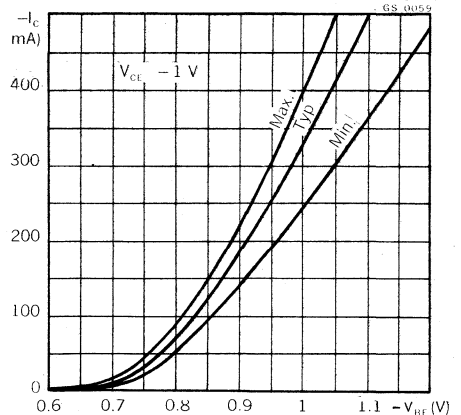
Parameter		Test conditions	Min.	Typ.	Max.	Unit
h_{FE}^*	DC current gain	$I_C = -10 \text{ mA}$		90		—
		$V_{CE} = -10 \text{ V}$				—
		$I_C = -100 \text{ mA}$	40	90		—
		$V_{CE} = -10 \text{ V}$				—
		$I_C = -150 \text{ mA}$		45		—
		$V_{CE} = -1 \text{ V}$				—
		$I_C = -300 \text{ mA}$	20	35		—
		$V_{CE} = -1 \text{ V}$				—
f_T	Transition frequency	$I_C = -50 \text{ mA}$ $V_{CE} = -10 \text{ V}$		200		MHz
C_{CBO}	Collector-base capacitance	$I_E = 0$ $V_{CB} = -10 \text{ V}$ $f = 1 \text{ MHz}$		6		pF

* Pulsed: pulse duration = 300 μs , duty factor = 1%

Typical output characteristics

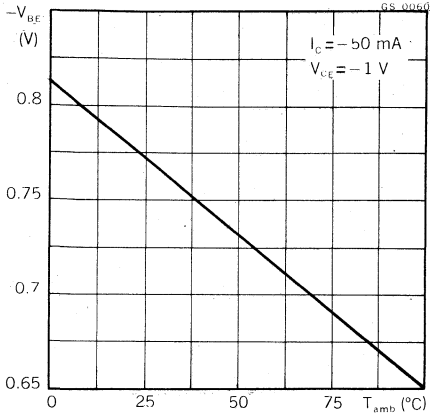


DC transconductance

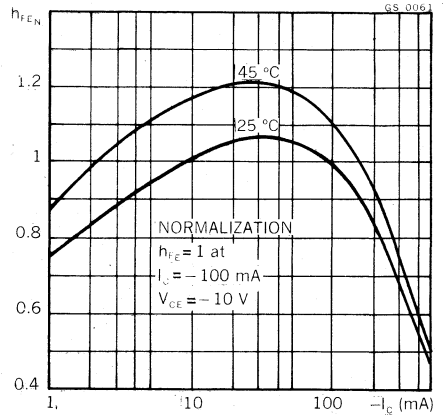


BC 139

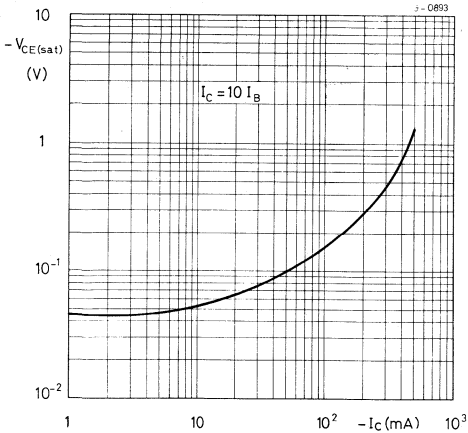
Base-emitter voltage



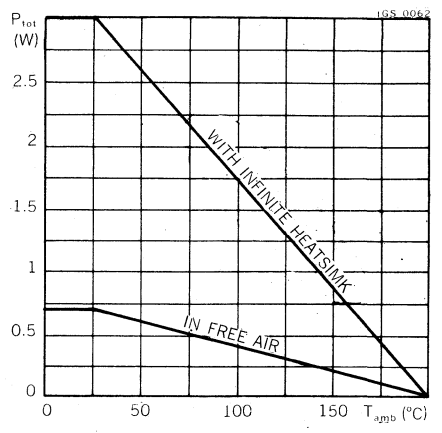
DC normalized current gain



Collector-emitter saturation voltage



Power rating chart



BC 140
BC 141

SILICON PLANAR NPN

GENERAL PURPOSE TRANSISTORS

The BC 140 and BC 141 are silicon planar epitaxial NPN transistors in TO-39 metal case. They are particularly designed for audio amplifiers and switching applications up to 1 A.

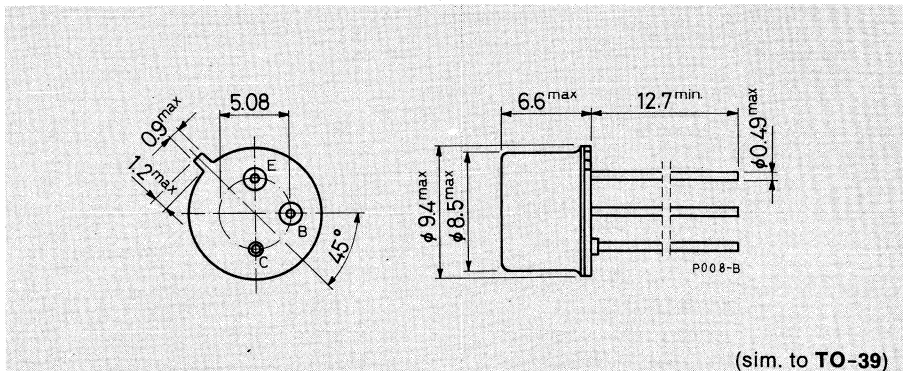
The complementary PNP types are the BC 160 and BC 161.

ABSOLUTE MAXIMUM RATINGS

		BC 140	BC 141
V_{CBO}	Collector-base voltage ($I_E = 0$)	60 V	80 V
V_{CEO}	Collector-emitter voltage ($I_B = 0$)	40 V	60 V
V_{EBO}	Emitter-base voltage ($I_C = 0$)		7 V
I_C	Collector current		1 A
I_B	Base current		0.1 A
P_{tot}	Total power dissipation at $T_{amb} \leq 25^\circ\text{C}$ at $T_{case} \leq 25^\circ\text{C}$		0.8 W 4 W
T_{stg}	Storage temperature		-55 to 200 °C
T_j	Junction temperature		200 °C

MECHANICAL DATA

Dimensions in mm



BC 140 BC 141

THERMAL DATA

$R_{th\ j-case}$	Thermal resistance junction-case	max	44	°C/W
$R_{th\ j-amb}$	Thermal resistance junction-ambient	max	220	°C/W

ELECTRICAL CHARACTERISTICS ($T_{amb} = 25\text{ °C}$ unless otherwise specified)

Parameter	Test conditions	Min.	Typ.	Max.	Unit
I_{CBO} Collector cutoff current ($I_E = 0$)	$V_{CB} = 50\text{ V}$ $V_{CB} = 50\text{ V}$ $T_{amb} = 150\text{ °C}$			200 200	nA μA
$V_{(BR)\ CBO}$ Collector-base breakdown voltage ($I_E = 0$)	$I_C = 100\ \mu\text{A}$ for BC 140 for BC 141	60 80			V V
$V_{(BR)\ CEO}^*$ Collector-emitter breakdown voltage ($I_B = 0$)	$I_C = 10\text{ mA}$ for BC 140 for BC 141	40 60			V V
$V_{(BR)\ EBO}$ Emitter-base breakdown voltage ($I_C = 0$)	$I_E = 100\ \mu\text{A}$	7			V
$V_{CE(sat)}^*$ Collector-emitter saturation voltage	$I_C = 100\text{ mA}$ $I_B = 10\text{ mA}$ $I_C = 500\text{ mA}$ $I_B = 50\text{ mA}$ $I_C = 1\text{ A}$ $I_B = 0.1\text{ A}$		0.1 0.35 0.6		V V V
V_{BE}^* Base-emitter voltage	$I_C = 1\text{ A}$ $V_{CE} = 1\text{ V}$	1.25	1.6		V

* Pulsed: pulse duration = 300 μs , duty factor = 1%

BC 140 BC 141

ELECTRICAL CHARACTERISTICS (continued)

Parameter	Test conditions	Min.	Typ.	Max.	Unit
h_{FE}^* DC current gain	$I_C = 100 \mu A$ $V_{CE} = 1 V$ for BC 140-141 for BC 140-141 Gr. 6 for BC 140-141 Gr. 10		75		—
			28		—
			40		—
	$I_C = 100 mA$ $V_{CE} = 1 V$ for BC 140-141 for BC 140-141 Gr. 6 for BC 140-141 Gr. 10	40	140	250	—
		40	63	100	—
		63	100	160	—
$I_C = 1 A$ $V_{CE} = 1 V$ for BC 140-141 for BC 140-141 Gr. 6 for BC 140-141 Gr. 10		26		—	
		15		—	
		20		—	
h_{FE1}/h_{FE2} Matched pair ratio	$I_C = 100 mA$ $V_{CE} = 1 V$		1.25		—
f_T Transition frequency	$I_C = 50 mA$ $V_{CE} = 10 V$	50			MHz
C_{CBO} Collector-base capacitance	$I_E = 0$ $V_{CB} = 20 V$ $f = 1 MHz$		12		pF
t_{on} Turn-on time	$I_C = 100 mA$ $I_{B1} = 5 mA$			250	ns
t_{off} Turn-off time	$I_C = 100 mA$ $I_{B1} = I_{B2} = 5 mA$			850	ns

* Pulsed: pulse duration = 300 μs , duty factor = 1%

SILICON PLANAR PNP

BC 153
BC 154

LOW-NOISE AUDIO AMPLIFIERS

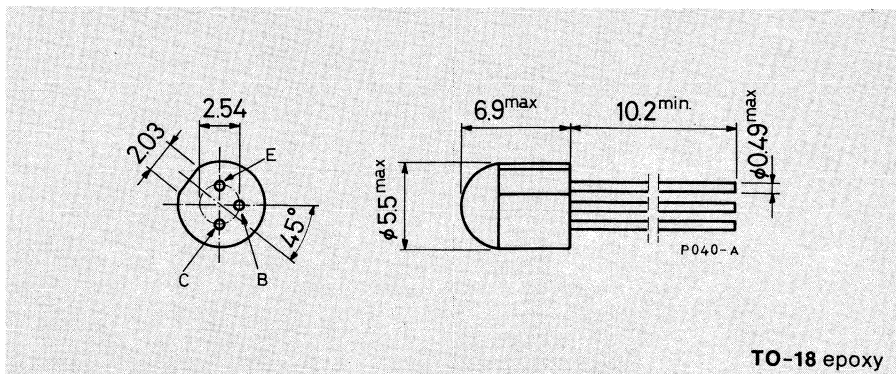
The BC 153 and BC 154 are silicon planar epitaxial PNP transistors in TO-18 epoxy package. They are specifically designed for use in low-noise audio preamplifiers.

ABSOLUTE MAXIMUM RATINGS

V_{CBO}	Collector-base voltage ($I_E = 0$)	-40	V
V_{CEO}	Collector-emitter voltage ($I_B = 0$)	-40	V
V_{EBO}	Emitter-base voltage ($I_C = 0$)	-5	V
I_C	Collector current	-100	mA
P_{tot}	Total power dissipation at $T_{amb} \leq 25^\circ\text{C}$ at $T_{case} \leq 25^\circ\text{C}$	0.2 0.5	W
T_{stg}	Storage temperature	-55 to 125	$^\circ\text{C}$
T_j	Junction temperature	125	$^\circ\text{C}$

MECHANICAL DATA

Dimensions in mm



BC 153 BC 154

THERMAL DATA

$R_{th\ j-case}$	Thermal resistance junction-case	max	200	°C/W
$R_{th\ j-amb}$	Thermal resistance junction-ambient	max	500	°C/W

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

Parameter	Test conditions	Min.	Typ.	Max.	Unit
I_{CBO} Collector cutoff current ($I_E = 0$)	$V_{CB} = -30\text{ V}$			-50	nA
$V_{(BR)\ CBO}$ Collector-base breakdown voltage ($I_E = 0$)	$I_C = -10\text{ }\mu\text{A}$	-40			V
$V_{(BR)\ CEO}$ Collector-emitter breakdown voltage ($I_B = 0$)	$I_C = -5\text{ mA}$	-40			V
$V_{(BR)\ EBO}$ Emitter-base breakdown voltage ($I_C = 0$)	$I_E = -10\text{ }\mu\text{A}$	-5			V
$V_{CE(sat)}$ Collector-emitter saturation voltage	$I_C = -10\text{ mA}$ $I_B = -0.5\text{ mA}$			-0.25	V
h_{FE} DC current gain	$I_C = -10\text{ }\mu\text{A}$ $V_{CE} = -5\text{ V}$ for BC 153 for BC 154 $I_C = -100\text{ }\mu\text{A}$ $V_{CE} = -5\text{ V}$ for BC 153 for BC 154 $I_C = -1\text{ mA}$ $V_{CE} = -5\text{ V}$ for BC 153 for BC 154 $I_C = -10\text{ mA}$ $V_{CE} = -5\text{ V}$ for BC 153 for BC 154		115 190 50 160 50 160 50 160	125 215 135 230 135 225	— — — — — — — —
f_T Transition frequency	$I_C = -1\text{ mA}$ $V_{CE} = -5\text{ V}$		70		MHz
C_{CBO} Collector-base capacitance	$I_E = 0$ $V_{CB} = -5\text{ V}$ $f = 1\text{ MHz}$		4		pF

BC 153 BC 154

ELECTRICAL CHARACTERISTICS (continued)

Parameter		Test conditions	Min. Typ. Max.	Unit
NF	Noise figure	$I_C = -20 \mu\text{A}$ $V_{CE} = -5 \text{ V}$ $R_g = 10 \text{ k}\Omega$ $f = 1 \text{ kHz}$ $B = 200 \text{ Hz}$ for BC 153 for BC 154	1 0.75 2.5	dB dB
		$I_C = -250 \mu\text{A}$ $V_{CE} = -5 \text{ V}$ $R_g = 1 \text{ k}\Omega$ $f = 1 \text{ kHz}$ $B = 200 \text{ Hz}$ for BC 153 for BC 154	1 0.75 2.5	dB dB
h_{ie}	Input impedance	$I_C = -1 \text{ mA}$ $V_{CE} = -5 \text{ V}$ $f = 1 \text{ kHz}$ for BC 153 for BC 154	5.2 7.1	$\text{k}\Omega$ $\text{k}\Omega$
h_{re}	Reverse voltage ratio	$I_C = -1 \text{ mA}$ $V_{CE} = -5 \text{ V}$ $f = 1 \text{ kHz}$ for BC 153 for BC 154	1.8×10^{-4} 2.9×10^{-4}	— —
h_{oe}	Output admittance	$I_C = -1 \text{ mA}$ $V_{CE} = -5 \text{ V}$ $f = 1 \text{ kHz}$ for BC 153 for BC 154	15 16	μS μS

BC 160
BC 161

SILICON PLANAR NPN

GENERAL PURPOSE TRANSISTORS

The BC 160 and BC 161 are silicon planar epitaxial PNP transistors in TO-39 metal case. They are particularly designed for audio amplifiers and switching applications up to 1 A.

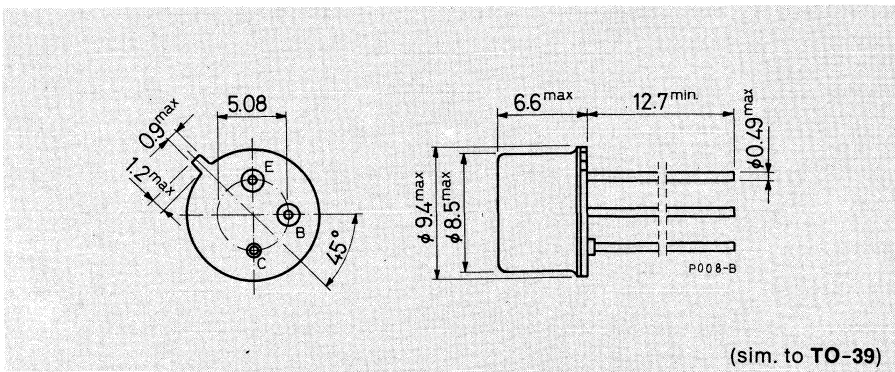
The complementary NPN types are the BC 140 and BC 141.

ABSOLUTE MAXIMUM RATINGS

		BC 160	BC 161
V_{CBO}	Collector-base voltage ($I_E = 0$)	-60 V	-80 V
V_{CEO}	Collector-emitter voltage ($I_B = 0$)	-40 V	-60 V
V_{EBO}	Emitter-base voltage ($I_C = 0$)		-5 V
I_C	Collector current		-1 A
I_B	Base current		-0.1 A
P_{tot}	Total power dissipation at $T_{amb} \leq 25^\circ\text{C}$ at $T_{case} \leq 25^\circ\text{C}$		0.8 W 4 W
T_{stg}	Storage temperature		-55 to 200 °C
T_j	Junction temperature		200 °C

MECHANICAL DATA

Dimensions in mm



BC 160 BC 161

THERMAL DATA

$R_{th\ j-case}$	Thermal resistance junction-case	max	44	°C/W
$R_{th\ j-amb}$	Thermal resistance junction-ambient	max	220	°C/W

ELECTRICAL CHARACTERISTICS ($T_{amb} = 25\text{ °C}$ unless otherwise specified)

Parameter	Test conditions	Min.	Typ.	Max.	Unit
I_{CBO} Collector cutoff current ($I_E = 0$)	$V_{CB} = -50\text{ V}$ $V_{CB} = -50\text{ V } T_{amb} = 150\text{ °C}$			-200 -200	nA μA
$V_{(BR)\ CBO}$ Collector-base breakdown voltage ($I_E = 0$)	$I_C = -100\ \mu\text{A}$ for BC 160 for BC 161	-60 -80			V V
$V_{(BR)\ CEO}^*$ Collector-emitter breakdown voltage ($I_B = 0$)	$I_C = -10\text{ mA}$ for BC 160 for BC 161	-40 -60			V V
$V_{(BR)\ EBO}$ Emitter-base breakdown voltage ($I_C = 0$)	$I_E = -100\ \mu\text{A}$	-5			V
$V_{CE(sat)}^*$ Collector-emitter saturation voltage	$I_C = -0.1\text{ A } I_B = -10\text{ mA}$ $I_C = -0.5\text{ A } I_B = -50\text{ mA}$ $I_C = -1\text{ A } I_B = -0.1\text{ A}$		-0.1 -0.35 -0.6		V V V
V_{BE}^* Base-emitter voltage	$I_C = -1\text{ A } V_{CE} = -1\text{ V}$	-1.1	-1.6		V
h_{FE}^* DC current gain	$I_C = -100\ \mu\text{A } V_{CE} = -1\text{ V}$ for BC 160-161 for BC 160-161 Gr. 6 for BC 160-161 Gr. 10 $I_C = -100\text{ mA } V_{CE} = -1\text{ V}$ for BC 160-161 for BC 160-161 Gr. 6 for BC 160-161 Gr. 10 $I_C = -1\text{ A } V_{CE} = -1\text{ V}$ for BC 160-161 for BC 160-161 Gr. 6 for BC 160-161 Gr. 10		110 46 80 40 40 63 26 15 20	250 100 160	— — — — — — — — —

ELECTRICAL CHARACTERISTICS (continued)

Parameter		Test conditions	Min. Typ. Max.	Unit
h_{FE1}/h_{FE2}	Matched pair ratio	$I_C = -100 \text{ mA}$ $V_{CE} = -1 \text{ V}$	1.25	—
f_T	Transition frequency	$I_C = -50 \text{ mA}$ $V_{CE} = -10 \text{ V}$	50	MHz
C_{CBO}	Collector-base capacitance	$I_E = 0$ $V_{CB} = -20 \text{ V}$ $f = 1 \text{ MHz}$	15	pF
t_{on}	Turn-on time	$I_C = -100 \text{ mA}$ $I_{B1} = -5 \text{ mA}$	500	ns
t_{off}	Turn-off time	$I_C = -100 \text{ mA}$ $I_{B1} = I_{B2} = -5 \text{ mA}$	650	ns

* Pulsed: pulse duration = 300 μs , duty factor = 1%

BC 177
BC 178
BC 179

SILICON PLANAR PNP

LOW NOISE GENERAL PURPOSE AUDIO AMPLIFIERS

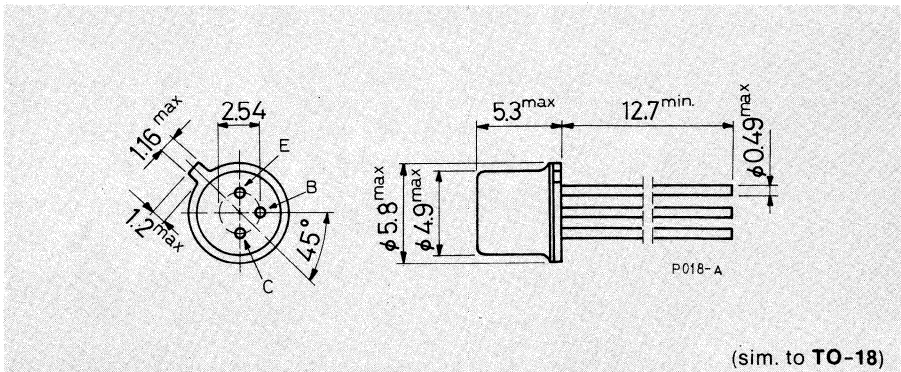
The BC 177, BC 178 and BC 179 are silicon planar epitaxial PNP transistors in TO-18 metal case. They are suitable for use in driver audio stages, low noise input audio stages and as low power, high gain general purpose transistors. The complementary NPN types are respectively the BC 107, BC 108, BC 109.

ABSOLUTE MAXIMUM RATINGS

		BC 177	BC 178	BC 179
V_{CBO}	Collector-base voltage ($I_E = 0$)	-50 V	-30 V	-25 V
V_{CES}	Collector-emitter voltage ($V_{BE} = 0$)	-45 V	-25 V	-20 V
V_{CEO}	Collector-emitter voltage ($I_B = 0$)	-45 V	-25 V	-20 V
V_{EBO}	Emitter-base voltage ($I_C = 0$)	-5 V		
I_{EM}	Emitter peak current	200 mA		
I_C	Collector current	-100 mA		
I_{CM}	Collector peak current	-200 mA		
P_{tot}	Total power dissipation at $T_{amb} \leq 25^\circ C$	300 mW		
	at $T_{case} \leq 115^\circ C$	300 mW		
T_{stg}	Storage temperature	-65 to 175 °C		
T_j	Junction temperature	175 °C		

MECHANICAL DATA

Dimensions in mm



BC 177
BC 178
BC 179

THERMAL DATA

$R_{th\ j-case}$	Thermal resistance junction-case	max	200	°C/W
$R_{th\ j-amb}$	Thermal resistance junction-ambient	max	500	°C/W

ELECTRICAL CHARACTERISTICS ($T_{amb} = 25\text{ °C}$ unless otherwise specified)

Parameter	Test conditions	Min.	Typ.	Max.	Unit
I_{CES} Collector cutoff current ($V_{BE} = 0$)	$V_{CE} = -20\text{ V}$		-1	-100	nA
$V_{(BR)\ CEO}$ Collector-emitter breakdown voltage ($I_B = 0$)	$I_C = -2\text{ mA}$ for BC 177 for BC 178 for BC 179	-45 -25 -20			V V V
$V_{(BR)\ CES}$ Collector-emitter breakdown voltage ($V_{BE} = 0$)	$I_C = -10\text{ }\mu\text{A}$ for BC 177 for BC 178 for BC 179	-50 -30 -25			V V V
$V_{(BR)\ EBO}$ Emitter-base breakdown voltage ($I_C = 0$)	$I_E = -10\text{ }\mu\text{A}$	-5			V
$V_{CE(sat)}$ Collector-emitter saturation voltage	$I_C = -10\text{ mA}$ $I_B = -0.5\text{ mA}$ $I_C = -100\text{ mA}$ $I_B = -5\text{ mA}$		-75	-250	mV mV
V_{BE} Base-emitter voltage	$I_C = -2\text{ mA}$ $V_{CE} = -5\text{ V}$	-600	-640	-750	mV
$V_{BE(sat)}$ Base-emitter saturation voltage	$I_C = -10\text{ mA}$ $I_B = -0.5\text{ mA}$ $I_C = -100\text{ mA}$ $I_B = -5\text{ mA}$		-720		mV mV
h_{FE} DC current gain	$I_C = -10\text{ }\mu\text{A}$ $V_{CE} = -5\text{ V}$	30			—

ELECTRICAL CHARACTERISTICS (continued)

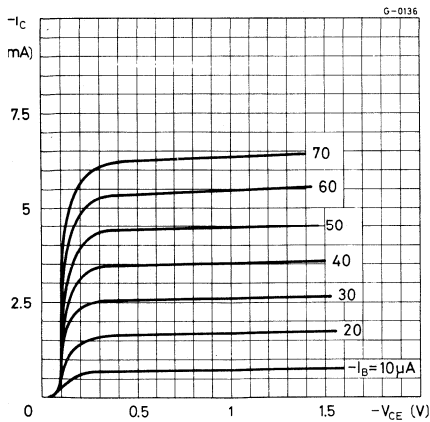
Parameter		Test conditions	Min.	Typ.	Max.	Unit
h_{fe}	Small signal current gain	$I_C = -2 \text{ mA}$ $V_{CE} = -5 \text{ V}$ $f = 1 \text{ kHz}$ for BC 177 Gr. 6 for BC 177 Gr. A for BC 178 Gr. 6 for BC 178 Gr. A for BC 178 Gr. B for BC 179 Gr. A for BC 179 Gr. B	75 125 75 125 240 125 240	150 260 150 260 500 260 500	— — — — — — —	
f_T	Transition frequency	$I_C = -10 \text{ mA}$ $V_{CE} = -5 \text{ V}$	200			MHz
C_{CBO}	Collector-base capacitance	$I_E = 0$ $V_{CB} = -10 \text{ V}$	5.5			pF
NF	Noise figure	$I_C = -0.2 \text{ mA}$ $V_{CE} = -5 \text{ V}$ $R_g = 2 \text{ k}\Omega$ $f = 1 \text{ kHz}$ $B = 200 \text{ Hz}$ for BC 177 for BC 178 for BC 179	2 2 1.2	10 10 4	dB dB dB	
h_{ie}	Input impedance	$I_C = -2 \text{ mA}$ $V_{CE} = -5 \text{ V}$ $f = 1 \text{ kHz}$ for BC 177 Gr. 6 for BC 177 Gr. A for BC 178 Gr. 6 for BC 178 Gr. A for BC 178 Gr. B for BC 179 Gr. A for BC 179 Gr. B	1.5 2.7 1.5 2.7 5.2 2.7 5.2		k Ω k Ω k Ω k Ω k Ω k Ω k Ω	
h_{re}	Reverse voltage ratio	$I_C = -2 \text{ mA}$ $V_{CE} = -5 \text{ V}$ $f = 1 \text{ kHz}$ for BC 177 Gr. 6 for BC 177 Gr. A for BC 178 Gr. 6 for BC 178 Gr. A for BC 178 Gr. B for BC 179 Gr. A for BC 179 Gr. B	1.8×10^{-4} 2.7×10^{-4} 1.8×10^{-4} 2.7×10^{-4} 4.5×10^{-4} 2.7×10^{-4} 4.5×10^{-4}		— — — — — — —	

BC 177
BC 178
BC 179

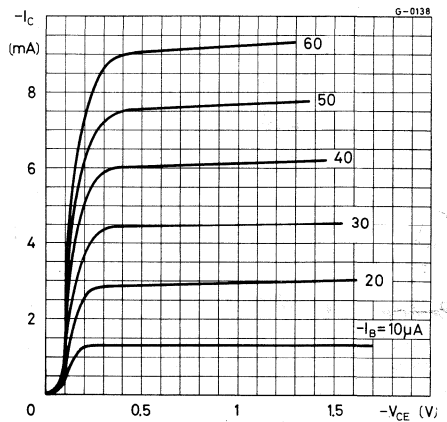
ELECTRICAL CHARACTERISTICS (continued)

Parameter	Test conditions	Min.	Typ.	Max.	Unit
h_{oe} Output admittance	$I_C = -2 \text{ mA}$ $V_{CE} = -5 \text{ V}$ $f = 1 \text{ kHz}$				
	for BC 177 Gr. 6		20		μS
	for BC 177 Gr. A		25		μS
	for BC 178 Gr. 6		20		μS
	for BC 178 Gr. A		25		μS
	for BC 178 Gr. B		35		μS
	for BC 179 Gr. A		25		μS
	for BC 179 Gr. B		35		μS

Typical output characteristics
 (for **BC 177** only)

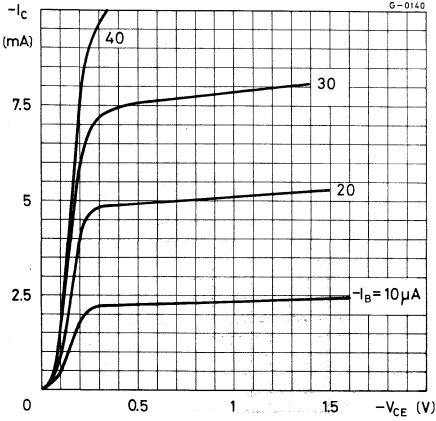


Typical output characteristics
 (for **BC 178** only)

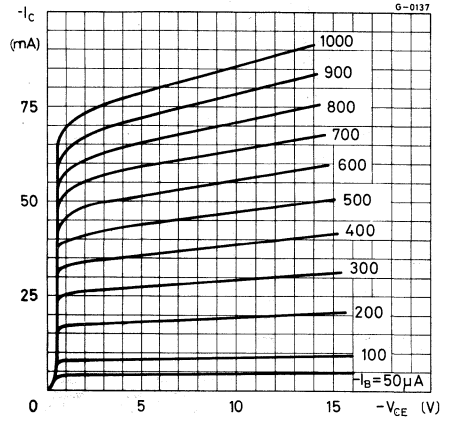


BC 177
BC 178
BC 179

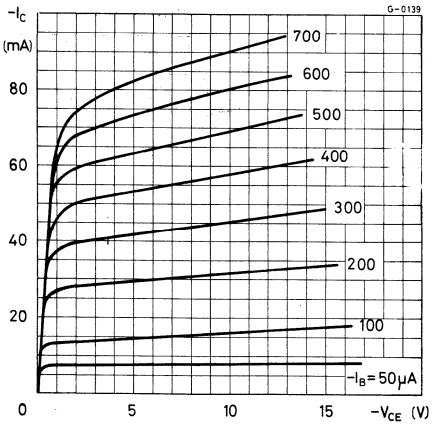
Typical output characteristics
 (for **BC 179** only)



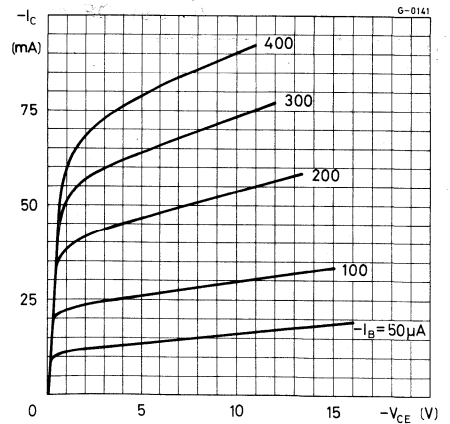
Typical output characteristics
 (for **BC 177** only)



Typical output characteristics
 (for **BC 178** only)

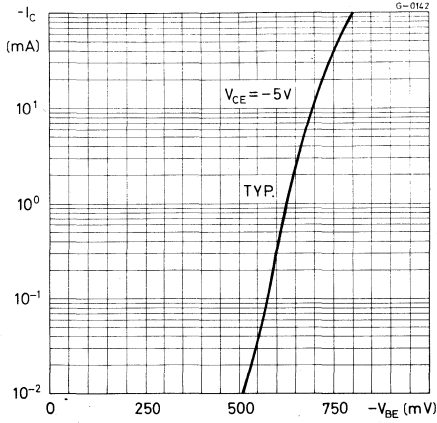


Typical output characteristics
 (for **BC 179** only)

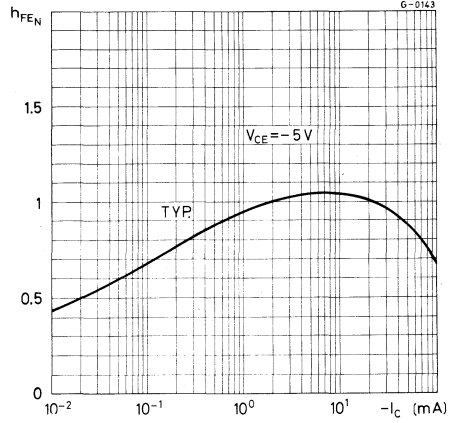


BC 177
BC 178
BC 179

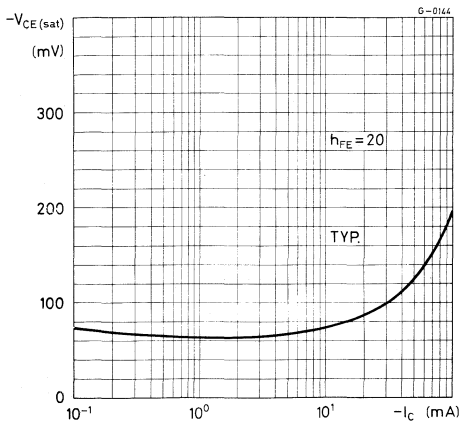
DC transconductance



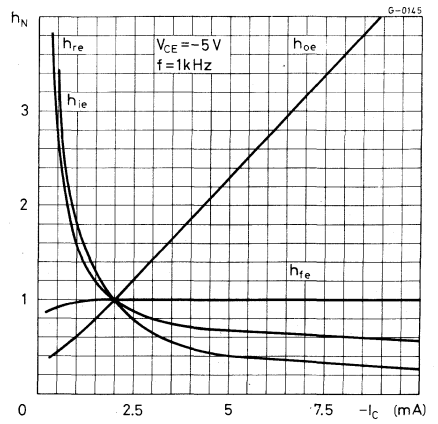
DC normalized current gain



Collector-emitter saturation voltage

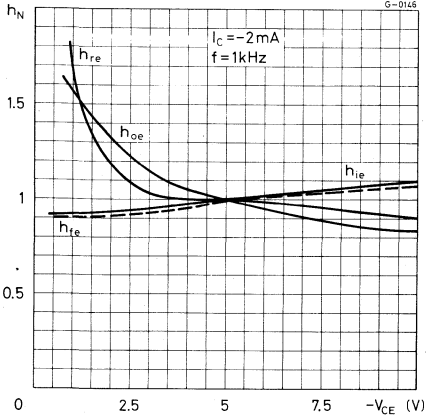


Typical normalized h parameters

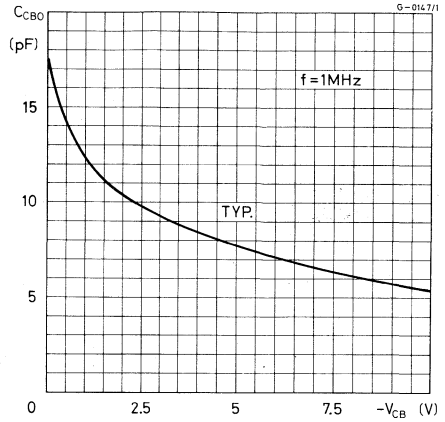


BC 177
BC 178
BC 179

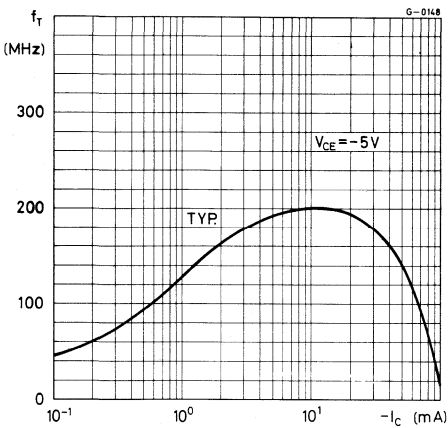
Typical normalized h parameters



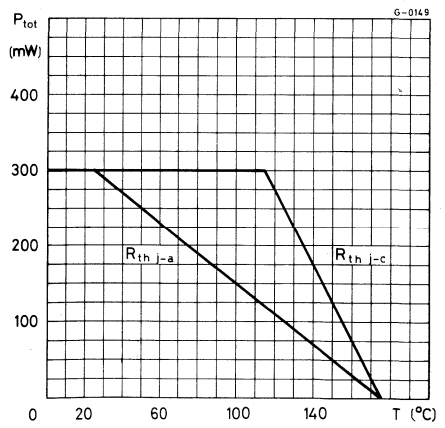
Collector-base capacitance



Transition frequency



Power rating chart



SILICON PLANAR PNP

BC 204
BC 205
BC 206

GENERAL PURPOSE AMPLIFIERS

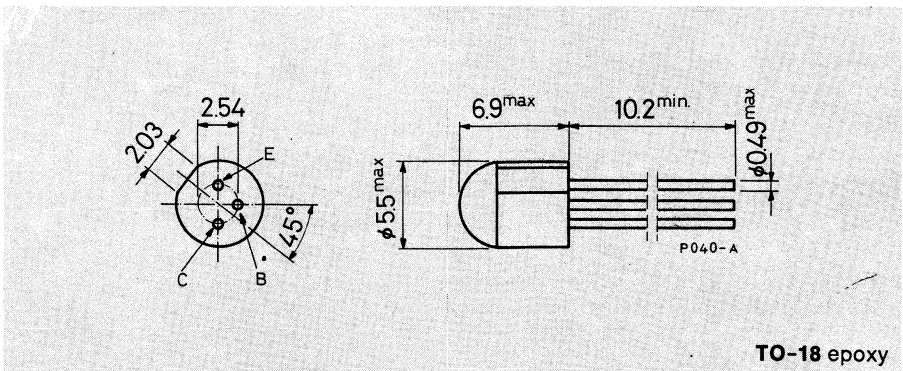
The BC 204, BC 205 and BC 206 are silicon planar epitaxial PNP transistors in TO-18 epoxy package. They are intended for general amplifier applications and TV signal processing.

ABSOLUTE MAXIMUM RATINGS

ABSOLUTE MAXIMUM RATINGS		BC 204	BC 205 BC 206
V_{CBO}	Collector-base voltage ($I_E = 0$)	-50 V	-25 V
V_{CEO}	Collector-emitter voltage ($I_B = 0$)	-45 V	-20 V
V_{EBO}	Emitter-base voltage ($I_C = 0$)		-5 V
I_C	Collector current		-100 mA
→ P_{tot}	Total power dissipation at $T_{amb} \leq 25^\circ C$		0.3 W
	at $T_{case} \leq 25^\circ C$		0.5 W
T_{stg}	Storage temperature		-55 to 125 °C
T_j	Junction temperature		125 °C

MECHANICAL DATA

Dimensions in mm



BC 204
BC 205
BC 206

THERMAL DATA

$R_{th\ j-case}$	Thermal resistance junction-case	max	200 °C/W
$\rightarrow R_{th\ j-amb}$	Thermal resistance junction-ambient	max	330 °C/W

ELECTRICAL CHARACTERISTICS ($T_{amb} = 25\text{ °C}$ unless otherwise specified)

Parameter	Test conditions	Min.	Typ.	Max.	Unit
I_{CBO} Collector cutoff current ($I_E = 0$)	for BC 204 $V_{CB} = -45\text{ V}$ $V_{CB} = -45\text{ V}$ $T_{amb} = 65\text{ °C}$ for BC 205-BC 206 $V_{CB} = -20\text{ V}$ $V_{CB} = -20\text{ V}$ $T_{amb} = 65\text{ °C}$			-50 -3	nA μA
$V_{(BR)\ CBO}$ Collector-base breakdown voltage ($I_E = 0$)	$I_C = -10\ \mu\text{A}$ for BC 204 for BC 205-BC 206	-50 -25			V V
$V_{(BR)\ CEO}$ Collector-emitter breakdown voltage ($I_B = 0$)	$I_C = -5\text{ mA}$ for BC 204 for BC 205-BC 206	-45 -20			V V
$V_{(BR)\ EBO}$ Emitter-base breakdown voltage ($I_C = 0$)	$I_E = -10\ \mu\text{A}$	-5			V
$V_{CE(sat)}$ Collector-emitter saturation voltage	$I_C = -10\text{ mA}$ $I_B = -0.5\text{ mA}$		-0.1	-0.3	V
V_{BE} Base-emitter voltage	$I_C = -2\text{ mA}$ $V_{CE} = -5\text{ V}$	-0.55	-0.65	-0.75	V

BC 204
BC 205
BC 206

ELECTRICAL CHARACTERISTICS (continued)

Parameter		Test conditions	Min.	Typ.	Max.	Unit
h _{FE}	DC current gain	I _C = -2 mA V _{CE} = -5 V for BC 204 for BC 204 Gr. VI for BC 204 Gr. A for BC 204 Gr. B for BC 205 for BC 205 Gr. A for BC 205 Gr. B for BC 206 for BC 206 Gr. B	50	160	450	—
			50	90	120	—
			110	180	220	—
			200	300	450	—
			110	270	450	—
			110	180	220	—
			200	350	450	—
			200	400	—	—
			200	350	450	—
			I _C = -10 μA V _{CE} = -5 V	110	—	—
				80	—	—
				130	—	—
				200	—	—
				200	—	—
130	—	—				
270	—	—				
for BC 206	320	—	—			
	270	—	—			
f _T	Transition frequency	I _C = -10 mA V _{CE} = -5 V	160			MHz
C _{CBO}	Collector-base capacitance	I _E = 0 V _{CB} = -10 V f = 1 MHz	4			pF
NF	Noise figure	I _C = -200 μA V _{CE} = -5 V f = 1 kHz B = 200 Hz for BC 204/205 for BC 206	2	10		dB
			1	4		dB

BC 207
BC 208
BC 209

SILICON PLANAR NPN

GENERAL PURPOSE AUDIO AMPLIFIERS

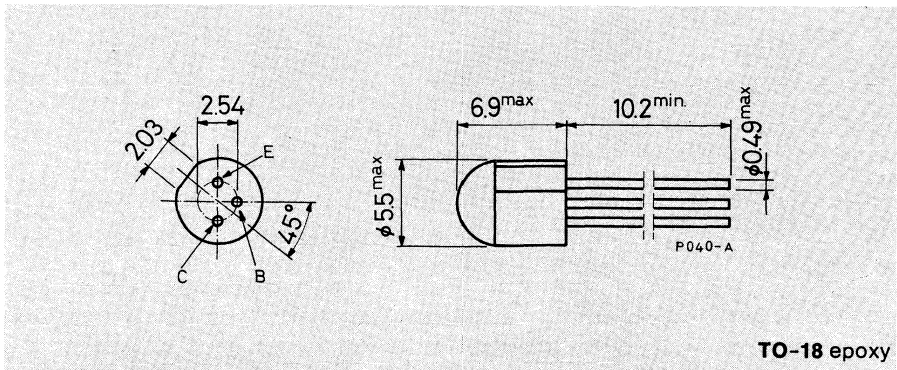
The BC 207, BC 208 and BC 209 are silicon planar epitaxial NPN transistors in TO-18 epoxy package. They are intended for use in driver or input stages of audio amplifier and in signal processing circuits of TV receivers.

ABSOLUTE MAXIMUM RATINGS

		BC 207	BC 208 BC 209
V_{CBO}	Collector-base voltage ($I_E = 0$)	50 V	25 V
V_{CEO}	Collector-emitter voltage ($I_B = 0$)	45 V	20 V
V_{EBO}	Emitter-base voltage ($I_C = 0$)	5 V	
I_C	Collector current	100 mA	
→ P_{tot}	Total power dissipation at $T_{amb} \leq 25^\circ\text{C}$ at $T_{case} \leq 25^\circ\text{C}$	0.3 W	
		0.5 W	
T_{stg}	Storage temperature	-55 to 125 °C	
T_j	Junction temperature	125 °C	

MECHANICAL DATA

Dimensions in mm



BC 207 BC 208 BC 209

THERMAL DATA

$R_{th\ j-case}$	Thermal resistance junction-case	max	200	°C/W
→ $R_{th\ j-amb}$	Thermal resistance junction-ambient	max	330	°C/W

ELECTRICAL CHARACTERISTICS ($T_{amb} = 25\text{ °C}$ unless otherwise specified)

Parameter	Test conditions	Min.	Typ.	Max.	Unit
I_{CBO} Collector cutoff current ($I_E = 0$)	$V_{CB} = 40\text{ V}$ $V_{CB} = 40\text{ V}$ $T_{amb} = 65\text{ °C}$			50 50	nA μA
$V_{(BR)\ CBO}$ Collector-base breakdown voltage ($I_E = 0$)	$I_C = 10\ \mu\text{A}$ for BC 207 for BC 208-BC 209	50 25			V V
$V_{(BR)\ CEO}$ Collector-emitter breakdown voltage ($I_B = 0$)	$I_C = 10\text{ mA}$ for BC 207 for BC 208-BC 209	45 20			V V
$V_{(BR)\ EBO}$ Emitter-base breakdown voltage ($I_C = 0$)	$I_E = 10\ \mu\text{A}$	5			V
$V_{CE(sat)}$ * Collector-emitter saturation voltage	$I_C = 10\text{ mA}$ $I_B = 0.5\text{ mA}$ $I_C = 100\text{ mA}$ $I_B = 5\text{ mA}$			0.25 0.6	V V
h_{FE} DC current gain	$I_C = 2\text{ mA}$ $V_{CE} = 5\text{ V}$ for BC 207 for BC 207 Gr. A for BC 207 Gr. B for BC 208 for BC 208 Gr. A for BC 208 Gr. B for BC 208 Gr. C for BC 209 for BC 209 Gr. B for BC 209 Gr. C	110 110 200 110 110 200 420 200 200 420	230 180 290 350 180 290 520 350 290 520	450 220 450 800 220 450 800 800 450 800	— — — — — — — — — — —

* Pulsed: pulse duration = 300 μs , duty factor = 1%.

ELECTRICAL CHARACTERISTICS (continued)

Parameter		Test conditions	Min.	Typ.	Max.	Unit
h_{FE}	DC current gain	$I_C = 10 \mu A$ $V_{CE} = 5 V$ for BC 207 for BC 207 Gr. A for BC 207 Gr. B for BC 208 for BC 208 Gr. A for BC 208 Gr. B for BC 208 Gr. C for BC 209 for BC 209 Gr. B for BC 209 Gr. C	40	120 90 150 120 90 150 270 210 150 270	— — — — — — — — — —	
f_T	Transition frequency	$V_{CE} = 5 V$ $I_C = 10 mA$		200		MHz
NF	Noise figure	$I_C = 0.2 mA$ $V_{CE} = 5 V$ $R_g = 2 k\Omega$ $f = 1 kHz$ $B = 200 Hz$ for BC 207 for BC 208 for BC 209		2 2 1.5	10 10 4	dB dB dB
C_{CBO}	Collector-base capacitance	$I_E = 0$ $V_{CB} = 10 V$ $f = 1 MHz$		3.1	6	pF
h_{ie}	Input impedance	$I_C = 2 mA$ $V_{CE} = 5 V$ $f = 1 kHz$ for BC 207 for BC 207 Gr. A for BC 207 Gr. B for BC 208 for BC 208 Gr. A for BC 208 Gr. B for BC 208 Gr. C for BC 209 for BC 209 Gr. B for BC 209 Gr. C		4 3 4.8 5.5 3 4.8 7 5.5 4.8 7	$k\Omega$ $k\Omega$ $k\Omega$ $k\Omega$ $k\Omega$ $k\Omega$ $k\Omega$ $k\Omega$ $k\Omega$ $k\Omega$	

BC 225

SILICON PLANAR PNP

AUDIO AMPLIFIER

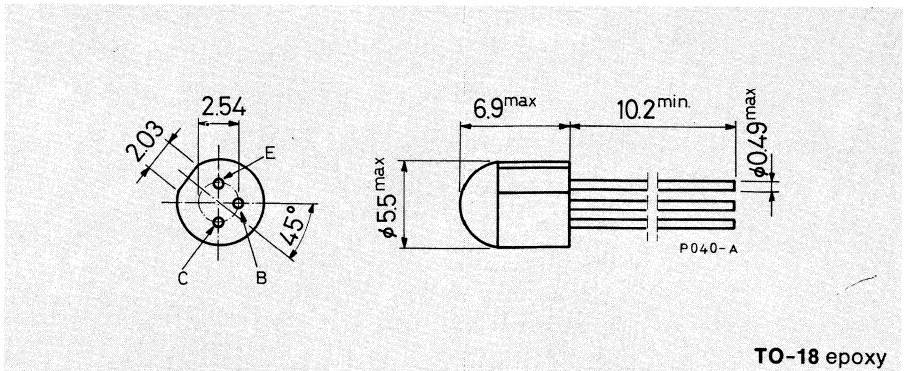
The BC 225 is a silicon planar PNP transistor in a TO-18 epoxy package. Designed for audio applications, it presents good current gain linearity from 10 μ A to 50 mA.

ABSOLUTE MAXIMUM RATINGS

V_{CBO}	Collector-base voltage ($I_E = 0$)	-40 V
V_{CEO}	Collector-emitter voltage ($I_B = 0$)	-40 V
V_{EBO}	Emitter-base voltage ($I_C = 0$)	-5 V
I_C	Collector current	-100 mA
P_{tot}	Total power dissipation at $T_{amb} \leq 25^\circ\text{C}$	0.2 W
	at $T_{case} \leq 25^\circ\text{C}$	0.5 W
T_{stg}	Storage temperature	-55 to 125 $^\circ\text{C}$
T_j	Junction temperature	125 $^\circ\text{C}$

MECHANICAL DATA

Dimensions in mm



BC 225

THERMAL DATA

$R_{th\ j-case}$	Thermal resistance junction-case	max	200	°C/W
$R_{th\ j-amb}$	Thermal resistance junction-ambient	max	500	°C/W

ELECTRICAL CHARACTERISTICS ($T_{amb} = 25\text{ °C}$ unless otherwise specified)

Parameter	Test conditions	Min.	Typ.	Max.	Unit
I_{CBO} Collector cutoff current ($I_E = 0$)	$V_{CB} = -30\text{ V}$			-100	nA
$V_{(BR)\ CBO}$ Collector-base breakdown voltage ($I_E = 0$)	$I_C = -10\ \mu\text{A}$	-40			V
$V_{(BR)\ CEO}$ Collector-emitter breakdown voltage ($I_B = 0$)	$I_C = -5\text{ mA}$	-40			V
$V_{(BR)\ EBO}$ Emitter-base breakdown voltage ($I_C = 0$)	$I_E = -10\ \mu\text{A}$	-5			V
$V_{CE(sat)}$ Collector-emitter saturation voltage	$I_C = -10\text{ mA}$ $I_B = -0.5\text{ mA}$		-0.1	-0.25	V
	$I_C = -50\text{ mA}$ $I_B = -5\text{ mA}$		-0.16		V
V_{BE} Base-emitter voltage	$I_C = -1\text{ mA}$ $V_{CE} = -5\text{ V}$	-0.65			V
h_{FE} DC current gain	$I_C = -10\ \mu\text{A}$ $V_{CE} = -5\text{ V}$		130		—
	$I_C = -100\ \mu\text{A}$ $V_{CE} = -5\text{ V}$	90	155		—
	$I_C = -1\text{ mA}$ $V_{CE} = -5\text{ V}$	90	170		—
	$I_C = -10\text{ mA}$ $V_{CE} = -5\text{ V}$	90	165		—
	$I_C = -50\text{ mA}$ $V_{CE} = -5\text{ V}$		140		—
f_T Transition frequency	$I_C = -1\text{ mA}$ $V_{CE} = -5\text{ V}$		70		MHz
C_{CBO} Collector-base capacitance	$I_E = 0$ $V_{CB} = -5\text{ V}$ $f = 1\text{ MHz}$		4		pF
NF Noise figure	$I_C = -20\ \mu\text{A}$ $V_{CE} = -5\text{ V}$ $R_g = 10\text{ k}\Omega$ $f = 1\text{ kHz}$ $B = 200\text{ Hz}$		1		dB
	$I_C = -0.25\text{ mA}$ $V_{CE} = -5\text{ V}$ $R_g = 1\text{ k}\Omega$ $f = 1\text{ kHz}$ $B = 200\text{ Hz}$		1		dB

SILICON PLANAR PNP

AUDIO DRIVERS OR OUTPUT STAGES

The BC 297 and BC 298 are silicon planar epitaxial PNP transistors in TO-18 metal case. They are particularly intended for use in high current high gain applications, in driver stages of hi-fi equipments or in output stages of low power class B amplifiers.

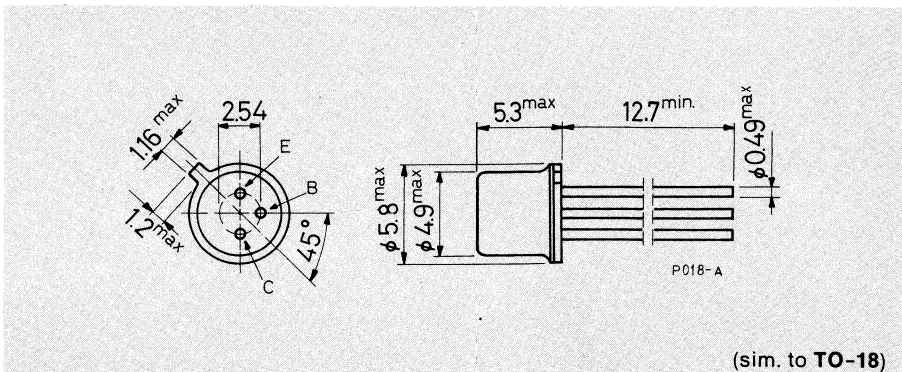
The complementary NPN types are the BC 377 and BC 378, respectively.

ABSOLUTE MAXIMUM RATINGS

		BC 297	BC 298
V_{CES}	Collector-emitter voltage ($V_{BE} = 0$)	-50 V	-30 V
V_{CEO}	Collector-emitter voltage ($I_B = 0$)	-45 V	-25 V
V_{EBO}	Emitter-base voltage ($I_C = 0$)		-5 V
I_E	Emitter current		1.2 A
I_C	Collector current		-1 A
I_B	Base current		-0.2 A
P_{tot}	Total power dissipation at $T_{amb} \leq 25^\circ\text{C}$		375 mW
	at $T_{case} \leq 75^\circ\text{C}$		1 W
T_{stg}	Storage temperature	-65 to 175 °C	
T_j	Junction temperature	175 °C	

MECHANICAL DATA

Dimensions in mm



BC 297 BC 298

THERMAL DATA

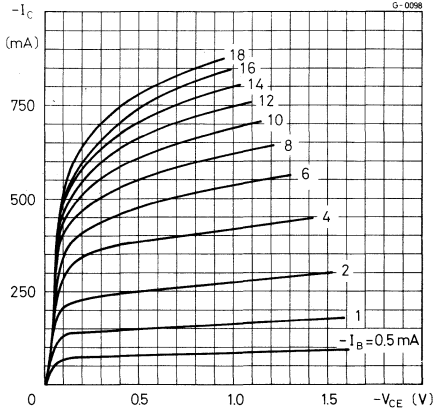
$R_{th\ j-case}$	Thermal resistance junction-case	max	100	°C/W
$R_{th\ j-amb}$	Thermal resistance junction-ambient	max	400	°C/W

ELECTRICAL CHARACTERISTICS ($T_{case} = 25\text{ °C}$ unless otherwise specified)

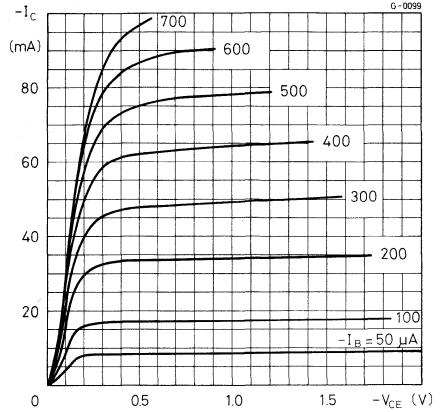
Parameter	Test conditions	Min.	Typ.	Max.	Unit
I_{CES} Collector cutoff current ($V_{BE} = 0$)	for BC 297 $V_{CE} = -50\text{ V}$ for BC 298 $V_{CE} = -30\text{ V}$			-100 -100	nA nA
$V_{(BR)\ CEO}$ Collector-emitter breakdown voltage ($I_B = 0$)	$I_C = -10\text{ mA}$ for BC 297 for BC 298	-45 -25			V V
$V_{(BR)\ EBO}$ Emitter-base breakdown voltage ($I_C = 0$)	$I_E = -10\text{ }\mu\text{A}$	-5			V
$V_{CE(sat)}$ Collector-emitter saturation voltage	$I_C = -500\text{ mA}$ $I_B = -50\text{ mA}$			-0.7	V
V_{BE} Base-emitter voltage	$I_C = -100\text{ mA}$ $V_{CE} = -1\text{ V}$		-770		mV
$V_{BE(sat)}$ Base-emitter saturation voltage	$I_C = -500\text{ mA}$ $I_B = -50\text{ mA}$			-1.2	V
h_{FE} DC current gain	Gr. 6 $I_C = -100\text{ mA}$ $V_{CE} = -1\text{ V}$ Gr. 7 $I_C = -100\text{ mA}$ $V_{CE} = -1\text{ V}$ $I_C = -300\text{ mA}$ $V_{CE} = -1\text{ V}$	75 125 30		150 260	— — —
h_{FE1}/h_{FE2} Matched pair ratio	$I_C = -100\text{ mA}$ $V_{CE} = -1\text{ V}$			1.41	—
f_T Transition frequency	$I_C = -50\text{ mA}$ $V_{CE} = -10\text{ V}$		250		MHz
C_{CBO} Collector-base capacitance	$I_E = 0$ $V_{CB} = -10\text{ V}$			8	pF
C_{EBO} Emitter-base capacitance	$I_C = 0$ $V_{EB} = -0.5\text{ V}$			30	pF

BC 297 BC 298

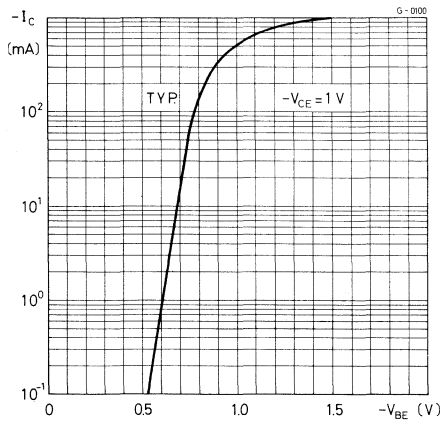
Typical output characteristics



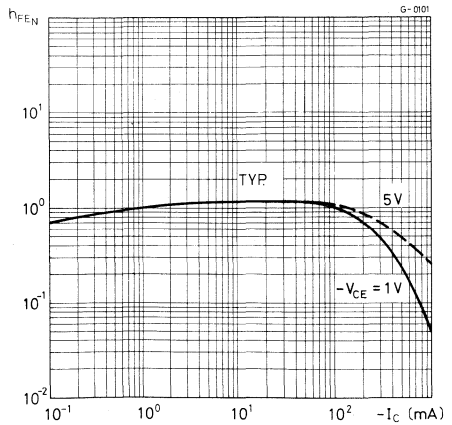
Typical output characteristics



DC transconductance

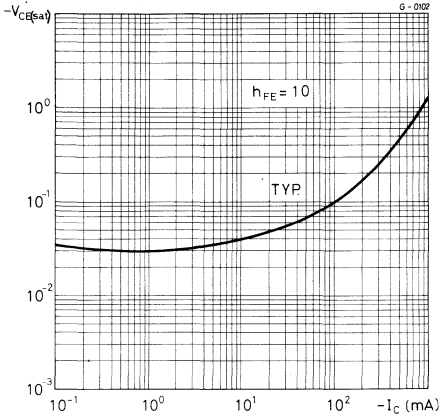


DC normalized current gain

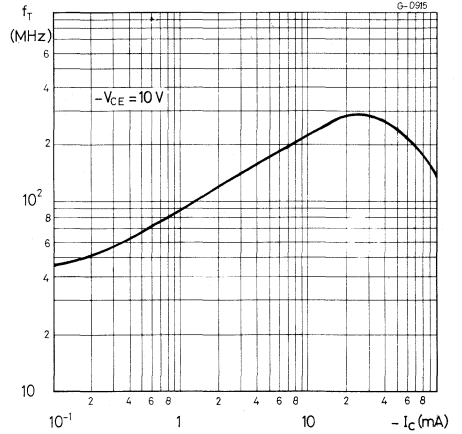


BC 297 BC 298

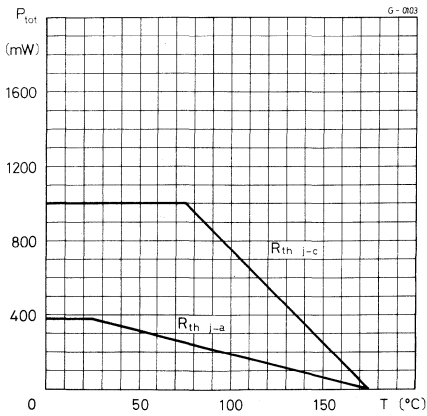
Collector-emitter saturation voltage



Typical transition frequency



Power rating chart



BC 300
BC 301
BC 302

SILICON PLANAR NPN

MEDIUM POWER AUDIO DRIVERS

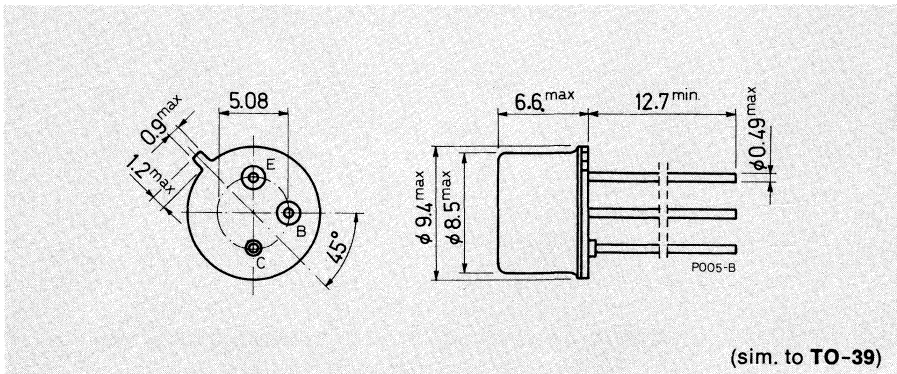
The BC 300, BC 301 and BC 302 are silicon planar epitaxial NPN transistors in TO-39 metal case. They are intended for audio driver stages in commercial and industrial equipments. In addition they are useful as high speed saturated switches and general purpose amplifiers. The PNP types complementary to BC 301 and BC 302 are respectively the BC 303 and BC 304.

ABSOLUTE MAXIMUM RATINGS

		BC 300	BC 301	BC 302
V_{CBO}	Collector-base voltage ($I_E = 0$)	120 V	90 V	60 V
V_{CEO}	Collector-emitter voltage ($I_B = 0$)	80 V	60 V	45 V
V_{CEV}	Collector-emitter voltage ($V_{BE} = -1.5$ V)	120 V	90 V	—
V_{EBO}	Emitter-base voltage ($I_C = 0$)	7 V		
I_C	Collector current	0.5 A		
I_{CM}	Collector peak current	1 A		
I_{BM}	Base peak current	0.5 A		
P_{tot}	Total power dissipation at $T_{amb} \leq 25^\circ\text{C}$ at $T_{case} \leq 25^\circ\text{C}$	0.85 W		
T_{stg}	Storage temperature	-65 to 175 °C		
T_j	Junction temperature	175 °C		

MECHANICAL DATA

Dimensions in mm



(sim. to TO-39)

BC 300
BC 301
BC 302

THERMAL DATA

$R_{th\ j-case}$	Thermal resistance junction-case	max	25	°C/W
$R_{th\ j-amb}$	Thermal resistance junction-ambient	max	175	°C/W

ELECTRICAL CHARACTERISTICS (T_{case} = 25 °C unless otherwise specified)

Parameter	Test conditions	Min.	Typ.	Max.	Unit
I_{CBO} Collector cutoff current ($I_E = 0$)	$V_{CB} = 60\text{ V}$		5	20	nA
I_{EBO} Emitter cutoff current ($I_C = 0$)	$V_{EB} = 7\text{ V}$			20	nA
$V_{CEO(sus)}$ *Collector-emitter voltage ($I_B = 0$)	$I_C = 100\text{ mA}$ for BC 300 for BC 301 for BC 302	80 60 45			V V V
$V_{CEV(sus)}$ *Collector-emitter voltage	$I_C = 100\text{ mA}$ $V_{BE} = -1.5\text{ V}$ for BC 300 for BC 301	120 90			V V
$V_{CE(sat)}$ Collector-emitter saturation voltage	$I_C = 150\text{ mA}$ $I_B = 15\text{ mA}$		0.2	0.5	V
V_{BE} Base-emitter voltage	$I_C = 150\text{ mA}$ $V_{CE} = 10\text{ V}$		0.78		V
h_{FE} DC current gain	Gr. 4 $I_C = 150\text{ mA}$ $V_{CE} = 10\text{ V}$ Gr. 5 $I_C = 150\text{ mA}$ $V_{CE} = 10\text{ V}$ Gr. 6 $I_C = 150\text{ mA}$ $V_{CE} = 10\text{ V}$ $I_C = 0.1\text{ mA}$ $V_{CE} = 10\text{ V}$ $I_C = 500\text{ mA}$ $V_{CE} = 10\text{ V}$	40 70 120 20 20		80 140 240	— — — — —
f_T Transition frequency	$I_C = 10\text{ mA}$ $V_{CE} = 10\text{ V}$		120		MHz
C_{CBO} Collector-base capacitance	$I_E = 0$ $V_{CB} = 10\text{ V}$		10		pF
h_{ie} Input impedance	$I_C = 5\text{ mA}$ $V_{CE} = 10\text{ V}$ $f = 1\text{ kHz}$		1.1		kΩ

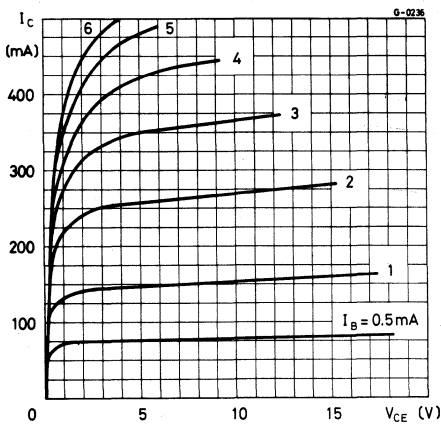
* Pulsed; pulse duration = 300 μs, duty factor = 1.5%

BC 300
BC 301
BC 302

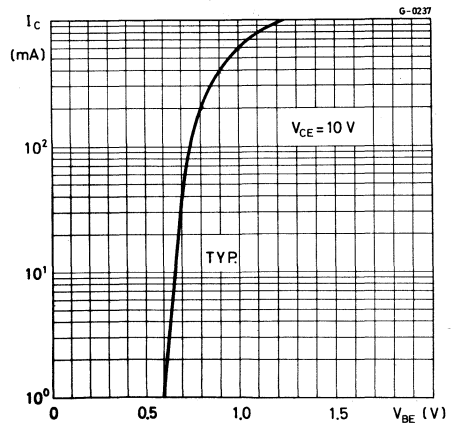
ELECTRICAL CHARACTERISTICS (continued)

Parameter	Test conditions	Min.	Typ.	Max.	Unit
h_{re} Reverse voltage ratio	$I_C = 5 \text{ mA}$ $f = 1 \text{ kHz}$ $V_{CE} = 10 \text{ V}$		1.7×10^{-4}		—
h_{fe} Small signal current gain	$I_C = 5 \text{ mA}$ $f = 1 \text{ kHz}$ $V_{CE} = 10 \text{ V}$		140		—
h_{oe} Output admittance	$I_C = 5 \text{ mA}$ $f = 1 \text{ kHz}$ $V_{CE} = 10 \text{ V}$		14		μS

Typical output characteristics

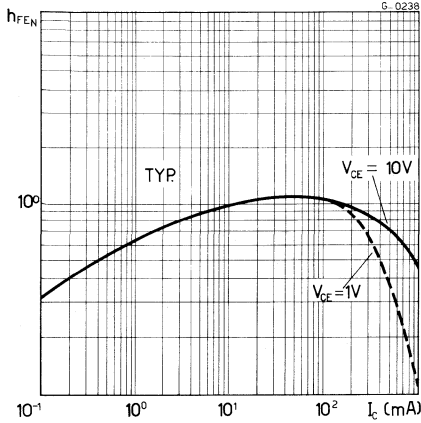


DC transconductance

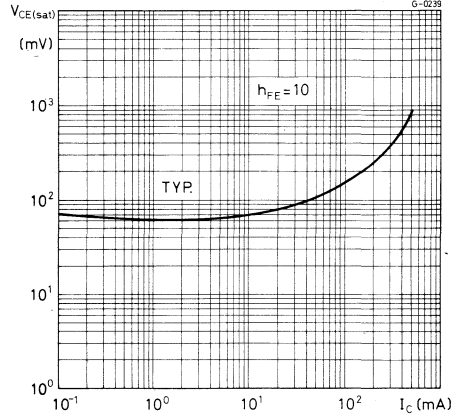


BC 300
BC 301
BC 302

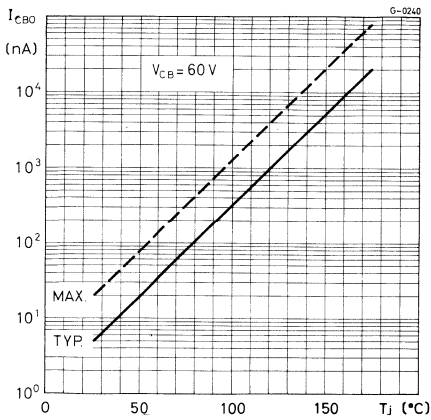
DC normalized current gain



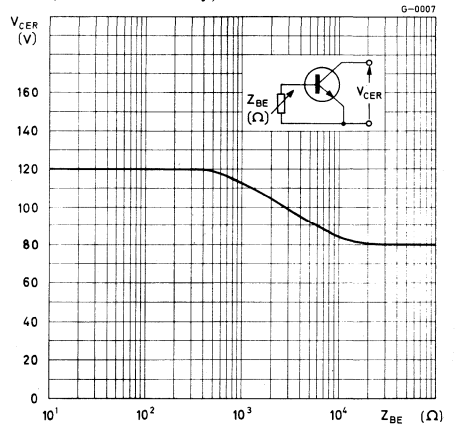
Collector-emitter saturation voltage



Collector cutoff current

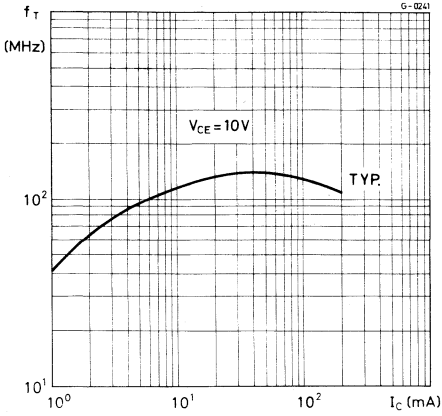


Collector-emitter breakdown voltage (for BC 300 only)

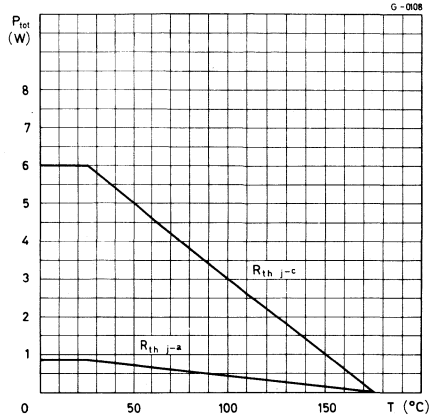


BC 300
BC 301
BC 302

Transition frequency



Power rating chart



BC 303
BC 304

SILICON PLANAR PNP

MEDIUM POWER AUDIO DRIVERS

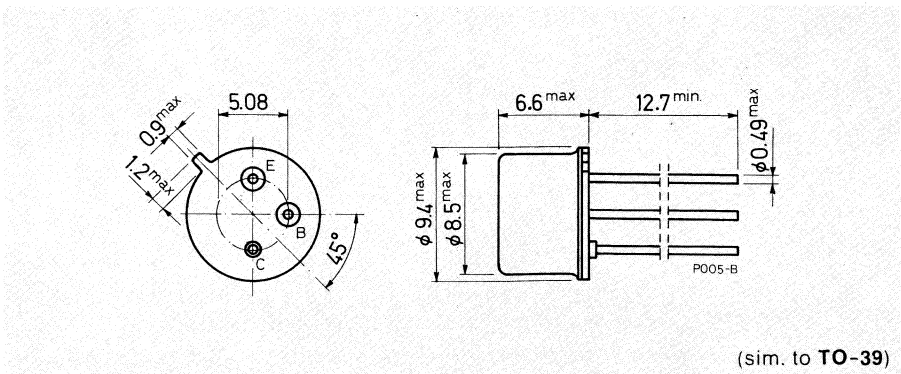
The BC 303 and BC 304 are silicon planar epitaxial PNP transistors in TO-39 metal case. They are intended particularly as audio driver stages in commercial and professional equipments. In addition they are useful as high speed saturated switches and general purpose amplifiers. The complementary NPN types are respectively the BC 301 and BC 302.

ABSOLUTE MAXIMUM RATINGS

		BC 303	BC 304
V_{CBO}	Collector-base voltage ($I_E = 0$)	-85 V	-60 V
V_{CEO}	Collector-emitter voltage ($I_B = 0$)	-60 V	-45 V
V_{CEV}	Collector-emitter voltage ($V_{BE} = 1.5$ V)	-85 V	—
V_{EBO}	Emitter-base voltage ($I_C = 0$)		-7 V
I_C	Collector current	-0.5 A	
i_{CM}	Collector peak current	-1 A	
i_{BM}	Base peak current	-0.5 A	
P_{tot}	Total power dissipation at $T_{amb} \leq 25^\circ\text{C}$ at $T_{case} \leq 25^\circ\text{C}$	0.85 W	6 W
T_{stg}	Storage temperature	-65 to 175 °C	
T_j	Junction temperature	175 °C	

MECHANICAL DATA

Dimensions in mm



(sim. to TO-39)

BC 303 BC 304

THERMAL DATA

$R_{th\ j-case}$	Thermal resistance junction-case	max	25	°C/W
$R_{th\ j-amb}$	Thermal resistance junction-ambient	max	175	°C/W

ELECTRICAL CHARACTERISTICS (T_{case} = 25 °C unless otherwise specified)

Parameter	Test conditions	Min.	Typ.	Max.	Unit
I_{CBO} Collector cutoff current ($I_E = 0$)	$V_{CB} = -60\text{ V}$		-5	-20	nA
I_{EBO} Emitter cutoff current ($I_C = 0$)	$V_{EB} = -5\text{ V}$			-20	nA
$V_{CEO(sus)}$ *Collector-emitter voltage ($I_B = 0$)	$I_C = -100\text{ mA}$ for BC 303 for BC 304	-60 -45			V V
$V_{CEV(sus)}$ *Collector-emitter voltage (for BC 303 only)	$I_C = -100\text{ mA}$ $V_{BE} = 1.5\text{ V}$	-85			V
$V_{CE(sat)}$ Collector-emitter saturation voltage	$I_C = -150\text{ mA}$ $I_B = -15\text{ mA}$		-0.25	-0.65	V
V_{BE} Base-emitter voltage	$I_C = -150\text{ mA}$ $V_{CE} = -10\text{ V}$		-0.78		V
h_{FE} DC current gain	Gr. 4 $I_C = -150\text{ mA}$ $V_{CE} = -10\text{ V}$ Gr. 5 $I_C = -150\text{ mA}$ $V_{CE} = -10\text{ V}$ Gr. 6 $I_C = -150\text{ mA}$ $V_{CE} = -10\text{ V}$ $I_C = 0.1\text{ mA}$ $V_{CE} = -10\text{ V}$ $I_C = -500\text{ mA}$ $V_{CE} = -10\text{ V}$	40	70	120	80 140 240 — — —
f_T Transition frequency	$I_C = -10\text{ mA}$ $V_{CE} = -10\text{ V}$		75		MHz
C_{CBO} Collector-base capacitance	$I_E = 0$ $V_{CB} = -10\text{ V}$		15		pF
h_{ie} Input impedance	$I_C = -5\text{ mA}$ $V_{CE} = -10\text{ V}$ $f = 1\text{ kHz}$		0.9		kΩ

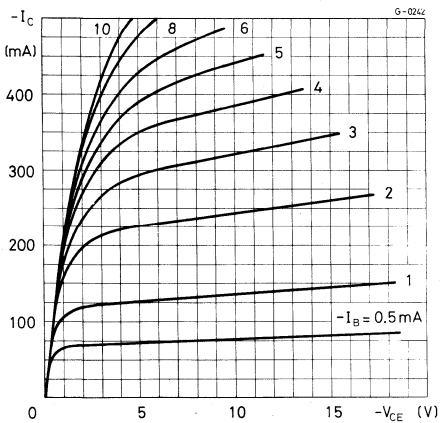
* Pulsed: pulse duration = 300 μs, duty factor = 1.5%

BC 303 BC 304

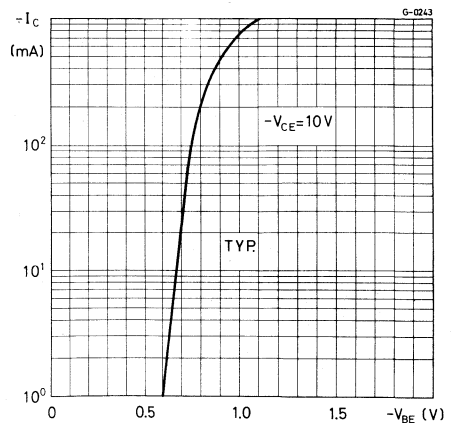
ELECTRICAL CHARACTERISTICS (continued)

Parameter	Test conditions	Min.	Typ.	Max.	Unit
h_{re} Reverse voltage ratio	$I_C = -5 \text{ mA}$ $f = 1 \text{ kHz}$ $V_{CE} = -10 \text{ V}$		1.7×10^{-4}		—
h_{fe} Small signal current gain	$I_C = -5 \text{ mA}$ $f = 1 \text{ kHz}$ $V_{CE} = -10 \text{ V}$		140		—
h_{oe} Output admittance	$I_C = -5 \text{ mA}$ $f = 1 \text{ kHz}$ $V_{CE} = -10 \text{ V}$		45		μS

Typical output characteristics

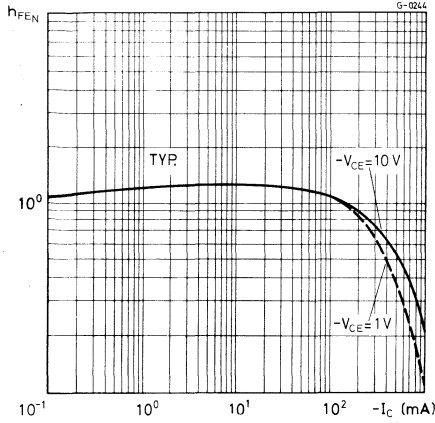


DC transconductance

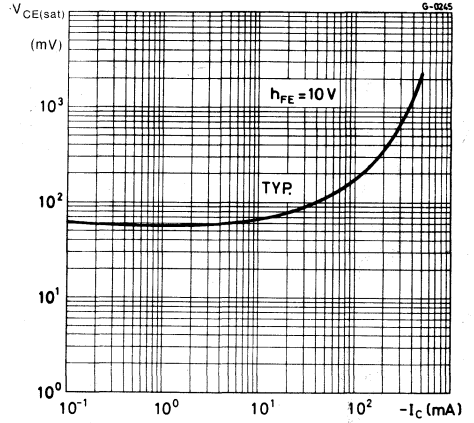


BC 303 BC 304

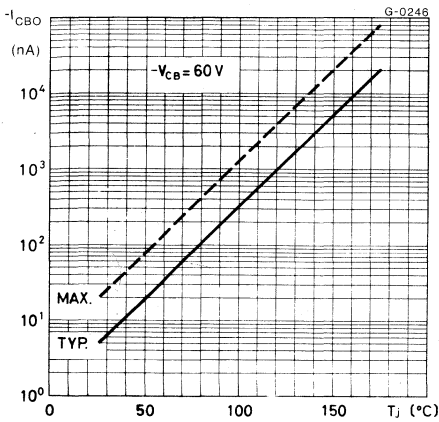
DC normalized current gain



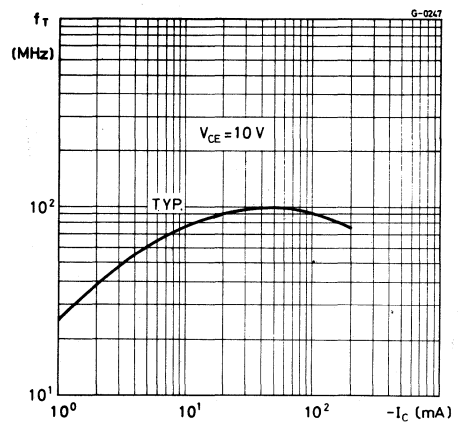
Collector-emitter saturation voltage



Collector cutoff current



Transition frequency



BC 377
BC 378

SILICON PLANAR NPN

AUDIO DRIVERS OR OUTPUT STAGES

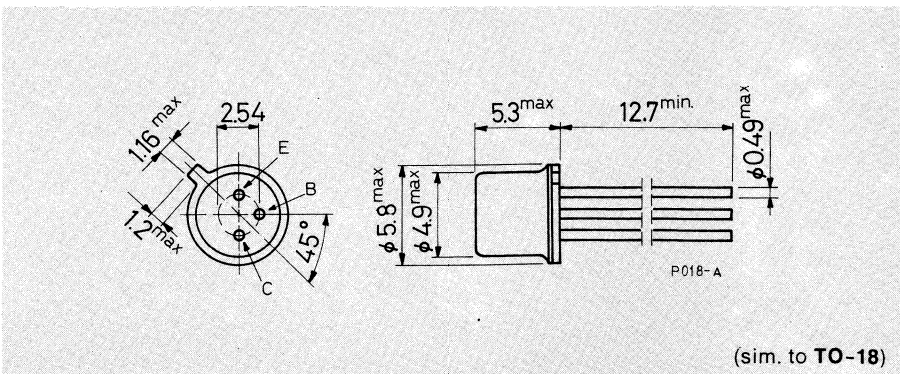
The BC 377 and BC 378 are silicon planar epitaxial NPN transistors in TO-18 metal case. They are particularly intended for use in high current, high gain applications, in driver stages of hi-fi equipments or in output stages of low power class B amplifiers. The complementary PNP types are the BC 297 and BC 298, respectively.

ABSOLUTE MAXIMUM RATINGS

		BC 377	BC 378
V_{CES}	Collector-emitter voltage ($V_{EB} = 0$)	50 V	30 V
V_{CEO}	Collector-emitter voltage ($I_B = 0$)	45 V	25 V
V_{EBO}	Emitter-base voltage ($I_C = 0$)	6 V	
I_E	Emitter current	-1.2 A	
I_C	Collector current	1 A	
I_B	Base current	0.2 A	
P_{tot}	Total power dissipation at $T_{amb} \leq 25^\circ\text{C}$ at $T_{case} \leq 75^\circ\text{C}$	375 mW	
T_{stg}	Storage temperature	-65 to 175 °C	
T_j	Junction temperature	175 °C	

MECHANICAL DATA

Dimensions in mm



BC 377 BC 378

THERMAL DATA

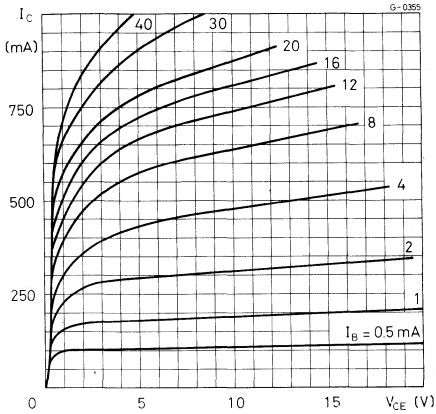
$R_{th\ j-case}$	Thermal resistance junction-case	max	100	°C/W
$R_{th\ j-amb}$	Thermal resistance junction-ambient	max	400	°C/W

ELECTRICAL CHARACTERISTICS ($T_{case} = 25\text{ °C}$ unless otherwise specified)

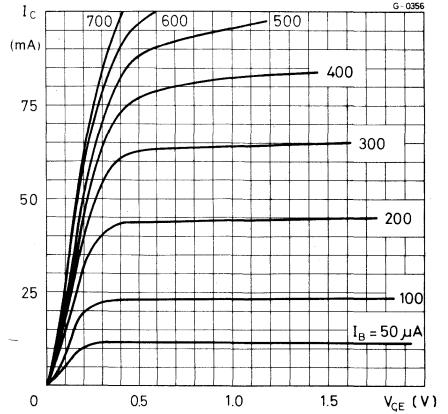
Parameter	Test conditions	Min.	Typ.	Max.	Unit
I_{CES} Collector cutoff current ($V_{BE} = 0$)	for BC 377 $V_{CE} = 50\text{ V}$ for BC 378 $V_{CE} = 30\text{ V}$			15 15	nA nA
$V_{(BR)\ EBO}$ Emitter-base breakdown voltage ($I_C = 0$)	$I_E = 10\ \mu\text{A}$	6			V
$V_{(BR)\ CEO}$ Collector-emitter breakdown voltage ($I_B = 0$)	$I_C = 2\text{ mA}$ for BC 377 for BC 378	45 25			V V
$V_{CE(sat)}$ Collector-emitter saturation voltage	$I_C = 500\text{ mA}$ $I_B = 50\text{ mA}$			0.7	V
V_{BE} Base-emitter voltage	$I_C = 100\text{ mA}$ $V_{CE} = 1\text{ V}$		740		mV
$V_{BE(sat)}$ Base-emitter saturation voltage	$I_C = 500\text{ mA}$ $I_B = 50\text{ mA}$			1.2	V
h_{FE} DC current gain Gr. 6 Gr. 7	$I_C = 100\text{ mA}$ $V_{CE} = 1\text{ V}$ $I_C = 100\text{ mA}$ $V_{CE} = 1\text{ V}$ $I_C = 300\text{ mA}$ $V_{CE} = 1\text{ V}$	75 125 40		150 260	— — —
h_{FE1}/h_{FE2} Matched pair ratio	$I_C = 100\text{ mA}$ $V_{CE} = 1\text{ V}$			1.41	—
f_T Transition frequency	$I_C = 50\text{ mA}$ $V_{CE} = 10\text{ V}$		300		MHz
C_{CBO} Collector-base capacitance	$I_E = 0$ $V_{CB} = 10\text{ V}$		8		pF
C_{EBO} Emitter-base capacitance	$I_C = 0$ $V_{EB} = 0.5\text{ V}$		30		pF

BC 377 BC 378

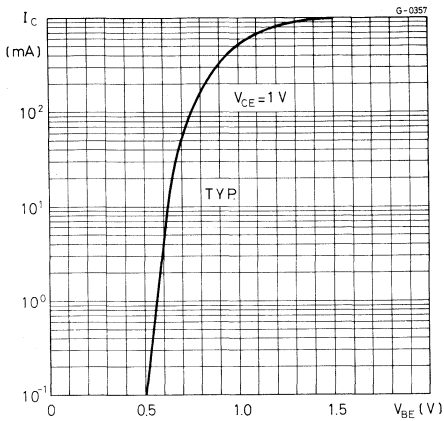
Typical output characteristics



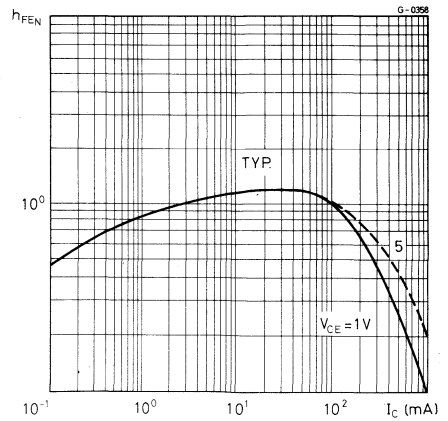
Typical output characteristics



DC transconductance

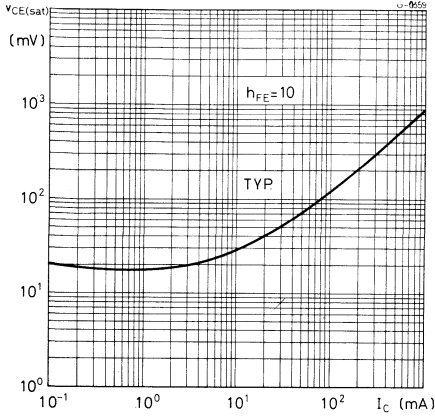


DC normalized current gain

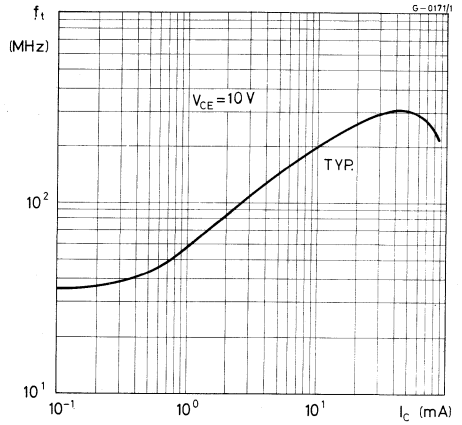


BC 377 BC 378

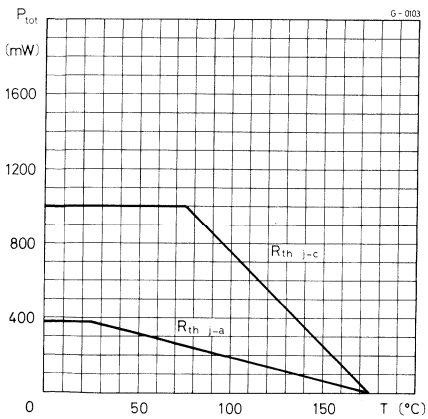
Collector-emitter saturation voltage



Transition frequency



Power rating chart



BC 393

SILICON PLANAR PNP

HIGH VOLTAGE AMPLIFIER

The BC 393 is a silicon planar epitaxial PNP transistor in Jedec TO-18 metal case, designed for general purpose high-voltage and video amplifier applications.

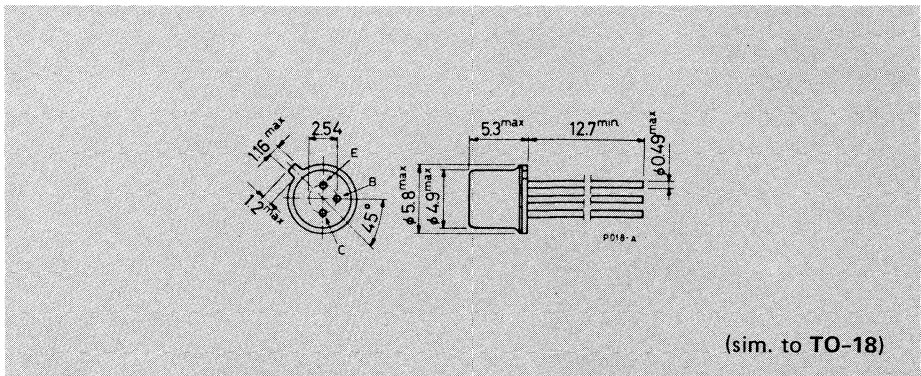
The complementary NPN type is the BC 394.

ABSOLUTE MAXIMUM RATINGS

V_{CBO}	Collector-base voltage ($I_E = 0$)	-180	V
V_{CEO}	Collector-emitter voltage ($I_B = 0$)	-180	V
V_{EBO}	Emitter-base voltage ($I_C = 0$)	-6	V
I_C	Collector current	-100	mA
P_{tot}	Total power dissipation at $T_{amb} \leq 25^\circ\text{C}$	0.4	W
	at $T_{case} \leq 25^\circ\text{C}$	1.4	W
T_{stg}	Storage temperature	-55 to 200	$^\circ\text{C}$
T_j	Junction temperature	200	$^\circ\text{C}$

MECHANICAL DATA

Dimensions in mm



BC 393

THERMAL DATA

$R_{th\ j-case}$	Thermal resistance junction-case	max	125	°C/W
$R_{th\ j-amb}$	Thermal resistance junction-ambient	max	440	°C/W

ELECTRICAL CHARACTERISTICS ($T_{amb} = 25\text{ °C}$ unless otherwise specified)

Parameter	Test conditions	Min.	Typ.	Max.	Unit
I_{CBO}	Collector cutoff current ($I_E = 0$)			50 50	nA μA
$V_{(BR)CBO}$	Collector-base breakdown voltage ($I_E = 0$)		-180		V
$V_{CEO(sus)}$ *	Collector-emitter sustaining voltage ($I_B = 0$)		-180		V
$V_{(BR)EBO}$	Emitter-base breakdown voltage ($I_C = 0$)		-6		V
$V_{CE(sat)}$	Collector-emitter saturation voltage	$I_C = -10\text{ mA}$ $I_C = -50\text{ mA}$	$I_B = -1\text{ mA}$ $I_B = -5\text{ mA}$	-100 -300 -230	mV mV
$V_{BE(sat)}$	Base-emitter saturation voltage	$I_C = -10\text{ mA}$ $I_C = -50\text{ mA}$	$I_B = -1\text{ mA}$ $I_B = -5\text{ mA}$	-750 -900 -850	mV mV
h_{FE} *	DC current gain	$I_C = -1\text{ mA}$ $I_C = -10\text{ mA}$	$V_{CE} = -10\text{ V}$ $V_{CE} = -10\text{ V}$	50 140 150	— —
f_T	Transition frequency	$I_C = -10\text{ mA}$	$V_{CE} = -10\text{ V}$	50 120	MHz
C_{CBO}	Collector-base capacitance	$I_E = 0$ $f = 1\text{ MHz}$	$V_{CB} = -10\text{ V}$	4 7	pF

* Pulsed: pulse duration = 300 μs , duty cycle = 1%

BC 394

SILICON PLANAR NPN

HIGH VOLTAGE AMPLIFIER

The BC 394 is a silicon planar epitaxial NPN transistor in Jedec TO-18 metal case, designed for general purpose high-voltage and video amplifier applications.

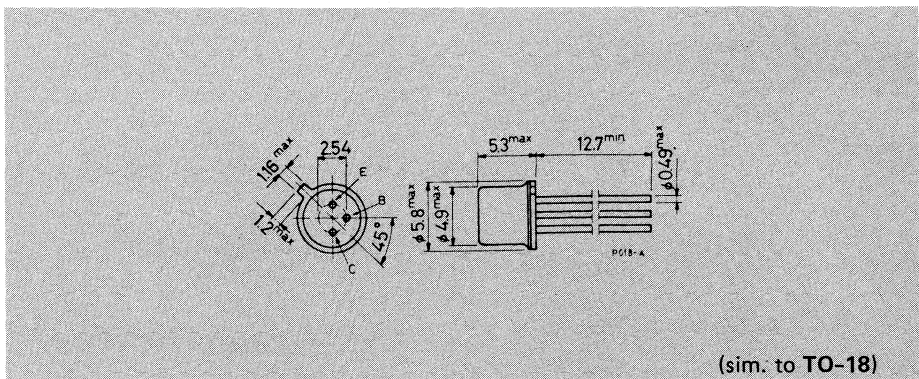
The complementary PNP type is the BC 393.

ABSOLUTE MAXIMUM RATINGS

V_{CBO}	Collector-base voltage ($I_E = 0$)	180	V
V_{CEO}	Collector-emitter voltage ($I_B = 0$)	180	V
V_{EBO}	Emitter-base voltage ($I_C = 0$)	6	V
I_C	Collector current	100	mA
P_{tot}	Total power dissipation at $T_{amb} \leq 25^\circ\text{C}$	0.4	W
	at $T_{case} \leq 25^\circ\text{C}$	1.4	W
T_{stg}	Storage temperature	-55 to 200	$^\circ\text{C}$
T_j	Junction temperature	200	$^\circ\text{C}$

MECHANICAL DATA

Dimensions in mm



BC 394

THERMAL DATA

$R_{th\ j-case}$	Thermal resistance junction-case	max	125	°C/W
$R_{th\ j-amb}$	Thermal resistance junction-ambient	max	440	°C/W

ELECTRICAL CHARACTERISTICS ($T_{amb} = 25\text{ °C}$ unless otherwise specified)

Parameter	Test conditions	Min.	Typ.	Max.	Unit
I_{CBO}	Collector cutoff current ($I_E = 0$) $V_{CB} = 100V$ $V_{CB} = 100V$ $T_{amb} = 150\text{ °C}$			50 50	nA μA
$V_{(BR)CBO}$	Collector-base breakdown voltage ($I_E = 0$) $I_C = 100\ \mu A$	180			V
$V_{CEO(sus)}$	*Collector-emitter sustaining voltage ($I_B = 0$) $I_C = 10\text{ mA}$	180			V
$V_{(BR)EBO}$	Emitter-base breakdown voltage ($I_C = 0$) $I_E = 100\ \mu A$	6			V
$V_{CE(sat)}$	Collector-emitter saturation voltage $I_C = 10\text{ mA}$ $I_B = 1\text{ mA}$ $I_C = 50\text{ mA}$ $I_B = 5\text{ mA}$		200 400	300	mV mV
$V_{BE(sat)}$	Base-emitter saturation voltage $I_C = 10\text{ mA}$ $I_B = 1\text{ mA}$ $I_C = 50\text{ mA}$ $I_B = 5\text{ mA}$		750 850	900	mV mV
h_{FE}^*	DC current gain $I_C = 1\text{ mA}$ $V_{CE} = 10V$ $I_C = 10\text{ mA}$ $V_{CE} = 10V$	30	80 90		— —
f_T	Transition frequency $I_C = 10\text{ mA}$ $V_{CE} = 10V$	50	90		MHz
C_{CBO}	Collector-base capacitance $I_E = 0$ $V_{CB} = 10V$ $f = 1\text{ MHz}$		5		pF

* Pulsed: pulse duration = 300 μs , duty cycle = 1%

BC 440
BC 441

SILICON PLANAR NPN

MEDIUM POWER AMPLIFIER

The BC 440 and BC 441 are silicon planar epitaxial NPN transistors in TO-39 metal case. They are intended for general purpose applications, especially for driver stages.

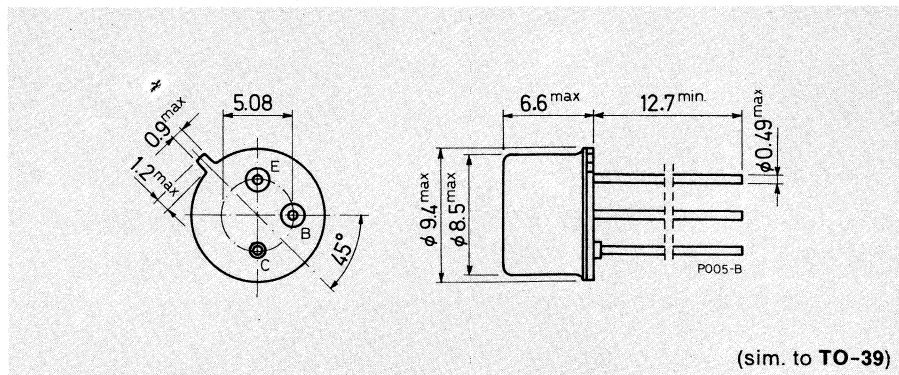
The complementary PNP types are respectively the BC 460 and BC 461.

ABSOLUTE MAXIMUM RATINGS

	BC 440	BC 441	
V_{CBO}	Collector-base voltage ($I_E = 0$)	50 V	75 V
$V_{CEO (sus)}$	Collector-emitter voltage ($I_B = 0$)	40 V	60 V
V_{CER}	Collector-emitter voltage ($R_{BE} \leq 100 \Omega$)	50 V	75 V
V_{EBO}	Emitter-base voltage ($I_C = 0$)	5 V	
I_{CM}	Collector peak current	2 A	
I_{BM}	Base peak current	1 A	
P_{tot}	Total power dissipation at $T_{amb} \leq 25^\circ C$ at $T_{case} \leq 25^\circ C$	1 W 10 W	
T_{stg}	Storage temperature	-65 to 200 °C	
T_j	Junction temperature	200 °C	

MECHANICAL DATA

Dimensions in mm



BC 440 BC 441

THERMAL DATA

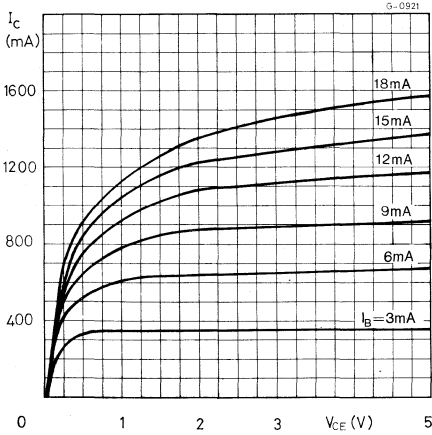
$R_{th\ j-case}$	Thermal resistance junction-case	max	17.5	°C/W
$R_{th\ j-amb}$	Thermal resistance junction-ambient	max	175	°C/W

ELECTRICAL CHARACTERISTICS ($T_{case} = 25\text{ °C}$ unless otherwise specified)

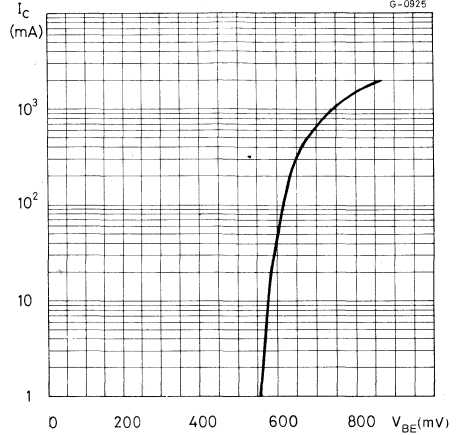
Parameter	Test conditions	Min.	Typ.	Max.	Unit
I_{CBO} Collector cutoff current ($I_E = 0$)	$V_{CB} = 40\text{ V}$			100	nA
I_{CER} Collector cutoff current ($R_{BE} = 100\ \Omega$)	for BC 440 $V_{CE} = 50\text{ V}$ for BC 441 $V_{CE} = 70\text{ V}$			10 10	μA μA
$V_{(BR)\ EBO}$ Emitter-base breakdown voltage ($I_C = 0$)	$I_E = 100\ \mu\text{A}$		5		V
$V_{CEO(sus)}$ Collector-emitter voltage ($I_B = 0$)	$I_C = 100\text{ mA}$ for BC 440 for BC 441	40 60			V V
$V_{CE(sat)}$ Collector-emitter saturation voltage	$I_C = 1\text{ A}$ $I_B = 100\text{ mA}$			1	V
$V_{BE(sat)}$ Base-emitter saturation voltage	$I_C = 1\text{ A}$ $I_B = 100\text{ mA}$			1.5	V
h_{FE} DC current gain	Gr. 4 $I_C = 500\text{ mA}$ $V_{CE} = 4\text{ V}$ Gr. 5 $I_C = 500\text{ mA}$ $V_{CE} = 4\text{ V}$ Gr. 6 $I_C = 500\text{ mA}$ $V_{CE} = 4\text{ V}$ $I_C = 1\text{ A}$ $V_{CE} = 2\text{ V}$ (for BC 440 only)	40 60 115 20		70 130 250	— — — —
h_{FE1}/h_{FE2} Matched pair ratio	$I_C = 500\text{ mA}$ $V_{CE} = 4\text{ V}$			1.4	—
f_T Transition frequency	$I_C = 50\text{ mA}$ $V_{CE} = 4\text{ V}$		50		MHz

BC 440 BC 441

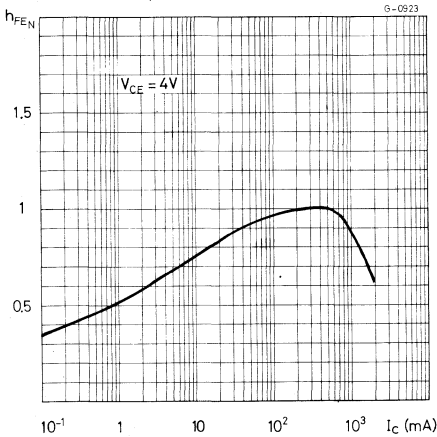
Typical output characteristics



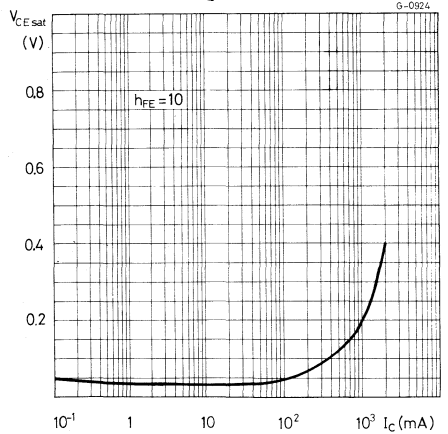
Typical DC transconductance



Typical DC normalized current gain



Typical collector-emitter saturation voltage



SILICON PLANAR PNP

MEDIUM POWER AMPLIFIER

The BC 460 and BC 461 are silicon planar epitaxial PNP transistors in TO-39 metal case. They are intended for general purpose applications, especially for driver stages.

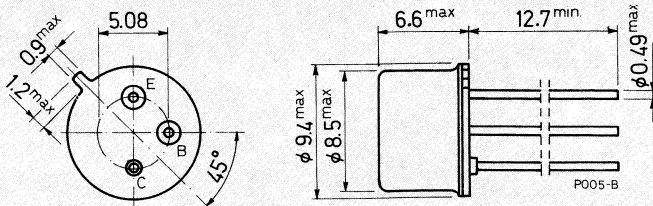
The complementary NPN types are respectively the BC 440 and BC 441.

ABSOLUTE MAXIMUM RATINGS

		BC 460	BC 461
V_{CBO}	Collector-base voltage ($I_E = 0$)	-50 V	-75 V
$V_{CEO (sus)}$	Collector-emitter voltage ($I_B = 0$)	-40 V	-60 V
V_{CER}	Collector-emitter voltage ($R_{BE} \leq 100 \Omega$)	-50 V	-75 V
V_{EBO}	Emitter-base voltage ($I_C = 0$)		-5 V
I_{CM}	Collector peak current		-2 A
I_{BM}	Base peak current		-1 A
P_{tot}	Total power dissipation at $T_{amb} \leq 25^\circ C$ at $T_{case} \leq 25^\circ C$		1 W 10 W
T_{stg}	Storage temperature		-65 to 200 °C
T_j	Junction temperature		200 °C

MECHANICAL DATA

Dimensions in mm



(sim. to TO-39)

BC 460 BC 461

THERMAL DATA

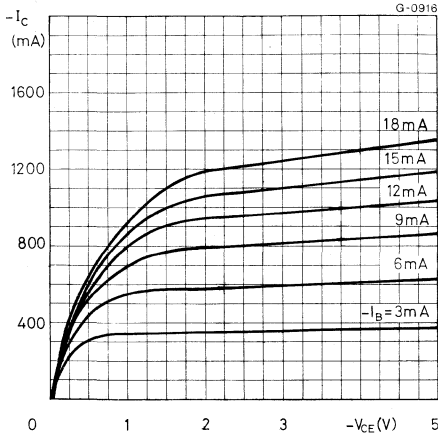
$R_{th\ j-case}$	Thermal resistance junction-case	max	17.5	°C/W
$R_{th\ j-amb}$	Thermal resistance junction-ambient	max	175	°C/W

ELECTRICAL CHARACTERISTICS (T_{case} = 25 °C unless otherwise specified)

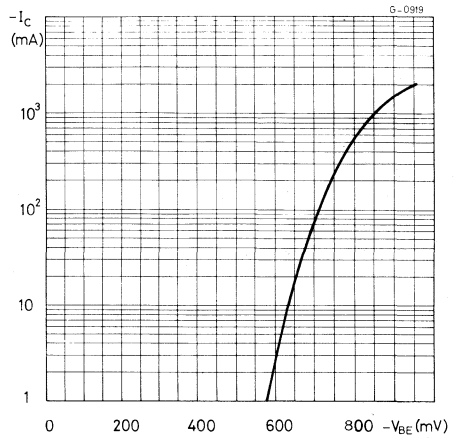
Parameter	Test conditions	Min.	Typ.	Max.	Unit
I_{CBO} Collector cutoff current ($I_E = 0$)	$V_{CB} = -40\text{ V}$			-100	nA
I_{CER} Collector cutoff current ($R_{BE} = 100\ \Omega$)	for BC 460 $V_{CE} = -50\text{ V}$ for BC 461 $V_{CE} = -70\text{ V}$			-10 -10	μA μA
$V_{(BR)\ EBO}$ Emitter-base breakdown voltage ($I_C = 0$)	$I_E = -100\ \mu\text{A}$			-5	V
$V_{CEO(sus)}$ Collector-emitter voltage ($I_B = 0$)	$I_C = -100\text{ mA}$ for BC 460 for BC 461	-40 -60			V V
$V_{CE(sat)}$ Collector-emitter saturation voltage	$I_C = -1\text{ A}$ $I_B = -100\text{ mA}$			-1	V
$V_{BE(sat)}$ Base-emitter saturation voltage	$I_C = -1\text{ A}$ $I_B = -100\text{ mA}$			-1.5	V
h_{FE} DC current gain	Gr. 4 $I_C = -500\text{ mA}$ $V_{CE} = -4\text{ V}$ Gr. 5 $I_C = -500\text{ mA}$ $V_{CE} = -4\text{ V}$ Gr. 6 $I_C = -500\text{ mA}$ $V_{CE} = -4\text{ V}$ $I_C = -1\text{ A}$ $V_{CE} = -2\text{ V}$ (for BC 460 only)	40 60 115 20	70 130 250		— — — —
h_{FE1}/h_{FE2} Matched pair ratio	$I_C = -500\text{ mA}$ $V_{CE} = -4\text{ V}$			1.4	—
f_T Transition frequency	$I_C = -50\text{ mA}$ $V_{CE} = -4\text{ V}$		50		MHz

BC 460 BC 461

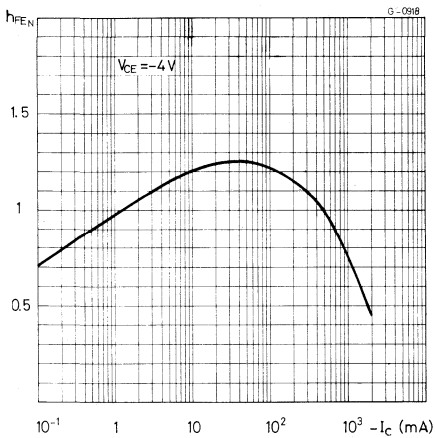
Typical output characteristics



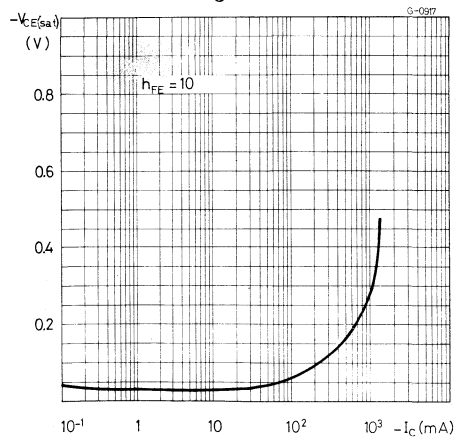
Typical DC transconductance



Typical DC normalized current gain



Typical collector-emitter saturation voltage



BC 477
BC 478
BC 479

SILICON PLANAR PNP

LOW NOISE GENERAL PURPOSE AUDIO AMPLIFIERS

The BC 477, BC 478 and BC 479 are silicon planar epitaxial PNP transistors in TO-18 metal case.

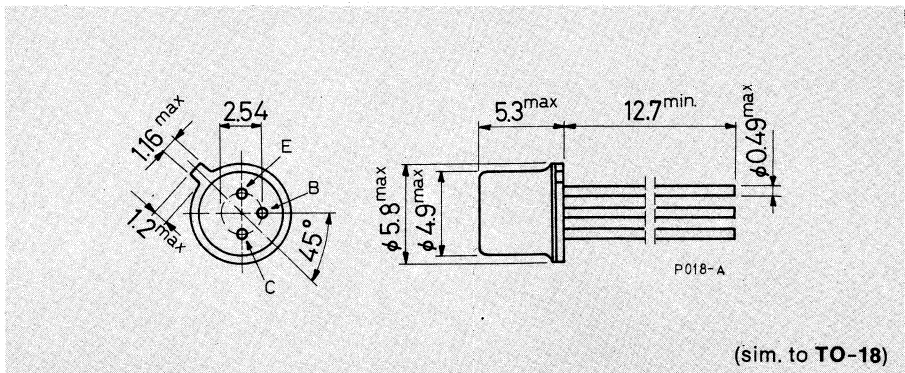
The BC 477 is a high voltage type designed for use in audio amplifiers or driver stages, and in the signal processing circuits of TV sets. The BC 478 and BC 479 are respectively low noise and very low noise types, designed for general preamplifier or amplifier applications.

ABSOLUTE MAXIMUM RATINGS

		BC 477	BC 478	BC 479
V_{CES}	Collector-emitter voltage ($V_{BE} = 0$)	-90 V	-50 V	-40 V
V_{CEO}	Collector-emitter voltage ($I_B = 0$)	-80 V	-50 V	-40 V
V_{EBO}	Emitter-base voltage ($I_C = 0$)	-6 V		
I_C	Collector current	-150 mA		
P_{tot}	Total power dissipation at $T_{amb} \leq 25^\circ\text{C}$	0.36 W		
	at $T_{case} \leq 25^\circ\text{C}$	1.2 W		
T_{stg}	Storage temperature	-55 to 200°C		
T_j	Junction temperature	200°C		

MECHANICAL DATA

Dimensions in mm



BC 477
BC 478
BC 479

THERMAL DATA

$R_{th\ j-case}$	Thermal resistance junction-case	max	146	°C/W
$R_{th\ j-amb}$	Thermal resistance junction-ambient	max	480	°C/W

ELECTRICAL CHARACTERISTICS ($T_{amb} = 25\text{ °C}$ unless otherwise specified)

Parameter	Test conditions	Min.	Typ.	Max.	Unit
I_{CES} Collector cutoff current ($V_{BE} = 0$)	for BC 477 $V_{CE} = -70\text{ V}$ $V_{CE} = -70\text{ V}$ $T_{amb} = 125\text{ °C}$ for BC 478 $V_{CE} = -40\text{ V}$ $V_{CE} = -40\text{ V}$ $T_{amb} = 125\text{ °C}$ for BC 479 $V_{CE} = -30\text{ V}$ $V_{CE} = -30\text{ V}$ $T_{amb} = 125\text{ °C}$			-10 -10 -10 -10 -10 -10	nA μA nA μA nA μA
I_{EBO} Emitter cutoff current ($I_C = 0$)	$V_{EB} = -4\text{ V}$			-10	nA
$V_{(BR)\ CES}$ Collector-emitter breakdown voltage ($V_{BE} = 0$)	$I_C = -10\text{ μA}$ for BC 477 for BC 478 for BC 479	-90 -50 -40			V V V
$V_{(BR)\ CEO}^*$ Collector-emitter breakdown voltage ($I_B = 0$)	$I_C = -5\text{ mA}$ for BC 477 for BC 478 for BC 479	-80 -50 -40			V V V
$V_{(BR)\ EBO}$ Emitter-base breakdown voltage ($I_C = 0$)	$I_E = -10\text{ μA}$	-6			V

* Pulsed: pulse duration = 300 μs, duty factor = 1%

BC 477
BC 478
BC 479

ELECTRICAL CHARACTERISTICS (continued)

Parameter	Test conditions	Min.	Typ.	Max.	Unit
$V_{CE(sat)}$ * Collector-emitter saturation voltage	$I_C = -10\text{ mA}$ $I_B = -0.5\text{ mA}$		-0.1	-0.25	V
	$I_C = -100\text{ mA}$ $I_B = -5\text{ mA}$		-0.3		V
V_{BE} * Base-emitter voltage	$I_C = -2\text{ mA}$ $V_{CE} = -5\text{ V}$	-0.55	-0.65	-0.75	V
$V_{BE(sat)}$ * Base-emitter saturation voltage	$I_C = -10\text{ mA}$ $I_B = -0.5\text{ mA}$		-0.75	-0.9	V
	$I_C = -100\text{ mA}$ $I_B = -5\text{ mA}$		-0.9		V
h_{FE} * DC current gain	$I_C = -10\text{ }\mu\text{A}$ $V_{CE} = -5\text{ V}$ for BC 477 for BC 477 Gr. VI for BC 477 Gr. A for BC 478 for BC 478 Gr. A for BC 478 Gr. B		30	115	—
			30	70	—
			50	130	—
			50	195	—
			50	130	—
			100	250	—
	$I_C = -2\text{ mA}$ $V_{CE} = -5\text{ V}$ for BC 477 for BC 477 Gr. VI for BC 477 Gr. A for BC 478 for BC 478 Gr. A for BC 478 Gr. B		100	290	—
			100	250	—
			70	250	—
			70	130	—
			110	250	—
			110	450	—
	$I_C = -10\text{ mA}$ $V_{CE} = -5\text{ V}$ for BC 477 for BC 477 Gr. VI for BC 477 Gr. A for BC 478 for BC 478 Gr. A for BC 478 Gr. B		110	250	—
			110	450	—
			110	250	—
			220	450	—
			220	—	—
			220	450	—
for BC 479 for BC 479 Gr. B		220	450	—	
		220	450	—	
		220	450	—	
		220	450	—	
		220	450	—	
		220	450	—	
$I_C = -10\text{ mA}$ $V_{CE} = -5\text{ V}$ for BC 477 for BC 477 Gr. VI for BC 477 Gr. A for BC 478 for BC 478 Gr. A for BC 478 Gr. B		160	—	—	
		100	—	—	
		180	—	—	
		270	—	—	
		180	—	—	
		350	—	—	
for BC 479 for BC 479 Gr. B		400	—	—	
		350	—	—	

* Pulsed: pulse duration = 300 μs , duty factor = 1%

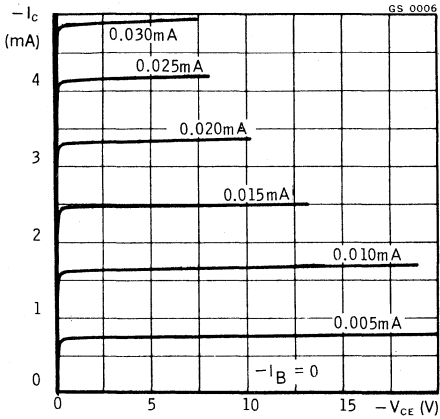
BC 477
BC 478
BC 479

ELECTRICAL CHARACTERISTICS (continued)

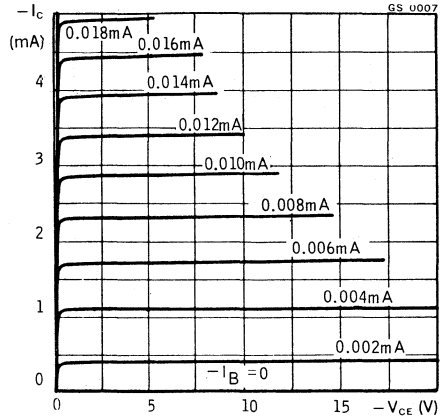
Parameter	Test conditions	Min.	Typ.	Max.	Unit	
h_{fe} Small signal current gain	$I_C = -2 \text{ mA}$ $V_{CE} = -5 \text{ V}$ $f = 1 \text{ kHz}$					
	for BC 477 for BC 477 Gr. VI for BC 477 Gr. A for BC 478 for BC 478 Gr. A for BC 478 Gr. B for BC 479 for BC 479 Gr. B	75 75 125 125 125 240 240 240		260 150 260 500 260 500 500	— — — — — — — —	
	$I_C = -10 \text{ mA}$ $V_{CE} = -5 \text{ V}$ $f = 20 \text{ MHz}$		7.5		—	
C_{CBO} Collector-base capacitance	$I_E = 0$ $V_{CB} = -5 \text{ V}$		4	6	pF	
C_{EBO} Emitter-base capacitance	$I_C = 0$ $V_{EB} = -0.5 \text{ V}$		11	15	pF	
NF Noise figure	$I_C = -20 \mu\text{A}$ $V_{CE} = -5 \text{ V}$ $R_g = 10 \text{ k}\Omega$ $f = 10 \text{ Hz to } 10 \text{ kHz}$ $B = 15.7 \text{ kHz}$ for BC 479		0.8	3.5	dB	
	$I_C = -200 \mu\text{A}$ $V_{CE} = -5 \text{ V}$ $R_g = 2 \text{ k}\Omega$ $f = 10 \text{ Hz to } 10 \text{ kHz}$ $B = 15.7 \text{ kHz}$ for BC 478 for BC 479		1.5 1		dB dB	
	$I_C = -20 \mu\text{A}$ $V_{CE} = -5 \text{ V}$ $R_g = 10 \text{ k}\Omega$ $f = 1 \text{ kHz}$ $B = 200 \text{ Hz}$ for BC 479		0.5	2.5	dB	
	$I_C = -200 \mu\text{A}$ $V_{CE} = -5 \text{ V}$ $R_g = 2 \text{ k}\Omega$ $f = 1 \text{ kHz}$ $B = 200 \text{ Hz}$ for BC 477 for BC 478 for BC 479			2 1.2 0.8	10 6 4	dB dB dB

BC 477 BC 478 BC 479

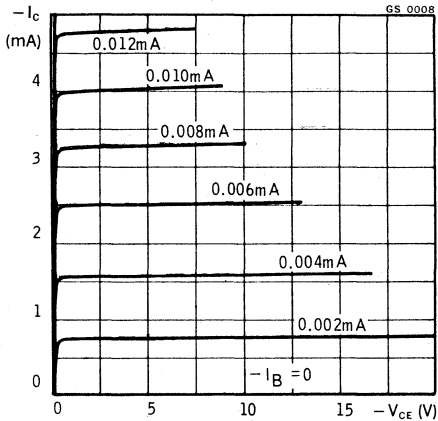
Typical output characteristics
(for BC 477 only)



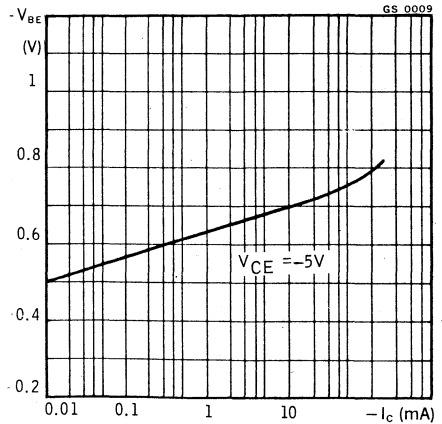
Typical output characteristics
(for BC 478 only)



Typical output characteristics
(for BC 479 only)

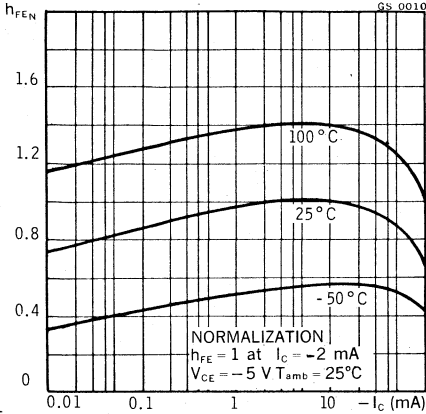


DC transconductance

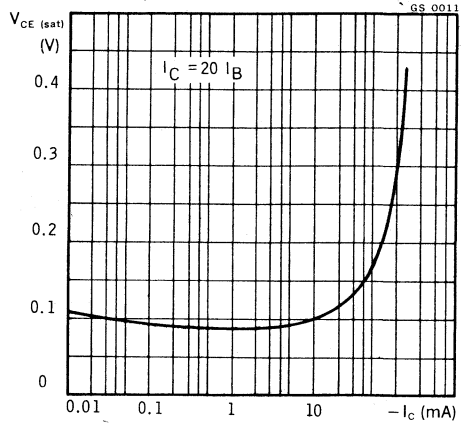


BC 477
BC 478
BC 479

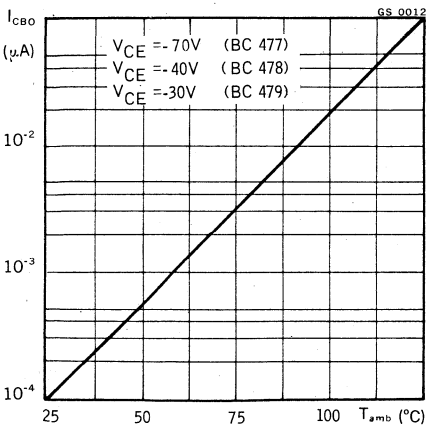
DC normalized current gain



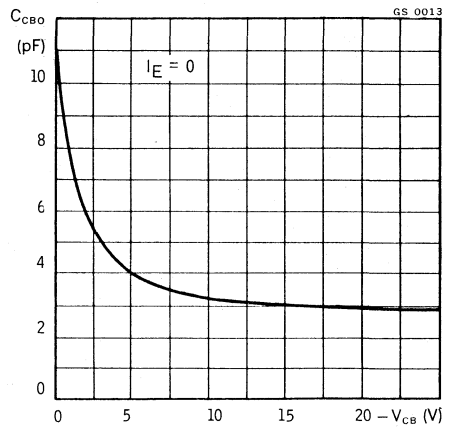
Typical collector-emitter saturation voltage



Typical collector cutoff current

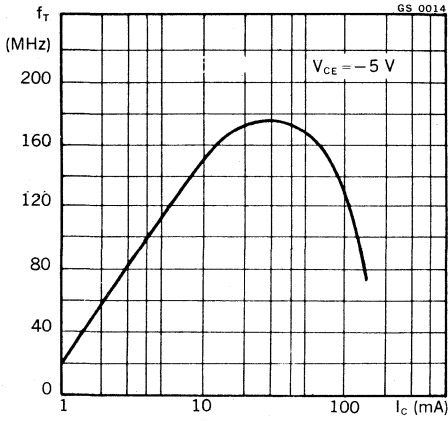


Typical collector-base capacitance

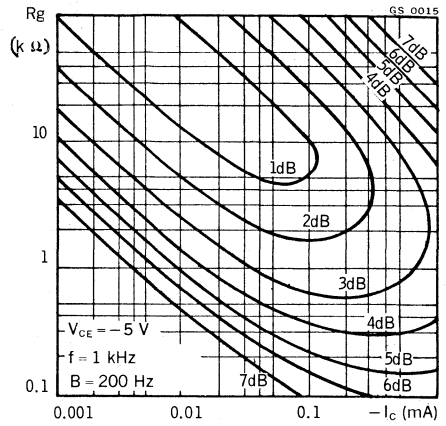


BC 477
BC 478
BC 479

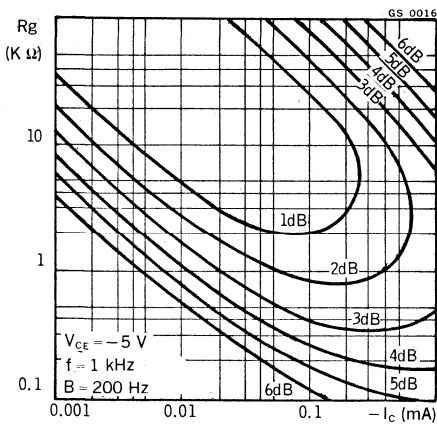
Transition frequency



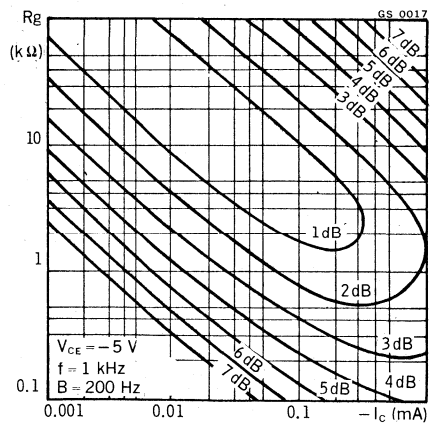
Noise figure (for BC 477 only)



Noise figure (for BC 478 only)

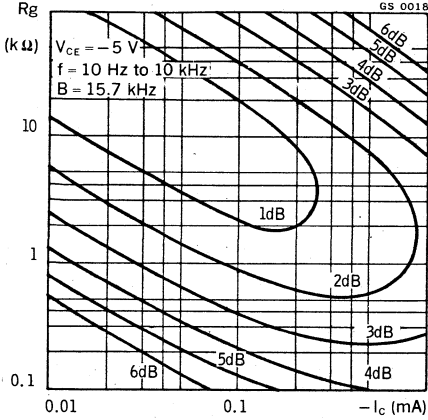


Noise figure (for BC 479 only)

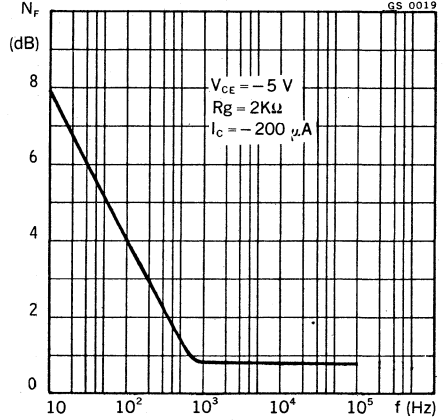


BC 477
BC 478
BC 479

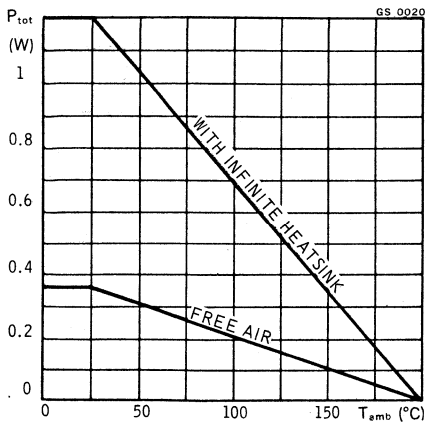
Noise figure (for BC 479 only)



Noise figure (for BC 479 only)



Power rating chart



SILICON PLANAR NPN**UHF AMPLIFIER AND MIXER-OSCILLATOR**

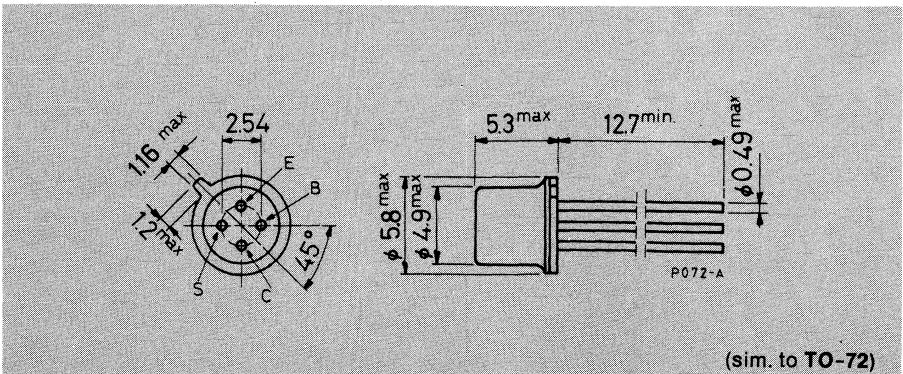
The BF 155 is a silicon planar NPN transistor in a TO-72 metal case. It is specifically designed for UHF amplifier and mixer-oscillator applications up to 900 MHz.

ABSOLUTE MAXIMUM RATINGS

V_{CBO}	Collector-base voltage ($I_E = 0$)	40 V
V_{CEO}	Collector-emitter voltage ($I_B = 0$)	40 V
V_{EBO}	Emitter-base voltage ($I_C = 0$)	3 V
I_C	Collector current	20 mA
P_{tot}	Total power dissipation at $T_{amb} \leq 25^\circ\text{C}$	200 mW
	at $T_{case} \leq 25^\circ\text{C}$	300 mW
T_{stg}	Storage temperature	-55 to 200 °C
T_j	Junction temperature	200 °C

MECHANICAL DATA

Dimensions in mm



BF 155

THERMAL DATA

$R_{th\ j-case}$	Thermal resistance junction-case	max	580	°C/W
$R_{th\ j-amb}$	Thermal resistance junction-ambient	max	875	°C/W

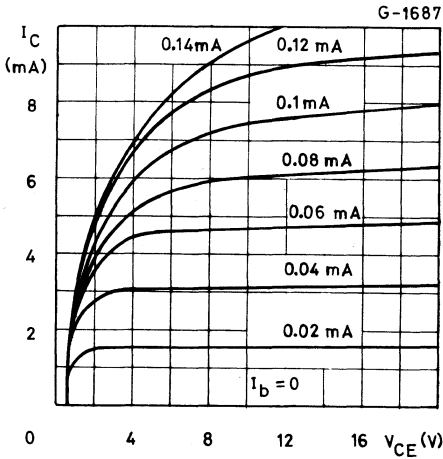
ELECTRICAL CHARACTERISTICS ($T_{amb} = 25\text{ °C}$ unless otherwise specified)

Parameter	Test conditions	Min.	Typ.	Max.	Unit
I_{CB0} Collector cutoff current ($I_E = 0$)	$V_{CB} = 10\text{ V}$			100	nA
$V_{(BR)\ CBO}$ Collector-base breakdown voltage ($I_E = 0$)	$I_C = 100\ \mu\text{A}$	40			V
$V_{(BR)\ CEO}^*$ Collector-emitter breakdown voltage ($I_B = 0$)	$I_C = 5\text{ mA}$	40			V
$V_{(BR)\ EBO}$ Emitter-base breakdown voltage ($I_C = 0$)	$I_E = 100\ \mu\text{A}$	3			V
V_{BE} Base-emitter voltage	$I_C = 2.5\text{ mA}$ $V_{CE} = 12\text{ V}$			0.85	V
h_{FE}^* DC current gain	$I_C = 2.5\text{ mA}$ $V_{CE} = 12\text{ V}$	20	70		—
f_T Transition frequency	$I_C = 2.5\text{ mA}$ $V_{CE} = 12\text{ V}$	400	600		MHz
$-C_{re}$ Reverse capacitance	$I_C = 2.5\text{ mA}$ $V_{CE} = 12\text{ V}$ $f = 1\text{ MHz}$		0.4		pF
NF Noise figure	$I_C = 2.5\text{ mA}$ $V_{CB} = 12\text{ V}$ $R_g = 50\ \Omega$ $f = 800\text{ MHz}$		7	9	dB
G_{pb} Power gain	$I_C = 2.5\text{ mA}$ $V_{CB} = 12\text{ V}$ $f = 800\text{ MHz}$	8	10		dB
f_{max} Maximum oscillation frequency	$I_C = 2.5\text{ mA}$ $V_{CB} = 12\text{ V}$		2.5		GHz

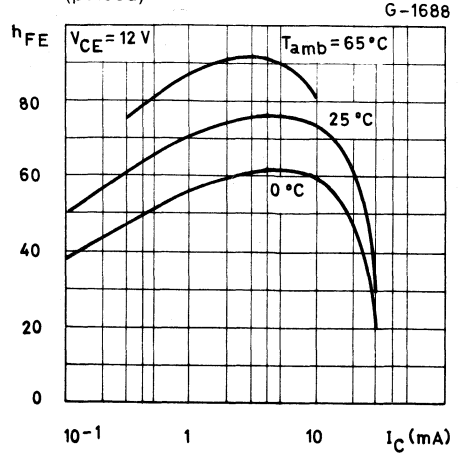
* Pulsed: pulse duration = 300 μs ; duty factor = 1%

BF 155

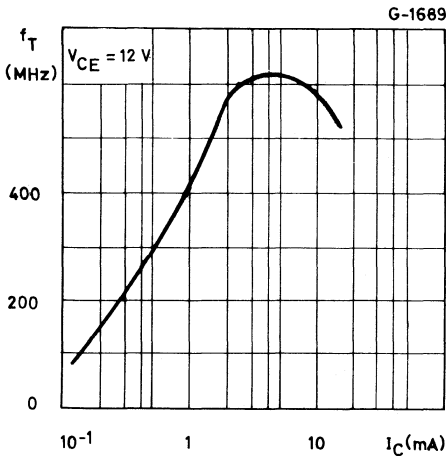
Typical output characteristics



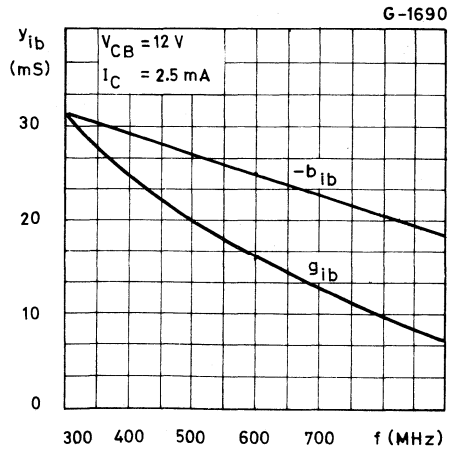
Typical DC current gain (pulsed)



Typical transition frequency

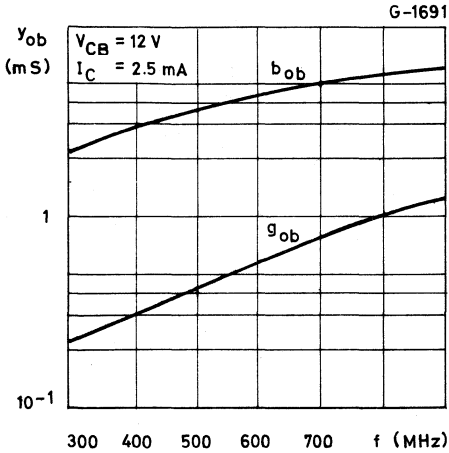


Typical input admittance

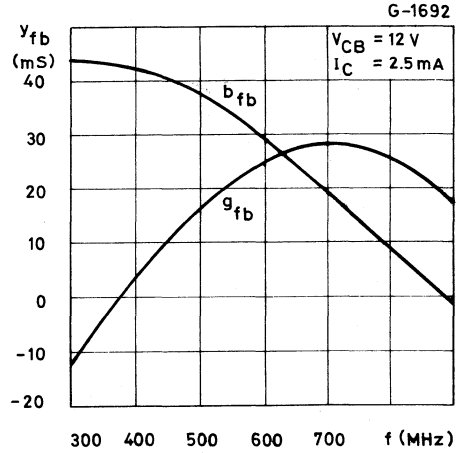


BF 155

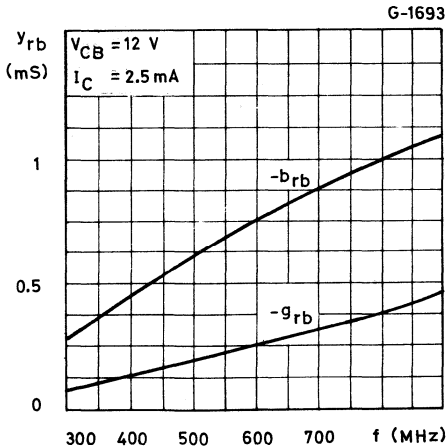
Typical output admittance



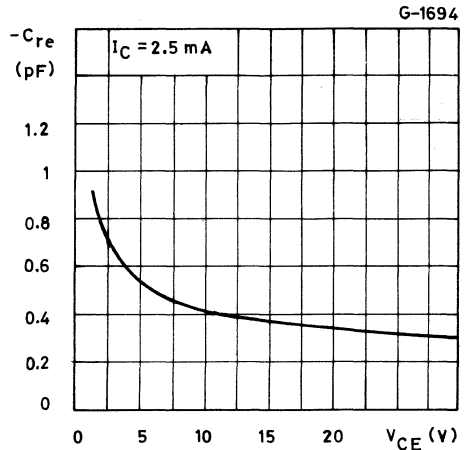
Typical forward transadmittance



Typical reverse transadmittance



Typical reverse capacitance



BF 158

SILICON PLANAR NPN

IF AMPLIFIER FOR TV

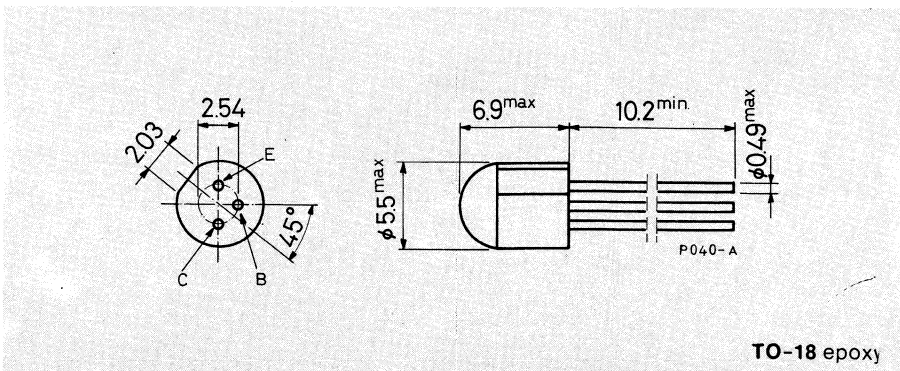
The BF 158 is a silicon planar NPN transistor in a TO-18 epoxy package. It is designed for use as IF amplifier in TV receiver.

