SEMICONDUCTORS AND INTEGRATED CIRCUITS

Part 2 **October 1968**

DATA HANDBOOK SYSTEM

To provide you with a comprehensive source of information on electronic components, subassemblies and materials, our Data Handbook System is made up of three series of handbooks, each comprising several parts.

The three series, identified by the colours noted, are:

Electron tubes	blue
Semiconductors and Integrated circuits	red
Components and Materials	green

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

We have made every effort to ensure that each series is as accurate, comprehensive and up-to-date as possible, and we hope you will find it to be a valuable source of reference. You will understand that we can not guarantee that all products listed in any one edition of the handbook will remain available, or that their specifications will not be changed, before the next edition is published. If you need confirmation that the published data about any of our products are the latest available, therefore, may we ask that you contact our representative. He is at your service and will be glad to answer your inquiries.

SEMICONDUCTORS AND INTEGRATED CIRCUITS

This (red) series comprises the following volumes:

Part 1 September 1968

Former issue: August 1967

General section

Signal diodes

Variable capacitance diodes

Voltage regulator diodes

Rectifier diodes

Thyristors

Rectifier stacks

Accessories and heatsinks

Part 2 October 1968

Former issue: September 1967

General section

Germanium transistors

Photo devices

Accessories and heatsinks

Part 3/4 November 1968

General section

Silicon transistors

Accessories and heatsinks

Part 5 January 1969

General section

Digital integrated circuits

Linear integrated circuits

Former issue (Parts 3/4 and 5):
Part 3, October 1967

General section

Type designation
Rating systems
Letter symbols

PRO ELECTRON TYPE DESIGNATION CODE

FOR SEMICONDUCTOR DEVICES

This type designation code applies to discrete devices either with or without junctions, and to multiple devices [1])

The type designation consists of:

TWO LETTERS FOLLOWED BY A SERIAL NUMBER

The first letter distinguishes between junction and non-junction devices and gives an indication of the material

A Devices with one or more junctions, using material with a band gap of 0.6 to 1.0 eV, such as germanium

B Devices with one or more junctions, using material with a band gap of 1.0 to 1.3 eV, such as silicon

C Devices with one or more junctions, using material with a band gap of 1.3 eV and more, such as gallium arsenide

D Devices with one or more junctions, using material with a band gap of less than 0.6 eV, such as indium antimonide

R Devices without junction, using materials such as those employed in Hall generators and photoconductive cells

[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 discrete devices described above.
Multiples of dissimilar devices of other nature are designated by the second letter G.

The second letter indicates primarily the main application respectively main application and construction if a further differentiation is essential

A	Detection diode, high speed diode, mixer diode
B	Variable capacitance diode
C	Transistor for a.f. applications ($R_{th\ j\text{-}mb} > 15\ ^oC/W$)
D	Power transistor for a.f. applications ($R_{th\ j\text{-}mb} \leq 15\ ^oC/W$)
E	Tunnel diode
F	Transistor for r.f. applications ($R_{th\ j\text{-}mb} > 15\ ^oC/W$)
G	Multiple of dissimilar devices (see note at page 1)
H	Field probe
K	Hall generator in an open magnetic circuit, e.g. magnetogram or signal probe
L	Power transistor for r.f. applications ($R_{th\ j\text{-}mb} \leq 15\ ^oC/W$)
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 ($R_{th\ j\text{-}mb} > 15\ ^oC/W$)
S	Transistor for switching applications ($R_{th\ j\text{-}mb} > 15\ ^oC/W$)
T	Electrically, or by means of light, triggered controlling and switching power device having a breakdown characteristic ($R_{th\ j\text{-}mb} \leq 15\ ^oC/W$)
U	Power transistor for switching applications ($R_{th\ j\text{-}mb} \leq 15\ ^oC/W$)
X	Multiplier diode, e.g. varactor, step recovery diode
Y	Rectifying diode, booster diode, efficiency diode
Z	Voltage reference or voltage regulator diode

The serial number consists of:

Three figures for semiconductor devices designed for use primarily in consumer goods

One letter and two figures for semiconductor devices designed for use primarily in professional equipment

EXAMPLES

AF139 Germanium r.f. transistor intended primarily for "entertainment" applications

BYX27 Silicon rectifying diode intended primarily for "industrial" applications

OLD SYSTEM

The first letter is always "O", indicating a semiconductor device. The second (and third) letter(s) indicate the general class of device.

A	- diode or rectifier	C	- transistor
AP	- photodiode	CP	- phototransistor
AZ	- zener diode	RP	- photoconductive cell

The group of figures is a serial number indicating a particular design or development.

EXAMPLES

OA81	Semiconductor diode
OAZ200	Zener diode
OC72	Transistor

RATING SYSTEMS

ACCORDING TO I.E.C. PUBLICATION 134

1. DEFINITIONS OF TERMS USED

1.1 Electronic device. An electronic tube or valve, transistor or other semiconductor device.
Note: This definition excludes inductors, capacitors, resistors and similar components.

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

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

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

1.5 Rating system. The set of principles upon which ratings are established and which determine their interpretation.
Note: The rating system indicates the division of responsibility between the device manufacturer and the circuit designer, with the object of ensuring that the working conditions do not exceed the ratings.

2. ABSOLUTE MAXIMUM RATING SYSTEM

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

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

p.t.o.

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

3. DESIGN MAXIMUM RATING SYSTEM

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

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

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

4. DESIGN CENTRE RATING SYSTEM

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

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

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

NOTE

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

LETTER SYMBOLS

LETTER SYMBOLS FOR SEMICONDUCTOR DEVICES
excluding power diodes and thyristors

This system is based on the Recommendations of the INTERNATIONAL ELECTROTECHNICAL COMMISSION as published in I.E.C. Publication 148.

QUANTITY SYMBOLS

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

   Examples: i, v, p

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

   Examples: I, V, P

SUBSCRIPTS FOR QUANTITY SYMBOLS

1. Total values are indicated by upper case subscripts.

   Examples: I_C, I_{CM}, I_{CAV}, i_C, V_{EB}

2. Values of varying components are indicated by lower case subscripts.

   Examples: i_c, I_c, v_{eb}, V_{eb}

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

   For maximum (peak) values : M or m

   For average values : AV or av (only if it is necessary to distinguish between d.c. and average)

   For d.c. values : no additional subscript

   For root-mean-square values : (rms)

   Examples: I_C, I_{cm}, I_{CAV}, $I_{c(rms)}$, $I_{C(rms)}$

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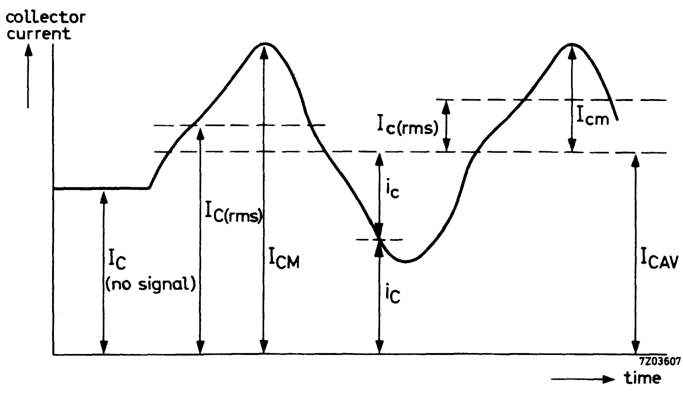
4. List of subscripts (examples, see figure 1)

A, a	=	Anode terminal
K, k	=	Cathode terminal
E, e	=	Emitter terminal
B, b	=	Base terminal
C, c	=	Collector terminal
(BR)	=	Break-down
X, x	=	Specified circuit
M, m	=	Maximum (peak) value
AV, av	=	Average value
(rms)	=	R.M.S. value
F, f	=	Forward
R, r	=	As first subscript : Reverse. As second subscript : Repetitive
O	=	As third subscript : The terminal not mentioned is open circuited
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)

5. Examples of the application of the rules:
Figure 1 represents a transistor collector current, consisting of a direct current and a signal, as a function of time.

Fig. 1



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CONVENTIONS FOR SUBSCRIPT SEQUENCE

1. Currents

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

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.

2. 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.

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.

3. 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}

4. 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_{B2-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.

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ELECTRICAL PARAMETER SYMBOLS

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

   Examples: h_{ib}, z_{fb}, y_{oc}, h_{FE}

2. 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

SUBSCRIPTS FOR PARAMETER SYMBOLS

1. 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.

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

   Examples: h_{ib}, z_{ob}

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

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

   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.

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4. 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.

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

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

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

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Letter symbol	Definition
C_c [1]	Collector capacitance (emitter open-circuited to a.c. and d.c.)
C_d [1]	Diode capacitance
C_e [1]	Emitter capacitance (collector open-circuited to a.c. and d.c.)
C_{ib}, C_{ie}, C_{ob}, C_{oe} [1]	See y parameters
d	Distortion
F	Noise figure
f	Frequency
f_{hfb}, f_{hfe}, f_{yfe}	Cut-off frequency (frequency at which the parameter indicated by the subscript is 0.7 of its low frequency value)
f_T	Transition frequency (Gain-bandwidth product)
g_{ie}, g_{ib}, g_{oe}, g_{ob}	See y parameters
G_p	Power gain
G_S	Source conductance
G_{tr}	Transducer gain
G_{UM}	Maximum unilateralised power gain
h_{FB}, h_{FC}, h_{FE}	Static value of the forward current transfer ratio or D.C. current gain (output voltage held constant)
h_{fb}, h_{fc}, h_{fe}	Small-signal value of the forward current transfer ratio or Small-signal current gain (output short-circuited to a.c.)
h_{IB}, h_{IC}, h_{IE}	Static value of the input resistance (output voltage held constant
h_{ib}, h_{ic}, h_{ie}	Small-signal value of the input impedance (output short-circuited to a.c.)

[1] As an exception to the general rule for electrical parameters capacitances are represented by the upper-case letter.

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Letter symbol	Definition
h_{OB}, h_{OC}, h_{OE}	Static value of the output conductance (input current held constant)
h_{ob}, h_{oc}, h_{oe}	Small-signal value of the output admittance (input open-circuited to a.c.)
h_{RB}, h_{RC}, h_{RE}	Static value of the reverse voltage transfer ratio (input current held constant)
h_{rb}, h_{rc}, h_{re}	Small-signal value of the reverse voltage transfer ratio (input open-circuited to a.c.)
I_B, I_C, I_E	Total d.c. (or average) current
I_b, I_c, I_e	Varying component of the current
i_B, i_C, i_E	Instantaneous total value of the current
i_b, i_c, i_e	Instantaneous value of the varying component of the current
I_{BAV}, I_{CAV}, I_{EAV}	Total average current (to distinguish between average and d.c. if necessary)
I_{BEX}, I_{CEX}	Total base, respectively collector current under specified conditions. These symbols are commonly used in case of a reverse biased emitter junction
I_{BM}, I_{CM}, I_{EM}	Maximum (peak) value of the total current
I_{bm}, I_{cm}, I_{em}	Maximum (peak) value of the varying component of the current
I_{CBO}	Collector cut-off current (open emitter)
I_{CEO}	Collector cut-off current (open base)
I_{CBS} or I_{CES}	Collector cut-off current (emitter short-circuited to base)
I_{EBO}	Emitter cut-off current (open collector)
I_F	Total forward current of a diode (d.c. or average)
i_F	Instantaneous total value of the forward current of a diode
I_{FAV}	Total average forward current of a diode (to distinguish between average and d.c. if necessary)
I_{FM}	Peak forward current of a diode

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Letter symbol	Definition
I_i, I_o	Input, respectively output current of a specified circuit
I_R	Total reverse (cut-off) current of a diode
i_R	Instantaneous total value of the reverse current of a diode
I_{RRM}	Repetitive peak reverse current of a diode
I_{RSM}	Non repetitive peak reverse current of a diode
I_Z	Zener current (d.c. or average)
I_{ZM}	Peak zener current
I_{ZS}	Non repetitive zener current
P_i, P_o	Input, respectively output power of a specified circuit
P_{tot}	Total power dissipation in the device
P_Z	Zener power dissipation
P_{ZM}	Peak zener power dissipation
P_{ZSM}	Non repetitive peak zener power dissipation
Q_s	Recovered charge
r_D	Diode (internal) series resistance
R_S	Source resistance
R_{th}	Thermal resistance
$R_{th\ j-a}$	Thermal resistance from junction to ambient
$R_{th\ j-mb}$	Thermal resistance from junction to mounting base
$R_{th\ j-c}$	Thermal resistance from junction to case
$R_{th\ mb-h}$	Thermal resistance from mounting base to heatsink
r_Z	Dynamic-slope resistance of a zener diode
S_Z	Temperature coefficient of the operating voltage of a zener diode
T_{amb}	Ambient temperature
T_{case}	Case temperature

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Letter symbol	Definition
t_d	Delay time
t_f	Fall time
t_{fr}	Forward recovery time of a diode
T_j	Junction temperature
t_{off}	Turn off time ($t_{off} = t_s + t_f$)
t_{on}	Turn on time ($t_{on} = t_d + t_r$)
t_r	Rise time
t_{rr}	Reverse recovery time of a diode
t_s	Storage time
T_{stg}	Storage temperature
V_{BB}, V_{CC}, V_{EE}	Supply voltage
V_{BE}, V_{CB}, V_{CE}, V_{EB}	Total value of the voltage (d.c. or average)
V_{be}, V_{cb}, V_{ce}, V_{eb}	Varying component of the voltage
v_{BE}, v_{CB}, v_{CE}, v_{EB}	Instantaneous value of the total voltage
v_{be}, v_{cb}, v_{ce}, v_{eb}	Instantaneous value of the varying component of the voltage
V_{BEfl}	Base-emitter floating voltage (open base)
V_{BEsat}, V_{CEsat}	Saturation voltage at specified bottoming conditions
$V_{(BR)}$	Breakdown voltage
$V_{(BR)CBO}$, $V_{(BR)CEO}$, $V_{(BR)EBO}$	Breakdown voltage between the terminal indicated by the first subscript and the reference terminal (second subscript) when the third terminal is open circuited
$V_{(BR)CER}$	Collector-emitter breakdown voltage with a specified resistance between emitter and base
$V_{(BR)CES}$	Collector-emitter breakdown voltage with the emitter short circuited to the base
V_{CBO}, V_{CEO}, V_{EBO}	Voltage of the terminal indicated by the first subscript w.r.t. the reference terminal (second subscript) with the third terminal open circuited
V_{CEK}	Knee voltage at specified conditions

7Z3 0347

Letter symbol	Definition	
V_{CER}	Collector-emitter voltage with a specified resistance between emitter and base	
V_{CES}	Collector-emitter voltage with the emitter short circuited to the base	
$V_{CE.sust}$	Collector-emitter sustaining voltage under the condition, indicated by the third subscript	
V_{CEX}	Collector-emitter voltage in a specified circuit. This symbol is commonly used to indicate a reverse biased emitter junction	
V_{EBfl}	Emitter-base floating voltage (open emitter)	
V_F	Continuous forward voltage of a diode	
V_{FM}	Peak forward voltage of a diode	
V_i, V_o	Input, respectively output voltage of a specified circuit	
V_{pt}	Punch through voltage	
V_R	Continuous reverse voltage of a diode	
V_{RM}	Peak reverse voltage of a diode	
V_{RSM}	Non repetitive peak reverse voltage of a diode	
V_Z	Operating voltage (zener voltage) of a zener diode	
y_{ib}, y_{ie}	Input admittance	Output short circuited to a.c.
g_{ib}, g_{ie}	Input conductance	Output short circuited to a.c.
C_{ib}, C_{ie}	Input capacitance	Output short circuited to a.c.
φ_{ib}, φ_{ie}	Phase angle of input admittance	Output short circuited to a.c.
y_{fb}, y_{fe}	Transfer admittance	Output short circuited to a.c.
g_{fb}, g_{fe}	Transfer conductance	Output short circuited to a.c.
C_{fb}, C_{fe}	Transfer capacitance	Output short circuited to a.c.
φ_{fb}, φ_{fe}	Phase angle of transfer admittance	Output short circuited to a.c.

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Letter symbol	Definition	
y_{ob}, y_{oe}	Output admittance	Input short circuited to a.c.
g_{ob}, g_{oe}	Output conductance	
C_{ob}, C_{oe}	Output capacitance	
φ_{ob}, φ_{oe}	Phase angle of output admittance	
y_{rb}, y_{re}	Feedback admittance	Input short circuited to a.c.
g_{rb}, g_{re}	Feedback conductance	
C_{rb}, C_{re}	Feedback capacitance	
φ_{rb}, φ_{re}	Phase angle of feedback admittance	

7Z3 0349

Germanium transistors

GERMANIUM P-N-P TRANSISTOR

Low noise germanium transistor in all glass envelope for use as input stage of tape recorders with a speed of up to 19 cm/s.

RATINGS (Limiting values)

Collector-base voltage (open emitter)	$-V_{CBO}$	max.	15	V
Collector-emitter voltage with $R_{BE} < 1.5$ kΩ	$-V_{CER}$	max.	15	V
Collector current (peak value)	$-I_{CM}$	max.	10	mA
Total dissipation up to $T_{amb} = 25$ °C	P_{tot}	max.	80	mW
Junction temperature	T_j	max.	75	°C

CHARACTERISTICS $T_j = 25$ °C

Small signal current gain

$-I_C = 0.3$ mA; $-V_{CE} = 5$ V	h_{fe}	typ. 60 35 to 160		

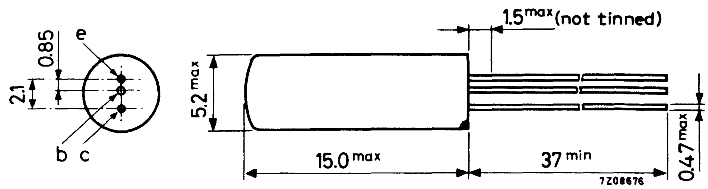
Cut-off frequency

$I_E = 0.3$ mA; $-V_{CB} = 5$ V	f_{hfb}	>	2	MHz

Noise figure at f = 30 Hz to 15 kHz

$I_E = 0.3$ mA; $-V_{CB} = 5$ V; $R_S = 1.5$ kΩ	F	<	5	dB

MECHANICAL DATA Dimensions in mm



The coloured dot indicates the collector.

FOR NEW DESIGN THE SUCCESSOR
TYPES BC179 AND BC159 ARE RECOMMENDED

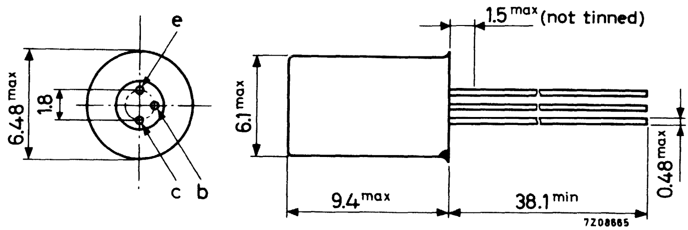
GERMANIUM ALLOY TRANSISTOR

P-N-P transistor in a TO-1 metal envelope intended for use in pre-amplifier or driver stages.

QUICK REFERENCE DATA				
Collector-base voltage (open emitter)	$-V_{CBO}$	max.	32	V
Collector-emitter voltage (open base)	$-V_{CEO}$	max.	12	V
Collector current (d.c.)	$-I_C$	max.	100	mA
Total power dissipation up to T_{amb} = 45 °C with cooling fin No. 56227 on a heatsink of at least 12.5 cm^2	P_{tot}	max.	500	mW
Junction temperature	T_j	max.	90	°C
D.C. current gain at T_{amb} = 25 °C				
$-I_C$ = 2 mA; $-V_{CE}$ = 5 V	h_{FE}	>	50	
		typ.	100	
Small signal current gain at T_{amb} = 25 °C				
I_E = 2 mA; $-V_{CB}$ = 5 V; f = 1 kHz	h_{fe}	typ.	125	
		80 to	170	
Transition frequency				
$-I_C$ = 10 mA; $-V_{CE}$ = 2 V	f_T	typ.	1.7	MHz

MECHANICAL DATA Dimensions in mm

TO-1



The coloured dot indicates the collector

Accessories available: 56200, 56208, 56209, 56210, 56226, 56227

RATINGS (Limiting values) [1]

Voltages

Collector-base voltage (open emitter)	$-V_{CBO}$	max.	32	V
Collector-emitter voltage (open base)	$-V_{CEO}$	max.	12	V
Collector-emitter voltage with $R_{BE} < 1\ k\Omega$	$-V_{CER}$	max.	32	V
Emitter-base voltage (open collector)	$-V_{EBO}$	max.	10	V

Currents

Collector current (d.c.)	$-I_C$	max.	100	mA
→ Emitter current (peak value)	I_{EM}	max.	200	mA

Power dissipation

Total power dissipation up to T_{amb} = 45 °C with cooling fin No. 56227 mounted on a heatsink of at least 12.5 cm²	P_{tot}	max.	500	mW

Temperatures

Storage temperature	T_{stg}		-55 to +90	°C
Junction temperature	T_j	max.	90	°C

THERMAL RESISTANCE

From junction to ambient in free air	$R_{th\ j\text{-}a}$	=	0.3	°C/mW
From junction to ambient with cooling fin No. 56227 mounted on a heatsink of at least 12.5 cm²	$R_{th\ j\text{-}a}$	=	0.09	°C/mW

[1]) Limiting values according to the Absolute Maximum System as defined in IEC publication 134.

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

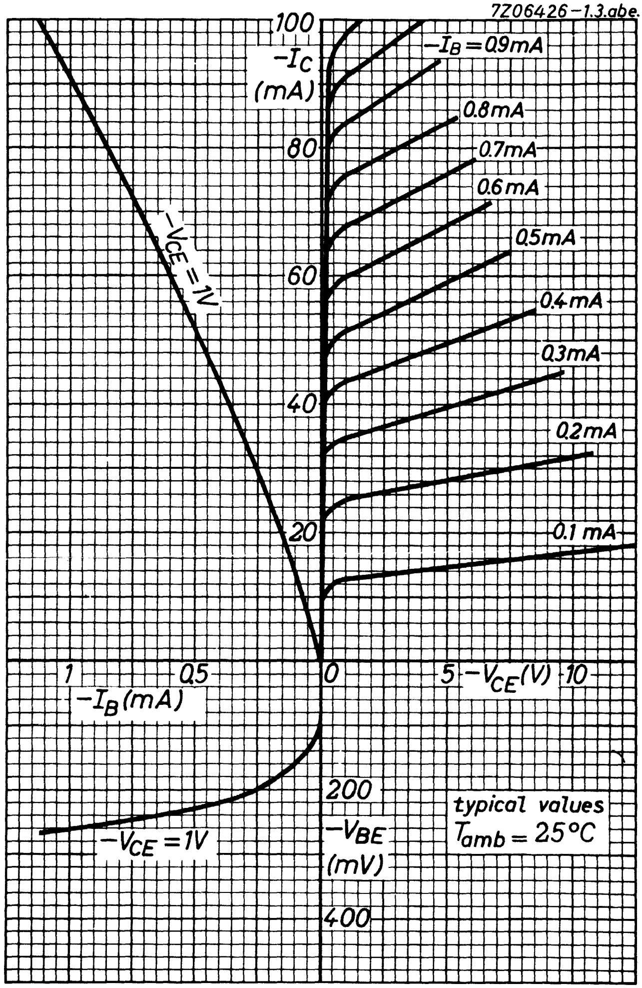
Collector cut-off current				
$I_E = 0$; $-V_{CB} = 10$ V	$-I_{CBO}$	<	10	μA
$I_E = 0$; $-V_{CB} = 32$ V; $T_j = 75$ °C	$-I_{CBO}$	<	800	μA
Emitter cut-off current				
$I_C = 0$; $-V_{EB} = 5$ V; $T_j = 75$ °C	$-I_{EBO}$	<	550	μA
Emitter-base voltage				
$I_E = 2$ mA; $-V_{CB} = 5$ V	V_{EB}	typ.	105	mV
$I_E = 100$ mA; $V_{CB} = 0$	V_{EB}	<	400	mV
D.C. current gain				
$-I_C = 2$ mA; $-V_{CE} = 5$ V	h_{FE}	> typ.	50 100	
$-I_C = 50$ mA; $V_{CB} = 0$	h_{FE}	typ.	95	
$-I_C = 100$ mA; $V_{CB} = 0$	h_{FE}	typ.	80	
Collector capacitance at f = 0.45 MHz				
$I_E = I_e = 0$; $-V_{CB} = 5$ V	C_c	typ. <	40 50	pF pF
Feedback impedance at f = 0.45 MHz				
$-I_C = 1$ mA; $-V_{CE} = 5$ V	$\|z_{rb}\|$	typ.	90	Ω
Transition frequency				
$-I_C = 10$ mA; $-V_{CE} = 2$ V	f_T	> typ.	1.3 1.7	MHz MHz
Cut-off frequency				
$-I_C = 10$ mA; $-V_{CE} = 2$ V	f_{hfe}	> typ.	10 17	kHz kHz
Noise figure at f = 1 kHz				
$-I_C = 0.5$ mA; $-V_{CE} = 5$ V; $R_S = 500$ Ω Bandwidth = 200 Hz	F	typ. <	4 10	dB dB

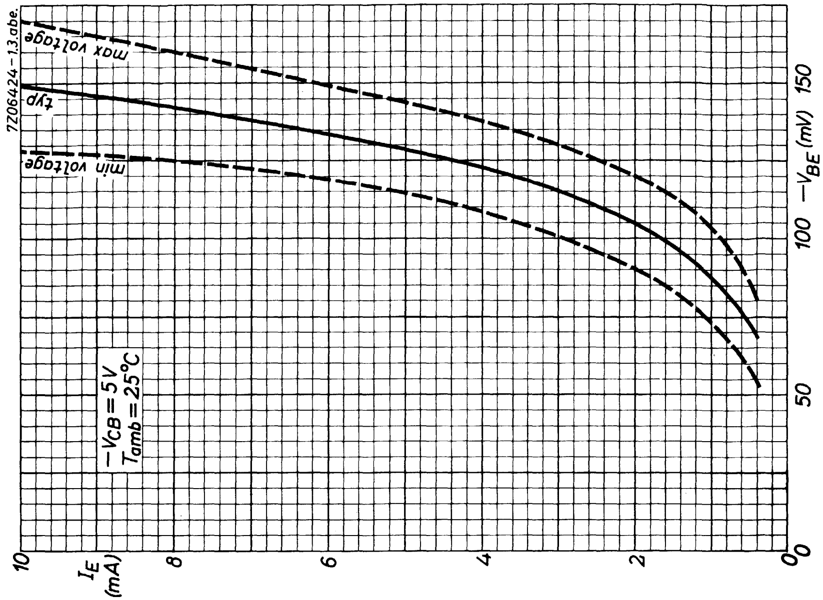
CHARACTERISTICS (continued) T_{amb} = 25 °C unless otherwise specified

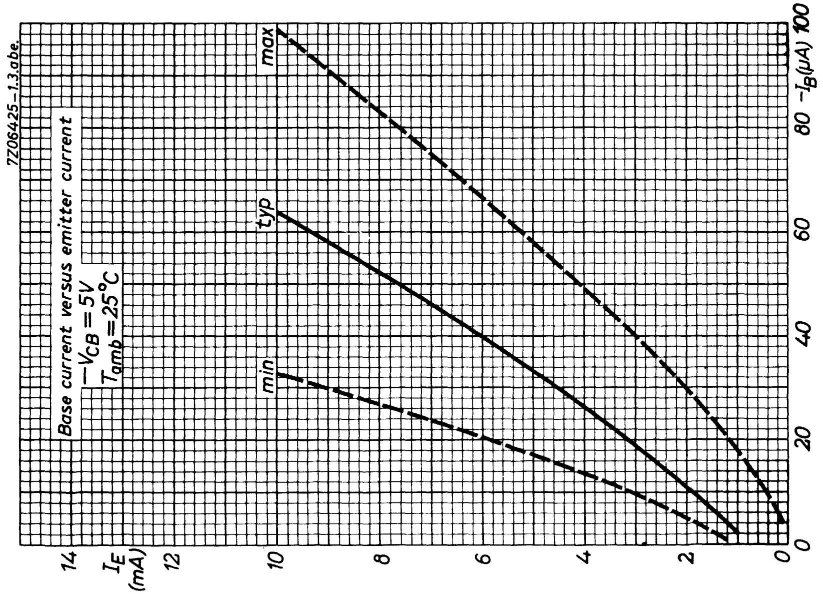
h parameters at f = 1 kHz

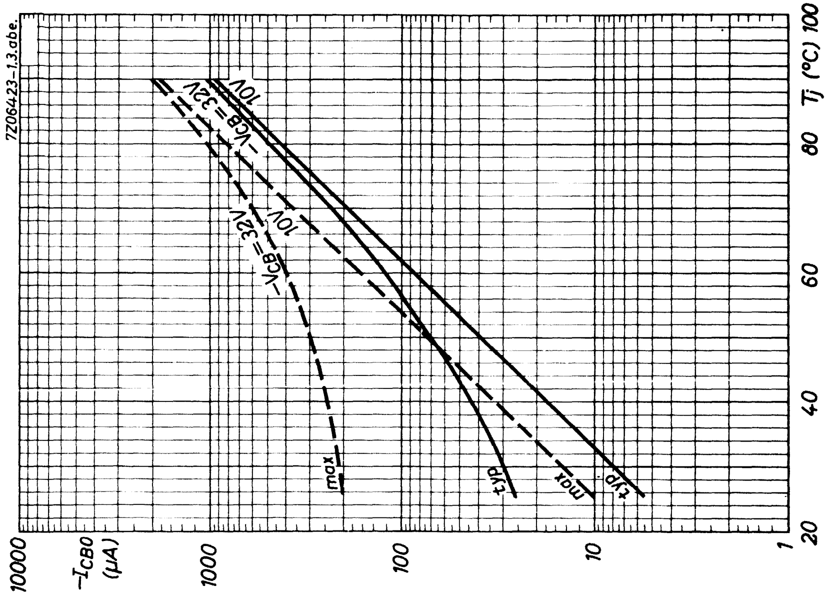
$-I_C$ = 2 mA; $-V_{CE}$ = 5 V

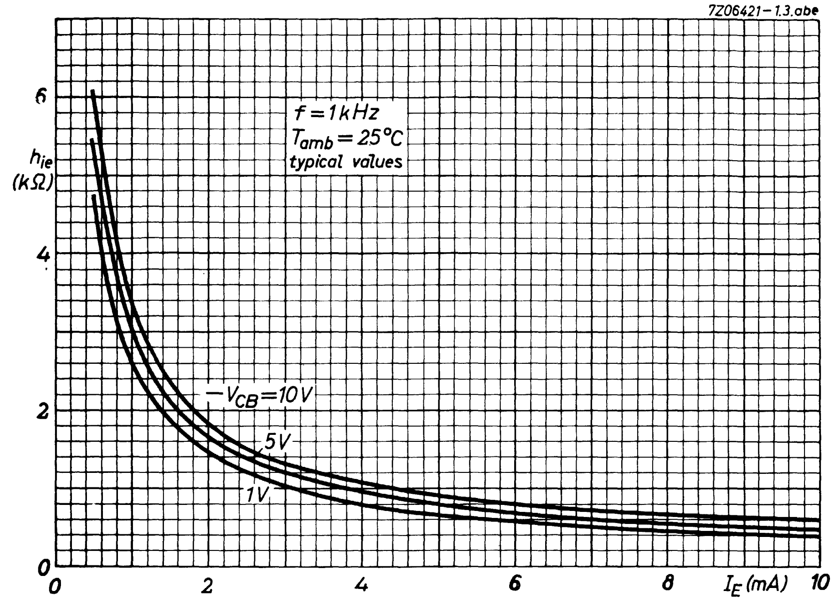
Input impedance	h_{ie}	typ.	1.7	kΩ
			1.1 to 2.5	kΩ
Reverse voltage transfer	h_{re}	typ.	6.5	10^{-4}
		<	8.5	10^{-4}
Small signal current gain	h_{fe}	typ.	125	
			80 to 170	
Output admittance	h_{oe}	typ.	80	$\mu\Omega^{-1}$
		<	110	$\mu\Omega^{-1}$

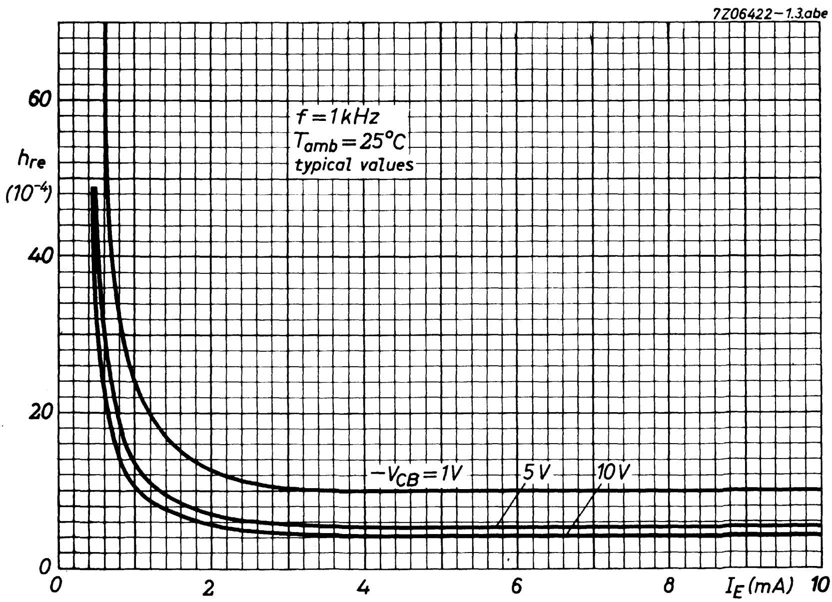

7Z06426-1.3.abe.
100
$-I_C$
(mA)
80
60
40
20
$-I_B = 0.9mA$
0.8mA
0.7mA
0.6mA
0.5mA
0.4mA
0.3mA
0.2mA
0.1 mA
$-V_{CE} = 1V$
1
0.5
0
5
$-V_{CE}(V)$
10
$-I_B(mA)$
200
$-V_{BE}$
(mV)
400
$-V_{CE} = 1V$
typical values
$T_{amb} = 25°C$

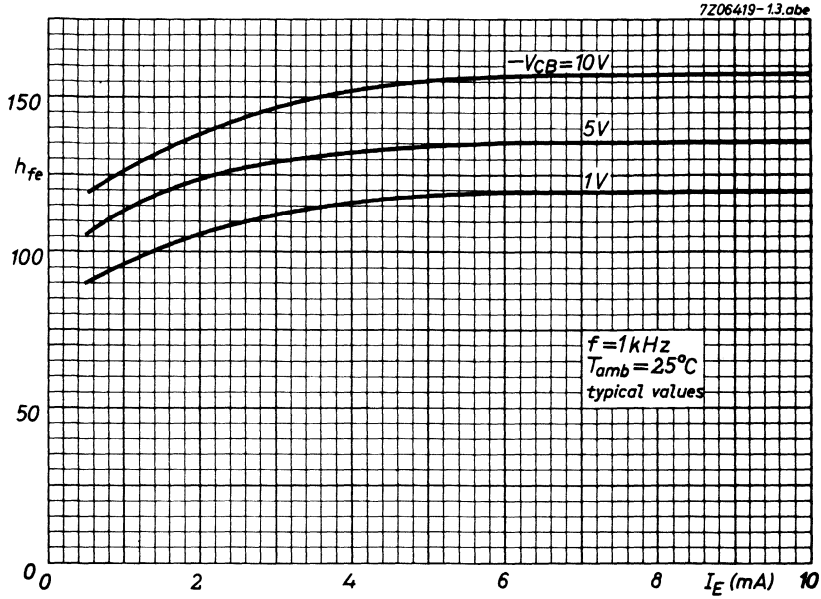

7Z06424-1.3.abe.
max voltage
typ
min voltage
$-V_{CB} = 5V$
$T_{amb} = 25°C$
$-V_{BE}$ (mV)
150
100
50
0
I_E (mA)
10
8
6
4
2
0

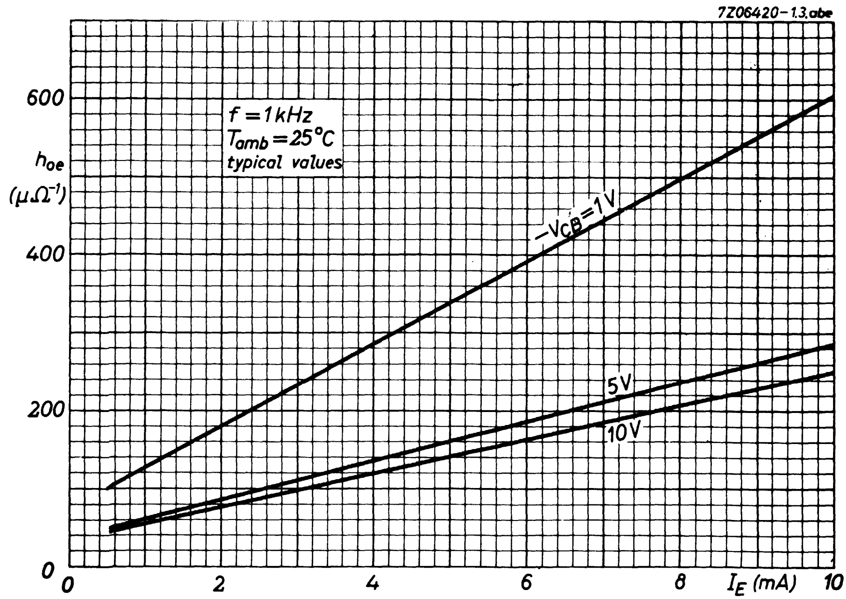

7Z06425-1.3.abe.
Base current versus emitter current
$-V_{CB} = 5V$
$T_{amb} = 25°C$
max
typ
min
$-I_B$ (μA)
100
80
60
40
20
0
I_E (mA)
14
12
10
8
6
4
2
0

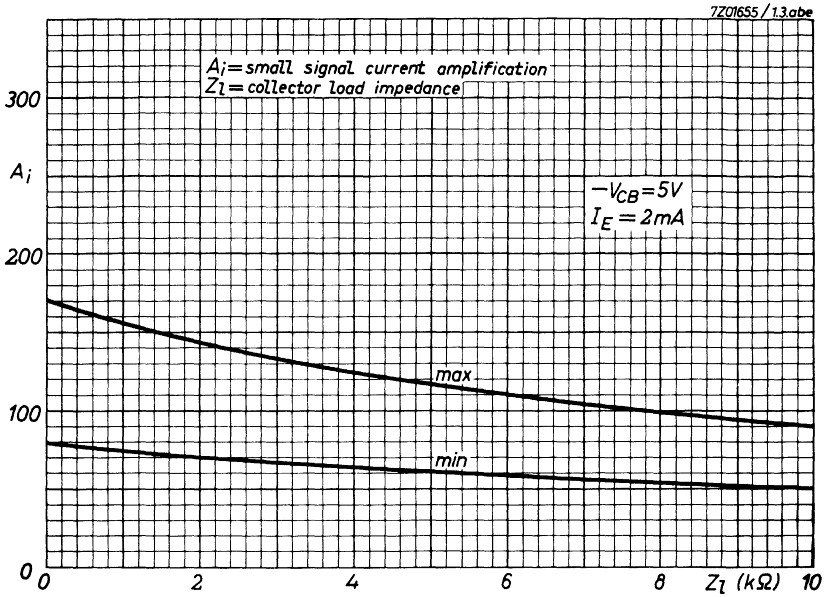

7Z06423-1.3.abe.
10000
$-I_{CBO}$ (μA)
1000
100
10
1
20
40
60
80
100
T_j (°C)
$-V_{CB}$ = 32V
10V
$-V_{CB}$ = 32V
10V
max
typ
max
typ

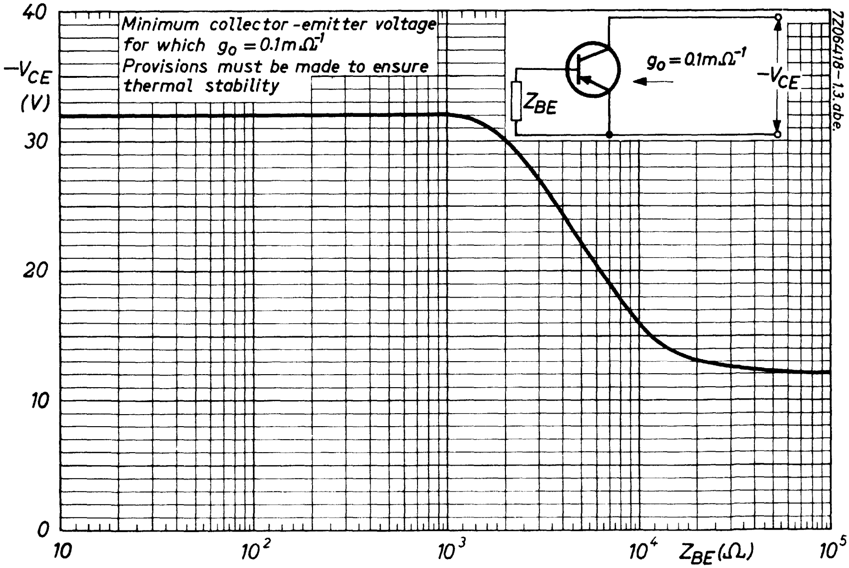

7Z06421-1.3.abe
f = 1 kHz
T_amb = 25°C
typical values
h_ie
(kΩ)
6
4
2
0
−V_CB = 10 V
5 V
1 V
0
2
4
6
8
I_E (mA)
10


7Z06422-1.3.abe
f = 1 kHz
T_amb = 25°C
typical values
h_re
(10^-4)
60
40
20
0
−V_CB = 1 V
5 V
10 V
0
2
4
6
8
I_E (mA)
10


7Z06419-1.3.abe
$-V_{CB}=10V$
5V
1V
150
h_{fe}
100
50
0
0
2
4
6
8
10
I_E (mA)
f = 1 kHz
T_{amb} = 25°C
typical values


7Z06420-1.3.abe
600
h_{oe}
($\mu\Omega^{-1}$)
400
200
0
0
2
4
6
8
10
I_E (mA)
f = 1 kHz
T_{amb} = 25°C
typical values
$-V_{CB}=1V$
5V
10V


7Z01655 / 1.3.abe
Ai = small signal current amplification
Zl = collector load impedance
300
Ai
200
100
0
−VCB = 5V
IE = 2mA
max
min
0
2
4
6
8
Zl (kΩ)
10


7Z06418 - 1.3.abe.
40
−VCE
(V)
30
20
10
0
Minimum collector-emitter voltage
for which go = 0.1mΩ⁻¹
Provisions must be made to ensure
thermal stability
go = 0.1mΩ⁻¹
ZBE
−VCE
10
10²
10³
10⁴
ZBE (Ω)
10⁵

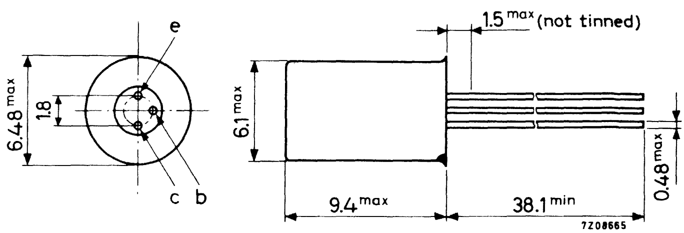
GERMANIUM ALLOY TRANSISTOR

P-N-P transistor in a TO-1 metal envelope intended for use in pre-amplifier or driver stages.

QUICK REFERENCE DATA				
Collector-base voltage (open emitter)	$-V_{CBO}$	max.	32	V
Collector-emitter voltage (open base)	$-V_{CEO}$	max.	12	V
Collector current (d.c.)	$-I_C$	max.	100	mA
Total power dissipation up to T_{amb} = 45 °C with cooling fin No. 56227 on a heatsink of at least 12.5 cm^2	P_{tot}	max.	500	mW
Junction temperature	T_j	max.	90	°C
D.C. current gain at T_{amb} = 25 °C				
$-I_C$ = 2 mA; $-V_{CE}$ = 5 V	h_{FE}	>	65	
		typ.	140	
Small signal current gain at T_{amb} = 25 °C				
I_E = 2 mA; $-V_{CB}$ = 5 V; f = 1 kHz	h_{fe}	typ.	180	
		130 to	300	
Transition frequency				
$-I_C$ = 10 mA; $-V_{CE}$ = 2 V	f_T	typ.	2.3	MHz

MECHANICAL DATA Dimensions in mm

TO-1



The coloured dot indicates the collector

Accessories available: 56200, 56208, 56209, 56210, 56226, 56227

RATINGS (Limiting values) [1])

Voltages

Collector-base voltage (open emitter)	$-V_{CBO}$	max.	32	V
Collector-emitter voltage (open base)	$-V_{CEO}$	max.	12	V
Collector-emitter voltage with $R_{BE} < 1\ k\Omega$	$-V_{CER}$	max.	32	V
Emitter-base voltage (open collector)	$-V_{EBO}$	max.	10	V

Currents

Collector current (d.c.)	$-I_C$	max.	100	mA
→ Emitter current (peak value)	I_{EM}	max.	200	mA

Power dissipation

Total power dissipation up to T_{amb} = 45 °C with cooling fin No. 56227 mounted on a heatsink of at least 12.5 cm^2	P_{tot}	max.	500	mW

Temperatures

Storage temperature	T_{stg}		-55 to +90	°C
Junction temperature	T_j	max.	90	°C

THERMAL RESISTANCE

From junction to ambient in free air	$R_{th\ j-a}$	=	0.3	°C/mW
From junction to ambient with cooling fin No. 56227 mounted on a heatsink of at least 12.5 cm^2	$R_{th\ j-a}$	=	0.09	°C/mW

[1]) Limiting values according to the Absolute Maximum System as defined in IEC publication 134.

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

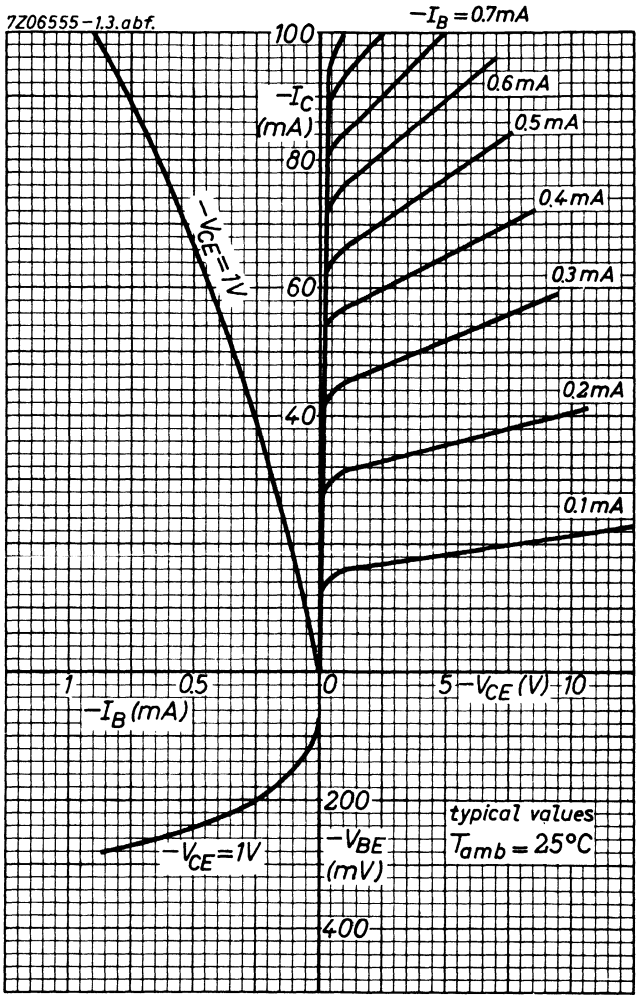
Collector cut-off current				
$I_E = 0$; $-V_{CB} = 10$ V	$-I_{CBO}$	<	10	μA
$I_E = 0$; $-V_{CB} = 32$ V; $T_j = 75$ °C	$-I_{CBO}$	<	800	μA
Emitter cut-off current				
$I_C = 0$; $-V_{EB} = 5$ V; $T_j = 75$ °C	$-I_{EBO}$	<	550	μA
Emitter-base voltage				
$I_E = 2$ mA; $-V_{CB} = 5$ V	V_{EB}	typ.	105	mV
$I_E = 100$ mA; $V_{CB} = 0$	V_{EB}	<	400	mV
D.C. current gain				
$-I_C = 2$ mA; $-V_{CE} = 5$ V	h_{FE}	>	65	
		typ.	140	
$-I_C = 50$ mA; $V_{CB} = 0$	h_{FE}	typ.	135	
$-I_C = 100$ mA; $V_{CB} = 0$	h_{FE}	typ.	105	
Collector capacitance at f = 0.45 MHz				
$I_E = I_e = 0$; $-V_{CB} = 5$ V	C_c	typ.	40	pF
		<	50	pF
Feedback impedance at f = 0.45 MHz				
$-I_C = 1$ mA; $-V_{CE} = 5$ V	$\|z_{rb}\|$	typ.	90	Ω
Transition frequency				
$-I_C = 10$ mA; $-V_{CE} = 2$ V	f_T	>	1.7	MHz
		typ.	2.3	MHz
Cut-off frequency				
$-I_C = 10$ mA; $-V_{CE} = 2$ V	f_{hfe}	>	10	kHz
		typ.	17	kHz
Noise figure at f = 1 kHz				
$-I_C = 0.5$ mA; $-V_{CE} = 5$ V; $R_S = 500$ Ω; Bandwidth = 200 Hz	F	typ.	4	dB
		<	10	dB

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

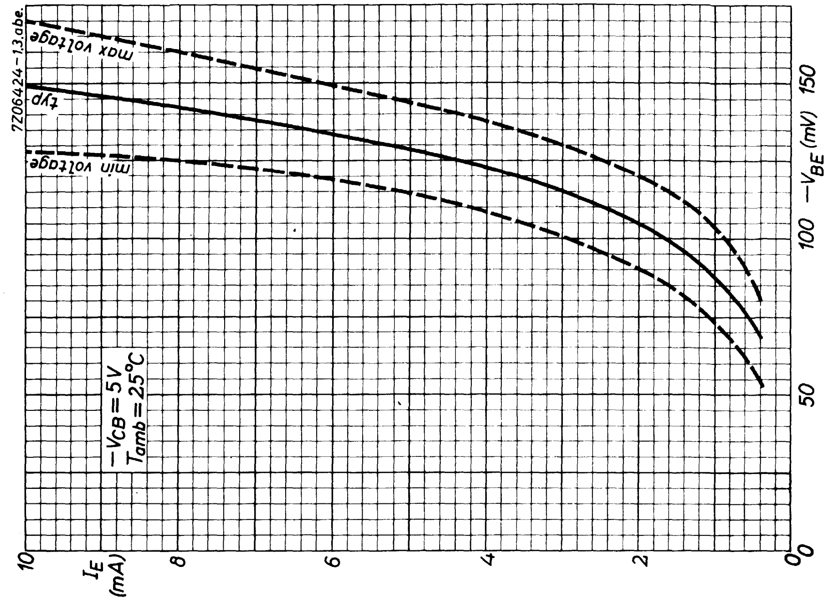
h parameters at f = 1 kHz

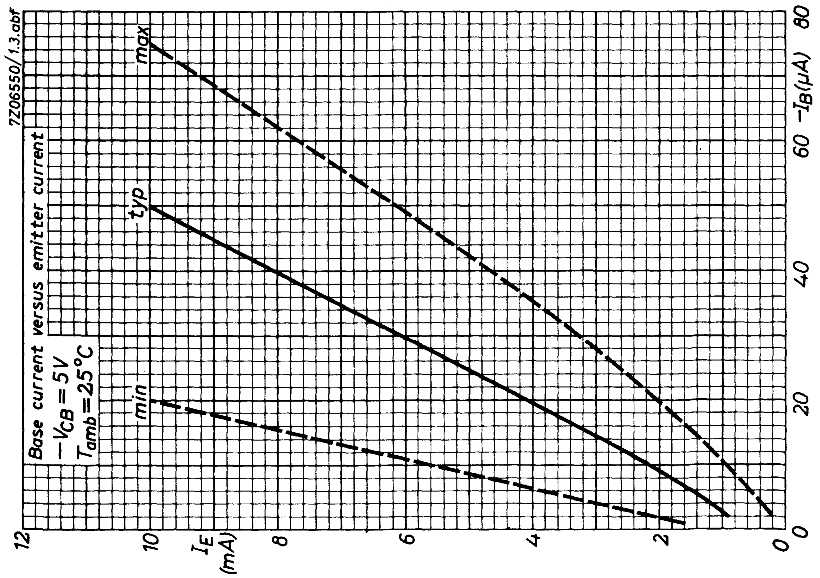
$-I_C$ = 2 mA; $-V_{CE}$ = 5 V

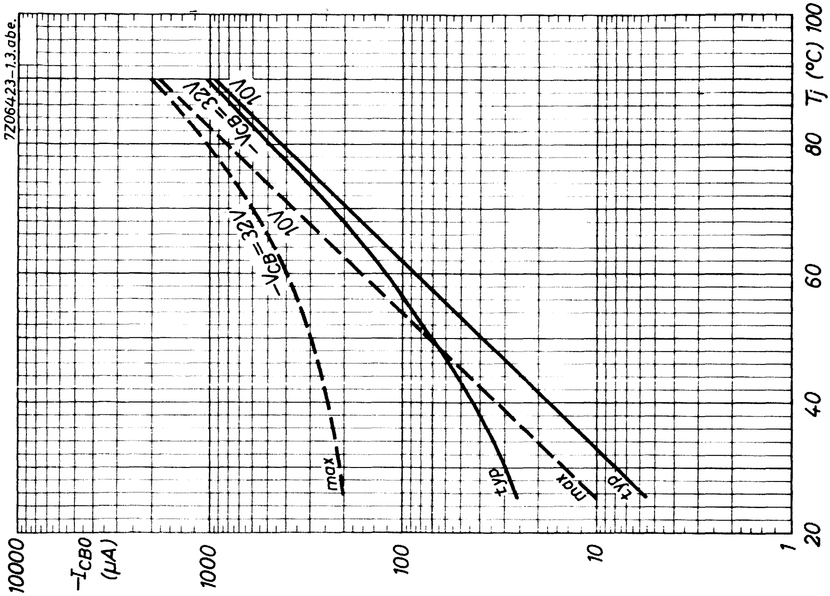
Input impedance	h_{ie}	typ.	2.4	kΩ
			1.7 to 3.8	kΩ
Reverse voltage transfer	h_{re}	typ.	8.0	10^{-4}
		<	13.0	10^{-4}
Small signal current gain	h_{fe}	typ.	180	
			130 to 300	
Output admittance	h_{oe}	typ.	100	$\mu\Omega^{-1}$
		<	170	$\mu\Omega^{-1}$

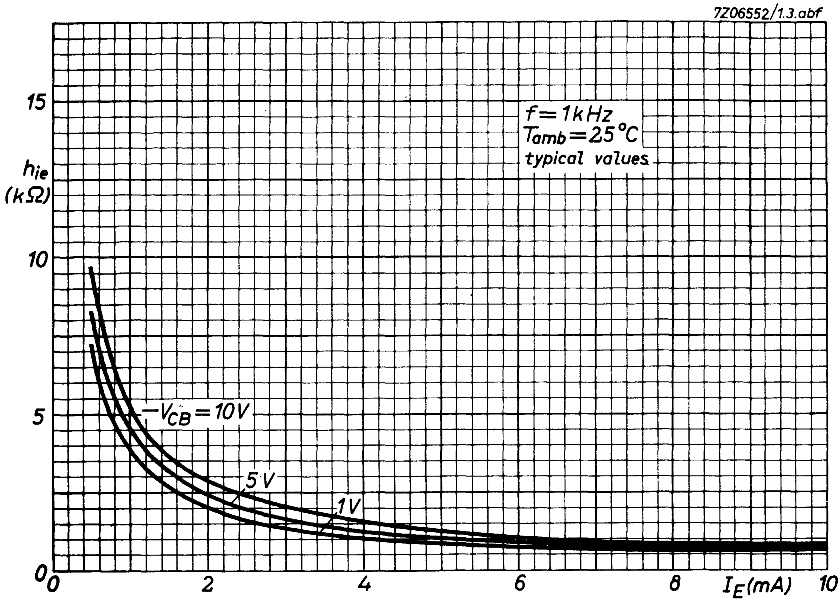


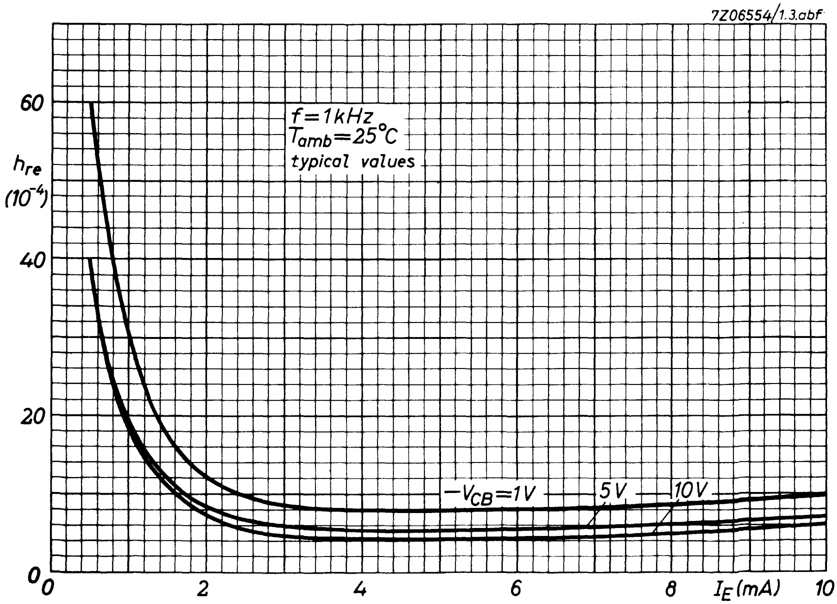
7Z06555-1.3.abf.
$-I_B = 0.7mA$
0.6mA
0.5mA
0.4mA
0.3mA
0.2mA
0.1mA
$-I_C$ (mA)
100
80
60
40
$-V_{CE} = 1V$
1
0.5
0
5
$-V_{CE}$ (V)
10
$-I_B$ (mA)
200
400
$-V_{BE}$ (mV)
$-V_{CE} = 1V$
typical values
$T_{amb} = 25°C$

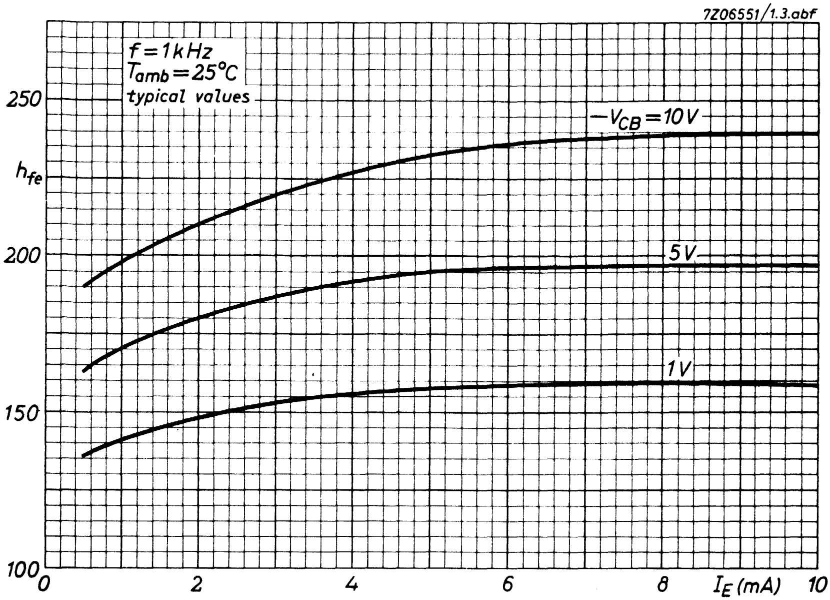

7Z06424-1.3.abe.
max voltage
typ
min voltage
$-V_{CB} = 5\,V$
$T_{amb} = 25\,°C$
I_E (mA)
10
8
6
4
2
0
0
50
100
150
$-V_{BE}$ (mV)

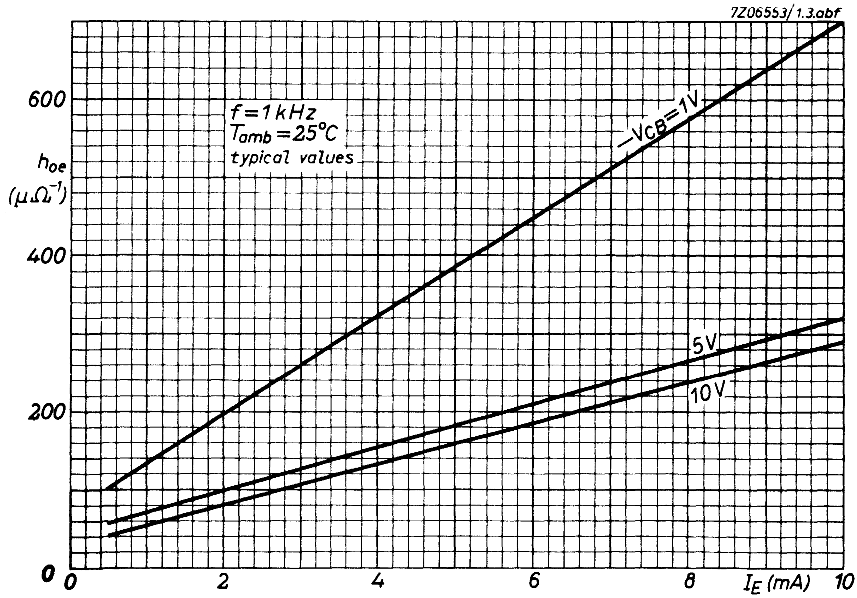

7Z06550/1.3.abf
Base current versus emitter current
$-V_{CB} = 5\,V$
$T_{amb} = 25\,°C$
max
typ
min
I_E (mA)
12
10
8
6
4
2
0
0
20
40
60
80
$-I_B$ (μA)

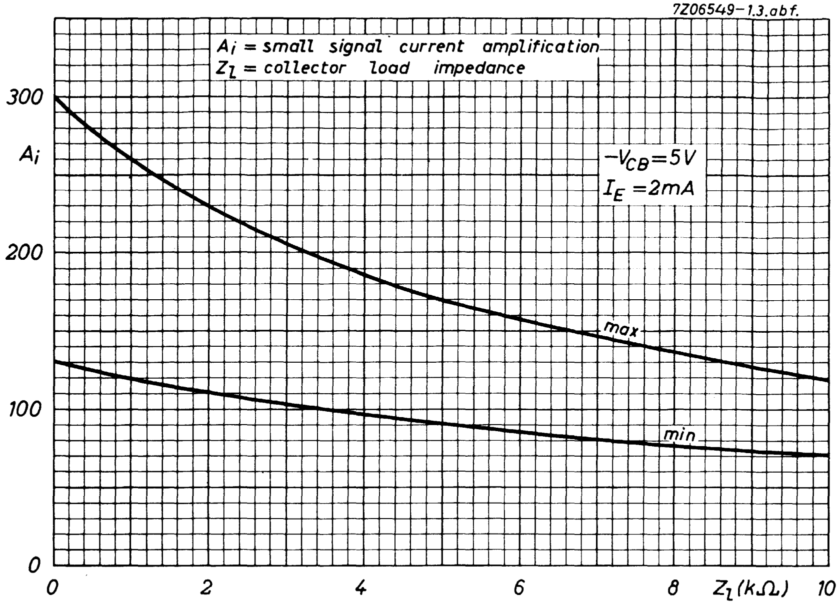

7Z06423-1.3.abe.
Tj (°C)
20
40
60
80
100
−ICBO (μA)
10000
1000
100
10
1
10V
−VCB = 32V
10V
−VCB = 32V
max
typ
max
typ

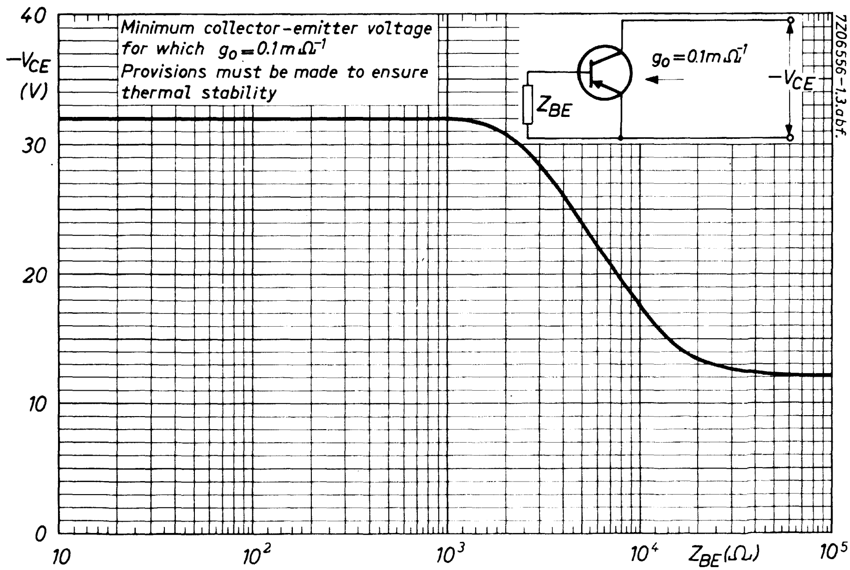

7Z06552/1.3.abf
f = 1 kHz
T_{amb} = 25 °C
typical values
h_{ie} (kΩ)
15
10
5
0
$-V_{CB}$ = 10 V
5 V
1 V
0
2
4
6
8
I_E (mA)
10


7Z06554/1.3.abf
f = 1 kHz
T_{amb} = 25 °C
typical values
h_{re} (10^{-4})
60
40
20
0
$-V_{CB}$ = 1 V
5 V
10 V
0
2
4
6
8
I_E (mA)
10


7Z06551/1.3.abf
f = 1 kHz
T_{amb} = 25°C
typical values
250
h_{fe}
200
150
100
0
2
4
6
8
I_E (mA)
10
$-V_{CB}$ = 10 V
5 V
1 V


7Z06553/1.3.abf
f = 1 kHz
T_{amb} = 25°C
typical values
600
h_{oe}
($\mu\Omega^{-1}$)
400
200
0
0
2
4
6
8
I_E (mA)
10
$-V_{CB}$ = 1 V
5 V
10 V


7Z06549-1.3.abf.
A_i = small signal current amplification
Z_l = collector load impedance
300
A_i
200
100
0
$-V_{CB}$=5V
I_E =2mA
max
min
0
2
4
6
8
Z_l (kΩ)
10


40
$-V_{CE}$
(V)
30
20
10
0
Minimum collector-emitter voltage
for which g_o=0.1mΩ^{-1}
Provisions must be made to ensure
thermal stability
Z_{BE}
g_o=0.1mΩ^{-1}
$-V_{CE}$
7Z06556-1.3.abf.
10
10^2
10^3
10^4
Z_{BE}(Ω)
10^5

GERMANIUM ALLOY TRANSISTORS

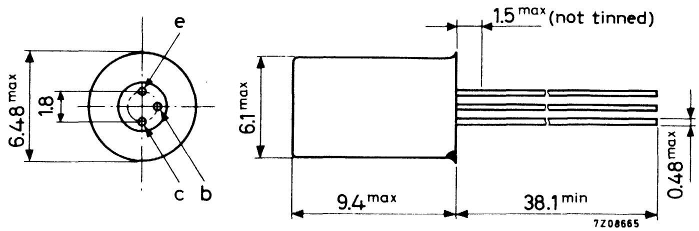
The AC127 is an n-p-n audio transistor in a TO-1 metal envelope.
The AC127 is intended for use together with the p-n-p transistors AC128 or AC132 as matched pair in class B output stages with complementary symmetry or in driver stages.
The AC127/01 is electrically equivalent to the AC127, constructed integrally with a heat conducting block, which gives better heat transfer.
The thermal resistance from junction to heatsink shows an improvement (≈ 10 °C/W) as compared with that obtained with the AC127 when using heat conducting clip 56227.

QUICK REFERENCE DATA				
Collector-base voltage (open emitter)	V_{CBO}	max.	32	V
Collector-emitter voltage (open base)	V_{CEO}	max.	12	V
Collector current (d.c.)	I_C	max.	500	mA
Total power dissipation up to T_{amb} = 45 °C with cooling fin on a heatsink of at least 12.5 cm^2	P_{tot}	max.	340	mW
Junction temperature (incidentally)	T_j	max.	100	°C
D.C. current gain at T_{amb} = 25 °C I_C = 20 mA; V_{CB} = 0	h_{FE}	typ.	100	
Transition frequency I_C = 10 mA; V_{CB} = 2 V	f_T	typ.	2.5	MHz

MECHANICAL DATA Dimensions in mm

AC127

TO-1

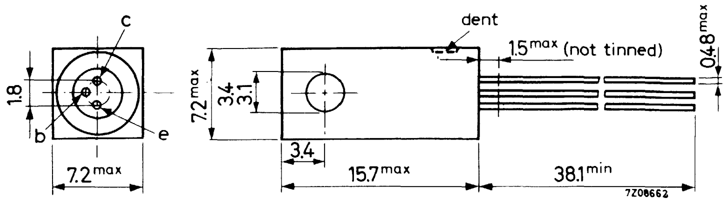


The coloured dot indicates the collector

Accessories available: 56200, 56208, 56209, 56210, 56226, 56227

MECHANICAL DATA (continued) Dimensions in mm

AC127/01



The dent indicates the collector

RATINGS (Limiting values) [1])

Voltages

Collector-base voltage (open emitter)	V_{CBO}	max.	32	V
Collector-emitter voltage (open base)	V_{CEO}	max.	12	V
Collector-emitter voltage with $R_{BE} < 70\ \Omega$	V_{CER}	max.	32	V
Emitter-base voltage (open collector)	V_{EBO}	max.	10	V

Currents

Collector current (d.c.)	I_C	max.	500	mA
Base current (d.c.)	I_B	max.	25	mA

Power dissipation

Total power dissipation up to T_{amb} = 45 °C with cooling fin mounted on a heatsink of at least 12.5 cm^2	P_{tot}	max.	340	mW

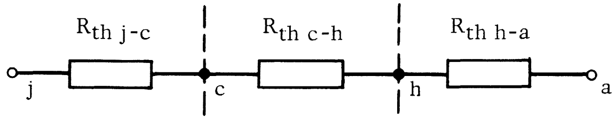
Temperatures

Storage temperature	T_{stg}		-55 to +90	°C
Junction temperature: continuous	T_j	max.	90	°C
incidentally	T_j	max.	100	°C

[1]) Limiting values according to the Absolute Maximum System as defined in IEC publication 134.

THERMAL RESISTANCE

From junction to ambient in free air		AC127	AC127/01	
without cooling clip	$R_{th\ j\text{-}a}$ =	370	250	°C/W
with cooling clip 56227 on 1.5 mm blackened Al. heatsink of 12.5 cm^2	$R_{th\ j\text{-}a}$ =	160		°C/W
with cooling clip 56227 on infinite heatsink	$R_{th\ j\text{-}a}$ =	125		°C/W
From junction to case	$R_{th\ j\text{-}c}$ =	110	115	°C/W



	$R_{th\ j\text{-}c}$	$R_{th\ c\text{-}h}$	$R_{th\ h\text{-}a}$	
AC127 with clip 56227	110	15		°C/W
AC127/01	115	0.5		°C/W

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

Collector cut-off current

$I_E = 0$; $V_{CB} = 0.5$ V	I_{CBO}	<	10	μA
$I_E = 0$; $V_{CB} = 32$ V; $T_j = 75$ °C	I_{CBO}	<	1100	μA

Emitter cut-off current

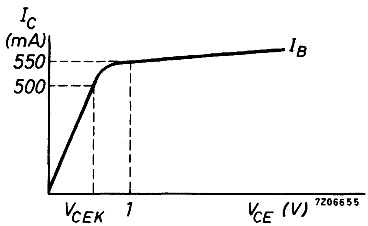
$I_C = 0$; $V_{EB} = 5$ V; $T_j = 75$ °C	I_{EBO}	<	550	μA

Emitter-base voltage

$-I_E = 2$ mA; $V_{CB} = 5$ V	$-V_{EB}$	typ.	120	mV
$-I_E = 500$ mA; $V_{CB} = 0$	$-V_{EB}$	<	1200	mV

Knee voltage

$I_C = 500$ mA; I_B = value for which $I_C = 550$ mA at $V_{CE} = 1$ V	V_{CEK}	<	1	V



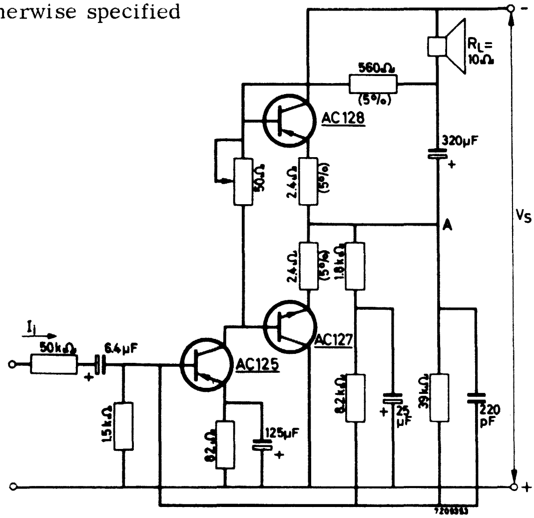
CHARACTERISTICS (continued) T_{amb} = 25 °C unless otherwise specified

D.C. current gain				
I_C = 20 mA; V_{CB} = 0	h_{FE}	typ.	100	
I_C = 50 mA; V_{CB} = 0	h_{FE}	typ.	105	
I_C = 200 mA; V_{CB} = 0	h_{FE}	typ.	90	
I_C = 500 mA; V_{CB} = 0	h_{FE}	typ.	50	
Collector capacitance at f = 0.45 MHz				
$I_E = I_e$ = 0; V_{CB} = 5 V	C_c	typ.	70	pF
Feedback impedance at f = 0.45 MHz				
I_C = 1 mA; V_{CE} = 5 V	$\|z_{rb}\|$	typ.	70	Ω
Transition frequency				
I_C = 10 mA; V_{CE} = 2 V	f_T	>	1.5	MHz
		typ.	2.5	MHz
Cut-off frequency				
I_C = 10 mA; V_{CE} = 2 V	f_{hfe}	>	10	kHz
		typ.	20	kHz
Noise figure at f = 1 kHz				
I_C = 0.5 mA; V_{CE} = 5 V; R_S = 500 Ω Bandwidth = 200 Hz	F	typ.	4	dB
		<	10	dB
D.C. current gain ratio of matched pair AC127/AC128				
$\|I_C\|$ = 300 mA; V_{CB} = 0	h_{FE1}/h_{FE2}	typ.	1.1	
matched pair AC127/AC132				
$\|I_C\|$ = 50 mA; V_{CB} = 0	h_{FE1}/h_{FE2}	typ.	1.1	
		<	1.25	

APPLICATION INFORMATION

1. AC127/AC128 as matched pair in a class B amplifier with complementary symmetry delivering an output power of 550 mW.

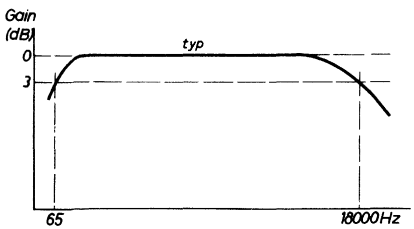
Tolerance of resistors:
10% unless otherwise specified



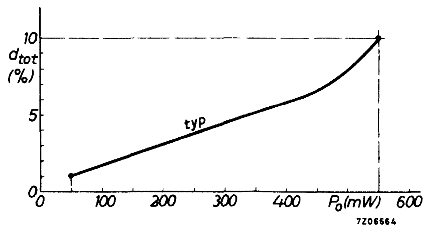
Stable continuous operation is ensured up to an ambient temperature of 45 °C, provided each transistor is mounted with a cooling fin type No. 56226.

OPERATING CHARACTERISTICS T_{amb} = 25 °C

Supply voltage	V_S	=	9	V
Output power (d_{tot} = 10%)	P_o	>	500	mW
		typ.	550	mW



Typical frequency response



Typical distortion as a function of output power

APPLICATION INFORMATION (continued)

Output stage

Emitter current (zero signal)	$\lvert I_E \rvert$	=	3	mA
Collector current (peak value)	$\lvert I_{CM} \rvert$	typ.	300	mA
Midtap voltage at point A	V_A	typ.	4.9	V

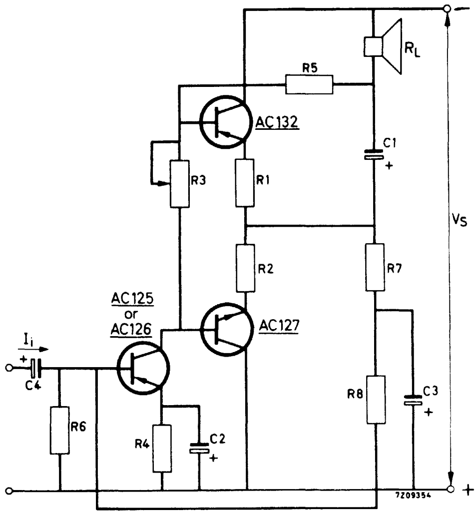
Driver stage

Collector current	$-I_C$	typ.	7	mA

Sensitivity

Input current (P_o = 550 mW)	$I_{i(rms)}$	typ.	120	µA
Input current (P_o = 50 mW)	$I_{i(rms)}$	typ.	35	µA

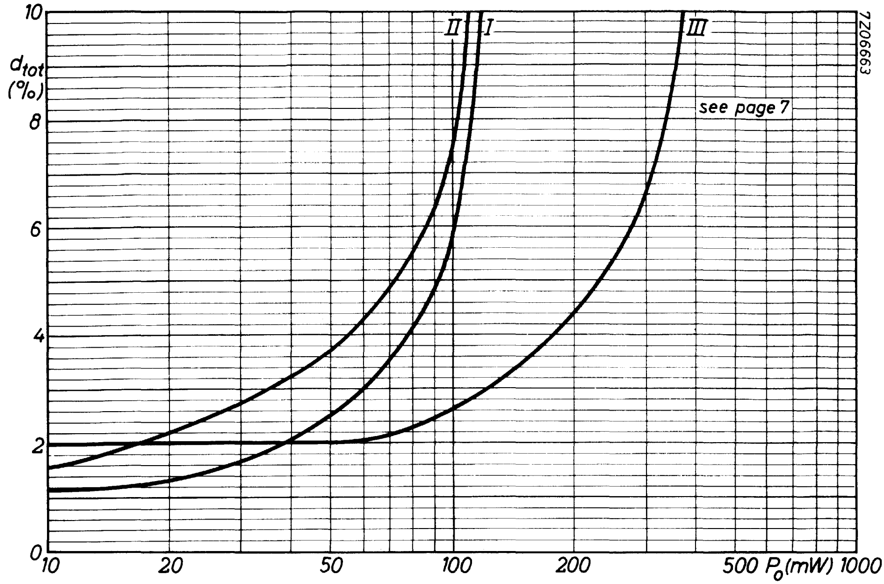
2. AC127/AC132 as matched pair in a class B amplifier with complementary symmetry delivering an output power of 370 mW.

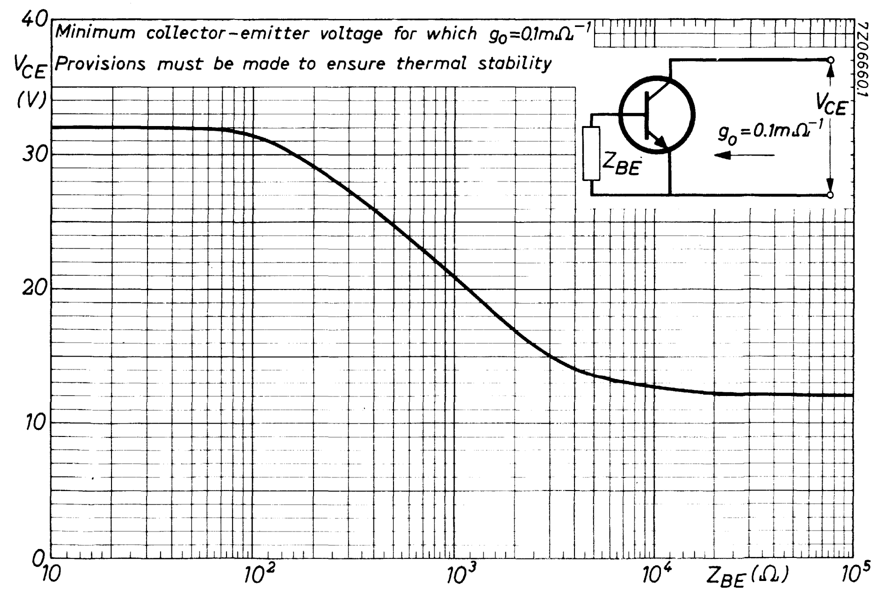


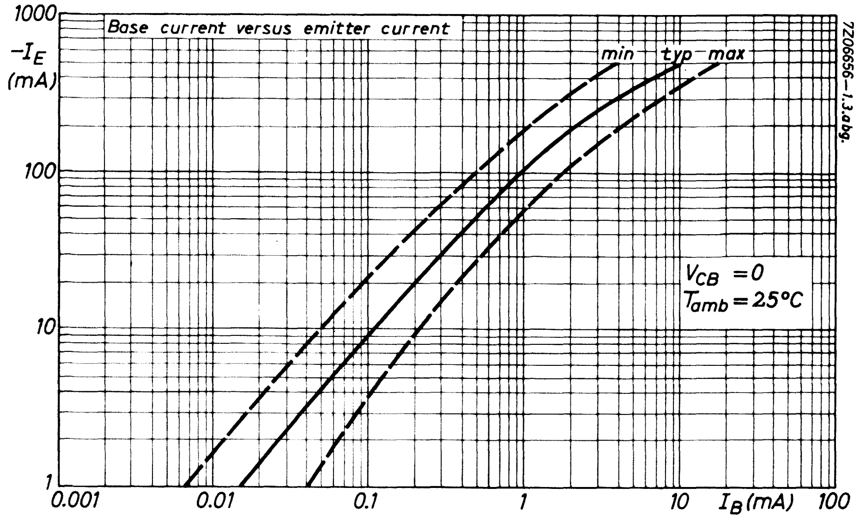
Stable continuous operation is ensured up to an ambient temperature of 45 °C, provided each transistor is mounted with a cooling fin.

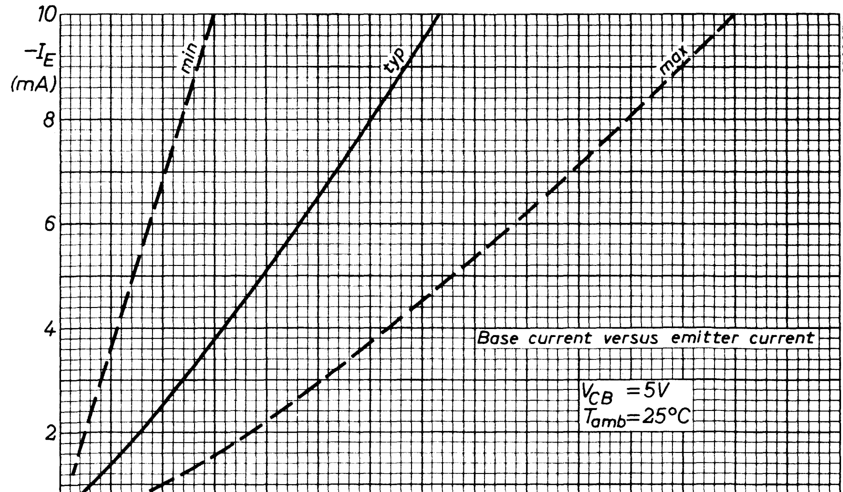
APPLICATION INFORMATION (continued)

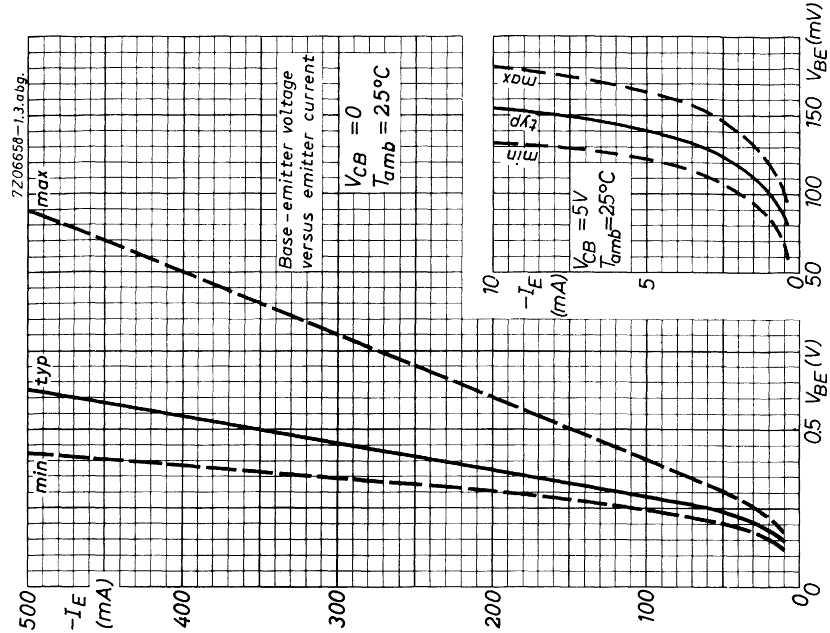
			I	II	III	
Supply voltage	V_S	=	6	9	9	V
Output power (at d = 10%)	P_o	typ.	115	110	370	mW
		>	105	100	300	mW
Distortion	d_{tot}	See page 8				
Output stage						
Emitter current (zero signal)	I_{E_1}	=	2	2	2	mA
	$-I_{E_2}$	=	2	2	2	mA
Emitter resistors	R1	=	3.3	4.7	3.9	Ω
	R2	=	3.3	4.7	3.9	Ω
Bias resistor	R3	<	100	250	50	Ω
Coupling capacitor	C1	=	200	64	320	μF
Load resistance	R_L	=	25	70	15	Ω
Collector current (peak value) at P_o max.	$\lvert I_{CM} \rvert$	typ.	90	50	200	mA
Driver stage						
Collector current	$-I_C$	typ.	2.7	1.2	7.6	mA
Emitter resistor	R4	=	180	680	82	Ω
Collector resistor	R5	=	910	3300	510	Ω
Bias resistors	R6	=	4.7	6.8	1.8	kΩ
	R7	=	3.9	4.7	2.2	kΩ
	R8	=	15	24	6.8	kΩ
Decoupling capacitors	C2	=	40	25	120	μF
	C3	=	25	25	25	μF
Coupling capacitor	C4	=	6.4	6.4	6.4	μF
Input current at P_o max.						
with AC125	$I_{i(rms)}$	typ.	20	10	55	μA
with AC126	$I_{i(rms)}$	typ.	15	8	40	μA
Input current at P_o = 50 mW						
with AC125	$I_{i(rms)}$	typ.	11.5	6	17	μA
with AC126	$I_{i(rms)}$	typ.	9	4.5	12.5	μA
Total harmonic distortion at P_o = 50 mW	d_{tot}	typ.	2.5	3.8	2.0	%

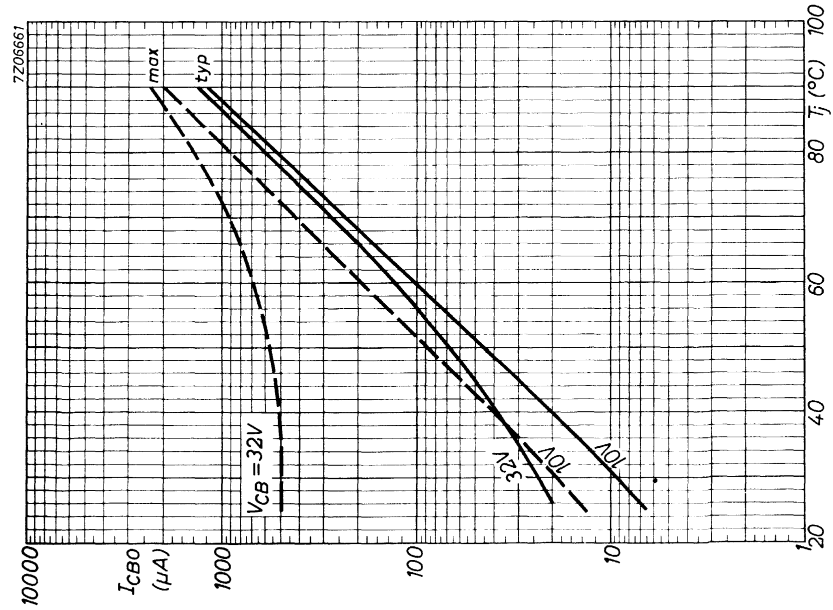

7Z06663
d_{tot} (%)
II
I
III
see page 7
500 P_o(mW) 1000
0
2
4
6
8
10
10
20
50
100
200


7Z06660.1
V_{CE} (V)
Minimum collector-emitter voltage for which $g_o = 0.1 m\Omega^{-1}$
Provisions must be made to ensure thermal stability
Z_{BE}
V_{CE}
$g_o = 0.1 m\Omega^{-1}$
Z_{BE} (Ω)
0
10
20
30
40
10
10^2
10^3
10^4
10^5


Base current versus emitter current
1000
100
10
1
$-I_E$ (mA)
0.001
0.01
0.1
1
10
I_B (mA)
100
min
typ
max
V_{CB} = 0
T_{amb} = 25°C
7Z06656-1.3.abg.


10
$-I_E$ (mA)
8
6
4
2
0
0
20
40
60
80
100
120
I_B (μA)
140
min
typ
max
Base current versus emitter current
V_{CB} = 5V
T_{amb} = 25°C
7Z06659


7Z06658-1.3.abg.
Base-emitter voltage versus emitter current
V_{CB} = 0
T_{amb} = 25°C
max
typ
min
$-I_E$ (mA)
V_{BE} (V)
V_{BE} (mV)
V_{CB} = 5V
T_{amb} = 25°C


7Z06661
max
typ
V_{CB} = 32V
32V
10V
10V
I_{CBO} (μA)
T_j (°C)

GERMANIUM ALLOY TRANSISTORS

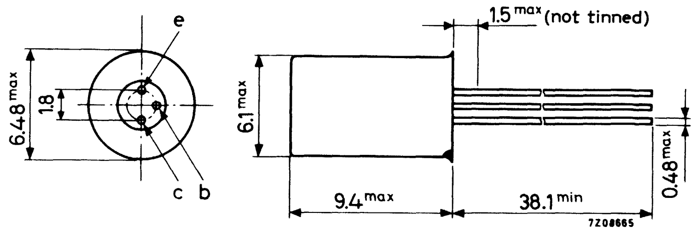
The AC128 is a p-n-p audio transistor in a TO-1 metal envelope.
The AC128 is intended for use in class A or class B output stages with battery voltages up to 14 V and an output power of up to 4 W.
Type 2-AC128 consists of 2 transistors AC128 selected for operation in a low distortion class B amplifier.
The AC128/01 is electrically equivalent to the AC128, constructed integrally with a heat conducting block which gives better heat transfer.
The thermal resistance from junction to heatsink shows an improvement (≈ 10 °C/W) as compared with that obtained with the AC128 when using heat conducting clip 56227.
Type 2-AC128 and type 2-AC128/01 consist of 2 transistors AC128 and AC128/01 resp. selected for operation in a low distortion class B amplifier.

QUICK REFERENCE DATA

Collector-base voltage (open emitter)	$-V_{CBO}$	max.	32	V
Collector-emitter voltage (open base)	$-V_{CEO}$	max.	16	V
Collector current (d.c.)	$-I_C$	max.	1	A
Total power dissipation up to T_{amb} = 25 °C with cooling fin on a heatsink of at least 12.5 cm^2	P_{tot}	max.	1	W
Junction temperature (incidentally)	T_j	max.	100	°C
D.C. current gain at T_{amb} = 25 °C; $-I_C$ = 50 mA; V_{CB} = 0	h_{FE}	typ.	90	
			55 to 175	
Transition frequency; $-I_C$ = 10 mA; $-V_{CE}$ = 2 V	f_T	typ.	1.5	MHz

MECHANICAL DATA Dimensions in mm

AC128
TO-1

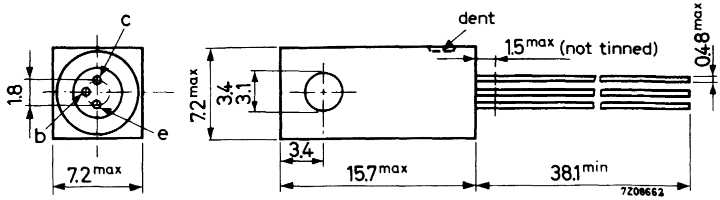


The coloured dot indicates the collector

Accessories available: 56200, 56208, 56209, 56210, 56226, 56227

MECHANICAL DATA (continued) Dimensions in mm

AC128/01



The dent indicates the collector

RATINGS (Limiting values) [1])

Voltages

Collector-base voltage (open emitter)	$-V_{CBO}$	max.	32	V
Collector-emitter voltage (open base)	$-V_{CEO}$	max.	16	V
Collector-emitter voltage with $R_{BE} < 400\ \Omega$	$-V_{CER}$	max.	32	V
Emitter-base voltage (open collector)	$-V_{EBO}$	max.	10	V

Currents

Collector current (d.c.)	$-I_C$	max.	1000	mA
Collector current (peak value)	$-I_{CM}$	max.	2000	mA
→ Emitter current (peak value)	I_{EM}	max.	2000	mA

Power dissipation

Total power dissipation up to $T_{amb} = 25\ ^oC$ with cooling fin mounted on a heatsink of at least 12.5 cm^2	P_{tot}	max.	1000	mW

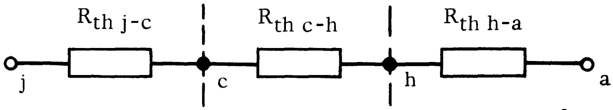
Temperatures

Storage temperature	T_{stg}		-55 to +100	^oC
Junction temperature: continuous	T_j	max.	90	^oC
incidentally	T_j	max.	100	^oC

1) Limiting values according to the Absolute Maximum System as defined in IEC publication 134.

THERMAL RESISTANCE

From junction to ambient in free air		AC128	AC128/01	
without cooling clip	$R_{th\ j\text{-}a}$	= 290	180	°C/W
with cooling clip 56227	$R_{th\ j\text{-}a}$	= 140		°C/W
with cooling clip 56227 on 1.5 mm blackened Al. heatsink of 12.5 cm^2	$R_{th\ j\text{-}a}$	= 80		°C/W
with cooling clip 56227 on infinite heatsink	$R_{th\ j\text{-}a}$	= 55		°C/W
From junction to case	$R_{th\ j\text{-}c}$	= 40	45	°C/W



	$R_{th\ j\text{-}c}$	$R_{th\ c\text{-}h}$	$R_{th\ h\text{-}a}$	
AC128 with clip 56227	40	15		°C/W
AC128/01	45	0.5		°C/W

CHARACTERISTICS

T_{amb} = 25 °C unless otherwise specified

Collector cut-off current

$I_E = 0$; $-V_{CB} = 10$ V	$-I_{CBO}$	<	10	μA
$I_E = 0$; $-V_{CB} = 32$ V	$-I_{CBO}$	<	200	μA

Emitter cut-off current

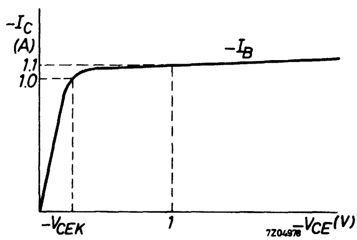
$I_C = 0$; $-V_{EB} = 10$ V	$-I_{EBO}$	<	200	μA
$I_C = 0$; $-V_{EB} = 5$ V; $T_j = 75$ °C	$-I_{EBO}$	<	500	μA

Emitter-base voltage

$I_E = 50$ mA; $V_{CB} = 0$	V_{EB}	<	300	mV
$I_E = 300$ mA; $V_{CB} = 0$	V_{EB}	<	450	mV

Knee voltage

$-I_C = 1$ A; $-I_B$ = value for which $-I_C = 1.1$ A at $-V_{CE} = 1$ V	$-V_{CEK}$	<	0.6	V



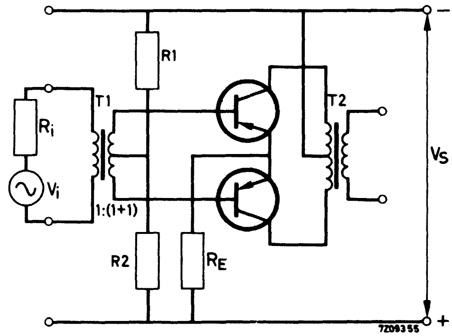
CHARACTERISTICS (continued) T_{amb} = 25 °C unless otherwise specified

D.C. current gain		
$-I_C$ = 50 mA; V_{CB} = 0	h_{FE}	typ. 90 55 to 175
$-I_C$ = 300 mA; V_{CB} = 0	h_{FE}	typ. 90 60 to 175
$-I_C$ = 1 A; V_{CB} = 0	h_{FE}	typ. 80 45 to 165
Collector capacitance		
$I_E = I_e$ = 0; $-V_{CB}$ = 5 V	C_c	typ. 100 pF
Base resistance		
$-I_C$ = 1 mA; $-V_{CE}$ = 5 V	$r_{bb'}$	typ. 25 Ω
Transition frequency		
$-I_C$ = 10 mA; $-V_{CE}$ = 2 V	f_T	> 1.0 MHz typ. 1.5 MHz
Cut-off frequency		
$-I_C$ = 10 mA; $-V_{CE}$ = 2 V	f_{hfe}	> 10 kHz typ. 15 kHz
Small signal current gain linearity		
(see also page 10)	λ_{500}	> 0.50 1) typ. 0.60 1)
D.C. current gain ratio of matched pair AC127/AC128		
$\lvert I_C \rvert$ = 300 mA; V_{CB} = 0	h_{FE1}/h_{FE2}	typ. 1.1
matched pair 2-AC128		
$\lvert I_C \rvert$ = 50 mA; V_{CB} = 0	h_{FE1}/h_{FE2}	typ. 1.1 < 1.25
$\lvert I_C \rvert$ = 300 mA; V_{CB} = 0	h_{FE1}/h_{FE2}	typ. 1.1 < 1.25

1) $\lambda_{500} = \frac{A_i \text{ at } 500 \text{ mA}}{A_{i\,max}}$, where A_i = loaded small signal current amplification.

APPLICATION INFORMATION

Class B operation with matched pair 2-AC128



To provide stability the total resistance in the base circuit of each transistor should be less than 100 Ω.

Supply voltage	V_S	=	6	9	9	V
Ambient temperature	T_{amb}	up to	55	55	45	°C
Emitter current (zero signal)	I_E	=	2x3	2x3	2x3	mA
Bias resistor [1]	R1	=	2.0	2.2	3.5[2]	kΩ
Bias resistor [1]	R2	=	47	39	[3]	Ω
Common emitter resistor	R_E	=	2.2	3.9	1.5	Ω
Input (source) resistance	R_i	=	1.5	1.5	1.0	kΩ
Load resistance	$R_{cc\sim}$	=	65	98	62	Ω
Dissipation (two transistors) [4]	P_{tot}	typ.	2x0.425	2x0.65	2x1.05	W
Power delivered to transformer	P_o	typ.	0.75	1.1	1.9	W
Collector current (peak value) at P_o max	$-I_{CM}$	typ.	300	300	500	mA
Collector current at P_o max	$-I_C$	typ.	2x95	2x95	2x150	mA
Input voltage at P_o max	V_i	typ.	5.5	6.0	6.6[5]	V
Total harmonic distortion at P_o max	d_{tot}	typ.	3.5	4.0	5.5	%
Input voltage at P_o = 50 mW	V_i	typ.	1.6	1.4	1.1[5]	V
Total harmonic distortion at P_o = 50 mW	d_{tot}	typ.	2.0	2.0	2.5	%

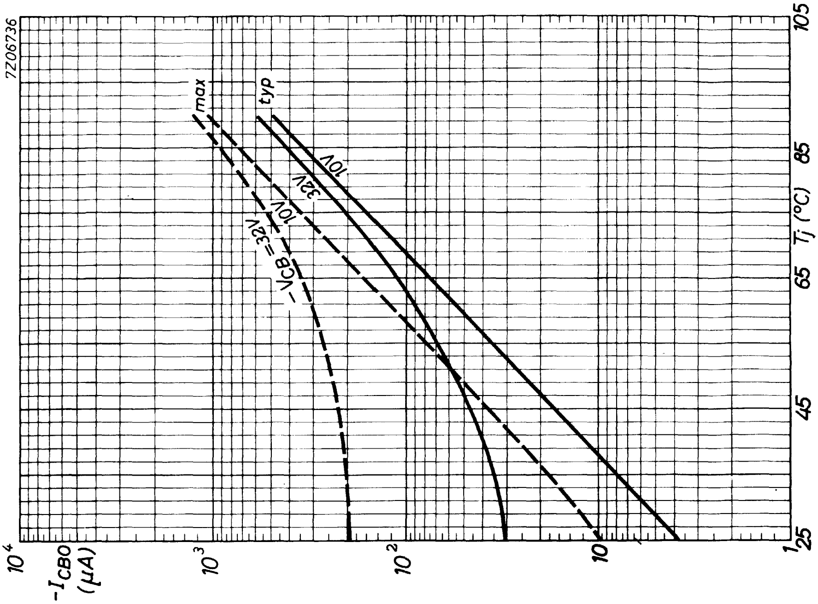
1) Tolerance of bias resistors: 5 %

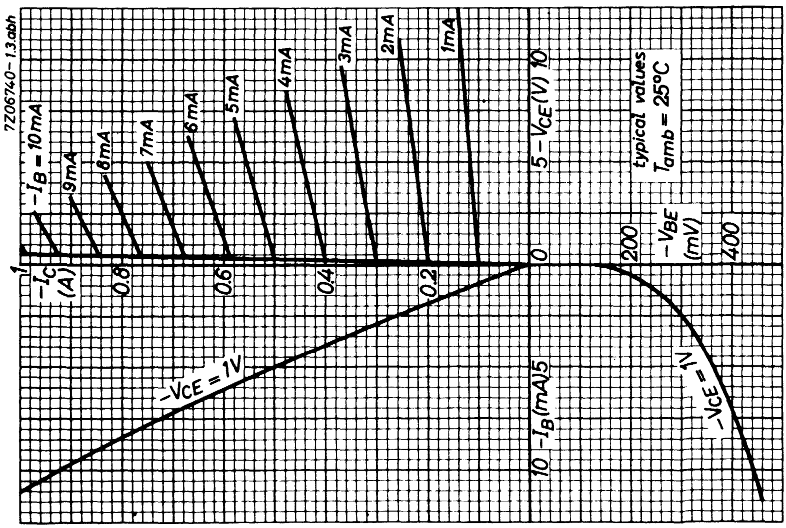
2) Variable resistor

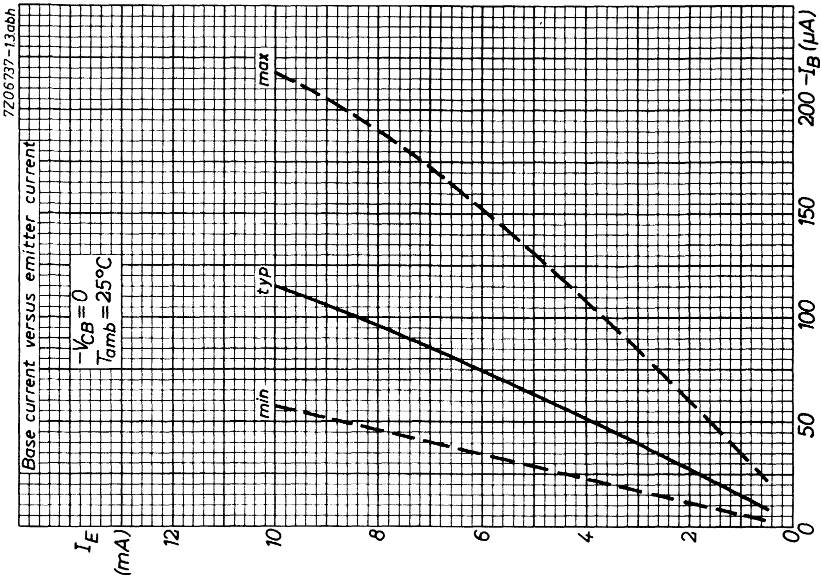
3) This resistance is composed of a 68 Ω resistor in parallel with a 130 Ω NTC resistor. Code number 2322 610 12131.

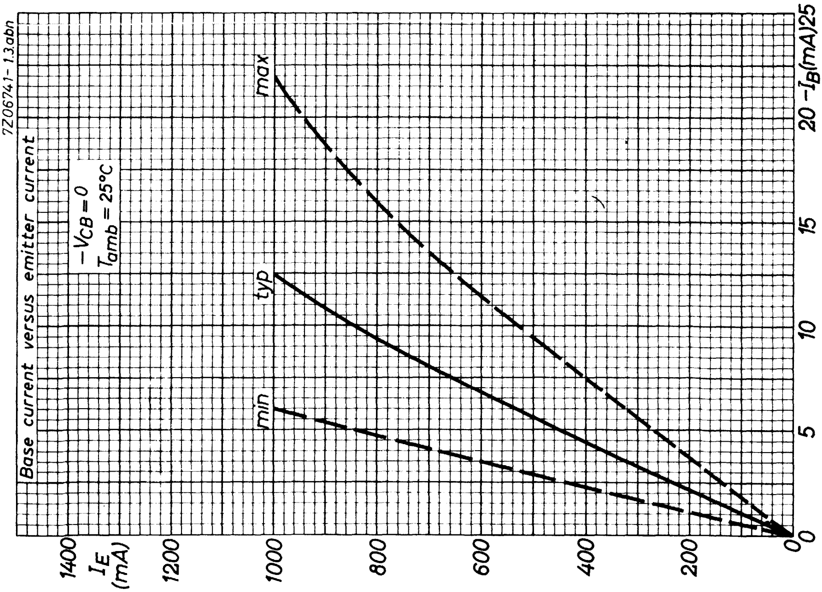
4) Mounted on cooling fin 56227 at T_{amb} up to 20 °C.

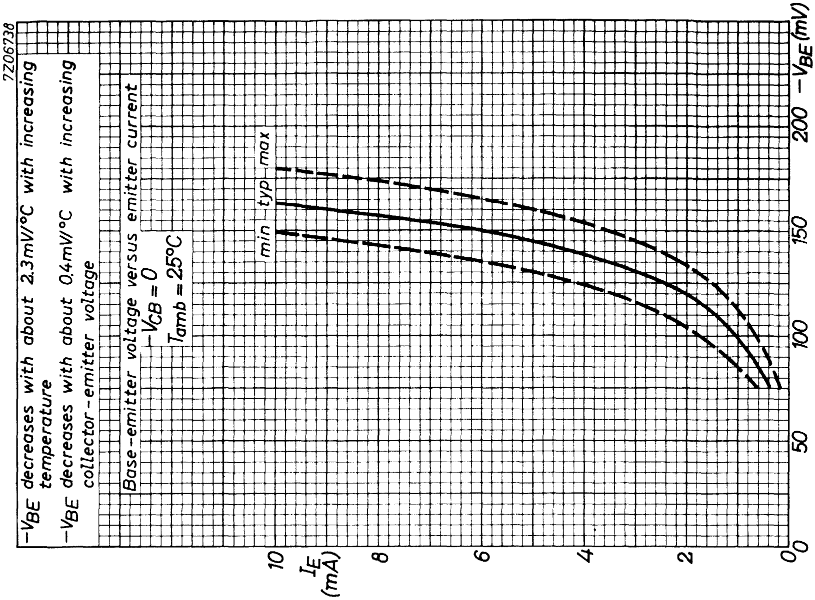
5) Losses in the driver transformer are not taken into account.

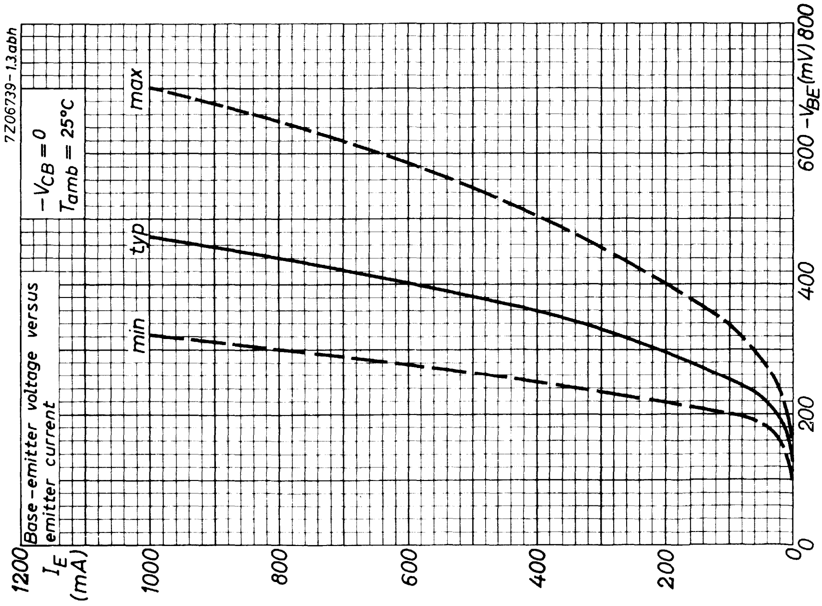

7Z06736
max
typ
10V
32V
10V
$-V_{CB}$ = 32V
$-I_{CBO}$ (μA)
10^4
10^3
10^2
10
1
T_j (°C)
25
45
65
85
105

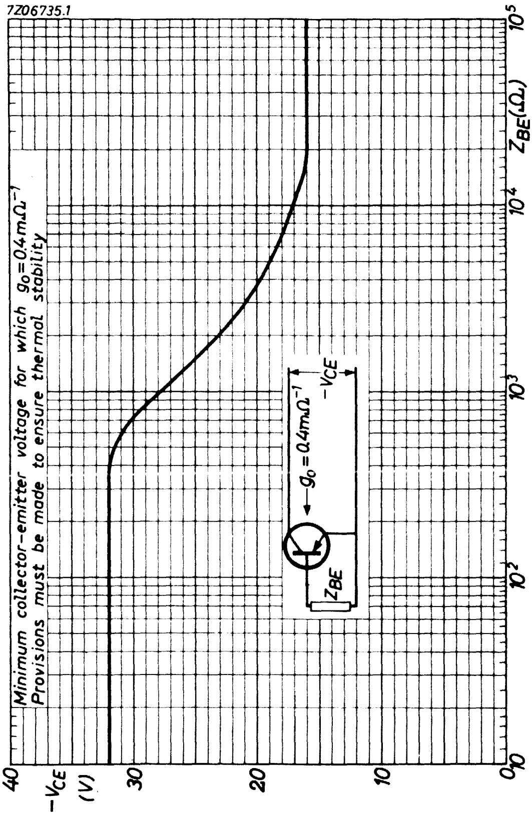

7Z06740-1.3.abh
$-I_B$ = 10 mA
9mA
8mA
7mA
6mA
5mA
4mA
3mA
2mA
1mA
$-V_{CE}$(V)
0
5
10
$-I_C$ (A)
1
0.8
0.6
0.4
0.2
$-V_{CE}$ = 1V
$-I_B$(mA)
5
10
200
400
$-V_{BE}$ (mV)
$-V_{CE}$ = 1V
typical values
T_{amb} = 25°C

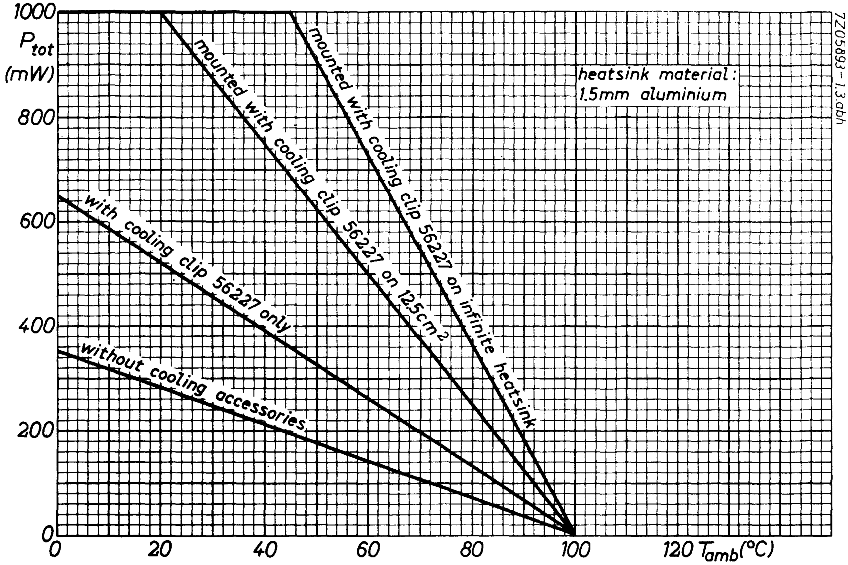

7Z06737-1.3abh
Base current versus emitter current
−VCB = 0
Tamb = 25°C
max
typ
min
IE (mA)
12
10
8
6
4
2
0
0
50
100
150
200 −IB (μA)

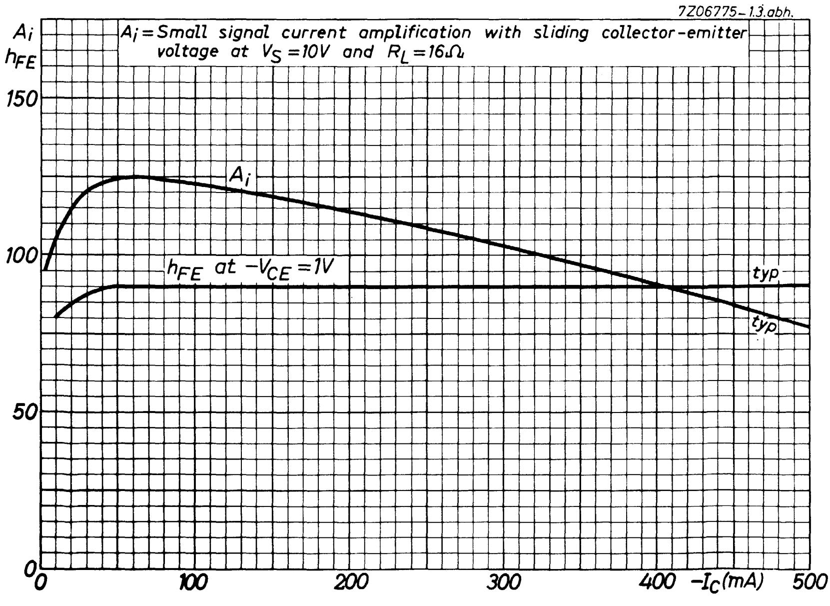

7Z06741-1.3abn
Base current versus emitter current
−VCB = 0
Tamb = 25°C
max
typ
min
1400 IE (mA)
1200
1000
800
600
400
200
0
0
5
10
15
20 −IB (mA) 25


7Z06738
−V_BE decreases with about 2.3mV/°C with increasing temperature
−V_BE decreases with about 0.4mV/°C with increasing collector-emitter voltage
Base-emitter voltage versus emitter current
−V_CB = 0
T_amb = 25°C
min
typ
max
I_E (mA)
10
8
6
4
2
0
0
50
100
150
200
−V_BE (mV)


7Z06739-1.3abh
−V_CB = 0
T_amb = 25°C
Base-emitter voltage versus emitter current
min
typ
max
I_E (mA)
1200
1000
800
600
400
200
0
0
200
400
600
−V_BE (mV) 800


7Z06735.1
Minimum collector-emitter voltage for which g0=0.4mΩ-1
Provisions must be made to ensure thermal stability
-g0=0.4mΩ-1
-VCE
ZBE
-VCE (V)
40
30
20
10
0
10
10²
10³
10⁴
10⁵
ZBE(Ω)


7Z05893-1.3.abh
1000
P_{tot}
(mW)
800
600
400
200
0
0
20
40
60
80
100
120 T_{amb}(°C)
heatsink material:
1.5mm aluminium
mounted with cooling clip 56227 on infinite heatsink
mounted with cooling clip 56227 on 12,5cm²
with cooling clip 56227 only
without cooling accessories


7Z06775-1.3.abh.
A_i
h_{FE}
150
100
50
0
0
100
200
300
400
$-I_C$(mA)
500
A_i=Small signal current amplification with sliding collector-emitter voltage at V_S=10V and R_L=16Ω
A_i
h_{FE} at $-V_{CE}$=1V
typ
typ

SYMMETRICAL GERMANIUM TRANSISTOR

N-P-N transistor in a TO-1 metal envelope. The AC130 is primarily intended for use in horizontal deflection synchronization circuits.

RATINGS Limiting values according to the Absolute Maximum System as defined in IEC publication 134.

Collector-base voltage (open emitter)	V_{CBO}	max.	20	V
Collector-emitter voltage (open base)	V_{CEO}	max.	10	V
Collector-emitter voltage with $R_{BE} \leq 10\,k\Omega$	V_{CER}	max.	15	V
Collector current (d.c.)	I_C	max.	100	mA
Total power dissipation up to $T_{amb} = 25\,^oC$	P_{tot}	max.	145	mW
Junction temperature	T_j	max.	90	^oC

THERMAL RESISTANCE

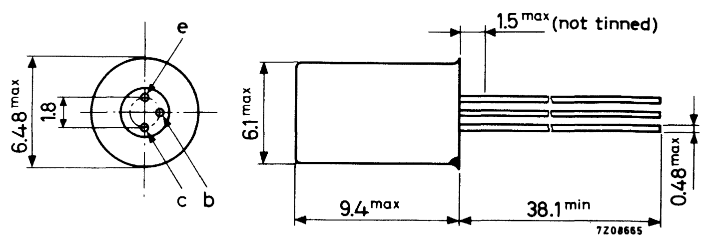
From junction to ambient in free air	$R_{th\ j\text{-}a}$	=	0.45	$^oC/mW$

CHARACTERISTICS $T_j = 25\,^oC$ unless otherwise specified

Saturation voltages				
$I_C = 10$ mA; $I_B = 1$ mA	V_{CEsat}	typ.	15	mV
	V_{BEsat}	typ.	245	mV
D.C. current gain				
$I_C = 10$ mA; $V_{CE} = 1$ V	h_{FE}	>	25	
		typ.	65	
Ration between h_{FE} and h_{FC}				
for each individual transistor	$\frac{h_{FE}}{h_{FC}}$	typ.	1	
			0.5 to 2	
Transition frequency				
$I_C = 10$ mA; $V_{CE} = 1$ V	f_T	>	2	MHz

MECHANICAL DATA Dimensions in mm

TO-1



The coloured dot indicates the collector.

Because of its very good symmetrical properties the collector and emitter can be connected interchangeably.

GERMANIUM ALLOY TRANSISTORS

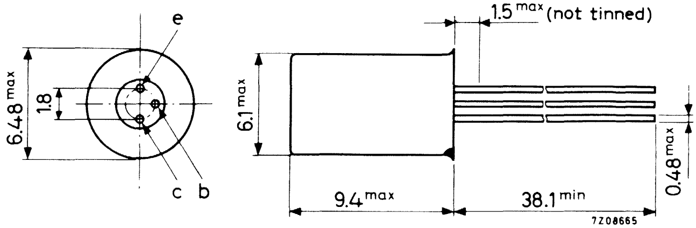
The AC132 is a p-n-p audio transistor in a TO-1 metal envelope.
The AC132 is intended for use together with the n-p-n transistor AC127 as matched pair AC127/AC132 in class B output stages with complementary symmetry.
The 2-AC132 consists of 2 transistors AC132 selected for operation in class B output stages.
The AC132/01 is electrically equivalent to the AC132, constructed integrally with a heat conducting block which gives better heat transfer.
The thermal resistance from junction to heatsink shows an improvement (≈ 10 °C/W) as compared with that obtained with the AC132 when using heat conducting clip 56227.

QUICK REFERENCE DATA

Collector-base voltage (open emitter)	$-V_{CBO}$	max.	32	V
Collector-emitter voltage (open base)	$-V_{CEO}$	max.	12	V
Collector current (d.c.)	$-I_C$	max.	200	mA
Total power dissipation up to T_{amb} = 45 °C with cooling fin on a heatsink of at least 12.5 cm^2	P_{tot}	max.	500	mW
Junction temperature	T_j	max.	90	°C
D.C. current gain at T_{amb} = 25 °C $-I_C$ = 20 mA; V_{CB} = 0	h_{FE}	typ.	135	
Transition frequency $-I_C$ = 10 mA; $-V_{CE}$ = 2 V	f_T	typ.	2.0	MHz

MECHANICAL DATA Dimensions in mm

AC132
TO-1

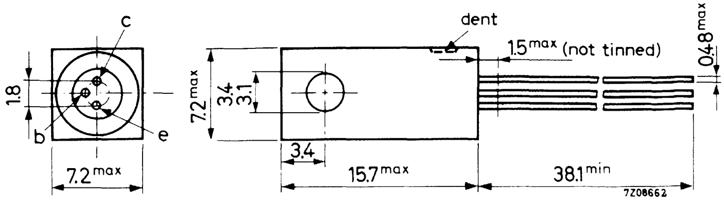


The coloured dot indicates the collector

Accessories available: 56200, 56208, 56209, 56210, 56226, 56227

MECHANICAL DATA (continued) Dimensions in mm

AC132/01



The dent indicates the collector

RATINGS (Limiting values) [1])

Voltages

Collector-base voltage (open emitter)	$-V_{CBO}$	max.	32	V
Collector-emitter voltage (open base)	$-V_{CEO}$	max.	12	V
Collector-emitter voltage with $R_{BE} < 1$ kΩ	$-V_{CER}$	max.	32	V
Emitter-base voltage (open collector)	$-V_{EBO}$	max.	10	V

Currents

Collector current (d.c.)	$-I_C$	max.	200	mA
→ Emitter current (peak value)	I_{EM}	max.	200	mA

Power dissipation

Total power dissipation up to T_{amb} = 45 °C with cooling fin mounted on a heatsink of at least 12.5 cm^2	P_{tot}	max.	500	mW

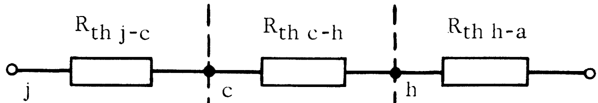
Temperatures

Storage temperature	T_{stg}		-55 to +90	°C
Junction temperature	T_j	max.	90	°C

[1]) Limiting values according to the Absolute Maximum System as defined in IEC publication 134.

THERMAL RESISTANCE

		AC132	AC132/01	
From junction to ambient in free air				
without cooling clip	$R_{th\ j\text{-}a}$ =	300	190	°C/W
with cooling clip 56227 on 1.5 mm blackened Al. heatsink of 12.5 cm^2	$R_{th\ j\text{-}a}$ =	90		°C/W
with cooling clip 56227 on infinite heatsink	$R_{th\ j\text{-}a}$ =	65		°C/W
From junction to case	$R_{th\ j\text{-}c}$ =	50	55	°C/W



	j–c	c–h	h–a	
AC132 with clip 56227	50	15		°C/W
AC132/01	55	0.5		°C/W

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

Collector cut-off current

$I_E = 0$; $-V_{CB} = 0.5$ V	$-I_{CBO}$	<	10	μA
$I_E = 0$; $-V_{CB} = 32$ V; $T_j = 75$ °C	$-I_{CBO}$	<	800	μA

Emitter cut-off current

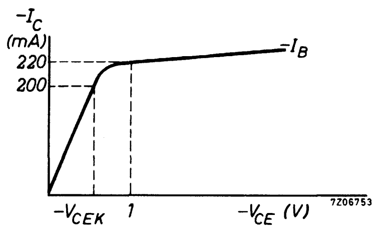
$I_C = 0$; $-V_{EB} = 5$ V; $T_j = 75$ °C	$-I_{EBO}$	<	550	μA

Emitter-base voltage

$I_E = 2$ mA; $-V_{CB} = 5$ V	V_{EB}	typ.	105	mV
$I_E = 200$ mA; $V_{CB} = 0$	V_{EB}	<	550	mV

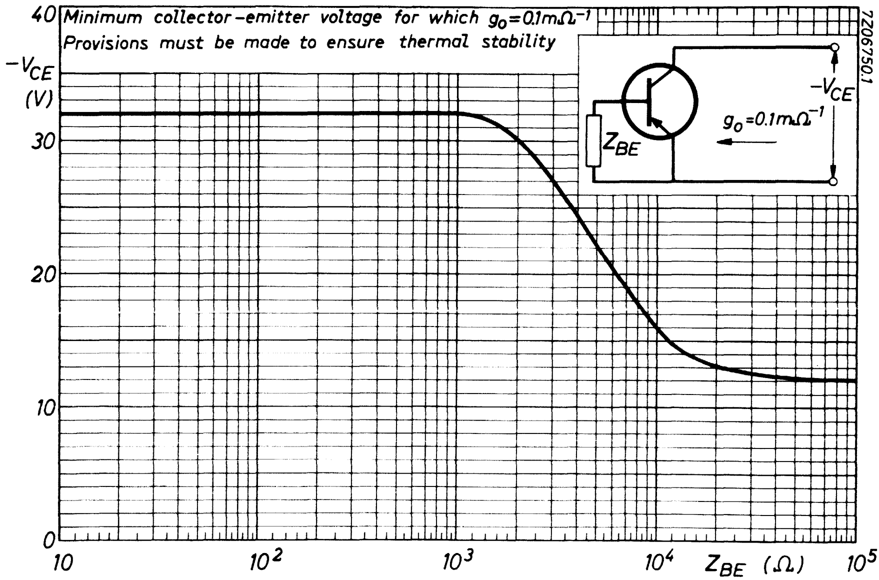
Knee voltage

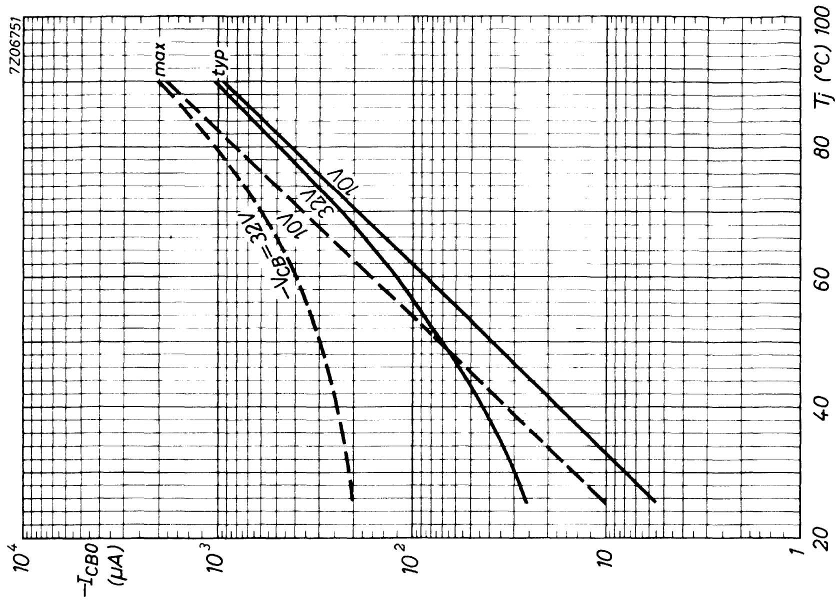
$-I_C = 200$ mA; $-I_B$ = value for which $-I_C = 220$ mA at $-V_{CE} = 1$ V	$-V_{CEK}$	<	350	mV

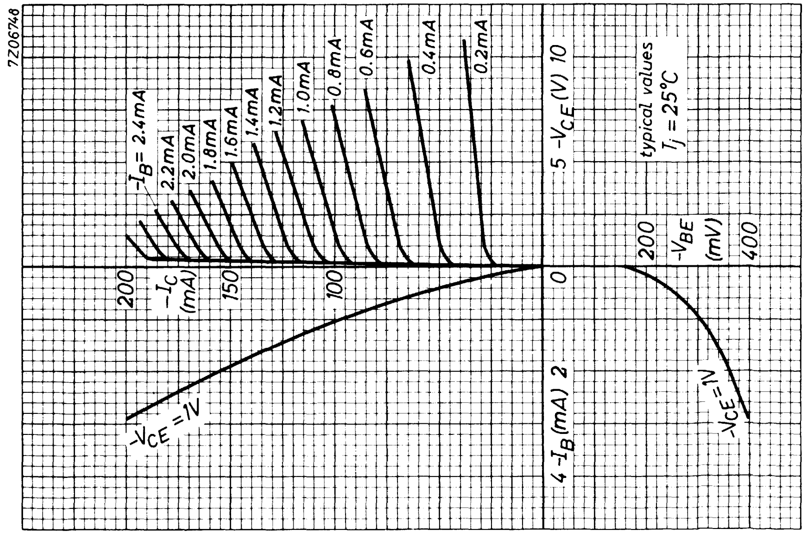


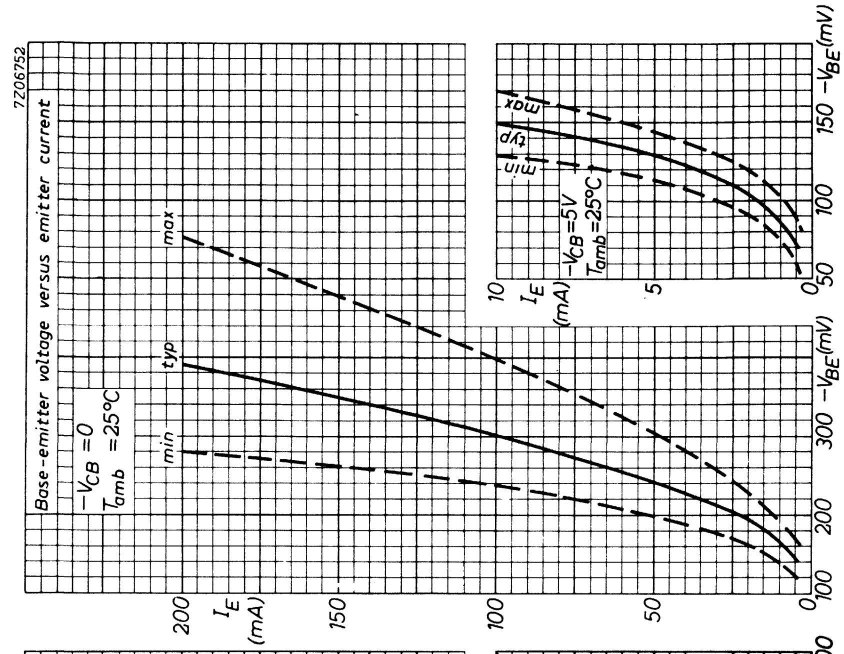
CHARACTERISTICS (continued) T_{amb} = 25 °C unless otherwise specified

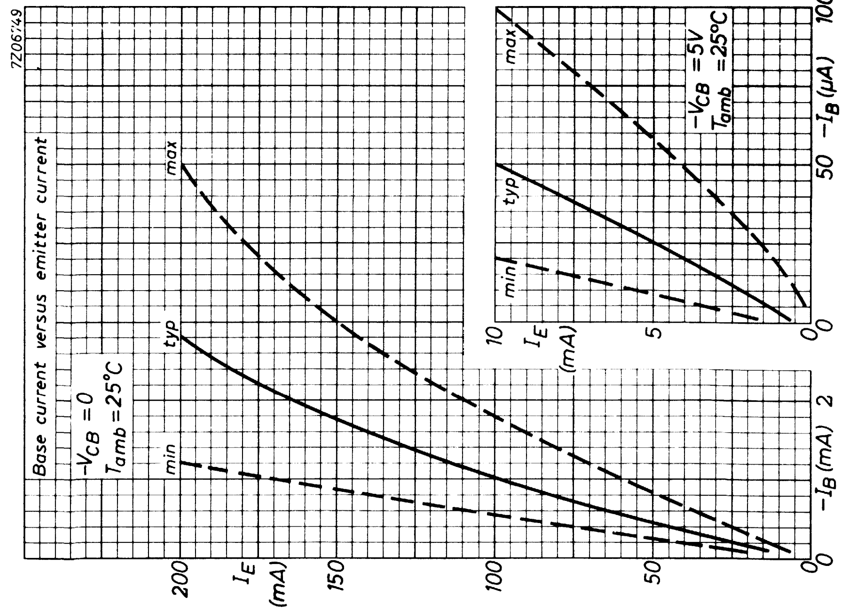
D.C. current gain				
$-I_C$ = 20 mA; V_{CB} = 0	h_{FE}	typ.	135	
$-I_C$ = 50 mA; V_{CB} = 0	h_{FE}	typ.	115	
$-I_C$ = 200 mA; V_{CB} = 0	h_{FE}	typ.	70	
Collector capacitance at f = 0.45 MHz				
$I_E = I_e$ = 0; $-V_{CB}$ = 5 V	C_c	typ.	40	pF
Feedback impedance at f = 0.45 MHz				
$-I_C$ = 1 mA; $-V_{CE}$ = 5 V	$\|z_{rb}\|$	typ.	90	Ω
Transition frequency				
$-I_C$ = 10 mA; $-V_{CE}$ = 2 V	f_T	>	1.3	MHz
		typ.	2.0	MHz
Cut-off frequency				
$-I_C$ = 10 mA; $-V_{CE}$ = 2 V	f_{hfe}	>	10	kHz
		typ.	17	kHz
Noise figure at f = 1 kHz				
$-I_C$ = 0.5 mA; $-V_{CE}$ = 5 V; R_S = 500 Ω Bandwidth = 200 Hz	F	typ.	4	dB
		<	10	dB
D.C. current gain ratio of matched pair AC127/AC132				
$\|I_C\|$ = 50 mA; V_{CB} = 0	h_{FE1}/h_{FE2}	typ.	1.1	
		<	1.25	
matched pair 2-AC132				
$\|I_C\|$ = 20 mA; V_{CB} = 0	h_{FE1}/h_{FE2}	typ.	1.1	
		<	1.25	
$\|I_C\|$ = 200 mA; V_{CB} = 0	h_{FE1}/h_{FE2}	typ.	1.1	
		<	1.25	


Minimum collector-emitter voltage for which $g_o = 0.1 m\Omega^{-1}$
Provisions must be made to ensure thermal stability
7Z06750.1
40
30
20
10
0
$-V_{CE}$ (V)
10
10^2
10^3
10^4
10^5
Z_{BE} (Ω)
Z_{BE}
$-V_{CE}$
$g_o = 0.1 m\Omega^{-1}$


7Z06751
max
typ
$-V_{CB}=32V$
10V
32V
10V
T_j (°C)
20
40
60
80
100
$-I_{CBO}$ (μA)
10^4
10^3
10^2
10
1

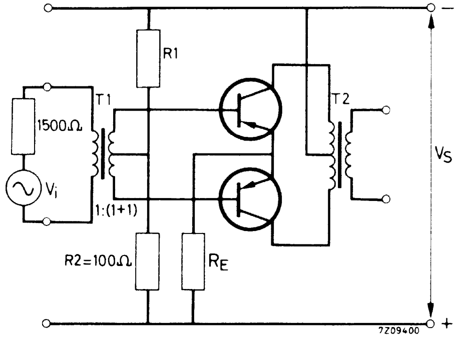

7Z06748
$-I_B=2.4mA$
2.2mA
2.0mA
1.8mA
1.6mA
1.4mA
1.2mA
1.0mA
0.8mA
0.6mA
0.4mA
0.2mA
5 $-V_{CE}$ (V) 10
typical values
$T_j=25°C$
200
$-I_C$ (mA)
150
100
0
$-V_{BE}$ (mV)
400
$-V_{CE}=1V$
$-V_{CE}=1V$
4 $-I_B$ (mA) 2


7Z06752
Base-emitter voltage versus emitter current
$-V_{CB} = 0$
$T_{amb} = 25°C$
max
typ
min
I_E (mA)
200
150
100
50
0
$-V_{BE}$ (mV)
100
200
300
$-V_{CB} = 5V$
$T_{amb} = 25°C$
10
5
0
50
100
150


7Z06749
Base current versus emitter current
$-V_{CB} = 0$
$T_{amb} = 25°C$
max
typ
min
I_E (mA)
200
150
100
50
0
$-I_B$ (mA)
2
$-V_{CB} = 5V$
$T_{amb} = 25°C$
10
5
0
$-I_B$ (μA)
50
100

APPLICATION INFORMATION

Audio frequency amplifier with matched pair 2-AC132 in class B operation.



The transistors may be used without cooling fins or heatsinks.
Stable continuous operation is ensured at an ambient temperature of up to 45 °C.

CHARACTERISTICS T_{amb} = 25 °C

Supply voltage	V_S	=	6	9	V
Emitter current (zero signal)	I_E	=	2x1.5	2x1.5	mA
Bias resistor	R_1	=	5.6	6.8	kΩ
Common emitter resistor	R_E	=	5	14	Ω
Load resistance	$R_{cc\sim}$	=	160	292	Ω
Total power dissipation	P_{tot}	typ.	2x180	2x220	mW
Power delivered to transformer output	P_o	typ.	310	365	mW
Collector current (peak value) at $P_{o\ max}$	$-I_{CM}$	typ.	125	100	mA
Collector current at $P_{o\ max}$	$-I_C$	typ.	40	32	mA
Input voltage at $P_{o\ max}$	V_i	typ.	4	3.8	V
Total harmonic distortion at $P_{o\ max}$	d_{tot}	typ.	7	6	%
Input voltage at P_o = 50 mW	V_i	typ.	1.40	1.35	V
Total harmonic distortion at P_o = 50 mW	d_{tot}	typ.	2.5	3.0	%

GERMANIUM ALLOY TRANSISTOR

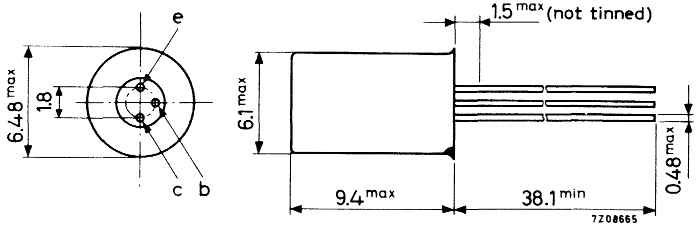
N-P-N transistor in a TO-1 metal envelope intended for use in low noise pre-amplifiers.

RATINGS Limiting values according to the Absolute Maximum System as defined in IEC publication 134.

Voltages				
Collector-base voltage (open emitter)	V_{CBO}	max.	32	V
Collector-emitter voltage (open base)	V_{CEO}	max.	12	V
Collector-emitter voltage with $R_{BE} < 70\,\Omega$	V_{CER}	max.	32	V
Emitter-base voltage (open collector)	V_{EBO}	max.	10	V
Current				
Collector current (d.c.)	I_C	max.	10	mA
Power dissipation				
Total power dissipation up to $T_{amb} = 25\ ^oC$	P_{tot}	max.	200	mW
Temperatures				
Storage temperature	T_{stg}		-55 to +90	^oC
Junction temperature: continuous	T_j	max.	90	^oC
incidentally	T_j	max.	100	^oC

MECHANICAL DATA Dimensions in mm

TO-1



The coloured dot indicates the collector

Accessories available: 56200, 56208, 56209, 56210, 56226, 56227

FOR NEW DESIGN THE SUCCESSOR TYPES BC109 OR BC149 ARE RECOMMENDED

THERMAL RESISTANCE

From junction to ambient in free air	$R_{th\ j\text{-}a}$ =	0.37 °C/mW

CHARACTERISTICS T_j = 25 °C unless otherwise specified

Collector cut-off current				
I_E = 0; V_{CB} = 10 V	I_{CBO}	<	10	μA
I_E = 0; V_{CB} = 32 V; T_j = 75 °C	I_{CBO}	<	900	μA
Emitter cut-off current				
I_C = 0; V_{EB} = 10 V	I_{EBO}	<	200	μA
I_C = 0; V_{EB} = 5 V; T_j = 75 °C	I_{EBO}	<	550	μA
Small signal current gain at f = 1 kHz				
I_C = 500 μA; V_{CE} = 5 V	h_{fe}	45 to 110		
Collector capacitance at f = 0.45 MHz				
$I_E = I_e$ = 0; V_{CB} = 5 V	C_c	typ.	70	pF
Feedback impedance at f = 0.45 MHz				
I_C = 1 mA; V_{CE} = 5 V	$\|z_{rb}\|$	typ.	70	Ω
Transition frequency				
I_C = 10 mA; V_{CE} = 2 V	f_T	>	1.5	MHz
		typ.	2.5	MHz
Cut-off frequency				
I_C = 10 mA; V_{CE} = 2 V	f_{hfe}	>	10	kHz
		typ.	20	kHz
Noise figure at f = 1 kHz				
I_C = 0.5 mA; V_{CE} = 5 V; R_S = 500 Ω Bandwidth = 200 Hz	F	typ.	3	dB
		<	4	dB

GERMANIUM ALLOYED MEDIUM POWER TRANSISTORS

The AC187 is a n-p-n audio transistor in a TO-1 metal envelope.
The AC187 is primarily intended for use together with the p-n-p medium power transistor AC188 as matched pair AC187/AC188 to about 3 W complementary symmetry class B output stages.
The AC187/01 is electrically equivalent to the AC187, constructed integrally with a heat conducting block, which gives better heat transfer.
The thermal resistance from junction to heatsink shows an improvement (≈10 °C/W) as compared with that obtained with the AC187 when using heat conducting clip 56227.
The AC187/01 is also available as matched pair with the AC188/01.

QUICK REFERENCE DATA

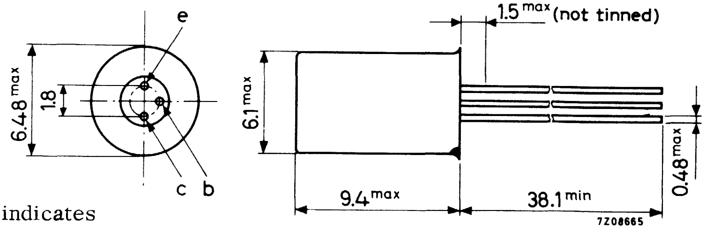
Collector-base voltage (open emitter)	V_{CBO}	max.	25	V
Collector-emitter voltage (open base)	V_{CEO}	max.	15	V
Collector current (peak value)	I_{CM}	max.	2	A
Total power dissipation up to T_{amb} = 46 °C	P_{tot}	max.	0.8	W
Junction temperature	T_j	max.	90	°C
D.C. current gain at T_j = 25 °C				
I_C = 300 mA; V_{CE} = 1 V	h_{FE}		100 to 500	
Cut-off frequency				
I_C = 10 mA; V_{CE} = 2 V	f_{hfe}	typ.	20	kHz

MECHANICAL DATA

Dimensions in mm

AC187

TO-1



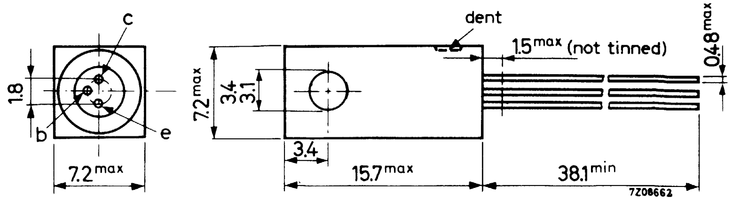
The coloured dot indicates the collector

Accessories available: 56200; 56208; 56209; 56210; 56226; 56227

MECHANICAL DATA (continued)

Dimensions in mm

AC187/01



The dent indicates the collector

RATINGS (Limiting values) [1]

Voltages

Collector-base voltage (open emitter)	V_{CBO}	max. 25	V
Collector-emitter voltage (open base)	V_{CEO}	max. 15	V
Collector-emitter voltage $I_C \leq 600$ mA; $R_{BE} \leq 1\ \Omega$	V_{CER}	max. 18	V
Emitter-base voltage (open collector)	V_{EBO}	max. 10	V

Currents

Collector current (d.c. or average over any 50 ms period)	I_C	max. 1	A
Collector current (peak value)	I_{CM}	max. 2	A

Power dissipation

Total power dissipation up to $T_{amb} = 46\ ^oC$ [2]	P_{tot}	max. 0.8	W

Temperatures

Storage temperature	T_{stg}	-55 to +75	^oC
Junction temperature	T_j	max. 90	^oC

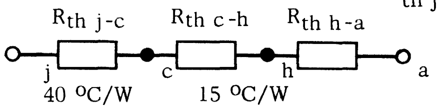
[1]) Limiting values according to the Absolute Maximum System as defined in IEC publication 134.

[2]) The allowable peak power in class B speach and musical driven amplifiers is 1.1 W

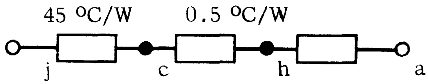
THERMAL RESISTANCE

From junction to ambient in free air		AC187	AC187/01	
without cooling clip	$R_{th\ j-a}$ =	290	180	°C/W
with cooling clip 56227	$R_{th\ j-a}$ =	140		°C/W
with cooling clip 56227 on 1.5mm blackened Al. heatsink of 12.5 cm^2	$R_{th\ j-a}$ =	80	70.5	°C/W
with cooling clip 56227 on infinite heatsink	$R_{th\ j-a}$ =	55		°C/W
From junction to case	$R_{th\ j-c}$ =	40	45	°C/W

AC187 with cooling clip 56227



AC187/01



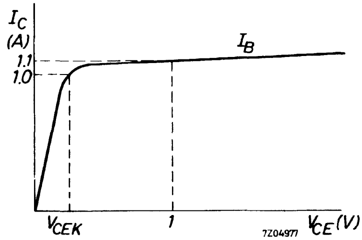
CHARACTERISTICS T_j = 25 °C unless otherwise specified

Collector cut-off current				
I_E = 0; V_{CB} = 25 V	I_{CBO}	typ. <	15 100	μA μA
I_E = 0; V_{CB} = 25 V; T_j = 90 °C	I_{CBO}	<	2.5	mA
$-V_{BE}$ = 1.0 V; V_{CE} = 25 V	I_{CEX}	<	100	μA
Emitter cut-off current				
I_C = 0; V_{EB} = 10 V	I_{EBO}	typ. <	15 100	μA μA
I_C = 0; V_{EB} = 10 V; T_j = 90 °C	I_{EBO}	typ. <	1.2 2.5	mA mA
Base-emitter voltage				
I_C = 5 mA; V_{CE} = 10 V	V_{BE}		95 to 135	mV
I_C = 300 mA; V_{CE} = 1 V	V_{BE}	<	550	mV
Emitter-base floating voltage				
I_E = 0; V_{CB} = 25 V; T_j = 90 °C	V_{EBfl}	<	400	mV

CHARACTERISTICS (continued) T_j = 25 °C unless otherwise specified

Knee voltage

I_C = 1 A; I_B = value for which I_C = 1.1 A at V_{CE} = 1 V	V_{CEK}	<	800	mV



D.C. current gain

I_C = 5 mA; V_{CE} = 10 V	h_{FE}	>	70	
I_C = 300 mA; V_{CE} = 1 V	h_{FE}	typ.	200	
		100 to	500	
I_C = 1 A; V_{CE} = 1 V	h_{FE}	>	50	

Collector capacitance at f = 450 kHz

I_E = I_e = 0; V_{CB} = 5 V	C_c	typ.	150	pF
		<	180	pF

Transition frequency

I_C = 10 mA; V_{CE} = 2 V	f_T	>	1	MHz
		typ.	5	MHz

Cut-off frequency

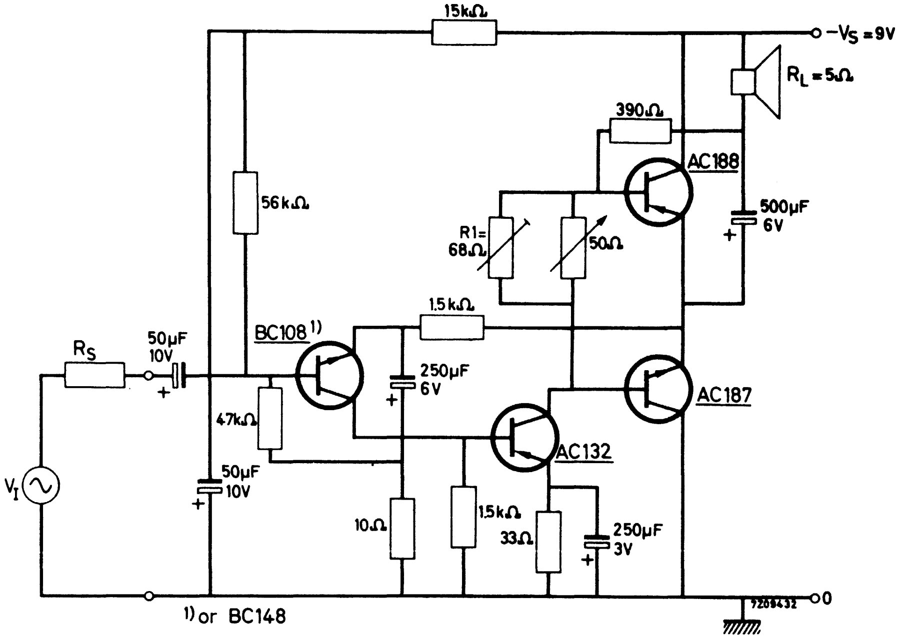
I_C = 10 mA; V_{CE} = 2 V	f_{hfe}	typ.	20	kHz

D.C. current gain ratio of matched pair AC187/AC188

$\|I_C\|$ = 500 mA; $\|V_{CE}\|$ = 1 V	h_{FE1}/h_{FE2}	<	1 : 1.25

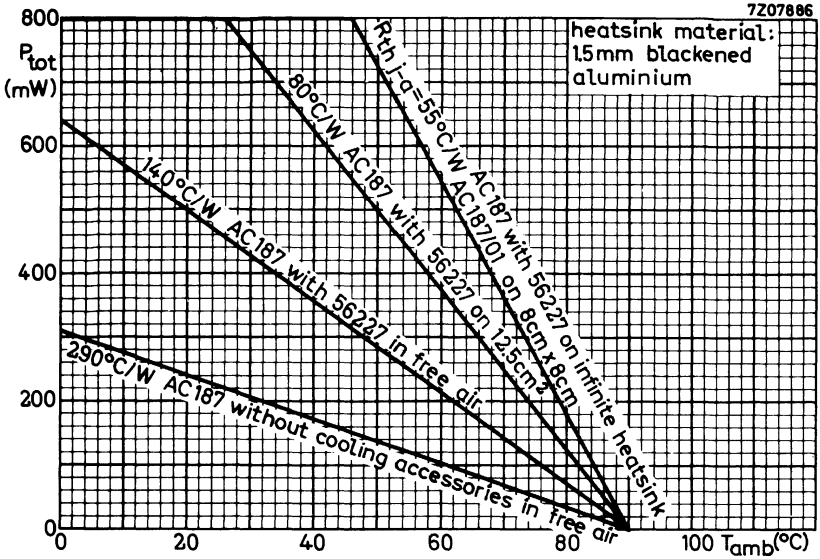
APPLICATION INFORMATION

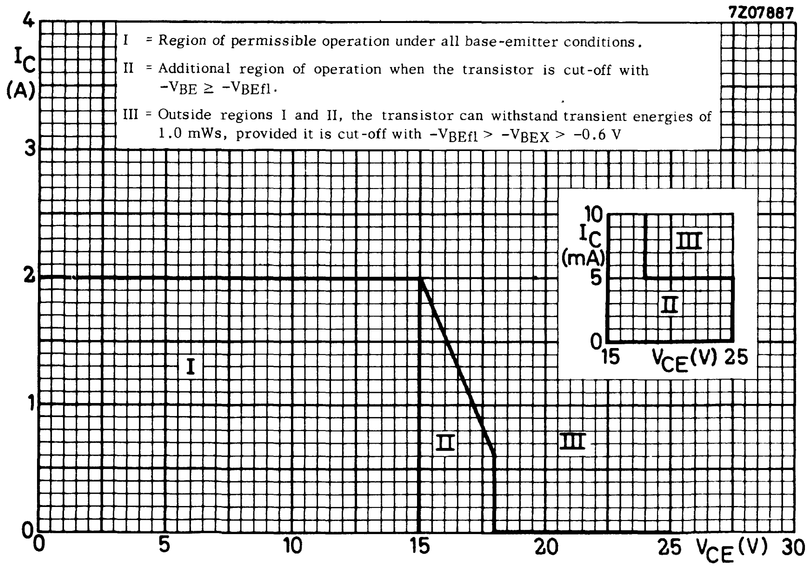
1.5 W transformerless audio frequency amplifier with matched pair AC187/AC188 in complementary symmetry class B output stage up to T_{amb} = 45 °C.

