PHILIPS

DATA HANDBOOK

PHILIPS ELECTRONIC COMPONENTS AND MATERIALS DIVISION

SEMICONDUCTORS AND INTEGRATED CIRCUITS

PART 2 SEPTEMBER 1967

Germanium Transistors

Photoelectric Devices

Accessories and Heatsinks

SEMICONDUCTORS AND INTEGRATED CIRCUITS

Part 2 September 1967

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

The contents of this (red) series has been rearranged and will appear in three volumes as listed below.

Part 1 August 1967	Former issue
General section Low power diodes Variable capacitance diodes Zener diodes Power diodes Thyristors Rectifier stacks	Part 1 October 1966
Accessories and Heatsinks	Part 2 October 1966

Part 2 September 1967	
General section	Part 1 October 1966
Germanium transistors	Part 1 and 2 October 1966
Photosensitive devices Accessories and Heatsinks	Part 2 October 1966

Part 3 October 1967	
General section	Part 1 October 1966
Silicon transistors Integrated circuits Accessories and Heatsinks	Part 2 October 1966

General section

Index of type numbers
Type designation
Rating systems
Letter symbols

INDEX OF TYPE NUMBERS

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

Type No.	Section	Type No.	Section	Type No.	Section
AC107	GeTr	AF125	GeTr	ASZ18	GeTr
AC125	GeTr	AF126	GeTr	ASZ20	GeTr
AC126	GeTr	AF127	GeTr	ASZ21	GeTr
AC127	GeTr	AF139	GeTr	ASZ23	GeTr
AC127/01	GeTr	AF178	GeTr	AU101	GeTr
AC128	GeTr	AF179	GeTr	AU102	GeTr
AC128/01	GeTr	AF180	GeTr	AU103	GeTr
AC130	GeTr	AF181	GeTr	AU104	GeTr
AC132	GeTr	AF185	GeTr	AUY10	GeTr
AC132/01	GeTr	AF186	GeTr	BPY10	Ph
AC172	GeTr	AF239	GeTr	OAP12	Ph
AC187	GeTr	AFY16	GeTr	OC22	GeTr
AC187/01	GeTr	AFY19	GeTr	OC23	GeTr
AC188	GeTr	AFY40	GeTr	OC24	GeTr
AC188/01	GeTr	AFZ12	GeTr	OC26	GeTr
AD139	GeTr	ASY26	GeTr	OC30	GeTr
AD149	GeTr	ASY27	GeTr	OC44	GeTr
AD161	GeTr	ASY28	GeTr	OC45	GeTr
AD162	GeTr	ASY29	GeTr	OC46	GeTr
ADY26	GeTr	ASY31	GeTr	OC47	GeTr
ADZ11	GeTr	ASY32	GeTr	OC57	GeTr
ADZ12	GeTr	ASY73	GeTr	OC58	GeTr
AF102	GeTr	ASY74	GeTr	OC59	GeTr
AF114	GeTr	ASY75	GeTr	OC60	GeTr
AF115	GeTr	ASY76	GeTr	OC70	GeTr
AF116	GeTr	ASY77	GeTr	OC71	GeTr
AF117	GeTr	ASY80	GeTr	OC72	GeTr
AF118	GeTr	ASZ15	GeTr	OC74	GeTr
AF121	GeTr	ASZ16	GeTr	OC75	GeTr
AF124	GeTr	ASZ17	GeTr	OC76	GeTr

GeTr = Germanium Transistors
Ph = Photoelectric devices

7Z3 1442

GeTr = Germanium Transistors
Ph = Photoelectric devices

For Mounting Accessories and Heatsinks refer to the separate index, in the section Accessories, pages 2 and 3.

7Z3 1443

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.

7Z3 0364

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 ($R_{th\ j\text{-}mb} \leq 15\ ^oC/W$)[1]
- 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 [1]
- Z Voltage reference or voltage regulator diode [1]

[1] For the type designation of a range see page 4

7Z3 0365

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

7Z3 0366

TYPE DESIGNATION FOR A RANGE OF SEMICONDUCTOR DEVICES

The type designation of a range of variants of:

a) voltage reference or voltage regulator diodes (second letter Z)

b) rectifying diodes (second letter Y)

c) thyristors (second letter T)

distinctly belonging to one basic type may be qualified by a suffix part which is clearly separated from the basic part by a dash (-)
The basic part being the same for the whole range, is in accordance with the designation code for discrete devices.

The suffix part consists of:

a) for voltage reference or voltage regulator diodes

one letter followed by the typical zener voltage and where appropriate the letter R [1])
The first letter indicates the nominal tolerance of the zener voltage in %

A	1%
B	2%
C	5%
D	10%
E	15%

The typical zener voltage is related to the nominal current rating for the whole range. The letter V is used to denote the decimal point when this occurs.

→ b) for rectifying diodes

a number and where appropriate the letter R [1])
The number generally indicates the maximum repetitive peak reverse voltage
For controlled avalanche types it indicates the maximum crest working reverse voltage

→ c) for thyristors

a number and where appropriate the letter R [1])
The number generally indicates either the maximum repetitive peak reverse voltage or the maximum repetitive peak off-state voltage, whichever is lower
For controlled avalanche types it indicates the maximum crest working reverse voltage

[1]) The letter R indicates reverse polarity (stud anode). The normal polarity (stud cathode) and symmetrical executions are not specially indicated.

7Z3 1225

EXAMPLES

BZY88series	Range of silicon voltage regulator diodes for industrial applications
BZY88-C9V1	The particular type out of the range with a typical zener voltage of 9.1 V ± 5%
BYX13-1200	The particular normal polarity type out of the BYX13series with a maximum repetitive peak reverse voltage of 1200 V
BTX13-200R	The particular reverse polarity type out of the BTX13 thyristor range of which the lower maximum repetitive peak voltage is 200 V

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

7Z3 0368

TYPE DESIGNATION FOR SEMICONDUCTOR RECTIFIER STACKS

The type designation consists of:

Three letters followed by a serial number

The first 2 letters indicate the type of stack:

OS Denotes a semiconductor rectifier diode stack

OT Denotes a semiconductor stack in which also thyristors are used

The third letter indicates the type of circuit:

A Single phase half wave

B Two phase half wave

C Three phase half wave (three phase star)

D Four phase half wave (four phase star)

E Six phase half wave (six phase star)

F Three phase double Y with interphase transformer

H Single phase full wave (single phase bridge)

J Single phase magnetic amplifier bridge

K Three phase full wave (three phase bridge)

L Four phase full wave (four phase bridge)

M Voltage doubler (half a single phase full wave)

S Miscellaneous (such as combinations of single diodes and passive components)

The serial number is sometimes followed by a suffix letter for the indication of variants.

7Z3 0632

TYPE DESIGNATION FOR NETWORKS

This code applies to networks in non-accessible envelopes, such as integrated circuit devices.
The type designations according to this code distinguish between solitary networks and networks belonging to a family. A family is defined as a group of networks which are related in their specifications, and primarily designed to be mutually connected.

The type designation consists of:

THREE LETTERS FOLLOWED BY THREE FIGURES

The two first letters indicate a family respectively a solitary type

Family types: FA, FB, FC, etc.
GA, GB, GC, etc.

Solitary types: TA, TB, TC, etc.

The third letter indicates the circuit function in categories

A Linear amplification
B Frequency conversion/demodulation
C Oscillating/generating (continuous)
D Multiples of dissimilar linear networks
G Multiple of non-interconnected discrete devices when belonging to a family of networks
H Logic
J Storage (continuous)
K Timing (incl. temporary storage)
L Digital level conversion
Y Miscellaneous

The two first figures represent the serial number

The third figure indicates the temperature range

1 0 to +75 °C
2 −55 to +125 °C
0 other temperature ranges

7Z3 0633

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.

7Z3 0362

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.

7Z3 0363

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}, $I_{c(rms)}$, $I_{C(rms)}$

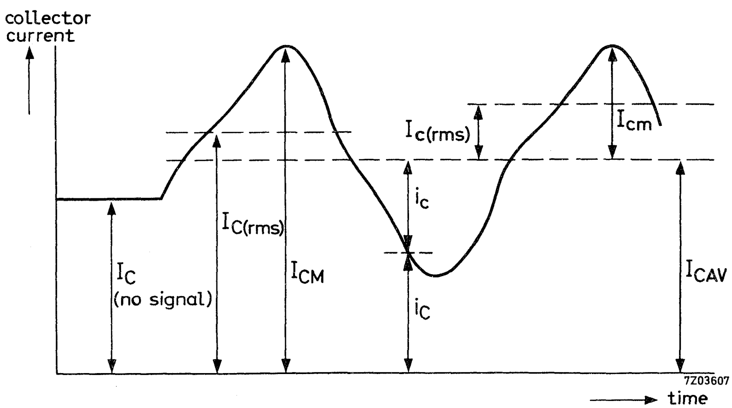
7Z3 0339

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



7Z3 0340

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.

7Z3 0341

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.

7Z3 0342

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

7Z3 0343

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.

7Z3 0344

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

7Z3 0345

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

7Z3 0346

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.

7Z3 0348

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

LETTER SYMBOLS
FOR POWER DIODES AND THYRISTORS

This system is based on the Recommendations of the INTERNATIONAL ELECTROTECHNICAL COMMISSION.

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.
2. Values of varying components are indicated by lower case subscripts.
3. For power rectifier diodes and thyristors the terminal(s) are not indicated in the subscripts, except for the gate-terminal of thyristors.
4. List of subscripts:

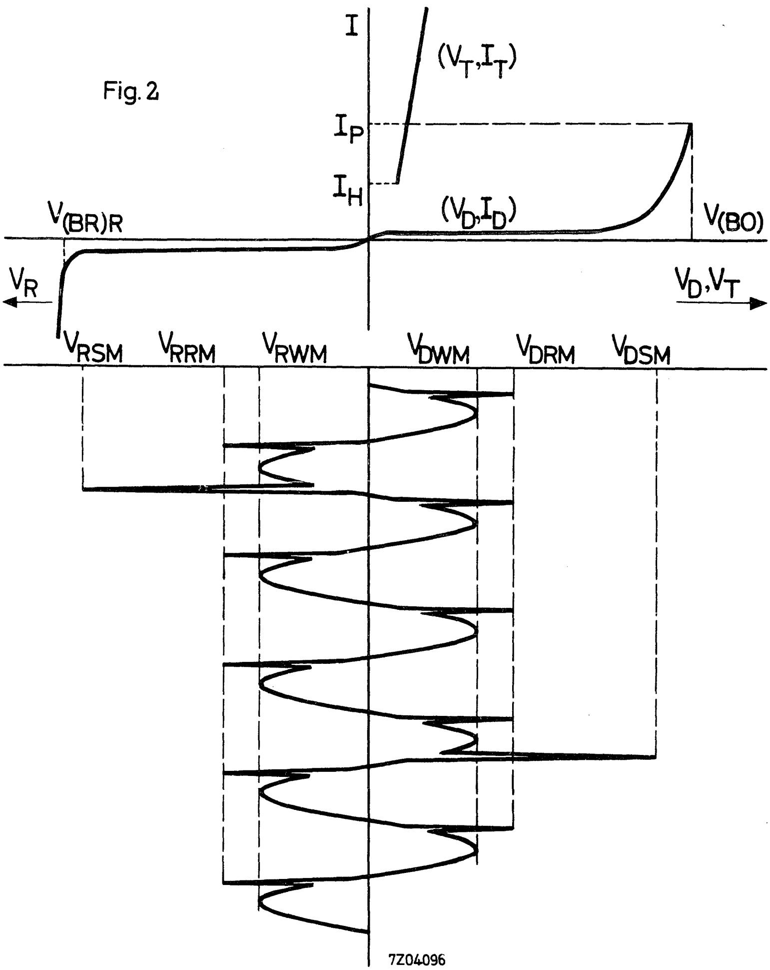
G, g	=	Gate terminal
F, f	=	Forward [1]
D, d	=	Forward off-state [1]; non trigger (gate voltage or current)
T, t	=	Forward on-state [1]; trigger (gate voltage or current)
R, r	=	As first subscript; Reverse As second subscript: Repetitive
AV, av	=	Average value
M, m	=	Maximum (peak or crest) value
(rms)	=	R.M.S. value
(BR)	=	Breakdown
(BO)	=	Breakover
H	=	Holding
P	=	Pick-up
Q	=	Turn off
S	=	As a second subscript: Non repetitive
W	=	Working

[1]) For the anode-cathode voltage of thyristors F is replaced either by D or by T, to distinguish between "off-state" (non triggered) and "on-state" (triggered).

7Z3 0350

5. Examples of the application of the rules.
   Fig. 2 represents a simplified thyristor characteristic together with an anode-cathode voltage as a function of time (no gate signal).

Fig. 2



7Z3 0351

LIST OF LETTER SYMBOLS IN ALPHABETICAL ORDER
for Rectifier Diodes (R) and Thyristors (T)

Instantaneous values (i, p, v) and a.c. components (lower case subscripts) have been omitted.

Letter symbol	R	T	Description
I_D	-	T	Off-state current (d.c.)
I_F	R	-	Forward current (d.c. or average)
I_{FAV}	R	-	Total average forward current (to distinguish between average and d.c. if necessary)
I_{FGM}	-	T	Forward peak gate current
I_{FRM}	R	-	Repetitive peak forward current
I_{FSM}	R	-	Non repetitive peak forward current
I_H	-	T	Holding current
I_{GT}	-	T	Gate current to trigger the device
I_P	-	T	Pick up current
I_R	R	T	Reverse current (d.c.)
I_{RG}	-	T	Reverse gate current
I_{RRM}	R	T	Repetitive peak reverse current
I_T	-	T	Forward on-state current (d.c.)
I_{TAV}	-	T	Average (forward) on-state current
$I_{T(rms)}$	-	T	R.M.S. value of the (forward) on-state current
I_{TRM}	-	T	Repetitive peak (forward) on-state current
I_{TSM}	-	T	Non repetitive peak (forward) on-state current
P_{GAV}	-	T	Average gate power dissipation
P_{GM}	-	T	Peak gate power dissipation
P_{RAV}	R	T	Average reverse power dissipation
P_{RRM}	R	T	Repetitive peak reverse power dissipation

7Z3 0352

Letter symbol	R	T	Description
P_{RSM}	R	T	Non repetitive peak reverse power dissipation
$V_{(BO)}$	–	T	Breakover voltage
$V_{(BR)R}$	R	T	Reverse breakdown voltage
V_D	–	T	Continuous off-state voltage
V_{DRM}	–	T	Repetitive peak off-state voltage
V_{DSM}	–	T	Non repetitive peak off-state voltage
V_{DWM}	–	T	Crest working off-state voltage
V_F	R	–	Continuous forward voltage
V_{FGM}	–	T	Forward peak voltage, gate-cathode
V_{GD}	–	T	Gate-cathode voltage not to trigger the device
V_{GT}	–	T	Gate-cathode voltage to trigger the device
V_R	R	T	Continuous reverse voltage
V_{RGM}	–	T	Reverse peak voltage, gate-cathode
V_{RRM}	R	T	Repetitive peak reverse voltage
V_{RSM}	R	T	Non repetitive peak reverse voltage
V_{RWM}	R	T	Crest working reverse voltage
V_T	–	T	Continuous (forward) on-state voltage

7Z3 0353

Germanium transistors

AC107

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) [1])

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. 35 to 160	60	
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

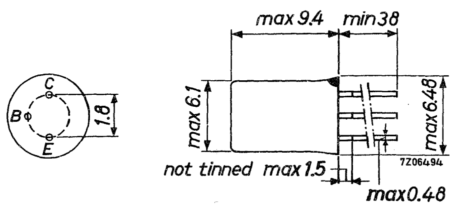
GERMANIUM ALLOY TRANSISTOR

P-N-P transistor in a TO-1 metal envelope intended for use in pre-amplifier or driver stages with battery voltages up to 14 V.

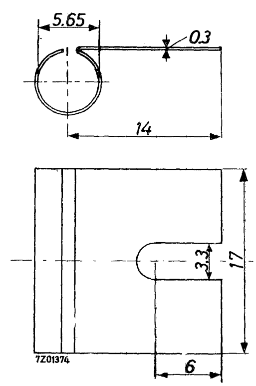
QUICK REFERENCE DATA				
Collector-base voltage (open emitter)	$-V_{CBO}$	max.	32	V
Collector-emitter voltage (open base)	$-V_{CEO}$	max.	12	V
Collector current (d.c.)	$-I_C$	max.	100	mA
Total power dissipation up to T_{amb} = 45 °C with cooling fin No. 56227 on a heatsink of at least 12.5 cm^2	P_{tot}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

MECHANICAL DATA Dimensions in mm

TO-1



The red dot indicates the collector



Cooling fin: 56227
7Z3 0842

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.	100	mA
Base current (d.c.)	$-I_B$	max.	5	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	$R_{th\ j\text{-}a}$	=	0.3	°C/mW
From junction to ambient with cooling fin No. 56227 mounted on a heatsink of at least 12.5 cm^2	$R_{th\ j\text{-}a}$	=	0.09	°C/mW

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

7Z3 0843

CHARACTERISTICS $T_{amb} = 25\ ^oC$ 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; $T_j = 75\ ^oC$	$-I_{CBO}$	<	800	µA
Emitter cut-off current				
$I_C = 0$; $-V_{EB} = 5$ V; $T_j = 75\ ^oC$	$-I_{EBO}$	<	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; $R_S = 500\ \Omega$ Bandwidth = 200 Hz	F	typ. <	4 10	dB dB

7Z3 0844

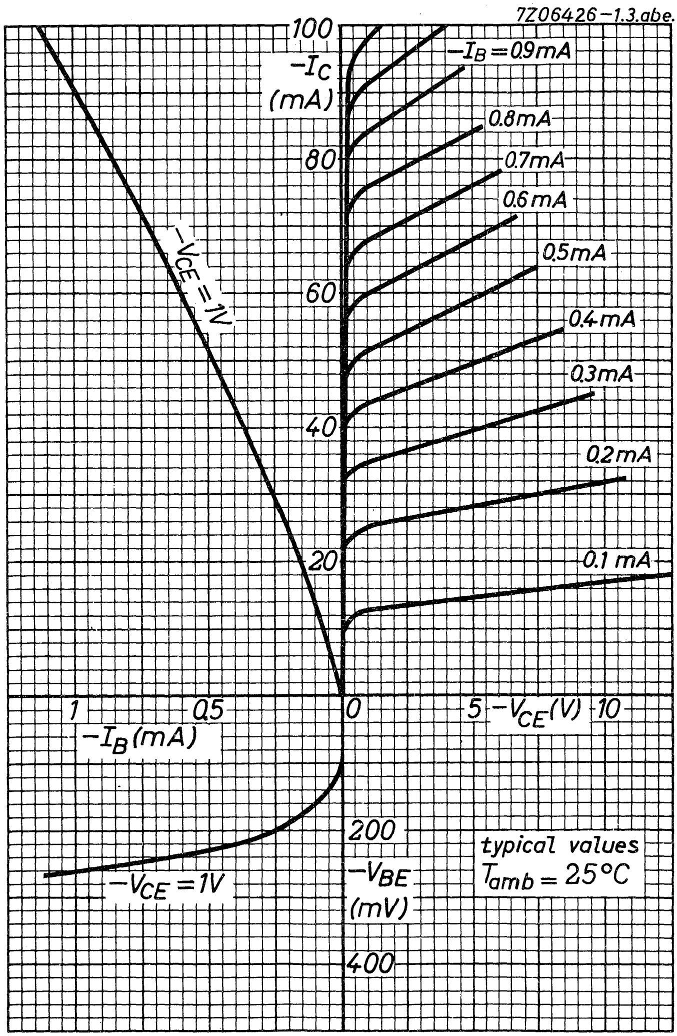
CHARACTERISTICS (continued) T_{amb} = 25 °C unless otherwise specified

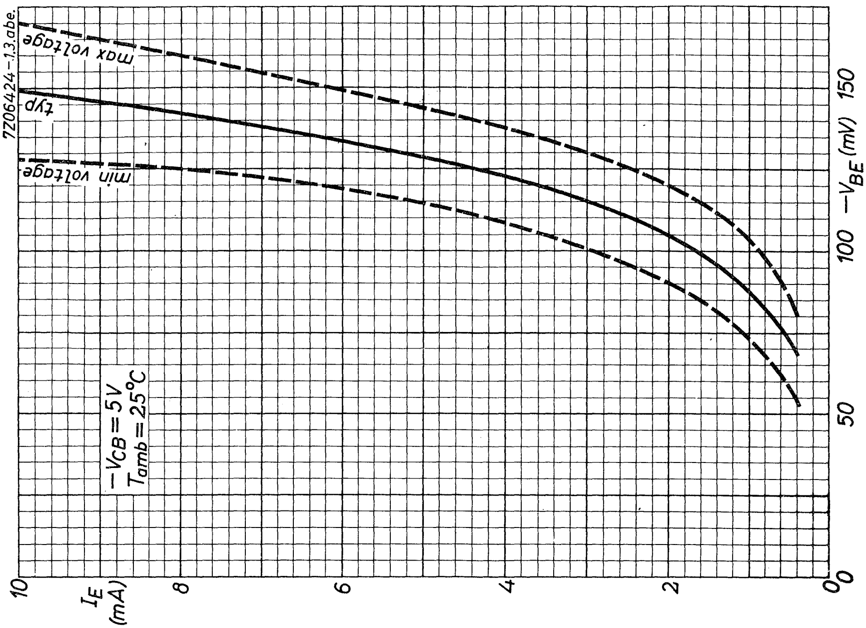
h parameters at f = 1 kHz

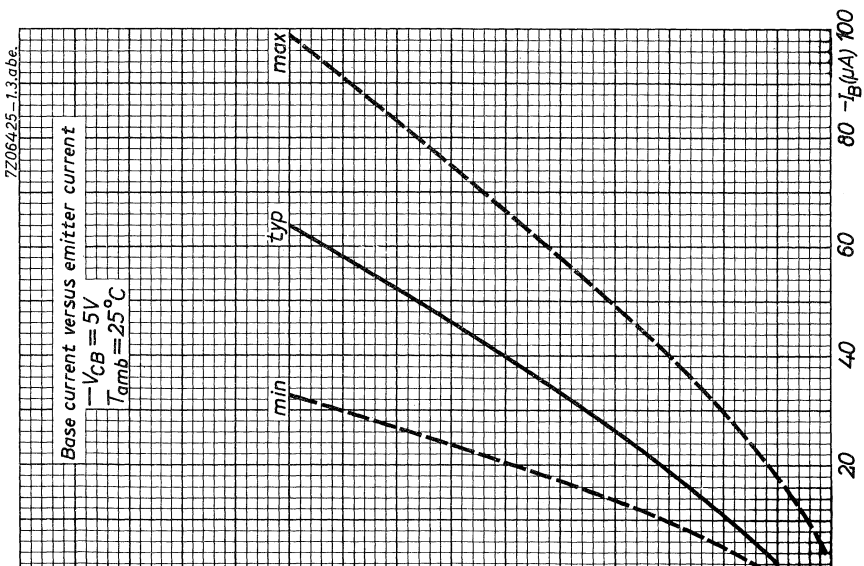
$-I_C$ = 2 mA; $-V_{CE}$ = 5 V

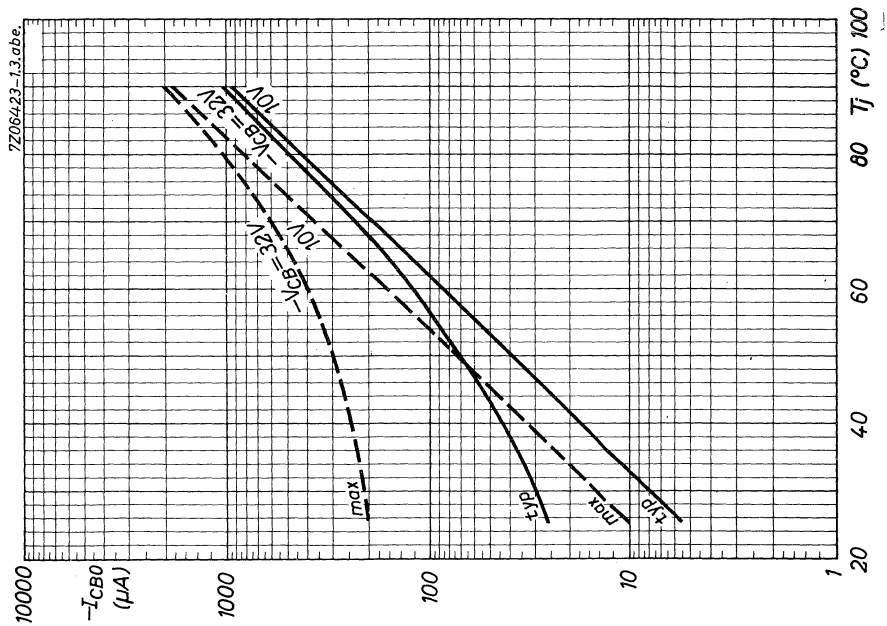
Input impedance	h_{ie}	typ.	1.7	kΩ
		1.1 to	2.5	kΩ
Reverse voltage transfer	h_{re}	typ.	6.5	10^{-4}
		<	8.5	10^{-4}
Small signal current gain	h_{fe}	typ.	125	
		80 to	170	
Output admittance	h_{oe}	typ.	80	$\mu\Omega^{-1}$
		<	110	$\mu\Omega^{-1}$

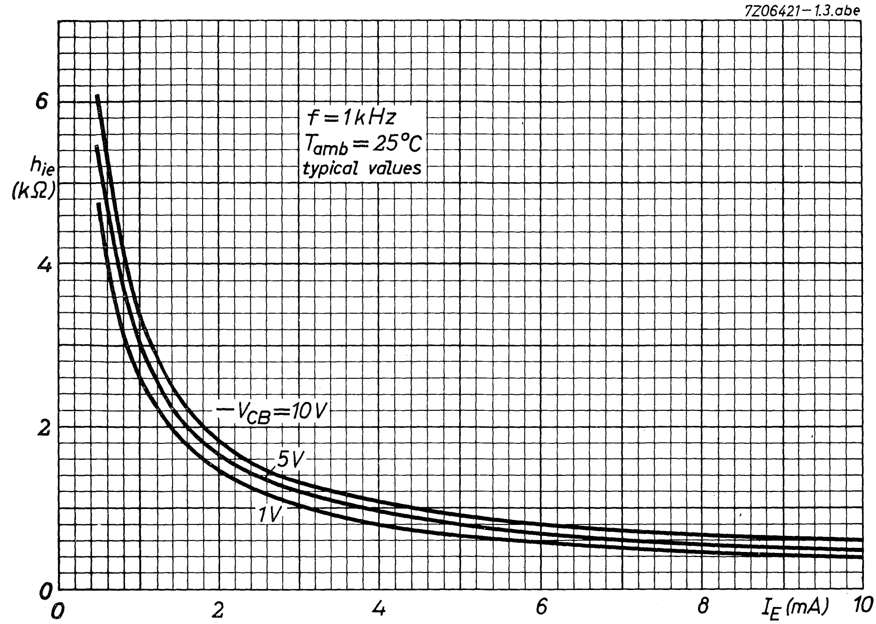
7Z3 0845

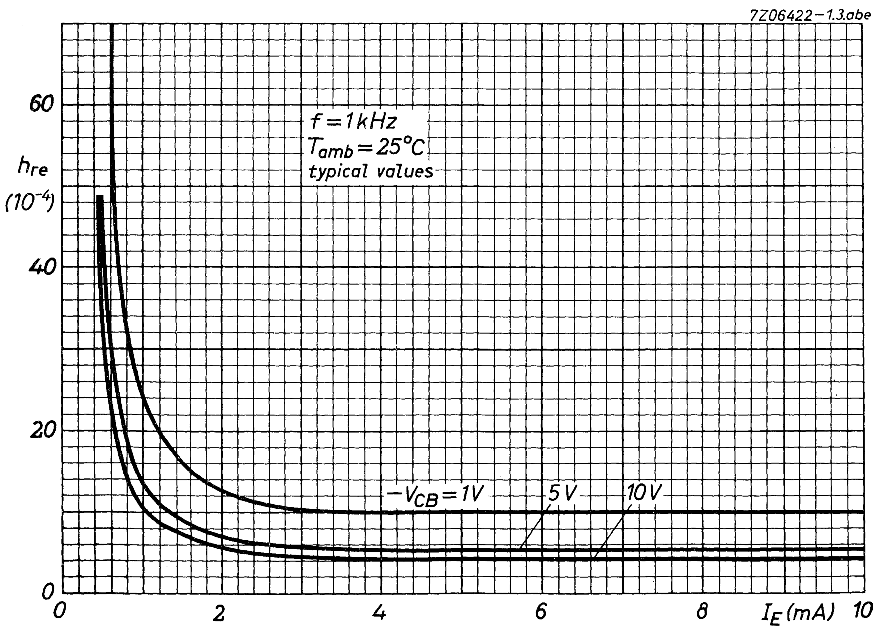

7Z06426-1.3.abe.
100
$-I_C$
(mA)
80
60
40
20
$-I_B = 0.9mA$
0.8mA
0.7mA
0.6 mA
0.5mA
0.4mA
0.3mA
0.2mA
0.1 mA
$-V_{CE} = 1V$
1
0.5
0
5
$-V_{CE}(V)$
10
$-I_B(mA)$
200
$-V_{BE}$
(mV)
400
$-V_{CE} = 1V$
typical values
$T_{amb} = 25°C$

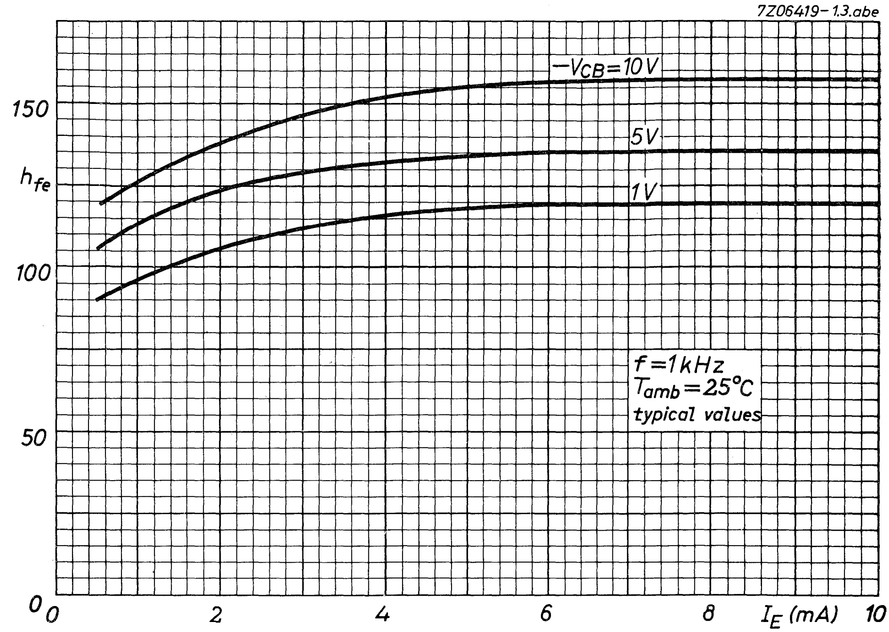

7Z06424-1.3.abe.
max voltage
typ
min voltage
$-V_{CB} = 5V$
$T_{amb} = 25°C$
I_E (mA)
10
8
6
4
2
0
0
50
100
150
$-V_{BE}$ (mV)

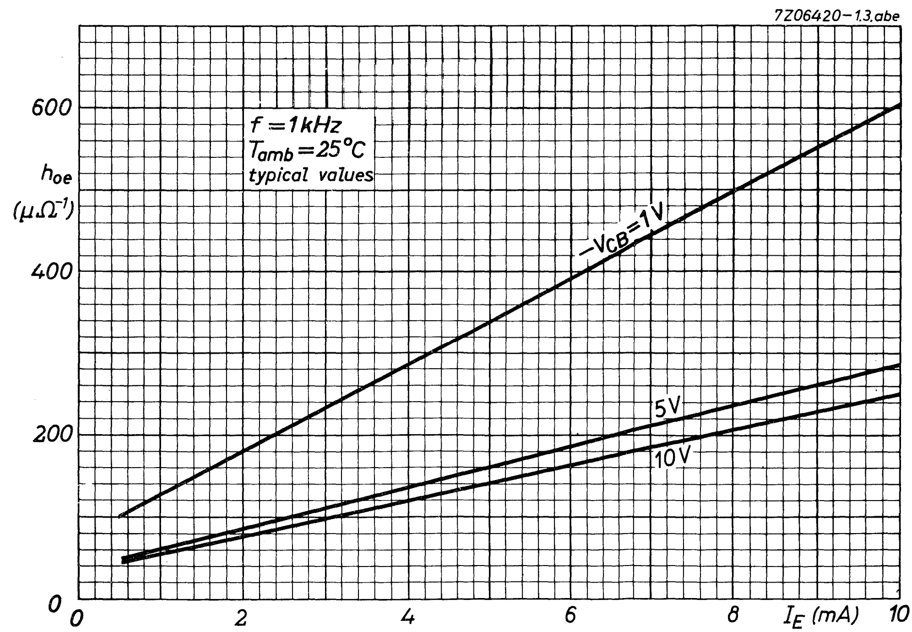

7Z06425-1.3.abe.
Base current versus emitter current
$-V_{CB} = 5V$
$T_{amb} = 25°C$
max
typ
min
I_E (mA)
14
12
10
8
6
4
2
0
0
20
40
60
80
100
$-I_B$ (μA)

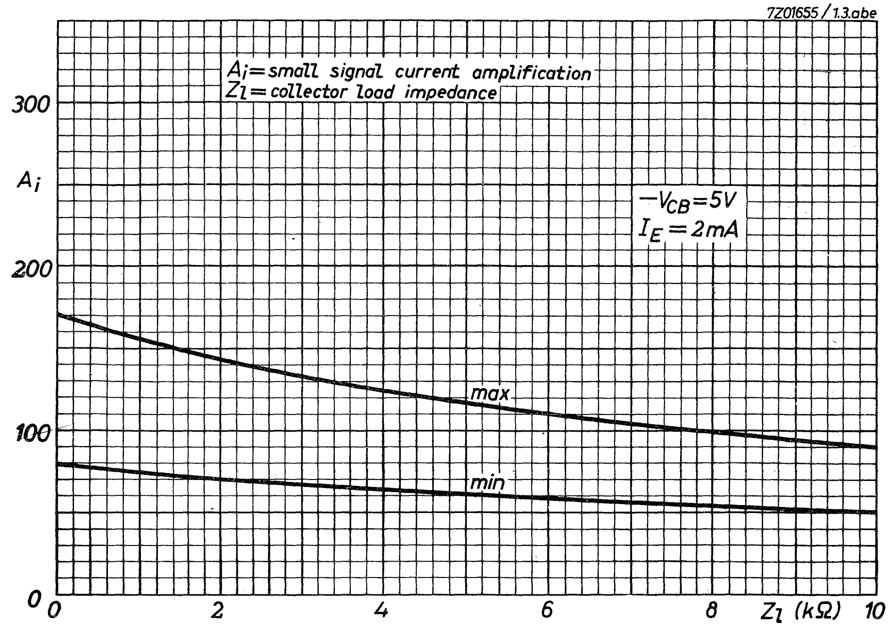

7Z06423-1.3.abe.
−I_CBO (µA)
10000
1000
100
10
1
Tj (°C)
20
40
60
80
100
−V_CB = 32V
10V
−V_CB = 32V
10V
max
typ
max
typ

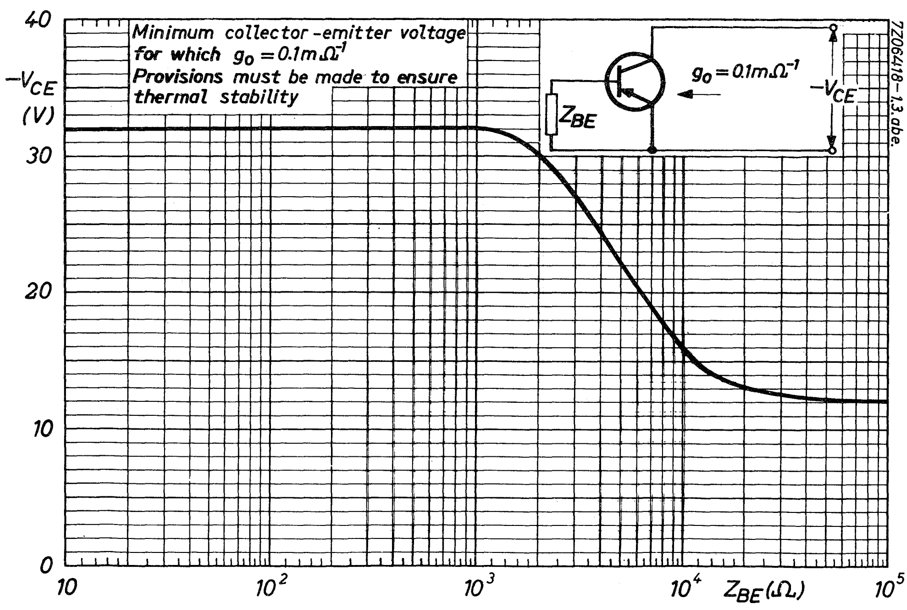

7Z06421−1.3.abe
f = 1 kHz
T_amb = 25°C
typical values
h_ie
(kΩ)
−V_CB = 10 V
5 V
1 V
I_E (mA)
0
2
4
6
8
10


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


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


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


7Z01655 / 1.3.abe
A_i = small signal current amplification
Z_l = collector load impedance
$-V_{CB}$ = 5V
I_E = 2mA
max
min
A_i
300
200
100
0
0
2
4
6
8
10
Z_l (kΩ)


Minimum collector-emitter voltage for which g_o = 0.1mΩ⁻¹
Provisions must be made to ensure thermal stability
g_o = 0.1mΩ⁻¹
Z_{BE}
$-V_{CE}$
7Z06418-1.3.abe.
$-V_{CE}$ (V)
40
30
20
10
0
10
10^2
10^3
10^4
10^5
Z_{BE} (Ω)

GERMANIUM ALLOY TRANSISTOR

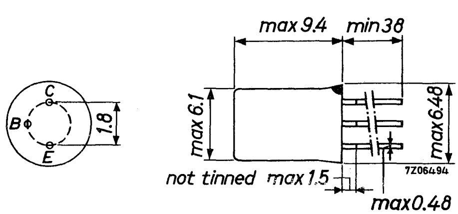
P-N-P transistor in a TO-1 metal envelope intended for use in pre-amplifier or driver stages with battery voltages up to 14 V.

QUICK REFERENCE DATA

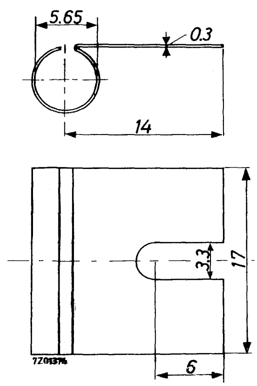
Collector-base voltage (open emitter)	$-V_{CBO}$	max.	32	V
Collector-emitter voltage (open base)	$-V_{CEO}$	max.	12	V
Collector current (d.c.)	$-I_C$	max.	100	mA
Total power dissipation up to T_{amb} = 45 °C with cooling fin No. 56227 on a heatsink of at least 12.5 cm^2	P_{tot}	max.	500	mW
Junction temperature	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 red dot indicates the collector



Cooling fin: 56227

7Z3 0846

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
Base current (d.c.)	$-I_B$	max.	5	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.

7Z3 0862

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

7Z3 0847

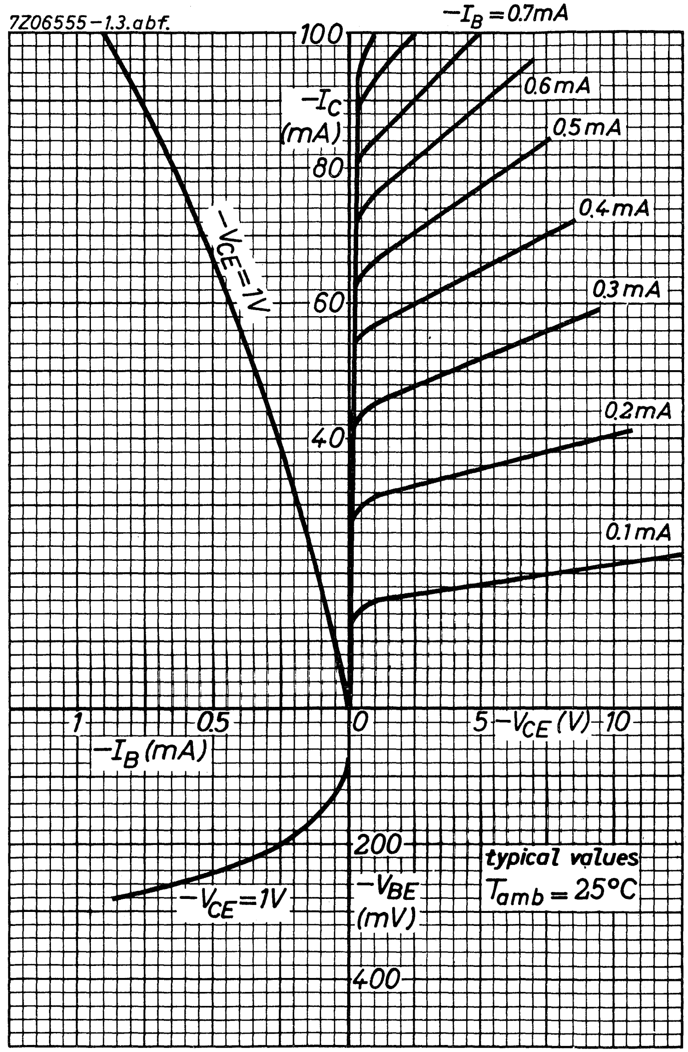
CHARACTERISTICS (continued) T_{amb} = 25 °C unless otherwise specified

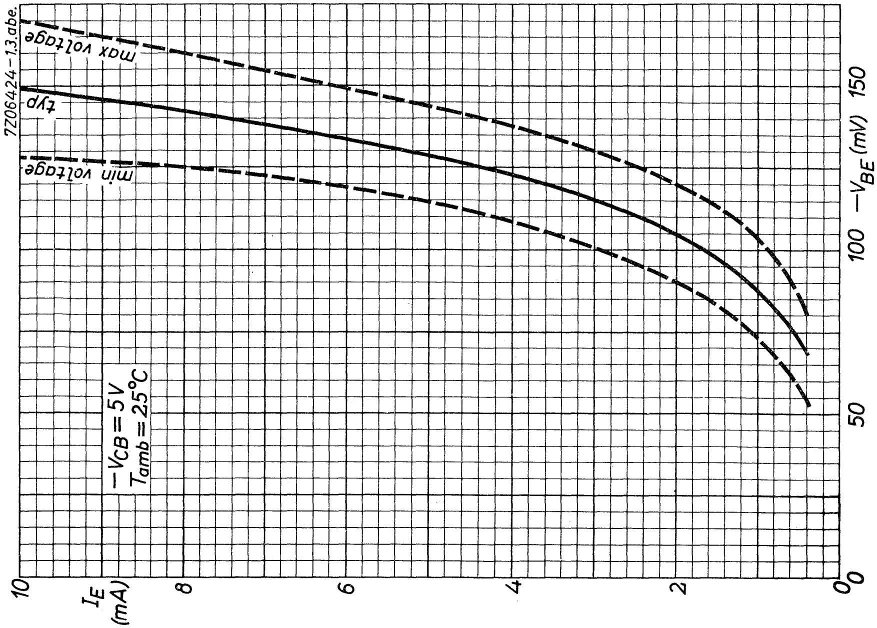
h parameters at f = 1 kHz

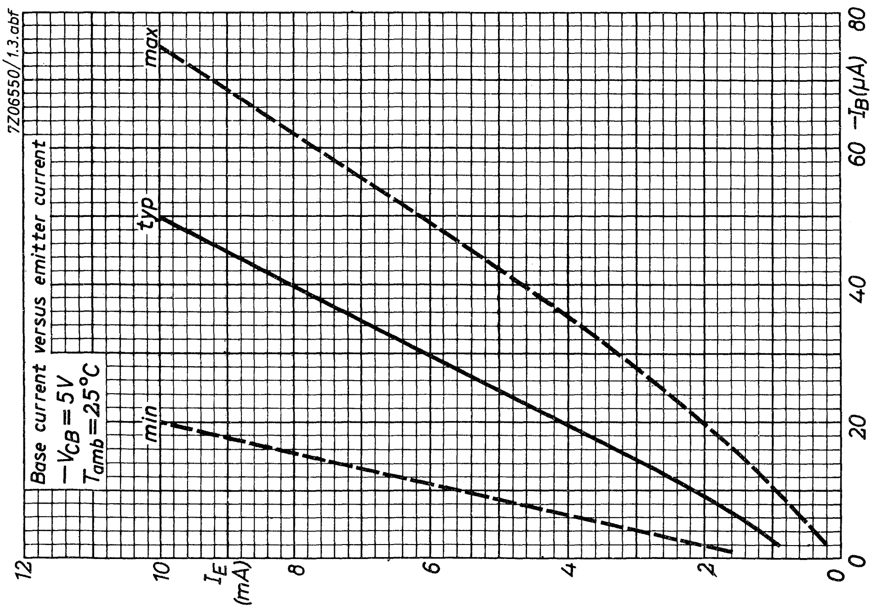
$-I_C$ = 2 mA; $-V_{CE}$ = 5 V

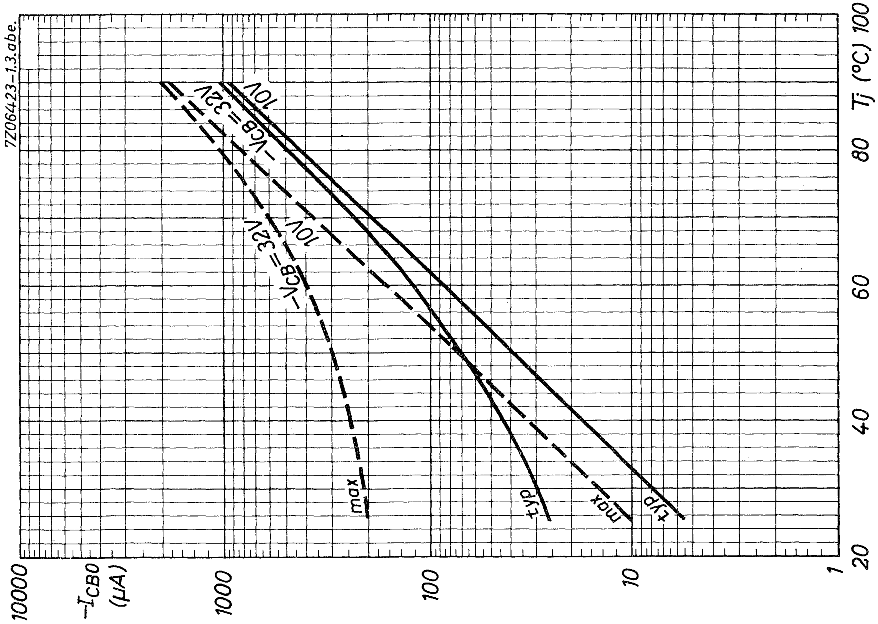
Input impedance	h_{ie}	typ.	2.4	kΩ
			1.7 to 3.8	kΩ
Reverse voltage transfer	h_{re}	typ.	8.0	10^{-4}
		<	13.0	10^{-4}
Small signal current gain	h_{fe}	typ.	180	
			130 to 300	
Output admittance	h_{oe}	typ.	100	$\mu\Omega^{-1}$
		<	170	$\mu\Omega^{-1}$

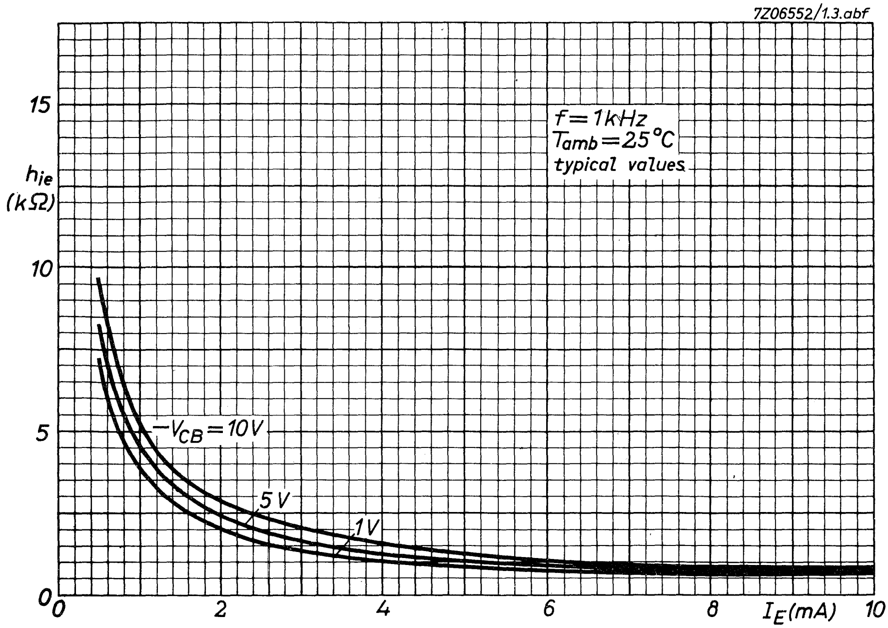
7Z3 0848

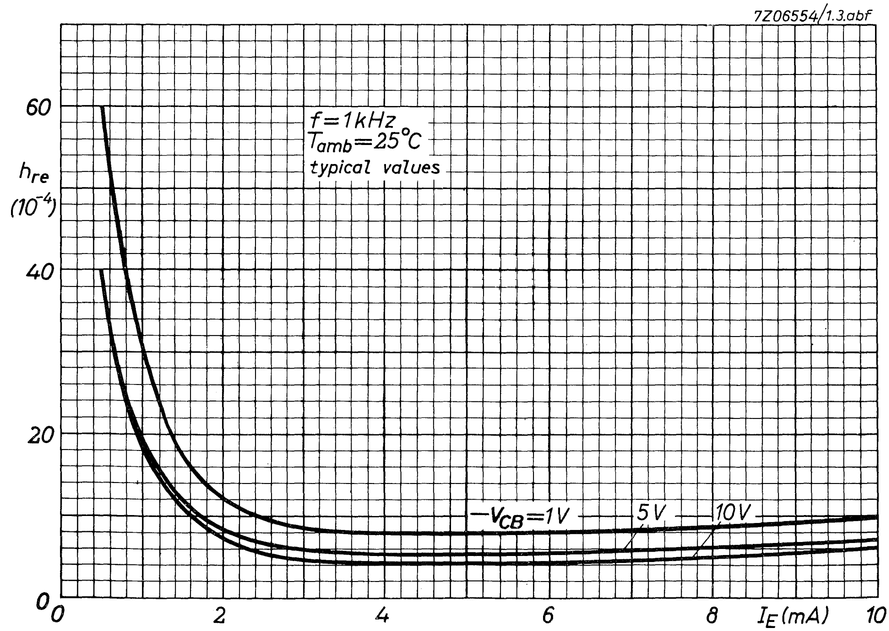

7Z06555-1.3.abf.
$-I_B = 0.7mA$
0.6mA
0.5mA
0.4mA
0.3mA
0.2mA
0.1mA
$-I_C$ (mA)
100
80
60
40
$-V_{CE} = 1V$
1
0.5
0
5
$-V_{CE}$ (V)
10
$-I_B$ (mA)
200
$-V_{BE}$ (mV)
400
$-V_{CE} = 1V$
typical values
$T_{amb} = 25°C$

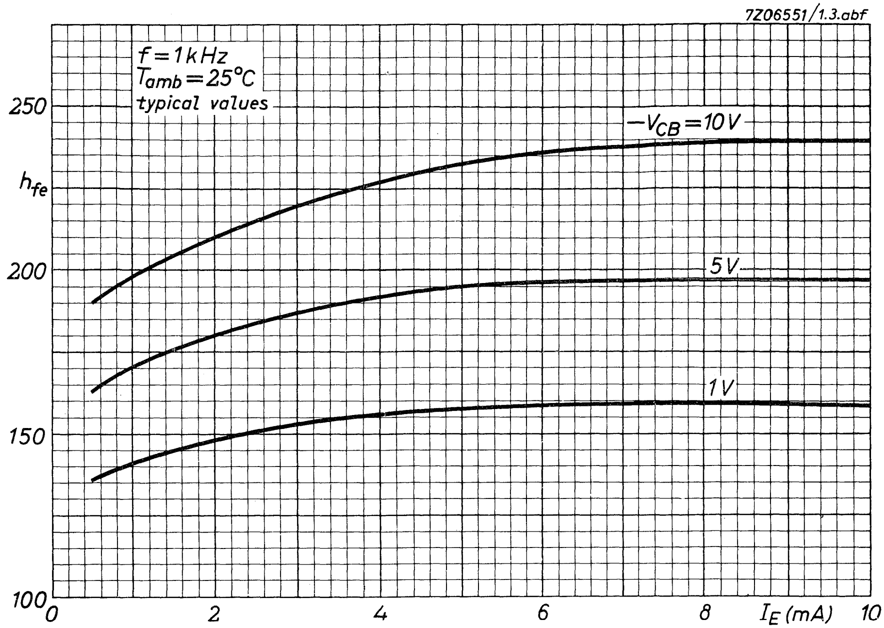

7Z06424-1.3.abe.
max voltage
typ
min voltage
−V_CB = 5V
T_amb = 25°C
I_E (mA)
10
8
6
4
2
0
0
50
100
150
−V_BE (mV)

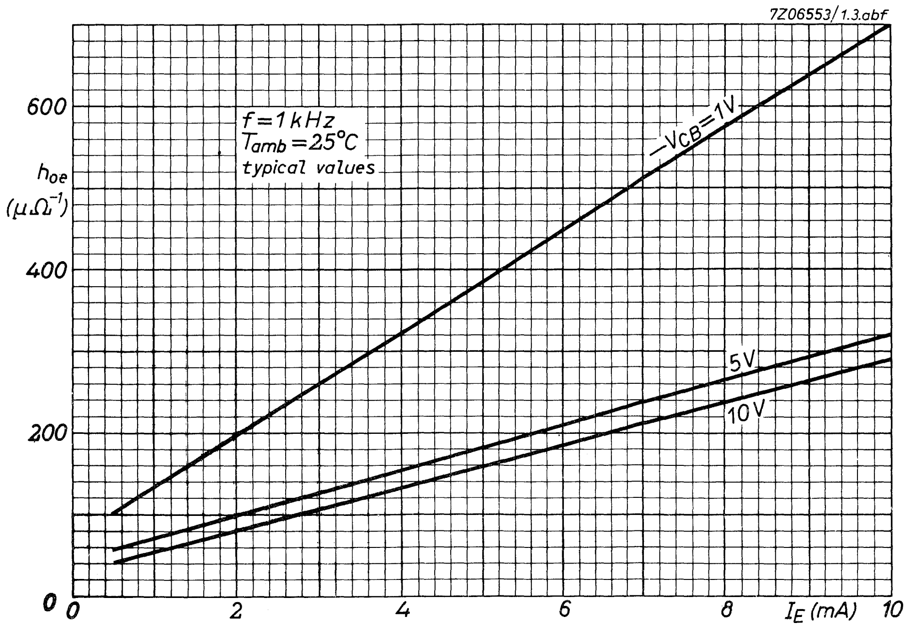

7Z06550/1.3.abf
Base current versus emitter current
−V_CB = 5V
T_amb = 25°C
max
typ
min
I_E (mA)
12
10
8
6
4
2
0
0
20
40
60
80
−I_B (μA)

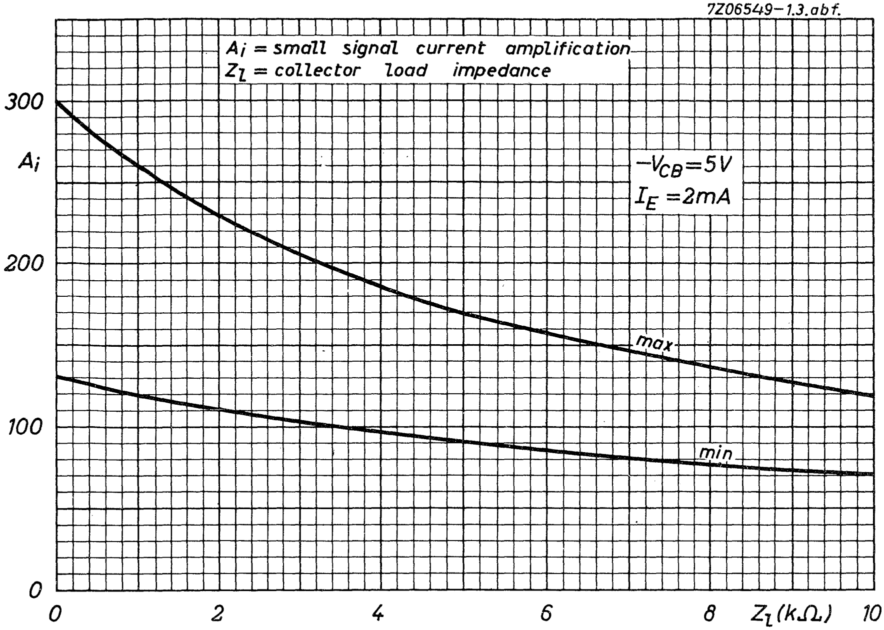

7Z06423-1.3.abe.
10V
−VCB = 32V
10V
−VCB = 32V
max
typ
max
typ
−ICBO
(μA)
10000
1000
100
10
1
20
40
60
80
100
Tj (°C)

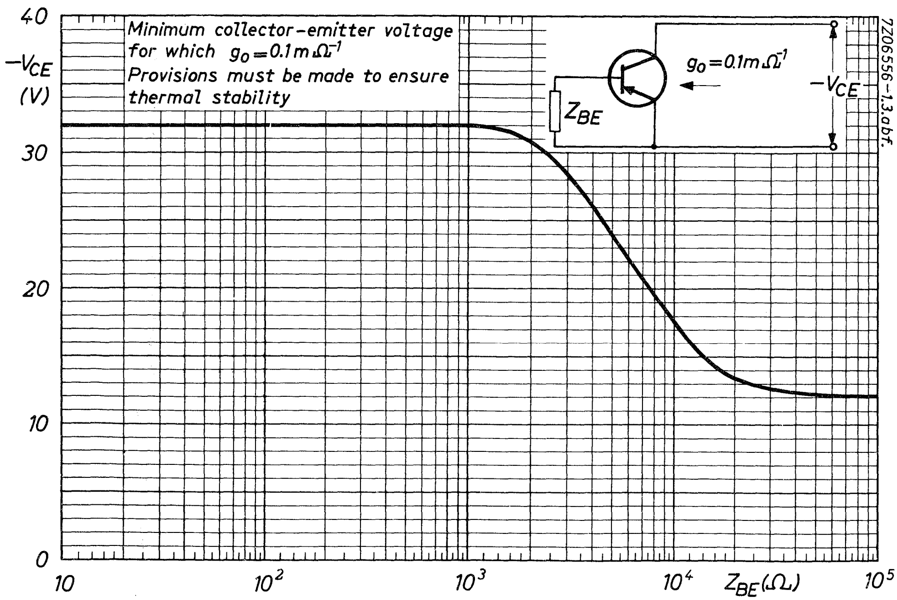

7Z06552/1.3.abf
f=1kHz
Tamb=25°C
typical values
hie
(kΩ)
15
10
5
0
−VCB=10V
5V
1V
0
2
4
6
8
IE(mA)
10


7Z06554/1.3.abf
f=1kHz
Tamb=25°C
typical values
hre
(10-4)
60
40
20
0
−VCB=1V
5V
10V
0
2
4
6
8
IE(mA)
10


7Z06551/1.3.abf
f = 1 kHz
Tamb = 25°C
typical values
250
hfe
200
150
100
0
2
4
6
8
IE (mA)
10
−VCB = 10 V
5 V
1 V


7Z06553/1.3.abf
f = 1 kHz
Tamb = 25°C
typical values
600
hoe
(µΩ⁻¹)
400
200
0
0
2
4
6
8
IE (mA)
10
−VCB = 1 V
5 V
10 V


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


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

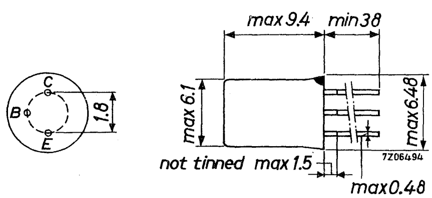
GERMANIUM ALLOY TRANSISTOR

N-P-N transistor in a TO-1 metal envelope intended for use together with the p-n-p transistors AC128 or AC132 as matched pair in class B output or driver stages with complementary symmetry.

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 $T_{amb} = 45\,^{o}C$ 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	^{o}C
D.C. current gain at $T_{amb} = 25\,^{o}C$				
$I_C = 20$ 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

TO-1



The blue dot indicates the collector

Accessories see page 4

7Z3 1116

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 $T_{amb} = 45\ ^oC$ 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	^oC
Junction temperature: continuous	T_j	max.	90	^oC
incidentally	T_j	max.	100	^oC

THERMAL RESISTANCE

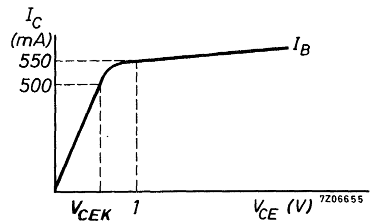
From junction to ambient in free air	$R_{th\ j\text{-}a}$	=	0.37	$^oC/mW$
From junction to case	$R_{th\ j\text{-}c}$	=	0.11	$^oC/mW$
From junction to ambient with cooling fin mounted on a heatsink of at least 12.5 cm^2	$R_{th\ j\text{-}a}$	=	0.16	$^oC/mW$

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

7Z3 0864

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; $V_{CB} = 0$	$-V_{EB}$	typ.	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



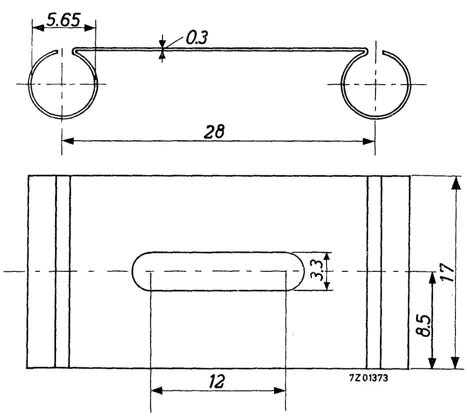
D.C. current gain				
$I_C = 20$ mA; $V_{CB} = 0$	h_{FE}	typ.	100	
$I_C = 50$ mA; $V_{CB} = 0$	h_{FE}	typ.	105	
$I_C = 200$ mA; $V_{CB} = 0$	h_{FE}	typ.	90	
$I_C = 500$ mA; $V_{CB} = 0$	h_{FE}	typ.	50	
Collector capacitance at f = 0.45 MHz				
$I_E = I_e = 0$; $V_{CB} = 5$ V	C_c	typ.	70	pF
Feedback impedance at f = 0.45 MHz				
$I_C = 1$ mA; $V_{CE} = 5$ V	$\|z_{rb}\|$	typ.	70	Ω

7Z3 0865

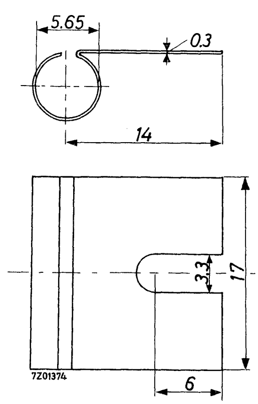
CHARACTERISTICS (continued) T_{amb} = 25 °C unless otherwise specified

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	

ACCESSORIES



Cooling fin: 56226



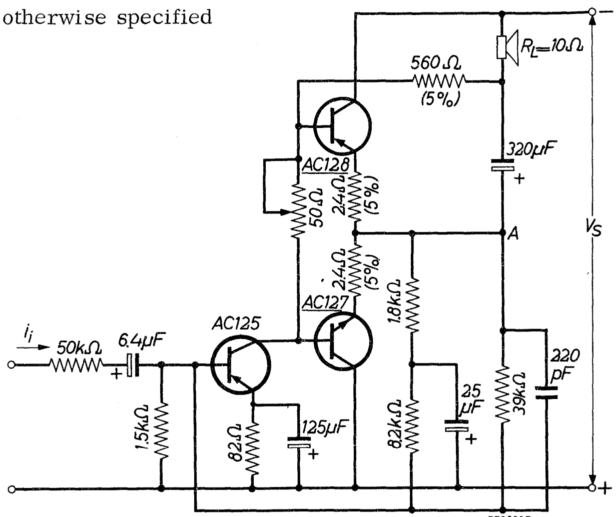
Cooling fin: 56227

7Z3 0866

APPLICATION INFORMATION

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

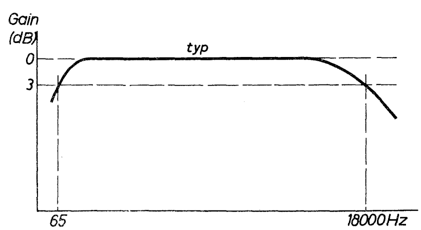
Tolerance of resistors:
10% unless otherwise specified



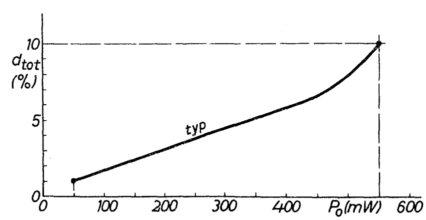
Stable continuous operation is ensured up to an ambient temperature of 45 °C provided each transistor is mounted with a cooling fin type No. 56226.

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

7Z3 0867

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

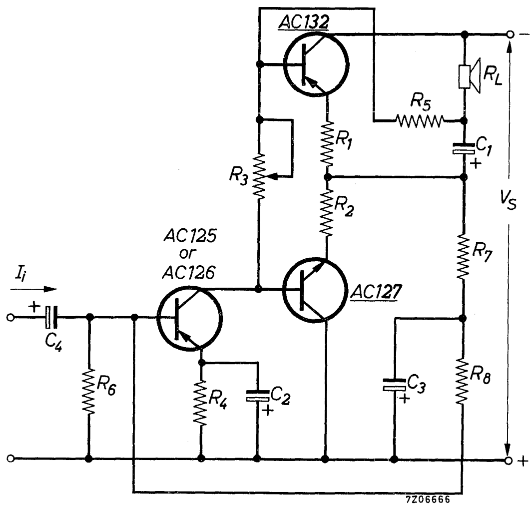
Driver stage

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.



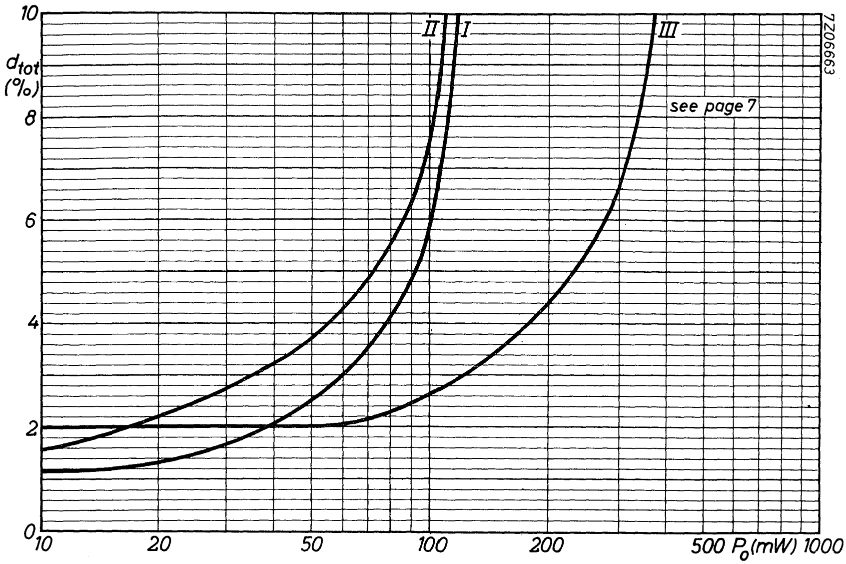
Stable continuous operation is ensured up to an ambient temperature of 45 °C, provided each transistor is mounted with a cooling fin.

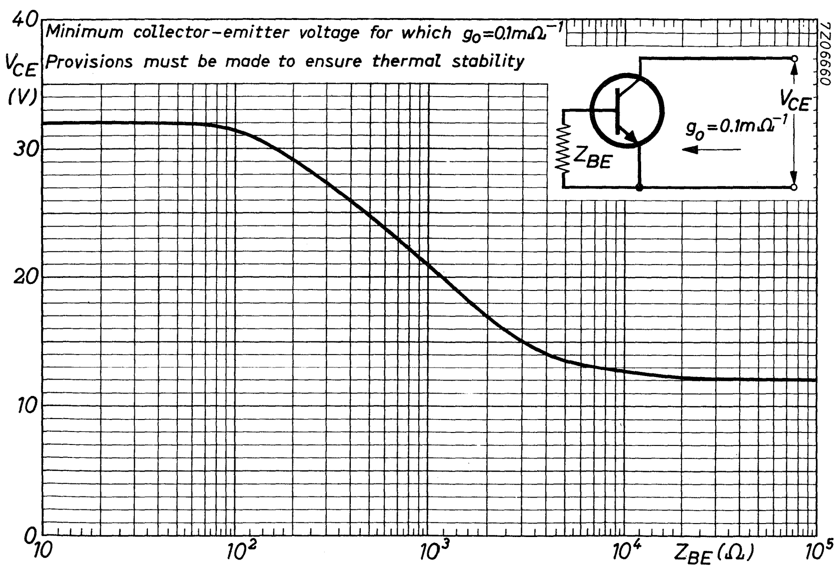
7Z3 0868

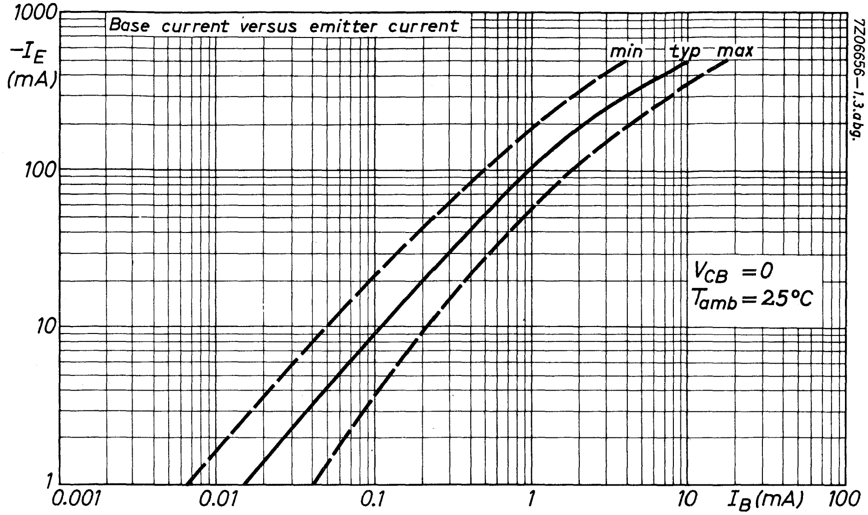
APPLICATION INFORMATION (continued)

			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 A				
<u>Output stage</u>						
Emitter current (zero signal)	I_{E1}	=	2	2	2	mA
	$-I_{E2}$	=	2	2	2	mA
Emitter resistors	R_1	=	3.3	4.7	3.9	Ω
	R_2	=	3.3	4.7	3.9	Ω
Bias resistor	R_3	<	100	250	50	Ω
Coupling capacitor	C_1	=	200	64	320	μF
Load resistance	R_L	=	25	70	15	Ω
Collector current (peak value) at P_o max.	$\|I_{CM}\|$	typ.	90	50	200	mA
<u>Driver stage</u>						
Collector current	$-I_C$	typ.	2.7	1.2	7.6	mA
Emitter resistor	R_4	=	180	680	82	Ω
Collector resistor	R_5	=	910	3300	510	Ω
Bias resistors	R_6	=	4.7	6.8	1.8	kΩ
	R_7	=	3.9	4.7	2.2	kΩ
	R_8	=	15	24	6.8	kΩ
Decoupling capacitors	C_2	=	40	25	120	μF
	C_3	=	25	25	25	μF
Coupling capacitor	C_4	=	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	%

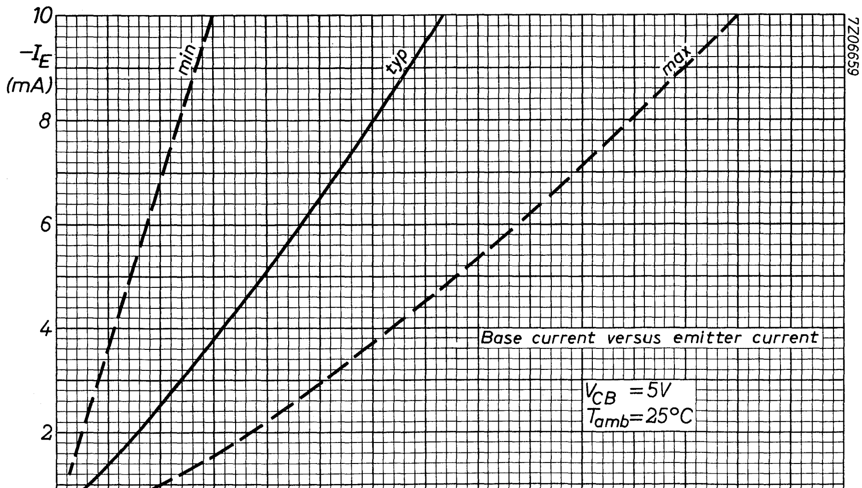
7Z3 0869


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

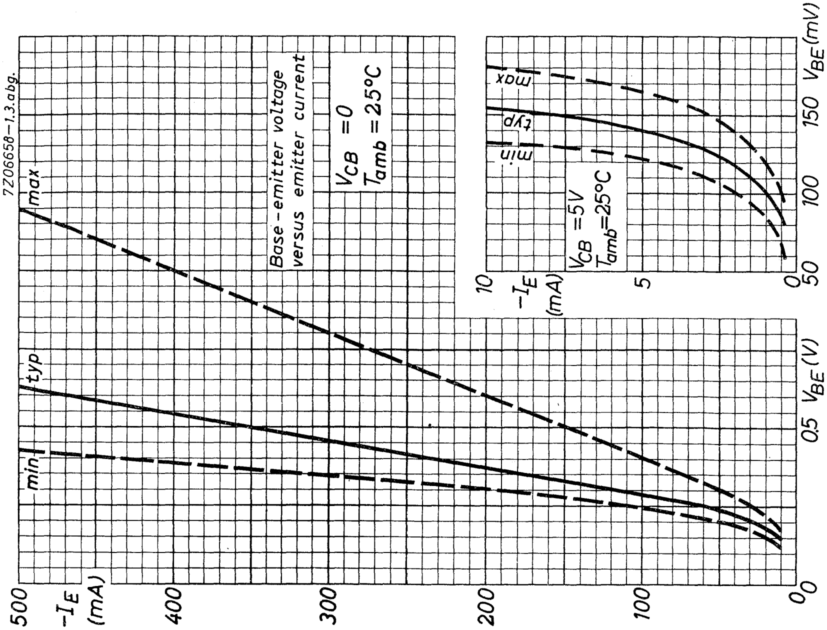

7Z06660
Minimum collector-emitter voltage for which g_o=0.1mΩ^{-1}
Provisions must be made to ensure thermal stability
40
V_{CE} (V)
30
20
10
0
Z_{BE}
V_{CE}
g_o=0.1mΩ^{-1}
10
10^2
10^3
10^4
Z_{BE} (Ω)
10^5

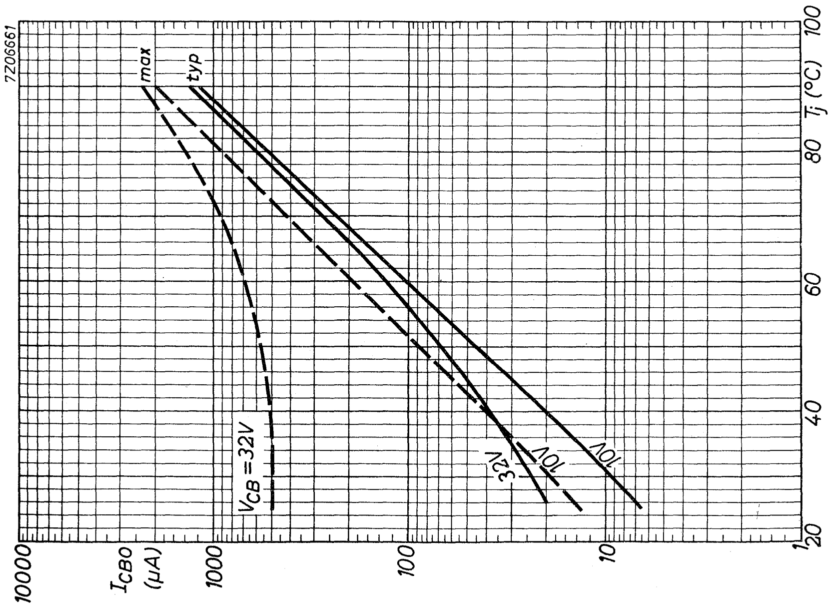


Base current versus emitter current
1000
$-I_E$
(mA)
100
10
1
0.001
0.01
0.1
1
10
I_B(mA)
100
min
typ
max
V_{CB} = 0
T_{amb} = 25°C
7Z06656—1.3.abg.



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)
500
400
300
200
100
0
V_{BE} (V)
0.5
0
max
typ
min
V_{CB} = 5V
T_{amb} = 25°C
$-I_E$ (mA)
10
5
0
V_{BE} (mV)
50
100
150

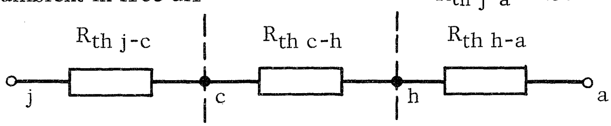

7Z06661
max
typ
V_{CB} = 32V
32V
10V
10V
I_{CBO} (μA)
10000
1000
100
10
1
T_j (°C)
20
40
60
80
100

GERMANIUM ALLOY TRANSISTOR

N-P-N transistor, 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.

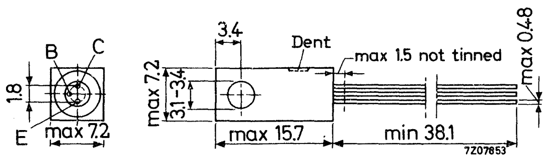
THERMAL RESISTANCE

From junction to ambient in free air $R_{th\ j-a}$ = 250 °C/W



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

MECHANICAL DATA



The dent indicates the collector side

For further data and curves of this type please refer to type AC127

7Z3 1326

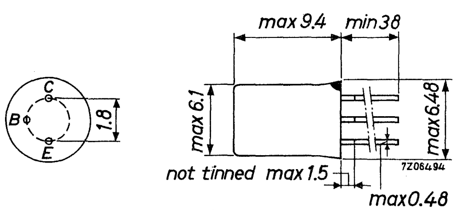
GERMANIUM ALLOY TRANSISTOR

P-N-P transistor in a TO-1 metal envelope 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.

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

TO-1



The red dot indicates the collector

Accessories see page 4. 7Z3 0870

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
Base current (d.c.)	$-I_B$	max.	40	mA

Power dissipation

Total power dissipation up to T_{amb} = 25 °C 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		°C
Junction temperature: continuous	T_j	max.	90	°C
incidentally	T_j	max.	100	°C

THERMAL RESISTANCE

From junction to ambient in free air	$R_{th\ j-a}$	=	0.29	°C/mW
From junction to case	$R_{th\ j-c}$	=	0.04	°C/mW
From junction to ambient with cooling fin in free air	$R_{th\ j-a}$	=	0.14	°C/mW
From junction to ambient with cooling fin mounted on a heatsink of at least 12.5 cm^2	$R_{th\ j-a}$	=	0.08	°C/mW

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

7Z3 0871

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

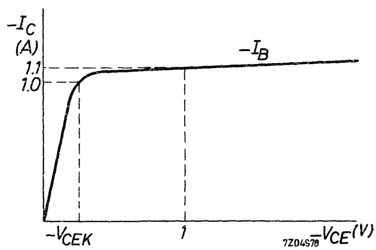
$I_C = 0$; $-V_{EB} = 10$ V	$-I_{EBO}$	<	200	μA
$I_C = 0$; $-V_{EB} = 5$ V; $T_j = 75$ °C	$-I_{EBO}$	<	500	μA

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



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

7Z3 0872

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

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 E)	λ_{500}	>	0.50 [1]
		typ.	0.60 [1]

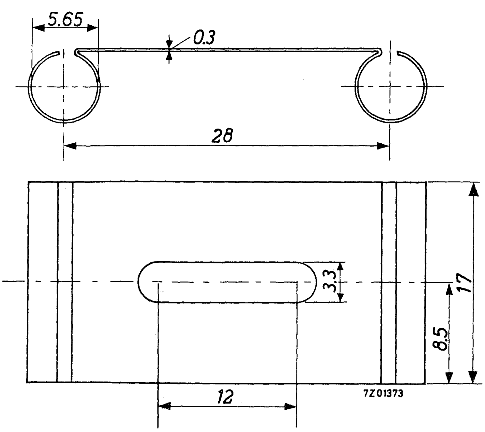
D.C. current gain ratio of matched pair AC127/AC128

$\lvert I_C \rvert$ = 300 mA; V_{CB} = 0	h_{FE1}/h_{FE2}	typ.	1.1

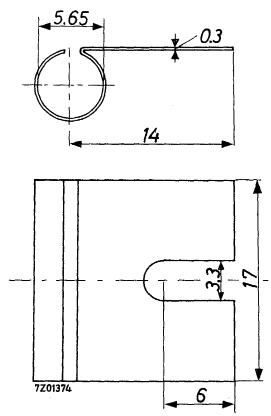
matched pair 2-AC128

$\lvert I_C \rvert$ = 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

ACCESSORIES



Cooling fin: 56226



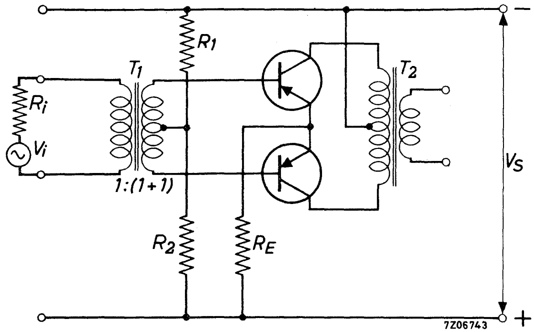
Cooling fin: 56227

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

7Z3 0873

APPLICATION INFORMATION

Class B operation with matched pair 2-AC128

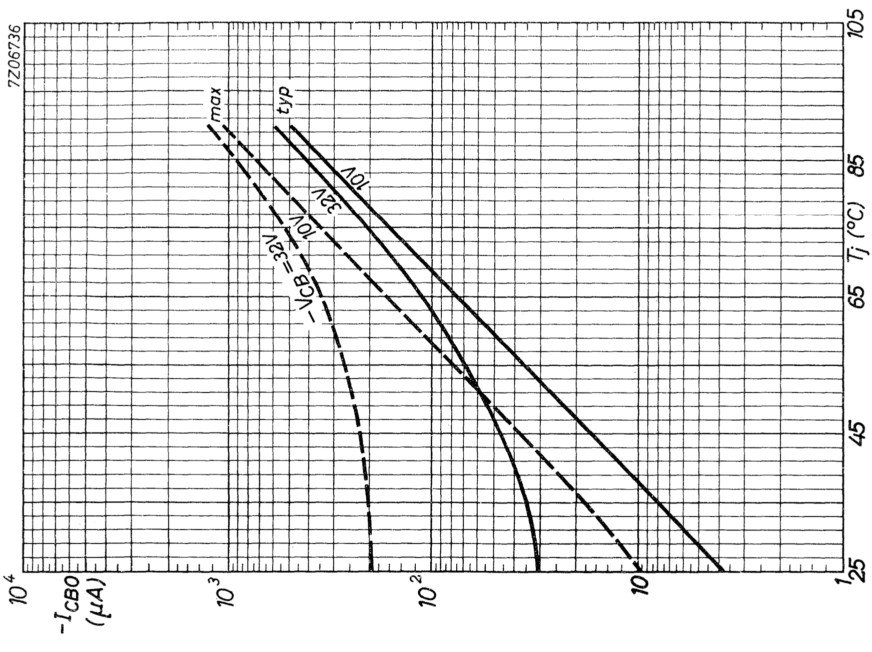


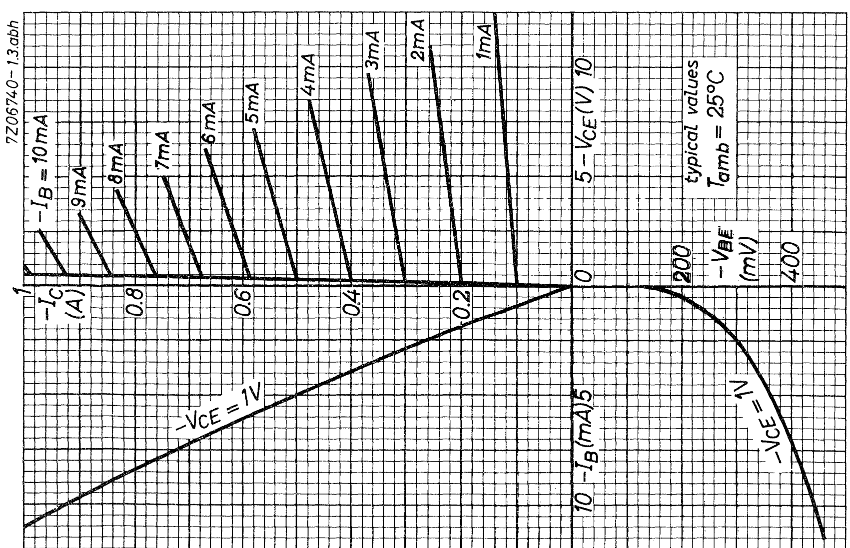
To provide stability the total resistance in the base circuit of each transistor should be less than 100 Ω.

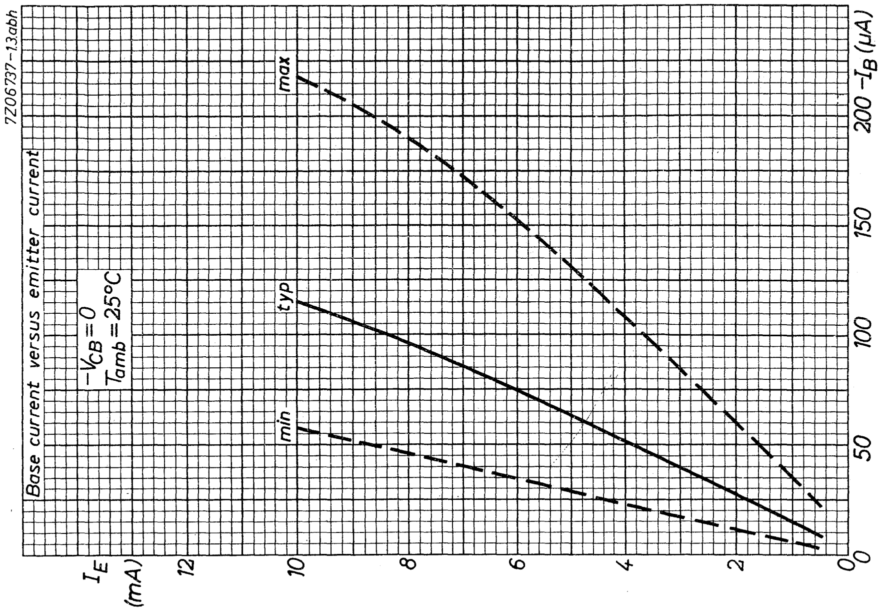
Supply voltage	V_S	=	6	9	9	V
Ambient temperature	T_{amb}	up to	55	55	45	°C
Emitter current (zero signal)	I_E	=	2x3	2x3	2x3	mA
Bias resistor [1]	R_1	=	2.0	2.2	3.5[2]	kΩ
Bias resistor [1]	R_2	=	47	39	[3]	Ω
Common emitter resistor	R_E	=	2.2	3.9	1.5	Ω
Input (source) resistance	R_i	=	1.5	1.5	1.0	kΩ
Load resistance	$R_{cc\sim}$	=	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	%

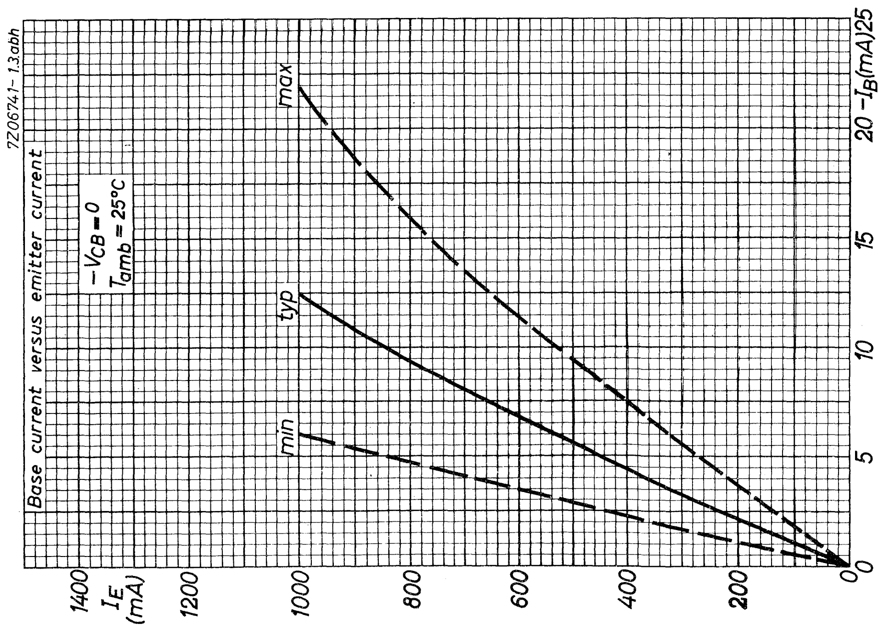
[1]) Tolerance of bias resistors: 5 %
[2]) Variable resistor
[3]) This resistance is composed of a 68 Ω resistor in parallel with a 130 Ω NTC resistor. Code number 2322 610 12131.
[4]) Mounted on cooling fin 56227 at T_{amb} up to 20 °C.
[5]) Losses in the driver transformer are not taken into account.

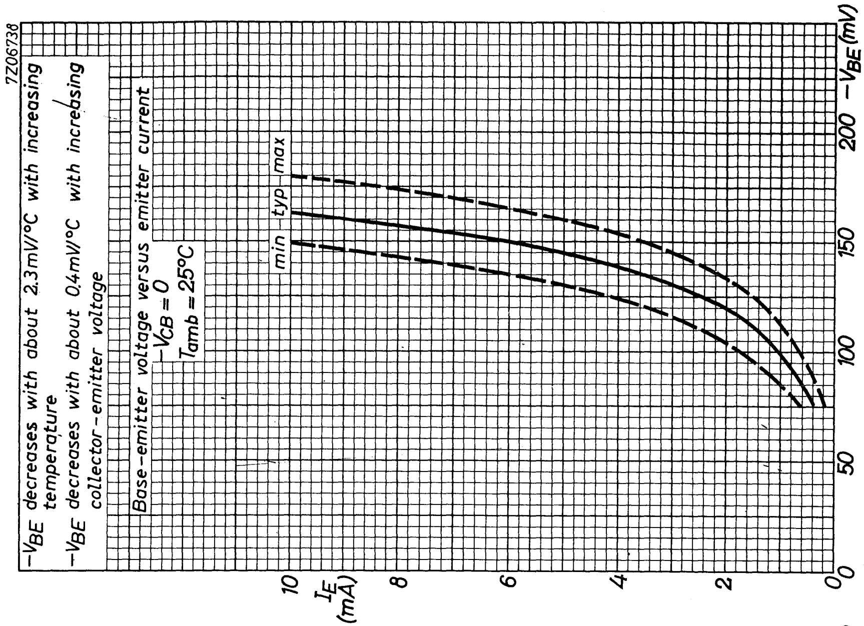
7Z3 0874

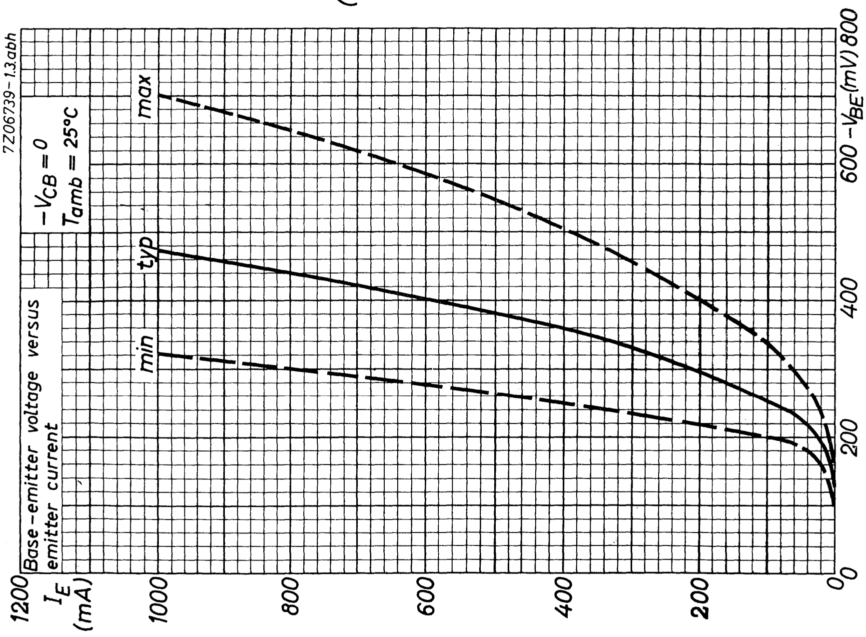

7Z06736
max
typ
10V
32V
10V
−VCB = 32V
Tj (°C)
25
45
65
85
105
10^4
10^3
10^2
10
1
−ICBO (μA)

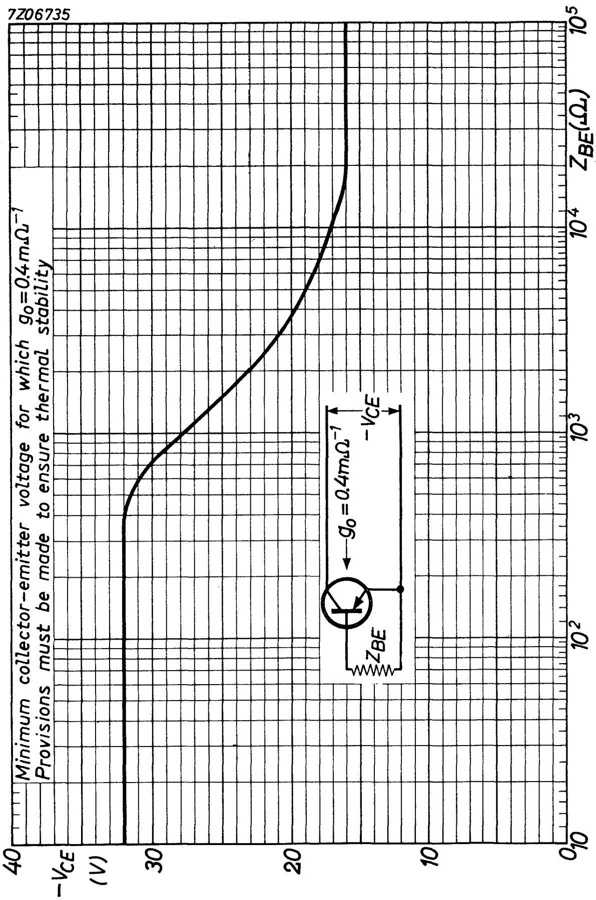

7Z06740−1.3.abh
−IB = 10mA
9mA
8mA
7mA
6mA
5mA
4mA
3mA
2mA
1mA
−IC (A)
1
0.8
0.6
0.4
0.2
0
5 −VCE (V) 10
typical values
Tamb = 25°C
200
400
−VBE (mV)
−VCE = 1V
−VCE = 1V
10 −IB (mA) 5

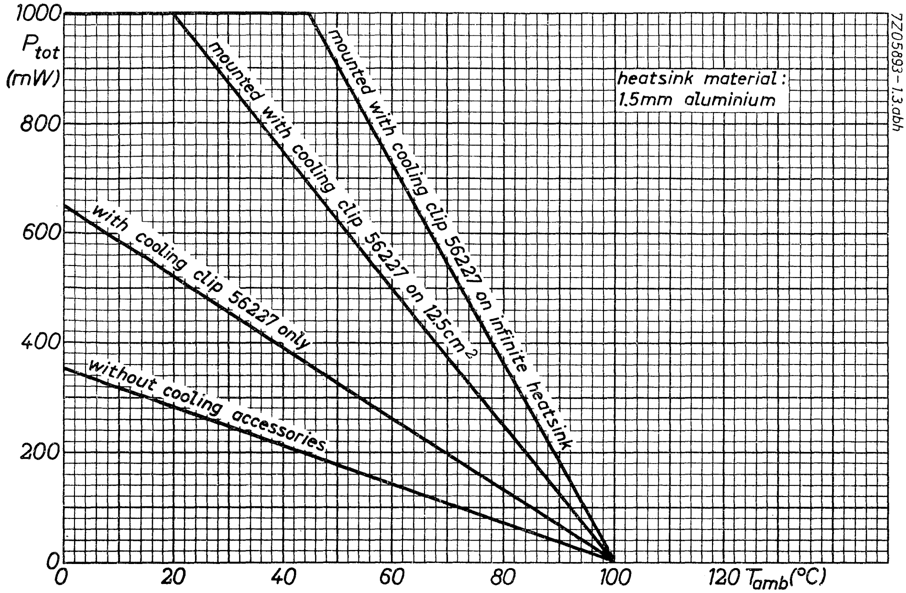

7Z06737-1.3abh
Base current versus emitter current
−VCB = 0
Tamb = 25°C
max
typ
min
IE (mA)
12
10
8
6
4
2
0
0
50
100
150
200 −IB (μA)

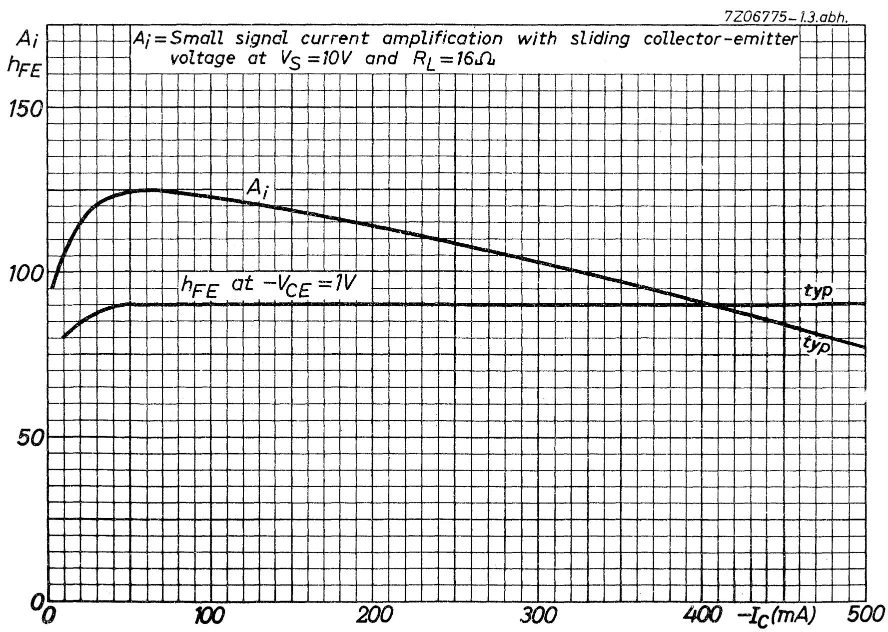

7Z06741-1.3abh
Base current versus emitter current
−VCB = 0
Tamb = 25°C
max
typ
min
1400
IE (mA)
1200
1000
800
600
400
200
0
0
5
10
15
20 −IB (mA) 25


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)


7Z06739-1.3.abh
Base-emitter voltage versus emitter current
$-V_{CB} = 0$
$T_{amb} = 25°C$
min
typ
max
1200
I_E (mA)
1000
800
600
400
200
0
0
200
400
600
800
$-V_{BE}$ (mV)


7Z06735
Minimum collector-emitter voltage for which go=0.4mΩ-1
Provisions must be made to ensure thermal stability
go=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

GERMANIUM ALLOY TRANSISTOR

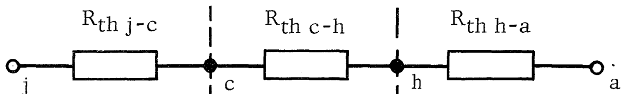
P-N-P transistor, electrically equivalent to the AC128, constructed integrally with a heat conducting block which gives better heat transfer.

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-AC128/01 consists of 2 transistors AC128/01 selected for operation in a low distortion class B amplifier.

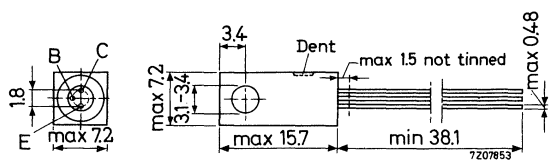
THERMAL RESISTANCE

From junction to ambient in free air $R_{th\ j-a}$ = 180 °C/W



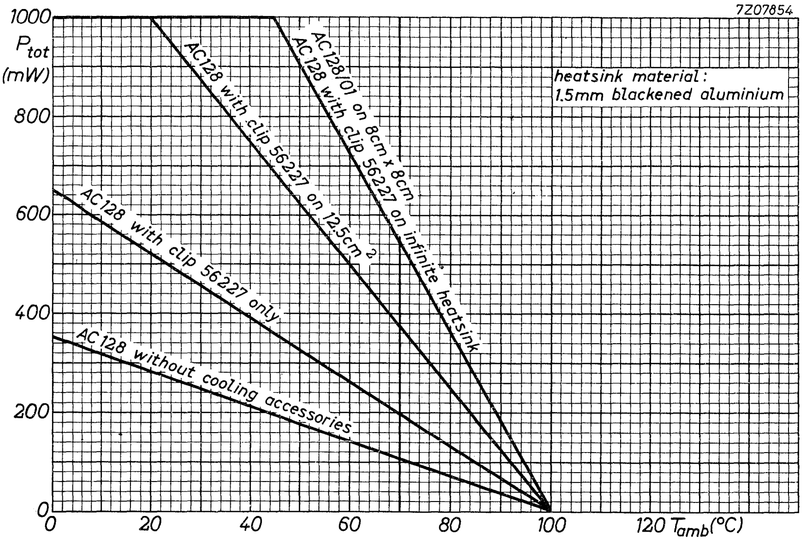
	$R_{th\ j-c}$	$R_{th\ c-h}$	$R_{th\ h-a}$	
AC128 with clip 56227	40	15		°C/W
AC128/01	45	0.5		°C/W

MECHANICAL DATA



The dent indicates the collector side

7Z3 1327



For further data and curves of this type
please refer to type AC128

7Z3 1328

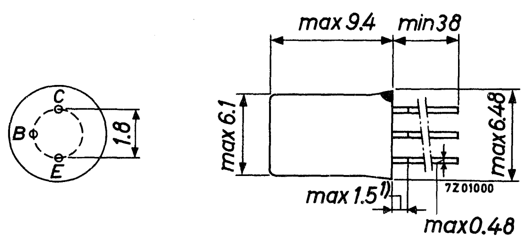
SYMMETRICAL GERMANIUM TRANSISTOR

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

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.	100	mA
Total power dissipation up to T_{amb} = 25 °C	P_{tot}	max.	145	mW
Junction temperature	T_j	max.	90	°C
D.C. current gain at T_j = 25 °C				
I_C = 10 mA; V_{CE} = 1 V	h_{FE}	>	25	
		typ.	65	
Transition frequency				
I_C = 10 mA; V_{CE} = 1 V	f_T	>	2	MHz

MECHANICAL DATA Dimensions in mm

TO-1



[1]) Not tinned

The coloured dot indicates the collector.

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

7Z3 0803

RATINGS (Limiting values) [1]

Voltages

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

Current

Collector current (d.c.)	I_C	max.	100	mA

Power dissipation

Total power dissipation up to $T_{amb} = 25\ ^oC$	P_{tot}	max.	145	mW

Temperatures

Storage temperature	T_{stg}		−55 to +90	^oC
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

Collector cut-off current

$I_E = 0$; $V_{CB} = 20$ V	I_{CBO}	<	3	μA
$I_E = 0$; $V_{CB} = 20$ V; $T_j = 60\ ^oC$	I_{CBO}	<	35	μA

Emitter-base voltage [2]

$-I_E = 10$ mA; $V_{CB} = 0$	$-V_{EB}$	<	250	mV

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	

Ratio between h_{FE} and h_{FC} for each individual transistor

	$\frac{h_{FE}}{h_{FC}}$	typ.	1	
			0.5 to 2	

Collector capacitance at f = 450 kHz

$I_E = I_e = 0$; $V_{CB} = 10$ V	C_c	typ.	10	pF
		<	25	pF

Transition frequency

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

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

[2] $-V_{EB}$ decreases with about 2.2 mV/^oC at increasing temperature.

7Z3 0804

GERMANIUM ALLOY TRANSISTOR

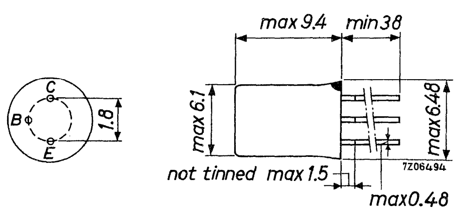
P-N-P transistor in a TO-1 metal envelope intended for use together with the n-p-n transistor AC127 as matched pair AC127/AC132 in class B output stages with complementary symmetry.
Type 2-AC132 consists of 2 transistors AC132 selected for operation in class B output stages.

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.	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

TO-1



The red dot indicates the collector

Accessories see page 4.

7Z3 0875

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
Base current (d.c.)	$-I_B$	max.	10	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

THERMAL RESISTANCE

From junction to ambient in free air	$R_{th\ j-a}$	=	0.30	°C/mW
From junction to case	$R_{th\ j-c}$	=	0.05	°C/mW
From junction to ambient with cooling fin 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.

7Z3 0876

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

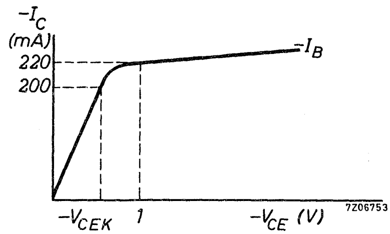
I_C = 0; $-V_{EB}$ = 5 V; T_j = 75 °C	$-I_{EBO}$	<	550	µA

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



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

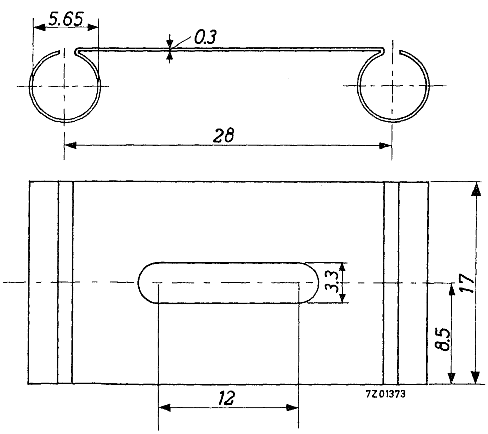
$-I_C$ = 1 mA; $-V_{CE}$ = 5 V	$\|z_{rb}\|$	typ.	90	Ω

7Z3 0877

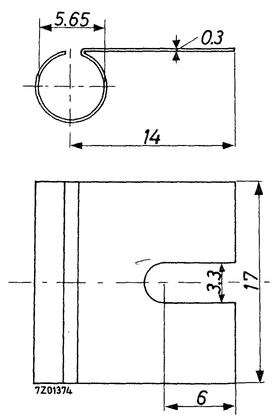
CHARACTERISTICS (continued) T_{amb} = 25 °C unless otherwise specified

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	

ACCESSORIES



Cooling fin: 56226

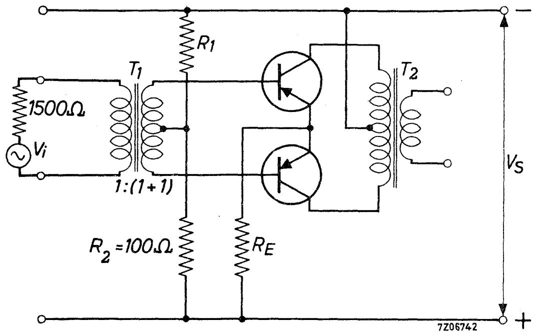


Cooling fin: 56227

7Z3 0878

APPLICATION INFORMATION

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

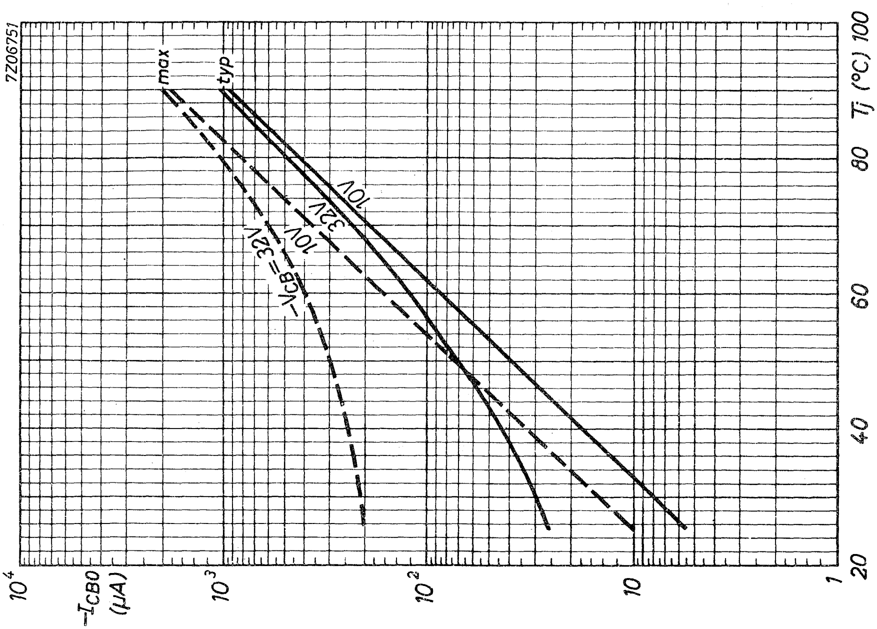


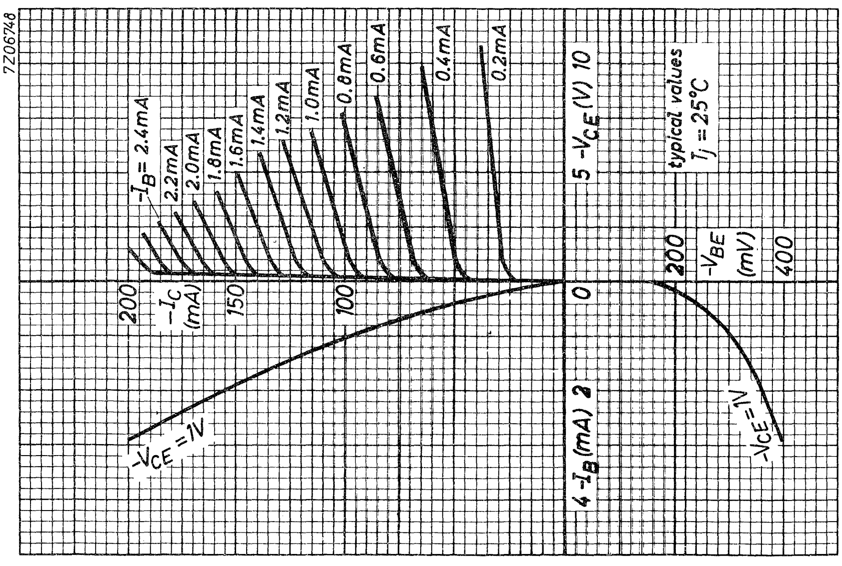
The transistors may be used without cooling fins or heatsinks.
Stable continuous operation is ensured at an ambient temperature of up to 45 °C.

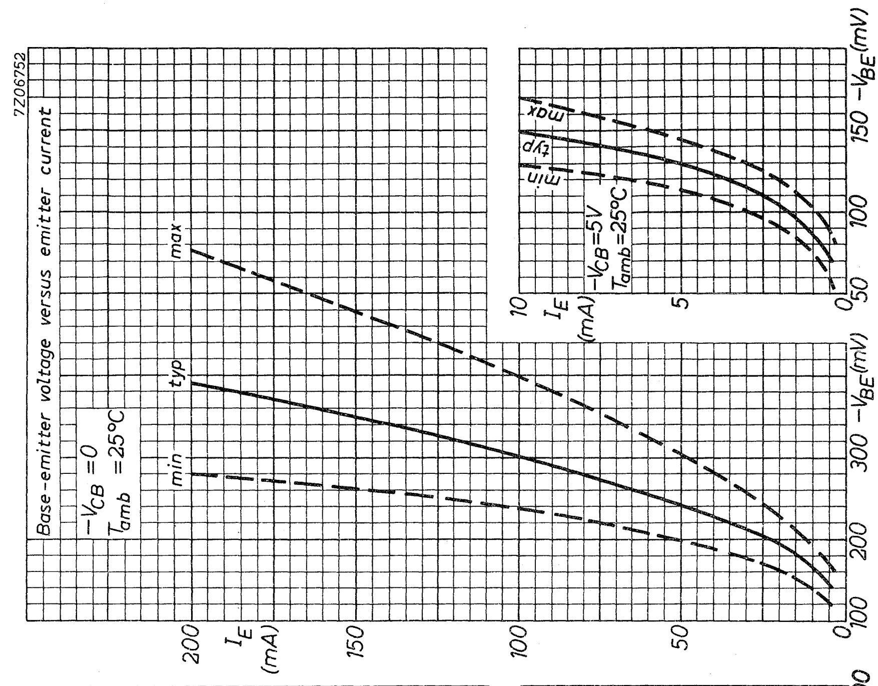
CHARACTERISTICS T_{amb} = 25 °C

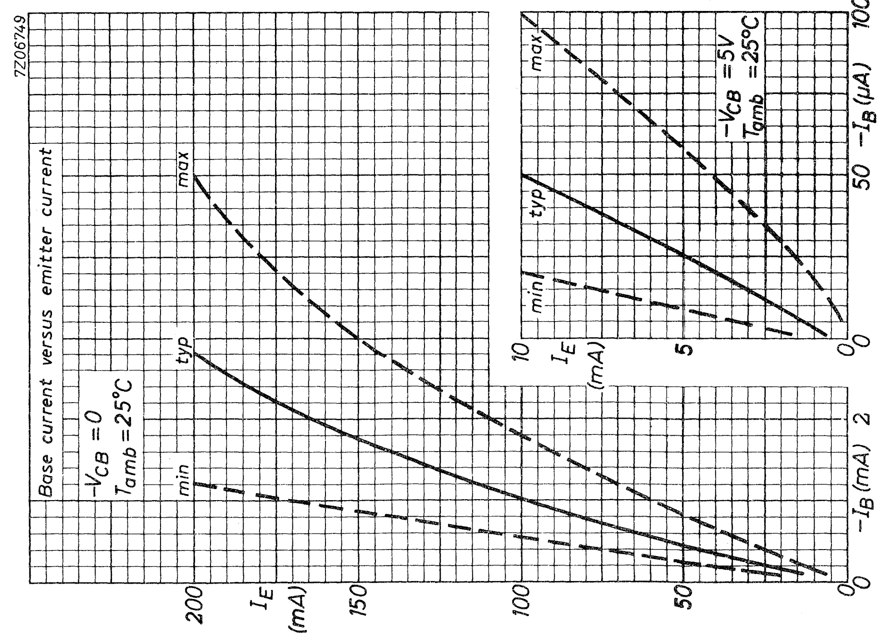
Supply voltage	V_S	=	6	9	V
Emitter current (zero signal)	I_E	=	2x1.5	2x1.5	mA
Bias resistor	R_1	=	5.6	6.8	kΩ
Common emitter resistor	R_E	=	5	14	Ω
Load resistance	$R_{cc\sim}$	=	160	292	Ω
Total power dissipation	P_{tot}	typ.	2x180	2x220	mW
Power delivered to transformer output	P_o	typ.	310	365	mW
Collector 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	%

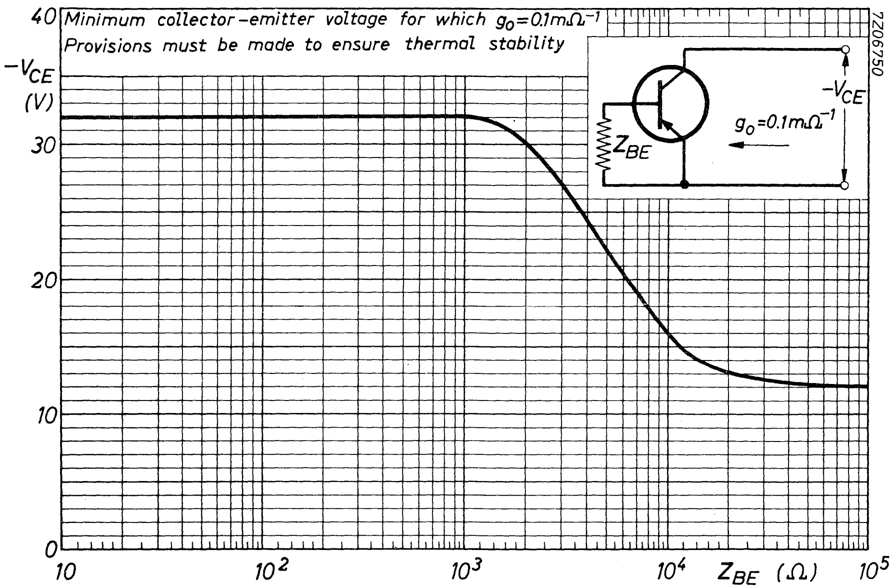
7Z3 0879


7Z06751
max
typ
10V
32V
10V
$-V_{CB}$ = 32V
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
$-I_C$ (mA)
200
150
100
0
200
$-V_{BE}$ (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)
$-V_{BE}$ (mV)
$-V_{CB} = 5V$
$T_{amb} = 25°C$


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

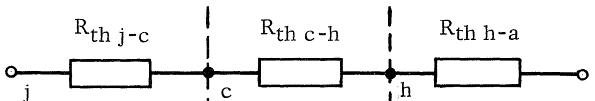

Minimum collector-emitter voltage for which $g_o = 0.1 m\Omega^{-1}$
Provisions must be made to ensure thermal stability
7Z06750
$-V_{CE}$ (V)
40
30
20
10
0
10
10^2
10^3
10^4
10^5
Z_{BE} (Ω)
$-V_{CE}$
$g_o = 0.1 m\Omega^{-1}$
Z_{BE}

GERMANIUM ALLOY TRANSISTOR

P-N-P transistor, 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 AC128 when using heat conducting clip 56227.

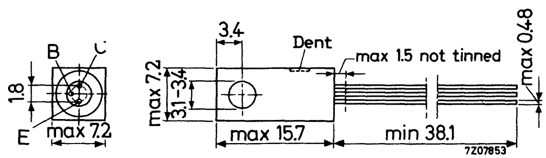
THERMAL RESISTANCE

From junction to ambient in free air $R_{th\ j-a}$ = 190 °C/W



	$R_{th\ j-c}$	$R_{th\ c-h}$	$R_{th\ h-a}$	
AC132 with clip 56227	50	15		°C/W
AC132/01	55	0.5		°C/W

MECHANICAL DATA



The dent indicates the collector side

For further data and curves of this type please refer to type AC132

7Z3 1329

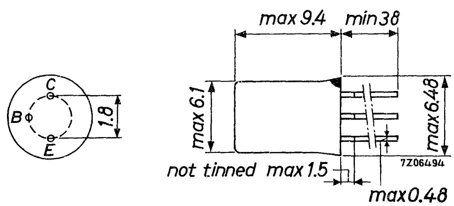
GERMANIUM ALLOY TRANSISTOR

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

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.	10	mA
Total power dissipation up to T_{amb} = 25 °C	P_{tot}	max.	200	mW
Junction temperature (incidentally)	T_j	max.	100	°C
Small signal current gain at T_{amb} = 25 °C				
I_C = 500 μA; V_{CE} = 5 V; f = 1 kHz	h_{fe}		45 to 110	
Transition frequency				
I_C = 10 mA; V_{CB} = 2 V	f_T	typ.	2.5	MHz

MECHANICAL DATA Dimensions in mm

TO-1



The blue dot indicates the collector

7Z3 0880

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

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

THERMAL RESISTANCE

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

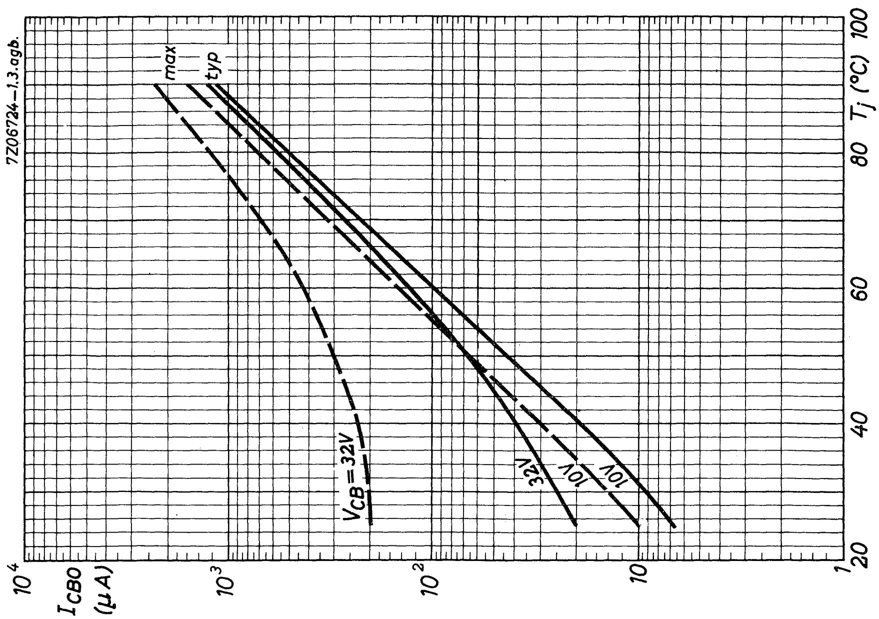
[1]) Limiting values according to the Absolute Maximum System as defined in IEC publication 134.

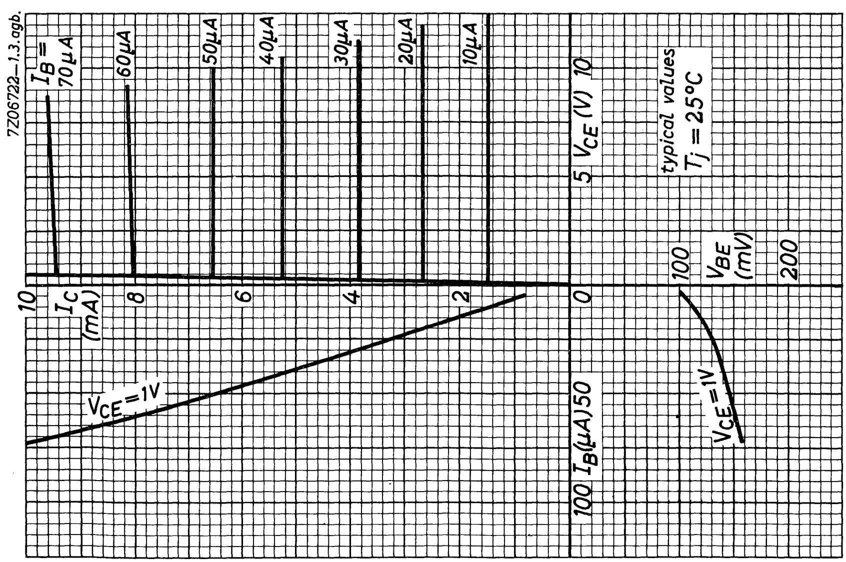
7Z3 0881

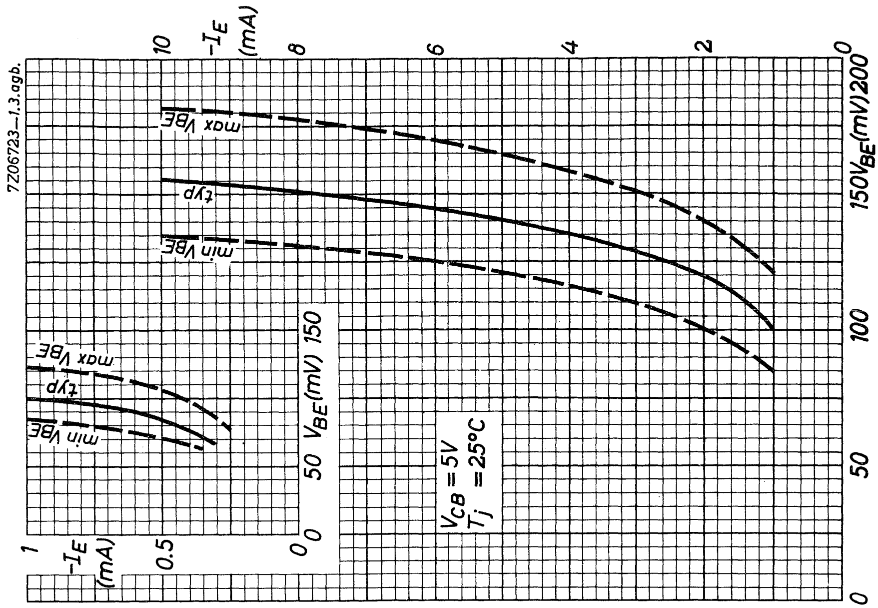
CHARACTERISTICS $T_j = 25\ ^oC$ unless otherwise specified

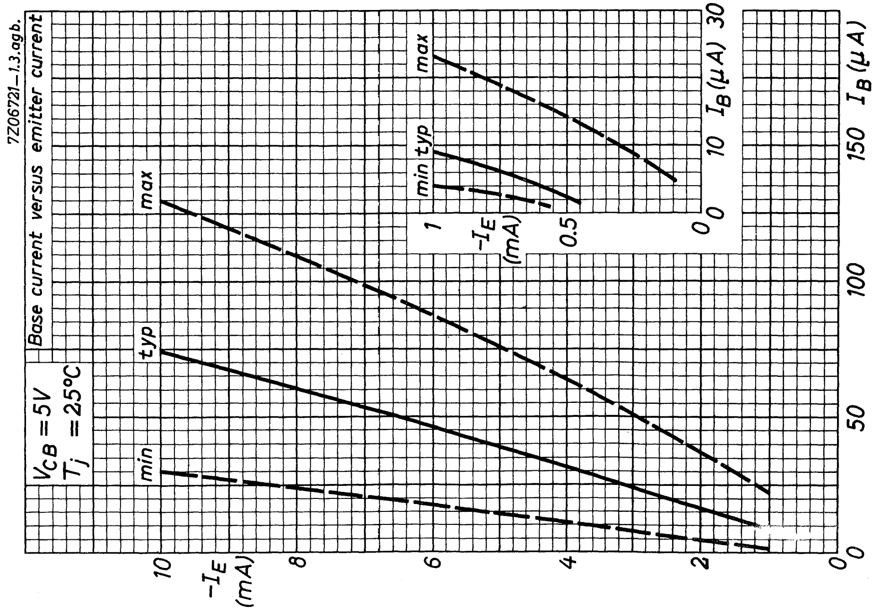
Collector cut-off current				
$I_E = 0$; $V_{CB} = 10$ V	I_{CBO}	<	10	μA
$I_E = 0$; $V_{CB} = 32$ V; $T_j = 75\ ^oC$	I_{CBO}	<	900	μA
Emitter cut-off current				
$I_C = 0$; $V_{EB} = 10$ V	I_{EBO}	<	200	μA
$I_C = 0$; $V_{EB} = 5$ V; $T_j = 75\ ^oC$	I_{EBO}	<	550	μA
Small signal current gain at f = 1 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	$\lvert z_{rb} \rvert$	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; $R_S = 500\ \Omega$ Bandwidth = 200 Hz	F	typ.	3	dB
		<	4	dB

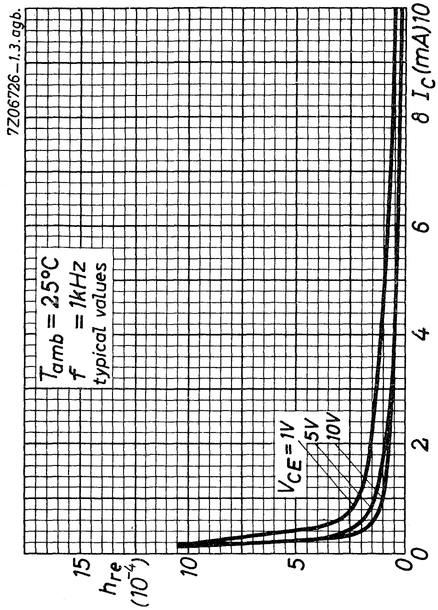
7Z3 0882

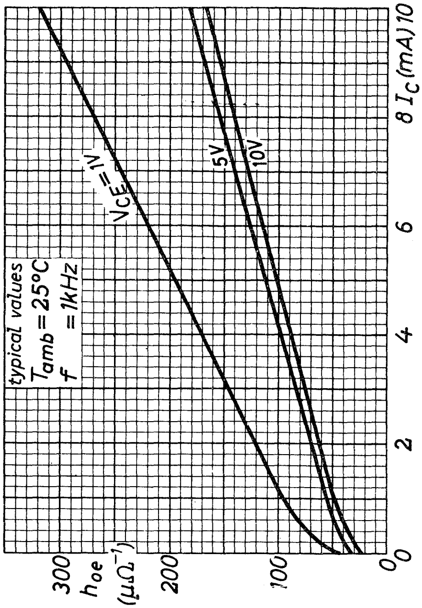

7Z06724—1.3.agb.
max
typ
$V_{CB} = 32V$
32V
10V
10V
I_{CBO} (μA)
10^4
10^3
10^2
10
1
T_j (°C)
20
40
60
80
100

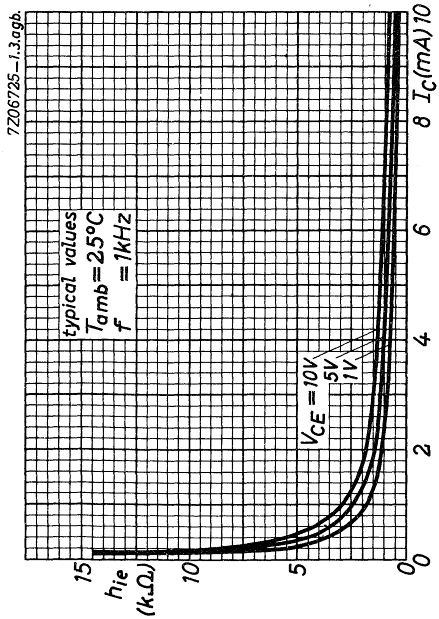

7Z06722—1.3.agb.
$I_B = 70 \mu A$
60μA
50μA
40μA
30μA
20μA
10μA
I_C (mA)
10
8
6
4
2
0
5
10
V_{CE} (V)
typical values
$T_j = 25°C$
$V_{CE} = 1V$
I_B (μA)
50
100
V_{BE} (mV)
200

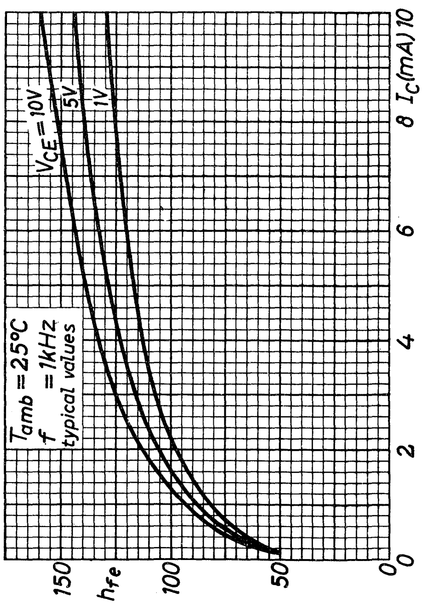

7Z06723—1.3.agb.
V_{CB} = 5V
T_j = 25°C
max V_{BE}
typ
min V_{BE}
$-I_E$ (mA)
V_{BE} (mV)

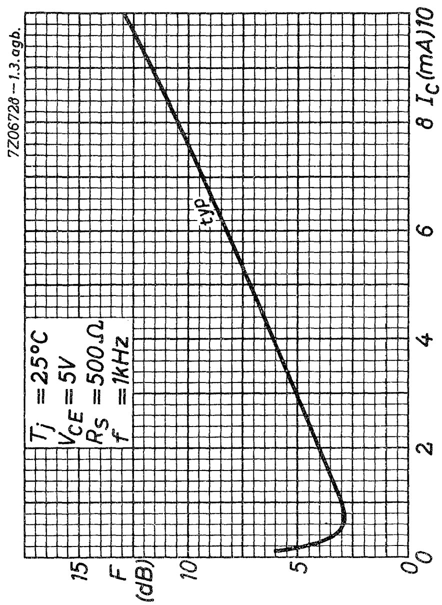

7Z06721—1.3.agb.
Base current versus emitter current
V_{CB} = 5V
T_j = 25°C
max
typ
min
$-I_E$ (mA)
I_B (μA)

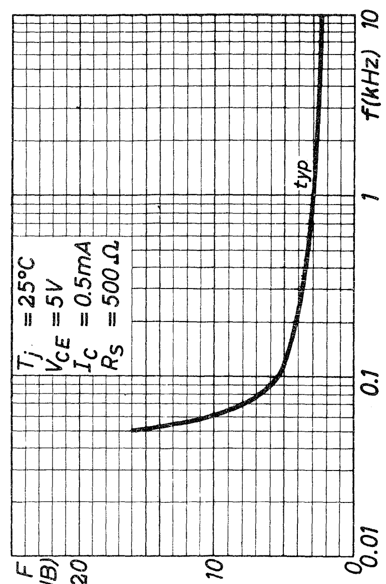

7Z06726–1.3.agb.
T_{amb} = 25°C
f = 1kHz
typical values
V_{CE} = 1V
5V
10V
15
h_{re}
(10^{-4})
10
5
0
0
2
4
6
8 I_C(mA) 10

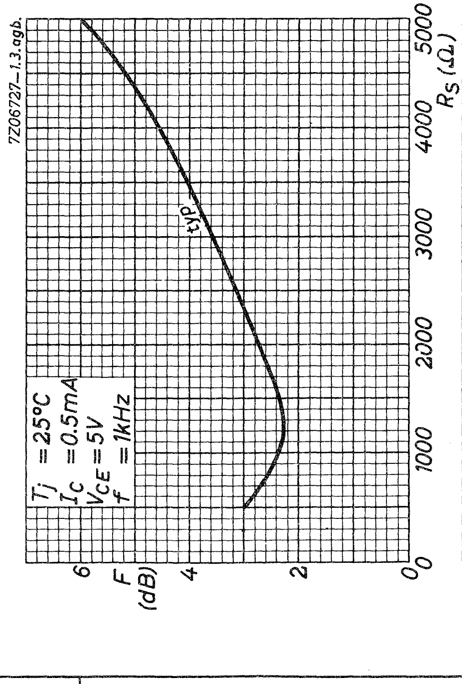

typical values
T_{amb} = 25°C
f = 1kHz
V_{CE} = 1V
5V
10V
300
h_{oe}
($\mu\Omega^{-1}$)
200
100
0
0
2
4
6
8 I_C(mA) 10

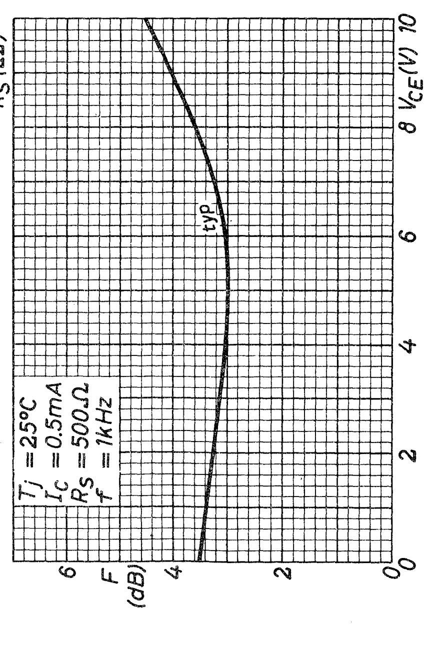

7Z06725–1.3.agb.
typical values
T_{amb} = 25°C
f = 1kHz
V_{CE} = 10V
5V
1V
15
h_{ie}
(kΩ)
10
5
0
0
2
4
6
8 I_C(mA) 10

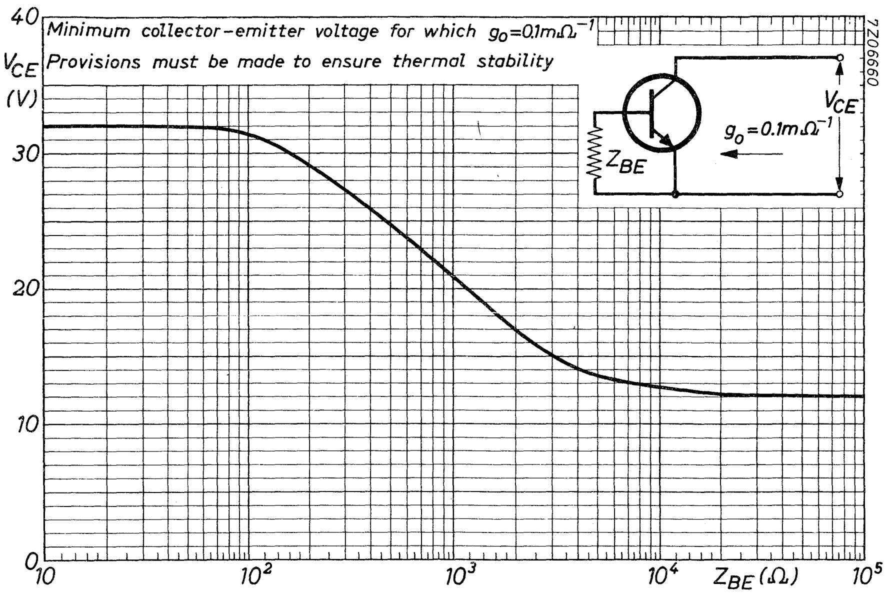

T_{amb} = 25°C
f = 1kHz
typical values
V_{CE} = 10V
5V
1V
150
h_{fe}
100
50
0
0
2
4
6
8 I_C(mA) 10


7Z06728 – 1.3.agb.
T_j = 25°C
V_{CE} = 5V
R_S = 500 Ω
f = 1kHz
typ
F (dB)
0
5
10
15
0
2
4
6
8
I_C (mA) 10


T_j = 25°C
V_{CE} = 5V
I_C = 0.5mA
R_S = 500 Ω
typ
F (dB)
0
10
20
0.01
0.1
1
f (kHz) 10


7Z06727 – 1.3.agb.
T_j = 25°C
I_C = 0.5mA
V_{CE} = 5V
f = 1kHz
typ
F (dB)
0
2
4
6
0
1000
2000
3000
4000
5000
R_S (Ω)


T_j = 25°C
I_C = 0.5mA
R_S = 500 Ω
f = 1kHz
typ
F (dB)
0
2
4
6
0
2
4
6
8
V_{CE} (V) 10



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

GERMANIUM ALLOYED MEDIUM POWER TRANSISTOR

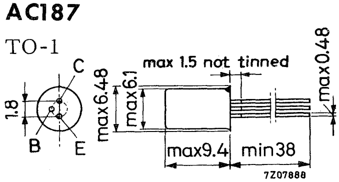
The AC187 is a n-p-n audio transistor in a TO-1 metal envelope.
The AC187 is primarily intended for use together with the p-n-p medium power transistor AC188 as matched pair AC187/AC188 to about 3 W complementary symmetry class B output stages.
The AC187/01 is electrically equivalent to the AC187, constructed integrally with a heat conducting block, which gives better heat transfer.
The thermal resistance from junction to heatsink shows an improvement ($\approx 10\ ^{\circ}C/W$) 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

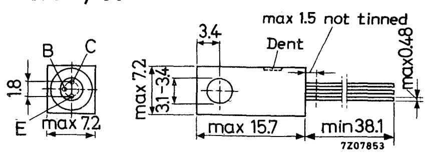
MECHANICAL DATA Dimensions in mm

AC187

TO-1



AC187/01



The coloured dot indicates the collector

Accessories available: 56200; 56208; 56209; 56210; 56226; 56227. 7Z3 1330

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

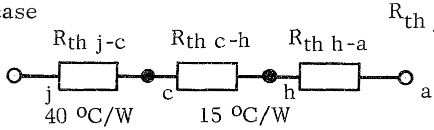
Temperatures

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

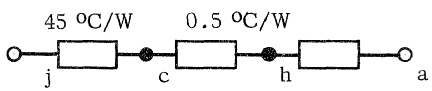
THERMAL RESISTANCE

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

AC187 with cooling clip 56227



AC187/01



---

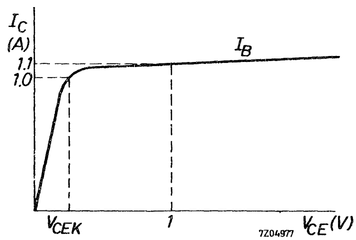
[1]) Limiting values according to the Absolute Maximum System as defined in IEC publication 134.

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

7Z3 1331

CHARACTERISTICS T_j = 25 °C unless otherwise specified

Collector cut-off current				
I_E = 0; V_{CB} = 25 V	I_{CBO}	typ.	15	μA
		<	100	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	μA
		<	100	μA
I_C = 0; V_{EB} = 10 V; T_j = 90 °C	I_{EBO}	typ.	1.2	mA
		<	2.5	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
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

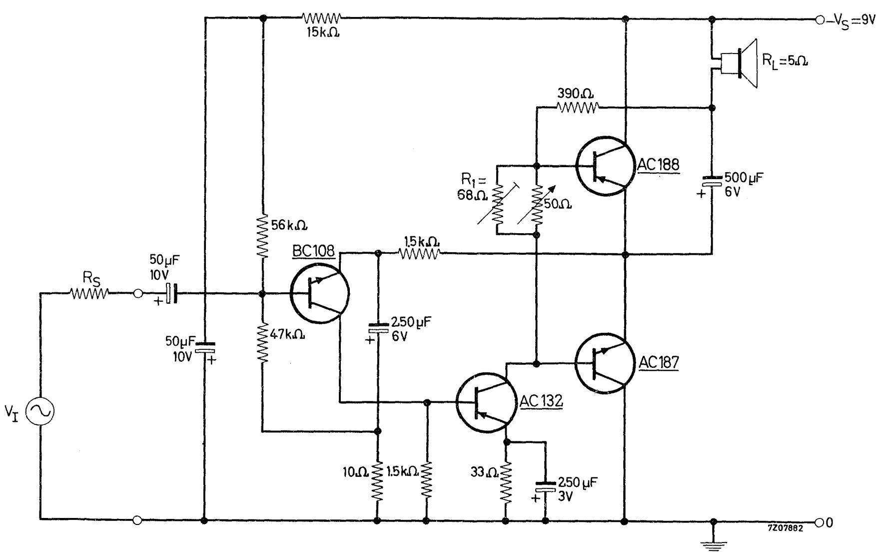
7Z3 1332

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

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.