ABSOLUTE MAXIMUM RATINGS

V_{CB0}	Collector-base voltage ($I_E = 0$)	30	V
V_{CE0}	Collector-emitter voltage ($I_B = 0$)	12	V
V_{EB0}	Emitter-base voltage ($I_C = 0$)	2	V
P_{tot}	Total power dissipation at $T_{amb} \leq 25^\circ\text{C}$	0.2	W
	at $T_{case} \leq 25^\circ\text{C}$	0.5	W
T_{stg}	Storage temperature	-55 to 125	$^\circ\text{C}$
T_j	Junction temperature	125	$^\circ\text{C}$

MECHANICAL DATA

Dimensions in mm



BF 158

THERMAL DATA

$R_{th\ j-case}$	Thermal resistance junction-case	max	200	°C/W
$R_{th\ j-amb}$	Thermal resistance junction-ambient	max	500	°C/W

ELECTRICAL CHARACTERISTICS ($T_{amb} = 25\text{°C}$ unless otherwise specified)

Parameter	Test conditions	Min.	Typ.	Max.	Unit
I_{CBO} Collector cutoff current ($I_E = 0$)	$V_{CB} = 15\text{ V}$			100	nA
$V_{(BR)\ CBO}$ Collector-base breakdown voltage ($I_E = 0$)	$I_C = 100\ \mu\text{A}$	30			V
$V_{CEO\ (sus)}$ Collector-emitter sustaining voltage ($I_B = 0$)	$I_C = 3\text{ mA}$	12			V
$V_{(BR)\ EBO}$ Emitter-base breakdown voltage ($I_C = 0$)	$I_E = 100\ \mu\text{A}$	2			V
$V_{CE\ (sat)}$ Collector-emitter saturation voltage	$I_C = 10\text{ mA}$ $I_B = 1\text{ mA}$			0.5	V
h_{FE} DC current gain	$I_C = 4\text{ mA}$ $V_{CE} = 10\text{ V}$	20	50		—
f_T Transition frequency	$I_C = 5\text{ mA}$ $V_{CE} = 10\text{ V}$		700		MHz
$-C_{re}$ Reverse capacitance	$I_C = 5\text{ mA}$ $V_{CE} = 10\text{ V}$		0.8	1.2	pF
NF Noise figure	$I_C = 4\text{ mA}$ $V_{CE} = 10\text{ V}$ $R_g = 400\ \Omega$ $f = 40\text{ MHz}$		3.5		dB
G_{pe} Power gain	$I_C = 5\text{ mA}$ $V_{CE} = 10\text{ V}$ $f = 40\text{ MHz}$	22	26		dB
g_{oe} Output conductance	$I_C = 5\text{ mA}$ $V_{CE} = 10\text{ V}$ $f = 40\text{ MHz}$		0.2	0.3	mS

SILICON PLANAR NPN**IF AMPLIFIER FOR AM/FM RADIOS**

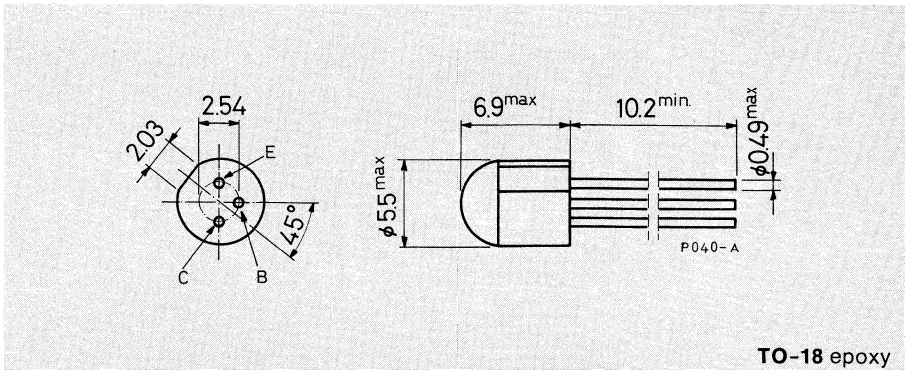
The BF 160 is a silicon planar NPN transistor in a TO-18 epoxy package. It is designed for intermediate frequency (5.5 MHz TV - 10.7 MHz FM) and for general AM-FM applications.

ABSOLUTE MAXIMUM RATINGS

V_{CBO}	Collector-base voltage ($I_E = 0$)	30 V
V_{CEO}	Collector-emitter voltage ($I_B = 0$)	12 V
V_{EBO}	Emitter-base voltage ($I_C = 0$)	2 V
P_{tot}	Total power dissipation at $T_{amb} \leq 25^\circ\text{C}$	200 mW
	at $T_{case} \leq 25^\circ\text{C}$	500 mW
T_{stg}	Storage temperature	-55 to 125 °C
T_j	Junction temperature	125 °C

MECHANICAL DATA

Dimensions in mm



BF 160

THERMAL DATA

$R_{th\ j-case}$	Thermal resistance junction-case	max	200	°C/W
$R_{th\ j-amb}$	Thermal resistance junction-ambient	max	500	°C/W

ELECTRICAL CHARACTERISTICS ($T_{amb} = 25\text{ °C}$ unless otherwise specified)

Parameter		Test conditions	Min.	Typ.	Max.	Unit
I_{CBO}	Collector cutoff current ($I_E = 0$)	$V_{CB} = 15\text{ V}$ $V_{CB} = 15\text{ V}$ $T_{amb} = 65\text{ °C}$			100 5	nA μA
$V_{(BR)CBO}$	Collector-base breakdown voltage ($I_E = 0$)	$I_C = 100\ \mu\text{A}$	30			V
$V_{(BR)CEO}$	*Collector-emitter breakdown voltage ($I_B = 0$)	$I_C = 3\text{ mA}$	12			V
$V_{(BR)EBO}$	Emitter-base breakdown voltage ($I_C = 0$)	$I_E = 100\ \mu\text{A}$	2			V
h_{FE}^*	DC current gain	$I_C = 3\text{ mA}$ $V_{CE} = 10\text{ V}$	20	50		—
f_T	Transition frequency	$I_C = 3\text{ mA}$ $V_{CE} = 10\text{ V}$	400	600		MHz
$-C_{re}$	Reverse capacitance	$I_C = 3\text{ mA}$ $V_{CE} = 10\text{ V}$		0.8	1.2	pF
G_{pe}	Power gain	$I_C = 3\text{ mA}$ $V_{CE} = 8\text{ V}$ $f = 10.7\text{ MHz}$	28	32		dB

* Pulsed: pulse duration = 300 μs , duty factor = 1%.

SILICON PLANAR NPN

UHF AMPLIFIER, OSCILLATOR AND MIXER

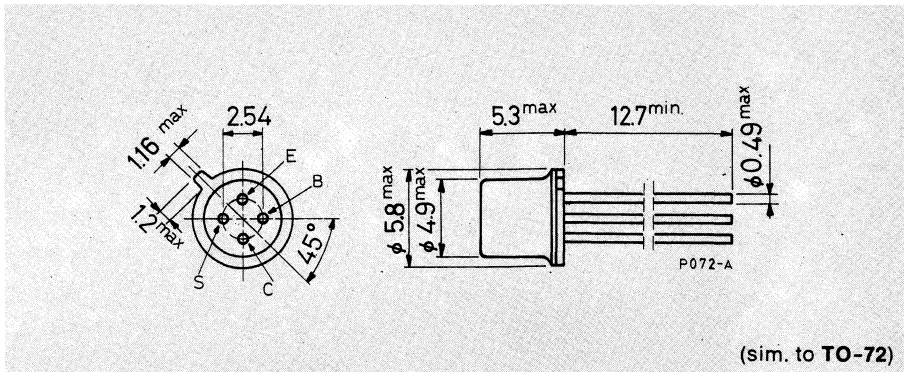
The BF 161 is a silicon planar NPN transistor in a TO-72 metal case, intended for UHF tuner applications.

ABSOLUTE MAXIMUM RATINGS

V_{CBO}	Collector-base voltage ($I_E = 0$)	50 V
V_{CEO}	Collector-emitter voltage ($I_B = 0$)	50 V
V_{EBO}	Emitter-base voltage ($I_C = 0$)	4 V
I_C	Collector current	20 mA
P_{tot}	Total power dissipation at $T_{amb} \leq 25^\circ\text{C}$	175 mW
	at $T_{case} \leq 25^\circ\text{C}$	260 mW
T_{stg}	Storage temperature	-55 to 175 $^\circ\text{C}$
T_j	Junction temperature	175 $^\circ\text{C}$

MECHANICAL DATA

Dimensions in mm



BF 161

THERMAL DATA

$R_{th\ j-case}$	Thermal resistance junction-case	max	580	°C/W
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ELECTRICAL CHARACTERISTICS ($T_{amb} = 25\text{ °C}$ unless otherwise specified)

Parameter	Test conditions	Min.	Typ.	Max.	Unit
I_{CBO} Collector cutoff current ($I_E = 0$)	$V_{CB} = 10\text{ V}$			100	nA
$V_{(BR)\ CBO}$ Collector-base breakdown voltage ($I_E = 0$)	$I_C = 50\ \mu\text{A}$	50			V
$V_{CEO(sus)}$ Collector-emitter sustaining voltage ($I_B = 0$)	$I_C = 5\text{ mA}$	50			V
$V_{(BR)\ EBO}$ Emitter-base breakdown voltage ($I_C = 0$)	$I_E = 50\ \mu\text{A}$	5			V
V_{BE} Base-emitter voltage	$I_C = 3\text{ mA}$ $V_{CE} = 24\text{ V}$		0.74		V
h_{FE} DC current gain	$I_C = 3\text{ mA}$ $V_{CE} = 10\text{ V}$	20	60		—
f_T Transition frequency	$I_C = 3\text{ mA}$ $V_{CE} = 10\text{ V}$	400	550		MHz
$-C_{re}$ Reverse capacitance	$I_C = 3\text{ mA}$ $V_{CE} = 10\text{ V}$ $f = 1\text{ MHz}$		0.3	0.45	pF
NF Noise figure	$I_C = 1.5\text{ mA}$ $V_{CB} = 24\text{ V}$ $f = 800\text{ MHz}$		6.5		dB
G_{pb} Power gain	$I_C = 1.5\text{ mA}$ $V_{CB} = 24\text{ V}$ $f = 800\text{ MHz}$		12		dB
Collector current for $\Delta G_{pb} = 30\text{ dB}$	$V_{CC} = 12\text{ V}$ $f = 800\text{ MHz}$		8		mA

BF 166

SILICON PLANAR NPN

HIGH FREQUENCY GENERAL PURPOSE AMPLIFIER

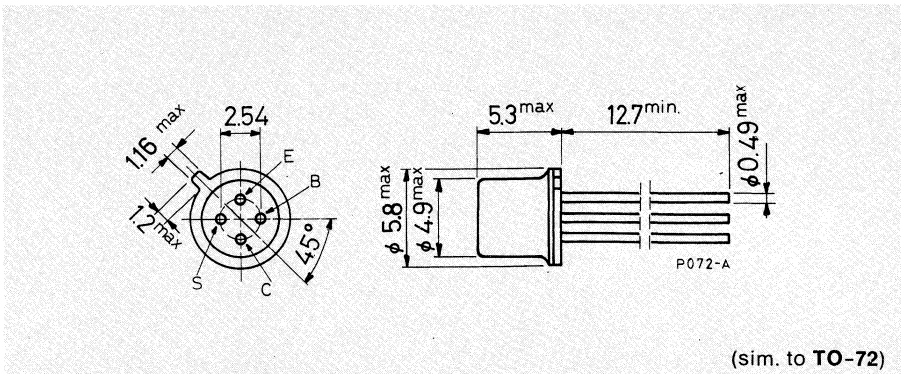
The BF 166 is a silicon planar NPN transistor in a TO-72 metal case. It is designed to be used as a gain-controlled VHF amplifier.

ABSOLUTE MAXIMUM RATINGS

V_{CBO}	Collector-base voltage ($I_E = 0$)	40	V
V_{CEO}	Collector-emitter voltage ($I_B = 0$)	40	V
V_{EBO}	Emitter-base voltage ($I_C = 0$)	3	V
P_{tot}	Total power dissipation at $T_{amb} \leq 25^\circ\text{C}$	175	mW
	at $T_{case} \leq 25^\circ\text{C}$	260	mW
T_{stg}	Storage temperature	-55 to 175	$^\circ\text{C}$
T_j	Junction temperature	175	$^\circ\text{C}$

MECHANICAL DATA

Dimensions in mm



BF 166

THERMAL DATA

$R_{th\ j\text{-case}}$	Thermal resistance junction-case	max	580	$^{\circ}\text{C}/\text{W}$
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ELECTRICAL CHARACTERISTICS ($T_{amb} = 25^{\circ}\text{C}$ unless otherwise specified)

Parameter	Test conditions	Min.	Typ.	Max.	Unit
I_{CBO} Collector cutoff current ($I_E = 0$)	$V_{CB} = 10\text{ V}$			100	nA
$V_{(BR)\ CBO}$ Collector-base breakdown voltage ($I_E = 0$)	$I_C = 100\ \mu\text{A}$	40			V
$V_{CEO\ (sus)}$ Collector-emitter sustaining voltage ($I_B = 0$)	$I_C = 1\text{ mA}$	40			V
$V_{(BR)\ EBO}$ Emitter-base breakdown voltage ($I_C = 0$)	$I_E = 10\ \mu\text{A}$	3			V
V_{BE}^* Base-emitter voltage	$I_C = 2.5\text{ mA}$ $V_{CE} = 12\text{ V}$			0.9	V
h_{FE}^* DC current gain	$I_C = 2.5\text{ mA}$ $V_{CE} = 12\text{ V}$	20	50		—
f_T Transition frequency	$I_C = 3\text{ mA}$ $V_{CE} = 12\text{ V}$	400	500		MHz
$-C_{re}$ Reverse capacitance	$I_C = 2.5\text{ mA}$ $V_{CE} = 12\text{ V}$		0.4	0.6	pF
NF Noise figure	$I_C = 2.5\text{ mA}$ $V_{CE} = 12\text{ V}$ $R_g = 50\ \Omega$ $f = 200\text{ MHz}$		3	5	dB
G_{pe} Power gain (neutralized)	$I_C = 3\text{ mA}$ $V_{CE} = 10\text{ V}$ $f = 200\text{ MHz}$	16	18		dB
$I_C\ (AGC)$ Collector current for $\Delta G_{pb} = 30\text{ dB}$	$V_{CC} = 12\text{ V}$ $f = 200\text{ MHz}$			14	mA

* Pulsed: pulse duration = 300 μs , duty factor = 1%

BF 167

SILICON PLANAR NPN

TV AGC IF AMPLIFIER

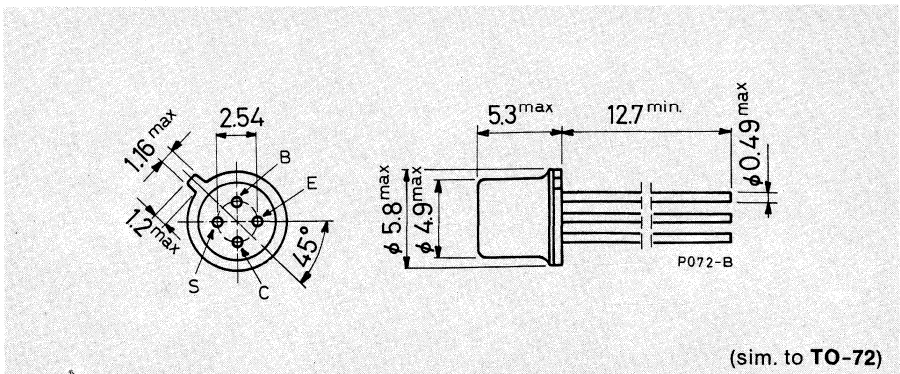
The BF 167 is a silicon planar NPN transistor in a TO-72 metal case. It is particularly designed for use in forward AGC IF amplifiers of TV receivers. It is characterized by very low feedback capacitance due to a screening diffusion under the base pad.

ABSOLUTE MAXIMUM RATINGS

V_{CES}	Collector-emitter voltage ($V_{BE} = 0$)	40 V
V_{CEO}	Collector-emitter voltage ($I_B = 0$)	30 V
V_{EBO}	Emitter-base voltage ($I_C = 0$)	4 V
I_C	Collector current	25 mA
P_{tot}	Total power dissipation at $T_{amb} \leq 25^\circ\text{C}$	150 mW
T_{stg}	Storage temperature	-55 to 175 °C
T_j	Junction temperature	175 °C

MECHANICAL DATA

Dimensions in mm



BF 167

THERMAL DATA

$R_{th\ j-amb}$	Thermal resistance junction-ambient	max	1000	°C/W
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ELECTRICAL CHARACTERISTICS ($T_{amb} = 25\text{ °C}$ unless otherwise specified)

Parameter	Test conditions	Min.	Typ.	Max.	Unit
I_{CES} Collector cutoff current ($V_{BE} = 0$)	$V_{CE} = 10\text{ V}$ $V_{CE} = 10\text{ V}$ $T_{amb} = 100\text{ °C}$			50 5	nA μA
$V_{(BR)\ CES}$ Collector-emitter breakdown voltage ($V_{BE} = 0$)	$I_C = 10\ \mu\text{A}$	40			V
$V_{(BR)\ CEO}$ Collector-emitter breakdown voltage ($I_B = 0$)	$I_C = 5\text{ mA}$	30			V
$V_{(BR)\ EBO}$ Emitter-base breakdown voltage ($I_C = 0$)	$I_E = 10\ \mu\text{A}$	4			V
V_{BE}^* Base-emitter voltage	$I_C = 4\text{ mA}$ $V_{CE} = 10\text{ V}$		0.74		V
h_{FE}^* DC current gain	$I_C = 1\text{ mA}$ $V_{CE} = 10\text{ V}$ $I_C = 4\text{ mA}$ $V_{CE} = 10\text{ V}$ $I_C = 10\text{ mA}$ $V_{CE} = 10\text{ V}$		30	35 45 20	— — —
f_T Transition frequency	$I_C = 4\text{ mA}$ $V_{CE} = 10\text{ V}$		600		MHz
$-C_{re}$ Reverse capacitance	$I_C = 0$ $V_{CE} = 10\text{ V}$ $f = 1\text{ MHz}$		0.15		pF
NF Noise figure	$I_C = 4\text{ mA}$ $V_{CE} = 10\text{ V}$ $R_g = 100\ \Omega$ $f = 36\text{ MHz}$		3		dB
G_{pe}^{**} Power gain	$I_E = 4\text{ mA}$ $V_{CE} = 10\text{ V}$ $f = 36\text{ MHz}$	24	28		dB

* Pulsed: pulse duration = 300 μs , duty factor = 1%

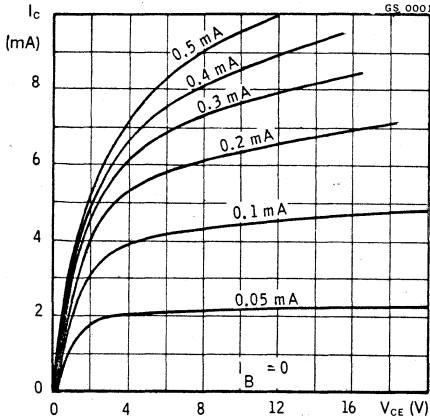
** See test circuit

ELECTRICAL CHARACTERISTICS (continued)

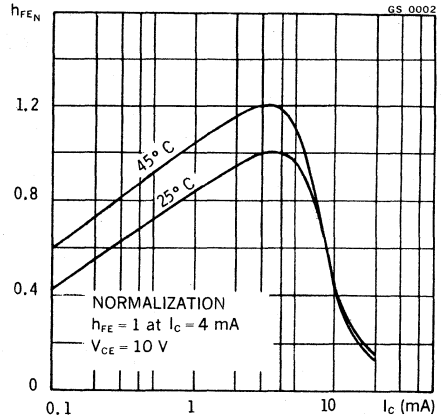
Parameter	Test conditions	Min.	Typ.	Max.	Unit
ΔG_{pe} Power gain control	$V_{EE} = -25 \text{ V}$ $R_{EE} = 3.9 \text{ k}\Omega$ $f = 36 \text{ MHz}$		60		dB
g_{ie} Input conductance	$I_C = 4 \text{ mA}$ $V_{CE} = 10 \text{ V}$ $f = 36 \text{ MHz}$		3.8		mS
b_{ie} Input susceptance	$I_C = 4 \text{ mA}$ $V_{CE} = 10 \text{ V}$ $f = 36 \text{ MHz}$		5		mS
g_{fe} Forward transconductance	$I_C = 4 \text{ mA}$ $V_{CE} = 10 \text{ V}$ $f = 36 \text{ MHz}$		95		mS
b_{fe} Forward transsusceptance	$I_C = 4 \text{ mA}$ $V_{CE} = 10 \text{ V}$ $f = 36 \text{ MHz}$		34		mS
g_{oe} Output conductance	$I_C = 4 \text{ mA}$ $V_{CE} = 10 \text{ V}$ $f = 36 \text{ MHz}$		62		μS
b_{oe} Output susceptance	$I_C = 4 \text{ mA}$ $V_{CE} = 10 \text{ V}$ $f = 36 \text{ MHz}$		270		μS

BF 167

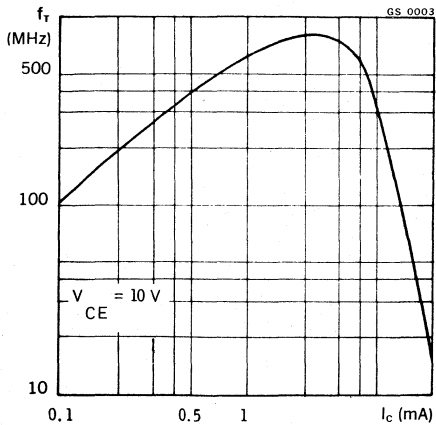
Typical output characteristics



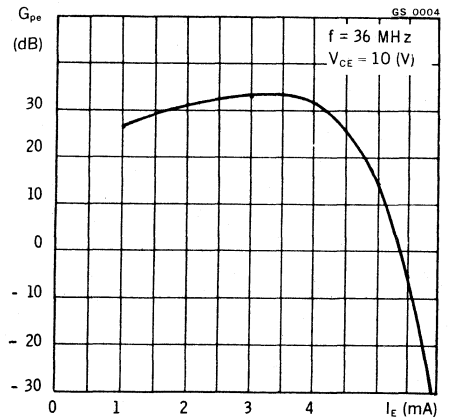
DC normalized current gain



Transition frequency

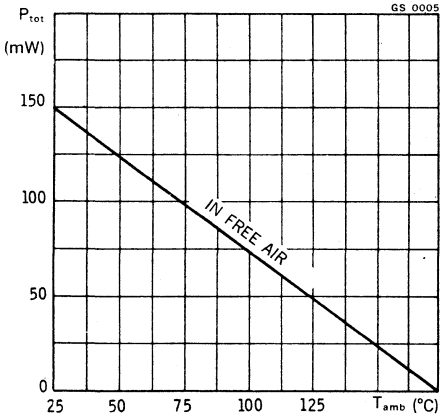


Power gain



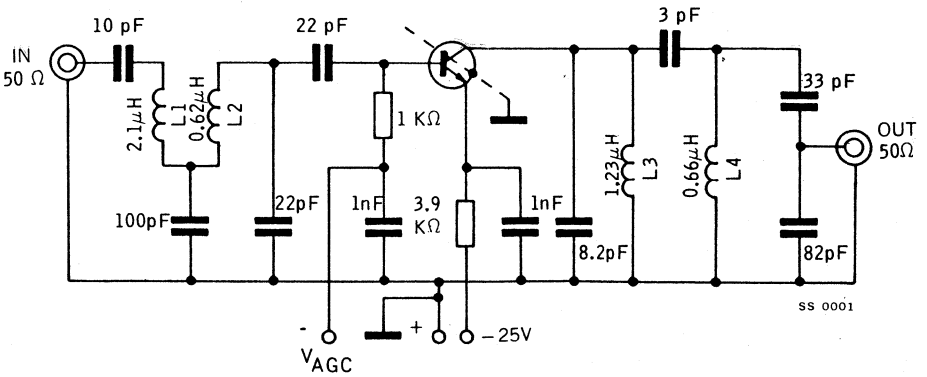
BF 167

Power rating chart



TEST CIRCUIT

Power gain ($f = 36$ MHz)



BF 173

SILICON PLANAR NPN

VIDEO IF AMPLIFIER

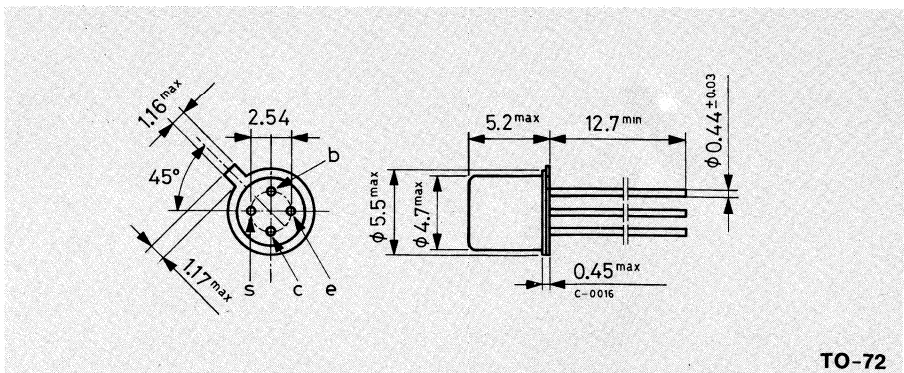
The BF 173 is a silicon planar epitaxial NPN transistor in a Jedec TO-72 metal case with a very low feedback capacitance. This transistor is intended for use in video IF amplifiers, particularly for the output stage.

ABSOLUTE MAXIMUM RATINGS

V_{CBO}	Collector-base voltage ($I_E = 0$)	40 V
V_{CEO}	Collector-emitter voltage ($I_B = 0$)	25 V
V_{EBO}	Emitter-base voltage ($I_C = 0$)	4 V
I_C	Collector current	25 mA
P_{tot}	Total power dissipation at $T_{amb} \leq 25^\circ\text{C}$	175 mW
	at $T_{case} \leq 25^\circ\text{C}$	230 mW
T_{stg}	Storage temperature	-55 to 175 °C
T_j	Junction temperature	175 °C

MECHANICAL DATA

Dimensions in mm



BF 173

THERMAL DATA

$R_{th\ j-amb}$	Thermal resistance junction-ambient	max	850 °C/W
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ELECTRICAL CHARACTERISTICS ($T_{case} = 25\text{ °C}$ unless otherwise specified)

Parameter	Test conditions	Min.	Typ.	Max.	Unit
I_{CES} Collector cutoff current ($V_{BE} = 0$)	$V_{CE} = 20\text{ V}$			20	nA
I_{EBO} Emitter cutoff current ($I_C = 0$)	$V_{EB} = 4\text{ V}$			100	μA
$V_{(BR)\ CBO}$ Collector-base breakdown voltage ($I_E = 0$)	$I_C = 100\ \mu\text{A}$	40			V
$V_{(BR)\ CEO}$ Collector-emitter breakdown voltage ($I_B = 0$)	$I_C = 2\text{ mA}$	25			V
V_{BE} Base-emitter voltage	$I_C = 7\text{ mA}$ $V_{CE} = 10\text{ V}$			0.9	V
f_T Transition frequency	$I_C = 5\text{ mA}$ $V_{CE} = 10\text{ V}$		1000		MHz
$-C_{re}$ Reverse capacitance	$I_C = 5\text{ mA}$ $V_{CE} = 10\text{ V}$ $f = 0.5\text{ MHz}$		0.23		pF
I_B Base current	$I_C = 7\text{ mA}$ $V_{CE} = 10\text{ V}$		61	185	μA
V_o^* Output voltage	$I_C = 7.2\text{ mA}$ $V_{CE} = 12\text{ V}$ $f = 38.9\text{ MHz}$	6	7.7		V
G_{tr} Transducer power gain	$I_C = 7.2\text{ mA}$ $V_{CE} = 12\text{ V}$ $f = 36.4\text{ MHz}$		26		dB
g_{ie} Input conductance	$I_C = 7\text{ mA}$ $V_{CE} = 10\text{ V}$ $f = 35\text{ MHz}$		3		mS
C_{ie} Input capacitance	$I_C = 7\text{ mA}$ $V_{CE} = 10\text{ V}$ $f = 35\text{ MHz}$		22		pF

* Voltage across the detector load $R_L = 2.7\text{ k}\Omega$ for 30% synchronisation pulse compression

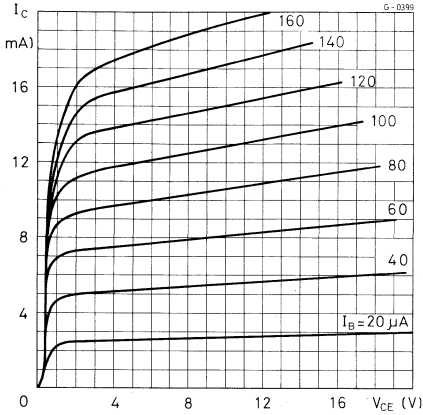
ELECTRICAL CHARACTERISTICS (continued)

Parameter	Test conditions	Min. Typ. Max.	Unit
$ y_{re} $ Reverse transadmittance	$I_C = 7 \text{ mA}$ $V_{CE} = 10 \text{ V}$ $f = 35 \text{ MHz}$	55	μS
ϕ_{re} Phase angle of reverse transadmittance	$I_C = 7 \text{ mA}$ $V_{CE} = 10 \text{ V}$ $f = 35 \text{ MHz}$	267°	—
$ y_{fe} $ Forward transadmittance	$I_C = 7 \text{ mA}$ $V_{CE} = 10 \text{ V}$ $f = 35 \text{ MHz}$	165	mS
ϕ_{fe} Phase angle of forward transadmittance	$I_C = 7 \text{ mA}$ $V_{CE} = 10 \text{ V}$ $f = 35 \text{ MHz}$	336°	—
g_{oe} Output conductance	$I_C = 7 \text{ mA}$ $V_{CE} = 10 \text{ V}$ $f = 35 \text{ MHz}$	65	μS
C_{oe} Output capacitance	$I_C = 7 \text{ mA}$ $V_{CE} = 10 \text{ V}$ $f = 35 \text{ MHz}$	1.9	pF
G_{UM}^* Maximum unilateralized power gain	$I_C = 7 \text{ mA}$ $V_{CE} = 10 \text{ V}$ $f = 35 \text{ MHz}$	44.5	dB

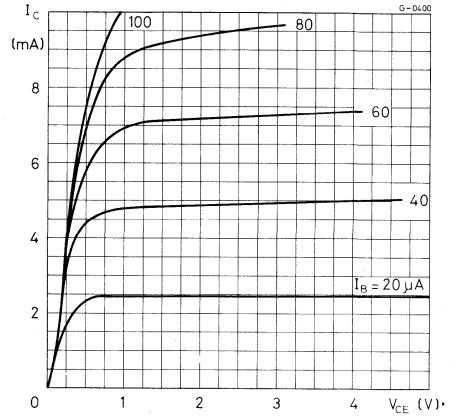
$$* G_{UM} = 10 \log \frac{|y_{fe}|^2}{4 g_{ie} g_{oe}}$$

BF 173

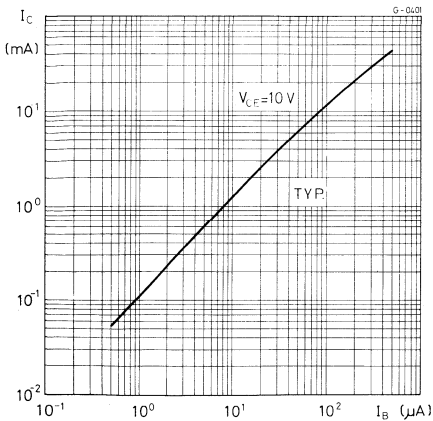
Typical output characteristics



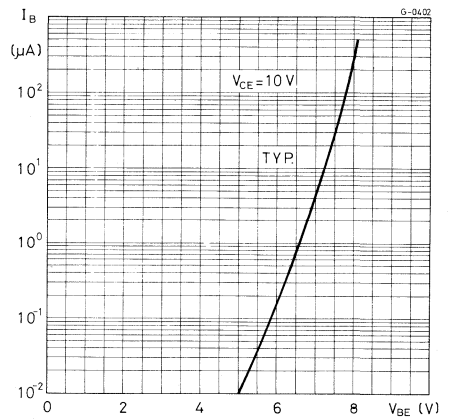
Typical output characteristics



Collector characteristic

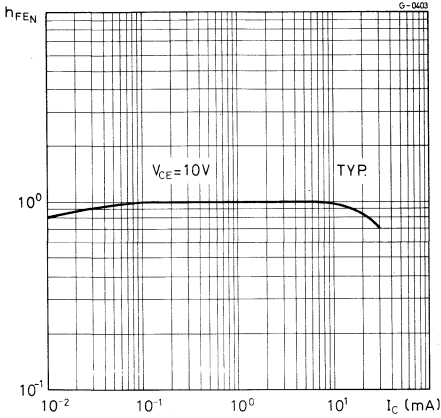


Input characteristic

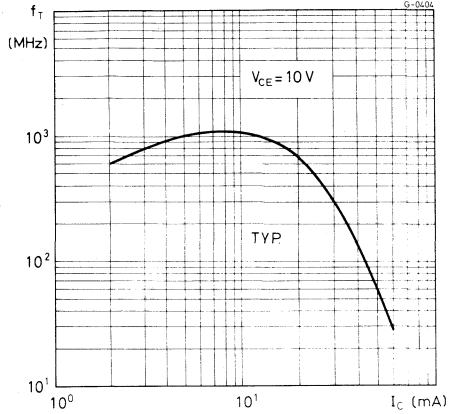


BF 173

DC normalized current gain

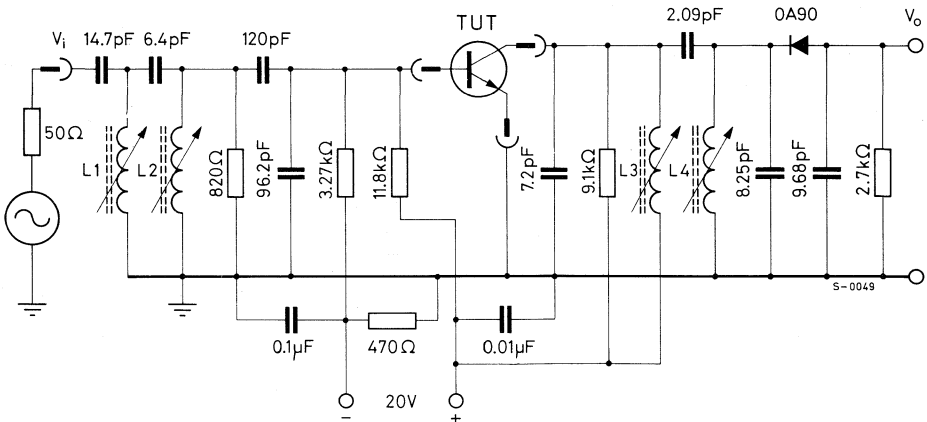


Transition frequency



TEST CIRCUIT

G_{tr} test circuit



$L_1 = 0.8 \mu H$, 9 turns $\varnothing 0.15$ mm. enameled silk-covered copper wire. $L_2 = 0.25 \mu H$, 4 turns $\varnothing 0.15$ mm. enameled silk-covered copper wire. $L_3 = 1.7 \mu H$, 12.5 turns $\varnothing 0.15$ mm. enameled silk-covered copper wire. $L_4 = 1.3 \mu H$, 11 turns $\varnothing 0.15$ mm. enameled silk-covered copper wire.

SILICON PLANAR NPN**AMPLIFIER AND CONVERTER FOR FM TUNERS**

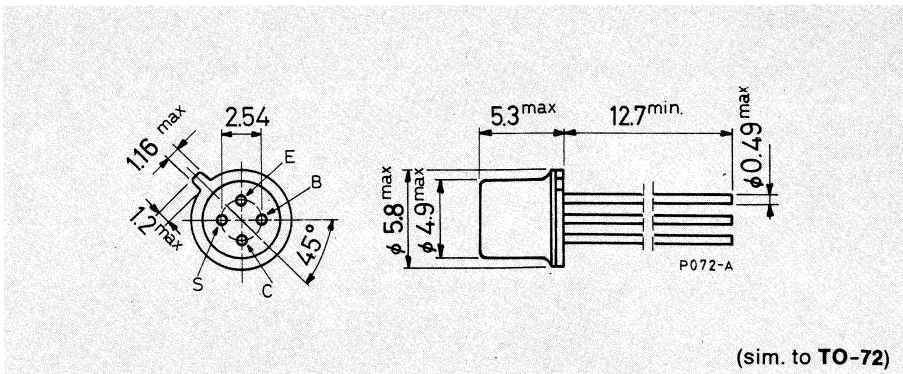
The BF 222 is a silicon planar NPN transistor in a TO-72 metal case. This device is designed for tuners of FM receivers, and features low noise, high gain and excellent forward AGC.

ABSOLUTE MAXIMUM RATINGS

V_{CBO}	Collector-base voltage ($I_E = 0$)	50 V
V_{CEO}	Collector-emitter voltage ($I_B = 0$)	40 V
V_{EBO}	Emitter-base voltage ($I_C = 0$)	4 V
I_C	Collector current	20 mA
P_{tot}	Total power dissipation at $T_{amb} \leq 25^\circ\text{C}$	175 mW
T_{stg}	Storage temperature	-55 to 175 °C
T_j	Junction temperature	175 °C

MECHANICAL DATA

Dimensions in mm



BF 222

THERMAL DATA

$R_{th\ j-amb}$	Thermal resistance junction-ambient	max	875 °C/W
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ELECTRICAL CHARACTERISTICS (T_{amb} = 25 °C unless otherwise specified)

Parameter	Test conditions	Min.	Typ.	Max.	Unit
I_{CBO} Collector cutoff current ($I_E = 0$)	$V_{CB} = 10\text{ V}$		1		nA
$V_{(BR)\ CBO}$ Collector-base breakdown voltage ($I_E = 0$)	$I_C = 50\ \mu\text{A}$	50			V
$V_{(BR)\ CEO}^*$ Collector-emitter breakdown voltage ($I_B = 0$)	$I_C = 5\text{ mA}$	40			V
$V_{(BR)\ EBO}$ Emitter-base breakdown voltage ($I_C = 0$)	$I_E = 50\ \mu\text{A}$	4			V
V_{BE} Base-emitter voltage	$I_C = 2\text{ mA}$ $V_{CE} = 7\text{ V}$		0.74		V
h_{FE} DC current gain	$I_C = 2\text{ mA}$ $V_{CE} = 7\text{ V}$	20	60		—
f_T Transition frequency	$I_C = 2\text{ mA}$ $V_{CE} = 7\text{ V}$		400		MHz
$-C_{re}$ Reverse capacitance	$I_C = 2\text{ mA}$ $V_{CE} = 7\text{ V}$ $f = 1\text{ MHz}$		0.4		pF
NF Noise figure	$I_C = 4\text{ mA}$ $V_{CE} = 5\text{ V}$ $R_g = 150\ \Omega$ $f = 100\text{ MHz}$			5	dB
G_{pe} Power gain	$I_C = 4\text{ mA}$ $V_{CE} = 5\text{ V}$ $f = 100\text{ MHz}$		20		dB
ΔG_{pe} Power gain control	$I_E = 9\text{ mA}$ $V_{CC} = 7\text{ V}$ $R_{DC} = 510\ \Omega$ $f = 100\text{ MHz}$		30		dB

* Pulsed: pulse duration = 300 μs , duty factor = 1%

BF 233
BF 234

SILICON PLANAR NPN

AM MIXER OSCILLATOR, AM-FM IF AMPLIFIER

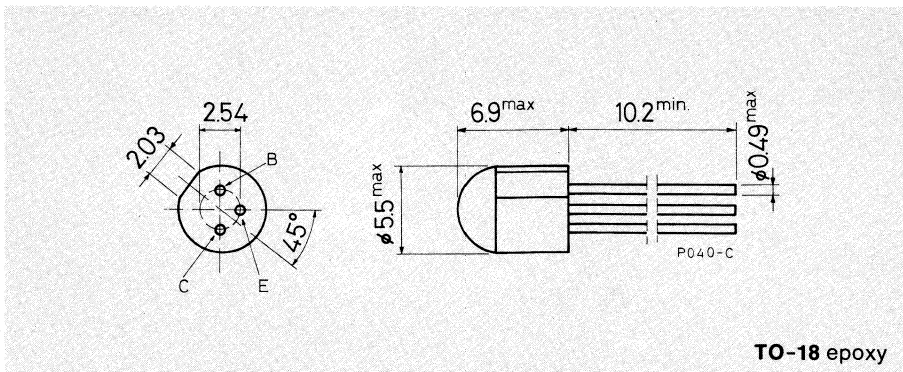
The BF 233 and BF 234 are silicon planar epitaxial NPN transistors in TO-18 epoxy package. They are intended for use in AM mixer/oscillator stages, IF amplifiers for AM/FM radio receivers and in sound IF stages for TV receivers.

ABSOLUTE MAXIMUM RATINGS

V_{CBO}	Collector-base voltage ($I_E = 0$)	30 V
V_{CEO}	Collector-emitter voltage ($I_B = 0$)	30 V
V_{EBO}	Emitter-base voltage ($I_C = 0$)	4 V
I_C	Collector current	50 mA
P_{tot}	Total power dissipation at $T_{amb} \leq 25^\circ\text{C}$	200 mW
T_{stg}	Storage temperature	-55 to 125 °C
T_j	Junction temperature	125 °C

MECHANICAL DATA

Dimensions in mm



BF 233 BF 234

THERMAL DATA

$R_{th\ j-amb}$	Thermal resistance junction-ambient	max	500	°C/W
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ELECTRICAL CHARACTERISTICS ($T_{amb} = 25\text{ °C}$ unless otherwise specified)

Parameter	Test conditions	Min.	Typ.	Max.	Unit
I_{CBO} Collector cutoff current ($I_E = 0$)	$V_{CB} = 10\text{ V}$			200	nA
$V_{(BR)\ CBO}$ Collector-base breakdown voltage ($I_E = 0$)	$I_C = 10\ \mu\text{A}$	30			V
$V_{CEO\ (sus)}$ Collector-emitter sustaining voltage ($I_B = 0$)	$I_C = 2\text{ mA}$	30			V
V_{EBO} Emitter-base voltage ($I_C = 0$)	$I_E = 10\ \mu\text{A}$	4			V
V_{BE} Base-emitter voltage	$I_C = 1\text{ mA}$ $V_{CE} = 10\text{ V}$	0.64	0.7	0.74	V
h_{FE} DC current gain	$I_C = 1\text{ mA}$ $V_{CE} = 10\text{ V}$ for BF 233 Gr. 2 for BF 233 Gr. 3 for BF 233 Gr. 4 for BF 233 Gr. 5 for BF 233 Gr. 6 for BF 234	40	60	70	—
		60	80	100	—
		90	115	150	—
		140	175	220	—
		200	245	350	—
		90	120	330	—
f_T Transition frequency	$I_C = 1\text{ mA}$ $V_{CE} = 10\text{ V}$	150	500		MHz
$-C_{re}$ Reverse capacitance	$I_C = 1\text{ mA}$ $V_{CE} = 10\text{ V}$ $f = 1\text{ MHz}$		0.5	1	pF
NF Noise figure	$I_C = 1\text{ mA}$ $V_{CE} = 10\text{ V}$ $R_g = 300\ \Omega$ $f = 470\text{ kHz}$		1.2		dB
NF_C Conversion noise figure	$I_C = 1\text{ mA}$ $V_{CE} = 10\text{ V}$ $R_g = 500\ \Omega$ $f = 200\text{ kHz}$ $f = 1\text{ MHz}$		4		dB
			3.5		dB
G_{pe} Power gain	$I_C = 1\text{ mA}$ $V_{CE} = 10\text{ V}$ $f = 470\text{ kHz}$		40		dB

SILICON PLANAR NPN

BF 257
BF 258
BF 259

HIGH VOLTAGE VIDEO AMPLIFIERS

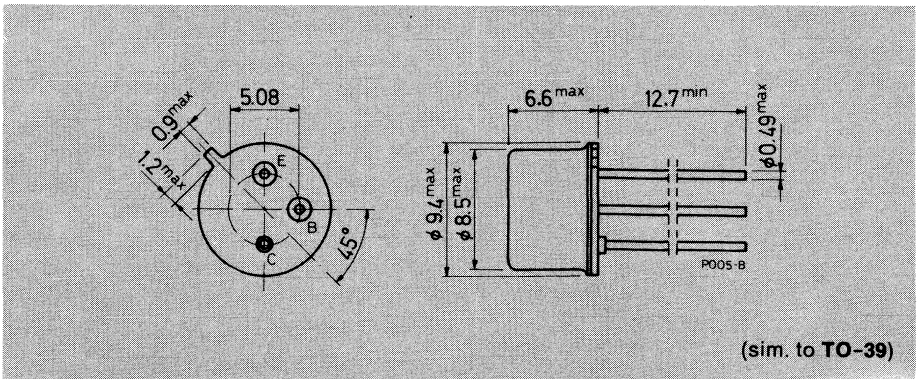
The BF 257, BF 258 and BF 259 are silicon planar epitaxial NPN transistors in TO-39 metal case. They are particularly designed for video output stages in CTV and MTV sets, class A audio output stages and drivers for horizontal deflection circuits.

ABSOLUTE MAXIMUM RATINGS

		BF 257	BF 258	BF 259
V_{CBO}	Collector-base voltage ($I_E = 0$)	160 V	250 V	300 V
V_{CEO}	Collector-emitter voltage ($I_B = 0$)	160 V	250 V	300 V
V_{EBO}	Emitter-base voltage ($I_C = 0$)	5 V		
I_C	Collector current	100 mA		
I_{CM}	Collector peak current	200 mA		
P_{tot}	Total power dissipation at $T_{case} \leq 50^\circ C$	5 W		
T_{stg}	Storage temperature	-55 to 200 °C		
T_j	Junction temperature	200 °C		

MECHANICAL DATA

Dimensions in mm



BF 257
BF 258
BF 259

THERMAL DATA

$R_{th\ j-case}$	Thermal resistance junction-case	max	30	°C/W
$R_{th\ j-amb}$	Thermal resistance junction-ambient	max	175	°C/W

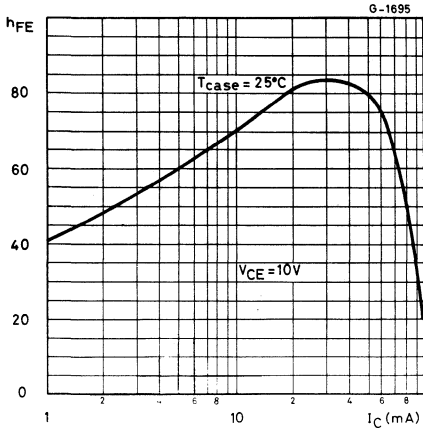
ELECTRICAL CHARACTERISTICS ($T_{amb} = 25\text{ °C}$ unless otherwise specified)

Parameter	Test conditions	Min.	Typ.	Max.	Unit
I_{CBO} Collector cutoff current ($I_E = 0$)	for BF 257 $V_{CB} = 100\text{ V}$ for BF 258 $V_{CB} = 200\text{ V}$ for BF 259 $V_{CB} = 250\text{ V}$			50 50 50	nA nA nA
$V_{(BR)\ CBO}$ Collector-base breakdown voltage ($I_E = 0$)	$I_C = 100\ \mu\text{A}$ for BF 257 for BF 258 for BF 259	160 250 300			V V V
$V_{(BR)\ CEO}^*$ Collector-emitter breakdown voltage ($I_B = 0$)	$I_C = 10\text{ mA}$ for BF 257 for BF 258 for BF 259	160 250 300			V V V
$V_{(BR)\ EBO}$ Emitter-base breakdown voltage ($I_C = 0$)	$I_E = 100\ \mu\text{A}$	5			V
$V_{CE(sat)}^*$ Collector-emitter saturation voltage	$I_C = 30\text{ mA}$ $I_B = 6\text{ mA}$			1	V
h_{FE}^* DC current gain	$I_C = 30\text{ mA}$ $V_{CE} = 10\text{ V}$	25			—
f_T Transition frequency	$I_C = 15\text{ mA}$ $V_{CE} = 10\text{ V}$		90		MHz
$-C_{re}$ Reverse capacitance	$I_C = 0$ $V_{CE} = 30\text{ V}$ $f = 1\text{ MHz}$		3		pF

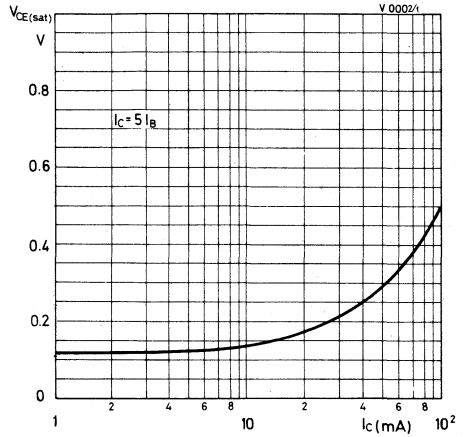
* Pulsed: pulse duration = 300 μs , duty factor = 1%

BF 257
BF 258
BF 259

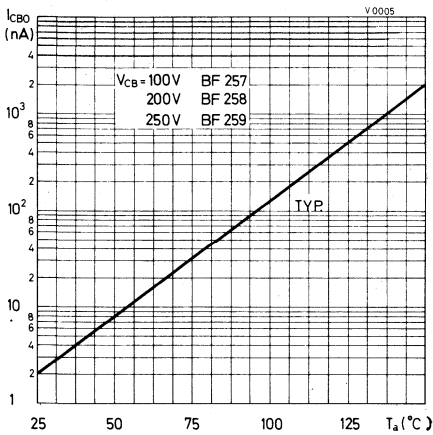
DC current gain



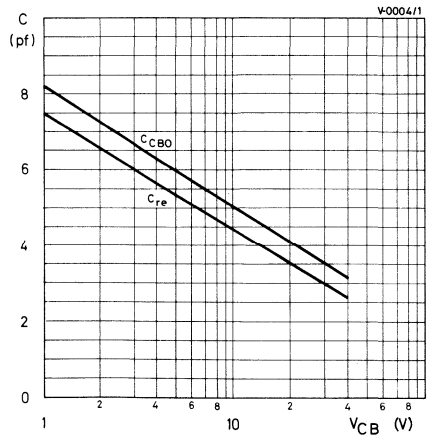
Collector-emitter saturation voltage



Collector cutoff current

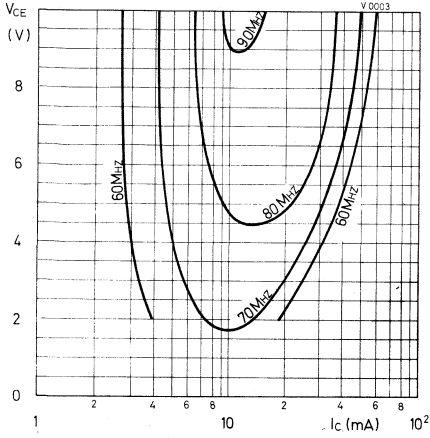


Collector-base capacitance

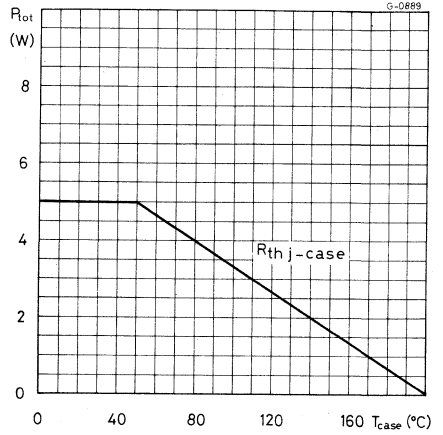


BF 257
BF 258
BF 259

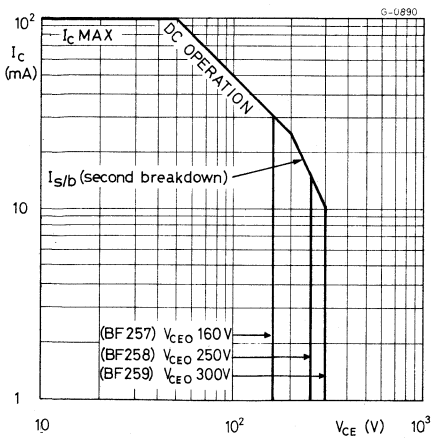
Transition frequency



Power rating chart



Safe operating area



SILICON PLANAR NPN

VIDEO IF AMPLIFIER

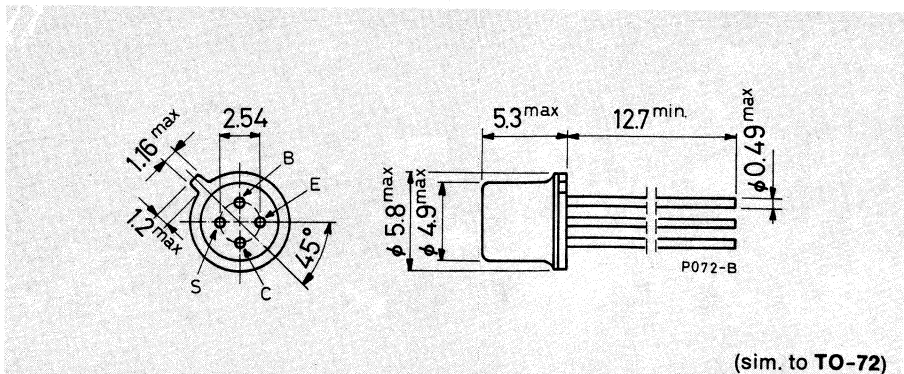
The BF 271 is a silicon planar NPN transistor in a TO-72 metal case. This device has been specifically designed for use in output stages of IF vision amplifiers. It features high power gain, low feedback capacitance and excellent linearity.

ABSOLUTE MAXIMUM RATINGS

V_{CBO}	Collector-base voltage ($I_E = 0$)	30 V
V_{CEO}	Collector-emitter voltage ($I_B = 0$)	25 V
V_{EBO}	Emitter-base voltage ($I_C = 0$)	4 V
I_C	Collector current	25 mA
P_{tot}	Total power dissipation at $T_{amb} \leq 25^\circ\text{C}$	250 mW
	at $T_{case} \leq 25^\circ\text{C}$	430 mW
T_{stg}	Storage temperature	-55 to 200 $^\circ\text{C}$
T_j	Junction temperature	200 $^\circ\text{C}$

MECHANICAL DATA

Dimensions in mm



BF 271

THERMAL DATA

$R_{th\ j-case}$	Thermal resistance junction-case	max	400	°C/W
$R_{th\ j-amb}$	Thermal resistance junction-ambient	max	700	°C/W

ELECTRICAL CHARACTERISTICS ($T_{amb} = 25\text{ °C}$ unless otherwise specified)

Parameter	Test conditions	Min.	Typ.	Max.	Unit
I_{CES} Collector cutoff current ($V_{BE} = 0$)	$V_{CE} = 10\text{ V}$		100		nA
$V_{(BR)\ CBO}$ Collector-base breakdown voltage ($I_E = 0$)	$I_C = 10\ \mu\text{A}$	30			V
$V_{(BR)\ CEO}$ Collector-emitter breakdown voltage ($I_B = 0$)	$I_C = 1\text{ mA}$	25			V
$V_{(BR)\ EBO}$ Emitter-base breakdown voltage ($I_C = 0$)	$I_E = 10\ \mu\text{A}$	4			V
V_{BE} Base-emitter voltage	$I_C = 10\text{ mA}$ $V_{CE} = 5\text{ V}$		780		mV
h_{FE}^* DC current gain	$I_C = 1\text{ mA}$ $V_{CE} = 10\text{ V}$ $I_C = 10\text{ mA}$ $V_{CE} = 10\text{ V}$	30	55 75		— —
f_T Transition frequency	$I_C = 10\text{ mA}$ $V_{CE} = 10\text{ V}$		900		MHz
$-C_{re}$ Reverse capacitance	$I_C = 0$ $V_{CE} = 10\text{ V}$ $f = 1\text{ MHz}$		0.22		pF
G_{pe} Power gain	$I_C = 10\text{ mA}$ $V_{CE} = 10\text{ V}$ $f = 36\text{ MHz}$	24	27		dB
g_{ie} Input conductance	$I_C = 10\text{ mA}$ $V_{CE} = 10\text{ V}$ $f = 36\text{ MHz}$		4.8		mS

Pulsed: pulse duration = 300 μs ; duty factor = 1%

BF 271

ELECTRICAL CHARACTERISTICS (continued)

Parameter	Test conditions	Min. Typ. Max.	Unit
b_{ie} Input susceptance	$I_C = 10 \text{ mA}$ $V_{CE} = 10 \text{ V}$ $f = 36 \text{ MHz}$	5.2	mS
g_{fe} Forward transconductance	$I_C = 10 \text{ mA}$ $V_{CE} = 10 \text{ V}$ $f = 36 \text{ MHz}$	200	mS
b_{fe} Forward transusceptance	$I_C = 10 \text{ mA}$ $V_{CE} = 10 \text{ V}$ $f = 36 \text{ MHz}$	80	mS
g_{oe} Output conductance	$I_C = 10 \text{ mA}$ $V_{CE} = 10 \text{ V}$ $f = 36 \text{ MHz}$	80	μS
b_{oe} Output susceptance	$I_C = 10 \text{ mA}$ $V_{CE} = 10 \text{ V}$ $f = 36 \text{ MHz}$	380	μS

BF 272A

SILICON PLANAR PNP

UHF-VHF AGC AMPLIFIER

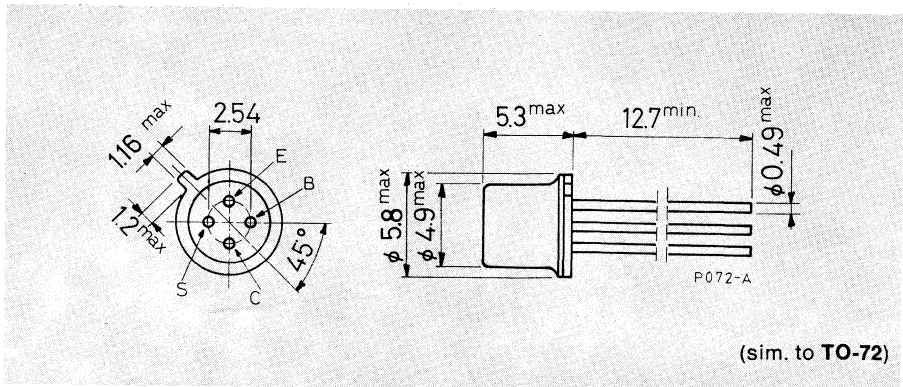
The BF 272A is a silicon planar epitaxial PNP transistor in a TO-72 metal case. This device is specifically designed for RF stages of UHF-VHF tuners. It features high gain, low feedback capacitance and very low noise figure.

ABSOLUTE MAXIMUM RATINGS

V_{CBO}	Collector-base voltage ($I_E = 0$)	-40 V
V_{CEO}	Collector-emitter voltage ($I_B = 0$)	-35 V
V_{EBO}	Emitter-base voltage ($I_C = 0$)	-3 V
I_C	Collector current	-20 mA
P_{tot}	Total power dissipation at $T_{amb} \leq 25^\circ\text{C}$	200 mW
T_{stg}	Storage temperature	-55 to 200 $^\circ\text{C}$
T_j	Junction temperature	200 $^\circ\text{C}$

MECHANICAL DATA

Dimensions in mm



BF 272A

THERMAL DATA

$R_{th\ j-amb}$ Thermal resistance junction-ambient	max 875 °C/W
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ELECTRICAL CHARACTERISTICS ($T_{amb} = 25\text{ °C}$ unless otherwise specified)

Parameter	Test conditions	Min.	Typ.	Max.	Unit
I_{CBO} Collector cutoff current ($I_E = 0$)	$V_{CB} = -20\text{ V}$			-100	nA
$V_{(BR)\ CBO}$ Collector-base breakdown voltage ($I_E = 0$)	$I_C = -10\ \mu\text{A}$	-40			V
$V_{(BR)\ CEO}$ Collector-emitter breakdown voltage ($I_B = 0$)	$I_C = -3\text{ mA}$	-35			V
$V_{(BR)\ EBO}$ Emitter-base breakdown voltage ($I_C = 0$)	$I_E = -10\ \mu\text{A}$	-3			V
V_{BE} Base-emitter voltage	$I_C = -3\text{ mA}$ $V_{CE} = -10\text{ V}$	-0.75			V
h_{FE} DC current gain	$I_C = -3\text{ mA}$ $V_{CE} = -10\text{ V}$	25	50		—
f_T Transition frequency	$I_C = -3\text{ mA}$ $V_{CE} = -10\text{ V}$	700	850		MHz
$-C_{re}$ Reverse capacitance	$I_C = 0$ $V_{CE} = -10\text{ V}$ $f = 1\text{ MHz}$		0.3		pF
C_{rb} Reverse capacitance	$I_C = 0$ $V_{CB} = -10\text{ V}$ $f = 1\text{ MHz}$		0.05	0.09	pF
NF^* Noise figure	$I_C = -3\text{ mA}$ $V_{CB} = -10\text{ V}$ $R_g = 50\ \Omega$ $f = 800\text{ MHz}$		3.5	5.5	dB
	$I_C = -3\text{ mA}$ $V_{CB} = -10\text{ V}$ $R_g = 50\ \Omega$ $f = 200\text{ MHz}$		2.5		dB
G_{pb}^* Power gain	$I_C = -3\text{ mA}$ $V_{CB} = -10\text{ V}$ $R_L = 2\text{ k}\Omega$ $f = 800\text{ MHz}$	12	15		dB
	$I_C = -3\text{ mA}$ $V_{CB} = -10\text{ V}$ $R_L = 2\text{ k}\Omega$ $f = 200\text{ MHz}$		19		dB

BF 272A

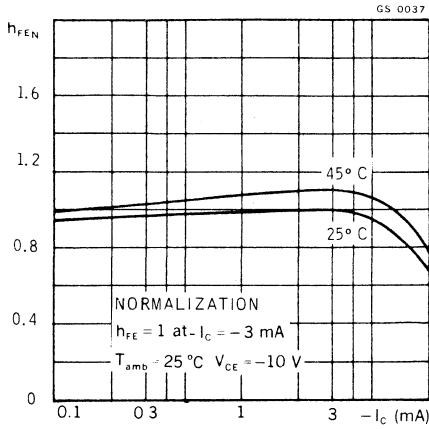
ELECTRICAL CHARACTERISTICS (continued)

Parameter	Test conditions	Min.	Typ.	Max.	Unit
$I_{C(AGC)^*}$ Collector current for $\Delta G_{pb} = 30$ dB	$f = 800$ MHz $V_{CC} = 10.8$ V	6.6		8	mA
g_{ib} Input conductance	$I_C = -3$ mA $V_{CB} = -10$ V $f = 800$ MHz $I_C = -3$ mA $V_{CB} = -10$ V $f = 200$ MHz		7		mS
b_{ib} Input susceptance	$I_C = -3$ mA $V_{CB} = -10$ V $f = 800$ MHz $I_C = -3$ mA $V_{CB} = -10$ V $f = 200$ MHz		-26		mS
g_{ob} Output conductance	$I_C = -3$ mA $V_{CB} = -10$ V $f = 800$ MHz $I_C = -3$ mA $V_{CB} = -10$ V $f = 200$ MHz		0.77		mS
b_{ob} Output susceptance	$I_C = -3$ mA $V_{CB} = -10$ V $f = 800$ MHz $I_C = -3$ mA $V_{CB} = -10$ V $f = 200$ MHz		5		mS
g_{fb} Forward transconductance	$I_C = -3$ mA $V_{CB} = -10$ V $f = 800$ MHz $I_C = -3$ mA $V_{CB} = -10$ V $f = 200$ MHz		11		mS
b_{fb} Forward transusceptance	$I_C = -3$ mA $V_{CB} = -10$ V $f = 800$ MHz $I_C = -3$ mA $V_{CB} = -10$ V $f = 200$ MHz		23		mS
g_{rb} Reverse transconductance	$I_C = -3$ mA $V_{CB} = -10$ V $f = 800$ MHz $I_C = -3$ mA $V_{CB} = -10$ V $f = 200$ MHz		-0.1		mS
b_{rb} Reverse transusceptance	$I_C = -3$ mA $V_{CB} = -10$ V $f = 800$ MHz $I_C = -3$ mA $V_{CB} = -10$ V $f = 200$ MHz		-0.35		mS
			-0.1		mS

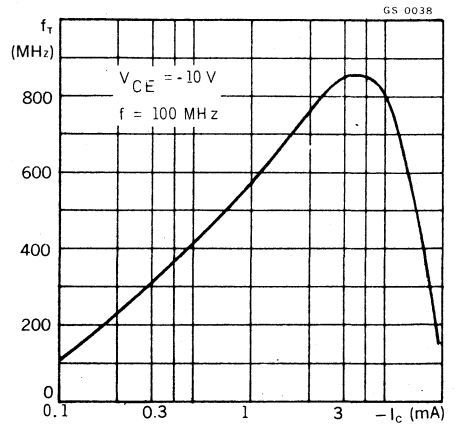
* See TEST CIRCUIT

BF 272A

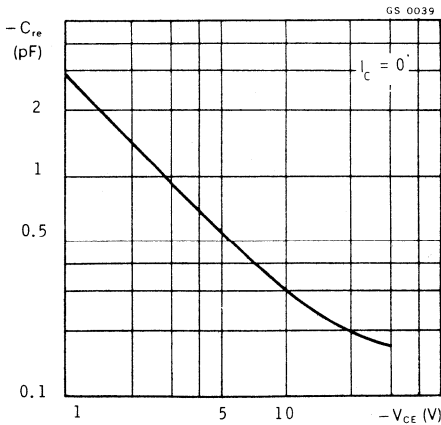
Normalized DC current gain



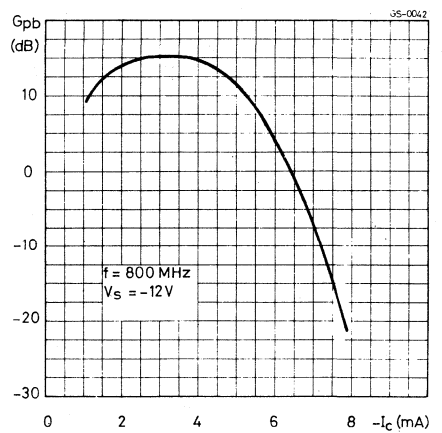
Transition frequency



Reverse capacitance

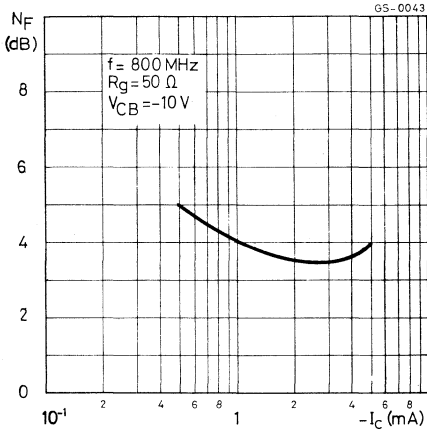


Power gain

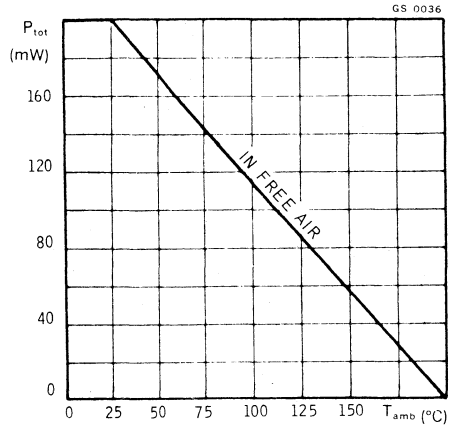


BF 272A

Noise figure

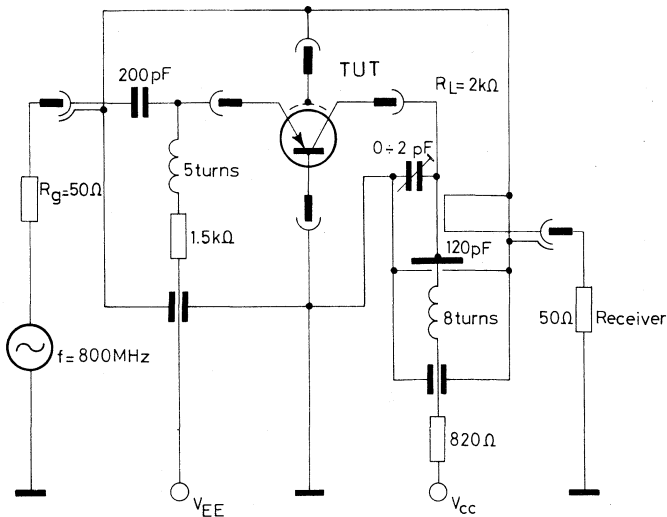


Power rating chart



TEST CIRCUIT

Power gain, AGC and noise figure ($f = 800 \text{ MHz}$)



BF 273

SILICON PLANAR NPN

AM CONVERTER AND AM-FM IF AMPLIFIER

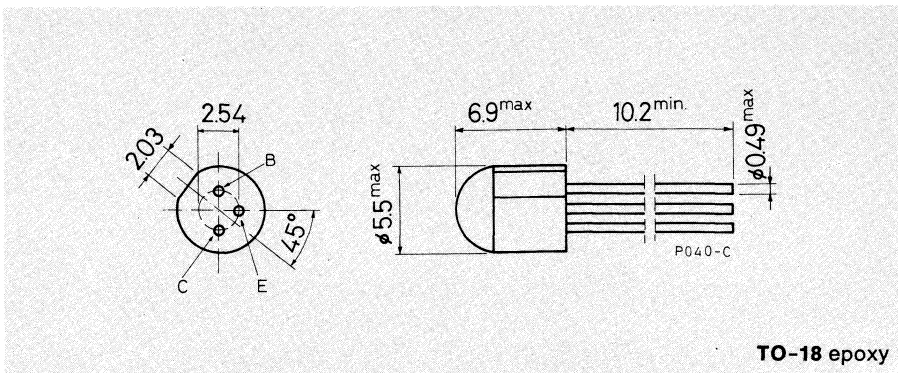
The BF 273 is a silicon planar NPN transistor in a TO-18 epoxy package, intended for use in AM converters and IF amplifiers for AM and AM/FM radios.

ABSOLUTE MAXIMUM RATINGS

V_{CBO}	Collector-base voltage ($I_E = 0$)	25 V
V_{CEO}	Collector-emitter voltage ($I_B = 0$)	20 V
V_{EBO}	Emitter-base voltage ($I_C = 0$)	4 V
I_C	Collector current	30 mA
P_{tot}	Total power dissipation at $T_{amb} \leq 25^\circ\text{C}$	200 mW
T_{stg}	Storage temperature	-55 to 125 °C
T_j	Junction temperature	125 °C

MECHANICAL DATA

Dimensions in mm



BF 273

THERMAL DATA

$R_{th\ j-amb}$	Thermal resistance junction-ambient	max	500	°C/W
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ELECTRICAL CHARACTERISTICS ($T_{amb} = 25\text{ °C}$ unless otherwise specified)

Parameter	Test conditions	Min.	Typ.	Max.	Unit
I_{CES} Collector cutoff current ($V_{BE} = 0$)	$V_{CE} = 10\text{ V}$ $V_{CE} = 10\text{ V}$ $T_{amb} = 100\text{ °C}$			100 50	nA μA
$V_{(BR)\ CBO}$ Collector-base breakdown voltage ($I_E = 0$)	$I_C = 10\ \mu\text{A}$	25			V
$V_{(BR)\ CEO}$ Collector-emitter breakdown voltage ($I_B = 0$)	$I_C = 1\text{ mA}$	20			V
$V_{(BR)\ EBO}$ Emitter-base breakdown voltage ($I_C = 0$)	$I_E = 10\ \mu\text{A}$	4			V
V_{BE} Base-emitter voltage	$I_C = 1\text{ mA}$ $V_{CE} = 10\text{ V}$	0.70			V
h_{FE} DC current gain	$I_C = 1\text{ mA}$ $V_{CE} = 10\text{ V}$ for BF 273 for BF 273 Gr. C for BF 273 Gr. D	35 70 35		120 75	— — —
f_T Transition frequency	$I_C = 1\text{ mA}$ $V_{CE} = 10\text{ V}$	400	600		MHz
NF Noise figure	$I_C = 1\text{ mA}$ $V_{CE} = 10\text{ V}$ $R_g = 400\ \Omega$ $f = 100\text{ MHz}$		2		dB
$-C_{re}$ Reverse capacitance	$I_C = 0$ $V_{CE} = 10\text{ V}$ $f = 1\text{ MHz}$		0.41		pF
G_{pe} Power gain	$I_C = 1\text{ mA}$ $V_{CE} = 10\text{ V}$ $f = 470\text{ kHz}$ $I_C = 1\text{ mA}$ $V_{CE} = 10\text{ V}$ $f = 10.7\text{ MHz}$ $I_C = 1\text{ mA}$ $V_{CE} = 10\text{ V}$ $f = 100\text{ MHz}$		40 30 21		dB dB dB

BF 273

ELECTRICAL CHARACTERISTICS (continued)

Parameter	Test conditions	Min.	Typ.	Max.	Unit
g_{ie} Input conductance	$I_C = 1 \text{ mA}$ $V_{CE} = 10 \text{ V}$ $f = 470 \text{ kHz}$		240		μS
	$I_C = 1 \text{ mA}$ $V_{CE} = 10 \text{ V}$ $f = 10.7 \text{ MHz}$		300		μS
	$I_C = 1 \text{ mA}$ $V_{CE} = 10 \text{ V}$ $f = 100 \text{ MHz}$		900		μS
b_{ie} Input susceptance	$I_C = 1 \text{ mA}$ $V_{CE} = 10 \text{ V}$ $f = 470 \text{ kHz}$		22		μS
	$I_C = 1 \text{ mA}$ $V_{CE} = 10 \text{ V}$ $f = 10.7 \text{ MHz}$		500		μS
	$I_C = 1 \text{ mA}$ $V_{CE} = 10 \text{ V}$ $f = 100 \text{ MHz}$		4.8		mS
b_{re} Reverse transusceptance	$I_C = 1 \text{ mA}$ $V_{CE} = 10 \text{ V}$ $f = 470 \text{ kHz}$		-1.2		μS
	$I_C = 1 \text{ mA}$ $V_{CE} = 10 \text{ V}$ $f = 10.7 \text{ MHz}$		-27.6		μS
	$I_C = 1 \text{ mA}$ $V_{CE} = 10 \text{ V}$ $f = 100 \text{ MHz}$		-260		μS
ϕ_{re} Reverse transadmittance phase	$I_C = 1 \text{ mA}$ $V_{CE} = 10 \text{ V}$ $f = 470 \text{ kHz}$		-90°		—
	$I_C = 1 \text{ mA}$ $V_{CE} = 10 \text{ V}$ $f = 10.7 \text{ MHz}$		-90°		—
	$I_C = 1 \text{ mA}$ $V_{CE} = 10 \text{ V}$ $f = 100 \text{ MHz}$		-90°		—
g_{fe} Forward transconductance	$I_C = 1 \text{ mA}$ $V_{CE} = 10 \text{ V}$ $f = 470 \text{ kHz}$		35		mS
	$I_C = 1 \text{ mA}$ $V_{CE} = 10 \text{ V}$ $f = 10.7 \text{ MHz}$		35		mS
	$I_C = 1 \text{ mA}$ $V_{CE} = 10 \text{ V}$ $f = 100 \text{ MHz}$		32		mS
b_{fe} Forward transusceptance	$I_C = 1 \text{ mA}$ $V_{CE} = 10 \text{ V}$ $f = 10.7 \text{ MHz}$		-1		mS
	$I_C = 1 \text{ mA}$ $V_{CE} = 10 \text{ V}$ $f = 100 \text{ MHz}$		-9		mS

BF 273

ELECTRICAL CHARACTERISTICS (continued)

Parameter	Test conditions	Min.	Typ.	Max.	Unit
g_{oe} Output conductance	$I_C = 1 \text{ mA}$ $V_{CE} = 10 \text{ V}$				
	$f = 470 \text{ kHz}$		7		μS
	$I_C = 1 \text{ mA}$ $V_{CE} = 10 \text{ V}$				
	$f = 10.7 \text{ MHz}$		11		μS
b_{oe} Output susceptance	$I_C = 1 \text{ mA}$ $V_{CE} = 10 \text{ V}$				
	$f = 470 \text{ kHz}$		4.4		μS
	$I_C = 1 \text{ mA}$ $V_{CE} = 10 \text{ V}$				
	$f = 10.7 \text{ MHz}$		100		μS
b_{oe} Output susceptance	$I_C = 1 \text{ mA}$ $V_{CE} = 10 \text{ V}$				
	$f = 100 \text{ MHz}$		940		μS

BF 274

SILICON PLANAR NPN

GAIN CONTROLLED AM-FM IF AMPLIFIER

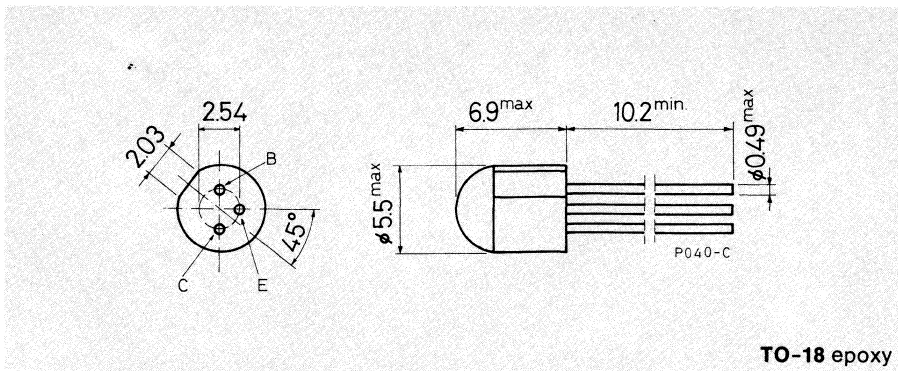
The BF 274 is a silicon planar NPN transistor in a TO-18 epoxy package, primarily intended for use in the gain controlled IF stages of AM and AM/FM radio receivers.

ABSOLUTE MAXIMUM RATINGS

V_{CBO}	Collector-base voltage ($I_E = 0$)	25	V
V_{CEO}	Collector-emitter voltage ($I_B = 0$)	20	V
V_{EBO}	Emitter-base voltage ($I_C = 0$)	4	V
I_C	Collector current	30	mA
P_{tot}	Total power dissipation at $T_{amb} \leq 25^\circ\text{C}$	200	mW
T_{stg}	Storage temperature	-55 to 125	$^\circ\text{C}$
T_j	Junction temperature	125	$^\circ\text{C}$

MECHANICAL DATA

Dimensions in mm



BF 274

THERMAL DATA

$R_{th\ j-amb}$	Thermal resistance junction-ambient	max	500	°C/W
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ELECTRICAL CHARACTERISTICS ($T_{amb} = 25\text{ °C}$ unless otherwise specified)

Parameter	Test conditions	Min.	Typ.	Max.	Unit
I_{CES} Collector cutoff current ($V_{BE} = 0$)	$V_{CE} = 10\text{ V}$ $V_{CE} = 10\text{ V}$ $T_{amb} = 100\text{ °C}$			100 50	nA μA
$V_{(BR)\ CBO}$ Collector-base breakdown voltage ($I_E = 0$)	$I_C = 10\ \mu\text{A}$		25		V
$V_{(BR)\ CEO}$ Collector-emitter breakdown voltage ($I_B = 0$)	$I_C = 1\text{ mA}$		20		V
$V_{(BR)\ EBO}$ Emitter-base breakdown voltage ($I_C = 0$)	$I_E = 10\ \mu\text{A}$		4		V
V_{BE} Base-emitter voltage	$I_C = 1\text{ mA}$ $V_{CE} = 10\text{ V}$		0.70		V
h_{FE} DC current gain	$I_C = 1\text{ mA}$ $V_{CE} = 10\text{ V}$ for BF 274 for BF 274 Gr. B for BF 274 Gr. C		70 100 70	250 120	— — —
f_T Transition frequency	$I_C = 1\text{ mA}$ $V_{CE} = 10\text{ V}$	400	700		MHz
$-C_{re}$ Reverse capacitance	$I_C = 0$ $V_{CE} = 10\text{ V}$ $f = 1\text{ MHz}$		0.41		pF
G_{pe} Power gain	$I_C = 1\text{ mA}$ $V_{CE} = 10\text{ V}$ $f = 470\text{ kHz}$ $I_C = 1\text{ mA}$ $V_{CE} = 10\text{ V}$ $f = 10.7\text{ MHz}$		40 30		dB dB
ΔG_{pe} Power gain control	$I_C = 100\ \mu\text{A}$ $V_{CE} = 10\text{ V}$ $f = 470\text{ kHz}$		20		dB

BF 287

SILICON PLANAR NPN

AM MIXER-OSCILLATOR AND AM-FM AMPLIFIER

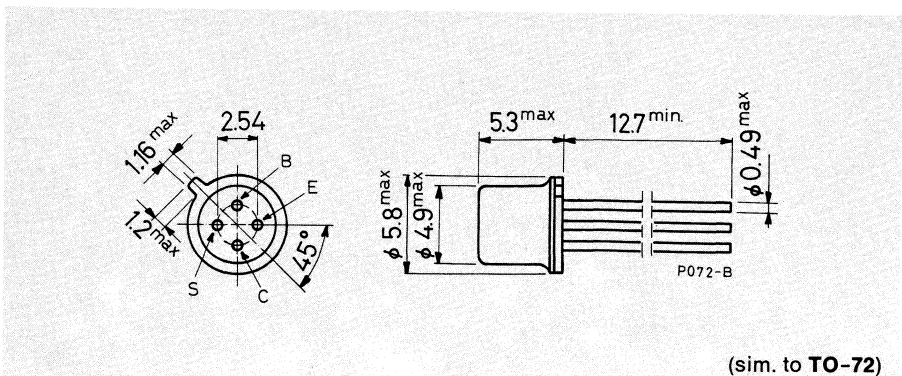
The BF 287 is a silicon planar NPN transistor in a TO-72 metal case. It is primarily intended for use in the AM mixer-oscillator stage and as IF amplifier of AM-FM radios.

ABSOLUTE MAXIMUM RATINGS

V_{CBO}	Collector-base voltage ($I_E = 0$)	40 V
V_{CEO}	Collector-emitter voltage ($I_B = 0$)	40 V
V_{EBO}	Emitter-base voltage ($I_C = 0$)	4 V
I_C	Collector current	20 mA
P_{tot}	Total power dissipation at $T_{amb} \leq 25^\circ\text{C}$ at $T_{case} \leq 45^\circ\text{C}$	250 mW 220 mW
T_{stg}	Storage temperature	-55 to 200 °C
T_j	Junction temperature	200 °C

MECHANICAL DATA

Dimensions in mm



BF 287

THERMAL DATA

$R_{th\ j-amb}$	Thermal resistance junction-ambient	max	700 °C/W
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ELECTRICAL CHARACTERISTICS ($T_{amb} = 25\text{ °C}$ unless otherwise specified)

Parameter	Test conditions	Min.	Typ.	Max.	Unit
I_{CES} Collector cutoff current ($V_{BE} = 0$)	$V_{CE} = 10\text{ V}$			100	nA
$V_{(BR)\ CBO}$ Collector-base breakdown voltage ($I_E = 0$)	$I_C = 10\ \mu\text{A}$	40			V
$V_{CEO\ (sus)}$ Collector-emitter sustaining voltage ($I_B = 0$)	$I_C = 5\text{ mA}$	40			V
$V_{(BR)\ EBO}$ Emitter-base breakdown voltage ($I_C = 0$)	$I_E = 100\ \mu\text{A}$	4			V
V_{BE} Base-emitter voltage	$I_C = 1\text{ mA}$ $V_{CE} = 7\text{ V}$ $I_C = 2\text{ mA}$ $V_{CE} = 10\text{ V}$		710 740		mV mV
h_{FE} DC current gain	$I_C = 1\text{ mA}$ $V_{CE} = 7\text{ V}$ $I_C = 2\text{ mA}$ $V_{CE} = 10\text{ V}$	30 40	50 60		— —
f_T Transition frequency	$I_C = 1\text{ mA}$ $V_{CE} = 7\text{ V}$ $f = 100\text{ MHz}$ $I_C = 2\text{ mA}$ $V_{CE} = 10\text{ V}$ $f = 100\text{ MHz}$		600 700		MHz MHz
G_{pe} Power gain	$I_C = 1\text{ mA}$ $V_{CE} = 7\text{ V}$ $f = 470\text{ kHz}$ $f = 10.7\text{ MHz}$ $I_C = 2\text{ mA}$ $V_{CE} = 10\text{ V}$ $f = 5.5\text{ MHz}$	42 18	45 22		dB dB dB
g_{ie} Input conductance	$I_C = 1\text{ mA}$ $V_{CE} = 7\text{ V}$ $f = 470\text{ kHz}$ $f = 10.7\text{ MHz}$		0.17 0.25		mS mS
b_{ie} Input susceptance	$I_C = 1\text{ mA}$ $V_{CE} = 7\text{ V}$ $f = 470\text{ kHz}$ $f = 10.7\text{ MHz}$		24 0.52		μS mS

BF 287

ELECTRICAL CHARACTERISTICS (continued)

Parameter		Test conditions	Min. Typ. Max.	Unit
g_{fe}	Forward transconductance	$I_C = 1 \text{ mA}$ $V_{CE} = 7 \text{ V}$ $f = 470 \text{ kHz}$ $f = 10.7 \text{ MHz}$	35 35	mS mS
$-b_{fe}$	Forward transusceptance	$I_C = 1 \text{ mA}$ $V_{CE} = 7 \text{ V}$ $f = 470 \text{ kHz}$ $f = 10.7 \text{ MHz}$	40 0.96	μS mS
g_{oe}	Output conductance	$I_C = 1 \text{ mA}$ $V_{CE} = 7 \text{ V}$ $f = 470 \text{ kHz}$ $f = 10.7 \text{ MHz}$	6 11	μS μS
b_{oe}	Output susceptance	$I_C = 1 \text{ mA}$ $V_{CE} = 7 \text{ V}$ $f = 470 \text{ kHz}$ $f = 10.7 \text{ MHz}$	4.5 100	μS μS

SILICON PLANAR NPN**GAIN CONTROLLED AM-FM IF AMPLIFIER**

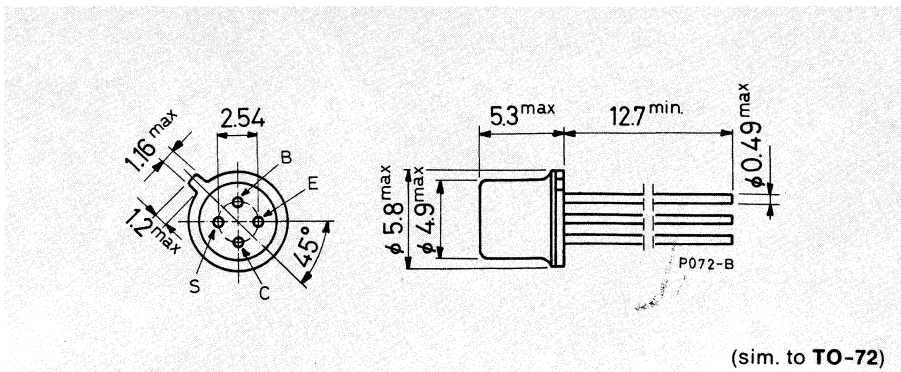
The BF 288 is a silicon planar NPN transistor in a TO-72 metal case. It is primarily intended for use in the gain controlled IF stages of AM and AM/FM radio receivers.

ABSOLUTE MAXIMUM RATINGS

V_{CBO}	Collector-base voltage ($I_E = 0$)	40 V
V_{CEO}	Collector-emitter voltage ($I_B = 0$)	40 V
V_{EBO}	Emitter-base voltage ($I_C = 0$)	4 V
I_C	Collector current	20 mA
P_{tot}	Total power dissipation at $T_{amb} \leq 25^\circ\text{C}$	250 mW
	at $T_{amb} \leq 45^\circ\text{C}$	220 mW
T_{stg}	Storage temperature	-55 to 200 °C
T_j	Junction temperature	200 °C

MECHANICAL DATA

Dimensions in mm



BF 288

THERMAL DATA

$R_{th\ j-amb}$	Thermal resistance junction-ambient	max	700 °C/W
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ELECTRICAL CHARACTERISTICS ($T_{amb} = 25\text{ °C}$ unless otherwise specified)

Parameter	Test conditions	Min.	Typ.	Max.	Unit
I_{CES} Collector cutoff current ($V_{BE} = 0$)	$V_{CE} = 7\text{ V}$			100	nA
$V_{(BR)\ CBO}$ Collector-base breakdown voltage ($I_E = 0$)	$I_C = 10\ \mu\text{A}$	40			V
$V_{CEO\ (sus)}$ Collector-emitter sustaining voltage ($I_B = 0$)	$I_C = 5\text{ mA}$	40			V
$V_{(BR)\ EBO}$ Emitter-base breakdown voltage ($I_C = 0$)	$I_E = 100\ \mu\text{A}$	4			V
V_{BE} Base-emitter voltage	$I_C = 1\text{ mA}$ $V_{CE} = 7\text{ V}$		740		mV
h_{FE} DC current gain	$I_C = 1\text{ mA}$ $V_{CE} = 7\text{ V}$	65	90		—
f_T Transition frequency	$I_C = 1\text{ mA}$ $V_{CE} = 7\text{ V}$		500		MHz
$-C_{re}$ Reverse capacitance	$V_{CE} = 7\text{ V}$ $f = 1\text{ MHz}$		0.24		pF
G_{pe} Power gain	$I_C = 1\text{ mA}$ $V_{CE} = 7\text{ V}$ $f = 470\text{ kHz}$ $f = 10.7\text{ MHz}$	42	45		dB
		18	22		dB
g_{ie} Input conductance	$I_C = 1\text{ mA}$ $V_{CE} = 7\text{ V}$ $f = 470\text{ kHz}$ $f = 10.7\text{ MHz}$		0.17		mS
			0.25		mS
b_{ie} Input susceptance	$I_C = 1\text{ mA}$ $V_{CE} = 7\text{ V}$ $f = 470\text{ kHz}$ $f = 10.7\text{ MHz}$		24		μS
			0.52		mS
g_{fe} Forward transconductance	$I_C = 1\text{ mA}$ $V_{CE} = 7\text{ V}$ $f = 470\text{ kHz}$ $f = 10.7\text{ MHz}$		35		mS
			35		mS

BF 288

ELECTRICAL CHARACTERISTICS (continued)

Parameter		Test conditions	Min. Typ. Max.	Unit
$-b_{fe}$	Forward transusceptance	$I_C = 1 \text{ mA}$ $V_{CE} = 7 \text{ V}$ $f = 470 \text{ kHz}$ $f = 10.7 \text{ MHz}$	40 0.95	μS mS
g_{oe}	Output conductance	$I_C = 1 \text{ mA}$ $V_{CE} = 7 \text{ V}$ $f = 470 \text{ kHz}$ $f = 10.7 \text{ MHz}$	6 11	μS μS
b_{oe}	Output susceptance	$I_C = 1 \text{ mA}$ $V_{CE} = 7 \text{ V}$ $f = 470 \text{ kHz}$ $f = 10.7 \text{ MHz}$	4.5 100	μS μS

BF 316A

SILICON PLANAR PNP

UHF MIXER OSCILLATOR

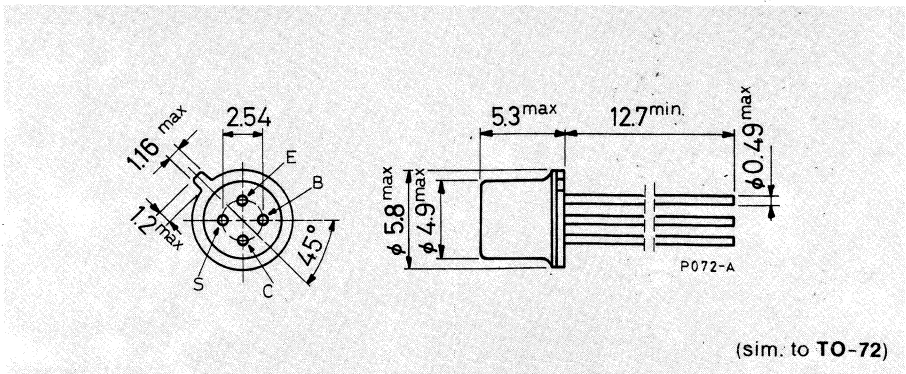
The BF 316 A is a silicon planar epitaxial PNP transistor in a TO-72 metal case. It is specifically designed for use as oscillator-mixer in UHF tuners.

ABSOLUTE MAXIMUM RATINGS

V_{CB0}	Collector-base voltage ($I_E = 0$)	-40 V
V_{CEO}	Collector-emitter voltage ($I_B = 0$)	-35 V
V_{EBO}	Emitter-base voltage ($I_C = 0$)	-3 V
I_C	Collector current	-20 mA
P_{tot}	Total power dissipation at $T_{amb} \leq 25^\circ\text{C}$	200 mW
T_{stg}	Storage temperature	-55 to 200 $^\circ\text{C}$
T_j	Junction temperature	200 $^\circ\text{C}$

MECHANICAL DATA

Dimensions in mm



BF 316A

THERMAL DATA

$R_{th\ j-amb}$	Thermal resistance junction-ambient	max	875 °C/W
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ELECTRICAL CHARACTERISTICS ($T_{amb} = 25\text{ °C}$ unless otherwise specified)

Parameter	Test conditions	Min.	Typ.	Max.	Unit
I_{CBO} Collector cutoff current ($I_E = 0$)	$V_{CB} = -20\text{ V}$			-100	nA
$V_{(BR)\ CBO}$ Collector-base breakdown voltage ($I_E = 0$)	$I_C = -10\ \mu\text{A}$	-40			V
$V_{(BR)\ CEO}$ Collector-emitter breakdown voltage ($I_B = 0$)	$I_C = -3\text{ mA}$	-35			V
$V_{(BR)\ EBO}$ Emitter-base breakdown voltage ($I_C = 0$)	$I_E = -10\ \mu\text{A}$	-3			V
V_{BE} Base-emitter voltage	$I_C = -3\text{ mA}$ $V_{CE} = -10\text{ V}$	-0.75			V
h_{FE} DC current gain	$I_C = -3\text{ mA}$ $V_{CE} = -10\text{ V}$	30	50		—
f_T Transition frequency	$I_C = -3\text{ mA}$ $V_{CE} = -10\text{ V}$	600			MHz
$-C_{re}$ Reverse capacitance	$I_C = 0$ $V_{CE} = -10\text{ V}$ $f = 1\text{ MHz}$	0.25			pF
NF Noise figure	$I_C = -3\text{ mA}$ $V_{CB} = -10\text{ V}$ $R_g = 50\ \Omega$ $f = 800\text{ MHz}$		5		dB
	$I_C = -3\text{ mA}$ $V_{CB} = -10\text{ V}$ $R_g = 50\ \Omega$ $f = 500\text{ MHz}$		3.5		dB
G_{pb} Power gain	$I_C = -3\text{ mA}$ $V_{CB} = -10\text{ V}$ $R_L = 2\text{ k}\Omega$ $f = 800\text{ MHz}$		12		dB
	$I_C = -3\text{ mA}$ $V_{CB} = -10\text{ V}$ $R_L = 2\text{ k}\Omega$ $f = 500\text{ MHz}$		17		dB

BF 316A

ELECTRICAL CHARACTERISTICS (continued)

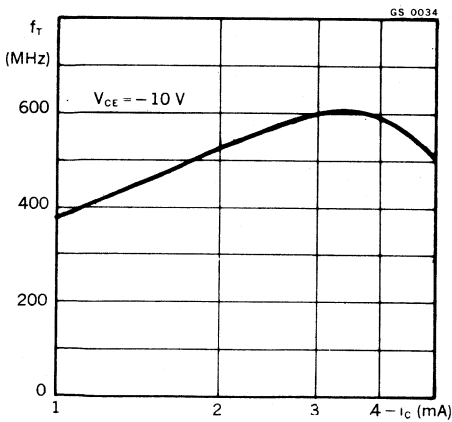
Parameter	Test conditions	Min.	Typ.	Max.	Unit
g_{ib} Input conductance	$I_C = -3 \text{ mA}$ $V_{CB} = -10 \text{ V}$ $f = 800 \text{ MHz}$		4.6		mS
	$I_C = -3 \text{ mA}$ $V_{CB} = -10 \text{ V}$ $f = 500 \text{ MHz}$		17		mS
b_{ib} Input susceptance	$I_C = -3 \text{ mA}$ $V_{CB} = -10 \text{ V}$ $f = 800 \text{ MHz}$		-23		mS
	$I_C = -3 \text{ mA}$ $V_{CB} = -10 \text{ V}$ $f = 500 \text{ MHz}$		-37		mS
g_{ob} Output conductance	$I_C = -3 \text{ mA}$ $V_{CB} = -10 \text{ V}$ $f = 800 \text{ MHz}$		0.6		mS
	$I_C = -3 \text{ mA}$ $V_{CB} = -10 \text{ V}$ $f = 500 \text{ MHz}$		0.32		mS
b_{ob} Output susceptance	$I_C = -3 \text{ mA}$ $V_{CB} = -10 \text{ V}$ $f = 800 \text{ MHz}$		5		mS
	$I_C = -3 \text{ mA}$ $V_{CB} = -10 \text{ V}$ $f = 500 \text{ MHz}$		3.2		mS
g_{fb} Forward transconductance	$I_C = -3 \text{ mA}$ $V_{CB} = -10 \text{ V}$ $f = 800 \text{ MHz}$		16		mS
	$I_C = -3 \text{ mA}$ $V_{CB} = -10 \text{ V}$ $f = 500 \text{ MHz}$		10		mS
b_{fb} Forward transsusceptance	$I_C = -3 \text{ mA}$ $V_{CB} = -10 \text{ V}$ $f = 800 \text{ MHz}$		13		mS
	$I_C = -3 \text{ mA}$ $V_{CB} = -10 \text{ V}$ $f = 500 \text{ MHz}$		39		mS
g_{rb} Reverse transconductance	$I_C = -3 \text{ mA}$ $V_{CB} = -10 \text{ V}$ $f = 800 \text{ MHz}$		-0.1		mS
	$I_C = -3 \text{ mA}$ $V_{CB} = -10 \text{ V}$ $f = 500 \text{ MHz}$		-0.04		mS
b_{rb} Reverse transsusceptance	$I_C = -3 \text{ mA}$ $V_{CB} = -10 \text{ V}$ $f = 800 \text{ MHz}$		-0.32		mS
	$I_C = -3 \text{ mA}$ $V_{CB} = -10 \text{ V}$ $f = 500 \text{ MHz}$		-0.26		mS

BF 316A

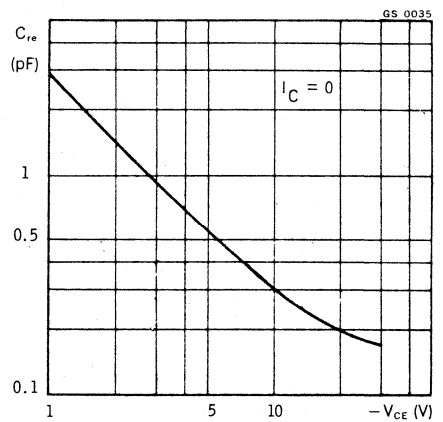
ELECTRICAL CHARACTERISTICS (continued)

Parameter	Test conditions	Min.	Typ.	Max.	Unit
$\phi_{fb} - \phi_{ib}$ Phase difference	$I_C = -3 \text{ mA}$ $V_{CB} = -10 \text{ V}$ $f = 800 \text{ MHz}$		118°		—
	$I_C = -3 \text{ mA}$ $V_{CB} = -10 \text{ V}$ $f = 500 \text{ MHz}$		141°		—
→ g_{ob} Output conductance	$I_C = -3 \text{ mA}$ $V_{CB} = -10 \text{ V}$ $f = 43 \text{ MHz}$		0.02		mS
→ C_{ob} Output capacitance	$I_C = -3 \text{ mA}$ $V_{CB} = -10 \text{ V}$ $f = 43 \text{ MHz}$		1		pF

Transition frequency



Reverse capacitance



BF 324

SILICON PLANAR PNP

PRELIMINARY DATA

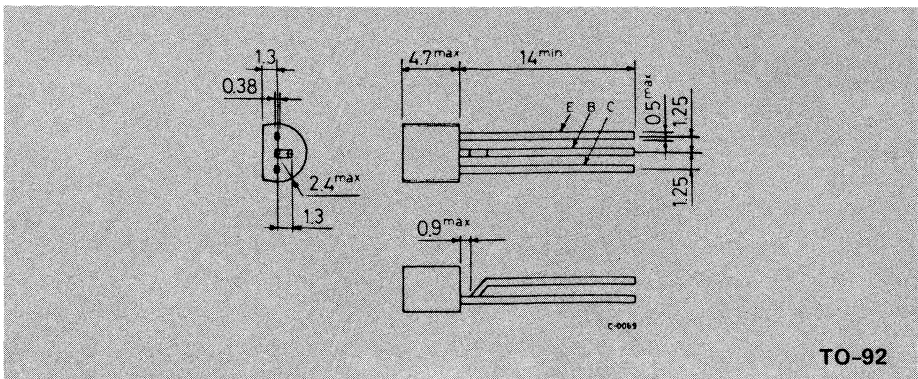
The BF 324 is a PNP silicon planar epitaxial transistor in Jedec TO-92 plastic package. It is especially intended for common base input stages in FM tuners.

ABSOLUTE MAXIMUM RATINGS

V_{CBO}	Collector-base voltage ($I_E = 0$)	-35	V
V_{CEO}	Collector-emitter voltage ($I_B = 0$)	-35	V
V_{EBO}	Emitter-base voltage ($I_C = 0$)	-4	V
I_C	Collector current	-30	mA
P_{tot}	Total power dissipation at $T_{amb} \leq 45^\circ\text{C}$	250	mW
T_{stg}	Storage temperature	-55 to 150	$^\circ\text{C}$
T_j	Junction temperature	150	$^\circ\text{C}$

MECHANICAL DATA

Dimensions in mm



BF 324

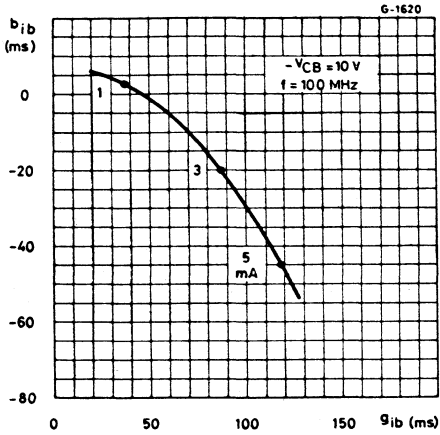
THERMAL DATA

$R_{th\ j-amb}$	Thermal resistance junction-ambient	max	420 °C/W
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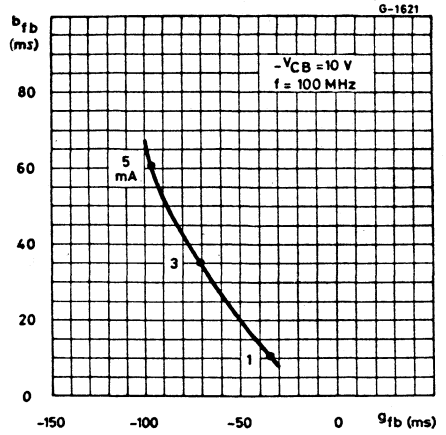
ELECTRICAL CHARACTERISTICS ($T_{amb} = 25^{\circ}\text{C}$ unless otherwise specified)

Parameter	Test conditions	Min.	Typ.	Max.	Unit
I_{CBO}	Collector cutoff current ($I_E = 0$)			-50	nA
$V_{(BR)CEO}$	Collector-emitter breakdown voltage ($I_B = 0$)			-35	V
$V_{(BR)EBO}$	Emitter-base breakdown voltage ($I_C = 0$)			-4	V
h_{FE}	DC current gain	$I_C = -1\text{ mA}$ $I_C = -4\text{ mA}$	$V_{CE} = -10\text{V}$ $V_{CE} = -10\text{V}$	45 25 50 160	- -
f_T	Transition frequency	$f = 100\text{ MHz}$ $I_C = -1\text{ mA}$ $I_C = -4\text{ mA}$ $I_C = -8\text{ mA}$	$V_{CE} = -10\text{V}$	400 500 450	MHz MHz MHz
C_{rb}	Reverse capacitance	$I_C = 0$ $f = 1\text{ MHz}$	$V_{CB} = -10\text{V}$	0.1	pF
NF	Noise figure	$I_C = -2\text{ mA}$ $R_g = 50\ \Omega$ $f = 100\text{ MHz}$	$V_{CC} = -10\text{V}$	3	dB

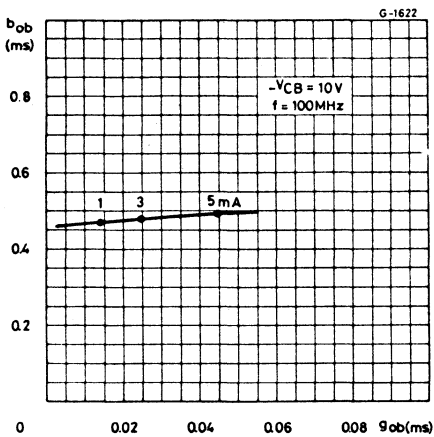
Typical input admittance



Typical transfer admittance



Typical output admittance



BF 454

SILICON PLANAR NPN

AM/FM IF AMPLIFIER

The BF 454 is a silicon planar NPN transistor in a TO-18 epoxy package, with low reverse capacitance, very low noise, high output impedance.

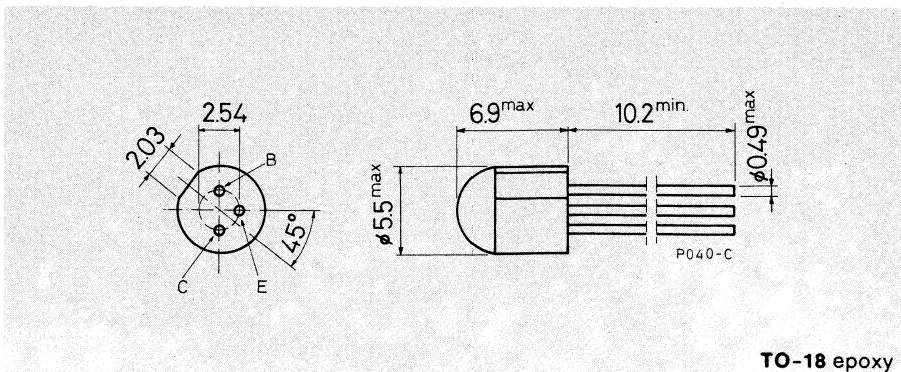
The BF 454 is especially suited for FM tuner stages, AM mixer/oscillators and for AM/FM IF amplifiers.

ABSOLUTE MAXIMUM RATINGS

V_{CBO}	Collector-base voltage ($I_E = 0$)	35 V
V_{CEO}	Collector-emitter voltage ($I_B = 0$)	25 V
V_{EBO}	Emitter-base voltage ($I_C = 0$)	4 V
I_C	Collector current	20 mA
P_{tot}	Total power dissipation at $T_{amb} \leq 25^\circ\text{C}$ at $T_{case} \leq 25^\circ\text{C}$	200 mW 500 mW
T_{stg}	Storage temperature	-55 to 125 °C
T_j	Junction temperature	125 °C

MECHANICAL DATA

Dimensions in mm



BF 454

THERMAL DATA

$R_{th j-amb}$	Thermal resistance junction-ambient	max	500	°C/W
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ELECTRICAL CHARACTERISTICS ($T_{amb} = 25^\circ\text{C}$ unless otherwise specified)

Parameter	Test conditions	Min.	Typ.	Max.	Unit
I_{CBO} Collector cutoff current ($I_E = 0$)	$V_{CB} = 10\text{ V}$			200	nA
$V_{(BR) CBO}$ Collector-base breakdown voltage ($I_E = 0$)	$I_C = 100\ \mu\text{A}$	35			V
$V_{CEO(sus)}$ *Collector-emitter sustaining voltage ($I_B = 0$)	$I_C = 1\text{ mA}$	25			V
$V_{(BR) EBO}$ Emitter-base breakdown voltage ($I_C = 0$)	$I_E = 10\ \mu\text{A}$	4			V
V_{BE} Base-emitter voltage	$I_C = 1\text{ mA}$ $V_{CE} = 10\text{ V}$	0.71			V
h_{FE} DC current gain Gr. B	$I_C = 1\text{ mA}$ $V_{CE} = 10\text{ V}$ $I_C = 1\text{ mA}$ $V_{CE} = 10\text{ V}$	110 65		200 220	— —
f_T Transition frequency	$I_C = 1\text{ mA}$ $V_{CE} = 10\text{ V}$ $f = 100\text{ MHz}$		400		MHz
$-C_{re}$ Reverse capacitance	$I_C = 0$ $V_{CE} = 10\text{ V}$ $f = 1\text{ MHz}$		0.5	0.8	pF
NF Noise figure	$I_C = 1\text{ mA}$ $V_{CE} = 10\text{ V}$ $R_g = 100\ \Omega$ $f = 100\text{ MHz}$		3		dB

* Pulsed: pulse duration = 300 μs , duty factor = 1%

BF 454

ELECTRICAL CHARACTERISTICS (continued)

Parameter	Test conditions	Min.	Typ.	Max.	Unit	
g_{ib} Input conductance	$I_C = 1 \text{ mA}$ $V_{CE} = 10 \text{ V}$ $f = 100 \text{ MHz}$		36		mS	
$-b_{ib}$ Input susceptance			3.5		mS	
$ Y_{fb} $ Forward transadmittance				34		mS
φ_{fb} Phase angle of the forward transadmittance				160°		—
g_{ob} Output conductance				22		μS
b_{ob} Output susceptance				0.86		mS

BF 455

SILICON PLANAR NPN

PREAMPLIFIER AND AM/FM IF AMPLIFIER

The BF 455 is a silicon planar NPN transistor in TO-18 epoxy package, with low reverse capacitance, very low noise, high output impedance.

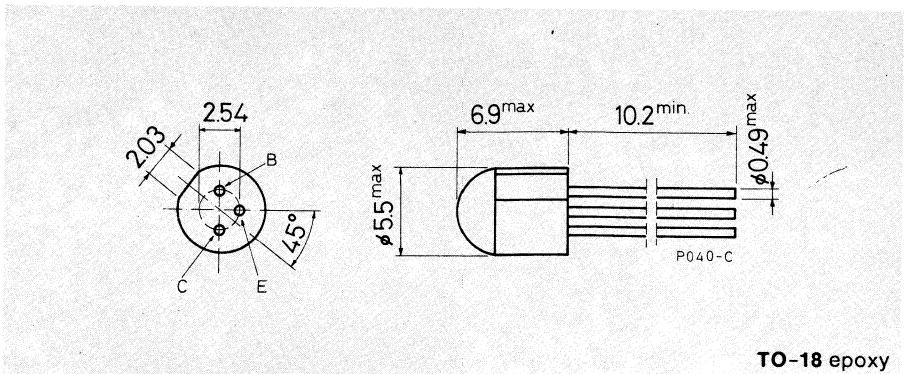
The BF 455 is especially suited for FM tuners, IF amplifiers in AM/FM receivers, AM input stages of car-radios.

ABSOLUTE MAXIMUM RATINGS

V_{CBO}	Collector-base voltage ($I_E = 0$)	35 V
V_{CEO}	Collector-emitter voltage ($I_B = 0$)	25 V
V_{EBO}	Emitter-base voltage ($I_C = 0$)	4 V
I_C	Collector current	20 mA
P_{tot}	Total power dissipation at $T_{amb} \leq 25^\circ\text{C}$	200 mW
	at $T_{case} \leq 25^\circ\text{C}$	500 mW
T_{stg}	Storage temperature	-55 to 125 °C
T_j	Junction temperature	125 °C

MECHANICAL DATA

Dimensions in mm



BF 455

THERMAL DATA

$R_{th\ j-amb}$	Thermal resistance junction-ambient	max	500	°C/W
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ELECTRICAL CHARACTERISTICS ($T_{amb} = 25\text{ °C}$ unless otherwise specified)

Parameter	Test conditions	Min.	Typ.	Max.	Unit
I_{CBO} Collector cutoff current ($I_E = 0$)	$V_{CB} = 10\text{ V}$			200	nA
$V_{(BR)\ CBO}$ Collector-base breakdown voltage ($I_E = 0$)	$I_C = 100\ \mu\text{A}$	35			V
$V_{CEO(sus)}$ *Collector-emitter sustaining voltage ($I_B = 0$)	$I_C = 1\text{ mA}$	25			V
$V_{(BR)\ EBO}$ Emitter-base breakdown voltage ($I_C = 0$)	$I_E = 10\ \mu\text{A}$	4			V
V_{BE} Base-emitter voltage	$I_C = 1\text{ mA}$ $V_{CE} = 10\text{ V}$	0.71			V
h_{FE} DC current gain	Gr. C $I_C = 1\text{ mA}$ $V_{CE} = 10\text{ V}$ Gr. D $I_C = 1\text{ mA}$ $V_{CE} = 10\text{ V}$ $I_C = 1\text{ mA}$ $V_{CE} = 10\text{ V}$	68		120	—
		38		75	—
		35		125	—
f_T Transition frequency	$I_C = 1\text{ mA}$ $V_{CE} = 10\text{ V}$ $f = 100\text{ MHz}$		400		MHz
$-C_{re}$ Reverse capacitance	$I_C = 0$ $V_{CE} = 10\text{ V}$ $f = 1\text{ MHz}$		0.5	0.8	pF
NF Noise figure	$I_C = 1\text{ mA}$ $V_{CE} = 10\text{ V}$ $R_g = 100\ \Omega$ $f = 100\text{ MHz}$		3		dB

* Pulsed: pulse duration = 300 μs , duty factor = 1%

BF 455

ELECTRICAL CHARACTERISTICS (continued)

Parameter		Test conditions	Min.	Typ.	Max.	Unit
g_{ib}	Input conductance	$I_C = 1 \text{ mA}$ $V_{CE} = 10 \text{ V}$ $f = 100 \text{ MHz}$		38		mS
$-b_{ib}$	Input susceptance			2		mS
$ Y_{fb} $	Forward transadmittance			34		mS
ϕ_{ib}	Phase angle of the forward transadmittance			150°		—
g_{ob}	Output conductance			13		μS
b_{ob}	Output susceptance			0.8		mS

BF 457
BF 458
BF 459

SILICON PLANAR NPN

PRELIMINARY DATA

HIGH VOLTAGE VIDEO AMPLIFIERS

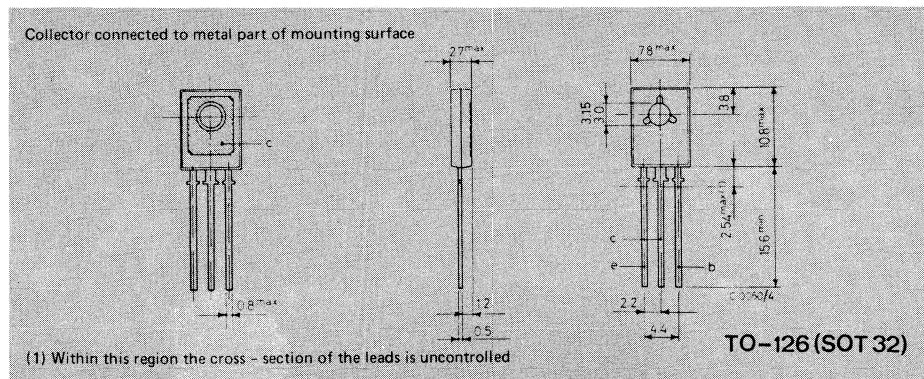
The BF 457, BF 458 and BF 459 are silicon planar epitaxial NPN transistors in Jedec TO-126 plastic package. They are particularly intended for use as video output stages in colour and black and white TV receivers, class A output stages and drivers for horizontal deflection circuits. These transistors have been studied in order to guarantee the maximum resistance against flash over.

ABSOLUTE MAXIMUM RATINGS

		BF 457	BF 458	BF 459
V_{CBO}	Collector-base voltage ($I_E = 0$)	160 V	250 V	300 V
V_{CEO}	Collector-emitter voltage ($I_B = 0$)	160 V	250 V	300 V
V_{EBO}	Emitter-base voltage ($I_C = 0$)	5 V		
I_{CM}	Collector peak current	300 mA		
I_{BM}	Base peak current	50 mA		
P_{tot}	Total power dissipation at $T_{amb} \leq 25^\circ C$ $T_{case} \leq 25^\circ C$	1.25 W		
T_{stg}	Storage temperature	-55 to 150 °C		
T_j	Junction temperature	150 °C		

MECHANICAL DATA

Dimensions in mm



BF 457
BF 458
BF 459

THERMAL DATA

$R_{th\ j-case}$	Thermal resistance junction-case	max	10 °C/W
$R_{th\ j-amb}$	Thermal resistance junction-ambient	max	100 °C/W

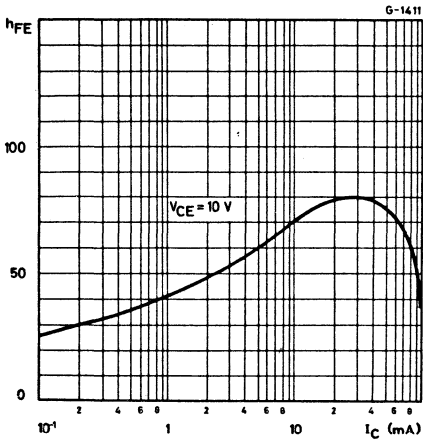
ELECTRICAL CHARACTERISTICS ($T_{case} = 25\text{ °C}$ unless otherwise specified)

Parameter	Test conditions	Min.	Typ.	Max.	Unit
I_{CBO} Collector cutoff current ($I_E = 0$)	for BF 457 $V_{CB} = 100V$ for BF 458 $V_{CB} = 200V$ for BF 459 $V_{CB} = 250V$			50 50 50	nA nA nA
→ $V_{(BR)CEO}$ * Collector-emitter sustaining voltage ($I_B = 0$)	$I_C = 10\text{ mA}$ for BF 457 for BF 458 for BF 459			160 250 300	V V V
$V_{(BR)EBO}$ Emitter-base breakdown voltage ($I_C = 0$)	$I_E = 100\ \mu A$			5	V
$V_{CE(sat)}$ Collector-emitter saturation voltage	$I_C = 50\text{ mA}$ $I_B = 10\text{ mA}$			1	V
h_{FE} DC current gain	$I_C = 30\text{ mA}$ $V_{CE} = 10V$	30	80		—
f_T Transition frequency	$I_C = 30\text{ mA}$ $V_{CE} = 10V$		90		MHz
$-C_{re}$ Reverse capacitance	$I_C = 0$ $f = 1\text{ MHz}$ $V_{CE} = 30V$		4		pF
C_{oe} Output capacitance	$I_C = 0$ $f = 1\text{ MHz}$ $V_{CE} = 30V$		5		pF

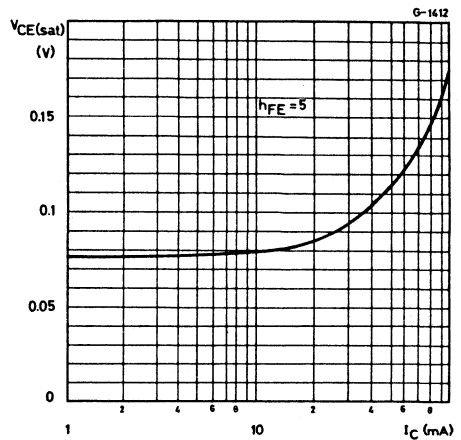
* Pulsed: pulse duration = 300 μs , duty cycle 1%

BF 457
BF 458
BF 459

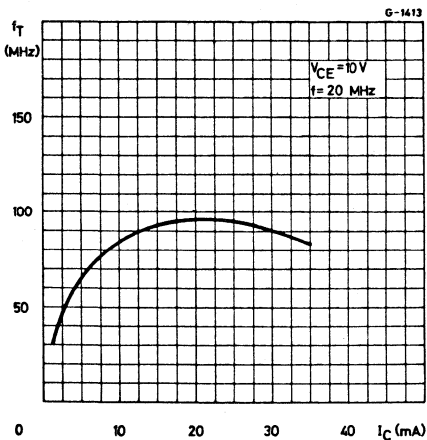
Typical DC current gain



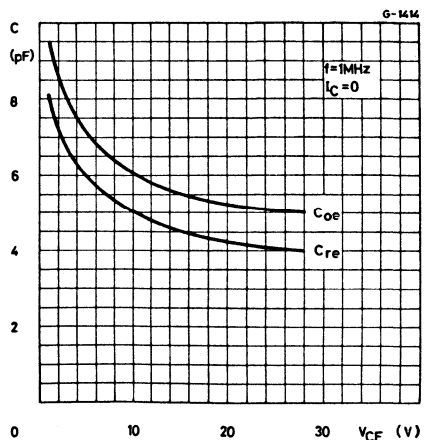
Typical collector-emitter saturation voltage



Typical transition frequency



Typical output and reverse capacitance



BF 479

SILICON PLANAR PNP

PRELIMINARY DATA

LOW-NOISE ULTRA LINEAR UHF-VHF AMPLIFIER

The BF 479 is a PNP silicon planar epitaxial transistor in a T-plastic package mainly intended for high current UHF-VHF stages of TV tuners.

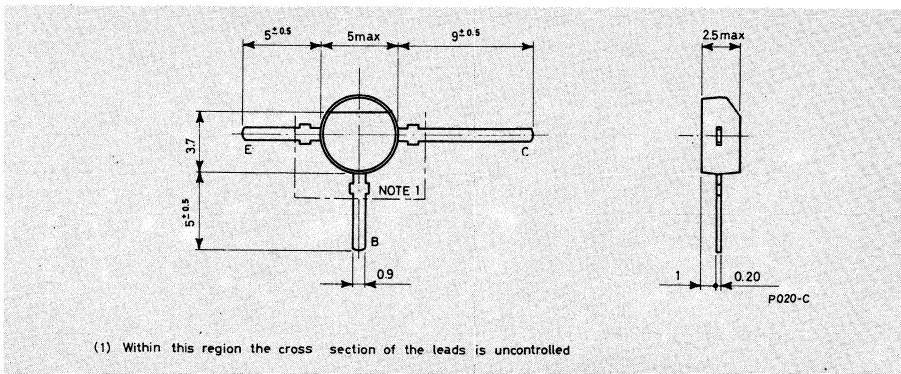
In this application, combined with a PIN diode attenuator circuit, it presents very low noise and very good cross modulation performances up to 900 MHz.

ABSOLUTE MAXIMUM RATINGS

V_{CBO}	Collector-base voltage ($I_E = 0$)	-30 V
V_{CEO}	Collector-emitter voltage ($I_B = 0$)	-25 V
V_{EBO}	Emitter-base voltage ($I_C = 0$)	-3 V
I_C	Collector current	-50 mA
P_{tot}	Total power dissipation at $T_{amb} \leq 45^\circ\text{C}$	170 mW
T_{stg}	Storage temperature	-55 to 150 $^\circ\text{C}$
T_j	Junction temperature	150 $^\circ\text{C}$

MECHANICAL DATA

Dimensions in mm



BF 479

THERMAL DATA

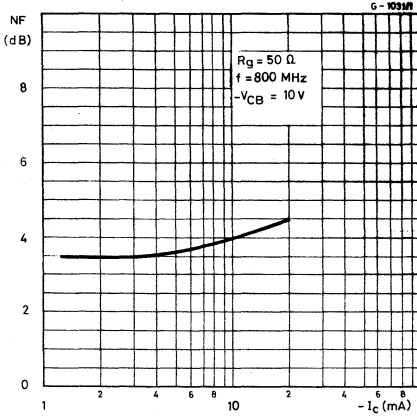
$R_{th\ j-amb}$	Thermal resistance junction-ambient	max	600	°C/W
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ELECTRICAL CHARACTERISTICS ($T_{amb} = 25\text{ °C}$ unless otherwise specified)

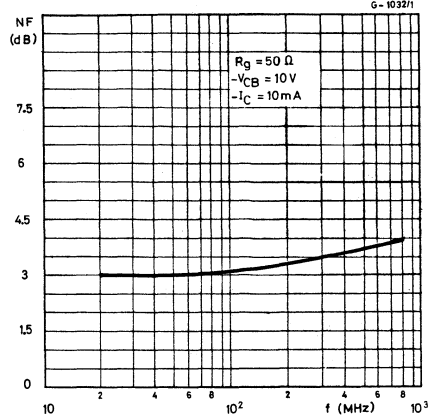
Parameter	Test conditions	Min.	Typ.	Max.	Unit
I_{CBO} Collector cutoff current ($I_E = 0$)	$V_{CB} = -20\text{ V}$			-100	nA
$V_{(BR)\ CBO}$ Collector-base breakdown voltage ($I_E = 0$)	$I_C = -100\ \mu\text{A}$	-30			V
$V_{(BR)\ CEO}$ Collector-emitter breakdown voltage ($I_B = 0$)	$I_C = -5\text{ mA}$	-25			V
$V_{(BR)\ EBO}$ Emitter-base breakdown voltage ($I_C = 0$)	$I_E = -10\ \mu\text{A}$	-3			V
h_{FE} DC current gain	$I_C = -10\text{ mA}$ $V_{CE} = -10\text{ V}$	20			—
f_T Transition frequency	$I_C = -10\text{ mA}$ $V_{CE} = -10\text{ V}$ $f = 100\text{ MHz}$		1.4		GHz
C_{CBO} Collector-base capacitance	$I_E = 0$ $V_{CB} = -10\text{ V}$ $f = 1\text{ MHz}$		0.7		pF
NF Noise figure	$V_{CB} = -10\text{ V}$ $R_g = 50\ \Omega$ $I_C = -3\text{ mA}$ $f = 200\text{ MHz}$ $I_C = -10\text{ mA}$ $f = 200\text{ MHz}$ $I_C = -3\text{ mA}$ $f = 800\text{ MHz}$ $I_C = -10\text{ mA}$ $f = 800\text{ MHz}$		2.5 3.3 3.5 4	5.5 6	dB dB dB dB
G_{db} Power gain	$I_C = -10\text{ mA}$ $V_{CB} = -10\text{ V}$ $R_L = 2\text{ k}\Omega$ $f = 800\text{ MHz}$	15	18		dB

BF 479

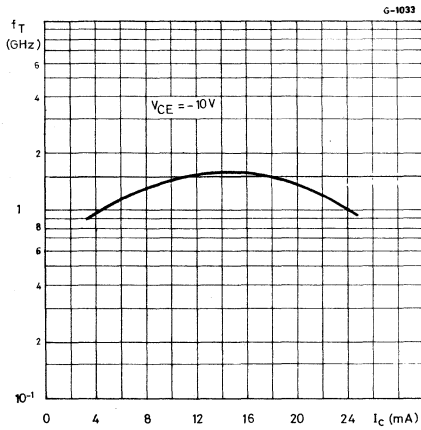
Typical noise figure



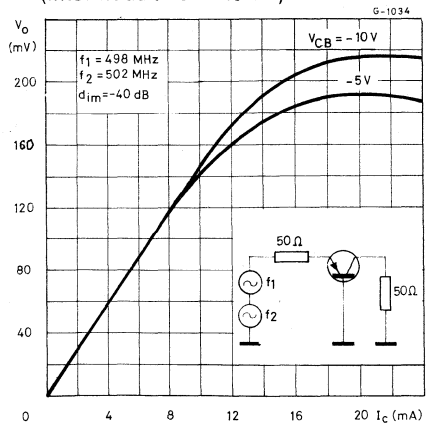
Typical noise figure



Typical transition frequency



Typical output voltage
(intermodulation -40 dB)



BF 506**SILICON PLANAR PNP****VHF OSCILLATOR MIXER**

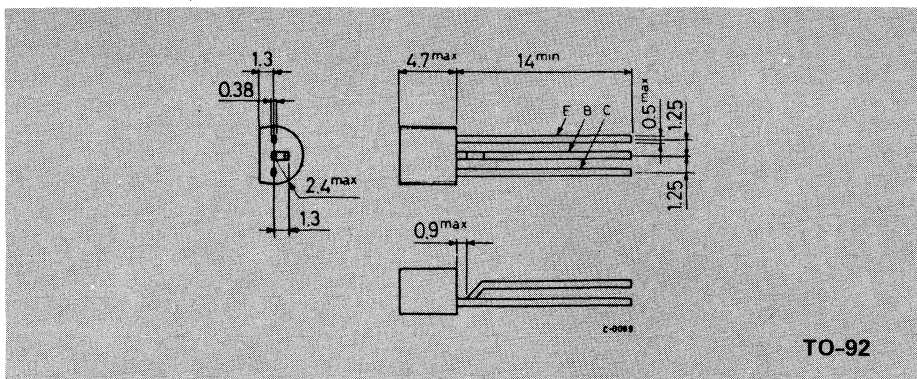
The BF 506 is a silicon planar epitaxial PNP transistor in Jedec TO-92 plastic package. It is intended for use as mixer and oscillator in the VHF range. However, it may also be used as not controlled preamplifier at low noise.

ABSOLUTE MAXIMUM RATINGS

V_{CBO}	Collector-base voltage ($I_E = 0$)	-40	V
V_{CEO}	Collector-emitter voltage ($I_B = 0$)	-35	V
V_{EBO}	Emitter-base voltage ($I_C = 0$)	-4	V
I_C	Collector current	-30	mA
I_B	Base current	-5	mA
P_{tot}	Total power dissipation at $T_{amb} \leq 45^\circ\text{C}$	250	mW
T_{stg}	Storage temperature	-55 to 150	$^\circ\text{C}$
T_J	Junction temperature	150	$^\circ\text{C}$

MECHANICAL DATA

Dimensions in mm



BF 506

THERMAL DATA

$R_{th\ j-amb}$	Thermal resistance junction-ambient	max	420 °C/W
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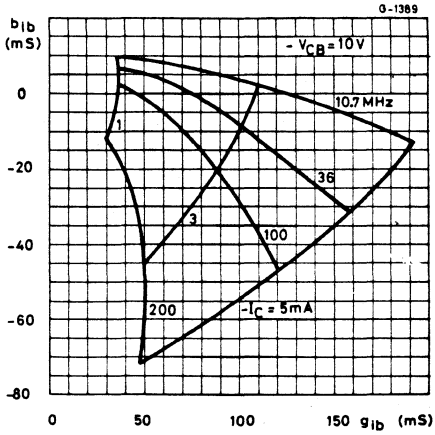
ELECTRICAL CHARACTERISTICS ($T_{amb} = 25^{\circ}\text{C}$ unless otherwise specified)

Parameter	Test conditions	Min.	Typ.	Max.	Unit
I_{CBO} Collector cutoff current ($I_E = 0$)	$V_{CB} = -20\text{V}$			-200	nA
$V_{(BR)CEO}$ Collector-emitter breakdown voltage ($I_B = 0$)	$I_C = -5\text{ mA}$	-35			V
$V_{(BR)EBO}$ Emitter-base breakdown voltage ($I_C = 0$)	$I_E = -10\ \mu\text{A}$	-4			V
h_{FE} DC current gain	$I_C = -3\text{ mA}$ $V_{CE} = -10\text{V}$		40		—
f_T Transition frequency	$I_C = -1\text{ mA}$ $V_{CE} = -10\text{V}$ $f = 100\text{ MHz}$		400		MHz
C_{CBO} Collector-base capacitance	$I_E = 0$ $V_{CB} = -10\text{V}$ $f = 1\text{ MHz}$		0.8		pF
C_{rb} Reverse capacitance	$I_C = 0$ $V_{CB} = -10\text{V}$ $f = 1\text{ MHz}$		0.13		pF
NF ^{*/**} Noise figure	$I_C = -1\text{ mA}$ $V_{CC} = -6\text{V}$ $R_g = 50\ \Omega$ $f = 200\text{ MHz}$		2.5	4	dB
G_{pb}^* Power gain	$I_C = -3\text{ mA}$ $V_{CC} = -10.8\text{V}$ $R_L = 1\text{ k}\Omega$ $f = 200\text{ MHz}$	14	17		dB

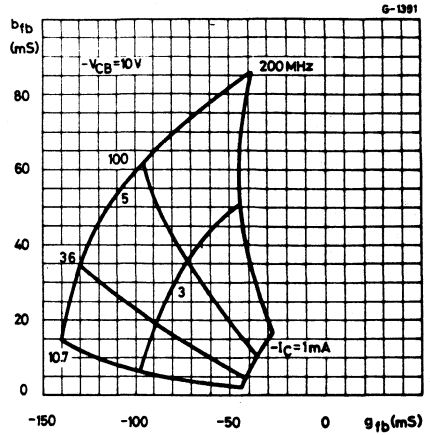
* See TEST CIRCUIT

** Input adapting for optimum source admittance

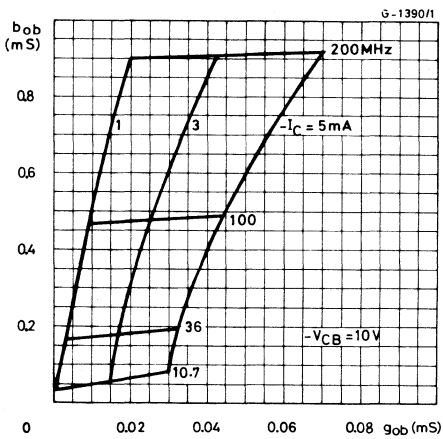
Typical input admittance



Typical transfer admittance



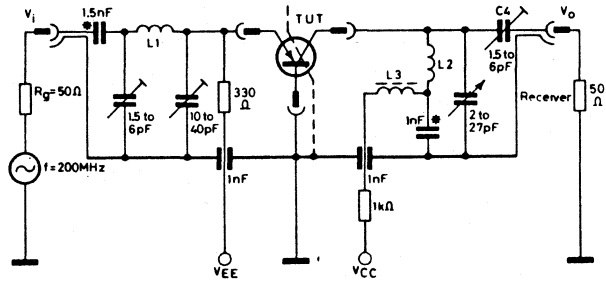
Typical output admittance



BF 506

TEST CIRCUIT

Power gain and noise figure



* Leadless ceramic disc capacitor
L1=3 turns 0.6mm enamel, 4mm dia.
L2=2 turns 1mm enamel, 6.5mm dia.

S-0877

SILICON PLANAR PNP**VHF AGC AMPLIFIER**

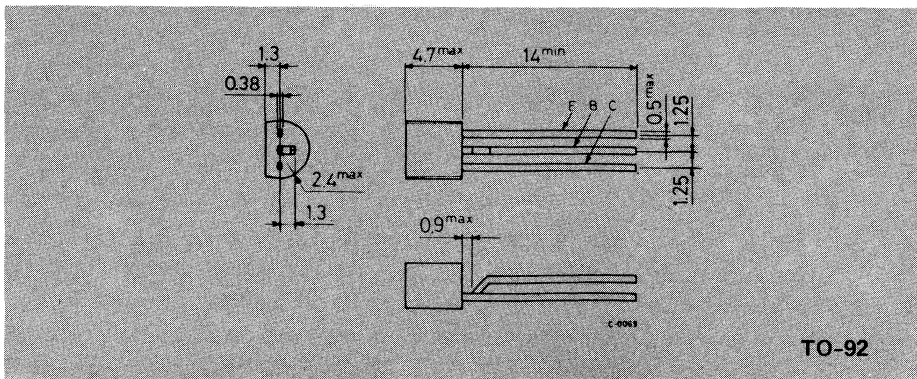
The BF 509 is a silicon planar epitaxial PNP transistor in Jedec TO-92 plastic package. It is intended for use as controlled VHF preamplifier when a high gain level with particularly reduced noise is required.

ABSOLUTE MAXIMUM RATINGS

V_{CBO}	Collector-base voltage ($I_E = 0$)	-40	V
V_{CEO}	Collector-emitter voltage ($I_B = 0$)	-35	V
V_{EBO}	Emitter-base voltage ($I_C = 0$)	-4	V
I_C	Collector current	-30	mA
I_B	Base current	-5	mA
P_{tot}	Total power dissipation at $T_{amb} \leq 45^\circ\text{C}$	250	mW
T_{stg}	Storage temperature	-55 to 150	$^\circ\text{C}$
T_j	Junction temperature	150	$^\circ\text{C}$

MECHANICAL DATA

Dimensions in mm

**TO-92**

BF 509

THERMAL DATA

$R_{thj-amb}$	Thermal resistance junction-ambient	max	420 °C/W
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ELECTRICAL CHARACTERISTICS ($T_{amb} = 25^{\circ}\text{C}$ unless otherwise specified)

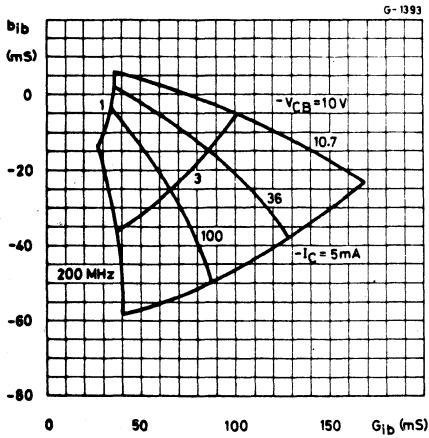
Parameter	Test conditions	Min.	Typ.	Max.	Unit
I_{CBO} Collector cutoff current ($I_E = 0$)	$V_{CB} = -20\text{V}$			-200	nA
$V_{(BR)CEO}$ Collector-emitter breakdown voltage ($I_B = 0$)	$I_C = -5\text{ mA}$	-35			V
$V_{(BR)EBO}$ Emitter-base breakdown voltage ($I_C = 0$)	$I_E = -10\ \mu\text{A}$	-4			V
h_{FE} DC current gain	$I_C = -3\text{ mA}$ $V_{CE} = -10\text{V}$		70		—
f_T Transition frequency	$I_C = -3\text{ mA}$ $V_{CE} = -10\text{V}$ $f = 100\text{ MHz}$		700		MHz
C_{CBO} Collector-base capacitance	$I_E = 0$ $V_{CB} = -10\text{V}$ $f = 1\text{ MHz}$		0.8		pF
C_{rb} Reverse capacitance	$I_C = 0$ $V_{CB} = -10\text{V}$ $f = 1\text{ MHz}$		0.13		pF
NF ^{*/**} Noise figure	$I_C = -3\text{ mA}$ $V_{CC} = -10.8\text{V}$ $R_g = 50\ \Omega$ $f = 200\text{ MHz}$		1.5	2.5	dB
G_{pb} [*] Power gain	$I_C = -3\text{ mA}$ $V_{CC} = -10.8\text{V}$ $R_L = 1\text{ k}\Omega$ $f = 200\text{ MHz}$		15	18	dB
$I_{C(AGC)}$ [*] Collector current for $\Delta G_{pb} = 30\text{ dB}$	$V_{CC} = 10.8\text{V}$ $f = 200\text{ MHz}$	7.3		8.8	mA

* See TEST CIRCUIT

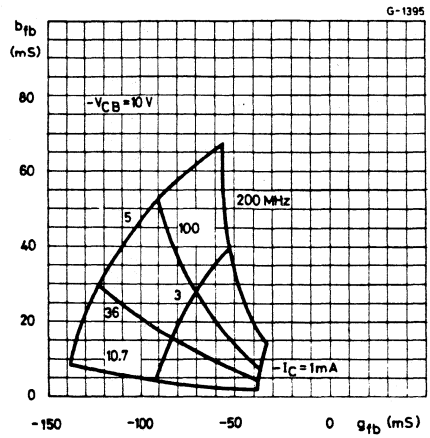
** Input adapting for optimum source admittance.