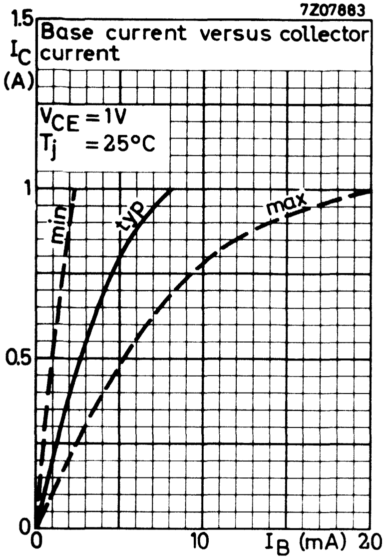


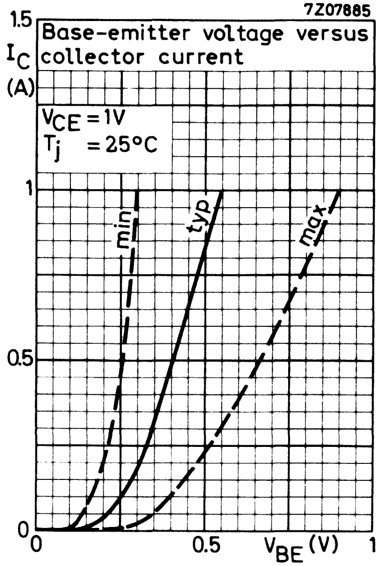
Typical input requirements for an output power of 50 mW	$V_{i\,(rms)}$ R_i	= 4 mV; $I_{i\,(rms)}$ = 0.12 µA; = 33 kΩ
Typical input requirements for an output power of 1.5 W	$V_{i\,(rms)}$ R_i	= 22 mV; $I_{i\,(rms)}$ = 0.66 µA; = 33 kΩ
Typical bandwidth (3 dB); R_S = 0	B	= 60 Hz to 65 kHz
Typical bandwidth (3 dB); R_S = 50 kΩ	B	= 65 Hz to 35 kHz
Quiescent current	$\lvert I_{cq} \rvert$	= 5 mA, adjustable with R1

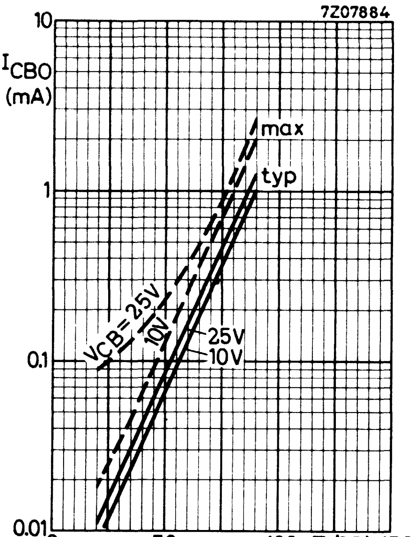
When using AC187 and AC188 each transistor should be mounted with cooling clip 56227 on 1.5 mm blackened Al. heatsink of 3 cm x 3 cm.
When using AC187/01 and AC188/01 each transistor should be mounted on 1.5 mm blackened Al. heatsink of 2.5 cm x 2.5 cm.


7Z07886
800
P_{tot}
(mW)
600
400
200
0
0
20
40
60
80
100 T_{amb}(°C)
heatsink material:
1.5mm blackened
aluminium
Rth j-a=55°C/W AC187 with 56227 on infinite heatsink
80°C/W AC187 with 56227 on 12.5cm²
AC187/01 on 8cm x 8cm
140°C/W AC187 with 56227 in free air
290°C/W AC187 without cooling accessories in free air


7Z07887
4
I_C
(A)
3
2
1
0
0
5
10
15
20
25 V_{CE}(V) 30
I = Region of permissible operation under all base-emitter conditions.
II = Additional region of operation when the transistor is cut-off with $-V_{BE} \geq -V_{BEfl}$.
III = Outside regions I and II, the transistor can withstand transient energies of 1.0 mWs, provided it is cut-off with $-V_{BEfl} > -V_{BEX} > -0.6$ V
I
II
III
10
I_C
(mA)
5
0
15
V_{CE}(V) 25
III
II


7Z07883
Base current versus collector current
I_C (A)
1.5
1
0.5
0
V_{CE} = 1V
T_j = 25°C
min
typ
max
0
10
I_B (mA) 20


7Z07885
Base-emitter voltage versus collector current
I_C (A)
1.5
1
0.5
0
V_{CE} = 1V
T_j = 25°C
min
typ
max
0
0.5
V_{BE} (V)
1


7Z07884
I_{CBO} (mA)
10
1
0.1
0.01
max
typ
V_{CB} = 25V
10V
25V
10V
0
50
100
T_j (°C) 150

GERMANIUM ALLOYED MEDIUM POWER TRANSISTORS

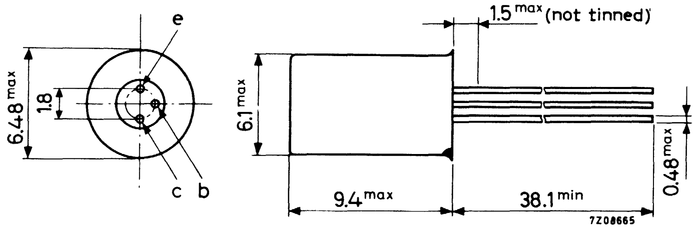
The AC188 is a p-n-p audio transistor in a TO-1 metal envelope.
The AC188 is primarily intended for use together with the n-p-n medium power transistor AC187 as matched pair AC187/AC188 to about 3 W complementary symmetry class B output stages.
The AC188/01 is electrically equivalent to the AC188, constructed integrally with a heat conducting block, which gives better heat transfer.
The thermal resistance from junction to heatsink shows an improvement (≈ 10 °C/W) as compared with that obtained with the AC188 when using heat conducting clip 56227.
The AC188/01 is also available as matched pair with the AC187/01.

QUICK REFERENCE DATA				
Collector-base voltage (open emitter)	$-V_{CBO}$	max.	25	V
Collector-emitter voltage (open base)	$-V_{CEO}$	max.	15	V
Collector current (peak value)	$-I_{CM}$	max.	2	A
Total power dissipation up to T_{amb} = 46 °C	P_{tot}	max.	0.8	W
Junction temperature	T_j	max.	90	°C
D.C. current gain at T_j = 25 °C				
$-I_C$ = 300 mA; $-V_{CE}$ = 1 V	h_{FE}	100 to 500		
Cut-off frequency				
$-I_C$ = 10 mA; $-V_{CE}$ = 2 V	f_{hfe}	typ.	10	kHz

MECHANICAL DATA

AC188

TO-1

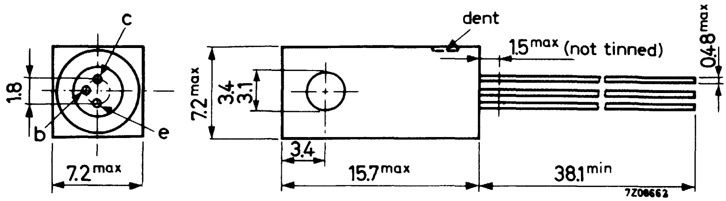


The coloured dot indicates the collector

Accessories available: 56200; 56208; 56209; 56210; 56226; 56227

MECHANICAL DATA (continued) Dimensions in mm

AC188/01



The dent indicates the collector

RATINGS (Limiting values) [1]

Voltages

Collector-base voltage (open emitter)	$-V_{CBO}$	max.	25	V
Collector-emitter voltage (open base)	$-V_{CEO}$	max.	15	V
Collector-emitter voltage $-I_C \leq 600$ mA; $R_{BE} \leq 1\ \Omega$	$-V_{CER}$	max.	18	V
Emitter-base voltage (open collector)	$-V_{EBO}$	max.	10	V

Currents

Collector current (d.c. or average over any 50 ms period)	$-I_C$	max.	1	A
Collector current (peak value)	$-I_{CM}$	max.	2	A

Power dissipation

Total power dissipation up to $T_{amb} = 46\ ^oC$ [2]	P_{tot}	max.	0.8	W

Temperatures

Storage temperature	T_{stg}		-55 to +75	^oC
Junction temperature	T_j	max.	90	^oC

[1] Limiting values according to the Absolute Maximum System as defined in IEC publication 134.

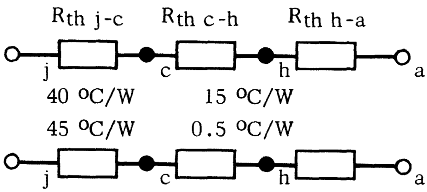
[2] The allowable peak power in class B speach and musical driven amplifiers is 1.1 W

THERMAL RESISTANCE

From junction to ambient in free air			AC188	AC188/01	
without cooling clip	$R_{th\ j-a}$	=	290	180	°C/W
with cooling clip 56227	$R_{th\ j-a}$	=	140		°C/W
with cooling clip 56227 on 1.5 mm Al blackened heatsink of 12.5 cm^2	$R_{th\ j-a}$	=	80	70.5	°C/W
with cooling clip 56227 on infinite heatsink	$R_{th\ j-a}$	=	55		°C/W
From junction to case	$R_{th\ j-c}$	=	40	45	°C/W

AC188 with cooling clip 56227

AC188/01



CHARACTERISTICS

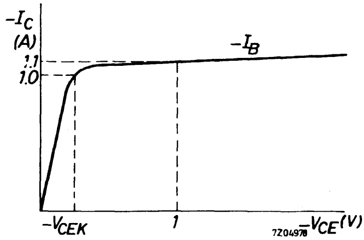
T_j = 25 °C unless otherwise specified

Collector cut-off current				
$I_E = 0$; $-V_{CB} = 25$ V	$-I_{CBO}$	typ.	20	μA
		<	200	μA
$I_E = 0$; $-V_{CB} = 25$ V; $T_j = 90$ °C	$-I_{CBO}$	<	1.4	mA
$+V_{BE} = 1.0$ V; $-V_{CE} = 25$ V	$-I_{CEX}$	<	200	μA
Emitter cut-off current				
$I_C = 0$; $-V_{EB} = 10$ V	$-I_{EBO}$	typ.	15	μA
		<	200	μA
$I_C = 0$; $-V_{EB} = 10$ V; $T_j = 90$ °C	$-I_{EBO}$	typ.	0.4	mA
		<	1.4	mA
Base-emitter voltage				
$-I_C = 5$ mA; $-V_{CE} = 10$ V	$-V_{BE}$		115 to 145	mV
$-I_C = 300$ mA; $-V_{CE} = 1$ V	$-V_{BE}$	<	450	mV
Emitter-base floating voltage				
$I_E = 0$; $-V_{CB} = 25$ V; $T_j = 90$ °C	$-V_{EBfl}$	<	400	mV

CHARACTERISTICS (continued) T_j = 25 °C unless otherwise specified

Knee voltage

$-I_C$ = 1 A; $-I_B$ = value for which $-I_C$ = 1.1 A at $-V_{CE}$ = 1 V	$-V_{CEK}$	< 600	mV



D.C. current gain

$-I_C$ = 5 mA; $-V_{CE}$ = 10 V	h_{FE}	> 70	
$-I_C$ = 300 mA; $-V_{CE}$ = 1 V	h_{FE}	typ. 200 100 to 500	
$-I_C$ = 1 A; $-V_{CE}$ = 1 V	h_{FE}	> 80	

Collector capacitance at f = 450 kHz

$I_E = I_e$ = 0; $-V_{CB}$ = 5 V	C_c	typ. 90 < 110	pF pF

Transition frequency

$-I_C$ = 10 mA; $-V_{CE}$ = 2 V	f_T	> 1 typ. 1.5	MHz MHz

Cut-off frequency

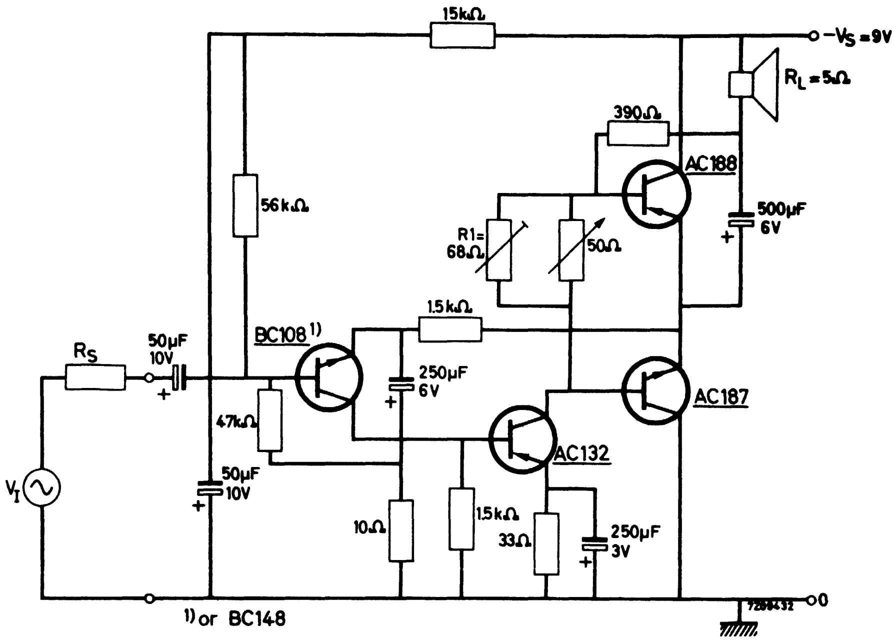
$-I_C$ = 10 mA; $-V_{CE}$ = 2 V	f_{hfe}	typ. 10	kHz

D.C. current gain ratio of matched pair AC187/AC188

$\|I_C\|$ = 500 mA; $\|V_{CE}\|$ = 1 V	h_{FE1}/h_{FE2}	< 1 : 1.25	

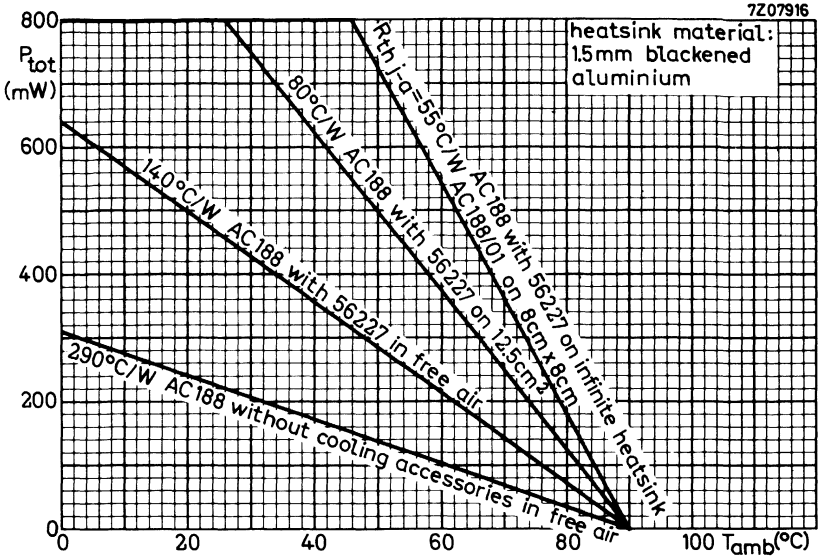
APPLICATION INFORMATION

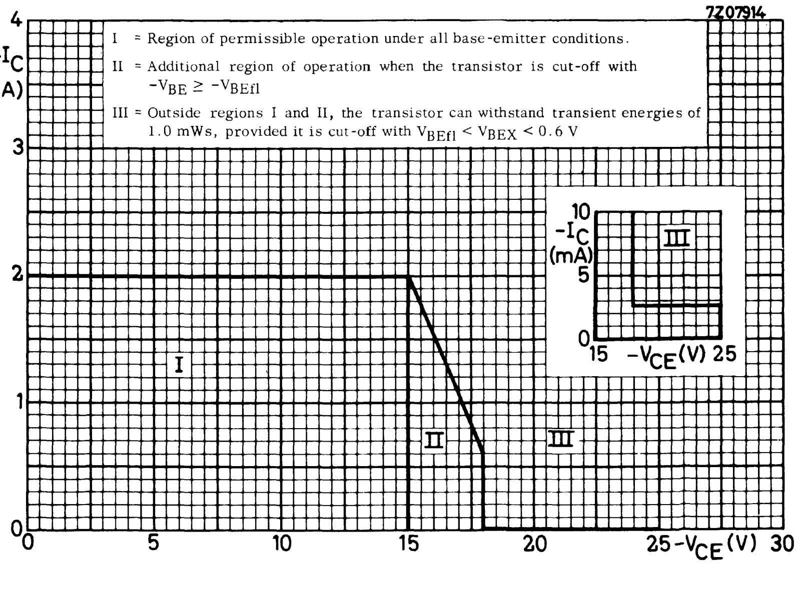
1.5 W transformerless audio frequency amplifier with matched pair AC187/AC188 in complementary symmetry class B output stage up to T_{amb} = 45 °C

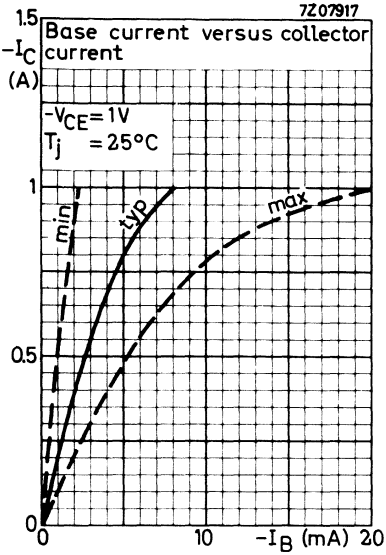


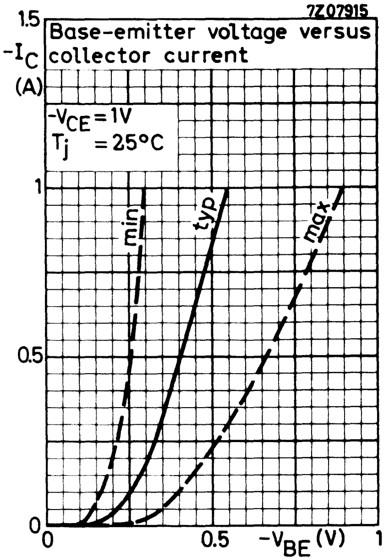
Typical input requirements for an output power of 50 mW	V_i(rms) R_i	= =	4 mV; I_i(rms) = 0.12 µA; 33 kΩ
Typical input requirements for an output power of 1.5 W	V_i(rms) R_i	= =	22 mV; I_i(rms) = 0.66 µA; 33 kΩ
Typical bandwidth (3 dB); R_S = 0	B	=	60 Hz to 65 kHz
Typical bandwidth (3 dB); R_S = 50 kΩ	B	=	65 Hz to 35 kHz
Quiescent current	$\lvert I_{cq} \rvert$	=	5 mA, adjustable with R1

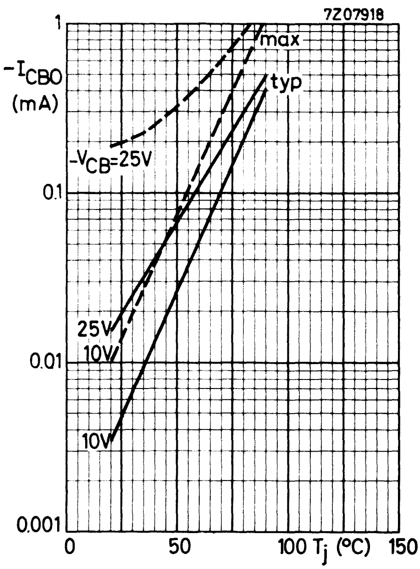
When using AC187 and AC188 each transistor should be mounted with cooling clip 56227 on 1.5 mm blackened Al. heatsink of 3 cm x 3 cm.
When using AC187/01 and AC188/01 each transistor should be mounted on 1.5 mm blackened Al. heatsink of 2.5 cm x 2.5 cm.


7Z07916
heatsink material:
1.5mm blackened
aluminium
800
P_{tot}
(mW)
600
400
200
0
0
20
40
60
80
100 T_{amb}(°C)
Rth j-a=55°C/W AC188 with 56227 on infinite heatsink
AC188/01 on 8cm x 8cm
80°C/W AC188 with 56227 on 12.5cm²
140°C/W AC188 with 56227 in free air
290°C/W AC188 without cooling accessories in free air


7Z07914
I = Region of permissible operation under all base-emitter conditions.
II = Additional region of operation when the transistor is cut-off with $-V_{BE} \geq -V_{BEfl}$
III = Outside regions I and II, the transistor can withstand transient energies of 1.0 mWs, provided it is cut-off with $V_{BEfl} < V_{BEX} < 0.6$ V
4
$-I_C$
(A)
3
2
1
0
0
5
10
15
20
25 $-V_{CE}$ (V) 30
I
II
III
10
$-I_C$
(mA)
5
0
15
$-V_{CE}$ (V) 25
III


7Z07917
Base current versus collector current
$-I_C$ (A)
1.5
1
0.5
0
$-V_{CE} = 1V$
$T_j = 25°C$
min
typ
max
0
10
$-I_B$ (mA)
20


7Z07915
Base-emitter voltage versus collector current
$-I_C$ (A)
1.5
1
0.5
0
$-V_{CE} = 1V$
$T_j = 25°C$
min
typ
max
0
0.5
$-V_{BE}$ (V)
1


7Z07918
$-I_{CBO}$ (mA)
1
0.1
0.01
0.001
max
typ
$-V_{CB}$=25V
25V
10V
10V
0
50
100 T_j (°C)
150

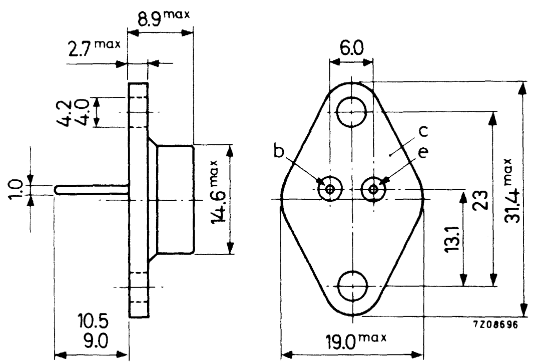
GERMANIUM ALLOYED POWER TRANSISTOR

P-N-P power transistor in a metal envelope with the collector connected to the mounting base.
It is primarily intended for use as matched pair 2-AD139 in low distortion class B push-pull output stages.

QUICK REFERENCE DATA				
Collector-base voltage (open emitter)	$-V_{CBO}$	max.	32	V
Collector-emitter voltage (open base)	$-V_{CEO}$	max.	16	V
Collector current (peak value)	$-I_{CM}$	max.	3	A
Total power dissipation up to T_{mb} = 45 °C	P_{tot}	max.	13	W
Junction temperature (incidentally)	T_j	max.	100	°C
D.C. current gain at T_j = 25 °C				
$-I_C$ = 1.0 A; V_{CB} = 0	h_{FE}	30 to 110		
Cut-off frequency				
$-I_C$ = 0.1 A; $-V_{CE}$ = 2 V	f_{hfe}	typ.	10	kHz

MECHANICAL DATA Dimensions in mm

Collector connected to mounting base



Accessories available: 56203

RATINGS (Limiting values) [1])

Voltages

Collector-base voltage (open emitter)	$-V_{CBO}$	max.	32	V
Collector-emitter voltage (open base)	$-V_{CEO}$	max.	16	V
Collector-emitter voltage with $R_{BE} < 50\ \Omega$	$-V_{CER}$	max.	32	V
Emitter-base voltage (open collector)	$-V_{EBO}$	max.	10	V

Currents

Collector current (d.c. or average over any 50 ms period)	$-I_C$	max.	1	A
Collector current (peak value)	$-I_{CM}$	max.	3	A

Power dissipation

Total power dissipation up to T_{mb} = 45 °C	P_{tot}	max.	13	W

Temperatures

Storage temperature	T_{stg}		-55 to +75	°C
Junction temperature: continuous	T_j	max.	90	°C
incidentally	T_j	max.	100	°C

THERMAL RESISTANCE

From junction to mounting base	$R_{th\ j\text{-}mb}$	=	4.0	°C/W
From mounting base to heatsink with mica washer	$R_{th\ mb\text{-}h}$	=	1.5	°C/W
without mica washer	$R_{th\ mb\text{-}h}$	=	0.5	°C/W

[1]) Limiting values according to the Absolute Maximum System as defined in IEC publication 134.

CHARACTERISTICS T_j = 25 °C unless otherwise specified

Collector cut-off current

$I_E = 0$; $-V_{CB} = 0.5$ V	$-I_{CBO}$	<	25	μA
$I_E = 0$; $-V_{CB} = 32$ V; $T_j = 90$ °C	$-I_{CBO}$	<	6	mA
$+V_{BE} = 1.0$ V; $-V_{CE} = 32$ V	$-I_{CEX}$	<	1	mA

Emitter cut-off current

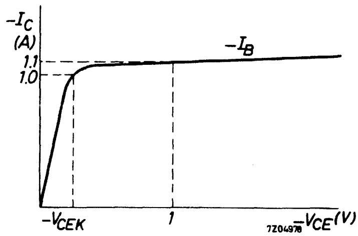
$I_C = 0$; $-V_{EB} = 10$ V	$-I_{EBO}$	<	1	mA

Base-emitter voltage

$-I_C = 10$ mA; $-V_{CE} = 10$ V	$-V_{BE}$	115 to 155	mV

Knee voltage

$-I_C = 1$ A; $-I_B$ = value for which $-I_C = 1.1$ A at $-V_{CE} = 1$ V	$-V_{CEK}$	<	400	mV



D.C. current gain

$-I_C = 10$ mA; $-V_{CB} = 10$ V	h_{FE}	>	20
$-I_C = 100$ mA; $V_{CB} = 0$	h_{FE}		25 to 100
$-I_C = 1$ A; $V_{CB} = 0$	h_{FE}		30 to 110

Current gain linearity

$V_S = 14$ V; $R_L = 12\ \Omega$ [1])	λ_1	>	0.45
		typ.	0.55

[1]) $\lambda_1 = \dfrac{A_i \text{ at } -I_C = 1 \text{ A}}{A_{i\,max}}$, where A_i = loaded small signal current amplification.

CHARACTERISTICS (continued) T_j = 25 °C unless otherwise specified

Cut-off frequency

$-I_C$ = 100 mA; $-V_{CE}$ = 2 V	f_{hfe}	>	10	kHz

D.C. current gain ratio of matched pair 2-AD139

$-I_C$ = 100 mA; V_{CB} = 0	h_{FE1}/h_{FE2}	<	1.25
$-I_C$ = 1 A; V_{CB} = 0	h_{FE1}/h_{FE2}	<	1.25

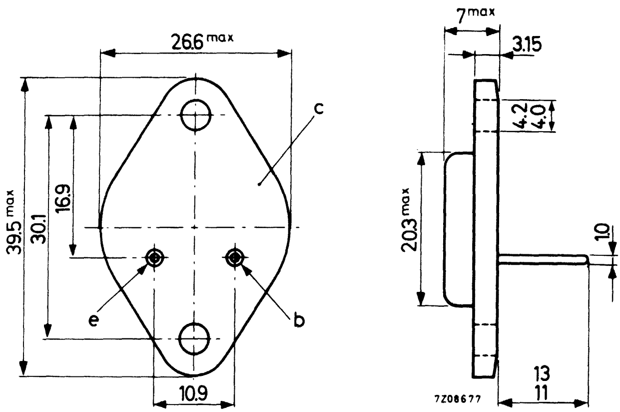
GERMANIUM ALLOYED POWER TRANSISTORS

P-N-P power transistor in a metal envelope with the collector connected to the mounting base.
It is primarily intended for use as matched pair 2-AD149 in class B push-pull output stages with an output power of up to 20 W.

QUICK REFERENCE DATA				
Collector-base voltage (open emitter)	$-V_{CBO}$	max.	50	V
Collector-emitter voltage (open base)	$-V_{CEO}$	max.	30	V
Collector current (d.c.)	$-I_C$	max.	3.5	A
Total power dissipation up to T_{mb} = 45 °C	P_{tot}	max.	32.5	W
Junction temperature (incidentally)	T_j	max.	110	°C
D.C. current gain at T_j = 25 °C				
$-I_C$ = 1 A; V_{CB} = 0 V	h_{FE}		30 to 100	
Cut-off frequency				
$-I_C$ = 0.5 A; $-V_{CE}$ = 2 V	f_{hfe}	typ.	10	kHz

MECHANICAL DATA Dimensions in mm

Collector connected to mounting base



Accessories available: 56201

RATINGS (Limiting values) [1]

Voltages

Collector-base voltage (open emitter)	$-V_{CBO}$	max.	50	V
Collector-emitter voltage (open base)	$-V_{CEO}$	max.	30	V
Collector-emitter voltage with $R_{BE} < 175\ \Omega$	$-V_{CER}$	max.	50	V
Emitter-base voltage (open collector)	$-V_{EBO}$	max.	20	V

Currents

Collector current (d.c.)	$-I_C$	max.	3.5	A
Base current (d.c.)	$-I_B$	max.	0.5	A

Power dissipation

→ Total power dissipation up to T_{mb} = 45 °C	P_{tot}	max.	32.5	W

Temperatures

Storage temperature	T_{stg}		-65 to +100	°C
Junction temperature: continuous	T_j	max.	100	°C
incidentally	T_j	max.	110	°C

THERMAL RESISTANCE

From junction to mounting base	$R_{th\ j\text{-}mb}$	=	2	°C/W
From mounting base to heatsink				
with mica washer and insulating bush	$R_{th\ mb\text{-}h}$	=	0.5	°C/W
without insulating materials and with lead washer	$R_{th\ mb\text{-}h}$	=	0.2	°C/W

[1]) Limiting values according to the Absolute Maximum System as defined in IEC publication 134.

CHARACTERISTICS $T_j = 25\ ^oC$ unless otherwise specified

Collector cut-off current

$I_E = 0$; $-V_{CB} = 50$ V	$-I_{CBO}$	<	3	mA
$I_E = 0$; $-V_{CB} = 14$ V; $T_j = 90\ ^oC$	$-I_{CBO}$	<	5	mA

Emitter cut-off current

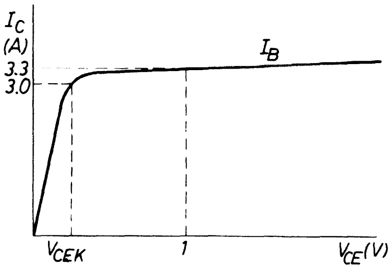
$I_C = 0$; $-V_{EB} = 20$ V	$-I_{EBO}$	<	3	mA

Base-emitter voltage

$-I_C = 15$ mA; $-V_{CE} = 14$ V	$-V_{BE}$	135 to 175		mV
$-I_C = 200$ mA; $-V_{CE} = 1$ V	$-V_{BE}$	<	300	mV
$-I_C = 3.5$ A; $-V_{CE} = 1$ V	$-V_{BE}$	<	1200	mV

Knee voltage

$-I_C = 3$ A; $-I_B$ = value for which
$-I_C = 3.3$ A at $-V_{CE} = 1$ V — $-V_{CEK}$ < 0.7 V



D.C. current gain

$-I_C = 1$ A; $V_{CB} = 0$	h_{FE}	30 to 100
$-I_C = 3$ A; $V_{CB} = 0$	h_{FE}	20 to 85

Collector capacitance at f = 450 kHz

$I_E = I_e = 0$; $-V_{CB} = 5$ V	C_c	typ.	220	pF

Emitter capacitance at f = 450 kHz

$I_C = I_c = 0$; $-V_{EB} = 5$ V	C_e	typ.	140	pF

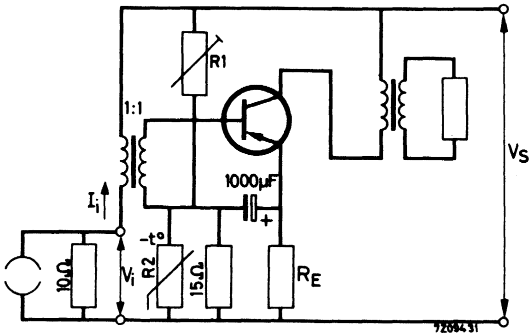
CHARACTERISTICS (continued) T_j = 25 °C unless otherwise specified

Transition frequency					
$-I_C = 0.5$ A; $-V_{CE} = 2$ V		f_T	>	300	kHz
			typ.	500	kHz
Cut-off frequency					
$-I_C = 0.5$ A; $-V_{CE} = 2$ V		f_{hfe}	>	7	kHz
			typ.	10	kHz
Feedback impedance at f = 450 kHz					
$I_E = 1$ mA; $-V_{CB} = 5$ V		$\|z_{rb}\|$	typ.	30	Ω
Small signal current gain linearity [1]					
(See page 10)		λ_{3A}	>	0.2	
			typ.	0.35	
D.C. current gain ratio of matched pair 2-AD149	$-I_C = 0.3$ A	h_{FE1}/h_{FE2}	typ.	1.1	
			<	1.25	
	$-I_C = 3$ A	h_{FE1}/h_{FE2}	typ.	1.1	
			<	1.25	

[1]) $\lambda_{3A} = \frac{A_i \text{ at } -I_C = 3\text{ A}}{A_{i\,max}}$

APPLICATION INFORMATION

AD149 in a class A output amplifier.



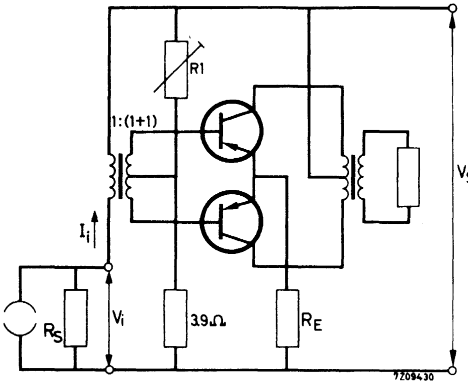
Stable continuous operation is ensured at an ambient temperature up to 55 °C provided each transistor is mounted on a 1.5 mm copper heatsink of at least 18 cm x 18 cm (circuit I) or 15 cm x 15 cm (circuit II).

Characteristics			I	II	
Supply voltage	V_S	=	7	14	V
		<	8	16	V
Collector current (zero signal)	$-I_C$	=	1.8	0.72	A
Bias resistor	R1	=	50	200	Ω
NTC resistor [1]	R2	=	50	50	Ω
Emitter resistor	R_E	=	0.3	0.5	Ω
Collector resistance	$R_{C\sim}$	=	4	23	Ω
Total power dissipation of the transistor	P_{tot}	<	4.3	4.1	W
Output power delivered to transformer	P_o	<	4	4	W
Input voltage (peak value) at P_o = 4 W	V_{IM}	typ.	0.48	0.40	V
Input current (peak value) at P_o = 4 W	I_{IM}	typ.	35	12	mA
Total distortion at P_o = 4 W	d_{tot}	typ.	9.5	7.5	%
Input current (peak value) at P_o = 50 mW	I_{IM}	typ.	2.5	1.0	mA
Total distortion at P_o = 50 mW	d_{tot}	typ.	2.5	1.5	%

[1]) NTC resistor should be mounted on the heatsink, close to the transistor.
Code number 2322 610 11509.

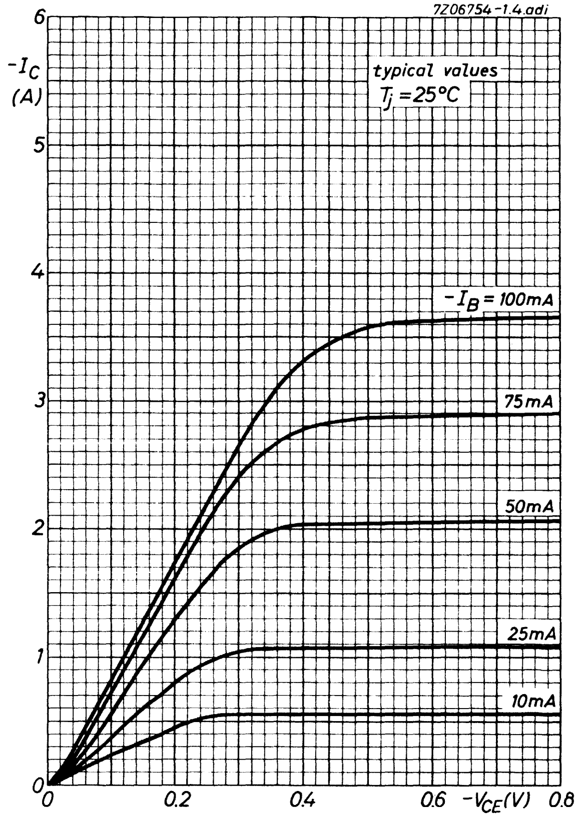
APPLICATION INFORMATION

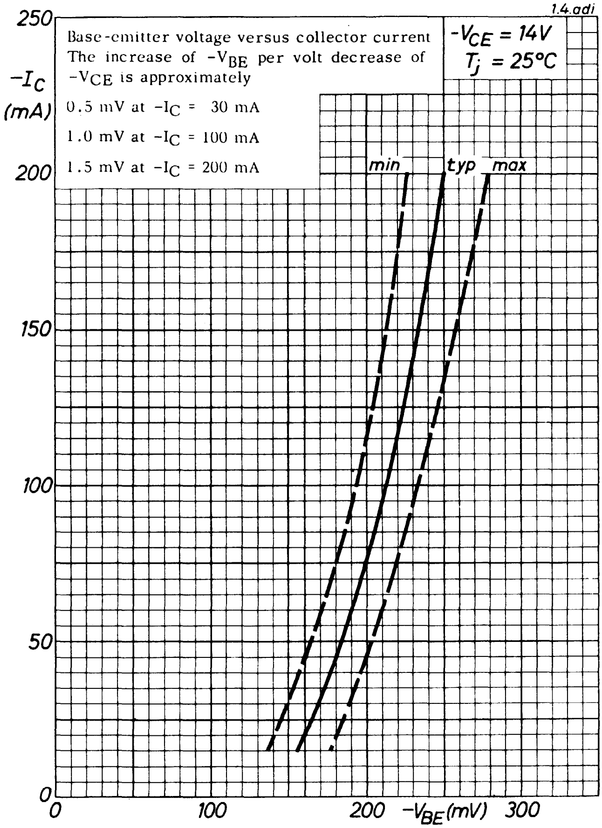
2-AD149 in a class B output amplifier.

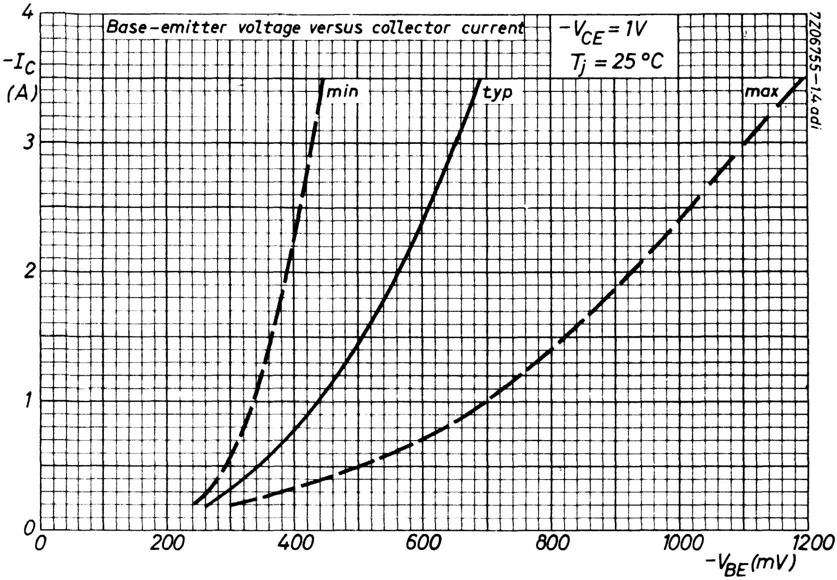


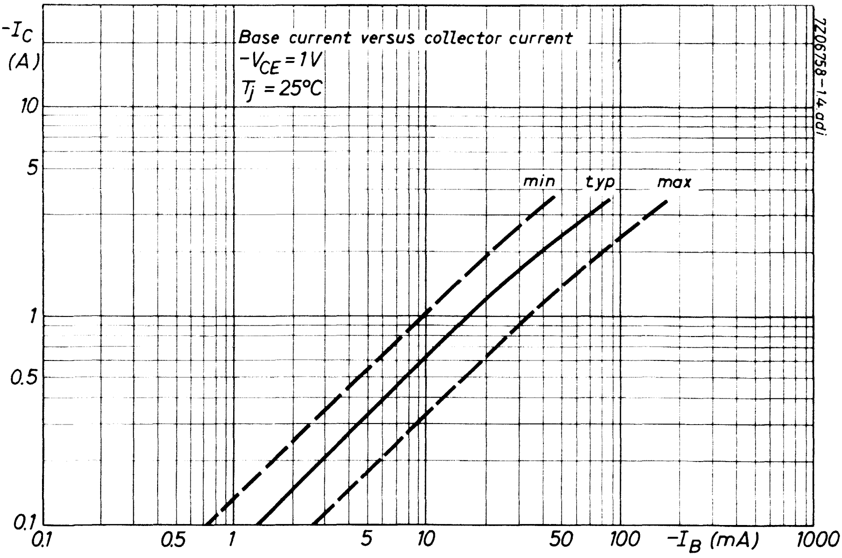
Stable continuous operation is ensured at an ambient temperature up to 55 °C provided each transistor is mounted on a 1.5 mm copper heatsink of at least 5 cm x 5 cm (circuit I) or 6 cm x 6 cm (circuit II).

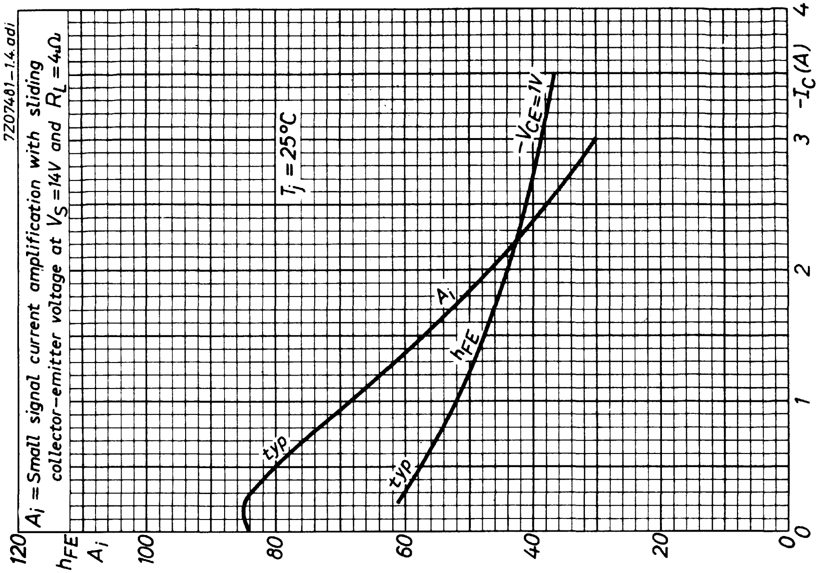
Characteristics			I	II	
Supply voltage	V_S	=	7	14	V
		<	8	16	V
Collector current (zero signal)	$-I_C$	=	60	60	mA
Bias resistor	R1	=	200	350	Ω
Emitter resistor	R_E	=	0	0.47	Ω
Source resistance	R_S	=	450	370	Ω
Collector resistance	$R_{cc\sim}$	=	9	16	Ω
Total power dissipation of the transistors	P_{tot}	<	9.75	20	W
Output power delivered to transformer	P_o	<	9.75	17.9	W
Collector current (peak value) at P_o max	$-I_{CM}$	typ.	3	3	A
Collector current at P_o max	$-I_C$	typ.	0.95	0.95	A
Input voltage (peak value) at P_o max	V_{IM}	typ.	0.81	2.2	V
Input current (peak value) at P_o max	I_{IM}	typ.	75	75	mA
Total distortion at P_o max	d_{tot}	typ.	10	10	%
Input current (peak value) at P_o = 50 mW	I_{IM}	typ.	4	2.5	mA
Total distortion at P_o = 50 mW	d_{tot}	typ.	2.5	2	%

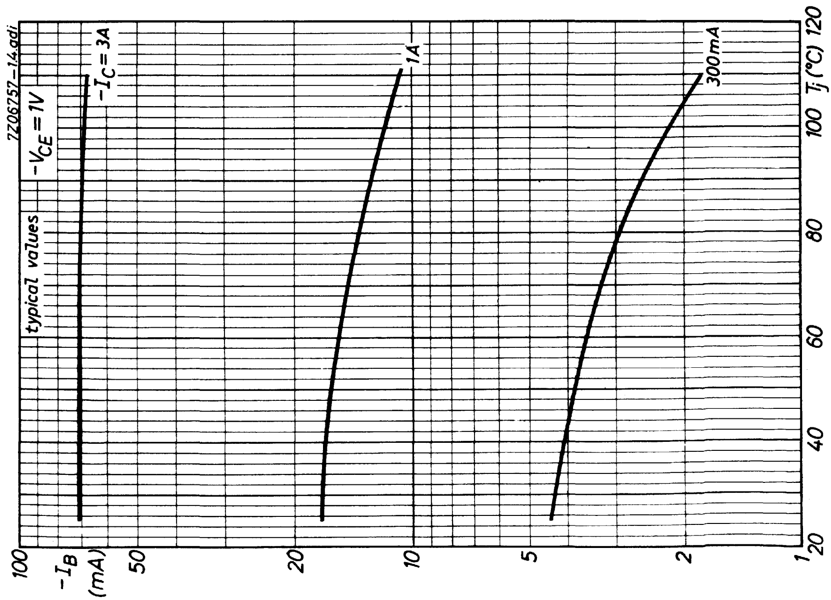

7Z06754-1.4.adi
$-I_C$ (A)
typical values
$T_j = 25\,^{\circ}C$
$-I_B$ = 100mA
75mA
50mA
25mA
10mA
6
5
4
3
2
1
0
0
0.2
0.4
0.6
$-V_{CE}$(V)
0.8

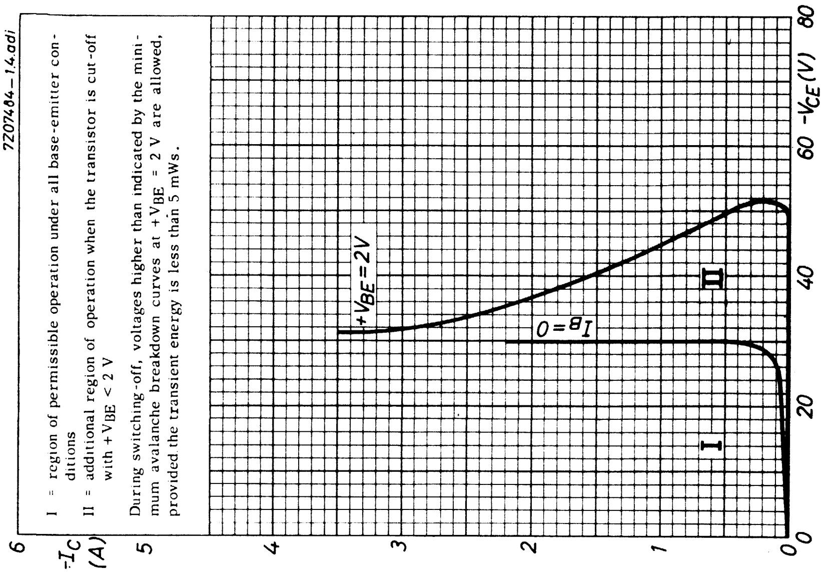

1.4.adi
Base-emitter voltage versus collector current
The increase of -VBE per volt decrease of -VCE is approximately
0.5 mV at -IC = 30 mA
1.0 mV at -IC = 100 mA
1.5 mV at -IC = 200 mA
-VCE = 14V
Tj = 25°C
-IC (mA)
250
200
150
100
50
0
min
typ
max
0
100
200
-VBE(mV)
300

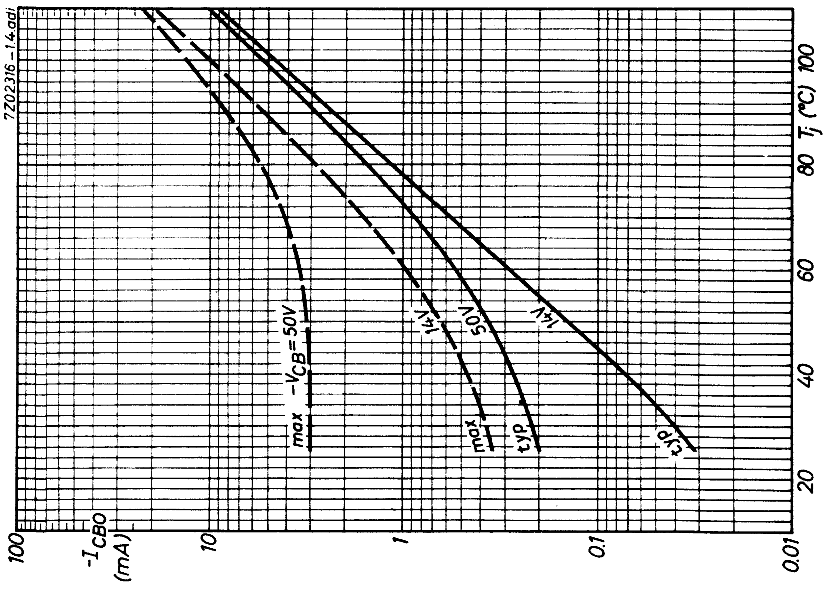

Base-emitter voltage versus collector current
$-V_{CE} = 1V$
$T_j = 25\ °C$
7206755-14.adi
$-I_C$ (A)
4
3
2
1
0
min
typ
max
0
200
400
600
800
1000
1200
$-V_{BE}$ (mV)

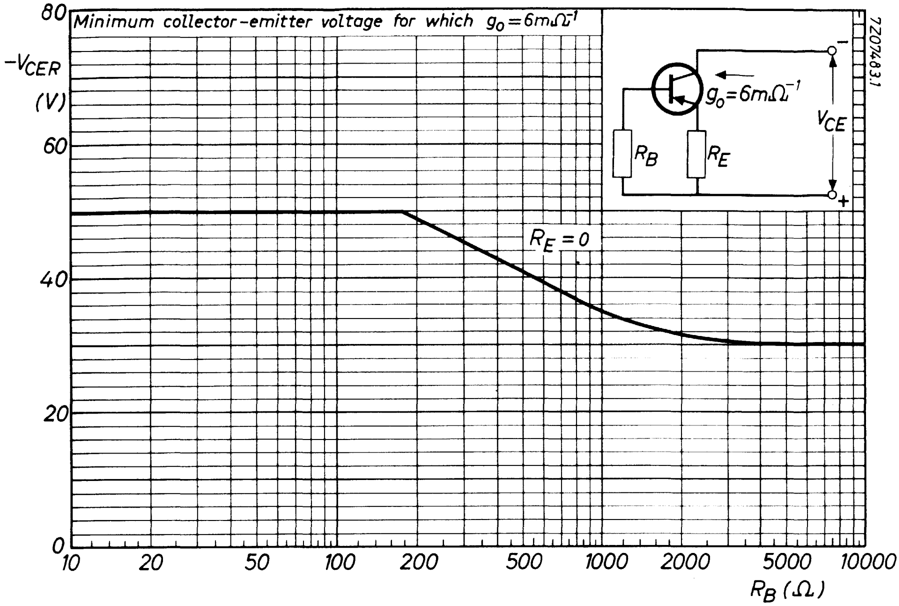

Base current versus collector current
$-V_{CE} = 1V$
$T_j = 25°C$
7206758-14.adi
$-I_C$ (A)
10
5
1
0.5
0.1
min
typ
max
0.1
0.5
1
5
10
50
100
$-I_B$ (mA)
1000

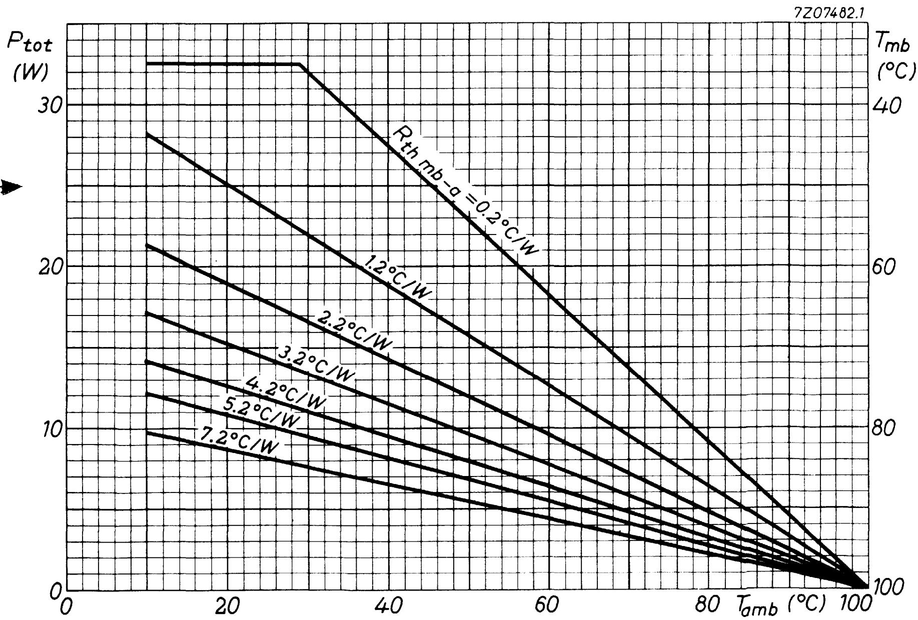

7Z07481—1.4.adi
Ai = Small signal current amplification with sliding collector-emitter voltage at VS = 14V and RL = 4Ω
Tj = 25°C
-VCE = 1V
Ai
hFE
typ
typ
hFE
Ai
120
100
80
60
40
20
0
0
1
2
3
4
-IC (A)


7Z06757—1.4.adi
-VCE = 1V
typical values
-IC = 3A
1A
300mA
-IB
(mA)
100
50
20
10
5
2
1
20
40
60
80
100
120
Tj (°C)


7Z07464—1.4.adi
I = region of permissible operation under all base-emitter conditions
II = additional region of operation when the transistor is cut-off with $+V_{BE} < 2$ V
During switching-off, voltages higher than indicated by the minimum avalanche breakdown curves at $+V_{BE} = 2$ V are allowed, provided the transient energy is less than 5 mWs.
$-I_C$ (A)
$+V_{BE}=2V$
$I_B=0$
I
II
$-V_{CE}$ (V)
0
1
2
3
4
5
6
20
40
60
80


7Z02316—1.4.adi
$-I_{CBO}$ (mA)
100
10
1
0.1
0.01
max $-V_{CB}=50V$
max 14V
typ 50V
typ 14V
T_j (°C)
20
40
60
80
100


Minimum collector-emitter voltage for which $g_o = 6m\Omega^{-1}$
7Z07483.1
$-V_{CER}$ (V)
80
60
40
20
0
$g_o = 6m\Omega^{-1}$
V_{CE}
R_B
R_E
$R_E = 0$
10
20
50
100
200
500
1000
2000
5000
10000
R_B (Ω)


7Z07482.1
P_{tot} (W)
T_{mb} (°C)
30
20
10
0
40
60
80
100
$R_{th\ mb-a}$ = 0.2°C/W
1.2°C/W
2.2°C/W
3.2°C/W
4.2°C/W
5.2°C/W
7.2°C/W
0
20
40
60
80
T_{amb} (°C)
100

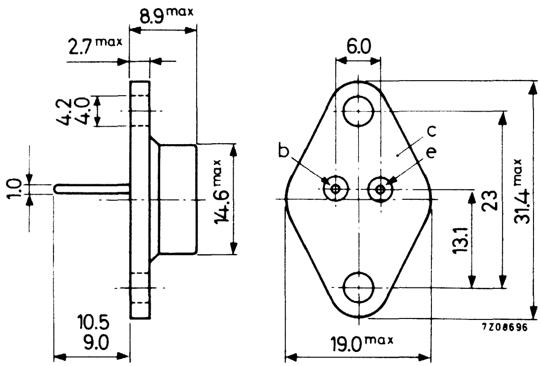
GERMANIUM ALLOYED POWER TRANSISTOR

N-P-N power transistor in a metal envelope with the collector connected to the mounting base.
The AD161 is primarily intended for use together with the p-n-p power transistor AD162 as matched pair AD161/AD162 in 10 W complementary symmetry class B output stages of mains operated amplifiers and radio receivers.

QUICK REFERENCE DATA				
Collector-base voltage (open emitter)	V_{CBO}	max.	32	V
Collector-emitter voltage (open base)	V_{CEO}	max.	20	V
Collector current (peak value)	I_{CM}	max.	3	A
Total power dissipation up to $T_{mb} = 75\,^oC$	P_{tot}	max.	4	W
Junction temperature (incidentally)	T_j	max.	100	^oC
D.C. current gain at $T_j = 25\,^oC$				
$I_C = 0.5$ A; $V_{CE} = 1$ V	h_{FE}	80 to 320		
Cut-off frequency				
$I_C = 0.3$ A; $V_{CE} = 2$ V	f_{hfe}	typ.	35	kHz

MECHANICAL DATA Dimensions in mm

Collector connected to mounting base



Accessories available: 56203

RATINGS (Limiting values) [1]

Voltages

Collector-base voltage (open emitter)	V_{CBO}	max.	32	V
Collector-emitter voltage (open base)	V_{CEO}	max.	20	V
Collector-emitter voltage with $-V_{BE} = 0.6$ V (See also page 4)	V_{CEX}	max.	32	V
Emitter-base voltage (open collector)	V_{EBO}	max.	10	V

Currents

Collector current (d.c. or average over any 50 ms period)	I_C	max.	1	A
Collector current (peak value)	I_{CM}	max.	3	A

Power dissipation

Total power dissipation up to T_{mb} = 72 °C	P_{tot}	max.	4	W

Temperatures

Storage temperature	T_{stg}		-65 to +90	°C
Junction temperature: continuous	T_j	max.	90	°C
incidentally	T_j	max.	100	°C

THERMAL RESISTANCE

From junction to mounting base	$R_{th\ j\text{-}mb}$	=	4.5	°C/W
From mounting base to heatsink with mica washer	$R_{th\ mb\text{-}h}$	=	1.5	°C/W
without mica washer	$R_{th\ mb\text{-}h}$	=	0.5	°C/W

CHARACTERISTICS T_j = 25 °C unless otherwise specified

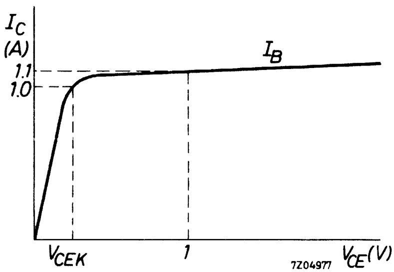
Collector cut-off current

$I_E = 0$; $V_{CB} = 32$ V	I_{CBO}	typ.	20	μA
		<	500	μA
$I_E = 0$; $V_{CB} = 32$ V; $T_j = 90$ °C	I_{CBO}	<	3	mA
$-V_{BE} = 0.6$ V; $V_{CE} = 32$ V; $T_j = 90$ °C	I_{CEX}	<	3	mA

[1]) Limiting values according to the Absolute Maximum System as defined in IEC publication 134.

CHARACTERISTICS (continued) T_j = 25 °C unless otherwise specified

Emitter cut-off current				
I_C = 0; V_{EB} = 10 V	I_{EBO}	typ.	20	μA
		<	200	μA
I_C = 0; V_{EB} = 10 V; T_j = 90 °C	I_{EBO}	<	2	mA
Base-emitter voltage [1]				
I_C = 5 mA; V_{CE} = 10 V	V_{BE}	110 to 140		mV
I_C = 50 mA; V_{CE} = 1 V	V_{BE}	<	300	mV
I_C = 500 mA; V_{CE} = 1 V	V_{BE}	<	650	mV
I_C = 2 A; V_{CE} = 1 V	V_{BE}	<	1100	mV
Knee voltage				
I_C = 1 A; I_B = value for which I_C = 1.1 A at V_{CE} = 1 V	V_{CEK}	<	600	mV



Floating voltage				
I_E = 0; V_{CB} = 32 V; T_j = 90 °C	V_{EBfl}	<	400	mV
Collector capacitance at f = 450 kHz				
$I_E = I_e$ = 0; V_{CB} = 5 V	C_c	typ.	150	pF
D.C. current gain				
I_C = 5 mA; V_{CE} = 10 V	h_{FE}	>	55	
I_C = 50 mA; V_{CE} = 1 V	h_{FE}	74 to 300		
I_C = 500 mA; V_{CE} = 1 V	h_{FE}	typ.	150	
		80 to 320		
I_C = 2 A; V_{CE} = 1 V	h_{FE}	>	40	

[1] V_{BE} decreases by about 2 mV/°C with increasing temperature.

CHARACTERISTICS (continued) T_j = 25 °C unless otherwise specified

Transition frequency

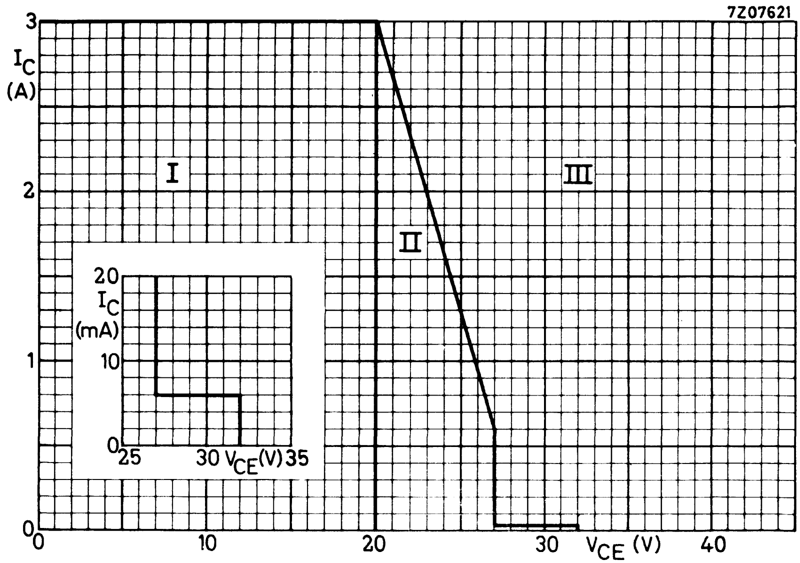
I_C = 10 mA; V_{CE} = 2 V	f_T	typ.	3	MHz

Cut-off frequency

I_C = 300 mA; V_{CE} = 2 V	f_{hfe}	>	20	kHz
		typ.	35	kHz

D.C. current gain ratio of matched pair AD161/AD162

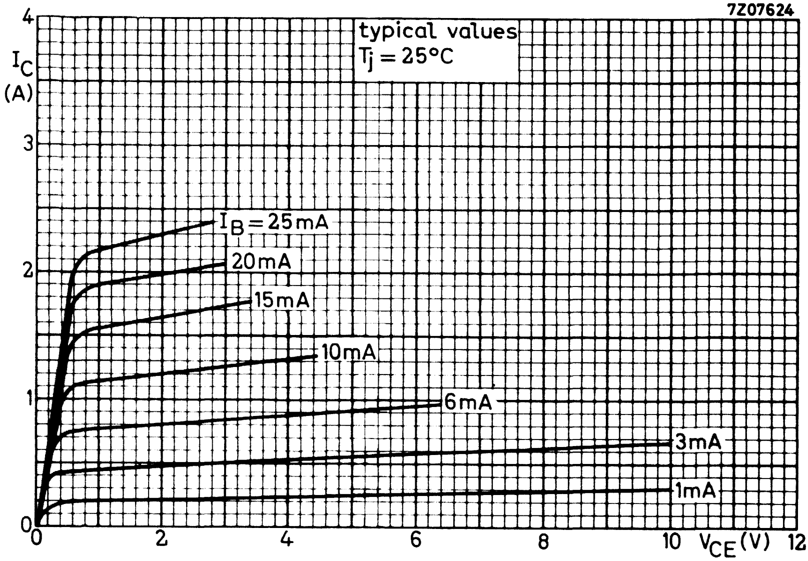
$\lvert I_C \rvert$ = 500 mA; $\lvert V_{CE} \rvert$ = 1 V	h_{FE1}/h_{FE2}	typ.	1.1
		<	1.25

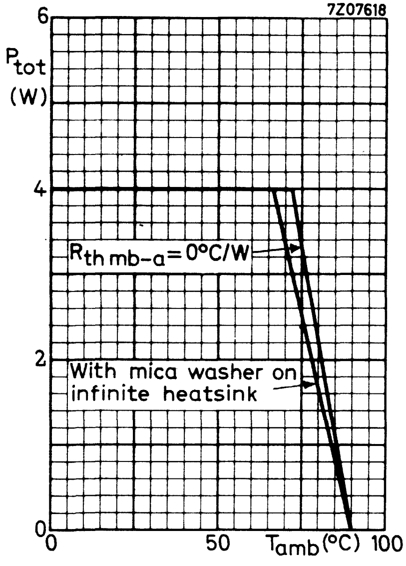


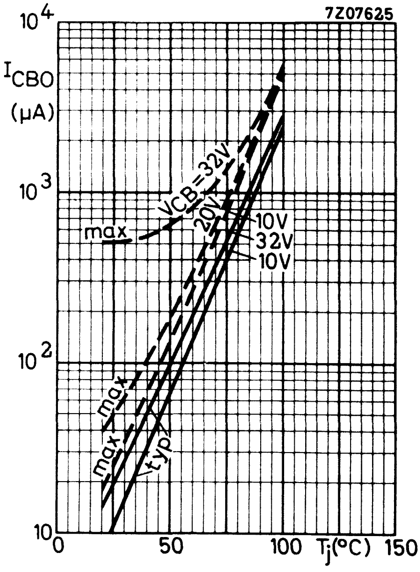
I = Region of permissible operation under all base-emitter conditions.

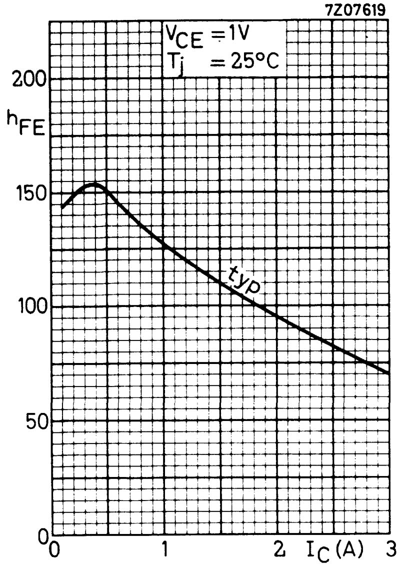
II = Additional region of operation when the transistor is cut-off with $-V_{BE} \geq -V_{BEfl}$.

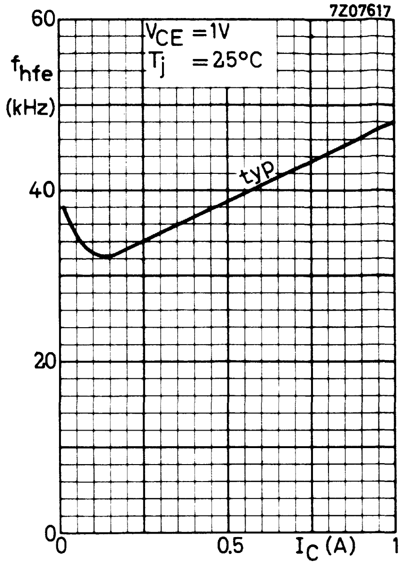
III = Outside regions I and II, the transistor can withstand transient energies of 1 mWs, provided it is cut-off with $-V_{BB} \leq 0.6$ V; R_i = 18 Ω.

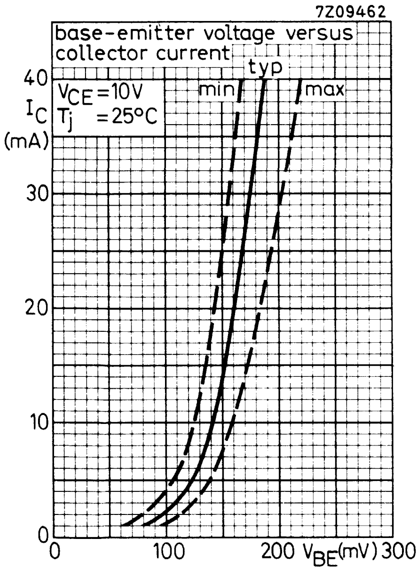

7Z07624
typical values
$T_j = 25°C$
I_C (A)
$I_B = 25mA$
20mA
15mA
10mA
6mA
3mA
1mA
V_{CE} (V)
0
2
4
6
8
10
12
1
2
3
4

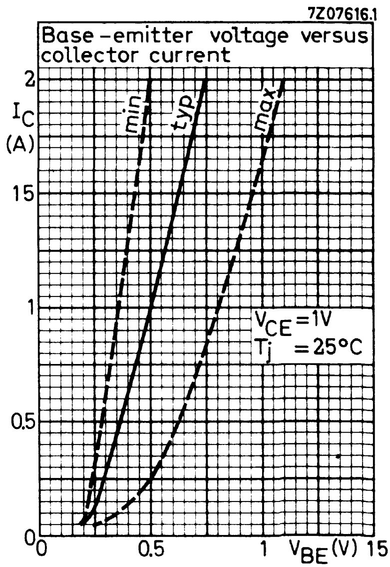

7Z07618
P_{tot} (W)
$R_{th\ mb-a} = 0°C/W$
With mica washer on infinite heatsink
T_{amb} (°C)
0
50
100
2
4
6

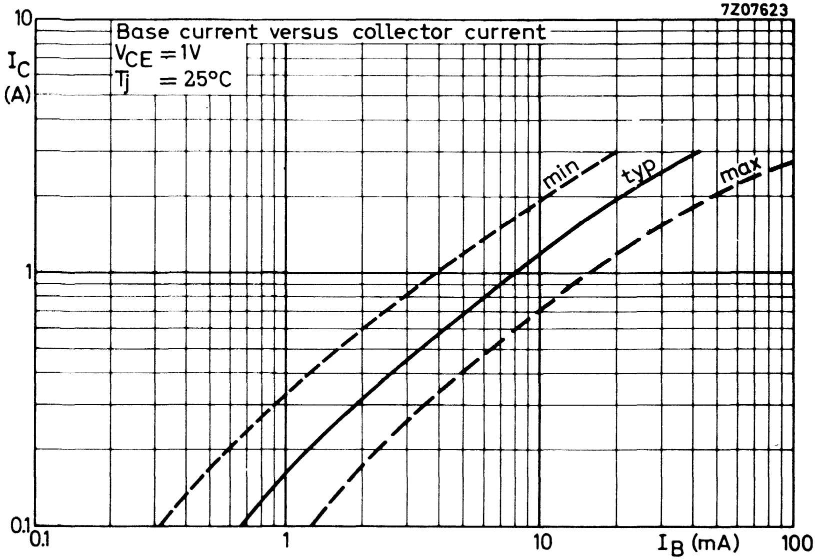

7Z07625
I_{CBO} (μA)
max
VCB=32V
20V
10V
32V
10V
max
max
typ
T_j (°C)
10
10^2
10^3
10^4
0
50
100
150

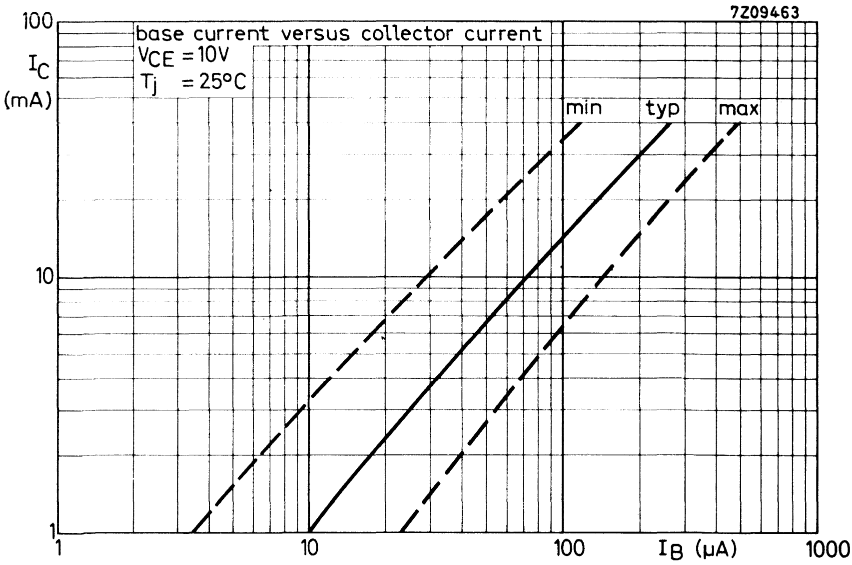

7Z07619
VCE = 1V
Tj = 25°C
hFE
200
150
100
50
0
typ
0
1
2
IC (A)
3


7Z07617
VCE = 1V
Tj = 25°C
fhfe
(kHz)
60
40
20
0
typ
0
0.5
IC (A)
1


7Z09462
base-emitter voltage versus
collector current
VCE = 10V
Tj = 25°C
IC
(mA)
40
30
20
10
0
min
typ
max
0
100
200
VBE (mV)
300

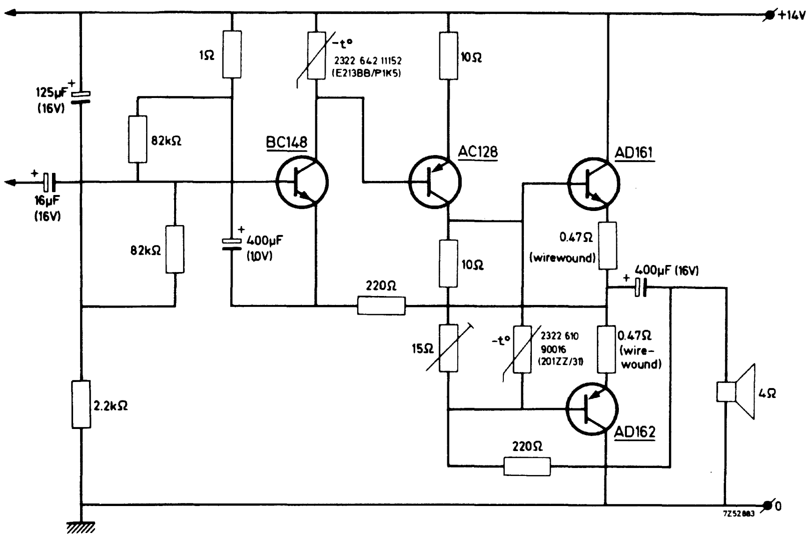

7Z07616.1
Base-emitter voltage versus
collector current
IC
(A)
2
15
1
0.5
0
min
typ
max
VCE = 1V
Tj = 25°C
0
0.5
1
VBE (V)
15


7Z07623
Base current versus collector current
V_{CE} = 1V
T_j = 25°C
I_C (A)
10
1
0.1
0.1
1
10
100
I_B (mA)
min
typ
max


7Z09463
base current versus collector current
V_{CE} = 10V
T_j = 25°C
I_C (mA)
100
10
1
1
10
100
1000
I_B (μA)
min
typ
max

APPLICATION INFORMATION

A. 4 W car radio amplifier for 12 V

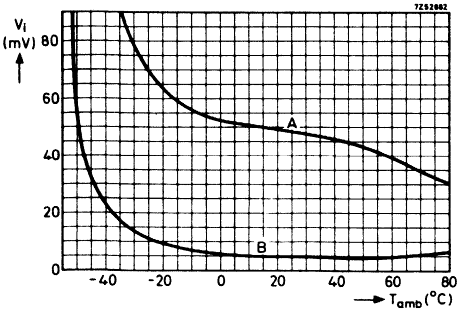


All transistors mounted on one heatsink which has a thermal resistance of $R_{th\ h-a} \leq 5.5\ ^{o}C/W$

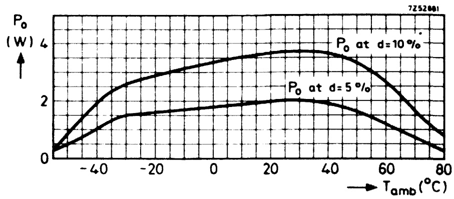
Performance at T_{amb} = 25 ^{o}C

Output power at d_{tot} = 10%	P_o	=	4	W
Sensitivity at P_o = 50 mW	V_i	=	5	mV
P_o = 4 W	V_i	=	48	mV
Input impedance	Z_i	=	10	kΩ
Frequency response (−3 dB)			200 Hz to 20	kHz
Operating ambient temperature	T_{amb}		20 to 70	^{o}C

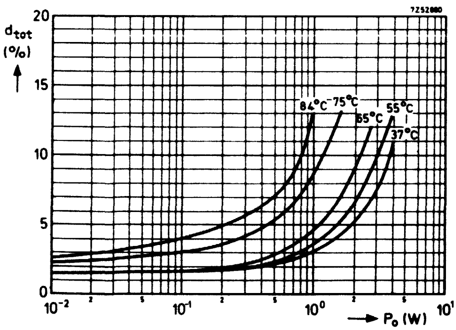
APPLICATION INFORMATION (continued)

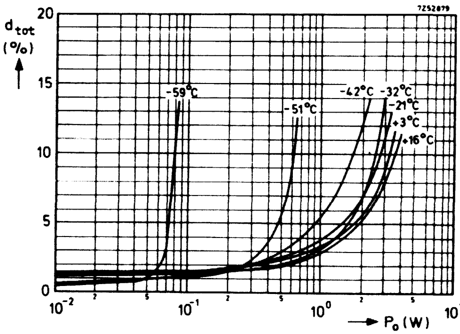


Input sensitivity at various ambient temperatures. Curve A for maximum output power at a distortion of 10%. Curve B for an output power of 50 mW.



The output power at two distortion levels as a function of the ambient temperature.

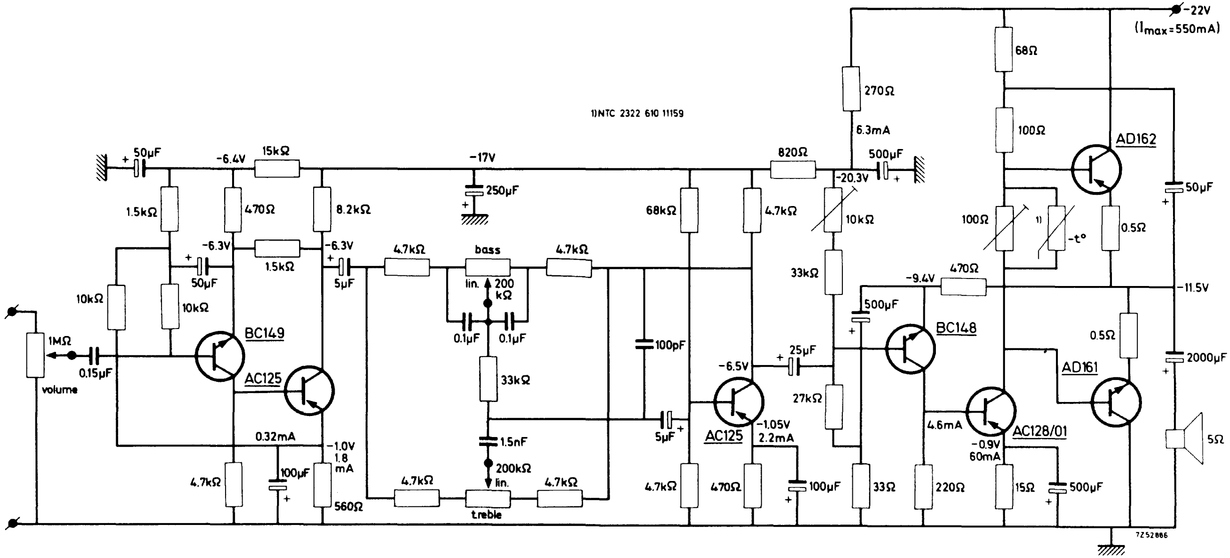




The distortion as a function of the output power at several ambient temperatures.

APPLICATION INFORMATION (continued)

B. 8 W amplifier with matched pair AD161/AD162



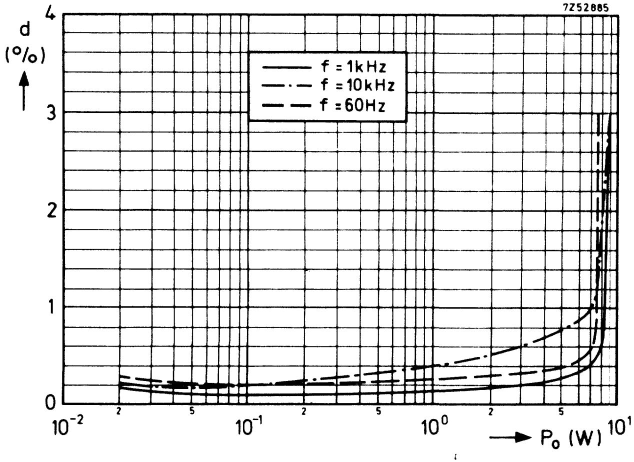
This amplifier can safely be employed up to an ambient temperature of 45 °C, provided the transistors AD161 and AD162 are mounted on a common heatsink of 200 cm^2, thickness 2 mm and the AC128/01 on a heatsink of 50 cm^2.

APPLICATION INFORMATION (continued)

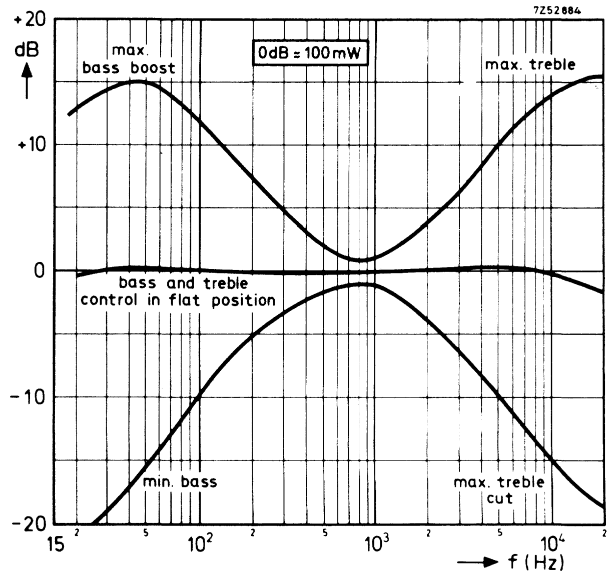
Performance

Output power at onset of clipping d_{tot} = 0.6%; f = 1 kHz	P_o	=	8	W
Sensitivity at P_o = 50 mW	V_i	=	8.7	mV
P_o = 8.7 W	V_i	=	110	mV
Input impedance	Z_i	=	500	kΩ

Signal-noise ratio at P_o = 8.7 W power supply unstabilized	S/N	=	56	dB
stabilized	S/N	=	70	dB
Frequency response (−3 dB)			20 Hz to 20	kHz
Bass control at 45 Hz			−16.5 to +15	dB
Treble control at 20 kHz			−18 to +15.5	dB



The distortion as function of the output power at three different frequencies.



Control facilities of the 8 W amplifier.

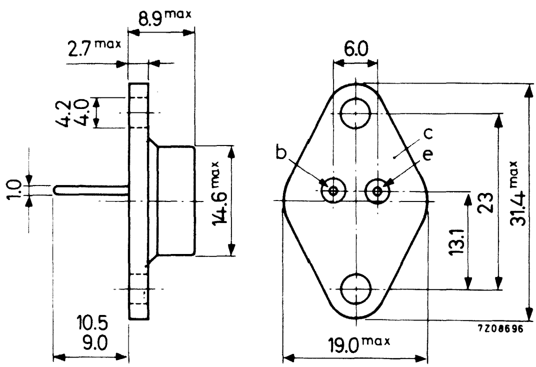
GERMANIUM ALLOYED POWER TRANSISTOR

P-N-P power transistor in a metal envelope with the collector connected to the mounting base.
It is primarily intended for use as matched pair 2-AD162 in class B push-pull output stages and together with the n-p-n power transistor AD161 as matched pair AD161/AD162 in 10 W complementary symmetry class B output stages of mains operated amplifiers and radio receivers.

QUICK REFERENCE DATA				
Collector-base voltage (open emitter)	$-V_{CBO}$	max.	32	V
Collector-emitter voltage (open base)	$-V_{CEO}$	max.	20	V
Collector current (peak value)	$-I_{CM}$	max.	3	A
Total power dissipation up to $T_{mb} = 63\ ^oC$	P_{tot}	max.	6	W
Junction temperature (incidentally)	T_j	max.	100	^oC
D.C. current gain at $T_j = 25\ ^oC$				
$-I_C = 0.5$ A; $-V_{CE} = 1$ V	h_{FE}	80 to 320		
Cut-off frequency				
$-I_C = 0.3$ A; $-V_{CE} = 2$ V	f_{hfe}	typ.	15	kHz

MECHANICAL DATA Dimensions in mm

Collector connected to mounting base



Accessories available: 56203

RATINGS (Limiting values) [1]

Voltages

Collector-base voltage (open emitter)	$-V_{CBO}$	max.	32	V
Collector-emitter voltage (open base)	$-V_{CEO}$	max.	20	V
Collector-emitter voltage with $+V_{BE} = 0.6$ V (See also page 4)	$-V_{CEX}$	max.	32	V
Emitter-base voltage (open collector)	$-V_{EBO}$	max.	10	V

Currents

Collector current (d.c. or average over any 50 ms period)	$-I_C$	max.	1	A
Collector current (peak value)	$-I_{CM}$	max.	3	A

Power dissipation

Total power dissipation up to T_{mb} = 63 °C	P_{tot}	max.	6	W

Temperatures

Storage temperature	T_{stg}		-65 to +90	°C
Junction temperature: continuous	T_j	max.	90	°C
incidentally	T_j	max.	100	°C

THERMAL RESISTANCE

From junction to mounting base	$R_{th\ j-mb}$	=	4.5	°C/W
From mounting base to heatsink with mica washer	$R_{th\ mb-h}$	=	1.5	°C/W
without mica washer	$R_{th\ mb-h}$	=	0.5	°C/W

[1]) Limiting values according to the Absolute Maximum System as defined in IEC publication 134.

CHARACTERISTICS T_j = 25 °C unless otherwise specified

Collector cut-off current

I_E = 0; $-V_{CB}$ = 32 V	$-I_{CBO}$	typ.	15	μA
		<	200	μA
I_E = 0; $-V_{CB}$ = 32 V; T_j = 90 °C	$-I_{CBO}$	<	2	mA
$+V_{BE}$ = 0.6 V; $-V_{CE}$ = 32 V; T_j = 90 °C	$-I_{CEX}$	<	2	mA

Emitter cut-off current

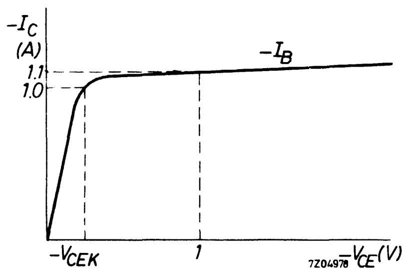
I_C = 0; $-V_{EB}$ = 10 V	$-I_{EBO}$	typ.	15	μA
		<	200	μA
I_C = 0; $-V_{EB}$ = 10 V; T_j = 90 °C	$-I_{EBO}$	<	2	mA

Base-emitter voltage [1]

$-I_C$ = 5 mA; $-V_{CE}$ = 10 V	$-V_{BE}$	115 to	145	mV
$-I_C$ = 50 mA; $-V_{CE}$ = 1 V	$-V_{BE}$	<	300	mV
$-I_C$ = 500 mA; $-V_{CE}$ = 1 V	$-V_{BE}$	<	550	mV
$-I_C$ = 2 A; $-V_{CE}$ = 1 V	$-V_{BE}$	<	850	mV

Knee voltage

$-I_C$ = 1 A; $-I_B$ = value for which
$-I_C$ = 1.1 A at $-V_{CE}$ = 1 V — $-V_{CEK}$ < 400 mV



Floating voltage

I_E = 0; $-V_{CB}$ = 32 V; T_j = 90 °C — $-V_{EBfl}$ < 400 mV

Collector capacitance at f = 450 kHz

$I_E = I_e$ = 0; $-V_{CB}$ = 5 V — C_c typ. 115 pF

[1]) $-V_{BE}$ decreases by about 2 mV/°C with increasing temperature.

CHARACTERISTICS (continued) T_j = 25 °C unless otherwise specified

D.C. current gain

$-I_C$ = 5 mA; $-V_{CE}$ = 10 V	h_{FE}	> 60
$-I_C$ = 50 mA; $-V_{CE}$ = 1 V	h_{FE}	74 to 300
$-I_C$ = 500 mA; $-V_{CE}$ = 1 V	h_{FE}	typ. 150 80 to 320
$-I_C$ = 2 A ; $-V_{CE}$ = 1 V	h_{FE}	> 60

Transition frequency

$-I_C$ = 10 mA; $-V_{CE}$ = 2 V	f_T	typ. 1.5 MHz

Cut-off frequency

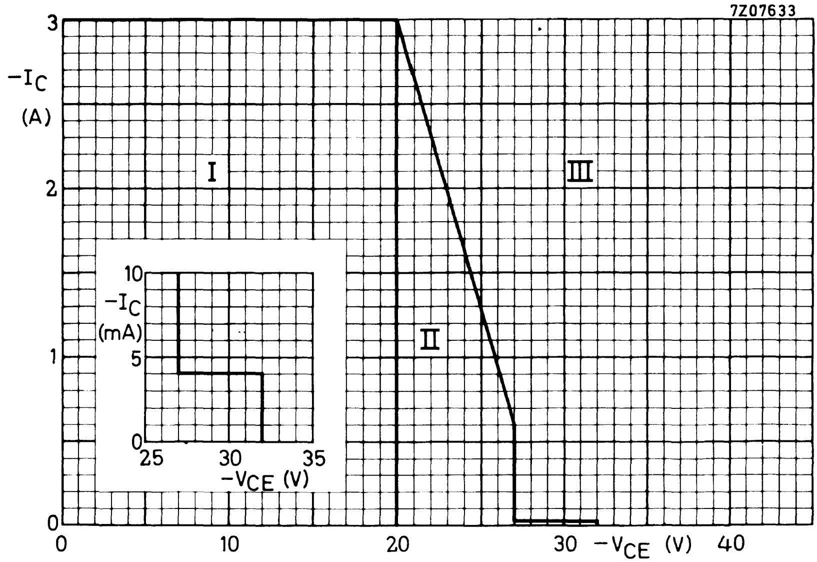
$-I_C$ = 300 mA; $-V_{CE}$ = 2 V	f_{hfe}	> 8 kHz typ. 15 kHz

D.C. current gain ratio of matched pair AD161/AD162

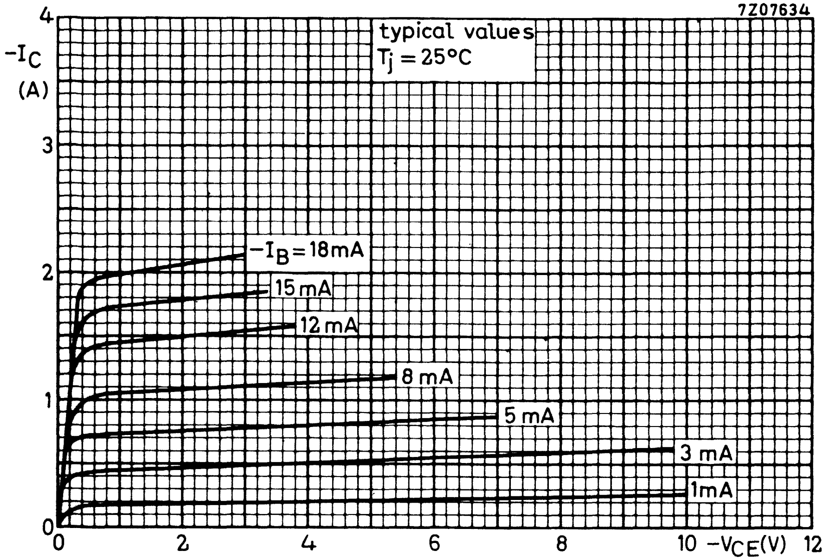
$\lvert I_C \rvert$ = 500 mA; $\lvert V_{CE} \rvert$ = 1 V	h_{FE1}/h_{FE2}	typ. 1.1 < 1.25

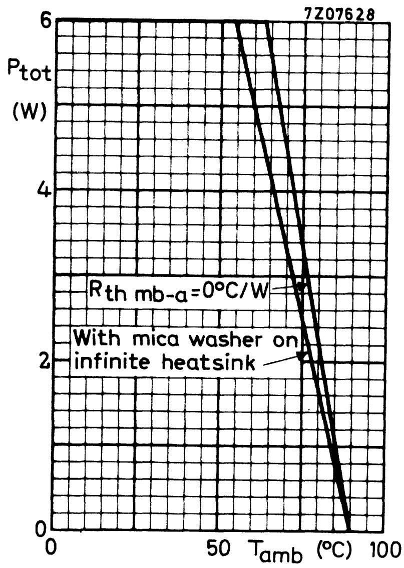
matched pair 2-AD162

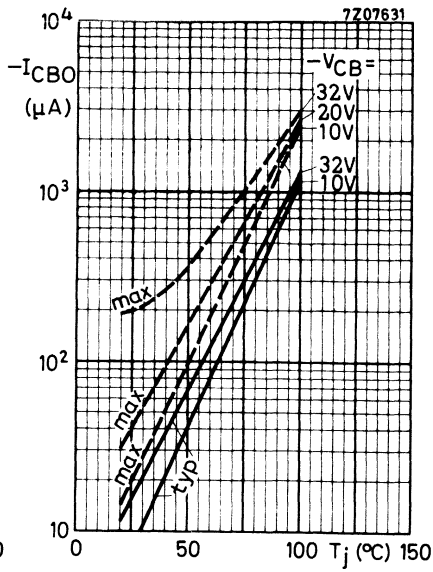
$-I_C$ = 50 mA; $-V_{CE}$ = 1 V $-I_C$ = 500 mA; $-V_{CE}$ = 1 V	h_{FE1}/h_{FE2}	typ. 1.1 < 1.25

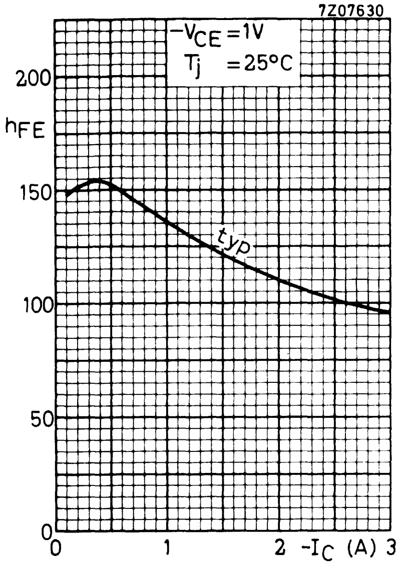


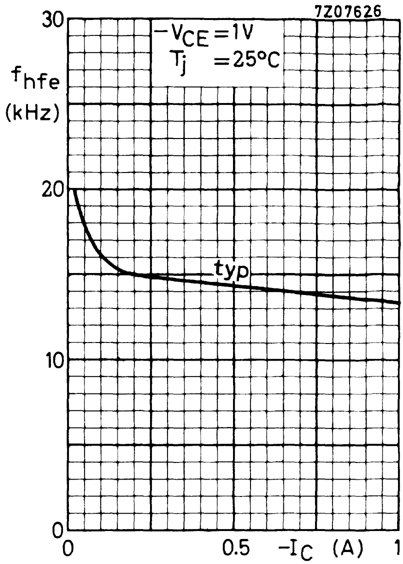
I Region of permissible operation under all base-emitter conditions.
II Additional region of operation when the transistor is cut-off with $V_{BE} \geq V_{BEfl}$.
III Outside regions I and II, the transistor can withstand transient energies of 4.5 mWs, provided it is cut-off with $+V_{BB} < 0.6$ V; R_i = 18 Ω.

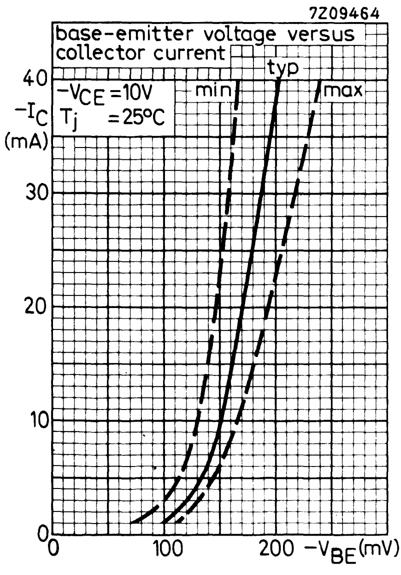

7Z07634
typical values
$T_j = 25°C$
$-I_C$ (A)
$-I_B = 18mA$
15 mA
12 mA
8 mA
5 mA
3 mA
1mA
$-V_{CE}$(V)
0
2
4
6
8
10
12
0
1
2
3
4

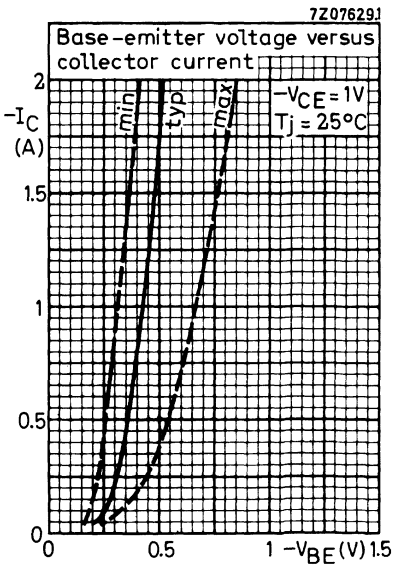

7Z07628
P_{tot} (W)
$R_{th\ mb-a} = 0°C/W$
With mica washer on
infinite heatsink
T_{amb} (°C)
0
50
100
0
2
4
6

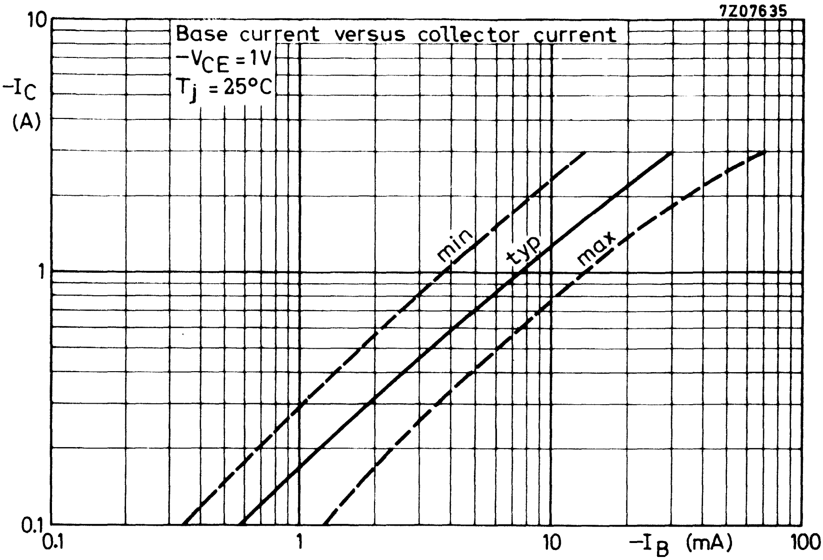

7Z07631
$-I_{CBO}$ (μA)
$-V_{CB}=$
32V
20V
10V
32V
10V
max
max
max
typ
T_j (°C)
0
50
100
150
10
10^2
10^3
10^4

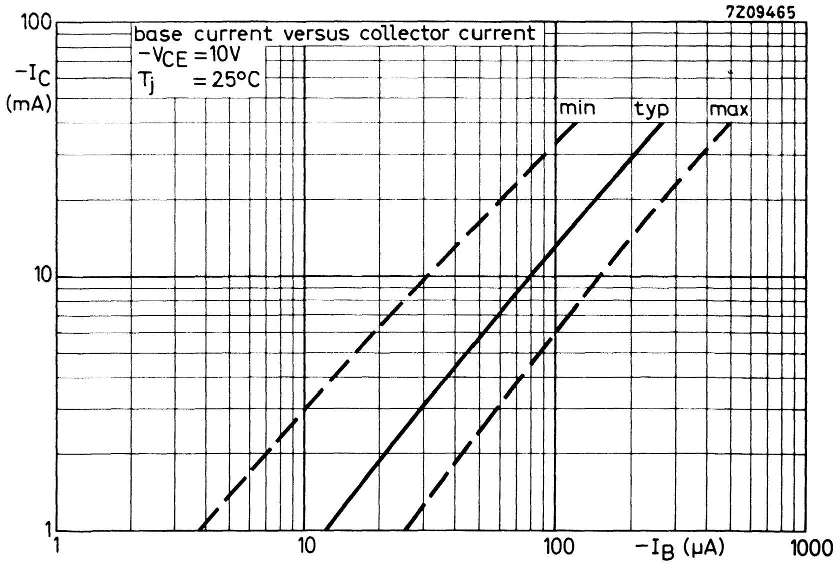

7Z07630
$-V_{CE} = 1V$
$T_j = 25°C$
h_{FE}
200
150
100
50
0
typ
0
1
2
3
$-I_C$ (A)


7Z07626
$-V_{CE} = 1V$
$T_j = 25°C$
f_{hfe} (kHz)
30
20
10
0
typ
0
0.5
1
$-I_C$ (A)


7Z09464
base-emitter voltage versus collector current
$-V_{CE} = 10V$
$T_j = 25°C$
$-I_C$ (mA)
40
30
20
10
0
min
typ
max
0
100
200
$-V_{BE}$ (mV)

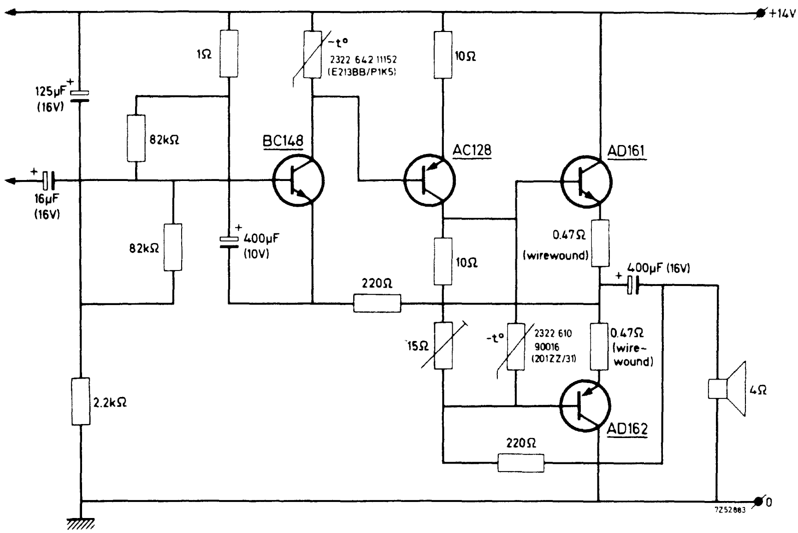

7Z07629.1
Base-emitter voltage versus collector current
$-V_{CE} = 1V$
$T_j = 25°C$
$-I_C$ (A)
2
1.5
1
0.5
0
min
typ
max
0
0.5
1
1.5
$-V_{BE}$ (V)


7Z07635
Base current versus collector current
$-V_{CE} = 1V$
$T_j = 25°C$
$-I_C$
(A)
10
1
0.1
0.1
1
10
$-I_B$ (mA)
100
min
typ
max


7Z09465
base current versus collector current
$-V_{CE} = 10V$
$T_j = 25°C$
$-I_C$
(mA)
100
10
1
1
10
100
$-I_B$ (μA)
1000
min
typ
max

APPLICATION INFORMATION

A. 4 W car radio amplifier for 12 V

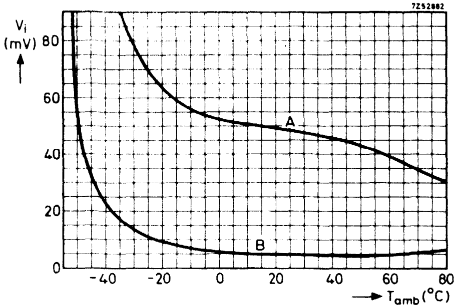


All transistors mounted on one heatsink which has a thermal resistance of $R_{th\ h\text{-}a} \leq 5.5\ ^{o}C/W$

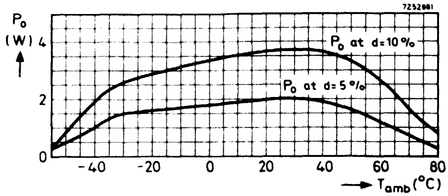
Performance at T_{amb} = 25 °C

Output power at d_{tot} = 10%	P_o	=	4	W
Sensitivity at P_o = 50 mW	V_i	=	5	mV
P_o = 4 W	V_i	=	48	mV
Input impedance	Z_i	=	10	kΩ
Frequency response (−3 dB)			200 Hz to 20	kHz
Operating ambient temperature	T_{amb}		20 to 70	°C

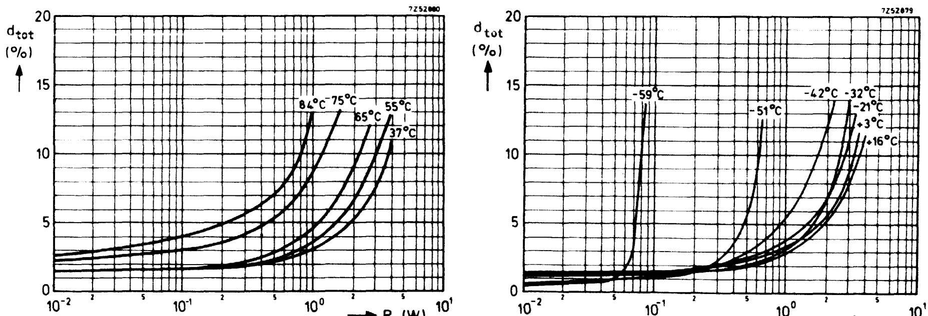
APPLICATION INFORMATION (continued)



Input sensitivity at various ambient temperatures. Curve A for maximum output power at a distortion of 10%. Curve B for an output power of 50 mW.



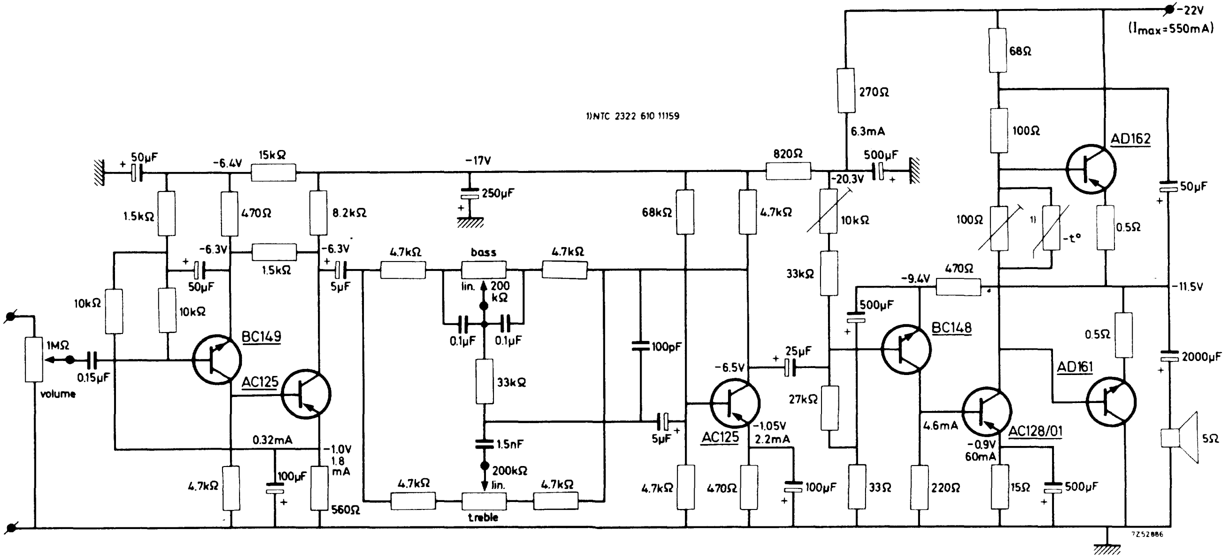
The output power at two distortion levels as a function of the ambient temperature.



The distortion as a function of the output power at several ambient temperatures.

APPLICATION INFORMATION (continued)

B. 8 W amplifier with matched pair AD161/AD162



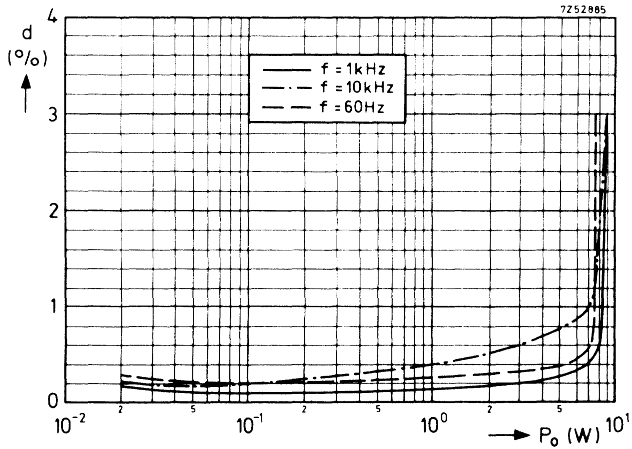
This amplifier can safely be employed up to an ambient temperature of 45 °C, provided the transistors AD161 and AD162 are mounted on a common heatsink of 200 cm^2, thickness 2 mm and the AC128/01 on a heatsink of 50 cm^2.

APPLICATION INFORMATION (continued)

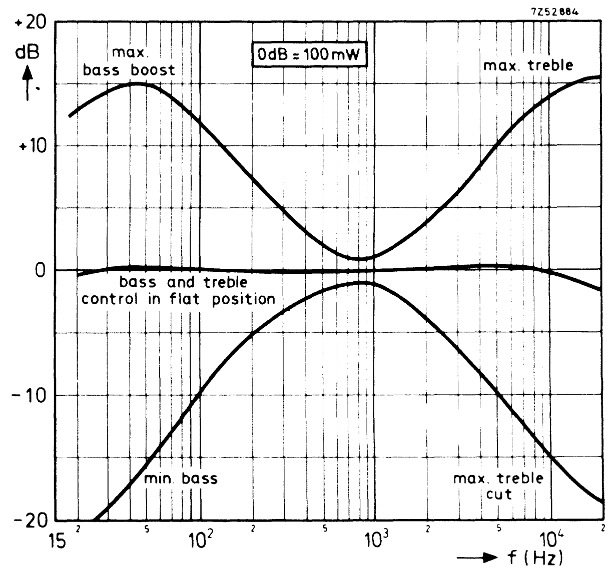
Performance

Output power at onset of clipping d_{tot} = 0.6%; f = 1 kHz	P_o = 8 W
Sensitivity at P_o = 50 mW	V_i = 8.7 mV
P_o = 8.7 W	V_i = 110 mV
Input impedance	Z_i = 500 kΩ

Signal-noise ratio at P_o = 8.7 W	
power supply unstabilized	S/N = 56 dB
stabilized	S/N = 70 dB
Frequency response (−3 dB)	20 Hz to 20 kHz
Bass control at 45 Hz	−16.5 to +15 dB
Treble control at 20 kHz	−18 to +15.5 dB



The distortion as function of the output power at three different frequencies.



Control facilities of the 8 W amplifier.

P-N-P POWER TRANSISTOR

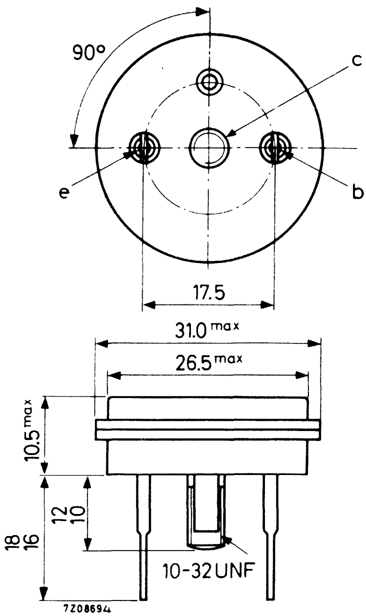
Germanium alloy transistor in a TO-36 metal envelope. The ADY26 is primarily intended for high power and high current application.

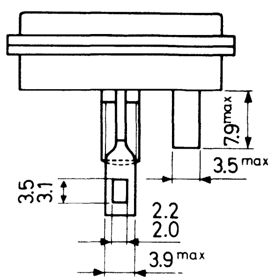
QUICK REFERENCE DATA				
Collector-base voltage (open emitter)	$-V_{CBO}$	max.	80	V
Collector-emitter voltage (open base)	$-V_{CEO}$	max.	60	V
Emitter-base voltage (open collector)	$-V_{EBO}$	max.	40	V
Collector current (peak value)	$-I_{CM}$	max.	30	A
Total power dissipation up to T_{mb} = 30 °C	P_{tot}	max.	100	W
Junction temperature	T_j	max.	90	°C
D.C. current gain at T_j = 25 °C I_E = 25 A; V_{CB} = 0	h_{FE}	>	15	

MECHANICAL DATA

Dimensions in mm

TO-36





Diameter of hole in heatsink: max. 5.2 mm
Supplied with device: 56213

Torque on nut: min. 8 cmkg
max. 17 cmkg

RATINGS (Limiting values) [1]

Voltages

Collector-base voltage (open emitter)	$-V_{CBO}$	max.	80	V
Collector-emitter voltage (open base) see also page 10	$-V_{CEO}$	max.	60	V
Emitter-base voltage (open collector)	$-V_{EBO}$	max.	40	V

Currents

Collector current (averaged over any 20 ms period)	$-I_C$	max.	25	A
Collector current (peak value)	$-I_{CM}$	max.	30	A
Base current (averaged over any 20 ms period)	$-I_B$	max.	3	A
Base current (peak value)	$-I_{BM}$	max.	5	A

Power dissipation

Total power dissipation up to $T_{mb} = 30\ ^oC$ see also page 11	P_{tot}	max.	100	W

Temperatures

Storage temperature	T_{stg}	-55 to +90		^oC
Junction temperature	T_j	max.	90	^oC

THERMAL RESISTANCE

From junction to mounting base	$R_{th\ j\text{-}mb}$	=	0.6	$^oC/W$

[1]) Limiting values according to the Absolute Maximum System as defined in IEC publication 134.

CHARACTERISTICS T_j = 25 °C unless otherwise specified

Collector cut-off current		
$I_E = 0$; $-V_{CB} = 2$ V	$-I_{CBO}$	typ. 50 μA < 200 μA
$I_E = 0$; $-V_{CB} = 80$ V	$-I_{CBO}$	typ. 0.5 mA < 4 mA
Emitter cut-off current		
$I_C = 0$; $-V_{EB} = 2$ V	$-I_{EBO}$	typ. 50 μA < 200 μA
$I_C = 0$; $-V_{EB} = 40$ V	$-I_{EBO}$	typ. 0.5 mA < 4 mA
Currents at reverse biased emitter junction		
$+V_{BE} = 1$ V; $-V_{CE} = 80$ V; $T_j = 90$ °C	$-I_{CEX}$	typ. 3 mA
Sustaining voltage		
$-I_C = 25$ A; $+V_{BE} = 2$ V	$-V_{CEXsust}$	> 40 V
Base-emitter voltage		
$I_E = 5$ A; $V_{CB} = 0$	$-V_{BE}$	typ. 0.6 V < 1 V
$I_E = 25$ A; $V_{CB} = 0$ [1]	$-V_{BE}$	typ. 1.2 V < 2 V
Saturation voltage [1]		
$-I_C = 25$ A; $-I_B = 2.5$ A	$-V_{CEsat}$	typ. 0.15 V < 0.5 V
Emitter floating voltage		
$I_E = 0$; $-V_{CB} = 80$ V	$-V_{EBfl}$	typ. 0.2 V < 1.0 V
D.C. current gain		
$I_E = 5$ A; $V_{CB} = 0$	h_{FE}	typ. 60 40 to 120
$I_E = 25$ A; $V_{CB} = 0$ [1]	h_{FE}	> 15 typ. 25
Collector capacitance		
$I_E = I_e = 0$; $-V_{CB} = 12$ V	C_c	typ. 350 pF

[1]) Measured under pulsed conditions to prevent excessive dissipation.

CHARACTERISTICS (continued) T_j = 25 °C unless otherwise specified

Small signal current gain

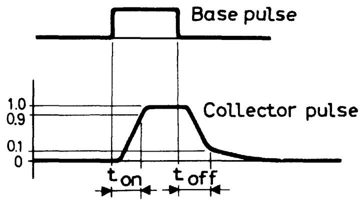
$-I_C$ = 1 A; $-V_{CE}$ = 12 V; f = 100 kHz	h_{fe}	>	1.0	
		typ.	1.7	

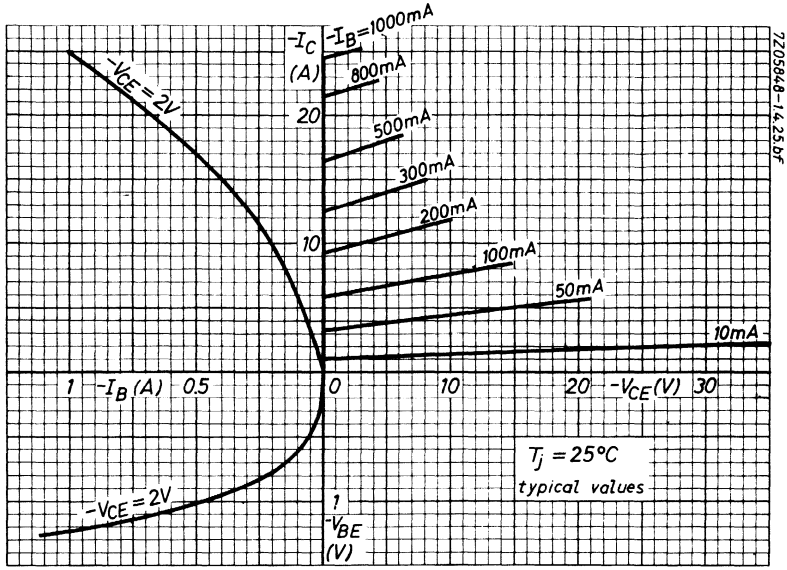
Turn on time

$-I_C$ = 25 A; $-I_B$ = 2 A; $-V_{CC}$ = 18 V	t_{on}	typ.	25	μs

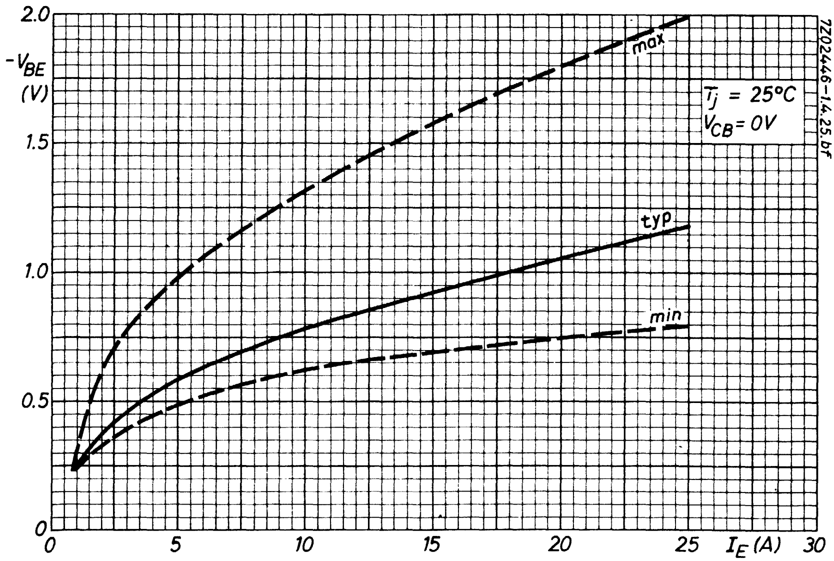
Turn off time

$-I_C$ = 25 A; V_{BEoff} = 6 V; R_{BE} = 10 Ω	t_{off}	typ.	75	μs

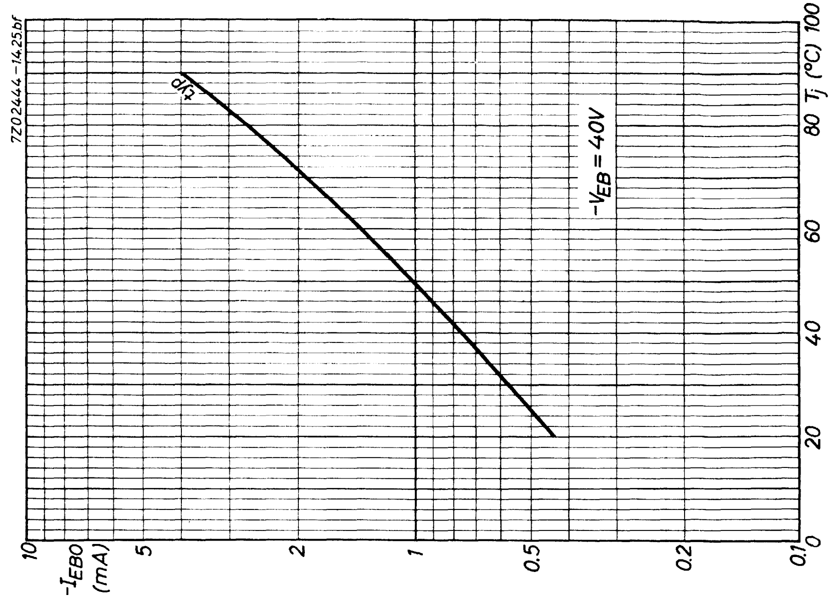


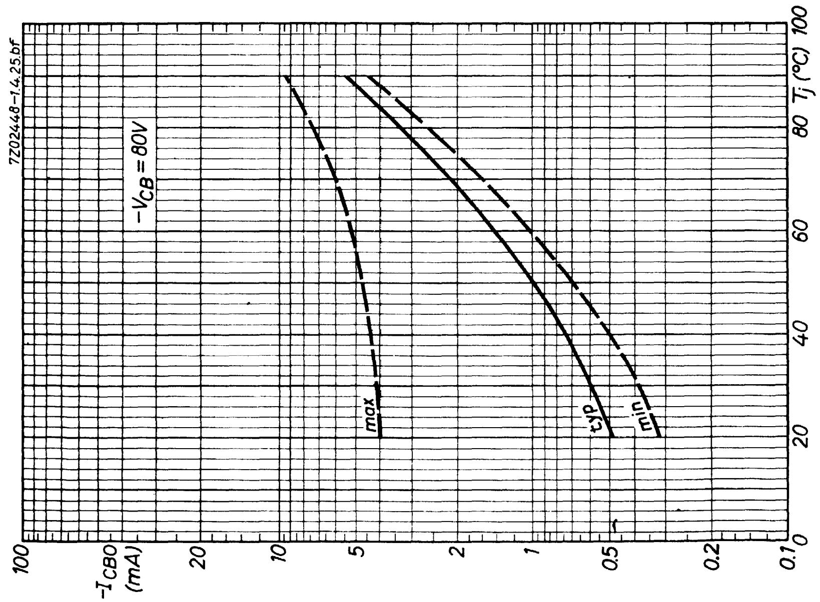


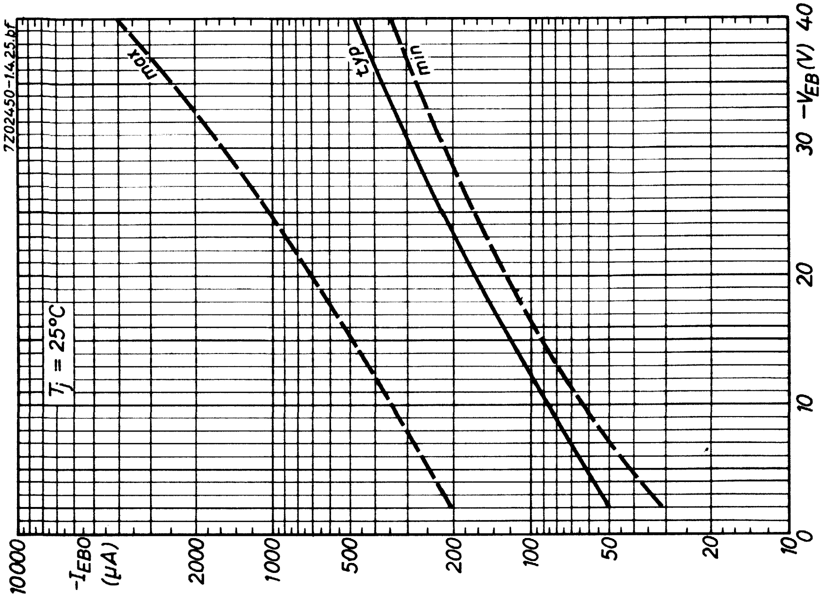
$-I_C$ (A)
$-I_B$=1000mA
800mA
500mA
300mA
200mA
100mA
50mA
10mA
20
10
$-V_{CE}$=2V
1
$-I_B$ (A)
0.5
0
10
20
$-V_{CE}$ (V)
30
T_j = 25°C
typical values
$-V_{CE}$=2V
1
$-V_{BE}$ (V)
7Z05848-1.4.25.bf

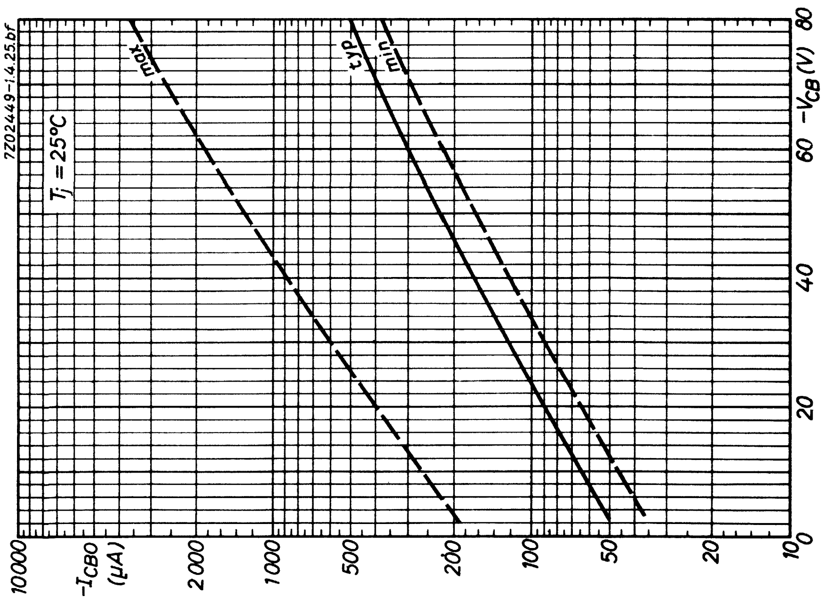


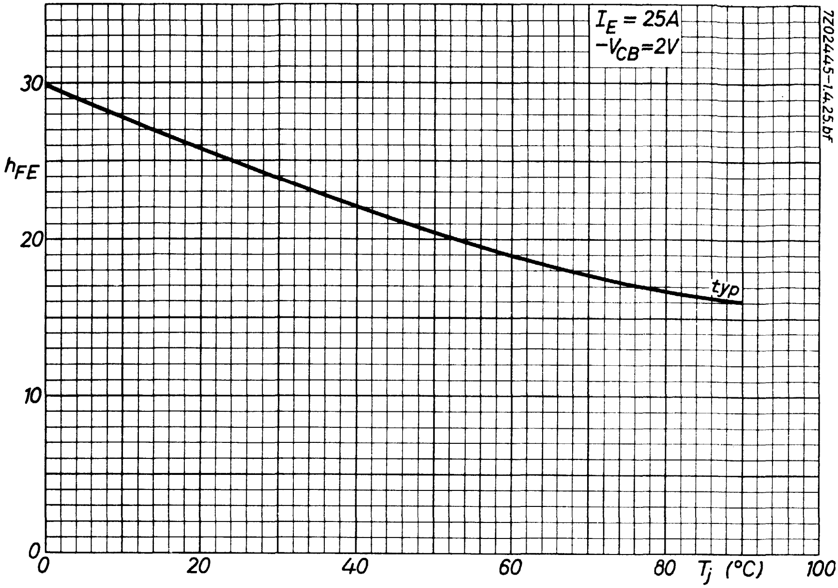
2.0
$-V_{BE}$ (V)
1.5
1.0
0.5
0
max
typ
min
T_j = 25°C
V_{CB}= 0V
0
5
10
15
20
25
I_E (A)
30
7Z02446-1.4.25.bf


7Z02444-1.4.25.bf
typ
$-V_{EB} = 40V$
T_j (°C)
0
20
40
60
80
100
$-I_{EBO}$ (mA)
10
5
2
1
0.5
0.2
0.1

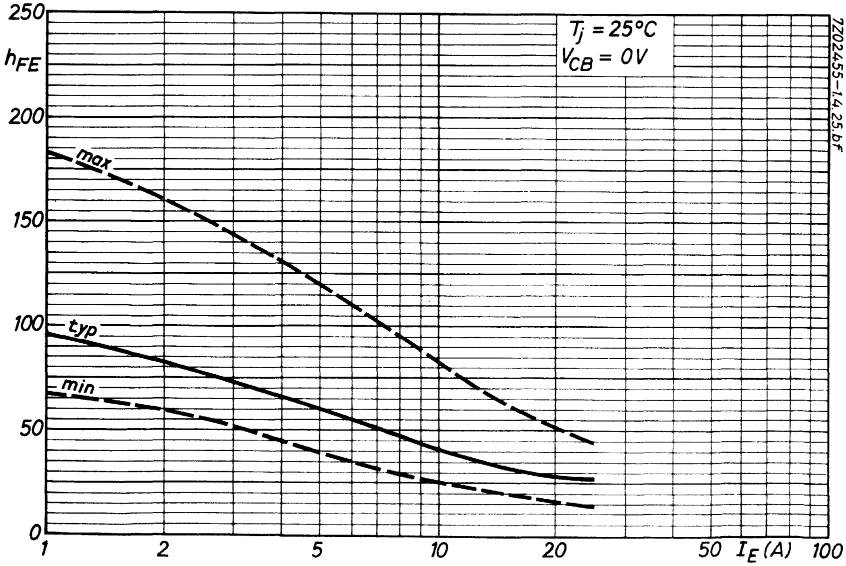

7Z02448-1.4.25.bf
$-V_{CB} = 80V$
max
typ
min
T_j (°C)
0
20
40
60
80
100
$-I_{CBO}$ (mA)
100
20
10
5
2
1
0.5
0.2
0.1


7Z02450-1.4.25.bf
T_j = 25°C
max
typ
min
$-I_{EBO}$ (μA)
10000
2000
1000
500
200
100
50
20
10
0
10
20
30
40
$-V_{EB}$ (V)

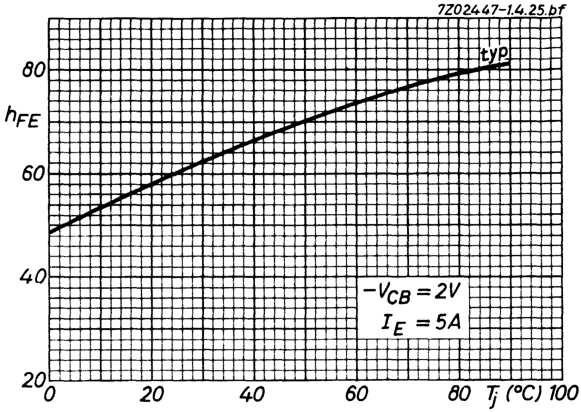

7Z02449-1.4.25.bf
T_j = 25°C
max
typ
min
$-I_{CBO}$ (μA)
10000
2000
1000
500
200
100
50
20
10
0
20
40
60
80
$-V_{CB}$ (V)

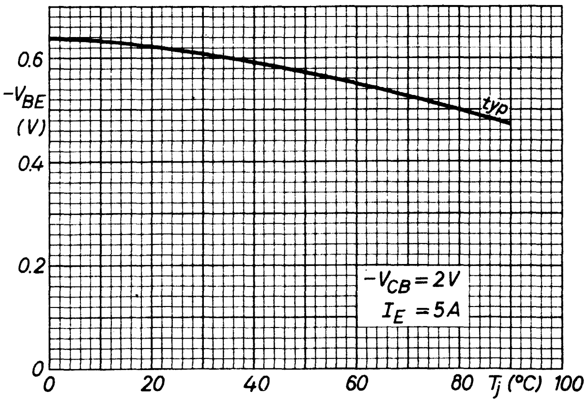


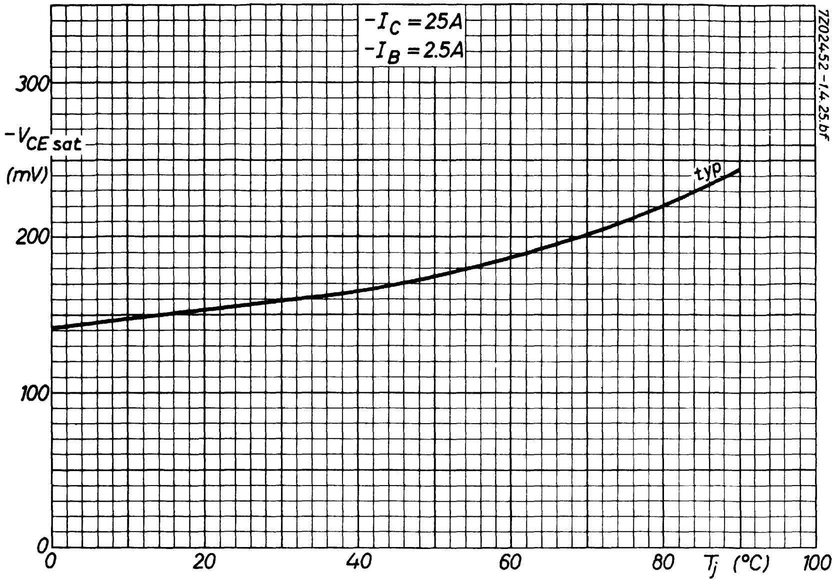
$I_E = 25A$
$-V_{CB}=2V$
7Z02445-1.4.25.bf
30
h_{FE}
20
10
0
0
20
40
60
80
T_j (°C)
100
typ



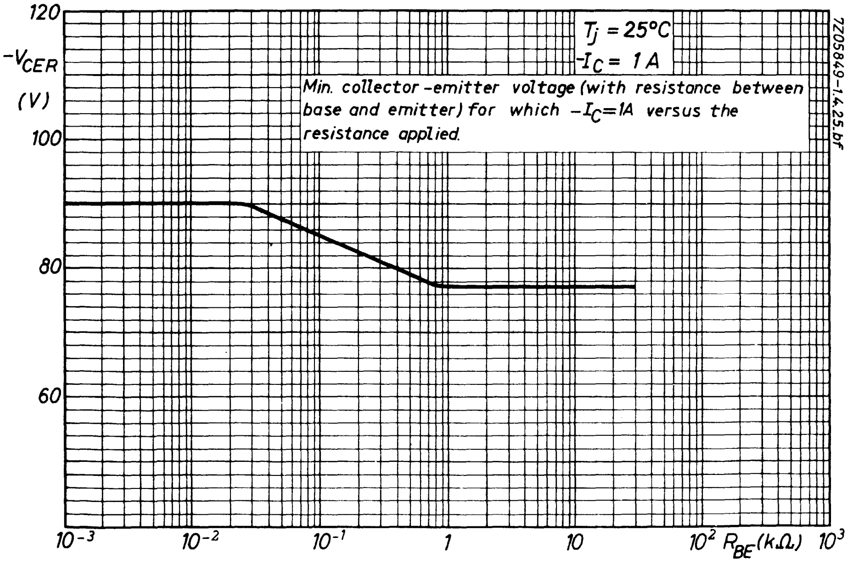
$T_j = 25°C$
$V_{CB} = 0V$
7Z02455-1.4.25.bf
250
h_{FE}
200
150
100
50
0
1
2
5
10
20
50
I_E (A)
100
max
typ
min


7Z02447-1.4.25.bf
typ
80
h_{FE}
60
40
20
$-V_{CB} = 2V$
$I_E = 5A$
0
20
40
60
80
T_j (°C)
100

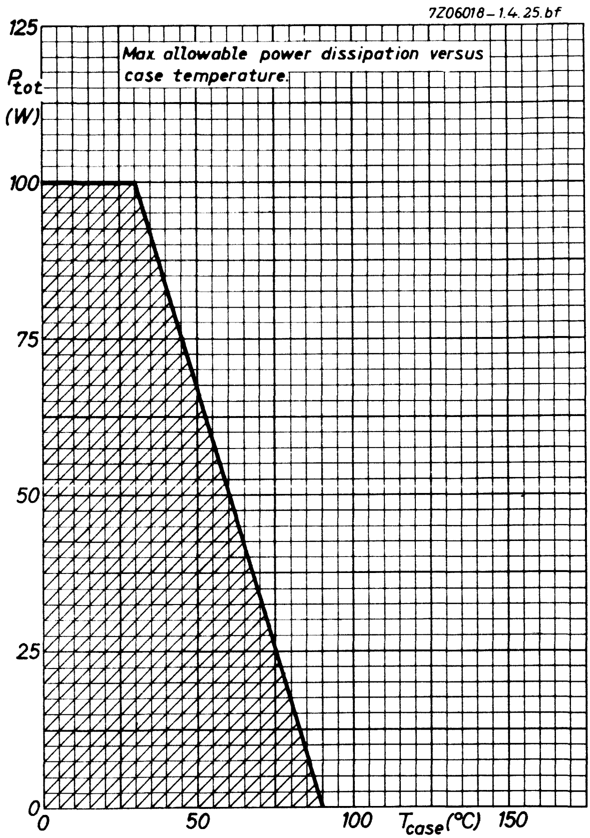

0.6
$-V_{BE}$
(V)
0.4
0.2
0
typ
$-V_{CB} = 2V$
$I_E = 5A$
0
20
40
60
80
T_j (°C)
100

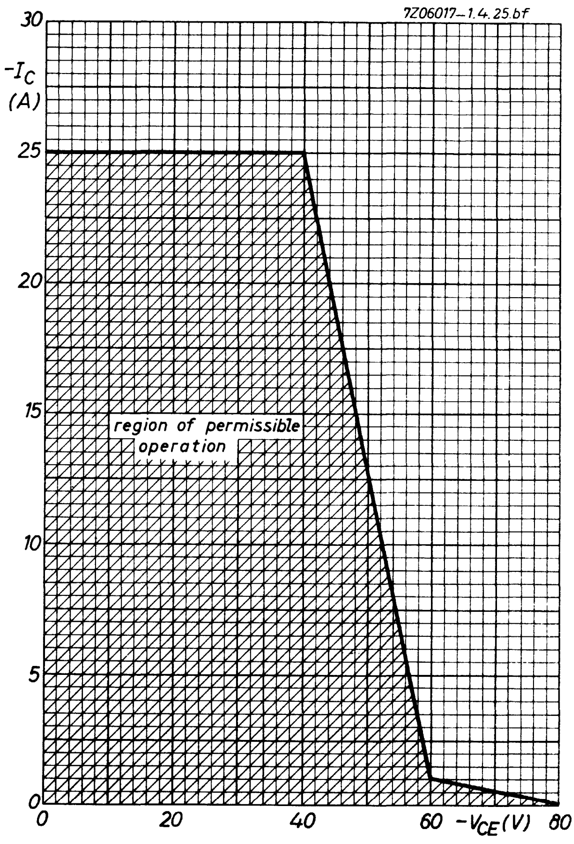


$-I_C = 25A$
$-I_B = 2.5A$
7Z02452-1.4.25.bf
300
$-V_{CE\,sat}$
(mV)
200
100
0
typ
0
20
40
60
80
T_j (°C)
100



$T_j = 25°C$
$-I_C = 1\,A$
Min. collector-emitter voltage (with resistance between base and emitter) for which $-I_C$=1A versus the resistance applied.
7Z05849-1.4.25.bf
120
$-V_{CER}$
(V)
100
80
60
10^{-3}
10^{-2}
10^{-1}
1
10
10^2
R_{BE} (kΩ)
10^3


7Z06018-1.4.25.bf
Max allowable power dissipation versus case temperature.
125
P_{tot}
(W)
100
75
50
25
0
0
50
100
T_{case} (°C)
150


7Z06017–1.4.25.bf
30
$-I_C$
(A)
25
20
15
10
5
0
0
20
40
60
$-V_{CE}$(V)
80
region of permissible operation

GERMANIUM ALLOYED POWER TRANSISTORS

P-N-P transistors in a TO-36 metal envelope.
The ADZ11 and ADZ12 are primarily intended for use in a.f. applications.

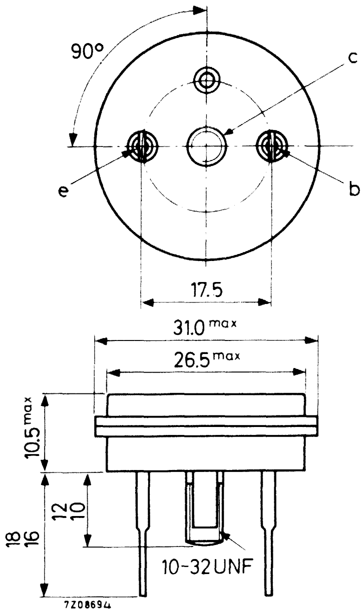
QUICK REFERENCE DATA

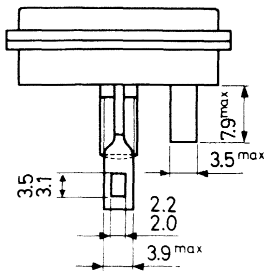
			ADZ11	ADZ12	
Collector-base voltage (open-emitter)	$-V_{CBO}$	max.	50	80	V
Collector-emitter voltage (open base)	$-V_{CEO}$	max.	40	60	V
Collector current (peak value)	$-I_{CM}$	max.	20		A
Total power dissipation up to T_{mb} = 55 °C	P_{tot}	max.	45		W
Junction temperature	T_j	max.	90		°C
D.C. current gain at T_j = 25 °C $-I_C$ = 1.2 A; V_{CB} = 0	h_{FE}		40 to 120		
Cut-off frequency I_E = 1 A; $-V_{CB}$ = 12 V ADZ11	f_{hfe}	>	80		kHz
ADZ12	f_{hfe}	>	100		kHz

MECHANICAL DATA

Dimensions in mm

TO-36





Diameter of hole in heatsink: max. 5.2 mm
Supplied with device: 56213

Torque on nut: min. 8 cmkg
max. 17 cmkg

RATINGS (Limiting values) [1]

			ADZ11	ADZ12	
Voltages					
Collector-base voltage (open emitter)	$-V_{CBO}$	max.	50	80	V
Collector-emitter voltage (open base)	$-V_{CEO}$	max.	40	60	V
Emitter-base voltage (open collector)	$-V_{EBO}$	max.	30	50	V
Currents					
Collector current (d.c.)	$-I_C$	max.	15		A
Collector current (peak value)	$-I_{CM}$	max.	20		A
Base current (d.c.)	$-I_B$	max.	2		A
Base current (peak value)	$-I_{BM}$	max.	4		A
Power dissipation					
Total power dissipation up to T_{mb} = 55 °C	P_{tot}	max.	45		W
Temperatures					
Storage temperature	T_{stg}		-55 to +75		°C
Junction temperature	T_j	max.	90		°C

THERMAL RESISTANCE

From junction to mounting base	$R_{th\ j\text{-}mb}$	=	0.8	°C/W

[1]) Limiting values according to the Absolute Maximum System as defined in IEC publication 134.