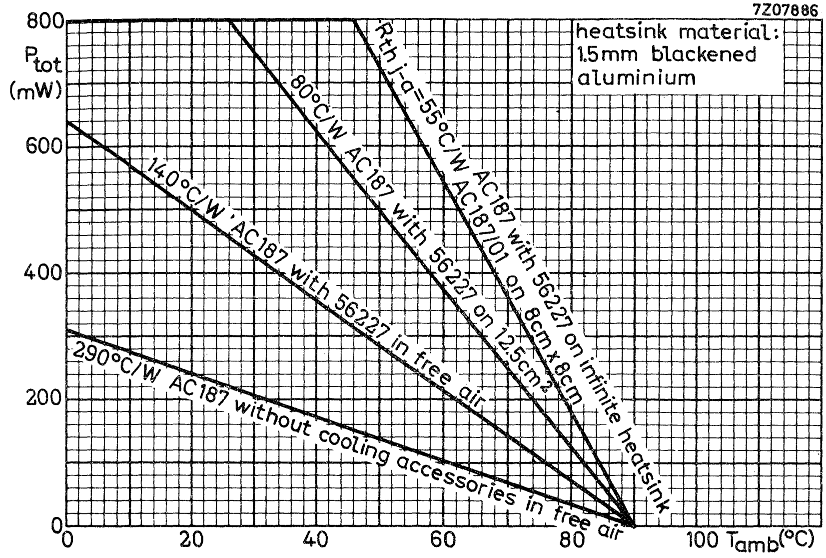


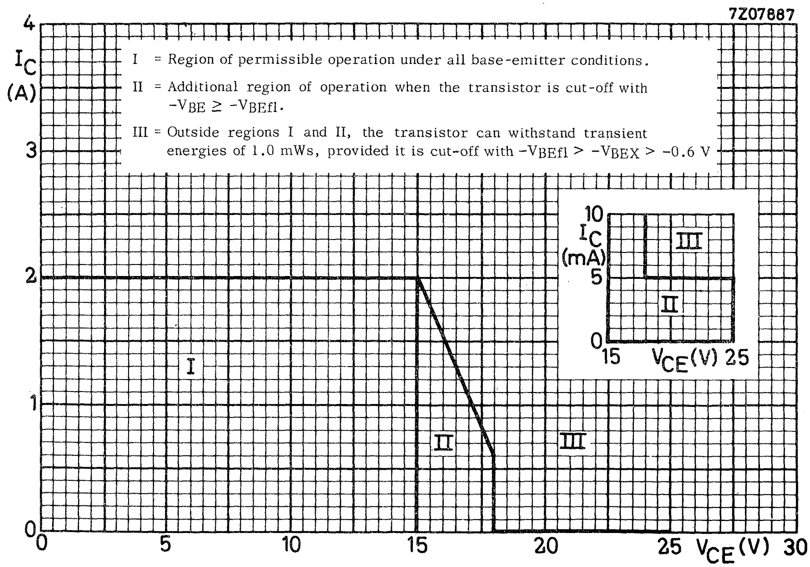
7Z3 1333

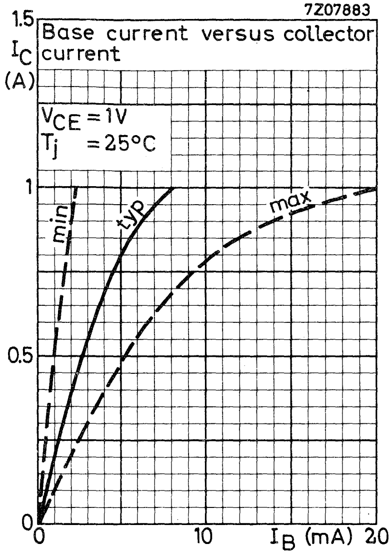
Typical input requirements for an output power of 50 mW	$V_{i\,(rms)}$ R_i	= 4 mV; $I_{i\,(rms)}$ = 0.12 μA; = 33 kΩ
Typical input requirements for an output power of 1.5 W	$V_{i\,(rms)}$ R_i	= 22 mV; $I_{i\,(rms)}$ = 0.66 μA; = 33 kΩ
Typical bandwidth (3 dB); R_S = 0	B	= 60 Hz to 65 kHz
Typical bandwidth (3 dB); R_S = 50 kΩ	B	= 65 Hz to 35 kHz
Quiescent current	$\lvert I_{cq} \rvert$	= 5 mA, adjustable with R_1

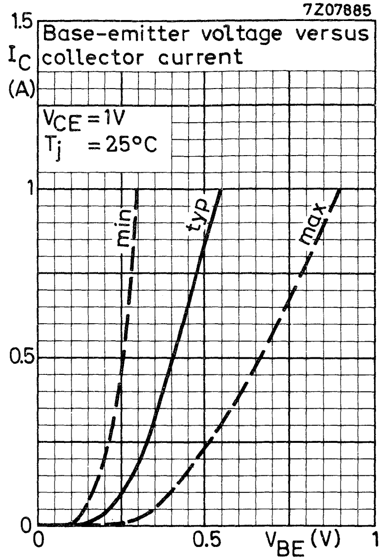
When using AC187 and AC188 each transistor should be mounted with cooling clip 56227 on 1.5 mm blackened Al. heatsink of 3 cm x 3 cm.
When using AC187/01 and AC188/01 each transistor should be mounted on 1.5 mm blackened Al. heatsink of 2.5 cm x 2.5 cm.

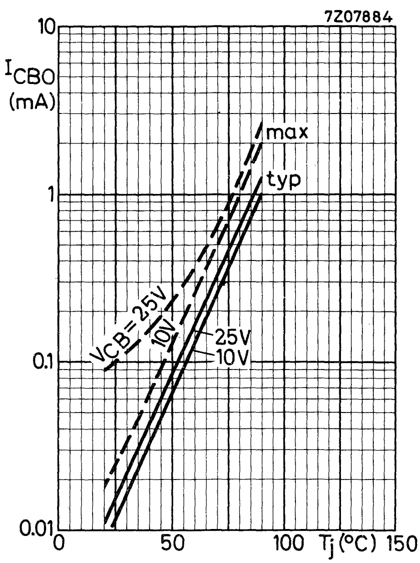
7Z3 1343


7Z07886
heatsink material:
1.5mm blackened
aluminium
Rth j-a=55°C/W AC187 with 56227 on infinite heatsink
AC187/01 on 8cm x 8cm
80°C/W AC187 with 56227 on 12.5cm²
140°C/W AC187 with 56227 in free air
290°C/W AC187 without cooling accessories in free air
Ptot (mW)
Tamb(°C)


7Z07887
I = Region of permissible operation under all base-emitter conditions.
II = Additional region of operation when the transistor is cut-off with -VBE ≥ -VBEfl.
III = Outside regions I and II, the transistor can withstand transient energies of 1.0 mWs, provided it is cut-off with -VBEfl > -VBEX > -0.6 V
IC (A)
VCE (V)
IC (mA)
VCE(V)


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 TRANSISTOR

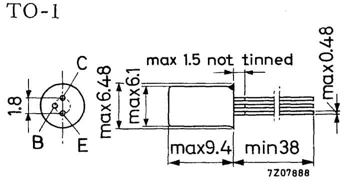
The AC188 is a p-n-p audio transistor in a TO-1 metal envelope.
The AC188 is primarily intended for use together with the n-p-n medium power transistor AC187 as matched pair AC187/AC188 to about 3 W complementary symmetry class B output stages.
The AC188/01 is electrically equivalent to the AC188, constructed integrally with a heat conducting block, which gives better heat transfer.
The thermal resistance from junction to heatsink shows an improvement (≈10 $^{o}C/W$) 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.	20	kHz

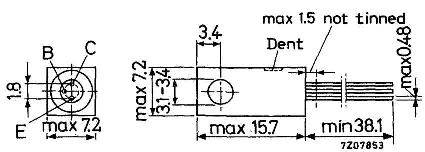
MECHANICAL DATA

AC188

TO-1



AC188/01



The coloured dot indicates the collector

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

7Z3 1344

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

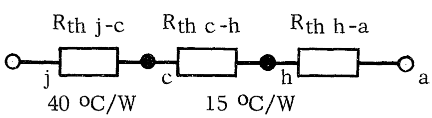
Temperatures

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

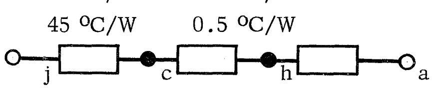
THERMAL RESISTANCE

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

AC188 with cooling clip 56227



AC188/01



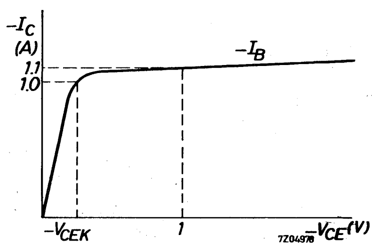
1) Limiting values according to the Absolute Maximum System as defined in IEC publication 134.

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

7Z3 1345

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
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	pF
		<	110	pF

7Z3 1346

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

Transition frequency

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

Cut-off frequency

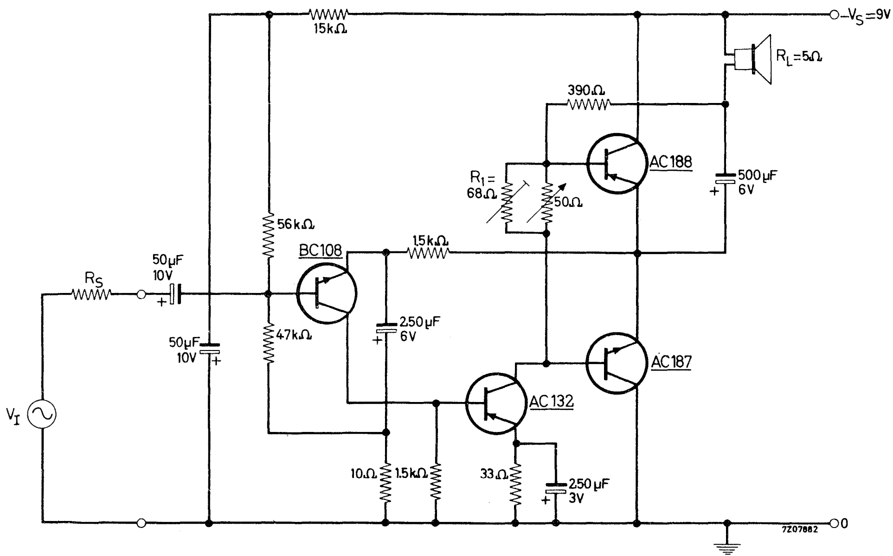
$-I_C$ = 10 mA; $-V_{CE}$ = 2 V	f_{hfe}	typ. 10	kHz

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

$\lvert I_C \rvert$ = 500 mA; $\lvert V_{CE} \rvert$ = 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



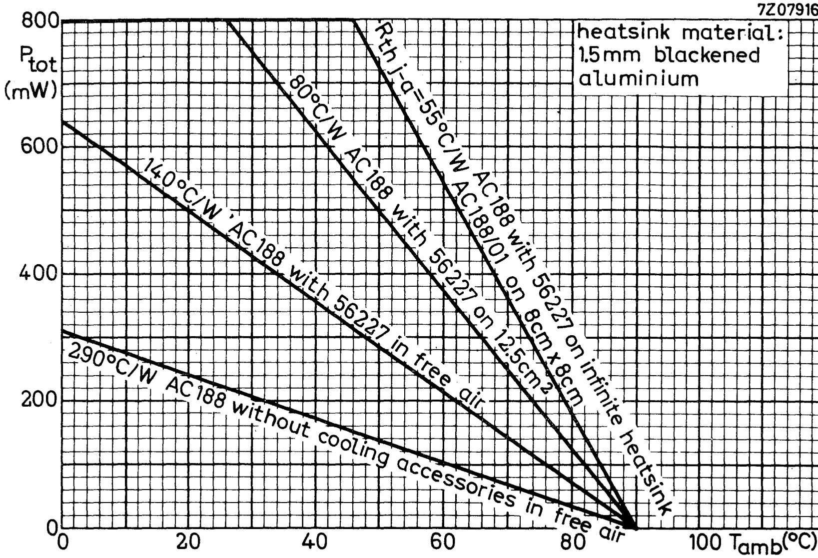
7Z3 1347

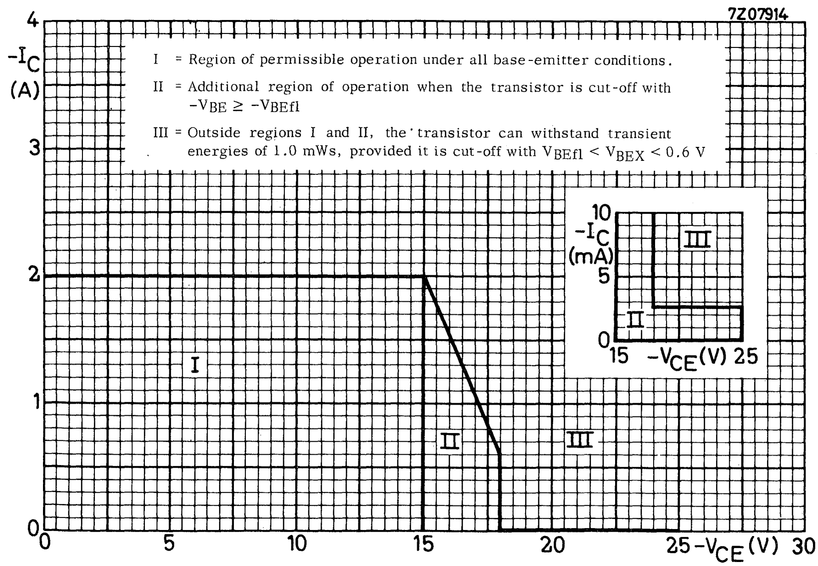
APPLICATION INFORMATION (continued)

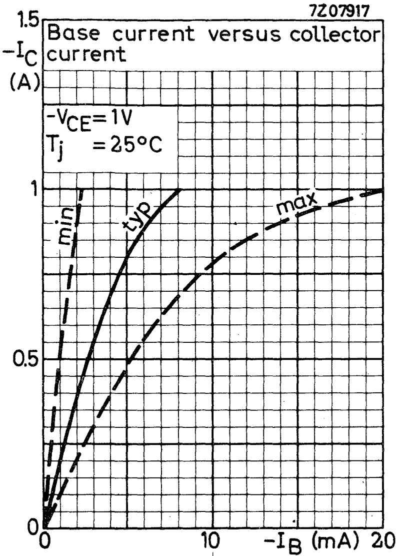
Typical input requirements for an output power of 50 mW	$V_{i(rms)}$ R_i	= 4 mV; $I_{i(rms)}$ = 0.12 μA; = 33 kΩ
Typical input requirements for an output power of 1.5 W	$V_{i(rms)}$ R_i	= 22 mV; $I_{i(rms)}$ = 0.66 μA; = 33 kΩ
Typical bandwidth (3 dB); R_S = 0	B	= 60 Hz to 65 kHz
Typical bandwidth (3 dB); R_S = 50 kΩ	B	= 65 Hz to 35 kHz
Quiescent current	$\lvert I_{cq} \rvert$	= 5 mA, adjustable with R_1

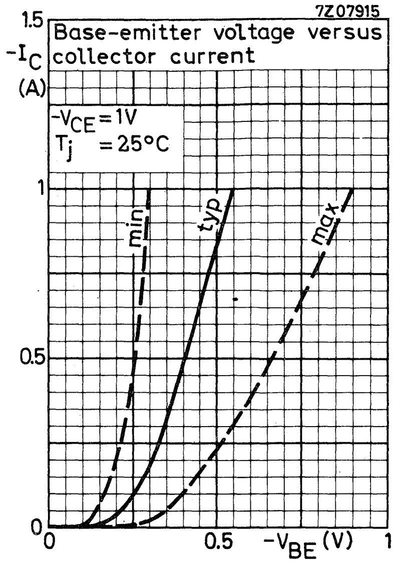
When using AC187 and AC188 each transistor should be mounted with cooling clip 56227 on 1.5 mm blackened Al. heatsink of 3 cm x 3 cm.
When using AC187/01 and AC188/01 each transistor should be mounted on 1.5 mm blackened Al. heatsink of 2.5 cm x 2.5 cm.

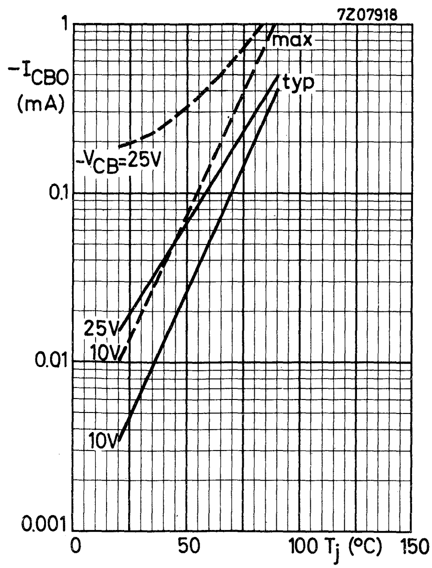
7Z3 1348


7Z07916
heatsink material:
1.5mm blackened
aluminium
P_{tot} (mW)
800
600
400
200
0
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
0
20
40
60
80
100 T_{amb} (°C)


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
$-I_C$ (A)
4
3
2
1
0
I
II
III
10
$-I_C$ (mA)
5
0
15
$-V_{CE}$ (V)
25
0
5
10
15
20
25 $-V_{CE}$ (V) 30


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


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


7Z07918
1
$-I_{CBO}$
(mA)
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

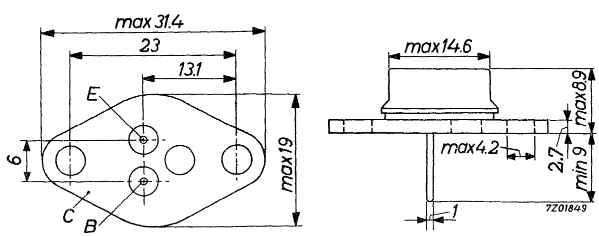
P-N-P power transistor in a metal envelope with the collector connected to the mounting base.
It is primarily intended for use as matched pair 2-AD139 in low distortion class B push-pull output stages.

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 and mounting instructions see page 4.

7Z3 0883

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 $R_{BE} < 50\ \Omega$ (See also page C)	$-V_{CER}$	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 ^oC	P_{tot}	max.	13	W

Temperatures

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

THERMAL RESISTANCE

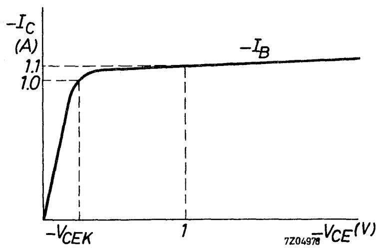
From junction to mounting base	$R_{th\ j-mb}$	=	4.0	$^oC/W$
From mounting base to heatsink with mica washer	$R_{th\ mb-h}$	=	1.5	$^oC/W$
without mica washer	$R_{th\ mb-h}$	=	0.5	$^oC/W$

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

7Z3 0884

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

Collector cut-off current				
$I_E = 0;\ -V_{CB} = 0.5\ V$	$-I_{CBO}$	<	25	μA
$I_E = 0;\ -V_{CB} = 32\ V;\ T_j = 90\ ^oC$	$-I_{CBO}$	<	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 see page C			
$V_S = 14\ V;\ R_L = 12\ \Omega$ [1]	λ_1	> typ.	0.45 0.55

---

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

7Z3 0885

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

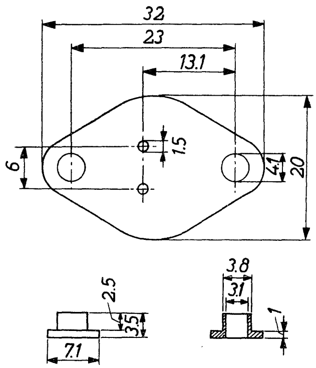
Cut-off frequency

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

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

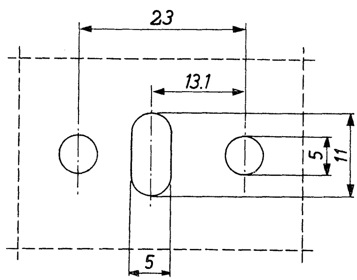
$-I_C$ = 100 mA; V_{CB} = 0	h_{FE1}/h_{FE2}	<	1.25
$-I_C$ = 1 A; V_{CB} = 0	h_{FE1}/h_{FE2}	<	1.25

ACCESSORIES AND MOUNTING INSTRUCTIONS Dimensions in mm



56239

Mica washer (50 to 100 μm) and insulation bushes

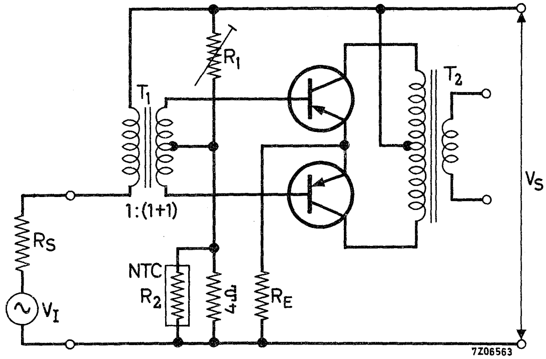


Bore-hole dimensions for heatsink

7Z3 0886

APPLICATION INFORMATION

Class B push-pull output stage with matched pair 2-AD139.

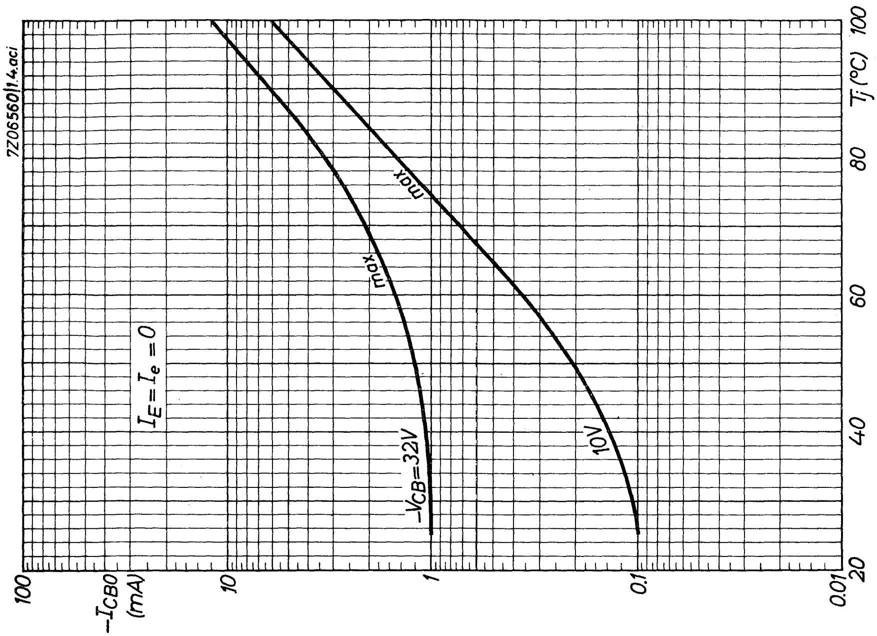


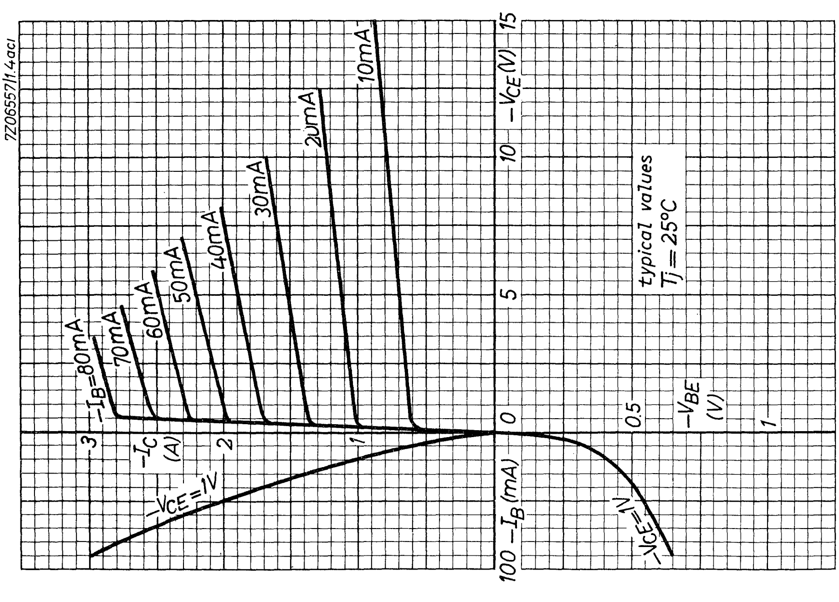
Stable continuous operation is ensured at an ambient temperature of up to 60 °C provided each transistor is mounted on a 1.5 mm copper heatsink of at least 10 cm x 10 cm.

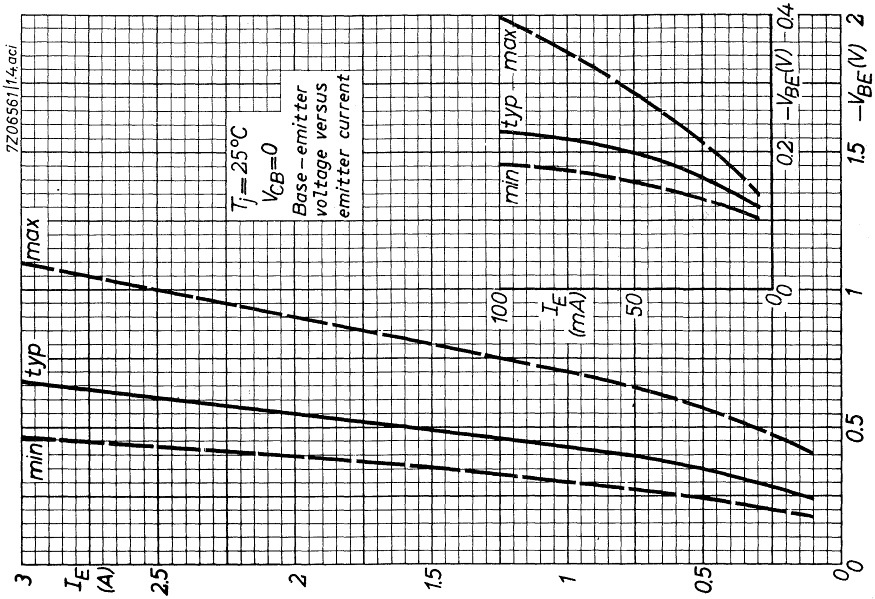
Supply voltage	V_S	=	7	14	V
		<	8	16	V
Collector current (zero signal)	$-I_C$	=	60	60	mA
Bias resistor	R_1	=	100	200	Ω
NTC resistor [1]	R_2	=	4	4	Ω
Common emitter resistor	R_E	=	0.1	0.39	Ω
Source resistance	R_S	=	200	130	Ω
Load resistance	$R_{cc\sim}$	=	17.5	72	Ω
Total power dissipation	P_{tot}	typ.	2x2.55	2x2.55	W
Output power delivered to transformer	P_o	typ.	2x2.5	2x2.5	W
Collector current (peak value) at P_o = 5 W	$-I_{CM}$	typ.	1500	750	mA
Collector current at P_o = 5 W	$-I_C$	typ.	480	240	mA
Input voltage (peak value) at P_o = 5 W	V_{IM}	typ.	7.5	2.65	V
Input current (peak value) at P_o = 5 W	I_{IM}	typ.	36	16.7	mA
Total harmonic distortion at P_o = 5 W	d_{tot}	typ.	6	4.5	%
Input current (peak value) at P_o = 50 mW	I_{IM}	typ.	3.4	1.67	mA
Total harmonic distortion at P_o = 50 mW	d_{tot}	typ.	1.5	1	%

[1]) The NTC resistor should be mounted on the heatsink, close to the transistor. Code number 2322 610 11408.

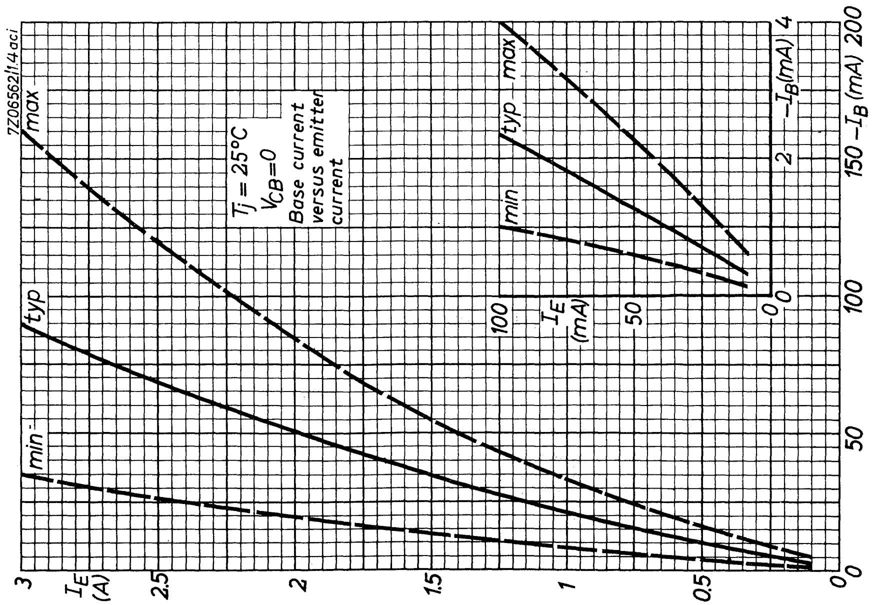
7Z3 0887


7Z06560|1.4.aci
$I_E = I_e = 0$
max
max
$-V_{CB}$=32V
10V
$-I_{CBO}$ (mA)
100
10
1
0.1
0.01
20
40
60
80
100
T_j (°C)

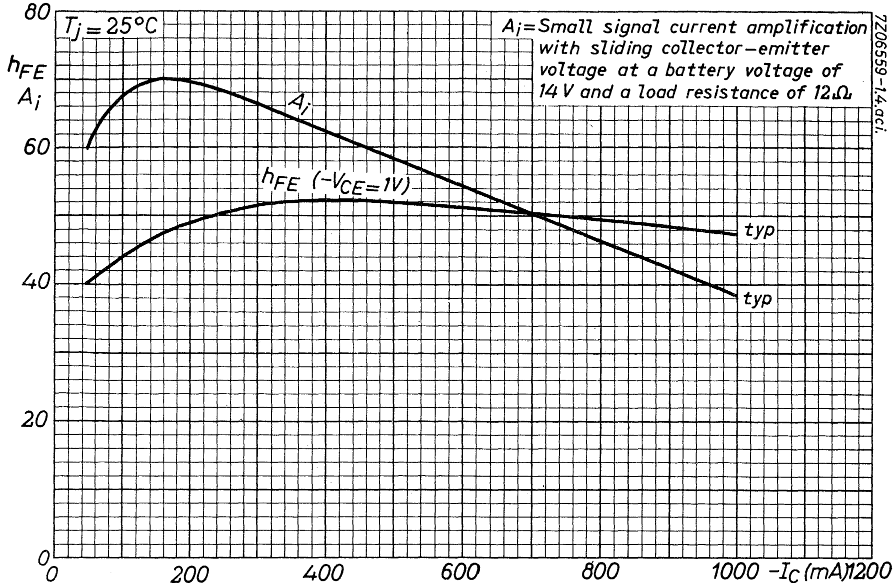

7Z06557|1.4.aci
$-I_B$=80mA
70mA
60mA
50mA
40mA
30mA
20mA
10mA
typical values
T_j = 25°C
$-V_{CE}$ (V)
0
5
10
15
$-I_C$ (A)
1
2
3
$-V_{CE}$=1V
$-V_{CE}$=1V
$-V_{BE}$ (V)
0.5
1
100 $-I_B$ (mA)

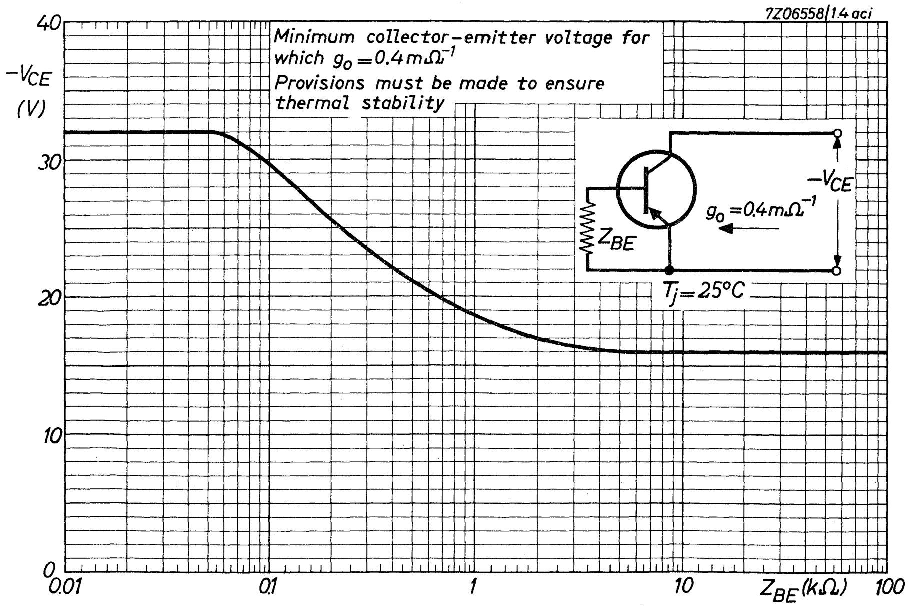


7Z06561.1.4.aci
$T_j = 25°C$
$V_{CB}=0$
Base-emitter voltage versus emitter current
max
typ
min
I_E (A)
$-V_{BE}$ (V)
I_E (mA)
$-V_{BE}$ (V)



7Z06562.1.4.aci
$T_j = 25°C$
$V_{CB}=0$
Base current versus emitter current
max
typ
min
I_E (A)
$-I_B$ (mA)
I_E (mA)
$-I_B$ (mA)


7Z06559-1.4.aci
$T_j = 25°C$
A_i = Small signal current amplification with sliding collector-emitter voltage at a battery voltage of 14 V and a load resistance of 12 Ω
h_{FE}
A_i
h_{FE} ($-V_{CE}$=1V)
typ
typ
80
60
40
20
0
0
200
400
600
800
1000
1200
$-I_C$ (mA)


7Z06558/1.4 aci
Minimum collector-emitter voltage for which $g_o = 0.4 m\Omega^{-1}$
Provisions must be made to ensure thermal stability
$-V_{CE}$ (V)
40
30
20
10
0
0.01
0.1
1
10
100
Z_{BE} (kΩ)
Z_{BE}
$-V_{CE}$
$g_o = 0.4 m\Omega^{-1}$
$T_j = 25°C$

GERMANIUM ALLOYED POWER TRANSISTORS

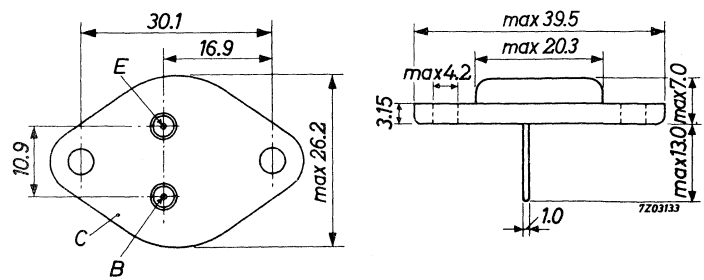
P-N-P power transistor in a TO-3 metal envelope with the collector connected to the mounting base.
It is primarily intended for use as matched pair 2-AD149 in class B push-pull output stages with an output power of up to 20 W and in frame deflection output stages.

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} = 65 °C	P_{tot}	max.	22.5	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

TO-3

Collector connected to mounting base



Accessories and mounting instructions see page 4. 7Z3 1130

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} = 65 °C	P_{tot}	max.	22.5	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.

7Z3 1131

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

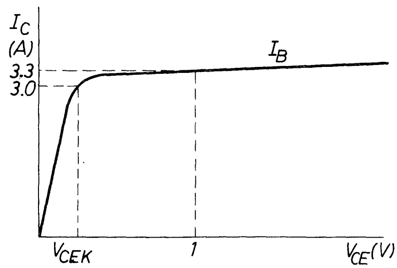
$I_C = 0;\ -V_{EB} = 20$ V	$-I_{EBO}$	<	3	mA

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

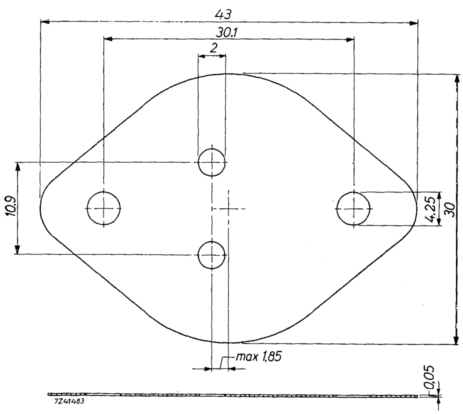
$I_C = I_c = 0;\ -V_{EB} = 5$ V	C_e	typ.	140	pF

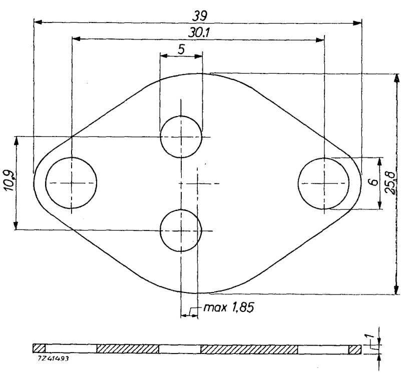
7Z3 1132

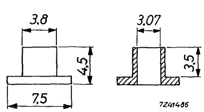
CHARACTERISTICS (continued) T_j = 25 °C unless otherwise specified

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	$\lvert z_{rb} \rvert$	typ.	30	Ω
Small signal current gain linearity [1]				
(See page D)	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	

ACCESSORIES AND MOUNTING INSTRUCTIONS Dimensions in mm







Type number: 56201e
Mica washer; 2 insulating bushes and lead washer

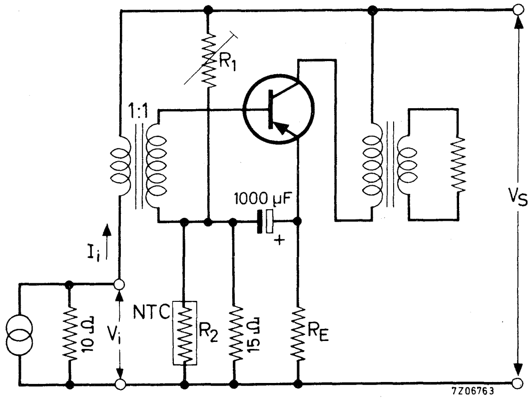
---

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

7Z3 1133

APPLICATION INFORMATION

AD149 in a class A output amplifier.



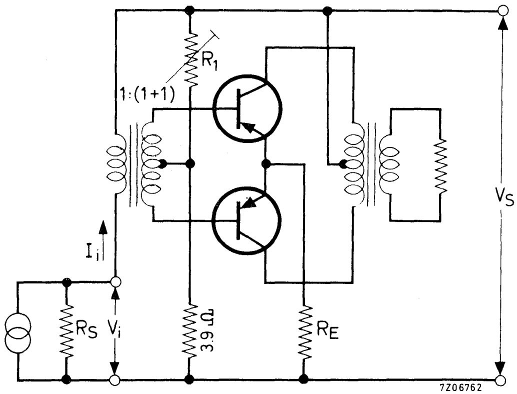
Stable continuous operation is ensured at an ambient temperature up to 55 °C provided each transistor is mounted on a 1.5 mm copper heatsink of at least 18 cm x 18 cm (circuit I) or 15 cm x 15 cm (circuit II).

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	R_1	=	50	200	Ω
NTC resistor [1]	R_2	=	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. 7Z3 1134

APPLICATION INFORMATION

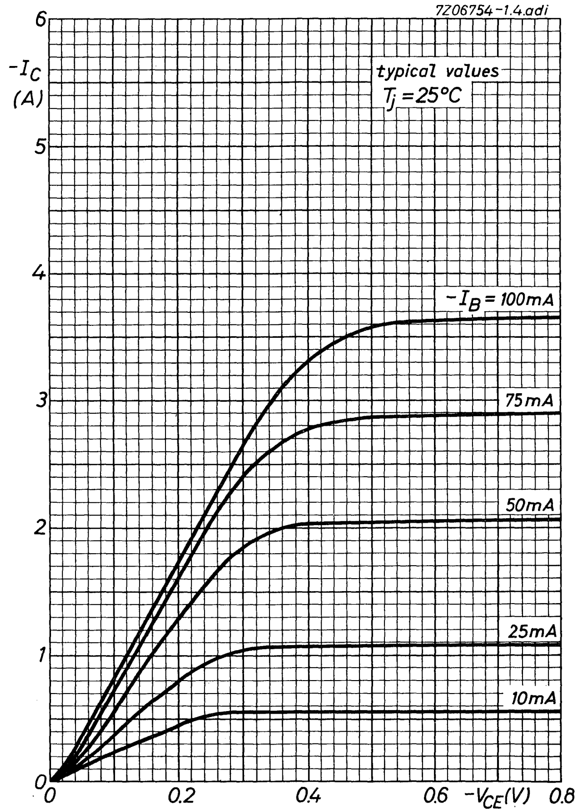
2-AD149 in a class B output amplifier.

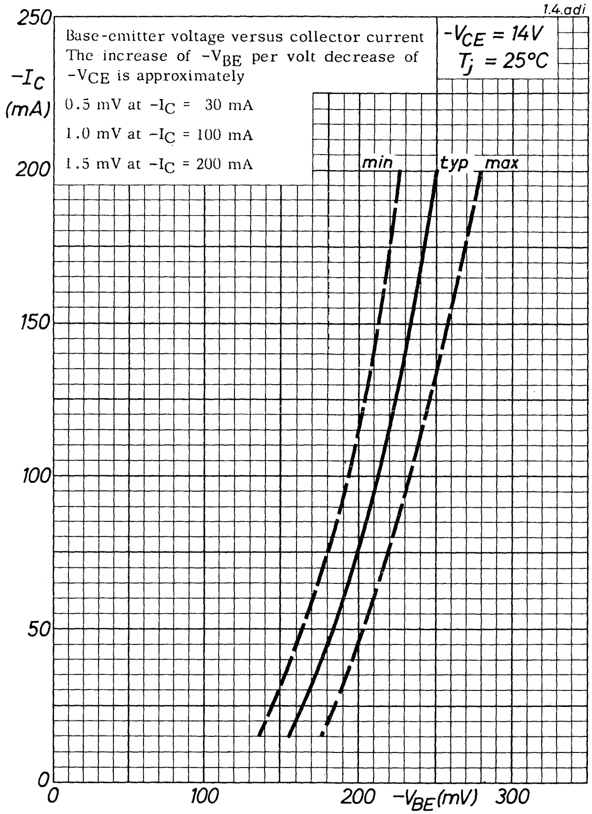


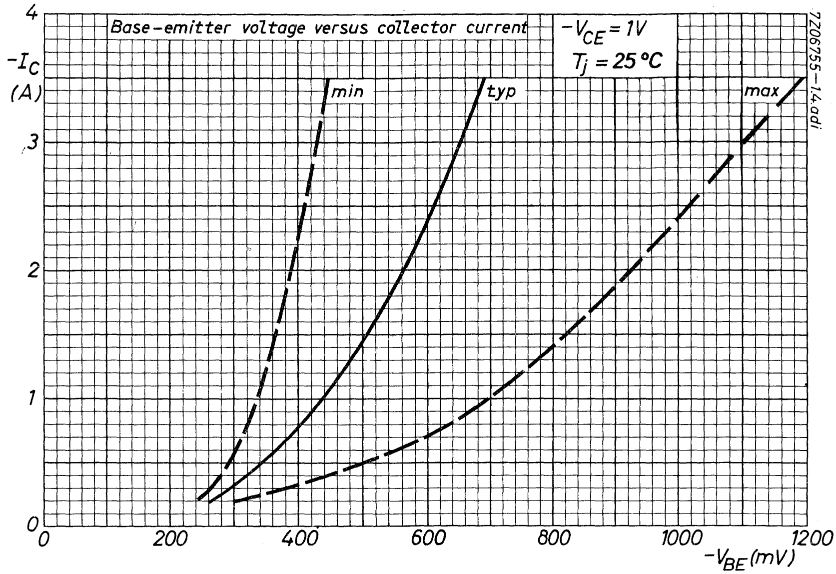
Stable continuous operation is ensured at an ambient temperature up to 55 °C provided each transistor is mounted on a 1.5 mm copper heatsink of at least 5 cm x 5 cm (circuit I) or 6 cm x 6 cm (circuit II).

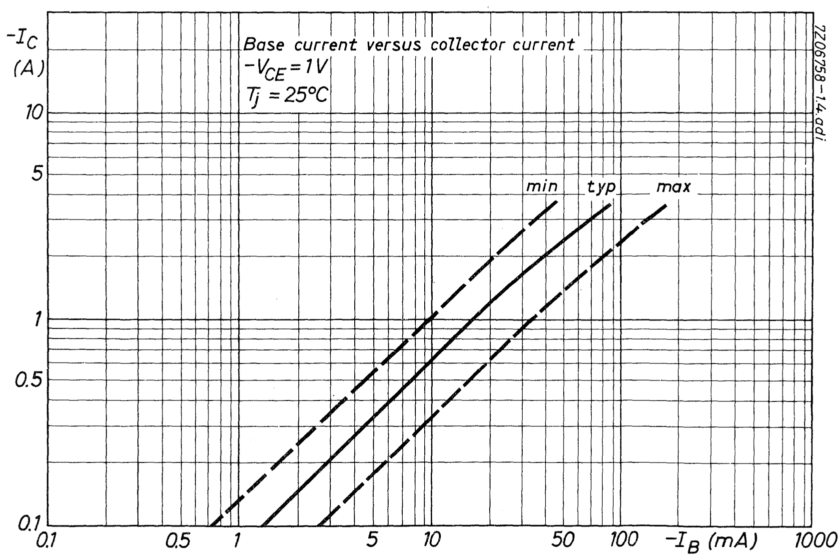
Characteristics			I	II	
Supply voltage	V_S	=	7	14	V
		<	8	16	V
Collector current (zero signal)	$-I_C$	=	60	60	mA
Bias resistor	R_1	=	200	350	Ω
Emitter resistor	R_E	=	0	0.47	Ω
Source resistance	R_S	=	450	370	Ω
Collector resistance	$R_{cc\sim}$	=	9	16	Ω
Total power dissipation of the transistors	P_{tot}	<	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	%

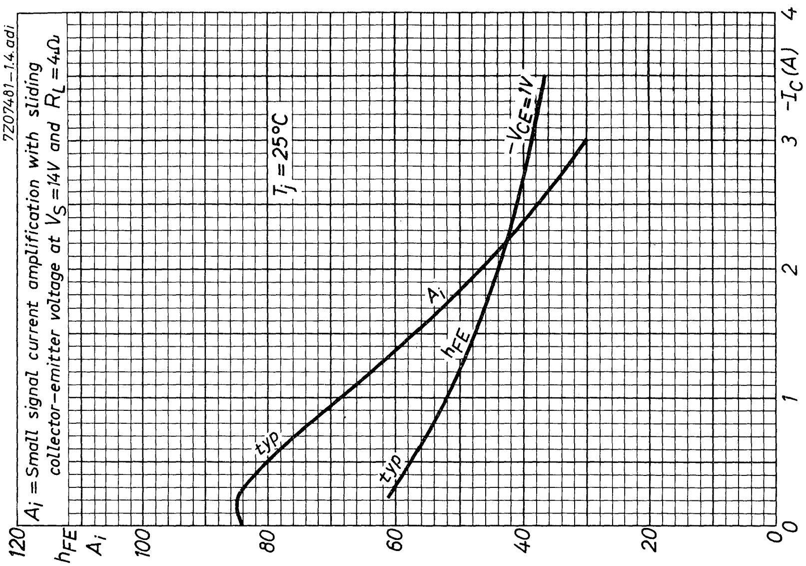
7Z3 1135

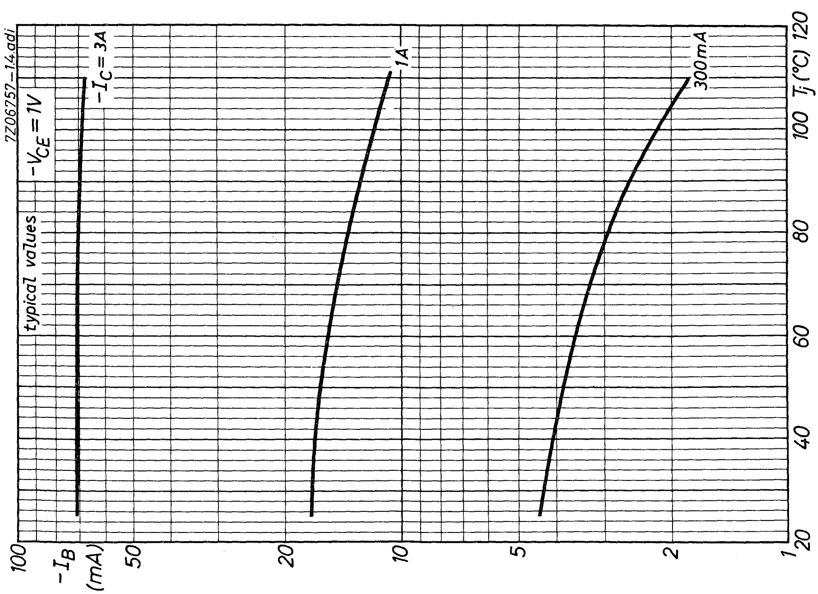

7Z06754-1.4.adi
6
$-I_C$
(A)
typical values
$T_j = 25°C$
5
4
$-I_B = 100mA$
3
75mA
2
50mA
25mA
1
10mA
0
0
0.2
0.4
0.6
$-V_{CE}(V)$
0.8

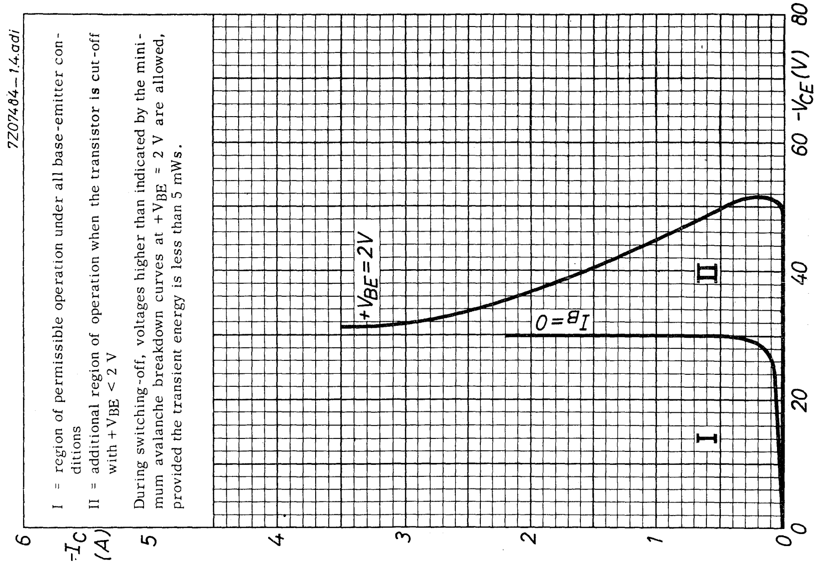

1.4.adi
Base-emitter voltage versus collector current
The increase of -VBE per volt decrease of -VCE is approximately
0.5 mV at -IC = 30 mA
1.0 mV at -IC = 100 mA
1.5 mV at -IC = 200 mA
-VCE = 14V
Tj = 25°C
-IC (mA)
250
200
150
100
50
0
min
typ
max
0
100
200
-VBE(mV)
300

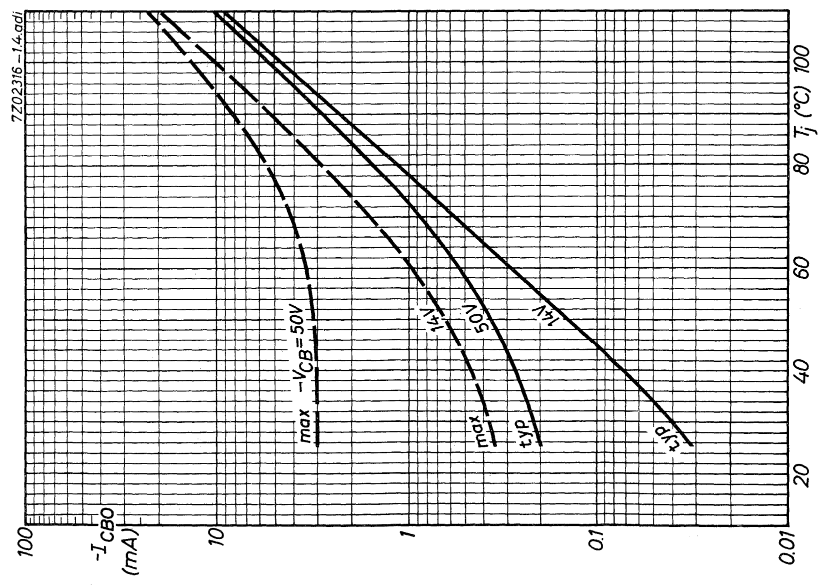

Base-emitter voltage versus collector current
$-V_{CE} = 1V$
$T_j = 25°C$
7Z06755-1.4.adi
$-I_C$ (A)
min
typ
max
$-V_{BE}$ (mV)
0
1
2
3
4
0
200
400
600
800
1000
1200

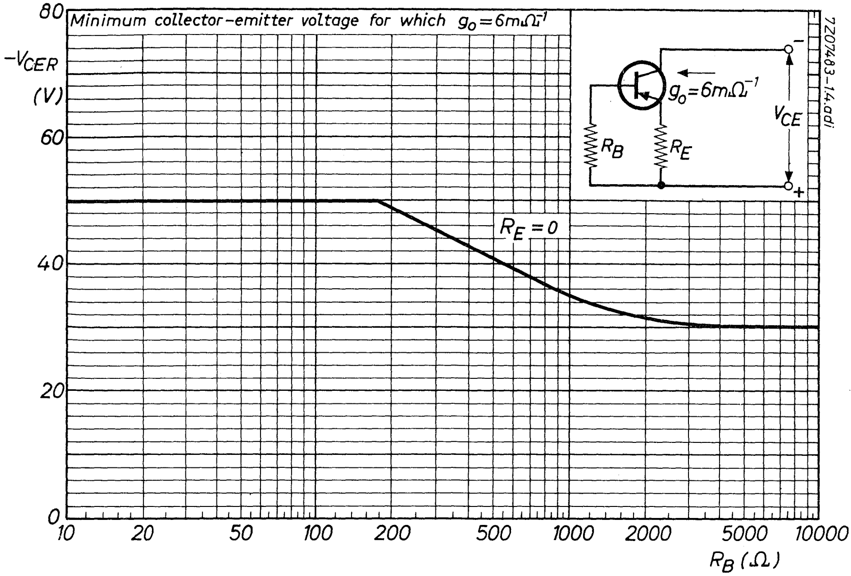

Base current versus collector current
$-V_{CE} = 1V$
$T_j = 25°C$
7Z06758-1.4.adi
$-I_C$ (A)
min
typ
max
$-I_B$ (mA)
0.1
0.5
1
5
10
0.1
0.5
1
5
10
50
100
1000

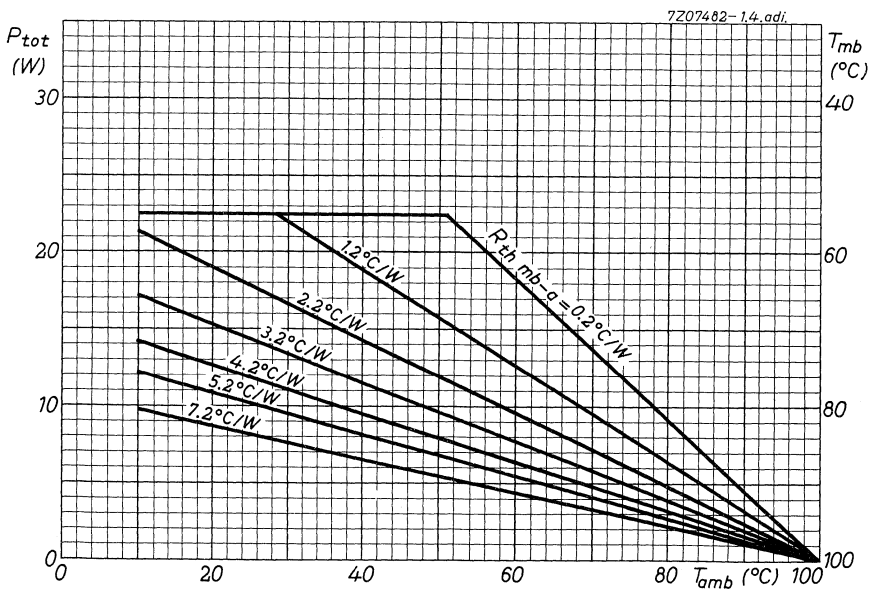

7Z07481-1.4.adi
A_i = Small signal current amplification with sliding
collector-emitter voltage at V_S = 14V and R_L = 4Ω
T_j = 25°C
$-V_{CE}$ = 1V
A_i
h_{FE}
typ
typ
h_{FE}
A_i
120
100
80
60
40
20
0
0
1
2
3
4
$-I_C$ (A)


7Z06757-14.adi
typical values
$-V_{CE}$ = 1V
$-I_C$ = 3A
1A
300mA
100
$-I_B$
(mA)
50
20
10
5
2
1
20
40
60
80
100
120
T_j (°C)


7Z07484–1.4.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.
+V_BE=2V
I_B=0
I
II
-I_C (A)
-V_CE (V)
0
1
2
3
4
5
6
20
40
60
80


7Z02316–1.4.adi
-I_CBO (mA)
T_j (°C)
max -V_CB=50V
max 14V
typ 50V
typ 14V
100
10
1
0.1
0.01
20
40
60
80
100


Minimum collector-emitter voltage for which $g_o = 6m\Omega^{-1}$
$-V_{CER}$ (V)
80
60
40
20
0
10
20
50
100
200
500
1000
2000
5000
10000
R_B (Ω)
$R_E = 0$
$g_o = 6m\Omega^{-1}$
V_{CE}
R_B
R_E
7Z07483-1.4.adi


7Z07482-1.4.adi.
P_{tot} (W)
30
20
10
0
T_{mb} (°C)
40
60
80
100
0
20
40
60
80
T_{amb} (°C)
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

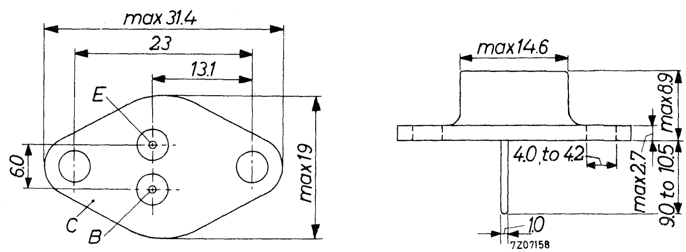
GERMANIUM ALLOYED POWER TRANSISTOR

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 11 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 $T_{mb} = 75\,^{o}C$	P_{tot}	max.	4	W
Junction temperature (incidentally)	T_j	max.	100	^{o}C
D.C. current gain at $T_j = 25\,^{o}C$				
$I_C = 0.5$ 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 and mounting instructions see page 4.

7Z3 0942

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 A)	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

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

7Z3 0943

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

Emitter cut-off current

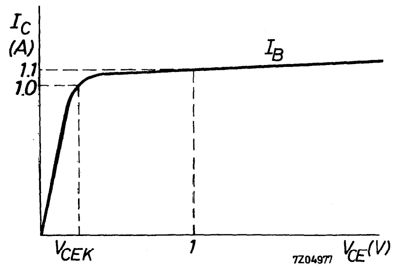
$I_C = 0$; $V_{EB} = 10$ V	I_{EBO}	typ.	20	μA
		<	200	μA
$I_C = 0$; $V_{EB} = 10$ V; $T_j = 90$ °C	I_{EBO}	<	2	mA

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

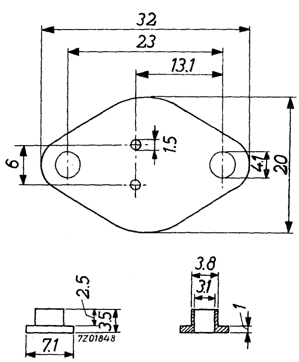
[1]) V_{BE} decreases by about 2 mV/°C with increasing temperature.

7Z3 0944

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

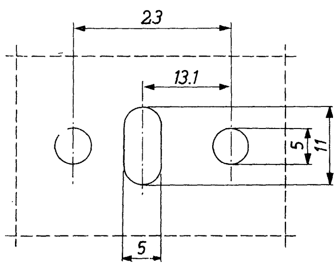
D.C. current gain		
I_C = 5 mA; V_{CE} = 10 V	h_{FE}	> 55
I_C = 50 mA; V_{CE} = 1 V	h_{FE}	74 to 300
I_C = 500 mA; V_{CE} = 1 V	h_{FE}	typ. 150 80 to 320
I_C = 2 A; V_{CE} = 1 V	h_{FE}	> 40
Transition frequency		
I_C = 10 mA; V_{CE} = 2 V	f_T	typ. 3 MHz
Cut-off frequency		
I_C = 300 mA; V_{CE} = 2 V	f_{hfe}	> 20 kHz typ. 35 kHz
D.C. current gain ratio of matched pair AD161/AD162		
I_C = 500 mA; V_{CE} = 1 V	h_{FE1}/h_{FE2}	typ. 1.1 < 1.25

ACCESSORIES AND MOUNTING INSTRUCTIONS Dimensions in mm



56239

Mica washer (50 to 100 μm) and insulation bushes

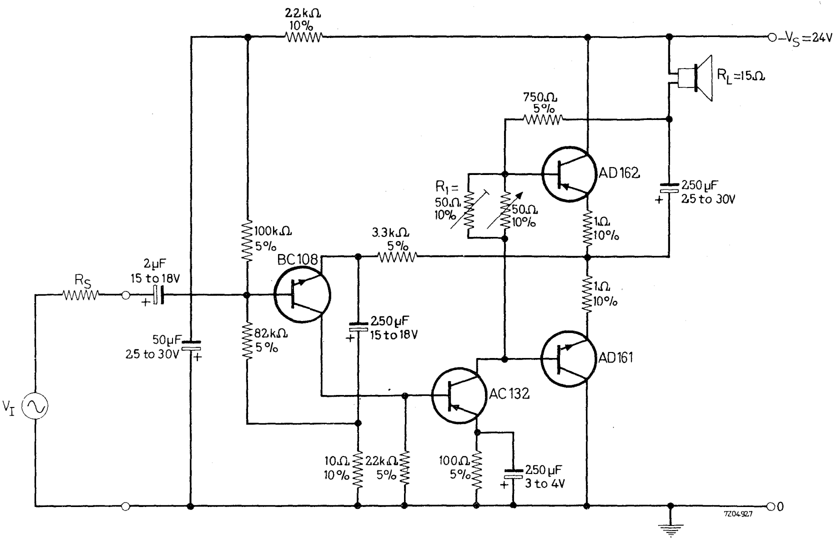


Bore-hole dimensions for heatsink

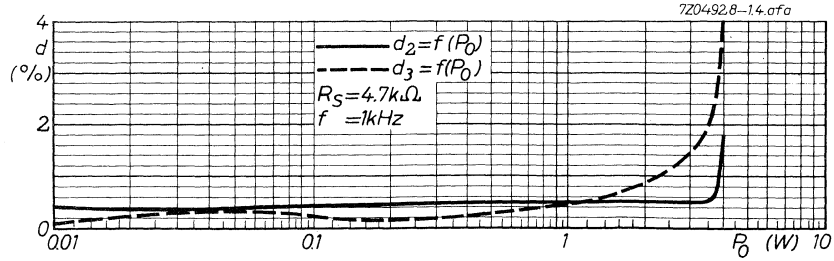
7Z3 0945

APPLICATION INFORMATION

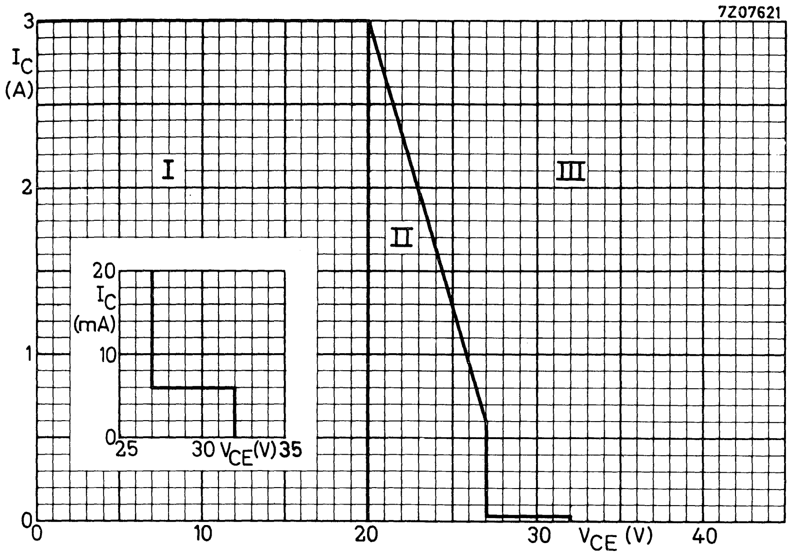
4 W transformerless audio frequency amplifier with matched pair AD161/AD162 in complementary symmetry class B output stage.



Typical input requirements for an output power of 4 W	$V_{i(rms)}$	=	28 mV; $I_{i(rms)}$ = 0.7 μA;
	R_i	=	40 kΩ; T_{amb} max. 45 °C
Typical bandwidth (3 dB)	B	=	70 Hz to 16 kHz
Quiescent current	I_{cq}	=	8 mA, adjustable with R_1
Heatsink for AC132			10 cm^2 Al, thickness 1 mm
Heatsinks for AD161 and AD162	$R_{th\ h\text{-}a}$	<	14.5 °C/W
Supply voltage	$-V_S$	=	24 V, max. 27 V



7Z3 0153

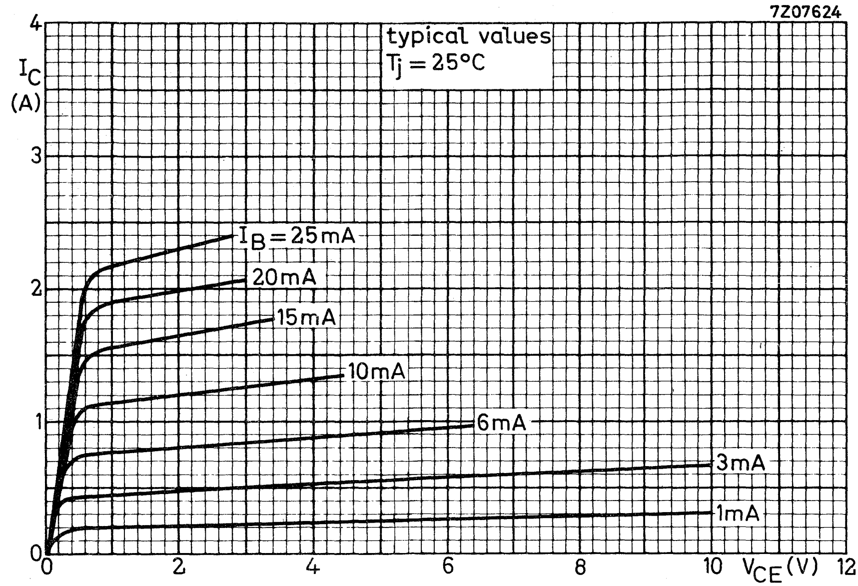


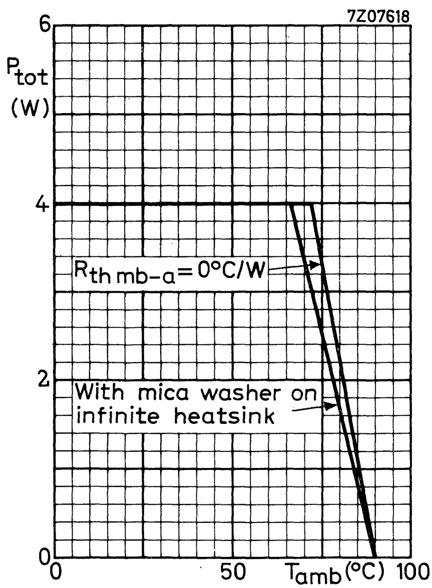
I = Region of permissible operation under all base-emitter conditions.

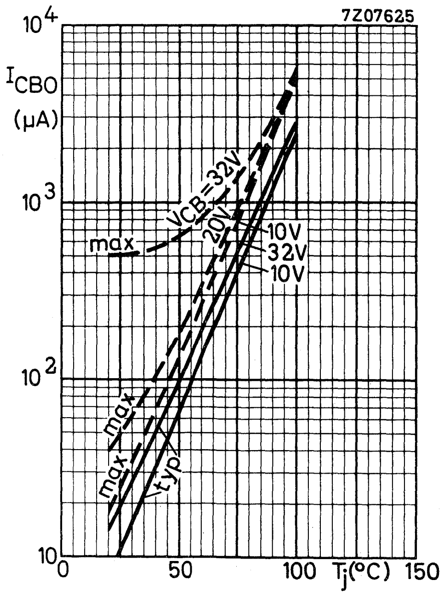
II = Additional region of operation when the transistor is cut-off with $-V_{BE} \geq -V_{BEfl}$.

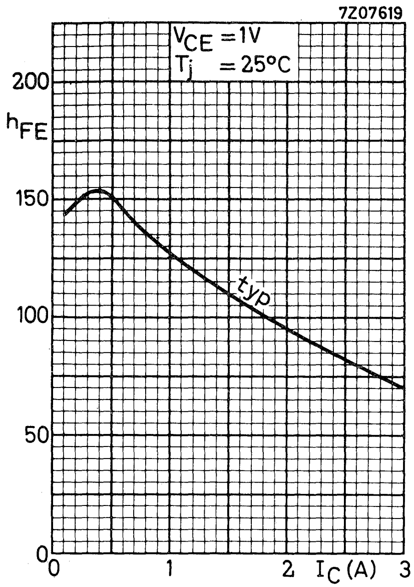
III = Outside regions I and II, the transistor can withstand transient energies of 1 mWs, provided it is cut-off with $-V_{BB} \leq 0.6$ V; R_i = 18 Ω.

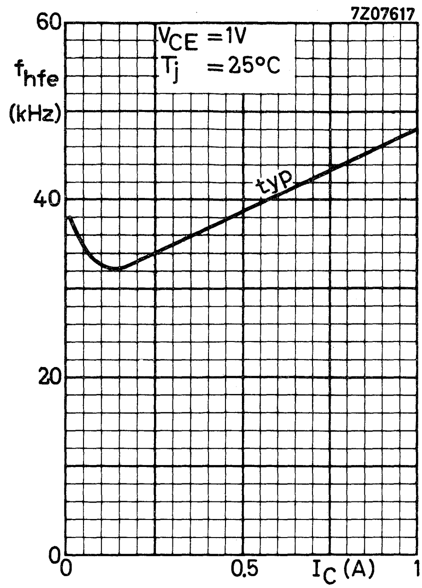
7Z3 0946

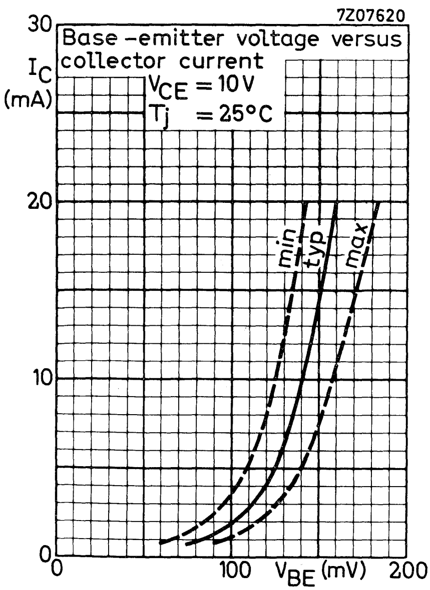

7Z07624
typical values
Tj = 25°C
IC
(A)
IB = 25mA
20mA
15mA
10mA
6mA
3mA
1mA
VCE (V)
0
1
2
3
4
0
2
4
6
8
10
12

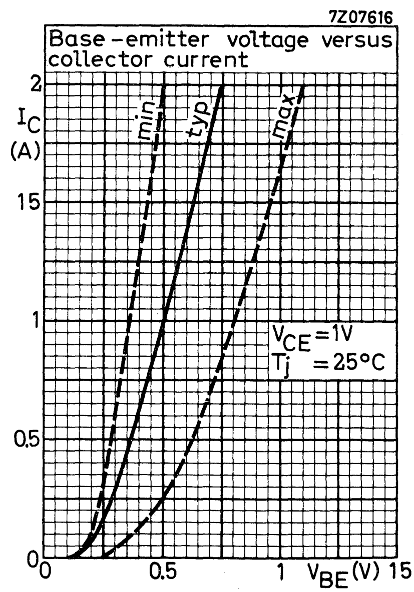

7Z07618
Ptot
(W)
Rth mb-a = 0°C/W
With mica washer on
infinite heatsink
Tamb (°C)
0
2
4
6
0
50
100

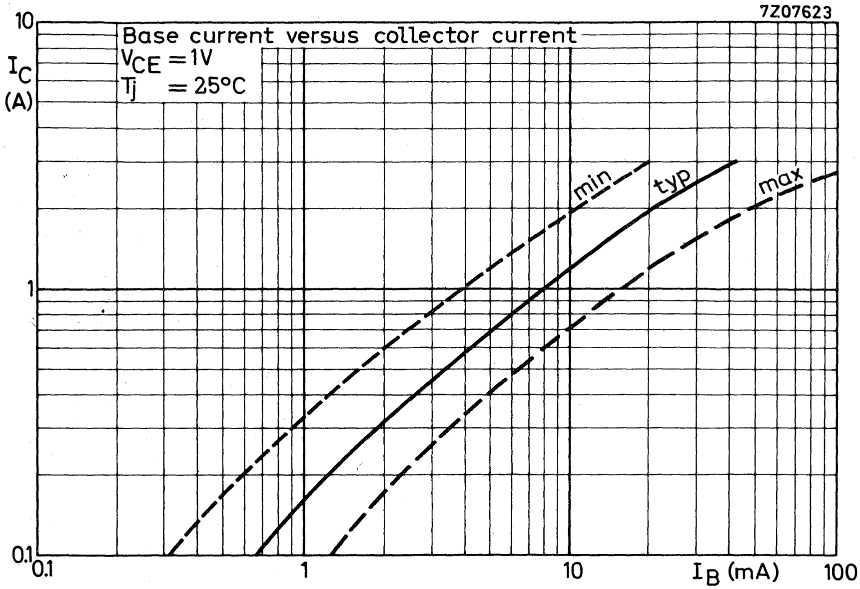

7Z07625
ICBO
(μA)
max
VCB = 32V
20V
10V
32V
10V
max
max
typ
Tj (°C)
10
10²
10³
10⁴
0
50
100
150

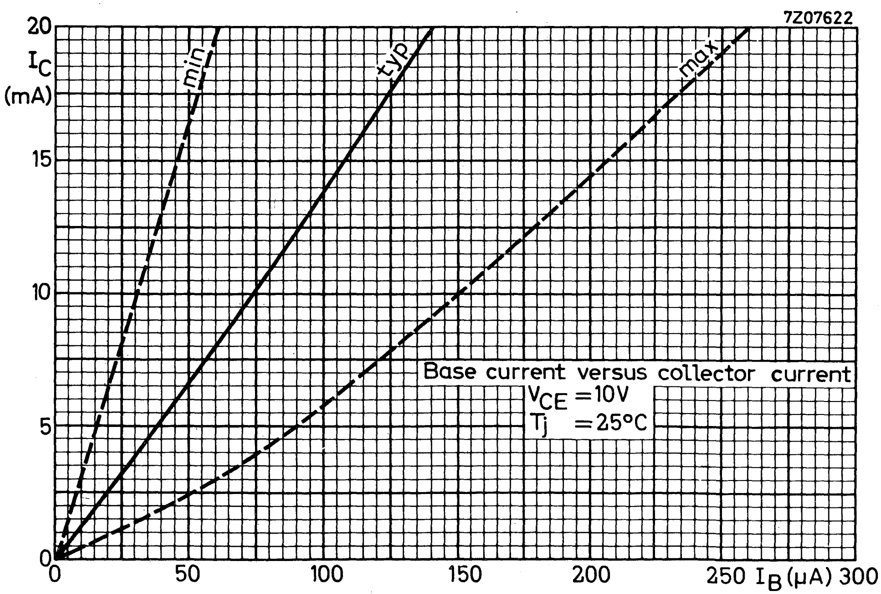

7Z07619
V_{CE} = 1V
T_j = 25°C
200
h_{FE}
150
100
50
0
typ
0
1
2
I_C (A)
3


7Z07617
60
V_{CE} = 1V
T_j = 25°C
f_{hfe}
(kHz)
40
typ
20
0
0
0.5
I_C (A)
1


7Z07620
30
Base-emitter voltage versus collector current
I_C
(mA)
V_{CE} = 10 V
T_j = 25°C
20
min
typ
max
10
0
0
100
V_{BE} (mV)
200


7Z07616
Base-emitter voltage versus collector current
2
I_C
(A)
min
typ
max
15
1
V_{CE} = 1V
T_j = 25°C
0.5
0
0
0.5
1
V_{BE} (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
I_B (mA)
100
min
typ
max


7Z07622
I_C (mA)
20
15
10
5
0
0
50
100
150
200
250
I_B (μA)
300
min
typ
max
Base current versus collector current
V_{CE} = 10V
T_j = 25°C

GERMANIUM ALLOYED POWER TRANSISTOR

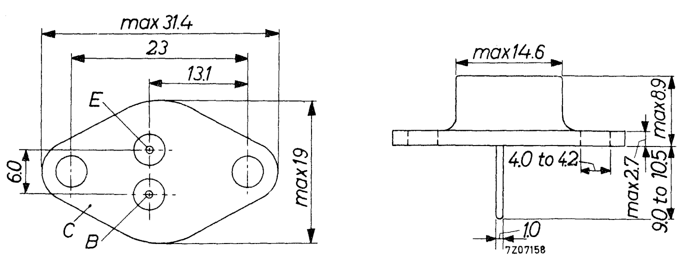
P-N-P power transistor in a metal envelope with the collector connected to the mounting base.
It is primarily intended for use as matched pair 2-AD162 in class B push-pull output stages and together with the n-p-n power transistor AD161 as matched pair AD161/AD162 in 11 W complementary symmetry class 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 °C	P_{tot}	max.	6	W
Junction temperature (incidentally)	T_j	max.	100	°C
D.C. current gain at T_j = 25 °C				
$-I_C$ = 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 and mounting instructions see page 4. 7Z3 0947

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 A)	$-V_{CEX}$	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

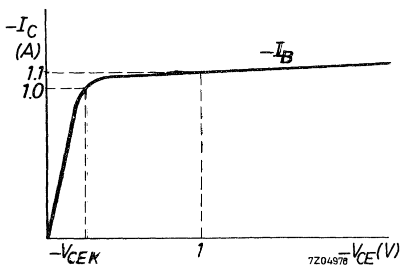
→ From junction to mounting base	$R_{th\ j\text{-}mb}$	=	4.5	°C/W
From mounting base to heatsink with mica washer	$R_{th\ mb\text{-}h}$	=	1.5	°C/W
without mica washer	$R_{th\ mb\text{-}h}$	=	0.5	°C/W

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

7Z3 0948

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 ←

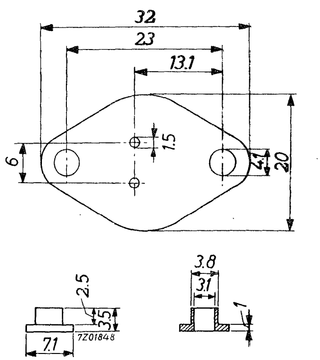
1) $-V_{BE}$ decreases by about 2 mV/°C with increasing temperature.

7Z3 0949

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

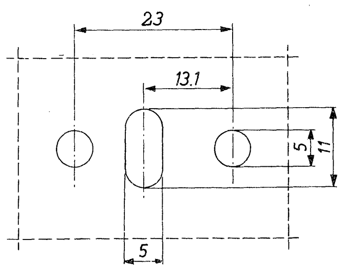
D.C. current gain		
$-I_C$ = 5 mA; $-V_{CE}$ = 10 V	h_{FE}	> 60
$-I_C$ = 50 mA; $-V_{CE}$ = 1 V	h_{FE}	74 to 300
$-I_C$ = 500 mA; $-V_{CE}$ = 1 V	h_{FE}	typ. 150 80 to 320
$-I_C$ = 2 A; $-V_{CE}$ = 1 V	h_{FE}	> 60
Transition frequency		
$-I_C$ = 10 mA; $-V_{CE}$ = 2 V	f_T	typ. 1.5 MHz
Cut-off frequency		
$-I_C$ = 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

ACCESSORIES AND MOUNTING INSTRUCTIONS Dimensions in mm



56239

Mica washer (50 to 100 μm)
and insulation bushes

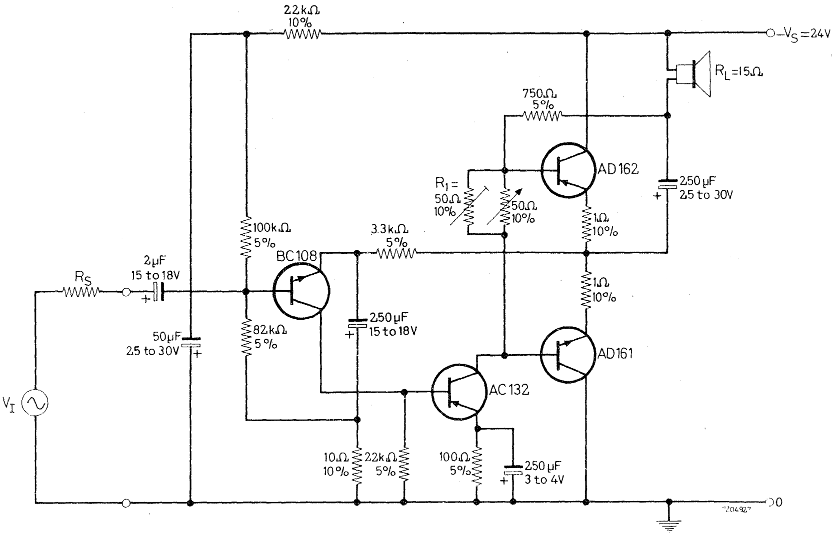


Bore-hole dimensions
for heatsink

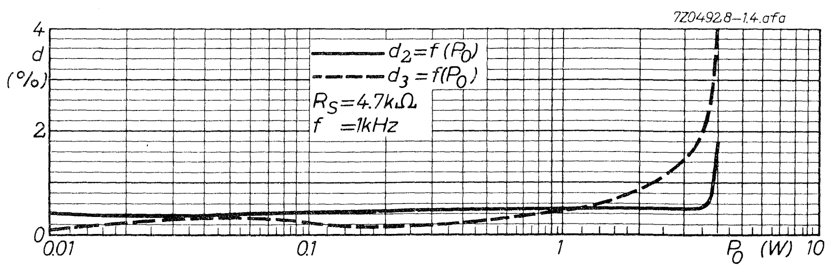
7Z3 0950

APPLICATION INFORMATION

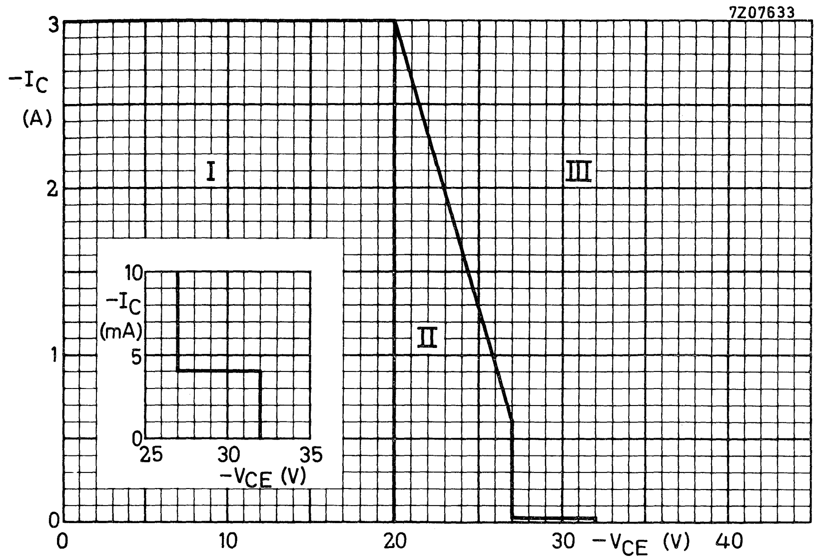
4 W transformerless audio frequency amplifier with matched pair AD161/AD162 in complementary symmetry class B output stage.



Typical input requirements for an output power of 4 W	$V_{i(rms)}$	=	28 mV; $I_{i(rms)}$ = 0.7 μA;
	R_i	=	40 kΩ; T_{amb} max. 45 °C
Typical bandwidth (3 dB)	B	=	70 Hz to 16 kHz
Quiescent current	I_{cq}	=	8 mA; adjustable with R_1
Heatsink for AC132			10 cm^2 Al, thickness 1 mm
Heatsinks for AD161 and AD162	$R_{th\ h-a}$	<	14.5 °C/W
Supply voltage	$-V_S$	=	24 V, max. 27 V



7Z3 1246

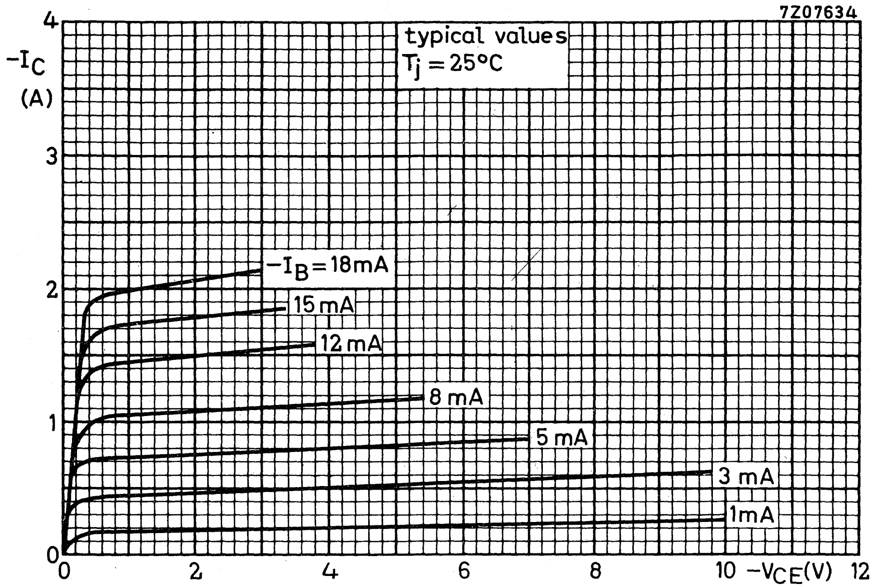


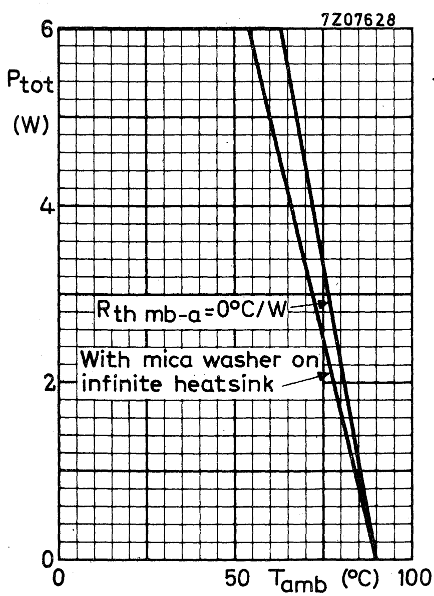
I = Region of permissible operation under all base-emitter conditions.

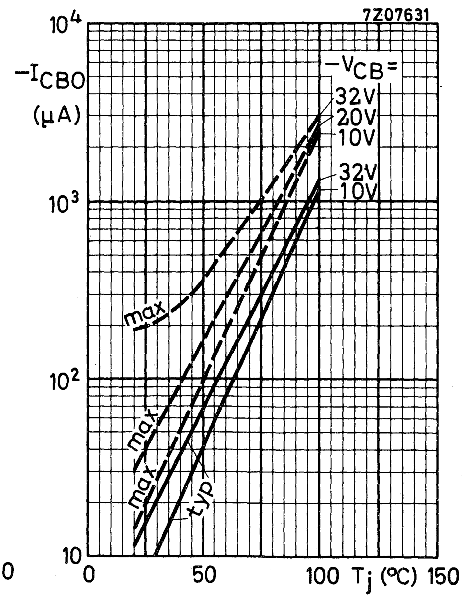
II = Additional region of operation when the transistor is cut-off with $V_{BE} \geq V_{BEfl}$.

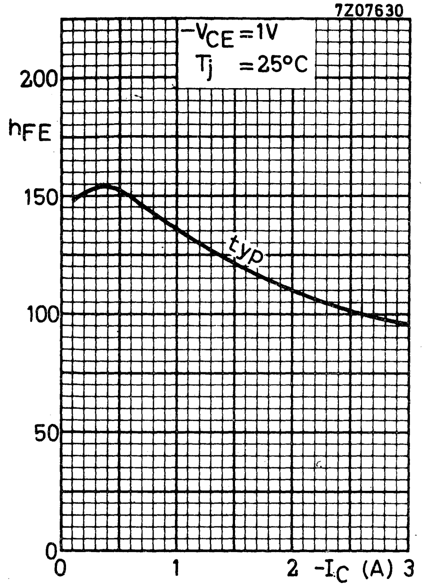
III = Outside regions I and II, the transistor can withstand transient energies of 4.5 mWs, provided it is cut-off with $+V_{BB} < 0.6$ V; $R_i = 18\ \Omega$.

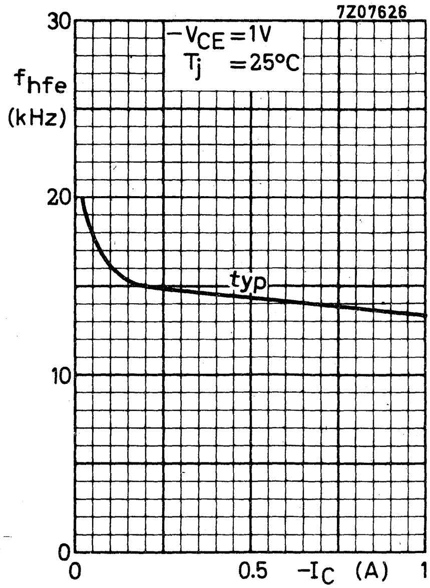
7Z3 0951

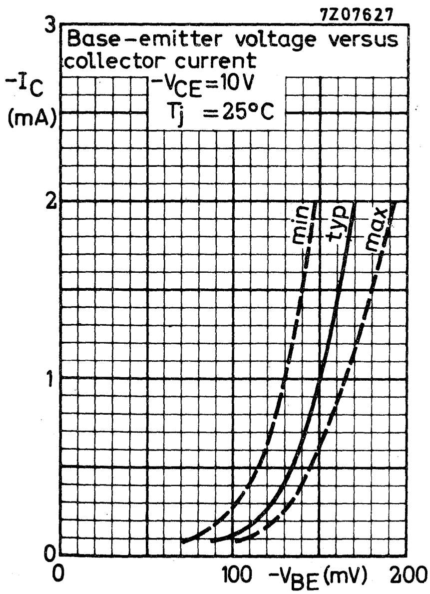

7Z07634
typical values
$T_j = 25°C$
$-I_C$ (A)
$-I_B = 18mA$
15 mA
12 mA
8 mA
5 mA
3 mA
1mA
$-V_{CE}$(V)
0
1
2
3
4
6
8
10
12

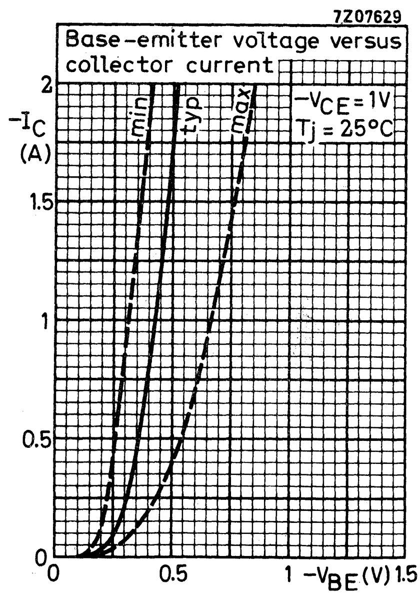

7Z07628
P_{tot} (W)
$R_{th\ mb-a} = 0°C/W$
With mica washer on
infinite heatsink
T_{amb} (°C)
0
2
4
6
50
100

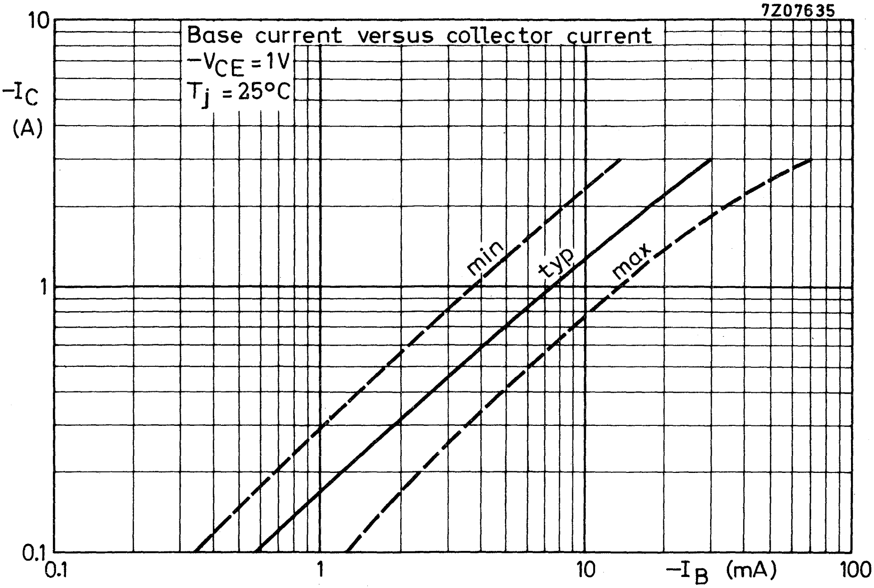

7Z07631
$-I_{CBO}$ (μA)
$-V_{CB} =$
32V
20V
10V
32V
10V
max
max
max
typ
T_j (°C)
10
10^2
10^3
10^4
0
50
100
150

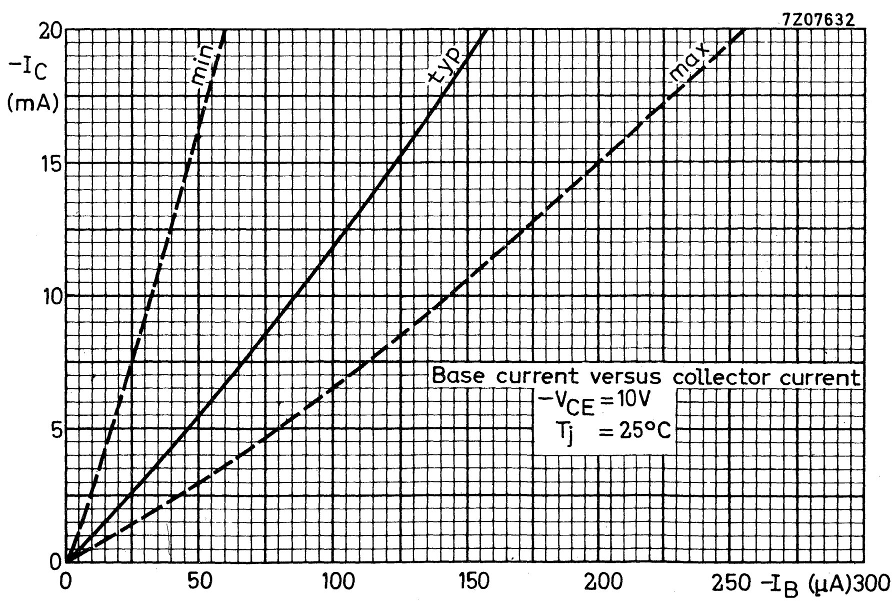

7Z07630
$-V_{CE}=1V$
$T_j = 25°C$
h_{FE}
typ
200
150
100
50
0
0
1
2
3
$-I_C$ (A)


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


7Z07627
Base-emitter voltage versus collector current
$-V_{CE}=10V$
$T_j = 25°C$
$-I_C$ (mA)
min
typ
max
3
2
1
0
0
100
200
$-V_{BE}$ (mV)


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


7Z07632
$-I_C$
(mA)
20
15
10
5
0
0
50
100
150
200
250
$-I_B$ (μA)
300
min
typ
max
Base current versus collector current
$-V_{CE} = 10V$
$T_j = 25°C$

GERMANIUM ALLOYED POWER TRANSISTORS

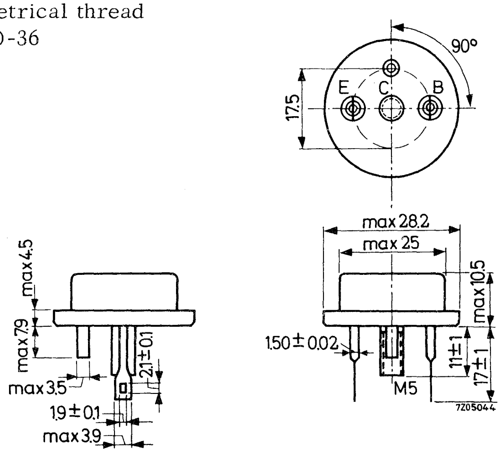
P-N-P transistors in a metal envelope with the collector connected to the case. The ADZ11 and ADZ12 are primarily intended for use in a.f. applications.

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

MECHANICAL DATA Dimensions in mm

Except for the metrical thread conforming to TO-36



7Z3 1459

RATINGS (Limiting values) [1]

Voltages

			ADZ11	ADZ12	
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	$R_{th\ j-mb}$	=	0.8 °C/W

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

7Z3 1460

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

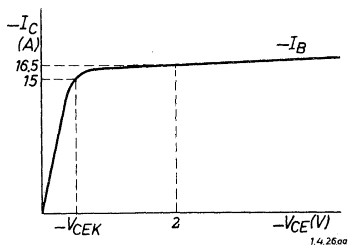
$I_C = 0$; $-V_{EB} = 2$ V	$-I_{EBO}$	<	0.2	mA
$I_C = 0$; $-V_{EB} = -V_{EBOmax}$	$-I_{EBO}$	<	8	mA

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

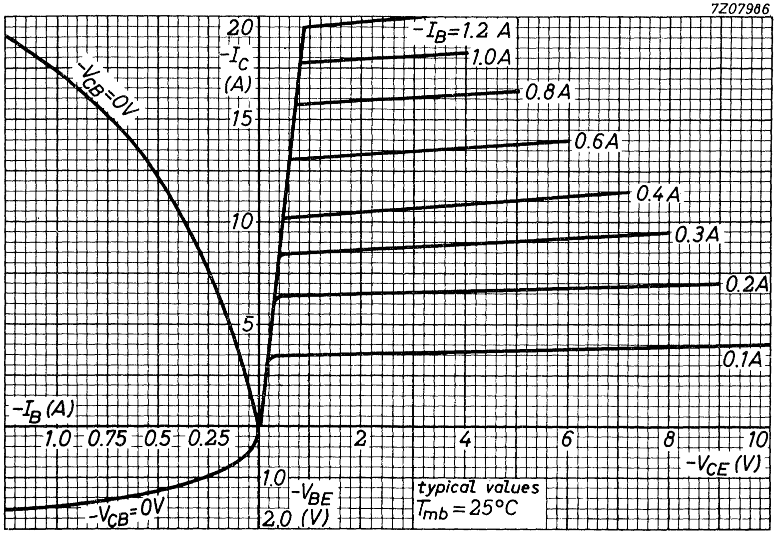
D.C. current gain

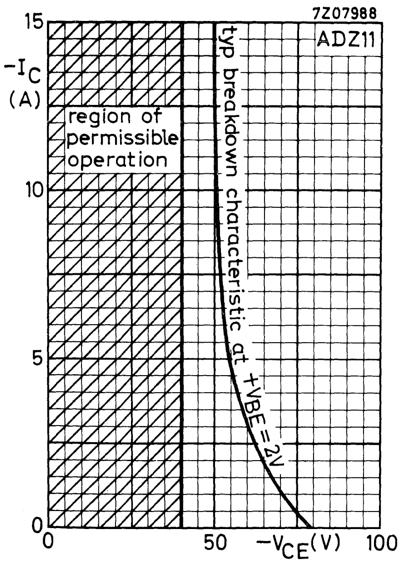
$-I_C = 1.2$ A; $V_{CB} = 0$	h_{FE}	40 to 120	
$-I_C = 5$ A; $V_{CB} = 0$	h_{FE}	>	25
$-I_C = 15$ A; $V_{CB} = 0$	h_{FE}	>	15

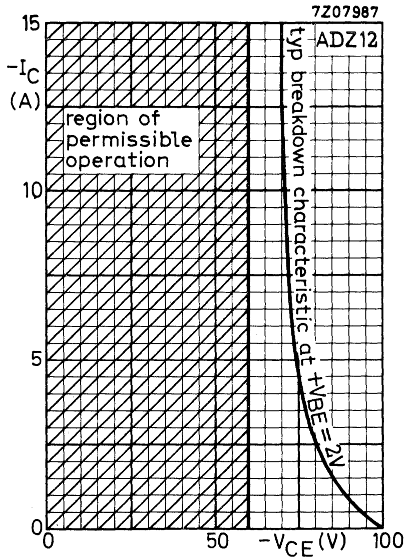
Cut-off frequency

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

7Z3 1461


7Z07986
20
$-I_C$
(A)
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
$-V_{BE}$
2.0 (V)
$-V_{CB}=0V$
typical values
$T_{mb}=25°C$


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


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

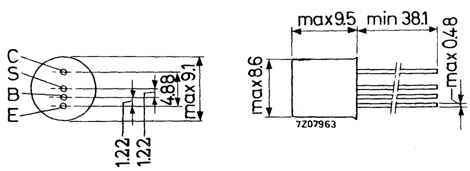
ALLOY DIFFUSED GERMANIUM TRANSISTOR

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.

QUICK REFERENCE DATA				
Collector-base voltage (open emitter)	$-V_{CBO}$	max.	25	V
Collector current (d.c.)	$-I_C$	max.	10	mA
Total power dissipation up to T_{amb} = 45 °C	P_{tot}	max.	50	mW
Junction temperature	T_j	max.	75	°C
Thermal resistance from junction to ambient	$R_{th\ j\text{-}a}$	=	0.6	°C/mW
Feedback capacitance at f = 450 kHz				
$-I_C$ = 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 Ω	F	typ.	6	dB

MECHANICAL DATA Dimensions in mm

TO-7



Accessories available : 56207

7Z3 1418

RATINGS (Limiting values) [1])

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 °C	P_{tot}	max.	50	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.

7Z3 1419

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

Collector cut-off current				
$I_E = 0$; $-V_{CB} = 12$ V	$-I_{CBO}$	<	10	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 impedance at f = 2 MHz				
$I_E = 1$ mA; $-V_{CB} = 12$ V	$\|z_{rb}\|$	typ.	10	Ω
y parameters at f = 200 MHz (common base)				
$I_E = 1$ mA; $-V_{CB} = 12$ V				
Input conductance	g_{ib}	typ.	30	$m\Omega^{-1}$
Input capacitance	$-C_{ib}$	typ.	12	pF
Feedback admittance	y_{rb}	typ.	0.4	$m\Omega^{-1}$
Phase angle of feedback admittance	$\|\varphi_{rb}\|$	typ.	90°	
Transfer admittance	y_{fb}	typ.	25	$m\Omega^{-1}$
Phase angle of transfer admittance	$\|\varphi_{fb}\|$	typ.	90°	
Output conductance	g_{ob}	typ.	0.3	$m\Omega^{-1}$
Output capacitance	C_{ob}	typ.	1.8	pF
y parameters at f = 35 MHz (common emitter)				
$-I_C = 1$ mA; $-V_{CE} = 12$ V				
Output conductance	g_{oe}	typ.	10	$\mu\Omega^{-1}$
Output capacitance	C_{oe}	typ.	2	pF
Small signal current gain at f = 1 kHz				
$-I_C = 1$ mA; $-V_{CE} = 12$ V	h_{fe}	>	20	
Feedback capacitance at f = 0.45 MHz				
$-I_C = 1$ mA; $-V_{CE} = 12$ V	$-C_{re}$	typ.	0.8	pF

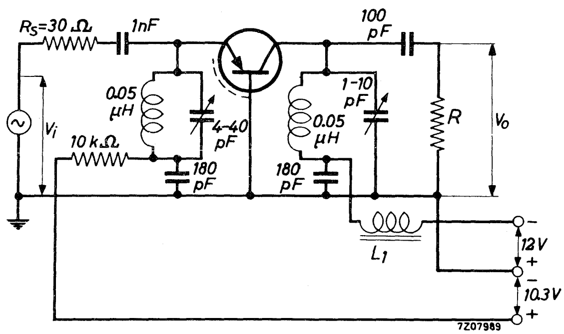
7Z3 1420

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

Frequency at which $\|h_{fe}\|$ = 1				
I_E = 1 mA; $-V_{CB}$ = 12 V	f_1	typ.	180	MHz
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
Transducer gain				
I_E = 1 mA; $-V_{CB}$ = 12 V; f = 200 MHz	G_{tr}	>	10	dB
		typ.	13	dB

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

Basic circuit for measuring the transducer gain

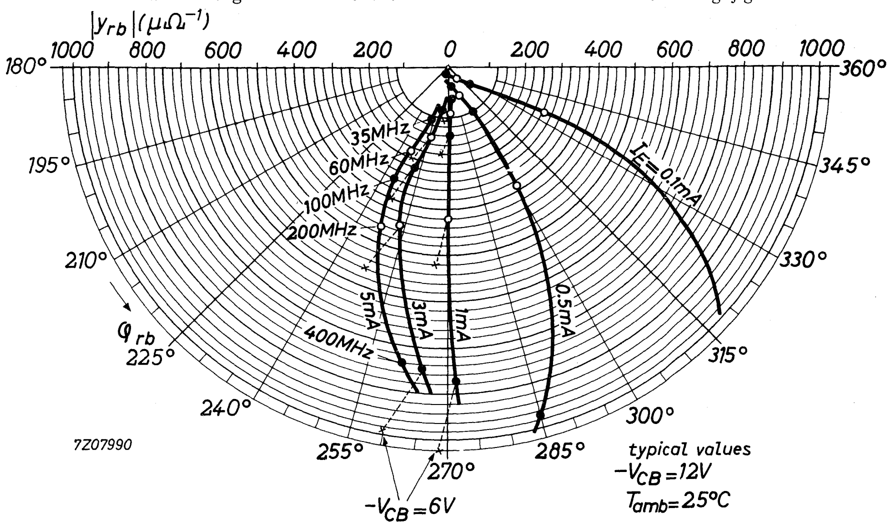


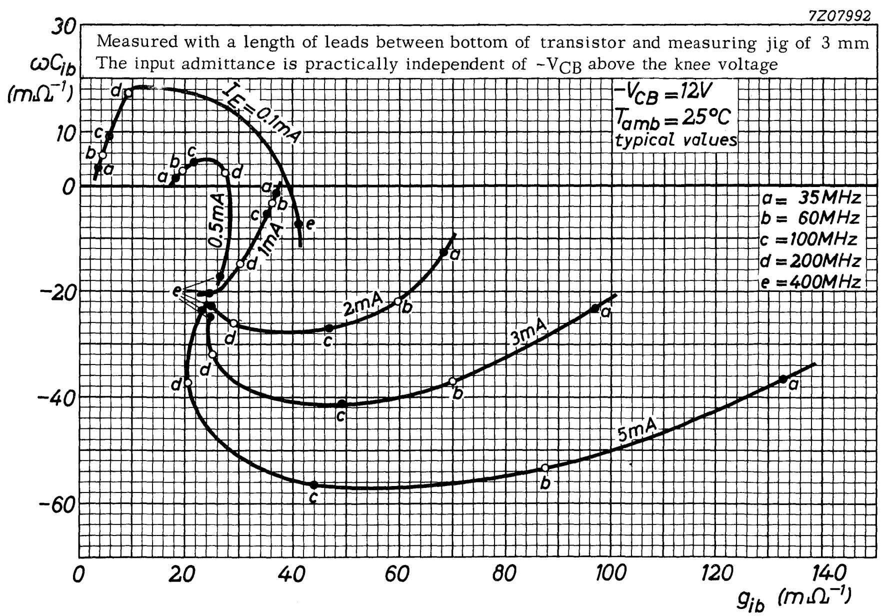
The resistor R is choosen such that the total load, consisting of R and the tuned circuit in parallel, R_1 = 2.0 kΩ

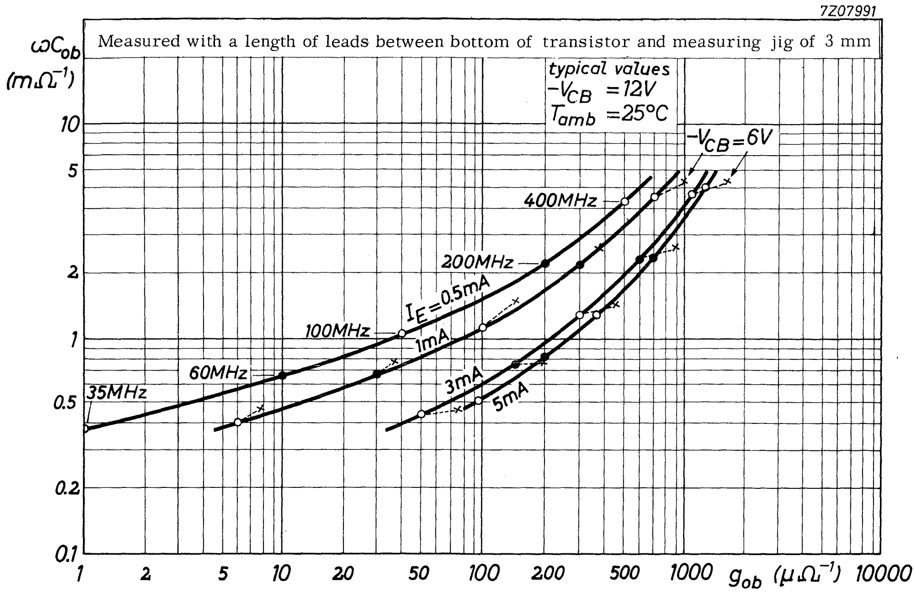
L_1 is a ferrite bead

7Z3 1421

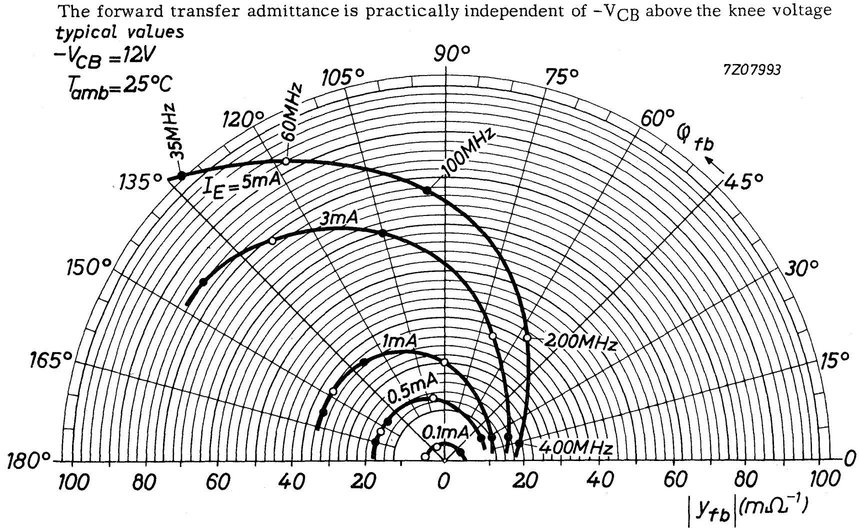
Measured with a length of leads between bottom of transistor and measuring jig of 3 mm







Measured with a length of leads between bottom of transistor and measuring jig of 3 mm
The forward transfer admittance is practically independent of $-V_{CB}$ above the knee voltage



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).

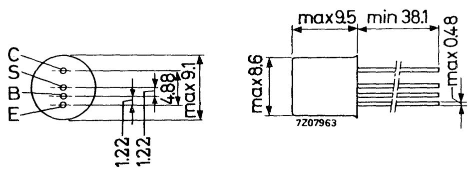
Total power dissipation up to T_{amb} = 45 °C	P_{tot}	max. 75	mW

THERMAL RESISTANCE

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

MECHANICAL DATA Dimensions in mm

TO-7



Accessories available : 56207

For further data and curves of the types AF114, AF115, AF116 and AF117 please refer to types AF124, AF125, AF126 and AF127 respectively

---

7Z3 1437

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. For example it is used in the video output stage of television receivers.

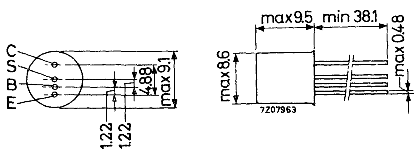
QUICK REFERENCE DATA				
Collector-base voltage (open emitter)	$-V_{CBO}$	max.	70	V
Collector current (d.c.)	$-I_C$	max.	30	mA
Total power dissipation up to T_{amb} = 45 °C with cooling fin 56207	P_{tot}	max.	375	mW
Junction temperature	T_j	max.	75	°C
Thermal resistance from junction to ambient with cooling fin 56207	$R_{th\ j-a}$	=	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

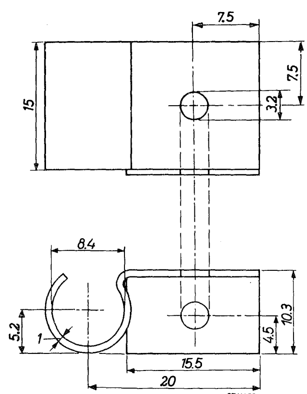
MECHANICAL DATA

Dimensions in mm

TO-7

Shield lead connected to case





Cooling fin 56207, painted black

7Z3 1410

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.

7Z3 1411

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

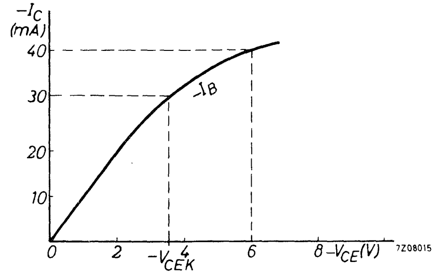
$-I_C = 10$ mA; $-V_{CE} = 2$ V	$-I_B$	typ.	55	μA
		<	275	μA

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	$\|z_{rb}\|$	typ.	30	Ω

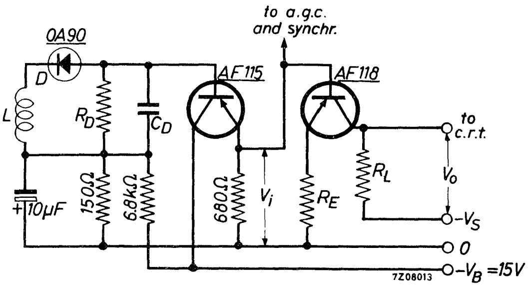
Transfer admittance at f = 10.7 MHz

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

7Z3 1402

APPLICATION INFORMATION

A. The AF 118 in a video output stage for supply voltages up to 70 V.

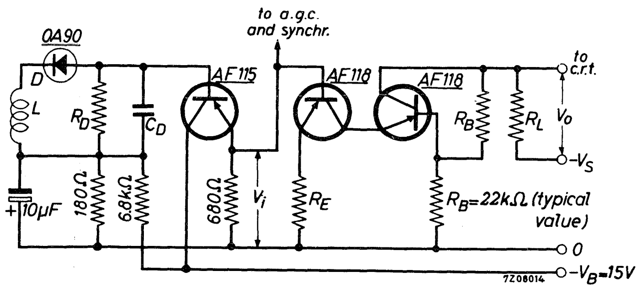


D, R_D and C_D = detection circuit

R_E should be chosen according to $A_v = \frac{V_o}{V_i} \approx \frac{R_L}{R_E}$, where A_v is the voltage amplification of the output stage.

Supply voltage	$-V_S$ =	50	60	70	V
Load resistance	R_L =	2.7	3.9	4.7	kΩ
Output voltage (black to white)	V_o =	32	39	45	V
Bandwidth (−3 dB)	B =	6.0	4.1	3.4	MHz

B. The AF 118 in a video output stage for supply voltages up to 110 V.



D, R_D and C_D = detection circuit

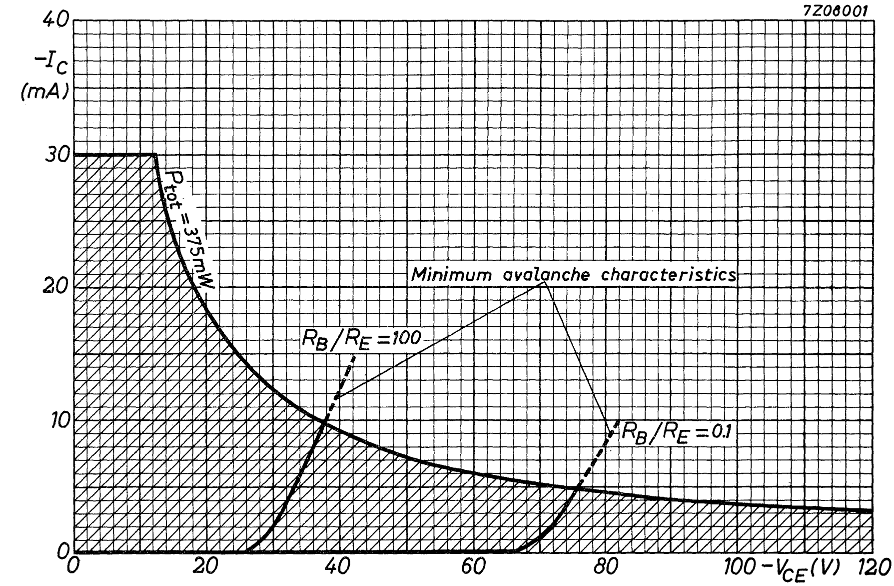
R_E should be chosen according to $A_v = \frac{V_o}{V_i} \approx \frac{1}{R_E} \cdot \frac{2\,R_B \cdot R_L}{2\,R_B + R_L}$

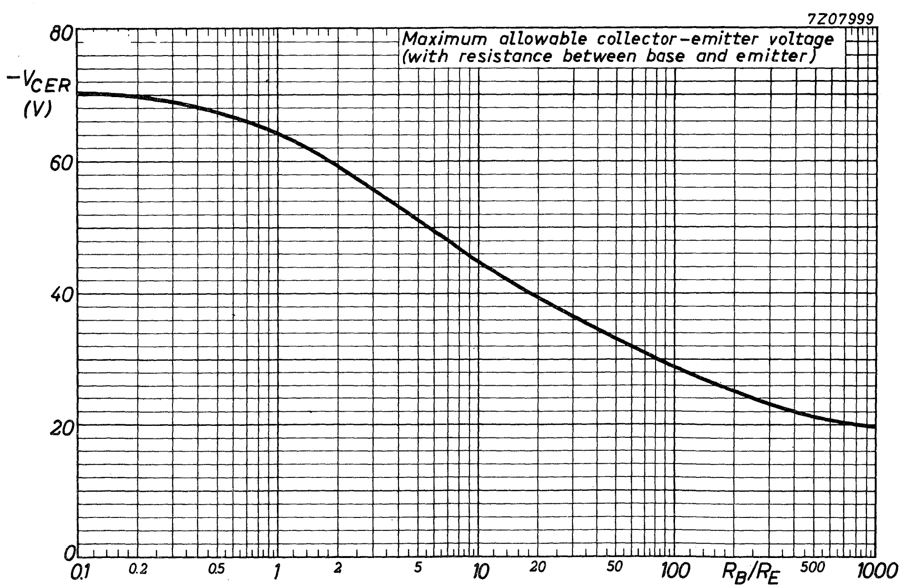
Supply voltage	$-V_S$	90	110	V
Load resistance	R_L	4.7	6.8	kΩ
Output voltage (black to white)	V_o	57	65	V
Bandwidth (−3 dB)	B	3.5	2.4	MHz

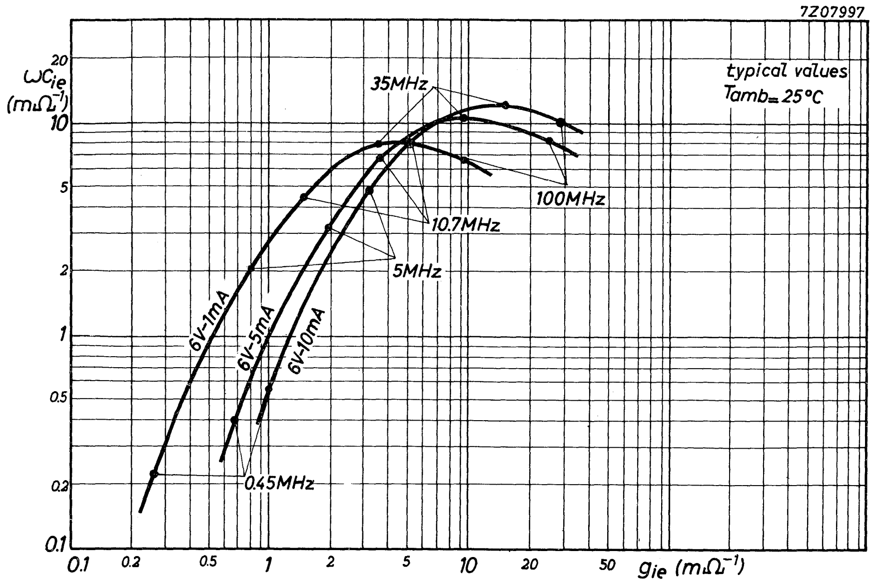
NOTES L = secondary winding of the coupling transformer between last i.f. stage and video detector.

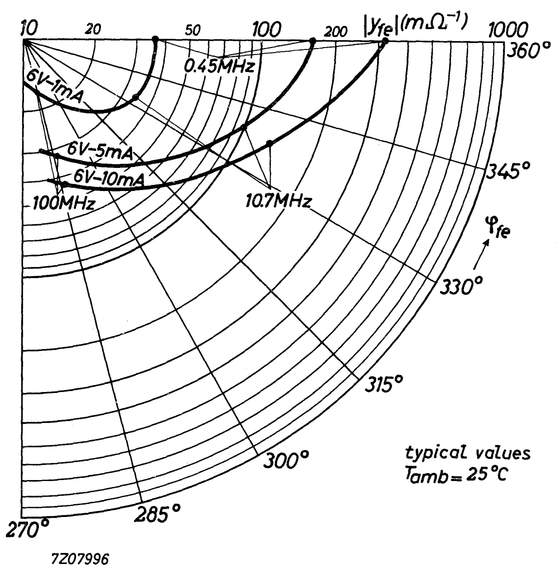
If necessary enhancing of the bandwidth by a peaking coil in series with R_L (shunt compensation) or by a peaking coil in series with the lead to the cathode ray tube (series compensation) is possible.

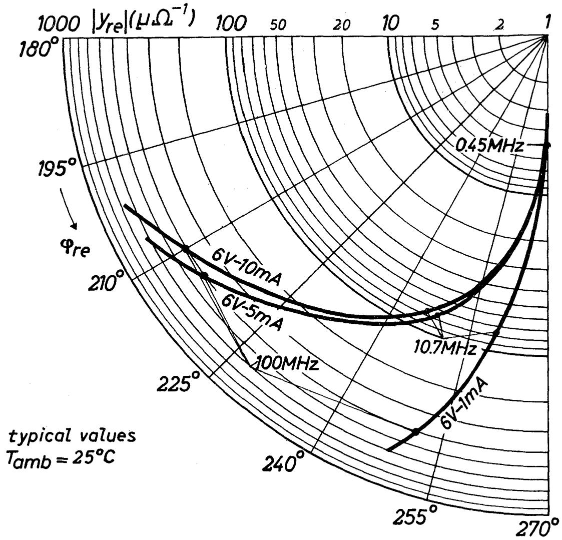
7Z3 1415


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


7Z07999
Maximum allowable collector-emitter voltage
(with resistance between base and emitter)
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

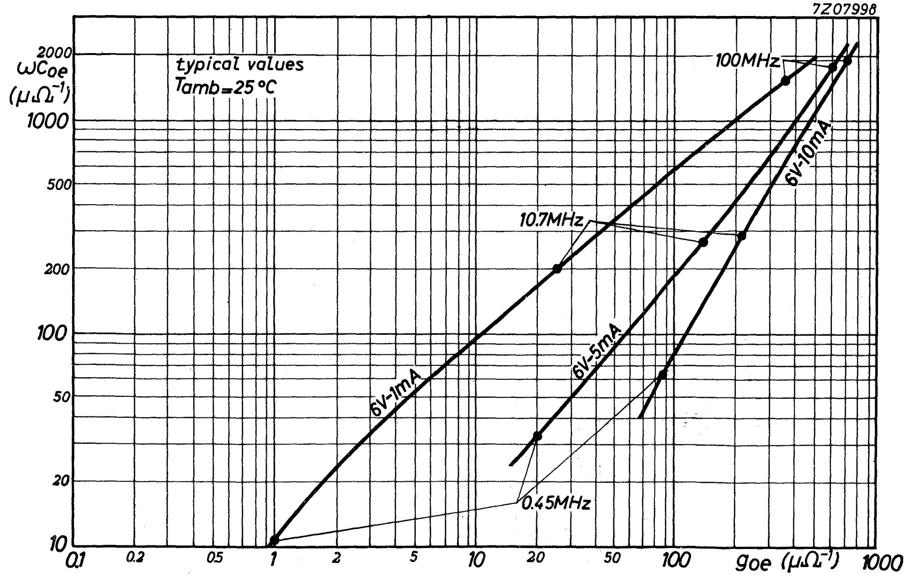

7Z07997
typical values
Tamb= 25°C
ωcie
(mΩ-1)
gie (mΩ-1)
35MHz
100MHz
10.7MHz
5MHz
0.45MHz
6V-1mA
6V-5mA
6V-10mA

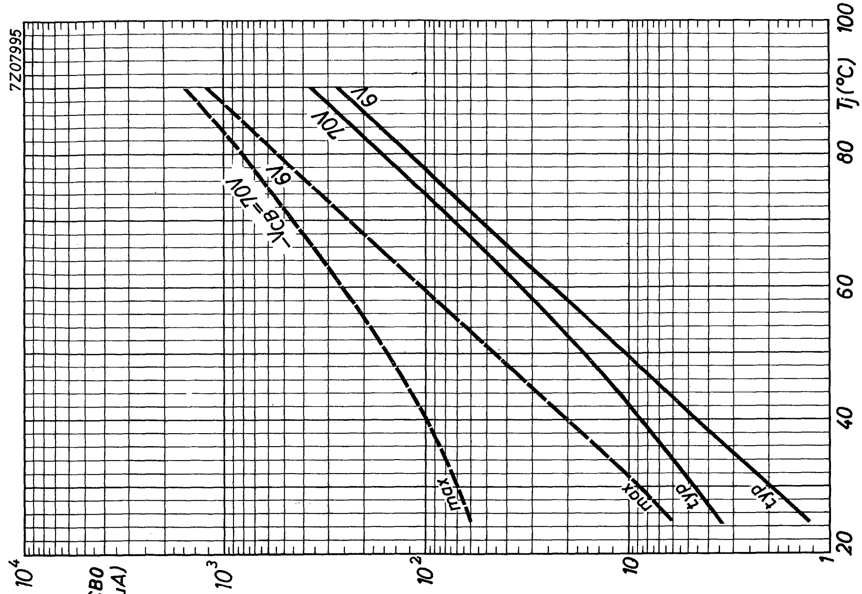

|yfe|(mΩ-1)
0.45MHz
6V-1mA
6V-5mA
6V-10mA
100MHz
10.7MHz
φfe
typical values
Tamb= 25°C
7Z07996

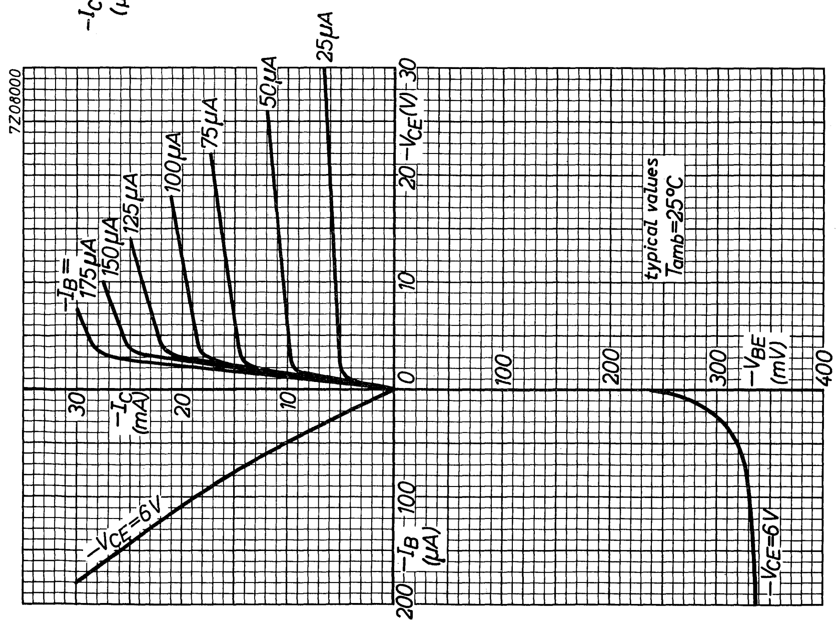


7Z07994

7Z07998




7Z07995
−I_CBO (µA)
10^4
10^3
10^2
10
1
20
40
60
80
100
Tj(°C)
−V_CB=10V
6V
10V
6V
max
max
typ
typ


7Z08000
−I_B=
175µA
150µA
125µA
100µA
75µA
50µA
25µA
−V_CE(V)
30
20
10
0
−I_C (mA)
typical values
T_amb=25°C
−V_BE (mV)
100
200
300
400
−I_B (µA)
−V_CE=6V
−V_CE=6V

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	$\|y_{fe}\|$	typ.	80	$m\Omega^{-1}$

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 $T_{amb} = 45\ ^oC$ with cooling clip 56263	P_{tot}	max.	140	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

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

7Z3 0302

CHARACTERISTICS (continued) $T_{amb} = 25\ ^{o}C$

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	$\|y_{re}\|$	typ.	21	$\mu\Omega^{-1}$
Phase angle of feedback admittance	φ_{re}	typ.	270^{o}	
Transfer admittance	$\|y_{fe}\|$	typ.	71	$m\Omega^{-1}$
Phase angle of transfer admittance	φ_{fe}	typ.	350^{o}	
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	$\|y_{re}\|$	typ.	40	$\mu\Omega^{-1}$
Phase angle of feedback admittance	φ_{re}	typ.	270^{o}	
Transfer admittance	$\|y_{fe}\|$	typ.	70	$m\Omega^{-1}$
Phase angle of transfer admittance	φ_{fe}	typ.	347^{o}	
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	$\|y_{re}\|$	typ.	100	$\mu\Omega^{-1}$
Phase angle of feedback admittance	φ_{re}	typ.	260^{o}	
Transfer admittance	$\|y_{fe}\|$	typ.	80	$m\Omega^{-1}$
Phase angle of transfer admittance	φ_{fe}	typ.	322^{o}	
Output conductance	g_{oe}	typ.	100	$\mu\Omega^{-1}$
Output capacitance	C_{oe}	typ.	1.8	pF

7Z3 0303

CHARACTERISTICS (continued) $T_{amb} = 25\ ^oC$

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

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

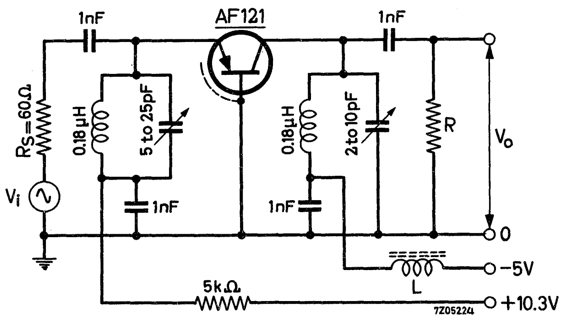
Input conductance	g_{ib}	typ.	32	$m\Omega^{-1}$
Input capacitance	$-C_{ib}$	typ.	35	pF
Feedback admittance	$\lvert y_{rb} \rvert$	typ.	320	$\mu\Omega^{-1}$
Phase angle of feedback admittance	φ_{rb}	typ.	240^o	
Transfer admittance	$\lvert y_{fb} \rvert$	typ.	34	$m\Omega^{-1}$
Phase angle of transfer admittance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

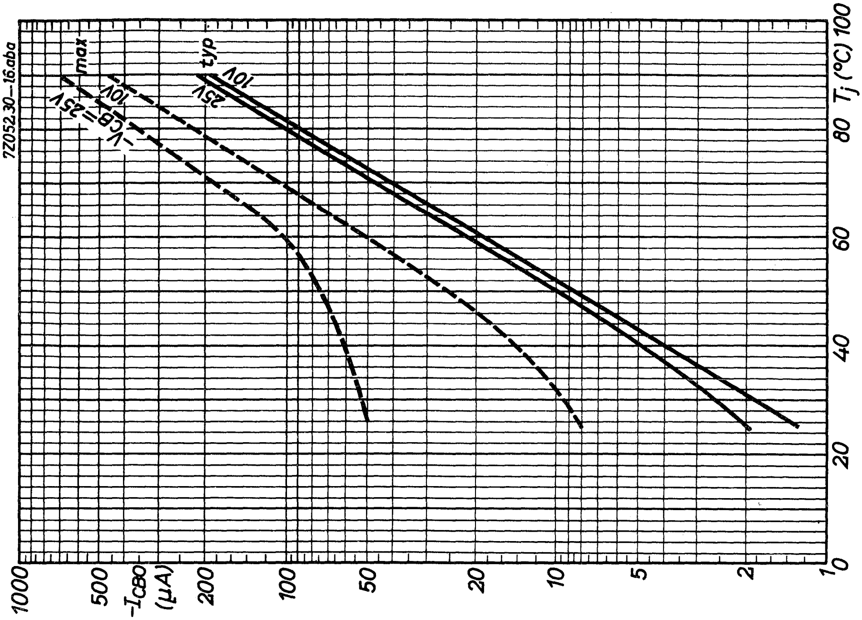


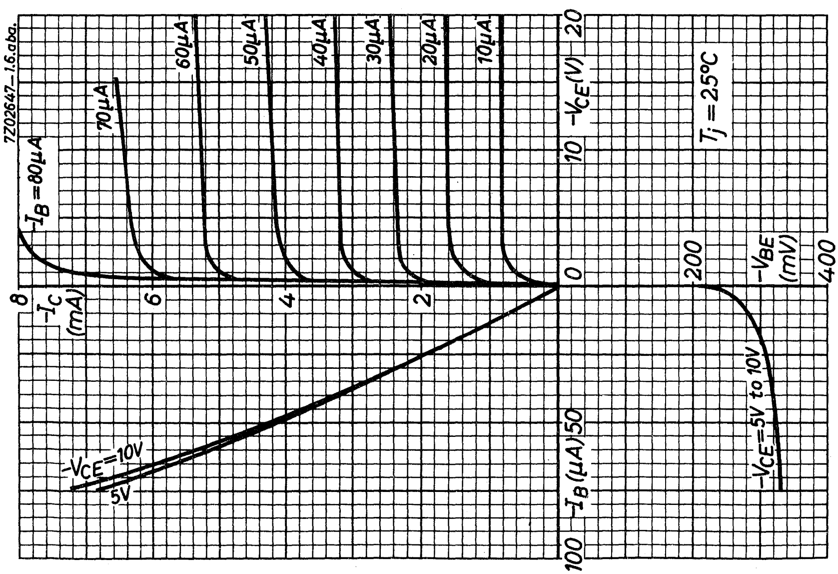
The resistor R is choosen such that the total load, consisting of R and the tuned circuit in parallel, $R_L = 3.3$ kΩ

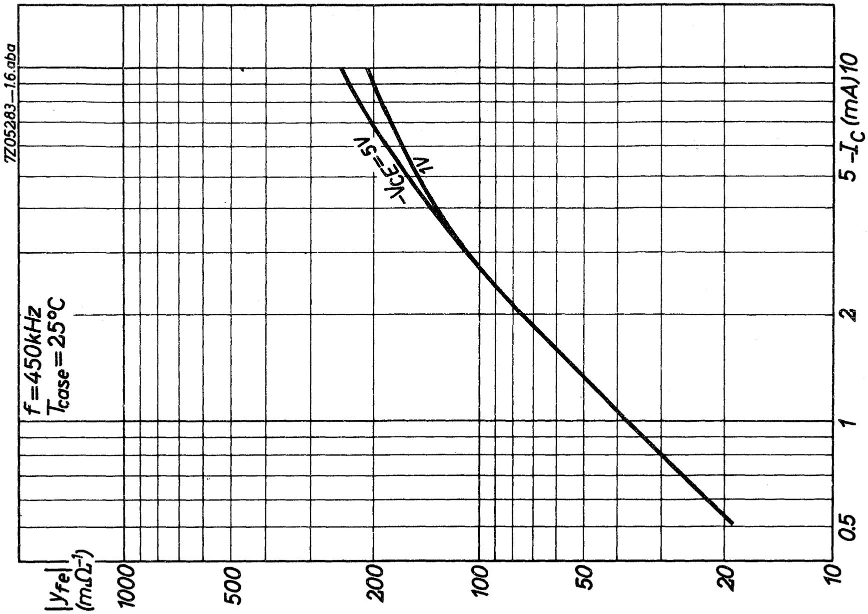
L is a ferrite wide-band choke

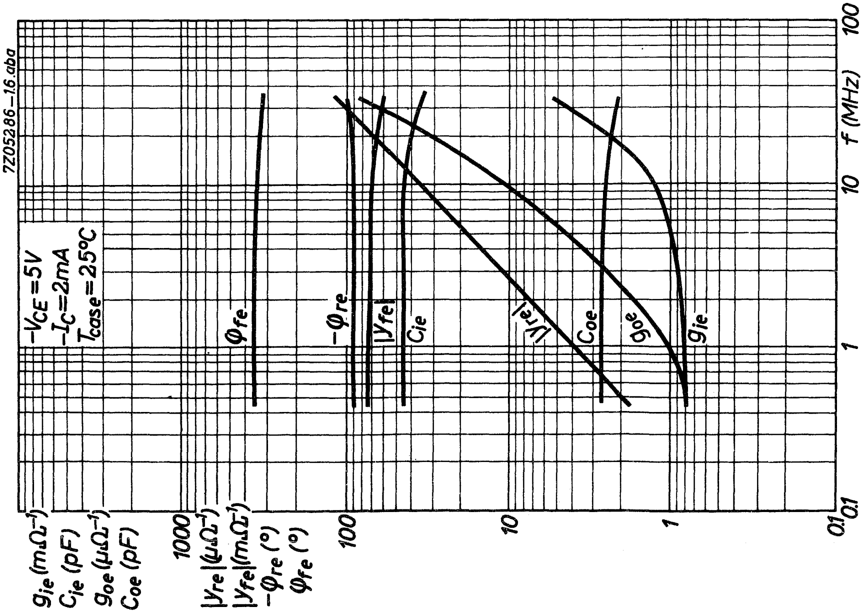
[1]) Length of leads between bottom of transistor and measuring jig is 5 mm.