BF 509

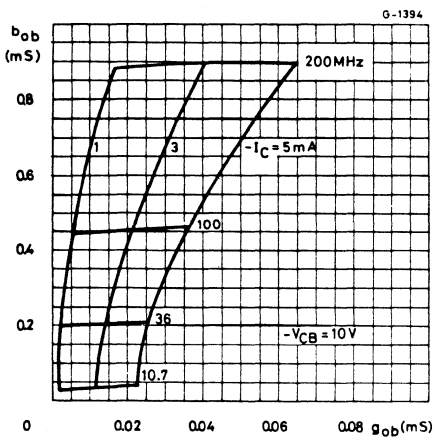
Typical input admittance



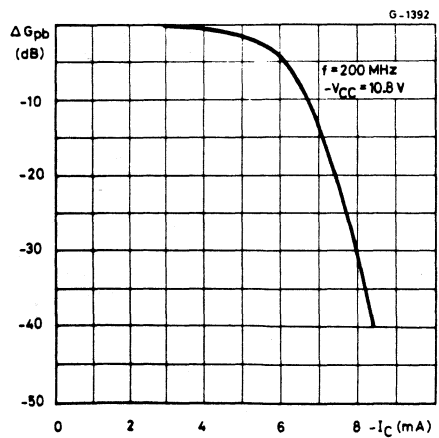
Typical transfer admittance



Typical output admittance



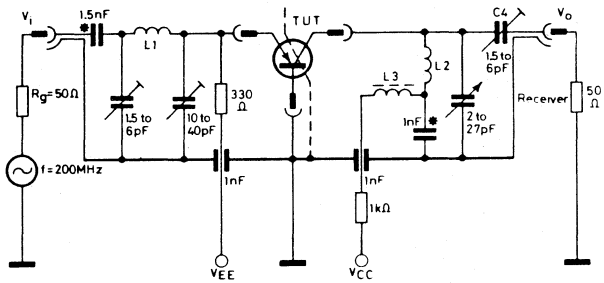
Typical power gain variation vs. AGC current



BF 509

TEST CIRCUIT

Power gain, AGC and noise figure



* Leadless ceramic disc capacitor
L1 = 3 turns 0.6 mm enamel, 4 mm dia.
L2 = 2 turns 1 mm enamel, 6.5 mm dia.

S-0877

BF 516

SILICON PLANAR PNP

UHF-VHF AMPLIFIER

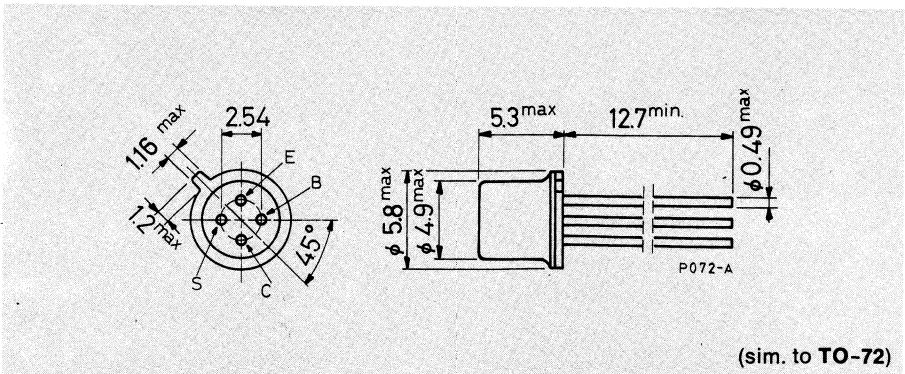
The BF 516 is a silicon planar epitaxial PNP transistor in a TO-72 metal case, intended as general purpose amplifier up to 1 GHz.

ABSOLUTE MAXIMUM RATINGS

V_{CBO}	Collector-base voltage ($I_E = 0$)	-40 V
V_{CEO}	Collector-emitter voltage ($I_B = 0$)	-35 V
V_{EBO}	Emitter-base voltage ($I_C = 0$)	-3 V
I_C	Collector current	-20 mA
P_{tot}	Total power dissipation at $T_{amb} \leq 25^\circ\text{C}$	200 mW
T_{stg}	Storage temperature	-55 to 200 $^\circ\text{C}$
T_j	Junction temperature	200 $^\circ\text{C}$

MECHANICAL DATA

Dimensions in mm



BF 516

THERMAL DATA

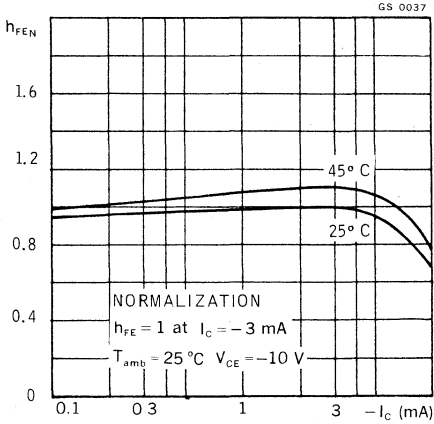
$R_{th\ j-amb}$	Thermal resistance junction-ambient	max	875 °C/W
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ELECTRICAL CHARACTERISTICS (T_{amb} = 25 °C unless otherwise specified)

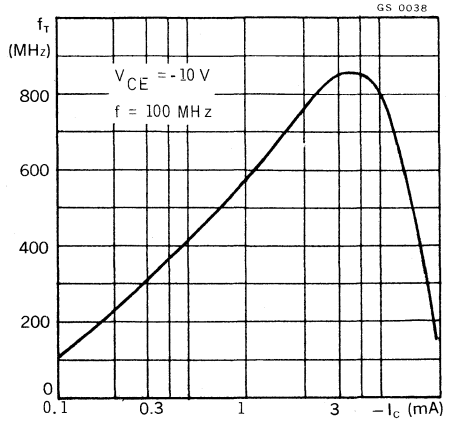
	Parameter	Test conditions	Min.	Typ.	Max.	Unit
	I_{CBO} Collector cutoff current ($I_E = 0$)	$V_{CB} = -20\text{ V}$			-100	nA
	$V_{(BR)\ CBO}$ Collector-base breakdown voltage ($I_E = 0$)	$I_C = -10\ \mu\text{A}$	-40			V
	$V_{(BR)\ CEO}$ Collector-emitter breakdown voltage ($I_B = 0$)	$I_C = -3\text{ mA}$	-35			V
	$V_{(BR)\ EBO}$ Emitter-base breakdown voltage ($I_C = 0$)	$I_E = -10\ \mu\text{A}$	-3			V
	V_{BE} Base-emitter voltage	$I_C = -3\text{ mA}$ $V_{CE} = -10\text{ V}$	-0.75			V
	h_{FE} DC current gain	$I_C = -3\text{ mA}$ $V_{CE} = -10\text{ V}$	25	50		—
→	f_T Transition frequency	$I_C = -3\text{ mA}$ $V_{CE} = -10\text{ V}$		850		MHz
	$-C_{re}$ Reverse capacitance	$I_C = 0$ $V_{CB} = -10\text{ V}$ $f = 1\text{ MHz}$		0.3		pF
→	C_{rb} Reverse capacitance	$I_C = 0$ $V_{CE} = -10\text{ V}$ $f = 1\text{ MHz}$		0.05		pF
	NF Noise figure	$I_C = -3\text{ mA}$ $V_{CB} = -12\text{ V}$ $R_g = 50\ \Omega$ $f = 800\text{ MHz}$ $I_C = -3\text{ mA}$ $V_{CB} = -12\text{ V}$ $R_g = 50\ \Omega$ $f = 200\text{ MHz}$		3.5	6	dB
	G_{pb} Power gain	$I_C = -3\text{ mA}$ $V_{CB} = -12\text{ V}$ $R_L = 2\text{ k}\Omega$ $f = 800\text{ MHz}$ $I_C = -3\text{ mA}$ $V_{CB} = -12\text{ V}$ $R_L = 2\text{ k}\Omega$ $f = 200\text{ MHz}$		11	14	dB
					19	dB

BF 516

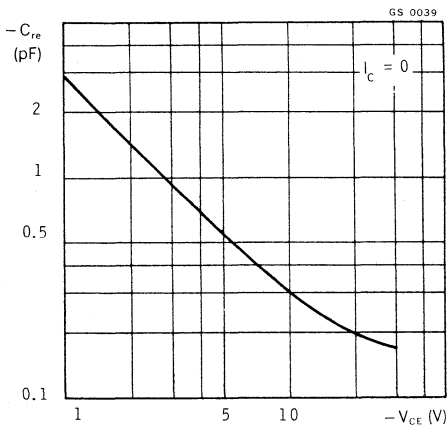
Normalized DC current gain



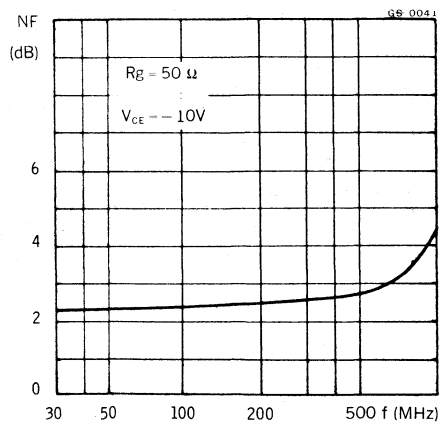
Transition frequency



Reverse capacitance



Noise figure



BF 657
BF 658
BF 659

SILICON PLANAR NPN

PRELIMINARY DATA

MEDIUM POWER VIDEO AMPLIFIERS

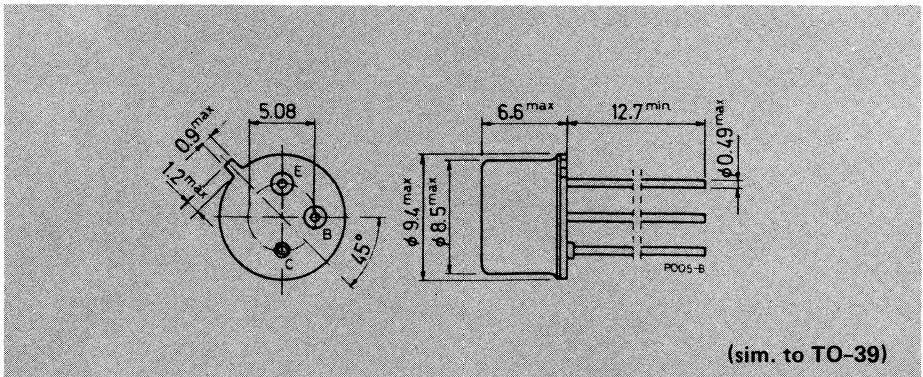
The BF 657, BF 658 and BF 659 are silicon planar epitaxial NPN transistors in TO-39 metal case. They are particularly designed for application with precision "IN-LINE" large screen CRT (thermal resistance $\leq 20^\circ\text{C/W}$).

ABSOLUTE MAXIMUM RATINGS

	BF 657	BF 658	BF 659
V_{CBO}	160 V	250 V	300 V
V_{CEO}	160 V	250 V	300 V
V_{EBO}	5 V		
I_C	100 mA		
I_{CM}	200 mA		
P_{tot}	7 W		
	3 W		
T_{stg}	-55 to 200 °C		
T_j	200 °C		

MECHANICAL DATA

Dimensions in mm



(sim. to TO-39)

BF 657
BF 658
BF 659

THERMAL DATA

$R_{th\ j-case}$	Thermal resistance junction-case	max	20 °C/W
$R_{th\ j-amb}$	Thermal resistance junction-ambient	max	175 °C/W

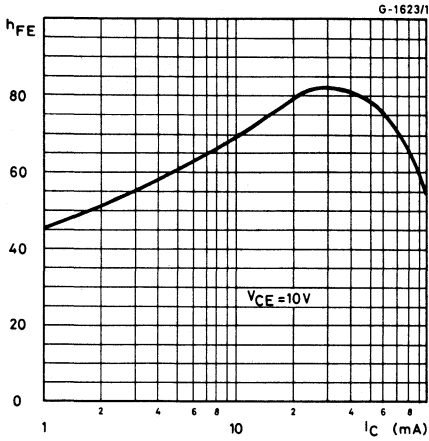
ELECTRICAL CHARACTERISTICS ($T_{amb} = 25^{\circ}C$ unless otherwise specified)

Parameter	Test conditions	Min.	Typ.	Max.	Unit
I_{CBO} Collector cutoff current ($I_E = 0$)	for BF 657 $V_{CB} = 100V$ for BF 658 $V_{CB} = 200V$ for BF 659 $V_{CB} = 250V$			50 50 50	nA nA nA
$V_{(BR)CBO}$ Collector-base breakdown voltage ($I_E = 0$)	$I_C = 100\ \mu A$ for BF 657 for BF 658 for BF 659	160 250 300			V V V
$V_{(BR)CEO}^*$ Collector-emitter breakdown voltage ($I_B = 0$)	$I_C = 10\ mA$ for BF 657 for BF 658 for BF 659	160 250 300			V V V
$V_{(BR)EBO}$ Emitter-base breakdown voltage ($I_C = 0$)	$I_E = 100\ \mu A$	5			V
$V_{CE(sat)}^*$ Collector-emitter saturation voltage	$I_C = 30\ mA$ $I_B = 6\ mA$			1	V
h_{FE}^* DC current gain	$I_C = 30\ mA$ $V_{CE} = 10V$	25			—
f_T Transition frequency	$I_C = 15\ mA$ $V_{CE} = 10V$		90		MHz
$-C_{re}$ Reverse capacitance	$I_C = 0$ $V_{CE} = 30V$ $f = 1\ MHz$		3		pF

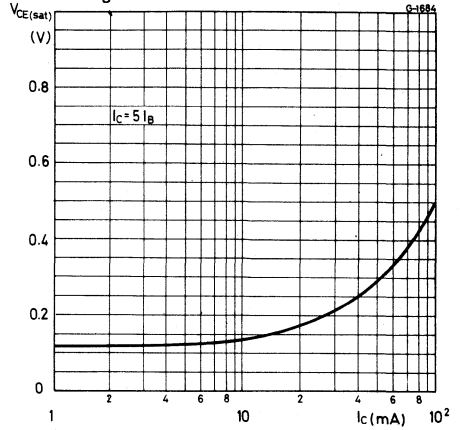
* Pulsed: pulse duration = 300 μs , duty factor = 1%

BF 657
BF 658
BF 659

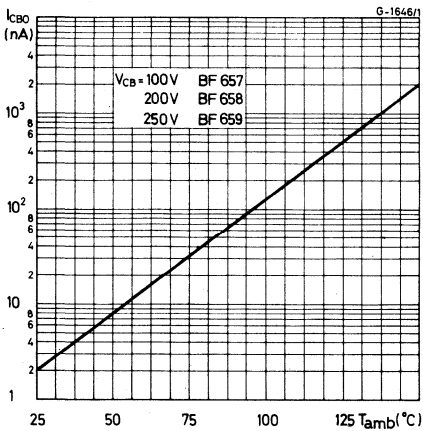
Typical DC current gain



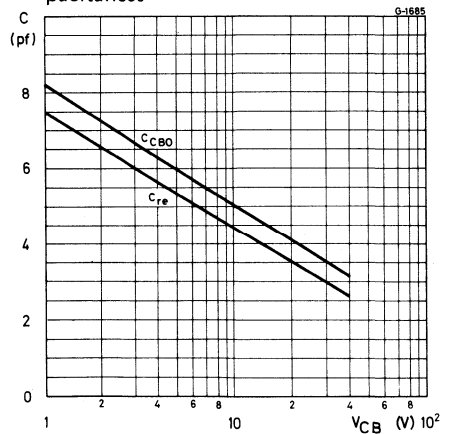
Typical collector-emitter saturation voltage



Typical collector cutoff current

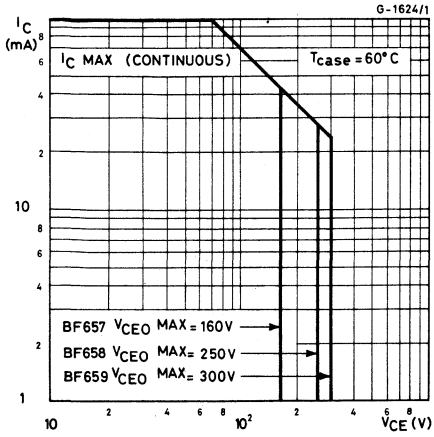


Typical collector-base and reverse capacitances

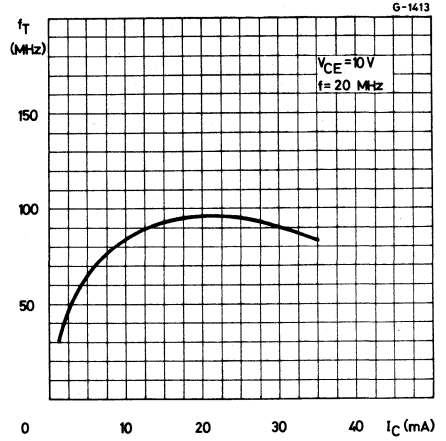


BF 657
BF 658
BF 659

Typical transition frequency



Safe operating areas



BF 679
BF 679M

SILICON PLANAR PNP

UHF-VHF AGC AMPLIFIER AND OSCILLATOR MIXER

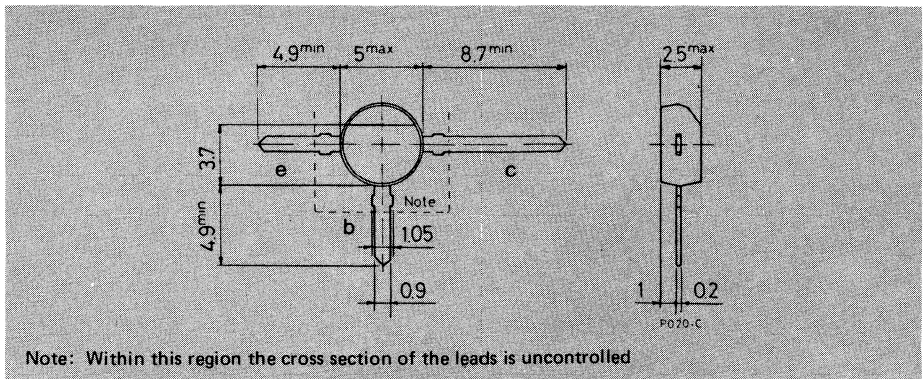
The BF 679 and BF 679M are silicon planar epitaxial PNP transistors in T-plastic package intended for the use in UHF-VHF range up to 900 MHz. Because of its low noise and gain characteristics versus current, the BF 679 is particularly suited as a controlled preamplifier stage in TV varicap tuners. The BF 679M because of its low thermal drift and high oscillation stability is particularly suggested as oscillator mixer.

ABSOLUTE MAXIMUM RATINGS

V_{CBO}	Collector-base voltage ($I_E = 0$)	-40	V
V_{CEO}	Collector-emitter voltage ($I_B = 0$)	-35	V
V_{EBO}	Emitter-base voltage ($I_C = 0$)	-3	V
I_C	Collector current	-30	mA
I_B	Base current	-5	mA
P_{tot}	Total power dissipation at $T_{amb} \leq 45^\circ\text{C}$	170	mW
T_{stg}	Storage temperature	-55 to 150	$^\circ\text{C}$
T_j	Junction temperature	150	$^\circ\text{C}$

MECHANICAL DATA

Dimensions in mm



BF 679 BF 679M

THERMAL DATA

$R_{th\ j-amb}$ Thermal resistance junction-ambient	max 600 °C/W
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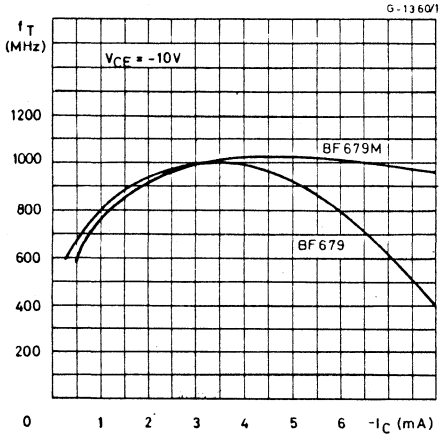
ELECTRICAL CHARACTERISTICS ($T_{amb} = 25^{\circ}C$ unless otherwise specified)

	Parameter	Test conditions	Min. Typ. Max.	Unit
	I_{CBO} Collector cutoff current ($I_E = 0$)	$V_{CB} = -20V$	-100	nA
	$V_{(BR)CBO}$ Collector-base breakdown voltage ($I_E = 0$)	$I_C = -100\ \mu A$	-40	V
	$V_{(BR)CEO}$ Collector-emitter breakdown voltage ($I_B = 0$)	$I_C = -5\ mA$	-35	V
	$V_{(BR)EBO}$ Emitter-base breakdown voltage ($I_C = 0$)	$I_E = -10\ \mu A$	-3	V
→	h_{FE} DC current gain	$I_C = -3\ mA$ $V_{CE} = -10V$	25 60	
→	f_T Transition frequency	$I_C = -3\ mA$ $V_{CE} = -10V$ $f = 100\ MHz$	700 1000	MHz
	C_{CBO} Collector-base capacitance	$I_E = 0$ $V_{CB} = -10V$ $f = 100\ MHz$	0.6	pF
	C_{rbd} Reverse capacitance	$I_C = 0$ $V_{CB} = -10V$ $f = 100\ MHz$	0.07	pF
	NF* Noise figure	$I_C = -3\ mA$ $V_{CC} = -10.8V$ $R_g = 50\ \Omega$ $f = 800\ MHz$	3.5 5	dB
	G_{pb}^* Power gain	$I_C = -3\ mA$ $V_{CC} = -10.8V$ $R_L = 2\ k\Omega$ $f = 800\ MHz$	12 15	dB
→	$I_{C(AGC)}^*$ Collector current for $\Delta G_{pb} = 30\ dB$	for BF 679 only $f = 800\ MHz$ $V_{CC} = -10.8V$	6.4 7.8	mA

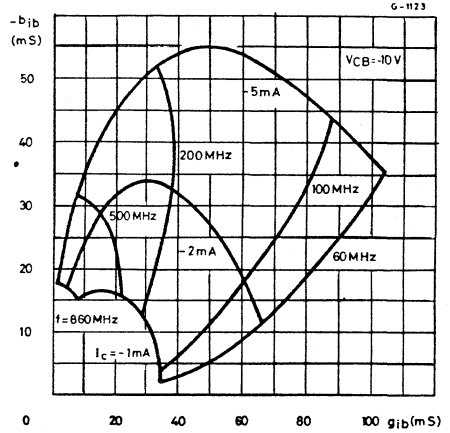
*See TEST CIRCUIT

BF 679 BF 679M

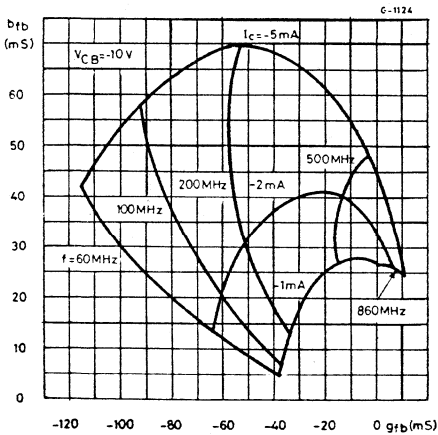
Typical transition frequency



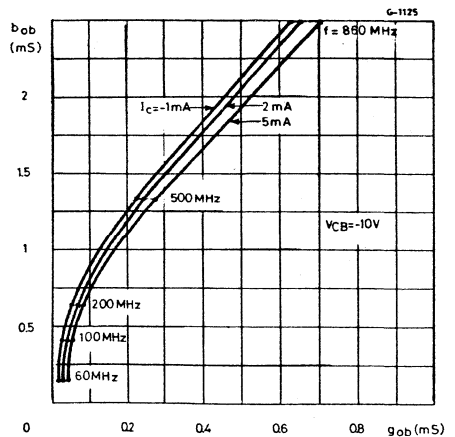
Typical input admittance
(for BF 679 only)



Typical transfer admittance
(for BF 679 only)

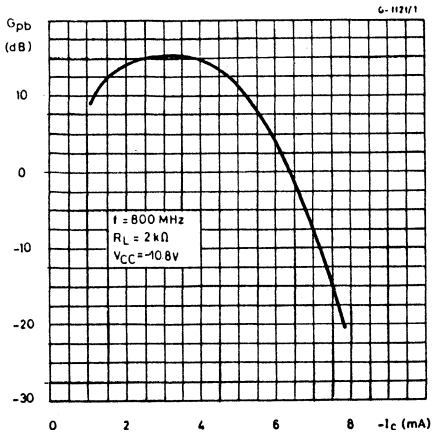


Typical output admittance
(for BF 679 only)



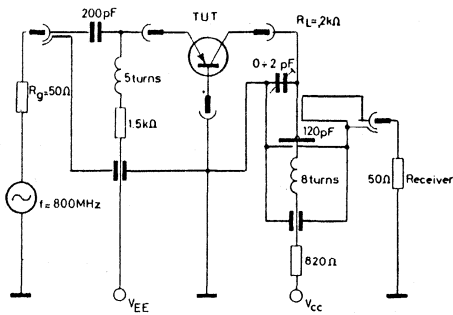
BF 679 BF 679M

Typical power gain (for BF 679 only)



TEST CIRCUIT

Power gain, AGC and noise figure



BF 680

SILICON PLANAR PNP

PRELIMINARY DATA

UHF MIXER-OSCILLATOR

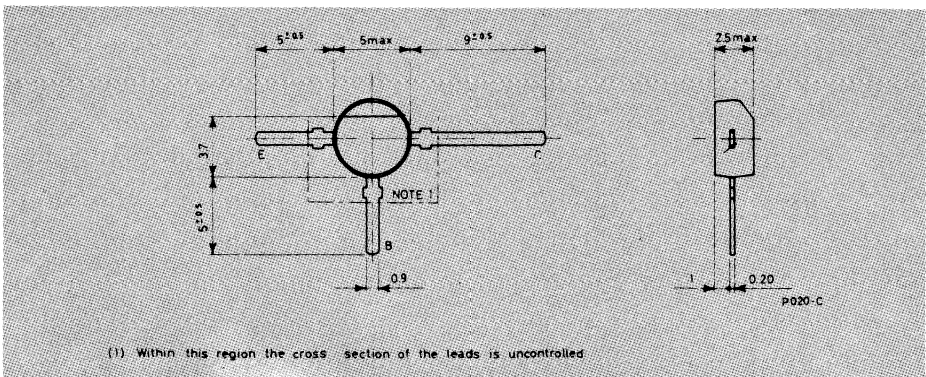
The BF 680 is a PNP silicon planar epitaxial transistor in T-plastic package. It is intended for use in TV varicap tuners as mixer-oscillator stage up to 900 MHz.

ABSOLUTE MAXIMUM RATINGS

V_{CBO}	Collector-base voltage ($I_E = 0$)	-40	V
V_{CEO}	Collector-emitter voltage ($I_B = 0$)	-35	V
V_{EBO}	Emitter-base voltage ($I_C = 0$)	-3	V
I_C	Collector current	-30	mA
I_B	Base current	-5	mA
P_{tot}	Total power dissipation at $T_{amb} \leq 45^\circ\text{C}$	170	mW
T_{stg}	Storage temperature	-55 to 150	$^\circ\text{C}$
T_j	Junction temperature	150	$^\circ\text{C}$

MECHANICAL DATA

Dimensions in mm



BF 680

THERMAL DATA

$R_{th\ j-amb}$ Thermal resistance junction-ambient	max 600 °C/W
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ELECTRICAL CHARACTERISTICS ($T_{amb} = 25\text{ °C}$ unless otherwise specified)

Parameter	Test conditions	Min.	Typ.	Max.	Unit
I_{CBO} Collector cutoff current ($I_E = 0$)	$V_{CB} = -20\text{ V}$			-100	nA
$V_{(BR)\ CBO}$ Collector-base breakdown voltage ($I_E = 0$)	$I_C = -100\ \mu\text{A}$	-40			V
$V_{(BR)\ CEO}$ Collector-emitter breakdown voltage ($I_B = 0$)	$I_C = -5\text{ mA}$	-35			V
$V_{(BR)\ EBO}$ Emitter-base breakdown voltage ($I_C = 0$)	$I_E = -10\ \mu\text{A}$	-3			V
h_{FE} DC current gain	$I_C = -3\text{ mA}$ $V_{CE} = -10\text{ V}$	35	50		—
f_T Transition frequency	$I_C = -3\text{ mA}$ $V_{CE} = -10\text{ V}$ $f = 100\text{ MHz}$		650		MHz
C_{CBO} Collector-base capacitance	$I_E = 0$ $V_{CB} = -10\text{ V}$ $f = 100\text{ MHz}$		0.6		pF
C_{rb} Reverse capacitance	$I_C = 0$ $V_{CB} = -10\text{ V}$ $f = 100\text{ MHz}$		0.07		pF
NF* Noise figure	$I_C = -3\text{ mA}$ $V_{CB} = -10\text{ V}$ $R_g = 50\ \Omega$ $f = 800\text{ MHz}$		5.5		dB
G_{pb}^* Power gain	$I_C = -3\text{ mA}$ $V_{CB} = -10\text{ V}$ $R_L = 2\text{ k}\Omega$ $f = 800\text{ MHz}$	11	14		dB

* See TEST CIRCUIT

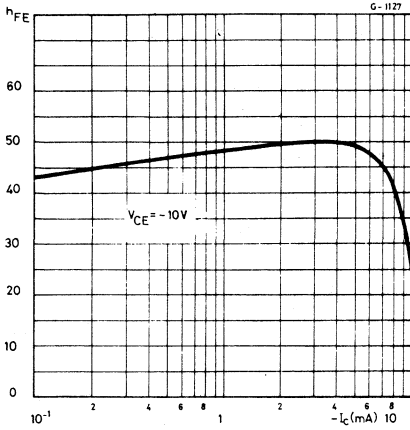
BF 680

ELECTRICAL CHARACTERISTICS (continued)

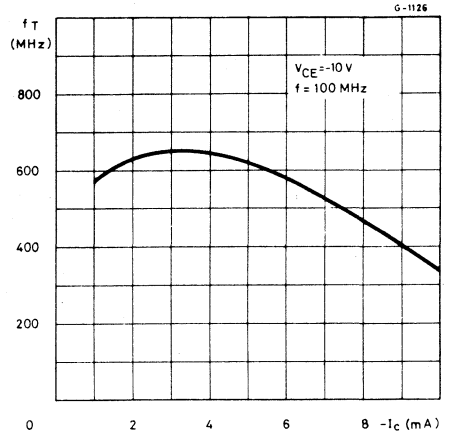
Parameter	Test conditions	Min.	Typ.	Max.	Unit
g_{ib} Input conductance	$I_C = -2 \text{ mA}$ $V_{CE} = -10 \text{ V}$ $f = 860 \text{ MHz}$ $f = 500 \text{ MHz}$		7 14		mS mS
$-b_{ib}$ Input susceptance	$I_C = -2 \text{ mA}$ $V_{CE} = -10 \text{ V}$ $f = 860 \text{ MHz}$ $f = 500 \text{ MHz}$		19 24		mS mS
$ y_{fb} $ Forward transadmittance	$I_C = -2 \text{ mA}$ $V_{CE} = -10 \text{ V}$ $f = 860 \text{ MHz}$ $f = 500 \text{ MHz}$		25 42		mS mS
φ_{fb} Phase angle of the forward transadmittance	$I_C = -2 \text{ mA}$ $V_{CE} = -10 \text{ V}$ $f = 860 \text{ MHz}$ $f = 500 \text{ MHz}$		50° 110°		— —
g_{ob} Output conductance	$I_C = -2 \text{ mA}$ $V_{CE} = -10 \text{ V}$ $f = 860 \text{ MHz}$ $f = 500 \text{ MHz}$		0.8 0.4		mS mS
b_{ob} Output susceptance	$I_C = -2 \text{ mA}$ $V_{CE} = -10 \text{ V}$ $f = 860 \text{ MHz}$ $f = 500 \text{ MHz}$		2.5 1.6		mS mS

BF 680

Typical DC current gain

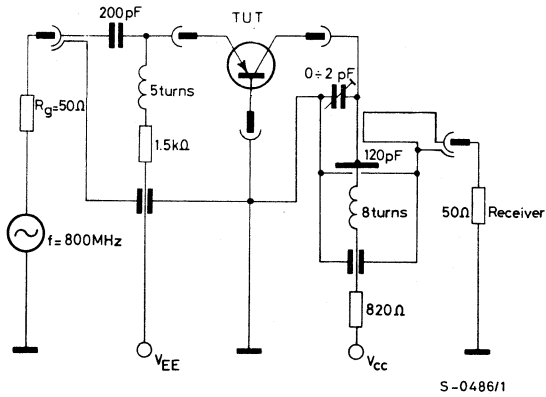


Typical transition frequency



TEST CIRCUIT

Power gain and noise figure



INTEGRATED CIRCUITS

MOS INTEGRATED CIRCUIT

PRELIMINARY DATA

RHYTHM GENERATOR

- LOW POWER DISSIPATION: < 120 mW
- DRIVES 8 SOUND GENERATORS (INSTRUMENTS)
- 15 PROGRAMMABLE RHYTHMS (NOT AVAILABLE IN COMBINATION)
- MASK PROGRAMMABLE RESET COUNTS: 24 or 32
- DOWN BEAT OUTPUT
- EXTERNAL RESET
- OPEN DRAIN OUTPUTS
- STANDARD MUSIC CONTENT AVAILABLE
- TECHNICAL NOTE NO 131 AVAILABLE FOR FULL INFORMATION

The M 252 is a monolithic rhythm generator specifically designed for electronic organs and other musical instruments.

Constructed on a single chip using low threshold P - channel silicon gate technology it is supplied in a 16 - lead dual in-line ceramic or plastic package.

ABSOLUTE MAXIMUM RATINGS

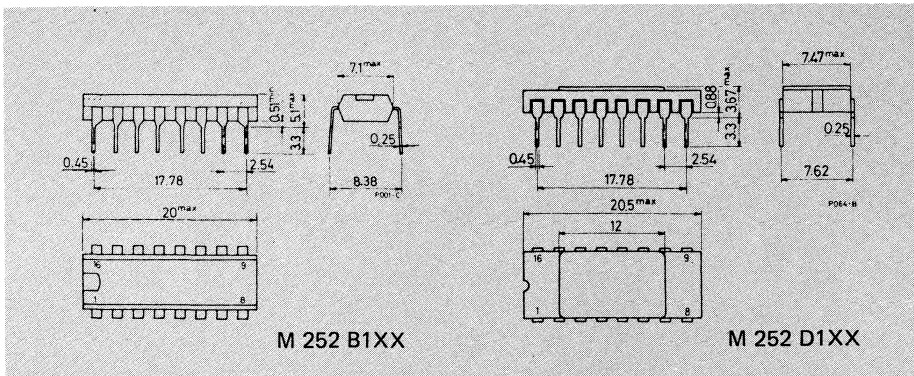
V_{GG}^*	Source supply voltage	-20 to 0.3	V
V_i^*	Input voltage	-20 to 0.3	V
I_o	Output current (at any pin)	3	mA
T_{stg}	Storage temperature	-65 to 150	°C
T_{op}	Operating temperature	0 to 70	°C

* This voltage is with respect to V_{SS} pin voltage

ORDERING NUMBERS: M 252 B1 XX for dual in-line plastic package
 M 252 D1 XX for dual in-line ceramic package
 M 252 B1 or D1 AA for standard music content

MECHANICAL DATA

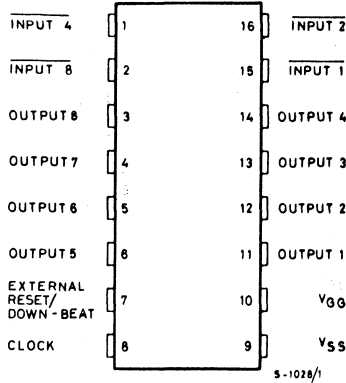
Dimensions in mm



M 252

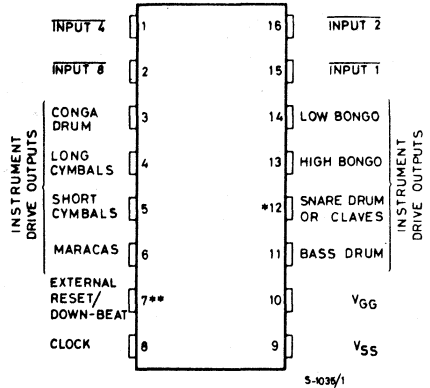
CONNECTION DIAGRAMS

(top view)



M 252 D1 or B1 - AA

Standard content configuration



* This output must be connected so as to drive the "snare drum" when the rhythms from 1 to 9 (see rhythm selection) are selected, and the "claves" when the rhythms from 10 to 15 (see rhythm selection) are selected.

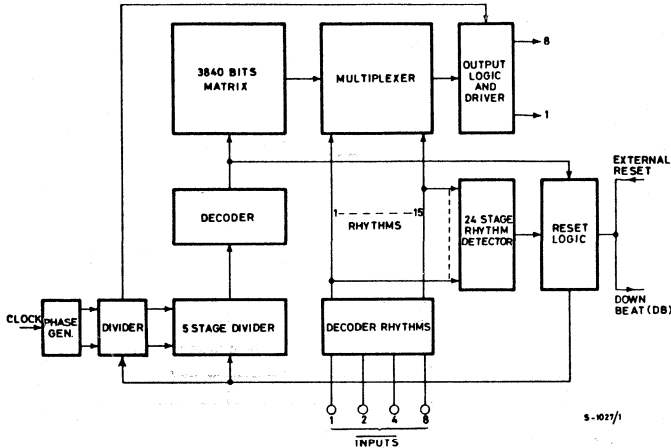
** This pin generates a down-beat trigger which can be used to drive an external lamp to indicate the start of each measure.

RHYTHM SELECTION

The following binary code must be generated to select each rhythm (logic positive)

RHYTHM	CODE				STANDARD CONTENT
	INPUT 8	INPUT 4	INPUT 2	INPUT 1	
1	1	1	1	0	Waltz 3/4
2	1	1	0	1	Jazz Waltz 3/4
3	1	1	0	0	Tango 2/4
4	1	0	1	1	March 2/4
5	1	0	1	0	Swing 4/4
6	1	0	0	1	Foxtrot 4/4
7	1	0	0	0	Slow Rock 6/8
8	0	1	1	1	Rock Pop 4/4
9	0	1	1	0	Shuffle 2/4
10	0	1	0	1	Mambo 4/4
11	0	1	0	0	Beguine 4/4
12	0	0	1	1	Cha Cha 4/4
13	0	0	1	0	Bajon 4/4
14	0	0	0	1	Samba 4/4
15	0	0	0	0	Bossa Nova 4/4
No selected rhythm	1	1	1	1	

BLOCK DIAGRAM



STATIC ELECTRICAL CHARACTERISTICS (positive logic, $V_{GG} = -11.4$ to $-12.6V$, $V_{SS} = 4.75$ to $5.25V$, $T_{amb} = 0$ to $70^\circ C$ unless otherwise specified)

Parameter	Test conditions	Min.	Typ.	Max.	Unit
-----------	-----------------	------	------	------	------

CLOCK INPUT

V_{IH}	Clock high voltage	$V_{SS}-1.5$		V_{SS}	V
V_{IL}	Clock low voltage	V_{GG}		$V_{SS}-4.1$	V

DATA INPUTS ($\overline{IN1} \dots \overline{IN8}$)

V_{IH}	Input high voltage	$V_{SS}-1.5$		V_{SS}	V
V_{IL}	Input low voltage	V_{GG}		$V_{SS}-4.1$	V
I_{LI}	Input leakage current	$V_i = V_{SS}-10V$	$T_{amb} = 25^\circ C$	10	μA

EXTERNAL RESET

V_{IH}	Input high voltage	$V_{SS}-1.5$		V_{SS}	V
V_{IL}	Input low voltage	V_{GG}		$V_{SS}-4.1$	V
R_{IN}	Internal resistance to V_{GG}	$V_o = V_{SS}-5V$		400 600	k Ω

M 252

STATIC ELECTRICAL CHARACTERISTICS (continued)

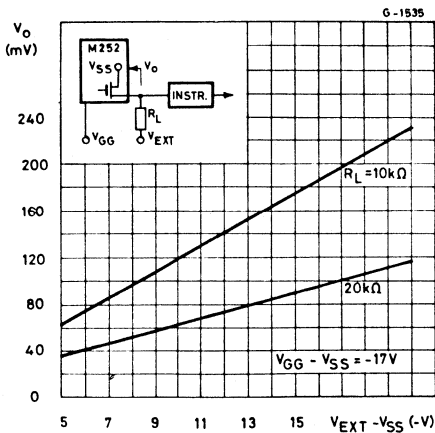
Parameter	Test conditions	Min.	Typ.	Max.	Unit
-----------	-----------------	------	------	------	------

DATA OUTPUTS

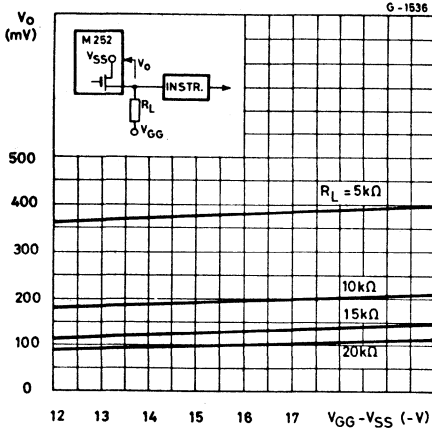
R_{ON}	Output resistance	$V_o = V_{SS} - 1$ to V_{SS}	250	500	Ω
V_{OH}	Output high voltage	$I_L = 1$ mA	$V_{SS} - 0.5$	V_{SS}	V
I_{LO}	Output leakage current	$V_i = V_{IH}$ $T_{amb} = 25^\circ\text{C}$		10	μA

POWER DISSIPATION

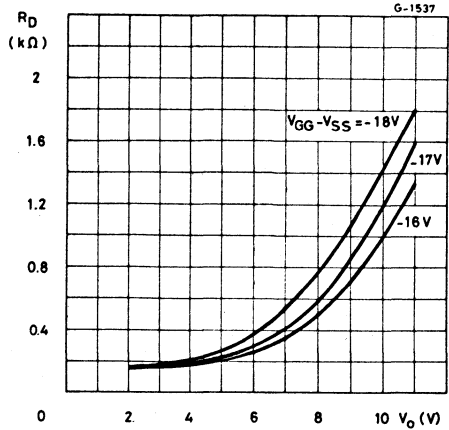
I_{GG}	Supply current	$T_{amb} = 25^\circ\text{C}$	7	15	mA
----------	----------------	------------------------------	---	----	----



Output voltage vs. supply voltage
($V_{GG}-V_{SS}$)



Output dynamic resistance vs. output voltage



DYNAMIC ELECTRICAL CHARACTERISTICS (positive logic $V_{GG} = -11.4$ to $-12.6V$, $V_{SS} = 4.75$ to $5.25V$, $T_{amb} = 0$ to 70 °C unless otherwise specified)

Parameter	Test conditions	Min.	Typ.	Max.	Unit
-----------	-----------------	------	------	------	------

CLOCK INPUT

f	Clock repetition rate	DC	100		kHz
t_{pw}^*	Pulse width	5			μs
t_r^{**}	Rise time		100		μs
t_f^{**}	Fall time		100		μs

EXTERNAL RESET

t_{pw}	Pulse width	5			μs
----------	-------------	---	--	--	---------

* Measured at 50% of the swing

** Measured between 10% and 90% of the swing

TYPICAL APPLICATIONS

Figure 1 shows the typical application of the M 252(AA).

With two M 252 devices it is possible to increase the number of rhythms or the number of instruments available, or the number of elementary times, as shown in figures 2, 3 and 4 respectively.

The use of a memory matrix allows the customer complete flexibility, since modification of the memory is quick and relatively cheap.

Fig. 1 - Rhythm system (standard content)

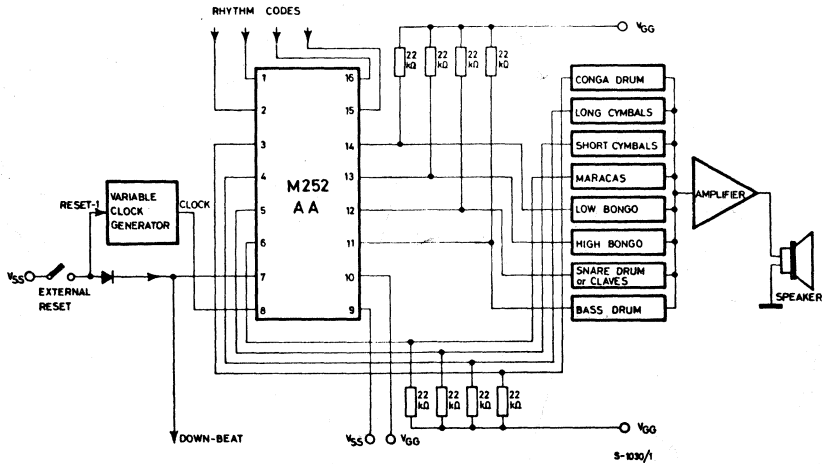
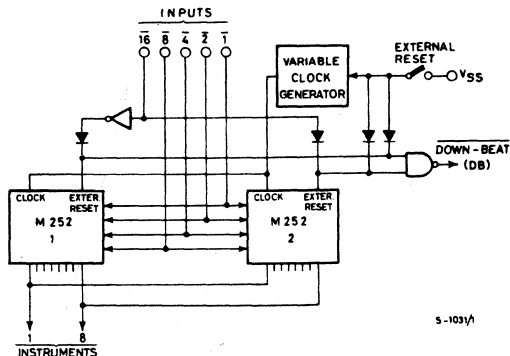


Fig. 2 - Increase in number of rhythms (positive logic)



M 252

TYPICAL APPLICATIONS (continued)

Fig. 3 - Increase in number of instruments

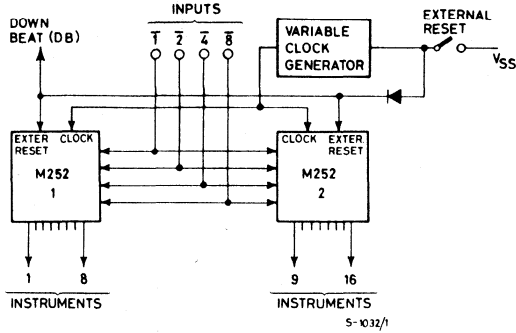
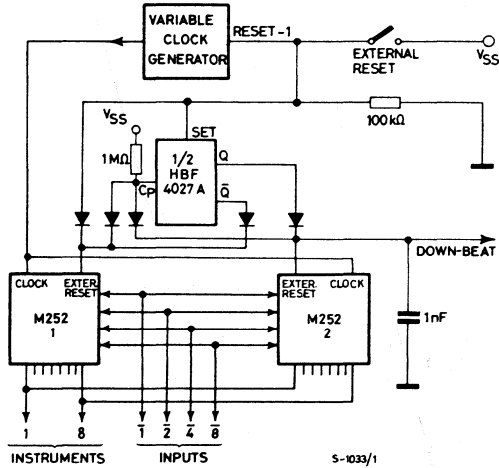
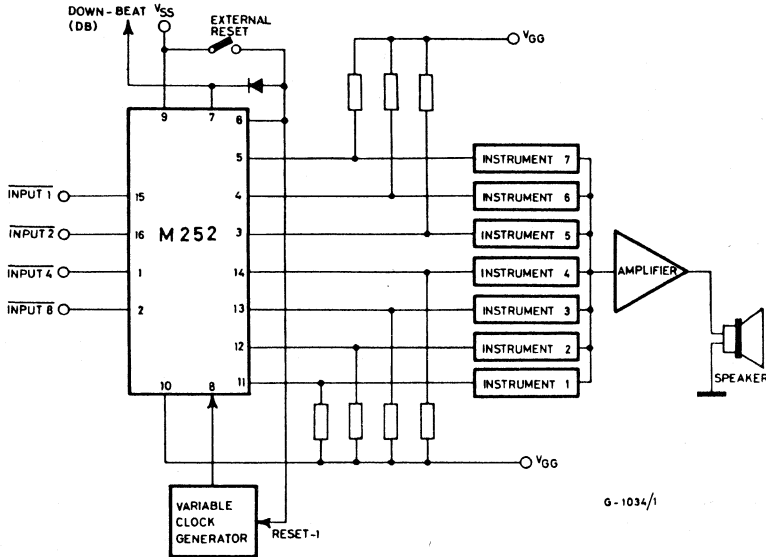


Fig. 4 - Increasing the number of elementary times



Note: The total number of elementary times is given by the sum of the elementary times of the individual devices

CIRCUIT FOR CHANGING THE NUMBER OF ELEMENTARY TIMES



To obtain a required number of elementary times "N" simply put a cross in the "N + 1" position of the column which now represents the reset output, rather than the 8th instrument. The DB output can be used as down-beat because it appears at the beginning of each measure. Since the pulse is only 2 - 3 μ s long it must, however, be stretched and buffered to enable it to drive a lamp.

Full information on the use of the M 252 in electronic organs and other applications will be found in Technical Note no. 131 available on request.

COMPLETING THE TRUTH TABLE

The ROM truth table has been organized in 32 rows which represent elementary times and 120 columns (15 groups of 8) where each group represents a rhythm which has as its disposition 8 programmable instruments. To programme each rhythm one indicates (with a cross) in the appropriate boxes the timing for each beat required for each instrument.

In the given truth table we show an example of how to programme three imaginary rhythms, the first is in 4/4 time, the second in 3/4 time and the third in different time, chosen randomly. Each cross corresponds to a beat of the indicated instrument or, in logic terms, to the presence of a "1" level (positive logic) at the output.

The absence of a cross indicates that the corresponding instrument is not used in that part of the rhythm. Rhythm 3 is an example of how to programme for a time which differs from 4/4 or 3/4. This is achieved by using output 8 to reset the rhythm and not to drive an instrument. The rhythm is valid till elementary time no. 15.

MOS INTEGRATED CIRCUIT

PRELIMINARY DATA

RHYTHM GENERATOR

- LOW POWER DISSIPATION: < 120 mW
- DRIVES 8 SOUND GENERATORS (INSTRUMENTS)
- 12 PROGRAMMABLE RHYTHMS (ALSO AVAILABLE IN COMBINATION)
- MASK PROGRAMMABLE RESET COUNTS: 24 or 32
- DOWN BEAT OUTPUT
- EXTERNAL RESET
- OPEN DRAIN OUTPUTS
- STANDARD MUSIC CONTENT AVAILABLE
- TECHNICAL NOTE NO 131 AVAILABLE FOR FULL INFORMATION

The M 253 is a monolithic rhythm generator specifically designed for electronic organs and other musical instruments.

Constructed on a single chip using low threshold P - channel silicon gate technology it is supplied in a 24 - lead dual in-line ceramic or plastic package.

ABSOLUTE MAXIMUM RATINGS

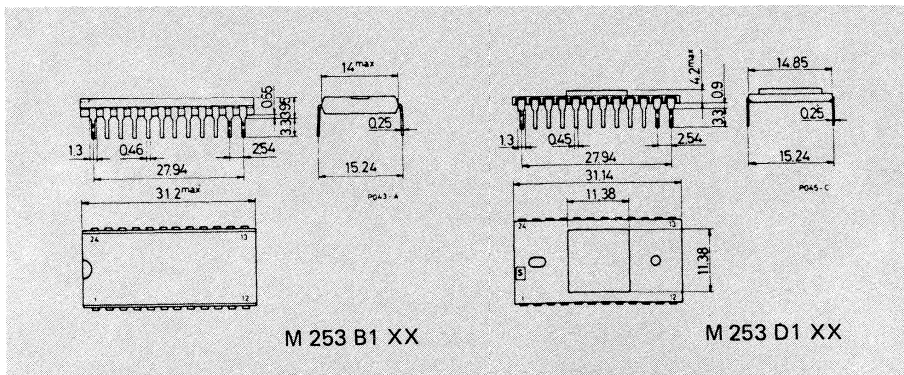
V_{GG}^*	Source supply voltage	-20 to 0.3	V
V_i^*	Input voltage	-20 to 0.3	V
I_o	Output current (at any pin)	3	mA
T_{stg}	Storage temperature	-65 to 150	°C
T_{op}	Operating temperature	0 to 70	°C

* This voltage is with respect to V_{SS} pin voltage

ORDERING NUMBERS: M 253 B1 XX for dual in-line plastic package
 M 253 D1 XX for dual in-line ceramic package
 M 253 B1 or D1 AA for standard music content

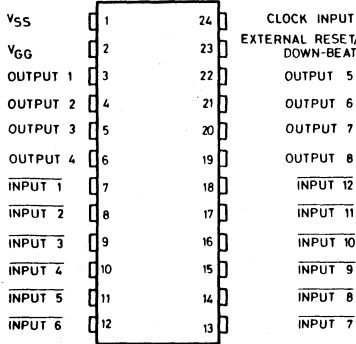
MECHANICAL DATA

Dimensions in mm



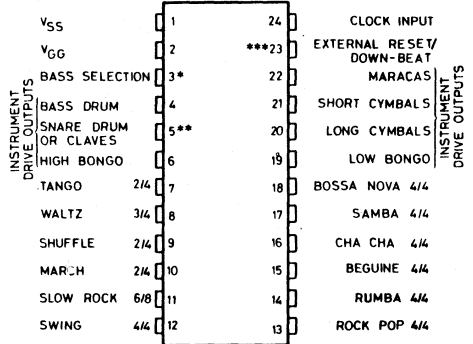
M 253

CONNECTION DIAGRAMS (top view)



5-1038/1

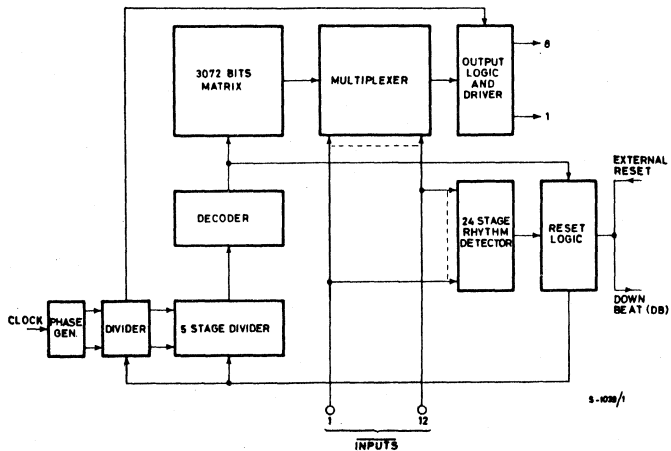
M 253 D1 or B1 - AA Standard content configuration



5-1045/1

- * This output allows the musician to obtain a "basso alternato" accompaniment using two notes of his choice.
- ** This output must be connected so as to drive the "snare drum" when the rhythms corresponding to pins 7, 8, 9, 10, 11, 12 and 13 are generated, and the "claves" when the rhythms corresponding to pins 14, 15, 16, 17 and 18 are generated. It can also be used to modulate a chord played on the organ.
- *** This pin generates a down-beat trigger which can be used to drive an external lamp to indicate the start of each measure.

BLOCK DIAGRAM



STATIC ELECTRICAL CHARACTERISTICS(positive logic, $V_{GG} = -11.4$ to $-12.6V$, $V_{SS} = 4.75$ to $5.25V$, $T_{amb} = 0$ to $70\text{ }^{\circ}C$ unless otherwise specified)

Parameter	Test conditions	Min.	Typ.	Max.	Unit
-----------	-----------------	------	------	------	------

CLOCK INPUT

V_{IH}	Clock high voltage		$V_{SS}-1.5$	V_{SS}	V
V_{IL}	Clock low voltage		V_{GG}	$V_{SS}-4.1$	V

DATA INPUTS ($\overline{IN1}$ $\overline{IN12}$)

V_{IH}	Input high voltage		$V_{SS}-1.5$	V_{SS}	V
V_{IL}	Input low voltage		V_{GG}	$V_{SS}-4.1$	V
I_{LI}	Input leakage current	$V_i = V_{SS}-10V$ $T_{amb} = 25^{\circ}C$		10	μA

EXTERNAL RESET

V_{IH}	Input high voltage		$V_{SS}-1.5$	V_{SS}	V
V_{IL}	Input low voltage		V_{GG}	$V_{SS}-4.1$	V
R_{IN}	Internal resistance to V_{GG}	$V_o = V_{SS}-5V$	400	600	k Ω

DATA OUTPUTS

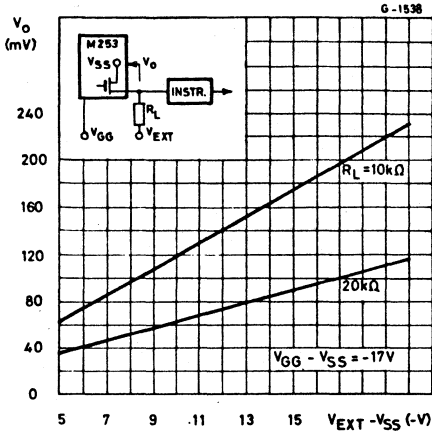
R_{ON}	Output resistance	$V_o = V_{SS}-1$ to V_{SS}	250	500	Ω
V_{OH}	Output high voltage	$I_L = 1\text{ mA}$	$V_{SS}-0.5$	V_{SS}	V
I_{LO}	Output leakage current	$V_i = V_{IH}$ $V_o = V_{SS}-10V$ $T_{amb} = 25\text{ }^{\circ}C$		10	μA

POWER DISSIPATION

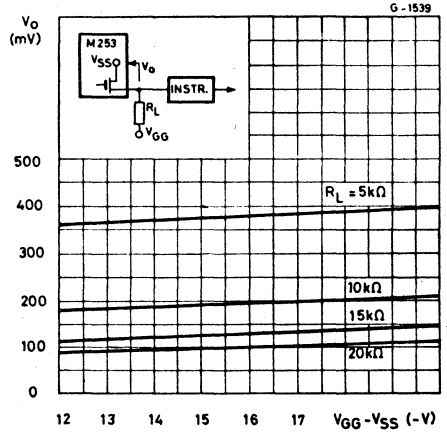
I_{GG}	Supply current	$T_{amb} = 25\text{ }^{\circ}C$	7	15	mA
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M 253

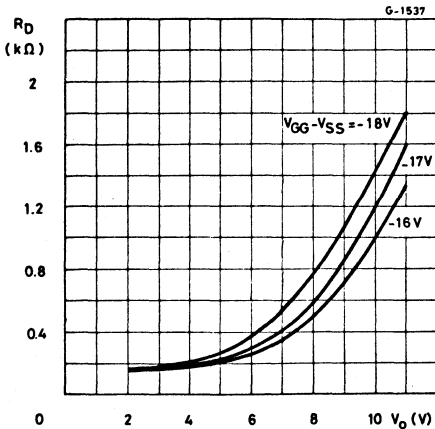
Output voltage vs. external supply voltage ($V_{EXT}-V_{SS}$)



Output voltage vs. supply voltage ($V_{GG}-V_{SS}$)



Output dynamic resistance vs. output voltage



DYNAMIC ELECTRICAL CHARACTERISTICS (positive logic, $V_{GG} = -11.4$ to $-12.6V$, $V_{SS} = 4.75$ to $5.25V$, $T_{amb} = 0$ to $70\text{ }^{\circ}C$ unless otherwise specified)

Parameter	Test conditions	Min.	Typ.	Max.	Unit
-----------	-----------------	------	------	------	------

CLOCK INPUT

f	Clock repetition rate	DC	100		kHz
t_{pw}^*	Pulse width	5			μs
t_r^{**}	Rise time		100		μs
t_f^{**}	Fall time		100		μs

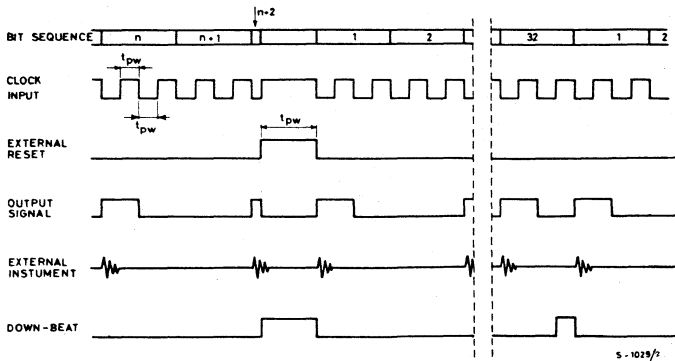
EXTERNAL RESET

t_{pw}	Pulse width	5			μs
----------	-------------	---	--	--	---------

* Measured at 50% of the swing

** Measured between 10% and 90% of the swing

TIMING WAVEFORMS (positive logic)



S-1029/1

Note: In these timing waveforms it has been assumed, for example, that in the truth table bits $n + 1$ and 2 have not been programmed i.e. the musical instrument has not been introduced. All the other bits have been programmed for the introduction of the instrument.

TYPICAL APPLICATIONS

Figure 1 shows the typical application of the M 253 (AA).

With two M 253 devices it is possible to increase the number of rhythms or the number of instruments available, or the number of elementary times, as shown in figures 2, 3 and 4 respectively.

The use of a memory matrix allows the customer complete flexibility, since modification of the memory is quick and relatively cheap.

Fig. 1 - Rhythm system (standard content)

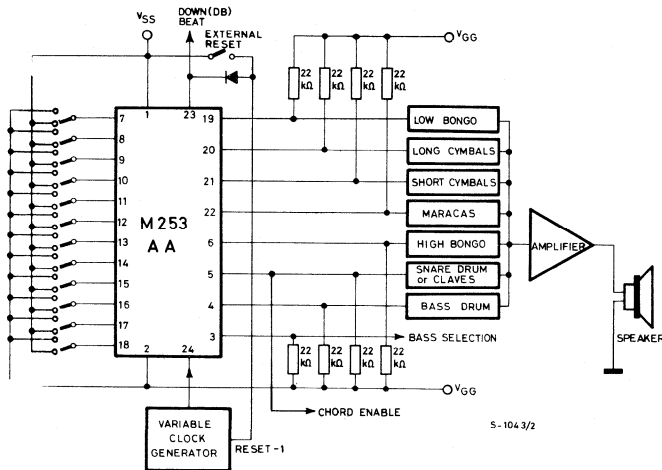
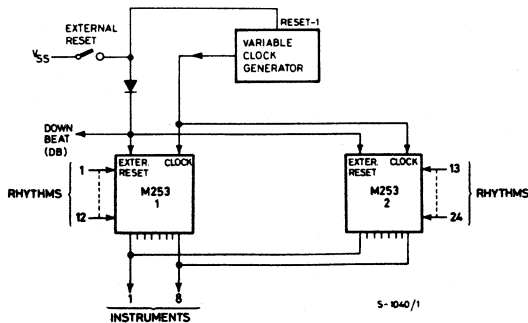


Fig. 2 - Increase in number of rhythms



The rhythms may be selected from both devices simultaneously.

TYPICAL APPLICATIONS (continued)

Fig. 3 - Increase in number of instruments

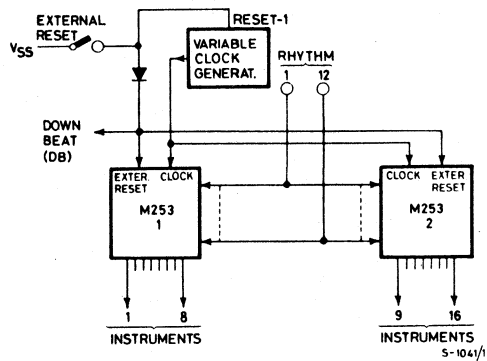
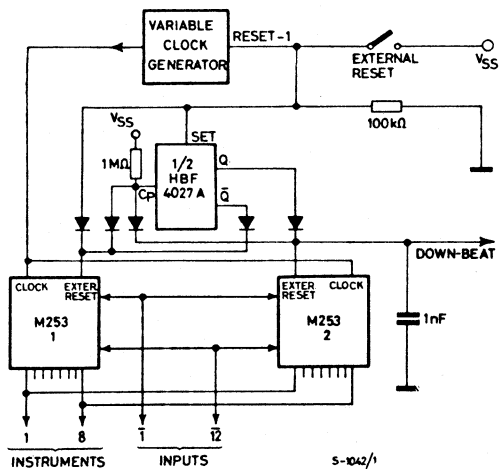
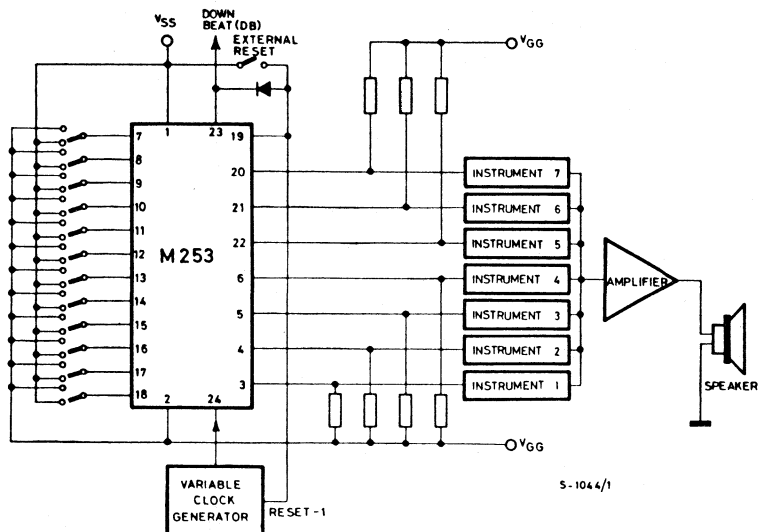


Fig. 4 - Increasing the number of elementary times



Note: The total number of elementary times is given by the sum of the elementary times of the individual devices

CIRCUIT FOR CHANGING THE NUMBER OF ELEMENTARY TIMES



To obtain a required number of elementary times "N" simply put a cross in the "N + 1" position of the column which now represents the reset output, rather than the 8th instrument.

The DB output can be used as down-beat because it appears at the beginning of each measure. Since the pulse is only 2 - 3 μ s long it must, however, be stretched and buffered to enable it to drive a lamp.

Full information on the use of the M 253 in electronic organs and other applications will be found in Technical Note no. 131 available on request.

COMPLETING THE TRUTH TABLE

The ROM truth table has been organized in 32 rows which represent elementary times and 96 columns (12 groups of 8) where each group represents a rhythm which has at its disposition 8 programmable instruments. To programme each rhythm one indicates (with a cross) in the appropriate boxes the timing for each beat required for each instrument.

In the given truth table we show an example of how to programme three imaginary rhythms, the first is in 4/4 time, the second in 3/4 time and the third in different time, chosen randomly. Each cross corresponds to a beat of the indicated instrument or, in logic terms, to the presence of a "1" level (positive logic) at the output.

The absence of a cross indicates that the corresponding instrument is not used in that part of the rhythm. Rhythm 3 is an example of how to programme for a time which differs from 4/4 or 3/4. This is achieved by using output 8 to reset the rhythm and not to drive an instrument. The rhythm is valid till elementary time no. 15.

M 253

COUNT TO 32	RHYTHM 11								RHYTHM 12							
	OUTPUT 1	OUTPUT 2	OUTPUT 3	OUTPUT 4	OUTPUT 5	OUTPUT 6	OUTPUT 7	OUTPUT 8	OUTPUT 1	OUTPUT 2	OUTPUT 3	OUTPUT 4	OUTPUT 5	OUTPUT 6	OUTPUT 7	OUTPUT 8
1																
2																
3																
4																
5																
6																
7																
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SAJ 210

LINEAR INTEGRATED CIRCUIT

7-STAGE FREQUENCY DIVIDER FOR ELECTRONIC ORGANS

- HIGH CROSSTALK IMMUNITY - TYP. 70 dB
- OUTPUT SHORT CIRCUIT PROTECTION

The SAJ 210 is a monolithic integrated circuit in a 14-lead quad in-line or dual in-line plastic package. It has been created by means of the standard bipolar technique and especially developed for use as frequency divider for electronic organs. Seven flip-flops connected in 5 groups are housed on one silicon chip. The input and the output of each flip-flop is externally accessible.

ABSOLUTE MAXIMUM RATINGS

V_s	Supply voltage	14	V
V_i	Input voltage	$V_i = V_s$	
I_o^*	Output current	5	mA
P_{tot}	Power dissipation at $T_{amb} \leq 70^\circ\text{C}$	0.5	W
T_{stg}	Storage temperature	-55 to 125	$^\circ\text{C}$
T_{op}	Operating temperature	0 to 70	$^\circ\text{C}$

* With reference to Fig. 5, the current can be greater than 5 mA, but for $t < 0.1$ ms

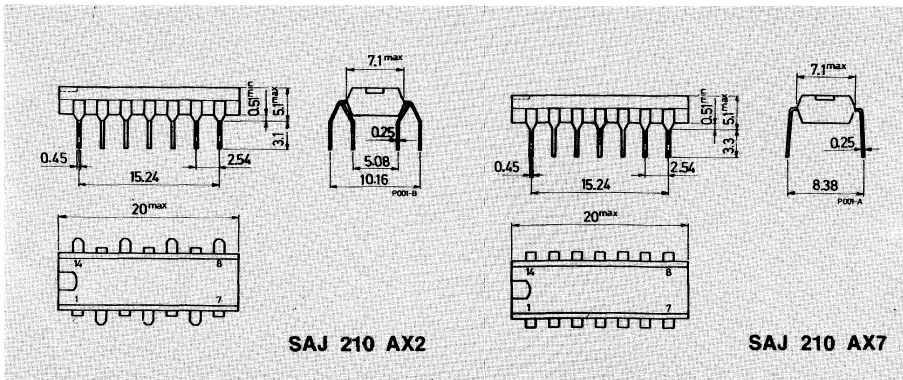
ORDERING NUMBERS:

SAJ 210 AX2 (for 14-lead quad in-line plastic package)

SAJ 210 AX7 (for 14-lead dual in-line plastic package)

MECHANICAL DATA

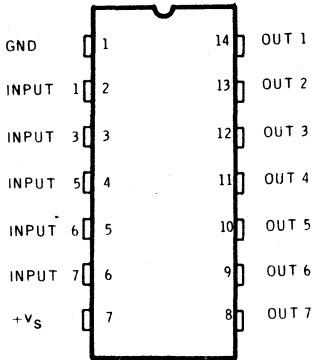
Dimensions in mm



SAJ 210

CONNECTION DIAGRAM

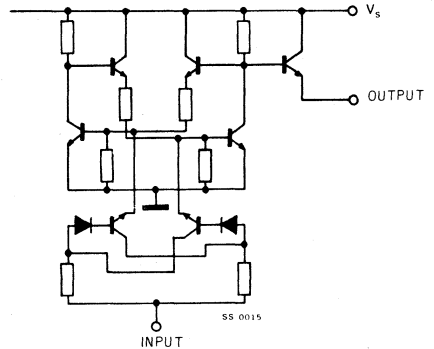
(top view)



SS 0014

SCHEMATIC DIAGRAM

(each flip-flop)



ELECTRICAL CHARACTERISTICS

($T_{amb} = 25^{\circ}\text{C}$, $V_s = 9\text{ V}$ unless otherwise specified)

Parameter	Test conditions	Min.	Typ.	Max.	Unit
-----------	-----------------	------	------	------	------

DATA INPUT

V_{IL}	Input low level	$V_s = 8$ to 14 V	0	1.5	V
V_{IH}^*	Input high level	$V_s = 8$ to 14 V	6		V
I_{IH}	Input high level current	$V_i = 8\text{ V}$	1	3	mA

DATA OUTPUT

V_{OL}	Output low level	$R_L = 3\text{ k}\Omega$		0.1	V
V	Output voltage impressed	Low level		6	V
V_{OH}	Output high level	$R_L = 3\text{ k}\Omega$ $V_s = 12\text{ V}$	$R_L = 3\text{ k}\Omega$	7 9.5	V V
t_r	Rise time	$V_i = 8\text{ V}$	$C_L = 10\text{ pF}$		0.1 μs
t_f	Fall time	$R_L = 3\text{ k}\Omega$	$C_L = 10\text{ pF}$		0.2 μs
I_d	Total current drain	$R_L = 3\text{ k}\Omega$ All flip-flops at high level All flip-flops at low level		35 16	mA mA

ELECTRICAL CHARACTERISTICS (continued)

Parameter	Test conditions	Min.	Typ.	Max.	Unit
V_o Output swing	$R_L = 3\text{ k}\Omega$		7.6		V
** Cross talk immunity level	$R_L = 3\text{ k}\Omega$ $C_L = 10\text{ pF}$		70		dB
R_o Dynamic output resistance	V_o Impressed = 0 to 2 V at high level at low level		160 6		Ω M Ω
Ripple on output voltage at 2 f out (peak to peak)	$V_i = 8\text{ V}$		5		mV

* Input high level is never reached if the input pulse is lower than 3.5 V

** Two independent dividers are triggered

Divider A: triggering frequency 20 kHz

Divider B: triggering frequency 2240 Hz

V_o B 1120 Hz

Cross talk level = $20 \log \frac{V_o \text{ B } 1120 \text{ Hz}}{V_o \text{ B } 10 \text{ kHz}}$

Fig. 1 - Typical input current vs input voltage

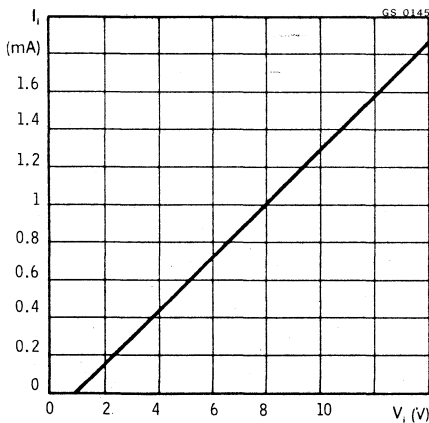
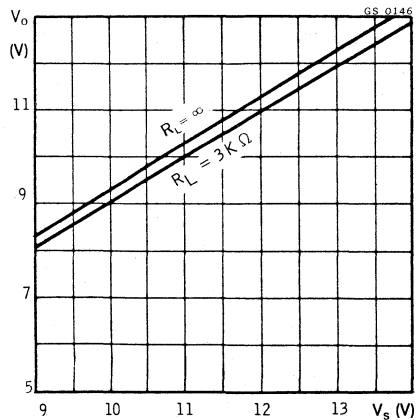


Fig. 2 - Typical output level vs supply voltage



SAJ 210

Fig. 3 - Typical input voltage for triggering

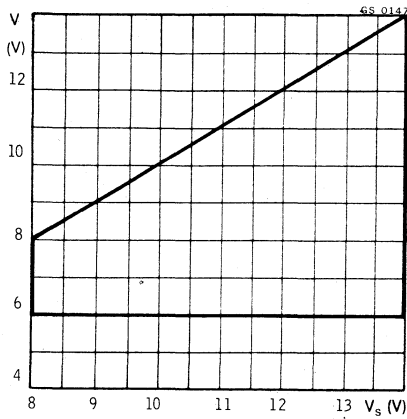


Fig. 4 - Power rating chart

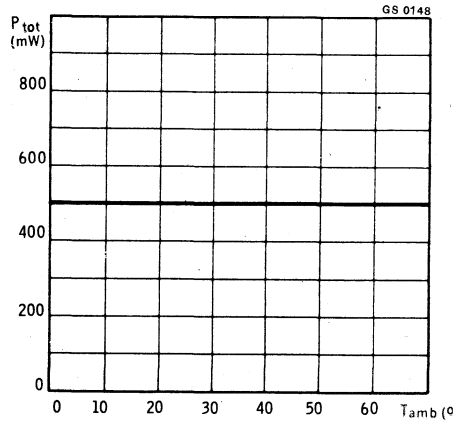
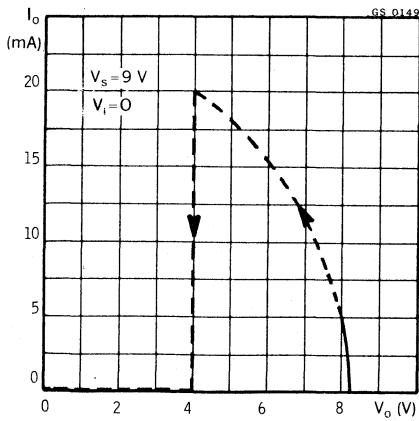
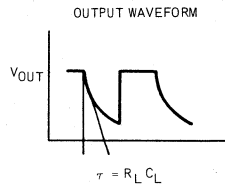
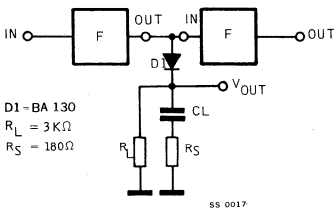
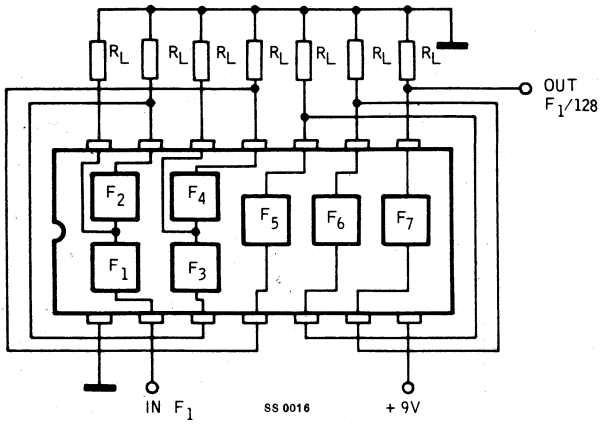


Fig. 5 - Typical output current vs output voltage



TYPICAL APPLICATIONS



LINEAR INTEGRATED CIRCUIT

TAA 550 TBA 271

VOLTAGE STABILIZER

- LOW TEMPERATURE COEFFICIENT
- LOW ZENER RESISTANCE

The TAA 550/TBA 271 is a monolithic integrated voltage stabilizer in a TO-18 two pins metal case. It is especially designed as voltage supplier for varicap diodes in television tuners.

The TAA 550/TBA 271 is supplied in 3 groups of stabilized voltage identified by a letter after the code, as shown in the "ORDERING NUMBERS".

ABSOLUTE MAXIMUM RATINGS

I_z	Zener current at $T_{case} \leq 70^\circ\text{C}$	15 mA
T_{stg}	Storage temperature	-20 to 150 °C
T_{op}	Operating temperature	*

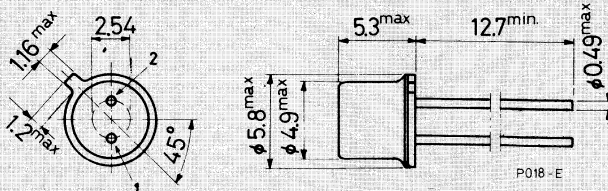
* Refer to "Power rating chart" (Fig. 1)

ORDERING NUMBERS: TAA 550 A or TBA 271 A (for V_z range : 30-32 V)
TAA 550 B or TBA 271 B (for V_z range : 32-34 V)
TAA 550 C or TBA 271 C (for V_z range : 34-36 V)

MECHANICAL DATA

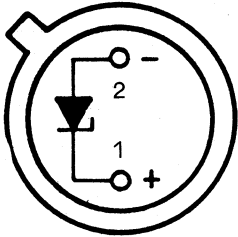
Dimensions in mm

Lead 1 connected to case



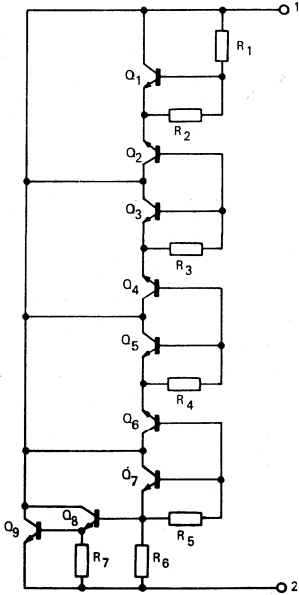
TAA 550 TBA 271

CONNECTION DIAGRAM (bottom view)



SS 0036

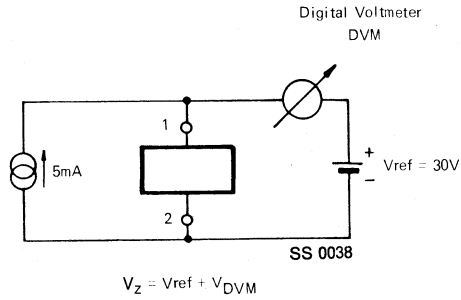
SCHEMATIC DIAGRAM



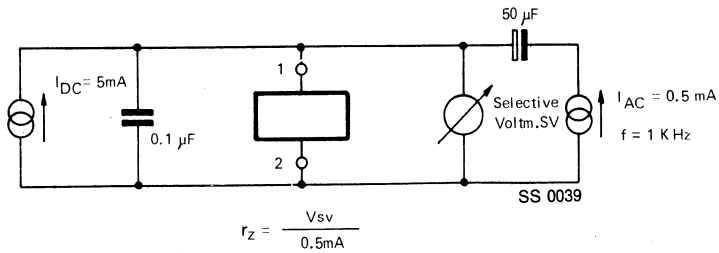
SS 0037

TEST CIRCUITS

Circuit No. 1 (for V_z measurement)



Circuit No. 2 (for r_z measurement)



TAA 550 TBA 271

THERMAL DATA

$R_{th\ j-case}$	Thermal resistance junction-case	max	150	°C/W
$R_{th\ j-amb}$	Thermal resistance junction-ambient	max	400	°C/W

ELECTRICAL CHARACTERISTICS ($T_{amb} = 25\text{ °C}$ unless otherwise specified)

Parameter	Test conditions	Min.	Typ.	Max.	Unit
V_z Zener voltage	$I_z = 5\text{ mA}$ (circuit No. 1) for TAA 550 A/TBA 271 A for TAA 550 B/TBA 271 B for TAA 550 C/TBA 271 C	30 32 34	31 33 35	32.2 34.2 36	V V V
r_z Zener dynamic resistance	$I_z = 5\text{ mA}$ $I_{AC} = 0.5\text{ mA}$ $f = 1\text{ kHz}$ (circuit No. 2)		10	25	Ω
$\frac{\Delta V_z}{\Delta T_{amb}}$ Temperature coefficient	$I_z = 5\text{ mA}$ $\Delta T_{amb} = 0\text{ to }50\text{ °C}$	-3.2		+1.6	mV/°C

Fig. 1 - Power rating chart

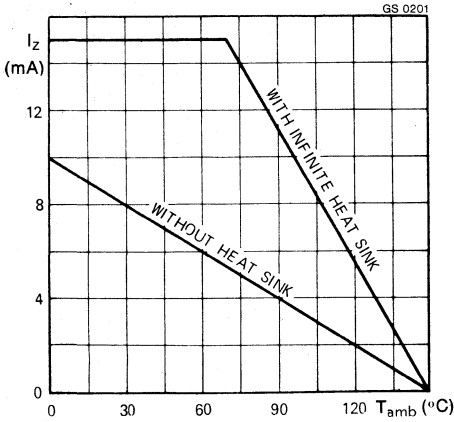


Fig. 2 - Typical zener dynamic resistance vs zener current

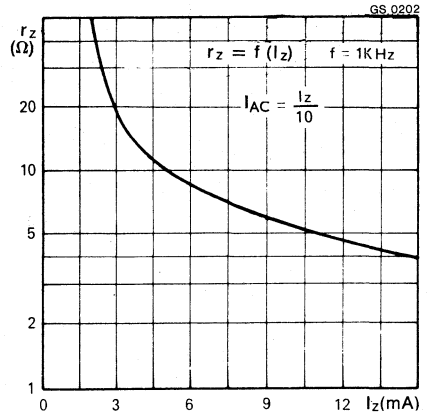


Fig. 3 - Typical temperature coefficient

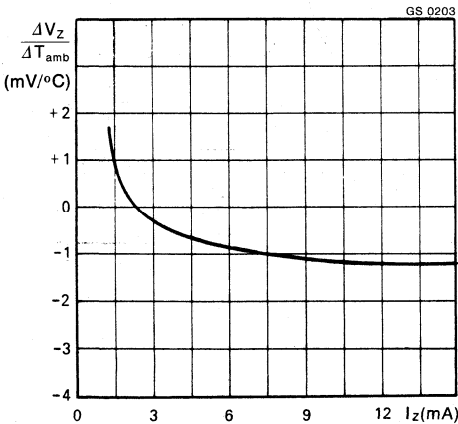
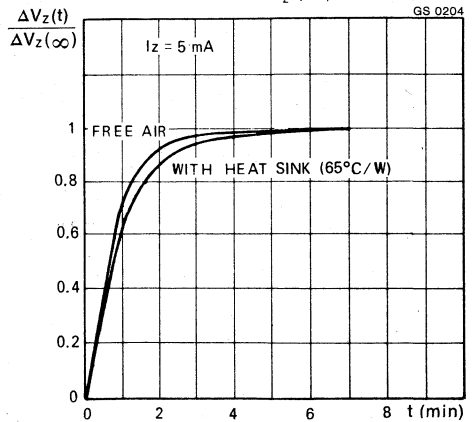
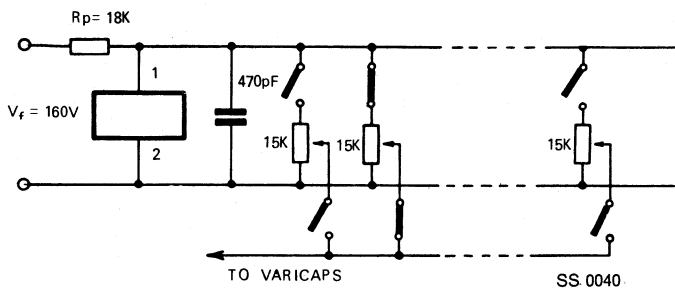


Fig. 4 - Typical $\frac{\Delta V_z(t)}{\Delta V_z(\infty)}$ vs time



TAA 550 TBA 271

TYPICAL APPLICATION



TAA 611A

LINEAR INTEGRATED CIRCUIT

AUDIO AMPLIFIER

- OUTPUT POWER 1.8 W (9 V - 4 Ω)
- LOW DISTORTION
- LOW QUIESCENT CURRENT
- HIGH INPUT IMPEDANCE

The TAA 611 A is a monolithic integrated circuit in a 14-lead quad in-line plastic package or in a TO-100 metal case.

It is particularly designed for use in radio receivers and record-players as audio amplifier. The usable range of supply voltage varies from 6 V to 12 V and the circuit requires a minimum number of external components.

ABSOLUTE MAXIMUM RATINGS

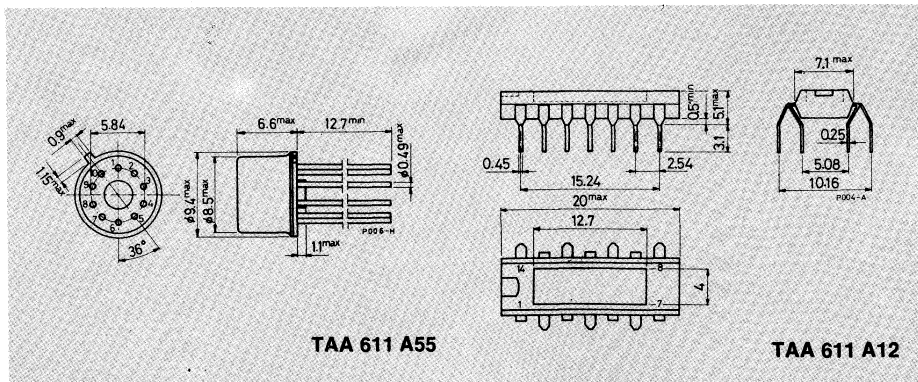
ABSOLUTE MAXIMUM RATINGS		TAA 611 A12	TAA 611 A55
V_s	Supply voltage	12 V	
V_i^*	Input voltage	-0.5 to 12 V	
I_o	Output peak current	1 A	
$\rightarrow P_{tot}$	Power dissipation at $T_{amb} \leq 25^\circ\text{C}$	1.35 W	0.57 W
	at $T_{case} \leq 70^\circ\text{C}$	—	1.6 W
	at $T_{case} \leq 100^\circ\text{C}$	3.1 W	—
$\rightarrow T_{stg}, T_j$	Storage and junction temperature	-40 to 150°C	

* For $V_s < 12\text{ V}$, $V_{i\text{ max}} = V_s$

ORDERING NUMBERS: TAA 611 A55 (for TO-100 metal case)
TAA 611 A12 (for quad in-line plastic package)

MECHANICAL DATA

Dimensions in mm



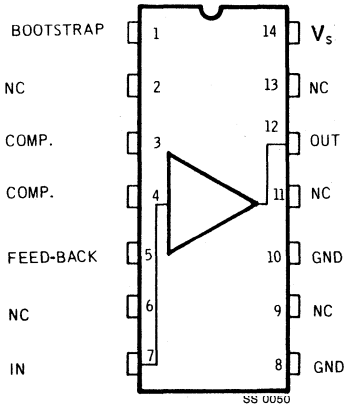
TAA 611 A55

TAA 611 A12

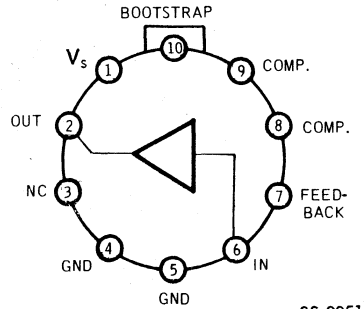
TAA 611A

CONNECTION DIAGRAMS

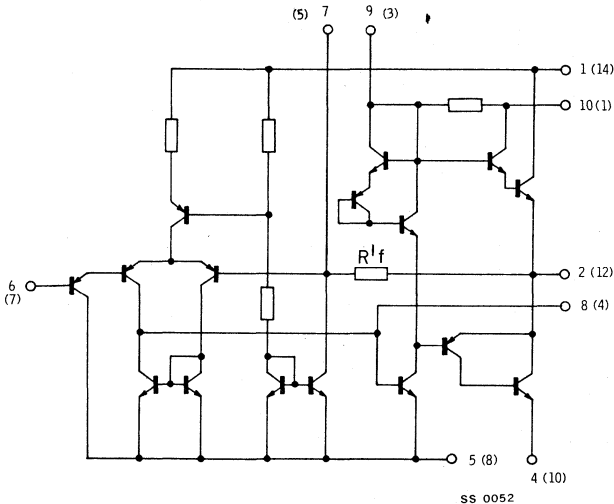
For TAA 611 A12



For TAA 611 A55



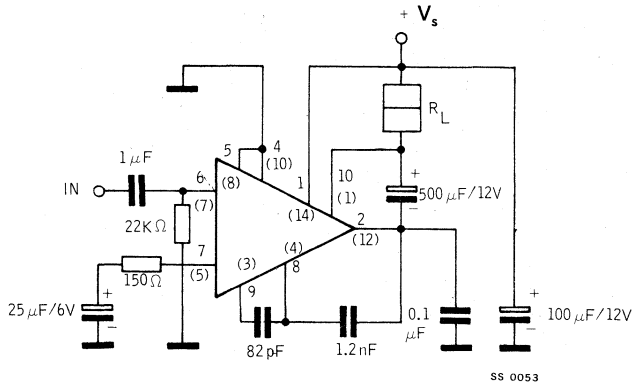
SCHEMATIC DIAGRAM



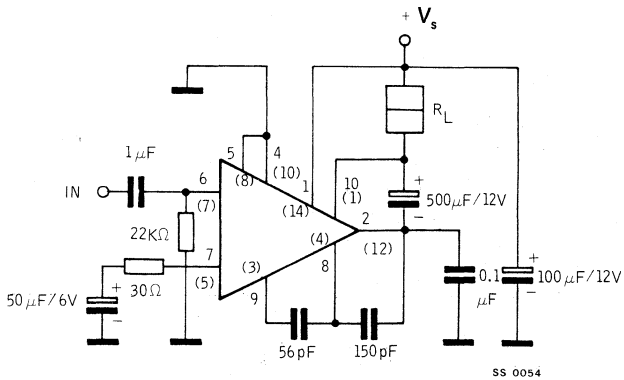
The pin numbers in brackets refer to the TAA 611 A12 and those without brackets refer to the TAA 611 A55.

TEST CIRCUITS

Circuit No. 1 ($G_v = 50$)



Circuit No. 2 ($G_v = 250$)



TAA 611A

THERMAL DATA (maximum values)

		TAA 611 A12	TAA 611 A55
→ $R_{th\ j-case}$	Thermal resistance junction-case	16 °C/W	50 °C/W
$R_{th\ j-amb}$	Thermal resistance junction-ambient	93 °C/W	220 °C/W

ELECTRICAL CHARACTERISTICS

($T_{amb} = 25\text{ °C}$, $V_s = 9\text{ V}$, refer to the test circuit no. 2 unless otherwise specified)

	Parameter	Test conditions	Min.	Typ.	Max.	Unit
	V_o Quiescent output voltage			4.8		V
	I_d Total quiescent drain current			3		mA
	I_d Quiescent drain current of output transistors			1		mA
	I_d Drain current	$P_o = 1.15\text{ W}$ $R_L = 8\ \Omega$		170		mA
→	I_b Input bias current			0.1	0.8	μA
→	P_o^* Output power	$d = 2\%$ $f = 1\text{ kHz}$ $V_s = 6\text{ V}$ $R_L = 4\ \Omega$ $V_s = 6\text{ V}$ $R_L = 8\ \Omega$ $V_s = 9\text{ V}$ $R_L = 4\ \Omega$ $V_s = 9\text{ V}$ $R_L = 8\ \Omega$ $d = 10\%$ $f = 1\text{ kHz}$ $V_s = 6\text{ V}$ $R_L = 4\ \Omega$ $V_s = 6\text{ V}$ $R_L = 8\ \Omega$ $V_s = 9\text{ V}$ $R_L = 4\ \Omega$ $V_s = 9\text{ V}$ $R_L = 8\ \Omega$		0.50 0.35 1.4 0.9 0.65 0.45 1.8 0.85	1.15	W W W W W W W W
	R_f' Internal feedback resistance (see schematic diagram)			7.5		$\text{k}\Omega$
→	Z_i Input impedance (open loop)			5		$\text{M}\Omega$

TAA 611A

ELECTRICAL CHARACTERISTICS (continued)

Parameter	Test conditions	Min.	Typ.	Max.	Unit
d Distortion	Test circuit 1				
	$P_o = 50 \text{ mW}$ $V_s = 9 \text{ V}$		0.4		%
	$R_L = 8 \Omega$ $f = 1 \text{ kHz}$				
	$P_o = 0.5 \text{ W}$ $V_s = 9 \text{ V}$		0.3		%
	$R_L = 8 \Omega$ $f = 1 \text{ kHz}$				
	Test circuit 2				
	$P_o = 50 \text{ mW}$ $V_s = 9 \text{ V}$		1.7		%
	$R_L = 8 \Omega$ $f = 1 \text{ kHz}$				
	$P_o = 0.5 \text{ W}$ $V_s = 9 \text{ V}$		1.2		%
	$R_L = 8 \Omega$ $f = 1 \text{ kHz}$				
G_v Voltage gain (open loop)	$R_L = 8 \Omega$		68		dB

* External heatsink not required except for TAA 611 A55 at $V_s = 9 \text{ V}$, $R_L = 4 \Omega$

Fig. 1 - Typical output power vs load resistance

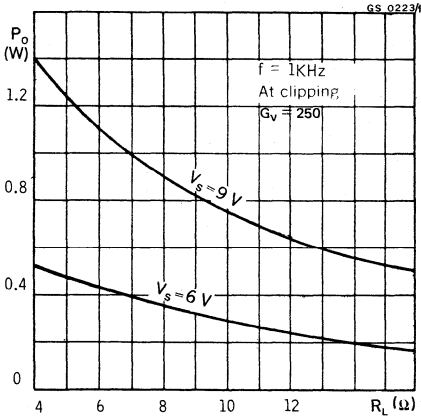
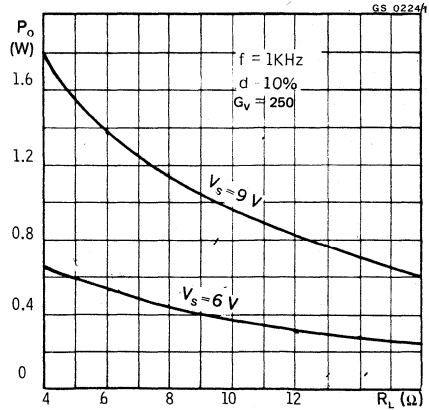


Fig. 2 - Typical output power vs load resistance



TAA 611A

Fig. 3 - Typical distortion vs output power

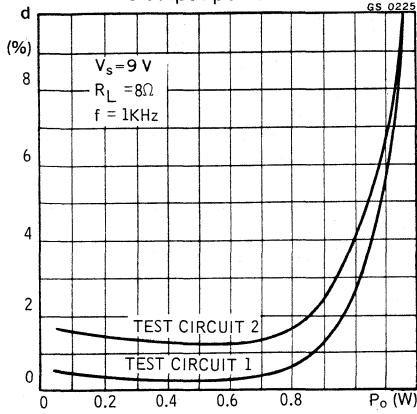


Fig. 4 - Typical distortion vs output power

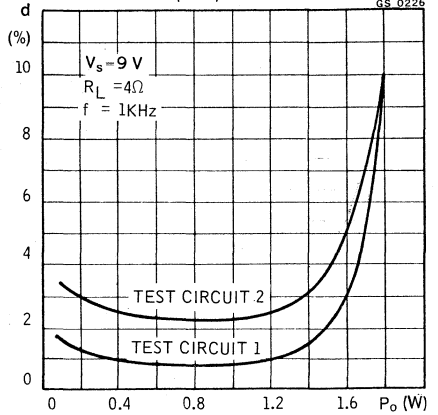


Fig. 5 - Typical relative frequency response

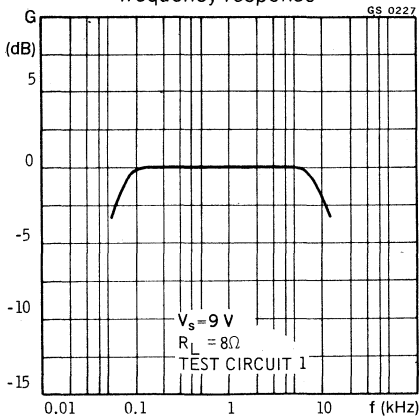
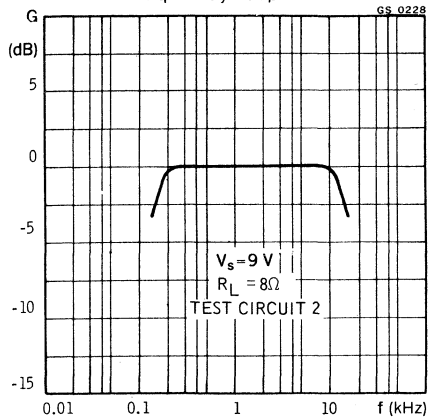
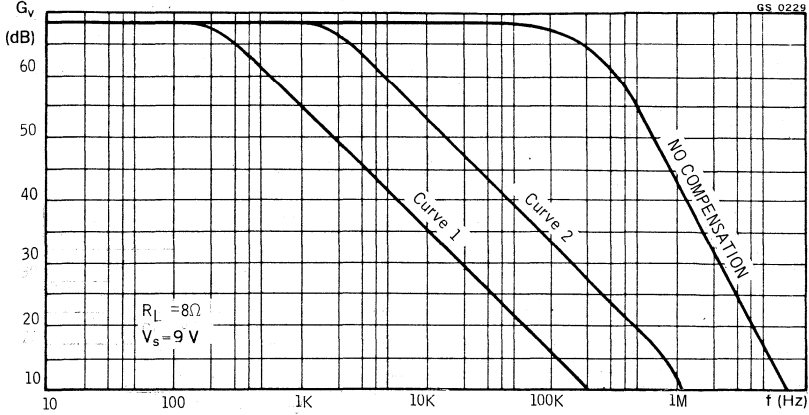


Fig. 6 - Typical relative frequency response



TAA 611A

Fig. 7 - Typical voltage gain (open loop) vs frequency



Curve 1: TAA611 A 55, $C_{9-8} = 82\text{pF}$	$C_{8-2} = 1.2\text{ nF}$	$C_{10-1} = 0.1\text{ }\mu\text{F}$
TAA611 A 12, $C_{3-4} = 82\text{pF}$	$C_{4-12} = 1.2\text{ nF}$	$C_{1-14} = 0.1\text{ }\mu\text{F}$
Curve 2: TAA611 A 55, $C_{9-8} = 56\text{pF}$	$C_{8-2} = 150\text{ pF}$	$C_{10-1} = 0.1\text{ }\mu\text{F}$
TAA611 A 12, $C_{3-4} = 56\text{pF}$	$C_{4-12} = 150\text{ pF}$	$C_{1-14} = 0.1\text{ }\mu\text{F}$

Fig. 8 - Typical output power vs input voltage

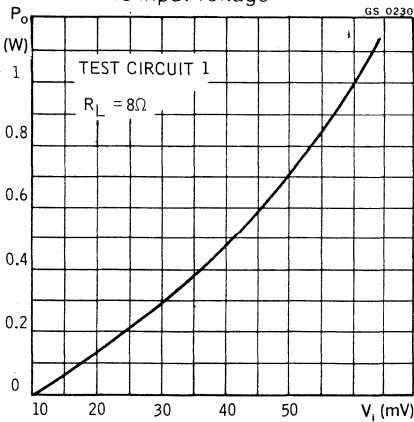
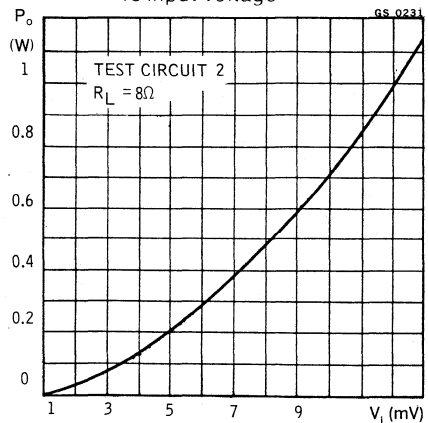


Fig. 9 - Typical output power vs input voltage



TAA 611A

Fig. 10 - Typical power dissipation and efficiency vs output power

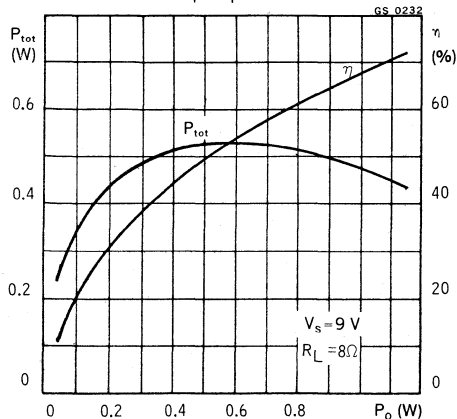


Fig. 11 - Typical power dissipation and efficiency vs output power

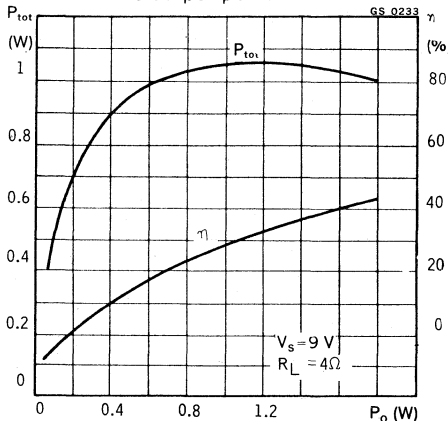


Fig. 12 - Typical power dissipation and efficiency vs output power

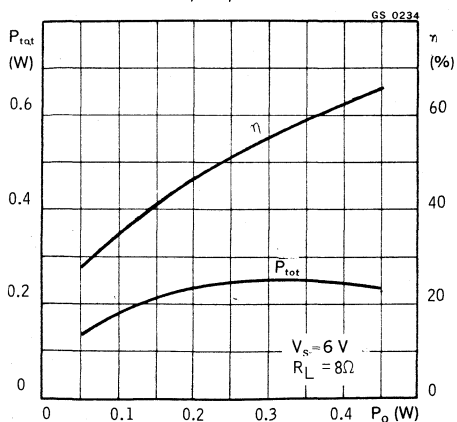
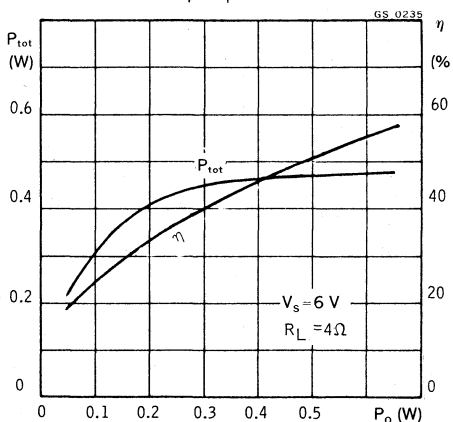


Fig. 13 - Typical power dissipation and efficiency vs output power



TAA 611A

Fig. 14 - Typical drain current vs output power

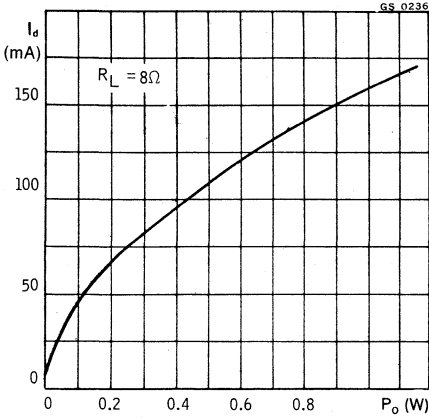


Fig. 15 - Maximum power dissipation vs load resistance

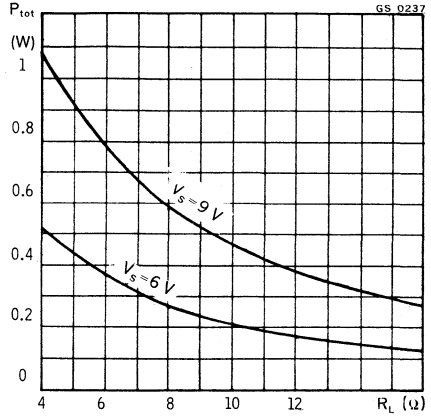


Fig. 16 - Power rating chart (TAA 611 A55)

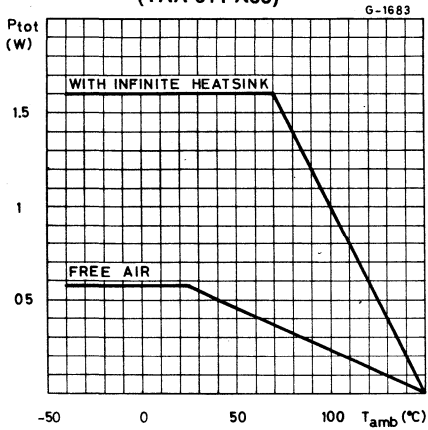
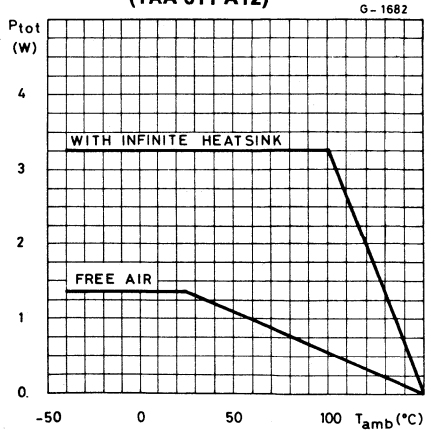


Fig. 17 - Power rating chart (TAA 611 A12)



TAA 611A

Fig. 18 - Typical quiescent drain current vs supply voltage

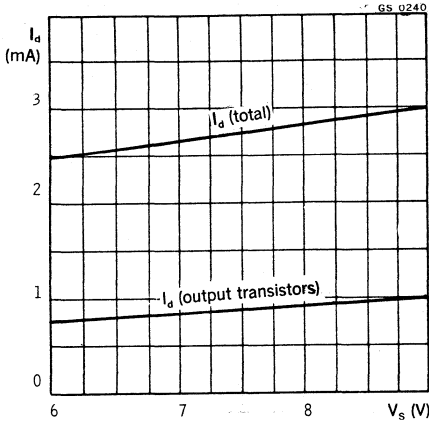


Fig. 19 - Typical quiescent drain current vs ambient temperature

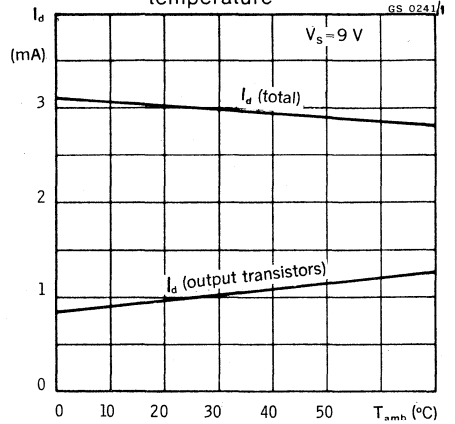
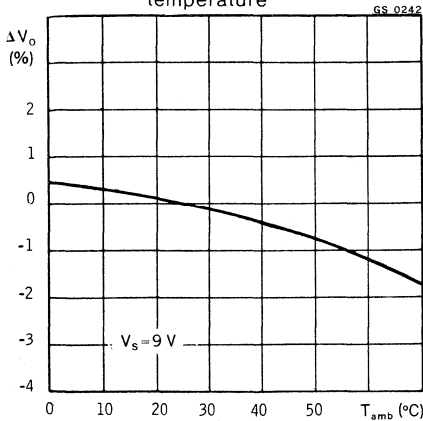


Fig. 20 - Typical quiescent output voltage vs ambient temperature



TYPICAL APPLICATIONS

Fig. 21 - Audio amplifier for record-player

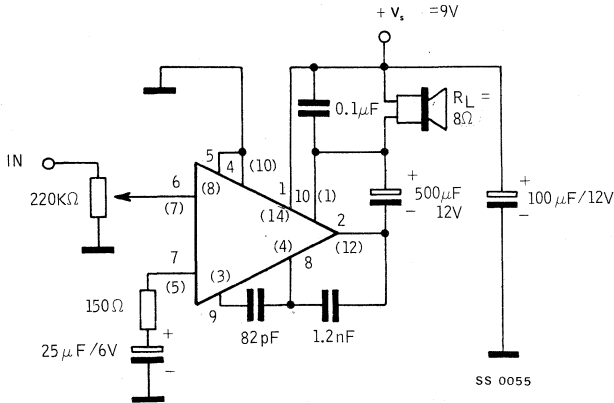
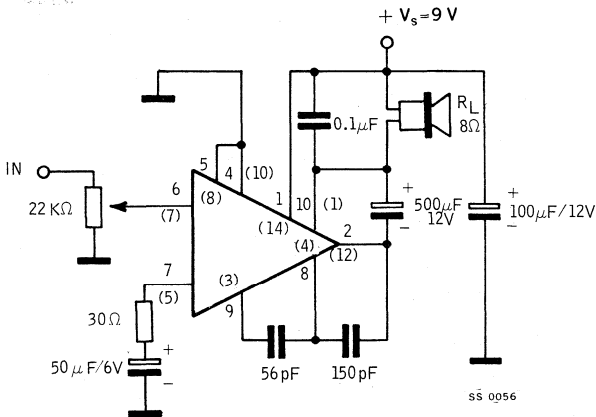


Fig. 22 - Audio amplifier for radio



The pin numbers in brackets refer to the TAA 611 A12 and those without brackets refer to the TAA 611 A55.

LINEAR INTEGRATED CIRCUIT

AUDIO AMPLIFIER

- OUTPUT POWER 2.1 W (12 V - 8 Ω)
- LOW DISTORTION
- LOW QUIESCENT CURRENT
- HIGH INPUT IMPEDANCE

The TAA 611 B is a monolithic integrated circuit in a 14-lead quad in-line plastic package.

It is particularly designed for use in radio receivers and record-players as audio amplifier. The usable range of supply voltage varies from 6 V to 15 V and the circuit requires a minimum number of external components.

ABSOLUTE MAXIMUM RATINGS

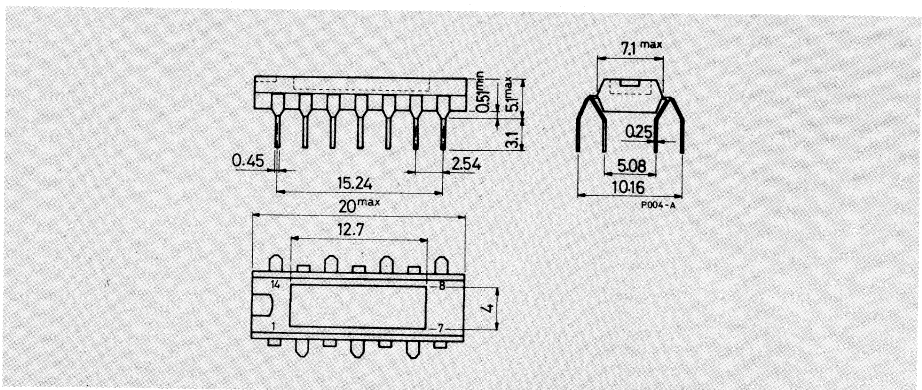
V_s	Supply voltage	15	V
V_i^*	Input voltage	-0.5 to 15	V
I_o	Output peak current	1	A
P_{tot}	Power dissipation at $T_{amb} \leq 25^\circ\text{C}$	1.35	W
$\rightarrow T_{stg}, T_j$	Storage and junction temperature	-40 to 150	$^\circ\text{C}$

* For $V_s < 15$ V, $V_{i\ max} = V_s$

ORDERING NUMBER: TAA 611 B12

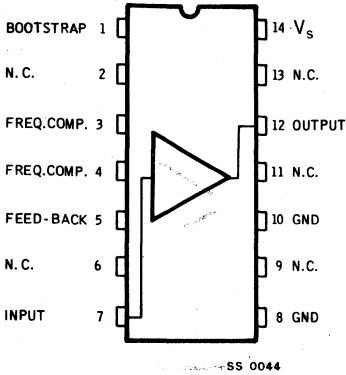
MECHANICAL DATA

Dimensions in mm

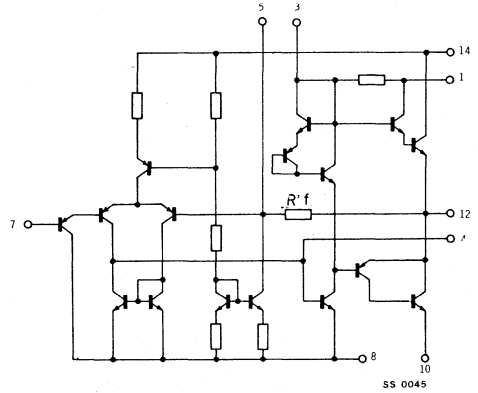


TAA 611B

CONNECTION DIAGRAM

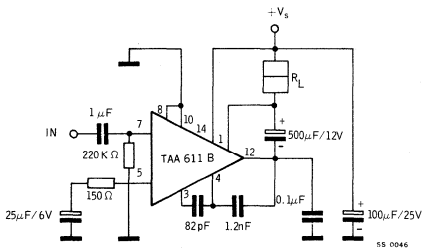


SCHEMATIC DIAGRAM

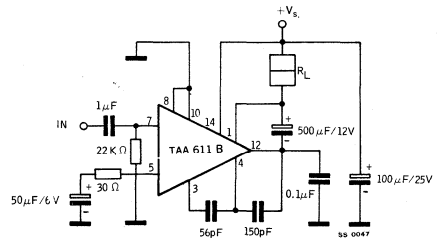


TEST CIRCUITS

Circuit No. 1 ($G_v = 50$)



Circuit No. 2 ($G_v = 250$)



TAA 611B

THERMAL DATA

→ $R_{th\ j-case}$	Thermal resistance junction-case	max	16	°C/W
$R_{th\ j-amb}$	Thermal resistance junction-ambient	max	93	°C/W

ELECTRICAL CHARACTERISTICS

($T_{amb} = 25\text{°C}$, refer to the test circuit no. 2 unless otherwise specified)

	Parameter	Test conditions	Min.	Typ.	Max.	Unit
	V_o Quiescent output voltage	$V_s = 9\text{ V}$ $V_s = 12\text{ V}$		4.8 6.3		V V
	I_d Total quiescent drain current	$V_s = 9\text{ V}$ $V_s = 12\text{ V}$		3 3.5		mA mA
	I_d Quiescent drain current of output transistors	$V_s = 9\text{ V}$ $V_s = 12\text{ V}$		1 1.2		mA mA
	I_d Drain current	$R_L = 8\ \Omega$ $P_o = 1.15\text{ W}$ $V_s = 9\text{ V}$ $P_o = 2.1\text{ W}$ $V_s = 12\text{ V}$		170 235		mA mA
→	I_b Input bias current	$V_s = 9\text{ V}$ $V_s = 12\text{ V}$		60 0.1	1	nA μA
→	P_o Output power	$d = 2\%$ $f = 1\text{ kHz}$ $V_s = 9\text{ V}$ $R_L = 8\ \Omega$ $V_s = 12\text{ V}$ $R_L = 8\ \Omega$ $d = 10\%$ $f = 1\text{ kHz}$ $V_s = 9\text{ V}$ $R_L = 8\ \Omega$ $V_s = 12\text{ V}$ $R_L = 8\ \Omega$		0.9 1.7 1.15 2.1		W W W W
	R_f Internal feedback resistance (see schematic diagram)			7.5		k Ω
→	Z_i Input impedance	open loop		5		M Ω

TAA 611B

ELECTRICAL CHARACTERISTICS (continued)

Parameter	Test conditions	Min.	Typ.	Max.	Unit
d Distortion	Test circuit 1 $R_L = 8 \Omega$ $f = 1 \text{ kHz}$ $P_o = 50 \text{ mW}$ $V_s = 9 \text{ V}$ $P_o = 50 \text{ mW}$ $V_s = 12 \text{ V}$ $P_o = 0.5 \text{ W}$ $V_s = 9 \text{ V}$ $P_o = 1 \text{ W}$ $V_s = 12 \text{ V}$		0.4		%
			0.3		%
			0.3		%
			0.2		%
	Test circuit 2 $R_L = 8 \Omega$ $f = 1 \text{ kHz}$ $P_o = 50 \text{ mW}$ $V_s = 9 \text{ V}$ $P_o = 50 \text{ mW}$ $V_s = 12 \text{ V}$ $P_o = 0.5 \text{ W}$ $V_s = 9 \text{ V}$ $P_o = 1 \text{ W}$ $V_s = 12 \text{ V}$		1.7		%
			1.5		%
			1.2		%
			1		%
G_v Voltage gain (open loop)	$R_L = 8 \Omega$ $V_s = 9 \text{ V}$ $R_L = 8 \Omega$ $V_s = 12 \text{ V}$		68		dB
			70		dB

TAA 611B

Fig. 1 - Typical output power vs load resistance

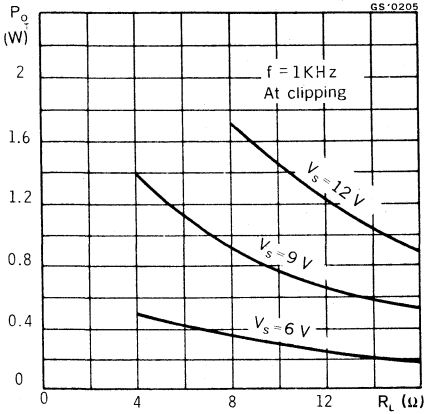


Fig. 2 - Typical output power vs load resistance

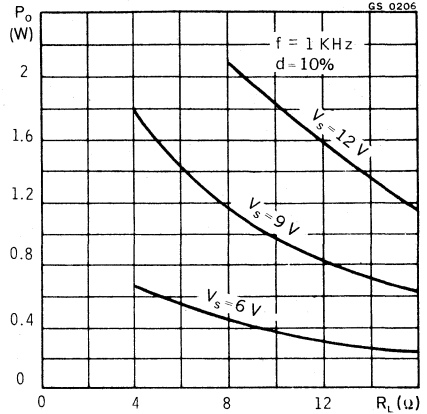


Fig. 3 - Typical distortion vs output power

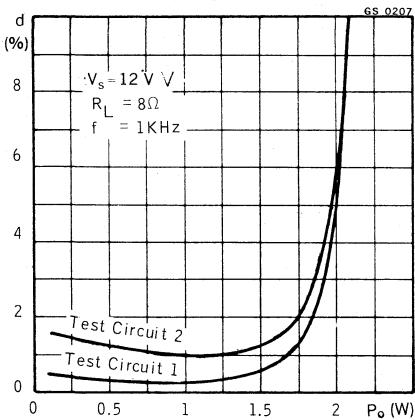
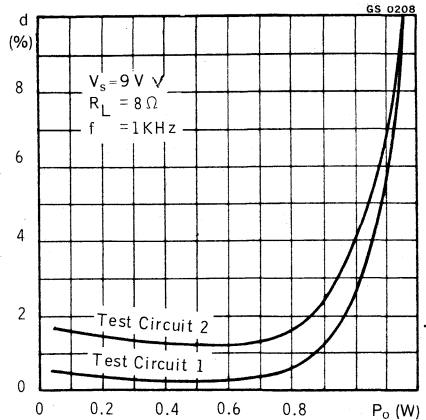


Fig. 4 - Typical distortion vs output power



TAA 611B

Fig. 5 - Typical voltage gain (open loop) vs frequency

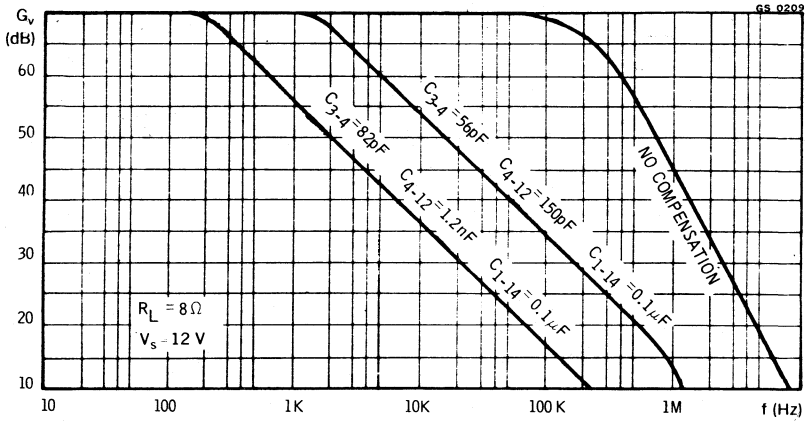


Fig. 6 - Typical relative frequency response

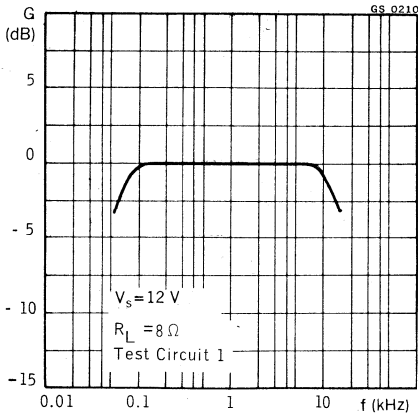


Fig. 7 - Typical relative frequency response

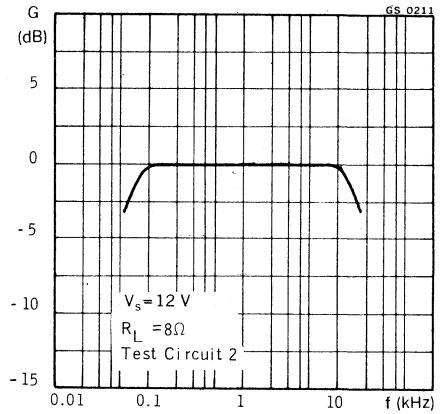


Fig. 8 - Typical output power vs input voltage

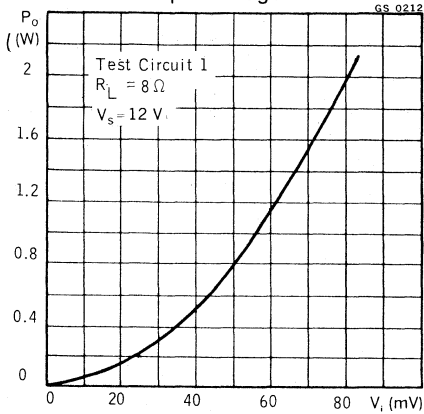


Fig. 9 - Typical output power vs input voltage

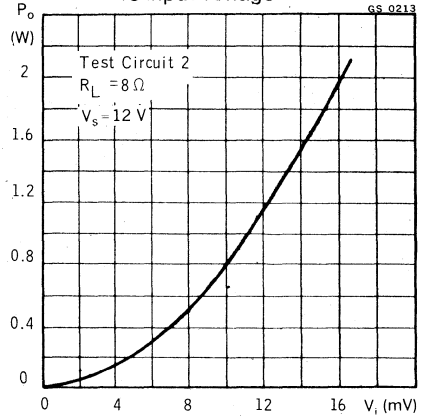


Fig. 10 - Typical power dissipation and efficiency vs output power

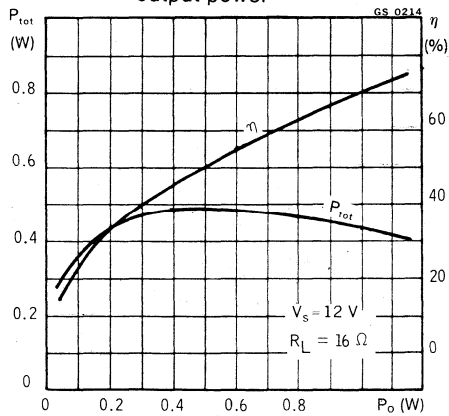
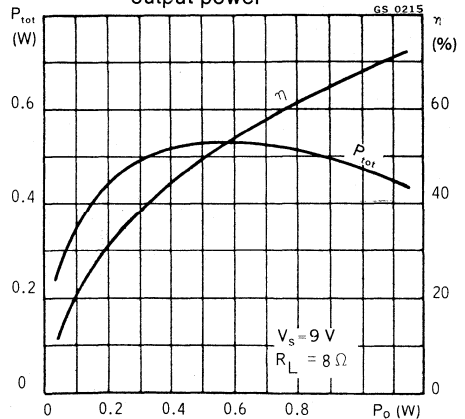


Fig. 11 - Typical power dissipation and efficiency vs output power



TAA 611B

Fig. 12 - Typical power dissipation and efficiency vs output power

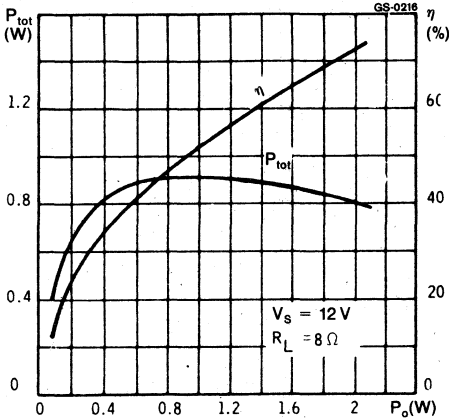


Fig. 13 - Typical drain current vs output power

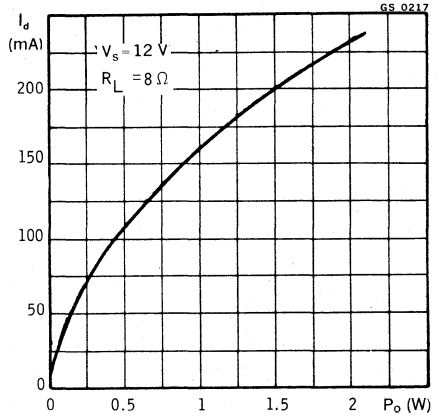


Fig. 14 - Maximum power dissipation vs load resistance

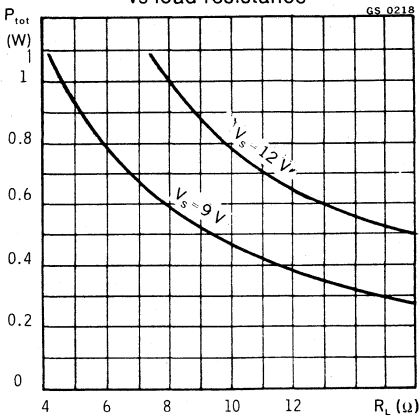


Fig. 15 - Power rating chart

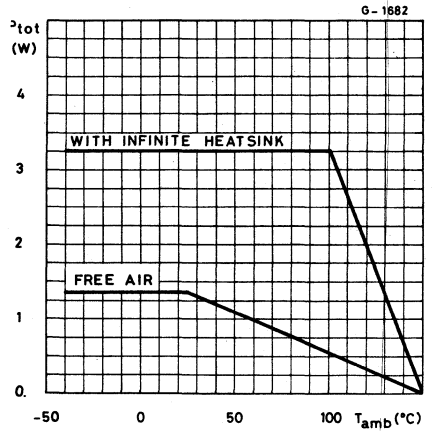


Fig. 16 - Typical quiescent drain current vs supply voltage

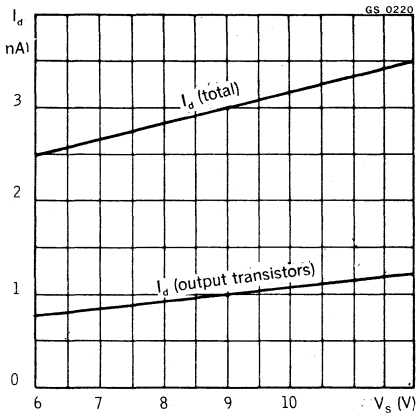


Fig. 17 - Typical quiescent drain current vs ambient temperature

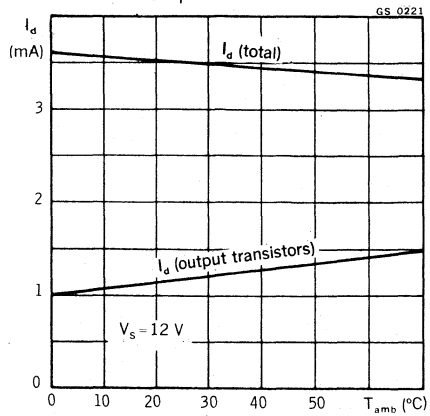
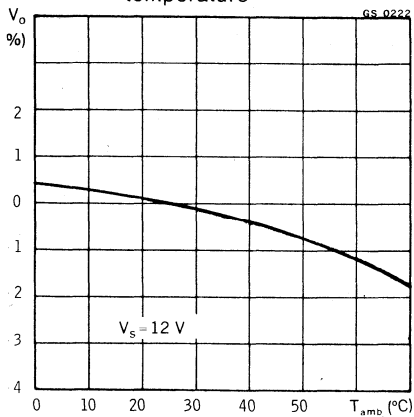


Fig. 18 - Quiescent output voltage variation vs ambient temperature



TAA 611B

TYPICAL APPLICATIONS

Fig. 19 - Audio amplifier for radio

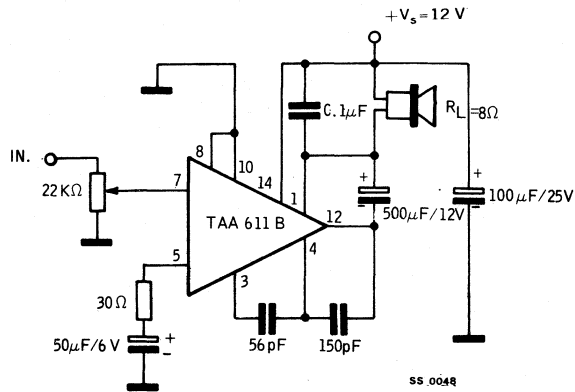
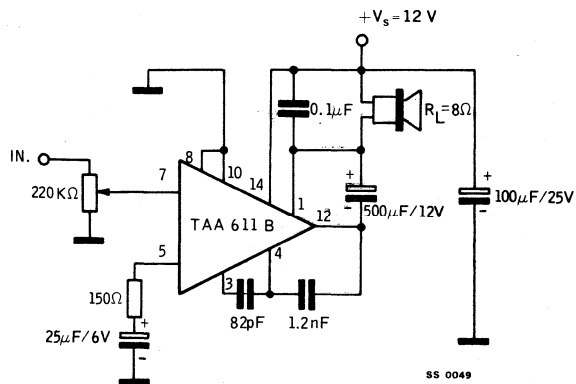


Fig. 20 - Audio amplifier for record-player



LINEAR INTEGRATED CIRCUIT**AUDIO AMPLIFIER**

- OUTPUT POWER 3.3 W (15 V - 8 Ω)
- LOW DISTORTION
- LOW QUIESCENT CURRENT
- SELF CENTERING BIAS
- HIGH IMPEDANCE

The TAA 611C is a monolithic integrated circuit in a 14-lead quad in-line power plastic package.

It is particularly designed for use as audio amplifier in radio receivers, record players and portable TV sets. The usable range of supply voltage varies from 6 to 18 V, and the circuit requires a minimum number of external components.

The package has very low thermal resistance. To decrease the thermal resistance further an external heat-sink can easily be mounted by means of ordinary hardware.