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

Collector cut-off current

$I_E = 0$; $-V_{CB} = 2$ V	$-I_{CBO}$	<	0.2	mA
$I_E = 0$; $-V_{CB} = -V_{CBOmax}$	$-I_{CBO}$	<	8	mA

Emitter cut-off current

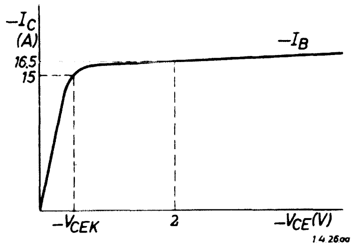
$I_C = 0$; $-V_{EB} = 2$ V	$-I_{EBO}$	<	0.2	mA
$I_C = 0$; $-V_{EB} = -V_{EBOmax}$	$-I_{EBO}$	<	8	mA

Emitter-base voltage

$-I_C = 1.2$ A; $V_{CB} = 0$	V_{EB}	<	0.7	V
$-I_C = 5$ A; $V_{CB} = 0$	V_{EB}	<	1.2	V
$-I_C = 15$ A; $V_{CB} = 0$	V_{EB}	<	2	V

Knee voltage

$-I_C = 15$ A; $-I_B$ = value for which $-I_C = 16.5$ A at $-V_{CE} = 2$ V	$-V_{CEK}$	<	1	V



Emitter floating voltage

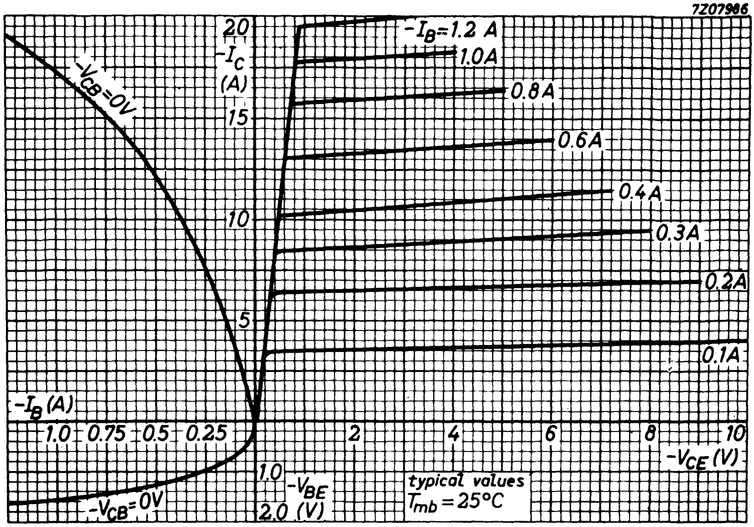
$I_E = 0$; $-V_{CB} = -V_{CBOmax}$	$-V_{EBfl}$	<	1	V

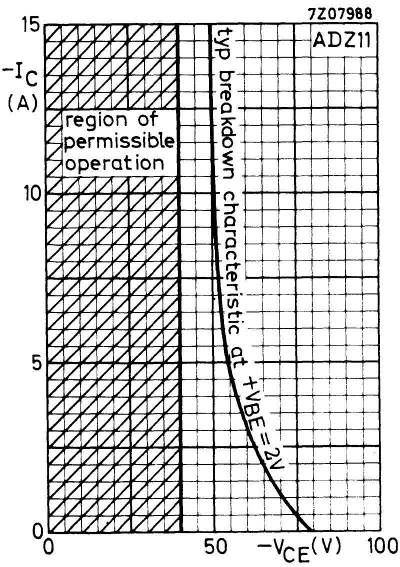
D.C. current gain

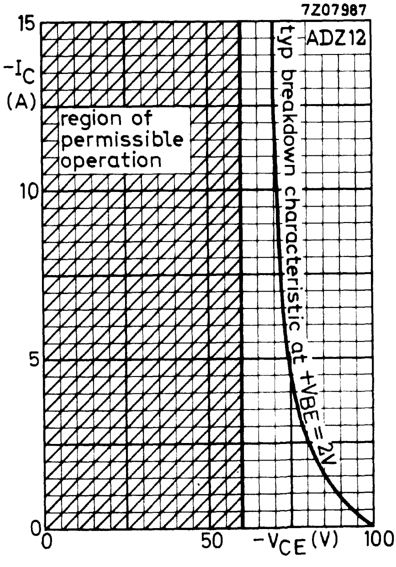
$-I_C = 1.2$ A; $V_{CB} = 0$	h_{FE}	40 to 120	
$-I_C = 5$ A; $V_{CB} = 0$	h_{FE}	>	25
$-I_C = 15$ A; $V_{CB} = 0$	h_{FE}	>	15

Cut-off frequency

$I_E = 1$ A; $-V_{CB} = 12$ V	ADZ11:	f_{hfe}	>	80	kHz
	ADZ12:	f_{hfe}	>	100	kHz


7Z07986
$-I_C$ (A)
20
15
10
5
$-I_B = 1.2$ A
1.0A
0.8A
0.6A
0.4A
0.3A
0.2A
0.1A
$-V_{CB} = 0V$
$-I_B$ (A)
1.0
0.75
0.5
0.25
2
4
6
8
10
$-V_{CE}$ (V)
1.0
2.0
$-V_{BE}$ (V)
$-V_{CB} = 0V$
typical values
$T_{mb} = 25°C$


7Z07988
ADZ11
15
$-I_C$ (A)
10
5
0
region of permissible operation
typ breakdown characteristic at $+V_{BE} = 2V$
0
50
$-V_{CE}$ (V)
100


7Z07987
ADZ12
15
$-I_C$ (A)
10
5
0
region of permissible operation
typ breakdown characteristic at $+V_{BE} = 2V$
0
50
$-V_{CE}$ (V)
100

ALLOY DIFFUSED GERMANIUM TRANSISTOR

P-N-P transistor in a hermetically sealed in TO-7 metal envelope. The transistor is intended for low noise high gain v.h.f. amplifiers, oscillators or convertor circuits up to 260 MHz.
The transistor is absolutely moisture proof.

RATINGS (Limiting values)

Voltages				
Collector-base voltage (open emitter)	$-V_{CBO}$	max.	25	V
Emitter-base voltage (open collector)	$-V_{EBO}$	max.	0.5	V
Currents				
Collector current (d.c.)	$-I_C$	max.	10	mA
Emitter current (d.c.)	I_E	max.	10	mA
Reverse emitter current (d.c.)	$-I_E$	max.	1	mA
Power dissipation				
Total power dissipation up to $T_{amb} = 45\ ^oC$	P_{tot}	max.	50	mW
Temperatures				
Storage temperature	T_{stg}		-55 to +75	^oC
Junction temperature: continuous	T_j	max.	75	^oC
incidentally	T_j	max.	90	^oC

THERMAL RESISTANCE

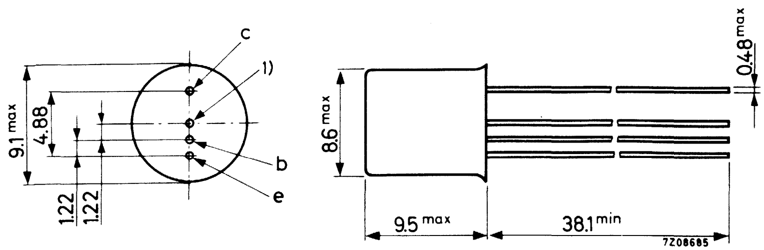
From junction to ambient in free air	$R_{th\ j\text{-}a}$	=	0.6	$^oC/mW$

CHARACTERISTICS $T_{amb} = 25\ ^oC$

Feedback capacitance at f = 0.45 MHz				
$-I_C = 1$ mA; $-V_{CE} = 12$ V	$-C_{re}$	typ.	0.8	pF
Noise figure at f = 200 MHz				
$-I_C = 1$ mA; $-V_{CE} = 12$ V; $R_S = 30\ \Omega$	F	typ.	6	dB
		<	7.5	dB

MECHANICAL DATA Dimensions in mm

TO-7



1) = shield lead (connected to case)

Accessories available: 56207

FOR NEW DESIGN THE SUCCESSOR TYPES AF239, AF240 (P-N-P) OR BF182, BF183, BF200 (N-P-N) ARE RECOMMENDED

GERMANIUM ALLOY DIFFUSED TRANSISTORS

P-N-P transistors in TO-7 metal envelopes with the shield lead connected to the case.

RATING (Limiting value according to the Absolute Maximum System as defined in IEC publication 134).

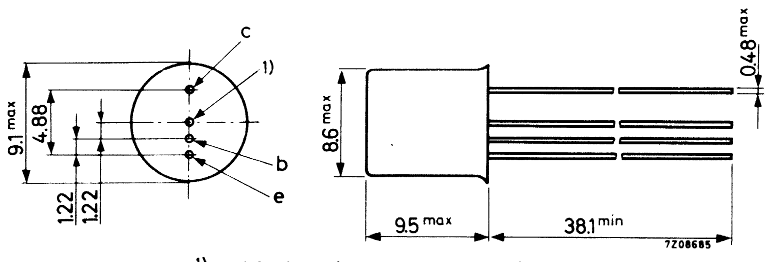
Total power dissipation up to T_{amb} = 45 °C	P_{tot}	max.	75 mW

THERMAL RESISTANCE

From junction to ambient in free air	$R_{th\ j-a}$	=	0.6 °C/mW

MECHANICAL DATA Dimensions in mm

TO-7



1) = shield lead (connected to case)

The AF114 to 117 have been superseded by the AF124 to 127 (same crystal in TO-72 envelope). For data and curves refer to the latter.

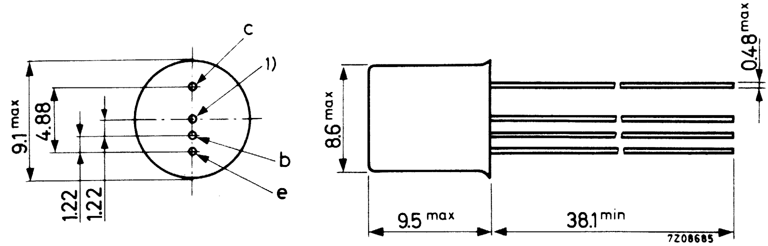
ALLOY-DIFFUSED GERMANIUM TRANSISTOR

P-N-P transistor in a TO-7 metal envelope with a shield lead connected to the case. The transistor is intended for medium power, high voltage and high frequency applications.

QUICK REFERENCE DATA				
Collector-base voltage (open emitter)	$-V_{CBO}$	max.	70	V
Collector current (d.c.)	$-I_C$	max.	30	mA
Total power dissipation up to T_{amb} = 45 °C with cooling fin 56207	P_{tot}	max.	375	mW
Junction temperature	T_j	max.	75	°C
Thermal resistance from junction to ambient with cooling fin 56207	$R_{th\ j\text{-}a}$	=	0.12	°C/mW
Feedback capacitance at f = 10.7 MHz				
I_E = 10 mA; $-V_{CB}$ = 6 V	$-C_{re}$	typ.	1.8	pF

MECHANICAL DATA Dimensions in mm

TO-7



1) = shield lead (connected to case)

Accessory available: 56207

FOR NEW DESIGN THE SUCCESSOR TYPES BF177 to 179 (N-P-N) ARE RECOMMENDED

RATINGS (Limiting values) [1]

Voltage

Collector-base voltage (open emitter)	$-V_{CBO}$	max.	70	V
Collector-emitter voltage (open base)	$-V_{CEO}$	max.	20	V
Collector-emitter voltage $R_B/R_E < 0.1$	$-V_{CEX}$	max.	70	V

Currents

Collector current (d.c.)	$-I_C$	max.	30	mA
Base current	$-I_B$	max.	3	mA
Reverse base current	I_B	max.	1	mA

Power dissipation

Total power dissipation up to T_{amb} = 45 °C with cooling fin 56207	P_{tot}	max.	375	mW

Temperatures

Storage temperature	T_{stg}	-55 to +75		°C
Junction temperature : continuous	T_j	max.	75	°C
incidentally	T_j	max.	90	°C

THERMAL RESISTANCE

From junction to ambient in free air	$R_{th\ j\text{-}a}$	=	0.25	°C/mW
From junction to ambient with cooling fin	$R_{th\ j\text{-}a}$	=	0.12	°C/mW

[1]) Limiting values according to the Absolute Maximum System as defined in IEC publication 134.

CHARACTERISTICS T_{amb} 25 °C unless otherwise specified

Collector cut-off current

$I_E = 0$; $-V_{CB} = 70$ V	$-I_{CBO}$	<	60	μA
$I_E = 0$; $-V_{CB} = 70$ V; $T_j = 90$ °C	$-I_{CBO}$	<	1.6	mA

Base current

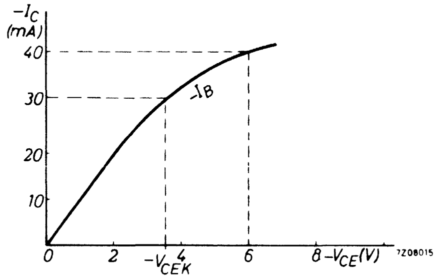
$-I_C = 10$ mA; $-V_{CE} = 2$ V	$-I_B$	typ.	55	μA
		<	275	μA

Base-emitter voltage

$-I_C = 10$ mA; $-V_{CE} = 2$ V	$-V_{BE}$	<	375	mV

Knee voltage

$-I_C = 30$ mA; $-I_B$ = value for which $-I_C = 40$ mA at $-V_{CE} = 6$ V	$-V_{CEK}$	typ.	3.5	V
		<	5	V



Feedback capacitance at f = 10.7 MHz

$-I_C = 10$ mA; $-V_{CE} = 6$ V	$-C_{re}$	typ.	1.8	pF
		<	2.3	pF

Frequency at which $|h_{fe}| = 1$

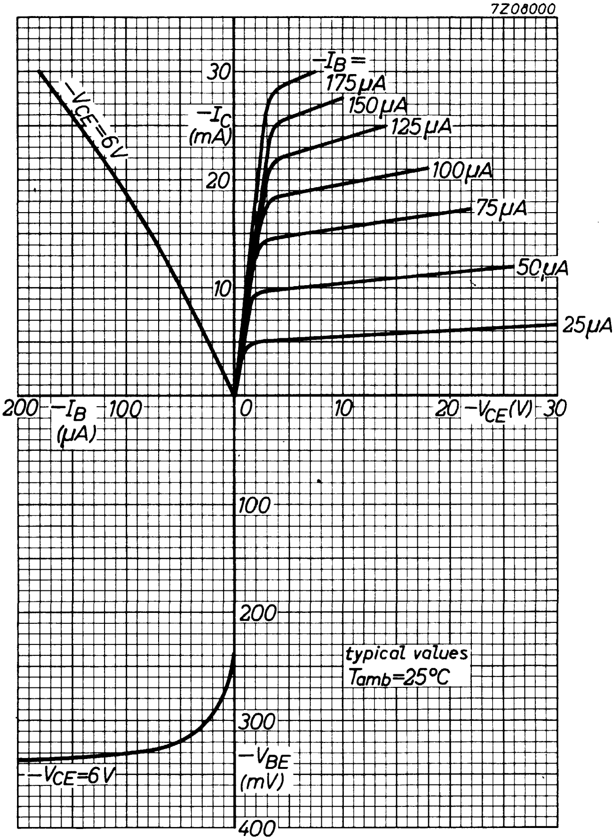
$I_E = 10$ mA; $-V_{CB} = 6$ V	f_1	>	125	MHz
		typ.	175	MHz

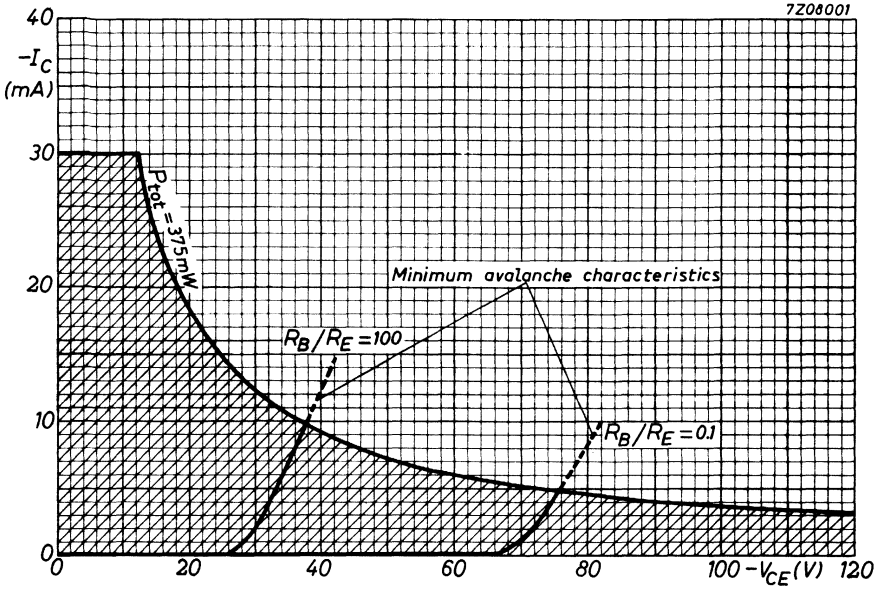
Feedback impedance at f = 2 MHz

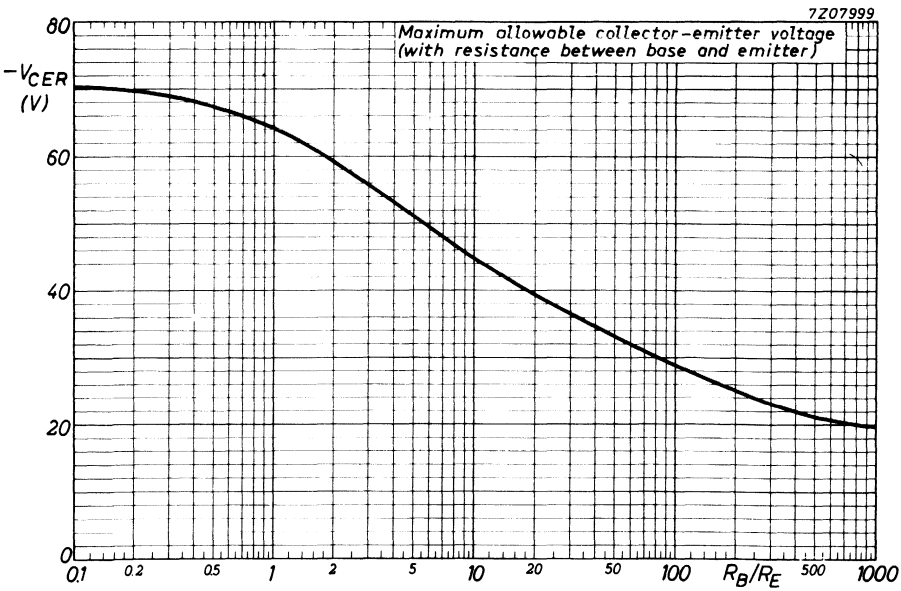
$I_E = 10$ mA; $-V_{CB} = 6$ V	$\lvert z_{rb} \rvert$	typ.	30	Ω

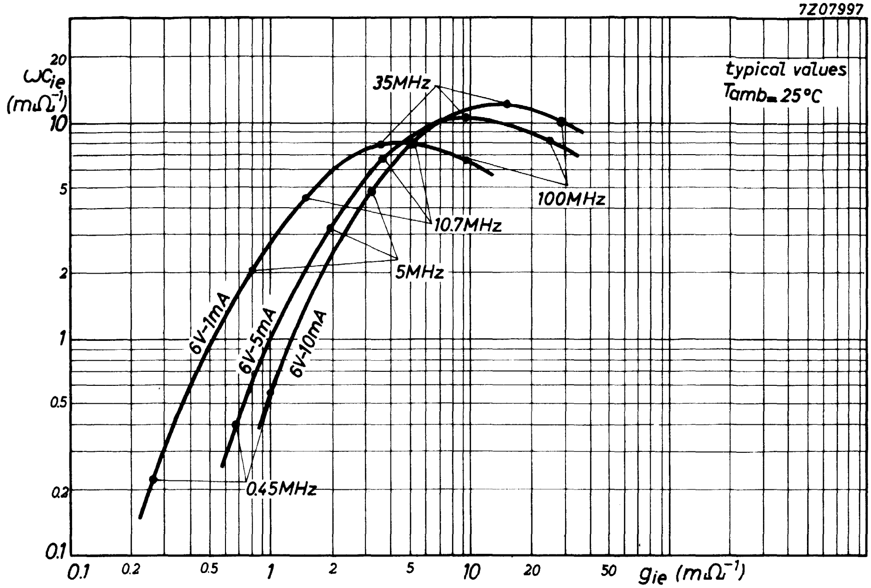
Transfer admittance at f = 10.7 MHz

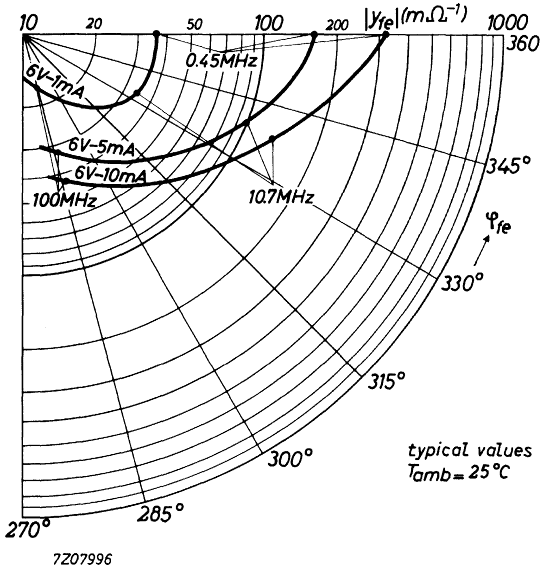
$-I_C = 10$ mA; $-V_{CE} = 6$ V	$\lvert y_{fe} \rvert$	>	100	$m\Omega^{-1}$
		typ.	130	$m\Omega^{-1}$

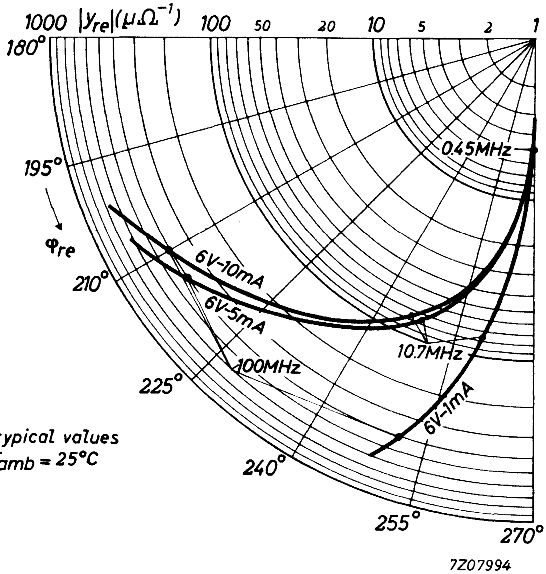

7Z08000
$-I_B$ =
175 μA
150 μA
125 μA
100 μA
75 μA
50 μA
25 μA
$-I_C$ (mA)
30
20
10
$-V_{CE}$=6V
200
$-I_B$ (μA)
100
0
10
20
$-V_{CE}$(V)
30
100
200
300
400
$-V_{BE}$ (mV)
typical values
T_{amb}=25°C
$-V_{CE}$=6V

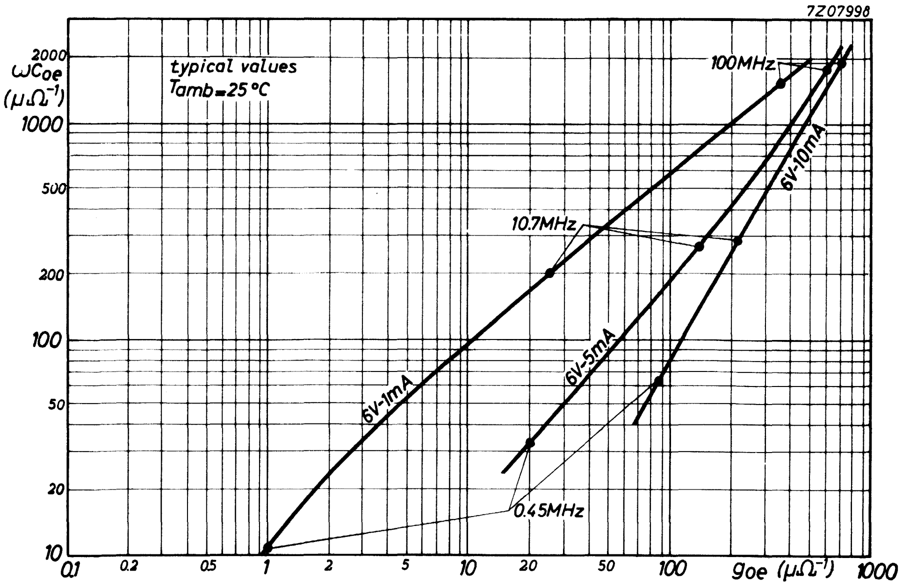

7Z08001
40
$-I_C$
(mA)
30
20
10
0
0
20
40
60
80
100 $-V_{CE}$(V) 120
P_{tot} = 375mW
Minimum avalanche characteristics
R_B/R_E =100
R_B/R_E =0.1

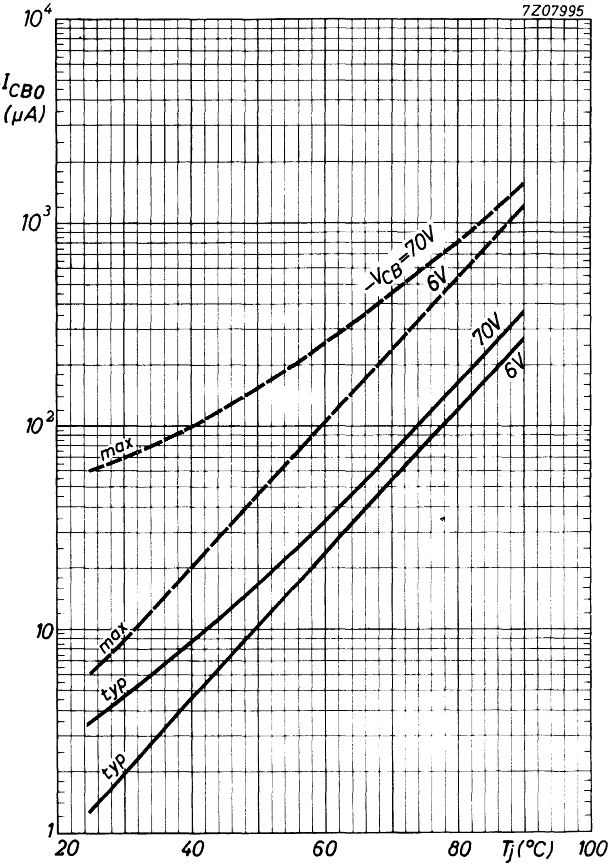

7Z07999
80
$-V_{CER}$
(V)
60
40
20
0
0.1
0.2
0.5
1
2
5
10
20
50
100
R_B/R_E
500
1000
Maximum allowable collector-emitter voltage
(with resistance between base and emitter)


7Z07997
ωC_{ie} $(m\Omega^{-1})$
typical values
T_{amb} = 25 °C
35MHz
100MHz
10.7MHz
5MHz
0.45MHz
6V-1mA
6V-5mA
6V-10mA
g_{ie} $(m\Omega^{-1})$
0.1
0.2
0.5
1
2
5
10
20
50


10
20
50
100
200
$|y_{fe}|$ $(m\Omega^{-1})$
1000
360°
345°
330°
315°
300°
285°
270°
φ_{fe}
0.45MHz
6V-1mA
6V-5mA
6V-10mA
100MHz
10.7MHz
typical values
T_{amb} = 25 °C
7Z07996


1000 |y_re|(μΩ⁻¹) 100 50 20 10 5 2 1
180°
195°
φ_re
210°
225°
240°
255°
270°
6V-10mA
6V-5mA
6V-1mA
0.45MHz
10.7MHz
100MHz
typical values
T_amb = 25°C
7Z07994


7Z07998
ωC_oe (μΩ⁻¹)
2000
1000
500
200
100
50
20
10
typical values
T_amb = 25 °C
100MHz
10.7MHz
0.45MHz
6V-1mA
6V-5mA
6V-10mA
0.1 0.2 0.5 1 2 5 10 20 50 100 g_oe (μΩ⁻¹) 1000

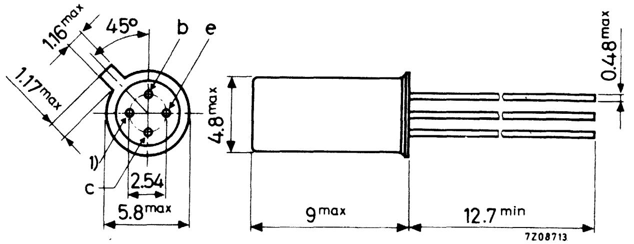

7Z07995
10^4
$-I_{CBO}$ (μA)
10^3
10^2
10
1
$-V_{CB}$=70V
6V
70V
6V
max
max
typ
typ
20
40
60
80
T_j(°C)
100

R.F. GERMANIUM ALLOY-DIFFUSED TRANSISTOR

P-N-P transistor in a metal envelope with insulated leads and a shield lead connected to the case. It is intended for application at frequencies up to 100 MHz.

QUICK REFERENCE DATA				
Collector-base voltage (open emitter)	$-V_{CBO}$	max.	25	V
Collector-emitter voltage $R_B/R_E < 100$; $R_E > 200\ \Omega$	$-V_{CER}$	max.	25	V
Collector current (peak value)	$-I_{CM}$	max.	15	mA
Total power dissipation up to $T_{amb} = 45\ ^oC$	P_{tot}	max.	140	mW
Junction temperature, incidentally	T_j	max.	90	^oC
Feedback capacitance at f = 0.45 MHz $-I_C = 1$ mA; $-V_{CE} = 10$ V	$-C_{re}$	typ.	450	fF
Transition frequency $-I_C = 3$ mA; $-V_{CE} = 10$ V	f_T	typ.	270	MHz
Transfer admittance at f = 35 MHz $-I_C = 3$ mA; $-V_{CE} = 10$ V	$\lvert y_{fe}\rvert$	typ.	80	$m\Omega^{-1}$

MECHANICAL DATA Dimensions in mm



1)= shield lead (connected to case)

Accessories available: 56246, 56263

RATINGS (Limiting values) [1])

Voltages

Collector-base voltage (open emitter)	$-V_{CBO}$	max.	25	V
Collector-emitter voltage $R_B/R_E < 100$; $R_E > 200\ \Omega$	$-V_{CER}$	max.	25	V

Currents

Collector current (d.c.)	$-I_C$	max.	10	mA
Collector current (peak value)	$-I_{CM}$	max.	15	mA
Reverse emitter current	$-I_E$	max.	1	mA

Power dissipation

Total power dissipation up to T_{amb} = 45 °C with cooling clip 56263	P_{tot}	max.	140	mW

Temperatures

Storage temperature	T_{stg}		-55 to +75	°C
Junction temperature: continuous	T_j	max.	75	°C
incidentally	T_j	max.	90	°C

THERMAL RESISTANCE

From junction to ambient in free air	$R_{th\ j\text{-}a}$	= 0.45	°C/mW
From junction to case	$R_{th\ j\text{-}c}$	= 0.22	°C/mW
From junction to ambient with cooling clip 56263	$R_{th\ j\text{-}a}$	= 0.32	°C/mW

[1]) Limiting values according to the Absolute Maximum System as defined in IEC publication 134.

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

Collector cut-off current				
$I_E = 0$; $-V_{CB} = 10$ V	$-I_{CBO}$	typ.	1.2	μA
		<	8	μA
$I_E = 0$; $-V_{CB} = 10$ V; $T_j = 75$ °C	$-I_{CBO}$	<	150	μA
Base current				
$-I_C = 3$ mA; $-V_{CE} = 10$ V	$-I_B$	typ.	40	μA
		<	100	μA
Base-emitter voltage				
$-I_C = 3$ mA; $-V_{CE} = 10$ V	$-V_{BE}$	typ.	320	mV
			280 to 380	mV
Feedback capacitance at f = 0.45 MHz				
$-I_C = 1$ mA; $-V_{CE} = 10$ V	$-C_{re}$	typ.	450	fF [1])
			250 to 650	fF [1])
Transition frequency				
$-I_C = 3$ mA; $-V_{CE} = 10$ V	f_T	typ.	270	MHz
Noise figure at f = 100 MHz [2])				
$I_E = 2$ mA; $-V_{CB} = 5$ V	F	typ.	4.5	dB
		<	6	dB
y parameters at f = 0.45 MHz (common emitter) [3])				
$-I_C = 2$ mA; $-V_{CE} = 5$ V				
Input conductance	g_{ie}	typ.	0.8	$m\Omega^{-1}$
Input capacitance	C_{ie}	typ.	45	pF
Feedback admittance	$\|y_{re}\|$	typ.	1.7	$\mu\Omega^{-1}$
Phase angle of feedback admittance	φ_{re}	typ.	270°	
Transfer admittance	$\|y_{fe}\|$	typ.	73	$m\Omega^{-1}$
Phase angle of transfer admittance	φ_{fe}	typ.	0	
Output conductance	g_{oe}	typ.	0.8	$\mu\Omega^{-1}$
Output capacitance	C_{oe}	typ.	2.7	pF

1) 1 fF = 1 femtofarad = 10^{-15} F
2) To obtain minimum noise figure the terminating admittance at the input of the transistor shall be $Y_S = (11-6j)\ m\Omega^{-1}$
3) Length of leads between bottom of transistor and measuring jig is 5 mm

CHARACTERISTICS (continued) T_{amb} = 25 °C

y parameters at f = 5.5 MHz (common emitter) 1)

$-I_C$ = 2 mA; $-V_{CE}$ = 5 V

Input conductance	g_{ie}	typ.	1.0	$m\Omega^{-1}$
Input capacitance	C_{ie}	typ.	45	pF
Feedback admittance	$\lvert y_{re} \rvert$	typ.	21	$\mu\Omega^{-1}$
Phase angle of feedback admittance	φ_{re}	typ.	270°	
Transfer admittance	$\lvert y_{fe} \rvert$	typ.	71	$m\Omega^{-1}$
Phase angle of transfer admittance	φ_{fe}	typ.	350°	
Output conductance	g_{oe}	typ.	5	$\mu\Omega^{-1}$
Output capacitance	C_{oe}	typ.	2.6	pF

y parameters at f = 10.7 MHz (common emitter) 1)

$-I_C$ = 2 mA; $-V_{CE}$ = 5 V

Input conductance	g_{ie}	typ.	1.3	$m\Omega^{-1}$
Input capacitance	C_{ie}	typ.	45	pF
Feedback admittance	$\lvert y_{re} \rvert$	typ.	40	$\mu\Omega^{-1}$
Phase angle of feedback admittance	φ_{re}	typ.	270°	
Transfer admittance	$\lvert y_{fe} \rvert$	typ.	70	$m\Omega^{-1}$
Phase angle of transfer admittance	φ_{fe}	typ.	347°	
Output conductance	g_{oe}	typ.	13	$\mu\Omega^{-1}$
Output capacitance	C_{oe}	typ.	2.5	pF

y parameters at f = 35 MHz (common emitter) 1)

$-I_C$ = 3 mA; $-V_{CE}$ = 10 V

Input conductance	g_{ie}	typ.	6.5	$m\Omega^{-1}$
Input capacitance	C_{ie}	typ.	35	pF
Feedback admittance	$\lvert y_{re} \rvert$	typ.	100	$\mu\Omega^{-1}$
Phase angle of feedback admittance	φ_{re}	typ.	260°	
Transfer admittance	$\lvert y_{fe} \rvert$	typ.	80	$m\Omega^{-1}$
Phase angle of transfer admittance	φ_{fe}	typ.	322°	
Output conductance	g_{oe}	typ.	100	$\mu\Omega^{-1}$
Output capacitance	C_{oe}	typ.	1.8	pF

1) Length of leads between bottom of transistor and measuring jig is 5 mm.

CHARACTERISTICS (continued) T_{amb} = 25 °C

y parameters at f= 100 MHz (common base) [1]

I_E = 2 mA; $-V_{CB}$ = 5 V

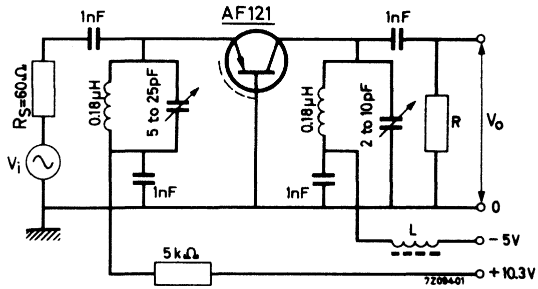
Input conductance	g_{ib}	typ.	32	$m\Omega^{-1}$
Input capacitance	$-C_{ib}$	typ.	35	pF
Feedback admittance	$\|y_{rb}\|$	typ.	320	$\mu\Omega^{-1}$
Phase angle of feedback admittance	φ_{rb}	typ.	240°	
Transfer admittance	$\|y_{fb}\|$	typ.	34	$m\Omega^{-1}$
Phase angle of transfer admittance	φ_{fb}	typ.	110°	
Output conductance	g_{ob}	typ.	250	$\mu\Omega^{-1}$
Output capacitance	C_{ob}	typ.	1.6	pF

Transducer gain

$$G_{tr} = \frac{\text{output power in load } R_L}{\text{available power from source } R_S}$$

I_E = 2 mA; $-V_{CB}$ = 5 V; f = 100 MHz G_{tr} > 17 dB, typ. 19 dB

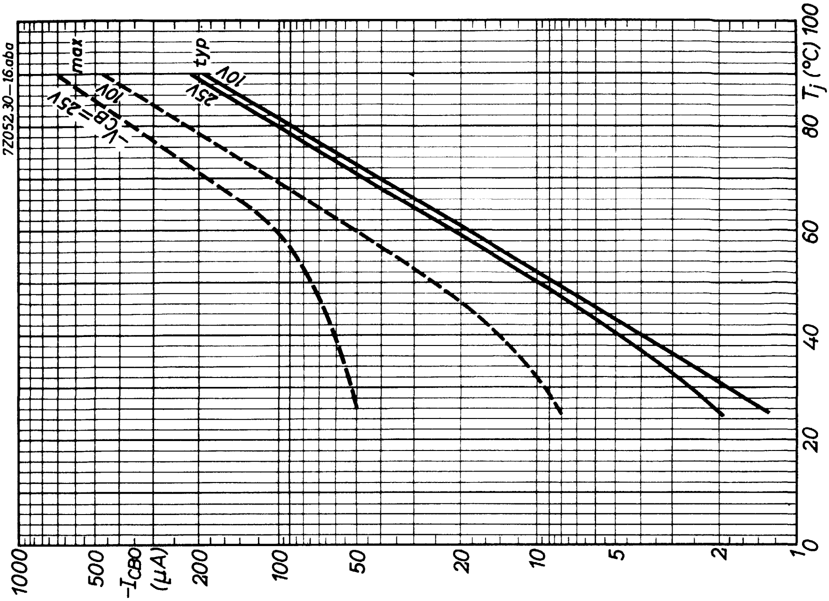
Basic circuit for measuring the transducer gain

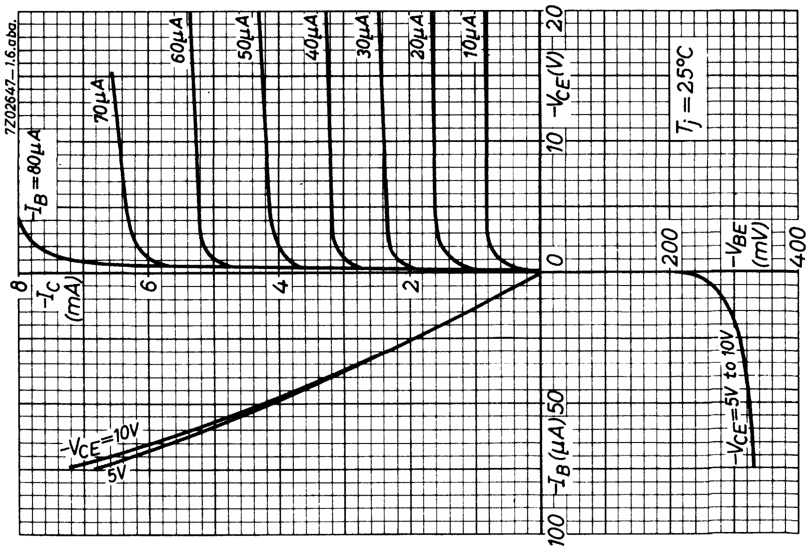


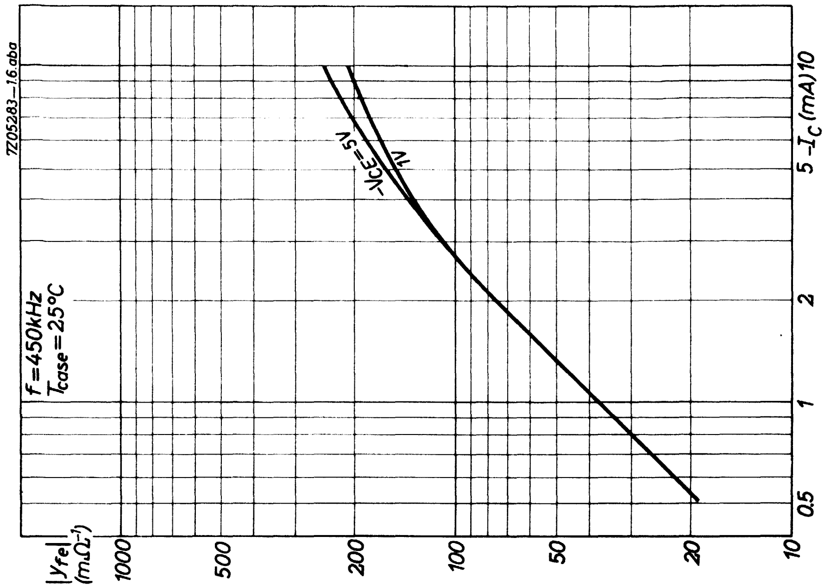
The resistor R is choosen such that the total load, consisting of R and the tuned circuit in parallel, R_L = 3.3 kΩ

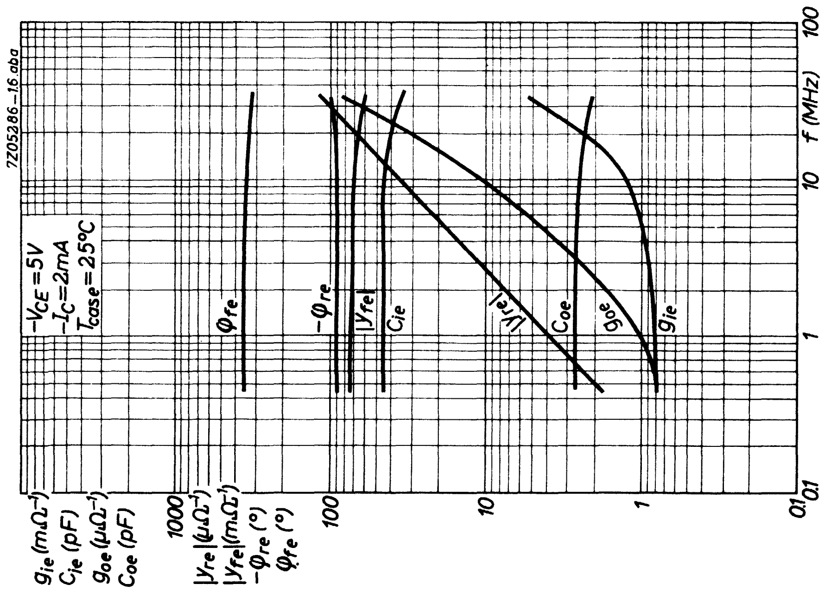
L is a ferrite wide-band choke

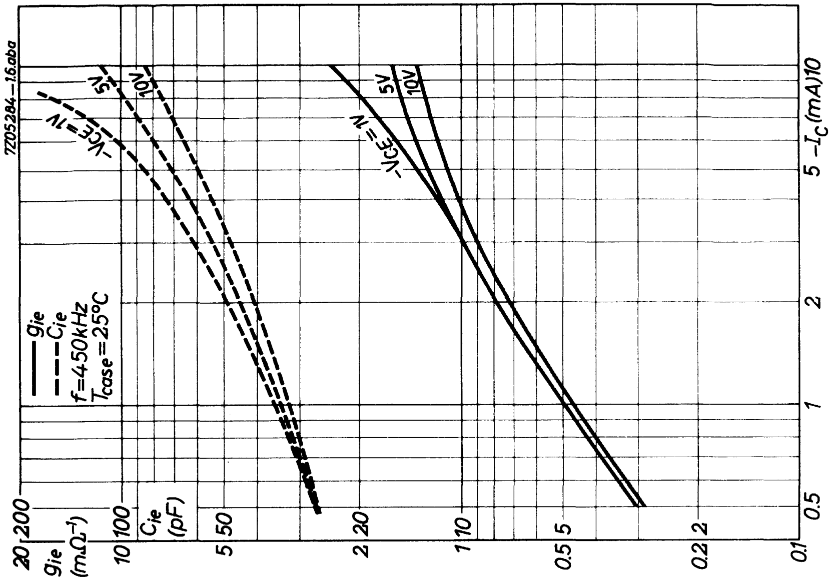
[1]) Length of leads between bottom of transistor and measuring jig is 5 mm.

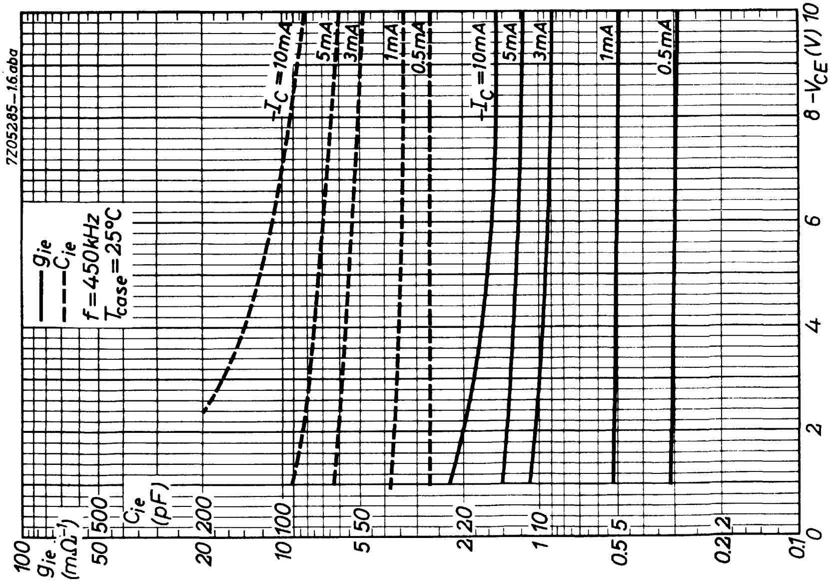

7Z05230-16.aba
max
typ
$-V_{CB}=25V$
10V
25V
10V
$-I_{CBO}$ (μA)
T_j (°C)
1000
500
200
100
50
20
10
5
2
1
0
20
40
60
80
100

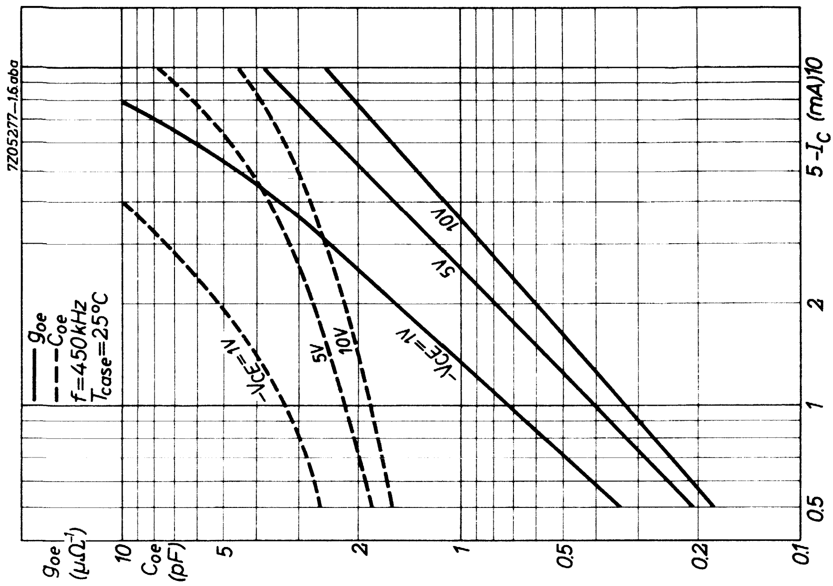

7Z02647-1.6.aba.
$-I_B=80\mu A$
70μA
60μA
50μA
40μA
30μA
20μA
10μA
$-V_{CE}$ (V)
$T_j=25°C$
$-I_C$ (mA)
$-V_{CE}=10V$
5V
$-I_B$ (μA)
$-V_{BE}$ (mV)
$-V_{CE}=5V$ to 10V
0
2
4
6
8
10
20
50
100
200
400

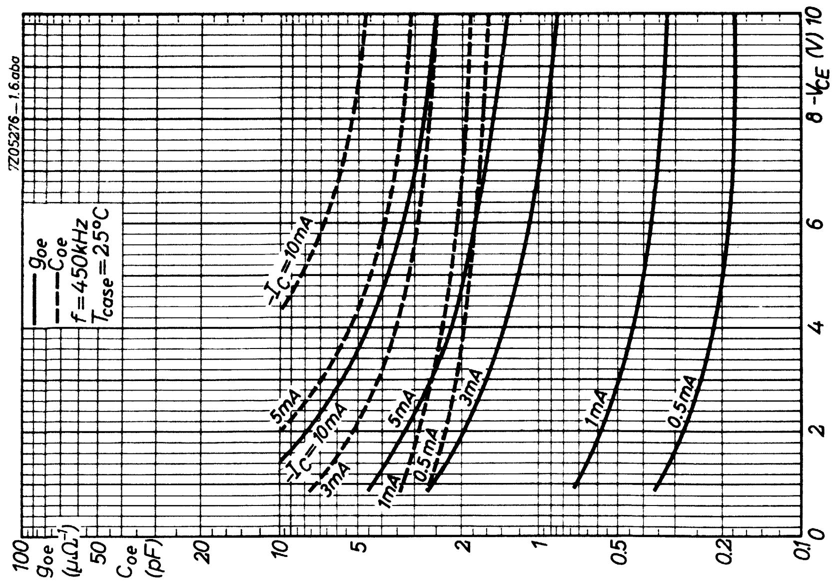

7Z05283–1.6.aba
f = 450kHz
T_{case} = 25°C
$-V_{CE}$ = 5V
1V
$|y_{fe}|$ ($m\Omega^{-1}$)
1000
500
200
100
50
20
10
0.5
1
2
5
10
$-I_C$ (mA)

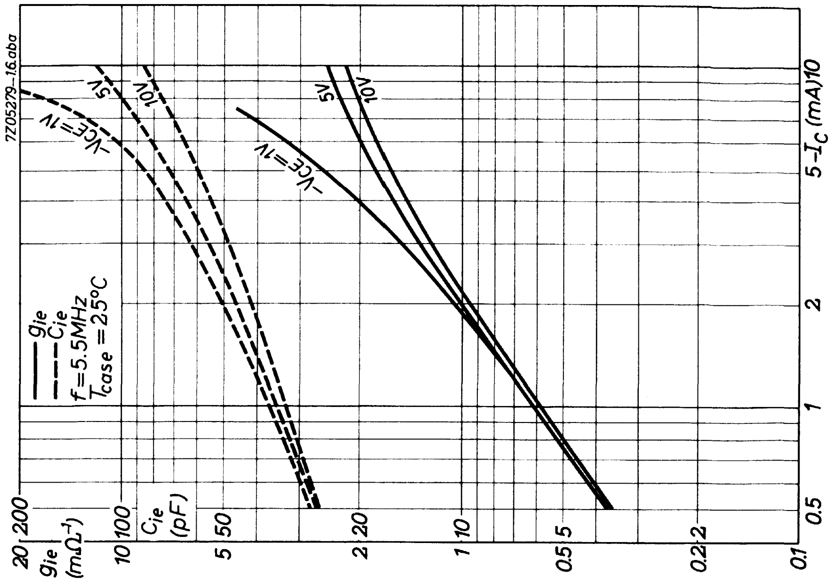

7Z05286–1.6.aba
$-V_{CE}$ = 5V
$-I_C$ = 2mA
T_{case} = 25°C
φ_{fe}
$-\varphi_{re}$
$|y_{fe}|$
C_{ie}
$|y_{re}|$
C_{oe}
g_{oe}
g_{ie}
g_{ie} ($m\Omega^{-1}$)
C_{ie} (pF)
g_{oe} ($\mu\Omega^{-1}$)
C_{oe} (pF)
$|y_{re}|$ ($\mu\Omega^{-1}$)
$|y_{fe}|$ ($m\Omega^{-1}$)
$-\varphi_{re}$ (°)
φ_{fe} (°)
1000
100
10
1
0.1
0.01
0.1
1
10
100
f (MHz)

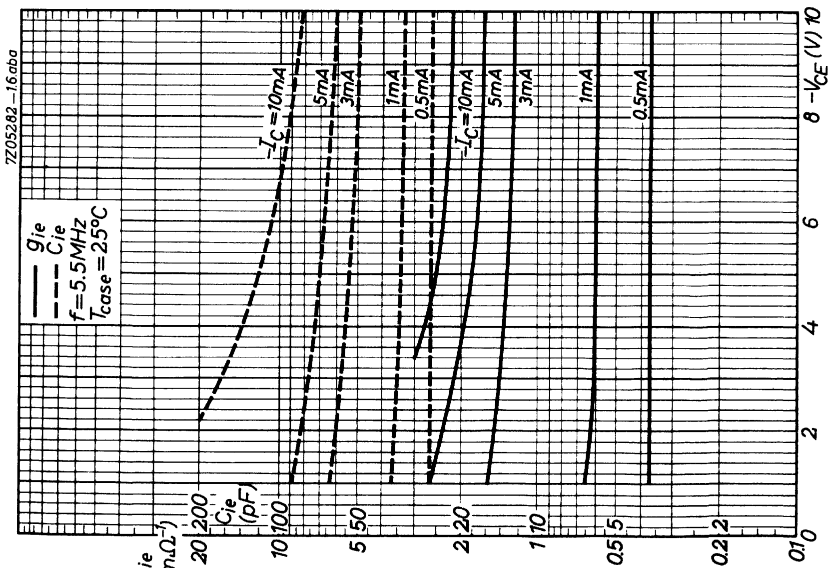

7Z05284–1.6.aba
g_{ie}
C_{ie}
f=450kHz
T_{case}=25°C
$-V_{CE}$=1V
5V
10V
g_{ie} (mΩ⁻¹)
C_{ie} (pF)
$-I_C$(mA)

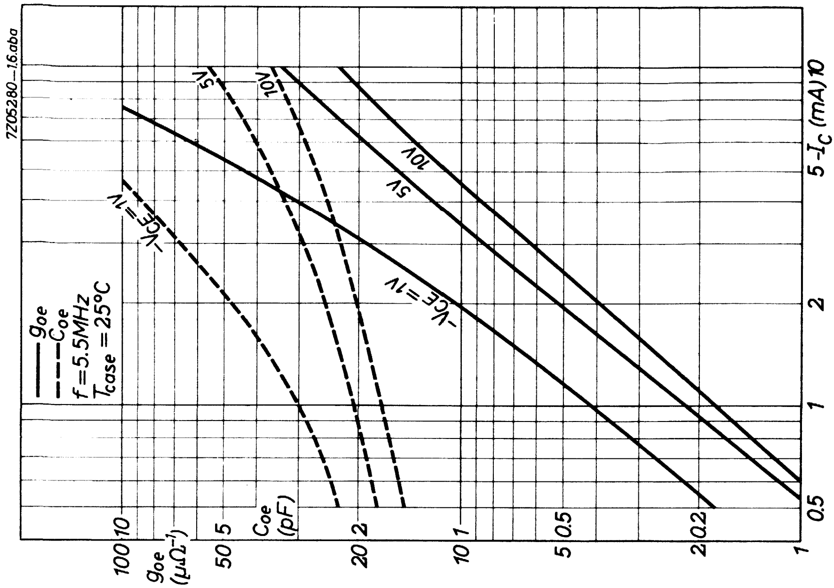

7Z05285–1.6.aba
g_{ie}
C_{ie}
f=450kHz
T_{case}=25°C
$-I_C$=10mA
5mA
3mA
1mA
0.5mA
g_{ie} (mΩ⁻¹)
C_{ie} (pF)
$-V_{CE}$(V)

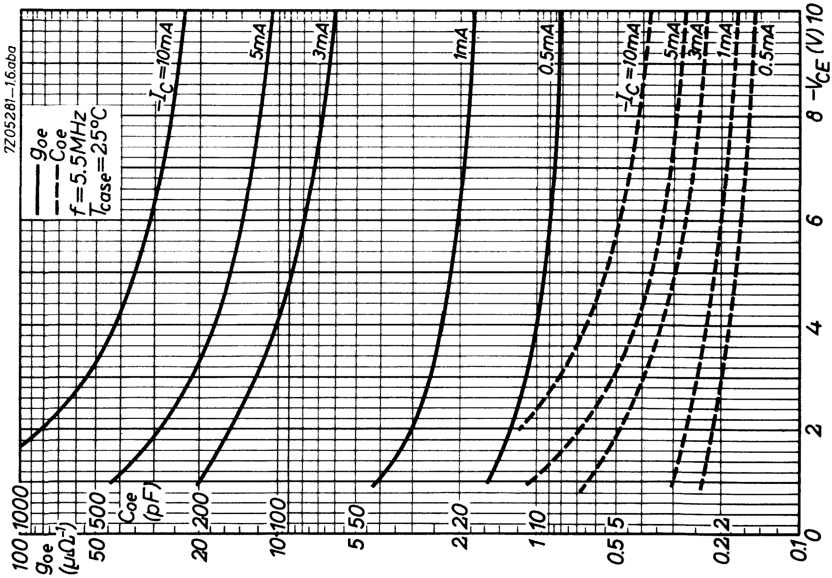

7Z05277-1.6.aba
—— g_{oe}
– – – C_{oe}
f = 450 kHz
T_{case} = 25°C
g_{oe} (μΩ⁻¹)
C_{oe} (pF)
$-V_{CE}$ = 1V
5V
10V
$-V_{CE}$ = 1V
5V
10V
$-I_C$ (mA)
0.5
1
2
5
10
0.1
0.2
0.5
1
2
5
10

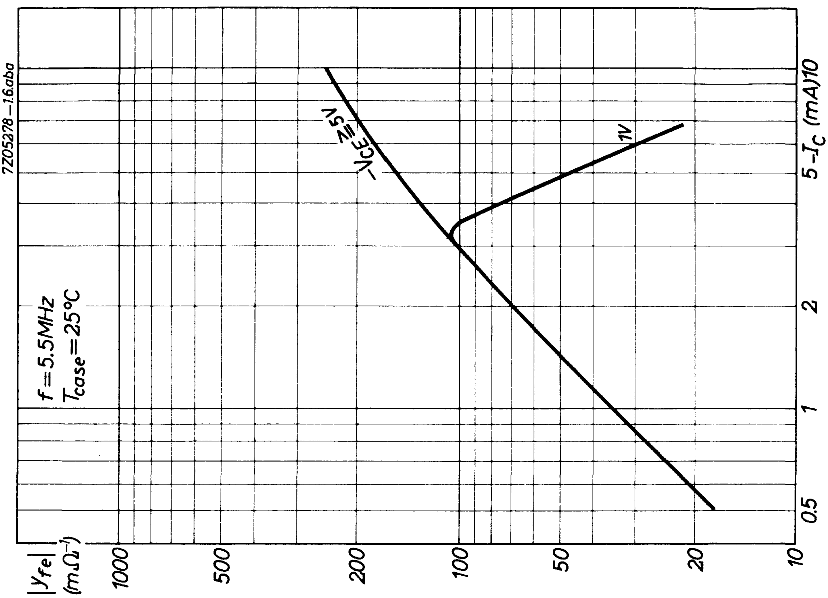

7Z05276-1.6.aba
—— g_{oe}
– – – C_{oe}
f = 450 kHz
T_{case} = 25°C
g_{oe} (μΩ⁻¹)
C_{oe} (pF)
$-I_C$ = 10mA
5mA
3mA
$-I_C$ = 10mA
5mA
3mA
1mA
0.5mA
0.5mA
1mA
$-V_{CE}$ (V)
0
2
4
6
8
10
100
50
20
10
5
2
1
0.5
0.2
0.1


7Z05279-1.6.aba
g_{ie}
C_{ie}
f = 5.5MHz
T_{case} = 25°C
$-V_{CE}$ = 1V
5V
10V
g_{ie} (mΩ^{-1})
C_{ie} (pF)
$-I_C$ (mA)

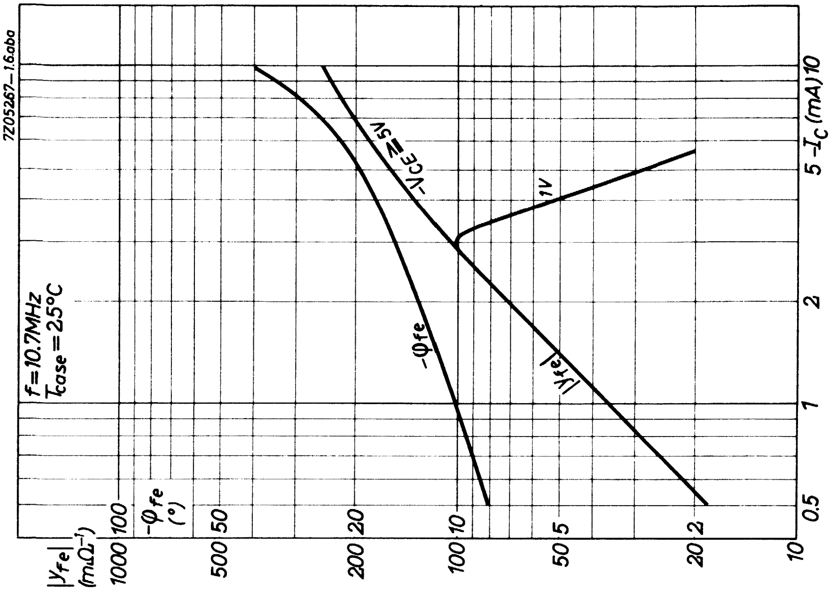

7Z05282-1.6.aba
g_{ie}
C_{ie}
f = 5.5MHz
T_{case} = 25°C
$-I_C$ = 10mA
5mA
3mA
1mA
0.5mA
g_{ie} (mΩ^{-1})
C_{ie} (pF)
$-V_{CE}$ (V)

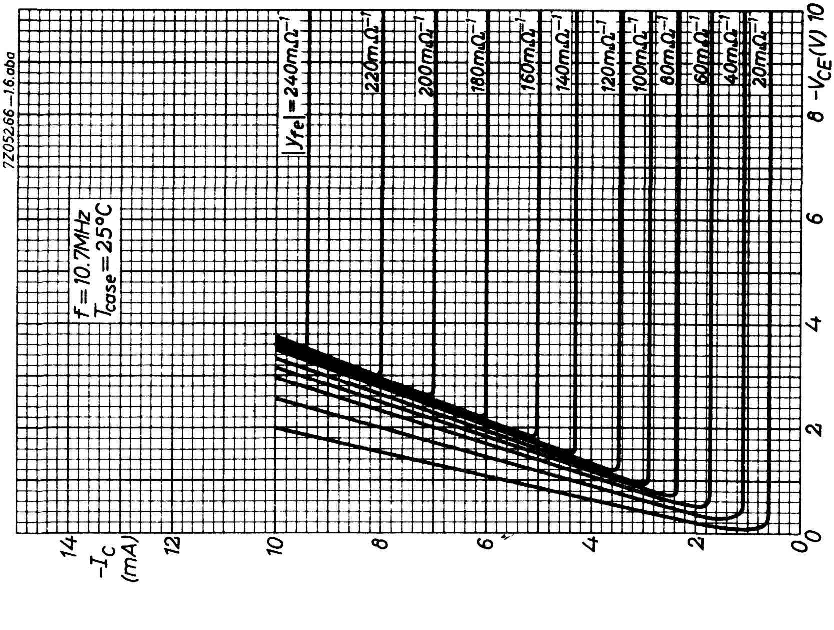

7Z05280–1.6.aba
goe
Coe
f = 5.5MHz
Tcase = 25°C
$-V_{CE}$ = 1V
5V
10V
goe ($\mu\Omega^{-1}$)
Coe (pF)
$-I_C$ (mA)

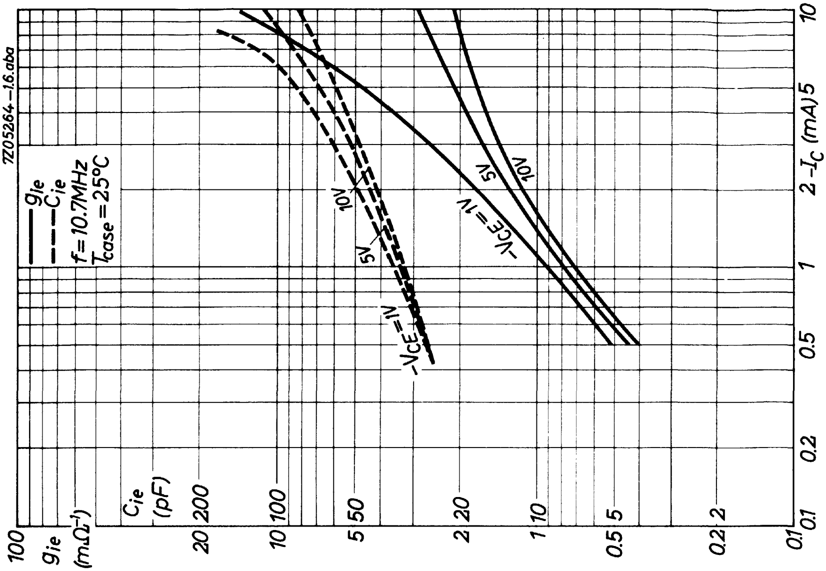

7Z05281–1.6.aba
goe
Coe
f = 5.5MHz
Tcase = 25°C
$-I_C$ = 10mA
5mA
3mA
1mA
0.5mA
goe ($\mu\Omega^{-1}$)
Coe (pF)
$-V_{CE}$ (V)

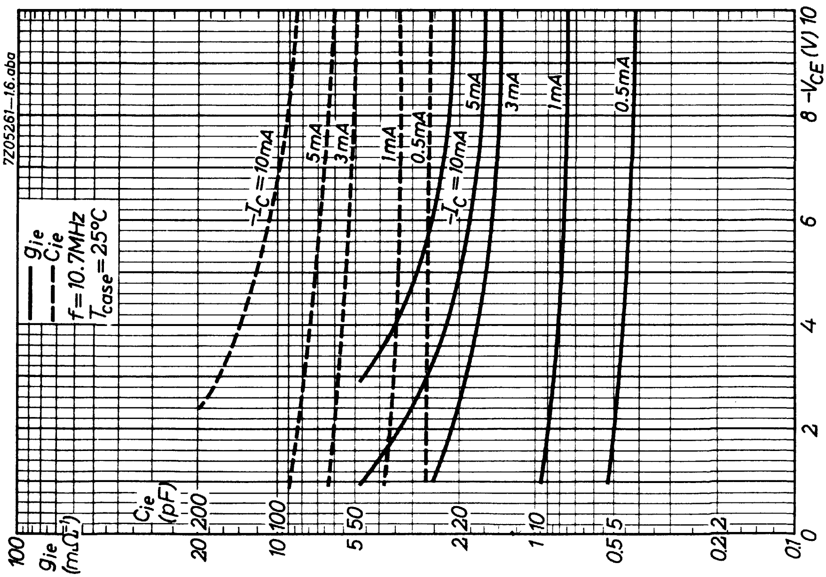


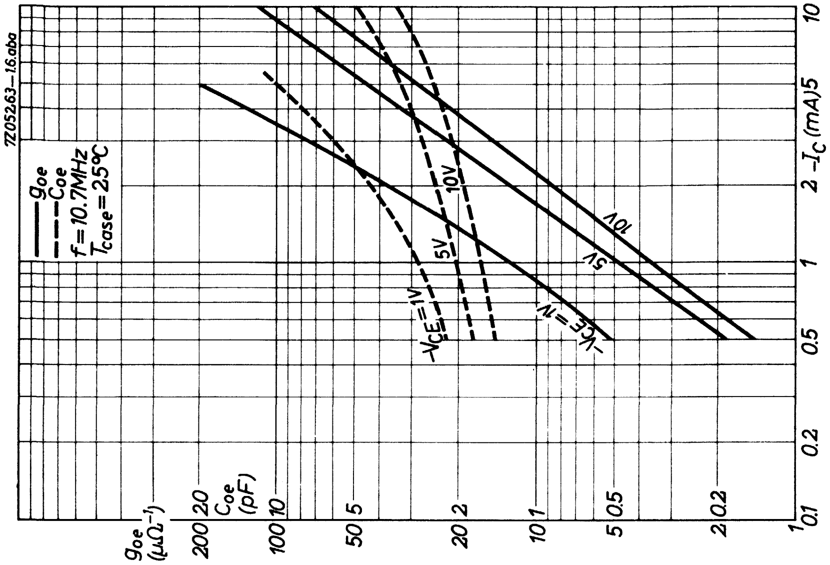
7Z05278—1.6.aba
f = 5.5MHz
Tcase = 25°C
−VCE = 5V
1V
|yfe|
(mΩ⁻¹)
1000
500
200
100
50
20
10
0.5
1
2
5
−IC (mA) 10

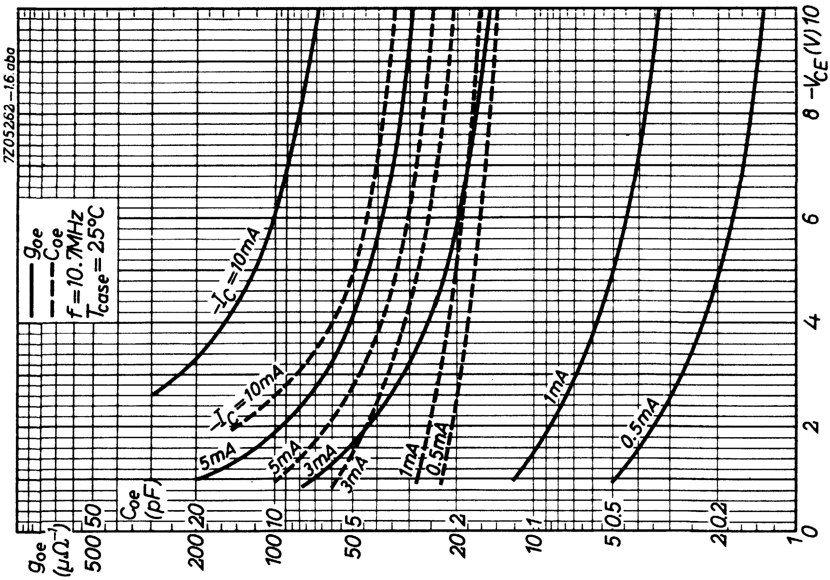

7Z05267–1.6.aba
f = 10.7MHz
Tcase = 25°C
−VCE = 5V
1V
−φfe
|yfe|
|yfe| (mΩ⁻¹)
−φfe (°)
−IC (mA)

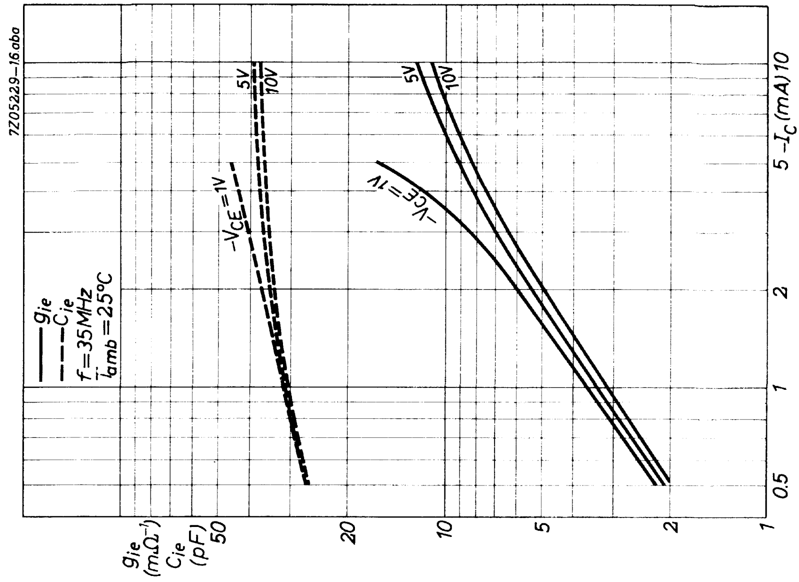

7Z05266–1.6.aba
f = 10.7MHz
Tcase = 25°C
|yfe| = 240mΩ⁻¹
220mΩ⁻¹
200mΩ⁻¹
180mΩ⁻¹
160mΩ⁻¹
140mΩ⁻¹
120mΩ⁻¹
100mΩ⁻¹
80mΩ⁻¹
60mΩ⁻¹
40mΩ⁻¹
20mΩ⁻¹
−IC (mA)
−VCE (V)

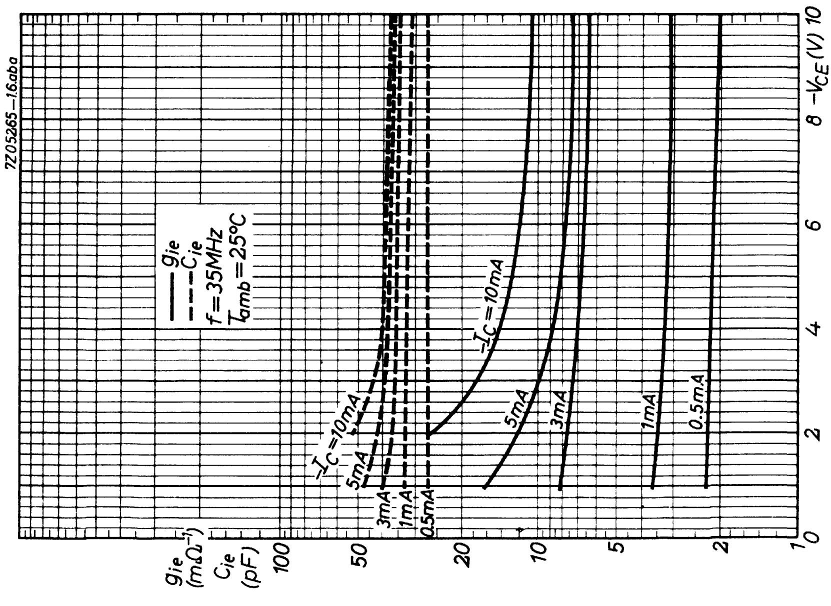

7Z05264—1.6.aba
gie
Cie
f=10.7MHz
Tcase=25°C
10V
5V
−VCE=1V
−VCE=1V
5V
10V
gie (mΩ⁻¹)
Cie (pF)
100
20 200
10 100
5 50
2 20
1 10
0.5 5
0.2 2
0.1
0.1
0.2
0.5
1
2 −IC (mA) 5
10

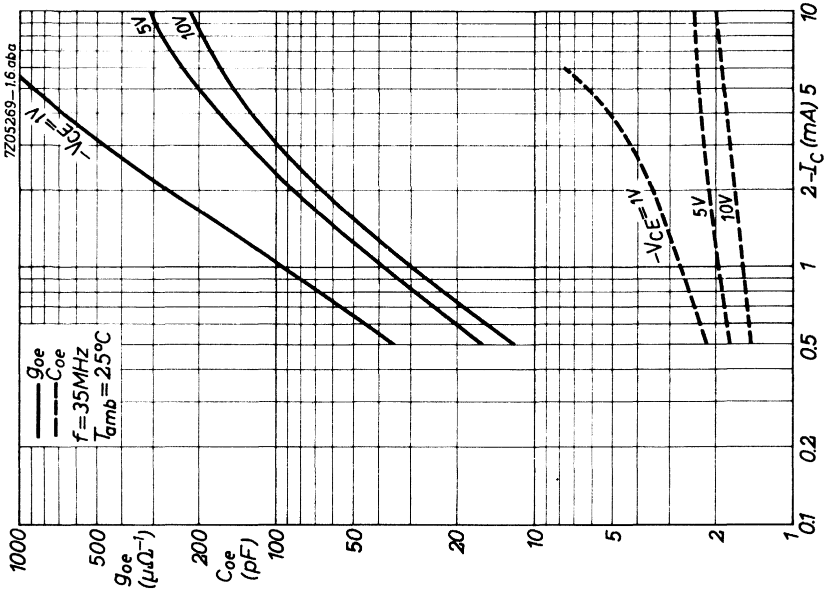

7Z05261—1.6.aba
gie
Cie
f=10.7MHz
Tcase=25°C
−IC=10mA
5mA
3mA
1mA
0.5mA
−IC=10mA
5mA
3mA
1mA
0.5mA
gie (mΩ⁻¹)
Cie (pF)
100
20 200
10 100
5 50
2 20
1 10
0.5 5
0.2 2
0.1
0
2
4
6
8 −VCE (V) 10

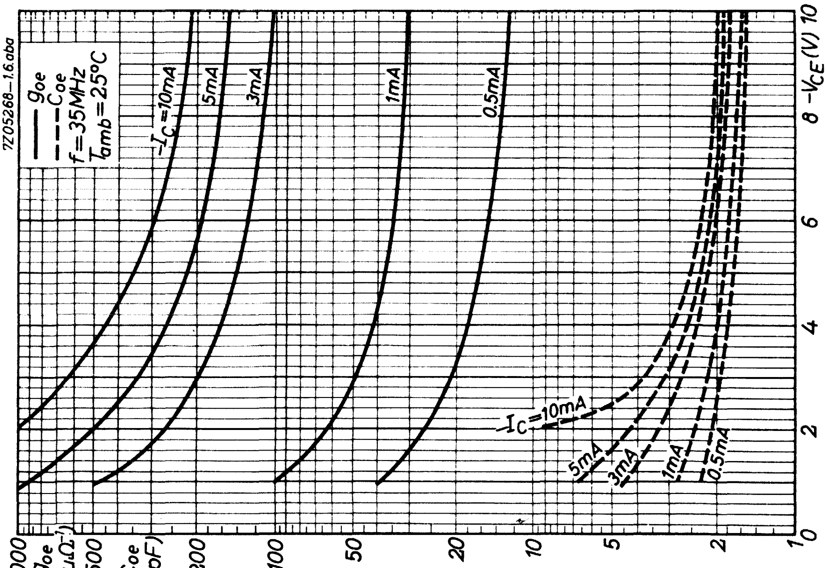

7Z05263–1.6.abo
goe
Coe
f = 10.7MHz
Tcase = 25°C
−IC (mA)
−VCE = 1V
5V
10V
goe (μΩ⁻¹)
Coe (pF)

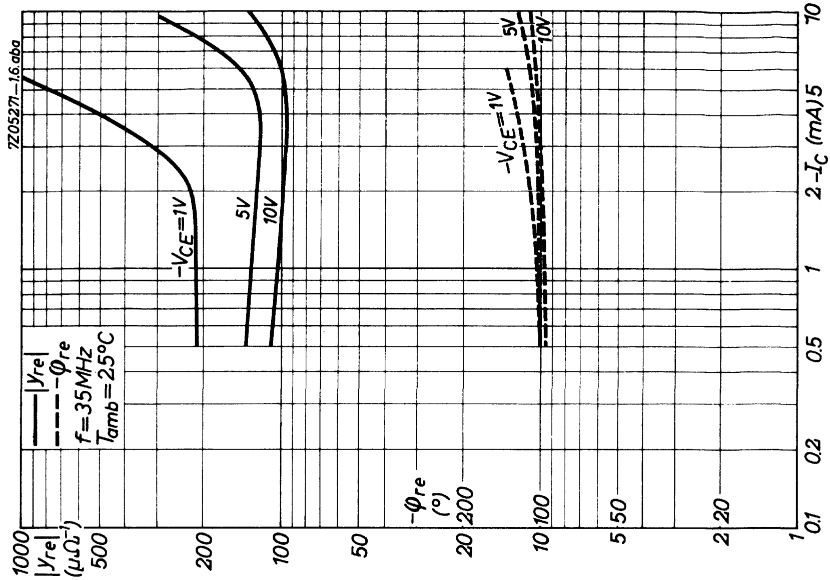

7Z05262–1.6.abo
goe
Coe
f = 10.7MHz
Tcase = 25°C
−VCE (V)
−IC = 10mA
5mA
3mA
1mA
0.5mA
goe (μΩ⁻¹)
Coe (pF)

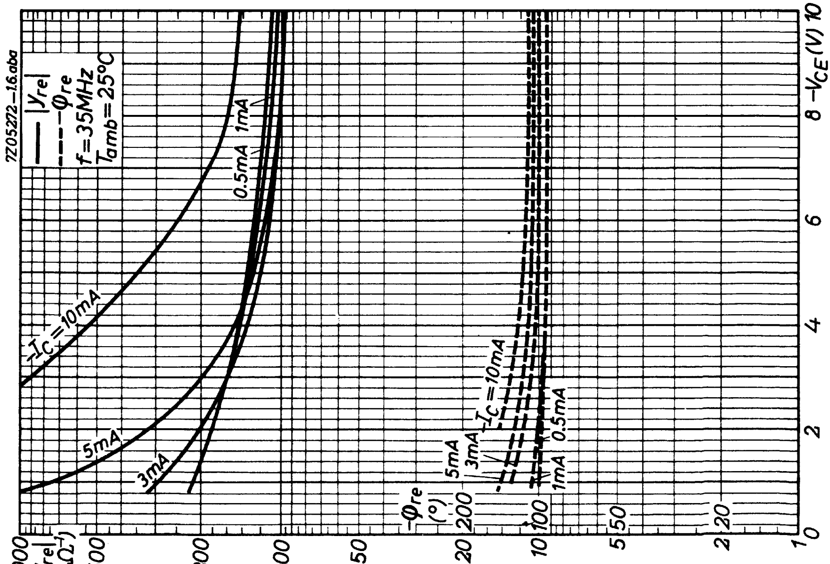

7Z05229-16.aba
gie
Cie
f = 35MHz
Tamb = 25°C
–VCE = 1V
5V
10V
–VCE = 1V
5V
10V
gie (mΩ⁻¹)
Cie (pF)
50
20
10
5
2
1
0.5
1
2
5 –IC (mA) 10

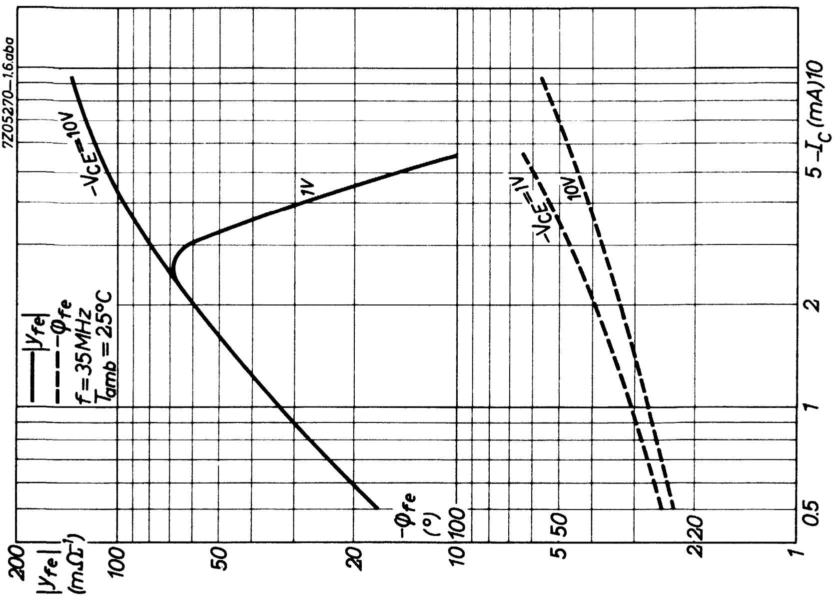

7Z05265-1.6.aba
gie
Cie
f = 35MHz
Tamb = 25°C
–IC = 10mA
5mA
3mA
1mA
0.5mA
–IC = 10mA
5mA
3mA
1mA
0.5mA
gie (mΩ⁻¹)
Cie (pF)
100
50
20
10
5
2
1
0
2
4
6
8 –VCE (V) 10


7Z05269-1.6.aba
— g_{oe}
- - - C_{oe}
f = 35MHz
T_{amb} = 25°C
$-V_{CE}$ = 1V
5V
10V
$-V_{CE}$ = 1V
5V
10V
g_{oe} (μΩ⁻¹)
C_{oe} (pF)
1000
500
200
100
50
20
10
5
2
1
0.1
0.2
0.5
1
2
5
10
$-I_C$ (mA)

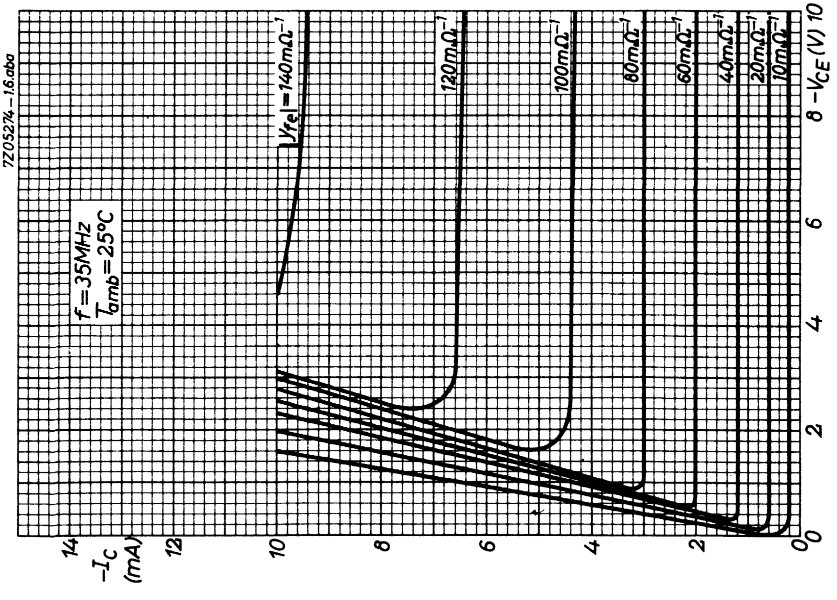

7Z05268-1.6.aba
— g_{oe}
- - - C_{oe}
f = 35MHz
T_{amb} = 25°C
$-I_C$ = 10mA
5mA
3mA
1mA
0.5mA
$-I_C$ = 10mA
5mA
3mA
1mA
0.5mA
g_{oe} (μΩ⁻¹)
C_{oe} (pF)
1000
500
200
100
50
20
10
5
2
1
0
2
4
6
8
10
$-V_{CE}$ (V)


7Z05271—1.6.aba
|yre|
−φre
f=35MHz
Tamb=25°C
−VCE=1V
5V
10V
−VCE=1V
5V
10V
|yre| (μΩ⁻¹)
1000
500
200
100
50
20
10
5
2
1
−φre (°)
200
100
50
20
0.1
0.2
0.5
1
2
5
10
−IC (mA)

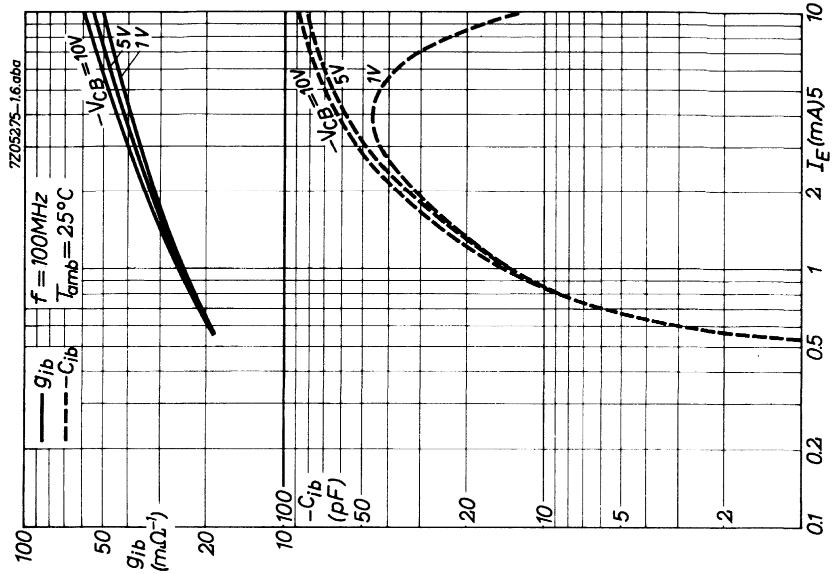

7Z05272—1.6.aba
|yre|
−φre
f=35MHz
Tamb=25°C
−IC=10mA
5mA
3mA
0.5mA
1mA
−IC=10mA
5mA
3mA
0.5mA
1mA
|yre| (μΩ⁻¹)
1000
500
200
100
50
20
10
5
2
1
−φre (°)
200
100
50
20
0
2
4
6
8
10
−VCE(V)

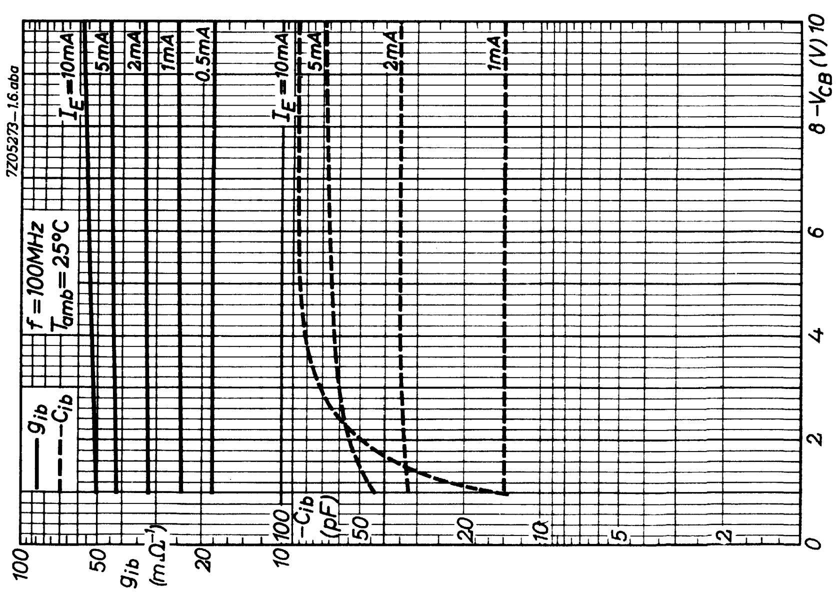


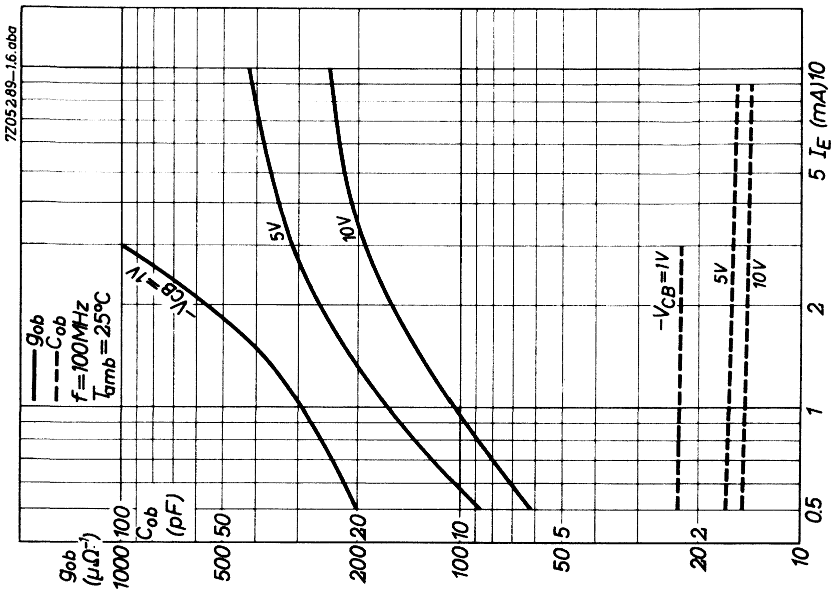
7Z05270-1.6.aba
|yfe|
-φfe
f = 35MHz
Tamb = 25°C
-VCE = 10V
1V
-VCE = 1V
10V
|yfe| (mΩ⁻¹)
-φfe (°)
-IC (mA)
200
100
50
20
10
5
2
1
0.5
2
5
10

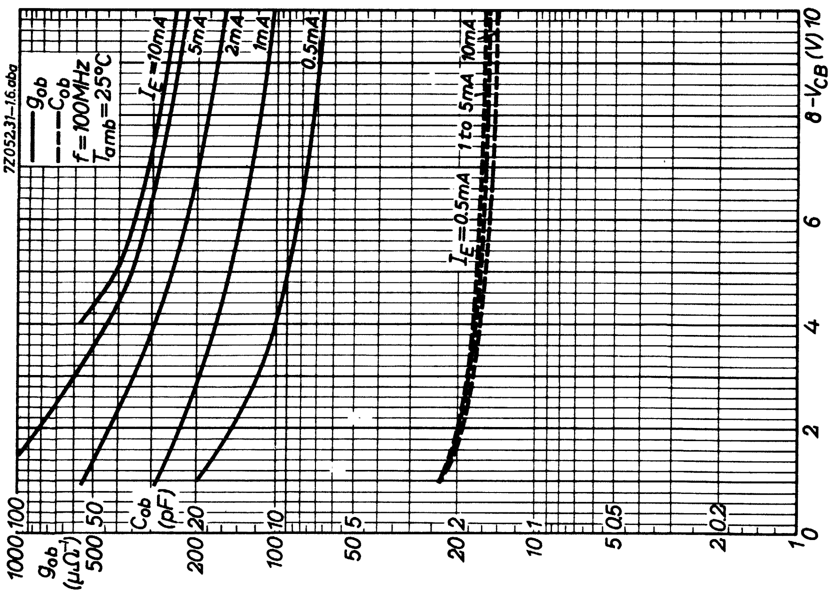


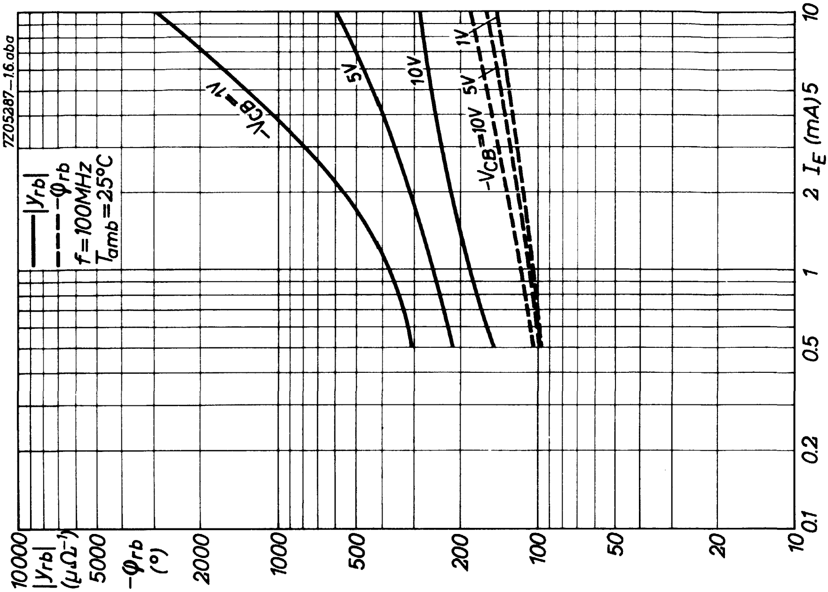
7Z05274-1.6.aba
f = 35MHz
Tamb = 25°C
|yfe| = 140mΩ⁻¹
120mΩ⁻¹
100mΩ⁻¹
80mΩ⁻¹
60mΩ⁻¹
40mΩ⁻¹
20mΩ⁻¹
10mΩ⁻¹
-IC (mA)
-VCE (V)
14
12
10
8
6
4
2
0

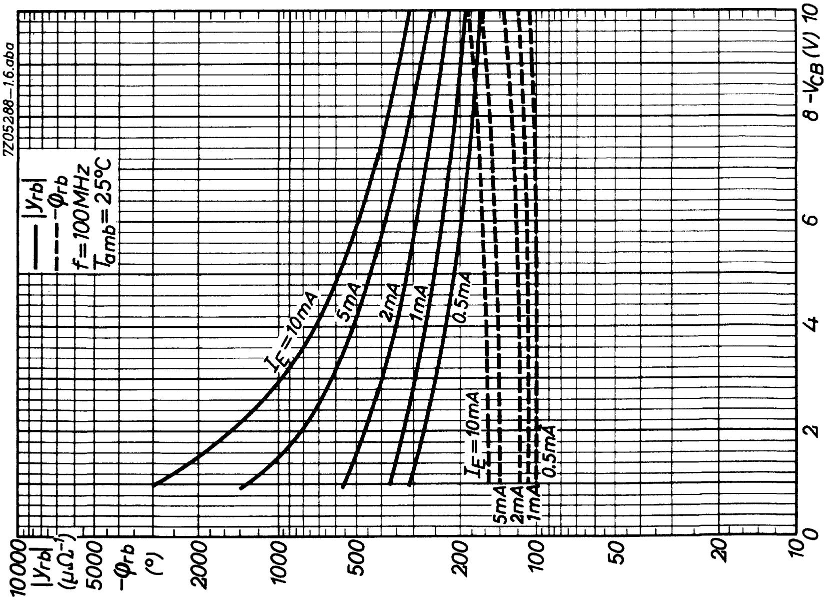

7Z05275-1.6.aba
f = 100MHz
T_{amb} = 25°C
g_{ib}
$-C_{ib}$
$-V_{CB}$ = 10V
5V
1V
g_{ib} ($m\Omega^{-1}$)
$-C_{ib}$ (pF)
I_E (mA)

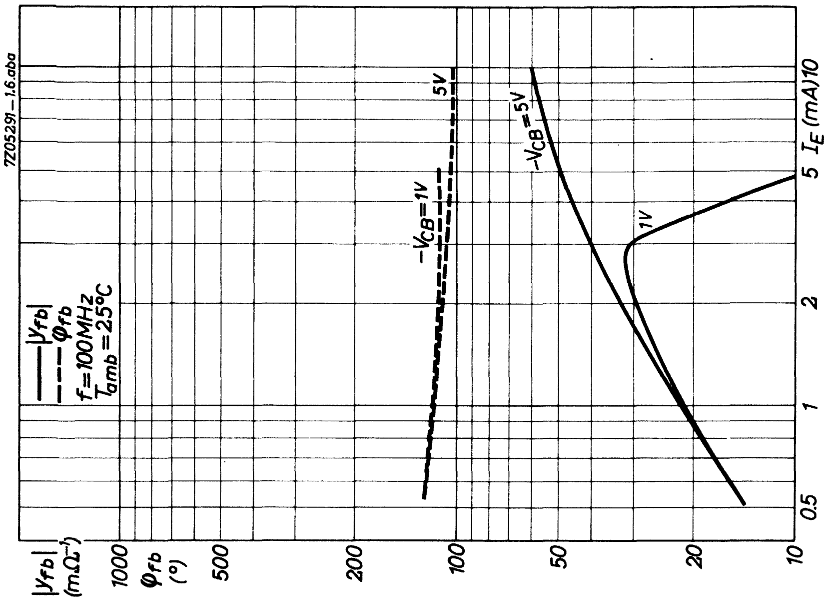

7Z05273-1.6.aba
f = 100MHz
T_{amb} = 25°C
g_{ib}
$-C_{ib}$
I_E = 10mA
5mA
2mA
1mA
0.5mA
g_{ib} ($m\Omega^{-1}$)
$-C_{ib}$ (pF)
$-V_{CB}$ (V)

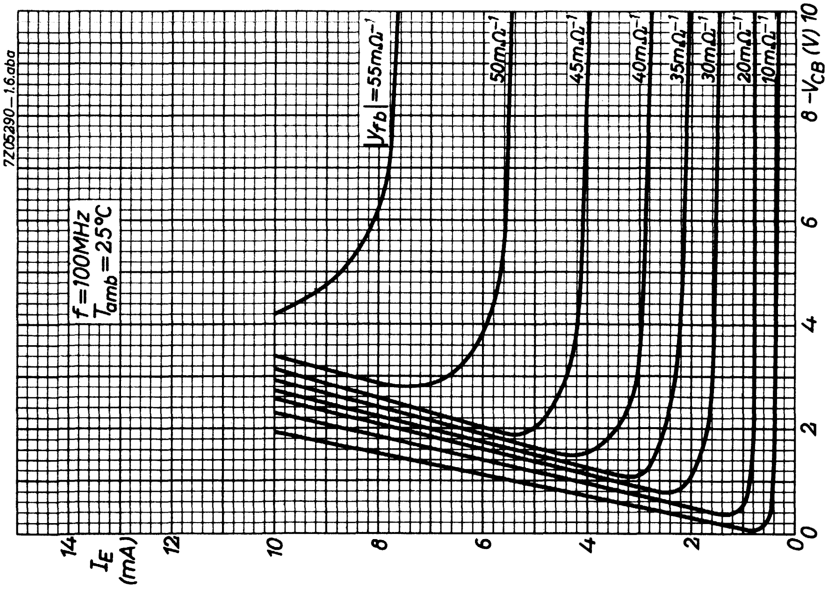

7Z05289-1.6.aba
gob
Cob
f=100MHz
Tamb=25°C
−VCB=1V
5V
10V
−VCB=1V
5V
10V
gob (μΩ⁻¹)
1000
500
200
100
50
20
10
Cob (pF)
100
50
20
10
5
2
0.5
1
2
5
IE (mA)10


7Z05231-1.6.aba
gob
Cob
f=100MHz
Tamb=25°C
IE=10mA
5mA
2mA
1mA
0.5mA
IE=0.5mA
1 to 5mA
10mA
gob (μΩ⁻¹)
1000
500
200
100
50
20
10
5
2
1
Cob (pF)
100
50
20
10
5
2
1
0.5
0.2
0
2
4
6
8
−VCB (V)10


7Z05287-1.6.aba
|y_rb|
-φ_rb
f=100MHz
T_amb=25°C
-V_CB=1V
5V
10V
1V
5V
-V_CB=10V
I_E (mA)
|y_rb| (μΩ⁻¹)
-φ_rb (°)
10000
5000
2000
1000
500
200
100
50
20
10
0.1
0.2
0.5
1
2
5
10


7Z05288-1.6.aba
|y_rb|
-φ_rb
f=100MHz
T_amb=25°C
I_E=10mA
5mA
2mA
1mA
0.5mA
I_E=10mA
5mA
2mA
1mA
0.5mA
-V_CB (V)
|y_rb| (μΩ⁻¹)
-φ_rb (°)
10000
5000
2000
1000
500
200
100
50
20
10
0
2
4
6
8
10


7Z05291-1.6.aba
|yfb|
φfb
f=100MHz
Tamb=25°C
-VCB=1V
5V
-VCB=5V
1V
|yfb| (mΩ⁻¹)
1000
φfb (°)
500
200
100
50
20
10
0.5
1
2
5
IE (mA) 10


7Z05290-1.6.aba
f=100MHz
Tamb=25°C
|yfb|=55mΩ⁻¹
50mΩ⁻¹
45mΩ⁻¹
40mΩ⁻¹
35mΩ⁻¹
30mΩ⁻¹
20mΩ⁻¹
10mΩ⁻¹
14
IE (mA)
12
10
8
6
4
2
0
0
2
4
6
8 -VCB (V) 10

GERMANIUM ALLOY DIFFUSED TRANSISTOR

P-N-P transistor in a TO-72 metal envelope with a shield lead connected to the case. It has low noise and high power gain up to frequencies of 100 MHz and is intended for use as r.f. amplifier in f.m. receivers.

RATINGS (Limiting values) [1])

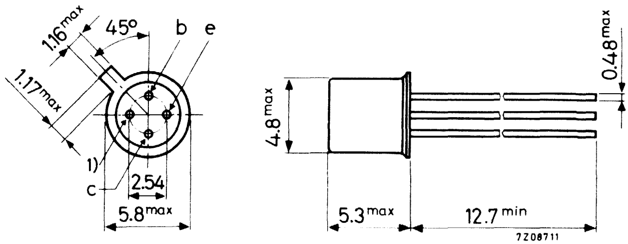
Collector-base voltage (open emitter)	$-V_{CBO}$	max.	32	V
Collector-emitter voltage ($Z_B/Z_E < 15$)	$-V_{CER}$	max.	32	V
Collector-emitter voltage (open base)	$-V_{CEO}$	max.	15	V
Collector current (d.c.)	$-I_C$	max.	10	mA
Base current (d.c.)	$\lvert I_B \rvert$	max.	1	mA
Reverse emitter current	$-I_E$	max.	1	mA
Total power dissipation up to $T_{amb} = 45\ ^oC$	P_{tot}	max.	60	mW
Storage temperature	T_{stg}		-55 to +75	^oC
Junction temperature: continuous	T_j	max.	75	^oC
incidentally	T_j	max.	90	^oC

THERMAL RESISTANCE

From junction to ambient in free air	$R_{th\ j-a}$	=	0.75	$^oC/mW$
From junction to case	$R_{th\ j-c}$	=	0.4	$^oC/mW$

MECHANICAL DATA Dimensions in mm

TO-72



1) = shield lead (connected to case)

Accessories available: 56246, 56263

[1]) Limiting values according to the Absolute Maximum System as defined in IEC publication 134.

CHARACTERISTICS

T_{amb} = 25 °C unless otherwise specified

Collector cut-off current				
$I_E = 0$; $-V_{CB} = 6$ V	$-I_{CBO}$	typ.	1.2	μA
		<	8	μA
$I_E = 0$; $-V_{CB} = 6$ V; $T_j = 75$ °C	$-I_{CBO}$	typ.	90	μA
		<	180	μA
Base current				
$I_E = 1$ mA; $-V_{CB} = 6$ V	$-I_B$	typ.	7	μA
		<	25	μA
Base-emitter voltage				
$-I_C = 1$ mA; $-V_{CE} = 6$ V	$-V_{BE}$	typ.	270	mV
			210 to 330	mV
Small signal current gain at f = 1 kHz				
$-I_C = 1$ mA; $-V_{CE} = 6$ V	h_{fe}	typ.	150	
Feedback capacitance at f = 450 kHz				
$-I_C = 1$ mA; $-V_{CE} = 6$ V	$-C_{re}$	typ.	1.5	pF
y parameters at f = 100 MHz (common base)				
$I_E = 1$ mA; $-V_{CB} = 6$ V [1]				
Input conductance	g_{ib}	typ.	15	$m\Omega^{-1}$
Input capacitance	$-C_{ib}$	typ.	5	pF
Feedback admittance	$\lvert y_{rb} \rvert$	typ.	0.45	$m\Omega^{-1}$
Phase angle of feedback admittance	φ_{rb}	typ.	250°	
Transfer admittance	$\lvert y_{fb} \rvert$	typ.	16	$m\Omega^{-1}$
Phase angle of transfer admittance	φ_{fb}	typ.	95°	
Output conductance	g_{ob}	typ.	0.3	$m\Omega^{-1}$
Output capacitance	C_{ob}	typ.	2.5	pF
Feedback impedance at f = 2 MHz				
$I_E = 1$ mA; $-V_{CB} = 6$ V	$\lvert z_{rb} \rvert$	typ.	20	Ω

[1]) Length of leads between transistor bottom and measuring jig: 5 mm

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

Transition frequency

I_E = 1 mA; $-V_{CB}$ = 6 V	f_T	typ.	75	MHz

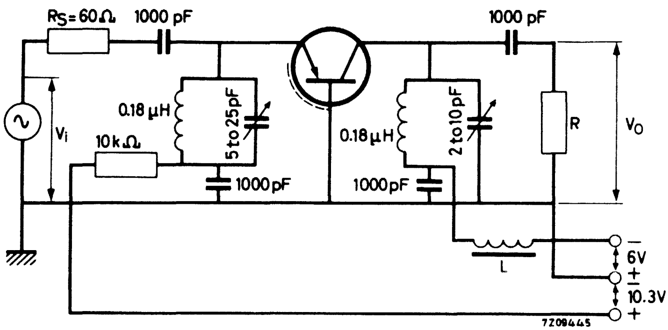
Noise figure at f = 100 MHz

I_E = 1 mA; $-V_{CB}$ = 6 V; R_S = 60 Ω	F	typ.	8	dB
		<	9.5	dB

Power gain at f = 100 MHz

$G_p = \frac{V_o2}{V_i2} \cdot \frac{4 R_S}{R_\ell} = 0.073 \frac{V_o2}{V_i2}$	G_p	>	12.5	dB
		typ.	14	dB

Test circuit

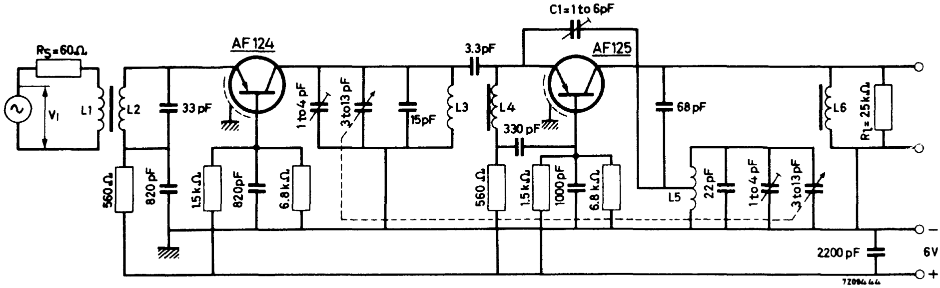


R is chosen such that the total load impedance R_l consisting of R and the tuned circuit in parallel is 3.3 kΩ.

L = ferrite bead

APPLICATION INFORMATION

Front-end unit of a f.m. tuner

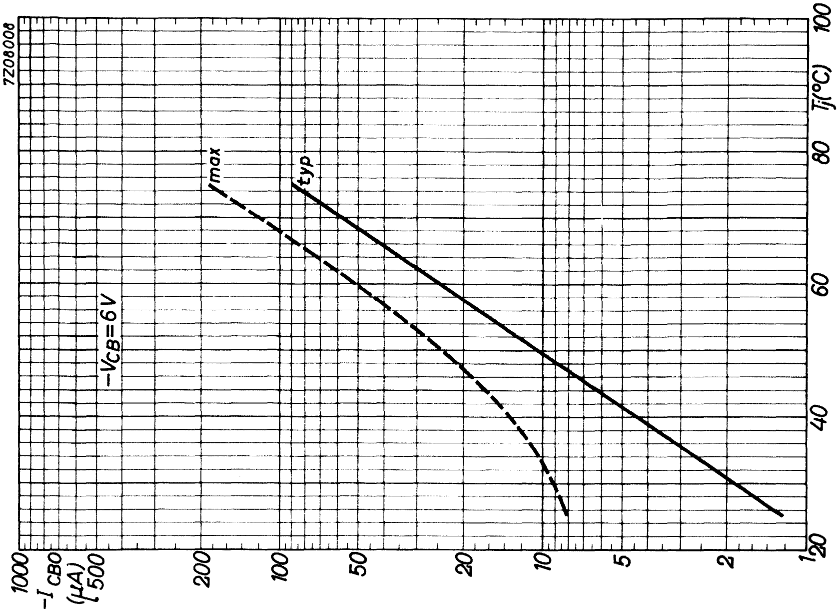


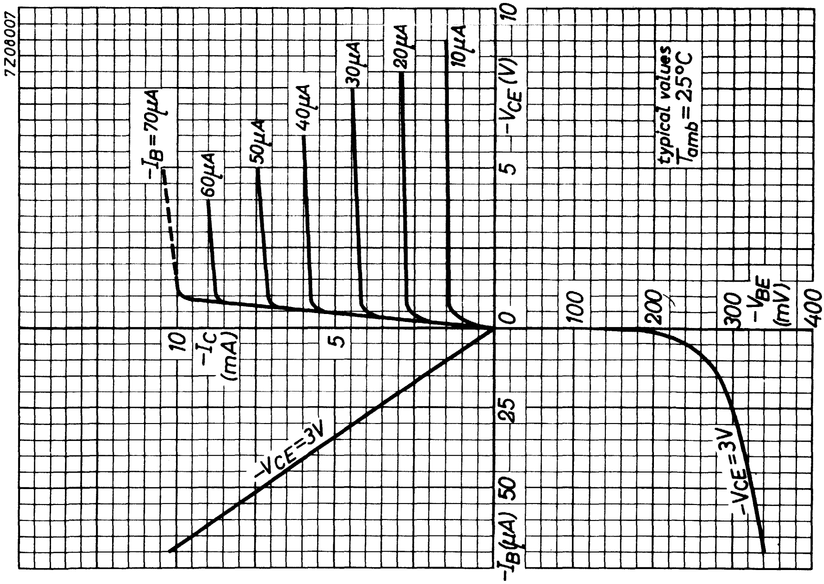
The oscillator voltage at the emitter of the AF 125 should be adjusted to 80 mV by means of C1 at a battery voltage V_S = 4 V

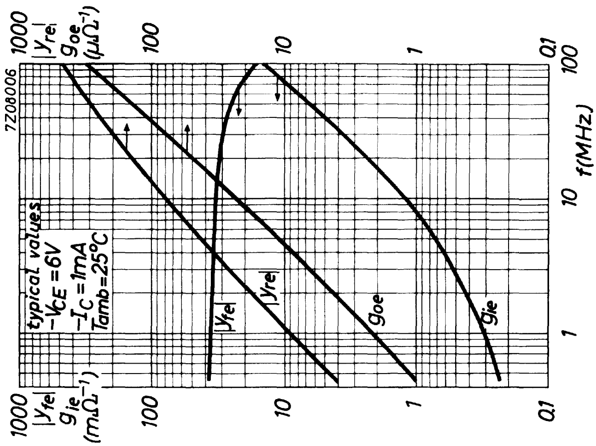
L1 = 4.5 turns enamelled Cu wire (0.3 mm), wound between L_2.
L2 = 4 turns enamelled Cu wire (1 mm), winding pitch 2 mm, inductance 0.18 μH, unloaded Q-factor 60 to 80.
L3 = 3.25 turns silvered Cu wire (1 mm), winding pitch 2 mm, inductance 0.086 μH, unloaded Q-factor 200.
L4 = 6 turns enamelled Cu wire (0.5 mm), closely wound, inductance 0.65 μH.
L5 = 2.5 turns silvered Cu wire (1 mm), winding pitch 2 mm, inductance 0.062 μH, unloaded Q-factor > 200; tap at 1.125 turns from earth.
L6 = 18 turns enamelled Cu wire (36 x 0.03), soldering graded, stranded, open covered, closely wound; inductance 2.9 μH; unloaded Q-factor 120; loaded Q-factor with 25 kΩ : 60.

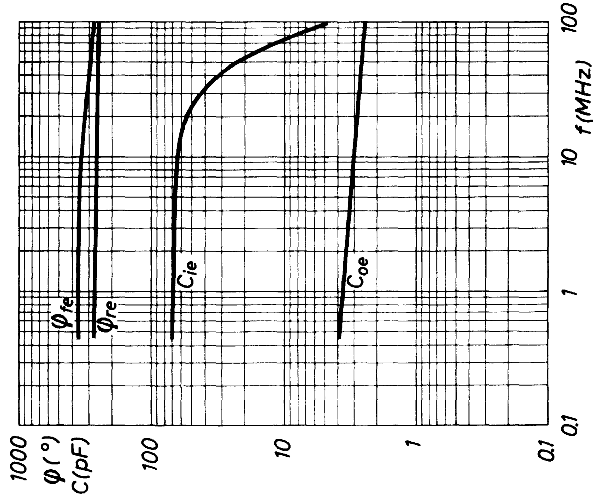
Frequency range	f		87 to 101	MHz
Collector current AF124	$-I_C$		1.4	mA
AF125	$-I_C$		1.5	mA
Total power gain	G_p	>	24	dB
		typ.	28	dB
Noise figure	F	typ.	8	dB
		<	9.5	dB
Oscillator voltage at aerial terminals		typ.	1.5	mV
Image rejection		typ.	27	dB

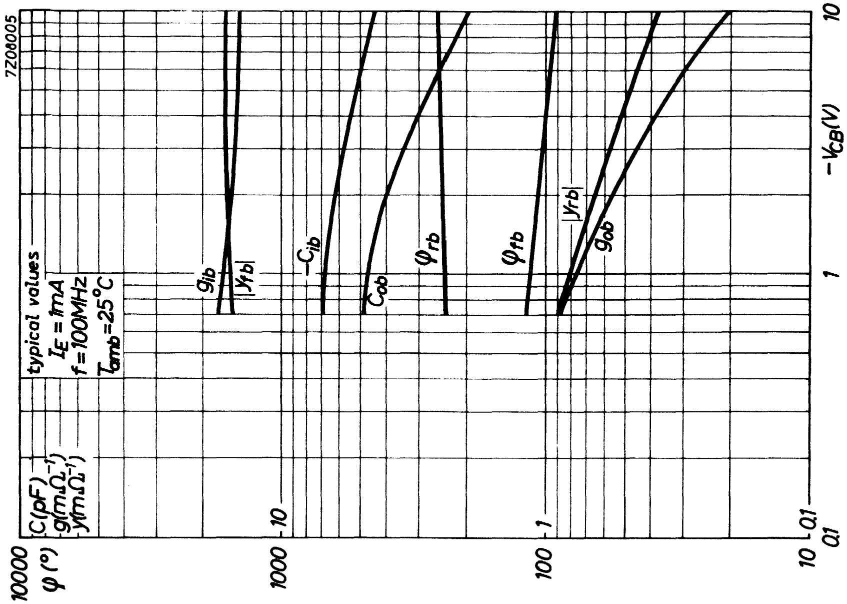
The shift of the oscillator frequency a a f· nction of the battery voltage is about 50 kHz from 6 to 5 V and about ¹00 kHz from 5 to 4 V.

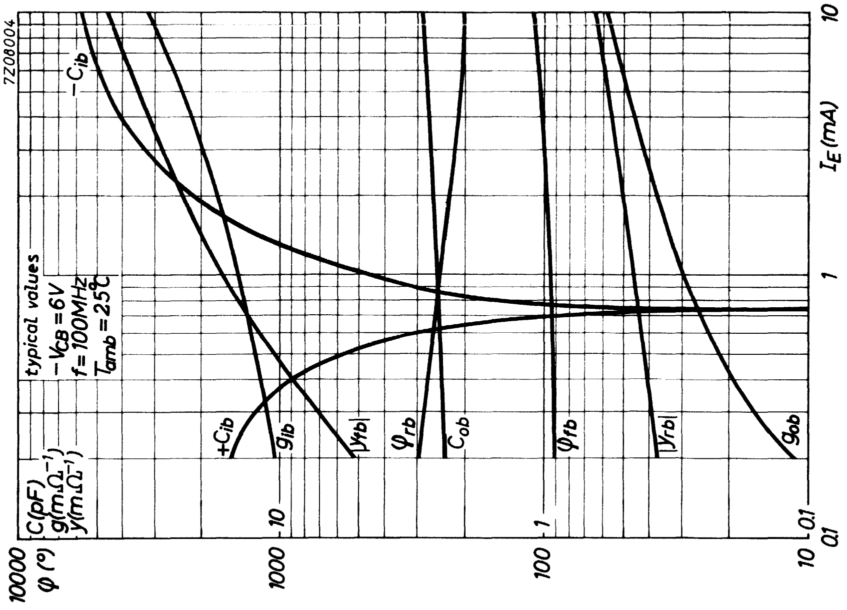

7Z08008
$-V_{CB}=6V$
max
typ
T_j(°C)
20
40
60
80
100
$-I_{CBO}$ (μA)
1000
500
200
100
50
20
10
5
2
1

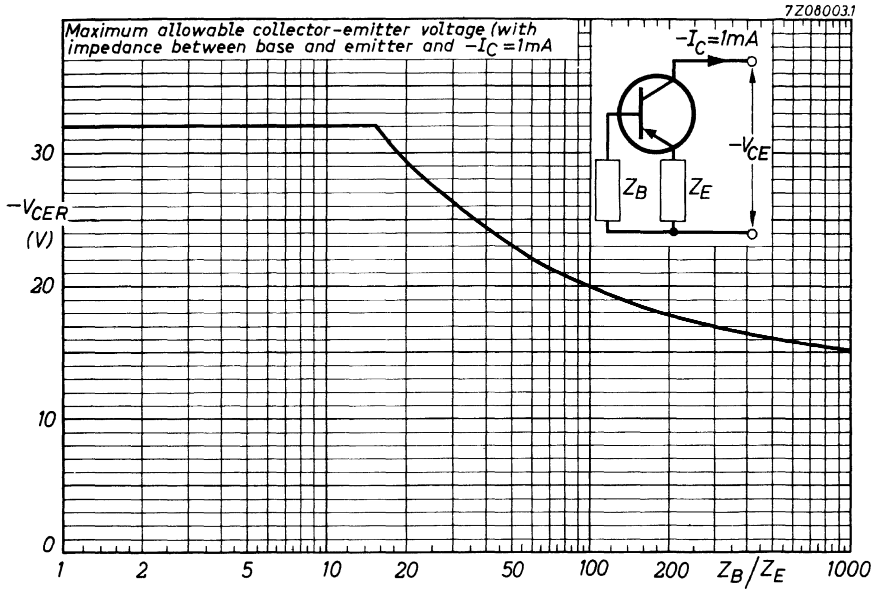

7Z08007
$-I_B=70μA$
60μA
50μA
40μA
30μA
20μA
10μA
$-V_{CE}$ (V)
10
5
0
typical values
$T_{amb}=25°C$
$-I_C$ (mA)
10
5
$-V_{CE}=3V$
25
50
$-I_B$(μA)
100
200
300
400
$-V_{BE}$ (mV)
$-V_{CE}=3V$


7Z08006
typical values
$-V_{CE}$ = 6V
$-I_C$ = 1mA
T_{amb} = 25°C
$|y_{fe}|$
$|y_{re}|$
g_{oe}
g_{ie}
$|y_{re}|$ g_{oe} ($\mu\Omega^{-1}$)
$|y_{fe}|$ g_{ie} ($m\Omega^{-1}$)
f (MHz)
1000
100
10
1
0.1


φ_{fe}
φ_{re}
C_{ie}
C_{oe}
φ (°)
C (pF)
f (MHz)
1000
100
10
1
0.1


7Z08005
typical values
I_E = 1mA
f = 100MHz
T_{amb} = 25°C
C(pF)
g(mΩ⁻¹)
y(mΩ⁻¹)
φ (°)
10000
1000
100
10
10
1
0.1
0.1
1
10
$-V_{CB}$(V)
g_{ib}
$|y_{fb}|$
$-C_{ib}$
C_{ob}
φ_{rb}
φ_{fb}
$|y_{rb}|$
g_{ob}


7Z08004
typical values
$-V_{CB}$ = 6V
f = 100MHz
T_{amb} = 25°C
C(pF)
g(mΩ⁻¹)
y(mΩ⁻¹)
φ (°)
10000
1000
100
10
10
1
0.1
0.1
1
10
I_E(mA)
$-C_{ib}$
$+C_{ib}$
g_{ib}
$|y_{fb}|$
φ_{rb}
C_{ob}
φ_{fb}
$|y_{rb}|$
g_{ob}


7Z08003.1
Maximum allowable collector-emitter voltage (with impedance between base and emitter and $-I_C = 1mA$
$-I_C = 1mA$
$-V_{CE}$
Z_B
Z_E
$-V_{CER}$ (V)
30
20
10
0
1
2
5
10
20
50
100
200
Z_B/Z_E
1000

GERMANIUM ALLOY DIFFUSED TRANSISTOR

P-N-P transistor in a TO-72 metal envelope with a shield lead connected to the case. It has a high conversion gain up to frequencies of 100 MHz and is intended for use as r.f. amplifiers and mixer-oscillator in short-wave receivers up to 27 MHz.

RATINGS (Limiting values) [1])

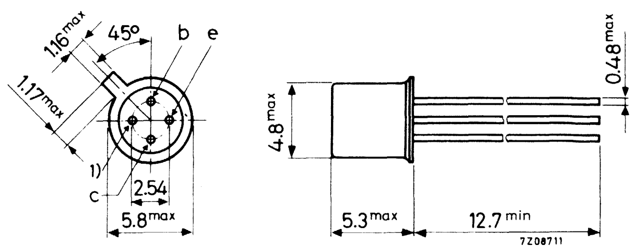
Collector-base voltage (open emitter)	$-V_{CBO}$	max.	32	V
Collector-emitter voltage ($Z_B/Z_E < 15$)	$-V_{CER}$	max.	32	V
Collector-emitter voltage (open base)	$-V_{CEO}$	max.	15	V
Collector current (d.c.)	$-I_C$	max.	10	mA
Base current (d.c.)	$\lvert I_B \rvert$	max.	1	mA
Reverse emitter current	$-I_E$	max.	1	mA
Total power dissipation up to $T_{amb} = 45\ ^oC$	P_{tot}	max.	60	mW
Storage temperature	T_{stg}	-55 to +75		^oC
Junction temperature: continuous	T_j	max.	75	^oC
incidentally	T_j	max.	90	^oC

THERMAL RESISTANCE

From junction to ambient in free air	$R_{th\ j\text{-}a}$	=	0.75	$^oC/mW$
From junction to case	$R_{th\ j\text{-}c}$	=	0.4	$^oC/mW$

MECHANICAL DATA Dimensions in mm

TO-72



1) = shield lead (connected to case)

Accessories available: 56246, 56263

[1]) Limiting values according to the Absolute Maximum System as defined in IEC publication 134.

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

Collector cut-off current

$I_E = 0$; $-V_{CB} = 6$ V	$-I_{CBO}$	typ.	1.2	μA
		<	8	μA
$I_E = 0$; $-V_{CB} = 6$ V; $T_j = 75$ °C	$-I_{CBO}$	typ.	90	μA
		<	180	μA

Base current

$I_E = 1$ mA; $-V_{CB} = 6$ V	$-I_B$	typ.	7	μA
		<	25	μA

Base-emitter voltage

$-I_C = 1$ mA; $-V_{CE} = 6$ V	$-V_{BE}$	typ.	270	mV
		210 to	330	mV

Small signal current gain at f = 1 kHz

$-I_C = 1$ mA; $-V_{CE} = 6$ V	h_{fe}	typ.	150	

Feedback capacitance at f = 450 kHz

$-I_C = 1$ mA; $-V_{CE} = 6$ V	$-C_{re}$	typ.	1.5	pF

y parameters [1]

$I_E = 1$ mA; $-V_{CB} = 6$ V at f = 100 MHz

Input conductance	g_{ib}	typ.	15	$m\Omega^{-1}$
Input capacitance	$-C_{ib}$	typ.	5	pF
Feedback admittance	$\|y_{rb}\|$	typ.	0.45	$m\Omega^{-1}$
Phase angle of feedback admittance	φ_{rb}	typ.	250°	
Transfer admittance	$\|y_{fb}\|$	typ.	15	$m\Omega^{-1}$
Phase angle of transfer admittance	φ_{fb}	typ.	95°	
Output conductance	g_{ob}	typ.	0.35	$m\Omega^{-1}$
Output capacitance	C_{ob}	typ.	25	pF

$-I_C = 1$ mA; $-V_{CE} = 6$ V

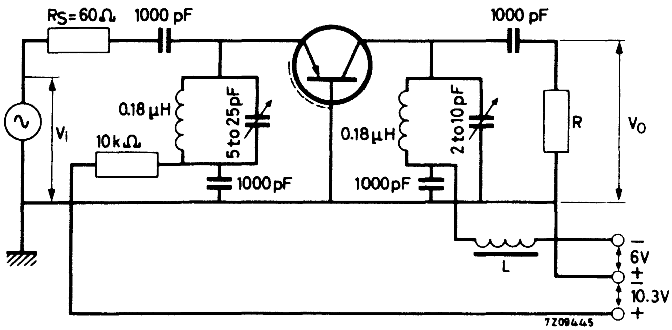
			f = 10.7	0.45	MHz
Input conductance	g_{ie}	typ.	1.3	0.25	$m\Omega^{-1}$
Input capacitance	C_{ie}	typ.	65	70	pF
Feedback admittance	$\|y_{re}\|$	typ.	80	4	$\mu\Omega^{-1}$
Phase angle of feedback admittance	φ_{re}	typ.	260°	270°	
Transfer admittance	$\|y_{fe}\|$	typ.	34	37	$m\Omega^{-1}$
Phase angle of transfer admittance	φ_{fe}	typ.	335°	0	
Output conductance	g_{oe}	typ.	25	1.0	$\mu\Omega^{-1}$
Output capacitance	C_{oe}	typ.	3.0	4	pF

[1]) Length of leads between transistor bottom and measuring jig: 5 mm.

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

Feedback impedance at f = 2 MHz				
I_E = 1 mA; $-V_{CB}$ = 6 V	$\lvert z_{rb} \rvert$	typ.	25	Ω
Transition frequency				
I_E = 1 mA; $-V_{CB}$ = 6 V	f_T	typ.	75	MHz
Noise figure at I_E = 1 mA; $-V_{CB}$ = 6 V				
R_S = 60 Ω; f = 100 MHz	F	typ.	9.5	dB
R_S = 200 Ω; f = 10.7 MHz	F	typ.	3.0	dB
R_S = 500 Ω; f = 1 MHz	F	typ.	1.5	dB
		<	3	dB
Conversion noise figure at I_E = 1 mA; $-V_{CB}$ = 6 V				
R_S = 500 Ω; f = 1 MHz	F_c	typ.	3	dB
		<	5	dB
R_S = 2 kΩ; f = 200 kHz	F_c	typ.	4	dB
		<	7	dB
Power gain at f = 100 MHz				
$G_p = \frac{V_o^2}{V_i^2} \cdot \frac{4 R_S}{R_\ell} = 0.073 \frac{V_o^2}{V_i^2}$	G_p	>	10	dB
		typ.	13	dB

Test circuit:



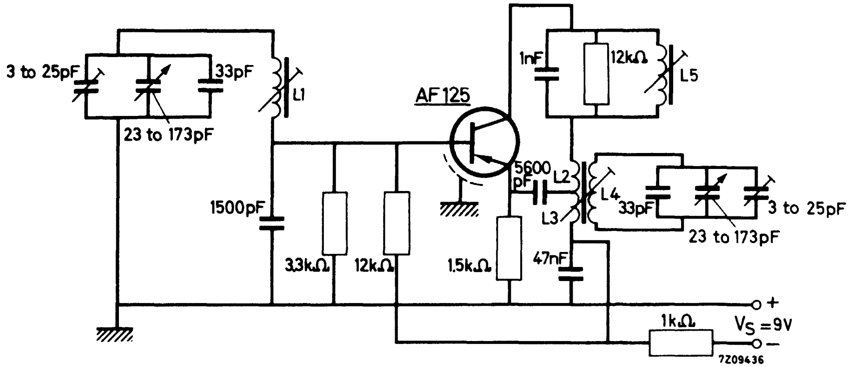
R is chosen such that the total load impedance R_ℓ consisting of R and the tuned circuit in parallel is 3.3 kΩ.

L = ferrite bead

APPLICATION INFORMATION

1. Front-end unit of a f.m. tuner see AF124

2. Self-oscillating mixer stage (15.1 to 26.1 MHz)



L_1 = 5.5 turns enamelled Cu wire (0.25 mm), closely wound on coil former with diameter of 7 mm; inductance 0.59 μH; unloaded Q-factor 100 at f = 15 MHz and 115 at f = 26 MHz.

L_2 = 1.25 turns enamelled Cu wire (0.25 mm), wound in L_4 at earth side.

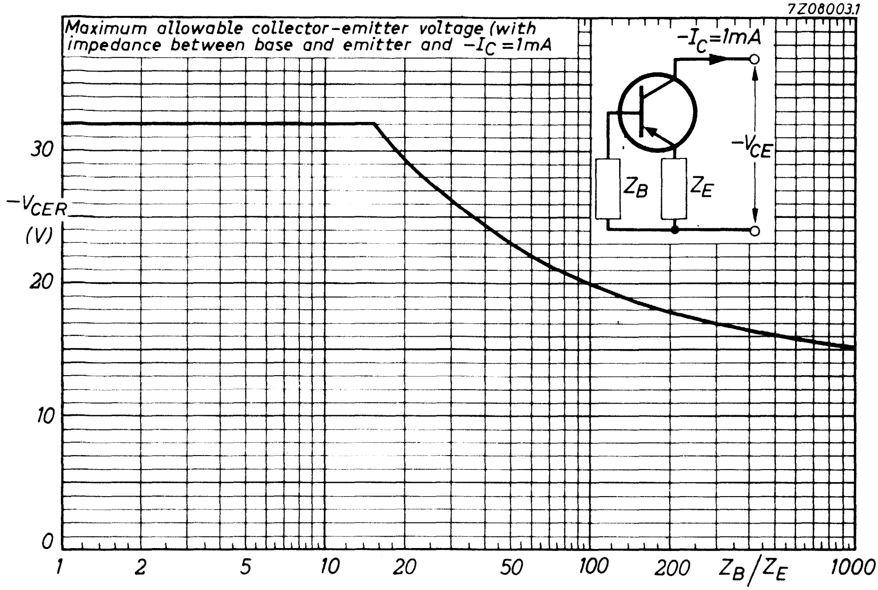
L_3 = 1 turn enamelled Cu wire (0.25 mm), wound in L_4 at earth side.

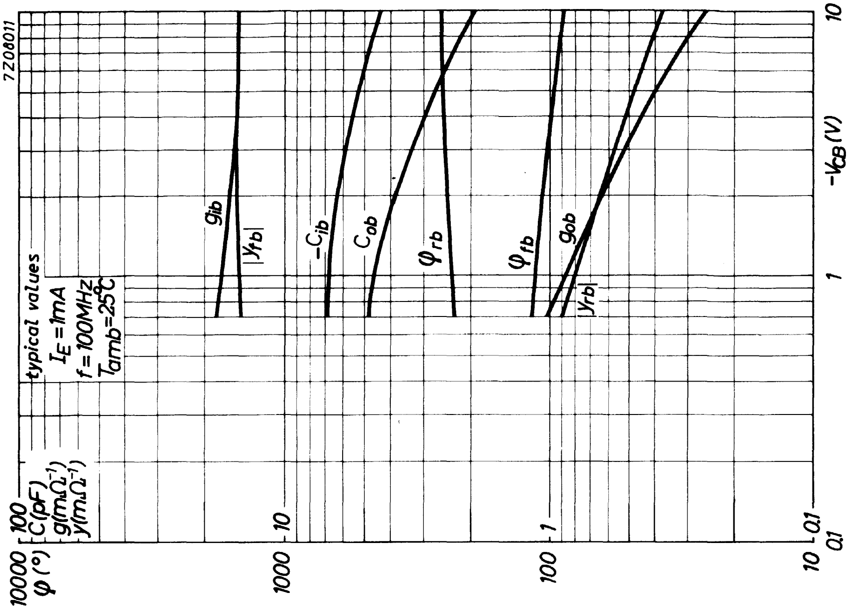
L_4 = 6.5 turns enamelled Cu wire (0.9 mm), closely wound on coil former with diameter of 7 mm; inductance 0.46 μH; unloaded Q-factor 110 at f = 15 MHz and f = 26 MHz

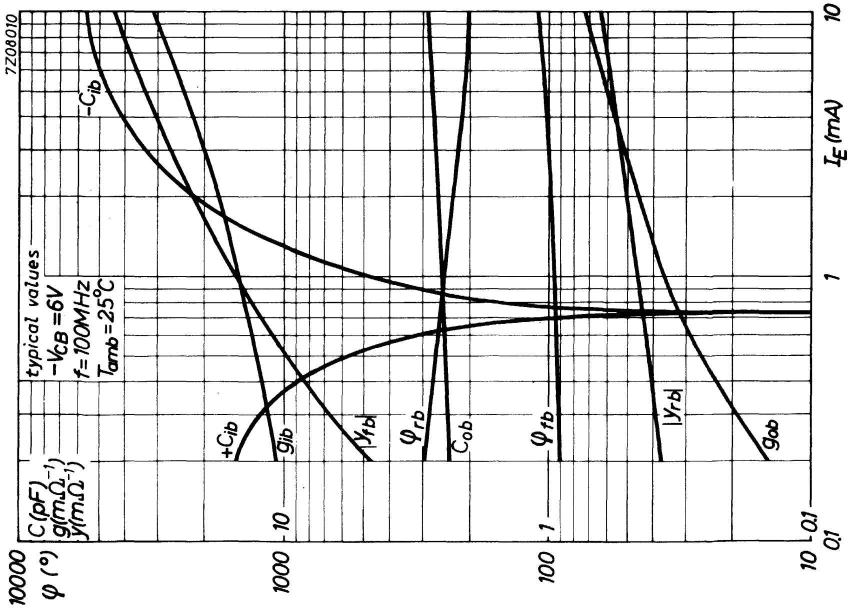
L_5 = Inductance 125 μH; unloaded Q-factor 140.

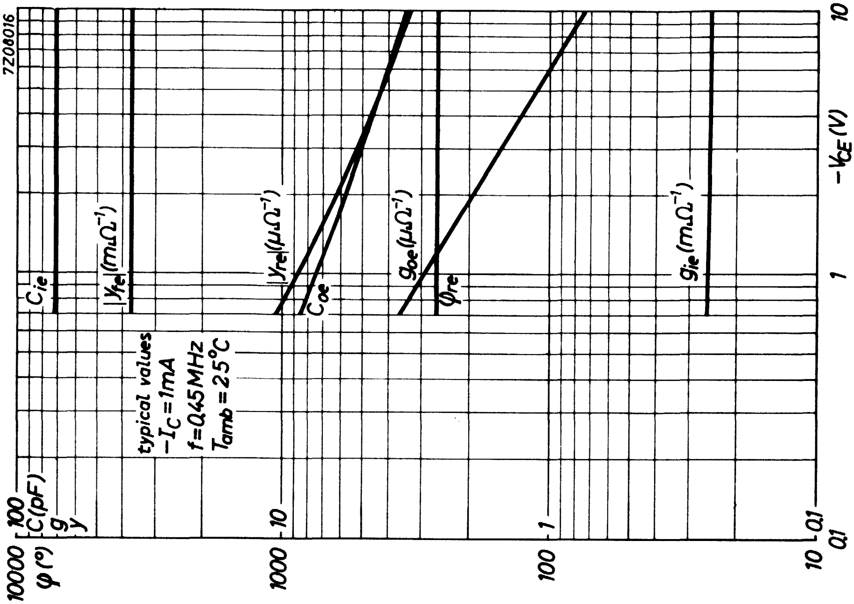
Battery voltage	V_S	=	9	V
Collector-emitter voltage	$-V_{CE}$	=	6	V
Emitter current	I_E	=	1	mA

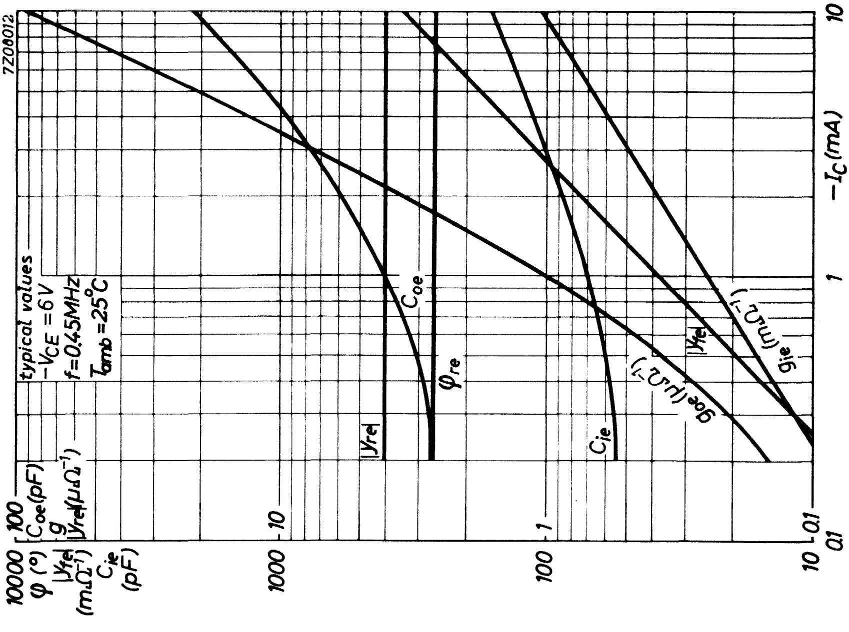
			f = 15	20	26	MHz
Oscillator voltage between emitter and earth	V_{osc}	typ.	0.11	0.14	0.15	V
Frequency shift by a battery voltage variation from 9 to 6 V	Δf_{osc}	typ.	3	2	10	kHz
Conversion gain, defined as the ratio between the i.f. power in a 10 kΩ load (the total i.f. impedance in the collector circuit) and the available r.f. power in the aerial circuit	$\frac{P_o}{P_i}$	typ.	26	23	20	dB

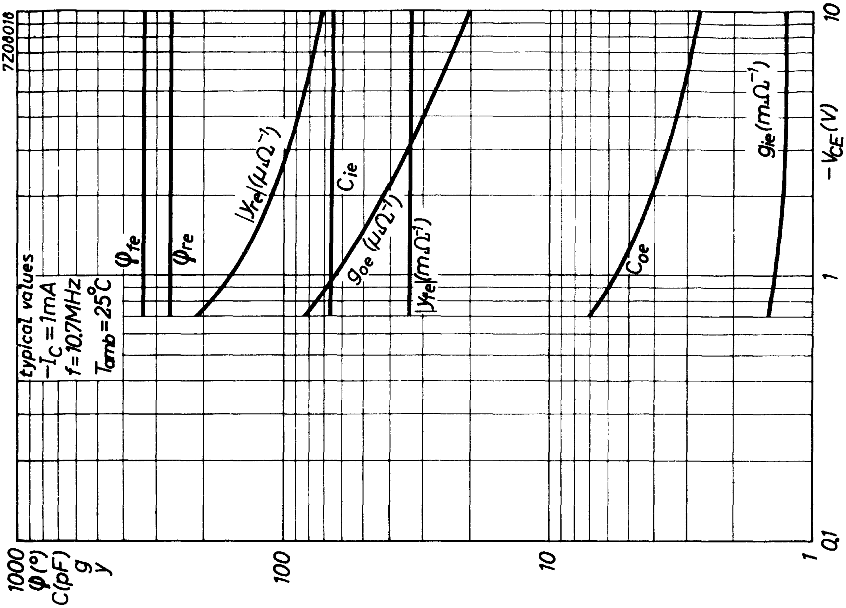

7Z08003.1
Maximum allowable collector-emitter voltage (with impedance between base and emitter and $-I_C = 1mA$
$-I_C=1mA$
$-V_{CE}$
Z_B
Z_E
$-V_{CER}$
(V)
30
20
10
0
1
2
5
10
20
50
100
200
Z_B/Z_E
1000

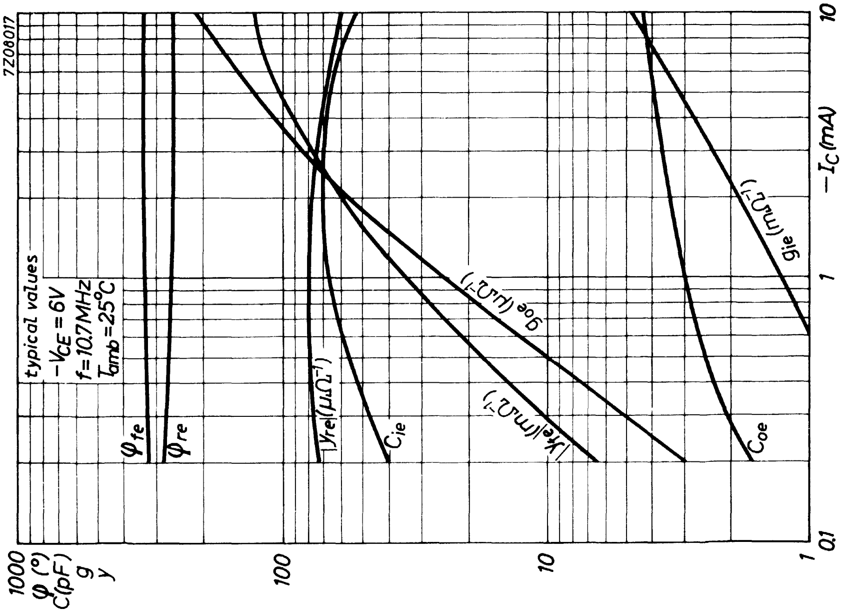

7Z08011
typical values
I_E = 1mA
f = 100MHz
T_amb = 25°C
10000
φ (°)
1000
100
10
100
C (pF)
g(mΩ-1)
y(mΩ-1)
10
1
0.1
0.1
1
10
-V_CB (V)
g_ib
|y_fb|
-C_ib
C_ob
φ_rb
φ_fb
g_ob
|y_rb|

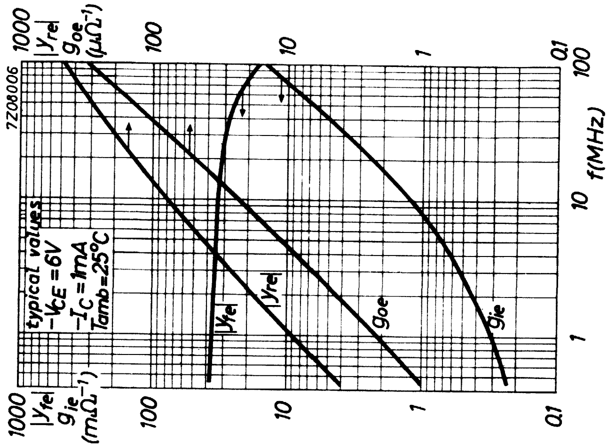

7Z08010
typical values
-V_CB = 6V
f = 100MHz
T_amb = 25°C
10000
φ (°)
1000
100
10
C (pF)
g(mΩ-1)
y(mΩ-1)
10
1
0.1
0.1
1
10
I_E (mA)
-C_ib
+C_ib
g_ib
|y_fb|
φ_rb
C_ob
φ_fb
|y_rb|
g_ob


7Z08016
typical values
−I_C = 1mA
f = 0.45MHz
T_amb = 25°C
C_ie
|y_fe| (mΩ⁻¹)
|y_re| (μΩ⁻¹)
C_oe
g_oe (μΩ⁻¹)
φ_re
g_ie (mΩ⁻¹)
10000
φ (°)
1000
100
10
100
C (pF)
g
y
10
1
0.1
0.1
1
10
−V_CE (V)

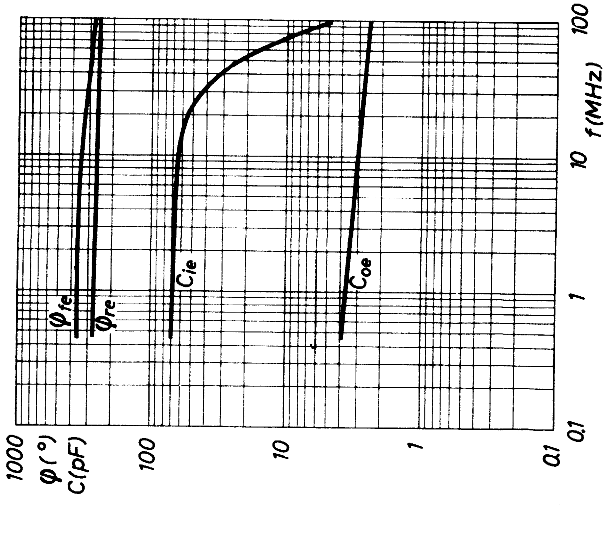

7Z08012
typical values
−V_CE = 6V
f = 0.45MHz
T_amb = 25°C
C_oe
φ_re
|y_re|
C_ie
g_oe (μΩ⁻¹)
|y_fe|
g_ie (mΩ⁻¹)
10000
φ (°)
|y_fe| (mΩ⁻¹)
C_ie (pF)
1000
100
10
100
C_oe (pF)
g
|y_re| (μΩ⁻¹)
10
1
0.1
0.1
1
10
−I_C (mA)


7Z08018
typical values
$-I_C = 1mA$
$f = 10.7MHz$
$T_{amb} = 25°C$
φ_{fe}
φ_{re}
$|y_{re}|(\mu\Omega^{-1})$
C_{ie}
$g_{oe}(\mu\Omega^{-1})$
$|y_{fe}|(m\Omega^{-1})$
C_{oe}
$g_{ie}(m\Omega^{-1})$
1000
$\varphi(°)$
C(pF)
g
y
100
10
1
0.1
1
10
$-V_{CE}(V)$

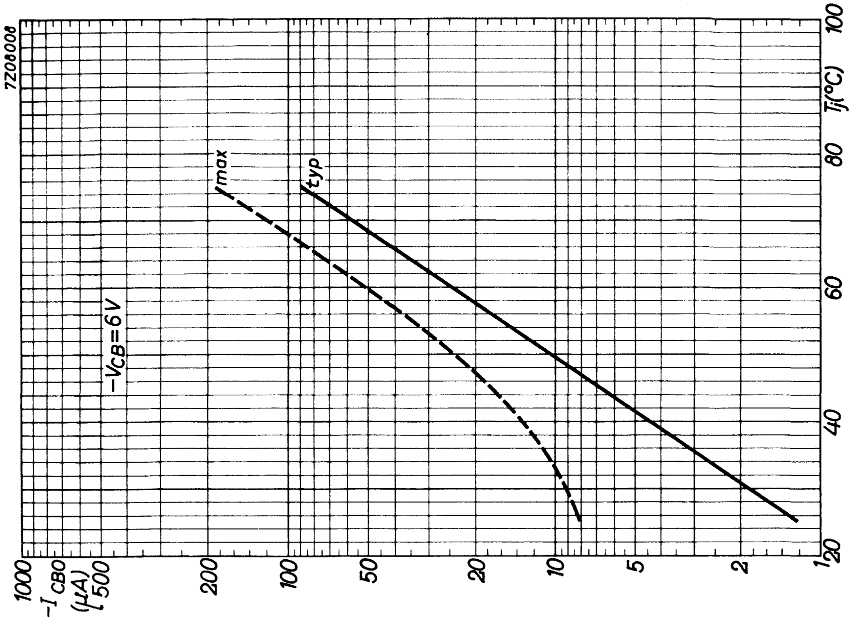

7Z08017
typical values
$-V_{CE} = 6V$
$f = 10.7MHz$
$T_{amb} = 25°C$
φ_{fe}
φ_{re}
$|y_{re}|(\mu\Omega^{-1})$
C_{ie}
$|y_{fe}|(m\Omega^{-1})$
$g_{oe}(\mu\Omega^{-1})$
C_{oe}
$g_{ie}(m\Omega^{-1})$
1000
$\varphi(°)$
C(pF)
g
y
100
10
1
0.1
1
10
$-I_C(mA)$

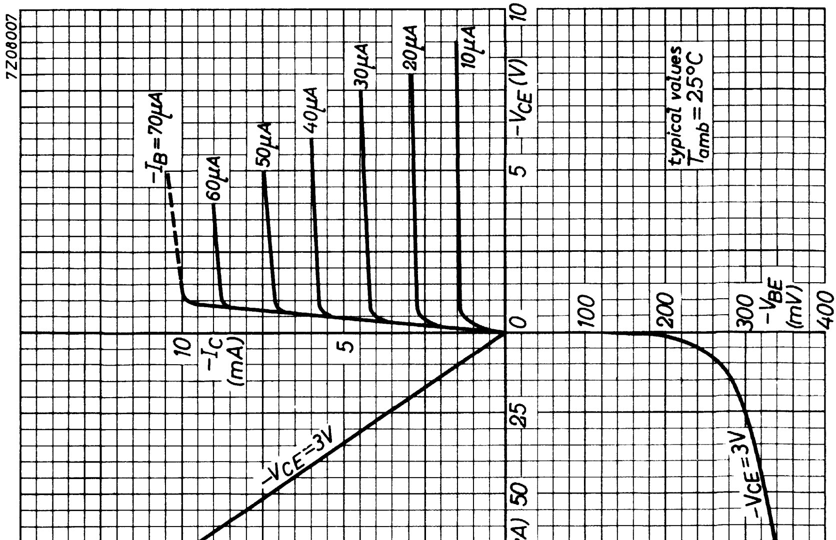


7Z08006
typical values
−VCE = 6V
−IC = 1mA
Tamb = 25°C
|yfe|
gie
(mΩ−1)
|yre|
goe
(μΩ−1)
|yfe|
|yre|
goe
gie
1000
100
10
1
0.1
1
10
100
f (MHz)



1000
φ (°)
C (pF)
100
10
1
0.1
φfe
φre
Cie
Coe
0.1
1
10
100
f (MHz)


7Z08008
$-V_{CB}=6V$
max
typ
T_j(°C)
100
80
60
40
20
1000
$-I_{CBO}$ (μA)
500
200
100
50
20
10
5
2
1


7Z08007
$-I_B=70\mu A$
60μA
50μA
40μA
30μA
20μA
10μA
$-V_{CE}$(V)
10
5
0
typical values
$T_{amb}=25°C$
10
$-I_C$ (mA)
5
100
200
300
$-V_{BE}$ (mV)
400
25
50
$-I_B$(μA)
$-V_{CE}=3V$
$-V_{CE}=3V$

GERMANIUM ALLOY DIFFUSED TRANSISTOR

P-N-P transistor in a TO-72 metal envelope with a shield lead connected to the case. It has low output conductance and low collector capacitance at 10.7 MHz and low noise and good a.g.c. performance for use as i.f. amplifier in a.m. and f.m. receivers and as amplifier and mixer-oscillator in short-wave receivers up to 16 MHz.