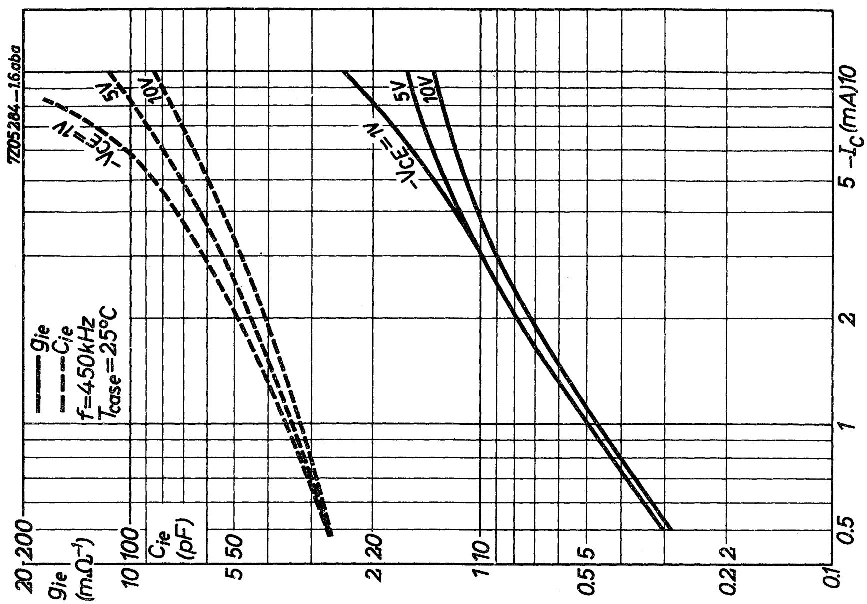
7Z3 0304

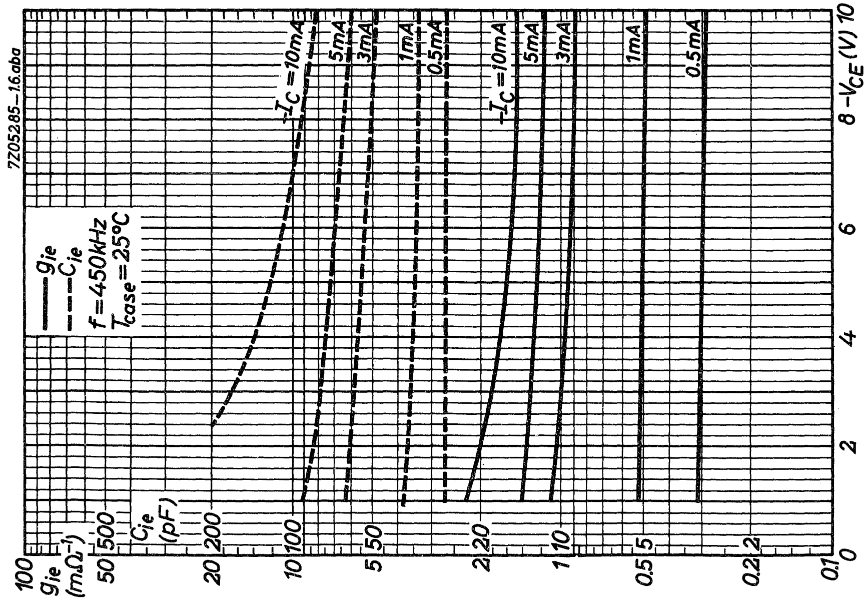

7Z05230—16.aba
max
$-V_{CB} = 25V$
10V
typ
25V
10V
1000
500
$-I_{CBO}$ (μA)
200
100
50
20
10
5
2
1
0
20
40
60
80
T_j (°C) 100

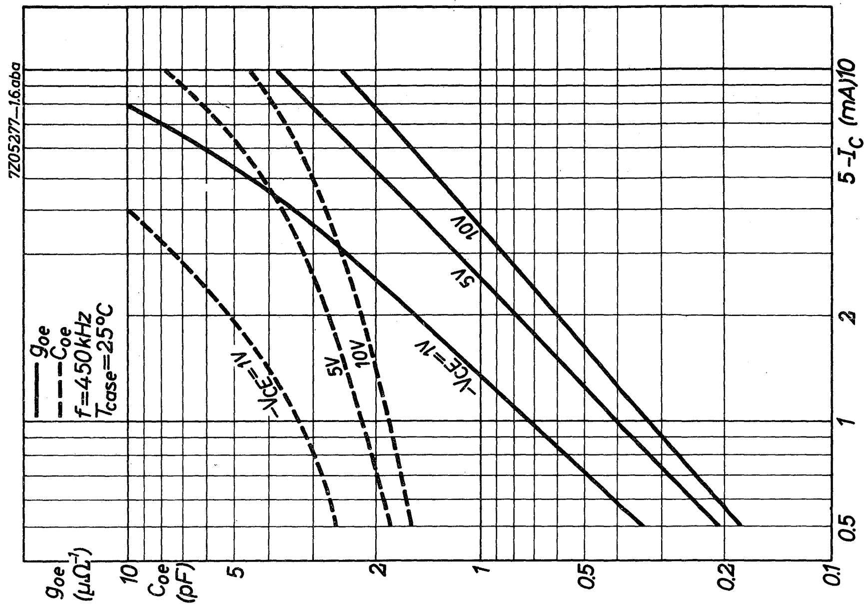

7Z02647—1.6.aba
$-I_B = 80\mu A$
70μA
60μA
50μA
40μA
30μA
20μA
10μA
$-V_{CE}$ (V)
0
10
20
$T_j = 25°C$
8
$-I_C$ (mA)
6
4
2
$-V_{CE} = 10V$
5V
50
$-I_B$ (μA)
100
200
400
$-V_{BE}$ (mV)
$-V_{CE} = 5V$ to 10V

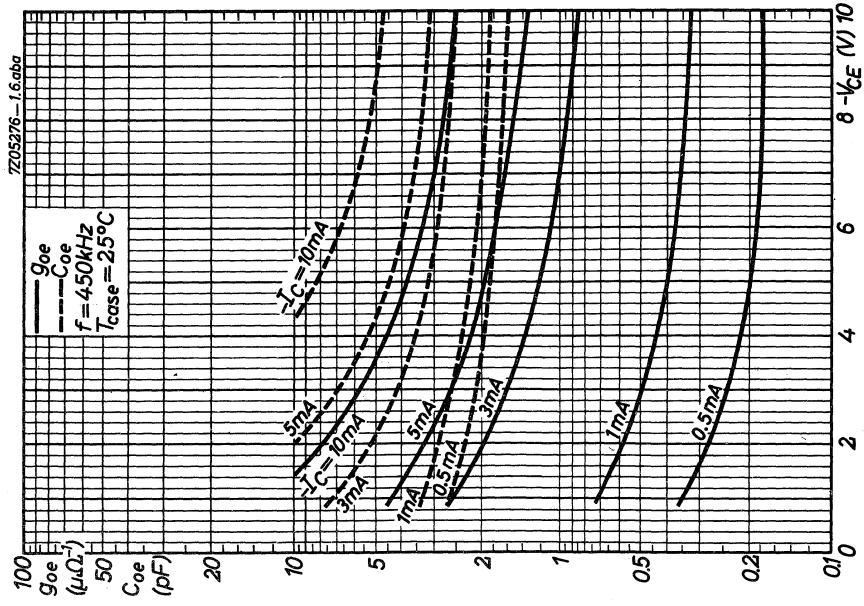

7Z05283—1.6.aba
f=450kHz
Tcase=25°C
-VCE=5V
1V
|yfe| (mΩ⁻¹)
1000
500
200
100
50
20
10
0.5
1
2
5 -IC (mA) 10

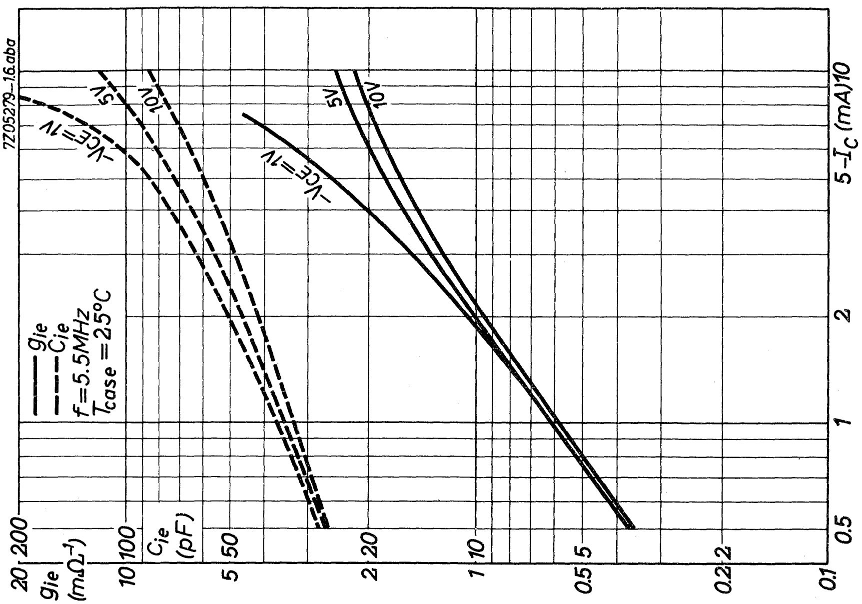

7Z05286—1.6.aba
-VCE=5V
-IC=2mA
Tcase=25°C
φfe
-φre
|yfe|
Cie
|yre|
Coe
goe
gie
gie (mΩ⁻¹)
Cie (pF)
goe (μΩ⁻¹)
Coe (pF)
|yre| (μΩ⁻¹)
|yfe| (mΩ⁻¹)
-φre (°)
φfe (°)
1000
100
10
1
0.1
0.1
1
10
f (MHz)
100

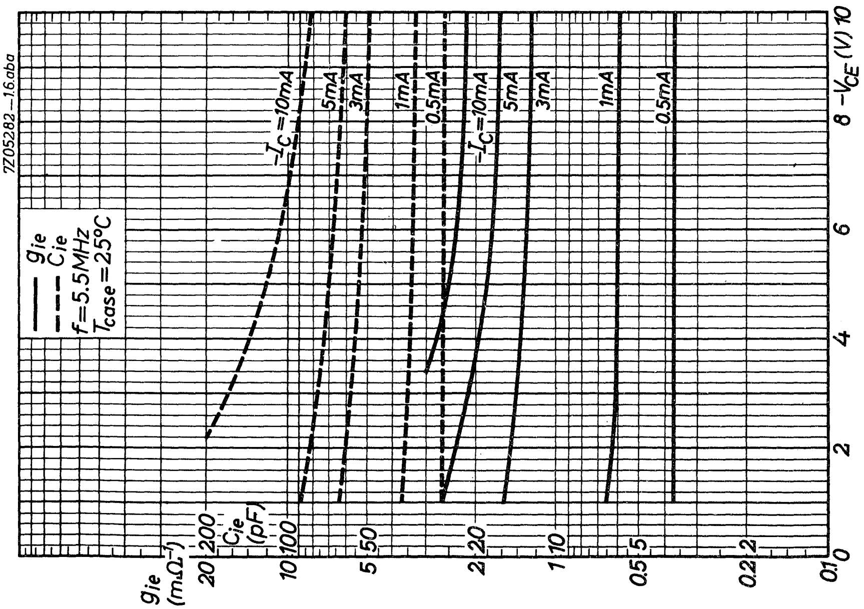

7Z05284–1.6.aba
gie
Cie
f=450kHz
Tcase=25°C
−VCE=1V
5V
10V
gie (mΩ⁻¹)
Cie (pF)
−IC (mA)
0.5
1
2
5
10

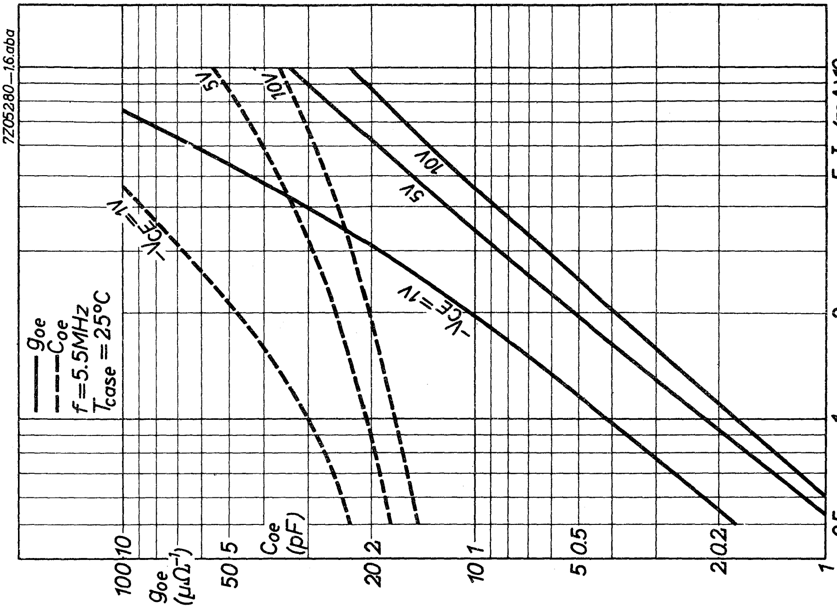

7Z05285–1.6.aba
gie
Cie
f=450kHz
Tcase=25°C
−IC=10mA
5mA
3mA
1mA
0.5mA
gie (mΩ⁻¹)
Cie (pF)
−VCE (V)
0
2
4
6
8
10

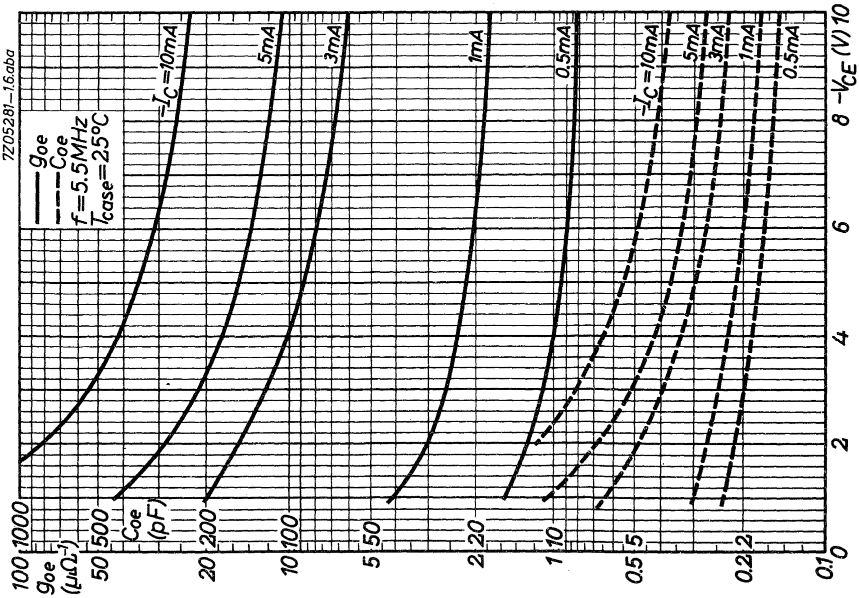

7Z05277—1.6.aba
goe
Coe
f = 450 kHz
Tcase = 25°C
−VCE = 1V
5V
10V
goe (μΩ⁻¹)
Coe (pF)
10
5
2
1
0.5
0.2
0.1
0.5
1
2
5
10
−IC (mA)

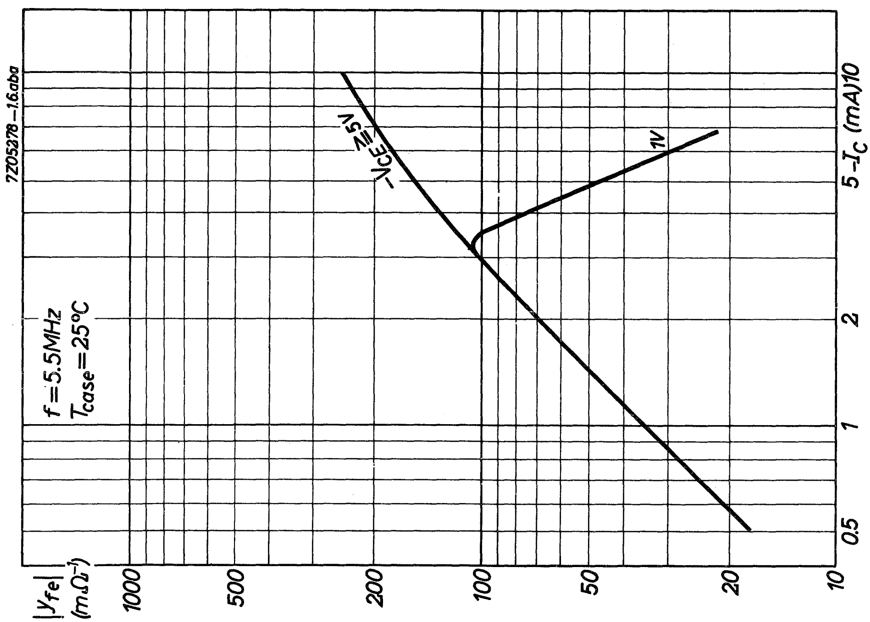

7Z05276—1.6.aba
goe
Coe
f = 450 kHz
Tcase = 25°C
−IC = 10mA
5mA
3mA
1mA
0.5mA
100
goe (μΩ⁻¹)
50
Coe (pF)
20
10
5
2
1
0.5
0.2
0.1
0
2
4
6
8
10
−VCE (V)

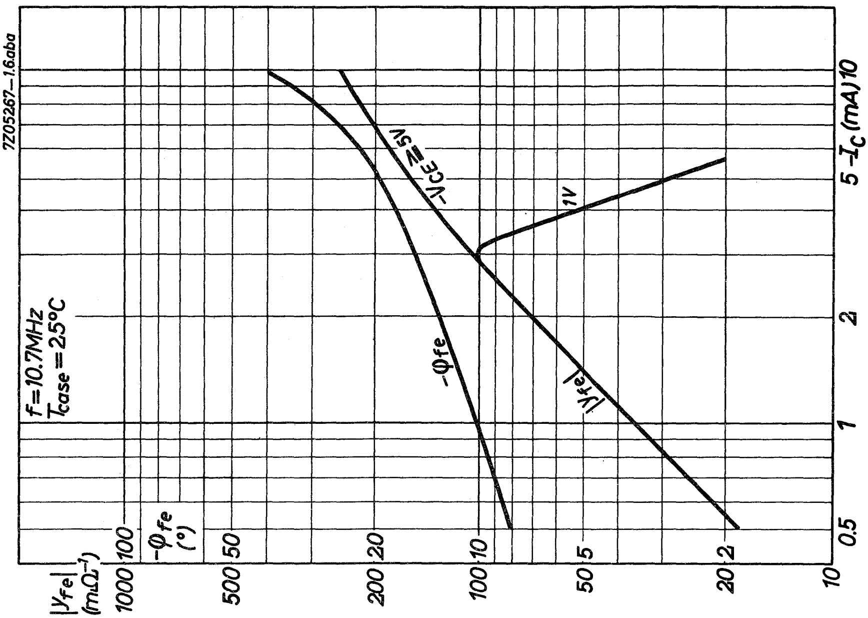

7Z05279-1.6.aba
g_ie
C_ie
f=5.5MHz
T_case=25°C
-V_CE=1V
5V
10V
-I_C (mA)
g_ie (mΩ^-1)
C_ie (pF)

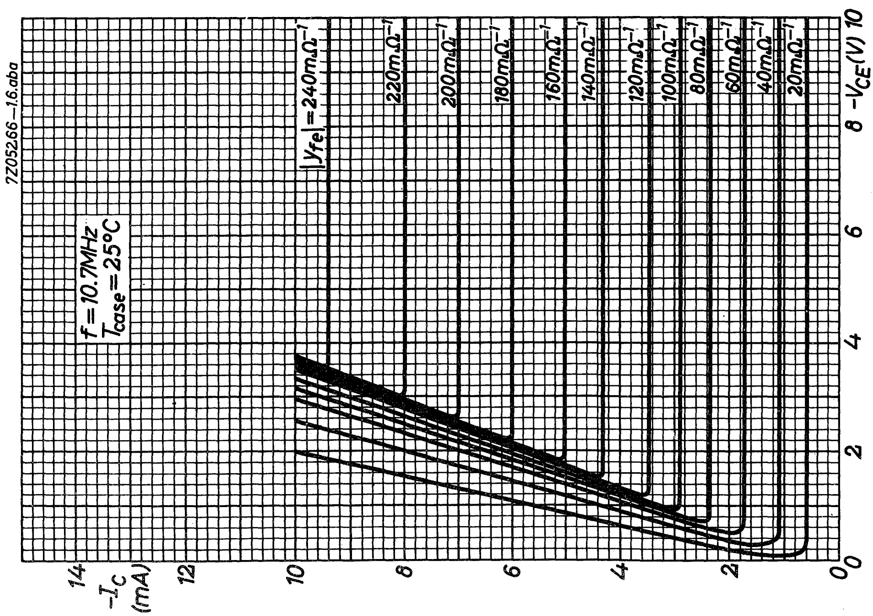

7Z05282-1.6.aba
g_ie
C_ie
f=5.5MHz
T_case=25°C
-I_C=10mA
5mA
3mA
1mA
0.5mA
-V_CE (V)
g_ie (mΩ^-1)
C_ie (pF)

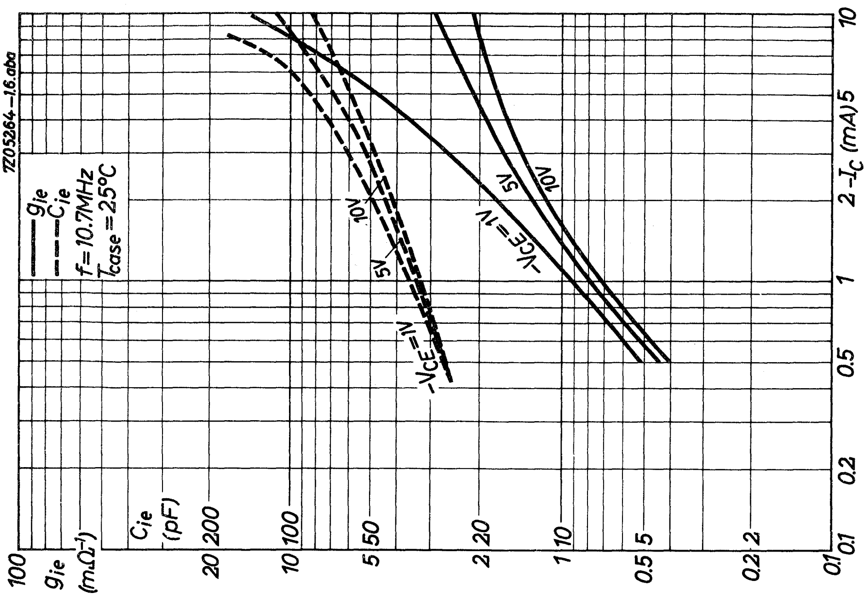

7Z05280—1.6.aba
goe
Coe
f = 5.5MHz
Tcase = 25°C
−VCE = 1V
5V
10V
−IC (mA)
goe (μΩ⁻¹)
Coe (pF)

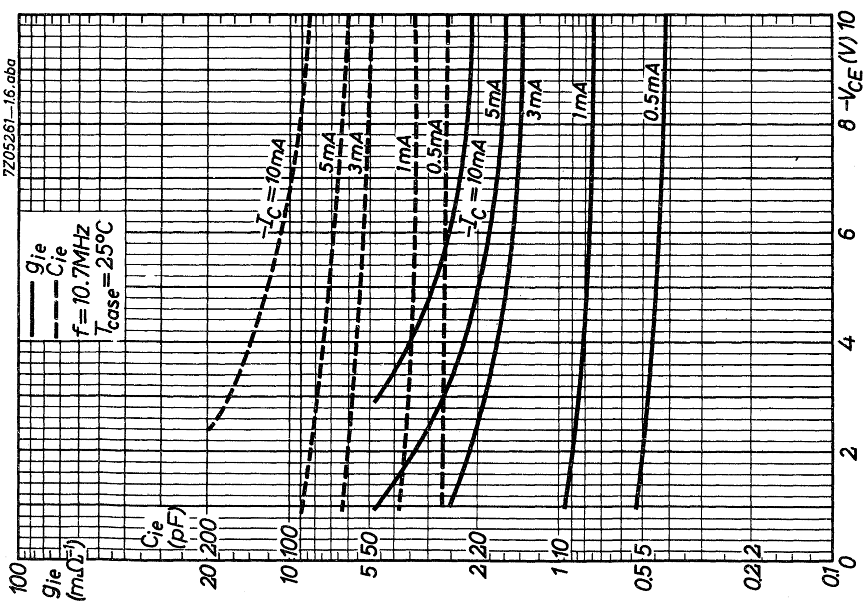

7Z05281—1.6.aba
goe
Coe
f = 5.5MHz
Tcase = 25°C
−IC = 10mA
5mA
3mA
1mA
0.5mA
−VCE (V)
goe (μΩ⁻¹)
Coe (pF)

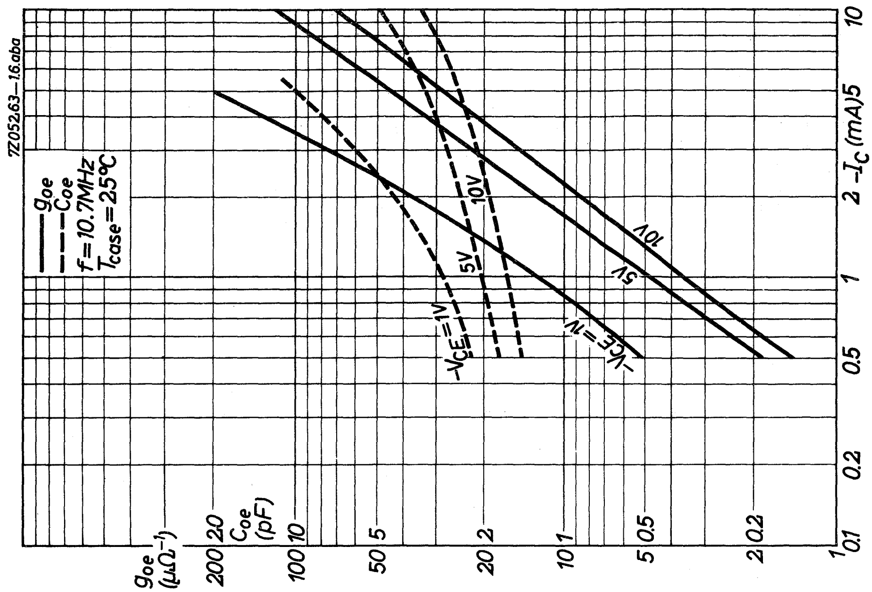

7Z05278 -1.6.aba
f = 5.5MHz
Tcase = 25°C
−VCE = 5V
1V
|yfe|
(mΩ⁻¹)
1000
500
200
100
50
20
10
0.5
1
2
5 −IC (mA) 10

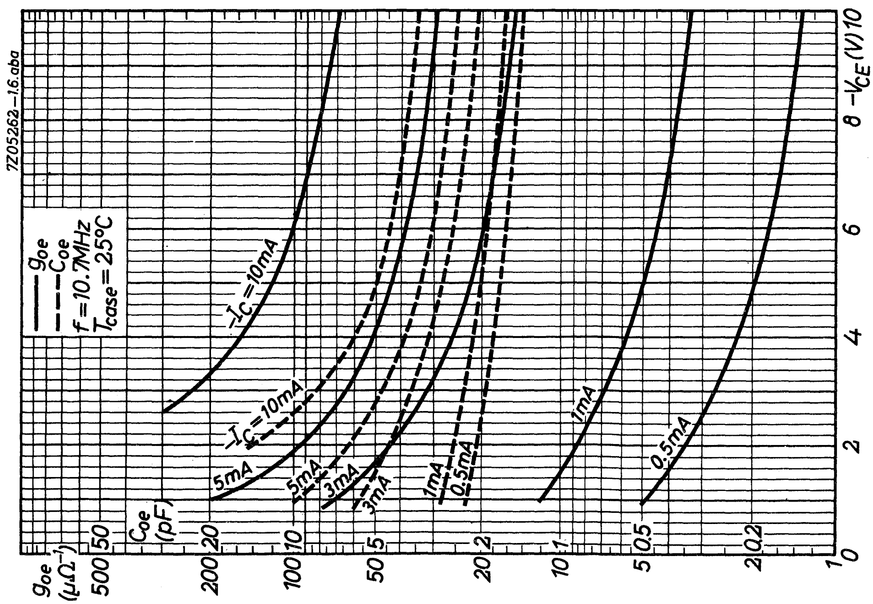

7Z05267—1.6.aba
f = 10.7MHz
T_{case} = 25°C
$-V_{CE}$ = 5V
1V
$-\varphi_{fe}$
$|y_{fe}|$
$|y_{fe}|$ ($m\Omega^{-1}$)
$-\varphi_{fe}$ (°)
1000
500
200
100
50
20
10
100
50
20
10
5
2
0.5
1
2
5
$-I_C$ (mA) 10

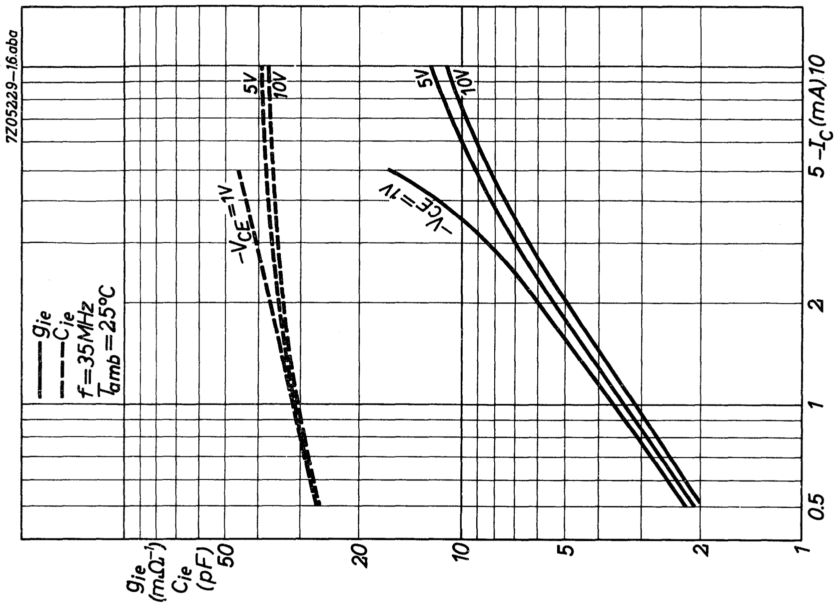

7Z05266—1.6.aba
f = 10.7MHz
T_{case} = 25°C
$|y_{fe}|$ = 240$m\Omega^{-1}$
220$m\Omega^{-1}$
200$m\Omega^{-1}$
180$m\Omega^{-1}$
160$m\Omega^{-1}$
140$m\Omega^{-1}$
120$m\Omega^{-1}$
100$m\Omega^{-1}$
80$m\Omega^{-1}$
60$m\Omega^{-1}$
40$m\Omega^{-1}$
20$m\Omega^{-1}$
14
$-I_C$ (mA)
12
10
8
6
4
2
0
0
2
4
6
8
$-V_{CE}$ (V) 10

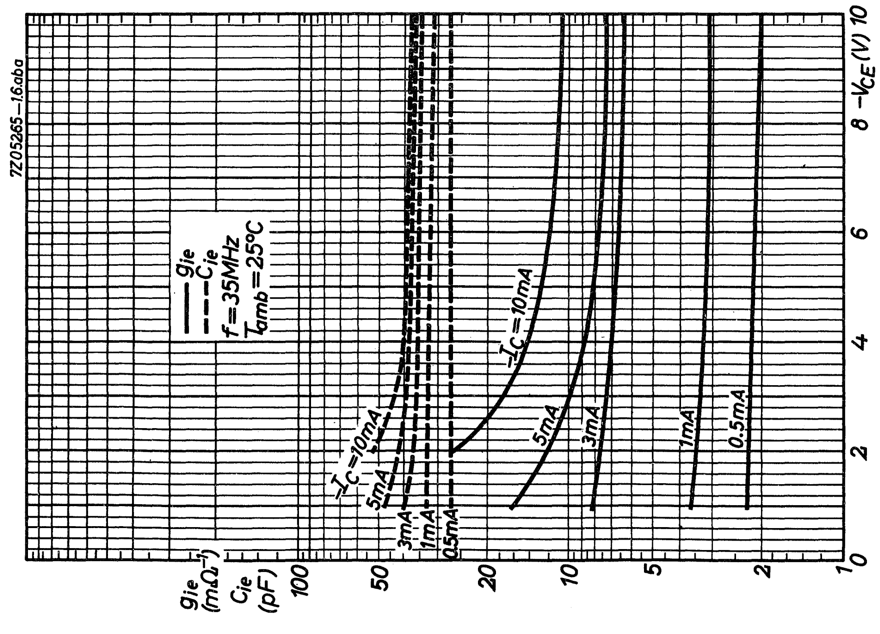

7Z05264-1.6.aba
g_{ie}
C_{ie}
f = 10.7MHz
T_{case} = 25°C
g_{ie} ($m\Omega^{-1}$)
C_{ie} (pF)
$-V_{CE}$ = 1V
5V
10V
$-I_C$ (mA)

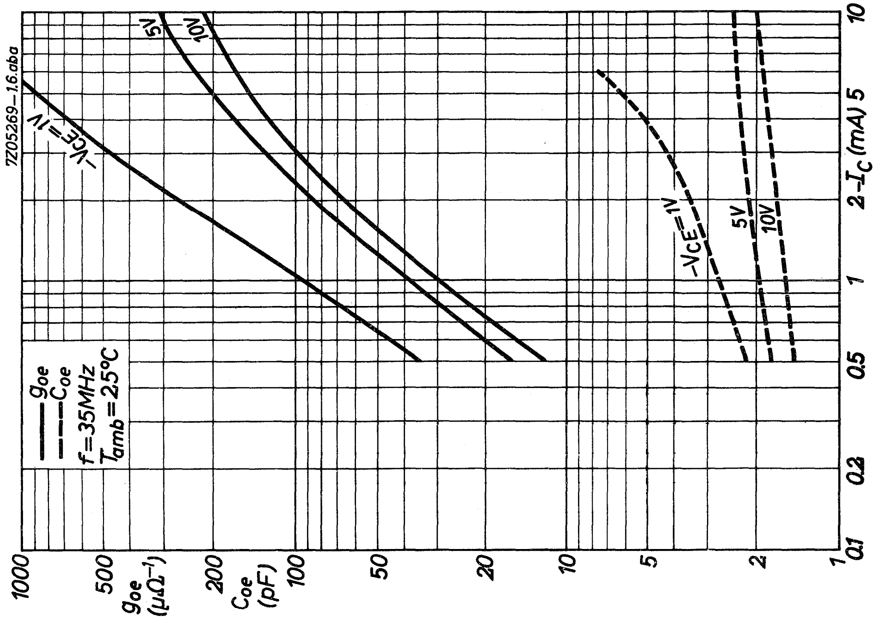

7Z05261-1.6.aba
g_{ie}
C_{ie}
f = 10.7MHz
T_{case} = 25°C
g_{ie} ($m\Omega^{-1}$)
C_{ie} (pF)
$-I_C$ = 10mA
5mA
3mA
1mA
0.5mA
$-V_{CE}$ (V)

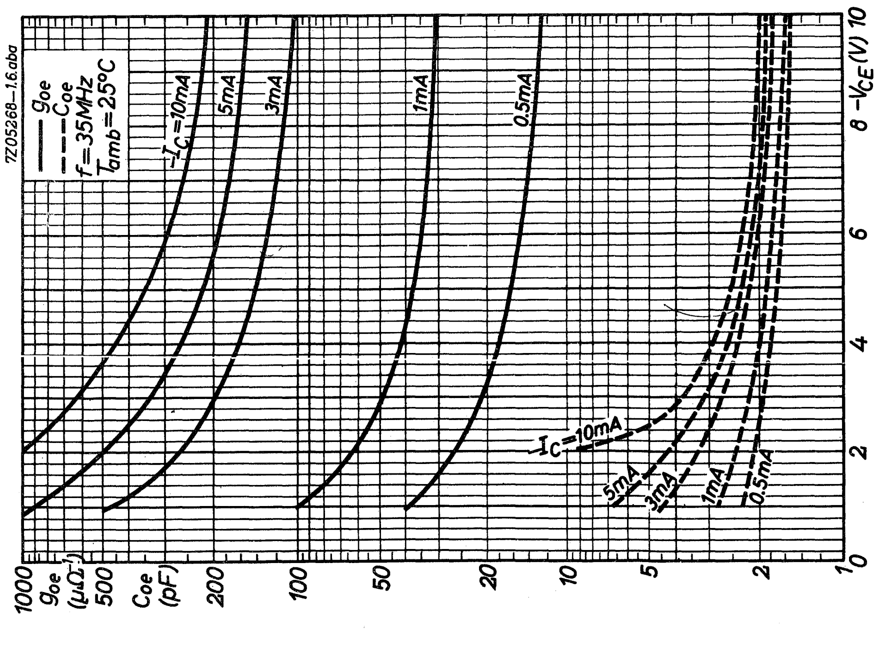

7Z05263—1.6.aba
g_{oe}
C_{oe}
f = 10.7MHz
T_{case} = 25°C
$-V_{CE}$ = 1V
5V
10V
g_{oe} (μΩ^{-1})
C_{oe} (pF)
$-I_C$ (mA)

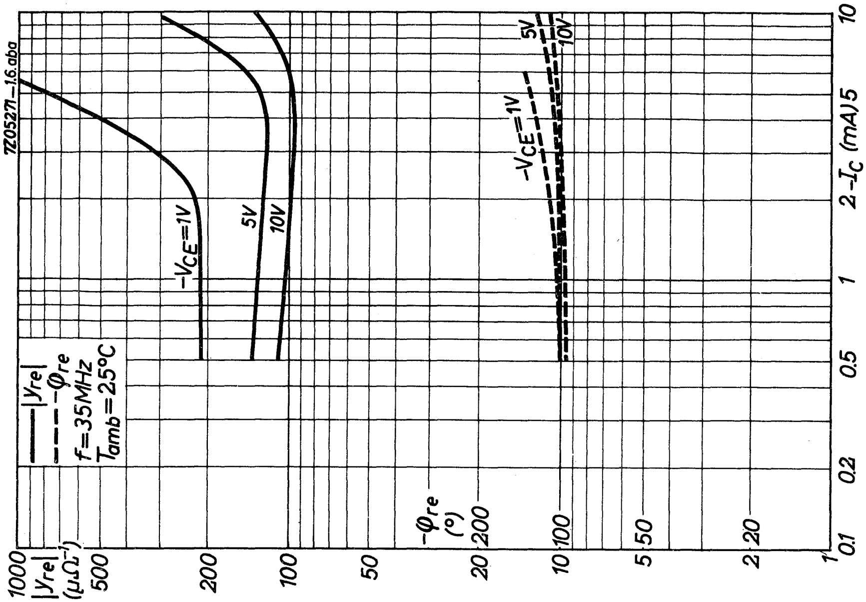

7Z05262—1.6.aba
g_{oe}
C_{oe}
f = 10.7MHz
T_{case} = 25°C
$-I_C$ = 10mA
5mA
3mA
1mA
0.5mA
g_{oe} (μΩ^{-1})
C_{oe} (pF)
$-V_{CE}$ (V)

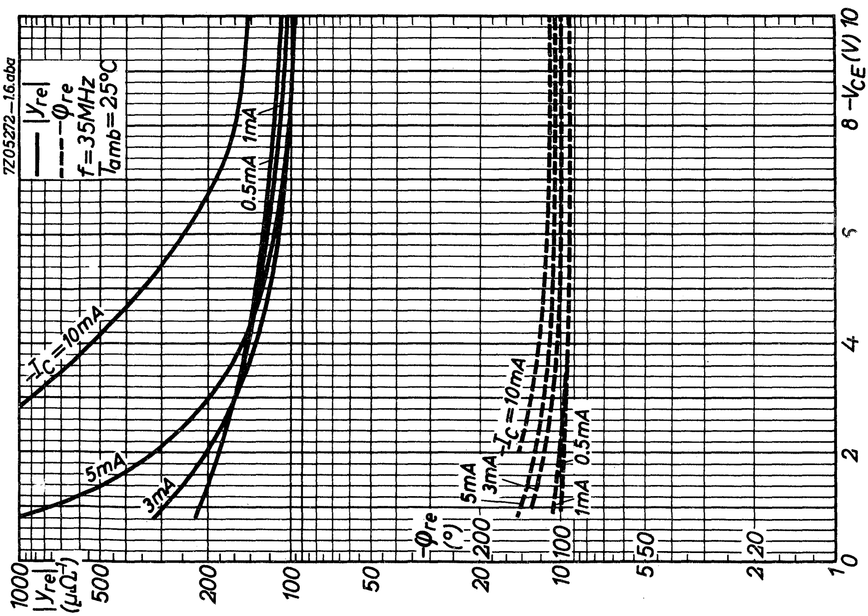

7Z05229-1.6.aba
gie
Cie
f = 35MHz
Tamb = 25°C
5V
10V
-VCE = 1V
-IC (mA)
0.5
1
2
5
10
gie (mΩ⁻¹)
Cie (pF)
50
20
10
5
2
1

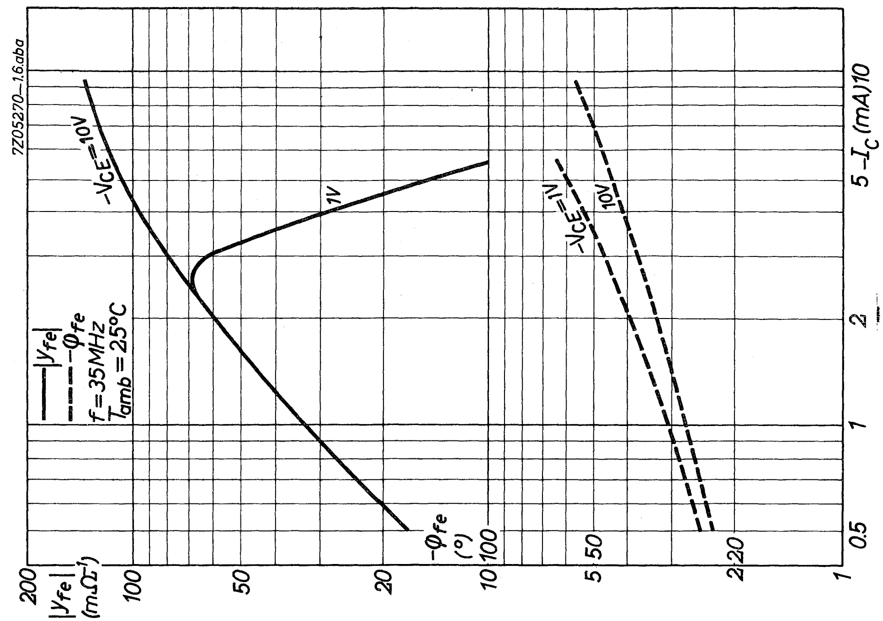

7Z05265-1.6.aba
gie
Cie
f = 35MHz
Tamb = 25°C
-IC = 10mA
5mA
3mA
1mA
0.5mA
-VCE (V)
0
2
4
6
8
10
gie (mΩ⁻¹)
Cie (pF)
100
50
20
10
5
2
1

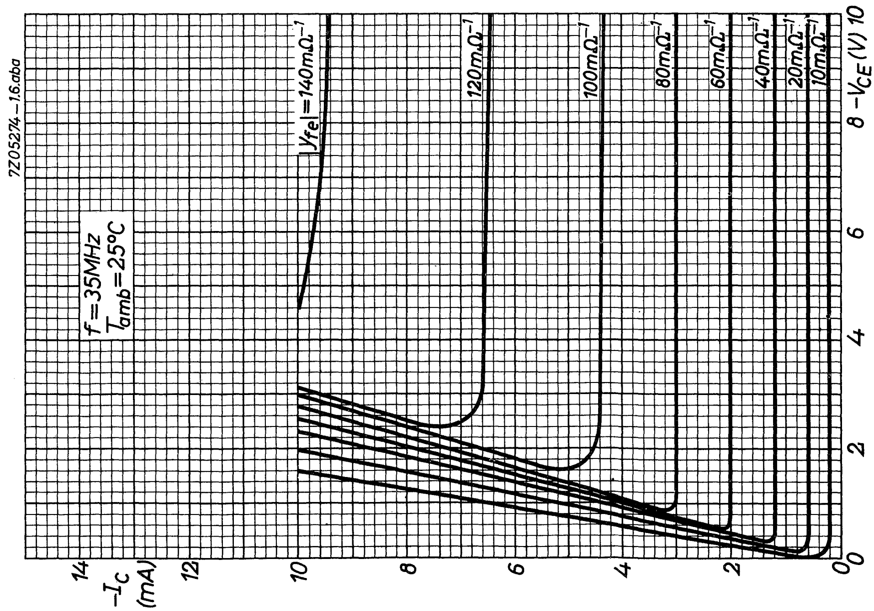

7Z05269-1.6.aba
g_{oe}
C_{oe}
f=35MHz
T_{amb}=25°C
$-V_{CE}$=1V
5V
10V
g_{oe} ($\mu\Omega^{-1}$)
C_{oe} (pF)
$-I_C$ (mA)
1000
500
200
100
50
20
10
5
2
1
0.1
0.2
0.5
1
2
5
10

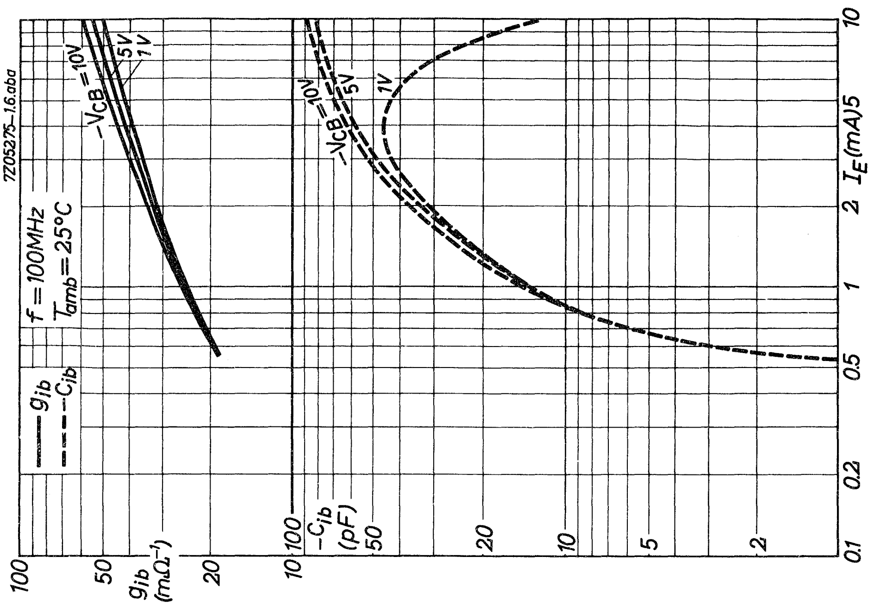

7Z05268-1.6.aba
g_{oe}
C_{oe}
f=35MHz
T_{amb}=25°C
$-I_C$=10mA
5mA
3mA
1mA
0.5mA
$-I_C$=10mA
5mA
3mA
1mA
0.5mA
g_{oe} ($\mu\Omega^{-1}$)
C_{oe} (pF)
$-V_{CE}$ (V)
1000
500
200
100
50
20
10
5
2
1
0
2
4
6
8
10

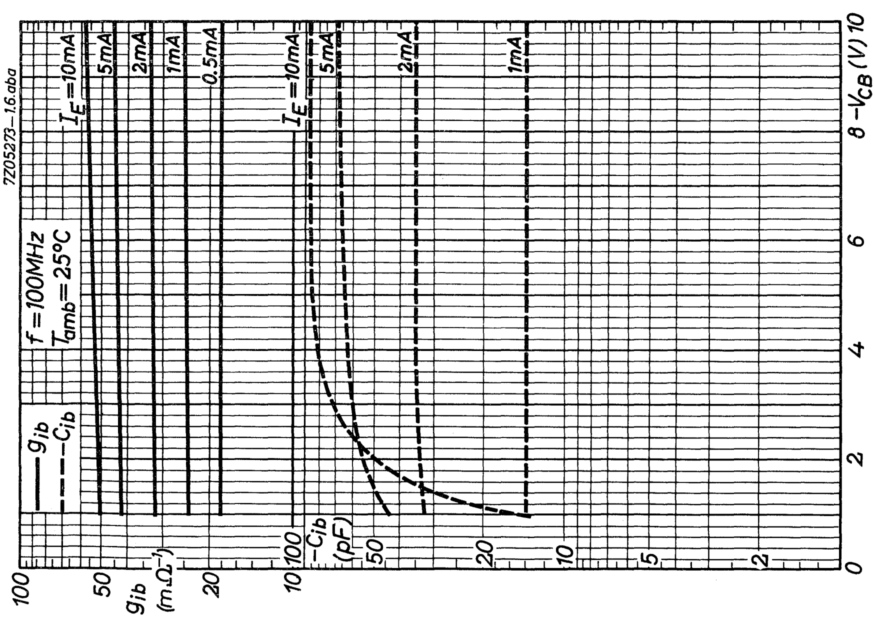

7Z05271—1.6.aba
|yre|
−φre
f=35MHz
Tamb=25°C
−VCE=1V
5V
10V
−VCE=1V
5V
10V
|yre| (μΩ⁻¹)
1000
500
200
100
50
20
10
5
2
1
−φre (°)
200
100
50
20
0.1
0.2
0.5
1
2 −IC (mA) 5
10

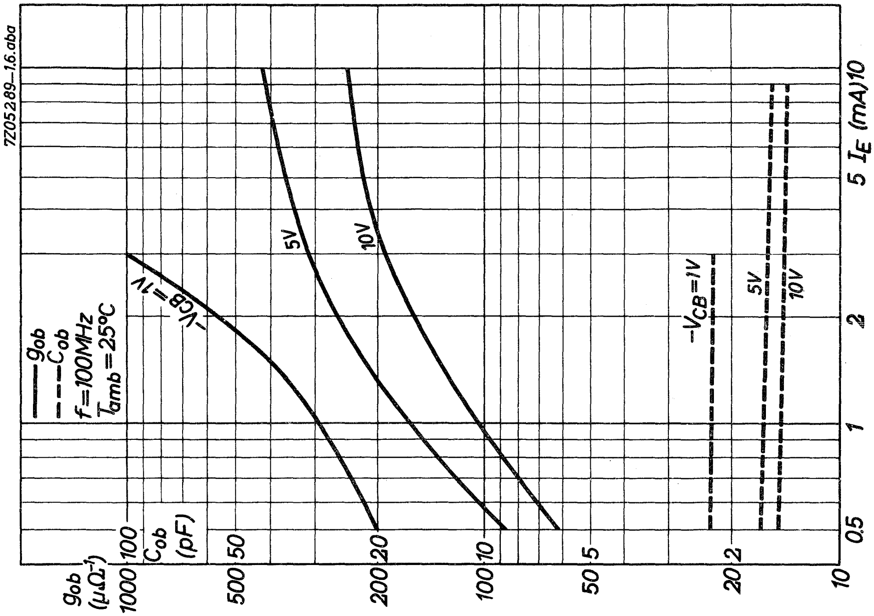

7Z05272—1.6.aba
|yre|
−φre
f=35MHz
Tamb=25°C
−IC=10mA
5mA
3mA
0.5mA
1mA
−IC=10mA
5mA
3mA
0.5mA
1mA
|yre| (μΩ⁻¹)
1000
500
200
100
50
20
10
5
2
1
−φre (°)
200
100
50
20
0
2
4
6
8 −VCE (V) 10

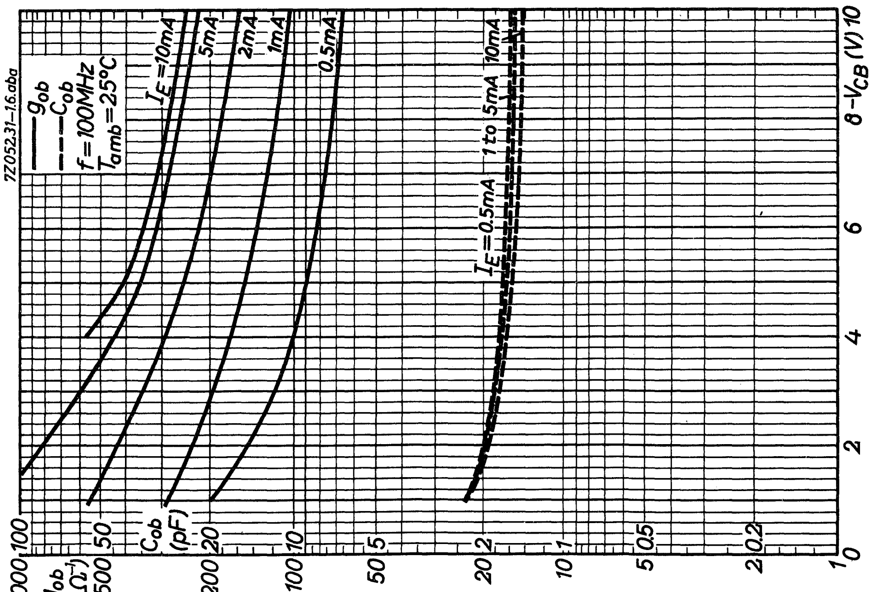

7Z05270—1.6.aba
|yfe|
−φfe
f = 35MHz
Tamb = 25°C
−VCE=10V
1V
−VCE=1V
10V
|yfe|
(mΩ⁻¹)
−φfe
(°)
−IC (mA)
200
100
50
20
10
5
2
1
0.5
1
2
5
10

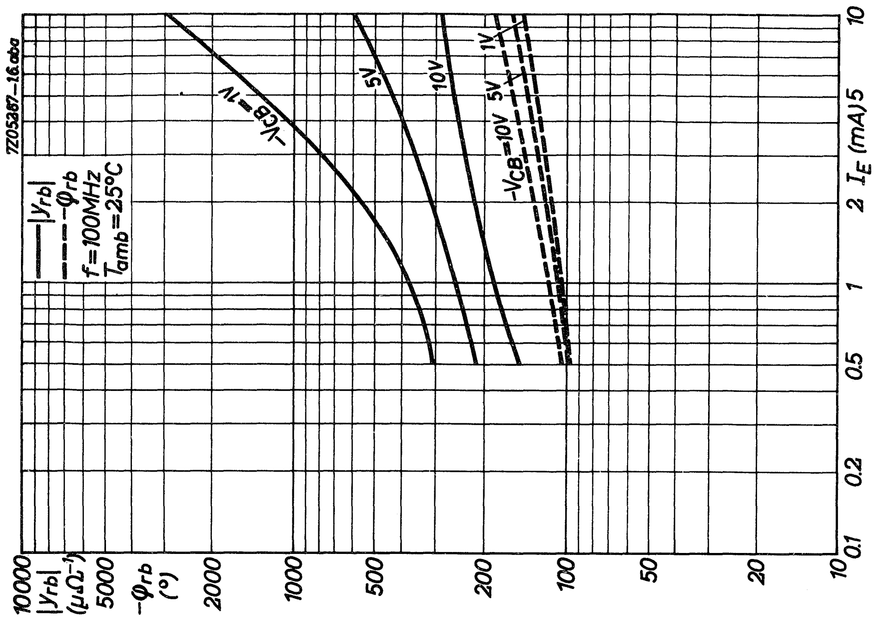

7Z05274—1.6.aba
f = 35MHz
Tamb = 25°C
|yfe| = 140mΩ⁻¹
120mΩ⁻¹
100mΩ⁻¹
80mΩ⁻¹
60mΩ⁻¹
40mΩ⁻¹
20mΩ⁻¹
10mΩ⁻¹
−IC
(mA)
−VCE (V)
14
12
10
8
6
4
2
0
0
2
4
6
8
10

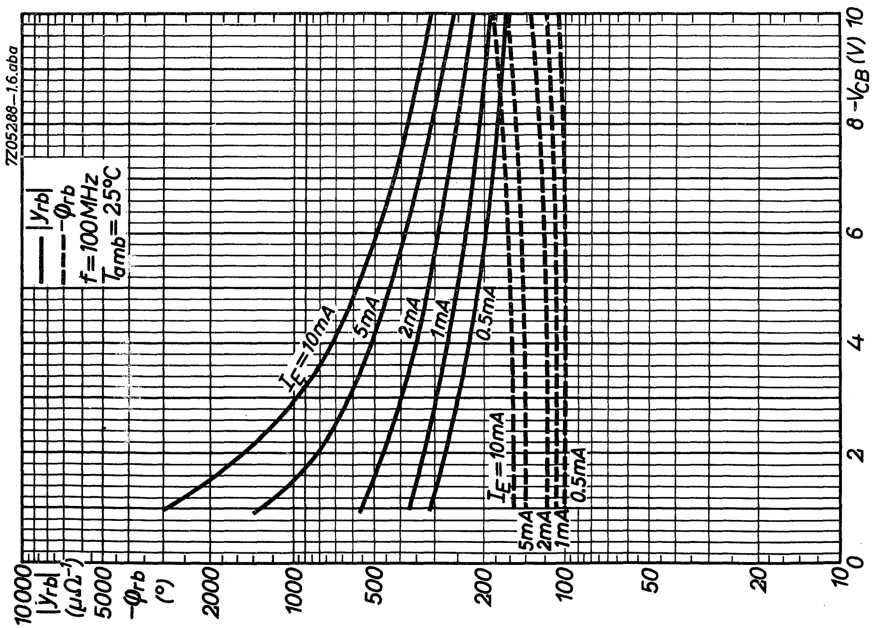

7Z05275-1.6.aba
f = 100MHz
T_{amb} = 25°C
g_{ib}
$-C_{ib}$
$-V_{CB}$ = 10V
5V
1V
g_{ib} ($m\Omega^{-1}$)
$-C_{ib}$ (pF)
I_E (mA)
100
50
20
10
5
2
0.1
0.2
0.5
1

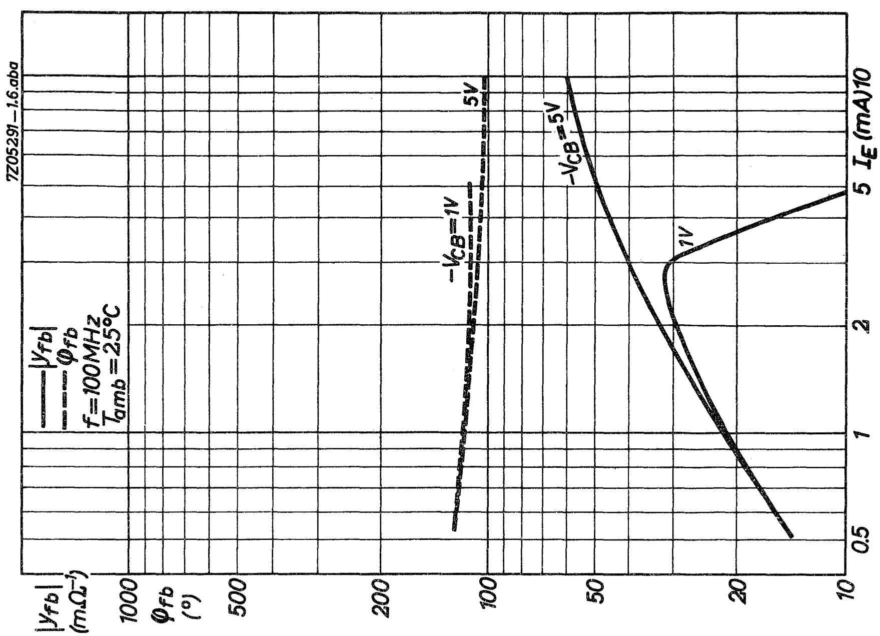

7Z05273-1.6.aba
f = 100MHz
T_{amb} = 25°C
g_{ib}
$-C_{ib}$
I_E = 10mA
5mA
2mA
1mA
0.5mA
g_{ib} ($m\Omega^{-1}$)
$-C_{ib}$ (pF)
$-V_{CB}$ (V)
100
50
20
10
5
2
0
4
6
8

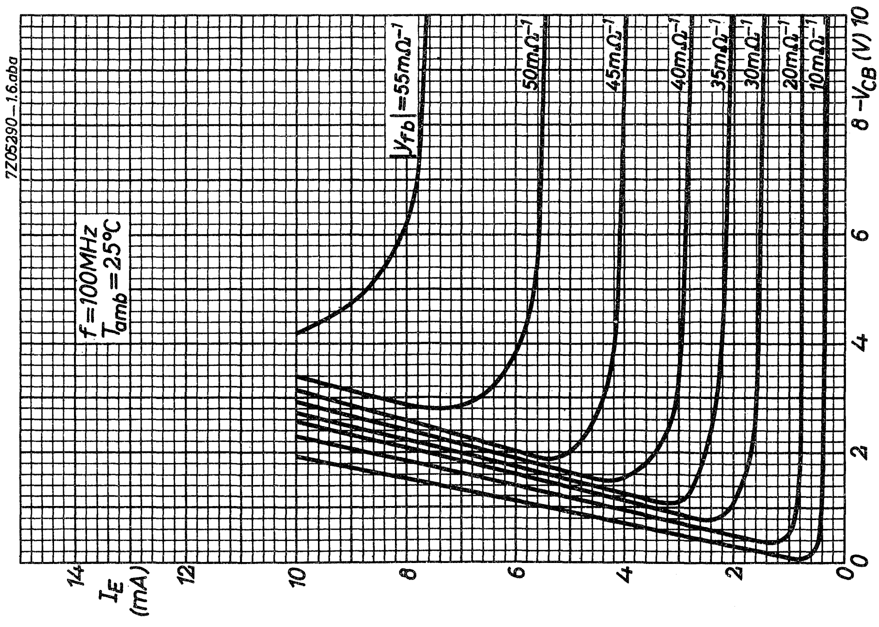

7Z05289-1.6.aba
gob
Cob
f=100MHz
Tamb=25°C
−VCB=1V
5V
10V
−VCB=1V
5V
10V
IE (mA)
gob (μΩ⁻¹)
Cob (pF)


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
−VCB (V)
gob (μΩ⁻¹)
Cob (pF)


7Z05287-1.6.aba
|y_rb|
-φ_rb
f=100MHz
T_amb=25°C
-V_CB=1V
5V
10V
1V
5V
-V_CB=10V
|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
I_E (mA)


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
|y_rb| (μΩ⁻¹)
-φ_rb (°)
10000
5000
2000
1000
500
200
100
50
20
10
0
2
4
6
8
10
-V_CB (V)


7Z05291—1.6.aba
|yfb|
φfb
f=100MHz
Tamb=25°C
−VCB=1V
5V
−VCB=5V
1V
|yfb| (mΩ⁻¹)
φfb (°)
1000
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])

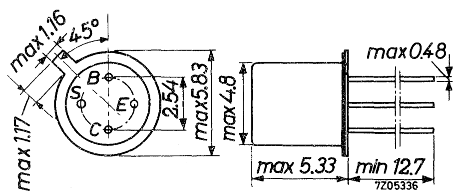
Collector-base voltage (open emitter)	$-V_{CBO}$	max.	32	V
Collector-emitter voltage ($Z_B/Z_E < 15$)	$-V_{CER}$	max.	32	V
Collector-emitter voltage (open base)	$-V_{CEO}$	max.	15	V
Collector current (d.c.)	$-I_C$	max.	10	mA
Base current (d.c.)	$\|I_B\|$	max.	1	mA
Reverse emitter current	$-I_E$	max.	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

TO-72
insulated electrodes



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

7Z3 1438

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

7Z3 1439

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

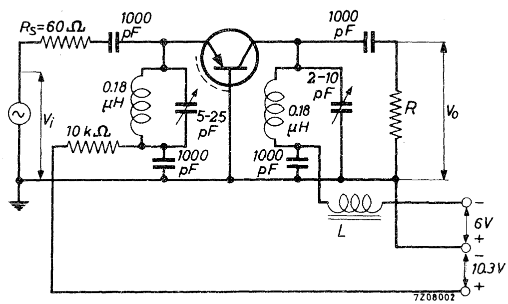
I_E = 1 mA; $-V_{CB}$ = 6 V; R_S = 60 Ω	F	typ.	8	dB
		<	9.5	dB

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



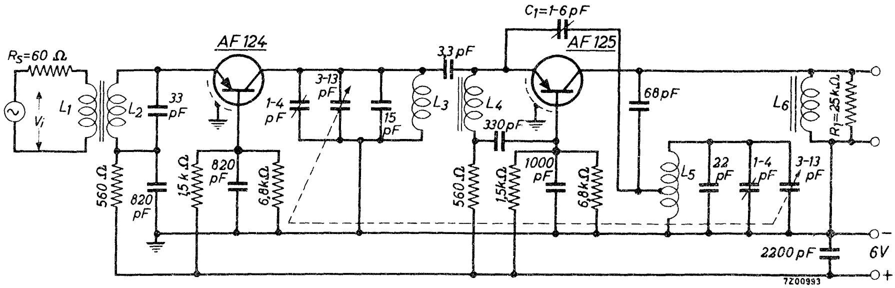
R is chosen such that the total load impedance R_l consisting of R and the tuned circuit in parallel is 3.3 kΩ.

L = ferrite bead

7Z3 1440

APPLICATION INFORMATION

Front-end unit of a f.m. tuner



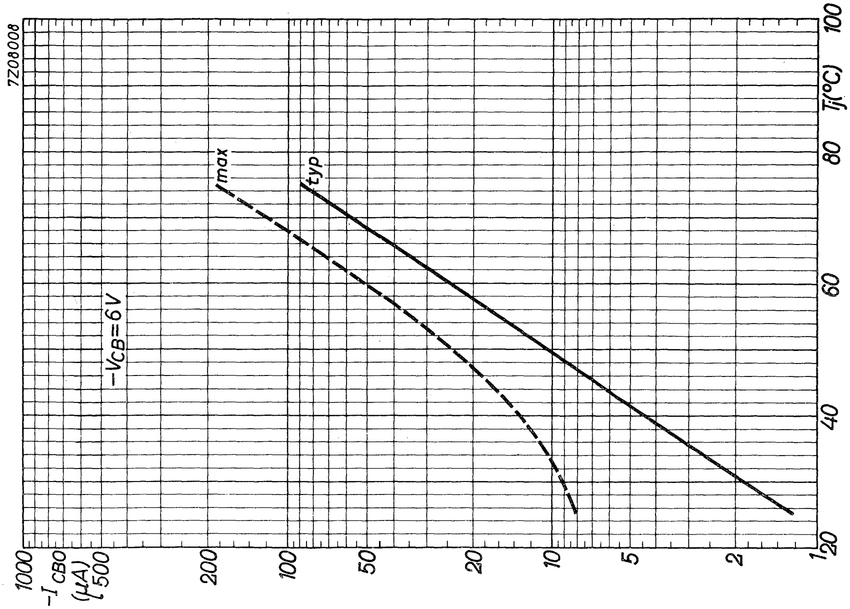
The oscillator voltage at the emitter of the AF 125 should be adjusted to 80 mV by means of C_1 at a battery voltage V_S = 4 V

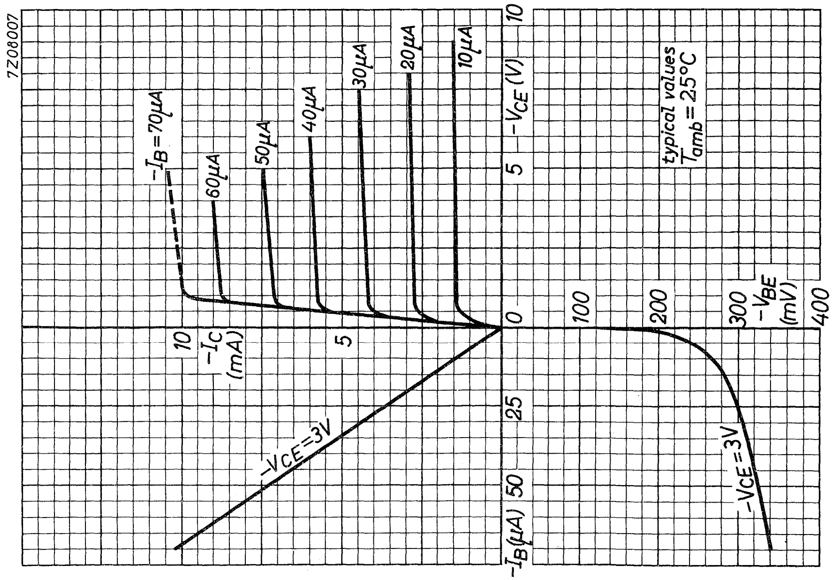
L_1 = 4.5 turns enamelled Cu wire (0.3 mm), wound between L_2.
L_2 = 4 turns enamelled Cu wire (1 mm), winding pitch 2 mm, inductance 0.18 μH, unloaded Q-factor 60 to 80.
L_3 = 3.25 turns silvered Cu wire (1 mm), winding pitch 2 mm, inductance 0.086 μH, unloaded Q-factor 200.
L_4 = 6 turns enamelled Cu wire (0.5 mm), closely wound, inductance 0.65 μH.
L_5 = 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.
L_6 = 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.

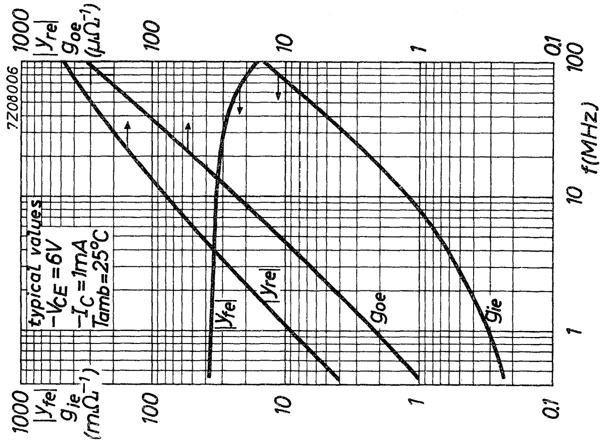
Frequency range	f		87 to 101	MHz
Collector current AF124	$-I_C$		1.4	mA
AF125	$-I_C$		1.5	mA
Total power gain	G_p	>	24	dB
		typ.	28	dB
Noise figure	F	typ.	8	dB
		<	9.5	dB
Oscillator voltage at aerial terminals		typ.	1.5	mV
Image rejection		typ.	27	dB

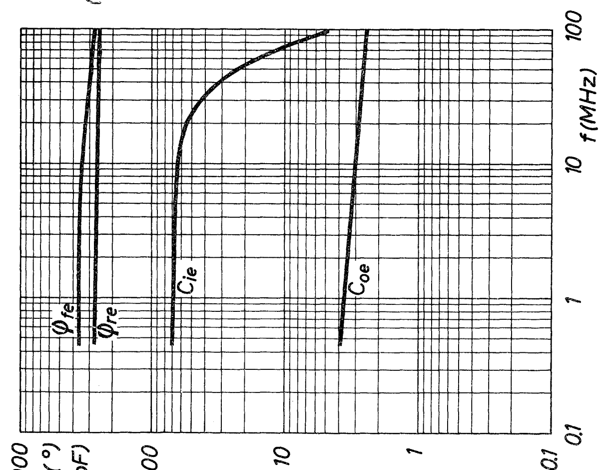
The shift of the oscillator frequency as a function of the battery voltage is about 50 kHz from 6 to 5 V and about 100 kHz from 5 to 4 V.

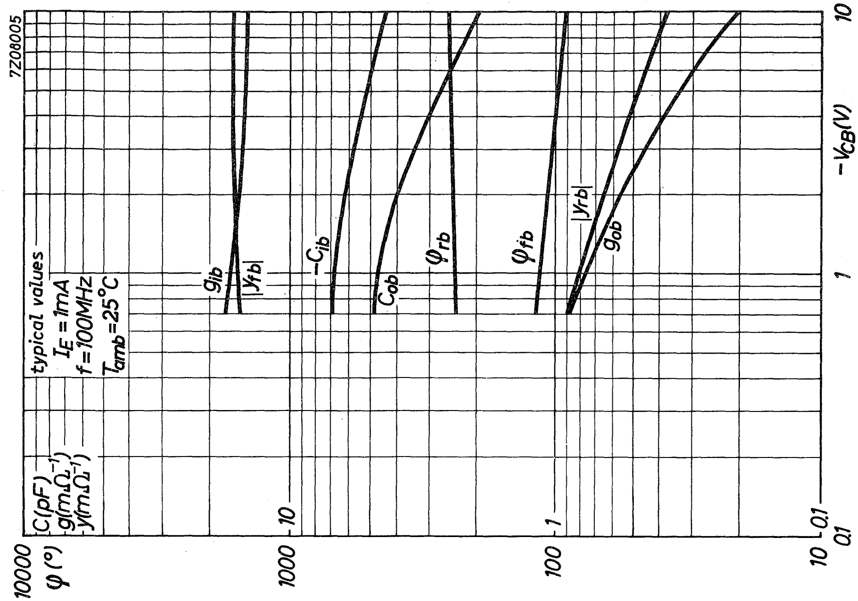
7Z3 1441

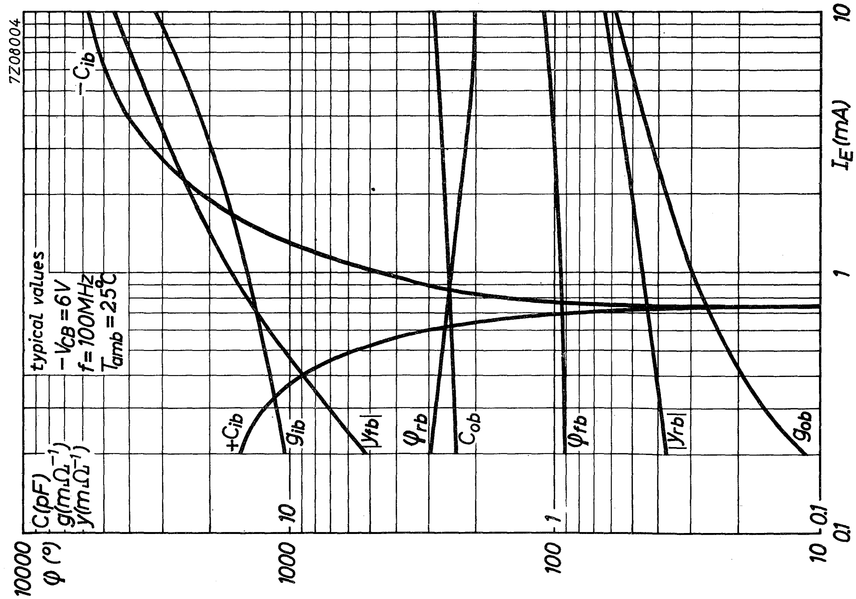

7Z08008
$-V_{CB}=6V$
max
typ
$-I_{CBO}$ (μA)
T_j (°C)
1000
500
200
100
50
20
10
5
2
1
20
40
60
80
100

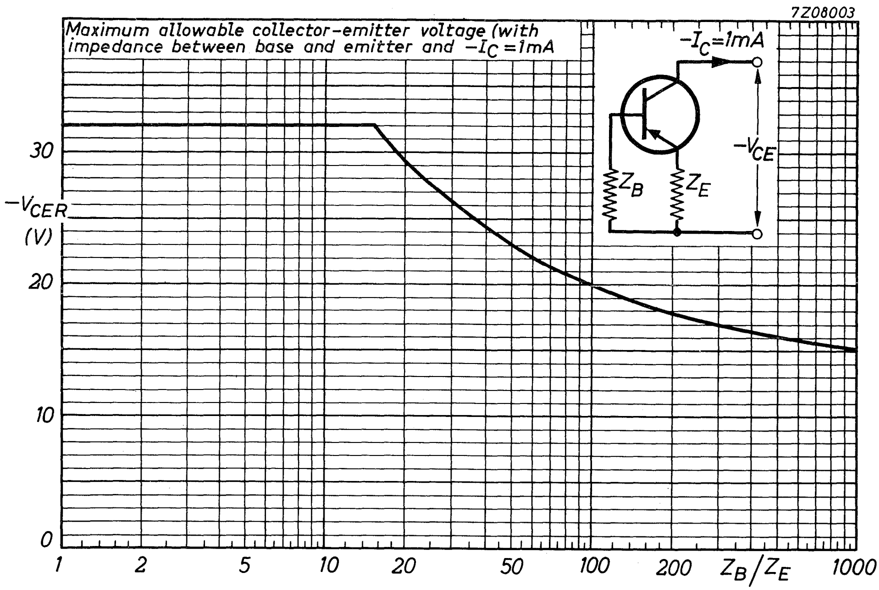

7Z08007
$-I_B = 70\mu A$
60μA
50μA
40μA
30μA
20μA
10μA
$-V_{CE}$ (V)
typical values
$T_{amb} = 25°C$
$-I_C$ (mA)
$-V_{CE}=3V$
$-V_{CE}=3V$
$-V_{BE}$ (mV)
$-I_B$ (μA)
0
5
10
25
50
100
200
300
400


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)


φ_{fe}
φ_{re}
C_{ie}
C_{oe}
φ (°)
C (pF)
f (MHz)


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
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])

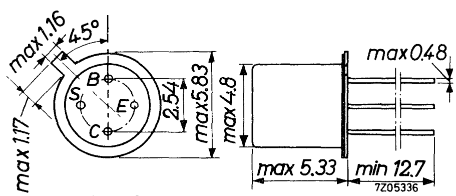
Collector-base voltage (open emitter)	$-V_{CBO}$	max.	32	V
Collector-emitter voltage ($Z_B/Z_E < 15$)	$-V_{CER}$	max.	32	V
Collector-emitter voltage (open base)	$-V_{CEO}$	max.	15	V
Collector current (d.c.)	$-I_C$	max.	10	mA
Base current (d.c.)	$\lvert I_B \rvert$	max.	1	mA
Reverse emitter current	$-I_E$	max.	1	mA
Total power dissipation up to $T_{amb} = 45\ ^{o}C$	P_{tot}	max.	60	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	$R_{th\ j\text{-}a}$	=	0.75	$^{o}C/mW$
From junction to case	$R_{th\ j\text{-}c}$	=	0.4	$^{o}C/mW$

MECHANICAL DATA

TO-72
insulated electrodes



S=Shield lead connected to case

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

7Z3 1444

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

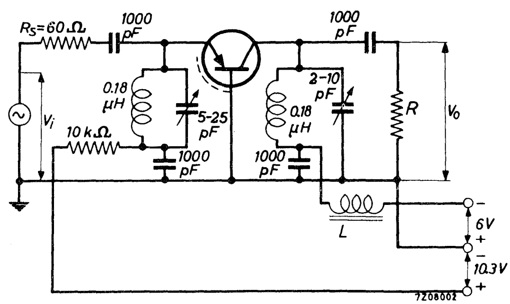
[1]) Length of leads between transistor bottom and measuring jig: 5 mm.

7Z3 1445

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:



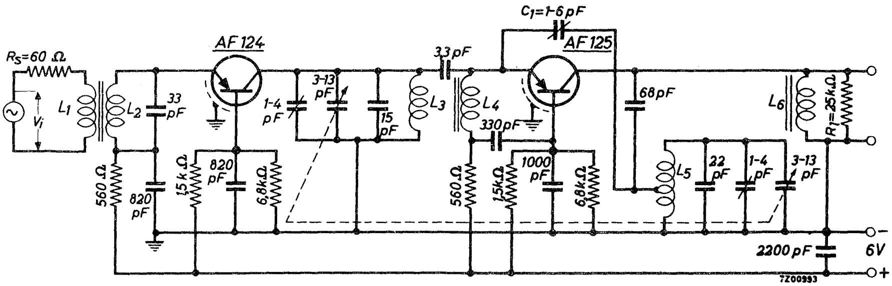
R is chosen such that the total load impedance R_ℓ consisting of R and the tuned circuit in parallel is 3.3 kΩ.

L = ferrite bead

7Z3 1446

APPLICATION INFORMATION

Front-end unit of a f.m. tuner



The oscillator voltage at the emitter of the AF125 should be adjusted to 80 mV by means of C_1 at a battery voltage V_S = 4 V.

L_1 = 4.5 turns enamelled Cu wire (0.3 mm), wound between L_2.
L_2 = 4 turns enamelled Cu wire (1 mm), winding pitch 2 mm, inductance 0.18 μH, unloaded Q-factor 60 to 80.
L_3 = 3.25 turns silvered Cu wire (1 mm), winding pitch 2 mm, inductance 0.086 μH, unloaded Q-factor 200.
L_4 = 6 turns enamelled Cu wire (0.5 mm), closely wound, inductance 0.65 μH.
L_5 = 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.
L_6 = 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.

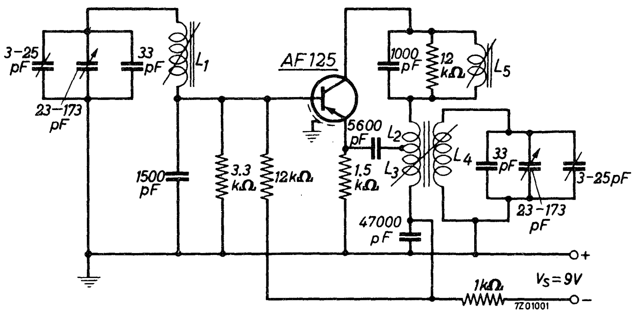
Frequency range	f		87 to 101	MHz
Collector current AF124	$-I_C$		1.4	mA
AF125	$-I_C$		1.5	mA
Total power gain	G_p	>	24	dB
		typ.	28	dB
Noise figure	F	typ.	8	dB
		<	9.5	dB
Oscillator voltage at aerial terminals		typ.	1.5	mV
Image rejection		typ.	27	dB

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

7Z3 1447

APPLICATION INFORMATION (continued)

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.

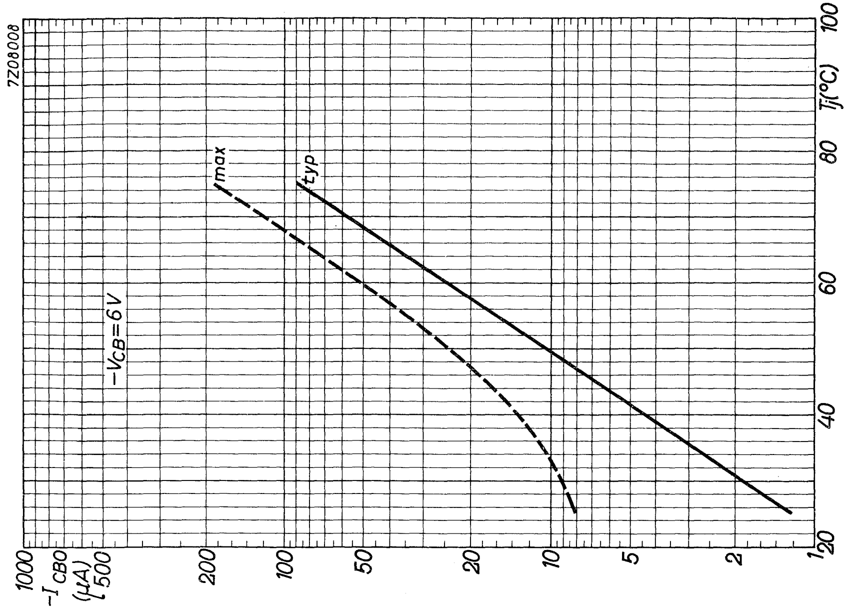
L_4 = 6.5 turns enamelled Cu wire (0.9 mm), closely wound on coil former with diameter of 7 mm; inductance 0.46 μH; unloaded Q-factor 110 at f = 15 MHz and f = 26 MHz

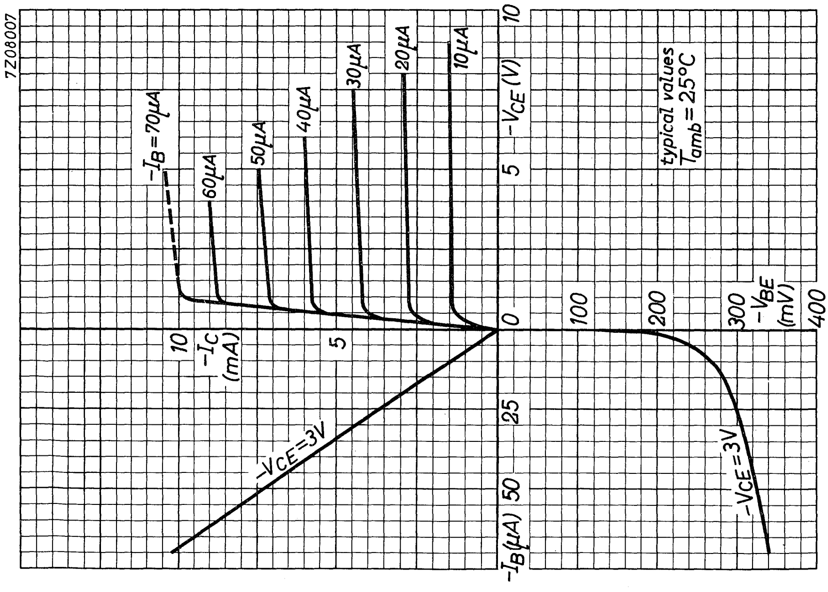
L_5 = Inductance 125 μH; unloaded Q-factor 140.

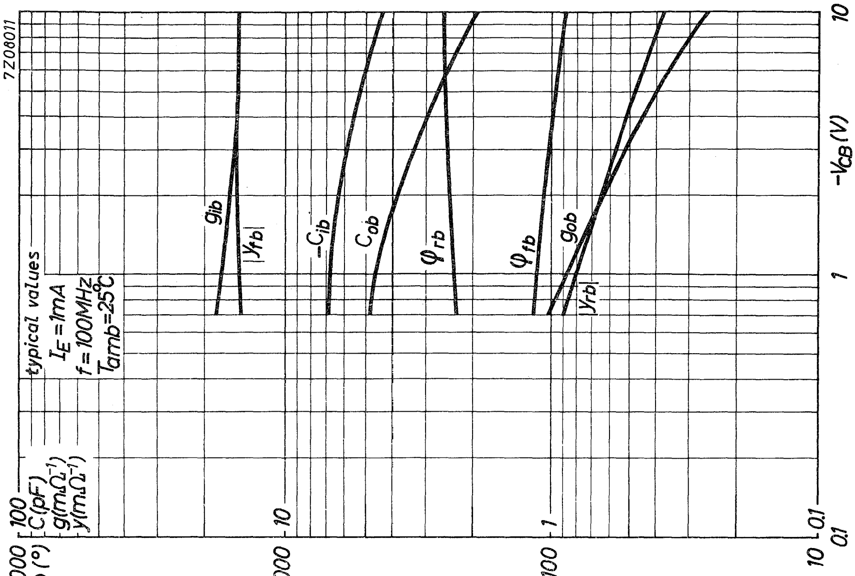
Battery voltage	V_S	=	9	V
Collector-emitter voltage	$-V_{CE}$	=	6	V
Emitter current	I_E	=	1	mA

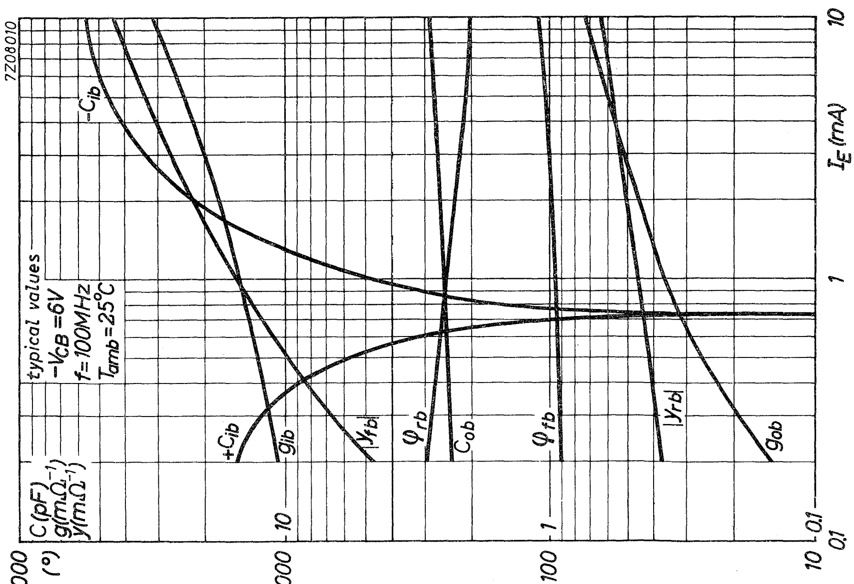
			f = 15	20	26	MHz
Oscillator voltage between emitter and earth	V_{osc}	typ.	0.11	0.14	0.15	V
Frequency shift by a battery voltage variation from 9 to 6 V	Δf_{osc}	typ.	3	2	10	kHz
Conversion gain, defined as the ratio between the i.f. power in a 10 kΩ load (the total i.f. impedance in the collector circuit)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

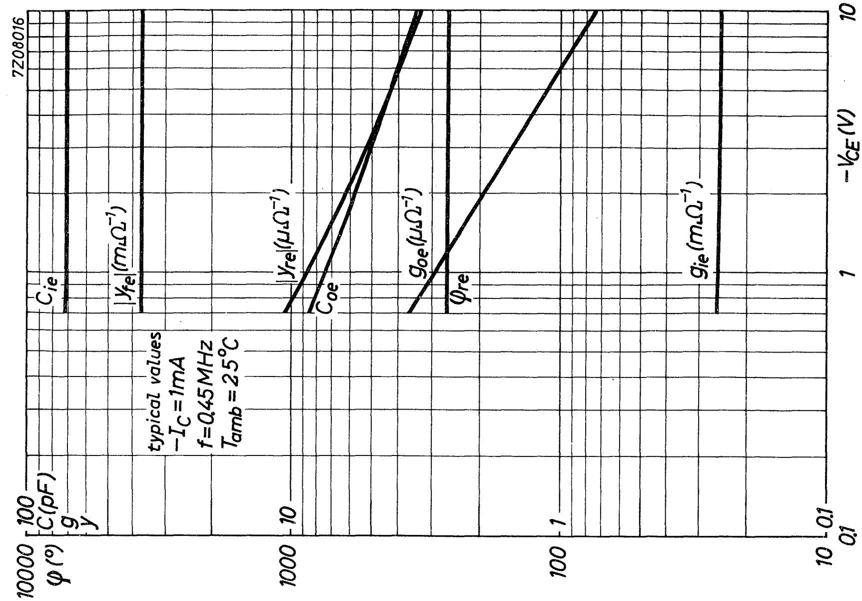
7Z3 1448

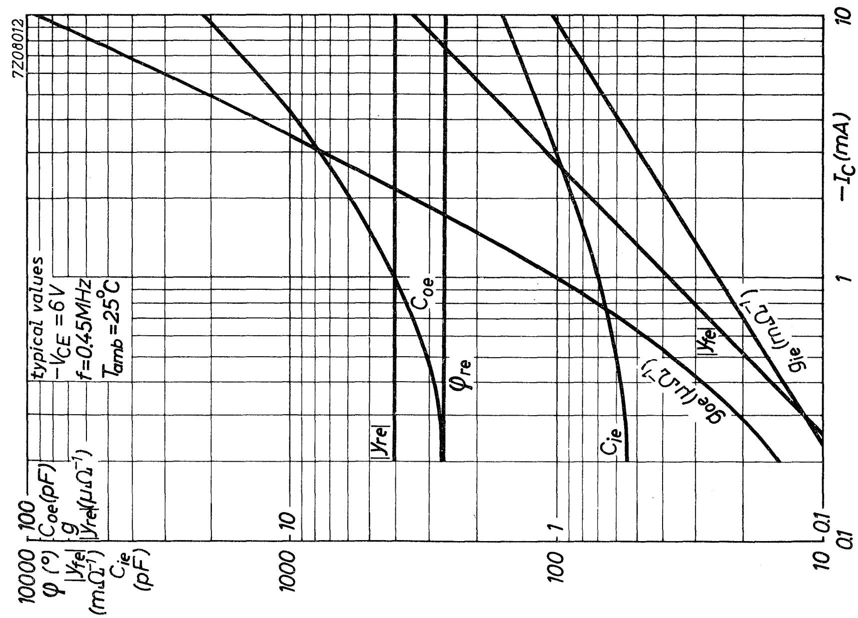

7Z08008
$-V_{CB}=6V$
max
typ
$-I_{CBO}$ (μA)
1000
500
200
100
50
20
10
5
2
1
T_j (°C)
20
40
60
80
100

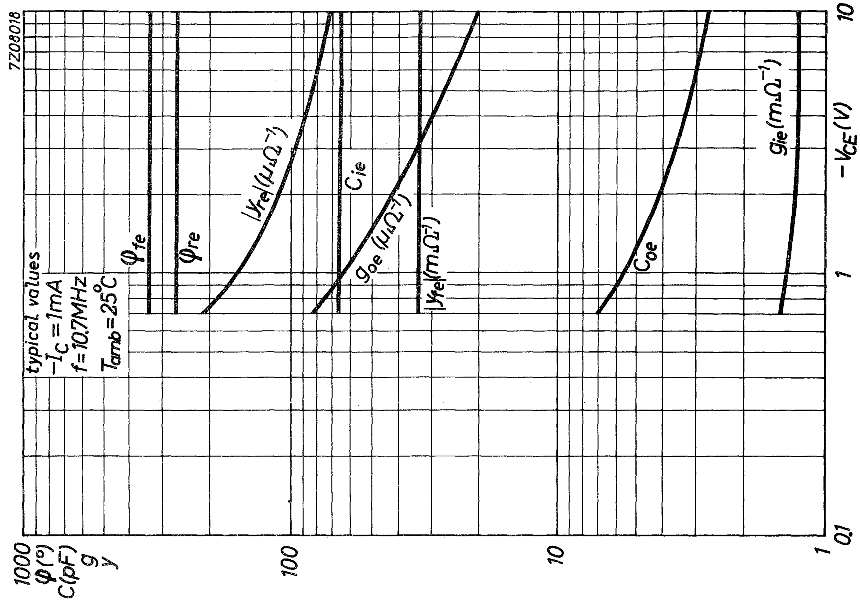

7Z08007
$-I_B=70\mu A$
$60\mu A$
$50\mu A$
$40\mu A$
$30\mu A$
$20\mu A$
$10\mu A$
$-V_{CE}$ (V)
0
5
10
typical values
$T_{amb}=25°C$
$-I_C$ (mA)
10
5
$-V_{CE}=3V$
25
50
$-I_B$ (μA)
$-V_{CE}=3V$
100
200
300
400
$-V_{BE}$ (mV)

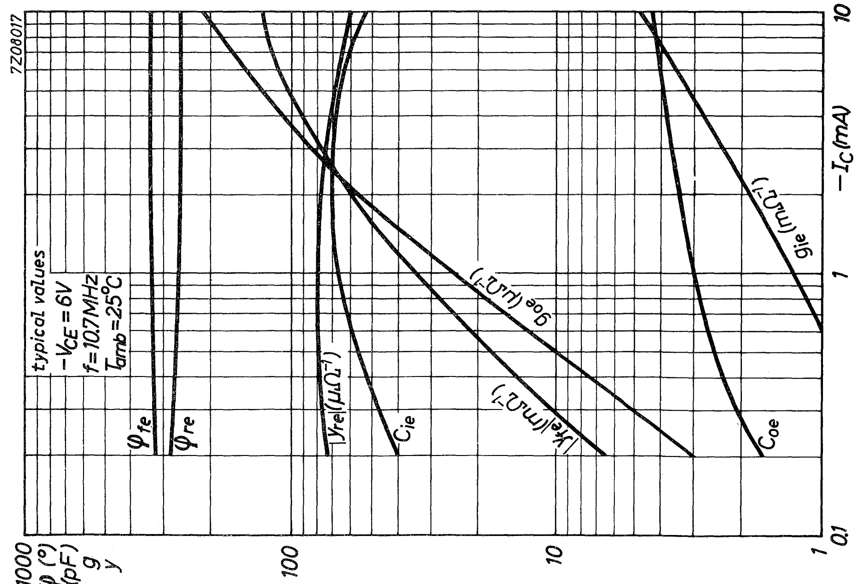

7Z08011
typical values
I_E = 1mA
f = 100MHz
T_{amb} = 25°C
10000
φ (°)
100
C (pF)
g(mΩ⁻¹)
y(mΩ⁻¹)
1000
10
100
1
10
0.1
0.1
1
10
$-V_{CB}$ (V)
g_{ib}
$|y_{fb}|$
$-C_{ib}$
C_{ob}
$φ_{rb}$
$φ_{fb}$
g_{ob}
$|y_{rb}|$

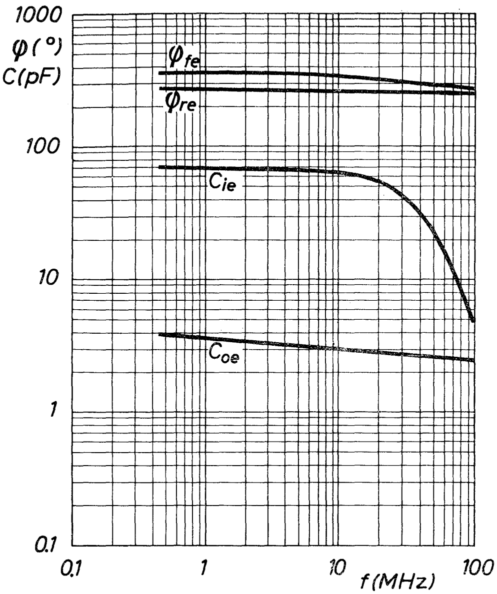

7Z08010
typical values
$-V_{CB}$ = 6V
f = 100MHz
T_{amb} = 25°C
10000
φ (°)
C (pF)
g(mΩ⁻¹)
y(mΩ⁻¹)
1000
10
100
1
10
0.1
0.1
1
10
I_E (mA)
$-C_{ib}$
$+C_{ib}$
g_{ib}
$|y_{fb}|$
$φ_{rb}$
C_{ob}
$φ_{fb}$
$|y_{rb}|$
g_{ob}

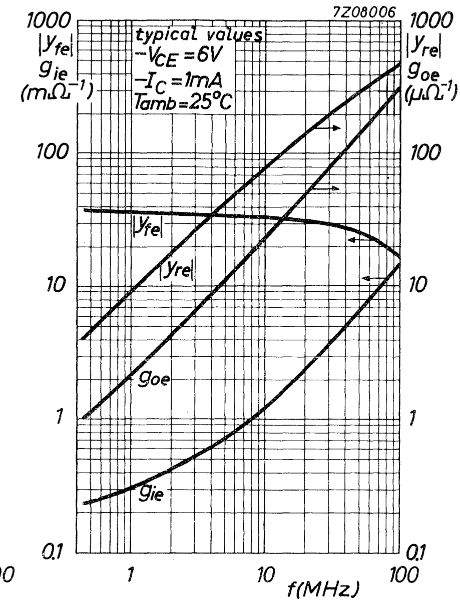

7Z08016
typical values
$-I_C = 1mA$
$f = 0.45MHz$
$T_{amb} = 25°C$
C_{ie}
$|y_{fe}| (m\Omega^{-1})$
$|y_{re}| (\mu\Omega^{-1})$
C_{oe}
$g_{oe} (\mu\Omega^{-1})$
φ_{re}
$g_{ie} (m\Omega^{-1})$
φ (°)
C (pF)
g
y
10000
1000
100
10
0.1
1
$-V_{CE}$ (V)

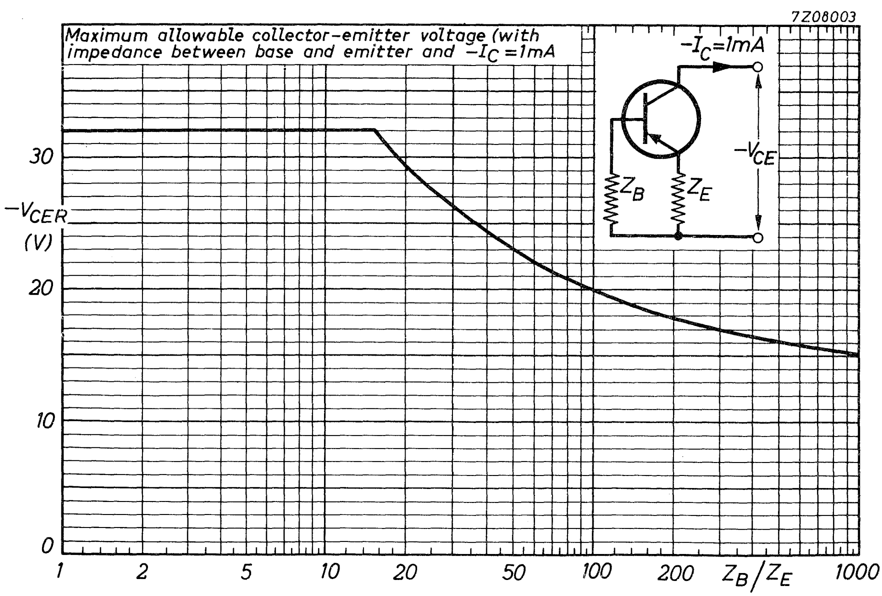

7Z08012
typical values
$-V_{CE} = 6V$
$f = 0.45MHz$
$T_{amb} = 25°C$
C_{oe}
φ_{re}
$|y_{re}|$
C_{ie}
$g_{oe} (\mu\Omega^{-1})$
$|y_{fe}|$
$g_{ie} (m\Omega^{-1})$
φ (°)
$|y_{fe}|$ $(m\Omega^{-1})$
C_{ie} (pF)
C_{oe} (pF)
g
$|y_{re}| (\mu\Omega^{-1})$
10000
1000
100
10
0.1
1
$-I_C$ (mA)


7Z08018
typical values
−I_C = 1mA
f = 10.7MHz
T_amb = 25°C
φ_fe
φ_re
|y_re| (μΩ⁻¹)
C_ie
g_oe (μΩ⁻¹)
|y_fe| (mΩ⁻¹)
C_oe
g_ie (mΩ⁻¹)
1000 φ(°) 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| (μΩ⁻¹)
C_ie
|y_fe| (mΩ⁻¹)
g_oe (μΩ⁻¹)
C_oe
g_ie (mΩ⁻¹)
1000 φ(°) C(pF) g y
100
10
1
0.1
1
10
−I_C (mA)


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


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


7Z08003
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 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])

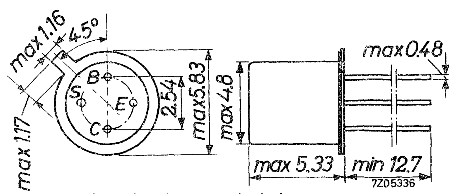
Collector-base voltage (open emitter)	$-V_{CBO}$	max.	32	V
Collector-emitter voltage ($Z_B/Z_E < 15$)	$-V_{CER}$	max.	32	V
Collector-emitter voltage (open base)	$-V_{CEO}$	max.	15	V
Collector current (d.c.)	$-I_C$	max.	10	mA
Base current (d.c.)	$\|I_B\|$	max.	1	mA
Reverse emitter current	$-I_E$	max.	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	$R_{th\ j\text{-}a}$	=	0.75	°C/mW
From junction to case	$R_{th\ j\text{-}c}$	=	0.4	°C/mW

MECHANICAL DATA

TO-72
insulated electrodes



S=Shield lead connected to case

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

7Z3 1449

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 (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	$\lvert y_{re}\rvert$	typ.	100	4.0	$\mu\Omega^{-1}$
Phase angle of feedback admittance	φ_{re}	typ.	260°	270°	
Transfer admittance	$\lvert y_{fe}\rvert$	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	$\lvert z_{rb}\rvert$	typ.	27	Ω

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

7Z3 1450

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

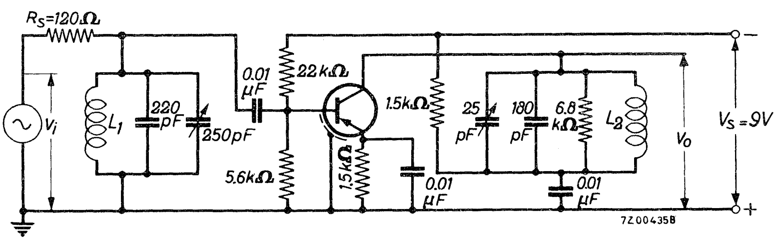
R_S = 500 Ω; f = 1 MHz	F_c	typ.	3	dB
		<	5	dB
R_S = 2 kΩ; f = 200 kHz	F_c	typ.	4	dB
		<	7	dB

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:

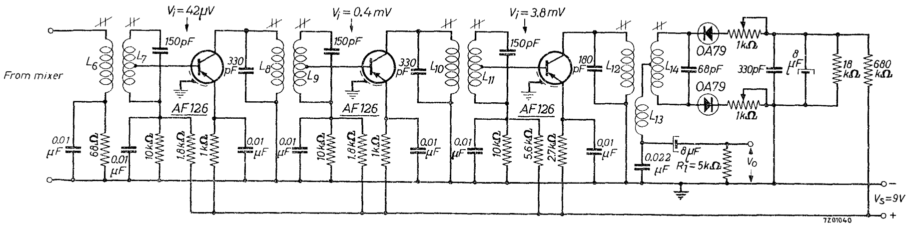


Total collector resistance R_l = 4.8 kΩ
L_1 = 0.5 μH; unloaded Q-factor 100
L_2 = 2.47 μH; unloaded Q-factor 100

7Z3 1451

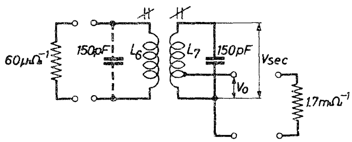
APPLICATION INFORMATION

I.F. amplifier for 10.7 MHz



Emitter current of each transistor $I_E = 1.0$ mA

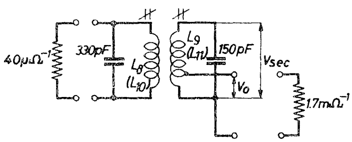
Coil data :



$L_6 = 1.4\ \mu H$; $Q_0 \geq 120$; $Q_L = 70$

$L_7 = 1.4\ \mu H$; $Q_0 \geq 110$; $Q_L = 92$

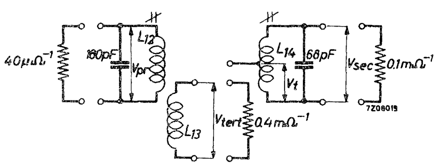
$kQ_L = 1.25 \qquad \frac{V_o}{V_{sec}} = 0.1$



$L_8 = L_{10} = 0.67\ \mu H$; $Q_0 \geq 110$; $Q_L = 92$

$L_9 = L_{11} = 1.4\ \mu H$; $Q_0 \geq 110$; $Q_L = 92$

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



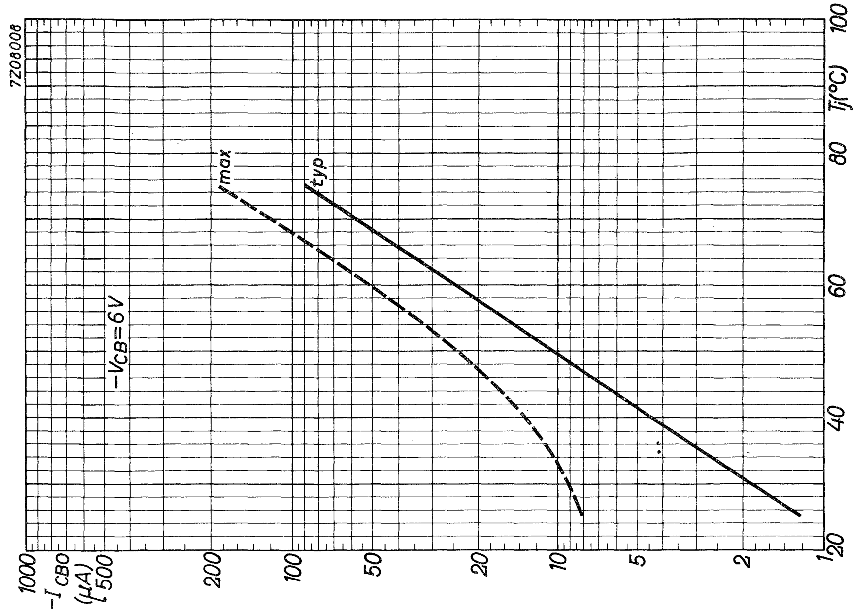
$L_{12} = 1.2\ \mu H$; $Q_0 = 90$

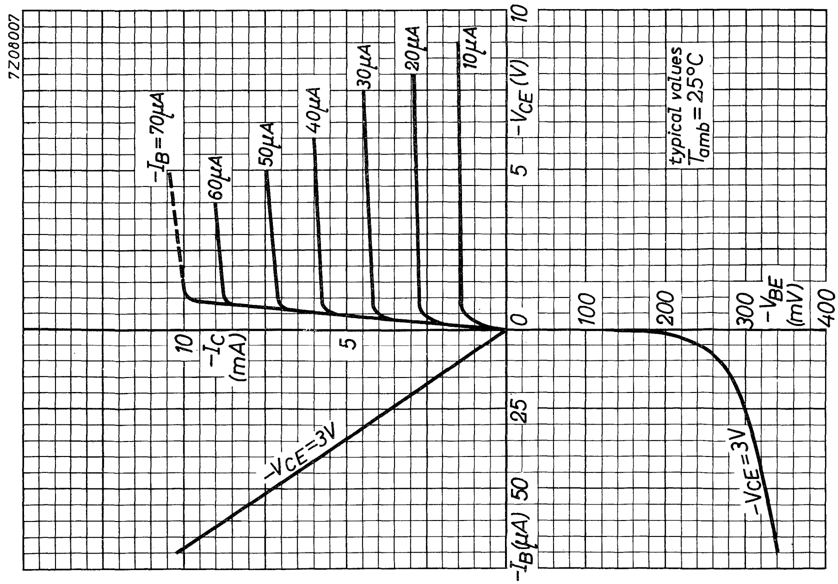
$L_{14} = 3.05\ \mu H$; $Q_0 = 90$ (bifilarly wound)

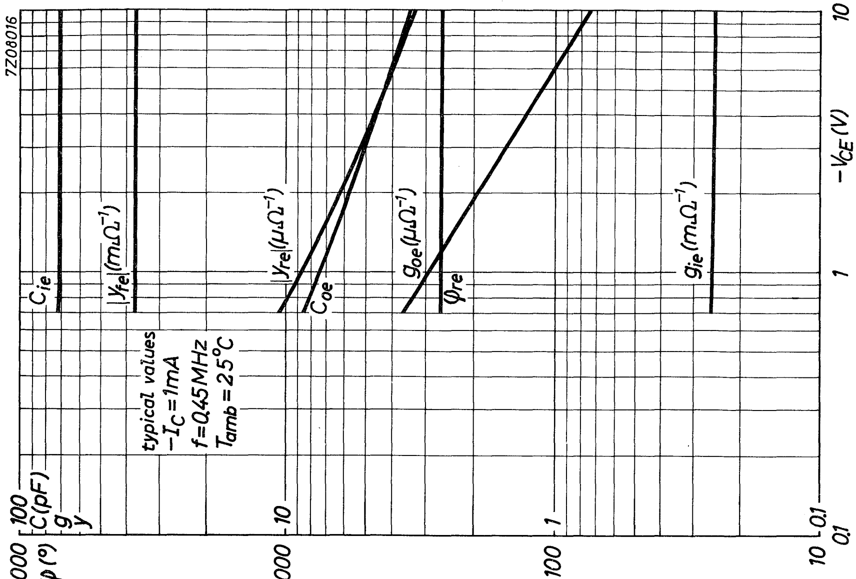
$kQ_L = 0.7$

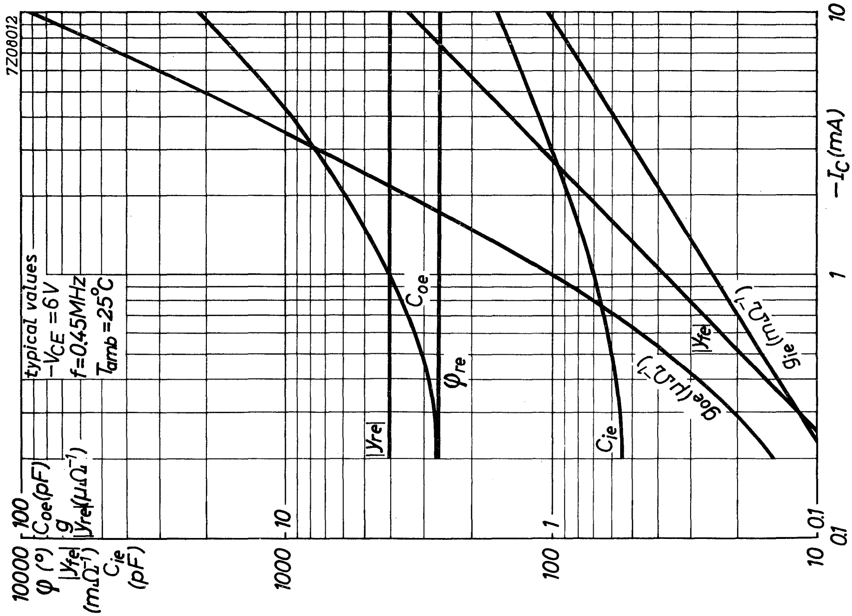
$\frac{V_{tert}}{V_{pr}} = 0.45; \frac{V_t}{V_{sec}} = 0.5$

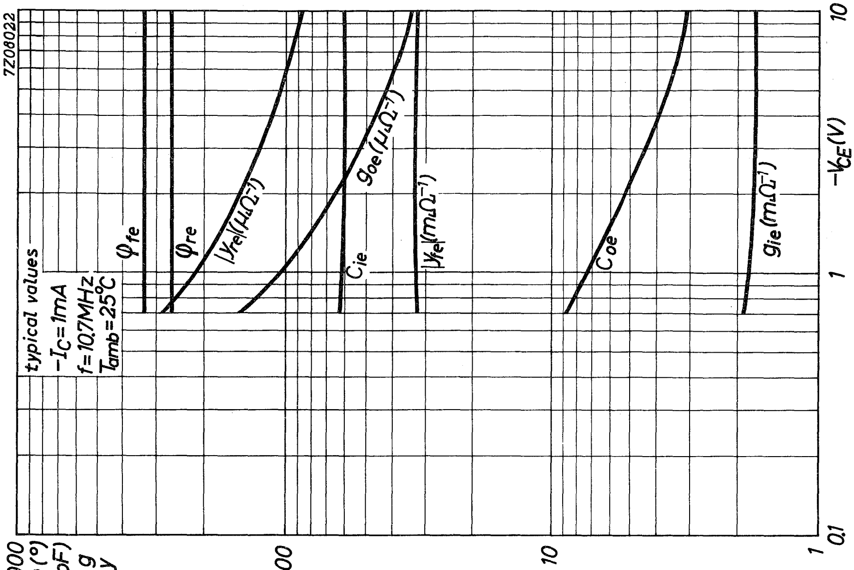
7Z3 1452

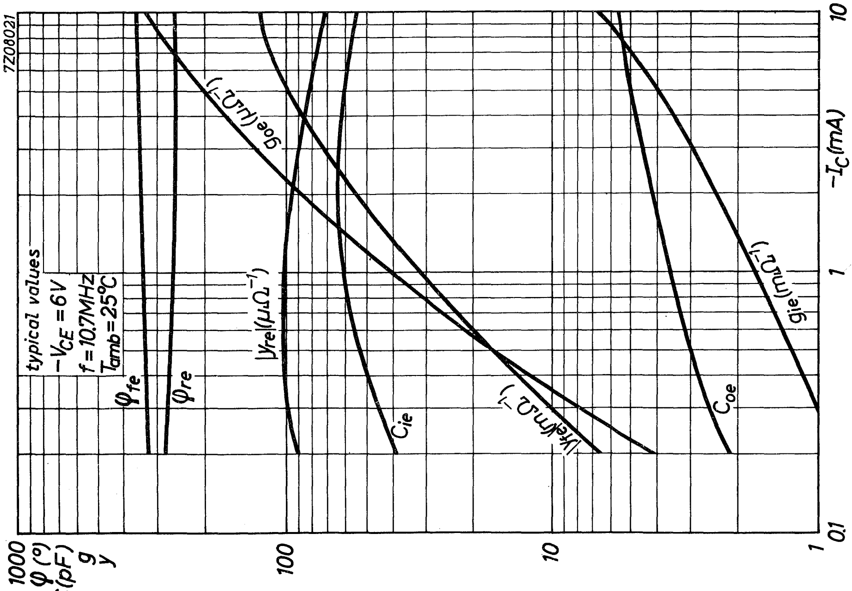

7Z08008
$-V_{CB}=6V$
max
typ
$-I_{CBO}$ (μA)
1000
500
200
100
50
20
10
5
2
1
T_j(°C)
20
40
60
80
100

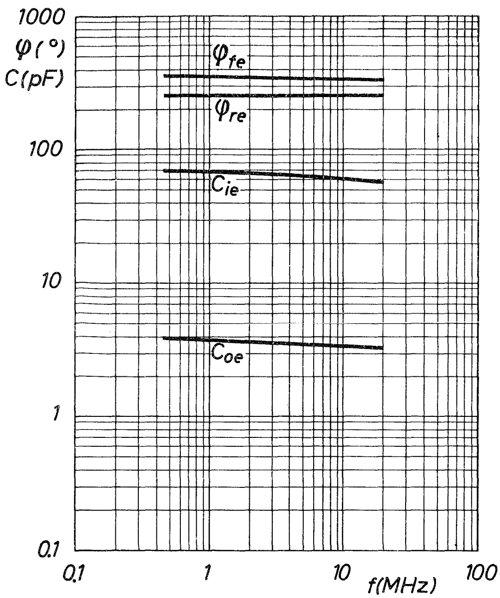

7Z08007
$-I_B=70\mu A$
60μA
50μA
40μA
30μA
20μA
10μA
$-V_{CE}$ (V)
0
5
10
$-I_C$ (mA)
10
5
typical values
$T_{amb}=25°C$
$-V_{CE}=3V$
$-V_{CE}=3V$
$-I_B$(μA)
25
50
$-V_{BE}$ (mV)
100
200
300
400

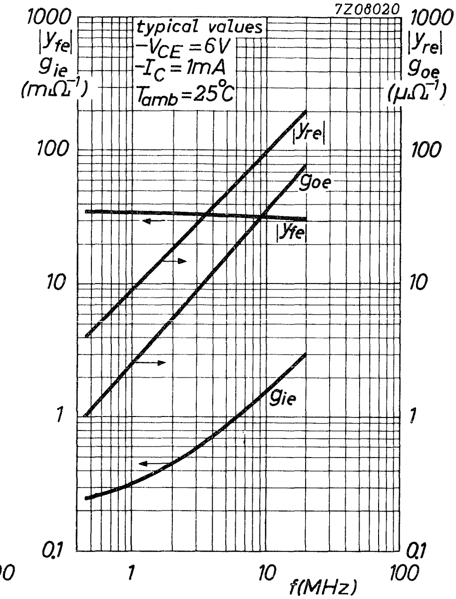

7Z08016
typical values
−I_C = 1mA
f = 0.45MHz
T_amb = 25°C
10000 φ (°)
100 C (pF) g y
1000
10
100
1
10
0.1
0.1
1
10
−V_CE (V)
C_ie
|y_fe| (mΩ⁻¹)
|y_re| (μΩ⁻¹)
C_oe
g_oe (μΩ⁻¹)
φ_re
g_ie (mΩ⁻¹)

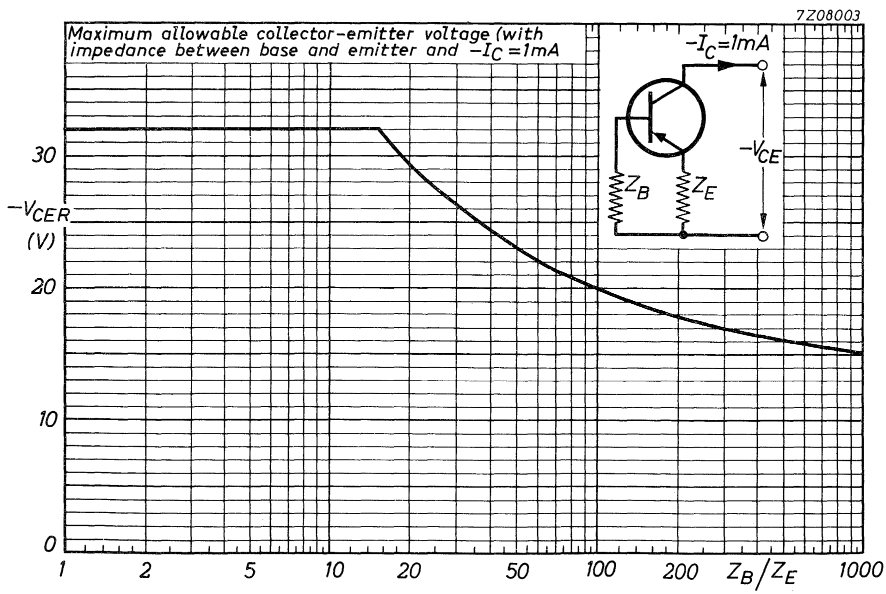

7Z08012
typical values
−V_CE = 6V
f = 0.45MHz
T_amb = 25°C
10000 φ (°) |y_fe| (mΩ⁻¹) C_ie (pF)
100 C_oe (pF) g |y_re| (μΩ⁻¹)
1000
10
100
1
10
0.1
0.1
1
10
−I_C (mA)
C_oe
φ_re
|y_re|
C_ie
g_oe (μΩ⁻¹)
|y_fe|
g_ie (mΩ⁻¹)


7Z08022
typical values
−IC=1mA
f=10.7MHz
Tamb=25°C
φfe
φre
|yre|(μΩ−1)
goe(μΩ−1)
Cie
|yfe|(mΩ−1)
Coe
gie(mΩ−1)
1000
φ(°)
C(pF)
g
y
100
10
1
0.1
1
10
−VCE(V)


7Z08021
typical values
−VCE=6V
f=10.7MHz
Tamb=25°C
φfe
φre
|yre|(μΩ−1)
goe(μΩ−1)
Cie
|yfe|(mΩ−1)
Coe
gie(mΩ−1)
1000
φ(°)
C(pF)
g
y
100
10
1
0.1
1
10
−IC(mA)


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


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


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

GERMANIUM ALLOY DIFFUSED TRANSISTOR

P-N-Ptransistor 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])

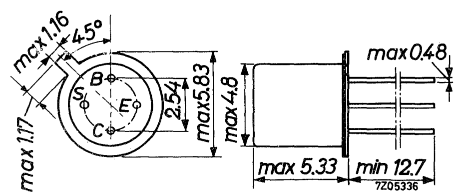
Collector-base voltage (open emitter)	$-V_{CBO}$	max.	32	V
Collector-emitter voltage ($Z_B/Z_E < 15$)	$-V_{CER}$	max.	32	V
Collector-emitter voltage (open base)	$-V_{CEO}$	max.	15	V
Collector current (d.c.)	$-I_C$	max.	10	mA
Base current (d.c.)	$\|I_B\|$	max.	1	mA
Reverse emitter current	$-I_E$	max.	1	mA
Total power dissipation up to T_{amb} = 45 °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

TO-72
insulated electrodes



S=Shield lead connected to case

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

7Z3 1453

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	$\|y_{re}\|$	typ.	4.0	$\mu\Omega^{-1}$
Phase angle of feedback admittance	φ_{re}	typ.	270°	
Transfer admittance	$\|y_{fe}\|$	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	$\|z_{rb}\|$	typ.	35	Ω

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

7Z3 1454

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

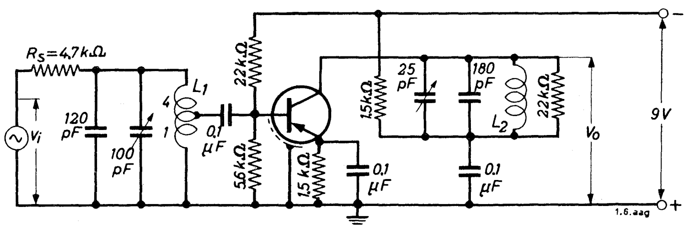
R_S = 500 Ω; f = 1 MHz	F_c	typ.	3	dB
		<	5	dB
R_S = 2 kΩ; f = 200 kHz	F_c	typ.	4	dB
		<	7	dB

Power gain at f = 0.45 MHz

$$G_p = \frac{V_o^2}{V_i^2} \cdot \frac{4 R_S}{R_l} = 0.94 \frac{V_o^2}{V_i^2}$$

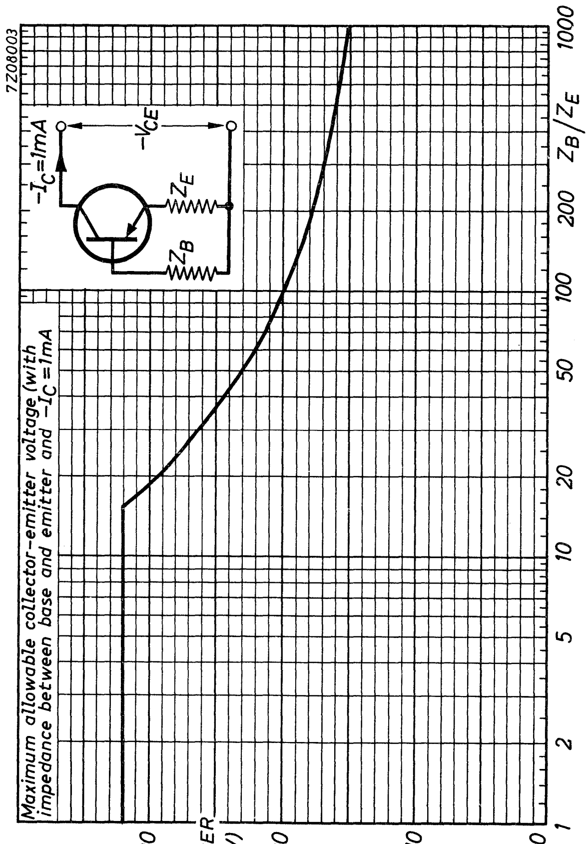
G_p	>	40	dB
	typ.	42	dB

Test circuit :

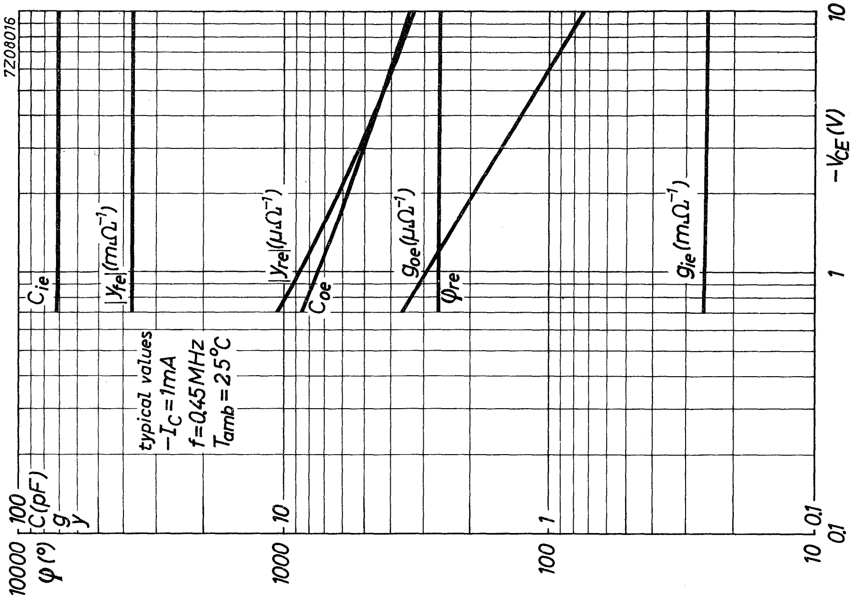


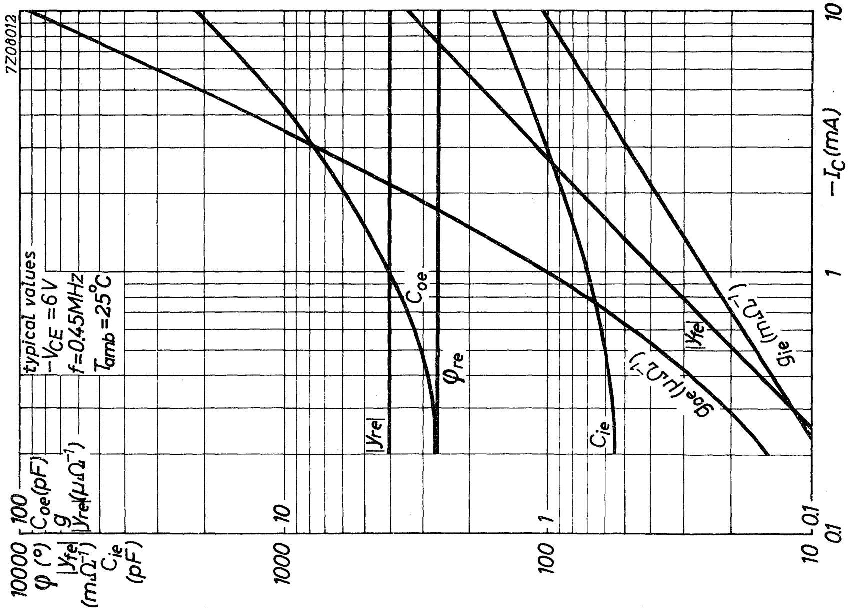
Total collector resistance R_l = 20 kΩ
L_1 = 625 μH; unloaded Q-factor 140; tap at 0.2
L_2 = 625 μH; unloaded Q-factor 140

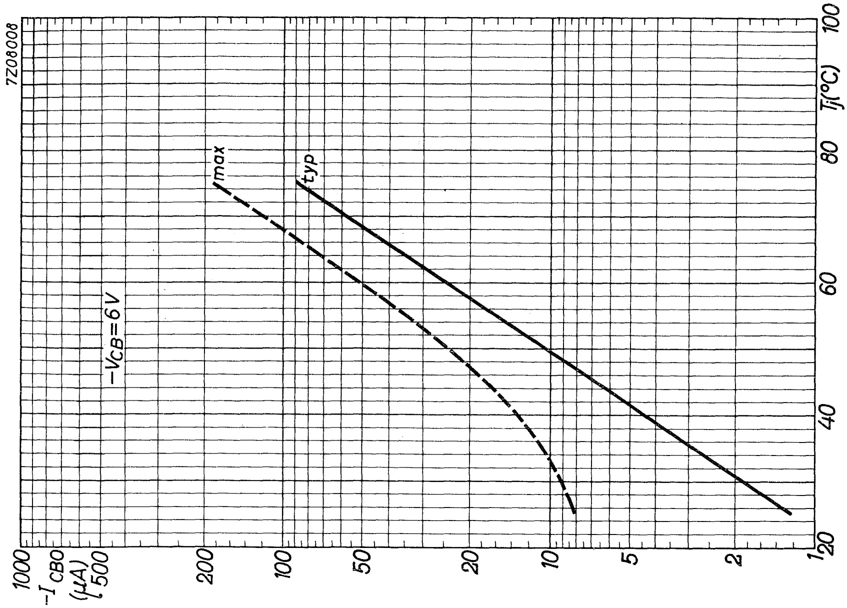
7Z3 1455

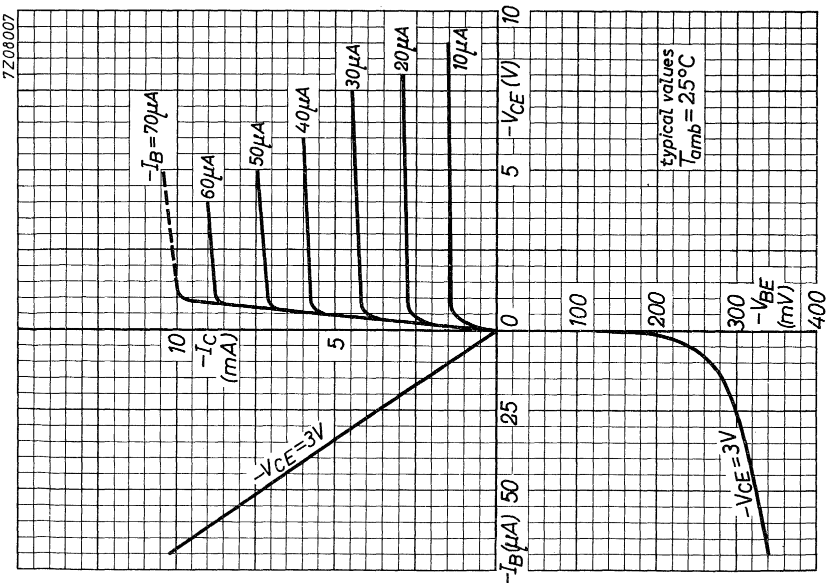


Maximum allowable collector-emitter voltage (with impedance between base and emitter and −I_C=1mA
7Z08003
−I_C=1mA
−V_CE
Z_E
Z_B
−V_CER (V)
30
20
10
0
Z_B/Z_E
1
2
5
10
20
50
100
200
1000


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


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


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


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

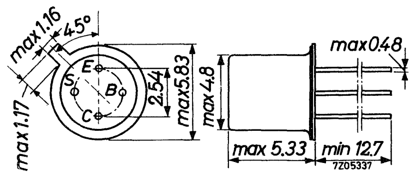
U.H.F. GERMANIUM MESA TRANSISTOR

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



S=Shield lead connected to case

7Z3 0413

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.

7Z3 0048

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

7Z3 0049

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

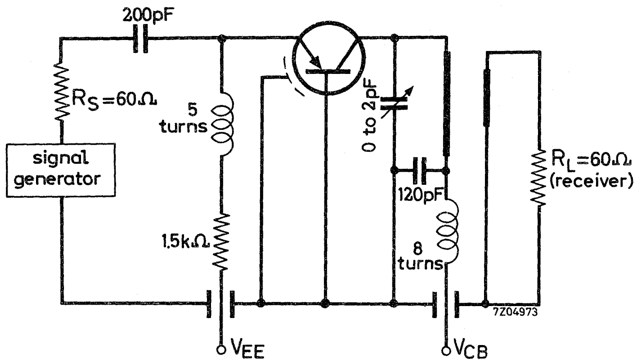
[1]) Measured with a lead length of 5 mm.

7Z3 0050

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

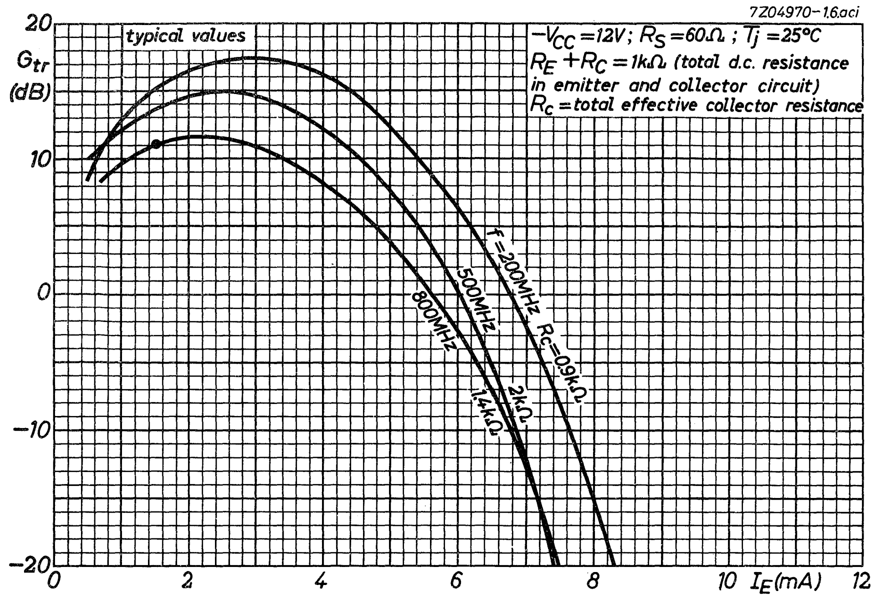
f = 800 MHz	G_{tr}	>	9	dB
		typ.	11	dB
f = 860 MHz	G_{tr}	>	7.5	dB
		typ.	10	dB

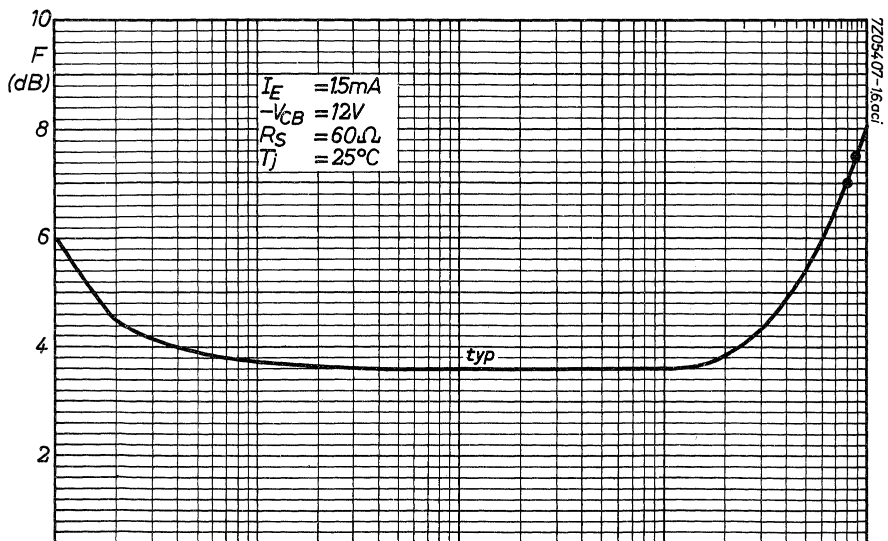
Reverse transducer gain

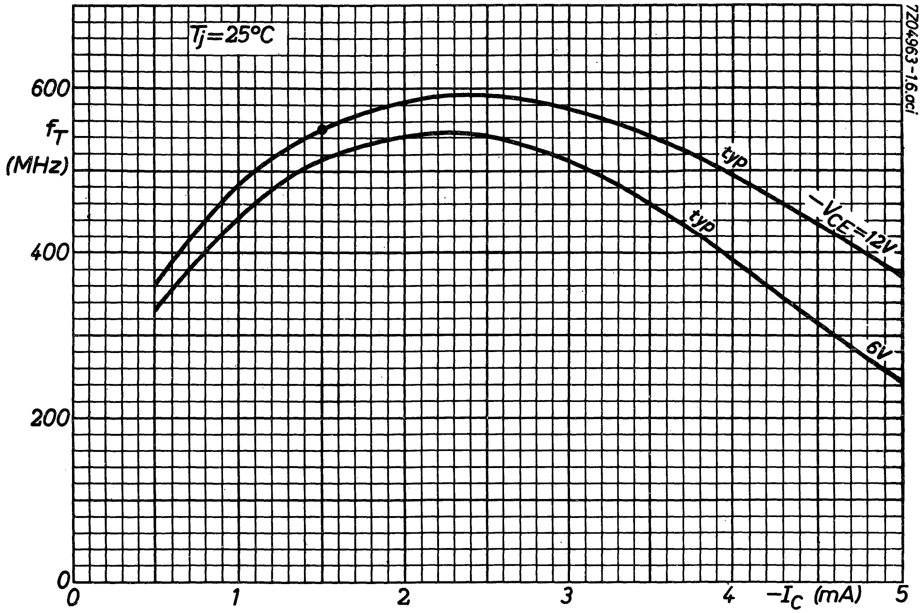
I_E = 1.5 mA; $-V_{CB}$ = 12 V; f = 800 MHz $G_{tr\ rev}$ typ. −23 dB

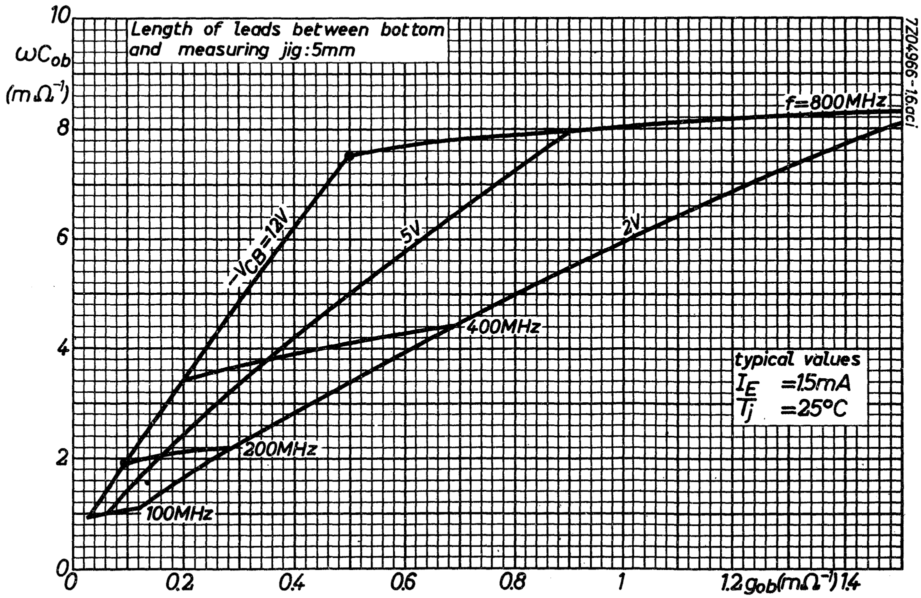
The reverse transducer gain is measured in the above circuit, with the source and the load resistance interchanged.

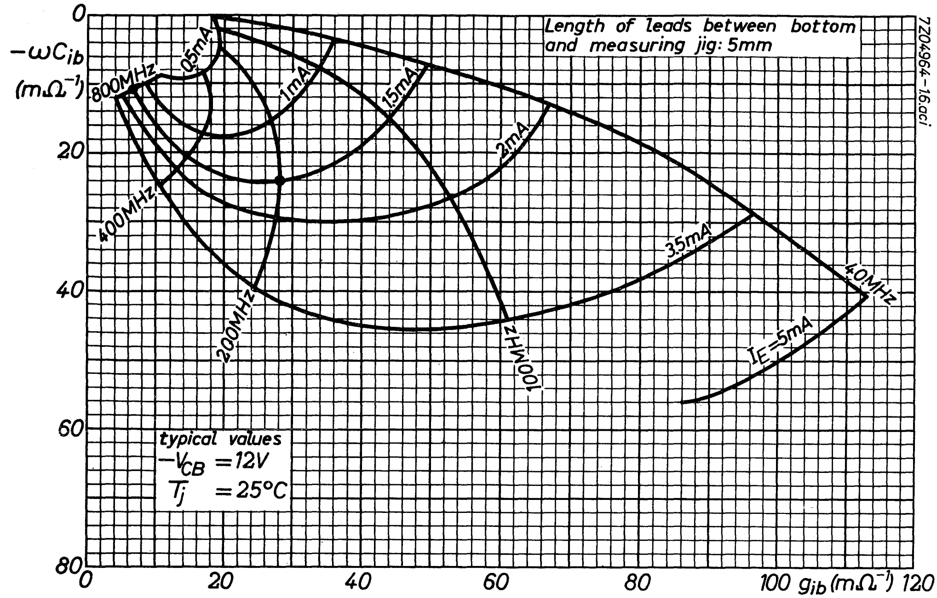
7Z3 0053

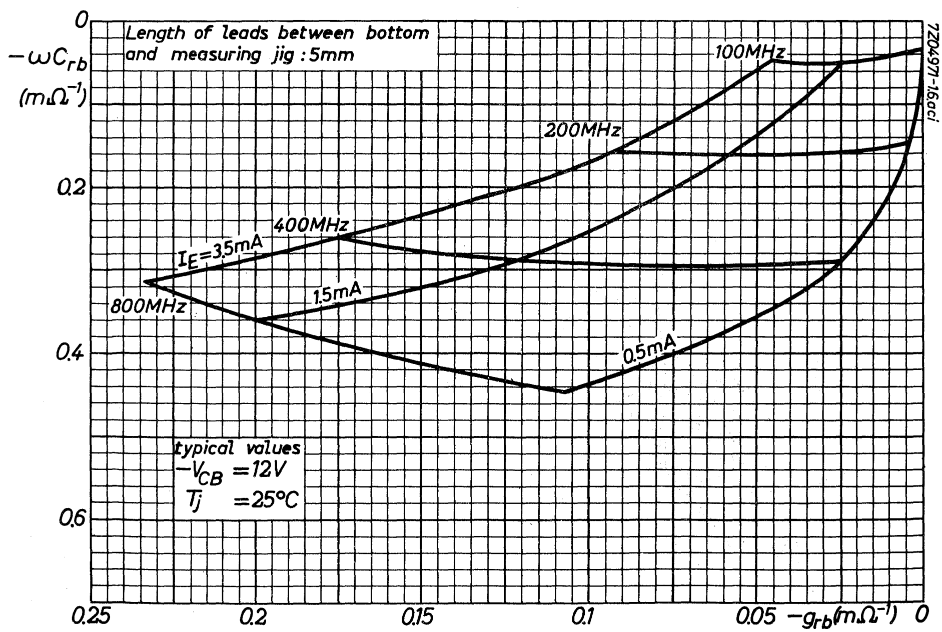

7Z04970-1.6.aci
typical values
$-V_{CC}$ = 12V; R_S = 60Ω ; T_j = 25°C
$R_E + R_C$ = 1kΩ (total d.c. resistance in emitter and collector circuit)
R_c = total effective collector resistance
G_{tr} (dB)
f = 200MHz R_c = 0.9kΩ
500MHz
2kΩ
800MHz
1.4kΩ
I_E (mA)
20
10
0
−10
−20
0
2
4
6
8
10
12

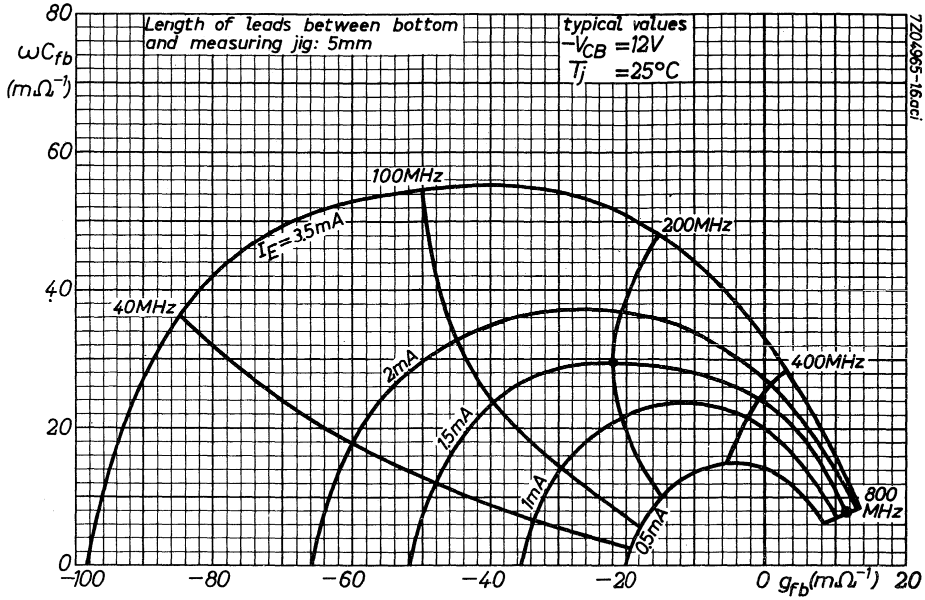

7Z05407-1.6.aci
I_E = 1.5mA
$-V_{CB}$ = 12V
R_S = 60Ω
T_j = 25°C
F (dB)
typ
f (MHz)
10
8
6
4
2
0
0.1
1
10
100
1000

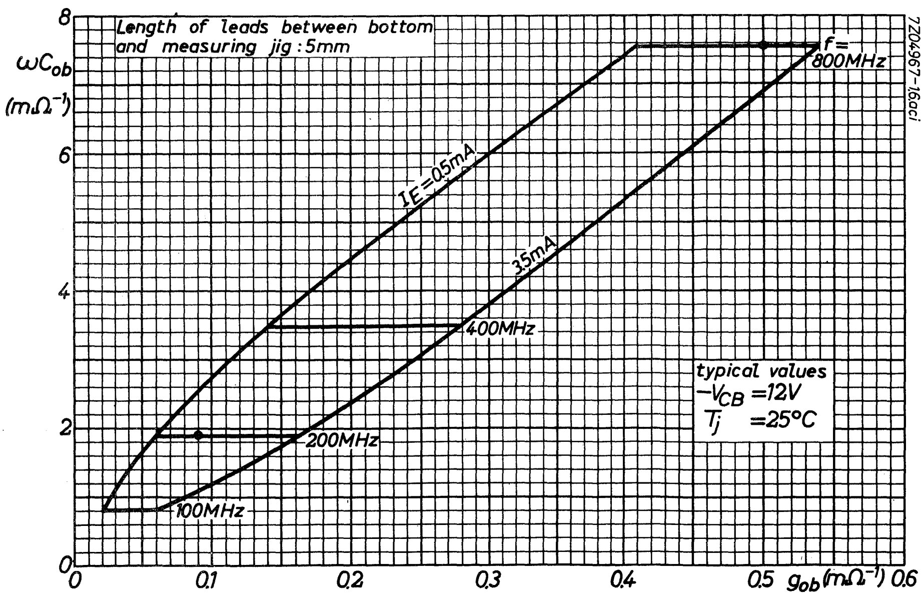

Tj=25°C
600
400
200
0
fT
(MHz)
typ
typ
−VCE=12V
6V
0
1
2
3
4
−IC (mA)
5
7Z04963-1.6.aci

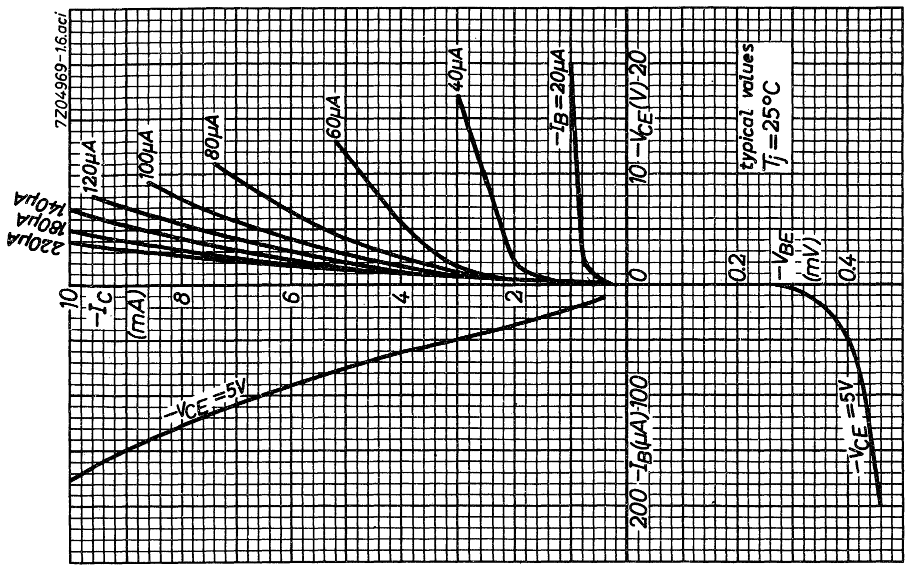

Length of leads between bottom
and measuring jig:5mm
10
ωCob
(mΩ-1)
8
6
4
2
0
f=800MHz
−VCB=12V
5V
2V
400MHz
200MHz
100MHz
typical values
IE =1.5mA
Tj =25°C
0
0.2
0.4
0.6
0.8
1
1.2 gob(mΩ-1) 1.4
7Z04966-1.6.aci

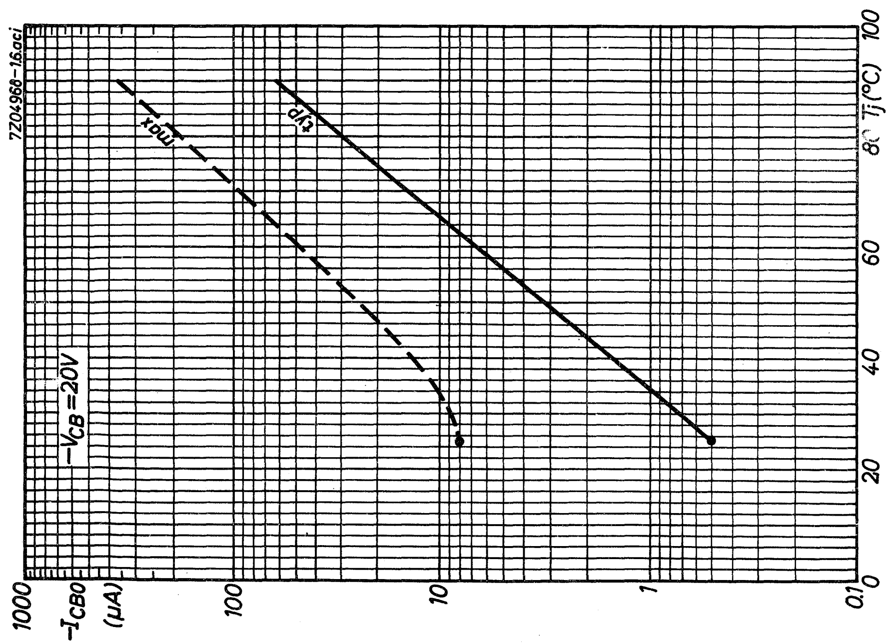

Length of leads between bottom and measuring jig: 5mm
7Z04964-1.6.aci
$-\omega C_{ib}$ ($m\Omega^{-1}$)
800MHz
0.5mA
1mA
1.5mA
2mA
400MHz
200MHz
100MHz
3.5mA
40MHz
I_E=5mA
typical values
$-V_{CB}$ = 12V
T_j = 25°C
0
20
40
60
80
100
120
g_{ib} ($m\Omega^{-1}$)


Length of leads between bottom and measuring jig: 5mm
7Z04971-1.6.aci
$-\omega C_{rb}$ ($m\Omega^{-1}$)
100MHz
200MHz
400MHz
I_E=3.5mA
1.5mA
800MHz
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
$-g_{rb}$ ($m\Omega^{-1}$)


80
ωCfb
(mΩ⁻¹)
60
40
20
0
−100
−80
−60
−40
−20
0 gfb(mΩ⁻¹) 20
Length of leads between bottom
and measuring jig: 5mm
typical values
−VCB =12V
Tj =25°C
7Z04965-16.aci
100MHz
200MHz
IE=3.5mA
40MHz
2mA
1.5mA
1mA
0.5mA
400MHz
800
MHz


8
ωCob
(mΩ⁻¹)
6
4
2
0
0
0.1
0.2
0.3
0.4
0.5 gob(mΩ⁻¹) 0.6
Length of leads between bottom
and measuring jig : 5mm
7Z04967-16.aci
f=
800MHz
IE=0.5mA
3.5mA
400MHz
200MHz
100MHz
typical values
−VCB =12V
Tj =25°C


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


7Z04968-1.6.aci
$-V_{CB} = 20V$
$-I_{CB0}$ (µA)
T_j (°C)
max
typ
1000
100
10
1
0.1
0
20
40
60
80
100

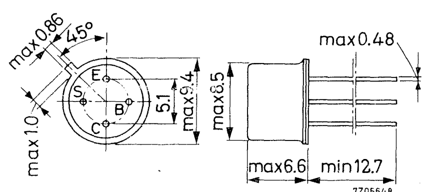
R.F. GERMANIUM ALLOY DIFFUSED TRANSISTOR

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.