ABSOLUTE MAXIMUM RATINGS

V_s	Supply voltage (no signal)	22	V
V_s	Operating supply voltage	18	V
V_i^*	Input voltage	-0.5 to 20	V
I_o	Output peak current	1	A
P_{tot}	Power dissipation at $T_{amb} \leq 25^\circ\text{C}^{**}$	1.35	W
	at $T_{amb} \leq 25^\circ\text{C}^{***}$	2	W
	at $T_{case} \leq 100^\circ\text{C}$	3.1	W
T_{stg}, T_j	Storage and junction temperature	-40 to 150	$^\circ\text{C}$

* For $V_s < 20$ V, $V_{i\ max} = V_s$

** For TAA 611 C72

*** For TAA 611 CX1 and TAA 611 C11

ORDERING NUMBERS:

TAA 611 C72 (for quad in-line plastic package with spacer)

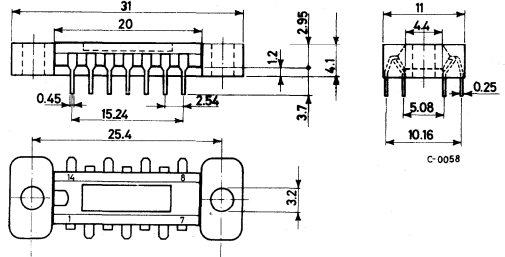
TAA 611 CX1 (for quad in-line plastic package with external bar)

TAA 611 C11 (for quad in-line plastic package with inverted external bar)

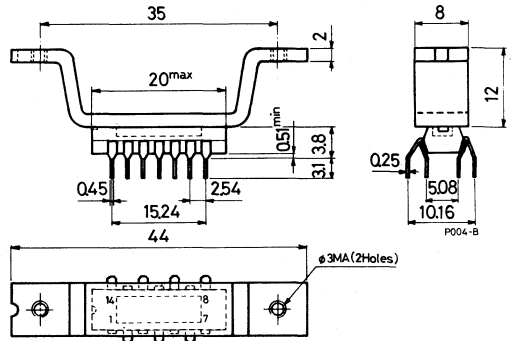
TAA 611C

MECHANICAL DATA (Dimensions in mm)

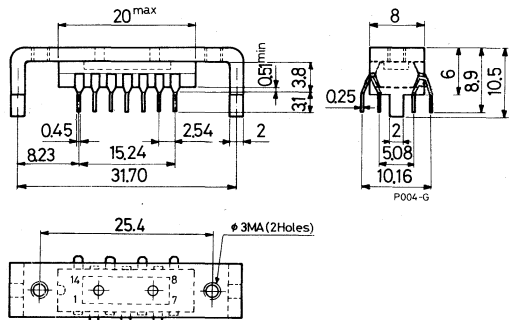
Quad in-line plastic package with spacer for TAA 611 C72 (see also "MOUNTING INSTRUCTIONS")



Quad in-line plastic package with external bar for TAA 611 CX1

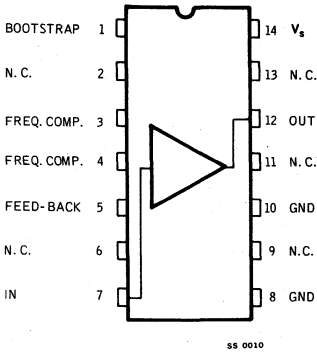


Quad in-line plastic package with inverted external bar for TAA 611 C11

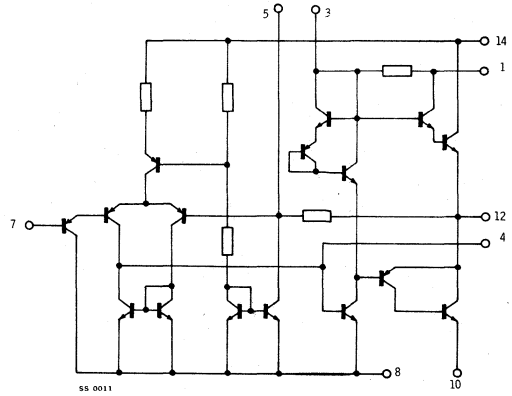


TAA 611C

CONNECTION DIAGRAM

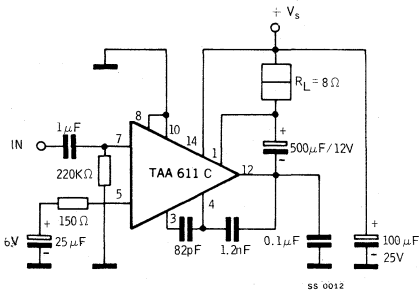


SCHEMATIC DIAGRAM

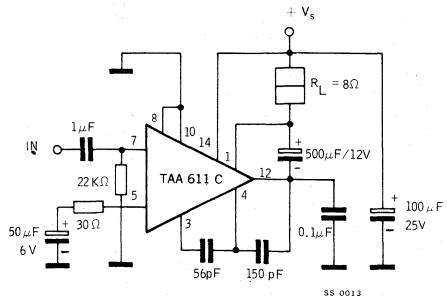


TEST CIRCUITS

Circuit No. 1 ($G_v = 50$)



Circuit No. 2 ($G_v = 250$)



TAA 611C

THERMAL DATA

			TAA 611 C72	TAA 611 CX1 TAA 611 C11	
→	$R_{th\ j-case}$	Thermal resistance junction-case	max	16 °C/W	16 °C/W
→	$R_{th\ j-amb}$	Thermal resistance junction-ambient	max	93 °C/W	63 °C/W

ELECTRICAL CHARACTERISTICS

($T_{amb} = 25\text{ °C}$, refer to the test circuit no. 2 unless otherwise specified)

Parameter	Test conditions	Min.	Typ.	Max.	Unit
V_o Quiescent output voltage	$V_s = 12\text{ V}$		6.3		V
	$V_s = 15\text{ V}$		7.9		V
I_d Total quiescent drain current	$V_s = 12\text{ V}$		3.5		mA
	$V_s = 15\text{ V}$		4		mA
I_d Quiescent drain current of output transistors	$V_s = 12\text{ V}$		1.2		mA
	$V_s = 15\text{ V}$		1.8		mA
I_d Drain current	$V_s = 12\text{ V}$ $P_o = 2.1\text{ W}$ $R_L = 8\ \Omega$		235		mA
	$V_s = 15\text{ V}$ $P_o = 3.3\text{ W}$ $R_L = 8\ \Omega$		300		mA
→ I_b Input bias current	$V_s = 12\text{ V}$ $V_s = 15\text{ V}$		75 0.1	1	nA μA
→ P_o^* Output power	$d = 2\%$ $f = 1\text{ kHz}$ $V_s = 9\text{ V}$ $R_L = 4\ \Omega$ $V_s = 9\text{ V}$ $R_L = 8\ \Omega$ $V_s = 12\text{ V}$ $R_L = 8\ \Omega$ $V_s = 15\text{ V}$ $R_L = 8\ \Omega$ $V_s = 15\text{ V}$ $R_L = 16\ \Omega$ $d = 10\%$ $f = 1\text{ kHz}$ $V_s = 9\text{ V}$ $R_L = 4\ \Omega$ $V_s = 9\text{ V}$ $R_L = 8\ \Omega$ $V_s = 12\text{ V}$ $R_L = 8\ \Omega$ $V_s = 15\text{ V}$ $R_L = 8\ \Omega$ $V_s = 15\text{ V}$ $R_L = 16\ \Omega$		1.4 0.9 1.7 2.8 1.6 1.8 1.15 2.1 2.5 3.3 1.9		W W W W W W W W W W

* External heatsink not required except for the conditions $V_s = 15\text{ V}$, $R_L = 8\ \Omega$

TAA 611C

ELECTRICAL CHARACTERISTICS (continued)

Parameter	Test conditions	Min.	Typ.	Max.	Unit
R'_f Internal feedback resistance (see schematic diagram)			7.5		Ω
Z_i Input impedance	open loop		5		M Ω
d Distortion	Circuit No. 1 $R_L = 8 \Omega$ $f = 1 \text{ kHz}$ $V_s = 12 \text{ V}$ $P_o = 50 \text{ mW}$ $V_s = 15 \text{ V}$ $P_o = 50 \text{ mW}$ $V_s = 12 \text{ V}$ $P_o = 1 \text{ W}$ $V_s = 15 \text{ V}$ $P_o = 1 \text{ W}$		0.3		%
	Circuit No. 2 $R_L = 8 \Omega$ $f = 1 \text{ kHz}$ $V_s = 12 \text{ V}$ $P_o = 50 \text{ mW}$ $V_s = 15 \text{ V}$ $P_o = 50 \text{ mW}$ $V_s = 12 \text{ V}$ $P_o = 1 \text{ W}$ $V_s = 15 \text{ V}$ $P_o = 1 \text{ W}$		1.5		%
			1.5		%
			1		%
			1		%
G_v Voltage gain (open loop)	$V_s = 12 \text{ V}$ $R_L = 8 \Omega$ $V_s = 15 \text{ V}$ $R_L = 8 \Omega$		70		dB
			72		dB

TAA 611C

Fig. 1 - Typical distortion vs output power

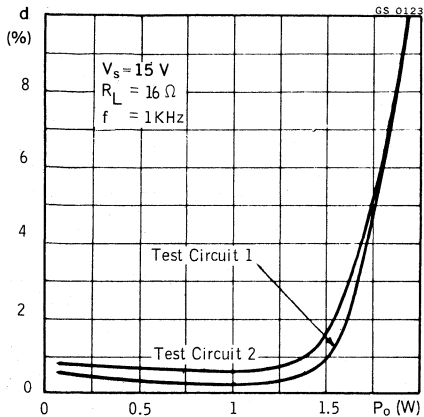


Fig. 2 - Typical distortion vs output power

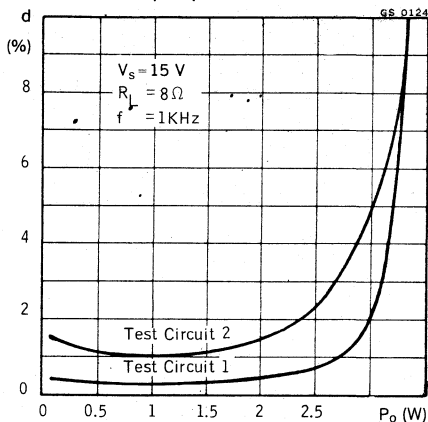


Fig. 3 - Typical distortion vs output power

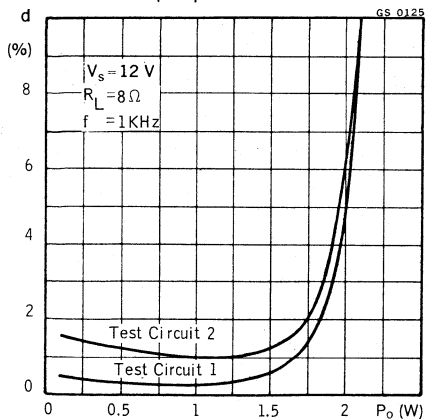
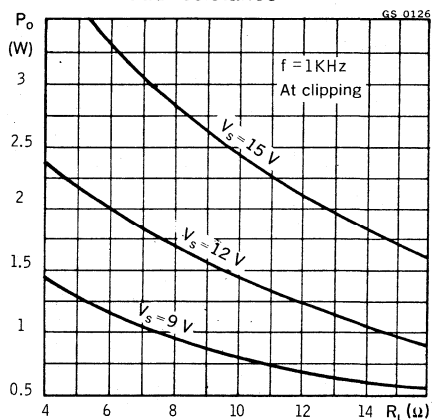


Fig. 4 - Typical output power vs load resistance



TAA 611C

Fig. 5 - Typical output power vs load resistance

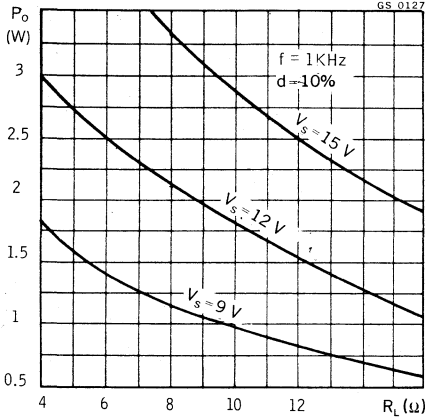


Fig. 6 - Maximum power dissipation vs load resistance

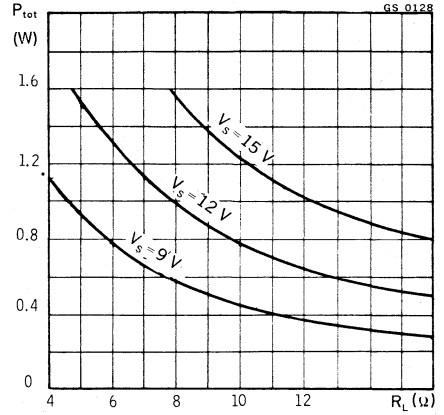
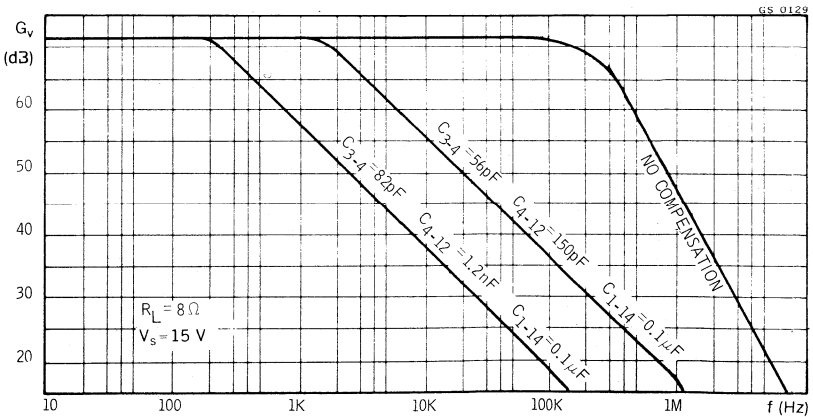


Fig. 7 - Typical voltage gain (open loop) vs frequency



TAA 611C

Fig. 8 - Typical relative frequency response

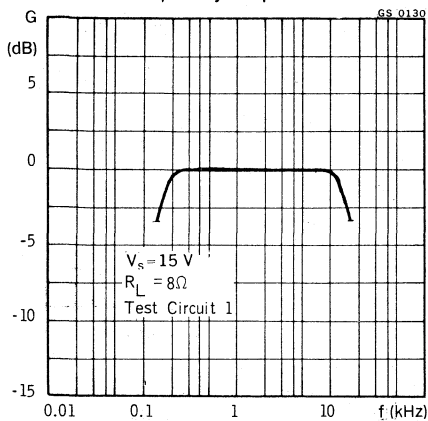


Fig. 9 - Typical relative frequency response

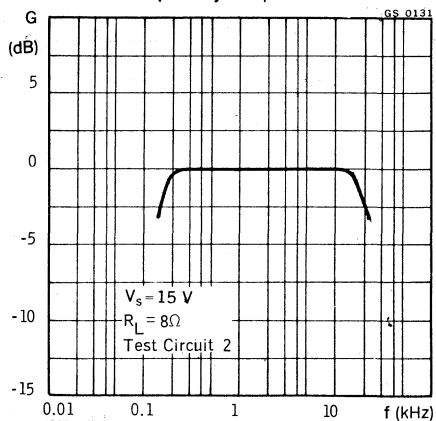


Fig. 10 - Typical output power vs input voltage

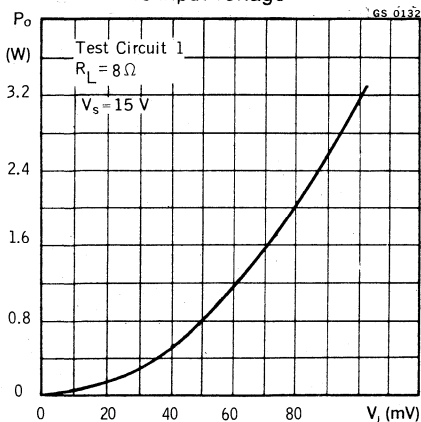


Fig. 11 - Typical output power vs input voltage

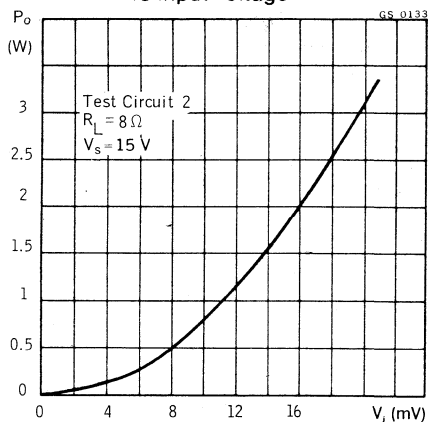


Fig. 12 - Typical power dissipation and efficiency vs output power

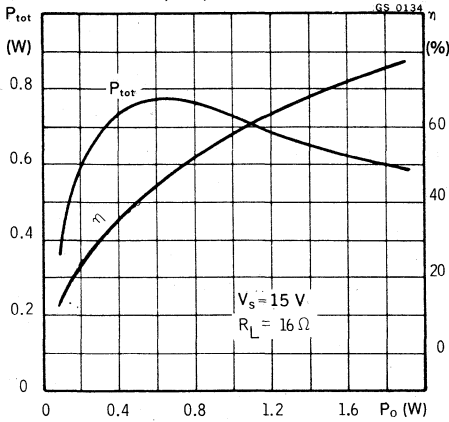


Fig. 13 - Typical power dissipation and efficiency vs output power

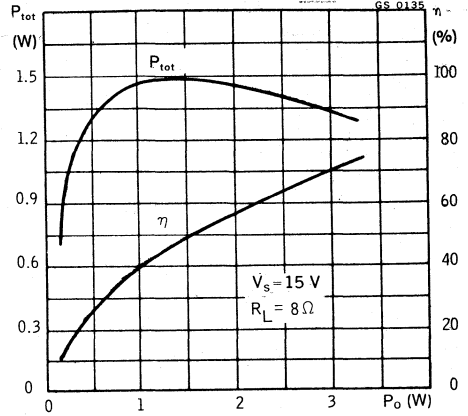


Fig. 14 - Typical power dissipation and efficiency vs output power

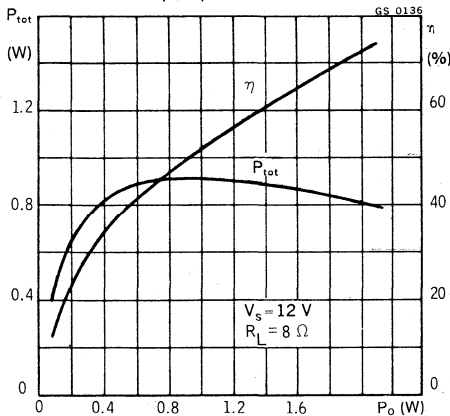
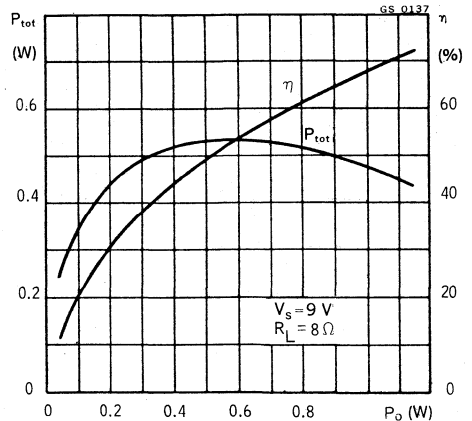


Fig. 15 - Typical power dissipation and efficiency vs output power



TAA 611C

Fig. 16 - Typical drain current vs output power

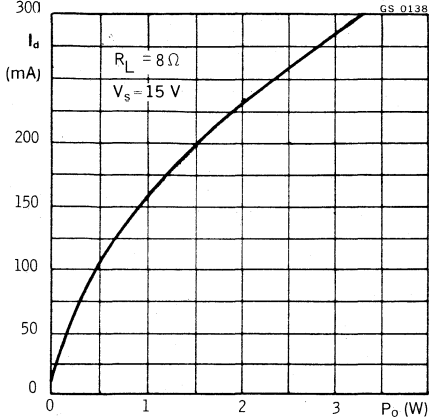


Fig. 17 - Typical quiescent drain current vs supply voltage

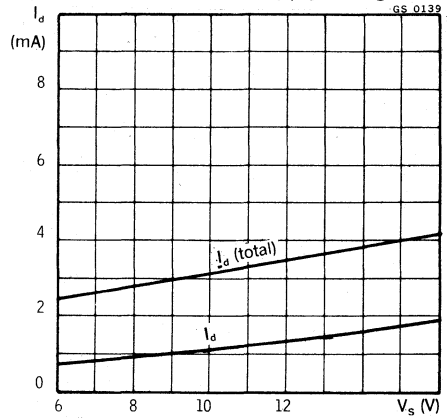


Fig. 18 - Typical total quiescent drain current vs ambient temperature

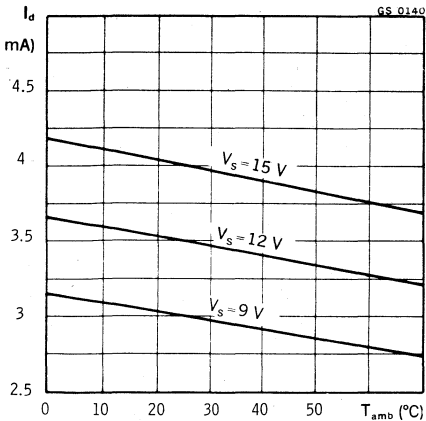
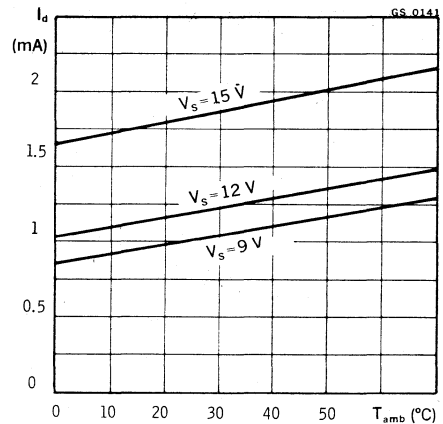


Fig. 19 - Typical quiescent drain current of output transistors vs ambient temperature



TAA 611C

Fig. 20 - Typical output voltage variation vs ambient temperature

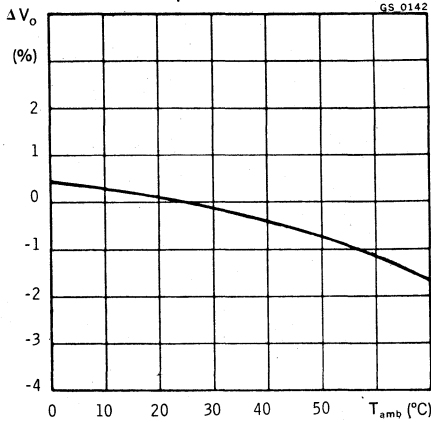


Fig. 21 - Power rating chart (TAA 611 CX1 and TAA 611 C11)

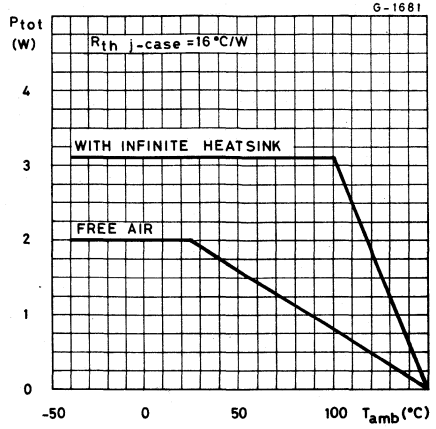
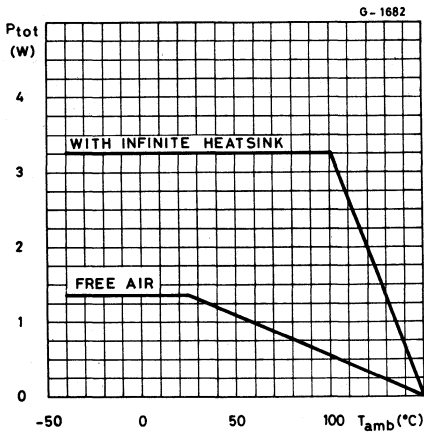


Fig. 22 - Power rating chart (TAA 611 C72)



TAA 611C

TYPICAL APPLICATIONS

Fig. 23 - Audio amplifier
for radio

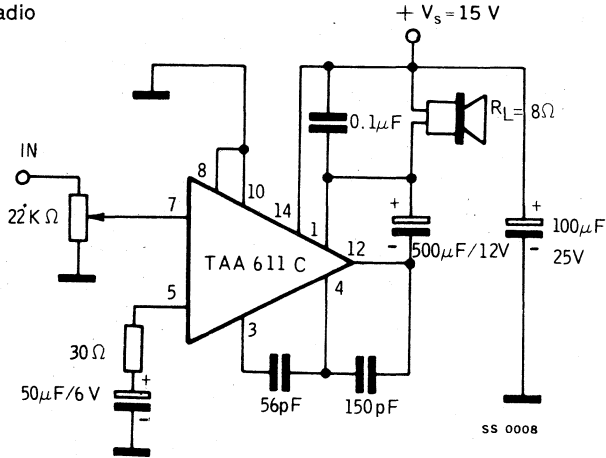
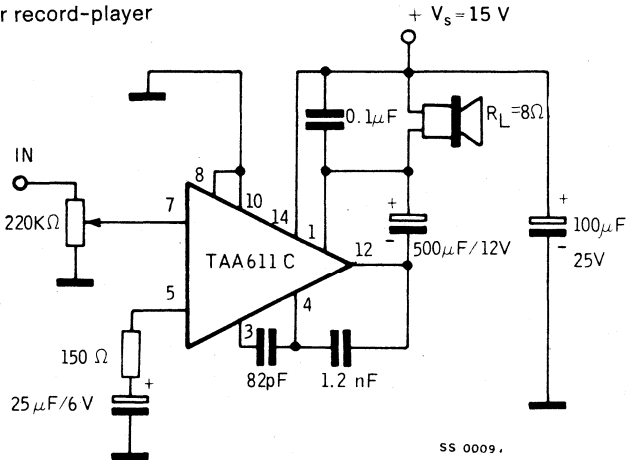


Fig. 24 - Audio amplifier
for record-player

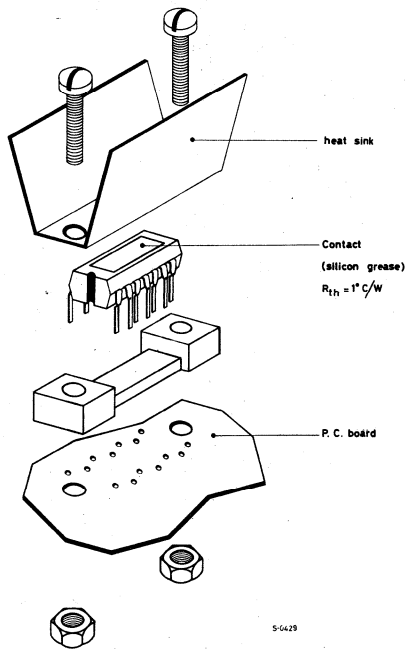


MOUNTING INSTRUCTIONS

Heat-sinking with spacer.

Fig. 25 shows a method of mounting the TAA 611C with the spacer, satisfactory both mechanically and from the point of view of heat dissipation. Better thermal contact between package and heat-sink can be obtained by using a small quantity of silicon grease. For heat dissipation the desired thermal resistance is obtained by fixing the elements shown to a heat-sink of suitable dimensions.

Fig. 25



S-6429

TAA 611C

MOUNTING INSTRUCTIONS (continued)

Heat-sinking with external bar.

Power dissipation can be achieved by means of an additional external heat-sink fixed with two screws (both packages) or by soldering the pins of the external bar to suitable copper areas on the p.c. board (TAA 611 C11).

- A. In the former case, the thermal resistance case-ambient of the added heat-sink can be calculated as follows:

$$R_{th} = \frac{(T_{jmax} - T_{amb}) - P_{tot} \cdot R_{th\ j-case}}{P_{tot}}$$

where:

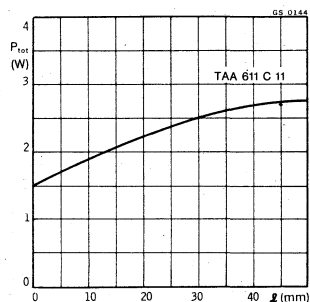
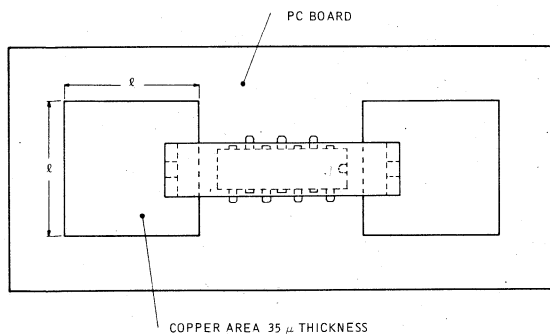
T_{jmax} = Max junction temperature

T_{amb} = Ambient temperature

P_{tot} = Power dissipation

$R_{th\ j-case}$ = Thermal resistance junction-case

- B. If copper areas on the p.c. board are used (TAA 611 C11) the diagrams enclosed give the maximum power dissipation as a function of copper area, with copper thickness $35\ \mu$ and ambient temperature $55\ ^\circ\text{C}$.



LINEAR INTEGRATED CIRCUIT

SYNCHRONOUS DEMODULATOR FOR PAL COLOUR TV SETS

The TAA 630 S is a silicon monolithic integrated circuit in a 16-lead dual in-line plastic package. It incorporates the following functions:

- active synchronous demodulators for F (B-Y) and $\pm F$ (R-Y) signals
- matrix for G-Y signal [G-Y = -0.51 (R-Y) - 0.19 (B-Y)]
- flip-flop
- PAL switch and colour killer.

It is intended for PAL colour television receivers employing colour difference output stages with clamping circuits.

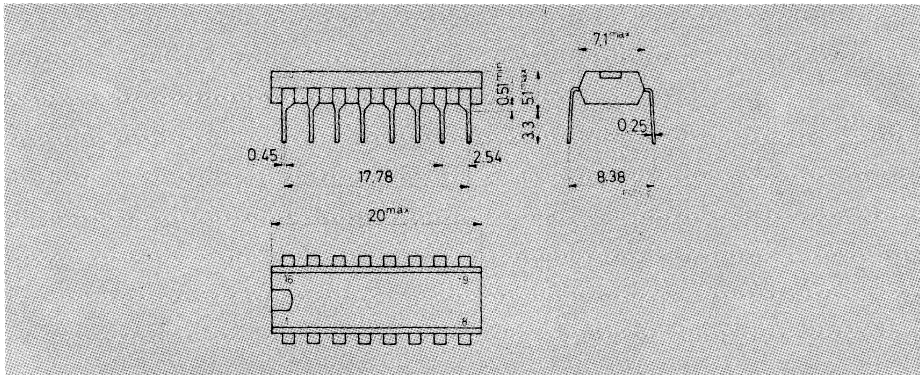
ABSOLUTE MAXIMUM RATINGS

V_s	Supply voltage (between pins 6 and 16 - see note)	13.2 V
V_i	Reverse identification input voltage	-5 V
I_i	Identification input current	1 mA
I_o	Output current (from pins 4, 5 and 7)	5 mA
P_{tot}	Total power dissipation: at $T_{amb} \leq 50^\circ\text{C}$ (see note)	550 mW
T_{stg}	Storage temperature	-20 to 125 °C
T_{op}	Operating temperature	-20 to 60 °C

NOTE: $V_s = 16\text{ V}$ and $P_{tot} = 800\text{ mW}$ (at $T_{amb} \leq 50^\circ\text{C}$) are permissible during warm up time of tubes in mixed sets

MECHANICAL DATA

Dimensions in mm



TAA 630S

ELECTRICAL CHARACTERISTICS

(measured using the test circuit of fig. 3 at $T_{amb} = 25\text{ }^{\circ}\text{C}$)

Parameter	Test conditions	Min.	Typ.	Max.	Unit
-----------	-----------------	------	------	------	------

STATIC (DC) CHARACTERISTICS

I_1	Input current for identification circuit ON	$V_{10} \cong 0.9\text{ V}$	80		μA
V_1	Input voltage for identification circuit ON		0.75		V
V_1	Input voltage for identification circuit OFF			0.4	V
V_4^*	DC voltage at (R-Y) output			see note	V
V_5^*	DC voltage at (G-Y) output			see note	V
V_7	DC voltage at (B-Y) output			7.3	V
V_{10}	Killer input voltage for colour ON			0.9	V
V_{10}	Killer input voltage for colour OFF			0.3	V

DYNAMIC CHARACTERISTICS

V_1	Peak to peak identification input voltage	$V_{10} \cong 0.9\text{ V}$ $f = 7.8\text{ kHz}$	4		V
V_3	Peak to peak flip-flop output voltage			2.5	V
V_4	R-Y output voltage swing	$V_{10} \cong 0.9\text{ V}$ $f = 4.4\text{ MHz}$ Linearity $m \cong 0.7$		3.2	V
V_5	G-Y output voltage swing			1.8	V
V_7	B-Y output voltage swing			4	V

TAA 630S

ELECTRICAL CHARACTERISTICS (continued)

Parameter	Test conditions	Min.	Typ.	Max.	Unit
V_2^{**} R-Y reference input voltage	$V_{10} \geq 0.9 \text{ V}$ $f = 4.4 \text{ MHz}$		1		V
V_8^{**} B-Y reference input voltage			1		V
V_{14} Peak flip-flop input voltage	$V_{10} \geq 0.9 \text{ V}$ $f = 15.6 \text{ kHz}$		-2.5	-5	V
V_{15} Peak flip-flop input voltage			-2.5	-5	V
V_4/V_{13}^{***} R-Y demodulator gain	$V_{10} \geq 0.9 \text{ V}$ $f = 4.4 \text{ MHz}$ V_i (peak to peak) = 50 mV		7		—
V_7/V_{13} B-Y demodulator gain to R-Y demodulator					
V_9/V_4 gain ratio			1.78		—
R_9 Parallel input resistance at pin 9	$V_{10} \geq 0.9 \text{ V}$ $f = 4.4 \text{ MHz}$ $V_i = 20 \text{ mV}$		800		Ω
C_9 Parallel input capacitance at pin 9				10	pF
R_{13} Parallel input resistance at pin 13			800		Ω
C_{13} Parallel input capacitance at pin 13				10	pF
$ Z_4 $ R-Y output impedance				100	Ω
$ Z_5 $ G-Y output impedance	$V_{10} \geq 0.9 \text{ V}$			100	Ω
$ Z_7 $ B-Y output impedance				100	Ω
$ Z_2 $ Parallel input impedance at pin 2	$V_{10} \geq 0.9 \text{ V}$ $f = 4.4 \text{ MHz}$ $V_i = 400 \text{ mV}$		900		Ω
$ Z_8 $ Parallel input impedance at pin 8				900	Ω

NOTES: * Adjustable to the same level of V_7 by variable resistors, or by variable voltages $\leq 1.2 \text{ V}$, connected between pins 11 and 16 for V_4 and between pins 12 and 16 for V_5 .

** Maximum permissible range : 0.5 to 2 V (peak to peak).

*** Peak to peak output voltage to peak to peak input voltage ratio.

TAA 630S

Fig. 3 - Test circuit

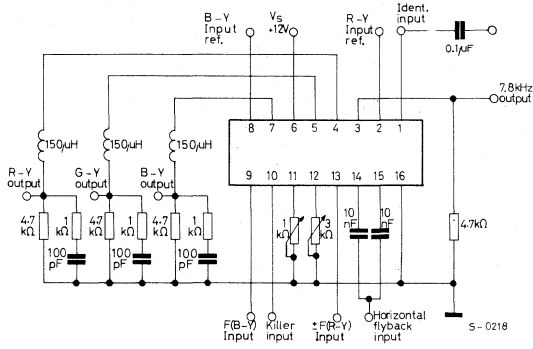
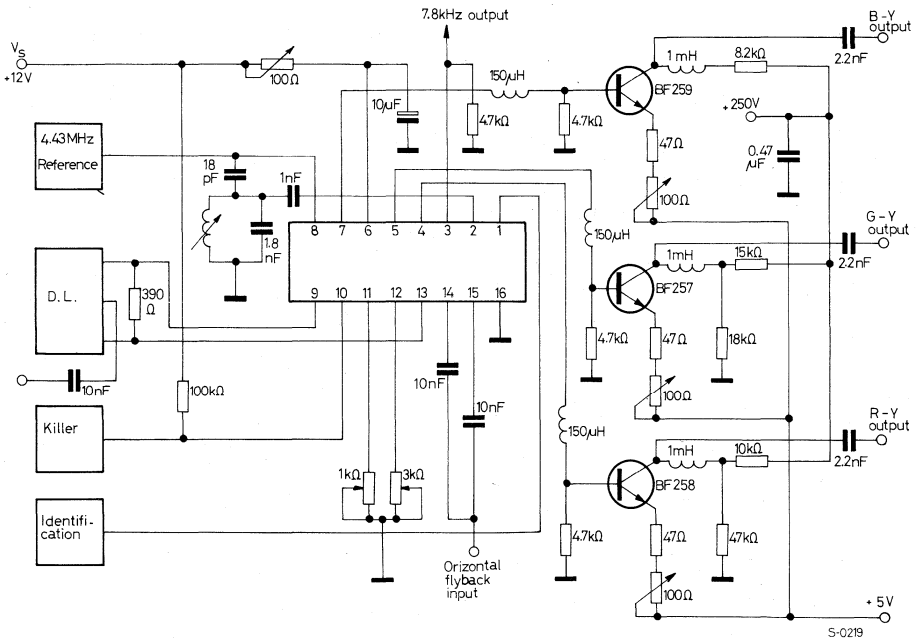


Fig. 4 - Typical application circuit



LINEAR INTEGRATED CIRCUIT

FM IF AMPLIFIER-LIMITER AND DETECTOR

- HIGH GAIN
- FREQUENCY RANGE 5 kHz to 60 MHz
- THRESHOLD LIMITING VOLTAGE $100\mu\text{V}$ (5.5 MHz)
- COINCIDENCE GATE DETECTOR
- AUDIO OUTPUT VOLTAGE $1.4 V_{\text{rms}}$ ($d = 1\%$)

The TAA 661 is a monolithic integrated circuit in a 14-lead quad in-line plastic package or in a Jedec TO-100 metal case. Particularly designed for use in TV sound IF or FM IF amplifiers, it includes: a limiter amplifier, a coincidence detector and a voltage regulator. By using the TAA 661 the ratio detector transformer is eliminated and the audio signal is capable of driving an output amplifier directly. Detector alignment is obtained by adjusting a single coil which provides the quadrature signal to the coincidence gate detector.

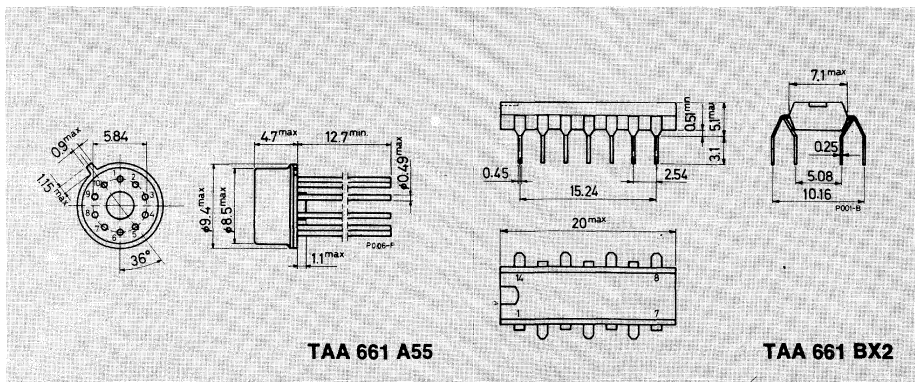
ABSOLUTE MAXIMUM RATINGS

V_s	Supply voltage	15 V
P_{tot}	Power dissipation at $T_{\text{amb}} \leq 70^\circ\text{C}$	350 mW
	for TAA 661 A55	500 mW
	for TAA 661 BX2	
T_{stg}	Storage temperature	-25 to 125 °C
T_{op}	Operating temperature	0 to 70 °C

ORDERING NUMBERS: TAA 661 A55 (for TO-100 metal case)
TAA 661 BX2 (for 14-lead quad in-line plastic package)

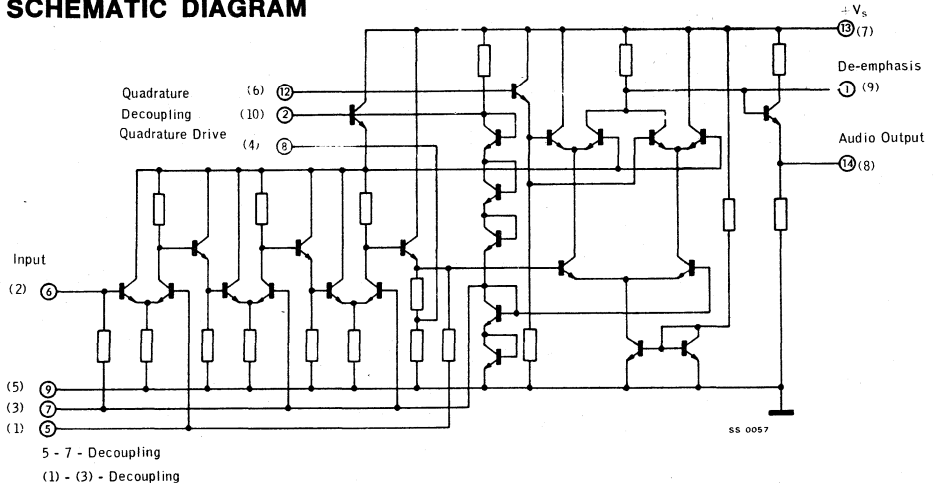
MECHANICAL DATA

Dimensions in mm



TAA 661

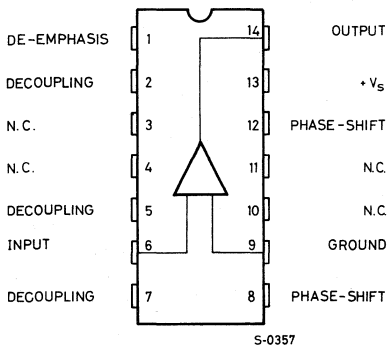
SCHEMATIC DIAGRAM



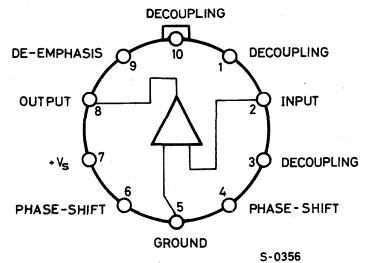
NOTE: the number in brackets refers to the TO-100 package

CONNECTION DIAGRAMS

For TAA 661 BX2



For TAA 661 A55



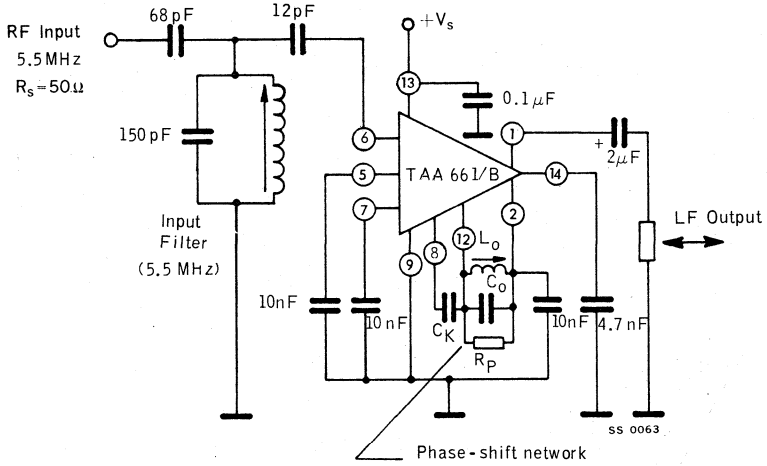
TAA 661

ELECTRICAL CHARACTERISTICS (continued)

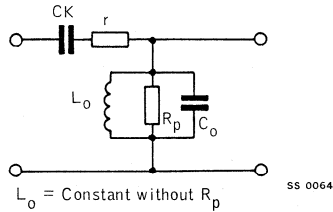
Parameter		Test conditions	Min. Typ. Max.	Unit
AMR	Amplitude modulation rejection	$V_s = 12\text{ V}$ $V_i = 10\text{ mV}$ $f = 5.5\text{ MHz}$ $f_m = 1\text{ kHz}$ $\Delta f = \pm 50\text{ kHz}$ $m = 0.3$	45	dB
R_i	Input resistance	$f = 5.5\text{ MHz}$ $f = 10.7\text{ MHz}$	2.5 2	$k\Omega$ $k\Omega$
C_i	Input capacitance	$V_s = 9\text{ V}$ $f = 5.5\text{ MHz}$	2.5	pF
Z_o	Output impedance	$V_s = 6\text{ V}$ $V_s = 9\text{ V}$ $V_s = 12\text{ V}$	200 150 100	Ω Ω Ω
R_L	Min. load impedance without clipping	$V_s = 6\text{ V}$ $V_s = 9\text{ V}$ $V_s = 12\text{ V}$	10 4 2	$k\Omega$ $k\Omega$ $k\Omega$
R_{5-6}	Resistance between pins 5 and 6 of the TAA 661 A55	$f = 5.5\text{ MHz}$ $V_s = 6\text{ V}$ $V_s = 9\text{ V}$ $V_s = 12\text{ V}$	50 50 50	$k\Omega$ $k\Omega$ $k\Omega$
C_{5-6}	Capacitance between pins 5 and 6 of the TAA 661 A55	$f = 5.5\text{ MHz}$	3	pF

TAA 661

TAA 661 AS TV SOUND IF AMPLIFIER (outputs referred to the TAA 661 BX2)



PHASE SHIFT NETWORK



	a	b	c	d	e	f
Co/pF	120	100	56	33	15	—

TAA 661

Fig. 1 - Typical distortion

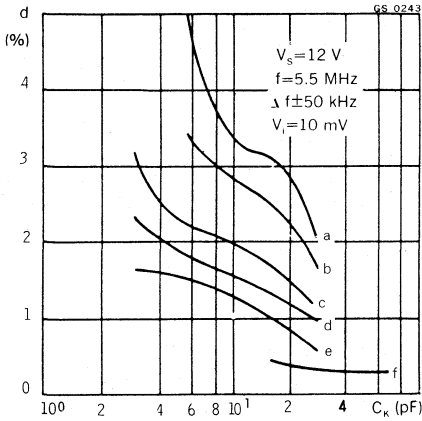


Fig. 2 - Typical amplitude modulation rejection

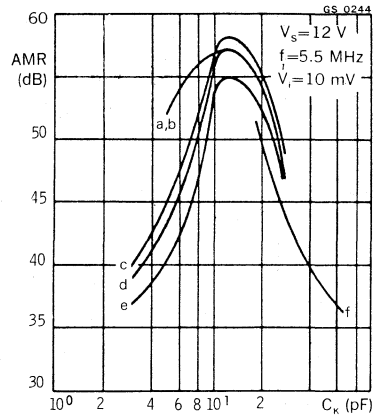


Fig. 3 - Typical amplitude modulation rejection vs input voltage

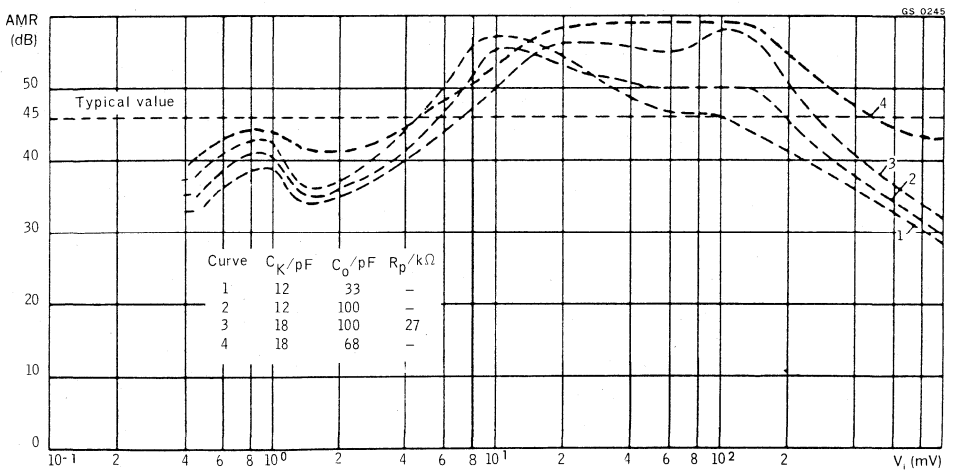


Fig. 4 - Typical recovered output voltage

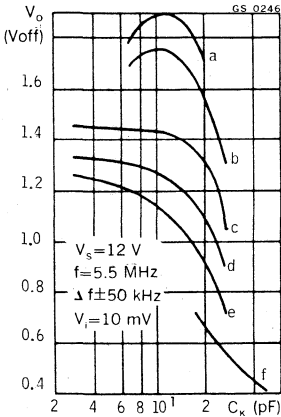
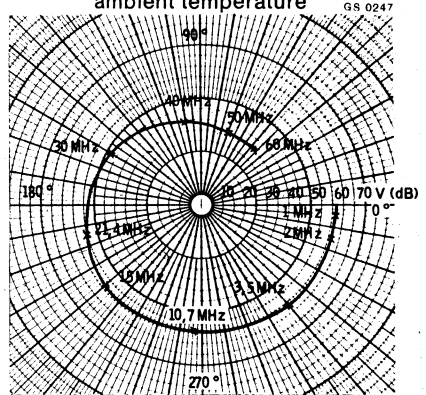
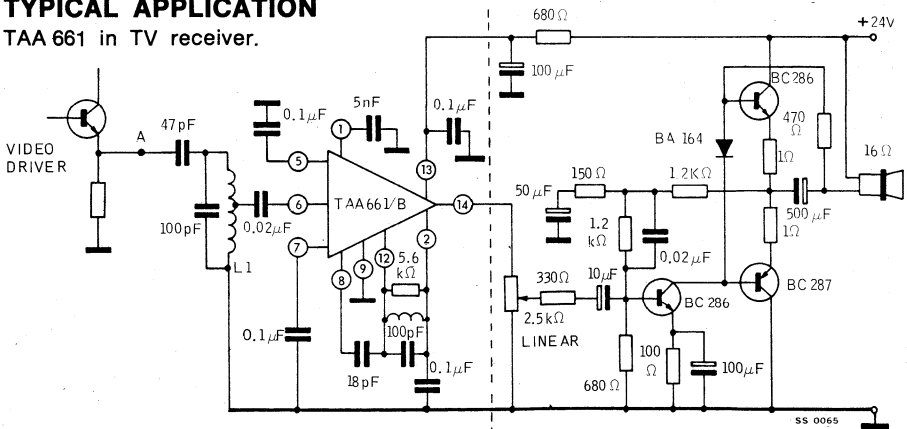


Fig. 5 - Phase response of the TAA 661 wide band amplifier measured at 25 °C ambient temperature



TYPICAL APPLICATION

TAA 661 in TV receiver.



Notes:

- Pin numbers shown are for the TAA 661 BX2.
- $L_1 = 24$ turns of 0.16 mm nylon covered copper wired with tapping at turn 12 from ground.
- $L_2 = 35$ turns of 0.16 mm nylon covered copper wired.
- Neosid former K4/21.5/0.5 - Neosid core GW4 x 0.5 x 10FE10($Q_o = 80$).

LINEAR INTEGRATED CIRCUIT

DUAL LOW NOISE OPERATIONAL AMPLIFIER

- SINGLE or DUAL SUPPLY OPERATION
- LOW NOISE FIGURE
- HIGH GAIN
- LARGE INPUT VOLTAGE RANGE
- EXCELLENT GAIN STABILITY VERSUS SUPPLY VOLTAGE
- NO LATCH UP
- OUTPUT SHORT CIRCUIT PROTECTED

The TBA 231 is a monolithic integrated dual operational amplifier in a 14-lead dual in-line plastic package.

These low-noise, high-gain amplifiers show extremely stable operating characteristics over a wide range of supply voltage and temperatures.

The device is intended for a variety of applications requiring two high performance operational amplifiers, such as phono and tape stereo preamplifier, TV remote control receiver, etc.

ABSOLUTE MAXIMUM RATINGS

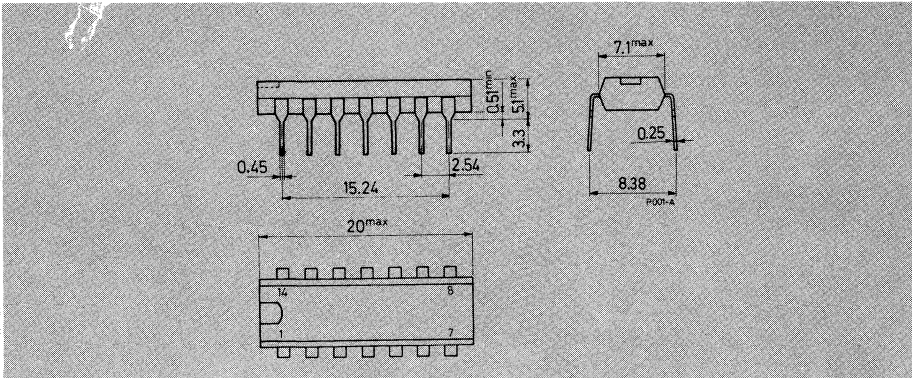
V_s	Supply voltage	± 18	V
	Differential input voltage	± 5	V
	* Common mode input voltage	± 15	V
P_{tot}	Power dissipation at $T_{amb} \leq 60^\circ\text{C}$	500	mW
T_{stg}	Storage temperature	-40 to 150	$^\circ\text{C}$
T_{op}	Operating temperature	0 to 70	$^\circ\text{C}$

* For $V_s \leq \pm 15\text{ V}$, $V_i \text{ max} = V_s$

ORDERING NUMBER: TBA 231

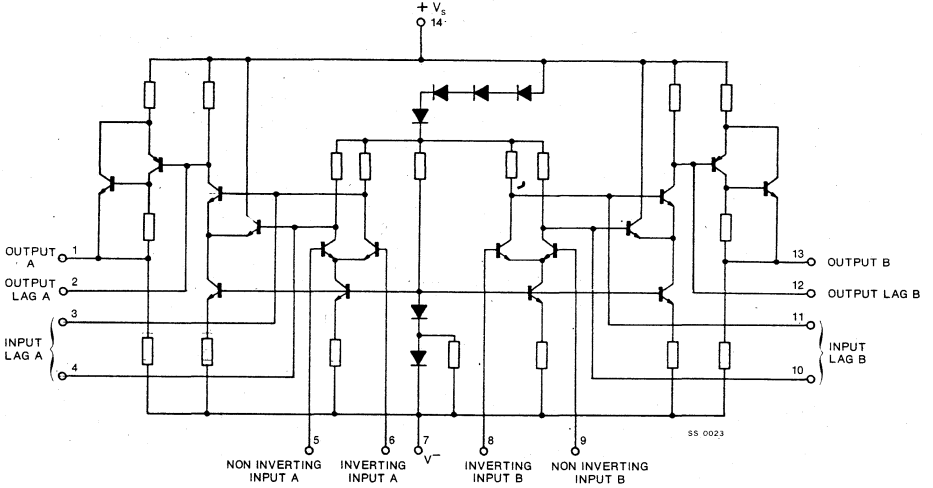
MECHANICAL DATA

Dimensions in mm

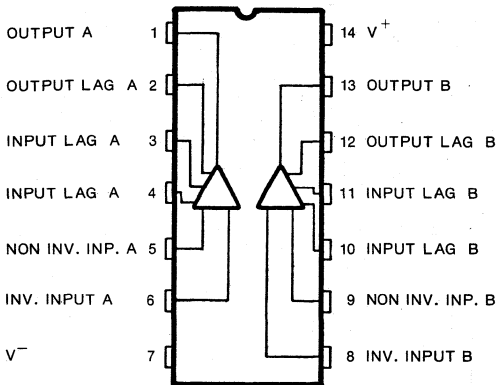


TBA 231

SCHEMATIC DIAGRAM

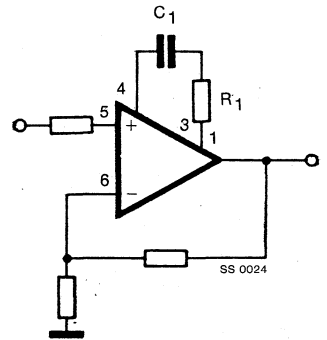


CONNECTION DIAGRAM



TEST CIRCUIT

Frequency response



THERMAL DATA

$R_{th\ j-amb}$ Thermal resistance junction-ambient	max 180 °C/W
---	--------------

ELECTRICAL CHARACTERISTICS

($T_{amb} = 25\text{ °C}$, $R_L = 50\text{ k}\Omega$ to pin 7 unless otherwise specified)

Parameter	Test conditions	Min.	Typ.	Max.	Unit
-----------	-----------------	------	------	------	------

$V_s = \pm 15\text{ V}$

I_d	Quiescent drain current	$V_o = 0$	9	14	mA
$ V_{BE1} - V_{BE2} $	Input offset voltage	$R_s = 200\ \Omega$	1	6	mV
$ I_{B1} - I_{B2} $	Input offset current		50	1000	nA
I_b	Input bias current		250	2000	nA
	Common mode input voltage range		± 10	± 11	V
R_i	Input resistance	$f = 1\text{ kHz}$	37	150	k Ω
G_v	Voltage gain	$V_o = \pm 5\text{ V}$	6500	20.000	—
V_o	Positive output voltage swing		+12	+13	V
V_o	Negative output voltage swing		-14	-15	V
R_o	Output resistance	$f = 1\text{ kHz}$	5		k Ω
CMRR	Common mode rejection ratio	$R_s = 200\ \Omega$	70	90	dB
SVR	Supply voltage rejection	$R_s = 200\ \Omega$	50		$\mu\text{V/V}$
SR	Slew rate	Unity gain $C_1 = 0.1\ \mu\text{F}$ $R_1 = 4.7\ \Omega$ see frequency response test circuit	1		V/ μs
	Channel separation	$R_s = 10\text{ k}\Omega$ $f = 10\text{ kHz}$	140		dB
NF	Noise figure	$R_s = 10\text{ k}\Omega$ $B = 10\text{ Hz to }10\text{ kHz}$	1.5		dB

TBA 231

ELECTRICAL CHARACTERISTICS (continued)

Parameter	Test conditions	Min.	Typ.	Max.	Unit
-----------	-----------------	------	------	------	------

$$V_s = \pm 4 \text{ V}$$

I_d	Quiescent drain current	$V_o = 0$	2.5		mA
$ V_{BE1} - V_{BE2} $	Input offset voltage	$R_s = 200 \Omega$	1	6	mV
$ I_{B1} - I_{B2} $	Input offset current		50	1000	nA
I_b	Input bias current		250		nA
G_V	Voltage gain	$V_o = \pm 1 \text{ V}$	2500	15.000	—
V_o	Positive output voltage swing		+2.5	+2.8	V
V_o	Negative output voltage swing		-3.6	-4	V

Fig. 1 - Power rating chart

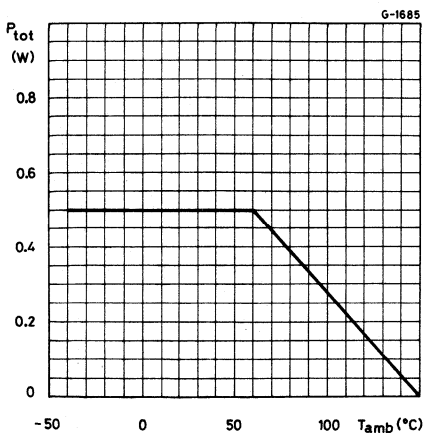
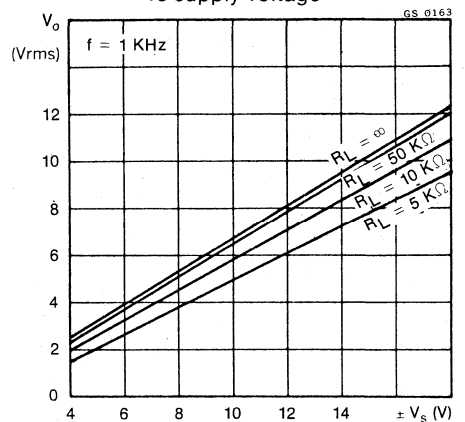


Fig. 2 - Typical output capability vs supply voltage



TBA 231

Fig. 3 - Typical quiescent drain current vs supply voltage

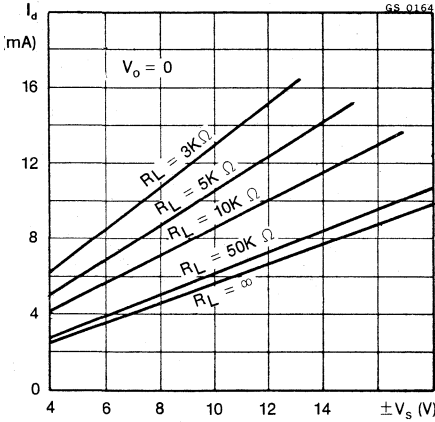


Fig. 4 - Typical open loop voltage gain vs supply voltage

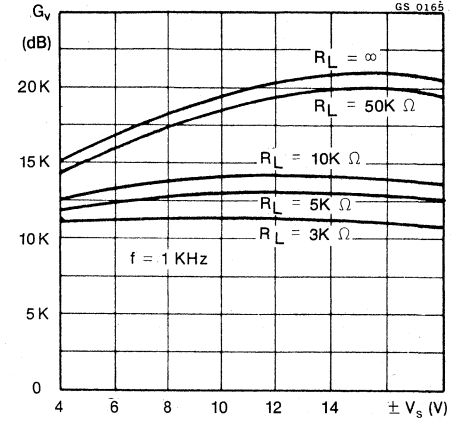


Fig. 5 - Typical open loop frequency response using recommended compensation networks

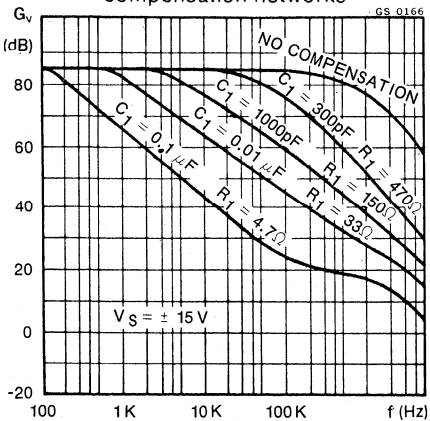
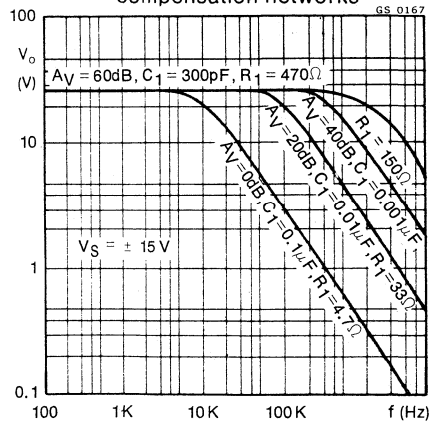


Fig. 6 - Output voltage swing vs frequency for various compensation networks



TBA 231

Fig. 7 - Typical input noise voltage vs frequency

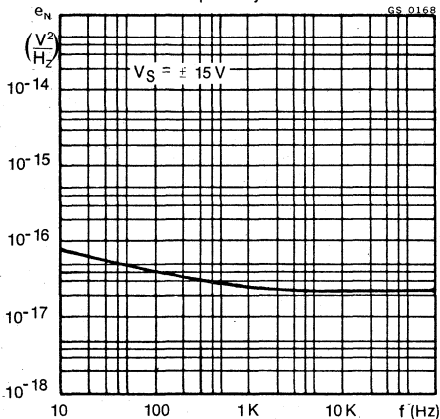


Fig. 8 - Typical input noise current vs frequency

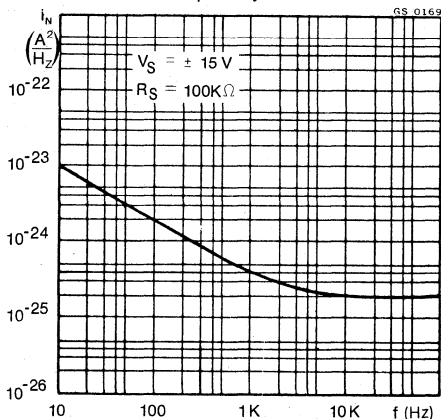


Fig. 9 - Typical closed loop gain vs frequency

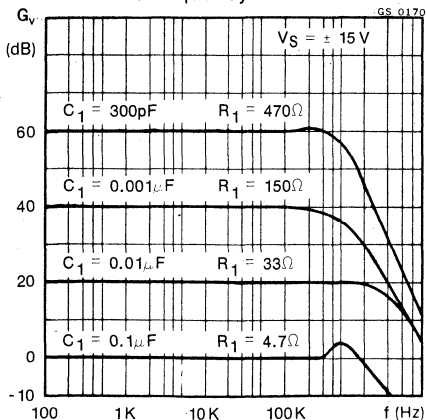
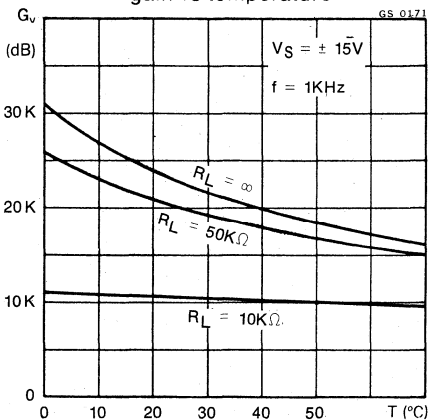


Fig. 10 - Typical open loop voltage gain vs temperature



LINEAR INTEGRATED CIRCUIT

TV SIGNAL PROCESSING CIRCUIT

The TBA 311 is a monolithic integrated circuit in a 16-lead dual in-line or quad in-line plastic package. It is intended for use as signal processing circuit for black and white and colour television sets.

The circuit is designed for receivers equipped with tubes or transistors in the deflection and video output stages, and with PNP or NPN transistors in the tuner and NPN in the IF amplifier.

Only signals with the negative modulation can be handled by the circuit. The circuit is protected against short circuit between video output and GND. The TBA 311 includes:

- VIDEO PREAMPLIFIER with EMITTER FOLLOWER OUTPUT
- GATED AGC for VIDEO IF AMPLIFIER and TUNER
- NOISE INVERTER CIRCUIT for GATING AGC and SYNC. PULSE SEPARATOR
- HORIZONTAL SYNC. PULSE SEPARATOR
- VERTICAL SYNC. PULSE SEPARATOR
- BLANKING FACILITY for the VIDEO AMPLIFIER

ABSOLUTE MAXIMUM RATINGS

V_s	Supply voltage	16 V
P_{tot}	Power dissipation at $T_{amb} \leq 70^\circ\text{C}$	500 mW
T_{stg}	Storage temperature	-55 to 125 °C
T_{op}	Operating temperature	-25 to 70 °C

ORDERING NUMBERS:

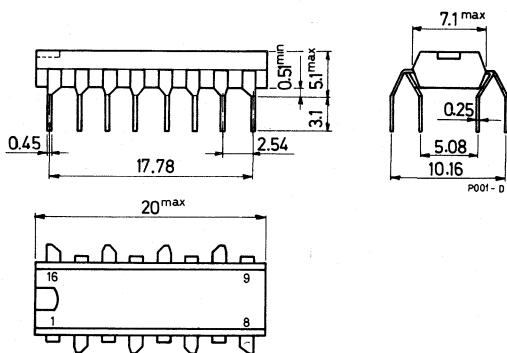
TBA 311 A22 (for 16-lead quad in-line plastic package)

TBA 311 A17 (for 16-lead dual in-line plastic package)

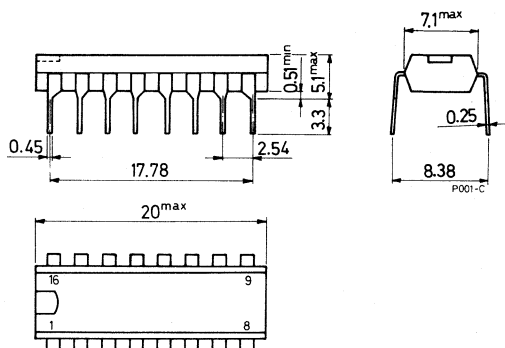
TBA 311

MECHANICAL DATA (Dimensions in mm)

Quad in-line plastic package
for TBA 311 A22

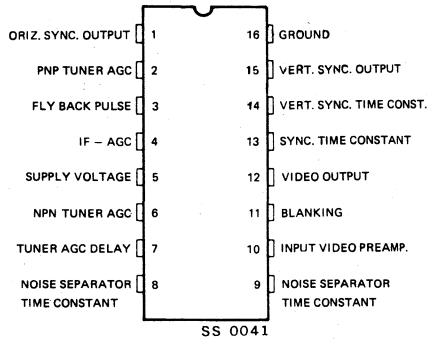


Dual in-line plastic package
for TBA 311 A17

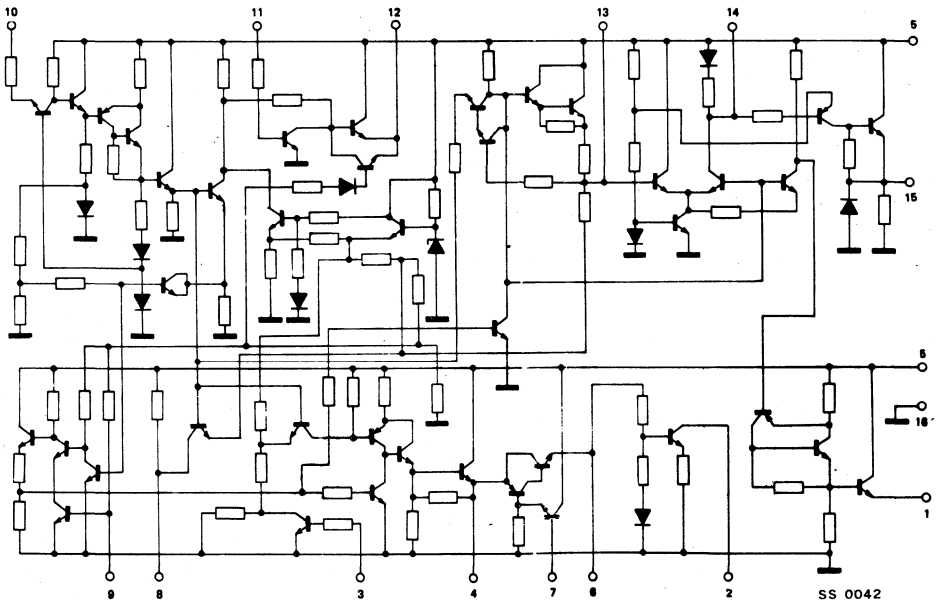


TBA 311

CONNECTION DIAGRAM

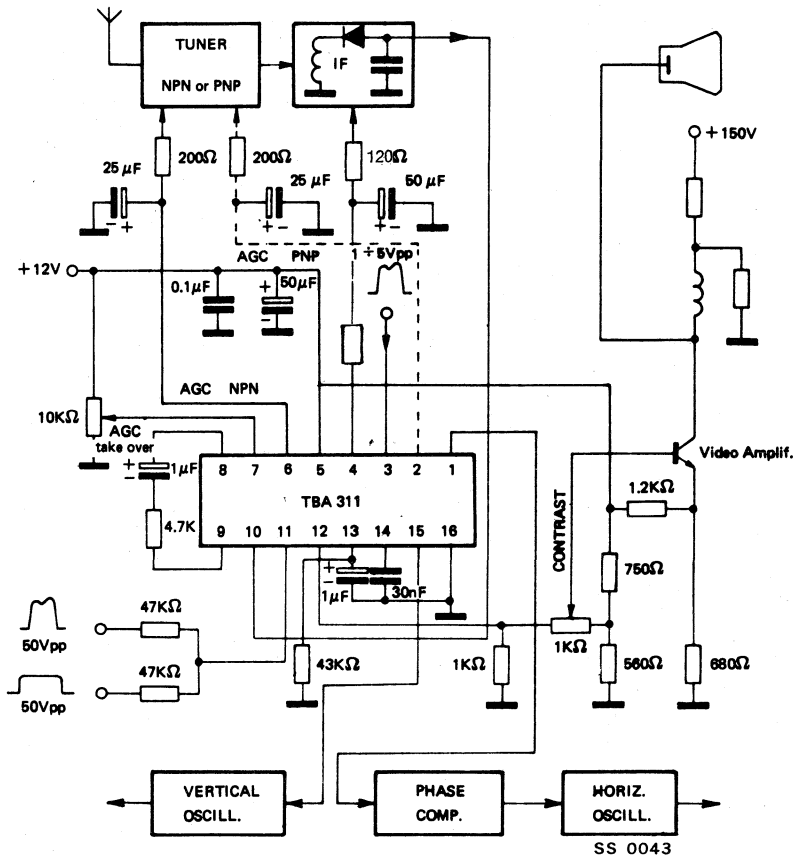


SCHEMATIC DIAGRAM



TBA 311

TEST CIRCUIT



TBA 311

ELECTRICAL CHARACTERISTICS

($T_{amb} = 25\text{ }^{\circ}\text{C}$, $V_s = 12\text{ V}$ unless otherwise specified, see also test circuit)

Parameter	Min.	Typ.	Max.	Unit
I_d Quiescent drain current		14		mA

VIDEO AMPLIFIER

R_i Input resistance (pin 10)		2.7		$k\Omega$
C_i Input capacitance (pin 10)		0.8		pF
B Bandwidth (-3 dB)		5		MHz
G_v Voltage gain		9.5		dB
V_i Peak to peak video input voltage (pin 10)	(1)	2		V
V_o Peak to peak video output voltage (pin 12)	(2)	6		V
V Black level at the output (pin 12)	(3)	5		V
I_o Available video peak output current	(4)	20		mA
$\frac{\Delta V_o}{\Delta T_{amb}}$ Video output voltage temperature drift	(5)	1		mV/ $^{\circ}\text{C}$
$\frac{\Delta V}{\Delta T_{amb}}$ Black level temperature drift		0.2		mV/ $^{\circ}\text{C}$
$\frac{\Delta V}{\Delta V_s}$ Black level drift at the output with supply voltage variation		0.5		V/V

VIDEO BLANKING

V_i Peak to peak input voltage (pin 11)		1	5	V
R_i Input resistance (pin 11)		1		$k\Omega$

AGC CIRCUIT

V Control voltage IF amplifier (pin 4)		0 to 7.5		V
V Control voltage tuner NPN (pin 6)		0 to 6.5		V
PNP (pin 2)		12 to 6		V

TBA 311

ELECTRICAL CHARACTERISTICS (continued)

Parameter	Min.	Typ.	Max.	Unit
$\frac{\Delta V_i}{\Delta V}$ Signal expansion for full control of IF amplifier and tuner		10		%
V Peak to peak keying input pulse (pin 3) (6)	1		5	V
R_i Input resistance (pin 3)		2		k Ω

SYNC. CIRCUITS

V_o Output voltage of horizontal sync. pulse (pin 1)	8.4	10		V
Z_o Horizontal output impedance (pin 1)		100		Ω
V_o Output voltage of vertical sync. pulse (pin 15)	8.4	9.5		V
Z_o Vertical output impedance (pin 15)		2		k Ω

NOTES:

- 1) Negative going video signal (no pre-bias needed for the detector).
- 2) Video signal with negative going sync. pulse.
- 3) Only valid if the video signal is in accordance with the CCIR standard.
- 4) The total load on pin 12 must be such that under nominal conditions $I_o \leq 20$ mA.
- 5) Because the integrated circuit reaches 95% of its final working temperature in 100 seconds, the temperature variations to be considered are those caused by the slower rise in cabinet temperature and by changes in room temperature.
- 6) The TBA 311 may be operated unkeyed but then point 3 must be connected to the positive supply line via a resistor of suitable value (e.g. 10 k Ω). However, the following consequences should be borne in mind:
 - The decoupling capacitors at the IF and tuner control points must be larger to prevent ripple voltages due to the vertical sync pulses. In consequence the AGC will not follow fast signal fluctuations (aircraft flutter).

TBA 331

LINEAR INTEGRATED CIRCUIT

GENERAL PURPOSE

The TBA 331 is an assembly of 5 silicon NPN transistors on a common monolithic substrate in a Jedec TO-116 14-lead dual in-line plastic package. Two transistors are internally connected to form a differential amplifier.

The transistors of the TBA 331 are well suited to low noise general purposes and to a wide variety of applications in low power systems in the DC through VHF range. They may be used as discrete components in conventional circuits, in addition, they provide the very significant inherent integrated circuit advantages of close electrical and thermal matching.

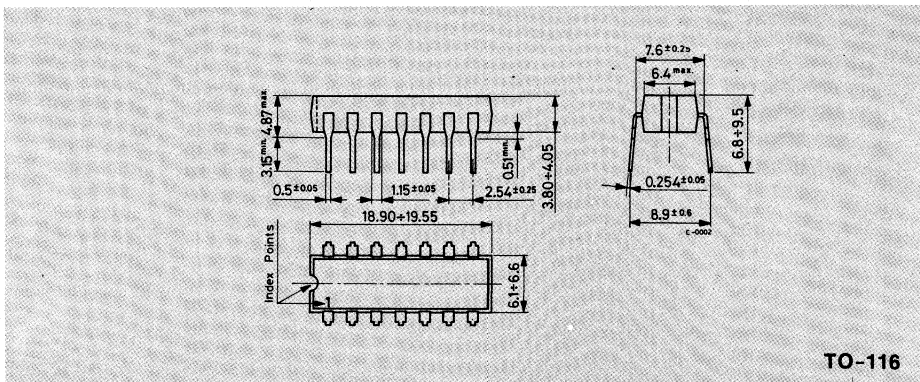
ABSOLUTE MAXIMUM RATINGS

		Each transistor	Total package
V_{CBO}	Collector-base voltage ($I_E = 0$)	20	— V
V_{CEO}	Collector-emitter voltage ($I_B = 0$)	15	— V
V_{CSS}^*	Collector-substrate voltage	20	— V
V_{EBO}	Emitter-base voltage ($I_C = 0$)	5	— V
I_C	Collector current	50	— mA
P_{tot}	Total power dissipation at $T_{amb} \leq 55^\circ\text{C}$ at $T_{amb} > 55^\circ\text{C}$	300	750 mW Derate at 6.67 mW/°C
T_{stg}, T_j	Storage and junction temperature	-40 to 150 °C	
T_{op}	Operating temperature	0 to 85 °C	

* The collector of each transistor of the TBA 331 is isolated from the substrate by an integrated diode. The substrate (pin 13) must be connected to the most negative point in the external circuit to maintain isolation between transistors and to provide for normal transistor action.

MECHANICAL DATA

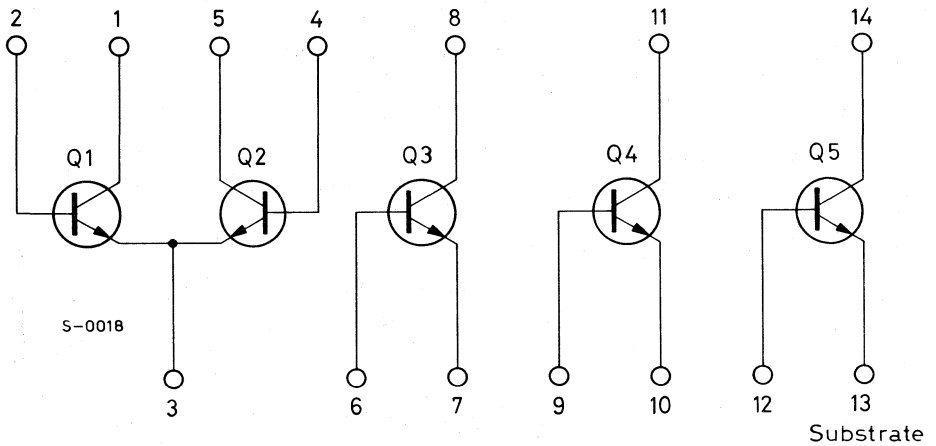
Dimensions in mm



TO-116

TBA 331

SCHEMATIC DIAGRAM



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

Parameter	Test conditions	Min.	Typ.	Max.	Unit	Fig.
I_{CBO}	Collector cutoff current ($I_E = 0$) $V_{CB} = 10\text{ V}$		0.002	40	nA	1
I_{CEO}	Collector cutoff current ($I_B = 0$) $V_{CE} = 10\text{ V}$		see curve	0.5	μA	2
$ I_{B1} - I_{B2} $	Input offset current $I_C = 1\text{ mA}$ $V_{CE} = 3\text{ V}$		0.3	2	μA	7

ELECTRICAL CHARACTERISTICS (continued)

Parameter	Test conditions	Min.	Typ.	Max.	Unit	Fig.
V_{CBO} Collector-base voltage ($I_E = 0$)	$I_C = 10 \mu A$	20	60		V	—
V_{CEO} Collector-emitter voltage ($I_B = 0$)	$I_C = 1 \text{ mA}$	15	24		V	—
V_{CSS} Collector-substrate voltage ($I_{CSS} = 0$)	$I_C = 10 \mu A$	20	60		V	—
$V_{CE} \text{ (sat)}$ Collector-emitter saturation voltage	$I_B = 1 \text{ mA}$ $I_C = 10 \text{ mA}$		0.23		V	—
V_{EBO} Emitter-base voltage ($I_C = 0$)	$I_E = 10 \mu A$	5	7		V	—
V_{BE} Base-emitter voltage	$I_E = 1 \text{ mA}$ $V_{CE} = 3 \text{ V}$		0.715		V	4
	$I_E = 10 \text{ mA}$ $V_{CE} = 3 \text{ V}$		0.8		V	4
$ V_{BE1} - V_{BE2} $ Input offset voltage	$I_C = 1 \text{ mA}$ $V_{CE} = 3 \text{ V}$		0.45	5	mV	4-6
$ V_{BE3} - V_{BE4} $ Input offset voltage	$I_C = 1 \text{ mA}$ $V_{CE} = 3 \text{ V}$		0.45	5	mV	4-6
$ V_{BE4} - V_{BE5} $ Input offset voltage	$I_C = 1 \text{ mA}$ $V_{CE} = 3 \text{ V}$		0.45	5	mV	4-6
$ V_{BE5} - V_{BE4} $ Input offset voltage	$I_C = 1 \text{ mA}$ $V_{CE} = 3 \text{ V}$		0.45	5	mV	4-6
$\frac{\Delta V_{BE}}{\Delta T}$ Base-emitter voltage temperature coefficient	$I_C = 1 \text{ mA}$ $V_{CE} = 3 \text{ V}$		-1.9		mV/°C	5
$\frac{ V_{BE1} - V_{BE2} }{\Delta T}$ Input offset voltage temperature coefficient	$I_C = 1 \text{ mA}$ $V_{CE} = 3 \text{ V}$		1.1		$\mu V/^\circ C$	6

TBA 331

ELECTRICAL CHARACTERISTICS (continued)

Parameter	Test conditions	Min.	Typ.	Max.	Unit	Fig.
h_{FE} DC current gain	$I_C = 10 \text{ mA}$ $V_{CE} = 3 \text{ V}$		100		—	3
	$I_C = 1 \text{ mA}$ $V_{CE} = 3 \text{ V}$	40	100		—	3
	$I_C = 10 \mu\text{A}$ $V_{CE} = 3 \text{ V}$		54		—	3
f_T Transition frequency	$I_C = 3 \text{ mA}$ $V_{CE} = 3 \text{ V}$	300	550		MHz	14
NF Noise figure	$I_C = 100 \mu\text{A}$ $V_{CE} = 3 \text{ V}$ $f = 1 \text{ kHz}$ $R_g = 1 \text{ k}\Omega$		3.25		dB	8
h_{ie} Input impedance	$I_C = 1 \text{ mA}$ $V_{CE} = 3 \text{ V}$ $f = 1 \text{ kHz}$		3.5		$\text{k}\Omega$	9
h_{fe} Forward current transfer ratio	$I_C = 1 \text{ mA}$ $V_{CE} = 3 \text{ V}$ $f = 1 \text{ kHz}$		110		—	9
h_{re} Reverse voltage transfer ratio	$I_C = 1 \text{ mA}$ $V_{CE} = 3 \text{ V}$ $f = 1 \text{ kHz}$		1.8×10^{-4}		—	9
h_{oe} Output admittance	$I_C = 1 \text{ mA}$ $V_{CE} = 3 \text{ V}$ $f = 1 \text{ kHz}$		15.6		μS	9
y_{ie} Input admittance	$I_C = 1 \text{ mA}$ $V_{CE} = 3 \text{ V}$ $f = 1 \text{ MHz}$		$0.3 + j0.04$		mS	11
y_{fe} Forward transadmittance	$I_C = 1 \text{ mA}$ $V_{CE} = 3 \text{ V}$ $f = 1 \text{ MHz}$		$31 - j1.5$		mS	10
y_{re} Reverse transadmittance	$I_C = 1 \text{ mA}$ $V_{CE} = 3 \text{ V}$ $f = 1 \text{ MHz}$		see curve		mS	13

TBA 331

ELECTRICAL CHARACTERISTICS (continued)

Parameter	Test Conditions	Min.	Typ.	Max.	Unit	Fig.
y_{oe} Output admittance	$I_C = 1 \text{ mA}$ $V_{CE} = 3 \text{ V}$ $f = 1 \text{ MHz}$			0.001 + j0.03	mS	12
C_{EBO} Emitter-base capacitance	$I_C = 0$ $V_{EB} = 3 \text{ V}$		0.6		pF	—
C_{CBO} Collector-base capacitance	$I_E = 0$ $V_{CB} = 3 \text{ V}$		0.58		pF	—
C_{CSS} Collector-sustrate capacitance	$I_C = 0$ $V_{CSS} = 3 \text{ V}$		2.8		pF	—

Fig. 1 - Typical collector cutoff current

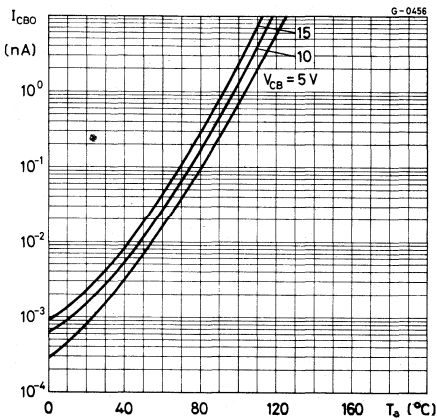
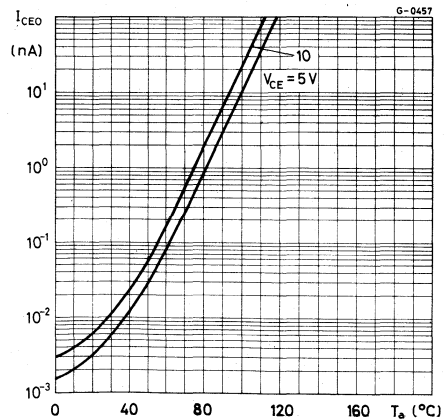


Fig. 2 - Typical collector cutoff current



TBA 331

Fig. 3 - Typical DC current gain

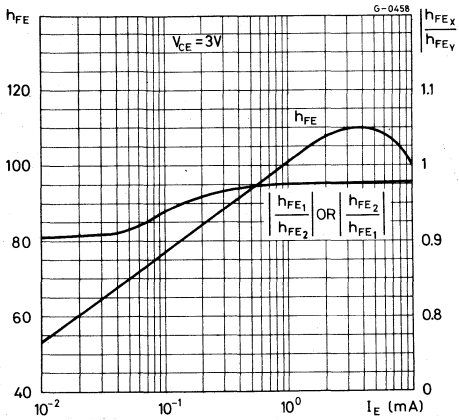


Fig. 4 - Typical input voltage and input voltage offset

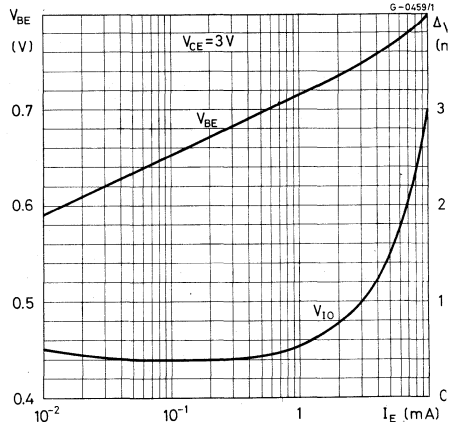


Fig. 5 - Typical input characteristic for each transistor

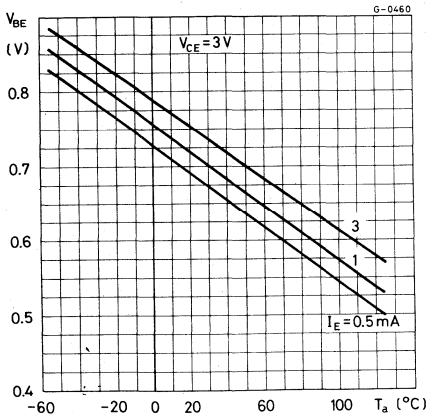


Fig. 6 - Typical input voltage offset

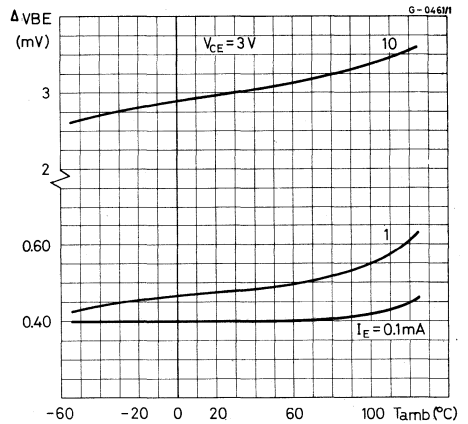


Fig. 7 - Typical input current offset for matched transistor pair

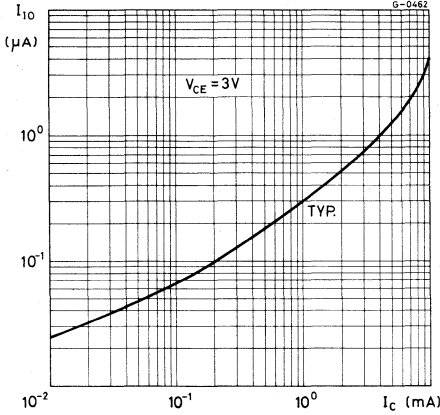


Fig. 8 - Typical noise figure

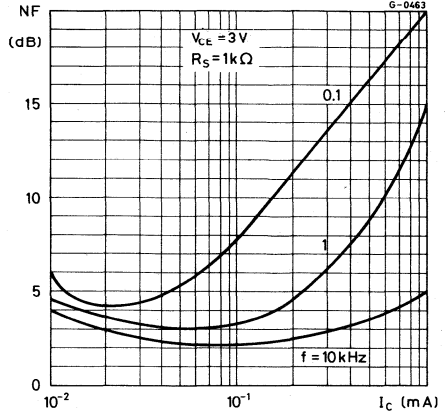


Fig. 9 - Typical normalized h parameters

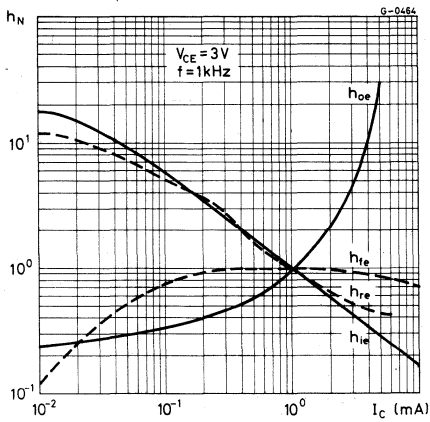
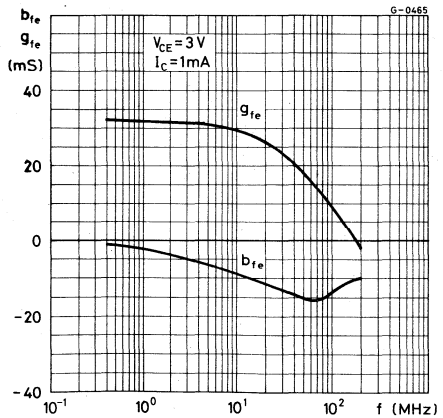


Fig. 10 - Typical forward admittance



TBA 331

Fig. 11 - Typical input admittance

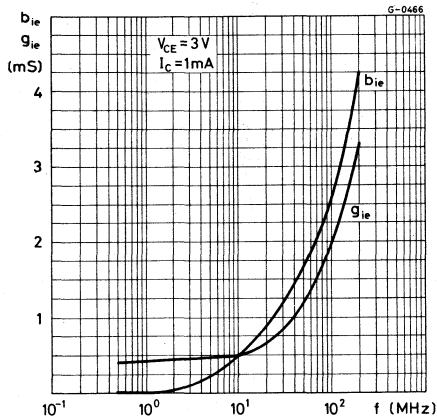


Fig. 12 - Typical output admittance

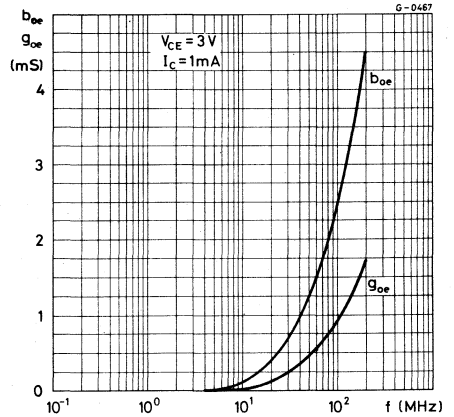


Fig. 13 - Typical reverse admittance

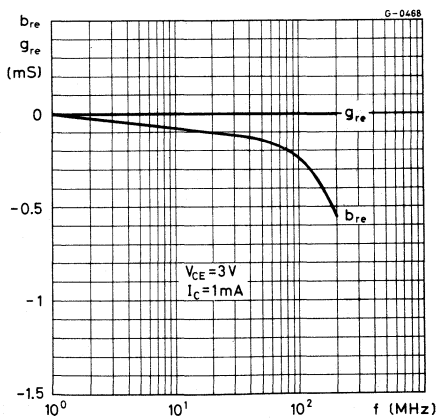
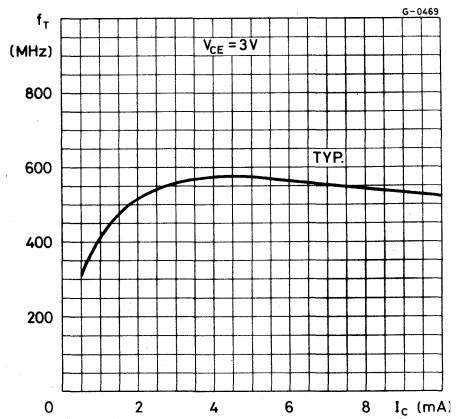


Fig. 14 - Transition frequency



LINEAR INTEGRATED CIRCUIT

VOLTAGE REGULATOR

- OUTPUT CURRENT ≥ 100 mA
- TIGHT TOLERANCE for OUTPUT VOLTAGE
- LOAD REGULATION $\leq 1\%$
- RIPPLE REJECTION 57 dB TYPICAL
- OVERLOAD and SHORT CIRCUIT PROTECTION

The TBA 435 is an integrated monolithic 8.5 V voltage regulator in TO-39 metal case which can supply more than 100 mA. The device features high temperature stability, internal overload and short circuit protection, low output impedance and excellent transient response. The TBA 435 is intended for use as voltage supply for consumer circuits and for any other industrial application.

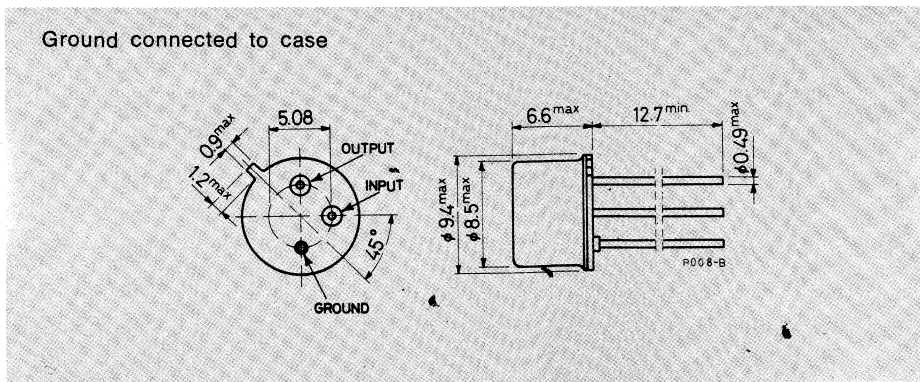
ABSOLUTE MAXIMUM RATINGS

V_i	Input voltage	20	V
P_{tot}	Power dissipation at $T_{amb} = 25^\circ\text{C}$	0.75	W
	at $T_{case} = 25^\circ\text{C}$	4	W
T_{stg}	Storage temperature	-55 to 150	$^\circ\text{C}$
T_j	Junction temperature	175	$^\circ\text{C}$
T_{op}	Operating temperature	0 to 70	$^\circ\text{C}$

ORDERING NUMBER: TBA 435A X5

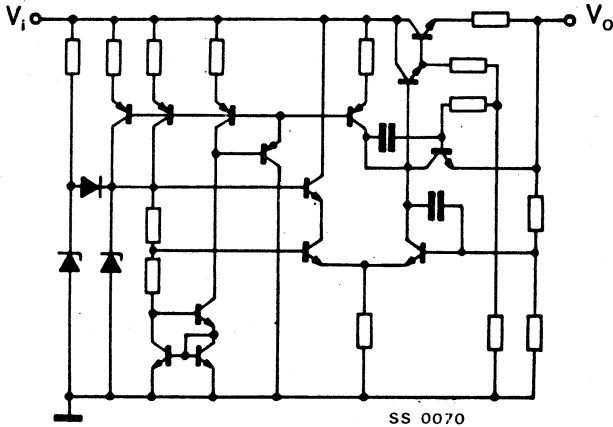
MECHANICAL DATA

Dimensions in mm



TBA 435

SCHEMATIC DIAGRAM



THERMAL DATA

$R_{th\ j-case}$	Thermal resistance junction-case	max	37.5	°C/W
$R_{th\ j-amb}$	Thermal resistance junction-ambient	max	200	°C/W

ELECTRICAL CHARACTERISTICS ($T_j = 25\text{ °C}$ unless otherwise specified)

Parameter	Test conditions	Min.	Typ.	Max.	Unit
V_o Output voltage	$V_i = 11.5\text{ V to }20\text{ V}$ $I_o = 5\text{ mA}$ $C_L = 10\text{ }\mu\text{F}$	8.1	8.5	8.9	V
$\frac{\Delta V_o}{V_o}$ Load regulation	$V_i = 11.5\text{ V to }20\text{ V}$ $I_o = 5\text{ mA to }100\text{ mA}$ $C_L = 10\text{ }\mu\text{F}$		0.3	1	%
I_o Regulated current	$V_i = 15\text{ V}$ $\frac{\Delta V_o}{V_o} \leq 1\%$	100	140		mA

ELECTRICAL CHARACTERISTICS (continued)

Parameter		Test conditions	Min.	Typ.	Max.	Unit
I_o	Max. regulated current	$V_i = 15\text{ V}$	130	150	200	mA
R_o	Output resistance	$V_i = 15\text{ V}$ $I_o = 5\text{ mA to }100\text{ mA}$		0.1		Ω
$\frac{\Delta V_o}{V_o}$	Line regulation	$V_i = 11.5\text{ V to }20\text{ V}$ $I_o = 5\text{ mA}$		0.15	0.6	%
SVR	Supply voltage rejection	$V_i = 13.5\text{ V}$ $\Delta V_i = 4\text{ V}_{pp}$ $I_o = 5\text{ mA}$ $C_L = 10\text{ }\mu\text{F}$ $f = 100\text{ Hz}$	46	57		dB
e_N	Output noise voltage	$V_i = 15\text{ V}$ $I_o = 5\text{ mA}$ $C_L = 10\text{ }\mu\text{F}$ $B = 100\text{ Hz to }100\text{ kHz}$		100		μV
I_d	Quiescent drain current	$V_i = 20\text{ V}$ $I_o = 0$	5	9	16	mA
$\frac{\Delta V_o}{\Delta T_{amb}}$	Temperature coefficient	$V_i = 15\text{ V}$ $I_o = 5\text{ mA}$ $C_L = 10\text{ }\mu\text{F}$ $T_{amb} = 0\text{ to }70\text{ }^\circ\text{C}$		0.85		mV/ $^\circ\text{C}$
I_{sc}	Output short circuit current	$V_i = 20\text{ V}$ $V_o = 0$		40	60	mA

TBA 435

Fig. 1 - Typical output voltage vs output current

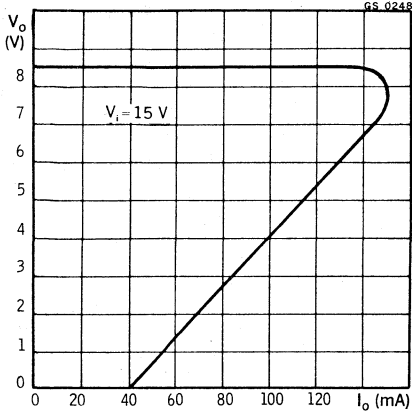


Fig. 2 - Power rating chart

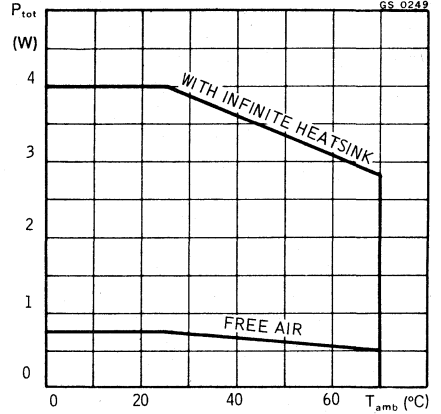


Fig. 3 - Maximum output current vs junction temperature

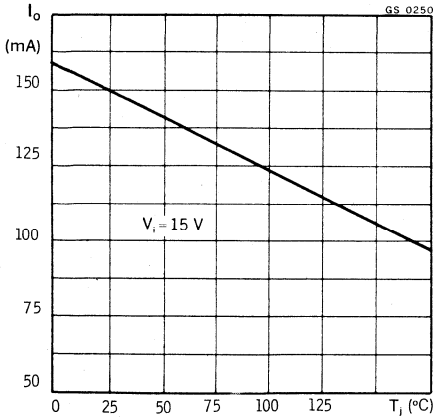


Fig. 4 - Typical ripple rejection vs regulated output current

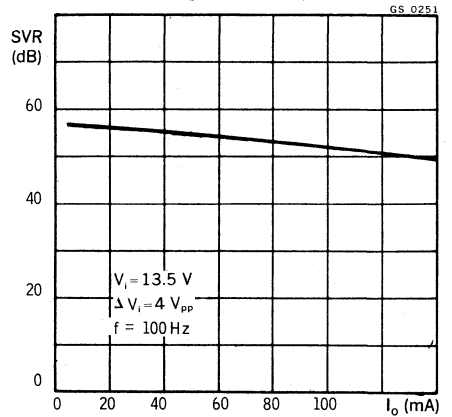


Fig. 5 - Typical ripple rejection vs frequency

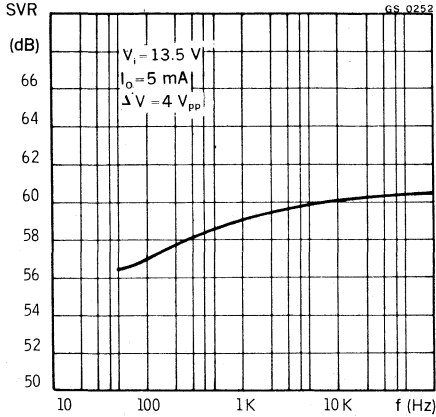


Fig. 6 - Maximum output current vs input voltage

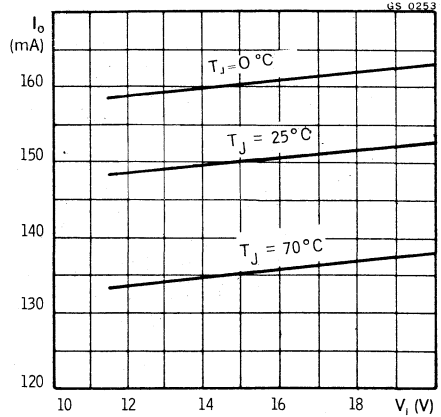


Fig. 7 - Typical short circuit output current vs input voltage

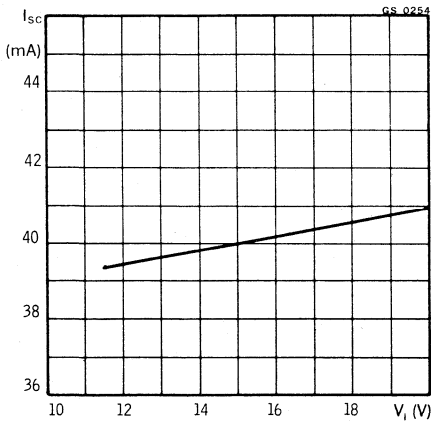
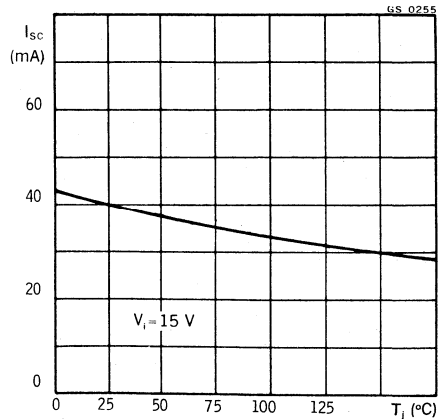


Fig. 8 - Typical short circuit output current vs junction temperature



TBA 435

Fig. 9 - Typical dropout voltage vs output current

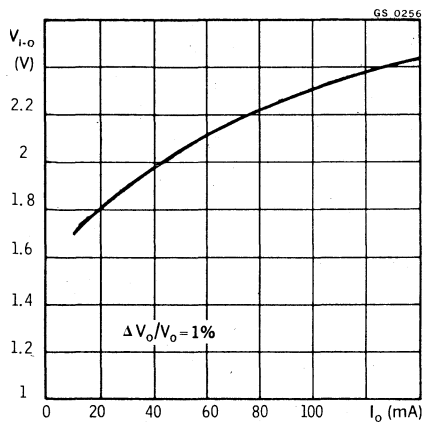


Fig. 10 - Typical quiescent drain current vs junction temperature

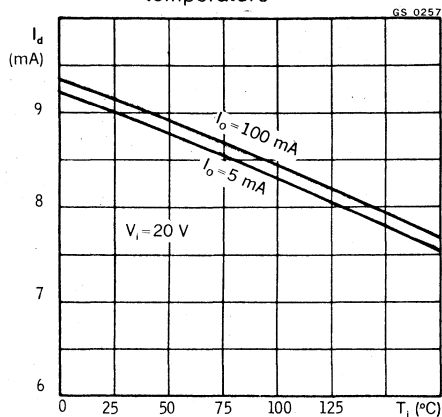


Fig. 11 - Typical quiescent drain current vs input voltage

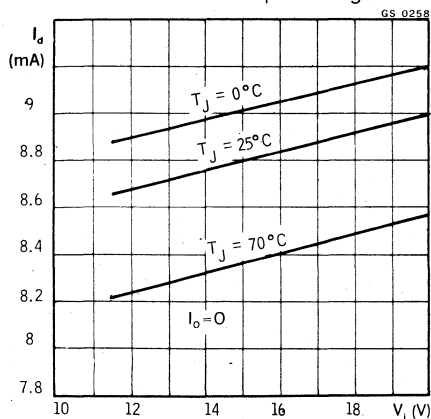
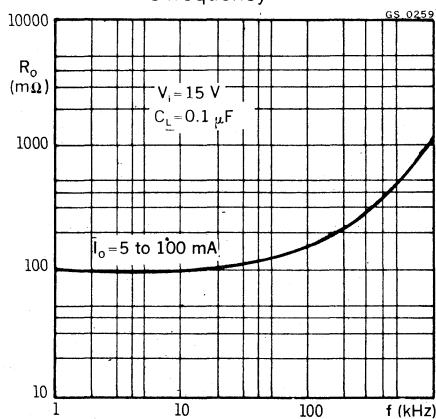
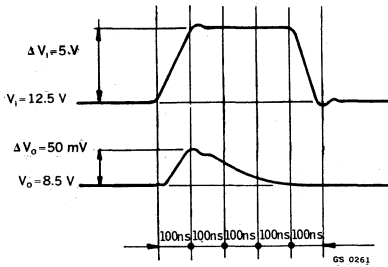


Fig. 12 - Typical output resistance vs frequency

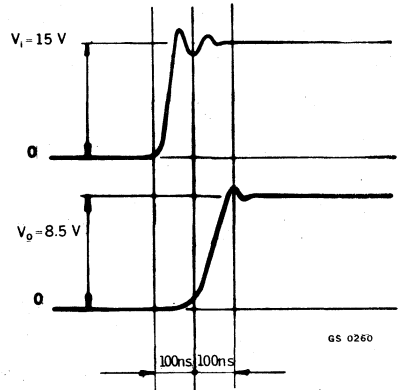


TBA 435

Line transient response
($I_o = 5 \text{ mA}$)



Turn-on time
($I_o = 100 \text{ mA}$)



TYPICAL APPLICATIONS

Fig. 13 - Positive output voltage regulator

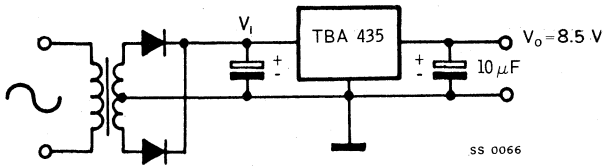
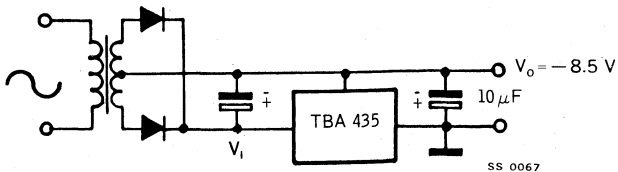
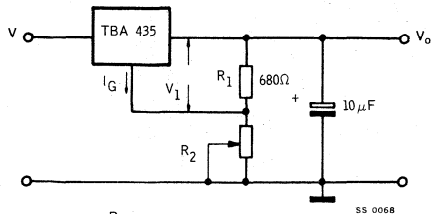


Fig. 14 - Negative output voltage regulator



TBA 435

Fig. 15 - Adjustable output voltage regulator



$$V_o = V_1 \left(1 + \frac{R_2}{R_1}\right) + I_o R_2$$

$$V_1 = 18 \text{ V}$$

$$V_o = 8.5 \text{ to } 11 \text{ V}$$

$$I_o > 80 \text{ mA}$$

$$R_o \approx 100 \text{ m}\Omega$$

$$R_2 = \text{potentiometer } 0 \text{ to } 150 \Omega$$

SS 0068

Typical adjustable output voltage vs output current

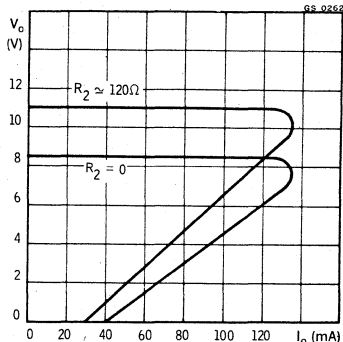
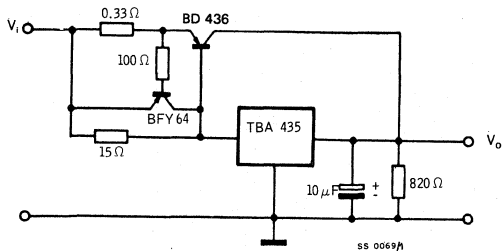


Fig. 16 - PNP current boost circuit



$$V_1 = 15 \text{ V}$$

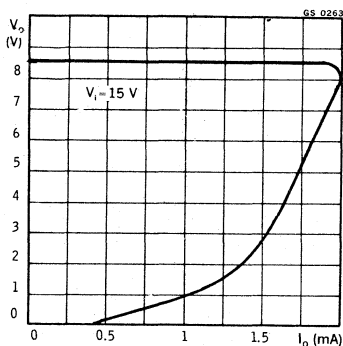
$$V_o = 8.5 \text{ V}$$

$$I_o = 2 \text{ A}$$

$$R_o \approx 20 \text{ m}\Omega$$

SS 0069/1

Typical output voltage vs output current



LINEAR INTEGRATED CIRCUIT

VOLTAGE REGULATOR

- OUTPUT CURRENT ≥ 100 mA
- TIGHT TOLERANCE for OUTPUT VOLTAGE
- LOAD REGULATION $\leq 1\%$
- RIPPLE REJECTION 60 dB TYPICAL
- OVERLOAD and SHORT CIRCUIT PROTECTION

The TBA 625A is an integrated monolithic 5 V voltage regulator in TO-39 metal case which can supply more than 100 mA. The device features high temperature stability, internal overload and short circuit protection, low output impedance and excellent transient response. The TBA 625A is intended for use as voltage supply for digital circuits and for any other industrial application.

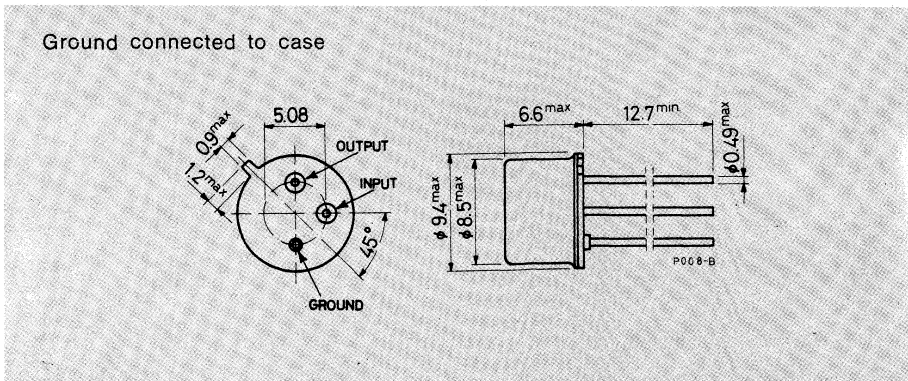
ABSOLUTE MAXIMUM RATINGS

V_i	Input voltage	20	V
P_{tot}	Power dissipation at $T_{amb} = 25^\circ\text{C}$	0.75	W
	at $T_{case} = 25^\circ\text{C}$	4	W
T_{stg}	Storage temperature	-55 to 150	$^\circ\text{C}$
T_j	Junction temperature	175	$^\circ\text{C}$
T_{op}	Operating temperature	0 to 70	$^\circ\text{C}$

ORDERING NUMBER: TBA 625A X5

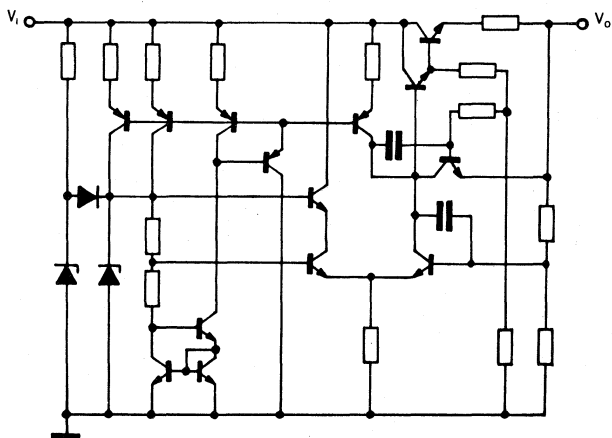
MECHANICAL DATA

Dimensions in mm



TBA 625A

SCHEMATIC DIAGRAM



SS 0071

THERMAL DATA

$R_{th\ j-case}$	Thermal resistance junction-case	max	37.5	$^{\circ}C/W$
$R_{th\ j-amb}$	Thermal resistance junction-ambient	max	200	$^{\circ}C/W$

ELECTRICAL CHARACTERISTICS $(T_j = 25^{\circ}C$ unless otherwise specified)

Parameter	Test conditions	Min.	Typ.	Max.	Unit
V_o Output voltage	$V_i = 8\ V$ to $20\ V$ $I_o = 5\ mA$ $C_L = 10\ \mu F$	4.75	5	5.25	V
$\frac{\Delta V_o}{V_o}$ Load regulation	$V_i = 8\ V$ to $20\ V$ $I_o = 5\ mA$ to $100\ mA$ $C_L = 10\ \mu$		0.3	1	%
I_o Regulated current	$V_i = 12\ V$ $\frac{\Delta V_o}{V_o} \leq 1\%$	100	140		mA

TBA 625A

ELECTRICAL CHARACTERISTICS (continued)

Parameter		Test conditions	Min.	Typ.	Max.	Unit
I_o	Max. regulated current	$V_i = 12\text{ V}$	130	150	200	mA
R_o	Output resistance	$V_i = 12\text{ V}$ $I_o = 5\text{ mA to } 100\text{ mA}$		0.1		Ω
$\frac{\Delta V_o}{V_o}$	Line regulation	$V_i = 8\text{ V to } 20\text{ V}$ $I_o = 5\text{ mA}$ $C_L = 10\ \mu\text{F}$		0.2	1	%
SVR	Supply voltage rejection	$V_i = 10\text{ V}$ $\Delta V_i = 4\text{ V}_{pp}$ $I_o = 5\text{ mA}$ $C_L = 10\ \mu\text{F}$ $f = 100\text{ Hz}$	46	60		dB
e_N	Output noise voltage	$V_i = 12\text{ V}$ $I_o = 5\text{ mA}$ $C_L = 10\ \mu\text{F}$ $B = 10\text{ Hz to } 100\text{ kHz}$		70		μV
I_d	Quiescent drain current	$V_i = 20\text{ V}$ $I_o = 0$	5	9	16	mA
$\frac{\Delta V_o}{\Delta T_{amb}}$	Temperature coefficient	$V_i = 12\text{ V}$ $I_o = 5\text{ mA}$ $C_L = 10\ \mu\text{F}$ $T_{amb} = 0\text{ to } 70\text{ }^\circ\text{C}$		0.5		$\text{mV}/^\circ\text{C}$
I_{sc}	Output short circuit current	$V_i = 20\text{ V}$ $V_o = 0$	45	65		mA

TBA 625A

Fig. 1 - Typical output voltage vs output current

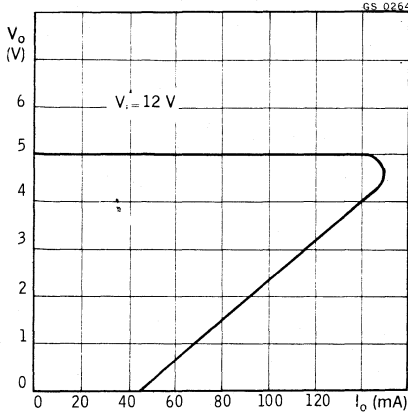


Fig. 2 - Power rating chart

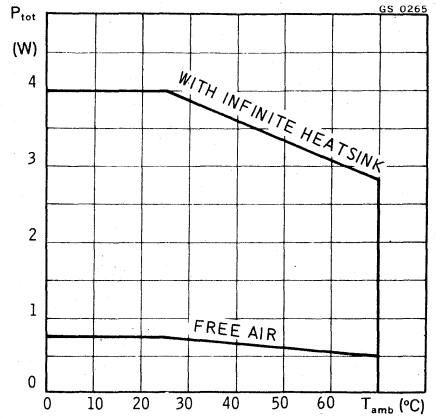


Fig. 3 - Maximum output current vs junction temperature

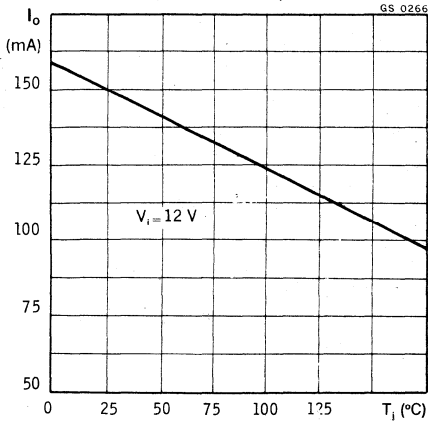


Fig. 4 - Typical ripple rejection vs regulated output current

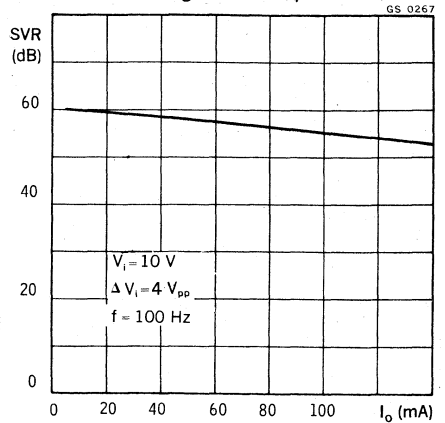


Fig. 5 - Typical ripple rejection vs frequency

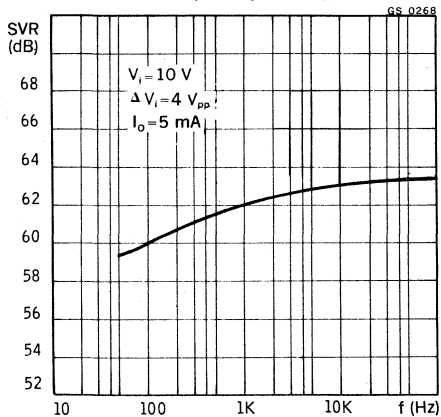


Fig. 6 - Maximum output current vs input voltage

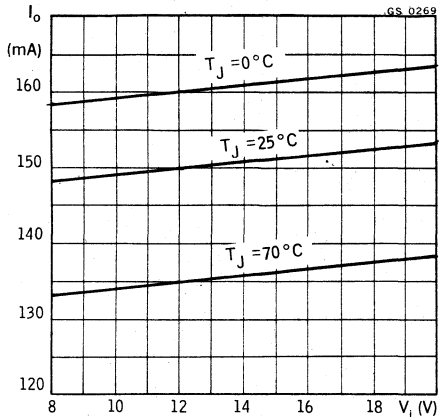


Fig. 7 - Typical short circuit output current vs input voltage

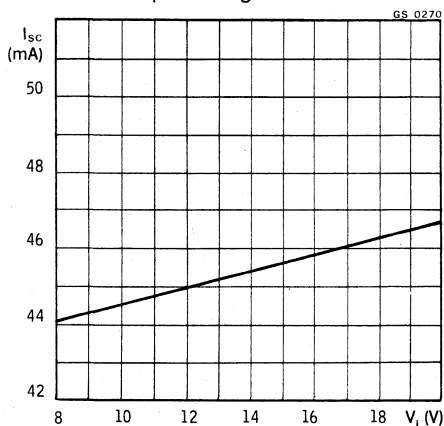
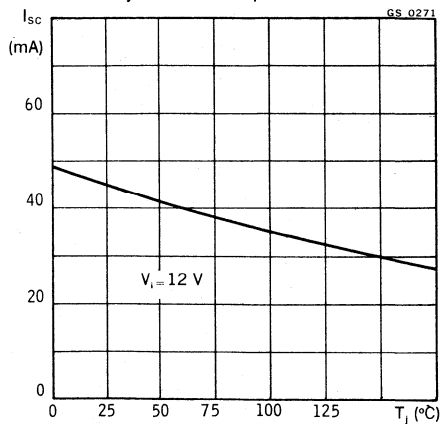


Fig. 8 - Typical short circuit output current vs junction temperature



TBA 625A

Fig. 9 - Typical dropout voltage vs output current

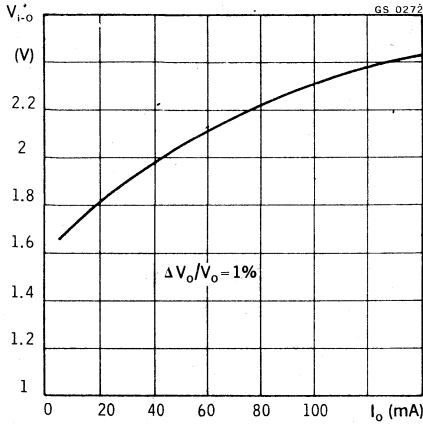


Fig. 10 - Typical quiescent drain current vs junction temperature

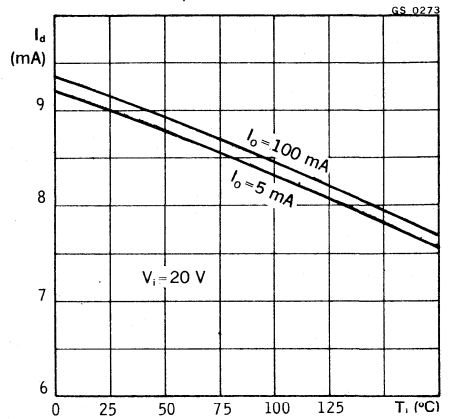


Fig. 11 - Typical quiescent drain current vs input voltage

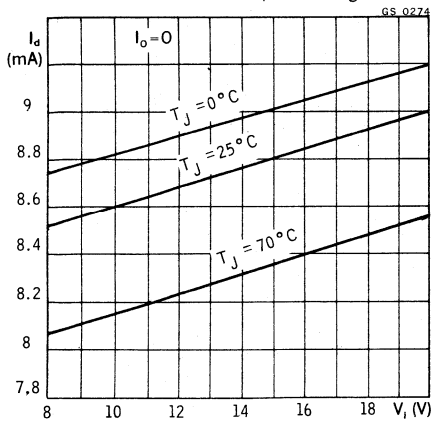
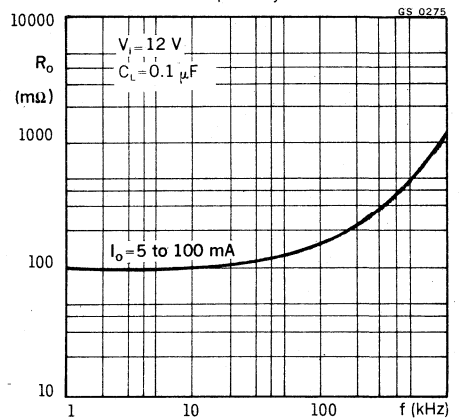
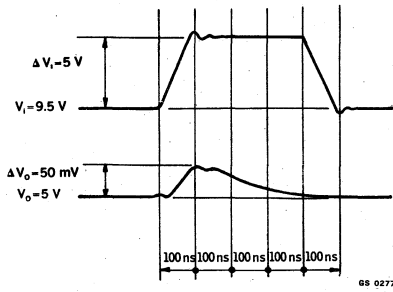


Fig. 12 - Typical output resistance vs frequency

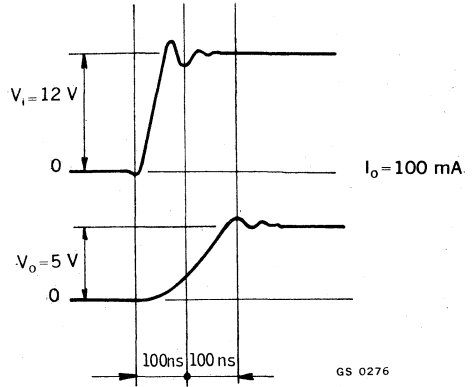


TBA 625A

Line transient response
($I_o = 5 \text{ mA}$)



Turn-on time
($I_o = 100 \text{ mA}$)



TYPICAL APPLICATIONS

Fig. 13 - Positive output voltage regulator

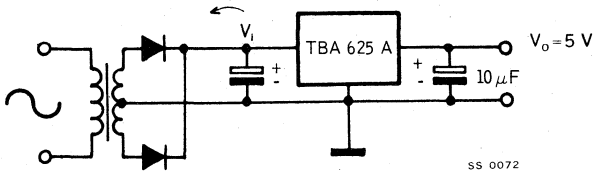
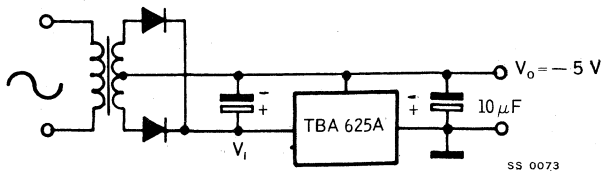
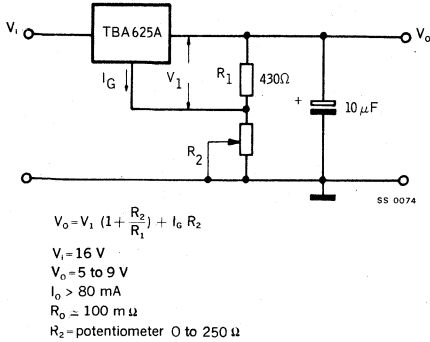


Fig. 14 - Negative output voltage regulator



TBA 625A

Fig. 15 - Adjustable output voltage regulator



Typical adjustable output voltage vs output current

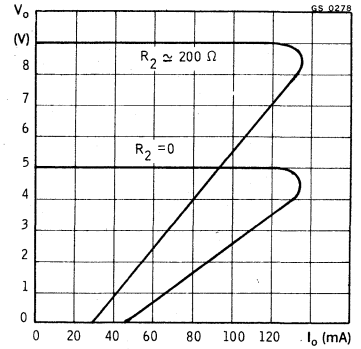
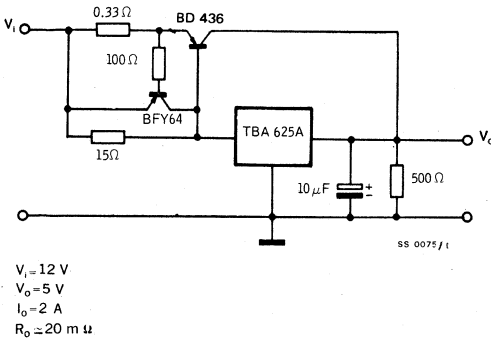
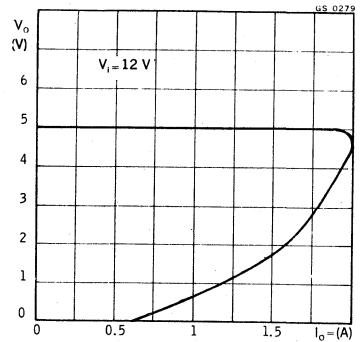


Fig. 16 - PNP current boost circuit



Typical output voltage vs output current



LINEAR INTEGRATED CIRCUIT

VOLTAGE REGULATOR

- OUTPUT CURRENT ≥ 100 mA
- TIGHT TOLERANCE for OUTPUT VOLTAGE
- LOAD REGULATION $\leq 1\%$
- RIPPLE REJECTION 54 dB TYPICAL
- OVERLOAD and SHORT CIRCUIT PROTECTION

The TBA 625B is an integrated monolithic 12 V voltage regulator in TO-39 metal case which can supply more than 100 mA. The device features high temperature stability, internal overload and short circuit protection, low output impedance and excellent transient response. The TBA 625B is intended for use as voltage supply for digital circuits with high noise immunity, linear integrated circuits and for any other industrial applications.

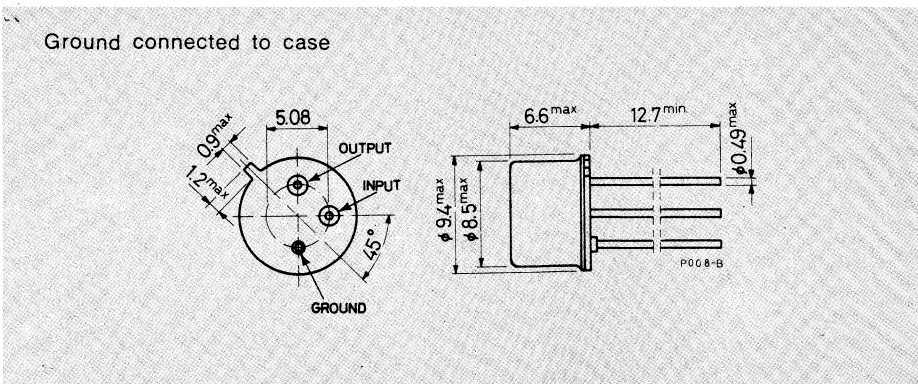
ABSOLUTE MAXIMUM RATINGS

V_i	Input voltage	27	V
P_{tot}	Power dissipation at $T_{amb} = 25^\circ\text{C}$	0.75	W
	at $T_{case} = 25^\circ\text{C}$	4	W
T_{stg}	Storage temperature	-55 to 150	$^\circ\text{C}$
T_j	Junction temperature	175	$^\circ\text{C}$
T_{op}	Operating temperature	0 to 70	$^\circ\text{C}$

ORDERING NUMBER: TBA 625B X5

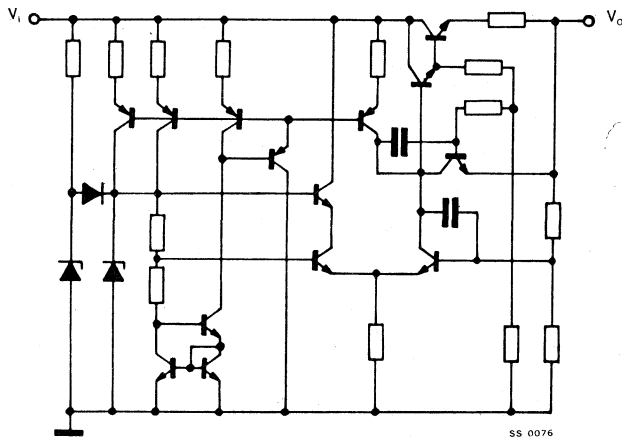
MECHANICAL DATA

Dimensions in mm



TBA 625B

SCHEMATIC DIAGRAM



THERMAL DATA

$R_{th\ j-case}$	Thermal resistance junction-case	max	37.5	°C/W
$R_{th\ j-amb}$	Thermal resistance junction-ambient	max	200	°C/W

ELECTRICAL CHARACTERISTICS ($T_j = 25\text{ °C}$ unless otherwise specified)

Parameter	Test conditions	Min.	Typ.	Max.	Unit
V_o Output voltage	$V_i = 15\text{ V to }27\text{ V}$ $I_o = 5\text{ mA}$ $C_L = 10\text{ }\mu\text{F}$	11.4	12	12.6	V
$\frac{\Delta V_o}{V_o}$ Load regulation coefficient	$V_i = 15\text{ V to }27\text{ V}$ $I_o = 5\text{ mA to }100\text{ mA}$ $C_L = 10\text{ }\mu\text{F}$		0.3	1	%
I_o Regulated current	$V_i = 12\text{ V}$ $\frac{\Delta V_o}{V_o} \leq 1\%$	100	140		mA

ELECTRICAL CHARACTERISTICS (continued)

Parameter	Test conditions	Min.	Typ.	Max.	Unit
I_o Max. regulated current	$V_i = 21\text{ V}$	120	150	200	mA
R_o Output resistance	$V_i = 21\text{ V}$ $I_o = 5\text{ mA to }100\text{ mA}$		0.1		Ω
$\frac{\Delta V_o}{V_o}$ Line regulation coefficient	$V_i = 15\text{ V to }27\text{ V}$ $I_o = 5\text{ mA}$ $C_L = 10\ \mu\text{F}$		0.2	0.5	%
SVR Supply voltage rejection	$V_i = 17\text{ V}$ $\Delta V_i = 4\text{ V}_{pp}$ $I_o = 5\text{ mA}$ $C_L = 10\ \mu\text{F}$ $f = 100\text{ Hz}$		46	54	dB
e_N Output noise voltage	$V_i = 21\text{ V}$ $I_o = 5\text{ mA}$ $C_L = 10\ \mu\text{F}$ $B = 10\text{ Hz to }100\text{ kHz}$		150		μV
I_d Quiescent drain current	$V_i = 27\text{ V}$ $I_o = 0$	6	10	18	mA
$\frac{\Delta V_o}{\Delta T_{amb}}$ Voltage/temperature coefficient	$V_i = 21\text{ V}$ $I_o = 5\text{ mA}$ $C_L = 10\ \mu\text{F}$ $T_{amb} = 0\text{ to }70\text{ }^\circ\text{C}$		0.85		mV/ $^\circ\text{C}$
I_{sc} Output short circuit current	$V_i = 27\text{ V}$ $V_o = 0$		35	55	mA

TBA 625B

Fig. 1 - Typical output voltage vs output current

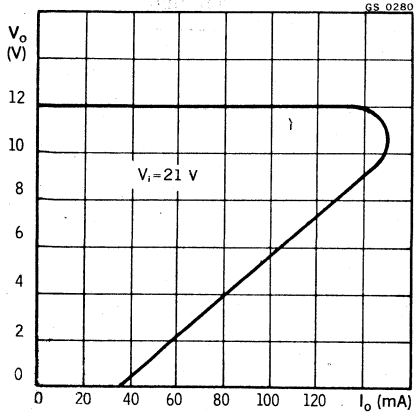


Fig. 2 - Power rating chart

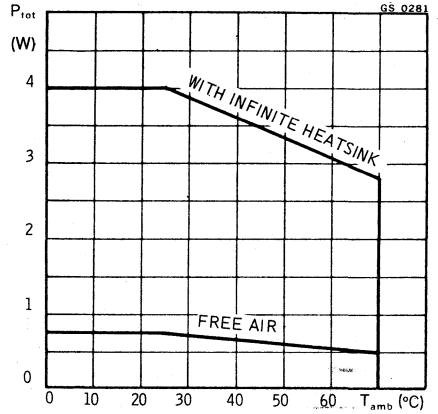


Fig. 3 - Maximum output current vs junction temperature

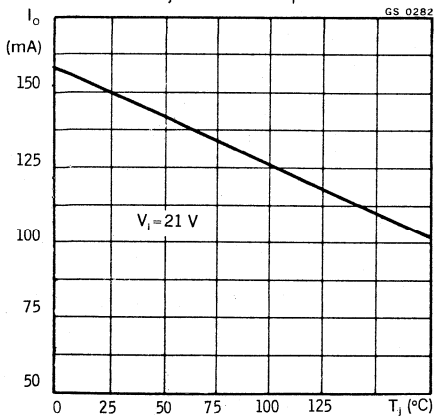


Fig. 4 - Typical ripple rejection vs regulated output current

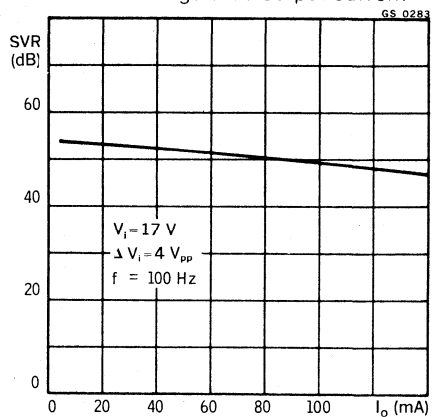


Fig. 5 - Typical ripple rejection vs frequency

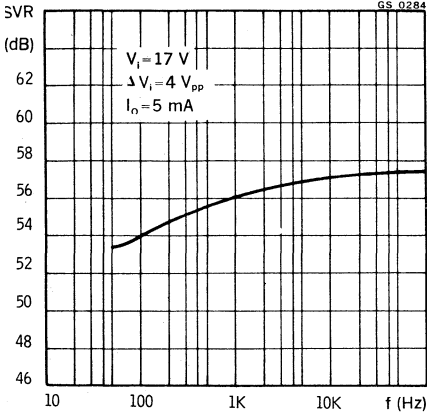


Fig. 6 - Maximum output current vs input voltage

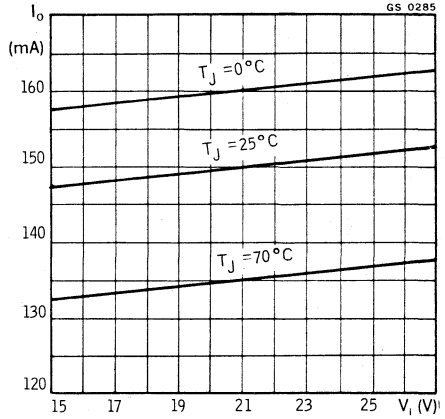


Fig. 7 - Typical short circuit output current vs input voltage

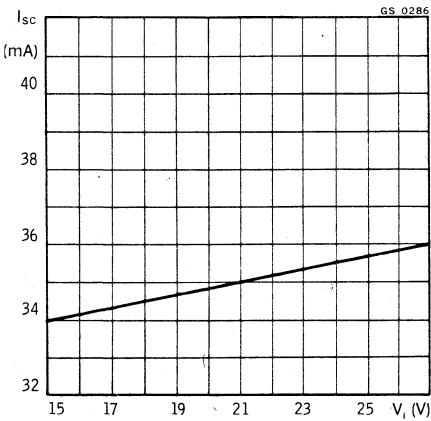
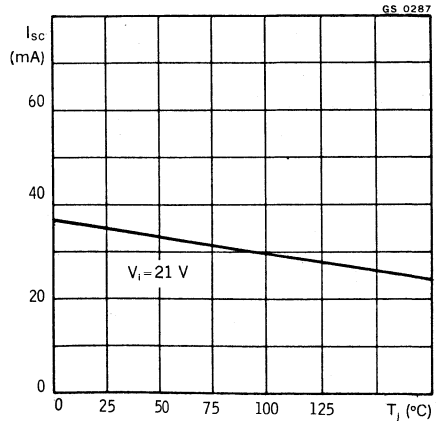


Fig. 8 - Typical short circuit output current vs junction temperature



TBA 625B

Fig. 9 - Typical dropout voltage vs output current

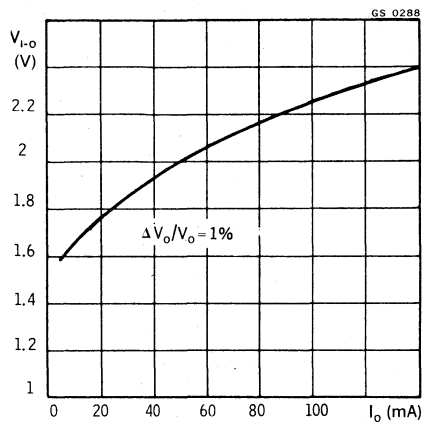


Fig. 10 - Typical quiescent drain current vs junction temperature

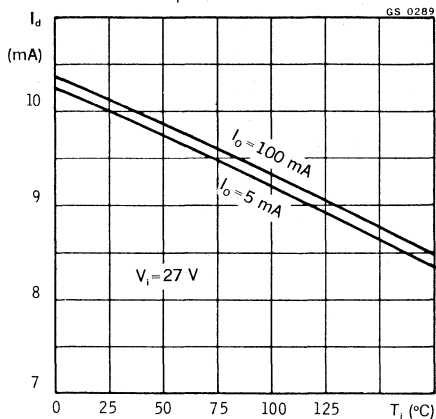


Fig. 11 - Typical quiescent drain current vs input voltage

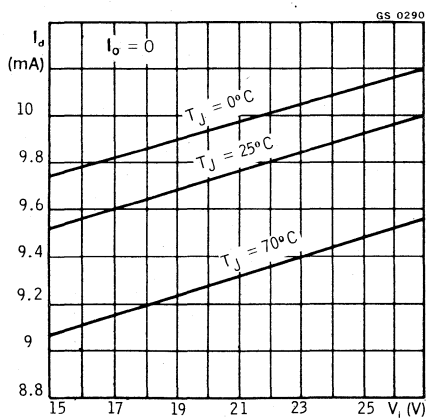
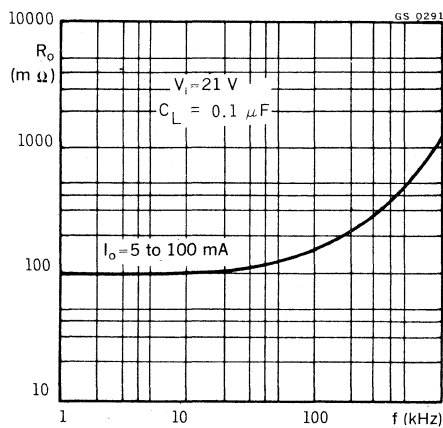


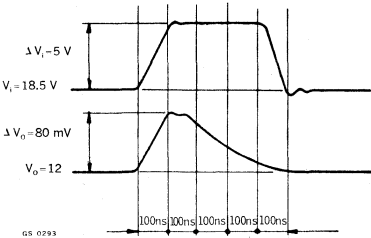
Fig. 12 - Typical output resistance vs frequency



TBA 625B

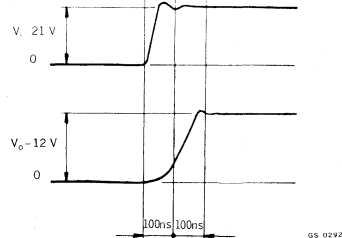
Line transient response

($I_o = 5 \text{ mA}$)



Turn-on time

($I_o = 100 \text{ mA}$)



TYPICAL APPLICATIONS

Fig. 13 - Positive output voltage regulator

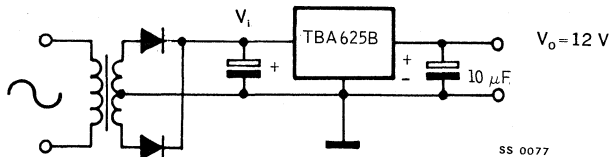
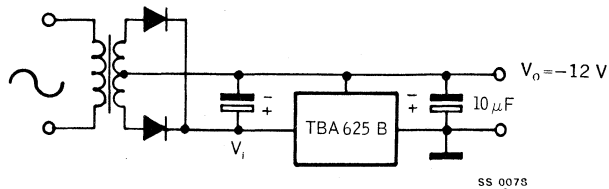
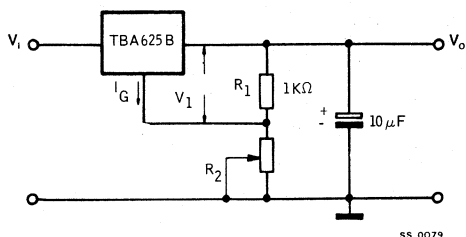


Fig. 14 - Negative output voltage regulator



TBA 625B

Fig. 15 - Adjustable output voltage regulator



$$V_o = V_i \left(1 + \frac{R_2}{R_1}\right) + I_G R_2$$

$V_1 = 24 \text{ V}$
 $V_o = 12 \text{ to } 15 \text{ V}$
 $I_o > 80 \text{ mA}$
 $R_1 \approx 100 \text{ m}\Omega$
 $R_2 = \text{potentiometer } 0 \text{ to } 150 \Omega$

Typical adjustable output voltage vs output current

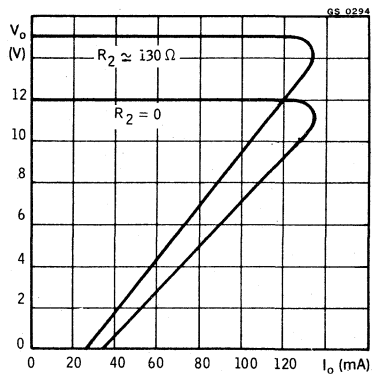
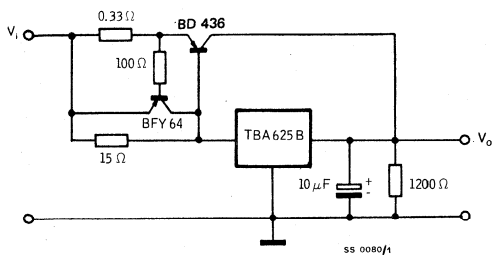
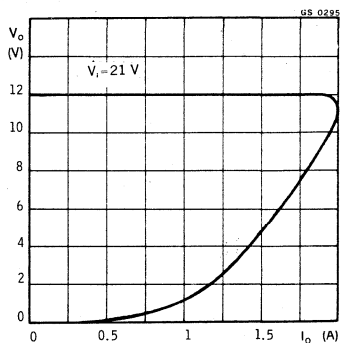


Fig. 16 - PNP current boost circuit



$V_i = 21 \text{ V}$
 $V_o = 12 \text{ V}$
 $I_o = 2 \text{ A}$
 $R_o \approx 20 \text{ m}\Omega$

Typical output voltage vs output current



LINEAR INTEGRATED CIRCUIT

VOLTAGE REGULATOR

- OUTPUT CURRENT ≥ 100 mA
- TIGHT TOLERANCE for OUTPUT VOLTAGE
- LOAD REGULATION $\leq 1\%$
- RIPPLE REJECTION 51 dB TYPICAL
- OVERLOAD and SHORT CIRCUIT PROTECTION

The TBA 625C is an integrated monolithic 15 V voltage regulator in TO-39 metal case which can supply more than 100 mA. The device features high temperature stability, internal overload and short circuit protection, low output impedance and excellent transient response. The TBA 625C is intended for use as voltage supply for digital circuits with high noise immunity, linear integrated circuits and for any other industrial applications.