RATINGS (Limiting values) [1])

Collector-base voltage (open emitter)	$-V_{CBO}$	max.	32	V
Collector-emitter voltage (Z_B/Z_E < 15)	$-V_{CER}$	max.	32	V
Collector-emitter voltage (open base)	$-V_{CEO}$	max.	15	V
Collector current (d.c.)	$-I_C$	max.	10	mA
Base current (d.c.)	$\|I_B\|$	max.	1	mA
Reverse emitter current	$-I_E$	max.	1	mA
Total power dissipation up to T_{amb} = 45 °C	P_{tot}	max.	60	mW
Storage temperature	T_{stg}		-55 to +75	°C
Junction temperature : continuous	T_j	max.	75	°C
incidentally	T_j	max.	90	°C

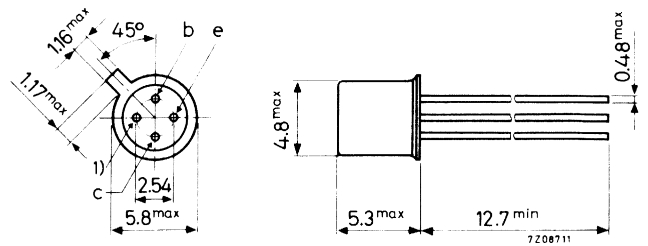
THERMAL RESISTANCE

From junction to ambient in free air	$R_{th\ j-a}$	=	0.75	°C/mW
From junction to case	$R_{th\ j-c}$	=	0.4	°C/mW

MECHANICAL DATA

Dimensions in mm

TO-72



1) = shield lead (connected to case)

Accessories available: 56246, 56263

[1]) Limiting values according to the Absolute Maximum System as defined in IEC publication 134.

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

Collector cut-off current				
$I_E = 0$; $-V_{CB} = 6$ V	$-I_{CBO}$	typ. <	1.2 8	μA μA
$I_E = 0$; $-V_{CB} = 6$ V; $T_j = 75$ °C	$-I_{CBO}$	typ. <	90 180	μA μA
Base current				
$I_E = 1$ mA; $-V_{CB} = 6$ V	$-I_B$	typ. <	7 25	μA μA
Base-emitter voltage				
$-I_C = 1$ mA; $-V_{CE} = 6$ V	$-V_{BE}$	typ. 210 to	270 330	mV mV
Small signal current gain at f = 1 kHz				
- $-I_C = 1$ mA; $-V_{CE} = 6$ V	h_{fe}	typ.	150	
Feedback capacitance at f = 450 kHz				
$-I_C = 1$ mA; $-V_{CE} = 6$ V	$-C_{re}$	typ.	1.5	pF

y parameters (common emitter)

$-I_C = 1$ mA; $-V_{CE} = 6$ V [1])

			f = 10.7	0.45	MHz
Input conductance	g_{ie}	typ.	1.7	0.25	$m\Omega^{-1}$
Input capacitance	C_{ie}	typ.	60	70	pF
Feedback admittance	$\|y_{re}\|$	typ.	100	4.0	$\mu\Omega^{-1}$
Phase angle of feedback admittance	φ_{re}	typ.	260°	270°	
Transfer admittance	$\|y_{fe}\|$	typ.	32	37	$m\Omega^{-1}$
Phase angle of transfer admittance	φ_{fe}	typ.	335°	0	
Output conductance	g_{oe}	typ.	40	1.0	$\mu\Omega^{-1}$
Output capacitance	C_{oe}	typ.	3.5	4.0	pF

Feedback impedance at f = 2 MHz

$I_E = 1$ mA; $-V_{CB} = 6$ V	$\|z_{rb}\|$	typ.	27	Ω

[1]) Length of leads between transistor bottom and measuring jig : 5 mm

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

Transition frequency

I_E = 1 mA; $-V_{CB}$ = 6 V	f_T	typ.	75	MHz

Noise figure at I_E = 1 mA; $-V_{CB}$ = 6 V

R_S = 60 Ω; f = 10.7 MHz	F	typ.	3.0	dB
		<	4.5	dB
R_S = 500 Ω; f = 1 MHz	F	typ.	1.5	dB
		<	3.0	dB

Conversion noise figure

I_E = 1 mA; $-V_{CB}$ = 6 V

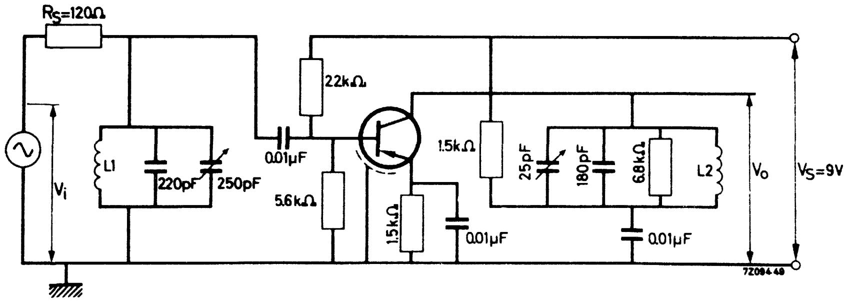
R_S = 500 Ω; f = 1 MHz	F_c	typ.	3	dB
		<	5	dB
R_S = 2 kΩ; f = 200 kHz	F_c	typ.	4	dB
		<	7	dB

Power gain at f = 10.7 MHz

$$G_p = \frac{V_o^2}{V_i^2} \cdot \frac{4\,R_S}{R_l} = 0.1\,\frac{V_o^2}{V_i^2}$$

G_p	>	19	dB
	typ.	25	dB

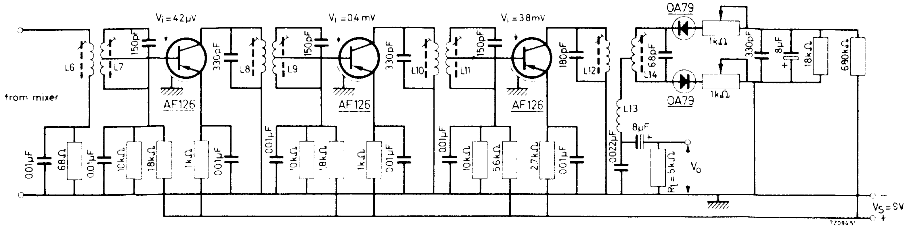
Test circuit:



Total collector resistance R_l = 4.8 kΩ
L1 = 0.5 µH; unloaded Q-factor 100
L2 = 2.47 µH; unloaded Q-factor 100

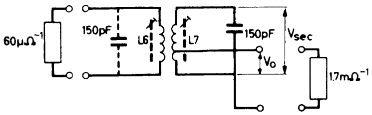
APPLICATION INFORMATION

I.F. amplifier for 10.7 MHz



Emitter current of each transistor I_E = 1.0 mA

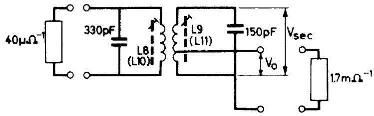
Coil data :



L6 = 1.4 μH; $Q_0 \geq 120$; $Q_L = 70$

L7 = 1.4 μH; $Q_0 \geq 110$; $Q_L = 92$

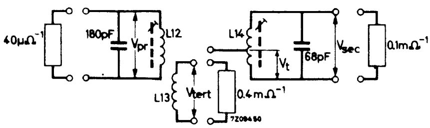
$kQ_L = 1.25$ $\quad \frac{V_o}{V_{sec}} = 0.1$



L8 = L10 = 0.67 μH; $Q_0 \geq 110$; $Q_L = 92$

L9 = L11 = 1.4 μH; $Q_0 \geq 110$; $Q_L = 92$

$kQ_L = 1.25$ $\quad \frac{V_o}{V_{sec}} = 0.1$

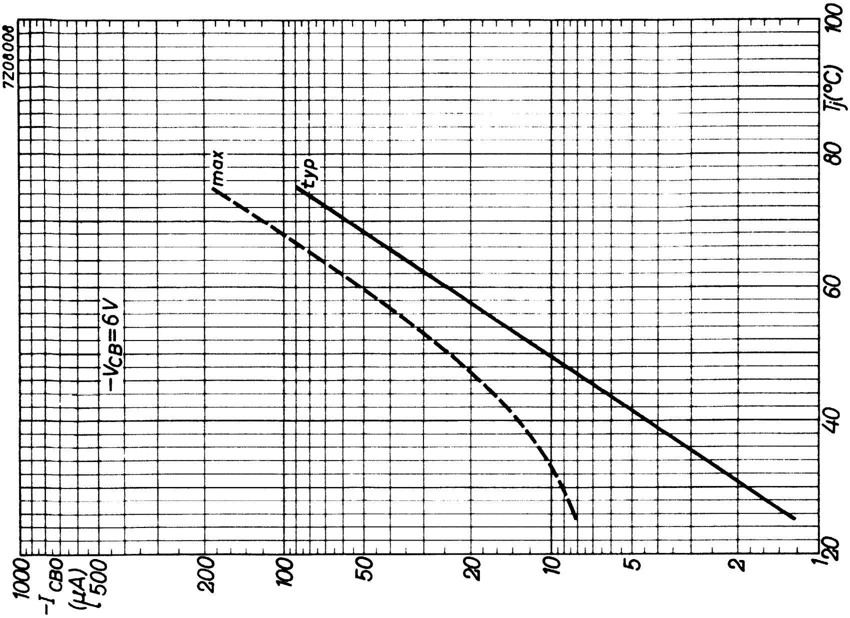


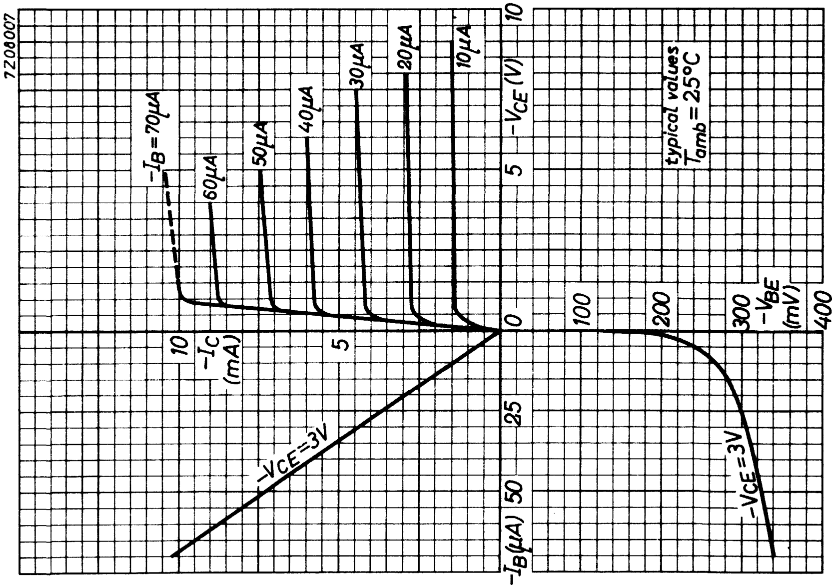
L12 = 1.2 μH; $Q_0 = 90$

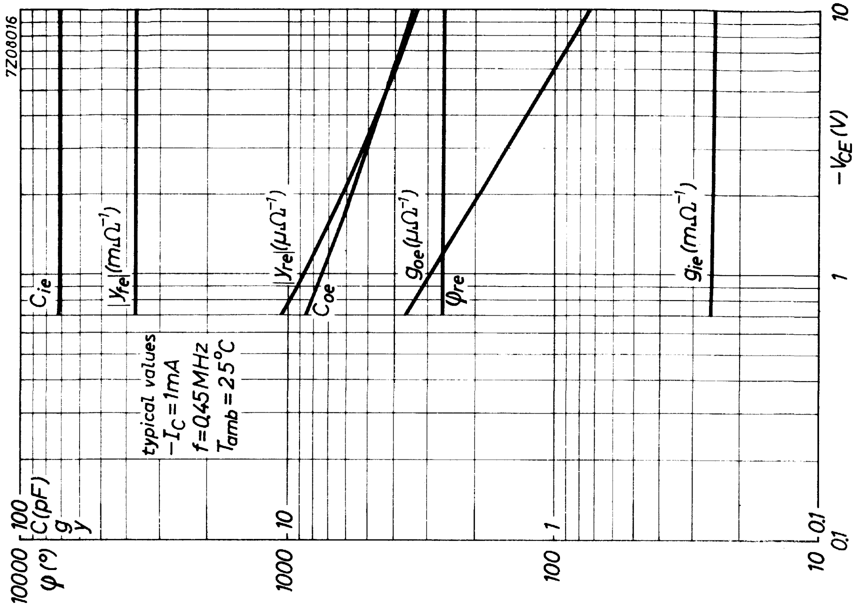
L14 = 3.05 μH; $Q_0 = 90$ (bifilarly wound)

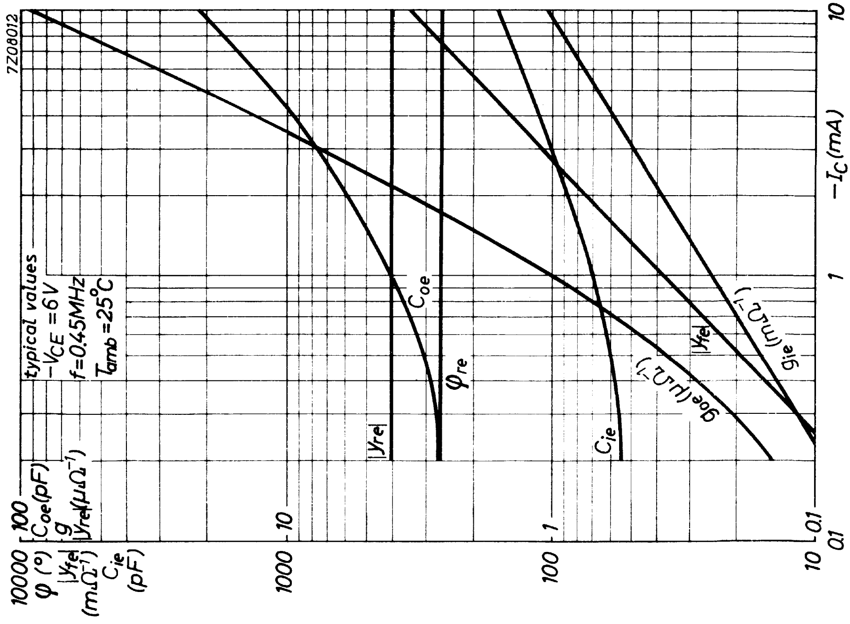
$kQ_L = 0.7$

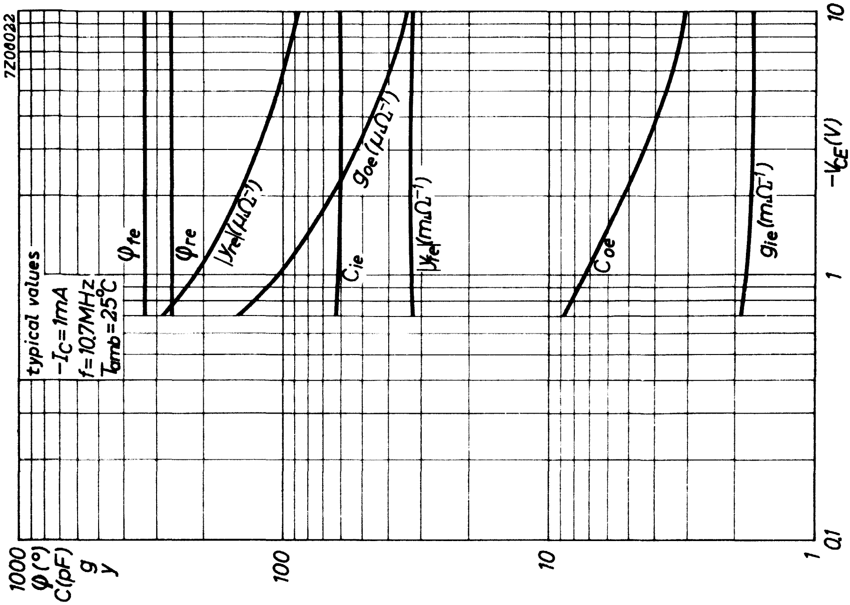
$\frac{V_{tert}}{V_{pr}} = 0.45$; $\frac{V_t}{V_{sec}} = 0.5$

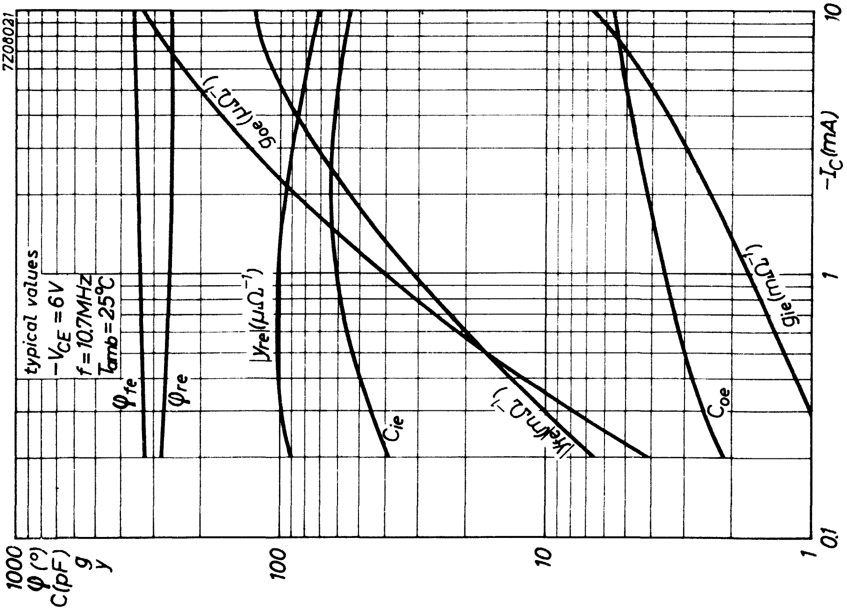

7Z08008
$-V_{CB}=6V$
max
typ
T_j(°C)
20
40
60
80
100
$-I_{CBO}$ (µA)
1000
500
200
100
50
20
10
5
2
1

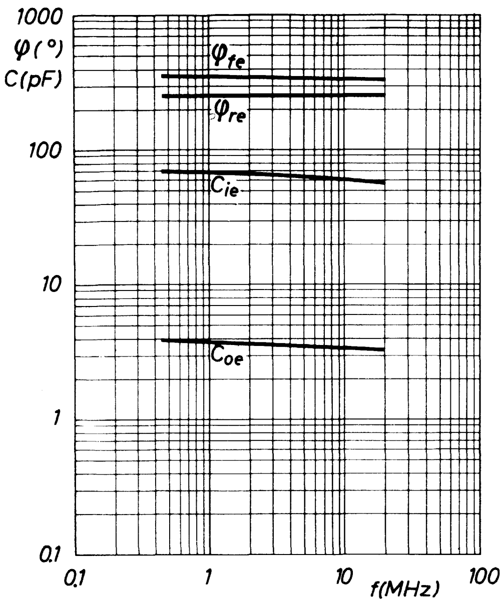

7Z08007
$-I_B=70\mu A$
60µA
50µA
40µA
30µA
20µA
10µA
$-V_{CE}$ (V)
0
5
10
typical values
$T_{amb}=25°C$
$-I_C$ (mA)
10
5
$-V_{CE}=3V$
25
50
$-I_B$ (µA)
100
200
300
400
$-V_{BE}$ (mV)
$-V_{CE}=3V$

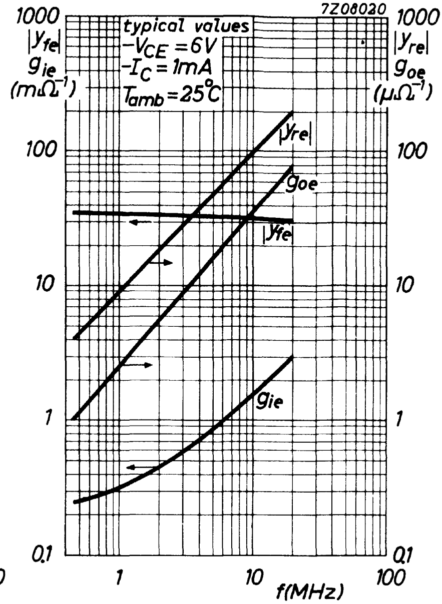

7Z08016
typical values
−I_C = 1mA
f = 0.45MHz
T_amb = 25°C
C_ie
|y_fe| (mΩ⁻¹)
|y_re| (μΩ⁻¹)
C_oe
g_oe (μΩ⁻¹)
φ_re
g_ie (mΩ⁻¹)
10000
φ (°)
100
C (pF)
g
y
1000
10
100
1
10
0.1
0.1
1
10
−V_CE (V)

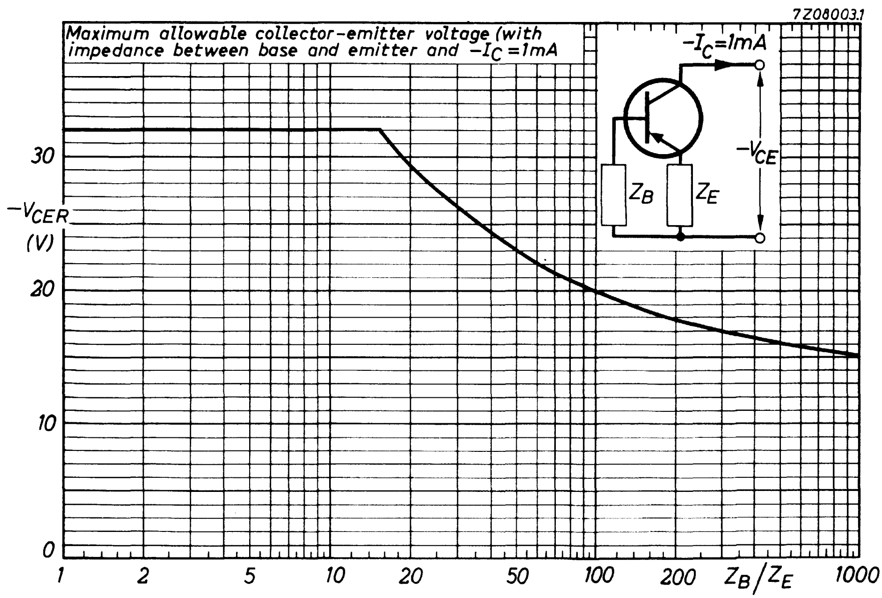

7Z08012
typical values
−V_CE = 6V
f = 0.45MHz
T_amb = 25°C
C_oe
φ_re
|y_re|
C_ie
g_oe (μΩ⁻¹)
|y_fe|
g_ie (mΩ⁻¹)
10000
φ (°)
|y_fe| (mΩ⁻¹)
C_ie (pF)
100
C_oe (pF)
g
|y_re| (μΩ⁻¹)
1000
10
100
1
10
0.1
0.1
1
10
−I_C (mA)


7Z08022
typical values
−I_C = 1mA
f = 10.7MHz
T_amb = 25°C
φ_fe
φ_re
|y_re|(μΩ⁻¹)
g_oe(μΩ⁻¹)
C_ie
|y_fe|(mΩ⁻¹)
C_oe
g_ie(mΩ⁻¹)
−V_CE(V)
0.1
1
10
1000
φ(°)
C(pF)
g
y
100
10
1


7Z08021
typical values
−V_CE = 6V
f = 10.7MHz
T_amb = 25°C
φ_fe
φ_re
|y_re|(μΩ⁻¹)
g_oe(μΩ⁻¹)
C_ie
|y_fe|(mΩ⁻¹)
C_oe
g_ie(mΩ⁻¹)
−I_C(mA)
0.1
1
10
1000
φ(°)
C(pF)
g
y
100
10
1


1000
φ (°)
C (pF)
φfe
φre
100
Cie
10
Coe
1
0.1
0.1
1
10
f(MHz)
100


7Z08020
1000
|yfe|
gie
(mΩ⁻¹)
typical values
−VCE = 6V
−IC = 1mA
Tamb = 25°C
1000
|yre|
goe
(μΩ⁻¹)
|yre|
goe
|yfe|
gie
100
10
1
0.1
1
10
f(MHz)
100


7Z08003.1
Maximum allowable collector-emitter voltage (with impedance between base and emitter and −IC = 1mA
−IC=1mA
ZB
ZE
−VCE
30
−VCER
(V)
20
10
0
1
2
5
10
20
50
100
200
ZB/ZE
1000

GERMANIUM ALLOY DIFFUSED TRANSISTOR

P-N-P transistor in a TO-72 metal envelope with a shield lead connected to the case. It has a low collector capacitance, low noise and good a.g.c. performance and is intended for use as i.f. amplifier, r.f. amplifier and mixer-oscillator in a.m. receivers up to 6 MHz.

RATINGS (Limiting values) [1])

Collector-base voltage (open emitter)	$-V_{CBO}$	max.	32	V
Collector-emitter voltage ($Z_B/Z_E < 15$)	$-V_{CER}$	max.	32	V
Collector-emitter voltage (open base)	$-V_{CEO}$	max.	15	V
Collector current (d.c.)	$-I_C$	max.	10	mA
Base current (d.c.)	$\|I_B\|$	max.	1	mA
Reverse emitter current	$-I_E$	max.	1	mA
Total power dissipation up to $T_{amb} = 45\ ^oC$	P_{tot}	max.	60	mW
Storage temperature	T_{stg}	-55 to +75		^oC
Junction temperature : continuous	T_j	max.	75	^oC
incidentally	T_j	max.	90	^oC

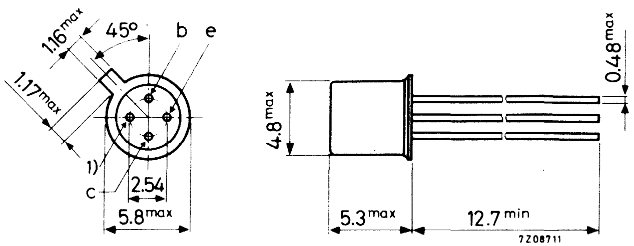
THERMAL RESISTANCE

From junction to ambient in free air	$R_{th\ j-a}$	=	0.75	$^oC/mW$
From junction to case	$R_{th\ j-c}$	=	0.4	$^oC/mW$

MECHANICAL DATA

Dimensions in mm

TO-72



1) = shield lead (connected to case)

Accessories available: 56246, 56263

[1]) Limiting values according to the Absolute Maximum System as defined in IEC publication 134.

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

Collector cut-off current				
$I_E = 0$; $-V_{CB} = 6$ V	$-I_{CBO}$	typ.	1.2	μA
		<	8	μA
$I_E = 0$; $-V_{CB} = 6$ V; $T_j = 75$ °C	$-I_{CBO}$	typ.	90	μA
		<	180	μA
Base current				
$I_E = 1$ mA; $-V_{CB} = 6$ V	$-I_B$	typ.	7	μA
		<	25	μA
Base-emitter voltage				
$-I_C = 1$ mA; $-V_{CE} = 6$ V	$-V_{BE}$	typ.	270	mV
			210 to 330	mV
Small signal current gain at f = 1 kHz				
$-I_C = 1$ mA; $-V_{CE} = 6$ V	h_{fe}	typ.	150	
Feedback capacitance at f = 450 kHz				
$-I_C = 1$ mA; $-V_{CE} = 6$ V	$-C_{re}$	typ.	1.5	pF
y parameters at f = 0.45 MHz (common emitter)				
$-I_C = 1$ mA; $-V_{CE} = 6$ V [1]				
Input conductance	g_{ie}	typ.	0.25	$m\Omega^{-1}$
Input capacitance	C_{ie}	typ.	70	pF
Feedback admittance	$\lvert y_{re} \rvert$	typ.	4.0	$\mu\Omega^{-1}$
Phase angle of feedback admittance	φ_{re}	typ.	270°	
Transfer admittance	$\lvert y_{fe} \rvert$	typ.	37	$m\Omega^{-1}$
Phase angle of transfer admittance	φ_{fe}	typ.	0	
Output conductance	g_{oe}	typ.	1.0	$\mu\Omega^{-1}$
Output capacitance	C_{oe}	typ.	4.0	pF
Feedback impedance at f = 2 MHz				
$I_E = 1$ mA; $-V_{CB} = 6$ V	$\lvert z_{rb} \rvert$	typ.	35	Ω

[1]) Length of leads between transistor bottom and measuring jig : 5 mm

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

Transition frequency

I_E = 1 mA; $-V_{CB}$ = 6 V	f_T	typ.	75	MHz

Noise figure at f = 1.0 MHz

I_E = 1 mA; $-V_{CB}$ = 6 V; R_S = 500 Ω	F	typ.	1.5	dB
		<	3	dB

Conversion noise figure

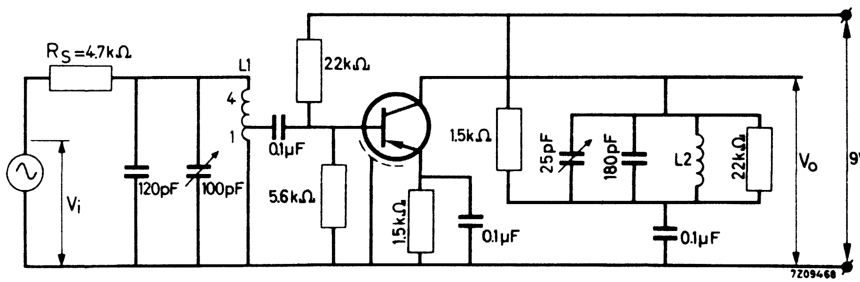
I_E = 1 mA; $-V_{CB}$ = 6 V

R_S = 500 Ω; f = 1 MHz	F_c	typ.	3	dB
		<	5	dB
R_S = 2 kΩ; f = 200 kHz	F_c	typ.	4	dB
		<	7	dB

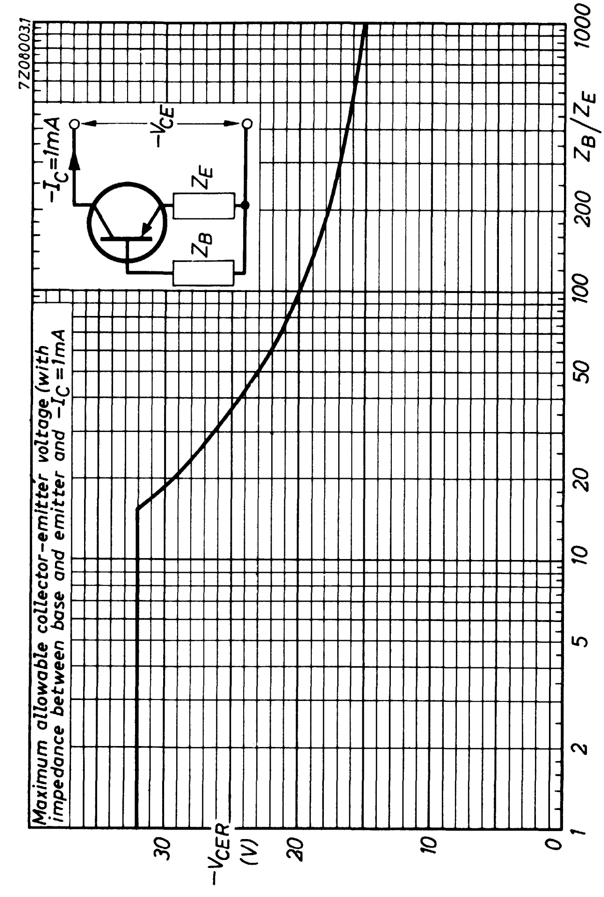
Power gain at f = 0.45 MHz

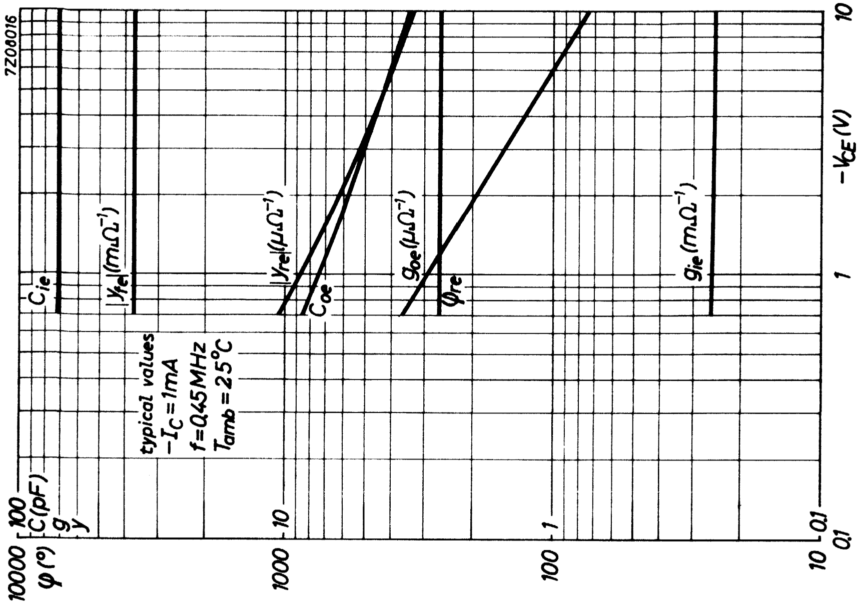
$G_p = \frac{V_o^2}{V_i^2} \cdot \frac{4R_S}{R_l} = 0.94 \frac{V_o^2}{V_i^2}$	G_p	>	40	dB
		typ.	42	dB

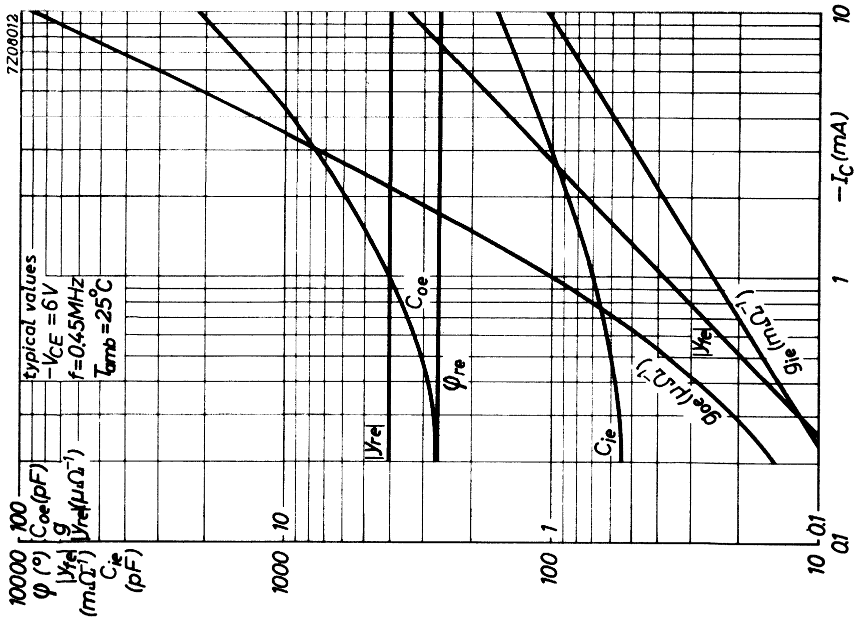
Test circuit :

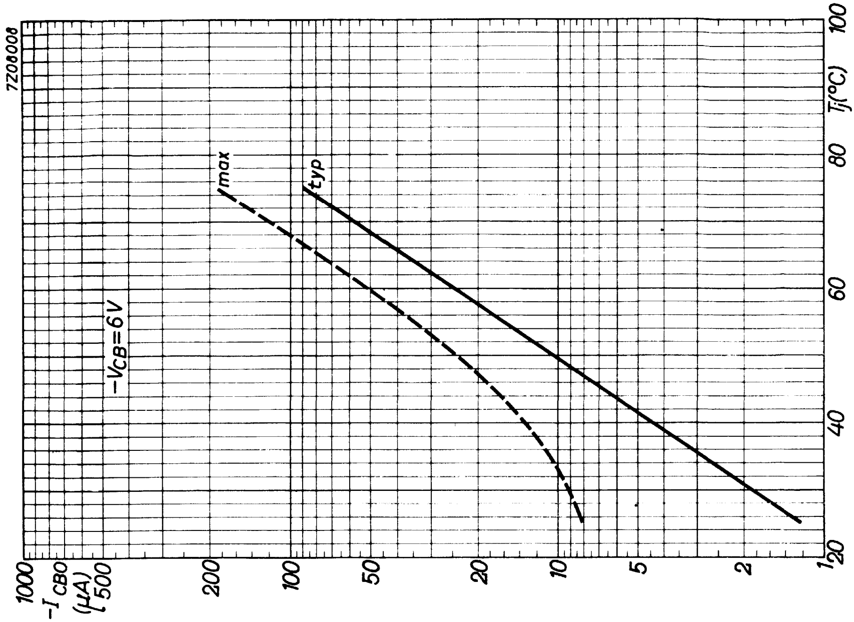


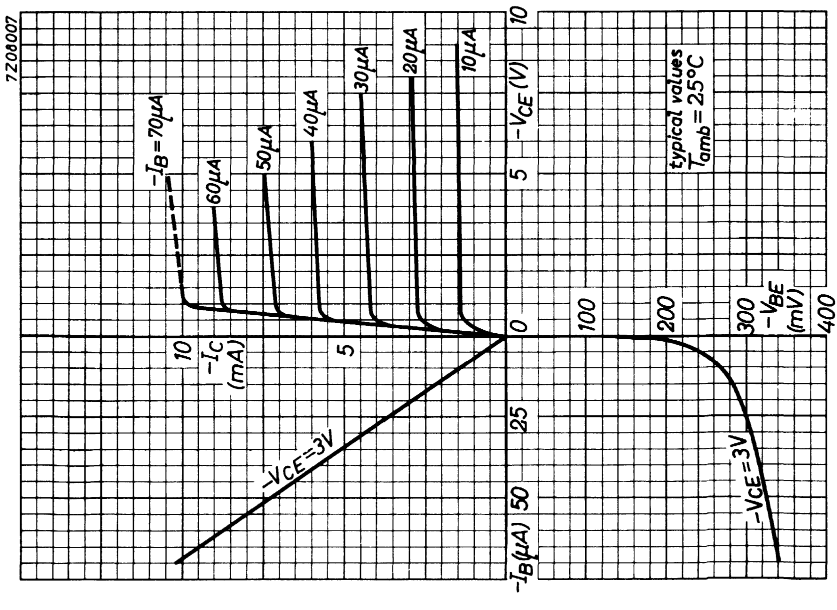
Total collector resistance R_ℓ = 20 kΩ
L1 = 625 μH; unloaded Q-factor 140; tap at 0.2
L2 = 625 μH; unloaded Q-factor 140


7Z08003.1
Maximum allowable collector-emitter voltage (with impedance between base and emitter and −I_C = 1mA
−I_C = 1mA
−V_CE
Z_E
Z_B
−V_CER (V)
30
20
10
0
1
2
5
10
20
50
100
200
1000
Z_B/Z_E


7Z08016
10000
φ (°)
1000
100
10
100
C(pF)
g
y
10
1
0.1
0.1
1
10
$-V_{CE}$(V)
C_{ie}
$|y_{fe}|$(mΩ^{-1})
typical values
$-I_C$ = 1mA
f = 0.45MHz
T_{amb} = 25°C
$|y_{re}|$(μΩ^{-1})
C_{oe}
g_{oe}(μΩ^{-1})
$φ_{re}$
g_{ie}(mΩ^{-1})


7Z08012
10000
φ (°)
$|y_{fe}|$
(mΩ^{-1})
C_{ie}
(pF)
1000
100
10
100
C_{oe}(pF)
g
$|y_{re}|$(μΩ^{-1})
10
1
0.1
0.1
1
10
$-I_C$(mA)
typical values
$-V_{CE}$ = 6V
f = 0.45MHz
T_{amb} = 25°C
C_{oe}
$φ_{re}$
$|y_{re}|$
C_{ie}
g_{oe}(μΩ^{-1})
$|y_{fe}|$
g_{ie}(mΩ^{-1})


7Z08008
$-V_{CB}=6V$
max
typ
$T_j(°C)$
100
80
60
40
20
1000
$-I_{CBO}$ (μA)
500
200
100
50
20
10
5
2
1


7Z08007
$-I_B=70\mu A$
60μA
50μA
40μA
30μA
20μA
10μA
$-V_{CE}$ (V)
10
5
0
typical values
$T_{amb}=25°C$
10
$-I_C$ (mA)
5
100
200
300
400
$-V_{BE}$ (mV)
25
50
$-I_B$ (μA)
$-V_{CE}=3V$
$-V_{CE}=3V$

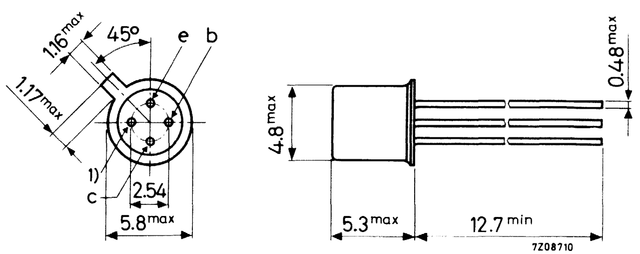
U.H.F. GERMANIUM MESA TRANSISTOR

P-N-P transistor in a TO-72 metal envelope, primarily intended for use in pre-amplifier, mixer or oscillator circuits up to frequencies of 860 MHz.

QUICK REFERENCE DATA				
Collector-base voltage (open emitter)	$-V_{CBO}$	max.	20	V
Collector-emitter voltage (open base)	$-V_{CEO}$	max.	15	V
Collector current (d.c.)	$-I_C$	max.	10	mA
Total power dissipation up to T_{amb} = 45 °C	P_{tot}	max.	60	mW
Junction temperature	T_j	max.	90	°C
Transition frequency				
$-I_C$ = 1.5 mA; $-V_{CE}$ = 12 V	f_T	typ.	550	MHz
Max. unilateralised power gain				
I_E = 1.5 mA; $-V_{CB}$ = 12 V; f = 800 MHz	G_{UM}	typ.	11.5	dB
Noise figure				
I_E = 1.5 mA; $-V_{CB}$ = 12 V;				
f = 800 MHz; R_S = 60 Ω	F	typ.	7	dB

MECHANICAL DATA Dimensions in mm

TO-72



1) = shield lead (connected to case)

Accessories available: 56246, 56263

RATINGS (Limiting values) [1]

Voltages

Collector-base voltage (open emitter)	$-V_{CBO}$	max.	20	V
Collector-emitter voltage (open base)	$-V_{CEO}$	max.	15	V
Emitter-base voltage (open collector)	$-V_{EBO}$	max.	0.3	V

Currents

Collector current (d.c.)	$-I_C$	max.	10	mA
Collector current (peak value)	$-I_{CM}$	max.	10	mA

Power dissipation

Total power dissipation up to $T_{amb} = 45\,^oC$	P_{tot}	max.	60	mW

Temperatures

Storage temperature	T_{stg}		-30 to +75	^oC
Junction temperature	T_j	max.	90	^oC

THERMAL RESISTANCE

From junction to ambient in free air	$R_{th\ j-a}$	=	0.75	$^oC/mW$
From junction to case	$R_{th\ j-c}$	=	0.40	$^oC/mW$

[1]) Limiting values according to the Absolute Maximum System as defined in IEC publication 134.

CHARACTERISTICS T_j = 25 °C unless otherwise specified

Collector cut-off current

$I_E = 0$; $-V_{CB} = 20$ V	$-I_{CBO}$	typ.	0.5	μA
		<	8	μA
$I_B = 0$; $-V_{CE} = 15$ V	$-I_{CEO}$	<	500	μA

Emitter cut-off current

$I_C = 0$; $-V_{EB} = 0.3$ V	$-I_{EBO}$	typ.	2	μA
		<	100	μA

Base current

$I_E = 1.5$ mA; $-V_{CB} = 12$ V	$-I_B$	typ.	30	μA
		<	150	μA
$I_E = 2$ mA; $-V_{CB} = 6$ V	$-I_B$	typ.	36	μA
$I_E = 5$ mA; $-V_{CB} = 6$ V	$-I_B$	typ.	66	μA

Emitter-base voltage

$I_E = 1.5$ mA; $-V_{CB} = 12$ V	V_{EB}	typ.	380	mV
		320 to	430	mV
$I_E = 2$ mA; $-V_{CB} = 6$ V	V_{EB}	typ.	380	mV
		320 to	430	mV
$I_E = 5$ mA; $-V_{CB} = 6$ V	V_{EB}	typ.	405	mV
		360 to	450	mV

Transition frequency

$-I_C = 1.5$ mA; $-V_{CE} = 12$ V	f_T	typ.	550	MHz

Reverse transfer time constant

$I_E = 1.5$ mA; $-V_{CB} = 12$ V; f = 2.5 MHz	$r_{bb'} \cdot C_{b'c}$	typ.	3	ps

Feedback capacitance at f = 450 kHz

$-I_C = 1.5$ mA; $-V_{CE} = 12$ V	$-C_{re}$	typ.	250	fF [1])

Noise figure at $R_S = 60\ \Omega$

$I_E = 1.5$ mA; $-V_{CB} = 12$ V; f = 800 MHz	F	typ.	7	dB
		<	8.2	dB
f = 860 MHz	F	typ.	7.5	dB
		<	8.8	dB

[1]) 1 fF = 1 femtofarad = 10^{-15} F

CHARACTERISTICS (continued) T_j = 25 °C unless otherwise specified

y parameters at f = 800 MHz [1])

I_E = 1.5 mA; $-V_{CB}$ = 12 V

Input conductance	g_{ib}	typ.	7	$m\Omega^{-1}$
Input capacitance	$-C_{ib}$	typ.	2.2	pF
Input susceptance	$-\omega C_{ib}$	typ.	11	$m\Omega^{-1}$
Feedback admittance	$\|y_{rb}\|$	typ.	0.4	$m\Omega^{-1}$
Phase angle of feedback admittance	φ_{rb}	typ.	240°	
Transfer admittance	$\|y_{fb}\|$	typ.	14	$m\Omega^{-1}$
Phase angle of transfer admittance	φ_{fb}	typ.	35°	
Output conductance	g_{ob}	typ.	0.5	$m\Omega^{-1}$
Output capacitance	C_{ob}	typ.	1.5	pF

y parameters at f = 200 MHz [1])

I_E = 1.5 mA; $-V_{CB}$ = 12 V

Input conductance	g_{ib}	typ.	28	$m\Omega^{-1}$
Input capacitance	$-C_{ib}$	typ.	19	pF
Input susceptance	$-\omega C_{ib}$	typ.	24	$m\Omega^{-1}$
Feedback admittance	$\|y_{rb}\|$	typ.	0.17	$m\Omega^{-1}$
Phase angle of feedback admittance	φ_{rb}	typ.	250°	
Transfer admittance	$\|y_{fb}\|$	typ.	37	$m\Omega^{-1}$
Phase angle of transfer admittance	φ_{fb}	typ.	126°	
Output conductance	g_{ob}	typ.	90	$\mu\Omega^{-1}$
Output capacitance	C_{ob}	typ.	1.5	pF

Maximum unilateralised power gain

$$G_{UM} = \frac{|y_{fb}|^2}{4\, g_{ib} g_{ob}}$$

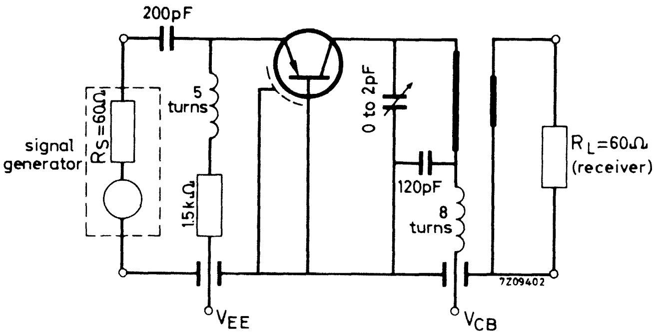
I_E = 1.5 mA; $-V_{CB}$ = 12 V; f = 800 MHz	G_{UM}	typ.	11.5	dB

[1]) Measured with a lead length of 5 mm.

CHARACTERISTICS (continued) T_j = 25 °C unless otherwise specified

Transducer gain

Basic circuit for measuring the transducer gain G_{tr}.



Total effective collector resistance R_C = 1.4 kΩ

$$G_{tr} = \frac{\text{output power in load } R_L}{\text{available power from source } R_S}$$

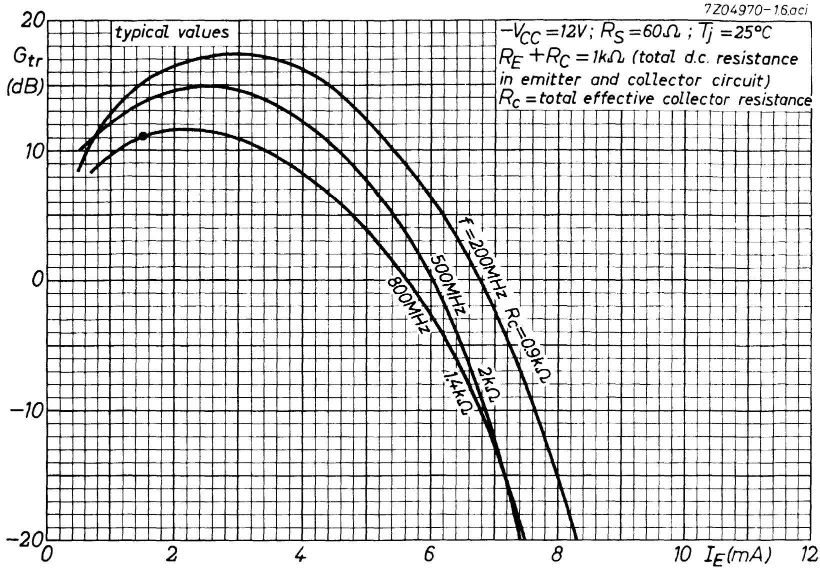
I_E = 1.5 mA; $-V_{CB}$ = 12 V

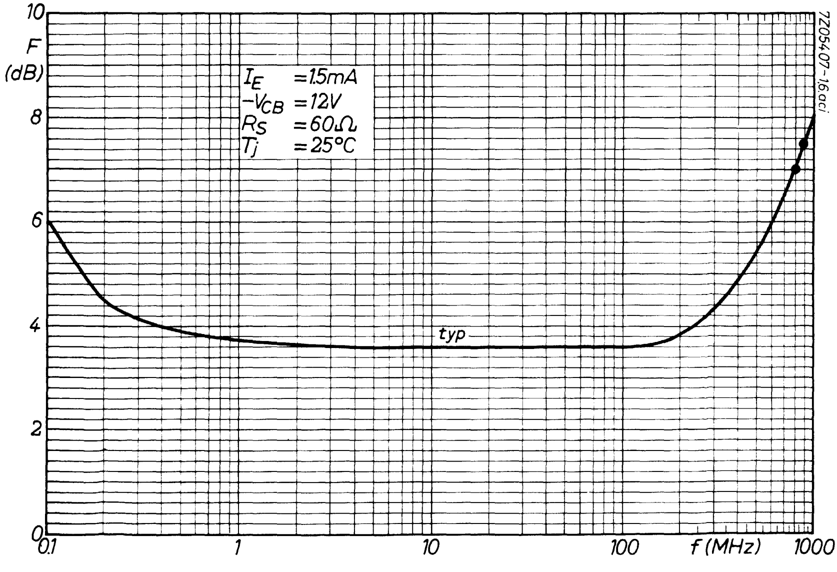
f = 800 MHz	G_{tr}	>	9	dB
		typ.	11	dB
f = 860 MHz	G_{tr}	>	7.5	dB
		typ.	10	dB

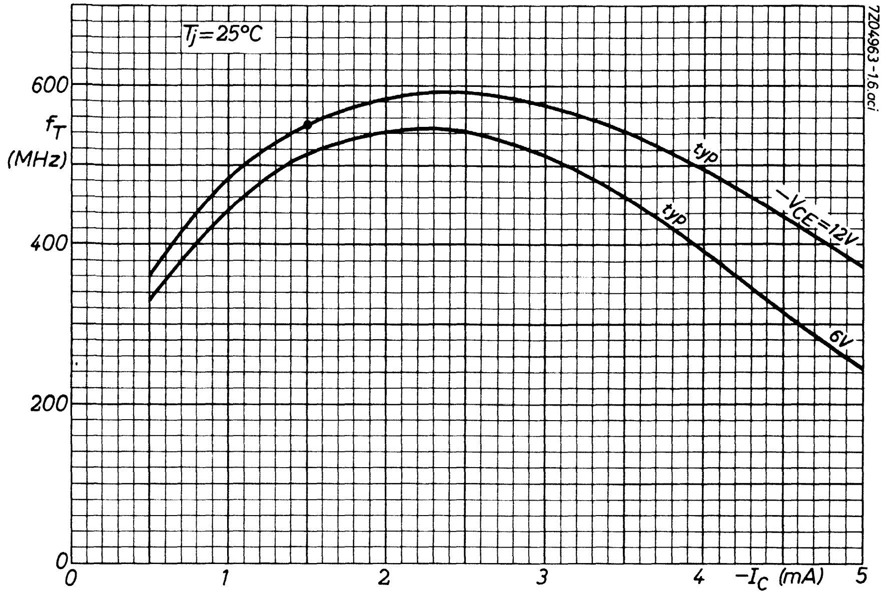
Reverse transducer gain

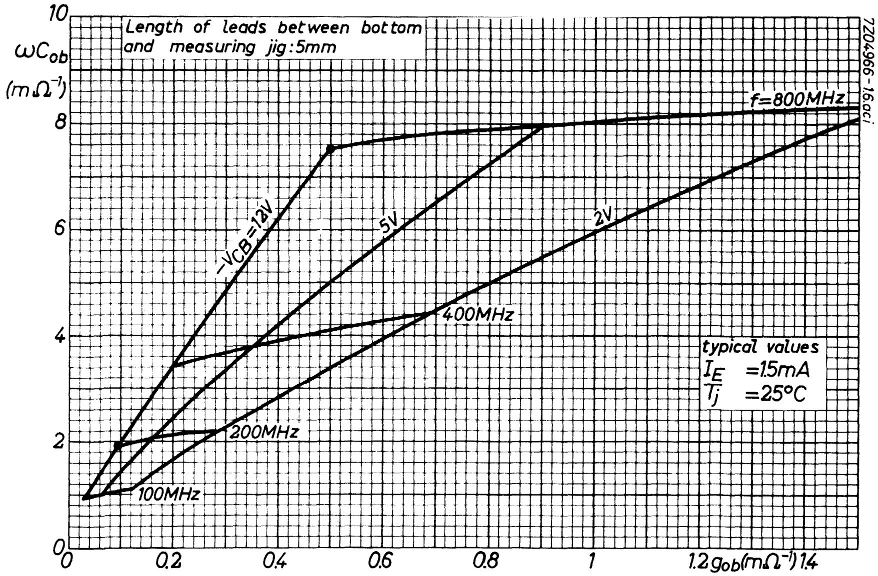
I_E = 1.5 mA; $-V_{CB}$ = 12 V; f = 800 MHz $G_{tr\ rev}$ typ. −23 dB

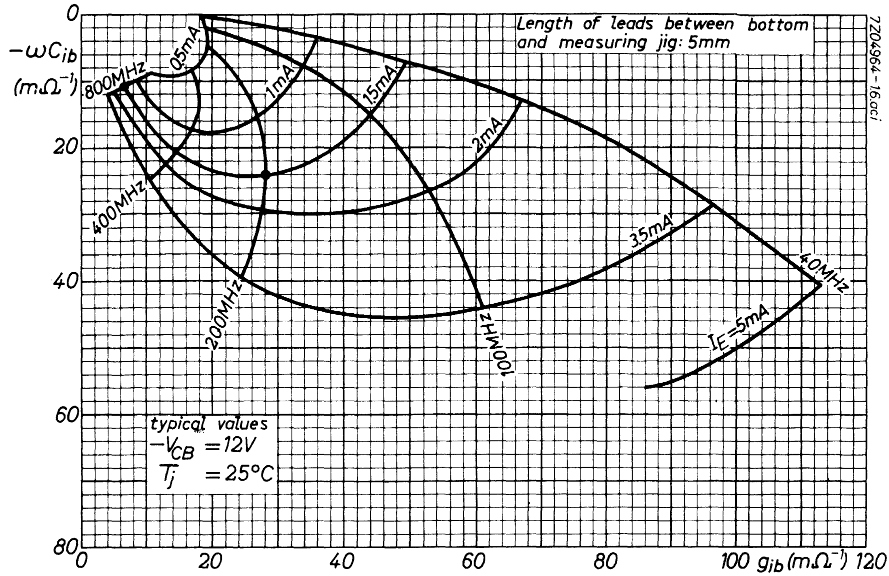
The reverse transducer gain is measured in the above circuit, with the signal generator and the load (receiver) interchanged.


7Z04970-1.6.aci
typical values
$-V_{CC}$ = 12V; R_S = 60Ω ; T_j = 25°C
$R_E + R_C$ = 1kΩ (total d.c. resistance in emitter and collector circuit)
R_c = total effective collector resistance
G_{tr} (dB)
20
10
0
−10
−20
0
2
4
6
8
10
12
I_E (mA)
f = 200MHz
R_c = 0.9kΩ
500MHz
2kΩ
800MHz
1.4kΩ

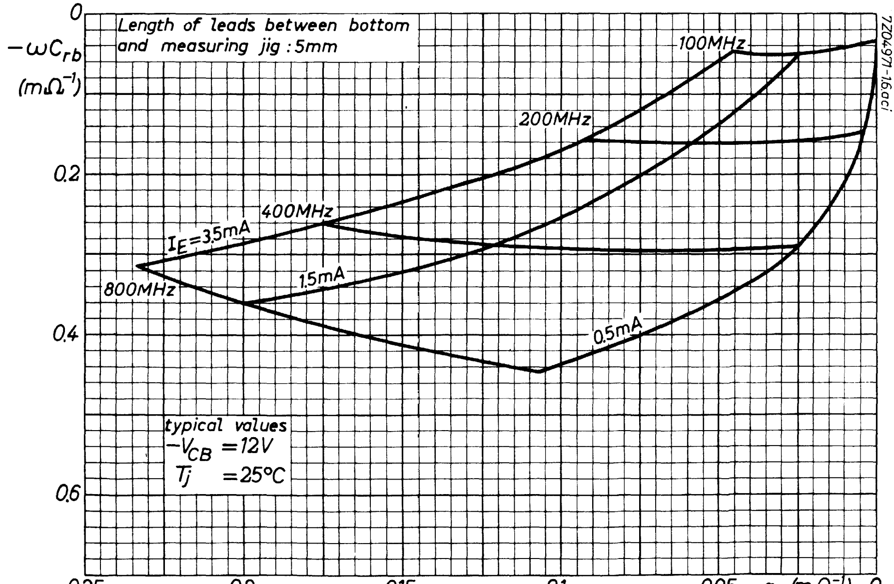

7Z05407-1.6.aci
I_E = 1.5mA
$-V_{CB}$ = 12V
R_S = 60Ω
T_j = 25°C
F (dB)
10
8
6
4
2
0
0.1
1
10
100
1000
f (MHz)
typ


Tj=25°C
600
400
200
0
fT
(MHz)
typ
typ
-VCE=12V
6V
0
1
2
3
4
-IC (mA)
5
7Z04963-1.6.aci

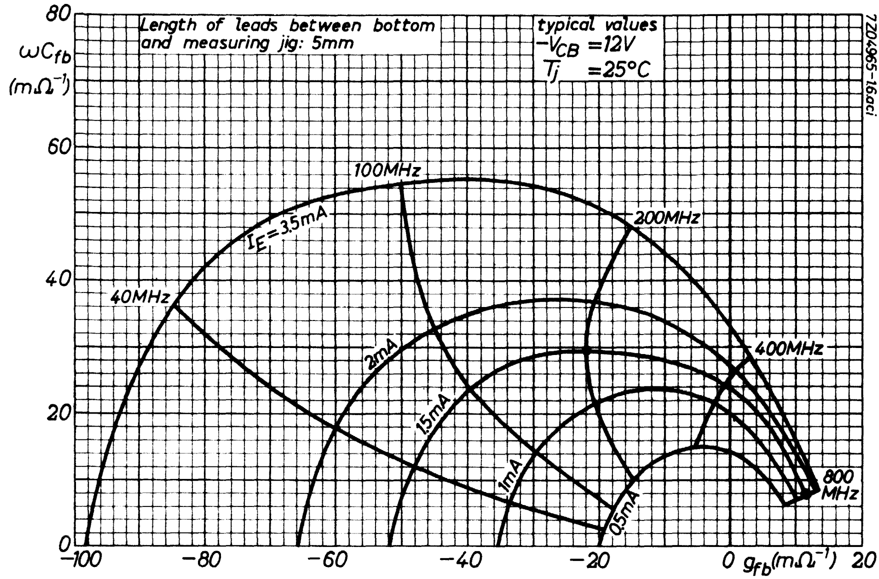

Length of leads between bottom and measuring jig: 5mm
10
ωCob
(mΩ-1)
8
6
4
2
0
f=800MHz
-VCB=12V
5V
2V
400MHz
200MHz
100MHz
typical values
IE =1.5mA
Tj =25°C
0
0.2
0.4
0.6
0.8
1
1.2 gob(mΩ-1) 1.4
7Z04966-1.6.aci



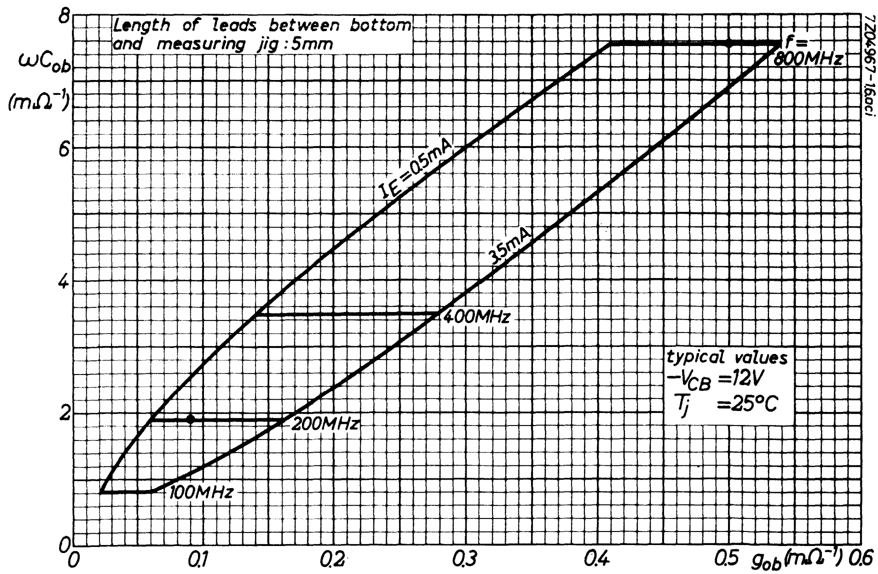
Length of leads between bottom and measuring jig: 5mm
7Z04964-16.aci
$-\omega C_{ib}$ $(m\Omega^{-1})$
g_{ib} $(m\Omega^{-1})$
800MHz
0.5mA
1mA
1.5mA
2mA
3.5mA
40MHz
I_E=5mA
400MHz
200MHz
100MHz
typical values
$-V_{CB}$ =12V
T_j =25°C
0
20
40
60
80
100
120



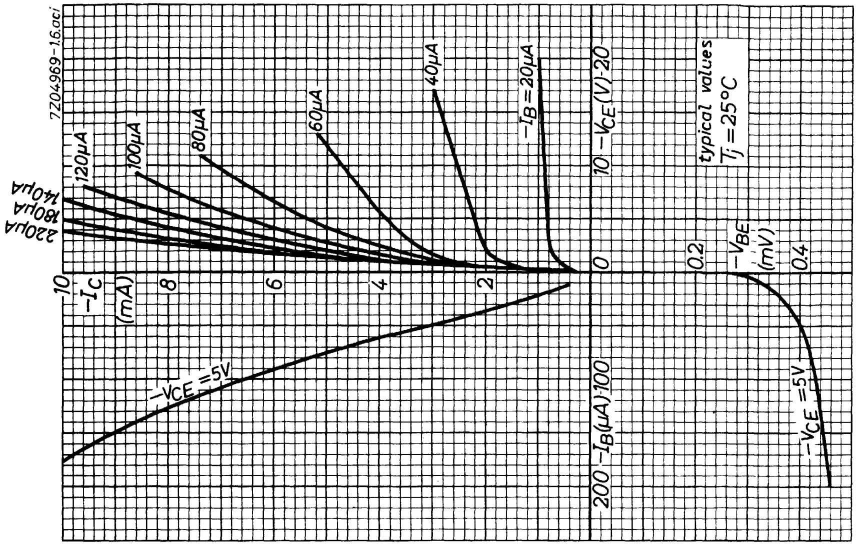
Length of leads between bottom and measuring jig: 5mm
7Z04971-16.aci
$-\omega C_{rb}$ $(m\Omega^{-1})$
$-g_{rb}$ $(m\Omega^{-1})$
100MHz
200MHz
400MHz
I_E=3.5mA
800MHz
1.5mA
0.5mA
typical values
$-V_{CB}$ =12V
T_j =25°C
0
0.2
0.4
0.6
0.25
0.15
0.1
0.05

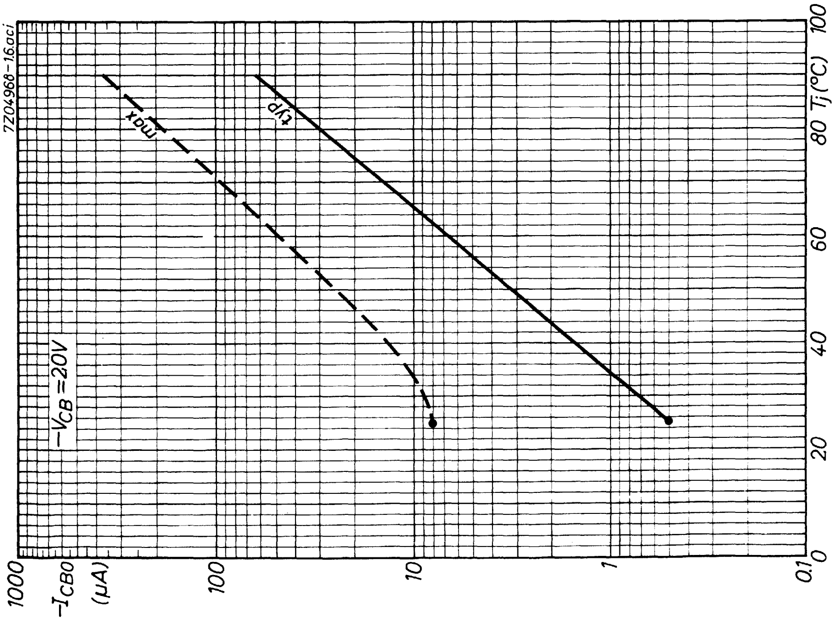


7Z04965-16.aci
Length of leads between bottom and measuring jig: 5mm
typical values
$-V_{CB}$ =12V
T_j =25°C
80
ωC_{fb}
$(m\Omega^{-1})$
60
40
20
0
−100
−80
−60
−40
−20
0 $g_{fb}(m\Omega^{-1})$ 20
100MHz
200MHz
40MHz
400MHz
800 MHz
I_E=3.5mA
2mA
1.5mA
1mA
0.5mA



7Z04967-16.aci
Length of leads between bottom and measuring jig: 5mm
typical values
$-V_{CB}$ =12V
T_j =25°C
8
ωC_{ob}
$(m\Omega^{-1})$
6
4
2
0
0
0.1
0.2
0.3
0.4
0.5 $g_{ob}(m\Omega^{-1})$ 0.6
f= 800MHz
400MHz
200MHz
100MHz
I_E=0.5mA
3.5mA


7Z04969-1.6.aci
typical values
$T_j = 25\,°C$
$-I_B = 20\,\mu A$
$40\,\mu A$
$60\,\mu A$
$80\,\mu A$
$100\,\mu A$
$120\,\mu A$
$140\,\mu A$
$180\,\mu A$
$220\,\mu A$
0
10
$-V_{CE}$ (V)
20
10
8
6
4
2
$-I_C$ (mA)
0.2
0.4
$-V_{BE}$ (mV)
$-V_{CE} = 5\,V$
$-V_{CE} = 5\,V$
100
200
$-I_B$ (μA)


7Z04968-1.6.aci
max
typ
$-V_{CB} = 20\,V$
1000
100
10
1
0.1
$-I_{CBO}$ (μA)
0
20
40
60
80
100
T_j (°C)

R.F. GERMANIUM ALLOY DIFFUSED TRANSISTOR

P-N-P transistor in a TO-12 metal envelope with a shield lead connected to the case. The AF178 is primarily intended for application in v.h.f. amplifier-, oscillator- and converter circuits. It has a low noise and a high gain up to frequencies of 260 MHz.

RATINGS Limiting values according to the Absolute Maximum System as defined in IEC publication 134.

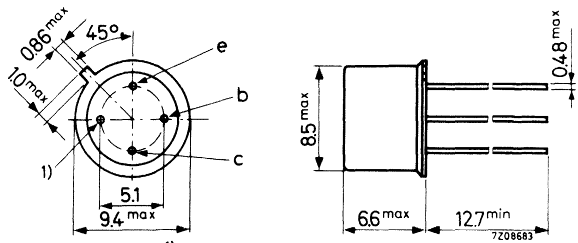
Collector-base voltage (open-emitter)	$-V_{CBO}$	max.	25	V
Emitter-base voltage (open collector)	$-V_{EBO}$	max.	0.5	V
Collector current (d.c.)	$-I_C$	max.	10	mA
Base current (d.c.)	$-I_B$	max.	1	mA
Total power dissipation up to T_{amb} = 45 °C	P_{tot}	max.	75	mW
Storage temperature	T_{stg}		-55 to +75	°C
Junction temperature: continuous	T_j	max.	75	°C
incidentally	T_j	max.	90	°C

THERMAL RESISTANCE

From junction to ambient in free air	$R_{th\ j-a}$	=	0.6	°C/mW

MECHANICAL DATA Dimensions in mm

TO-12



1) = shield lead (connected to case)

Accessories available: 56245, 56265

FOR NEW DESIGN THE SUCCESSOR TYPES BF182; BF183 (N-P-N) OR AF139 (P-N-P) ARE RECOMMENDED

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

Collector cut-off current				
$I_E = 0$; $-V_{CB} = 12$ V	$-I_{CBO}$	<	10	μA
$I_E = 0$; $-V_{CB} = 25$ V	$-I_{CBO}$	<	50	μA
Base current				
$-I_C = 1$ mA; $-V_{CE} = 12$ V	$-I_B$	<	50	μA
Base-emitter voltage				
$-I_C = 1$ mA; $-V_{CE} = 12$ V	$-V_{BE}$	220 to 360		mV
Feedback capacitance at f = 0.45 MHz				
$-I_C = 1$ mA; $-V_{CE} = 12$ V	$-C_{re}$	typ.	0.8	pF
Transition frequency				
$I_E = 1$ mA; $-V_{CB} = 12$ V	f_T	typ.	180	MHz
Feedback impedance at f = 2 MHz				
$I_E = 1$ mA; $-V_{CB} = 12$ V	$\|z_{rb}\|$	typ.	10	Ω
Small signal current gain at f = 1 kHz				
$-I_C = 1$ mA; $-V_{CE} = 12$ V	h_{fe}	>	20	
Noise figure at f = 200 MHz				
$-I_C = 1$ mA; $-V_{CE} = 12$ V; $R_S = 30$ Ω	F	typ.	6	dB
		<	7.5	dB

R.F. GERMANIUM ALLOY-DIFFUSED TRANSISTOR

P-N-P transistor in a TO-12 metal envelope with a shield lead connected to the case. The AF179 is primarily intended for application in i.f. amplifiers of television receivers.

RATINGS Limiting values according to the Absolute Maximum System as defined in IEC publication 134.

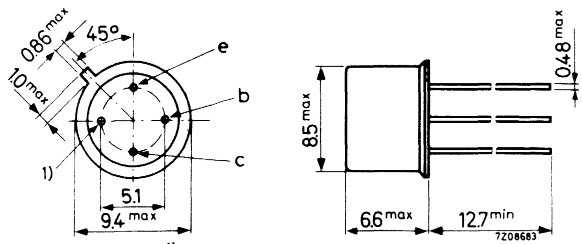
Collector-base voltage (open emitter)	$-V_{CBO}$	max.	25	V
Collector-emitter voltage $R_B/R_E \leq 100$; $R_E \geq 200\ \Omega$	$-V_{CER}$	max.	25	V
Collector current (d.c.)	$-I_C$	max.	10	mA
Collector current (peak value)	$-I_{CM}$	max.	15	mA
Total power dissipation up to $T_{amb} = 45\ ^oC$ with cooling fin 56265	P_{tot}	max.	180	mW
Storage temperature	T_{stg}	-65 to +80		^oC
Junction temperature: continuous	T_j	max.	80	^oC
incidentally	T_j	max.	90	^oC

THERMAL RESISTANCE

From junction to ambient in free air	$R_{th\ j\text{-}a}$ =	0.37	$^oC/mW$
From junction to case	$R_{th\ j\text{-}c}$ =	0.17	$^oC/mW$
From junction to ambient with cooling clip 56265	$R_{th\ j\text{-}a}$ =	0.25	$^oC/mW$

MECHANICAL DATA Dimensions in mm

TO-12



1) = shield lead (connected to case)

Accessories available: 56245, 56265

FOR NEW DESIGN THE SUCCESSOR TYPES BF173 OR BF197 (N-P-N) ARE RECOMMENDED

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

Collector cut-off current				
$I_E = 0$; $-V_{CB} = 10$ V	$-I_{CBO}$	typ.	1.2	µA
		<	8	µA
$I_E = 0$; $-V_{CB} = 10$ V; $T_j = 75$ °C	$-I_{CBO}$	<	150	µA
Base current				
$-I_C = 3$ mA; $-V_{CE} = 10$ V	$-I_B$	typ.	30	µA
		<	100	µA
Base-emitter voltage				
$-I_C = 3$ mA; $-V_{CE} = 10$ V	$-V_{BE}$	typ.	330	mV
			280 to 380	mV
Feedback capacitance at f = 0.45 MHz				
$-I_C = 1$ mA; $-V_{CE} = 10$ V	$-C_{re}$	typ.	480	fF [1]
			330 to 680	fF [1]
Transition frequency				
$-I_C = 3$ mA; $-V_{CE} = 10$ V	f_T	typ.	270	MHz
y parameters at f = 35 MHz (common emitter) [2]				
$-I_C = 3$ mA; $-V_{CE} = 10$ V				
Input conductance	g_{ie}	typ.	6.5	$m\Omega^{-1}$
Input capacitance	C_{ie}	typ.	35	pF
Feedback admittance	$\|y_{re}\|$	typ.	100	$\mu\Omega^{-1}$
Phase angle of feedback admittance	φ_{re}	typ.	260°	
Transfer admittance	$\|y_{fe}\|$	typ.	80	$m\Omega^{-1}$
Phase angle of transfer admittance	φ_{fe}	typ.	322°	
Output conductance	g_{oe}	typ.	100	$\mu\Omega^{-1}$
Output capacitance	C_{oe}	typ.	1.8	pF

[1]) 1 fF = 1 femtofarad = 10^{-15} F

[2]) Length of leads between bottom of transistor and measuring jig is 3 mm

R.F. GERMANIUM ALLOY-DIFFUSED TRANSISTOR

P-N-P transistor in a TO-12 metal envelope with the shield lead connected to the case. It is intended for use in r.f. amplifiers in television tuners with forward gain control at frequencies up to 220 MHz.

RATINGS Limiting values according to the Absolute Maximum System as defined in IEC publication 134.

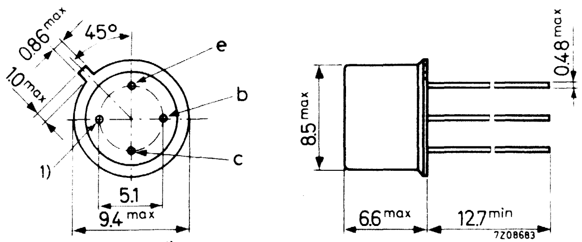
Collector-base voltage (open emitter)	$-V_{CBO}$	max.	25	V
Collector-emitter voltage (R_B/R_E < 100)	$-V_{CER}$	max.	25	V
Collector current (averaged over any 20 ms period)	$-I_{CAV}$	max.	25	mA
Collector current (peak value)	$-I_{CM}$	max.	25	mA
Total power dissipation up to T_{amb} = 25 °C in free air	P_{tot}	max.	156	mW
up to T_{case} = 55 °C	P_{tot}	max.	143	mW
Storage temperature	T_{stg}		−55 to +75	°C
Junction temperature	T_j	max.	75	°C

THERMAL RESISTANCE

From junction to ambient in free air	$R_{th\ j-a}$	=	0.32	°C/mW
From junction to case	$R_{th\ j-c}$	=	0.14	°C/mW

MECHANICAL DATA Dimensions in mm

TO-12



1)= shield lead (connected to case)

Accessories available: 56245, 56265

FOR NEW DESIGN THE SUCCESSOR TYPES BF200 (N-P-N) OR AF239 (P-N-P) ARE RECOMMENDED

CHARACTERISTICS T_j = 25 °C unless otherwise specified

Collector cut-off current				
$I_E = 0$; $-V_{CB} = 10$ V	$-I_{CBO}$	<	10	μA
$I_E = 0$; $-V_{CB} = 10$ V; $T_j = 60$ °C	$-I_{CBO}$	<	100	μA
Base current				
$-I_C = 3$ mA; $-V_{CE} = 10$ V	$-I_B$	typ.	55	μA
		<	150	μA
Base-emitter voltage				
$-I_C = 3$ mA; $-V_{CE} = 10$ V	$-V_{BE}$	typ.	350	mV
		270 to	400	mV
Noise figure at f = 200 MHz				
$G_S = 40$ mΩ^{-1}; $B_S = 0$	F	typ.	3.5	dB
Feedback capacitance at f = 450 kHz				
$-I_C = 1$ mA; $-V_{CE} = 10$ V	$-C_{re}$	<	290	fF

GERMANIUM ALLOY-DIFFUSED TRANSISTOR

P-N-P transistor in a TO-12 metal envelope with a shield lead connected to the case. It has a forward gain control characteristic and is primarily intended for use in the control stage of television intermediate frequency amplifiers.

RATINGS Limiting values according to the Absolute Maximum System as defined in IEC publication 134.

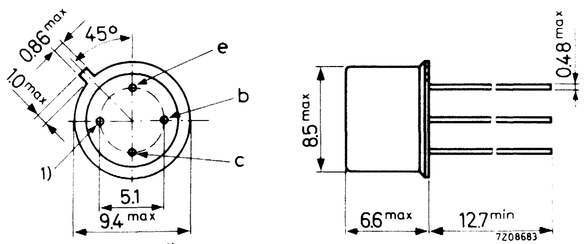
Collector-base voltage (open emitter)	$-V_{CBO}$	max.	30	V
Collector-emitter voltage ($R_B/R_E \leq 100$)	$-V_{CER}$	max.	30	V
Emitter-base voltage (open collector)	$-V_{EBO}$	max.	0.6	V
Collector current (d.c.)	$-I_C$	max.	20	mA
Collector current (peak value)	$-I_{CM}$	max.	20	mA
Total power dissipation up to $T_{amb} = 25\,^{o}C$	P_{tot}	max.	156	mW
Storage temperature	T_{stg}		-55 to +75	^{o}C
Junction temperature: continuous	T_j	max.	75	^{o}C
incidentally	T_j	max.	90	^{o}C

THERMAL RESISTANCE

From junction to ambient in free air	$R_{th\ j-a}$ =	0.32	$^{o}C/mW$
From junction to case	$R_{th\ j-c}$ =	0.14	$^{o}C/mW$

MECHANICAL DATA Dimensions in mm

TO-12



1)= shield lead (connected to case)

Accessories available: 56245, 56265

FOR NEW DESIGN THE SUCCESSOR TYPES BF167, BF196 (N-P-N) ARE RECOMMENDED

CHARACTERISTICS $T_j = 25\ ^oC$ unless otherwise specified

Collector cut-off current				
$I_E = 0;\ -V_{CB} = 10$ V	$-I_{CBO}$	<	7	μA
$I_E = 0;\ -V_{CB} = 10$ V; $T_j = 75\ ^oC$	$-I_{CBO}$	typ.	70	μA
		<	250	μA
Base current				
$I_E = 3$ mA; $-V_{CB} = 10$ V	$-I_B$	typ.	50	μA
		<	150	μA
$I_E = 10$ mA; $-V_{CB} = 6$ V	$-I_B$	typ.	235	μA
			75 to 400	μA
Base-emitter voltage				
$-I_C = 3$ mA; $-V_{CE} = 10$ V	$-V_{BE}$	typ.	360	mV
			320 to 400	mV
Feedback capacitance at f = 450 kHz				
$-I_C = 1$ mA; $-V_{CE} = 10$ V	$-C_{re}$	typ.	400	fF 1)
			300 to 550	fF 1)
Transition frequency				
$-I_C = 3$ mA; $-V_{CE} = 10$ V	f_T	typ.	170	MHz
y parameters at f = 35 MHz (common emitter)				
$-I_C = 3$ mA; $-V_{CE} = 10$ V				
Input conductance	g_{ie}	typ.	10	$m\Omega^{-1}$
Input capacitance	C_{ie}	typ.	45	pF
Feedback admittance	$\lvert y_{re} \rvert$	typ.	75	$\mu\Omega^{-1}$
Phase angle of feedback admittance	φ_{re}	typ.	270°	
Transfer admittance	$\lvert y_{fe} \rvert$	typ.	85	$m\Omega^{-1}$
Phase angle of transfer admittance	φ_{fe}	typ.	310°	
Output conductance	g_{oe}	typ.	60	$\mu\Omega^{-1}$
Output capacitance	C_{oe}	typ.	3	pF
Maximum unilateralised power gain				
$G_{UM} = \dfrac{\lvert y_{fe} \rvert^2}{4 g_{ie} g_{oe}}$				
$-I_C = 3$ mA; $-V_{CE} = 10$ V; f = 35 MHz	G_{UM}	typ.	35	dB

1) 1 fF = 1 femtofarad = 10^{-15} F

GERMANIUM ALLOY-DIFFUSED TRANSISTOR

P-N-P transistor in a TO-12 metal envelope with a shield lead connected to the case. It has a low leakage current at high temperature and a low noise. The AF185 is intended for application in r.f. amplifier, mixer-oscillator and i.f. amplifier stages in car radios, up to frequencies of 27 MHz.

RATINGS Limiting values according to the Absolute Maximum System as defined in IEC publication 134.

Collector-base voltage (open emitter)	$-V_{CBO}$	max.	32	V
Collector-emitter voltage ($Z_B/Z_E < 15$)	$-V_{CER}$	max.	32	V
Collector-emitter voltage (open base)	$-V_{CEO}$	max.	15	V
Collector current (d.c.)	$-I_C$	max.	30	mA
Base current (d.c.)	$-I_B$	max.	1	mA
Total power dissipation up to $T_{amb} = 45\,^oC$	P_{tot}	max.	120	mW
Storage temperature	T_{stg}		-55 to +100	^oC
Junction temperature: continuous	T_j	max.	90	^oC
incidentally	T_j	max.	100	^oC

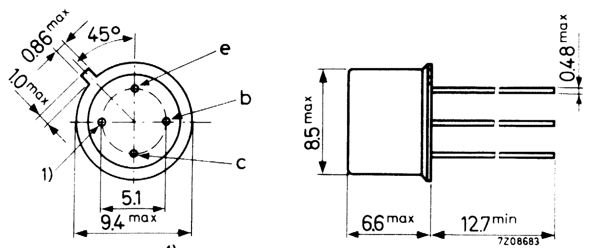
THERMAL RESISTANCE

From junction to ambient in free air	$R_{th\ j\text{-}a}$	=	0.45	$^oC/mW$

MECHANICAL DATA

Dimensions in mm

TO-12



1)= shield lead (connected to case)

Accessories available: 56245, 56265

FOR NEW DESIGN THE SUCCESSOR TYPE
BF195 (N-P-N) IS RECOMMENDED

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

Collector cut-off current				
$I_E = 0$; $-V_{CB} = 10$ V	$-I_{CBO}$	typ.	0.5	μA
		<	3	μA
$I_E = 0$; $-V_{CB} = 10$ V; $T_j = 75$ °C	$-I_{CBO}$	<	45	μA
Base current				
$I_E = 1$ mA; $-V_{CB} = 10$ V	$-I_B$		5 to 25	μA
Emitter-base voltage				
$I_E = 1$ mA; $-V_{CB} = 10$ V	V_{EB}	typ.	280	mV
			220 to 340	mV
Feedback capacitance at f = 450 kHz				
$-I_C = 1$ mA; $-V_{CE} = 10$ V	$-C_{re}$	typ.	1.5	pF
Transition frequency				
$-I_C = 1$ mA; $-V_{CE} = 10$ V	f_T	typ.	80	MHz
Real part of input impedance at f = 35 MHz				
$-I_C = 1$ mA; $-V_{CE} = 10$ V	Re (h_{ie})	typ.	30	Ω
Noise figure				
$-I_C = 1$ mA; $-V_{CE} = 10$ V				
f = 0.2 MHz; R_S = 200 Ω	F	typ.	1.5	dB
f = 1 MHz; R_S = 200 Ω	F	typ.	1.5	dB
f = 1 MHz; R_S = 50 Ω	F	typ.	3	dB
		<	4	dB
f = 10.7 MHz; R_S = 300 Ω	F	typ.	1.5	dB
Conversion noise figure				
$-I_C = 1$ mA; $-V_{CE} = 10$ V				
f = 0.2 MHz; R_S = 500 Ω	F_c	typ.	4.5	dB
		<	8	dB
f = 1 MHz; R_S = 300 Ω	F_c	typ.	3	dB
		<	5	dB

NOTE The small signal parameters have been measured with a lead length of 5 mm between bottom of transistor and measuring jig.

U.H.F. GERMANIUM ALLOY-DIFFUSED TRANSISTOR

P-N-P transistor in metal case, primarily intended for use in a forward-gain-controlled pre-amplifier and mixer oscillator unit at frequencies up to 900 MHz.

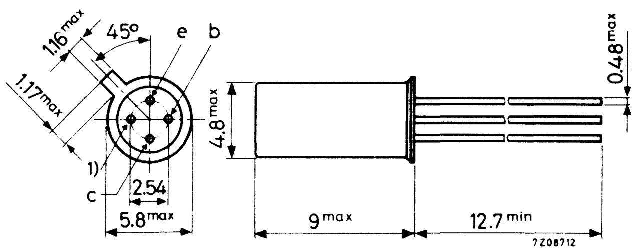
RATINGS Limiting values according to the Absolute Maximum System as defined in IEC publication 134.

Collector-base voltage (open emitter)	$-V_{CBO}$	max.	25	V
Collector current (peak value)	$-I_{CM}$	max.	15	mA
Total power dissipation up to T_{amb} = 45 °C	P_{tot}	max.	70	mW
Junction temperature	T_j	max.	75	°C

THERMAL RESISTANCE

From junction to ambient	$R_{th\ j\text{-}a}$	=	0.65	°C/mW

MECHANICAL DATA Dimensions in mm



1) = shield lead (connected to case)

The AF186 is supplied in pairs
Marked with black dot: pre-amplifier
Marked with red dot : mixer-oscillator

Accessories available: 56246, 56263

FOR NEW DESIGN THE SUCCESSOR TYPES AF239 (P-N-P) OR BF180 (N-P-N) ARE RECOMMENDED

CHARACTERISTICS T_j = 25 °C unless otherwise specified

Transition frequency

$-I_C$ = 2 mA; $-V_{CE}$ = 10 V	f_T	typ.	820	MHz

Power gain at f = 860 MHz (pre-amplifier)

I_E = 2 mA; $-V_{CB}$ = 10 V G_S = 20 mΩ^{-1}; G_L = 2 mΩ^{-1}	G_p	typ.	8.5	dB

Noise figure at f = 800 MHz

$-I_C$ = 2 mA; $-V_{CE}$ = 10 V Source conductance G_S = 20 mΩ^{-1}	F	typ.	8.0	dB

U.H.F GERMANIUM MESA TRANSISTOR

P-N-P transistor in a TO-72 metal envelope, primarily intended for use in pre-amplifier, mixer or oscillator circuits up to frequencies of 890 MHz.

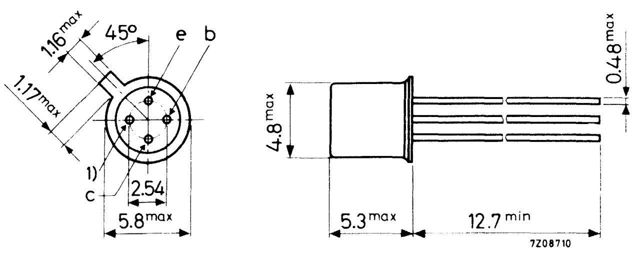
QUICK REFERENCE DATA

Collector-base voltage (open emitter)	$-V_{CBO}$	max.	20	V
Collector-emitter voltage (open base)	$-V_{CEO}$	max.	15	V
Collector current (d.c.)	$-I_C$	max.	15	mA
Total power dissipation up to T_{amb} = 45 °C	P_{tot}	max.	60	mW
Junction temperature	T_j	max.	90	°C
Transition frequency				
$-I_C$ = 2 mA; $-V_{CE}$ = 10 V	f_T	typ.	650	MHz
Max. unilateralised power gain				
I_E = 2 mA; $-V_{CB}$ = 10 V; f = 800 MHz	G_{UM}	typ.	17	dB
Noise figure				
I_E = 2 mA; $-V_{CB}$ = 10 V				
G_S = 16.7 mΩ^{-1}; B_S = 0				
f = 200 MHz	F	typ.	3	dB
f = 800 MHz	F	typ.	5	dB

MECHANICAL DATA

Dimensions in mm

TO-72



1) = shield lead (connected to case)

Accessories available: 56246, 56263

RATINGS (Limiting values) [1]

Voltages

Collector-base voltage (open emitter)	$-V_{CBO}$	max.	20	V
Collector-emitter voltage (open base)	$-V_{CEO}$	max.	15	V
Emitter-base voltage (open collector)	$-V_{EBO}$	max.	0.3	V

Currents

Collector current (d.c.)	$-I_C$	max.	15	mA
Collector current (peak value)	$-I_{CM}$	max.	15	mA

Power dissipation

Total power dissipation up to T_{amb} = 45 °C	P_{tot}	max.	60	mW

Temperatures

Storage temperature	T_{stg}	−30 to +75		°C
Junction temperature	T_j	max.	90	°C

THERMAL RESISTANCE

From junction to ambient in free air	$R_{th\ j-a}$	=	0.75	°C/mW
From junction to case	$R_{th\ j-c}$	=	0.40	°C/mW

[1]) Limiting values according to the Absolute Maximum System as defined in IEC publication 134.

CHARACTERISTICS T_j = 25 °C unless otherwise specified

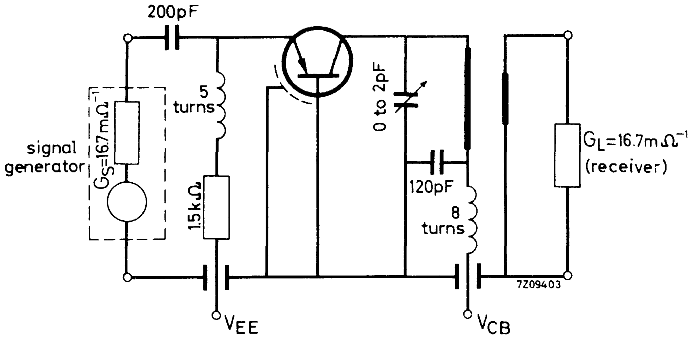
Collector cut-off current		
V_{EB} = 0; $-V_{CB}$ = 20 V	$-I_{CBS}$	typ. 0.5 µA < 8 µA
I_B = 0; $-V_{CE}$ = 15 V	$-I_{CEO}$	< 500 µA
Emitter cut-off current		
I_C = 0; $-V_{EB}$ = 0.3 V	$-I_{EBO}$	< 100 µA
Base current		
I_E = 2 mA; $-V_{CB}$ = 10 V	$-I_B$	typ. 60 µA < 200 µA
I_E = 5 mA; $-V_{CB}$ = 5 V	$-I_B$	typ. 167 µA
I_E = 10 mA; $-V_{CB}$ = 2 V	$-I_B$	< 1 mA
Emitter-base voltage		
I_E = 2 mA; $-V_{CB}$ = 10 V	V_{EB}	typ. 350 mV
I_E = 5 mA; $-V_{CB}$ = 5 V	V_{EB}	typ. 400 mV
Transition frequency		
$-I_C$ = 2 mA; $-V_{CE}$ = 10 V	f_T	typ. 650 MHz
Feeback capacitance at f = 1 MHz		
$-I_C$ = 2 mA; $-V_{CE}$ = 10 V	$-C_{re}$	typ. 230 fF [1])
Noise figure		
I_E = 2 mA; $-V_{CB}$ = 10 V		
G_S = 16.7 mΩ^{-1}; B_S = 0		
f = 200 MHz	F	typ. 3 dB
f = 800 MHz	F	typ. 5 dB < 6 dB
f = 900 MHz	F	typ. 6 dB < 7 dB
Maximum unilateralised power gain		
$G_{UM} = \frac{\lvert y_{fb}\rvert^2}{4\, g_{ib} g_{ob}}$		
I_E = 2 mA; $-V_{CB}$ = 10 V; f = 800 MHz	G_{UM}	typ. 17 dB

[1]) 1 fF = 1 femtofarad = 10^{-15} F

CHARACTERISTICS (continued)

Transducer gain at T_{amb} = 25 °C

Basic circuit for measuring the transducer gain G_{tr} at f = 800 and 900 MHz.

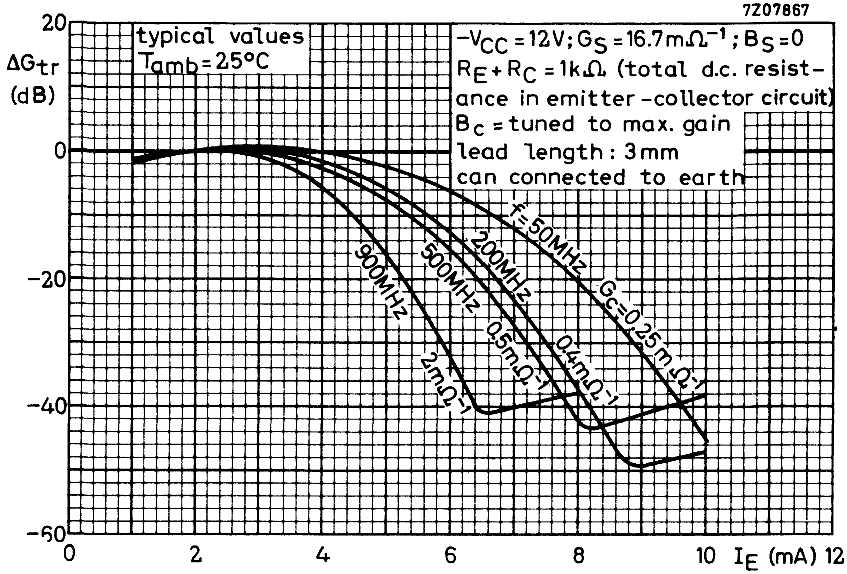


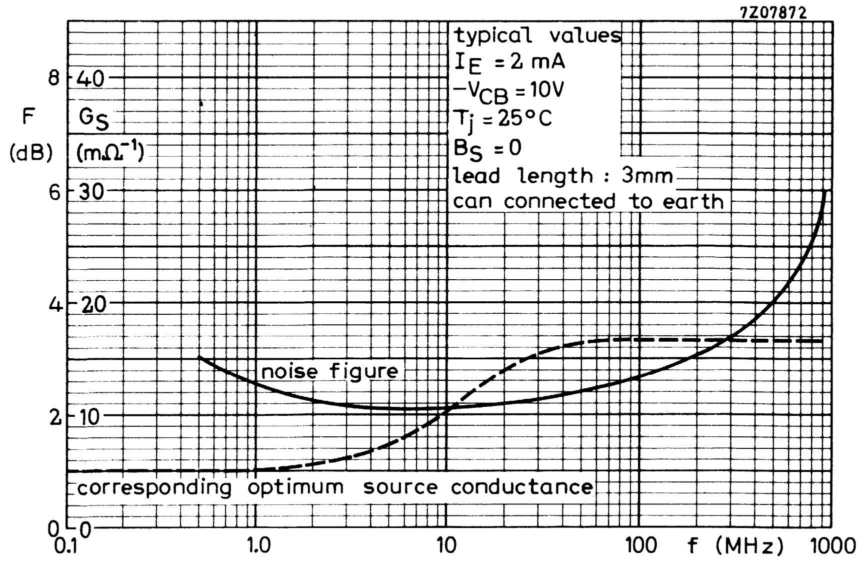
$$G_{tr} = \frac{\text{output power in load } G_L}{\text{available power from source } G_S}$$

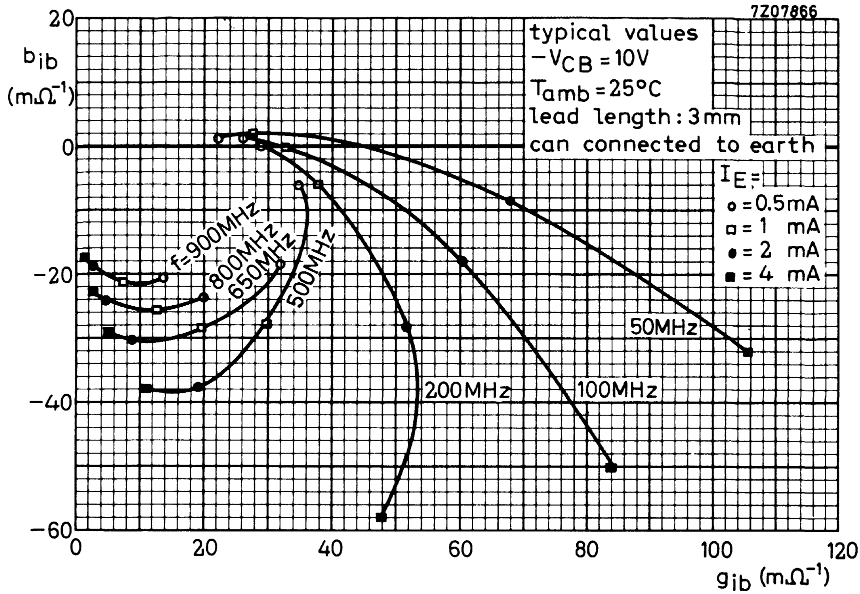
I_E = 2 mA; $-V_{CB}$ = 10 V; lead length: 3 mm; can connected to earth.

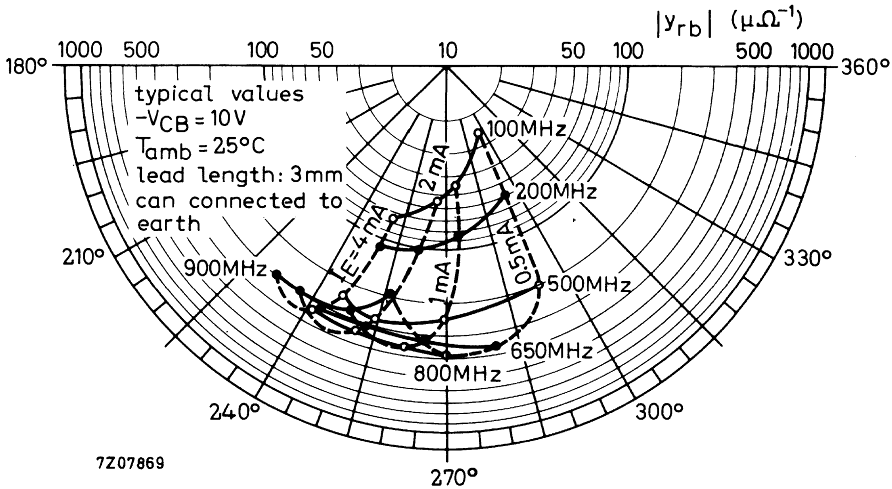
f = 50 MHz; G_c = 0.25 mΩ^{-1}	G_{tr}	typ.	22.5	dB
f = 200 MHz; G_c = 0.4 mΩ^{-1}	G_{tr}	typ.	21.5	dB
f = 500 MHz; G_c = 0.5 mΩ^{-1}	G_{tr}	typ.	18	dB
f = 800 MHz; G_c = 0.5 mΩ^{-1}	G_{tr}	>	11.5	dB
		typ.	14	dB
G_c = 2 mΩ^{-1}	G_{tr}	>	9	dB
		typ.	11.5	dB
f = 900 MHz; G_c = 0.5 mΩ^{-1}	G_{tr}	typ.	12.5	dB
G_c = 2 mΩ^{-1}	G_{tr}	typ.	10.5	dB

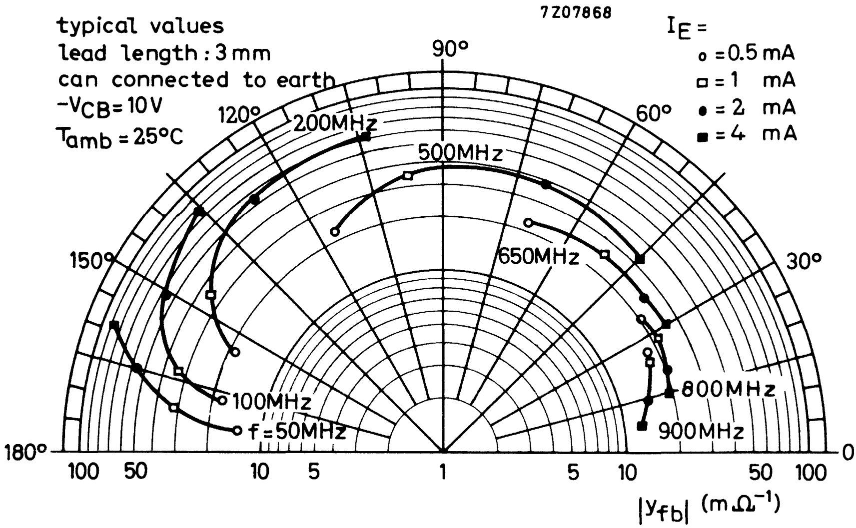
G_c = total effective collector conductance.

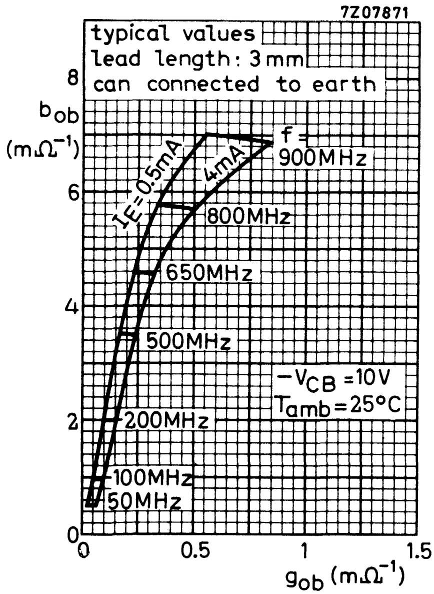

7Z07867
typical values
T_{amb} = 25°C
$-V_{CC}$ = 12V; G_S = 16.7mΩ^{-1}; B_S = 0
$R_E + R_C$ = 1kΩ (total d.c. resistance in emitter-collector circuit)
B_C = tuned to max. gain
lead length: 3mm
can connected to earth
ΔG$_{tr}$ (dB)
I_E (mA)
f = 50MHz
200MHz
500MHz
900MHz
G_C = 0.25mΩ^{-1}
0.4mΩ^{-1}
0.5mΩ^{-1}
2mΩ^{-1}

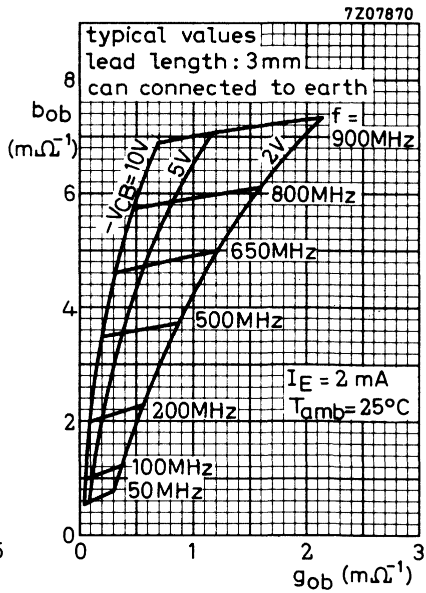

7Z07872
typical values
I_E = 2 mA
$-V_{CB}$ = 10V
T_j = 25°C
B_S = 0
lead length : 3mm
can connected to earth
F (dB)
G_S (mΩ^{-1})
noise figure
corresponding optimum source conductance
f (MHz)

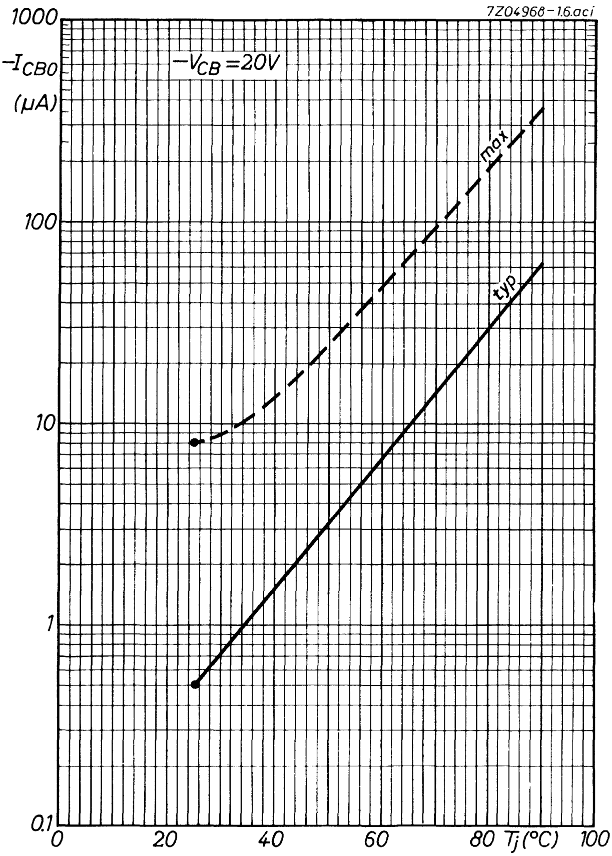

7Z07866
typical values
$-V_{CB} = 10V$
$T_{amb} = 25°C$
lead length: 3mm
can connected to earth
I_E =
o = 0.5mA
□ = 1 mA
● = 2 mA
■ = 4 mA
b_{ib}
$(m\Omega^{-1})$
20
0
−20
−40
−60
0
20
40
60
80
100
120
g_{ib} $(m\Omega^{-1})$
f=900MHz
800MHz
650MHz
500MHz
200MHz
100MHz
50MHz


$|y_{rb}|$ $(\mu\Omega^{-1})$
1000
500
100
50
10
50
100
500
1000
180°
360°
210°
330°
240°
300°
270°
typical values
$-V_{CB} = 10V$
$T_{amb} = 25°C$
lead length: 3mm
can connected to earth
100MHz
200MHz
500MHz
650MHz
800MHz
900MHz
I_E=4mA
2mA
1mA
0.5mA
7Z07869


7Z07868
typical values
lead length : 3 mm
can connected to earth
$-V_{CB}$ = 10 V
T_{amb} = 25°C
I_E =
o = 0.5 mA
□ = 1 mA
• = 2 mA
■ = 4 mA
90°
120°
60°
150°
30°
180°
0
200MHz
500MHz
650MHz
100MHz
f = 50MHz
800MHz
900MHz
100
50
10
5
1
5
10
50
100
$|y_{fb}|$ ($m\Omega^{-1}$)


7Z07871
typical values
lead length: 3 mm
can connected to earth
b_{ob} ($m\Omega^{-1}$)
f = 900MHz
I_E = 0.5mA
4mA
800MHz
650MHz
500MHz
200MHz
100MHz
50MHz
$-V_{CB}$ = 10V
T_{amb} = 25°C
g_{ob} ($m\Omega^{-1}$)
0
0.5
1
1.5
2
4
6
8


7Z07870
typical values
lead length: 3 mm
can connected to earth
b_{ob} ($m\Omega^{-1}$)
f = 900MHz
$-V_{CB}$ = 10V
5V
2V
800MHz
650MHz
500MHz
200MHz
100MHz
50MHz
I_E = 2 mA
T_{amb} = 25°C
g_{ob} ($m\Omega^{-1}$)
0
1
2
3
4
6
8


7Z04968-1.6.aci
1000
$-I_{CBO}$
(μA)
$-V_{CB} = 20V$
max
100
typ
10
1
0.1
0
20
40
60
80
T_j (°C)
100

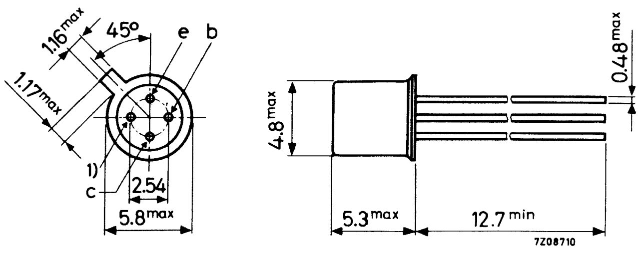
U.H.F. GERMANIUM MESA TRANSISTOR

P-N-P transistor in a TO-72 metal envelope with the shield lead connected to the case, intended for mixer and oscillator circuits in variable capacitance tuners up to frequencies of 890 MHz.

QUICK REFERENCE DATA				
Collector-base voltage (open emitter)	$-V_{CBO}$	max.	20	V
Collector-emitter voltage (open base)	$-V_{CEO}$	max.	15	V
Collector current (d.c.)	$-I_C$	max.	10	mA
Total power dissipation up to T_{amb} = 45 °C	P_{tot}	max.	60	mW
Junction temperature	T_j	max.	90	°C
Transition frequency at f = 100 MHz $-I_C$ = 2 mA; $-V_{CE}$ = 10 V	f_T	typ.	650	MHz
Transducer gain at f = 800 MHz (common base) I_E = 2 mA; $-V_{CB}$ = 10 V G_S = 16.7 mΩ^{-1}; G_L = 0.5 mΩ^{-1}	G_{tr}	typ.	14	dB
Noise figure I_E = 2 mA; $-V_{CB}$ = 10 V G_S = 16.7 mΩ^{-1}; B_S = 0; f = 200 MHz	F	typ.	4.5	dB
f = 800 MHz	F	typ.	5.5	dB

MECHANICAL DATA Dimensions in mm

TO-72



1) = shield lead (connected to case)

Accessories available: 56246; 56263

RATINGS (Limiting values) [1])

Voltages

Collector-base voltage (open emitter)	$-V_{CBO}$	max.	20	V
Collector-emitter voltage (open base)	$-V_{CEO}$	max.	15	V
Emitter-base voltage (open collector)	$-V_{EBO}$	max.	0.3	V

Current

Collector current (d.c.)	$-I_C$	max.	10	mA
Collector current (peak value)	$-I_{CM}$	max.	10	mA

Power dissipation

Total power dissipation up to T_{amb} = 45 °C	P_{tot}	max.	60	mW

Temperatures

Storage temperature	T_{stg}	−30 to +75		°C
Junction temperature	T_j	max.	90	°C

THERMAL RESISTANCE

From junction to ambient in free air	$R_{th\ j\text{-}a}$	=	0.75	°C/mW
From junction to case	$R_{th\ j\text{-}c}$	=	0.4	°C/mW

[1]) Limiting values according to the Absolute Maximum System as defined in IEC publication 134.

CHARACTERISTICS T_j = 25 °C unless otherwise specified

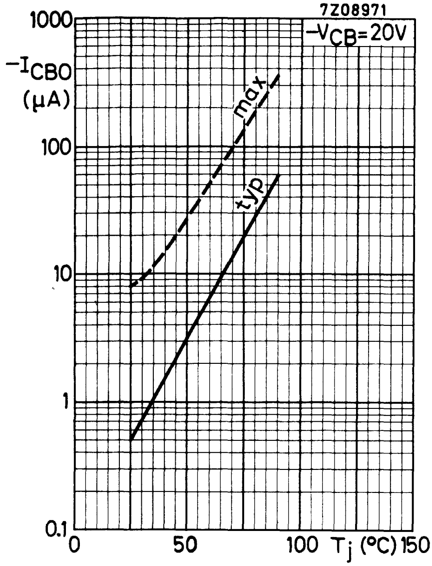
Collector cut-off current				
$V_{EB} = 0$; $-V_{CB} = 20$ V	$-I_{CBS}$	typ.	0.5	μA
		<	8	μA
$I_B = 0$; $-V_{CE} = 15$ V	$-I_{CEO}$	<	500	μA
Emitter cut-off current				
$I_C = 0$; $-V_{EB} = 0.3$ V	$-I_{EBO}$	<	100	μA
Base current				
$-I_C = 2$ mA; $-V_{CE} = 10$ V	$-I_B$	typ.	80	μA
		<	200	μA
Emitter-base voltage				
$-I_C = 2$ mA; $-V_{CE} = 10$ V	$-V_{BE}$	typ.	370	mV
D.C. current gain				
$-I_C = 2$ mA; $-V_{CE} = 10$ V	h_{FE}	>	10	
		typ.	25	
Transition frequency				
$-I_C = 2$ mA; $-V_{CE} = 10$ V	f_T	typ.	650	MHz
Feedback capacitance at f = 1 MHz				
$-I_C = 1$ mA; $-V_{CE} = 10$ V	$-C_{re}$	typ.	260	fF
Noise figure				
$I_E = 2$ mA; $-V_{CB} = 10$ V				
$G_S = 16.7$ mΩ^{-1}; $B_S = 0$; f = 200 MHz	F	typ.	4.5	dB
f = 800 MHz	F	typ.	5.5	dB

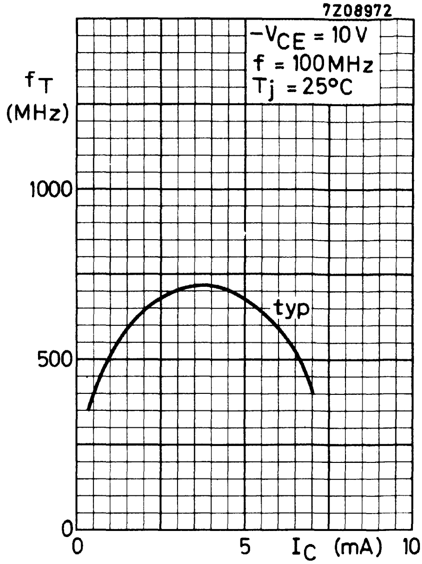
Transducer gain at f = 800 MHz (common base) [1]

$$\text{Gain in dB} = 10 \log \frac{\text{output power in load } G_L}{\text{available power from source } G_S}$$

$I_E = 2$ mA; $-V_{CB} = 10$ V; $G_S = 16.7$ mΩ^{-1}				
$G_L = 0.5$ mΩ^{-1}	G_{tr}	typ.	14	dB
$G_L = 2$ mΩ^{-1}	G_{tr}	typ.	12	dB

[1]) Length of leads is 3 mm from can to earth.


7Z08971
−VCB=20V
−ICBO
(μA)
1000
100
10
1
0.1
max
typ
0
50
100
Tj (°C)
150


7Z08972
−VCE = 10 V
f = 100 MHz
Tj = 25°C
fT
(MHz)
1000
500
0
typ
0
5
IC (mA)
10

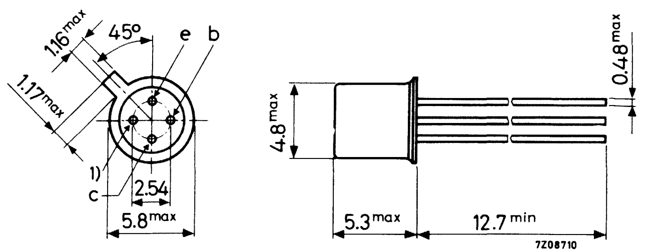
U.H.F. GERMANIUM MESA TRANSISTOR

P-N-Ptransistor in a TO-72 metal envelope, primarily intended for use in pre-amplifier, mixer or oscillator circuits up to frequencies of 860 MHz.

QUICK REFERENCE DATA				
Collector-base voltage (open emitter)	$-V_{CBO}$	max.	30	V
Collector-emitter voltage (open base)	$-V_{CEO}$	max.	25	V
Collector current (d.c.)	$-I_C$	max.	8	mA
Total power dissipation up to T_{amb} = 45 °C	P_{tot}	max.	60	mW
Junction temperature	T_j	max.	90	°C
Transition frequency				
$-I_C$ = 1.5 mA; $-V_{CE}$ = 12 V	f_T	typ.	550	MHz
Max. unilateralised power gain				
I_E = 1.5 mA; $-V_{CB}$ = 12 V; f = 800 MHz	G_{UM}	typ.	11.5	dB
Noise figure				
I_E = 1.5 mA; $-V_{CB}$ = 12 V;				
f = 800 MHz; R_S = 60 Ω	F	typ.	7	dB

MECHANICAL DATA Dimensions in mm

TO-72



1) = shield lead (connected to case)

Accessories available: 56246, 56263

RATINGS (Limiting values) [1]

Voltages

Collector-base voltage (open emitter)	$-V_{CBO}$	max.	30	V
Collector-emitter voltage (open base)	$-V_{CEO}$	max.	25	V
Emitter-base voltage (open collector)	$-V_{EBO}$	max.	0.5	V

Currents

Collector current (d.c.)	$-I_C$	max.	8	mA
Collector current (peak value)	$-I_{CM}$	max.	8	mA

Power dissipation

Total power dissipation up to T_{amb} = 45 °C	P_{tot}	max.	60	mW

Temperatures

Storage temperature	T_{stg}		−30 to +75	°C
Junction temperature	T_j	max.	90	°C

THERMAL RESISTANCE

From junction to ambient in free air	$R_{th\ j\text{-}a}$	=	0.75	°C/mW
From junction to case	$R_{th\ j\text{-}c}$	=	0.40	°C/mW

[1]) Limiting values according to the Absolute Maximum System as defined in IEC publication 134.

CHARACTERISTICS $T_j = 25\ ^oC$ unless otherwise specified

Collector cut-off current				
$I_E = 0;\ -V_{CB} = 20$ V	$-I_{CBO}$	typ.	0.7	μA
		<	3	μA
$I_E = 0;\ -V_{CB} = 20$ V; $T_j = 60\ ^oC$	$-I_{CBO}$	typ.	7	μA
		<	30	μA
$I_B = 0;\ -V_{CE} = 15$ V	$-I_{CEO}$	<	500	μA
Emitter cut-off current				
$I_C = 0;\ -V_{EB} = 0.5$ V	$-I_{EBO}$	typ.	4	μA
		<	100	μA
Base current				
$I_E = 1.5$ mA; $-V_{CB} = 12$ V	$-I_B$	typ.	25	μA
		<	150	μA
$I_E = 2$ mA; $-V_{CB} = 6$ V	$-I_B$	typ.	31	μA
$I_E = 5$ mA; $-V_{CB} = 6$ V	$-I_B$	typ.	56	μA
Emitter-base voltage				
$I_E = 1.5$ mA; $-V_{CB} = 12$ V	V_{EB}	typ.	380	mV
		320 to	430	mV
$I_E = 2$ mA; $-V_{CB} = 6$ V	V_{EB}	typ.	380	mV
		320 to	430	mV
$I_E = 5$ mA; $-V_{CB} = 6$ V	V_{EB}	typ.	405	mV
		360 to	450	mV
Transition frequency				
$-I_C = 1.5$ mA; $-V_{CE} = 12$ V	f_T	typ.	550	MHz
Reverse transfer time constant				
$I_E = 1.5$ mA; $-V_{CB} = 12$ V; f = 2.5 MHz	$r_{bb'} \cdot C_{b'c}$	typ.	3	ps
Feedback capacitance at f = 450 kHz				
$-I_C = 1.5$ mA; $-V_{CE} = 12$ V	$-C_{re}$	typ.	250	fF [1]

[1] 1 fF = 1 femtofarad = 10^{-15} F

CHARACTERISTICS (continued) $T_j = 25\ ^{o}C$ unless otherwise specified

y parameters at f = 800 MHz [1])

$I_E = 1.5$ mA; $-V_{CB} = 12$ V

Input conductance	g_{ib}	typ.	7	$m\Omega^{-1}$
Input susceptance	$-b_{ib}$	typ.	11	$m\Omega^{-1}$
Input capacitance	$-C_{ib}$	typ.	2.2	pF
Feedback admittance	$\lvert y_{rb} \rvert$	typ.	0.4	$m\Omega^{-1}$
Phase angle of feedback admittance	φ_{rb}	typ.	240^{o}	
Transfer admittance	$\lvert y_{fb} \rvert$	typ.	14	$m\Omega^{-1}$
Phase angle of transfer admittance	φ_{fb}	typ.	35^{o}	
Output conductance	g_{ob}	typ.	0.5	$m\Omega^{-1}$
Output capacitance	C_{ob}	typ.	1.5	pF

Maximum unilateralised power gain

$$G_{UM} = \frac{|y_{fb}|^2}{4\, g_{ib} g_{ob}}$$

$I_E = 1.5$ mA; $-V_{CB} = 12$ V; f = 800 MHz	G_{UM}	typ.	11.5	dB

[1]) Measured with a lead length of 5 mm.

CHARACTERISTICS (continued) T_j = 25 °C unless otherwise specified

Transducer gain

$$G_{tr} = \frac{\text{output power in load } R_L}{\text{available power from source } R_S}$$

I_E = 1.5 mA; $-V_{CB}$ = 12 V; f = 800 MHz	G_{tr}	>	10.2	dB
		typ.	11	dB

Reverse transducer gain

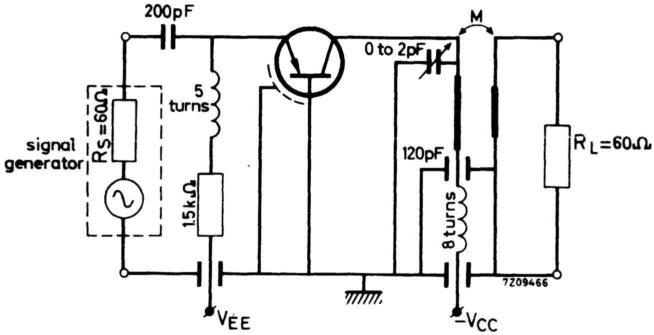
I_E = 1.5 mA; $-V_{CB}$ = 12 V; f = 800 MHz	$G_{tr\ rev}$	typ.	-23	dB

The reverse transducer gain is measured in the circuit below, with load and source (including R_S) interchanged.

Noise figure

I_E = 1.5 mA; $-V_{CB}$ = 12 V; f = 800 MHz	F	typ.	7	dB
		<	8	dB

Basic circuit for measuring the transducer gain G_{tr} and the noise figure F.



Total effective collector resistance R_C = 1.4 kΩ

GERMANIUM ALLOY DIFFUSED TRANSISTOR

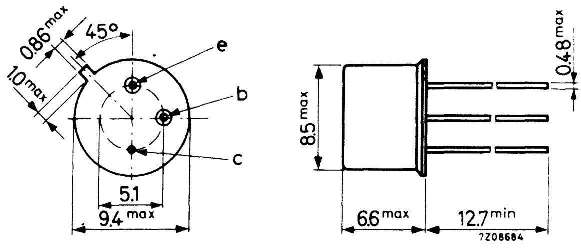
P-N-P transistor in a TO-39 metal envelope, primarily intended for use as a power amplifier in transmitting circuits up to frequencies of 180 MHz.

QUICK REFERENCE DATA				
Collector-base voltage (open emitter)	$-V_{CBO}$	max.	32	V
Collector-emitter voltage (V_{BE} = 0)	$-V_{CES}$	max.	32	V
Collector current (d.c.)	$-I_C$	max.	150	mA
Total power dissipation up to T_{case} = 65 °C	P_{tot}	max.	800	mW
Junction temperature	T_j	max.	90	°C
Transition frequency				
I_E = 100 mA; $-V_{CB}$ = 5 V	f_T	typ.	350	MHz

MECHANICAL DATA Dimensions in mm

TO-39

Collector connected to case



Accessories available: 56218, 56245, 56265

RATINGS (Limiting values) [1])

Voltages

Collector-base voltage (open emitter)	$-V_{CBO}$	max.	32	V
Collector-emitter voltage (V_{BE} = 0)	$-V_{CES}$	max.	32	V

Currents

Collector current (d.c.)	$-I_C$	max.	150	mA
Collector current (peak value)	$-I_{CM}$	max.	300	mA
Emitter current (d.c.)	I_E	max.	200	mA
Emitter current (peak value)	I_{EM}	max.	350	mA
Reverse emitter current (d.c.)	$-I_E$	max.	10	mA
Reverse emitter current (peak value)	$-I_{EM}$	max.	30	mA

Power dissipation

Total power dissipation up to T_{case} = 65 °C	P_{tot}	max.	800	mW

Temperatures

Storage temperature	T_{stg}		-55 to +75	°C
Junction temperature : continuous	T_j	max.	90	°C
incidentally	T_j	max.	100	°C

THERMAL RESISTANCE

From junction to ambient in free air	$R_{th\ j-a}$	=	0.25	°C/mW
on a heatsink of 12.5 cm^2	$R_{th\ j-a}$	=	0.08	°C/mW
From junction to case	$R_{th\ j-c}$	=	0.035	°C/mW

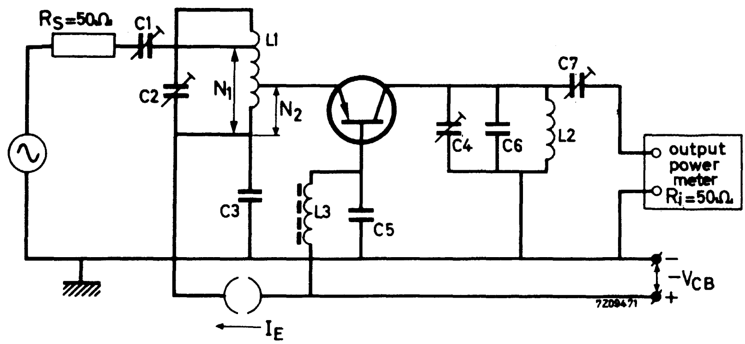
[1]) Limiting values according to the Absolute Maximum System as defined in IEC publication 134.

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

Collector cut-off current				
$I_E = 0$; $-V_{CB} = 10$ V	$-I_{CBO}$	<	10	μA
$I_E = 0$; $-V_{CB} = 32$ V	$-I_{CBO}$	<	1	mA
Emitter cut-off current				
$I_C = 0$; $-V_{EB} = 0.5$ V	$-I_{EBO}$	<	1	mA
Base current				
$I_E = 100$ mA; $-V_{CB} = 2$ V	$-I_B$	<	3	mA
$I_E = 80$ mA; $-V_{CB} = 12$ V	$-I_B$	typ. < 	1 2	mA mA
Saturation voltage				
$-I_C = 300$ mA; $-I_B = 20$ mA	$-V_{CE\,sat}$	<	1	V
Collector capacitance at f = 0.5 MHz				
$I_E = I_e = 0$; $-V_{CB} = 10$ V	C_c	typ.	12	pF
Real part of input impedance				
$I_E = 100$ mA; $-V_{CB} = 5$ V; f = 100 MHz	$Re(h_{ie})$	typ.	18	Ω
Transition frequency				
$I_E = 100$ mA; $-V_{CB} = 5$ V	f_T	> typ.	225 350	MHz MHz

APPLICATION INFORMATION

V.H.F. power amplifier circuit at T_{amb} = 25 °C



f	= 80	180 MHz
C1	= 50	15 pF
C2	= 50	15 pF
C3	= 10	1 nF
C4	= 50	15 pF
C5 [1]	= 10	0.12 nF
C6	= 82	0 pF
C7	= 100	15 pF

f	= 80	180 MHz
L1	= 0.1	0.08 μH
L2	= 0.03	0.02 μH
L3	= h.f. choke	
N_1/N_{tot}	= 1	0.5
N_2/N_{tot}	= 0.5	0.22
Q_1	> 150	200
Q_2	> 150	200

Performance in common base configuration

I_E = 80 mA; $-V_{CB}$ = 12 V

Output power at	f = 80 MHz	P_o	> 500	mW
	f = 180 MHz	P_o	> 400	mW
Power gain at	f = 80 MHz	G_p [2]	> 10	dB
	f = 180 MHz	G_p [2]	> 9	dB

Note

Care should be taken to reduce the case to heatsink capacitance, especially at 180 MHz.

[1]) C_5 should be chosen such that its series conductance can be neglected (e.g. a tubular ceramic capacitor mounted in a copper block).

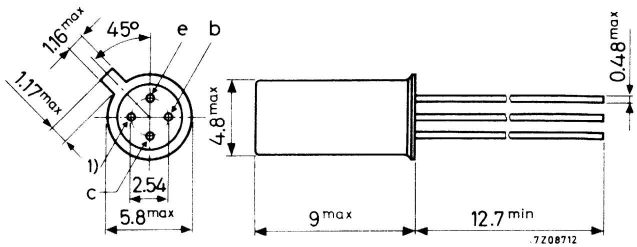
[2]) Without insertion losses and stated minimum P_o.

U.H.F. GERMANIUM EPITAXIAL MESA TRANSISTOR

P-N-P transistor in a metal envelope, with insulated electrodes and a shield lead connected to the case. It is primarily intended for use in output stages of aerial amplifiers up to frequencies of 860 MHz.

QUICK REFERENCE DATA				
Collector-base voltage (open emitter)	$-V_{CBO}$	max.	32	V
Collector-emitter voltage (open base)	$-V_{CEO}$	max.	20	V
Collector current (d.c.)	$-I_C$	max.	20	mA
Total power dissipation up to T_{amb} = 30 °C	P_{tot}	max.	140	mW
Junction temperature	T_j	max.	90	°C
Transition frequency				
$-I_C$ = 6 mA; $-V_{CE}$ = 12 V	f_T	typ.	700	MHz
Transducer gain at T_j = 70 °C				
I_E = 4 mA; $-V_{CB}$ = 20 V; f = 800 MHz	G_{tr}	typ.	12	dB
Noise figure				
I_E = 1.5 mA; $-V_{CB}$ = 12 V;				
f = 800 MHz; R_S = 60 Ω	F	typ.	7	dB

MECHANICAL DATA Dimensions in mm



1) = shield lead (connected to case)

Accessories available: 56246, 56263

RATINGS (Limiting values) [1])

Voltages

Collector-base voltage (open emitter)	$-V_{CBO}$	max.	32	V
Collector-emitter voltage (open base)	$-V_{CEO}$	max.	20	V
Emitter-base voltage (open collector)	$-V_{EBO}$	max.	0.3	V

Currents

Collector current (d.c.)	$-I_C$	max.	20	mA
Collector current (peak value)	$-I_{CM}$	max.	20	mA

Power dissipation

Total power dissipation up to T_{amb} = 30 °C with cooling fin No. 56263	P_{tot}	max.	140	mW

Temperatures

Storage temperature	T_{stg}		-30 to +75	°C
Junction temperature	T_j	max.	90	°C

THERMAL RESISTANCE

From junction to ambient in free air	$R_{th\ j\text{-}a}$	=	0.55	°C/mW
From junction to ambient with cooling fin No. 56263	$R_{th\ j\text{-}a}$	=	0.42	°C/mW
From junction to case	$R_{th\ j\text{-}c}$	=	0.32	°C/mW

[1]) Limiting values according to the Absolute Maximum System as defined in IEC publication 134.

CHARACTERISTICS $T_j = 25\ ^oC$ unless otherwise specified

Collector cut-off currents				
$I_E = 0$; $-V_{CB} = 20$ V	$-I_{CBO}$	typ. <	0.5 8	μA μA
$I_E = 0$; $-V_{CB} = 20$ V; $T_j = 60\ ^oC$	$-I_{CBO}$	<	50	μA
$I_B = 0$; $-V_{CE} = 20$ V	$-I_{CEO}$	<	1	mA
Emitter cut-off current				
$I_C = 0$; $-V_{EB} = 0.3$ V	$-I_{EBO}$	typ. <	2 100	μA μA
Base current				
$I_E = 1.5$ mA; $-V_{CB} = 12$ V	$-I_B$	typ. <	30 150	μA μA
$I_E = 4$ mA; $-V_{CB} = 20$ V	$-I_B$	<	400	μA
Emitter-base voltage				
$I_E = 1.5$ mA; $-V_{CB} = 12$ V	V_{EB}	typ. 320 to	380 430	mV mV
$I_E = 4$ mA; $-V_{CB} = 20$ V	V_{EB}	typ. 360 to	400 450	mV mV
Feedback capacitance at f = 450 kHz				
$-I_C = 1$ mA; $-V_{CE} = 12$ V	$-C_{re}$	typ.	250	fF [1]
Feedback time constant				
$I_E = 1$ mA; $-V_{CB} = 12$ V; f = 2.5 MHz	$r_{bb'} \cdot C_{b'c}$	typ. <	3 6	ps ps
Transition frequency				
$-I_C = 1.5$ mA; $-V_{CE} = 12$ V	f_T	typ.	550	MHz
$-I_C = 6$ mA; $-V_{CE} = 12$ V	f_T	typ.	700	MHz
Emitter capacitance at f = 1 MHz				
$I_C = I_c = 0$; $-V_{EB} = 0.15$ V	C_e	typ.	3.5	pF
Base resistance				
I_E = value for which $C_{ib} = 0$; $-V_{CB} = 12$ V; f = 50 MHz	r_b	typ. <	60 100	Ω Ω

[1]) 1 fF = 1 femtofarad = 10^{-15} F

CHARACTERISTICS (continued) T_j = 25 °C unless otherwise specified

Noise figure at f = 800 MHz

I_E = 1.5 mA; $-V_{CB}$ = 12 V; R_S = 60 Ω	F	typ.	7	dB

Transducer gain

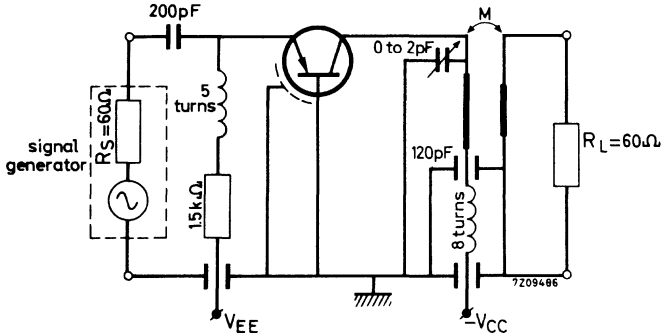
$$G_{tr} = \frac{\text{output power in load } R_L}{\text{available power from source } R_S}$$

I_E = 4 mA; $-V_{CB}$ = 20 V; f = 800 MHz; T_j = 70 °C	G_{tr}	>	10	dB
		typ.	12	dB

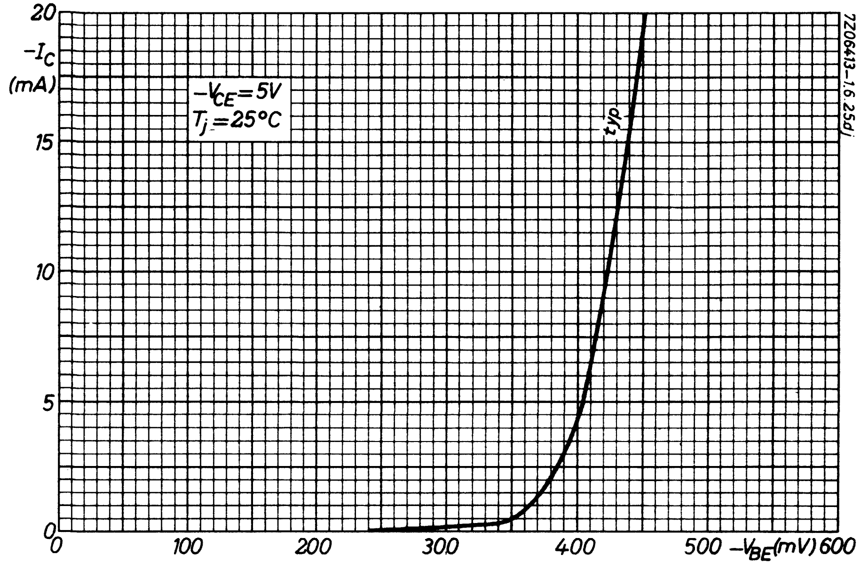
Output power

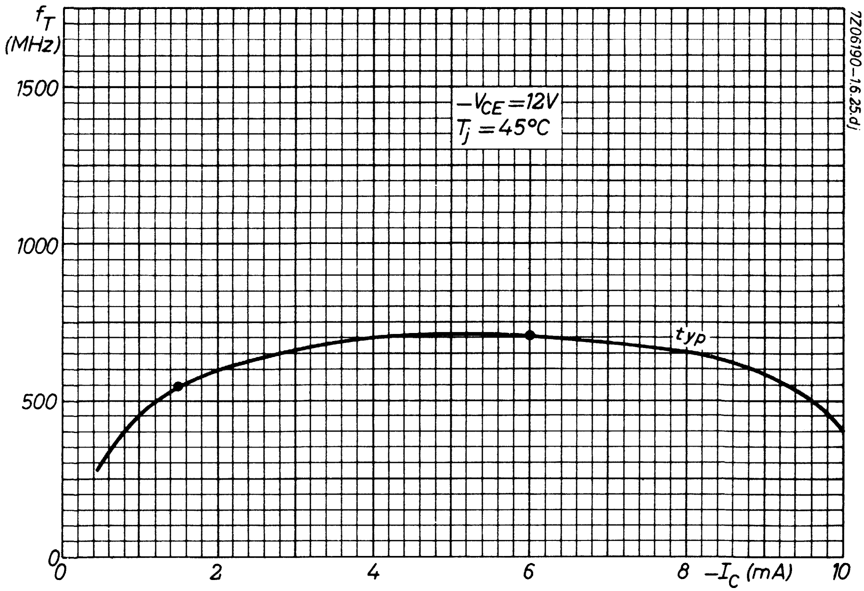
d_{im} = −30 dB; I_E = 4 mA; $-V_{CB}$ = 20 V; f = 800 MHz; T_j = 70 °C	P_o	>	1.5	mW
		typ.	2.7	mW

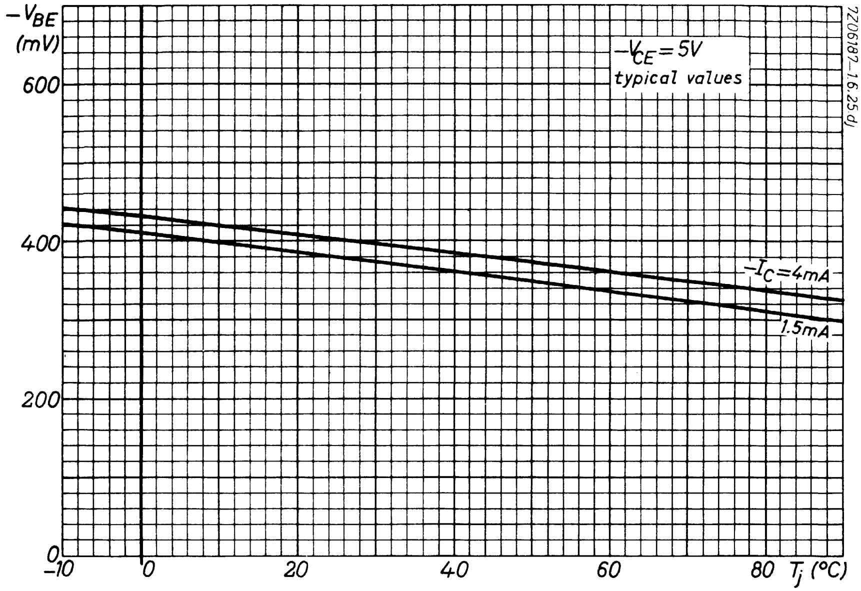
Basic circuit for measuring the transducer gain G_{tr} and the output power P_o

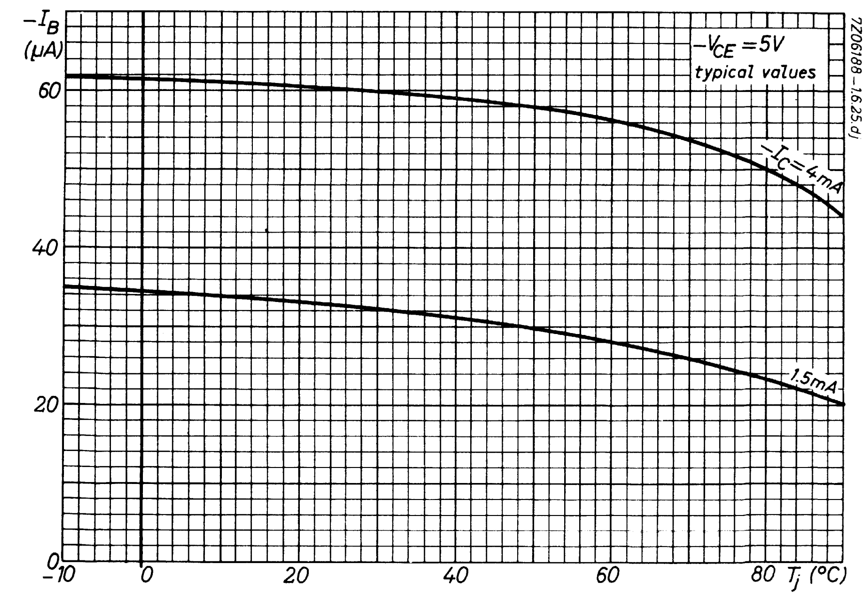


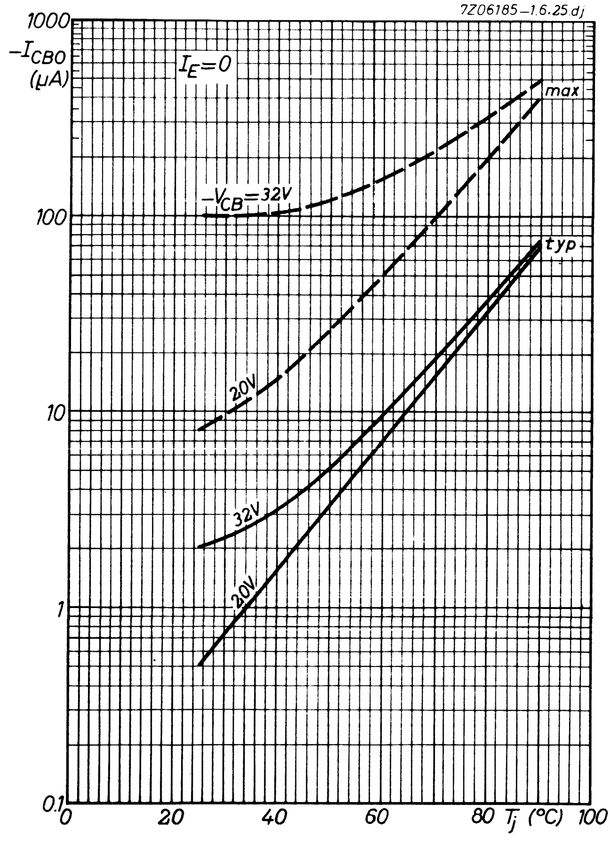
Total effective collector resistance R_c = 1.4 kΩ

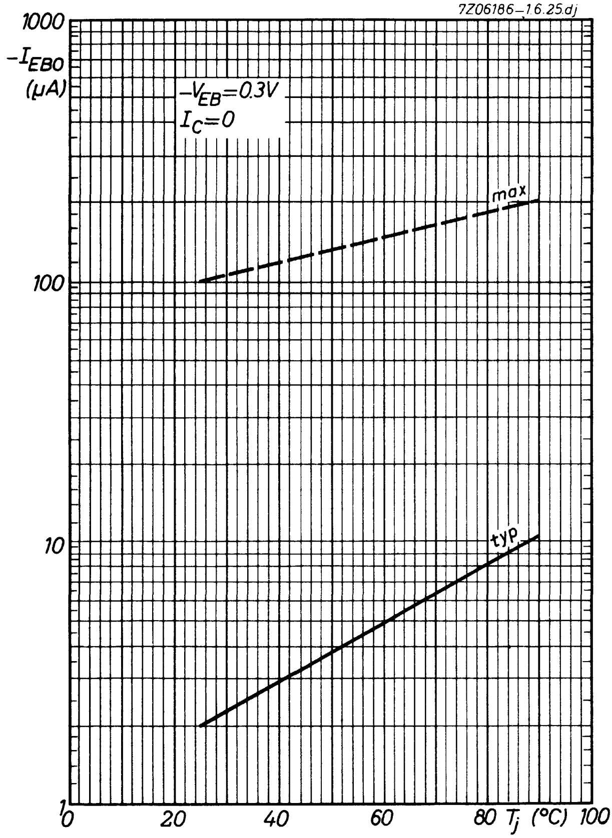

20
$-I_C$
(mA)
15
10
5
0
0
100
200
300
400
500
$-V_{BE}$(mV)
600
$-V_{CE}=5V$
$T_j=25°C$
typ
7Z06413-1.6.25dj


f_T
(MHz)
1500
1000
500
0
0
2
4
6
8
$-I_C$ (mA)
10
$-V_{CE}=12V$
$T_j=45°C$
typ
7Z06190-1.6.25dj


$-V_{BE}$
(mV)
600
400
200
0
−10
0
20
40
60
80
T_j (°C)
$-V_{CE} = 5V$
typical values
$-I_C = 4mA$
1.5mA
7Z06187–1.6.25.d)


$-I_B$
(μA)
60
40
20
0
−10
0
20
40
60
80
T_j (°C)
$-V_{CE} = 5V$
typical values
$-I_C = 4mA$
1.5mA
7Z06188–1.6.25.d)


7Z06185–1.6.25.dj
1000
$-I_{CBO}$
(μA)
100
10
1
0.1
$I_E=0$
$-V_{CB}=32V$
20V
32V
20V
max
typ
0
20
40
60
80
T_j (°C)
100


7Z06186–1.6.25.dj
1000
$-I_{EBO}$
(μA)
$-V_{EB}=0.3V$
$I_C=0$
max
100
10
typ
1
0
20
40
60
80
T_j (°C)
100

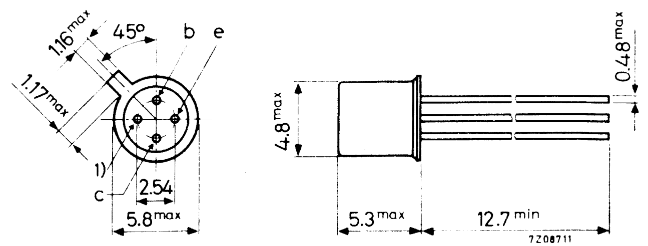
GERMANIUM ALLOY DIFFUSED TRANSISTOR

P-N-P transistor in a TO-72 metal envelope with a shield lead connected to the case. The transistor is intended for v.h.f. operation up to 200 MHz.