QUICK REFERENCE DATA				
Collector-base voltage (open emitter)	$-V_{CBO}$	max.	25	V
Collector current (d.c.)	$-I_C$	max.	10	mA
Total power dissipation up to T_{amb} = 45 °C	P_{tot}	max.	75	mW
Junction temperature	T_j	max.	75	°C
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

MECHANICAL DATA Dimensions in mm

TO-12



S = Shield lead connected to case

7Z3 1429

RATINGS (Limiting values) [1]

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
Base current (d.c.)	$-I_B$	max.	1	mA
Reverse emitter current	$-I_E$	max.	1	mA

Power dissipation

Total power dissipation up to T_{amb} = 45 °C	P_{tot}	max.	75	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	$R_{th\ j\text{-}a}$	=	0.6	°C/mW

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

7Z3 1430

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

7Z3 1431

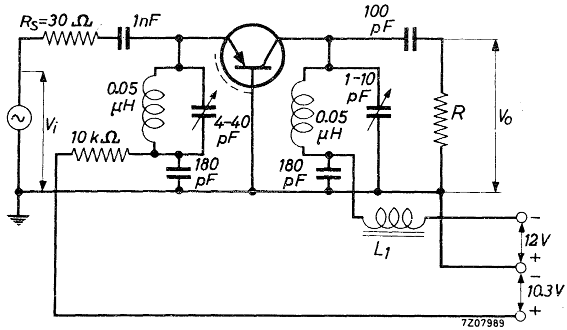
CHARACTERISTICS (continued)

Power gain at f = 200 MHz

$$G_p = \frac{V_o^2}{V_i^2} \cdot \frac{4\,R_S}{R_L} = 0.06\,\frac{V_o^2}{V_i^2}$$

G_p	>	10	dB
	typ.	13	dB

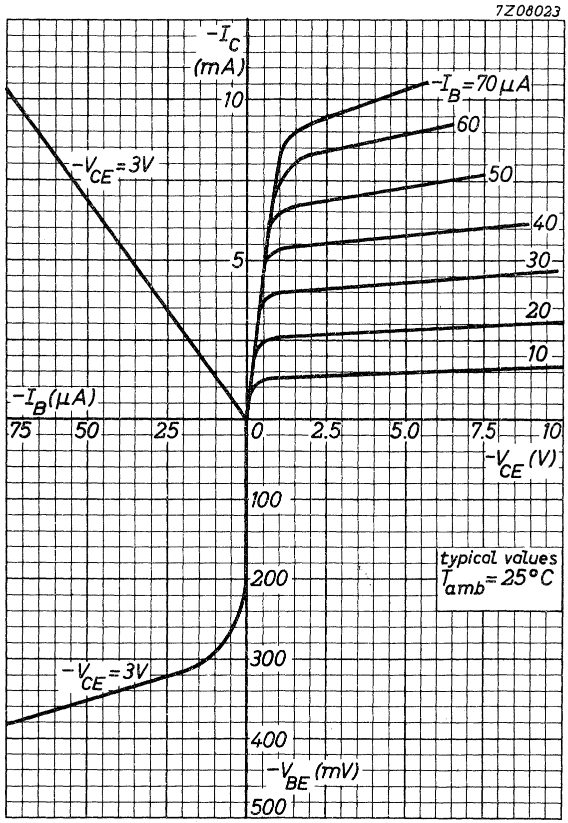
Basic circuit for measuring the power gain



The resistor R is chosen such that the total load impedance R_L = 2.0 kΩ, consisting of R and the tuned circuit in parallel.

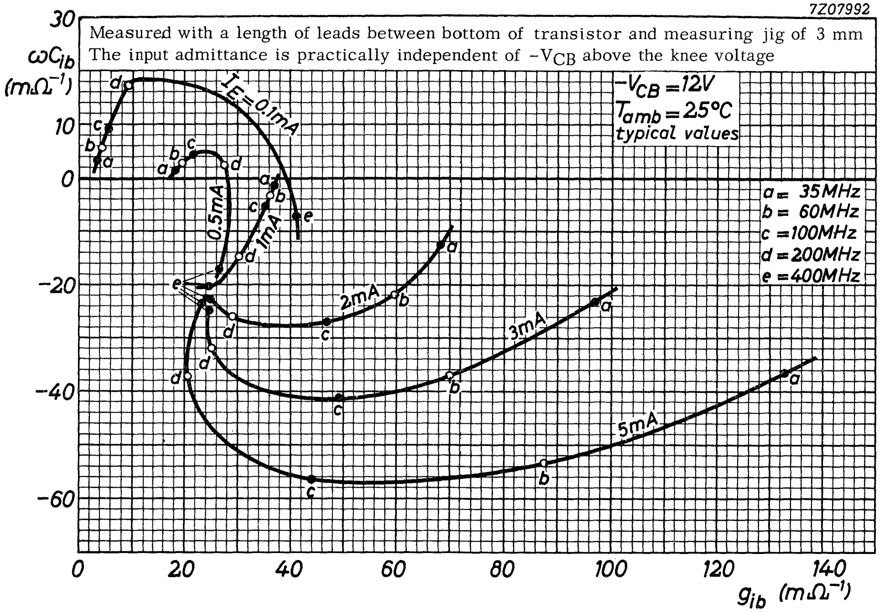
L = ferrite bead.

7Z3 1432


7Z08023
$-I_C$ (mA)
10
5
$-I_B$=70 μA
60
50
40
30
20
10
$-V_{CE}$=3V
$-I_B$ (μA)
75
50
25
0
2.5
5.0
7.5
10
$-V_{CE}$ (V)
100
200
300
400
500
$-V_{BE}$ (mV)
$-V_{CE}$=3V
typical values
T_{amb}= 25°C

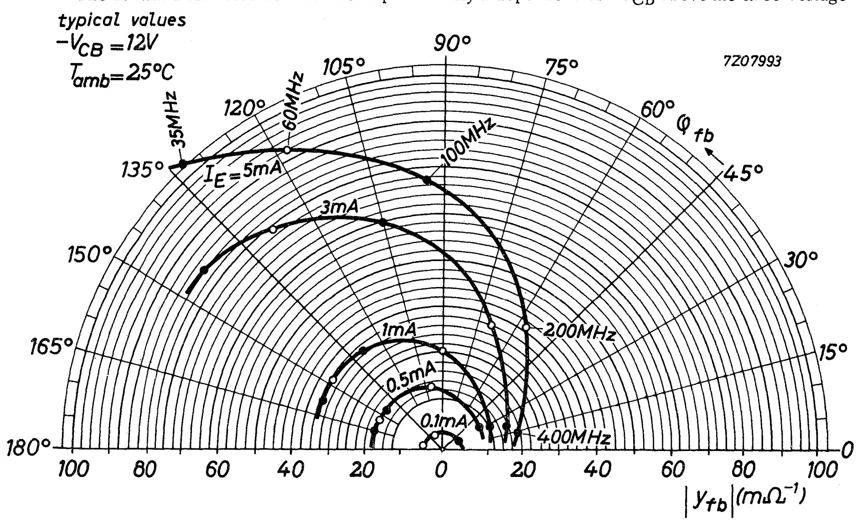
7Z07992

Measured with a length of leads between bottom of transistor and measuring jig of 3 mm
The input admittance is practically independent of $-V_{CB}$ above the knee voltage

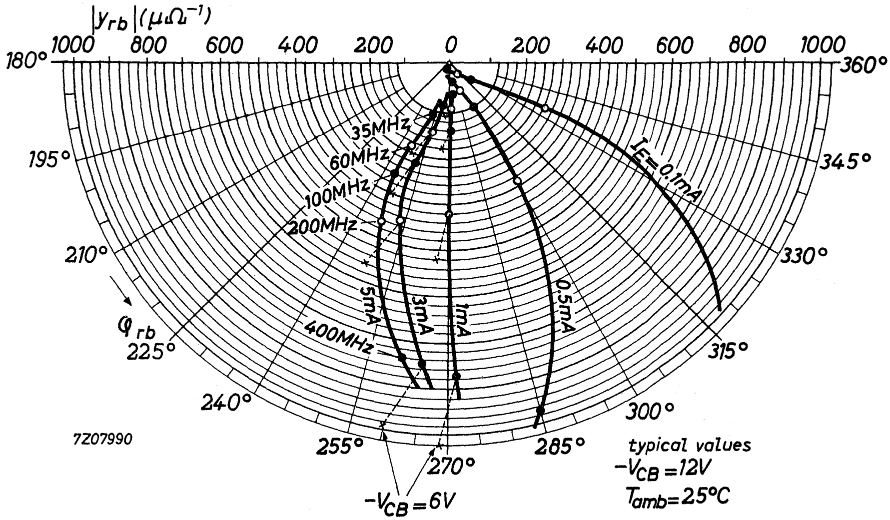


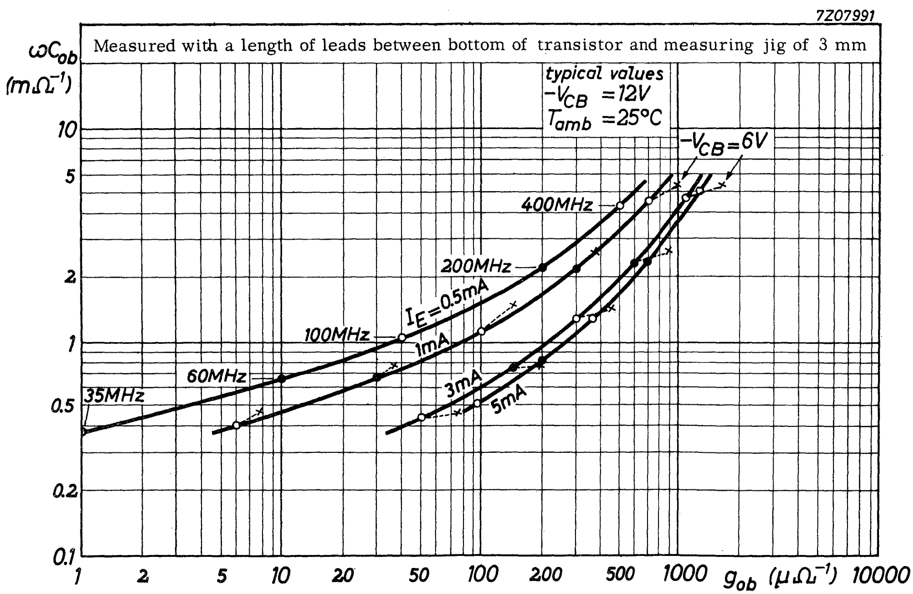
Measured with a length of leads between bottom of transistor and measuring jig of 3 mm
The forward transfer admittance is practically independent of $-V_{CB}$ above the knee voltage

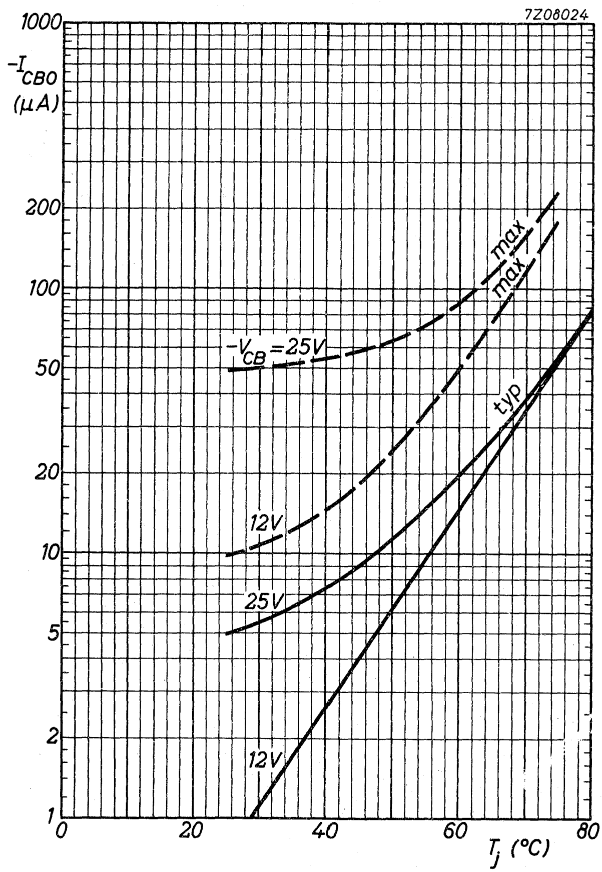
7Z07993



Measured with a length of leads between bottom of transistor and measuring jig of 3 mm






7Z08024
1000
$-I_{CBO}$
(μA)
200
100
50
20
10
5
2
1
0
20
40
60
80
T_j (°C)
max
max
$-V_{CB}$ = 25V
12V
typ
25V
12V

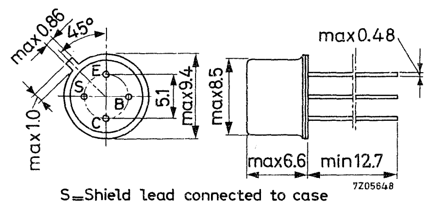
R.F. GERMANIUM ALLOY-DIFFUSED TRANSISTOR

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.

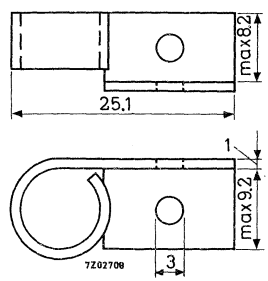
QUICK REFERENCE DATA				
Collector-base voltage (open emitter)	$-V_{CBO}$	max.	25	V
Collector-emitter voltage $R_B/R_E \leq 100$; $R_E \geq 200\ \Omega$	$-V_{CER}$	max.	25	V
Collector current (peak value)	$-I_{CM}$	max.	15	mA
Total power dissipation up to $T_{amb} = 45\,^oC$	P_{tot}	max.	180	mW
Junction 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.	480	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	$\|y_{fe}\|$	typ.	80	$m\Omega^{-1}$

MECHANICAL DATA Dimensions in mm

TO-12



S=Shield lead connected to case



Type number of cooling fin and mounting clip 56265

7Z3 0575

RATINGS (Limiting values) [1])

Voltages

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

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 $T_{amb} = 45\,^oC$ with cooling clip 56265	P_{tot}	max.	180	mW

Temperatures

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	$^oC/mW$

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

7Z3 0576

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

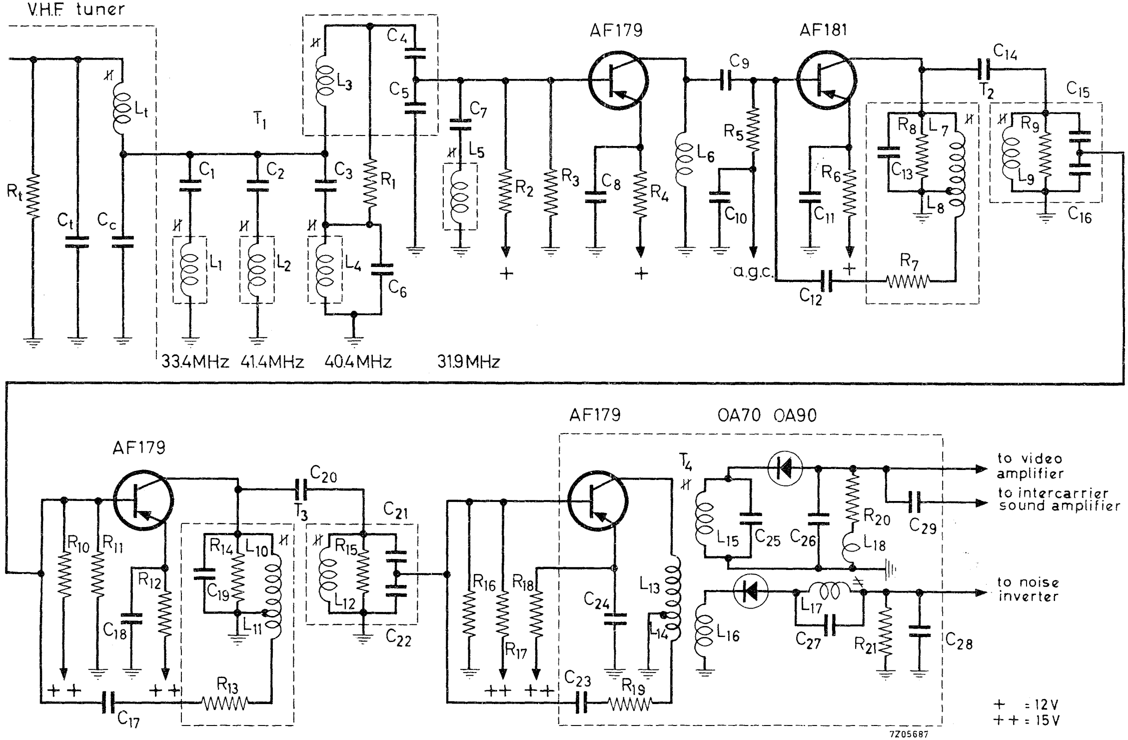
[1] 1 fF = 1 femtofarad = 10^{-15} F

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

7Z3 0577

APPLICATION INFORMATION

Four-stage vision i.f. amplifier



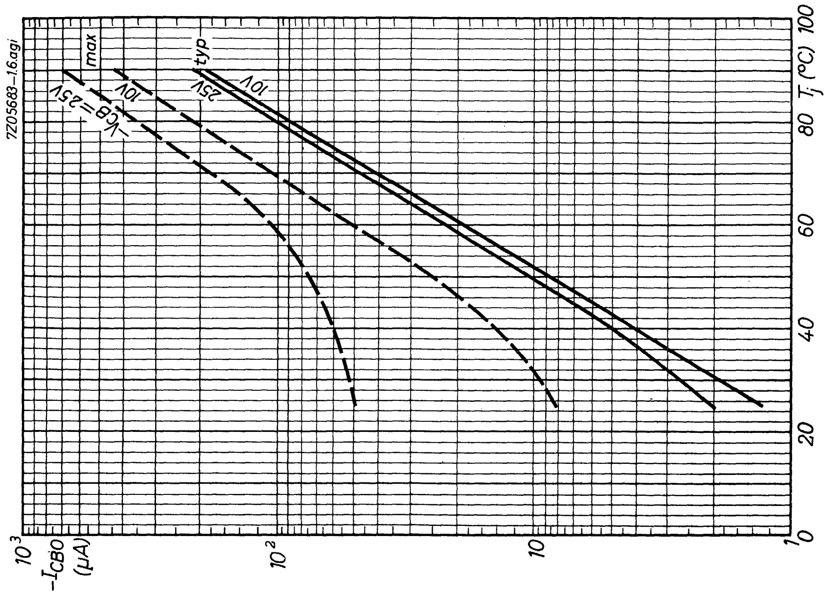
7Z3 0578

APPLICATION INFORMATION (continued)

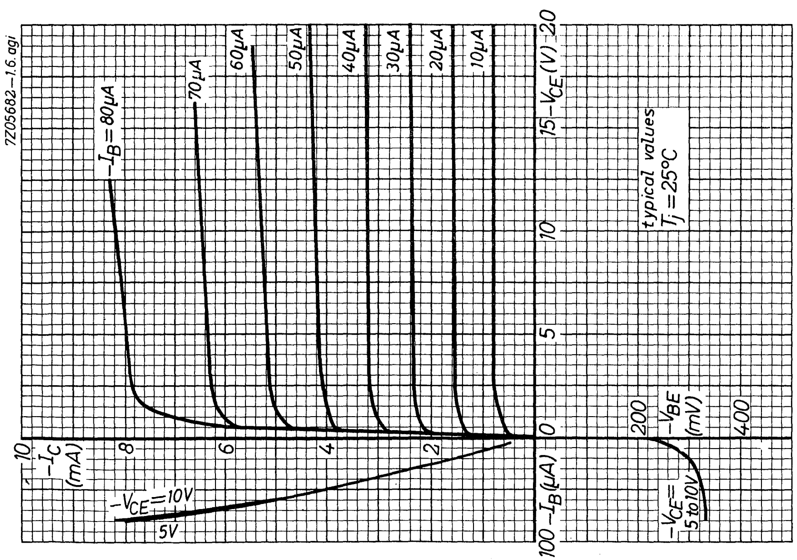
Components

R_1	2.2 kΩ	C_1	15 pF, ceramic plate, 30 V, ± 5%
R_2, R_{12}	1.5 kΩ	C_2, C_{26}, C_{28}	10 pF, ceramic plate, 30 V, ± 0.5 pF
R_3	1.8 kΩ	C_3, C_4, C_{27}	22 pF, ceramic plate, 30 V, ± 5%
R_4, R_9	680 Ω	C_5, C_{15}, C_{16}, C_{22}	100 pF, ceramic plate, 30 V, ± 5%
R_5, R_{18}	1 kΩ	C_6, C_7, C_{21}	39 pF, ceramic plate, 30 V, ± 5%
R_6	470 Ω	C_8, C_{10}, C_{11}, C_{18}, C_{24}	2.2 nF, pin-up ceramic, 500 V, -20 to +50%
R_7, R_{13}, R_{19}	150 Ω	C_9	1 nF, pin-up ceramic, 500 V, -20 to +50%
R_8, R_{14}	10 kΩ	C_{12}, C_{17}	3.3 pF, ceramic, 500 V, ± 0.5 pF
R_{10}, R_{15}	3.9 kΩ	C_{13}, C_{19}, C_{20}	3.9 pF, ceramic plate, 30 V, ± 0.5 pF
R_{11}	8.2 kΩ	C_{14}	6.8 pF, ceramic plate, 30 V, ± 0.5 pF
R_{16}	6.8 kΩ	C_{23}, C_{25}	5.6 pF, ceramic plate, 30 V, ± 0.5 pF
R_{17}, R_{20}	2.7 kΩ	C_{29}	4.7 pF, ceramic plate, 30 V, ± 0.5 pF
R_{21}	18 kΩ	C_c	68 pF + 30 pF (capacitance of screened connecting cable)
R_t	3.9 kΩ	C_t	6.8 pF + 2 pF (transistor output capacitance)
Carbon resistors, 1/8 W, ± 10%		L_6	100 μH
		L_{18}	350 μH

7Z3 1118



7Z05683-1.6.agi
max
typ
$-V_{CB}=25V$
10V
25V
10V
T_j (°C)
0
20
40
60
80
100
10^3
$-I_{CBO}$ (μA)
10^2
10
1



7Z05682-1.6.agi
$-I_B=80\mu A$
70μA
60μA
50μA
40μA
30μA
20μA
10μA
typical values
$T_j=25°C$
$-V_{CE}$ (V)
0
5
10
15
20
$-I_C$ (mA)
10
8
6
4
2
$-V_{CE}=10V$
5V
$-I_B$ (μA)
100
$-V_{BE}$ (mV)
200
400
$-V_{CE}=$ 5 to 10V

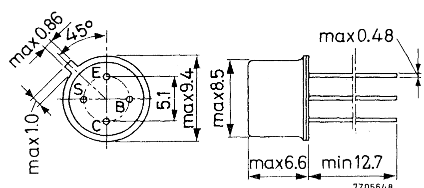
R.F. GERMANIUM ALLOY-DIFFUSED TRANSISTOR

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.

QUICK REFERENCE DATA				
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 (peak value)	$-I_{CM}$	max.	25	mA
Total power dissipation up to T_{amb} = 25 °C	P_{tot}	max.	156	mW
Junction temperature	T_j	max.	75	°C
Max. unilateralised power gain				
$-I_C$ = 3 mA; $-V_{CE}$ = 10 V; f = 200 MHz	G_{UM}	typ.	25	dB
Gain control range at f = 200 MHz	ΔG_{tr}	typ.	40	dB
Noise figure at f = 200 MHz				
G_S = 40 mΩ^{-1}; B_S = 0	F	typ.	3.5	dB

MECHANICAL DATA Dimensions in mm

TO-12



S=Shield lead connected to case

RATINGS (Limiting values) [1])

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

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

7Z3 1152

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				
$G_S = 40\ m\Omega^{-1}$; $B_S = 0$	F	typ.	3.5	dB
Feedback capacitance at f = 450 kHz				
$-I_C = 1$ mA; $-V_{CE} = 10$ V	$-C_{re}$	<	290	fF

y parameters (common emitter) leadlength: 3 mm

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

		f = 50 MHz	200 MHz
Input conductance	g_{ie}	typ. 7.0	27 $m\Omega^{-1}$
Input capacitance	C_{ie}	typ. 38	5.0 pF
Feedback admittance	$\|y_{re}\|$	typ. 110	235 $\mu\Omega^{-1}$
Phase angle of feedback admittance	φ_{re}	typ. 260	250°
Transfer admittance	$\|y_{fe}\|$	typ. 96	52 $m\Omega^{-1}$
Phase angle of transfer admittance	φ_{fe}	typ. 330	270°
Output conductance	g_{oe}	typ. 22	70 $\mu\Omega^{-1}$
Output capacitance	C_{oe}	typ. 3.0	3.0 pF

y parameters (common base) leadlength: 3 mm

$I_E = 3$ mA; $-V_{CB} = 10$ V

		f = 50 MHz	200 MHz
Input conductance	g_{ib}	typ. 92	27 $m\Omega^{-1}$
Input capacitance	$-C_{ib}$	typ. 102	38 pF
Feedback admittance	$\|y_{rb}\|$	typ. 55	160 $\mu\Omega^{-1}$
Phase angle of feedback admittance	φ_{rb}	typ. 290	325°
Transfer admittance	$\|y_{fb}\|$	typ. 96	52 $m\Omega^{-1}$
Phase angle of transfer admittance	φ_{fb}	typ. 150	90°
Output conductance	g_{ob}	typ. 22	70 $\mu\Omega^{-1}$
Output capacitance	C_{ob}	typ. 3.0	3.0 pF

Max. unilateralised power gain

$-I_C = 3$ mA; $-V_{CE} = 10$ V	G_{UM}	typ.	25 dB

7Z3 1153

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.

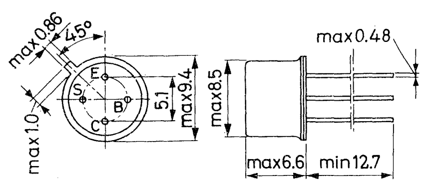
QUICK REFERENCE DATA

Collector-base voltage (open emitter)	$-V_{CBO}$	max.	32	V
Collector-emitter voltage (open base)	$-V_{CEO}$	max.	15	V
Collector current (d.c.)	$-I_C$	max.	30	mA
Total power dissipation up to T_{amb} = 45 °C	P_{tot}	max.	120	mW
Junction temperature	T_j	max.	90	°C
Transition frequency				
$-I_C$ = 1 mA; $-V_{CE}$ = 10 V	f_T	typ.	80	MHz
Thermal resistance from junction to ambient in free air	$R_{th\ j\text{-}a}$	=	0.45	°C/mW

MECHANICAL DATA

Dimensions in mm

TO-12



S = Shield lead connected to case

7Z3 1433

RATINGS (Limiting values) [1]

Voltages

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

Currents

Collector current (d.c.)	$-I_C$	max.	30	mA
Base current (d.c.)	$-I_B$	max.	1	mA
Reverse emitter current (d.c.)	$-I_E$	max.	1	mA
Reverse emitter current (peak value)	$-I_{EM}$	max.	10	mA

Power dissipation

Total power dissipation up to $T_{amb} = 45\ ^oC$	P_{tot}	max.	120	mW

Temperatures

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	$R_{th\ j-a}$	=	0.45	$^oC/mW$

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

7Z3 1434

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

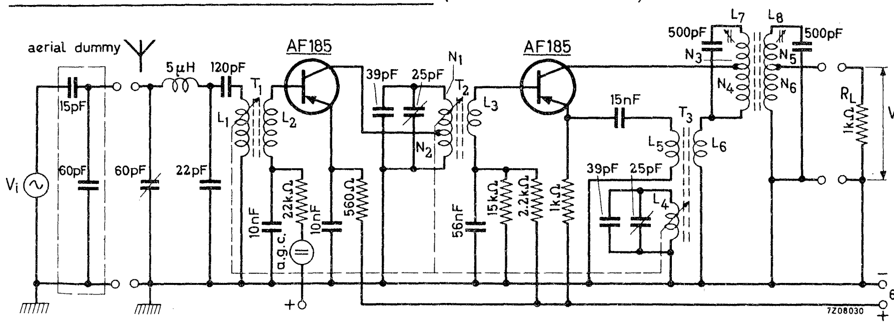
Collector cut-off current				
$I_E = 0$; $-V_{CB} = 10$ V	$-I_{CBO}$	typ. <	0.5 3	μA μA
$I_E = 0$; $-V_{CB} = 10$ V; $T_j = 75$ °C	$-I_{CBO}$	<	45	μA
Base current				
$I_E = 1$ mA; $-V_{CB} = 10$ V	$-I_B$		5 to 25	μA
Emitter-base voltage				
$I_E = 1$ mA; $-V_{CB} = 10$ V	V_{EB}	typ. 220 to	280 340	mV 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 4	dB 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 8	dB dB
f = 1 MHz; $R_S = 300$ Ω	F_c	typ. <	3 5	dB dB

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

7Z3 1435

APPLICATION INFORMATION

Medium-wave r.f. circuit for car radio (0.53 to 1.68 MHz)



Stable continuous operation is ensured up to an ambient temperature of 60 °C

D.C. adjustments

Emitter current of r.f. transistor $I_E = 1.0$ mA

Emitter current of mixer transistor $I_E = 0.7$ mA

Sensitivity at a frequency of 1 MHz, a modulation depth of 30% and a bandwidth of 4.5 kHz at a signal to noise ratio

S/N =	26 dB	20 dB
V_i =	26 μV	13 μV

Voltage gain $V_o/V_i = 350$

COIL DATA

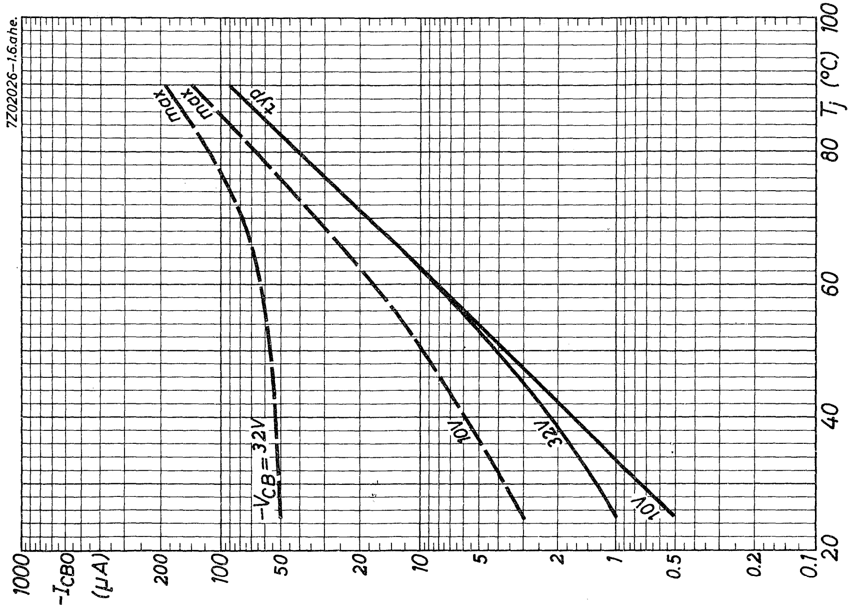
Coil No.	T_1	T_2	T_3	L_7	L_8
Measuring frequency	1 MHz	1 MHz	1.45 MHz	0.45 MHz	0.45 MHz
Inductance	L_1 = 150 to 1500 μH	N_1+N_2 = 150 to 1500 μH	L_4 = 94 to 444 μH	N_3+N_4 = 250 μH	N_5+N_6 = 250 μH
Total tuning capacitance	60 pF	60 pF		500 pF	500 pF
Q_0	80	80		150	150
Tapping ratio	$\frac{V_{L2}}{V_i} = 0.33$ [1]	$\frac{V_{N2}}{V_{N1}+V_{N2}} = 0.14$ $\frac{V_{L3}}{V_{N2}} = 0.5$	$\frac{V_{L6}}{V_{L4}} = 0.14$ $\frac{V_{L5}}{V_{L6}} = 0.14$	$\frac{V_{N4}}{V_{N3}+V_{N4}} = 0.3$	$\frac{V_{N6}}{V_{N5}+V_{N6}} = 0.07$

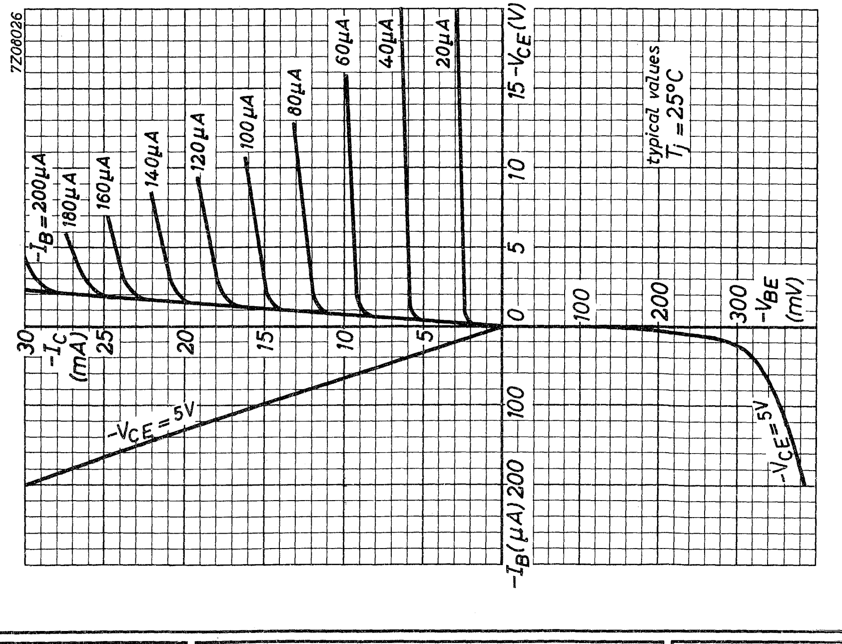
Source impedance across L_2 at 1 MHz = 200 Ω

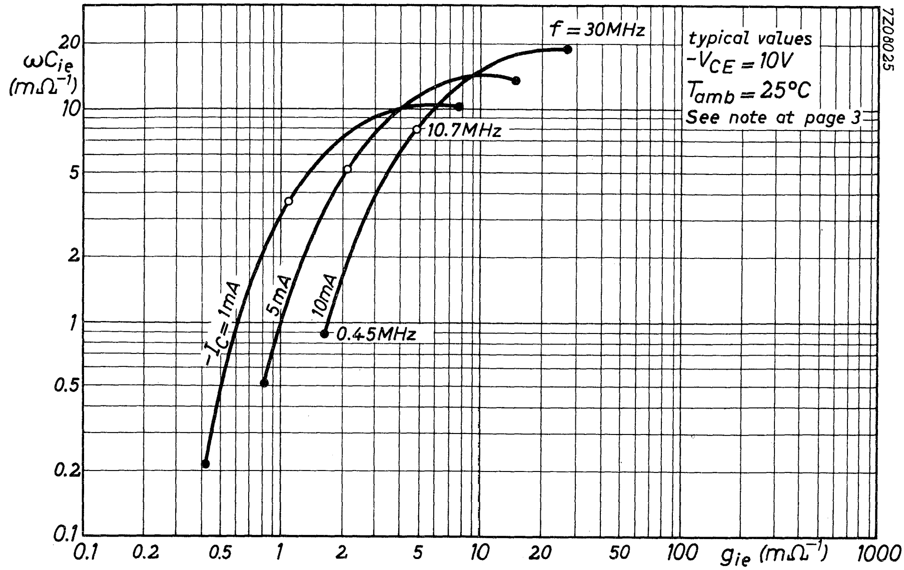
Coupling between L_7 and L_8 : $kQ_o = 1.2$

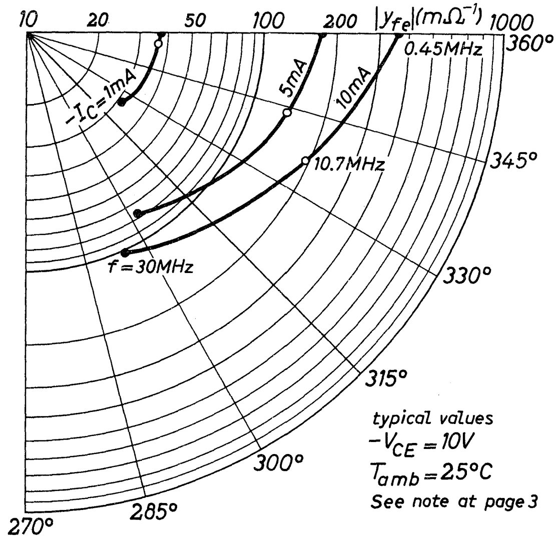
[1]) Measured without AF185

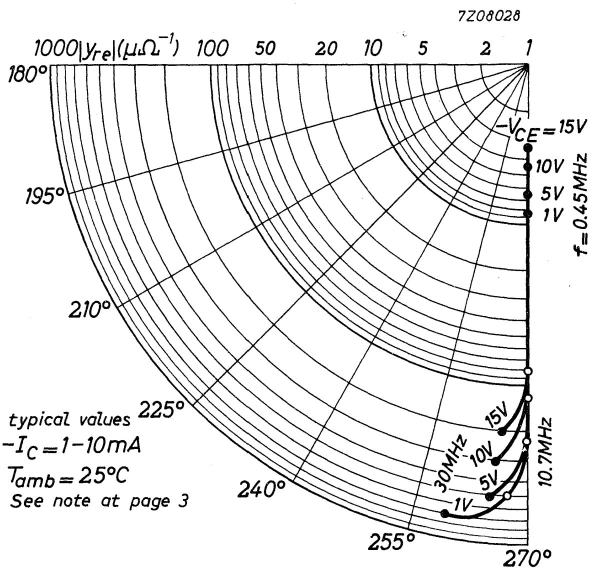
7Z3 1436

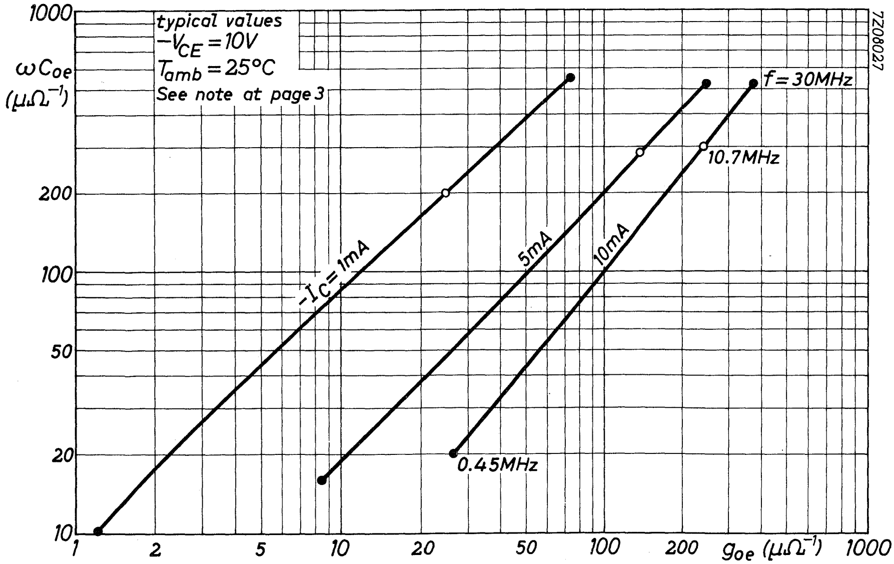

7Z02026-1.6.ahe.
Tj (°C)
-ICBO (μA)
max
max
typ
-VCB = 32V
10V
32V
10V

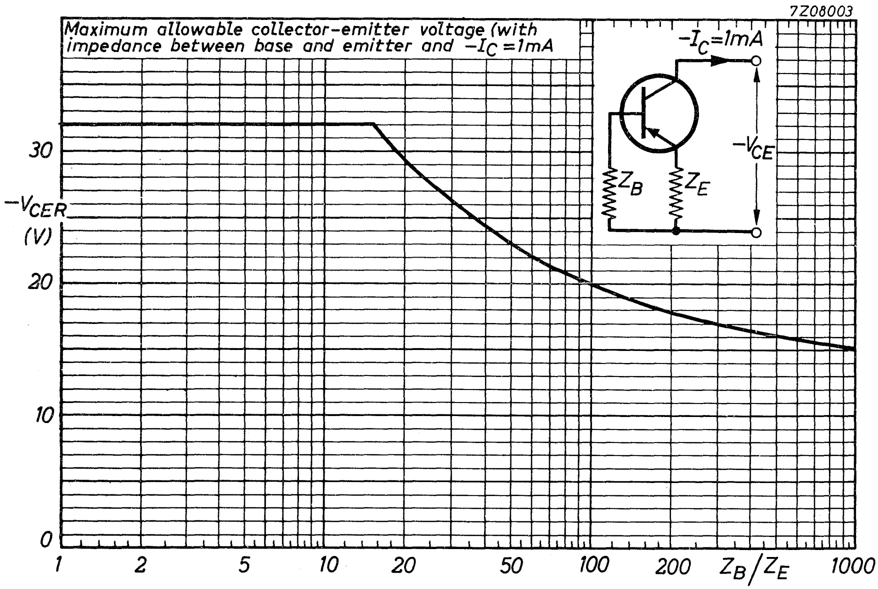

7Z08026
-IB = 200μA
180μA
160μA
140μA
120μA
100μA
80μA
60μA
40μA
20μA
typical values
Tj = 25°C
-VCE (V)
-IC (mA)
-VCE = 5V
-VBE (mV)
-VCE = 5V
-IB (μA)


7Z08025
ωC_{ie} $(m\Omega^{-1})$
20
10
5
2
1
0.5
0.2
0.1
0.1
0.2
0.5
1
2
5
10
20
50
100
g_{ie} $(m\Omega^{-1})$
1000
f = 30MHz
10.7MHz
0.45MHz
$-I_C$ = 1mA
5mA
10mA
typical values
$-V_{CE}$ = 10V
T_{amb} = 25°C
See note at page 3


7Z08029
10
20
50
100
200
$|y_{fe}|$ $(m\Omega^{-1})$
1000
360°
345°
330°
315°
300°
285°
270°
0.45MHz
10.7MHz
f = 30MHz
$-I_C$ = 1mA
5mA
10mA
typical values
$-V_{CE}$ = 10V
T_{amb} = 25°C
See note at page 3


7Z08028
1000|y_{re}|($\mu\Omega^{-1}$) 100 50 20 10 5 2 1
180°
195°
210°
225°
240°
255°
270°
$-V_{CE}$=15V
10V
5V
1V
f=0.45MHz
15V
10V
5V
1V
30MHz
10.7MHz
typical values
$-I_C$=1–10mA
T_{amb}=25°C
See note at page 3


7Z08027
typical values
$-V_{CE}$=10V
T_{amb}=25°C
See note at page 3
ωC_{oe} ($\mu\Omega^{-1}$)
1000
200
100
50
20
10
1 2 5 10 20 50 100 200 g_{oe} ($\mu\Omega^{-1}$) 1000
$-I_C$=1mA
5mA
10mA
f=30MHz
10.7MHz
0.45MHz


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

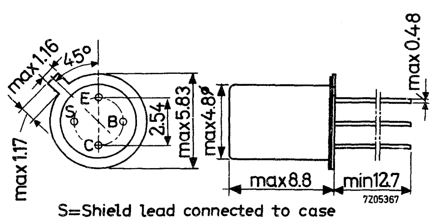
U.H.F. GERMANIUM ALLOY-DIFFUSED TRANSISTOR

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.

QUICK REFERENCE DATA				
Collector-base voltage (open emitter)	$-V_{CBO}$	max.	25	V
Collector current (peak value)	$-I_{CM}$	max.	15	mA
Total dissipation up to T_{amb} = 45 °C	P_{tot}	max.	70	mW
Junction temperature	T_j	max.	75	°C
Transition frequency $-I_C$ = 2 mA; $-V_{CE}$ = 10 V	f_T	typ.	820	MHz
Power gain of pre-amplifier I_E = 2 mA; $-V_{CB}$ = 10 V f = 860 MHz; T_j = 25 °C	G_p	typ.	9	dB
Noise figure at 800 MHz $-I_C$ = 2 mA; $-V_{CE}$ = 10 V Source conductance G_S = 20 mΩ^{-1}	F	typ.	8	dB
Thermal resistance	$R_{th\ j-a}$	=	0.65	°C/mW

MECHANICAL DATA

Dimensions in mm



S=Shield lead connected to case

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

7Z3 0394

RATINGS (Limiting values) [1])

Voltages

Collector-base voltage (open emitter)	$-V_{CBO}$	max.	25	V
Collector-emitter voltage (resistance between base and emitter)	$-V_{CER}$	max.	25	V

Currents

Collector current (d.c.)	$-I_C$	max.	15	mA
Collector current (peak value)	$-I_{CM}$	max.	15	mA
Emitter current (d.c.)	I_E	max.	16	mA
Emitter current (peak value)	I_{EM}	max.	16	mA
Base current (d.c.)	$-I_B$	max.	1	mA
Base current (peak value)	$-I_{BM}$	max.	1	mA
Reverse emitter current	$-I_E$	max.	1	mA

Power dissipation

Total power dissipation up to T_{amb} = 45 °C	P_{tot}	max.	70	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	$R_{th\ j-a}$	=	0.65	°C/mW

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

7Z3 0395

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

Collector cut-off current				
$I_E = 0;\ -V_{CB} = 10$ V	$-I_{CBO}$	<	3.5	μA
$I_E = 0;\ -V_{CB} = 25$ V	$-I_{CBO}$	typ.	0.65	μA
		<	50	μA
Emitter cut-off current				
$I_C = 0;\ -V_{EB} = 0.3$ V	$-I_{EBO}$	typ.	0.5	μA
Base-emitter voltage				
$I_E = 2$ mA; $-V_{CB} = 10$ V	$-V_{BE}$		260 to 380	mV
Base current				
$I_E = 2$ mA; $-V_{CB} = 10$ V	$-I_B$	<	50	μA
$I_E = 10$ mA; $-V_{CB} = 5$ V	$-I_B$	<	800	μA
Power gain at f = 900 MHz				
$I_E = 2$ mA; $-V_{CB} = 10$ V Source conductance $G_S = 20\ m\Omega^{-1}$ Load conductance $G_L = 2\ m\Omega^{-1}$				
Pre-amplifier	G_p	>	5.5	dB
		typ.	8.5	dB
Mixer-oscillator	G_p	>	7	dB
		typ.	8.5	dB
Transition frequency				
$-I_C = 2$ mA; $-V_{CE} = 10$ V	f_T	typ.	820	MHz
Feedback capacitance at f = 10.7 MHz				
$-I_C = 2$ mA; $-V_{CE} = 10$ V	$-C_{re}$	typ.	0.25	pF
		<	0.40	pF
Noise figure				
$-I_C = 2$ mA; $-V_{CE} = 10$ V Source conductance $G_S = 20\ m\Omega^{-1}$				
At f = 500 MHz	F	typ.	6.5	dB
At f = 800 MHz	F	typ.	8.0	dB
		<	10	dB

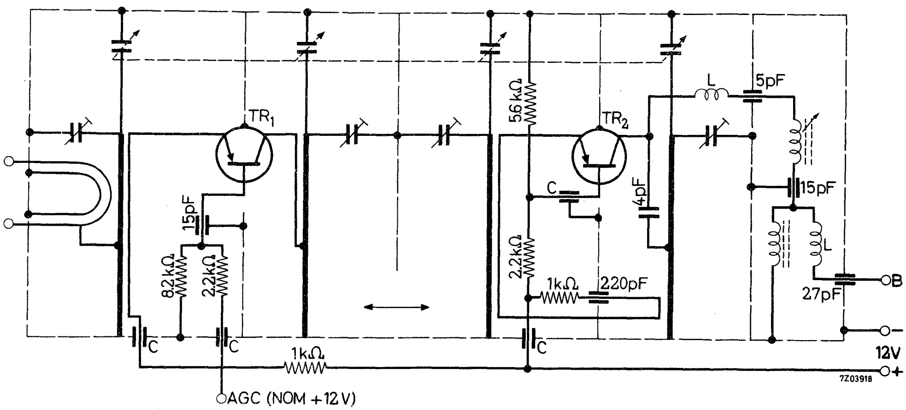
7Z3 0396

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

			Pre-amplifier (black dot)	Mixer-oscillator (red dot)	
y parameters at f = 35 MHz					
I_E = 2 mA; $-V_{CB}$ = 10 V					
Output conductance	g_{ob}	typ.		15	$\mu\Omega^{-1}$
Output capacitance	C_{ob}	typ.		1.5	pF
y parameters at f = 500 MHz					
I_E = 2 mA; $-V_{CB}$ = 10 V					
Input conductance	g_{ib}	typ.	17	17	$m\Omega^{-1}$
Input capacitance	$-C_{ib}$	typ.	4	4	pF
Feedback admittance	$\|y_{rb}\|$	typ.	0.35	0.35	$m\Omega^{-1}$
Phase angle of feedback admittance	φ_{rb}	typ.	245°	245°	
Transfer admittance	$\|y_{fb}\|$	typ.	25	25	$m\Omega^{-1}$
Phase angle of transfer admittance	φ_{fb}	typ.	90°	90°	
Output conductance	g_{ob}	typ.	0.35	0.35	$m\Omega^{-1}$
Output capacitance	C_{ob}	typ.	1.2	1.2	pF
y parameters at f = 900 MHz					
I_E = 2 mA; $-V_{CB}$ = 10 V					
Input conductance	g_{ib}	typ.	11	14	$m\Omega^{-1}$
Input capacitance	$-C_{ib}$	typ.	1.8	1.8	pF
Feedback admittance	$\|y_{rb}\|$	typ.	0.6	0.7	$m\Omega^{-1}$
Phase angle of feedback admittance	φ_{rb}	typ.	230°	230°	
Transfer admittance	$\|y_{fb}\|$	typ.	18	22	$m\Omega^{-1}$
Phase angle of transfer admittance	φ_{fb}	typ.	55°	50°	
Output conductance	g_{ob}	typ.	0.7	0.9	$m\Omega^{-1}$
Output capacitance	C_{ob}	typ.	1.2	1.2	pF

7Z3 0397

APPLICATION INFORMATION



L = 0.2 μH

C = Feed-through capacitance of 820 pF

TR_1 = Pre-amplifier (black dot)

TR_2 = Mixer-oscillator (red dot)

<u>Tuner gain</u>

at 860 MHz	typ.	22	dB
470 MHz	typ.	16	dB

<u>Tuner noise</u>

at 860 MHz	typ.	10.5	dB
	<	13	dB
470 MHz	typ.	7.5	dB

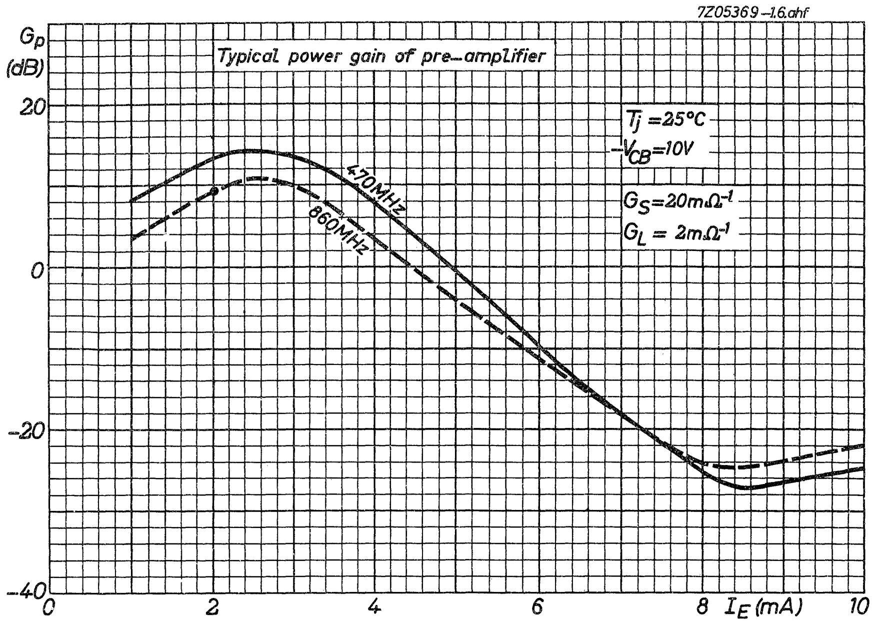
NOTES:

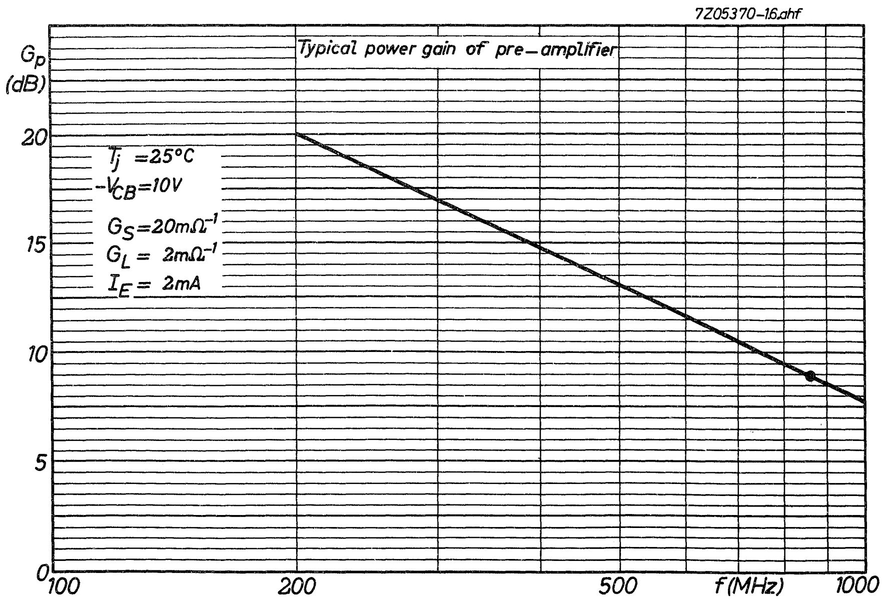
1. Tuner gain (in dB) =

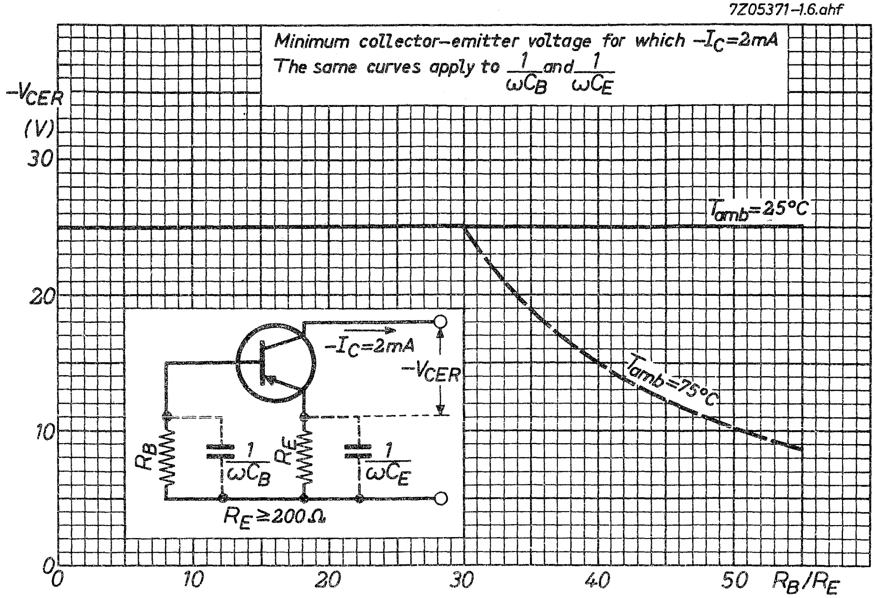
$$10 \log \frac{\text{output power in a load of } 50\ \Omega \text{ connected to point B (see figure)}}{\text{available power of a source of } 300\ \Omega \text{ connected to the aerial terminals}}$$

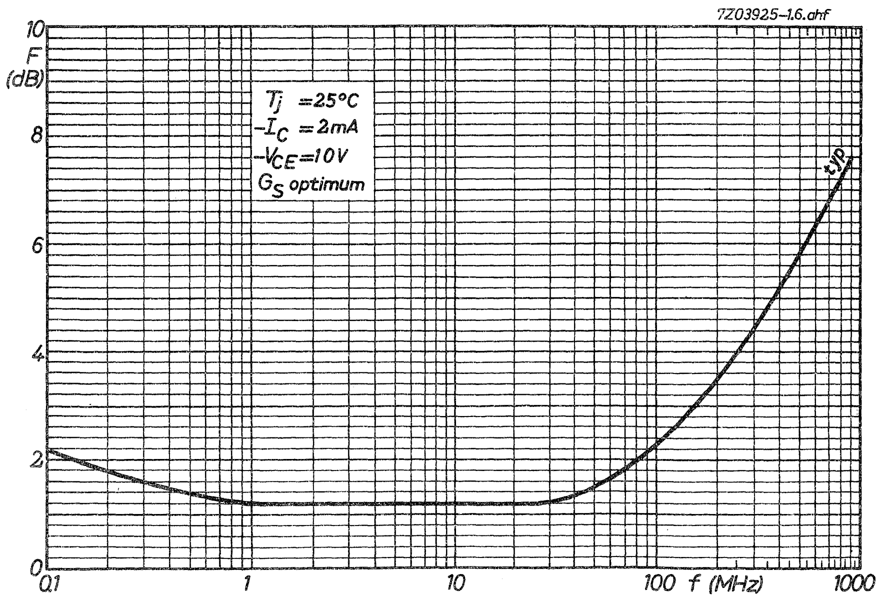
2. Typical gain control range of the tuner is 35 dB.

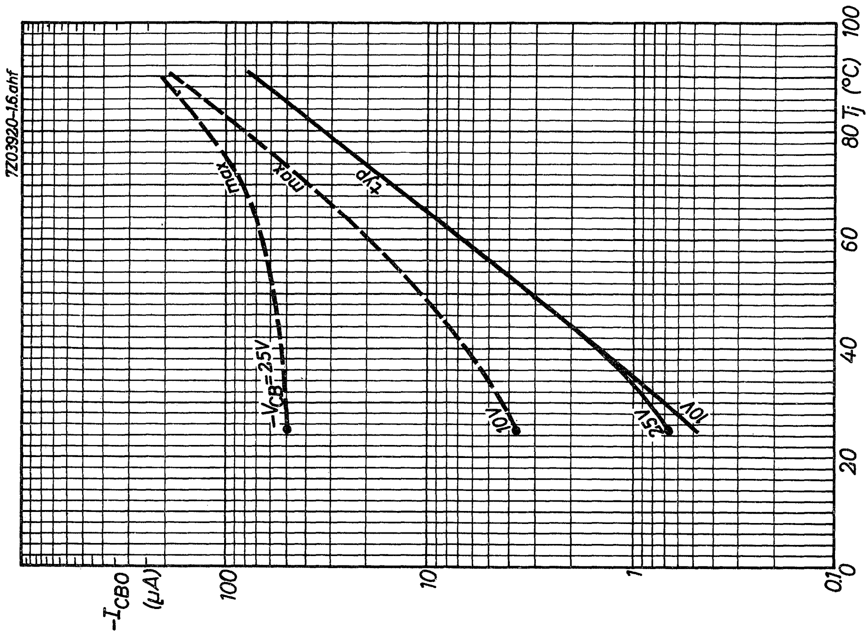
7Z3 0398

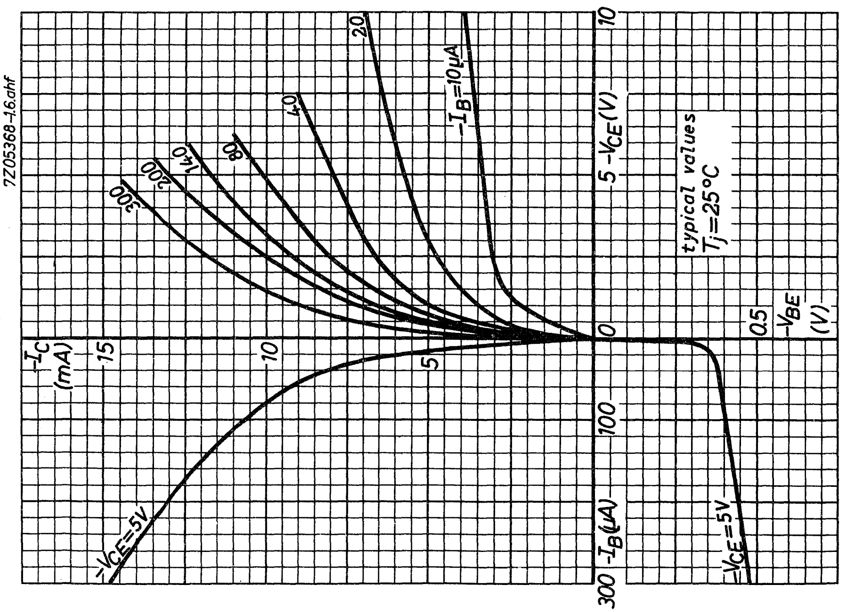

7Z05369-1.6.ahf
Typical power gain of pre-amplifier
G_p (dB)
20
0
-20
-40
T_j =25°C
$-V_{CB}$=10V
G_S=20mΩ^{-1}
G_L = 2mΩ^{-1}
470MHz
860MHz
0
2
4
6
8
I_E (mA)
10


7Z05370-1.6.ahf
Typical power gain of pre-amplifier
G_p (dB)
20
15
10
5
0
T_j =25°C
$-V_{CB}$=10V
G_S=20mΩ^{-1}
G_L = 2mΩ^{-1}
I_E = 2mA
100
200
500
f (MHz)
1000


7Z05371-1.6.ahf
Minimum collector-emitter voltage for which $-I_C$=2mA
The same curves apply to $\frac{1}{\omega C_B}$ and $\frac{1}{\omega C_E}$
$-V_{CER}$ (V)
T_{amb}=25°C
T_{amb}=75°C
$-I_C$=2mA
$-V_{CER}$
R_B
R_E
$\frac{1}{\omega C_B}$
$\frac{1}{\omega C_E}$
$R_E \geq 200\,\Omega$
0
10
20
30
40
50
R_B/R_E


7Z03925-1.6.ahf
10
F (dB)
8
6
4
2
0
T_j = 25°C
$-I_C$ = 2mA
$-V_{CE}$=10V
G_S optimum
typ
0.1
1
10
100 f (MHz)
1000


7Z03920-1.6.ahf
-ICBO
(μA)
100
10
1
0.1
0
20
40
60
80 Tj (°C)
100
max
max
typ
-VCB=25V
10V
25V
10V


7Z05368-1.6.ahf
-IC
(mA)
15
10
5
0
5 -VCE (V)
10
-IB=10μA
20
40
80
140
200
300
typical values
Tj=25°C
0.5
-VBE
(V)
100
300 -IB (μA)
-VCE=5V
-VCE=5V

U.H.F GERMANIUM MESA TRANSISTOR

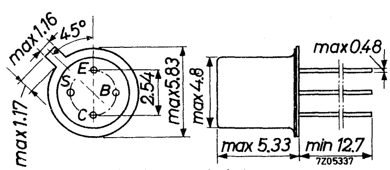
P-N-P transistor in a TO-72 metal envelope, primarily intended for use in pre-amplifier, mixer or oscillator circuits up to frequencies of 890 MHz.

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



S=Shield lead connected to case

7Z3 1320

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.

7Z3 1321

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				
$G_S = 16.7\ m\Omega^{-1}$; $B_S = 0$				
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

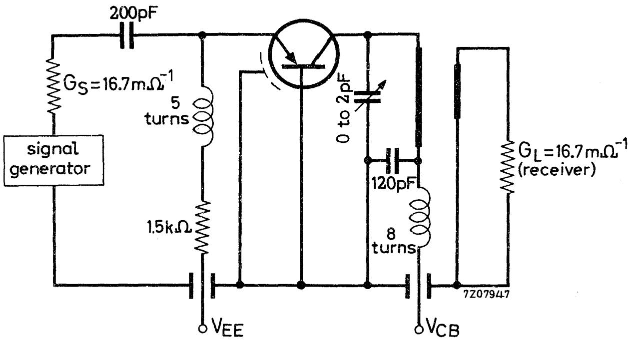
[1] 1 fF = 1 femtofarad = 10^{-15} F

7Z3 1322

CHARACTERISTICS (continued)

Transducer gain at T_{amb} = 25 °C

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



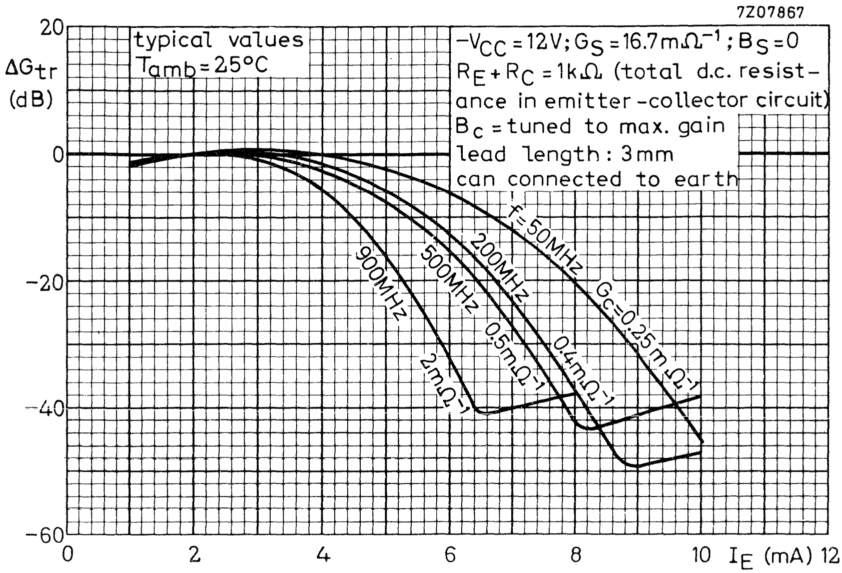
$$G_{tr} = \frac{\text{output power in load } G_L}{\text{available power from source } G_S}$$

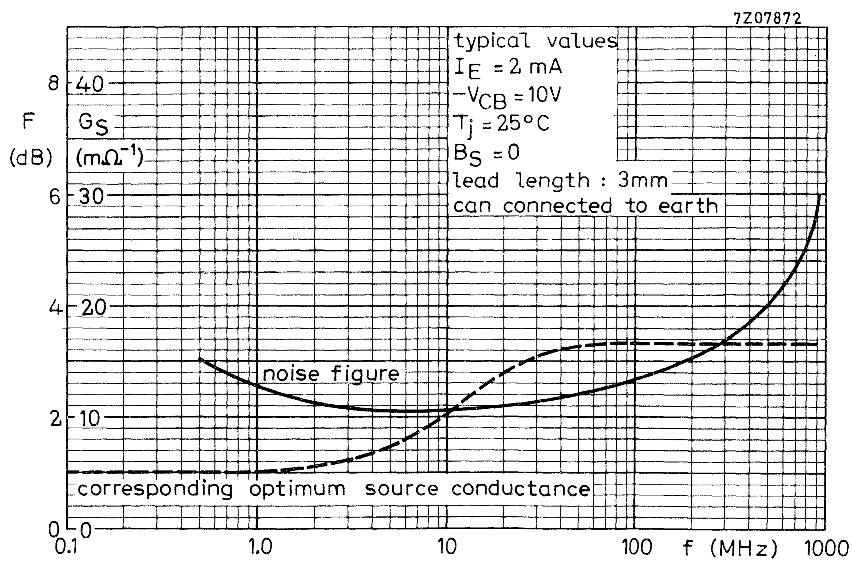
I_E = 2 mA; $-V_{CB}$ = 10 V; lead length: 3 mm; can connected to earth.

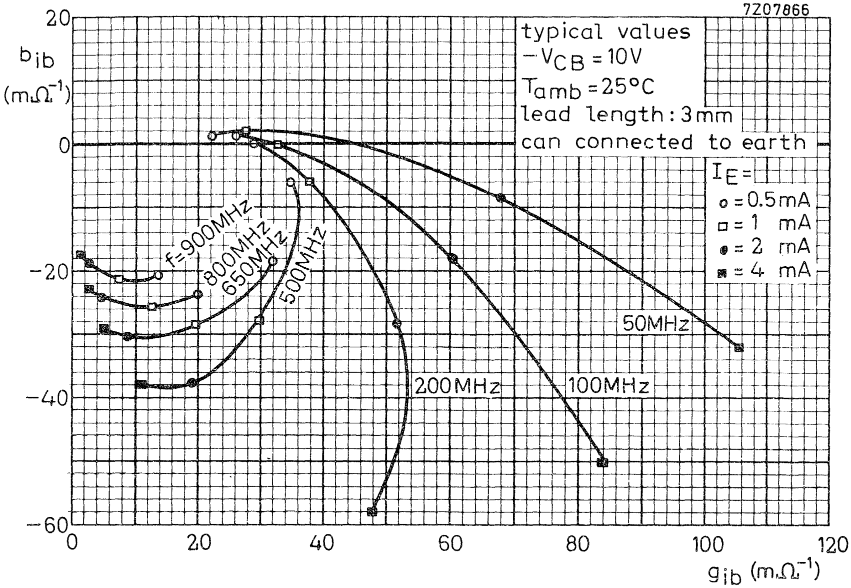
f = 50 MHz; G_c = 0.25 mΩ^{-1}	G_{tr}	typ.	22.5	dB
f = 200 MHz; G_c = 0.4 mΩ^{-1}	G_{tr}	typ.	21.5	dB
f = 500 MHz; G_c = 0.5 mΩ^{-1}	G_{tr}	typ.	18	dB
f = 800 MHz; G_c = 0.5 mΩ^{-1}	G_{tr}	>	11.5	dB
		typ.	14	dB
G_c = 2 mΩ^{-1}	G_{tr}	>	9	dB
		typ.	11.5	dB
f = 900 MHz; G_c = 0.5 mΩ^{-1}	G_{tr}	typ.	12.5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

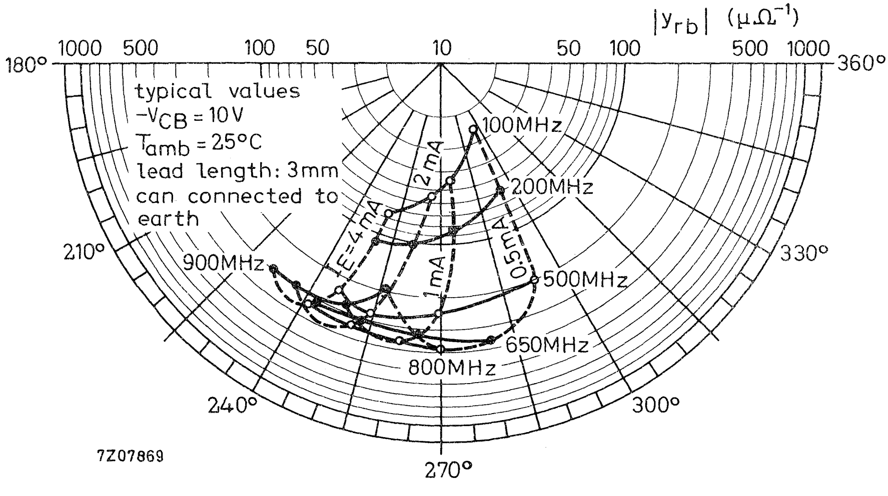
G_c = total effective collector conductance.

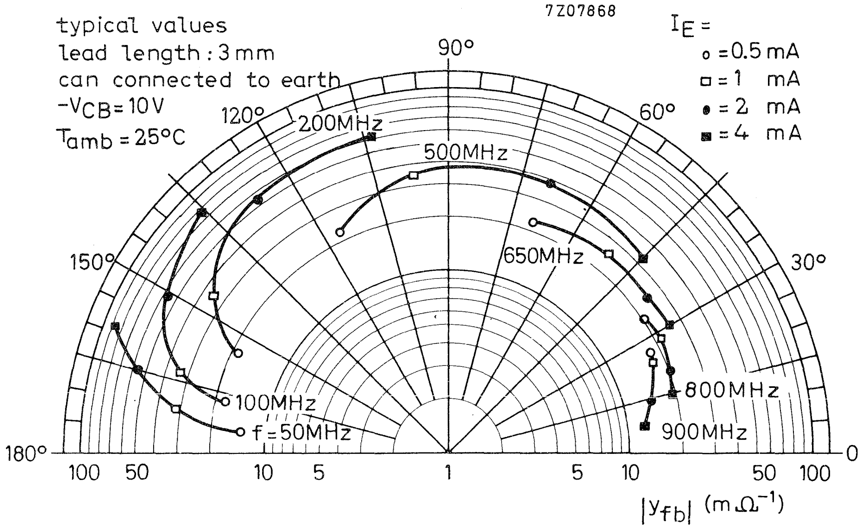
7Z3 1323

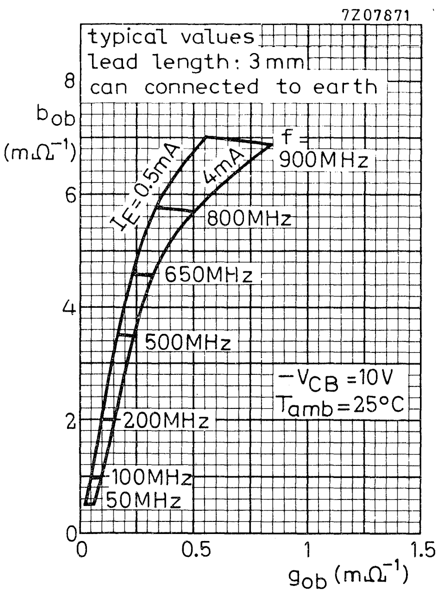

7Z07867
typical values
T_{amb} = 25°C
$-V_{CC}$ = 12V; G_S = 16.7 mΩ⁻¹; B_S = 0
$R_E + R_C$ = 1kΩ (total d.c. resistance in emitter-collector circuit)
B_c = tuned to max. gain
lead length: 3mm
can connected to earth
ΔGtr (dB)
20
0
−20
−40
−60
0
2
4
6
8
10
12
IE (mA)
f = 50MHz
200MHz
500MHz
900MHz
Gc = 0.25 mΩ⁻¹
0.4 mΩ⁻¹
0.5 mΩ⁻¹
2 mΩ⁻¹

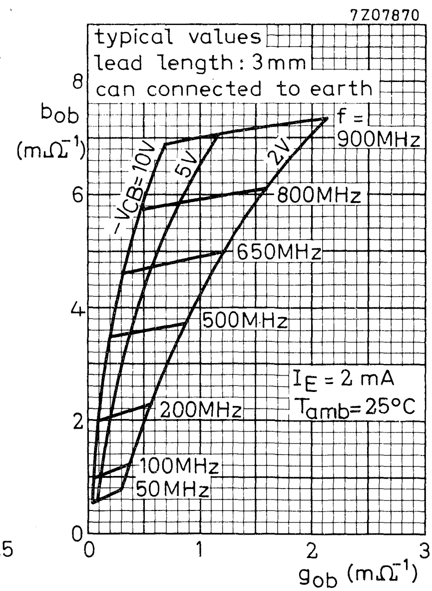

7Z07872
typical values
I_E = 2 mA
$-V_{CB}$ = 10V
T_j = 25°C
B_S = 0
lead length : 3mm
can connected to earth
F (dB)
Gs (mΩ⁻¹)
0
2
4
6
8
10
20
30
40
0.1
1.0
10
100
1000
f (MHz)
noise figure
corresponding optimum source conductance

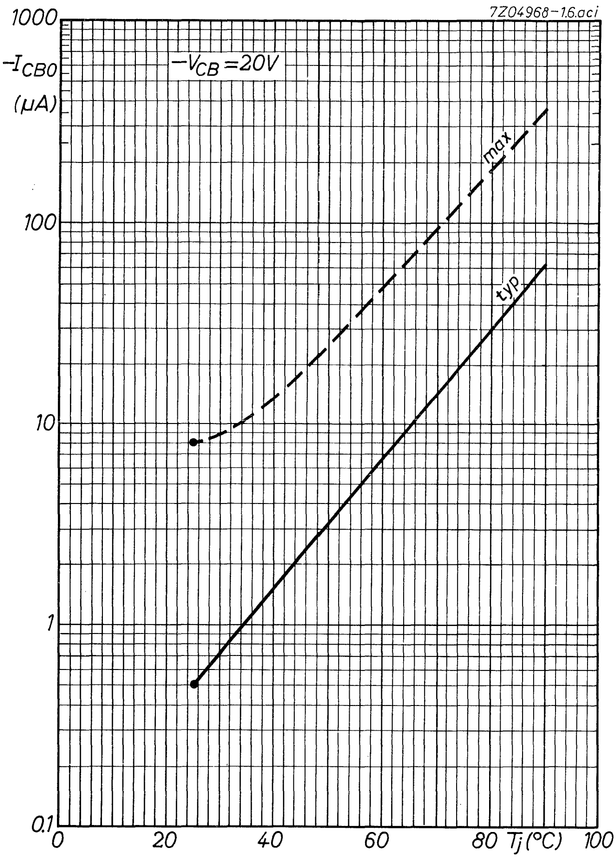

7Z07866
typical values
$-V_{CB}$ = 10V
T_{amb} = 25°C
lead length: 3mm
can connected to earth
I_E =
o = 0.5mA
□ = 1 mA
● = 2 mA
■ = 4 mA
b_{ib} (mΩ^{-1})
g_{ib} (mΩ^{-1})
f=900MHz
800MHz
650MHz
500MHz
200MHz
100MHz
50MHz
20
0
−20
−40
−60
0
20
40
60
80
100
120


|y_{rb}| (μΩ^{-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
800MHz
900MHz
100MHz
f = 50MHz
100 50 10 5 1 5 10 50 100
$|y_{fb}|$ (mΩ^{-1})


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


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


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

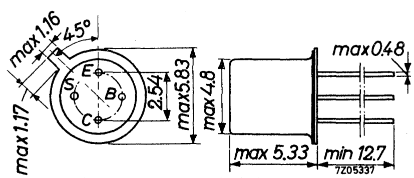
U.H.F. GERMANIUM MESA TRANSISTOR

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



S=Shield lead connected to case

7Z3 0790

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	$R_{th\ j-a}$	=	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.

7Z3 0791

CHARACTERISTICS

T_j = 25 °C 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; $T_j = 60$ °C	$-I_{CBO}$	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

7Z3 0792

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 susceptance	$-b_{ib}$	typ.	11	$m\Omega^{-1}$
Input capacitance	$-C_{ib}$	typ.	2.2	pF
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

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.

7Z3 0793

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

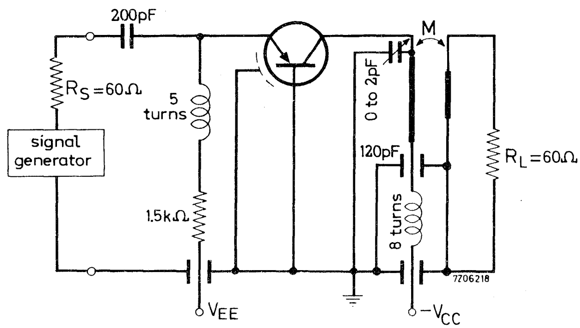
I_E = 1.5 mA; $-V_{CB}$ = 12 V; f = 800 MHz	$G_{tr\ rev}$	typ.	−23	dB

The reverse transducer gain is measured in the circuit below, with load and source (including R_S) interchanged.

Noise figure

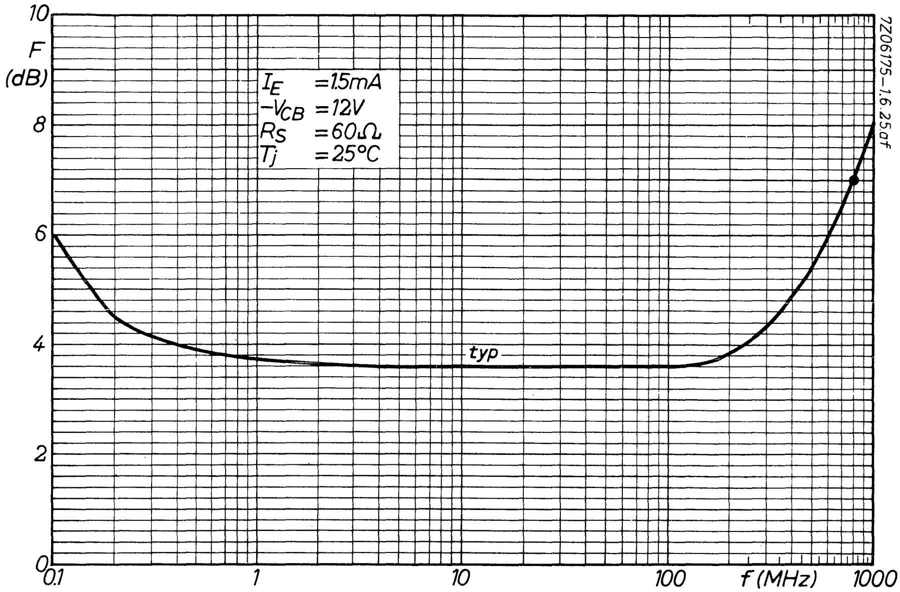
I_E = 1.5 mA; $-V_{CB}$ = 12 V; f = 800 MHz	F	typ.	7	dB
		<	8	dB

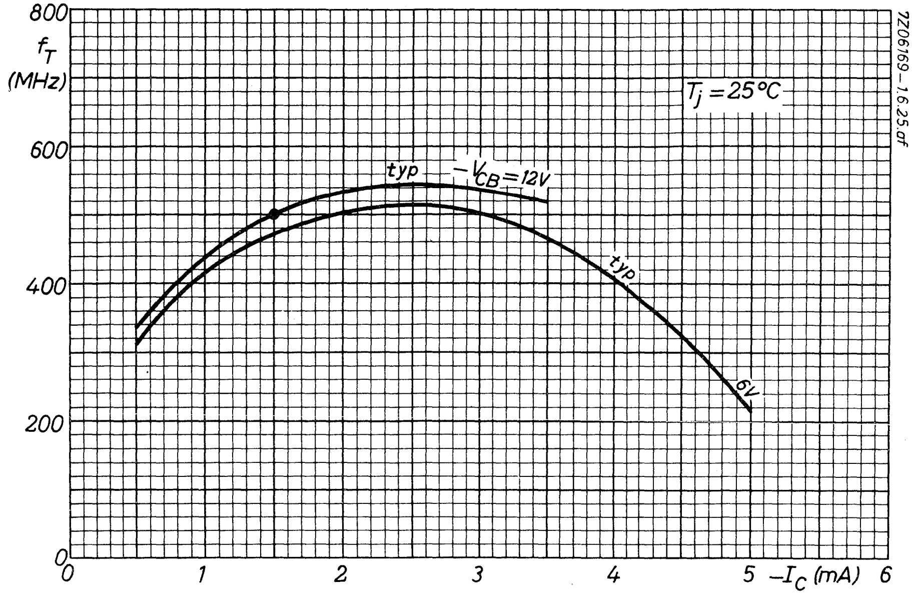
Basic circuit for measuring the transducer gain G_{tr} and the noise figure F.

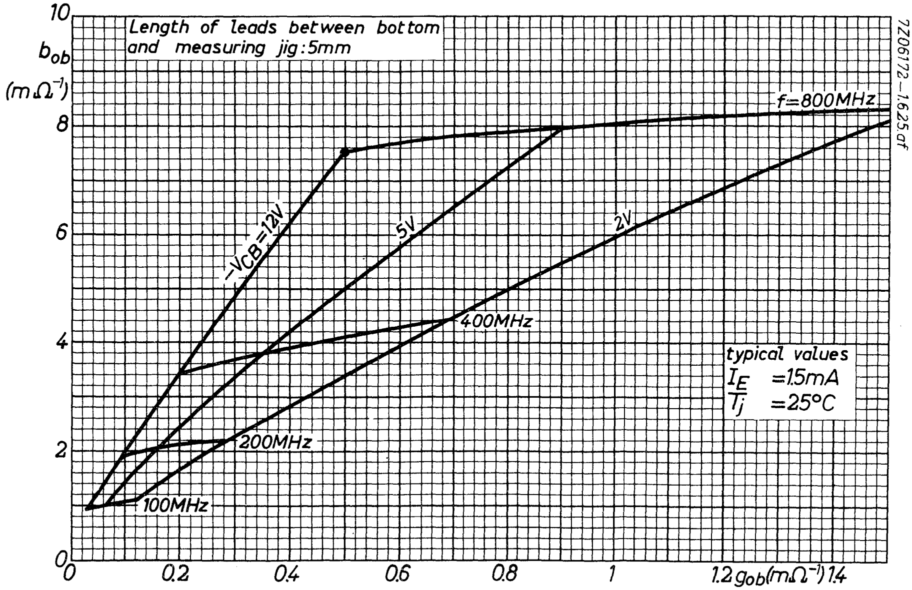


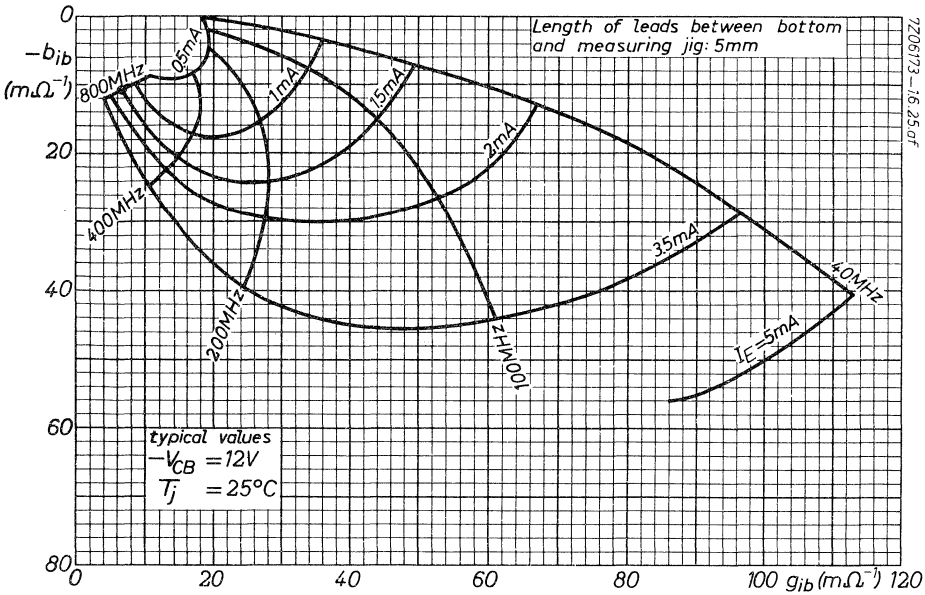
Total effective collector resistance R_c = 1.4 kΩ

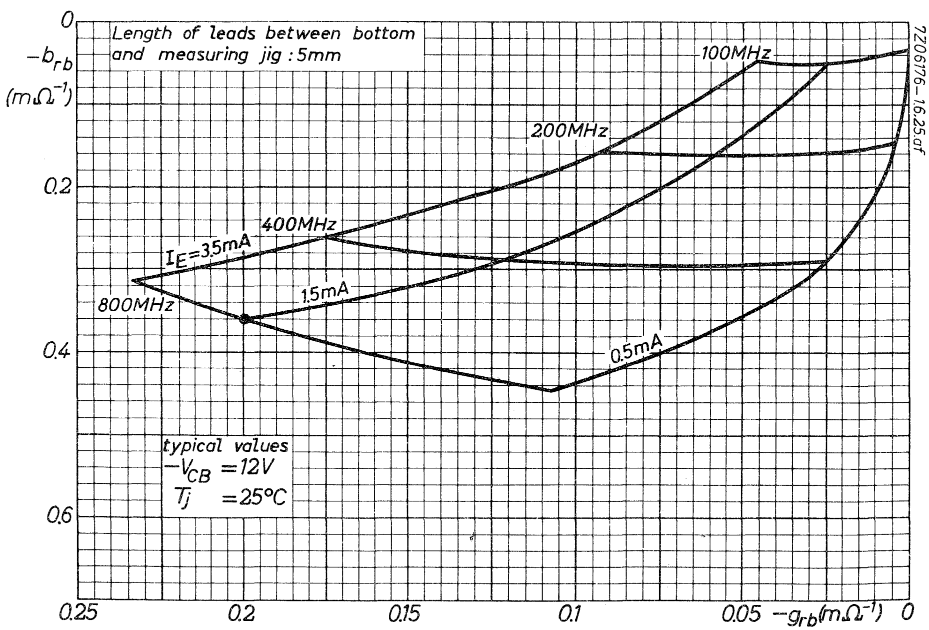
7Z3 0794

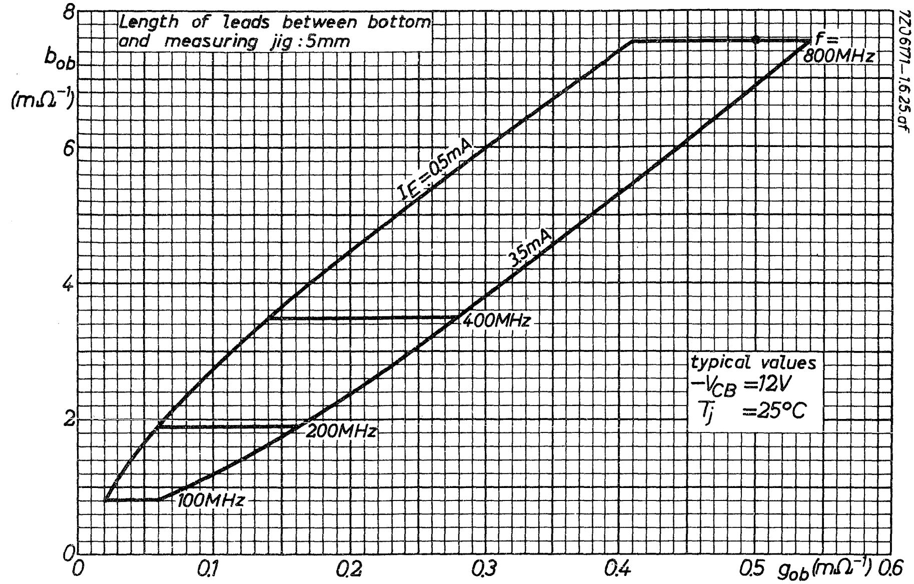

10
F
(dB)
8
6
4
2
0
I_E = 1.5mA
$-V_{CB}$ = 12V
R_S = 60Ω
T_j = 25°C
typ
0.1
1
10
100
f (MHz)
1000
7Z06175-1.6.25af

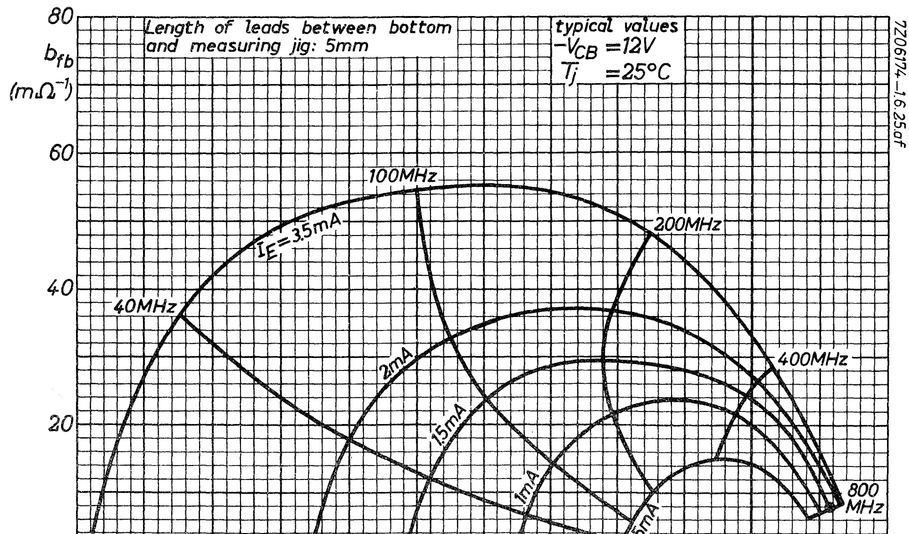

800
f_T
(MHz)
600
400
200
0
0
1
2
3
4
5
6
$-I_C$ (mA)
$T_j = 25°C$
typ
$-V_{CB} = 12V$
typ
6V
7Z06169-1.6.25.af

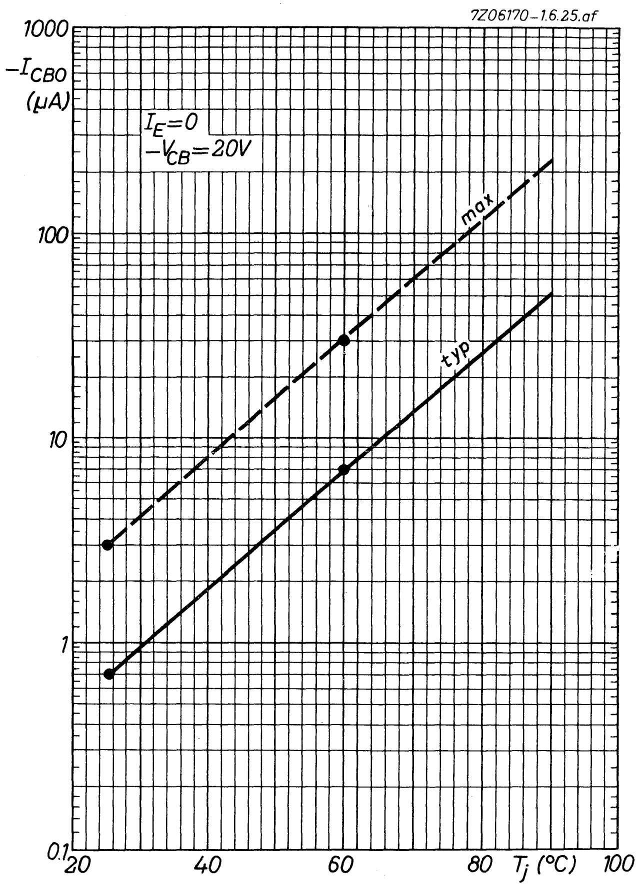

10
b_{ob}
$(m\Omega^{-1})$
8
6
4
2
0
0
0.2
0.4
0.6
0.8
1
1.2
$g_{ob}(m\Omega^{-1})$
1.4
Length of leads between bottom
and measuring jig: 5mm
f=800MHz
$-V_{CB}=12V$
5V
2V
400MHz
200MHz
100MHz
typical values
I_E =1.5mA
T_j =25°C
7Z06172-1.6.25.af


0
20
40
60
80
$-b_{ib}$
$(m\Omega^{-1})$
Length of leads between bottom and measuring jig: 5mm
7Z06173-16.25af
0.5mA
1mA
1.5mA
2mA
3.5mA
I_E=5mA
800MHz
400MHz
200MHz
100MHz
40MHz
typical values
$-V_{CB}$ =12V
T_j =25°C
0
20
40
60
80
100 g_{ib} $(m\Omega^{-1})$ 120


0
0.2
0.4
0.6
$-b_{rb}$
$(m\Omega^{-1})$
Length of leads between bottom and measuring jig: 5mm
7Z06176-16.25af
100MHz
200MHz
400MHz
800MHz
I_E=3.5mA
1.5mA
0.5mA
typical values
$-V_{CB}$ =12V
T_j =25°C
0.25
0.2
0.15
0.1
0.05 $-g_{rb}$ $(m\Omega^{-1})$ 0


Length of leads between bottom and measuring jig : 5mm
8
b_{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
I_E = 0.5mA
3.5mA
400MHz
200MHz
100MHz
typical values
$-V_{CB}$ = 12V
T_j = 25°C
7Z06171-1.6.25.af


Length of leads between bottom and measuring jig: 5mm
typical values
$-V_{CB}$ = 12V
T_j = 25°C
80
b_{fb}
$(m\Omega^{-1})$
60
40
20
0
−100
−80
−60
−40
−20
0
$g_{fb}(m\Omega^{-1})$
20
100MHz
200MHz
I_E = 3.5mA
40MHz
400MHz
2mA
1.5mA
1mA
0.5mA
800 MHz
7Z06174-1.6.25.af


7Z06170-1.6.25.af
1000
$-I_{CBO}$
(μA)
$I_E=0$
$-V_{CB}=20V$
max
100
typ
10
1
0.1
20
40
60
80
T_j (°C)
100

GERMANIUM ALLOY DIFFUSED TRANSISTOR

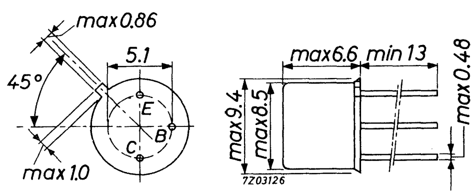
P-N-P transistor in a TO-39 metal envelope, primarily intended for use as a power amplifier in transmitting circuits up to frequencies of 180 MHz.

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



7Z3 1466

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.

7Z3 1467

CHARACTERISTICS

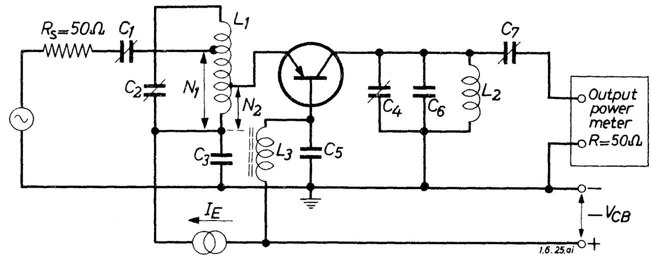
T_{amb} = 25 ^{o}C unless otherwise specified

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	mA
		<	2	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	>	225	MHz
		typ.	350	MHz

7Z3 1468

APPLICATION INFORMATION

V.H.F. power amplifier circuit at T_{amb} = 25 °C



f	= 80	180 MHz
C_1	= 50	15 pF
C_2	= 50	15 pF
C_3	= 10	1 nF
C_4	= 50	15 pF
C_5 [1]	= 10	0.12 nF
C_6	= 82	0 pF
C_7	= 100	15 pF

f	= 80	180 MHz
L_1	= 0.1	0.08 μH
L_2	= 0.03	0.02 μH
L_3	= 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

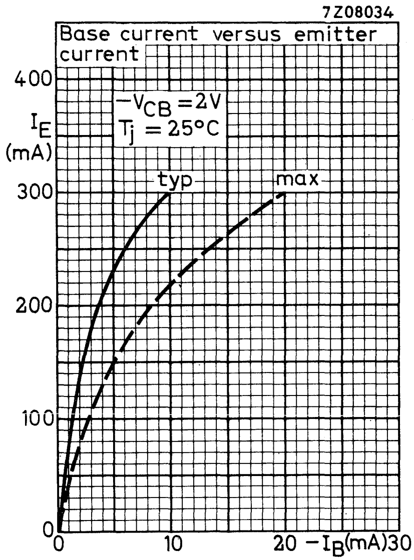
Care should be taken to reduce the case to heatsink capacitance, especially at 180 MHz.

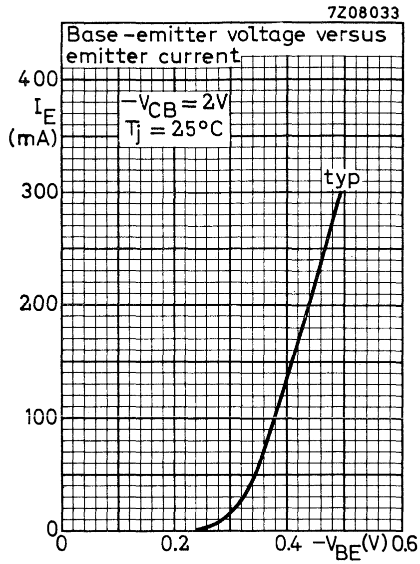
---

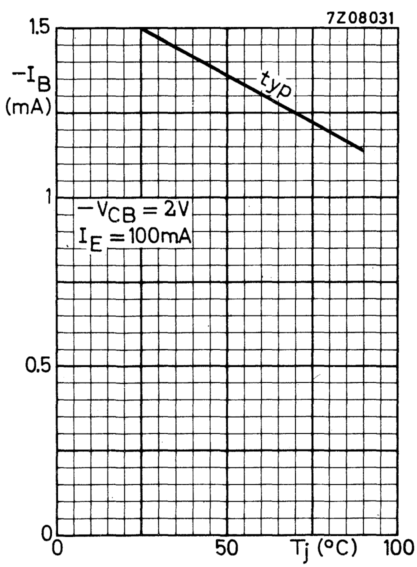
[1]) C_5 should be chosen such that its series conductance can be neglected (e.g. a tubular ceramic capacitor mounted in a copper block).

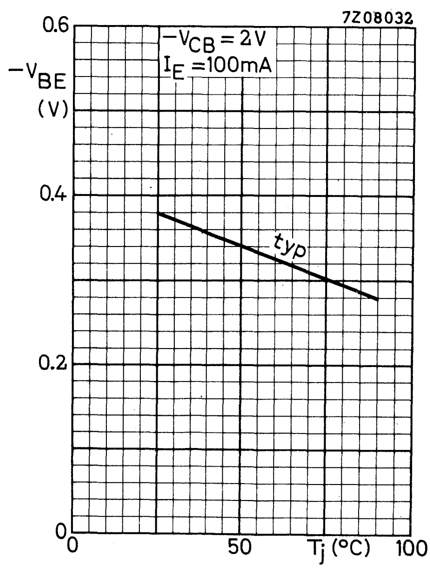
[2]) Without insertion losses and stated minimum P_o.

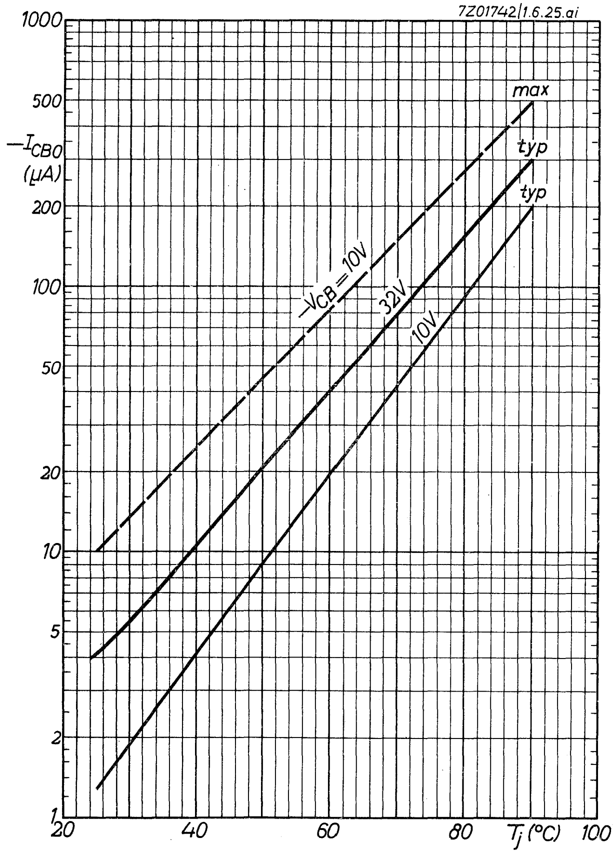
7Z3 1469


7Z08034
Base current versus emitter current
$-V_{CB}$ = 2V
T_j = 25°C
I_E (mA)
typ
max
400
300
200
100
0
0
10
20
$-I_B$(mA)
30


7Z08033
Base-emitter voltage versus emitter current
$-V_{CB}$ = 2V
T_j = 25°C
I_E (mA)
typ
400
300
200
100
0
0
0.2
0.4
$-V_{BE}$(V)
0.6


7Z08031
$-I_B$ (mA)
1.5
1
0.5
0
typ
$-V_{CB}$ = 2V
I_E = 100mA
0
50
T_j (°C)
100


7Z08032
$-V_{BE}$ (V)
0.6
0.4
0.2
0
$-V_{CB}$ = 2V
I_E = 100mA
typ
0
50
T_j (°C)
100


7Z01742/1.6.25.ai
1000
500
$-I_{CBO}$ (μA)
200
100
50
20
10
5
2
1
20
40
60
80
T_j (°C)
100
max
typ
typ
$-V_{CB}=10V$
32V
10V

U.H.F. GERMANIUM EPITAXIAL MESA TRANSISTOR

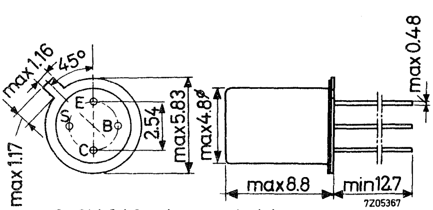
P-N-P transistor in a metal envelope, with insulated electrodes and a shield lead connected to the case. It is primarily intended for use in output stages of aerial amplifiers up to frequencies of 860 MHz.

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

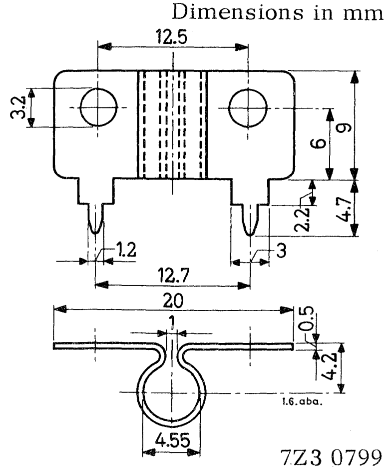
MECHANICAL DATA

Dimensions in mm

insulated electrodes



S=Shield lead connected to case



Cooling fin: 56263

7Z3 0799

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.

7Z3 0800

CHARACTERISTICS T_j = 25 °C unless otherwise specified

Collector cut-off currents				
$I_E = 0$; $-V_{CB} = 20$ V	$-I_{CBO}$	typ.	0.5	μA
		<	8	μA
$I_E = 0$; $-V_{CB} = 20$ V; $T_j = 60$ °C	$-I_{CBO}$	<	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	μA
		<	100	μA
Base current				
$I_E = 1.5$ mA; $-V_{CB} = 12$ V	$-I_B$	typ.	30	μA
		<	150	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.	380	mV
		320 to	430	mV
$I_E = 4$ mA; $-V_{CB} = 20$ V	V_{EB}	typ.	400	mV
		360 to	450	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	ps
		<	6	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	Ω
		<	100	Ω

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

7Z3 0801

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

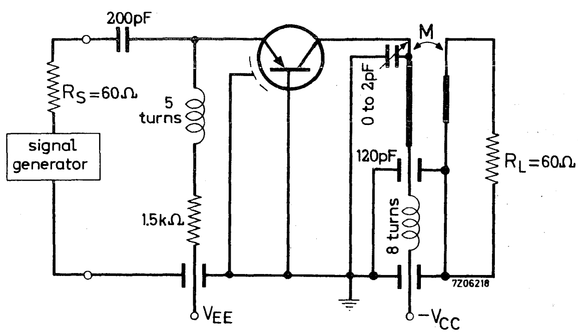
$$G_{tr} = \frac{\text{output power in load } R_L}{\text{available power from source } R_S}$$

I_E = 4 mA; $-V_{CB}$ = 20 V; f = 800 MHz; T_j = 70 °C	G_{tr}	>	10	dB
		typ.	12	dB

Output power

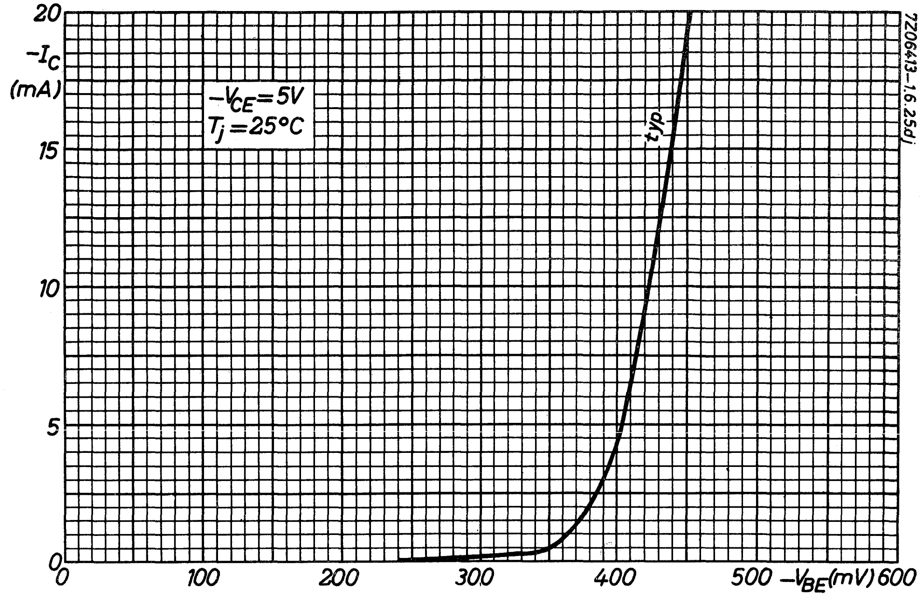
d_{im} = −30 dB; I_E = 4 mA; $-V_{CB}$ = 20 V; f = 800 MHz; T_j = 70 °C	P_o	>	1.5	mW
		typ.	2.7	mW

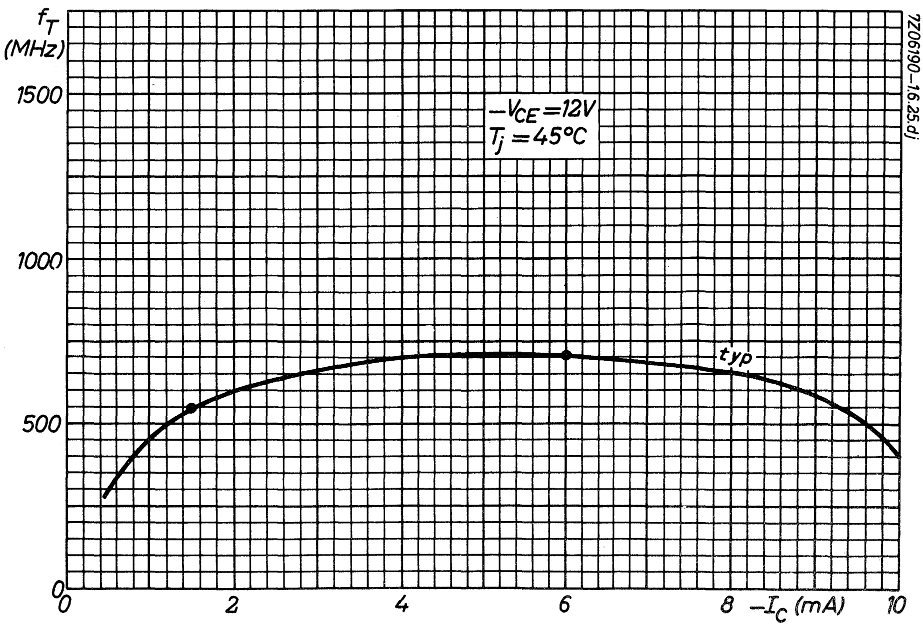
Basic circuit for measuring the transducer gain G_{tr} and the output power P_o

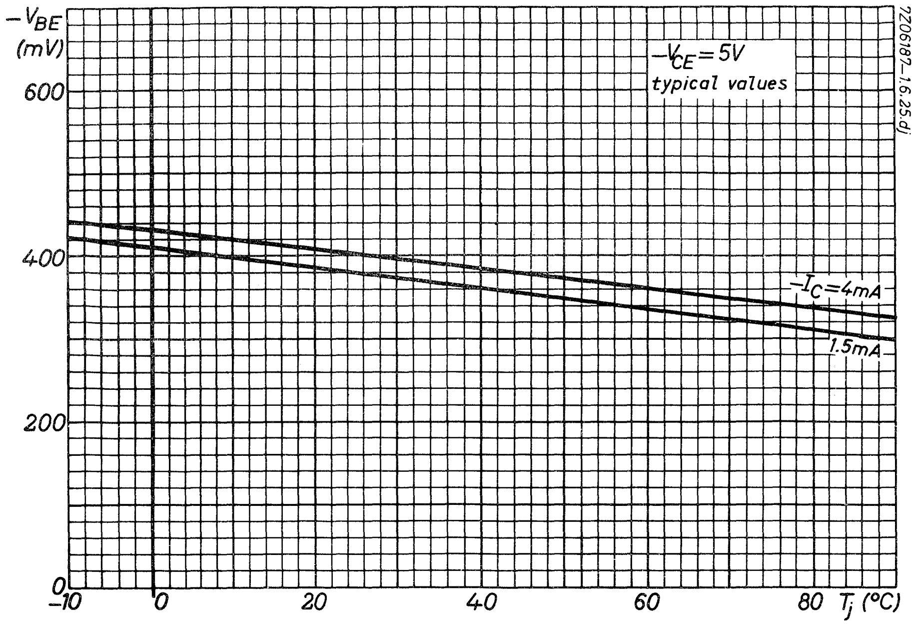


Total effective collector resistance R_c = 1.4 kΩ

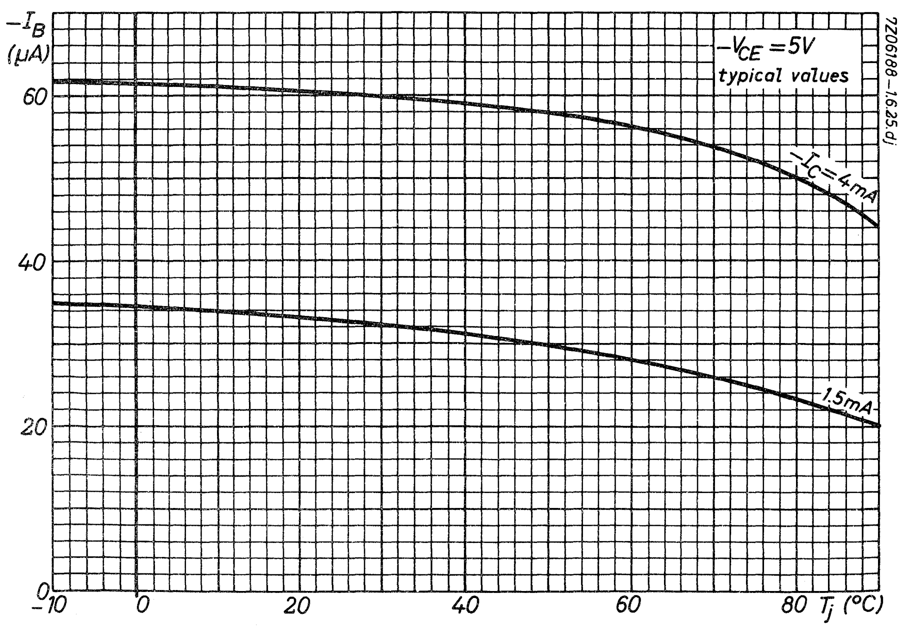
7Z3 0802


20
$-I_C$
(mA)
$-V_{CE}=5V$
$T_j=25°C$
typ
15
10
5
0
0
100
200
300
400
500 $-V_{BE}$(mV) 600
7Z06413-1.6.25d.j

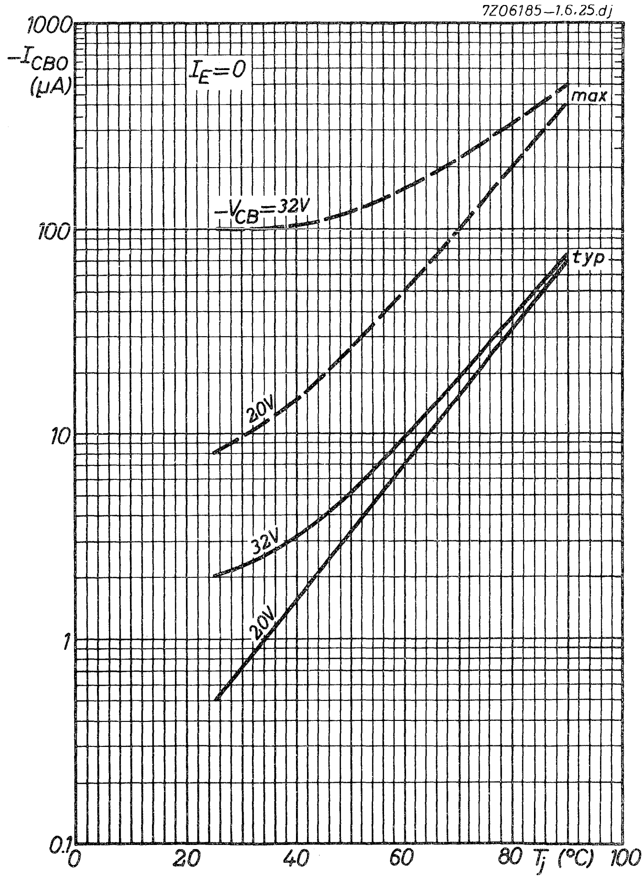

f_T
(MHz)
1500
$-V_{CE}=12V$
$T_j=45°C$
1000
500
typ
0
0
2
4
6
8 $-I_C$ (mA)
10
7Z06190-1.6.25.d.j

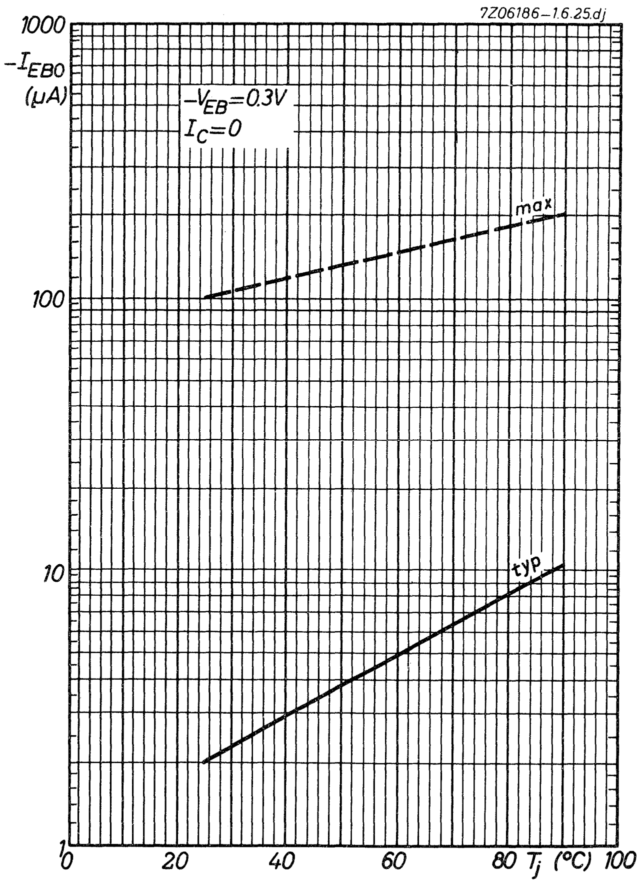


−V_BE (mV)
600
400
200
0
−10
0
20
40
60
80
Tj (°C)
−V_CE = 5V
typical values
−I_C = 4mA
1.5mA
7Z06187-1.6.25.dj



−I_B (μA)
60
40
20
0
−10
0
20
40
60
80
Tj (°C)
−V_CE = 5V
typical values
−I_C = 4mA
1.5mA
7Z06188-1.6.25.dj


7Z06185–1.6.25.dj
1000
$-I_{CBO}$
(μA)
$I_E=0$
max
$-V_{CB}=32V$
100
typ
20V
10
32V
20V
1
0.1
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

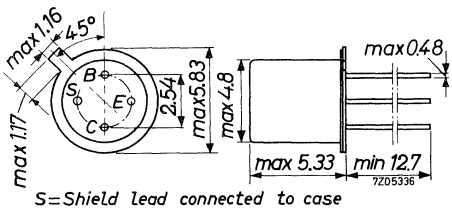
GERMANIUM ALLOY DIFFUSED TRANSISTOR

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 °C	P_{tot}	max.	85	mW
Junction temperature	T_j	max.	75	°C
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 Ω	F	typ.	6.0	dB

MECHANICAL DATA Dimensions in mm

TO-72



S=Shield lead connected to case

7Z3 1462

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 °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

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

7Z3 1463

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

7Z3 1464

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])

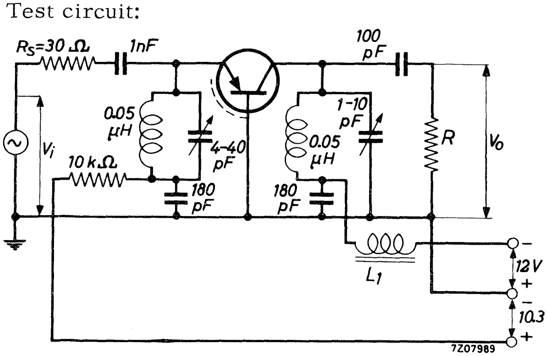
Input conductance	g_{ie}	typ.	28	$m\Omega^{-1}$
Input capacitance	C_{ie}	typ.	13	pF
Feedback admittance	$\lvert y_{re}\rvert$	typ.	500	$\mu\Omega^{-1}$
Phase angle of feedback admittance	φ_{re}	typ.	250°	
Transfer admittance	$\lvert y_{fe}\rvert$	typ.	34	$m\Omega^{-1}$
Phase angle of transfer admittance	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	$\lvert y_{rb}\rvert$	typ.	410	$\mu\Omega^{-1}$
Phase angle of feedback admittance	φ_{rb}	typ.	280°	
Transfer admittance	$\lvert y_{fb}\rvert$	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

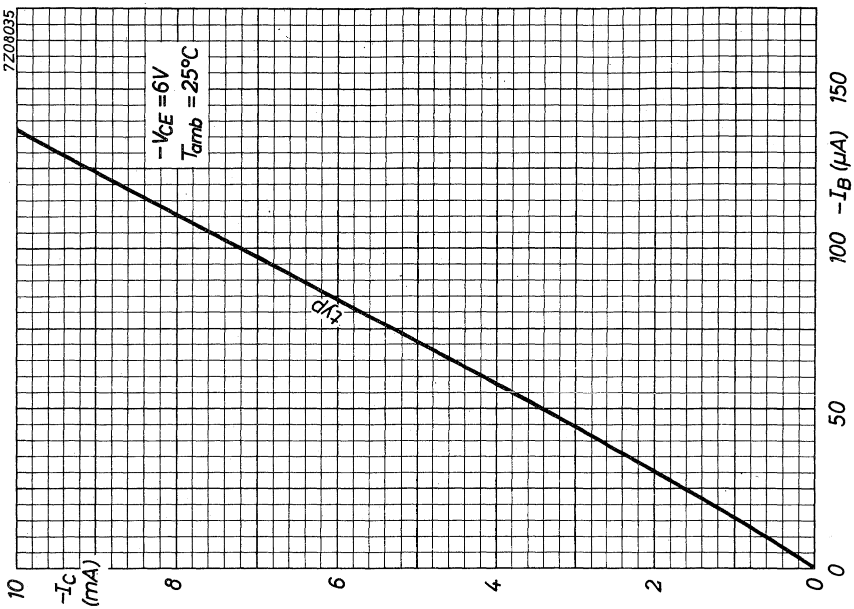
Test circuit:

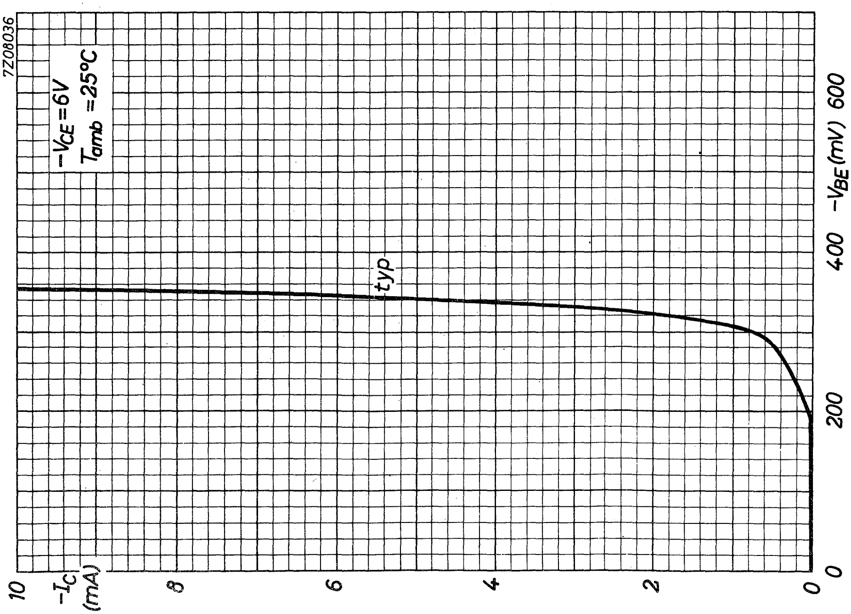


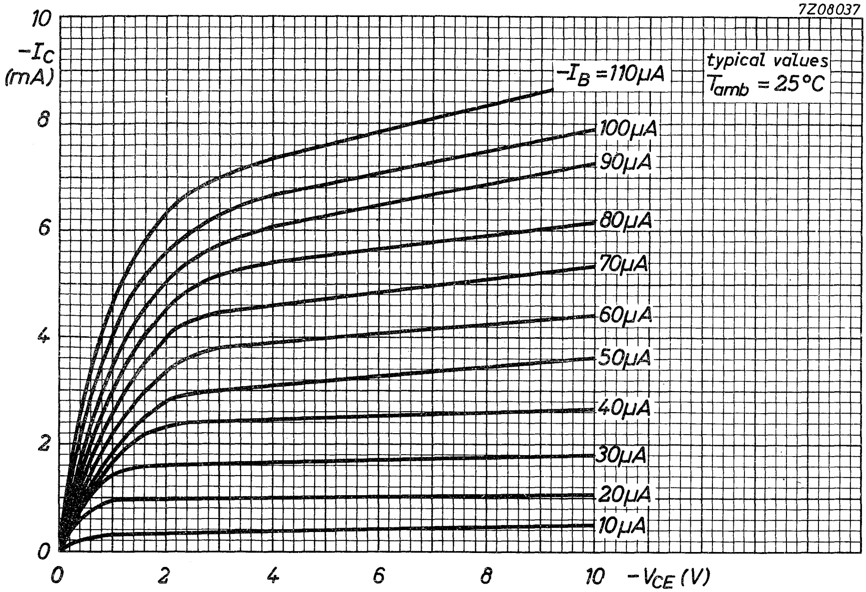
R is chosen such that the total load impedance R_ℓ (R and the tuned circuit in parallel) is 2 kΩ.
L = ferrite bead

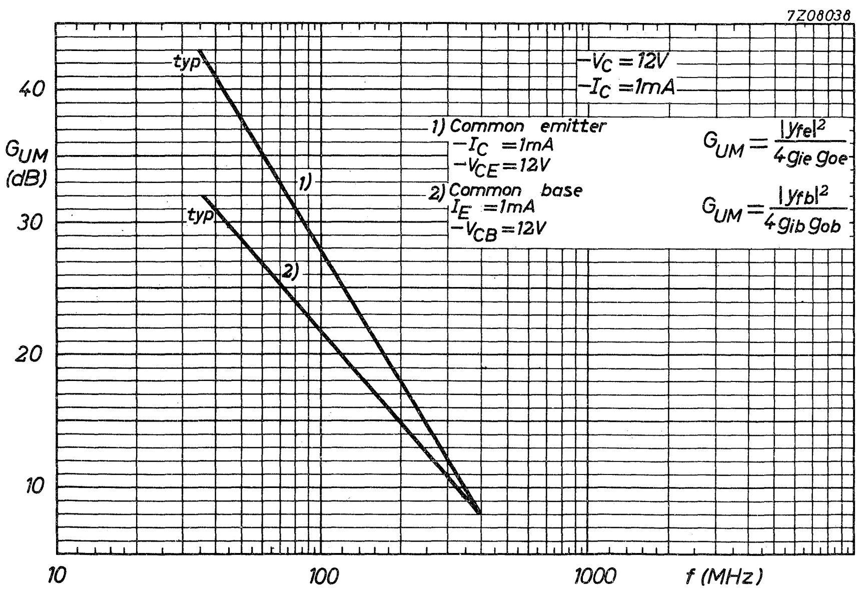
1) Measured with a length of leads between transistor bottom and measuring jig of 5 mm.