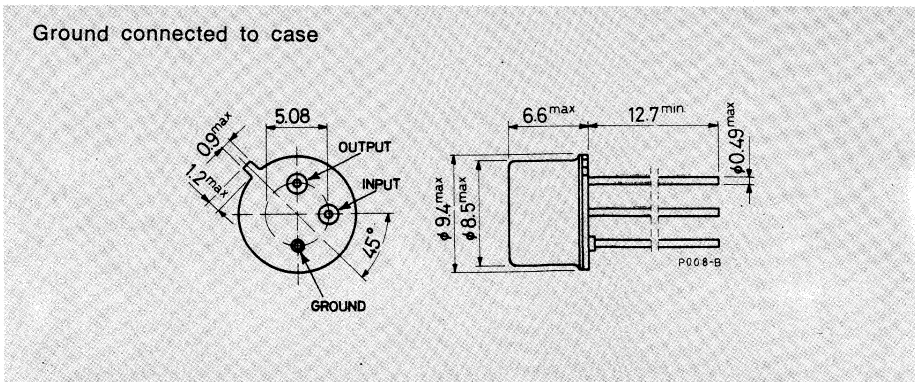
ABSOLUTE MAXIMUM RATINGS

V_i	Input voltage	27	V
P_{tot}	Power dissipation at $T_{amb} = 25^\circ\text{C}$	0.75	W
	at $T_{case} = 25^\circ\text{C}$	4	W
T_{op}	Storage temperature	-55 to 150	$^\circ\text{C}$
T_j	Junction temperature	175	$^\circ\text{C}$
T_{op}	Operating temperature	0 to 70	$^\circ\text{C}$

ORDERING NUMBER: TBA 625C X5

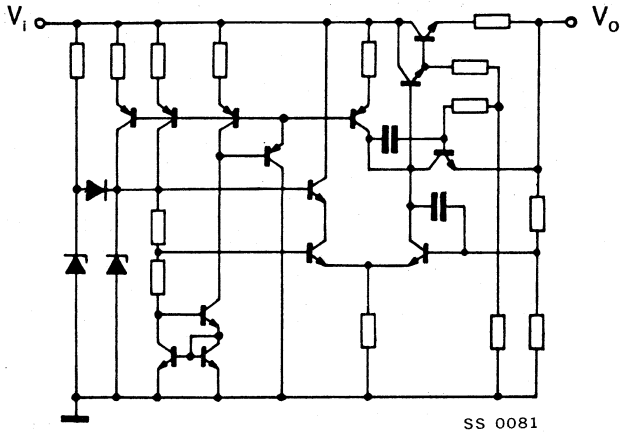
MECHANICAL DATA

Dimensions in mm



TBA 625C

SCHEMATIC DIAGRAM



THERMAL DATA

$R_{th\ j-case}$	Thermal resistance junction-case	max	37.5	°C/W
$R_{th\ j-amb}$	Thermal resistance junction-ambient	max	200	°C/W

ELECTRICAL CHARACTERISTICS ($T_j = 25\text{ °C}$ unless otherwise specified)

Parameter	Test conditions	Min.	Typ.	Max.	Unit
V_o Output voltage	$V_i = 18\text{ V to }27\text{ V}$ $I_o = 5\text{ mA}$ $C_L = 10\text{ }\mu\text{F}$	14.25	15	15.75	V
$\frac{\Delta V_o}{V_o}$ Load regulation	$V_i = 18\text{ V to }27\text{ V}$ $I_o = 5\text{ mA to }100\text{ mA}$ $C_L = 10\text{ }\mu\text{F}$		0.3	1	%
I_o Regulated current	$V_i = 24\text{ V}$ $\frac{\Delta V_o}{V_o} \leq 1\%$	100	140		mA

TBA 625C

ELECTRICAL CHARACTERISTICS (continued)

Parameter	Test conditions	Min.	Typ.	Max.	Unit	
I_o	Max. regulated current	$V_i = 24\text{ V}$			120 150 200	mA
R_o	Output resistance	$V_i = 24\text{ V}$ $I_o = 5\text{ mA to } 100\text{ mA}$			0.1	Ω
$\frac{\Delta V_o}{V_o}$	Line regulation	$V_i = 18\text{ V to } 27\text{ V}$ $I_o = 5\text{ mA}$ $C_L = 10\ \mu\text{F}$			0.25 0.5	%
SVR	Supply voltage rejection	$V_i = 20\text{ V}$ $\Delta V_i = 4\text{ V}_{pp}$ $I_o = 5\text{ mA}$ $C_L = 10\ \mu\text{F}$ $f = 100\text{ Hz}$			46 51	dB
e_N	Output noise voltage	$V_i = 24\text{ V}$ $I_o = 5\text{ mA}$ $C_L = 10\ \mu\text{F}$ $B = 10\text{ Hz to } 100\text{ kHz}$			200	μV
I_d	Quiescent drain current	$V_i = 27\text{ V}$ $I_o = 0$			6 10 18	mA
$\frac{\Delta V_o}{\Delta T_{amb}}$	Temperature coefficient	$V_i = 24\text{ V}$ $I_o = 5\text{ mA}$ $C_L = 10\ \mu\text{F}$ $T_{amb} = 0\text{ to } 70\text{ }^\circ\text{C}$			1.5	mV/ $^\circ\text{C}$
I_{sc}	Output short circuit current	$V_i = 27\text{ V}$ $V_o = 0$			30 50	mA

TBA 625C

Fig. 1 - Typical output voltage vs output current

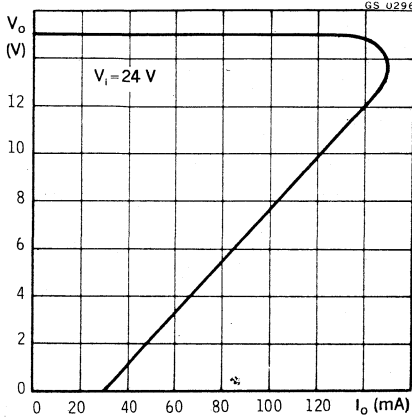


Fig. 2 - Power rating chart

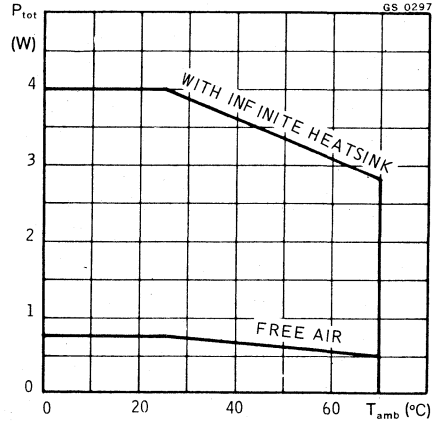


Fig. 3 - Maximum output current vs junction temperature

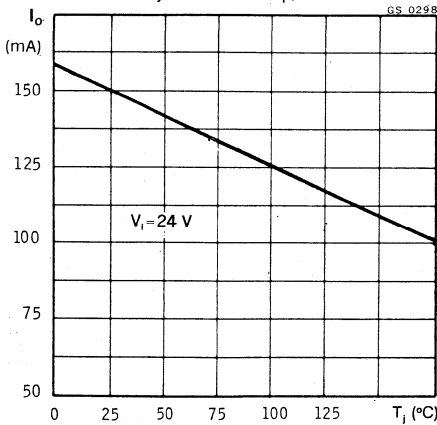


Fig. 4 - Typical ripple rejection vs regulated output current

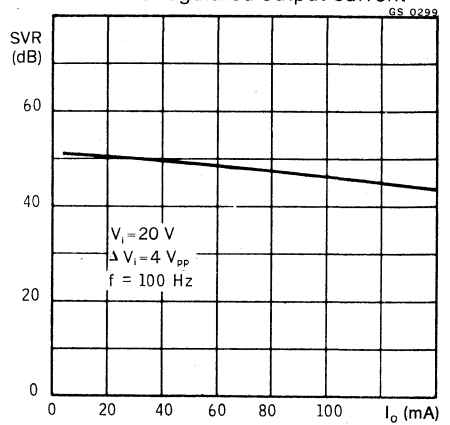


Fig. 5 - Typical ripple rejection vs frequency

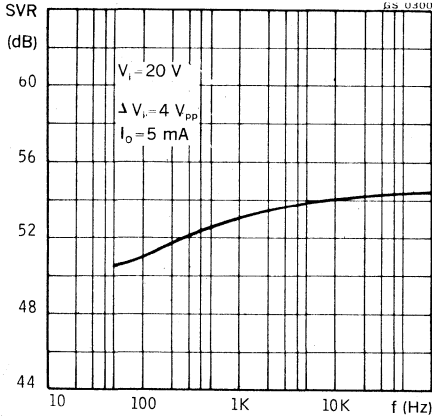


Fig. 6 - Maximum output current vs input voltage

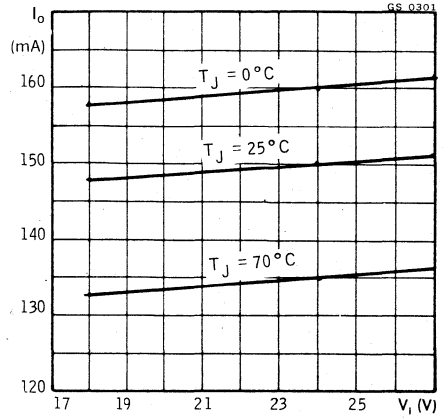


Fig. 7 - Typical short circuit output current vs input voltage

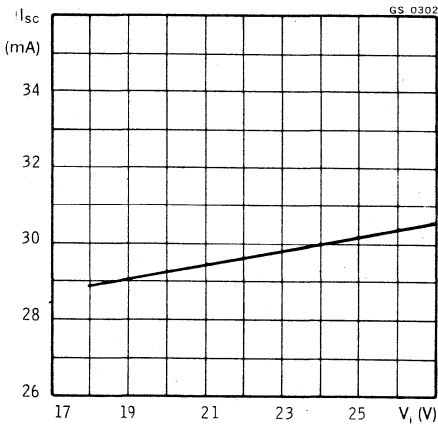
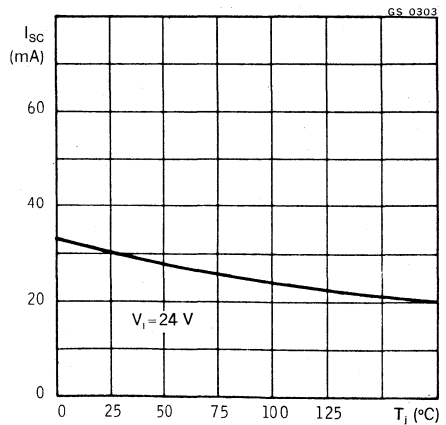


Fig. 8 - Typical short circuit output current vs junction temperature



TBA 625C

Fig. 9 - Typical dropout voltage vs output current

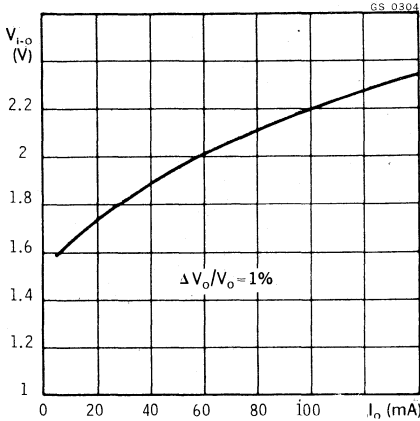


Fig. 10 - Typical quiescent drain current vs junction temperature

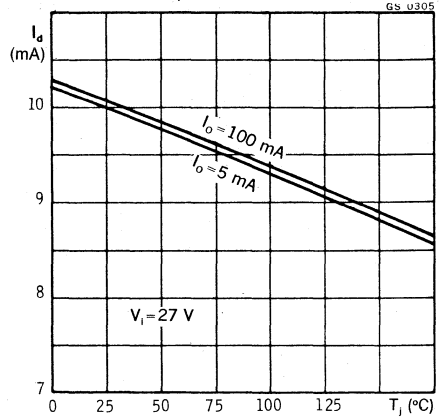


Fig. 11 - Typical quiescent drain current vs input voltage

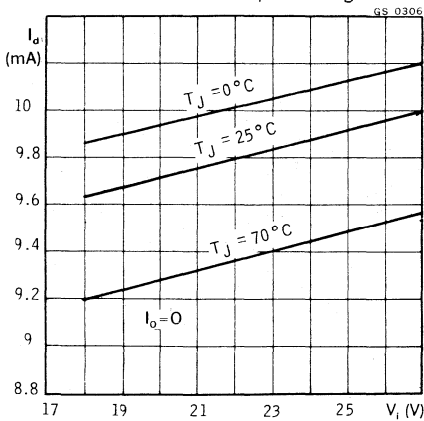
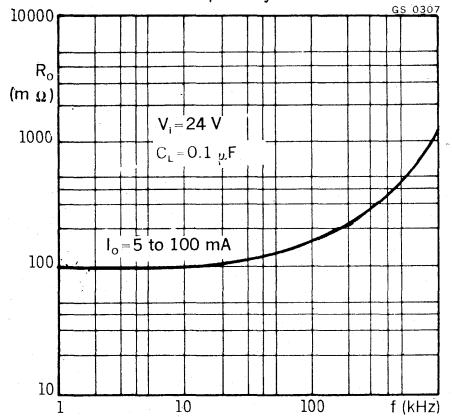


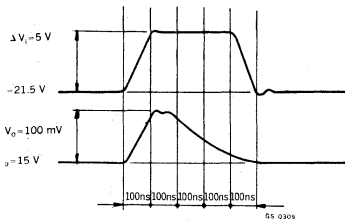
Fig. 12 - Typical output resistance vs frequency



TBA 625C

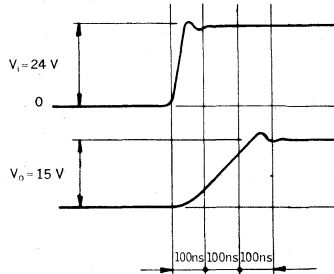
Line transient response

$I_o = 5 \text{ mA}$



Turn-on time

($I_o = 100 \text{ mA}$)



GS 0308

TYPICAL APPLICATIONS

Fig. 13 - Positive output voltage regulator

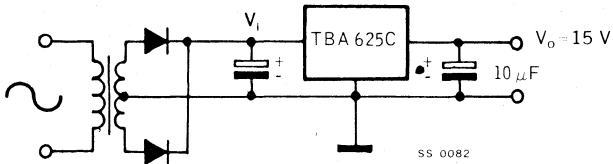
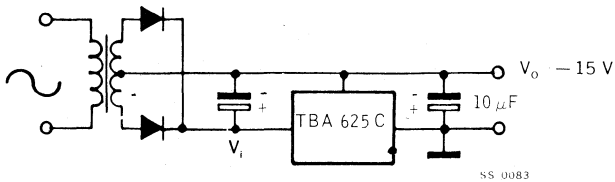
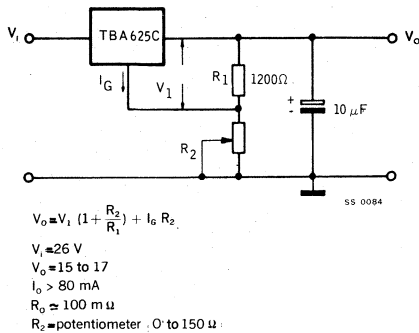


Fig. 14 - Negative output voltage regulator



TBA 625C

Fig. 15 - Adjustable output voltage regulator



Typical adjustable output voltage vs output current

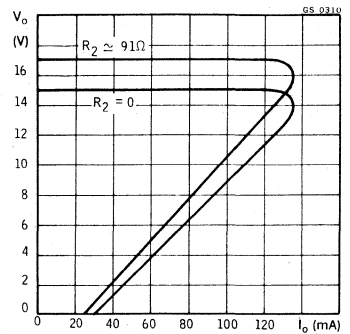
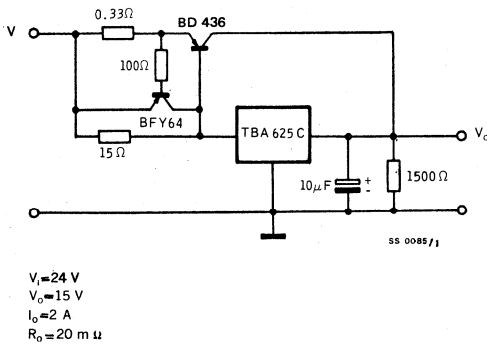
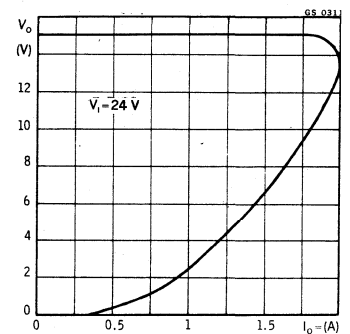


Fig. 16 - PNP current boost circuit



Typical output voltage vs output current



LINEAR INTEGRATED CIRCUIT**AUDIO AMPLIFIER**

- OUTPUT POWER 2.2 W (9 V - 4 Ω)
- LOW DISTORTION
- LOW QUIESCENT CURRENT
- SELF CENTERING BIAS
- HIGH INPUT IMPEDANCE

The TBA 641 A is a monolithic integrated circuit in a 14-lead quad in-line plastic package. It is particularly designed for use as audio power amplifier in portable radio receivers, tape recorders, record players and in industrial applications which require high output power, low distortion and high reliability performance.

Special features of the circuit include a low quiescent current, self centering bias operation at supply voltage ranging from 6 V to 12 V, direct coupling of the input. The circuit requires a minimum of external components.

ABSOLUTE MAXIMUM RATINGS

V_s	Supply voltage	12	V
V_i	Input voltage	-0.5 to $+V_s$	V
I_o	Output peak current	2	A
P_{tot}	Power dissipation at $T_{amb} \leq 25^\circ\text{C}$	1.5	W
	at $T_{case} \leq 100^\circ\text{C}$	3.8	W
T_{stg}	Storage temperature	-40 to 150	$^\circ\text{C}$
T_j	Junction temperature	150	$^\circ\text{C}$

ORDERING NUMBERS:

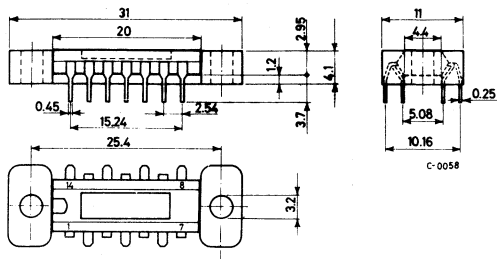
TBA 641 A72 for quad in-line plastic package with spacer

TBA 641 A12 for quad in-line plastic package

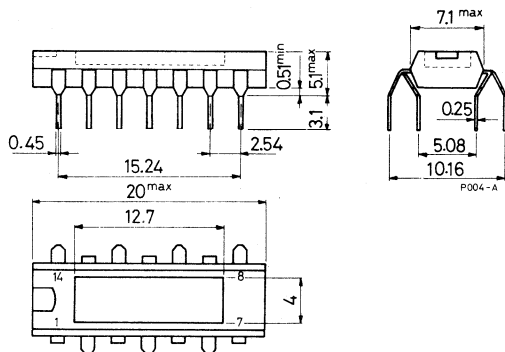
TBA 641A

MECHANICAL DATA (Dimensions in mm)

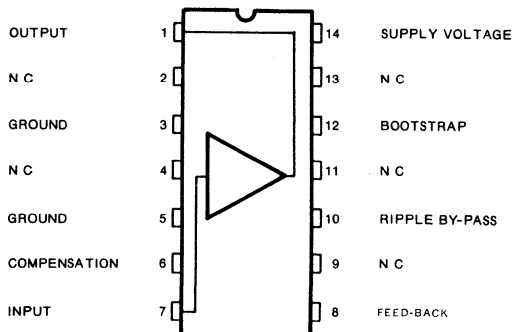
Quad in-line plastic package
with spacer for TBA 641 A72
(see also "MOUNTING
INSTRUCTIONS")



Quad in-line plastic package
for TBA 641 A12



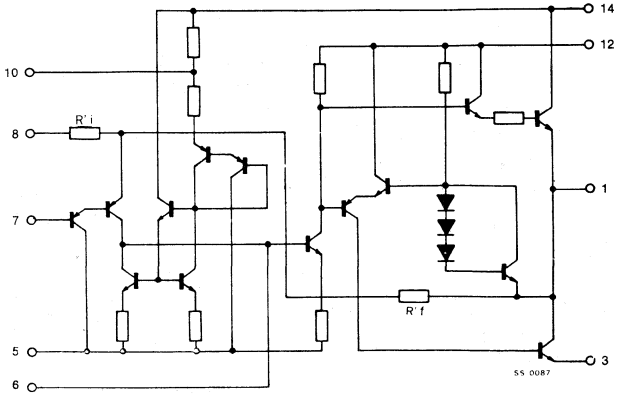
CONNECTION DIAGRAM



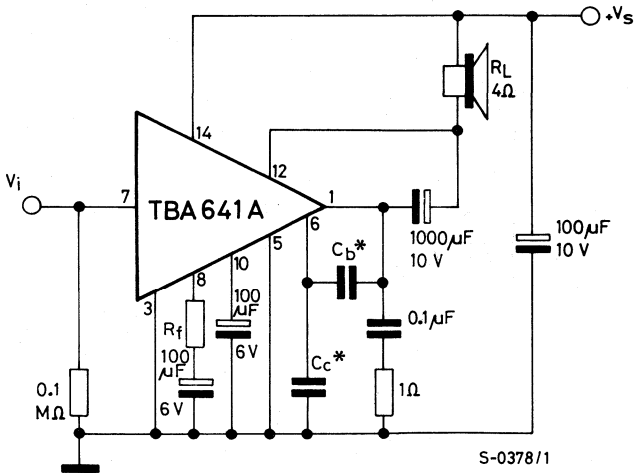
SS 0086

TBA 641A

SCHEMATIC DIAGRAM



TEST AND APPLICATION CIRCUIT



* C_b, C_c see fig.4

TBA 641A

THERMAL DATA

→	$R_{th\ j-case}$	Thermal resistance junction-case	max	13	°C/W
→	$R_{th\ j-amb}$	Thermal resistance junction-ambient	max	83	°C/W

ELECTRICAL CHARACTERISTICS

(See test circuit; $T_{amb} = 25\text{ °C}$, $V_s = 9\text{ V}$ and $R_L = 4\ \Omega$ unless otherwise specified)

	Parameter	Test conditions	Min.	Typ.	Max.	Unit
	V_o Quiescent output voltage (pin 1)		4	4.5	5	V
	I_d Total quiescent drain current	$P_o = 0$		8	18	mA
	I_d Quiescent drain current of output transistors	$P_o = 0$		6		mA
	I_d Drain current	$P_o = 2.2\text{ W}$		340		mA
→	I_b Bias current (pin 7)			0.1	1	μA
	P_o Output power	$d = 10\%$ $f = 1\text{ kHz}$ $G_v = 46\text{ dB}$	1.8	2.2		W
	R'_f Internal feedback resistance	See schematic diagram		7		$\text{k}\Omega$
	R'_i Internal feedback resistance	See schematic diagram		35		Ω
	Z_i Input impedance (pin 7)	$f = 1\text{ kHz}$ $G_v = 46\text{ dB}$		3		$\text{M}\Omega$
	d Distortion	$f = 1\text{ kHz}$ $G_v = 46\text{ dB}$ $P_o = 50\text{ mW}$ $P_o = 1\text{ W}$		0.6	0.6	% %
	G_v Voltage gain	$R_f = 0$		46		dB
	e_N Input noise voltage	$R_s = 22\text{ k}\Omega$ $B = 10\text{ kHz}$		2.5		μV

Fig. 1 - Typical output power vs supply voltage

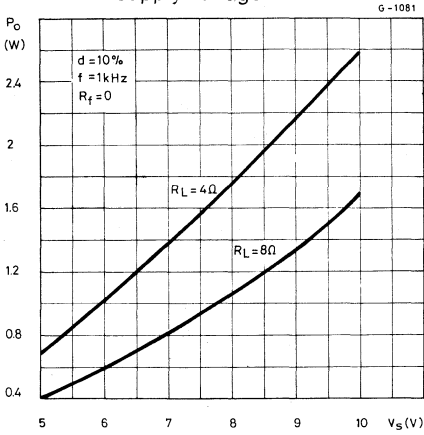


Fig. 2 - Typical distortion vs output power

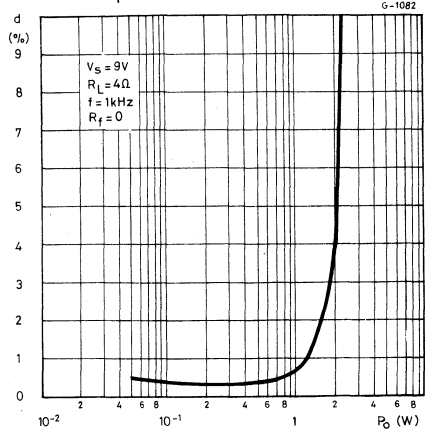


Fig. 3 - Typical voltage gain vs feedback resistance (R_f)

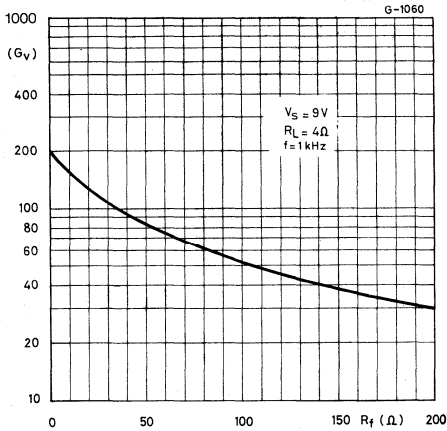
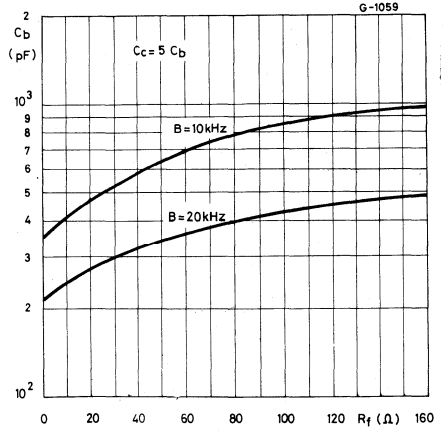


Fig. 4 - Typical value of C_b vs R_f for various values of B



TBA 641A

Fig. 5 - Typical output power vs input voltage

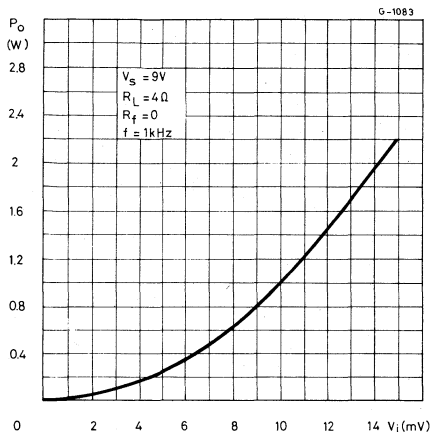


Fig. 6 - Typical power dissipation and efficiency vs output power

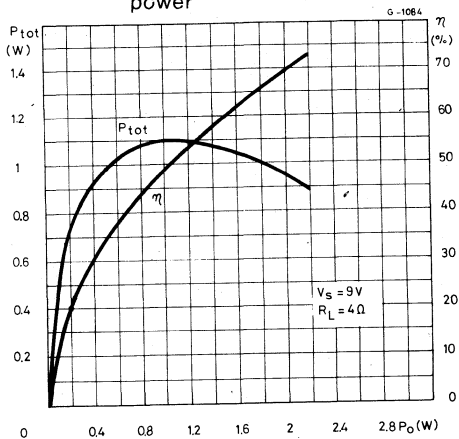


Fig. 7 - Typical drain current vs output power

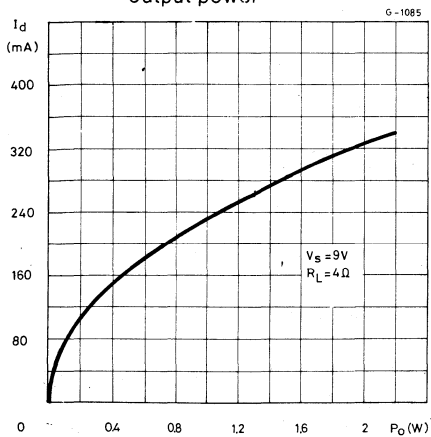
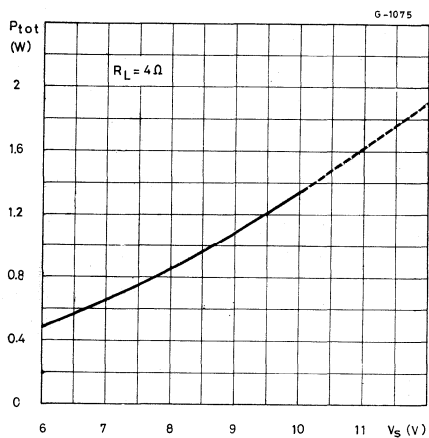


Fig. 8 - Maximum power dissipation *



* The dotted line refers to TBA 641 A72 with additional heat-sink

Fig. 9 - Power rating chart

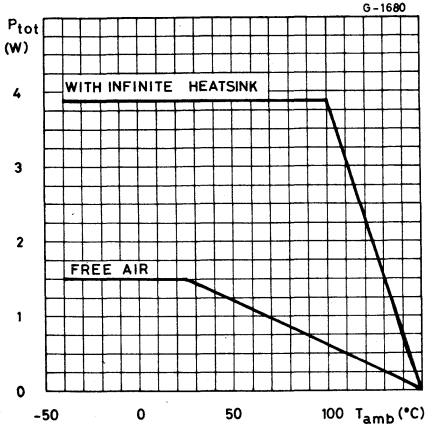


Fig. 10 - Typical quiescent drain current vs supply voltage

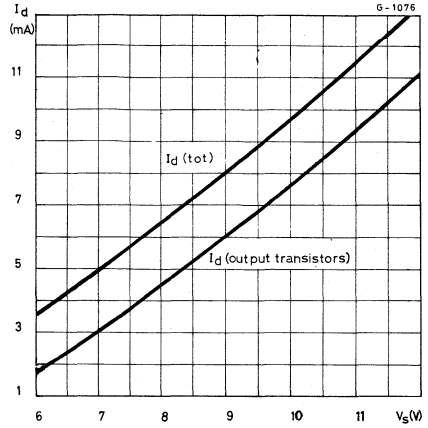


Fig. 11 - Typical quiescent drain current vs ambient temperature

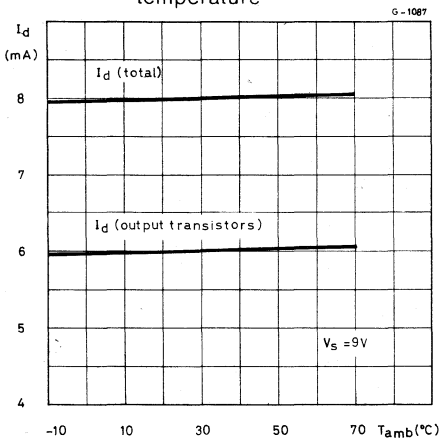
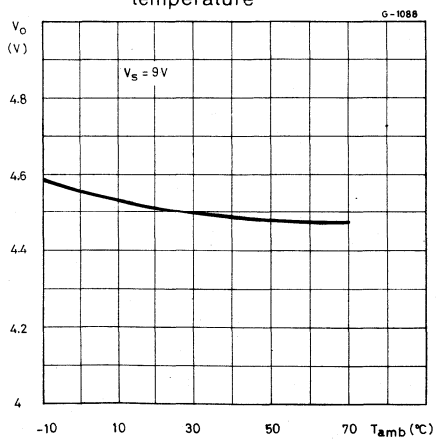
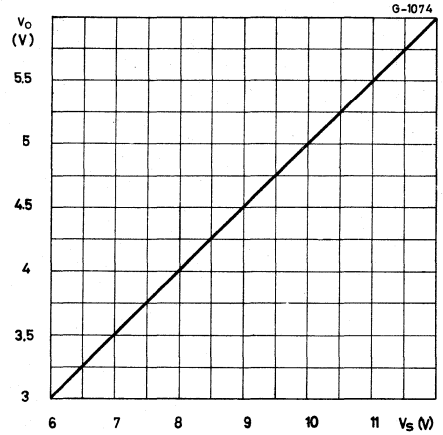


Fig. 12 - Typical quiescent output voltage vs ambient temperature



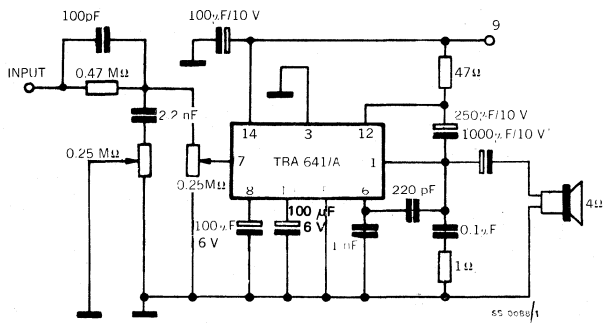
TBA 641A

Fig. 13 - Typical quiescent output voltage vs supply voltage



TYPICAL APPLICATION

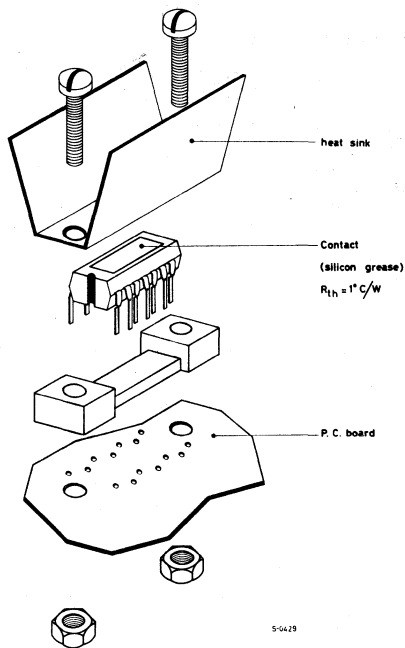
Fig. 14 - Portable record-player amplifier



MOUNTING INSTRUCTIONS

Fig. 15 shows a method of mounting the TBA 641 A with the spacer, satisfactory both mechanically and from the point of view of heat dissipation. Better thermal contact between package and heat-sink can be obtained by using a small quantity of silicon grease. For heat dissipation the desired thermal resistance is obtained by fixing the elements shown to a heat-sink of suitable dimensions.

Fig. 15



LINEAR INTEGRATED CIRCUIT**AUDIO AMPLIFIER**

- OUTPUT POWER 4.5 W (14 V - 4 Ω)
- LOW DISTORTION
- LOW QUIESCENT CURRENT
- HIGH INPUT IMPEDANCE

The TBA 641 B is a monolithic integrated circuit in a 14-lead quad in-line power plastic package. It is particularly designed for use as audio power amplifier in radio and television receivers, and in industrial applications which require high output power, low distortion and high reliability performance. Special features of the circuit include a low quiescent current, self centering bias for operation at supply voltage ranging from 6 V to 16 V, direct coupling of the input. The circuit requires a minimum of external components.

ABSOLUTE MAXIMUM RATINGS

V_s	Supply voltage (no signal)	18	V
V_s	Operating supply voltage	16	V
V_i	Input voltage	-0.5 to $+V_s$	V
I_o	Peak output current	2.5	A
→ P_{tot}	Power dissipation at $T_{amb} \leq 25^\circ\text{C}^*$	1.5	W
	$T_{amb} \leq 25^\circ\text{C}^{**}$	2.3	W
	$T_{case} \leq 70^\circ\text{C}$	6	W
T_{stg}, T_j	Storage and junction temperature	-40 to 150	$^\circ\text{C}$

* For TBA 641 B72

** For TBA 641 BX1 and TBA 641 B11

ORDERING NUMBERS:

TBA 641 B72 for quad in-line plastic package with spacer

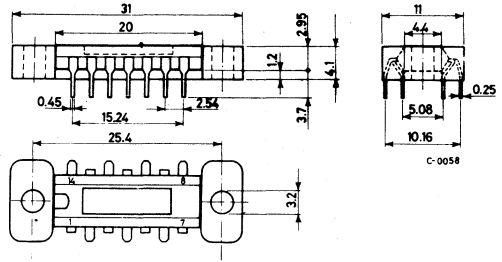
TBA 641 BX1 for quad in-line plastic package with external bar

TBA 641 B11 for quad in-line plastic package with inverted external bar

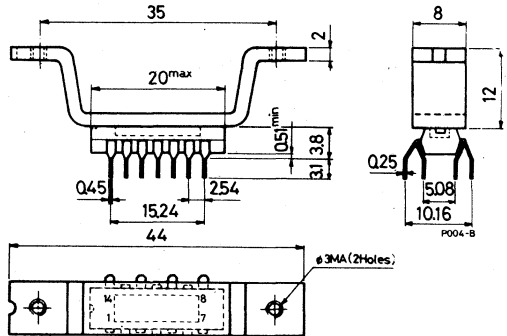
TBA 641B

MECHANICAL DATA (Dimensions in mm)

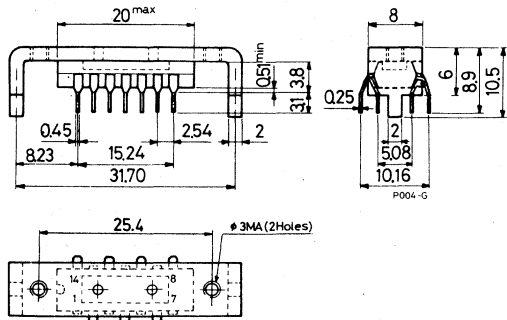
Quad in-line plastic package
with spacer for TBA 641 B72
(see also "MOUNTING
INSTRUCTIONS")



Quad in-line plastic package
with external bar
for TBA 641 BX1

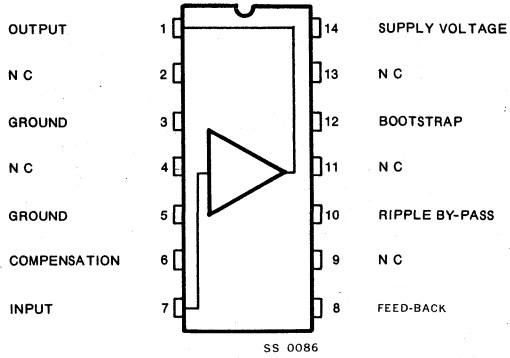


Quad in-line plastic package
with inverted external bar
for TBA 641 B11

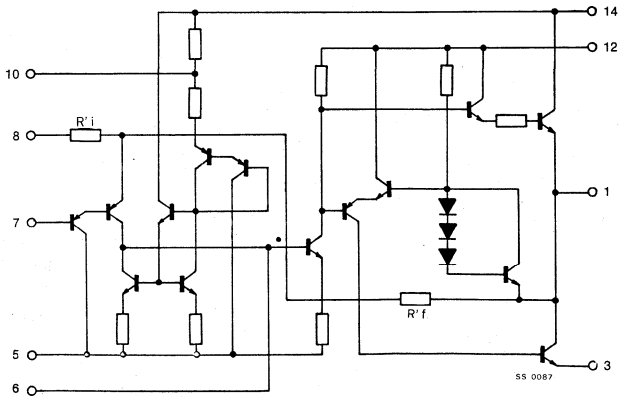


TBA 641B

CONNECTION DIAGRAM

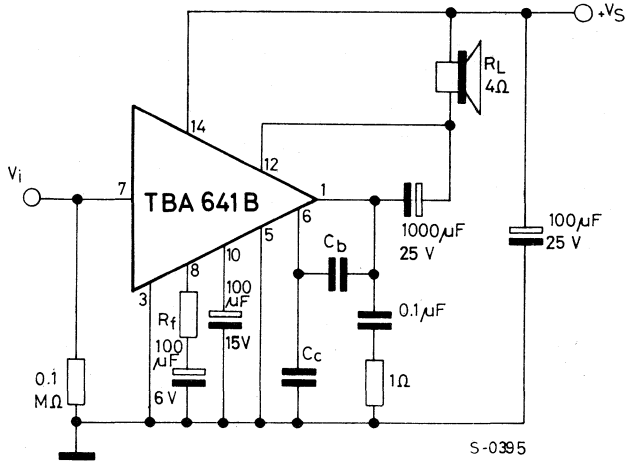


SCHEMATIC DIAGRAM



TBA 641B

TEST AND APPLICATION CIRCUIT



THERMAL DATA

			TBA 641 B72	TBA 641 BX1 TBA 641 B11
→ $R_{th\ j-case}$	Thermal resistance junction-case	max	13 °C/W	13 °C/W
→ $R_{th\ j-amb}$	Thermal resistance junction-ambient	max	83 °C/W	55 °C/W

ELECTRICAL CHARACTERISTICS

(See test circuit; $T_{amb} = 25\text{ °C}$, $V_s = 14\text{ V}$ and $R_L = 4\ \Omega$ unless otherwise specified)

Parameter		Test conditions	Min.	Typ.	Max.	Unit
V_o	Quiescent output voltage (pin 1)		6.5	7	8	V
I_d	Total quiescent drain current	$P_o = 0$		16	32	mA
I_d	Quiescent drain current of output transistors	$P_o = 0$		13		mA
I_d	Drain current	$P_o = 4.5\text{ W}$		485		mA
I_b	Bias current (pin 7)			250		nA

ELECTRICAL CHARACTERISTICS (continued)

Parameter	Test conditions	Min.	Typ.	Max.	Unit
P_o Output power	$d = 10\%$ $f = 1 \text{ kHz}$ $G_v = 46 \text{ dB}$	4	4.5		W
R'_f Internal feedback resistance	See schematic diagram		7		$\text{k}\Omega$
R'_i Internal feedback resistance	See schematic diagram		35		Ω
Z_i Input impedance (pin 7)	$f = 1 \text{ kHz}$ $G_v = 46 \text{ dB}$		3		$\text{M}\Omega$
d Distortion	$f = 1 \text{ kHz}$ $G_v = 46 \text{ dB}$ $P_o = 50 \text{ mW}$ $P_o = 2 \text{ W}$		0.3 0.8		% %
G_v Voltage gain	$R_f = 0$		46		dB
e_N Input noise voltage	$R_s = 22 \text{ k}\Omega$ $B = 10 \text{ kHz}$		3.4		μV

Fig. 1 - Typical output power vs supply voltage

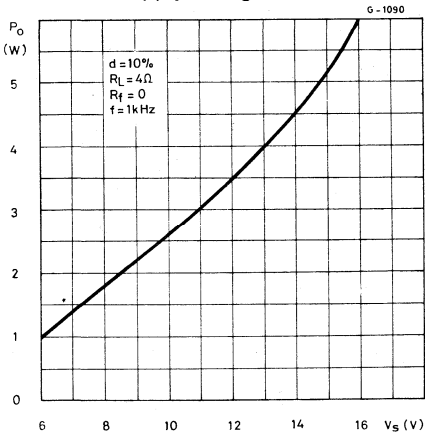
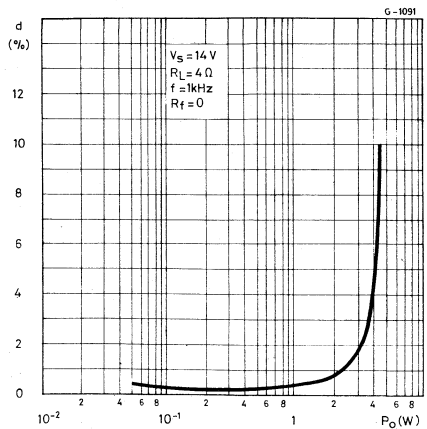


Fig. 2 - Typical distortion vs output power



TBA 641B

Fig. 3 - Typical voltage gain vs feedback resistance (R_f)

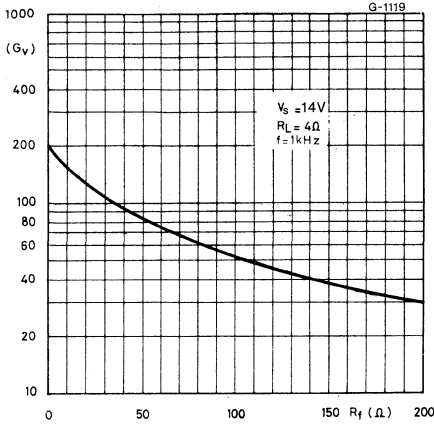


Fig. 4 - Typical value of C_b vs R_f for various values of B

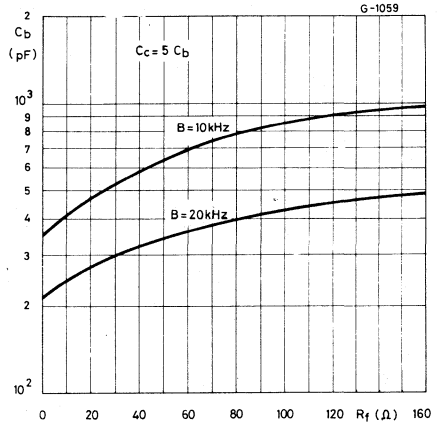


Fig. 5 - Typical output power vs input voltage

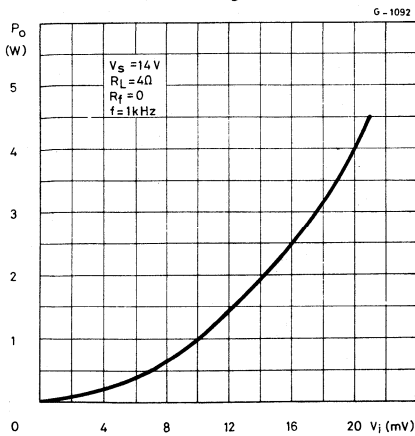
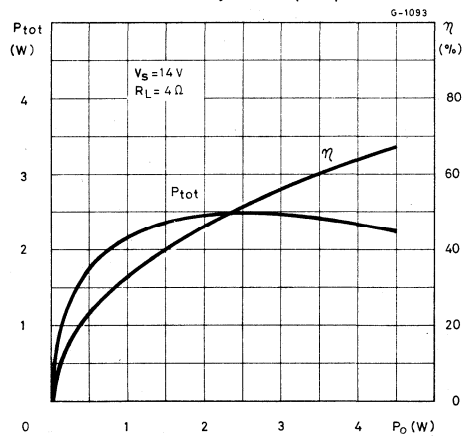


Fig. 6 - Typical power dissipation and efficiency vs output power



TBA 641B

Fig. 7 - Typical drain current vs output power

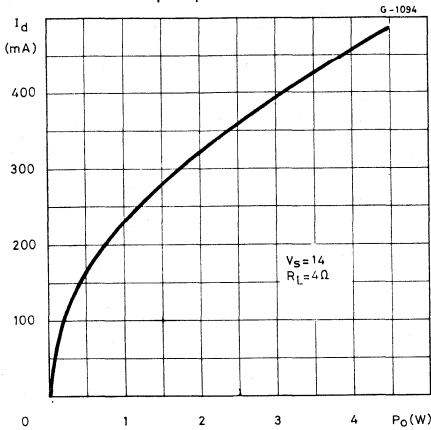


Fig. 8 - Maximum power dissipation vs supply voltage

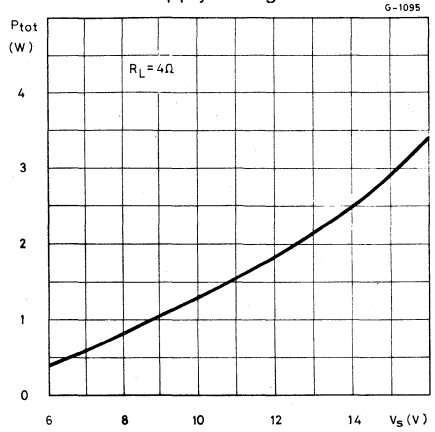


Fig. 9 - Power rating chart (TBA 641 BX1 and TBA 641 B11)

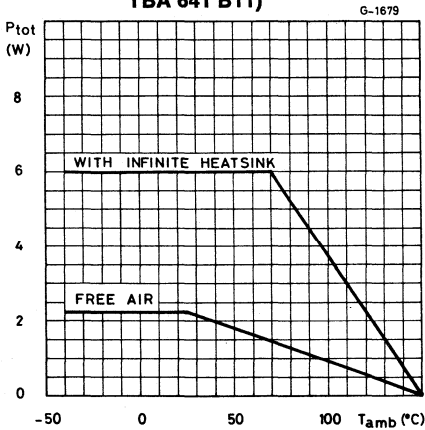
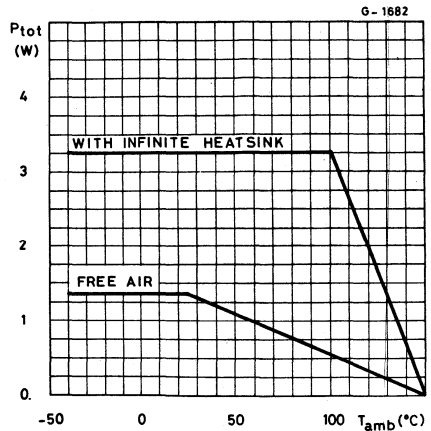


Fig. 10 - Power rating chart (TBA 641 B72)



TBA 641B

Fig. 11 - Typical quiescent drain current vs supply voltage

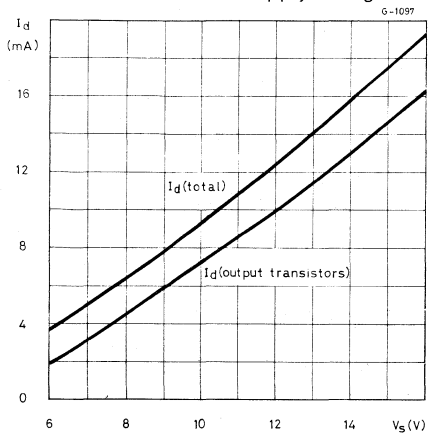


Fig. 12 - Typical quiescent drain current vs ambient temperature

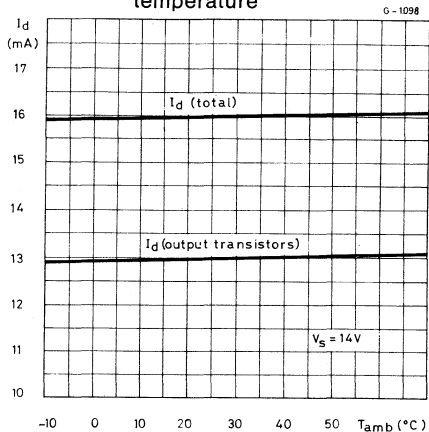


Fig. 13 - Typical quiescent output voltage vs ambient temperature

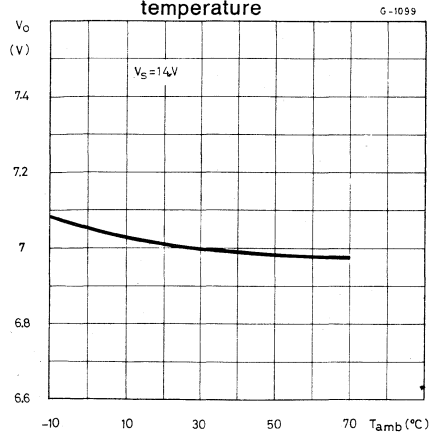
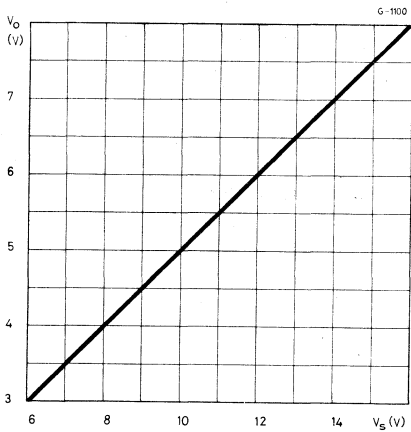
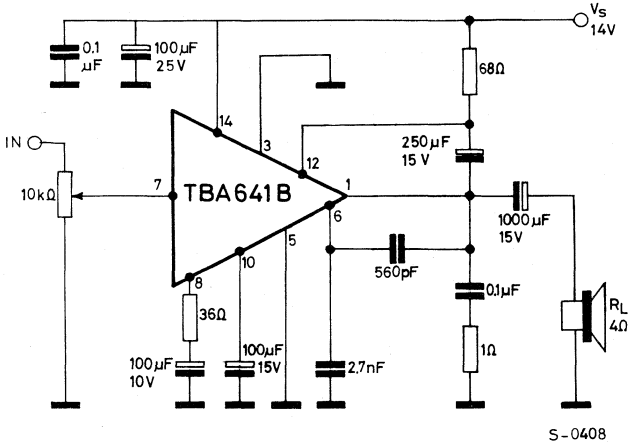


Fig. 14 - Typical quiescent output voltage vs supply voltage



TBA 641B

TYPICAL APPLICATION



MOUNTING INSTRUCTIONS

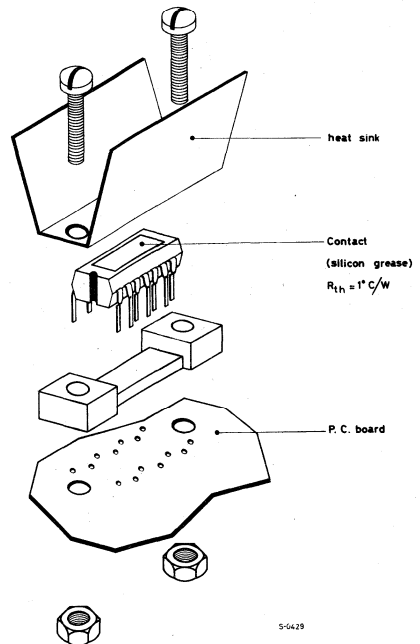


Fig. 15-Shows a method of mounting the TBA 641 B with the spacer, satisfactory both mechanically and from the point of view of heat dissipation. Better thermal contact between package and heat-sink can be obtained by using a small quantity of silicon grease. For heat dissipation the desired thermal resistance is obtained by fixing the elements shown to a heat-sink of suitable dimensions.

TBA 641B

MOUNTING INSTRUCTIONS (continued)

Power dissipation can be achieved by means of an additional external heat-sink fixed with two screws (both packages) or by soldering the pins of the external bar to suitable copper areas on the p.c. board (TBA 641 B11)

- A. In the former case, the thermal resistance case-ambient of the added heat-sink can be calculated as follows:

$$R_{th} = \frac{(T_{jmax} - T_{amb}) - P_{tot} \cdot R_{th\ j-case}}{P_{tot}}$$

where:

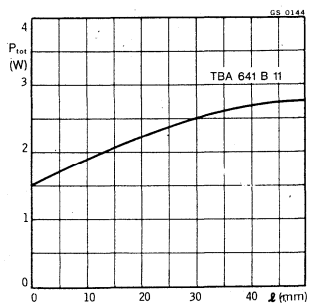
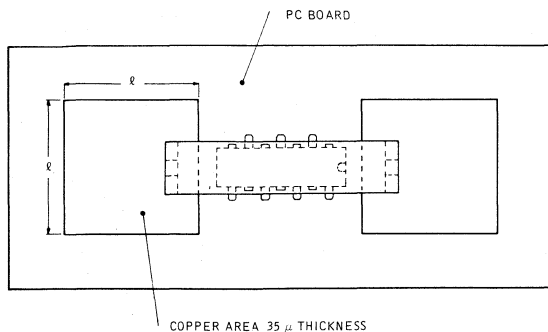
T_{jmax} = Max junction temperature

T_{amb} = Ambient temperature

P_{tot} = Power dissipation

$R_{th\ j-case}$ = Thermal resistance junction-case

- B. If copper areas on the p.c. board are used (TBA 641 B11) the diagrams enclosed give the maximum power dissipation as a function of copper area, with copper thickness $35\ \mu$ and ambient temperature $55\ ^\circ\text{C}$.



LINEAR INTEGRATED CIRCUIT

TUNER AND IF AMPLIFIER FOR AM RADIO

- AUDIO OUTPUT VOLTAGE 0.6 V
- LOW NOISE and HIGH GAIN
- WIDE VOLTAGE SUPPLY RANGE 4.5 V to 18 V
- HIGH SIGNAL HANDLING CAPABILITY 1 V

The TBA 651 is a monolithic integrated circuit in a 16-lead dual in-line plastic package which processes the high frequency signal from antenna to detector in AM receivers. It is particularly intended for car radios and high quality radio receivers.

The TBA 651 consists of five stages: RF amplifier, mixer, oscillator, IF amplifier and AGC control. It features wide voltage supply range (4.5 to 18 V), high gain, low noise and high sensitivity.

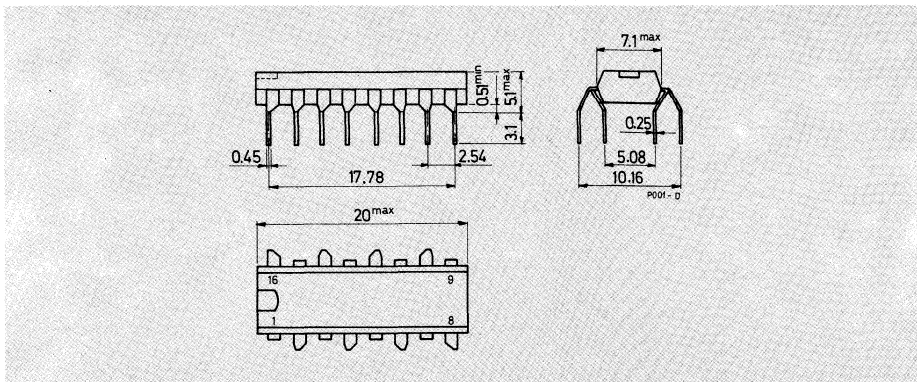
ABSOLUTE MAXIMUM RATINGS

V_s	Supply voltage	18 V
P_{tot}	Power dissipation at $T_{\text{amb}} \leq 80^\circ\text{C}$	250 mW
T_{stg}, T_j	Storage and junction temperature	-40 to 150 $^\circ\text{C}$
T_{op}	Operating temperature	-20 to 80 $^\circ\text{C}$

ORDERING NUMBER: TBA 651

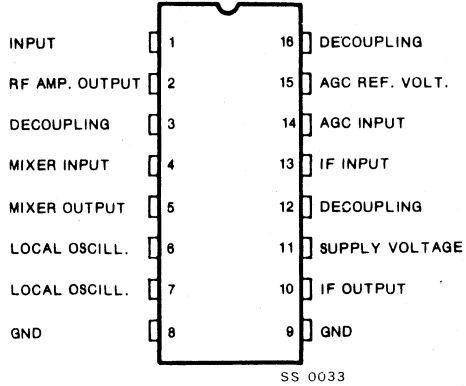
MECHANICAL DATA

Dimensions in mm

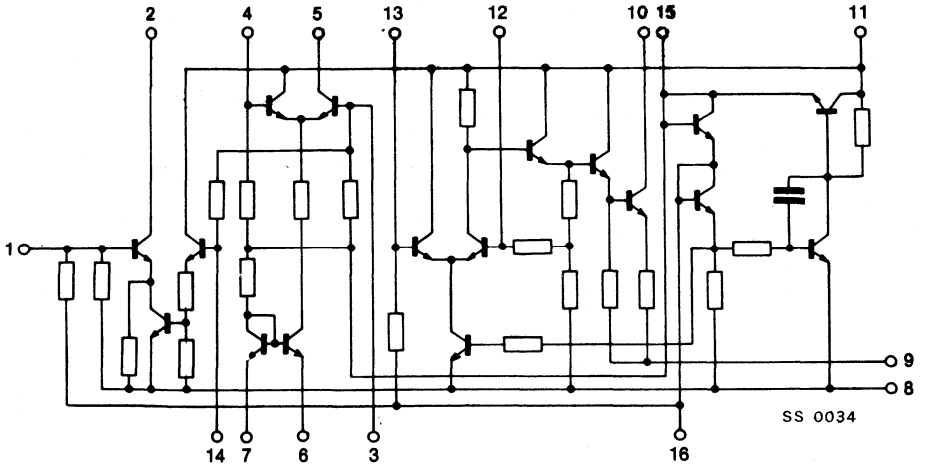


TBA 651

CONNECTION DIAGRAM

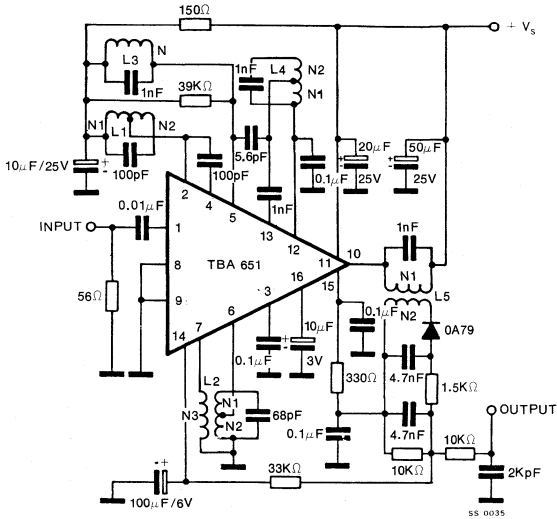


SCHEMATIC DIAGRAM



TBA 651

TEST CIRCUIT (f = 1.6 MHz)



THERMAL DATA

$R_{th\ j-amb}$	Thermal resistance junction-ambient	max	280 °C/W
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ELECTRICAL CHARACTERISTICS

($T_{amb} = 25\text{ °C}$, $V_s = 12\text{ V}$ unless otherwise specified)

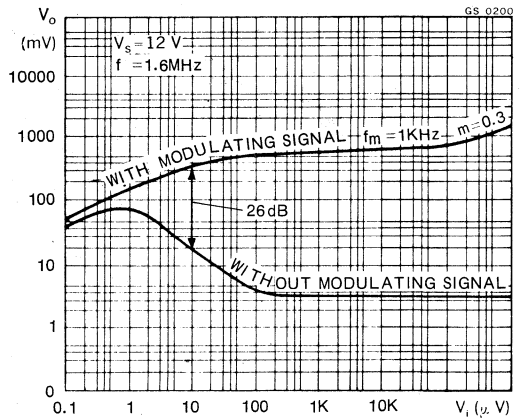
Parameter	Test conditions	Min.	Typ.	Max.	Unit
I_d	Quiescent drain current		11.5		mA
V_i	Input voltage at pin 1	signal to noise ratio = 26 dB		10	μV
		d = 5% f = 1.6 MHz $f_m = 1\text{ kHz}$ m = 0.8		100	mV
V_o	Recovered audio output voltage	f = 1.6 MHz $f_m = 1\text{ kHz}$ m = 0.3			
		$V_i = 100\ \mu\text{V}$ $V_i = 1.5\ \mu\text{V}$		0.5 180	V mV

TBA 651

ELECTRICAL CHARACTERISTICS (continued)

Parameter	Test conditions	Min.	Typ.	Max.	Unit
V_i Signal handling capability at pin 1			1		V
AGC range	for 10 dB expansion of output voltage		80		dB
R_i rf amplifier input resistance at pin 1	$f = 1.6 \text{ MHz}$		1.4		$k\Omega$
R_i Mixer input resistance at pin 4	$f = 1.6 \text{ MHz}$		2.5		$k\Omega$
R_i IF amplifier input resistance at pin 13	$f = 455 \text{ kHz}$		4		$k\Omega$

Fig. 1 - Typical output voltage vs input voltage



TBA 780

LINEAR INTEGRATED CIRCUIT

WIDE-BAND AMPLIFIER, FM DETECTOR, AUDIO PREAMPLIFIER/DRIVER

The TBA 780 provides, in a single monolithic silicon chip, a major subsystem for the sound section of TV receivers in a 14-lead quad in-line or dual in-line plastic package. As shown in the schematic diagram the TBA 780 contains a multistage wide-band IF amplifier/limiter section, active filter, an FM-detector stage, electronic attenuator, a Zener diode regulated power supply section and AF amplifier section specifically designed to directly drive an NPN power transistor or high-transconductance tube. In the TBA 780, the demodulation can be effected by a single tuned discriminator coil (differential peak detector).

Because of the circuit being so inclusive, a minimum number of external components is required. A particular feature of the TBA 780 is the electronic attenuator, which performs the conventional volume control function.

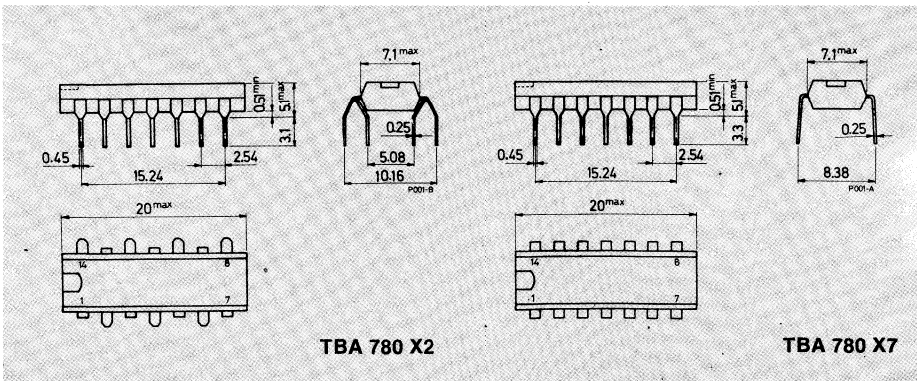
ABSOLUTE MAXIMUM RATINGS

I_s	Supply current (pin 5)	50 mA
I_o	Output current (pin 12)	6 mA
V_i	Input-signal voltage (between pins 1 and 2)	± 3 V
P_{tot}	Total power dissipation: at $T_{amb} \leq 25^\circ\text{C}$	850 mW
T_{stg}	Storage temperature	-25 to 150 $^\circ\text{C}$
T_{op}	Operating temperature	0 to 85 $^\circ\text{C}$

ORDERING NUMBERS: TBA 780 X2 for quad in-line plastic package
TBA 780 X7 for dual in-line plastic package

MECHANICAL DATA

Dimensions in mm



TBA 780

ELECTRICAL CHARACTERISTICS ($T_{amb} = 25^\circ\text{C}$, DC volume control $P_2 = 0$ and $V_S = +30\text{ V}$ applied to terminal 5 through a $620\ \Omega$ resistor, unless otherwise specified)

Parameter	Test conditions	Min.	Typ.	Max.	Unit	Fig.
I_5 Supply current	$V_S = 9\text{ V}$ (applied direct. to pin 5)	10	16	24	mA	—
$V_{i(\text{threshold})}$ Input limiting voltage (pin 2)	$f = 5.5\text{ MHz}$ $f_m = 1\text{ kHz}$ $\Delta f = \pm 50\text{ kHz}$		200	400	μV	—
V_o Recovered audio voltage (pin 8)	$V_i = 100\text{ mV}$ $f = 5.5\text{ MHz}$ $f_m = 1\text{ kHz}$ $\Delta f = \pm 50\text{ kHz}$	0.5	0.75		V_{rms}	3
d Distortion (pin 8)			0.9	2	%	
V_o Audio output voltage (pin 12)	d = 5% f = 1 kHz	2	2.5		V_{rms}	4
V_o DC output voltage (pin 12)		8.5		11.75	V	—
DC volume control range	$P_2 = \infty$	60	80		dB	3
Max. play-through voltage			0.075	1	mV	
R_i Input resistance (pin 2)	f = 5.5 MHz		17		k Ω	—
R_o Output resistance (pin 9)			3.25		k Ω	

TBA 780

ELECTRICAL CHARACTERISTICS (continued)

Parameter	Test conditions	Min.	Typ.	Max.	Unit	Fig.
R_o Output resistance (pin 12)	$f = 1 \text{ kHz}$	270			Ω	—
R_o Output resistance (pin 7)		7.5			$k\Omega$	
R_o Output resistance (pin 8)		300			Ω	
C_i Input capacitance (pin 2)	$f = 5.5 \text{ MHz}$	4			pF	—
C_o Output capacitance (pin 9)		7.5			pF	
G_v Audio voltage gain	$f = 1 \text{ kHz}$ $V_i = 0.1 \text{ V}$	17.5	20		dB	4
P_{tot} Total power dissipation		343	370	400	mW	—
AMR Amplitude modulation rejection	$f = 5.5 \text{ MHz}$	40	50		dB	3

TBA 780

SCHEMATIC DIAGRAM

Fig. 1

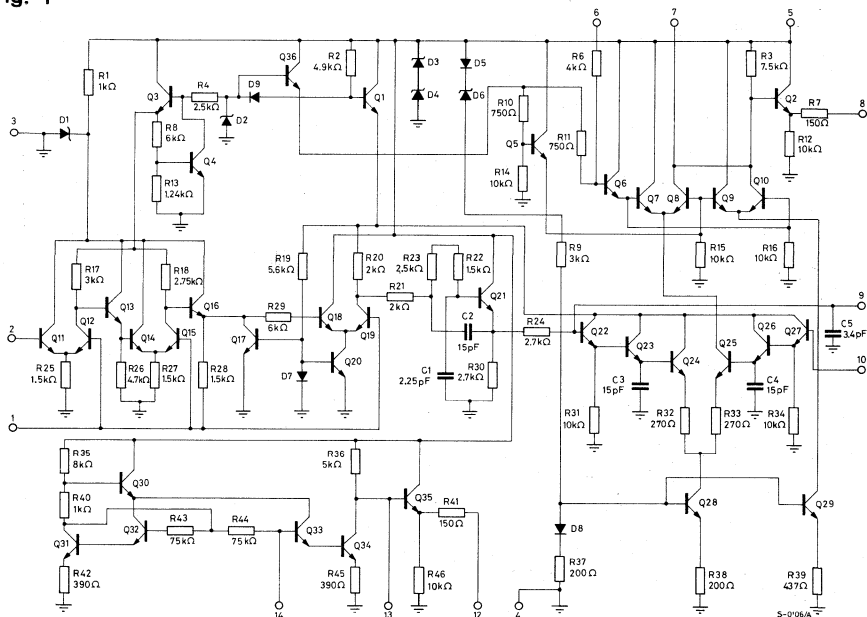
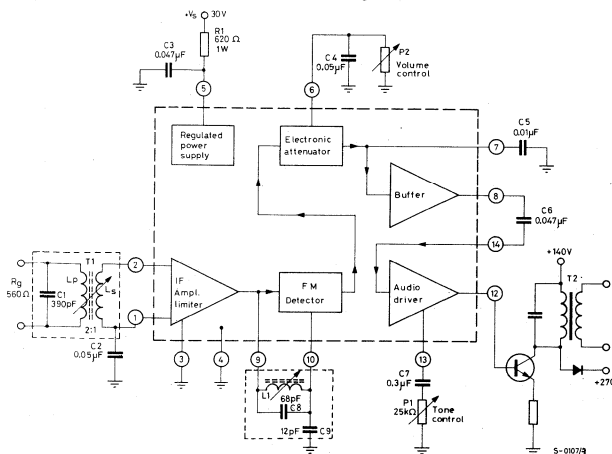


Fig. 2 - Typical application using TBA 780 and class A output transistor



- 1) $T_1 = 5.5 \text{ MHz}$ transformer
 $L_p = 5.5 \mu\text{H}$; $Q_0=80$; 19 turns
 $\varnothing 0.15 \text{ mm}$ silk-covered
 copper wire with powdered-iron core
 $L_s = 9 \text{ turns } \varnothing 0.15 \text{ mm}$
- 2) $T_2 = \text{Audio output transformer}$:
 The dimensions of the transformer and of the circuit parameters are to be evaluated on the basis of the output power desired and of the load to be used
- 3) $L_1 = \text{Single tuned discriminator coil: } 12 \mu\text{H}$; $Q_0=50$ (58 turns $\varnothing 0.08 \text{ mm}$ with powdered-iron core)

TBA 780

Fig. 3 - Input limiting voltage, AM rejection, recovered audio, total harmonic distortion, maximum attenuation, maximum "play-through" test circuit

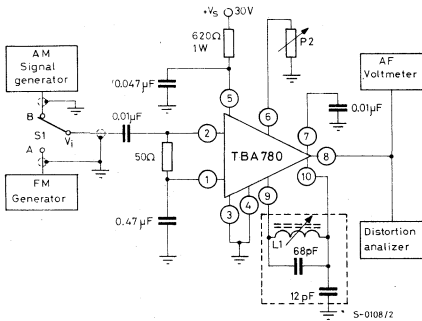


Fig. 4 - Audio voltage gain (undistorted output) test circuit

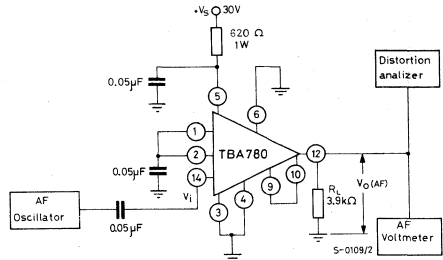
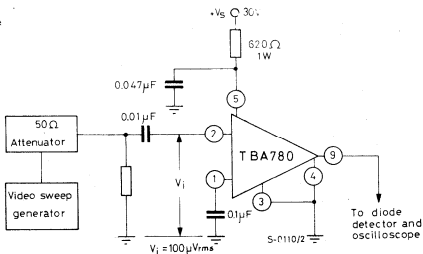


Fig. 5 - IF amplifier voltage gain test circuit



TBA 780

Fig. 6 - Typical IF amplifier voltage gain

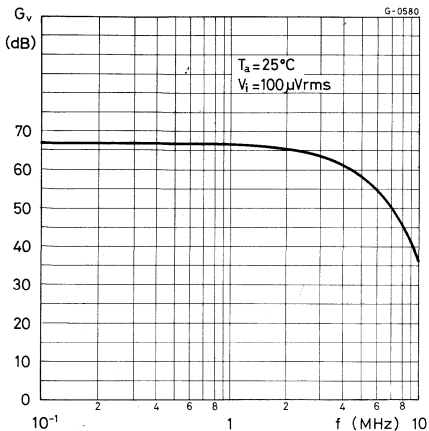


Fig. 7 - Typical AF amplifier voltage gain

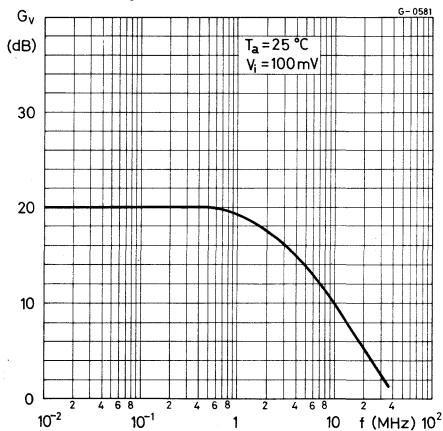


Fig. 8 - Typical FM detector output voltage versus input voltage

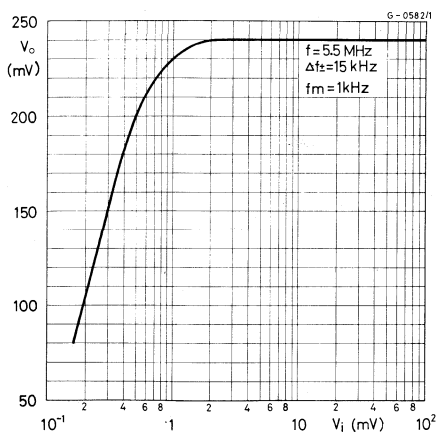
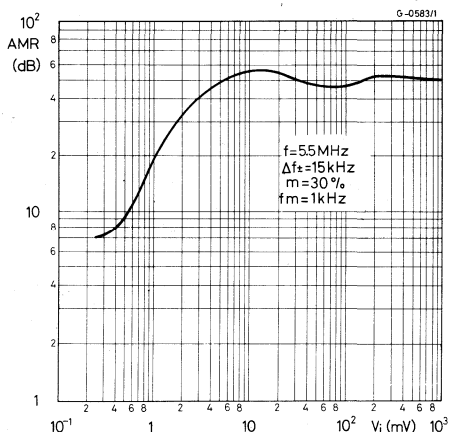


Fig. 9 - Typical amplitude-modulation rejection versus input voltage



TBA 780

Fig. 10 - Typical gain reduction versus resistance (P2) (terminal 6 to gnd)

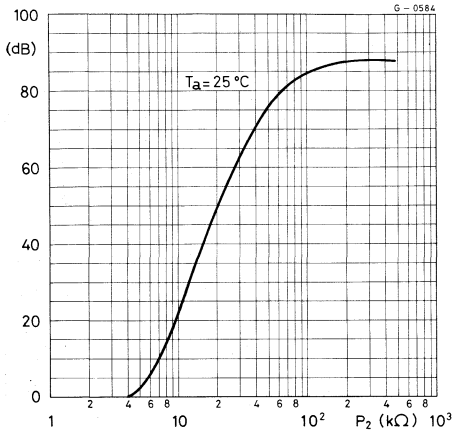
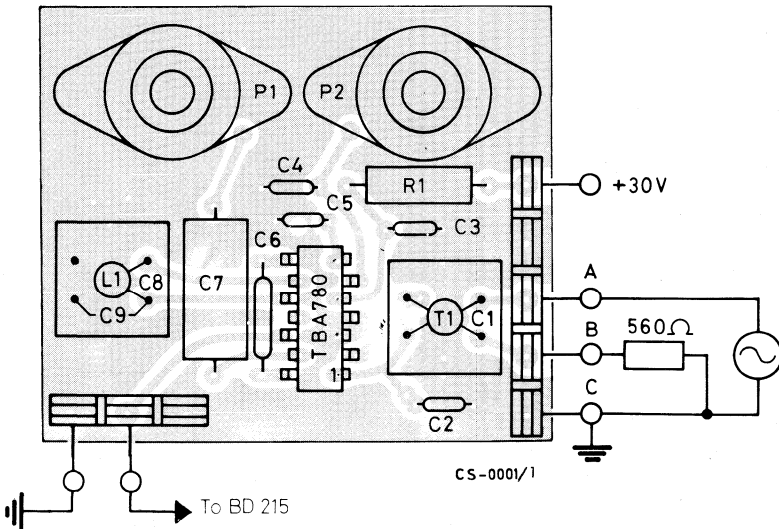


Fig. 11 - P.C. board layout. 1:1 scale (fig. 2 circuit)



TBA 800

LINEAR INTEGRATED CIRCUIT

AUDIO POWER AMPLIFIER

The TBA 800 is an monolithic integrated power amplifier in a 12-lead quad in-line plastic package. The external cooling tabs enable 2.5 W output power to be achieved without external heat-sink and 5 W output power using a small area of the P.C. board Copper as a heat sink.

It is intended for use as a low frequency Class B amplifier.

The TBA 800 provides 5 W output power at 24 V/16 Ω and works with a wide range of supply voltage (5 to 30 V); it gives high output current (up to 1.5 A), high efficiency (75% at 5 W output), very low harmonic distortion and no cross-over distortion.

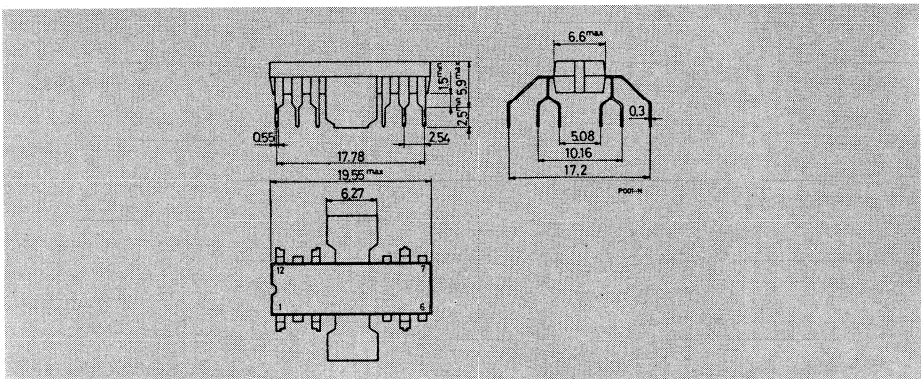
ABSOLUTE MAXIMUM RATINGS

V_s	Supply voltage	30	V
i_o	Peak output current (non repetitive)	2	A
I_o	Peak output current (repetitive)	1.5	A
P_{tot}	Power dissipation at $T_{amb} = 80^\circ\text{C}$ at $T_{tab} = 90^\circ\text{C}$	1 5	W
T_{stg}, T_j	Storage and junction temperature	-40 to 150	$^\circ\text{C}$

ORDERING NUMBER: TBA 800

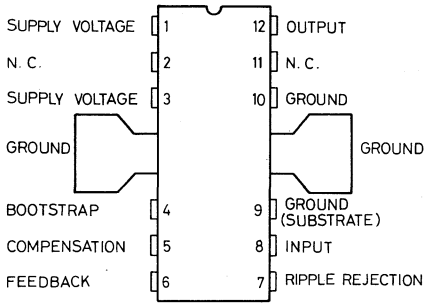
MECHANICAL DATA

Dimensions in mm

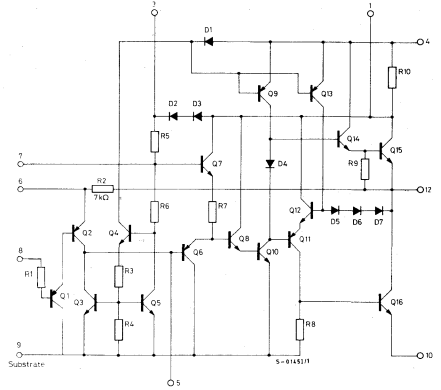


TBA 800

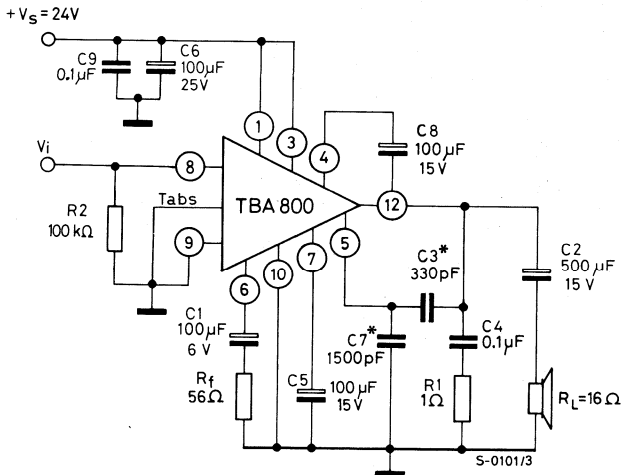
CONNECTION AND SCHEMATIC DIAGRAMS



S-0329



TEST CIRCUIT



* C3, C7 see fig. 5

TBA 800

THERMAL DATA

$R_{th\ j-tab}$	Thermal resistance junction-tab	max	12 °C/W
$R_{th\ j-amb}$	Thermal resistance junction-ambient	max	70* °C/W

* Obtained with tabs soldered to printed circuit with minimized copper area.

ELECTRICAL CHARACTERISTICS (Refer to the test circuit, $T_{amb} = 25^{\circ}\text{C}$, $V_s = 24\text{ V}$, $R_L = 16\ \Omega$, unless otherwise specified)

Parameter		Test conditions	Min.	Typ.	Max.	Unit
V_o	Quiescent output voltage (pin 12)		11	12	13	V
I_d	Quiescent drain current (pin 1)			9	20	mA
I_b	Bias current (pin 8)			1	5	μA
P_o	Output power	$d = 10\%$ $f = 1\text{ kHz}$	4.4	5		W
$V_{i(rms)}$	Input saturation voltage		220			mV
V_i^*	Input sensitivity	$P_o = 5\text{ W}$ $f = 1\text{ kHz}$		80		mV
R_i	Input resistance (pin 8)			5		$\text{M}\Omega$
B	Frequency response (-3 dB)	$C3 = 330\text{ pF}$		40 to 20,000		Hz
d	Distortion	$P_o = 50\text{ mW to } 2.5\text{ W}$ $f = 1\text{ kHz}$		0.5		%
G_v	Voltage gain (open loop)	$f = 1\text{ kHz}$		80		dB
G_v	Voltage gain (closed loop)	$f = 1\text{ kHz}$	39	42	45	dB

* See fig. 6

TBA 800

ELECTRICAL CHARACTERISTICS (continued)

Parameter		Test conditions	Min. Typ. Max.	Unit
e_N	Input noise voltage	$R_g = 0$ $B(-3 \text{ dB}) = 40 \text{ to } 20,000 \text{ Hz}$	5	μV
i_N	Input noise current	$B(-3 \text{ dB}) = 40 \text{ to } 20,000 \text{ Hz}$	0.2	nA
η	Efficiency	$P_o = 5 \text{ W}$ $f = 1 \text{ kHz}$	75	%
SVR	Supply voltage rejection ratio	$f_{\text{ripple}} = 100 \text{ Hz}$		
		$C_5 = 25 \mu\text{F}$ $C_5 = 100 \mu\text{F}$	35 38	dB dB
I_d	Drain current	$P_o = 5 \text{ W}$	280	mA

Fig. 1 - Typical output power versus supply voltage

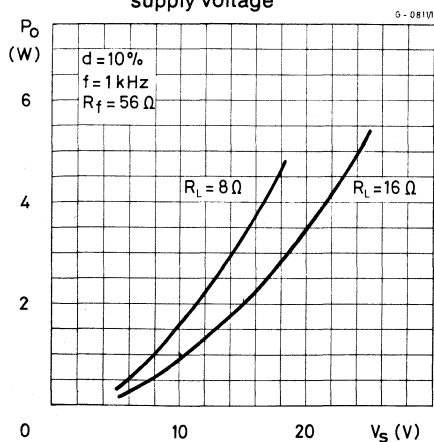


Fig. 2 - Maximum power dissipation versus supply voltage

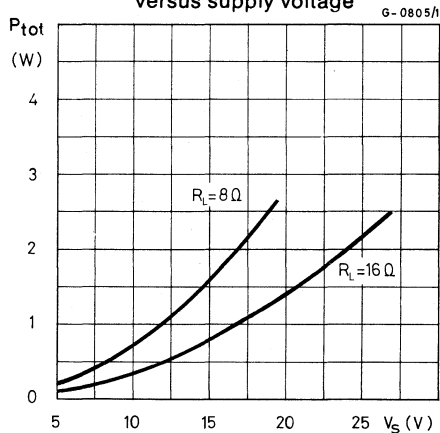


Fig. 3 - Typical distortion versus output power

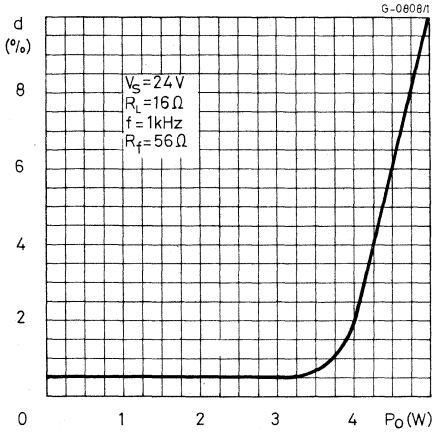


Fig. 4 - Typical distortion versus frequency

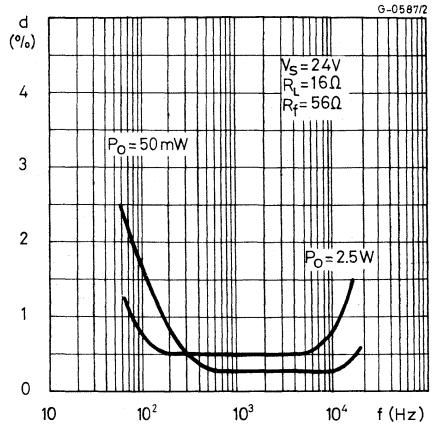


Fig. 5 - Value of C3 versus R_f for various values of B

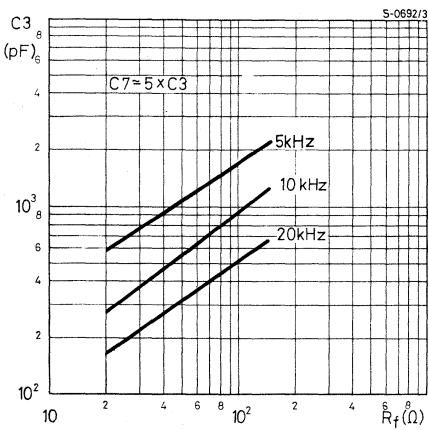
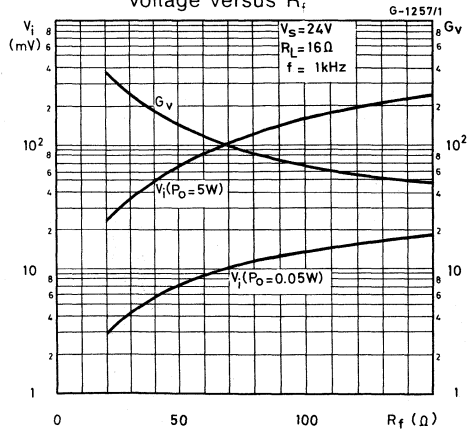


Fig. 6 - Typical voltage gain (closed loop) and typical input voltage versus R_f



TBA 800

Fig. 7 - Typical power dissipation and efficiency versus output power

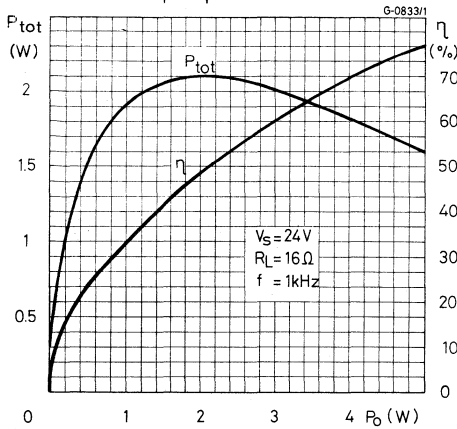


Fig. 8 - Typical quiescent output voltage (pin 12) versus supply voltage

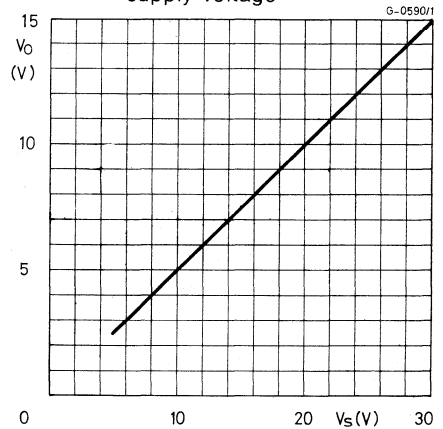


Fig. 9 - Typical quiescent current versus supply voltage

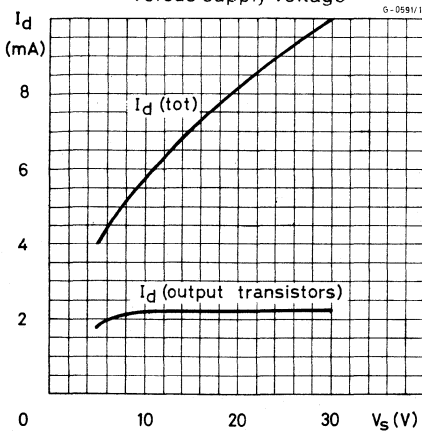
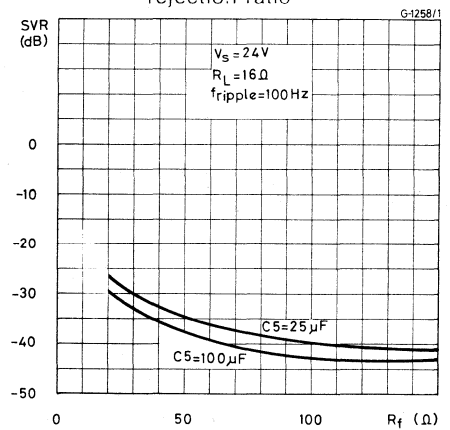


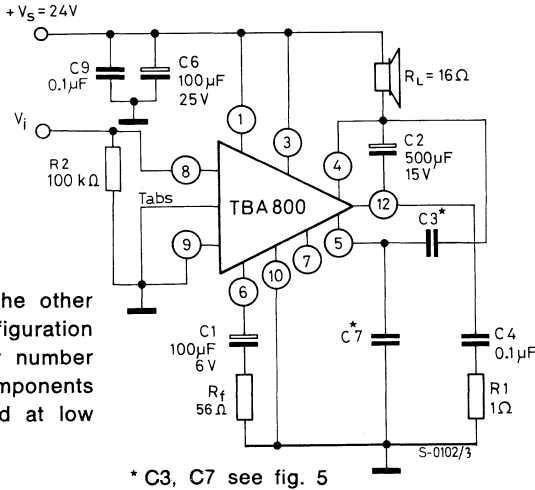
Fig. 10 - Typical supply voltage rejection ratio



TBA 800

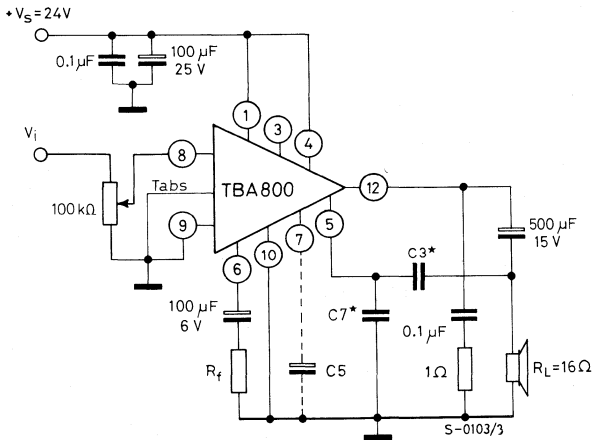
APPLICATION INFORMATION

Fig. 11 - Circuit with the load connected to the supply voltage



Compared with the other circuits, this configuration entails a smaller number of external components and can be used at low supply voltages.

Fig. 12 - Circuit with load connected to ground without bootstrap



This circuit is only for use at high voltages. The pin 3 is left open circuit, this automatically inserts diodes D2 - D3 (see schematic diagram) and this enables a symmetrical wave to be obtained at the output. Refer to figs. 13 and 14 for distortion and output power.

* C3, C7 see fig. 5

TBA 800

Fig. 13 - Typical distortion versus output power (fig. 12 circuit)

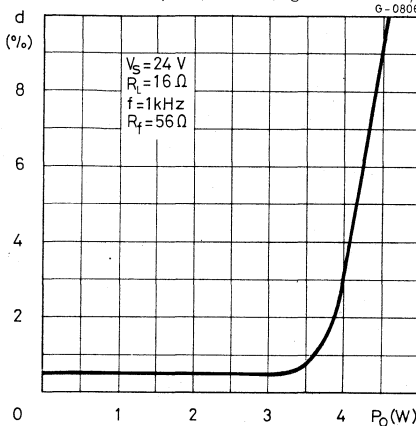


Fig. 14 - Typical output power versus supply voltage (fig. 12 circuit)

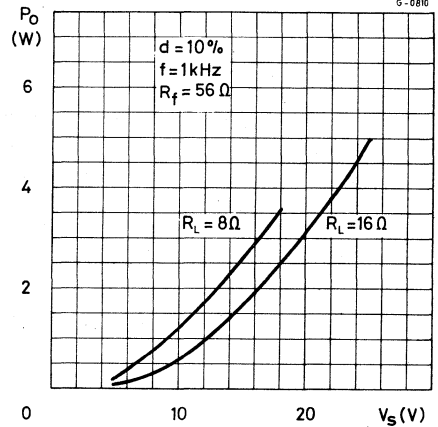
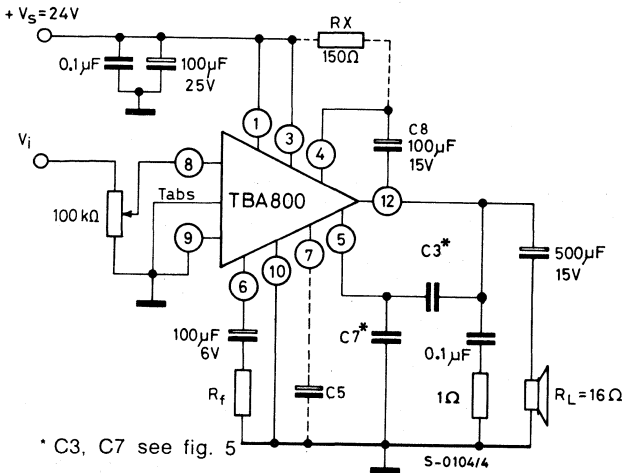


Fig. 15 - Circuit with load connected to ground with bootstrap



* C3, C7 see fig. 5

The bootstrap capacitor C8 enables the same electrical characteristics as those of the test circuit to be achieved. For low supply voltage operation (e.g. 9 to 14 V), RX (150 Ω) is connected between pin 1 and pin 4.

N.B. - For the circuits of figures 12 and 15 an excellent supply voltage ripple rejection is obtained by connecting the capacitor C5 (10 to 100 μF - 15 V) between pin 7 and ground.

TBA 800

MOUNTING INSTRUCTIONS

The tabs on the TBA 800 can be used to conduct away the heat generated in the integrated circuit so that the junction temperature does not exceed the permissible maximum (150 °C).

This may be done by connecting tabs to an external heat sink, or by soldering them to a suitable Copper area of the printed circuit board (fig. 16 a).

Fig. 16 b shows a simple type of heat sink. Assuming an area of copper on the printed circuit board of only 2 cm², the total R_{th} between junction to ambient is approximately 28 °C/W.

External heat sink or printed circuit copper area must be connected to electrical ground.

In the latter case, fig. 17 shows the maximum dissipated power (for $T_{amb} = 55$ °C and $T_{amb} = 70$ °C) as a function of the side of two equal square Copper areas having a thickness of 35 μ (1.4 mils).

During soldering the tabs temperature must not exceed 260 °C and the soldering time must not be longer than 12 seconds.

Fig. 16 a - Example of an area of P.C. board copper soldered to the tabs of the TBA 800, which is used as a heat sink

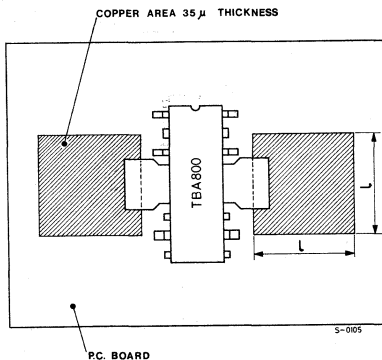
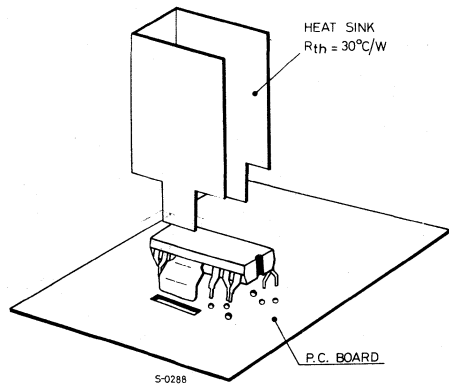


Fig. 16 b - Example of TBA 800 with external heatsink



TBA 800

Fig. 17 - Power that can be dissipated versus "l"

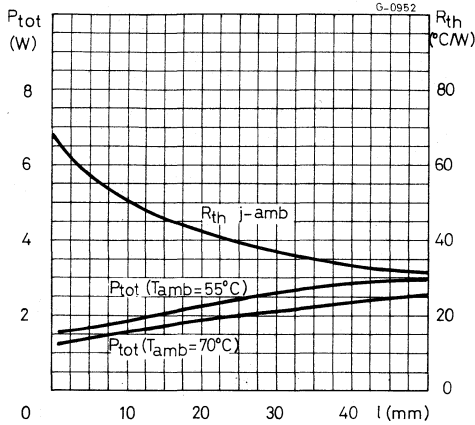


Fig. 18 - Power rating characteristics

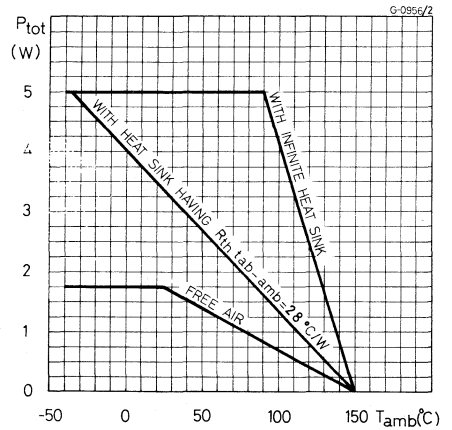
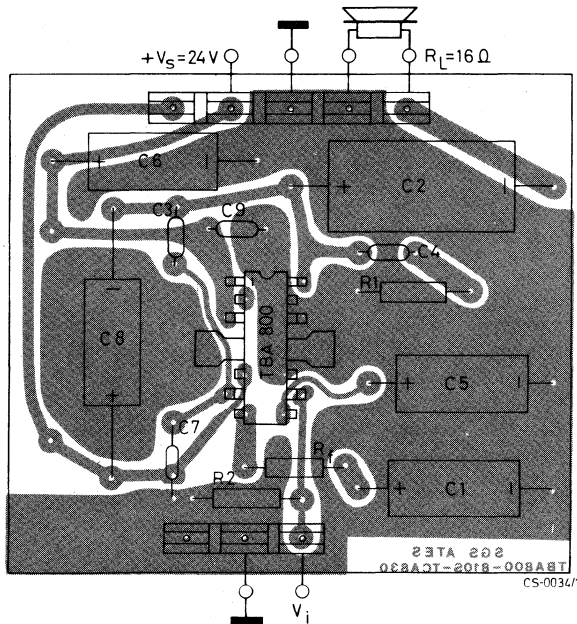
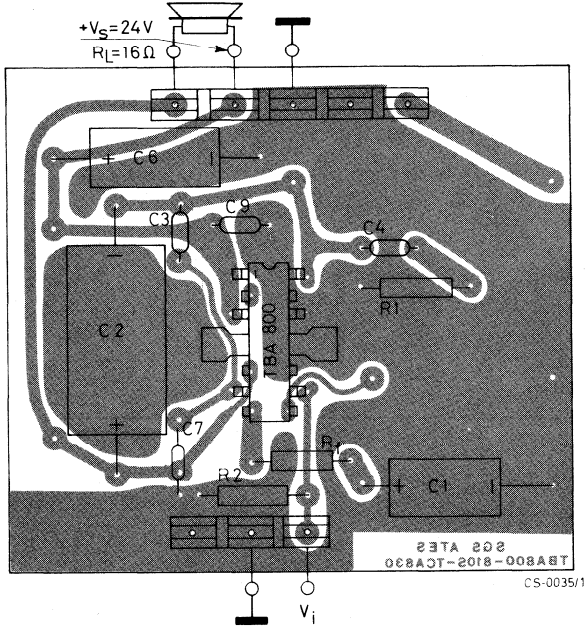


Fig. 19 - P.C. board and component layout of the test circuit (1:1 scale)



TBA 800

Fig. 20 - P.C. board and component layout of the fig. 11 circuit (1:1 scale)



PROCEDURE TO CALCULATE AREA OF COPPER NEEDED

1) Calculate maximum power dissipation

$$P_{\text{tot}} = 0.4 \cdot \frac{V_{S \text{ max}}^2}{8 R_L} + V_{S \text{ max}} I_d$$

where:

- $V_{S \text{ max}}$ = maximum value of supply voltage (increase 10% if not stabilized)
- R_L = load resistance
- I_d = quiescent drain current (for typical value see fig. 9); maximum value at $V_S = 24 \text{ V}$ is 20 mA (for worst case design)

PROCEDURE TO CALCULATE AREA OF COPPER NEEDED (continued)

2) From fig. 17 and knowing $T_{\text{amb max}}$, calculate ℓ .

Examples:

a) V_S (not stabilized) = 24 V; $R_L = 16 \Omega$; $T_{\text{amb max}} = 55^\circ\text{C}$

$$P_{\text{tot}} = 0.4 \cdot \frac{(24 + 2.4)^2}{8 \cdot 16} + (24 + 2.4) \cdot 20 \cdot 10^{-3} = 2.6 \text{ W}$$

From fig 17 and for $T_{\text{amb max}} = 55^\circ\text{C}$, $\ell \cong 25 \text{ mm}$.

For geometries different from the one of fig. 16 note that copper areas near the tabs have better efficiency as regards power dissipation. Therefore additional safety factors must be added for worst case design.

b) V_S (stabilized) = 12 V; $R_L = 8 \Omega$

$$P_{\text{tot}} = 0.4 \cdot \frac{12^2}{8 \cdot 8} + 0.02 \cdot 12 = 1 \text{ W}$$

The fig. 17 shows that no heat sink is required if $T_{\text{amb}} \leq 55^\circ\text{C}$.

LINEAR INTEGRATED CIRCUITS

TBA 810S TBA 810AS

7 W AUDIO POWER AMPLIFIER WITH THERMAL SHUT-DOWN

The TBA 810 S is a monolithic integrated circuit in a 12-lead quad in-line plastic package, intended for use as a low frequency class B amplifier.

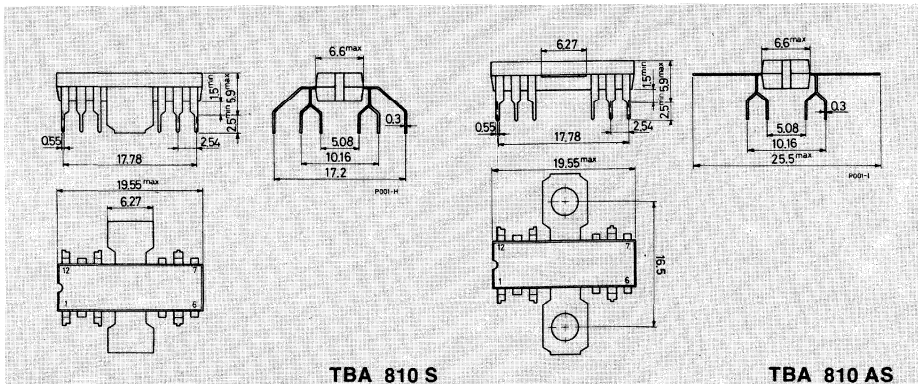
The TBA 810 S provides 7 W output power at 16 V/4 Ω , 6 W at 14.4 V/4 Ω , 2.5 W at 9 V/4 Ω , 1 W at 6 V/4 Ω and works with a wide range of supply voltages (4 to 20 V); it gives high output current (up to 2.5 A), high efficiency (75% at 6 W output), very low harmonic and cross-over distortion. The circuit is provided with a thermal limiting circuit which fundamentally changes the criteria normally used in determining the size of the heatsink, in addition the TBA 810 S/AS can withstand short-circuit on the load for supply voltages up to 15 V.

The TBA 810 AS has the same electrical characteristics as the TBA 810 S, but its cooling tabs are flat and pierced so that an external heatsink can easily be attached.

V_s	Supply voltage	20	V
	Output peak current (non-repetitive)	3.5	A
	Output peak current (repetitive)	2.5	A
P_{tot}	Power dissipation: at $T_{amb} \leq 80^\circ\text{C}$ (for TBA 810 S)	1	W
	at $T_{tab} \leq 100^\circ\text{C}$ (for TBA 810 AS)	5	W
T_{stg}, T_j	Storage and junction temperature	-40 to 150	$^\circ\text{C}$

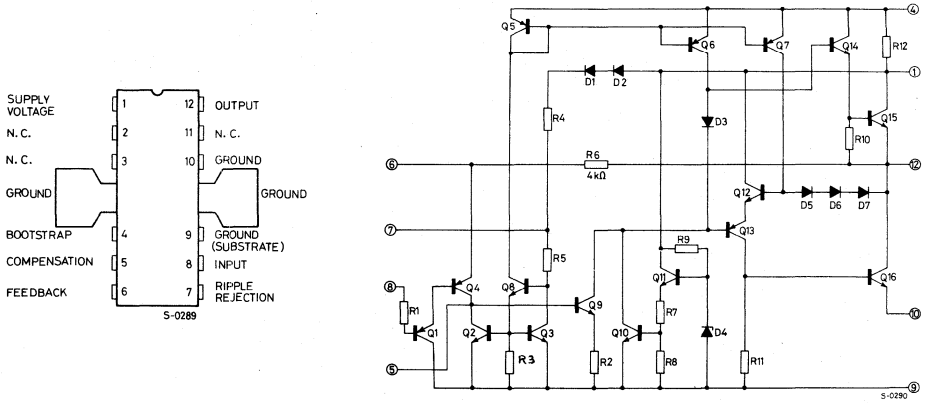
MECHANICAL DATA

Dimensions in mm

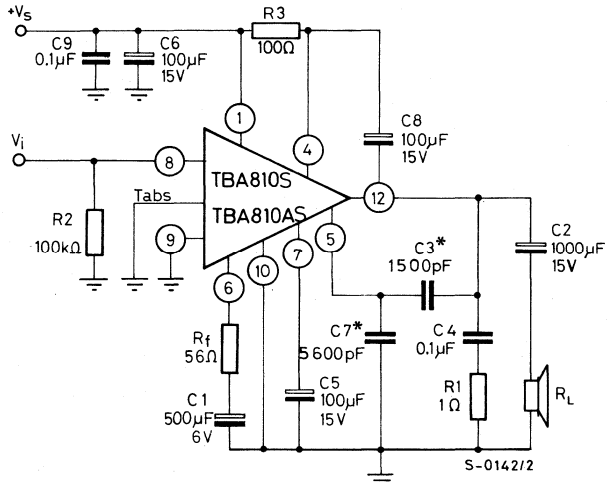


TBA 810S TBA 810AS

CONNECTION AND SCHEMATIC DIAGRAM



TEST AND APPLICATION CIRCUIT



* C_3 , C_7 see fig. 6

TBA 810S TBA 810AS

THERMAL DATA			TBA 810S	TBA 810AS
$R_{th\ j-tab}$	Thermal resistance junction-tab	max	12 °C/W	10 °C/W
$R_{th\ j-amb}$	Thermal resistance junction-ambient	max	70* °C/W	80 °C/W

* Obtained with tabs soldered to printed circuit with minimized copper area

ELECTRICAL CHARACTERISTICS (Refer to the test circuit; $T_{amb} = 25\text{ °C}$)

Parameter	Test conditions	Min.	Typ.	Max.	Unit
V_s	Supply voltage (pin 1)	4		20	V
V_o	Quiescent output voltage (pin 12)	6.4	7.2	8	V
I_d	Quiescent drain current	$V_s = 14.4\text{ V}$			mA
I_b	Bias current (pin 8)				μA
P_o	Output power	$d = 10\%$ $R_L = 4\ \Omega$ $f = 1\text{ kHz}$ $V_s = 16\text{ V}$ $V_s = 14.4\text{ V}$ $V_s = 9\text{ V}$ $V_s = 6\text{ V}$			W W W W
$V_{i(rms)}$	Input saturation voltage				220 mV
V_i	Input sensitivity	$P_o = 6\text{ W}$ $V_s = 14.4\text{ V}$ $R_L = 4\ \Omega$ $f = 1\text{ kHz}$ $R_f = 56\ \Omega$ $R_f = 22\ \Omega$			mV mV
R_i	Input resistance (pin 8)				M Ω
B	Frequency response (-3 dB)	$V_s = 14.4\text{ V}$ $R_L = 4\ \Omega$ $C3 = 820\text{ pF}$ $C3 = 1500\text{ pF}$			Hz Hz

TBA 810S TBA 810AS

ELECTRICAL CHARACTERISTICS (continued)

	Parameter	Test conditions	Min.	Typ.	Max.	Unit
	d Distortion	$P_o = 50 \text{ mW to } 3 \text{ W}$ $V_s = 14.4 \text{ V}$ $R_L = 4 \Omega$ $f = 1 \text{ kHz}$		0.3		%
	G_v Voltage gain (open loop)	$V_s = 14.4 \text{ V}$ $R_L = 4 \Omega$ $f = 1 \text{ kHz}$		80		dB
	G_v Voltage gain (closed loop)	$V_s = 14.4 \text{ V}$ $R_L = 4 \Omega$ $f = 1 \text{ kHz}$	34	37	40	dB
	e_N Input noise voltage	$V_s = 14.4 \text{ V}$ $R_g = 0$ B (-3 dB) = 20 Hz to 20,000 Hz		2		μV
	i_N Input noise current	$V_s = 14.4 \text{ V}$ B (-3 dB) = 20 Hz to 20,000 Hz		0.1		nA
	η Efficiency	$P_o = 5 \text{ W}$ $V_s = 14.4 \text{ V}$ $R_L = 4 \Omega$ $f = 1 \text{ kHz}$		70		%
→	SVR Supply voltage rejection	$V_s = 14.4 \text{ V}$ $R_L = 4 \Omega$ $f_{\text{ripple}} = 100 \text{ Hz}$		48		dB
→	I_d Drain current	$P_o = 6 \text{ W}$ $V_s = 14.4 \text{ V}$ $R_L = 4 \Omega$		600		mA
→	* Thermal shut-down case temperature	$P_{\text{tot}} = 2.8 \text{ W}$		120		$^{\circ}\text{C}$

* See figs. 7 and 16

TBA 810S TBA 810AS

Fig. 1 - Typical output power versus supply voltage

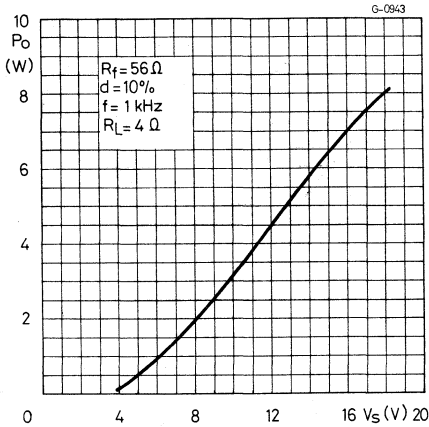


Fig. 2 - Maximum power dissipation versus supply voltage (sine wave operation)

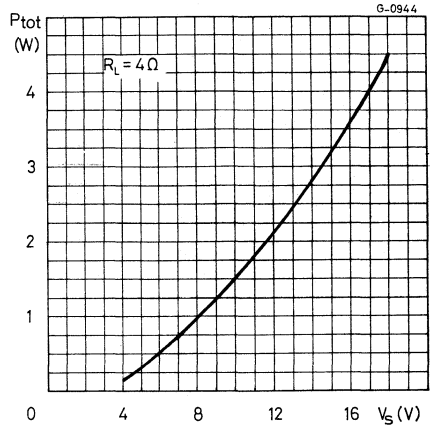


Fig. 3 - Typical distortion versus output power

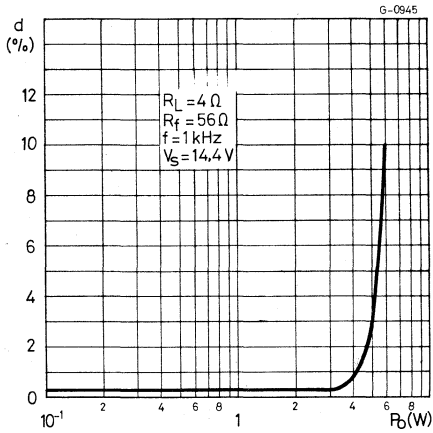
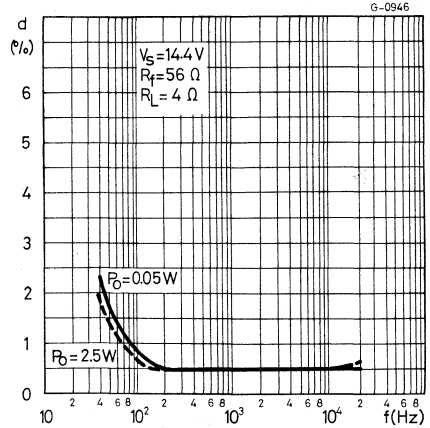


Fig. 4 - Typical distortion versus frequency



TBA 810S TBA 810AS

Fig. 5 - Typical relative voltage gain (closed loop) and typical input voltage versus feedback resistance (R_f)

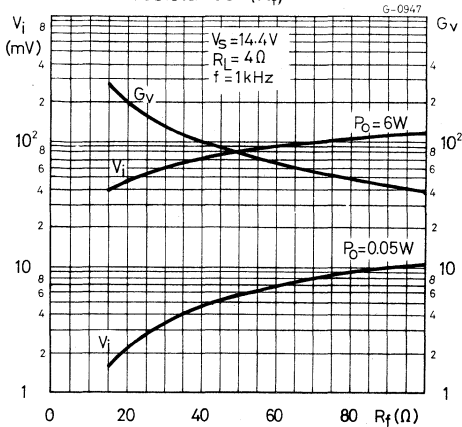


Fig. 6 - Typical value of $C3$ versus R_f for various values of B

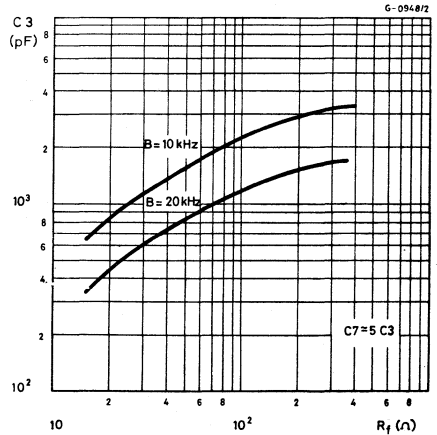


Fig. 7 - Typical power dissipation and efficiency versus output power

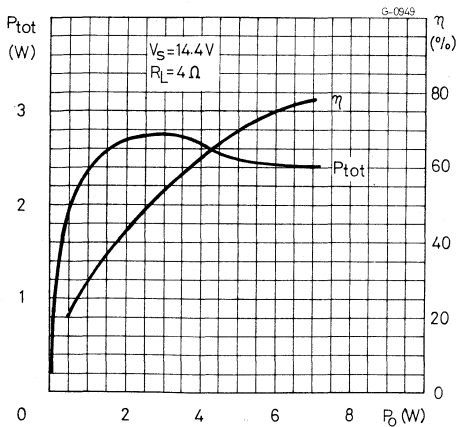
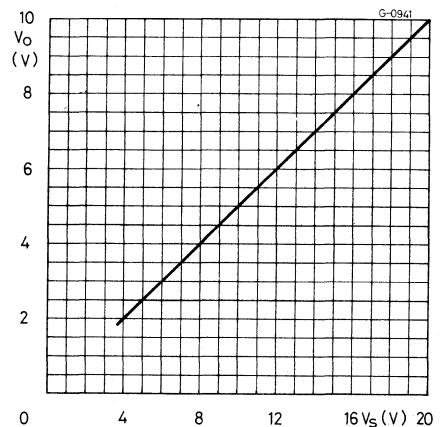


Fig. 8 - Typical quiescent output voltage (pin 12) versus supply voltage



TBA 810S TBA 810AS

Fig. 9 - Typical quiescent current versus supply voltage

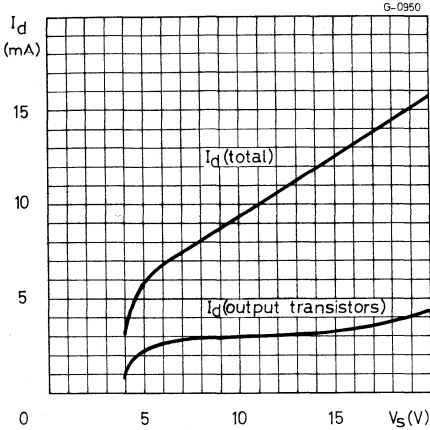
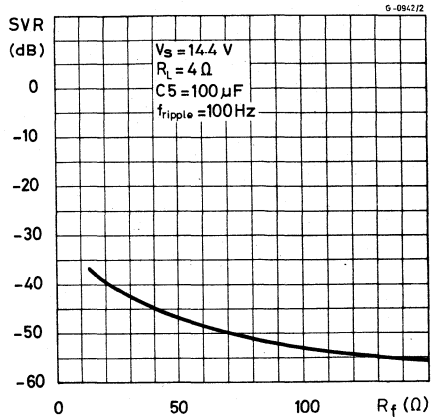
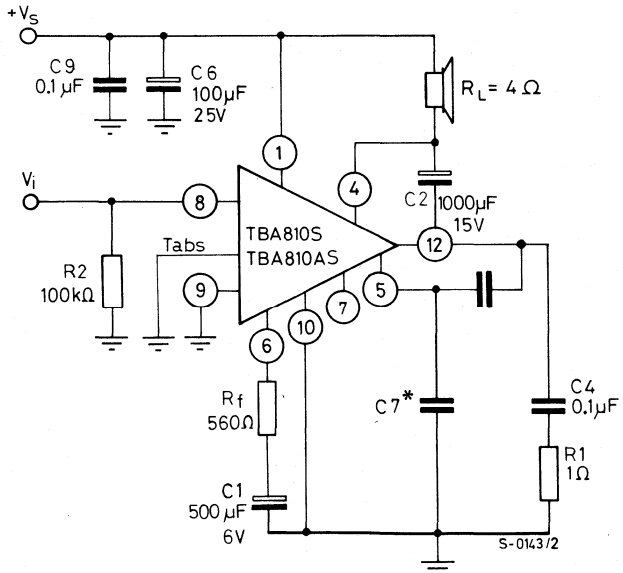


Fig. 10 - Typical supply voltage rejection



For portable equipment the circuit in Fig. 11 has the advantages of fewer external components and a better behaviour at low supply voltages (down to 4 V).

Fig. 11 - Typical circuit with load connected to the supply voltage



* C_3 , C_7 see fig. 6

TBA 810S TBA 810AS

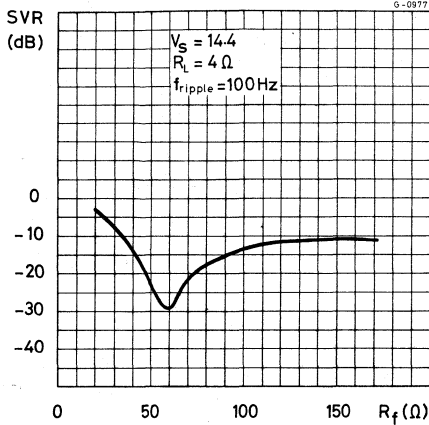


Fig. 12 - Typical supply voltage rejection versus R_f (fig. 11 circuit)

MOUNTING INSTRUCTIONS

The thermal power dissipated in the circuit may be removed by connecting the tabs to an external heat sink (TBA 810 AS - fig. 13) or by soldering them to an area of copper on the printed circuit board (TBA 810 S - fig. 14).

During soldering the tabs temperature must not exceed 260°C and the soldering time must not be longer than 12 seconds.

Fig. 15a and 15b show two ways that can be used for mounting the device.

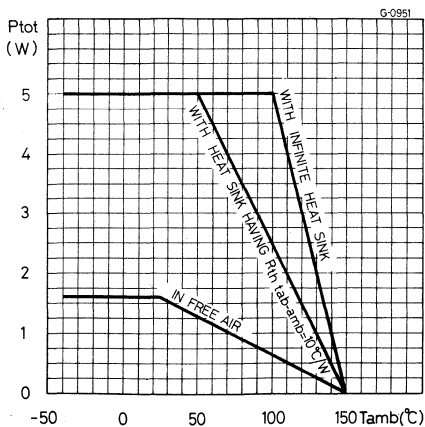
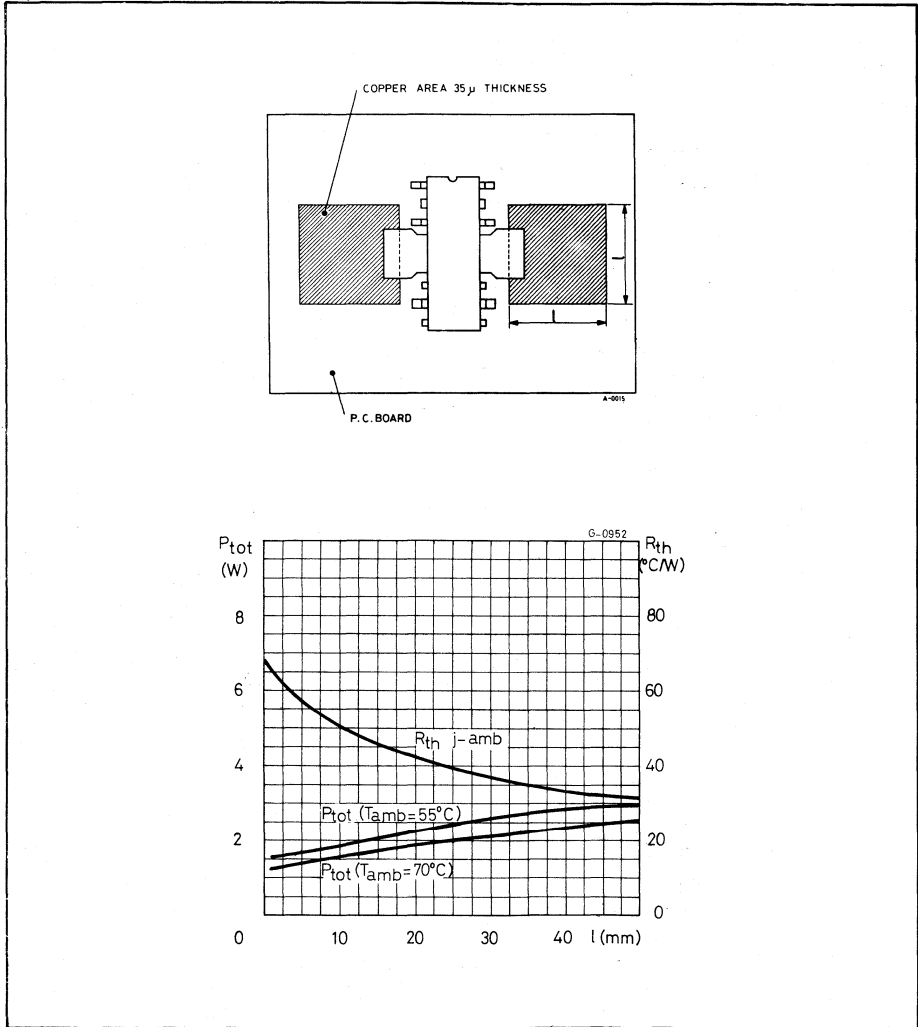


Fig. 13 - Maximum power dissipation versus ambient temperature (for TBA 810 AS only)

Fig. 14 - Maximum power dissipation versus copper area of the P.C. board
(for TBA 810 S only)



TBA 810S TBA 810AS

Fig. 15a shows a method, of mounting the TBA 810 S, that is satisfactory both from the point of view of heat dissipation and from mechanical considerations. For TBA 810 AS the desired thermal resistance is obtained by fixing the elements shown in fig. 15b, to a suitably dimensioned plate. This plate can also act as a support for the whole printed circuit board; the mechanical stresses do not damage the integrated circuit. This is firmly fixed to the element, in fig. 15b.

Fig. 15a

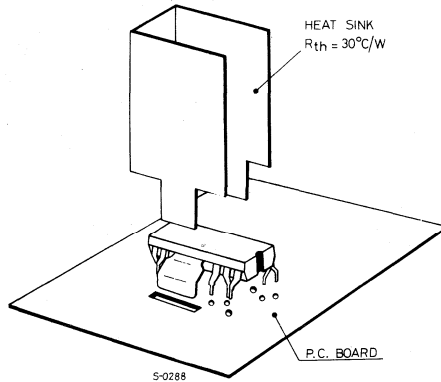
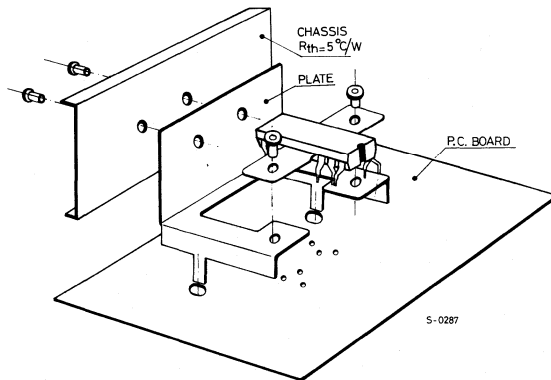


Fig. 15b

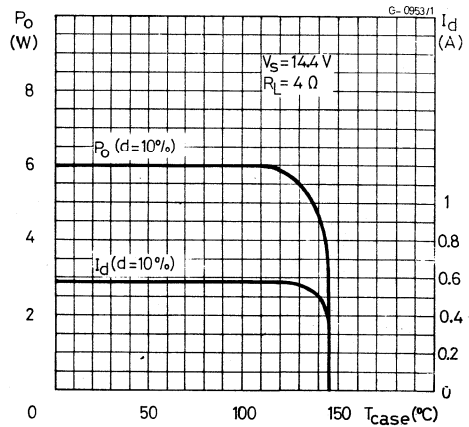


THERMAL SHUT-DOWN

The presence of a thermal limiting circuit offers the following advantages:

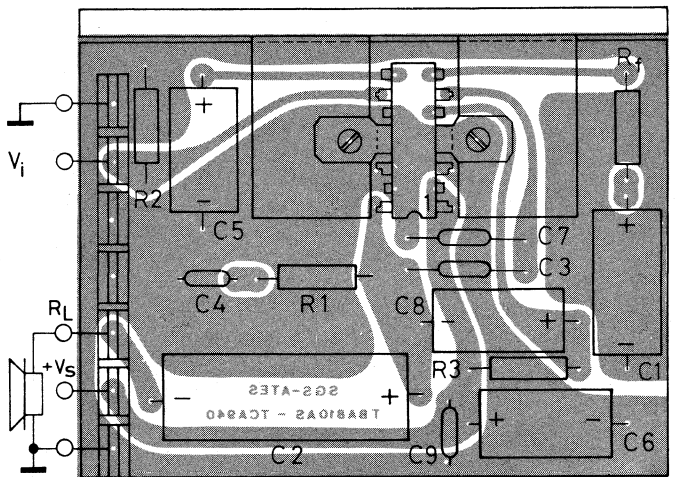
- 1) an overload on the output (even if it is permanent), or an above-limit ambient temperature can be easily supported
- 2) the heatsink can have a smaller factor of safety compared with that of a conventional circuit. There is no device damage in the case of too high a junction temperature: all that happens is that P_o (and therefore P_{tot}) and I_d are reduced (fig. 16).

Fig. 16 - Output power and drain current versus package temperature



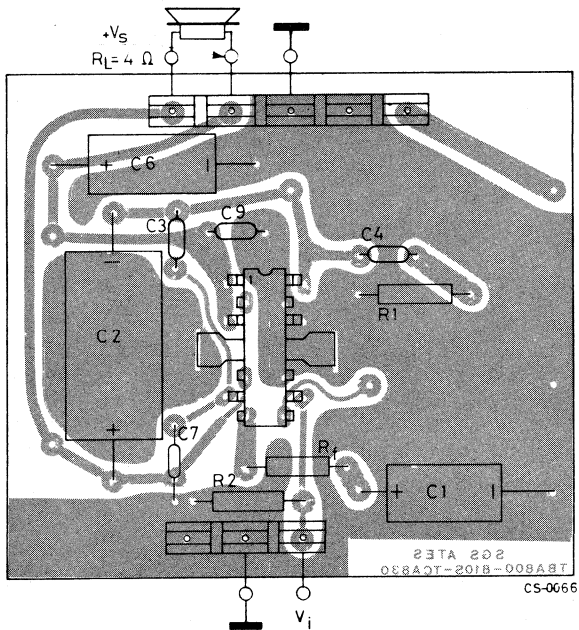
TBA 810S TBA 810AS

Fig. 17 - P.C. board and component layout for the test and application circuit



CS-0033/1

Fig. 18 - P.C. board and component layout for the fig. 11 circuit



CS-0666

TBA 820

LINEAR INTEGRATED CIRCUIT

AUDIO AMPLIFIER

The TBA 820 is an integrated monolithic audio amplifier in a 14-lead quad in-line plastic package.

It is intended for use as low frequency class B amplifier with wide range of supply voltage: 3 to 16 V.

Main features are: minimum working voltage of 3 V, low quiescent current, low number of external components, good ripple rejection, no cross-over distortion, mounting compatibility with TAA 611 (see note on last page).