QUICK REFERENCE DATA				
Collector-base voltage (open emitter)	$-V_{CBO}$	max.	20	V
Collector-emitter voltage (open base)	$-V_{CEO}$	max.	10	V
Collector current (d.c.)	$-I_C$	max.	10	mA
Total power dissipation up to $T_{amb} = 25\ ^oC$	P_{tot}	max.	85	mW
Junction temperature	T_j	max.	75	^oC
Transition frequency				
$-I_C = 1$ mA; $-V_{CE} = 6$ V	f_T	typ.	180	MHz
Noise figure				
$-I_C = 1$ mA; $-V_{CE} = 12$ V f = 200 MHz; $R_S = 30\ \Omega$	F	typ.	6.0	dB

MECHANICAL DATA Dimensions in mm

TO-72



1) = shield lead (connected to case)

Accessories available: 56246, 56263

RATINGS (Limiting values) [1])

Voltages

Collector-base voltage (open emitter)	$-V_{CBO}$	max.	20	V
Collector-emitter voltage ($+V_{BE} = 0.5$ V)				
$-I_C$ up to 10 mA	$-V_{CEX}$	max.	20	V
Collector-emitter voltage (open base)	$-V_{CEO}$	max.	10	V
Emitter-base voltage (open collector)	$-V_{EBO}$	max.	0.5	V

Currents

Collector current (d.c.)	$-I_C$	max.	10	mA
Base current (d.c.)	$-I_B$	max.	1.0	mA
Emitter current (d.c.)	I_E	max.	10	mA
Reverse emitter current (d.c.)	$-I_E$	max.	1.0	mA

Power dissipation

Total power dissipation up to $T_{amb} = 25\ ^oC$	P_{tot}	max.	85	mW

Temperatures

Storage temperature	T_{stg}		-55 to +75	^oC
Junction temperature, continuous	T_j	max.	75	^oC
incidentally	T_j	max.	90	^oC

THERMAL RESISTANCE

From junction to ambient in free air	$R_{th\ j-a}$	=	0.6	$^oC/mW$

1) Limiting values according to the Absolute Maximum System as defined in IEC publication 134.

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

Collector cut-off current				
$I_E = 0$; $-V_{CB} = 6$ V	$-I_{CBO}$	typ.	1.0	μA
		<	6.0	μA
$I_E = 0$; $-V_{CB} = 20$ V	$-I_{CBO}$	typ.	2.6	μA
		<	50	μA
Emitter cut-off current				
$I_C = 0$; $-V_{EB} = 0.5$ V	$-I_{EBO}$	typ.	2.0	μA
		<	27	μA
Base-emitter voltage				
$-I_C = 1$ mA; $-V_{CE} = 6$ V	$-V_{BE}$	typ.	310	mV
		220 to	380	mV
$-I_C = 10$ mA; $-V_{CE} = 2$ V	$-V_{BE}$	typ.	380	mV
D.C. current gain				
$-I_C = 1$ mA; $-V_{CE} = 6$ V	h_{FE}	>	20	
		typ.	60	
$-I_C = 10$ mA; $-V_{CE} = 2$ V	h_{FE}	>	25	
		typ.	60	
Transition frequency				
$-I_C = 1$ mA; $-V_{CE} = 6$ V	f_T	>	135	MHz
		typ.	180	MHz
Feedback impedance at f = 2 MHz				
$-I_C = 1$ mA; $-V_{CE} = 6$ V	$\lvert z_{rb} \rvert$	typ.	10	Ω
Small signal current gain at f = 1 kHz				
$-I_C = 1$ mA; $-V_{CE} = 6$ V	h_{fe}	>	20	
		typ.	70	
Feedback capacitance at f = 450 kHz				
$-I_C = 1$ mA; $-V_{CE} = 6$ V	$-C_{re}$	typ.	1.0	pF
		<	1.5	pF
Noise figure				
$-I_C = 1$ mA; $-V_{CE} = 12$ V; f = 200 MHz; $R_S = 30$ Ω	F	typ.	6.0	dB
		<	7.5	dB

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

y parameters at f = 200 MHz (common emitter)
$-I_C$ = 1 mA; $-V_{CE}$ = 12 V [1])

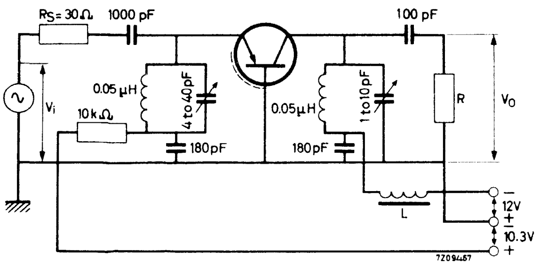
Input conductance	g_{ie}	typ.	28	$m\Omega^{-1}$
Input capacitance	C_{ie}	typ.	13	pF
Feedback admittance	$\|y_{re}\|$	typ.	500	$\mu\Omega^{-1}$
Phase angle of feedback admittance	φ_{re}	typ.	250°	
Transfer admittance	$\|y_{fe}\|$	typ.	34	$m\Omega^{-1}$
Phase angle of transfer admittance	φ_{fe}	typ.	292°	
Output conductance	g_{oe}	typ.	220	$\mu\Omega^{-1}$
Output capacitance	C_{oe}	typ.	2.0	pF

y parameters at f = 100 MHz (common emitter)
I_E = 1 mA; $-V_{CB}$ = 10 V [1])

Input conductance	g_{ib}	typ.	32.5	$m\Omega^{-1}$
Input capacitance	$-C_{ib}$	typ.	10	pF
Feedback admittance	$\|y_{rb}\|$	typ.	410	$\mu\Omega^{-1}$
Phase angle of feedback admittance	φ_{rb}	typ.	280°	
Transfer admittance	$\|y_{fb}\|$	typ.	30	$m\Omega^{-1}$
Phase angle of transfer admittance	φ_{fb}	typ.	115°	
Output conductance	g_{ob}	typ.	220	$\mu\Omega^{-1}$
Output capacitance	C_{ob}	typ.	2.0	pF

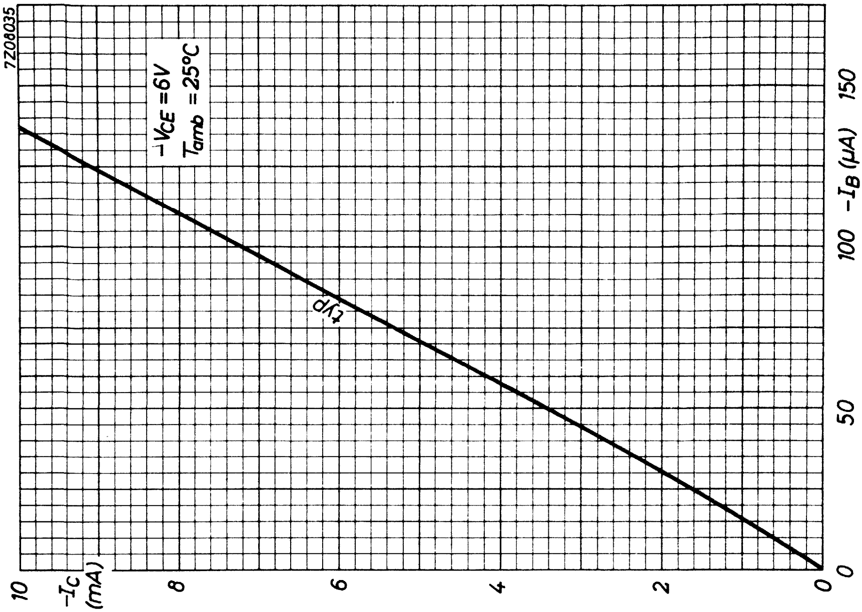
Power gain	G_p	>	10	dB
		typ.	13	dB

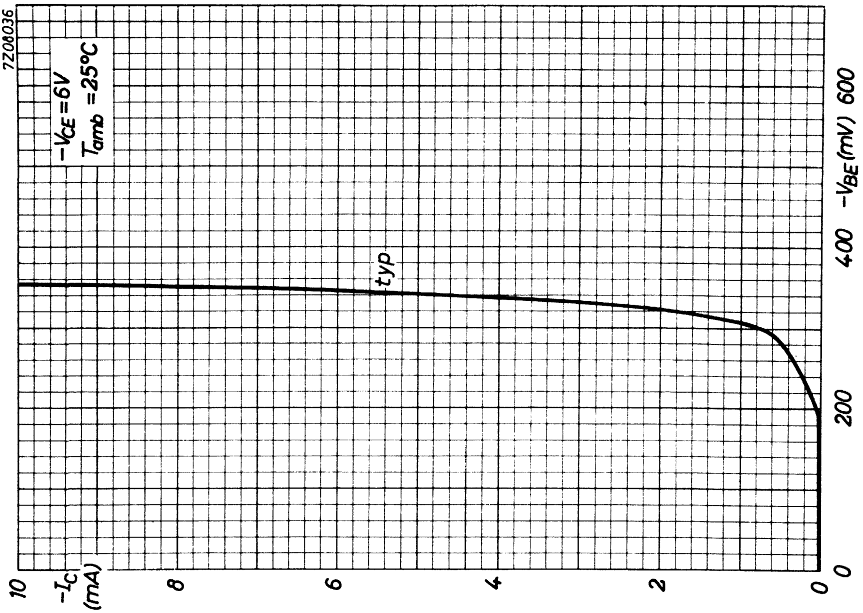
Test circuit:

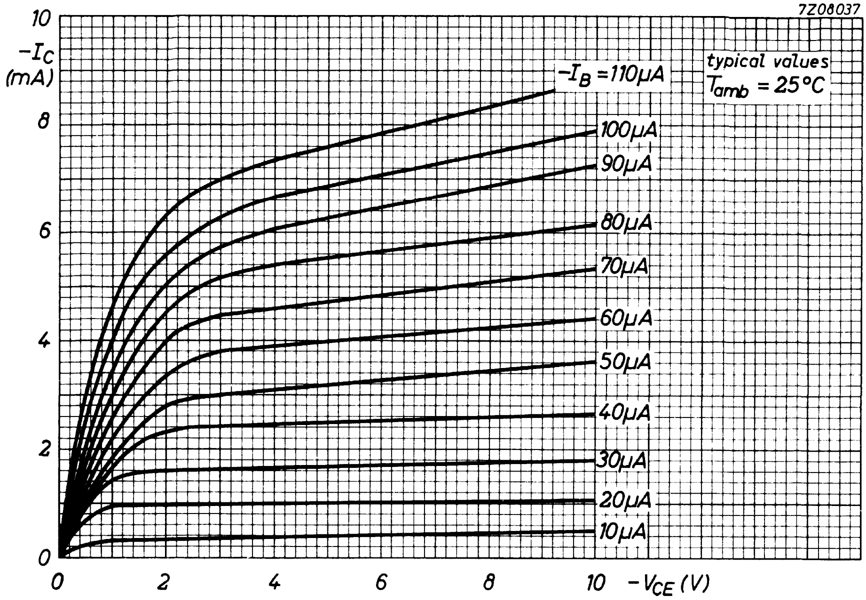


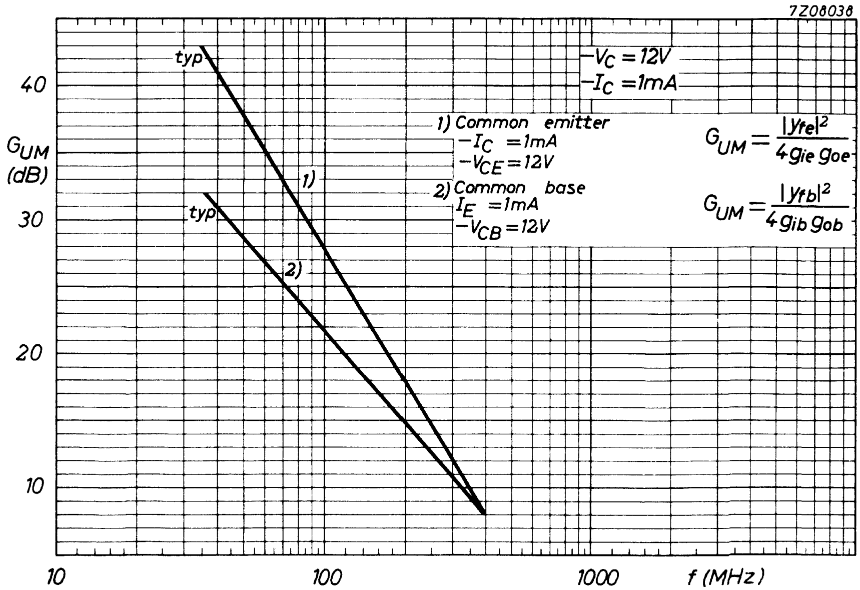
R is chosen such that the total load impedance R_ℓ (R and the tuned circuit in parallel) is 2 kΩ.
L = ferrite bead

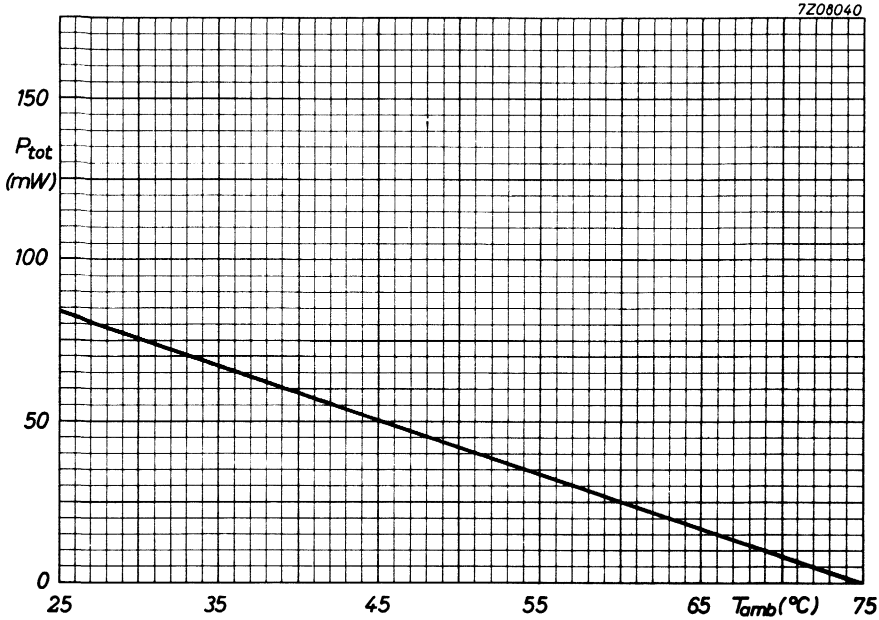
1) Measured with a length of leads between transistor bottom and measuring jig of 5 mm.

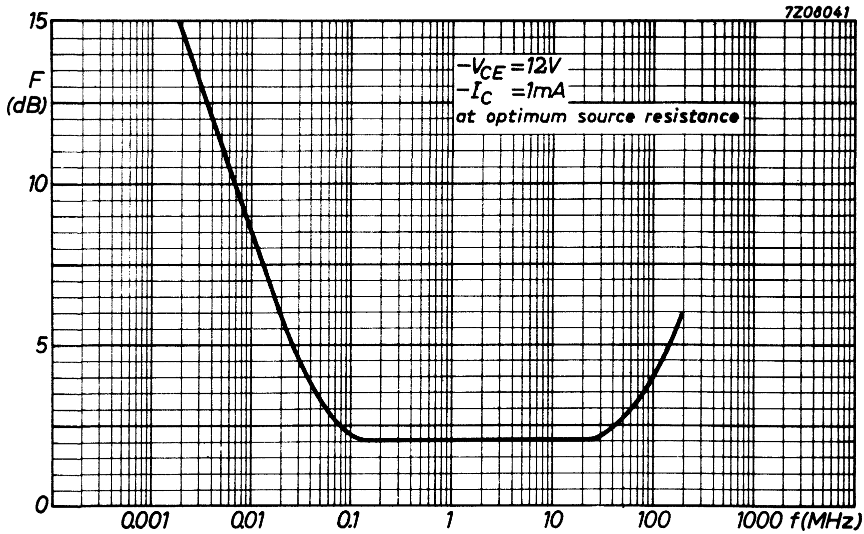

7Z08035
$-V_{CE}$ = 6V
T_{amb} = 25°C
typ
$-I_C$ (mA)
10
8
6
4
2
0
$-I_B$ (μA)
0
50
100
150

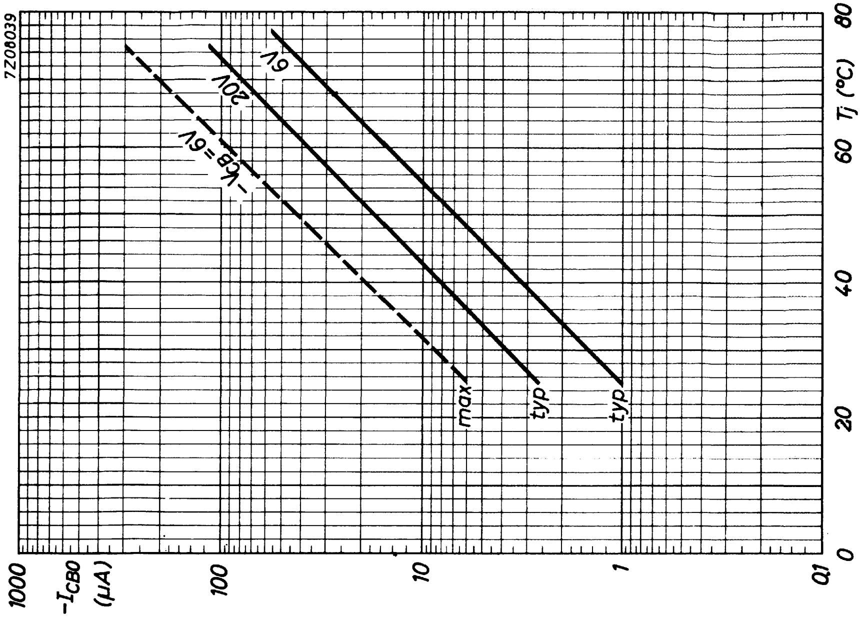

7Z08036
$-V_{CE}$ = 6V
T_{amb} = 25°C
typ
$-I_C$ (mA)
10
8
6
4
2
0
$-V_{BE}$ (mV)
0
200
400
600

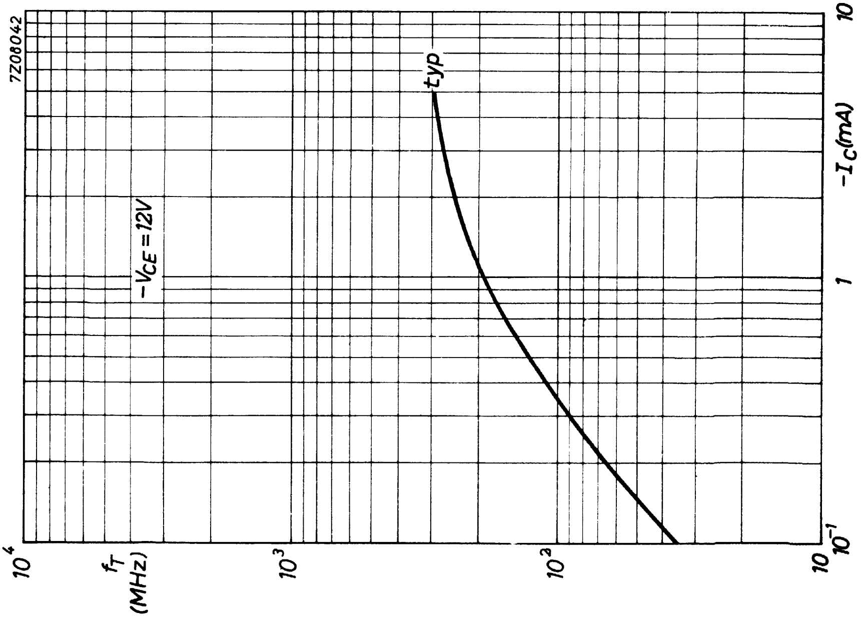

7Z08037
10
$-I_C$
(mA)
8
6
4
2
0
0
2
4
6
8
10
$-V_{CE}$ (V)
typical values
T_{amb} = 25 °C
$-I_B$ = 110µA
100µA
90µA
80µA
70µA
60µA
50µA
40µA
30µA
20µA
10µA

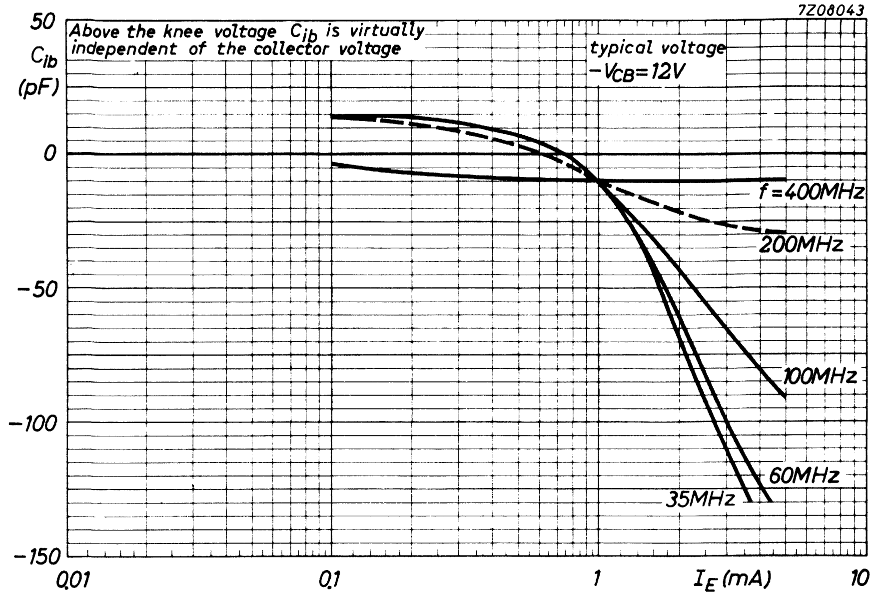

7Z08038
40
G_{UM}
(dB)
30
20
10
10
100
1000
f (MHz)
typ
typ
1)
2)
$-V_C$ = 12V
$-I_C$ = 1mA
1) Common emitter
$-I_C$ = 1mA
$-V_{CE}$ = 12V
2) Common base
I_E = 1mA
$-V_{CB}$ = 12V
$G_{UM} = \frac{|y_{fe}|^2}{4 g_{ie} g_{oe}}$
$G_{UM} = \frac{|y_{fb}|^2}{4 g_{ib} g_{ob}}$

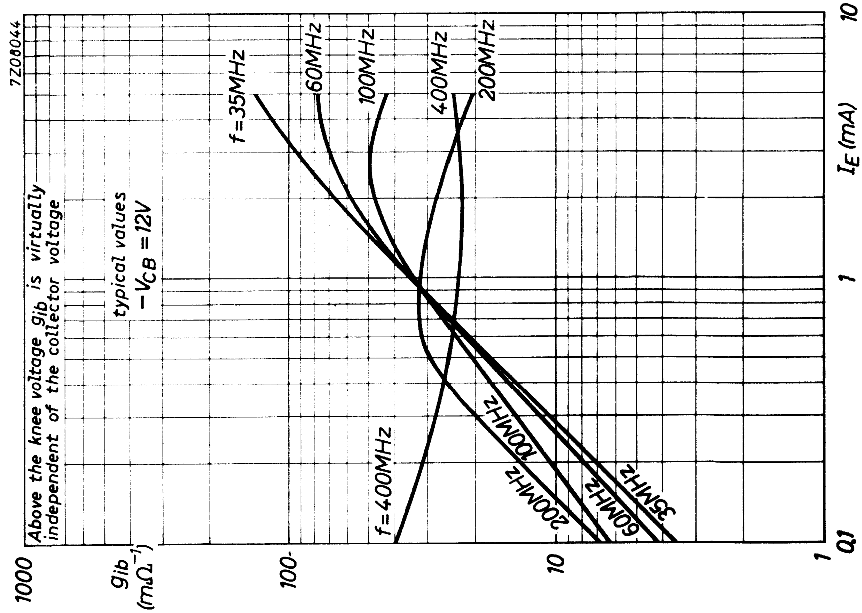

7Z08040
150
P_{tot}
(mW)
100
50
0
25
35
45
55
65
T_{amb}(°C)
75

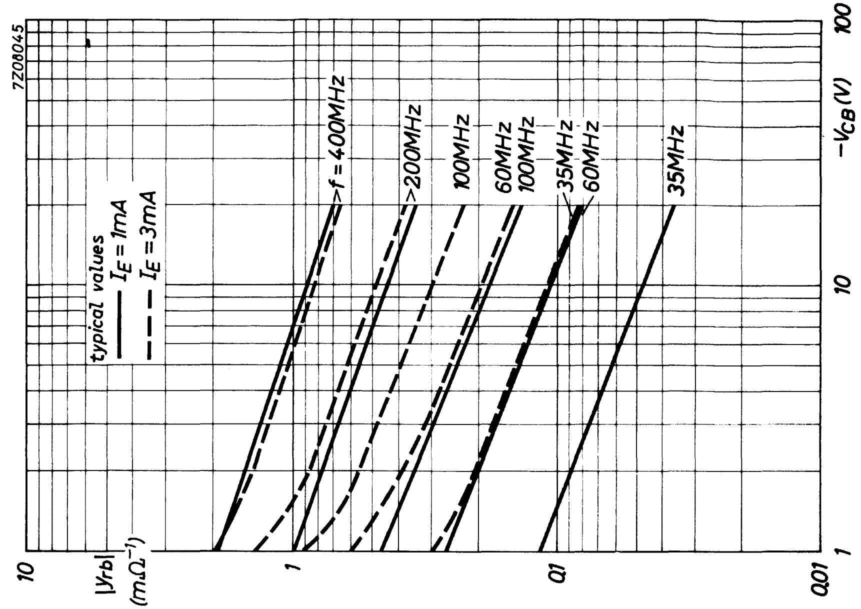

7Z08041
15
F
(dB)
10
5
0
$-V_{CE}$ = 12V
$-I_C$ = 1mA
at optimum source resistance
0.001
0.01
0.1
1
10
100
1000 f(MHz)

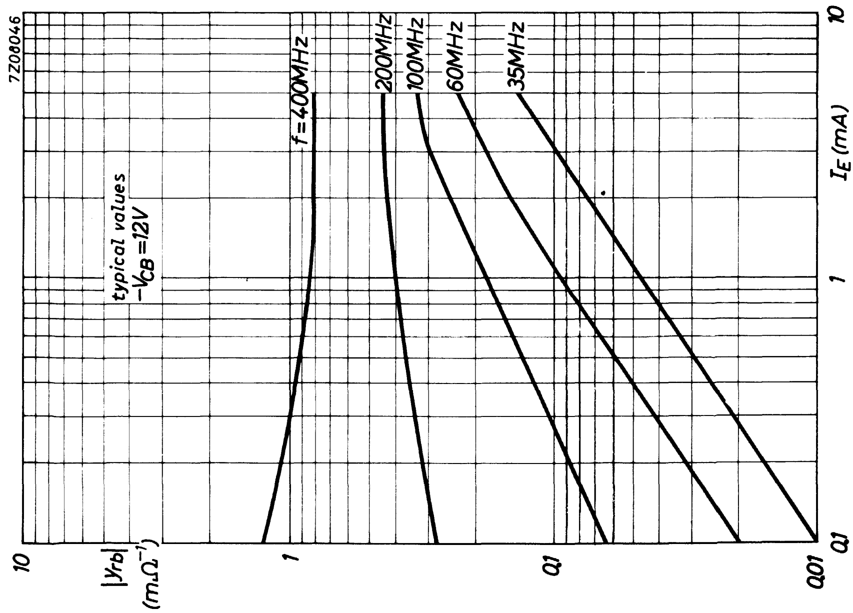

7Z08039
1000
$-I_{CBO}$ (μA)
100
10
1
0.1
0
20
40
60
80
T_j (°C)
$-V_{CB}$=6V
20V
6V
max
typ
typ

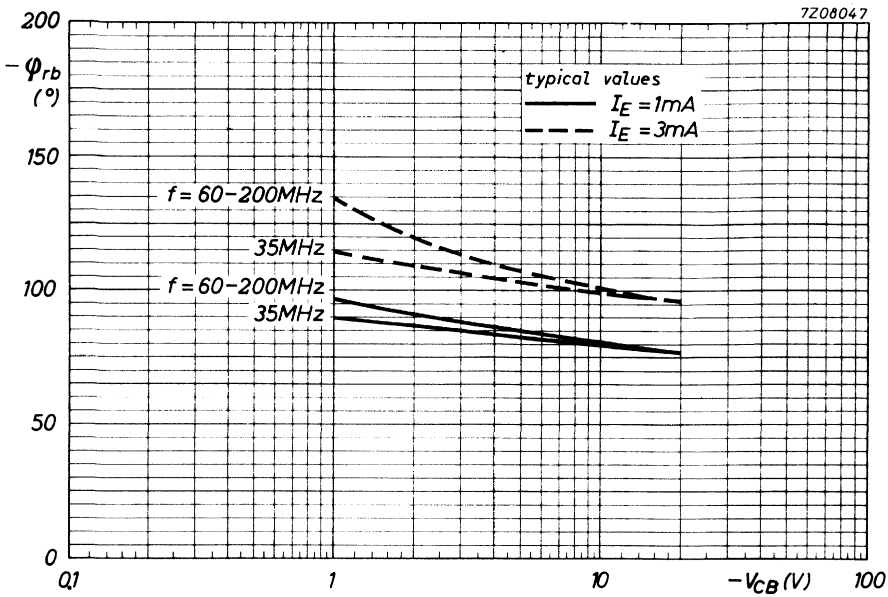

7Z08042
10^4
f_T (MHz)
10^3
10^3
10
10^{-1}
1
10
$-I_C$(mA)
$-V_{CE}$=12V
typ

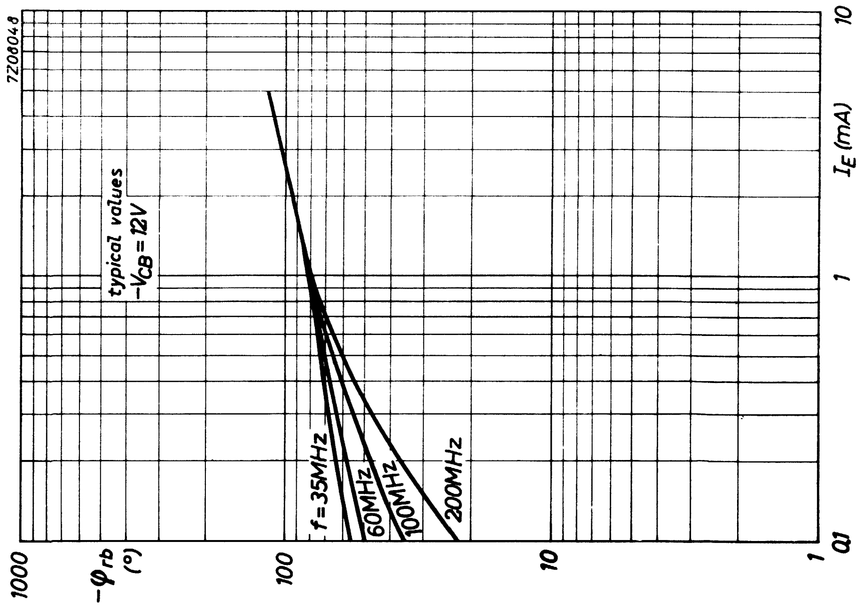

7Z08043
Above the knee voltage C_{ib} is virtually independent of the collector voltage
typical voltage
$-V_{CB}=12V$
50
C_{ib} (pF)
0
-50
-100
-150
f =400MHz
200MHz
100MHz
60MHz
35MHz
0.01
0.1
1
I_E (mA)
10

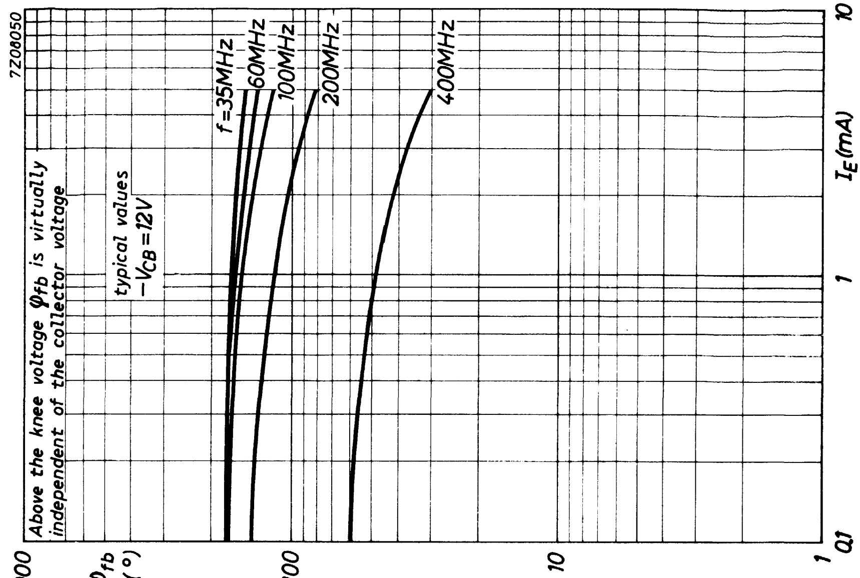

7Z08044
Above the knee voltage g_{ib} is virtually independent of the collector voltage
typical values
$-V_{CB}=12V$
f =35MHz
60MHz
100MHz
400MHz
200MHz
f =400MHz
200MHz
100MHz
60MHz
35MHz
I_E (mA)
10
1
0.1
1000
g_{ib} (mΩ^{-1})
100
10
1

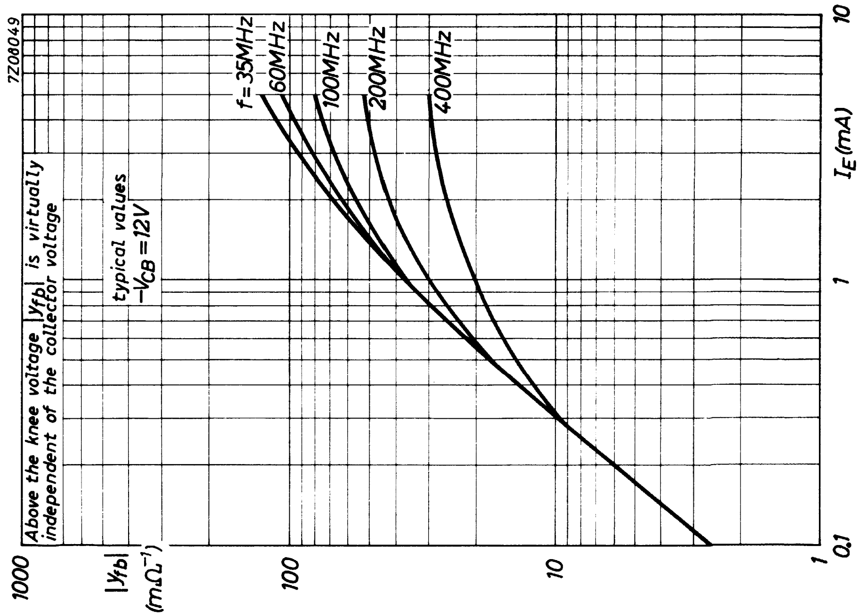

7Z08045
typical values
$I_E = 1mA$
$I_E = 3mA$
>f = 400MHz
>200MHz
100MHz
60MHz
100MHz
35MHz
60MHz
35MHz
$|y_{rb}|$ $(m\Omega^{-1})$
10
1
0.1
0.01
1
10
100
$-V_{CB}(V)$

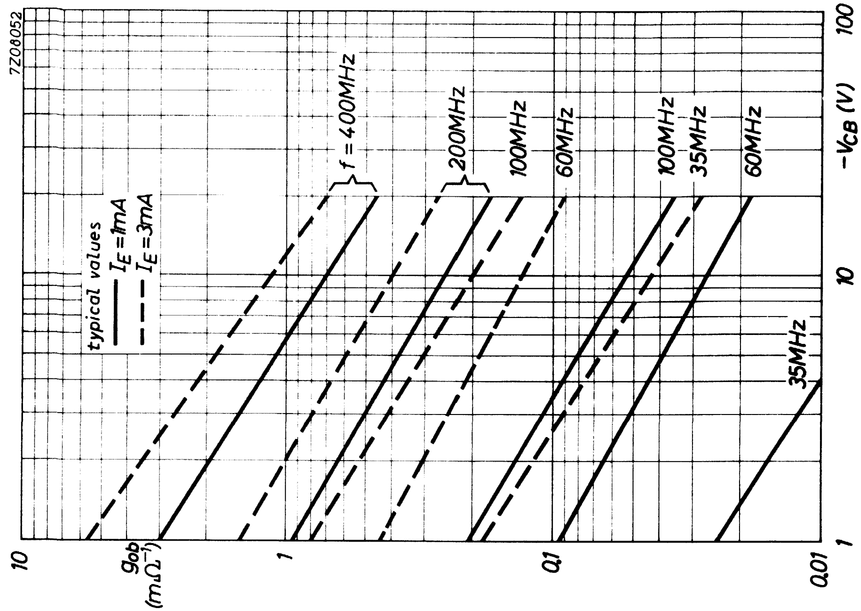

7Z08046
typical values
$-V_{CB} = 12V$
f = 400MHz
200MHz
100MHz
60MHz
35MHz
$|y_{rb}|$ $(m\Omega^{-1})$
10
1
0.1
0.01
0.1
1
10
$I_E (mA)$

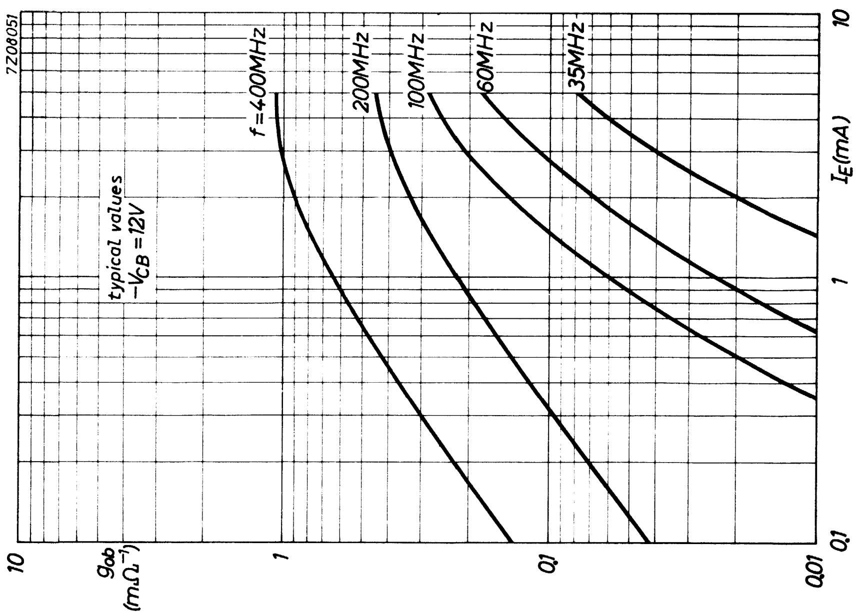

7Z08047
200
$-\varphi_{rb}$
(°)
150
100
50
0
0,1
1
10
$-V_{CB}$ (V)
100
typical values
I_E = 1mA
I_E = 3mA
f = 60–200MHz
35MHz
f = 60–200MHz
35MHz

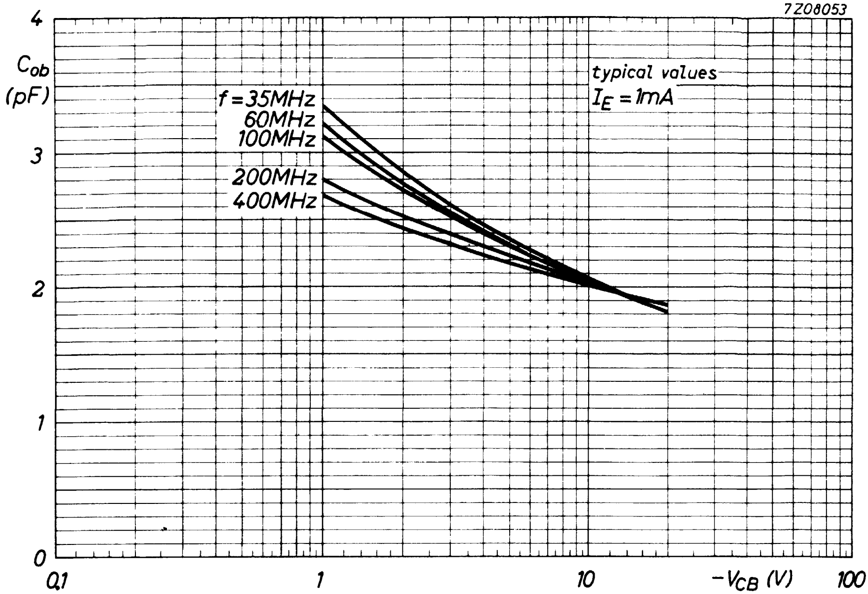

7Z08048
typical values
$-V_{CB}$ = 12V
I_E (mA)
10
1
0,1
1000
$-\varphi_{rb}$
(°)
100
10
1
f = 35MHz
60MHz
100MHz
200MHz

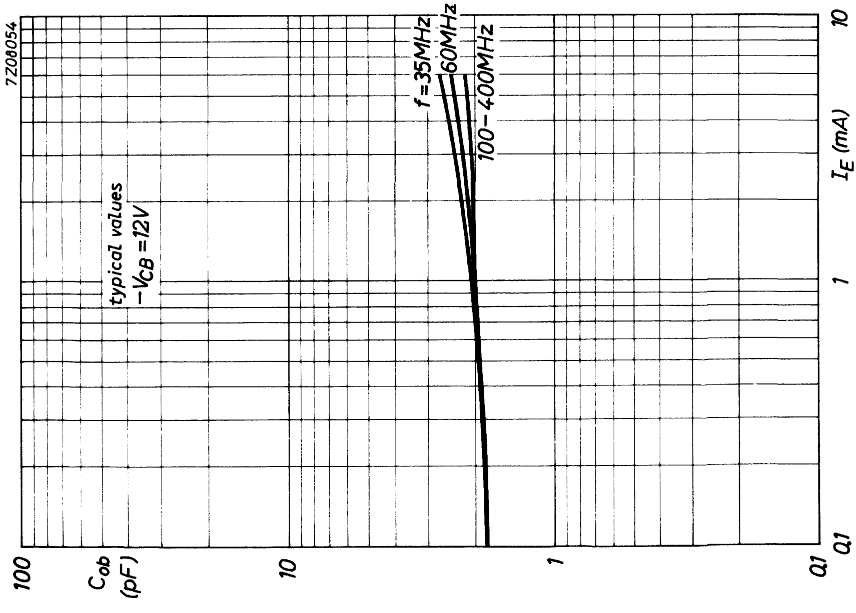

7Z08050
Above the knee voltage φ_{fb} is virtually independent of the collector voltage
typical values
$-V_{CB} = 12V$
f = 35MHz
60MHz
100MHz
200MHz
400MHz
φ_{fb} (°)
1000
100
10
1
0.1
1
10
I_E (mA)

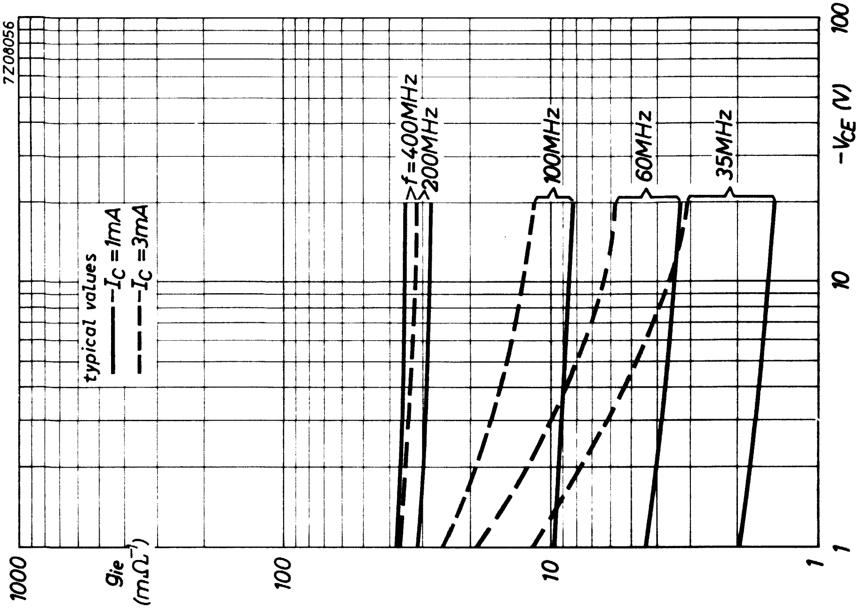

7Z08049
Above the knee voltage $|y_{fb}|$ is virtually independent of the collector voltage
typical values
$-V_{CB} = 12V$
f = 35MHz
60MHz
100MHz
200MHz
400MHz
$|y_{fb}|$ (mΩ^{-1})
1000
100
10
1
0.1
1
10
I_E (mA)

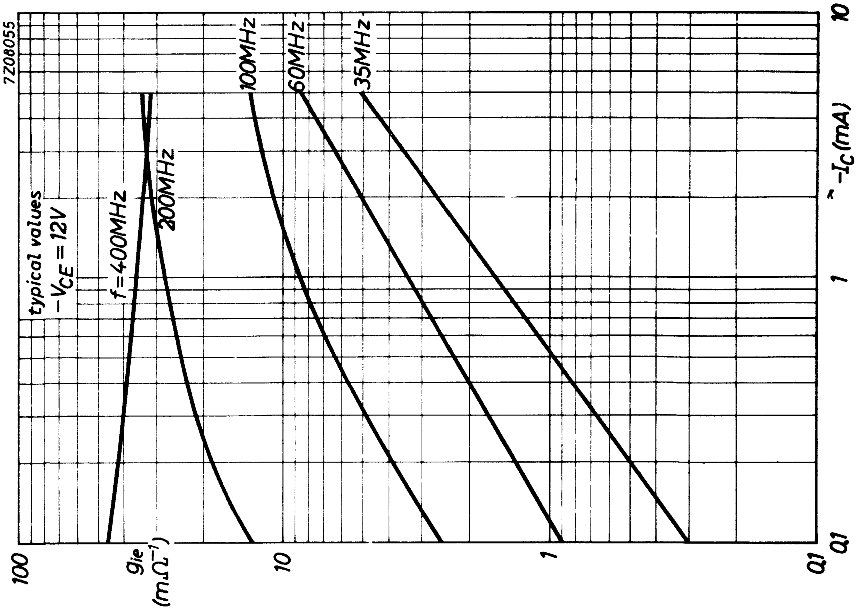

7Z08052
typical values
I_E = 1mA
I_E = 3mA
f = 400MHz
200MHz
100MHz
60MHz
100MHz
35MHz
60MHz
35MHz
g_ob (mΩ⁻¹)
10
1
0.1
0.01
−V_CB (V)
1
10
100

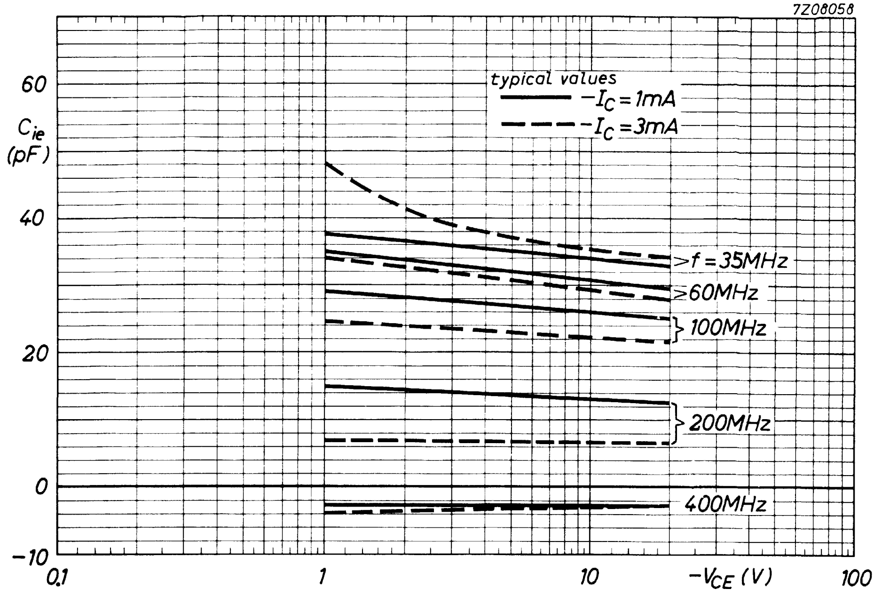

7Z08051
typical values
−V_CB = 12V
f = 400MHz
200MHz
100MHz
60MHz
35MHz
g_ob (mΩ⁻¹)
10
1
0.1
0.01
I_E (mA)
0.1
1
10

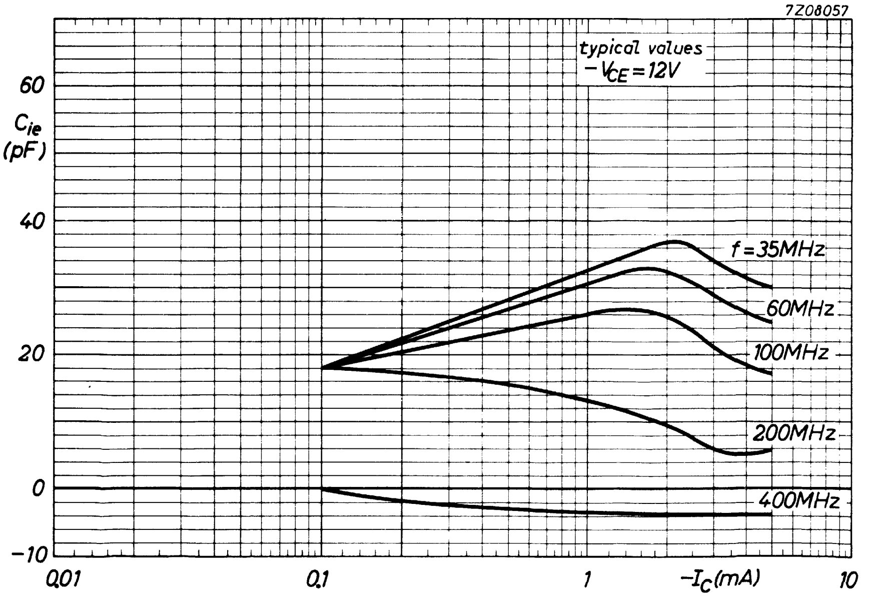

7Z08053
4
3
2
1
0
C_{ob} (pF)
typical values
$I_E = 1mA$
f = 35MHz
60MHz
100MHz
200MHz
400MHz
0.1
1
10
100
$-V_{CB}$ (V)

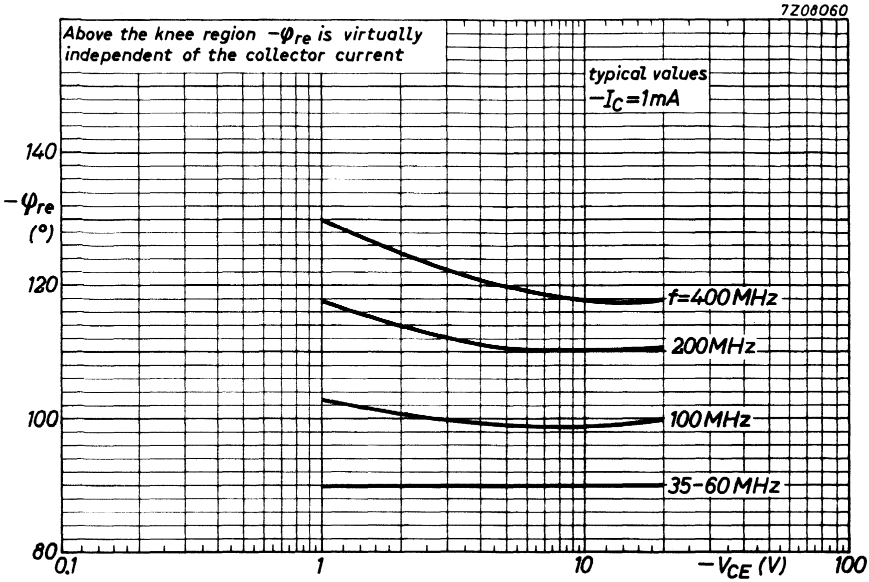

7Z08054
typical values
$-V_{CB} = 12V$
f = 35MHz
60MHz
100−400MHz
I_E (mA)
10
1
0.1
100
10
1
0.1
C_{ob} (pF)

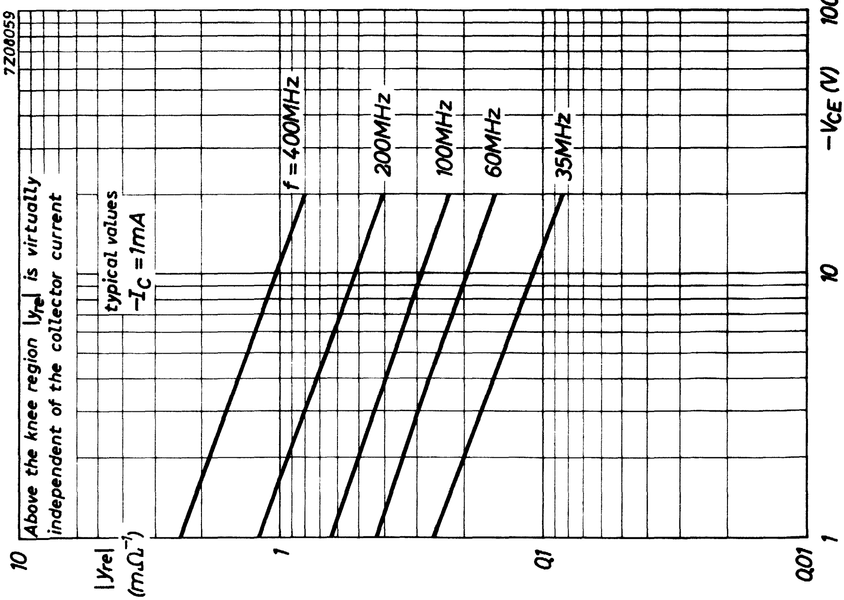

7Z08056
typical values
$-I_C = 1mA$
$-I_C = 3mA$
f=400MHz
200MHz
100MHz
60MHz
35MHz
g_{ie} $(m\Omega^{-1})$
1000
100
10
1
1
10
100
$-V_{CE}$ (V)

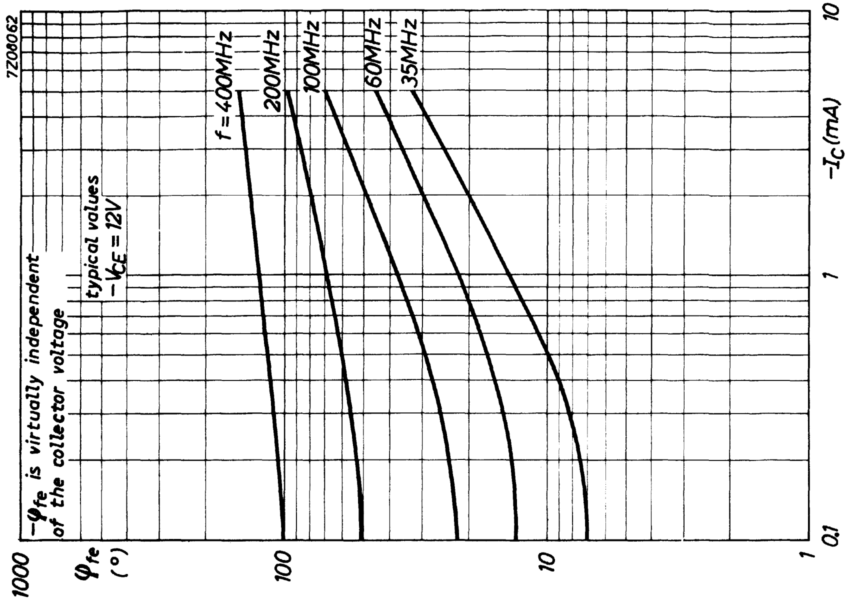

7Z08055
typical values
$-V_{CE} = 12V$
f=400MHz
200MHz
100MHz
60MHz
35MHz
g_{ie} $(m\Omega^{-1})$
100
10
1
0.1
0.1
1
10
$-I_C$ (mA)

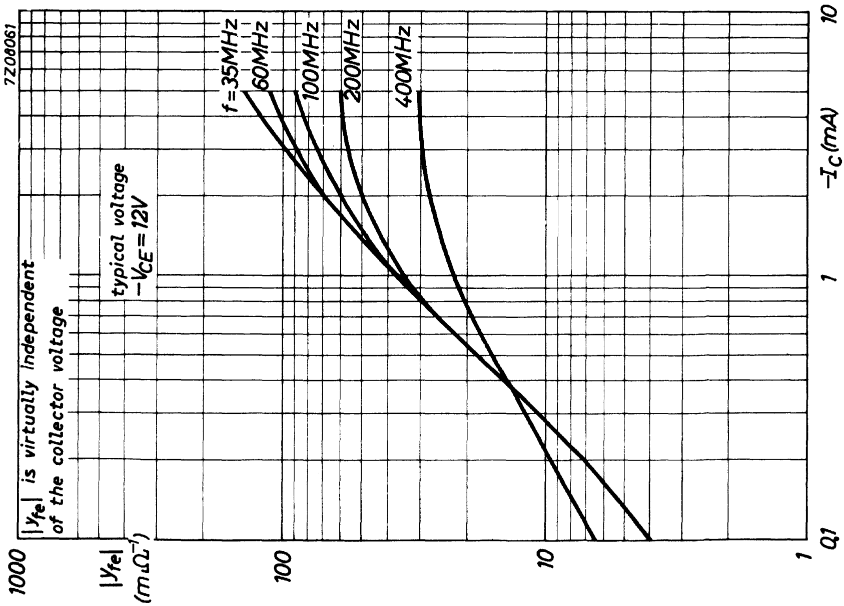

7Z08058
typical values
$-I_C = 1mA$
$-I_C = 3mA$
C_{ie} (pF)
60
40
20
0
−10
>f = 35MHz
>60MHz
} 100MHz
} 200MHz
400MHz
0,1
1
10
$-V_{CE}$ (V)
100


7Z08057
typical values
$-V_{CE} = 12V$
C_{ie} (pF)
60
40
20
0
−10
f = 35MHz
60MHz
100MHz
200MHz
400MHz
0,01
0,1
1
$-I_C$(mA)
10


7Z08060
Above the knee region $-\varphi_{re}$ is virtually independent of the collector current
typical values
$-I_C$=1mA
140
$-\varphi_{re}$
(°)
120
100
80
f=400MHz
200MHz
100MHz
35-60MHz
0.1
1
10
$-V_{CE}$ (V)
100


7Z08059
Above the knee region $|y_{re}|$ is virtually independent of the collector current
typical values
$-I_C$ =1mA
f =400MHz
200MHz
100MHz
60MHz
35MHz
$-V_{CE}$ (V)
100
10
1
10
$|y_{re}|$
(mΩ^{-1})
1
0.1
0.01


7Z08062
−φfe is virtually independent of the collector voltage
typical values
−VCE = 12V
f = 400MHz
200MHz
100MHz
60MHz
35MHz
1000
φfe (°)
100
10
1
0.1
1
10
−IC (mA)


7Z08061
|yfe| is virtually independent of the collector voltage
typical voltage
−VCE = 12V
f = 35MHz
60MHz
100MHz
200MHz
400MHz
1000
|yfe| (mΩ⁻¹)
100
10
1
0.1
1
10
−IC (mA)

GERMANIUM ALLOYED TRANSISTORS

P-N-P transistors in a TO-5 metal envelope with the base connected to the case. These general purpose transistors are primarily intended for medium current medium speed computer logic applications.

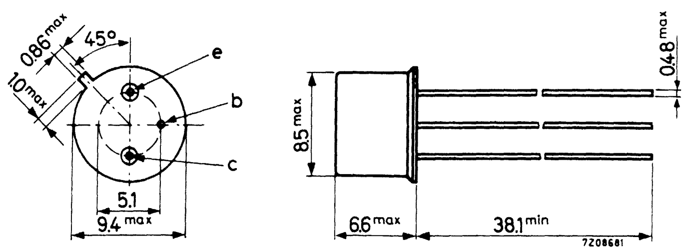
RATINGS Limiting values according to the Absolute Maximum System as defined in IEC publication 134.

Voltages			ASY26	ASY27	
Collector-base voltage (open emitter)	$-V_{CBO}$	max.	30	25	V
Collector-emitter voltage (open base)	$-V_{CEO}$	max.	15	15	V
Collector-emitter voltage at $+V_{BE} = 0.2$ V	$-V_{CEX}$	max.	25	20	V
Emitter-base voltage (open collector)	$-V_{EBO}$	max.	20	20	V

Currents				
Collector current (d.c. or average over any 20 ms period)	$-I_C$	max.	200	mA
Collector current (peak value)	$-I_{CM}$	max.	300	mA
Power dissipation				
Total power dissipation up to $T_{amb} = 25\ ^oC$	P_{tot}	max.	150	mW
Temperatures				
Storage temperature	T_{stg}		-65 to +100	^oC
Junction temperature	T_j	max.	85	^oC

MECHANICAL DATA Dimensions in mm

TO-5
Base connected to case



Accessories available: 56218, 56245, 56265

THERMAL RESISTANCE

From junction to ambient in free air	$R_{th\ j\text{-}a}$	=	0.4	$^oC/mW$
From junction to case	$R_{th\ j\text{-}c}$	=	0.2	$^oC/mW$

CHARACTERISTICS

$T_j = 25\ ^oC$ unless otherwise specified

			ASY26	ASY27	
Collector cut-off current					
$I_E = 0;\ -V_{CB} = 30$ V	$-I_{CBO}$	<	7		μA
$I_E = 0;\ -V_{CB} = 25$ V	$-I_{CBO}$	<		7	μA
$I_E = 0;\ -V_{CB} = 30$ V; $T_j = 60\ ^oC$	$-I_{CBO}$	<	35		μA
$I_E = 0;\ -V_{CB} = 25$ V; $T_j = 60\ ^oC$	$-I_{CBO}$	<		35	μA
Emitter cut-off current					
$I_C = 0;\ -V_{EB} = 5$ V	$-I_{EBO}$	<	3	3	μA
Currents at reverse biased emitter junction					
$-V_{CE} = 25$ V; $+V_{BE} = 0.2$ V; $T_j = 60\ ^oC$	$-I_{CEX}$	<	35		μA
$-V_{CE} = 20$ V; $+V_{BE} = 0.2$ V; $T_j = 60\ ^oC$	$-I_{CEX}$	<		35	μA
$-V_{CE} = 20$ V; $+V_{BE} = 5$ V; $T_j = 60\ ^oC$	$+I_{BEX}$	<	35	35	μA
Base-emitter voltage					
$-I_C = 100$ mA; $-V_{CE} = 1$ V	$-V_{BE}$	<	0.65	0.55	V
$-I_C = 300$ mA; $-V_{CE} = 1$ V	$-V_{BE}$	<	1.5	1.4	V
Collector-emitter saturation voltage					
$-I_C = 10$ mA; $-I_B = 0.33$ mA	$-V_{CE\,sat}$	<	0.20		V
$-I_C = 10$ mA; $-I_B = 0.2$ mA	$-V_{CE\,sat}$	<		0.20	V
$-I_C = 50$ mA; $-I_B = 2$ mA	$-V_{CE\,sat}$	<	0.25		V
$-I_C = 50$ mA; $-I_B = 1.25$ mA	$-V_{CE\,sat}$	<		0.25	V
Base-emitter saturation voltage					
$-I_C = 10$ mA; $-I_B = 0.4$ mA	$-V_{BE\,sat}$	> <	0.20 0.37		V V
$-I_C = 10$ mA; $-I_B = 0.25$ mA	$-V_{BE\,sat}$	> <		0.15 0.32	V V
$-I_C = 50$ mA; $-I_B = 2.4$ mA	$-V_{BE\,sat}$	<	0.55		V
$-I_C = 50$ mA; $-I_B = 1.55$ mA	$-V_{BE\,sat}$	<		0.45	V

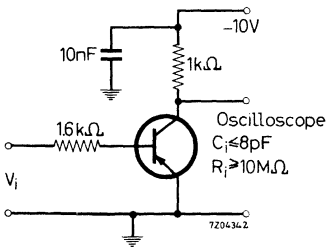
CHARACTERISTICS (continued) T_j = 25 °C unless otherwise specified

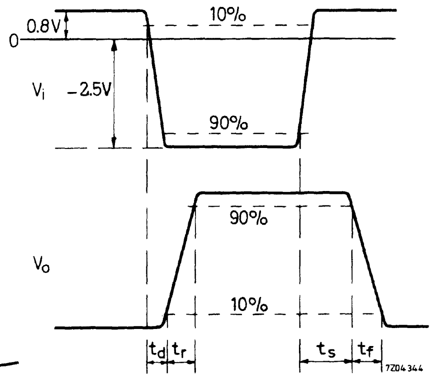
			ASY26	ASY27	
Collector-emitter sustaining voltage					
$-I_C$ = 5 mA; I_B = 0	$-V_{CEO\,sust}$	>	15	15	V
Punch through voltage	V_{pt}	>	25	20	V
Base-emitter floating voltage					
I_B = 0; $-V_{CE}$ = 25 V; T_j = 60 °C	$-V_{BE\,fl}$	<	0.20		V
I_B = 0; $-V_{CE}$ = 20 V; T_j = 60 °C	$-V_{BE\,fl}$	<		0.20	V
D.C. current gain					
$-I_C$ = 10 mA; $-V_{CE}$ = 1 V	h_{FE}	>	30	50	
		typ.	45	80	
$-I_C$ = 20 mA; $-V_{CE}$ = 1 V	h_{FE}	>	30	50	
		typ.	47	78	
		<	80	150	
$-I_C$ = 100 mA; $-V_{CE}$ = 1 V	h_{FE}	>	20	30	
		typ.	39	58	
$-I_C$ = 200 mA; $-V_{CE}$ = 1 V	h_{FE}	>	15	20	
		typ.	27	40	
Collector capacitance at f = 1 MHz					
$I_E = I_e$ = 0; $-V_{CB}$ = 5 V	C_c	typ.	11	11	pF
		<	16	16	pF
Emitter capacitance at f = 1 MHz					
$I_C = I_c$ = 0; $-V_{EB}$ = 5 V	C_e	typ.	7	6	pF
		<	13	13	pF
Transition frequency					
$-I_C$ = 3 mA; $-V_{CE}$ = 5 V	f_T	>	4	6	MHz
		typ.	8	14	MHz
h parameters at f = 1 kHz					
$-I_C$ = 2 mA; $-V_{CE}$ = 5 V					
Input impedance	h_{ie}	typ.	0.75	1.4	kΩ
Reverse voltage transfer ratio	h_{re}	typ.	5.0	7.5	10^{-4}
Small signal current gain	h_{fe}	typ.	50	90	
Output admittance	h_{oe}	typ.	65	100	$\mu\Omega^{-1}$

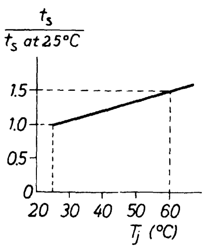
CHARACTERISTICS (continued) T_j = 25 °C unless otherwise specified

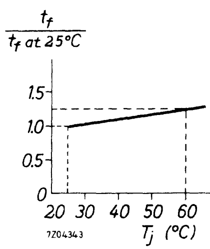
Switching characteristics			ASY26	ASY27	
Desaturation time constant $I_C = 0;\ -I_B = 1$ mA	τ_s	<	1.25	1.25	μs
Current feed time constant $-I_{CM} = 50$ mA; $-V_{CE} = 0.75$ V	τ_c	<	2.2	2.2	μs
Voltage feed time constant $-I_{CM} = 1$ mA; $-V_{CE} = 0.75$ V	τ_v	<	0.2	0.2	μs
Switching times (See test circuit)					
delay time	t_d	typ.	65	50	ns
		<	90	75	ns
rise time	t_r	typ.	275	200	ns
		<	490	350	ns
storage time	t_s	typ.	500	600	ns
		<	1350	1500	ns
fall time	t_f	typ.	475	400	ns
		<	730	620	ns

Test circuit:









GERMANIUM ALLOYED TRANSISTORS

N-P-N transistors in a TO-5 metal envelope with the base connected to the case. These general purpose transistors are primarily intended for medium current medium speed computor logic applications.

RATINGS Limiting values according to the Absolute Maximum System as defined in IEC publication 134.

Voltages			ASY28	ASY29	
Collector-base voltage (open emitter)	V_{CBO}	max.	30	25	V
Collector-emitter voltage (open base)	V_{CEO}	max.	15	15	V
Collector-emitter voltage at $-V_{BE}$ = 0.2 V	V_{CEX}	max.	25	20	V
Emitter-base voltage (open collector)	V_{EBO}	max.	20	20	V

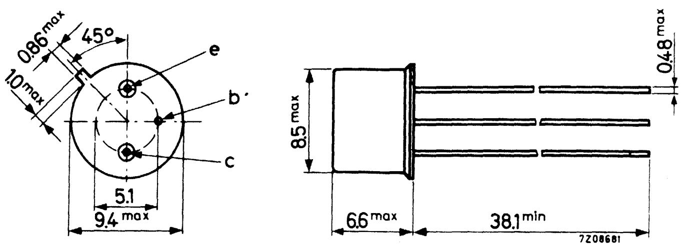
Currents				
Collector current (d.c. or average over any 20 ms period)	I_C	max.	200	mA
Collector current (peak value)	I_{CM}	max.	300	mA

Power dissipation				
Total power dissipation up to T_{amb} = 25 °C	P_{tot}	max.	150	mW

Temperatures				
Storage temperature	T_{stg}		-65 to +100	°C
Junction temperature	T_j	max.	85	°C

MECHANICAL DATA Dimensions in mm

TO-5
Base connected to case



Accessories available: 56218, 56245, 56263.

THERMAL RESISTANCE

From junction to ambient in free air	$R_{th\ j-a}$	=	0.4	°C/mW
From junction to case	$R_{th\ j-c}$	=	0.2	°C/mW

CHARACTERISTICS T_j = 25 °C unless otherwise specified

			ASY28	ASY29	
Collector cut-off current					
I_E = 0; V_{CB} = 30 V	I_{CBO}	<	7		μA
I_E = 0; V_{CB} = 25 V	I_{CBO}	<		7	μA
I_E = 0; V_{CB} = 30 V; T_j = 60 °C	I_{CBO}	<	35		μA
I_E = 0; V_{CB} = 25 V; T_j = 60 °C	I_{CBO}	<		35	μA
Emitter cut-off current					
I_C = 0; V_{EB} = 5 V	I_{EBO}	<	3	3	μA
Currents at reverse biased emitter junction					
V_{CE} = 25 V; $-V_{BE}$ = 0.2 V; T_j = 60 °C	I_{CEX}	<	35		μA
V_{CE} = 20 V; $-V_{BE}$ = 0.2 V; T_j = 60 °C	I_{CEX}	<		35	μA
V_{CE} = 20 V; $-V_{BE}$ = 5 V; T_j = 60 °C	$-I_{BEX}$	<	35	35	μA
Base-emitter voltage					
I_C = 100 mA; V_{CE} = 1 V	V_{BE}	<	0.65	0.55	V
I_C = 300 mA; V_{CE} = 1 V	V_{BE}	<	1.5	1.4	V
Collector-emitter saturation voltage					
I_C = 10 mA; I_B = 0.33 mA	$V_{CE\,sat}$	<	0.20		V
I_C = 10 mA; I_B = 0.2 mA	$V_{CE\,sat}$	<		0.20	V
I_C = 50 mA; I_B = 2 mA	$V_{CE\,sat}$	<	0.25		V
I_C = 50 mA; I_B = 1.25 mA	$V_{CE\,sat}$	<		0.25	V
Base-emitter saturation voltage					
I_C = 10 mA; I_B = 0.4 mA	$V_{BE\,sat}$	>	0.20		V
		<	0.37		V
I_C = 10 mA; I_B = 0.25 mA	$V_{BE\,sat}$	>		0.15	V
		<		0.32	V
I_C = 50 mA; I_B = 2.4 mA	$V_{BE\,sat}$	<	0.55		V
I_C = 50 mA; I_B = 1.55 mA	$V_{BE\,sat}$	<		0.45	V

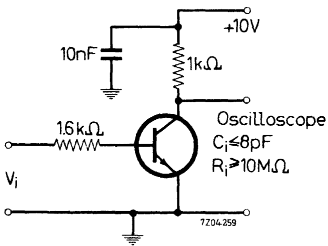
CHARACTERISTICS (continued) T_j = 25 °C unless otherwise specified

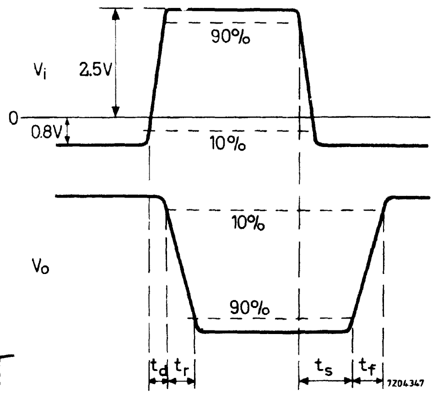
			ASY28	ASY29	
Collector-emitter sustaining voltage					
I_C = 5 mA; I_B = 0	$V_{CEO\,sust}$	>	15	15	V
Punch through voltage	V_{pt}	>	25	20	V
Base-emitter floating voltage					
I_B = 0; V_{CE} = 25 V; T_j = 60 °C	$V_{BE\,fl}$	<	0.20		V
I_B = 0; V_{CE} = 20 V; T_j = 60 °C	$V_{BE\,fl}$	<		0.20	V
D.C. current gain					
I_C = 10 mA; V_{CE} = 1 V	h_{FE}	>	30	50	
		typ.	43	113	
I_C = 20 mA; V_{CE} = 1 V	h_{FE}	>	30	50	
		typ.	46	113	
		<	80	150	
I_C = 100 mA; V_{CE} = 1 V	h_{FE}	>	20	30	
		typ.	43	102	
I_C = 200 mA; V_{CE} = 1 V	h_{FE}	>	15	20	
		typ.	32	84	
Collector capacitance at f = 1 MHz					
$I_E = I_e$ = 0; V_{EB} = 5 V	C_c	typ.	11	11	pF
		<	16	16	pF
Emitter capacitance at f = 1 MHz					
$I_C = I_c$ = 0; V_{EB} = 5 V	C_e	typ.	7	6	pF
		<	13	13	pF
Transition frequency					
I_C = 3 mA; V_{CE} = 5 V	f_T	>	4	10	MHz
		typ.	14	20	MHz
h parameters at f = 1 kHz					
I_C = 2 mA; V_{CE} = 5 V					
Input impedance	h_{ie}	typ.	0.75	1.4	kΩ
Reverse voltage transfer ratio	h_{re}	typ.	3.5	5.0	10^{-4}
Small signal current gain	h_{fe}	typ.	50	90	
Output admittance	h_{oe}	typ.	45	70	$\mu\Omega^{-1}$

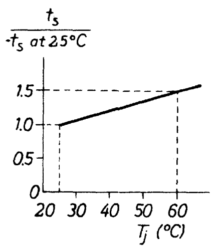
CHARACTERISTICS (continued) T_j = 25 °C unless otherwise specified

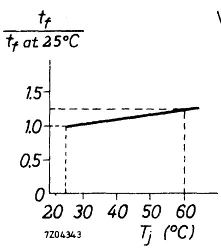
Switching characteristics			ASY28	ASY29	
Desaturation time constant $I_C = 0$; $I_B = 1$ mA	τ_s	<	1.4	1.4	μs
Current feed time constant $I_{CM} = 50$ mA; $V_{CE} = 0.75$ V	τ_c	<	2.2	2.2	μs
Voltage feed time constant $I_{CM} = 1$ mA; $V_{CE} = 5$ V	τ_v	<	0.2	0.2	μs
Switching times (See test circuit)					
delay time	t_d	typ.	50	45	ns
		<	90	75	ns
rise time	t_r	typ.	175	140	ns
		<	400	300	ns
storage time	t_s	typ.	450	500	ns
		<	700	800	ns
fall time	t_f	typ.	325	300	ns
		<	620	520	ns

Test circuit:









GERMANIUM ALLOYED TRANSISTORS

P-N-P transistors in all-glass construction for medium current, medium speed computer logic applications.

RATINGS (Limiting values) [1])

Voltages

Collector-base voltage (open emitter)	$-V_{CBO}$	max.	25	V
Collector-emitter voltage (open base)	$-V_{CEO}$	max.	15	V
Collector-emitter voltage ($+V_{BE}$ = 0.2 V)	$-V_{CEX}$	max.	20	V
Emitter-base voltage (open collector)	$-V_{EBO}$	max.	20	V

Currents

Collector current (d.c. or average over any 20 ms period)	$-I_C$	max.	100	mA
Collector current (peak value)	$-I_{CM}$	max.	200	mA

Power dissipation

Total power dissipation up to T_{amb} = 25 °C	P_{tot}	max.	125	mW

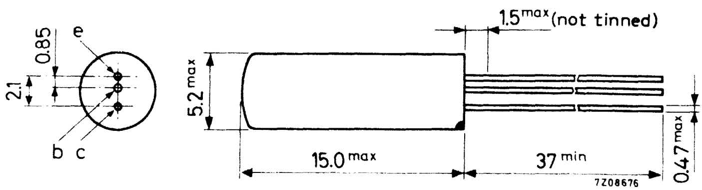
Temperatures

Storage temperature	T_{stg}	-55 to +75		°C
Junction temperature	T_j	max.	75	°C

THERMAL RESISTANCE

From junction to ambient in free air	$R_{th\ j\text{-}a}$	=	0.4	°C/mW
From junction to case	$R_{th\ j\text{-}c}$	=	0.2	°C/mW

MECHANICAL DATA Dimensions in mm



The coloured dot indicates the collector

[1]) Limiting values according to the Absolute Maximum System as defined in IEC publication 134.

CHARACTERISTICS T_j = 25 °C unless otherwise specified

Collector cut-off current				
$I_E = 0$; $-V_{CB} = 5$ V	$-I_{CBO}$	<	3	μA
Emitter cut-off current				
$I_C = 0$; $-V_{EB} = 5$ V	$-I_{EBO}$	<	3	μA
Currents at reverse biased emitter junction				
$-V_{CE} = 20$ V; $+V_{BE} = 0.2$ V; $T_j = 60$ °C	$-I_{CEX}$	<	35	μA
$-V_{CE} = 20$ V; $+V_{BE} = 5$ V; $T_j = 60$ °C	$+I_{BEX}$	<	35	μA
Collector-emitter sustaining voltage				
$-I_C = 5$ mA; $I_B = 0$	$-V_{CEOsust}$	>	15	V
Punch-through voltage	V_{pt}	>	20	V
Base-emitter floating voltage				
$I_B = 0$; $-V_{CE} = 20$ V; $T_j = 60$ °C	$-V_{BEfl}$	<	0.20	V
Collector capacitance				
$I_E = I_e = 0$; $-V_{CB} = 5$ V	C_c	<	16	pF
Emitter capacitance				
$I_C = I_c = 0$; $-V_{EB} = 5$ V	C_e	<	13	pF
Switching characteristics				
Desaturation time constant $I_C = 0$; $-I_B = 1$ mA	τ_s	<	1.4	μs
Current feed time constant $-I_{CM} = 50$ mA; $-V_{CE} = 0.75$ V	τ_c	<	2.2	μs
Voltage feed time constant $-I_{CM} = 1$ mA; $-V_{CE} = 0.75$ V	τ_v	<	0.2	μs

CHARACTERISTICS (continued) T_j = 25 °C

			ASY31	ASY32	
Base-emitter voltage					
$-I_C$ = 50 mA; $-I_B$ = 1.55 mA	$-V_{BE}$	<	–	0.45	V
$-I_C$ = 50 mA; $-I_B$ = 2.4 mA	$-V_{BE}$	<	0.55	–	V
$-I_C$ = 100 mA; V_{CB} = 0	$-V_{BE}$	<	0.65	0.55	V
Saturation voltages					
$-I_C$ = 10 mA; $-I_B$ = 0.20 mA	$-V_{CEsat}$	<	–	0.20	V
$-I_C$ = 10 mA; $-I_B$ = 0.33 mA	$-V_{CEsat}$	<	0.20	–	V
$-I_C$ = 50 mA; $-I_B$ = 1.25 mA	$-V_{CEsat}$	<	–	0.25	V
$-I_C$ = 50 mA; $-I_B$ = 2 mA	$-V_{CEsat}$	<	0.25	–	V
$-I_C$ = 10 mA; $-I_B$ = 0.25 mA	$-V_{BEsat}$		–	0.15 to 0.32	V
$-I_C$ = 10 mA; $-I_B$ = 0.4 mA	$-V_{BEsat}$		0.20 to 0.37	–	V
D.C. current gain					
$-I_C$ = 10 mA; V_{CB} = 0	h_{FE}	>	30	50	
$-I_C$ = 20 mA; V_{CB} = 0	h_{FE}		30 to 80	50 to 150	
$-I_C$ = 100 mA; V_{CB} = 0	h_{FE}	>	20	30	
Transition frequency					
$-I_C$ = 3 mA; $-V_{CE}$ = 5 V	f_T	>	4	6	MHz

SYMMETRICAL N-P-N SWITCHING TRANSISTORS

Symmetrical N-P-N germanium alloy transistors in a TO-5 metal envelope with the base connected to the case intended for high current medium speed switching applications.

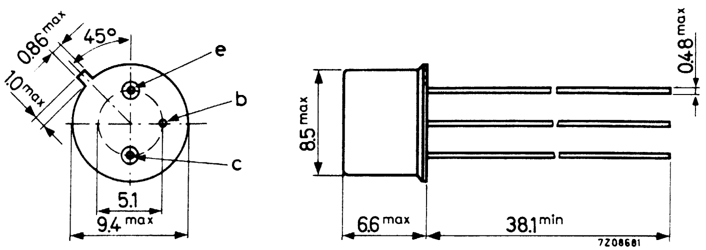
QUICK REFERENCE DATA

			ASY73	ASY74	ASY75	
Collector-base voltage (open emitter)	V_{CBO}	max.	30	30	30	V
Collector-emitter voltage (open base)	V_{CEO}	max.	15	15	15	V
Collector-current (d.c. or average)	I_C	max.	400	400	400	mA
Total power dissipation up to T_{amb} = 25 °C	P_{tot}	max.	140	140	140	mW
Junction temperature	T_j	max.	75	75	75	°C
D.C. current gain at T_j = 25 °C						
$-I_E$ = 200 mA; V_{CB} = 0	h_{FE}	>	20	35	50	
$-I_C$ = 200 mA; V_{EB} = 0	h_{FC}	>	12	20	20	
Transition frequency						
$-I_E$ = 3 mA; V_{CB} = 5 V	f_T	>	4	6	10	MHz
Desaturation time constant						
I_B = 1 mA; I_C = 0	τ_s		<1.75	1.75	1.75	μs

MECHANICAL DATA

Dimensions in mm

TO-5
Base connected to case



Accessories available: 56218, 56245, 56265.

RATINGS (Limiting values) [1])

Voltages

Collector-base voltage (open-emitter)	V_{CBO}	max.	30	V
Collector-emitter voltage (open base)	V_{CEO}	max.	15	V [2])
Collector-emitter voltage with $-V_{BE}$ = 0.2 V	V_{CEX}	max.	20	V [2])
Emitter-base voltage (open collector)	V_{EBO}	max.	30	V

Currents

Collector current (d.c. or average over any 20 ms period)	I_C	max.	400	mA
Emitter current (d.c. or average over any 20 ms period)	$-I_E$	max.	400	mA
Base current (d.c. or average over any 20 ms period)	I_B	max.	40	mA
Base current (peak value)	I_{BM}	max.	400	mA

Power dissipation

Total steady state power dissipation up to T_{amb} = 25 ^oC	P_{tot}	max.	140	mW

Temperatures

Storage temperature	T_{stg}		-55 to 85	^oC
Operating junction temperature	T_j	max.	75	^oC

THERMAL RESISTANCE

From junction to ambient in free air	$R_{th\ j-a}$	=	0.35	^oC/mW
From junction to case	$R_{th\ j-c}$	=	0.2	^oC/mW

[1]) Limiting values according to the Absolute Maximum System as defined in IEC publication 134.

[2]) For switch-off transients with inductive load see page 12

CHARACTERISTICS T_j = 25 °C unless otherwise specified

Collector cut-off current

$I_E = 0$; $V_{CB} = 5$ V	I_{CBO}	<	3	μA
$V_{CB} = 30$ V; $T_j = 55$ °C	I_{CBO}	<	100	μA

Emitter cut-off current

$I_C = 0$; $V_{EB} = 5$ V	I_{EBO}	<	3	μA
$V_{EB} = 30$ V; $T_j = 55$ °C	I_{EBO}	<	100	μA

Currents at reverse biased emitter junction

$V_{CE} = 20$ V; $-V_{BE} = 0.2$ V; $T_j = 55$ °C	I_{CEX}	<	50	μA
$-V_{BE} = 20$ V; $V_{CB} = 20$ V; $T_j = 55$ °C	$-I_{BEX}$	<	50	μA

Saturation voltages

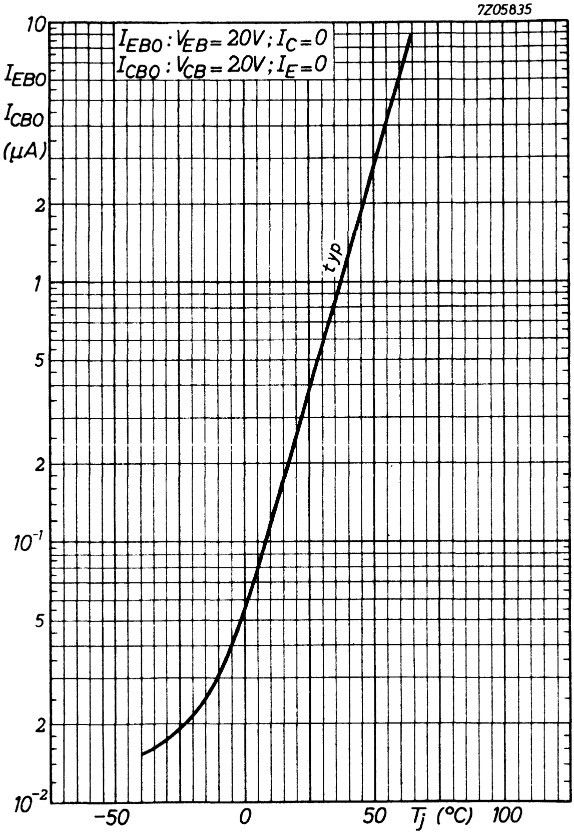
ASY73.	$I_C = 50$ mA; $I_B = 2.5$ mA	V_{CEsat}	<	0.22	V
	$I_C = 200$ mA; $I_B = 10$ mA	V_{CEsat}	<	0.30	V
	$I_E = 200$ mA; $I_B = 16.5$ mA	V_{ECsat}	<	0.30	V
	$I_C = 50$ mA; $I_B = 3$ mA	$V_{BE\,sat}$	<	0.50	V
	$I_C = 200$ mA; $I_B = 12$ mA	$V_{BE\,sat}$	<	0.90	V
ASY74.	$I_C = 50$ mA; $I_B = 1.25$ mA	V_{CEsat}	<	0.22	V
	$I_C = 200$ mA; $I_B = 5.7$ mA	V_{CEsat}	<	0.30	V
	$I_C = 400$ mA; $I_B = 20$ mA	V_{CEsat}	<	0.37	V
	$I_E = 200$ mA; $I_B = 10$ mA	V_{ECsat}	<	0.30	V
	$I_C = 50$ mA; $I_B = 1.5$ mA	$V_{BE\,sat}$	<	0.38	V
	$I_C = 200$ mA; $I_B = 7$ mA	$V_{BE\,sat}$	<	0.70	V
	$I_C = 400$ mA; $V_{CB} = 0$	$V_{BE\,sat}$	<	0.90	V
ASY75.	$I_C = 50$ mA; $I_B = 0.75$ mA	V_{CEsat}	<	0.22	V
	$I_C = 200$ mA; $I_B = 4$ mA	V_{CEsat}	<	0.30	V
	$I_C = 400$ mA; $I_B = 13.5$ mA	V_{CEsat}	<	0.37	V
	$I_E = 200$ mA; $I_B = 10$ mA	V_{ECsat}	<	0.30	V
	$I_C = 50$ mA; $I_B = 0.95$ mA	$V_{BE\,sat}$	<	0.34	V
	$I_C = 200$ mA; $I_B = 5$ mA	$V_{BE\,sat}$	<	0.60	V
	$I_C = 400$ mA; $V_{CB} = 0$	$V_{BE\,sat}$	<	0.70	V

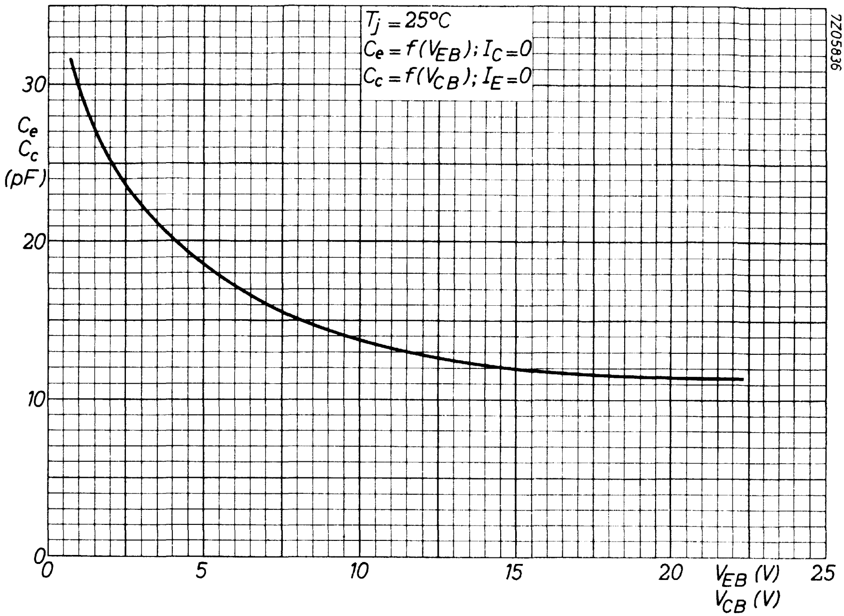
Sustaining voltage

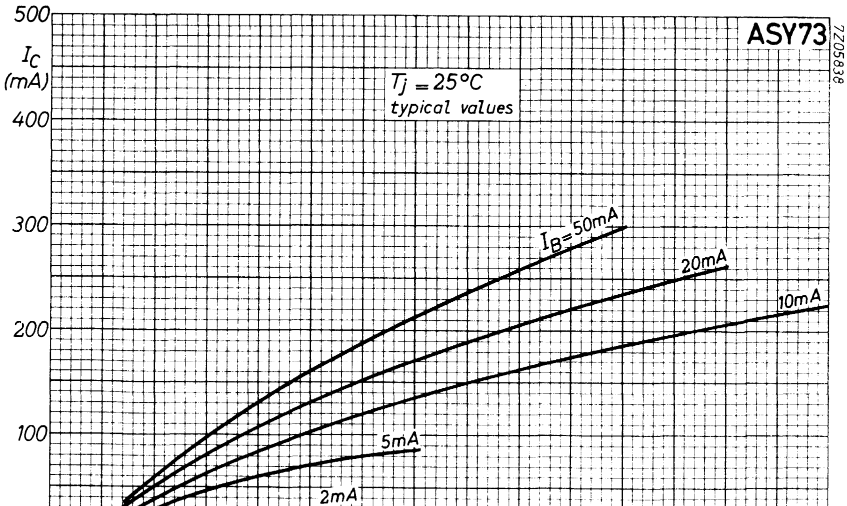
$I_C = 10$ mA; $I_B = 0$	$V_{CEOsust}$	>	15	V

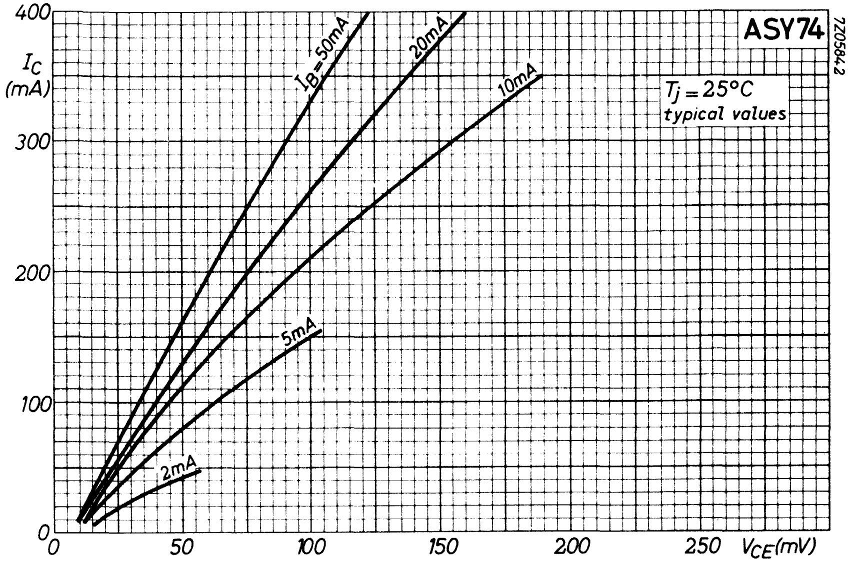
CHARACTERISTICS (continued) T_j = 25 °C unless otherwise specified

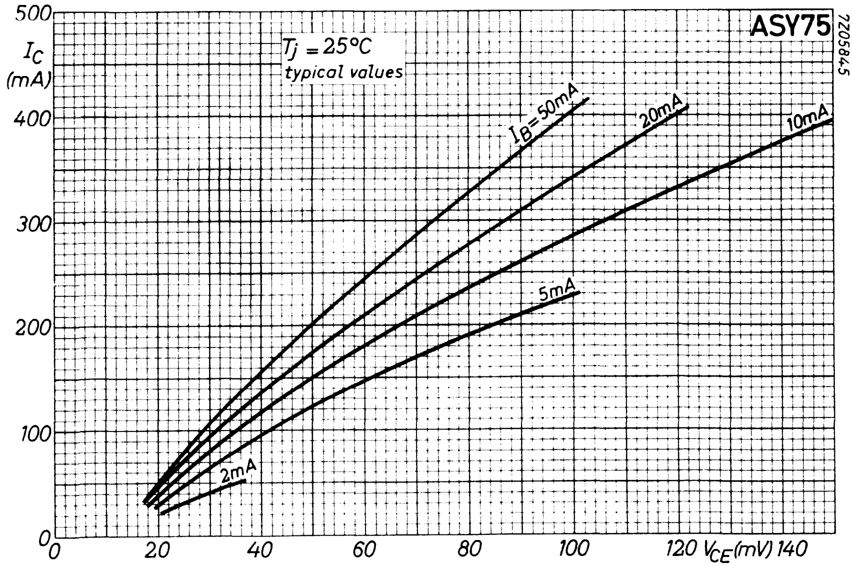
Punch-through voltage	V_{pt}	>	20	V
Floating potential				
$I_E = 0$; $V_{CB} = 20$ V; $T_j = 55$ °C	V_{EBfl}	<	180	mV
$I_C = 0$; $V_{CB} = 20$ V; $T_j = 55$ °C	V_{CBfl}	<	180	mV
D.C. current gain				
ASY73 $V_{CB} = 0$; $-I_E = 50$ mA	h_{FE}	>	25	
$V_{CB} = 0$; $-I_E = 200$ mA	h_{FE}	>	20	
$V_{EB} = 0$; $-I_C = 200$ mA	h_{FC}	>	12	
ASY74 $V_{CB} = 0$; $-I_E = 50$ mA	h_{FE}	>	40	
$V_{CB} = 0$; $-I_E = 200$ mA	h_{FE}	>	35	
$V_{CB} = 0$; $-I_E = 400$ mA	h_{FE}	>	20	
$V_{EB} = 0$; $-I_C = 200$ mA	h_{FC}	>	20	
ASY75 $V_{CB} = 0$; $-I_E = 50$ mA	h_{FE}	>	65	
$V_{CB} = 0$; $-I_E = 200$ mA	h_{FE}	>	50	
$V_{CB} = 0$; $-I_E = 400$ mA	h_{FE}	>	30	
$V_{EB} = 0$; $-I_C = 200$ mA	h_{FC}	>	20	
Switching parameters				
Desaturation time constant $I_B = 1$ mA; $I_C = 0$	τ_s	<	1.75	μs
Current-feed time constant $I_{CM} = 200$ mA; $V_{CE} = 0.75$ V	τ_c	<	1.75	μs
Voltage-feed time constant $I_{CM} = 1$ mA; $V_{CE} = 5$ V	τ_v	<	0.20	μs
Collector capacitance at f = 1 MHz				
$I_E = I_e = 0$; $V_{CB} = 5$ V	C_c	<	30	pF
Emitter capacitance at f = 1 MHz				
$I_C = I_c = 0$; $V_{EB} = 5$ V	C_e	<	30	pF
Transition frequency				
$-I_E = 3$ mA; $V_{CB} = 5$ V ASY73	f_T	>	4	MHz
$-I_E = 3$ mA; $V_{CB} = 5$ V ASY74	f_T	>	6	MHz
$-I_E = 3$ mA; $V_{CB} = 5$ V ASY75	f_T	>	10	MHz

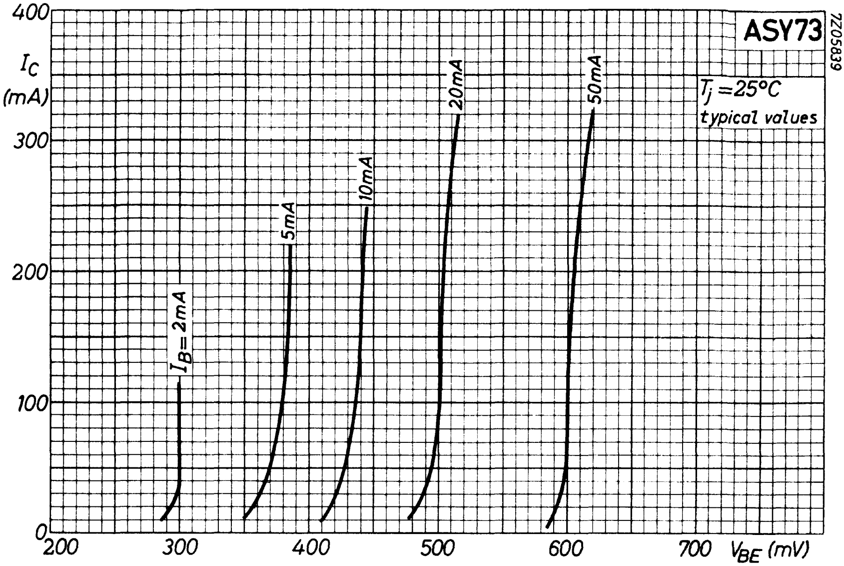

7Z05835
$I_{EBO}: V_{EB} = 20V; I_C = 0$
$I_{CBO}: V_{CB} = 20V; I_E = 0$
I_{EBO}
I_{CBO}
(μA)
10
2
1
5
2
10^{-1}
5
2
10^{-2}
typ
−50
0
50
T_j (°C)
100

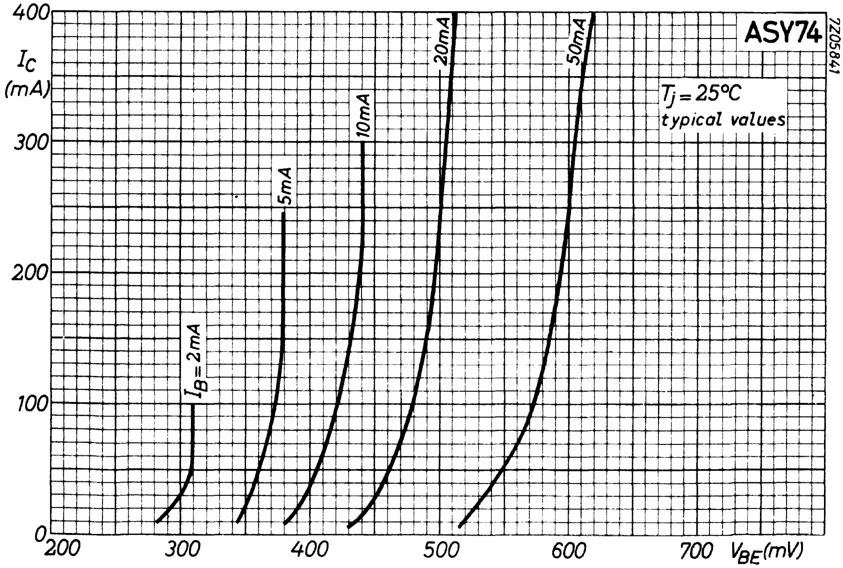

$T_j = 25°C$
$C_e = f(V_{EB}); I_C = 0$
$C_c = f(V_{CB}); I_E = 0$
7Z05836
C_e
C_c
(pF)
30
20
10
0
0
5
10
15
20
25
V_{EB} (V)
V_{CB} (V)

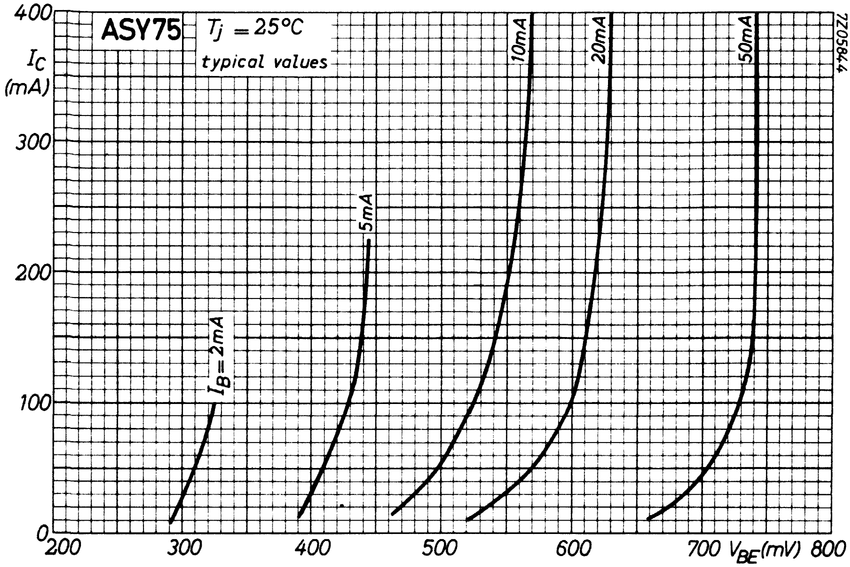

ASY73
7Z05838
$T_j = 25°C$
typical values
I_C
(mA)
500
400
300
200
100
0
0
20
40
60
80
100
120
140
V_{CE}(mV)
I_B=50mA
20mA
10mA
5mA
2mA

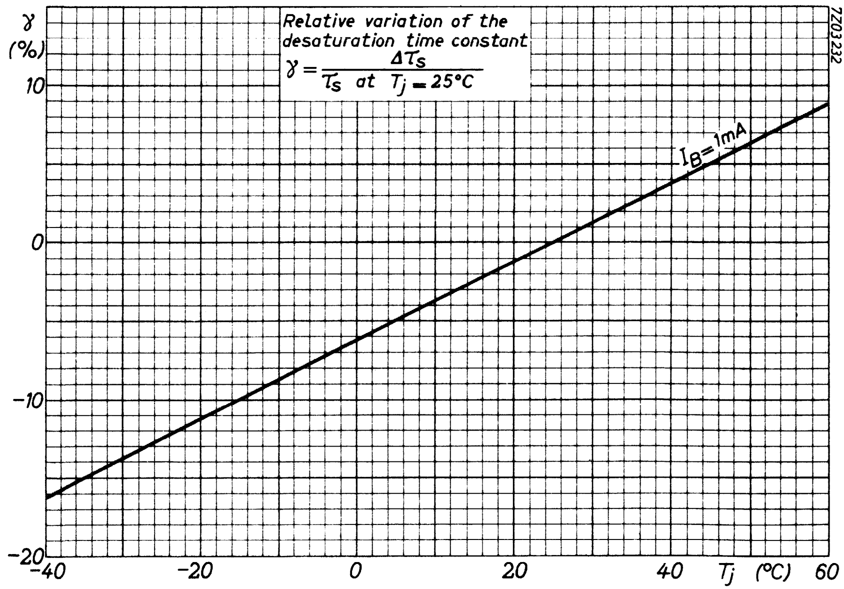

400
300
200
100
0
I_C
(mA)
I_B=50mA
20mA
10mA
5mA
2mA
ASY74
7Z05842
T_j = 25°C
typical values
0
50
100
150
200
250
V_{CE}(mV)

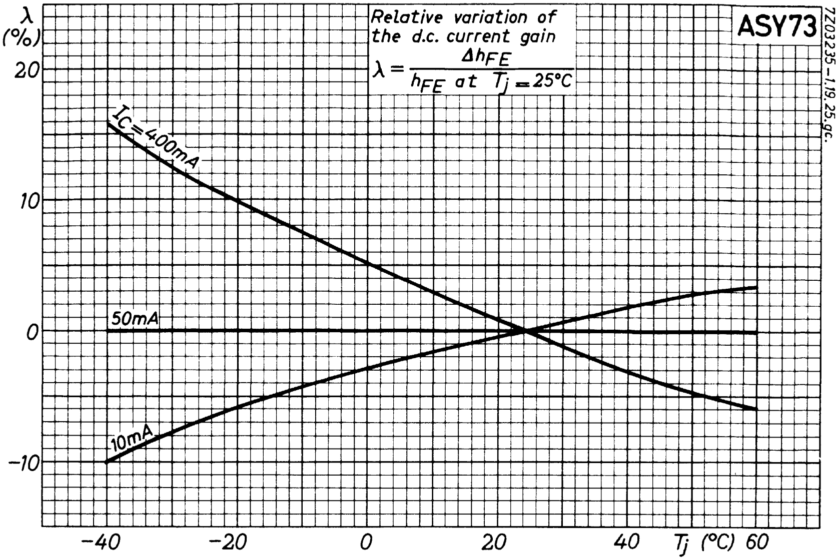

500
400
300
200
100
0
I_C
(mA)
ASY75
7Z05845
T_j = 25°C
typical values
I_B=50mA
20mA
10mA
5mA
2mA
0
20
40
60
80
100
120
V_{CE}(mV)
140

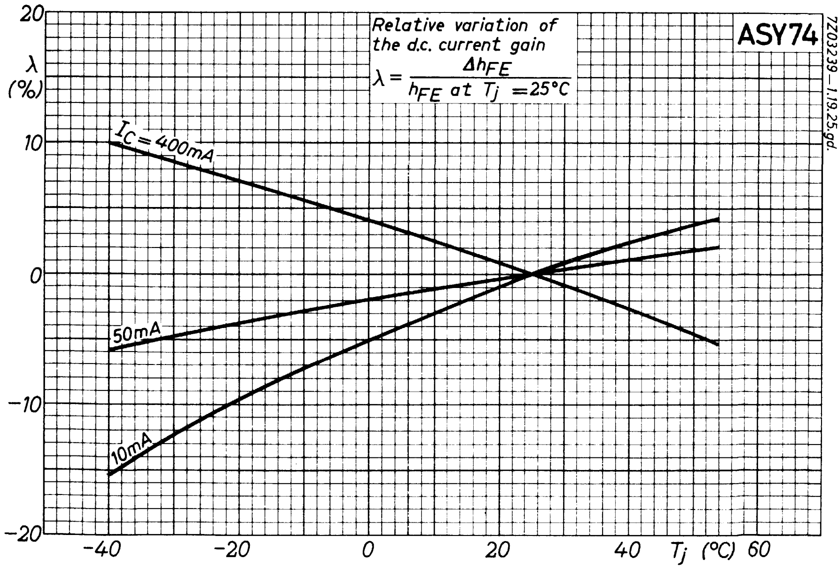

ASY73
7Z05839
T_j = 25°C
typical values
I_C (mA)
0
100
200
300
400
I_B = 2mA
5mA
10mA
20mA
50mA
200
300
400
500
600
700
V_{BE} (mV)

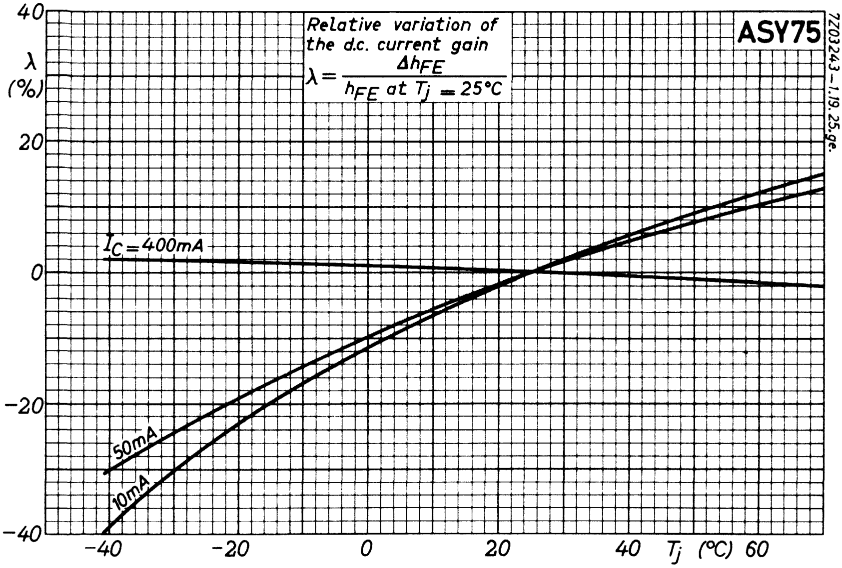

ASY74
7Z05841
T_j = 25°C
typical values
I_C (mA)
0
100
200
300
400
I_B = 2mA
5mA
10mA
20mA
50mA
200
300
400
500
600
700
V_{BE} (mV)

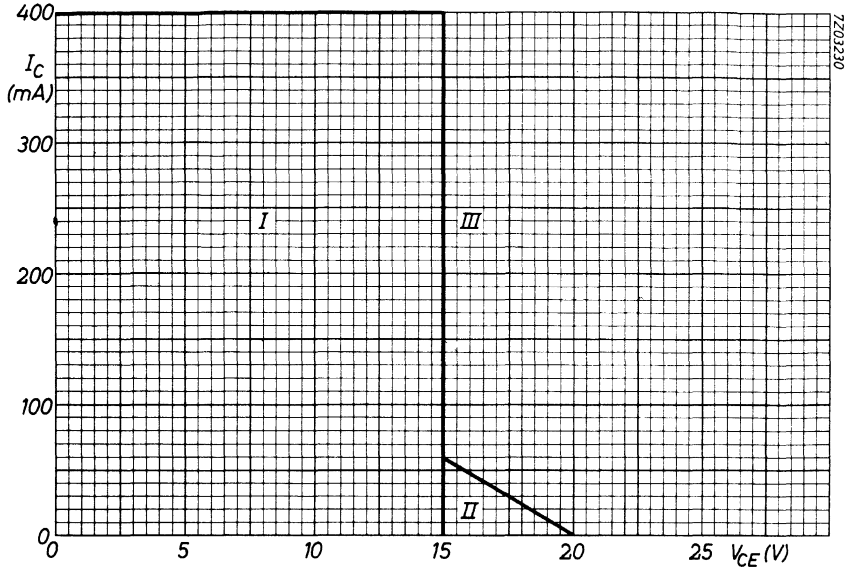

ASY75
$T_j = 25°C$
typical values
I_C (mA)
400
300
200
100
0
200
300
400
500
600
700
800
V_{BE} (mV)
$I_B = 2mA$
5mA
10mA
20mA
50mA
7Z05844


Relative variation of the desaturation time constant
$\gamma = \frac{\Delta\tau_s}{\tau_s \text{ at } T_j = 25°C}$
γ (%)
10
0
-10
-20
-40
-20
0
20
40
60
T_j (°C)
$I_B = 1mA$
7Z03232


λ
(%)
20
10
0
−10
Relative variation of
the d.c. current gain
λ = Δh_FE / h_FE at T_j = 25°C
ASY73
7Z03235−1.19.25.gc.
I_C = 400mA
50mA
10mA
−40
−20
0
20
40
T_j (°C)
60


20
λ
(%)
10
0
−10
−20
Relative variation of
the d.c. current gain
λ = Δh_FE / h_FE at T_j = 25°C
ASY74
7Z03239−1.19.25.gd.
I_C = 400mA
50mA
10mA
−40
−20
0
20
40
T_j (°C)
60


40
λ
(%)
20
0
−20
−40
Relative variation of
the d.c. current gain
$\lambda = \frac{\Delta h_{FE}}{h_{FE} \text{ at } T_j = 25°C}$
ASY75
7Z03243-1.19.25.ge.
I_C = 400mA
50mA
10mA
−40
−20
0
20
40
T_j (°C)
60



NOTES

I Region of permissible operation under all base-emitter conditions

II Additional region of operation when the transistor is cut-off

III During switching-off with inductive loads higher voltages than indicated by area I and area II are allowed, provided the inductive load is less than 250 μH and $0.2\ V < -V_{BE} < 2\ V$

P-N-P SWITCHING TRANSISTORS

Germanium p-n-p transistors in a TO-5 metal envelope with the base connected to the case. The ASY76, ASY77 and ASY80 are primarily intended for amplifying, switching and pulse oscillating applications.

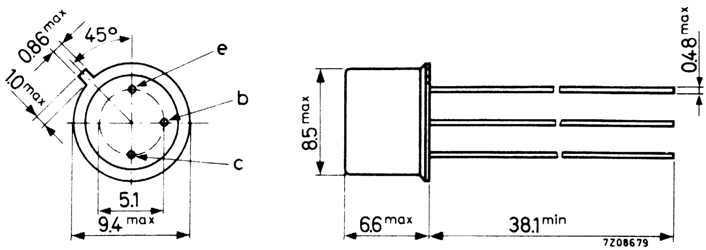
QUICK REFERENCE DATA

			ASY76	ASY77	ASY80	
Collector-base voltage (open emitter)	$-V_{CBO}$	max.	40	60	40	V
Collector-emitter voltage ($+V_{BE} = 0.6$ V)	$-V_{CEX}$	max.	32	60	40	V

Collector current (peak value)	$-I_{CM}$	max.	1000	mA
Total power dissipation up to $T_{amb} = 25\ ^oC$	P_{tot}	max.	500	mW
Junction temperature	T_j	max.	85	^oC
Thermal resistance from junction to case	$R_{th\ j\text{-}c}$	=	75	$^oC/W$
D.C. current gain at $T_j = 25\ ^oC$				
$-I_C = 600$ mA; $-V_{CE} = 1$ V ASY76, ASY77	h_{FE}	>	20	
$-I_C = 600$ mA; $-V_{CE} = 1$ V ASY80	h_{FE}	>	40	
Transition frequency $-I_C = 1$ mA; $-V_{CE} = 10$ V	f_T	typ.	0.9	MHz

MECHANICAL DATA Dimensions in mm

TO-5
Base connected to case



Accessories available: 56218, 56245, 56265

RATINGS (Limiting values) [1])

Voltages

			ASY76	ASY77	ASY80	
Collector-base voltage (open emitter)	$-V_{CBO}$	max.	40	60	40	V
Collector-emitter voltage with $+V_{BE} = 0.6$ V	$-V_{CEX}$	max.	32	60	40	V
Emitter-base voltage (open collector)	$-V_{EBO}$	max.	10	10	20	V

Currents

Collector current (d.c. or average over any 20 ms period)	$-I_C$	max.	500	mA
Collector current (peak value)	$-I_{CM}$	max.	1000	mA
Base current (d.c. or average over any 20 ms period)	$-I_B$	max.	40	mA
Base current (peak value)	$-I_{BM}$	max.	200	mA

Power dissipation

Total power dissipation up to $T_{amb} = 25\ ^{o}C$	P_{tot}	max.	500	mW

Temperatures

Storage temperature	T_{stg}		-65 to +85	^{o}C
Junction temperature	T_j	max.	85	^{o}C

THERMAL RESISTANCE

From junction to ambient in free air	$R_{th\ j-a}$	=	250	$^{o}C/W$
From junction to case	$R_{th\ j-c}$	=	75	$^{o}C/W$
From junction to ambient with cooling fin 56265 on a heatsink of 12.5 cm^2	$R_{th\ j-a}$	=	120	$^{o}C/W$

[1]) Limiting values according to the Absolute Maximum System as defined in IEC publication 134.

CHARACTERISTICS T_j = 25 °C unless otherwise specified

			ASY76	ASY77	ASY80	
Collector cut-off current						
$I_E = 0$; $-V_{CB} = 10$ V	$-I_{CBO}$	typ.	4.5	4.5	4.5	μA
		<	10	10	10	μA
$I_E = 0$; $-V_{CB} = 40$ V	$-I_{CBO}$	<	40	–	40	μA
$I_E = 0$; $-V_{CB} = 60$ V	$-I_{CBO}$	<	–	40	–	μA
Emitter cut-off current						
$I_C = 0$; $-V_{EB} = 10$ V	$-I_{EBO}$	<	20	20	20	μA
Currents at reverse biased emitter junction						
$-V_{CE} = 30$ V; $+V_{BE} = 0.5$ V	$-I_{CEX}$	<	30	–	30	μA
$-V_{CE} = 60$ V; $+V_{BE} = 0.5$ V	$-I_{CEX}$	<	–	30	–	μA
$-V_{CE} = 30$ V; $+V_{BE} = 0.5$ V; $T_j = 60$ °C	$-I_{CEX}$	<	200	–	200	μA
$-V_{CE} = 60$ V; $+V_{BE} = 0.5$ V; $T_j = 60$ °C	$-I_{CEX}$	<	–	200	–	μA
Sustaining voltage						
$-I_C = 600$ mA; $+V_{BE} = 0.6$ V	$-V_{CEXsust}$	>	–	–	32	V
Base-emitter voltage						
$I_E = 300$ mA; $V_{CB} = 0$	$-V_{BE}$	typ.	420	420	420	mV
		<	750	750	750	mV
Saturation voltages						
$-I_C = 300$ mA; $-I_B = 12$ mA	$-V_{CEsat}$	<	300	300	–	mV
$-I_C = 300$ mA; $-I_B = 6$ mA	$-V_{CEsat}$	<	–	–	400	mV
Emitter-base floating voltage						
$I_E = 0$; $-V_{CB} = 40$ V	$-V_{EBfl}$	<	300	–	300	mV
$I_E = 0$; $-V_{CB} = 60$ V	$-V_{EBfl}$	<	–	300	–	mV
D.C. current gain						
$-I_C = 10$ mA; $-V_{CE} = 6$ V	h_{FE}	>	45	45	–	
$-I_C = 50$ mA; $-V_{CB} = 0$	h_{FE}		–	–	60 to 165	
$-I_C = 300$ mA; $V_{CB} = 0$	h_{FE}		25 to 130	25 to 130	> 50	

CHARACTERISTICS (continued) T_j = 25 °C unless otherwise specified

Collector capacitance at f = 1 MHz					
$I_E = I_e = 0$; $-V_{CB} = 5$ V		C_c	typ.	40	pF
			<	60	pF
Emitter capacitance at f = 1 MHz					
$I_C = I_c = 0$; $-V_{EB} = 5$ V		C_e	typ.	30	pF
			<	50	pF
Transition frequency					
$-I_C = 10$ mA; $-V_{CE} = 5$ V	ASY76, ASY77	f_T	>	500	kHz
	ASY80	f_T	>	700	kHz
Noise figure at f = 1 kHz					
$I_E = 0.5$ mA; $-V_{CB} = 2$ V					
Bandwidth 200 Hz; $R_S = 500\ \Omega$		F	<	15	dB
Feedback impedance at f = 0.5 MHz					
$I_E = 1$ mA; $-V_{CB} = 5$ V		$\|z_{rb}\|$	typ.	75	Ω

POWER SWITCHING TRANSISTORS

P-N-P germanium low spread medium gain power transistors in a TO-3 metal case for power switching at high currents.

QUICK REFERENCE DATA

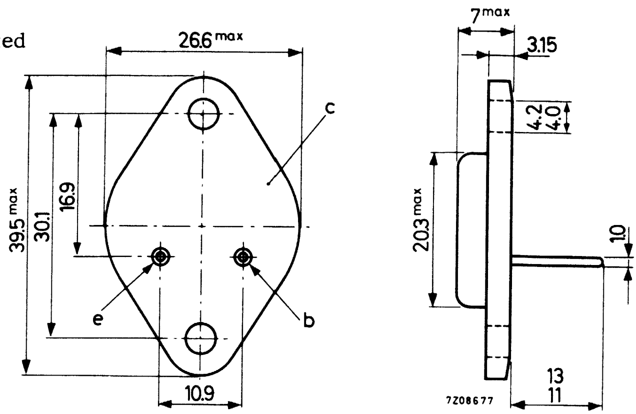
			ASZ 15	ASZ 16	ASZ 17	ASZ 18	
Collector-base voltage (open emitter)	$-V_{CBO}$	max.	100	60	60	100	V
Collector-emitter voltage (open base)	$-V_{CEO}$	max.	60	32	32	32	V
Total power dissipation up to T_{mb} = 45 °C	P_{tot}	max.	30	30	30	30	W
Junction temperature	T_j	max.	90	90	90	90	°C
D.C. current gain at T_j = 25 °C							
$-I_C$ = 1 A; $-V_{CE}$ = 1 V	h_{FE}	>	20	45	25	30	
		<	55	130	75	110	
$-I_C$ = 6 A; $-V_{CE}$ = 1 V	h_{FE}	>	15	35	20	20	
		<	30	80	45	65	
Transition frequency							
$-I_C$ = 1 A; $-V_{CE}$ = 5 V	f_T	typ.	200	250	220	220	kHz

MECHANICAL DATA

Dimensions in mm

TO-3

Collector connected to mounting base



Accessories available: 56201e

RATINGS (Limiting values) [1]

			ASZ 15	ASZ 16	ASZ 17	ASZ 18	
Voltages							
Collector-base voltage (open emitter) [2]	$-V_{CBO}$	max.	100	60	60	100	V
Collector-emitter voltage (open base) (see also pages 12 and 13)	$-V_{CEO}$	max.	60	32	32	32	V
Emitter-base voltage (open collector)	$-V_{EBO}$	max.	40	20	20	40	V

Currents				
Collector current (d.c.)	$-I_C$	max.	8	A
Collector current (peak value)	$-I_{CM}$	max.	10	A
Emitter current (d.c.)	I_E	max.	9	A
Emitter current (peak value	I_{EM}	max.	12	A
Base current (d.c.)	$-I_B$	max.	1	A
Base current (peak value)	$-I_{BM}$	max.	2	A
Power dissipation (see also page 9)				
Total power dissipation up to $T_{mb} = 45\ ^oC$	P_{tot}	max.	30	W
Temperatures				
Storage tmperature	T_{stg}		-65 to +90	^oC
Junction temperature: continuous	T_j	max.	90	^oC
incidentally	T_j	max.	100	^oC

THERMAL RESISTANCE

From junction to mounting base	$R_{th\ j-mb}$	=	1.5	$^oC/W$
From mounting base to heatsink	$R_{th\ mb-h}$	=	0.2	$^oC/W$
From mounting base to heatsink with lead washer and mica washer	$R_{th\ mb-h}$	=	0.5	$^oC/W$

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[1]) Limiting values according to the Absolute Maximum System as defined in IEC publication 134.

[2]) When switched from a thermally stable on state with max. junction temperature to a not stabilized cut-off condition, $-V_{CBO\,max}$ is allowed,
provided $T_{amb} < 55\ ^oC$ and $R_{th\ j-a} < 9\ ^oC/W$ for ASZ16 and ASZ17
$R_{th\ j-a} < 5\ ^oC/W$ for ASZ15 and ASZ18

CHARACTERISTICS

T_j = 25 °C unless otherwise specified

Collector current

$I_E = 0$; $-V_{CB} = 0.5$ V	$-I_{CBO}$	<	0.1	mA
$I_E = 0$; $-V_{CB} = -V_{CBOmax}$	$-I_{CBO}$	<	3.0	mA
$I_E = 0$; $-V_{CB} = -V_{CBOmax}$; $T_j = 100$ °C	$-I_{CBO}$	<	30	mA

Emitter current

$I_C = 0$; $-V_{EB} = -V_{EBOmax}$	$-I_{EBO}$	<	3.0	mA

			ASZ15	ASZ16	ASZ17	ASZ18	
Base current							
$I_E = 1$ A; $V_{CB} = 0$	$-I_B$	>	17.5	7.2	13	9	mA
		<	50	21.5	38	33	mA
$I_E = 6$ A; $V_{CB} = 0$	$-I_B$	>	190	73	130	90	mA
		<	375	165	285	285	mA
Emitter-base voltage							
$I_E = 6$ A; $V_{CB} = 0$	V_{EB}	>	0.6	–	0.4	–	V
		<	1.6	1.4	1.4	1.6	V
Saturation voltages							
$-I_C = 10$ A; $-I_B = 1$ A	$-V_{CEsat}$	<	0.4	0.4	0.4	0.4	V
	$-V_{BEsat}$	<	1.4	1.4	1.4	1.4	V
Emitter-base floating voltage							
$I_E = 0$; $-V_{CB} = 60$ V	$-V_{EBfl}$	<	0.5	–	–	0.5	V
$I_E = 0$; $-V_{CB} = 48$ V	$-V_{EBfl}$	<	–	0.5	0.5	–	V
D.C. current gain							
$-I_C = 1$ A; $-V_{CE} = 1$ V	h_{FE}	>	20	45	25	30	
		<	55	130	75	110	
$-I_C = 6$ A; $-V_{CE} = 1$ V	h_{FE}	>	15	35	20	20	
		<	30	80	45	65	
Transition frequency							
$-I_C = 1$ A; $-V_{CE} = 5$ V	f_T	typ.	200	250	220	220	kHz
Collector capacitance (f = 500 kHz)							
$I_E = I_e = 0$; $-V_{CB} = 5$ V	C_c	typ.	190	190	190	190	pF
Emitter capacitance (f = 500 kHz)							
$I_C = I_c = 0$; $-V_{EB} = 5$ V	C_e	typ.	150	150	150	150	pF

CHARACTERISTICS (continued) T_j = 25 °C unless otherwise specified

D.C. current gain ratio
of matched pairs

$-I_C$ = 0.3 A	h_{FE1}/h_{FE2}	<	1.25
$-I_C$ = 6.0 A	h_{FE1}/h_{FE2}	<	1.25

Switching times

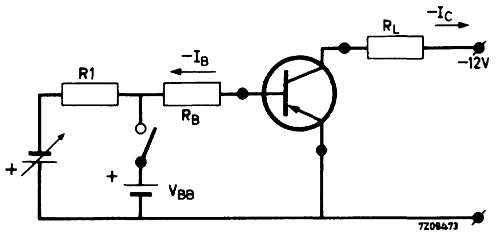
Circuit I: R_B = 10 Ω; R1 = 220 Ω; R_L = 12 Ω

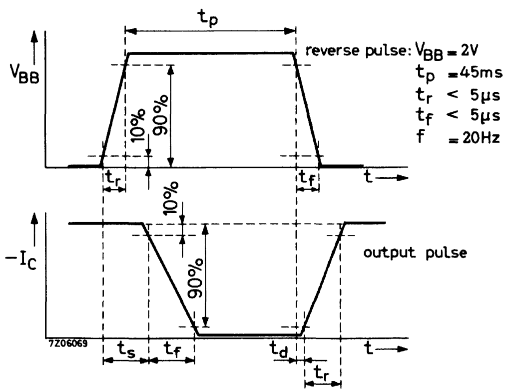
ASZ15: $-I_B$ = 75 mA	$-I_C$ = 1 A	delay time	t_d	<	2	µs
ASZ16: $-I_B$ = 35 mA		rise time	t_r	<	25	µs
ASZ17: $-I_B$ = 60 mA		storage time	t_s	<	10	µs
ASZ18: $-I_B$ = 50 mA		fall time	t_f	<	20	µs

Circuit II: R_B = 1 Ω; R1 = 13 Ω; R_L = 1.2 Ω

ASZ15: $-I_B$ = 1.35 A	$-I_C$ = 10 A	delay time	t_d	<	1	µs
ASZ16: $-I_B$ = 0.6 A		rise time	t_r	<	20	µs
ASZ17: $-I_B$ = 1.0 A		storage time	t_s	<	15	µs
ASZ18: $-I_B$ = 1.0 A		fall time	t_f	<	35	µs

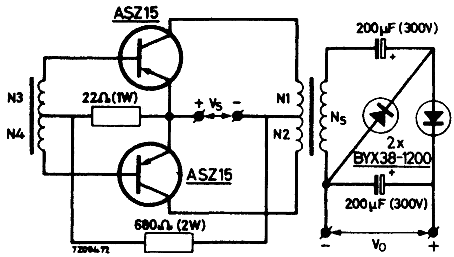
Test circuit:





APPLICATION INFORMATION

Typical operation in a d.c. to d.c. converter



The data below have been designed for continuous operation up to T_{amb} = 55 °C. Incidentally, operation up to T_{amb} = 60 °C is permitted. (Based on $R_{th\ j\text{-}a}$ = 15 °C/W per transistor)

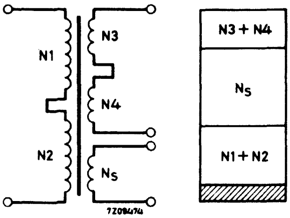
V_S	=	28	V
I_S	=	2.5	A
P_S	=	70	W
V_O	=	220	V
I_O	=	270	mA
P_O	=	60	W
η	=	86	%
f	=	450	Hz

Losses

In transistors	:	2x2	W
In diodes	:	2x0.3	W
In biasing resistors	:	1.7	W
In transformer	:	3.7	W

Transformer data

The transformer core consists of square loop material (Telcon HCR alloy type 227)
Stacking height = 15 mm



N1 + N2
N3 + N4 are bifilarly wound

N1 = N2 = 46 turns of enamelled copper wire, 1 mm

N3 = N4 = 5 turns of enamelled copper wire, 0.5 mm

N_S = 190 turns of enamelled copper wire, 0.5 mm

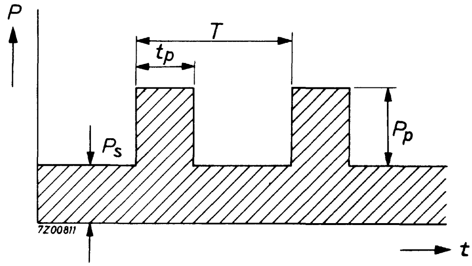
OPERATING NOTES

Determination of peak power ratings under fault conditions and/or surge operation shorter than the temperature stabilisation time

$$P_p = \frac{T_{j\,max} - T_{amb} - (R_{th\,j\text{-}mb} + R_{th\,mb\text{-}h} + R_{th\,h\text{-}a}) \cdot P_s}{R_{th\,t} + \delta . R_{th\,h\text{-}a}}$$

For a pulse duration, longer than the temperature stabilisation time

$$P_p = \frac{T_{j\,max} - T_{amb}}{R_{th\,j\text{-}mb} + R_{th\,mb\text{-}h} + R_{th\,h\text{-}a}} - P_s$$



Where:

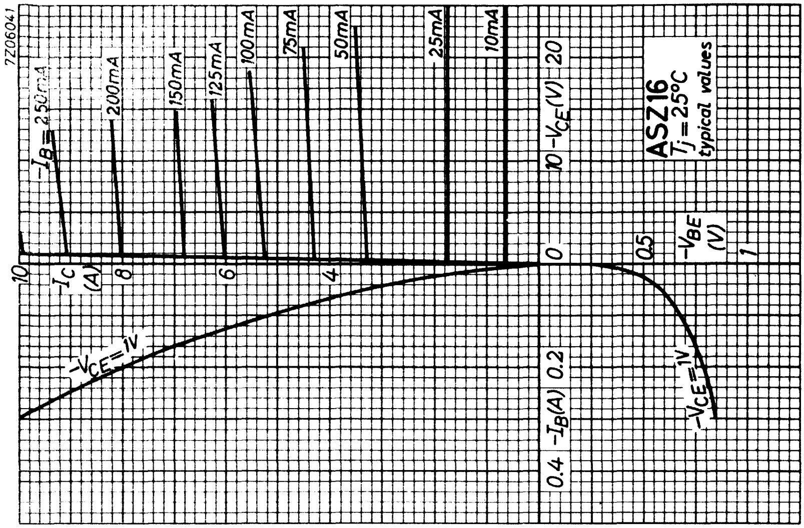
t_p	=	pulse duration
T	=	pulse period
δ	=	duty cycle = t_p/T
P_s	=	steady state power dissipation
P_p	=	permissible pulse power dissipation over P_s
$R_{th\,j\text{-}mb}$	=	thermal resistance from junction to mounting base
$R_{th\,mb\text{-}h}$	=	thermal resistance from mounting base to heatsink
$R_{th\,h\text{-}a}$	=	thermal resistance from heatsink to ambient
$R_{th\,t}$	=	transient thermal resistance = f(t, δ); see page 14 (for durations longer than the temperature stabilisation time $R_{th\,t} = R_{th\,j\text{-}h} = R_{th\,j\text{-}mb} + R_{th\,mb\text{-}h}$)
$T_{j\,max}$	=	maximum permissible junction temperature
T_{amb}	=	ambient temperature

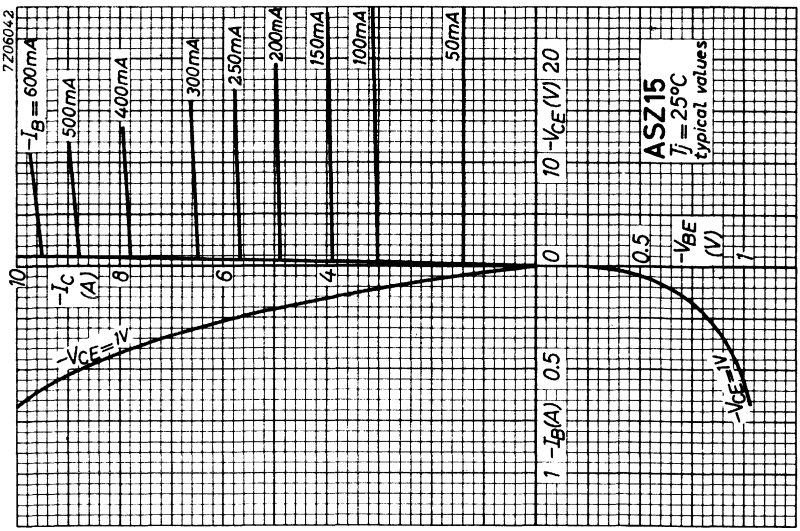
Temperature stabilisation time = 1 s (see page 14)

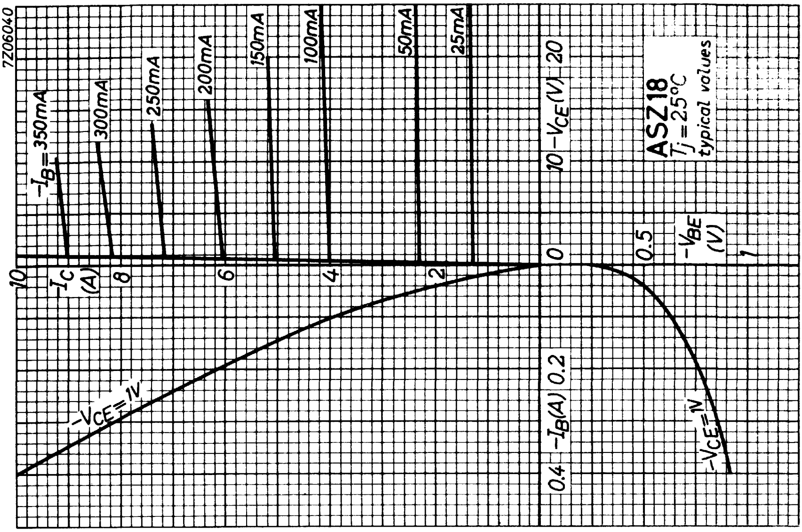
Example: P_s = 5 W, t = 1 ms, δ = 0.1, $R_{th\,mb\text{-}h}$ = 0.5 ^{o}C/W, $R_{th\,h\text{-}a}$ = 4.25 ^{o}C/W and T_{amb} = 25 ^{o}C

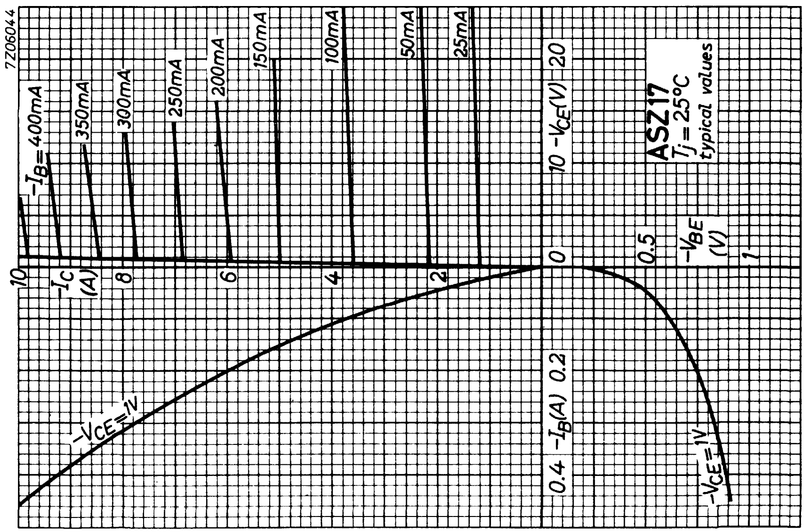
From t = 1 ms and δ = 0.1 it follows that $R_{th\,t}$ = 0.28 ^{o}C/W(page 14)

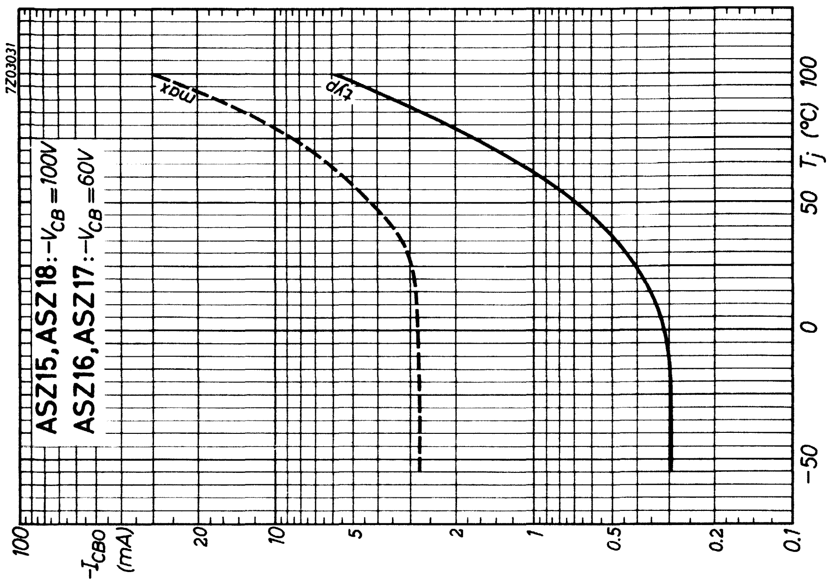
Then $$P_p = \frac{90 - 25 - (1.5 + 0.5 + 4.25) \times 5}{0.28 + 0.1 \times 4.25} \approx 47.5\ W$$

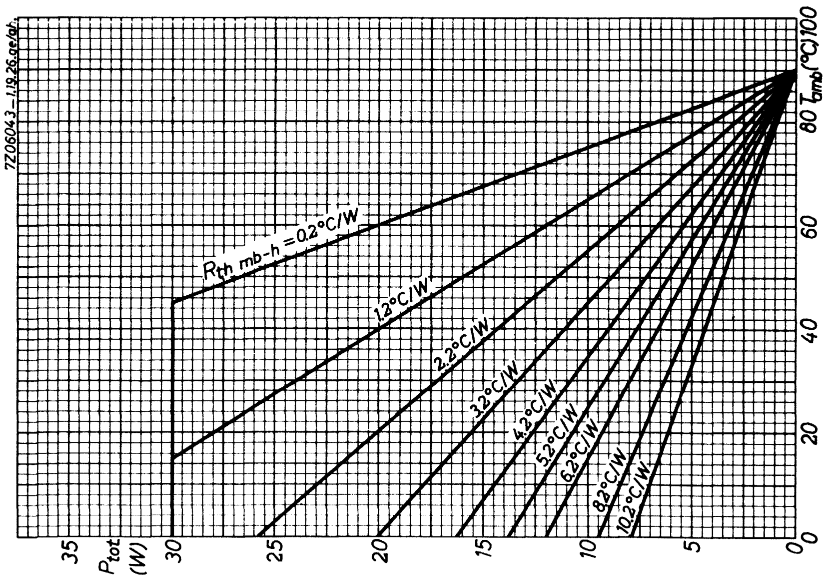

7Z06041
ASZ16
Tj = 25°C
typical values
-I_B = 250mA
200mA
150mA
125mA
100mA
75mA
50mA
25mA
10mA
0
10 -V_CE(V) 20
10
-I_C (A)
8
6
4
0.5
-V_BE (V)
1
-V_CE=1V
0.2
-I_B(A)
0.4
-V_CE=1V

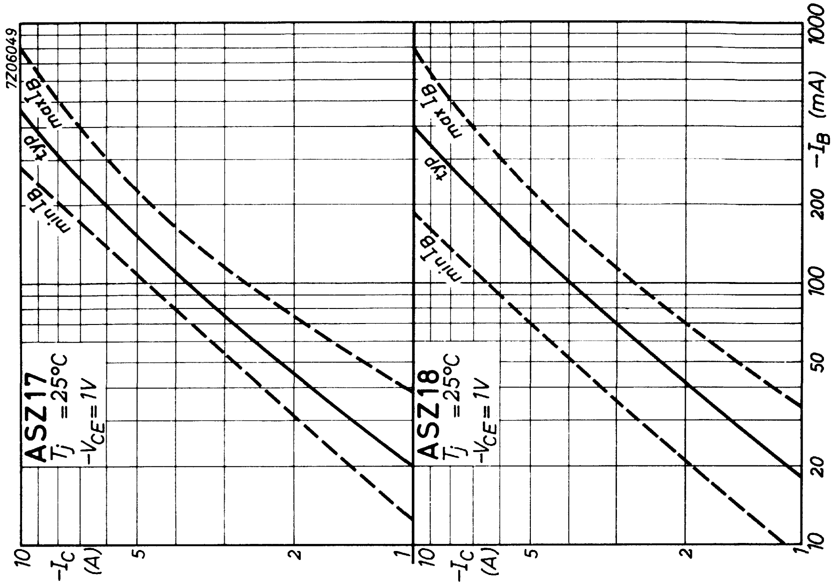

7Z06042
ASZ15
Tj = 25°C
typical values
-I_B = 600mA
500mA
400mA
300mA
250mA
200mA
150mA
100mA
50mA
0
10 -V_CE(V) 20
10
-I_C (A)
8
6
4
0.5
-V_BE (V)
1
-V_CE=1V
0.5
1 -I_B(A)
-V_CE=1V

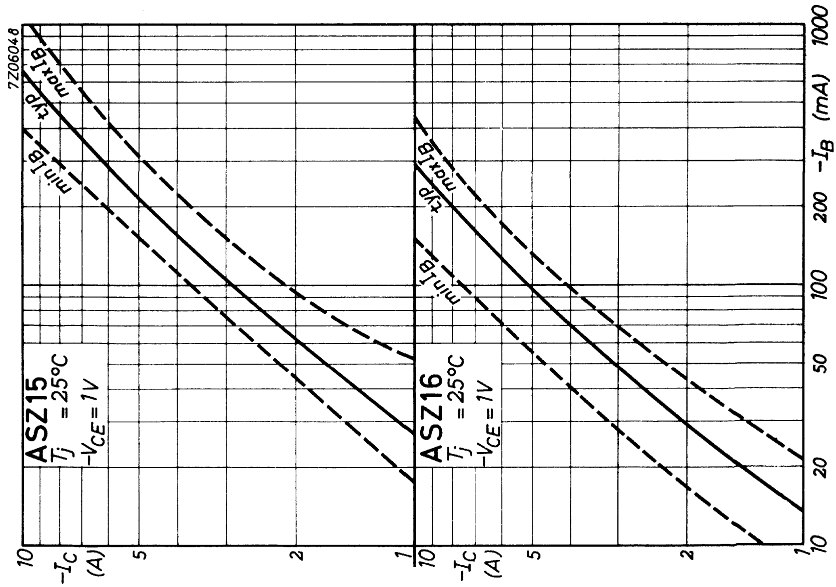

7Z06040
ASZ18
$T_j = 25°C$
typical values
$-I_B = 350mA$
300mA
250mA
200mA
150mA
100mA
50mA
25mA
10 $-V_{CE}(V)$ 20
$-I_C$ (A)
10
8
6
4
2
0
0.5
$-V_{BE}$ (V)
1
$-V_{CE} = 1V$
$-V_{CE} = 1V$
$-I_B(A)$ 0.2
0.4

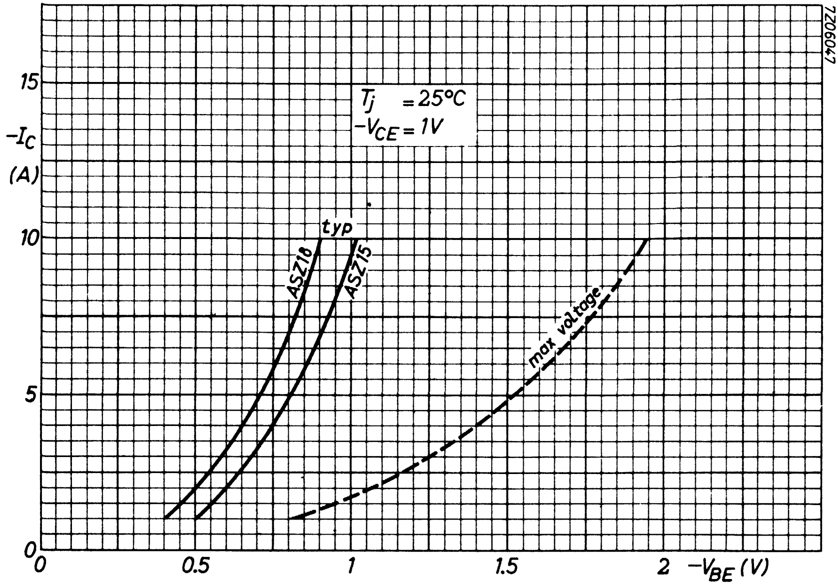

7Z06044
ASZ17
$T_j = 25°C$
typical values
$-I_B = 400mA$
350mA
300mA
250mA
200mA
150mA
100mA
50mA
25mA
10 $-V_{CE}(V)$ 20
$-I_C$ (A)
10
8
6
4
2
0
0.5
$-V_{BE}$ (V)
1
$-V_{CE} = 1V$
$-V_{CE} = 1V$
$-I_B(A)$ 0.2
0.4

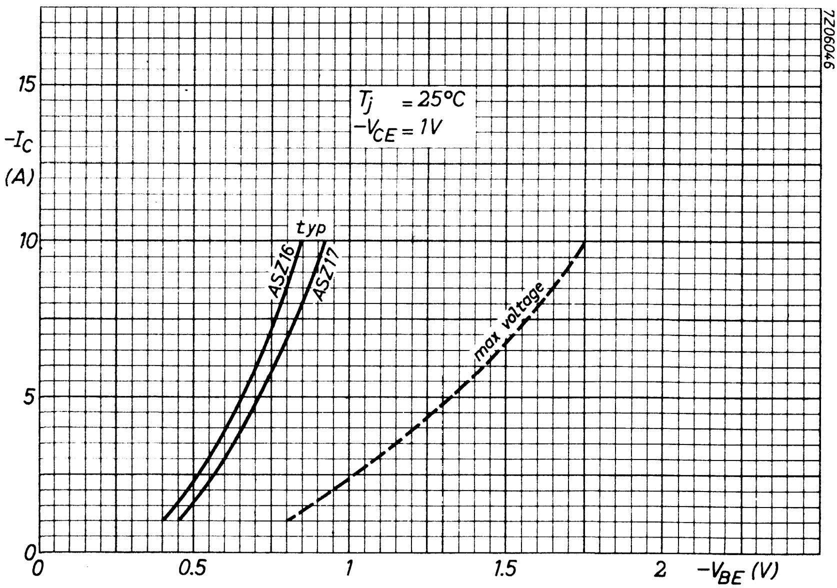

7Z03031
ASZ15, ASZ18: $-V_{CB}$ = 100V
ASZ16, ASZ17: $-V_{CB}$ = 60V
max
typ
$-I_{CBO}$ (mA)
100
20
10
5
2
1
0.5
0.2
0.1
T_j (°C)
−50
0
50
100

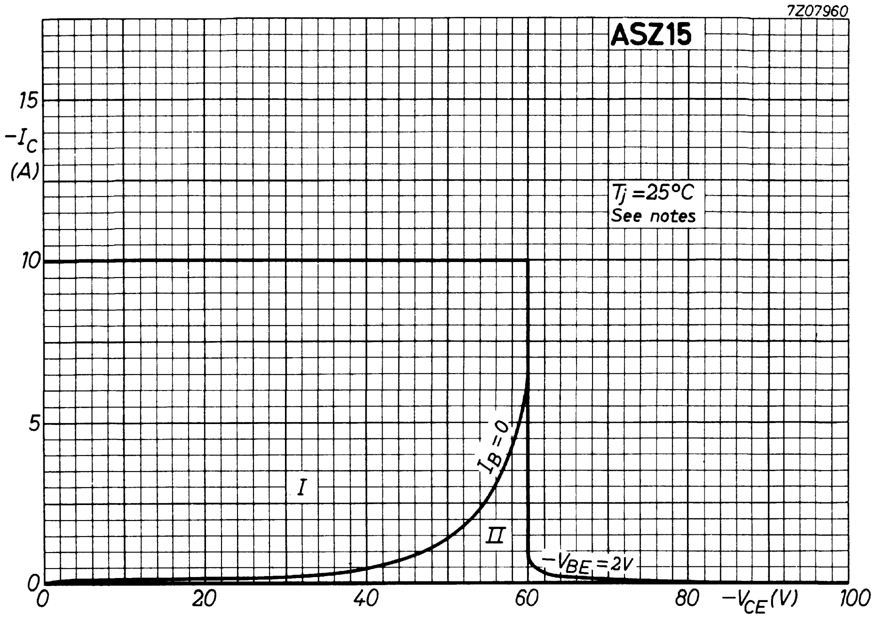

7Z06043-1.19.26.ge/gt.
$R_{th\ mb-h}$ = 0.2°C/W
1.2°C/W
2.2°C/W
3.2°C/W
4.2°C/W
5.2°C/W
6.2°C/W
8.2°C/W
10.2°C/W
P_{tot} (W)
35
30
25
20
15
10
5
0
T_{amb} (°C)
0
20
40
60
80
100


7Z06049
ASZ17
Tj = 25°C
−VCE = 1V
ASZ18
Tj = 25°C
−VCE = 1V
max IB
typ
min IB
−IC (A)
−IB (mA)
10
5
2
1
20
50
100
200
1000

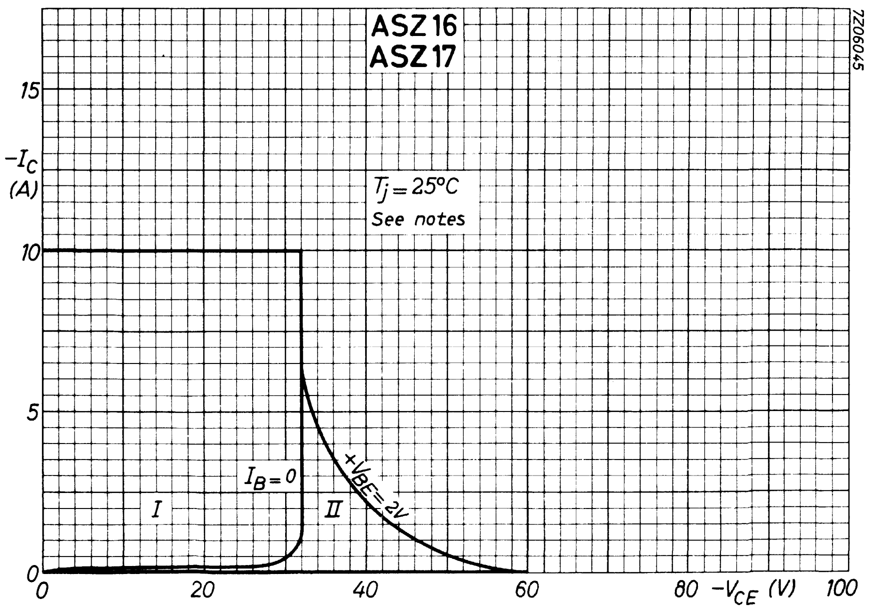

7Z06048
ASZ15
Tj = 25°C
−VCE = 1V
ASZ16
Tj = 25°C
−VCE = 1V
max IB
typ
min IB
−IC (A)
−IB (mA)
10
5
2
1
20
50
100
200
1000


7Z06047
15
$-I_C$
(A)
10
5
0
0
0.5
1
1.5
2
$-V_{BE}$ (V)
T_j = 25°C
$-V_{CE}$ = 1V
typ
ASZ18
ASZ15
max voltage

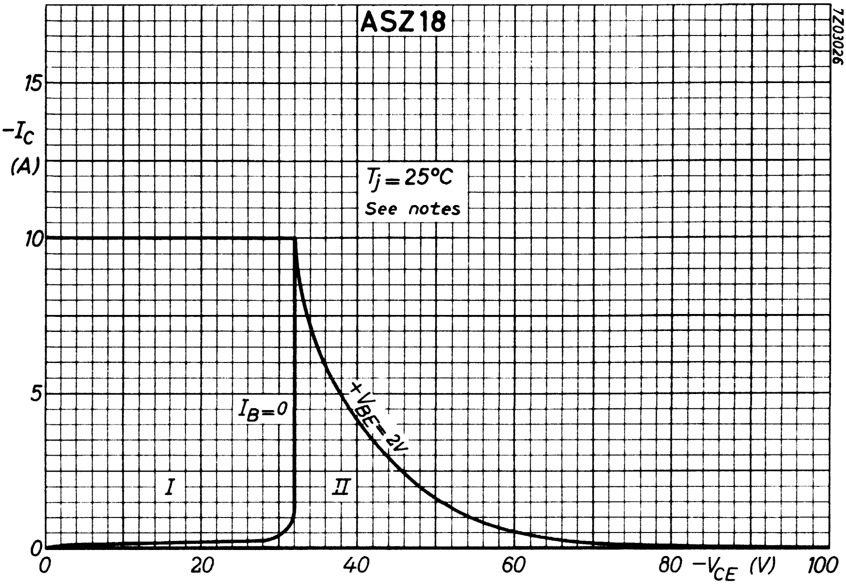

7Z06046
15
$-I_C$
(A)
10
5
0
0
0.5
1
1.5
2
$-V_{BE}$ (V)
T_j = 25°C
$-V_{CE}$ = 1V
typ
ASZ16
ASZ17
max voltage



7Z07960
ASZ15
15
$-I_C$
(A)
T_j =25°C
See notes
10
5
$I_B=0$
I
II
$-V_{BE}=2V$
0
0
20
40
60
80
$-V_{CE}(V)$
100



ASZ16
ASZ17
7Z06045
15
$-I_C$
(A)
T_j = 25°C
See notes
10
5
$I_B=0$
I
II
$+V_{BE}=2V$
0
0
20
40
60
80
$-V_{CE}$ (V)
100

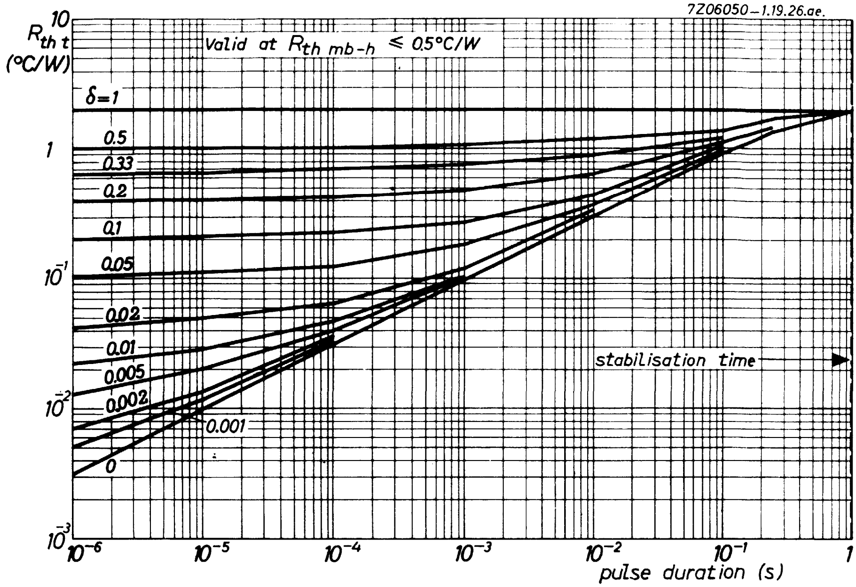


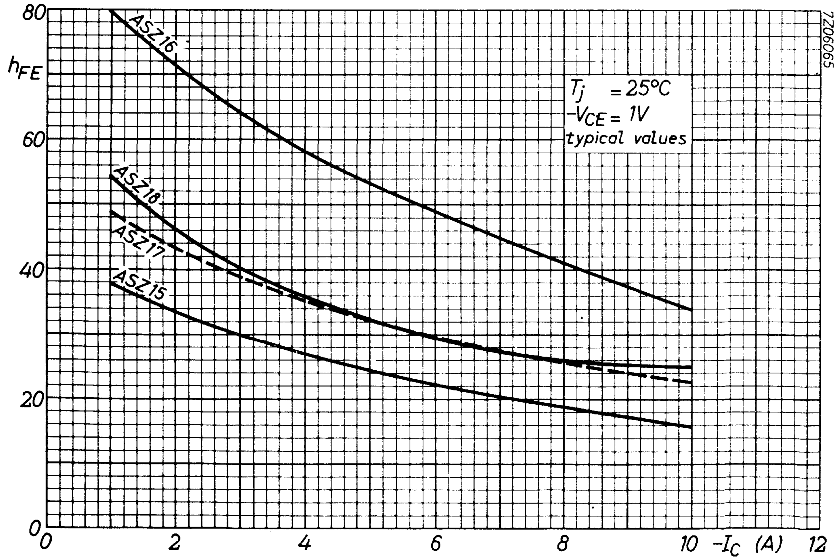
NOTES

I region of permissible operation under all base-emitter conditions

II additional region of operation when the transistor is cut-off with $+V_{BE} = 2$ V

During switching-off, voltages higher than indicated by the minimum avalanche breakdown curves at $+V_{BE} = 2$ V are allowed, provided the transient energy is less than 8 mWs.