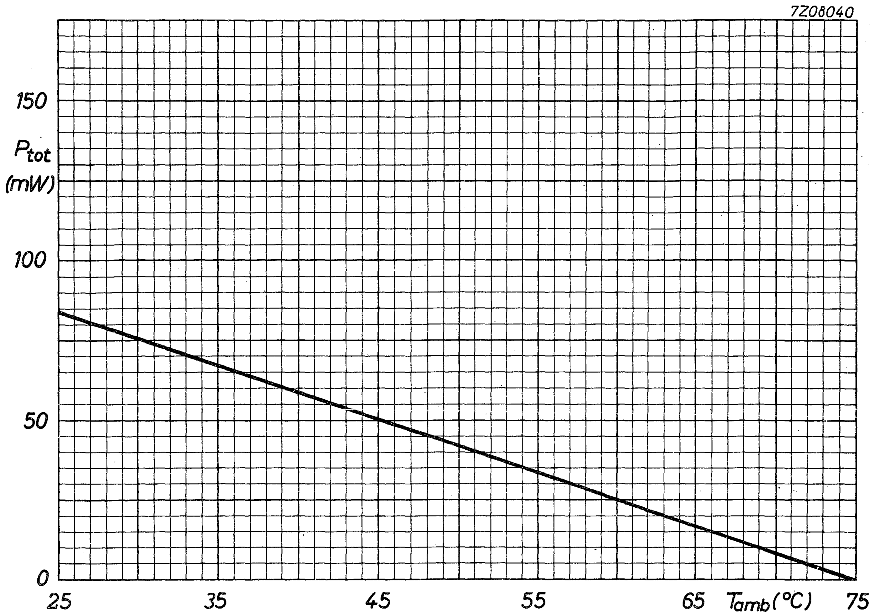
7Z3 1465

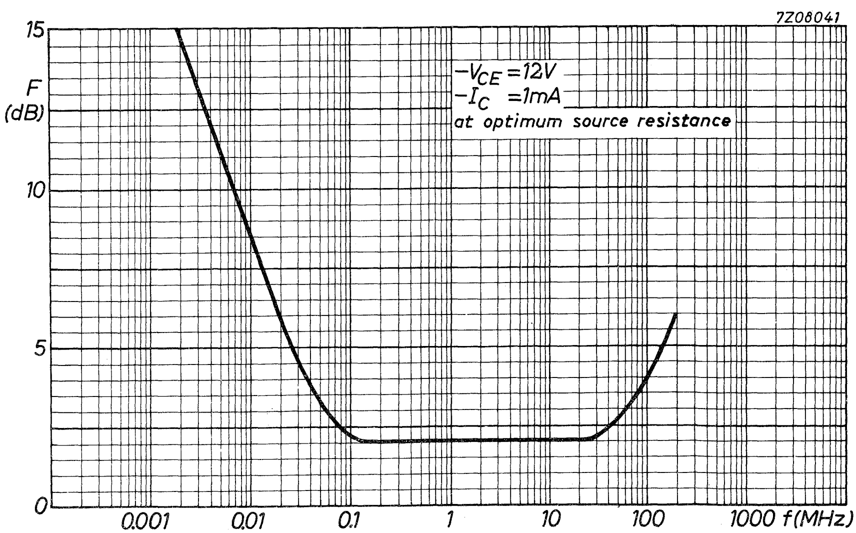

7Z08035
−V_CE = 6V
T_amb = 25°C
typ
−I_B (μA)
0
50
100
150
−I_C (mA)
0
2
4
6
8
10

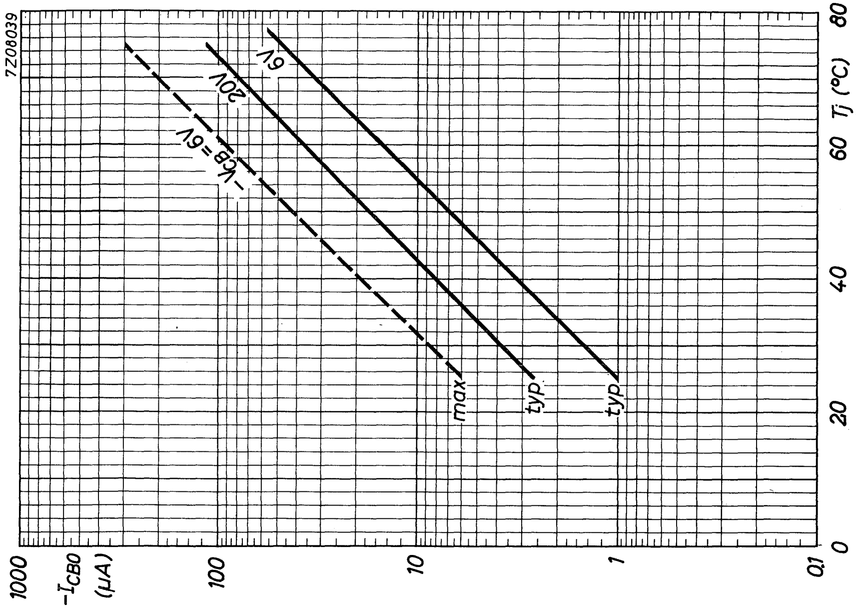

7Z08036
−V_CE = 6V
T_amb = 25°C
typ
−V_BE (mV)
0
200
400
600
−I_C (mA)
0
2
4
6
8
10

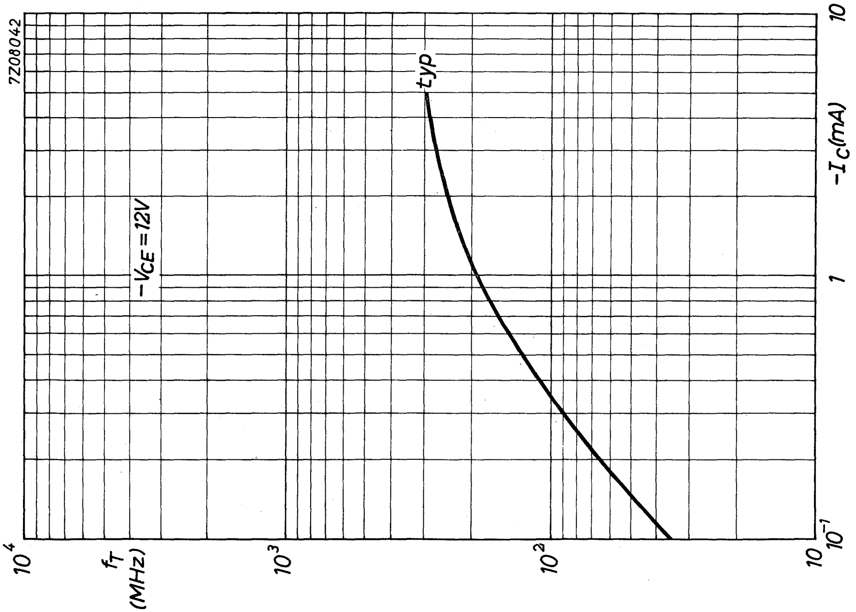

7Z08037
10
$-I_C$
(mA)
8
6
4
2
0
typical values
T_{amb} = 25 °C
$-I_B$ = 110 μA
100 μA
90 μA
80 μA
70 μA
60 μA
50 μA
40 μA
30 μA
20 μA
10 μA
0
2
4
6
8
10
$-V_{CE}$ (V)

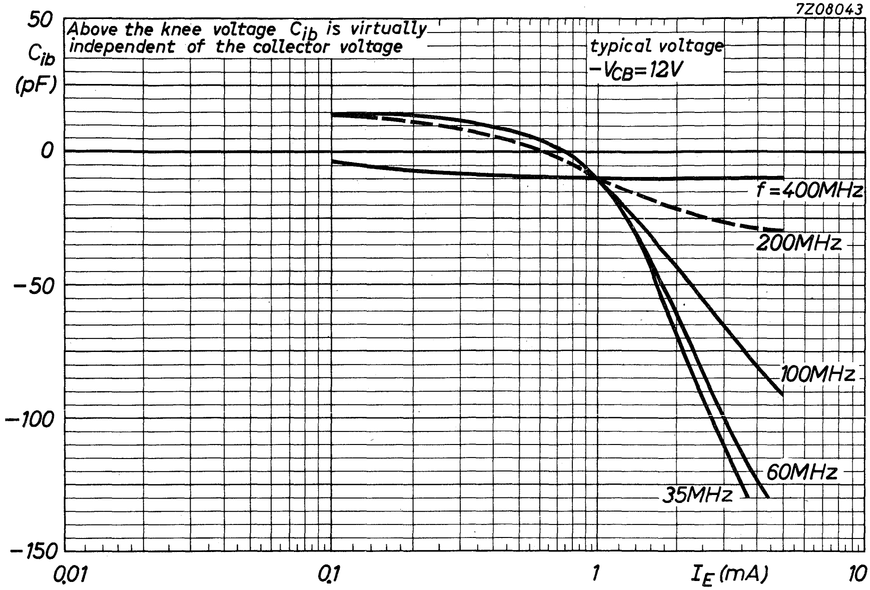

7Z08038
40
G_{UM}
(dB)
30
20
10
typ
typ
1)
2)
$-V_C$ = 12V
$-I_C$ = 1mA
1) Common emitter
$-I_C$ = 1mA
$-V_{CE}$ = 12V
2) Common base
I_E = 1mA
$-V_{CB}$ = 12V
$G_{UM} = \frac{|y_{fe}|^2}{4 g_{ie} g_{oe}}$
$G_{UM} = \frac{|y_{fb}|^2}{4 g_{ib} g_{ob}}$
10
100
1000
f (MHz)

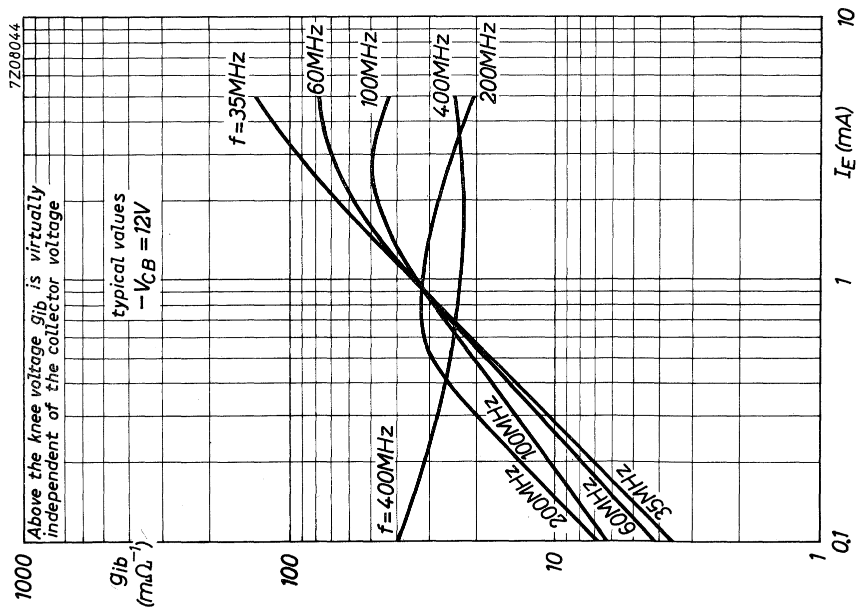

7Z08040
150
P_{tot}
(mW)
100
50
0
25
35
45
55
65
T_{amb} (°C)
75

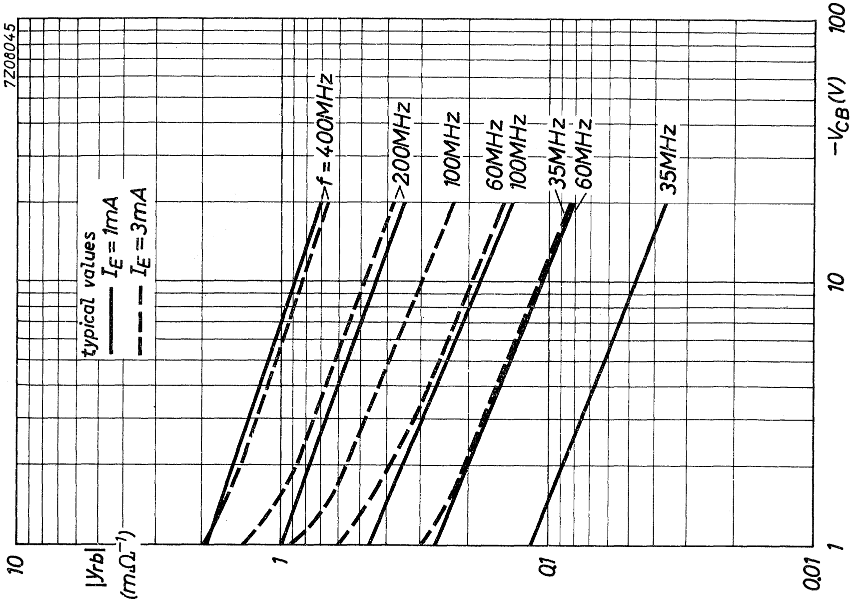

7Z08041
15
F
(dB)
10
5
0
$-V_{CE}$ = 12V
$-I_C$ = 1mA
at optimum source resistance
0.001
0.01
0.1
1
10
100
1000 f (MHz)

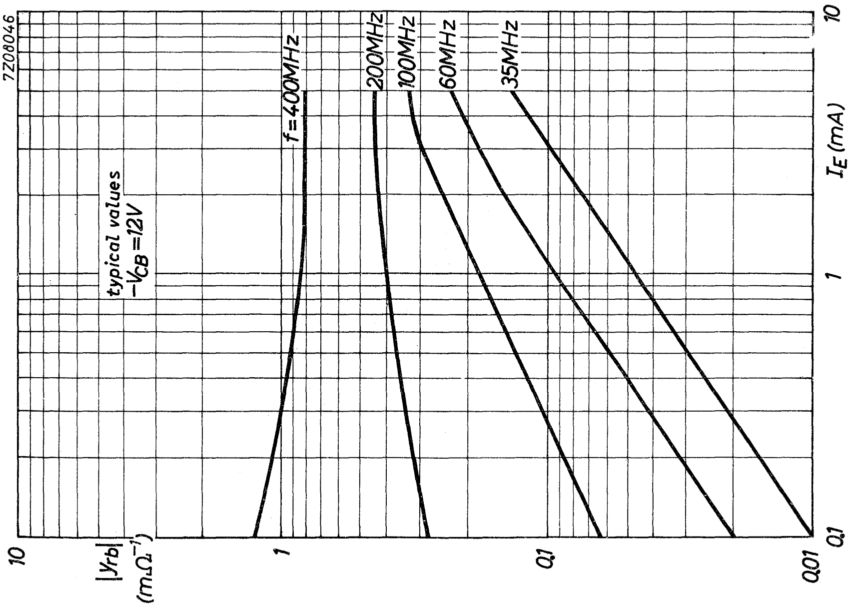

7Z08039
1000
$-I_{CBO}$
(μA)
100
10
1
0.1
$-V_{CB}=6V$
20V
6V
max
typ
typ
0
20
40
60
80
Tj (°C)

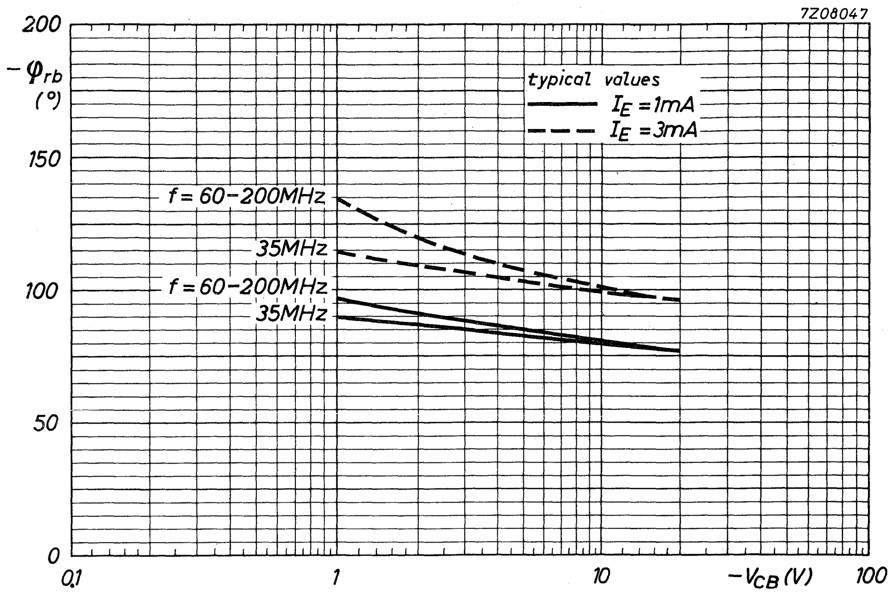

7Z08042
10^4
f_T
(MHz)
10^3
10^2
10
$-V_{CE}=12V$
typ
10^{-1}
1
10
$-I_C$(mA)

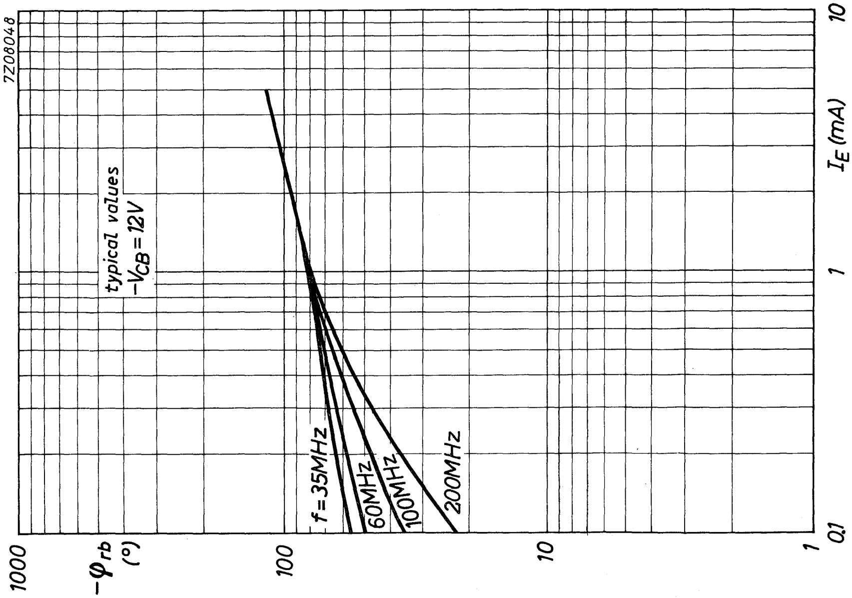

7Z08043
50
C_{ib}
(pF)
0
−50
−100
−150
Above the knee voltage C_{ib} is virtually independent of the collector voltage
typical voltage
$-V_{CB}$=12V
f=400MHz
200MHz
100MHz
60MHz
35MHz
0.01
0.1
1
I_E (mA)
10


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
1000
g_{ib}
$(m\Omega^{-1})$
100
10
1
10
I_E (mA)
1
0.1

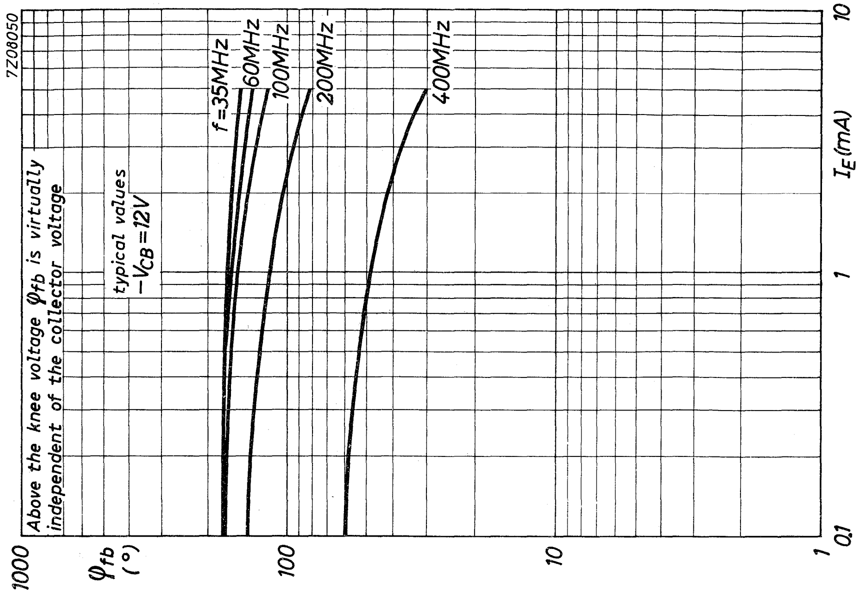

7Z08045
typical values
— I_E = 1mA
– – I_E = 3mA
f = 400MHz
200MHz
100MHz
60MHz
100MHz
35MHz
60MHz
35MHz
$|y_{rb}|$ (mΩ^{-1})
10
1
0.1
0.01
$-V_{CB}$ (V)
1
10
100

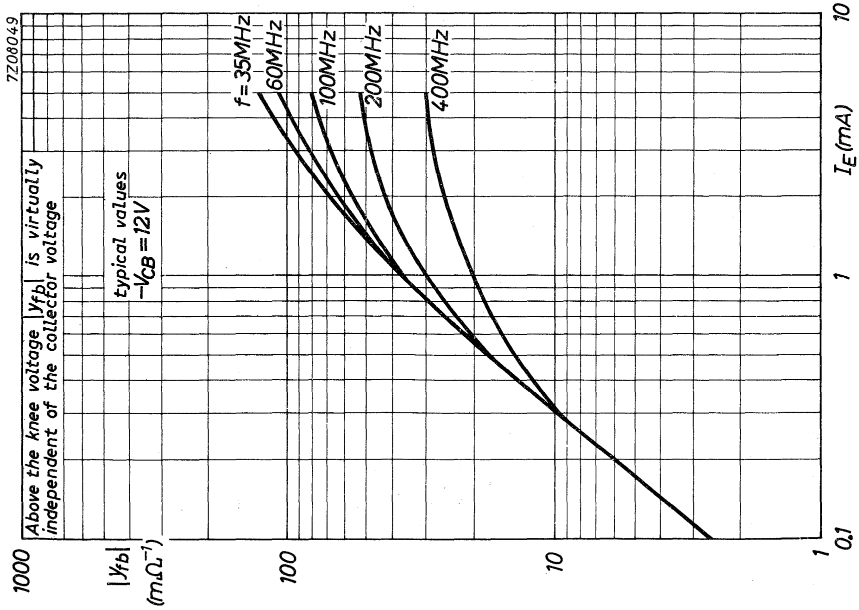

7Z08046
typical values
$-V_{CB}$ = 12V
f = 400MHz
200MHz
100MHz
60MHz
35MHz
$|y_{rb}|$ (mΩ^{-1})
10
1
0.1
0.01
I_E (mA)
0.1
1
10

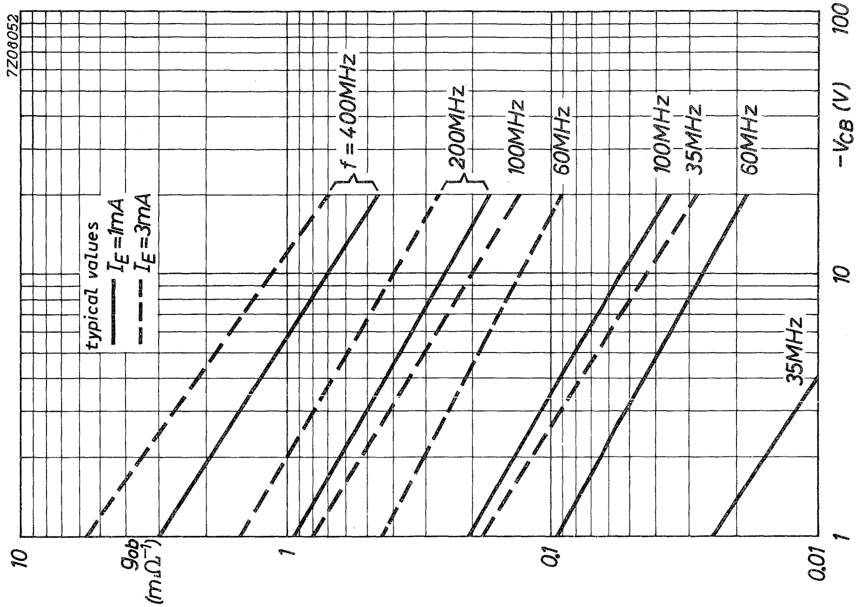

7Z08047
200
$-\varphi_{rb}$
(°)
150
100
50
0
0.1
1
10
100
$-V_{CB}$ (V)
typical values
I_E = 1mA
I_E = 3mA
f = 60–200MHz
35MHz
f = 60–200MHz
35MHz

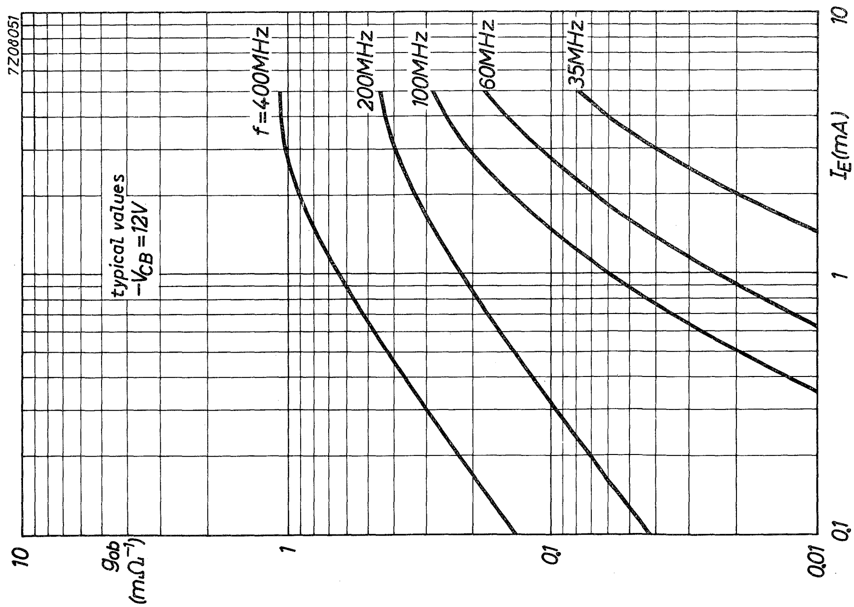

7Z08048
typical values
$-V_{CB}$ = 12V
f = 35MHz
60MHz
100MHz
200MHz
1000
100
10
1
$-\varphi_{rb}$
(°)
10
1
0.1
I_E (mA)

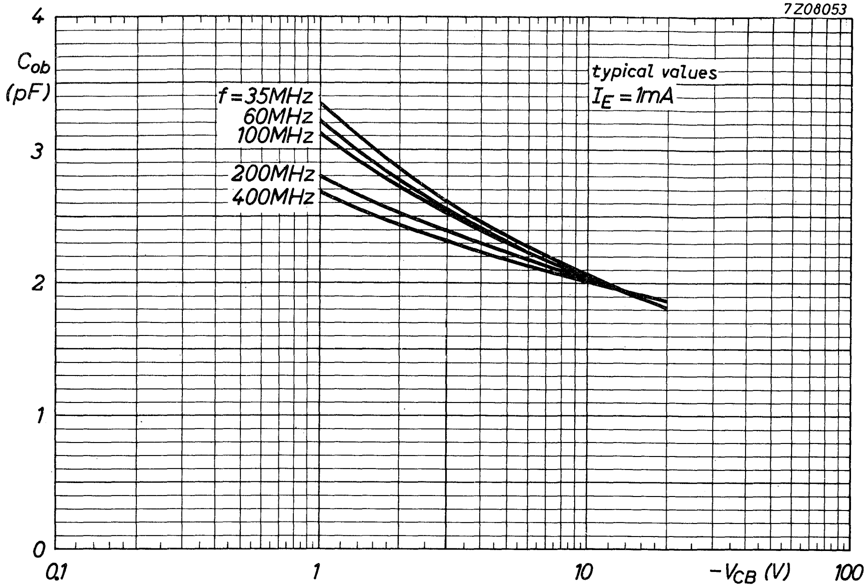
AFZ12

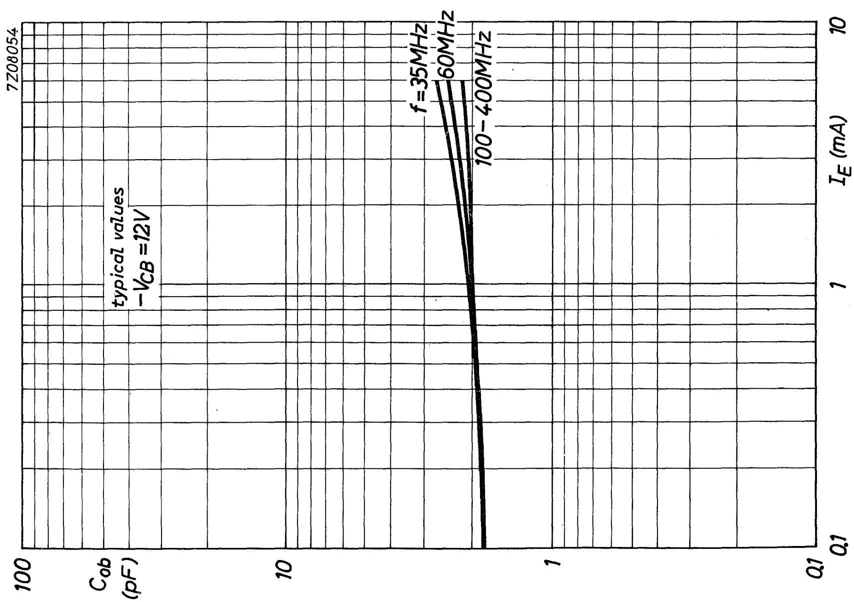

7Z08050
Above the knee voltage φfb is virtually independent of the collector voltage
typical values
−VCB = 12V
f = 35MHz
60MHz
100MHz
200MHz
400MHz
φfb (°)
1000
100
10
1
0.1
1
10
IE (mA)

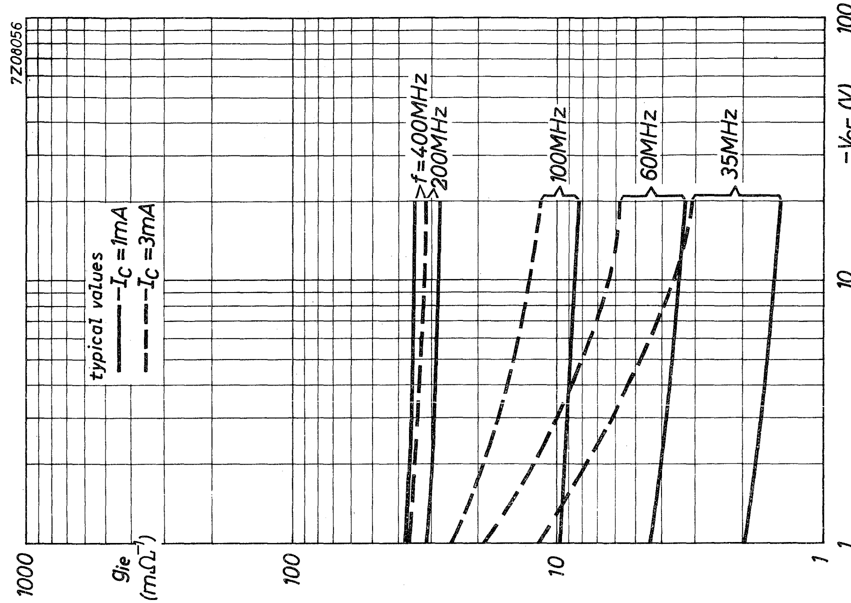

7Z08049
Above the knee voltage |yfb| is virtually independent of the collector voltage
typical values
−VCB = 12V
f = 35MHz
60MHz
100MHz
200MHz
400MHz
|yfb| (mΩ⁻¹)
1000
100
10
1
0.1
1
10
IE (mA)

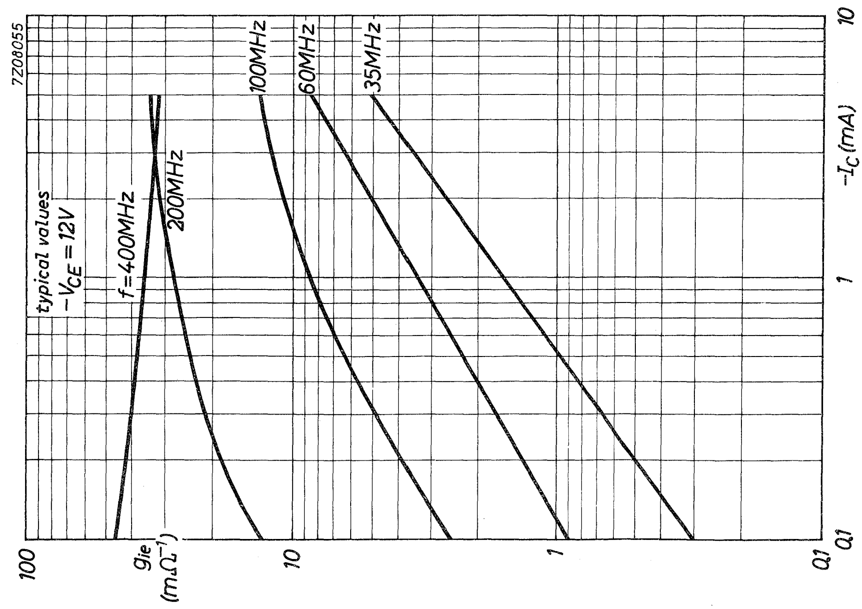

7Z08052
typical values
I_E =1mA
I_E =3mA
f = 400MHz
200MHz
100MHz
60MHz
100MHz
35MHz
60MHz
35MHz
g_{ob} ($m\Omega^{-1}$)
10
1
0.1
0.01
$-V_{CB}$ (V)
1
10
100

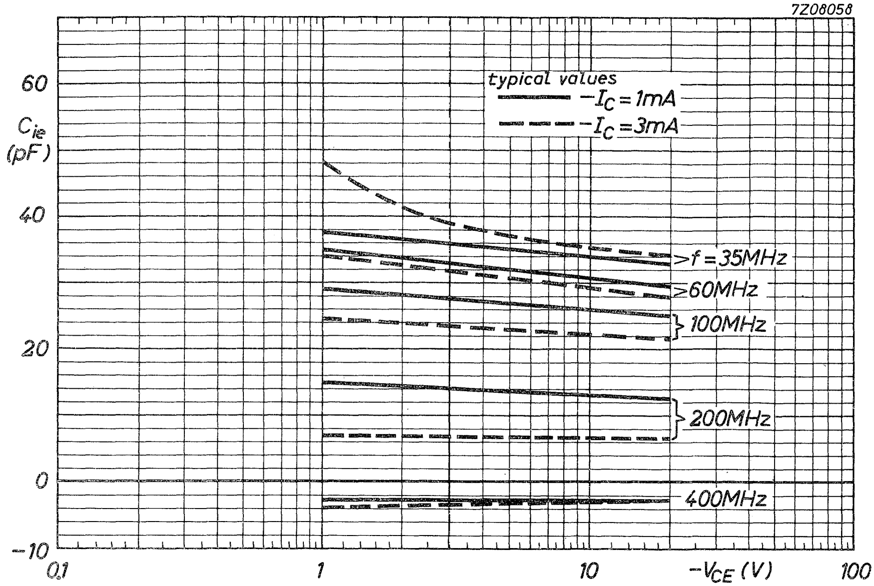

7Z08051
typical values
$-V_{CB}$ =12V
f =400MHz
200MHz
100MHz
60MHz
35MHz
g_{ob} ($m\Omega^{-1}$)
10
1
0.1
0.01
I_E(mA)
0.1
1
10

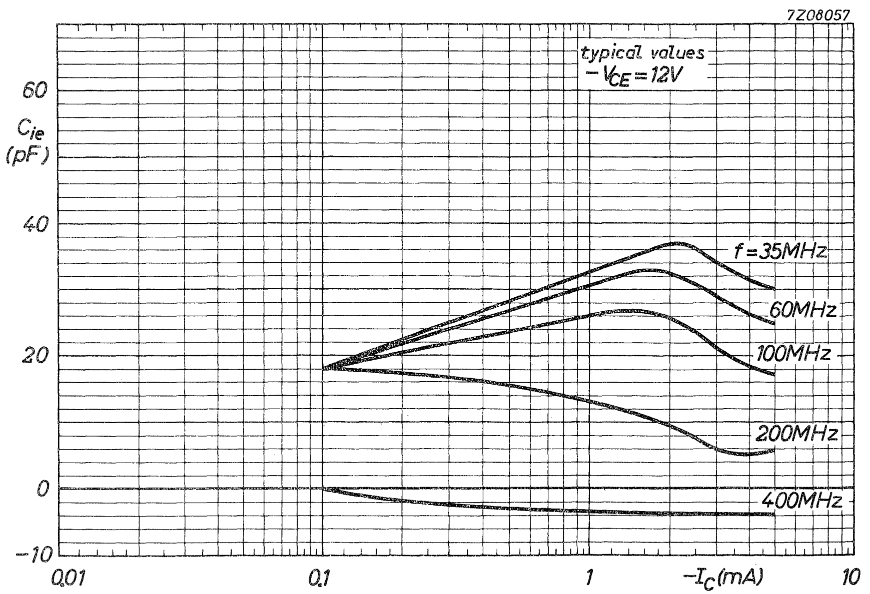

7Z08053
4
3
2
1
0
C_{ob} (pF)
typical values
$I_E = 1mA$
f = 35MHz
60MHz
100MHz
200MHz
400MHz
0.1
1
10
$-V_{CB}$ (V)
100

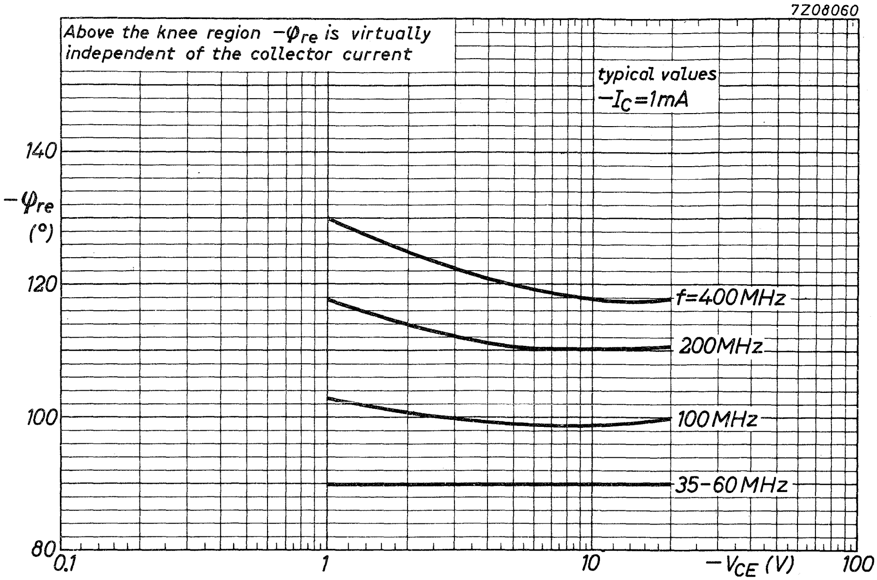

7Z08054
typical values
$-V_{CB} = 12V$
f = 35MHz
60MHz
100 - 400MHz
10
1
0.1
I_E (mA)
100
C_{ob} (pF)
10
1
0.1

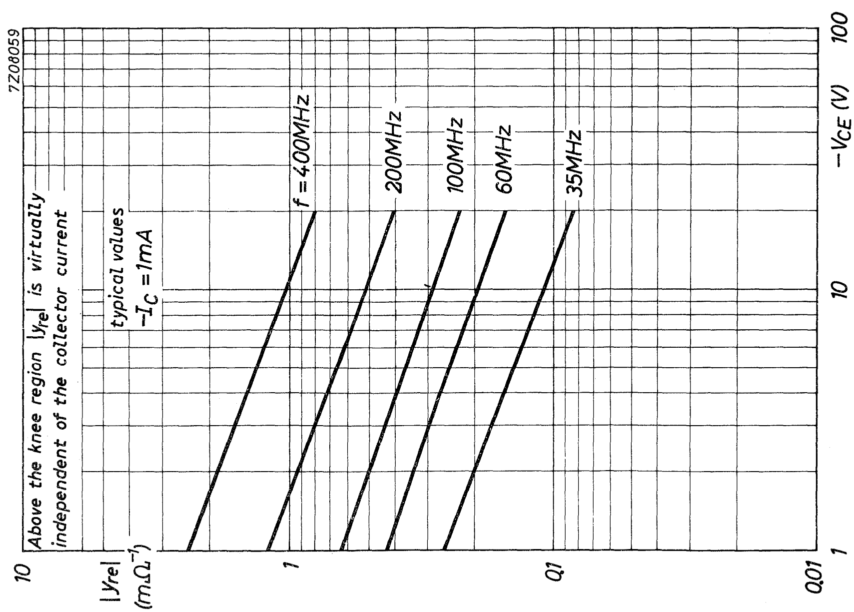

7Z08056
typical values
—— $-I_C = 1mA$
— — $-I_C = 3mA$
f = 400MHz
200MHz
100MHz
60MHz
35MHz
g_{ie} ($m\Omega^{-1}$)
1000
100
10
1
1
10
100
$-V_{CE}$ (V)

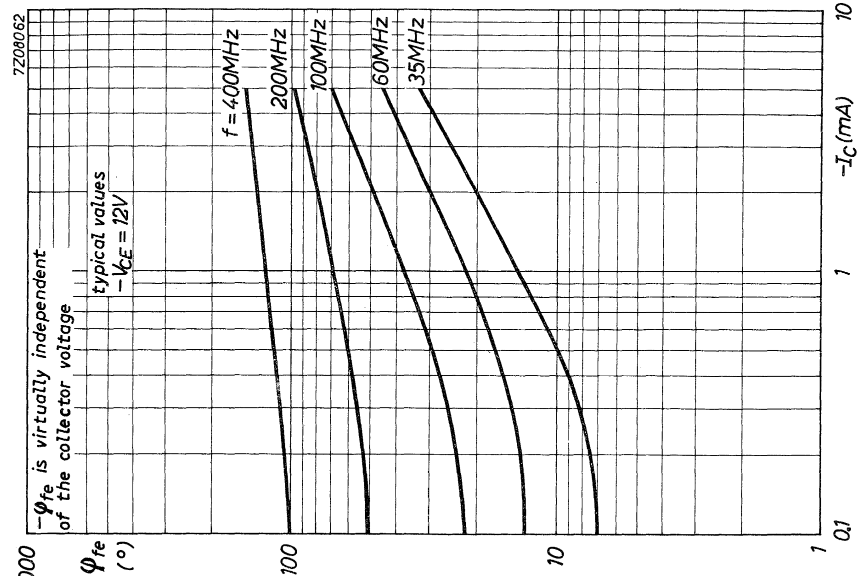

7Z08055
typical values
$-V_{CE} = 12V$
f = 400MHz
200MHz
100MHz
60MHz
35MHz
g_{ie} ($m\Omega^{-1}$)
100
10
1
0.1
0.1
1
10
$-I_C$ (mA)

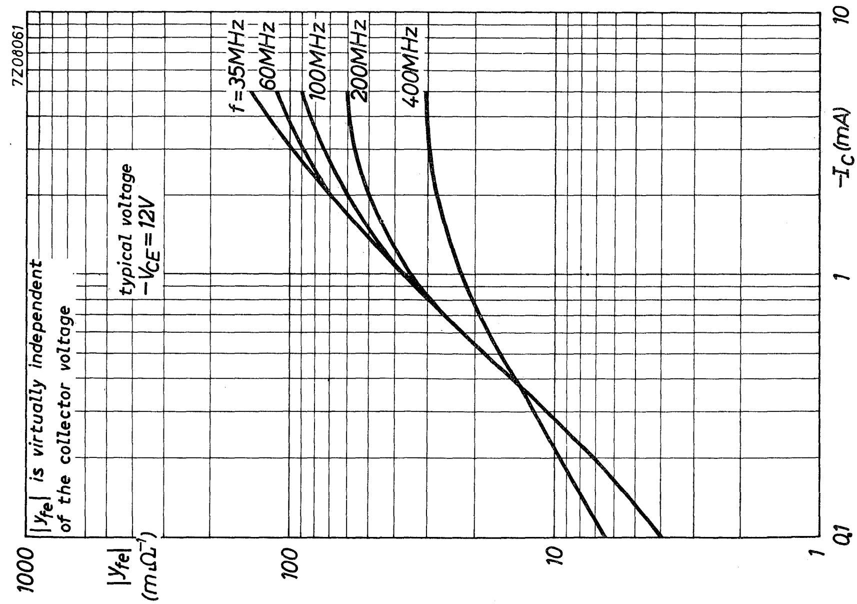

7Z08058
typical values
$-I_C = 1mA$
$-I_C = 3mA$
C_{ie} (pF)
60
40
20
0
−10
f = 35MHz
60MHz
100MHz
200MHz
400MHz
0.1
1
10
$-V_{CE}$ (V)
100


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
100
$-V_{CE}$ (V)
10
1
10
$|y_{re}|$
(mΩ^{-1})
1
0.1
0.01


7Z08062
$-\varphi_{fe}$ is virtually independent of the collector voltage
typical values
$-V_{CE} = 12V$
f = 400MHz
200MHz
100MHz
60MHz
35MHz
1000
φ_{fe} (°)
100
10
1
0.1
1
10
$-I_C$ (mA)


7Z08061
$|y_{fe}|$ is virtually independent of the collector voltage
typical voltage
$-V_{CE} = 12V$
f = 35MHz
60MHz
100MHz
200MHz
400MHz
1000
$|y_{fe}|$ ($m\Omega^{-1}$)
100
10
1
0.1
1
10
$-I_C$ (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.

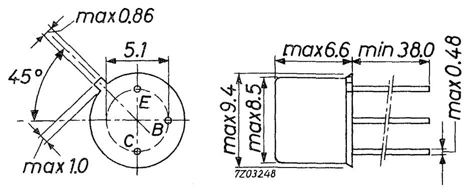
QUICK REFERENCE DATA

			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 current (peak value)	$-I_{CM}$	max.	300	300	mA
Total power dissipation up to T_{amb} = 25 °C	P_{tot}	max.	150	150	mW
Junction temperature	T_j	max.	85	85	°C
D.C. current gain at T_j = 25 °C					
$-I_C$ = 20 mA; $-V_{CE}$ = 1 V	h_{FE}	>	30	50	
$-I_C$ = 200 mA; $-V_{CE}$ = 1 V	h_{FE}	>	15	20	
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
Transition frequency					
$-I_C$ = 3 mA; $-V_{CE}$ = 5 V	f_T	typ.	8	14	MHz
Turn on time ($t_d + t_r$)	t_{on}	typ.	340	250	ns
Turn off time ($t_s + t_f$)	t_{off}	typ.	975	1000	ns

MECHANICAL DATA

Dimensions in mm

TO-5
Base connected to case



7Z3 0019

RATINGS (Limiting values) [1]

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 °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

CHARACTERISTICS T_j = 25 °C unless otherwise specified

Collector cut-off current

			ASY26	ASY27	
$I_E = 0$; $-V_{CB}$ = 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

			ASY26	ASY27	
$I_C = 0$; $-V_{EB}$ = 5 V	$-I_{EBO}$	<	3	3	μA

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

7Z3 0020

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

			ASY26	ASY27	
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
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

7Z3 1422

CHARACTERISTICS (continued) $T_j = 25\ ^oC$

		ASY26	ASY27	
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	$\mu\Omega^{-1}$
Switching characteristics				
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

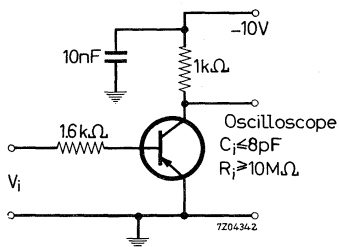
7Z3 0022

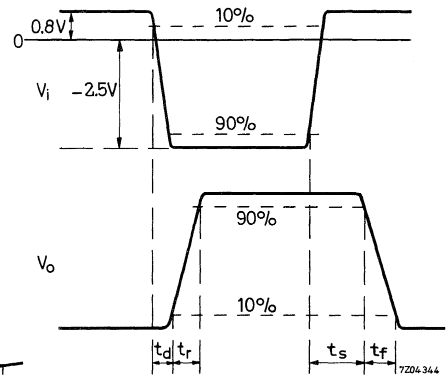
CHARACTERISTICS (continued) $T_j = 25\ ^oC$

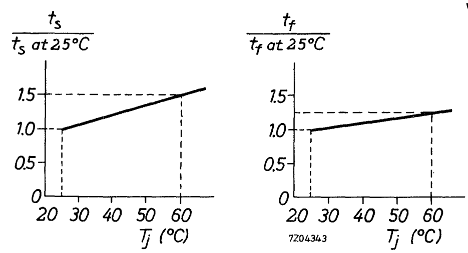
Switching times (See test circuit)

			ASY26	ASY27	
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

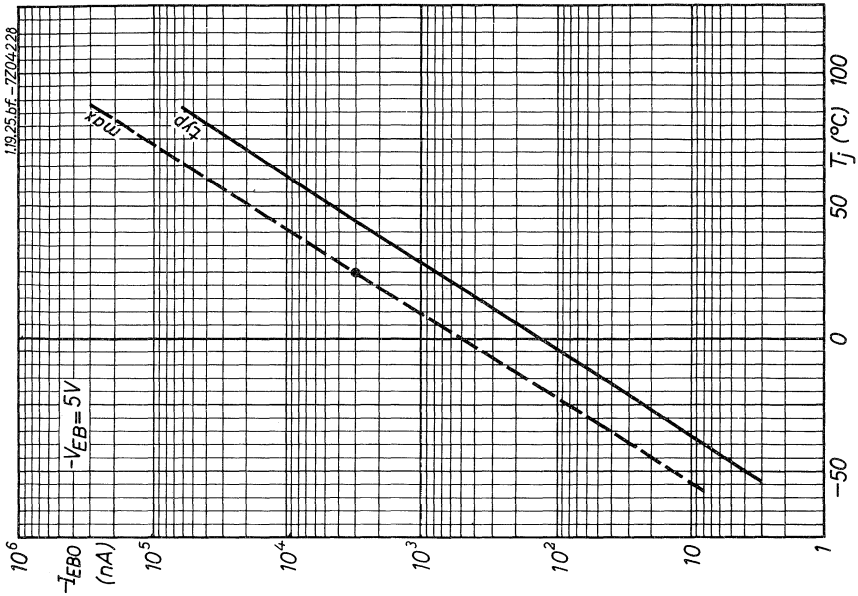
Test circuit:

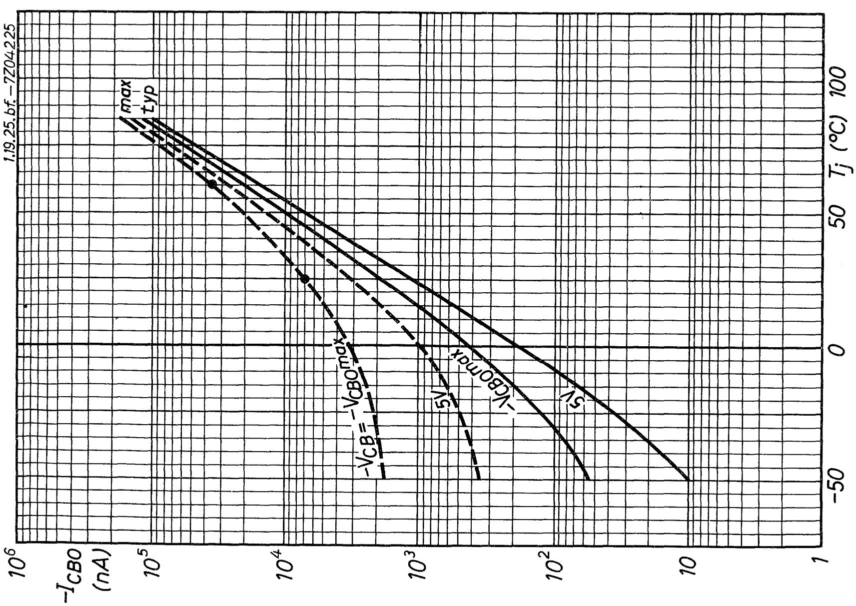


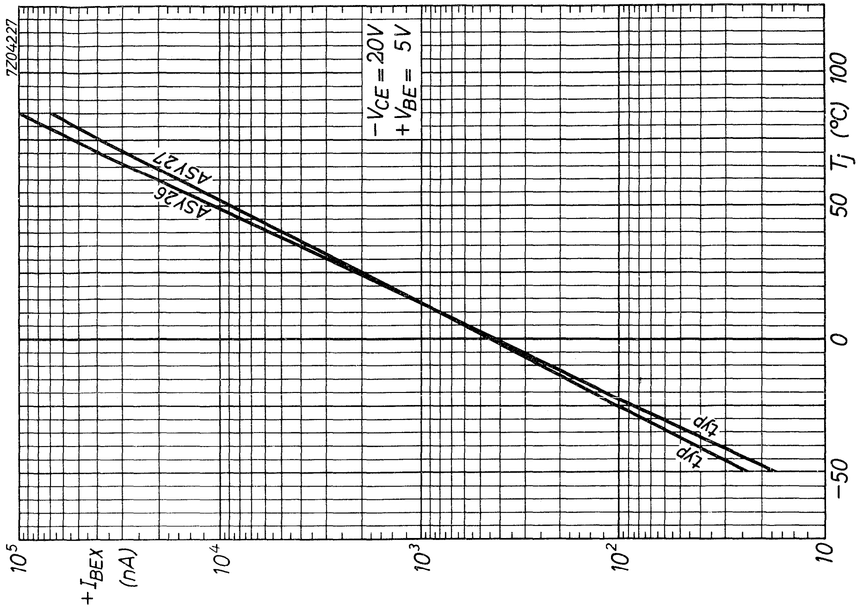


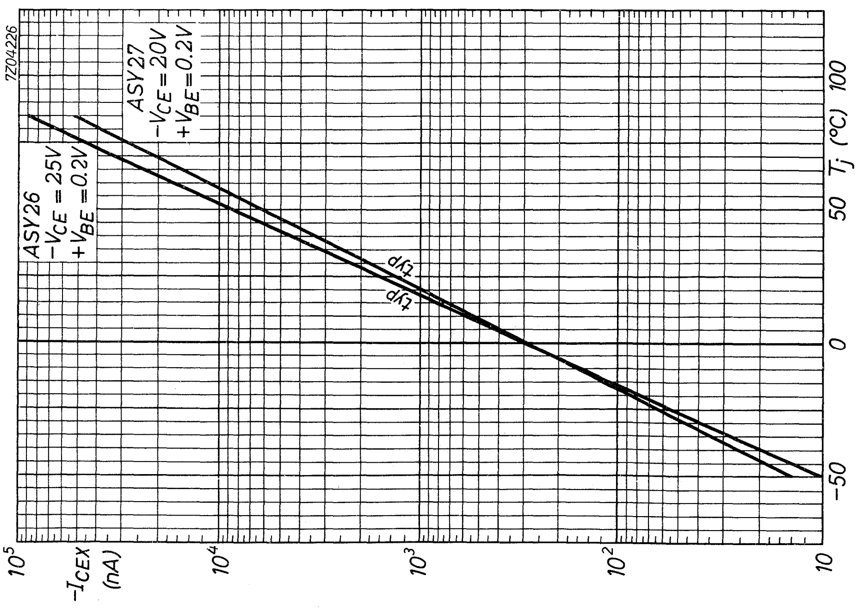


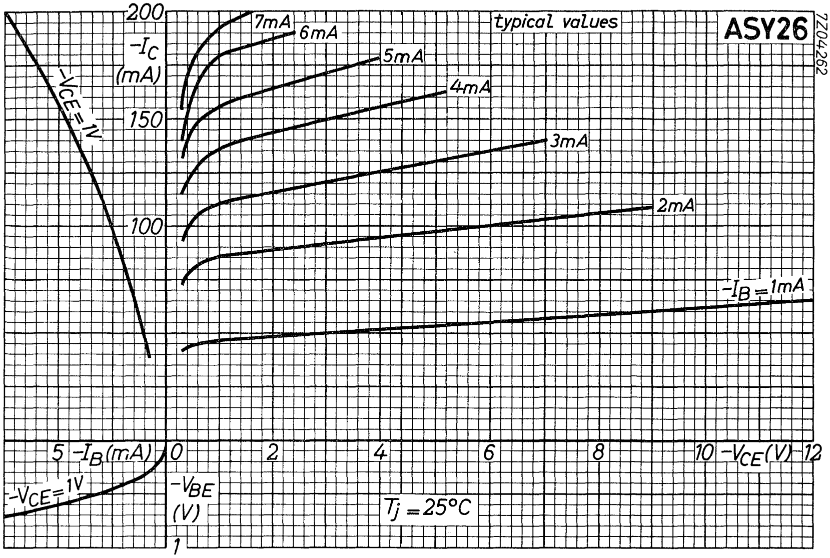
7Z3 0023

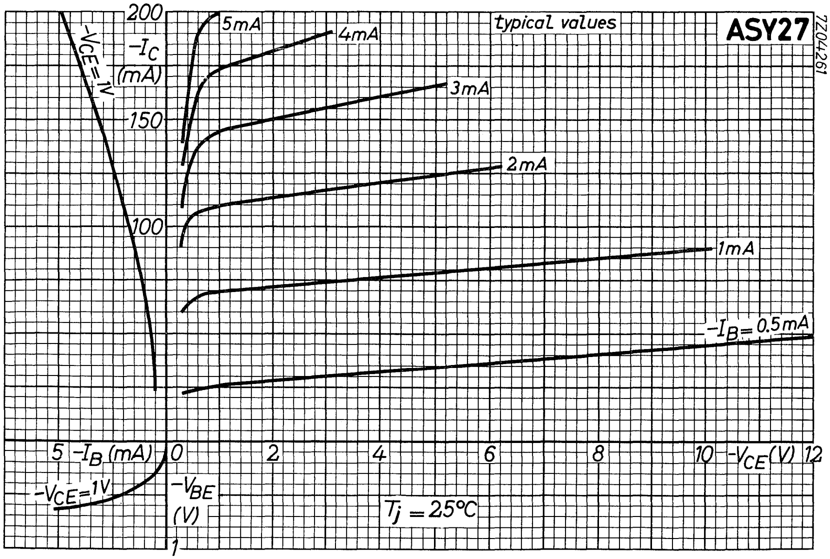

1.19.25.bf.-7Z04228
$-V_{EB}=5V$
max
typ
$-I_{EBO}$ (nA)
10^6
10^5
10^4
10^3
10^2
10
1
T_j (°C)
−50
0
50
100

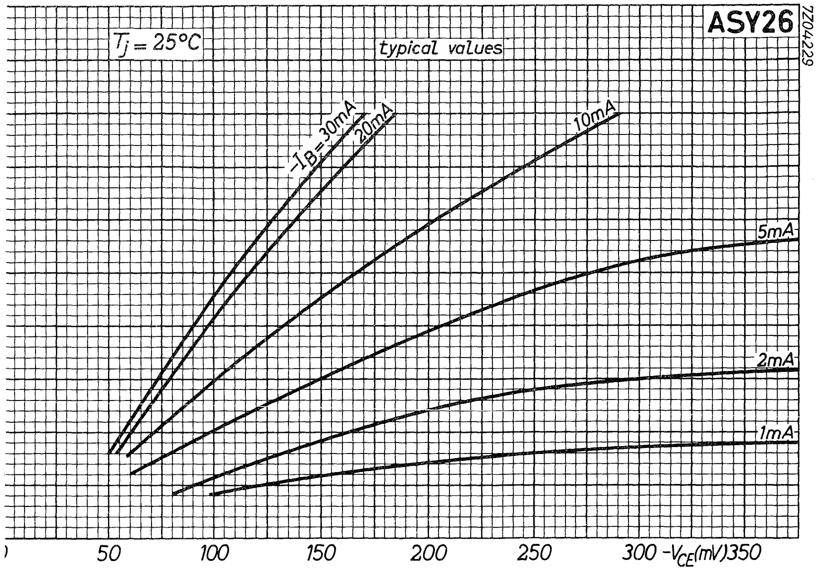

1.19.25.bf.-7Z04225
max
typ
$-V_{CB}=-V_{CBOmax}$
5V
$-V_{CBOmax}$
5V
$-I_{CBO}$ (nA)
10^6
10^5
10^4
10^3
10^2
10
1
T_j (°C)
−50
0
50
100

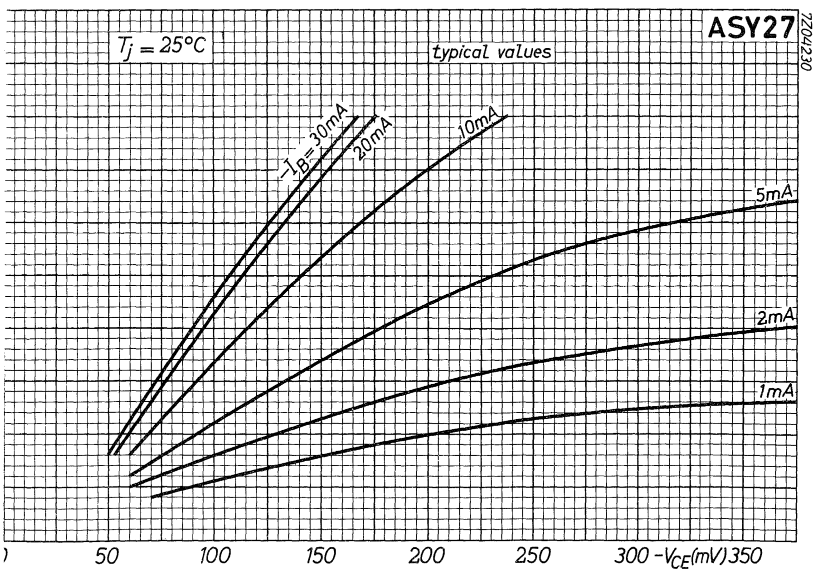

7Z04227
$-V_{CE} = 20V$
$+V_{BE} = 5V$
ASY27
ASY26
typ
typ
$+I_{BEX}$ (nA)
T_j (°C)

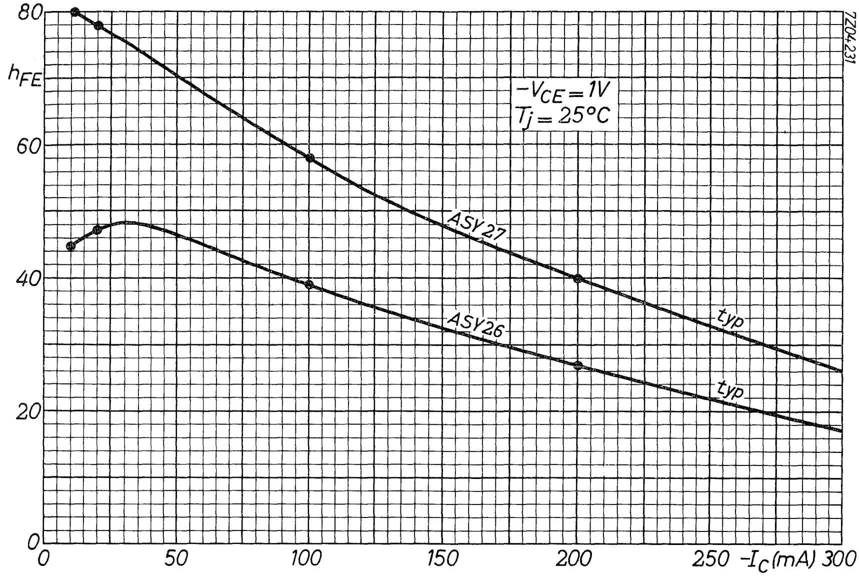

7Z04226
ASY26
$-V_{CE} = 25V$
$+V_{BE} = 0.2V$
ASY27
$-V_{CE} = 20V$
$+V_{BE} = 0.2V$
typ
typ
$-I_{CEX}$ (nA)
T_j (°C)

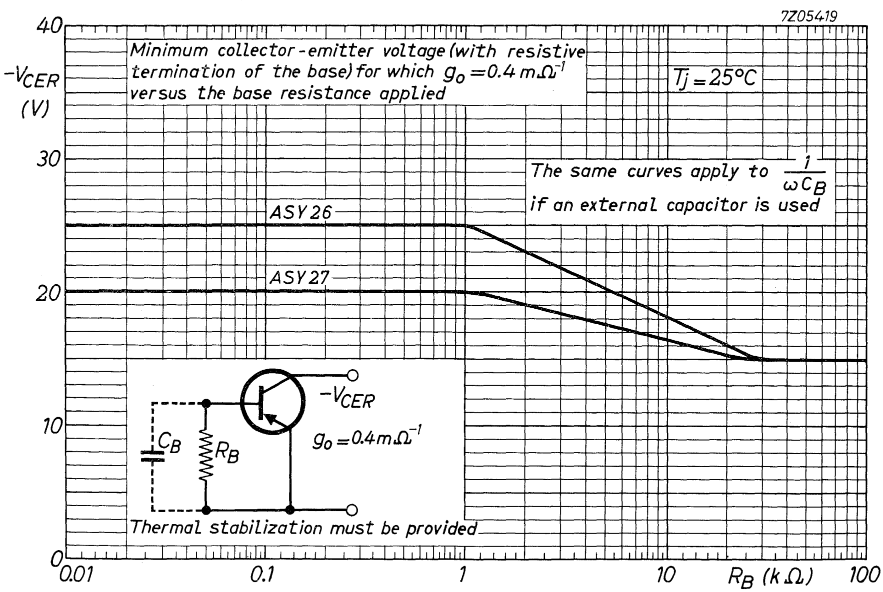

200
$-I_C$
(mA)
150
100
7mA
6mA
5mA
4mA
3mA
2mA
$-I_B = 1mA$
typical values
ASY26
7Z04262
$-V_{CE} = 1V$
5 $-I_B$ (mA)
0
2
4
6
8
10 $-V_{CE}$ (V) 12
$-V_{CE} = 1V$
$-V_{BE}$
(V)
1
$T_j = 25°C$

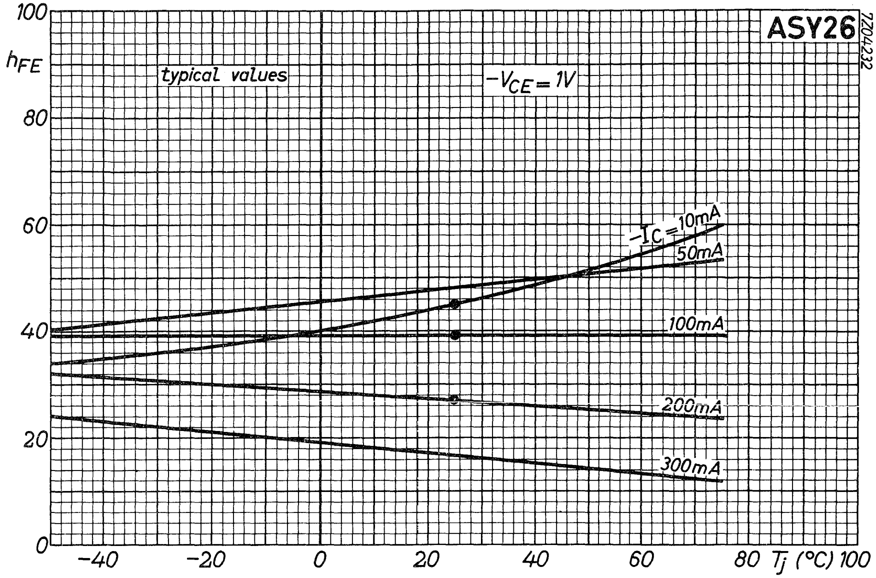

200
$-I_C$
(mA)
150
100
5mA
4mA
3mA
2mA
1mA
$-I_B = 0.5mA$
typical values
ASY27
7Z04261
$-V_{CE} = 1V$
5 $-I_B$ (mA)
0
2
4
6
8
10 $-V_{CE}$ (V) 12
$-V_{CE} = 1V$
$-V_{BE}$
(V)
1
$T_j = 25°C$

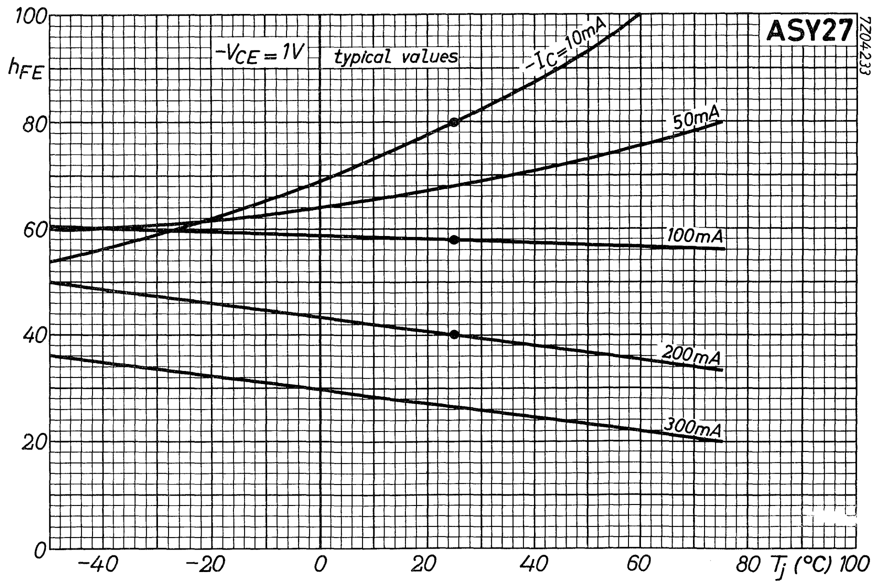

ASY26
7Z04229
$T_j = 25°C$
typical values
$-I_B = 30mA$
20mA
10mA
5mA
2mA
1mA
50
100
150
200
250
300 $-V_{CE}$(mV) 350

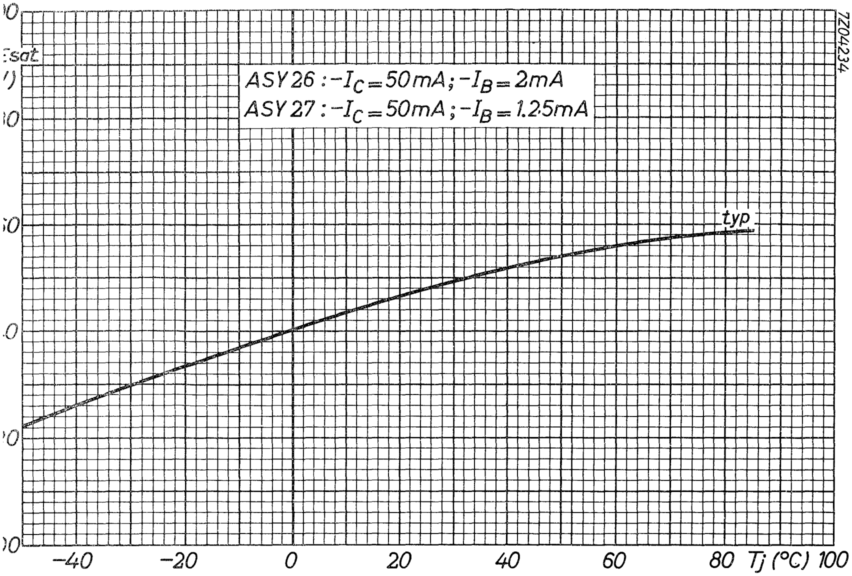

ASY27
7Z04230
$T_j = 25°C$
typical values
$-I_B = 30mA$
20mA
10mA
5mA
2mA
1mA
50
100
150
200
250
300 $-V_{CE}$(mV) 350

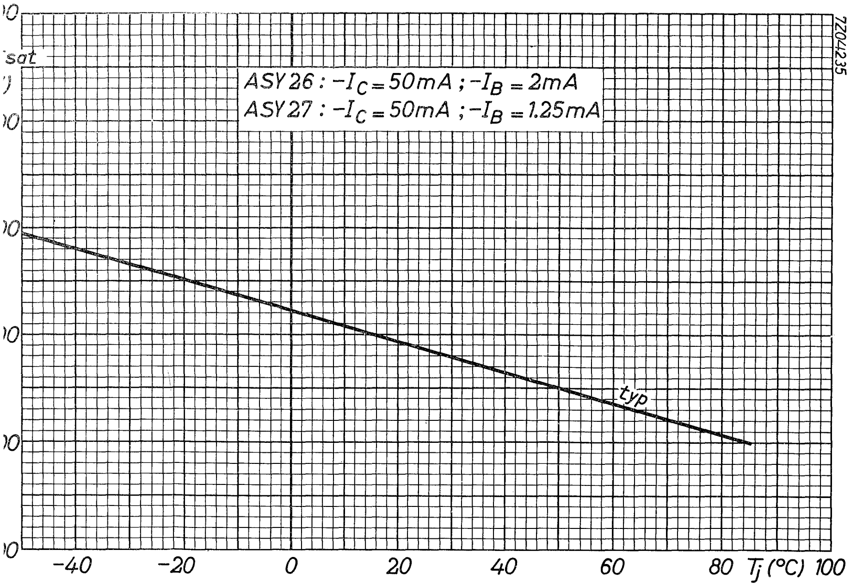

7Z04231
h_{FE}
$-V_{CE} = 1V$
$T_j = 25°C$
ASY27
typ
ASY26
typ
80
60
40
20
0
0
50
100
150
200
250
$-I_C$ (mA)
300

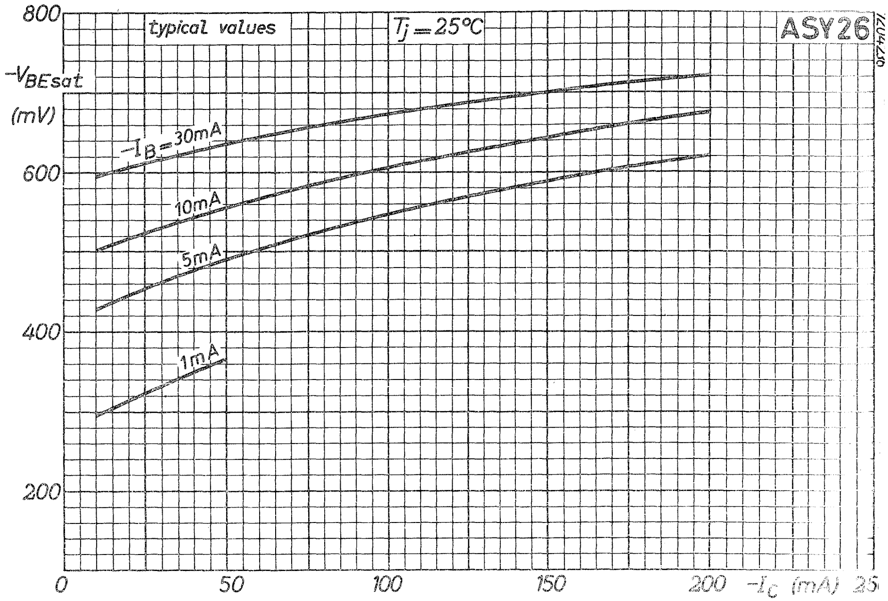

7Z05419
$-V_{CER}$
(V)
Minimum collector-emitter voltage (with resistive termination of the base) for which $g_o = 0.4\,m\Omega^{-1}$ versus the base resistance applied
$T_j = 25°C$
The same curves apply to $\frac{1}{\omega C_B}$ if an external capacitor is used
ASY26
ASY27
$-V_{CER}$
C_B
R_B
$g_o = 0.4\,m\Omega^{-1}$
Thermal stabilization must be provided
40
30
20
10
0
0.01
0.1
1
10
R_B (kΩ)
100

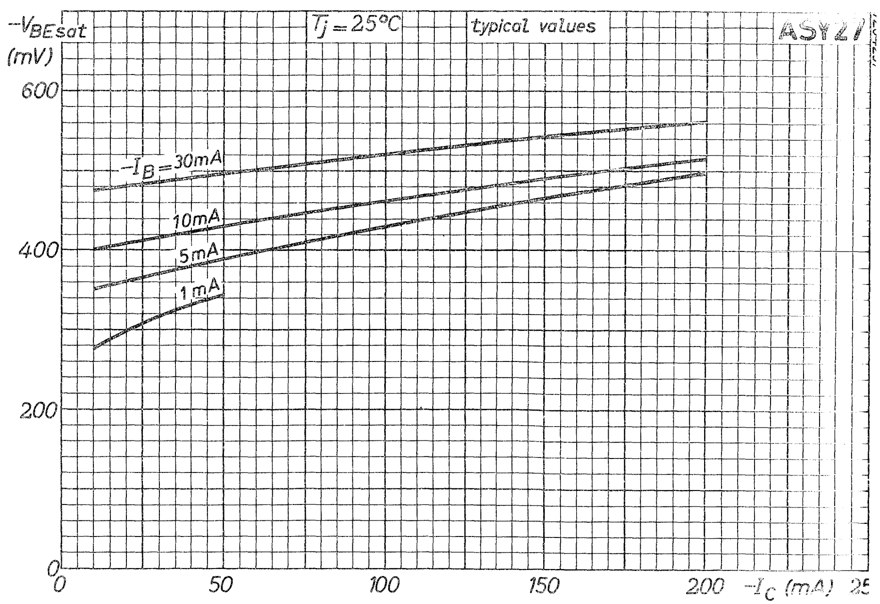

ASY26
7Z04232
h_{FE}
typical values
$-V_{CE}=1V$
$-I_C=10mA$
50mA
100mA
200mA
300mA
100
80
60
40
20
0
-40
-20
0
20
40
60
80 T_j (°C) 100

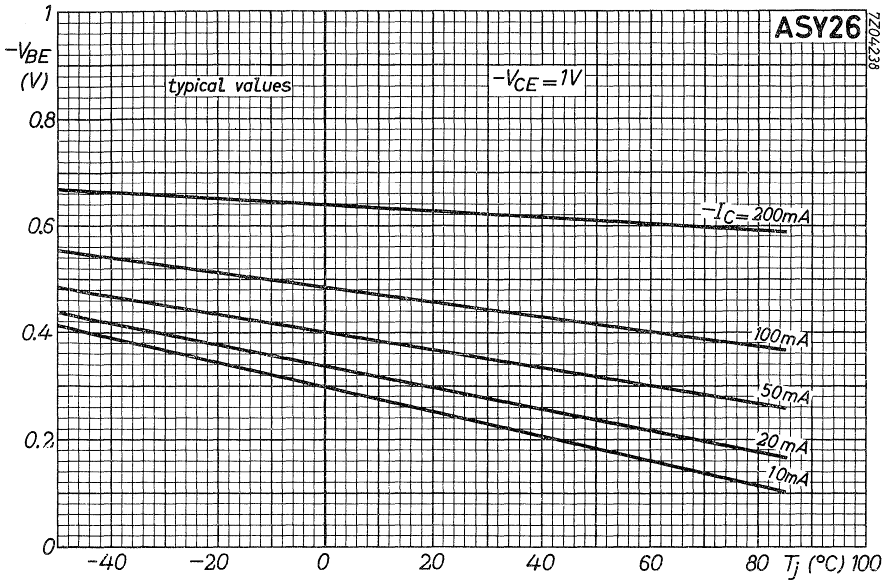

ASY27
7Z04233
h_{FE}
$-V_{CE}=1V$
typical values
$-I_C=10mA$
50mA
100mA
200mA
300mA
100
80
60
40
20
0
-40
-20
0
20
40
60
80 T_j (°C) 100

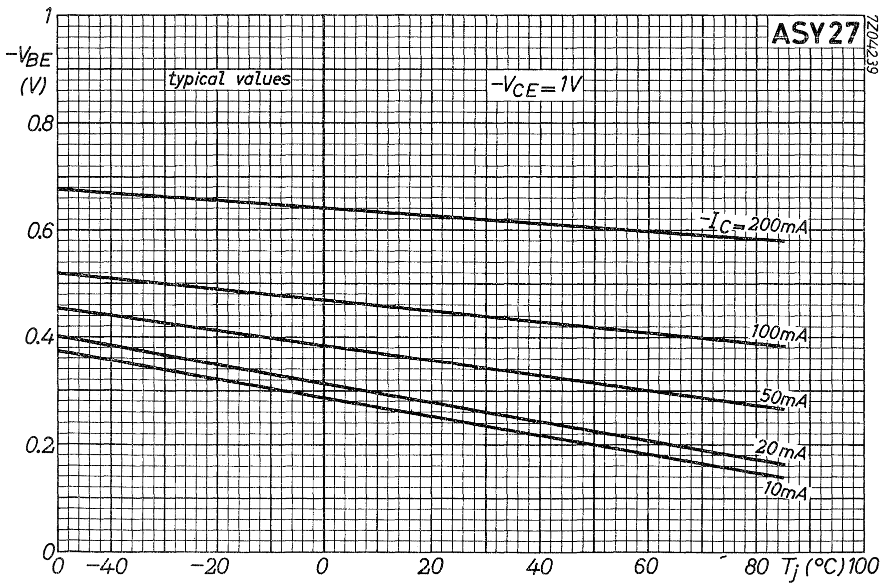

7Z04234
ASY 26 : $-I_C = 50mA; -I_B = 2mA$
ASY 27 : $-I_C = 50mA; -I_B = 1.25mA$
typ
-40
-20
0
20
40
60
80
T_j (°C)
100

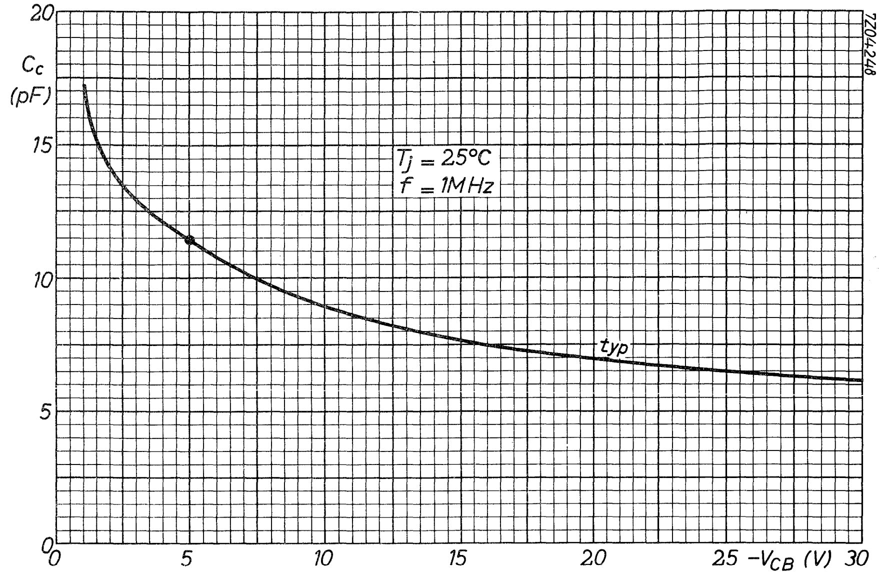

7Z04235
ASY 26 : $-I_C = 50mA; -I_B = 2mA$
ASY 27 : $-I_C = 50mA; -I_B = 1.25mA$
typ
-40
-20
0
20
40
60
80
T_j (°C)
100

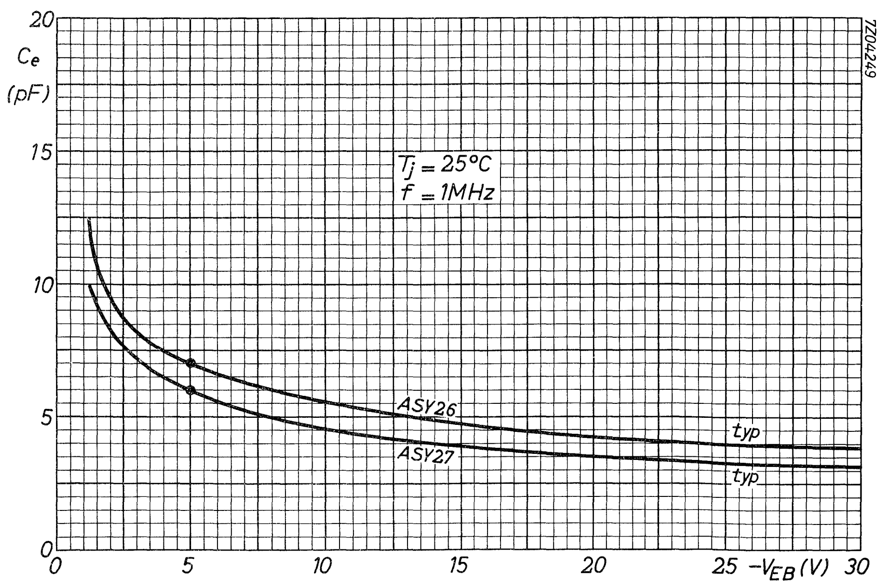

typical values
$T_j = 25°C$
ASY26
$-V_{BEsat}$
(mV)
800
600
400
200
0
$-I_B = 30mA$
10mA
5mA
1mA
50
100
150
200
$-I_C$ (mA)

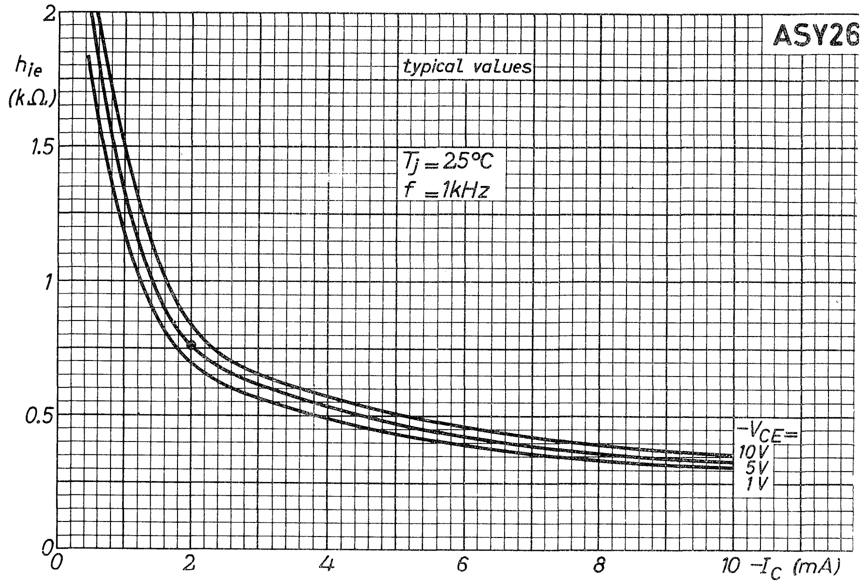

$-V_{BEsat}$
(mV)
$T_j = 25°C$
typical values
ASY27
600
400
200
0
$-I_B = 30mA$
10mA
5mA
1mA
50
100
150
200
$-I_C$ (mA)

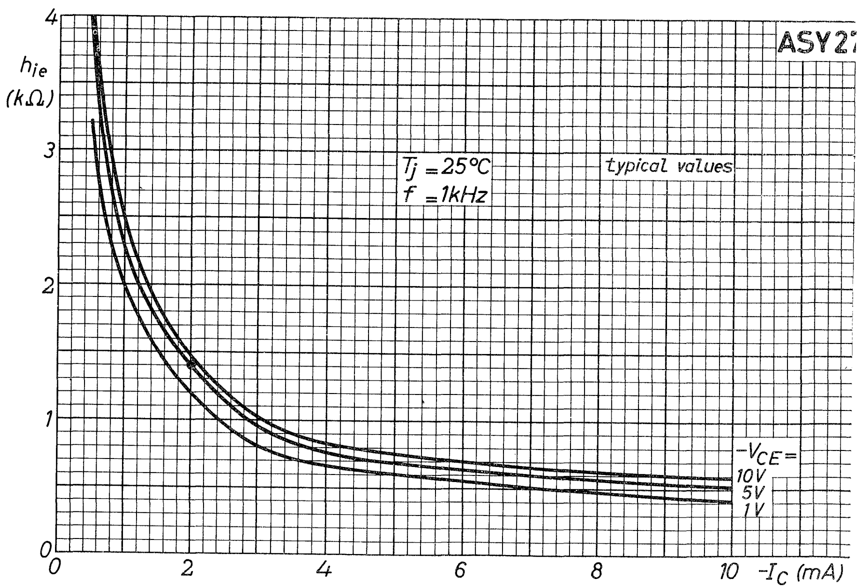

ASY26
7Z04238
$-V_{BE}$ (V)
typical values
$-V_{CE}=1V$
$-I_C=200mA$
100mA
50mA
20 mA
10mA
1
0.8
0.6
0.4
0.2
0
-40
-20
0
20
40
60
80
T_j (°C)
100

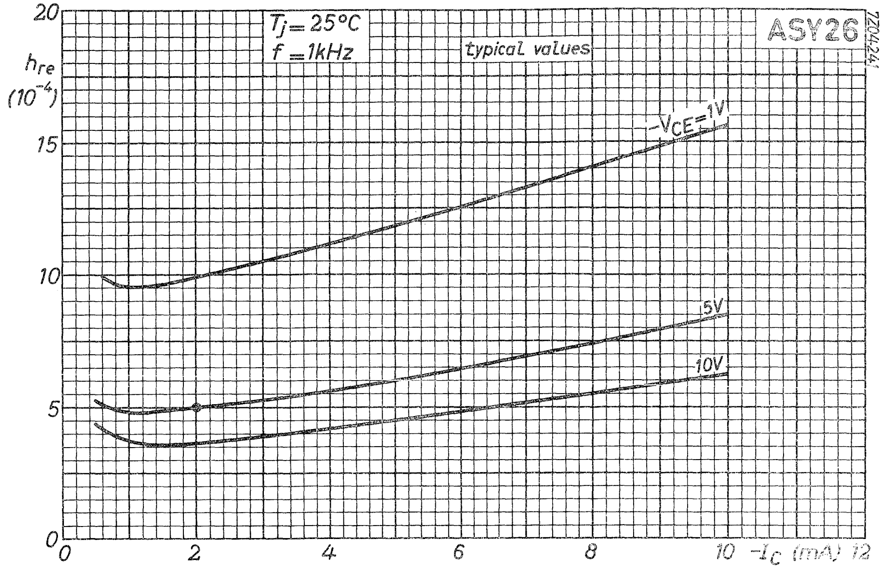

ASY27
7Z04239
$-V_{BE}$ (V)
typical values
$-V_{CE}=1V$
$-I_C=200mA$
100mA
50mA
20 mA
10mA
1
0.8
0.6
0.4
0.2
0
-40
-20
0
20
40
60
80
T_j (°C)
100

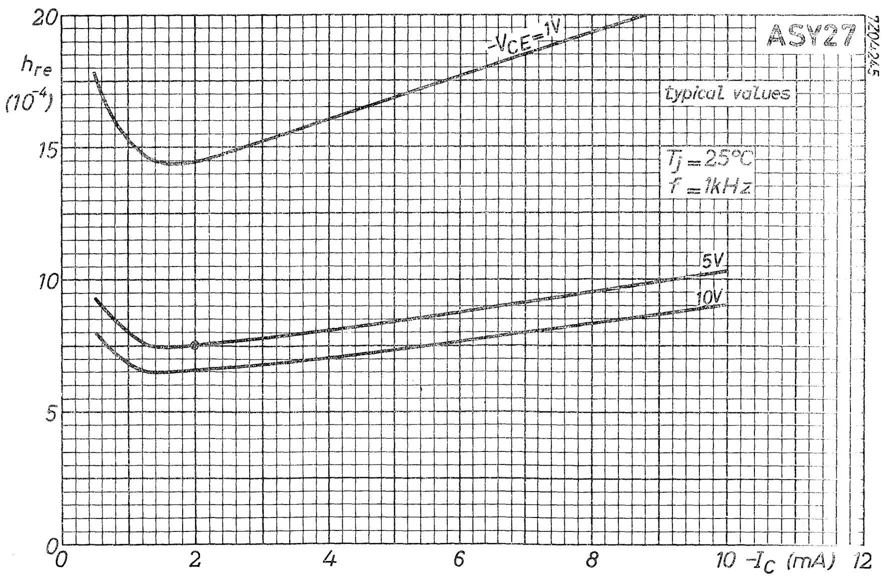

7Z04248
20
C_c
(pF)
15
10
5
0
$T_j = 25°C$
$f = 1MHz$
typ
0
5
10
15
20
25 $-V_{CB}$ (V) 30

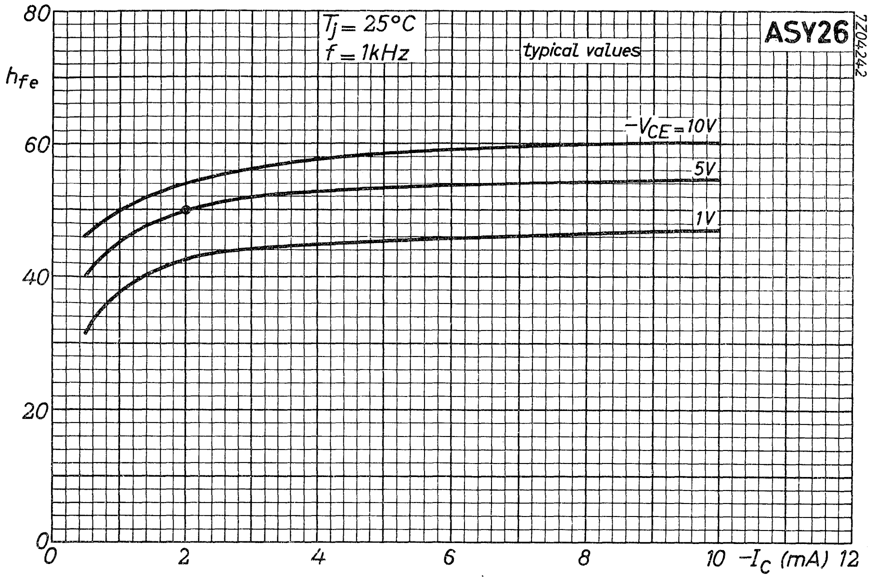

7Z04249
20
C_e
(pF)
15
10
5
0
$T_j = 25°C$
$f = 1MHz$
ASY26
ASY27
typ
typ
0
5
10
15
20
25 $-V_{EB}$ (V) 30

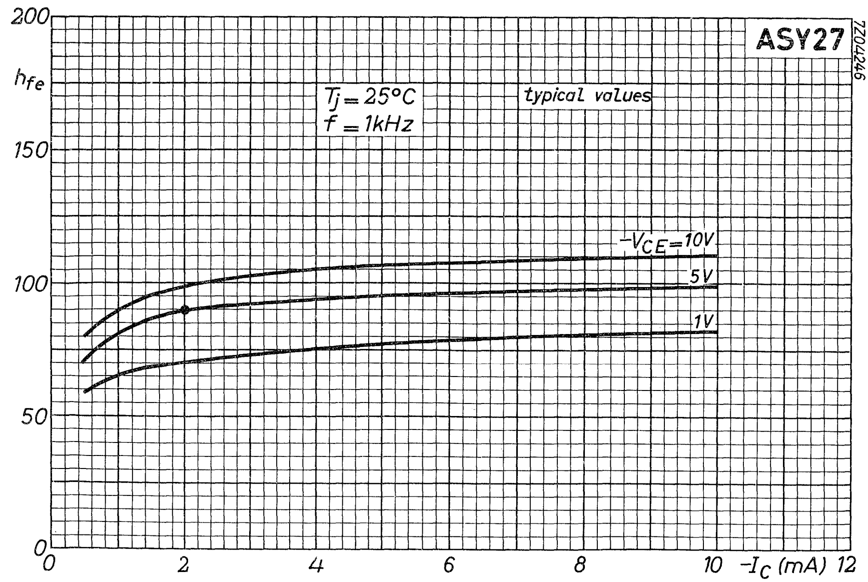

ASY26
typical values
h_{ie} (kΩ)
$T_j = 25°C$
$f = 1kHz$
$-V_{CE} =$
10 V
5 V
1 V
2
1.5
1
0.5
0
0
2
4
6
8
10 $-I_C$ (mA)

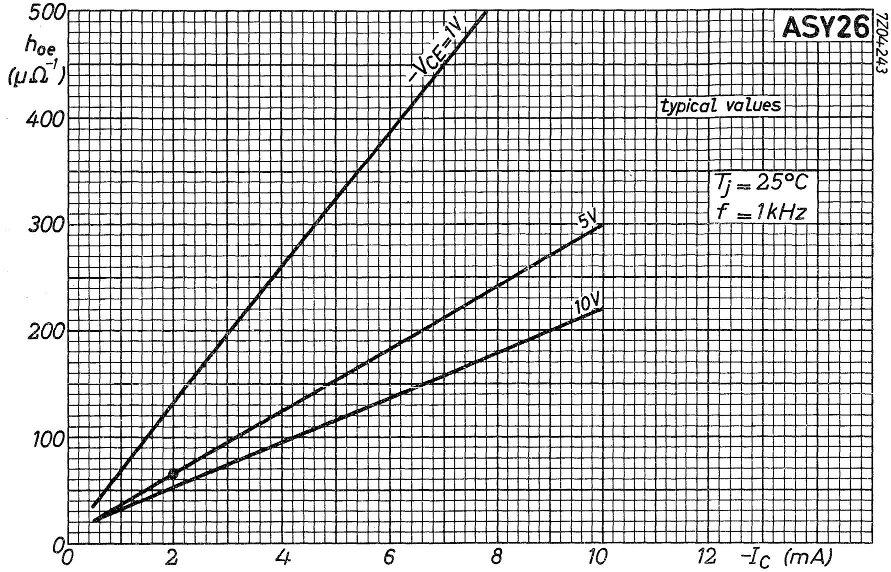

ASY27
h_{ie} (kΩ)
$T_j = 25°C$
$f = 1kHz$
typical values
$-V_{CE} =$
10 V
5 V
1 V
4
3
2
1
0
0
2
4
6
8
10 $-I_C$ (mA)

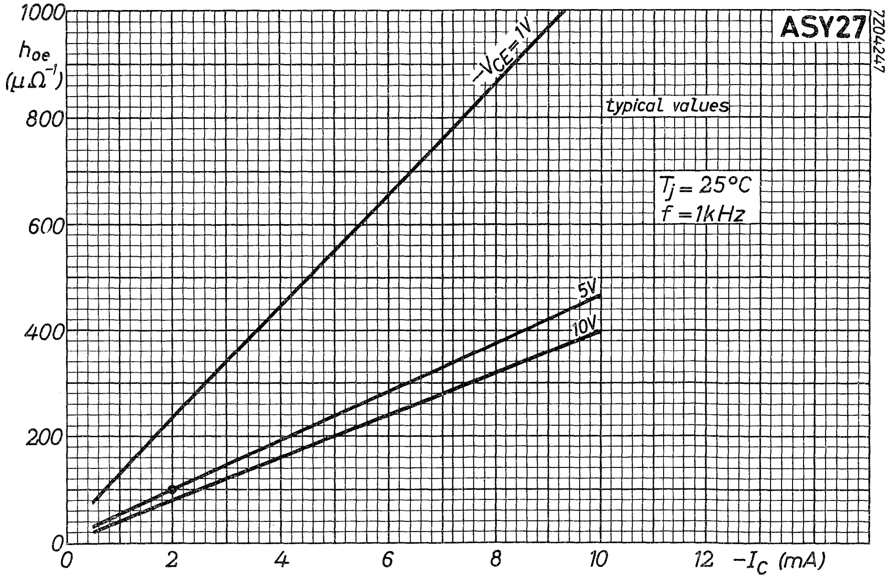

h_{re}
(10^{-4})
$T_j = 25°C$
$f = 1kHz$
typical values
ASY26
7Z04241
$-V_{CE} = 1V$
5V
10V
$-I_C$ (mA)
0
2
4
6
8
10
12
5
10
15
20

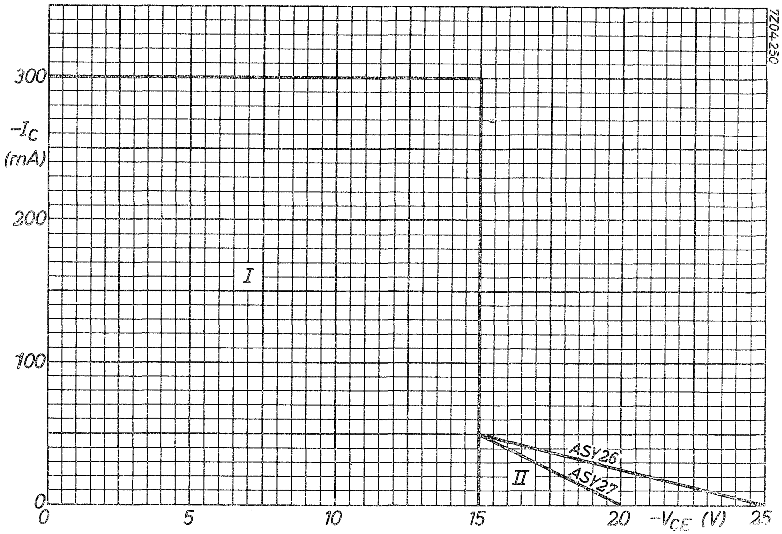

h_{re}
(10^{-4})
ASY27
7Z04245
$-V_{CE} = 1V$
typical values
$T_j = 25°C$
$f = 1kHz$
5V
10V
$-I_C$ (mA)
0
2
4
6
8
10
12
5
10
15
20


80
60
40
20
0
h_{fe}
$T_j = 25°C$
$f = 1kHz$
typical values
ASY26
7Z04242
$-V_{CE} = 10V$
5V
1V
0
2
4
6
8
10
$-I_C$ (mA)
12


200
150
100
50
0
h_{fe}
$T_j = 25°C$
$f = 1kHz$
typical values
ASY27
7Z04246
$-V_{CE} = 10V$
5V
1V
0
2
4
6
8
10
$-I_C$ (mA)
12


ASY26
7Z04243
h_{oe} ($\mu\Omega^{-1}$)
500
400
300
200
100
0
0
2
4
6
8
10
12
$-I_C$ (mA)
$-V_{CE}$=1V
5V
10V
typical values
T_j = 25°C
f = 1kHz


ASY27
7Z04247
h_{oe} ($\mu\Omega^{-1}$)
1000
800
600
400
200
0
0
2
4
6
8
10
12
$-I_C$ (mA)
$-V_{CE}$=1V
5V
10V
typical values
T_j = 25°C
f = 1kHz



I = permissible region of operation under all base-emitter conditions
II = additional region of operation when the transistor is cut-off with $+V_{BE} > 0.2$ V

Outside the permissible regions of operation the transistor can withstand
sient energies of 200 μWs, provided:

$$0.2 \text{ V} < +V_{BE} < 2 \text{ V}$$

7Z:

GERMANIUM ALLOYED TRANSISTORS

-N transistors in a TO-5 metal envelope with the base connected to the case. 3e general purpose transistors are primarily intended for medium current ium speed computor logic applications.

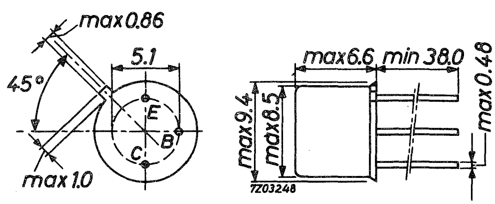
QUICK REFERENCE DATA

			ASY28	ASY29	
llector-base voltage (open emitter)	V_{CBO}	max.	30	25	V
llector-emitter voltage (open base)	V_{CEO}	max.	15	15	V
llector current (peak value)	I_{CM}	max.	300	300	mA
:al power dissipation ɔ to T_{amb} = 25 °C	P_{tot}	max.	150	150	mW
ction temperature	T_j	max.	85	85	°C
C. current gain at T_j = 25 °C					
; = 20 mA; V_{CE} = 1 V	h_{FE}	>	30	50	
; = 200 mA; V_{CE} = 1 V	h_{FE}	>	15	20	
lector-emitter saturation voltage					
; = 10 mA; I_B = 0.33 mA	$V_{CE\,sat}$	<	0.20		V
; = 10 mA; I_B = 0.2 mA	$V_{CE\,sat}$	<		0.20	V
ansition frequency					
; = 3 mA; V_{CE} = 5 V	f_T	typ.	14	20	MHz
:n on time ($t_d + t_r$)	t_{on}	typ.	225	185	ns
:n off time ($t_s + t_f$)	t_{off}	typ.	775	800	ns

HANICAL DATA Dimensions in mm

5

connected to case



7Z3 0024

RATINGS (Limiting values) [1]

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

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

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

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

7Z3 0025

CHARACTERISTICS (continued) $T_j = 25\ ^{o}C$ unless otherwise specified

			ASY28	ASY29	
Currents at reverse biased emitter junction					
$V_{CE} = 25$ V; $-V_{BE} = 0.2$ V; $T_j = 60\ ^{o}C$	I_{CEX}	<	35		μA
$V_{CE} = 20$ V; $-V_{BE} = 0.2$ V; $T_j = 60\ ^{o}C$	I_{CEX}	<		35	μA
$V_{CE} = 20$ V; $-V_{BE} = 5$ V; $T_j = 60\ ^{o}C$	$-I_{BEX}$	<	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 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
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; $T_j = 60\ ^{o}C$	$V_{BE\,fl}$	<	0.20		V
$I_B = 0$; $V_{CE} = 20$ V; $T_j = 60\ ^{o}C$	$V_{BE\,fl}$	<		0.20	V

7Z3 0026

RACTERISTICS (continued) $T_j = 25\ ^oC$

			ASY28	ASY29	
current gain					
= 10 mA; V_{CE} = 1 V	h_{FE}	>	30	50	
		typ.	43	113	
= 20 mA; V_{CE} = 1 V	h_{FE}	>	30	50	
		typ.	46	113	
		<	80	150	
= 100 mA; V_{CE} = 1 V	h_{FE}	>	20	30	
		typ.	43	102	
= 200 mA; V_{CE} = 1 V	h_{FE}	>	15	20	
		typ.	32	84	
ector capacitance at f = 1 MHz					
= I_e = 0; V_{EB} = 5 V	C_c	typ.	11	11	pF
		<	16	16	pF
ter capacitance at f = 1 MHz					
= I_c = 0; V_{EB} = 5 V	C_e	typ.	7	6	pF
		<	13	13	pF
isition frequency					
= 3 mA; V_{CE} = 5 V	f_T	>	4	10	MHz
		typ.	14	20	MHz
rameters at f = 1 kHz					
= 2 mA; V_{CE} = 5 V					
ut impedance	h_{ie}	typ.	0.75	1.4	kΩ
verse voltage transfer ratio	h_{re}	typ.	3.5	5.0	10^{-4}
all signal current gain	h_{fe}	typ.	50	90	
put admittance	h_{oe}	typ.	45	70	$\mu\Omega^{-1}$
ching characteristics					
turation time constant					
= 0; I_B = 1 mA	τ_s	<	1.4	1.4	µs
ent feed time constant					
M = 50 mA; V_{CE} = 0.75 V	τ_c	<	2.2	2.2	µs
age feed time constant					
M = 1 mA; V_{CE} = 5 V	τ_v	<	0.2	0.2	µs

29757 sc2 23

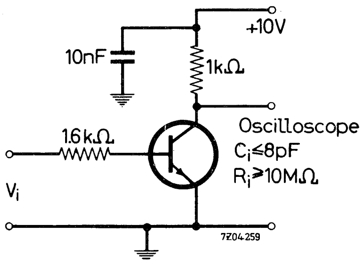
7Z3 0027

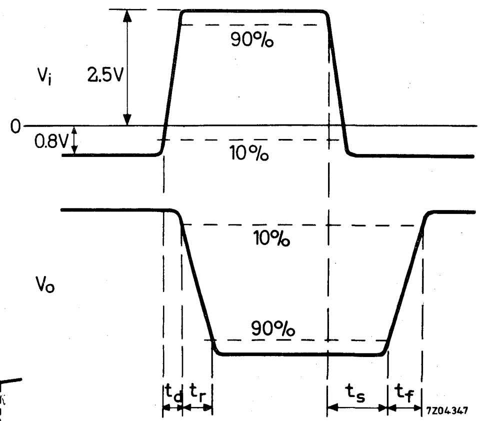
CHARACTERISTICS (continued) $T_j = 25\ ^oC$

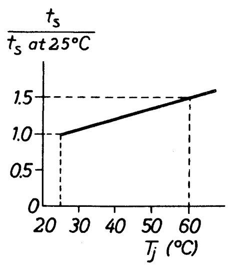
Switching times (See test circuit)

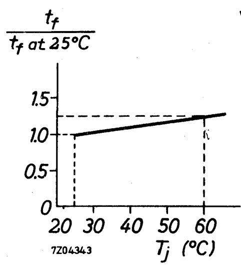
			ASY28	ASY29	
delay time	t_d	typ.	50	45	ns
		<	90	75	ns
rise time	t_r	typ.	175	140	ns
		<	400	300	ns
storage time	t_s	typ.	450	500	ns
		<	700	800	ns
fall time	t_f	typ.	325	300	ns
		<	620	520	ns

Test circuit:

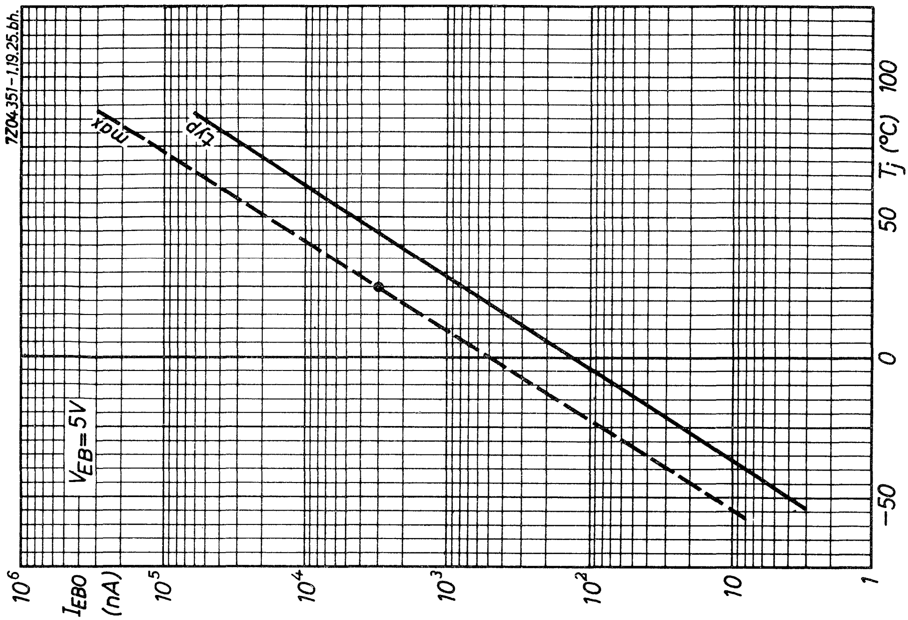


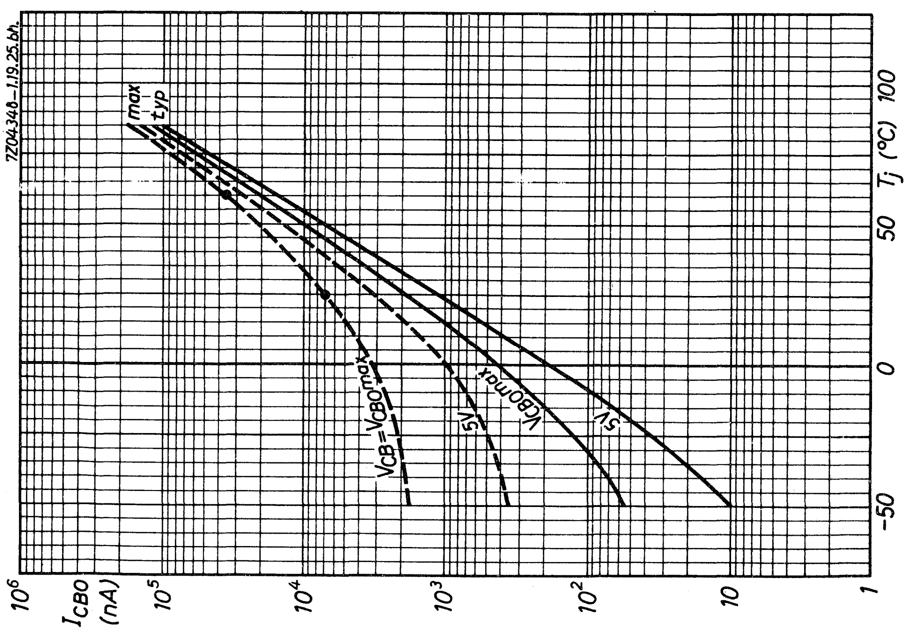


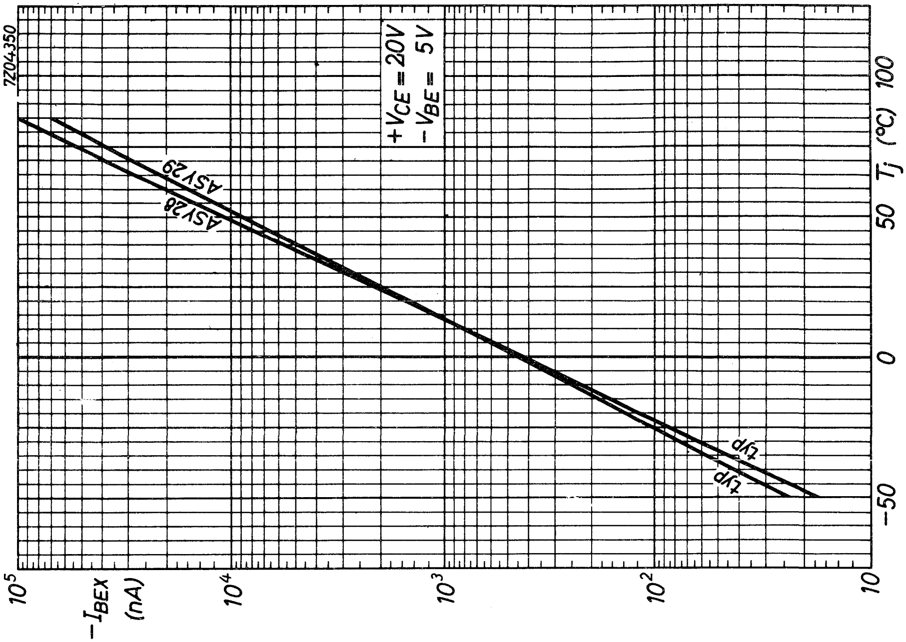


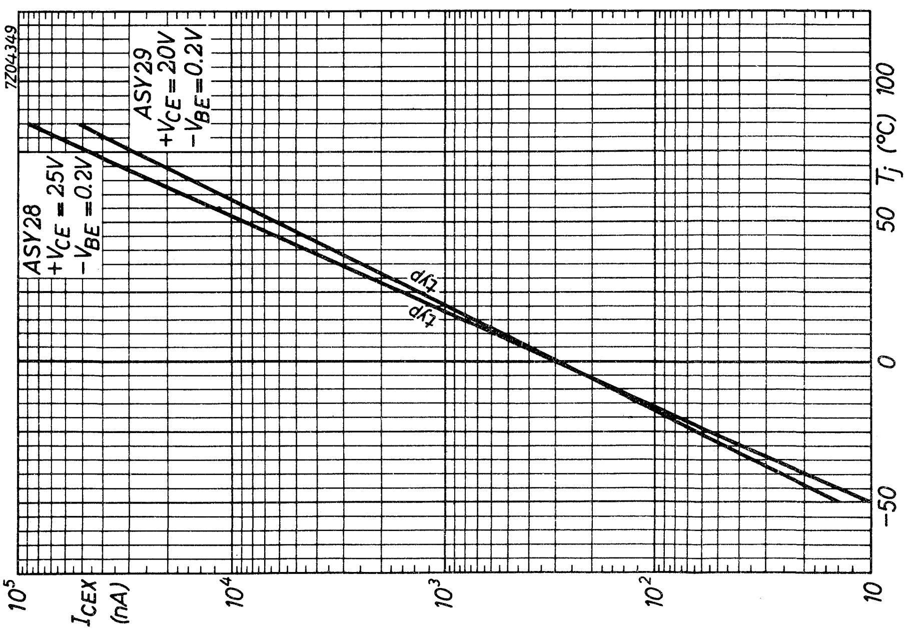


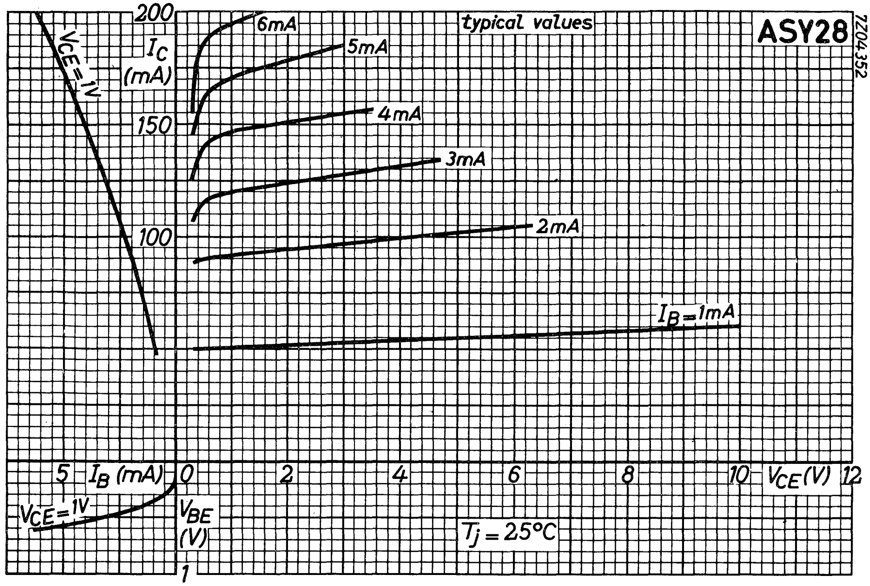
7Z3 0028

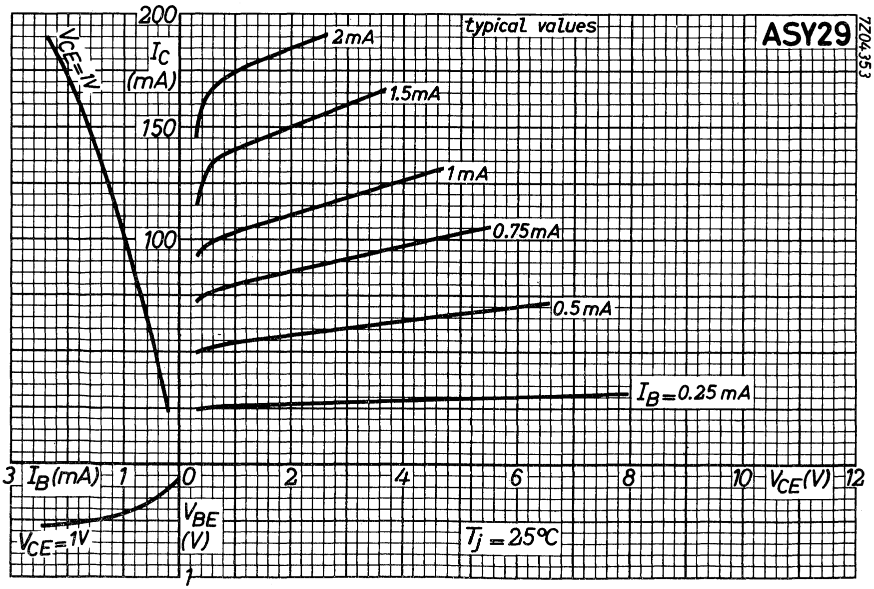

7Z04351-1.19.25.bh.
max
typ
V_EB=5V
I_EBO (nA)
10^6
10^5
10^4
10^3
10^2
10
1
T_j (°C)
-50
0
50
100

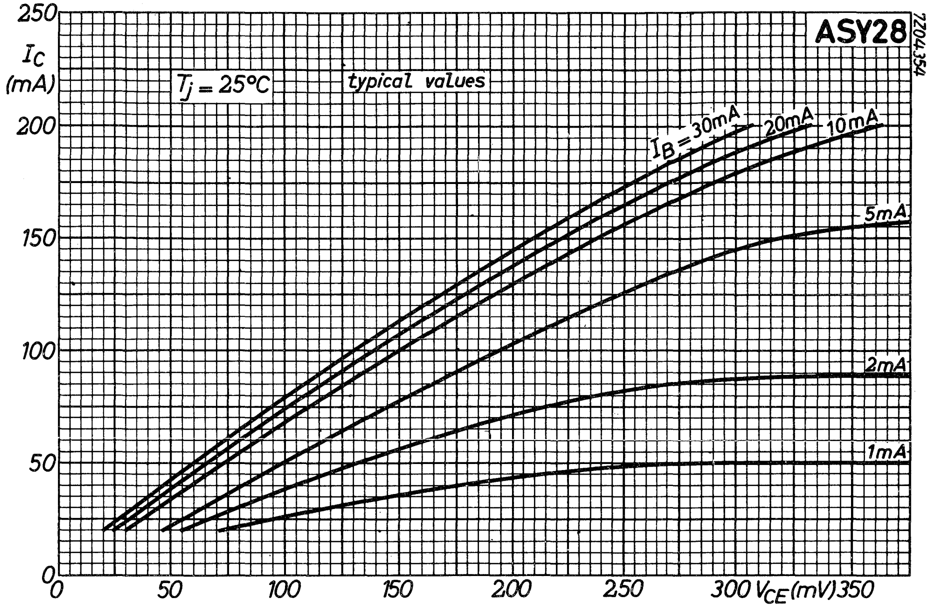

7Z04348-1.19.25.bh.
max
typ
V_CB=V_CBOmax
5V
V_CBOmax
5V
I_CBO (nA)
10^6
10^5
10^4
10^3
10^2
10
1
T_j (°C)
-50
0
50
100

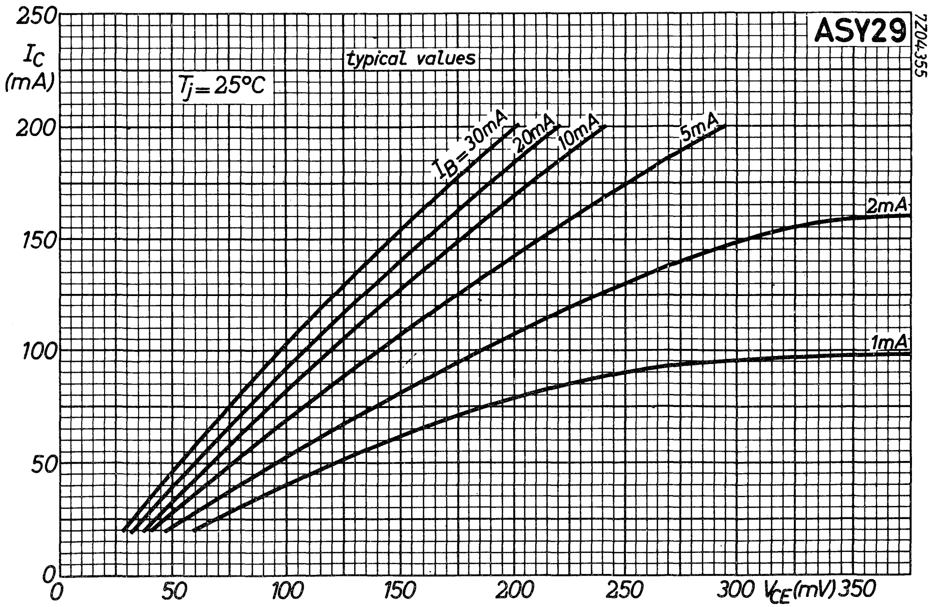

7Z04350
$+V_{CE} = 20V$
$-V_{BE} = 5V$
ASY29
ASY28
typ
typ
$-I_{BEX}$ (nA)
T_j (°C)
10^5
10^4
10^3
10^2
10
−50
0
50
100

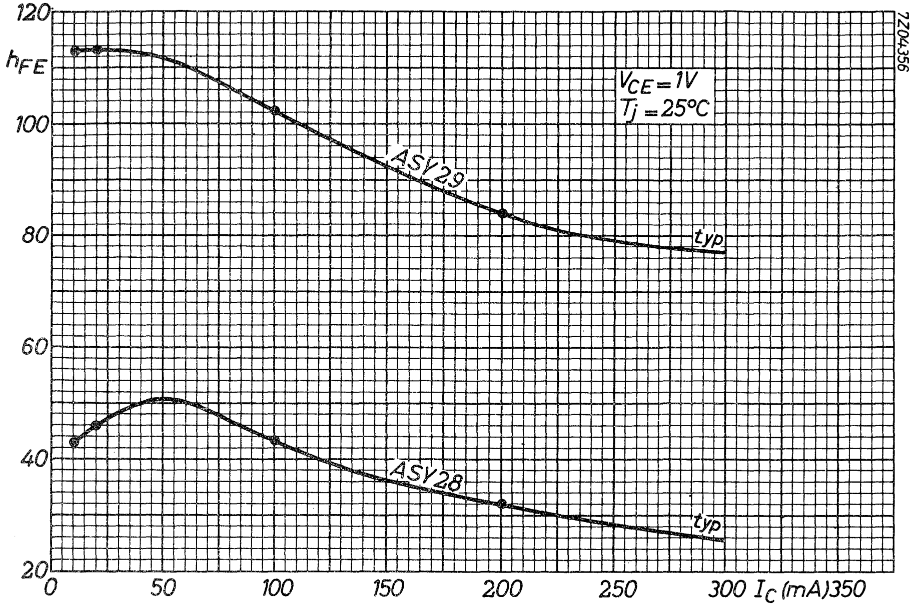

7Z04349
ASY28
$+V_{CE} = 25V$
$-V_{BE} = 0.2V$
ASY29
$+V_{CE} = 20V$
$-V_{BE} = 0.2V$
typ
typ
I_{CEX} (nA)
T_j (°C)
10^5
10^4
10^3
10^2
10
−50
0
50
100

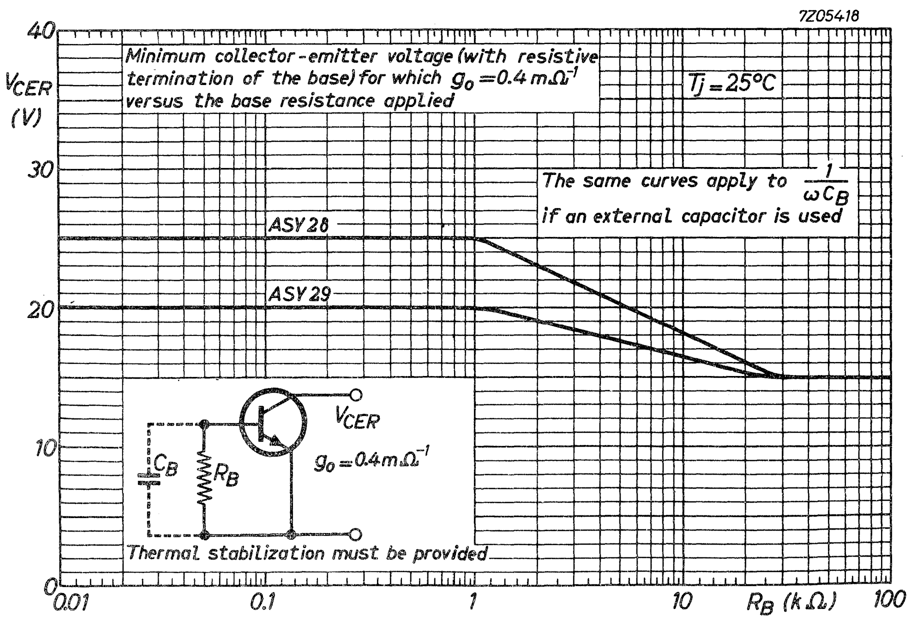

typical values
ASY28
7Z04352
200
I_C (mA)
150
100
6mA
5mA
4mA
3mA
2mA
I_B=1mA
V_{CE}=1V
5
I_B (mA)
0
2
4
6
8
10
V_{CE}(V)
12
V_{BE} (V)
1
$T_j = 25°C$

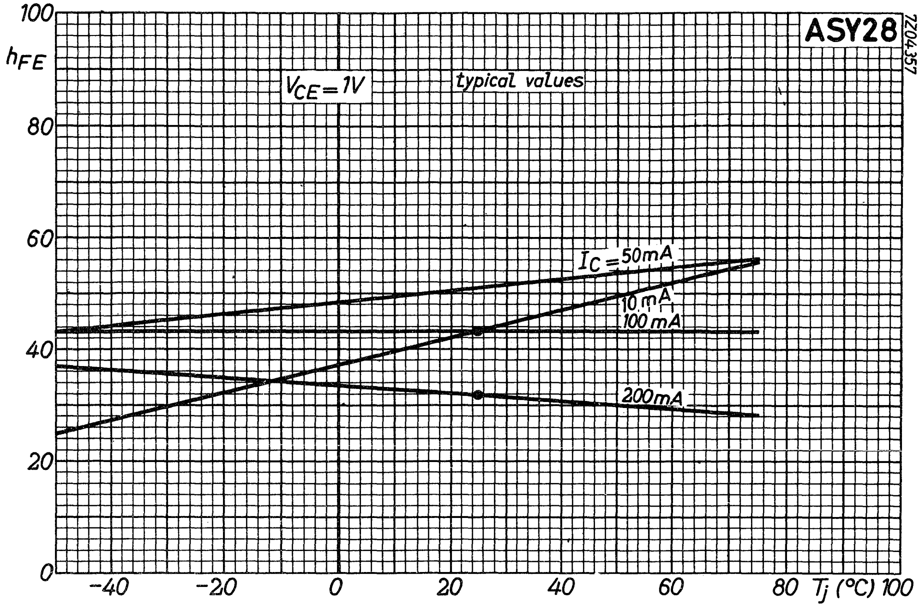

typical values
ASY29
7Z04353
200
I_C (mA)
150
100
2mA
1.5mA
1mA
0.75mA
0.5mA
I_B=0.25mA
V_{CE}=1V
3
I_B(mA)
1
0
2
4
6
8
10
V_{CE}(V)
12
V_{BE} (V)
1
$T_j = 25°C$

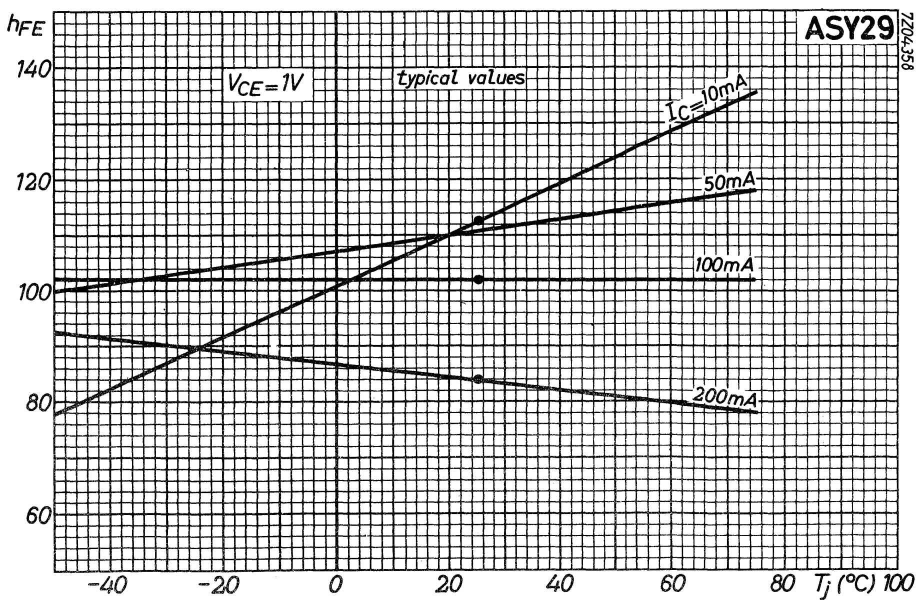

ASY28
7Z04354
I_C (mA)
$T_j = 25°C$
typical values
$I_B = 30mA$
20mA
10mA
5mA
2mA
1mA
0
50
100
150
200
250
300
350
V_{CE} (mV)

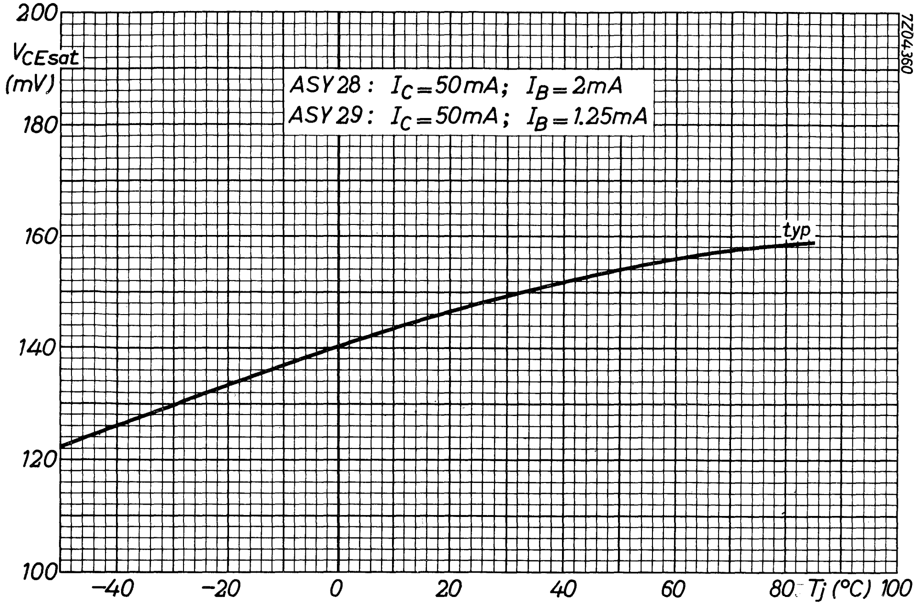

ASY29
7Z04355
I_C (mA)
$T_j = 25°C$
typical values
$I_B = 30mA$
20mA
10mA
5mA
2mA
1mA
0
50
100
150
200
250
300
350
V_{CE} (mV)

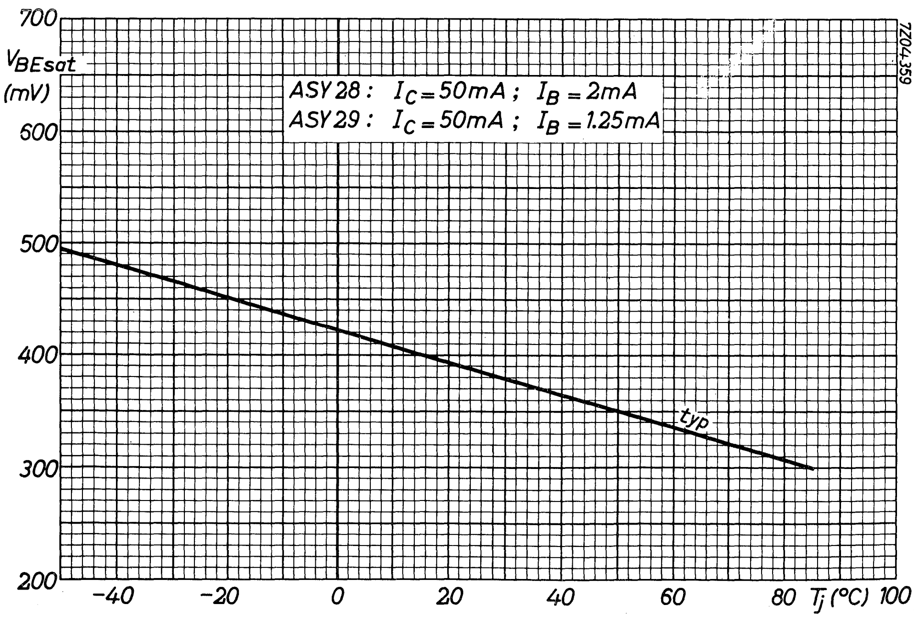

7Z04356
h_{FE}
$V_{CE} = 1V$
$T_j = 25°C$
ASY29
typ
ASY28
typ
120
100
80
60
40
20
0
50
100
150
200
250
300
I_C (mA)
350

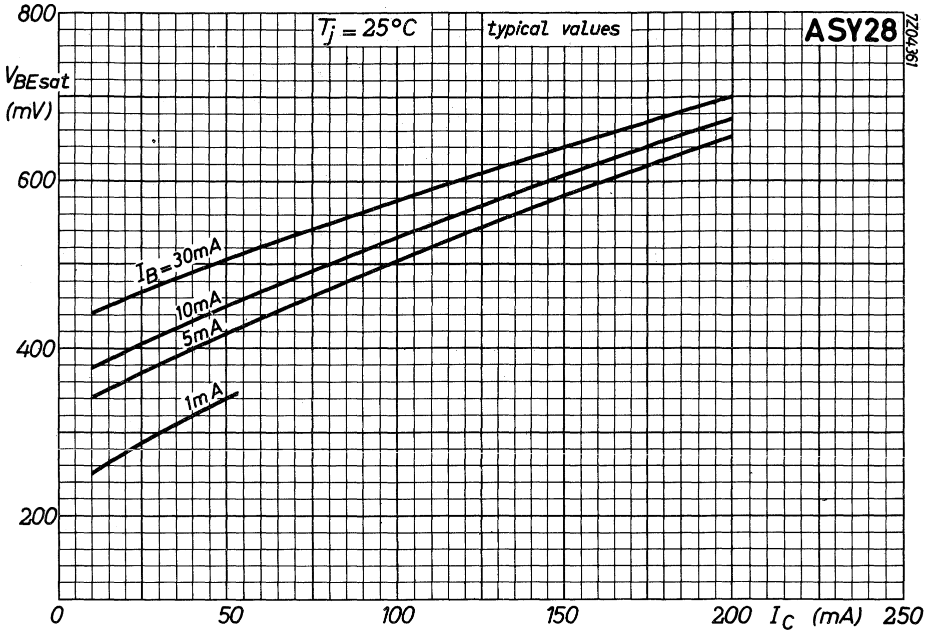

7Z05418
V_{CER} (V)
Minimum collector-emitter voltage (with resistive termination of the base) for which $g_o = 0.4\ m\Omega^{-1}$ versus the base resistance applied
$T_j = 25°C$
The same curves apply to $\frac{1}{\omega C_B}$ if an external capacitor is used
ASY28
ASY29
V_{CER}
C_B
R_B
$g_o = 0.4\ m\Omega^{-1}$
Thermal stabilization must be provided
40
30
20
10
0
0.01
0.1
1
10
R_B (kΩ)
100

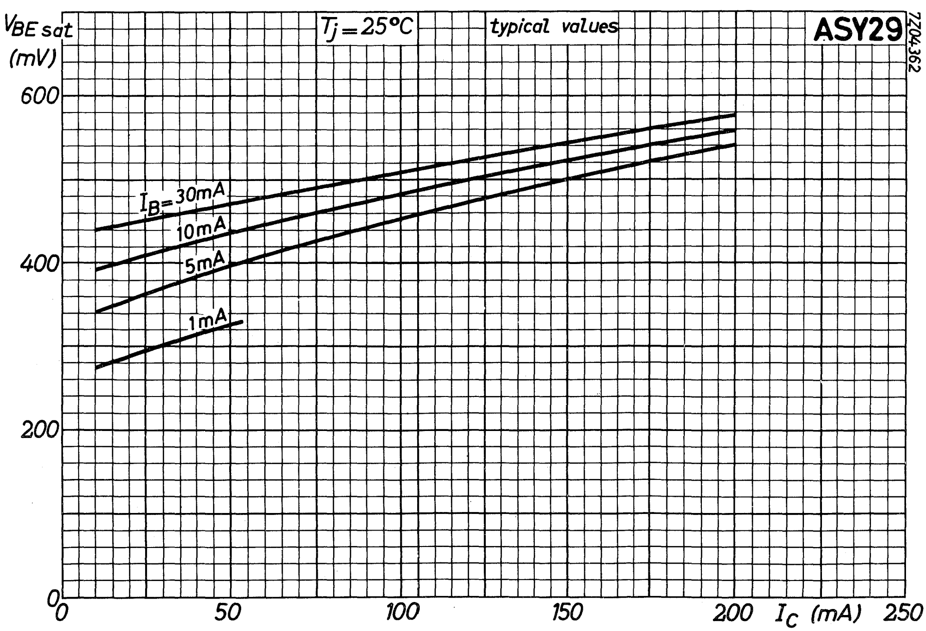

ASY28
7204357
hFE
VCE=1V
typical values
IC=50mA
10 mA
100 mA
200mA
100
80
60
40
20
0
-40
-20
0
20
40
60
80
Tj (°C) 100

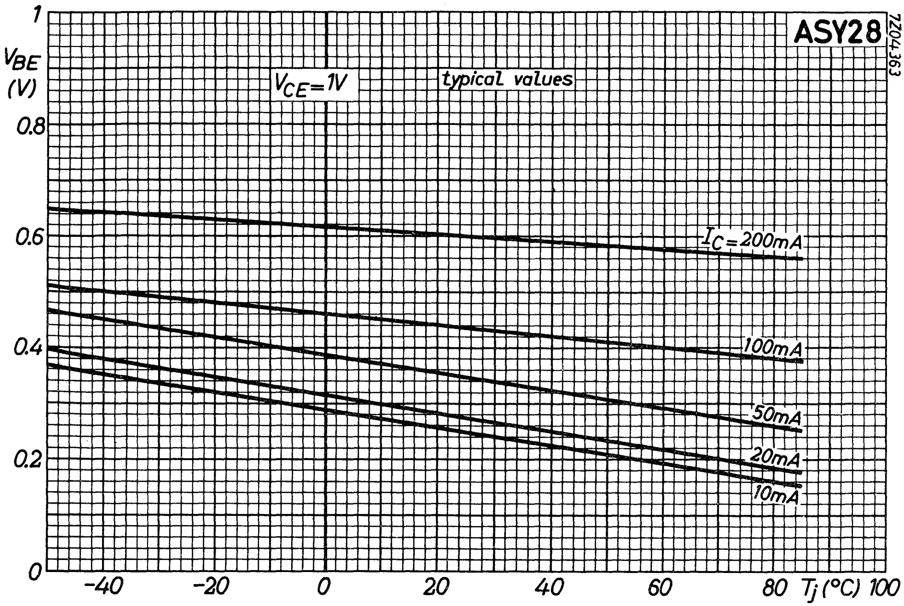

ASY29
7204358
hFE
VCE=1V
typical values
IC=10mA
50mA
100mA
200mA
140
120
100
80
60
-40
-20
0
20
40
60
80
Tj (°C) 100

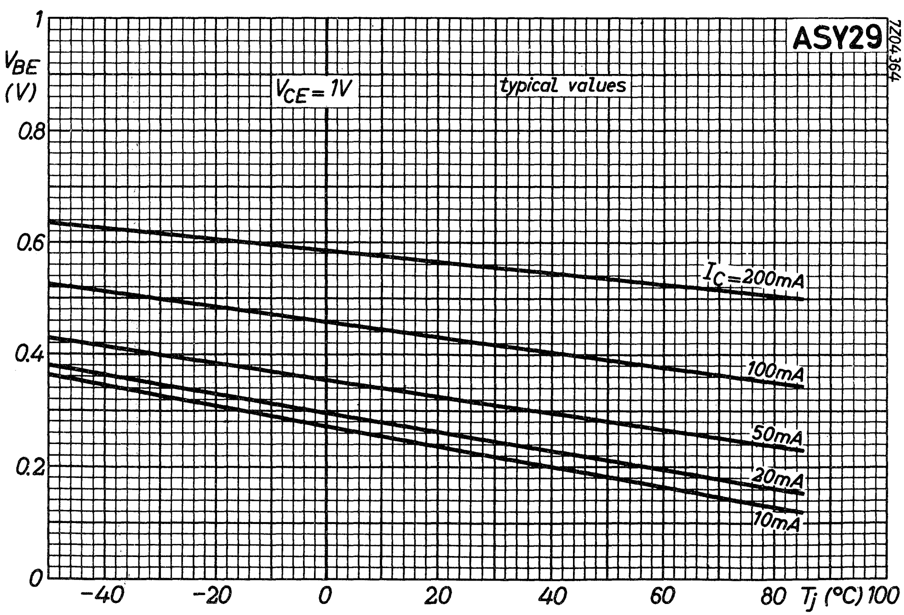

200
V_{CEsat}
(mV)
180
160
140
120
100
ASY 28 : $I_C = 50mA$; $I_B = 2mA$
ASY 29 : $I_C = 50mA$; $I_B = 1.25mA$
typ
−40
−20
0
20
40
60
80
T_j (°C)
100
7Z04360

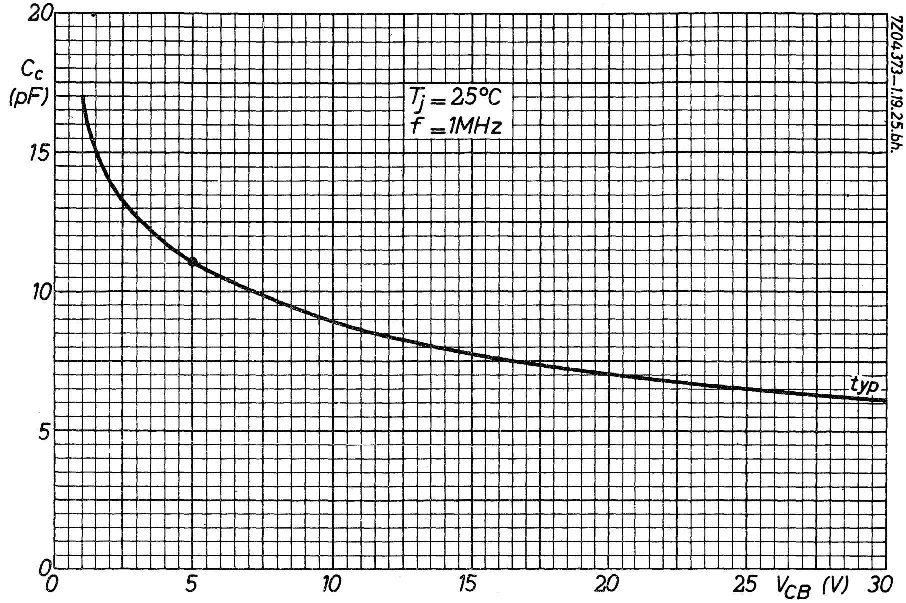

700
V_{BEsat}
(mV)
600
500
400
300
200
ASY 28 : $I_C = 50mA$; $I_B = 2mA$
ASY 29 : $I_C = 50mA$; $I_B = 1.25mA$
typ
−40
−20
0
20
40
60
80
T_j (°C)
100
7Z04359

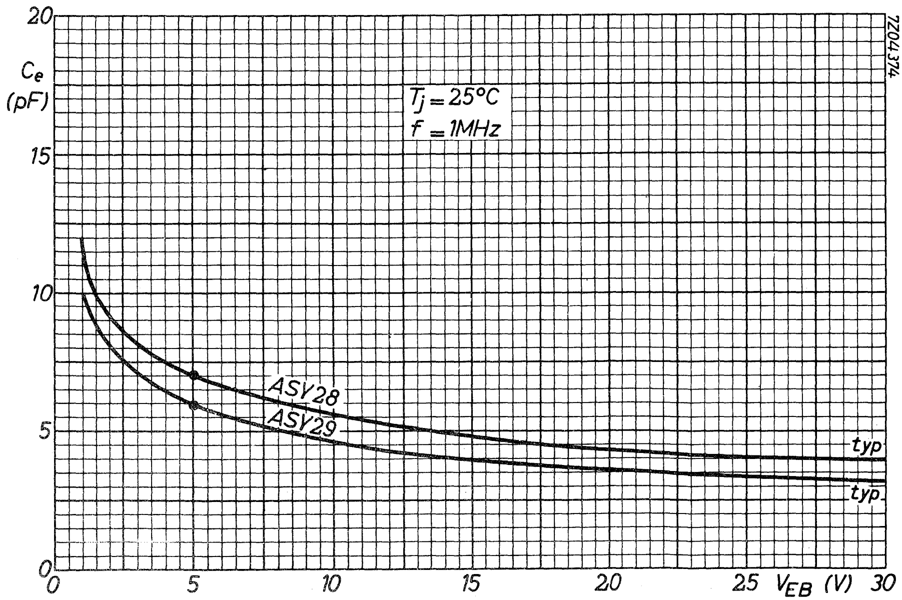

800
600
400
200
V_{BEsat} (mV)
$T_j = 25°C$
typical values
ASY28
7Z04361
$I_B = 30mA$
10mA
5mA
1mA
0
50
100
150
200
250
I_C (mA)

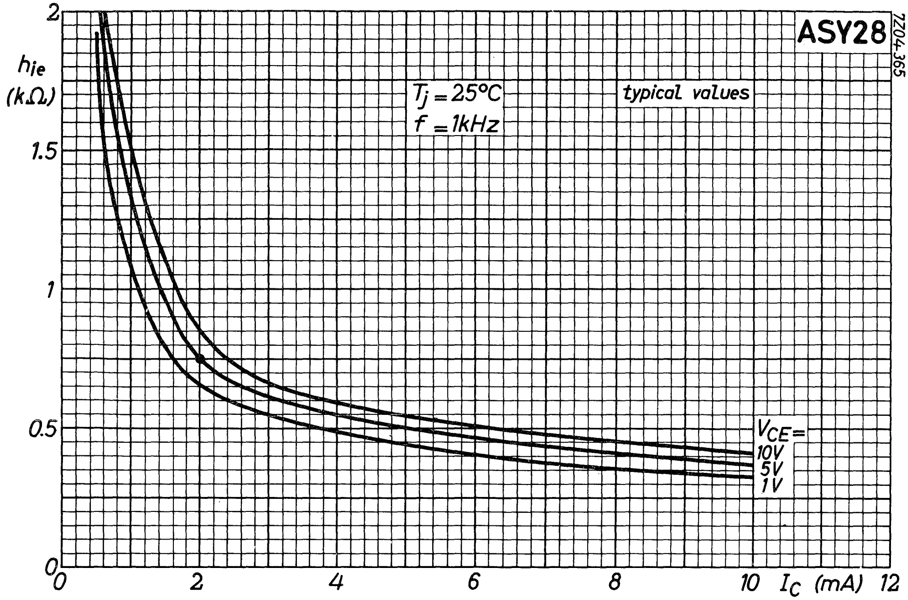

$V_{BE sat}$ (mV)
600
400
200
0
$T_j = 25°C$
typical values
ASY29
7Z04362
$I_B = 30mA$
10mA
5mA
1mA
0
50
100
150
200
250
I_C (mA)

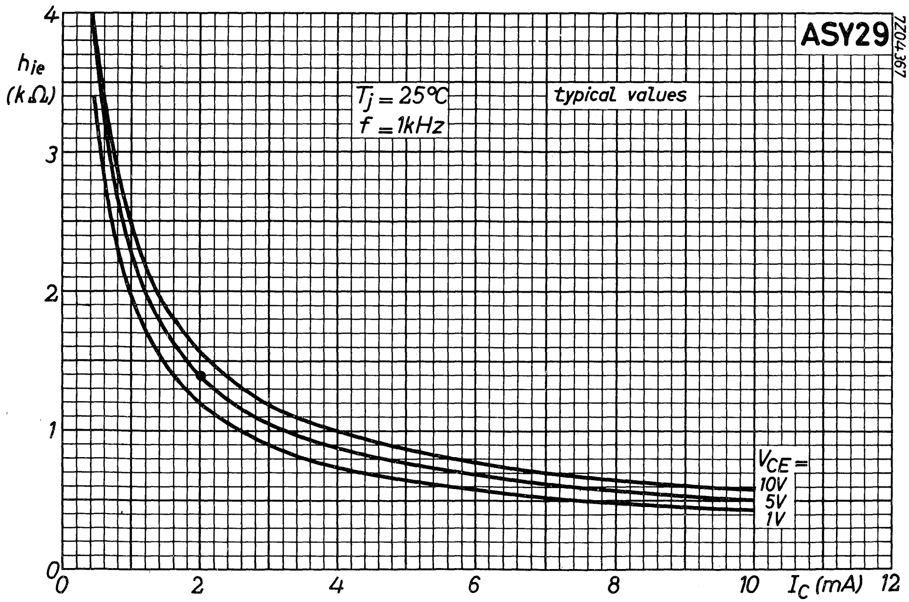

ASY28
7Z04363
V_{BE} (V)
V_{CE} = 1V
typical values
I_C = 200mA
100mA
50mA
20mA
10mA
1
0.8
0.6
0.4
0.2
0
-40
-20
0
20
40
60
80
T_j (°C)
100

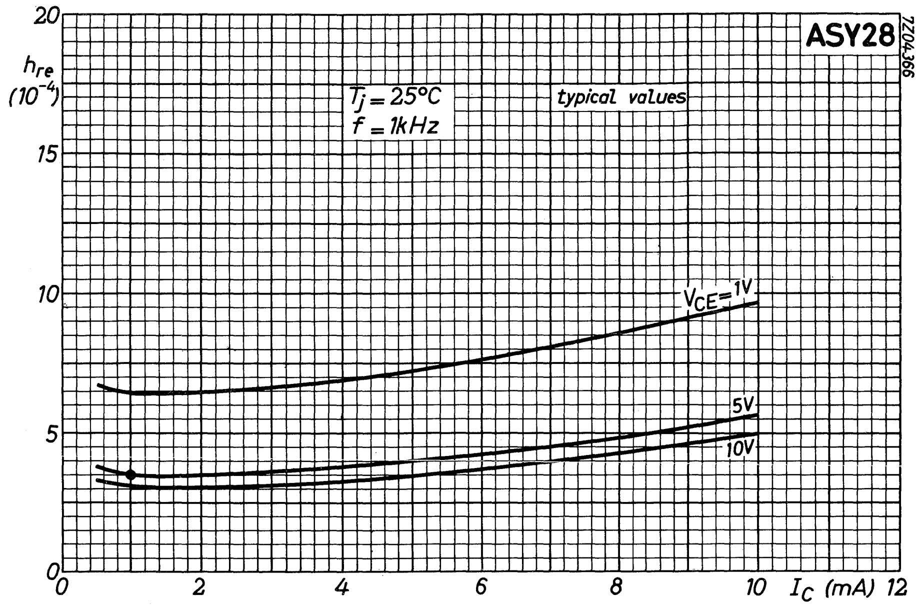

ASY29
7Z04364
V_{BE} (V)
V_{CE} = 1V
typical values
I_C = 200mA
100mA
50mA
20mA
10mA
1
0.8
0.6
0.4
0.2
0
-40
-20
0
20
40
60
80
T_j (°C)
100

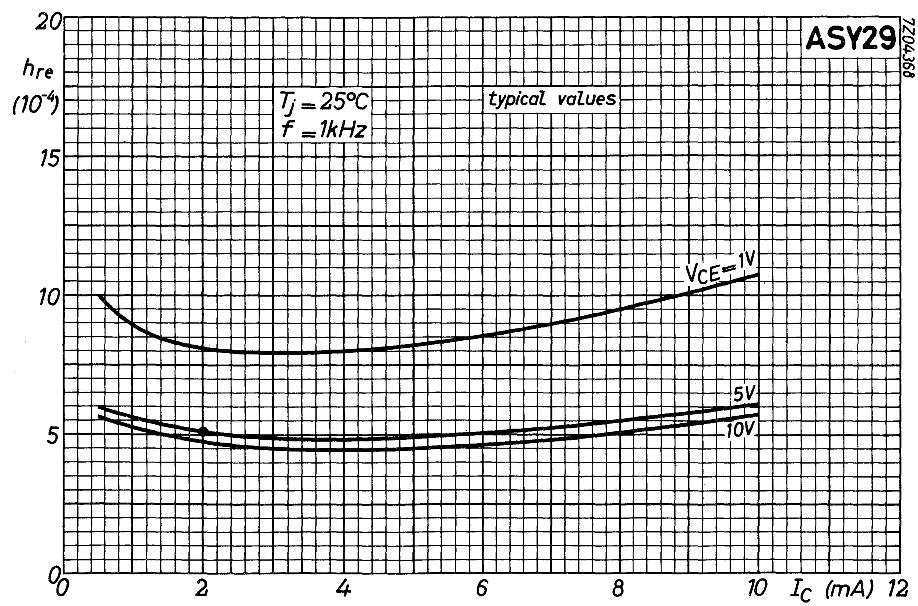

7Z04373-1.19.25.bh.
C_c
(pF)
$T_j = 25°C$
$f = 1MHz$
typ
20
15
10
5
0
0
5
10
15
20
25
V_{CB} (V)
30

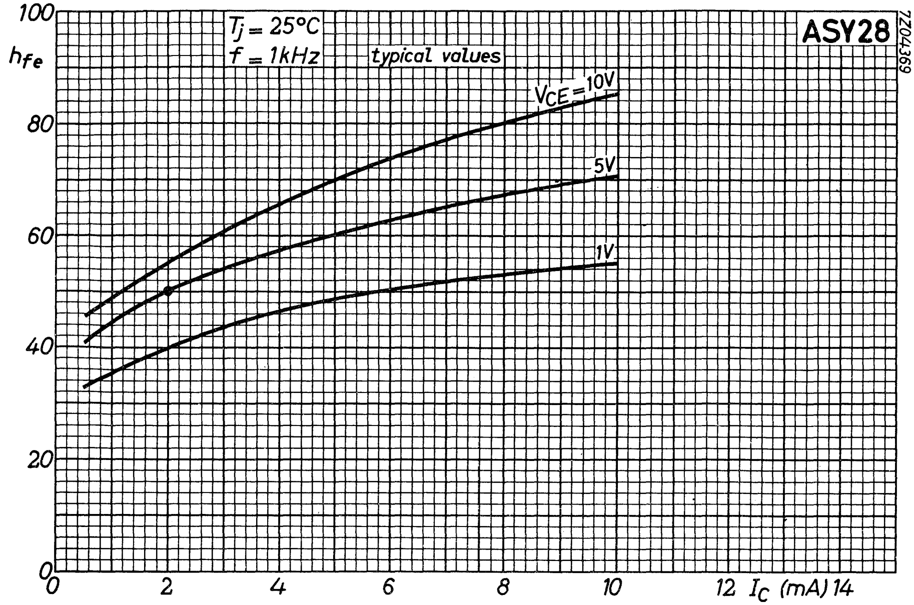

7Z04374
C_e
(pF)
$T_j = 25°C$
$f = 1MHz$
ASY28
ASY29
typ
typ
20
15
10
5
0
0
5
10
15
20
25
V_{EB} (V)
30

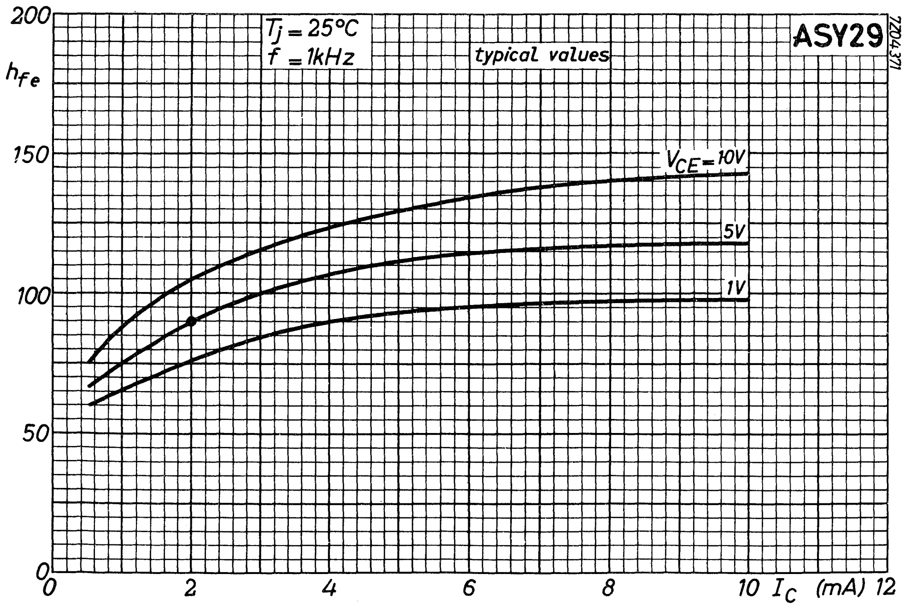

ASY28
7Z04365
h_{ie} (kΩ)
$T_j = 25°C$
f = 1kHz
typical values
V_{CE} =
10V
5V
1V
I_C (mA)
0
0.5
1
1.5
2
0
2
4
6
8
10
12

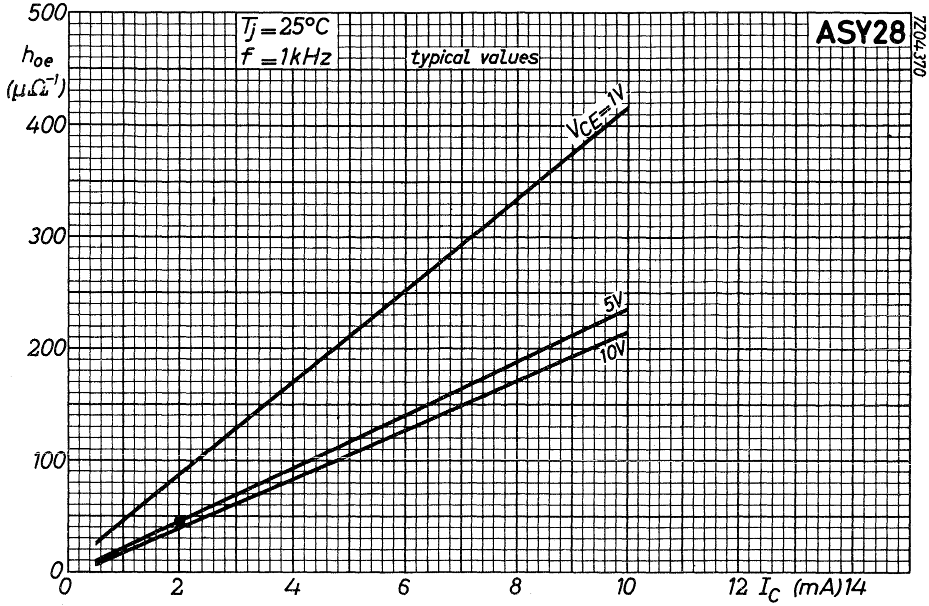

ASY29
7Z04367
h_{ie} (kΩ)
$T_j = 25°C$
f = 1kHz
typical values
V_{CE} =
10V
5V
1V
I_C (mA)
0
1
2
3
4
0
2
4
6
8
10
12

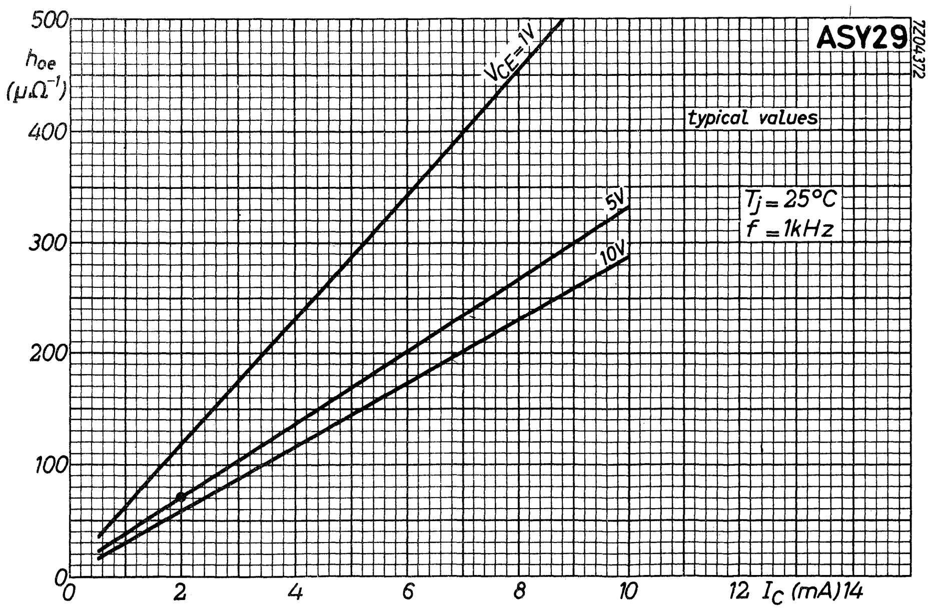

ASY28
7Z04366
h_{re} (10^{-4})
$T_j = 25°C$
$f = 1kHz$
typical values
$V_{CE} = 1V$
5V
10V
0
5
10
15
20
0
2
4
6
8
10
I_C (mA)
12

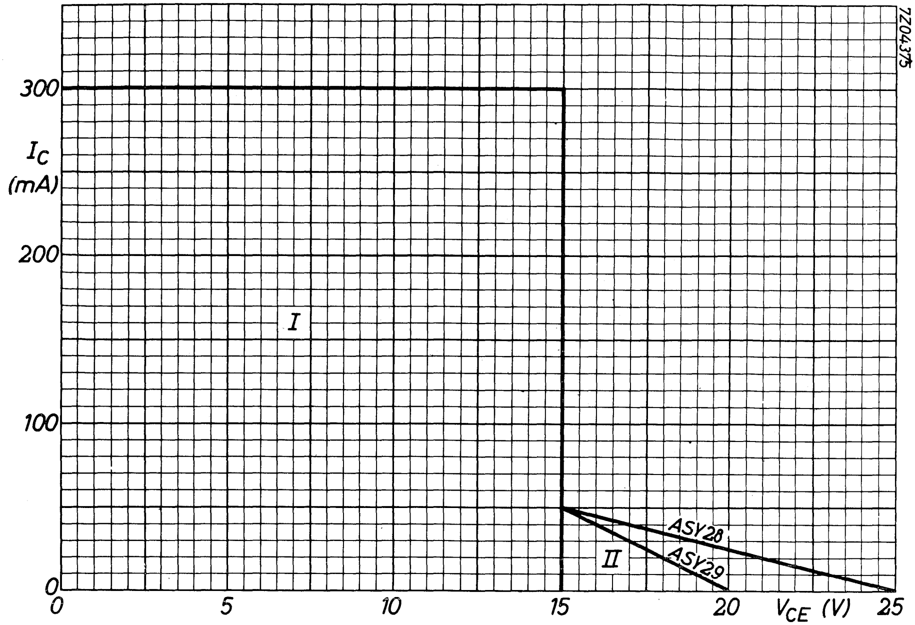

ASY29
7Z04368
h_{re} (10^{-4})
$T_j = 25°C$
$f = 1kHz$
typical values
$V_{CE} = 1V$
5V
10V
0
5
10
15
20
0
2
4
6
8
10
I_C (mA)
12


100
h_{fe}
80
60
40
20
0
0
2
4
6
8
10
12
I_C (mA)
14
$T_j = 25°C$
$f = 1kHz$
typical values
ASY28
$V_{CE} = 10V$
5V
1V
7Z04369


200
h_{fe}
150
100
50
0
0
2
4
6
8
10
I_C (mA)
12
$T_j = 25°C$
$f = 1kHz$
typical values
ASY29
$V_{CE} = 10V$
5V
1V
7Z04371


ASY28
7Z04370
$T_j = 25°C$
$f = 1kHz$
typical values
h_{oe}
$(\mu\Omega^{-1})$
500
400
300
200
100
0
$V_{CE}=1V$
5V
10V
0
2
4
6
8
10
12
I_C (mA)
14


ASY29
7Z04372
typical values
$T_j = 25°C$
$f = 1kHz$
h_{oe}
$(\mu\Omega^{-1})$
500
400
300
200
100
0
$V_{CE}=1V$
5V
10V
0
2
4
6
8
10
12
I_C (mA)
14



I = permissible region of operation under all base-emitter conditions
II = additional region of operation when the transistor is cut-off with $-V_{BE} > 0.2$ V

Outside the permissible regions of operation the transistor can withstand transient energies of 15 μWs, provided:

$$0.2\ \text{V} < -V_{BE} < 2\ \text{V and } I_C < 200\ \text{mA}$$

7Z3 0052

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 $T_{amb} = 25\ ^oC$	P_{tot}	max.	125	mW

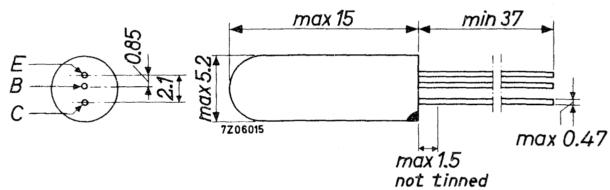
Temperatures

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

THERMAL RESISTANCE

From junction to ambient in free air	$R_{th\ j-a}$	=	0.4	$^oC/mW$
From junction to case	$R_{th\ j-c}$	=	0.2	$^oC/mW$

MECHANICAL DATA Dimensions in mm



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

7Z3 1423

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

7Z3 1424

CHARACTERISTICS (continued) $T_j = 25\ ^oC$

			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

7Z3 1425

SYMMETRICAL N-P-N SWITCHING TRANSISTORS

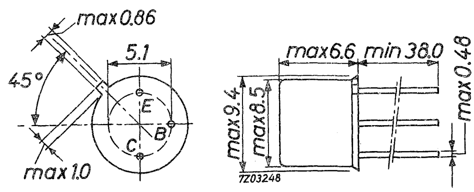
Symmetrical N-P-N germanium alloy transistors in a TO-5 metal envelope with the base connected to the case intended for high current medium speed switching applications.