Output power:

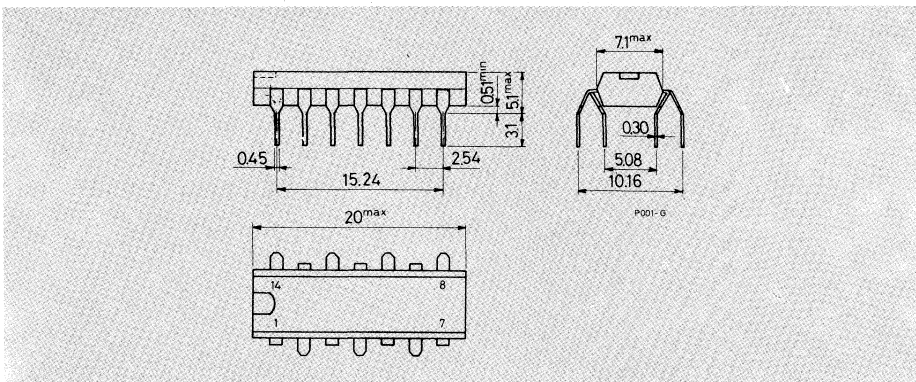
$P_o = 2 \text{ W}$ at 12 V - 8 Ω • $P_o = 1.6 \text{ W}$ at 9 V - 4 Ω • $P_o = 1.2 \text{ W}$ at 9 V - 8 Ω

ABSOLUTE MAXIMUM RATINGS

V_s	Supply voltage	16	V
I_o	Output peak current	1.5	A
P_{tot}	Power dissipation at $T_{amb} = 50^\circ\text{C}$	1.25	W
$T_{stg}; T_j$	Storage and junction temperature	-40 to 150	$^\circ\text{C}$

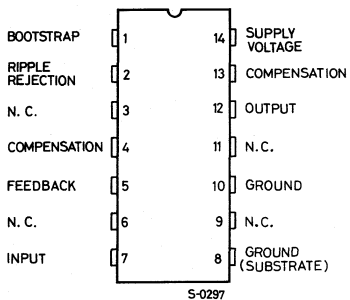
MECHANICAL DATA

Dimensions in mm

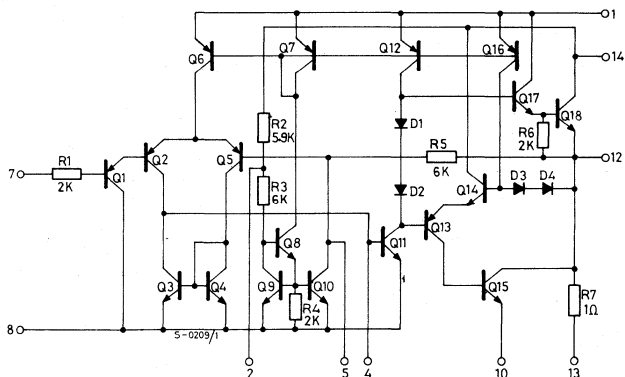


TBA 820

CONNECTION DIAGRAM



SCHEMATIC DIAGRAM



TBA 820

TEST AND APPLICATION CIRCUITS

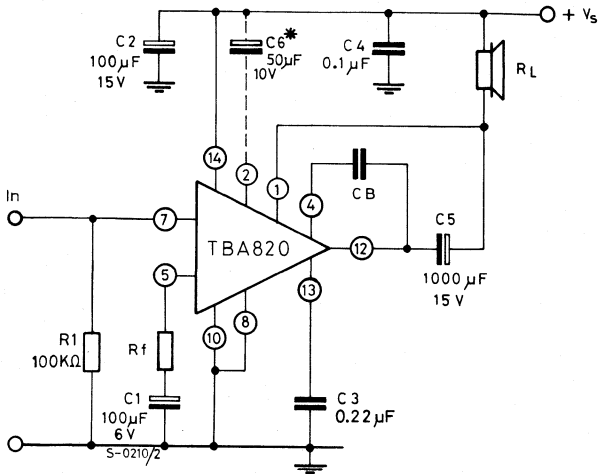


Fig. 1
Circuit diagram with
load connected to the
supply voltage

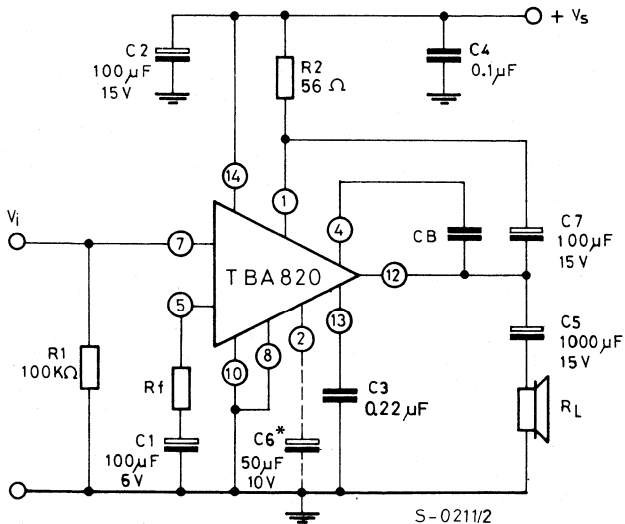


Fig. 2
Circuit diagram
with load connected
to ground

* Capacitor C6 must be used when high ripple rejection is requested

TBA 820

THERMAL DATA

$R_{th\ j-amb}$	Thermal resistance junction-ambient (copper frame)	max	80 °C/W
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ELECTRICAL CHARACTERISTICS

($T_{amb} = 25\text{ °C}$ unless otherwise specified)

	Parameter	Test conditions	Min.	Typ.	Max.	Unit	Fig.
	V_s Supply voltage		3		16	V	—
	V_o Quiescent output voltage (pin 12)	$V_s = 9\text{ V}$	4	4.5	5	V	—
→	I_d Quiescent drain current	$V_s = 9\text{ V}$		4	12	mA	—
→	I_o Bias current (pin 7)	$V_s = 9\text{ V}$		0.1	0.7	μA	—
→	P_o Output power	$d = 10\%$ $f = 1\text{ kHz}$ $R_f = 120\ \Omega$ $V_s = 12\text{ V}$ $R_L = 8\ \Omega$ $V_s = 9\text{ V}$ $R_L = 4\ \Omega$ $V_s = 9\text{ V}$ $R_L = 8\ \Omega$ $V_s = 6\text{ V}$ $R_L = 4\ \Omega$ $V_s = 3.5\text{ V}$ $R_L = 4\ \Omega$	0.9		2 1.6 1.2 0.75 0.22	W W W W W	1
	$V_{i(rms)}$ Input sensitivity	$P_o = 1.2\text{ W}$ $V_s = 9\text{ V}$ $R_L = 8\ \Omega$ $f = 1\text{ kHz}$ $R_f = 33\ \Omega$ $R_f = 120\ \Omega$			16 60	mV mV	1
	$V_{i(rms)}$ Input sensitivity	$P_o = 50\text{ mW}$ $V_s = 9\text{ V}$ $R_L = 8\ \Omega$ $f = 1\text{ kHz}$ $R_f = 33\ \Omega$ $R_f = 120\ \Omega$			3.5 12	mV mV	1
	R_i Input resistance			5		MΩ	—
	B Frequency response (-3 dB)	$V_s = 9\text{ V}$ $R_L = 8\ \Omega$ $R_f = 120\ \Omega$ $C_B = 680\text{ pF}$ $C_B = 220\text{ pF}$			25 to 7000 25 to 20000	Hz Hz	1
	d Distortion	$P_o = 500\text{ mW}$ $V_s = 9\text{ V}$ $R_L = 8\ \Omega$ $f = 1\text{ kHz}$ $R_f = 33\ \Omega$ $R_f = 120\ \Omega$			0.8 0.4	% %	1

TBA 820

ELECTRICAL CHARACTERISTICS (continued)

Parameter	Test conditions	Min.	Typ.	Max.	Unit	Fig.
G_v Voltage gain (open loop)	$V_s = 9\text{ V}$ $R_L = 8\ \Omega$ $f = 1\text{ kHz}$		75		dB	—
G_v Voltage gain (closed loop)	$V_s = 9\text{ V}$ $R_L = 8\ \Omega$ $f = 1\text{ kHz}$ $R_f = 33\ \Omega$ $R_f = 120\ \Omega$	31	45	37	dB dB	—
e_N Input noise voltage	$V_s = 9\text{ V}$ $B(-3\text{ dB}) =$ $= 25\text{ to }20000\text{ Hz}$		3		μV	—
i_N Input noise current	$V_s = 9\text{ V}$ $B(-3\text{ dB}) =$ $= 25\text{ to }20000\text{ Hz}$		0.4		nA	—
$\frac{S+N}{N}$ Signal and noise to noise ratio	$V_s = 9\text{ V}$ $R_L = 8\ \Omega$ $R_f = 120\ \Omega$ $B(-3\text{ dB}) =$ $= 25\text{ to }20000\text{ Hz}$ $R_1 = 100\text{ k}\Omega$ $P_o = 1.2\text{ W}$		70		dB	—
SVR Supply voltage rejection	$V_s = 9\text{ V}$ $R_L = 8\ \Omega$ $f(\text{ripple}) = 100\text{ Hz}$ $C_6 = 50\ \mu\text{F}$ $R_f = 120\ \Omega$		42		dB	2

Fig. 3 - Typical power output

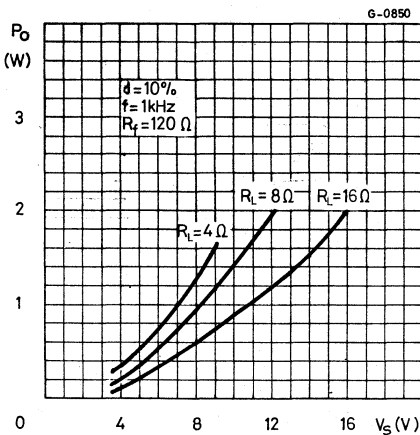
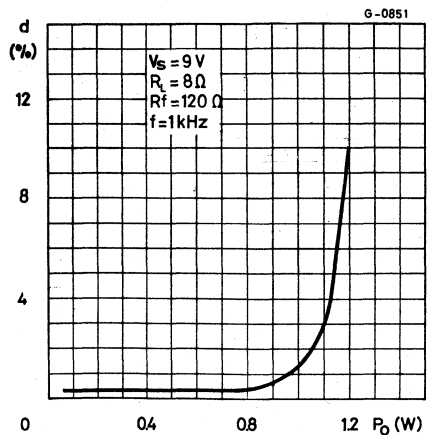


Fig. 4 - Typical distortion



TBA 820

Fig. 5 - Typical power dissipation and efficiency

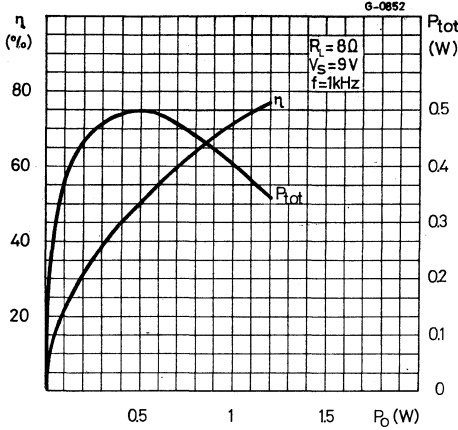


Fig. 6 - Maximum power dissipation (sine wave operation)

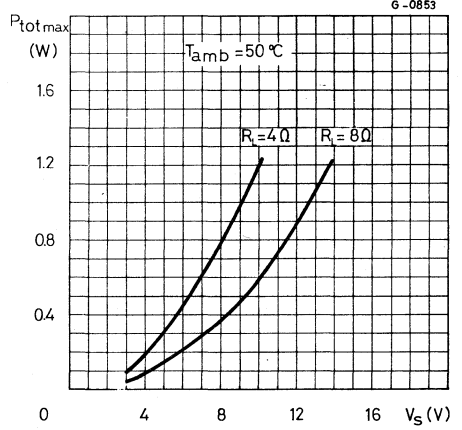


Fig. 7 - Typical value of C_B versus R_f

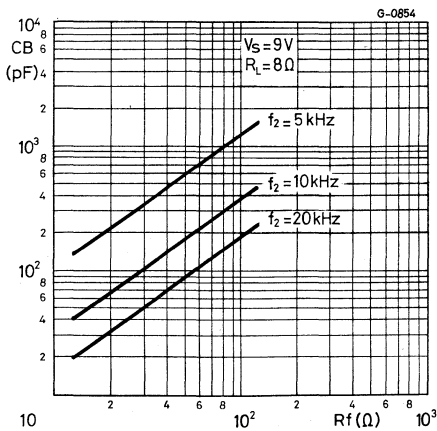


Fig. 8 - Typical relative frequency response

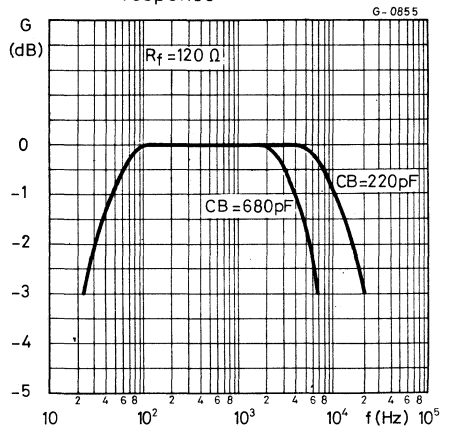


Fig. 9 - Typical input sensitivity

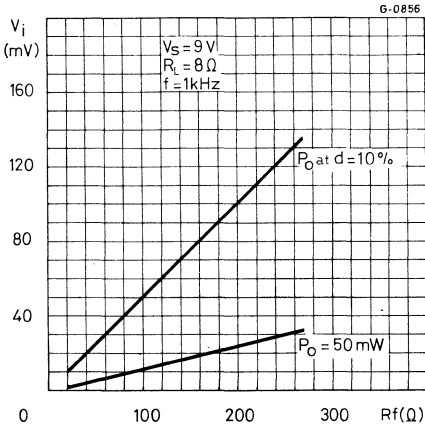


Fig. 10 - Typical voltage gain (closed loop)

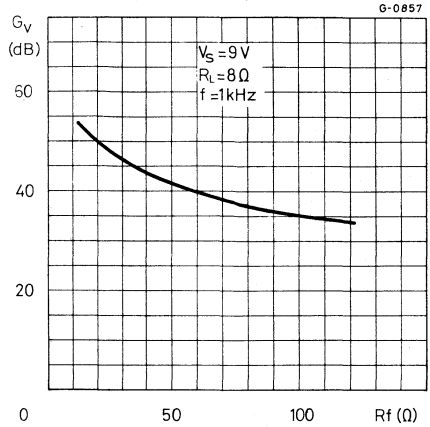


Fig. 11 - Typical distortion

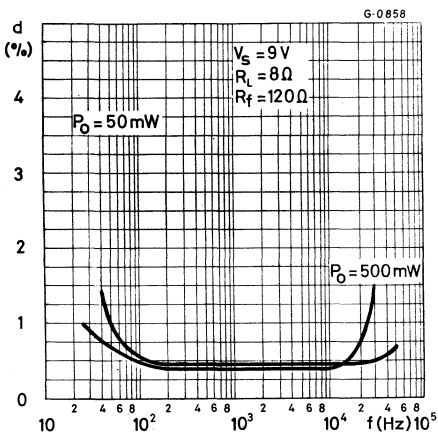
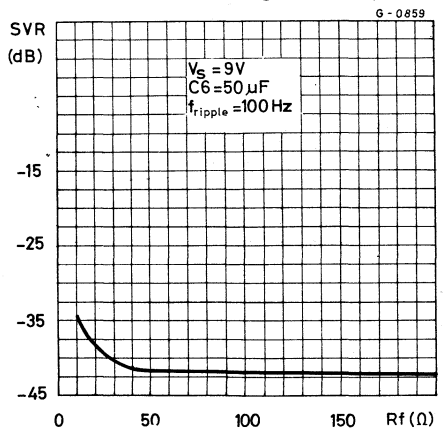


Fig. 12 - Typical supply voltage rejection (fig. 2 circuit)



TBA 820

Fig. 13 - Quiescent output voltage at pin 12

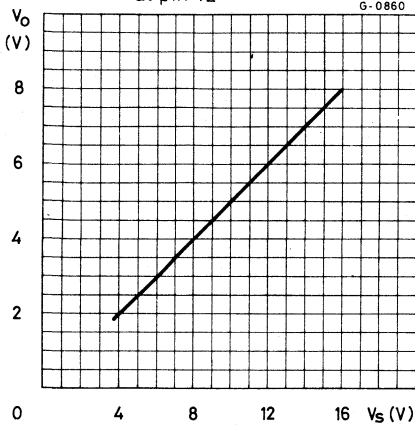


Fig. 14 - Quiescent current

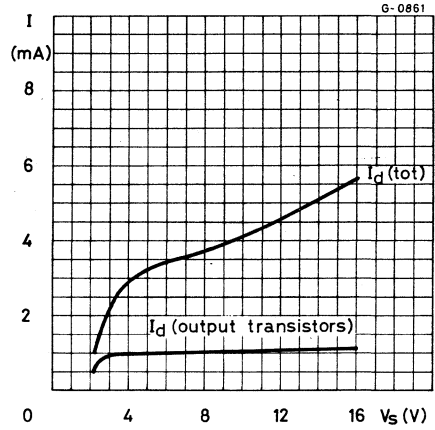


Fig. 15 - Power rating chart

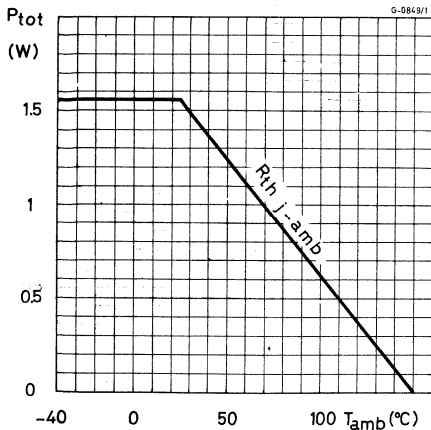
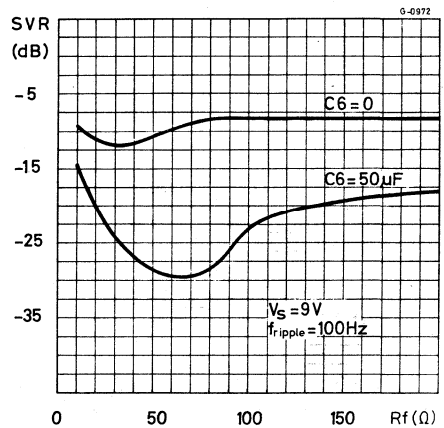


Fig. 16 - Typical supply voltage rejection ratio vs. R_f for fig. 1 circuit



NOTE: Mounting compatibility with TAA 611 provided that P.C. board strips of pins 2,3 and 13 are disconnected

LINEAR INTEGRATED CIRCUIT

TV HORIZONTAL AND VERTICAL PROCESSOR

The TCA 511 is a silicon monolithic integrated circuit in a 16-lead dual in-line plastic package. It incorporates the following functions: high stability horizontal oscillator, horizontal APC circuit with high noise immunity and large pull-in range, high stability vertical oscillator and sawtooth generator.

It is intended for driving TV horizontal and vertical transistorized output stages.

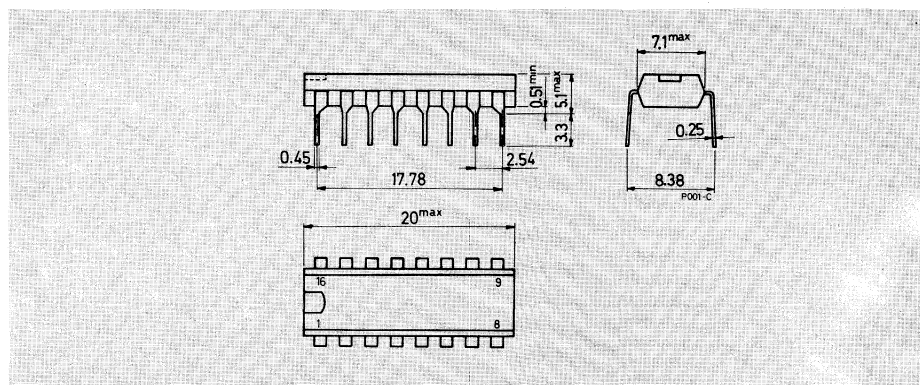
ABSOLUTE MAXIMUM RATINGS

V_s	Vertical section supply voltage (between pins 3 and 13)	15 V
V_s	Horizontal section supply voltage (between pins 4 and 13)	15 V
V_7, V_{12}, V_{15}	Pin 7, 12, 15 voltage (collector to ground)	15 V
V_i	Vertical sync. input voltage (between pins 2 and 13 - see note)	-5 V
V_i	Horizontal sync. input voltage (between pins 6 and 13 - see note)	-5 V
I_8	DC current (from pin 8)	30 mA
I_{12}, I_{14}, I_{15}	Peak current (into pins 12, 14 and 15)	50 mA
P_{tot}	Total power dissipation at $T_{amb} \leq 60^\circ\text{C}$	500 mW
T_{stg}	Storage temperature	-55 to 125 $^\circ\text{C}$
T_{op}	Operating temperature	0 to 60 $^\circ\text{C}$

NOTE: The positive input voltage at pin 2 and pin 6 must not be greater than the voltage at pin 3 and pin 4 respectively.

MECHANICAL DATA

Dimensions in mm



TCA 511

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

Parameter	Test conditions	Min.	Typ.	Max.	Unit	Fig.
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VERTICAL SECTION

I ₃	Quiescent current	V _s = 12 V f = 50 Hz		4	mA	2
V ₃ *	Supply voltage			9	V	
V ₁	Peak to peak oscillator sawtooth voltage	V _s = 12 V f = 50 Hz		2.6	V	
V ₂	Peak sync. input voltage	V _s = 12 V f = 50 Hz		3	V	3
V ₁₄	Low level output voltage	V _s = 12 V		1.5	V	
V ₁₅	Low level output voltage	I ₁₅ = 15 mA		0.5	V	
R ₂	Parallel input resistance at pin 2	V _s = 12 V V ₂ = 3 V		50	kΩ	—
t**	Output pulse width at pin 15	V _s = 12 V f = 50 Hz R ₁₀ = 15 kΩ		0.75	ms	2
Δf	Locking range	V _s = 12 V f = 50 Hz		-17	%	
$\frac{\Delta f}{\Delta T_{amb}}$	Frequency/temperature coefficient	V _s = 12 V T _{amb} = 20 to 70 °C		-0.015	$\frac{\text{Hz}}{^\circ\text{C}}$	

HORIZONTAL SECTION

I ₄	Quiescent current	V _s = 12 V f = 15625 Hz R ₁₁₋₁₃ = 0		19	mA	2
V ₄ *	Supply voltage			9	V	
V ₆	Peak sinc. input voltage	V _s = 12 V f = 15625 Hz		3	V	

TCA 511

ELECTRICAL CHARACTERISTICS (continued)

Parameter	Test conditions	Min.	Typ.	Max.	Unit	Fig.
V_8	Regulated output voltage		7.5		V	2
V_{10}	Peak to peak oscillator sawtooth voltage		3.3		V	
V_{12}	Low level output voltage	$V_s = 12\text{ V}$ $I_{12} = 15\text{ mA}$		0.45	V	3
R_6	Parallel input resistance at pin 6	$V_s = 12\text{ V}$ $V_6 = 3\text{ V}$	50		k Ω	—
t^{***}	Output pulse width at pin 12	$V_s = 12\text{ V}$ $f = 15625\text{ Hz}$ a) $R_{11-13} = 0$ b) $R_{11-13} = \infty$	13 35		μs μs	2
t_d	Leading edge of output pulse to leading edge of sync. pulse phasing	$V_s = 12\text{ V}$ $f = 15625\text{ Hz}$	4		μs	
Δf	Pull-in range		± 1.3		kHz	
Δf	Hold-in range		± 1.4		kHz	
$\frac{\Delta f}{\Delta V_9}$	Oscillator control sensitivity	$V_s = 12\text{ V}$	10		$\frac{\text{kHz}}{\text{V}}$	
$\frac{\Delta f}{\Delta t_d}$	APC loop gain		2		$\frac{\text{kHz}}{\mu\text{s}}$	
$\frac{\Delta f}{\Delta V_s}$	Oscillator frequency drift	$V_s = 9\text{ to }14\text{ V}$	+ 0.7		$\frac{\%}{\text{V}}$	
$\frac{\Delta f}{\Delta T_{\text{amb}}}$	Frequency/temperature coefficient	$V_s = 12\text{ V}$ $T_{\text{amb}} = 20\text{ to }70\text{ }^\circ\text{C}$	+ 5		$\frac{\text{Hz}}{^\circ\text{C}}$	

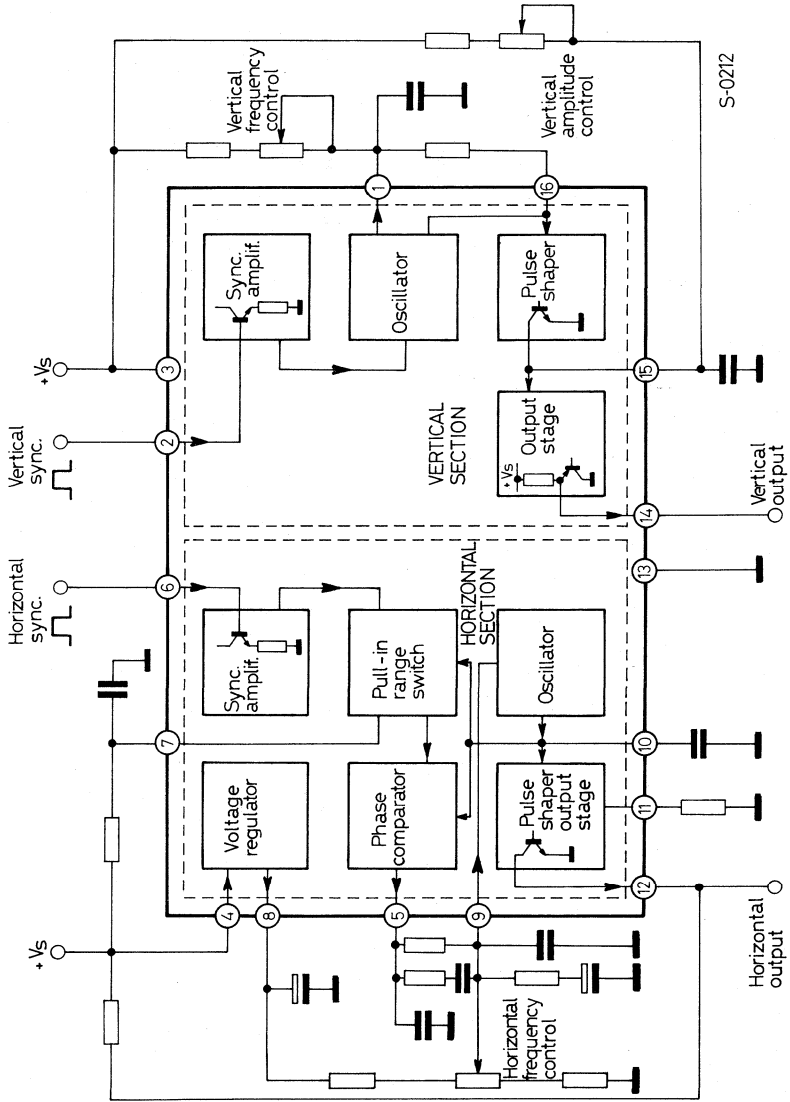
NOTES: * Minimum supply voltage for correct operation of the device.

** The output pulse width can be adjusted by means of the external resistance connected between pins 1 and 6.

*** The output pulse width can be adjusted by means of the external resistance or by a voltage $\leq 5.3\text{ V}$, connected between pin 11 and pin 13.

TCA 511

Fig. 1 - Functional block diagram



TCA 511

Fig. 2 - Test circuit

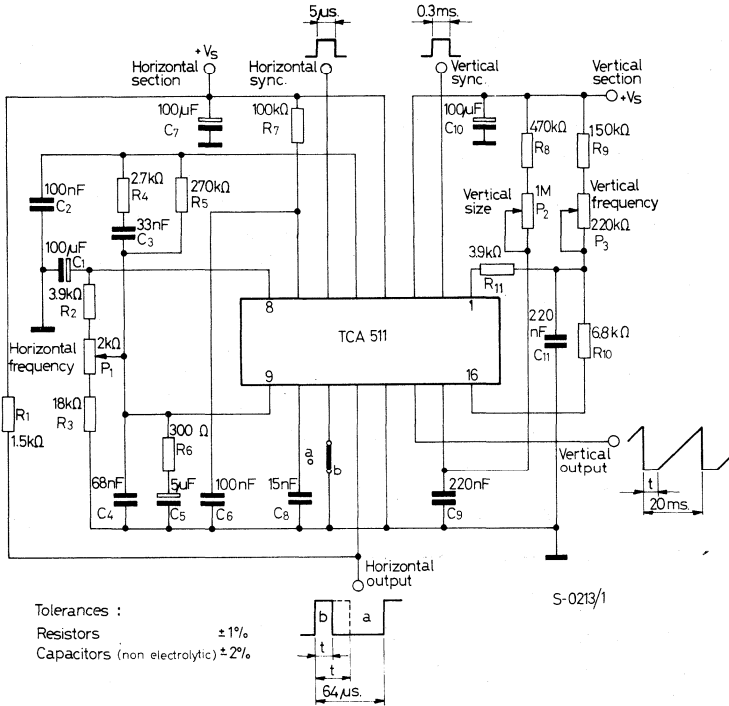
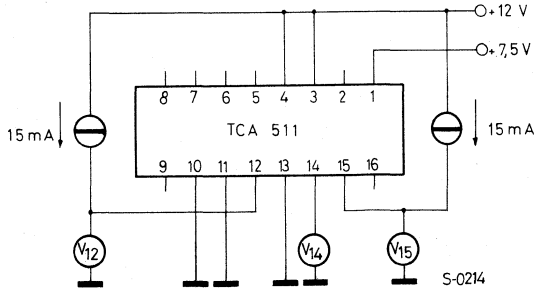


Fig. 3 - V_{12} , V_{14} and V_{15} test circuit



APPLICATION INFORMATION

Power Supply

The circuit can work with stabilized supply voltage having a value from 9 to 15 V. A dropping resistor and a filter capacitor may be used to obtain the supply from higher voltages; however, the voltage on pins 3 and 4 must never exceed the maximum permitted voltage.

Synchronization

Pins 2 and 6 can be DC driven if the reference level of the synchronization pulses is less than 1 V. With reference levels greater than this value, a coupling capacitor must be inserted in series with the input, and pins 2 and 6 must be connected to ground via a resistor.

Vertical Oscillator

The capacitor connected to pin 1 must be selected with regard to the frequency tolerance, to the thermal stability and to the capacitor's ageing.

The width of the output pulse, to be chosen according to the needs of the output stages, is defined by the resistor connected between pin 1 and pin 16.

Vertical Output

The vertical output is taken from pin 14, which is a buffered output of the sawtooth voltage generated at pin 15.

The output current from pin 14 is defined by an internal resistor in the integrated circuit. If a greater current is needed, a resistor may be connected between pin 14 and pin 3.

The oscillator output pulse is available at pin 15 if the capacitor C9 is not connected. This configuration is used for driving output stages in which the sawtooth is generated by Miller effect.

Horizontal Oscillator

The capacitor connected between pin 10 and ground must be selected with regard to the frequency tolerance, to the thermal stability and to the capacitor's ageing.

In multistandard receivers, the oscillation frequency may be changed by switching the value of the capacitor connected to pin 10.

TCA 511

APPLICATION INFORMATION (continued)

Phase Comparator

The phase comparator's output consists of current pulses acting on the oscillator control voltage.

The external components C2, C3, C4, C5, R4, R5 and R6 (fig. 2) define the circuit performance with respect to the pull-in range, the hold-in range and the frequency variations that occur on switching-on and switching-off.

Moreover the pull-in range depends on the absolute value of the voltage divider R2, P1 and R3.

A coincidence detector is connected to pin 7; this modifies the pull-in range and the noise immunity, depending on whether the system is synchronised or is searching for synchronization. The time constant applied to pin 7 avoids uncertainty during the switch from one state to the other.

Horizontal Output

The collector of the output transistor is connected to pin 12; its load resistor, externally connected between pin 12 and pin 4, defines the amplitude of the output current pulse.

The width of the output pulse can be varied between 13 and 35 μs by means of the resistor connected between pin 11 and ground, or else by means of a voltage ≤ 5.3 V applied between pin 11 and ground. This control acts upon the trailing edge of the pulse, hence the phase advance of the leading edge stays constant with respect to the synchronism.

TCA 830S

LINEAR INTEGRATED CIRCUIT

PRELIMINARY DATA

AUDIO POWER AMPLIFIER WITH THERMAL SHUT-DOWN

The TCA 830S is a monolithic integrated circuit in a 12-lead quad in-line plastic package, intended for use as a low frequency class B amplifier. The TCA 830S provides 4.2 W output power @ 14 V/4 Ω , 3.4 W @ 12 V/4 Ω , 2 W @ 9 V/4 Ω , 3.7 W @ 16 V/8 Ω and 2.3 W @ 12 V/8 Ω .

It works with a wide range of supply voltages (4 to 20 V), gives high output current (up to 2 A) and very low harmonic and cross-over distortion. The circuit is provided with a thermal limiting circuit which fundamentally changes the criteria normally used in determining the size of the heatsink, in addition the TCA 830S can withstand short-circuit on the load for supply voltages up to 14 V.

The TCA 830S is pin to pin equivalent to the TBA 810S.

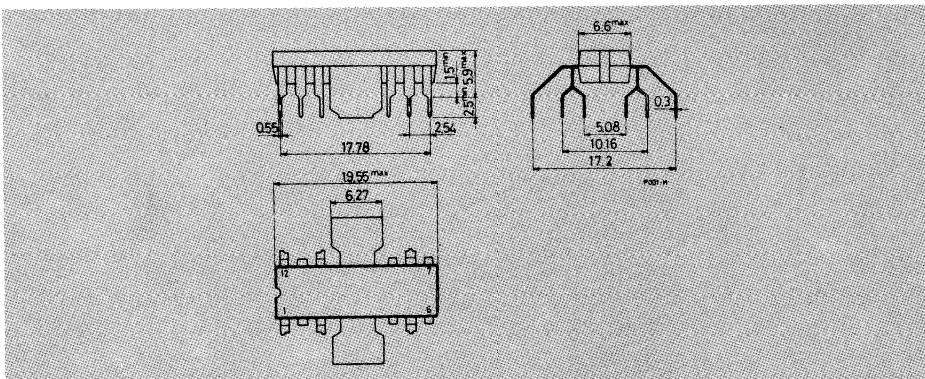
ABSOLUTE MAXIMUM RATINGS

V_s	Supply voltage	20 V
I_o	Output peak current (non-repetitive)	2.5 A
I_o	Output peak current (repetitive)	2 A
P_{tot}	Power dissipation: at $T_{amb} = 80^\circ\text{C}$	1 W
	at $T_{tab} = 90^\circ\text{C}$	5 W
T_{stg}, T_j	Storage and junction temperature	-40 to 150 $^\circ\text{C}$

ORDERING NUMBER: TCA 830S

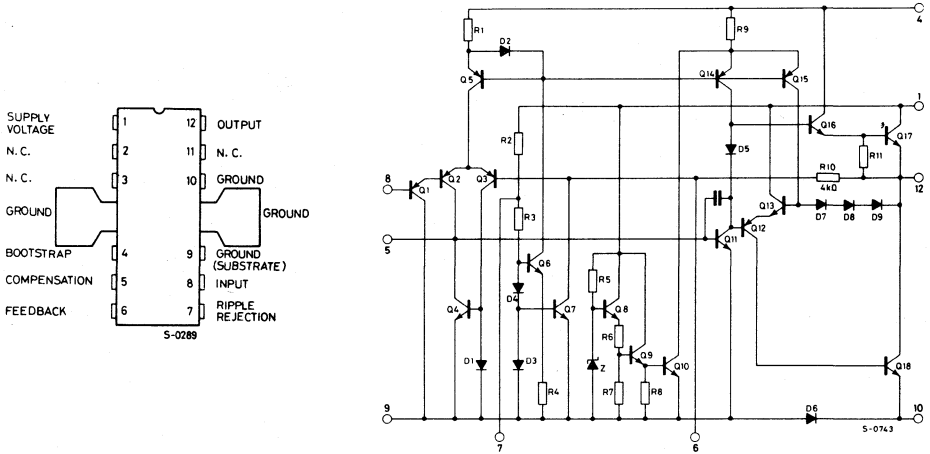
MECHANICAL DATA

Dimensions in mm

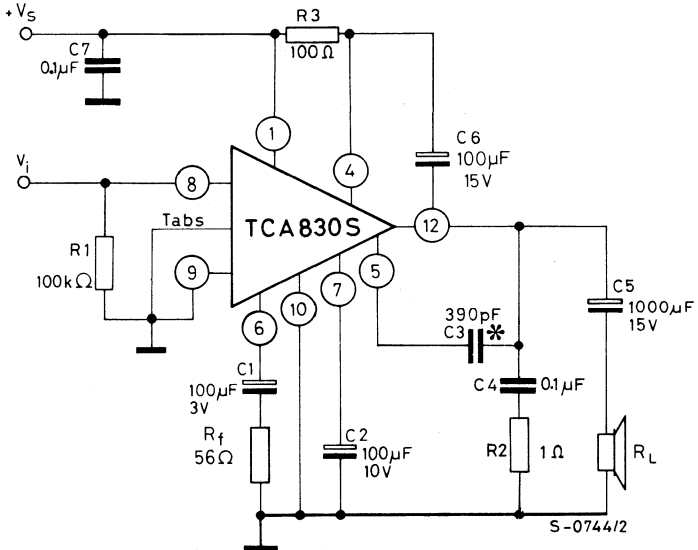


TCA 830S

CONNECTION AND SCHEMATIC DIAGRAMS



TEST AND APPLICATION CIRCUIT



* = C3 SEE FIG. 6

THERMAL DATA

$R_{th\ j-tab}$	Thermal resistance junction-tab	max	12	°C/W
$R_{th\ j-amb}$	Thermal resistance junction-ambient	max	70*	°C/W

* Obtained with tabs soldered to printed circuit with minimized copper area

ELECTRICAL CHARACTERISTICS (Refer to the test circuit, $T_{amb} = 25\text{ °C}$)

Parameter	Test conditions	Min.	Typ.	Max.	Unit	
V_s	Supply voltage (pin 1)	4		20	V	
V_o	Quiescent output voltage (pin 12)	$V_s = 12\text{ V}$	5.3	6	6.7	V
I_d	Quiescent drain current	$V_s = 9\text{ V}$		8.5	16	mA
I_b	Bias current (pin 8)	$V_s = 12\text{ V}$		0.2		μA
P_o	Output power	$d = 10\%$ $V_s = 14\text{ V}$ $V_s = 12\text{ V}$ $V_s = 9\text{ V}$ $V_s = 6\text{ V}$ $V_s = 16\text{ V}$ $V_s = 12\text{ V}$	$f = 1\text{ kHz}$ $R_L = 4\ \Omega$ $R_L = 4\ \Omega$ $R_L = 4\ \Omega$ $R_L = 4\ \Omega$ $R_L = 8\ \Omega$ $R_L = 8\ \Omega$	2.5	4.2 3.4 2 0.8 3.7 2.3	W W W W W W
$V_{i(rms)}$	Voltage for input saturation		220			mV
V_i	Input sensitivity	$P_o = 3.4\text{ W}$ $R_L = 4\ \Omega$	$V_s = 12\text{ V}$ $f = 1\text{ kHz}$		50	mV
B	Frequency response (-3 dB)	$V_s = 12\text{ V}$ C3 = 390 pF	$R_L = 4\ \Omega$		40 to 10,000	Hz
d	Distortion	$P_o = 50\text{ mW to } 2\text{ W}$ $V_s = 12\text{ V}$ $f = 1\text{ kHz}$	$R_L = 4\ \Omega$		0.3	%
R_i	Input resistance (pin 8)			5		MΩ
G_v	Voltage gain (open loop)	$V_s = 12\text{ V}$ $f = 1\text{ kHz}$	$R_L = 4\ \Omega$		75	dB

TCA 830S

ELECTRICAL CHARACTERISTICS (continued)

Parameter		Test conditions	Min.	Typ.	Max.	Unit
G_v	Voltage gain (closed loop)	$V_s = 12\text{ V}$ $R_L = 4\ \Omega$ $f = 1\text{ kHz}$	34	37	40	dB
e_N	Input noise voltage	$V_s = 12\text{ V}$ $R_1 = 0$ $B (-3\text{ dB}) = 40\text{ to }10,000\text{ Hz}$		2		μV
i_N	Input noise current	$V_s = 12\text{ V}$ $B (-3\text{ dB}) = 40\text{ to }10,000\text{ Hz}$		0.1		nA
η	Efficiency	$P_o = 3.4\text{ W}$ $V_s = 12\text{ V}$ $R_L = 4\ \Omega$ $f = 1\text{ kHz}$		62		%
SVR	Supply voltage rejection ratio	$V_s = 12\text{ V}$ $R_L = 4\ \Omega$ $f_{\text{ripple}} = 100\text{ Hz}$ $C_2 = 100\ \mu\text{F}$ $C_2 = 25\ \mu\text{F}$		45 38		dB dB
I_d	Drain current	$P_o = 3.4\text{ W}$ $V_s = 12\text{ V}$ $R_L = 4\ \Omega$		430		mA
	* Thermal shut-down case temperature	$P_{\text{tot}} = 2.2\text{ W}$		130		$^{\circ}\text{C}$

* See figs. 8 and 14

Fig. 1 - Typical output power versus supply voltage

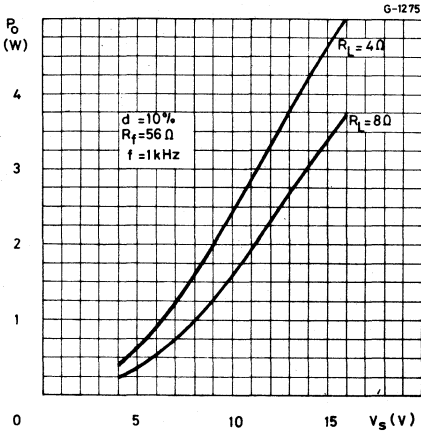


Fig. 2 - Maximum power dissipation versus supply voltage (sine wave operation)

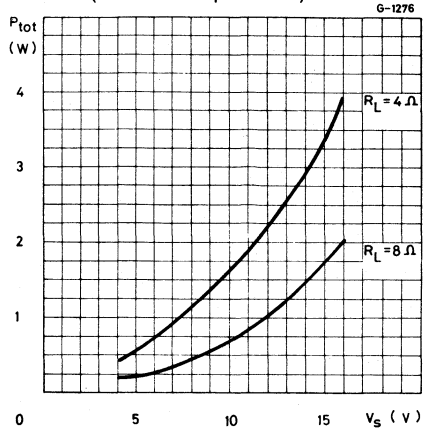


Fig. 3 - Typical distortion versus output power

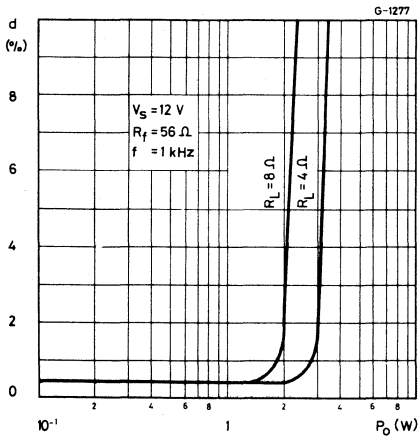
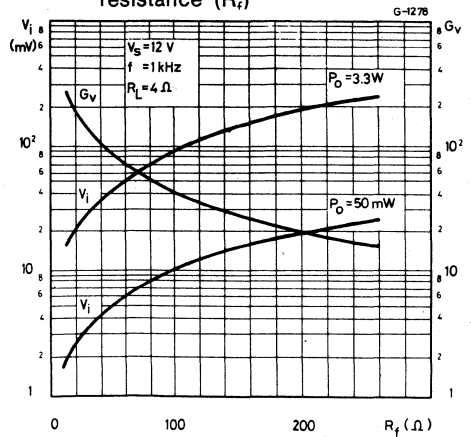


Fig. 4 - Typical voltage gain (closed loop) and typical input voltage versus feedback resistance (R_f)



TCA 830S

Fig. 5 - Typical distortion versus frequency

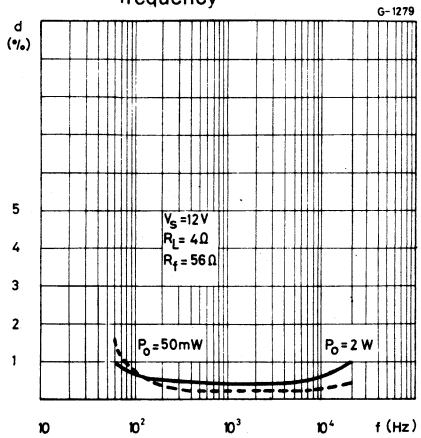


Fig. 6 - Typical value of C3 versus R_f for different bandwidths

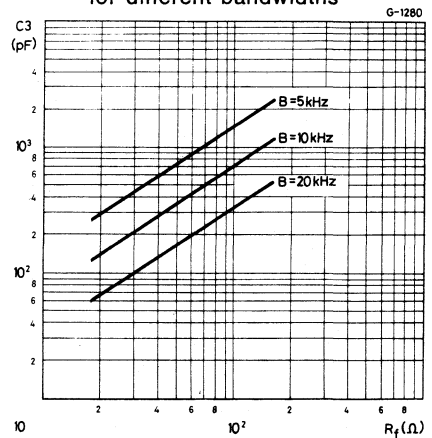


Fig. 7 - Typical supply voltage rejection ratio

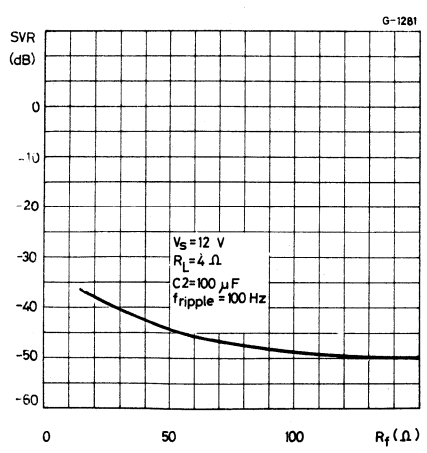
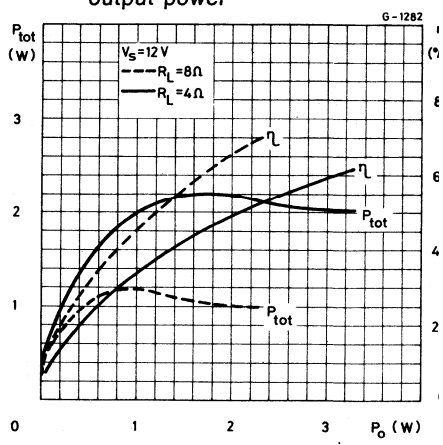


Fig. 8 - Typical power dissipation and efficiency versus output power



TCA 830S

Fig. 9 - Typical quiescent output voltage (pin 12) versus supply voltage

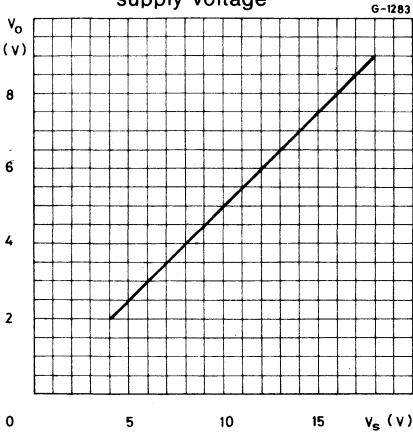
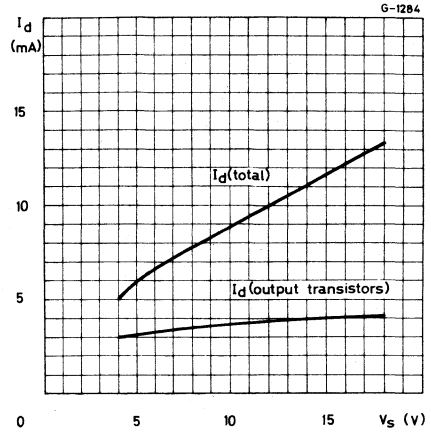


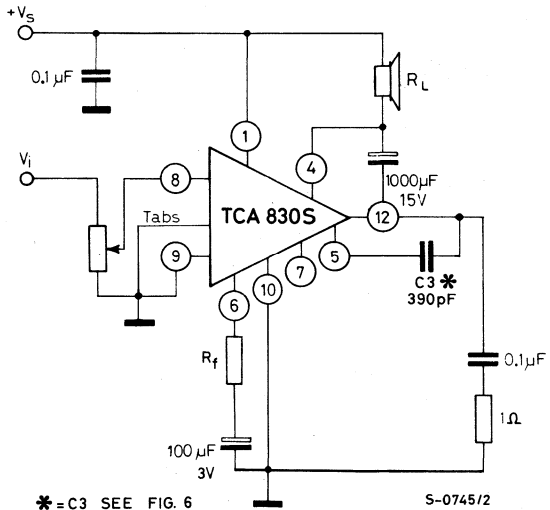
Fig. 10 - Typical quiescent current versus supply voltage



APPLICATION INFORMATION

For portable use the circuit in fig. 11 has the advantage of fewer external components.

Fig. 11 - Typical circuit with load connected to the supply voltage



TCA 830S

APPLICATION INFORMATION

For line operated equipment the bootstrap can be eliminated using the circuit of fig. 12. Gain is depended on R_x/R_f .

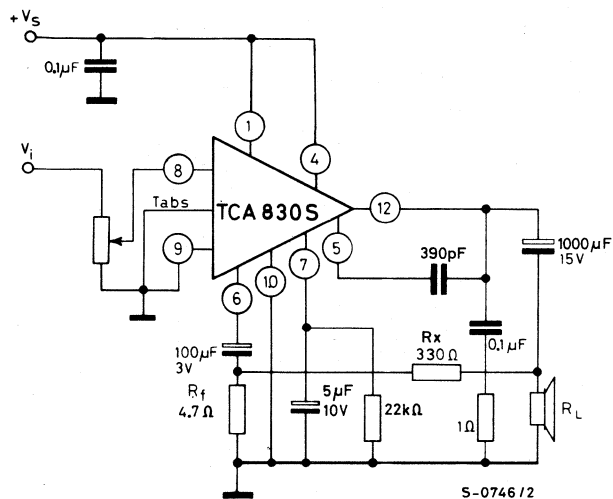


Fig. 12 - Circuit with load connected to ground and without bootstrap, in which G_v spread is reduced

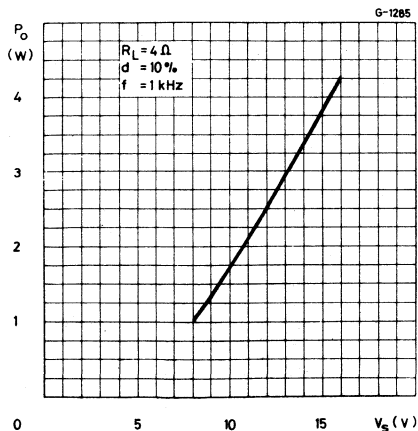


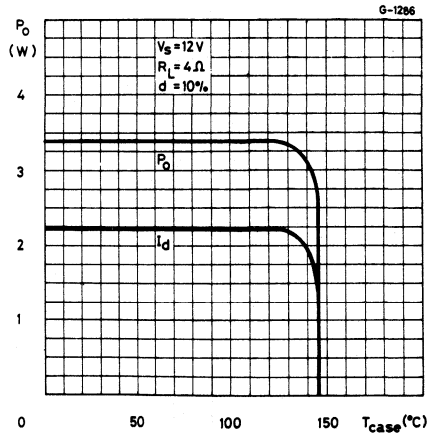
Fig. 13 - Typical output power versus supply voltage (see fig. 12)

THERMAL SHUT-DOWN

The presence of a thermal limiting circuit offers the following advantages:

- 1) an overload on the output (even if it is permanent) or an above-limit ambient temperature can be easily supported
- 2) the heatsink can have a smaller factor of safety compared with that of a conventional circuit. There is no device damage in the case of too high a junction temperature; all that happens is that P_o (and therefore P_{tot}) and I_d are reduced (fig. 14).

Fig. 14 - Output power and drain current versus package temperature



TCA 830S

MOUNTING INSTRUCTION

The thermal power dissipated in the circuit may be removed by connecting the tabs to an external heatsink or by soldering them to an area of copper on the printed circuit board (fig. 15).

Fig. 16 shows a simple type of heatsink. Assuming an area of copper on the printed circuit board of only 2 cm^2 , the total R_{th} between junction and ambient is approximately 28°C/W .

The external heatsink or area of printed circuit copper must be connected to electrical ground.

Fig. 17 gives the maximum power that can be dissipated (for $T_{amb} = 55$ and 70°C) as a function of the side of two equal square copper areas having a thickness of 35μ (1.4 mil). During soldering the tabs temperature must not exceed 260°C and the soldering time must not be longer than 12 seconds.

Fig. 15 - Example of area of P.C. board copper soldered to the tabs of the TCA 830S which is used as a heat-sink

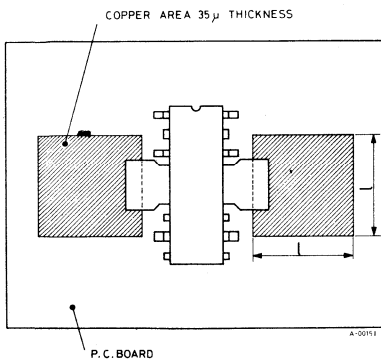
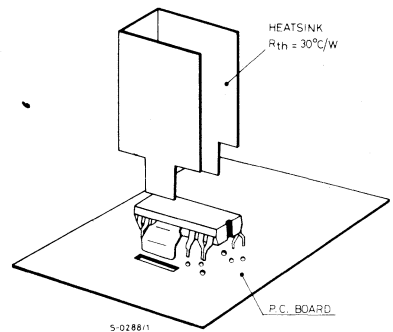


Fig. 16 - Example of TCA 830S with external heatsink



TCA 830S

Fig. 17 - Power that can be dissipated versus "l"

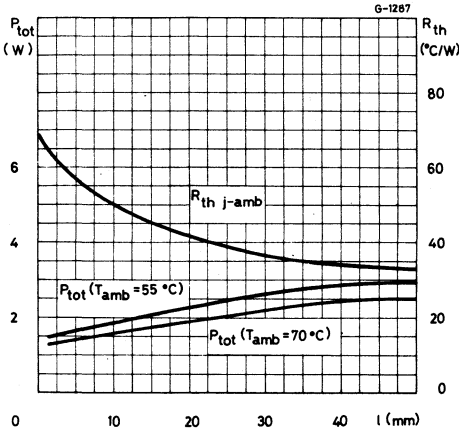


Fig. 18 - Maximum allowable power dissipation versus ambient temperature

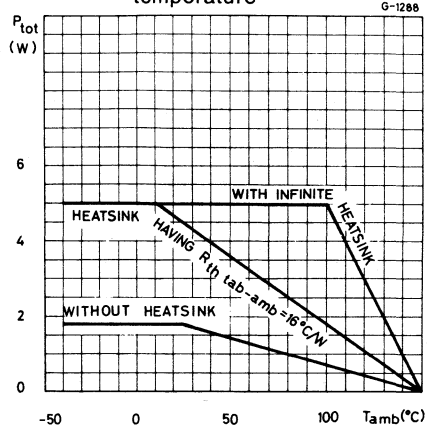
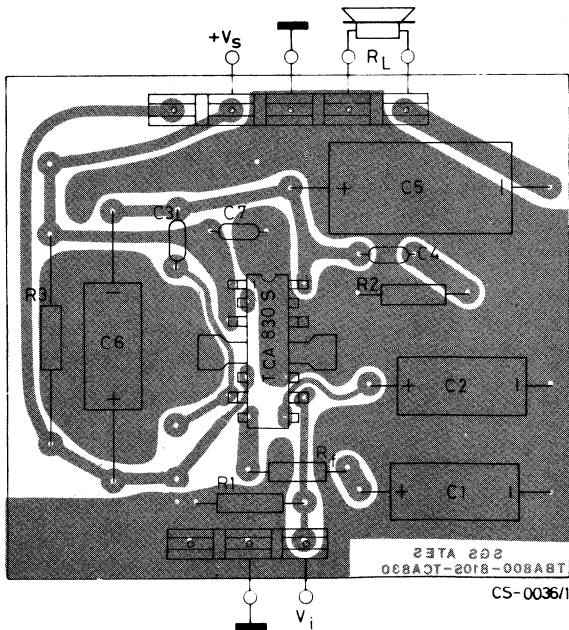


Fig. 19 - P.C. board and component layout of the test and application circuit (1:1 scale).



LINEAR INTEGRATED CIRCUITS

TCA 900 TCA 910

PRELIMINARY DATA

MOTOR SPEED REGULATORS

The TCA 900 and TCA 910 are linear integrated circuits in Jedec TO-126 plastic package. They are designed for use as speed regulators for DC motors of record players, tape recorders and cassettes.

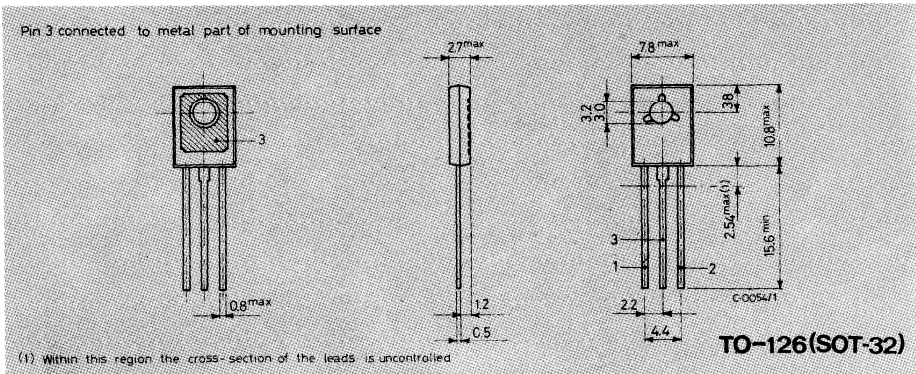
The TCA 900 is particularly suitable for battery operated portable equipments, and the TCA 910 for car-battery and mains operations.

ABSOLUTE MAXIMUM RATINGS

		TCA 900	TCA 910
V_s	Supply voltage	14 V	20 V
P_{tot}	Total power dissipation at $T_{amb} = 70^\circ\text{C}$ at $T_{case} = 100^\circ\text{C}$		0.8 W 5 W
$\rightarrow T_{stg}, T_j$	Storage and junction temperature		-40 to 150°C

MECHANICAL DATA

Dimensions in mm



TCA 900 TCA 910

THERMAL DATA

→ $R_{th\ j-case}$	Thermal resistance junction-case	max.	10	°C/W
→ $R_{th\ j-amb}$	Thermal resistance junction-ambient	max.	100	°C/W

ELECTRICAL CHARACTERISTICS ($T_{amb} = 25\text{ °C}$ and $R_s = \infty$ unless otherwise specified)

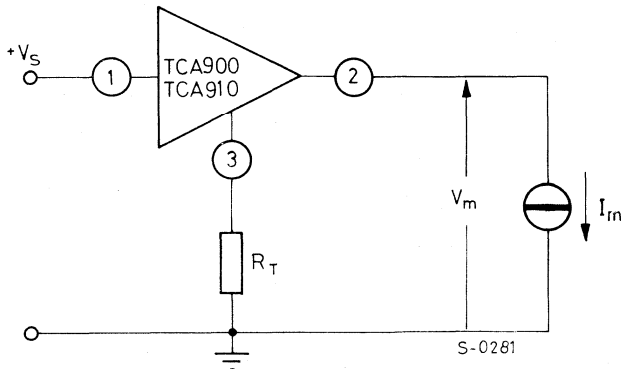
Parameter	Test conditions	Min.	Typ.	Max.	Unit	Fig.
V_{ref} Reference voltage (between pins 2 and 3)	$V_s = 5.5\text{ V}$ $I_m = 70\text{ mA}$ $R_T = 0$		2.6		V	1
I_{d3} Quiescent current (at pin 3)	$V_{1,3} = 5.5\text{ V}$ $I_2 = 0$ $R_T = 0$		2.6		mA	—
V_m Output voltage (for TCA 900 only)	$V_s = 5.5\text{ V}$ $I_m = 70\text{ mA}$ $R_T = 91\ \Omega$		3.6	3.9	V	1
V_m Output voltage (for TCA 910 only)	$V_s = 9\text{ V}$ $I_m = 70\text{ mA}$ $R_T = 270\ \Omega$		5.6	6.3	V	1
$V_{1,2}$ Dropout voltage	$\Delta V_m/V_m = -1\%$ $I_m = 70\text{ mA}$ $R_T = 91\ \Omega$		1.2		V	1
I_2 Limiting output current (at pin 2)	$V_{1,3} = 5.5\text{ V}$ $V_{2,3} = 0$		400		mA	—
$K = \Delta I_2/\Delta I_3$	$V_s = 5.5\text{ V}$ $I_2 = -70\text{ mA}$ $\Delta I_2 = \pm 10\text{ mA}$ $R_T = 0$		8.5		—	1
$\frac{\Delta V_m}{V_m}/\Delta V_s$ Line regulation (for TCA 900 only)	$V_s = 5.5\text{ V to }12\text{ V}$ $I_m = 70\text{ mA}$ $R_T = 91\ \Omega$		0.1		%/V	1

TCA 900 TCA 910

ELECTRICAL CHARACTERISTICS (continued)

Parameter	Test conditions	Min.	Typ.	Max.	Unit	Fig.
$\frac{\Delta V_m}{V_m} / \Delta V_s$ Line regulation (for TCA 910 only)	$V_s = 10 \text{ V to } 16 \text{ V}$ $I_m = 70 \text{ mA}$ $R_T = 270 \Omega$		0.1		%/V	1
$\frac{\Delta V_m}{V_m} / \Delta I_m$ Load regulation	$V_s = 5.5 \text{ V}$ $I_m = 40 \text{ to } 100 \text{ mA}$ $R_T = 0$		0.005		%/mA	1
$\frac{\Delta V_{ref}}{V_{ref}} / \Delta T_{amb}$ Temperature coefficient	$V_{1-3} = 5.5 \text{ V}$ $I_2 = -70 \text{ mA}$ $T_{amb} = -20 \text{ to } 70 \text{ }^\circ\text{C}$		0.01		%/°C	—

Fig. 1 - Test circuit.



TCA 900 TCA 910

Fig. 2 - Typical application circuit.

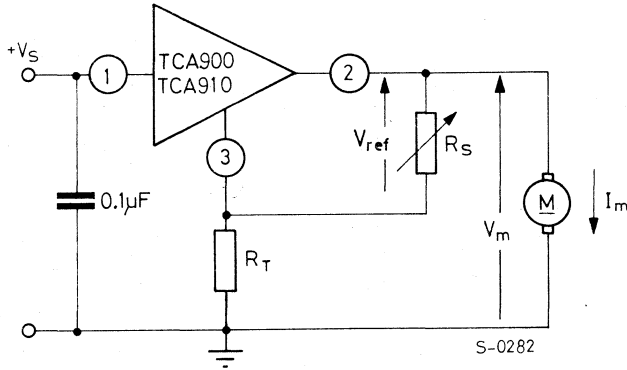


Fig. 3 - Normalized K_N versus I_2

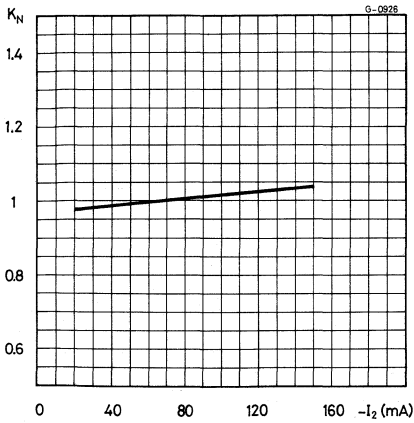
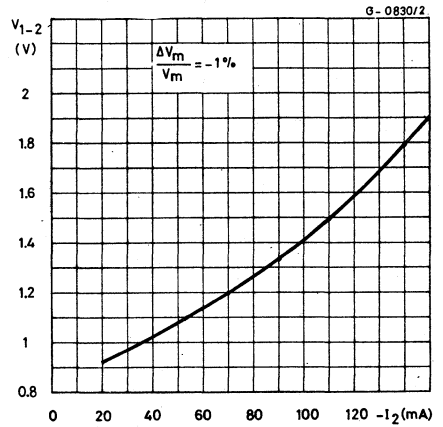


Fig. 4 - Dropout voltage versus output current



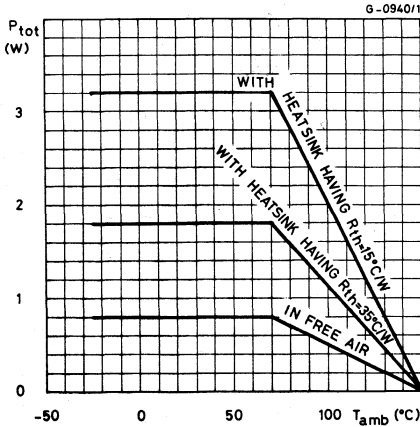


Fig. 5 - Maximum allowable power dissipation versus ambient temperature

APPLICATION INFORMATION

The regulator supplies the motor in such a way as to keep its speed constant, independent of supply voltage, applied torque and ambient temperature variations. The basic equation for the motor is:

$$V_m = E_0 + R_m I_m = a_1 n + a_2 c$$

- Where:
- V_m = supply voltage applied to the motor
 - E_0 = back electromotive force
 - n = motor speed (r.p.m)
 - R_m = internal resistance (of the motor)
 - I_m = current absorbed (by the motor)
 - a_1 and a_2 = constants
 - c = drive torque

TCA 900 TCA 910

A voltage supply with the following characteristics

$$E = E_0 \quad E = \text{electromotive force}$$

$$R_o = -R_m \quad R_o = \text{output resistance}$$

gives performance required.

This means that a variation in current absorbed by the motor, due to a variation in torque applied, causes a proportional variation in regulator output voltage.

In fig. 6 is shown the minimum allowable E_0 versus R_T .

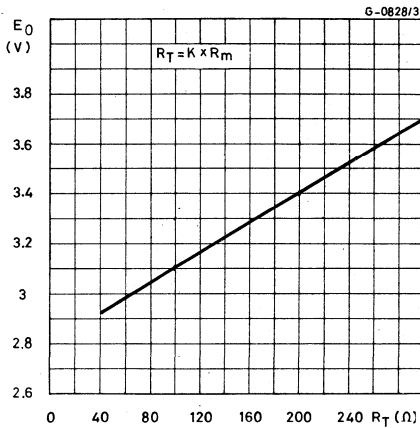


Fig. 6 - Minimum E_0 allowable versus R_T .

The TCA 900 and TCA 910 give a reference constant voltage V_{ref} (between pins 2 and 3) independent of variations of V_s , I_2 and ambient temperature.

They also give:

$$I_3 = I_{d3} + I_2/K$$

Where: I_3 = total current at pin 3
 I_{d3} = quiescent current at pin 3 ($I_2 = 0$)
 I_2 = current at pin 2
 K = constant.

The output voltage V_m , applied to the motor has the following value:

$$V_m = V_{ref} + R_T \left[\underbrace{\frac{V_{ref}}{R_s} \left(1 + \frac{1}{K} \right) + I_{d3}}_{\text{Term 1}} \right] + \underbrace{\frac{I_m}{K} R_T}_{\text{Term 2}}$$

Term 1 equals E_0 and fixes the motor speed by means of the variable resistor R_s ;

Term 2 $\frac{I_m}{K} \cdot R_T$ equals the term $R_m \cdot I_m$ and, therefore, compensates variations of torque applied.

Complete compensation is achieved when:

$$R_T = K R_m$$

If $R_{T \max} > K R_{m \min}$ instability may occur.

LINEAR INTEGRATED CIRCUIT

PRELIMINARY DATA

10 W AUDIO POWER AMPLIFIER WITH SHORT CIRCUIT PROTECTION AND THERMAL SHUT-DOWN

The TCA 940 is a monolithic integrated circuit in a 12-lead quad in-line plastic package, intended for use as a low frequency class B amplifier. The TCA 940 provides 10 W output power @ 20 V/4 Ω , 9 W @ 18 V/4 Ω , 7 W @ 16 V/4 Ω , 6.5 W @ 20 V/8 Ω and 5 W @ 18 V/8 Ω .

It gives high output current (up to 3 A), very low harmonic and cross-over distortion. Besides the thermal shut-down, the device contains a current limiting circuit which restricts the operation within the safe operating area of the power transistors.

The TCA 940 is pin to pin equivalent to the TBA 810 AS.

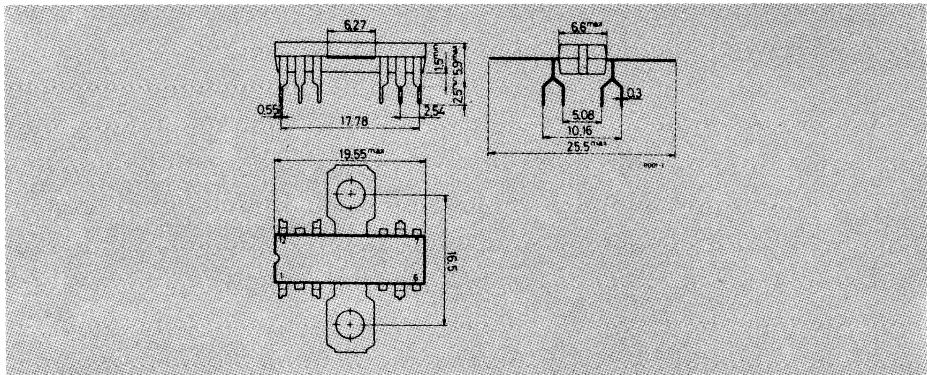
ABSOLUTE MAXIMUM RATINGS

V_s	Supply voltage	24	V
I_o	Output peak current (non-repetitive)	3.5	A
I_o	Output peak current (repetitive)	3	A
P_{tot}	Power dissipation: at $T_{amb} = 50^\circ\text{C}$	1.25	W
	at $T_{tab} = 70^\circ\text{C}$	8	W
T_{stg}, T_j	Storage and junction temperature	-40 to 150	$^\circ\text{C}$

ORDERING NUMBER: TCA 940

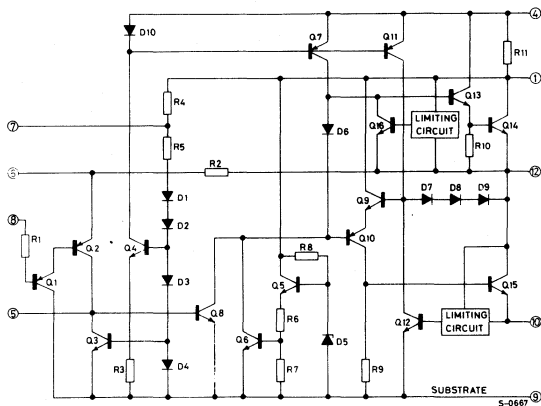
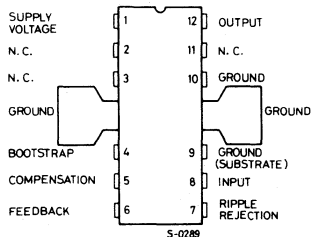
MECHANICAL DATA

Dimensions in mm

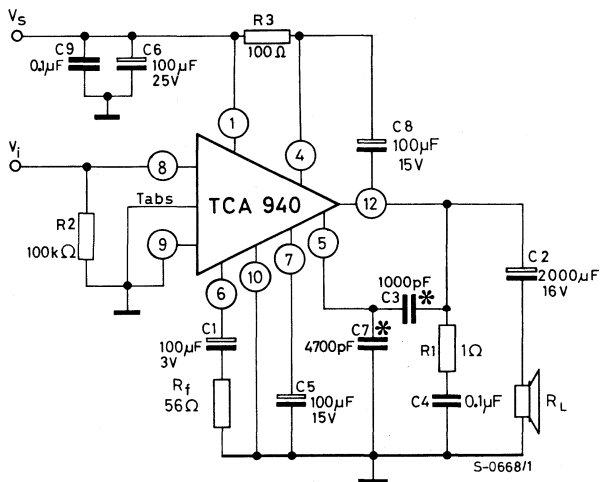


TCA 940

CONNECTION AND SCHEMATIC DIAGRAMS



TEST AND APPLICATION CIRCUIT



*=C3, C7 SEE FIG. 7

THERMAL DATA

$R_{th\ j-tab}$	Thermal resistance junction-tab	max	10	°C/W
$R_{th\ j-amb}$	Thermal resistance junction-ambient	max	80	°C/W

ELECTRICAL CHARACTERISTICS (Refer to the test circuit, $T_{amb} = 25\text{ }^{\circ}\text{C}$)

Parameter	Test conditions	Min.	Typ.	Max.	Unit	
V_s	Supply voltage (pin 1)	6		24	V	
V_o	Quiescent output voltage (pin 12)	$V_s = 18\text{ V}$	8.2	9	9.8	V
I_d	Quiescent drain current	$V_s = 24\text{ V}$	20	42	mA	
I_b	Bias current (pin 8)	$V_s = 18\text{ V}$	0.5	3	μA	
P_o	Output power	$d = 10\%$ $f = 1\text{ kHz}$ $V_s = 20\text{ V}, R_L = 4\ \Omega$ $V_s = 18\text{ V}, R_L = 4\ \Omega$ $V_s = 16\text{ V}, R_L = 4\ \Omega$ $V_s = 20\text{ V}, R_L = 8\ \Omega$ $V_s = 18\text{ V}, R_L = 8\ \Omega$	7	10 9 7 6.5 5	W W W W W	
$V_{i(rms)}$	Voltage for input saturation		250		mV	
V_i	Input sensitivity	$P_o = 9\text{ W}$ $V_s = 18\text{ V}$ $R_L = 4\ \Omega$ $f = 1\text{ kHz}$	90		mV	
B	Frequency response (-3 dB)	$V_s = 18\text{ V}$ $R_L = 4\ \Omega$ $C_3 = 1000\text{ pF}$	40 to 20,000		Hz	
d	Distortion	$P_o = 50\text{ mW to } 5\text{ W}$ $V_s = 18\text{ V}$ $R_L = 4\ \Omega$ $f = 1\text{ kHz}$	0.3		%	

TCA 940

ELECTRICAL CHARACTERISTICS (continued)

Parameter	Test conditions	Min.	Typ.	Max.	Unit
R_i Input resistance (pin 8)			5		M Ω
G_v Voltage gain (open loop)	$V_s = 18\text{ V}$ $R_L = 4\ \Omega$ $f = 1\text{ kHz}$		75		dB
G_v Voltage gain (closed loop)	$V_s = 18\text{ V}$ $R_L = 4\ \Omega$ $f = 1\text{ kHz}$	34	37	40	dB
e_N Input noise voltage	$V_s = 18\text{ V}$ $R_g = 0$ B (-3 dB) = 40 Hz to 20,000 Hz		3		μV
i_N Input noise current	$V_s = 18\text{ V}$ B (-3 dB) = 40 Hz to 20,000 Hz		0.15		nA
η Efficiency	$P_o = 9\text{ W}$ $V_s = 18\text{ V}$ $R_L = 4\ \Omega$ $f = 1\text{ kHz}$		65		%
SVR Supply voltage rejection ratio	$V_s = 24\text{ V}$ $R_L = 4\ \Omega$ $f_{\text{ripple}} = 100\text{ Hz}$		45		dB
I_d Drain current	$P_o = 9\text{ W}$ $V_s = 18\text{ V}$ $R_L = 4\ \Omega$		770		mA
* Thermal shut-down case temperature	$P_{\text{tot}} = 4.8\text{ W}$		110		$^{\circ}\text{C}$

* See figs. 9 and 15

TCA 940

Fig. 1 - Typical output power versus supply voltage

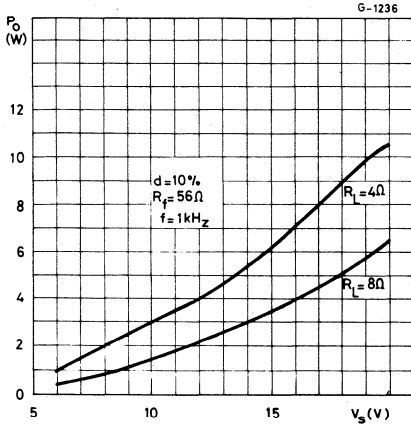


Fig. 2 - Maximum power dissipation versus supply voltage (sine wave operation)

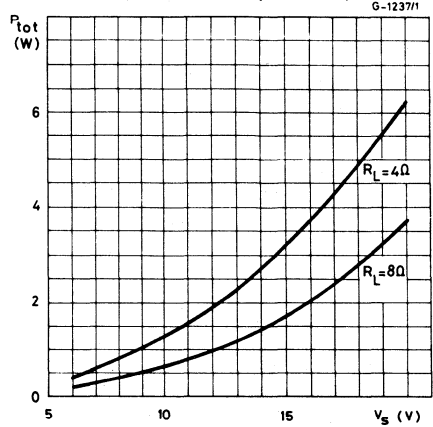


Fig. 3 - Typical distortion versus output power

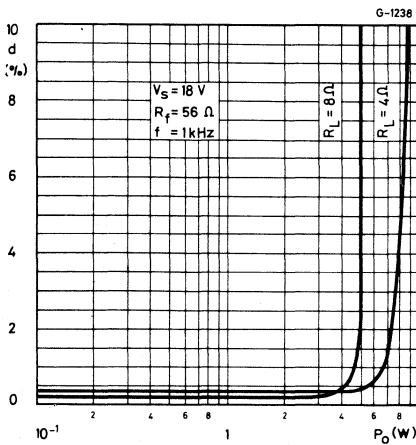
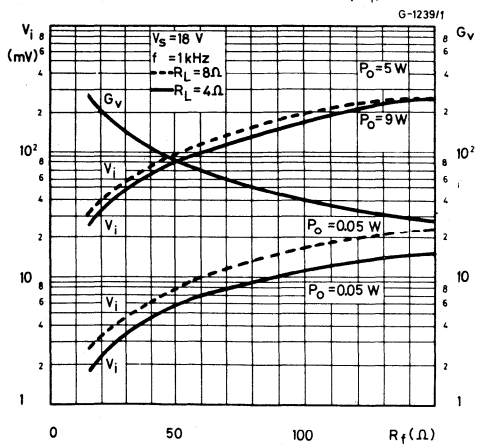


Fig. 4 - Typical voltage gain (closed loop) and typical input voltage versus feedback resistance (Rf)



TCA 940

Fig. 5 - Typical distortion versus frequency ($R_L = 4 \Omega$)

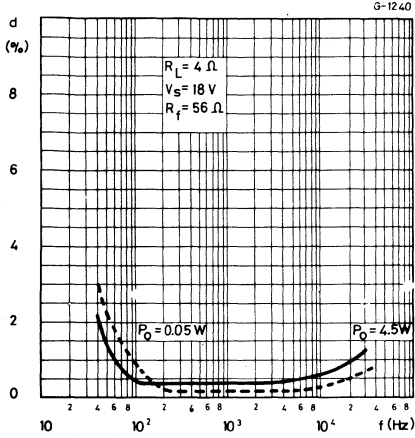


Fig. 6 - Typical distortion versus frequency ($R_L = 8 \Omega$)

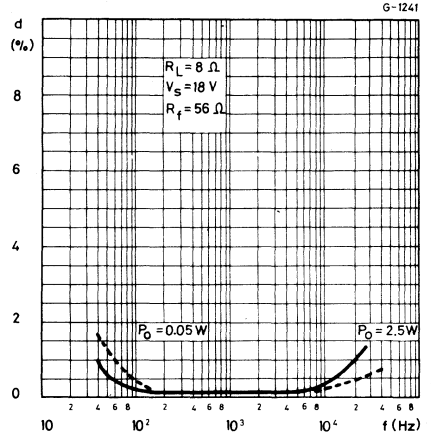


Fig. 7 - Typical value of C3 versus R_f for different bandwidths

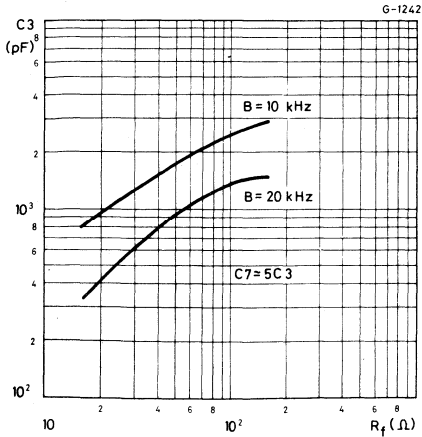


Fig. 8 - Typical supply voltage rejection ratio

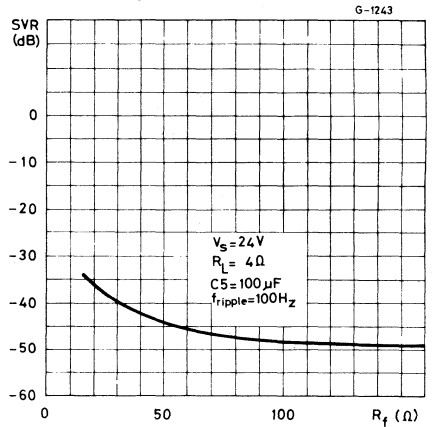


Fig. 9 - Typical power dissipation and efficiency versus output power ($R_L = 4 \Omega$)

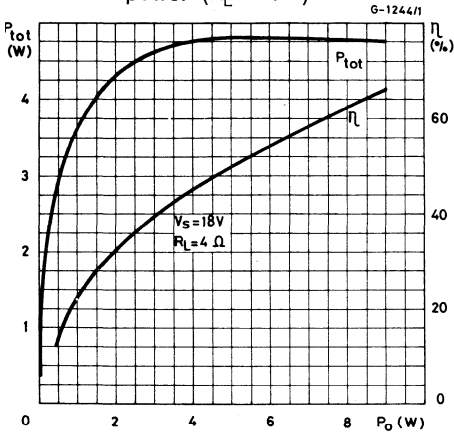


Fig. 10 - Typical power dissipation and efficiency versus output power ($R_L = 8 \Omega$)

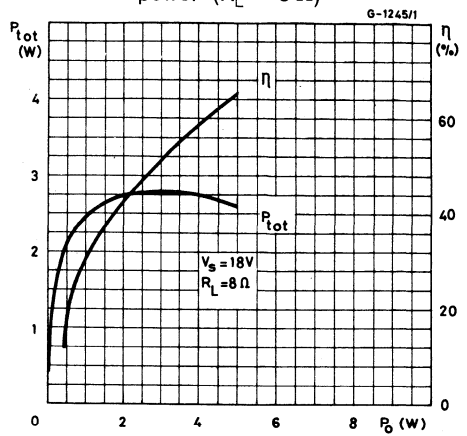


Fig. 11 - Typical quiescent output voltage (pin 12) versus supply voltage

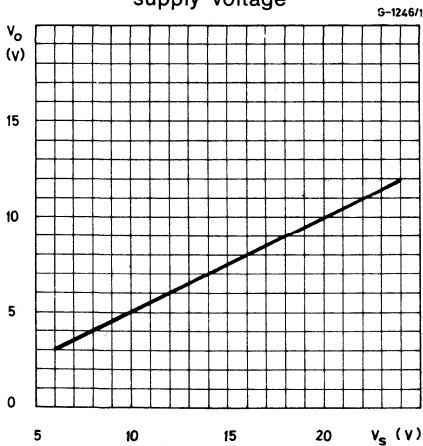
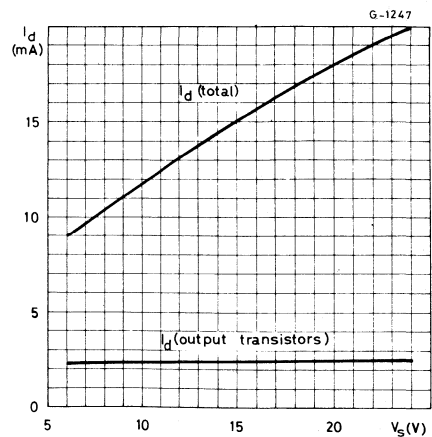


Fig. 12 - Typical quiescent current versus supply voltage



TCA 940

SHORT CIRCUIT PROTECTION

The most important innovation in the TCA 940 is an original circuit which limits the current of the output transistors. Fig. 13 shows that the maximum output current is a function of the collector-emitter voltage; hence the circuit works within the safe operating area of the output power transistors. This can therefore be considered as being power limiting rather than simple current limiting. The TCA 940 is thus protected against temporary overloads or short circuit by the above circuit. Should the short circuit exist for a longer time, the thermal shut-down comes into action and keeps the junction's temperature within safe limits.

Fig. 13 - Maximum output current versus voltage (V_{CE}) across each output transistor

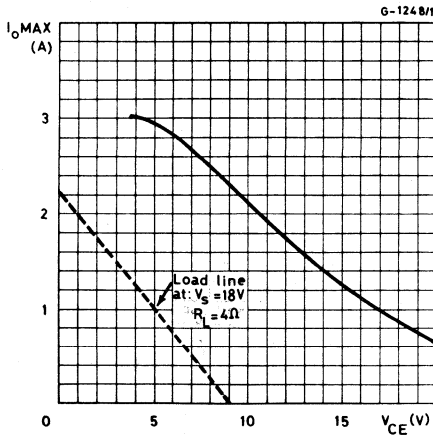
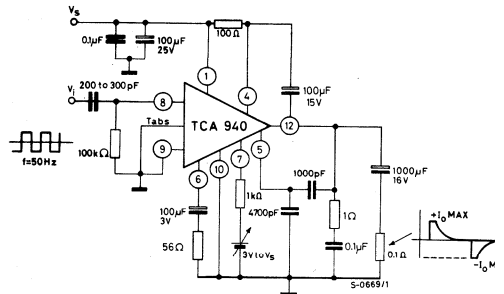


Fig. 14 - Test circuit for the limiting characteristics

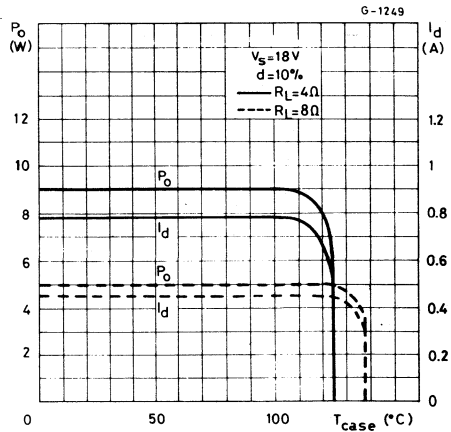


THERMAL SHUT-DOWN

The presence of a thermal limiting circuit offers the following advantages:

- 1) an overload on the output (even if it is permanent), or an above-limit ambient temperature can be easily supported
- 2) the heatsink can have a smaller factor of safety compared with that of a conventional circuit. There is no device damage in the case of too high a junction temperature: all that happens is that P_o (and therefore P_{tot}) and I_d are reduced (fig. 15).

Fig. 15 - Output power and drain current versus package temperature



TCA 940

MOUNTING INSTRUCTION

The power dissipated in the circuit may be removed by connecting the tabs to an external heatsink according to fig. 16. The desired thermal resistance may be obtained by fixing the TCA 940 to a suitably dimensioned plate as shown in fig. 17. This plate can also act as a support for the whole printed circuit board; the mechanical stresses do not damage the integrated circuit. During soldering the pins temperature must not exceed 260°C and the soldering time must not be longer than 12 seconds.

Fig. 16 - Maximum allowable power dissipation versus ambient temperature

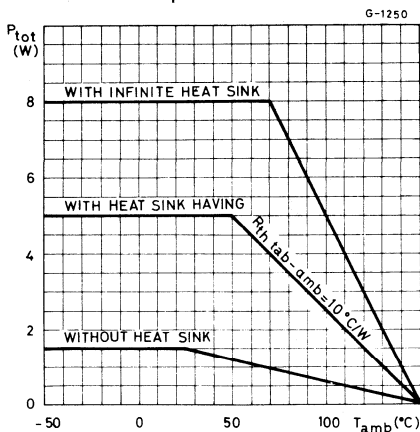
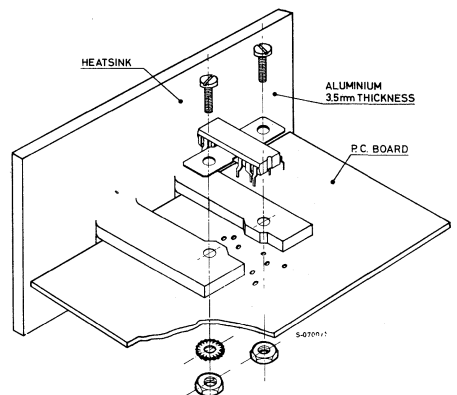
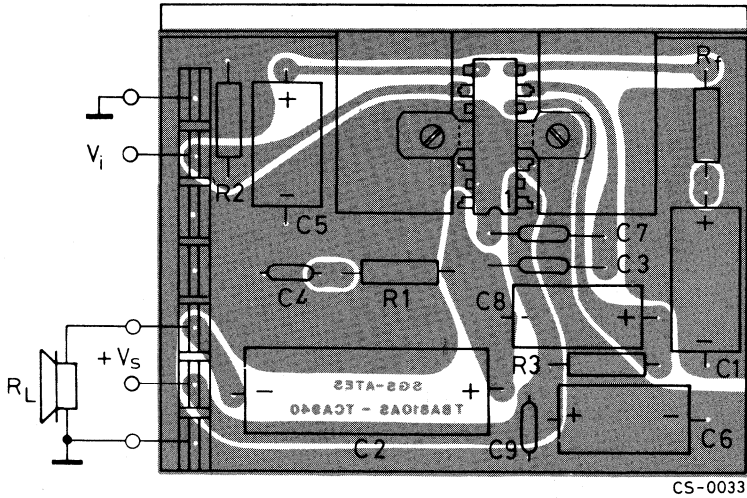


Fig. 17 - Mounting example



TCA 940

Fig. 18 - P.C. board and component layout of the test and application circuit (1:1 Scale).



LINEAR INTEGRATED CIRCUIT

PRELIMINARY DATA

AUDIO POWER AMPLIFIER WITH SHORT CIRCUIT PROTECTION AND THERMAL SHUT-DOWN

The TCA 940E is a monolithic integrated circuit in a 12-lead quad in-line plastic package, intended for use as a low frequency class B amplifier. The TCA 940E provides 6.5W output power @ 20 V/8 Ω and 5.4 W @ 18 V/8 Ω .

It gives very low harmonic and cross-over distortion. Besides the thermal shut-down, the device contains a current limiting circuit which restricts the operation within the safe operating area of the power transistors.

The TCA 940E is pin to pin equivalent to the TBA 810S.

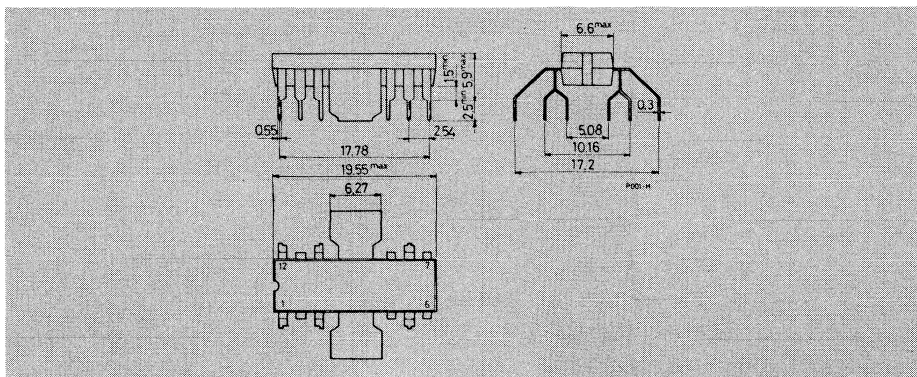
ABSOLUTE MAXIMUM RATINGS

V_s	Supply voltage	24	V
I_o	Output peak current (non-repetitive)	3.5	A
I_o	Output peak current (repetitive)	3	A
P_{tot}	Power dissipation: at $T_{amb} = 80^\circ\text{C}$ at $T_{tab} = 90^\circ\text{C}$	1	W
		5	W
T_{stg}, T_j	Storage and junction temperature	-40 to 150	$^\circ\text{C}$

ORDERING NUMBER: TCA 940E

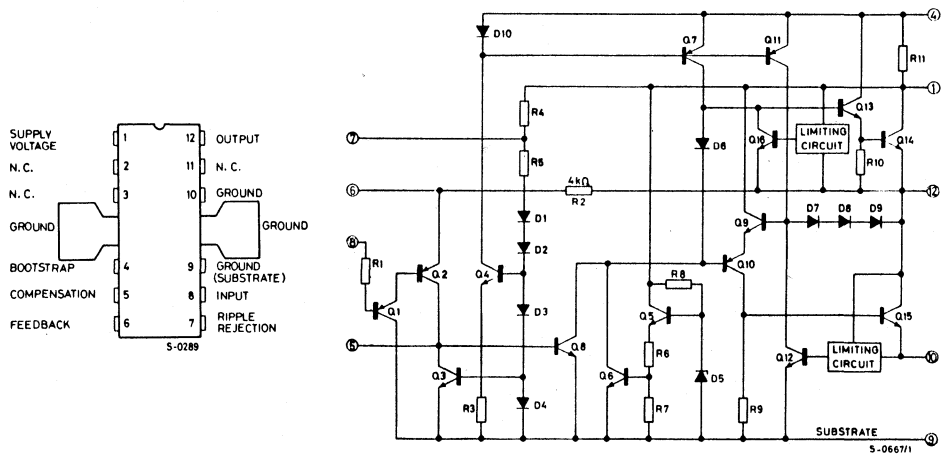
MECHANICAL DATA

Dimensions in mm

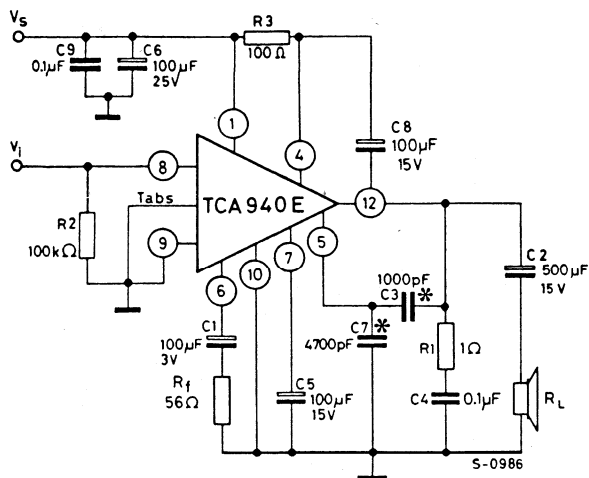


TCA 940 E

CONNECTION AND SCHEMATIC DIAGRAMS



TEST AND APPLICATION CIRCUIT



*=C3, C7 SEE FIG. 6

THERMAL DATA

$R_{th\ j-tab}$	Thermal resistance junction-tab	max	12	°C/W
$R_{th\ j-amb}$	Thermal resistance junction-ambient	max	70*	°C/W

* Obtained with tabs soldered to printed circuit with minimized copper area

ELECTRICAL CHARACTERISTICS (Refer to the test circuit, $T_{amb} = 25\text{ °C}$)

Parameter	Test conditions	Min.	Typ.	Max.	Unit
V_s	Supply voltage (pin 1)	6		24	V
V_o	Quiescent output voltage (pin 12)	$V_s = 18V$		8.2 9 9.8	V
I_d	Quiescent drain current	$V_s = 24V$		20 42	mA
I_b	Bias current (pin 8)	$V_s = 18V$		0.5 3	μA
P_o	Output power	$d = 10\%$ $V_s = 20V,$ $V_s = 18V,$	$f = 1\text{ kHz}$ $R_L = 8\ \Omega$ $R_L = 8\ \Omega$	5 6.5 5.4	W W
$V_{i(rms)}$	Voltage for input saturation			250	mV
V_i	Input sensitivity	$P_o = 5.4W$ $R_L = 8\ \Omega$	$V_s = 18V$ $f = 1\text{ kHz}$	110	mV
B	Frequency response (-3 dB)	$V_s = 18V$ $C_3 = 1000\text{ pF}$	$R_L = 8\ \Omega$	40 to 20,000	Hz
d	Distortion	$P_o = 50\text{ mW to } 3.5W$ $V_s = 18V$ $f = 1\text{ kHz}$	$R_L = 8\ \Omega$	0.2	%

TCA 940 E

ELECTRICAL CHARACTERISTICS (continued)

Parameter	Test conditions	Min.	Typ.	Max.	Unit
R_i Input resistance (pin 8)			5		$M\Omega$
G_v Voltage gain (open loop)	$V_s = 18V$ $f = 1 \text{ kHz}$ $R_L = 8\Omega$		75		dB
G_v Voltage gain (closed loop)	$V_s = 18V$ $f = 1 \text{ kHz}$ $R_L = 8\Omega$	34	37	40	dB
e_N Input noise voltage	$V_s = 18V$ $R_2 = 0$ $B (-3 \text{ dB}) = 40 \text{ Hz to } 20,000 \text{ Hz}$		3		μV
i_N Input noise current	$V_s = 18V$ $B (-3 \text{ dB}) = 40 \text{ Hz to } 20,000 \text{ Hz}$		0.15		nA
η Efficiency	$P_o = 5.4W$ $R_L = 8\Omega$ $V_s = 18V$ $f = 1 \text{ kHz}$		70		%
SVR Supply voltage rejection ratio	$V_s = 22V$ $f_{\text{ripple}} = 100 \text{ Hz}$ $R_L = 8\Omega$		45		dB
I_d Drain current	$P_o = 5.4W$ $R_L = 8\Omega$ $V_s = 18V$		460		mA
* Thermal shut-down case temperature	$P_{\text{tot}} = 2.8W$		120		$^{\circ}C$

* See figs. 8 and 14

Fig. 1 - Typical output power vs. supply voltage

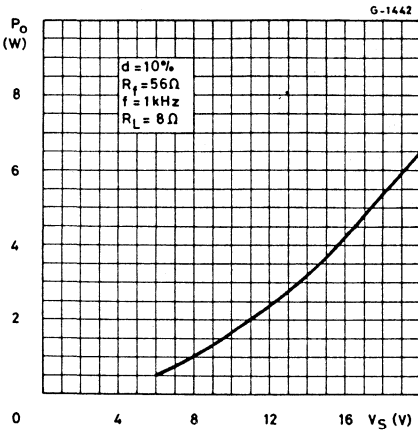


Fig. 2 - Maximum power dissipation vs. supply voltage (sine wave operation)

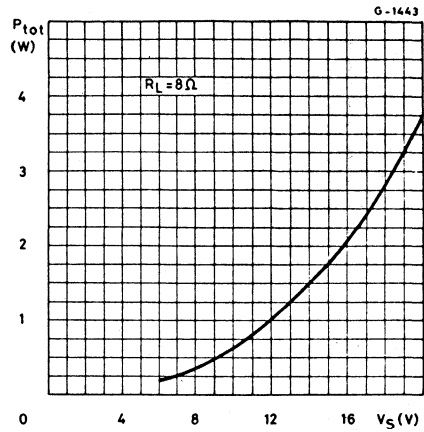


Fig. 3 - Typical distortion vs. output power

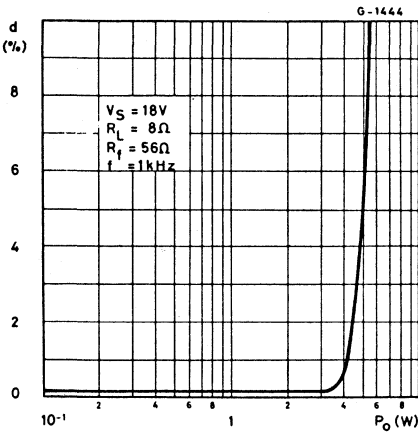
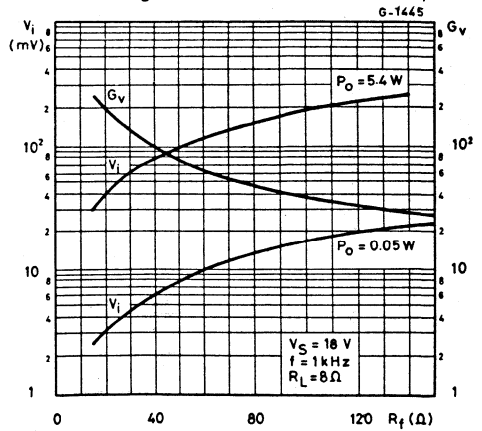


Fig. 4 - Typical voltage gain (closed loop) and typical input voltage vs. feedback resistance (R_f)



TCA 940 E

Fig. 5 - Typical distortion vs. frequency

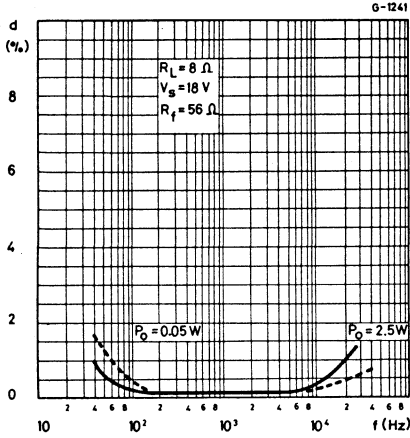


Fig. 6 - Typical value of C3 vs. R_f for different bandwidths

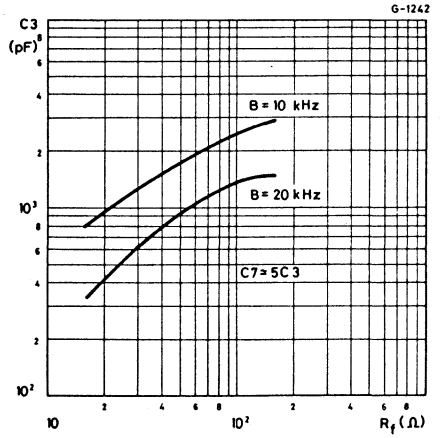


Fig. 7 - Typical supply voltage rejection ratio

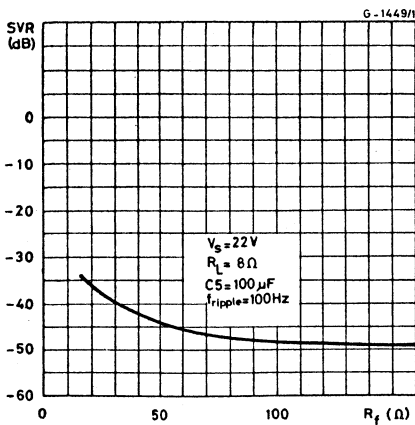
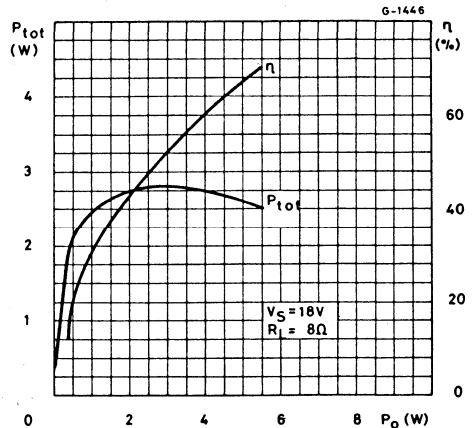


Fig. 8 - Typical power dissipation and efficiency vs. output power



TCA 940 E

Fig. 9 - Typical quiescent output voltage (pin 12) vs. supply voltage

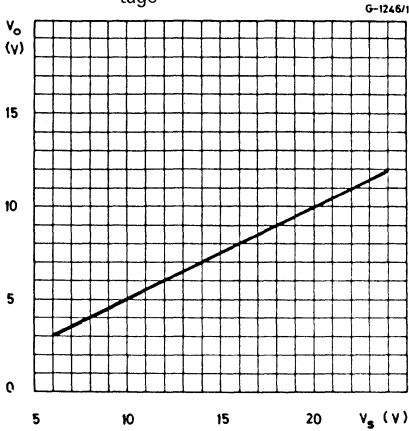
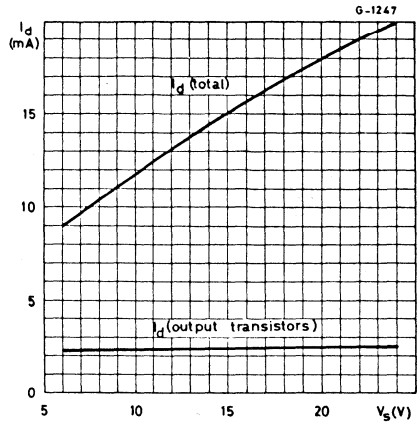


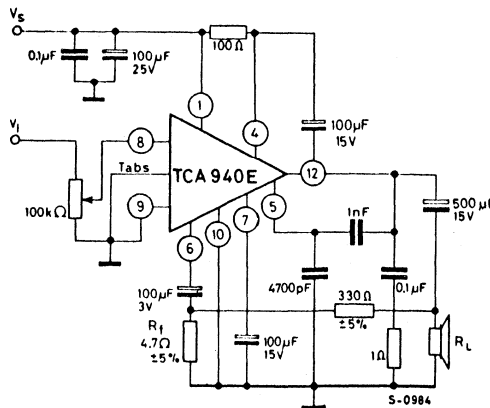
Fig. 10 - Typical quiescent current vs. supply voltage



APPLICATION INFORMATION

The application diagram in fig. 11 is advised if the device's gain spread is to be contained within ± 1 dB (for stereo applications)

Fig. 11 - Recommended circuit for maintaining the gain spread within ± 1 dB max.

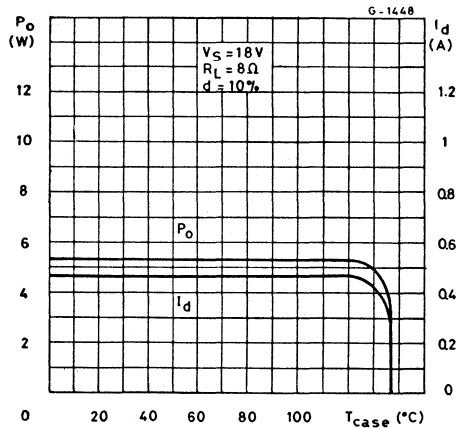


THERMAL SHUT-DOWN

The presence of a thermal limiting circuit offers the following advantages:

- 1) an overload on the output (even if it is permanent), or an above-limit ambient temperature can be easily supported
- 2) the heatsink can have a smaller factor of safety compared with that of a conventional circuit. There is no device damage in the case of too high a junction temperature: all that happens is that P_o (and therefore P_{tot}) and I_d are reduced (fig. 14)

Fig. 14 - Output power and drain current vs. package temperature



TCA 940 E

MOUNTING INSTRUCTION

The power dissipated in the circuit may be removed by connecting the tabs to an external heatsink, or by soldering them to an area of copper on the printed circuit board (Fig. 15). Fig. 16 shows a simple type of heatsink; assuming an area of copper on the printed circuit board of only 2 cm^2 , the total R_{th} between junction and ambient is approximately $28 \text{ }^\circ\text{C/W}$.

The external heatsink or area of printed circuit copper must be connected to electrical ground.

Fig. 17 gives the maximum dissipable power (for $T_{amb} = 55$ and $70 \text{ }^\circ\text{C}$) as a function of the side of two equal square copper areas having a thickness of 35μ (1.4 mil).

During soldering the tabs temperature must not exceed 260°C and the soldering time must not be longer than 12 seconds.

Fig. 15 - Example of area of P.C. board copper soldered to the tabs of the TCA940E which is used as a heatsink

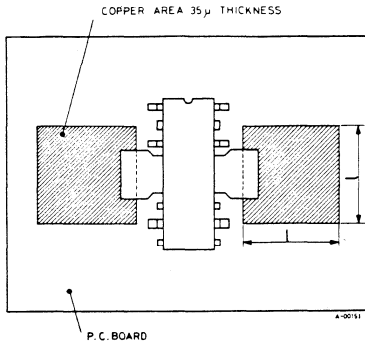


Fig. 16 - Example of TCA940E with external heatsink

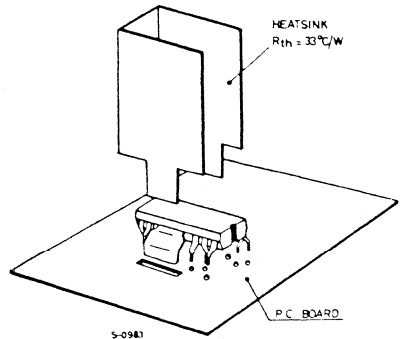


Fig. 17 - Power that can be dissipated vs. "l"

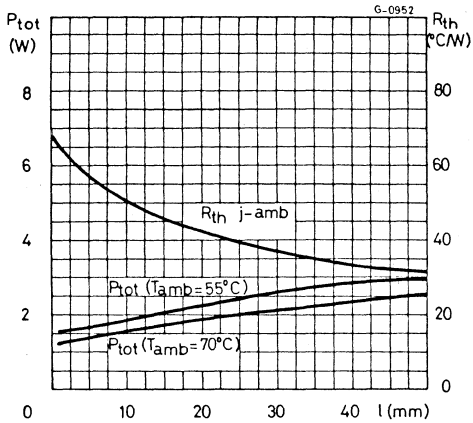


Fig. 18 - Maximum allowable power dissipation vs. ambient temperature

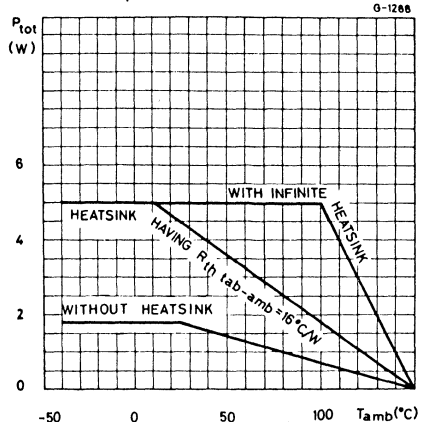
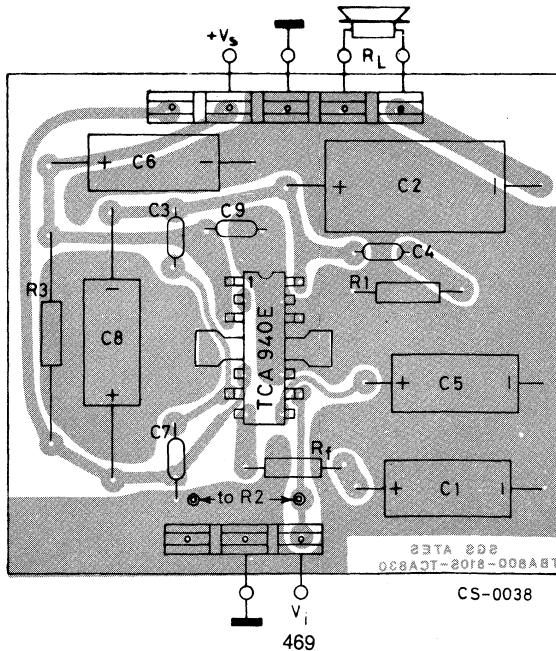


Fig. 19 - P.C. board and component layout of the test and application circuit (1:1 Scale)



TDA 440

LINEAR INTEGRATED CIRCUIT

PRELIMINARY DATA

COMPLETE TV VISION IF SYSTEM

The TDA 440 is a silicon monolithic integrated circuit in a 16 lead dual in-line plastic package. The functions incorporated are:

- gain controlled vision IF amplifier
- synchronous detector
- AGC detector with gating facility
- AGC amplifier for PNP tuner drive with variable delay
- video preamplifier with positive and negative outputs.

It is intended for use in black and white and colour TV receivers.

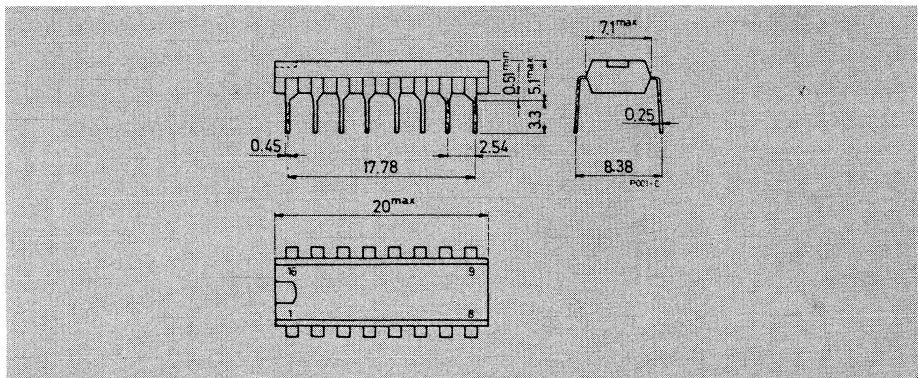
ABSOLUTE MAXIMUM RATINGS

V_s	Supply voltage (pin 13)	15	V
V_5	Voltage at pin 5	20	V
V_{10}	Voltage at pin 10	}	-1 V
			3 V
V_{11}	Voltage at pin 11 (with load connected to V_s)	8	V
I_{11}, I_{12}	Output current	5	mA
I_{14}	Supply current (into pin 14)	55	mA
P_{tot}	Total power dissipation at $T_{amb} \leq 70^\circ\text{C}$	800	mW
T_{stg}, T_j	Storage and junction temperature	-40 to 150	$^\circ\text{C}$

ORDERING NUMBER: TDA 440

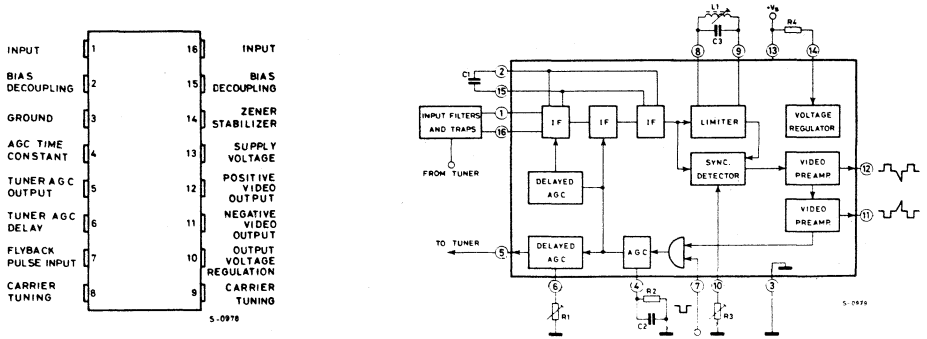
MECHANICAL DATA

Dimensions in mm

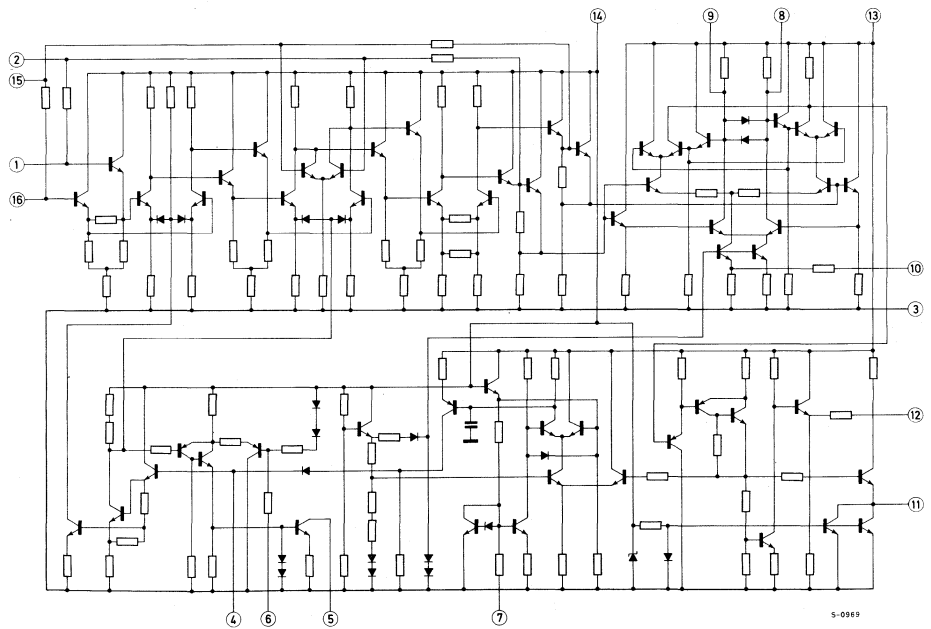


TDA 440

CONNECTION AND BLOCK DIAGRAMS



SCHEMATIC DIAGRAM



TDA 440

g. 1a - Test circuit for measurement of I_{13} , V_{11} , V_{12} , V_{14} and $\Delta V_{11}/\Delta V_{13}$

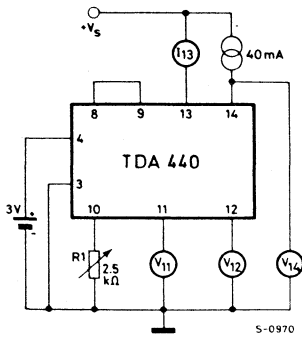
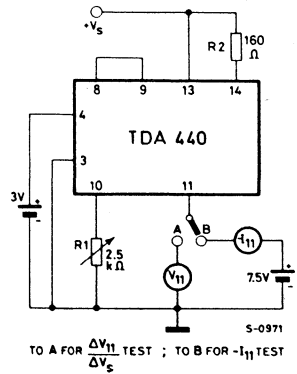
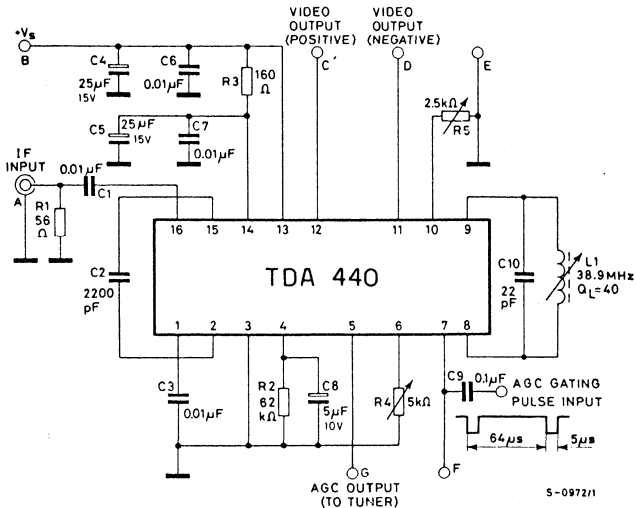


Fig. 1b - Test circuit for measurement of I_{11} and $\Delta V_{11}/\Delta V_s$



ig. 2 - Dynamic test circuit



TDA 440

Fig. 3a - Set-up for measurement of d_{im}

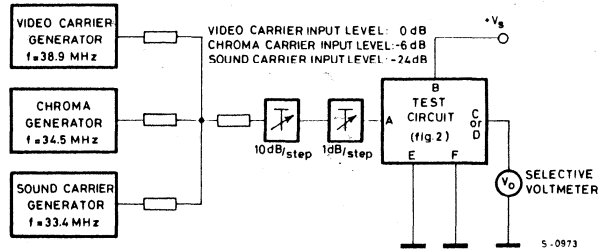


Fig. 3b - Set-up for measurement of ΔV_o

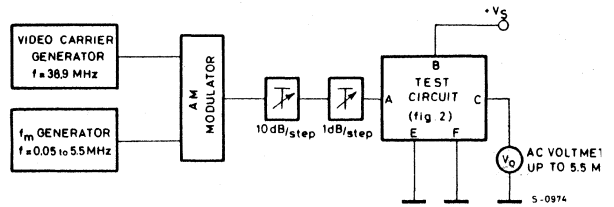


Fig. 3c - Set-up for measurement of I_s , V_i , ΔV_i , V_o , V_{11} and V_{12}

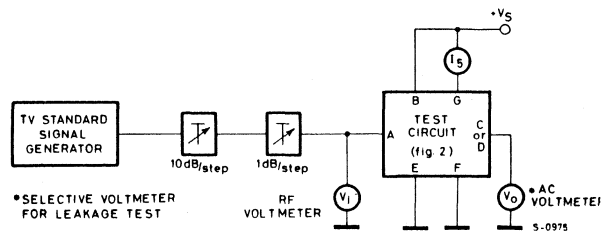
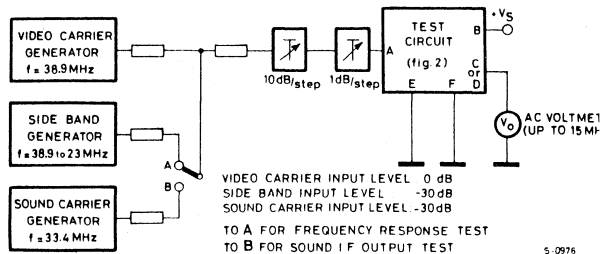


Fig. 3d - Set-up for measurement of B, V_{11} and V_{12}



TDA 440

HERMAL DATA

$r_{th\ j-amb}$ Thermal resistance junction-ambient	max 100 °C/W
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ELECTRICAL CHARACTERISTICS (Refer to the test circuits, $T_{amb} = 25^{\circ}\text{C}$)

Parameter	Test conditions	Min.	Typ.	Max.	Unit	Fig.
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STATIC (DC) CHARACTERISTICS

I_s Supply current (pin 13)	$V_s = 12\text{V}$	14	19	25	mA	1a
$I_{11}^{(1)}$ Output current		2.3	3.5	4.8	mA	1b
V_s Supply voltage (pin 13)	$I_{14} = 40\text{ mA}$	10		15	V	—
$V_{11}^{(2)}$ Output voltage	$V_s = 12\text{V}$	4.8		6.4	V	1a
$V_{12}^{(2)}$ Output voltage	$V_s = 12\text{V}$ $V_{11} = 5.5\text{V}$		5.6		V	
V_{14} Stabilized voltage	$I_{14} = 40\text{ mA}$	5.5	6	6.5	V	
$\frac{\Delta V_{11}}{\Delta V_s}$ Output voltage drift	$V_s = 11\text{ to }14\text{V}$		3.5		%	1b
$\frac{\Delta V_{11}}{\Delta V_{13}}$ Output voltage drift	$V_{13} = 11\text{ to }15\text{V}$ $I_{14} = 40\text{ mA}$		0.4		%	1a

DYNAMIC CHARACTERISTICS (refer to fig. 2 test circuit, $V_s = 12\text{V}$)

I_s Supply current		48	57	66	mA	—
$I_5^{(3)}$ Tuner AGC current	$V_7 = 0$ $R_4 = 5\text{ k}\Omega$ $f_0 = 38.9\text{ MHz}$	6	8		mA	3c
V_7 AGC gating pulse input peak voltage	$f = 15.6\text{ kHz}$	-1.5		-5	V	—
$V_i^{(4)}$ Input sensitivity	$V_7 = 0$ $f_0 = 38.9\text{ MHz}$ $V_{11} = 3.3\text{V peak to peak}$	140	200	280	μV	3c
ΔV_i AGC range	$V_7 = 0$ $\Delta V_o = 1\text{ dB}$ $f_0 = 38.9\text{ MHz}$ $V_{11} = 3.3\text{V peak to peak}$	50	55		dB	
V_o Peak to peak output voltage at pin 11	$V_7 = 0$ $V_{11} = 5.5\text{V}$ $f_0 = 38.9\text{ MHz}$ $V_i = \text{see note (5)}$	2.6	3.3	4.2	V	

TDA 440

ELECTRICAL CHARACTERISTICS (continued)

Parameter	Test conditions	Min.	Typ.	Max.	Unit	Fig.
ΔV_o	Video output variation over the AGC range (0 to 5.5 MHz) $V_7 = 0$ $\Delta V_i = 50$ dB $V_{11} = 3.3$ V peak to peak $f_o = 38.9$ MHz $f_m = 0$ to 5.5 MHz		1	2	dB	3b
V_{11}, V_{12}	Sound IF at video outputs (5.5 MHz) $V_7 = 0$ $V_i =$ see note (5) f_o (vision) = 38.9 MHz f_o (sound) = 33.4 MHz	30			mV	3d
	Differential error of the output voltage (B & W) $V_7 = 0$ $f_o = 38.9$ MHz $V_{11} = 3.3$ V peak to peak			15	%	—
V_{11}, V_{12}	Video carrier and video carrier 2 nd harmonic leakage at video outputs $V_7 = 0$ $V_i =$ see note (5)		15	30	mV	3c
V_{11}, V_{12}	Video carrier leakage at video outputs $f_o = 38.9$ MHz		5	15	mV	
B	Frequency response (-3 dB)	8	10		MHz	3d
d_{im}	Intermodulation products at video outputs $V_7 = 0$ $V_i =$ see note (5) f_o (vision) = 38.9 MHz f_o (sound) = 33.4 MHz f_o (chroma) = 34.5 MHz		-50	-40	dB	3a
R_i	Input resistance (between pins 1 and 16) $V_7 = 0$ $V_i =$ see note (5)		1.4		k Ω	—
C_i	Input capacitance (between pins 1 and 16) $f_o = 38.9$ MHz		2		pF	—

- NOTES: (1) Current flowing into pin 11 with the load connected to V_5 .
(2) V_{11} and V_{12} are adjustable simultaneously by means of the resistance, or by a variable voltage ≤ 0.6 V, connected between pin 10 and ground.
(3) Measured with an input voltage 10 dB higher than the V_i at which the tuner AGC current starts.
(4) RMS value of the unmodulated video carrier (modulation down).
(5) The input voltage V_i can have any value within the AGC range.

Fig. 4 - AGC regulation voltage vs. input voltage variation

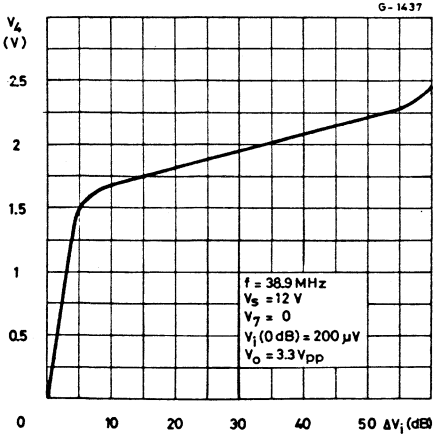


Fig. 5 - Tuner AGC output current vs. IF gain variation

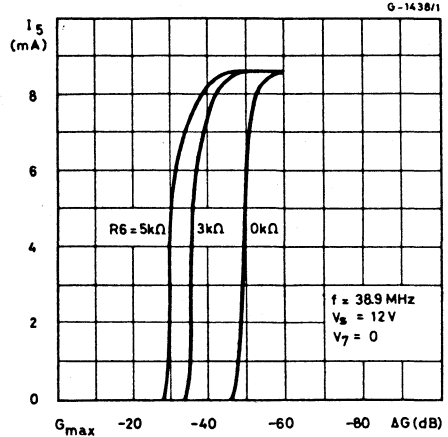


Fig. 6 - Output black level vs. supply voltage

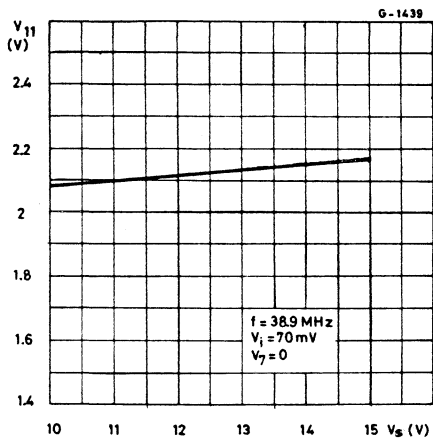
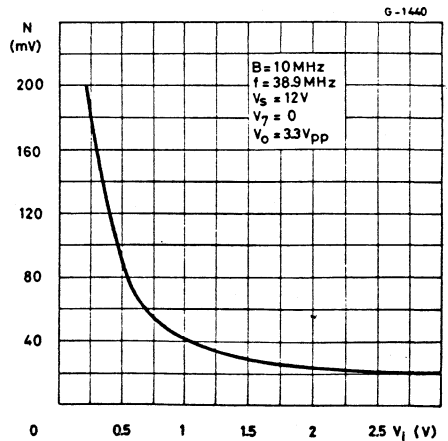


Fig. 7 - Output noise vs. input voltage



TDA 440

APPLICATION INFORMATION

The TDA 440 enables very compact IF amplifiers to be designed and provides the performance demanded by high quality receivers.

The input tuning-trapping circuitry and the detector network can be aligned independently with respect to each other.

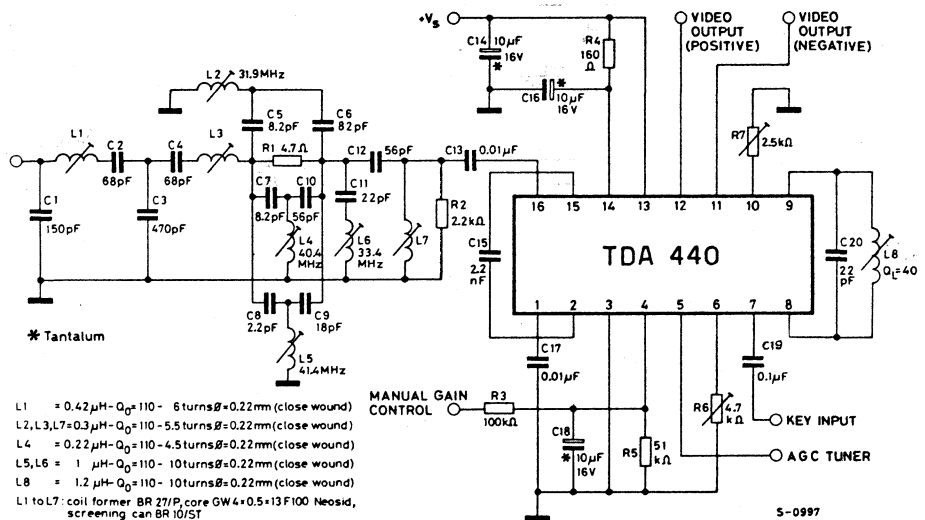
The value of Q for the parallel tuned circuit between pin 8 and 9 is not critical, although the higher it is, the better is the chroma-sound beat rejection but the tuning is more critical. Values of Q from 30 to 50 give good rejection with non-critical tuning.

The LC circuit between pins 8 and 9 is tuned to the vision carrier thus appreciably attenuating the sidebands. Hence a small amount of signal can be removed whose amplitude is almost constant over the whole working range of the AGC and it can be used to drive the AFC circuit.

The black level at the output is very stable against variations of V_s and of temperature: this enables the contrast control to be kept simple. The AGC is of the gated type and can take the top of the synchronism or the black level (back porch) as its reference: when the latter is used, the output black level is particularly stable.

For a more detailed description of the TDA 440 and related performance refer to SGS-ATES Application Note n. 127.

Fig. 8 - Typical application circuit.



TDA 440

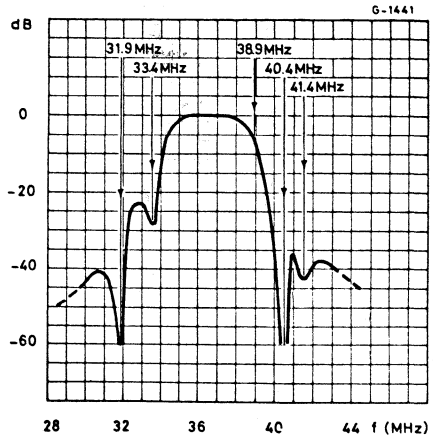
Typical performance of the Fig. 8 circuit

Frequency response (f_0 vision = 38.9 MHz, f_0 sound = 33.4 MHz) standard CCIR	
Sound carrier attenuation	28 dB
31.9 MHz trap attenuation	≥ 60 dB
40.4 MHz trap attenuation	≥ 56 dB
41.4 MHz trap attenuation	≥ 44 dB
AGC range	55 dB
Overall gain including IF filter and trap circuits (note 1)	86 dB
Intermodulation products over the whole AGC range (note 2)	- 55 dB

NOTES: (1) The gain is measured at video output 3.3V peak to peak and is defined as peak to peak output voltage to RMS input voltage (modulation down).

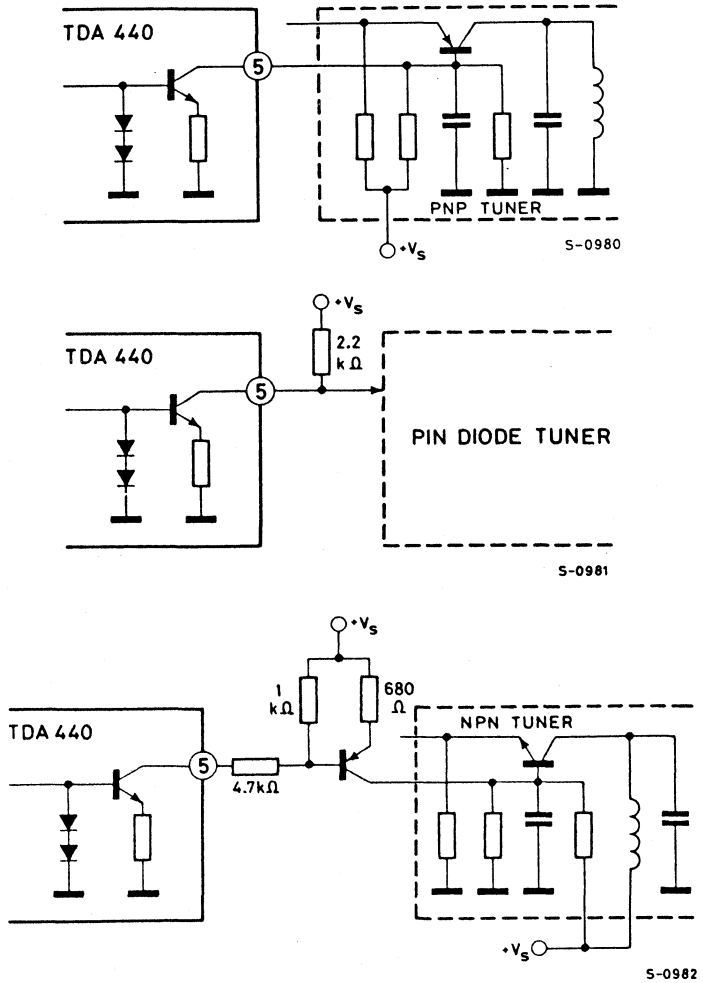
(2) Measured at 1.07 MHz, vision carrier level = 0 dB, chroma carrier level = -6 dB, sound carrier level = -6 dB.

Fig. 9 - Overall frequency response of the fig. 8 circuit.



TDA 440

Fig. 10 - Circuit options for tuner AGC driving



LINEAR INTEGRATED CIRCUIT

PRELIMINARY DATA

PREAMPLIFIER FOR CASSETTE RECORDERS WITH ALC

- EXCELLENT VERSATILITY in USE (V_s from 4 to 20V)
- HIGH OPEN LOOP GAIN
- LOW DISTORTION
- LOW NOISE
- LARGE AUTOMATIC LEVEL CONTROL RANGE
- GOOD SUPPLY RIPPLE REJECTION

The TDA 1054 is a monolithic integrated circuit in a 16-lead dual in-line plastic package. The functions incorporated are:

- low noise preamplifier
- automatic level control system (ALC)
- high gain equalization amplifier
- supply voltage rejection facility (SVRF)

It is intended as preamplifier in tape and cassette recorders and players, dictaphones, compressor and expander in telephonic equipments, Hi-Fi preamplifiers and in wire diffusion receivers etc.