7Z06050 – 1.19.26.ae.
$R_{th\,t}$ (°C/W)
Valid at $R_{th\,mb\text{-}h} \leq 0.5$°C/W
δ=1
0.5
0.33
0.2
0.1
0.05
0.02
0.01
0.005
0.002
0.001
0
stabilisation time
10
1
10^{-1}
10^{-2}
10^{-3}
10^{-6}
10^{-5}
10^{-4}
10^{-3}
10^{-2}
10^{-1}
1
pulse duration (s)


7Z06065
h_{FE}
ASZ16
ASZ18
ASZ17
ASZ15
T_j = 25°C
$-V_{CE}$ = 1V
typical values
80
60
40
20
0
0
2
4
6
8
10
$-I_C$ (A)
12

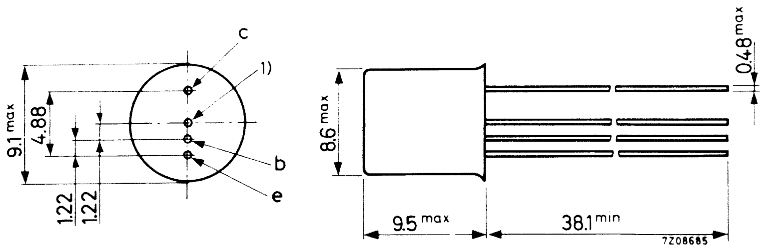
P-N-P ALLOY DIFFUSED TRANSISTOR

P-N-P alloy diffused germanium transistor in a TO-7 metal envelope. It is intended for use in wide band amplifier applications and current mode switching.

QUICK REFERENCE DATA				
Collector-base voltage (open emitter)	$-V_{CBO}$	max.	40	V
Collector-emitter voltage ($R_B/R_E < 6$)	$-V_{CER}$	max.	40	V
Collector current (d.c.)	$-I_C$	max.	25	mA
Total power dissipation up to $T_{amb} = 25\ ^oC$	P_{tot}	max.	110	mW
Junction temperature	T_j	max.	75	^oC
Thermal resistance from junction to ambient in free air	$R_{th\ j-a}$	=	0.6	$^oC/mW$

MECHANICAL DATA

TO-7 Dimensions in mm



1) = shield lead (connected to case)

Accessories available: 56207

RATINGS (Limiting values) [1])

Voltages

Collector-base voltage (open emitter)	$-V_{CBO}$	max.	40	V
Collector-emitter voltage (R_B/R_E < 6)	$-V_{CER}$	max.	40	V

Currents

Collector current (d.c.)	$-I_C$	max.	25	mA
Base current (d.c.)	$-I_B$	max.	25	mA
Reverse base current (d.c.)	I_B	max.	1	mA
Reverse base current (peak value)	I_{BM}	max.	10	mA

Power dissipation

Total power dissipation up to T_{amb} = 25 °C	P_{tot}	max.	110	mW

Temperatures

Storage temperature	T_{stg}		−55 to +75	°C
Junction temperature : continuous	T_j	max.	75	°C
incidentally	T_j	max.	90	°C

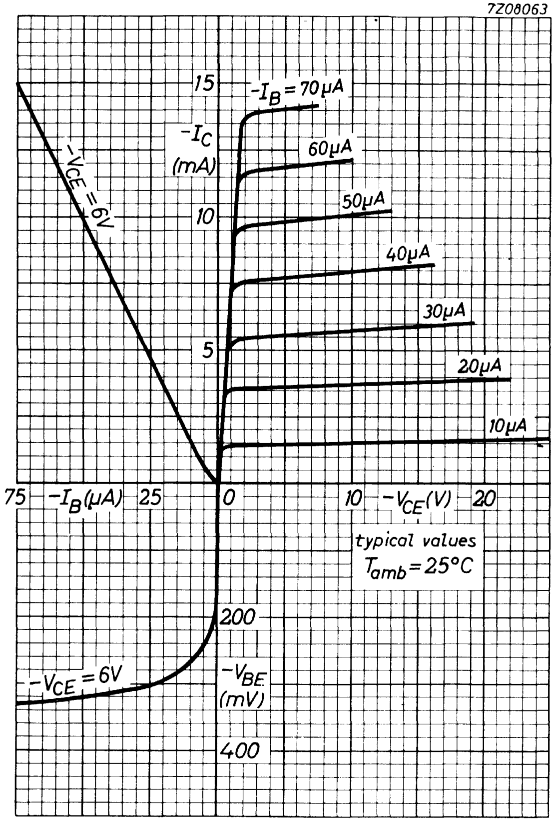
THERMAL RESISTANCE

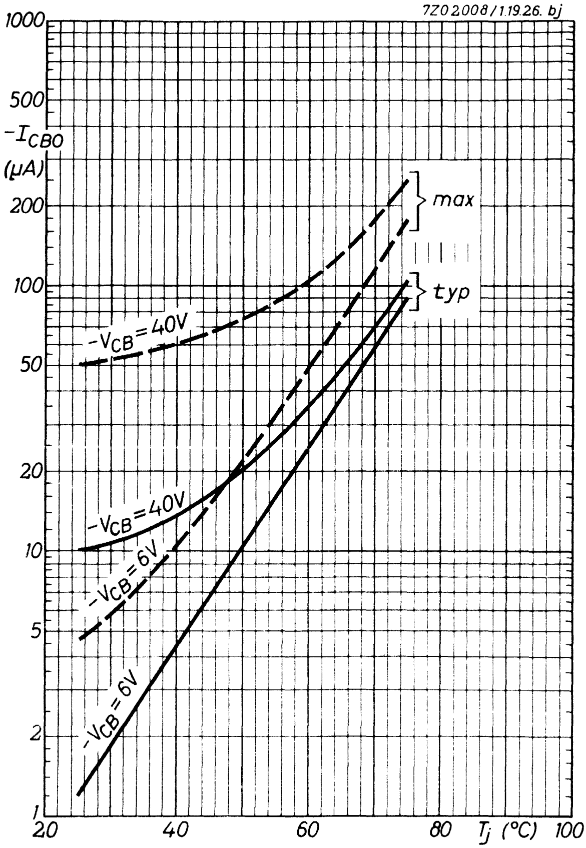
From junction to ambient in free air	$R_{th\ j-a}$	=	0.6	°C/mW

[1]) Limiting values according to the Absolute Maximum System as defined in IEC publication 134.

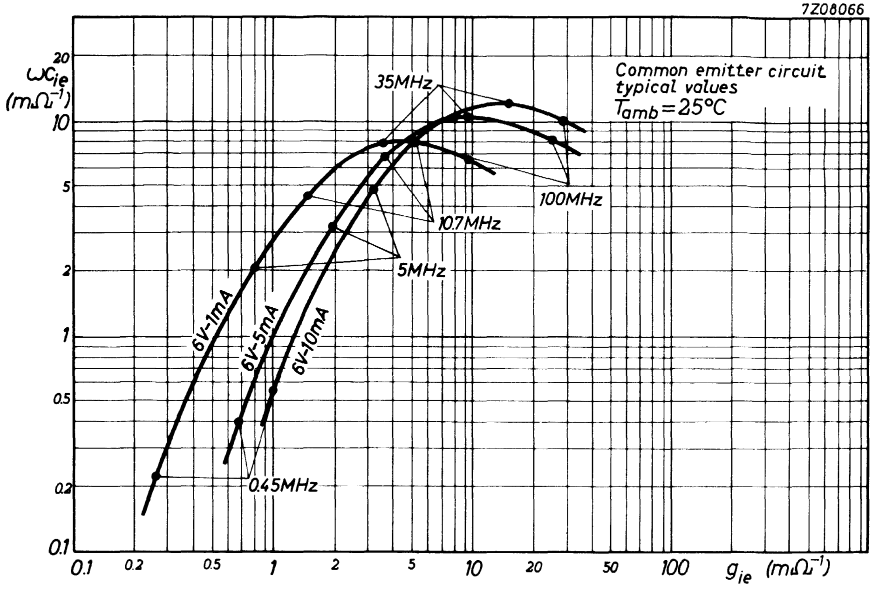
CHARACTERISTICS T_{amb} = 25 °C unless otherwise specified

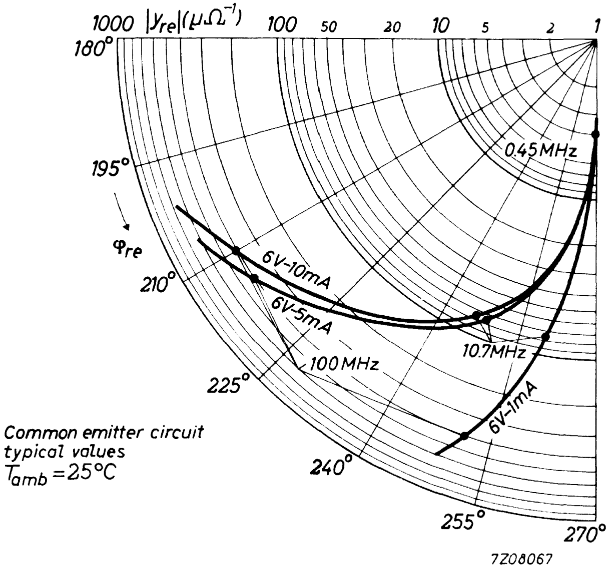
Collector cut-off current				
$I_E = 0$; $-V_{CB} = 6$ V	$-I_{CBO}$	<	4.5	μA
$I_E = 0$; $-V_{CB} = 40$ V	$-I_{CBO}$	<	50	μA
Emitter cut-off current				
$I_C = 0$; $-V_{EB} = 1$ V	$-I_{EBO}$	<	50	μA
Base current				
$I_E = 1$ mA; $-V_{CB} = 6$ V	$-I_B$	<	25	μA
$I_E = 10$ mA; $-V_{CB} = 2$ V	$-I_B$	>	20	μA
Base-emitter voltage				
$I_E = 1$ mA; $-V_{CB} = 6$ V	$-V_{BE}$		210 to 330	mV
$I_E = 10$ mA; $-V_{CB} = 2$ V	$-V_{BE}$		260 to 400	mV
Frequency at which $\|h_{fe}\| = 1$				
$I_E = 1$ mA; $-V_{CB} = 6$ V	f_1	>	40	MHz
		typ.	75	MHz
$I_E = 10$ mA; $-V_{CB} = 2$ V	f_1	>	100	MHz
Collector capacitance at f = 0.45 MHz				
$I_E = I_e = 0$; $-V_{CB} = 6$ V	C_c	<	2.5	pF
Feedback impedance at f = 2 MHz				
$I_E = 1$ mA; $-V_{CB} = 6$ V	$\|z_{rb}\|$	<	120	Ω
h parameters				
$I_E \leq 10$ mA; $-V_{CB} \leq 6$ V; $T_{amb} = 60$ °C	$-h_{fb}$	<	1.01	
$-I_C = 1$ mA; $-V_{CE} = 6$ V; f = 1 kHz	h_{fe}	>	45	
Noise figure at $R_S = 500\ \Omega$				
$-I_C = 1$ mA; $-V_{CE} = 6$ V; f = 1 kHz	F	typ.	15	dB
		<	20	dB
f = 450 kHz	F	<	6	dB

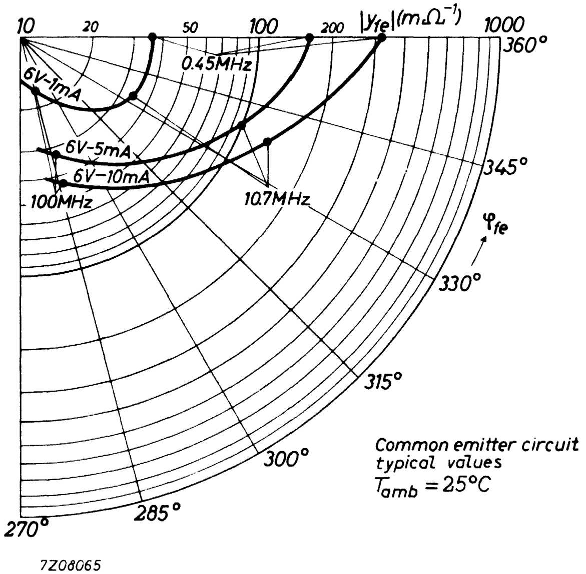

7Z08063
15
10
5
-I_C
(mA)
-I_B = 70 μA
60 μA
50 μA
40 μA
30 μA
20 μA
10 μA
-V_CE = 6V
75
-I_B (μA)
25
0
10
-V_CE (V)
20
typical values
T_amb = 25°C
200
-V_BE
(mV)
400
-V_CE = 6V



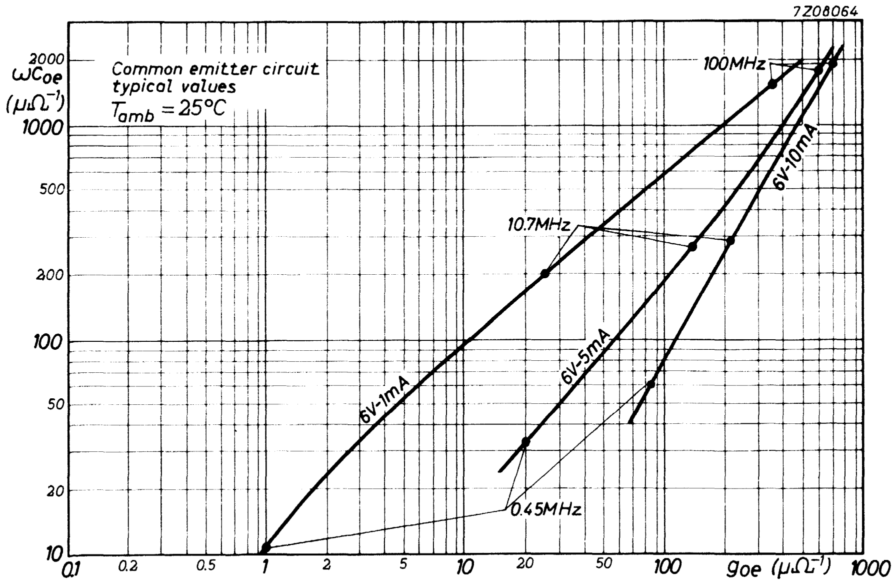
7Z02008/1.19.26. bj
1000
500
$-I_{CBO}$
(μA)
200
100
50
20
10
5
2
1
20
40
60
80
T_j (°C)
100
max
typ
$-V_{CB}$ = 40V
$-V_{CB}$ = 40V
$-V_{CB}$ = 6V
$-V_{CB}$ = 6V


7Z08066
ωC_{ie} $(m\Omega^{-1})$
Common emitter circuit typical values
$T_{amb} = 25°C$
35MHz
100MHz
10.7MHz
5MHz
0.45MHz
6V-1mA
6V-5mA
6V-10mA
g_{ie} $(m\Omega^{-1})$
0.1
0.2
0.5
1
2
5
10
20
50
100


1000 $|y_{re}|$ $(\mu\Omega^{-1})$ 100 50 20 10 5 2 1
180°
195°
210°
225°
240°
255°
270°
φ_{re}
0.45MHz
6V-10mA
6V-5mA
100MHz
10.7MHz
6V-1mA
Common emitter circuit typical values
$T_{amb} = 25°C$
7Z08067

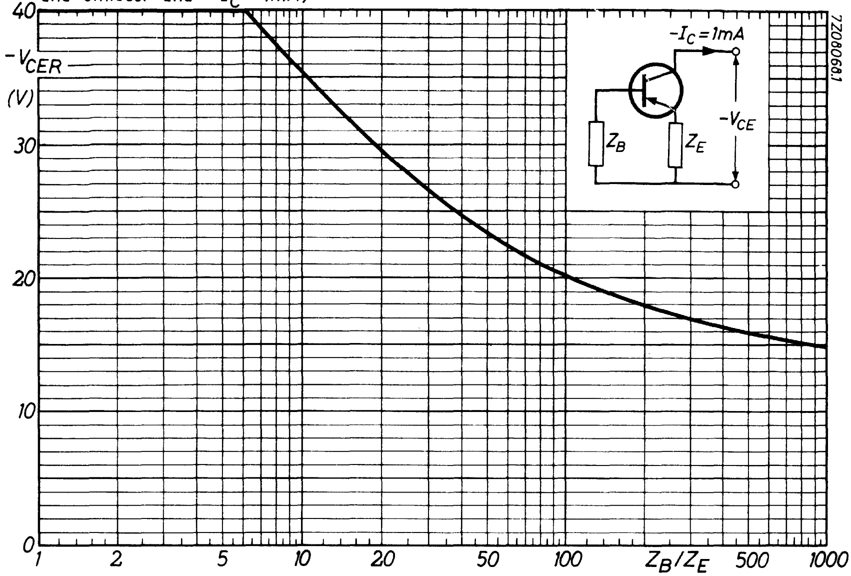


10
20
50
100
200
|y_fe| (mΩ⁻¹)
1000
360°
345°
330°
315°
300°
285°
270°
φ_fe
0.45MHz
6V-1mA
6V-5mA
6V-10mA
100MHz
10.7MHz
Common emitter circuit
typical values
T_amb = 25°C
7Z08065



7Z08064
ωC_oe (μΩ⁻¹)
2000
1000
500
200
100
50
20
10
Common emitter circuit
typical values
T_amb = 25°C
100MHz
10.7MHz
0.45MHz
6V-1mA
6V-5mA
6V-10mA
0.1
0.2
0.5
1
2
5
10
20
50
100
g_oe (μΩ⁻¹)
1000

Maximum allowable collector-emitter voltage (with impedance between base and emitter and $-I_C = 1mA$)



GERMANIUM ALLOY DIFFUSED TRANSISTOR

P-N-P transistor in a TO-18 metal envelope. It is intended for use in high-speed saturated logic applications.

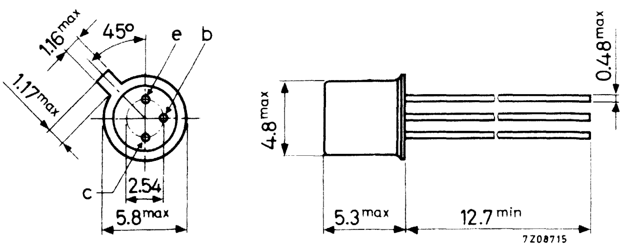
QUICK REFERENCE DATA				
Collector-base voltage (open emitter)	$-V_{CBO}$	max.	20	V
Collector-emitter voltage (open base)	$-V_{CEO}$	max.	15	V
Collector current (peak value)	$-I_{CM}$	max.	50	mA
Total power dissipation up to T_{amb} = 25 °C	P_{tot}	max.	120	mW
Junction temperature	T_j	max.	85	°C
D.C. current gain at T_{amb} = 25 °C				
$-I_C$ = 10 mA; $-V_{CE}$ = 0.5 V	h_{FE}	>	30	
Transition frequency				
I_E = 10 mA; $-V_{CB}$ = 2 V	f_T	>	300	MHz

MECHANICAL DATA

Dimensions in mm

TO-18

Collector connected to case



Accessories available: 56246, 56263

RATINGS (Limiting values) [1]

Voltages

Collector-base voltage (open emitter)	$-V_{CBO}$	max.	20	V
Collector-emitter voltage (open base)	$-V_{CEO}$	max.	15	V

Currents

Collector current (d.c. or average over any 20 ms period)	$-I_C$	max.	30	mA
Collector current (peak value)	$-I_{CM}$	max.	50	mA
Emitter current (d.c. or average over any 20 ms period)	I_E	max.	5	mA
Emitter current (peak value)	I_{EM}	max.	10	mA

Power dissipation

Total power dissipation up to T_{amb} = 25 °C	P_{tot}	max.	120	mW

Temperatures

Storage temperature	T_{stg}		-55 to +75	°C
Junction temperature	T_j	max.	85	°C

THERMAL RESISTANCE

From junction to ambient in free air	$R_{th\ j-a}$	=	0.50	°C/mW
From junction to case	$R_{th\ j-c}$	=	0.18	°C/mW

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

Emitter cut-off current

$I_C = 0$; $-V_{EB} = 0.5$ V	$-I_{EBO}$	<	2	μA

Currents at reverse biased emitter junction

$-V_{CE} = 15$ V; $-V_{EB} = 0.2$ V; $T_{amb} = 60$ °C	$-I_{CEX}$	<	60	μA
	$+I_{BEX}$	<	60	μA

[1] Limiting values according to the Absolute Maximum System as defined in IEC publication 134.

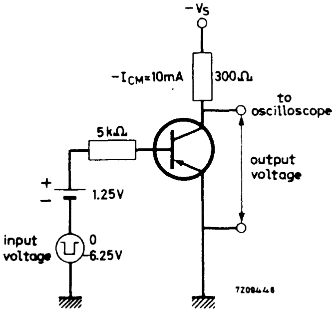
CHARACTERISTICS (continued) T_{amb} = 25 °C unless otherwise specified

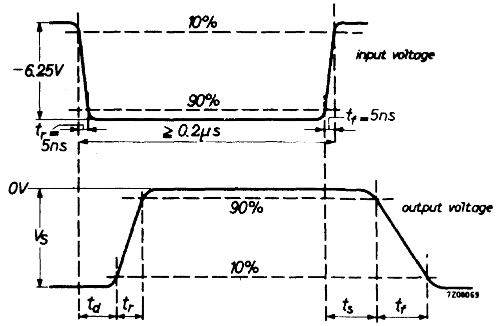
Breakdown voltages at T_{amb} = 60 °C				
$I_E = 0$; $-I_C = 100\ \mu A$	$-V_{(BR)\,CBO}$	>	20	V
$I_C = 0$; $-I_E = 100\ \mu A$	$-V_{(BR)\,EBO}$	>	2.5	V
Sustaining voltage				
$I_B = 0$; $-I_C = 5$ mA	$-V_{CEO\,sust}$	>	9	V
Saturation voltage				
$-I_C = 10$ mA; $-I_B = 1$ mA	$-V_{CE\,sat}$	<	0.35	V
$-I_C = 50$ mA; $-I_B = 3$ mA	$-V_{CE\,sat}$	<	1.10	V
Base-emitter voltage				
$-I_C = 10$ mA; $-I_B = 0.44$ mA	$-V_{BE}$	0.25 to	0.5	V
$-I_C = 30$ mA; $-I_B = 0.9$ mA	$-V_{BE}$	0.35 to	0.75	V
D.C. current gain				
$-I_C = 10$ mA; $-V_{CE} = 0.5$ V	h_{FE}	>	30	
$-I_C = 30$ mA; $-V_{CE} = 1.0$ V	h_{FE}	>	50	
Collector capacitance				
$I_E = I_e = 0$; $-V_{CB} = 6$ V	C_c	<	5	pF
Emitter capacitance				
$I_C = I_c = 0$; $-V_{EB} = 1$ V	C_e	<	12	pF
Transition frequency				
$I_E = 10$ mA; $-V_{CB} = 2$ V	f_T	>	300	MHz

CHARACTERISTICS (continued) Tamb = 25 °C unless otherwise specified

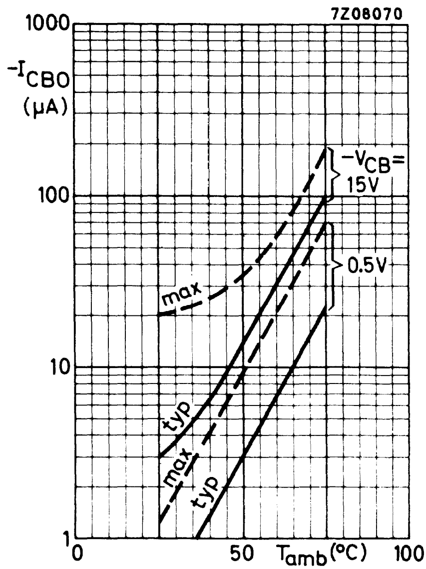
Switching characteristics

Test circuit:





Delay time	t_d	typ. 30 15 to 40	ns ns
Rise time	t_r	typ. 20 10 to 35	ns ns
Storage time	t_s	typ. 40 25 to 60	ns ns
Fall time	t_f	typ. 40 25 to 55	ns ns



ALLOY-DIFFUSED TRANSISTOR

P-N-P alloy-diffused germanium transistor in a TO-7 metal envelope with a shield lead connected to the case. It is intended for generation of short duration pulses.

RATINGS

Emitter-base voltage (open collector)	$-V_{EBO}$	max.	2.0	V
Collector current (peak value)	$-I_{CM}$	max.	100	mA
Total power dissipation up to T_{case} = 25 °C	P_{tot}	max.	100	mW
Storage temperature	T_{stg}		-55 to +75	°C
Junction temperature	T_j	max.	75	°C

THERMAL RESISTANCE

From junction to ambient in free air	$R_{th\ j-a}$	=	0.6	°C/mW
From junction to case	$R_{th\ j-c}$	=	0.5	°C/mW

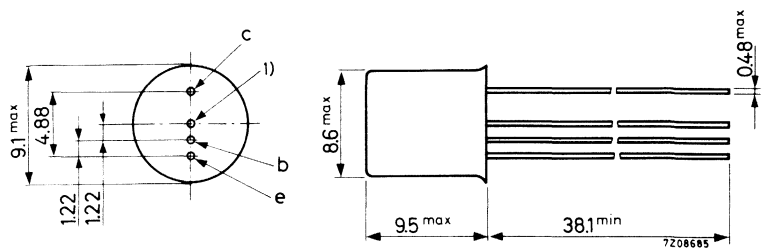
CHARACTERISTICS

Collector cut-off current $I_E = 0$; $-V_{CB} = 6$ V	$-I_{CBO}$	typ.	2	μA
		<	8	μA
Emitter cut-off current $I_C = 0$; $-V_{EB} = 0.5$ V	$-I_{EBO}$	typ.	100	nA
		<	500	nA
Collector-base breakdown voltage $I_E = 0$; $-I_C = 1$ mA	$-V_{(BR)CBO}$	typ.	24	V
			15 to 30	V
Collector capacitance $I_E = I_e = 0$; $-V_{CB} = 6$ V	C_c	<	4	pF
Collector current rise time when switched to $-I_{CM} = 60$ mA	t_r	typ.	1	ns

MECHANICAL DATA

Dimensions in mm

TO-7



1) = shield lead (connected to case)

GERMANIUM P-N-P POWER TRANSISTORS

Alloy diffused transistors in a metal envelope with the collector connected to the case. The AU101 is meant for use in a line deflection output stage; the AU102 for the corresponding driver stage.

RATINGS Limiting values according to the Absolute Maximum System as defined in IEC publication 134.

Collector-base voltage (open emitter)	AU101	$-V_{CBO}$	max.	120	V
	AU102	$-V_{CBO}$	max.	40	V
Collector current (d.c. and average)		$-I_C$	max.	10	A
Total power dissipation		P_{tot}	max.	10	W
Junction temperature (continuous)		T_j	max.	90	°C

THERMAL RESISTANCE

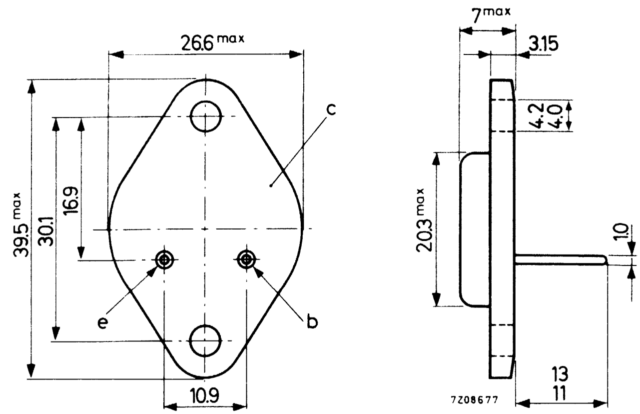
From junction to mounting base $R_{th\ j-mb}$ = 2.0 °C/W

CHARACTERISTICS T_j = 25 °C unless otherwise specified

D.C. current gain					
I_E = 10 A; V_{CB} = 0	AU101	h_{FE}		12 to 50	
	AU102	h_{FE}	>	7	
Transition frequency					
$-I_C$ = 0.5 A; $-V_{CE}$ = 2 V		f_T	>	400	kHz
Fall time from $-I_C$ = 8 A					
T_j = 90 °C	AU101	t_f	<	2.6	μs
	AU102	t_f	<	3.9	μs

MECHANICAL DATA Dimensions in mm

Collector connected to case



FOR NEW DESIGN THE SUCCESSOR TYPES
AU103, AU104 (P-N-P) OR BU105 (N-P-N) ARE RECOMMENDED

POWER TRANSISTOR

P-N-P germanium alloy-diffused transistor in a metal case, primarily intended for use in line-deflection output circuits of television receivers.

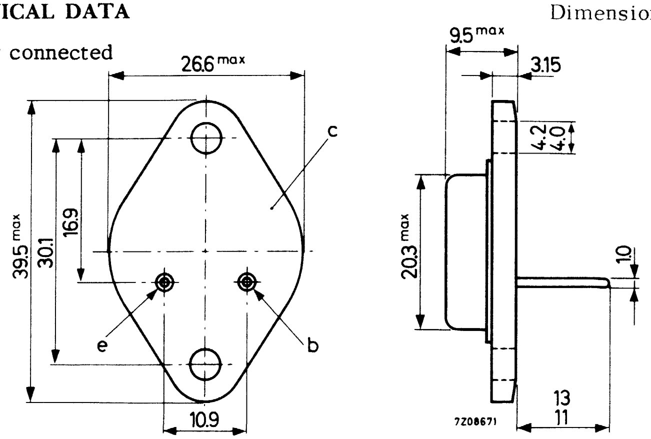
QUICK REFERENCE DATA

Collector-base voltage (open emitter)	$-V_{CBO}$	max.	155	V
Collector-emitter voltage ($+V_{BE}$ = 1 V)	$-V_{CEX}$	max.	155	V
Collector current (peak value)	$-I_{CM}$	max.	10	A
Total dissipation up to T_{mb} = 85 °C	P_{tot}	max.	10	W
Junction temperature	T_j	max.	90	°C
Thermal resistance	$R_{th\ j\text{-}mb}$	=	1.5	°C/W
Emitter-base breakdown voltage $-I_E$ = 100 mA (open collector)	$-V_{(BR)EBO}$	>	4	V
D.C. current gain at T_j = 25 °C $-I_C$ = 10 A; $-V_{CE}$ = 1 V	h_{FE}	>	15	
Transition frequency at T_j = 25 °C $-I_C$ = 0.5 A; $-V_{CE}$ = 2 V	f_T	typ.	15	MHz
Fall time	t_f	<	1.7	μs

MECHANICAL DATA

Dimensions in mm

Collector connected to case



Accessories available: 56201e

RATINGS (Limiting values) [1]

Voltages

Collector-base voltage (open emitter)	$-V_{CBO}$	max.	155	V
Collector-emitter voltage with $+V_{BE}$ = 1 V (See also page 5)	$-V_{CEX}$	max.	155	V

Currents

Collector current (d.c.)	$-I_C$	max.	10	A
Collector current (peak value)	$-I_{CM}$	max.	10	A [2]
Emitter current (d.c.)	I_E	max.	12.5	A
Emitter current (peak value)	I_{EM}	max.	12.5	A
Base current (d.c.)	$-I_B$	max.	2.5	A
Base current (peak value)	$-I_{BM}$	max.	2.5	A
Reverse base current (d.c.)	$+I_B$	max.	0.1	A
Reverse base current (peak value) t = 5 μs	$+I_{BM}$	max.	2.5	A

Power dissipation (See also page 6)

Total power dissipation up to T_{mb} = 85 ^{o}C	P_{tot}	max.	10	W

Temperatures

Storage temperature	T_{stg}	-55 to	+90	^{o}C
Junction temperature: continuous	T_j	max.	90	^{o}C
incidentally	T_j	max.	100	^{o}C

THERMAL RESISTANCE

From junction to mounting base	$R_{th\ j\text{-}mb}$	=	1.5	^{o}C/W
From mounting base to heatsink without mica washer	$R_{th\ mb\text{-}h}$	=	0.2	^{o}C/W
with mica washer	$R_{th\ mb\text{-}h}$	=	0.5	^{o}C/W

[1] Limiting values according to the Absolute Maximum System as defined in IEC publication 134.

[2] Non repetitive peak collector current: 20 A

CHARACTERISTICS

T_j = 25 °C unless otherwise specified

Collector cut-off current				
$I_E = 0$; $-V_{CB} = 155$ V	$-I_{CBO}$	<	10	mA
$I_E = 0$; $-V_{CB} = 155$ V; $T_j = 100$ °C	$-I_{CBO}$	<	60	mA
Base-emitter voltage				
$I_E = 10$ A; $-V_{CB} = 0.5$ V	$-V_{BE}$	<	0.75	V
Collector-emitter saturation voltage				
$-I_C = 10$ A; $-I_B = 0.8$ A (See also page 7)	$-V_{CEsat}$	<	0.7	V
Emitter-base breakdown voltage				
$I_C = 0$; $-I_E = 100$ mA	$-V_{(BR)EBO}$	>	4	V
D.C. current gain				
$-I_C = 10$ A; $-V_{CE} = 1$ V	h_{FE}	>	15	
Transition frequency				
$-I_C = 0.5$ A; $-V_{CE} = 2$ V	f_T	typ.	15	MHz
Switching times when switched from $-I_B = 0.8$ A to $V_{BE} = 4$ V measured at $-I_C = 10$ A (See also page 4 and page 7)				
storage time	t_s	<	3	µs
fall time	t_f	<	1.7	µs

MEASUREMENT OF SWITCHING TIMES

Fig.1: Circuit diagram

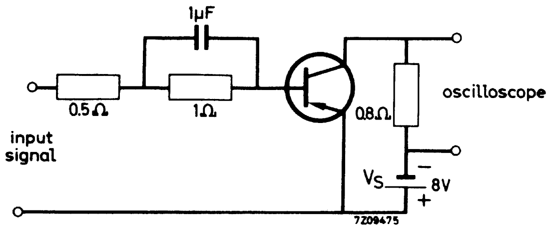


Fig.2: Input signal

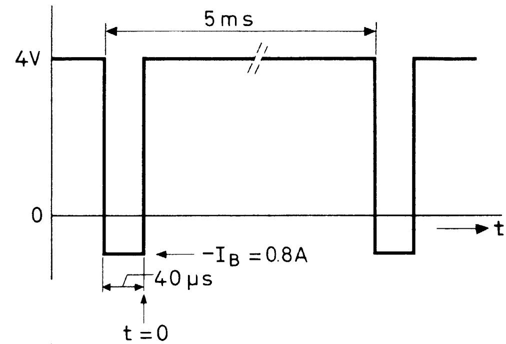
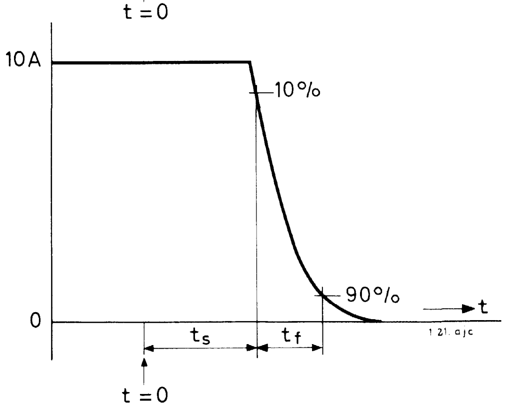
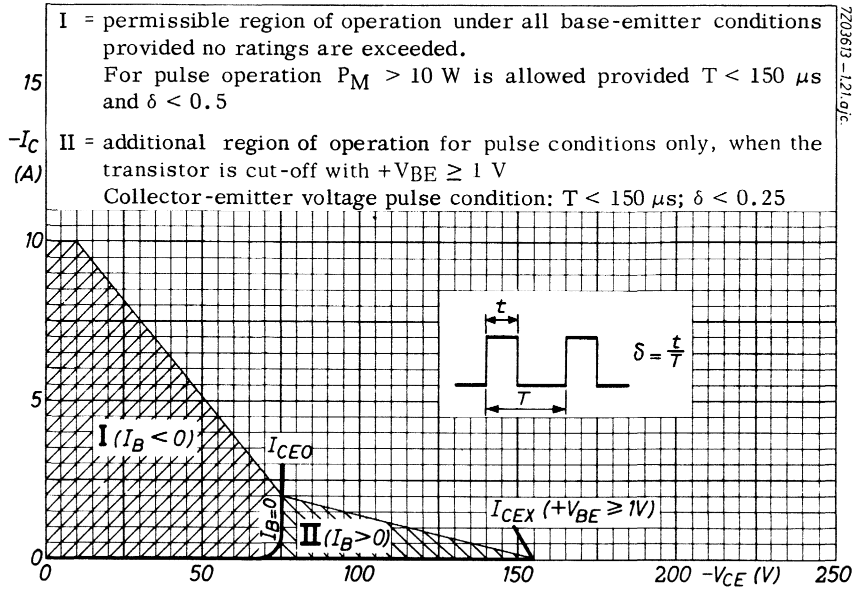
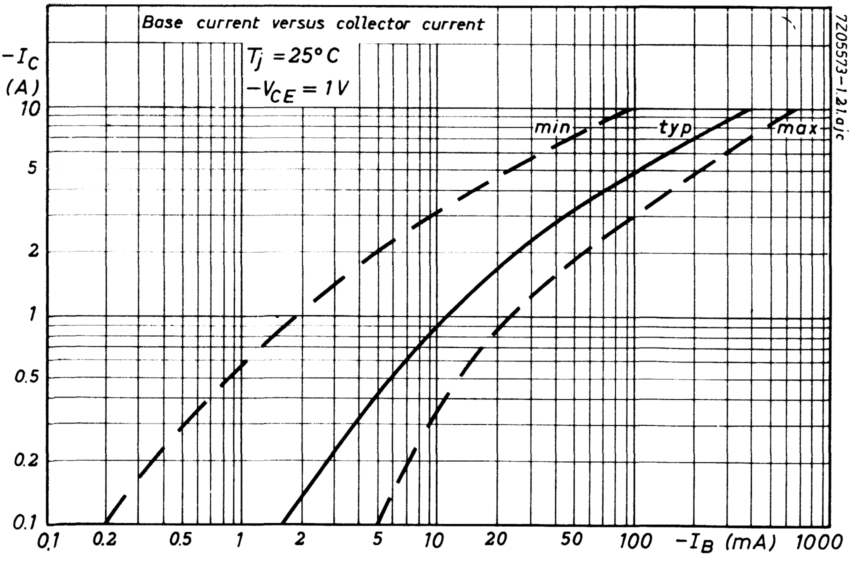
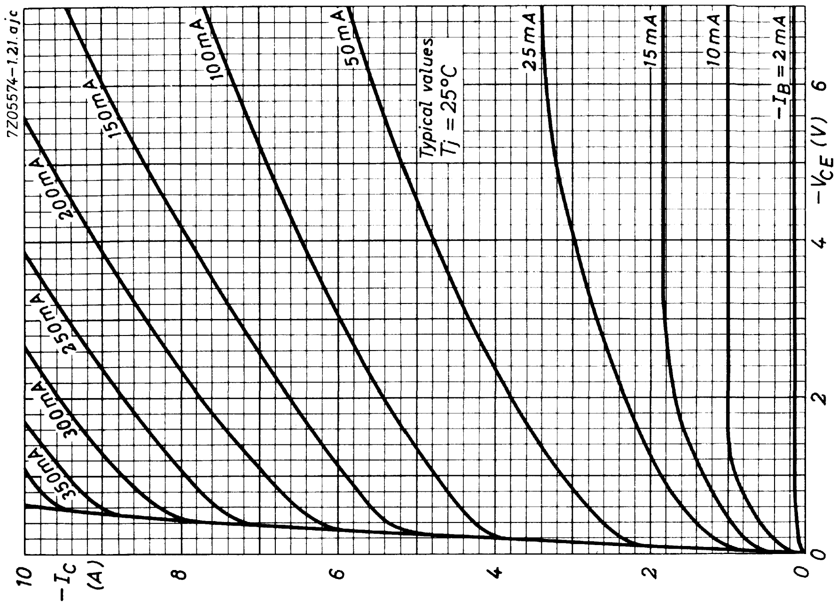


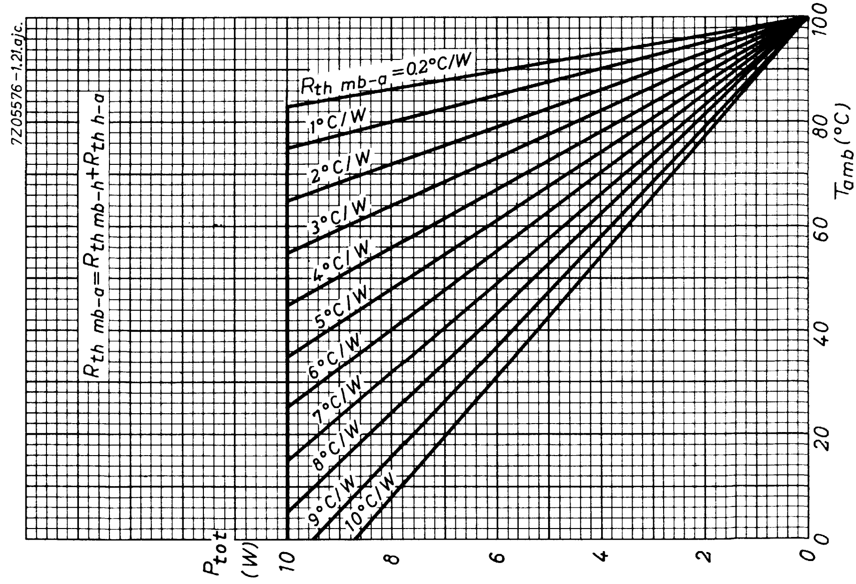
Fig.3: Output signal

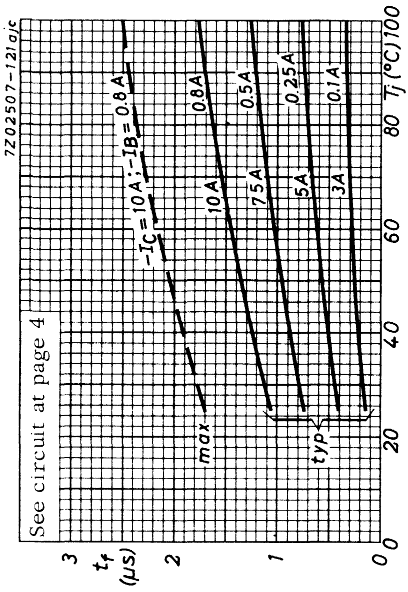


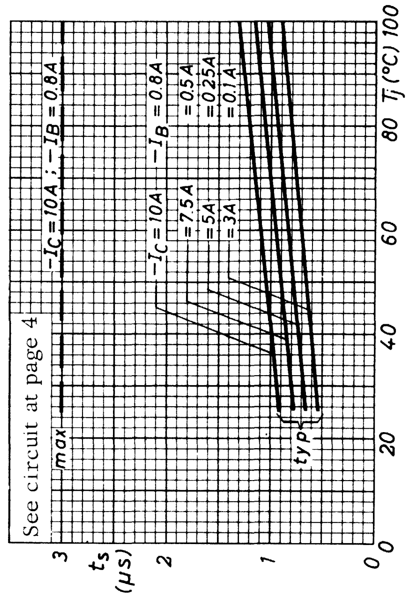

I = permissible region of operation under all base-emitter conditions provided no ratings are exceeded.
For pulse operation P_M > 10 W is allowed provided T < 150 μs and δ < 0.5
II = additional region of operation for pulse conditions only, when the transistor is cut-off with $+V_{BE} \geq 1$ V
Collector-emitter voltage pulse condition: T < 150 μs; δ < 0.25
7Z03613–1.21.a/c.
15
$-I_C$
(A)
10
5
0
0
50
100
150
200 $-V_{CE}$ (V)
250
I (I_B < 0)
I_{CEO}
I_B=0
II (I_B>0)
I_{CEX} ($+V_{BE} \geq 1V$)
t
T
$\delta = \frac{t}{T}$

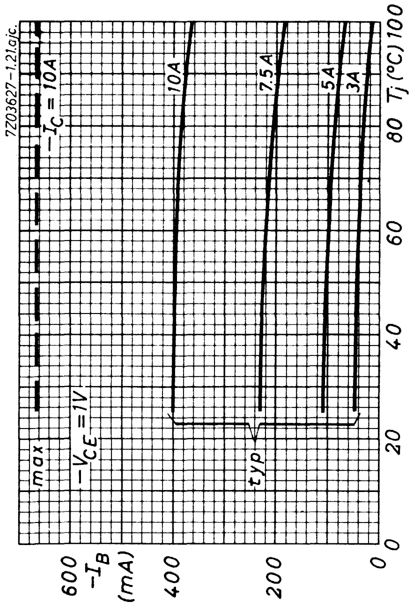

Base current versus collector current
T_j = 25°C
$-V_{CE}$ = 1 V
7Z05573-1.21.a/c
$-I_C$
(A)
10
5
2
1
0.5
0.2
0.1
0.1
0.2
0.5
1
2
5
10
20
50
100
$-I_B$ (mA)
1000
min
typ
max

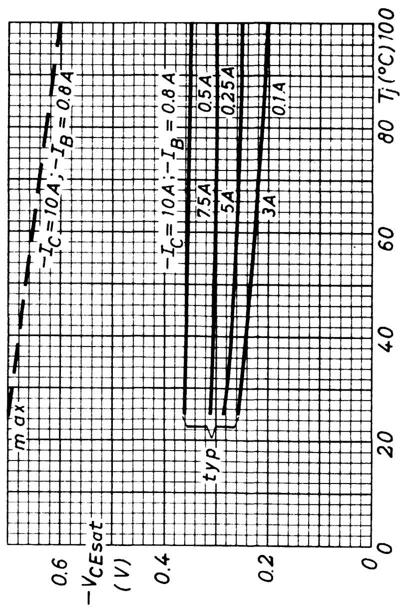

7Z05574-1.21.ajc
Typical values
$T_j = 25°C$
$-I_B = 2 mA$
10 mA
15 mA
25 mA
50 mA
100 mA
150 mA
200 mA
250 mA
300 mA
350 mA
$-V_{CE}$ (V)
$-I_C$ (A)
0
2
4
6
8
10


7Z05576-1.21.ajc.
$R_{th\ mb-a} = R_{th\ mb-h} + R_{th\ h-a}$
$R_{th\ mb-a} = 0.2°C/W$
1°C/W
2°C/W
3°C/W
4°C/W
5°C/W
6°C/W
7°C/W
8°C/W
9°C/W
10°C/W
P_{tot} (W)
T_{amb} (°C)
0
2
4
6
8
10
20
40
60
80
100

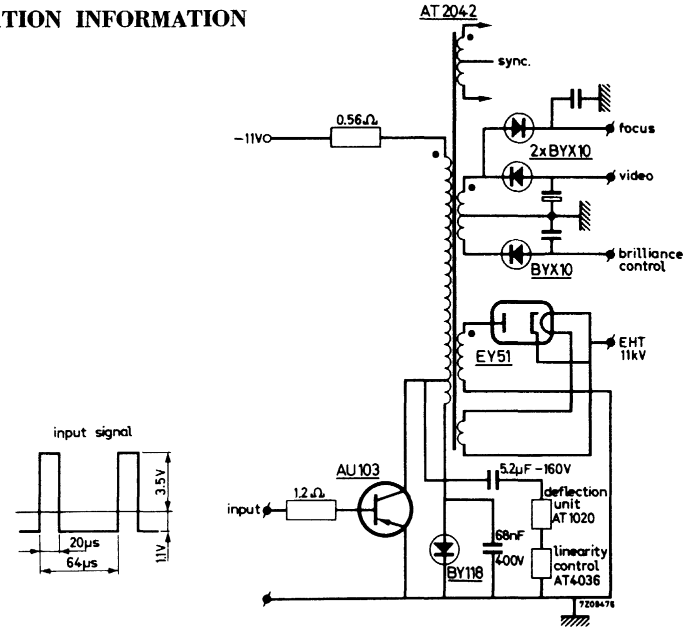

7Z02507-1.21 ajc
See circuit at page 4
t_f (μs)
T_j (°C)
$-I_C = 10A; -I_B = 0.8A$
10A 0.8A
7.5A 0.5A
5A 0.25A
3A 0.1A
max
typ


See circuit at page 4
t_s (μs)
T_j (°C)
$-I_C = 10A ; -I_B = 0.8A$
$-I_C = 10A$ $-I_B = 0.8A$
= 7.5A = 0.5A
= 5A = 0.25A
= 3A = 0.1A
max
typ

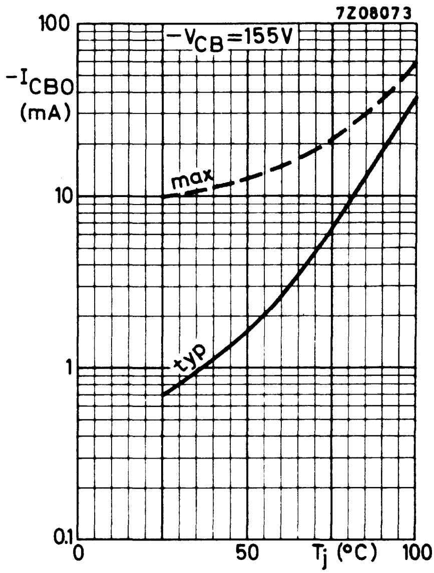

7Z03627-1.21.ajc.
$-I_B$ (mA)
T_j (°C)
$-I_C = 10A$
$-V_{CE} = 1V$
10A
7.5A
5A
3A
max
typ


$-V_{CEsat}$ (V)
T_j (°C)
$-I_C = 10A; -I_B = 0.8A$
$-I_C = 10A; -I_B = 0.8A$
7.5A 0.5A
5A 0.25A
3A 0.1A
max
typ

APPLICATION INFORMATION



Typical parallel efficiency circuit for 90° deflection with an E.H.T. of 11 kV and a flyback ratio of 17.5%



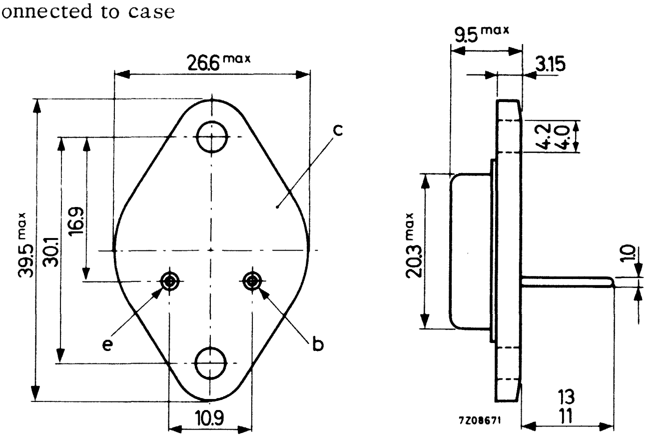
POWER TRANSISTOR

P-N-P germanium alloy-diffused transistor in a metal case, primarily intended for use in line-deflection output circuits of television receivers.

QUICK REFERENCE DATA				
Collector-base voltage (open emitter)	$-V_{CBO}$	max.	185	V
Collector-emitter voltage ($+V_{BE}$ = 1 V)	$-V_{CEX}$	max.	185	V
Collector current (peak value)	$-I_{CM}$	max.	12	A
Total dissipation up to T_{mb} = 77.5 °C	P_{tot}	max.	15	W
Junction temperature	T_j	max.	90	°C
Thermal resistance	$R_{th\ j\text{-}mb}$	=	1.5	°C/W
Emitter-base breakdown voltage				
$-I_E$ = 100 mA (open collector)	$-V_{(BR)EBO}$	>	4	V
D.C. current gain at T_j = 25 °C				
$-I_C$ = 12 A; $-V_{CE}$ = 1 V	h_{FE}	>	14	
Transition frequency at T_j = 25 °C				
$-I_C$ = 0.5 A; $-V_{CE}$ = 2 V	f_T	typ.	15	MHz
Fall time	t_f	<	1.8	μs

MECHANICAL DATA Dimensions in mm

Collector connected to case



Accessories available: 56201e

FOR NEW DESIGN THE SUCCESSOR TYPE BU105 (N-P-N) IS RECOMMENDED

RATINGS (Limiting values) [1]

Voltages

Collector-base voltage (open emitter)	$-V_{CBO}$	max.	185	V
Collector-emitter voltage with $+V_{BE}$ = 1 V (See also page 5)	$-V_{CEX}$	max.	185	V

Currents

Collector current (d.c.)	$-I_C$	max.	12	A
Collector current (peak value)	$-I_{CM}$	max.	12	A [2]
Emitter current (d.c.)	I_E	max.	14.5	A
Emitter current (peak value)	I_{EM}	max.	15.5	A
Base current (d.c.)	$-I_B$	max.	2.5	A
Base current (peak value)	$-I_{BM}$	max.	3.5	A
Reverse base current (d.c.)	$+I_B$	max.	0.1	A
Reverse base current (peak value) t = 5 μs	$+I_{BM}$	max.	3.0	A

Power dissipation (See also page 5)

Total power dissipation up to T_{mb} = 77.5 ^oC	P_{tot}	max.	15	W

Temperatures

Storage temperature	T_{stg}		-55 to +90	^oC
Junction temperature: continuous	T_j	max.	90	^oC
incidentally	T_j	max.	100	^oC

THERMAL RESISTANCE

From junction to mounting base	$R_{th\ j\text{-}mb}$	=	1.5	$^oC/W$
From mounting base to heatsink with lead washer, without mica washer	$R_{th\ mb\text{-}h}$	=	0.2	$^oC/W$
with lead washer and mica washer	$R_{th\ mb\text{-}h}$	=	0.5	$^oC/W$

[1]) Limiting values according to the Absolute Maximum System as defined in IEC publication 134.

[2]) Non repetitive peak collector current: 25 A.

CHARACTERISTICS T_j = 25 °C unless otherwise specified

Collector cut-off current				
I_E = 0; $-V_{CB}$ = 185 V	$-I_{CBO}$	<	10	mA
I_E = 0; $-V_{CB}$ = 185 V; T_j = 100 °C	$-I_{CBO}$	<	60	mA
Base-emitter voltage				
I_E = 10 A; $-V_{CB}$ = 0.5 V	$-V_{BE}$	<	0.75	V
$-I_C$ = 12 A; $-V_{CE}$ = 1 V	$-V_{BE}$	<	0.95	V
Saturation voltages (See also page 8)				
$-I_C$ = 12 A; $-I_B$ = 1.3 A	$-V_{CEsat}$	<	0.85	V
	$-V_{BEsat}$	<	0.85	V
Emitter-base breakdown voltage				
I_C = 0; $-I_E$ = 100 mA	$-V_{(BR)EBO}$	>	4	V
D.C. current gain				
$-I_C$ = 10 A; $-V_{CE}$ = 1 V	h_{FE}	>	15	
$-I_C$ = 12 A; $-V_{CE}$ = 1 V	h_{FE}	>	14	
Transition frequency				
$-I_C$ = 0.5 A; $-V_{CE}$ = 2 V	f_T	typ.	15	MHz
Switching times when switched from $-I_B$ = 1.3 A to $+V_{BE}$ = 4 V measured at $-I_C$ = 12 A (See also page 4 and page 6)				
storage time	t_s	<	3	μs
fall time	t_f	<	1.8	μs

MEASUREMENT OF SWITCHING TIMES

Fig. 1: Circuit diagram

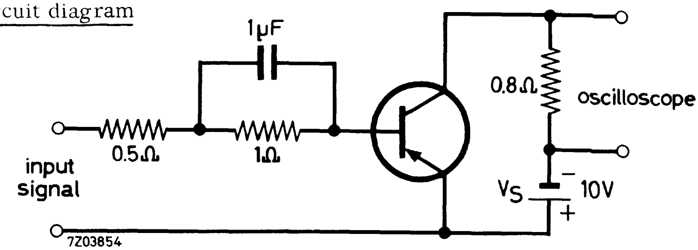


Fig. 2: Input signal

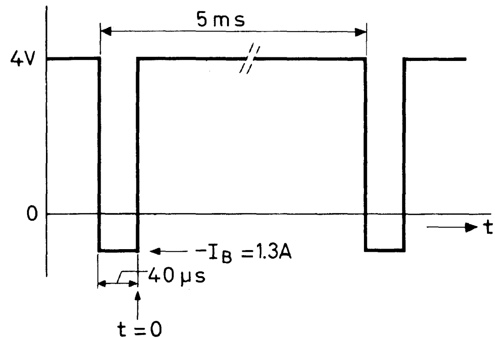
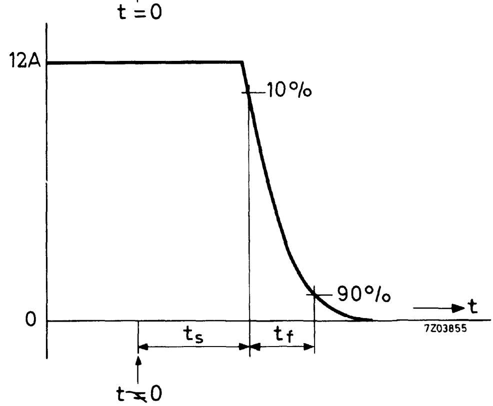
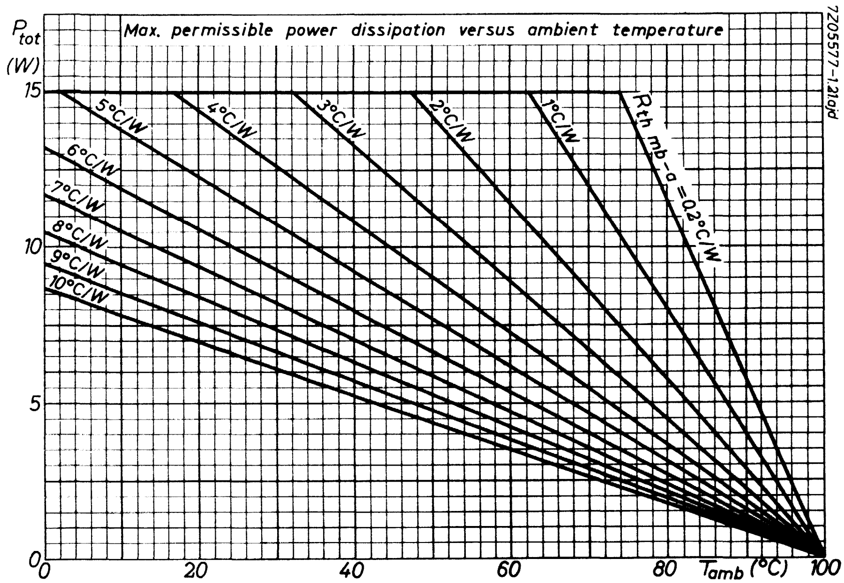
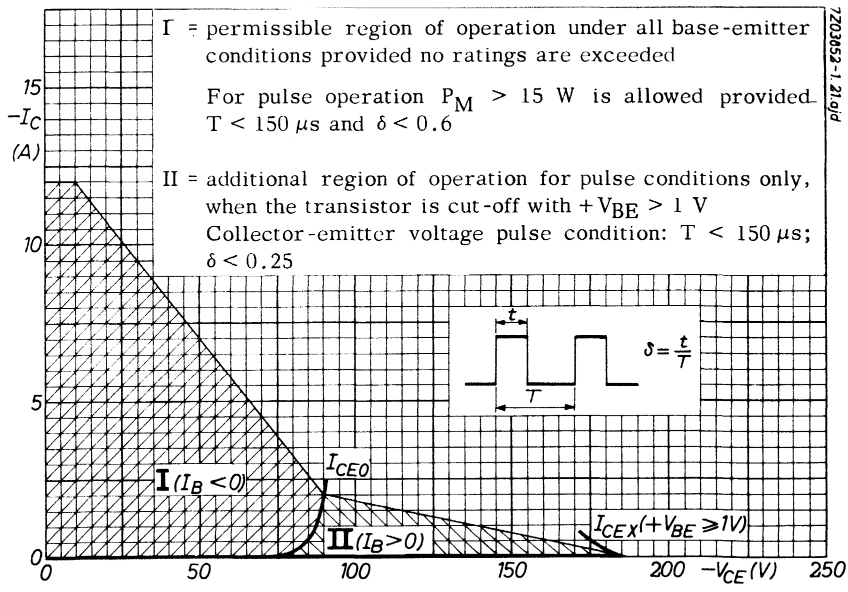
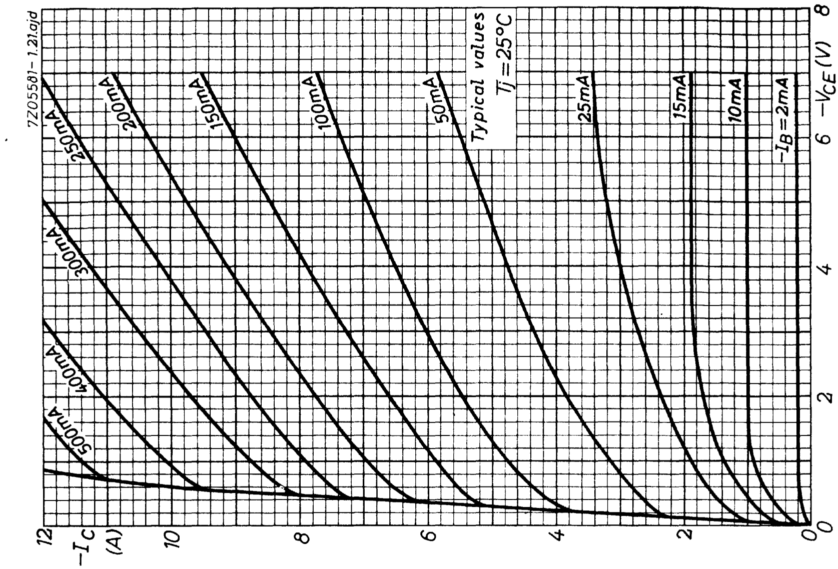


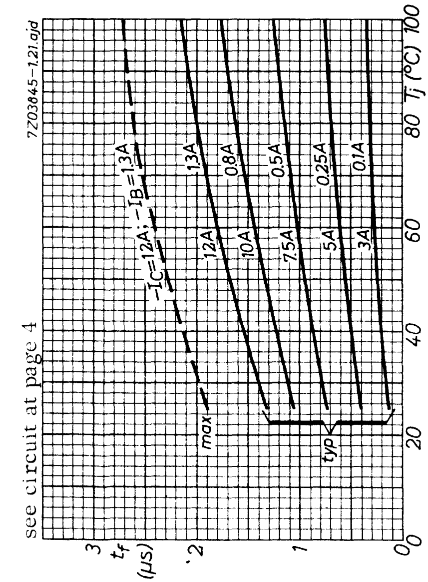
Fig. 3: Ouput signal

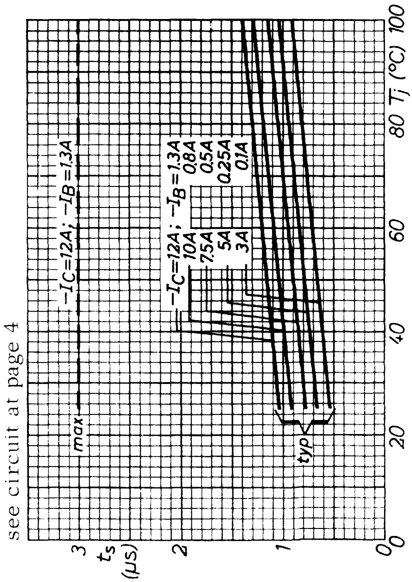


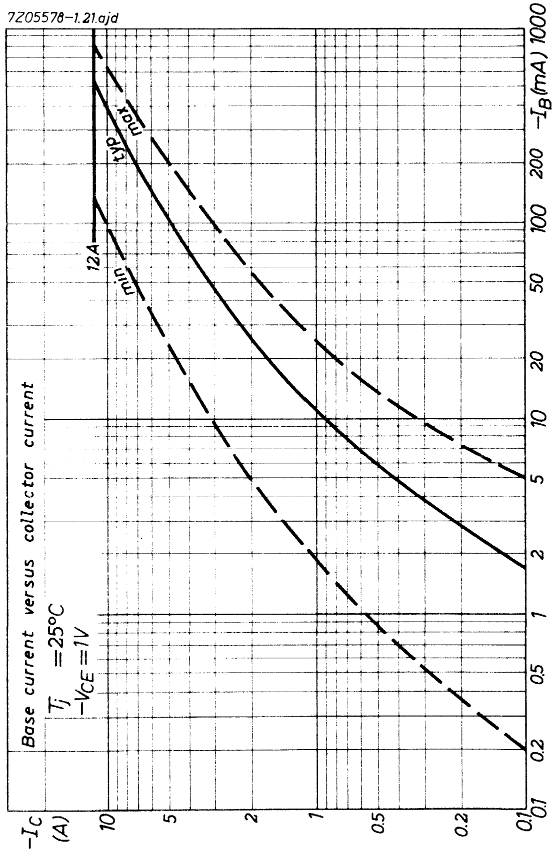

Max. permissible power dissipation versus ambient temperature
P_{tot} (W)
15
10
5
0
0
20
40
60
80
T_{amb} (°C)
100
$R_{th\ mb-a}$ = 0.2°C/W
1°C/W
2°C/W
3°C/W
4°C/W
5°C/W
6°C/W
7°C/W
8°C/W
9°C/W
10°C/W
7Z05577-1.21ajd

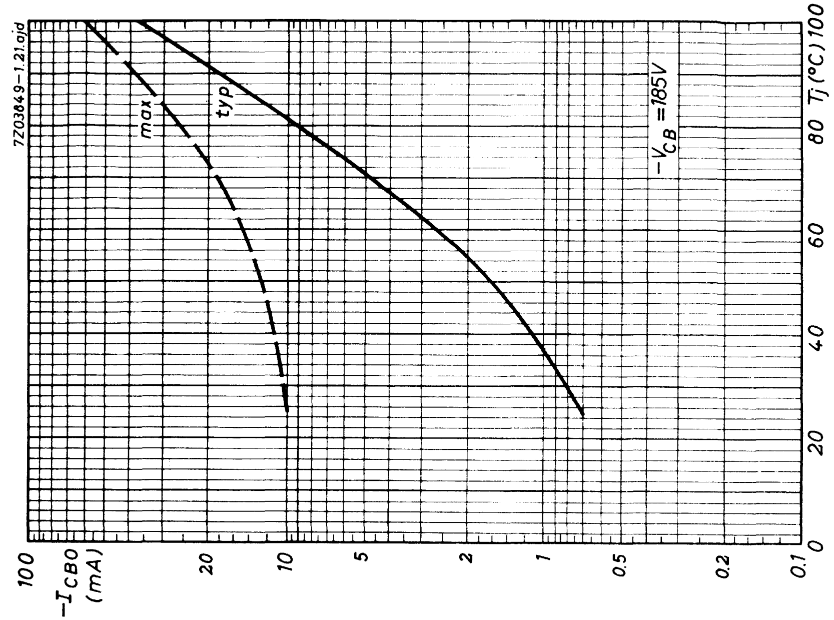

I = permissible region of operation under all base-emitter conditions provided no ratings are exceeded
For pulse operation P_M > 15 W is allowed provided $T < 150\ \mu s$ and $\delta < 0.6$
II = additional region of operation for pulse conditions only, when the transistor is cut-off with $+V_{BE} > 1$ V
Collector-emitter voltage pulse condition: $T < 150\ \mu s$; $\delta < 0.25$
$-I_C$ (A)
15
10
5
0
0
50
100
150
200
$-V_{CE}$ (V)
250
I (I_B < 0)
II (I_B > 0)
I_{CEO}
I_{CEX} ($+V_{BE} \geq 1V$)
t
T
$\delta = \frac{t}{T}$
7Z03852-1.21ajd

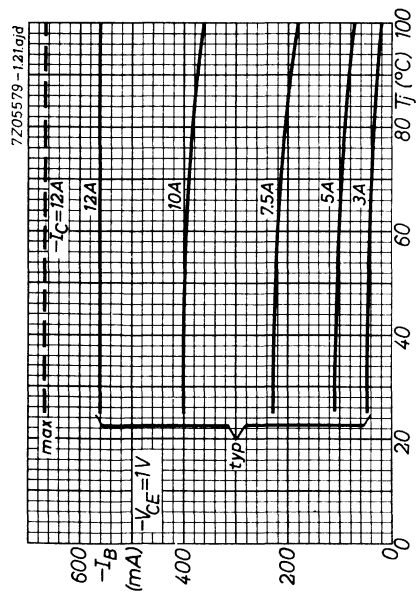

7Z05581-1.21.ajd
Typical values
Tj = 25°C
−IC (A)
−VCE (V)
500mA
400mA
300mA
250mA
200mA
150mA
100mA
50mA
25mA
15mA
10mA
−IB = 2mA

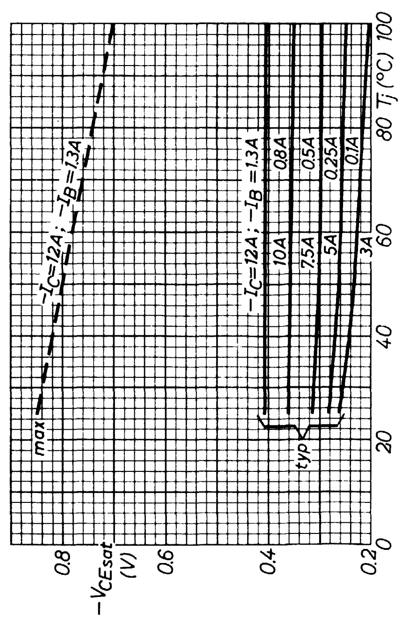

7Z03845-1.21.ajd
see circuit at page 4
tf (μs)
Tj (°C)
−IC=12A; −IB=1.3A
12A
1.3A
10A
0.8A
7.5A
0.5A
5A
0.25A
3A
0.1A
max
typ


see circuit at page 4
ts (μs)
Tj (°C)
−IC=12A; −IB=1.3A
−IC=12A; −IB=1.3A
10A 0.8A
7.5A 0.5A
5A 0.25A
3A 0.1A
max
typ

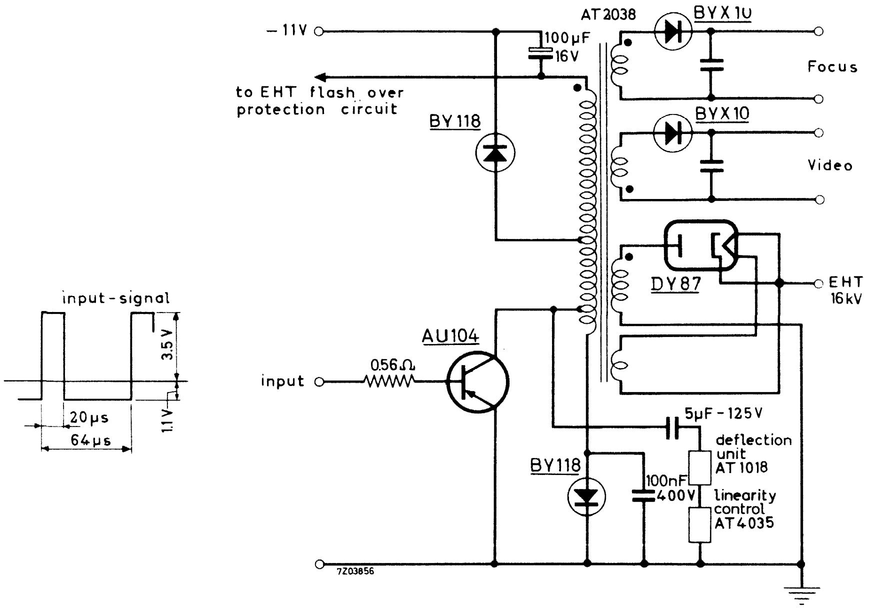

7Z05578-1.21.ajd
Base current versus collector current
T_j = 25°C
$-V_{CE}$ = 1V
$-I_C$ (A)
10
5
2
1
0.5
0.2
0.1
$-I_B$ (mA)
0.1
0.2
0.5
1
2
5
10
20
50
100
200
1000
12A
max
typ
min


7Z03849-1.21.ajd
max
typ
$-V_{CB} = 185V$
$-I_{CBO}$ (mA)
100
20
10
5
2
1
0.5
0.2
0.1
0
20
40
60
80
100
T_j (°C)


7Z05579-1.21.ajd
max
$-I_C=12A$
12A
10A
7.5A
5A
3A
typ
$-V_{CE}=1V$
$-I_B$ (mA)
600
400
200
0
0
20
40
60
80
100
T_j (°C)


max
$-I_C=12A; -I_B=1.3A$
$-I_C=12A; -I_B=1.3A$
10A 0.8A
7.5A 0.5A
5A 0.25A
3A 0.1A
typ
$-V_{CEsat}$ (V)
0.8
0.6
0.4
0.2
0
20
40
60
80
100
T_j (°C)

APPLICATION INFORMATION



Typical parallel-series efficiency circuit for 110° deflection with an E.H.T. of 16 kV and a flyback ratio of 19.5 %

POWER SWITCHING TRANSISTOR

P-N-P alloy diffused transistor for non-saturated switching.

RATINGS [1]

Voltages

Collector-base voltage (open emitter)	$-V_{CBO}$	max.	70	V
Collector-emitter voltage with $+V_{BE} > 0.2$ V	$-V_{CEX}$	max.	60	V

Currents

Collector current (d.c.)	$-I_C$	max.	700	mA
Emitter current (d.c.)	I_E	max.	750	mA
Reverse emitter current	$-I_E$	max.	50	mA
Base current (peak value)	$-I_{BM}$	max.	750	mA

Power dissipation

Total power dissipation up to $T_{mb} = 50$ °C	P_{tot}	max.	6	W

Temperatures

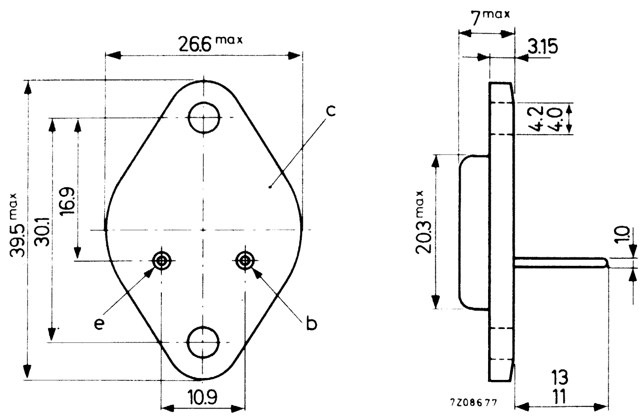
Storage temperature	T_{stg}		−55 to +75	°C
Junction temperature	T_j	max.	75	°C

THERMAL RESISTANCE

From junction to mounting base	$R_{th\ j\text{-}mb}$	=	4	°C/W
From mounting base to heatsink with lead washer and mica washer	$R_{th\ mb\text{-}h}$	=	0.5	°C/W

MECHANICAL DATA

Collector connected to mounting base

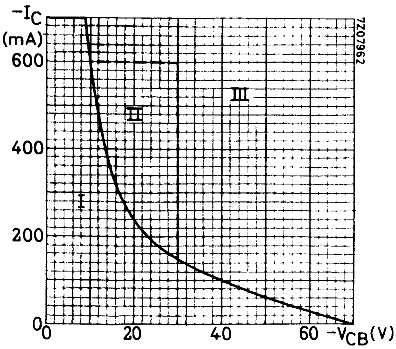


[1]) Limiting values according to the Absolute Maximum System as defined in IEC publication 134.

CHARACTERISTICS

T_j = 25 °C unless otherwise specified

Collector cut-off currents				
I_E = 0; $-V_{CB}$ = 60 V; T_j = 75 °C	$-I_{CBO}$	<	4.5	mA
R_{BE} = 56 Ω; $-V_{CE}$ = 60 V; T_{mb} = 60 °C	$-I_{CER}$	<	2	mA
Currents at reverse biased emitter junction				
$+V_{BE}$ = 1 V; $-V_{CE}$ = 60 V; T_{mb} = 60 °C	$-I_{CEX}$	<	1	mA
	$+I_{BEX}$	<	1	mA
Emitter-base voltage				
I_E = 600 mA; $-V_{CB}$ = 10 V; T_{mb} = 60 °C	V_{EB}	>	0.1	V
I_E = 600 mA; $-V_{CB}$ = 10 V; T_{mb} = 25 °C	V_{EB}	<	0.45	V
D.C. current gain				
I_E = 600 mA; $-V_{CB}$ = 10 V; T_{mb} = 25 °C	h_{FE}	>	40	
I_E = 600 mA; $-V_{CB}$ = 30 V; T_j = 75 °C	h_{FE}	>	100	
Collector capacitance				
I_E = I_e = 0; $-V_{CB}$ = 10 V	C_c	<	85	pF
I_E = I_e = 0; $-V_{CB}$ = 30 V	C_c	<	45	pF
Transition frequency				
$-I_C$ = 300 mA; $-V_{CE}$ = 10 V	f_T	>	60	MHz
		typ	120	MHz
Switching times				
delay time	t_d	<	0.2	µs
rise time	t_r	<	0.2	µs
fall time	t_f	<	0.2	µs



I Region of permissible d.c. operation up to T_j = 75 °C

II Additional region of permissible pulse operation t_p < 10 µs; δ < 0.25

III Permissible at switching off, provided L < 250 µH; t_{off} < 15 µs

P-N-P POWER TRANSISTORS

High frequency power transistors in a metal envelope for use in high speed industrial switching applications.
The OC22 is intended for use in digital computers and high quality audio amplifiers.
The OC23 is intended for use as pulse generator for a ferrite store.
The OC24 is intended for use in digital computers, medium frequency transmitters and carrier telephony applications.

RATINGS (Limiting values) [1])

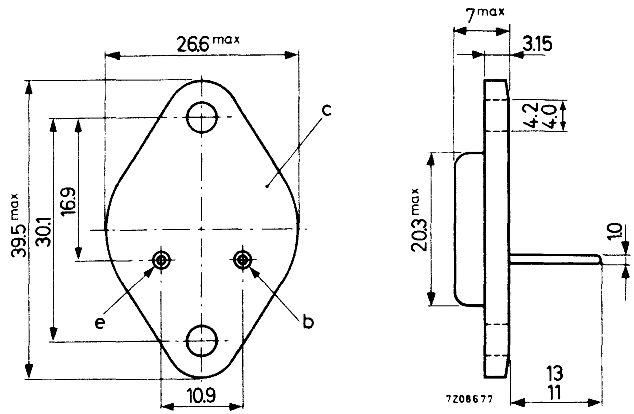
			OC22	OC23 OC24	
Collector-base voltage (open emitter)	$-V_{CBO}$	max.	32	40	V
Collector-emitter voltage (open base)	$-V_{CEO}$	max.	24	16	V
Collector current (peak value)	$-I_{CM}$	max.	2.0		A
Total power dissipation up to T_{mb} = 25 °C	P_{tot}	max.	21.5		W
Junction temperature	T_j	max.	90		°C

THERMAL RESISTANCE

From junction to mounting base	$R_{th\ j\text{-}mb}$	=	3.0	°C/W
From mounting base to heatsink without mica insulation	$R_{th\ mb\text{-}h}$	=	0.2	°C/W

MECHANICAL DATA Dimensions in mm

Collector connected to mounting base

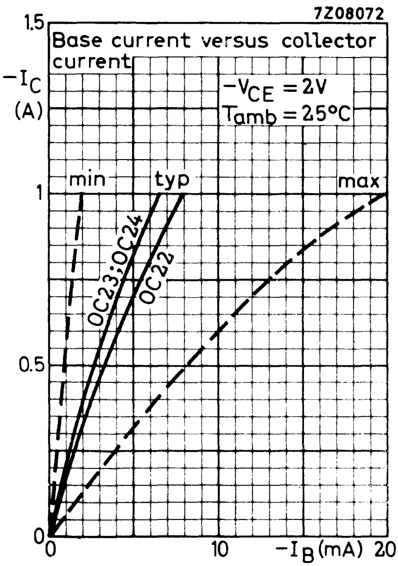


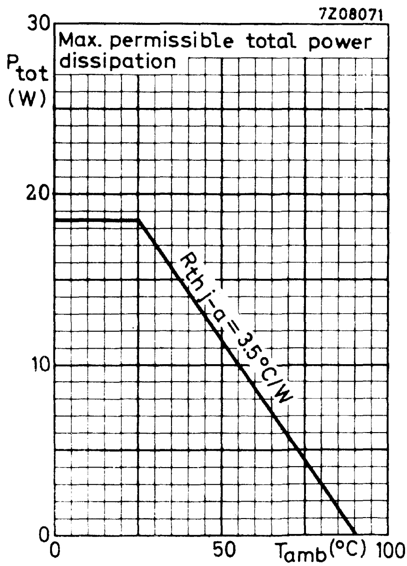
[1]) Limiting values according to the Absolute Maximum System as defined in IEC publication 134.

CHARACTERISTICS

T_{mb} = 25 °C unless otherwise specified

Collector cut-off current					
$I_E = 0$; $-V_{CB} = 10$ V	$-I_{CBO}$	typ.	20		μA
		<	100		μA
Base-emitter voltage					
$-I_C = 100$ mA; $-V_{CE} = 2$ V	$-V_{BE}$	typ.	0.25		V
$-I_C = 1$ A ; $-V_{CE} = 2$ V	$-V_{BE}$	typ.	0.8		V
D.C. current gain			OC22	OC23 OC24	
$-I_C = 100$ mA; $-V_{CE} = 2$ V	h_{FE}	typ.	170	200	
$-I_C = 1$ A; $-V_{CE} = 2$ V	h_{FE}	>	50	50	
		typ.	125	150	
Cut-off frequency					
$-I_C = 400$ mA; $-V_{CE} = 2$ V	f_{hfb}	typ.	2.5		MHz
Small signal current gain					
$-I_C = 400$ mA; $-V_{CE} = 2$ V	h_{fe}	typ.	180		





GERMANIUM POWER TRANSISTOR

P-N-P transistor in a metal case for use in class A and B output stages at battery voltages of 7 and 14 V.
Type 2-OC26 consists of a matched pair, selected for operation in class B output stages.

RATINGS (Limiting values)

Collector-base voltage (open emitter)	$-V_{CBO}$	max.	40	V
Collector-emitter voltage (open base)	$-V_{CEO}$	max.	20	V
Collector current	$-I_C$	max.	3.5	A
Total dissipation up to T_{mb} = 75 °C	P_{tot}	max.	12.5	W
Junction temperature	T_j	max.	90	°C

CHARACTERISTICS T_j = 25 °C

D.C. current gain

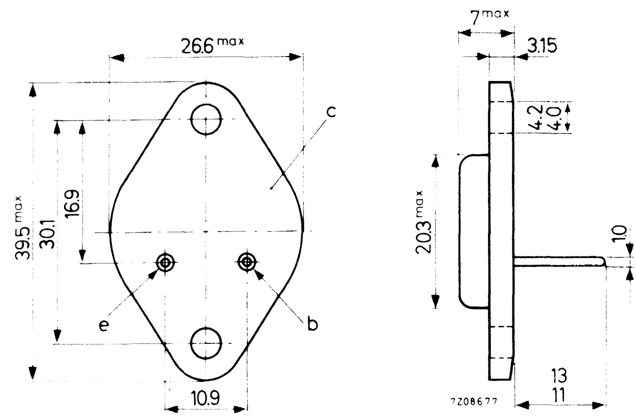
$-I_C$ = 30 mA; $-V_{CE}$ = 14 V	h_{FE}	20 to 75
$-I_C$ = 1 A; $-V_{CE}$ = 1 V	h_{FE}	20 to 55
$-I_C$ = 3 A; $-V_{CE}$ = 1 V	h_{FE}	15 to 45

Cut-off frequency

$-I_C$ = 1 A; $-V_{CE}$ = 6 V	f_{hfe}	typ.	4.5	kHz

MECHANICAL DATA Dimensions in mm

Collector connected to mounting base



FOR NEW DESIGN THE SUCCESSOR TYPE
AD149 IS RECOMMENDED

GERMANIUM POWER TRANSISTOR

P-N-P transistor in metal case for use in class A and B output stages at battery voltages of 7 and 14 V.
Type 2-OC30 consists of a matched pair, selected for operation in a class B circuit with low distortion and low spread in quiescent currents.

RATINGS (Limiting values)

Collector-base voltage (open emitter)	$-V_{CBO}$	max.	32	V
Collector-emitter voltage (open base)	$-V_{CEO}$	max.	16	V
Collector-emitter voltage with $R_{BE} < 500\ \Omega$	$-V_{CER}$	max.	32	V
Collector current (d.c. and average)	$-I_C$	max.	1.4	A
Total dissipation up to T_{mb} = 45 °C	P_{tot}	max.	4	W
Junction temperature	T_j	max.	75	°C

CHARACTERISTICS T_j = 25 °C

D.C. current gain

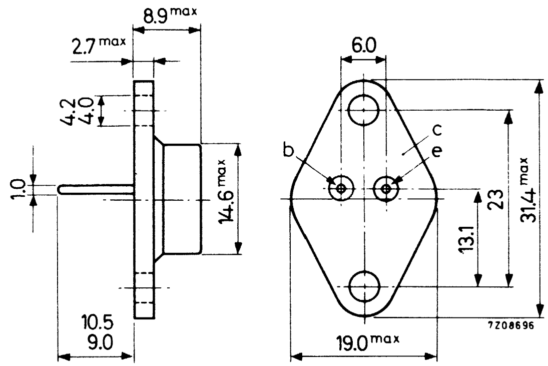
$-I_C$ = 10 mA; $-V_{CE}$ = 14 V	h_{FE}	typ.	32	
$-I_C$ = 100 mA; $-V_{CE}$ = 7 V	h_{FE}	typ.	36	
$-I_C$ = 800 mA; $-V_{CE}$ = 1 V	h_{FE}	typ.	28	
$-I_C$ = 1.5 A ; $-V_{CE}$ = 7 V	h_{FE}	typ.	22	

Cut-off frequency

$-I_C$ = 0.1 A; $-V_{CE}$ = 7 V	f_{hfe}	typ.	9	kHz

MECHANICAL DATA Dimensions in mm

Collector connected to mounting base



FOR NEW DESIGN THE SUCCESSOR TYPE AD162 IS RECOMMENDED

GERMANIUM H.F. TRANSISTORS

P-N-P germanium transistor in all-glass construction. It is intended primarily for converter and mixer-oscillator applications.

RATINGS (Limiting values)

Voltages

Collector-base voltage (open emitter)	$-V_{CBO}$	max.	15	V
Collector-emitter voltage (open base)	$-V_{CEO}$	max.	5	V
Collector-emitter voltage with $R_{BE} < 1.5$ kΩ	$-V_{CER}$	max.	15	V
Emitter-base voltage (open collector)	$-V_{EBO}$	max.	12	V

Currents

Collector current (d.c. or average over any 20 ms period)	$-I_C$	max.	5	mA
Collector current (peak value)	$-I_{CM}$	max.	10	mA

Power dissipation

Total power dissipation up to T_{amb} = 25 °C	P_{tot}	max.	85	mW

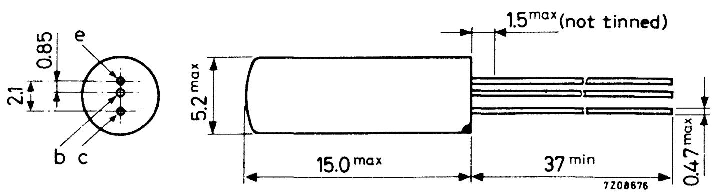
Temperatures

Storage temperature	T_{stg}		-55 to +75	°C
Junction temperature: continuous	T_j	max.	75	°C
incidentally	T_j	max.	90	°C

THERMAL RESISTANCE

From junction to ambient in free air	$R_{th\,j-a}$	=	0.6	°C/mW

MECHANICAL DATA Dimensions in mm



The coloured dot indicates the collector

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

			OC44	OC45	
Collector cut-off currents					
$I_E = 0$; $-V_{CB} = 2$ V	$-I_{CBO}$	typ.	0.5	0.5	μA
		<	2.0	2.0	μA
$I_E = 0$; $-V_{CB} = 15$ V	$-I_{CBO}$	<	10	10	μA
$I_B = 0$; $-V_{CE} = 2$ V	$-I_{CEO}$	typ.	25	12	μA
		<	75	40	μA
Emitter cut-off current					
$I_C = 0$; $-V_{EB} = 2$ V	$-I_{EBO}$	typ.	0.4	0.4	μA
		<	2.0	2.0	μA
$I_C = 0$; $-V_{EB} = 12$ V	$-I_{EBO}$	<	40	40	μA
Base-emitter voltage					
$-I_C = 1$ mA; $-V_{CE} = 6$ V	$-V_{BE}$	typ.	150	170	mV
			125 to 185	145 to 195	mV
Collector-base capacitance at f = 450 kHz					
$-I_C = 1$ mA; $-V_{CE} = 6$ V	$C_{b'c}$	typ.	10.5	10.5	pF
			7 to 14	7 to 14	pF
Small signal current gain at f = 1 kHz					
$-I_C = 1$ mA; $-V_{CE} = 6$ V	h_{fe}	typ.	100	50	
			45 to 225	25 to 125	
Cut-off frequency					
$I_E = 1$ mA; $-V_{CB} = 6$ V	f_{hfb}	>	7.5	3	MHz
		typ.	15	12	MHz
Base-resistance at f = 450 kHz					
$-I_C = 1$ mA; $-V_{CE} = 6$ V	$r_{bb'}$	typ.	110	75	Ω
		<	250	200	Ω
y parameters at f = 450 kHz (common emitter)					
$-I_C = 1$ mA; $-V_{CE} = 6$ V					
Input conductance	g_{ie}	typ.	0.6	1	$m\Omega^{-1}$
Input capacitance	C_{ie}	typ.	500	800	pF
Feedback admittance	$\|y_{re}\|$	typ.	20	20	$\mu\Omega^{-1}$
Transfer admittance	$\|y_{fe}\|$	typ.	30	28	$m\Omega^{-1}$
Output conductance	g_{oe}	typ.	25	20	$\mu\Omega^{-1}$
Output capacitance	C_{oe}	typ.	40	40	pF

GERMANIUM SWITCHING TRANSISTORS

Germanium p-n-p transistors in all glass construction for medium current, high speed, computer switching applications.

RATINGS (Limiting values) [1])

Collector-base voltage (open emitter)	$-V_{CBO}$	max.	20	V
Collector-emitter voltage with $+V_{BE} > 0.2$ V	$-V_{CEX}$	max.	20	V
Collector current (d.c. and average)	$-I_C$	max.	100	mA
Collector current (peak value)	$-I_{CM}$	max.	125	mA
Base current (d.c. and average)	$-I_B$	max.	15	mA
Total power dissipation up to T_{amb} = 25 °C	P_{tot}	max.	80	mW
Junction temperature: continuous	T_j	max.	75	°C
incidentally	T_j	max.	90	°C

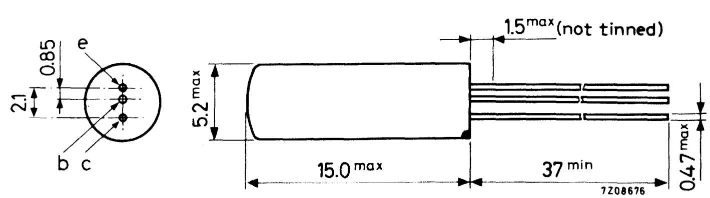
THERMAL RESISTANCE

From junction to ambient in free air $R_{th\ j\text{-}a}$ = 0.6 °C/mW

CHARACTERISTICS at T_j = 25 °C

		OC46	OC47
D.C. current gain			
$-I_C$ = 15 mA; $-V_{CB}$ = 0	h_{FE}	20 to 80	50 to 200
Cut-off frequency			
I_E = 3 mA; $-V_{CB}$ = 5 V	f_{hfb}	> 3 MHz	> 4.5 MHz

MECHANICAL DATA Dimensions in mm



The coloured dot indicates the collector

1) Limiting values according to the Absolute Maximum System as defined in IEC publication 134.

L.F. TRANSISTORS

Germanium alloy p-n-p transistors in a hermetically sealed-in subminiature metal case. The OC57, OC58 and OC59 are intended for use in pre-stages of hearing aids.

RATINGS (Limiting values)

Collector-base voltage (open emitter)	$-V_{CBO}$	max.	7	V
Collector-emitter voltage with $R_{BE} < 10\ k\Omega$	$-V_{CER}$	max.	7	V
Collector-emitter voltage (open base)	$-V_{CEO}$	max.	3	V
Collector current (d.c. or average)	$-I_C$	max.	5	mA
Collector current (peak value)	$-I_{CM}$	max.	10	mA
Total power dissipation up to $T_{amb} = 45\ ^oC$	P_{tot}	max.	20	mW
Junction temperature	T_j	max.	75	^oC

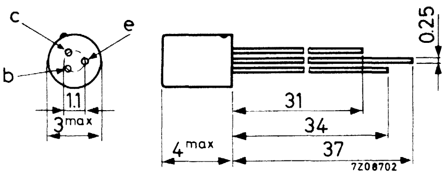
THERMAL RESISTANCE

From junction to ambient in free air	$R_{th\ j-a}$	=	1.5	$^oC/mW$

CHARACTERISTICS $T_{amb} = 25\ ^oC$ unless otherwise specified

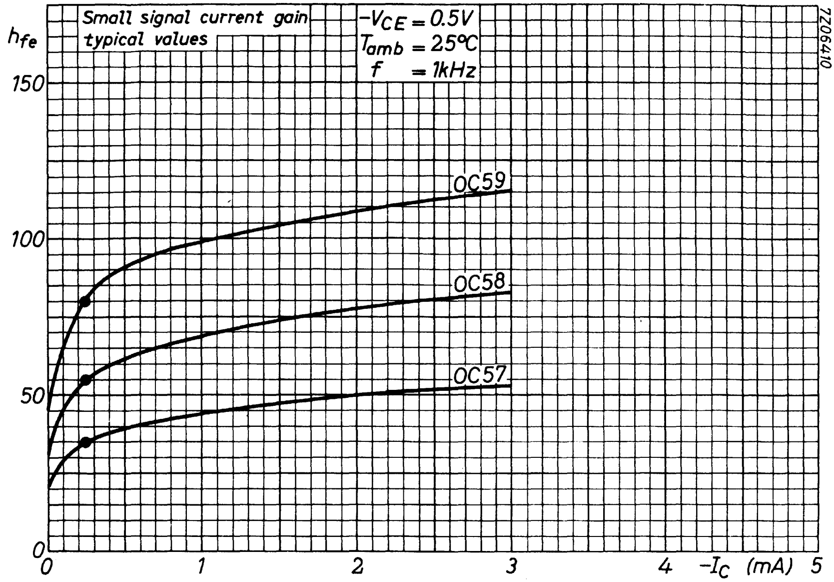
			OC57	OC58	OC59	
Collector cut-off currents						
$I_E = 0;\ -V_{CB} = 2$ V	$-I_{CBO}$	typ.	1.5	1.5	1.5	μA
$I_E = 0;\ -V_{CB} = 2$ V; $T_{amb} = 35\ ^oC$	$-I_{CBO}$	typ.	3.5	3.5	3.5	μA
$I_B = 0;\ -V_{CE} = 0.5$ V	$-I_{CEO}$	<	100	100	120	μA
$I_B = 0;\ -V_{CE} = 0.5$ V; $T_{amb} = 35\ ^oC$	$-I_{CEO}$	<	300	300	300	μA
Emitter cut-off current						
$I_C = 0;\ -V_{EB} = 2$ V	$-I_{EBO}$	typ.	1.5	1.5	1.5	μA
Base current						
$-I_C = 0.25$ mA; $-V_{CE} = 0.5$ V	$-I_B$	typ.	8	4.5	3.5	μA
Base-emitter voltage						
$-I_C = 0.25$ mA; $-V_{CE} = 0.5$ V	$-V_{BE}$	typ.	120	120	120	mV
Small signal current gain at f = 1 kHz						
$-I_C = 0.25$ mA; $-V_{CE} = 0.5$ V	h_{fe}	>	20	30	50	
		typ.	35	55	80	
Cut-off frequency						
$-I_C = 0.25$ mA; $-V_{CE} = 0.5$ V	f_{hfe}	>	10	10	10	kHz
Noise figure						
$I_E = 0.5$ mA; $-V_{CB} = 2$ V	F	<	10	10	10	dB

MECHANICAL DATA Dimensions in mm

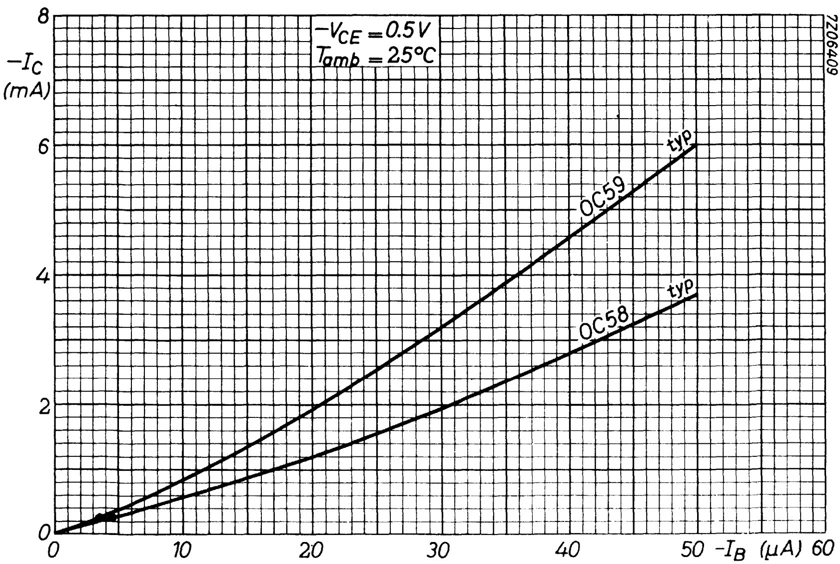


The coloured dot indicates the collector

FOR NEW DESIGN THE SUCCESSOR TYPE
BC146 (N-P-N) IS RECOMMENDED



Small signal current gain
typical values
$-V_{CE} = 0.5V$
$T_{amb} = 25°C$
$f = 1kHz$
h_{fe}
150
100
50
0
OC59
OC58
OC57
0
1
2
3
4
$-I_C$ (mA)
5
7Z06410



$-V_{CE} = 0.5V$
$T_{amb} = 25°C$
$-I_C$
(mA)
8
6
4
2
0
typ
OC59
typ
OC58
0
10
20
30
40
50
$-I_B$ (μA)
60
7Z06409

L.F. TRANSISTOR

Germanium alloy p-n-p transistor in a hermetically sealed-in subminiature metal case. It is intended for use in output-stages of hearing aids.

RATINGS (Limiting values)

Collector-base voltage (open emitter)	$-V_{CBO}$	max.	7	V
Collector-emitter voltage with R_{BE} < 10 kΩ	$-V_{CER}$	max.	7	V
Collector-emitter voltage (open base)	$-V_{CEO}$	max.	3	V
Collector current (d.c. or average)	$-I_C$	max.	5	mA
Collector current (peak value)	$-I_{CM}$	max.	10	mA
Total power dissipation up to T_{amb} = 45 °C	P_{tot}	max.	20	mW
Junction temperature	T_j	max.	75	°C

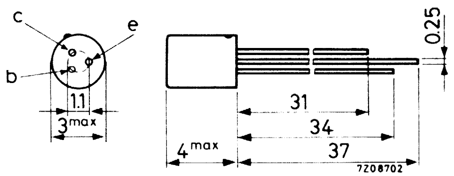
THERMAL RESISTANCE

From junction to ambient in free air	$R_{th\ j-a}$	=	1.5	°C/mW

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

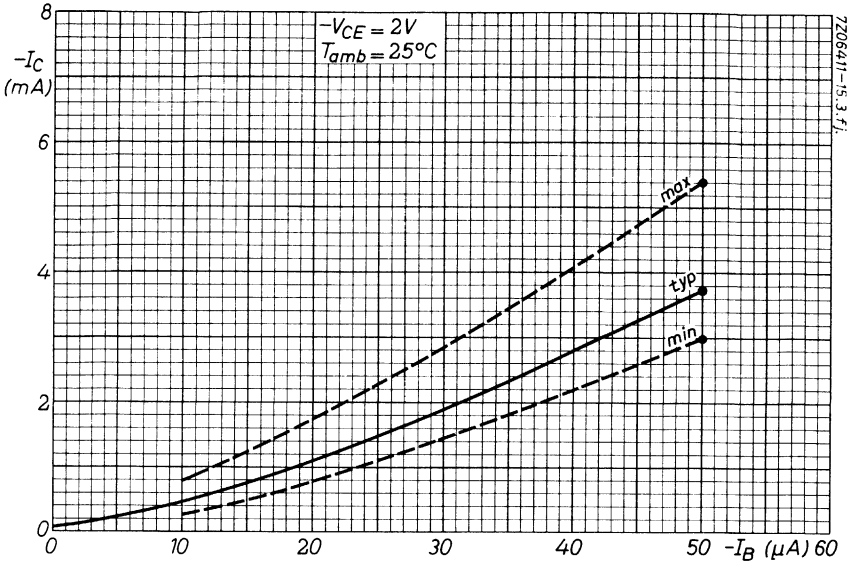
Collector cut-off currents				
I_E = 0; $-V_{CB}$ = 2 V	$-I_{CBO}$	typ.	1.5	μA
I_E = 0; $-V_{CB}$ = 2 V; T_{amb} = 35 °C	$-I_{CBO}$	typ.	3.5	μA
I_B = 0; $-V_{CE}$ = 2 V	$-I_{CEO}$	<	120	μA
I_B = 0; $-V_{CE}$ = 2 V; T_{amb} = 35 °C	$-I_{CEO}$	<	360	μA
Emitter cut-off current				
I_C = 0; $-V_{EB}$ = 2 V	$-I_{EBO}$	typ.	1.5	μA
Collector current				
$-I_B$ = 50 μA; $-V_{CE}$ = 2 V	$-I_C$		3 to 5.4	mA
		typ.	3.75	mA
Knee voltage				
$-I_C$ = 10 mA; $-I_B$ = value for which	$-V_{CEK}$	typ.	0.18	V
$-I_C$ = 11 mA at $-V_{CE}$ = 1 V		<	0.25	V
Small signal current gain at f = 1 kHz				
$-I_C$ = 0.5 mA; $-V_{CE}$ = 2 V	h_{fe}	typ.	60	
Noise figure				
I_E = 0.5 mA; $-V_{CB}$ = 2 V	F	<	15	dB

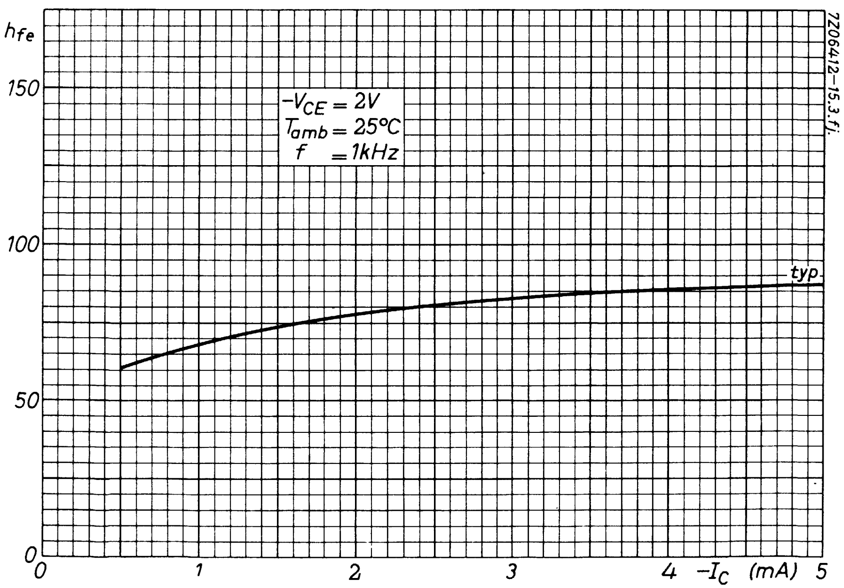
MECHANICAL DATA Dimensions in mm



The coloured dot indicates the collector

FOR NEW DESIGN THE SUCCESSOR TYPE
BC146 (N-P-N) IS RECOMMENDED


8
$-I_C$ (mA)
6
4
2
0
0
10
20
30
40
50
60
$-I_B$ (μA)
$-V_{CE} = 2V$
$T_{amb} = 25°C$
max
typ
min
7Z06411-15.3.f.j.


h_{fe}
150
100
50
0
0
1
2
3
4
5
$-I_C$ (mA)
$-V_{CE} = 2V$
$T_{amb} = 25°C$
f = 1kHz
typ
7Z06412-15.3.f.j.

GERMANIUM P-N-P TRANSISTOR

P-N-P transistor in all glass construction for general purpose applications.

RATINGS (Limiting values)

Collector-emitter voltage at $+V_{BE} > 0.1$ V	$-V_{CEX}$	max.	30	V
Collector current (d.c. and average)	$-I_C$	max.	10	mA
Collector current (peak value)	$-I_{CM}$	max.	50	mA
Total dissipation up to T_{amb} = 25 °C	P_{tot}	max.	125	mW
Junction temperature: continuous	T_j	max.	75	°C
incidentally	T_j	max.	90	°C

CHARACTERISTICS

D.C. current gain at T_j = 25 °C

$-I_C$ = 0.4 mA; $-V_{CE}$ = 4.5 V	h_{FE}	typ.	40
			21 to 65
$-I_C$ = 10 mA; $-V_{CE}$ = 4.5 V	h_{FE}	typ.	40
			18 to 53

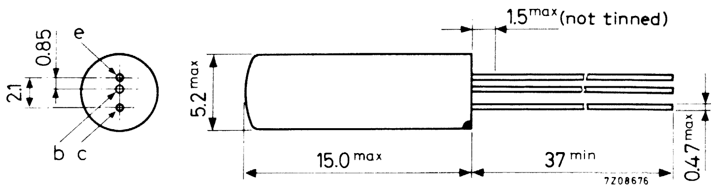
Small signal current gain at T_j = 25 °C

$-I_C$ = 0.5 mA; $-V_{CE}$ = 2 V	h_{fe}	typ.	30	

Cut-off frequency

$-I_C$ = 0.5 mA; $-V_{CE}$ = 2 V	f_{hfe}	typ.	15	kHz

MECHANICAL DATA Dimensions in mm



The coloured dot indicates the collector.

FOR NEW DESIGN THE SUCCESSOR TYPES
AC125, BC178 OR BC158 ARE RECOMMENDED

GERMANIUM TRANSISTOR

P-N-P germanium general purpose transistor in all-glass construction.

RATINGS (Limiting values)

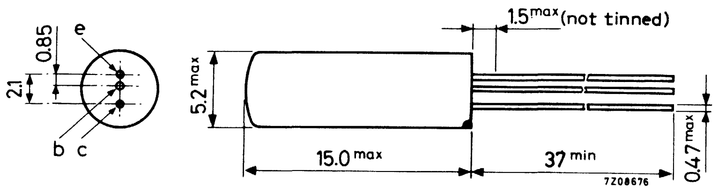
Collector-emitter voltage (open base)	$-V_{CEO}$	max.	10	V
Collector-emitter voltage (R_{BE} < 1 kΩ)	$-V_{CER}$	max.	30	V
Collector current (d.c. or average over any 20 ms period)	$-I_C$	max.	10	mA
Collector current (peak value)	$-I_{CM}$	max.	50	mA
Emitter current (d.c. or average over any 20 ms period)	I_E	max.	15	mA
Emitter current (peak value)	I_{EM}	max.	70	mA
Base current (d.c. or average over any 20 ms period)	$-I_B$	max.	5	mA
Base current (peak value)	$-I_{BM}$	max.	20	mA
Total power dissipation up to T_{amb} = 25 °C	P_{tot}	max.	125	mW
Storage temperature	T_{stg}	-55 to +75		°C
Junction temperature	T_j	max.	75	°C

THERMAL RESISTANCE

From junction to ambient in free air $R_{th\ j\text{-}a}$ = 0.4 °C/mW

MECHANICAL DATA

Dimensions in mm



The coloured dot indicates the collector

FOR NEW DESIGN THE SUCCESSOR TYPES
AC125, BC158 OR BC178 ARE RECOMMENDED

CHARACTERISTICS

T_{amb} = 25 °C

Condition	Symbol		Value	Unit
Collector cut-off currents				
$I_E = 0$; $-V_{CB} = 4.5$ V	$-I_{CBO}$	typ.	4.5	μA
		<	12	μA
$I_B = 0$; $-V_{CE} = 4.5$ V	$-I_{CEO}$	typ.	150	μA
		<	325	μA
Base-emitter voltage				
$-I_B = 10$ μA; $-V_{CE} = 4.5$ V	$-V_{BE}$	typ.	110	mV
		80 to	155	mV
$-I_B = 250$ μA; $-V_{CE} = 4.5$ V	$-V_{BE}$	typ.	270	mV
		210 to	385	mV
D.C. current gain				
$-I_C = 1$ mA; $-V_{CE} = 4.5$ V	h_{FE}	typ.	70	
		35 to	125	
$-I_C = 10$ mA; $-V_{CE} = 4.5$ V	h_{FE}	>	30	
		typ.	55	
h paramaters at f = 1 kHz (common base)				
$I_E = 3$ mA; $-V_{CB} = 2$ V				
Input impedance	h_{ib}	typ.	17	Ω
		10 to	25	Ω
Voltage feedback ratio	h_{rb}	typ.	8	10^{-4}
Small signal current gain	$-h_{fb}$	typ.	0.979	
		0.968 to	0.987	
Output admittance	h_{ob}	typ.	1.6	$\mu\Omega^{-1}$
		<	2.7	$\mu\Omega^{-1}$
h parameters at f = 1 kHz (common emitter)				
$-I_C = 3$ mA; $-V_{CE} = 2$ V				
Input impedance	h_{ie}	typ.	0.8	kΩ
		0.4 to	1.5	kΩ
Voltage feedback ratio	h_{re}	typ.	5.4	10^{-4}
		<	17	10^{-4}
Small signal current gain	h_{fe}	typ.	47	
		30 to	75	
Output admittance	h_{oe}	typ.	80	$\mu\Omega^{-1}$
		<	200	$\mu\Omega^{-1}$
Cut-off frequency				
$-I_C = 3$ mA; $-V_{CE} = 2$ V	f_{hfe}	typ.	10	kHz
Noise figure at f = 1 kHz				
$-I_C = 0.5$ mA; $-V_{CE} = 2$ V; $R_S = 500$ Ω	F	typ.	10	dB
		<	15	dB

GERMANIUM TRANSISTORS

P-N-P transistors in a metal envelope intended for a.f. medium power class A and B output stages.
Type 2-OC72 consists of two transistors OC72 selected for low distortion class B operation.

RATINGS (Limiting values)

Voltages

Collector-base voltage (open emitter)	$-V_{CBO}$	max.	32	V
Collector-emitter voltage (open base)	$-V_{CEO}$	max.	16	V
Collector-emitter voltage (R_{BE} < 1 kΩ)	$-V_{CER}$	max.	32	V
Emitter-base voltage (open collector)	$-V_{EBO}$	max.	10	V

Currents

Collector current (d.c. or average over any 20 ms period)	$-I_C$	max.	125	mA
Collector current (peak value)	$-I_{CM}$	max.	250	mA
Emitter current (peak value)	I_{EM}	max.	250	mA
Base current (peak value)	$\|I_{BM}\|$	max.	125	mA

Power dissipation

Total power dissipation up to T_{amb} = 25 °C with cooling fin 56200	P_{tot}	max.	165	mW

Temperatures

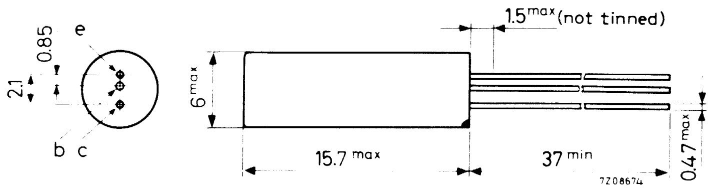
Storage temperature	T_{stg}		-55 to +75	°C
Junction temperature: continuous	T_j	max.	75	°C
incidentally	T_j	max.	90	°C

THERMAL RESISTANCE

From junction to ambient in free air	$R_{th\ j-a}$	=	0.4	°C/mW
From junction to ambient with cooling fin 56200 on a heatsink 12.5 cm^2	$R_{th\ j-a}$	=	0.3	°C/mW

MECHANICAL DATA

Dimensions in mm



The coloured dot indicates the collector

FOR NEW DESIGN THE SUCCESSOR TYPE 2-AC132 IS RECOMMENDED

CHARACTERISTICS T_{amb} = 25 °C

Collector cut-off currents

I_E = 0; $-V_{CB}$ = 10 V	$-I_{CBO}$	typ. 4.5 μA < 10 μA
I_B = 0; $-V_{EB}$ = 6 V	$-I_{CEO}$	typ. 125 μA 50 to 300 μA

Emitter cut-off current

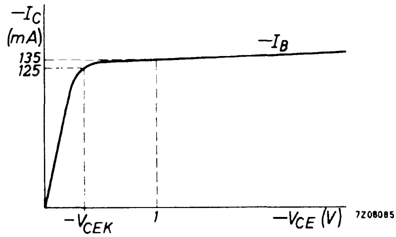
I_C = 0; $-V_{EB}$ = 10 V	$-I_{EBO}$	typ. 4.5 μA < 10 μA

Base-emitter voltage

$-I_C$ = 1.5 mA; $-V_{CE}$ = 6 V	$-V_{BE}$	130 to 170 mV
$-I_C$ = 80 mA; $-V_{CE}$ = 0.7 V	$-V_{BE}$	< 450 mV
$-I_C$ = 125 mA; $-V_{CE}$ = 0.7 V	$-V_{BE}$	< 700 mV

Knee voltage

$-I_C$ = 125 mA; $-I_B$ = value for which $-I_C$ = 135 mA at $-V_{CE}$ = 1 V	$-V_{CEK}$	< 400 mV



D.C. current gain

$-I_C$ = 10 mA; $-V_{CE}$ = 5.4 V	h_{FE}	typ. 70 45 to 120
$-I_C$ = 80 mA; $-V_{CE}$ = 0.7 V	h_{FE}	typ. 50 30 to 90
$-I_C$ = 125 mA; $-V_{CE}$ = 0.7 V	h_{FE}	> 25
$-I_C$ = 250 mA; $-V_{CE}$ = 1 V	h_{FE}	> 15

Cut-off frequencies

I_E = 10 mA; $-V_{CB}$ = 6 V	f_{hfb}	> 350 kHz
$-I_C$ = 10 mA; $-V_{CE}$ = 6 V	f_{hfe}	> 8 kHz

Noise figure at f = 1 kHz

I_E = 0.5 mA; $-V_{CE}$ = 2 V; R_S = 500 Ω	F	< 15 dB

D.C. current gain ratio of matched pair 2-OC72	h_{FE1}/h_{FE2}	typ. 1.15 1.0 to 1.3

GERMANIUM TRANSISTORS

P-N-P transistors in all-glass construction with metal cover. They are intended for class A and B output stages at battery voltages up to 9 V and power outputs up to 1 W. Type 2-OC74 consists of 2 transistors OC74 selected for low distortion class B operation with low spread in base-emitter voltages.

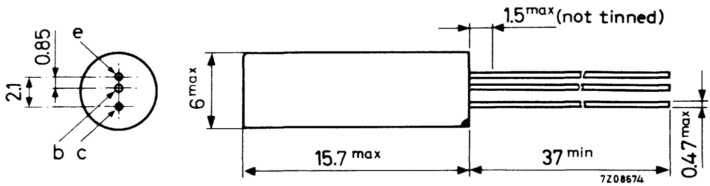
RATINGS (Limiting values)

Collector-base voltage (open emitter)	$-V_{CBO}$	max.	20	V
Collector-emitter voltage (R_{BE} < 500 Ω)	$-V_{CER}$	max.	20	V
Emitter-base voltage (open collector)	$-V_{EBO}$	max.	6	V
Collector current (d.c. or average over any 20 ms period)	$-I_C$	max.	300	mA
Emitter current (d.c. or average over any 20 ms period)	I_E	max.	310	mA
Total power dissipation up to T_{amb} = 25 °C with cooling fin 56200 on heatsink ≥ 12.5 cm²	P_{tot}	max.	550	mW
Storage temperature	T_{stg}	−55 to +75		°C
Junction temperature: continuous	T_j	max.	75	°C
incidentally	T_j	max.	90	°C

THERMAL RESISTANCE

From junction to ambient in free air	$R_{th\ j\text{-}a}$	=	0.22	°C/mW
From junction to ambient with cooling fin 56200 on heatsink ≥ 12.5 cm2	$R_{th\ j\text{-}a}$	=	0.09	°C/mW

MECHANICAL DATA Dimensions in mm

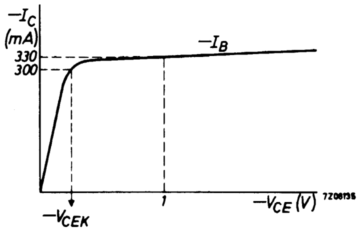


The coloured dot indicates the collector

FOR NEW DESIGN THE SUCCESSOR TYPE 2-AC128 IS RECOMMENDED

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

Collector cut-off current			
$I_E = 0$; $-V_{CB} = 9$ V	$-I_{CBO}$	< 20	μA
$I_E = 0$; $-V_{CB} = 9$ V; $T_j = 60$ °C	$-I_{CBO}$	< 330	μA
Emitter cut-off current			
$I_C = 0$; $-V_{EB} = 6$ V	$-I_{EBO}$	< 20	μA
$I_C = 0$; $-V_{EB} = 6$ V; $T_j = 60$ °C	$-I_{EBO}$	< 300	μA
Base-emitter voltage [1]			
$-I_C$ = 5 mA; $-V_{CE}$ = 6 V	$-V_{BE}$	135 to 175	mV
$-I_C$ = 50 mA; $-V_{CE}$ = 6 V	$-V_{BE}$	< 300	mV
$-I_C$ = 300 mA; $-V_{CE}$ = 1 V	$-V_{BE}$	< 700	mV
Knee voltage			
$-I_C$ = 300 mA; $-I_B$ = value for which $-I_C$ = 330 mA at $-V_{CE}$ = 1 V	$-V_{CEK}$	< 600	mV



D.C. current gain			
$-I_C$ = 5 mA; $-V_{CE}$ = 6 V	h_{FE}	40 to 200	
$-I_C$ = 50 mA; $-V_{CE}$ = 6 V	h_{FE}	60 to 150	
$-I_C$ = 300 mA; $-V_{CE}$ = 1 V	h_{FE}	40 to 100	
Cut-off frequency			
$-I_C$ = 50 mA; $-V_{CE}$ = 6 V	f_{hfe}	> 8	kHz
Noise figure at f = 1 kHz			
I_E = 5 mA; $-V_{CB}$ = 6 V	F	< 27	dB
D.C. current gain ratio of matched pair 2-OC74			
$-I_C$ = 50 mA; $-V_{CE}$ = 6 V	h_{FE1}/h_{FE2}	typ. 1.15 < 1.3	
$-I_C$ = 300 mA; $-V_{CE}$ = 1 V	h_{FE1}/h_{FE2}	typ. 1.15 < 1.3	

[1] $-V_{BE}$ decreases by about 2.3 mV/°C with increasing temperature.

GERMANIUM TRANSISTOR

P-N-P general purpose transistor in all glass construction.

RATINGS (Limiting values)

Voltages

Collector-emitter voltage (open base)	$-V_{CEO}$	max.	10	V
Collector-emitter voltage (R_{BE} < 500 Ω)	$-V_{CER}$	max.	30	V

Currents

Collector current (d.c. or average over any 20 ms period)	$-I_C$	max.	10	mA
Collector current (peak value)	$-I_{CM}$	max.	50	mA
Emitter current (peak value)	I_{EM}	max.	70	mA

Power dissipation

Total power dissipation up to T_{amb} = 25 °C	P_{tot}	max.	125	mW

Temperatures

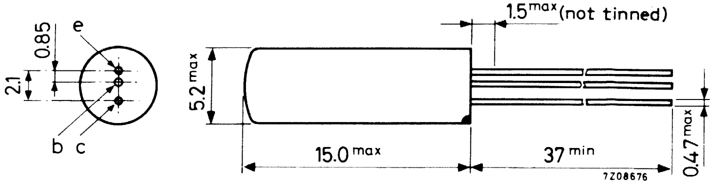
Storage temperature	T_{stg}	-55 to +75		°C
Junction temperature : continuous	T_j	max.	75	°C
incidentally	T_j	max.	90	°C

THERMAL RESISTANCE

From junction to ambient in free air	$R_{th\ j-a}$	=	0.4	°C/mW

MECHANICAL DATA

Dimensions in mm



The coloured dot indicates the collector

FOR NEW DESIGN THE SUCCESSOR TYPES
AC126, BC178 OR BC158 ARE RECOMMENDED

CHARACTERISTICS

$T_{amb} = 25\ ^oC$

Collector cut-off currents

$I_E = 0;\ -V_{CB} = 4.5$ V	$-I_{CBO}$	typ.	4.5	μA
		<	12	μA
$I_B = 0;\ -V_{CE} = 4.5$ V	$-I_{CEO}$	typ.	350	μA
		<	550	μA

Base-emitter voltage

$-I_C = 1.1$ mA; $-V_{CE} = 4.5$ V	$-V_{BE}$	typ.	120	mV
		90 to	175	mV
$-I_C = 22$ mA; $-V_{CE} = 4.5$ V	$-V_{BE}$	typ.	270	mV
		210 to	385	mV

D.C. current gain

$-I_C = 3$ mA; $-V_{CE} = 4.5$ V	h_{FE}	typ.	100	
		50 to	150	
$-I_C = 22$ mA; $-V_{CE} = 4.5$ V	h_{FE}	typ.	90	
		50 to	130	

Cut-off frequency

$-I_C = 3$ mA; $-V_{CE} = 2$ V	f_{hfe}	>	8	kHz

Noise figure at f = 1 kHz

$-I_C = 0.5$ mA; $-V_{CE} = 2$ V; $R_S = 500\ \Omega$	F	typ.	10	dB
		<	15	dB

h parameters at f = 1 kHz (common emitter)

$-I_C = 3$ mA; $-V_{CE} = 2$ V

Input impedance	h_{ie}	typ.	1.3	kΩ
Voltage feedback ratio	h_{re}	typ.	8	10^{-4}
Small signal current gain	h_{fe}	typ.	90	
		65 to	130	
Output admittance	h_{oe}	typ.	125	$\mu\Omega^{-1}$

h parameters at f = 1 kHz (common base)

$I_E = 3$ mA; $V_{CB} = 2$ V

Input impedance	h_{ib}	typ.	14	Ω
Voltage feedback ratio	h_{rb}	typ.	10	10^{-4}
Small signal current gain	$-h_{fb}$	typ.	0.989	
Output admittance	h_{oe}	typ.	1.4	$\mu\Omega^{-1}$

GERMANIUM SWITCHING TRANSISTOR

P-N-P transistor in all glass envelope with metal cover. It is primarily intended for switching and pulse-oscillating circuits such as d.c. converters.

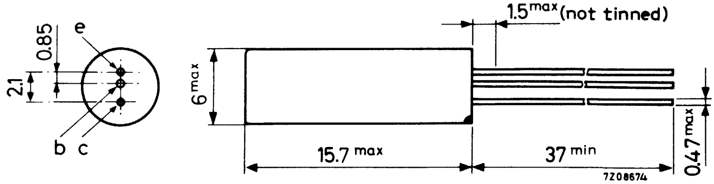
RATINGS (Limiting values)

Collector-base voltage (open emitter)	$-V_{CBO}$	max.	32	V
Collector-emitter voltage (R_{BE} < 1 kΩ)	$-V_{CER}$	max.	32	V
Collector-emitter voltage (open base)	$-V_{CEO}$	max.	16	V
Emitter-base voltage (open collector)	$-V_{EBO}$	max.	10	V
Collector current (d.c.)	$-I_C$	max.	125	mA
Collector current (peak value)	$-I_{CM}$	max.	250	mA
Base current (d.c.)	$-I_B$	max.	20	mA
Base current (peak value)	$-I_{BM}$	max.	125	mA
Total power dissipation up to T_{amb} = 25 °C	P_{tot}	max.	125	mW
Storage temperature	T_{stg}	-55 to +75		°C
Junction temperature: continuous	T_j	max.	75	°C
incidentally	T_j	max.	90	°C

THERMAL RESISTANCE

From junction to ambient in free air	$R_{th\ j\text{-}a}$	=	0.4	°C/mW

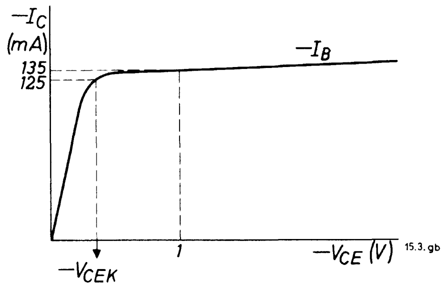
MECHANICAL DATA Dimensions in mm



The coloured dot indicates the collector

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

Collector cut-off current		
$I_E = 0$; $-V_{CB} = 10$ V	$-I_{CBO}$	typ. 4.5 μA < 10 μA
$I_B = 0$; $-V_{CE} = 6$ V	$-I_{CEO}$	typ. 200 μA < 600 μA
$+V_{BE} = 0.5$ V; $-V_{CE} = 30$ V	$-I_{CEX}$	typ. 7.5 μA < 15 μA
Emitter cut-off current		
$I_C = 0$; $-V_{EB} = 10$ V	$-I_{EBO}$	typ. 4.5 μA < 8 μA
Base-emitter voltage		
$I_E = 80$ mA; $-V_{CE} = 0.7$ V	$-V_{BE}$	< 0.45 V
$I_E = 125$ mA; $-V_{CE} = 0.7$ V	$-V_{BE}$	< 0.70 V
Knee voltage		
$-I_C = 125$ mA; $-I_B$ = value for which $-I_C = 135$ mA at $-V_{CE} = 1$ V	$-V_{CEK}$	typ. 0.3 V < 0.4 V



D.C. current gain		
$-I_C = 10$ mA; $-V_{CE} = 5.4$ V	h_{FE}	45 to 330
$-I_C = 80$ mA; $-V_{CE} = 0.7$ V	h_{FE}	30 to 230
$-I_C = 125$ mA; $-V_{CE} = 0.7$ V	h_{FE}	25 to 170
$-I_C = 250$ mA; $-V_{CE} = 1$ V	h_{FE}	15 to 125
Cut-off frequency		
$I_E = 10$ mA; $-V_{CB} = 6$ V	f_{hfb}	> 350 kHz typ. 900 kHz
Noise figure at f = 1 kHz		
$I_E = 0.5$ mA; $-V_{CE} = 2$ V; $R_S = 500\ \Omega$	F	typ. 8 dB < 15 dB

GERMANIUM SWITCHING TRANSISTOR

P-N-P transistor in all glass envelope with metal cover. It is primarily intended for switching and pulse-oscillating circuits such as d.c. converters.

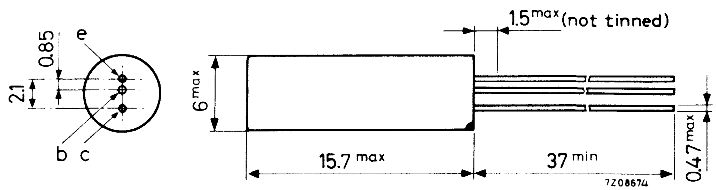
RATINGS (Limiting values)

Collector-base voltage (open emitter)	$-V_{CBO}$	max.	60	V
Collector-emitter voltage (R_{BE} < 400 Ω)	$-V_{CER}$	max.	60	V
Collector-emitter voltage (open base)	$-V_{CEO}$	max.	15	V
Emitter-base voltage (open collector)	$-V_{EBO}$	max.	10	V
Collector current (d.c.)	$-I_C$	max.	125	mA
Collector current (peak value)	$-I_{CM}$	max.	250	mA
Base current (d.c.)	$-I_B$	max.	20	mA
Base current (peak value)	$-I_{BM}$	max.	125	mA
Total power dissipation up to T_{amb} = 25 °C	P_{tot}	max.	125	mW
Storage temperature	T_{stg}		-55 to +75	°C
Junction temperature: continuous	T_j	max.	75	°C
incidentally	T_j	max.	90	°C

THERMAL RESISTANCE

From junction to ambient in free air $R_{th\ j\text{-}a}$ = 0.4 °C/mW

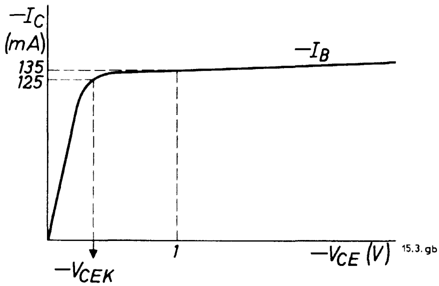
MECHANICAL DATA Dimensions in mm



The coloured dot indicates the collector

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

Collector cut-off current				
$I_E = 0$; $-V_{CB} = 10$ V	$-I_{CBO}$	typ.	4.5	μA
		<	10	μA
$I_B = 0$; $-V_{CE} = 6$ V	$-I_{CEO}$	typ.	200	μA
		<	600	μA
$+V_{BE} = 0.5$ V; $-V_{CE} = 60$ V	$-I_{CEX}$	typ.	15	μA
		<	30	μA
Emitter cut-off current				
$I_C = 0$; $-V_{EB} = 10$ V	$-I_{EBO}$	typ.	4.5	μA
		<	10	μA
Base-emitter voltage				
$I_E = 80$ mA; $-V_{CE} = 0.7$ V	$-V_{BE}$	<	0.45	V
$I_E = 125$ mA; $-V_{CE} = 0.7$ V	$-V_{BE}$	<	0.70	V
Knee voltage				
$-I_C = 125$ mA; $-I_B$ = value for which $-I_C = 135$ mA at $-V_{CE} = 1$ V	$-V_{CEK}$	<	0.4	V



D.C. current gain				
$-I_C = 10$ mA; $-V_{CE} = 5.4$ V	h_{FE}	>	45	
$-I_C = 80$ mA; $-V_{CE} = 0.7$ V	h_{FE}	>	30	
$-I_C = 125$ mA; $-V_{CE} = 0.7$ V	h_{FE}	>	25	
$-I_C = 250$ mA; $-V_{CE} = 1$ V	h_{FE}	>	15	
Cut-off frequency				
$I_E = 10$ mA; $-V_{CB} = 6$ V	f_{hfb}	>	350	kHz
Noise figure at f = 1 kHz				
$I_E = 0.5$ mA; $-V_{CE} = 2$ V; $R_S = 500\ \Omega$	F	<	15	dB

GERMANIUM P-N-P TRANSISTOR

Germanium transistor of the p-n-p type in all glass construction with metal envelope. It is meant for class A output and driver stages at battery voltages of up to 12 V.

RATINGS (Limiting values)

Collector-base voltage (open emitter)	$-V_{CBO}$	max.	26	V
Collector-emitter voltage (open base)	$-V_{CEO}$	max.	13	V
Collector current (d.c. and average)	$-I_C$	max.	300	mA
Total dissipation up to T_{amb} = 25 °C	P_{tot}	max.	550	mW
Junction temperature: continuous	T_j	max.	75	°C
incidentally	T_j	max.	90	°C

THERMAL RESISTANCE

From junction to ambient	$R_{th\ j\text{-}a}$	=	0.22	°C/mW

CHARACTERISTICS

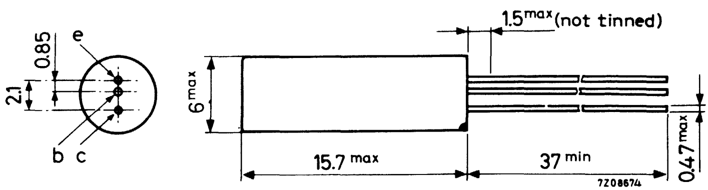
D.C. current gain at T_j = 25 °C

$-I_C$ = 5 mA; $-V_{CE}$ = 6 V	h_{FE}	typ.	50	
			25 to 125	
$-I_C$ = 50 mA; $-V_{CE}$ = 6 V	h_{FE}	typ.	60	
			40 to 100	
$-I_C$ = 300 mA; $-V_{CE}$ = 1 V	h_{FE}	typ.	40	
			25 to 75	

Cut-off frequency

$-I_C$ = 50 mA; $-V_{CE}$ = 6 V	f_{hfe}	typ.	16	kHz
		>	8	kHz

MECHANICAL DATA Dimensions in mm



The coloured dot indicates the collector.

GERMANIUM SWITCHING TRANSISTOR

P-N-P transistor in all glass envelope with metal cover, primarily intended for switching and pulse-oscillating circuits.

RATINGS (Limiting values)

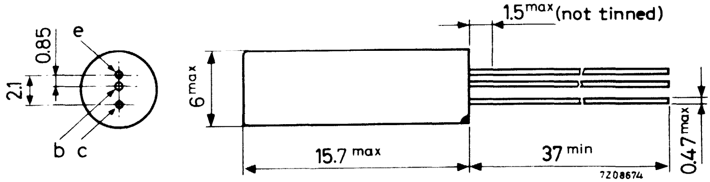
Collector-base voltage (open emitter)	$-V_{CBO}$	max.	32	V
Collector-emitter voltage (V_{BE} = 0)	$-V_{CES}$	max.	32	V
Emitter-base voltage (open collector)	$-V_{EBO}$	max.	20	V
Collector current (d.c. or average over any 50 ms period)	$-I_C$	max.	300	mA
Collector current (peak value)	$-I_{CM}$	max.	600	mA
Base current (d.c. or average over any 50 ms period)	$-I_B$	max.	40	mA
Base current (peak value)	$-I_{BM}$	max.	200	mA
Total power dissipation up to T_{amb} = 40 °C	P_{tot}	max.	550	mW
Storage temperature	T_{stg}		-55 to +75	°C
Junction temperature: continuous	T_j	max.	75	°C
incidentally	T_j	max.	90	°C

THERMAL RESISTANCE

From junction to ambient in free air $R_{th\ j-a}$ = 0.22 °C/mW

MECHANICAL DATA

Dimensions in mm



The coloured dot indicates the collector

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

Collector cut-off current

$I_E = 0$; $-V_{CB} = 12$ V	$-I_{CBO}$	typ.	10	µA
		<	20	µA
$I_E = 0$; $-V_{CB} = 12$ V; $T_{amb} = 60$ °C	$-I_{CBO}$	<	330	µA

Emitter cut-off current

$I_C = 0$; $-V_{EB} = 6$ V	$-I_{EBO}$	typ.	6	µA
		<	20	µA

Sustaining voltage

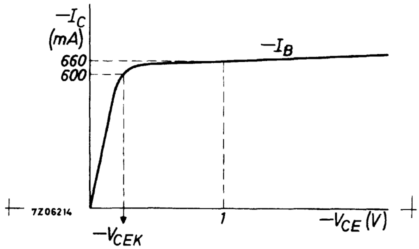
$-I_C = 600$ mA; $V_{BE} = 0$	$-V_{CESsust}$	>	32	V

Base-emitter voltage

$-I_C = 600$ mA; $V_{CB} = 0$	$-V_{BE}$	typ.	0.6	V

Knee voltage

$-I_C = 600$ mA; $-I_B$ = value for which $-I_C = 660$ mA at $-V_{CE} = 1$ V	$-V_{CEK}$	typ.	0.4	V
		<	0.9	V



Emitter-base floating voltage

$I_E = 0$; $-V_{CB} = 32$ V	V_{EBfl}	<	0.55	V

D.C. current gain

$-I_C = 50$ mA; $-V_{CE} = 6$ V	h_{FE}	typ.	180	
$-I_C = 600$ mA; $-V_{CB} = 0$	h_{FE}	typ.	85	

Cut-off frequency

$I_E = 50$ mA; $-V_{CB} = 6$ V	f_{hfb}	typ.	2	MHz

Feedback impedance at f = 0.5 MHz

$I_E = 1$ mA; $-V_{CE} = 6$ V	$\|z_{rb}\|$	typ.	60	Ω

GERMANIUM TRANSISTORS

P-N-P alloy transistors in TO-7 metal envelopes with the shield leads connected to the cases. They are intended for industrial switching applications.

RATINGS (Limiting values) [1])

Voltages			OC122	OC123	
Collector-base voltage (open emitter)	$-V_{CBO}$	max.	32	50	V
Collector-emitter voltage ($+V_{BE}$ > 0.5 V)	$-V_{CEX}$	max.	32	50	V
Emitter-base voltage (open collector)	$-V_{EBO}$	max.	12	15	V

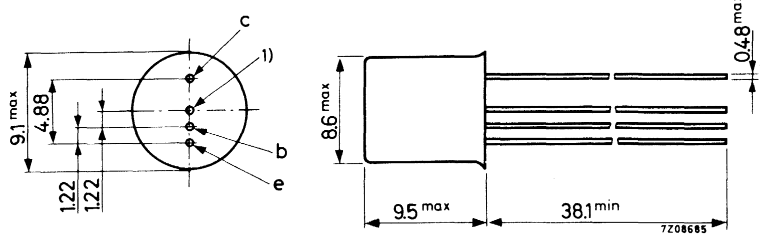
Currents				
Collector current (d.c. or average over any 20 ms period)	$-I_C$	max.	0.5	A
Collector current (peak value)	$-I_{CM}$	max.	2.0	A
Power dissipation				
Total power dissipation up to T_{amb} = 25 °C	P_{tot}	max.	300	mW
Temperatures				
Storage temperature	T_{stg}		-55 to +75	°C
Junction temperature	T_j	max.	90	°C

THERMAL RESISTANCE

From junction to ambient in free air	$R_{th\ j-a}$	=	0.22	°C/mW
From junction to case	$R_{th\ j-c}$	=	0.06	°C/mW

MECHANICAL DATA Dimensions in mm

TO-7



1) = shield lead (connected to case)

1) Limiting values according to the Absolute Maximum System as defined in IEC publication 134.

CHARACTERISTICS

			OC122	OC123	
Collector cut-off current					
$I_E = 0$; $-V_{CB} = 24$ V	$-I_{CBO}$	typ.	40		μA
		<	150		μA
$I_E = 0$; $-V_{CB} = 10$ V	$-I_{CBO}$	typ.		20	μA
		<		100	μA
Base-emitter voltage					
$-I_C = 100$ mA; $-V_{CE} = 2$ V	$-V_{BE}$	typ.	0.27	0.27	V
		<	0.35	0.35	V
D.C. current gain					
$-I_C = 100$ mA; $-V_{CE} = 6$ V	h_{FE}	>	50	50	
		typ.	180	160	
Collector capacitance					
$I_E = I_e = 0$; $-V_{CE} = 6$ V	C_c	typ.	170	170	pF
Transition frequency					
$-I_C = 100$ mA; $-V_{CE} = 2$ V	f_T	typ.	1.3	1.5	MHz

SYMMETRICAL SWITCHING TRANSISTOR

N-P-N germanium transistor with symmetrical structure in all glass construction. It is intended for high current, high speed computer switching applications.