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



7Z3 0688

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 $T_{amb} = 25$ °C	P_{tot}	max.	140	mW

Temperatures

Storage temperature	T_{stg}		−55 to 85	°C
Operating junction temperature	T_j	max.	75	°C

THERMAL RESISTANCE

From junction to ambient in free air	$R_{th\ j\text{-}a}$	=	0.35	°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.

[2]) For switch-off transients with inductive load see page I

7Z3 0689

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

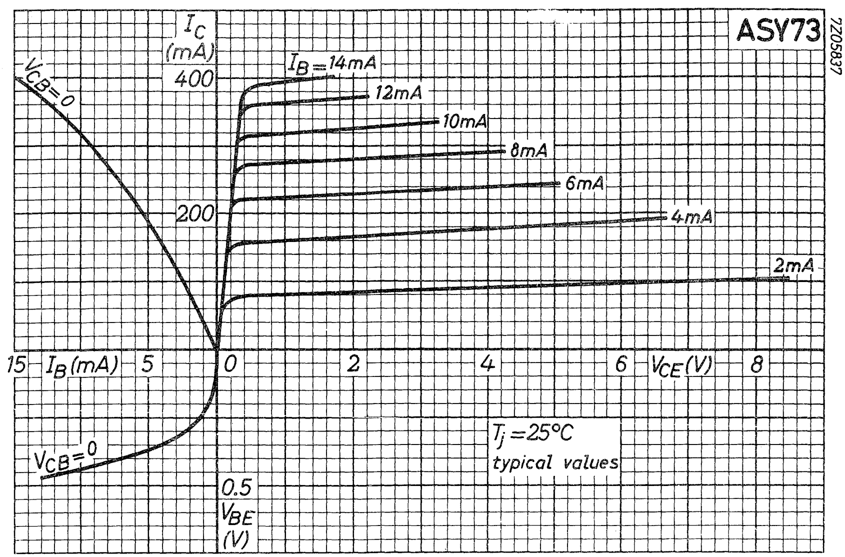
$I_C = 10$ mA; $I_B = 0$	$V_{CEOsust}$	>	15	V

7Z3 0690

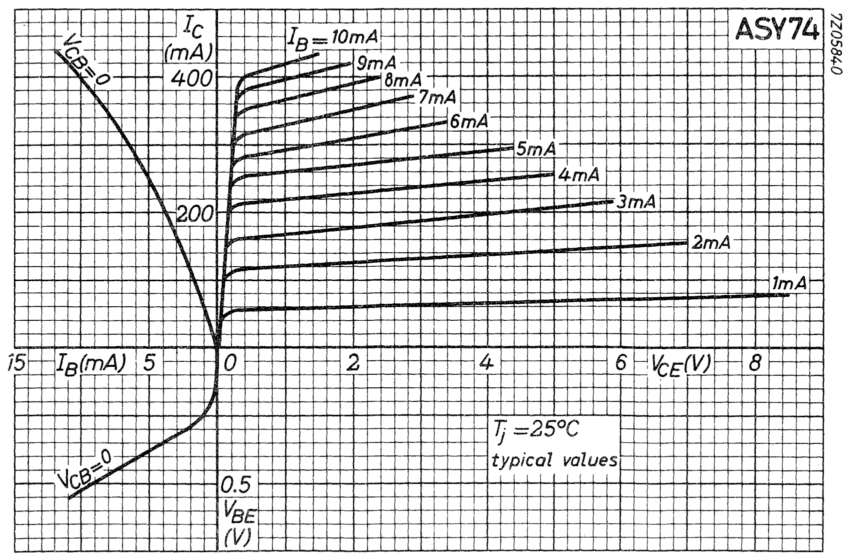
CHARACTERISTICS (continued) T_j = 25 °C unless otherwise specified

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

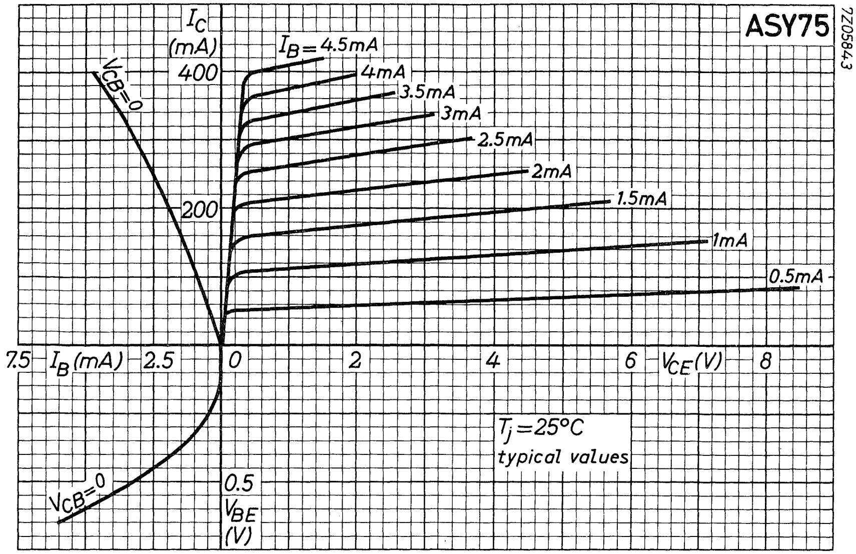
7Z3 0691

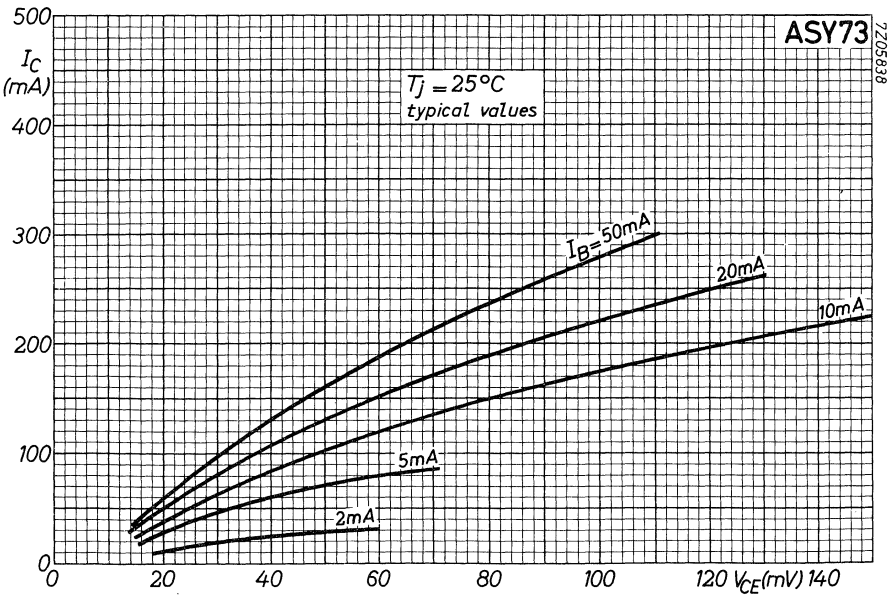


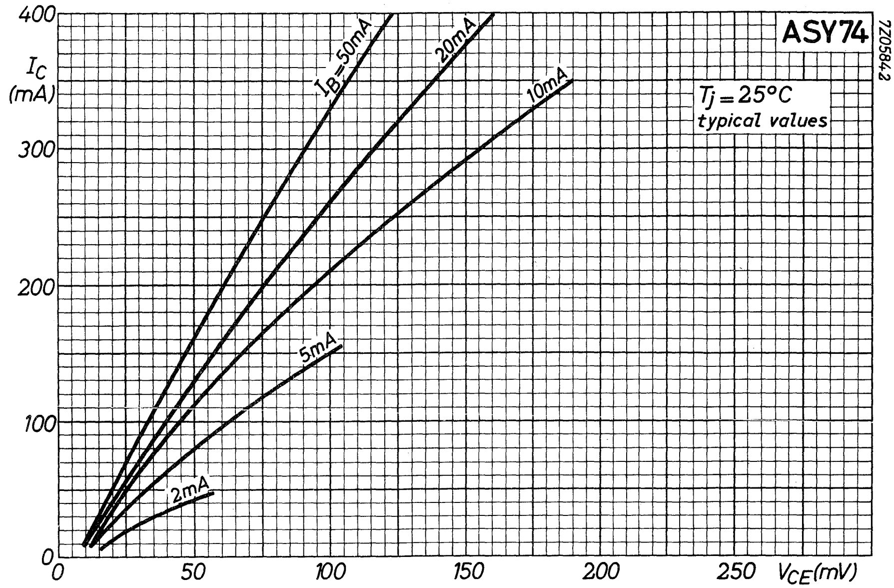
ASY73
7Z05837
I_C (mA)
400
200
I_B = 14mA
12mA
10mA
8mA
6mA
4mA
2mA
$V_{CB}=0$
15
I_B (mA)
5
0
2
4
6
V_{CE} (V)
8
T_j = 25°C
typical values
$V_{CB}=0$
0.5
V_{BE} (V)

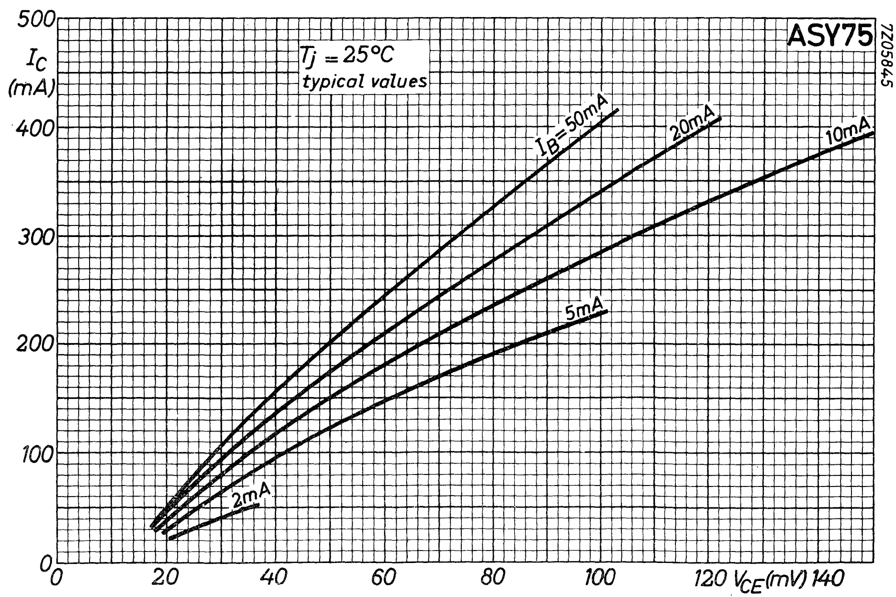


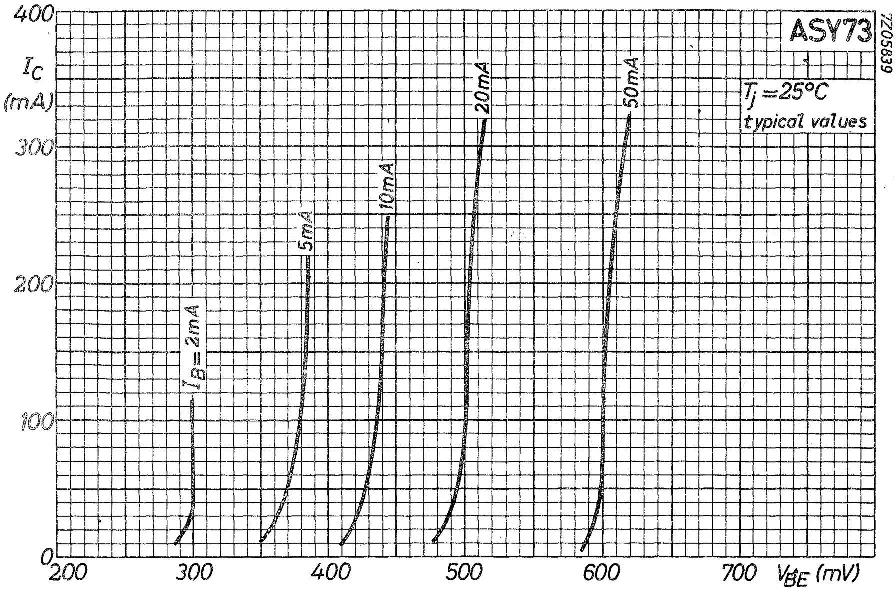
ASY74
7Z05840
I_C (mA)
400
200
I_B = 10mA
9mA
8mA
7mA
6mA
5mA
4mA
3mA
2mA
1mA
$V_{CB}=0$
15
I_B (mA)
5
0
2
4
6
V_{CE} (V)
8
T_j = 25°C
typical values
$V_{CB}=0$
0.5
V_{BE} (V)

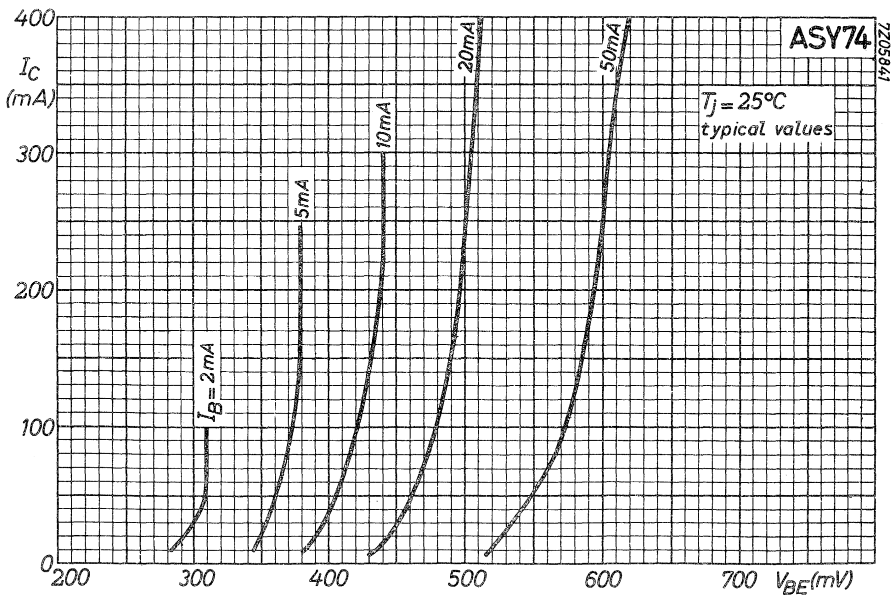

ASY75
7Z05843
I_C (mA)
400
200
I_B=4.5mA
4mA
3.5mA
3mA
2.5mA
2mA
1.5mA
1mA
0.5mA
V_{CB}=0
7.5
I_B (mA)
2.5
0
2
4
6
V_{CE}(V)
8
T_j=25°C
typical values
V_{CB}=0
0.5
V_{BE}
(V)

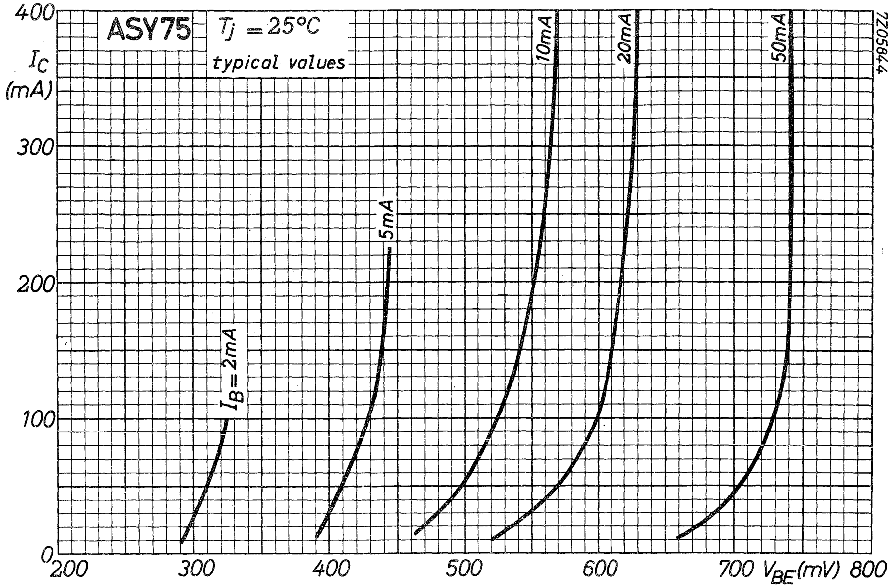

ASY73
7Z05838
500
I_C
(mA)
400
300
200
100
0
T_j =25°C
typical values
I_B=50mA
20mA
10mA
5mA
2mA
0
20
40
60
80
100
120 V_{CE}(mV) 140

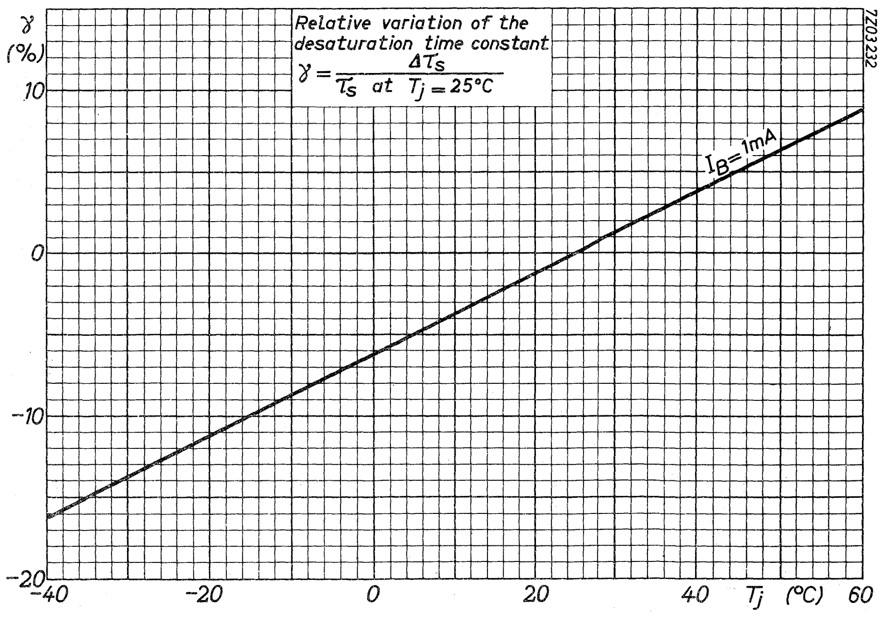

ASY74
7Z05842
$T_j = 25°C$
typical values
400
300
200
100
0
I_C
(mA)
I_B=50mA
20mA
10mA
5mA
2mA
0
50
100
150
200
250
V_{CE}(mV)

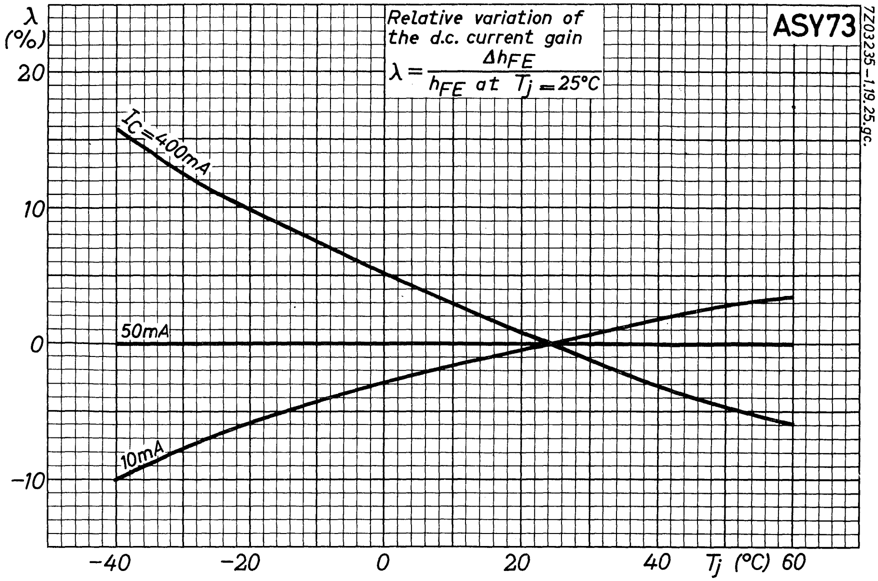

ASY75
7Z05845
$T_j = 25°C$
typical values
500
400
300
200
100
0
I_C
(mA)
I_B=50mA
20mA
10mA
5mA
2mA
0
20
40
60
80
100
120
V_{CE}(mV)
140

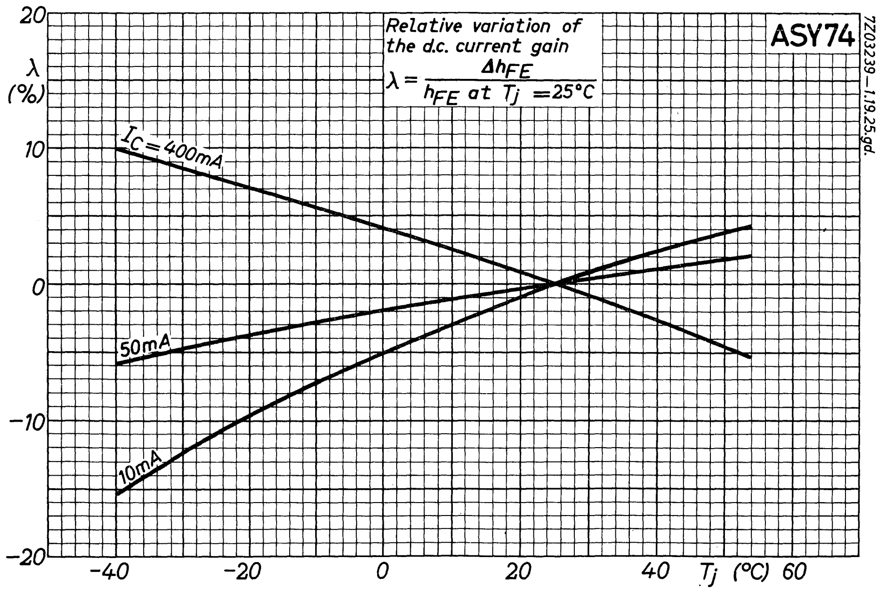

ASY73
7Z05839
I_C (mA)
400
300
200
100
0
200
300
400
500
600
700
V_{BE} (mV)
T_j = 25°C
typical values
I_B = 2mA
5mA
10mA
20mA
50mA

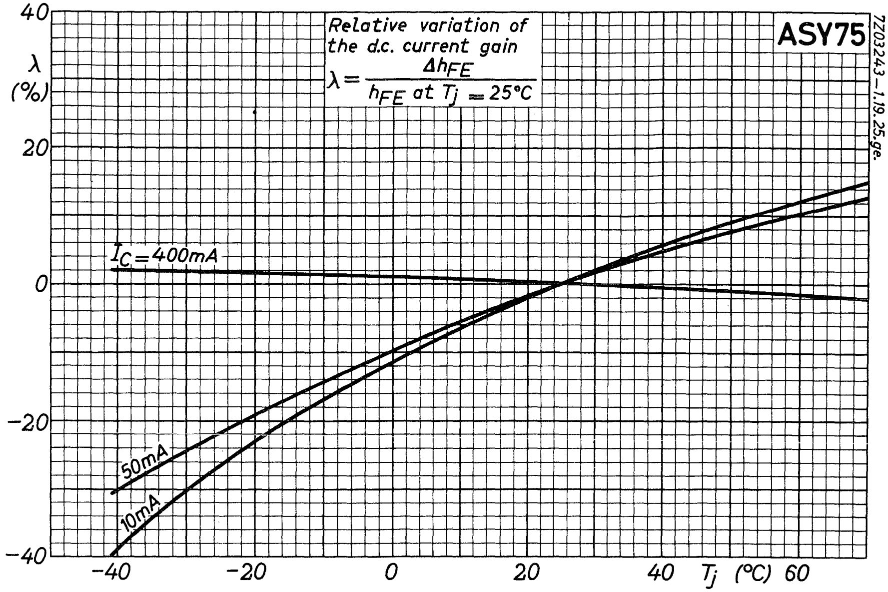

ASY74
7Z05841
I_C (mA)
400
300
200
100
0
200
300
400
500
600
700
V_{BE}(mV)
T_j = 25°C
typical values
I_B = 2mA
5mA
10mA
20mA
50mA

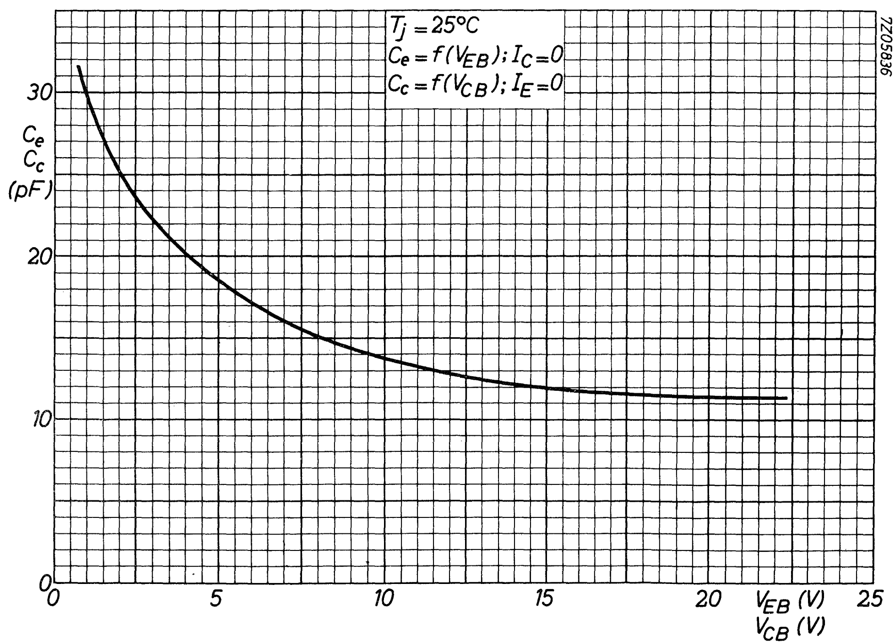

ASY75
$T_j = 25°C$
typical values
I_C (mA)
400
300
200
100
0
200
300
400
500
600
700
V_{BE} (mV)
800
$I_B = 2mA$
5mA
10mA
20mA
50mA
7Z05844

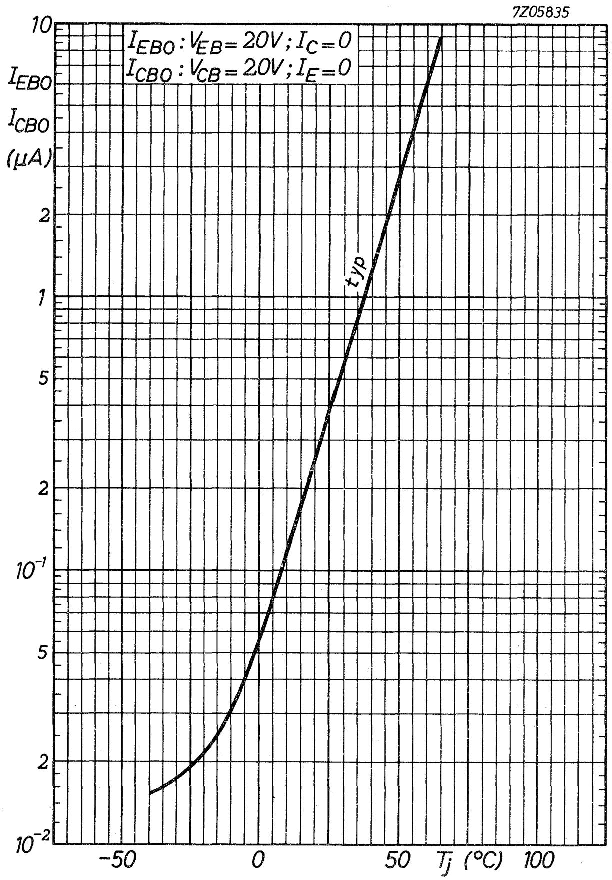

Relative variation of the desaturation time constant
$\gamma = \frac{\Delta\tau_s}{\tau_s \text{ at } T_j = 25°C}$
γ (%)
10
0
−10
−20
−40
−20
0
20
40
T_j (°C)
60
$I_B = 1mA$
7Z03232

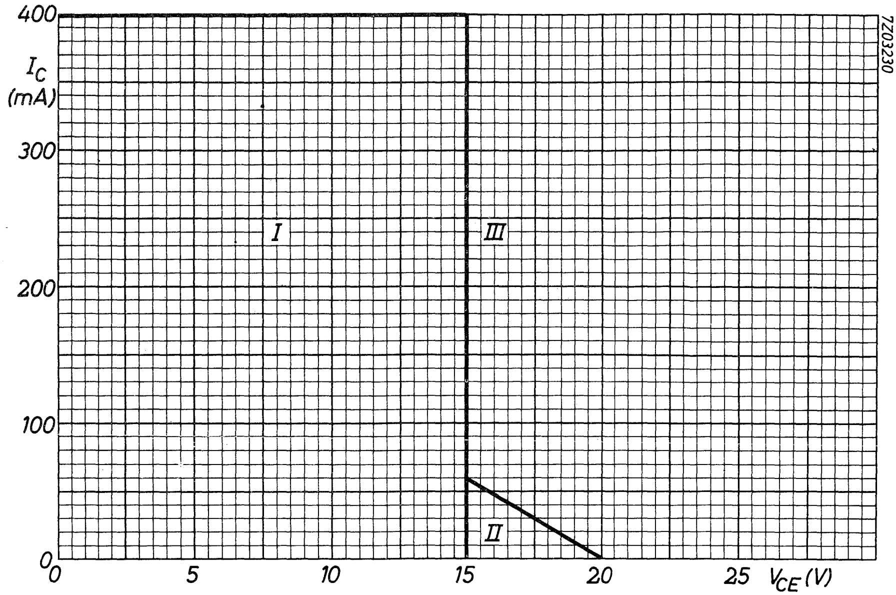

λ
(%)
20
10
0
−10
Relative variation of
the d.c. current gain
$\lambda = \frac{\Delta h_{FE}}{h_{FE} \text{ at } T_j = 25°C}$
ASY73
7Z03235–1.19.25.gc.
I_C=400mA
50mA
10mA
−40
−20
0
20
40
T_j (°C)
60


20
λ
(%)
10
0
−10
−20
Relative variation of
the d.c. current gain
$\lambda = \frac{\Delta h_{FE}}{h_{FE} \text{ at } T_j = 25°C}$
ASY74
7Z03239–1.19.25.gd.
I_C=400mA
50mA
10mA
−40
−20
0
20
40
T_j (°C)
60


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.
λ
(%)
40
20
0
−20
−40
$I_C = 400mA$
50mA
10mA
−40
−20
0
20
40
T_j (°C)
60


$T_j = 25°C$
$C_e = f(V_{EB}); I_C = 0$
$C_c = f(V_{CB}); I_E = 0$
7Z05836
C_e
C_c
(pF)
30
20
10
0
0
5
10
15
20
25
V_{EB} (V)
V_{CB} (V)


7Z05835
$I_{EBO}: V_{EB} = 20V; I_C = 0$
$I_{CBO}: V_{CB} = 20V; I_E = 0$
10
I_{EBO}
I_{CBO}
(μA)
2
1
5
2
10^{-1}
5
2
10^{-2}
typ
−50
0
50
T_j (°C)
100



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 $0.2\ V < -V_{BE} < 2\ V$

7Z3 0692

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.

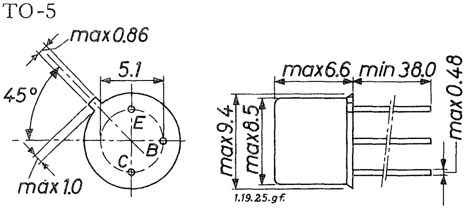
QUICK REFERENCE DATA

			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 $T_{amb} = 25\ ^{o}C$	P_{tot}	max.	500			mW
Junction temperature	T_j	max.	85			^{o}C
Thermal resistance from junction to case	$R_{th\ j\text{-}c}$	=	75			$^{o}C/W$
D.C. current gain at $T_j = 25\ ^{o}C$						
$-I_C = 600$ 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

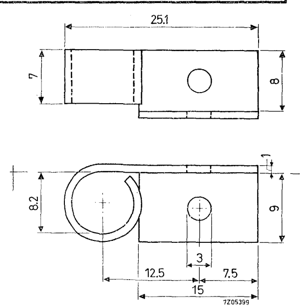
MECHANICAL DATA

Dimensions in mm

TO-5



Base connected to case



Type number of cooling and mounting clip 56265

7Z3 0570

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	$R_{th\ j\text{-}a}$	=	250	$^{o}C/W$
From junction to case	$R_{th\ j\text{-}c}$	=	75	$^{o}C/W$
From junction to ambient with cooling fin 56265 on a heatsink of 12.5 cm^2	$R_{th\ j\text{-}a}$	=	120	$^{o}C/W$

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

7Z3 0571

CHARACTERISTICS

T_j = 25 °C unless otherwise specified

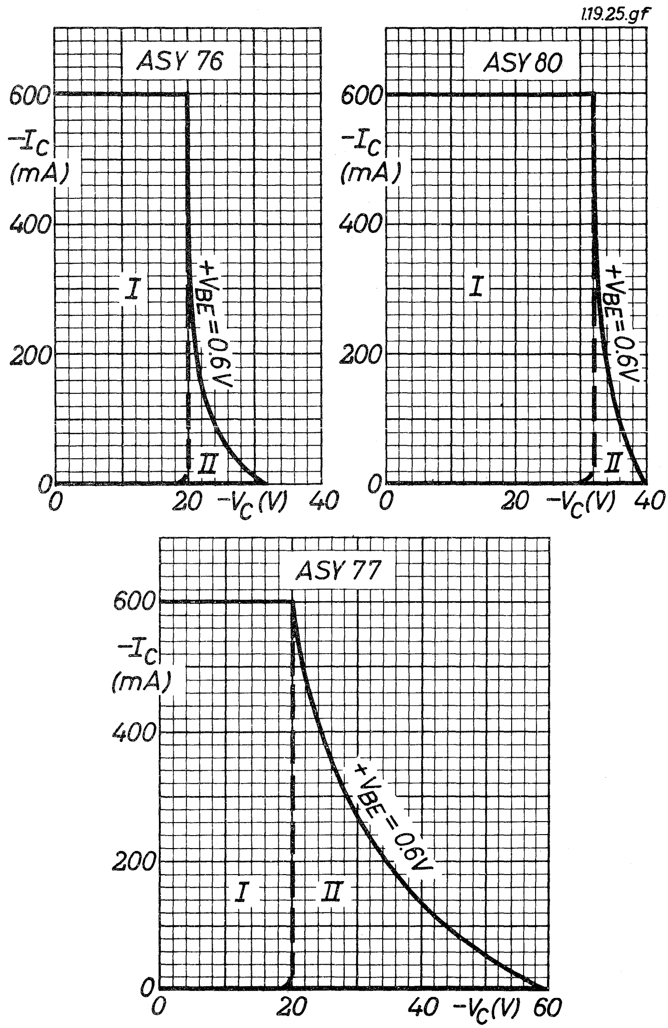
			ASY76	ASY77	ASY80	
Collector cut-off current						
$I_E = 0$; $-V_{CB} = 10$ V	$-I_{CBO}$	typ.	4.5	4.5	4.5	μA
		<	10	10	10	μA
$I_E = 0$; $-V_{CB} = 40$ V	$-I_{CBO}$	<	40	–	40	μA
$I_E = 0$; $-V_{CB} = 60$ V	$-I_{CBO}$	<	–	40	–	μA
Emitter cut-off current						
$I_C = 0$; $-V_{EB} = 10$ V	$-I_{EBO}$	<	20	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	

7Z3 0572

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		$\lvert z_{rb} \rvert$	typ.	75	Ω

7Z3 0573

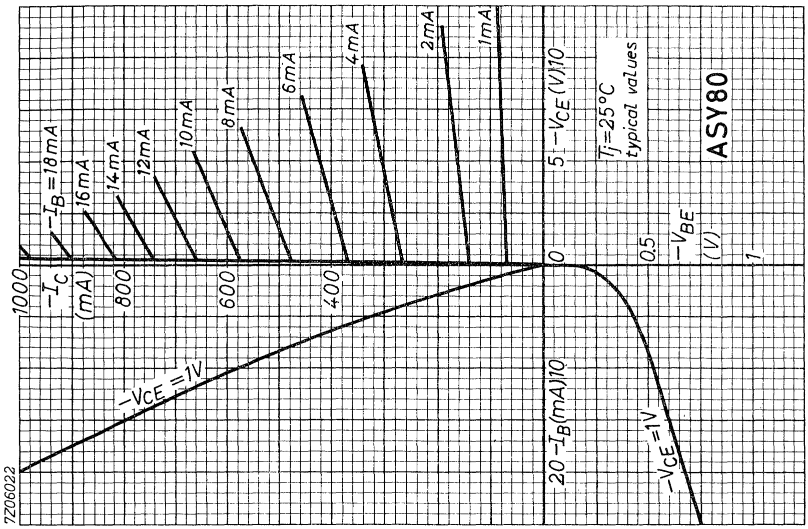


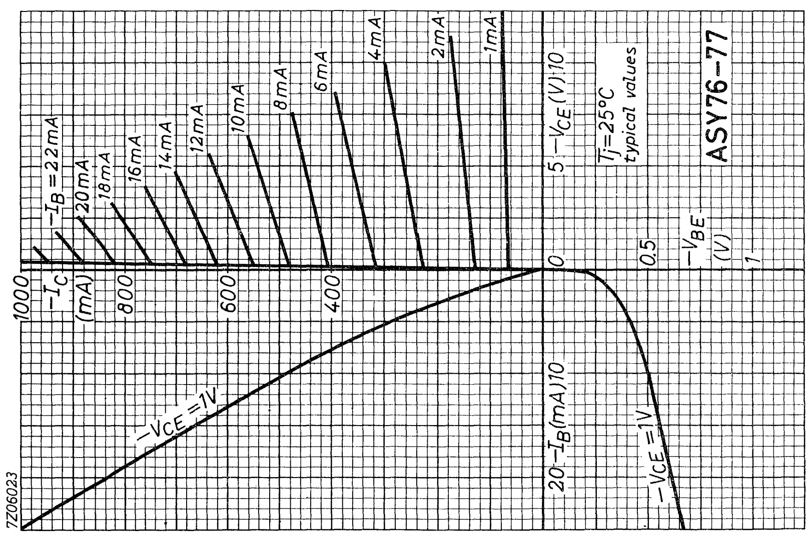
I = permissible region of operation under all base-emitter conditions

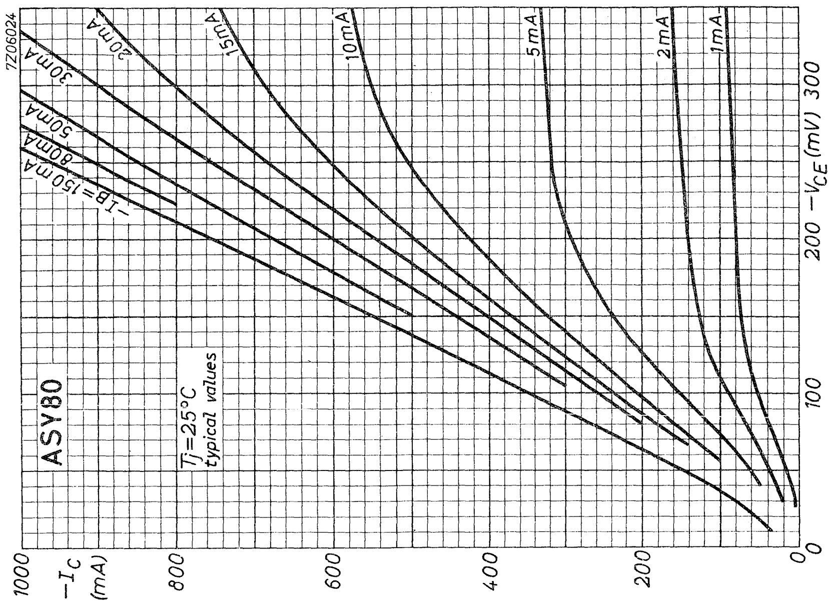
II = additional region of operation when the transistor is cut-off with $+V_{BE} = 0.6$ V.

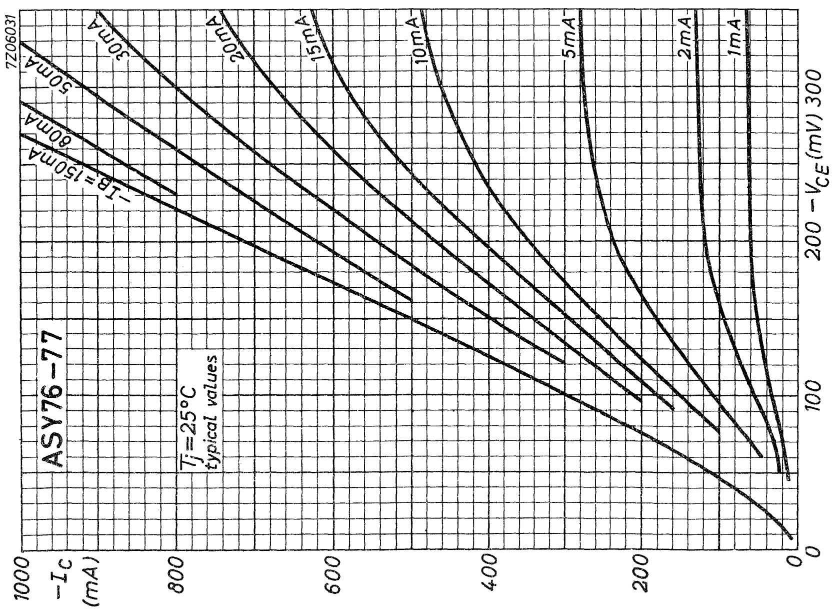
During switching off voltages higher than those indicated by the minimum avalanche curves at $+V_{BE} = 0.6$ V are allowed if the transient energy is less than 12 mWs.

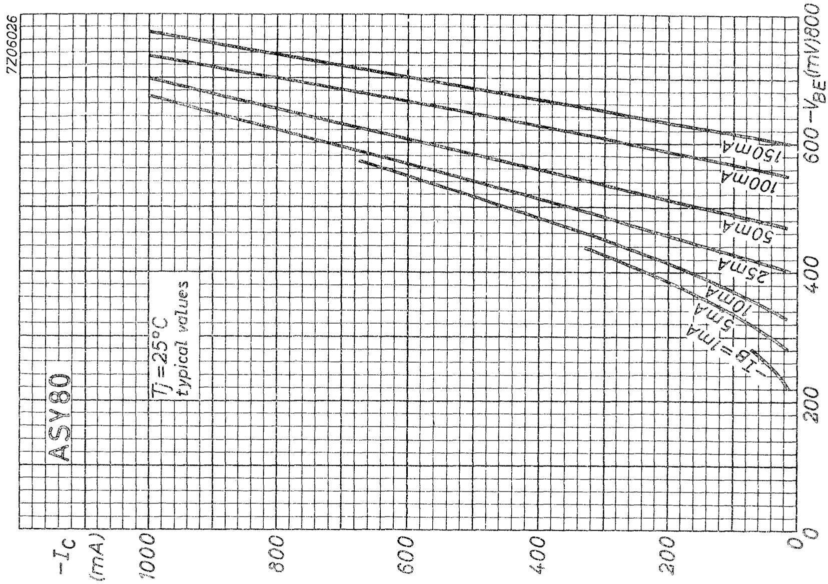
7Z3 0574

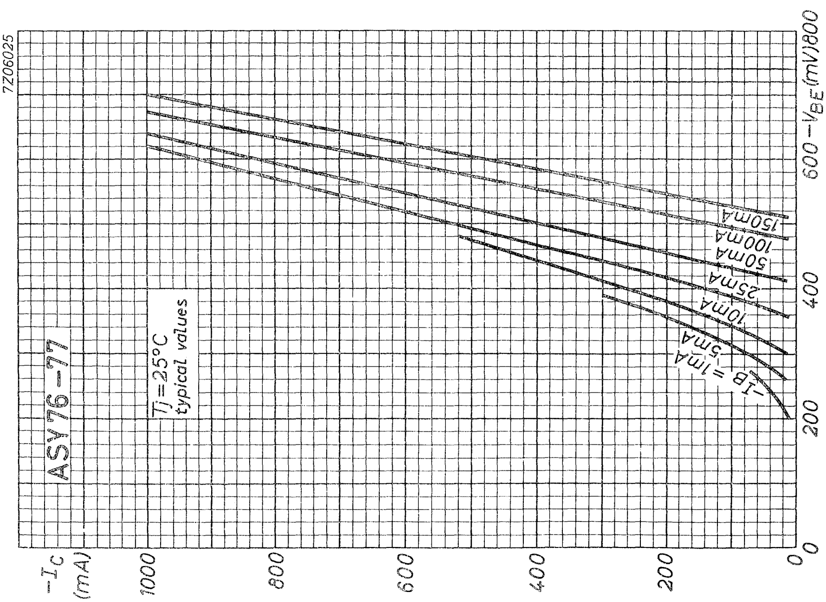

7Z06022
ASY80
T_j=25°C
typical values
$-I_B$=18mA
16mA
14mA
12mA
10mA
8mA
6mA
4mA
2mA
1mA
$-I_C$
(mA)
1000
800
600
400
0
5
$-V_{CE}$ (V) 10
$-V_{CE}$=1V
$-I_B$(mA)10
20
$-V_{BE}$
(V)
0.5
1

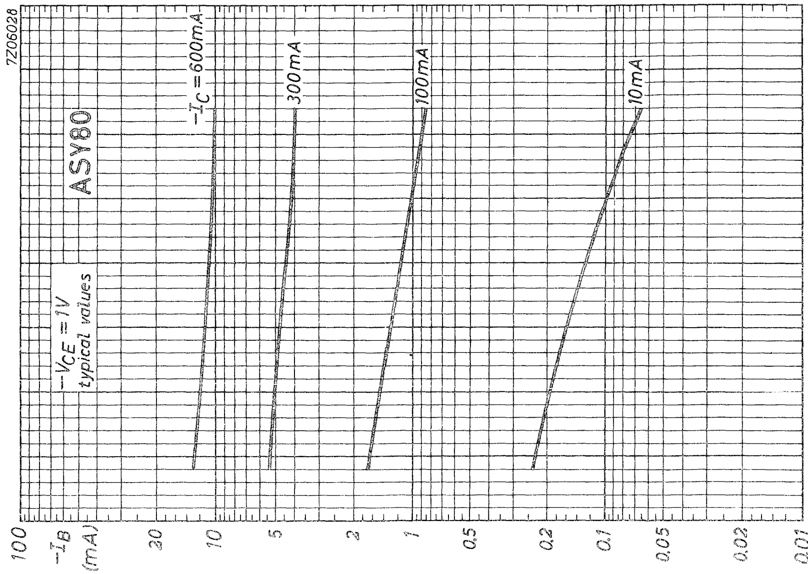

7Z06023
ASY76–77
T_j=25°C
typical values
$-I_B$=22mA
20mA
18mA
16mA
14mA
12mA
10mA
8mA
6mA
4mA
2mA
1mA
$-I_C$
(mA)
1000
800
600
400
0
5
$-V_{CE}$ (V) 10
$-V_{CE}$=1V
$-I_B$(mA)10
20
$-V_{BE}$
(V)
0.5
1

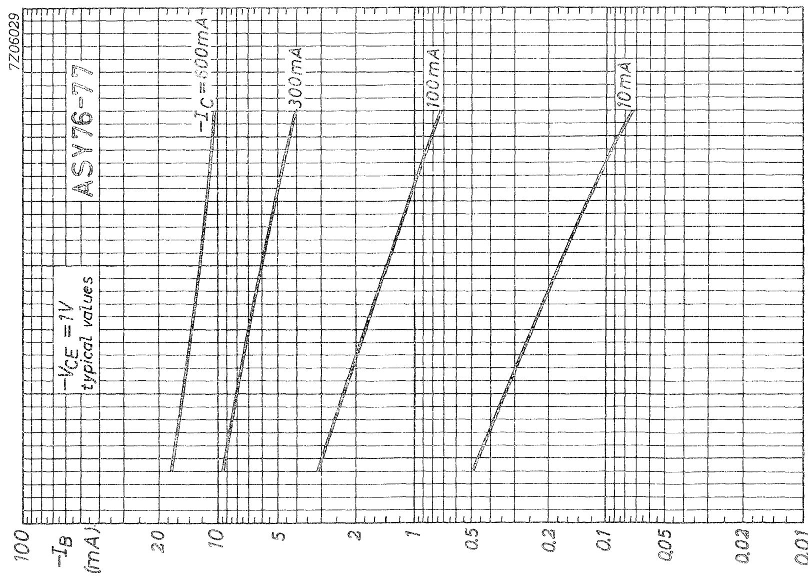

ASY80
T_j=25°C
typical values
7Z06024
$-I_B$=150mA
80mA
50mA
30mA
20mA
15mA
10mA
5mA
2mA
1mA
$-I_C$ (mA)
$-V_{CE}$ (mV)
1000
800
600
400
200
0
100
200
300

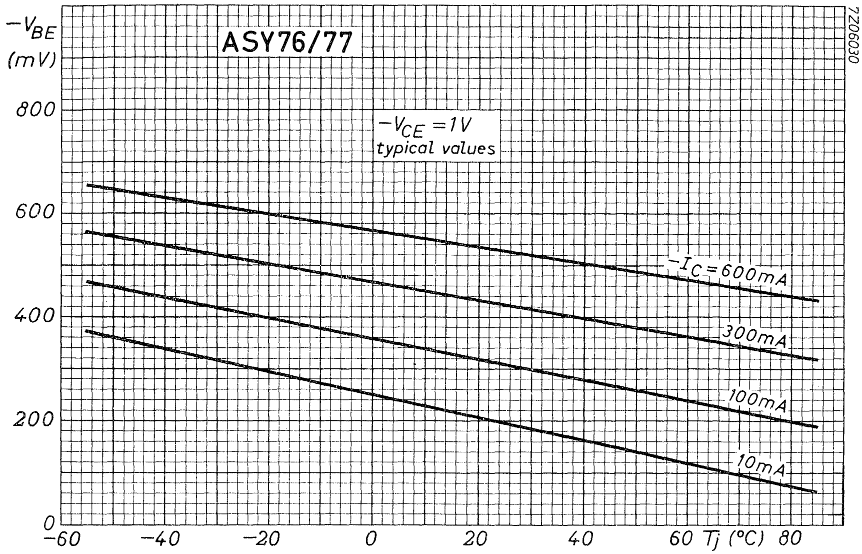

ASY76–77
T_j=25°C
typical values
7Z06031
$-I_B$=150mA
80mA
50mA
30mA
20mA
15mA
10mA
5mA
2mA
1mA
$-I_C$ (mA)
$-V_{CE}$ (mV)
1000
800
600
400
200
0
100
200
300

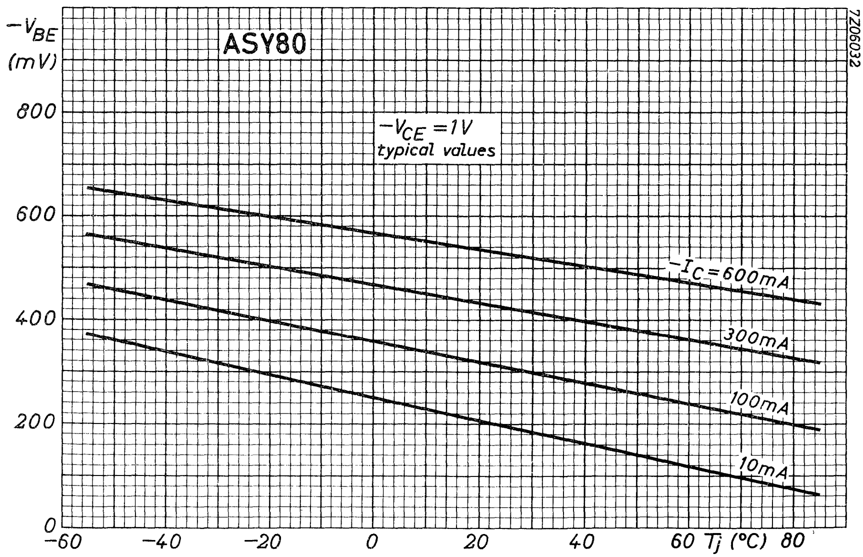

7Z06026
ASY80
Tj = 25°C
typical values
$-I_C$ (mA)
$-V_{BE}$ (mV)
$-I_B$ = 1mA
5mA
10mA
25mA
50mA
100mA
150mA
0
200
400
600
800
1000

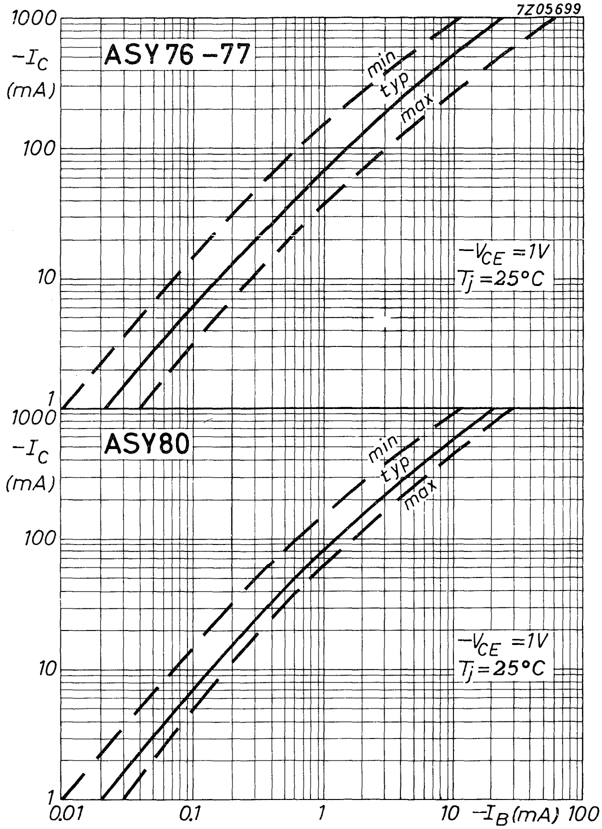

7Z06025
ASY76 – 77
Tj = 25°C
typical values
$-I_C$ (mA)
$-V_{BE}$ (mV)
$-I_B$ = 1mA
5mA
10mA
25mA
50mA
100mA
150mA
0
200
400
600
800
1000


7Z06028
ASY80
$-V_{CE} = 1V$
typical values
$-I_C = 600mA$
300mA
100mA
10mA
$-I_B$
(mA)
100
20
10
5
2
1
0.5
0.2
0.1
0.05
0.02
0.01
-50
0
50
100
Tj (°C)

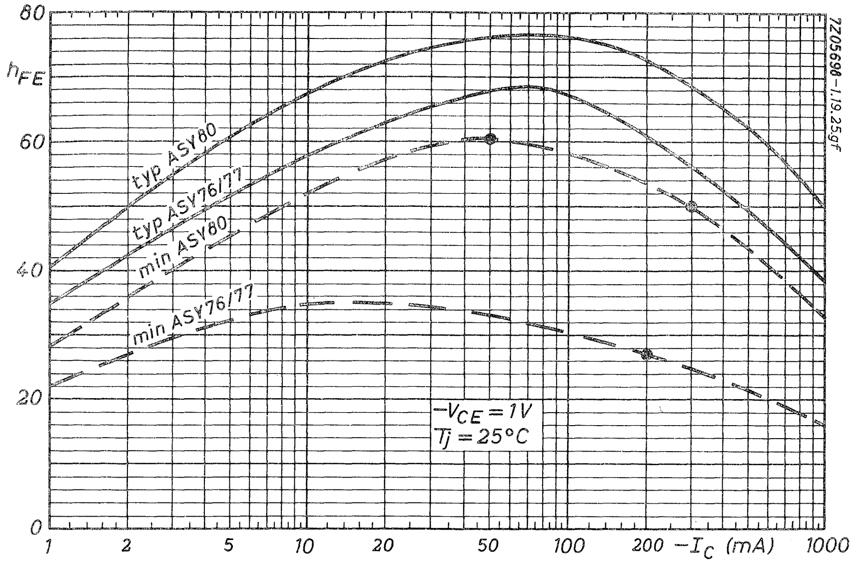

7Z06029
ASY76-77
$-V_{CE} = 1V$
typical values
$-I_C = 600mA$
300mA
100mA
10mA
$-I_B$
(mA)
100
20
10
5
2
1
0.5
0.2
0.1
0.05
0.02
0.01
-50
0
50
100
Tj (°C)

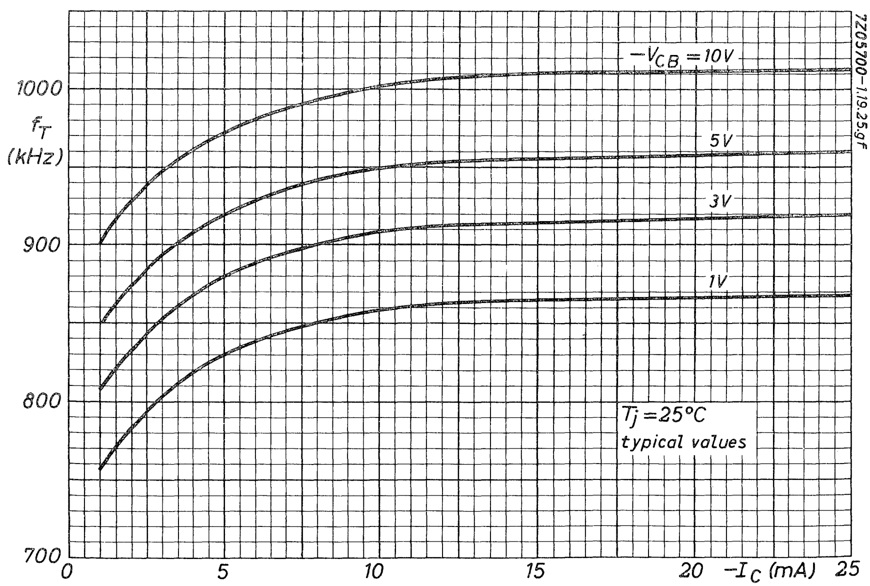

$-V_{BE}$ (mV)
ASY76/77
7Z06030
800
600
400
200
0
$-V_{CE}=1V$
typical values
$-I_C=600mA$
300mA
100mA
10mA
−60
−40
−20
0
20
40
60 T_j (°C) 80

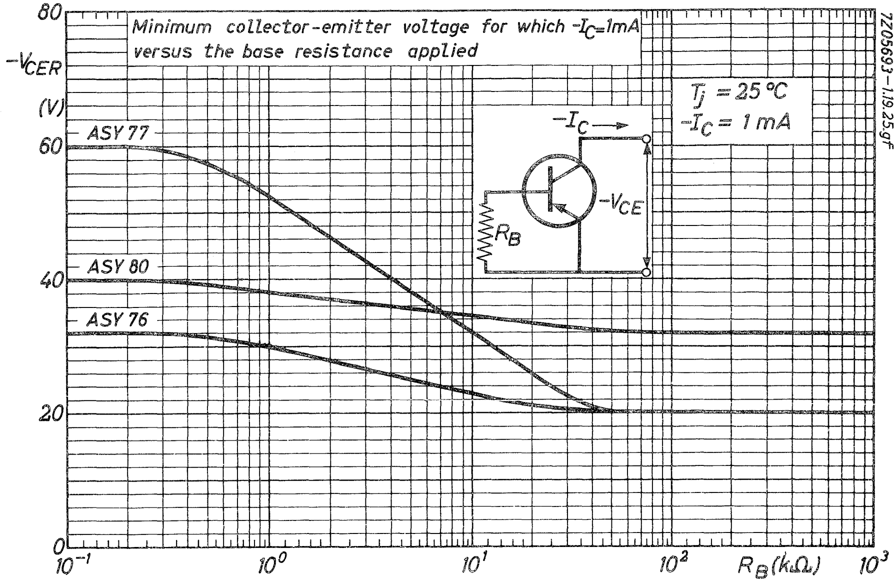

$-V_{BE}$ (mV)
ASY80
7Z06032
800
600
400
200
0
$-V_{CE}=1V$
typical values
$-I_C=600mA$
300mA
100mA
10mA
−60
−40
−20
0
20
40
60 T_j (°C) 80

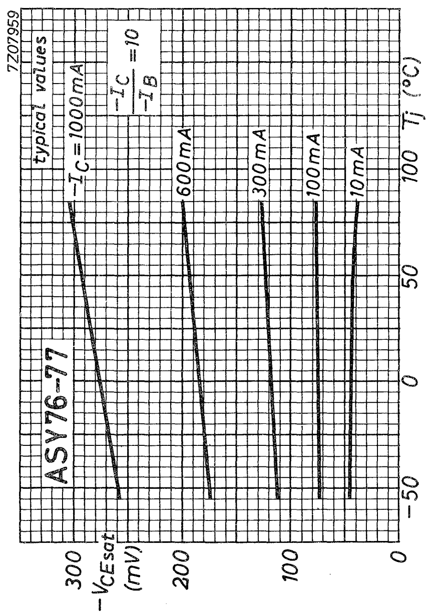


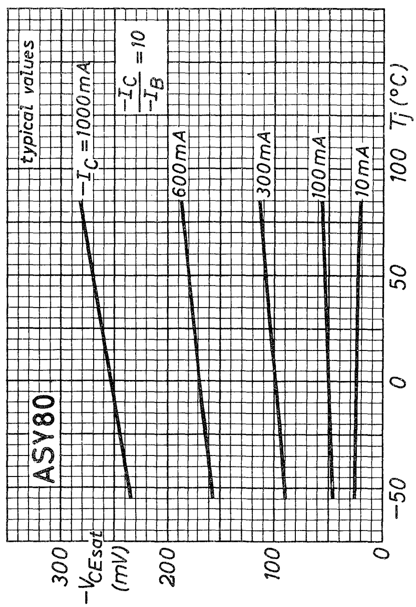
Base current as a function of collector current

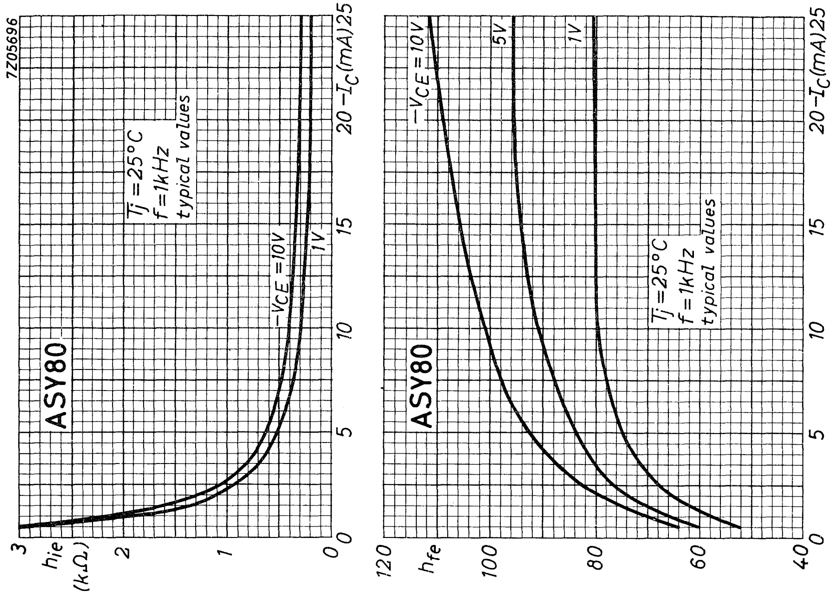

7Z05698-1.19.25gf
80
h_{FE}
60
40
20
0
typ ASY80
typ ASY76/77
min ASY80
min ASY76/77
$-V_{CE} = 1V$
$T_j = 25°C$
1
2
5
10
20
50
100
200
$-I_C$ (mA)
1000

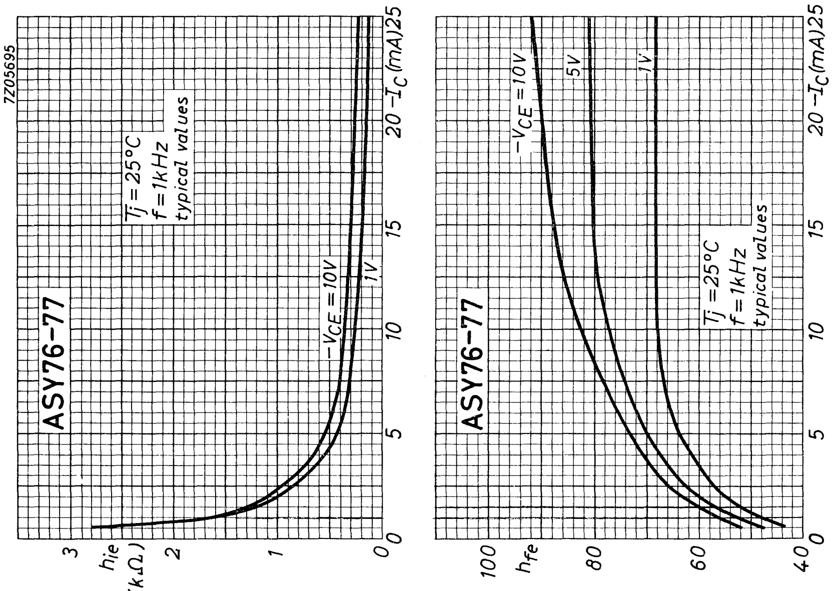

7Z05700-1.19.25gf
1000
f_T
(kHz)
900
800
700
$-V_{CB} = 10V$
5V
3V
1V
$T_j = 25°C$
typical values
0
5
10
15
20
$-I_C$ (mA)
25

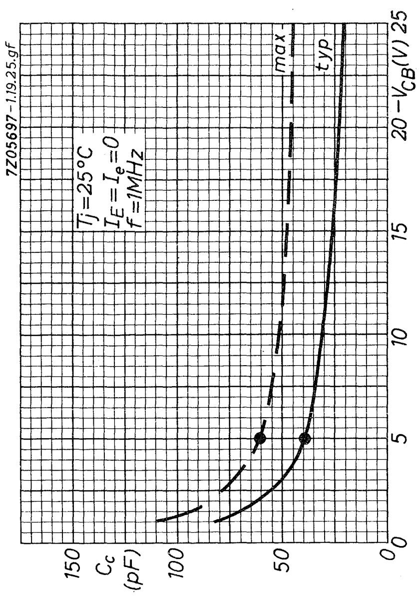

Minimum collector-emitter voltage for which $-I_C$=1mA versus the base resistance applied
$-V_{CER}$
(V)
80
60
40
20
0
ASY 77
ASY 80
ASY 76
T_j = 25 °C
$-I_C$ = 1 mA
$-I_C$
$-V_{CE}$
R_B
10^{-1}
10^0
10^1
10^2
10^3
R_B (kΩ)
7Z05693-1.19.25.gF

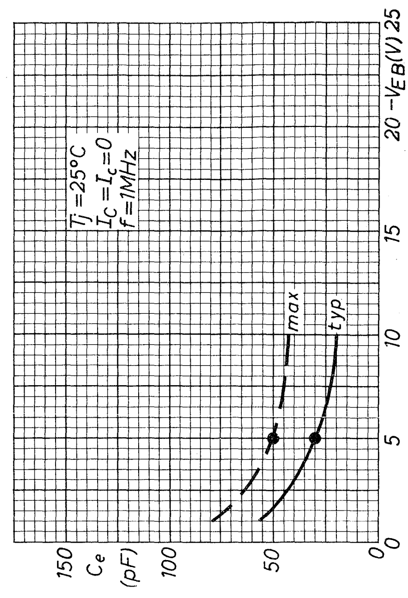

7Z07959
typical values
$\frac{-I_C}{-I_B}$ = 10
$-I_C$=1000mA
600mA
300mA
100mA
10mA
ASY76-77
T_j (°C)
100
50
0
−50
$-V_{CEsat}$
(mV)
300
200
100
0

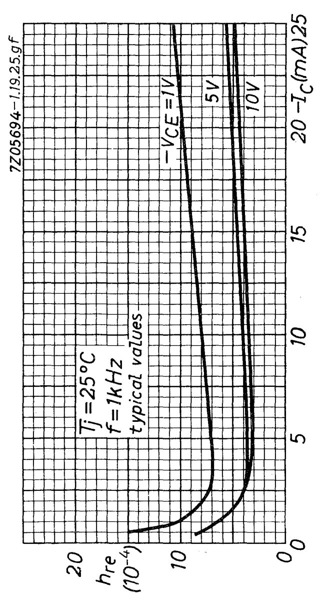

typical values
$\frac{-I_C}{-I_B}$ = 10
$-I_C$=1000mA
600mA
300mA
100mA
10mA
ASY80
T_j (°C)
100
50
0
−50
$-V_{CEsat}$
(mV)
300
200
100
0

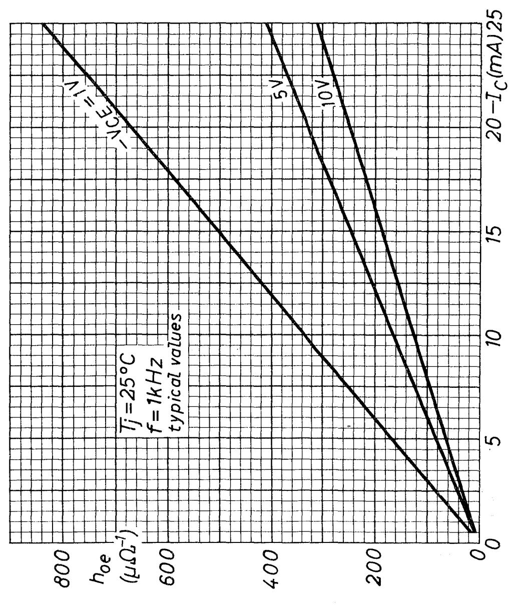

7Z05696
ASY80
$T_j = 25°C$
$f = 1kHz$
typical values
$-V_{CE} = 10V$
1V
5V
h_{ie}
$(k\Omega)$
h_{fe}
3
2
1
0
120
100
80
60
40
0
5
10
15
20
$-I_C$ (mA) 25

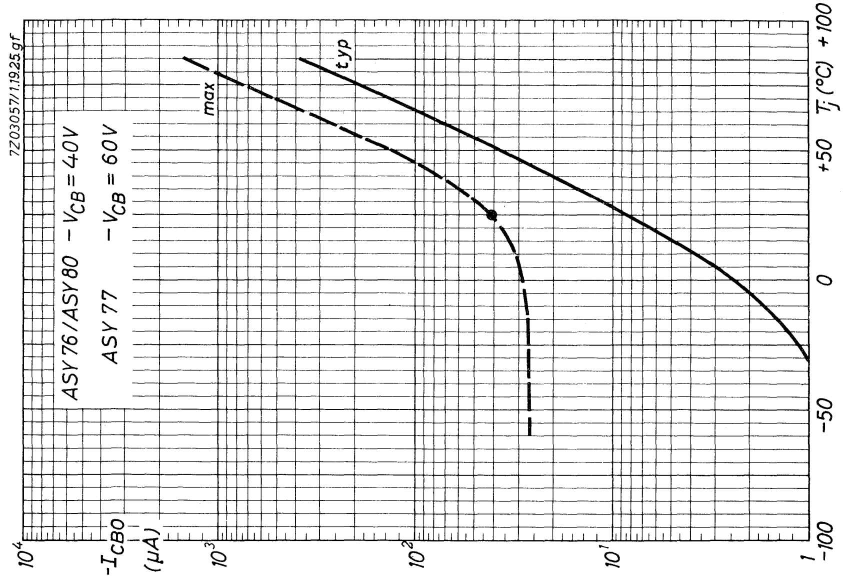

7Z05695
ASY76-77
$T_j = 25°C$
$f = 1kHz$
typical values
$-V_{CE} = 10V$
1V
5V
h_{ie}
$(k\Omega)$
h_{fe}
3
2
1
0
100
80
60
40
0
5
10
15
20
$-I_C$ (mA) 25

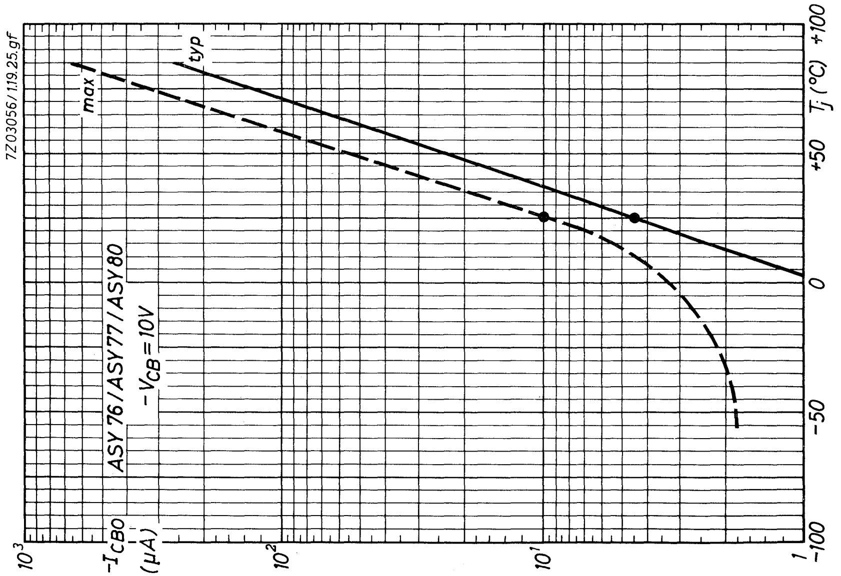

7Z05697-1.19.25.gf
Tj = 25°C
I_E = I_e = 0
f = 1MHz
max
typ
C_c
(pF)
150
100
50
0
0
5
10
15
20
−V_CB(V) 25


Tj = 25°C
I_C = I_c = 0
f = 1MHz
max
typ
C_e
(pF)
150
100
50
0
0
5
10
15
20
−V_EB(V) 25


7Z05694-1.19.25.gf
Tj = 25°C
f = 1kHz
typical values
−V_CE = 1V
5V
10V
h_re
(10^-4)
20
10
0
0
5
10
15
20
−I_C(mA) 25


Tj = 25°C
f = 1kHz
typical values
−V_CE = 1V
5V
10V
h_oe
(μΩ^-1)
800
600
400
200
0
0
5
10
15
20
−I_C(mA) 25


7Z03057/1.19.25.gf
ASY 76 / ASY 80 − V_{CB} = 40 V
ASY 77 − V_{CB} = 60 V
max
typ
$-I_{CBO}$ (μA)
10^4
10^3
10^2
10^1
1
−100
−50
0
+50
+100
T_j (°C)


7Z03056/1.19.25.gf
ASY 76 / ASY 77 / ASY 80
− V_{CB} = 10 V
max
typ
$-I_{CBO}$ (μA)
10^3
10^2
10^1
1
−100
−50
0
+50
+100
T_j (°C)

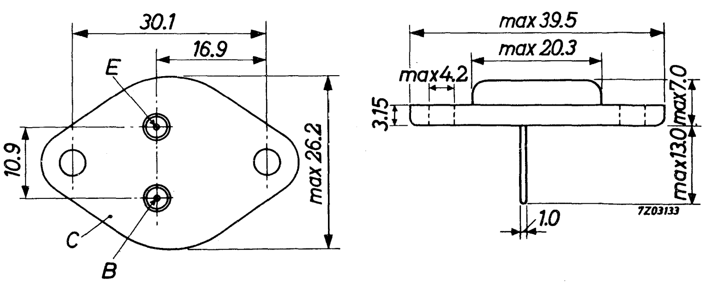
POWER SWITCHING TRANSISTORS

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 case



7Z3 0706

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 F and G)	$-V_{CEO}$	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 C)				
Total power dissipation up to T_{mb} = 45 °C	P_{tot}	max.	30	W
Temperatures				
Storage tmperature	T_{stg}		-65 to +90	°C
Junction temperature: continuous	T_j	max.	90	°C
Junction temperature: incidentally	T_j	max.	100	°C

THERMAL RESISTANCE

From junction to mounting base	$R_{th\ j\text{-}mb}$	=	1.5	°C/W
From mounting base to heatsink	$R_{th\ mb\text{-}h}$	=	0.2	°C/W
From mounting base to heatsink with lead washer and 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.

[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 $T_{amb} < 55$ °C and $R_{th\ j\text{-}a} < 9$ °C/W for ASZ16 and ASZ17
$R_{th\ j\text{-}a} < 5$ °C/W for ASZ15 and ASZ18

7Z3 1354

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

7Z3 0708

CHARACTERISTICS (continued) $T_j = 25\ ^oC$ 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

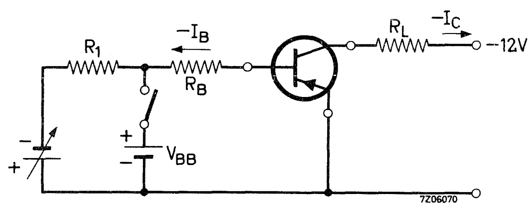
Circuit I: $R_B = 10\ \Omega$; $R_1 = 220\ \Omega$; $R_L = 12\ \Omega$

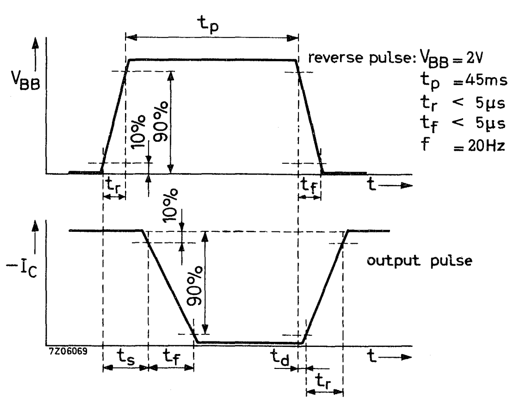
ASZ15: $-I_B = 75$ mA	$-I_C = 1$ A	delay time	t_d	<	2	µs
ASZ16: $-I_B = 35$ mA		rise time	t_r	<	25	µs
ASZ17: $-I_B = 60$ mA		storage time	t_s	<	10	µs
ASZ18: $-I_B = 50$ mA		fall time	t_f	<	20	µs

Circuit II: $R_B = 1\ \Omega$; $R_1 = 13\ \Omega$; $R_L = 1.2\ \Omega$

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:

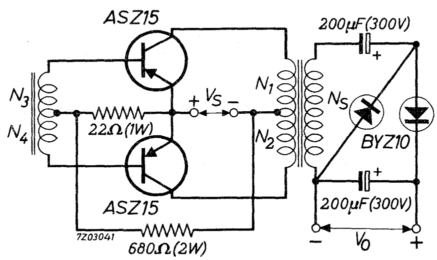




7Z3 0709

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 $R_{th\ j-a}$ = 15 °C/W per transistor)

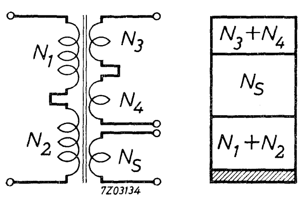
V_S	=	28	V
I_S	=	2.5	A
P_S	=	70	W
V_O	=	220	V
I_O	=	270	mA
P_O	=	60	W
η	=	86	%
f	=	450	Hz

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



$N_1 + N_2$, $N_3 + N_4$ are bifilarly wound

$N_1 = N_2$ = 46 turns of enamelled copper wire, 1 mm

$N_3 = N_4$ = 5 turns of enamelled copper wire, 0.5 mm

N_S = 190 turns of enamelled copper wire, 0.5 mm

7Z3 0710

OPERATING NOTES

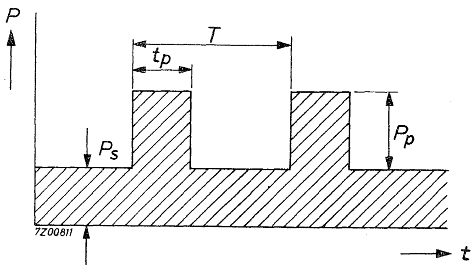
Determination of peak power ratings

For a pulse duration, 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:

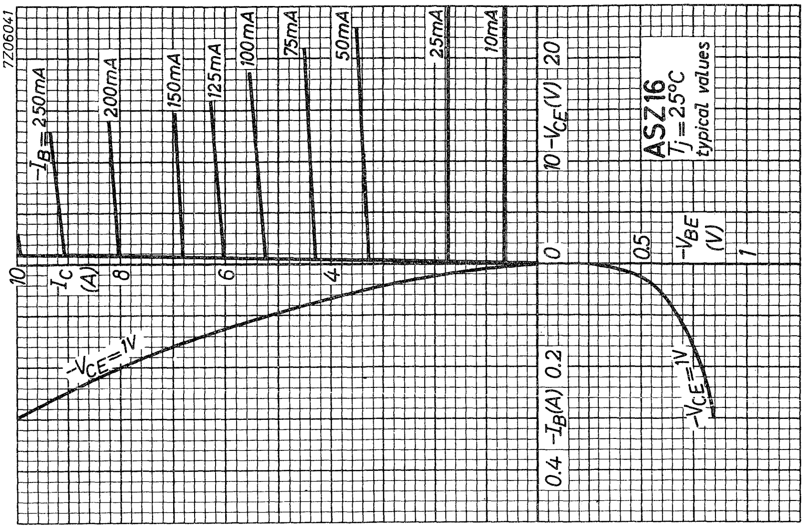
t_p = pulse duration
T = pulse period
δ = duty cycle = t_p/T
P_s = steady state power dissipation
P_p = permissible pulse power dissipation over P_s
$R_{th\,j\text{-}mb}$ = thermal resistance from junction to mounting base
$R_{th\,mb\text{-}h}$ = thermal resistance from mounting base to heatsink
$R_{th\,h\text{-}a}$ = thermal resistance from heatsink to ambient
$R_{th\,t}$ = transient thermal resistance = f(t, δ); see page H
(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 H)

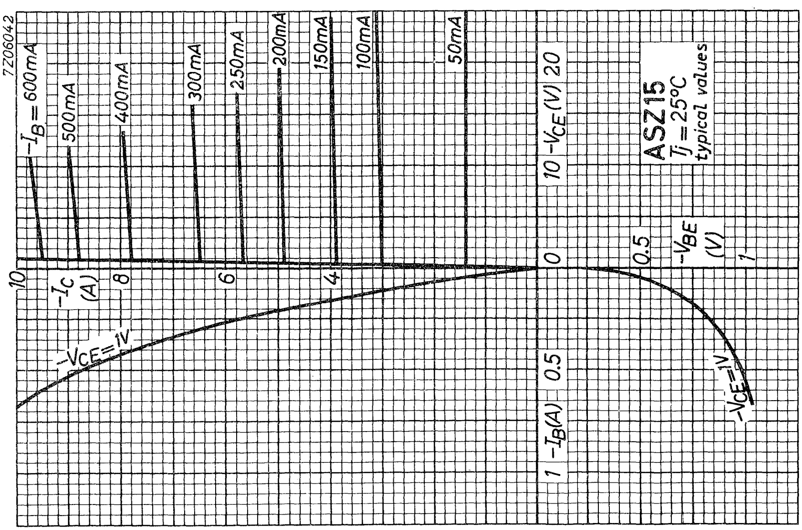
Example: P_s = 5 W, t = 1 ms, δ = 0.1, $R_{th\,mb\text{-}h}$ = 0.5 °C/W,
$R_{th\,h\text{-}a}$ = 4.25 °C/W and T_{amb} = 25 °C

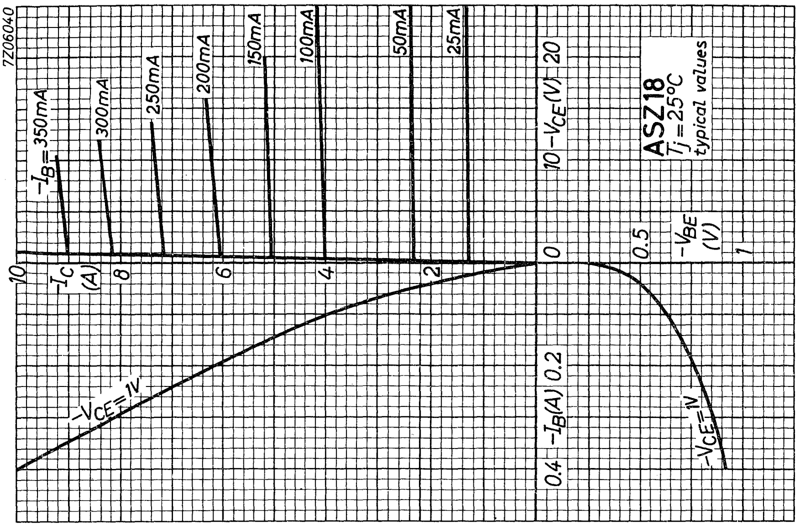
From t = 1 ms and δ = 0.1 it follows that $R_{th\,t}$ = 0.28 °C/W (page H)

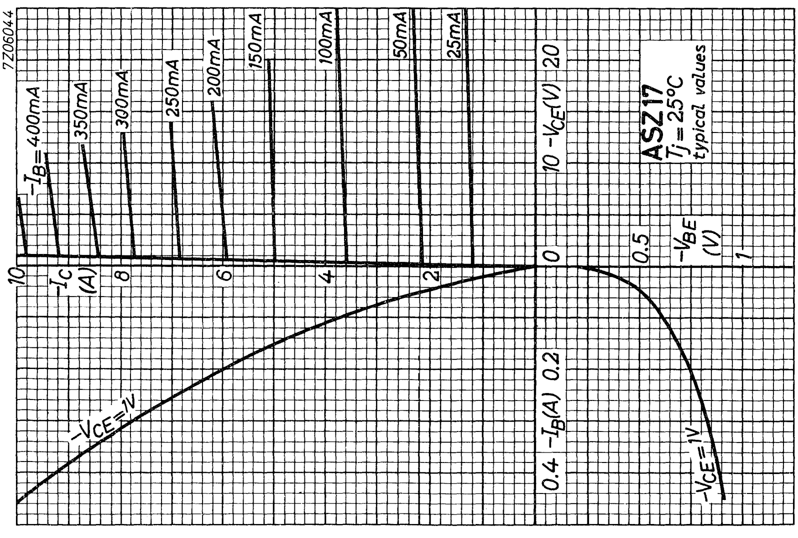
Then $P_p = \dfrac{90 - 25 - (1.5 + 0.5 + 4.25) \times 5}{0.28 + 0.1 \times 4.25} \approx 47.5$ W

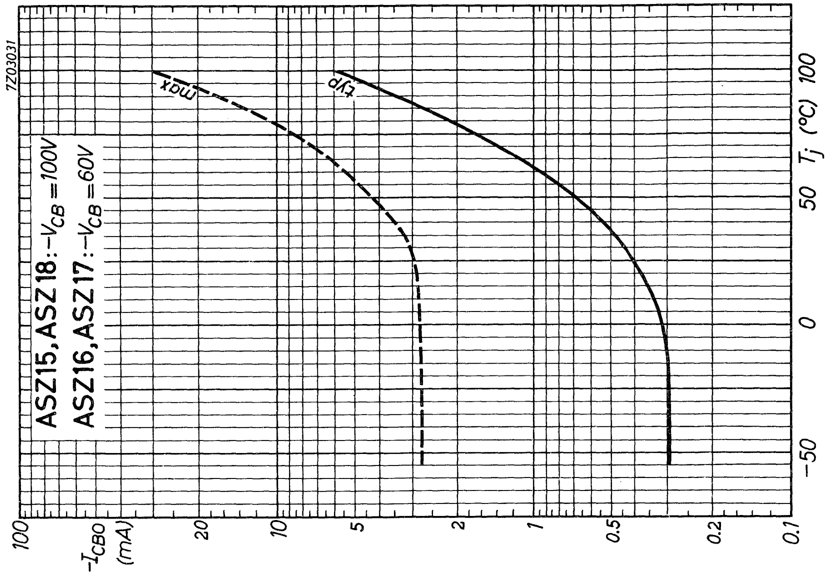
7Z3 1355

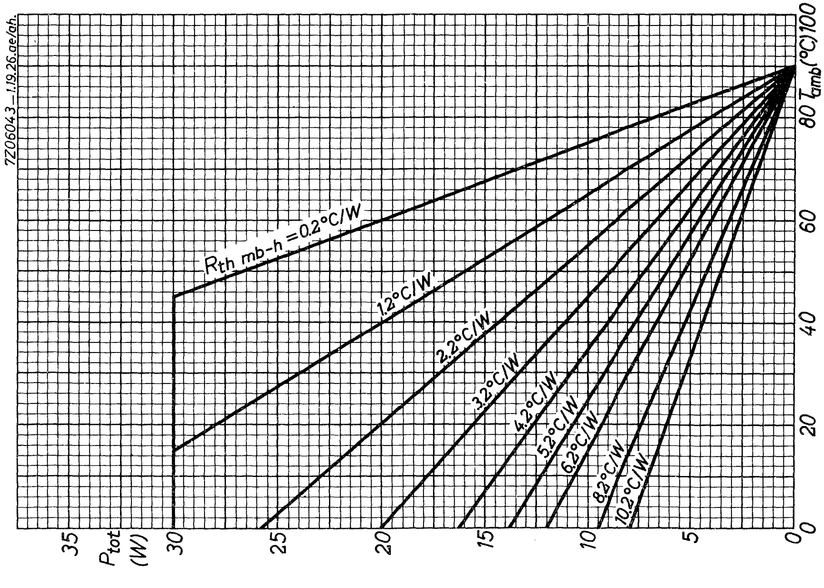

7Z06041
ASZ16
Tj = 25°C
typical values
$-I_B$ = 250mA
200mA
150mA
125mA
100mA
75mA
50mA
25mA
10mA
$-V_{CE}$ (V)
10
20
0
0.5
1
$-V_{BE}$ (V)
10
8
6
4
$-I_C$ (A)
0.2
0.4
$-I_B$ (A)
$-V_{CE}$ = 1V
$-V_{CE}$ = 1V

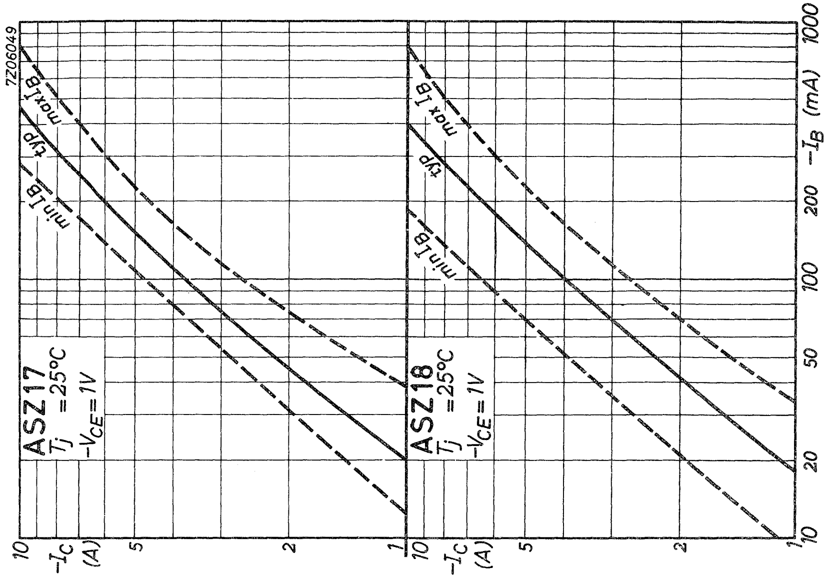

7Z06042
ASZ15
Tj = 25°C
typical values
$-I_B$ = 600mA
500mA
400mA
300mA
250mA
200mA
150mA
100mA
50mA
$-V_{CE}$ (V)
10
20
0
0.5
1
$-V_{BE}$ (V)
10
8
6
4
$-I_C$ (A)
0.5
1
$-I_B$ (A)
$-V_{CE}$ = 1V
$-V_{CE}$ = 1V

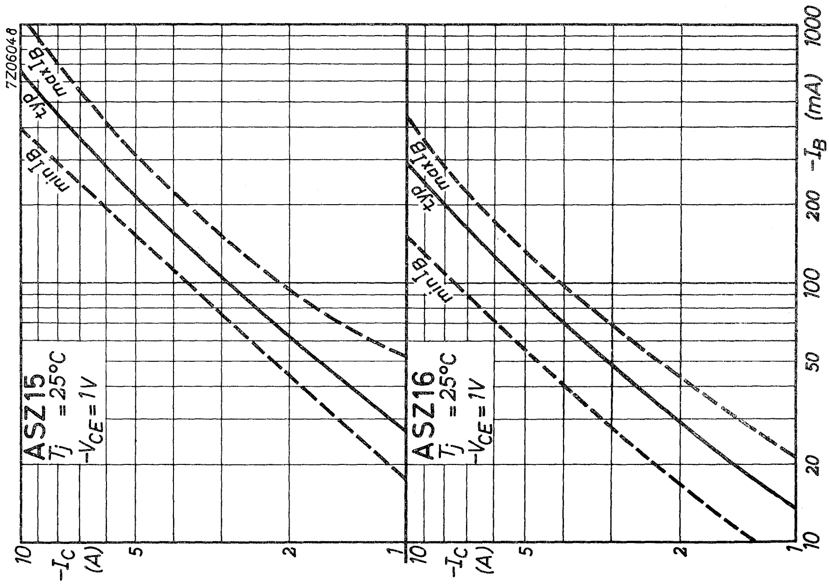

7Z06040
ASZ18
$T_j = 25°C$
typical values
$-I_B = 350mA$
300mA
250mA
200mA
150mA
100mA
50mA
25mA
$-I_C$ (A)
10
8
6
4
2
0
10 $-V_{CE}$(V) 20
0.5
$-V_{BE}$ (V)
1
0.4 $-I_B$(A) 0.2
$-V_{CE} = 1V$
$-V_{CE} = 1V$

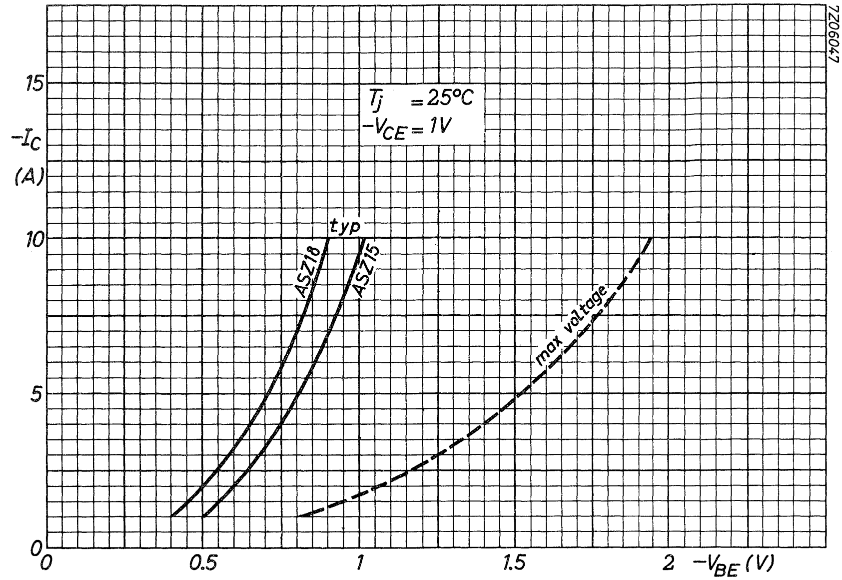

7Z06044
ASZ17
$T_j = 25°C$
typical values
$-I_B = 400mA$
350mA
300mA
250mA
200mA
150mA
100mA
50mA
25mA
$-I_C$ (A)
10
8
6
4
2
0
10 $-V_{CE}$(V) 20
0.5
$-V_{BE}$ (V)
1
0.4 $-I_B$(A) 0.2
$-V_{CE} = 1V$
$-V_{CE} = 1V$

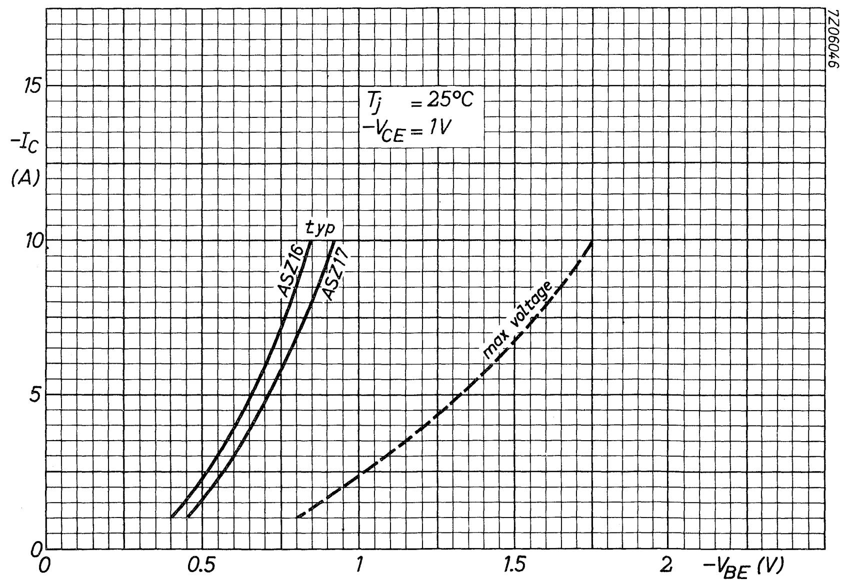

7Z03031
ASZ15, ASZ18: $-V_{CB}$ = 100V
ASZ16, ASZ17: $-V_{CB}$ = 60V
max
typ
$-I_{CBO}$ (mA)
100
20
10
5
2
1
0.5
0.2
0.1
T_j (°C)
−50
0
50
100

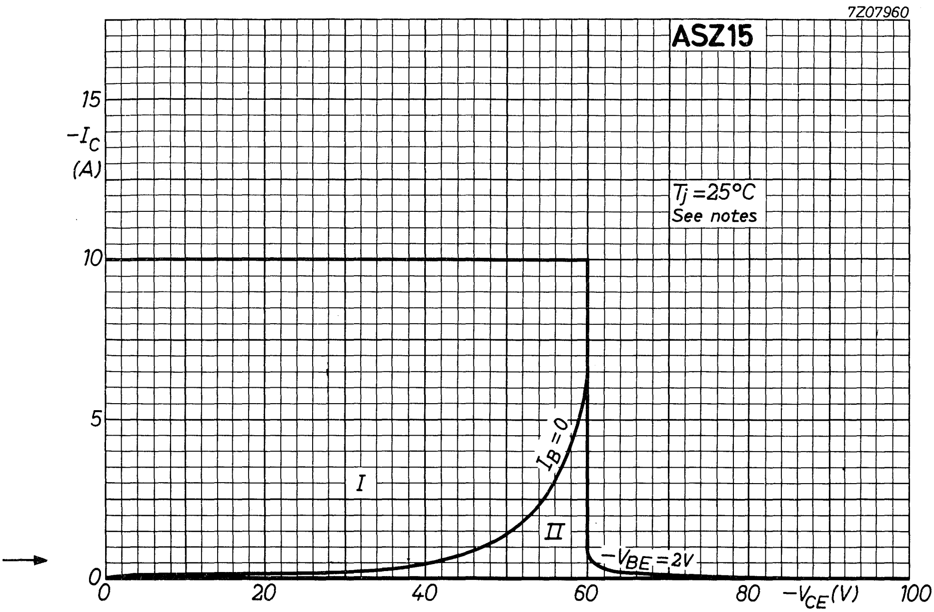

7Z06043–1.19.26.ae/ah.
$R_{th\ mb-h}$ = 0.2°C/W
1.2°C/W
2.2°C/W
3.2°C/W
4.2°C/W
5.2°C/W
6.2°C/W
8.2°C/W
10.2°C/W
P_{tot} (W)
35
30
25
20
15
10
5
0
T_{amb} (°C)
0
20
40
60
80
100

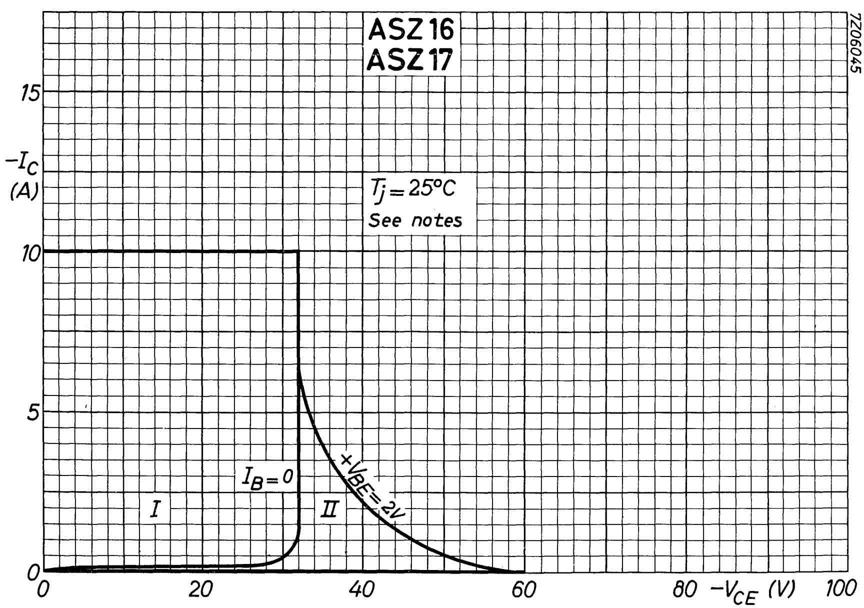

7Z06049
ASZ17
T_j = 25°C
$-V_{CE}$ = 1V
ASZ18
T_j = 25°C
$-V_{CE}$ = 1V
max I_B
typ
min I_B
$-I_C$ (A)
$-I_B$ (mA)
10
5
2
1
10
20
50
100
200
1000

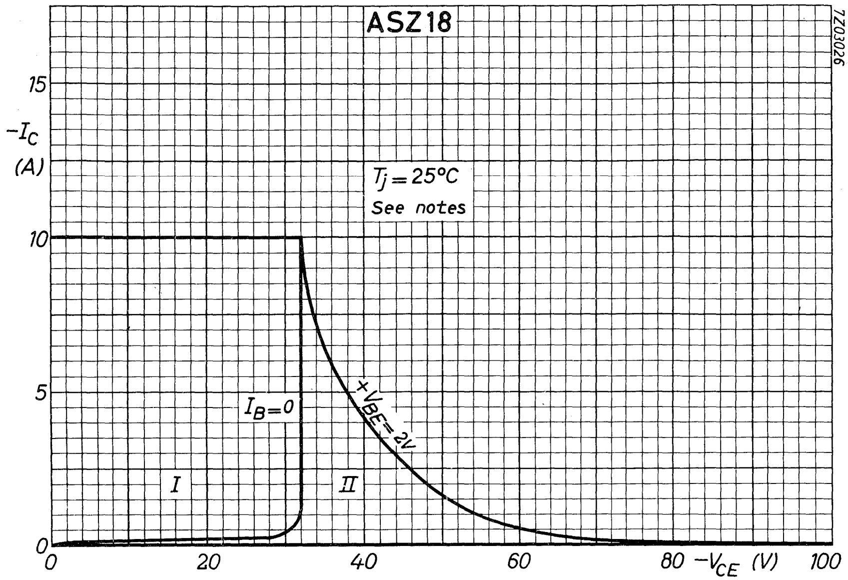

7Z06048
ASZ15
T_j = 25°C
$-V_{CE}$ = 1V
ASZ16
T_j = 25°C
$-V_{CE}$ = 1V
max I_B
typ
min I_B
$-I_C$ (A)
$-I_B$ (mA)
10
5
2
1
10
20
50
100
200
1000


7Z06047
$T_j = 25^oC$
$-V_{CE} = 1V$
$-I_C$
(A)
15
10
5
0
typ
ASZ18
ASZ15
max voltage
0
0.5
1
1.5
2
$-V_{BE}$ (V)


7Z06046
$T_j = 25^oC$
$-V_{CE} = 1V$
$-I_C$
(A)
15
10
5
0
typ
ASZ16
ASZ17
max voltage
0
0.5
1
1.5
2
$-V_{BE}$ (V)


7Z07960
ASZ15
15
$-I_C$
(A)
10
5
0
T_j =25°C
See notes
I_B=0
I
II
$-V_{BE}$=2V
0
20
40
60
80
$-V_{CE}$(V)
100


ASZ16
ASZ17
7Z06045
15
$-I_C$
(A)
10
5
0
T_j= 25°C
See notes
I_B=0
$+V_{BE}$=2V
I
II
0
20
40
60
80
$-V_{CE}$ (V)
100



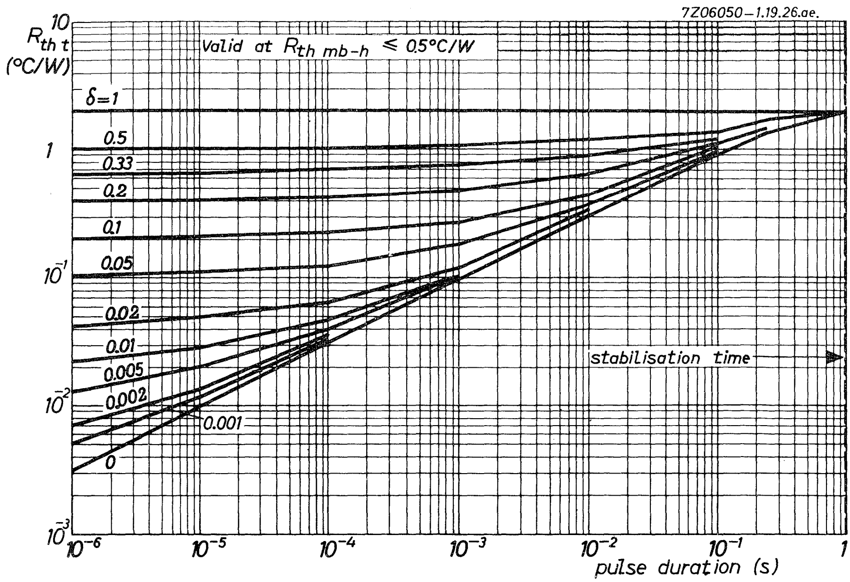
NOTES

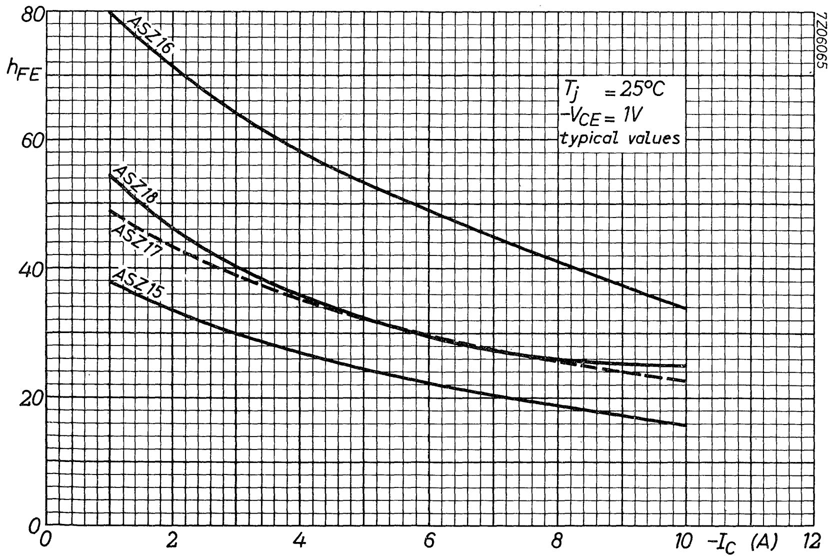
I region of permissible operation under all base-emitter conditions

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.

7Z3 0712


7Z06050-1.19.26.ae.
$R_{th\,t}$ (°C/W)
Valid at $R_{th\,mb-h} \leq 0.5$°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
pulse duration (s)


7Z06065
h_{FE}
T_j = 25°C
$-V_{CE}$ = 1V
typical values
ASZ16
ASZ18
ASZ17
ASZ15
$-I_C$ (A)

P-N-P ALLOY DIFFUSED TRANSISTOR

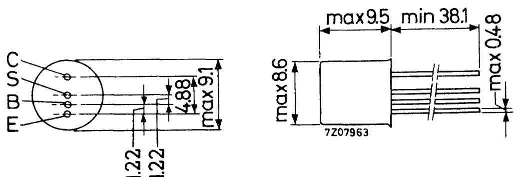
P-N-P alloy diffused germanium transistor in a TO-7 metal envelope. It is intended for use in wide band amplifier applications and current mode switching.

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	$R_{th\ j\text{-}a}$	=	0.6	$^oC/mW$

MECHANICAL DATA

TO-7 Dimensions in mm

Shield lead connected to case



Accessories available: 56207

7Z3 1426

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 $T_{amb} = 25\ ^oC$	P_{tot}	max.	110	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	$^oC/mW$

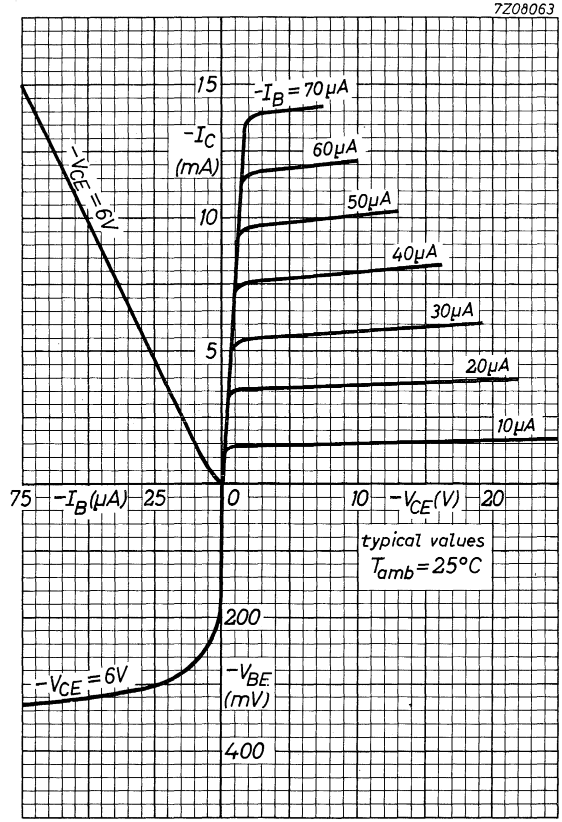
[1]) Limiting values according to the Absolute Maximum System as defined in IEC publication 134.

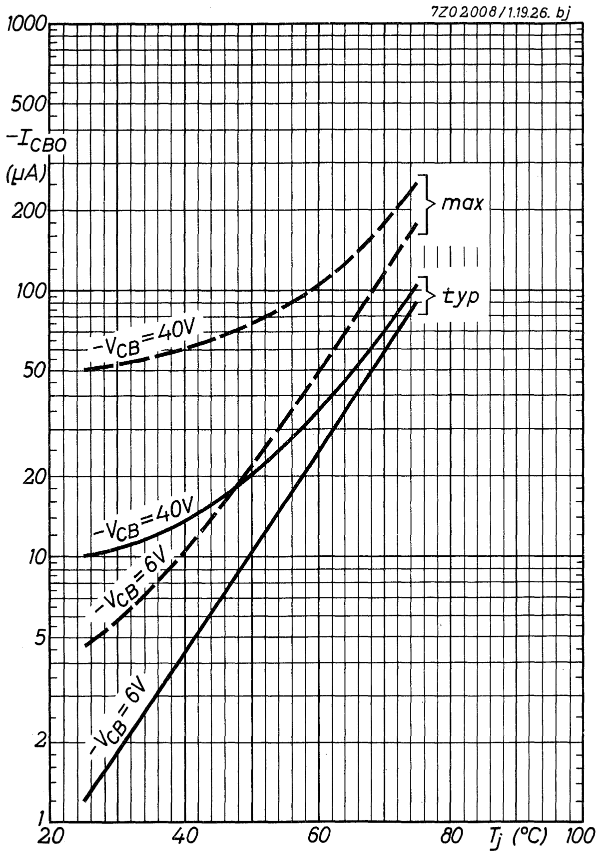
7Z3 1427

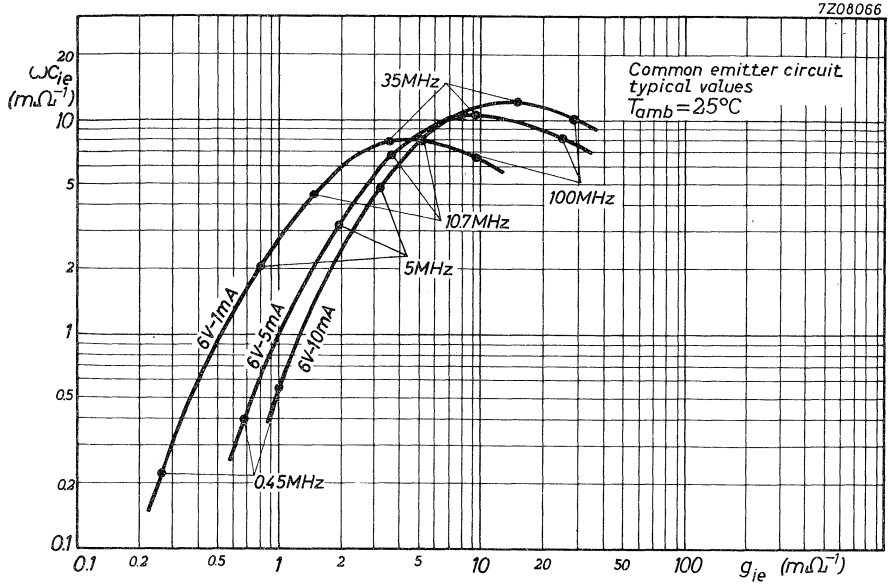
CHARACTERISTICS T_{amb} = 25 °C unless otherwise specified

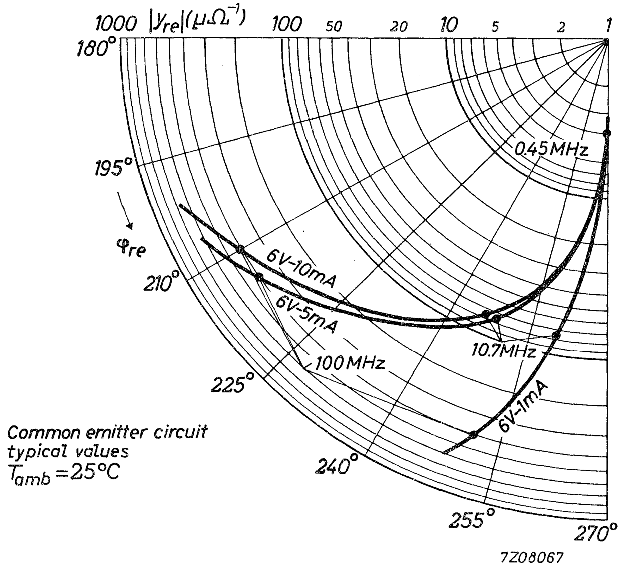
Collector cut-off current				
$I_E = 0$; $-V_{CB} = 6$ V	$-I_{CBO}$	<	4.5	μA
$I_E = 0$; $-V_{CB} = 40$ V	$-I_{CBO}$	<	50	μA
Emitter cut-off current				
$I_C = 0$; $-V_{EB} = 1$ V	$-I_{EBO}$	<	50	μA
Base current				
$I_E = 1$ mA; $-V_{CB} = 6$ V	$-I_B$	<	25	μA
$I_E = 10$ mA; $-V_{CB} = 2$ V	$-I_B$	>	20	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	> typ.	40 75	MHz 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 $R_S = 500$ Ω				
$-I_C = 1$ mA; $-V_{CE} = 6$ V; f = 1 kHz	F	typ. <	15 20	dB dB
f = 450 kHz	F	<	6	dB

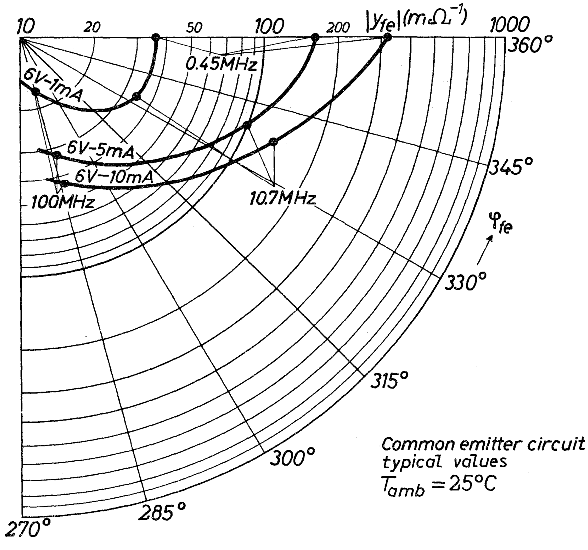
7Z3 1428


7Z08063
15
$-I_B = 70\mu A$
$-I_C$
(mA)
60µA
50µA
10
40µA
$-V_{CE} = 6V$
30µA
5
20µA
10µA
75
$-I_B(\mu A)$
25
0
10
$-V_{CE}(V)$
20
typical values
$T_{amb} = 25°C$
200
$-V_{CE} = 6V$
$-V_{BE}$
(mV)
400

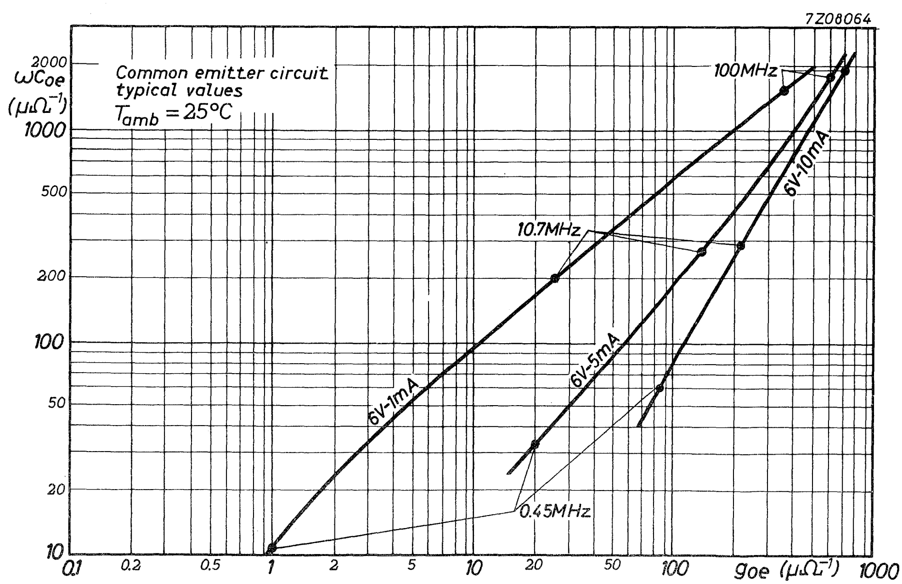

7Z02008/1.19.26. bj
1000
500
$-I_{CBO}$
(μA)
200
100
50
20
10
5
2
1
20
40
60
80
T_j (°C)
100
max
typ
$-V_{CB}=40V$
$-V_{CB}=40V$
$-V_{CB}=6V$
$-V_{CB}=6V$


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} ($m\Omega^{-1}$)

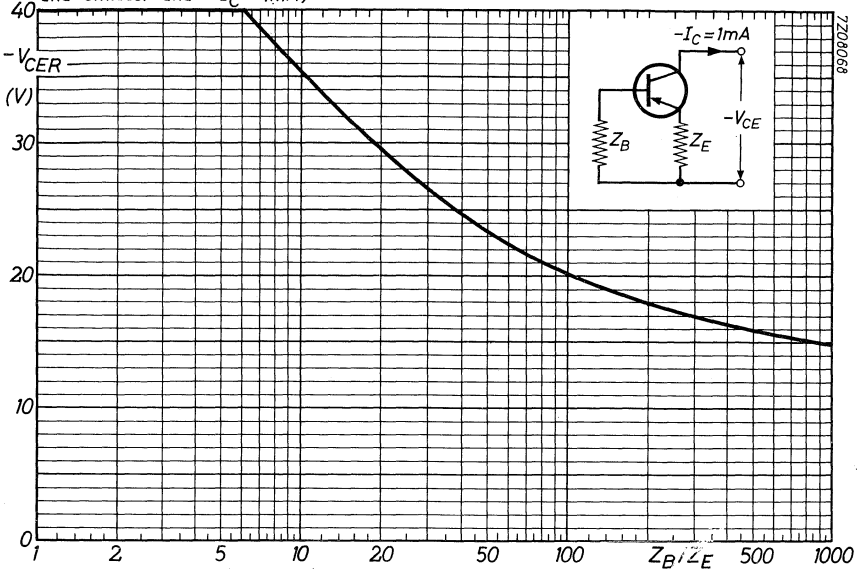

1000 $|y_{re}|$ ($\mu\Omega^{-1}$) 100 50 20 10 5 2 1
180°
195°
φ_{re}
210°
225°
240°
255°
270°
0.45MHz
6V-10mA
6V-5mA
100 MHz
10.7MHz
6V-1mA
Common emitter circuit
typical values
T_{amb} = 25°C
7Z08067


10
20
50
100
200
|y_fe|(mΩ⁻¹)
1000
360°
0.45MHz
6V-1mA
6V-5mA
6V-10mA
100MHz
10.7MHz
345°
φfe
330°
315°
300°
285°
270°
Common emitter circuit
typical values
Tamb = 25°C

7Z08065


7Z08064
2000
ωCoe
(μΩ⁻¹)
1000
500
200
100
50
20
10
Common emitter circuit
typical values
Tamb = 25°C
100MHz
6V-10mA
10.7MHz
6V-5mA
6V-1mA
0.45MHz
0.1
0.2
0.5
1
2
5
10
20
50
100
goe (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.

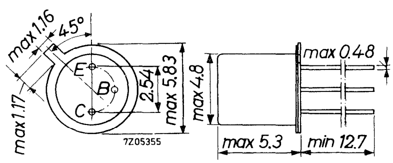
QUICK REFERENCE DATA				
Collector-base voltage (open emitter)	$-V_{CBO}$	max.	20	V
Collector-emitter voltage (open base)	$-V_{CEO}$	max.	15	V
Collector current (peak value)	$-I_{CM}$	max.	50	mA
Total power dissipation up to T_{amb} = 25 °C	P_{tot}	max.	120	mW
Junction temperature	T_j	max.	85	°C
D.C. 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



7Z3 1471

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.

7Z3 1472

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

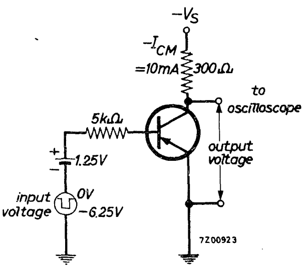
Breakdown voltages at T_{amb} = 60 °C				
I_E = 0; $-I_C$ = 100 μA	$-V_{(BR)\,CBO}$	>	20	V
I_C = 0; $-I_E$ = 100 μA	$-V_{(BR)\,EBO}$	>	2.5	V
Sustaining voltage				
I_B = 0; $-I_C$ = 5 mA	$-V_{CEO\,sust}$	>	9	V
Saturation voltage				
$-I_C$ = 10 mA; $-I_B$ = 1 mA	$-V_{CE\,sat}$	<	0.35	V
$-I_C$ = 50 mA; $-I_B$ = 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

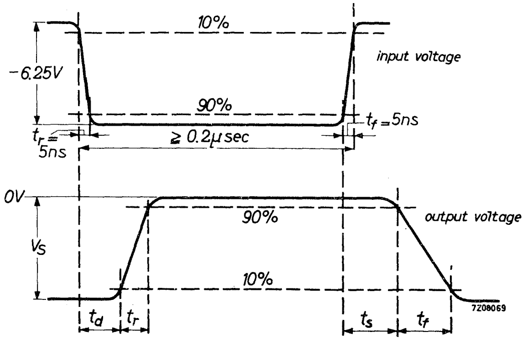
7Z3 1473

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

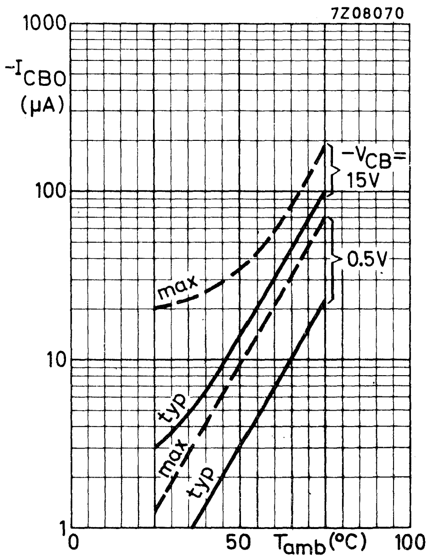
Switching characteristics

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



7Z3 1474

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	$R_{th\ j\text{-}a}$	=	0.6	°C/mW
From junction to case	$R_{th\ j\text{-}c}$	=	0.5	°C/mW

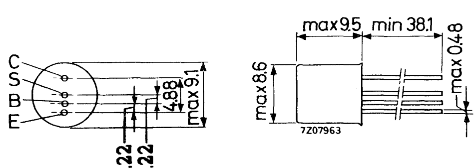
CHARACTERISTICS

Collector cut-off current $I_E = 0$; $-V_{CB} = 6$ V	$-I_{CBO}$	typ. <	2 8	μA μA
Emitter cut-off current $I_C = 0$; $-V_{EB} = 0.5$ V	$-I_{EBO}$	typ. <	100 500	nA nA
Collector-base breakdown voltage $I_E = 0$; $-I_C = 1$ mA	$-V_{(BR)CBO}$	typ.	24 15 to 30	V 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

TO-7

Shield lead connected to case



7Z3 1401

GERMANIUM P-N-P POWER TRANSISTORS

Alloy diffused transistors in TO-3 metal case 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) [1])

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

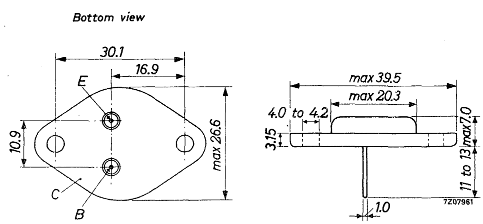
THERMAL RESISTANCE

From junction to mounting base	$R_{th\ j\text{-}mb}$	=	2.0	°C/W

CHARACTERISTICS $T_j = 25\ ^oC$ 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					
$T_j = 90\ ^oC$	AU101	t_f	<	2.6	μs
	AU102	t_f	<	3.9	μs

MECHANICAL DATA Dimensions in mm



TO-3
Collector connected to case

[1]) Limiting values according to the Absolute Maximum System as defined in IEC publication 134. 7Z3 1470

POWER TRANSISTOR

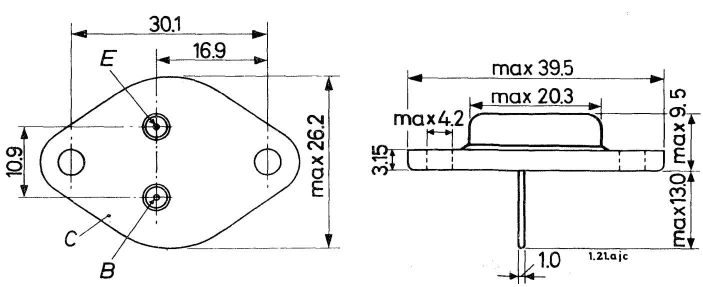
P-N-P germanium alloy-diffused transistor in a TO-3 metal case, primarily intended for use in line-detection output circuits of television receivers.

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	$R_{th\ j-mb}$	=	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

TO-3

Collector connected to case



Accessories see page 5 7Z3 0432

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 A)	$-V_{CEX}$	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 B)

Total power dissipation up to T_{mb} = 85 °C	P_{tot}	max.	10	W

Temperatures

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

THERMAL RESISTANCE

From junction to mounting base	$R_{th\ j-mb}$	=	1.5	°C/W
From mounting base to heatsink without mica washer	$R_{th\ mb-h}$	=	0.2	°C/W
with 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.

2) Non repetitive peak collector current: 20 A

7Z3 0433

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 C)	$-V_{CEsat}$	<	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 C)				
storage time	t_s	<	3	μs
fall time	t_f	<	1.7	μs

7Z3 1356

MEASUREMENT OF SWITCHING TIMES

Fig. 1: Circuit diagram

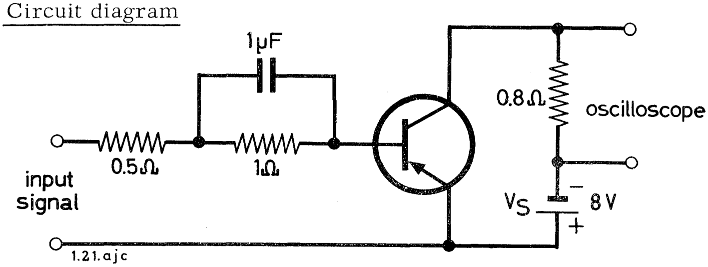


Fig. 2: Input signal

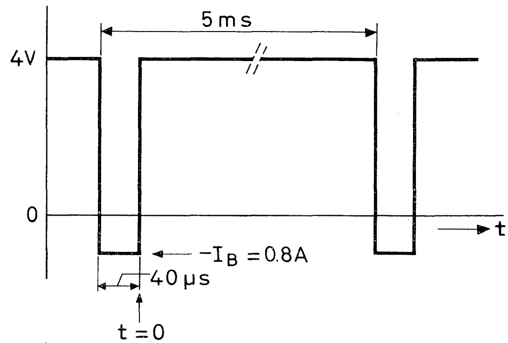
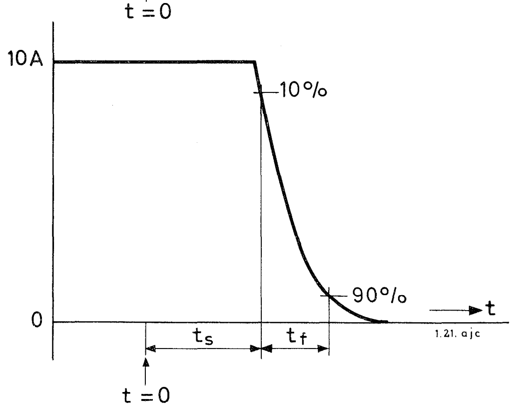
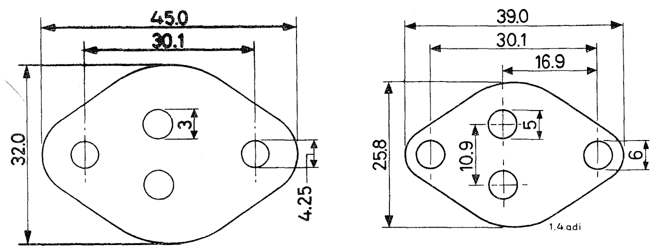


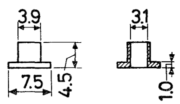
Fig. 3: Output signal



7Z3 0435

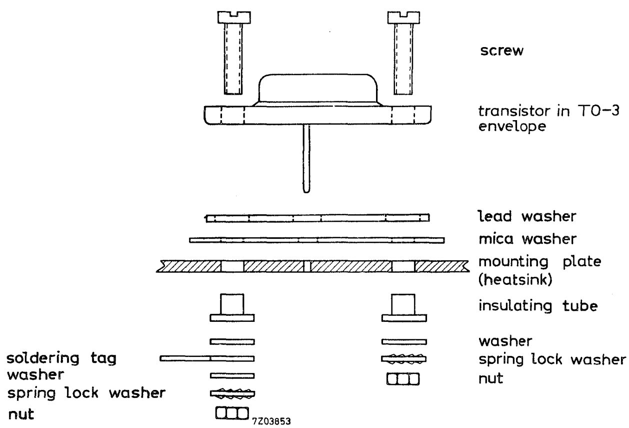
ACCESSORIES





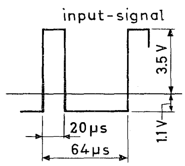
Type number 56201e
Mica insulation (50 μm); insulation tubes and a lead washer (1 mm)

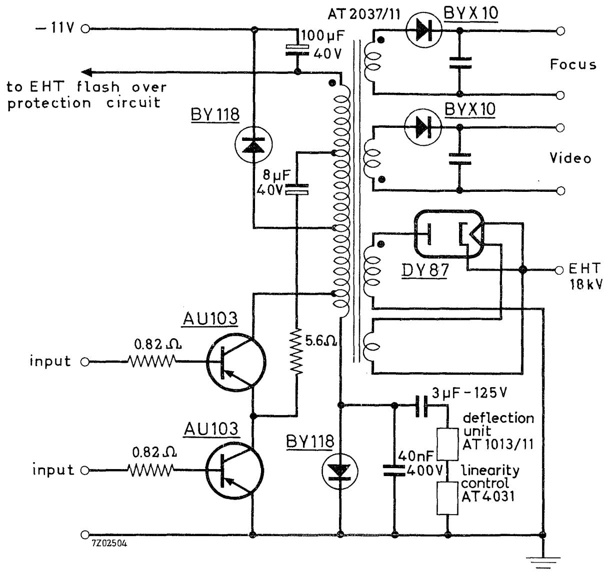
MOUNTING INSTRUCTIONS



1. For non-insulated mounting, remove mica washer
2. Torque on nut: max. 5 cm kg
3. For better heat transfer to the heatsink, use heatsink compound between the contact surfaces (e.g. Dow Corning 340).
4. For maximum cooling, the heatsink should be mounted vertically. 7Z3 1357

APPLICATION INFORMATION

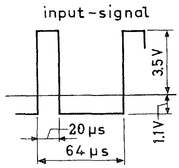


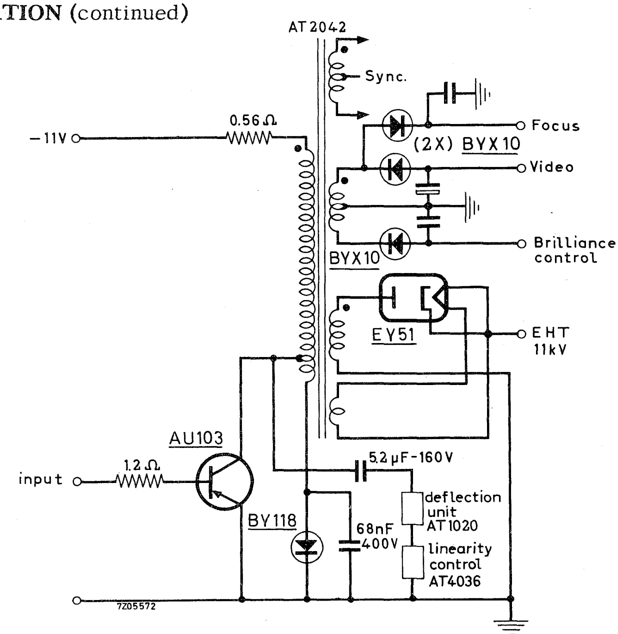


Circuit I : Typical parallel-series efficiency circuit for 110° deflection with an E.H.T. of 18 kV and a flyback ratio of 18%

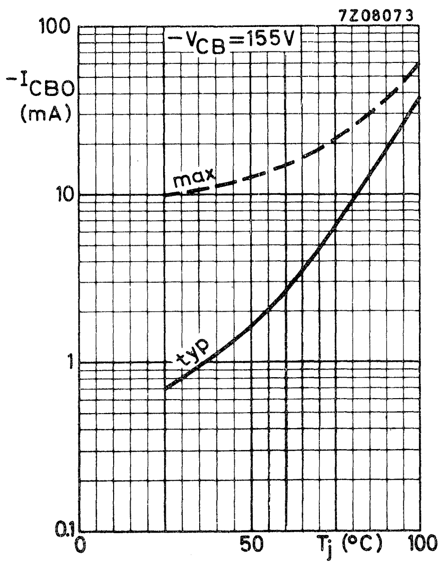
7Z3 0436

APPLICATION INFORMATION (continued)

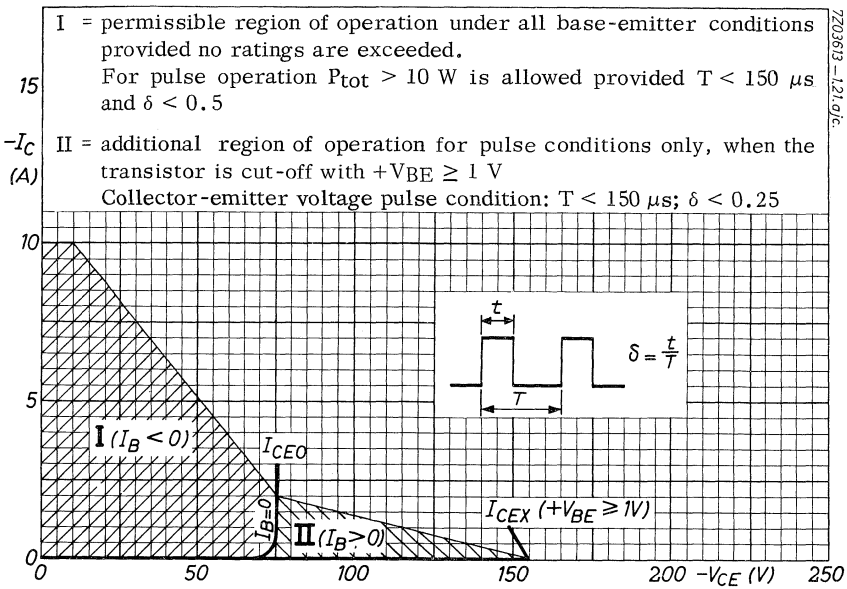




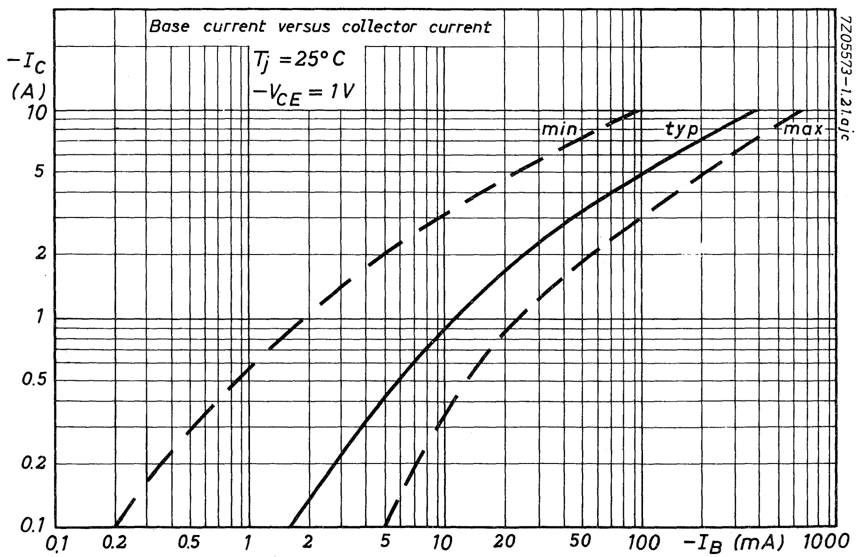
Circuit II: Typical parallel efficiency circuit for 90° deflection with an E.H.T. of 11 kV and a flyback ratio of 17.5%



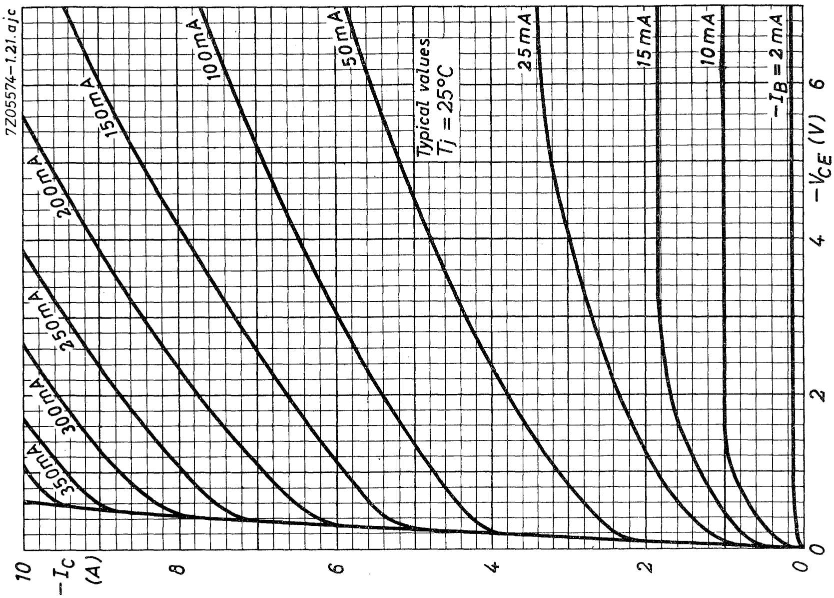
7Z3 1358

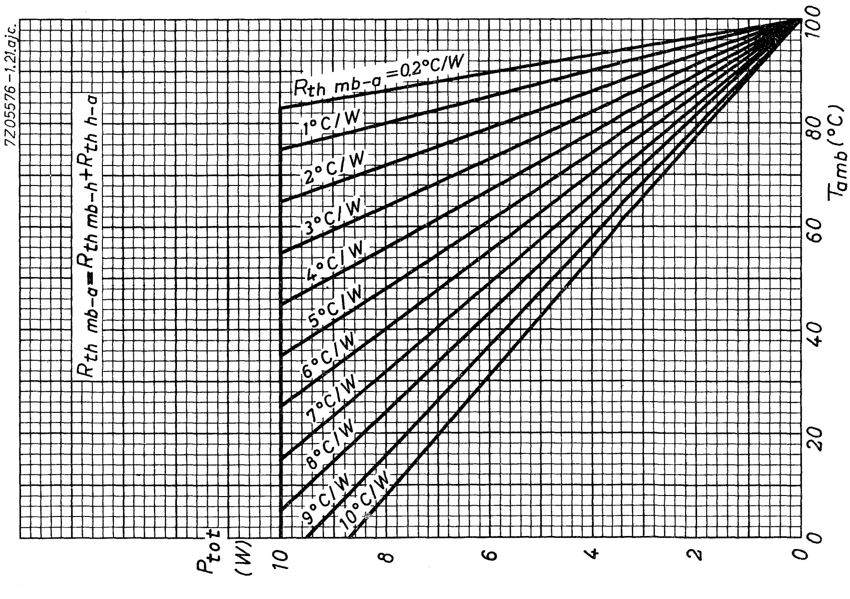


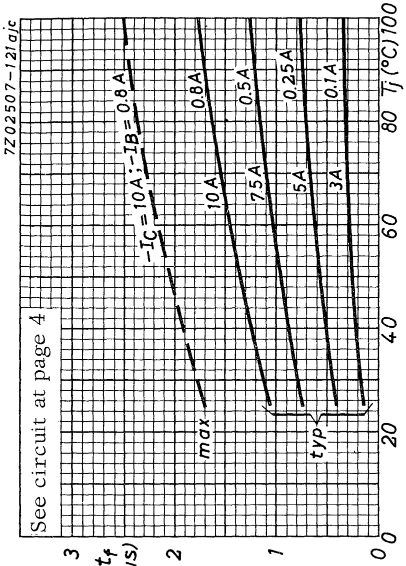
I = permissible region of operation under all base-emitter conditions provided no ratings are exceeded.
For pulse operation P_{tot} > 10 W is allowed provided T < 150 μs and δ < 0.5
II = additional region of operation for pulse conditions only, when the transistor is cut-off with $+V_{BE} \geq 1$ V
Collector-emitter voltage pulse condition: T < 150 μs; δ < 0.25
7Z03613-1.21.ajc.
15
$-I_C$
(A)
10
5
0
I (I_B < 0)
I_{CEO}
I_B=0
II (I_B > 0)
I_{CEX} ($+V_{BE} \geq 1V$)
t
T
δ = t/T
0
50
100
150
200 $-V_{CE}$ (V)
250

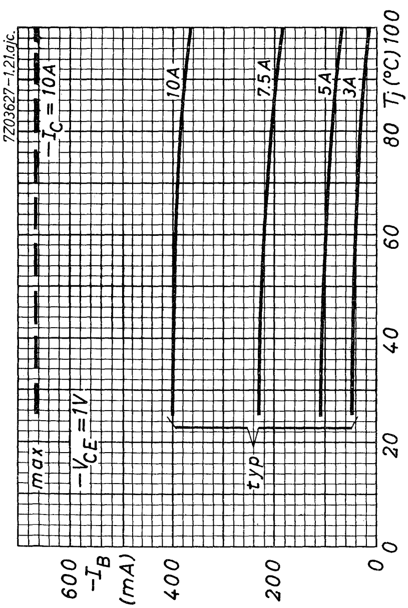


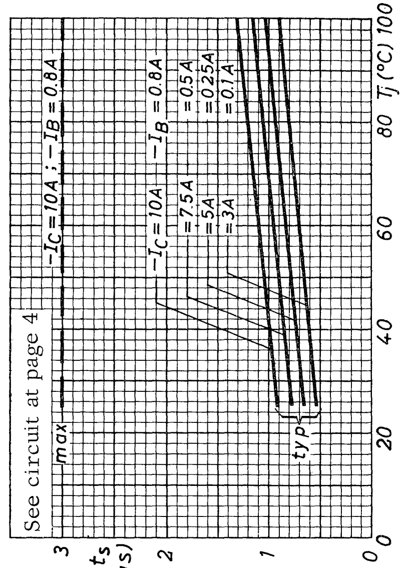
Base current versus collector current
T_j = 25° C
$-V_{CE}$ = 1 V
7Z05573-1.21.ajc
$-I_C$
(A)
10
5
2
1
0.5
0.2
0.1
min
typ
max
0.1
0.2
0.5
1
2
5
10
20
50
100
$-I_B$ (mA)
1000

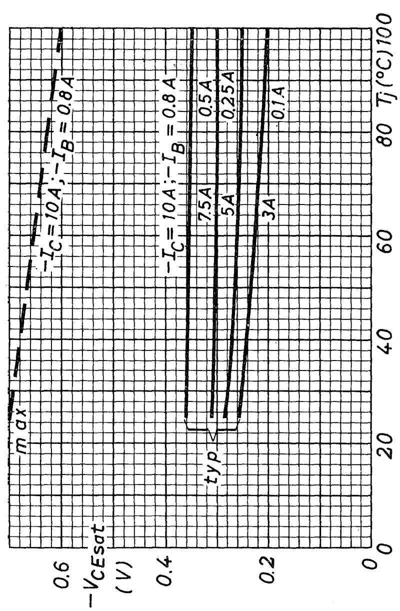

7Z05574-1.21.ajc
Typical values
$T_j = 25°C$
$-I_B = 2\,mA$
10 mA
15 mA
25 mA
50 mA
100 mA
150 mA
200 mA
250 mA
300 mA
350 mA
$-I_C$ (A)
$-V_{CE}$ (V)
10
8
6
4
2
0
0
2
4
6


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)
10
8
6
4
2
0
0
20
40
60
80
100


7Z02507-121ajc
See circuit at page 4
t_f (μs)
3
2
1
0
0
20
40
60
80
100
T_j (°C)
max
typ
$-I_C = 10A; -I_B = 0.8A$
10A 0.8A
7.5A 0.5A
5A 0.25A
3A 0.1A


7Z03627-1.21ajc.
$-I_B$ (mA)
600
400
200
0
0
20
40
60
80
100
T_j (°C)
max
$-I_C = 10A$
$-V_{CE} = 1V$
typ
10A
7.5A
5A
3A


See circuit at page 4
t_s (μs)
3
2
1
0
0
20
40
60
80
100
T_j (°C)
max
typ
$-I_C = 10A; -I_B = 0.8A$
$-I_C = 10A$ $-I_B = 0.8A$
= 7.5A = 0.5A
= 5A = 0.25A
= 3A = 0.1A


$-V_{CEsat}$ (V)
0.6
0.4
0.2
0
0
20
40
60
80
100
T_j (°C)
max
typ
$-I_C = 10A; -I_B = 0.8A$
$-I_C = 10A; -I_B = 0.8A$
7.5A 0.5A
5A 0.25A
3A 0.1A

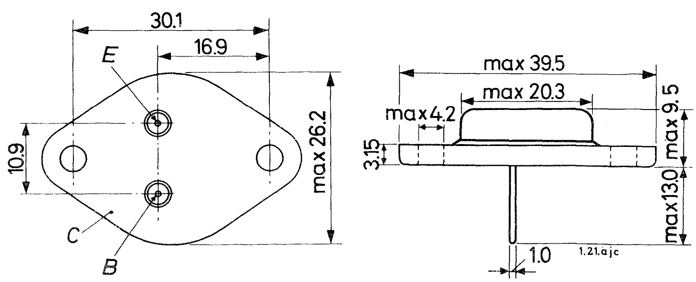
POWER TRANSISTOR

P-N-P germanium alloy-diffused transistor in a TO-3 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

TO-3
Collector connected to case



Accessories see page 5 7Z3 0438

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 A)	$-V_{CEX}$	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 A)

Total power dissipation up to T_{mb} = 77.5 °C	P_{tot}	max.	15	W

Temperatures

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

THERMAL RESISTANCE

From junction to mounting base	$R_{th\ j-mb}$	=	1.5	°C/W
From mounting base to heatsink with lead washer, without mica washer	$R_{th\ mb-h}$	=	0.2	°C/W
with lead washer and 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.