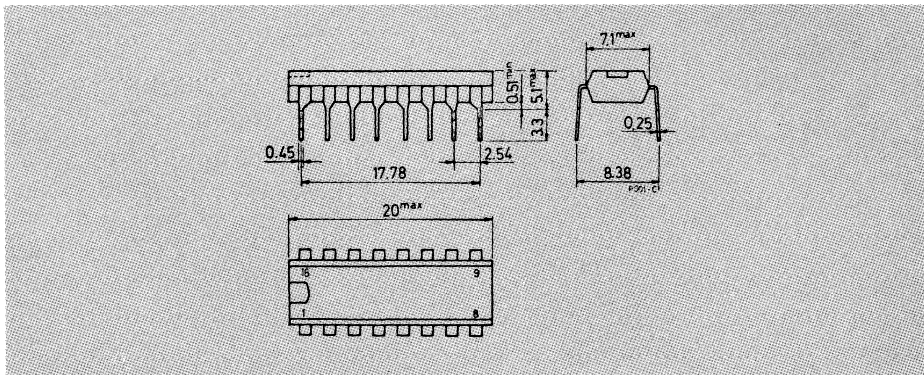
ABSOLUTE MAXIMUM RATINGS

V_s	Supply voltage	20	V
P_{tot}	Total power dissipation at $T_{amb} \leq 50^\circ\text{C}$	500	mW
T_{stg}, T_j	Storage and junction temperature	-40 to 150	$^\circ\text{C}$

ORDERING NUMBER: TDA 1054

MECHANICAL DATA

Dimensions in mm



THERMAL DATA

$R_{th\ j-amb}$ Thermal resistance junction–ambient	max 200 °C/W
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ELECTRICAL CHARACTERISTICS (Refer to the test circuit, $T_{amb} = 25\text{ °C}$)

Parameter	Test conditions	Min.	Typ.	Max.	Unit
V_s Supply voltage		4		20	V
I_d Quiescent drain current	$V_s = 9V$ $R_o = \infty$ $S1 = S2 = S3 = B$		6		mA
h_{FE} DC current gain (Q1 and Q2)	$I_C = 0.1\text{ mA}$ $V_{CE} = 5V$	300	500		–
e_N Input noise voltage (Q1)	$I_C = 0.1\text{ mA}$ $V_{CE} = 5V$ $f = 1\text{ kHz}$		2		$\frac{nV}{\sqrt{Hz}}$
i_N Input noise current (Q1)			0.5		$\frac{pA}{\sqrt{Hz}}$
NF Noise figure (Q1)	$I_C = 0.1\text{ mA}$ $V_{CE} = 5V$ $R_g = 4.7\text{ k}\Omega$ $B(-3\text{ dB}) = 20\text{ to }10,000\text{ Hz}$		0.5	4	dB
G_v Open loop voltage gain (equalization amplifier)	$V_s = 9V$ $f = 1\text{ kHz}$		60		dB
V_o Output voltage with ALC	$V_s = 9V$ $V_i = 100mV$ $f = 1\text{ kHz}$ $S1=S2=S3=A$		0.95		V
R1 (for SVRF system)			7.5		k Ω
R2 (for SVRF system)			120		Ω
e_N Equivalent input noise voltage (for equalization amplifier pin 11)	$V_s = 9V$ $R_g = 4.7\text{ k}\Omega$ $G_{V(closed)} = 100$ $S1 = B$ $B(-3\text{ dB}) = 20\text{ to }20,000\text{ Hz}$		1.3		μV
Drop-out (between pins 14 and 2)	$I_d = 6\text{ mA}$ $V_s = 9V$		0.8		V

TDA 1054

Fig. 1 - Equivalent input spot voltage and noise current vs. bias current (input transistor Q1)

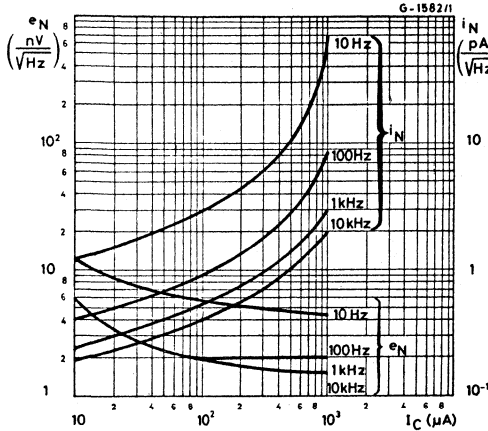


Fig. 2 - Equivalent input noise current vs. frequency (input transistor Q1)

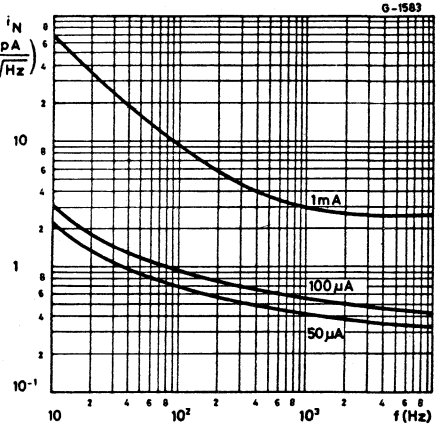


Fig. 3 - Equivalent input noise voltage vs. frequency (input transistor Q1)

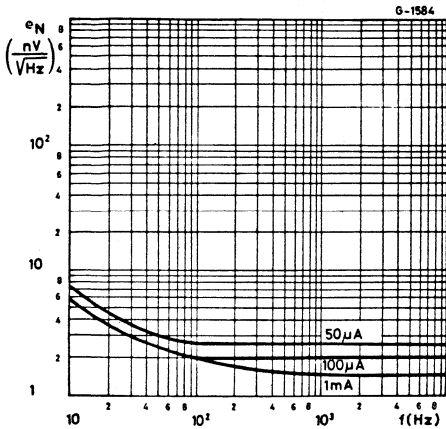


Fig. 4 - Typical noise figure vs. bias current (input transistor Q1)

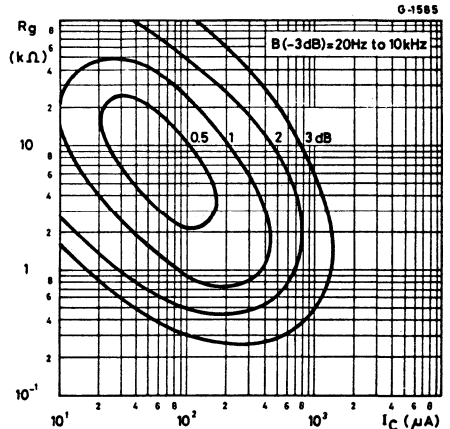


Fig. 5 - Optimum source resistance and minimum NF vs. bias current (input transistor Q1)

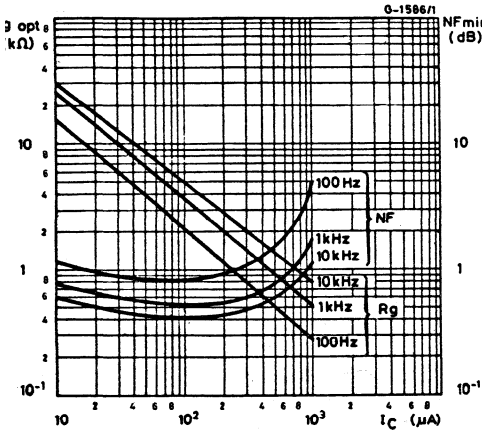


Fig. 6 - Typical current gain vs. collector current (input transistor Q1)

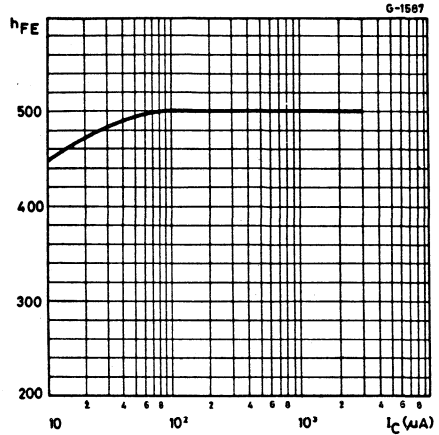


Fig. 7 - Typical open loop gain vs. frequency (equalization amplifier)

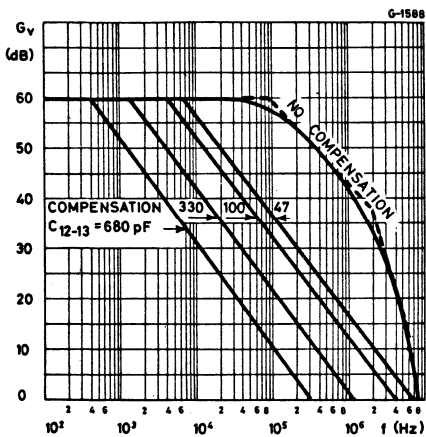
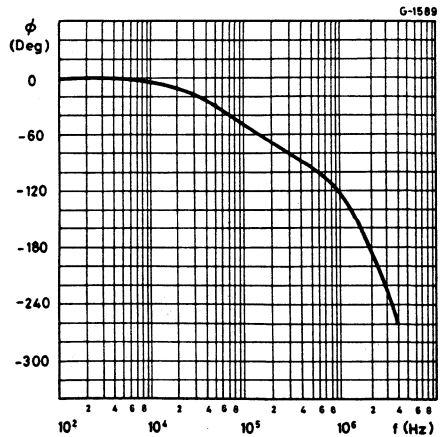


Fig. 8 - Typical open loop phase response vs. frequency (equalization amplifier)



TDA 1054

APPLICATION INFORMATION

Fig. 9 - Typical application circuit for battery-main tape and cassette player and recorder

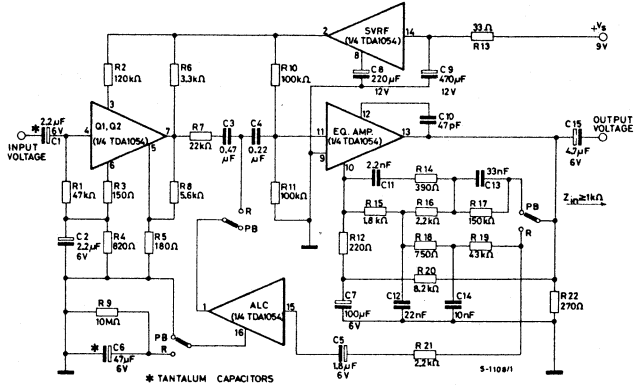
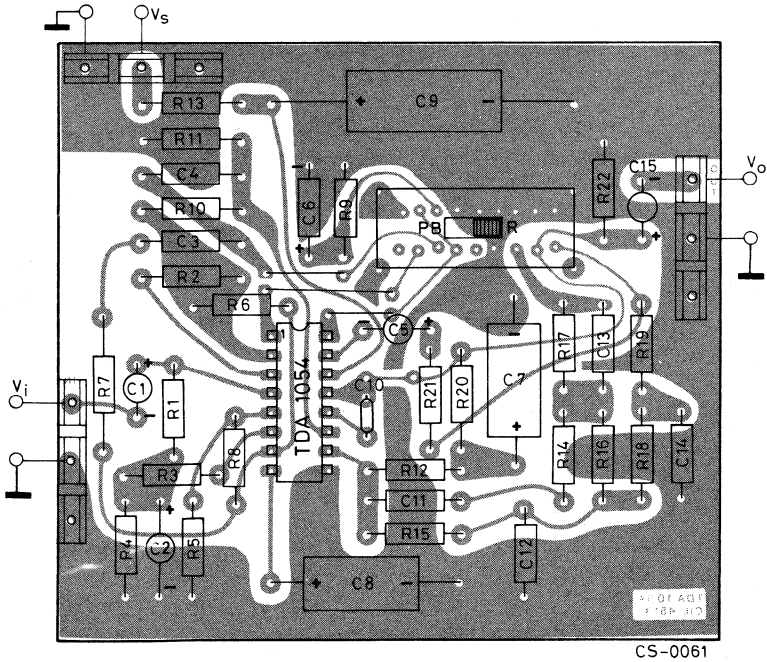


Fig. 10 - P.C. board and component layout of fig. 9 circuit (1:1 scale)



TDA 1054

Typical performance of circuit in fig. 9 ($T_{amb} = 25^{\circ}\text{C}$, $V_s = 9\text{V}$)

Parameter	Test conditions	Min.	Typ.	Max.	Unit
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PLAY-BACK

G_v	Voltage gain (open loop)	f = 20 to 20,000 Hz		110	dB
G_v	Voltage gain (closed loop)	f = 1 kHz		57	dB
$ Z_i $	Input impedance	f = 100 Hz		10	k Ω
		f = 1 kHz		41	k Ω
		f = 10 kHz		43	k Ω
$ Z_o $	Output impedance	f = 1 kHz		12	35 Ω
B	Frequency response			see fig. 12	
d	Distortion	$V_o = 1\text{V}$	f = 1 kHz	0.1	%
	Output back-ground noise	$Z_g = 300 \Omega + 120 \text{ mH}$ (DIN 45405)		1.3	mV
	*** Output weighted back-ground noise			1.3	mV
$\frac{S+N}{N}$	Signal to noise ratio	$V_o = 1\text{V}$	$Z_g = 300 \Omega + 120 \text{ mH}$	52	dB
SVR	Supply voltage ripple rejection at the output	$f_{(\text{ripple})} = 100 \text{ Hz}$		30	dB
t_{on}^{**}	Switch-on time	$V_o = 1\text{V}$		500	ms

RECORDING

G_v	Voltage gain (open loop)	f = 20 to 20,000 Hz		110	dB
G_v	Voltage gain (closed loop)	f = 1 kHz		70	dB
B	Frequency response			see fig. 14	
d*	Distortion without ALC	$V_o = 1\text{V}$	f = 1 kHz	0.3	%
d	Distortion with ALC	$V_o = 0.9\text{V}$	f = 1 kHz	0.4	%

Fig. 12 - Typical relative frequency response of fig. 9 circuit (Play-back)

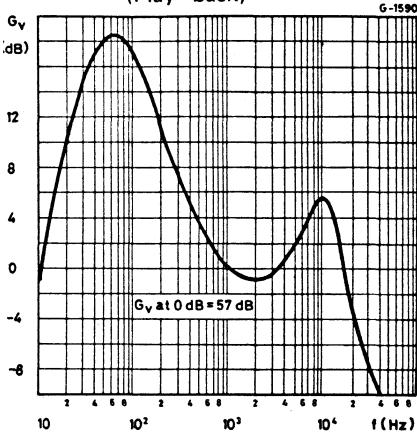


Fig. 13 - Typical distortion vs. frequency of fig. 9 circuit (Play-back)

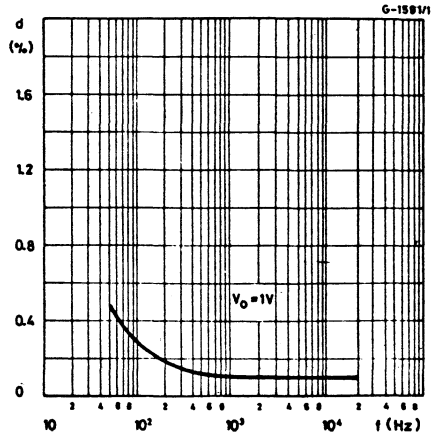


Fig. 14 - Typical relative frequency response of fig. 9 circuit (Recording)

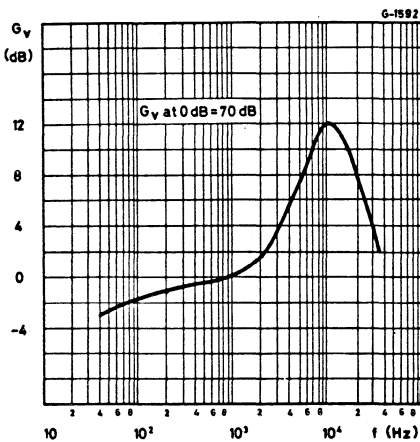
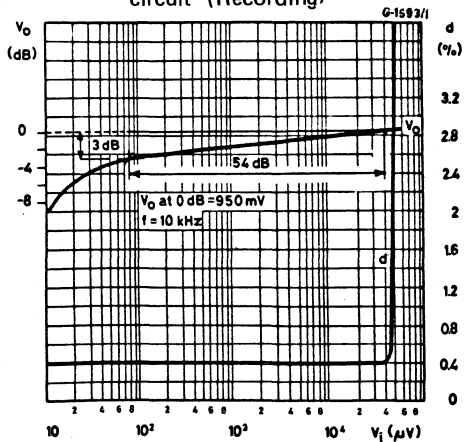


Fig. 15 - Typical output voltage variation and distortion with ALC vs. input voltage of fig. 9 circuit (Recording)



TDA 1054

Fig. 16 - Typical distortion vs. frequency with ALC of fig. 9 circuit (Recording)

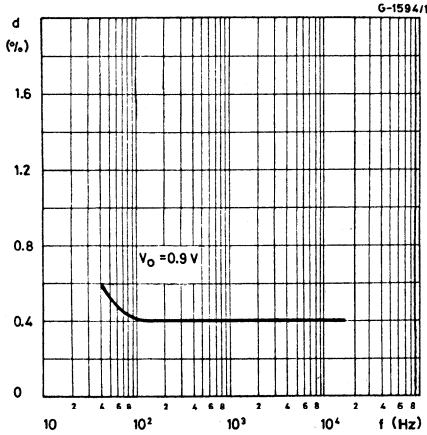


Fig. 17 - Typical limiting and level setting time vs. input signal variation

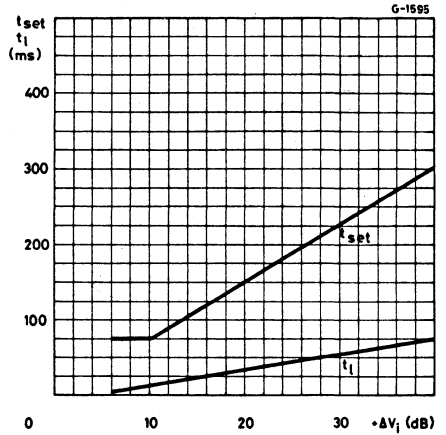


Fig. 18 - Economical application circuit

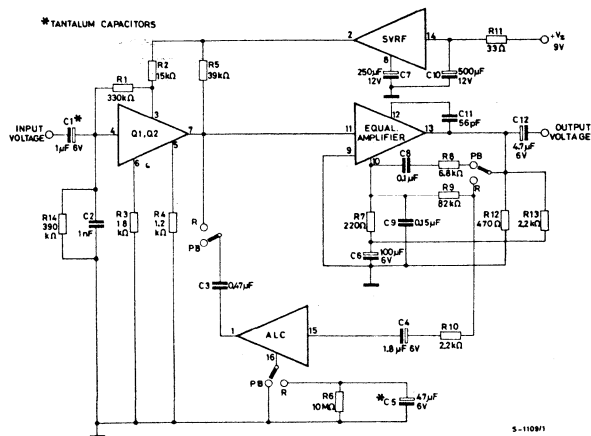
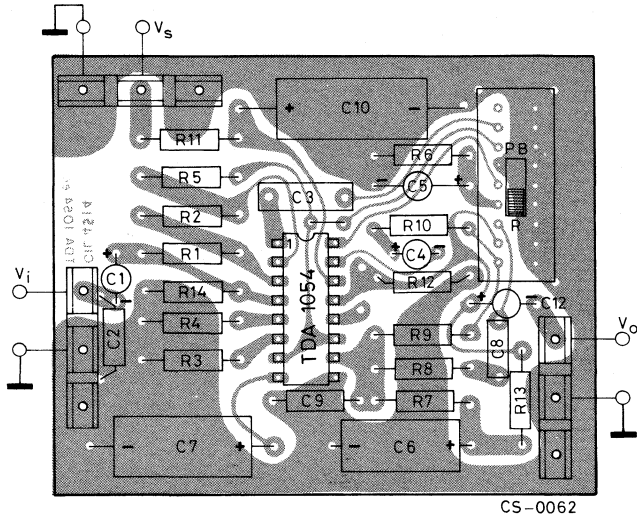


Fig. 19 - P.C. board and component layout of fig. 18 circuit (1:1 scale)



Typical performance of circuit in fig. 18 ($T_{amb} = 25^{\circ}\text{C}$, $V_s = 9\text{V}$)

Parameter	Test conditions	Min.	Typ.	Max.	Unit
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PLAY-BACK

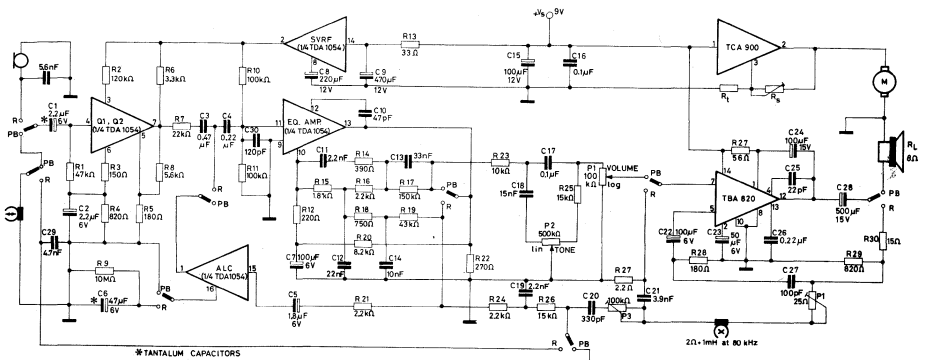
I_d	Quiescent drain current		18		mA
G_v	Voltage gain (closed loop)	$f = 1 \text{ kHz}$	56		dB
B	Frequency response	$f = 100 \text{ Hz}$	12		dB
		$f = 1 \text{ kHz}$	0		dB
		$f = 6 \text{ kHz}$	5		dB
		$f = 10 \text{ kHz}$	11		dB
		$f = 60 \text{ kHz}$	10		dB
d	Distortion	$V_o = 1\text{V}$ $f = 1 \text{ kHz}$	0.6		%
	Output weighted back-ground noise	$Z_g = 300 \Omega + 120 \text{ mH}$ (DIN 45405)	1.3		mV

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Typical performance of circuit in fig. 18 (continued)

Parameter	Test conditions	Min.	Typ.	Max.	Unit
RECORDING					
G_v	Voltage gain (closed loop)	f = 1 kHz		70	dB
B	Frequency response	f = 140 Hz		-3	dB
		f = 1 kHz		0	dB
		f = 10 kHz		4	dB
d	Distortion	$V_o = 0.9V$	f = 10 kHz	0.7	%
ALC	Range for 3 dB of output voltage variation	f = 10 kHz	$V_i \leq 40$ mV	54	dB

Fig. 20 - Complete cassette player and recorder



5-1190c

TDA 1054

Typical performance of circuit in fig. 21 (continued)

Parameter		Test conditions	Min. Typ. Max.	Unit
$\frac{S+N}{N}$	Signal to noise ratio for magnetic pick-ups	$R_g = 4.7 \text{ k}\Omega$ $B (-3 \text{ dB}) = 20 \text{ to } 20,000 \text{ Hz}$	66	dB
$ Z_i $	Input impedance for magnetic pick-ups	$f = 1 \text{ kHz}$	47	$\text{k}\Omega$
$ Z_i $	Input impedance for tuner		470	$\text{k}\Omega$
$ Z_i $	Input impedance for ceramic pick-up		100	$\text{k}\Omega$

Fig. 22 - Typical distortion vs. frequency (fig. 21 circuit)

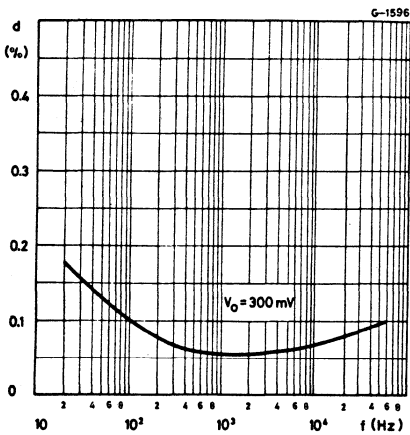
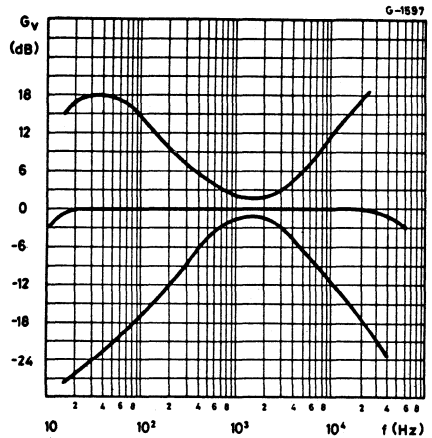


Fig. 23 - Typical frequency response (fig. 21 circuit)



LINEAR INTEGRATED CIRCUIT

PRELIMINARY DATA

TV VERTICAL DEFLECTION SYSTEM

The TDA 1170 is a silicon monolithic integrated circuit in a 12-lead quad in-line plastic package. It is designed mainly for use in large and small screen black and white TV receivers.

The functions incorporated are:

- oscillator
- voltage ramp generator
- high power gain amplifier
- flyback generator

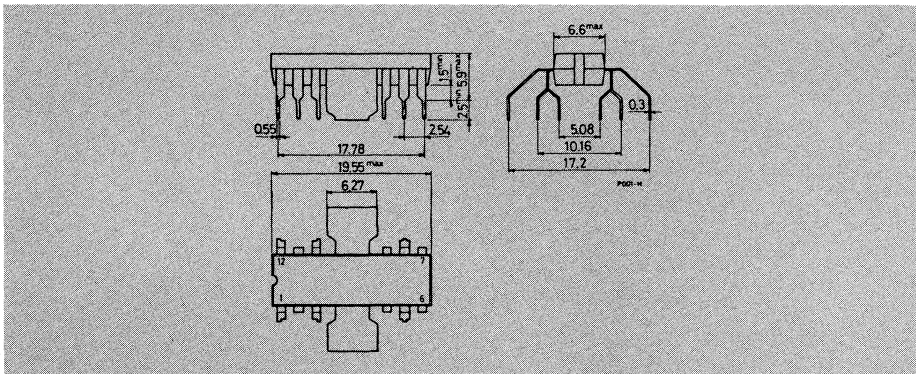
ABSOLUTE MAXIMUM RATINGS

V_s	Supply voltage (pin 2)	27	V
V_4-V_5	Flyback peak voltage	58	V
V_8	Sync. input voltage	± 12	V
V_{10}	Power amplifier input voltage	$\left. \begin{array}{l} 10 \\ -0.5 \end{array} \right\}$	V
I_o	Output peak current (non-repetitive) @ $t = 2$ ms	2	A
I_o	Output peak current $\left\{ \begin{array}{l} @ f = 50 \text{ Hz}, t \leq 10 \mu\text{s} \\ @ f = 50 \text{ Hz}, t > 10 \mu\text{s} \end{array} \right.$	$\left. \begin{array}{l} 2.5 \\ 1.5 \end{array} \right\}$	A
P_{tot}	Power dissipation: at $T_{tab} = 90^\circ\text{C}$	5	W
	at $T_{amb} = 80^\circ\text{C}$ (free air)	1	W
T_{stg}, T_j	Storage and junction temperature	-40 to 150	$^\circ\text{C}$

ORDERING NUMBER: TDA 1170

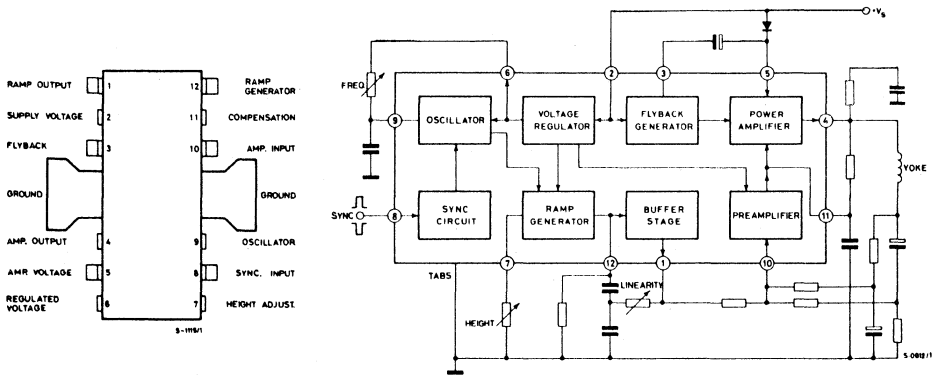
MECHANICAL DATA

Dimensions in mm

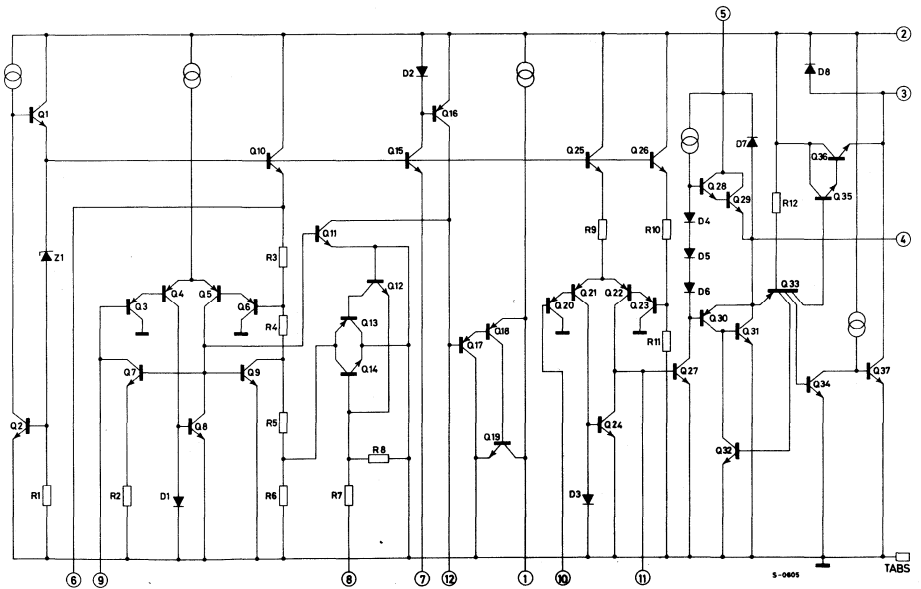


TDA 1170

CONNECTION AND BLOCK DIAGRAMS



SCHEMATIC DIAGRAM



THERMAL DATA

$R_{th\ j-tab}$	Thermal resistance junction-tab	max	12	°C/W
$R_{th\ j-amb}$	Thermal resistance junction-ambient	max	70*	°C/W

* Obtained with tabs soldered to printed circuit with minimized area

ELECTRICAL CHARACTERISTICS (Refer to the test circuits, $V_s = 25V$, $T_{amb} = 25\text{ °C}$ unless otherwise specified)

Parameter	Test conditions	Min.	Typ.	Max.	Unit	Fig.
-----------	-----------------	------	------	------	------	------

STATIC (DC) CHARACTERISTICS

$-I_9$	Oscillator bias current	$V_9 = 1V$	0.2	1	μA	1a	
$-I_{10}$	Amplifier input bias current	$V_{10} = 1V$	0.15	1	μA	1b	
$-I_{12}$	Ramp generator bias current		0.05	0.5	μA	1a	
V_s	Supply voltage		10		V	—	
V_4	Quiescent output voltage	$R2 = 10\text{ k}\Omega$ $V_s = 25V, R1 = 30\text{ k}\Omega$ $V_s = 10V, R1 = 10\text{ k}\Omega$	8 4	8.8 4.4	9.6 4.8	V V	1a
V_6, V_7	Regulated voltage		6	6.5	7	V	1b
$\frac{\Delta V_6}{\Delta V_s}, \frac{\Delta V_7}{\Delta V_s}$	Line regulation	$V_s = 10\text{ to }27V$	1.5			mV/V	

DYNAMIC CHARACTERISTICS (f = 50 Hz)

I_s	Supply current	$I_Y = 1A$	140		mA	2
I_Y	Peak to peak yoke current (pin 4)			1.6	A	
V_4	Flyback voltage	$I_Y = 1A$	51		V	
V_8	Peak sync. input voltage (positive or negative)		1		V	

TDA 1170

ELECTRICAL CHARACTERISTICS (continued)

Parameter	Test conditions	Min.	Typ.	Max.	Unit	Fig.
V_9	Peak to peak oscillator sawtooth voltage		2.4		V	2
R_8	Sync. input resistance	$V_8 = 1V$	3.5		$k\Omega$	
t_{fly}	Flyback time	$I_V = 1A$	0.6	0.8	ms	
δf	Pull-in range (below 50 Hz)		7		Hz	
$\frac{\delta f}{\Delta V_s}$	Oscillator frequency drift with supply voltage	$V_s = 10$ to 27V	0.01		$\frac{Hz}{V}$	
$\frac{\delta f}{\Delta T_{tab}}$	Oscillator frequency drift with tab temperature	$T_{tab} = 40$ to 120 °C	0.015		$\frac{Hz}{^\circ C}$	

Fig. 1a - Static test circuit for measurement of $-I_9$, $-I_{12}$ and V_4

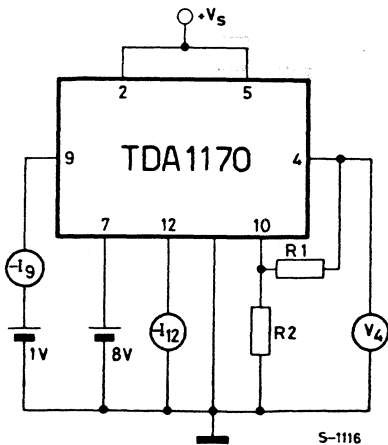
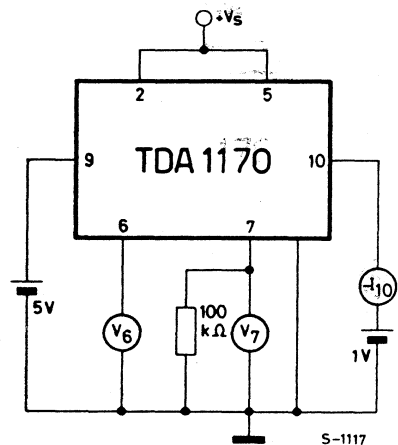


Fig. 1b - Static test circuit for measurement of $-I_{10}$, V_6 , V_7 , $\Delta V_6/\Delta V_s$ and $\Delta V_7/\Delta V_s$



TDA 1170

Fig. 2 - Dynamic test circuit

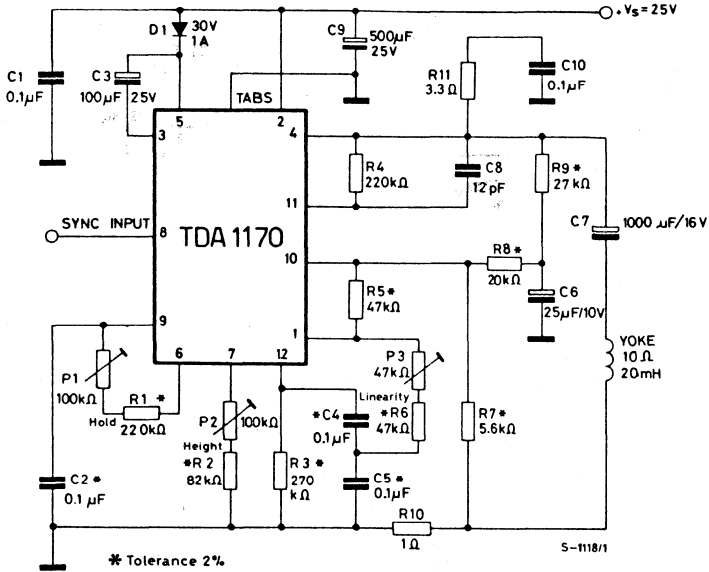


Fig. 3 - Relative quiescent voltage variation vs. supply voltage

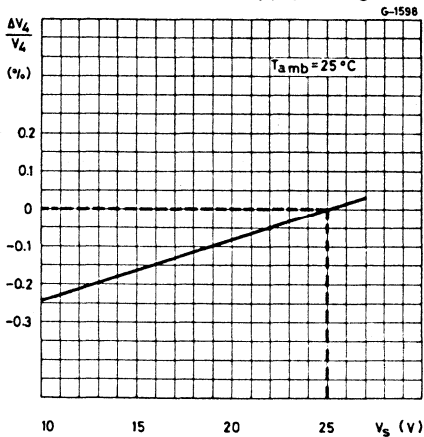
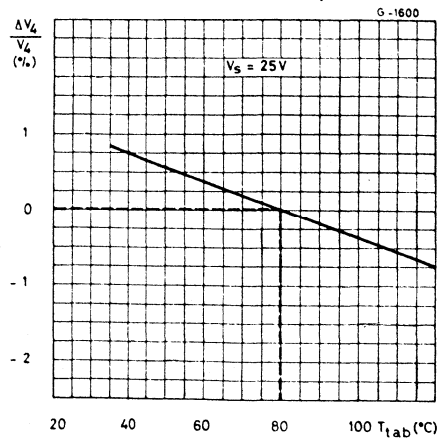


Fig. 4 - Relative quiescent voltage variation vs. tab temperature



TDA 1170

Fig. 5 - Regulated voltage vs. supply voltage

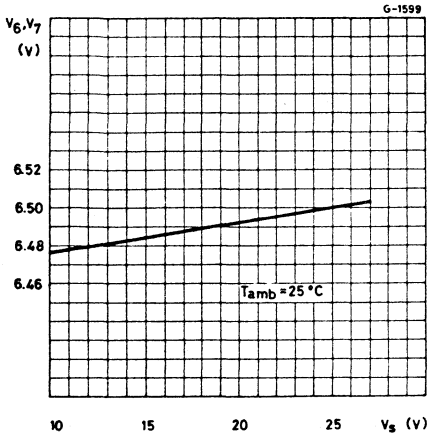


Fig. 6 - Regulated voltage vs. tab temperature

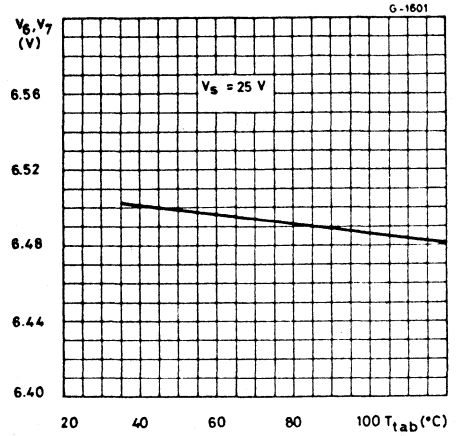


Fig. 7 - Frequency variation of unsynchronized oscillator vs. supply voltage

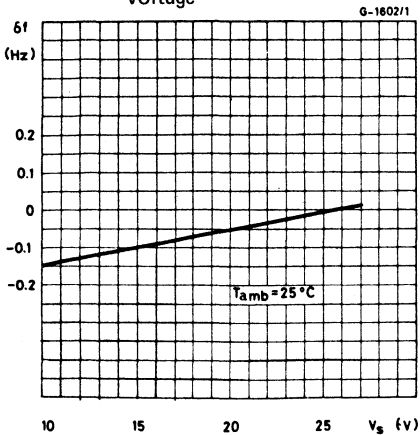
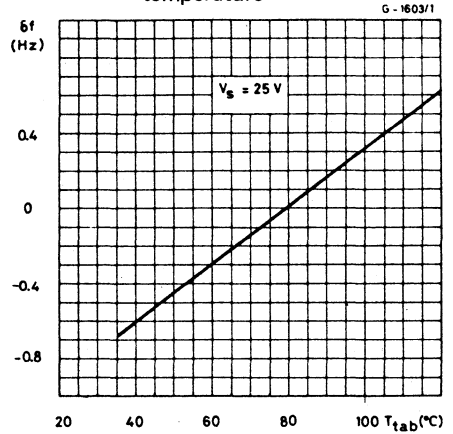


Fig. 8 - Frequency variation of unsynchronized oscillator vs. tab temperature



APPLICATION INFORMATION

The thermistor in series to the yoke is not required because the current feedback enables the yoke current to be independent of yoke resistance variations due to thermal effects. The oscillator is directly synchronized by the sync. pulses (positive or negative), therefore its free frequency must be lower than the sync. frequency. The flyback generator applies a voltage, about twice the supply voltage, to the yoke. This produces short flyback time together with a high useful power to dissipated power ratio.

The flyback time is:

$$t_{fly} \cong \frac{2}{3} \frac{L_Y I_Y}{V_s}$$

where: L_Y = Yoke inductance
 V_s = Supply voltage
 I_Y = Peak to peak yoke current

The supply current is :

$$I_s \cong \frac{I_Y}{8} + 0.02 \text{ (A)}$$

It does not depend on the value of V_s but only on yoke characteristics. The minimum value of V_s necessary for the required output current permits the maximum efficiency. The quiescent output voltage (pin 4) is fixed by the voltage feedback network R7, R8 and R9 (refer to fig. 2) according to:

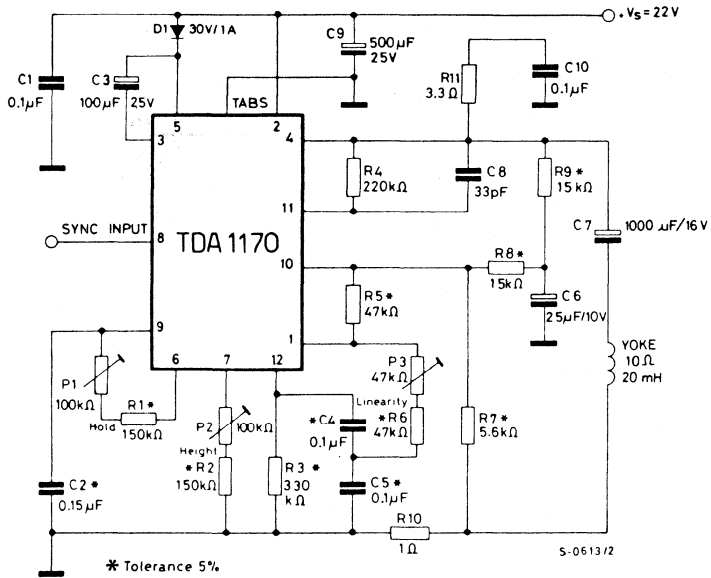
$$V_4 = V_{10} \frac{R7 + R8 + R9}{R7}$$

Pin 10 is the inverting input of the amplifier and its voltage is $V_{10} \cong 2V$.

For a more detailed description of the TDA 1170 and related performance refer to SGS-ATES Application note N. 129.

TDA 1170

Fig. 9 – Typical application circuit for B & W 24" 110° TV sets



Typical performance of circuit in fig. 9

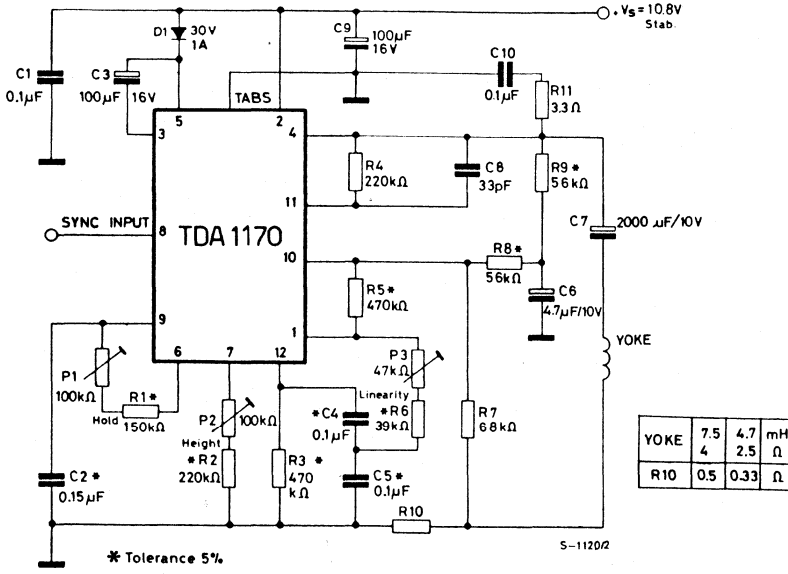
($V_s = 22V$; $I_Y = 1 A$; $R_Y = 10 \Omega$; $L_Y = 20 mH$)

I_s	Supply current	140	mA
t_{fly}	Flyback time	0.75	ms
I_Y	Maximum scanning current (peak to peak)	1.2	A
V_s	Operating supply voltage	20 to 24	V
P_{tot}	TDA 1170 power dissipation	2.2	W

For safe working up to $T_{amb} = 50^\circ C$ a heatsink of $R_{th} = 40^\circ C/W$ is required and each tab of the TDA 1170 must be soldered to $1 cm^2$ copper area of the printed circuit board.

TDA 1170

Fig. 10 - Typical application circuit for B & W small screen TV sets



Typical performance of circuit in fig. 10

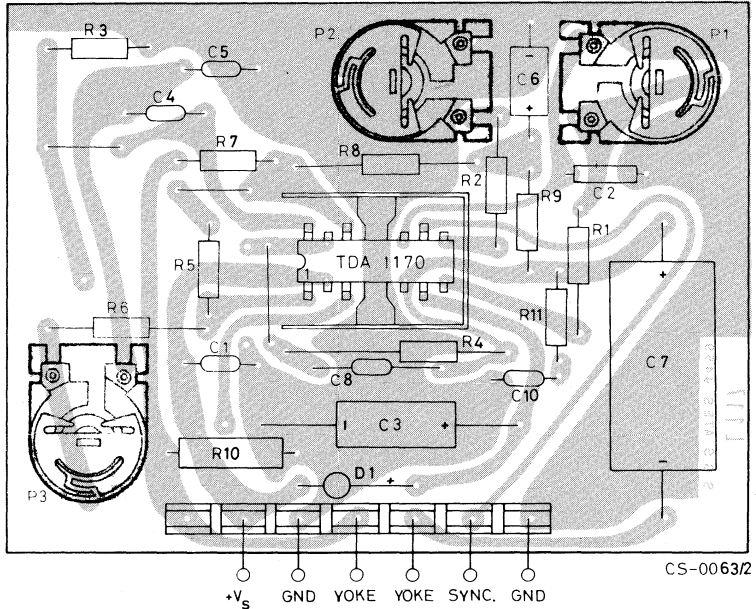
($V_s = 10.8\text{V}$; $I_V = 1\text{A}$; $R_Y = 4\Omega$; $L_Y = 7.5\text{mH}$)

I_s	Supply current	150	mA
t_{fly}	Flyback time	0.7	ms
I_Y	Maximum scanning current (peak to peak)	1.15	A
V_s	Operating supply voltage	10.8	V
P_{tot}	TDA 1170 power dissipation	1.3	W

For safe working up to $T_{\text{amb}} = 50^\circ\text{C}$ a heatsink of $R_{\text{th}} = 30^\circ\text{C/W}$ is required and each tab of the TDA 1170 must be soldered to 1cm^2 copper area of the printed circuit board.

TDA 1170

Fig. 11 - P.C. board and component layout for the circuit of fig. 9 and fig. 10 (1:1 scale)



C9 is not mounted on the P.C. board.

MOUNTING INSTRUCTIONS

The junction to ambient thermal resistance of the TDA 1170 can be reduced by soldering the tabs to a suitable copper area of the printed circuit board (fig. 12) or to an external heatsink (fig. 13).

The diagram of fig. 16 shows the maximum dissippable power P_{tot} and the $R_{th\ j-amb}$ as a function of the side "s" of two equal square copper areas having a thickness of $35\ \mu$ (1.4 mil). During soldering the tab temperature must not exceed $260\ ^\circ\text{C}$ and the soldering time must not be longer than 12 seconds.

The external heatsink or printed circuit copper area must be connected to electrical ground.

Fig. 12 - Example of P.C. board copper area used as heatsink

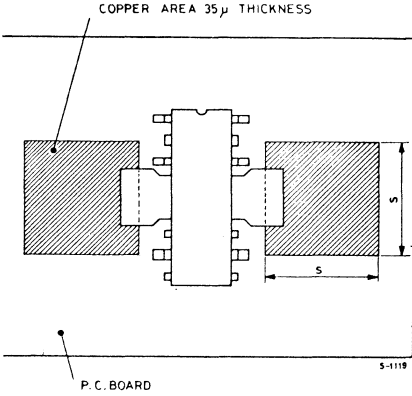


Fig. 13 - Example of TDA 1170 with external heatsink

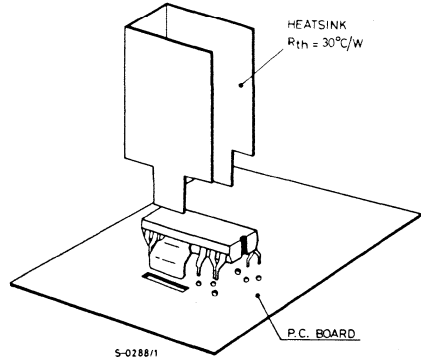


Fig. 14 - Maximum power dissipation and junction-ambient thermal resistance vs. "s"

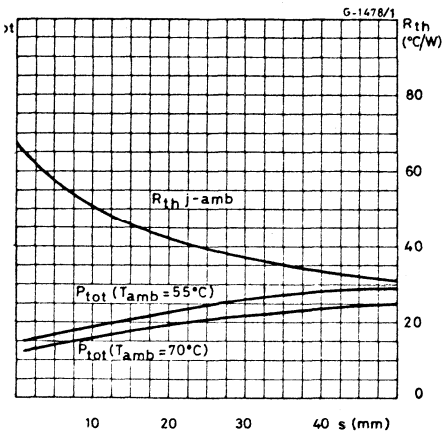
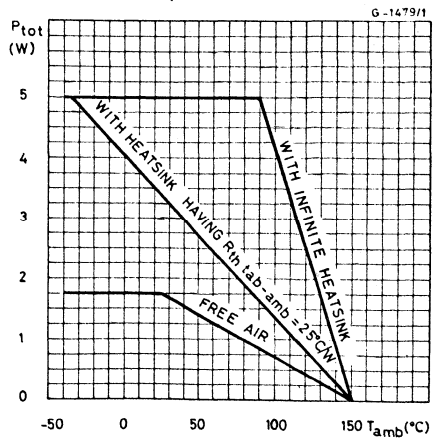


Fig. 15 - Maximum allowable power dissipation versus ambient temperature



TDA 1190

LINEAR INTEGRATED CIRCUIT

PRELIMINARY DATA

COMPLETE TV SOUND CHANNEL

The TDA 1190 is a silicon monolithic integrated circuit in a 12-lead quad in-line plastic package. It performs all the functions needed for the TV sound channel:

- IF limiter-amplifier
- active low-pass filter
- FM detector
- DC volume control
- AF preamplifier
- AF output stage

The TDA 1190 can give an output power of 4.2W ($d = 10\%$) into a 16Ω load at $V_s = 24V$, or 1.5W ($d = 10\%$) into an 8Ω load at $V_s = 12V$. This performance, together with the FM-IF section characteristics of high sensitivity, high AM rejection and low distortion, enables the device to be used in almost every type of television receivers. The device has no irradiation problems, hence no external screening is needed.

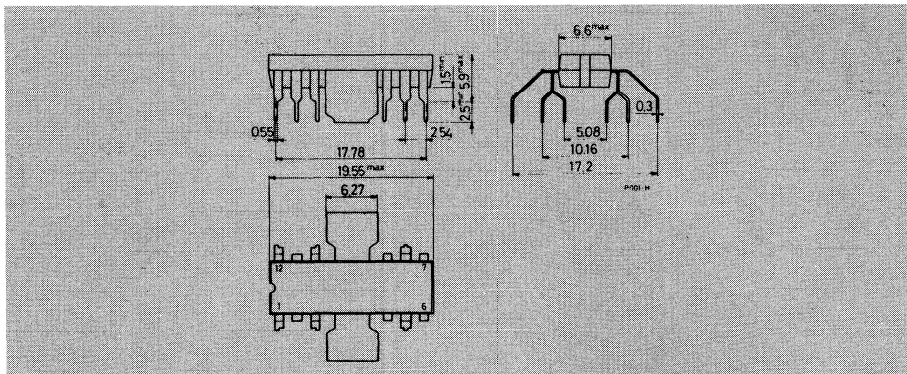
ABSOLUTE MAXIMUM RATINGS

V_s	Supply voltage (pin 10)	28	V
V_i	Input signal voltage (pin 1)	1	V
I_o	Output peak current (non-repetitive)	2	A
I_{oR}	Output peak current (repetitive)	1.5	A
P_{tot}	Power dissipation: at $T_{tab} = 90^\circ C$	5	W
	at $T_{amb} = 80^\circ C$ (free air)	1	W
T_{stg}, T_j	Storage and junction temperature	-40 to 150	$^\circ C$

ORDERING NUMBER: TDA 1190

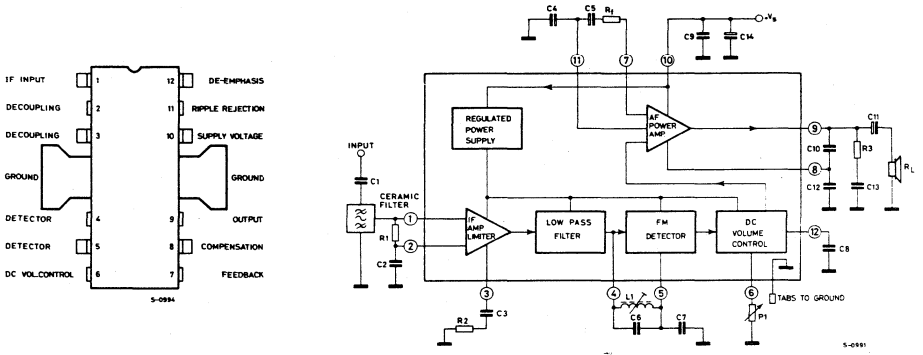
MECHANICAL DATA

Dimensions in mm

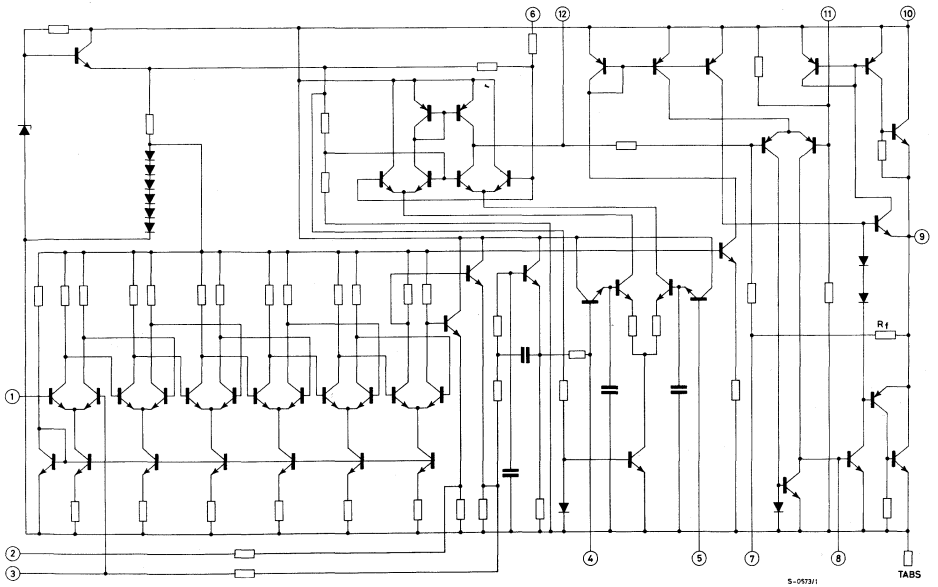


TDA 1190

CONNECTION AND BLOCK DIAGRAMS

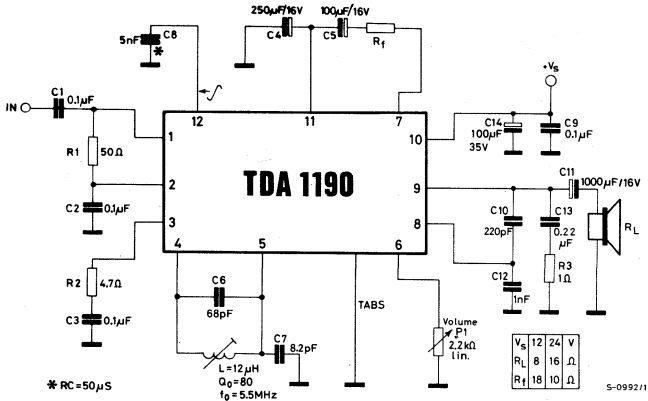


SCHEMATIC DIAGRAM



TDA 1190

TEST CIRCUIT



THERMAL DATA

$R_{th\ j-tab}$	Thermal resistance junction-tab	max	12	°C/W
$R_{th\ j-amb}$	Thermal resistance junction-ambient	max	70*	°C/W

* Obtained with tabs soldered to printed circuit with minimized copper area

ELECTRICAL CHARACTERISTICS (Refer to the test circuit, $V_s=24V$, $T_{amb}=25^\circ C$ unless otherwise specified)

Parameter	Test conditions	Min.	Typ.	Max.	Unit	
V_s	Supply voltage (pin 3)	9		28	V	
V_o	Quiescent output voltage (pin 9)	$V_s = 24V$	11	12	13	V
		$V_s = 12V$	5.5	6	6.5	V
I_d	Quiescent drain current	P1 = 2.2 kΩ $V_s = 24V$ $V_s = 12V$		22	35	mA
				19	31	mA

TDA 1190

ELECTRICAL CHARACTERISTICS (continued)

Parameter	Test conditions	Min.	Typ.	Max.	Unit
→ P _o Output power	d = 10% f _o = 5.5 MHz f _m = 1 kHz Δf = ± 25 kHz V _s = 24V R _L = 16Ω V _s = 12V R _L = 8Ω	3	4.2		W W
	d = 2% f _o = 5.5 MHz f _m = 1 kHz Δf = ± 25 kHz V _s = 24V R _L = 16Ω V _s = 12V R _L = 8Ω		3.4	1.35	W W
V _{i(threshold)} Input limiting voltage (-3 dB) at pin 1	f _o = 5.5 MHz f _m = 1 kHz Δf = ± 7.5 kHz P ₁ = 0		30		μV
d Distortion	P _o = 50 mW f _o = 5.5 MHz f _m = 1 kHz Δf = ± 7.5 kHz V _s = 24V R _L = 16Ω V _s = 12V R _L = 8Ω		0.55	0.65	% %
B Frequency response of audio amplifier (-3 dB)	R _L = 16Ω C ₁₀ = 220 pF C ₁₂ = 1000 pF P ₁ = 2.2 kΩ R _f = 18Ω R _f = 10Ω		50 to 12,000		Hz Hz
V _o Recovered audio voltage (pin 12)	V _i ≥ 1 mV f _o = 5.5 MHz f _m = 1 kHz Δf = ± 7.5 kHz P ₁ = 0		60		mV

ELECTRICAL CHARACTERISTICS (continued)

Parameter		Test conditions	Min.	Typ.	Max.	Unit
AMR	Amplitude modulation rejection	$V_i \geq 1 \text{ mV}$ $f_o = 5.5 \text{ MHz}$ $f_m = 1 \text{ kHz}$ $\Delta f = \pm 50 \text{ kHz}$ $m = 0.3$		55		dB
$\frac{S+N}{N}$	Signal and noise to noise ratio	$V_i \geq 1 \text{ mV}$ $V_o = 4 \text{ V}$ $f_o = 5.5 \text{ MHz}$ $f_m = 1 \text{ kHz}$ $\Delta f = \pm 50 \text{ kHz}$		70		dB
R_f	Internal feedback resistance (between pins 7 and 9)		3.5	5	6.5	$k\Omega$
R_i	Input resistance (pin 1)	$V_i = 1 \text{ mV}$		30		$k\Omega$
C_i	Input capacitance (pin 1)	$f_o = 5.5 \text{ MHz}$		5		pF
SVR	Supply voltage rejection ratio	$R_L = 4\Omega$ $f_{\text{ripple}} = 100 \text{ Hz}$ $P1 = 2.2 \text{ k}\Omega$		46		dB
	DC volume control attenuation	$P1 = 2.2 \text{ k}\Omega$		90		dB

TDA 1190

Fig. 1 - Typical relative audio output voltage and output noise vs. input signal

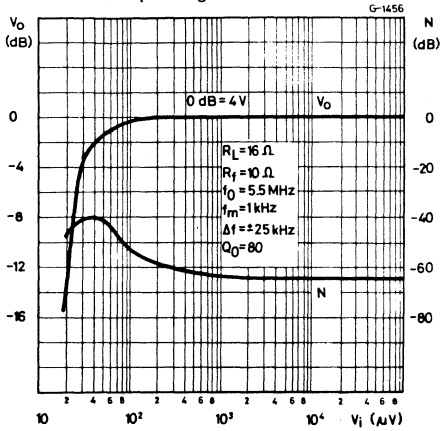


Fig. 2 - Typical output voltage attenuation vs. DC volume control resistance

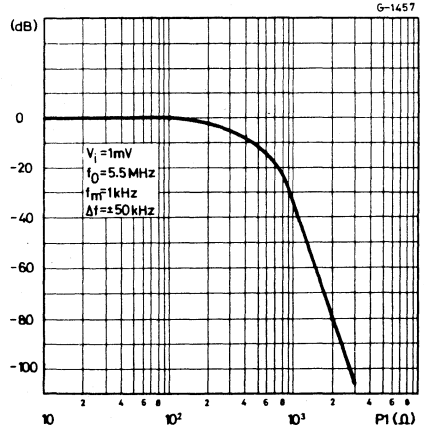


Fig. 3 - Typical amplitude modulation rejection vs. input signal

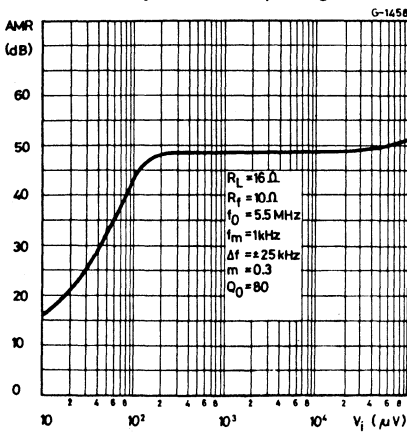


Fig. 4 - Typical ΔAMR vs. tuning frequency change

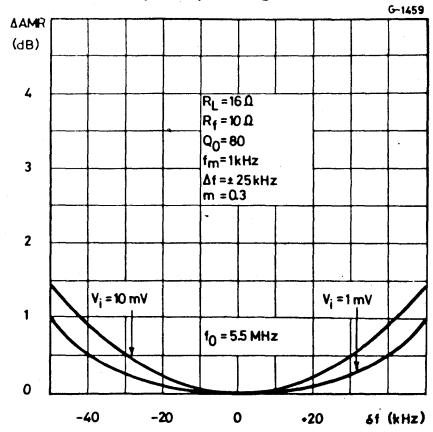


Fig. 5 - Typical recovered audio voltage vs. unloaded Q factor of the detector coil

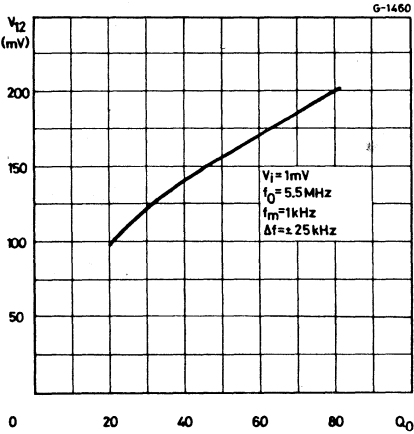


Fig. 6 - Typical distortion vs. output power

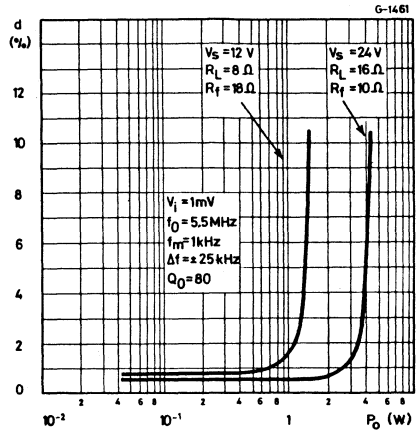


Fig. 7 - Typical distortion vs. frequency deviation

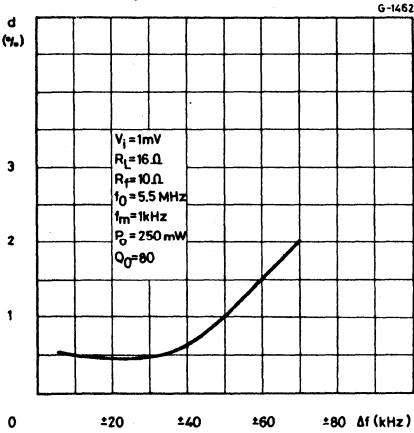
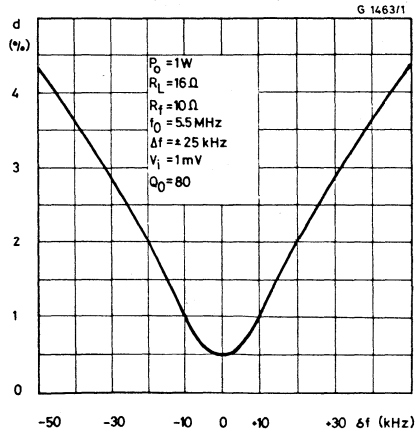


Fig. 8 - Typical distortion vs. tuning frequency change



TDA 1190

Fig. 9 - Typical audio amplifier frequency response

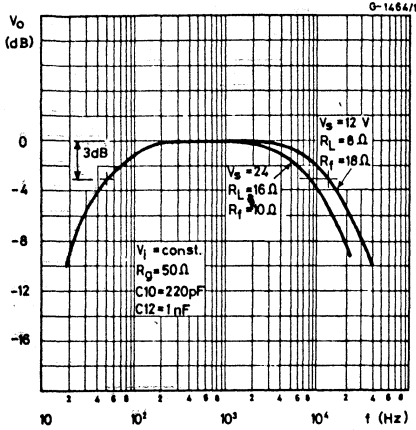


Fig. 10 - Typical overall frequency response

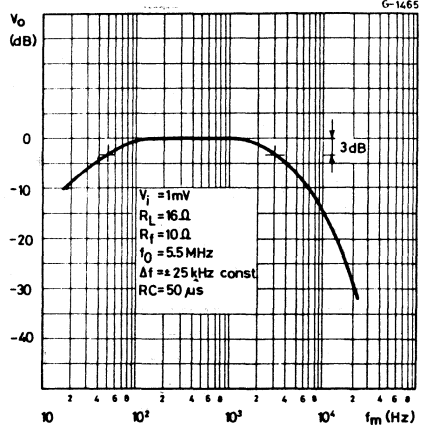


Fig. 11 - Typical supply voltage ripple rejection vs. ripple frequency

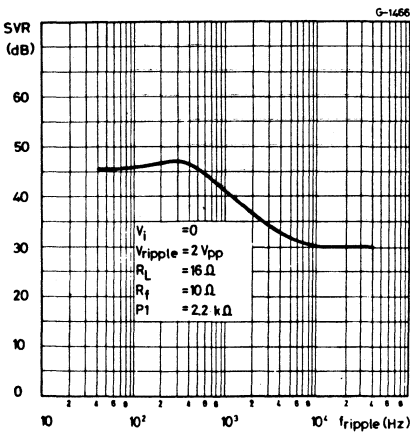


Fig. 12 - Typical supply voltage ripple rejection vs. volume control attenuation

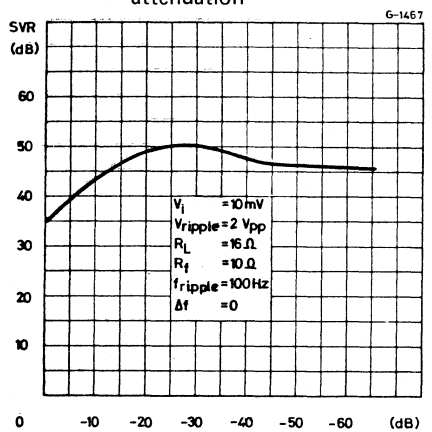


Fig. 13 - Typical output power vs. supply voltage

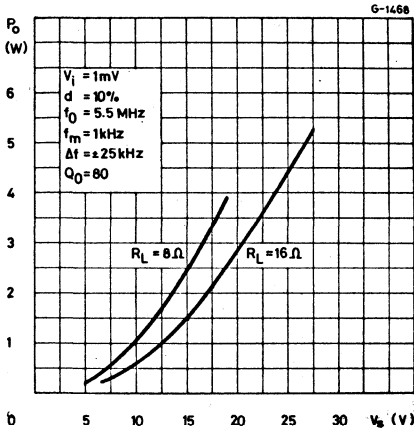


Fig. 14 - Maximum power dissipation vs. supply voltage (sine wave operation)

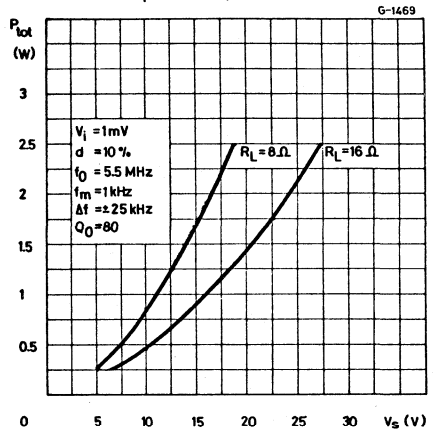


Fig. 15 - Typical power dissipation and efficiency vs. output power

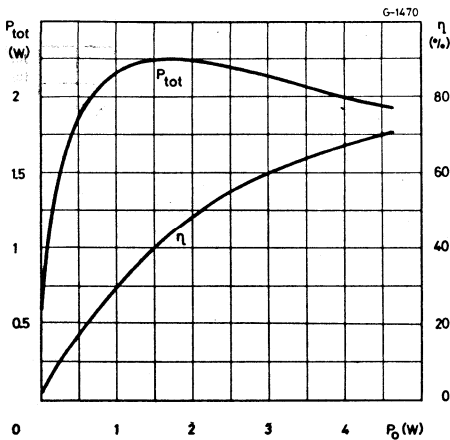
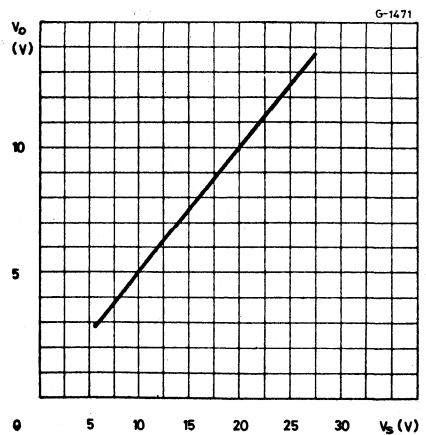


Fig. 16 - Typical quiescent output voltage (pin 9) vs. supply voltage



TDA 1190

APPLICATION INFORMATION

The electrical characteristics of the TDA 1190 remain almost constant over the frequency range 4.5 to 6 MHz, therefore it can be used in all television standards (FM mod.). The TDA 1190 has a high input impedance, so it can function with a ceramic filter or with a tuned circuit that provide the necessary input selectivity.

The value of the resistor connected to pin 7, determines the AC gain of the audio frequency amplifier.

This enables the desired gain to be selected in relation to the frequency deviation at which the AF amplifier's output stage must enter into clipping.

The capacitance connected between pins 9 and 8 determines the upper cut-off frequency of the audio band.

The capacitance connected between pin 12 and ground, together with the internal resistor of 10 k Ω , forms the de-emphasis network. The Boucherot cell eliminates the high frequency oscillations caused by the inductive load and the wires connecting the loudspeaker.

For a more detailed description of the TDA 1190 and related performance refer to SGS-ATES Application Note n. 128.

Fig. 17 - Typical application circuit

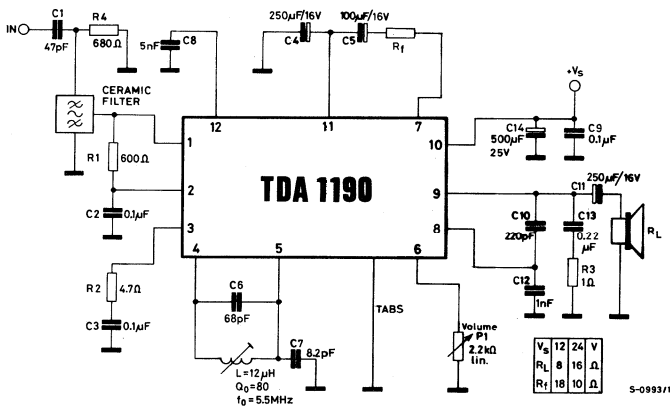
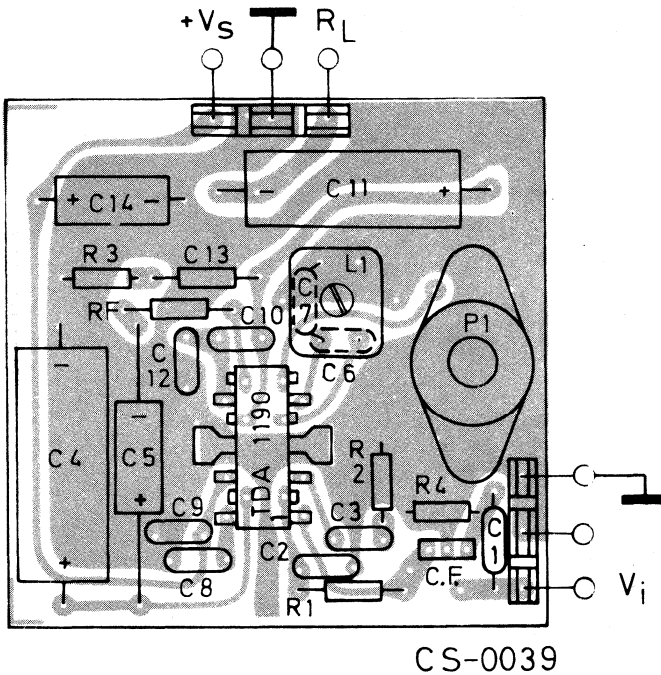


Fig. 18 - P.C. board and component layout of the circuit shown in fig. 17 (1:1 scale)



MOUNTING INSTRUCTION

The $R_{th\ j-amb}$ of the TDA 1190 can be reduced by soldering the tabs to a suitable copper area of the printed circuit board (Fig. 19) or to an external heatsink (Fig. 20).

The diagram of figure 21 shows the maximum dissippable power P_{tot} and the $R_{th\ j-amb}$ as a function of the side "ℓ" of two equal square copper areas having a thickness of $35\ \mu$ (1.4 mils).

During soldering the tab temperature must not exceed $260\ ^\circ\text{C}$ and the soldering time must not be longer than 12 seconds.

The external heatsink or printed circuit copper area must be connected to electrical ground.

TDA 1190

Fig. 19 - Example of P.C. board copper area which is used as heatsink

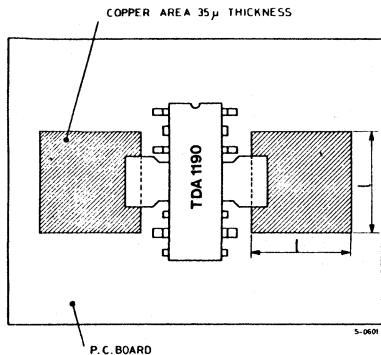


Fig. 20 - External heatsink mounting example

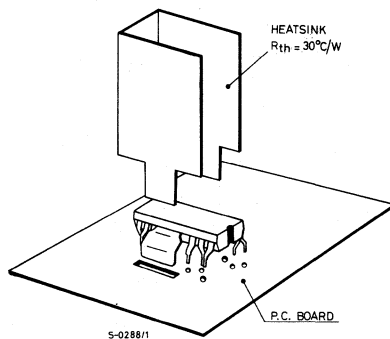


Fig. 21 - Maximum dissippable power and junction to ambient thermal resistance vs. side "l"

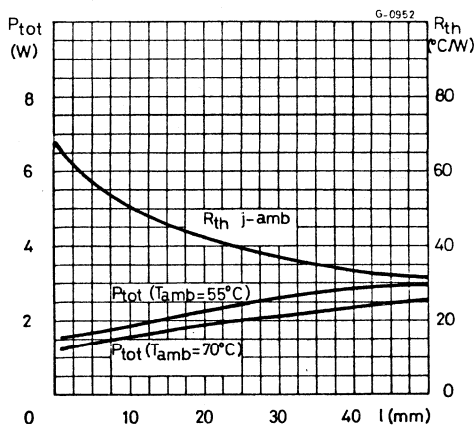
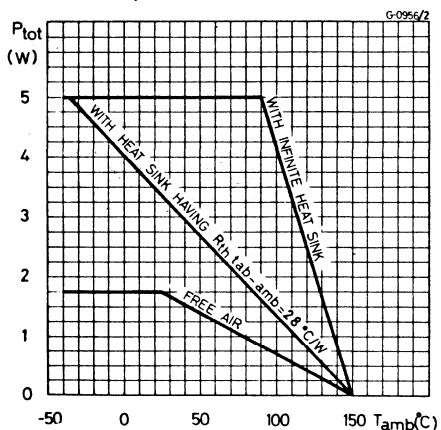


Fig. 22 - Maximum allowable power dissipation vs. ambient temperature



TDA 1200

LINEAR INTEGRATED CIRCUIT

FM-IF RADIO SYSTEM

PRELIMINARY DATA

- HIGH LIMITING SENSITIVITY
- HIGH AMR
- HIGH RECOVERED AUDIO
- GOOD CAPTURE RATIO
- LOW DISTORTION
- MUTING CAPABILITY

The TDA 1200 is a silicon monolithic integrated circuit in a 16-lead dual in-line plastic package. It provides a complete subsystem for amplification of FM signals.

The functions incorporated are:

- FM amplification and detection
- interchannel controlled muting
- AFC and delayed AGC for FM tuner
- switching of stereo decoder
- driving of a field strength meter

The TDA 1200 can be used for FM-IF amplifier application in HI-FI, car-radios and communication receivers.

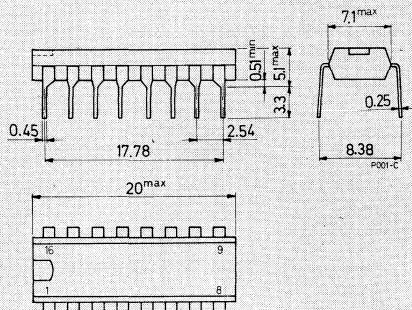
ABSOLUTE MAXIMUM RATINGS

V_s	Supply voltage	16 V
I_o	Output current (from pin 15)	2 mA
P_{tot}	Total power dissipation at $T_{amb} \leq 70^\circ\text{C}$	500 mW
T_{stg}	Storage temperature	-55 to 150 °C
T_{op}	Operating temperature	-25 to 70 °C

ORDERING NUMBER: TDA 1200

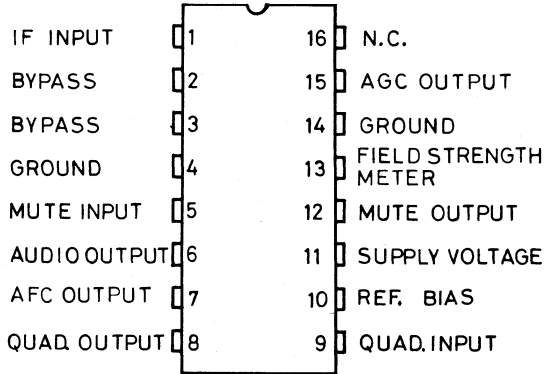
MECHANICAL DATA

Dimensions in mm



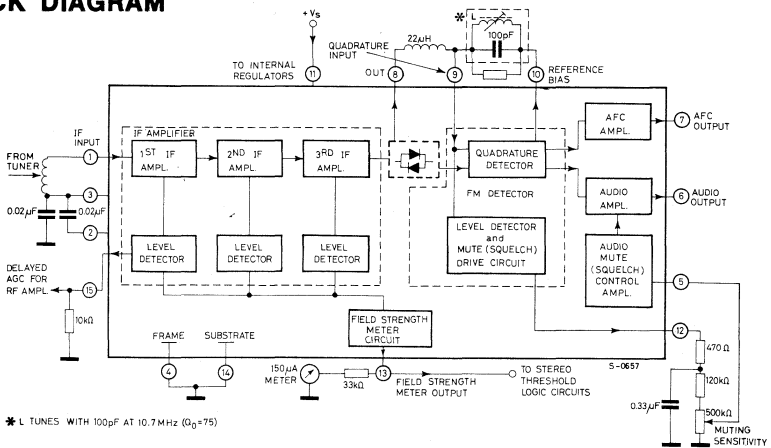
TDA 1200

CONNECTION DIAGRAM



S-0398/1

BLOCK DIAGRAM



TDA 1200

ELECTRICAL CHARACTERISTICS (continued)

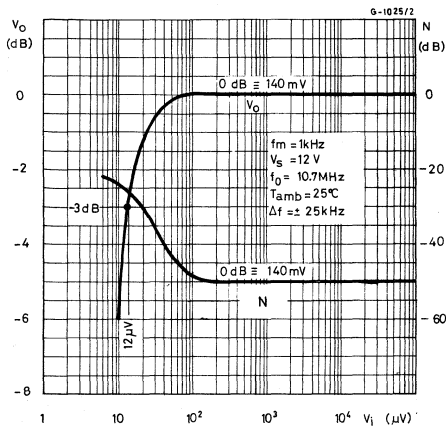
Parameter	Test conditions	Min.	Typ.	Max.	Unit
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DYNAMIC CHARACTERISTICS

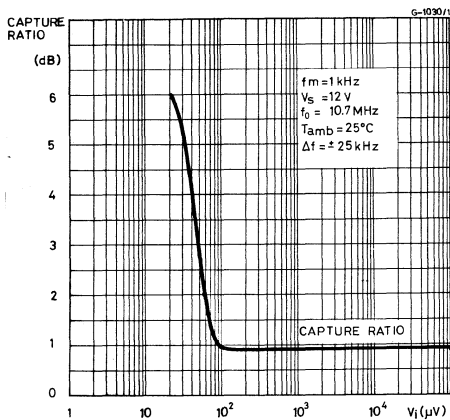
$V_{i(\text{threshold})}$	Input limiting voltage (-3 dB) at pin 1	$f_0 = 10.7 \text{ MHz}$ $f_m = 1 \text{ kHz}$ $\Delta f = \pm 25 \text{ kHz}$		12		μV
V_o	Recovered audio voltage (pin 6)	$V_i \geq 50 \mu\text{V}$ $f_0 = 10.7 \text{ MHz}$ $f_m = 1 \text{ kHz}$ $\Delta f = \pm 25 \text{ kHz}$		140		mV
d	Distortion	$V_i \geq 1 \text{ mV}$ $f_0 = 10.7 \text{ MHz}$ $f_m = 1 \text{ kHz}$ $\Delta f = \pm 75 \text{ kHz}$		0.5		%
$\frac{S+N}{N}$	Signal and noise to noise ratio	$f_0 = 10.7 \text{ MHz}$ $f_m = 1 \text{ kHz}$ $\Delta f = \pm 75 \text{ kHz}$		60		dB
AMR	Amplitude modulation rejection	$V_i \geq 1 \text{ mV}$ $f_0 = 10.7 \text{ MHz}$ $f_m = 1 \text{ kHz}$ $\Delta f = \pm 25 \text{ kHz}$ $m = 0.3$		40		dB
V_i	Input voltage for delayed AGC action (pin 1)			10		mV
$\frac{\Delta V_{15}}{\Delta V_i}$	AGC control slope	$V_i \geq 10 \text{ mV}$ $f_0 = 10.7 \text{ MHz}$		40		dB
$\frac{\Delta I_7}{\delta f}$	AFC control slope			1		$\frac{\mu\text{A}}{\text{kHz}}$
$\frac{\Delta V_{13}}{\Delta V_i}$	Field strength meter output slope			42		dB
V_{13}	Field strength meter output sensitivity	$V_i = 1 \text{ mV}$ $f_0 = 10.7 \text{ MHz}$		1.7		V

TDA 1200

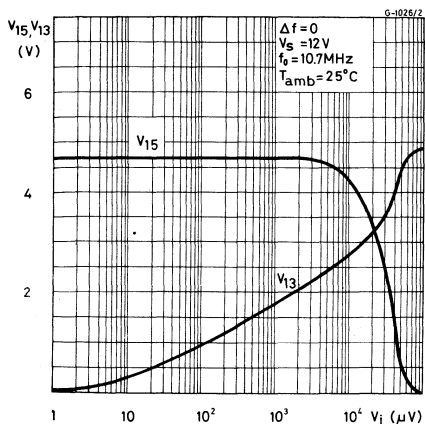
Typical relative recovered audio and noise output versus input voltage



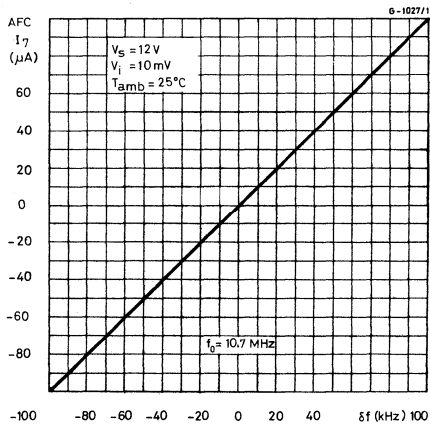
Typical capture ratio versus input voltage



Typical AGC (V_{15}) and field strength meter output (V_{13}) versus input signal

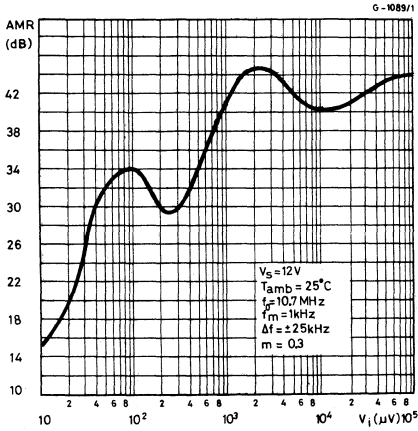


Typical AFC output current versus change-in tuning frequency

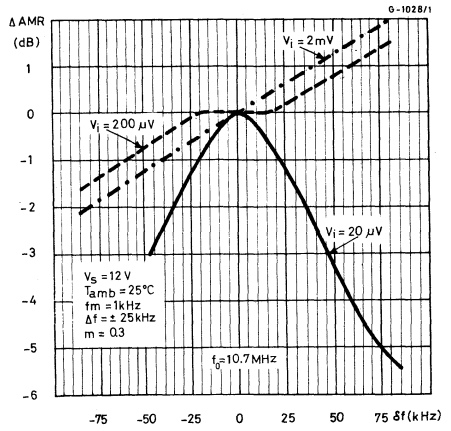


TDA 1200

Typical amplitude modulation rejection versus input signal

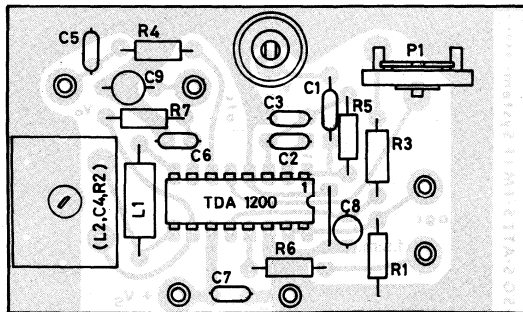


Typical AMR (relative to the value of $f_0 = 10.7$ MHz) versus change-in tuning frequency



APPLICATIONS

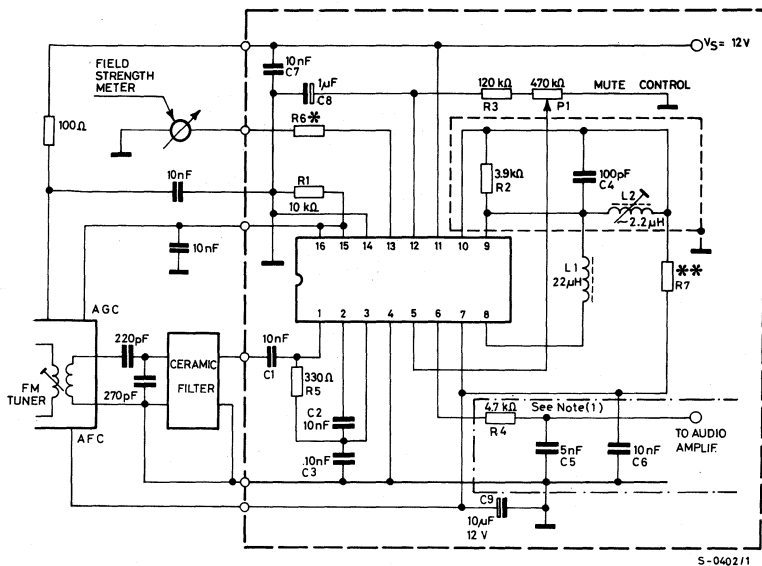
PC board and component layout of the circuit on next page (1:1 scale).



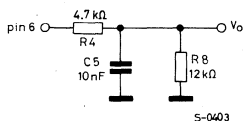
CS-0024

TDA 1200

Typical application circuit



NOTES: (1) When V_s is less than 12 V, a resistor $R8 = 12\text{ k}\Omega$ must be connected between audio output and ground, and the integrator capacitor $C5$ must be changed to 10 nF, as follows:



* Dependent on field strength meter sensitivity.

** Dependent on the tuner's AFC circuit.

LINEAR INTEGRATED CIRCUIT

PRELIMINARY DATA

TV VERTICAL DEFLECTION SYSTEM

The TDA 1270 is a silicon monolithic integrated circuit in a 12-lead quad in-line plastic package. It is designed mainly for driving complementary vertical deflection output stages in colour TV receivers.

The functions incorporated are:

- oscillator
- voltage ramp generator
- high power gain amplifier

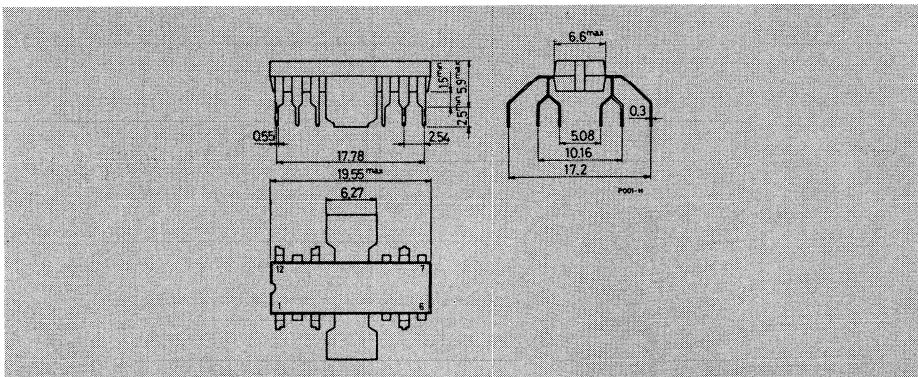
ABSOLUTE MAXIMUM RATINGS

V_s	Supply voltage (pins 2 and 5)	40	V	
V_4	Voltage at pin 4	41	V	
V_8	Sync. input voltage	± 12	V	
V_{10}	Power amplifier input voltage	$\left. \begin{array}{l} 10 \\ -0.5 \end{array} \right\}$	V	
			V	
I_o	Output peak current (non-repetitive) for $t = 2$ ms	2	A	
I_o	Output peak current	@ $f = 50$ Hz, $t \leq 10 \mu s$	2.5	A
		@ $f = 50$ Hz, $t > 10 \mu s$	1.5	A
P_{tot}	Power dissipation: at $T_{tab} = 90^\circ C$	5	W	
		at $T_{amb} = 80^\circ C$ (free air)	1	W
T_{stg}, T_j	Storage and junction temperature	-40 to 150	$^\circ C$	

ORDERING NUMBER: TDA 1270

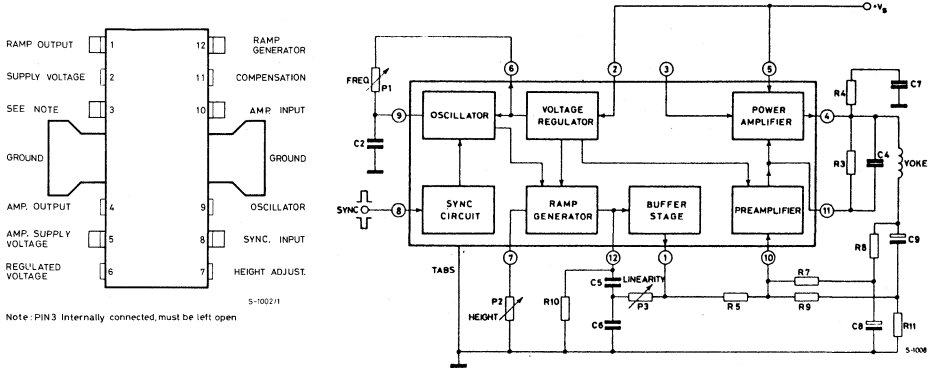
MECHANICAL DATA

Dimensions in mm

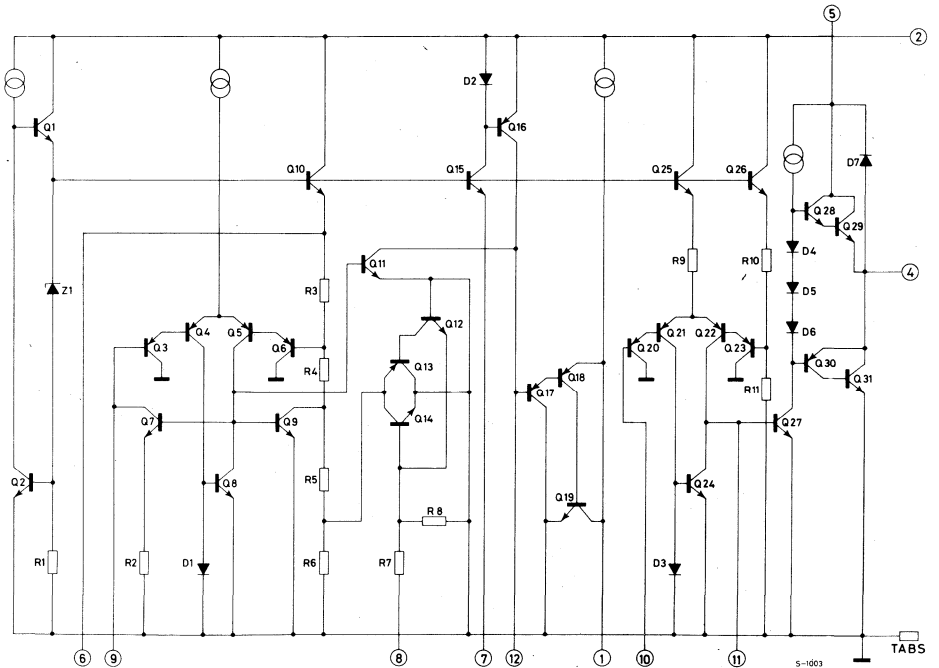


TDA 1270

CONNECTION AND BLOCK DIAGRAMS



SCHEMATIC DIAGRAM



THERMAL DATA

$R_{th\ j-tab}$	Thermal resistance junction–tab	max	12	°C/W
$R_{th\ j-amb}$	Thermal resistance junction–ambient	max	70*	°C/W

* Obtained with tabs soldered to printed circuit with minimized copper area

ELECTRICAL CHARACTERISTICS (Refer to the test circuits, $V_s = 32V$, $T_{amb} = 25\text{ °C}$ unless otherwise specified)

Parameter	Test conditions	Min.	Typ.	Max.	Unit	Fig.
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STATIC (DC) CHARACTERISTICS

$-I_9$	Oscillator bias current	$V_9 = 1V$	0.2	1	μA	1a	
$-I_{10}$	Amplifier input bias current	$V_{10} = 1V$	0.15	1	μA	1b	
$-I_{12}$	Ramp generator bias current		0.05	0.5	μA	1a	
V_s	Supply voltage		10		V	—	
V_4	Quiescent output voltage	$R2 = 10\text{ k}\Omega$ $V_s = 32V, R1 = 30\text{ k}\Omega$ $V_s = 10V, R1 = 10\text{ k}\Omega$	8 4	8.8 4.4	9.6 4.8	V V	1a
V_6, V_7	Regulated voltage		6	6.5	7	V	1b
$\frac{\Delta V_6}{\Delta V_s}, \frac{\Delta V_7}{\Delta V_s}$	Line regulation	$V_s = 10\text{ to }40V$	1.5		mV/V		

DYNAMIC CHARACTERISTICS (f = 50 Hz)

I_s	Supply current	$I_V = 0.5A$	70		mA	2
I_V	Peak to peak yoke current (pin 4)			1	A	
V_8	Peak sync. input voltage (positive negative)		1		V	

TDA 1270

ELECTRICAL CHARACTERISTICS (continued)

Parameter	Test conditions	Min.	Typ.	Max.	Unit	Fig.
V_9	Peak to peak oscillator sawtooth voltage		2.4		V	2
R_8	Sync. input resistance at pin 8 $V_8 = 1V$		3.5		$k\Omega$	
t_{fly}	Flyback time $I_V = 0.5A$		0.7		ms	
δf	Pull-in range (below 50 Hz)		7		Hz	
$\frac{\delta f}{\Delta V_s}$	Oscillator frequency drift with supply voltage $V_s = 10$ to $40V$		0.01		$\frac{Hz}{V}$	
$\frac{\delta f}{\Delta T_{tab}}$	Oscillator frequency drift with tab temperature $T_{tab} = 40$ to $120^\circ C$		0.015		$\frac{Hz}{^\circ C}$	

Fig. 1a- Static test circuit for measurement of $-I_9$, $-I_{12}$ and V_4

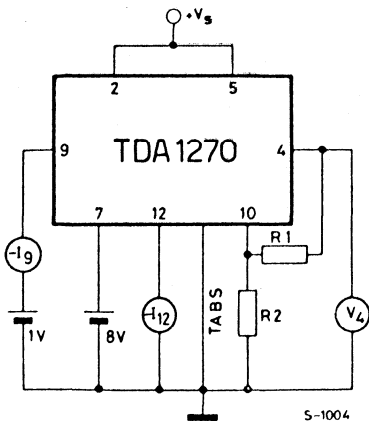
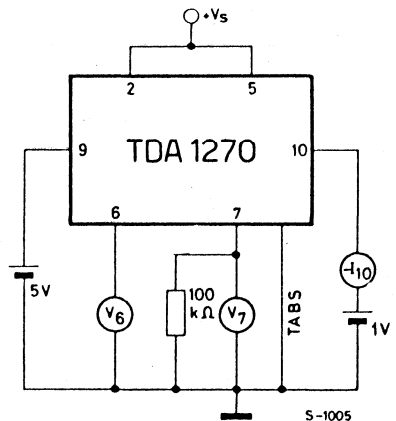


Fig. 1b- Static test circuit for measurement of $-I_{10}$, V_6 , V_7 , $\Delta V_6/\Delta V_s$ and $\Delta V_7/\Delta V_s$



TDA 1270

Fig. 2 - Dynamic test circuit

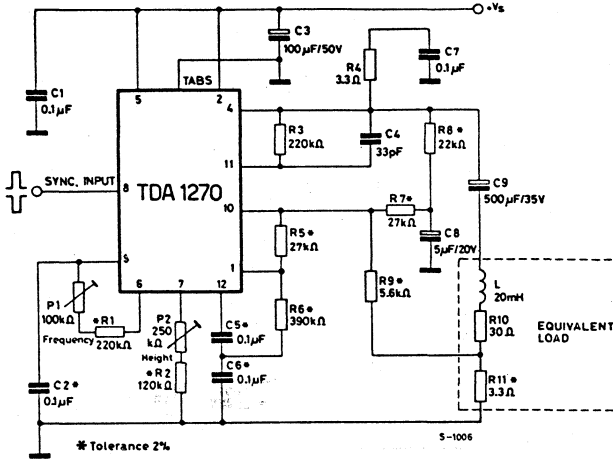


Fig. 3 - Relative quiescent voltage variation vs. supply voltage

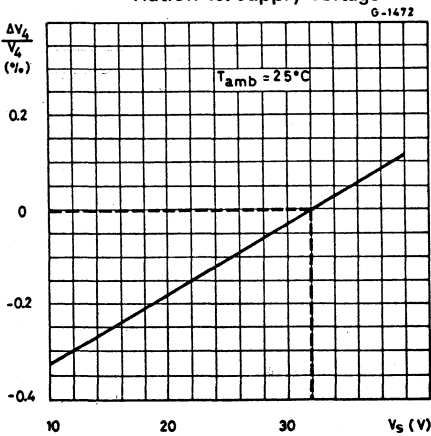
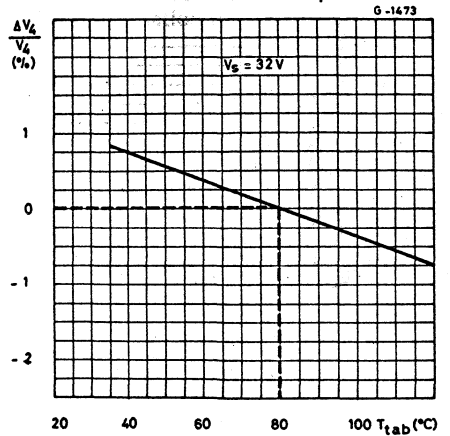


Fig. 4 - Relative quiescent voltage variation vs. tab temperature



TDA 1270

Fig. 5 - Regulated voltage vs. supply voltage

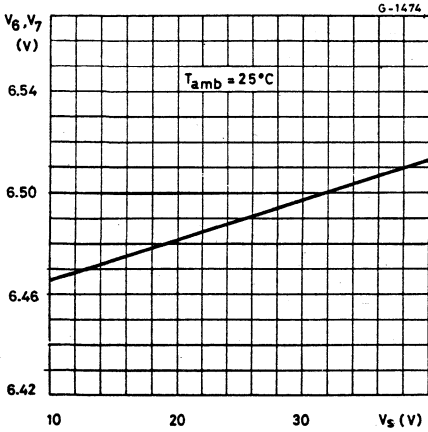


Fig. 6 - Regulated voltage vs. tab temperature

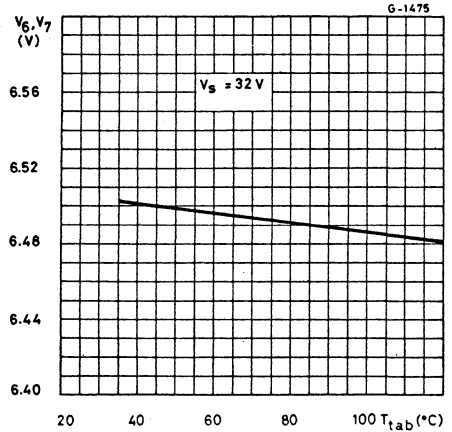


Fig. 7 - Frequency variation of unsynchronized oscillator vs. supply voltage

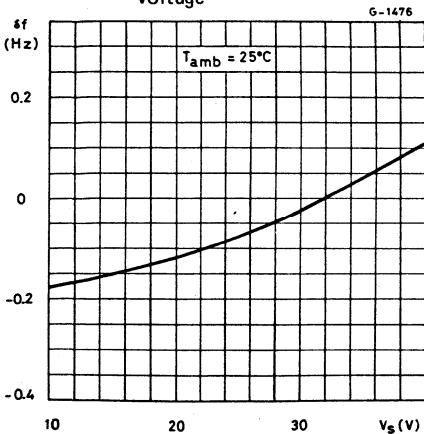
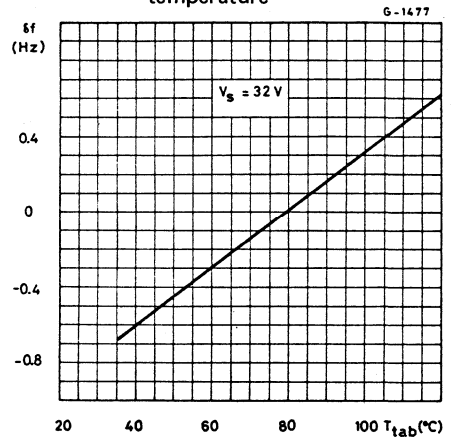


Fig. 8 - Frequency variation of unsynchronized oscillator vs. tab temperature



APPLICATION INFORMATION

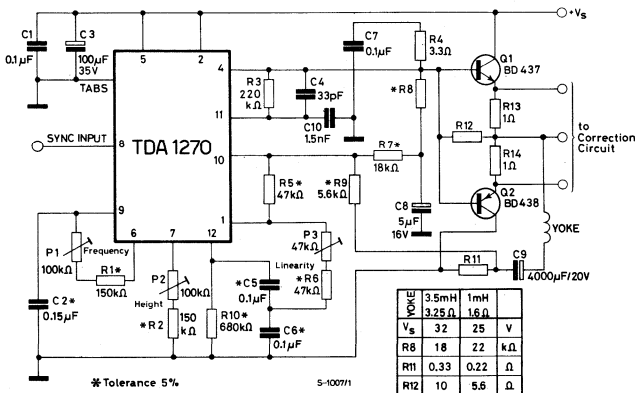
The high current capability of the TDA 1270 allows low current gain transistors to be used in driving low impedance yokes. The oscillator is directly synchronized by the sync. pulses, therefore its free frequency must be lower than the sync. frequency. The sync. input (pin 8) can be driven by positive or negative pulses.

The quiescent output voltage (pin 4) is fixed by the voltage feedback network R7, R8, and R9 (refer to fig. 9) according to:

$$V_4 = V_{10} \frac{R7 + R8 + R9}{R9}$$

Pin. 10 is the inverting input of the amplifier and its voltage is $V_{10} \cong 2V$.

Fig. 9 - Typical application circuit for large screen colour TV sets



Typical performance of circuit in fig. 9

I_s	Supply current
t_{fly}	Flyback time
I_V	Maximum scanning current (peak to peak)
V_s	Operating supply voltage
P_{tot}	TDA 1270 power dissipation
P_{tot}	Output transistors power dissipation
$R_{th \text{ tab-amb}}$	Heatsink R_{th} required for TDA 1270
$R_{th \text{ case-amb}}$	R_{th} of output transistors heatsink (total)

		YOKE	
		3.5 mH	1 mH
		3.25 Ω	1.6 Ω
I_s		0.5 A	0.8 A
t_{fly}		0.7 ms	0.6 ms
I_V		4 A	7.5 A
V_s		28 to 36V	23 to 27V
P_{tot}		1.5 W	2 W
P_{tot}		11 W	13 W
$R_{th \text{ tab-amb}}$		35 °C/W	30 °C/W
$R_{th \text{ case-amb}}$		6 °C/W	5 °C/W

Stable continuous operation is ensured up to an ambient temperature of 55 °C

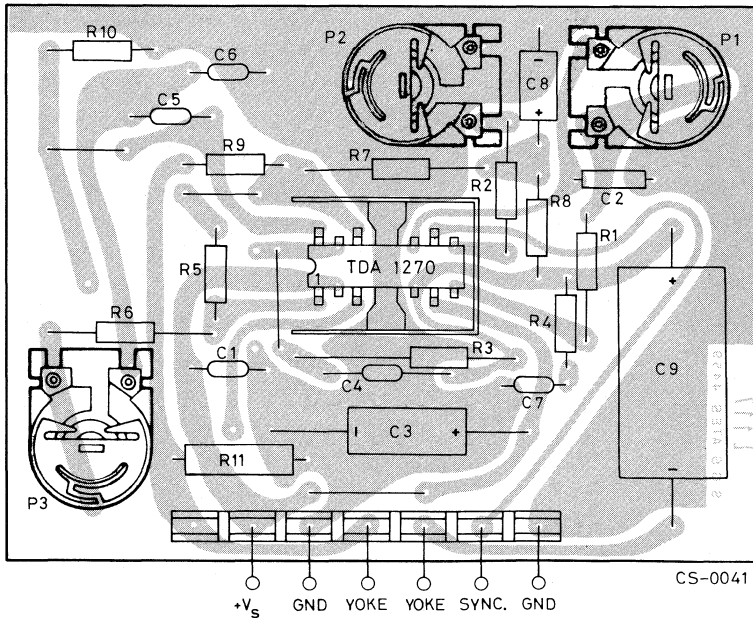
TDA 1270

Typical performance of circuit in fig. 11

I_s	Supply current	110	mA
t_{fly}	Flyback time	0.8	ms
I_y	Maximum scanning current (peak to peak)	0.9	A
V_s	Operating supply voltage	23 to 27	V
P_{tot}	TDA 1270 power dissipation	2.4	W

For safe working up to $T_{amb} = 50\text{ }^\circ\text{C}$ a heatsink of $R_{th} = 30\text{ }^\circ\text{C/W}$ is required and each tab of the TDA 1270 must be soldered to 1 cm² copper area of the printed circuit board.

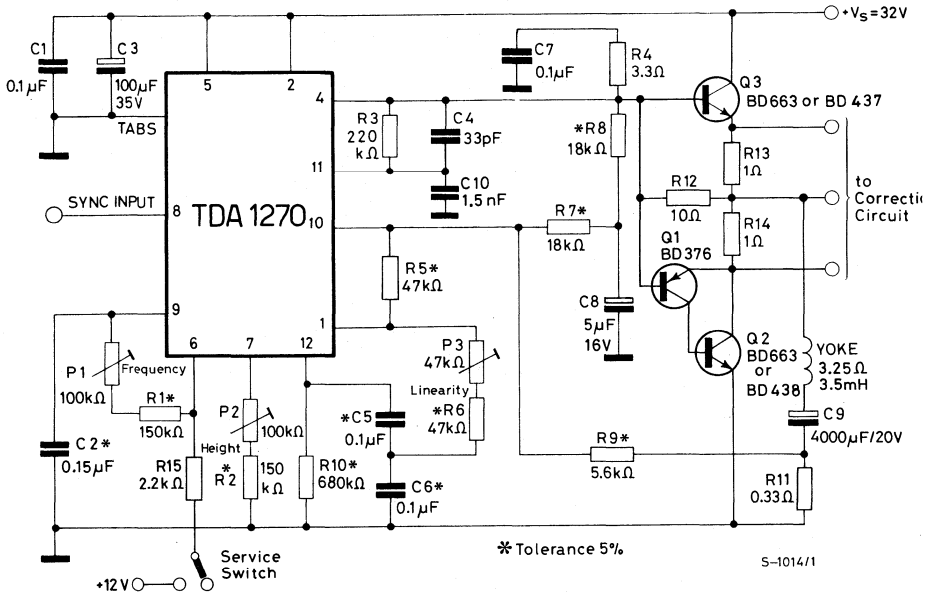
Fig. 12 - P.C. board and component layout for the circuit of fig. 11 (1:1 scale)



TDA 1270

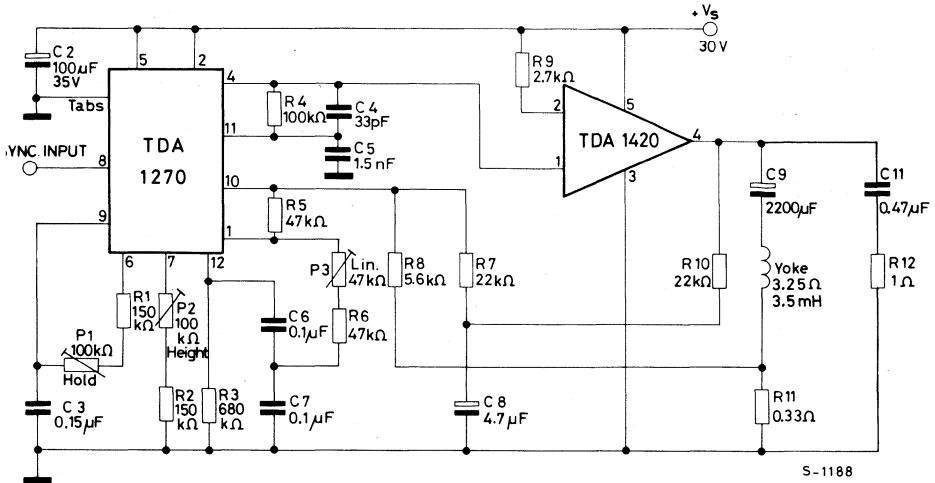
Fig. 13 shows an output stage employing two NPN power transistors and a service switch that stops the vertical deflection during convergence adjustment. For a more detailed description of the TDA 1270 and related performance refer to SGS-ATES Application Note N. 129.

Fig. 13 - Vertical deflection circuit employing two NPN power output transistors



TDA 1270

Fig. 14 - Vertical deflection circuit for large screen colour TV employing the integrated darlington pair TDA 1410



Typical performance of circuit in fig. 14

($V_s = 30V$; $R_Y = 3.25 \Omega$; $L_Y = 3.5 \text{ mH}$)

I_s	Supply current	0.5	A
t_{fly}	Flyback time	0.8	ms
V_s	Operating supply voltage	28 to 36	V
P_{tot}	TDA 1270 power dissipation	0.5	W
P_{tot}	TDA 1410 power dissipation	11	W
$R_{th \text{ case-amb}}$	Thermal resistance of TDA 1410 heatsink	6	$^{\circ}\text{C/W}$

MOUNTING INSTRUCTION

The junction to ambient thermal resistance of the TDA 1270 can be reduced by soldering the tabs to a suitable copper area of the printed circuit board (fig. 15) or to an external heatsink (fig. 16).

Fig. 17 gives the maximum power that can be dissipated (for $T_{amb} = 55$ and 70°C) as a function of the side "s" of two equal square copper areas having a thickness of 35μ (1.4 mil). During soldering the tab temperature must not exceed 260°C and the soldering time must not be longer than 12 seconds.

The external heatsink or printed circuit copper area must be connected to electrical ground.

TDA 1270

Fig. 15 - Example of P.C. board copper area used as heatsink

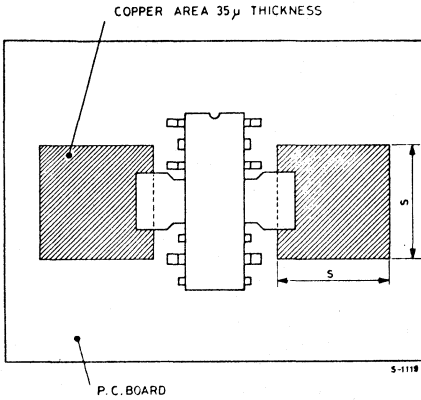


Fig. 16 - Example of TDA 1270 with external heatsink

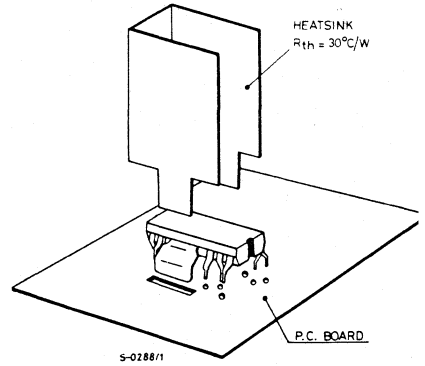


Fig. 17 - Maximum power dissipation and junction-ambient thermal resistance vs. "s"

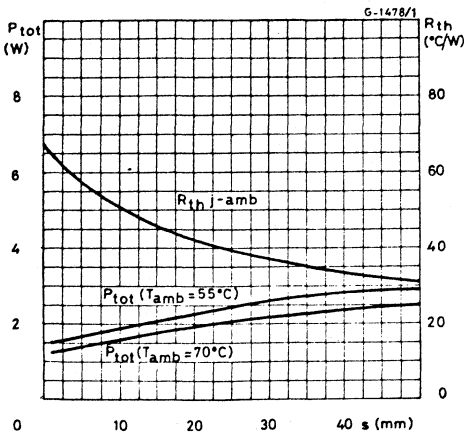
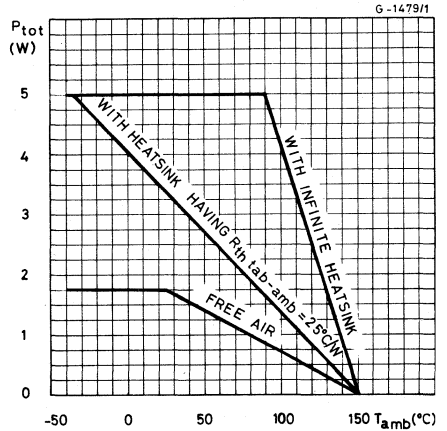


Fig. 18 - Maximum allowable power dissipation versus ambient temperature



LINEAR INTEGRATED CIRCUIT

5 V VOLTAGE REGULATOR

- OUTPUT CURRENT > 600 mA
- TIGHT TOLERANCE for OUTPUT VOLTAGE
- LOAD REGULATION LESS THAN 1%
- RIPPLE REJECTION 60 dB TYPICAL
- LOW OUTPUT IMPEDANCE
- EXCELLENT TRANSIENT RESPONSE
- HIGH TEMPERATURE STABILITY

The TDA 1405 is a silicon monolithic voltage regulator in Jedec TO-126 plastic package which can supply more than 600 mA. It incorporates the following functions:

- internal overload protection
- short-circuit protection

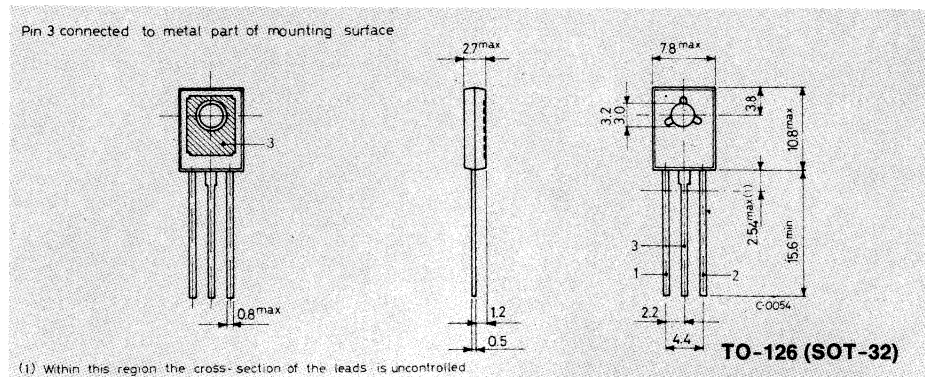
The TDA 1405 can be used for voltage regulation in consumer applications.

ABSOLUTE MAXIMUM RATINGS

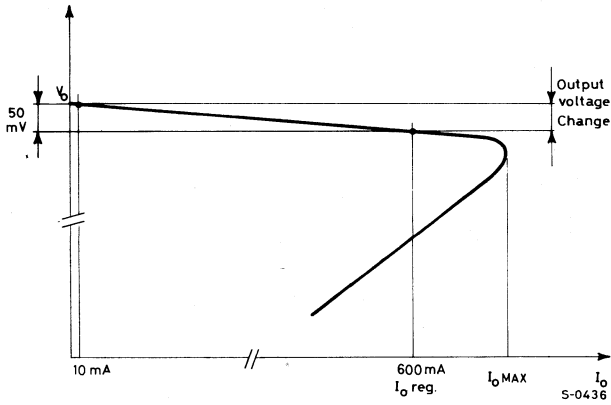
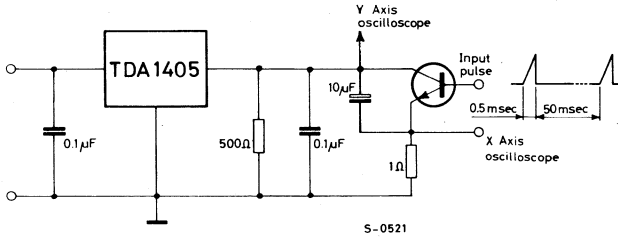
V_i	Input supply voltage	20	V
P_{tot}	Total power dissipation at $T_{amb} \leq 25^\circ\text{C}$ at $T_{case} \leq 25^\circ\text{C}$	1.25	W
T_{stg}, T_j	Storage and junction temperature	-55 to 150	$^\circ\text{C}$
T_{op}	Operating temperature	0 to 70	$^\circ\text{C}$

MECHANICAL DATA

Dimensions in mm



TEST CIRCUIT with output characteristic



THERMAL DATA

$R_{th\ j-case}$	Thermal resistance junction-case	max	9 °C/W
$R_{th\ j-amb}$	Thermal resistance junction-ambient	max	100 °C/W

TDA 1405

ELECTRICAL CHARACTERISTICS

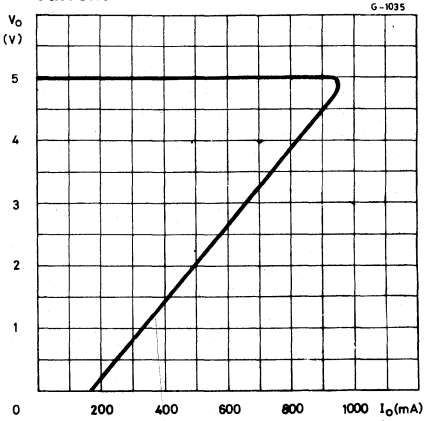
($T_j = 25\text{ }^\circ\text{C}$, $V_i = 12\text{ V}$ unless otherwise specified)

Parameter	Test conditions	Min.	Typ.	Max.	Unit
V_o Output voltage	$7.5\text{ V} \leq V_i \leq 20\text{ V}$ $I_o = 10\text{ mA}$ $C_L = 10\text{ }\mu\text{F}$	4.75	5	5.25	V
ΔV_o^* Load regulation	$I_o = 10\text{ to }600\text{ mA}$ $C_L = 10\text{ }\mu\text{F}$		0.3	1	%V
I_o^* Regulated output current	$\frac{\Delta V_o}{V_o} \leq 1\%$	600	850		mA
$I_o\text{MAX}^*$ Maximum output current	$T_{\text{case}} = 25\text{ }^\circ\text{C}$ $T_{\text{case}} = 70\text{ }^\circ\text{C}$		0.93 1	1.2	A A
I_{sc} Output short-circuit current	$V_o = 0$		200	250	mA
I_d Quiescent drain current	$V_i = 20\text{ V}$ $I_o = 0$		9		mA
ΔV_o Line regulation	$V_i = 7.5\text{ to }12\text{ V}$ $I_o = 10\text{ mA}$ $C_L = 10\text{ }\mu\text{F}$		5	23	mV
$\frac{\Delta V_o}{\Delta T_{\text{amb}}}$ Temperature coefficient	$I_o = 10\text{ mA}$ $C_L = 10\text{ }\mu\text{F}$ $T_{\text{amb}} = 0\text{ to }70\text{ }^\circ\text{C}$		0.5		mV/°C
e_N Output noise voltage	$I_o = 10\text{ mA}$ $C_L^{**} = 20\text{ }\mu\text{F}$ $B = 10\text{ Hz to }100\text{ kHz}$		70		μV
R_o Output resistance	$I_o = 600\text{ mA}$		15		$\text{m}\Omega$
SVR Supply voltage rejection	$V_i = 10\text{ V}$ $I_o = 10\text{ mA}$ $\Delta V_i = 4\text{ V peak to peak}$ $f = 100\text{ Hz}$ $C_L = 10\text{ }\mu\text{F}$	46	60		dB

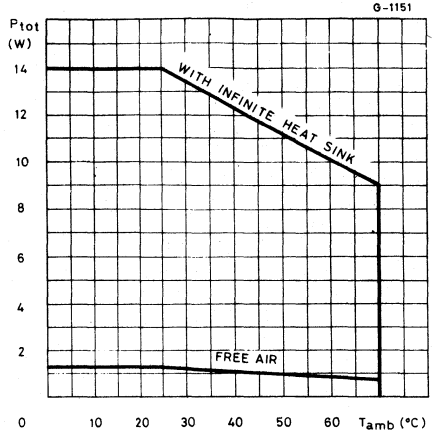
* Refer to the test circuit

** Tantalum capacitor

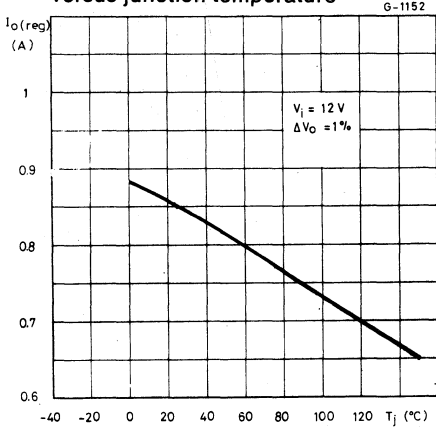
Typical output voltage versus output current



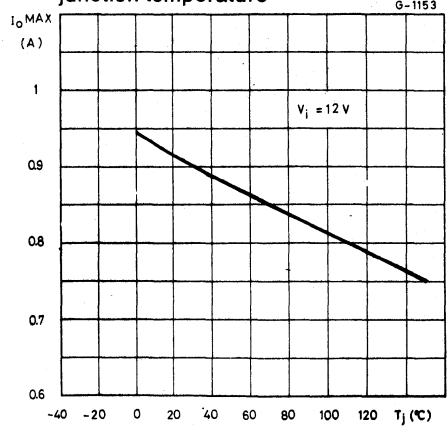
Power rating chart



Typical regulated output current versus junction temperature

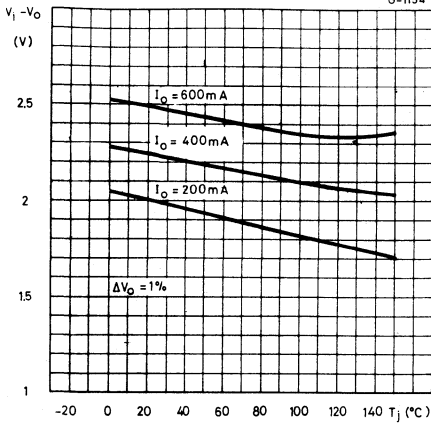


Maximum output current versus junction temperature

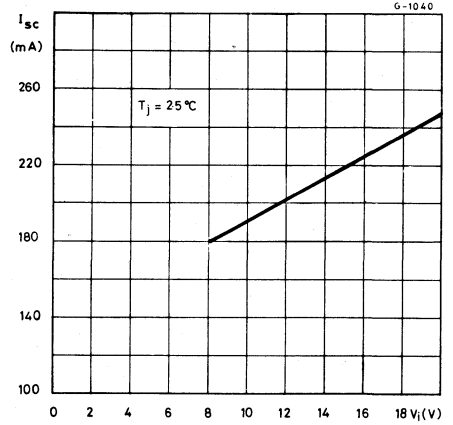


TDA 1405

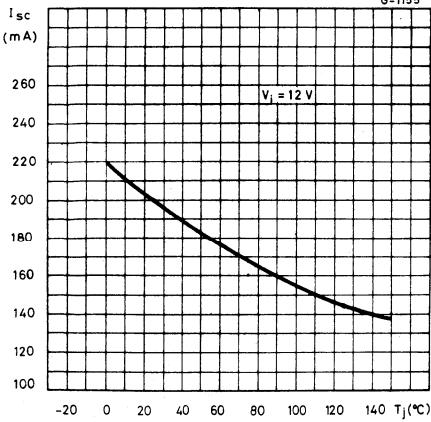
Typical dropout voltage versus junction temperature



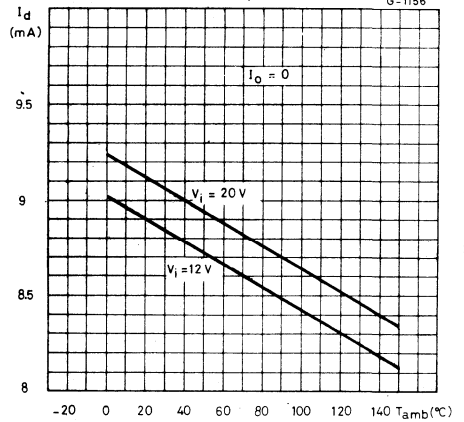
Typical short-circuit current versus input voltage



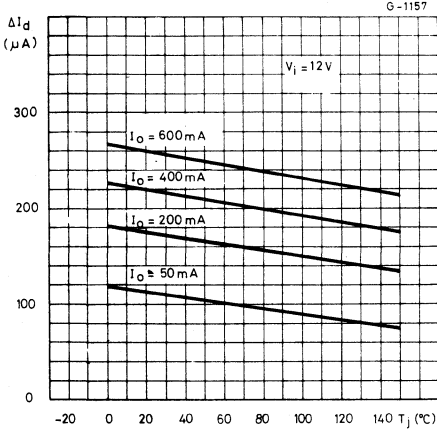
Typical short-circuit current versus junction temperature



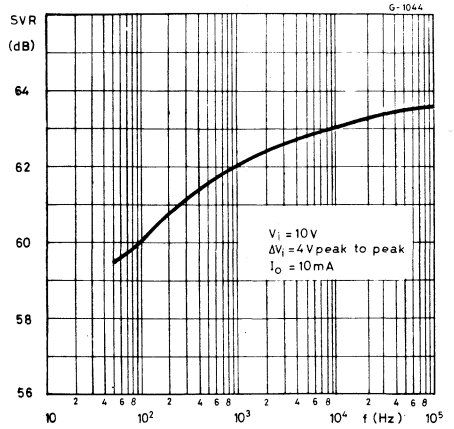
Typical quiescent drain current versus junction temperature



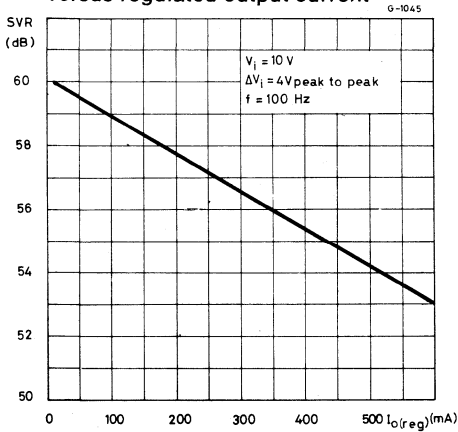
Typical quiescent drain current variation versus junction temperature



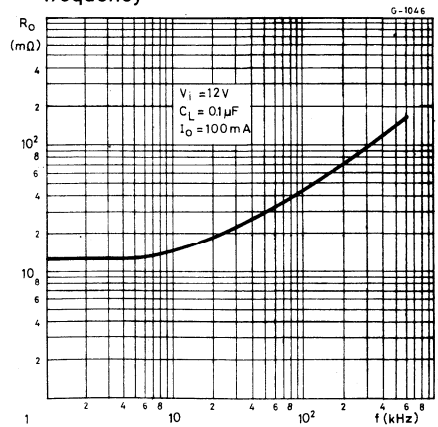
Typical supply voltage rejection versus frequency



Typical supply voltage rejection versus regulated output current

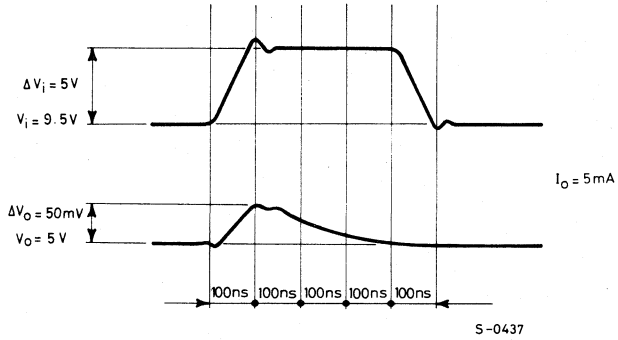


Typical output resistance versus frequency



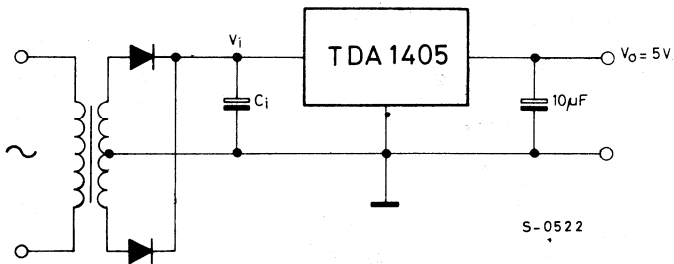
TDA 1405

Typical line transient response



APPLICATION INFORMATION

Typical connection circuit



APPLICATION INFORMATION (continued)

Circuit for increasing output voltage

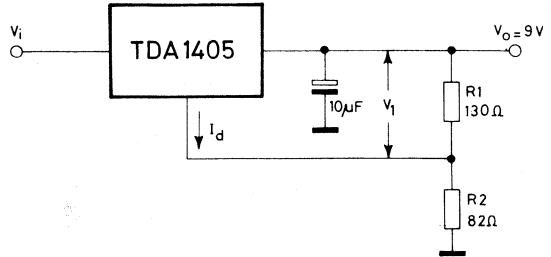
$$V_o = V_i \left(1 + \frac{R_2}{R_1}\right) + I_d \cdot R_2$$

$$V_i = 16 \text{ V}$$

$$I_d = 9 \text{ mA}$$

$$\frac{\delta I_d}{\delta T_{\text{amb}}} = -7 \mu\text{A}/^\circ\text{C typ.}$$

$$\frac{\delta I_d}{\delta V_i} = 30 \mu\text{A}/\text{V typ.}$$



S-0523

Circuit for increasing output current

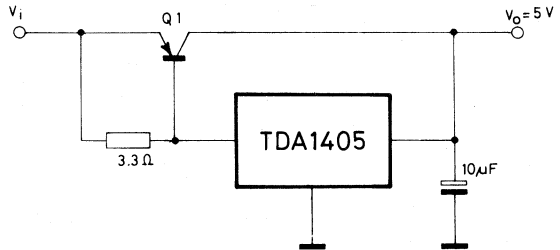
$$V_i = 12 \text{ V}$$

$$I_o \text{ MAX} = 5 \text{ A}$$

$$R_o \approx 2 \text{ m}\Omega$$

$$Q1 = \text{PNP transistor}$$

$$h_{FEQ1} \geq 20 \text{ at } I_{CQ1} = 5 \text{ A}$$



S-0524

Switching regulator with short-circuit protection

$$V_o = 5 \text{ V}$$

$$I_o \leq 4 \text{ A}$$

$$\Delta V_o \approx 100 \text{ mV peak to peak}$$

$$f \approx 10 \text{ kHz}$$

$$\eta = \frac{P_o}{P_i} \approx 65\%$$

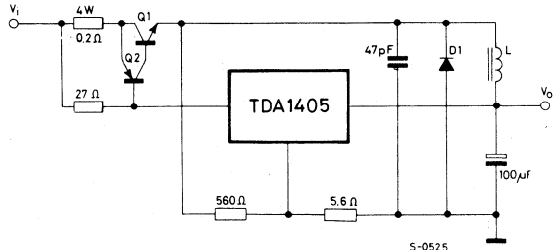
$$V_i = 10 \text{ to } 20 \text{ V}$$

$$Q1 = \text{BDX 70}$$

$$Q2 = \text{BC 116}$$

$$D1 = \text{Diode with } I_{FM} = 5 \text{ A}$$

$$L \approx 1.5 \text{ mH}$$



S-0525

LINEAR INTEGRATED CIRCUIT

PRELIMINARY DATA

MONOLITHIC QUASI-COMPLEMENTARY DUAL DARLINGTON IN PENTAWATT® PACKAGE

The TDA 1410 is a monolithic integrated circuit in Pentawatt® plastic package consisting of a pair of quasi-complementary (NPN-PNP) darlingtontons with the associated biasing system. Each darlingtonton can deliver a current in excess of 3A and can withstand a supply voltage of 36V. The device is intended for applications as:

- booster for operational amplifier
- DC motor driver
- stepping motor driver
- output stage for AC power amplifier up to 12W in Hi-Fi systems
- output stage for vertical deflection systems in colour TV etc.

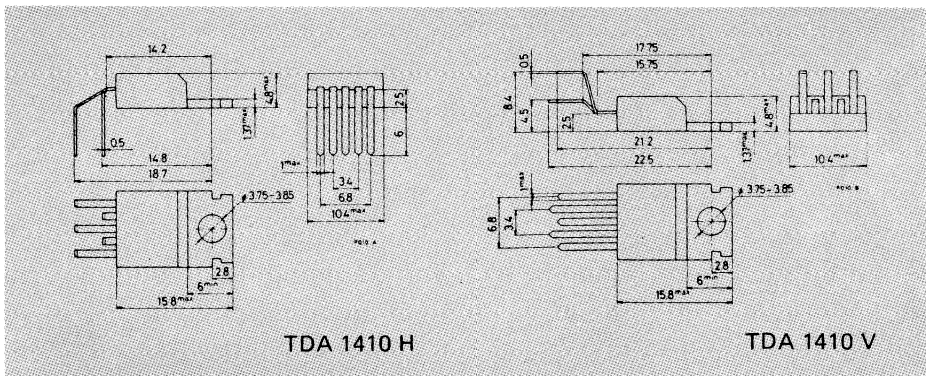
ABSOLUTE MAXIMUM RATINGS

V_{CEO}	Collector-emitter voltage ($I_B = 0$)	36	V
V_{CBO}	Collector-base voltage ($I_E = 0$)	50	V
I_o	Output peak current (repetitive)	3.5	A
I_o	DC output current	3	A
$I_{F D1}$	D1 forward current	0.3	A
$I_{F D2}$	D2 forward current	3	A
P_{tot}	Total power dissipation at $T_{case} = 60^\circ C$	30	W
T_j, T_{stg}	Junction and storage temperature	-40 to 150	$^\circ C$

ORDERING NUMBERS: TDA 1410 H
TDA 1410 V

MECHANICAL DATA

Dimensions in mm

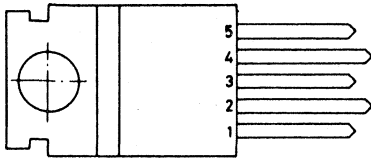


TDA 1410 H

TDA 1410 V

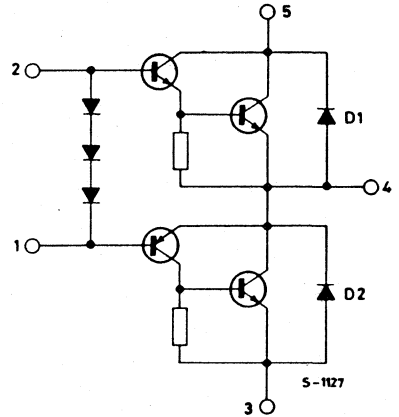
TDA 1410

CONNECTION AND SCHEMATIC DIAGRAMS



• V_S
OUTPUT
- V_S
INPUT
INPUT

5-1128



THERMAL DATA

$R_{th\ j-case}$ Thermal resistance junction-case	max.	3 °C/W
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ELECTRICAL CHARACTERISTICS ($T_{amb} = 25^\circ C$)

Parameter	Test conditions	Min.	Typ.	Max.	Unit
V_{CEO} Collector-emitter breakdown voltage		36			V
V_{CBO} Collector-base breakdown voltage	$I_C = 500\ \mu A$	50			V
$V_{(BR)CSSO}$ Collector-substrate breakdown voltage		50			V
$h_{FE(NPN)}$ DC forward current transfer ratio	$I_C = 2A$ $V_{CE} = 5V$	2000	5000		—
$h_{FE(PNP)}$ DC forward current transfer ratio	$I_C = -2A$ $V_{CE} = -5V$	800	2500		—

ELECTRICAL CHARACTERISTICS (continued)

Parameter	Test conditions	Min.	Typ.	Max.	Unit
I_d	Quiescent drain current $I_{2-1} = 5 \text{ mA}$ $V_s = 34 \text{ V}$		20		mA
$V_{CE(sat)}$	Collector-emitter saturation voltage (NPN-PNP) $I_C = 2\text{A} $ $h_{FE} = 200$		1.7	2.3	V
$V_{BE(NPN)}$	Base-emitter voltage (pins 2-4) $I_C = 2\text{A}$		2		V
$V_{BE(PNP)}$	Base-emitter voltage (pins 1-4) $I_C = -2\text{A}$		-0.9		V
$V_{F(D1)}$	D1 forward voltage $V_{3-5} = -34\text{V}$ $I_{F(D1)} = 0.3\text{A}$		1.5		V
$V_{F(D2)}$	D2 forward voltage $I_{F(D2)} = 3\text{A}$		5		V
$f_{T(NPN)}$	Cutoff frequency $I_C = 2\text{A}$ $V_{CE} = 10\text{V}$	10			MHz
$f_{T(PNP)}$	Cutoff frequency $I_C = -2\text{A}$ $V_{CE} = -10\text{V}$	5			MHz

Fig. 1 - Typical quiescent drain current vs. I_{2-1}

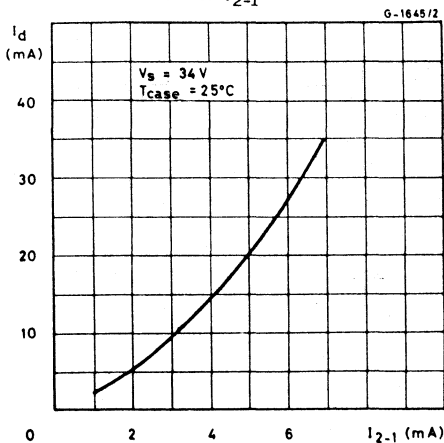
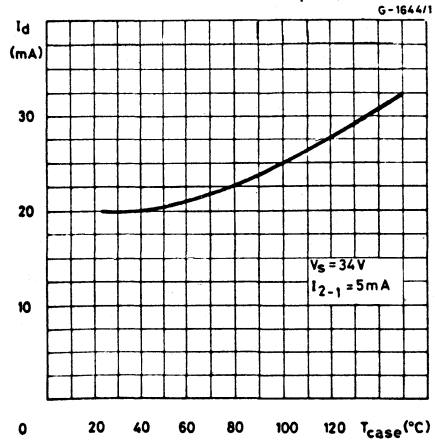


Fig. 2 - Typical quiescent drain current vs. case temperature



TDA 1410

Fig. 3 - Typical quiescent drain current vs. supply voltage

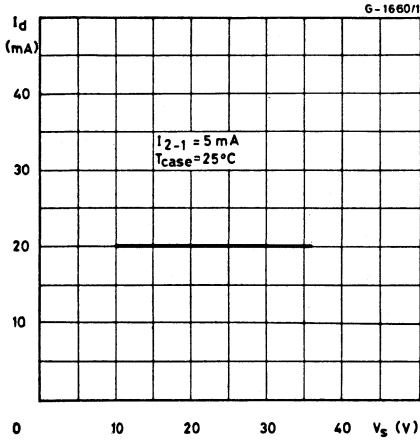


Fig. 4 - Typical DC current gain vs. collector current

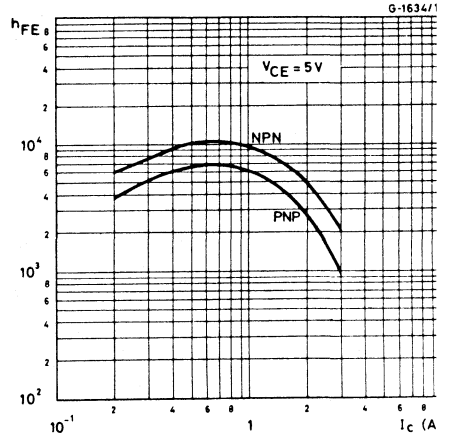


Fig. 5 - Typical $V_{CE(\text{sat})}$ vs. collector current

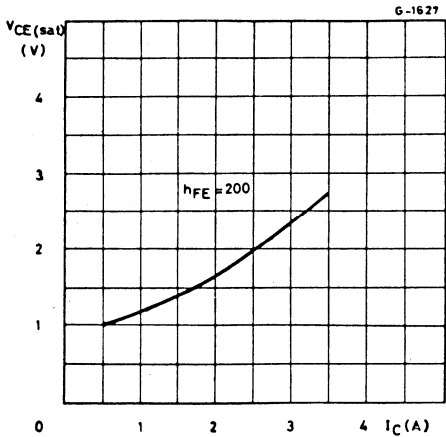
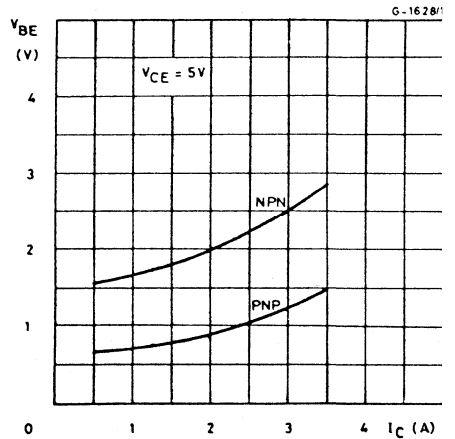


Fig. 6 - Typical V_{BE} vs. collector current



TDA 1410

Fig. 7 - Typical pulse response (rising edge)

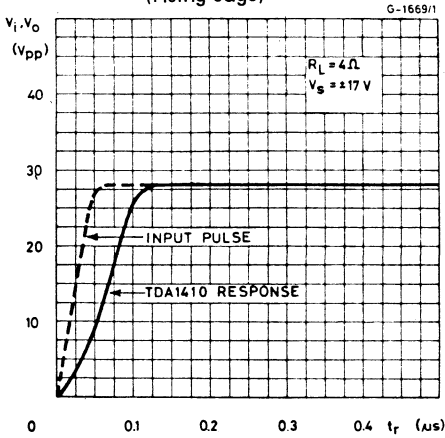


Fig. 8 - Typical pulse response (falling edge)

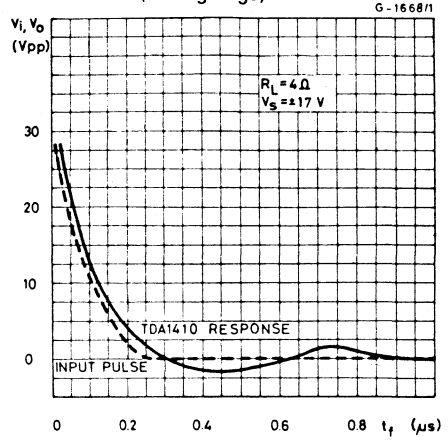


Fig. 9 - Typical output voltage swing vs. frequency

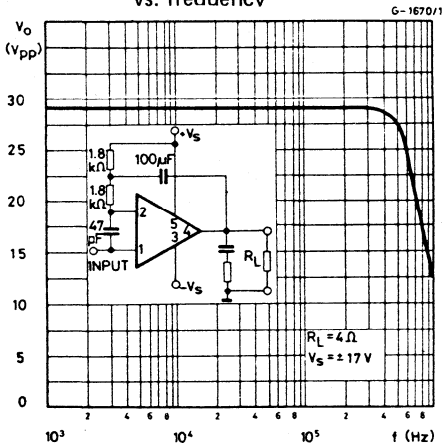
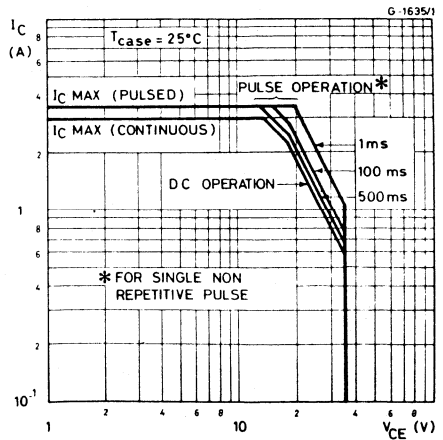


Fig. 10 - Safe operating areas



TDA 1410

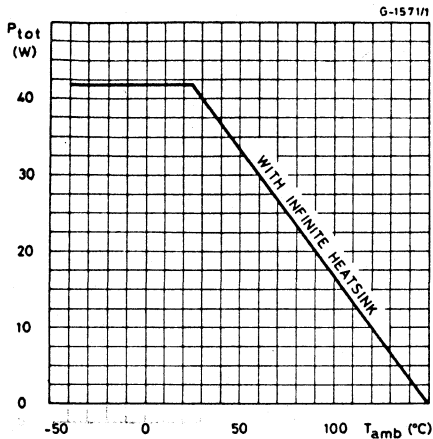
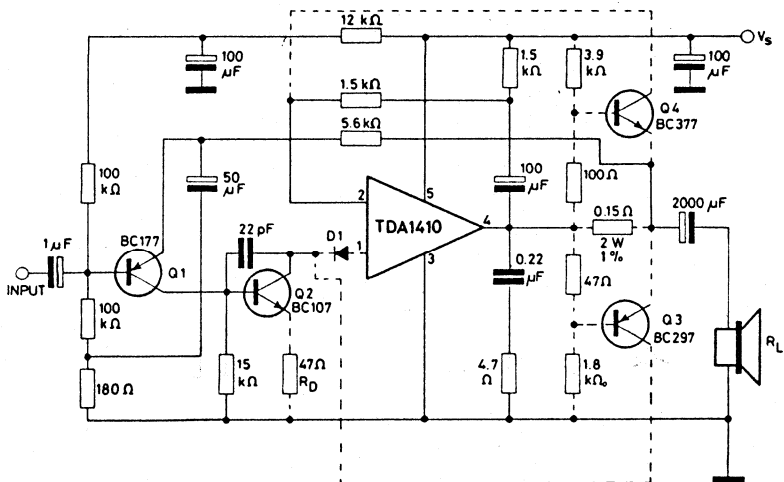


Fig. 11 - Derating characteristic

APPLICATION INFORMATION

Fig. 12- Hi-Fi audio amplifier with short circuit protection



5-1146/2

Typical performance of circuit in fig. 12

Parameter	Test conditions	Min.	Typ.	Max.	Unit
P _o Output power	d = 1% G _v = 30 dB				
	f = 40 to 15,000 Hz				
	V _s = 25V R _L = 4Ω	10	12		W
	V _s = 27V R _L = 8Ω	8	9		W
B Frequency response (-3 dB)	d = 10% G _v = 30 dB				
	f = 40 to 15,000 Hz				
	V _s = 25V R _L = 4Ω		16		W
	V _s = 27V R _L = 8Ω		12		W
I _d Drain current	V _s = 25V R _L = 4Ω				
	P _o = 18W		960		mA
	V _s = 27V R _L = 8Ω				
	P _o = 12W		575		mA

Fig. 13 - Output characteristics of the protected class B stage

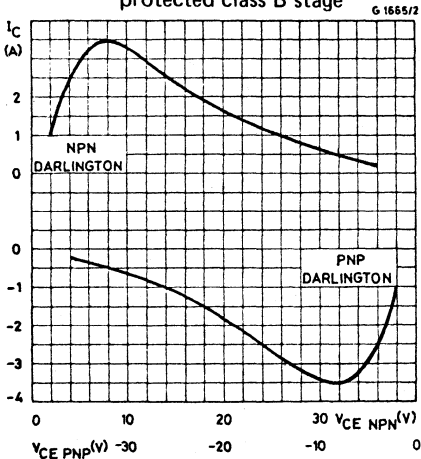
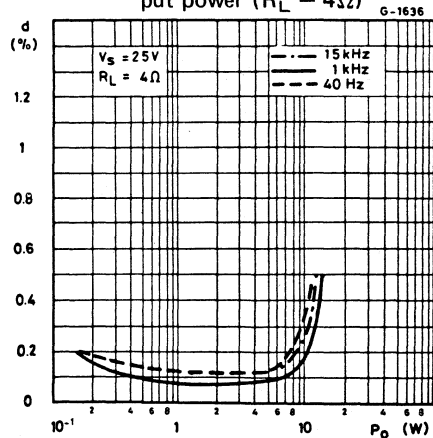


Fig. 14 - Typical distortion vs. output power ($R_L = 4\Omega$)



TDA 1410

Fig. 15 - Typical distortion vs. output power ($R_L = 4\Omega$)

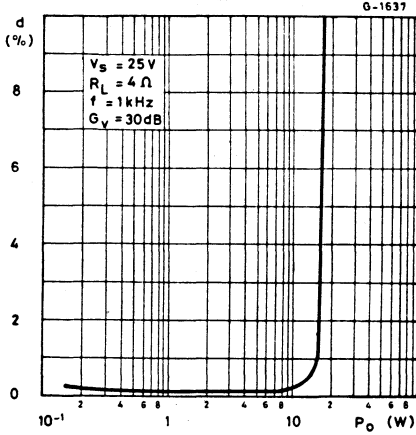


Fig. 16 - Sensitivity vs. output power ($R_L = 4\Omega$)

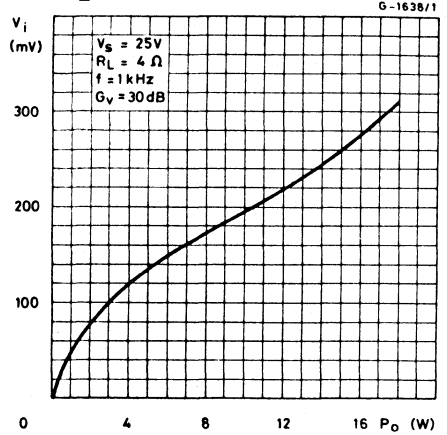


Fig. 17 - Typical power dissipation and efficiency vs. output power ($R_L = 4\Omega$)

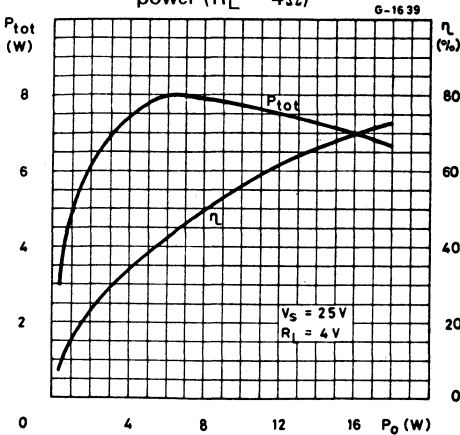


Fig. 18 - Typical distortion vs. output power ($R_L = 8\Omega$)

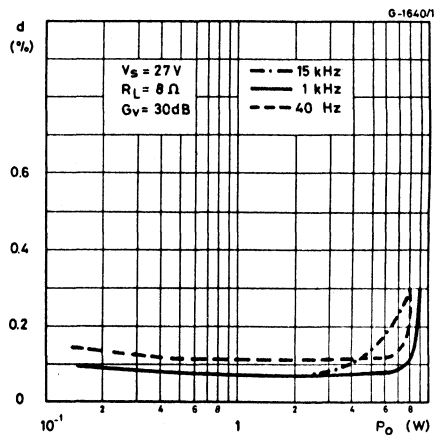


Fig. 19 - Typical distortion vs. output power ($R_L = 8\Omega$)

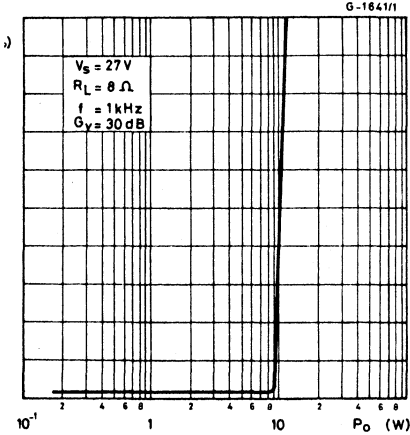


Fig. 20 - Typical sensitivity vs. output power ($R_L = 8\Omega$)

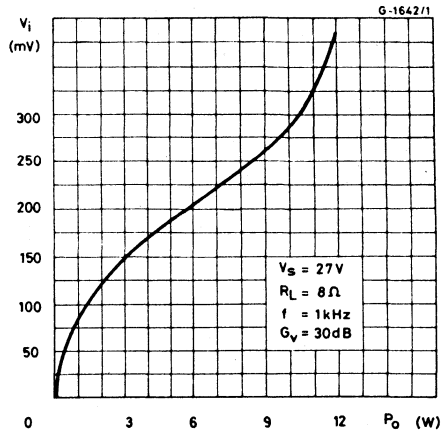


Fig. 21 - Typical power dissipation and efficiency vs. output power ($R_L = 8\Omega$)

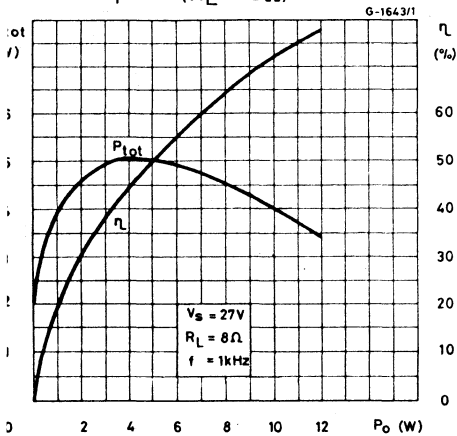
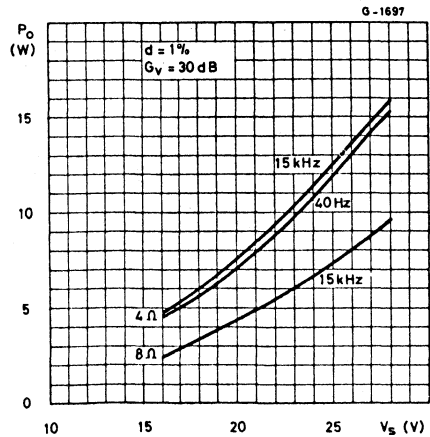


Fig. 22 - Typical output power vs. supply voltage



TDA 1410

Fig. 23 - H-Fi stereo amplifier with preamplifier-equalizer for ceramic pick-ups.
The final stage is identical to fig. 12.