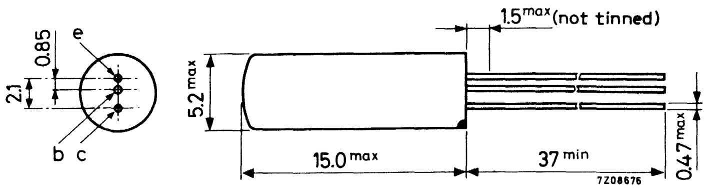
RATINGS (Limiting values)

Collector-base voltage (open emitter)	V_{CBO}	max.	20	V
Collector-emitter voltage with $-V_{BE} > 2$ V	V_{CEX}	max.	20	V
Emitter-base voltage (open collector)	V_{EBO}	max.	20	V
Collector current (d.c. or average over any 20 ms period)	I_C	max.	250	mA
Emitter current (d.c. or average over any 20 ms period)	$-I_E$	max.	250	mA
Base current (d.c. or average over any 20 ms period)	I_B	max.	40	mA
Base current (peak value)	I_{BM}	max.	250	mA
Total power dissipation up to $T_{amb} = 25\ ^oC$	P_{tot}	max.	145	mW
Storage temperature	T_{stg}		−55 to +75	^oC
Junction temperature	T_j	max.	75	^oC

THERMAL RESISTANCE

From junction to ambient in free air	$R_{th\ j-a}$	=	0.35	^oC/mW
From junction to case	$R_{th\ j-c}$	=	0.20	^oC/mW

MECHANICAL DATA Dimensions in mm



The coloured dot indicates the collector

The collector is not necessarily related to pin configuration.

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

Collector cut-off current				
$I_E = 0$; $V_{CB} = 5$ V	I_{CBO}	typ. <	0.3 3	μA μA
$I_E = 0$; $V_{CB} = 5$ V; $T_j = 60$ °C	I_{CBO}	typ. <	6 35	μA μA
$I_E = 0$; $V_{CB} = 20$ V; $T_j = 60$ °C	I_{CBO}	<	100	μA
Emitter cut-off current				
$I_C = 0$; $V_{EB} = 5$ V	I_{EBO}	typ. <	0.3 3	μA μA
$I_C = 0$; $V_{EB} = 5$ V; $T_j = 60$ °C	I_{EBO}	typ. <	6 35	μA μA
$I_C = 0$; $V_{EB} = 20$ V; $T_j = 60$ °C	I_{EBO}	<	100	μA
Sustaining voltage				
I_C 250 mA; $-V_{BE} = 2$ V	$V_{CEXsust}$	>	15	V
Base-emitter voltage				
$I_C = 200$ mA; $V_{CB} = 0$	V_{BE}	<	750	mV
Saturation voltages				
$I_C = 8.5$ mA; $I_B = 0.38$ mA	V_{CEsat}	<	175	mV
$I_C = 50$ mA; $I_B = 3.1$ mA	V_{CEsat}	typ. <	60 220	mV mV
	V_{BEsat}	typ. <	300 500	mV mV
Punch-through voltage	V_{pt}	>	20	V
D.C. current gain				
$I_C = 15$ mA; $V_{CB} = 0$	h_{FE}		20 to 84	
$I_C = 200$ mA; $V_{CB} = 0$	h_{FE}		15	
Transition frequency				
$I_C = 3$ mA; $V_{CE} = 5$ V	f_T	typ. >	6 3.5	MHz MHz
Switching parameters				
Current-drive time constant $I_{CM} = 200$ mA; $V_{CE} = 0.75$ V	τ_c	<	1.75	μs
Voltage-drive time constant $I_{CM} = 1$ mA; $V_{CE} = 5$ V	τ_v	<	0.15	μs

SYMMETRICAL SWITCHING TRANSISTOR

N-P-N germanium transistor with symmetrical structure in all glass construction. It is intended for high current, high speed computer switching applications.

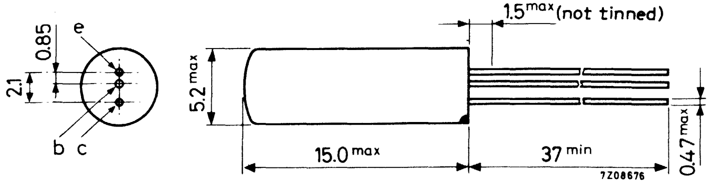
RATINGS (Limiting values)

Collector-base voltage (open emitter)	V_{CEO}	max.	20	V
Collector-emitter voltage with $-V_{BE} > 2$ V	V_{CEX}	max.	20	V
Emitter-base voltage (open collector)	V_{EBO}	max.	20	V
Collector current (d.c. or average over any 20 ms period)	I_C	max.	400	mA
Emitter current (d.c. or average over any 20 ms period)	$-I_E$	max.	400	mA
Base current (d.c. or average over any 20 ms period)	I_B	max.	40	mA
Base current (peak value)	I_{BM}	max.	400	mA
Total power dissipation up to T_{amb} = 25 °C	P_{tot}	max.	145	mW
Storage temperature	T_{stg}		-55 to +75	°C
Junction temperature	T_j	max.	75	°C

THERMAL RESISTANCE

From junction to ambient in free air	$R_{th\ j-a}$	=	0.35	°C/mW
From junction to case	$R_{th\ j-c}$	=	0.20	°C/mW

MECHANICAL DATA Dimensions in mm



The coloured dot indicates the collector

The collector is not necessarily related to pin configuration.

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

Collector cut-off current				
$I_E = 0$; $V_{CB} = 5$ V	I_{CBO}	typ. <	0.3 3	μA μA
$I_E = 0$; $V_{CB} = 5$ V; $T_j = 60$ °C	I_{CBO}	typ. <	6 35	μA μA
$I_E = 0$; $V_{CB} = 20$ V; $T_j = 60$ °C	I_{CBO}	<	100	μA
Emitter cut-off current				
$I_C = 0$; $V_{EB} = 5$ V	I_{EBO}	typ. <	0.3 3	μA μA
$I_C = 0$; $V_{EB} = 5$ V; $T_j = 60$ °C	I_{EBO}	typ. <	6 35	μA μA
$I_C = 0$; $V_{EB} = 20$ V; $T_j = 60$ °C	I_{EBO}	<	100	μA
Sustaining voltage				
$I_C = 400$ mA; $-V_{BE} = 2$ V	$V_{CEXsust}$	>	15	V
Base-emitter voltage				
$I_C = 200$ mA; $V_{CB} = 0$	V_{BE}	<	600	mV
Saturation voltages				
$I_C = 7.5$ mA; $I_B = 0.165$ mA	V_{CEsat} V_{BEsat}	< <	175 250	mV mV
$I_C = 50$ mA; $I_B = 1.25$ mA	V_{CEsat} V_{BEsat}	< <	220 380	mV mV
$I_C = 400$ mA; $I_B = 20$ mA	V_{CEsat} V_{BEsat}	< <	370 900	mV mV
Punch-through voltage	V_{pt}	>	20	V
D.C. current gain				
$I_C = 15$ mA; $V_{CB} = 0$	h_{FE}	50 to 150		
$I_C = 200$ mA; $V_{CB} = 0$	h_{FE}	36 to 67		
$I_E = 200$ mA; $V_{EB} = 0$	h_{FC}	>	21	
Transition frequency				
$I_C = 3$ mA; $V_{CE} = 5$ V	f_T	typ. >	12 4.5	MHz MHz
Switching parameters				
Current-drive time constant $I_{CM} = 200$ mA; $V_{CE} = 0.75$ V	τ_c	<	1.75	μs
Voltage-drive time constant $I_{CM} = 1$ mA; $V_{CE} = 5$ V	τ_v	<	0.15	μs

SYMMETRICAL SWITCHING TRANSISTOR

N-P-N germanium transistor with symmetrical structure in all glass construction. It is intended for high current, high speed computer switching applications.

RATINGS (Limiting values)

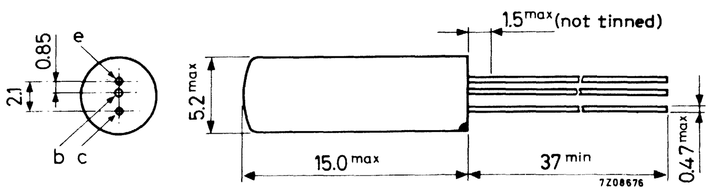
Collector-base voltage (open emitter)	V_{CEO}	max.	20	V
Collector-emitter voltage with $-V_{BE} > 2$ V	V_{CEX}	max.	20	V
Emitter-base voltage (open collector)	V_{EBO}	max.	20	V
Collector current (d.c. or average over any 20 ms period)	I_C	max.	400	mA
Emitter current (d.c. or average over any 20 ms period)	$-I_E$	max.	400	mA
Base current (d.c. or average over any 20 ms period)	I_B	max.	40	mA
Base current (peak value)	I_{BM}	max.	400	mA
Total power dissipation up to $T_{amb} = 25\ ^oC$	P_{tot}	max.	145	mW
Storage temperature	T_{stg}		-55 to +75	^oC
Junction temperature	T_j	max.	75	^oC

THERMAL RESISTANCE

From junction to ambient in free air	$R_{th\ j-a}$	=	0.35	$^oC/mW$
From junction to case	$R_{th\ j-c}$	=	0.20	$^oC/mW$

MECHANICAL DATA

Dimensions in mm



The coloured dot indicates the collector

The collector is not necessarily related to pin configuration.

CHARACTERISTICS

T_{amb} = 25 °C unless otherwise specified

Collector cut-off current				
$I_E = 0$; $V_{CB} = 5$ V	I_{CBO}	typ. <	0.3 3	μA μA
$I_E = 0$; $V_{CB} = 5$ V; $T_j = 60$ °C	I_{CBO}	typ. <	6 35	μA μA
$I_E = 0$; $V_{CB} = 20$ V; $T_j = 60$ °C	I_{CBO}	<	100	μA
Emitter cut-off current				
$I_C = 0$; $V_{EB} = 5$ V	I_{EBO}	typ. <	0.3 3	μA μA
$I_C = 0$; $V_{EB} = 5$ V; $T_j = 60$ °C	I_{EBO}	typ. <	6 35	μA μA
$I_C = 0$; $V_{EB} = 20$ V; $T_j = 60$ °C	I_{EBO}	typ.	100	μA
Sustaining voltage				
$I_C = 400$ mA; $-V_{BE} = 2$ V	$V_{CEXsust}$	>	15	V
Base-emitter voltage				
$I_C = 200$ mA; $V_{CB} = 0$	V_{BE}	<	450	mV
Saturation voltages				
$I_C = 7.5$ mA; $I_B = 0.094$ mA	V_{CEsat} V_{BEsat}	< <	175 250	mV mV
$I_C = 50$ mA; $I_B = 0.75$ mA	V_{CEsat} V_{BEsat}	< <	220 340	mV mV
$I_C = 400$ mA; $I_B = 13.3$ mA	V_{CEsat}	<	370	mV
$I_C = 400$ mA; $I_B = 20$ mA	V_{BEsat}	<	700	mV
Punch-through voltage	V_{pt}	>	20	V
D.C. current gain				
$I_C = 15$ mA; $V_{CB} = 0$	h_{FE}	80 to 200		
$I_C = 200$ mA; $V_{CB} = 0$	h_{FE}	50 to 134		
$I_E = 200$ mA; $V_{EB} = 0$	h_{FC}	>	21	
Transition frequency				
$I_C = 3$ mA; $V_{CE} = 5$ V	f_T	typ. <	20 9	MHz MHz
Switching parameters				
Current-drive time constant $I_{CM} = 200$ mA; $V_{CE} = 0.75$ V	τ_c	<	1.75	μs
Voltage-drive time constant $I_{CM} = 1$ mA; $V_{CE} = 5$ V	τ_v	<	0.15	μs

R.F. GERMANIUM TRANSISTORS

P-N-P alloy-diffused transistors in TO-7 metal case. The OC169, OC170 and OC171 have a low collector capacitance and high transconductance at high frequencies.

RATINGS (Limiting values) [1])

Collector-base voltage (open emitter)	$-V_{CBO}$	max.	20	V
Collector current (d.c. and average)	$-I_C$	max.	10	mA
Total dissipation up to T_{amb} = 45 °C	P_{tot}	max.	50	mW
Junction temperature: continuous	T_j	max.	75	°C
incidentally	T_j	max.	90	°C

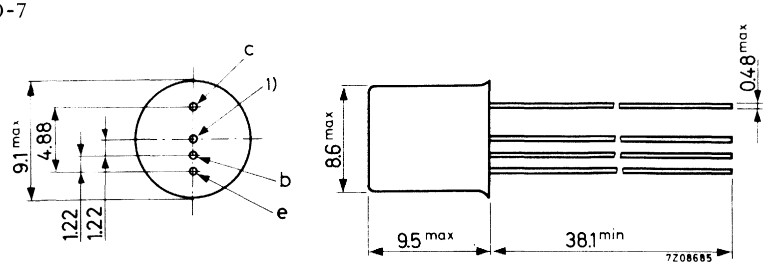
CHARACTERISTICS

Transition frequency

$-I_C$ = 1 mA; $-V_{CE}$ = 6 V	f_T	typ.	70	MHz

MECHANICAL DATA Dimensions in mm

TO-7



1) = shield lead (connected to case)

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[1]) Limiting values according to the Absolute Maximum System as defined in IEC publication 134.

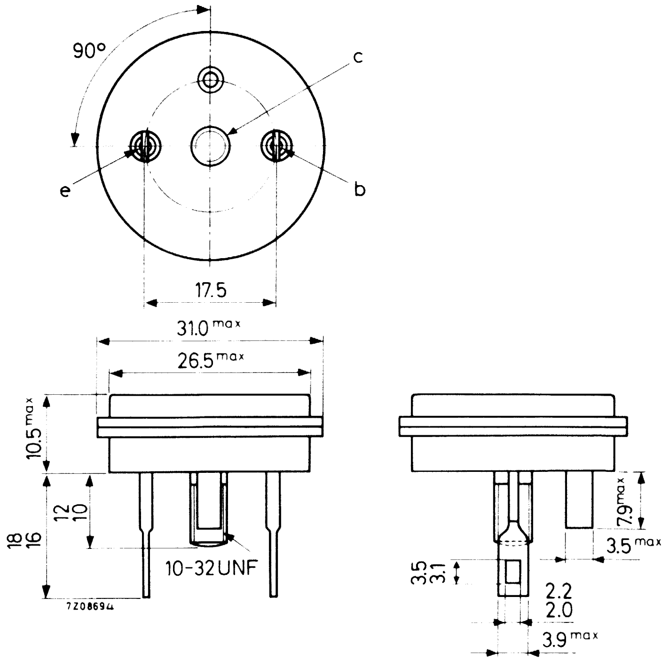
GERMANIUM POWER TRANSISTOR

P-N-P alloy transistor in a TO-36 metal envelope with the collector connected to the mounting base.

QUICK REFERENCE DATA				
Collector-base voltage ($+V_{BE}$ = 1.5 V)	$-V_{CBX}$	max.	80	V
Emitter-base voltage (open collector)	$-V_{EBO}$	max.	60	V
Emitter current (d.c.)	I_E	max.	15	A
Total power dissipation up to T_{mb} = 25 °C	P_{tot}	max.	150	W
Junction temperature	T_j	max.	100	°C
D.C. current gain at T_j = 25 °C				
$-I_C$ = 5 A; $-V_{CE}$ = 2 V	h_{FE}	>	25	
Cut-off frequency				
$-I_C$ = 5 A; $-V_{CE}$ = 6 V	f_{hfe}	typ.	10	kHz

MECHANICAL DATA Dimensions in mm

TO-36



Diameter of hole in heatsink: max. 5.2 mm

Supplied with device: 56213

Torque on nut: min. 8 cm kg
max. 17 cm kg

RATINGS (Limiting values) [1]

Voltages

Collector-base voltage ($+V_{BE}$ = 1.5 V)	$-V_{CBX}$	max.	80	V
Emitter-base voltage (open collector)	$-V_{EBO}$	max.	60	V

Currents

Emitter current (d.c.)	I_E	max.	15	A
Base current (d.c.)	$-I_B$	max.	4	A

Power dissipation

Total power dissipation up to T_{mb} = 25 °C	P_{tot}	max.	150	W

Temperatures

Storage temperature	T_{stg}		-65 to +100	°C
Junction temperature	T_j	max.	100	°C

THERMAL RESISTANCE

From junction to mounting base	$R_{th\ j\text{-}mb}$	=	0.5	°C/W
Thermal capacity (1 to 10 ms)			0.075	Ws/°C

[1]) Limiting values according to the Absolute Maximum System as defined in IEC publication 134.

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

Collector cut-off current				
$I_E = 0$; $-V_{CB} = 2$ V	$-I_{CBO}$	typ.	100	µA
$I_E = 0$; $-V_{CB} = 80$ V	$-I_{CBO}$	typ. <	2 8	mA mA
$I_E = 0$; $-V_{CB} = 80$ V; $T_j = 70$ °C	$-I_{CBO}$	<	15	mA
Emitter cut-off current				
$I_C = 0$; $-V_{EB} = 60$ V	$-I_{EBO}$	typ. <	1 8	mA mA
Breakdown voltages				
$-I_C = 1$ A; $I_B = 0$	$-V_{(BR)CEO}$	>	55	V
$-I_C = 300$ mA; $V_{BE} = 0$	$-V_{(BR)CES}$	>	70	V
Base-emitter voltage				
$-I_C = 5$ A; $-V_{CE} = 2$ V	$-V_{BE}$	typ. <	0.65 0.9	V V
Saturation voltages				
$-I_C = 12$ A; $-I_B = 2$ A	$-V_{CEsat}$	typ. <	0.3 0.9	V V
Emitter-base floating voltage				
$I_E = 0$; $-V_{CB} = 80$ V	$-V_{EBfl}$	<	1	V
D.C. current gain				
$-I_C = 5$ A; $-V_{CE} = 2$ V	h_{FE}		25 to 50	
$-I_C = 12$ A; $-V_{CE} = 2$ V	h_{FE}	typ.	20	
Cut-off frequency				
$-I_C = 5$ A; $-V_{CE} = 6$ V	f_{hfe}	typ.	10	kHz
Rise time				
$-I_C = 12$ A; $-I_B = 2$ A; $-V_{CE} = 12$ V	t_r	typ.	15	µs
Fall time				
$I_C = 0$; $+V_{BE} = 6$ V; $R_{BE} = 10\ \Omega$	t_f	typ.	15	µs

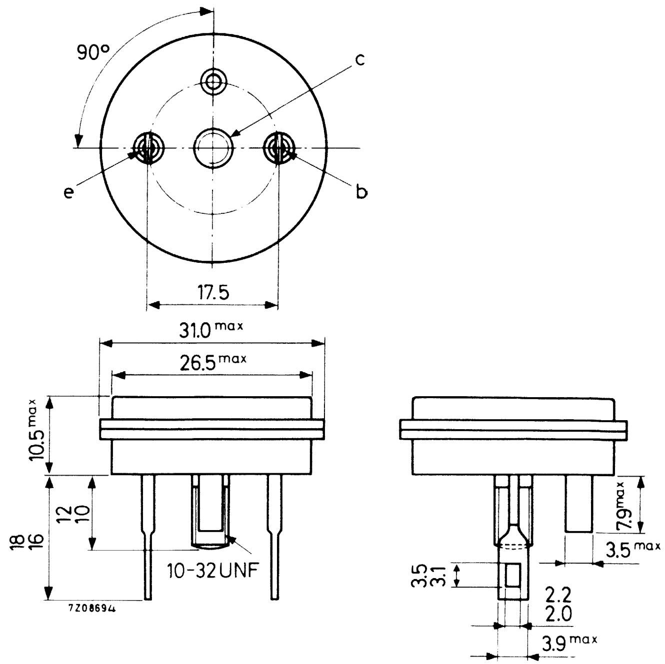
GERMANIUM POWER TRANSISTOR

P-N-P alloy transistor in a TO-36 metal envelope with the collector connected to the mounting base.

QUICK REFERENCE DATA				
Collector-base voltage ($+V_{BE}$ = 1.5 V)	$-V_{CBX}$	max.	40	V
Emitter-base voltage (open collector)	$-V_{EBO}$	max.	20	V
Emitter current (d.c.)	I_E	max.	15	A
Total power dissipation up to T_{mb} = 25 °C	P_{tot}	max.	150	W
Junction temperature	T_j	max.	100	°C
D.C. current gain at T_j = 25 °C				
$-I_C$ = 5 A; $-V_{CE}$ = 2 V	h_{FE}	>	35	
Cut-off frequency				
$-I_C$ = 5 A; $-V_{CE}$ = 6 V	f_{hfe}	typ.	10	kHz

MECHANICAL DATA Dimensions in mm

TO-36



Diameter of hole in heatsink: max. 5.2 mm
Supplied with device: 56213

Torque on nut: min. 8 cm kg
max. 17 cm kg

RATINGS (Limiting values) [1])

Voltages

Collector-base voltage ($+V_{BE}$ = 1.5 V)	$-V_{CBX}$	max.	40	V
Emitter-base voltage (open collector)	$-V_{EBO}$	max.	20	V

Currents

Emitter current (d.c.)	I_E	max.	15	A
Base current (d.c.)	$-I_B$	max.	4	A

Power dissipation

Total power dissipation up to T_{mb} = 25 °C	P_{tot}	max.	150	W

Temperatures

Storage temperature	T_{stg}		-65 to +100	°C
Junction temperature	T_j	max.	100	°C

THERMAL RESISTANCE

From junction to mounting base	$R_{th\,j\text{-}mb}$	=	0.5	°C/W
Thermal capacity (1 to 10 ms)			0.075	Ws/°C

[1]) Limiting values according to the Absolute Maximum System as defined in IEC publication 134.

CHARACTERISTICS $T_j = 25\ ^oC$ unless otherwise specified

Collector cut-off current				
$I_E = 0$; $-V_{CB} = 2$ V	$-I_{CBO}$	typ.	100	μA
$I_E = 0$; $-V_{CB} = 40$ V	$-I_{CBO}$	typ. <	2 8	mA mA
Emitter cut-off current				
$I_C = 0$; $-V_{EB} = 20$ V	$-I_{EBO}$	typ. <	1 8	mA mA
Breakdown voltages				
$-I_C = 300$ mA; $I_B = 0$	$-V_{BR(CEO)}$	typ.	40	V
$-I_C = 300$ mA; $V_{BE} = 0$	$-V_{BR(CES)}$	>	40	V
Base-emitter voltage				
$-I_C = 5$ A; $-V_{CE} = 2$ V	$-V_{BE}$	typ.	0.65	V
Saturation voltages				
$-I_C = 12$ A; $-I_B = 2$ A	$-V_{CEsat}$	typ.	0.3	V
Punch through voltage	V_{pt}	>	40	V
Emitter-base floating voltage				
$I_E = 0$; $-V_{CB} = 40$ V	$-V_{EBfl}$	<	1	V
D.C. current gain				
$-I_C = 5$; $-V_{CE} = 2$ V	h_{FE}		35 to 70	
$-I_C = 12$; $-V_{CE} = 2$ V	h_{FE}	typ.	25	
Cut-off frequency				
$-I_C = 5$ A; $-V_{CE} = 6$ V	f_{hfe}	typ.	10	kHz
Rise time				
$-I_C = 12$ A; $-I_B = 2$ A; $-V_{CE} = 12$ V	t_r	typ.	15	μs
Fall time				
$I_C = 0$; $+V_{BE} = 6$ V; $R_{BE} = 10\ \Omega$	t_f	typ.	15	μs

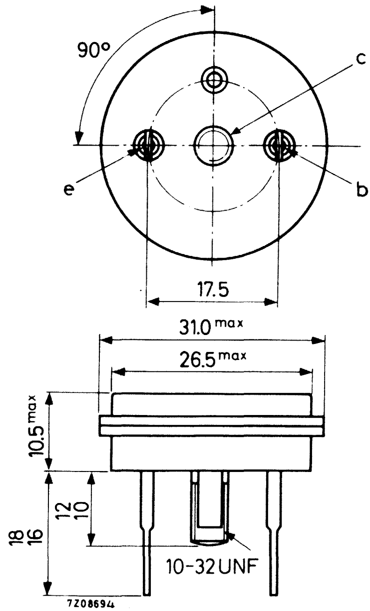
GERMANIUM POWER TRANSISTOR

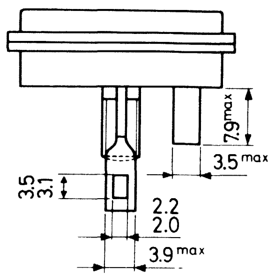
P-N-P alloy transistor in a TO-36 metal envelope with the collector connected to the mounting base.

QUICK REFERENCE DATA				
Collector-base voltage ($+V_{BE}$ = 1.5 V)	$-V_{CBX}$	max.	40	V
Emitter-base voltage (open collector)	$-V_{EBO}$	max.	20	V
Emitter current (d.c.)	I_E	max.	15	A
Total power dissipation up to T_{mb} = 25 °C	P_{tot}	max.	150	W
Junction temperature	T_j	max.	100	°C
D.C. current gain at T_j = 25 °C				
$-I_C$ = 5 A; $-V_{CE}$ = 2 V	h_{FE}	>	20	
Cut-off frequency				
$-I_C$ = 5 A; $-V_{CE}$ = 6 V	f_{hfe}	typ.	10	kHz

MECHANICAL DATA Dimensions in mm

TO-36





Diameter of hole in heatsink: max. 5.2 mm
Supplied with device: 56213

Torque on nut: min. 8 cm kg
max. 17 cm kg

RATINGS (Limiting values) [1]

Voltages

Collector-base voltage ($+V_{BE}$ = 1.5 V)	$-V_{CBX}$	max.	40	V
Emitter-base voltage (open collector)	$-V_{EBO}$	max.	20	V

Currents

Emitter current (d.c.)	I_E	max.	15	A
Base current (d.c.)	$-I_B$	max.	4	A

Power dissipation

Total power dissipation up to T_{mb} = 25 °C	P_{tot}	max.	150	W

Temperatures

Storage temperature	T_{stg}		-65 to +100	°C
Junction temperature	T_j	max.	100	°C

THERMAL RESISTANCE

From junction to mounting base	$R_{th\ j\text{-}mb}$	=	0.5	°C/W
Thermal capacity (1 to 10 ms)			0.075	Ws/°C

[1]) Limiting values according to the Absolute Maximum System as defined in IEC publication 134.

CHARACTERISTICS T_j = 25 °C unless otherwise specified

Collector cut-off current				
$I_E = 0$; $-V_{CB} = 2$ V	$-I_{CBO}$	typ.	100	µA
$I_E = 0$; $-V_{CB} = 40$ V	$-I_{CBO}$	typ. <	2 8	mA mA
Emitter cut-off current				
$I_C = 0$; $-V_{EB} = 20$ V	$-I_{EBO}$	typ. <	1 8	mA mA
Breakdown voltages				
$-I_C = 300$ mA; $I_B = 0$	$-V_{BR(CEO)}$	typ.	40	V
$-I_C = 300$ mA; $V_{BE} = 0$	$-V_{BR(CES)}$	>	40	V
Base-emitter voltage				
$-I_C = 5$ A; $-V_{CE} = 2$ V	$-V_{BE}$	typ.	0.65	V
Saturation voltages				
$-I_C = 12$ A; $-I_B = 2$ A	$-V_{CEsat}$	typ.	0.3	V
Punch through voltage	V_{pt}	>	40	V
Emitter-base floating voltage				
$I_E = 0$; $-V_{CB} = 40$ V	$-V_{EBfl}$	<	1	V
D.C. current gain				
$-I_C = 5$ A; $-V_{CE} = 2$ V	h_{FE}		20 to 40	
$-I_C = 12$ A; $-V_{CE} = 2$ V	h_{FE}	typ.	20	
Cut-off frequency				
$-I_C = 5$ A; $-V_{CE} = 6$ V	f_{hfe}	typ.	10	kHz
Rise time				
$-I_C = 12$ A; $-I_B = 2$ A; $-V_{CE} = 12$ V	t_r	typ.	15	µs
Fall time				
$I_C \doteq 0$; $+V_{BE} = 6$ V; $R_{BE} = 10$ Ω	t_f	typ.	15	µs

GERMANIUM POWER TRANSISTOR

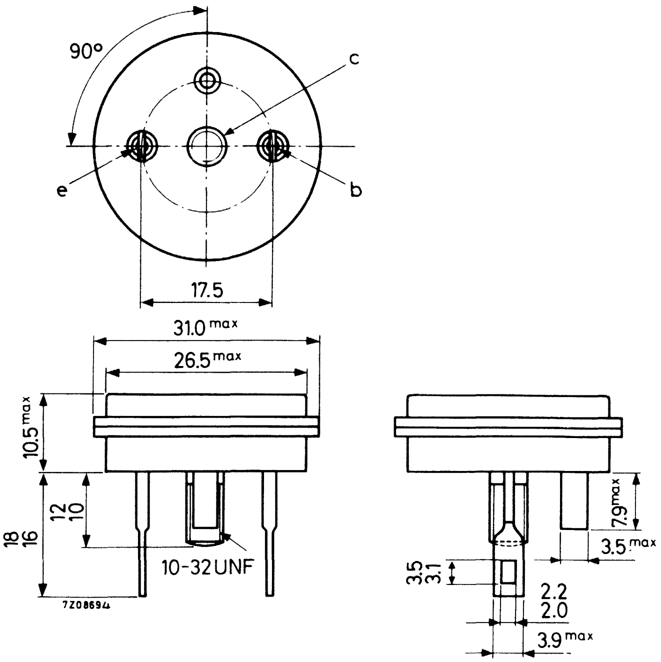
P-N-P alloy transistor in a TO-36 metal envelope with the collector connected to the mounting base.

QUICK REFERENCE DATA				
Collector-base voltage ($+V_{BE}$ = 1.5 V)	$-V_{CBX}$	max.	100	V
Emitter-base voltage (open collector)	$-V_{EBO}$	max.	80	V
Emitter current (d.c.)	I_E	max.	15	A
Total power dissipation up to T_{mb} = 25 °C	P_{tot}	max.	150	W
Junction temperature	T_j	max.	100	°C
D.C. current gain at T_j = 25 °C				
$-I_C$ = 5 A; $-V_{CE}$ = 2 V	h_{FE}	>	25	
Cut-off frequency				
$-I_C$ = 5 A; $-V_{CE}$ = 6 V	f_{hfe}	typ.	10	kHz

MECHANICAL DATA

Dimensions in mm

TO-36



Diameter of hole in heatsink: max. 5.2 mm
Supplied with device: 56213

Torque on nut: min. 8 cm kg
max. 17 cm kg

RATINGS (Limiting values) [1])

Voltages

Collector-base voltage ($+V_{BE}$ = 1.5 V)	$-V_{CBX}$	max.	100	V
Emitter-base voltage (open collector)	$-V_{EBO}$	max.	80	V

Currents

Emitter current (d.c.)	I_E	max.	15	A
Base current (d.c.)	$-I_B$	max.	4	A

Power dissipation

Total power dissipation up to T_{mb} = 25 ^{o}C	P_{tot}	max.	150	W

Temperatures

Storage temperature	T_{stg}		−65 to +100	^{o}C
Junction temperature	T_j	max.	100	^{o}C

THERMAL RESISTANCE

From junction to mounting base	$R_{th\ j\text{-}mb}$	=	0.5	^{o}C/W
Thermal capacity (1 to 10 ms)			0.075	Ws/^{o}C

[1]) Limiting values according to the Absolute Maximum System as defined in IEC publication 134.

CHARACTERISTICS T_j = 25 °C unless otherwise specified

Collector cut-off current				
$I_E = 0$; $-V_{CB} = 2$ V	$-I_{CBO}$	typ.	100	μA
$I_E = 0$; $-V_{CB} = 100$ V	$-I_{CBO}$	<	8	mA
$I_E = 0$; $-V_{CB} = 100$ V; $T_j = 70$ °C	$-I_{CBO}$	<	15	mA
Emitter cut-off current				
$I_C = 0$; $-V_{EB} = 80$ V	$-I_{EBO}$	typ.	1	mA
		<	8	mA
Breakdown voltages				
$-I_C = 1$ A; $I_B = 0$	$-V_{BR(CEO)}$	>	65	V
$-I_C = 300$ mA; $V_{BE} = 0$	$-V_{BR(CES)}$	>	80	V
Base-emitter voltage				
$-I_C = 5$ A; $-V_{CE} = 2$ V	$-V_{BE}$	typ.	0.65	V
		<	0.9	V
Saturation voltages				
$-I_C = 12$ A; $-I_B = 2$ A	$-V_{CEsat}$	typ.	0.3	V
		<	0.7	V
Emitter-base floating voltage				
$I_E = 0$; $-V_{CB} = 100$ V	$-V_{EBfl}$	<	1	V
D.C. current gain				
$-I_C = 5$ A; $-V_{CE} = 2$ V	h_{FE}		25 to 50	
$-I_C = 12$ A; $-V_{CE} = 2$ V	h_{FE}	typ.	20	
Cut-off frequency				
$-I_C = 5$ A; $-V_{CE} = 6$ V	f_{hfe}	typ.	10	kHz
Rise time				
$-I_C = 12$ A; $-I_B = 2$ A; $-V_{CE} = 12$ V	t_r	typ.	15	μs
Fall time				
$I_C = 0$; $+V_{BE} = 6$ V; $R_{BE} = 10\ \Omega$	t_f	typ.	15	μs

GERMANIUM ALLOYED TRANSISTORS

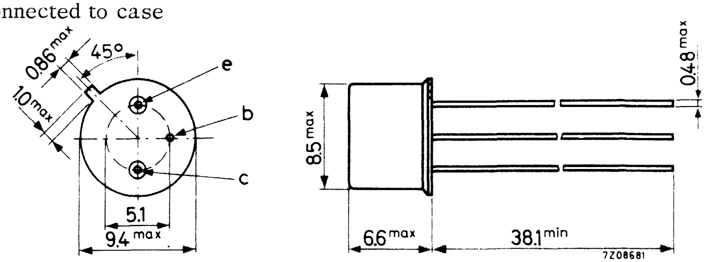
N-P-N transistors in a TO-5 metal envelope with the base connected to the case. These general purpose transistors are primarily intended for medium current medium speed computer logic applications.

QUICK REFERENCE DATA

			2N1302	1304	1306	1308	
Collector-base voltage (open emitter)	V_{CBO}	max.	25	25	25	25	V
Collector-emitter voltage (open base)	V_{CEO}	max.	25	20	15	15	V
Collector current (peak value)	I_{CM}	max.	300	300	300	300	mA
Total power dissipation up to $T_{amb} = 25\ ^oC$	P_{tot}	max.	150	150	150	150	mW
Junction temperature	T_j	max.	85	85	85	85	^oC
D.C. current gain at $T_j = 25\ ^oC$; $I_C = 10$ mA; $V_{CE} = 1$ V	h_{FE}	>	20	40	60	80	
Saturation voltage $I_C = 10$ mA; $I_B = \frac{I_C}{h_{FEmin}}$	V_{CEsat}	<	0.2	0.2	0.2	0.2	V
Transition frequency $I_C = 1$ mA; $V_{CE} = 5$ V	f_T	typ.	10	15	20	30	MHz
Turn on time $(t_d + t_r)$	t_{on}	typ.	285	270	225	220	ns
Turn off time $(t_s + t_f)$	t_{off}	typ.	865	850	815	790	ns

MECHANICAL DATA Dimensions in mm

TO-5
Base connected to case



Accessories available: 56218, 56245, 56265

RATINGS (Limiting values) [1]

Voltages			2N1302	1304	1306	1308	
Collector-base voltage (open emitter)	V_{CBO}	max.	25	25	25	25	V
Collector-emitter voltage (open base)	V_{CEO}	max.	25	20	15	15	V
Emitter-base voltage (open collector)	V_{EBO}	max.	25	25	25	25	V

Currents

Collector current (d.c. or average over any 20 ms period)	I_C	max.	200	mA
Collector current (peak value)	I_{CM}	max.	300	mA

Power dissipation

Total power dissipation up to T_{amb} = 25 °C	P_{tot}	max.	150	mW

Temperatures

Storage temperature	T_{stg}		−65 to +100	°C
Junction temperature	T_j	max.	85	°C

THERMAL RESISTANCE

From junction to ambient in free air	$R_{th\ j-a}$	=	0.4	°C/mW
From junction to case	$R_{th\ j-c}$	=	0.2	°C/mW

[1]) Limiting values according to the Absolute Maximum System as defined in IEC publication 134.

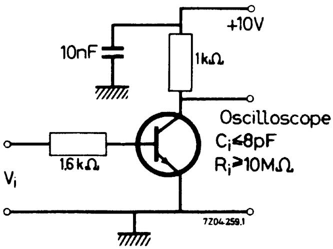
CHARACTERISTICS

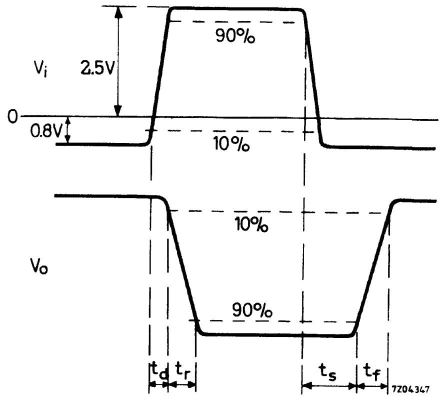
T_j = 25 °C unless otherwise specified

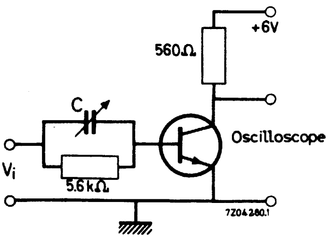
			2N1302	1304	1306	1308	
Collector cut-off current							
$I_E = 0$; $V_{CB} = 25$ V	I_{CBO}	typ.	3	3	3	3	μA
		<	6	6	6	6	μA
Emitter cut-off current							
$I_C = 0$; $V_{EB} = 25$ V	I_{EBO}	typ.	2.2	2.2	2.2	2.2	μA
		<	6	6	6	6	μA
Collector current at reverse biased emitter junction							
$-V_{BE} = 0.2$ V; $T_j = 55$ °C							
$V_{CE} = 20$ V	I_{CEX}	<	50	50			μA
$V_{CE} = 15$ V	I_{CEX}	<			50	50	μA
Saturation voltages							
$I_C = 10$ mA; $I_B = 0.5$ mA	V_{BEsat}	>	0.15	0.15	0.15	0.15	V
		typ.	0.30	0.25	0.24	0.23	V
		<	0.40	0.35	0.35	0.35	V
	V_{CEsat}	typ.	0.1				V
		<	0.2				V
$I_C = 10$ mA; $I_B = 0.25$ mA	V_{CEsat}	typ.		0.1			V
		<		0.2			V
$I_C = 10$ mA; $I_B = 0.17$ mA	V_{CEsat}	typ.			0.1		V
		<			0.2		V
$I_C = 10$ mA; $I_B = 0.13$ mA	V_{CEsat}	typ.				0.1	V
		<				0.2	V
Punch through voltage	V_{pt}	>	25	20	15	15	V
D.C. current gain							
$I_C = 10$ mA; $V_{CE} = 1$ V	h_{FE}	>	20	40	60	80	
		typ.	50	70	100	150	
		<		100	200	300	
$I_C = 200$ mA; $V_{CE} = 0.35$ V	h_{FE}	>	10	15	20	20	
		typ.	48	65	95	145	
Collector capacitance at f = 1 MHz							
$I_E = I_e = 0$; $V_{CB} = 5$ V	C_c	typ.	12	12	12	12	pF
		<	20	20	20	20	pF
Emitter capacitance at f = 1 MHz							
$I_C = I_c = 0$; $V_{EB} = 5$ V	C_e	typ.	8	8	8	8	pF
Transition frequency							
$I_C = 1$ mA; $V_{CE} = 5$ V	f_T	>	3	5	10	15	MHz
		typ.	10	15	20	30	MHz

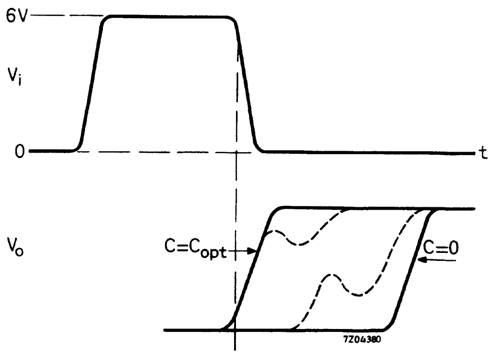
CHARACTERISTICS (continued) T_j = 25 °C unless otherwise specified

			2N1302	1304	1306	1308	
Switching times							
delay time	t_d	typ.	65	60	55	55	ns
rise time	t_r	typ.	220	210	170	165	ns
storage time	t_s	typ.	500	500	500	500	ns
fall time	t_f	typ.	365	350	315	290	ns
Recovered charge	Q_s	typ.	800	700	650	600	pC









Adjust C from zero to C_{opt}
$Q_s = C_{opt} \cdot V_i$

GERMANIUM ALLOYED TRANSISTORS

P-N-P transistors in a TO-5 metal envelope with the base connected to the case. These general purpose transistors are primarily intended for medium current medium speed computer logic applications.

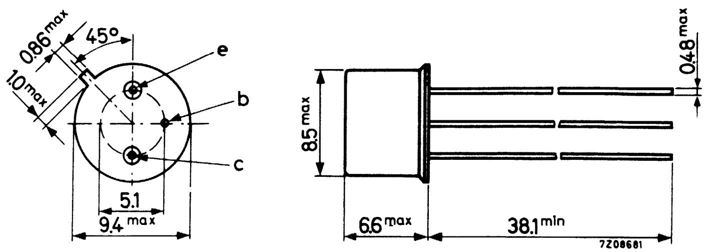
QUICK REFERENCE DATA

			2N1303	1305	1307	1309	
Collector-base voltage (open emitter)	$-V_{CBO}$	max.	30	30	30	30	V
Collector-emitter voltage (open base)	$-V_{CEO}$	max.	25	20	15	15	V
Collector current (peak value)	$-I_{CM}$	max.	300	300	300	300	mA
Total power dissipation up to T_{amb} = 25 °C	P_{tot}	max.	150	150	150	150	mW
Junction temperature	T_j	max.	85	85	85	85	°C
D.C. current gain at T_j = 25°C $-I_C$ = 10 mA; $-V_{CE}$ = 1 V	h_{FE}	>	20	40	60	80	
Saturation voltage $-I_C$ = 10 mA; $-I_B = \frac{-I_C}{h_{FEmin}}$	$-V_{CEsat}$	<	0.2	0.2	0.2	0.2	V
Transition frequency $-I_C$ = 1 mA; $-V_{CE}$ = 5 V	f_T	typ.	5	10	15	20	MHz
Turn on time ($t_d + t_r$)	t_{on}	typ.	360	255	230	200	ns
Turn off time ($t_s + t_f$)	t_{off}	typ.	1300	1150	1050	1050	ns

MECHANICAL DATA Dimensions in mm

TO-5

Base connected to case



Accessories available: 56218, 56245, 56265

RATINGS (Limiting values) [1]

Voltages

			2N1303	1305	1307	1309	
Collector-base voltage (open emitter)	$-V_{CBO}$	max.	30	30	30	30	V
Collector-emitter voltage (open base)	$-V_{CEO}$	max.	25	20	15	15	V
Emitter-base voltage (open collector)	$-V_{EBO}$	max.	25	25	25	25	V

Currents

Collector current (d.c. or average over any 20 ms period)	$-I_C$	max.	200	mA
Collector current (peak value)	$-I_{CM}$	max.	300	mA

Power dissipation

Total power dissipation up to T_{amb} = 25 °C	P_{tot}	max.	150	mW

Temperatures

Storage temperature	T_{stg}		-65 to +100	°C
Junction temperature	T_j	max.	85	°C

THERMAL RESISTANCE

From junction to ambient in free air	$R_{th\ j\text{-}a}$	=	0.4	°C/mW
From junction to case	$R_{th\ j\text{-}c}$	=	0.2	°C/mW

[1] Limiting values according to the Absolute Maximum System as defined in IEC publication 134.

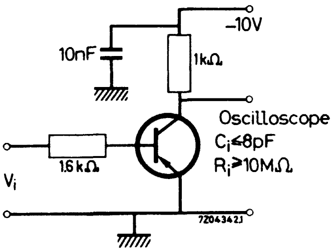
CHARACTERISTICS

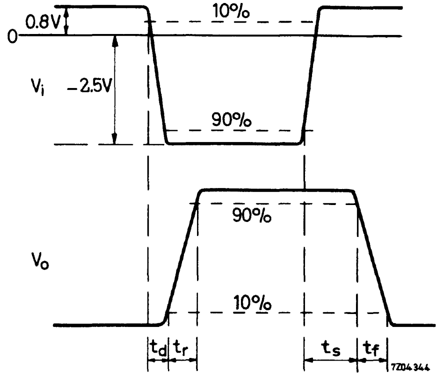
T_j = 25 °C unless otherwise specified

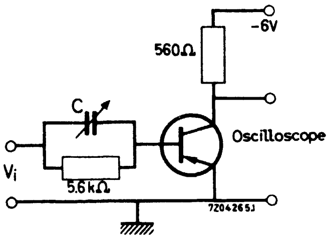
			2N1303	1305	1307	1309	
Collector cut-off current $I_E = 0$; $-V_{CB} = 25$ V	$-I_{CBO}$	typ.	3	3	3	3	μA
		<	6	6	6	6	μA
Emitter cut-off current $I_C = 0$; $-V_{EB} = 25$ V	$-I_{EBO}$	typ.	1.7	1.7	1.7	1.7	μA
		<	6	6	6	6	μA
Collector current at reverse biased emitter junction $-V_{CE} = 15$ V; $+V_{BE} = 0.2$ V $T_j = 55$ °C	$-I_{CEX}$	<	50	50	50	50	μA
Saturation voltages		>	0.15	0.15	0.15	0.15	V
$-I_C = 10$ mA; $-I_B = 0.5$ mA	$-V_{BEsat}$	typ.	0.30	0.25	0.24	0.23	V
		<	0.40	0.35	0.35	0.35	V
	$-V_{CEsat}$	typ.	0.1				V
		<	0.2				V
$-I_C = 10$ mA; $-I_B = 0.25$ mA	$-V_{CEsat}$	typ.		0.1			V
		<		0.2			V
$-I_C = 10$ mA; $-I_B = 0.17$ mA	$-V_{CEsat}$	typ.			0.1		V
		<			0.2		V
$-I_C = 10$ mA; $-I_B = 0.13$ mA	$-V_{CEsat}$	typ.				0.1	V
		<				0.2	V
Punch through voltage	V_{pt}	>	25	20	15	15	V
D.C. current gain		>	20	40	60	80	
$-I_C = 10$ mA; $-V_{CE} = 1$ V	h_{FE}	typ.	50	70	100	150	
		<		100	200	300	
$-I_C = 200$ mA; $-V_{CE} = 0.35$ V	h_{FE}	>	10	15	20	20	
		typ.	35	55	90	130	
Collector capacitance at f = 1 MHz $I_E = I_e = 0$; $-V_{CB} = 5$ V	C_c	typ.	10	10	10	10	pF
		<	20	20	20	20	pF
Emitter capacitance at f = 1 MHz $I_C = I_c = 0$; $-V_{EB} = 5$ V	C_e	typ.	7	7	7	7	pF
Transition frequency $-I_C = 1$ mA; $-V_{CE} = 5$ V	f_T	>	3	5	10	15	MHz
		typ.	5	10	15	20	MHz

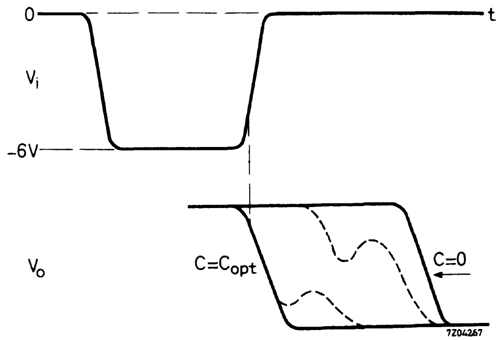
CHARACTERISTICS (continued) T_j = 25 °C unless otherwise specified

			2N1303	1305	1307	1309	
Switching times							
delay time	t_d	typ.	60	55	50	45	ns
rise time	t_r	typ.	300	200	180	155	ns
storage time	t_s	typ.	700	700	700	700	ns
fall time	t_f	typ.	600	450	350	350	ns
Recovered charge	Q_s	typ.	1000	1000	1000	1000	pC









Adjust C from zero to C_{opt}

$Q_s = C_{opt} \cdot V_i$

AUDIO FREQUENCY PACKAGE

The package 40809 comprises 4 transistors, intended for application in audio frequency d.c.-coupled amplifiers with complementary output stages with power outputs up to 1200 mW.

The matched pair AC127/AC128 (NPN/PNP, marked 3) consists of two transistors with high values of the d.c. amplification factor h_{FE}.

The AC128 (PNP, marked 2) should be used in the drive stage.

The AC127 (NPN, marked 1) is meant for use in the pre-amplifier stage.

APPLICATIONS

On the following pages four circuits are described in detail

QUICK REFERENCE DATA

Circuit		I	II	III	IV	
Supply voltage	V_S	6	6	9	9	V
Maximum output power (d_{tot} = 10%)	$P_{o\ max}$	350	700	650	1200	mW
Required input voltage (P_o = 50 mW) [1]						
without feedback	$V_{i(rms)}$	1.8	2.1	1.0	1.2	mV
with 6 dB feedback	$V_{i(rms)}$	3.5	5.0	2.5	2.0	mV

FOR DATA OF THE INDIVIDUAL TRANSISTORS REFER TO THE DATA SHEETS OF THE AC127 AND THE AC128

[1]) Spread of input sensitivity < 3 dB

TYPICAL OPERATION CHARACTERISTICS (f = 1 kHz)

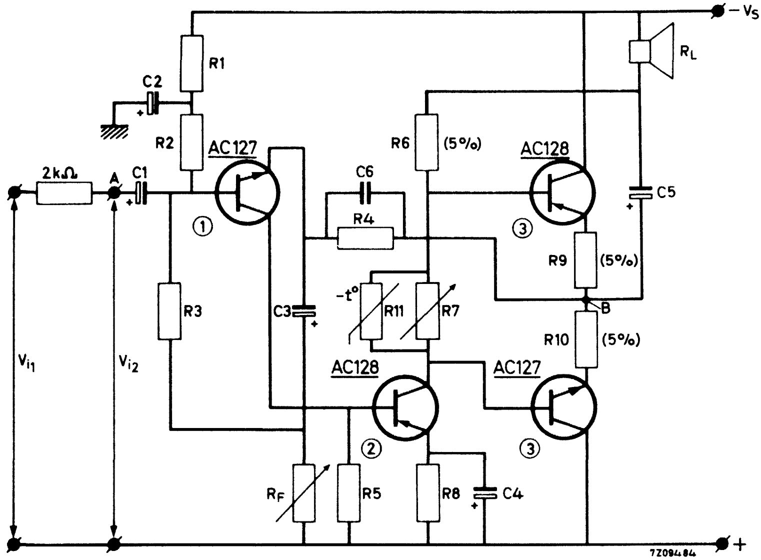
Circuit		I	II	III	IV	
Supply voltage	V_S	6	6	9	9	V
Max. output power at d_{tot} = 10%	$P_{o\ max}$	350	700	650	1200	mW
Input voltage at P_o = 50 mW						
without feedback	$V_{i(rms)}$	1.8	2.1	1.0	1.2	mV
with 6 dB feedback	$V_{i(rms)}$	3.5	5.0	2.5	2.0	mV
Input voltage at P_o = max.						
without feedback	$V_{i(rms)}$	5.3	8.6	4.6	5.6	mV
with 6 dB feedback	$V_{i(rms)}$	10.7	20.7	10.4	10.2	mV
Zero signal collector currents [1] of transistors 3	$\|I_C\|$	4	5	3	5	mA
Collector peak current at $P_{o\ max}$	I_{CM}	260	500	300	470	mA
Collector current of the driver transistor 2	$-I_C$	4.6	8.3	5.4	7.7	mA
Midtap voltage at B	V	3.3	3.6	4.9	4.9	V
Typical input resistance at A						
without feedback	R_i	3.8	6.0	3.3	2.8	kΩ
with 6 dB feedback	R_i	7.3	11.5	6.4	4.3	kΩ

Stable continuous operation is ensured up to T_{amb} = 45 °C, provided the output transistors are mounted as indicated in the following table

	I	II	III	IV
AC127	A	C	B	C
AC128	A	A	A	B

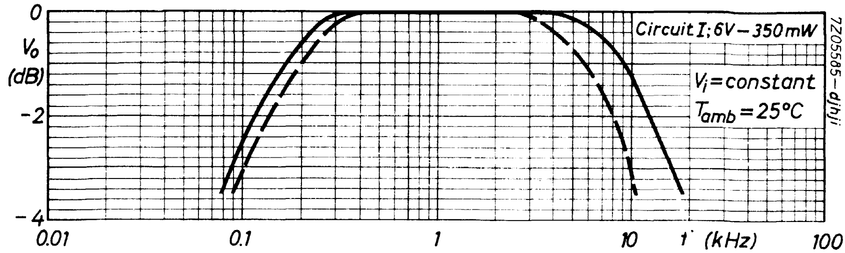
A = without cooling fin or heatsink in free air
B = with cooling fin (Type No.56227)
C = with cooling fin (Type No.56227) mounted on a 1.5 mm aluminium heatsink of at least 12.5 cm^2

[1]) To be adjusted with R7



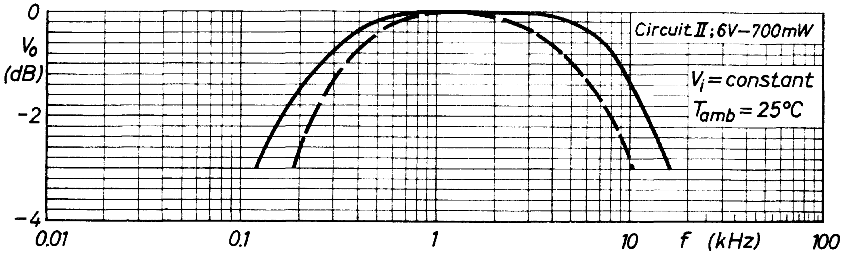
List of components

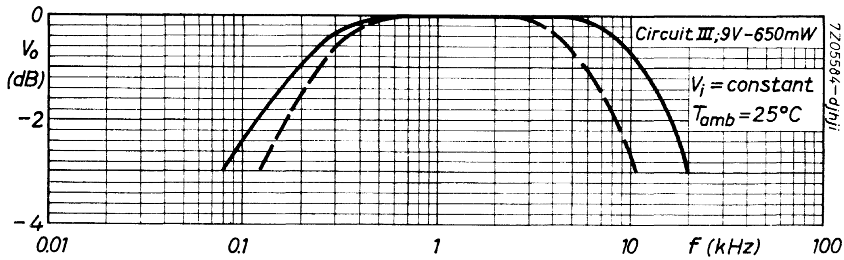
	Circuit	I	II	III	IV	
	R1	1.2	2.7	6.8	2.2	kΩ
	R2	22	18	33	18	kΩ
	R3	15	15	22	15	kΩ
	R4	2.2	2.2	3.3	2.2	kΩ
	R5	1.5	2.2	1.8	1.5	kΩ
	R6 (5%)	560	270	750	510	Ω
	R7	100	75	75	100	Ω
	R8	68	75	100	39	Ω
	R9 = R10 (5%)	1.5	0	2.4	0	Ω
	R11 (NTC)	–	130	–	130	Ω
	R_L	8	4	10	8	Ω
without feedback	R_F	0	0	0	0	
with 6 dB feedback	R_F	5.6	12	5.6	2.7	Ω
	C1	6.4	6.4	6.4	6.4	μF
Tolerance of resistors:	C2	100	100	100	100	μF
10 % unless otherwise	C3	320	125	320	400	μF
specified	C4	200	160	125	200	μF
	C5	400	1000	320	400	μF
	C6	-	3900	–	–	pF



Normalised output voltage versus frequency

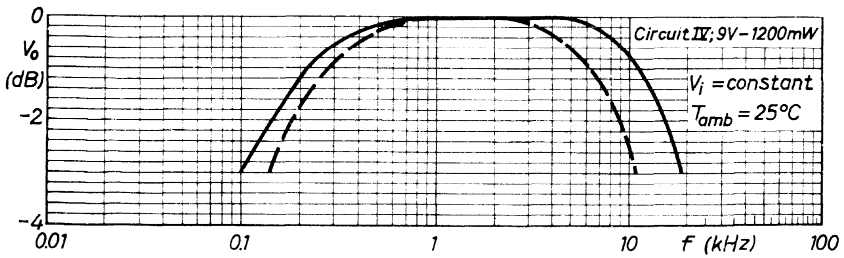
– – – without feedback
——— with feedback

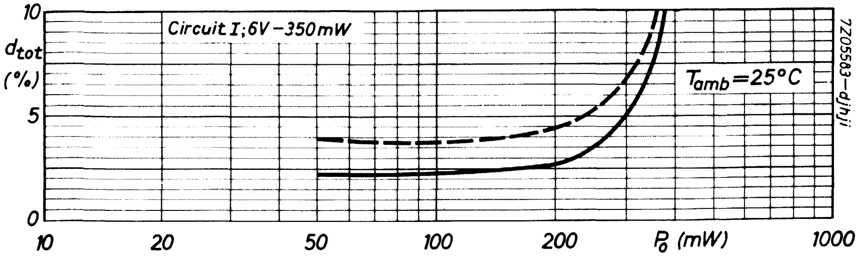




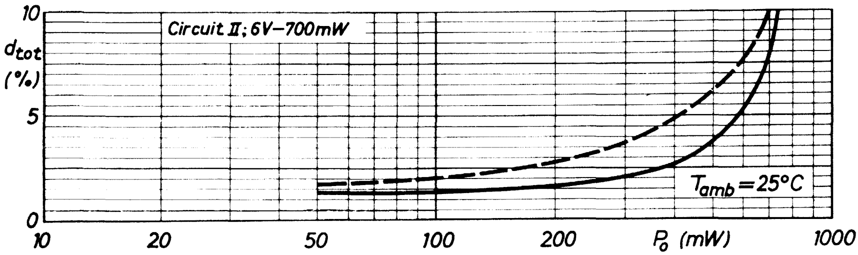
Normalised output voltage versus frequency

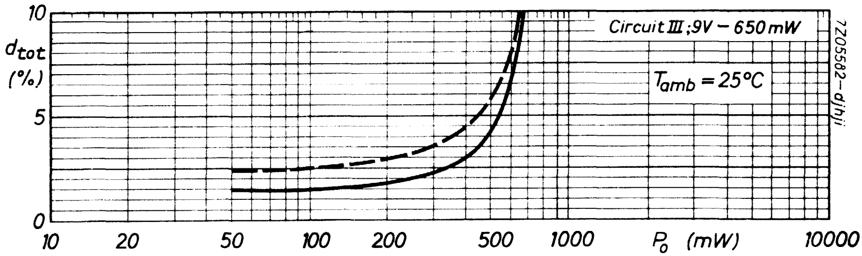
– – – without feeaback
——— with feedback



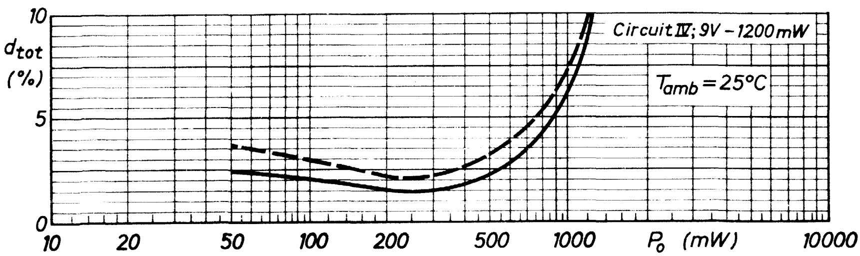


Typical values — — — without feedback
——— with feedback





Typical values — — — without feedback
——— with feedback



AUDIO FREQUENCY PACKAGE

The package 40819 comprises 4 transistors, selected on h_{FE} to give a low quiescent current of the driver stage and a low gain spread.
The package contains:
AC187 - pre-amplifier transistor
AC188 - driver transistor
AC187/01 and AC188/01-complementary output transistors.

QUICK REFERENCE DATA

The transistors are coded in red with the numerals given below.

Type number	code numeral	h_{FE} at I_C = 500 mA V_{CE} = 1 V	envelope	function
AC187	1	100 to 200	TO-1	pre-amplifier
AC188	2	100 to 200	TO-1	driver
AC187/01	3	150 to 500	cooling block	output stage
AC188/01	3	150 to 500	cooling block	output stage

FOR DATA OF THE INDIVIDUAL TRANSISTORS
REFER TO THE DATA SHEETS OF THE AC187; AC187/01 and AC188; AC188/01

APPLICATION INFORMATION

T_{amb} = 25 °C

Package 40819 in a.f. amplifier

Circuit		I	II	
Supply voltage	V_S	6	15	V
Max. output power at d_{tot} = 10 %	P_{omax}	1	3	W
Input voltage at P_o = 50 mW				
without feedback	$V_{i(rms)}$		0.7	mV
with feedback	$V_{i(rms)}$	10	1.2	mV
Input voltage at $P_o = P_{omax}$				
without feedback	$V_{i(rms)}$		5.5	mV
with feedback	$V_{i(rms)}$	41	10	mV
Zero signal collector current of transistors 3 (adjusted with R8)	$\lvert I_C \rvert$	5	5	mA
Collector current (peak value) at $P_o = P_{omax}$ of transistors 3	I_{CM}	710	750	mA
Collector current of the driver transistor 2	$-I_C$	10	9	mA
Midtap voltage at point A	V	2.8	8	V
Typical input resistance at point B				
without feedback	R_i		7	kΩ
with feedback	R_i	8	11	kΩ

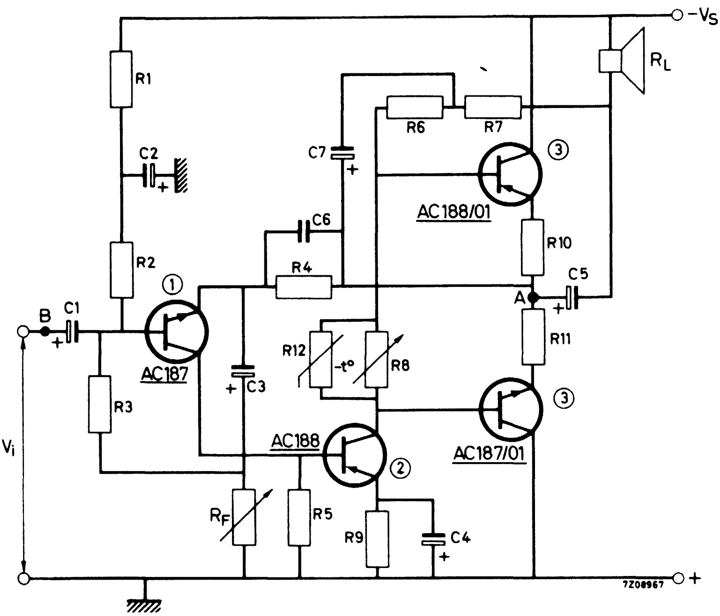
Notes

1. Stable continuous operation is ensured up to T_{amb} = 45 °C, provided the output transistors are mounted as specified below:

   Circuit I:
   For the AC187/01 and AC188/01 the heatsinks should have an area of approximately 5 cm^2 and a thickness of 1.5 mm.

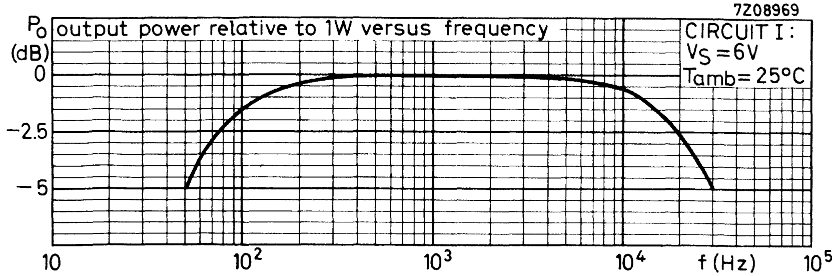
   Circuit II:
   For the AC187/01 and the AC188/01 the heatsinks should have areas of approximately 5 cm^2 and 20 cm^2 respectively and in each case a thickness of 1.5 mm.

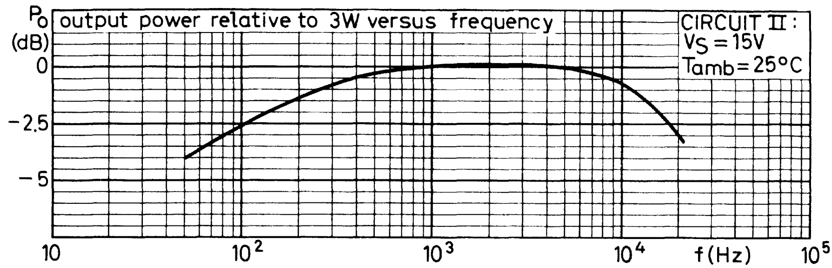
2. Figures and curves are typical ones unless otherwise specified.
3. A.C. information is given at f = 1 kHz unless otherwise specified.



List of components [1]	Circuit	I	II	
	R1	1.5	2.7	kΩ
	R2	10	47	kΩ
	R3	15	47	kΩ
	R4	2.2	1.8	kΩ
	R5	820	820	kΩ
	R6	0	390	Ω
	R7	270	390	Ω
	R8	100	150	Ω
	R9	0	12	Ω
	R10 = R11	0	1	Ω
	R12 (NTC)	130	50	Ω
	R_L	4	8	Ω
without feedback	R_F	0	0	
with feedback	R_F	36	1.5	Ω
	C1	6.4	40	μF
	C2	50	125	μF
	C3	50	1000	μF
	C4	0	64	μF
	C5	1000	800	μF
	C6	3300	4700	pF
	C7	0	80	μF

[1]) Tolerance of the resistors is 5%


7Z08969
Po (dB)
output power relative to 1W versus frequency
CIRCUIT I:
VS = 6V
Tamb = 25°C
0
−2.5
−5
10
10²
10³
10⁴
f (Hz)
10⁵


Po (dB)
output power relative to 3W versus frequency
CIRCUIT II:
VS = 15V
Tamb = 25°C
0
−2.5
−5
10
10²
10³
10⁴
f (Hz)
10⁵

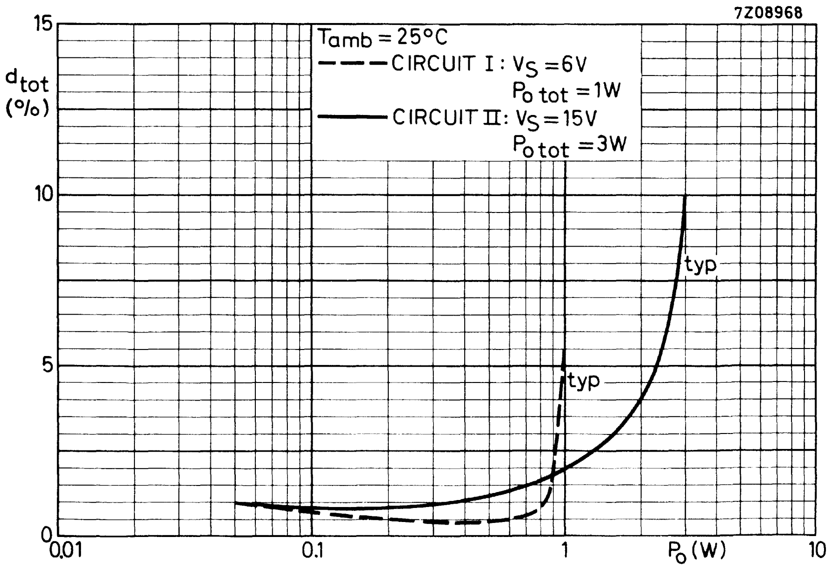

7Z08968
15
dtot (%)
Tamb = 25°C
CIRCUIT I: VS = 6V
Po tot = 1W
CIRCUIT II: VS = 15V
Po tot = 3W
10
typ
5
typ
0
0.01
0.1
1
Po (W)
10

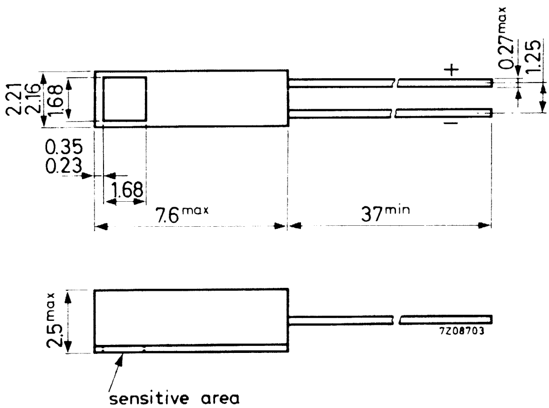
Photo devices

SILICON PHOTOVOLTAIC CELL

Silicon photovoltaic cell for use in tape and card readers.

QUICK REFERENCE DATA				
Sensitive area			2.8	mm^2
Light sensitivity at E = 2000 lux		typ.	32	μA
Ambient temperature	T_{amb}	max.	100	^oC
Peak spectral response	λ_m	typ.	0.8	μm

MECHANICAL DATA Dimensions in mm



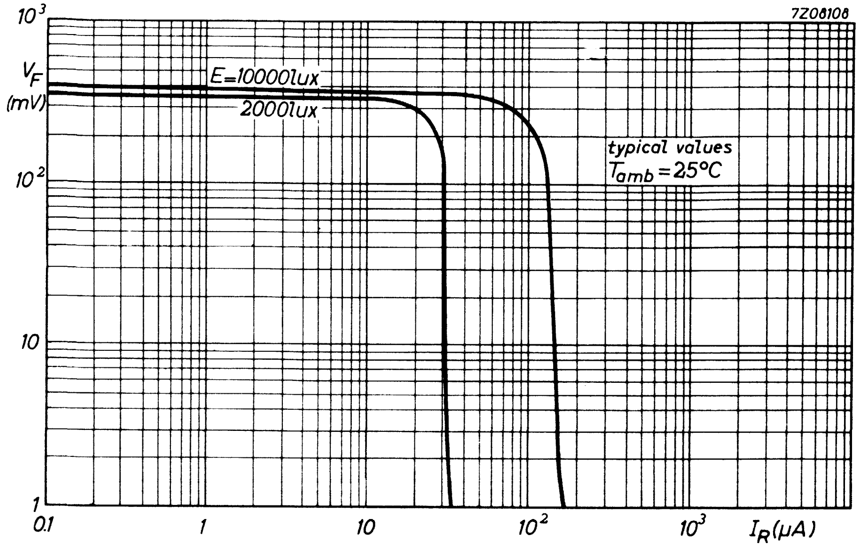
RATINGS (Limiting values) [1])

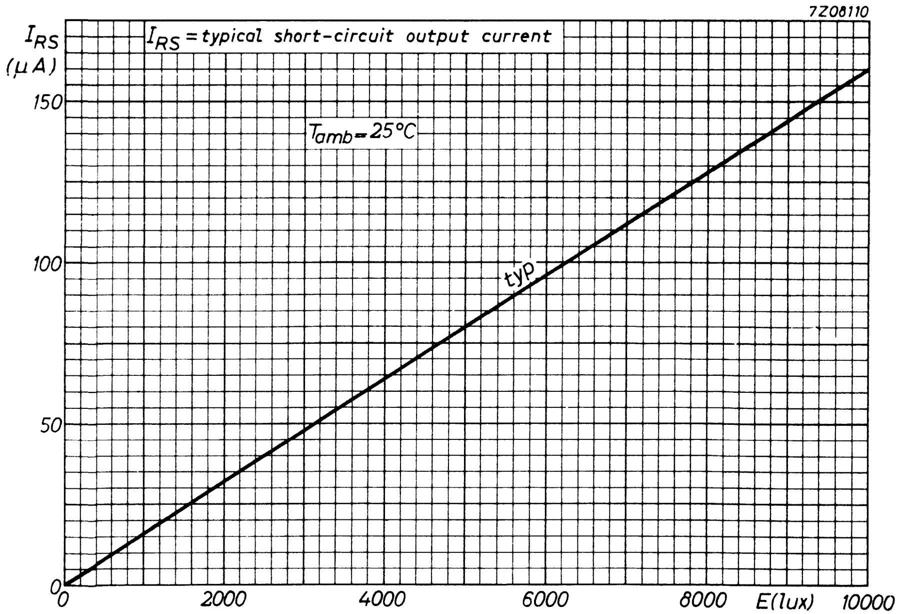
Reverse voltage	V_R	max.	1	V
Forward current	I_F	max.	10	mA
Temperatures				
Storage temperature	T_{stg}		−20 to +100	°C
Junction temperature	T_j	max.	100	°C

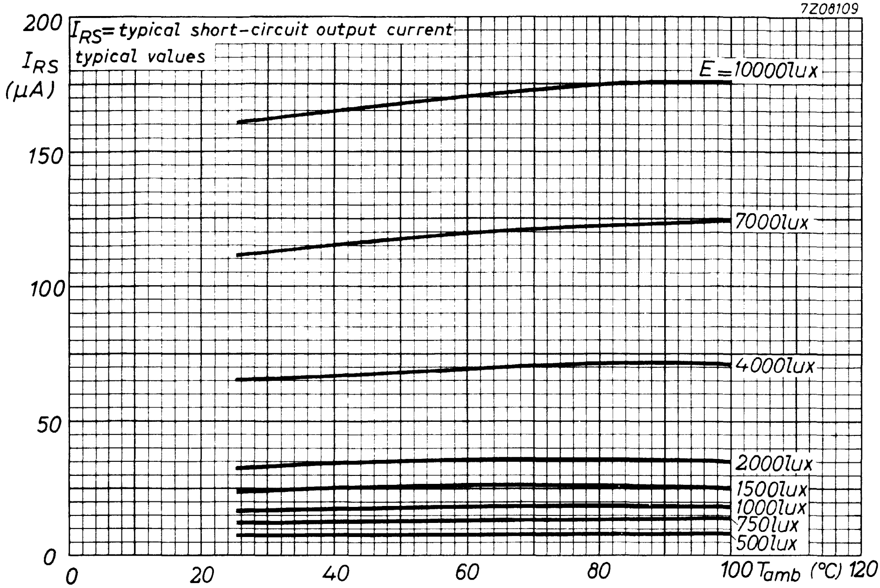
CHARACTERISTICS T_{amb} = 25 °C unless otherwise specified

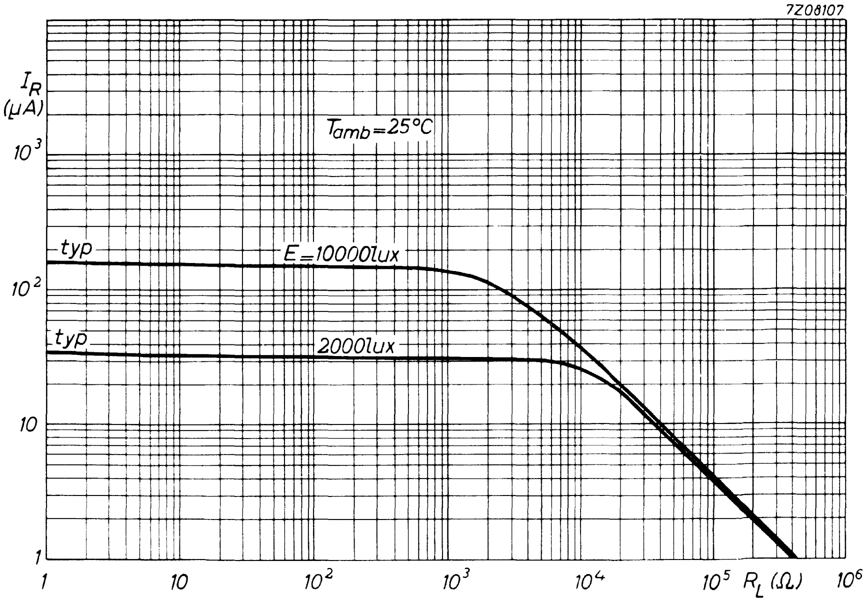
Dark reverse current				
V_R = 1 V	I_R	typ.	0.35	μA
		<	10	μA
V_R = 1 V; T_{amb} = 75 °C	I_R	<	30	μA
Short circuit current				
Colour temperature 2700 °K				
E = 2 000 lux	I_{RS}	typ.	32	μA
		15 to	50	μA
E = 10 000 lux	I_{RS}	typ.	160	μA
Peak spectral response	λ_m	typ.	0.8	μm
Sensitive area		typ.	2.8	mm^2
Diode capacitance at V = 0	C_d	<	1000	pF

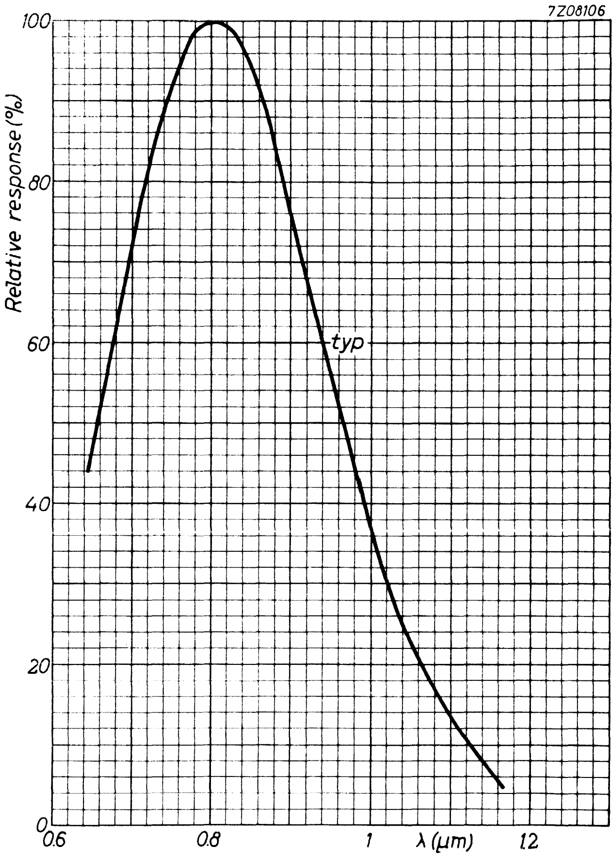
[1]) Limiting values according to the Absolute Maximum System as defined in IEC publication 134.

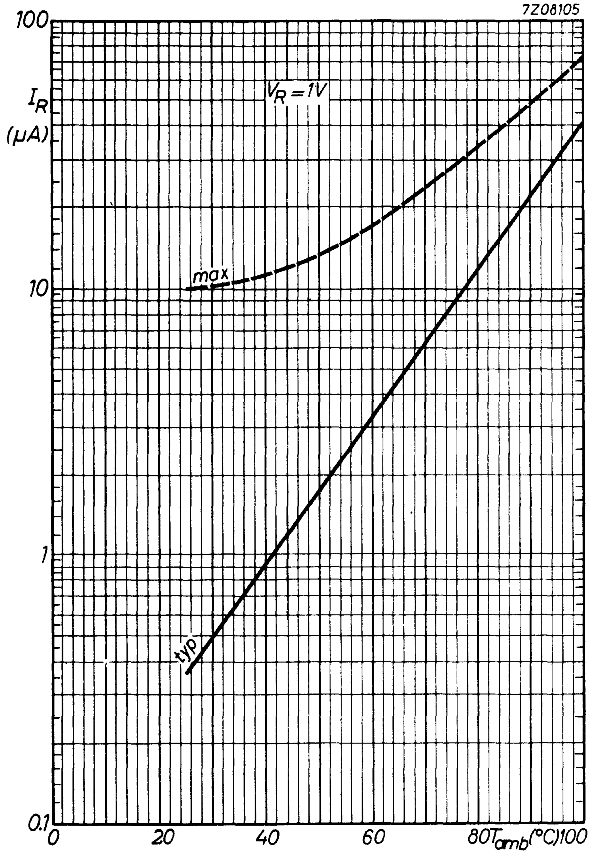

7Z08108
V_F (mV)
10^3
10^2
10
1
E=10000lux
2000lux
typical values
T_{amb} = 25°C
0.1
1
10
10^2
10^3
I_R(μA)


7Z08110
I_{RS} (μA)
I_{RS} = typical short-circuit output current
T_{amb} = 25°C
typ
150
100
50
0
0
2000
4000
6000
8000
E(lux)
10000


7Z08109
I_{RS} = typical short-circuit output current
typical values
I_{RS} (μA)
200
150
100
50
0
E = 10000 lux
7000 lux
4000 lux
2000 lux
1500 lux
1000 lux
750 lux
500 lux
0
20
40
60
80
100
T_{amb} (°C)
120


7Z08107
I_R (μA)
10^3
10^2
10
1
T_{amb} = 25 °C
typ
E = 10000 lux
typ
2000 lux
1
10
10^2
10^3
10^4
10^5
R_L (Ω)
10^6


7Z08106
Relative response (%)
100
80
60
40
20
0
typ
0.6
0.8
1
λ (μm)
1.2

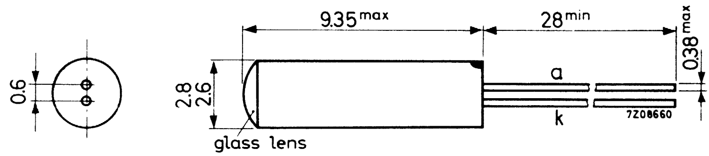

7Z08105
100
I_R
(μA)
10
1
0.1
0
20
40
60
80
T_{amb} (°C)
100
$V_R = 1V$
max
typ

GERMANIUM PHOTO-DIODE

Germanium general purpose photo-diode in a metal envelope.

QUICK REFERENCE DATA				
Sensitive area			1	mm^2
Light sensitivity			0.05	μA/lux
Ambient temperature	T_{amb}	max.	60	^oC
Peak spectral response	λ_m	typ.	1.55	μm

MECHANICAL DATA Dimensions in mm



The coloured dot indicates the anode

RATINGS (Limiting values) [1])

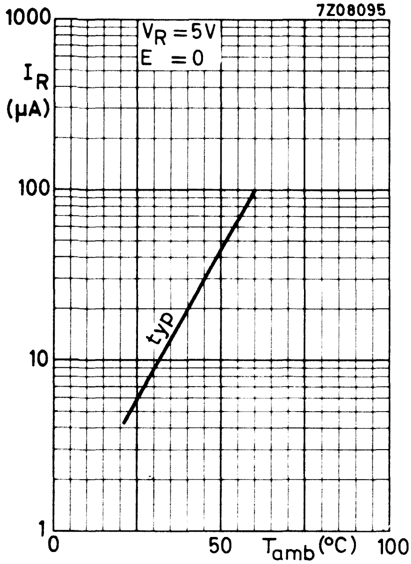
Reverse voltage	V_R	max.	30	V
Reverse current	I_R	max.	3	mA
Total power dissipation	P_{tot}	max.	30	mW

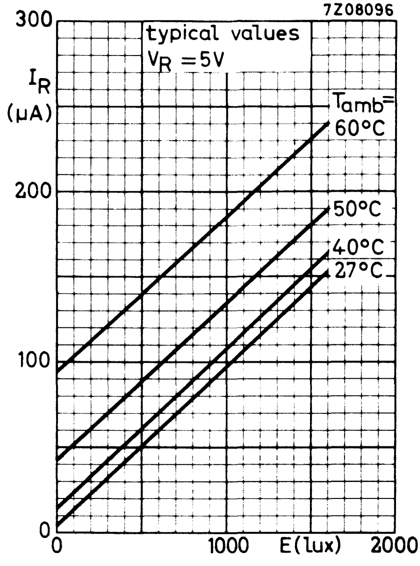
CHARACTERISTICS — T_{amb} = 25 °C and using a lamp of colour temperature 2500 °K

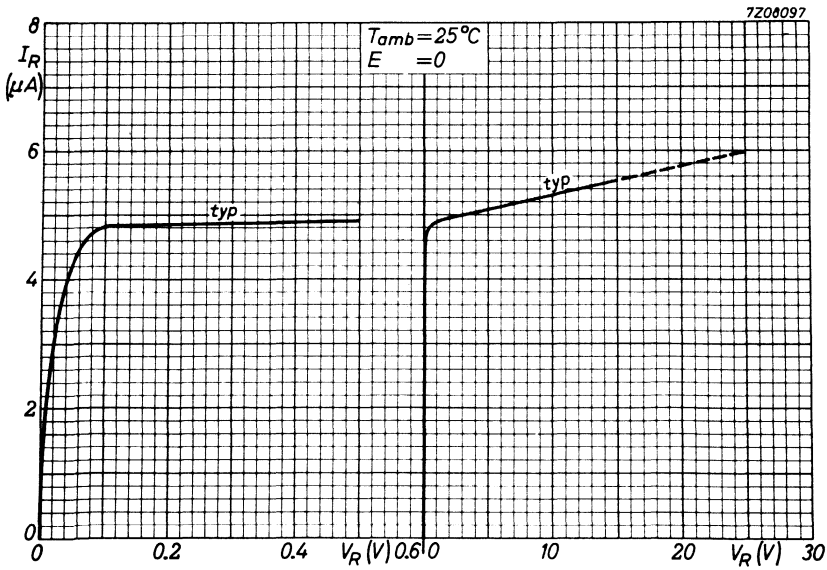
Dark reverse current at V_R = 10 V	I_R	<	15	μA
Noise of the dark current (r.m.s. value) V_R = 10 V; f = 10 kHz; B = 1 Hz		<	3	pA
Diode resistance (V_R = 0.5 to 30 V)	r_D	>	3	MΩ
Cut-off frequency at V_R = 10 V [2])	f_c	typ.	50	kHz
Peak spectral response	λ_m	typ.	1.55	μm
Zero spectral response	λ_0	typ.	2.0	μm
Sensitive area			1	mm^2
Light sensitivity			0.05	μA/lux

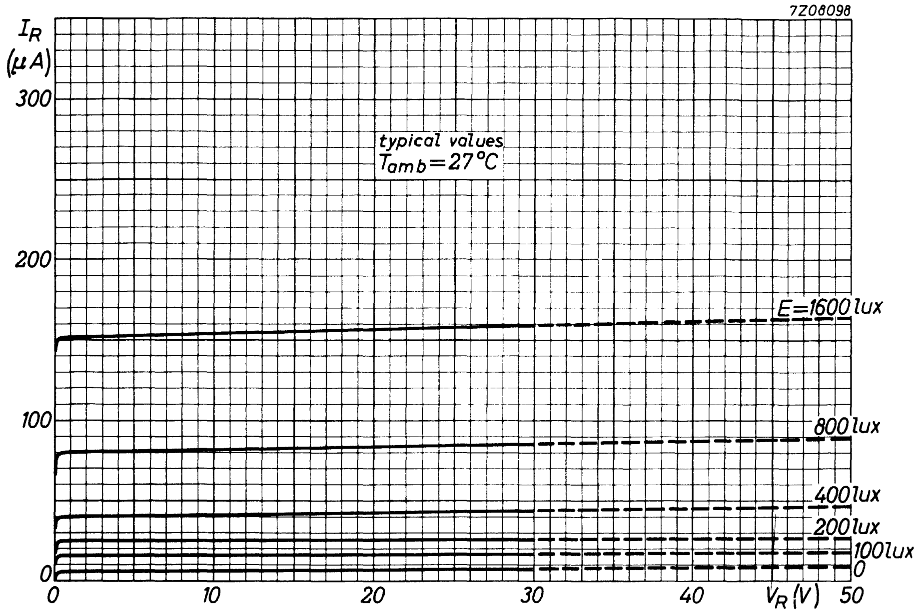
[1]) Limiting values according to the Absolute Maximum System as defined in IEC publication 134.

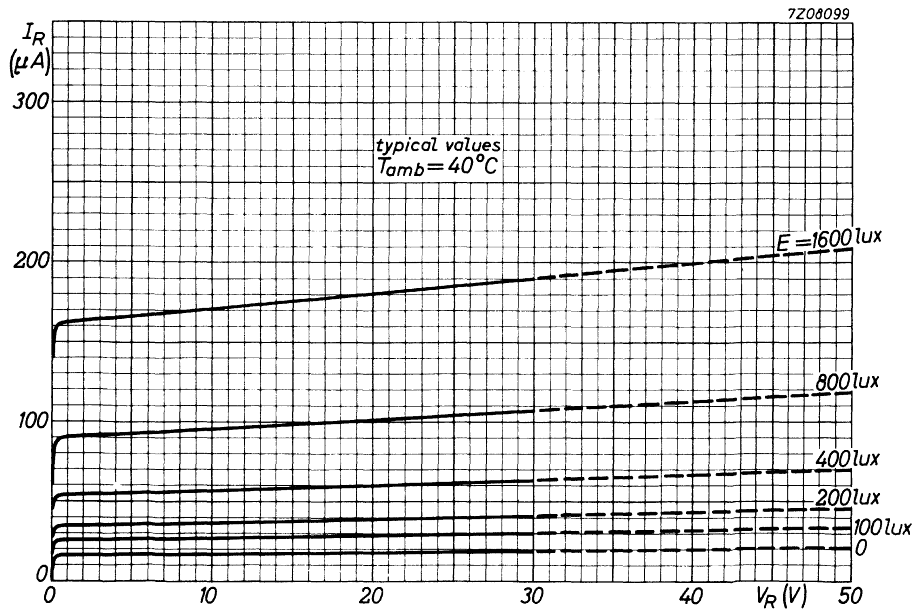
[2]) Frequency at which the sensitivity is 3 dB below the reference sensitivity, the latter being measured at V_R = 10 V; f = 1 kHz; T_{amb} = 20 °C.

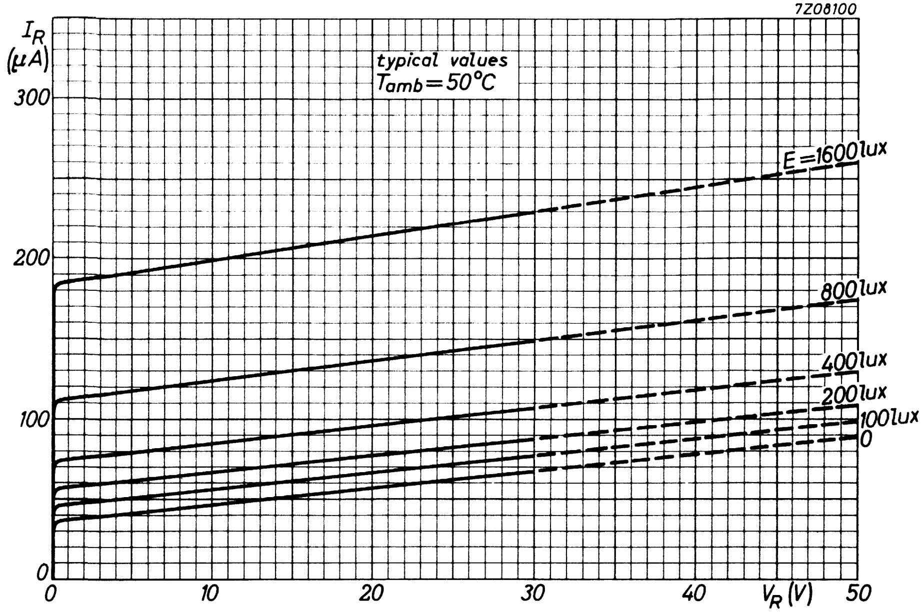

7Z08095
V_R = 5V
E = 0
I_R (μA)
1000
100
10
1
typ
0
50
T_{amb} (°C)
100

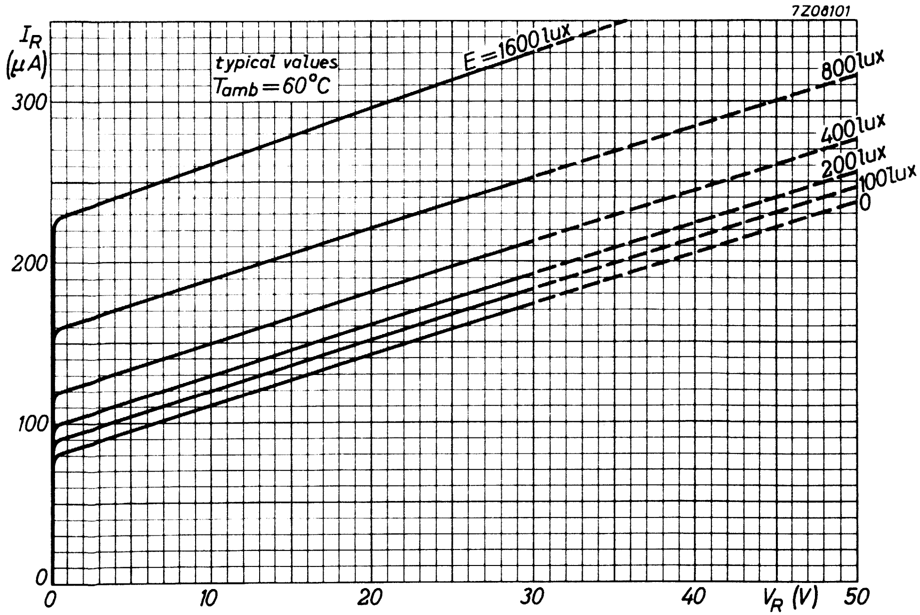

7Z08096
typical values
V_R = 5V
I_R (μA)
300
200
100
0
T_{amb} =
60°C
50°C
40°C
27°C
0
1000
E (lux)
2000

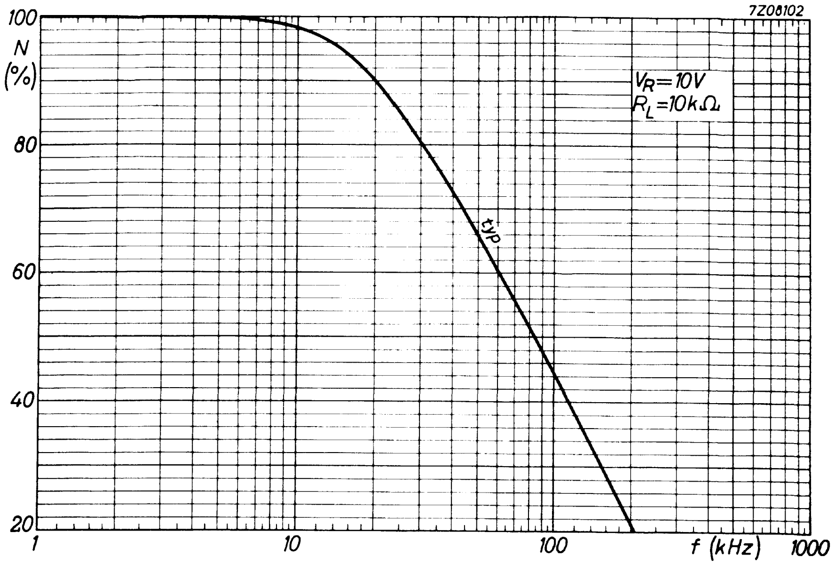

7Z08097
T_{amb} = 25°C
E = 0
I_R (μA)
8
6
4
2
0
typ
typ
0
0.2
0.4
V_R (V)
0.6
0
10
20
V_R (V)
30

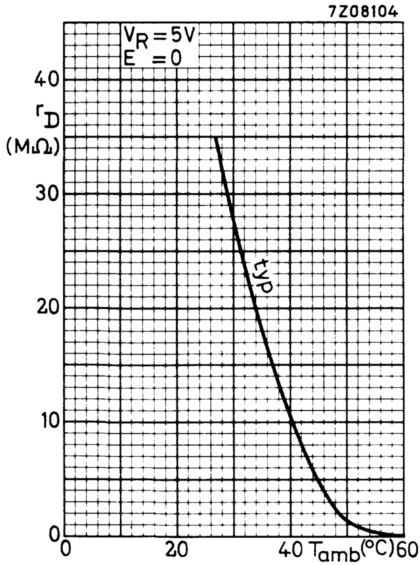

7Z08098
I_R (μA)
300
200
100
0
typical values
T_{amb} = 27 °C
E = 1600 lux
800 lux
400 lux
200 lux
100 lux
0
0
10
20
30
40
V_R (V)
50

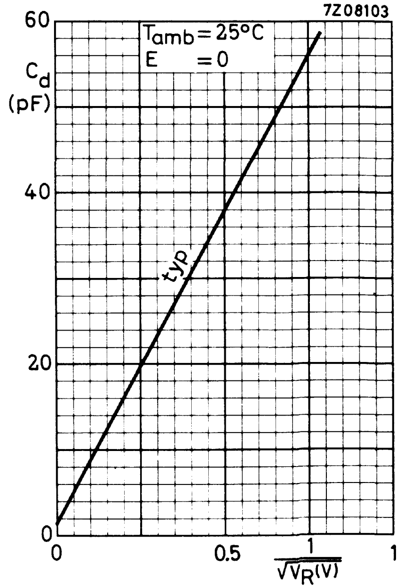

7Z08099
I_R (μA)
300
200
100
0
typical values
T_{amb} = 40 °C
E = 1600 lux
800 lux
400 lux
200 lux
100 lux
0
0
10
20
30
40
V_R (V)
50


7Z08100
I_R (μA)
300
200
100
0
typical values
T_{amb} = 50 °C
E = 1600 lux
800 lux
400 lux
200 lux
100 lux
0
0
10
20
30
40
V_R (V)
50


7Z08101
I_R (μA)
300
200
100
0
typical values
T_{amb} = 60 °C
E = 1600 lux
800 lux
400 lux
200 lux
100 lux
0
0
10
20
30
40
V_R (V)
50


7Z08102
100
N
(%)
80
60
40
20
V_R=10V
R_L=10kΩ
typ
1
10
100
f (kHz)
1000


7Z08104
V_R=5V
E =0
40
r_D
(MΩ)
30
20
10
0
typ
0
20
40 T_{amb}(°C) 60

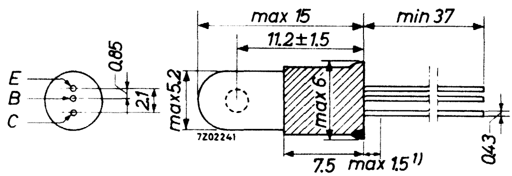

7Z08103
60
C_d
(pF)
40
20
0
T_{amb}=25°C
E =0
typ
0
0.5
$\frac{1}{\sqrt{V_R(V)}}$
1

GERMANIUM PHOTO-TRANSISTOR

P-N-P germanium photo-transistor intended for general purposes.

QUICK REFERENCE DATA				
Collector-base voltage (open emitter)	$-V_{CBO}$	max.	15	V
Collector-emitter voltage ($R_{BE} \leq 1$ kΩ)	$-V_{CER}$	max.	15	V
Collector current (d.c. or average)	$-I_C$	max.	20	mA
Total power dissipation up to $T_{amb} = 25$ °C	P_{tot}	max.	100	mW
Junction temperature	T_j	max.	65	°C
Light sensitivity (area 7 mm^2)	N	>	130	mA/lumen
Peak spectral response	λ_m	typ.	1.43	μm

MECHANICAL DATA Dimensions in mm



The coloured dot indicates the collector

The preferred direction of incident light is perpendicular to the plane of the leads, and is on the side of the bulb bearing the type number.

1) Not tinned.

RATINGS (Limiting values) [1])

Voltages

Collector-base voltage (open emitter)	$-V_{CBO}$	max.	15	V
Collector-base voltage (peak value)	$-V_{CBM}$	max.	15	V
Collector-emitter voltage ($R_{BE} \leq 1$ kΩ)	$-V_{CER}$	max.	15	V
Collector-emitter voltage (open base)	$-V_{CEO}$	max.	7.5	V
Collector-emitter voltage (peak value)	$-V_{CEM}$	max.	7.5	V

Currents

Collector current (d.c. or average)	$-I_C$	max.	20	mA
Collector current (peak value)	$-I_{CM}$	max.	20	mA

Power dissipation

Total power dissipation up to $T_{amb} = 25\,^{o}C$	P_{tot}	max.	100	mW

Temperatures

Storage temperature	T_{stg}	max.	65	^{o}C
Junction temperature	T_j	max.	65	^{o}C

THERMAL RESISTANCE

From junction to ambient in free air	$R_{th\ j-a}$	=	0.4	$^{o}C/mW$

CHARACTERISTICS

Collector-emitter dark cut-off current $I_B = 0$; $-V_{CE} = 4.5$ V	$-I_{CEO}$	<	325	μA
Cut-off frequency for modulated light	f_c	>	3	kHz
Collector current $-V_{CE} = 2$ V with uniform illumination of 75 ft. candle (807 lux) with preferred direction of incident light, colour temperature of the light source 2700 ^{o}K	$-I_C$	>	750	μA
Light sensitivity (area 7 mm^2)	N	>	130	mA/lumen
Peak spectral response	λ_m	typ.	1.43	μm
Zero spectral response	λ_0	typ.	1.9	μm

1) Limiting values according to the Absolute Maximum System as defined in IEC publication 134.

CHARACTERISTICS (continued)

Circuit diagram

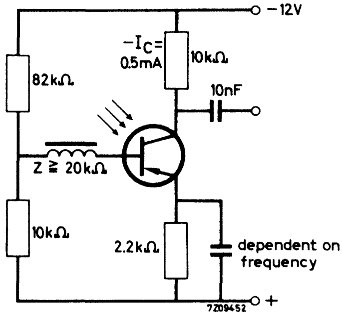
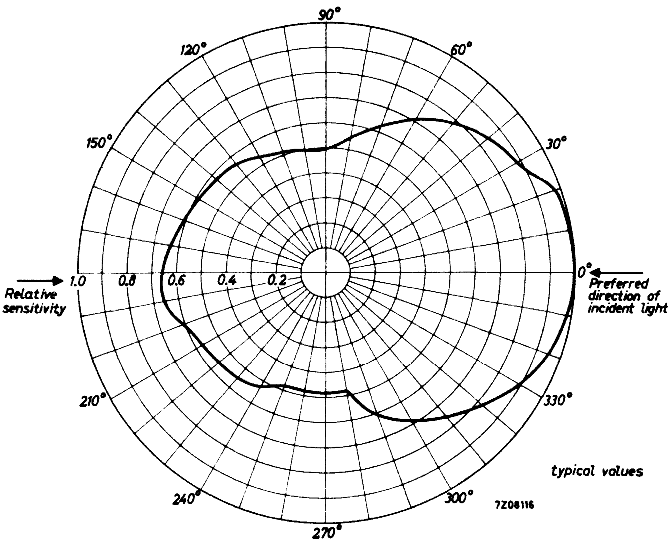
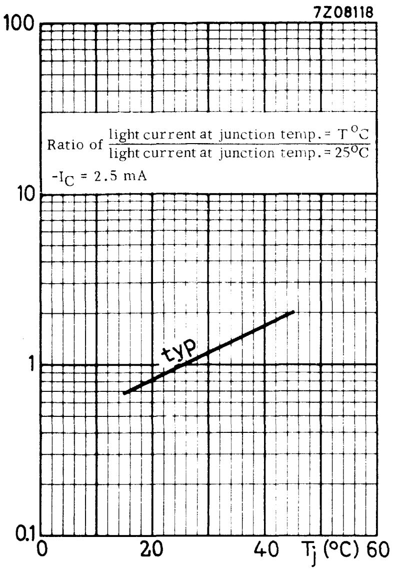
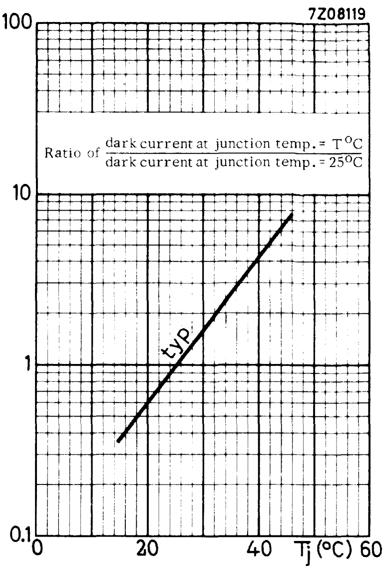
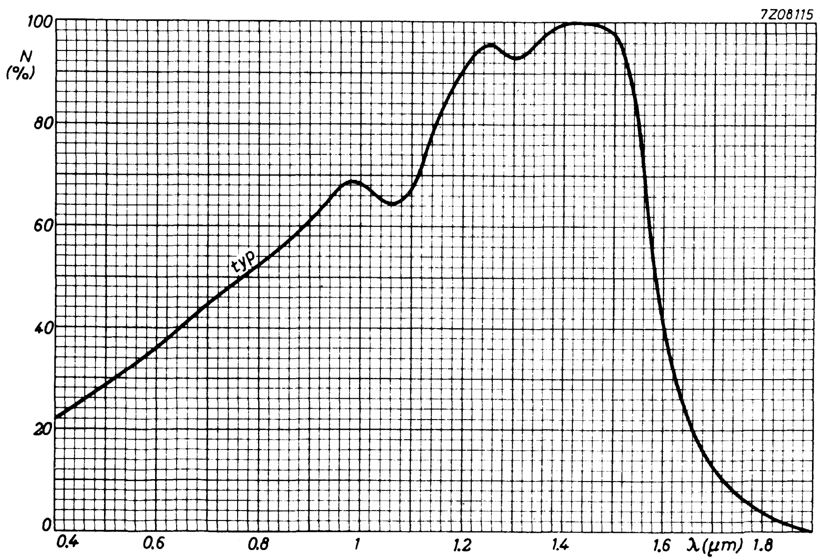


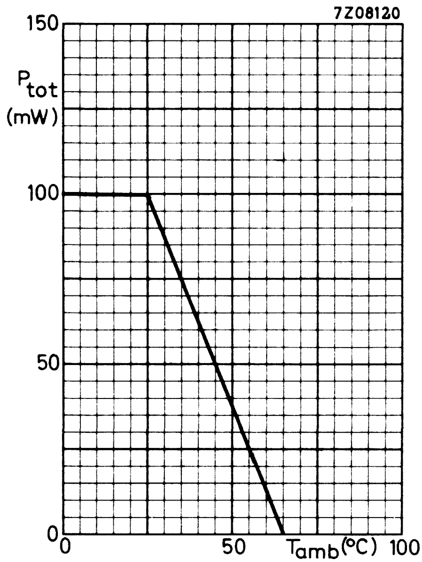
Photo-transistors are inherently sensitive to temperature variations, which result in variations of the output current which cannot be distinguished from the light signal. This is particularly so with an open circuit base connection, when thermal runaway is most likely to occur; for operation at elevated voltage and temperature the use of an external base emitter resistance is essential.
The function of this is to improve the light to dark current ratio by causing a much greater proportional decrease in dark current. It is recommended that for this purpose an NTC type resistor is used, the value required depending on the maximum ambient temperature and light level.

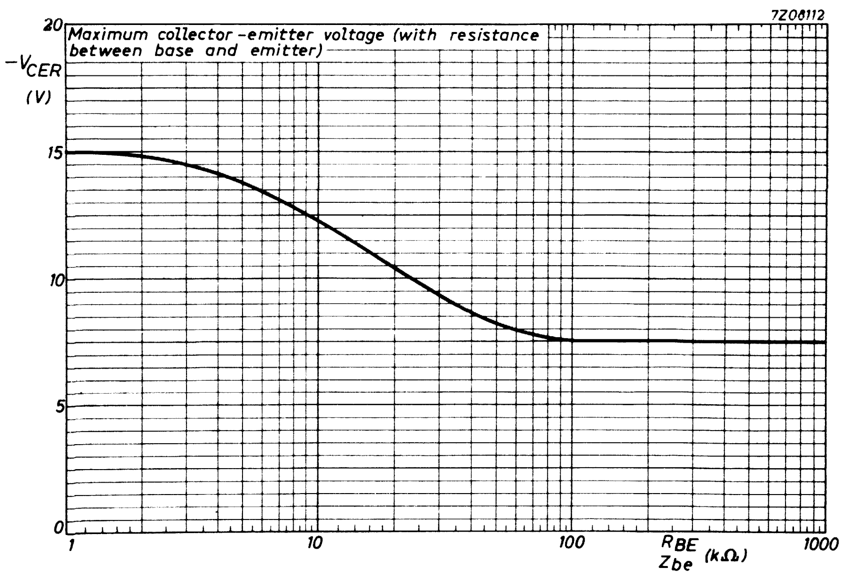


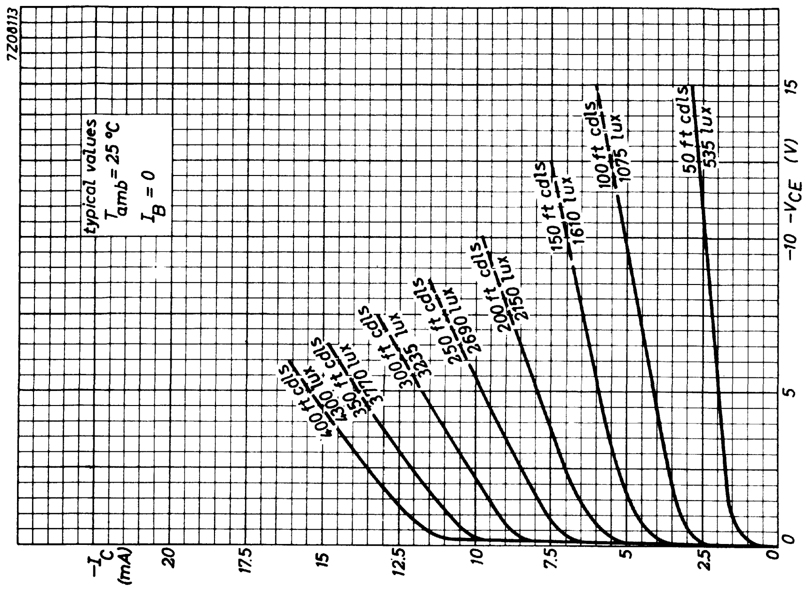

7Z08118
Ratio of light current at junction temp. = T °C / light current at junction temp. = 25°C
-I_C = 2.5 mA
typ
100
10
1
0.1
0
20
40
T_j (°C) 60

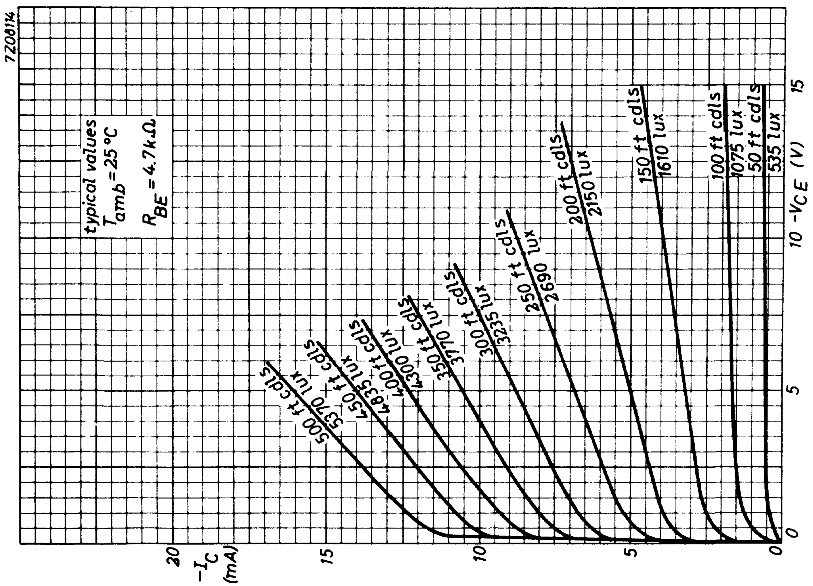

7Z08119
Ratio of dark current at junction temp. = T °C / dark current at junction temp. = 25°C
typ
100
10
1
0.1
0
20
40
T_j (°C) 60


7Z08115
N (%)
typ
100
80
60
40
20
0
0.4
0.6
0.8
1
1.2
1.4
1.6
λ(μm)
1.8


7Z08120
150
P_{tot}
(mW)
100
50
0
0
50
T_{amb} (°C)
100


7Z08112
Maximum collector-emitter voltage (with resistance between base and emitter)
20
$-V_{CER}$
(V)
15
10
5
0
1
10
100
1000
R_{BE}
Z_{be} (kΩ)


7Z08113
typical values
Tamb = 25 °C
IB = 0
400 ft cdls / 4300 lux
350 ft cdls / 3770 lux
300 ft cdls / 3235 lux
250 ft cdls / 2690 lux
200 ft cdls / 2150 lux
150 ft cdls / 1610 lux
100 ft cdls / 1075 lux
50 ft cdls / 535 lux
−IC (mA)
−VCE (V)


7Z08114
typical values
Tamb = 25 °C
RBE = 4.7 kΩ
500 ft cdls / 5370 lux
450 ft cdls / 4835 lux
400 ft cdls / 4300 lux
350 ft cdls / 3770 lux
300 ft cdls / 3235 lux
250 ft cdls / 2690 lux
200 ft cdls / 2150 lux
150 ft cdls / 1610 lux
100 ft cdls / 1075 lux
50 ft cdls / 535 lux
−IC (mA)
−VCE (V)

PHOTOCONDUCTIVE CELL

Indium antimonide photoconductive element mounted on a copper heatsink, recommended for operation at a temperature of 20 °C.
Sensitive to infra-red radiation extending to 7.5 μm and intended for use with mod-modulated or pulsed radiation.

RATINGS (Limiting values) [1])

Bias current at T_{amb} = 20 °C	I	max.	100	mA
Temperatures				
Operating ambient temperature	T_{amb}	max.	70	°C
Storage temperature	T_{stg}		- 50 to + 70	°C

CHARACTERISTICS T_{amb} = 20 °C unless otherwise specified

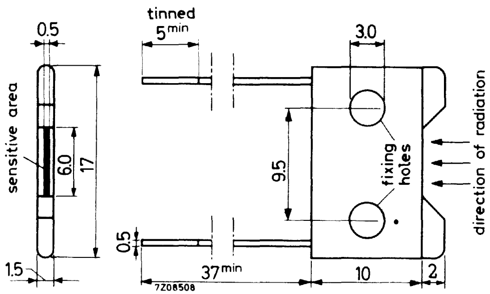
Peak spectral response	λ		6.0 to 6.3	μm
Spectral response range	from visible to		7.5	μm
Cell resistance	r_1		30 to 120	Ω
Time constant			0.1	μs
Sensitive area			6.0 x 0.5	mm^2
Sensitivity (6.0 μm radiation)		>	0.4	μV/μW
		typ.	1.0	μV/μW
(500 °K radiation)		typ.	0.3	μV/μW
D^* (6.0 μm, 800 Hz, 1 Hz)	see notes 1 and 2	>	8.5×10^7	$cm\sqrt{Hz}/W$
		typ.	2.0×10^8	$cm\sqrt{Hz}/W$
(500 °K, 800 Hz, 1 Hz)	see notes 1 and 2	typ.	6.0×10^7	$cm\sqrt{Hz}/W$
Noise equivalent power (N.E.P.)				
(6.0 μm, 800 Hz, 1 Hz)	see notes 1 and 2	typ.	8.6×10^{-10}	W
		<	2.0×10^{-9}	W
(500 °K, 800 Hz, 1 Hz)	see notes 1 and 2	typ.	2.5×10^{-9}	W

MECHANICAL DATA (see page 2)

[1]) Limiting values according to the Absolute Maximum System as defined in IEC publication 134.

MECHANICAL DATA

Dimensions in mm



NOTES

1. Measuring conditions.

The detector is attached to a heatsink which is maintained at a temperature of 20 °C and a bias current of 50 mA is applied. A parallel beam of monochromatic radiation of wavelength 4.4 μm, which would produce a steady irradiance of 68 $\mu W/cm^2$ at the sensitive element, is chopped at 800 Hz, giving an actual r.m.s. power at the element which amounts to

$$\frac{68}{2.2} = 31\ \mu W/cm^2$$

Measurements of the detector output are made with an amplifier tuned to 800 Hz and with a bandwidth of 50 Hz, and are referred to open circuit conditions i.e. correction is made for the shunting effects of the bias supply impedance and the amplifier input impedance. Under these test conditions, the ORP10 will exhibit a minimum signal-to-noise ratio of 45 and typical of 105. The sensitivities quoted at the wavelength of peak response and under black body conditions are calculated from these measurements, assuming the detector to have a typical response curve.

2. D* and N.E.P.

These are figures of merit for the materials of detectors.
D* is defined in the expression:

$$D^* = \frac{\frac{V_s}{V_n} \times \sqrt{A\,(\Delta f)}}{W}$$

where: V_s = signal voltage across detector terminals
V_n = noise voltage across detector terminals
A = detector area
(Δf) = bandwidth of measuring amplifier
W = radiation power incident on detector sensitive element in watts.

NOTES (continued)

The figures in brackets which follow D* refer to the measuring conditions e.g. D* (5.3 μm, 800 Hz, 1 Hz) denotes monochromatic radiation incident on the detector of wavelength 5.3 μm, chopping frequency 800 Hz, bandwidth 1 Hz.

The Noise Equivalent Power (N.E.P.) is related to D* by the expression:

$$\text{N.E.P.} = \frac{\sqrt{A}}{D^*}.$$

3. Variation of performance with bias current.

Both signal and noise vary with bias current. Typical curves are shown on page 5. At high currents the noise increases more rapidly than the signal, and therefore the signal-to-noise ratio has a peak value at some optimum current, which will vary slightly from cell to cell. A typical value is 50 mA. In addition the ohmic heating caused by bias currents above 60 mA causes the temperature of the element to become significantly greater than the substrate so that the signal decreases as described in note 4.

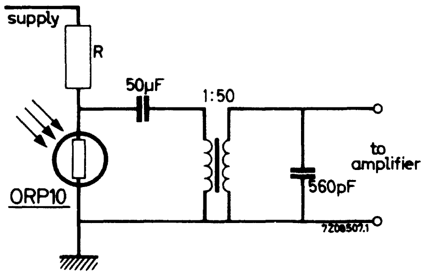
4. Variation of performance with element temperature.

As with all semiconductor photocells, the performance depends on the temperature of the sensitive element. In the case of the ORP10 this is influenced by the ambient temperature and ohmic heating caused by the d.c. bias current. To minimise fluctuations, the element is mounted on a copper base from which it is insulated by a layer of aluminium oxide, and can readily be attached to a large heatsink.
A typical variation of performance with temperature is given on page 5. The curve on page 5 shows the decrease in signal caused by the high current raising the temperature of the element.
On cooling, indium antimonide exhibits improved sensitivity and increased resistance. Below 15 $^{\circ}$C this is impractical with the ORP10 unless special precautions are taken to prevent condensation and icing on the exposed element.

5. Warning.

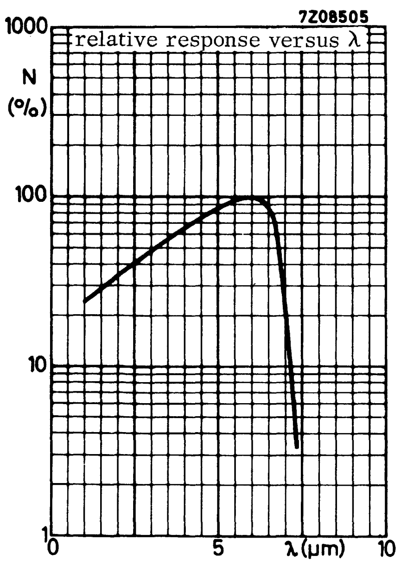
The sensitive surface is unprotected and should not be touched. It is stable in normal atmospheres but should not be exposed to high concentrations of the vapours of organic solvents. Care should be taken to avoid strain when attaching cells to heatsinks.

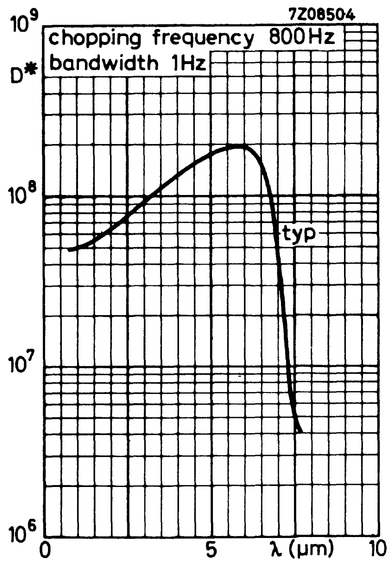
Recommended circuit for use with radiation chopped at 800 Hz.

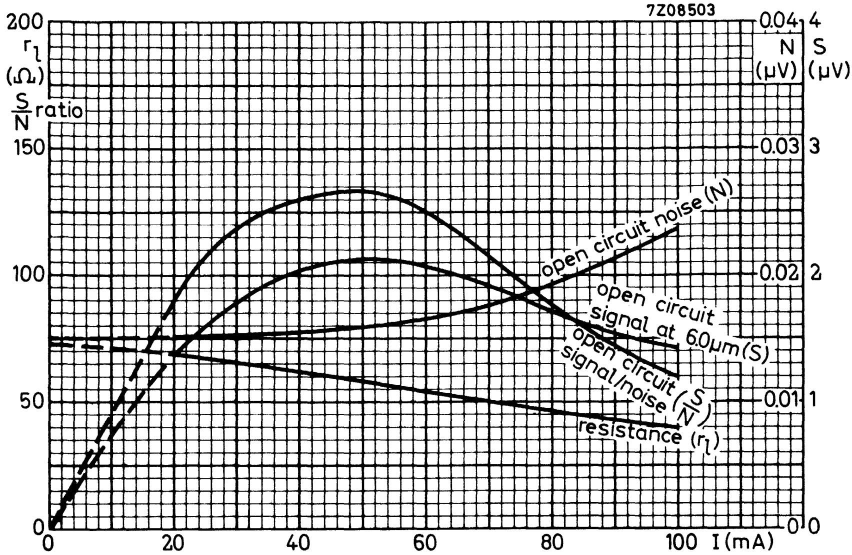


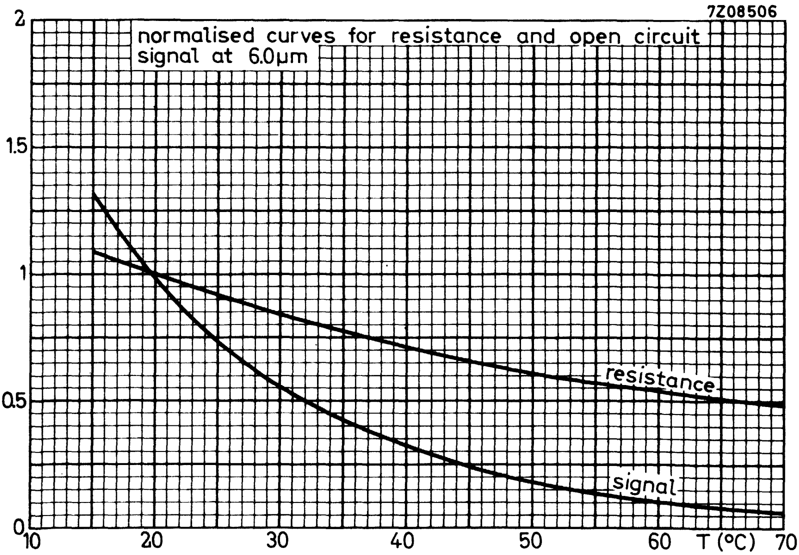
CIRCUIT NOTES

The transformer should be adequately screened to prevent stray pick-up.
The resistor R should be wire wound to minimise noise. It must be substantially larger than the cell resistance and its actual value will depend upon the supply voltage and the cell currents required. The 560 pF capacitor tunes the secondary to 800 Hz.






7Z08503
200
r_l
(Ω)
$\frac{S}{N}$ ratio
150
100
50
0
0
20
40
60
80
100 I (mA)
0.04
N
(μV)
0.03
0.02
0.01
0
4
S
(μV)
3
2
1
0
open circuit noise (N)
open circuit signal at 6.0μm (S)
open circuit signal/noise ($\frac{S}{N}$)
resistance (r_l)


7Z08506
normalised curves for resistance and open circuit signal at 6.0μm
2
1.5
1
0.5
0
10
20
30
40
50
60
T (°C)
70
resistance
signal

PHOTOCONDUCTIVE CELL

Indium antimonide photoconductive element mounted in a glass dewar vessel and cooled by liquid nitrogen. Sensitive to infra-red radiation extending to 5.6 μm and intended for use with modulated or pulsed radiation.

RATINGS (Limiting values) [1)]

Bias current at T_{amb} = 77 °K		5.0	mA
Temperatures			
Operating temperature	T	77	°K
Storage temperature	T_{stg}	- 55 to + 55	°C

CHARACTERISTICS T = 77 °K

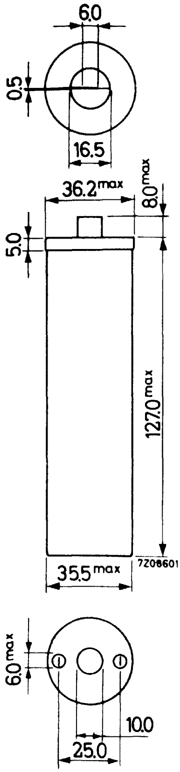
Peak spectral response	λ	5.3	μm
Spectral response range	from visible to	5.6	μm
Cell resistance	r_1	20 to 60	kΩ
Time constant		5	μs
Sensitive area		6.0 x 0.5	mm^2
Dwell time of liquid nitrogen	>	40	min.
Sensitivity (5.3 μm radiation)	>	12	mV/μW
	typ.	24	mV/μW
(500 °K radiation)	typ.	4.5	mV/μW
D* (5.3 μm, 800 Hz, 1 Hz) see notes 1 and 2	>	2.6×10^{10}	$cm\sqrt{Hz}/W$
	typ.	4.5×10^{10}	$cm\sqrt{Hz}/W$
(500 °K, 800 Hz, 1 Hz) see notes 1 and 2	typ.	8.0×10^{9}	$cm\sqrt{Hz}/W$
Noise equivalent power (N.E.P.)			
(5.3 μm, 800 Hz, 1 Hz) see notes 1 and 2	typ.	3.8×10^{-12}	W
	<	6.6×10^{-12}	W
(500 °K, 800 Hz, 1 Hz) see notes 1 and 2	typ.	2.2×10^{-11}	W

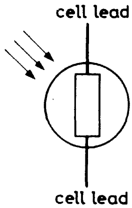
MECHANICAL DATA (see page 2)

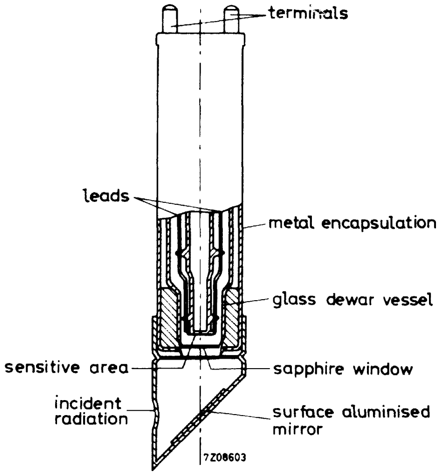
1) Limiting values according to the Absolute Maximum System as defined in IEC publication 134.

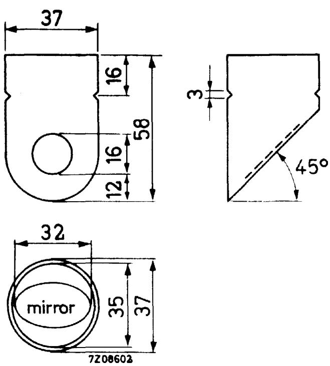
MECHANICAL DATA

Dimensions in mm









NOTES

1. Measuring conditions.

The detector is cooled to 77 °K by filling the dewar with liquid nitrogen and a bias current of 250 μA is applied. A parallel beam of monochromatic radiation of wavelength 4.4 μm, which would produce a steady irradiance of 7.6 μW/cm² at the sensitive element, is chopped at 800 Hz, giving an actual r.m.s. power at the element which amounts to

$$\frac{7.6}{2.2} = 3.45\ \mu W/cm^2$$

Measurements of the detector output are made with an amplifier tuned to 800 Hz and with a bandwidth of 50 Hz, and are referred to open circuit conditions i.e. correction is made for the shunting effects of the bias supply impedance and the amplifier input impedance. Under these test conditions, the ORP13 will exhibit a minimum signal-to-noise ratio of 1650 and typical of 3270. The sensitivities quoted at the wavelength of peak response and under black body conditions are calculated from these measurements, assuming the detector to have a typical response curve.

2. D* and N.E.P.

These are figures of merit for the materials of detectors.
D* is defined in the expression:

$$D^* = \frac{\frac{V_S}{V_n}\sqrt{A\,(\Delta f)}}{W}$$

where: V_S = signal voltage across detector terminals
V_n = noise voltage across detector terminals
A = detector area
(Δf) = bandwidth of measuring amplifier
W = radiation power incident on detector sensitive element in r.m.s. watts.

The figures in brackets which follow D* refer to the measuring conditions e.g. D* (5.3 μm, 800 Hz, 1 Hz) denotes monochromatic radiation incident on the detector of wavelength 5.3 μm, chopping frequency 800 Hz, bandwidth 1 Hz.

The Noise Equivalent Power (N.E.P.) is related to D* by the expression:

$$N.E.P. = \frac{\sqrt{A}}{D^*}$$

3. Variation of performance with bias current.

Both signal and noise vary with current in this type of cell. Typical curves are shown on page 5. At high currents the noise increases more rapidly than the signal, and therefore the signal-to-noise ratio has a peak value at some optimum current, which will vary slightly from cell to cell. A typical value is 250 μA.

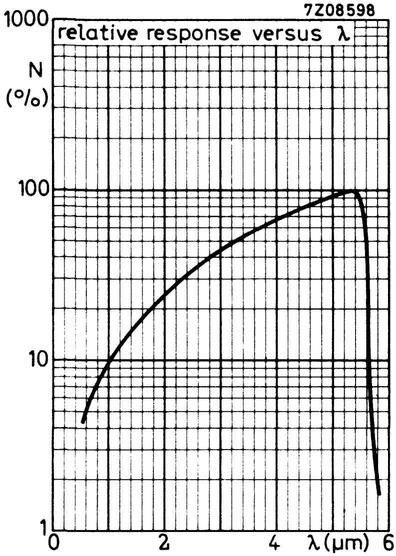
NOTES (continued)

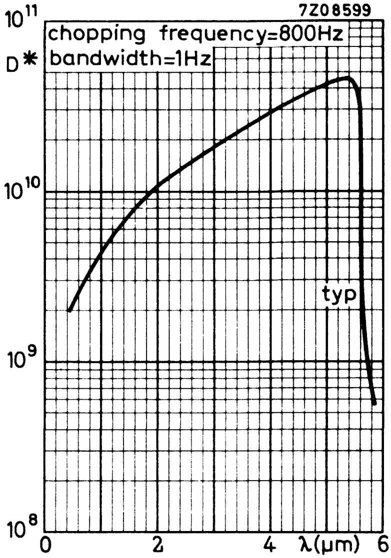
4. Effect of ambient radiation.

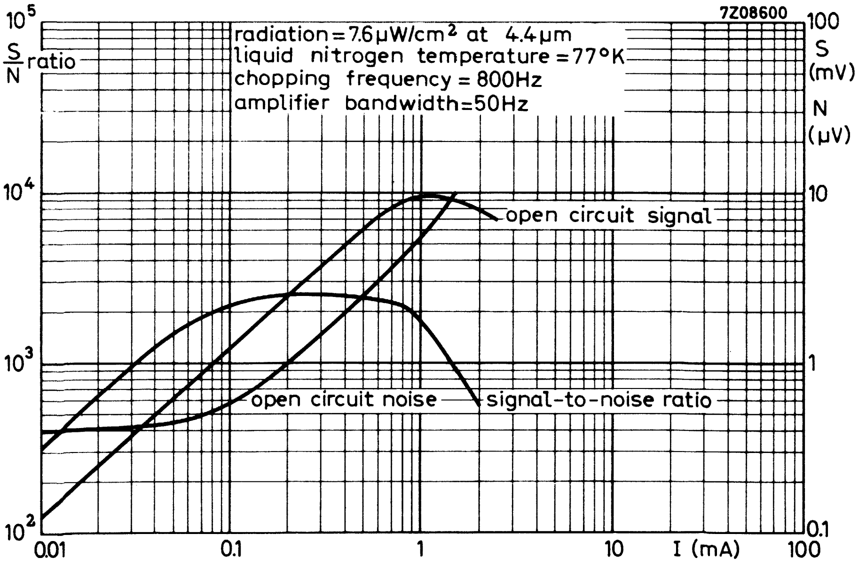
Care should be taken to avoid the incidence on the cell of appreciable radiation in the visible range. Such radiation will cause a decrease in the cell resistance and signal as long as the cell is kept cool. Normal daylight can cause this effect if seen for more than a few minutes. Precautions should be taken to prevent visible light reaching the sensitive element via the liquid nitrogen compartment.

5. Warning.

Care should be taken to ensure that the device is not allowed to reach room temperature while still biased.
The dewar vessel must always be completely dry before being refilled with liquid nitrogen. In very humid conditions, water vapour may condense at the top of the dewar vessel. Should this occur, the remaining liquid nitrogen should be allowed to boil off, the ice should be removed and precautions taken to avoid a recurrence.


7Z08598
relative response versus λ
N
(%)
1000
100
10
1
0
2
4
λ(μm)
6


7Z08599
chopping frequency=800Hz
bandwidth=1Hz
D*
10^11
10^10
10^9
10^8
typ
0
2
4
λ(μm)
6


7Z08600
radiation=7.6μW/cm² at 4.4μm
liquid nitrogen temperature=77°K
chopping frequency=800Hz
amplifier bandwidth=50Hz
S/N ratio
10^5
10^4
10^3
10^2
S (mV)
N (μV)
100
10
1
0.1
open circuit signal
open circuit noise
signal-to-noise ratio
0.01
0.1
1
10
I (mA)
100

PHOTOCONDUCTIVE CELL

Uncooled lead sulphide photoconductive cell intended for use with chopped or pulsating radiation, having a high infra-red sensitivity at normal room temperatures.

RATINGS (Limiting values) [1])

Applied voltage	V	max.	250	V
Bias current	I	max.	0.5	mA
Temperatures				
Ambient temperature (see note 3 at page 3)	T_{amb}	max.	60	°C
Storage temperature	T_{stg}	max.	60	°C

CHARACTERISTICS

Peak spectral response	λ	2.5	μm
Spectral response range	$\Delta\lambda$	0.3 to 3.5	μm
Sensitivity (See note 1 at page 2)			
Sources: black body at 200 °C (r.m.s. voltage over peak power)		180	μV/μW
tungsten lamp [2]) (peak current per lumen)		3	mA/lumen
Signal-to-noise ratio with black body at 200 °C	$\frac{S}{N}$	150	
Noise equivalent power (N.E.P.)			
Sources: black body at 200 °C (bandwidth 1 Hz)[3])		5.0×10^{-9}	W
tungsten lamp (2 ± 0.05 μm)		5.5×10^{-11}	W
Cell resistance (typical production spread) (See note 3 at page 3)		1 to 4	MΩ

---

[1]) Limiting values according to the Absolute Maximum System as defined in IEC publication 134.

[2]) Chopped light, 0.05 lumen from a lamp at colour temperature 2700 °K falling on the cell area and with 200 V applied to the cell.

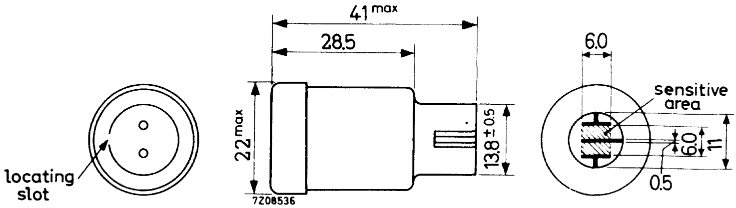
[3]) 4.9 μW of radiation falling on the cell area with 200 V applied to the cell and with a 1.0 MΩ load resistor. The chopping frequency of the radiation is 800 Hz and the measuring amplifier has a bandwidth of 50 Hz.

CHARACTERISTICS (continued)

Time constant (see note 2 at page 3)	75 μs
Variation of dark current with ambient temperature	-2 %/°C
Sensitive area (outer electrodes being 6.0 mm long and 6.0 mm apart)	36 mm^2

MECHANICAL DATA

Dimensions in mm



NOTES

1. Sensitivity

The 61SV differs from vacuum photoemissive cells in that the signal for a given irradiation energy is linearly proportional to the applied voltage.
At low or normal radiation levels the cell current changes linearly with illumination. At very high levels of illumination the current varies as the square root of the illumination.
The sensitivity of photoemissive cells is normally defined in units of μA/lumen, the energising light source being a tungsten lamp operated at 2700 °K. The 61SV has a high infra-red sensitivity, and its performance is usually defined in terms of volts across the cell load divided by radiation source in watts, when subjected to chopped radiation from a black body at some specified temperature.
As a limiting measure of cell sensitivity the signal-to-noise ratio for a given amount of chopped radiation from a black body is usually given, or what is the same thing, the noise equivalent power, i.e., the radiation falling on the cell which will produce a signal equal to the cell noise with a test amplifier bandwidth of 1 Hz.
For any applied cell voltage there is a definite noise output, and the radiation source energy required to produce a signal output just equal to this noise output is referred to as the noise equivalent power.
The sensitivity increases rapidly with the radiation source temperature. This is illustrated by the fact that if the source temperature changes from 200 to 500 °C the sensitivity increases by over 100 times.

NOTES (continued)

2. Frequency response

As contrasted with the virtually inertialess vacuum photoemissive cells, the 61SV has a time constant in the region of 75 μs. This represents the time for the signal to drop to e^{-1} of its value after the radiation on the cell has been cut-off. Because of this the sensitivity varies with the frequency of interruption of the radiation in accordance with the following relationship.

$$S = \frac{S_o}{\sqrt{1 + 4\pi^2 f^2 \tau^2}}$$

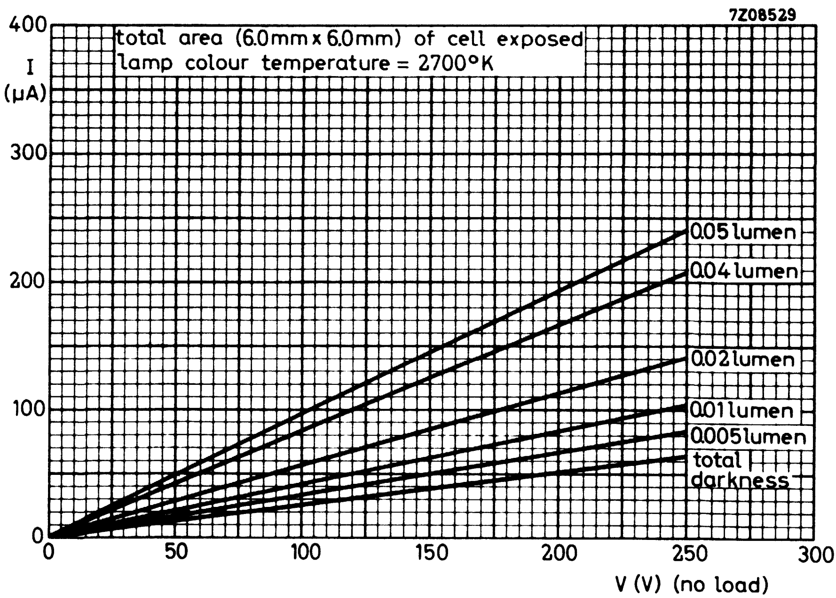
where S and S_o are the sensitivities at frequencies f and zero respectively and τ is the time constant.

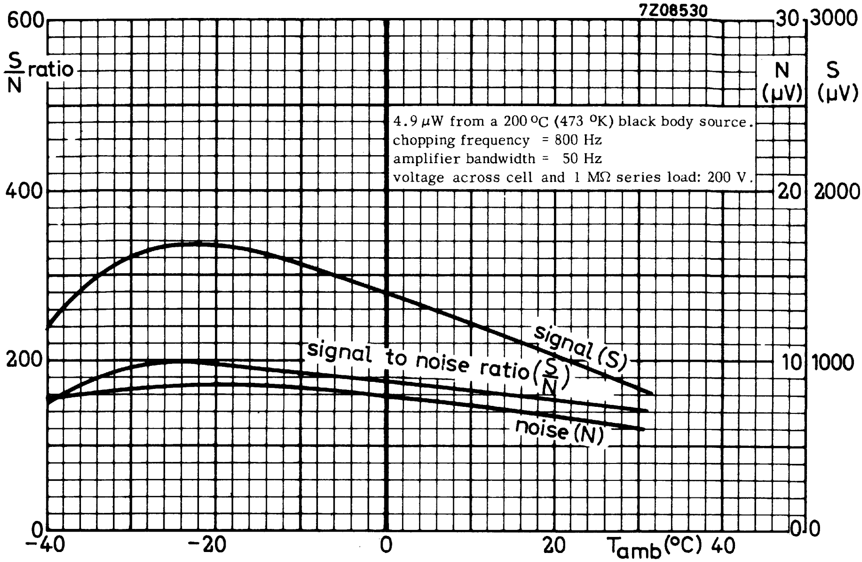
3. Ambient temperature

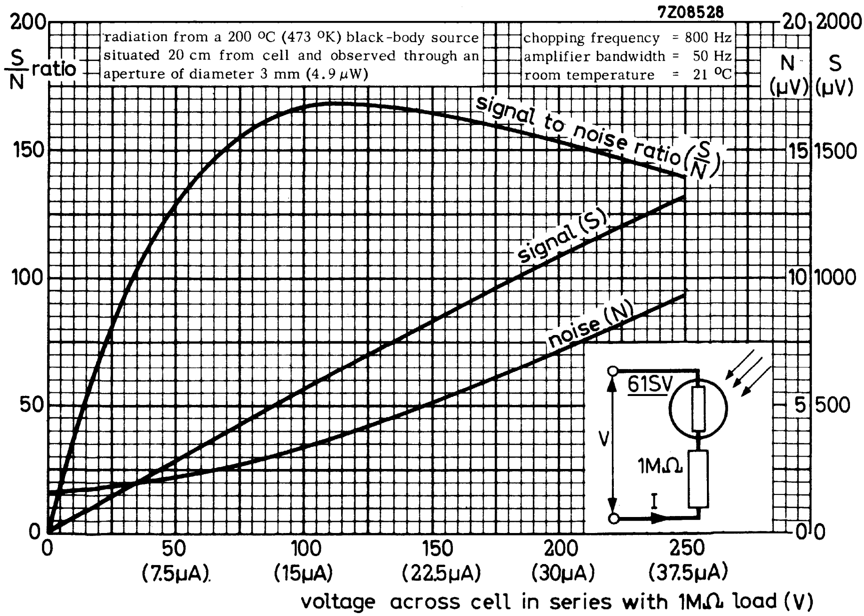
The sensitivity is susceptible to changes in ambient temperature. The change in signal sensitivity with ambient temperature for a black body source having a temperature of 200 °C can be expressed in the following manner over the temperature range −10 °C to +50 °C.

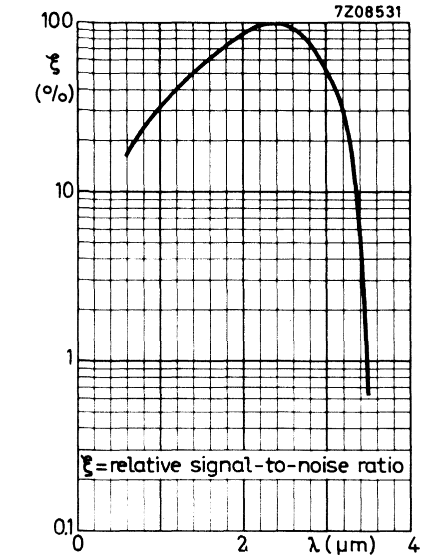
$$\frac{S_T}{S_{20}} = 1.4 - \frac{T}{50} \quad \text{or} \quad \Delta\frac{S_T}{S_{20}} = -\frac{\Delta T}{50}$$

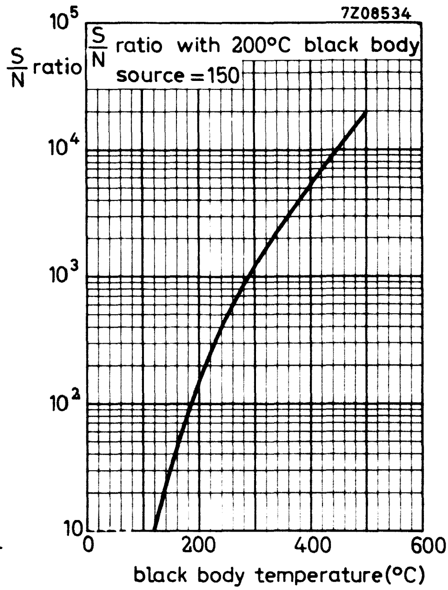
where S_T and S_{20} are the sensitivities at T °C and 20 °C respectively. The sensitivity changes 2% for each °C change of its value at 20 °C.

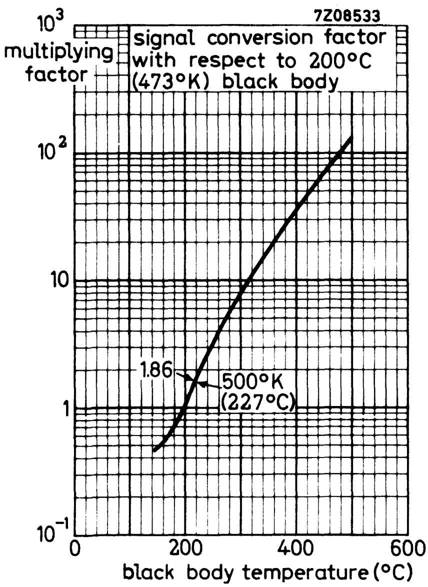


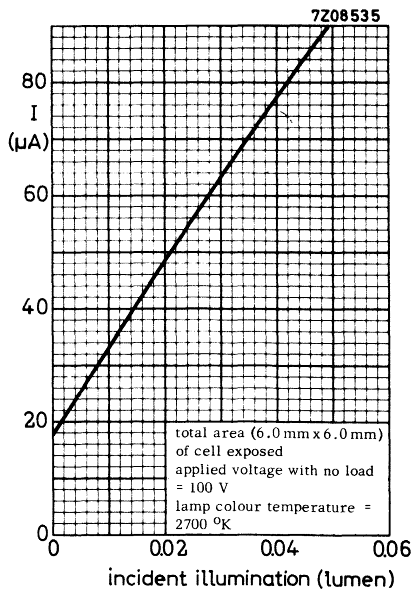

7Z08530
600
400
200
0
S/N ratio
30
20
10
0
3000
2000
1000
0
N (μV)
S (μV)
4.9 μW from a 200 °C (473 °K) black body source.
chopping frequency = 800 Hz
amplifier bandwidth = 50 Hz
voltage across cell and 1 MΩ series load: 200 V.
signal (S)
signal to noise ratio (S/N)
noise (N)
−40
−20
0
20
40
T_{amb} (°C)

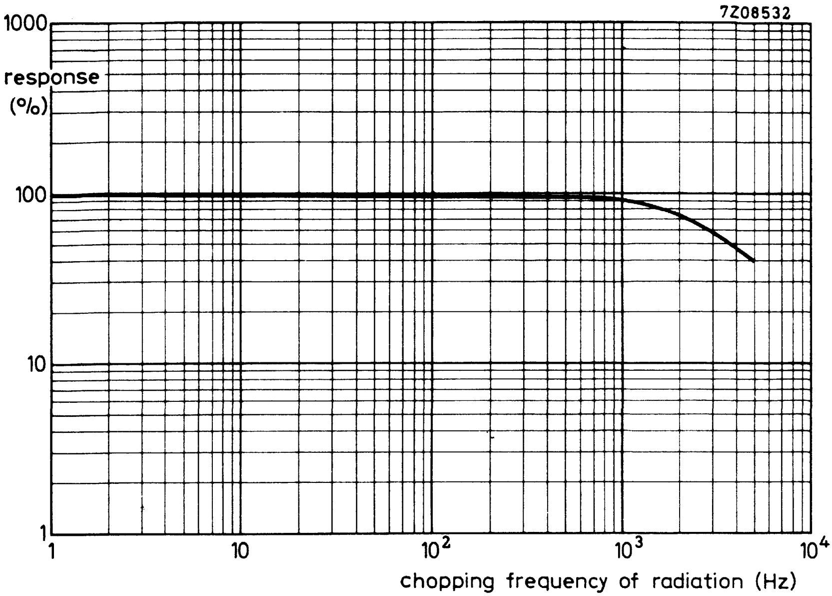

7Z08528
200
150
100
50
0
S/N ratio
20
15
10
5
0
2000
1500
1000
500
0
N (μV)
S (μV)
radiation from a 200 °C (473 °K) black-body source situated 20 cm from cell and observed through an aperture of diameter 3 mm (4.9 μW)
chopping frequency = 800 Hz
amplifier bandwidth = 50 Hz
room temperature = 21 °C
signal to noise ratio (S/N)
signal (S)
noise (N)
61SV
V
1MΩ
I
0
50 (7.5μA)
100 (15μA)
150 (22.5μA)
200 (30μA)
250 (37.5μA)
voltage across cell in series with 1MΩ load (V)


7Z08531
100
ξ
(%)
10
1
0.1
0
2
λ (μm)
4
ξ = relative signal-to-noise ratio


7Z08534
10^5
S/N ratio
S/N ratio with 200°C black body source = 150
10^4
10^3
10^2
10
0
200
400
600
black body temperature (°C)


7Z08533
10^3
multiplying factor
signal conversion factor with respect to 200°C (473°K) black body
10^2
10
1
10^{-1}
1.86
500°K (227°C)
0
200
400
600
black body temperature (°C)


7Z08535
80
I
(μA)
60
40
20
0
total area (6.0 mm x 6.0 mm) of cell exposed
applied voltage with no load = 100 V
lamp colour temperature = 2700 °K
0
0.02
0.04
0.06
incident illumination (lumen)


7Z08532
1000
response
(%)
100
10
1
1
10
10^2
10^3
10^4
chopping frequency of radiation (Hz)

Accessories and heatsinks

TABLE OF CONTENTS

INDEX OF TYPE NUMBERS

Introduction

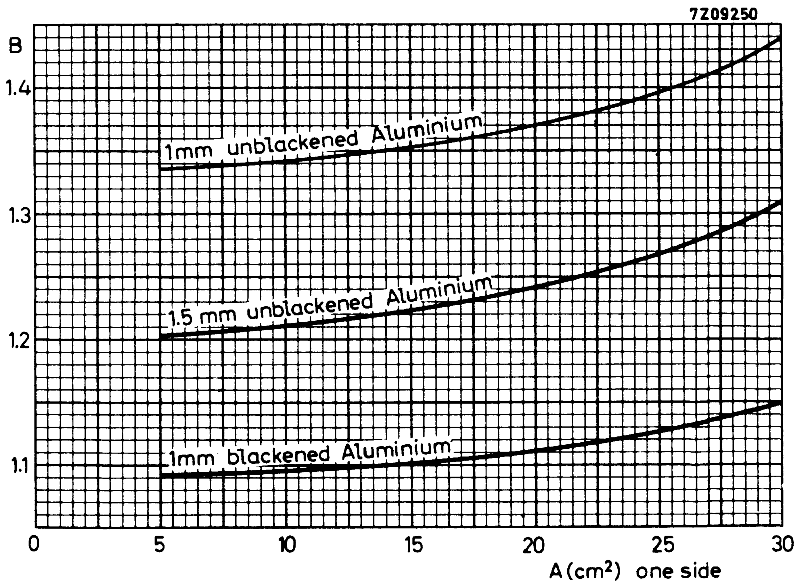
All information on thermal resistances of the accessories combined with flat heatsinks is valid for square heatsinks of blackened aluminium.
For a few variations the thermal resistance may be derived as follows:

a. Rectangular heatsinks (sides a and 2a)

When mounted with long side horizontal, multiply by 0.95.
When mounted with short side horizontal, multiply by 1.10.

b. Unblackened or thicker heatsinks

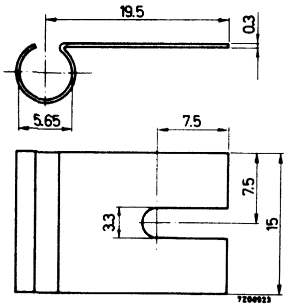
Multiply by the factor B given below as a function of the heatsink size A.