[2]) Non repetitive peak collector current: 25 A.

7Z3 0439

CHARACTERISTICS T_j = 25 ^oC 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 ^oC	$-I_{CBO}$	<	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 D)				
$-I_C$ = 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 B)				
storage time	t_s	<	3	μs
fall time	t_f	<	1.8	μs

7Z3 1359

MEASUREMENT OF SWITCHING TIMES

Fig. 1: Circuit diagram

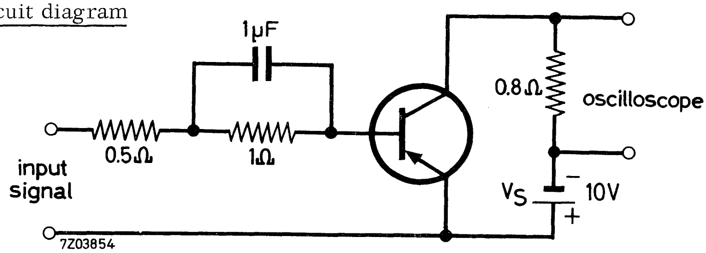


Fig. 2: Input signal

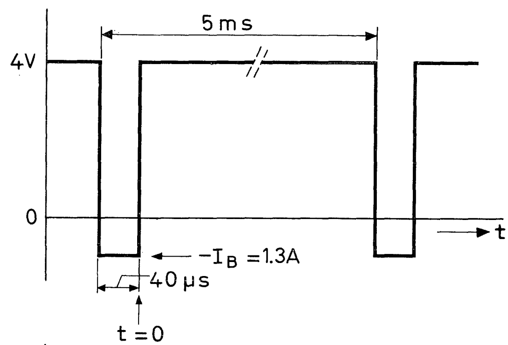
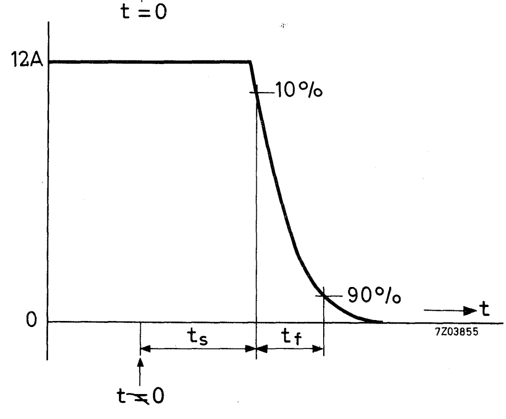
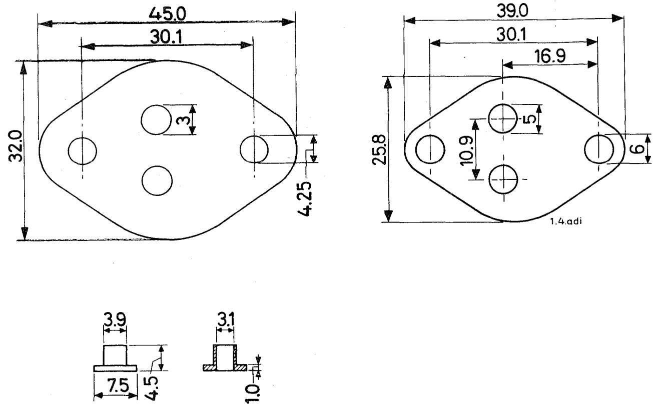


Fig. 3: Ouput signal



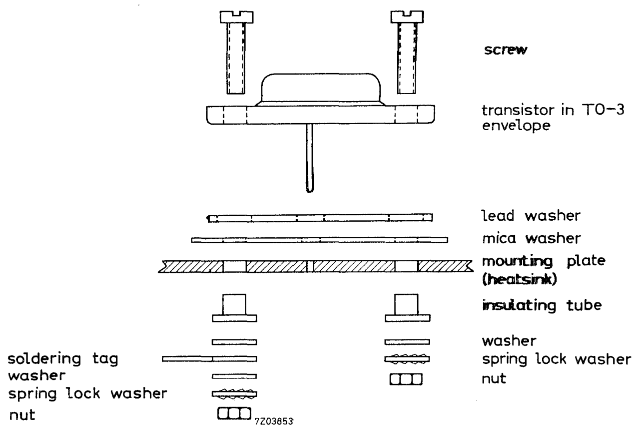
7Z3 0441

ACCESSORIES



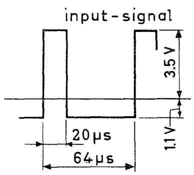
Type number 56201e
Mica insulation (50 μm); insulation tubes and lead washer (1 mm)

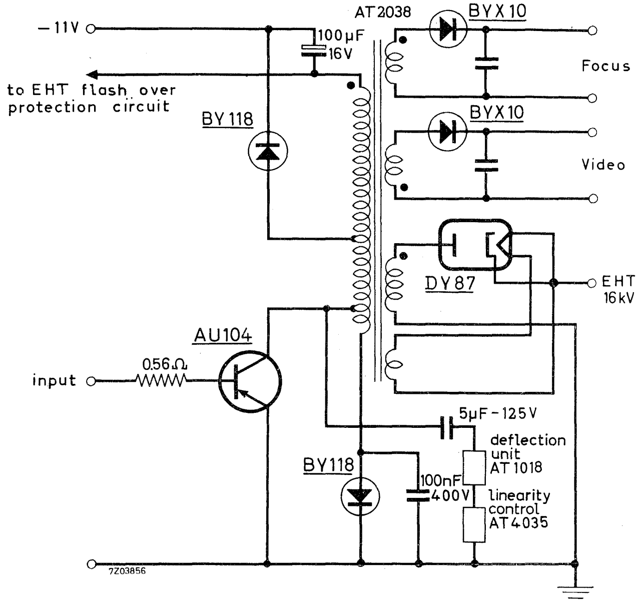
MOUNTING INSTRUCTIONS



1. For non-insulated mounting, remove mica washer
2. Torque on nut: max. 5 cm kg
3. For better heat transfer to the heatsink, use heatsink compound between the contact surfaces (e.g. Dow Corning 340).
4. For maximum cooling, the heatsink should be mounted vertically. 7Z3 1360

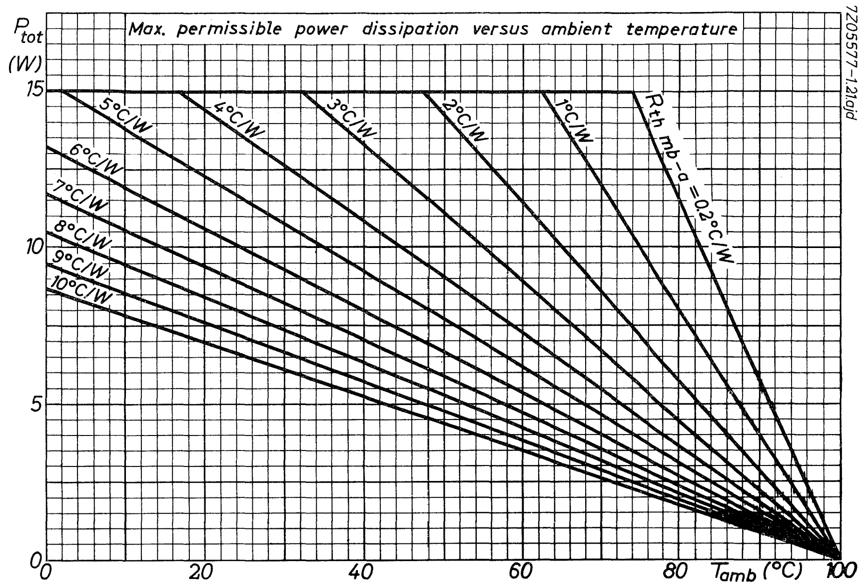
APPLICATION INFORMATION

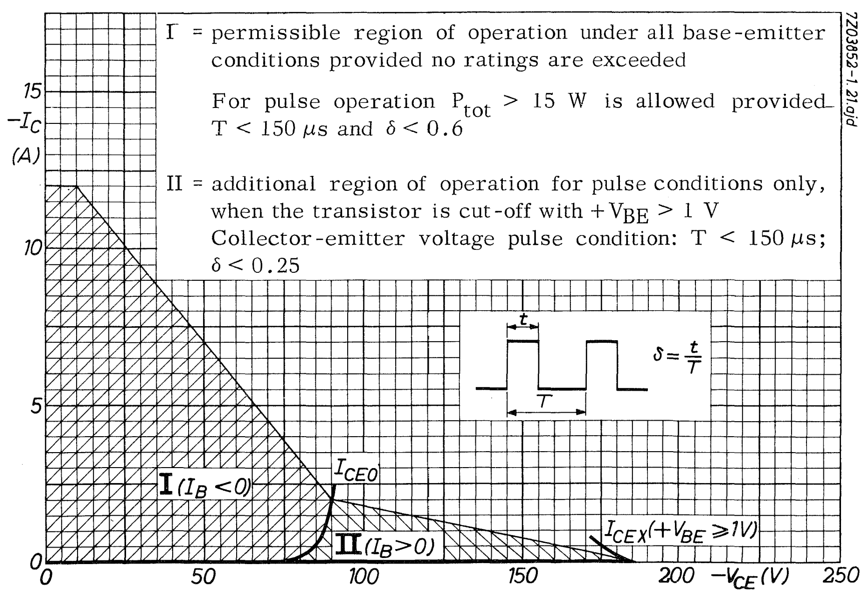


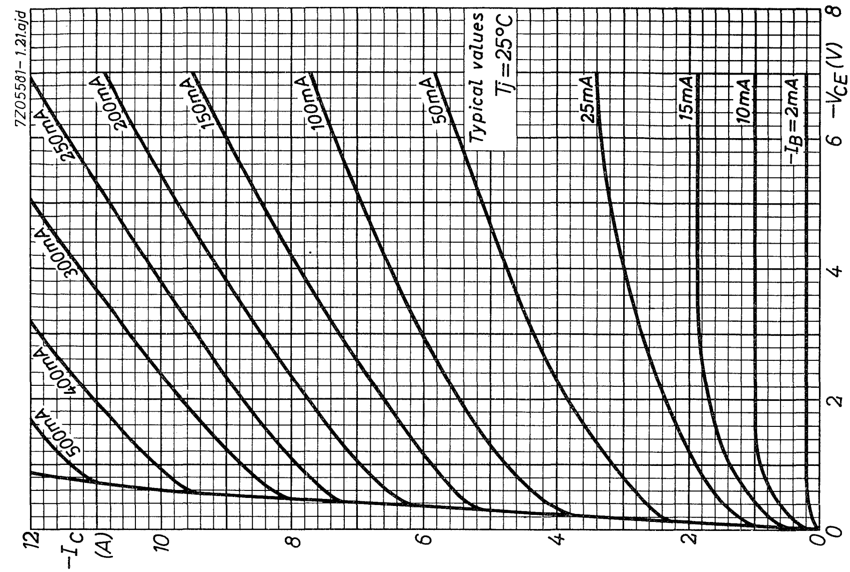


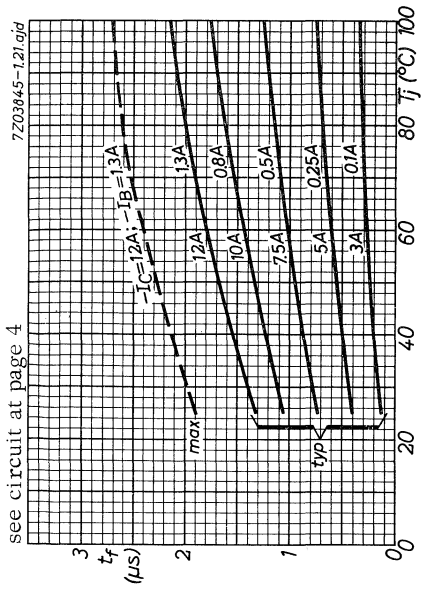
Typical parallel-series efficiency circuit for 110° deflection with an E.H.T. of 16 kV and a flyback ratio of 19.5 %

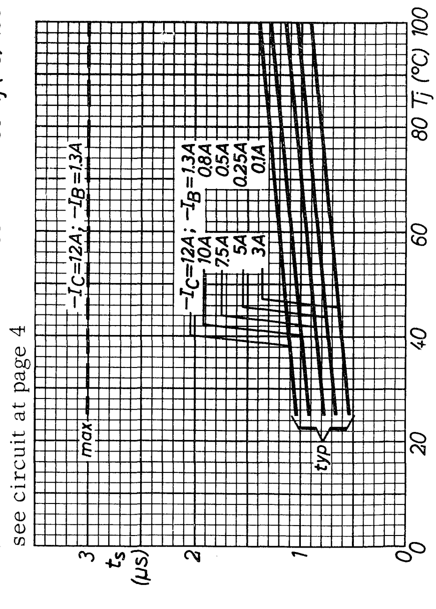
7Z3 1120

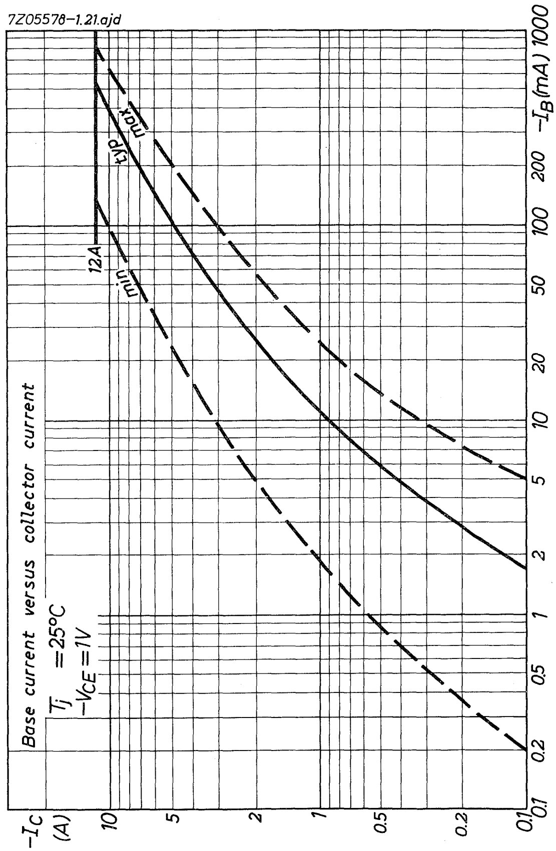

Max. permissible power dissipation versus ambient temperature
P_{tot} (W)
15
10
5
0
0
20
40
60
80
T_{amb} (°C)
100
$R_{th\ mb-a}$ = 0.2°C/W
1°C/W
2°C/W
3°C/W
4°C/W
5°C/W
6°C/W
7°C/W
8°C/W
9°C/W
10°C/W
7Z05577-1.21.ajd

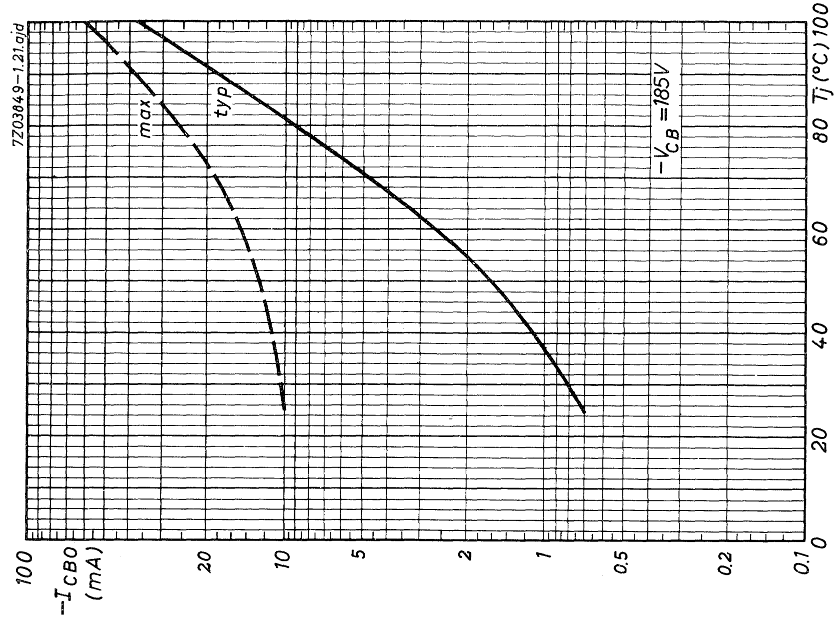

I = permissible region of operation under all base-emitter conditions provided no ratings are exceeded
For pulse operation P_{tot} > 15 W is allowed provided T < 150 μs and δ < 0.6
II = additional region of operation for pulse conditions only, when the transistor is cut-off with $+V_{BE}$ > 1 V
Collector-emitter voltage pulse condition: T < 150 μs; δ < 0.25
t
T
δ = t/T
$-I_C$ (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} ($+V_{BE}$ ⩾ 1V)
7Z03852-1.21.ajd

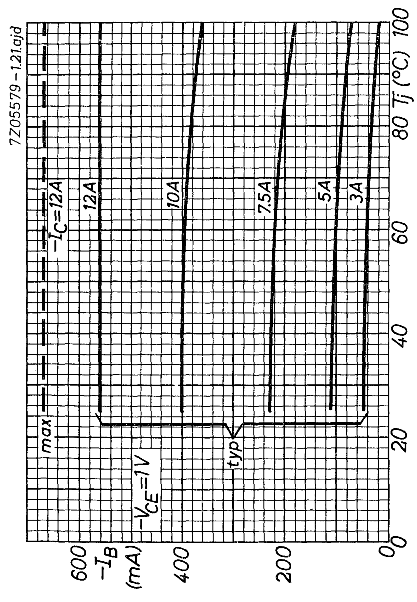

7Z05581-1.21.ajd
Typical values
Tj = 25°C
$-I_B$ = 2mA
10mA
15mA
25mA
50mA
100mA
150mA
200mA
250mA
300mA
400mA
500mA
$-I_C$ (A)
$-V_{CE}$ (V)
0
2
4
6
8
10
12

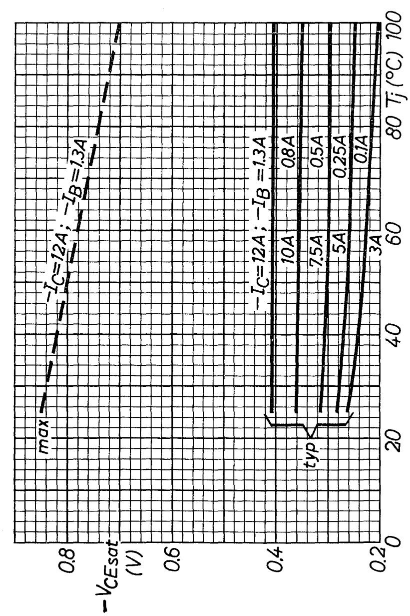

see circuit at page 4
7Z03845-1.21.ajd
t_f (μs)
T_j (°C)
max
typ
$-I_C$=12A; $-I_B$=1.3A
12A
1.3A
10A
0.8A
7.5A
0.5A
5A
0.25A
3A
0.1A
0
20
40
60
80
100
1
2
3


see circuit at page 4
t_s (μs)
T_j (°C)
max
typ
$-I_C$=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
0
20
40
60
80
100
1
2
3


7Z05578-1.21.ajd
Base current versus collector current
Tj =25°C
−VCE =1V
−IC (A)
−IB (mA)
typ
max
min
12A
1000
200
100
50
20
10
5
2
1
0.5
0.2
0.1
10
5
2
1
0.5
0.2
0.1


7Z03849-1.21.ajd
max
typ
$-V_{CB}=185V$
$-I_{CBO}$ (mA)
100
20
10
5
2
1
0.5
0.2
0.1
T_j (°C)
0
20
40
60
80
100


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
T_j (°C)
0
20
40
60
80
100


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
T_j (°C)
0
20
40
60
80
100

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

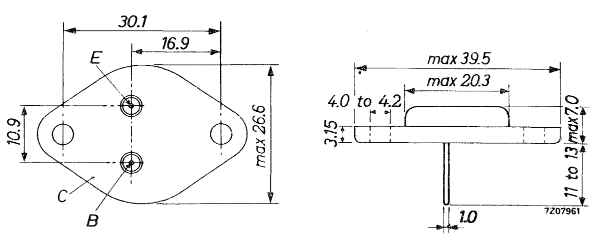
From junction to mounting base	$R_{th\ j\text{-}mb}$	=	4	°C/W
From mounting base to heatsink with lead washer and mica washer	$R_{th\ mb\text{-}h}$	=	0.5	°C/W

MECHANICAL DATA

TO-3

Collector connected to mounting base

Bottom view



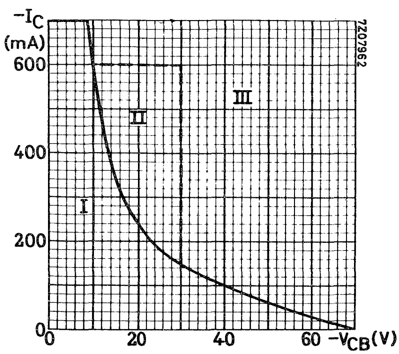
[1]) Limiting values according to the Absolute Maximum System as defined in IEC publication 134.

7Z3 1381

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

7Z3 1382

GERMANIUM POWER TRANSISTOR

P-N-P transistor in TO-3 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) [1])

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

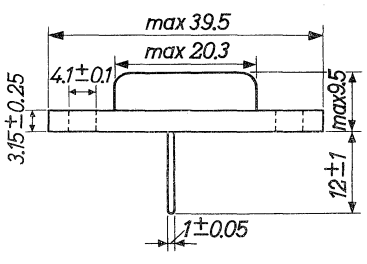
$-I_C$ = 30 mA; $-V_{CE}$ = 14 V	h_{FE}		20 to 75	
$-I_C$ = 1 A; $-V_{CE}$ = 1 V	h_{FE}		20 to 55	
$-I_C$ = 3 A; $-V_{CE}$ = 1 V	h_{FE}		15 to 45	

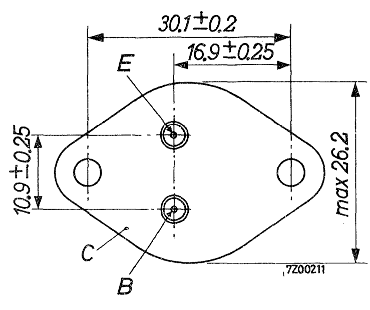
Cut-off frequency

$-I_C$ = 1 A; $-V_{CE}$ = 6 V	f_{hfe}	typ.	4.5	kHz

MECHANICAL DATA Dimensions in mm

TO-3





[1]) Limiting values according to the Absolute Maximum System as defined in IEC publication 134. 7Z3 0206

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.

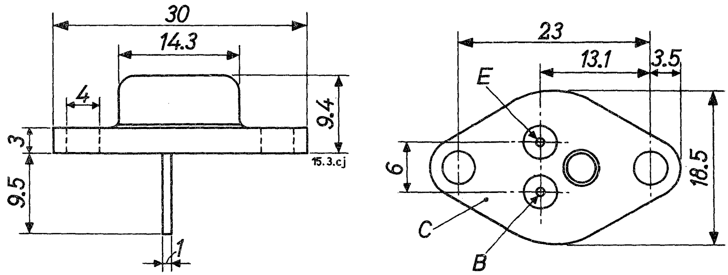
RATINGS (Limiting values) [1])

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; $-V_{CE}$ = 1 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



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

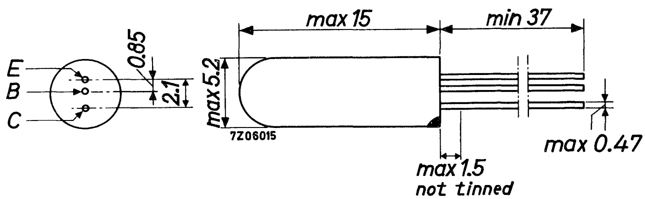
7Z3 0360

GERMANIUM H.F. TRANSISTORS

P-N-P germanium transistor in all-glass construction. It is intended primarily for converter and mixer-oscillator applications.

QUICK REFERENCE DATA					
Collector-base voltage (open emitter)		$-V_{CBO}$	max.	15	V
Collector-emitter voltage (open base)		$-V_{CEO}$	max.	5	V
Collector current (peak value)		$-I_{CM}$	max.	10	mA
Total power dissipation up to T_{amb} = 25 °C		P_{tot}	max.	85	mW
Thermal resistance from junction to ambient		$R_{th\ j\text{-}a}$	=	0.6	°C/mW
Cut-off frequency					
$-I_C$ = 1 mA; $-V_{CE}$ = 6 V	OC44	f_{hfb}	>	7.5	MHz
			typ.	15	MHz
	OC45	f_{hfb}	>	3	MHz
			typ.	12	MHz

MECHANICAL DATA Dimensions in mm



The red dot indicates the collector

7Z3 0752

RATINGS (Limiting values) [1]

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	$R_{th\,j\text{-}a}$	=	0.6	°C/mW

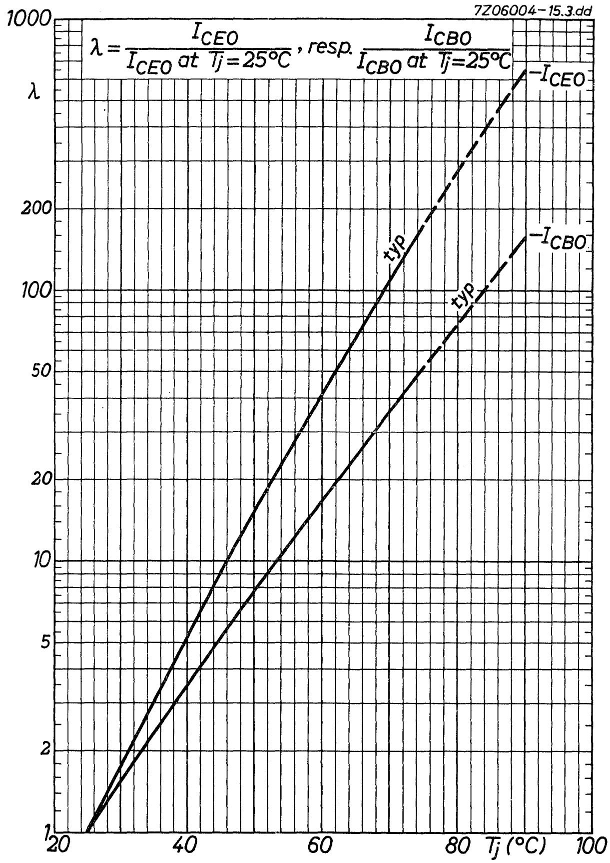
[1]) Limiting values according to the Absolute Maximum System as defined in IEC publication 134.

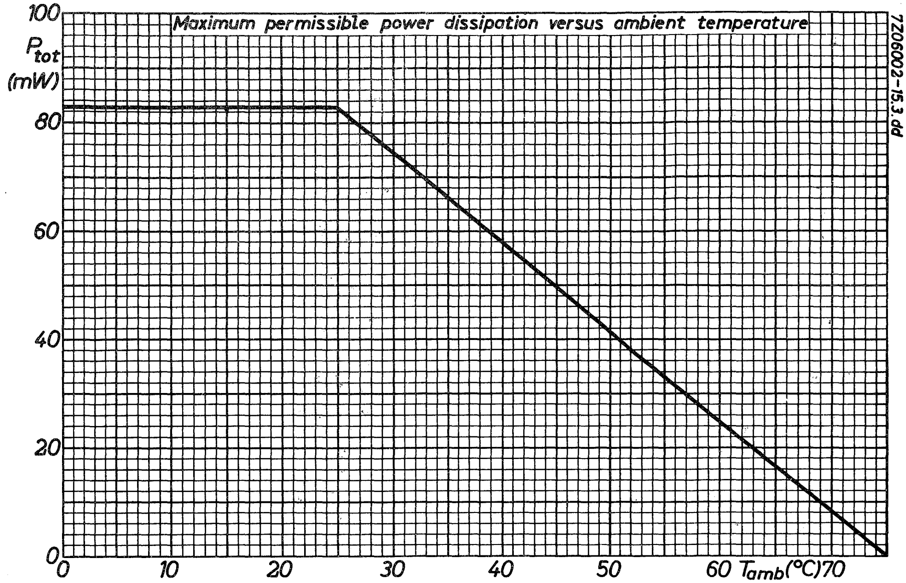
7Z3 0753

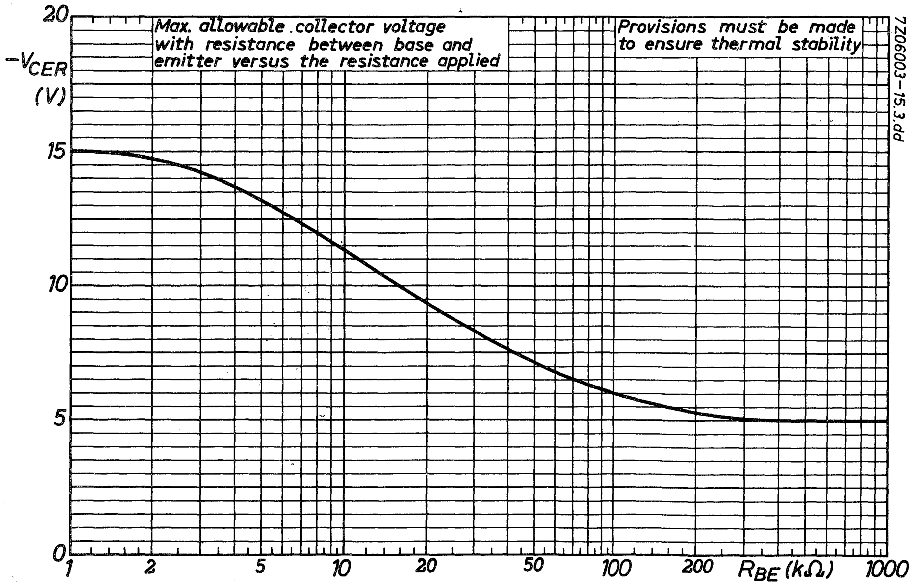
CHARACTERISTICS T_{amb} = 25 °C unless otherwise specified

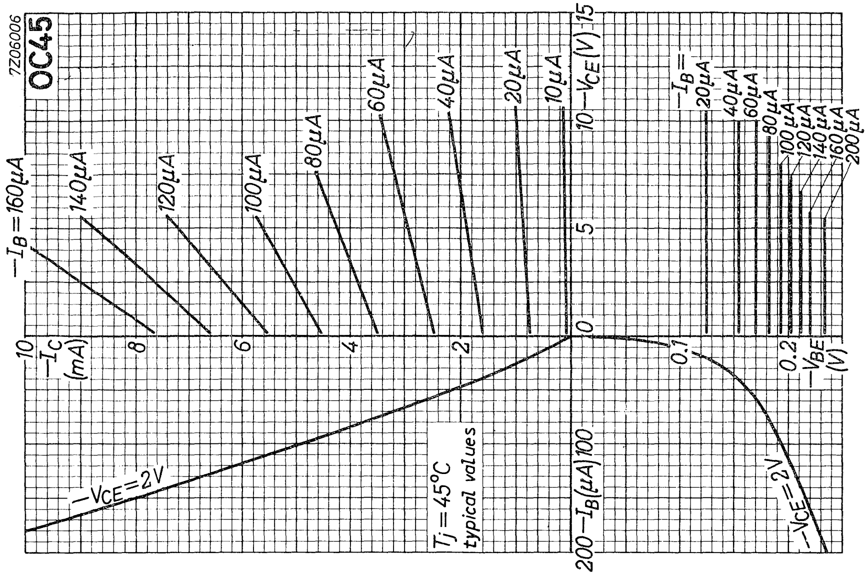
		OC44	OC45	
Collector cut-off currents				
$I_E = 0$; $-V_{CB} = 2$ V	$-I_{CBO}$	typ. 0.5	0.5	μA
		< 2.0	2.0	μA
$I_E = 0$; $-V_{CB} = 15$ V	$-I_{CBO}$	< 10	10	μA
$I_B = 0$; $-V_{CE} = 2$ V	$-I_{CEO}$	typ. 25	12	μA
		< 75	40	μA
Emitter cut-off current				
$I_C = 0$; $-V_{EB} = 2$ V	$-I_{EBO}$	typ. 0.4	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
D.C. current gain				
$-I_C = 1$ 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. 2	2	$\mu\Omega^{-1}$
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

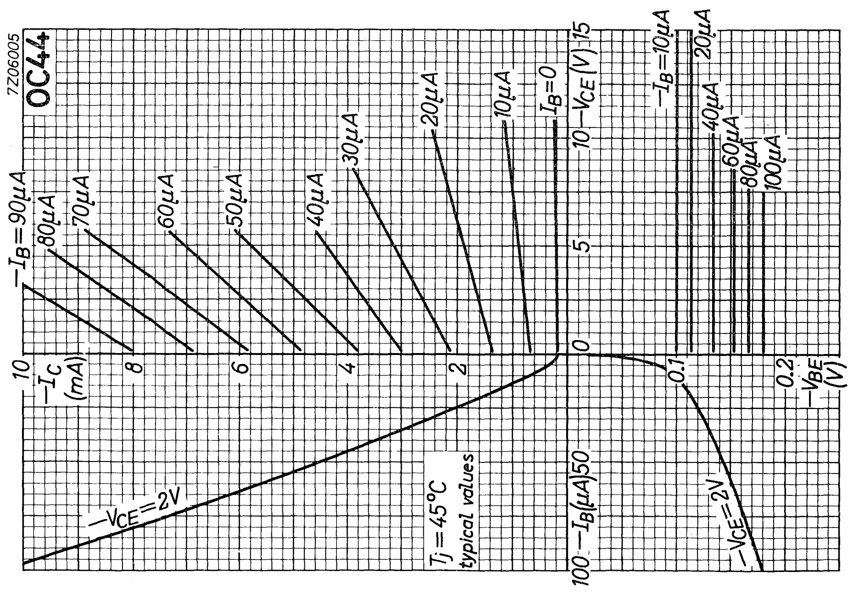
7Z3 0754


7Z06004−15.3.dd
$\lambda = \frac{I_{CEO}}{I_{CEO} \text{ at } T_j = 25^\circ C}$, resp. $\frac{I_{CBO}}{I_{CBO} \text{ at } T_j = 25^\circ C}$
1000
λ
200
100
50
20
10
5
2
1
20
40
60
80
T_j (°C)
100
$-I_{CEO}$
$-I_{CBO}$
typ
typ


Maximum permissible power dissipation versus ambient temperature
P_{tot} (mW)
100
80
60
40
20
0
0
10
20
30
40
50
60
T_{amb} (°C)
70
7Z06002-15.3.dd


Max. allowable collector voltage with resistance between base and emitter versus the resistance applied
Provisions must be made to ensure thermal stability
$-V_{CER}$ (V)
20
15
10
5
0
1
2
5
10
20
50
100
200
R_{BE} (kΩ)
1000
7Z06003-15.3.dd


7Z06006
OC45
$-I_B = 160\mu A$
140μA
120μA
100μA
80μA
60μA
40μA
20μA
10μA
$-V_{CE}$(V)
15
10
5
0
10
$-I_C$ (mA)
8
6
4
2
$-I_B =$
20μA
40μA
60μA
80μA
100μA
120μA
140μA
160μA
200μA
0.1
0.2
$-V_{BE}$ (V)
$-V_{CE} = 2V$
$T_j = 45°C$
typical values
100
200
$-I_B$(μA)


7Z06005
OC44
$-I_B = 90\mu A$
80μA
70μA
60μA
50μA
40μA
30μA
20μA
10μA
$I_B = 0$
$-V_{CE}$(V)
15
10
5
0
10
$-I_C$ (mA)
8
6
4
2
$-I_B = 10\mu A$
20μA
40μA
60μA
80μA
100μA
0.1
0.2
$-V_{BE}$ (V)
$-V_{CE} = 2V$
$T_j = 45°C$
typical values
50
100
$-I_B$(μA)

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

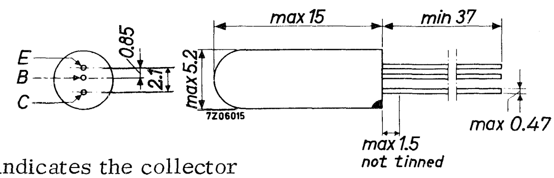
THERMAL RESISTANCE

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 red dot indicates the collector

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

7Z3 1373

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) [1])

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 °C	P_{tot}	max.	20	mW
Junction temperature	T_j	max.	75	°C

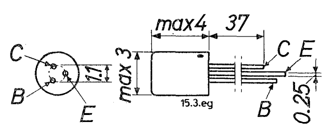
THERMAL RESISTANCE

From junction to ambient in free air	$R_{th\ j\text{-}a}$	=	1.5	°C/mW

CHARACTERISTICS T_{amb} = 25 °C 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; $T_{amb} = 35$ °C	$-I_{CBO}$	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; $T_{amb} = 35$ °C	$-I_{CEO}$	<	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

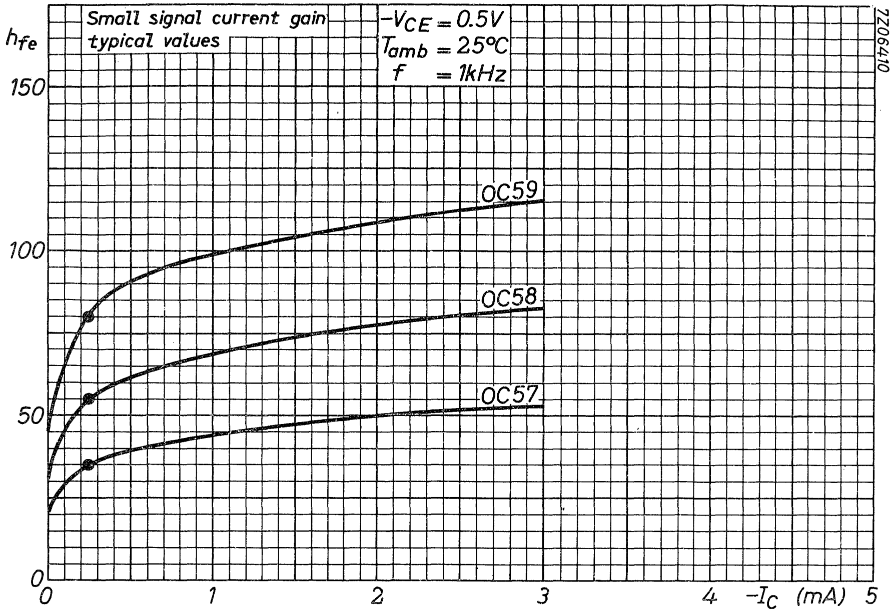
MECHANICAL DATA Dimensions in mm

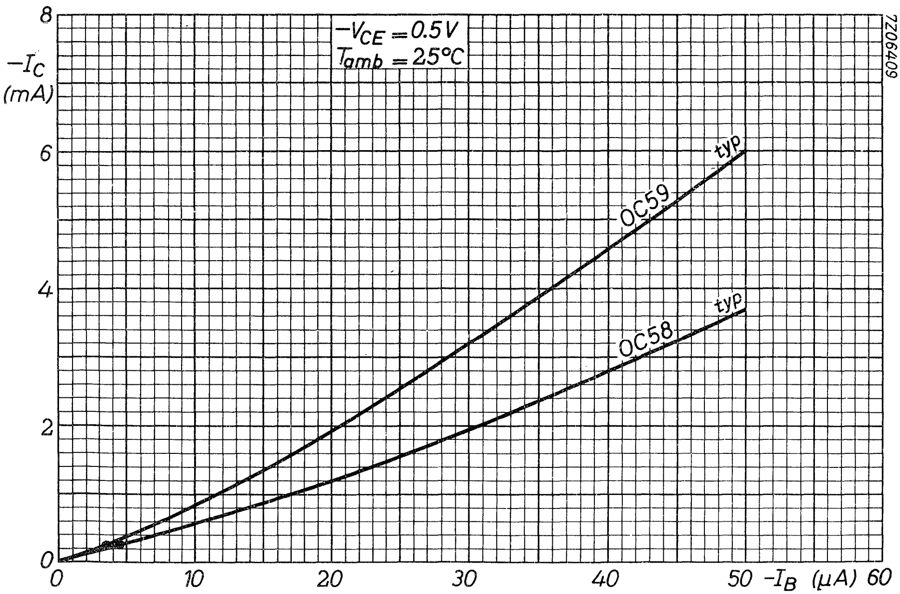


The red dot indicates the collector

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

7Z3 0827


Small signal current gain
typical values
$-V_{CE} = 0.5V$
$T_{amb} = 25°C$
$f = 1kHz$
7Z06410
h_{fe}
150
100
50
0
OC59
OC58
OC57
0
1
2
3
4
$-I_C$ (mA)
5


$-V_{CE} = 0.5V$
$T_{amb} = 25°C$
7Z06409
8
$-I_C$
(mA)
6
4
2
0
typ
OC59
typ
OC58
0
10
20
30
40
50
$-I_B$ (μA)
60

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) [1])

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

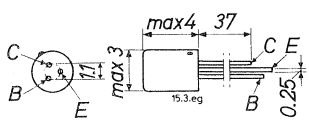
THERMAL RESISTANCE

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 $-I_C = 11$ mA at $-V_{CE} = 1$ V	$-V_{CEK}$	typ.	0.18	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

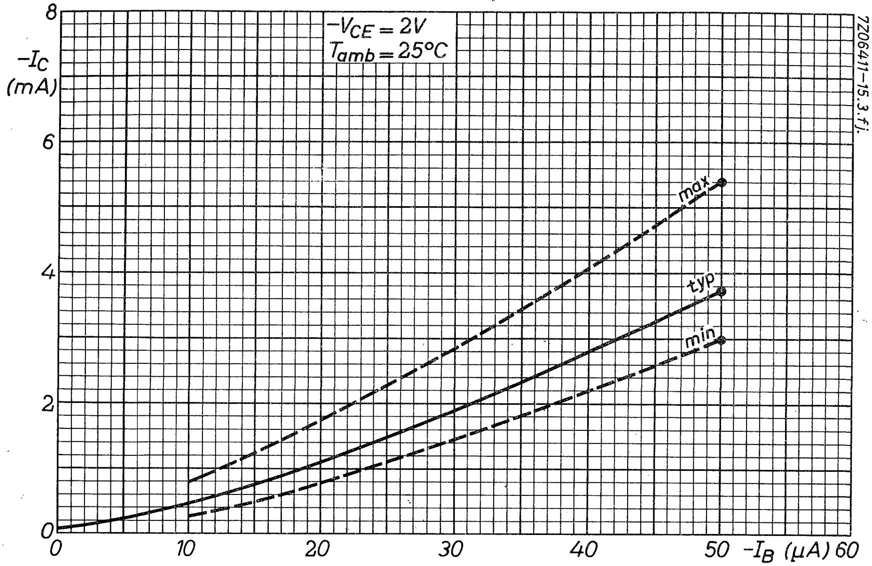
MECHANICAL DATA Dimensions in mm

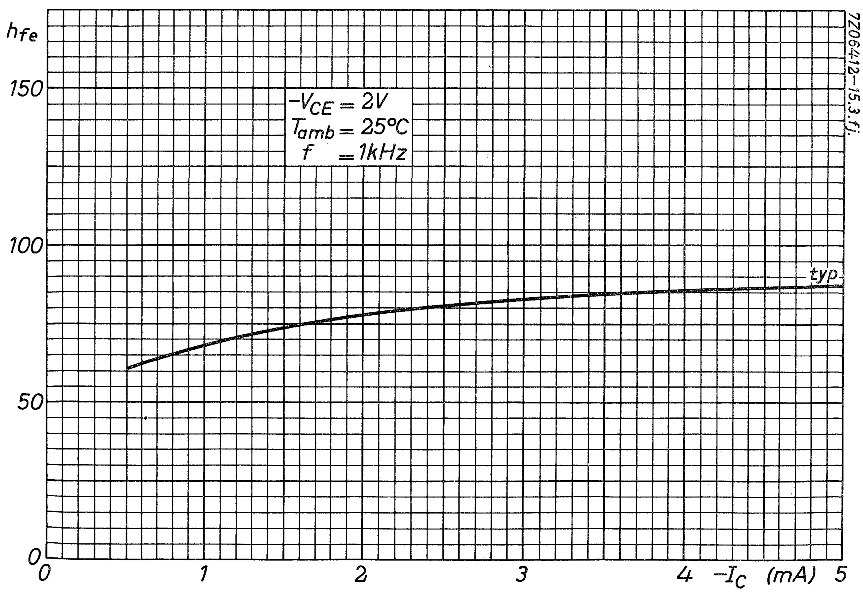


The red dot indicates the collector

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

7Z3 0828


$-V_{CE} = 2V$
$T_{amb} = 25°C$
$-I_C$ (mA)
$-I_B$ (µA)
max
typ
min
0
2
4
6
8
10
20
30
40
50
60
7Z06411-15.3.fj.


$-V_{CE} = 2V$
$T_{amb} = 25°C$
$f = 1kHz$
h_{fe}
$-I_C$ (mA)
typ
0
50
100
150
1
2
3
4
5
7Z06412-15.3.fj.

GERMANIUM P-N-P TRANSISTOR

P-N-P transistor in all glass construction for general purpose applications.

RATINGS (Limiting values) [1])

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	

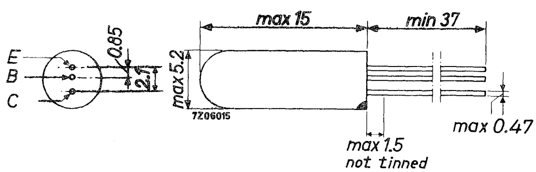
Small signal current gain at $T_j = 25$ °C

$-I_C = 0.5$ 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 red dot indicates the collector.

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

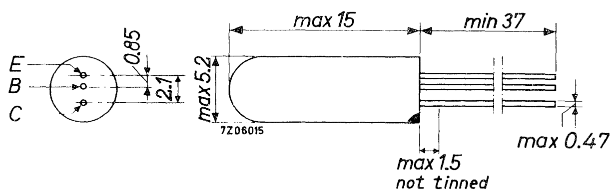
7Z3 1374

GERMANIUM TRANSISTOR

P-N-P germanium general purpose transistor in all-glass construction.

QUICK REFERENCE DATA				
Collector-emitter voltage (open base)	$-V_{CEO}$	max.	10	V
Collector-emitter voltage ($R_{BE} < 1$ kΩ)	$-V_{CER}$	max.	30	V
Collector current (peak value)	$-I_{CM}$	max.	50	mA
Total power dissipation up to $T_{amb} = 25$ °C	P_{tot}	max.	125	mW
Thermal resistance from junction to ambient in free air	$R_{th\ j\text{-}a}$	=	0.4	°C/mW
Cut-off frequency $-I_C = 3$ mA; $-V_{CE} = 2$ V	f_{hfe}	typ.	10	kHz

MECHANICAL DATA Dimensions in mm



The red dot indicates the collector

7Z3 1403

RATINGS (Limiting values) [1]

Voltages

Collector-emitter voltage (open base)	$-V_{CEO}$	max.	10	V
Collector-emitter voltage ($R_{BE} < 1$ kΩ)	$-V_{CER}$	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 (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

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

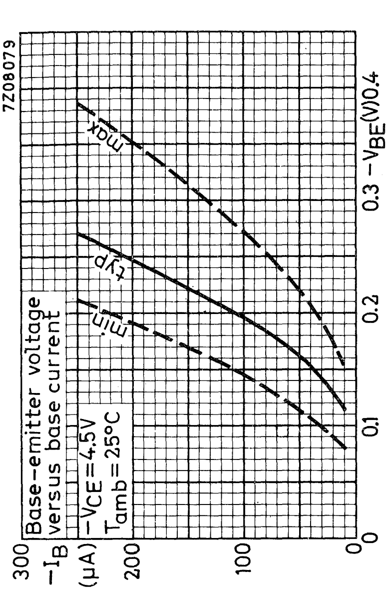
[1] Limiting values according to the Absolute Maximum System as defined in IEC publication 134.

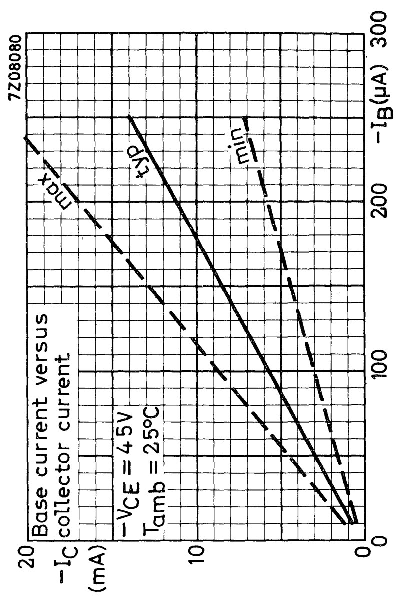
7Z3 1404

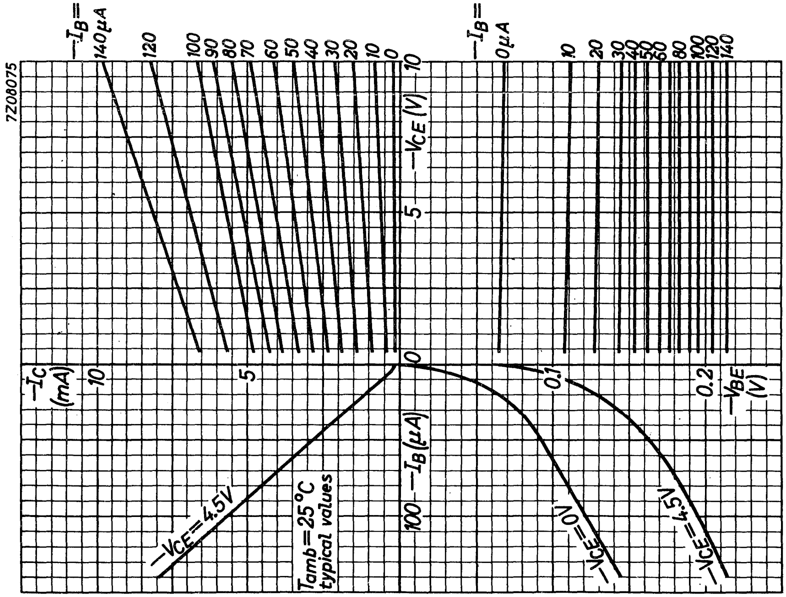
CHARACTERISTICS T_{amb} = 25 °C

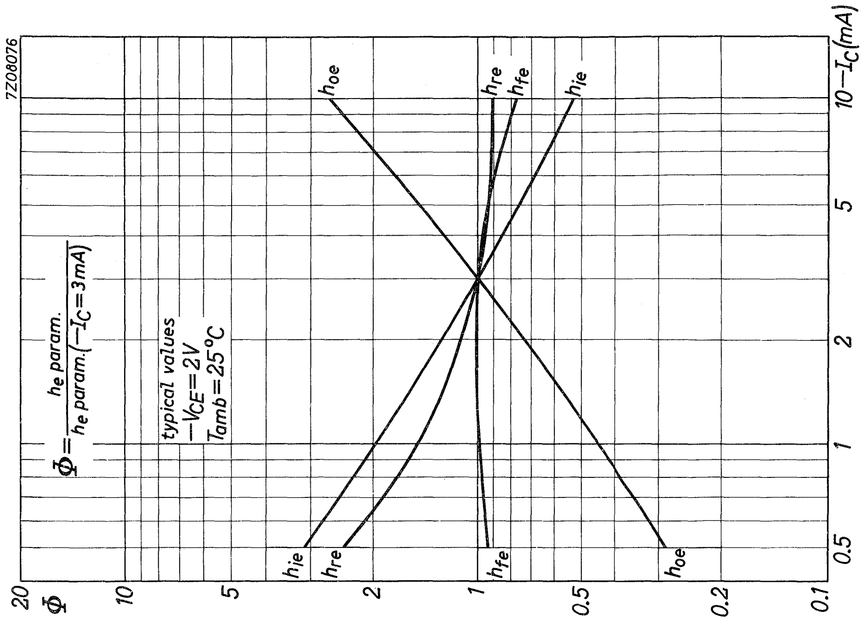
Collector cut-off currents				
I_E = 0; $-V_{CB}$ = 4.5 V	$-I_{CBO}$	typ.	4.5	μA
		<	12	μA
I_B = 0; $-V_{CE}$ = 4.5 V	$-I_{CEO}$	typ.	150	μA
		<	325	μA
Base-emitter voltage				
$-I_B$ = 10 μA; $-V_{CE}$ = 4.5 V	$-V_{BE}$	typ.	110	mV
		80 to	155	mV
$-I_B$ = 250 μA; $-V_{CE}$ = 4.5 V	$-V_{BE}$	typ.	270	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

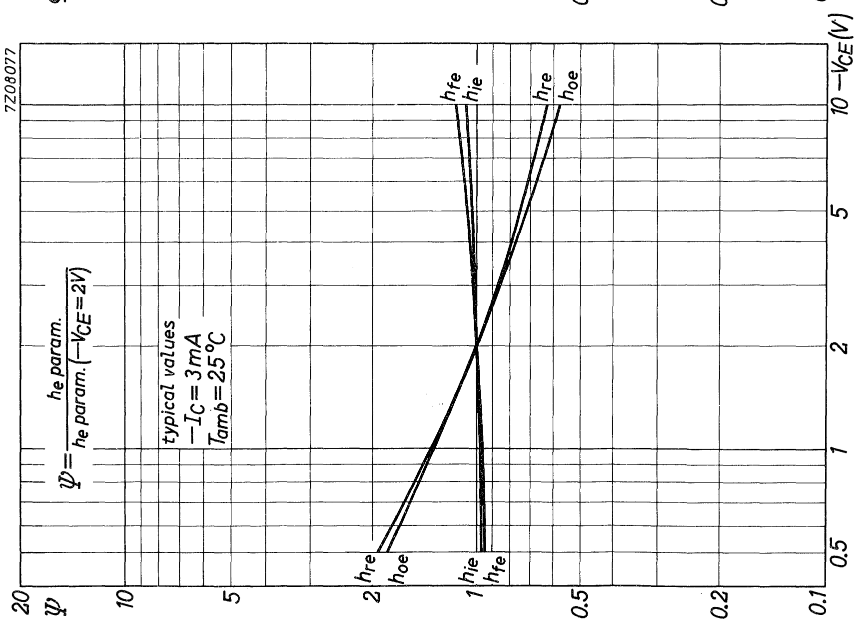
7Z3 1405

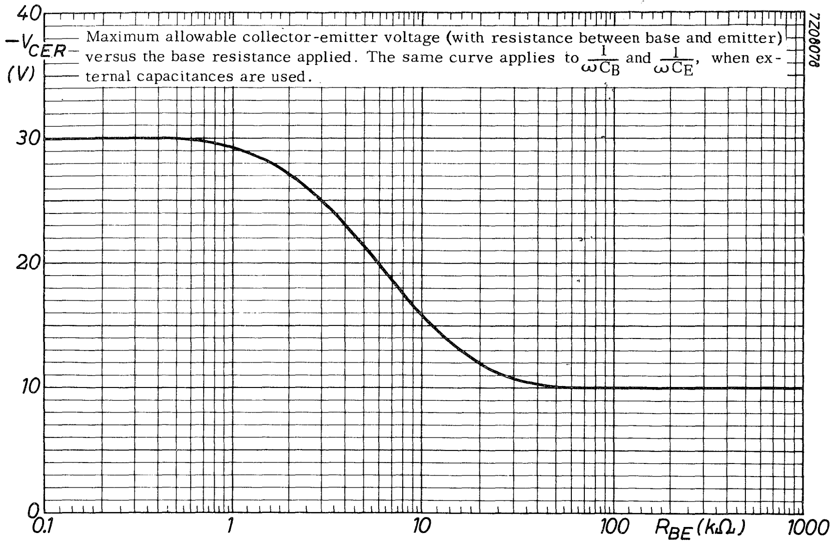

7Z08079
Base-emitter voltage
versus base current
$-V_{CE}$ = 4.5V
T_{amb} = 25°C
max
typ
min
$-I_B$ (μA)
$-V_{BE}$ (V)


7Z08080
Base current versus
collector current
$-V_{CE}$ = 4.5V
T_{amb} = 25°C
max
typ
min
$-I_C$ (mA)
$-I_B$ (μA)

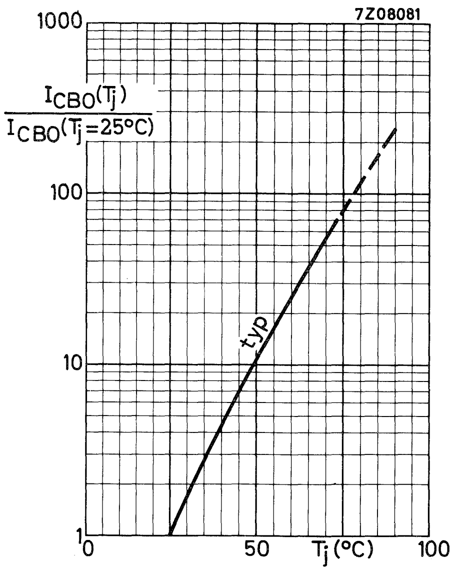

7Z08075
$-I_B$ = 140 μA
$-I_B$ = 0 μA
$-V_{CE}$ (V)
$-I_C$ (mA)
$-I_B$ (μA)
$-V_{BE}$ (V)
$-V_{CE}$ = 4.5V
$-V_{CE}$ = 0V
T_{amb} = 25°C
typical values


7Z08076
Φ = he param. / he param. (−IC = 3mA)
typical values
−VCE = 2V
Tamb = 25°C
hoe
hre
hfe
hie
hie
hre
hfe
hoe
20
Φ
10
5
2
1
0.5
0.2
0.1
0.5
1
2
5
10 −IC (mA)


7Z08077
Ψ = he param. / he param. (−VCE = 2V)
typical values
−IC = 3 mA
Tamb = 25°C
hfe
hie
hre
hoe
hre
hoe
hie
hfe
20
Ψ
10
5
2
1
0.5
0.2
0.1
0.5
1
2
5
10 −VCE (V)



Maximum allowable collector-emitter voltage (with resistance between base and emitter) versus the base resistance applied. The same curve applies to $\frac{1}{\omega C_B}$ and $\frac{1}{\omega C_E}$, when external capacitances are used.



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) [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 (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_{mb} = 25 °C with cooling fin 56200	P_{tot}	max.	165	mW

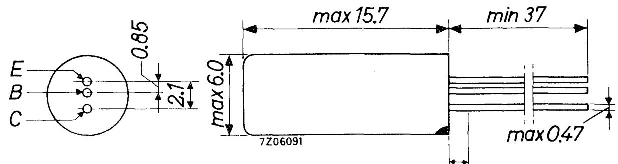
Temperatures

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	$R_{th\ j\text{-}a}$	=	0.4	°C/mW
From junction to ambient with cooling fin 56200 on a heatsink 12.5 cm^2	$R_{th\ j\text{-}a}$	=	0.3	°C/mW

MECHANICAL DATA Dimensions in mm



The red dot indicates the collector

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

7Z3 1408

CHARACTERISTICS

T_{amb} = 25 °C

Collector cut-off currents

$I_E = 0$; $-V_{CB} = 10$ V	$-I_{CBO}$	typ. 4.5 < 10	μA μA
$I_B = 0$; $-V_{EB} = 6$ V	$-I_{CEO}$	typ. 125 50 to 300	μA μA

Emitter cut-off current

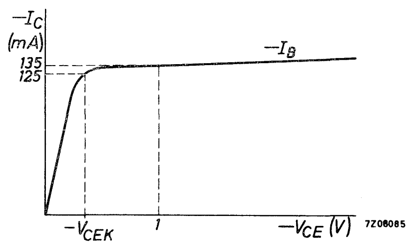
$I_C = 0$; $-V_{EB} = 10$ V	$-I_{EBO}$	typ. 4.5 < 10	μA μA

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

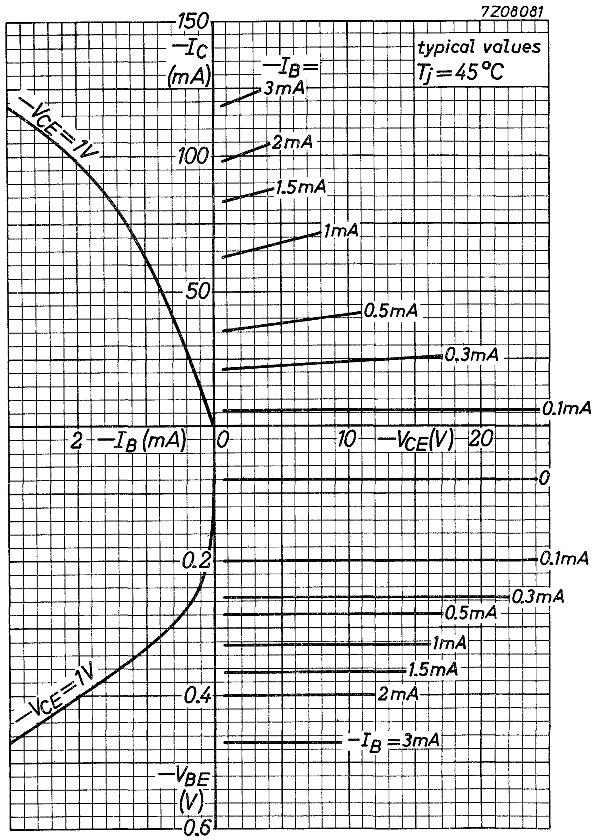
$I_E = 10$ mA; $-V_{CB} = 6$ V	f_{hfb}	> 350	kHz
$-I_C = 10$ mA; $-V_{CE} = 6$ V	f_{hfe}	> 8	kHz

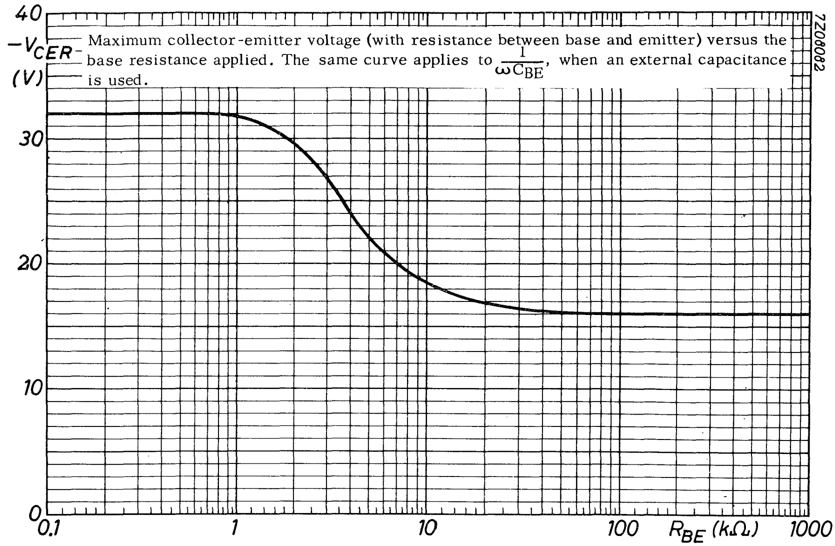
Noise figure at f = 1 kHz

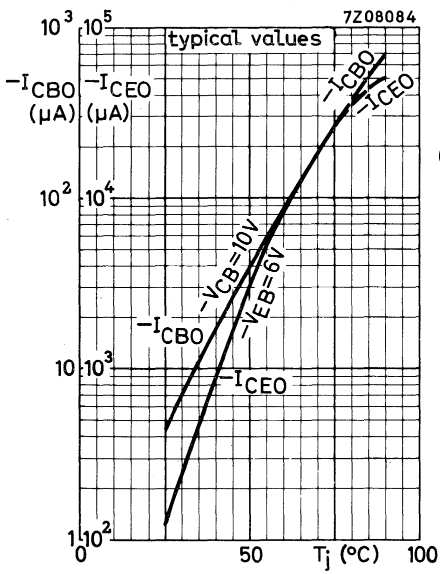
$I_E = 0.5$ mA; $-V_{CE} = 2$ V; $R_S = 500\ \Omega$	F	< 15	dB

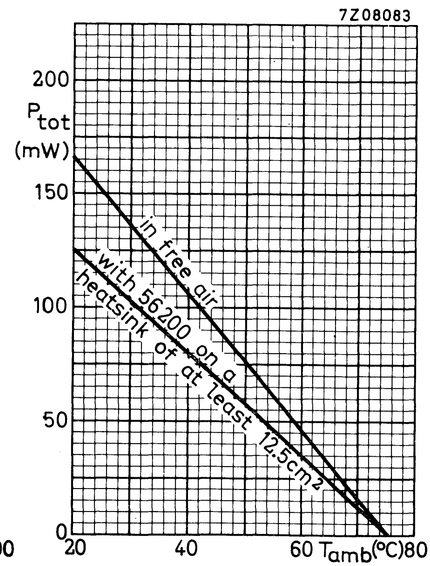
D.C. current gain ratio of matched pair 2-OC72	h_{FE1}/h_{FE2}	typ. 1.15 1.0 to 1.3

7Z3 1409


7Z08081
typical values
$T_j = 45\,^{\circ}C$
150
$-I_C$ (mA)
100
50
$-I_B =$
3mA
2mA
1.5mA
1mA
0.5mA
0.3mA
0.1mA
$-V_{CE} = 1V$
2
$-I_B$ (mA)
0
10
$-V_{CE}$(V)
20
0
0.1mA
0.3mA
0.5mA
1mA
1.5mA
2mA
$-I_B = 3mA$
0.2
0.4
0.6
$-V_{BE}$ (V)
$-V_{CE} = 1V$


7Z08082
Maximum collector-emitter voltage (with resistance between base and emitter) versus the base resistance applied. The same curve applies to $\frac{1}{\omega C_{BE}}$, when an external capacitance is used.
40
$-V_{CER}$
(V)
30
20
10
0
0.1
1
10
100
R_{BE} (kΩ)
1000


7Z08084
typical values
$-I_{CBO}$ (μA)
$-I_{CEO}$ (μA)
10^3
10^5
10^2
10^4
10
10^3
1
10^2
$-V_{CB}$=10V
$-V_{EB}$=6V
$-I_{CBO}$
$-I_{CEO}$
0
50
T_j (°C)
100


7Z08083
200
P_{tot} (mW)
150
100
50
0
in free air
with 56200 on a heatsink of at least 12.5cm²
20
40
60
T_{amb} (°C)
80

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) 1)

Voltages

Collector-base voltage (open emitter)	$-V_{CBO}$	max.	20	V
Collector-emitter voltage ($R_{BE} < 500\ \Omega$)	$-V_{CER}$	max.	20	V
Emitter-base voltage (open collector)	$-V_{EBO}$	max.	6	V

Currents

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

Power dissipation

Total power dissipation up to $T_{amb} = 25\ ^oC$ with cooling fin 56200 on heatsink $\geq 12.5\ cm^2$	P_{tot}	max.	550	mW

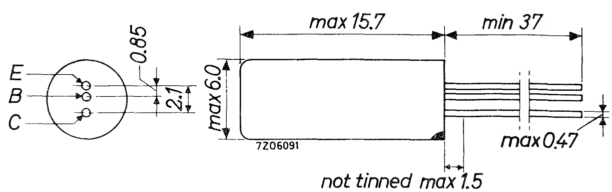
Temperatures

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	$R_{th\ j-a}$	=	0.22	$^oC/mW$
From junction to ambient with cooling fin 56200	$R_{th\ j-a}$	=	0.15	$^oC/mW$
From junction to ambient with cooling fin 56200 on heatsink $\geq 12.5\ cm^2$	$R_{th\ j-a}$	=	0.09	$^oC/mW$

MECHANICAL DATA Dimensions in mm

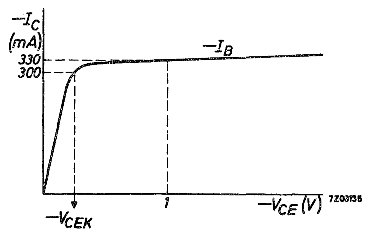


1) Limiting values according to the Absolute Maximum System as defined in IEC publication 134.

7Z3 1413

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

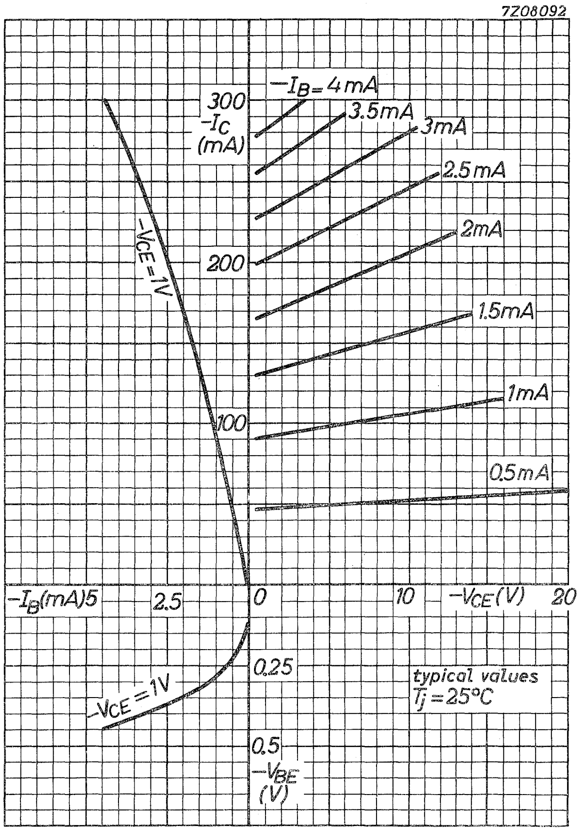
Collector cut-off current				
I_E = 0; $-V_{CB}$ = 9 V	$-I_{CBO}$	<	20	µA
I_E = 0; $-V_{CB}$ = 9 V; T_j = 60 °C	$-I_{CBO}$	<	330	µA
Emitter cut-off current				
I_C = 0; $-V_{EB}$ = 6 V	$-I_{EBO}$	<	20	µA
I_C = 0; $-V_{EB}$ = 6 V; T_j = 60 °C	$-I_{EBO}$	<	300	µA
Base-emitter voltage [1]				
$-I_C$ = 5 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

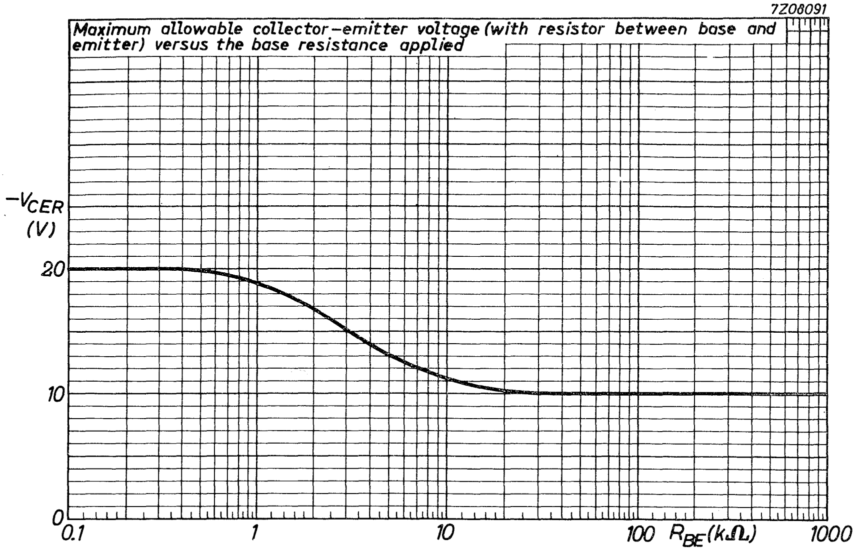


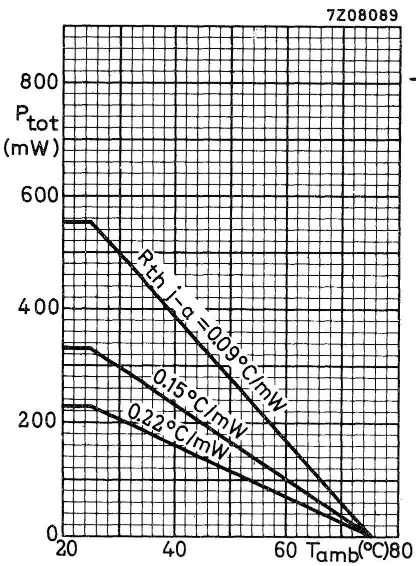
D.C. current gain				
$-I_C$ = 5 mA; $-V_{CE}$ = 6 V	h_{FE}	40 to 200		
$-I_C$ = 50 mA; $-V_{CE}$ = 6 V	h_{FE}	60 to 150		
$-I_C$ = 300 mA; $-V_{CE}$ = 1 V	h_{FE}	40 to 100		
Cut-off frequency				
$-I_C$ = 50 mA; $-V_{CE}$ = 6 V	f_{hfe}	>	8	kHz
Noise figure at f = 1 kHz				
I_E = 5 mA; $-V_{CB}$ = 6 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	

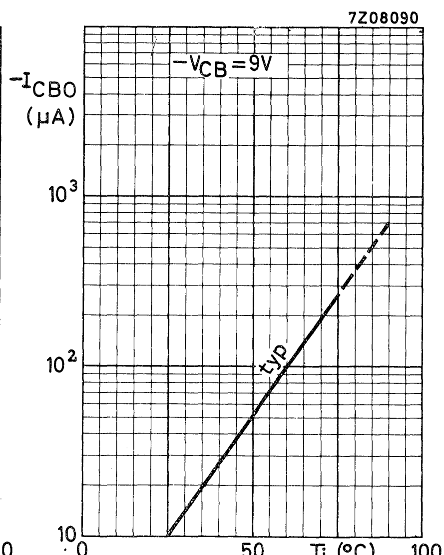
[1]) $-V_{BE}$ decreases by about 2.3 mV/°C with increasing temperature.

7Z3 1414


7Z08092
$-I_B = 4\,mA$
3.5mA
3mA
2.5 mA
2mA
1.5mA
1mA
0.5mA
300
$-I_C$ (mA)
200
100
$-V_{CE} = 1V$
$-I_B$(mA)5
2.5
0
10
$-V_{CE}$(V)
20
0.25
0.5
$-V_{BE}$ (V)
$-V_{CE} = 1V$
typical values
$T_j = 25°C$


7Z08091
Maximum allowable collector-emitter voltage (with resistor between base and emitter) versus the base resistance applied
$-V_{CER}$ (V)
20
10
0
0.1
1
10
100
R_{BE} (kΩ)
1000


7Z08089
800
P_{tot} (mW)
600
400
200
0
20
40
60
T_{amb} (°C)
80
Rth j-a = 0.09°C/mW
0.15°C/mW
0.22°C/mW


7Z08090
$-V_{CB} = 9V$
$-I_{CBO}$ (μA)
10^3
10^2
10
0
50
T_j (°C)
100
typ

GERMANIUM TRANSISTOR

P-N-P general purpose transistor in all glass construction.

RATINGS (Limiting values) [1])

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

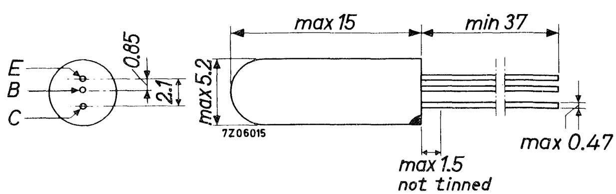
Temperatures

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 red dot indicates the collector

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

7Z3 1416

CHARACTERISTICS T_{amb} = 25 °C

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 Ω	F	typ.	10	dB
		<	15	dB

h parameters at f = 1 kHz (common emitter)

$-I_C$ = 3 mA; $-V_{CE}$ = 2 V

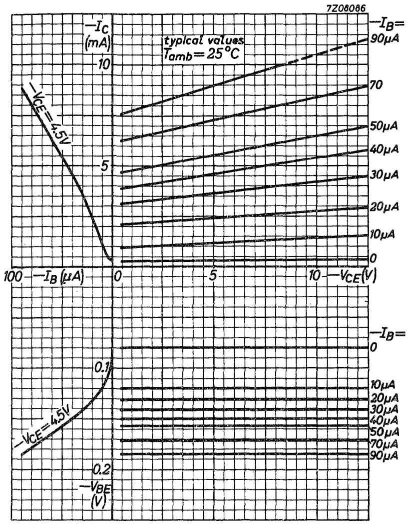
Input impedance	h_{ie}	typ.	1.3	kΩ
Voltage feedback ratio	h_{re}	typ.	8	10^{-4}
Small signal current gain	h_{fe}	typ.	90	
		65 to	130	
Output admittance	h_{oe}	typ.	125	$\mu\Omega^{-1}$

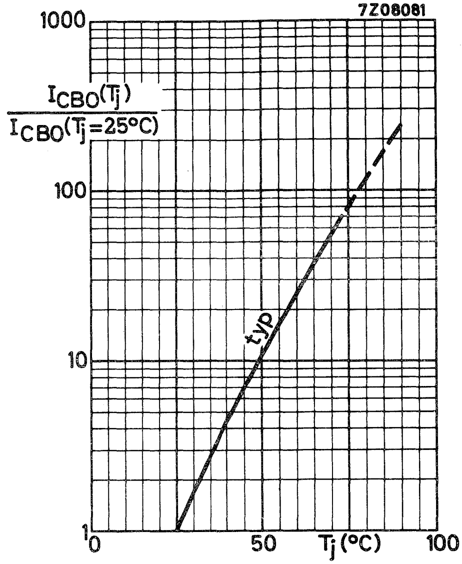
h parameters at f = 1 kHz (common base)

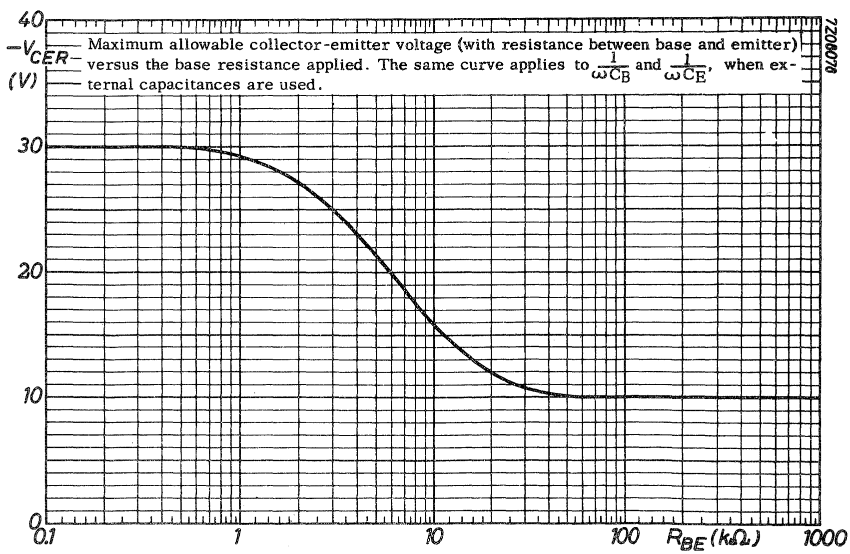
I_E = 3 mA; V_{CB} = 2 V

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	$\mu\Omega^{-1}$

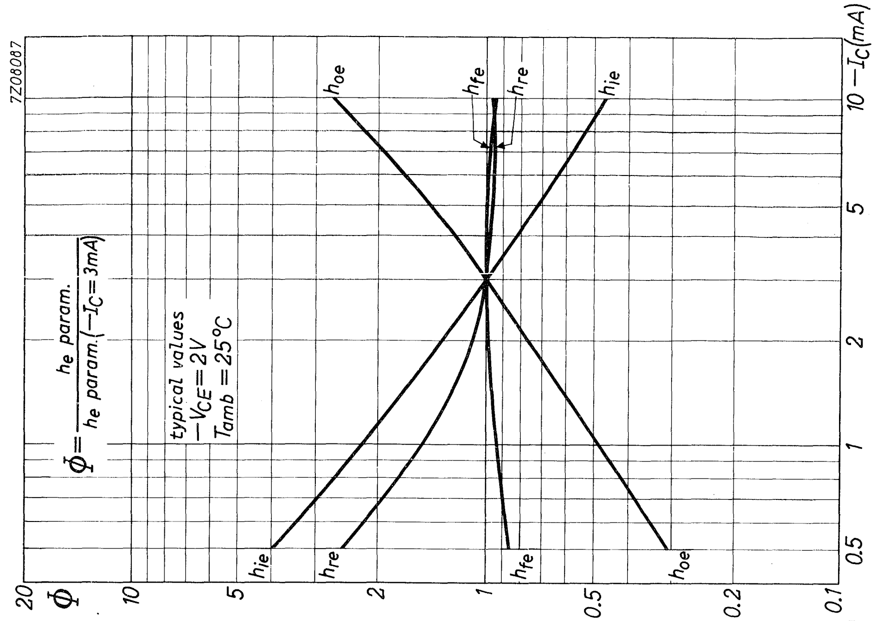
7Z3 1417

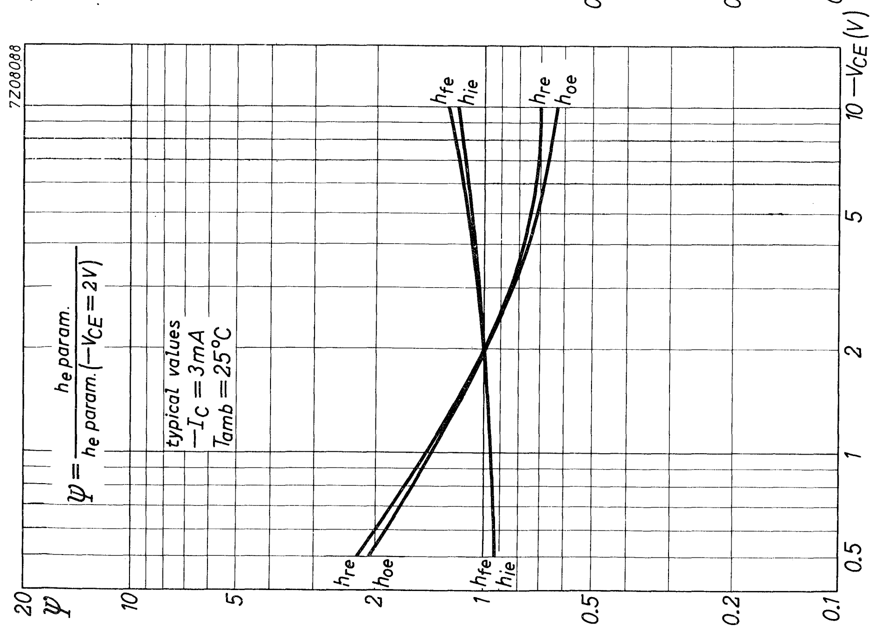






Maximum allowable collector-emitter voltage (with resistance between base and emitter) versus the base resistance applied. The same curve applies to $\frac{1}{\omega C_B}$ and $\frac{1}{\omega C_E}$, when external capacitances are used.


7Z08087
$\Phi = \frac{h_e \text{ param.}}{h_e \text{ param.} (-I_C = 3mA)}$
typical values
$-V_{CE} = 2V$
$T_{amb} = 25°C$
h_{oe}
h_{fe}
h_{re}
h_{ie}
Φ
20
10
5
2
1
0.5
0.2
0.1
0.5
1
2
5
10
$-I_C (mA)$

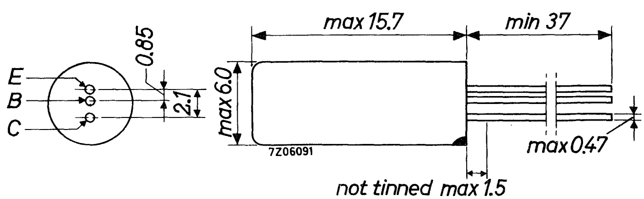

7Z08088
$\Psi = \frac{h_e \text{ param.}}{h_e \text{ param.} (-V_{CE} = 2V)}$
typical values
$-I_C = 3mA$
$T_{amb} = 25°C$
h_{fe}
h_{ie}
h_{re}
h_{oe}
Ψ
20
10
5
2
1
0.5
0.2
0.1
0.5
1
2
5
10
$-V_{CE} (V)$

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.

QUICK REFERENCE DATA			
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
Collector current (peak value)	$-I_{CM}$	max. 250	mA
Total power dissipation up to T_{amb} = 25 °C	P_{tot}	max. 165	mW
D.C. current gain			
$-I_C$ = 10 mA; $-V_{CE}$ = 5.4 V	h_{FE}	45 to 330	
Cut-off frequency			
I_E = 10 mA; $-V_{CB}$ = 6 V	f_{hfb}	> 350	kHz

MECHANICAL DATA Dimensions in mm



The red dot indicates the collector

7Z3 0722

RATINGS (Limiting values) [1]

Voltages

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

Currents

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
Reverse base current (peak value)	$+I_{BM}$	max.	125	mA

Power dissipation

Total power dissipation up to T_{amb} = 25 °C				
without cooling fin	P_{tot}	max.	125	mW
with cooling fin 56200 on a heatsink of at least 12.5 cm²	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

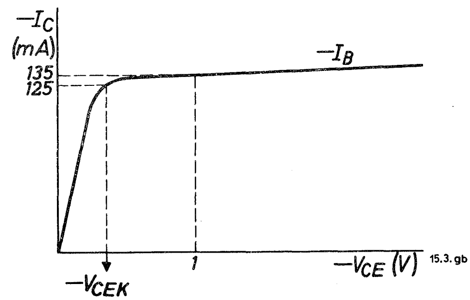
From junction to ambient in free air	$R_{th\ j\text{-}a}$	=	0.4	°C/mW
From junction to ambient with cooling fin 56200 on a heatsink of at least 12.5 cm²	$R_{th\ j\text{-}a}$	=	0.3	°C/mW

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

7Z3 0723

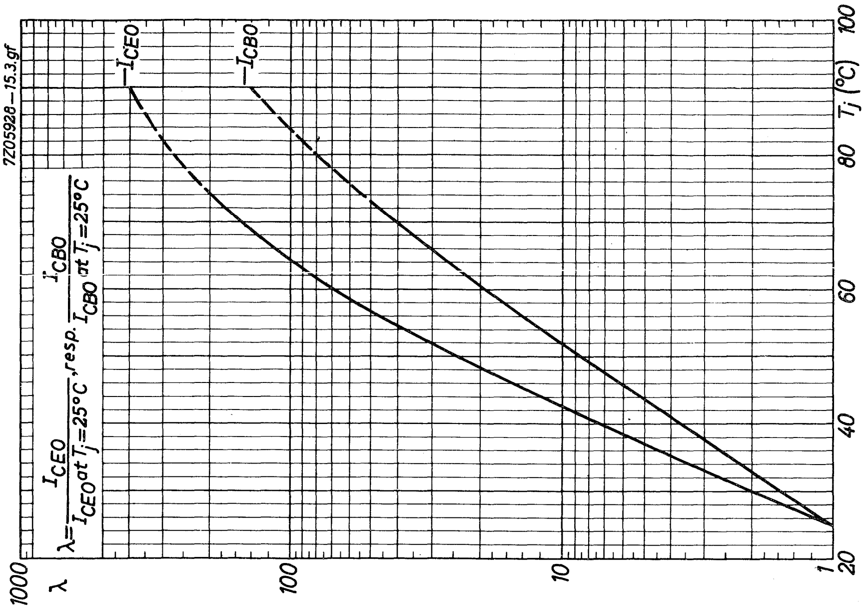
CHARACTERISTICS T_{amb} = 25 °C unless otherwise specified

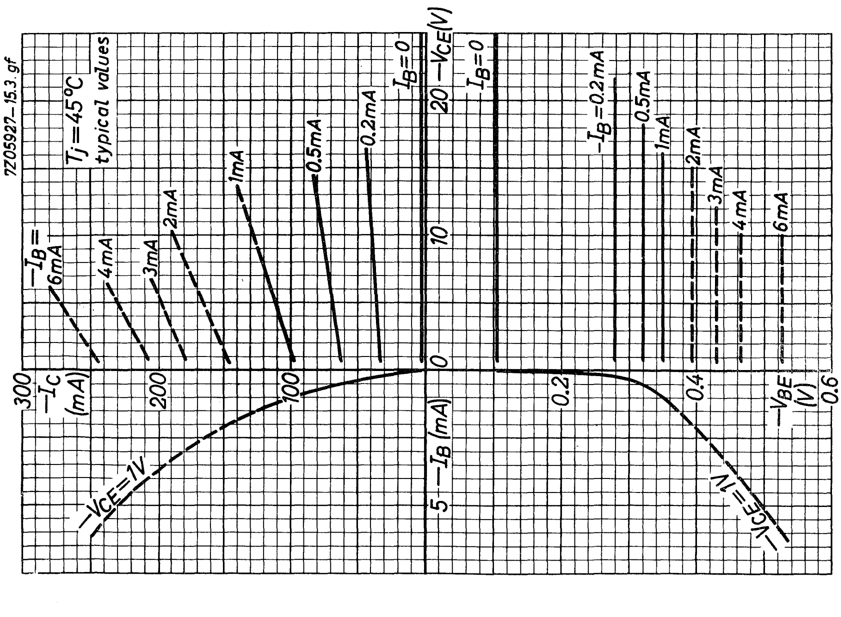
Collector cut-off current		
$I_E = 0$; $-V_{CB} = 10$ V	$-I_{CBO}$	typ. 4.5 µA < 10 µA
$I_B = 0$; $-V_{CE} = 6$ V	$-I_{CEO}$	typ. 200 µA < 600 µA
$+V_{BE} = 0.5$ V; $-V_{CE} = 30$ V	$-I_{CEX}$	typ. 7.5 µA < 15 µA
Emitter cut-off current		
$I_C = 0$; $-V_{EB} = 10$ V	$-I_{EBO}$	typ. 4.5 µA < 8 µA
Base-emitter 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

7Z3 0724


7Z05928—15.3.gf
λ = I_CEO / I_CEO at Tj = 25°C, resp. I_CBO / I_CBO at Tj = 25°C
—I_CEO
—I_CBO
λ
1000
100
10
1
20
40
60
80
100
Tj (°C)

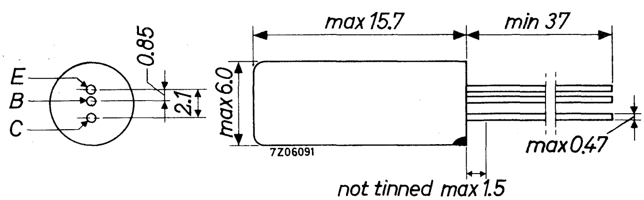

7Z05927—15.3.gf
Tj = 45°C
typical values
—I_B =
6mA
4mA
3mA
2mA
1mA
0.5mA
0.2mA
I_B = 0
—V_CE (V)
20
10
0
—I_C (mA)
300
200
100
5 —I_B (mA)
I_B = 0
—I_B = 0.2mA
0.5mA
1mA
2mA
3mA
4mA
6mA
0.2
0.4
0.6
—V_BE (V)
—V_CE = 1V
—V_CE = 1V

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.

QUICK REFERENCE DATA				
Collector-base voltage (open emitter)	$-V_{CBO}$	max.	60	V
Collector-emitter voltage ($R_{BE} < 400\ \Omega$)	$-V_{CER}$	max.	60	V
Collector-emitter voltage (open base)	$-V_{CEO}$	max.	15	V
Collector current (peak value)	$-I_{CM}$	max.	250	mA
Total power dissipation up to $T_{amb} = 25\ ^{o}C$	P_{tot}	max.	165	mW
D.C. current gain $-I_C = 10$ mA; $-V_{CE} = 5.4$ V	h_{FE}	45 to 330		
Cut-off frequency $I_E = 10$ mA; $-V_{CB} = 6$ V	f_{hfb}	>	350	kHz

MECHANICAL DATA Dimensions in mm



The red dot indicates the collector

7Z3 0730

RATINGS (limiting values) [1])

Voltages

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

Currents

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
Reverse base current (peak value)	$+I_{BM}$	max.	125	mA

Power dissipation

Total power dissipation up to T_{amb} = 25 °C

without cooling fin	P_{tot}	max.	125	mW
with cooling fin 56200 on a heatsink of at least 12.5 cm^2	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

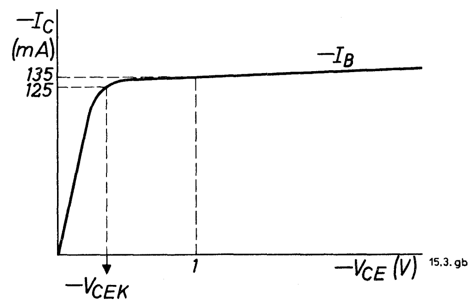
From junction to ambient in free air	$R_{th\,j\text{-}a}$	=	0.4	°C/mW
From junction to ambient with cooling fin 56200 on a heatsink of at least 12.5 cm^2	$R_{th\,j\text{-}a}$	=	0.3	°C/mW

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

7Z3 0731

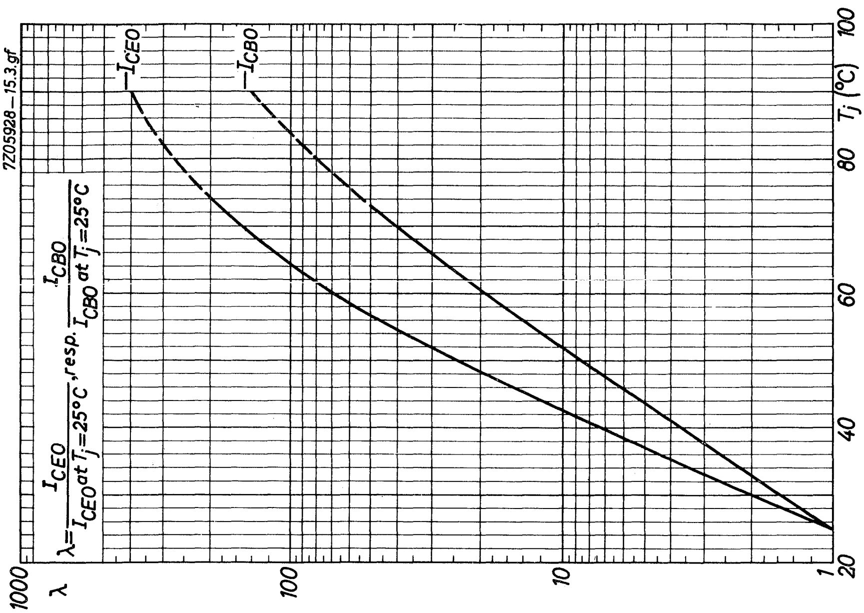
CHARACTERISTICS T_{amb} = 25 °C unless otherwise specified

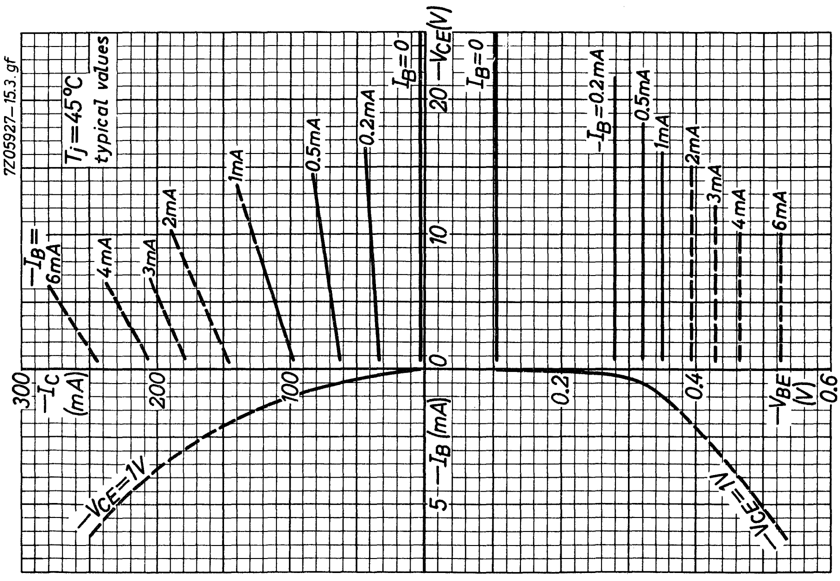
Collector cut-off current				
$I_E = 0$; $-V_{CB} = 10$ V	$-I_{CBO}$	typ.	4.5	μA
		<	10	μA
$I_B = 0$; $-V_{CE} = 6$ V	$-I_{CEO}$	typ.	200	μA
		<	600	μA
$+V_{BE} = 0.5$ V; $-V_{CE} = 60$ V	$-I_{CEX}$	typ.	15	μA
		<	30	μA
Emitter cut-off current				
$I_C = 0$; $-V_{EB} = 10$ V	$-I_{EBO}$	typ.	4.5	μA
		<	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

7Z3 0732


7Z05928–15.3.gf
$\lambda = \frac{I_{CEO}}{I_{CEO} \text{ at } T_j = 25°C}$, resp. $\frac{I_{CBO}}{I_{CBO} \text{ at } T_j = 25°C}$
$-I_{CEO}$
$-I_{CBO}$
λ
1000
100
10
1
20
40
60
80
100
T_j (°C)


7Z05927–15.3.gf
$T_j = 45°C$
typical values
$-I_B =$ 6mA
4mA
3mA
2mA
1mA
0.5mA
0.2mA
$I_B = 0$
$-V_{CE}$(V)
20
10
0
$-I_C$ (mA)
300
200
100
5
$-I_B$ (mA)
$-V_{CE} = 1V$
$I_B = 0$
$-I_B = 0.2mA$
0.5mA
1mA
2mA
3mA
4mA
6mA
0.2
0.4
0.6
$-V_{BE}$ (V)
$-V_{CE} = 1V$

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) [1])

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

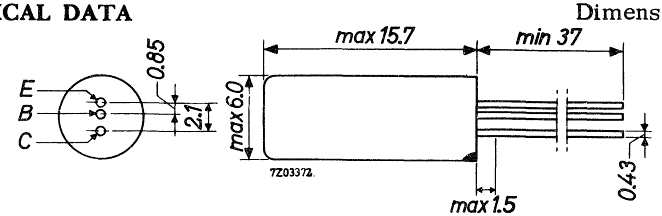
D.C. current gain at T_j = 25 °C

$-I_C$ = 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 red dot indicates the collector. Not tinned

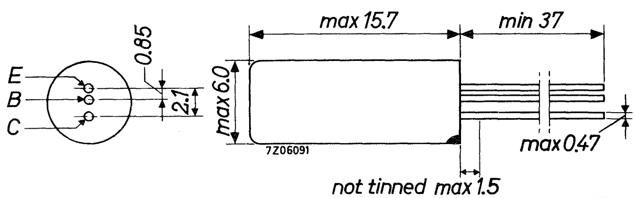
[1]) Limiting values according to the Absolute Maximum System as defined in IEC publication 134. 7Z3 0170

GERMANIUM SWITCHING TRANSISTOR

P-N-P transistor in all glass envelope with metal cover, primarily intended for switching and pulse-oscillating circuits.

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 (peak value)	$-I_{CM}$	max.	600	mA
Total power dissipation up to T_{amb} = 40 °C	P_{tot}	max.	550	mW
D.C. current gain				
$-I_C$ = 50 mA; $-V_{CE}$ = 6 V	h_{FE}	typ.	180	
Cut-off frequency				
I_E = 50 mA; $-V_{CB}$ = 6 V	f_{hfb}	typ.	2	MHz

MECHANICAL DATA Dimensions in mm



The red dot indicates the collector

7Z3 0733

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
Emitter-base voltage (open collector)	$-V_{EBO}$	max.	20	V

Currents

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

Power dissipation

Total power dissipation up to T_{amb} = 40 °C	P_{tot}	max.	550	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	$R_{th\ j\text{-}a}$	=	0.22	°C/mW
From junction to ambient with cooling fin 56200 on a heatsink of at least 12.5 cm^2	$R_{th\ j\text{-}a}$	=	0.09	°C/mW

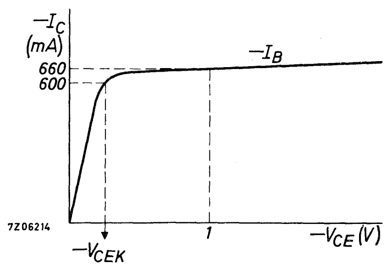
---

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

7Z3 0734

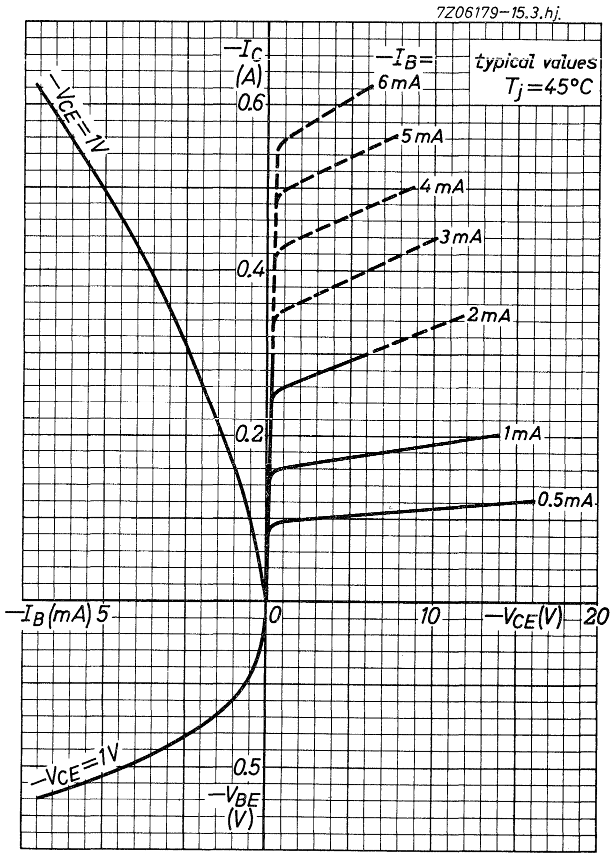
CHARACTERISTICS T_{amb} = 25 °C unless otherwise specified

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	$\lvert z_{rb} \rvert$	typ.	60	Ω

7Z3 0735


7Z06179–15.3.hj.
typical values
$T_j = 45°C$
$-I_C$ (A)
0.6
0.4
0.2
$-I_B=$
6 mA
5 mA
4 mA
3 mA
2 mA
1mA
0.5mA
$-V_{CE}=1V$
$-I_B$ (mA) 5
0
10
$-V_{CE}$(V)
20
$-V_{CE}=1V$
0.5
$-V_{BE}$ (V)

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

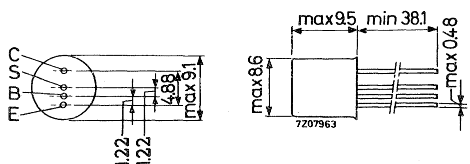
Currents				
Collector current (d.c. or average over any 20 ms period)	$-I_C$	max.	0.5	A
Collector current (peak value)	$-I_{CM}$	max.	2.0	A
Power dissipation				
Total power dissipation up to T_{amb} = 25 °C	P_{tot}	max.	300	mW
Temperatures				
Storage temperature	T_{stg}		-55 to +75	°C
Junction temperature	T_j	max.	90	°C

THERMAL RESISTANCE

From junction to ambient in free air	$R_{th\ j\text{-}a}$	=	0.22	°C/mW
From junction to case	$R_{th\ j\text{-}c}$	=	0.06	°C/mW

MECHANICAL DATA Dimensions in mm

TO-7
Shield lead connected to case



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

7Z3 1406

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

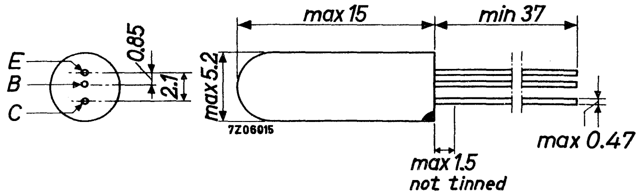
7Z3 1407

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.

QUICK REFERENCE DATA				
Collector-base voltage (open emitter)	V_{CBO}	max.	20	V
Emitter-base voltage (open collector)	V_{EBO}	max.	20	V
Collector-emitter voltage ($-V_{BE} > 2$ V)	V_{CEX}	max.	20	V
Collector current (d.c. or average)	I_C	max.	250	mA
Total power dissipation up to $T_{amb} = 25\ ^oC$	P_{tot}	max.	145	mW
Junction temperature	T_j	max.	75	^oC
D.C. current gain at $T_{amb} = 25\ ^oC$				
$I_C = 15$ mA; $V_{CB} = 0$	h_{FE}		20 to 84	
Transition frequency				
$I_C = 3$ mA; $V_{CE} = 5$ V	f_T	>	3.5	MHz

MECHANICAL DATA Dimensions in mm



The red dot indicates the collector

7Z3 0736

RATINGS (Limiting values) [1])

Voltages

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

Currents

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

Power dissipation

Total power dissipation up to $T_{amb} = 25$ °C	P_{tot}	max.	145	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	$R_{th\ j-a}$	=	0.35	°C/mW
From junction to case	$R_{th\ j-c}$	=	0.20	°C/mW

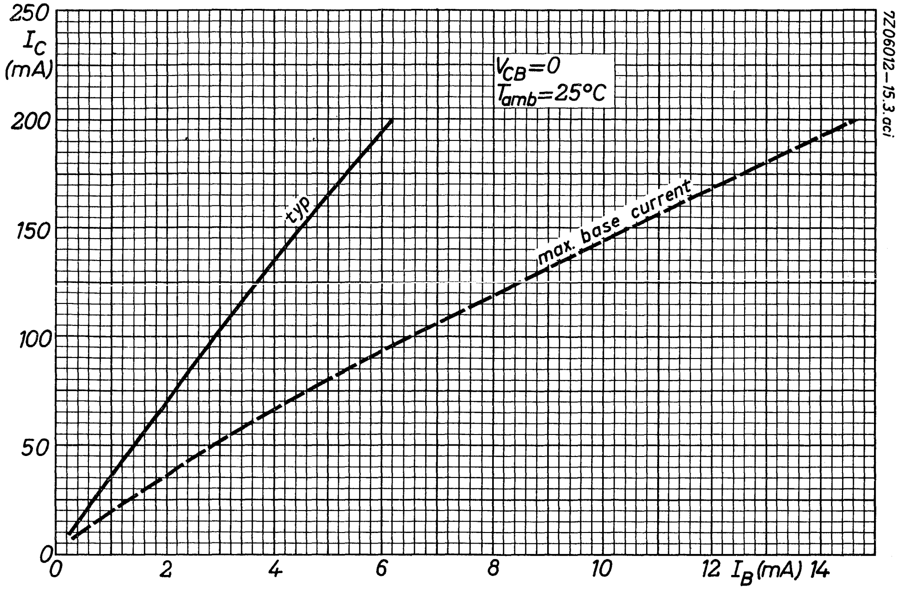
[1]) Limiting values according to the Absolute Maximum System as defined in IEC publication 134.

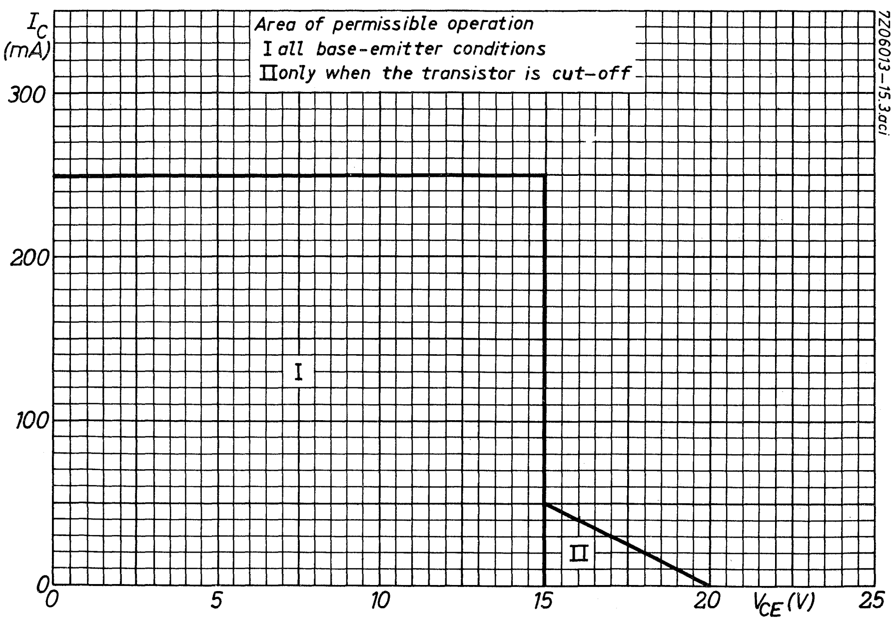
7Z3 0737

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

7Z3 0738


250
I_C
(mA)
200
150
100
50
0
0
2
4
6
8
10
12
I_B (mA)
14
$V_{CB}=0$
$T_{amb}=25°C$
typ
max. base current
7Z06012–15.3.aci


I_C
(mA)
300
200
100
0
0
5
10
15
20
V_{CE} (V)
25
Area of permissible operation
I all base-emitter conditions
II only when the transistor is cut-off
I
II
7Z06013–15.3.aci

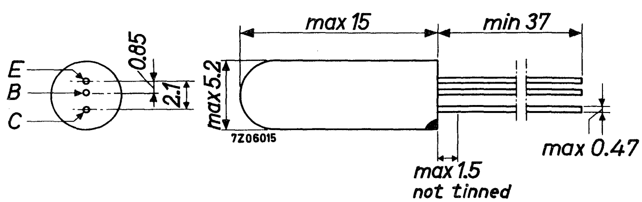
SYMMETRICAL SWITCHING TRANSISTOR

N-P-N germanium transistor with symmetrical structure in all glass construction. It is intended for high current, high speed computer switching applications.

QUICK REFERENCE DATA			
Collector-base voltage (open emitter)	V_{CBO}	max. 20	V
Emitter-base voltage (open collector)	V_{EBO}	max. 20	V
Collector-emitter voltage ($-V_{BE} > 2$ V)	V_{CEX}	max. 20	V
Collector current (d.c. or average)	I_C	max. 400	mA
Total power dissipation up to $T_{amb} = 25$ °C	P_{tot}	max. 145	mW
Junction temperature	T_j	max. 75	°C
D.C. current gain at $T_{amb} = 25$ °C			
$I_C = 15$ mA; $V_{CB} = 0$	h_{FE}	50 to 150	
Transition frequency			
$I_C = 3$ mA; $V_{CE} = 5$ V	f_T	> 4.5	MHz

MECHANICAL DATA

Dimensions in mm



The red dot indicates the collector

7Z3 0739

RATINGS (Limiting values) [1])

Voltages

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

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 power dissipation up to $T_{amb} = 25$ °C	P_{tot}	max.	145	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	$R_{th\ j\text{-}a}$	=	0.35	°C/mW
From junction to case	$R_{th\ j\text{-}c}$	=	0.20	°C/mW

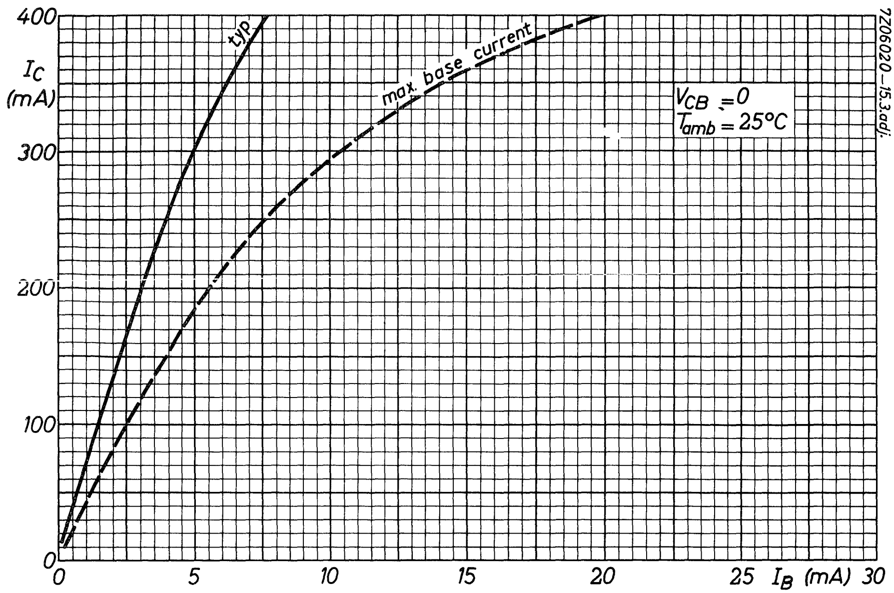
1) Limiting values according to the Absolute Maximum System as defined in IEC publication 134.

7Z3 0740

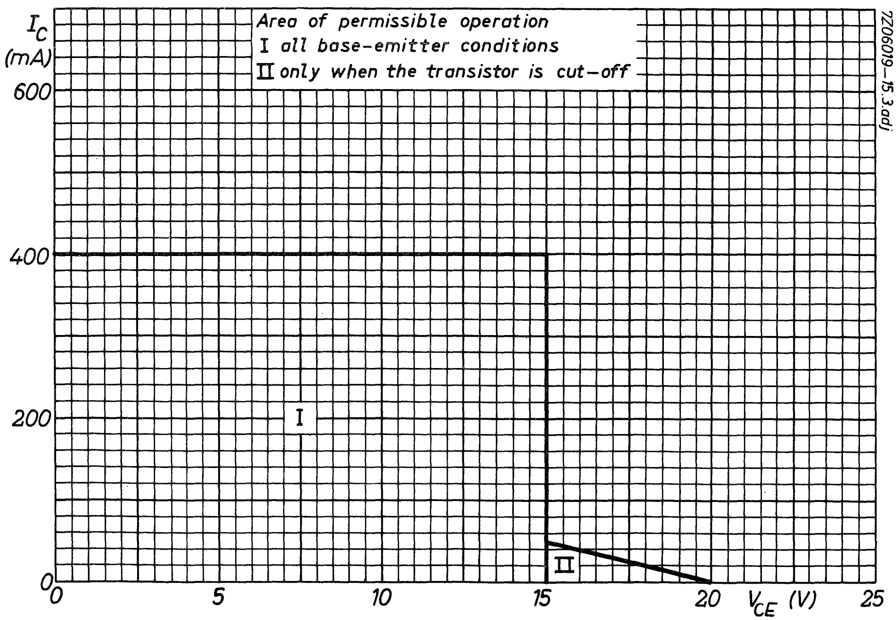
CHARACTERISTICS T_{amb} = 25 °C unless otherwise specified

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

7Z3 0741



400
I_C
(mA)
300
200
100
0
0
5
10
15
20
25
I_B (mA)
30
typ
max. base current
V_{CB} = 0
T_{amb} = 25°C
7Z06020–15.3.adj.



I_C
(mA)
600
400
200
0
0
5
10
15
20
V_{CE} (V)
25
Area of permissible operation
I all base-emitter conditions
II only when the transistor is cut-off
I
II
7Z06019–15.3.adj.

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.

QUICK REFERENCE DATA				
Collector-base voltage (open emitter)	V_{CBO}	max.	20	V
Emitter-base voltage (open collector)	V_{EBO}	max.	20	V
Collector-emitter voltage ($-V_{BE} > 2$ V)	V_{CEX}	max.	20	V
Collector current (d.c. or average)	I_C	max.	400	mA
Total power dissipation up to T_{amb} = 25 °C	P_{tot}	max.	145	mW
Junction temperature	T_j	max.	75	°C
D.C. current gain at T_{amb} = 25 °C				
I_C = 15 mA; V_{CB} = 0	h_{FE}	80 to 200		
Transition frequency				
I_C = 3 mA; V_{CE} = 5 V	f_T	>	9	MHz

RATINGS (Limiting values) [1])

Voltages

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

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 power dissipation up to T_{amb} = 25 °C	P_{tot}	max.	145	mW

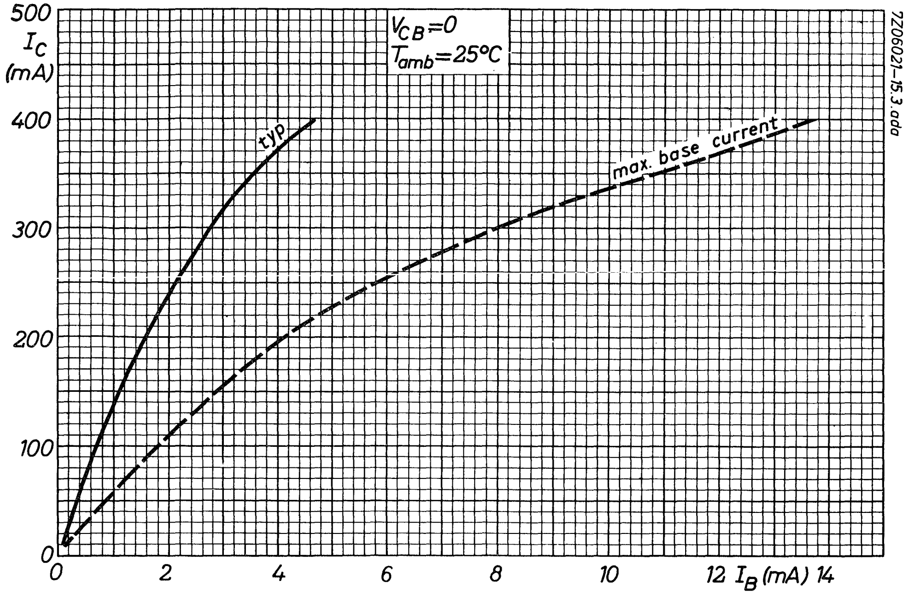
Temperatures

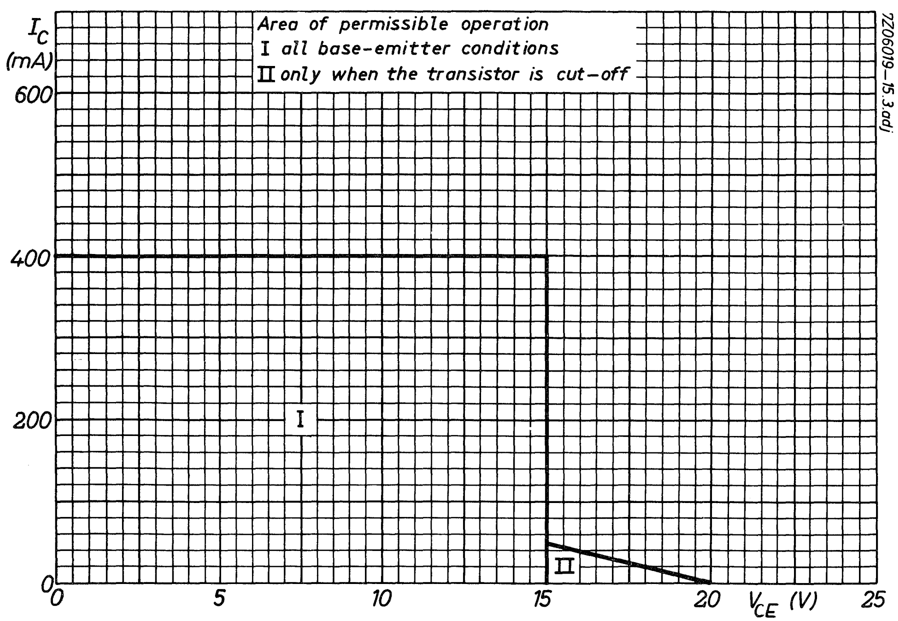
Storage temperature	T_{stg}		−55 to −175	°C
Junction temperature	T_j	max.	75	°C

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

Collector cut-off current				
$I_E = 0$; $V_{CB} = 5$ V	I_{CBO}	typ.	0.3	μA
		<	3	μA
$I_E = 0$; $V_{CB} = 5$ V; $T_j = 60$ °C	I_{CBO}	typ.	6	μA
		<	35	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	μA
		<	3	μA
$I_C = 0$; $V_{EB} = 5$ V; $T_j = 60$ °C	I_{EBO}	typ.	6	μA
		<	35	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}	<	175	mV
	V_{BEsat}	<	250	mV
$I_C = 50$ mA; $I_B = 0.75$ mA	V_{CEsat}	<	220	mV
	V_{BEsat}	<	340	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	MHz
		<	9	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

7Z3 0743


500
I_C
(mA)
400
300
200
100
0
0
2
4
6
8
10
12
I_B (mA)
14
$V_{CB}=0$
$T_{amb}=25°C$
typ
max. base current
7Z06021-15.3.ada


I_C
(mA)
600
400
200
0
0
5
10
15
20
V_{CE} (V)
25
Area of permissible operation
I all base-emitter conditions
II only when the transistor is cut-off
I
II
7Z06019-15.3.adj

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]

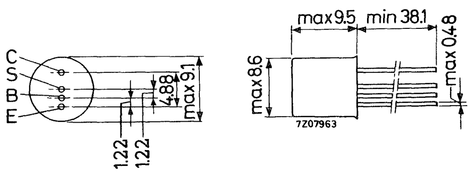
Collector-base voltage (open emitter)	$-V_{CBO}$	max.	20	V
Collector current (d.c. and average)	$-I_C$	max.	10	mA
Total dissipation up to T_{amb} = 45 °C	P_{tot}	max.	50	mW
Junction temperature: continuous	T_j	max.	75	°C
incidentally	T_j	max.	90	°C

CHARACTERISTICS

Transition frequency

$-I_C$ = 1 mA; $-V_{CE}$ = 6 V	f_T	typ.	70	MHz

MECHANICAL DATA Dimensions in mm



TO-7
Shield connected to case

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

7Z3 0171

GERMANIUM POWER TRANSISTOR

P-N-P alloy transistor in a metal envelope with the collector connected to the mounting base. Except for the metrical thread the outline conforms to TO-36.

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

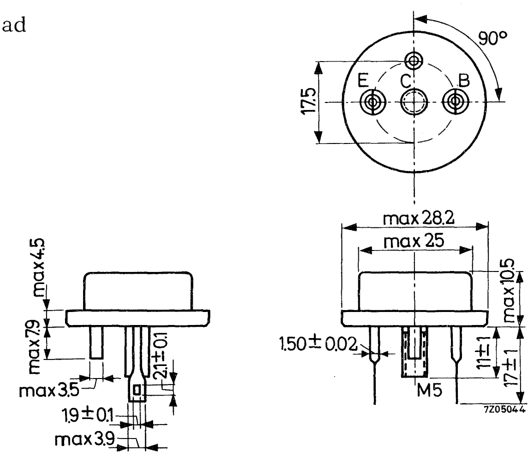
MECHANICAL DATA

Dimensions in mm

Except for the metrical thread conforming to TO-36

Collector connected to mounting base

Supplied with device:
Mica washer
Insulating ring
Cable lug
Lock washer
Hexagon nut



7Z3 1052

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	$R_{th\ j-mb}$	=	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.

7Z3 1053

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

7Z3 1054

GERMANIUM POWER TRANSISTOR

P-N-P alloy transistor in a metal envelope with the collector connected to the mounting base. Except for the metrical thread the outline conforms to TO-36.

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

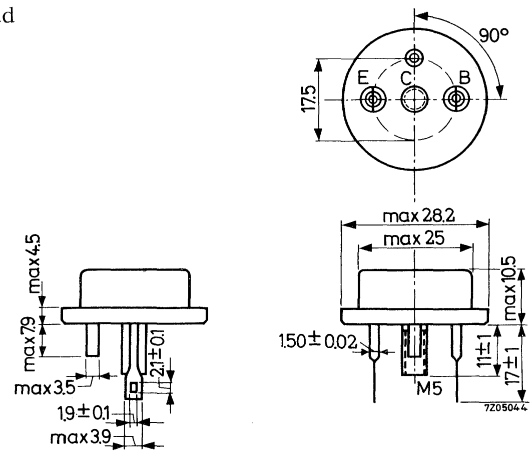
MECHANICAL DATA

Dimensions in mm

Except for the metrical thread conforming to TO-36.

Collector connected to mounting base

Supplied with device:
Mica washer
Insulating ring
Cable lug
Lock washer
Hexagon nut



7Z3 1068

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	$R_{th\ j-mb}$	=	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.

7Z3 1069

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

7Z3 1070

GERMANIUM POWER TRANSISTOR

P-N-P alloy transistor in a metal envelope with the collector connected to the mounting base. Except for the metrical thread the outline conforms to TO-36.

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

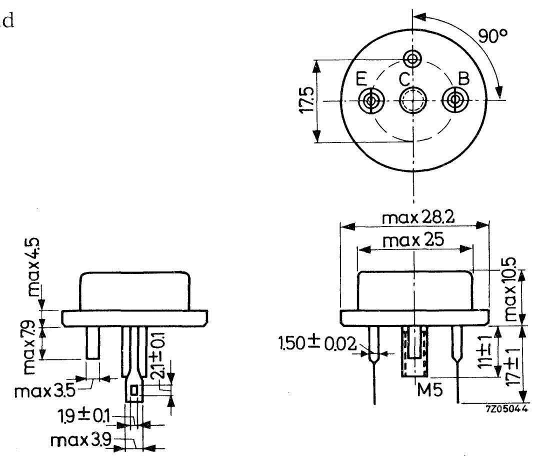
MECHANICAL DATA

Dimensions in mm

Except for the metrical thread conforming to TO-36

Collector connected to mounting base

Supplied with device:
Mica washer
Insulating ring
Cable lug
Lock washer
Hexagon nut



7Z3 1072

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.

7Z3 1073

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				
$I_C = 0$; $+V_{BE} = 6$ V; $R_{BE} = 10\ \Omega$	t_f	typ.	15	μs

7Z3 1074

GERMANIUM POWER TRANSISTOR

P-N-P alloy transistor in a metal envelope with the collector connected to the mounting base. Except for the metrical thread the outline conforms to TO-36.

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

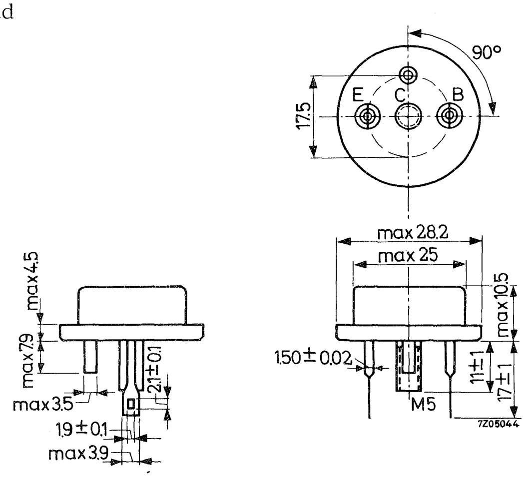
MECHANICAL DATA

Dimensions in mm

Except for the metrical thread conforming to TO-36

Collector connected to mounting base

Supplied with device:
Mica washer
Insulating ring
Cable lug
Lock washer
Hexagon nut



7Z3 1076

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 °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.

7Z3 1077

CHARACTERISTICS T_j = 25 °C unless otherwise specified

Conditions	Symbol		Value	Unit
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

7Z3 1078

GERMANIUM ALLOYED TRANSISTORS

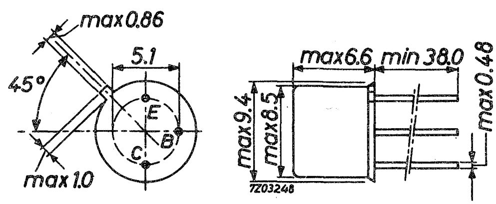
N-P-N transistors in a TO-5 metal envelope with the base connected to the case. These general purpose transistors are primarily intended for medium current medium speed computer logic applications.

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 °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.	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



7Z3 0039

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.