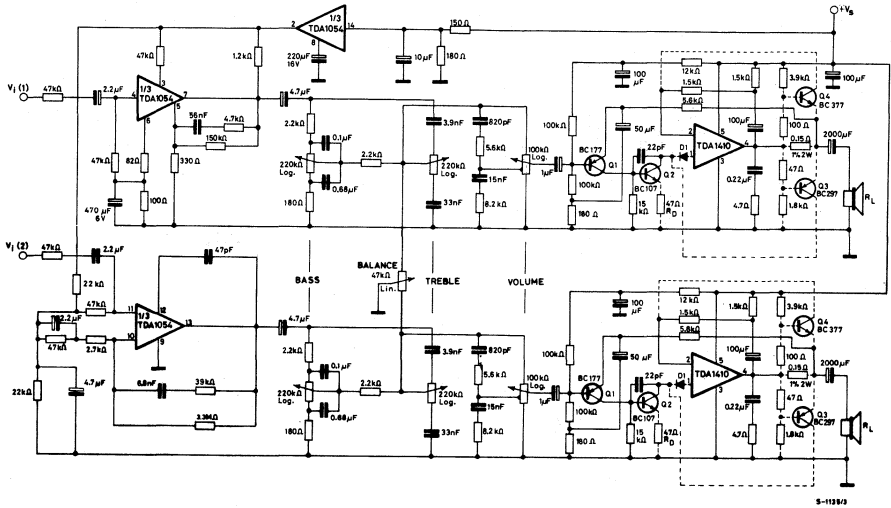
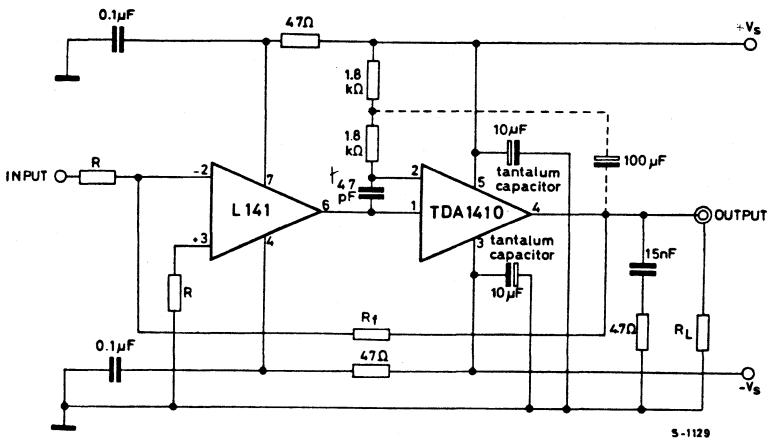


Fig. 24 - Booster for operational amplifier



TDA 1410

Fig.25 - L 141 + TDA 1410 output voltage swing vs. frequency

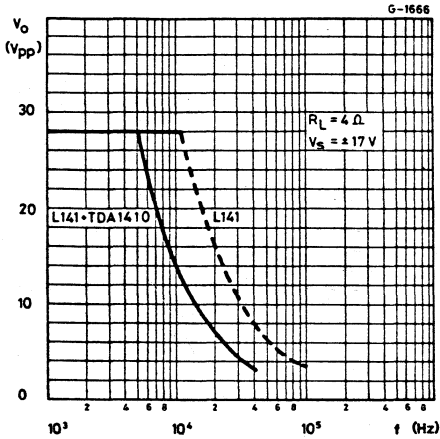
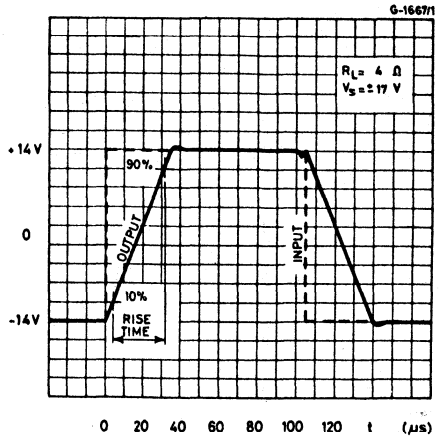


Fig.26 - L 141 + TDA 1410 transient response



Performance of circuit in fig. 24

	L 141 + TDA 1410
Max. supply voltage	$\pm 18V$
Max. power dissipation	30W at $T_{case} = 60^\circ C$
Input offset voltage	$\leq 5 mV$
Input offset current	$\leq 200 nA$
Input bias current	$\leq 500 nA$
Voltage gain	$\geq 86 dB (R_L = 4\Omega)$
Max. DC output current	3A

TDA 1410

Fig.29 - Bidirectional speed control of DC motor

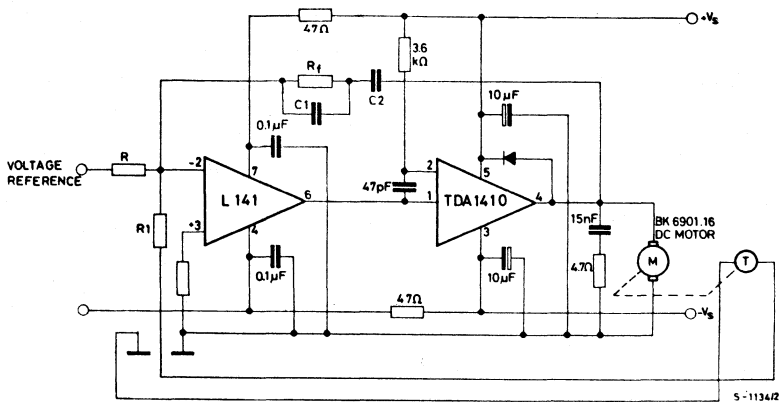
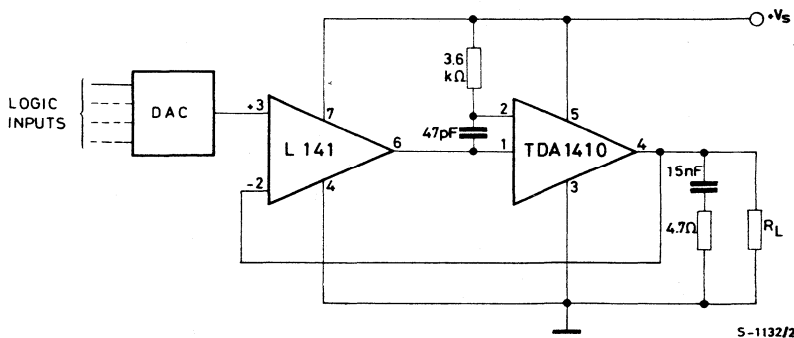


Fig.30 - Programmable supply voltage



LINEAR INTEGRATED CIRCUIT

12 V VOLTAGE REGULATOR

- OUTPUT CURRENT > 500 mA
- TIGHT TOLERANCE for OUTPUT VOLTAGE
- LOAD REGULATION LESS THAN 1%
- RIPPLE REJECTION 60 dB TYPICAL
- LOW OUTPUT IMPEDANCE
- EXCELLENT TRANSIENT RESPONSE
- HIGH TEMPERATURE STABILITY

The TDA 1412 is a silicon monolithic voltage regulator in Jedec TO-126 plastic package which can supply more than 500 mA. It incorporates the following functions:

- internal overload protection
- short-circuit protection

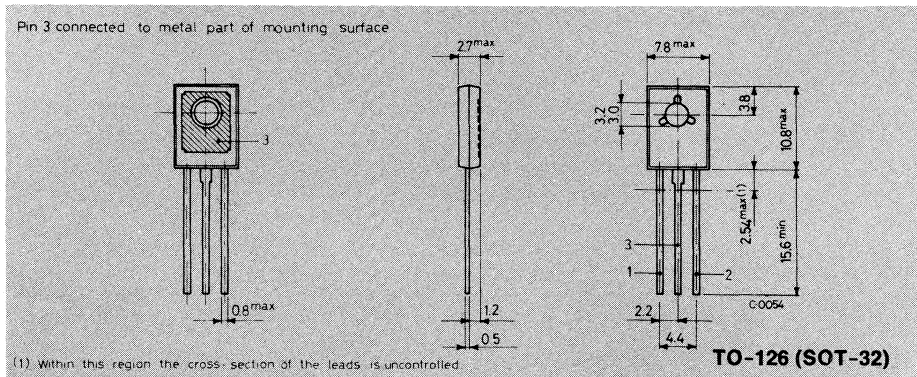
The TDA 1412 can be used for voltage regulation in consumer applications.

ABSOLUTE MAXIMUM RATINGS

V_i	Input supply voltage	27	V
P_{tot}	Total power dissipation at $T_{amb} \leq 25$ °C	1.25	W
	at $T_{case} \leq 25$ °C	14	W
T_{stg} , T_j	Storage and junction temperature	-55 to 150	°C
T_{op}	Operating temperature	0 to 70	°C

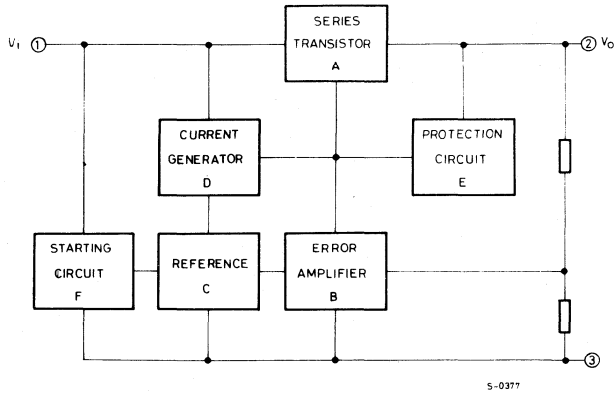
MECHANICAL DATA

Dimensions in mm

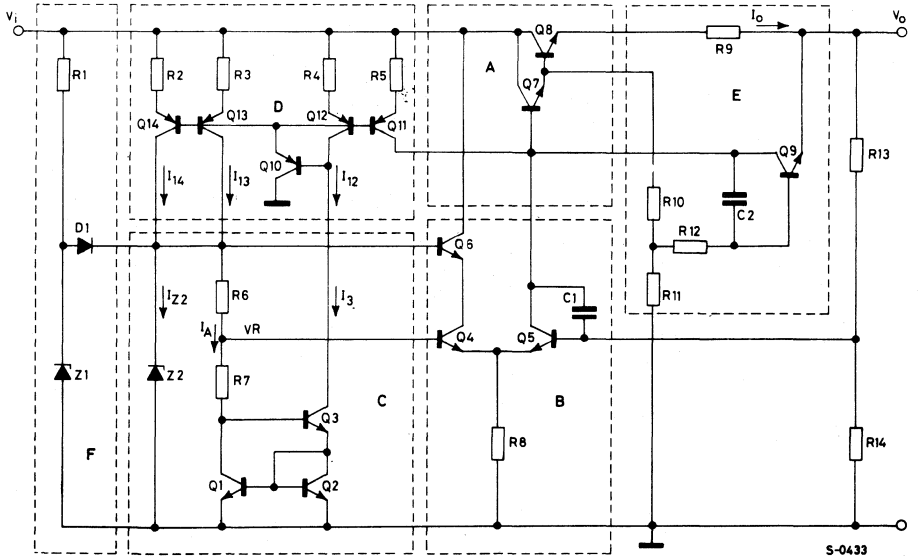


TDA 1412

BLOCK DIAGRAM

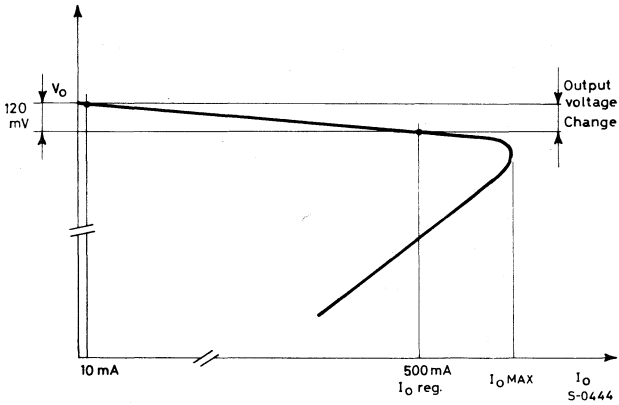
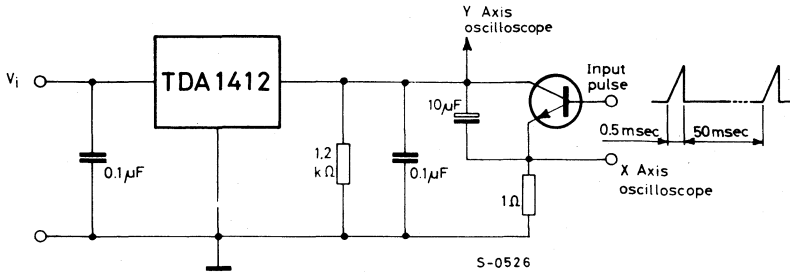


SCHEMATIC DIAGRAM



TDA 1412

TEST CIRCUIT with output characteristic



THERMAL DATA

$R_{th\ j-case}$	Thermal resistance junction-case	max	9 °C/W
$R_{th\ j-amb}$	Thermal resistance junction-ambient	max	100 °C/W

TDA 1412

ELECTRICAL CHARACTERISTICS

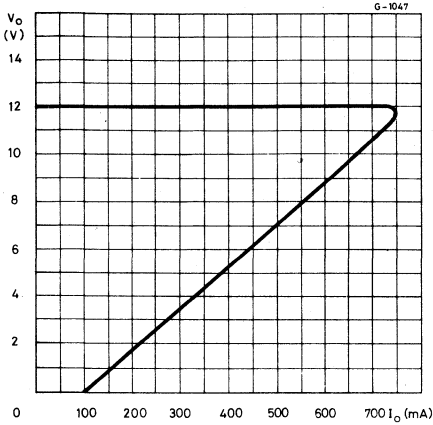
($T_i = 25^\circ\text{C}$, $V_i = 21\text{ V}$ unless otherwise specified)

Parameter	Test conditions	Min.	Typ.	Max.	Unit
V_o Output voltage	$14.5\text{ V} \leq V_i \leq 27\text{ V}$ $I_o = 10\text{ mA}$ $C_L = 10\ \mu\text{F}$	11.4	12	12.6	V
ΔV_o^* Load regulation	$I_o = 10\text{ to }500\text{ mA}$ $C_L = 10\ \mu\text{F}$		0.3	1	%V
I_o^* Regulated output current	$\frac{\Delta V_o}{V_o} \leq 1\%$	500	720		mA
$I_o\text{MAX}^*$ Maximum output current	$T_{\text{case}} = 25^\circ\text{C}$ $T_{\text{case}} = 70^\circ\text{C}$		0.75 0.8	1	A A
I_{sc} Output short-circuit current	$V_o = 0$		100	200	mA
I_d Quiescent drain current	$V_i = 27\text{ V}$ $I_o = 0$		10		mA
ΔV_o Line regulation	$V_i = 14.5\text{ to }21\text{ V}$ $I_o = 10\text{ mA}$ $C_L = 10\ \mu\text{F}$		6	33	mV
$\frac{\Delta V_o}{\Delta T_{\text{amb}}}$ Temperature coefficient	$I_o = 10\text{ mA}$ $C_L = 10\ \mu\text{F}$ $T_{\text{amb}} = 0\text{ to }70^\circ\text{C}$		1.2		mV/ $^\circ\text{C}$
e_N Output noise voltage	$I_o = 10\text{ mA}$ $C_L^{**} = 20\ \mu\text{F}$ $B = 10\text{ Hz to }100\text{ kHz}$		150		μV
R_o Output resistance	$I_o = 500\text{ mA}$		20		$\text{m}\Omega$
SVR Supply voltage rejection	$V_i = 19\text{ V}$ $I_o = 10\text{ mA}$ $\Delta V_i = 4\text{ V peak to peak}$ $f = 100\text{ Hz}$ $C_L = 10\ \mu\text{F}$	46	60		dB

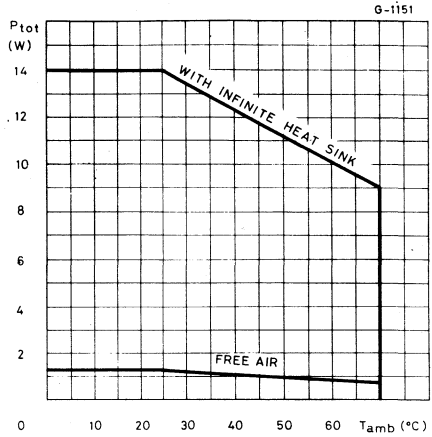
* Refer to the test circuit

** Tantalum capacitor

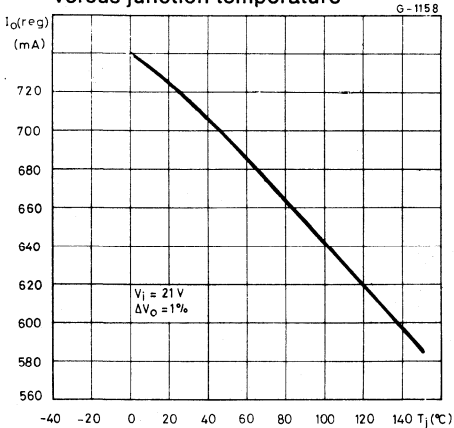
Typical output voltage versus output current



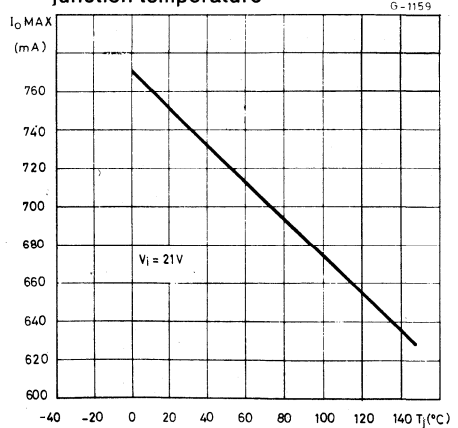
Power rating chart



Typical regulated output current versus junction temperature

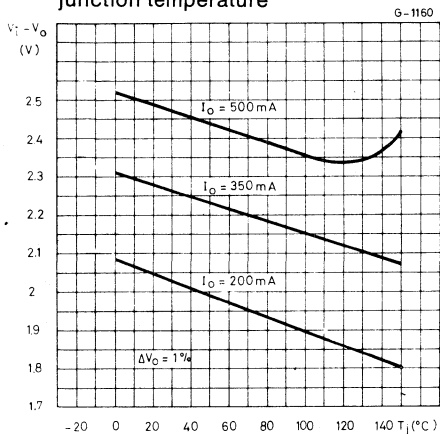


Maximum output current versus junction temperature

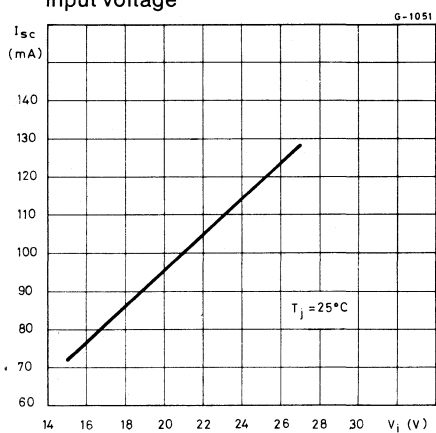


TDA 1412

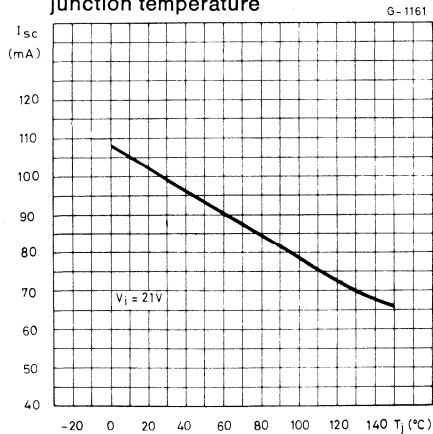
Typical dropout voltage versus junction temperature



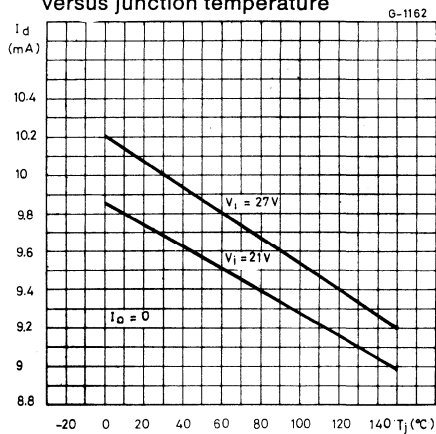
Typical short-circuit current versus input voltage



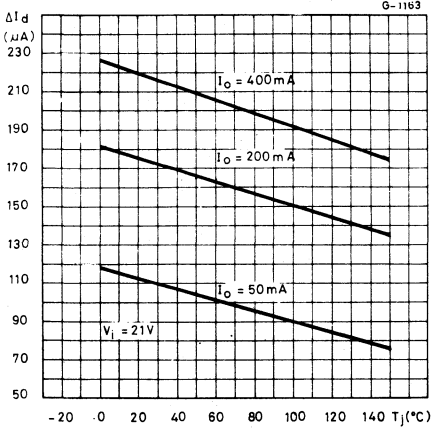
Typical short-circuit current versus junction temperature



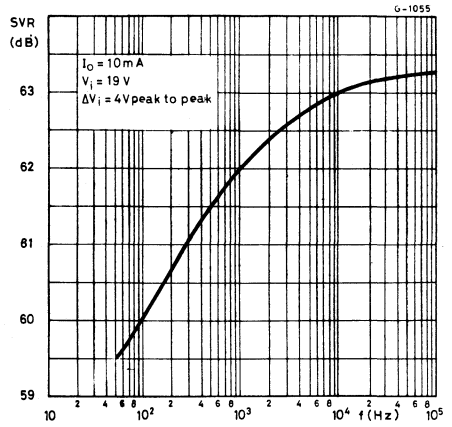
Typical quiescent drain current versus junction temperature



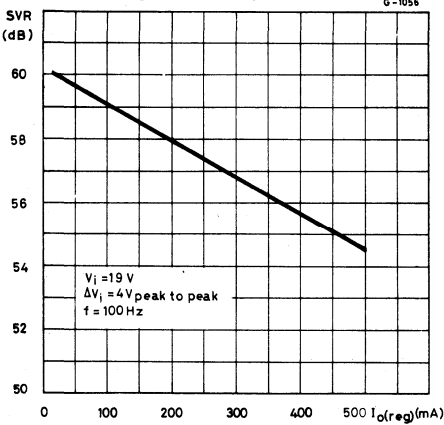
Typical quiescent drain current variation versus junction temperature



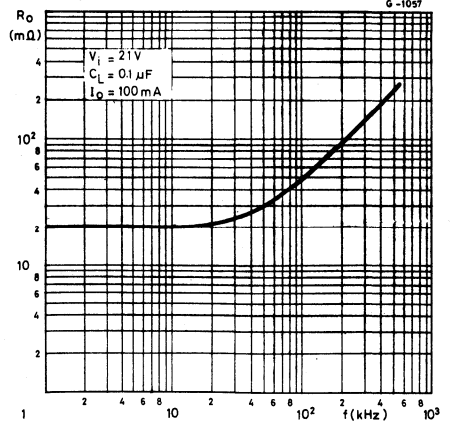
Typical supply voltage rejection versus frequency



Typical supply voltage rejection versus regulated output current

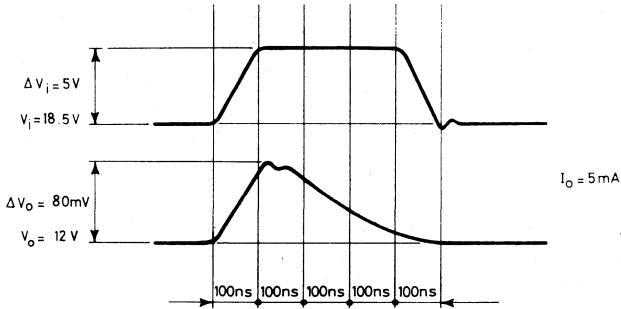


Typical output resistance versus frequency



TDA 1412

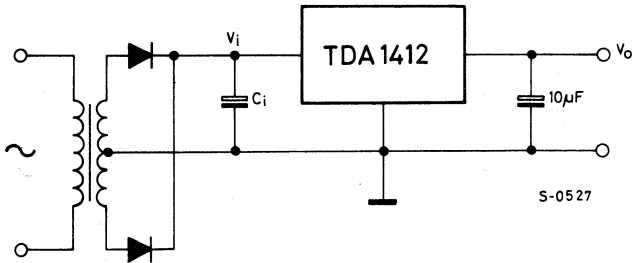
Typical line transient response



S-0445

APPLICATION INFORMATION

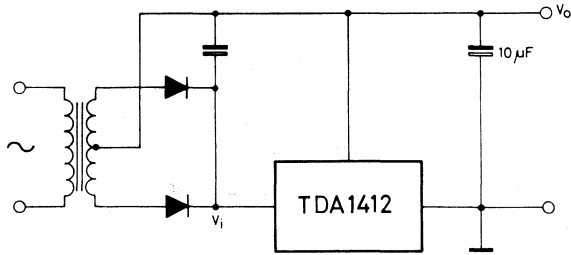
Typical connection circuit



S-0527

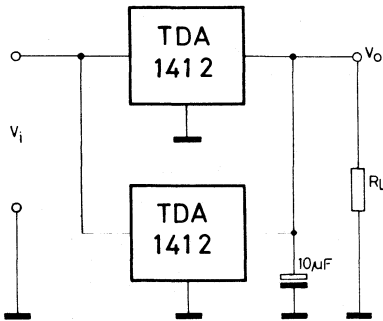
APPLICATION INFORMATION (continued)

Negative output voltage circuit

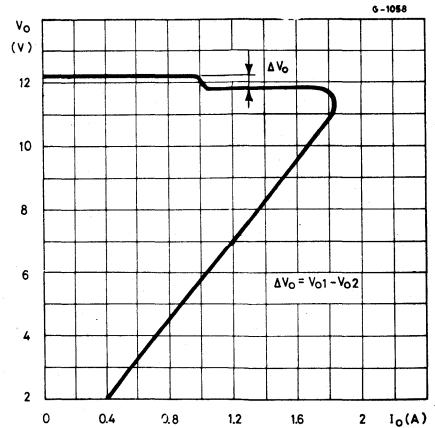


S-0528

Parallel connected voltage regulators and its output characteristics



S-0529



LINEAR INTEGRATED CIRCUIT

15 V VOLTAGE REGULATOR

- OUTPUT CURRENT > 450 mA
- TIGHT TOLERANCE for OUTPUT VOLTAGE
- LOAD REGULATION LESS THAN 1%
- RIPPLE REJECTION 56 dB TYPICAL
- LOW OUTPUT IMPEDANCE
- EXCELLENT TRANSIENT RESPONSE
- HIGH TEMPERATURE STABILITY

The TDA 1415 is a silicon monolithic voltage regulator in Jedec TO-126 plastic package which can supply more than 450 mA. It incorporates the following functions:

- internal overload protection
- short-circuit protection

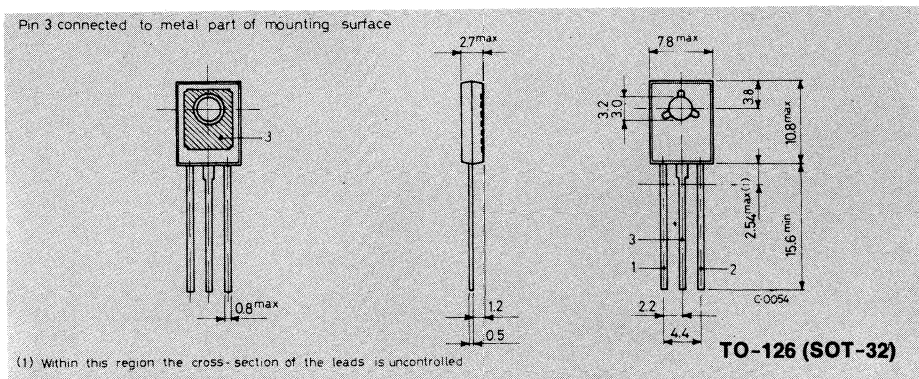
The TDA 1415 can be used for voltage regulation in consumer applications.

ABSOLUTE MAXIMUM RATINGS

V_i	Input supply voltage	27	V
P_{tot}	Total power dissipation at $T_{amb} \leq 25^\circ\text{C}$	1.25	W
	at $T_{case} \leq 25^\circ\text{C}$	14	W
T_{stg}, T_j	Storage and junction temperature	-55 to 150	$^\circ\text{C}$
T_{op}	Operating temperature	0 to 70	$^\circ\text{C}$

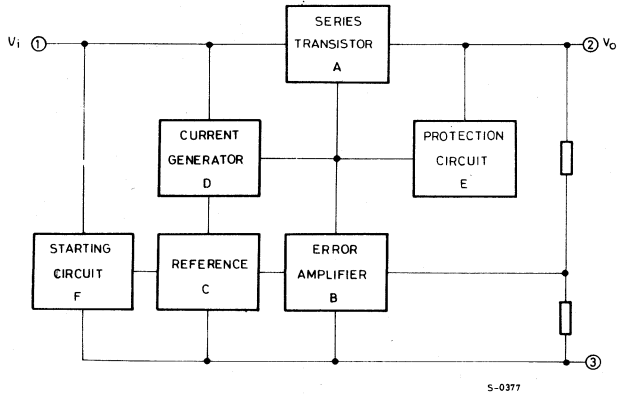
MECHANICAL DATA

Dimensions in mm

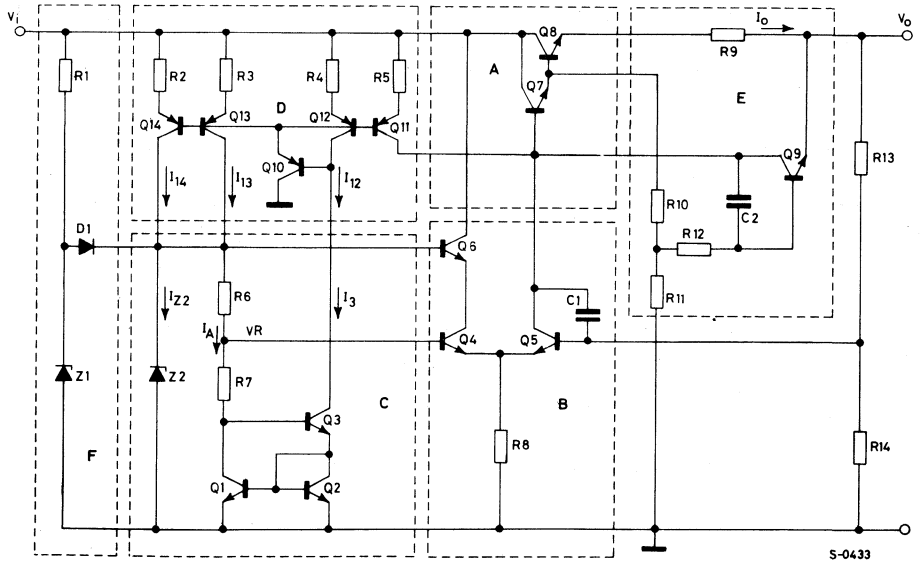


TDA 1415

BLOCK DIAGRAM

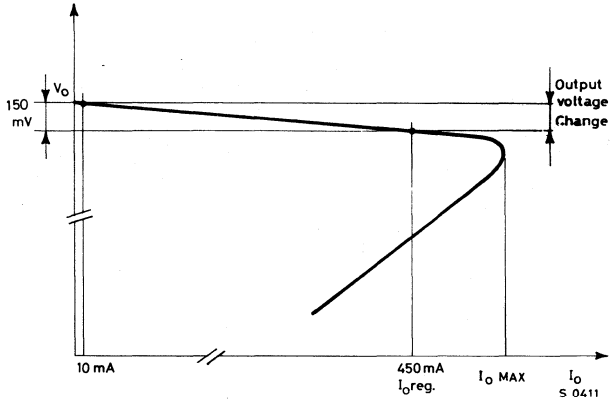
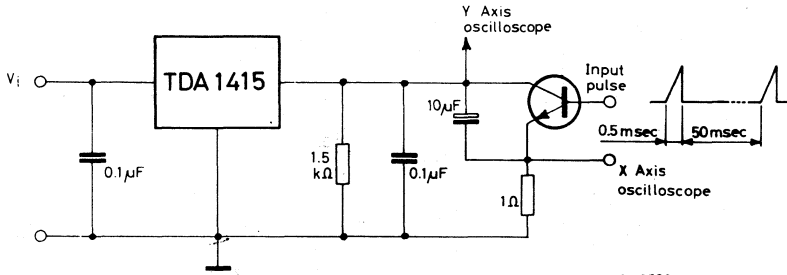


SCHEMATIC DIAGRAM



TDA 1415

TEST CIRCUIT with output characteristic



THERMAL DATA

$R_{th\ j\text{-case}}$	Thermal resistance junction-case	max	9 °C/W
$R_{th\ j\text{-amb}}$	Thermal resistance junction-ambient	max	100 °C/W

TDA 1415

ELECTRICAL CHARACTERISTICS

$T_i = 25^\circ\text{C}$, $V_i = 24\text{ V}$ unless otherwise specified)

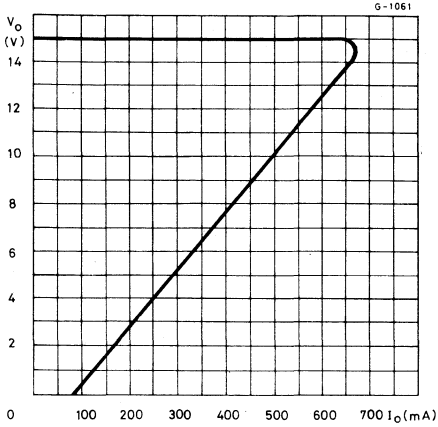
Parameter	Test conditions	Min.	Typ.	Max.	Unit
V_o Output voltage	$17.5\text{ V} \leq V_i \leq 27\text{ V}$ $I_o = 10\text{ mA}$ $C_L = 10\ \mu\text{F}$	14.25	15	15.75	V
ΔV_o^* Load regulation	$I_o = 10\text{ to }450\text{ mA}$ $C_L = 10\ \mu\text{F}$		0.3	1	%V
I_o^* Regulated output current	$\frac{\Delta V_o}{V_o} \leq 1\%$	450	600		mA
$I_o\text{MAX}^*$ Maximum output current	$T_{\text{case}} = 25^\circ\text{C}$ $T_{\text{case}} = 70^\circ\text{C}$		0.68	0.9	A A
I_{sc} Output short-circuit current	$V_o = 0$		85	160	mA
I_d Quiescent drain current	$V_i = 27\text{ V}$ $I_o = 0$		10		mA
ΔV_o Line regulation	$V_i = 17.5\text{ to }24\text{ V}$ $I_o = 10\text{ mA}$ $C_L = 10\ \mu\text{F}$		6	33	mV
$\frac{\Delta V_o}{\Delta T_{\text{amb}}}$ Temperature coefficient	$I_o = 10\text{ mA}$ $C_L = 10\ \mu\text{F}$ $T_{\text{amb}} = 0\text{ to }70^\circ\text{C}$		1.5		mV/°C
e_N Output noise voltage	$I_o = 10\text{ mA}$ $C_L^{**} = 20\ \mu\text{F}$ $B = 10\text{ Hz to }100\text{ kHz}$		180		μV
R_o Output resistance	$I_o = 450\text{ mA}$		60		m Ω
SVR Supply voltage rejection	$V_i = 22\text{ V}$ $I_o = 10\text{ mA}$ $\Delta V_i = 4\text{ V peak to peak}$ $f = 100\text{ Hz}$ $C_L = 10\ \mu\text{F}$		46	56	dB

* Refer to the test circuit

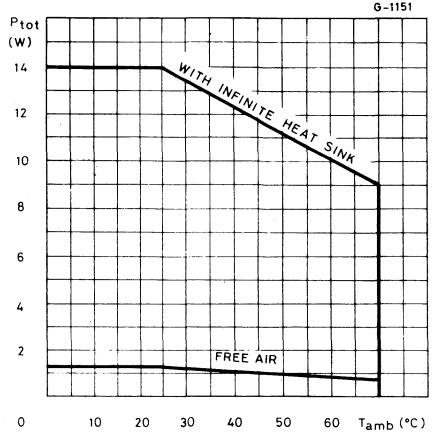
** Tantalum capacitor

TDA 1415

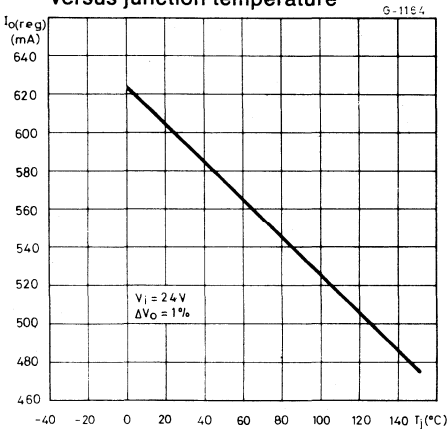
Typical output voltage versus output current



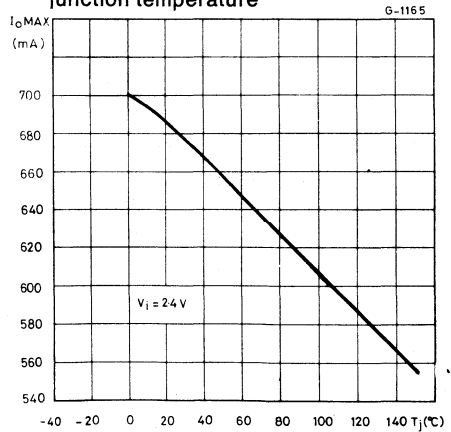
Power rating chart



Typical regulated output current versus junction temperature

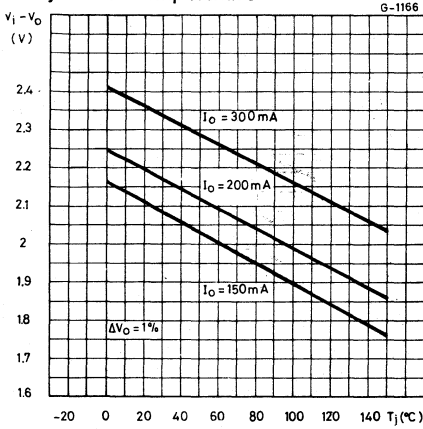


Maximum output current versus junction temperature

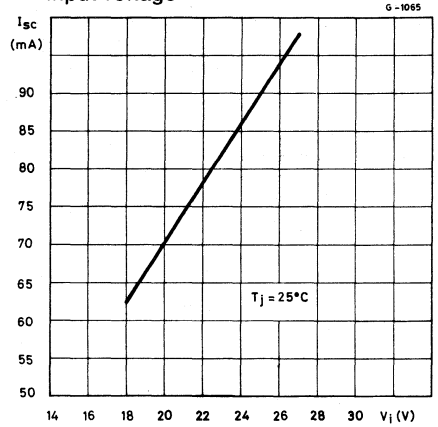


TDA 1415

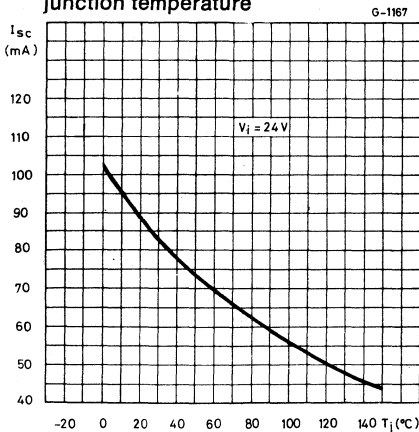
Typical dropout voltage versus junction temperature



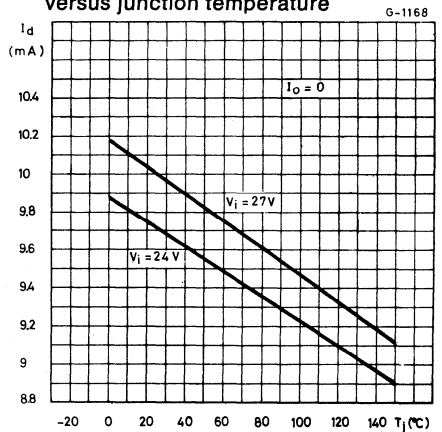
Typical short-circuit current versus input voltage



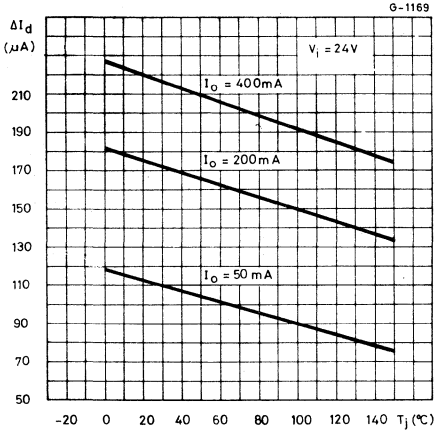
Typical short-circuit current versus junction temperature



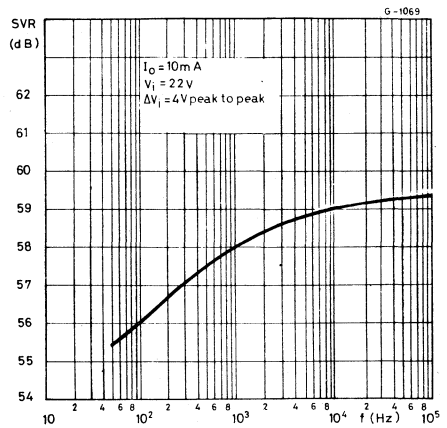
Typical quiescent drain current versus junction temperature



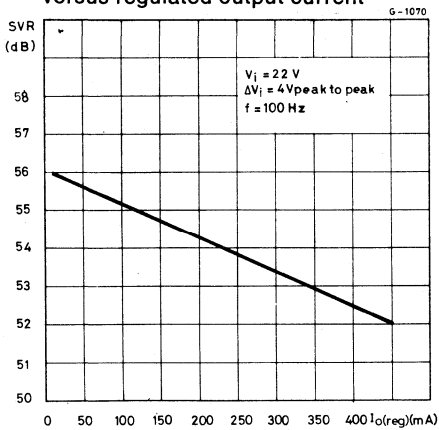
Typical quiescent drain current variation versus junction temperature



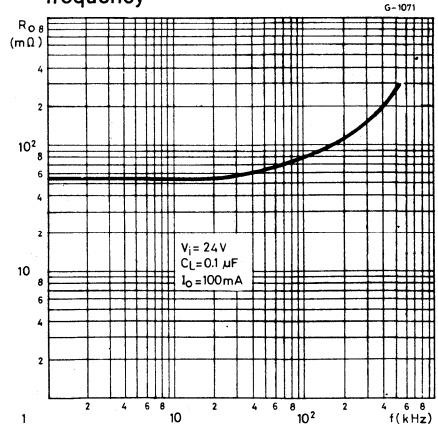
Typical supply voltage rejection versus frequency



Typical supply voltage rejection versus regulated output current

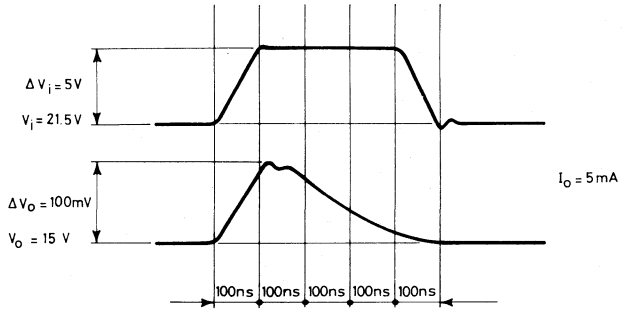


Typical output resistance versus frequency



TDA 1415

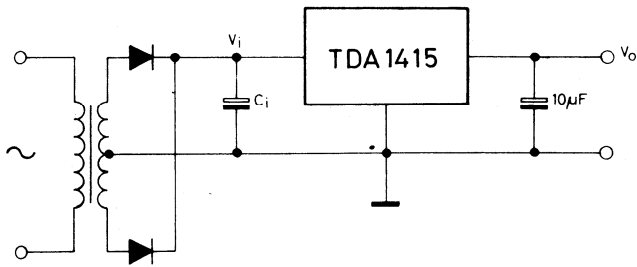
Typical line transient response



S-0412

APPLICATION INFORMATION

Typical connection circuit

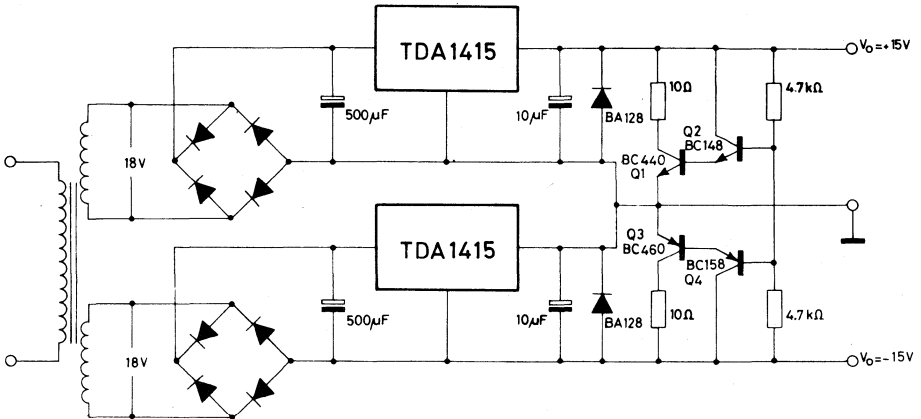


S-0531

TDA 1415

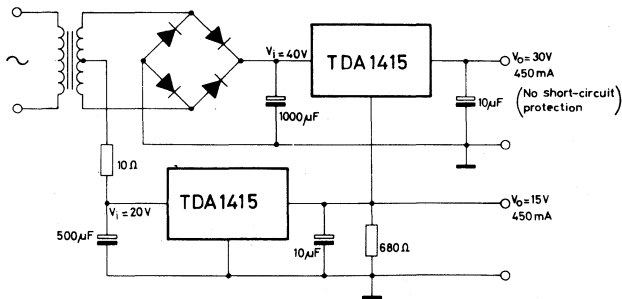
APPLICATION INFORMATION (continued)

Symmetrical ± 15 V voltage regulator circuit



S - 0532

Series regulators circuit connection



S-0533

TDA 1415

APPLICATION INFORMATION (continued)

Low consumption circuit to increase output voltage

$$V_o = V_1 \left(1 + \frac{R_2}{R_1}\right) + V_{BE} \left(1 + \frac{R_2}{R_1}\right) + \frac{I_d}{h_{FEQ1}} \cdot R_2$$

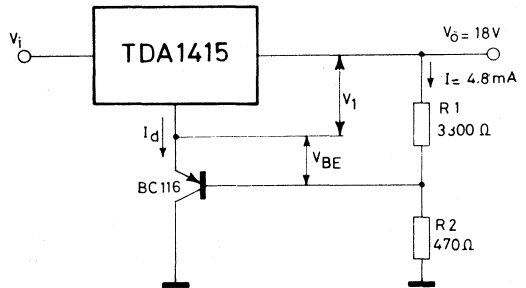
$$I_d = 10 \text{ mA}$$

$$V_i = 25 \text{ V}$$

$$\frac{\delta I_d}{\delta T_{amb}} = -7 \text{ } \mu\text{A}/^\circ\text{C typ.}$$

$$\frac{\delta I_d}{\delta V_i} = 30 \text{ } \mu\text{A}/\text{V typ.}$$

$$\frac{\delta V_{BE}}{\delta T_{amb}} = -2 \text{ mV}/^\circ\text{C}$$



S-0534

LINEAR INTEGRATED CIRCUIT

PRELIMINARY DATA

MONOLITHIC QUASI-COMPLEMENTARY DUAL DARLINGTON IN PENTAWATT® PACKAGE

The TDA 1420 is a monolithic integrated circuit in Pentawatt® plastic package consisting of a pair of quasi-complementary (NPN-PNP) darlington transistors with the associated biasing system. Each darlington can deliver a current in excess of 3A and can withstand a supply voltage of 44V. The device is intended for applications as:

- booster for operational amplifier
- DC motor driver
- stepping motor driver
- output stage for AC power amplifier up to 20W in Hi-Fi systems
- output stage for vertical deflection systems in colour TV etc.

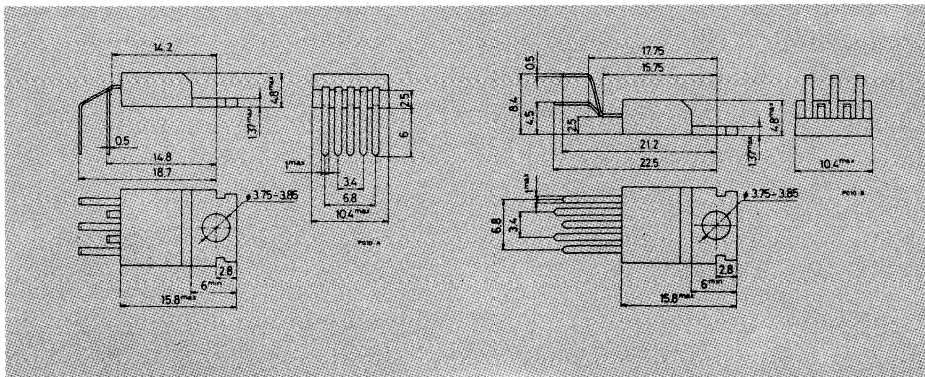
ABSOLUTE MAXIMUM RATINGS

V_{CEO}	Collector-emitter voltage ($I_B = 0$)	44	V
V_{CBO}	Collector-base voltage ($I_E = 0$)	55	V
I_o	Output peak current (repetitive)	3.5	A
I_o	DC output current	3	A
$I_{F D1}$	D1 forward current	0.3	A
$I_{F D2}$	D2 forward current	3	A
P_{tot}	Total power dissipation at $T_{case} = 60^\circ C$	30	W
T_j, T_{stg}	Junction and storage temperature	-40 to 150	$^\circ C$

ORDERING NUMBERS: TDA 1420 H
TDA 1420 V

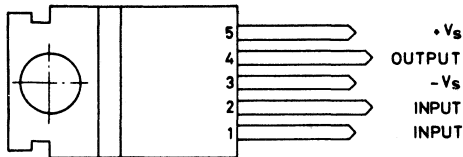
MECHANICAL DATA

Dimensions in mm

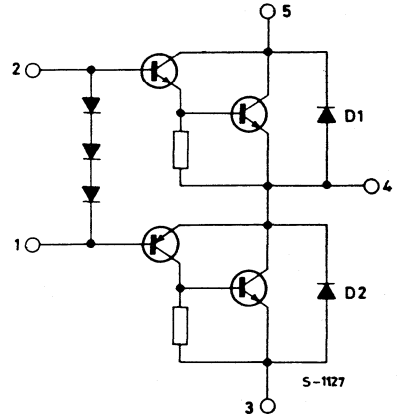


TDA 1420

CONNECTION AND SCHEMATIC DIAGRAMS



S-1128



THERMAL DATA

$R_{th\ j-case}$ Thermal resistance junction-case	max.	3 °C/W
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ELECTRICAL CHARACTERISTICS ($T_{amb} = 25^\circ\text{C}$)

Parameter	Test conditions	Min.	Typ.	Max.	Unit
V_{CEO} Collector-emitter breakdown voltage	$I_C = 500\ \mu\text{A}$	44			V
V_{CBO} Collector-base breakdown voltage		55			V
$V_{(BR)CSSO}$ Collector-substrate breakdown voltage		60			V
$h_{FE(NPN)}$ DC forward current transfer ratio	$I_C = 3\text{A}$ $V_{CE} = 5\text{V}$	1000	2500		—
$h_{FE(PNP)}$ DC forward current transfer ratio	$I_C = -3\text{A}$ $V_{CE} = -5\text{V}$	500	1000		—

ELECTRICAL CHARACTERISTICS (continued)

Parameter		Test conditions	Min. Typ. Max.	Unit
I_d	Quiescent drain current	$I_{2-1} = 5 \text{ mA}$ $V_s = 40 \text{ V}$	20	mA
$V_{CE(sat)}$	Collector-emitter saturation voltage (NPN-PNP)	$I_C = 3 \text{ A} $ $h_{FE} = 200$	2.3 2.7	V
$V_{BE(NPN)}$	Base-emitter voltage (pins 2-4)	$I_C = 3 \text{ A}$	2.5	V
$V_{BE(PNP)}$	Base-emitter voltage (pins 1-4)	$I_C = -3 \text{ A}$	-1.2	V
$V_{F(D1)}$	D1 forward voltage	$V_{3-5} = -40 \text{ V}$ $I_{F(D1)} = 0.3 \text{ A}$	1.7	V
$V_{F(D2)}$	D2 forward voltage	$I_{F(D2)} = 3 \text{ A}$	5	V
$f_{T(NPN)}$	Cutoff frequency	$I_C = 2 \text{ A}$ $V_{CE} = 10 \text{ V}$	10	MHz
$f_{T(PNP)}$	Cutoff frequency	$I_C = -2 \text{ A}$ $V_{CE} = -10 \text{ V}$	5	MHz

Fig. 1 - Typical quiescent drain current vs. I_{2-1}

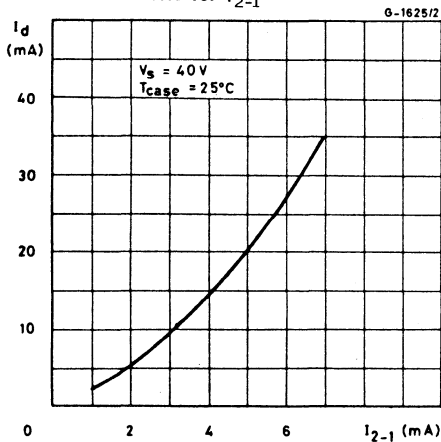
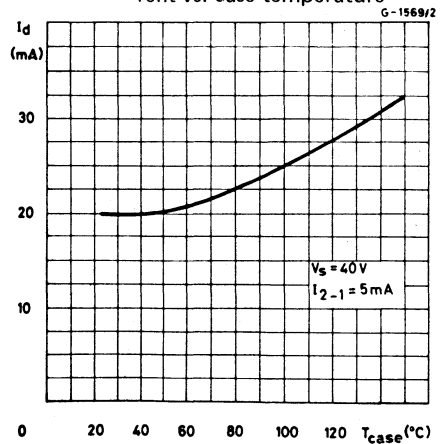


Fig. 2 - Typical quiescent drain current vs. case temperature



TDA 1420

Fig. 3 - Typical quiescent drain current vs. supply voltage

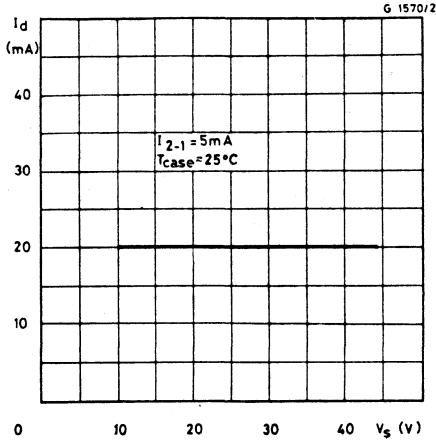


Fig. 4 - Typical DC current gain vs. collector current

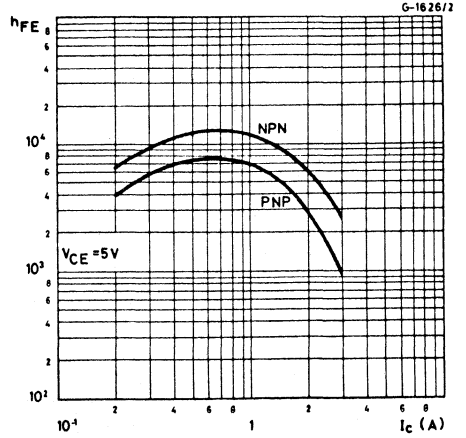


Fig. 5 - Typical $V_{CE(\text{sat})}$ vs. collector current

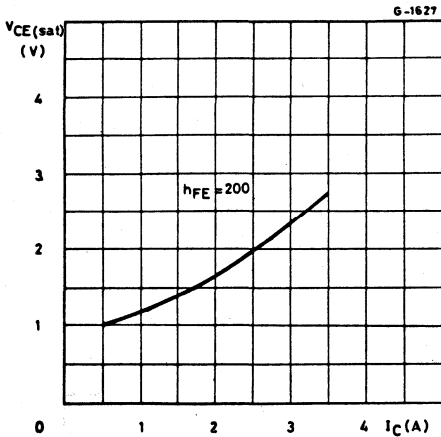


Fig. 6 - Typical V_{BE} vs. collector current

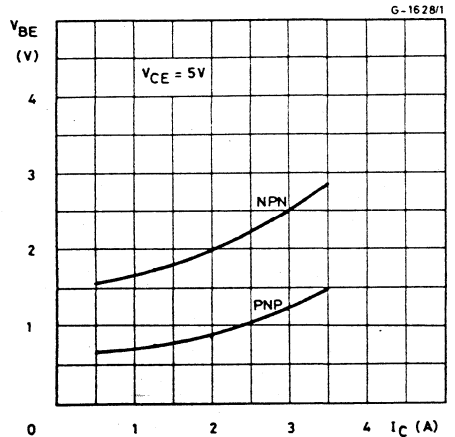


Fig. 7 - Typical pulse response (rising edge)

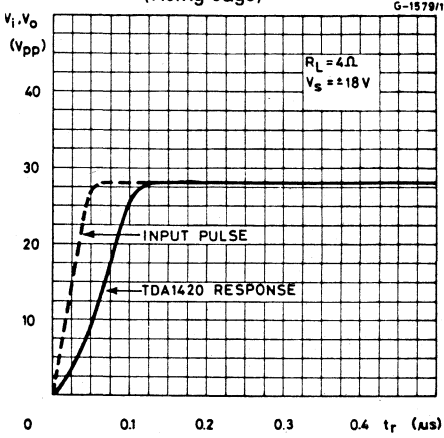


Fig. 8 - Typical pulse response (falling edge)

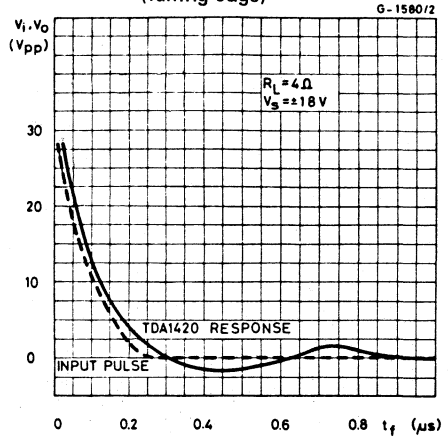


Fig. 9 - Typical output voltage swing

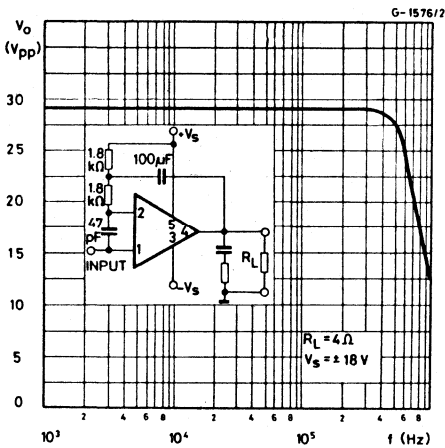
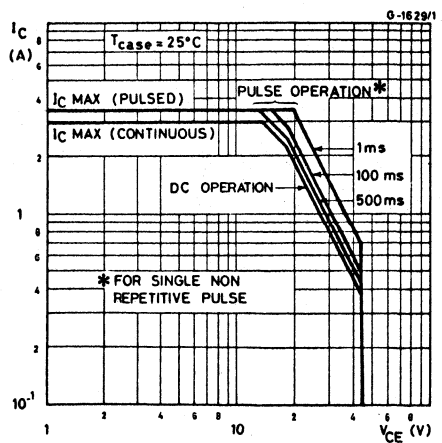


Fig. 10 - Safe operating areas



TDA 1420

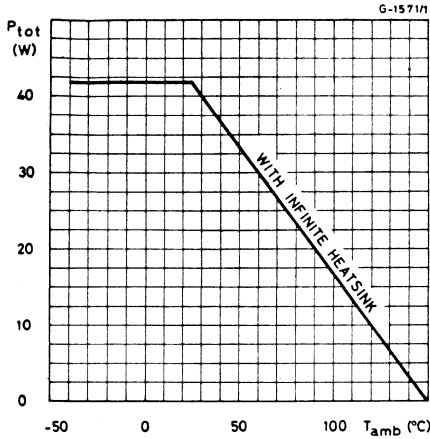
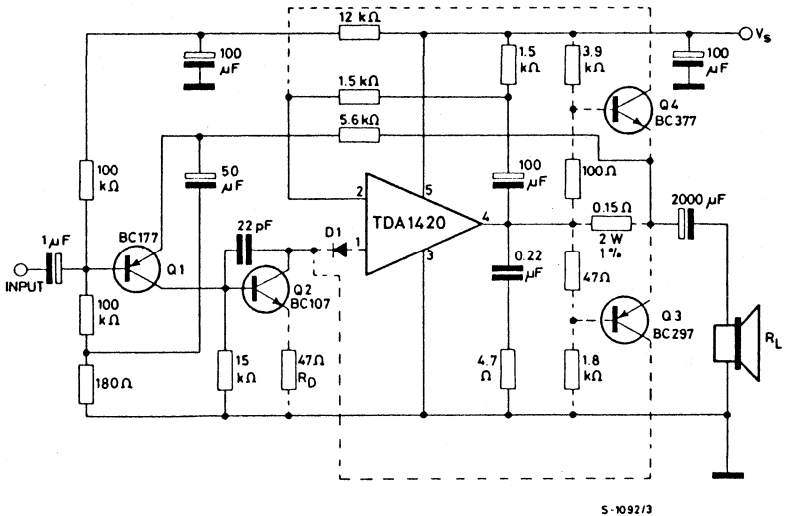


Fig. 11 - Derating characteristic

APPLICATION INFORMATION

Fig. 12- Hi-Fi audio amplifier with short circuit protection



Typical performance of circuit in fig. 12

Parameter	Test conditions	Min.	Typ.	Max.	Unit
P _o Output power	d = 1% G _v = 30 dB				
	f = 40 to 15,000 Hz				
	V _s = 34V R _L = 4Ω	20	22		W
	V _s = 36V R _L = 8Ω	15	17		W
B Frequency response (-3 dB)	d = 10% G _v = 30 dB				
	f = 1 kHz				
	V _s = 34V R _L = 4Ω		30		W
	V _s = 36V R _L = 8Ω		20		W
I _d Drain current	V _s = 34V R _L = 4Ω				
	P _o = 30W		1.3		A
	V _s = 36V R _L = 8Ω				
	P _o = 20W		720		mA

Fig. 13 - Output characteristics of the protected class B stage

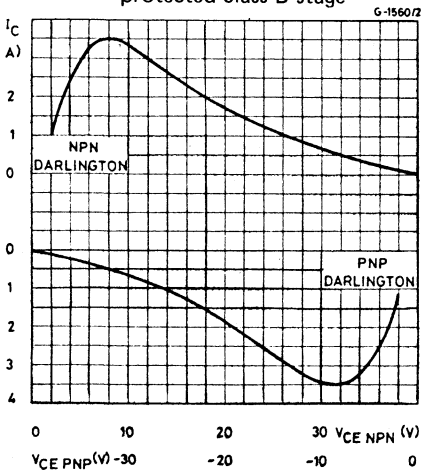
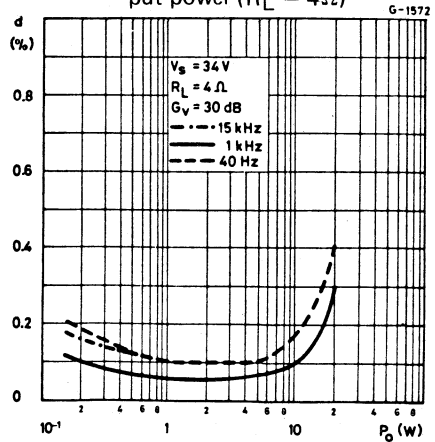


Fig. 14 - Typical distortion vs. output power ($R_L = 4\Omega$)



TDA 1420

Fig. 15 - Typical distortion vs. output power ($R_L = 4\Omega$)

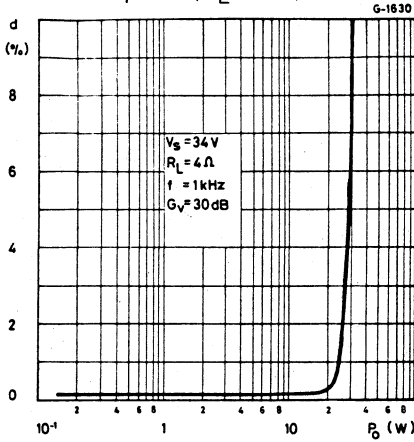


Fig. 16 - Sensitivity vs. output power ($R_L = 4\Omega$)

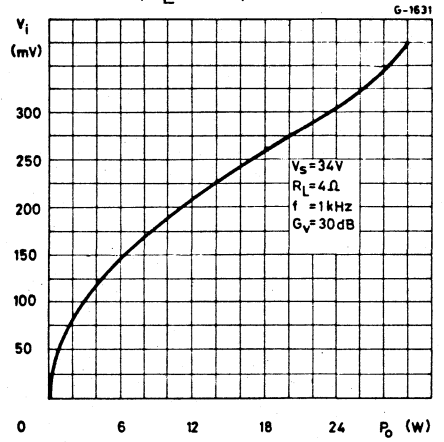


Fig. 17 - Typical power dissipation and efficiency vs. output power ($R_L = 4\Omega$)

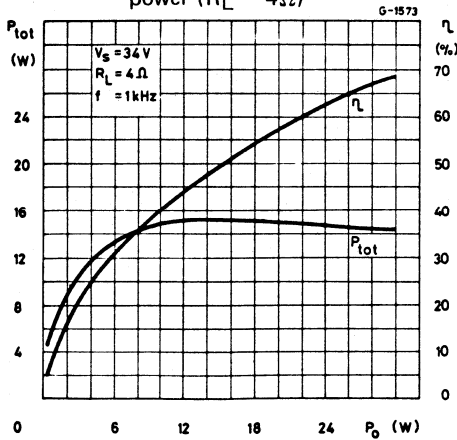


Fig. 18 - Typical distortion vs. output power ($R_L = 8\Omega$)

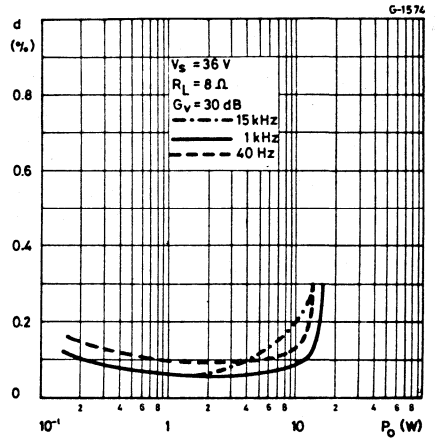


Fig. 19 - Typical distortion vs. output power ($R_L = 8\Omega$)

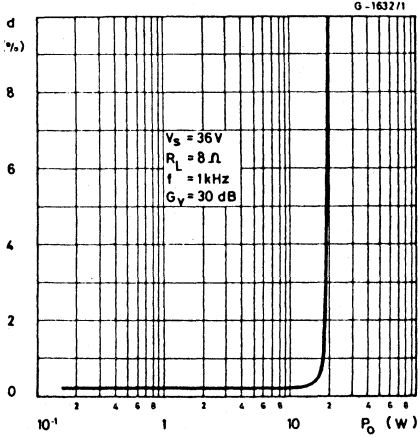


Fig. 20 - Typical sensitivity vs. output power ($R_L = 8\Omega$)

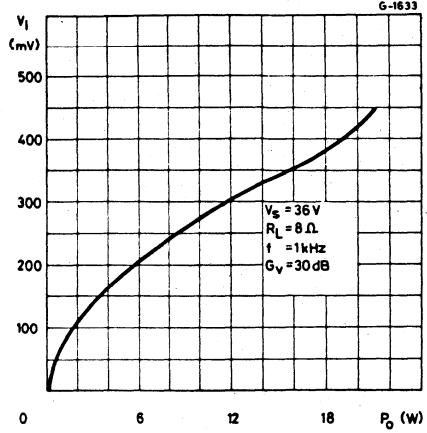


Fig. 21 - Typical power dissipation and efficiency vs. output power ($R_L = 8\Omega$)

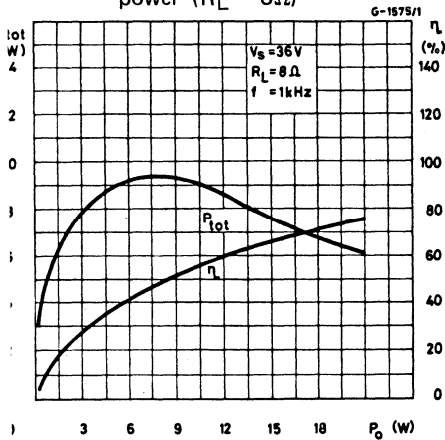


Fig. 22 - Typical output power vs. supply voltage

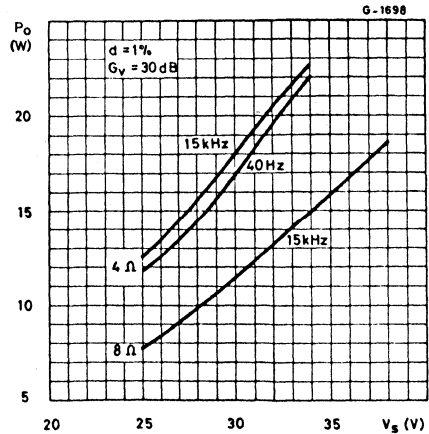


Fig. 25 - L 141 + TDA 1420 output voltage swing vs. frequency

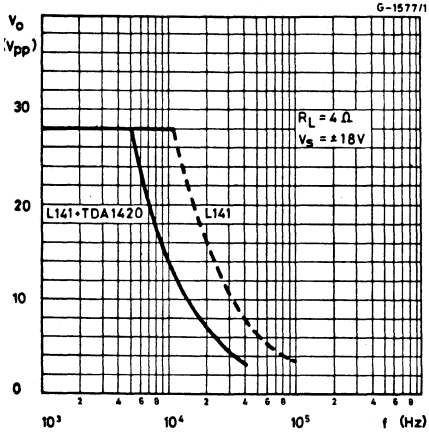
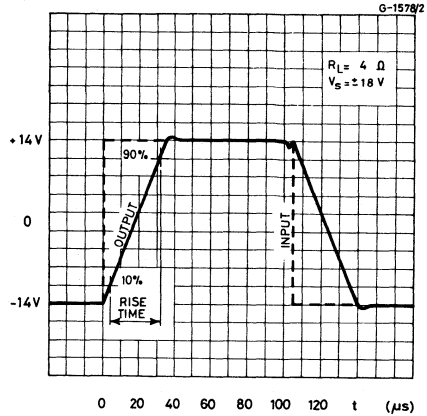


Fig. 26 - L 141 + TDA 1420 transient response



performance of circuit in fig. 24

L 141 + TDA 1420	
Max. supply voltage	$\pm 22V$
Max. power dissipation	30W at $T_{case} = 60^\circ C$
Input offset voltage	$\leq 5 mV$
Input offset current	$\leq 200 nA$
Input bias current	$\leq 500 nA$
Voltage gain	$\geq 86 dB (R_L = 4\Omega)$
Max. DC output current	3A

TDA 1420

Fig. 27 - Position control of DC motor

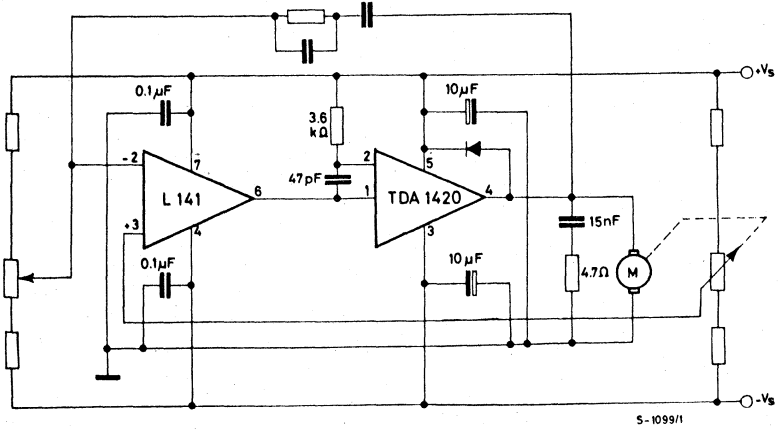


Fig. 28 - Stepping motor driver

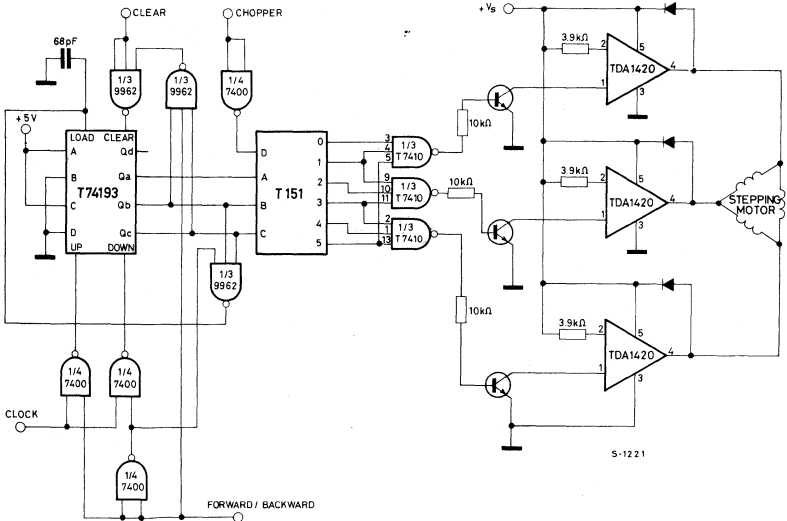


Fig. 29 - Bidirectional speed control of DC motor

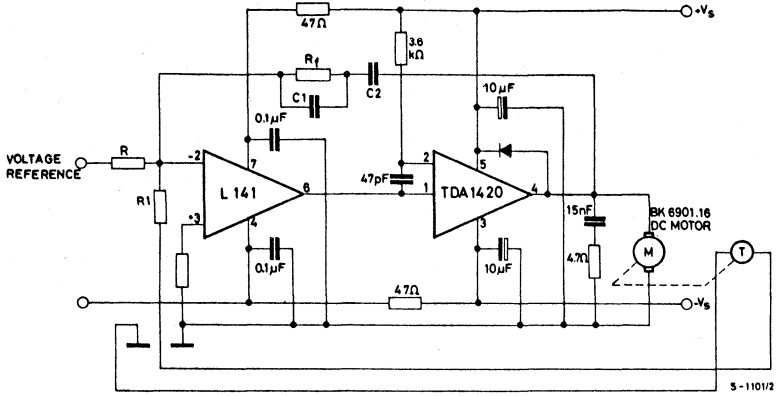
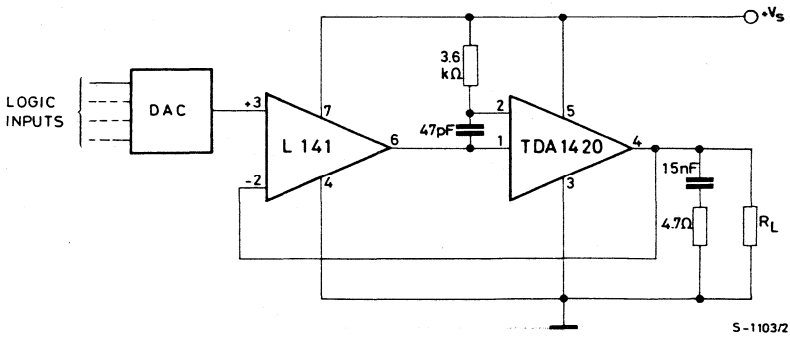


Fig. 30 - Programmable supply voltage



LINEAR INTEGRATED CIRCUIT

PRELIMINARY DATA

12 W Hi-Fi AUDIO POWER AMPLIFIER WITH SHORT CIRCUIT PROTECTION AND THERMAL SHUT-DOWN

The TDA 2010 is a monolithic integrated operational amplifier in a 14-lead quad in-line* plastic package, intended for use as a low frequency class B power amplifier. Typically it provides 12 W output power ($d = 1\%$) at $\pm 14 \text{ V}/4 \Omega$; at $V_s = \pm 14 \text{ V}$ the guaranteed output power is 10 W on a 4Ω load and 8 W on a 8Ω load (DIN norm 45500). The TDA 2010 provides high output current (up to 3.5 A) and has very low harmonic and cross-over distortion. Further, the device incorporates an original (and patented) short circuit protection system, comprising an arrangement for automatically limiting the dissipated power so as to keep the working point of the output transistors within their safe operating area. A conventional thermal shut-down system is also included. The TDA 2010 is pin to pin equivalent to TDA 2020.

*(or, optionally, dual in-line)

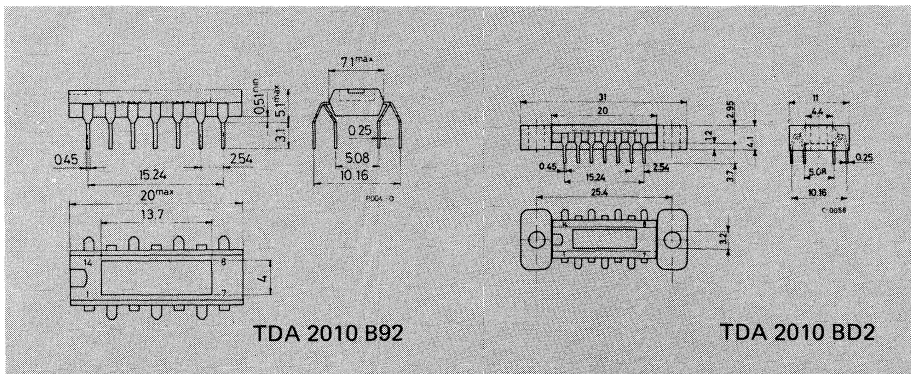
ABSOLUTE MAXIMUM RATINGS

V_s	Supply voltage	± 18	V
V_i	Input voltage	V_s	
V_{iD}	Differential input voltage	± 15	V
I_o	Output peak current (internally limited)	3.5	A
P_{tot}	Power dissipation at $T_{case} \leq 95 \text{ }^\circ\text{C}$	18	W
T_{stg}, T_j	Storage and junction temperature	-40 to 150	$^\circ\text{C}$

ORDERING NUMBERS: TDA 2010 B82 dual in-line plastic package
 TDA 2010 B92 quad in-line plastic package
 TDA 2010 BC2 dual in-line plastic package with spacer
 TDA 2010 BD2 quad in-line plastic package with spacer

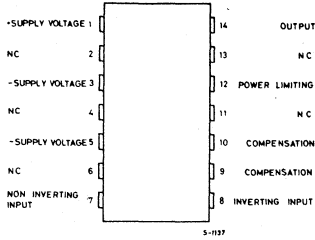
MECHANICAL DATA

Dimensions in mm

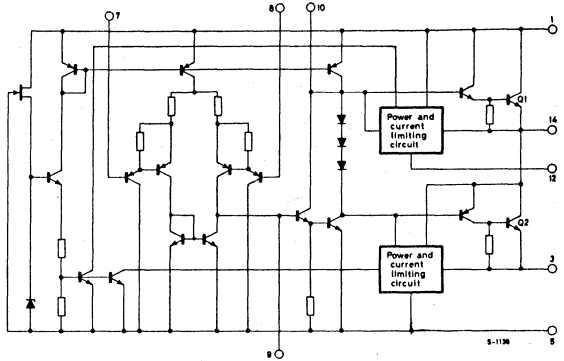


TDA 2010

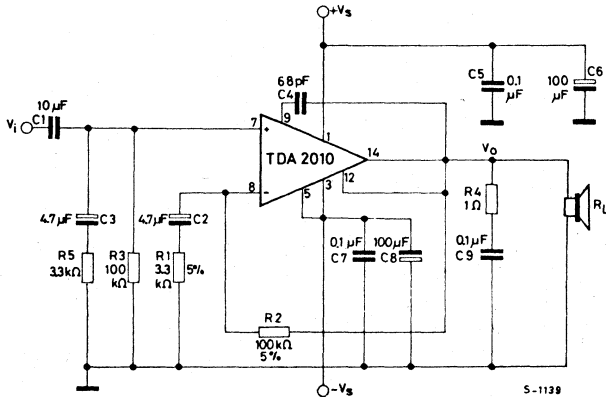
CONNECTION AND SCHEMATIC DIAGRAMS



The copper slug is electrically connected to pin 5 (substrate)



TEST CIRCUIT



THERMAL DATA

$R_{th\ j-case}$ Thermal resistance junction-case

max 3 °C/W

ELECTRICAL CHARACTERISTICS (Refer to the test circuit, $V_s = \pm 14V$, $T_{amb} = 25^\circ C$ unless otherwise specified)

Parameter	Test conditions	Min.	Typ.	Max.	Unit
V_s Supply voltage		± 5		± 18	V
I_d Quiescent drain current	$V_s = \pm 18V$		45		mA
I_b Bias current	$V_s = \pm 17V$		0.15		μA
$V_{i (off)}$ Input offset voltage			5		mV
$I_{i (off)}$ Input offset current			0.05		μA
$V_{o (off)}$ Output offset voltage			10	100	mV
P_o Output power	$d = 1\%$ $G_v = 30 \text{ dB}$ $T_{case} \leq 70^\circ C$ $f = 40 \text{ to } 15,000 \text{ Hz}$ $R_L = 4 \Omega$ $R_L = 8 \Omega$	10	12		W
	$d = 10\%$ $G_v = 30 \text{ dB}$ $T_{case} \leq 70^\circ C$ $f = 1 \text{ kHz}$ $R_L = 4 \Omega$ $R_L = 8 \Omega$	8	9		W
V_i Input sensitivity	$G_v = 30 \text{ dB}$ $f = 1 \text{ kHz}$ $P_o = 10 \text{ W}$ $R_L = 4 \Omega$ $P_o = 8 \text{ W}$ $R_L = 8 \Omega$		220		mV
			250		mV
B Frequency response(-3 dB)	$R_L = 4 \Omega$ $C4 = 68 \text{ pF}$	10 to 160,000			Hz
d Distortion	$P_o = 100 \text{ mW to } 10 \text{ W}$ $R_L = 4 \Omega$ $G_v = 30 \text{ dB}$ $T_{case} \leq 70^\circ C$ $f = 1 \text{ kHz}$ $f = 40 \text{ to } 15,000 \text{ Hz}$		0.1		%
	$P_o = 100 \text{ mW to } 8 \text{ W}$ $R_L = 8 \Omega$ $G_v = 30 \text{ dB}$ $T_{case} \leq 70^\circ C$ $f = 1 \text{ kHz}$ $f = 40 \text{ to } 15,000 \text{ Hz}$		0.3	1	%
d Distortion	$P_o = 100 \text{ mW to } 8 \text{ W}$ $R_L = 8 \Omega$ $G_v = 30 \text{ dB}$ $T_{case} \leq 70^\circ C$ $f = 1 \text{ kHz}$ $f = 40 \text{ to } 15,000 \text{ Hz}$		0.1		%
			0.2	1	%

ELECTRICAL CHARACTERISTICS (continued)

Parameter		Test conditions	Min. Typ. Max.	Unit
R_i	Input resistance (pin 7)		5	$M\Omega$
G_v	Voltage gain (open loop)	$R_L = 4\Omega$ $f = 1\text{ kHz}$	100	dB
G_v	Voltage gain (closed loop)		29.5 30 30.5	dB
e_N	Input noise voltage	$R_L = 4\Omega$	4	μV
i_N	Input noise current	$B(-3\text{ dB}) = 10\text{ to }20,000\text{ Hz}$	0.1	nA
SVR	Supply voltage rejection ratio	$R_L = 4\Omega$ $G_v = 30\text{ dB}$ $f_{\text{ripple}} = 100\text{ Hz}$	50	dB
I_d	Drain current	$P_o = 12\text{ W}$ $R_L = 4\Omega$	0.8	A
		$P_o = 9\text{ W}$ $R_L = 8\Omega$	0.5	A
Thermal shut-down junction temperature			145	$^{\circ}\text{C}$
* Thermal shut-down case temperature		$P_{\text{tot}} = 10.5\text{ W}$	120	$^{\circ}\text{C}$

* See fig. 15

Fig. 1 - Typical output power vs. supply voltage ($d = 1\%$)

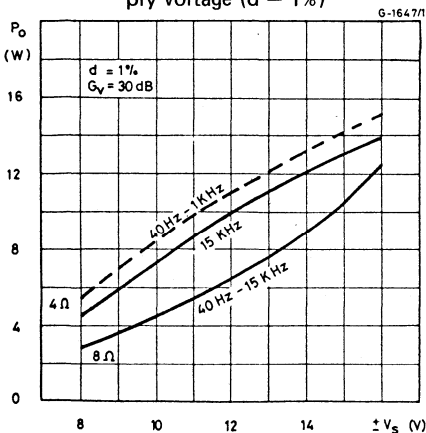


Fig. 2 - Typical output power vs. supply voltage ($d = 10\%$)

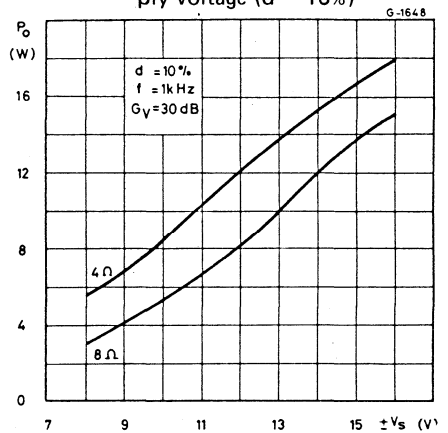


Fig. 3 - Typical distortion vs. output power ($R_L = 4 \Omega$)

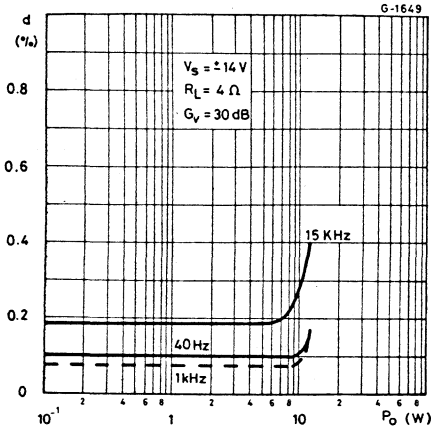


Fig. 4 - Typical distortion vs. output power ($R_L = 4 \Omega$)

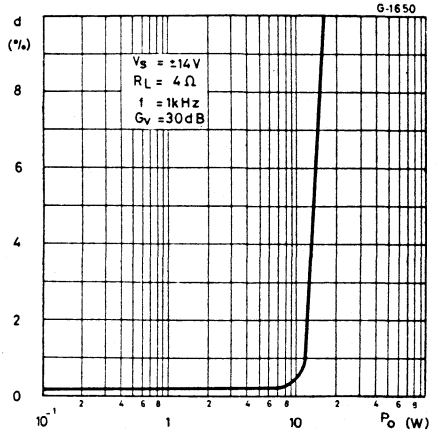


Fig. 5 - Typical distortion vs. output power ($R_L = 8 \Omega$)

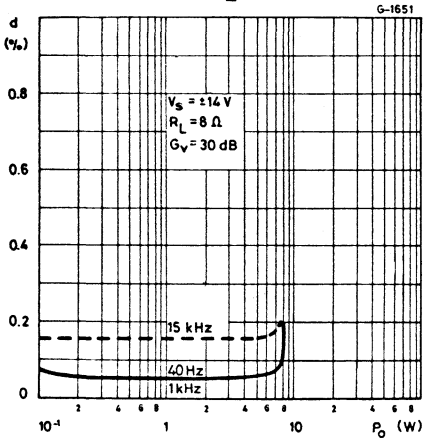


Fig. 6 - Typical distortion vs. output power ($R_L = 8 \Omega$)

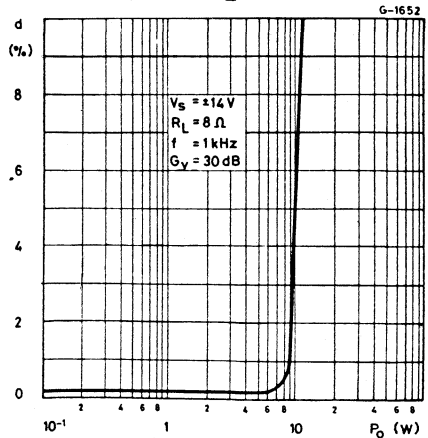


Fig. 7 - Typical distortion vs. frequency

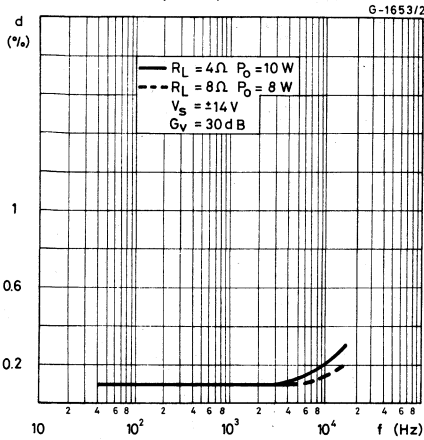


Fig. 8 - Typical output power vs. frequency

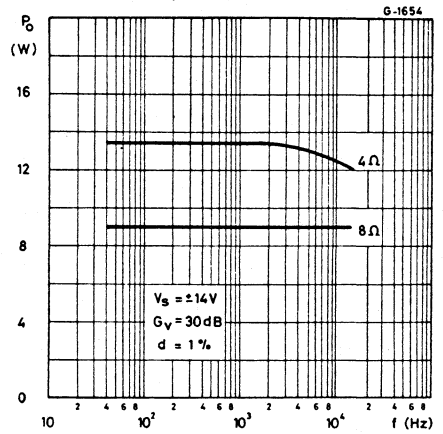


Fig. 9 - Typical sensitivity vs. output power ($R_L = 4\Omega$)

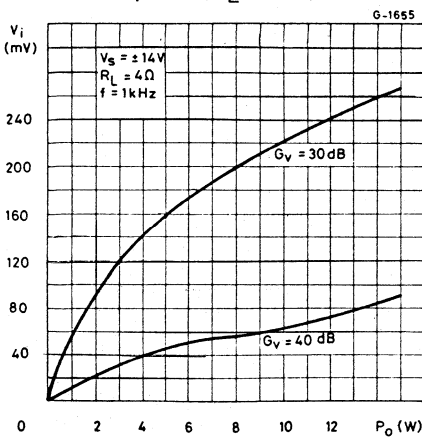


Fig. 10 - Typical sensitivity vs. output power ($R_L = 8\Omega$)

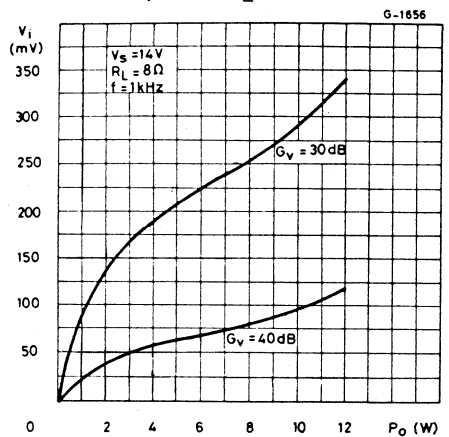


Fig. 11 - Open loop frequency response with different values of the rolloff capacitor C4

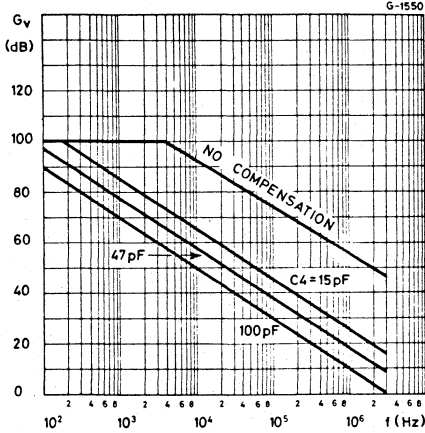


Fig. 12 - Typical value of C4 vs. voltage gain for different bandwidths

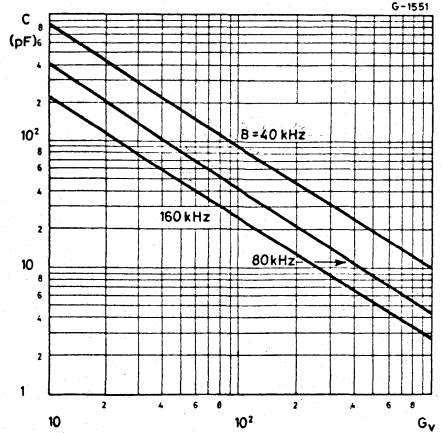


Fig. 13 - Typical quiescent current vs. supply voltage

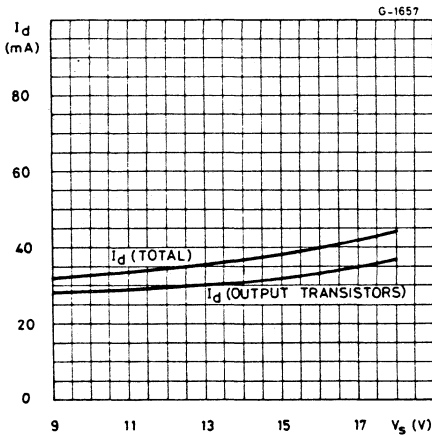


Fig. 14 - Typical supply voltage rejection ratio vs. voltage gain

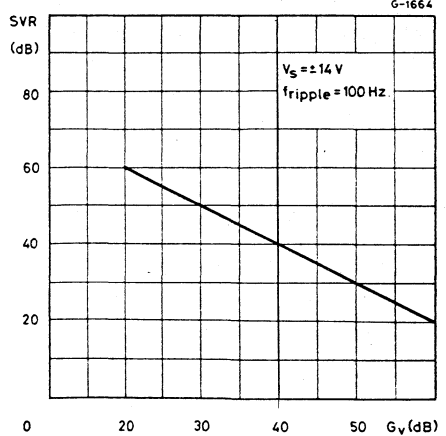


Fig. 15 - Typical power dissipation and efficiency vs. output power

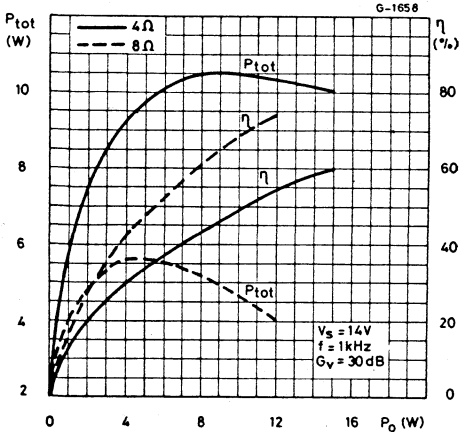
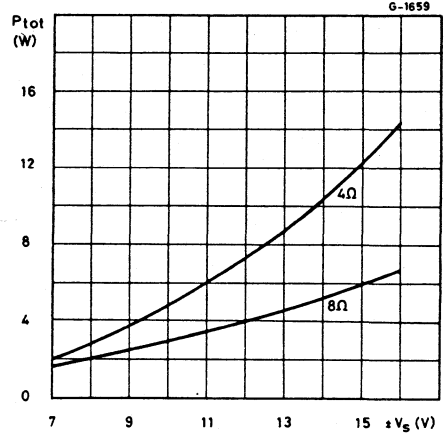
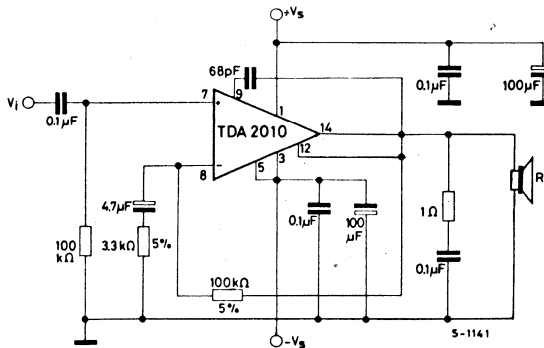


Fig. 16 - Maximum power dissipation vs. supply voltage (sine wave operation)



APPLICATION INFORMATION

Fig. 17 - Typical amplifier with split power supply



TDA 2010

Fig. 20 - Typical stereo amplifier with split power supply

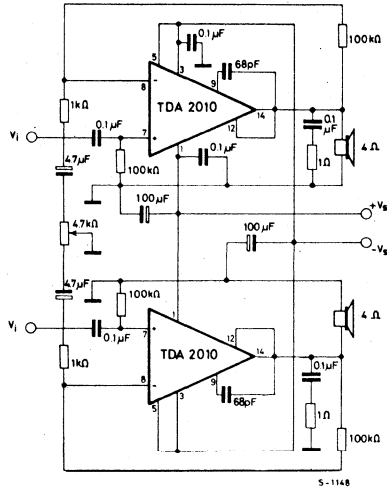
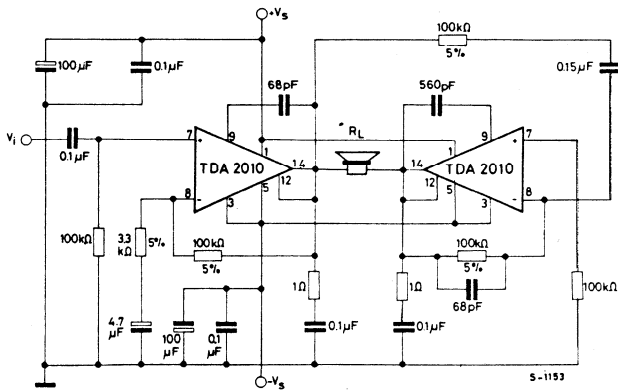


Fig. 21 - Typical bridge amplifier configuration with split power supply ($P_o = 20 W$, $V_s = \pm 13V$, $R_L = 8 \Omega$, $d \leq 1\%$)



SHORT CIRCUIT PROTECTION

The most important innovation in the TDA 2010 is an original circuit which limits the current of the output transistors. Fig. 22 shows that the maximum output current is a function of the collector-emitter voltage; hence the output transistors work within their safe operating area (fig. 23). This function can therefore be considered as being peak power limiting rather than simple current limiting. The TDA 2010 is thus protected against temporary overloads or short circuit. Should the short circuit exist for a longer time, the thermal shut-down comes into action and keeps the junction temperature within safe limits.

Fig. 22 - Maximum output current vs. voltage (V_{CE}) across each output transistor

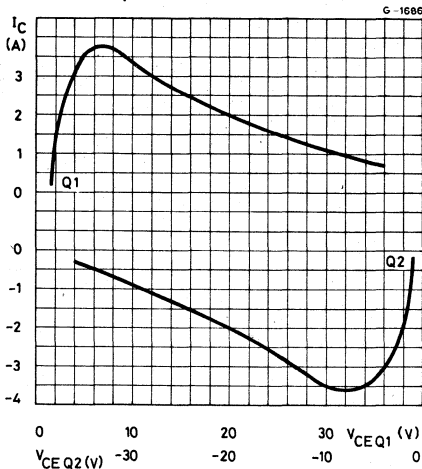
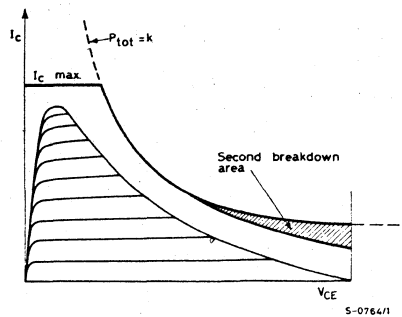


Fig. 23- Safe operating area and collector characteristics of the protected power transistor



THERMAL SHUT-DOWN

The presence of a thermal limiting circuit offers the following advantages:

- 1) an overload on the output (even if it is permanent), or an above-limit ambient temperature can be easily supported since the T_j cannot be higher than 150°C
- 2) the heatsink can have a smaller factor of safety compared with that of a conventional circuit. There is no possibility of device damage due to high junction temperature.

If, for any reason, the junction temperature increases up to 150°C , the thermal shut-down simply reduces the power dissipation and the current consumption.

Fig.24- Output power and drain current vs. case temperature ($R_L = 8\ \Omega$)

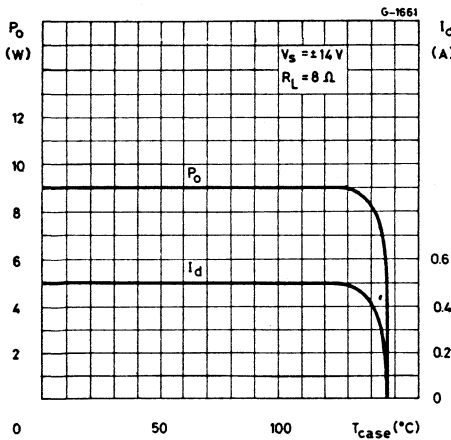
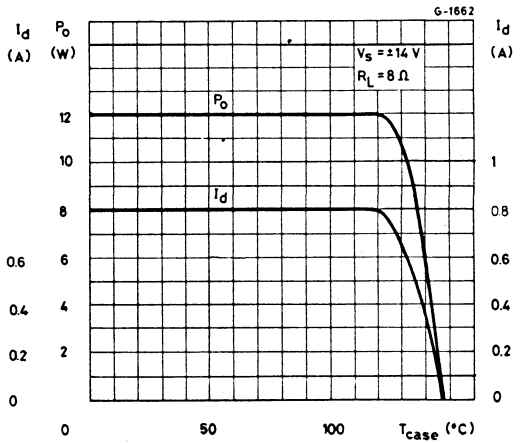


Fig.25- Output power and drain current vs. case temperature ($R_L = 4\ \Omega$)



MOUNTING INSTRUCTIONS

The power dissipated in the circuit must be removed by adding an external heatsink as shown in figs. 26 and 27.

The system for attaching the heatsink is very simple: it uses a plastic spacer which is supplied with the device.

Thermal contact between the copper slug (of the package) and the heatsink is guaranteed by the pressure which the screws exert via the spacer and the printed circuit board; this is due to the particular shape of the spacer.

Note: the most negative supply voltage is connected to the copper slug, hence to the heatsink (because it is in contact with the slug).

Fig.26 - Mounting system of TDA 2010

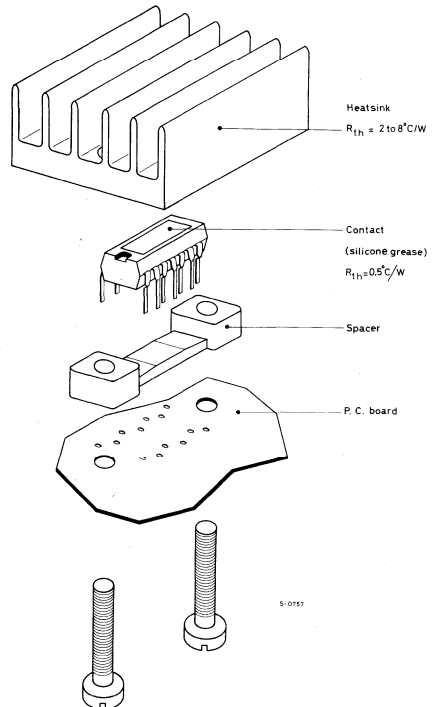
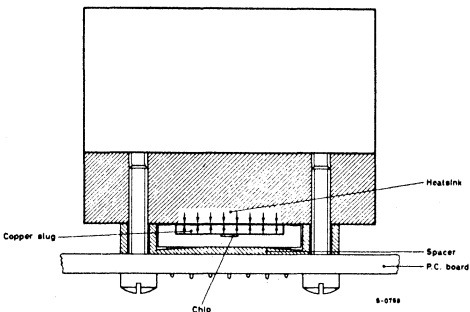
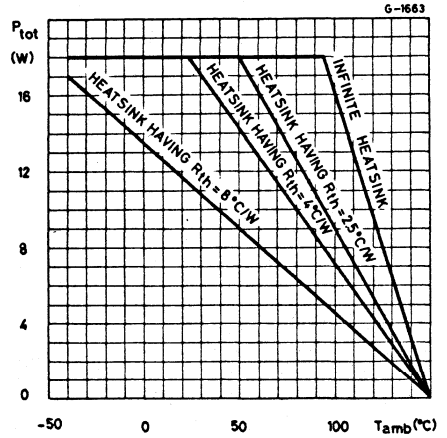


Fig.27 - Cross-section of mounting system



The maximum allowable power dissipation depends upon the size of the external heatsink (i. e. its thermal resistance); fig. 28 shows this dissippable power as a function of ambient temperature for different thermal resistance.

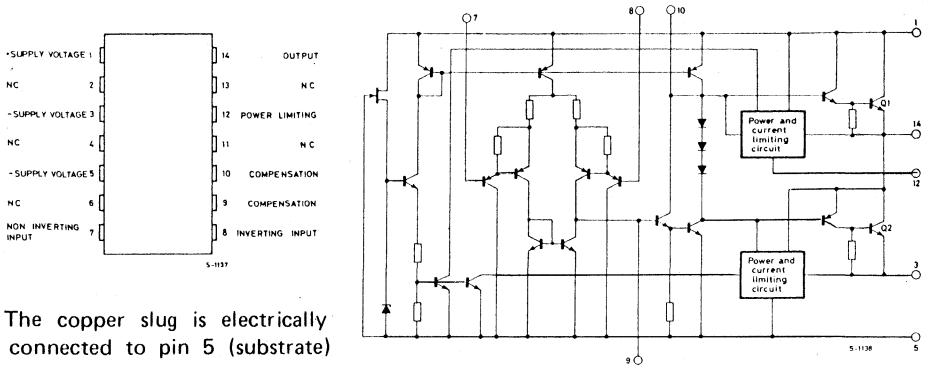
Fig.28 - Maximum allowable power dissipation vs. ambient temperature



For a more detailed description of the TDA 2010 and related performance refer to SGS-ATES Application Note n. 130.

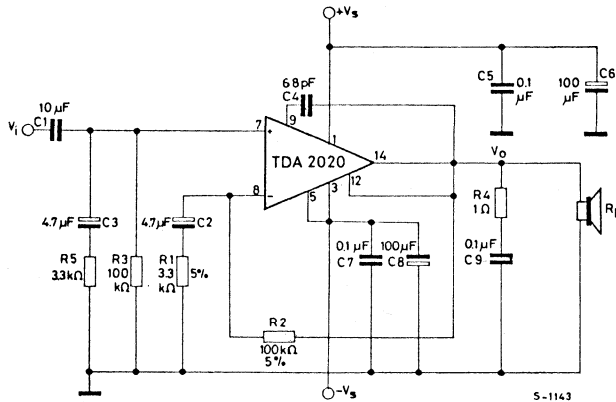
TDA 2020

CONNECTION AND SCHEMATIC DIAGRAMS



The copper slug is electrically connected to pin 5 (substrate)

TEST CIRCUIT



THERMAL DATA

$R_{th\ j\text{-case}}$	Thermal resistance junction-case	max	3	$^{\circ}\text{C/W}$
-------------------------	----------------------------------	-----	---	----------------------

ELECTRICAL CHARACTERISTICS (Refer to the test circuit, $V_s = \pm 17V$, $T_{amb} = 25^\circ C$ unless otherwise specified)

Parameter	Test conditions	Min.	Typ.	Max.	Unit
V_s Supply voltage		± 5		± 22	V
I_d Quiescent drain current	$V_s = \pm 22V$		60		mA
I_b Bias current	$V_s = \pm 17V$		0.15		μA
$V_{i(off)}$ Input offset voltage			5		mV
$I_{i(off)}$ Input offset current			0.05		μA
$V_{o(off)}$ Output offset voltage			10	100	mV
P_o Output power	$d = 1\%$ $G_v = 30 \text{ dB}$ $T_{case} \leq 70^\circ C$ $f = 40 \text{ to } 15,000 \text{ Hz}$ $V_s = \pm 17V$ $R_L = 4 \Omega$ $V_s = \pm 18V$ $R_L = 4 \Omega$ $V_s = \pm 18V$ $R_L = 8 \Omega$	15	18.5		W W W
	$d = 10\%$ $G_v = 30 \text{ dB}$ $T_{case} \leq 70^\circ C$ $f = 1 \text{ kHz}$ $V_s = \pm 17V$ $R_L = 4 \Omega$ $V_s = \pm 18V$ $R_L = 8 \Omega$		24	20	W W
V_i Input sensitivity	$G_v = 30 \text{ dB}$ $f = 1 \text{ kHz}$ $P_o = 15W$ $V_s = \pm 17V$ $R_L = 4 \Omega$ $V_s = \pm 18V$ $R_L = 8 \Omega$		260		mV mV
			380		
B Frequency response(-3 dB)	$R_L = 4 \Omega$ $C_4 = 68 \text{ pF}$		10 to 160,000		Hz
d Distortion	$P_o = 150 \text{ mW to } 15W$ $R_L = 4 \Omega$ $G_v = 30 \text{ dB}$ $T_{case} \leq 70^\circ C$ $f = 1 \text{ kHz}$ $f = 40 \text{ to } 15,000 \text{ Hz}$		0.2		%
			0.3	1	%
	$P_o = 150 \text{ mW to } 15W$ $V_s = \pm 18V$ $R_L = 8 \Omega$ $G_v = 30 \text{ dB}$ $T_{case} \leq 70^\circ C$ $f = 1 \text{ kHz}$ $f = 40 \text{ to } 15,000 \text{ Hz}$		0.1		%
			0.25		%

ELECTRICAL CHARACTERISTICS (continued)

Parameter		Test conditions	Min. Typ. Max.	Unit
R_i	Input resistance (pin 7)		5	M Ω
G_v	Voltage gain (open loop)	$R_L = 4 \Omega$ $f = 1 \text{ kHz}$	100	dB
G_v	Voltage gain (closed loop)		29.5 30 30.5	dB
e_N	Input noise voltage	$R_L = 4 \Omega$	4	μV
i_N	Input noise current	$B(-3 \text{ dB}) = 10 \text{ to } 20,000 \text{ Hz}$	0.1	nA
SVR	Supply voltage rejection ratio	$R_L = 4 \Omega$ $G_v = 30 \text{ dB}$ $f_{\text{ripple}} = 100 \text{ Hz}$	50	dB
I_d	Drain current	$P_o = 18.5\text{W}$ $R_L = 4 \Omega$	1	A
		$P_o = 16.5\text{W}$ $V_s = \pm 18\text{V}$ $R_L = 8 \Omega$	0.7	A
Thermal shut-down junction temperature			145	$^{\circ}\text{C}$
* Thermal shut-down case temperature		$P_{\text{tot}} = 15.5\text{W}$	105	$^{\circ}\text{C}$

* See fig. 15

Fig. 1 - Typical output power vs. supply voltage ($d = 1\%$)

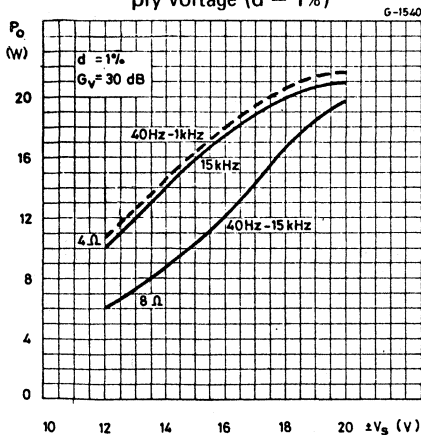


Fig. 2 - Typical output power vs. supply voltage ($d = 10\%$)

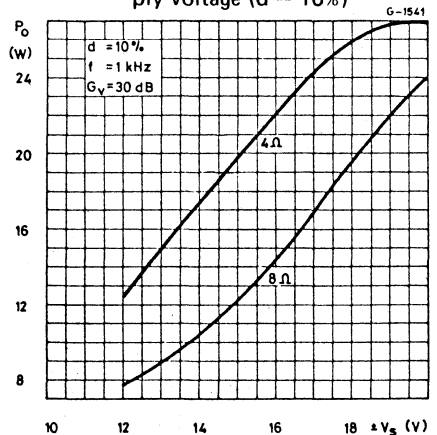


Fig. 3 - Typical distortion vs. output power ($R_L = 4 \Omega$)

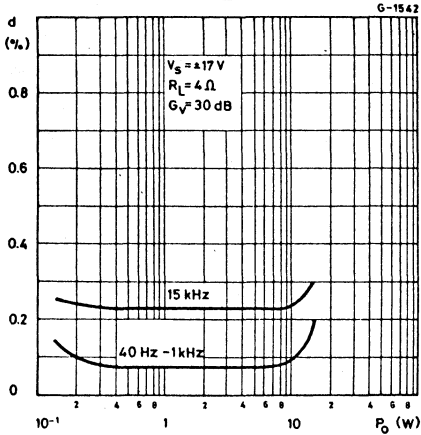


Fig. 4 - Typical distortion vs. output power ($R_L = 4 \Omega$)

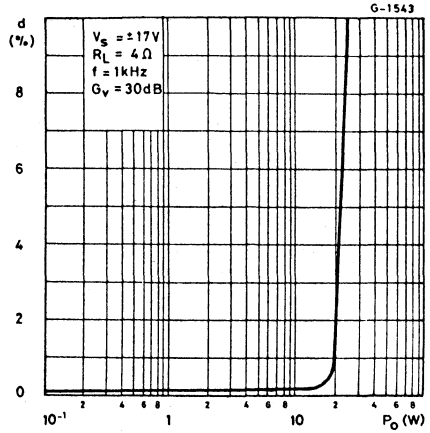


Fig. 5 - Typical distortion vs. output power ($R_L = 8 \Omega$)

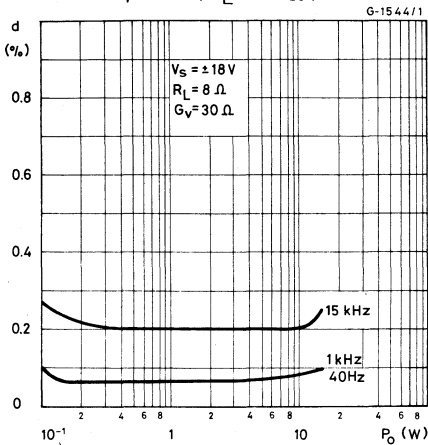


Fig. 6 - Typical distortion vs. output power ($R_L = 8 \Omega$)

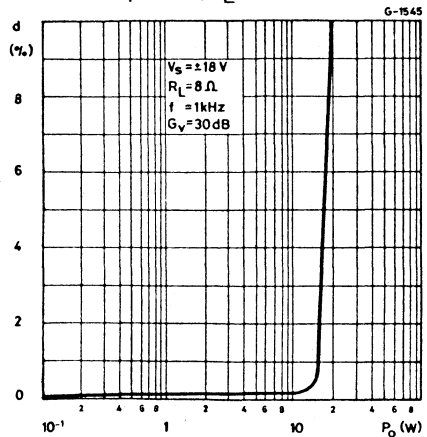


Fig. 7 - Typical distortion vs. frequency

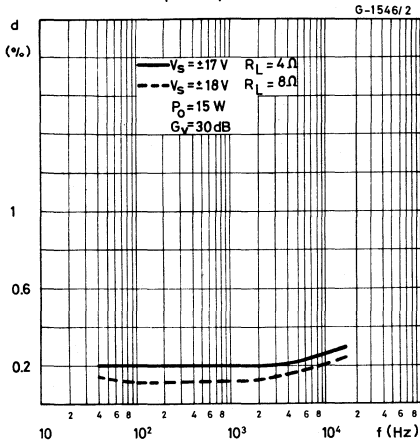


Fig. 8 - Typical output power vs. frequency

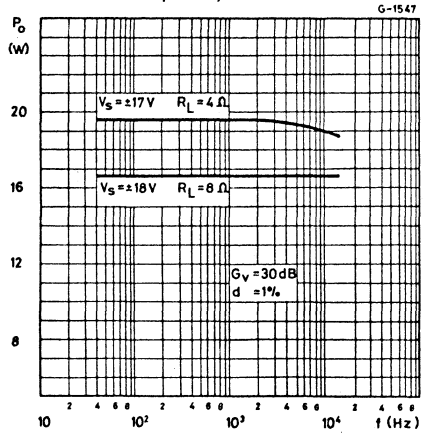


Fig. 9 - Typical sensitivity vs. output power ($R_L = 4\Omega$)

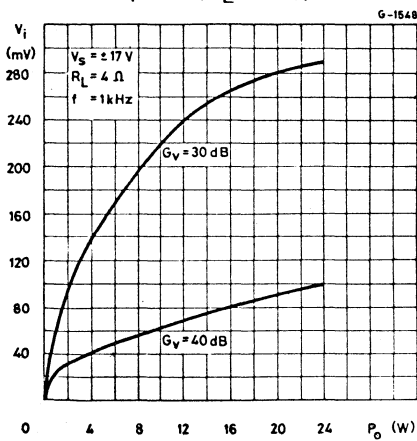


Fig. 10 - Typical sensitivity vs. output power ($R_L = 8\Omega$)

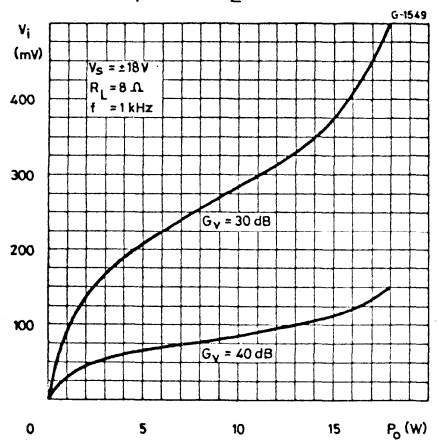


Fig. 11 - Open loop frequency response with different values of the rolloff capacitor C4

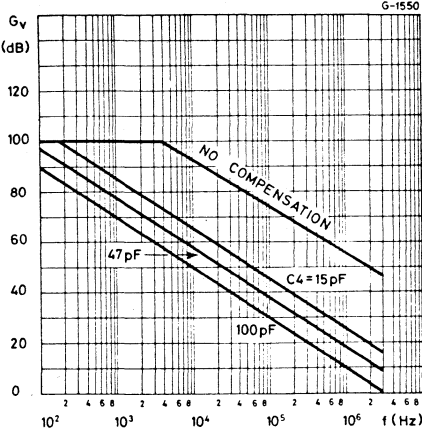


Fig. 12 - Typical value of C4 vs. voltage gain for different bandwidths

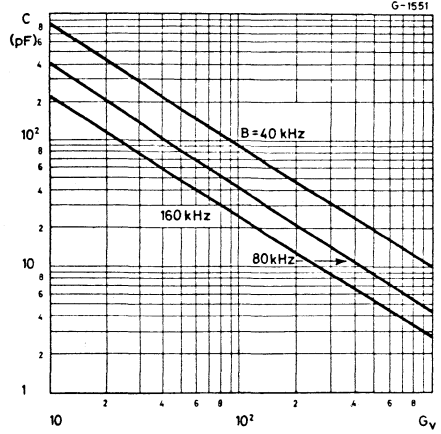


Fig. 13 - Typical quiescent current vs. supply voltage

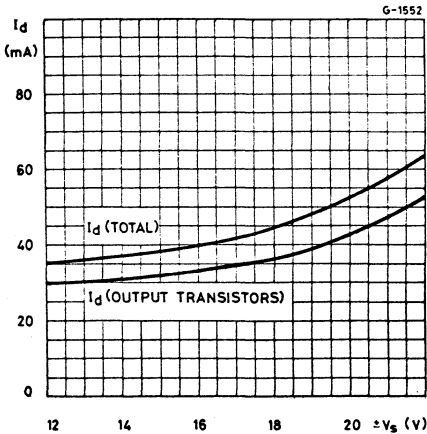
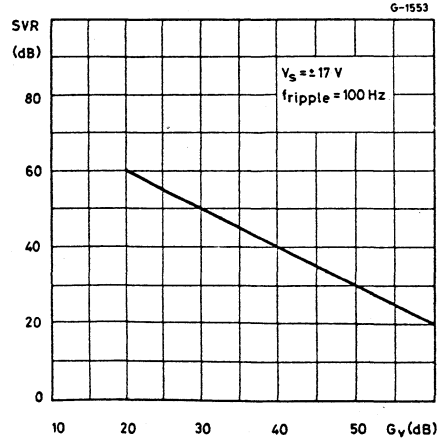


Fig. 14 - Typical supply voltage rejection ratio vs. voltage gain



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Fig. 15 - Typical power dissipation and efficiency vs. output power

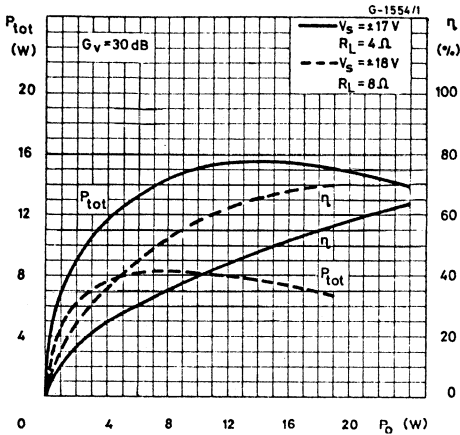
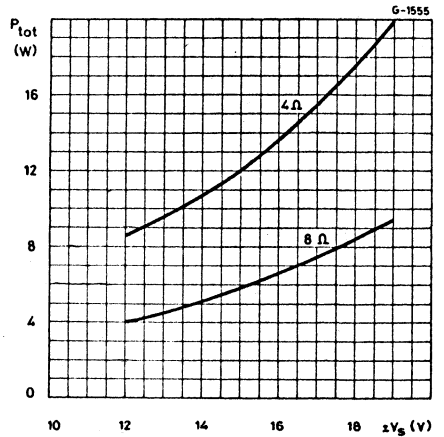


Fig. 16 - Maximum power dissipation vs. supply voltage (sine wave operation)



APPLICATION INFORMATION

Fig. 17 - Typical amplifier with split power supply

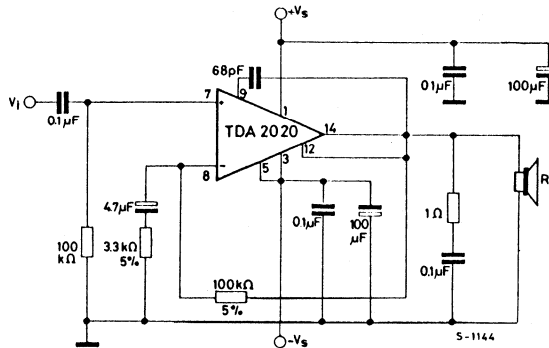


Fig. 18 - P.C. board and component layout for the circuit of fig. 17 (1:1 scale)

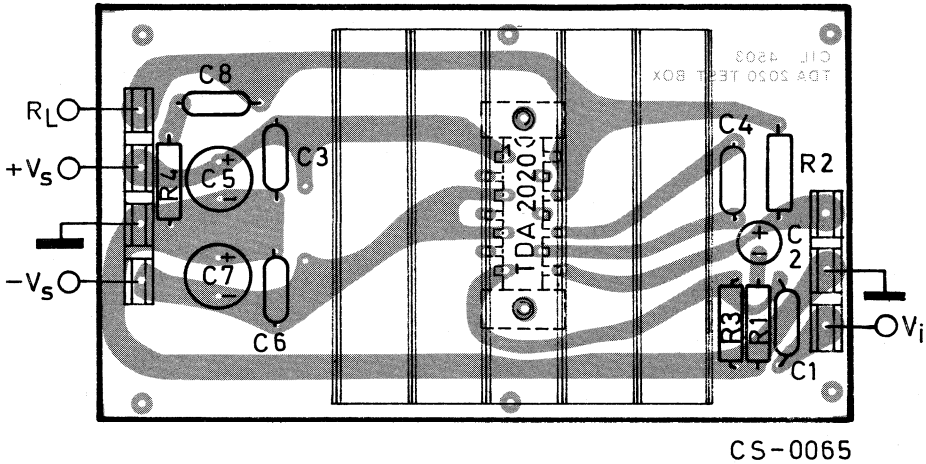
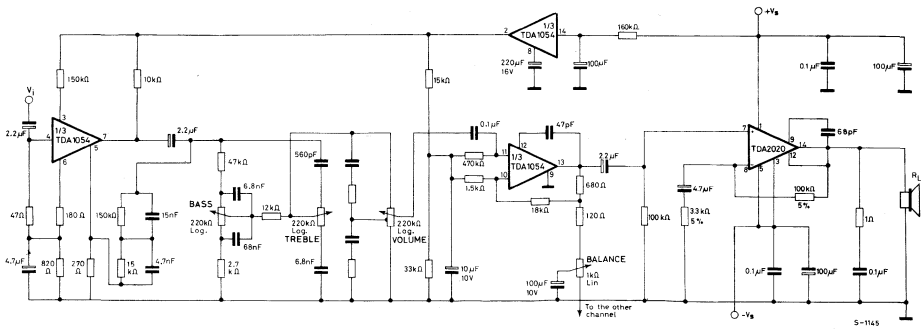


Fig. 19 - 15 W Hi-Fi stereo amplifier with preamplifier-equalizer for magnetic pick-ups



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Fig. 20 - Typical stereo amplifier with split power supply

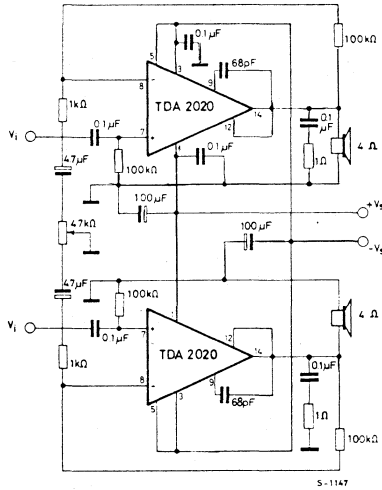
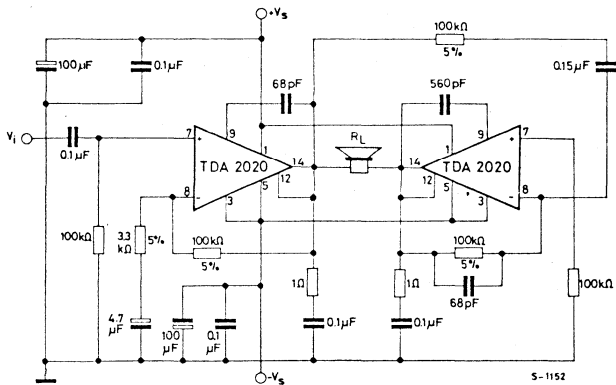


Fig. 21 - Typical bridge amplifier configuration with split power supply ($R_L = 8 \Omega$ $d \leq 1\%$; $P_O = 20 W$ @ $V_S = \pm 14 V$ and $P_O = 30 W$ @ $V_S = \pm 17 V$)



SHORT CIRCUIT PROTECTION

The most important innovation in the TDA 2020 is an original circuit which limits the current of the output transistors. Fig. 22 shows that the maximum output current is a function of the collector-emitter voltage; hence the output transistors work within their safe operating area (fig. 23). This function can therefore be considered as being peak power limiting rather than simple current limiting. The TDA 2020 is thus protected against temporary overloads or short circuit. Should the short circuit exists for a longer time, the thermal shut-down comes into action and keeps the junction temperature within safe limits.

Fig. 22 - Maximum output current vs. voltage (V_{CE}) across each output transistor

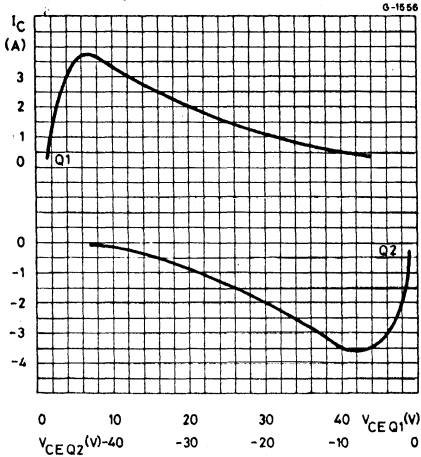
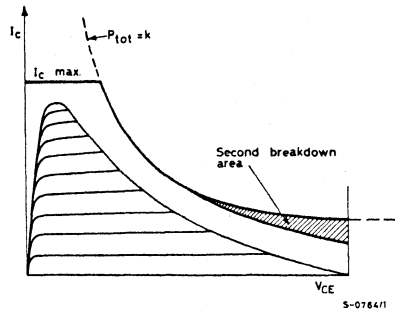


Fig. 23- Safe operating area and collector characteristics of the protected power transistor



THERMAL SHUT-DOWN

The presence of a thermal limiting circuit offers the following advantages:

- 1) an overload on the output (even if it is permanent), or an above-limit ambient temperature can be easily supported since the T_j cannot be higher than 150°C
- 2) the heatsink can have a smaller factor of safety compared with that of a conventional circuit. There is no possibility of device damage due to high junction temperature.

If, for any reason, the junction temperature increases up to 150°C , the thermal shut-down simply reduces the power dissipation and the current consumption.

Fig. 24 - Output power and drain current vs. case temperature ($R_L = 8\ \Omega$)

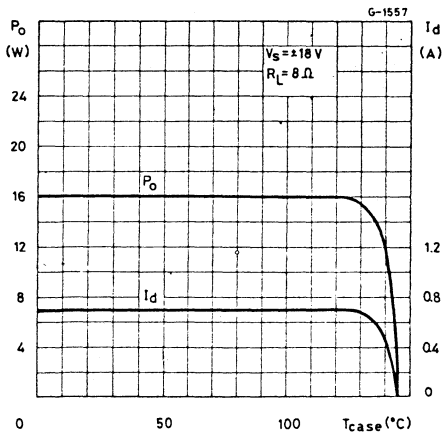
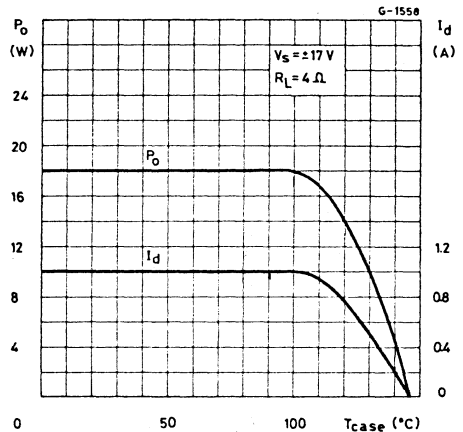


Fig. 25 - Output power and drain current vs. case temperature ($R_L = 4\ \Omega$)



MOUNTING INSTRUCTIONS

The power dissipated in the circuit must be removed by adding an external heatsink as shown in figs. 26 and 27.

The system for attaching the heatsink is very simple: it uses a plastic spacer which is supplied with the device.

Thermal contact between the copper slug (of the package) and the heatsink is guaranteed by the pressure which the screws exert via the spacer and the printed circuit board; this is due to the particular shape of the spacer.

Note: the most negative supply voltage is connected to the copper slug, hence to the heatsink (because it is in contact with the slug).

Fig. 26 - Mounting system of TDA 2020

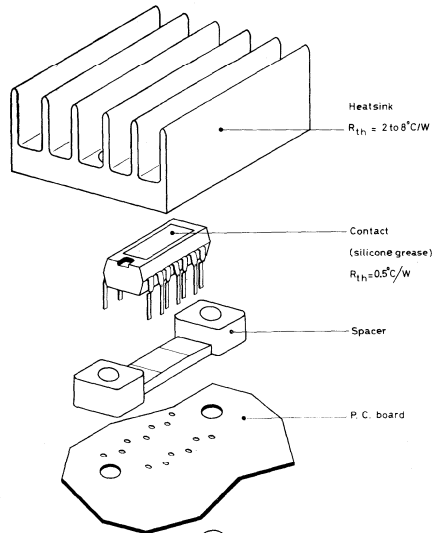
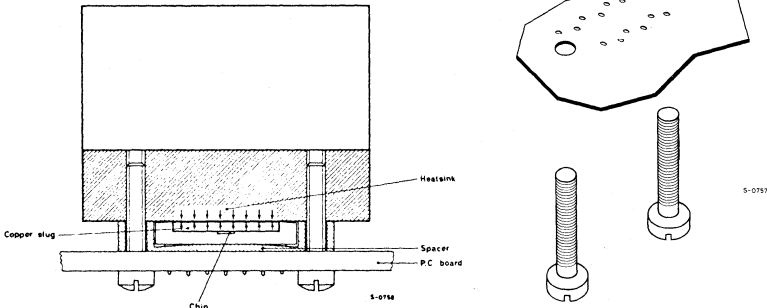


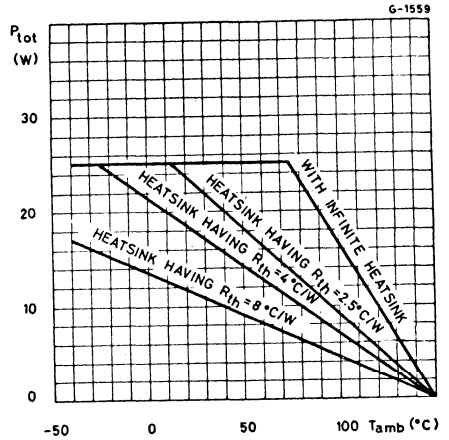
Fig. 27 - Cross-section of mounting system



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The maximum allowable power dissipation depends upon the size of the external heatsink (i. e. its thermal resistance); fig. 28 shows this dissipable power as a function of ambient temperature for different thermal resistance.

Fig.28 - Maximum allowable power dissipation vs. ambient temperature



For a more detailed description of the TDA 2020 and related performance refer to SGS-ATES Application Note n. 130.

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