COOLING FIN

MECHANICAL DATA

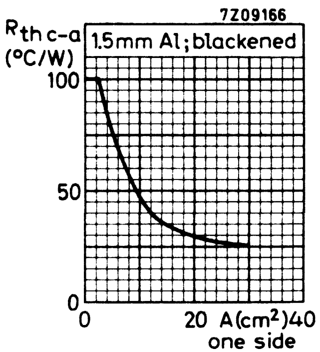
Dimensions in mm



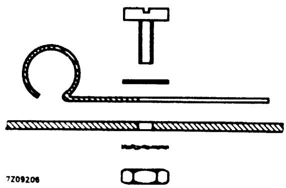
Fin material: brass, nickel plated

THERMAL RESISTANCE

From case to ambient with cooling fin only	$R_{th\ c\text{-}a}$ =	100 °C/W
with heatsink		see graph



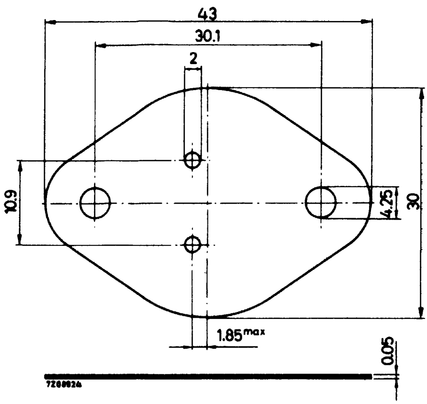
MOUNTING INSTRUCTIONS

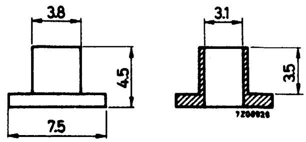


Torque on nut for good heat transfer: 5 cm kg

56201a MICA WASHER AND 2 INSULATING BUSHES

MECHANICAL DATA Dimensions in mm



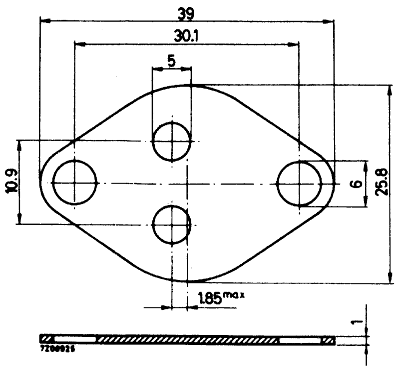


THERMAL RESISTANCE

From mounting base to heatsink $R_{th\ mb\text{-}h}$ = 1.0 °C/W

56201b LEAD WASHER

MECHANICAL DATA Dimensions in mm



MOUNTING ACCESSORIES

56201e consists of 56201a and 56201b

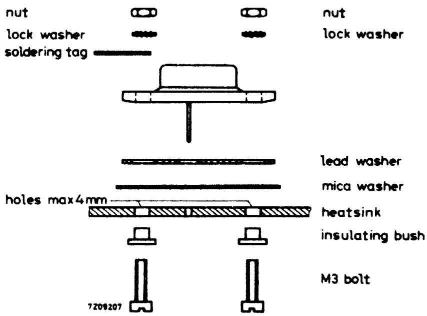
THERMAL RESISTANCE

From mounting base to heatsink
with mica washer and lead washer $R_{th\ mb\text{-}h}$ = 0.75 $^oC/W$

TEMPERATURE

Maximum allowable temperature T_{max} = 150 ^oC

MOUNTING INSTRUCTIONS

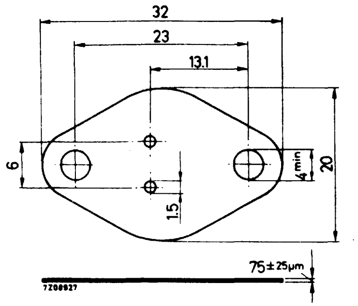


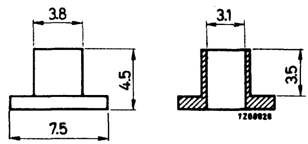
Torque on nut for good heat transfer: 5 cmkg

MICA WASHER AND 2 INSULATING BUSHES

MECHANICAL DATA

Dimensions in mm





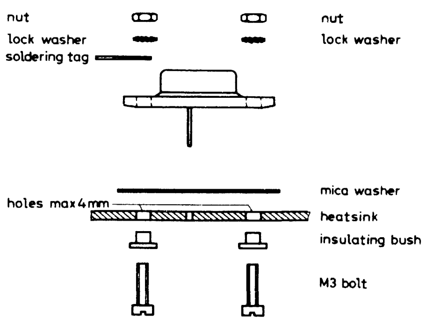
THERMAL RESISTANCE

From mounting base to heatsink $R_{th\ mb\text{-}h}$ = 1.5 °C/W

TEMPERATURE

Maximum allowable temperature T_{max} = 150 °C

MOUNTING INSTRUCTIONS

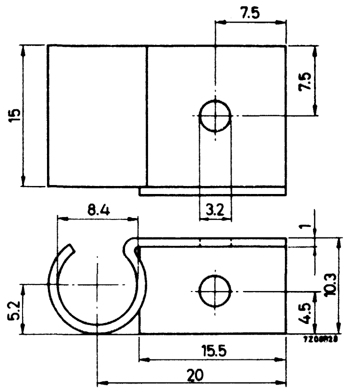


Torque on nut for good heat transfer: 5 cm kg

COOLING FIN

MECHANICAL DATA

Dimensions in mm

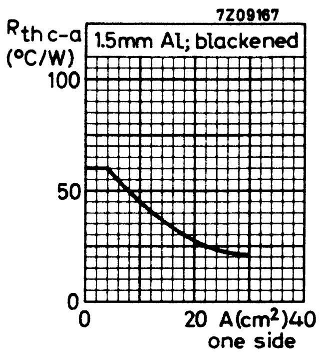


Fin material: aluminium, blackened

THERMAL RESISTANCE

From case to ambient with cooling fin only — $R_{th\ c\text{-}a}$ = 60 °C/W

with heatsink — see graph



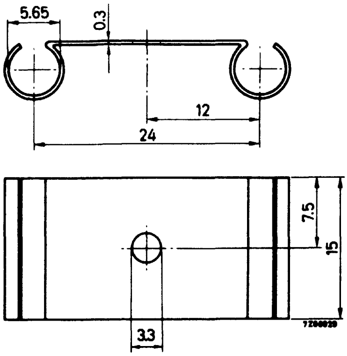
MOUNTING INSTRUCTIONS

Torque on M3 bolts for good heat transfer: 5 cm kg

COOLING FIN

MECHANICAL DATA

Dimensions in mm

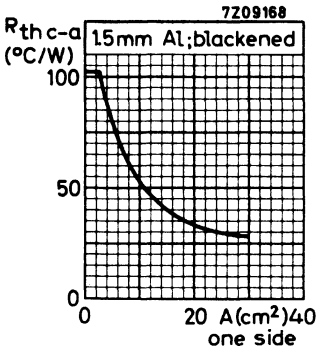


Fin material: brass, nickel plated

THERMAL RESISTANCE

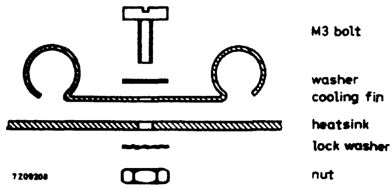
From case to ambient with cooling fin only $R_{th\ c\text{-}a}$ = 102 °C/W

with heatsink see graph



R_{th} values apply to each transistor, provided the two transistors have been mounted so that the heat flow from each is equal.

MOUNTING INSTRUCTIONS

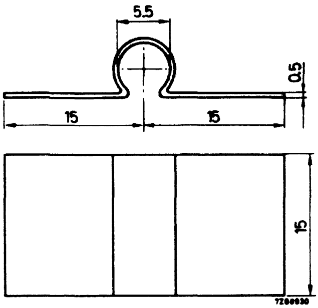


Torque on nut for good heat transfer: 5 cm kg

COOLING FIN

MECHANICAL DATA

Dimensions in mm



Fin material: brass, nickel plated

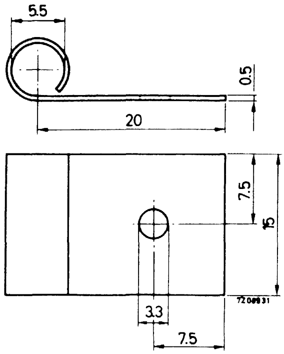
THERMAL RESISTANCE

From case to ambient with cooling fin only $R_{th\ c-a}$ = 75 °C/W

COOLING FIN

MECHANICAL DATA

Dimensions in mm

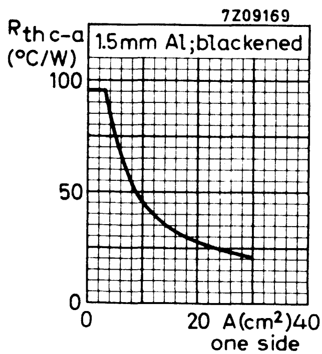


Fin material: brass, nickel plated

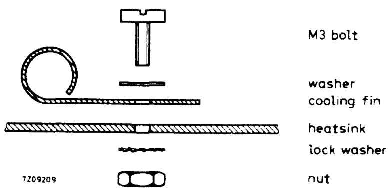
THERMAL RESISTANCE

From case to ambient with cooling fin only $R_{th\ c-a}$ = 95 °C/W

with heatsink see graph



MOUNTING INSTRUCTIONS

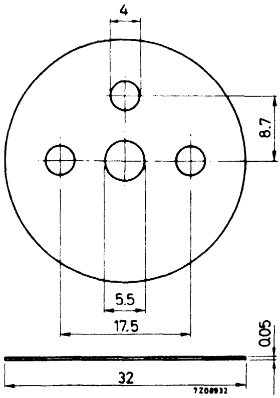


Torque on nut for good heat transfer: 5 cmkg

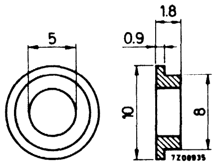
MOUNTING ACCESSORIES

MECHANICAL DATA

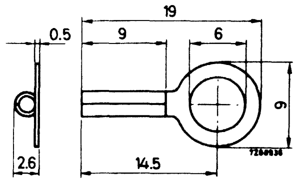
Dimensions in mm



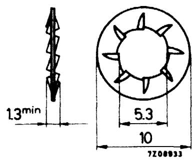
mica washer



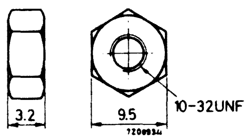
insulating ring



cable lug
material: brass, nickel plated



lock washer internal teeth
material: steel, nickel plated



hexagon nut
material: brass, nickel plated

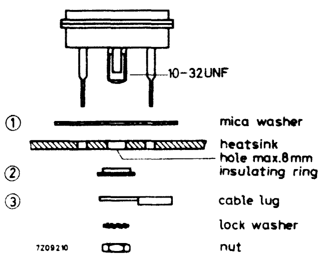
THERMAL RESISTANCE

From mounting base to heatsink — $R_{th\ mb\text{-}h}$ = 1 °C/W

TEMPERATURE

Maximum allowable temperature — T_{max} = 125 °C

MOUNTING INSTRUCTIONS



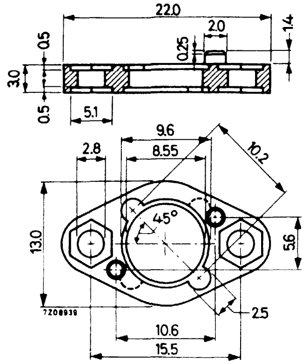
Torque on nut for good heat transfer: 20 cm

Non insulated mounting; without items 1, 2 and 3. (3 if necessary)

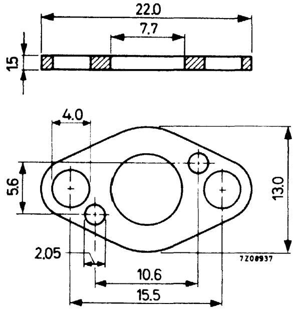
MOUNTING ACCESSORIES

MECHANICAL DATA

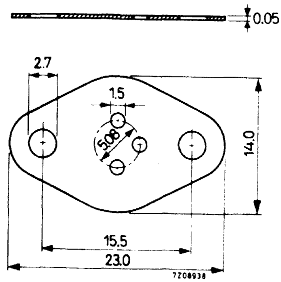
Dimensions in mm



top clamping washer
of insulating material



bottom clamping washer
material: brass, tin plated



mylar washer

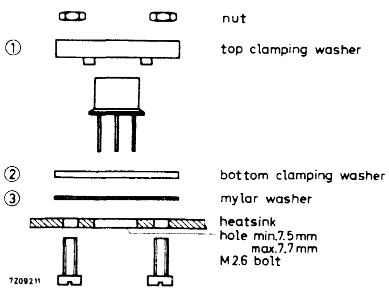
THERMAL RESISTANCE

From mounting base to heatsink non insulated mounting	$R_{th\ mb-h}$	=	1	°C/W
insulated mounting	$R_{th\ mb-h}$	=	6	°C/W

TEMPERATURE

Maximum allowable temperature T_{max} = 100 °C

MOUNTING INSTRUCTIONS

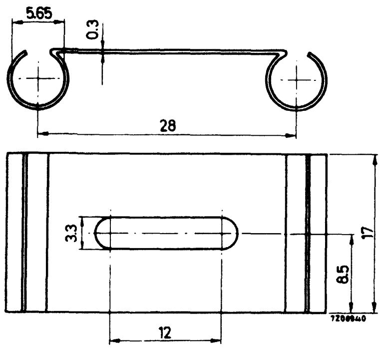


Non insulated mounting; without items 2 and 3. (Note: item 1 must than be mounted up-side down)

COOLING FIN

MECHANICAL DATA

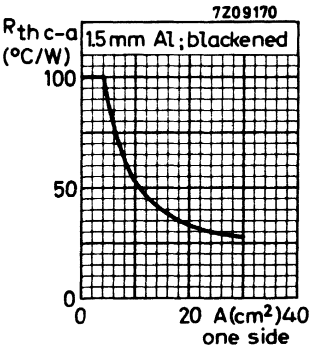
Dimensions in mm



Fin material: brass, nickel plated

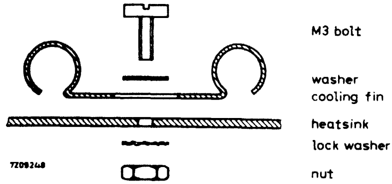
THERMAL RESISTANCE

From case to ambient with cooling fin only	$R_{th\ c-a}$	=	100 °C/W
with heatsink			see graph



R_{th} values apply to each transistor, provided the two transistors have been mounted so that the heat flow from each is equal.

MOUNTING INSTRUCTIONS

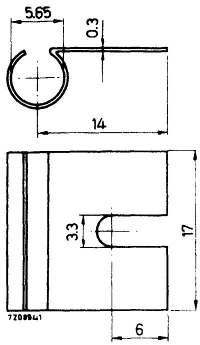


Torque on nut for good heat transfer: 5 cmkg

COOLING FIN

MECHANICAL DATA

Dimensions in mm

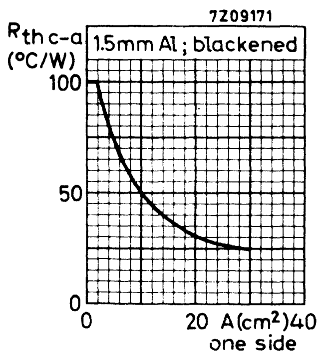


Fin material: brass, nickel plated

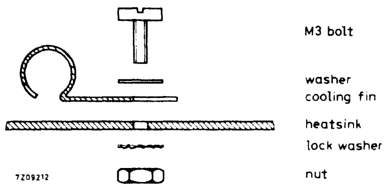
THERMAL RESISTANCE

From case to ambient with cooling fin only — $R_{th\ c\text{-}a}$ = 100 °C/W

with heatsink — see graph



MOUNTING INSTRUCTIONS

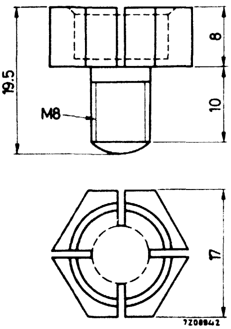


Torque on nut for good heat transfer: 5 cm kg

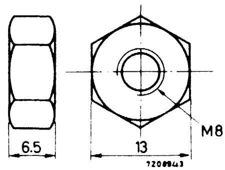
MOUNTING ADAPTOR

MECHANICAL DATA

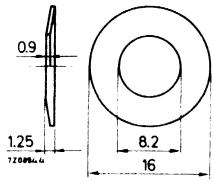
Dimensions in mm



mounting adaptor



hexagon nut
material: brass, nickel plated



dish spring
material: steel

THERMAL RESISTANCE

From diode case to heatsink $R_{th\ c\text{-}h}$ = 1.1 °C/W

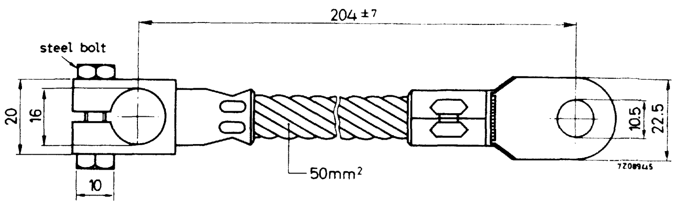
MOUNTING INSTRUCTIONS

Torque for mounting in a screw hole:	min.	80	cmkg
	max.	130	cmkg
on a heatsink	min.	60	cmkg
	max.	100	cmkg

FLEXIBLE TOP LEADS

56243

MECHANICAL DATA Dimensions in mm

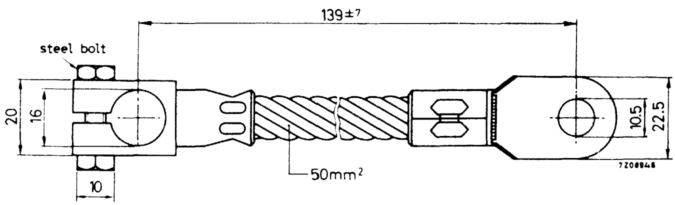


Weight: 170 g

Top lead 56243 should be used only for $I_{F(RMS)} \leq 400$ A.

56243A

MECHANICAL DATA Dimensions in mm



Weight: 140 g

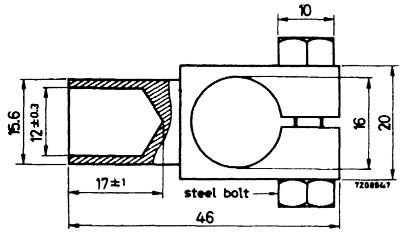
For $I_{F(RMS)} > 400$ A, top lead 56243A must be used.
This prevents the temperature of the top connection becoming too high.

CLAMP

56244

MECHANICAL DATA

Dimensions in mm

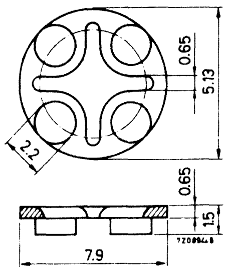


MOUNTING INSTRUCTIONS

The steel bolt ensures that sufficient torque can be applied to obtain good electrical contact.

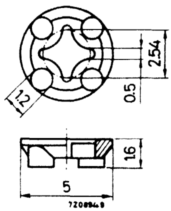
DISTANCE DISKS

56245



Insulating material

56246



Insulating material

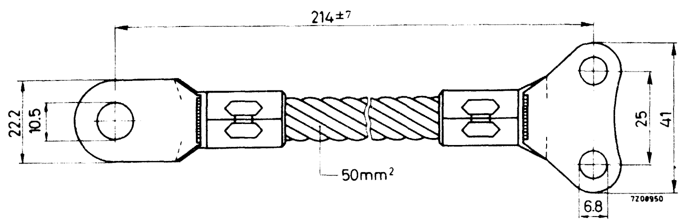
TEMPERATURE

Maximum allowable temperature T_{max} = 100 °C/W

56247 FLEXIBLE BASE LEAD

MECHANICAL DATA

Dimensions in mm

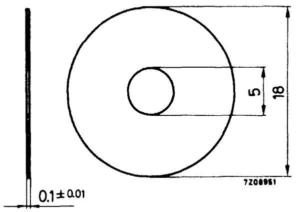


Weight: 130 g

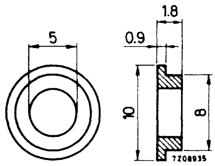
MOUNTING ACCESSORIES

MECHANICAL DATA

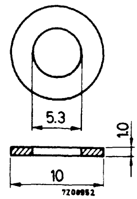
Dimensions in mm



mica washer



insulating ring



plain washer
material: brass, nickel plated

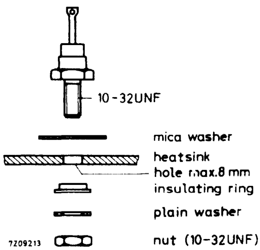
THERMAL RESISTANCE

From mounting base to heatsink (with mica washer) $R_{th\ mb\text{-}h}$ = 1.7 °C/W

TEMPERATURE

Maximum allowable temperature T_{max} = 125 °C

MOUNTING INSTRUCTIONS

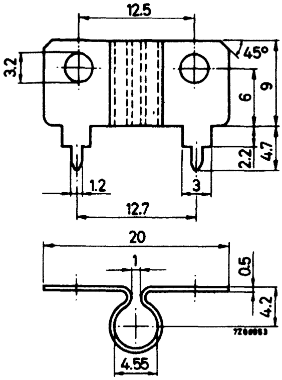


Notes: When using a tag for electrical contact insert tag between nut and plain washer or replace plain washer by tag.

COOLING FIN

MECHANICAL DATA

Dimensions in mm



Fin material: copper, tin plated

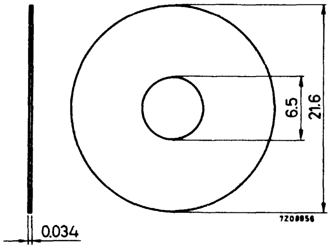
THERMAL RESISTANCE

From case to ambient $R_{th\ c-a}$ = 100 °C/W

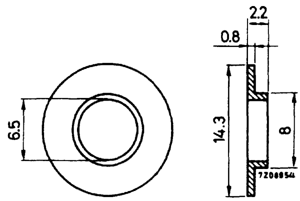
MOUNTING ACCESSORIES

MECHANICAL DATA

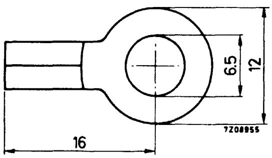
Dimensions in mm



Mica washer



Insulating ring



Soldering tag

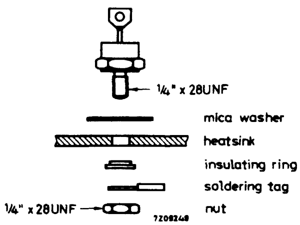
THERMAL RESISTANCE

From mounting base to heatsink with mica washer $R_{th\ mb\text{-}h}$ = 4 °C/W

TEMPERATURE

Maximum allowable temperature T_{max} = 175 °C

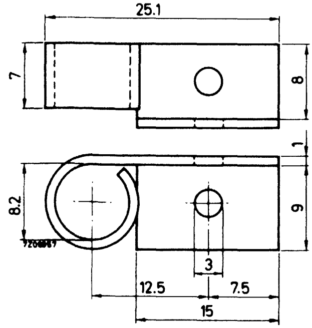
MOUNTING INSTRUCTIONS



COOLING FIN

MECHANICAL DATA

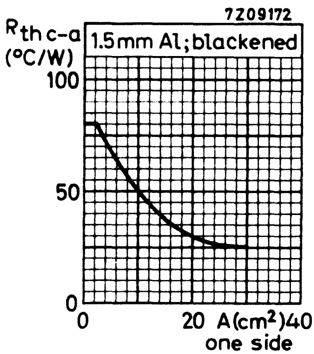
Dimensions in mm



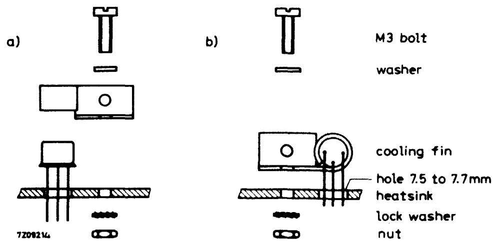
Fin material: aluminium, blackened

THERMAL RESISTANCE

From case to ambient with cooling fin only	$R_{th\ c\text{-}a}$	= 80 °C/W
with heatsink		see graph



MOUNTING INSTRUCTIONS

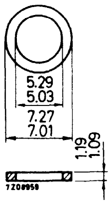


Torque on nut for good heat transfer: 5 cm kg

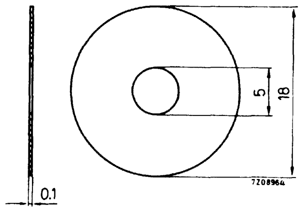
MOUNTING ACCESSORIES

MECHANICAL DATA

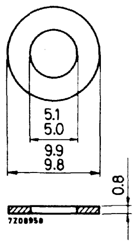
Dimensions in mm



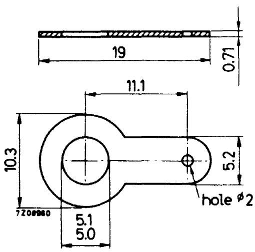
PTFE bush



2 mica washers



plain washer



terminal tag

THERMAL RESISTANCE

From mounting base to heatsink

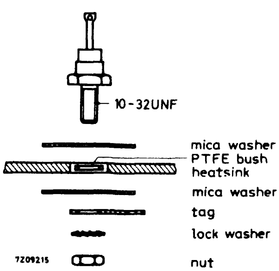
$R_{th\ mb\text{-}h}$ = 4 °C/W

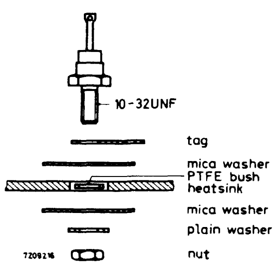
TEMPERATURE

Maximum allowable temperature

T_{max} = 175 °C

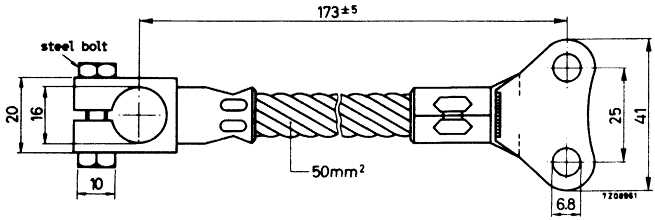
MOUNTING INSTRUCTIONS



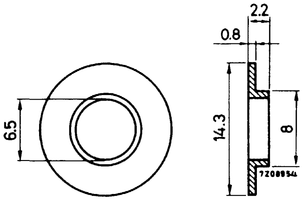


FLEXIBLE LEAD FOR SERIES CONNECTION

MECHANICAL DATA Dimensions in mm



INSULATING RING



Accessory 56299 is the insulating ring of 56264A.

Maximum operating temperature T_{max} = 175 °C

HEATSINKS

GENERAL

INTRODUCTION

Semiconductor rectifier diodes, thyristors and zener diodes for medium and high power have power losses which cannot be sufficiently transferred to the ambient air by these devices themselves. To prevent excessive junction temperatures the heat transfer capacity has to be improved.
This is achieved by heatsinks, which transfer the dissipated heat from the semiconductor junction to the ambient air by convection and radiation.

A flat metal plate is the simplest form of a heat transfer medium, but it is not the most efficient form for all conditions. In most cases a more complex form of heatsink will have advantages with regard to cost, size and weight.

This chapter offers, apart from information on heat transfer and the mechanical construction of assemblies, useful indications on how to take advantage of reverse-polarity diodes, etc., and, finally, the technical data on three types of heatsink with examples of calculation.

HEAT TRANSFER PATH

In a silicon rectifier the heat is generated inside the silicon wafer. From there the heat flows mainly to the base of the device and then via the heatsink to the surrounding air. The heat flow through heat conductors is analogous to the flow of electric current through electrical conductors. In this analogy the thermal resistance (R_{th} in $^{o}C/W$) corresponds with the electrical resistance (R in Ω).

Fig.1 shows the heat path from the junction to the ambient air as a series connection of three thermal resistances:

$R_{th\ j-mb}$: The thermal resistance from junction to mounting base. Its value can be found in the data sheets of the relevant semiconductor device.

$R_{th\ mb-h}$: The contact thermal resistance. This is the thermal resistance from mounting base to heatsink, resulting from the contact area being limited and the contact itself being imperfect. Its value can also be found in the data sheets.

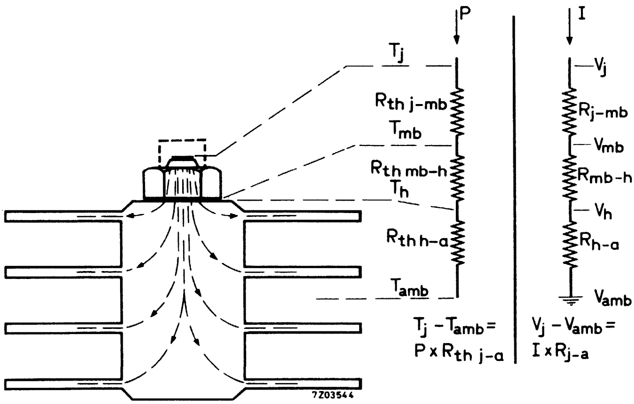
$R_{th\ h-a}$: The thermal resistance of the heatsink. This is the thermal resistance between the contact surface and the ambient air.

Once the heat has been transferred from heatsink to ambient, cool air must replace the heated air.

According to fig.1 the following formula can be used in heatsink calculations:

$$T_j - T_{amb} = P \times (R_{th\ j-mb} + R_{th\ mb-h} + R_{th\ h-a})$$

Fig.1 Analogy between heat conduction and electric conduction



MEANS TO IMPROVE HEAT TRANSFER

The contact thermal resistance can be made as small as possible by using:

1. a large contact area
2. plane contact surfaces by proper machining, grinding, etc. Heatsinks should be blanked or made burr-free after punching or drilling holes
3. sufficient pressure by applying at least the rated minimum torque. Use a torque spanner
4. silicon grease to fill up air pockets. A thin layer of air has a much higher resistance to heat flow than a thin film of grease (e.g. Dow Corning 340)

The thermal resistance of the heatsink can be reduced by:

1. painting or anodising the surface, which improves heat transfer by radiation
2. higher speed of the cooling air
3. larger size of the heatsink

The air flow can be obtained in the simplest way by natural convection. Any obstruction should be avoided. Therefore fins should be placed vertically, air intake and outlet apertures should be as large as possible. Ample spacing between heatsinks and adjacent structures and provisions to obtain a chimney effect also improve the air flow.

If free convection is not sufficient to remove the heat, a blower or a fan must be used. Forced air cooling also permits a substantially smaller heatsink.

INSULATED MOUNTING

In bridge rectifiers it may be desirable to insulate a diode electrically from its heatsink by means of a mica or teflon wahser. As a consequence the contact thermal resistance will be about 10 times that of the case without insulation. Since the total thermal resistance has a fixed maximum value for given values of P and T_{amb} (see previous section), the increase of $R_{th\ mb\text{-}h}$ has to be compensated by a considerable reduction of $R_{th\ h\text{-}a}$ (e.g. by using a much larger heatsink).

Furthermore, the creepage distances along the insulator may be too small for the high voltages occurring between diode and heatsink. In fig.2 the creepage distances A and B can be made sufficiently large; but C and D will always be small.

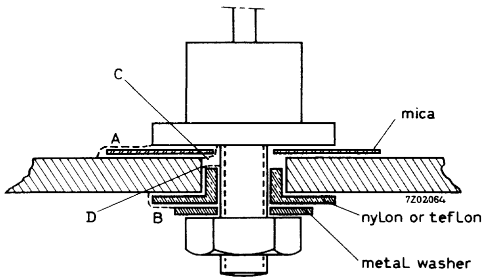


Fig.2 Creepage distances at an insulated diode
(C and D are the critical ones)

CONSTRUCTION OF ASSEMBLIES

In the previous sections some details have been given regarding the proper way of connecting a diode to a heatsink, positioning of heatsinks, etc.

For better current sharing of parallel-connected diodes a good thermal coupling of the devices is needed, which reduces differences in the forward characteristics. Two series-connected diodes should have a good thermal coupling in view of the reverse characteristics.

Thermal coupling can be obtained by mounting two diodes on one heatsink. On a plain cooling fin the two diodes should be mounted according to fig.3, on an extruded aluminium heatsink according to fig.4. A distance between the two diodes equal to one third of the heatsink length provides sufficient thermal coupling. For the electrical connection it is preferred to use a copper strip with a thickness of 1 mm. Mounting two diodes on one heatsink also saves mounting cost.

A flat plate with two diodes should have twice the area necessary for a separately mounted diode.
An extruded aluminium heatsink with two diodes should have twice the length necessary for a separately mounted diode.

An electrical series connection of two diodes mounted on one heatsink can be obtained by using diodes of different polarity. Figs. 5, 6, 7 and 8 show how the combination of normal and reverse-polarity diodes simplifies the assembly of single phase and three phase bridge rectifiers.

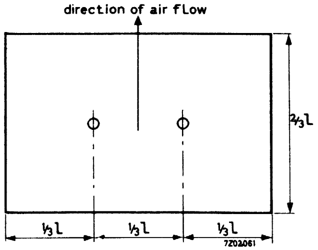


Fig.3. Dimensioning of a plain cooling fin with two diodes

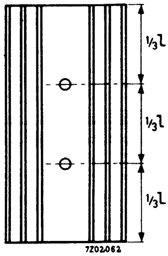


Fig.4. Extruded aluminium heat-sink with two diodes

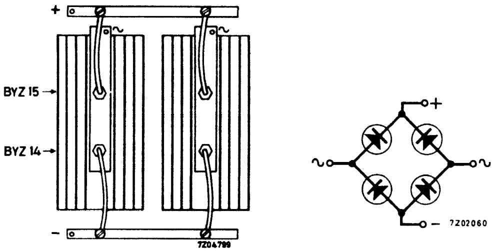


Fig.5. Single phase full wave rectifier with diodes of different polarity on extruded aluminium heatsinks

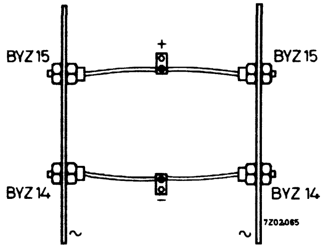


Fig.6. Single phase full wave rectifier with diodes of different polarity on plain cooling fins (Top view)

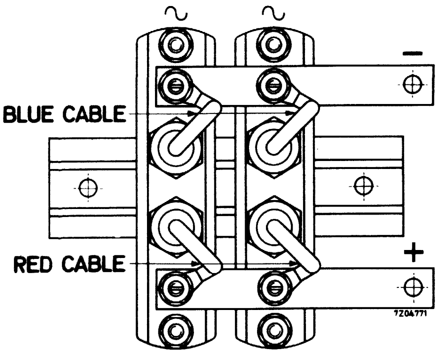


Fig.8. Single phase full wave rectifier with diodes of different polarity (red cable: reverse polarity; blue cable: normal polarity) on two double heatsinks 56250

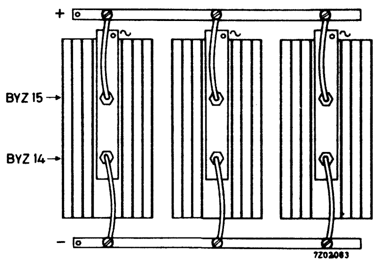
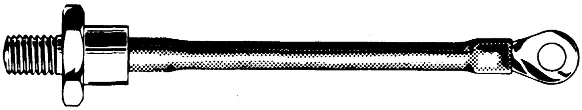


Fig.7. Three phase full wave rectifier with diodes of different polarity on extruded aluminium heat-sinks

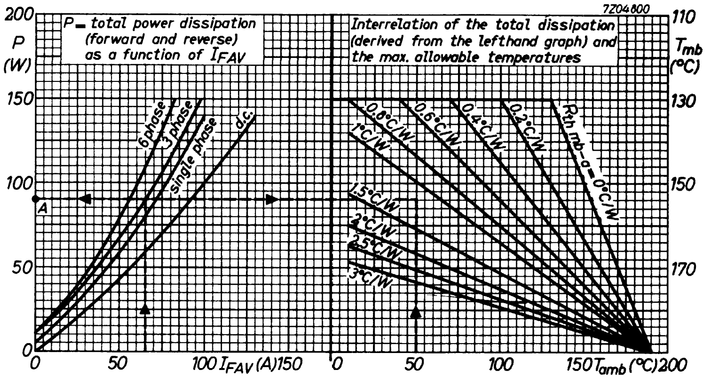
EXAMPLES OF HEATSINK CALCULATION

1. Devices without controlled avalanche properties.
Assume that the diode of which the outlines are shown, is used in a three phase 50 Hz rectifier circuit at T_{amb} = 50 °C. Further assume: average forward current per diode I_{FAV} = 65 A; contact thermal resistance $R_{th\ mb-h}$ = 0.1 °C/W



Stud: M12
Mounting base, across the flats: max. 27 mm

From the data of the diode the graph to be used is shown below.



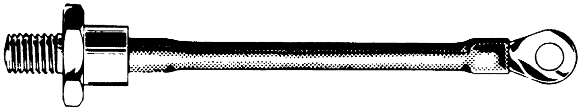
From the lefthand graph it follows that P_{tot} = 90 W per diode (point A).
From the righthand graph it follows that $R_{th\ mb-a}$ ≈ 1.2 °C/W.
Thus $R_{th\ h-a} = R_{th\ mb-a} - R_{th\ mb-h}$ = (1.2 - 0.1) °C/W = 1.1 °C/W.
This may be achieved by different types of heatsinks as shown below.

Type	Free convection	Forced cooling
flat, blackened bright	– –	125 cm^2; 2 m/s or 300 cm^2; 1 m/s 175 cm^2; 2 m/s
diecast 56274 56280	– applicable	≈ 1.5 m/s
extrusion 56230 bright blackened 56231 bright blackened	 1 = 12 cm 1 = 8 cm 1 = 7 cm 1 = 5 cm [1]	 1 = 5 cm [1]; 1 m/s 1 = 5 cm [1]; 1 m/s

[1]) Practical minimum length

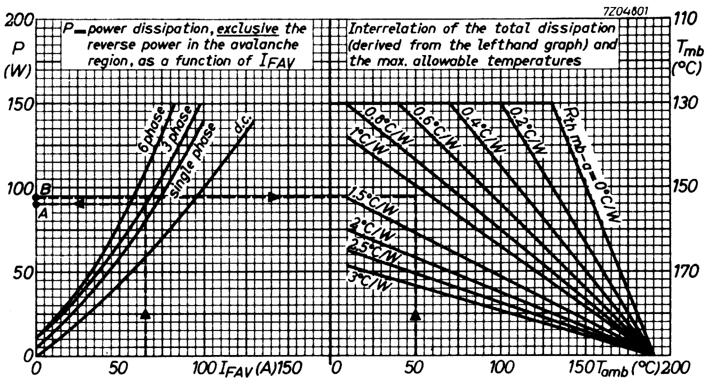
2. Devices with controlled avalanche proporties

Assume that the diode of which the outlines are shown, is used in a three phase 50 Hz rectifier circuit at T_{amb} = 50 °C. Further assume: average forward current per diode I_{FAV} = 65 A; contact thermal resistance $R_{th\ mb\text{-}h}$ = 0.1 °C/W; repetitive peak reverse power in the avalanche region (t = 10 μs) P_{RRM} = 8 kW (per diode).



Stud: M12
Mounting base, across the flats: max. 27 mm

From the data of this diode the graph to be used is shown below.



From the lefthand graph it follows that P_{tot} = 90 W per diode (point A).
The average reverse power in the avalanche region, averaged over any cycle, follows from $P_{RAV} = \delta \times P_{RRM}$, where the duty cycle $\delta = \frac{10\ \mu s}{20\ ms} = 0.0005$.

Thus P_{RAV} = 0.0005 x 8 kW = 4 W.

Therefore the total device power dissipation P_{tot} = 90 + 4 = 94 W (point B).
From the righthand graph it follows that $R_{th\ mb\text{-}a} \approx 1.1$ °C/W.
Hence the heatsink thermal resistance should be:

$$R_{th\ h\text{-}a} = R_{th\ mb\text{-}a} - R_{th\ mb\text{-}h} = (1.1 - 0.1)\ ^{\circ}C/W = 1\ ^{\circ}C/W.$$

A table of applicable heatsinks, similar to that on the foregoing page, can be derived for this case.

SELECTION GUIDE FOR DIODES

To simplify the selection of heatsinks, the table below indicates for each diecast heatsink the diodes for which is may be used.
For extruded heatsinks the most suitable combinations are given.
As an additional guide, the outlines of the appropriate diodes are shown beside the heatsink data.

	BYX38 BYX39	BYX25 BYX30 BYX42 BYX48	BYX13 BYY22	BYX21 BYX28 1)	BYZ14	BYX34	BYX23 BYX32	BYX14 BYX27 BYX33
Diecast								
56250					●		●	
56268	●							
56271			●	●		●		
56274					●		●	
56277			●	●				
56280					●		●	
56283								●
Extrusions								
56230 56231		●	●	●	●	●		
56259 56293					●	●	●	●
56290	●	●	●	●				

1) With adaptor 56232

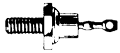
SELECTION GUIDE FOR THYRISTORS

To simplify the selection of heatsinks, the table below indicates for each diecast heatsink the thyristors for which it may be used.
For extruded heatsinks the most suitable combinations are given.
As an additional guide, the outlines of the appropriate thyristors are shown beside the heatsink data.

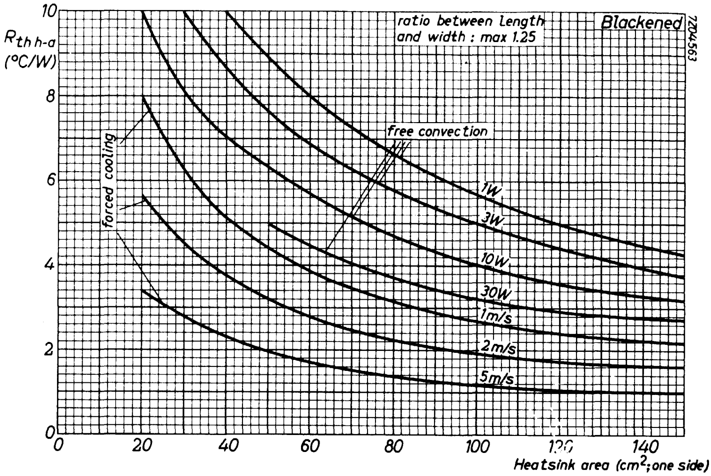
	BT101;102 BTX68 BTY79	BTX35 BTX64 BTY87	BTX36 BTX47 BTX48 BTY91	BTX81 BTX82	BTX37 BTX66 BTY95	BTX38 BTX49 BTX67 BTY99
Diecast 56253		●	●	●		
56256	●					
56279					●	●
56286					●	●
Extrusions 56230 56231		●	●	●	●	●
56259 56293					●	●
56290	●	●	●	●		

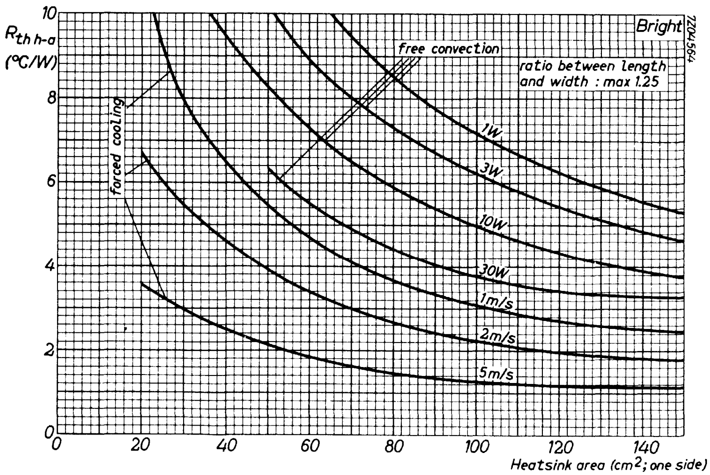
FLAT HEATSINKS

Thermal resistance of flat heatsinks of 2 mm copper or 3 mm aluminium.
The graphs are valid for the combination of device and heatsink.

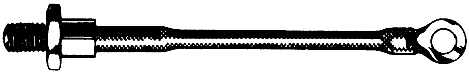


Studs: 10-32UNF
Mounting bases, across the flats: max. 11.0 mm

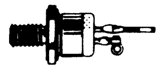




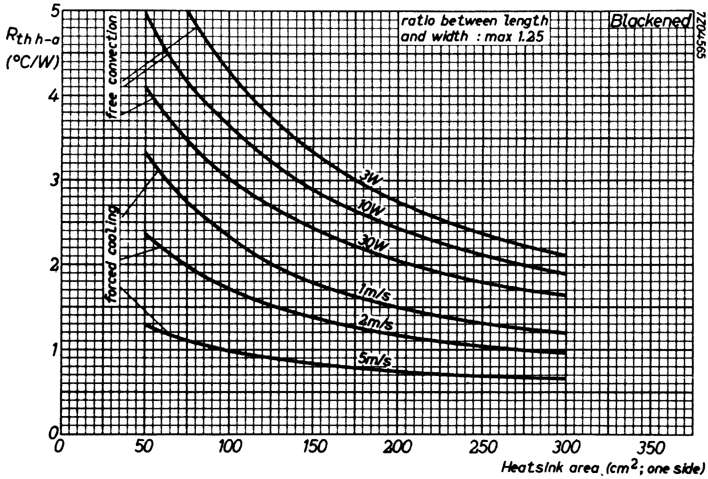
Thermal resistance of flat heatsinks of 2 mm copper or 3 mm aluminium.
The graphs are valid for the combination of device and heatsink.

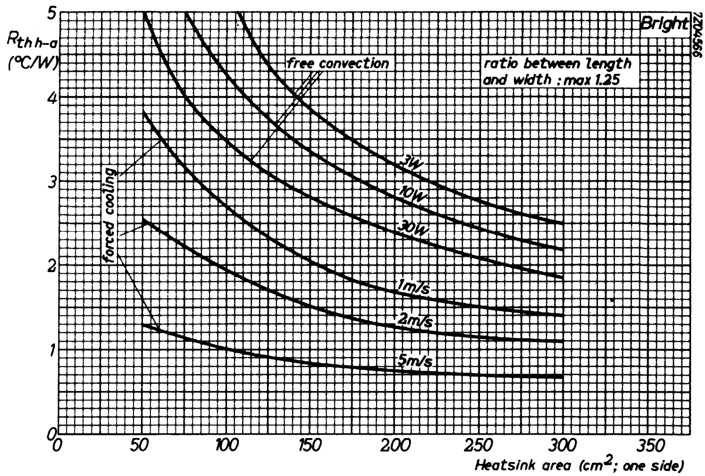


Stud: M8
Mounting base, across the flats: max. 17 mm

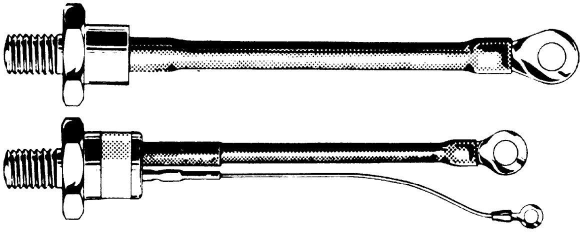


Stud: $\frac{1}{4}$" x 28 UNF
Mounting base, across the flats: max. 14.3 mm

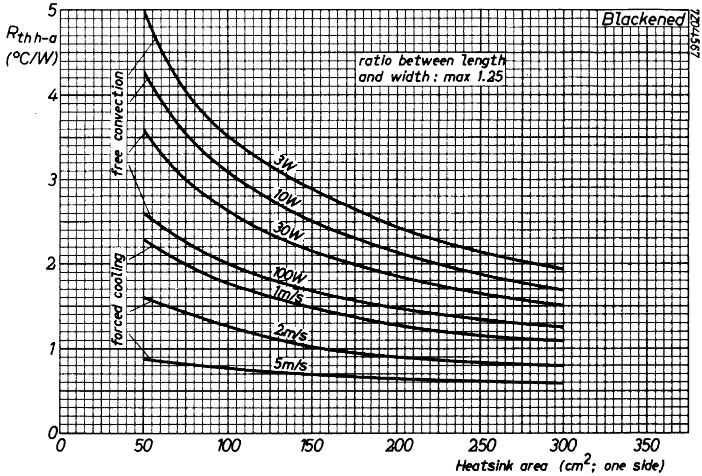


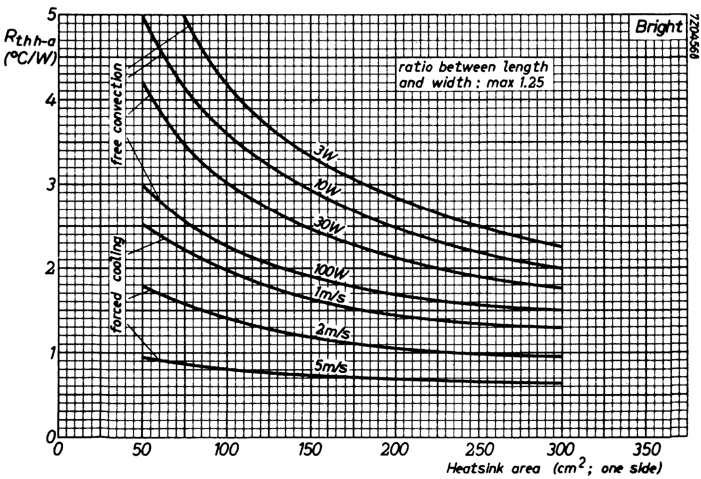


Thermal resistance of flat heatsinks of 2 mm copper or 3 mm aluminium.
The graphs are valid for the combination of device and heatsink.



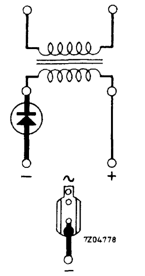
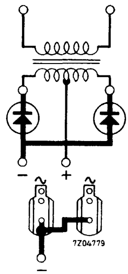
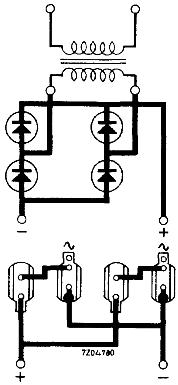
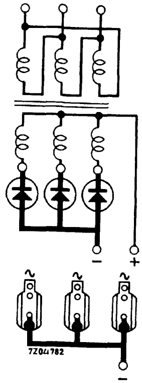
Studs: M12
Mounting bases, across the flats: max. 27 mm

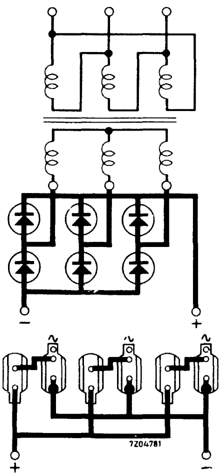
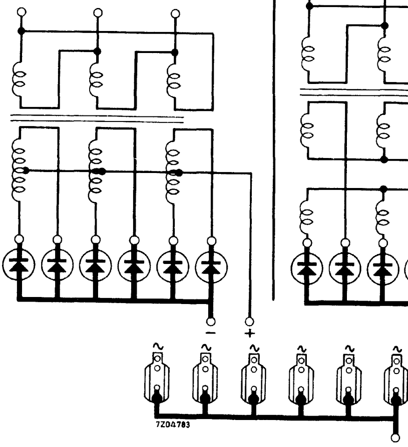
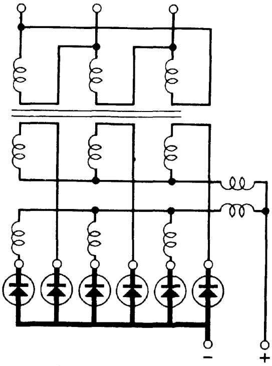


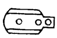


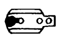
DIECAST HEATSINKS

RECTIFIER CIRCUITS ON SINGLE HEATSINKS

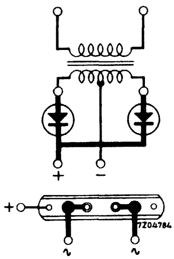
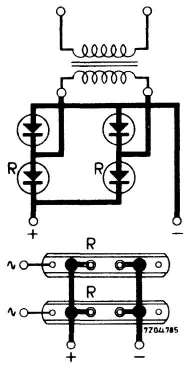
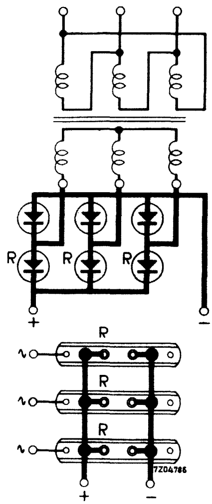
Single phase half wave	Two phase half wave	Single phase full wave (Single phase bridge)	Three phase half wave (Three phase star)
			

Three phase full wave (Three phase bridge)	Six phase half wave (Six phase star)	Three phase double Y with interphase transformer
		

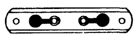
Diecast heatsink without insulator 

Diecast heatsink with insulator 

RECTIFIER CIRCUITS ON DOUBLE HEATSINKS

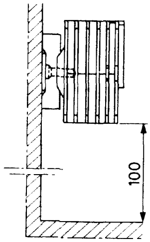
Two phase half wave	Single phase full wave (Single phase bridge)	Three phase full wave (Three phase bridge)
		

R = Reverse polarity diode

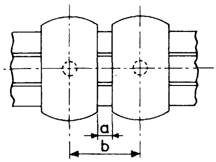
Diecast heatsink 56250 

MOUNTING INSTRUCTION FOR DIECAST HEATSINKS

1. At free convection cooling or forced air flow <0.5 m/s the heatsinks should be mounted with the fins vertical and with a distance to the chassis bottom > 100 mm.

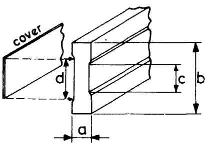


2. At forced air flow > 0.5 m/s the heatsinks may be mounted in any position.
3. Minimum distance between heatsinks in a row.



Heatsink	Distance (mm) a	b
56256/68	> 5.0	>25.0
56277	> 5.0	>40.0
56250/53	>10.0	>50.0
56258/71/74	>10.0	>50.0

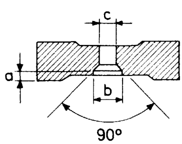
4. The rectifier devices should be fixed to their heatsinks with the torques specified in the relevant published data. Use a torque spanner.
5. For insulated mounting of heatsinks two sizes of mounting strips made of insulating material are available.



Strip	Dimensions (mm) a	b	c	d	Weight (g) (with cover)
56233	10.0	36	14.1	22	330
56234	13.5	50	20.1	28	615

Length 750 mm

6. Mounting holes to be made in the strips:



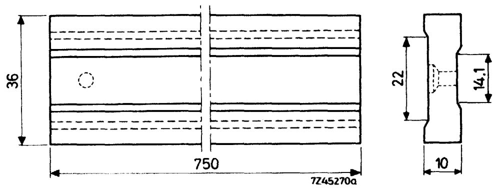
Heatsink	Strip	Dimensions in mm a	b	c
56256/68	56233	< 1.5	7.5	4.3
56253/58/71	56234	< 1.3	10.2	6.3
56274/77	56234	< 1.3	10.2	6.3
56250	56234	< 1.8	13.8	8.3

MOUNTING STRIPS

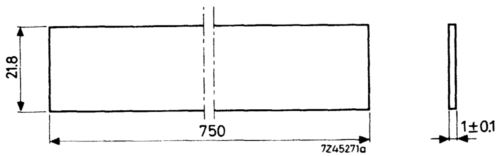
Type 56233 consists of the following components (1 to 2) Dimensions in mm

1.
1 mounting strip of insulating material

Weight with cover: 330 g



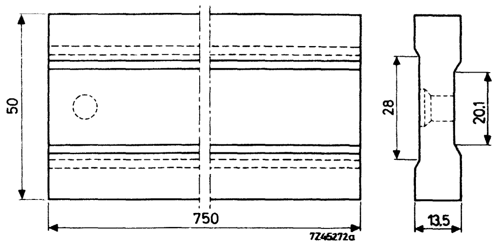
2.
1 insulating plate



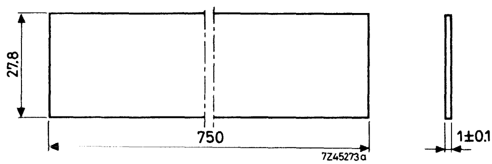
Type 56234 consists of the following components (1 to 2) Dimensions in mm

1.
1 mounting strip of insulating material

Weight with cover: 615 g



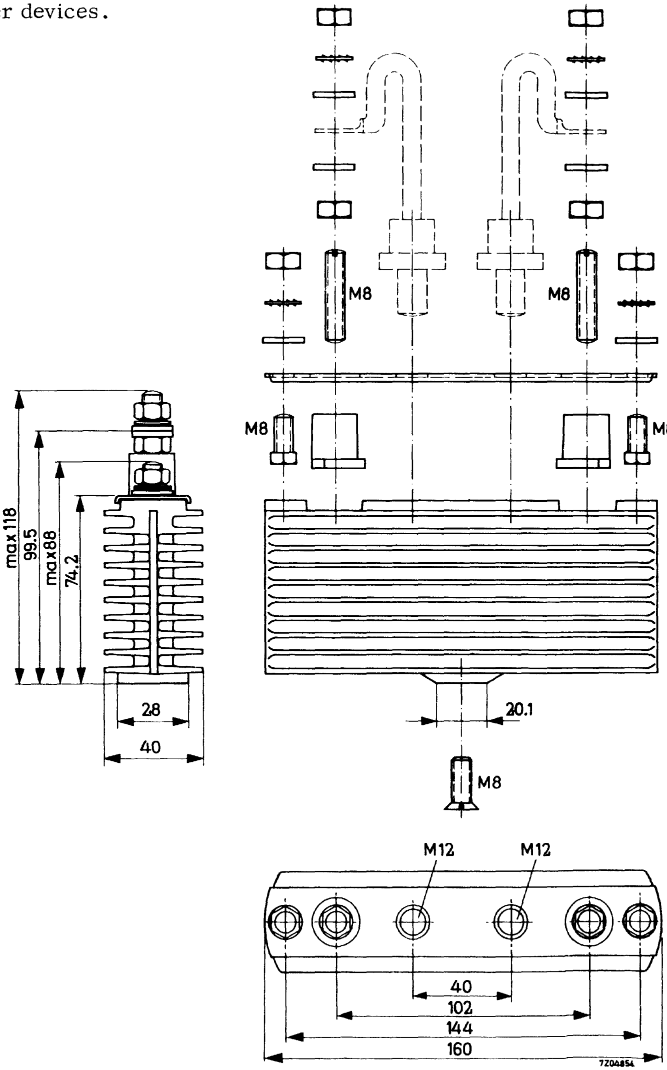
2.
1 insulating plate



DIECAST HEATSINK FOR TWO DEVICES

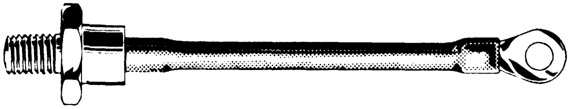
Diecast heatsink of aluminium alloy, painted black, with two M12 tap holes for two rectifier devices.

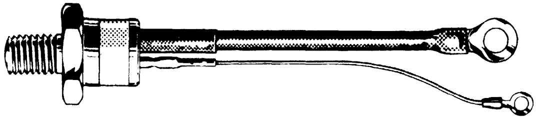
Dimensions in mm



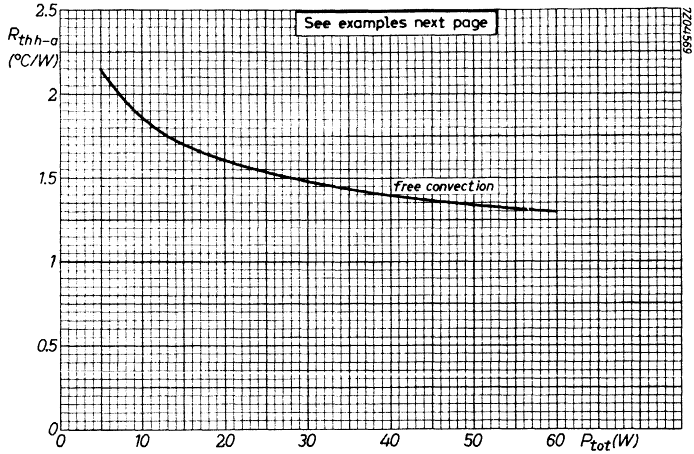
Weight 730 g

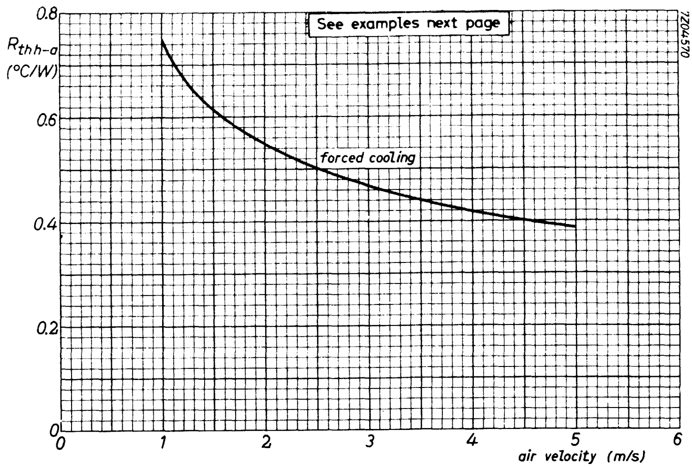
The graphs are valid for the combination of device and heatsink.





Studs: M12
Mounting base, across the flats: 27.0 mm





Calculations for the double heatsink 56250

For equal devices at equal conditions the maximum allowable mounting base temperature shall be calculated. After subtraction of the temperature drop caused by the contact thermal resistance the required heatsink thermal resistance can be determined.

For two different devices (with different $T_{j\ max}$, power dissipation and contact thermal resistance) the lower of the two maximum allowable mounting base temperatures shall be taken, after which the same procedure is followed.

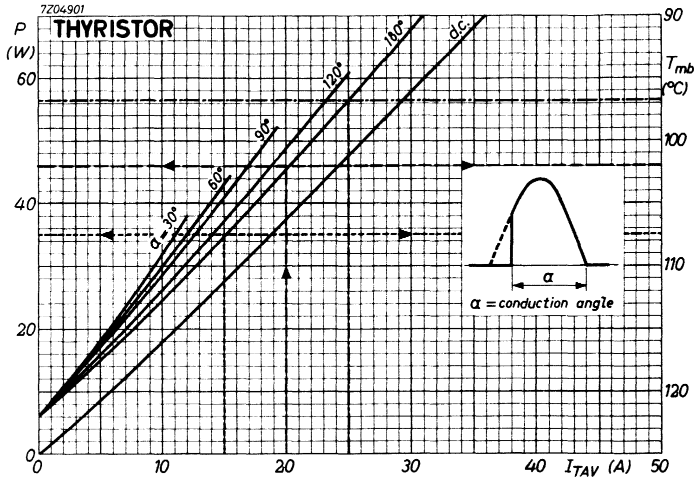
Examples

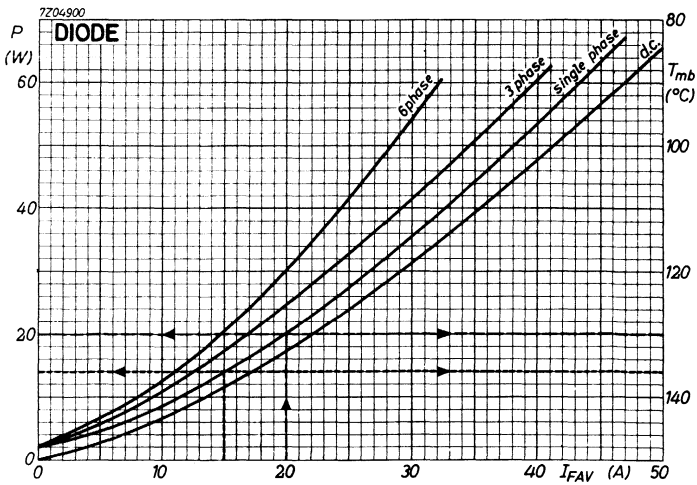
Consider a thyristor T and a diode D, used in single phase application ($\alpha = 180^o$), of which the curves to be used are shown on the next page. For all examples the contact thermal resistance $R_{th\ mb\text{-}h} = 0.1\ ^oC/W$.
In the table below, three different examples have been worked out.

	$T_1 + D_2$	$T_1 + D_2$	$T_1 + T_2$
Given: T_{amb}	30 ^oC	50 ^oC	45 ^oC
I_{AV}	15 A	20 A	25 A
From next page			
P_1	35 W	46 W	56.5 W
P_2	14 W	20 W	56.5 W
$P_{tot} = P_1 + P_2$	49 W	66 W	113 W
$T_{mb\ 1}$ max.	107.5 ^oC	102 ^oC	96.5 ^oC
$T_{mb\ 2}$ max.	136 ^oC	130 ^oC	96.5 ^oC
$P_1 \times R_{th\ mb\text{-}h} = \Delta T_{mb\text{-}h}$	3.5 ^oC	4.6 ^oC	5.7 ^oC
Maximum T_h	104 ^oC	97.4 ^oC	90.8 ^oC
T_{amb}	30 ^oC	50 ^oC	45 ^oC
Max. $\Delta T_{h\text{-}a}$	74 ^oC	47.4 ^oC	45.8 ^oC
$\frac{\text{Max. } \Delta T_{h\text{-}a}}{P_{tot}} =$	$\frac{74}{49} =$	$\frac{47.4}{66} =$	$\frac{45.8}{113} =$
Max. $R_{th\ h\text{-}a}$	1.5 $^oC/W$	0.72 $^oC/W$	0.4 $^oC/W$
From graphs on foregoing page follows:	Possible with free convection. 50 W: 1.35 $^oC/W$	Only with forced cooling. At least 1.1 m/s	Only with forced cooling. At least 4.5 m/s

Calculations for the double heatsink 56250 (continued)

The two graphs below give the power dissipation and the maximum allowable mounting base temperature versus the average forward current, for the thyristor T and the diode D, respectively.

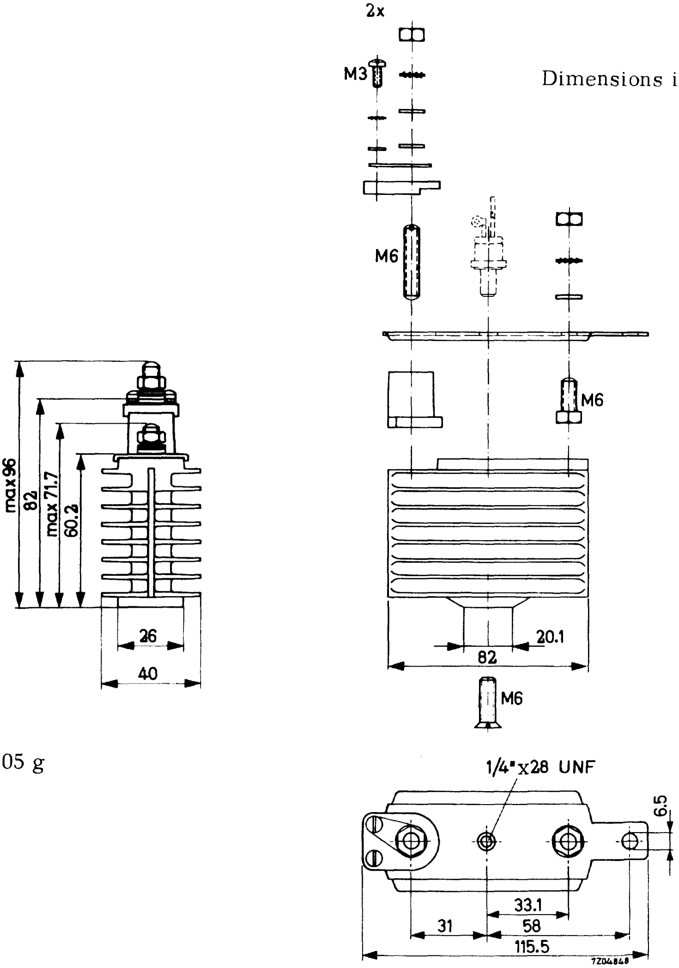




DIECAST HEATSINK

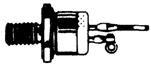
Diecast heatsink of aluminium alloy, painted black, with 1/4"x28 UNF tap hole for rectifier device.

Dimensions in mm

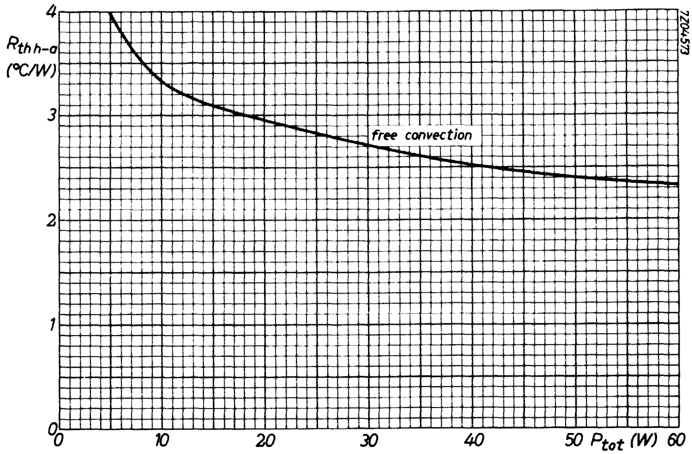


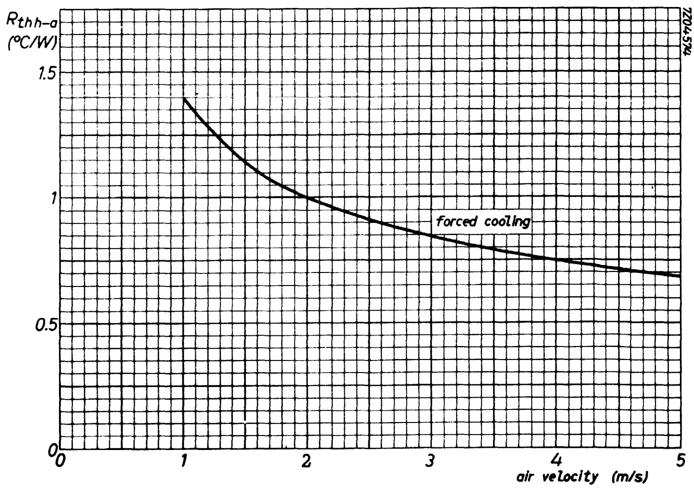
Weight 305 g

The graphs are valid for the combination of thyristor and heatsink.



Stud: $\frac{1}{4}$" x 28UNF
Mounting base, across the flats: max. 14.0 mm



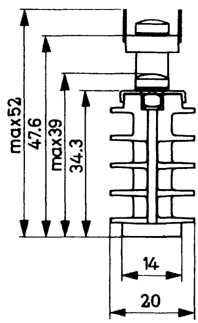


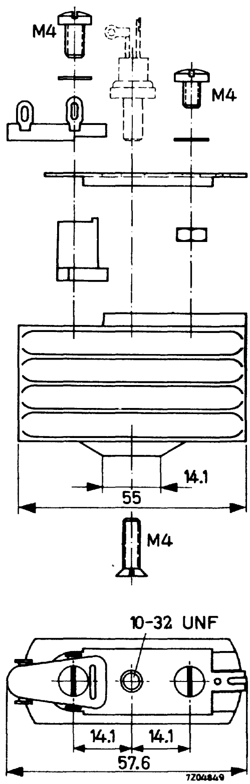
DIECAST HEATSINK

Diecast heatsink of aluminium alloy, painted black, with 10-32 UNF tap hole for rectifier device.

Dimensions in mm

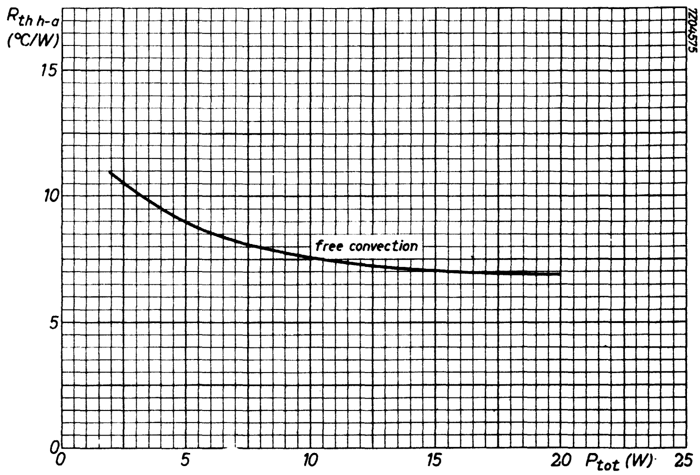
Weight: 55 g

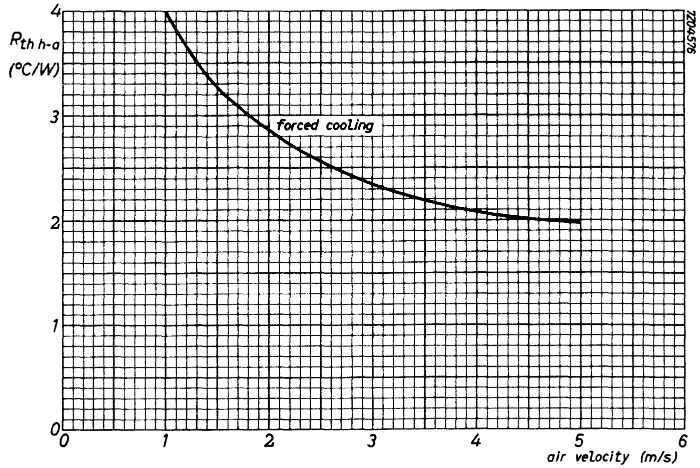




The graphs are valid for the combination of thyristor and heatsink.

Stud: 10 - 32UNF
Mounting base, across the flats: 11.0 mm



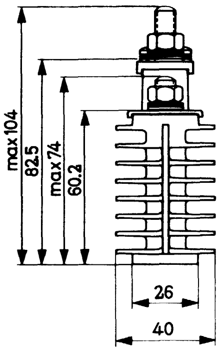


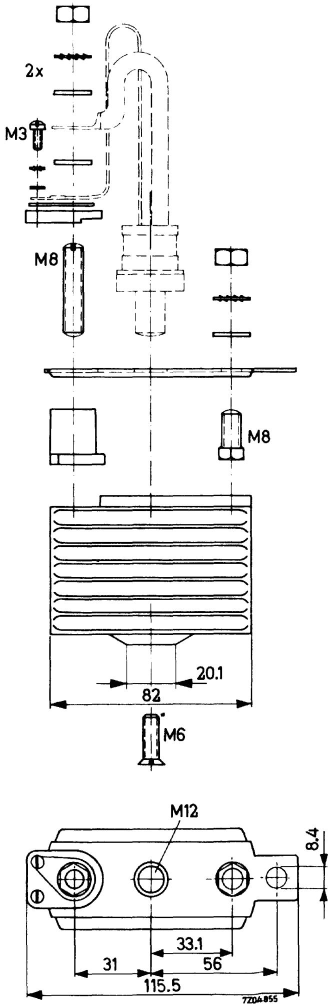
DIECAST HEATSINK

Diecast heatsink of aluminium alloy, painted black, with M12 tap hole for rectifier device.

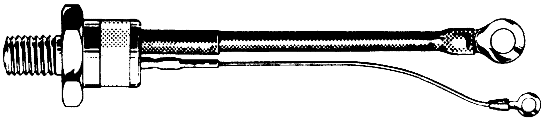
Dimensions in mm

Weight 290 g

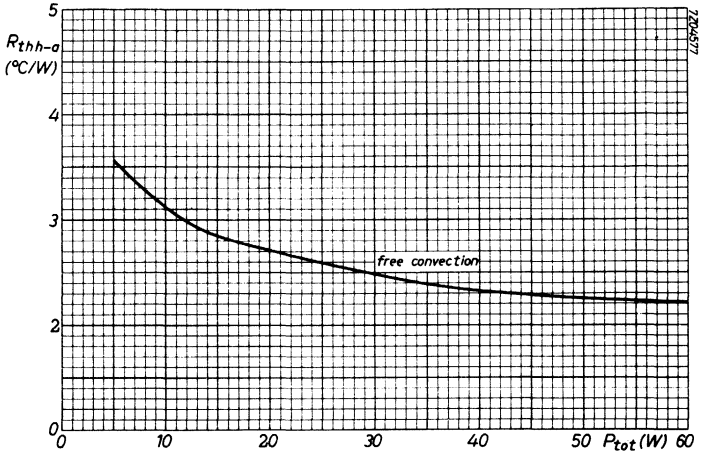


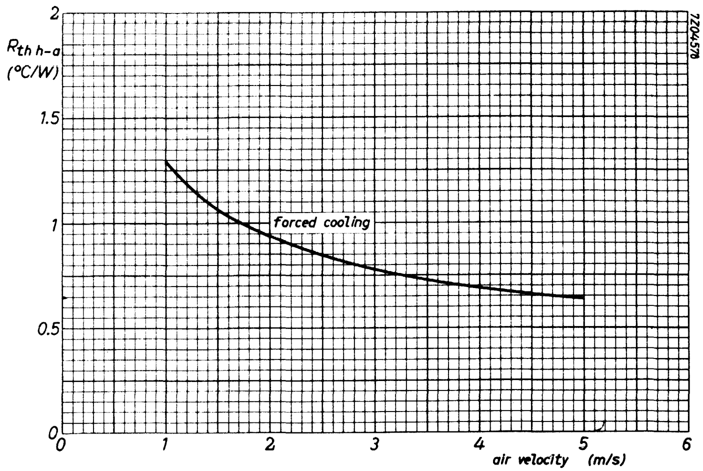


The graphs are valid for the combination of thyristor and heatsink.



Stud: M12
mounting base, across the flats: 27.0 mm



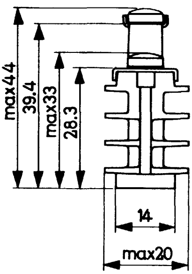


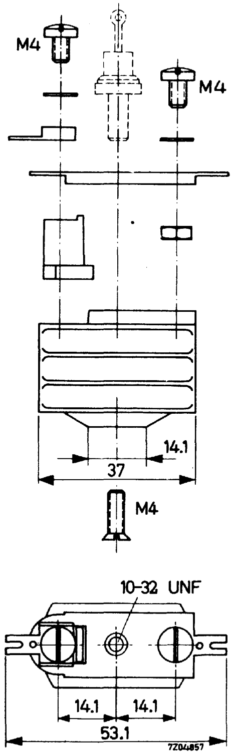
DIECAST HEATSINK

Diecast heatsink of aluminium alloy, painted black, with 10-32 UNF tap hole for rectifier device.

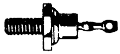
Dimensions in mm

Weight 33 g

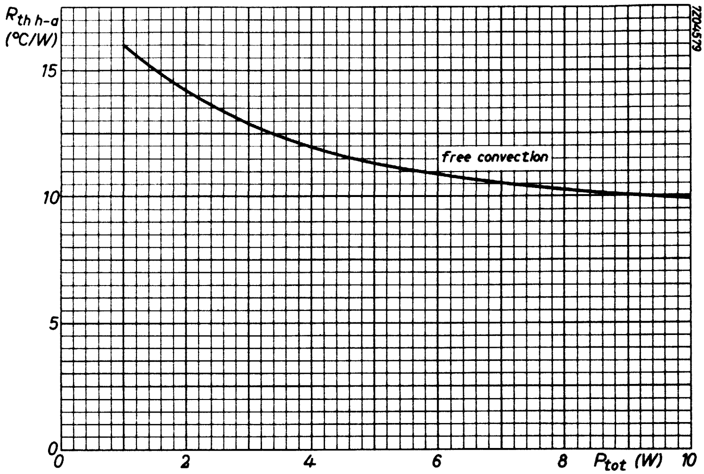


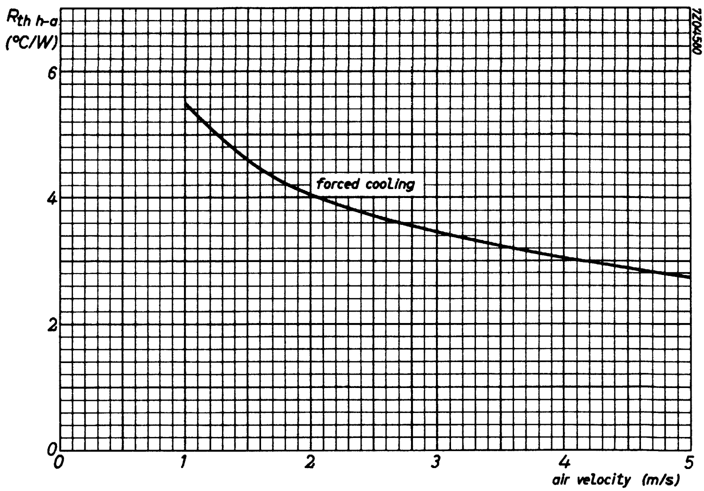


The graphs are valid for the combination of diode and heatsink.



Stud: 10 - 32UNF
Mounting base, across the flats: 11.0 mm



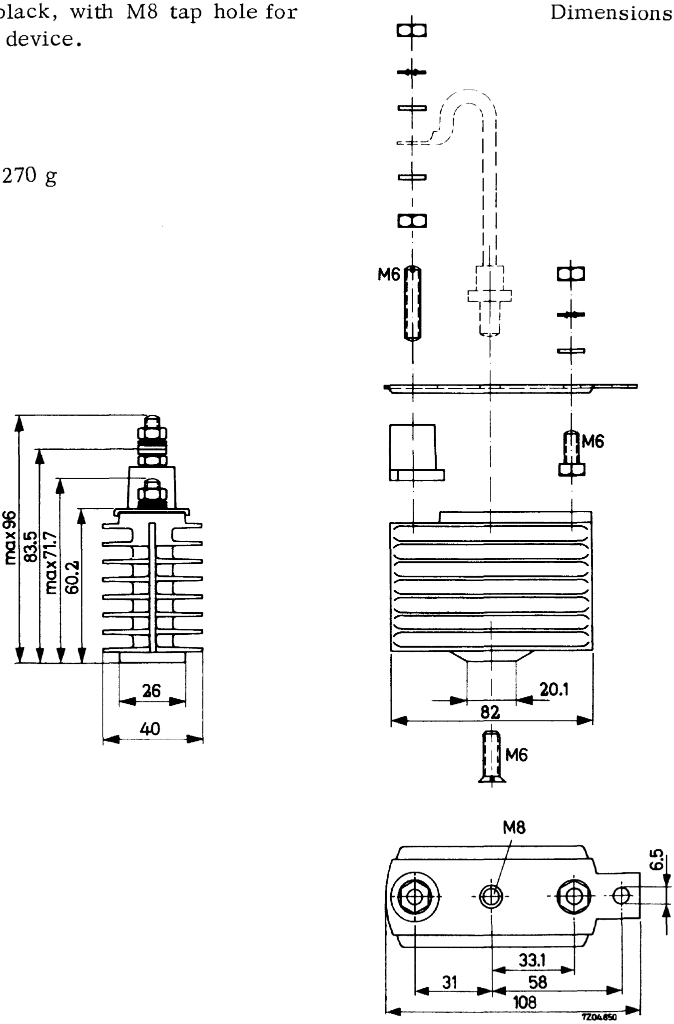


DIECAST HEATSINK

Diecast heatsink of aluminium alloy, painted black, with M8 tap hole for rectifier device.

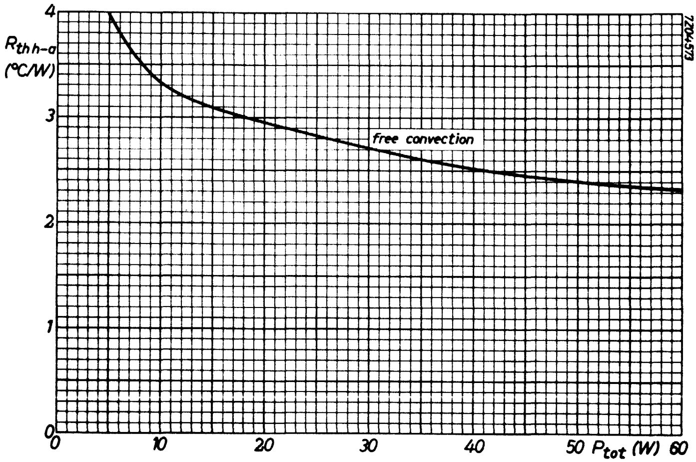
Dimensions in mm

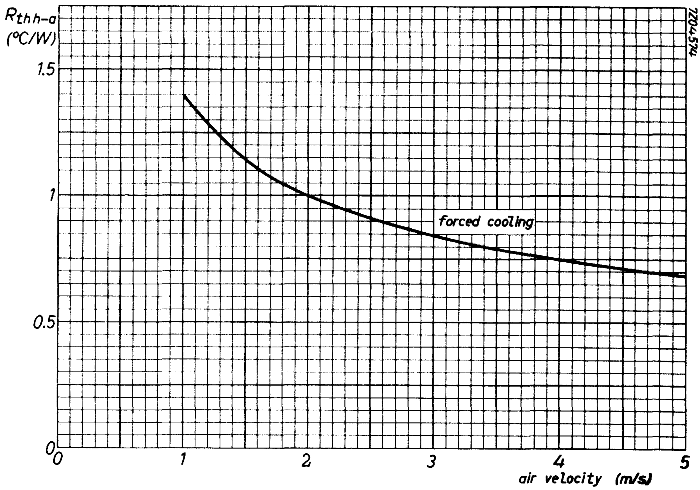
Weight 270 g



The graphs are valid for the combination of diode and heatsink.

Stud: M8
Mounting base, across the flats: 17.0 mm



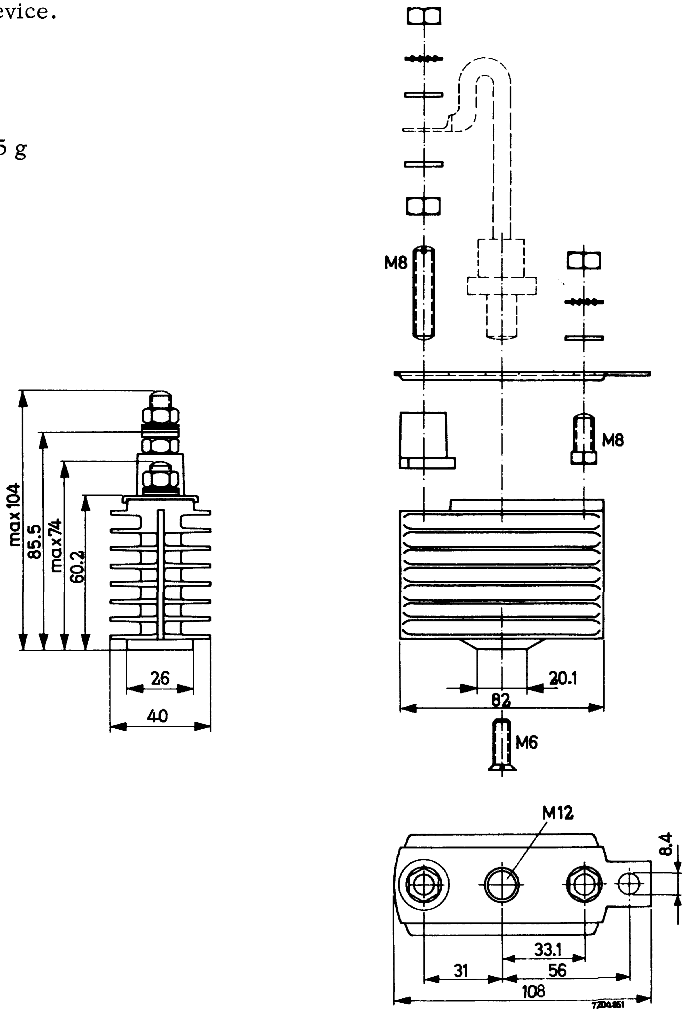


DIECAST HEATSINK

Diecast heatsink of aluminium alloy, painted black, with M12 tap hole for rectifier device.

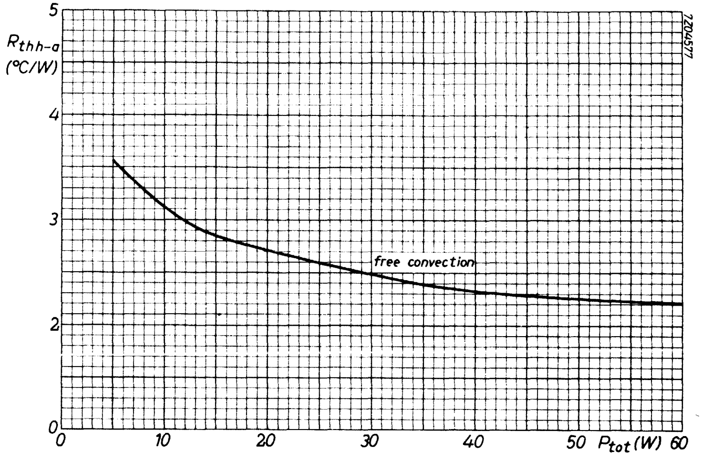
Weight 295 g

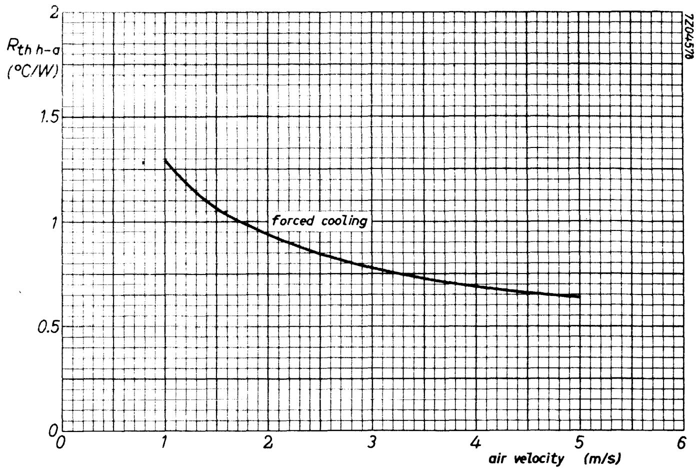
Dimensions in mm



The graphs are valid for the combination of diode and heatsink.

Stud: M12
Mounting base, across the flats: 27.0 mm



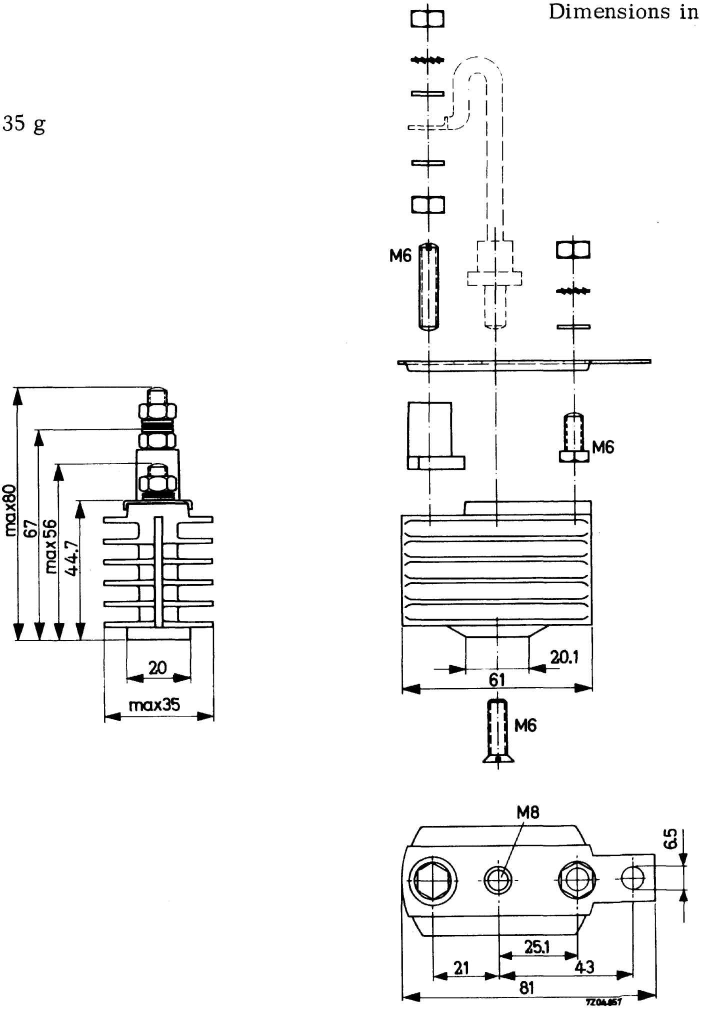


DIECAST HEATSINK

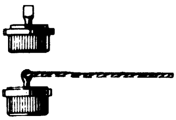
Diecast heatsink of aluminium alloy, painted black, with M8 tap hole for rectifier device.

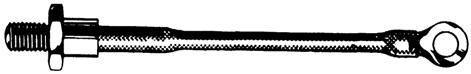
Dimensions in mm

Weight 135 g

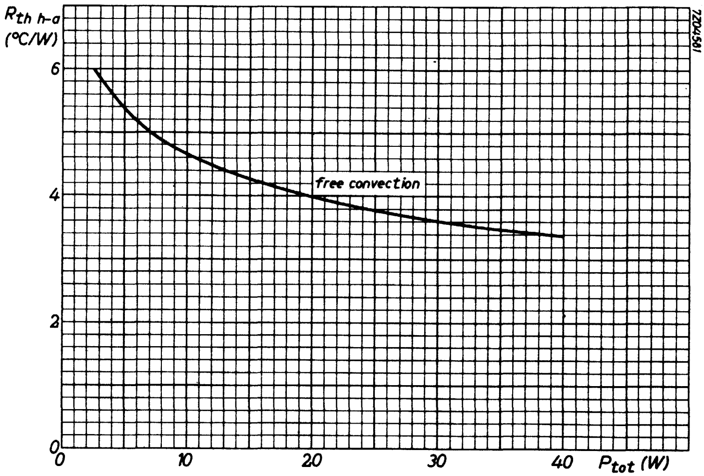


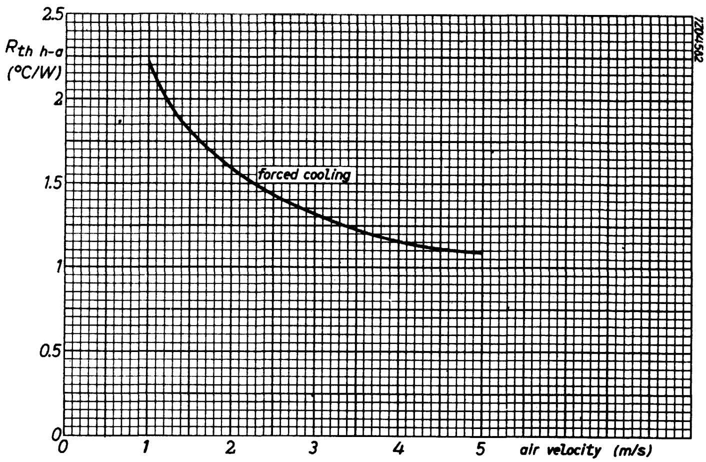
The graphs are valid for the combination of diode and heatsink.





Stud: M8
Mounting base, across the flats: 17.0 mm



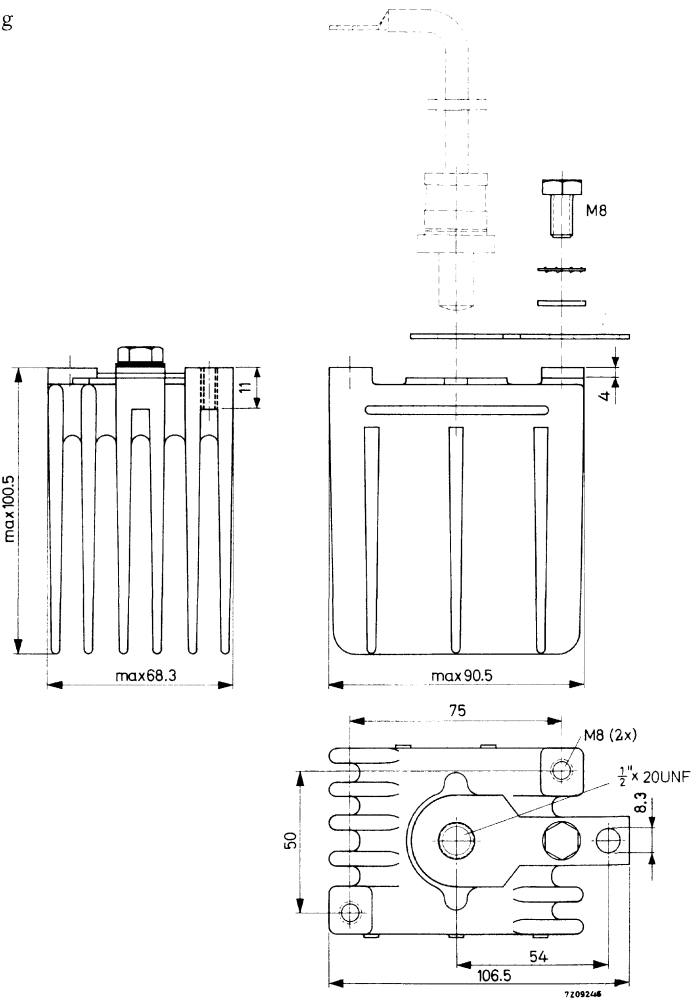


DIECAST HEATSINK

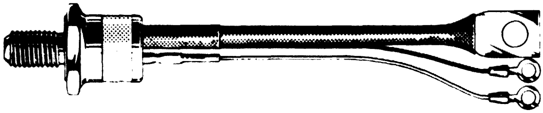
Diecast heatsink of aluminium allcy, painted black, with $\frac{1}{2}$" x 20UNF tap hole for rectifier device.

Dimensions in mm

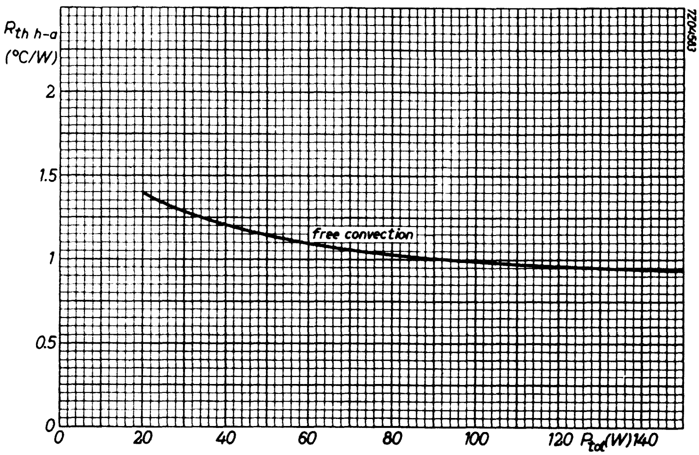
Weight: 690 g

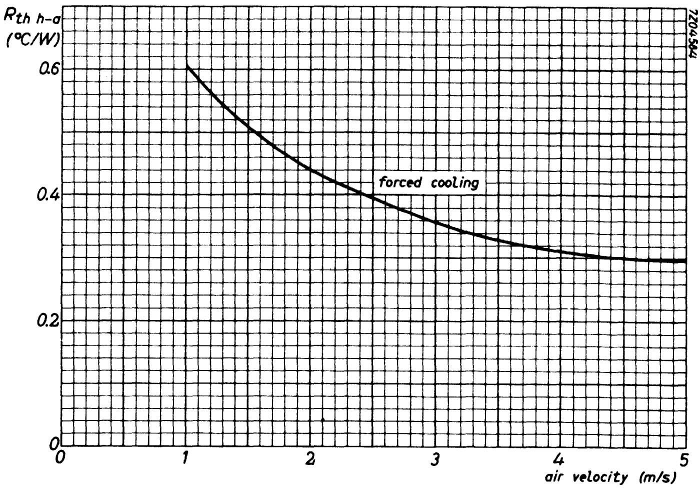


The graphs are valid for the combination of thyristor and heatsink.



Stud: $\frac{1}{2}$" x 20UNF
Mounting base, across the flats: 27.0 mm



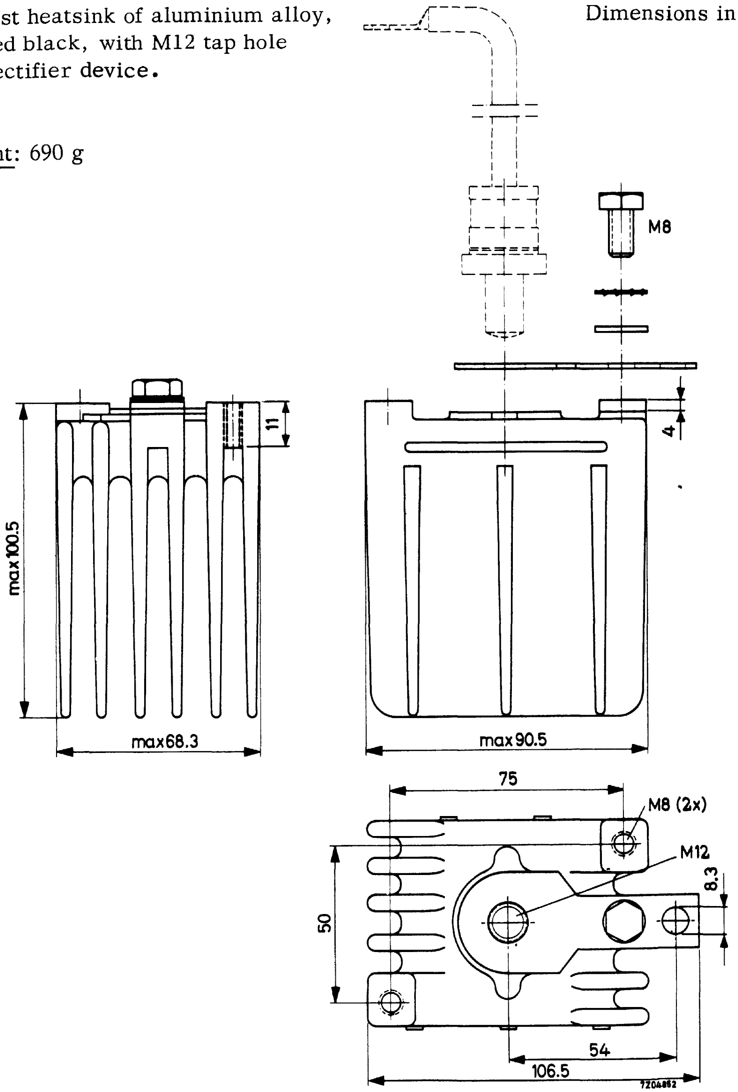


DIECAST HEATSINK

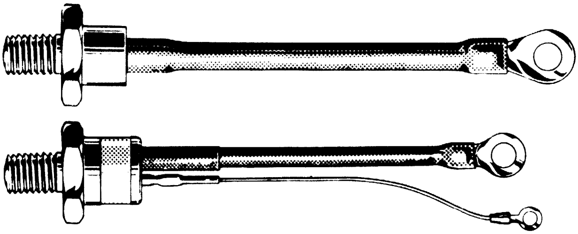
Diecast heatsink of aluminium alloy, painted black, with M12 tap hole for rectifier device.

Dimensions in mm

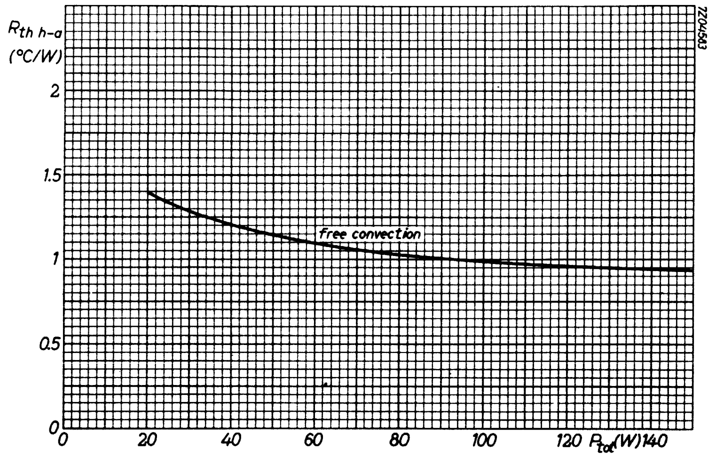
<u>Weight</u>: 690 g

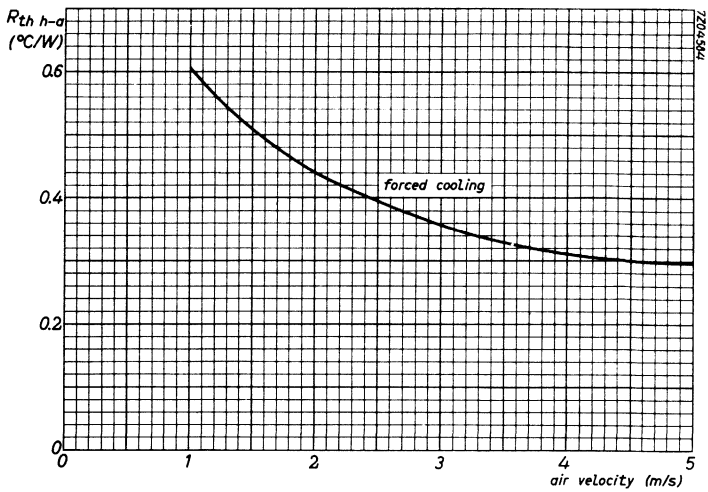


The graphs are valid for the combination of device and heatsink.



Stud: M12
Mounting base, across the flats: 27.0 mm



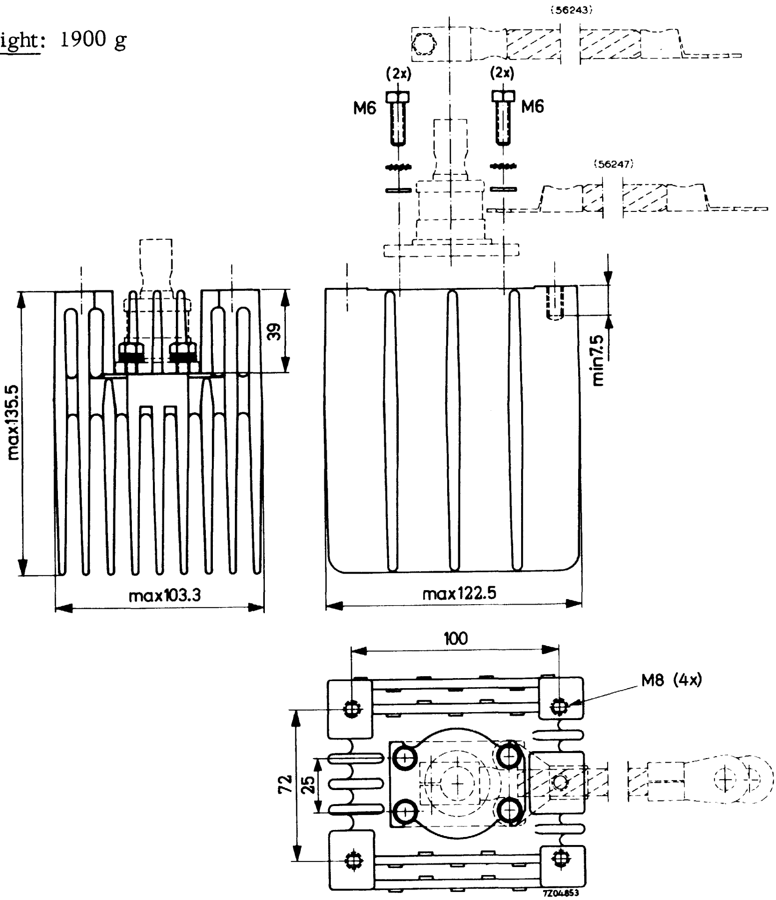


DIECAST HEATSINK

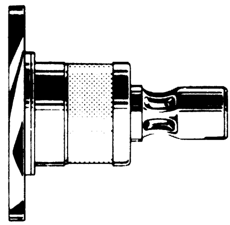
Diecast heatsink of aluminium alloy, painted black, intended for devices with flat mounting base.

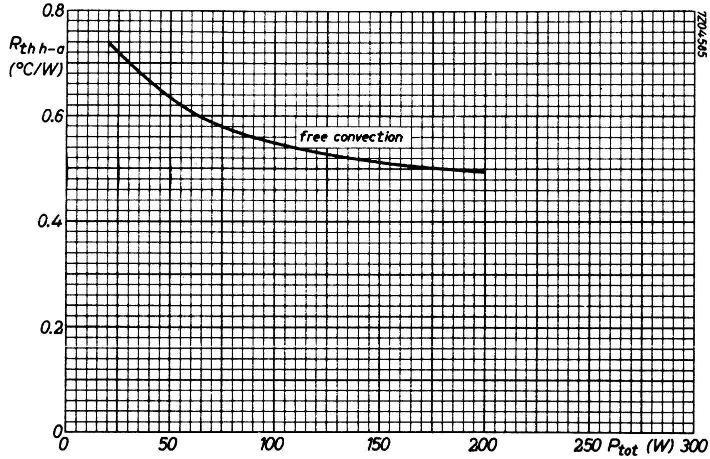
Dimensions in mm

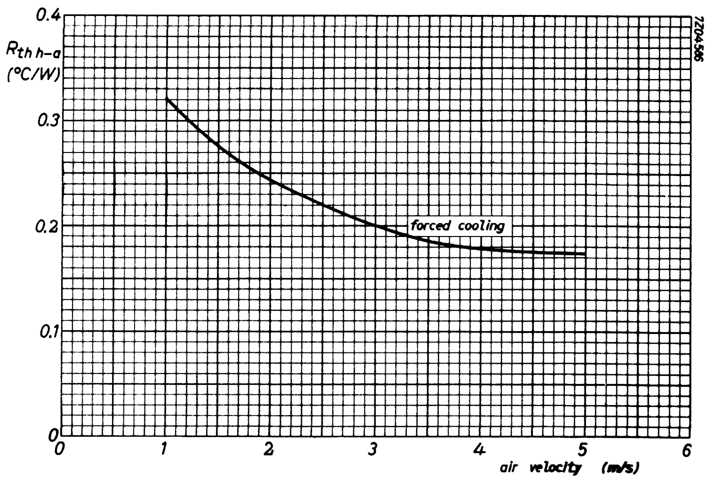
Weight: 1900 g



The graphs are valid for the combination of diode and heatsink.





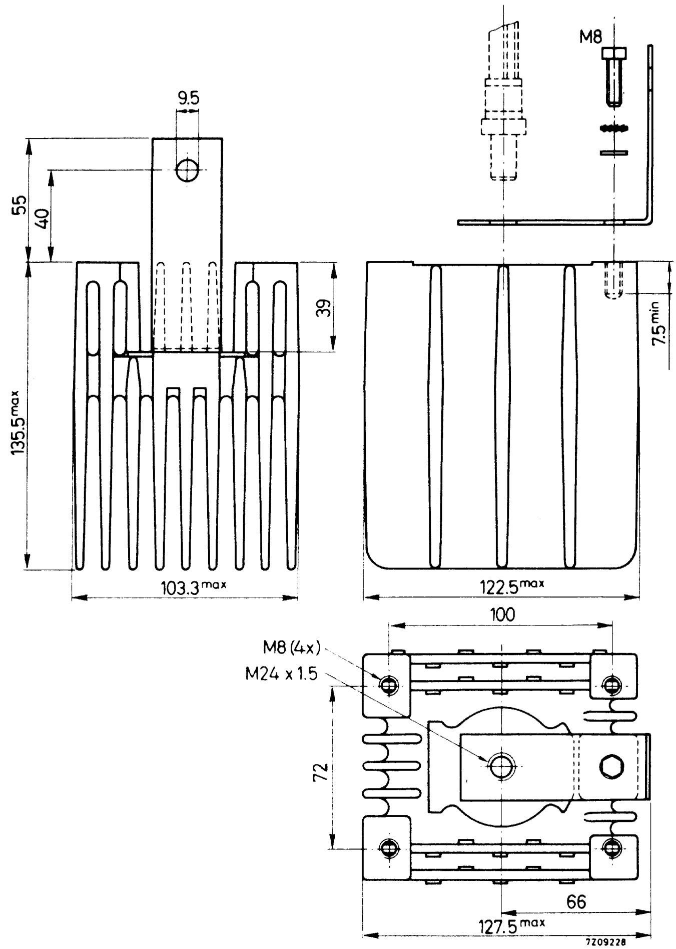


DIECAST HEATSINK

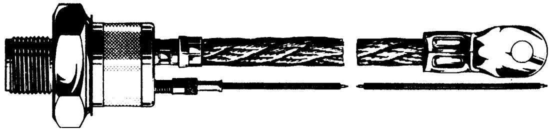
Diecast heatsink of aluminium alloy, painted black, with M24 x 1.5 tap hole for rectifier device.

Dimensions in mm

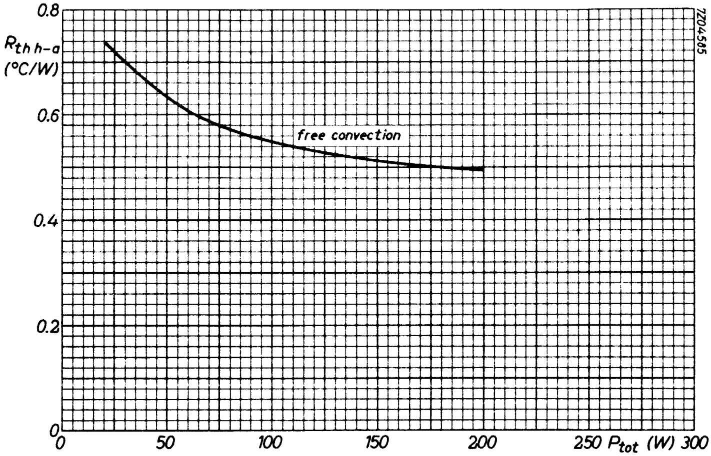
Weight: 1900 g

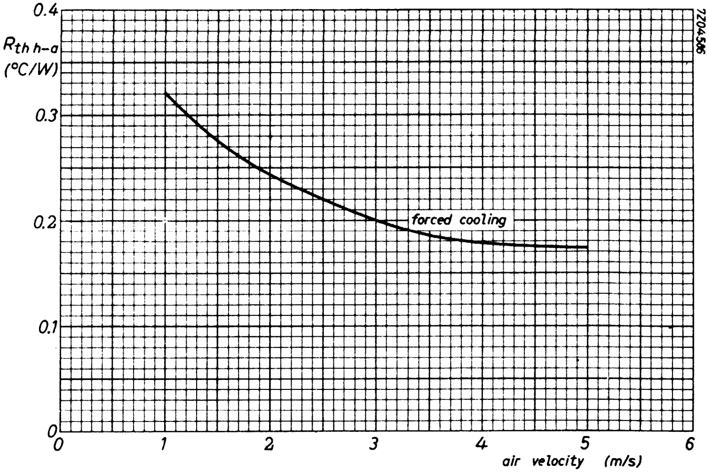


The graphs are valid for the combination of thyristor and heatsink.



Stud: M24 x 1.5
Mounting base, across the flats: 46 mm



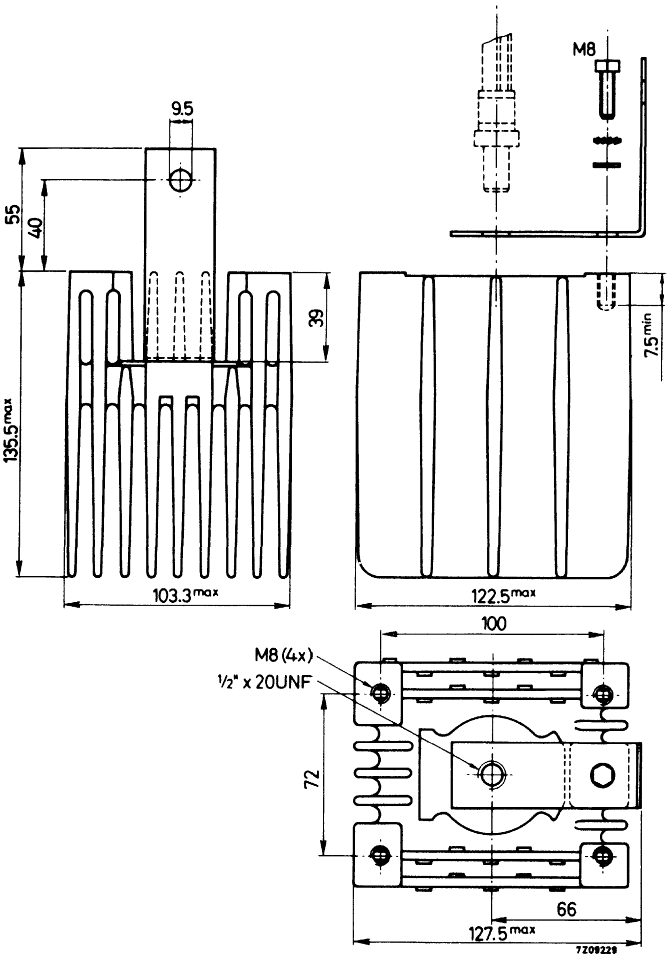


DIECAST HEATSINK

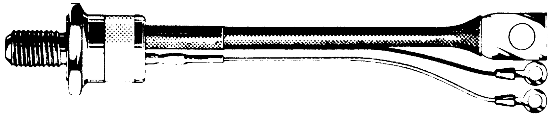
Diecast heatsink of aluminium alloy, painted black, with $\frac{1}{2}$" x 20UNF tap hole for rectifier device.

Dimensions in mm

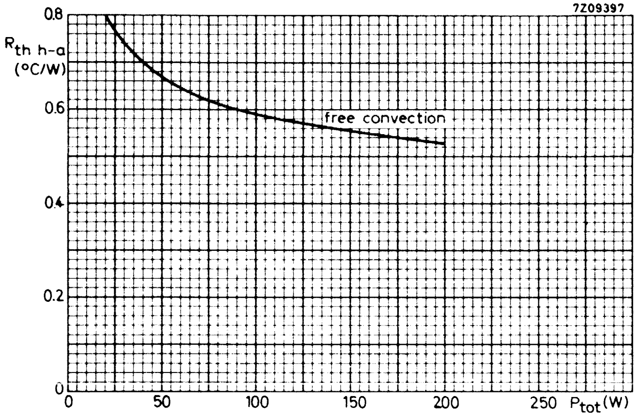
Weight: 1900 g

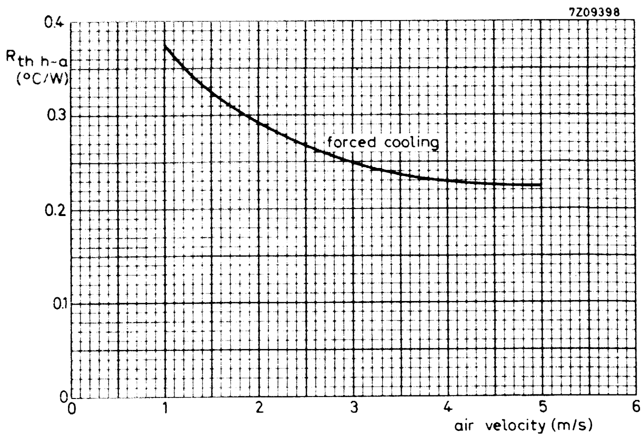


The graphs are valid for the combination of thyristor and heatsink.



Stud: $\frac{1}{2}$" x 20 UNF
Mounting base, across the flats: 27.0 mm





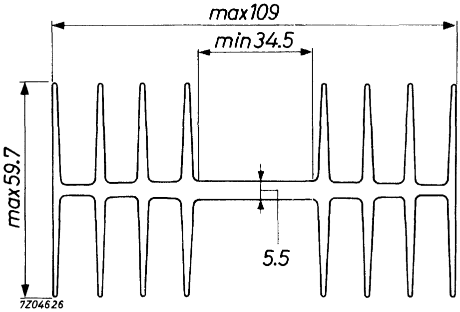
HEATSINK EXTRUSIONS

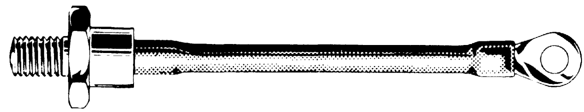
EXTRUDED ALUMINIUM HEATSINK

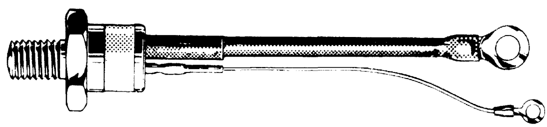
Extruded heatsink of aluminium alloy.
The extrusion is supplied unpainted, in lengths of 1.5 m.

Weight: 4 kg per 1.5 m.

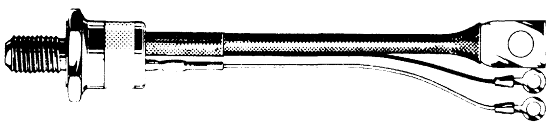
Dimensions in mm





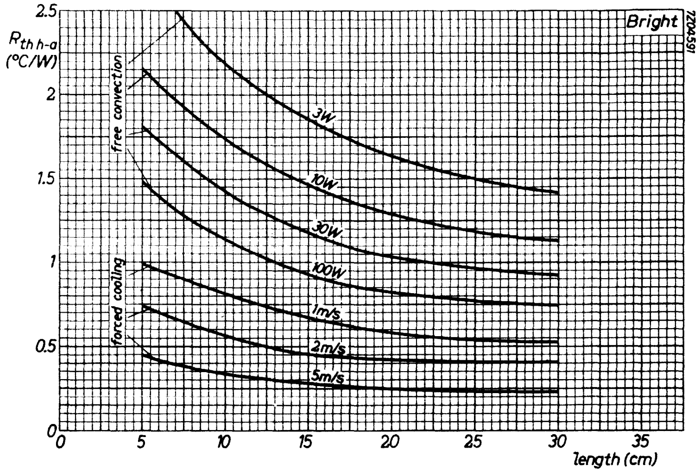


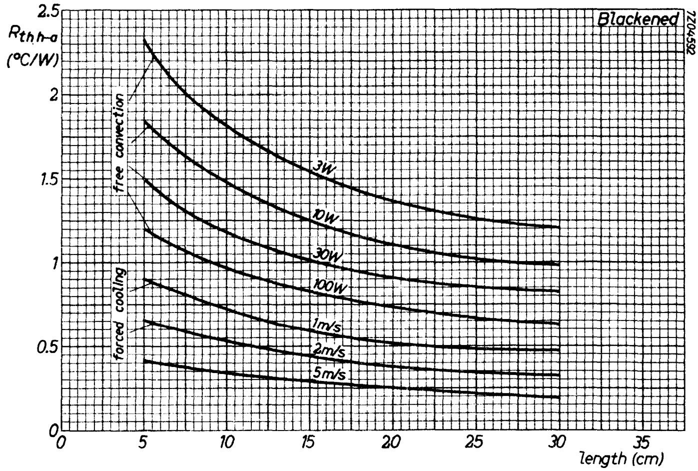
Studs: M12
Mounting bases, across the flats: 27.0 mm



Stud: $\frac{1}{2}$" x 20UNF
Mounting base, across the flats: 27.0 mm

The graphs are valid for the combination of rectifier device and heatsink.



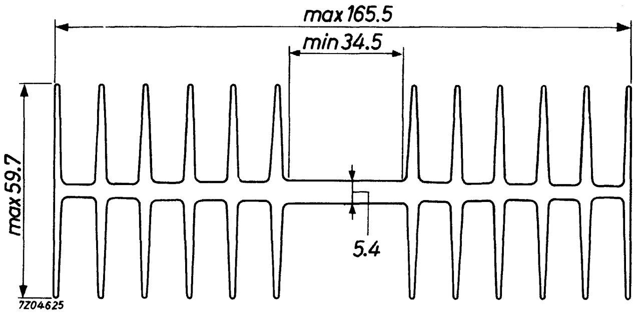


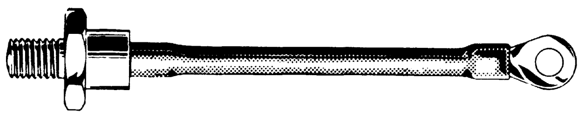
EXTRUDED ALUMINIUM HEATSINK

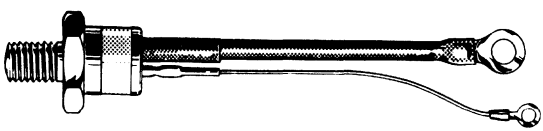
Extruded heatsink of aluminium alloy.
The extrusion is supplied unpainted, in lengths of 1.5 m.

Weight: 6 kg per 1.5 m.

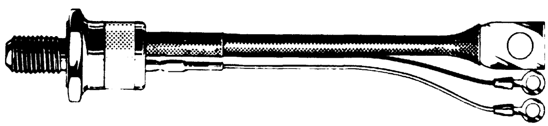
Dimensions in mm





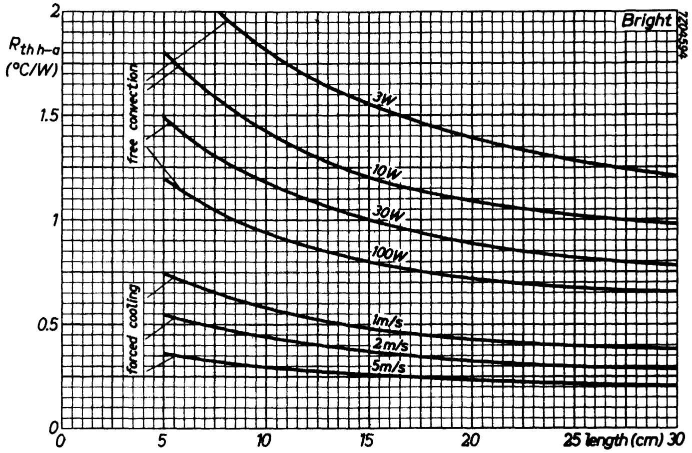


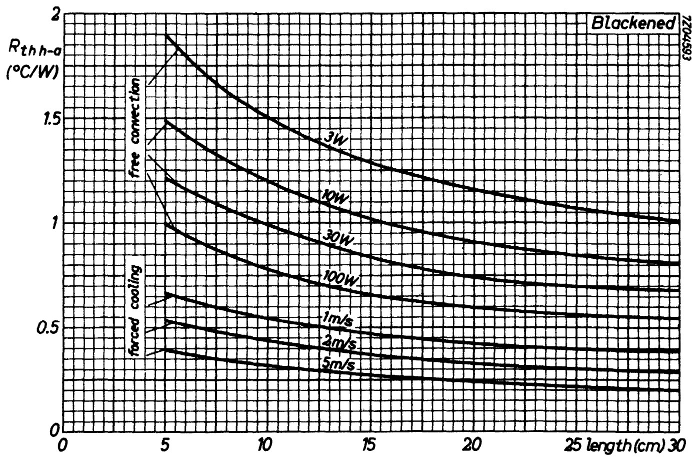
Studs: M12
Mounting bases, across the flats: 27.0 mm



Studs: ½" x 20UNF
Mounting base, across the flats: 27.0 mm

The graphs are valid for the combination of rectifier device and heatsink



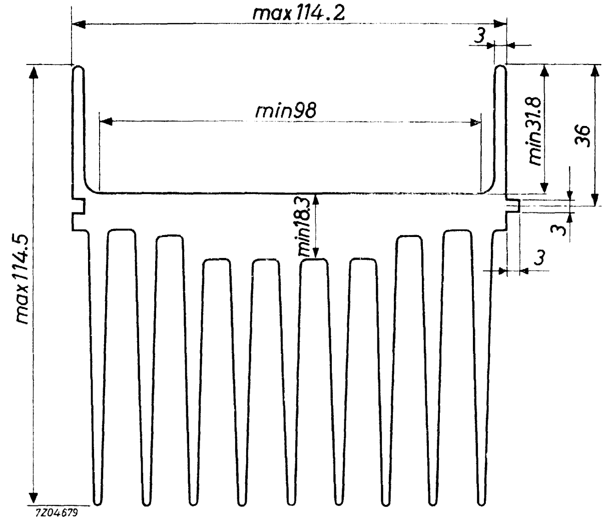


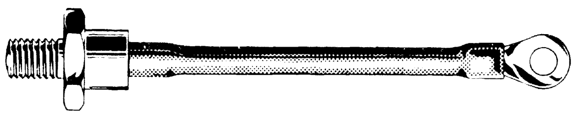
EXTRUDED ALUMINIUM HEATSINK

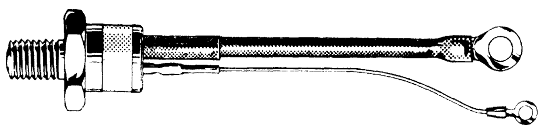
Extruded heatsink of aluminium alloy.
The extrusion is supplied unpainted, in lengths of 1.0 m.

Weight: 10.8 kg per 1.0 m.

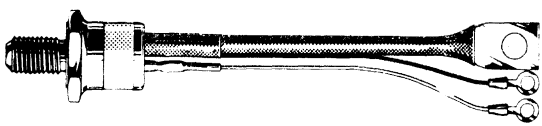
Dimensions in mm





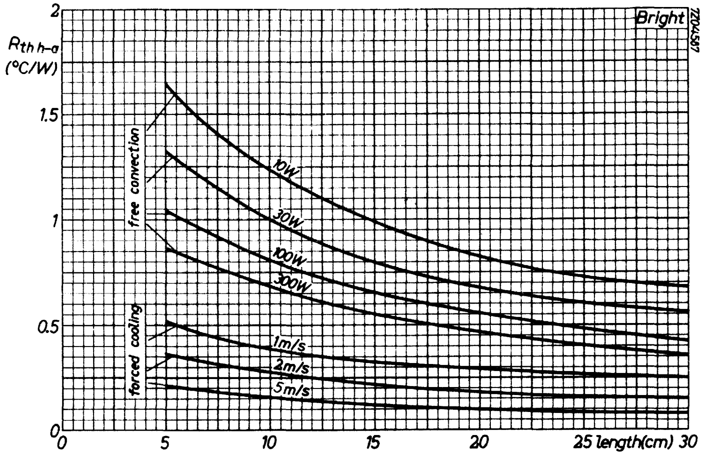


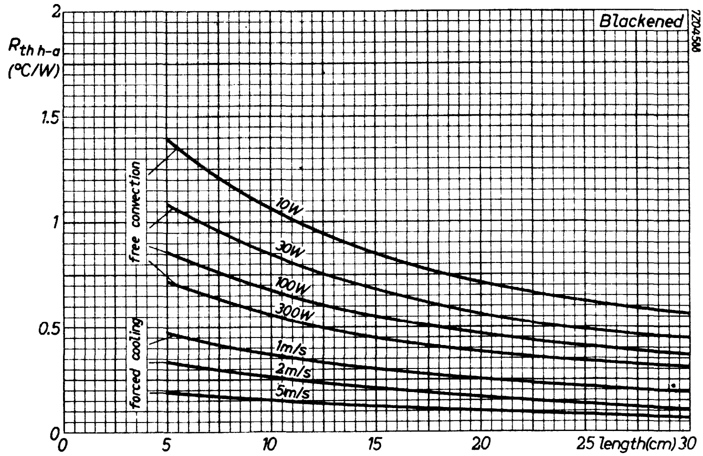
Studs: M12
Mounting bases, across the flats: 27.0 mm



Studs: $\frac{1}{2}$" x 20UNF
Mounting base, across the flats: 27.0 mm

The graphs are valid for the combination of rectifier device and heatsink.
For devices with a flat base see over.



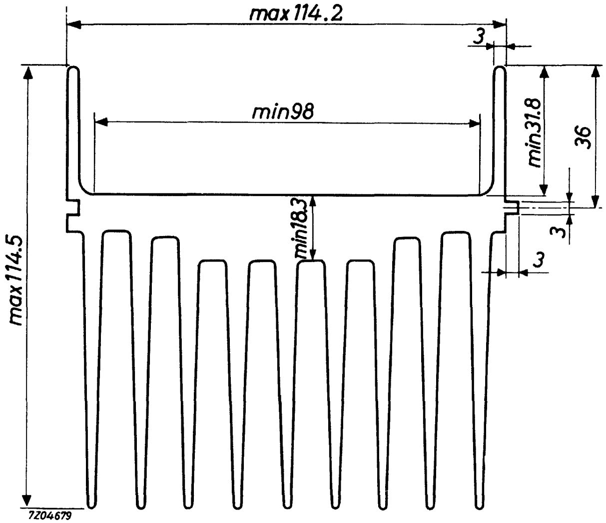


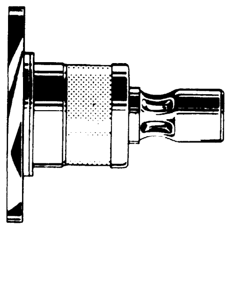
EXTRUDED ALUMINIUM HEATSINK

Extruded heatsink of aluminium alloy.
The extrusion is supplied unpainted, in lengths of 1.0 m.

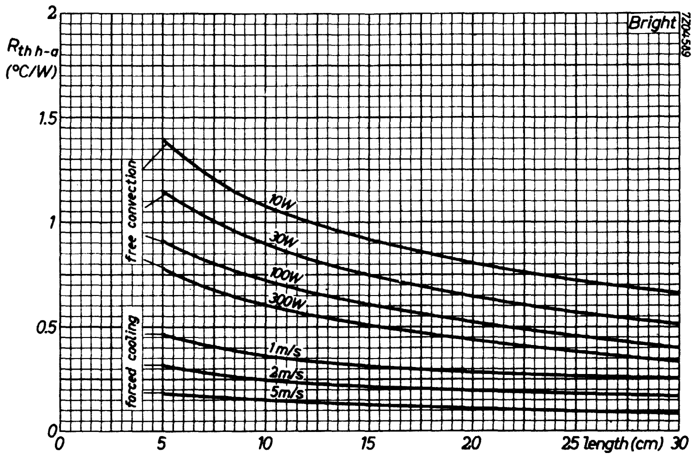
Weight: 10.8 kg per 1.0 m.

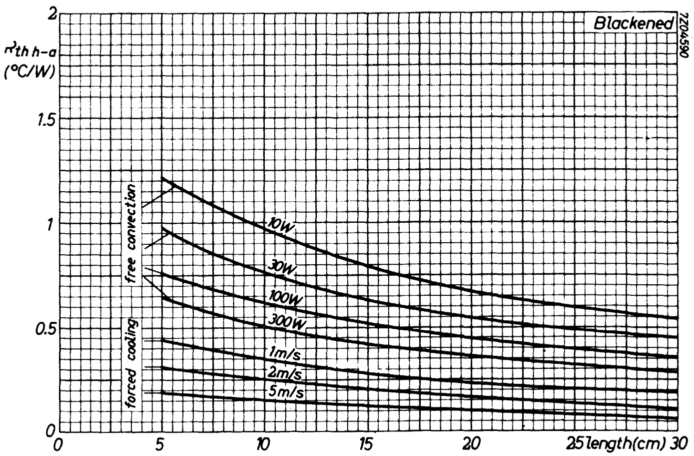
Dimensions in mm





The graphs are valid for the combination of rectifier device and heatsink.
For devices with threaded studs turn back one page.



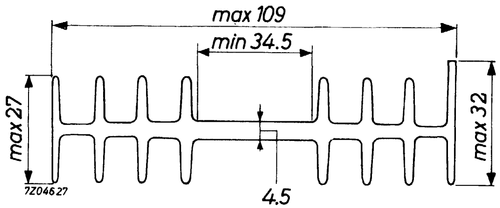


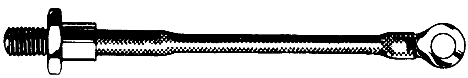
EXTRUDED ALUMINIUM HEATSINK

Extruded heatsink of aluminium alloy.
The extrusion is supplied unpainted, in lengths of 1.5 m.

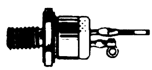
Weight: 2.4 kg per 1.5 m.

Dimensions in mm



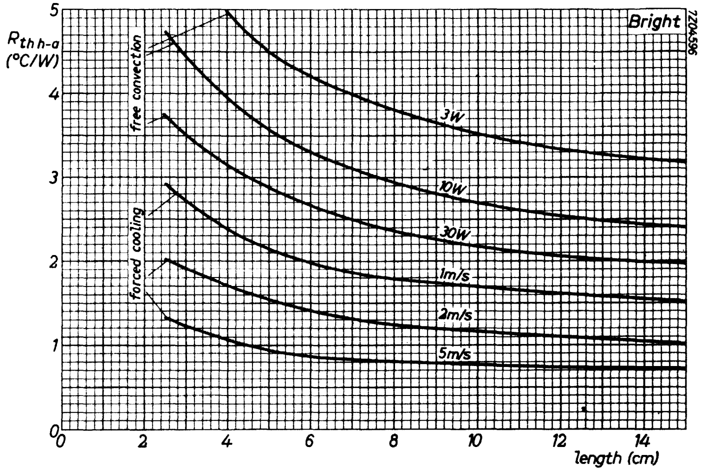


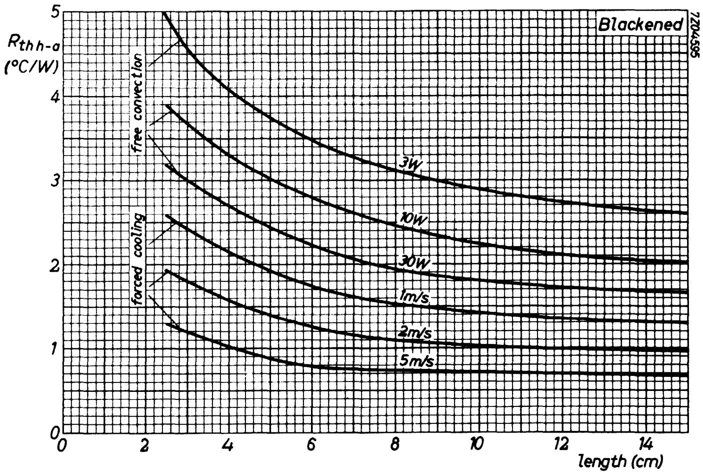
Stud: M8
Mounting base, across the flats: 17.0 mm



Stud: $\frac{1}{4}$" x 28UNF
Mounting base, across the flats: 14.3 mm

The graphs valid for the combination of rectifier device and heatsinks.



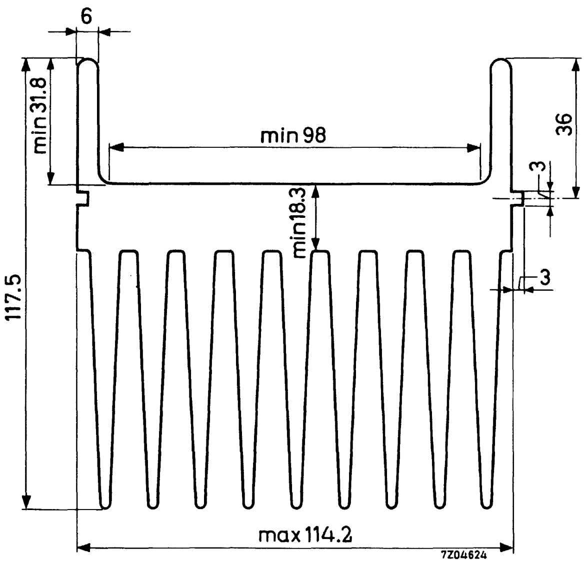


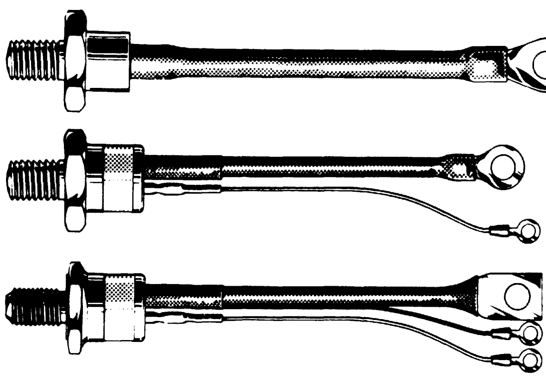
EXTRUDED ALUMINIUM HEATSINK

Extruded heatsink of aluminium alloy.
The extrusion is supplied unpainted, in lengths of 1.5 m.

Weight: 16.2 kg per 1.5 m.

Dimensions in mm

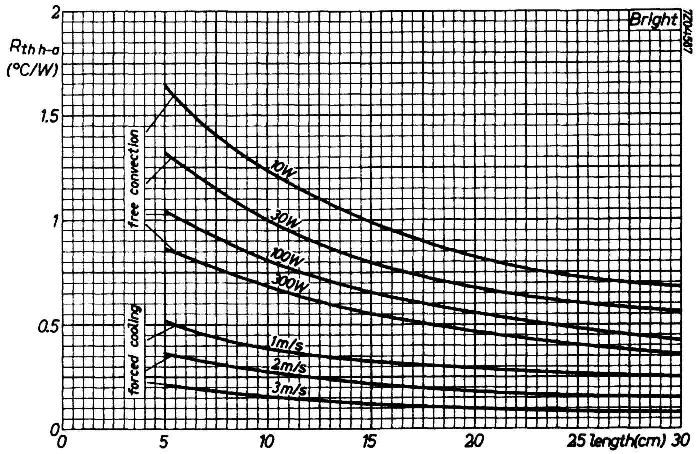


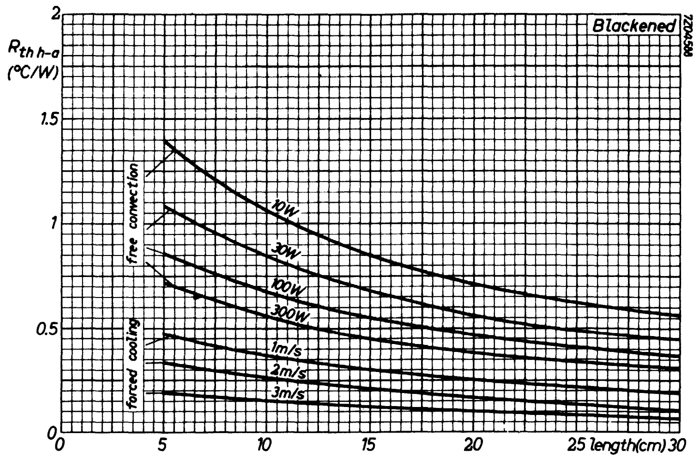


Studs: M12
Mounting bases, across the flats: 27.0 mm

Stud: $\frac{1}{2}$" x 20UNF
Mounting base, across the flats: 27.0 mm

The graphs are valid for the combination of rectifier device and heatsink.
For devices with a flat base see over.



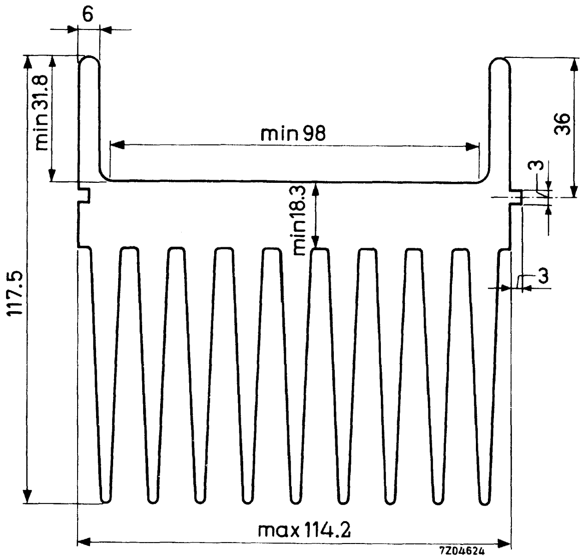


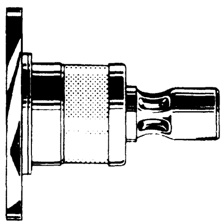
EXTRUDED ALUMINIUM HEATSINK

Extruded heatsink of aluminium alloy.
The extrusion is supplied unpainted, in lengths of 1.5 m.

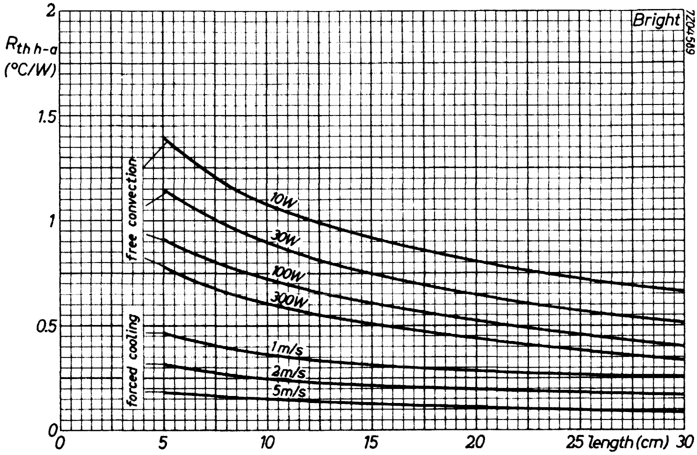
Weight: 16.2 kg per 1.5 m.

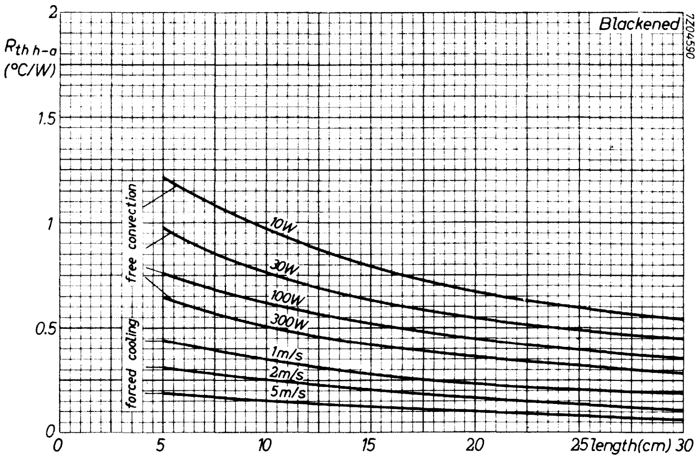
Dimensions in mm





The graphs are valid for the combination of rectifier device and heatsink.
For devices with threaded studs turn back one page.





INDEX OF TYPE NUMBERS

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

GeTr = Germanium Transistors
Ph = Photo devices

Type No.	Section	Type No.	Section	Type No.	Section
OC76	GeTr	OC170	GeTr	2N1303	GeTr
OC77	GeTr	OC171	GeTr	2N1304	GeTr
OC79	GeTr	OCP70	Ph	2N1305	GeTr
OC80	GeTr	ORP10	Ph	2N1306	GeTr
OC122	GeTr	ORP13	Ph	2N1307	GeTr
OC123	GeTr	2N174	GeTr	2N1308	GeTr
OC139	GeTr	2N277	GeTr	2N1309	GeTr
OC140	GeTr	2N441	GeTr	61SV	Ph
OC141	GeTr	2N1100	GeTr	40809	GeTr
OC169	GeTr	2N1302	GeTr	40819	GeTr

GeTr = Germanium Transistors
Ph = Photo devices

For Accessories and Heatsinks refer to the separate index, in the relevant section.