7Z3 0040

CHARACTERISTICS

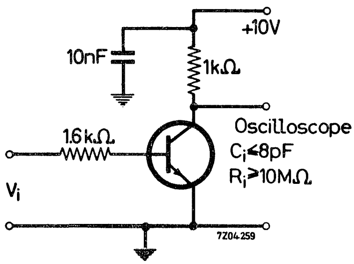
T_j = 25 °C unless otherwise specified

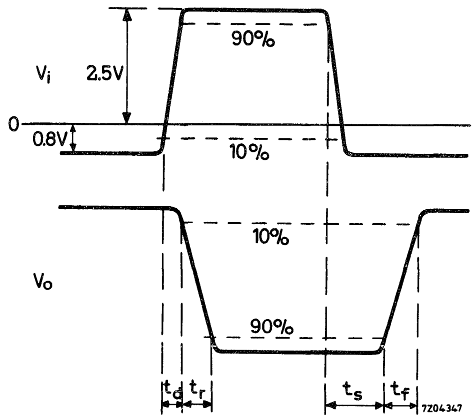
			2N1302	1304	1306	1308	
Collector cut-off current							
$I_E = 0$; $V_{CB} = 25$ V	I_{CBO}	typ.	3	3	3	3	μA
		<	6	6	6	6	μA
Emitter cut-off current							
$I_C = 0$; $V_{EB} = 25$ V	I_{EBO}	typ.	2.2	2.2	2.2	2.2	μA
		<	6	6	6	6	μA
Collector current at reverse biased emitter junction							
$-V_{BE} = 0.2$ 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

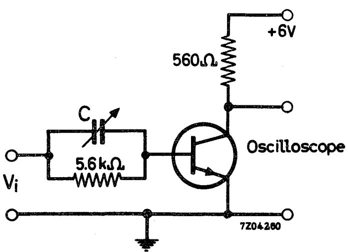
7Z3 0041

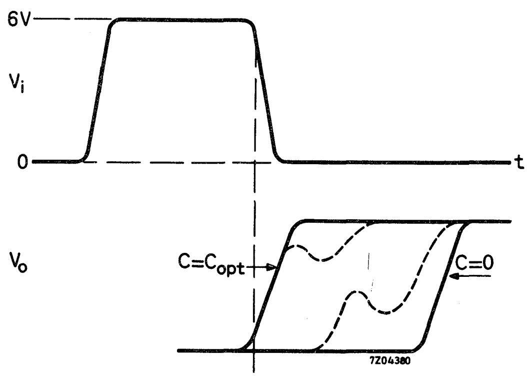
CHARACTERISTICS (continued) T_j = 25 °C unless otherwise specified

			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



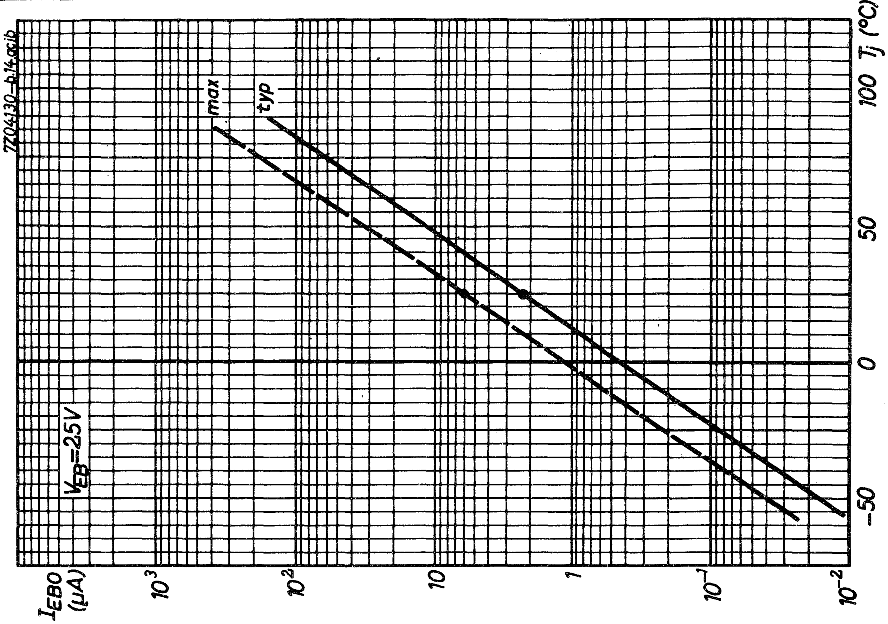


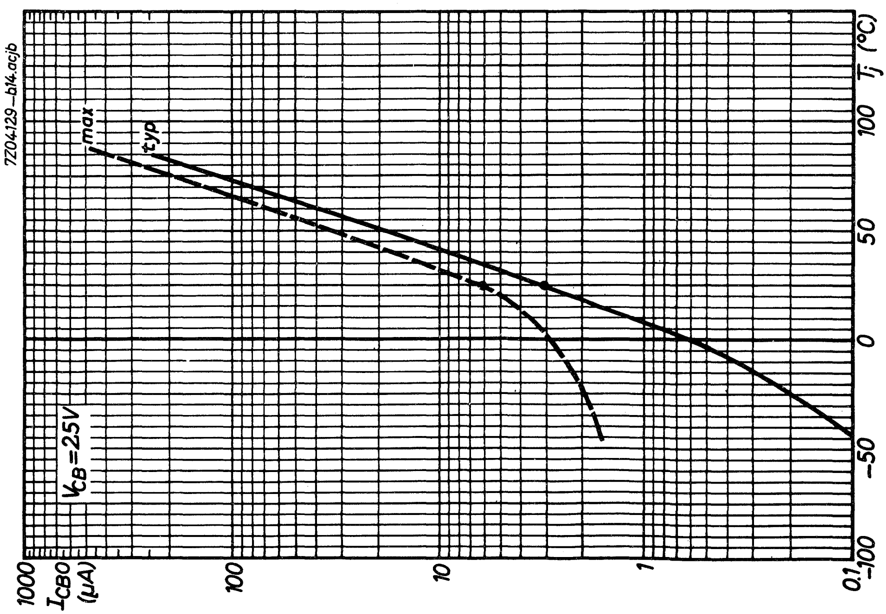


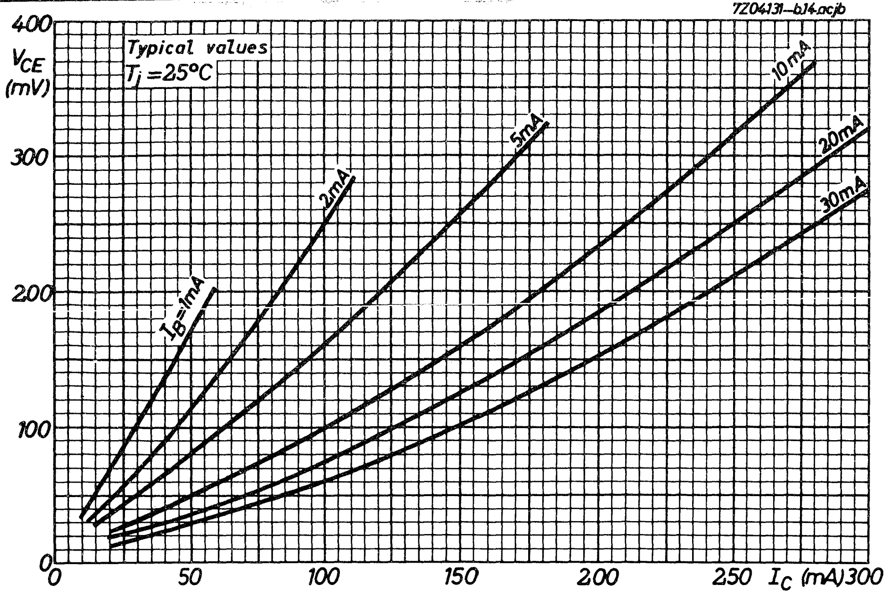


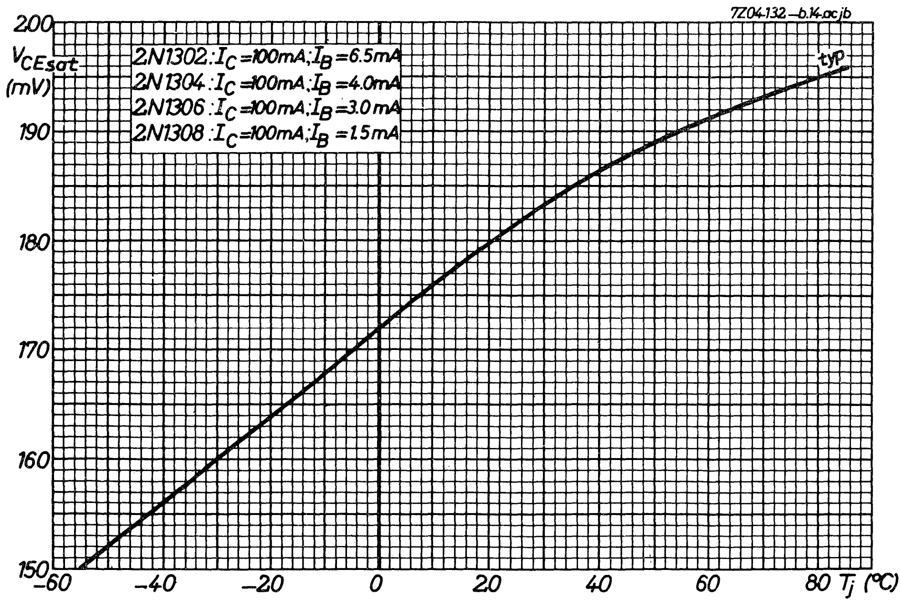
Adjust C from zero to C_{opt}
$Q_s = C_{opt} \cdot V_i$

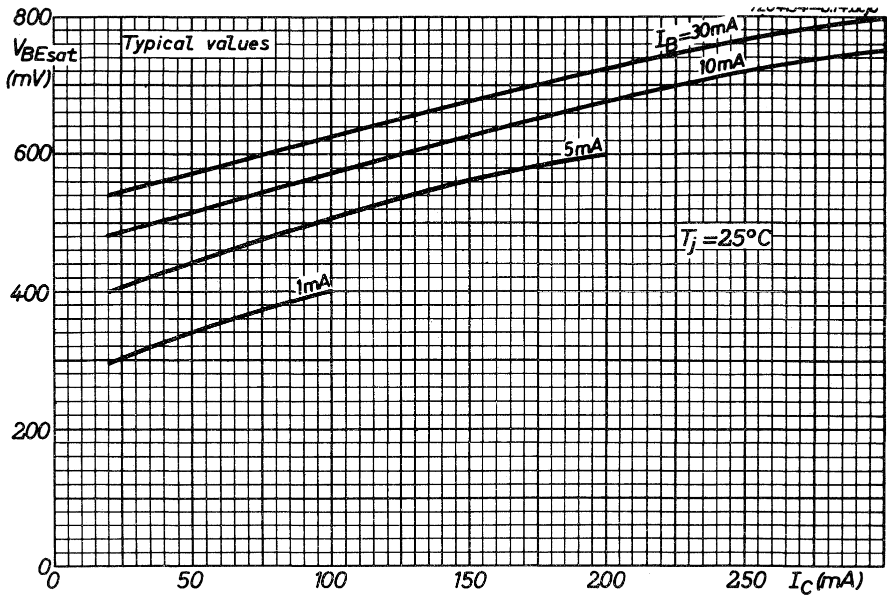
7Z3 0042

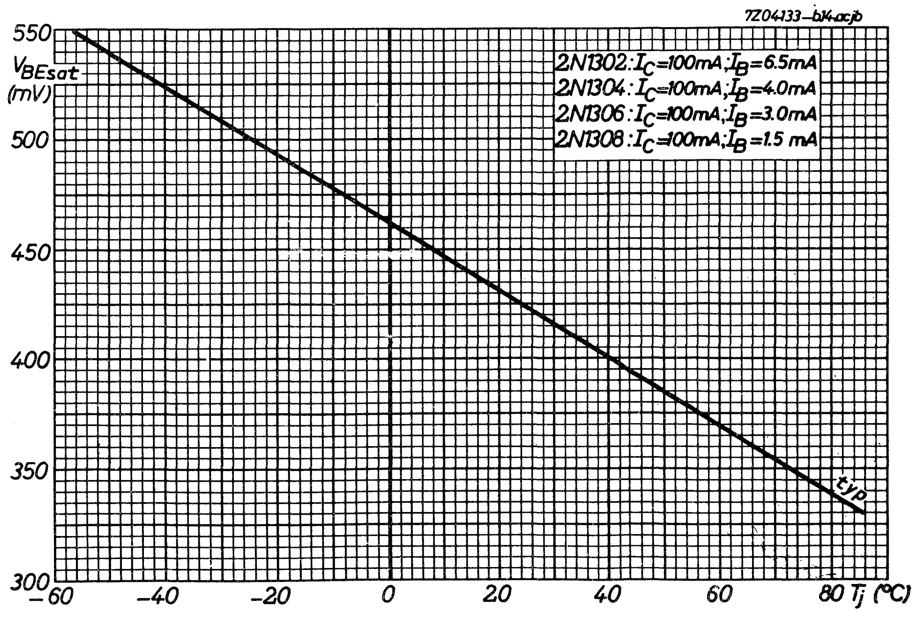

7Z04130–b14.acjb
I_{EBO} (µA)
V_{EB}=25V
max
typ
T_j (°C)
100
50
0
−50
10^3
10^2
10
1
10^{-1}
10^{-2}

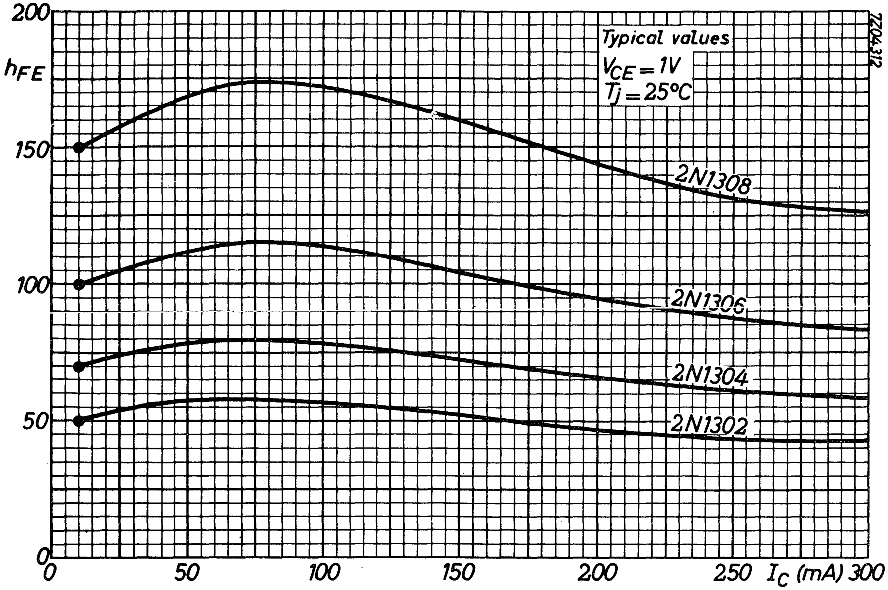

7Z04129–b14.acjb
I_{CBO} (µA)
V_{CB}=25V
max
typ
T_j (°C)
100
50
0
−50
−100
1000
100
10
1
0.1

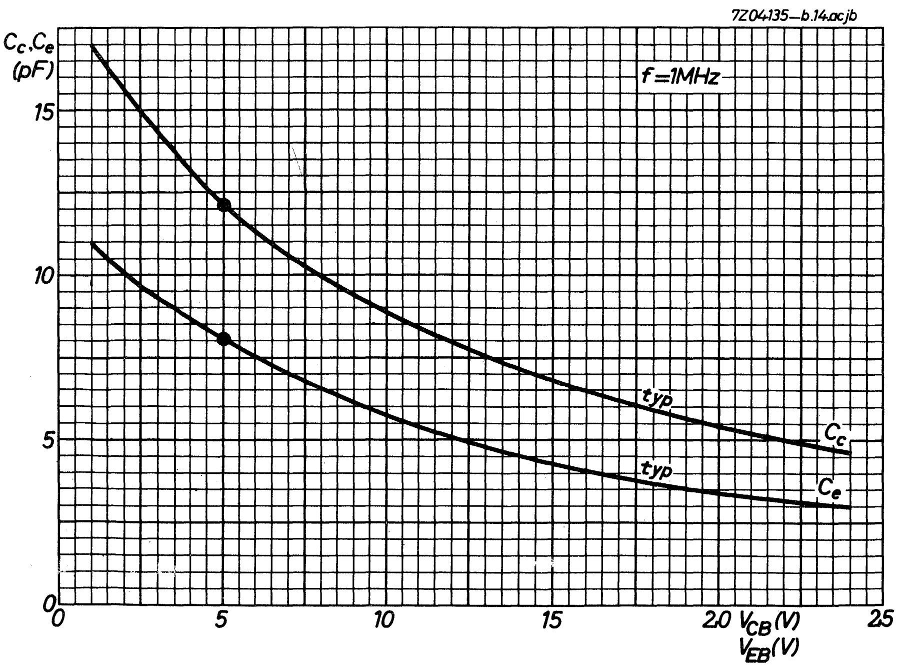

7Z04131—b14.acjb
Typical values
T_j = 25°C
V_{CE} (mV)
I_B = 1mA
2mA
5mA
10 mA
20mA
30mA
I_C (mA)
0
50
100
150
200
250
300
400

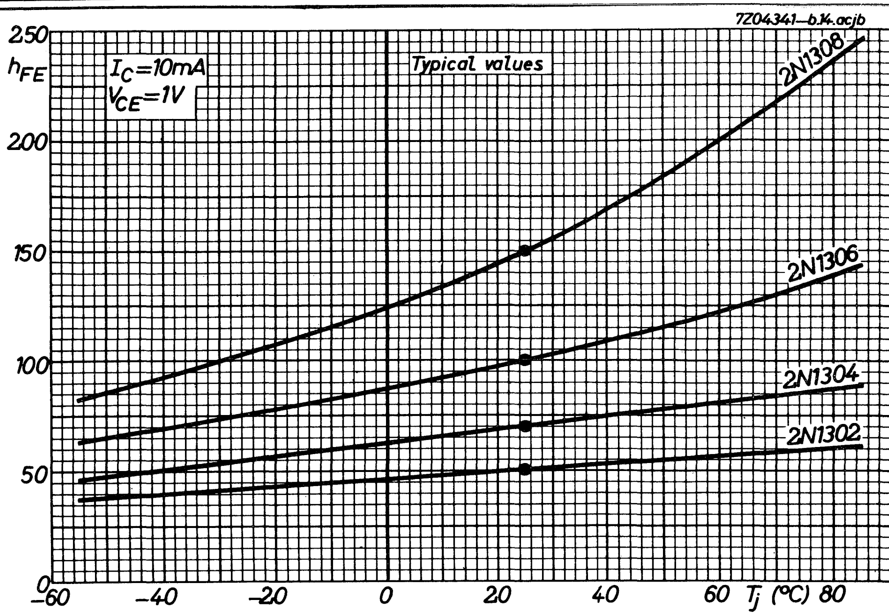

7Z04132—b14.acjb
V_{CEsat} (mV)
2N1302: I_C = 100mA; I_B = 6.5mA
2N1304: I_C = 100mA; I_B = 4.0mA
2N1306: I_C = 100mA; I_B = 3.0mA
2N1308: I_C = 100mA; I_B = 1.5mA
typ
T_j (°C)
150
160
170
180
190
200
−60
−40
−20
0
20
40
60
80

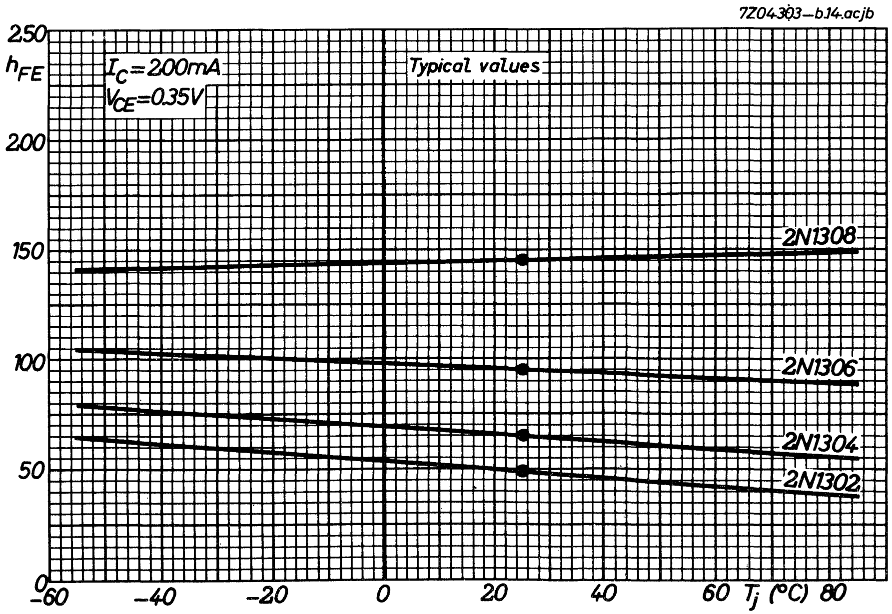

7Z04134—b14.acjb
Typical values
VBEsat (mV)
800
600
400
200
0
IB=30mA
10mA
5mA
1mA
Tj=25°C
0
50
100
150
200
250
IC (mA)


7Z04133—b14.acjb
VBEsat (mV)
550
500
450
400
350
300
2N1302: IC=100mA; IB=6.5mA
2N1304: IC=100mA; IB=4.0mA
2N1306: IC=100mA; IB=3.0mA
2N1308: IC=100mA; IB=1.5 mA
typ
−60
−40
−20
0
20
40
60
80
Tj (°C)


7Z04312
Typical values
$V_{CE} = 1V$
$T_j = 25°C$
h_{FE}
200
150
100
50
0
2N1308
2N1306
2N1304
2N1302
0
50
100
150
200
250
I_C (mA) 300


7Z04135—b.14.acjb
C_c, C_e (pF)
f = 1MHz
15
10
5
0
typ
typ
C_c
C_e
0
5
10
15
20
V_{CB}(V)
V_{EB}(V)
25


7Z04341–b.14.acjb
250
h_{FE}
I_C=10mA
V_{CE}=1V
Typical values
2N1308
200
150
2N1306
100
2N1304
2N1302
50
0
–60
–40
–20
0
20
40
60
T_j (°C)
80


7Z04303–b.14.acjb
250
h_{FE}
I_C=200mA
V_{CE}=0.35V
Typical values
200
2N1308
150
100
2N1306
2N1304
50
2N1302
0
–60
–40
–20
0
20
40
60
T_j (°C)
80

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

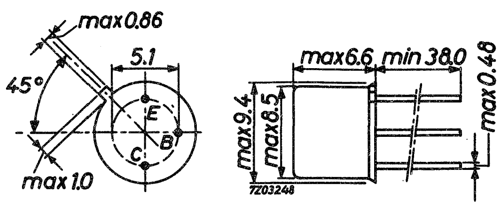
			2N1303	1305	1307	1309	
Collector-base voltage (open emitter)	$-V_{CBO}$	max.	30	30	30	30	V
Collector-emitter voltage (open base)	$-V_{CEO}$	max.	25	20	15	15	V
Collector current (peak value)	$-I_{CM}$	max.	300	300	300	300	mA
Total power dissipation up to $T_{amb} = 25\ ^{o}C$	P_{tot}	max.	150	150	150	150	mW
Junction temperature	T_j	max.	85	85	85	85	^{o}C
D.C. current gain at $T_j = 25^{o}C$ $-I_C = 10$ 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



7Z3 0043

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	$R_{th\ j-a}$	=	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.

7Z3 0044

CHARACTERISTICS

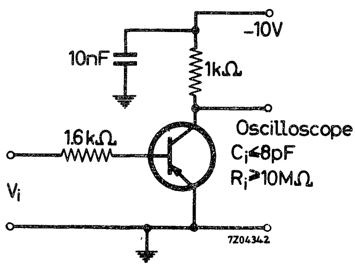
T_j = 25 °C unless otherwise specified

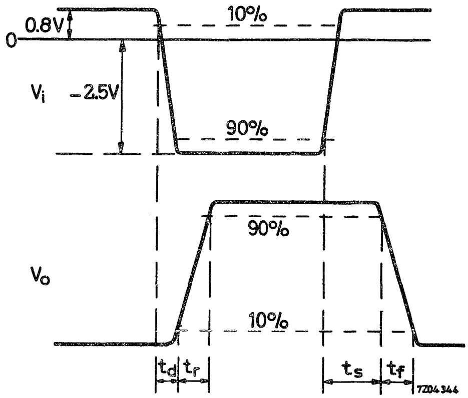
			2N1303	1305	1307	1309	
Collector cut-off current I_E = 0; $-V_{CB}$ = 25 V	$-I_{CBO}$	typ.	3	3	3	3	μA
		<	6	6	6	6	μA
Emitter cut-off current I_C = 0; $-V_{EB}$ = 25 V	$-I_{EBO}$	typ.	1.7	1.7	1.7	1.7	μA
		<	6	6	6	6	μA
Collector current at reverse biased emitter junction $-V_{CE}$ = 15 V; $+V_{BE}$ = 0.2 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

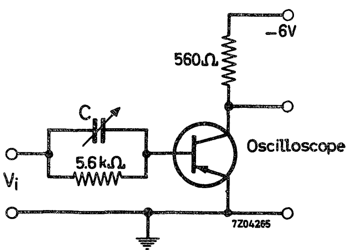
7Z3 0045

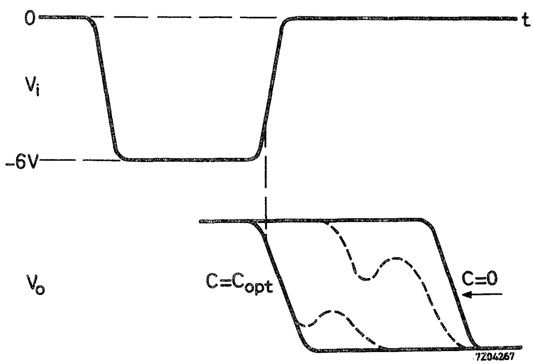
CHARACTERISTICS (continued) $T_j = 25\ ^oC$ unless otherwise specified

			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



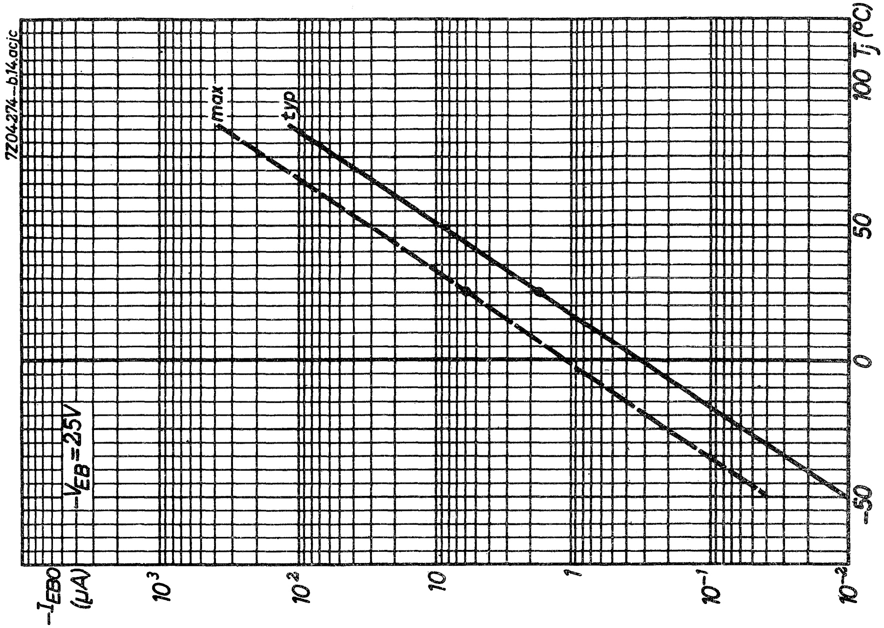


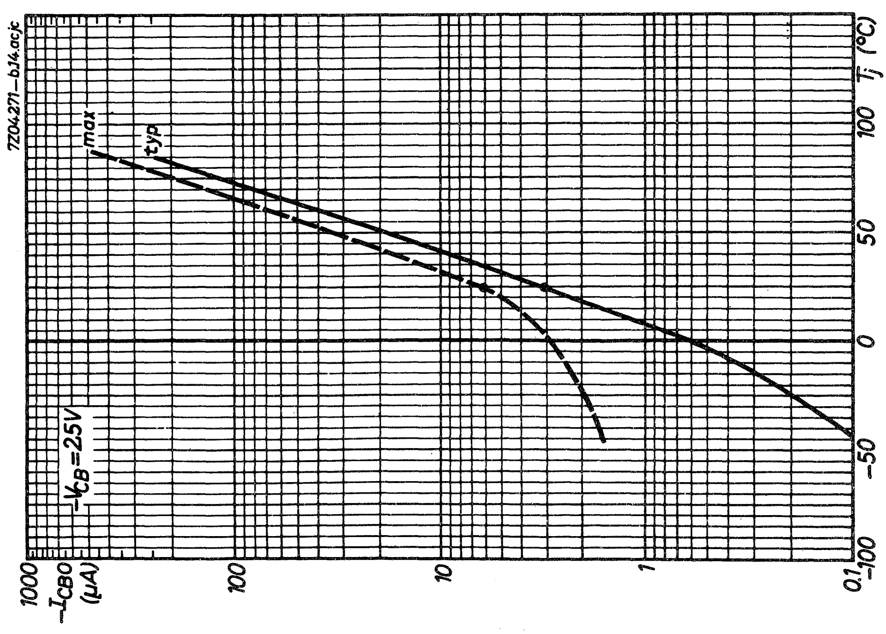


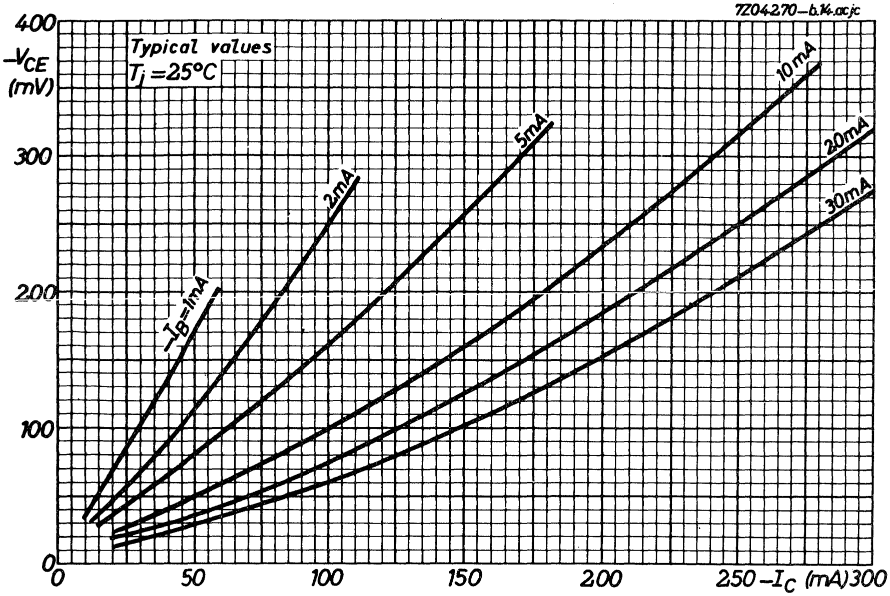


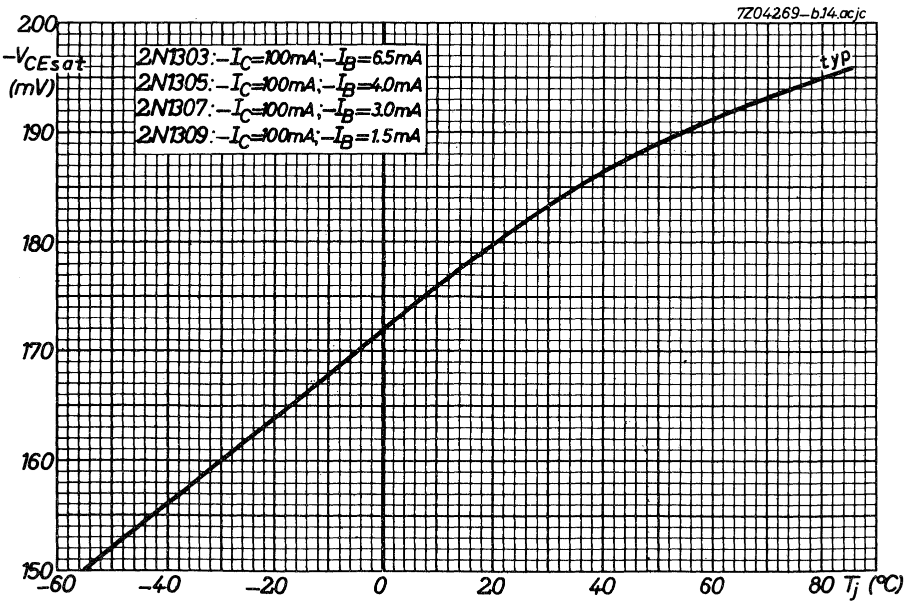
Adjust C from zero to C_{opt}
$Q_s = C_{opt} \cdot V_i$

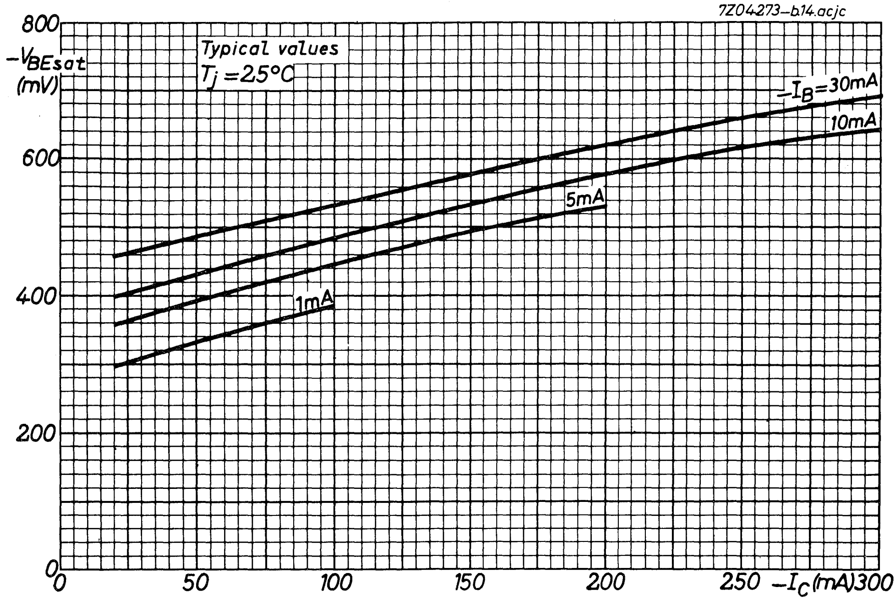
7Z3 0046

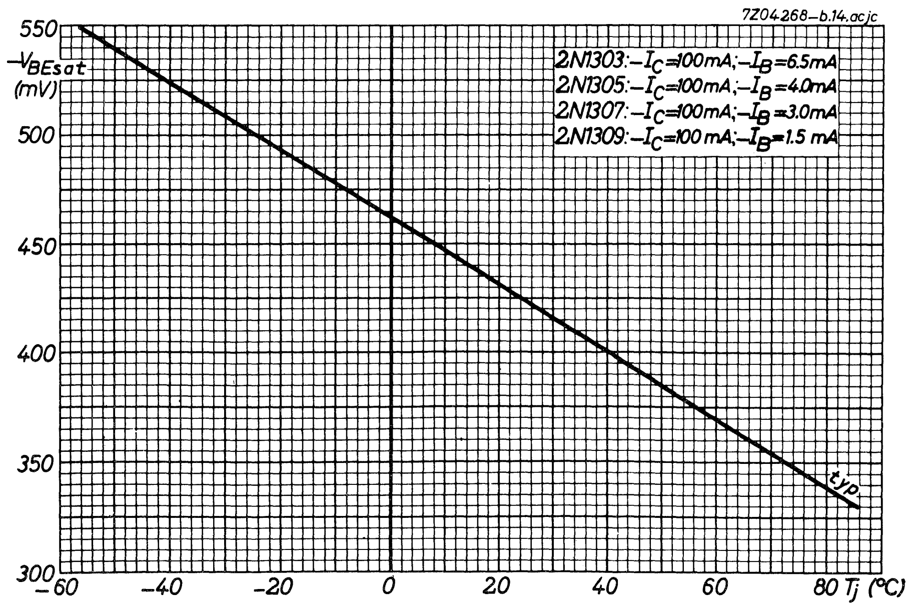

7Z04274—b14.acjc
max
typ
−V_EB = 25V
−I_EBO (μA)
10^3
10^2
10
1
10^-1
10^-2
T_j (°C)
100
50
0
−50

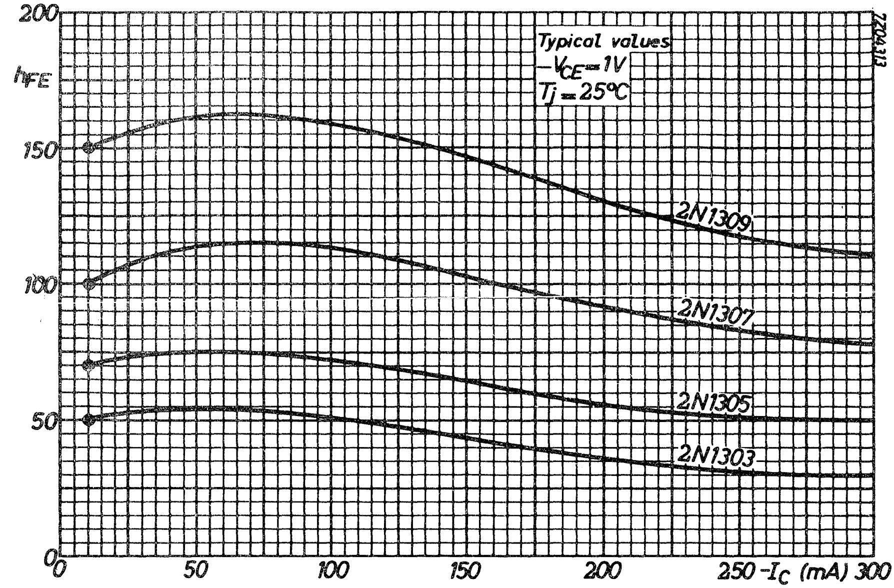

7Z04271—b14.acjc
max
typ
−V_CB = 25V
1000
−I_CBO (μA)
100
10
1
0.1
T_j (°C)
100
50
0
−50
−100

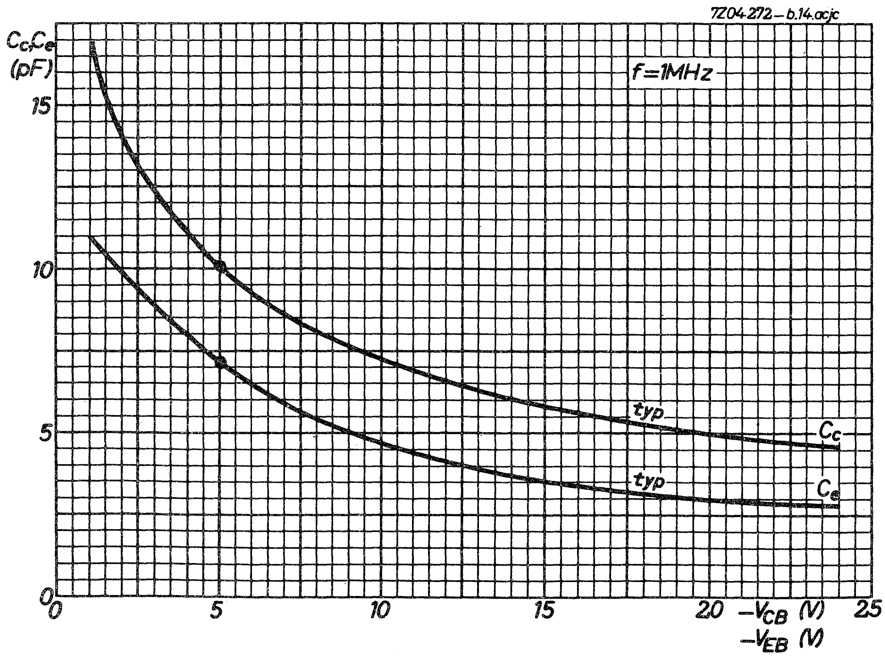

7Z04270–b.14.acjc
Typical values
$T_j = 25°C$
$-V_{CE}$ (mV)
$-I_B$=1mA
2mA
5mA
10 mA
20mA
30mA
$-I_C$ (mA)
0
50
100
150
200
250
300
400
300
200
100
0

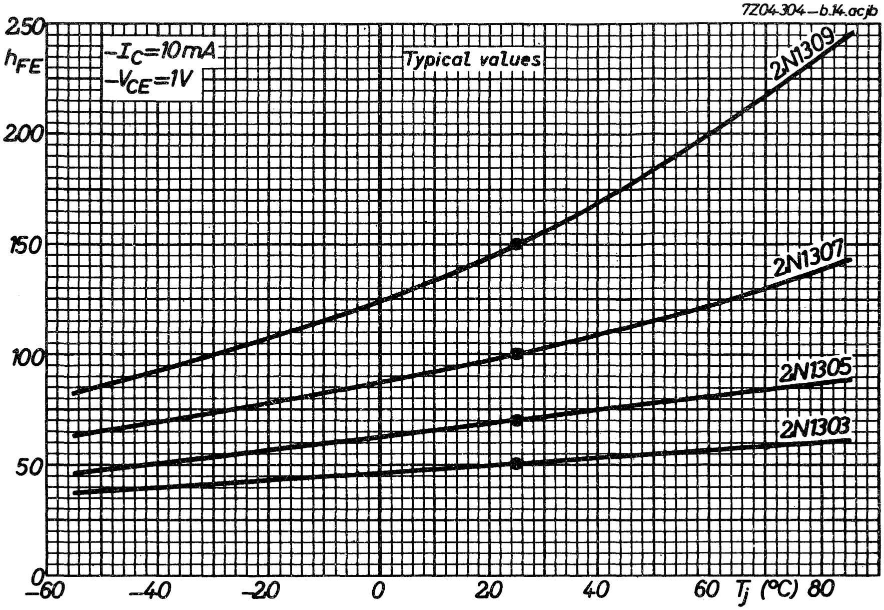

7Z04269–b.14.acjc
$-V_{CEsat}$ (mV)
2N1303: $-I_C$=100mA; $-I_B$=6.5mA
2N1305: $-I_C$=100mA; $-I_B$=4.0mA
2N1307: $-I_C$=100mA; $-I_B$=3.0mA
2N1309: $-I_C$=100mA; $-I_B$=1.5mA
typ
T_j (°C)
200
190
180
170
160
150
−60
−40
−20
0
20
40
60
80

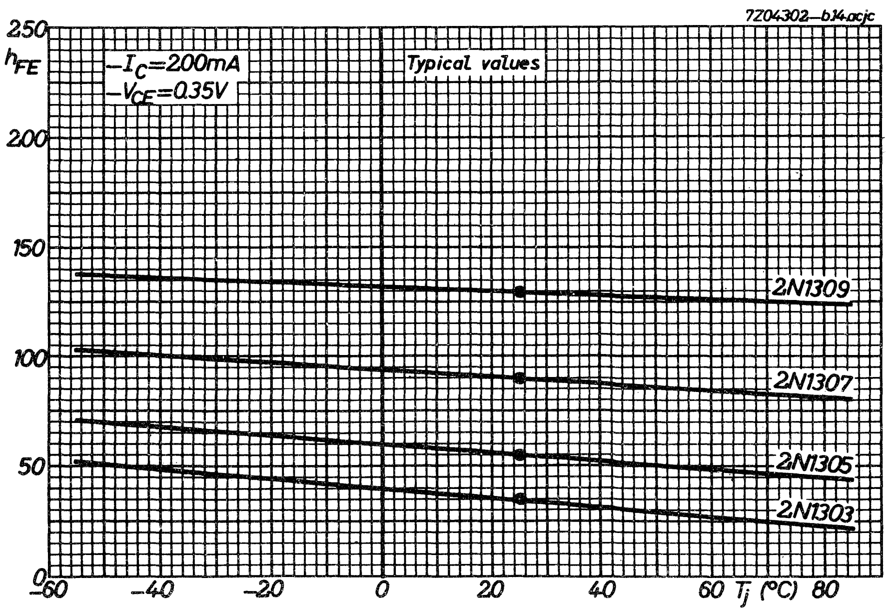

7Z04273–b.14.acjc
Typical values
Tj = 25°C
−VBEsat (mV)
800
600
400
200
0
−IB=30mA
10mA
5mA
1mA
0
50
100
150
200
250
−IC (mA)
300


7Z04268–b.14.acjc
−VBEsat (mV)
550
500
450
400
350
300
2N1303: −IC=100mA; −IB=6.5mA
2N1305: −IC=100mA; −IB=4.0mA
2N1307: −IC=100mA; −IB=3.0mA
2N1309: −IC=100 mA; −IB=1.5 mA
typ.
−60
−40
−20
0
20
40
60
80
Tj (°C)


Typical values
$-V_{CE} = 1V$
$T_j = 25°C$
h_{FE}
2N1309
2N1307
2N1305
2N1303
$-I_C$ (mA)
7Z04313


7Z04272 - b.14.acjc
C_c, C_e (pF)
f=1MHz
typ
typ
C_c
C_e
$-V_{CB}$ (V)
$-V_{EB}$ (V)


7Z04304–b.14.acjb
$-I_C$=10mA
$-V_{CE}$=1V
Typical values
h_{FE}
2N1309
2N1307
2N1305
2N1303
250
200
150
100
50
0
–60
–40
–20
0
20
40
60
T_j (°C)
80


7Z04302–b14.acjc
$-I_C$=200mA
$-V_{CE}$=0.35V
Typical values
h_{FE}
2N1309
2N1307
2N1305
2N1303
250
200
150
100
50
0
–60
–40
–20
0
20
40
60
T_j (°C)
80

AUDIO FREQUENCY PACKAGE

The package 40809 consists of 4 transistors, namely an AC127, an AC128 and a matched pair AC127/AC128, 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.

FOR THE DATA OF THE INDIVIDUAL TRANSISTORS PLEASE REFER TO THE DATA SHEETS OF THE AC127 AND THE AC128

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

1) Spread of input sensitivity < 3 dB

7Z3 0444

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

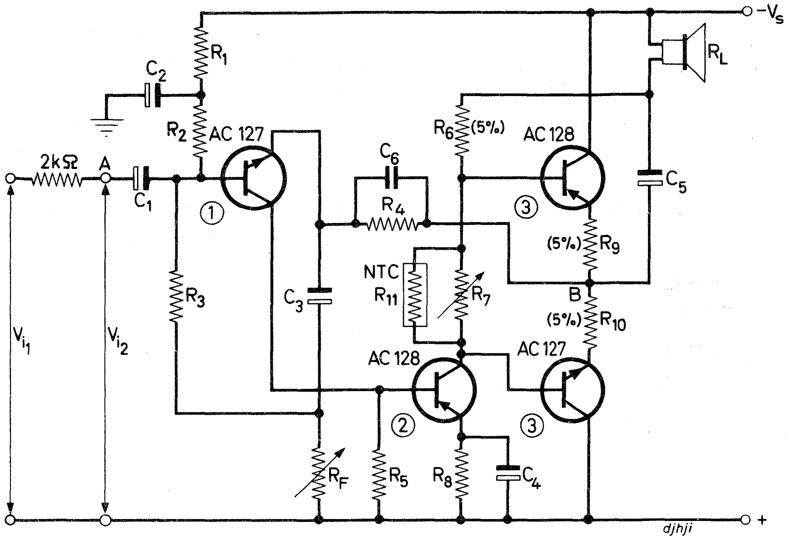
Stable continuous operation is ensured up to T_{amb} = 45 °C, provided the output transistors are mounted as indicated in the following table

	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 cm²

[1]) To be adjusted with R_7

7Z3 0445

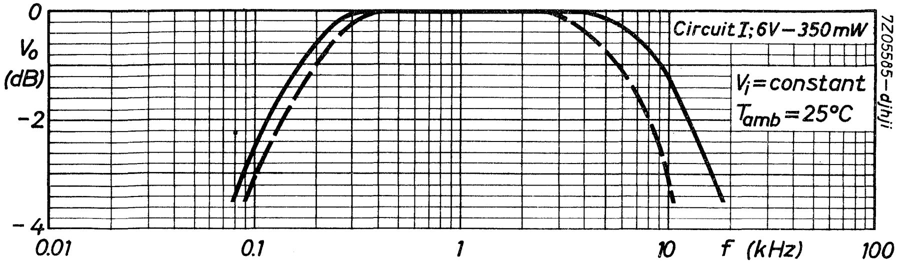


List of components

	Circuit	I	II	III	IV	
	R_1	1.2	2.7	6.8	2.2	kΩ
	R_2	22	18	33	18	kΩ
	R_3	15	15	22	15	kΩ
	R_4	2.2	2.2	3.3	2.2	kΩ
	R_5	1.5	2.2	1.8	1.5	kΩ
	R_6 (5%)	560	270	750	510	Ω
	R_7	100	75	75	100	Ω
	R_8	68	75	100	39	Ω
	$R_9 = R_{10}$ (5%)	1.5	0	2.4	0	Ω
	R_{11} (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
	C_1	6.4	6.4	6.4	6.4	μF
	C_2	100	100	100	100	μF
	C_3	320	125	320	400	μF
	C_4	200	160	125	200	μF
	C_5	400	1000	320	400	μF
	C_6	-	3900	–	–	pF

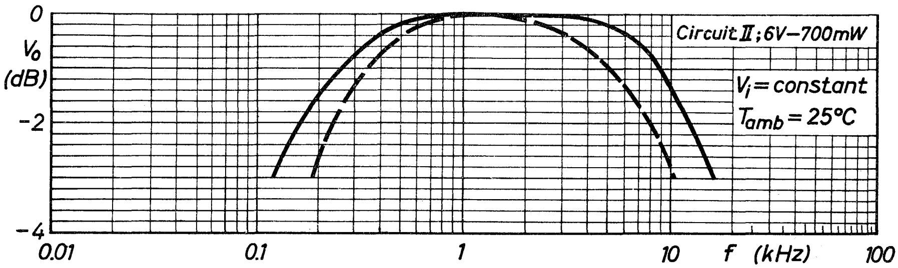
Tolerance of resistors: 10 % unless otherwise specified

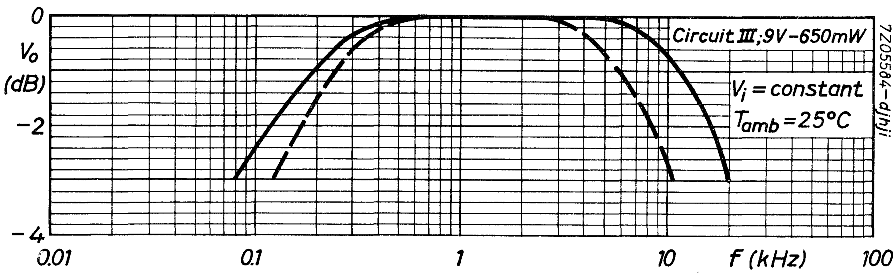
7Z3 0446



Normalised output voltage versus frequency

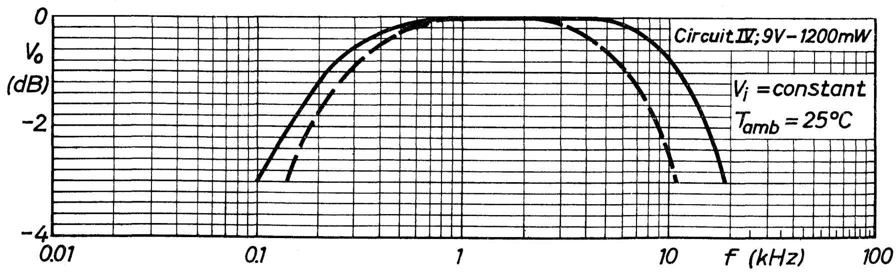
– – – without feedback
——— with feedback

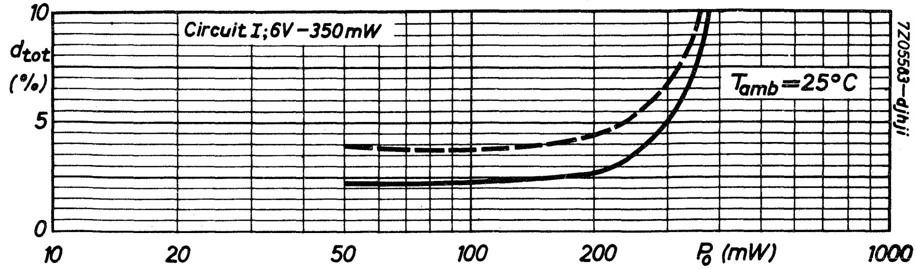




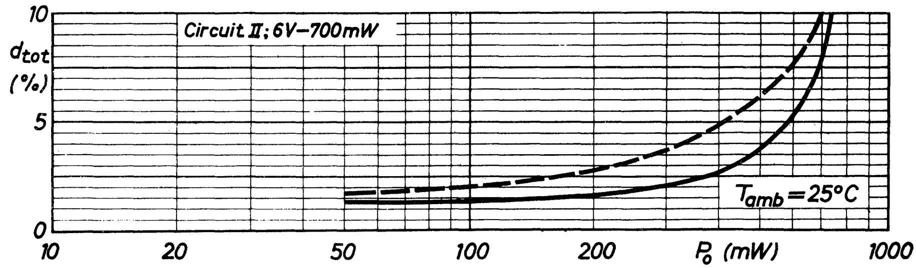
Normalised output voltage versus frequency

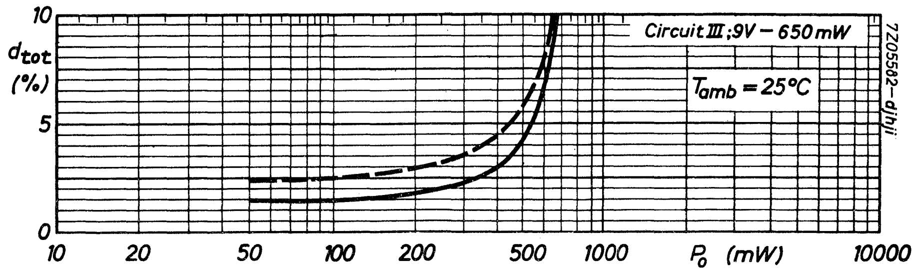
– – – without feedback
——— with feedback



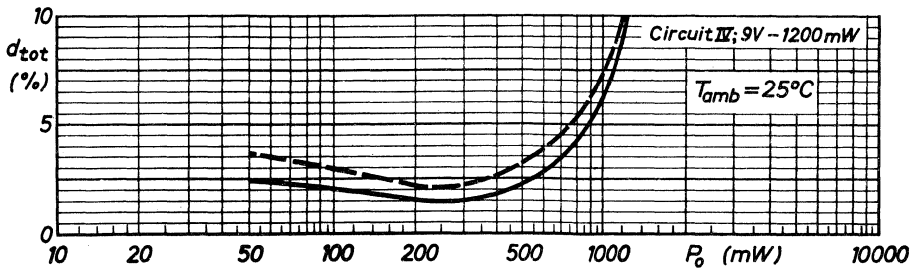


Typical values — — — without feedback
——— with feedback





Typical values — — — without feedback
——— with feedback



Photoelectric devices

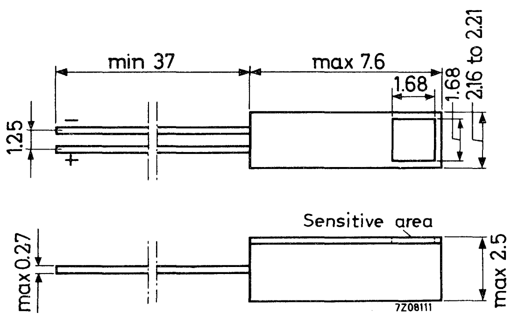
SILICON PHOTOVOLTAIC CELL

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



7Z3 1477

RATINGS (Limiting values) [1])

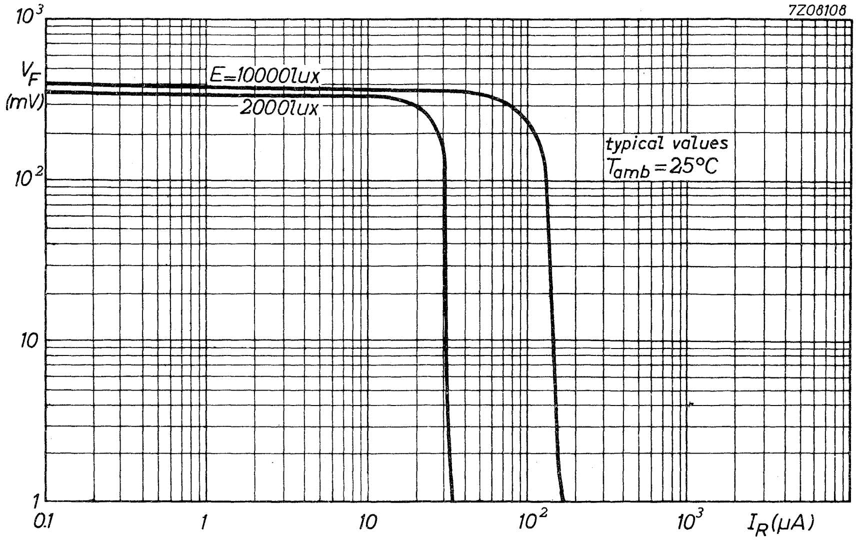
Reverse voltage	V_R	max.	1	V
Forward current	I_F	max.	10	mA
Temperatures				
Storage temperature	T_{stg}	−20 to +100		^oC
Junction temperature	T_j	max.	100	^oC

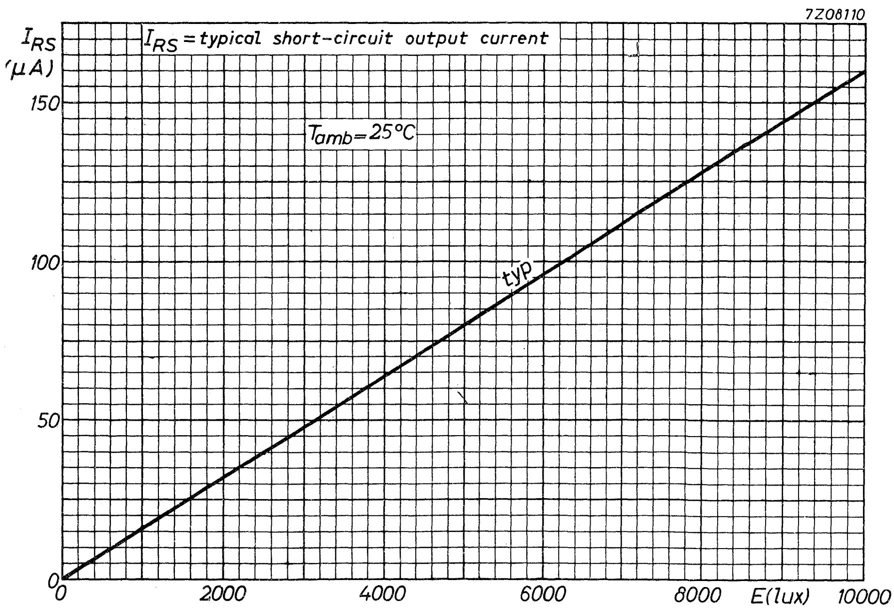
CHARACTERISTICS T_{amb} = 25 ^oC unless otherwise specified

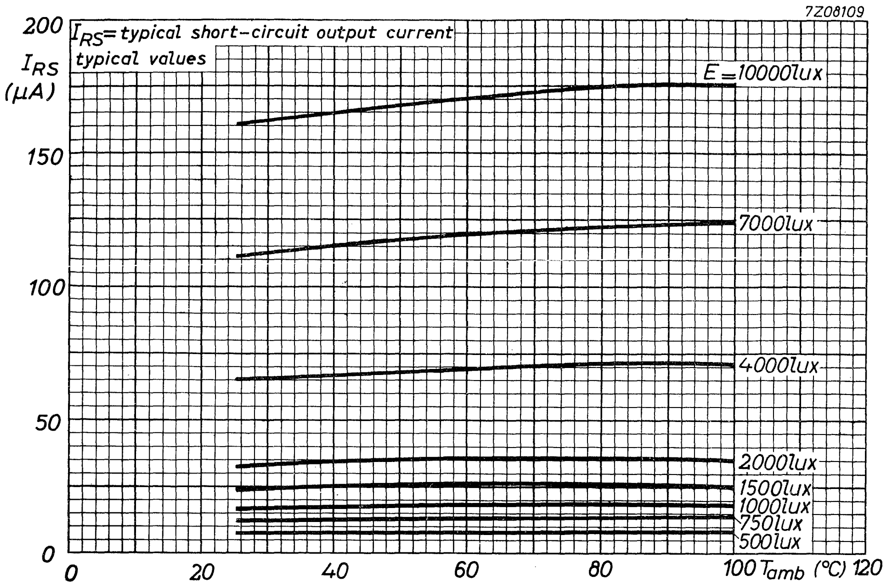
Dark reverse current				
V_R = 1 V	I_R	typ.	0.35	μA
		<	10	μA
V_R = 1 V; T_{amb} = 75 ^oC	I_R	<	30	μA
Short circuit current				
Colour temperature 2700 ^oK				
E = 2 000 lux	I_{RS}	typ.	32	μA
		15 to	50	μA
E = 10 000 lux	I_{RS}	typ.	160	μA
Peak spectral response	λ_m	typ.	0.8	μm
Sensitive area		typ.	2.8	mm^2
Diode capacitance at V = 0	C_d	<	1000	pF

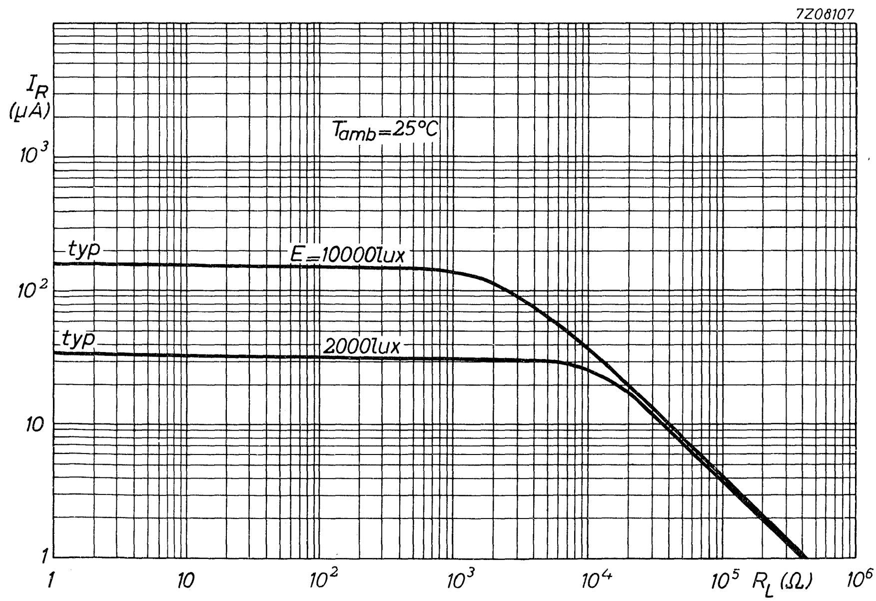
[1]) Limiting values according to the Absolute Maximum System as defined in IEC publication 134.

7Z3 1478

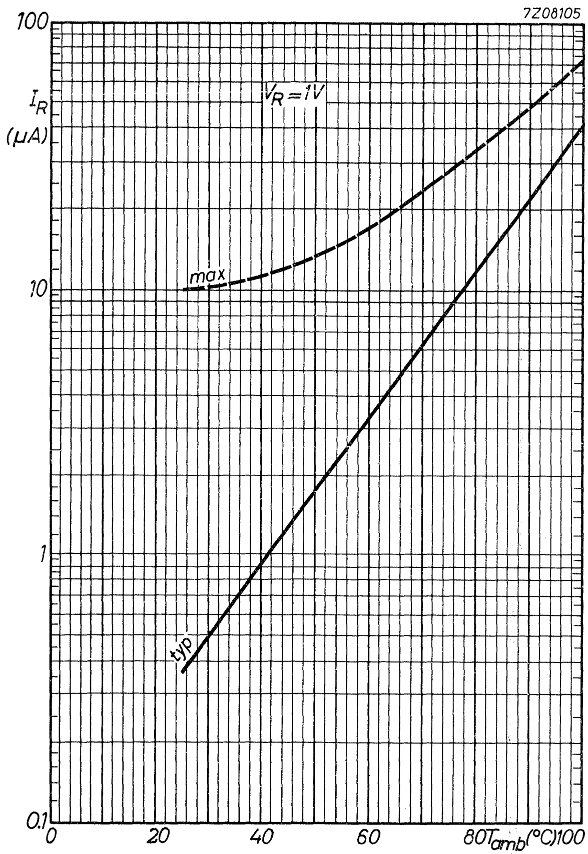

7Z08108
10^3
V_F
(mV)
10^2
10
1
0.1
1
10
10^2
10^3
I_R (μA)
E=10000lux
2000lux
typical values
T_{amb} = 25°C


7Z08110
I_{RS}
(μA)
150
100
50
0
0
2000
4000
6000
8000
E(lux)
10000
I_{RS} = typical short-circuit output current
T_{amb}=25°C
typ


7Z08109
I_{RS}= typical short-circuit output current
typical values
200
I_{RS}
(μA)
150
100
50
0
E = 10000lux
7000lux
4000lux
2000lux
1500lux
1000lux
750lux
500lux
0
20
40
60
80
100
T_{amb} (°C)
120


7Z08107
I_R
(μA)
T_{amb}=25°C
10^3
10^2
10
1
typ
E = 10000lux
typ
2000lux
1
10
10^2
10^3
10^4
10^5
R_L (Ω)
10^6


7Z08106
100
80
60
40
20
0
Relative response (%)
typ
0.6
0.8
1
λ (μm)
1.2


7Z08105
100
I_R
(μA)
$V_R = 1V$
max
10
1
typ
0.1
0
20
40
60
80
T_{amb} (°C)
100

Accessories and heatsinks

TABLE OF CONTENTS

7Z3 1273

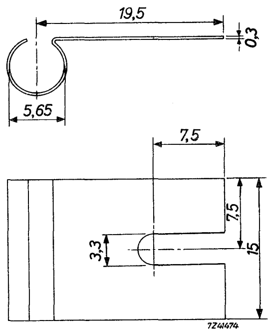
INDEX OF TYPE NUMBERS

7Z3 1274

7Z3 1275

COOLING FIN

Dimensions in mm

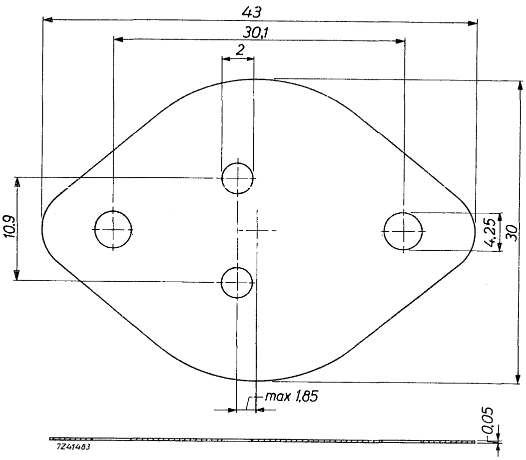


Fin material: brass, nickel plated

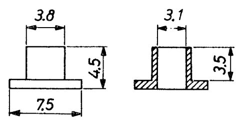
7Z3 0480

Type 56201e consists of the following components (1 to 3) Dimensions in mm

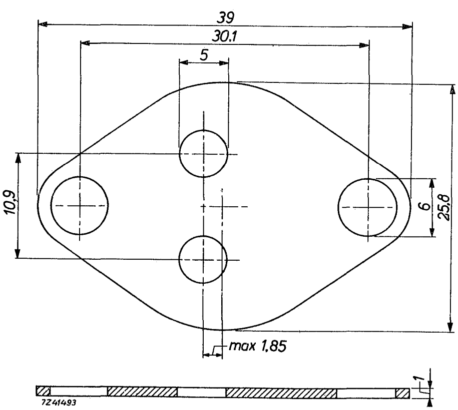
1.
1 mica washer



2. 2 insulating bushes



3.
1 lead washer

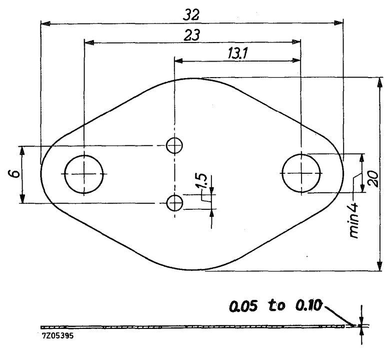


7Z3 1276

Type 56203 consists of the following components (1 to 2) Dimensions in mm

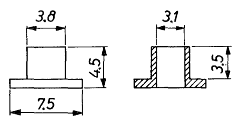
1.

1 mica washer



2

2 insulating bushes

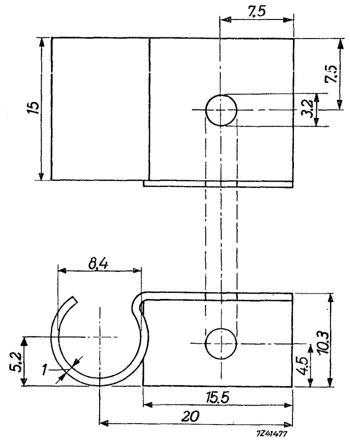


7Z3 1277

COOLING FINS

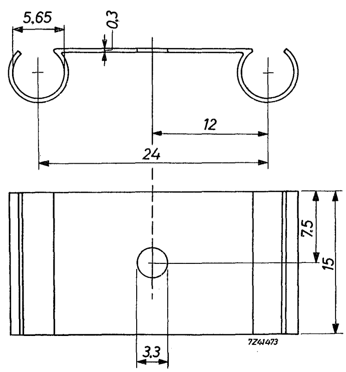
56207

Dimensions in mm



Material: aluminium, blackened

56208



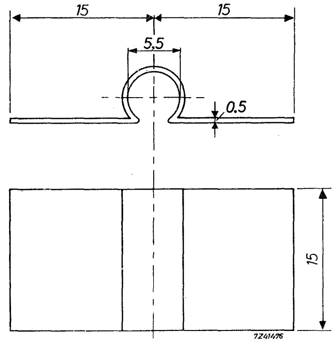
Material: brass, nickel plated

7Z3 0485

COOLING FINS

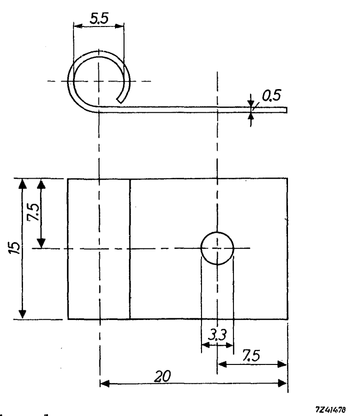
56209

Dimensions in mm



Material: brass, nickel plated

56210

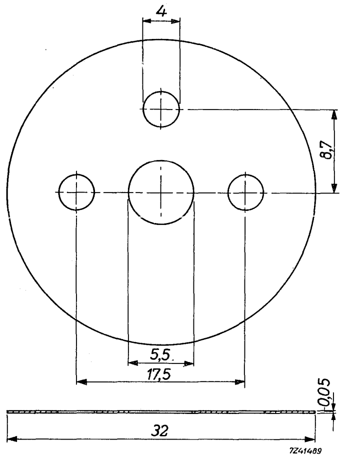


Material: brass, nickel plated

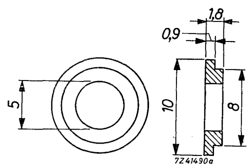
7Z3 0486

Type 56213 consists of the following components (1 to 5) Dimensions in mm

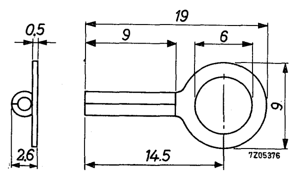
1.
1 mica washer



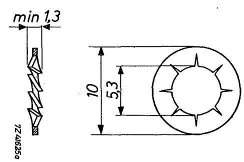
2.
1 insulating ring



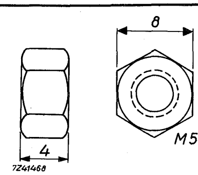
3.
1 cable lug
Material: brass, nickel plated



4.
1 lock washer, internal teeth
Material: steel, nickel plated



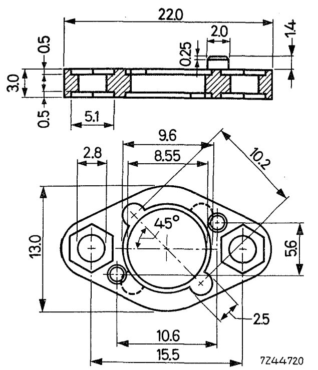
5.
1 hexagon nut
Material: brass, nickel plated



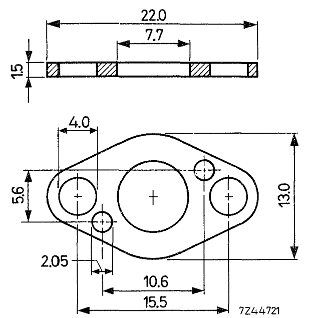
7Z3 1278

Type 56218 consists of the following components (1 to 3) Dimensions in mm

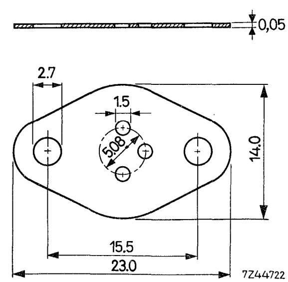
1.
1 top clamping washer of insulating material



2.
1 bottom clamping washer
Material: brass, tin plated



3.
1 mylar washer



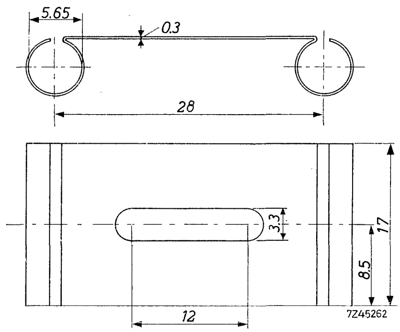
7Z3 1279

COOLING FINS

Dimensions in mm

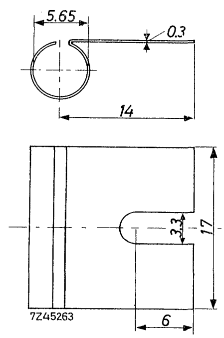
56226

Material:
brass, nickel plated



56227

Material:
brass, nickel plated

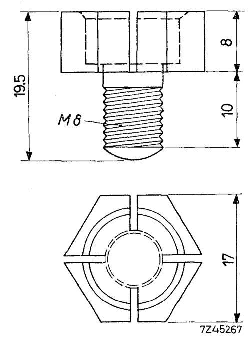


7Z3 0491

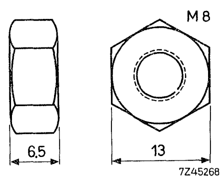
MOUNTING ADAPTOR

Type 56232 consists of the following components (1 to 3) Dimensions in mm

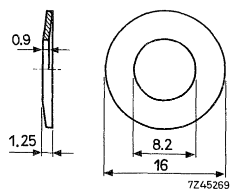
1.
1 mounting adaptor



2.
1 hexagon nut
Material: brass, nickel plated



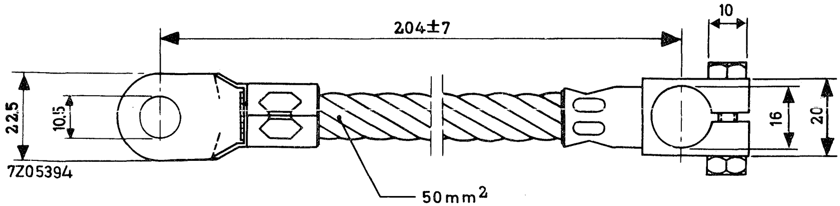
3.
1 dish spring
Material: steel



7Z3 1280

Type 56243 is a flexible top lead

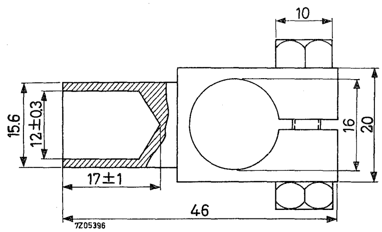
Dimensions in mm



7Z3 1281

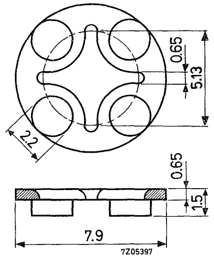
Type 56244 is a clamp

Dimensions in mm

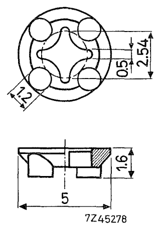


Types 56245 and 56246 are distance disks of insulating material

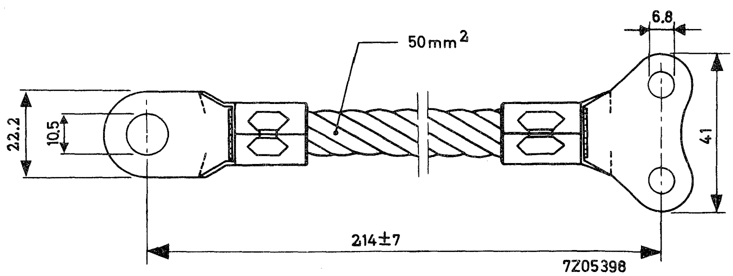
56245



56246



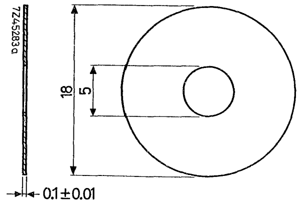
Type 56247 is a flexible base lead



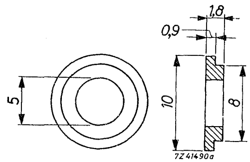
7Z3 0494

Type 56262A consists of the following components (1 to 3) Dimensions in mm

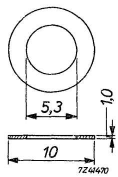
1.
1 mica washer



2.
1 insulating ring



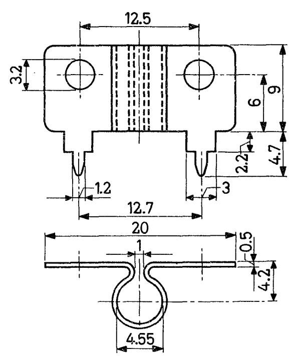
3.
1 plain washer
Material: brass, nickel plated



COOLING FIN

56263
Material: brass, tin plated

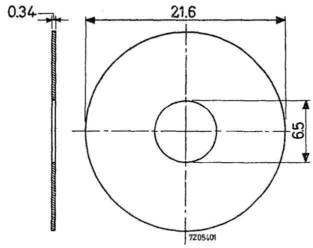
Dimensions in mm



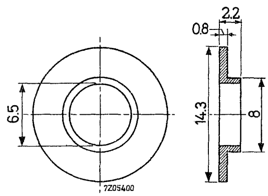
7Z3 1282

Type 56264A consists of the following components (1 to 3) Dimensions in mm

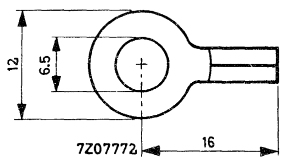
1.
1 mica washer



2.
1 insulating ring



3.
1 soldering tag

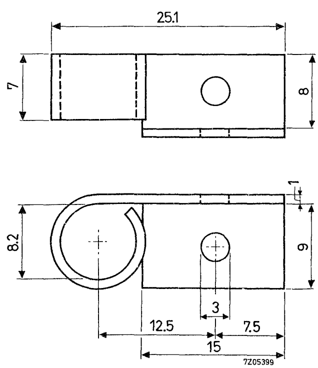


COOLING FIN

56265

Material:
aluminium, blackened

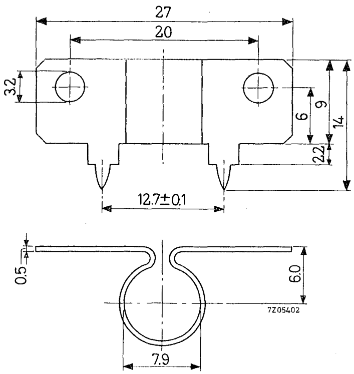
Dimensions in mm



7Z3 1283

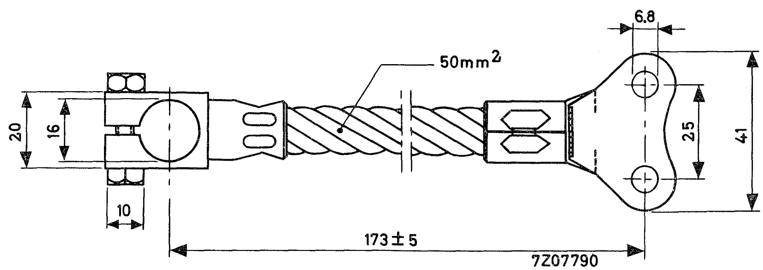
COOLING FIN

Dimensions in mm



Material: brass, tin plated

Type 56296 is a flexible lead



7Z3 1284

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:

$R_{th\ j\text{-}mb}$: The thermal resistance from junction to mounting base. Its value can be found in the data sheets of the relevant semiconductor device.

$R_{th\ mb\text{-}h}$: 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.

$R_{th\ h\text{-}a}$: The thermal resistance of the heatsink. This is the thermal resistance between the contact surface and the ambient air.

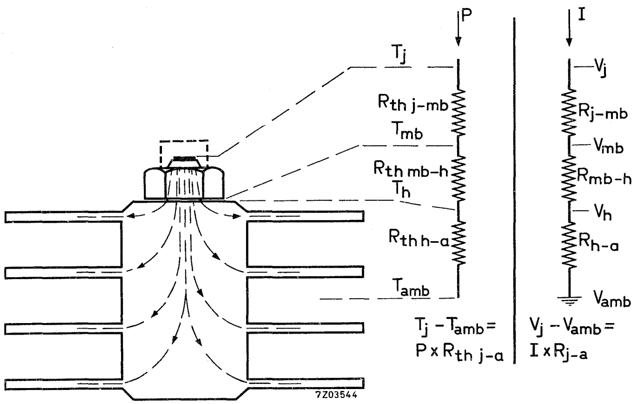
Once the heat has been transferred from heatsink to ambient, cool air must replace the heated air.

According to fig.1 the following formula can be used in heatsink calculations:

$$T_j - T_{amb} = P \times (R_{th\ j\text{-}mb} + R_{th\ mb\text{-}h} + R_{th\ h\text{-}a})$$

7Z3 0079

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.

7Z3 0080

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 $R_{th\ mb-h}$ has to be compensated by a considerable reduction of $R_{th\ h-a}$ (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.

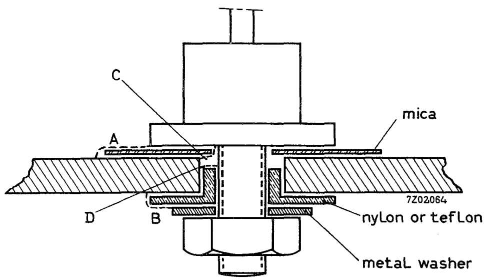


Fig.2 Creepage distances at an insulated diode
(C and D are the critical ones)

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.

7Z3 0081

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.

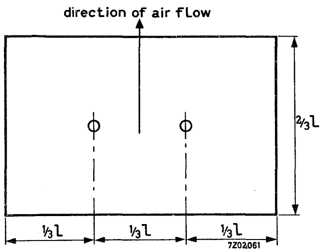


Fig.3. Dimensioning of a plain cooling fin with two diodes

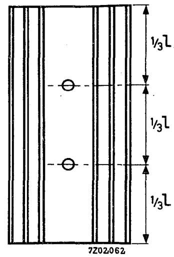


Fig.4. Extruded aluminium heatsink with two diodes

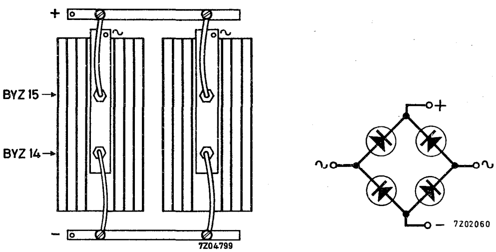


Fig.5. Single phase full wave rectifier with diodes of different polarity on extruded aluminium heatsinks

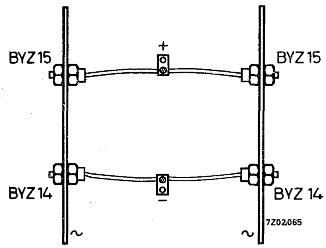


Fig.6. Single phase full wave rectifier with diodes of different polarity on plain cooling fins (Top view)

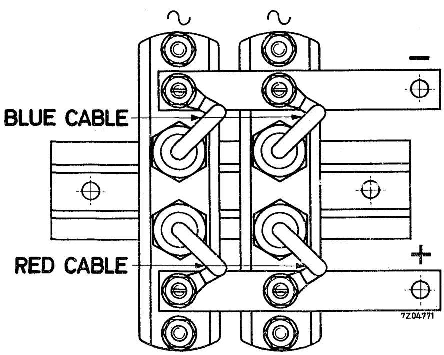


Fig.8. Single phase full wave rectifier with diodes of different polarity (red cable: reverse polarity; blue cable: normal polarity) on two double heatsinks 56250

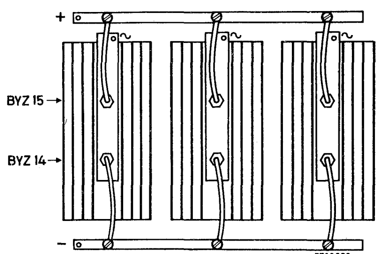


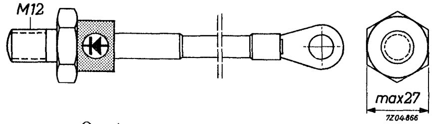
Fig.7. Three phase full wave rectifier with diodes of different polarity on extruded aluminium heatsinks

7Z3 0082

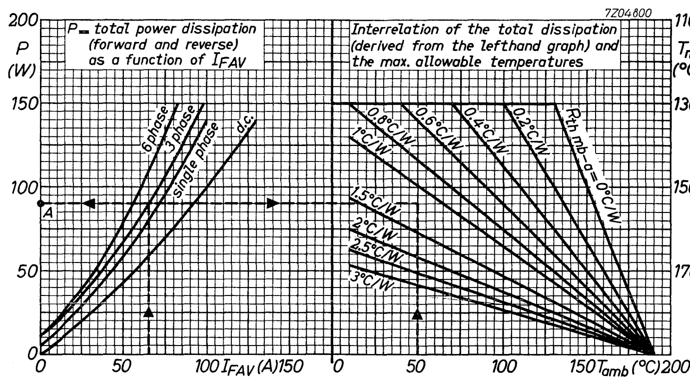
EXAMPLES OF HEATSINK CALCULATION

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 $R_{th\ mb\text{-}h}$ = 0.1 °C/mW.



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 $R_{th\ mb\text{-}a} \approx 1.2$ °C/W.
Thus $R_{th\ h\text{-}a} = R_{th\ mb\text{-}a} - R_{th\ mb\text{-}h}$ = (1.2 - 0.1) °C/W = 1.1 °C/W.
This may be achieved by different types of heatsinks as shown below.

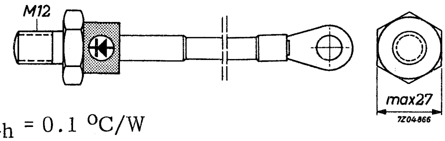
Type	Free convection	Forced cooling
flat, blackened	–	125 cm^2; 2 m/s or 300 cm^2; 1 m/s
bright	–	175 cm^2; 2 m/s
diecast 56274	–	≈ 1.5 m/s
56280	applicable	
extrusion		
56230 bright	l = 12 cm	l = 5 cm 1); 1 m/s
blackened	l = 8 cm	l = 5 cm 1); 1 m/s
56231 bright	l = 7 cm	
blackened	l = 5 cm 1)	

1) Practical minimum length

7Z3 0100

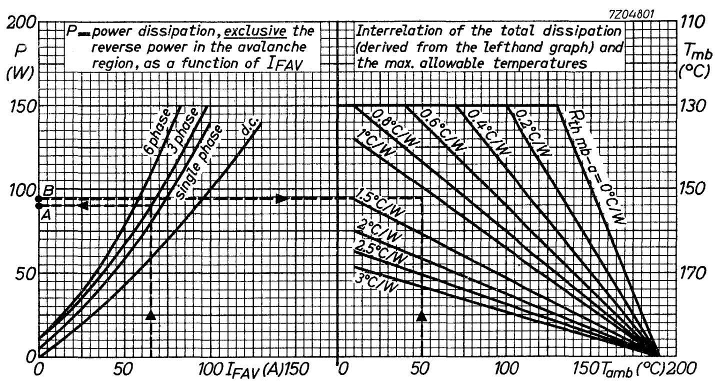
2. Devices with controlled avalanche properties.

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
repetitive peak reverse power in the avalanche region (t = 10 μs)
P_{RRM} = 8 kW (per diode).

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 $R_{th\ mb-a} \approx 1.1$ °C/W.
Hence the heatsink thermal resistance should be:

$$R_{th\ h-a} = R_{th\ mb-a} - R_{th\ mb-h} = (1.1 - 0.1)\ ^{o}C/W = 1\ ^{o}C/W.$$

A table of applicable heatsinks, similar to that on the foregoing page, can be derived for this case.

7Z3 1285

SELECTION GUIDE FOR DIODES

To simplify the selection of heatsinks, the table below indicates for each die-cast heatsink the diodes for which it 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.

	BYZ10-13 BYZ16-19	BYX13 BYY22	BYX25 BYX30	BYX20 1) BYX21 1) BYX28 1) BYY20 1) BYY21 1)	BYZ14	BYX23 BYX32	BYX14 BYX27 BYX33
Diecast 56248 56250					●	●	
56266 56268	●						
56269 56271		●		●			
56272 56274					●	●	
56275 56277		●		●			
56280					●	●	
56283							●
Extrusions 56230 56231		●	●	●	●		
56259 56293					●	●	●
56290	●	●	●	●			

1) With adaptor 56232

7Z3 0501

SELECTION GUIDE FOR THYRISTORS

To simplify the selection of heatsinks, the table below indicates for each die-cast 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.

	BTY79 BTY80 BTY81	BTX35 BTX64 BTY87	BTX36 BTY91	BTX12 BTX13	BTX37 BTX66 BTY95	BTX38 BTY99
Diecast						
56248 56250				●[1]		
56251 56253		●	●			
56254 56256	●					
56272 56258				●		
56280				●		
Extrusions						
56230 56231		●	●	●	●	●
56259 56293				●	●	●
56290	●	●	●			

1) Only on 56248 + 56257

7Z3 1287

FLAT HEATSINKS

7Z3 0104

FLAT HEATSINKS

For vertically mounted, flat, blackened cooling fins of 3 mm aluminium, the nomogram on next page gives the relation between the following variables: fin size, velocity of the cooling air, heatsink thermal resistance, type of diode mounted on the fin and, in the case of free convection cooling, the power dissipation of the diode. Explicit graphs of R_{th} versus heatsink area are shown on pages 32 to 34. Nomogram and graphs should not be used when a diode is insulated from the heatsink.

METHOD OF USING THE NOMOGRAM TO FIND THE REQUIRED HEATSINK AREA.

a. Free convection cooling

Assume that the type of diode, the power dissipated and the calculated max. value of the heatsink thermal resistance are given.

Draw a straight line through the thermal resistance value on scale 3, from the point on line 2 that corresponds with the free convection point of the diode used, to the vertical line 4. Then move horizontally to the free convection line. The intersection of the vertical through this point with the horizontal through the power dissipation value on scale 1 gives the required heatsink area (interpolate between the values of the lines 6).

Example:

An example has been drawn in the nomogram for a BYX13 diode, dissipating 17.5 W at an ambient temperature of 73 ^{o}C. According to the data sheets a heatsink thermal resistance of 3 ^{o}C/W is required.
The nomogram shows that the heatsink area shall be 125 cm^2.

b. Forced cooling

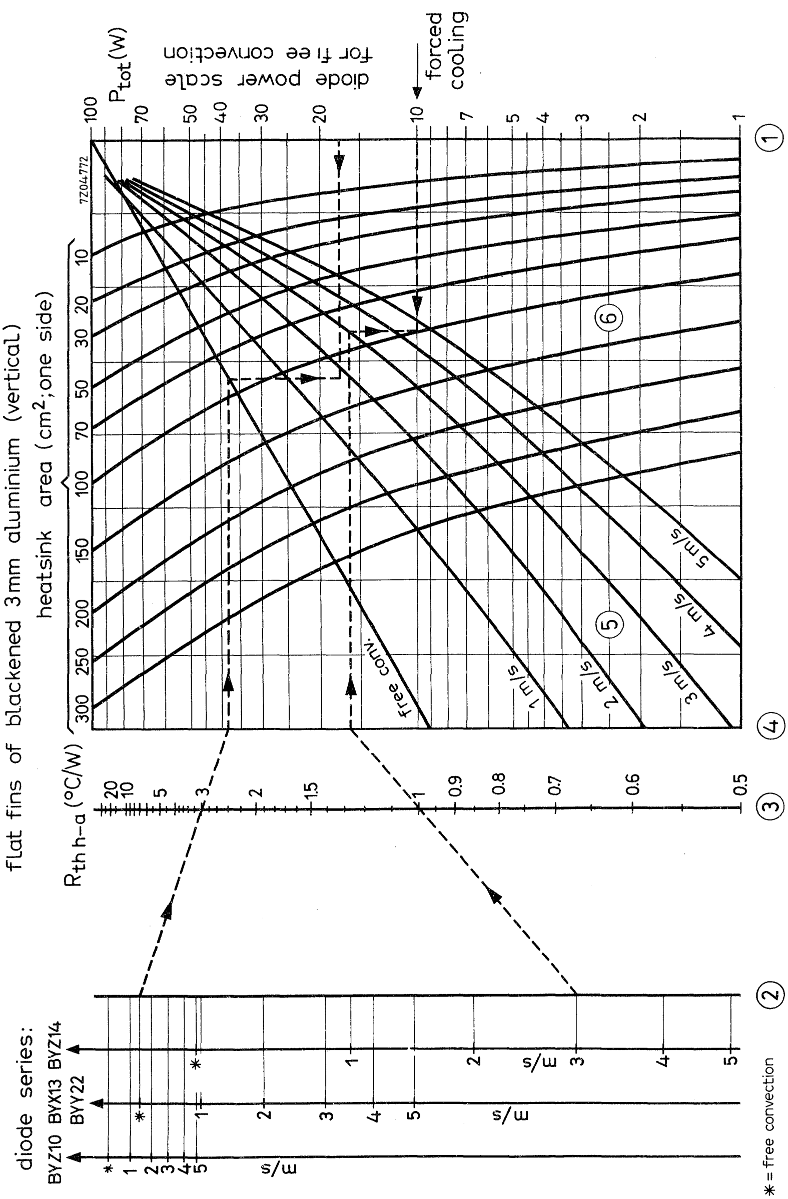
Assume that the type of diode, the calculated max. value of the heatsink thermal resistance and the velocity of the cooling are given.

Draw a straight line through the thermal resistance value or scale 3, from the point on line 2 that corresponds with both the air speed and the type of diode, to the vertical line 4. Then move horizontally to the appropriate line for the air speed (lines 5) and from there vertically to the intersection with the horizontal line through the arrow "forced cooling" at scale 1. This intersection gives the required heatsink area (interpolate between the values of the lines 6).

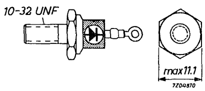
Example:

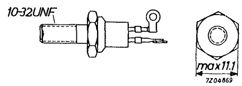
In the nomogram an example has been drawn for a BYZ14 diode, for which a required thermal resistance between mounting base and ambient of 1.15 ^{o}C/W has been calculated and which will be cooled with a forced velocity of 3 m/ s.
Since the contact thermal resistance is 0.15 ^{o}C/W, the heatsink thermal resistance should be 1 ^{o}C/W. The nomogram shows that the required heatsink area is 100 cm^2.

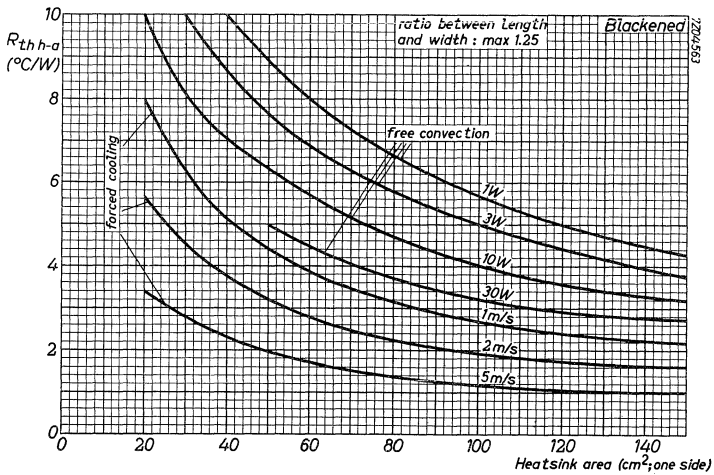
7Z3 1286

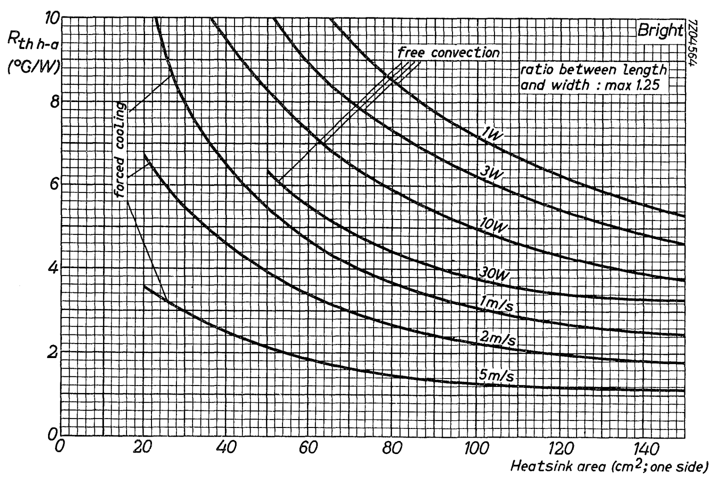

flat fins of blackened 3mm aluminium (vertical)
heatsink area (cm²; one side)
10 20 30 50 70 100 150 200 250 300
P_{tot} (W)
diode power scale for free convection
100 70 50 40 30 20 10 7 5 4 3 2 1
forced cooling
7Z04772
free conv.
1 m/s
2 m/s
3 m/s
4 m/s
5 m/s
$R_{th\,h-a}$ (°C/W)
20 10 5 3 2 1.5 1 0.9 0.8 0.7 0.6 0.5
diode series:
BYZ10 BYX13 BYZ14
BYY22
m/s
* = free convection
1
2
3
4
5
6

Thermal resistance of flat heatsinks of 2 mm copper or 3 mm aluminium.
The graphs are valid for the combination of device and heatsink.



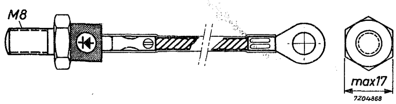


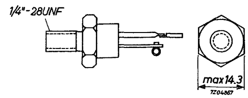


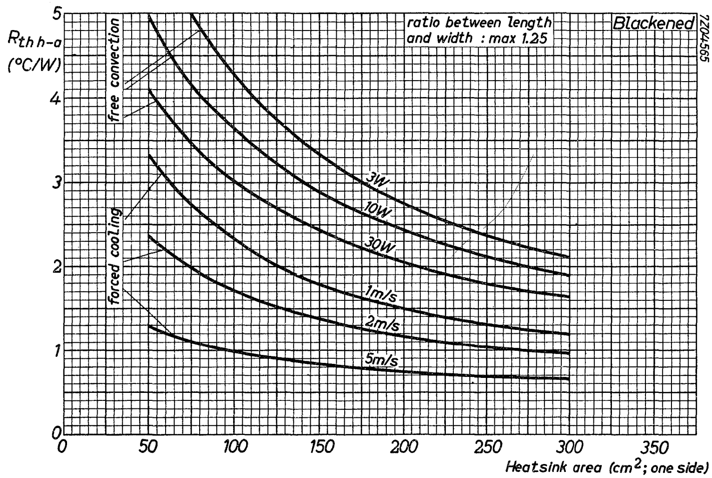


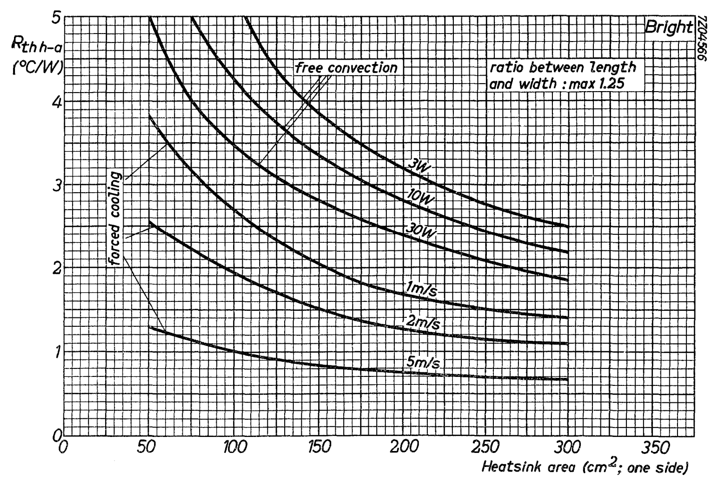
7Z3 0107

Thermal resistance of flat heatsinks of 2 mm copper or 3 mm aluminium.
The graphs are valid for the combination of device and heatsink.



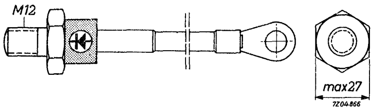


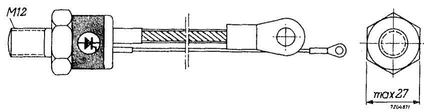


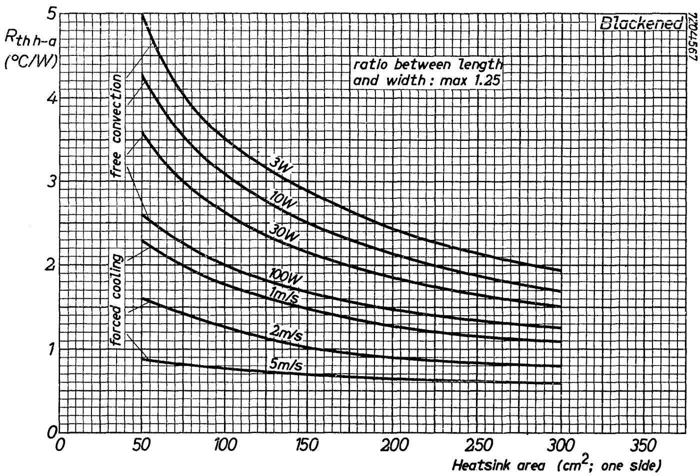


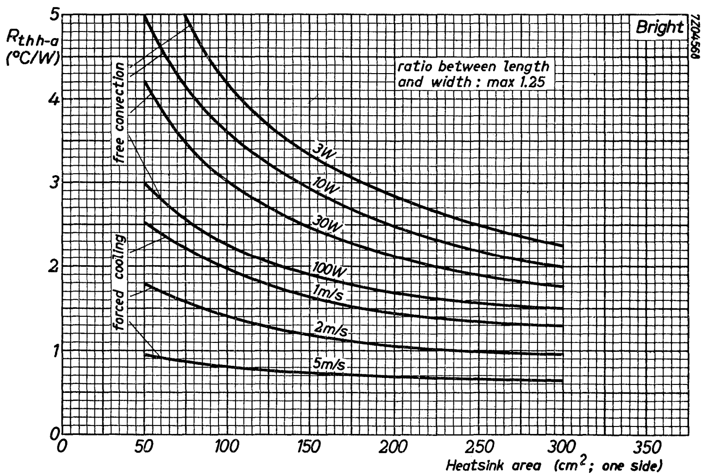
7Z3 0108

Thermal resistance of flat heatsinks of 2 mm copper or 3 mm aluminium.
The graphs are valid for the combination of device and heatsink.







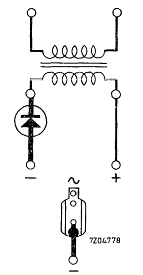
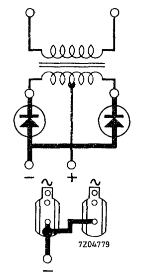
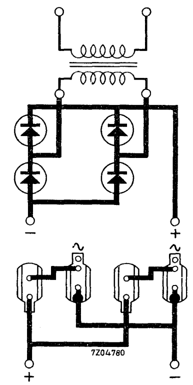
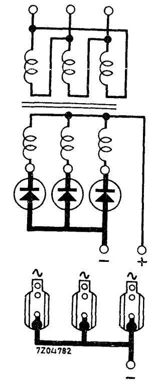


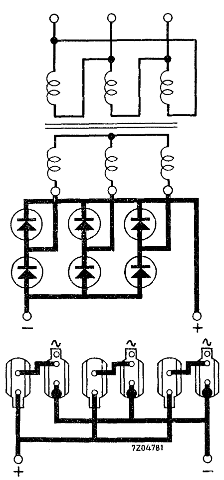
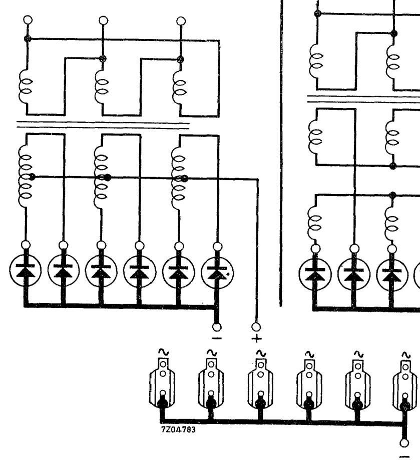
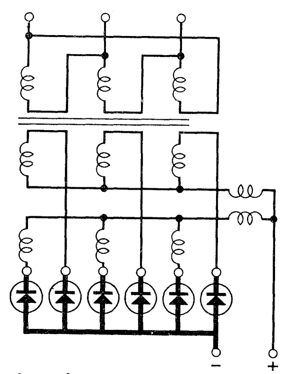
7Z3 0109

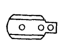
DIECAST HEATSINKS

7Z3 0110

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)
			

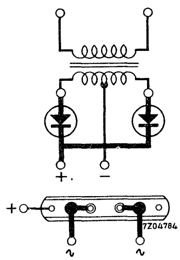
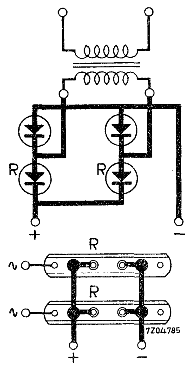
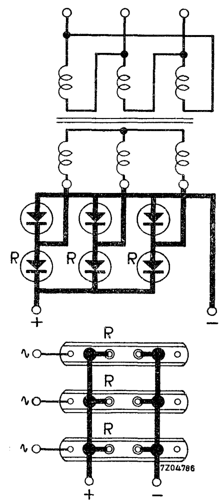
Three phase full wave (Three phase bridge)	Six phase half wave (Six phase star)	Three phase double Y with interphase transformer
		

Diecast heatsink without insulator 

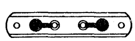
Diecast heatsink with insulator 

7Z3 0111

RECTIFIER CIRCUITS ON DOUBLE HEATSINKS

Two phase half wave	Single phase full wave (Single phase bridge)	Three phase full wave (Three phase bridge)
		

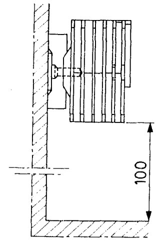
R = Reverse polarity diode

Diecast heatsink 56250 

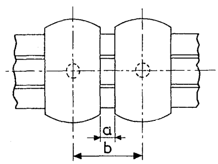
7Z3 0112

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.

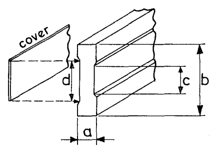


2. At forced air flow > 0.5 m/s the heatsinks may be mounted in any position.
3. Minimum distance between heatsinks in a row.



Heatsink	Distance (mm) a	b
56254/56/66/68	> 5.0	>25.0
56275/77	> 5.0	>40.0
56248/50/51/53	>10.0	>50.0
56258/69/71/72/74	>10.0	>50.0

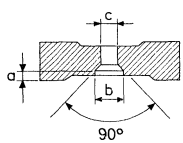
4. The rectifier devices should be fixed to their heatsinks with the torques specified in the relevant published data. Use a torque spanner.
5. For insulated mounting of heatsinks two sizes of mounting strips made of insulating material are available.



Strip	Dimensions (mm) a	b	c	d	Weight (g) (with c[illegible]
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
56254/56/66/68	56233	< 1.5	7.5	4.3
56251/53/58/69/71	56234	< 1.3	10.2	6.3
56272/74/75/77	56234	< 1.3	10.2	6.3
56248/50	56234	< 1.8	13.8	8.3

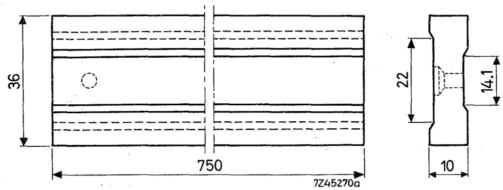
7Z3 0113

MOUNTING STRIPS

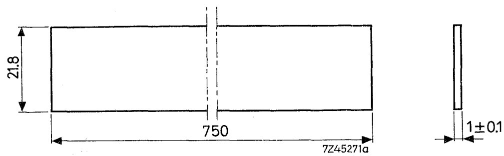
Type 56233 consists of the following components (1 to 2) Dimensions in mm

1\.
1 mounting strip of insulating material

Weight with cover: 330 g



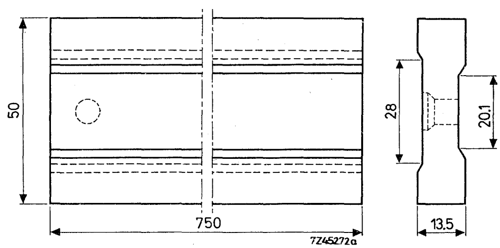
2\.
1 insulating plate



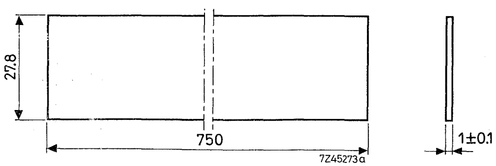
Type 56234 consists of the following components (1 to 2) Dimensions in mm

1\.
1 mounting strip of insulating material

Weight with cover: 615 g



2\.
1 insulating plate



7Z3 0114

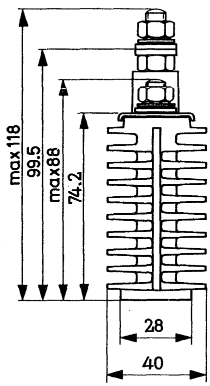
DIECAST HEATSINK FOR TWO DEVICES

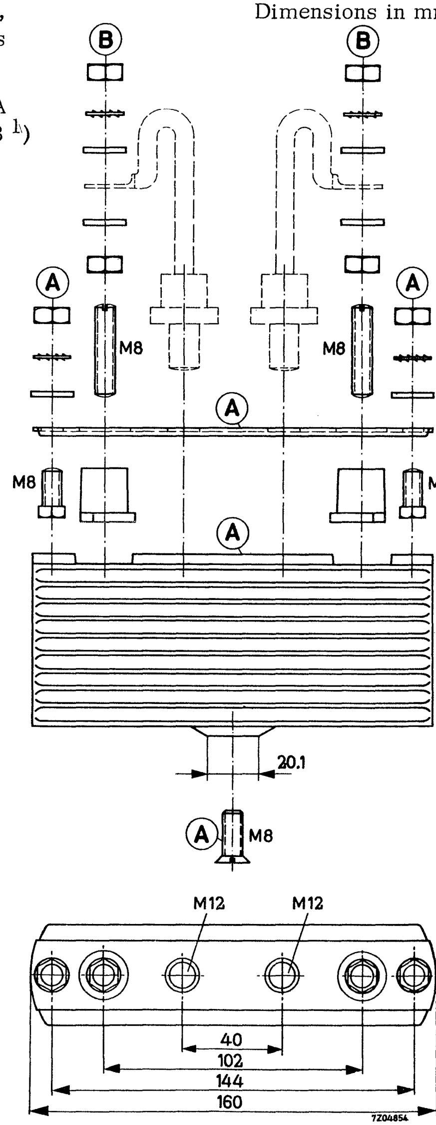
Diecast heatsink of aluminium alloy, painted black, with two M12 tap holes for two rectifier devices.

56248 = heatsink + fixing material A
56249 = insulator + fixing material B [1])
56250 = complete heatsink
56248 + 56249

[1]) For thyristor applications insulator 56257 is available

Dimensions in mm



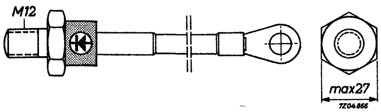


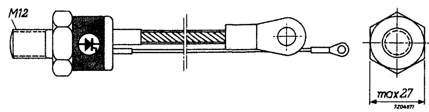
Weight

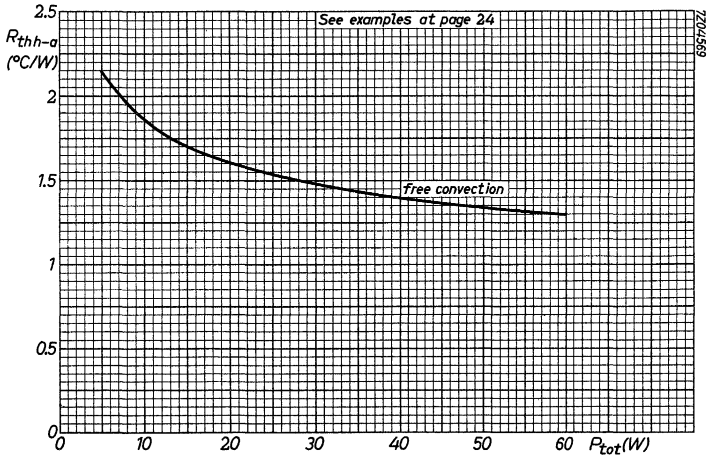
56248 : 640 g
56249 : 90 g
56250 : 730 g

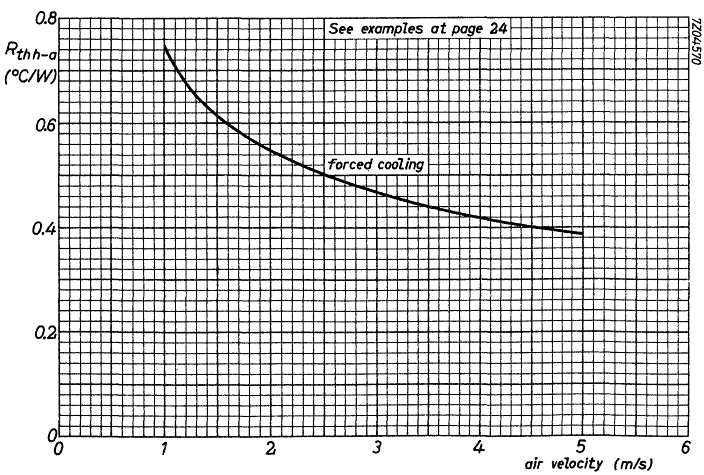
7Z3 1288

The graphs are valid for the combination of device and heatsink.









7Z3 0116

Calculations for the double heatsink 56248 or 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

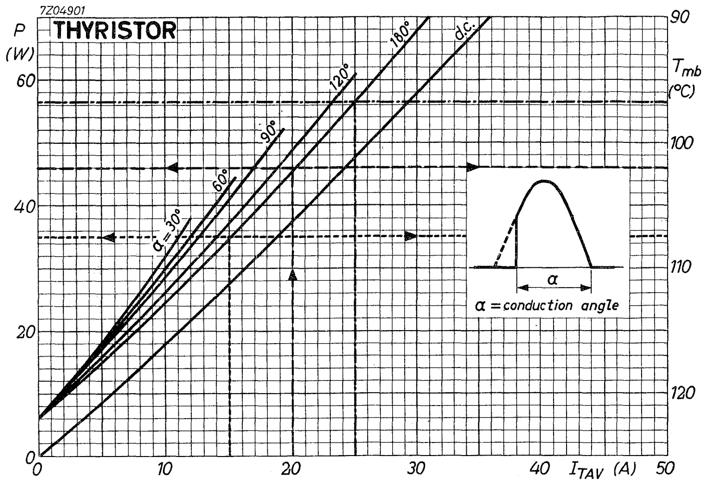
Consider a thyristor T and a diode D, used in single phase application ($\alpha = 180^o$), of which the curves to be used are shown on the next page. For all examples the contact thermal resistance $R_{th\ mb-h} = 0.1\ ^oC/W$.
In the table below, three different examples have been worked out.

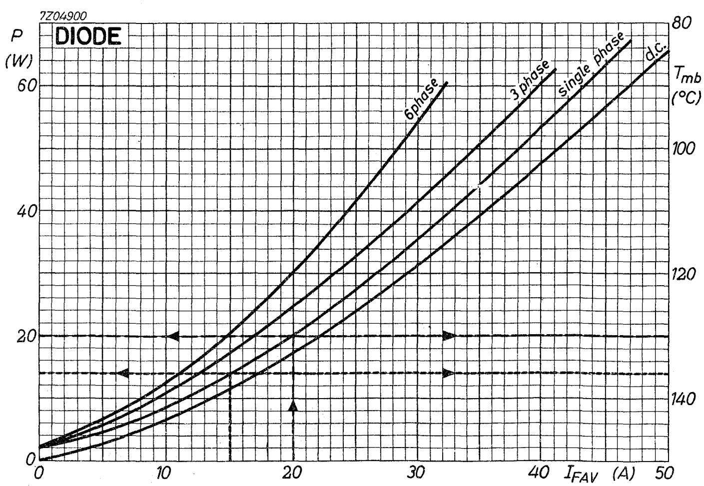
	$T_1 + D_2$	$T_1 + D_2$	$T_1 + T_2$
Given: T_{amb}	30 °C	50 °C	45 °C
I_{AV}	15 A	20 A	25 A
From next page			
P_1	35 W	46 W	56.5 W
P_2	14 W	20 W	56.5 W
$P_{tot} = P_1 + P_2$	49 W	66 W	113 W
$T_{mb\ 1}$ max.	107.5 °C	102 °C	96.5 °C
$T_{mb\ 2}$ max.	136 °C	130 °C	96.5 °C
$P_1 \times R_{th\ mb-h} = \Delta T_{mb-h}$	3.5 °C	4.6 °C	5.7 °C
Maximum T_h	104 °C	97.4 °C	90.8 °C
T_{amb}	30 °C	50 °C	45 °C
Max. ΔT_{h-a}	74 °C	47.4 °C	45.8 °C
$\frac{\text{Max. } \Delta T_{h-a}}{P_{tot}} =$	$\frac{74}{49} =$	$\frac{47.4}{66} =$	$\frac{45.8}{113} =$
Max. $R_{th\ h-a}$	1.5 °C/W	0.72 °C/W	0.4 °C/W
From graphs on foregoing page follows:	Possible with free convection. 50 W: 1.35 °C/W	Only with forced cooling. At least 1.1 m/s	Only with forced cooling. At least 4.5 m/s

7Z3 1289

Calculations for the double heatsink 56248 or 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.





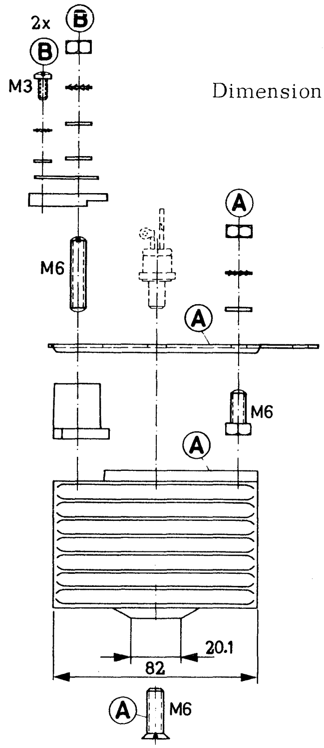
7Z3 0118

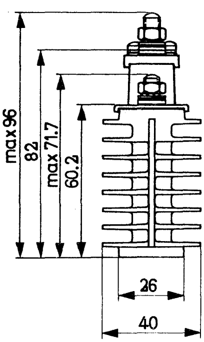
DIECAST HEATSINK

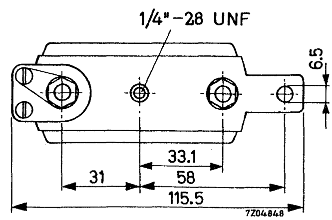
Diecast heatsink of aluminium alloy, painted black, with 1/4"-28 UNF tap hole for rectifier device.

56251 = heatsink + fixing material A
56252 = insulator + fixing material B
56253 = complete heatsink
56251 + 56252

Dimensions in mm





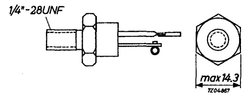


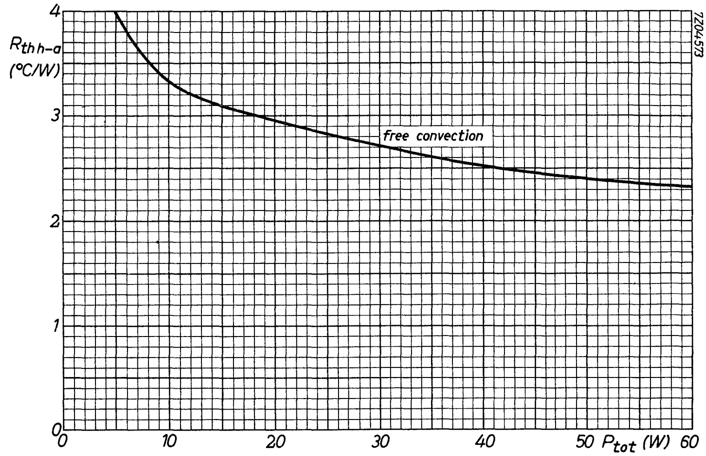
Weight

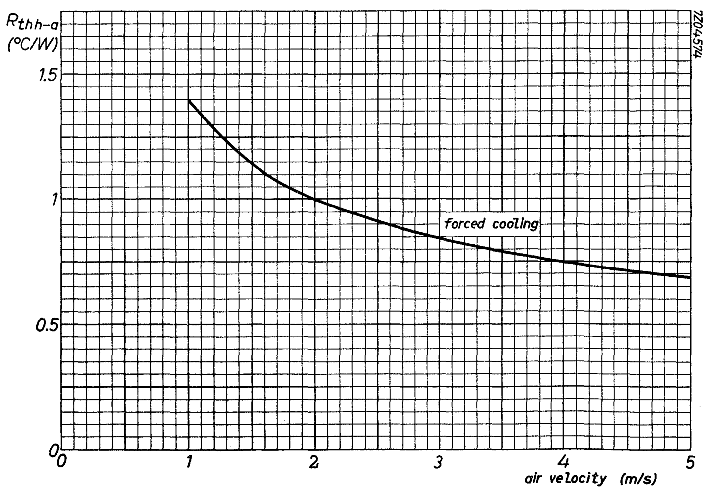
56251: 265 g
56252: 40 g
56253: 305 g

7Z3 0119

The graphs are valid for the combination of thyristor and heatsink.







7Z3 0120

DIECAST HEATSINK

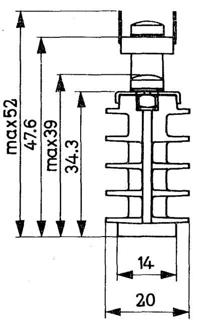
Diecast heatsink of aluminium alloy, painted black, with 10-32 UNF tap hole for rectifier device.

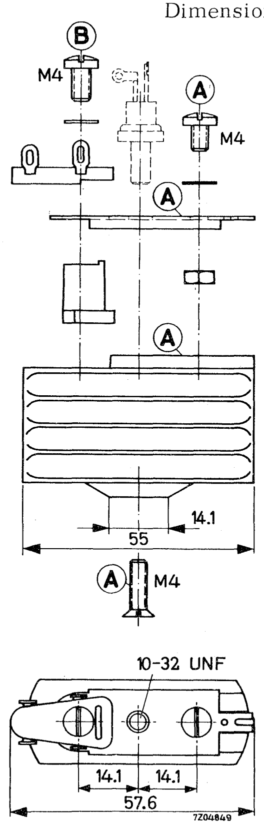
56254 = heatsink + fixing material A
56255 = insulator + fixing material B
56256 = complete heatsink 56254 + 56255

Dimensions in mm

Weight:

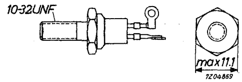
56254: 50 g
56255: 5 g
56256: 55 g

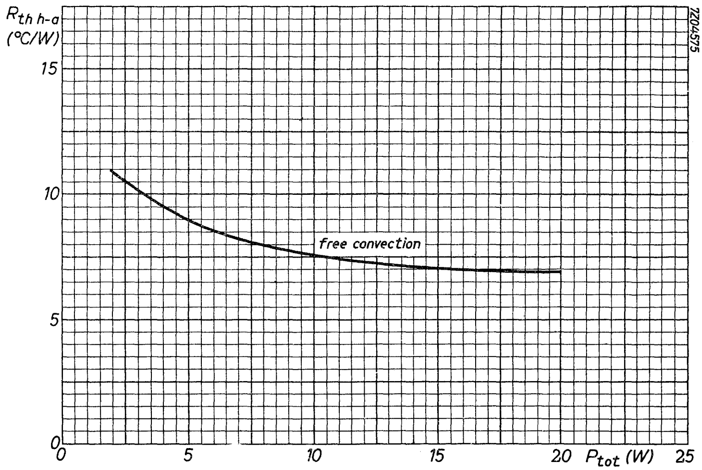


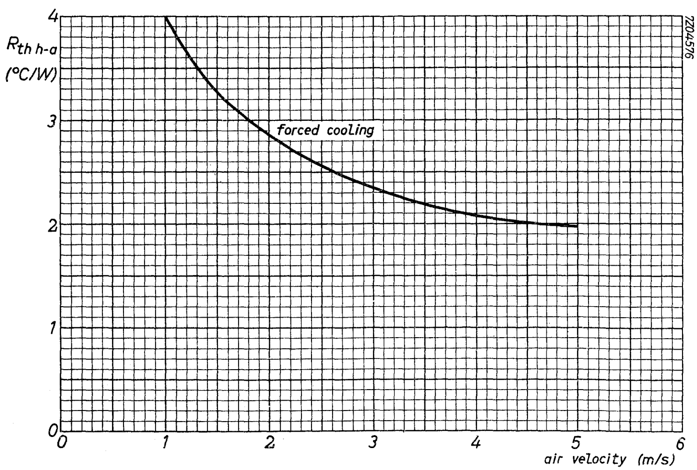


7Z3 0121

The graphs are valid for the combination of thyristor and heatsink.







7Z3 0122

DIECAST HEATSINK

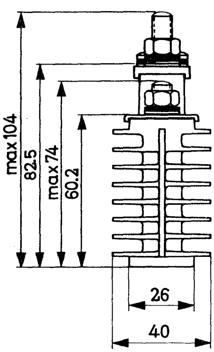
Diecast heatsink of aluminium alloy, painted black, with M12 tap hole for rectifier device.

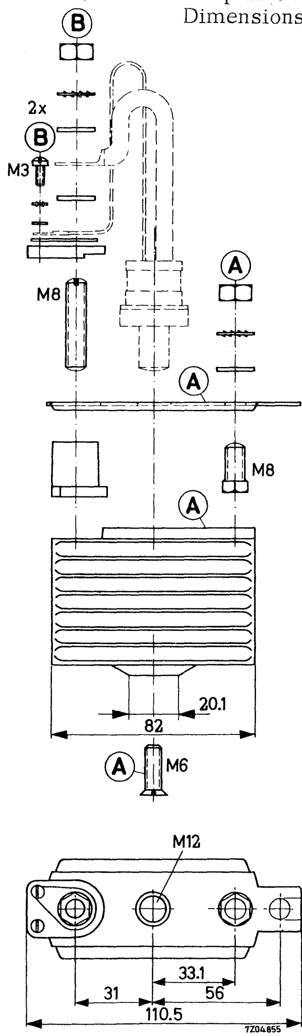
Dimensions in mm

56272 = heatsink + fixing material A
56257 = insulator + fixing material B
56258 = complete heatsink 56272 + 56257

Weight

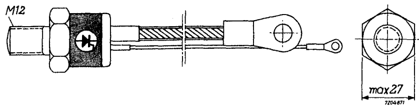
56272: 250 g
56257: 40 g
56258: 290 g

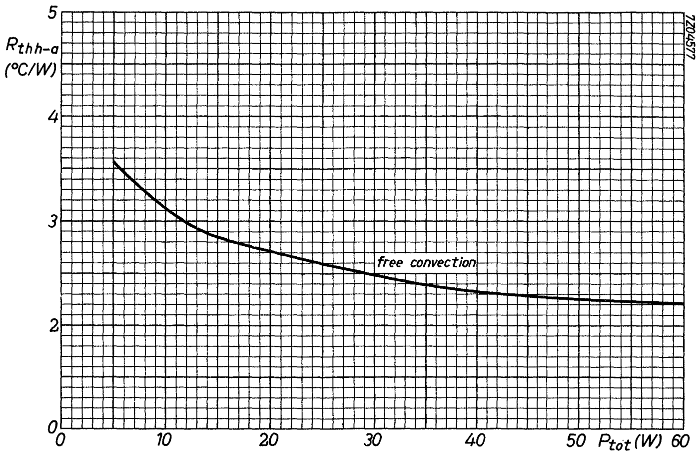


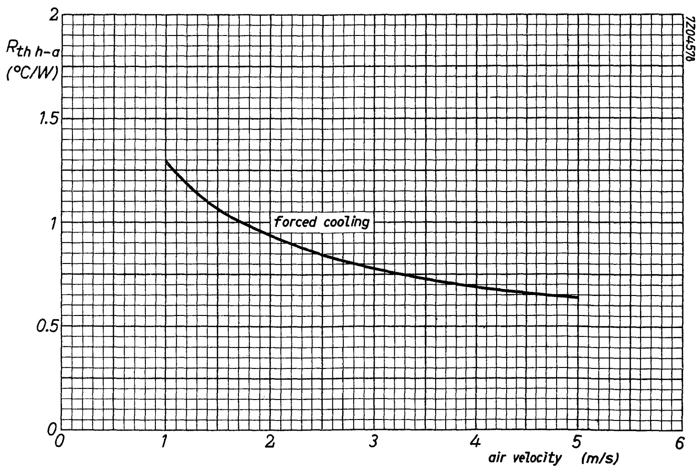


7Z3 0123

The graphs are valid for the combination of thyristor and heatsink.







7Z3 0124

DIECAST HEATSINK

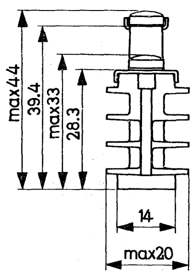
Diecast heatsink of aluminium alloy, painted black, with 10-32 UNF tap hole for rectifier device.

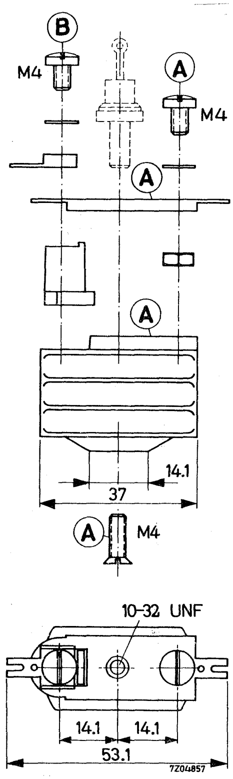
56266 = heatsink + fixing material A
56267 = insulator + fixing material B
56268 = complete heatsink 56266 + 56267

Dimensions in mm

Weight

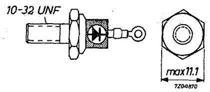
56266 : 28 g
56267 : 5 g
56268 : 33 g

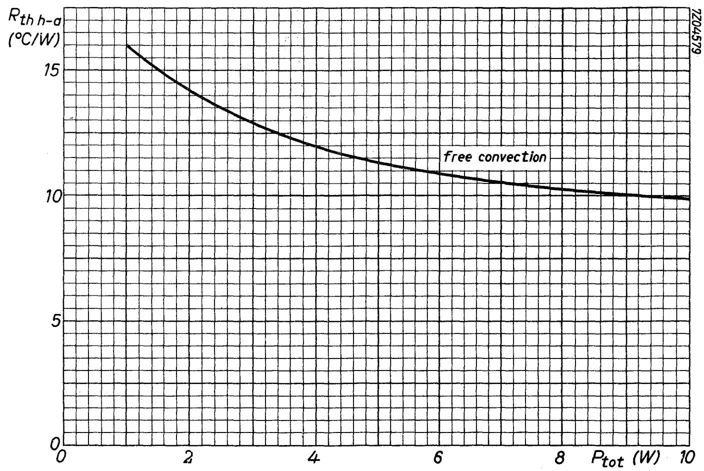


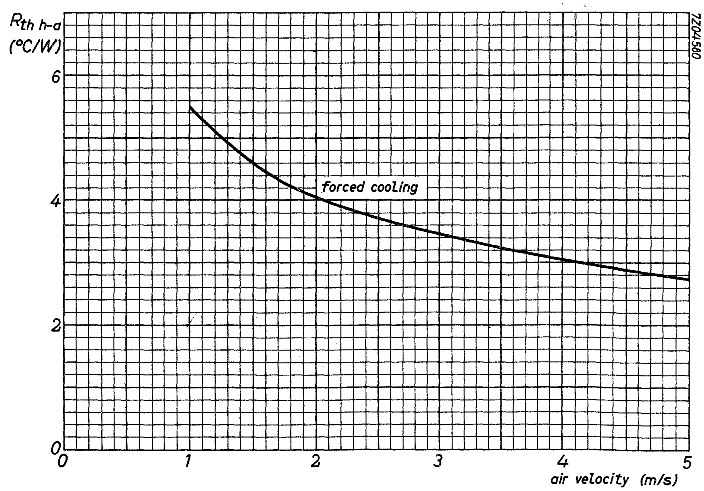


7Z3 0125

The graphs are valid for the combination of diode and heatsink.







7Z3 0126

DIECAST HEATSINK

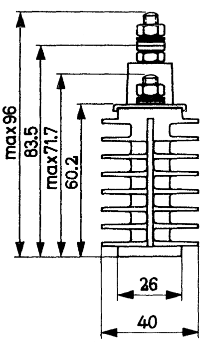
Diecast heatsink of aluminium alloy, painted black, with M8 tap hole for rectifier device.

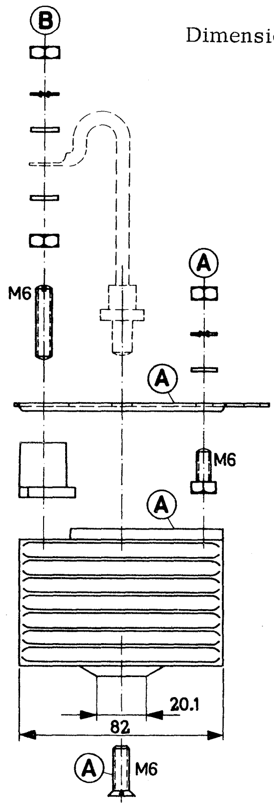
56269 = heatsink + fixing material (A)
56270 = insulator + fixing material (B)
56271 = complete heatsink 56269 + 56270

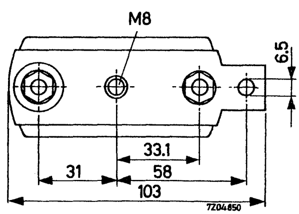
Weight

56269 : 245 g
56270 : 25 g
56271 : 270 g

Dimensions in mm

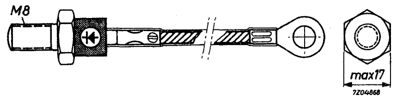


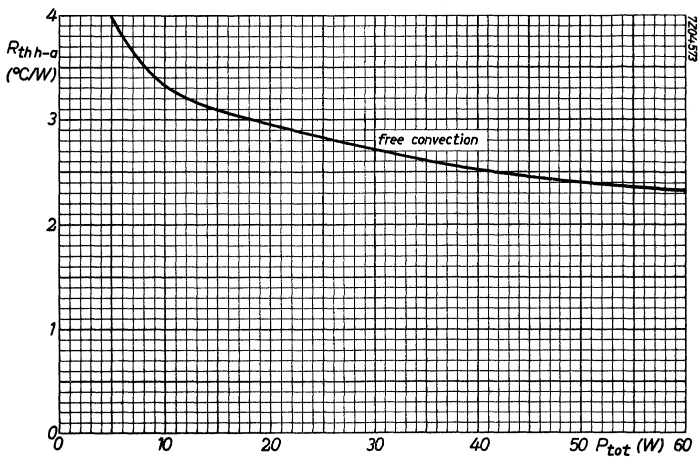


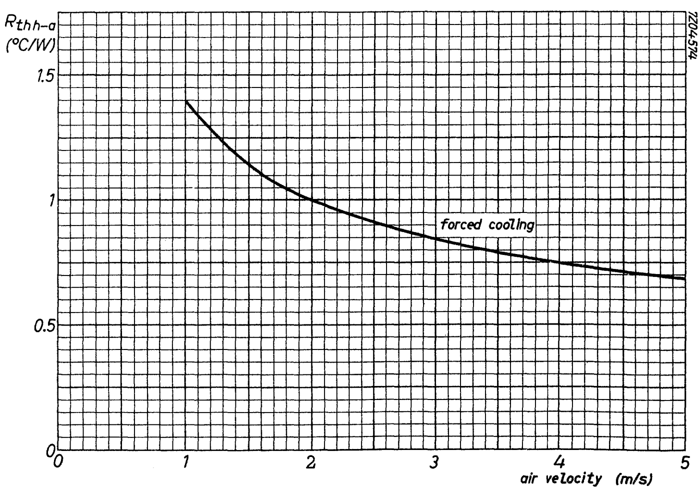


7Z3 0127

The graphs are valid for the combination of diode and heatsink.







7Z3 0128

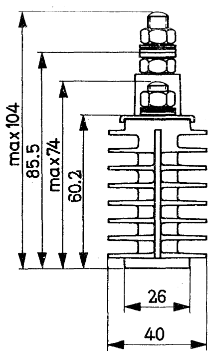
DIECAST HEATSINK

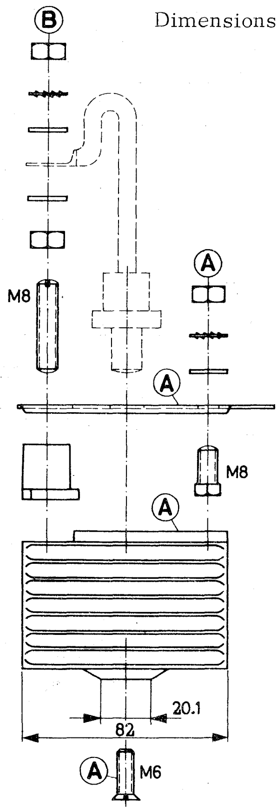
Diecast heatsink of aluminium alloy, painted black, with M12 tap hole for rectifier device.

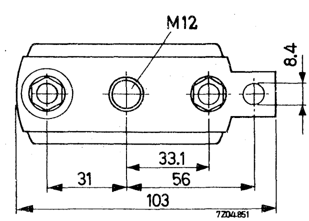
56272 = heatsink + fixing material (A)
56273 = insulator + fixing material (B)
56274 = complete heatsink 56272 + 56273

Weight
56272 : 250 g
56273 : 45 g
56274 : 295 g

Dimensions in mm

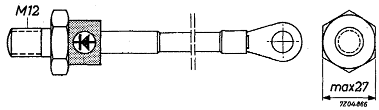


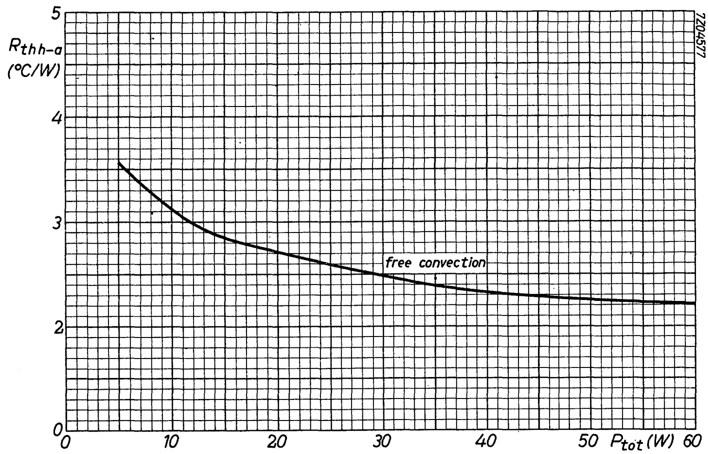


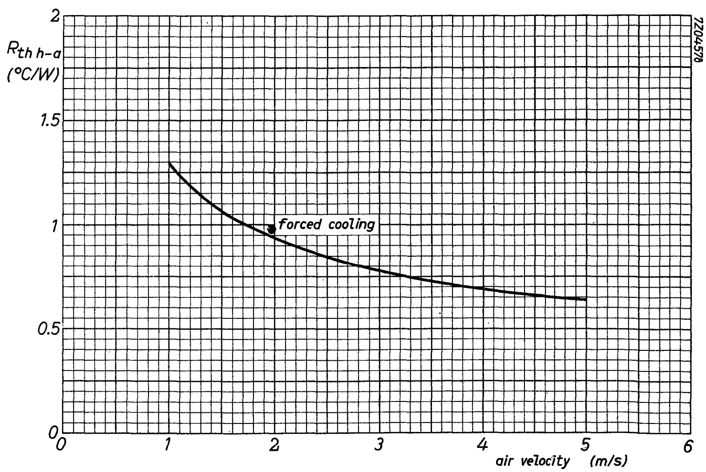


7Z3 0129

The graphs are valid for the combination of diode and heatsink.







7Z3 0130

DIECAST HEATSINK

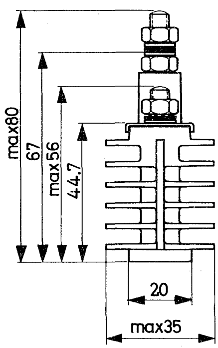
Diecast heatsink of aluminium alloy, painted black, with M8 tap hole for rectifier device.

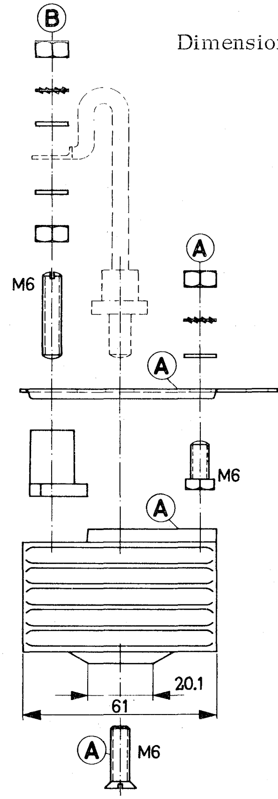
Dimensions in mm

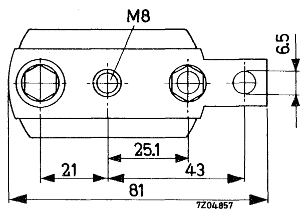
56275 = heatsink + fixing material A
56276 = insulator + fixing material B
56277 = complete heatsink 56275 + 56276

Weight

56275 : 115 g
56276 : 20 g
56277 : 135 g

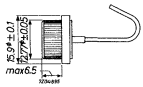




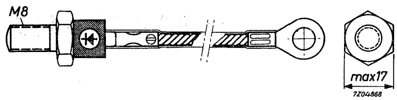


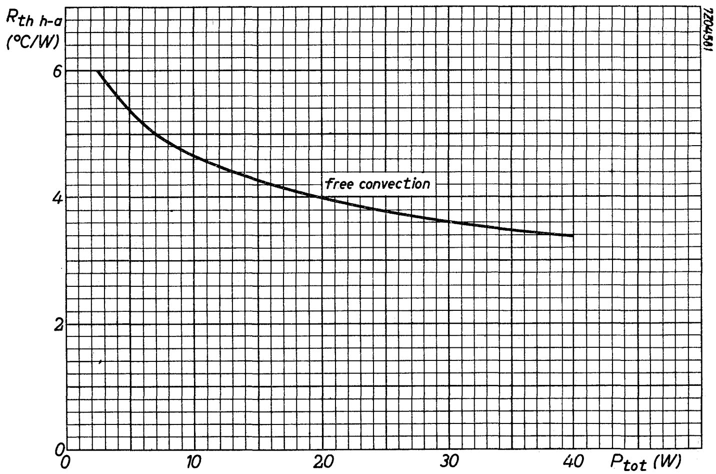
7Z3 0131

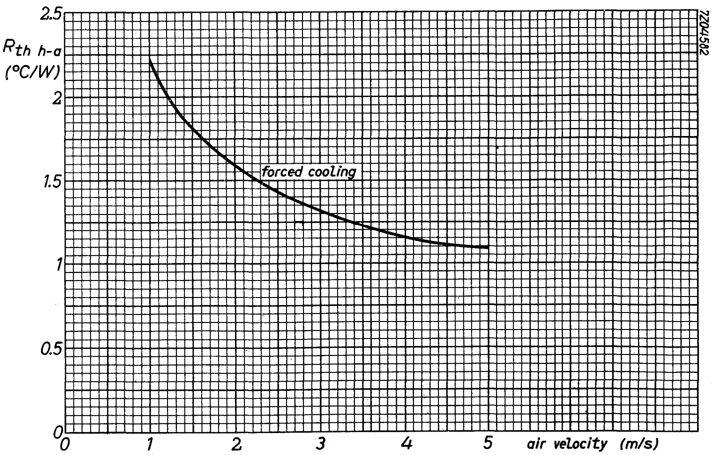
The graphs are valid for the combination of diode and heatsink.



With mounting adaptor 56232







7Z3 0132

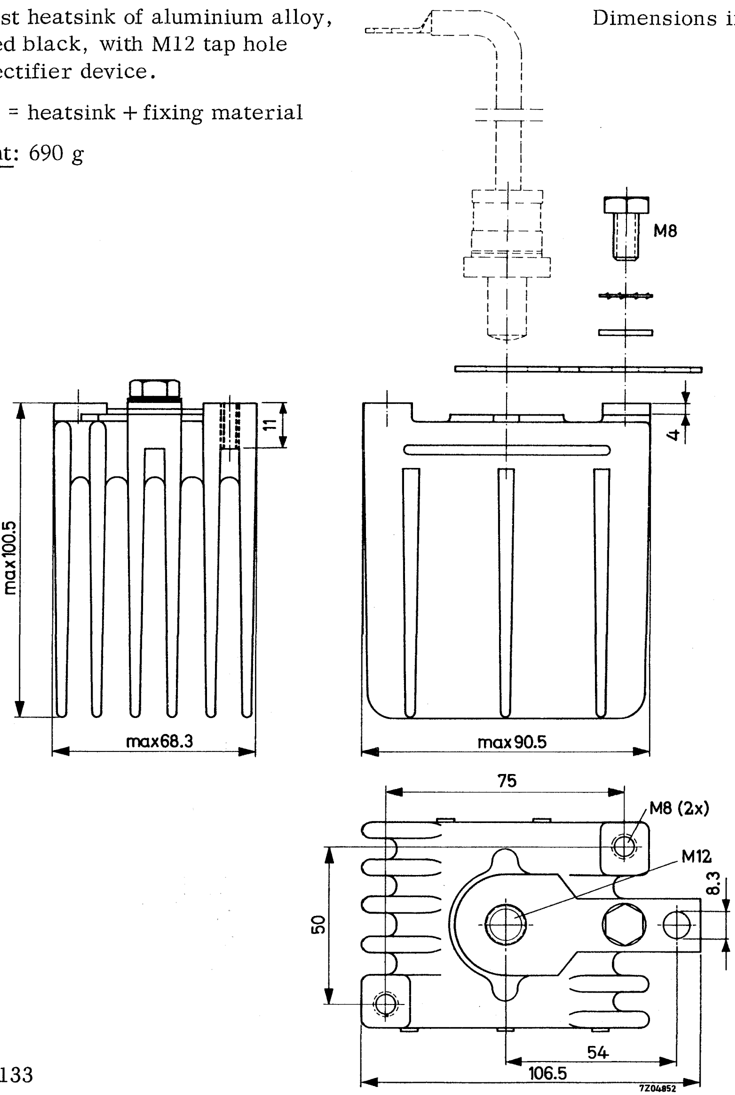
DIECAST HEATSINK

Diecast heatsink of aluminium alloy, painted black, with M12 tap hole for rectifier device.

56280 = heatsink + fixing material

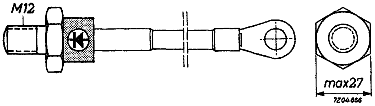
Weight: 690 g

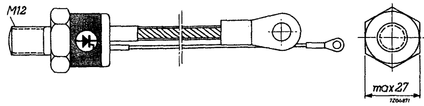
Dimensions in mm

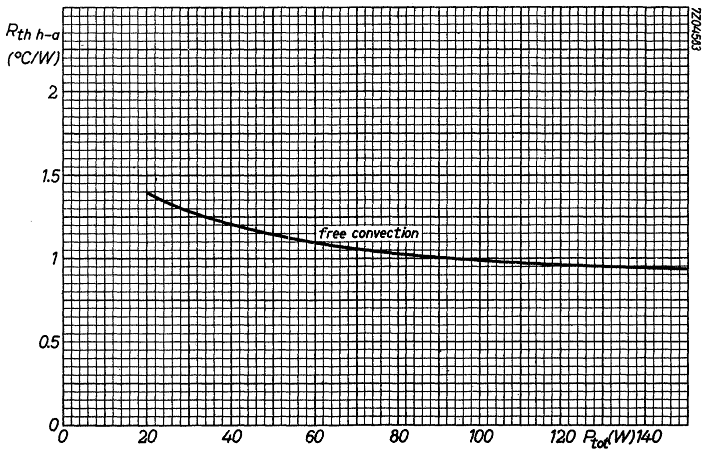


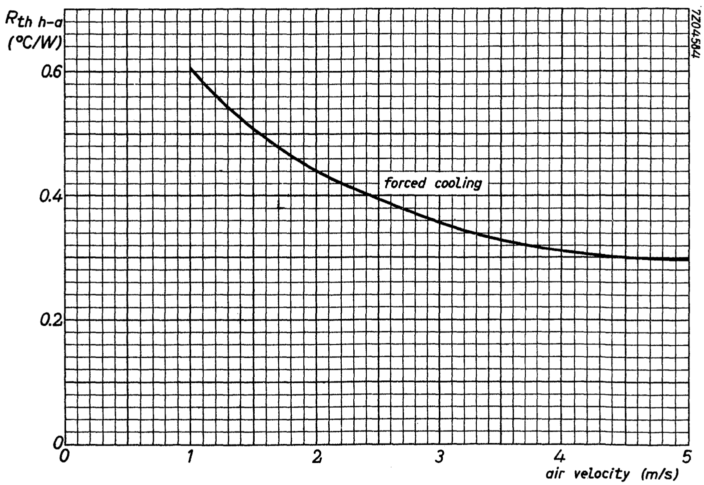
7Z3 0133

The graphs are valid for the combination of device and heatsink.









7Z3 0134

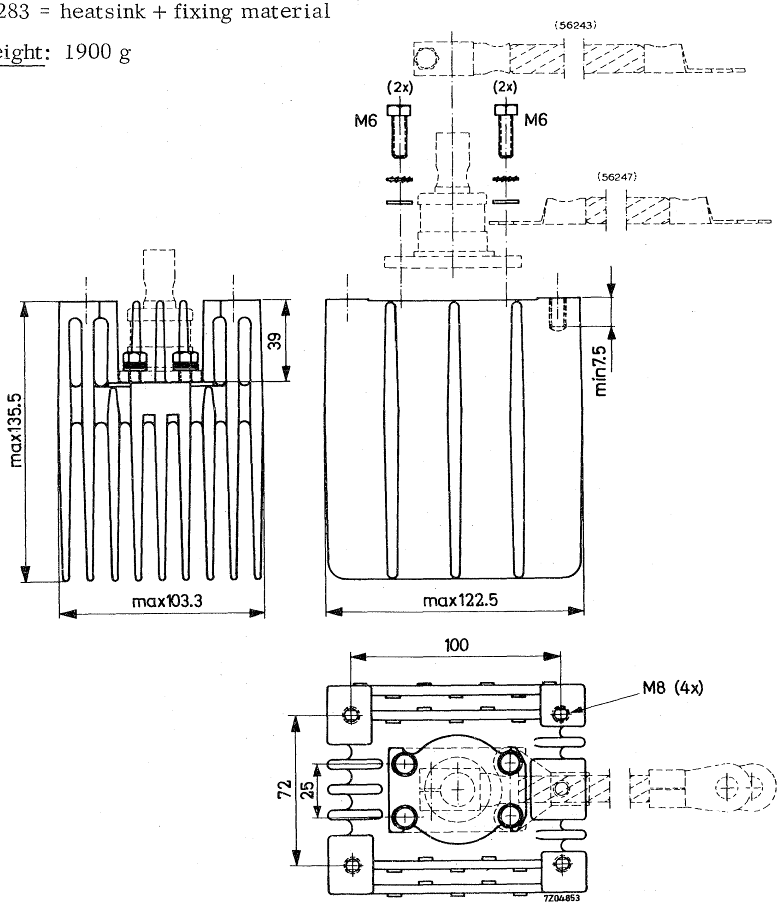
DIECAST HEATSINK

Diecast heatsink of aluminium alloy, painted black, intended for devices with flat mounting base.

56283 = heatsink + fixing material

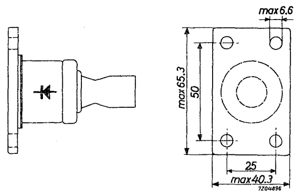
Weight: 1900 g

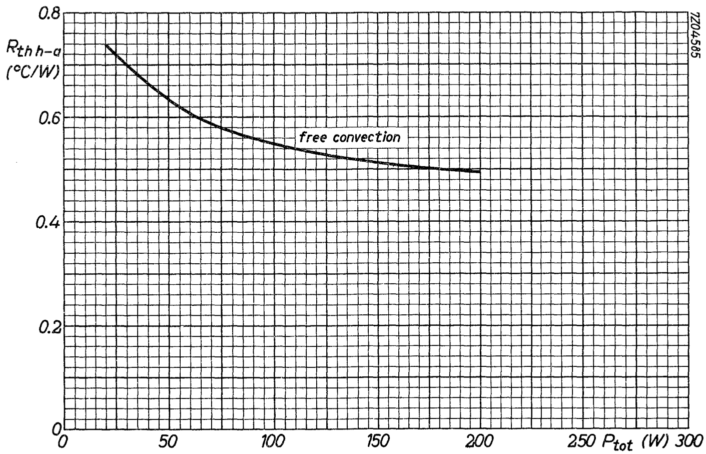
Dimensions in mm

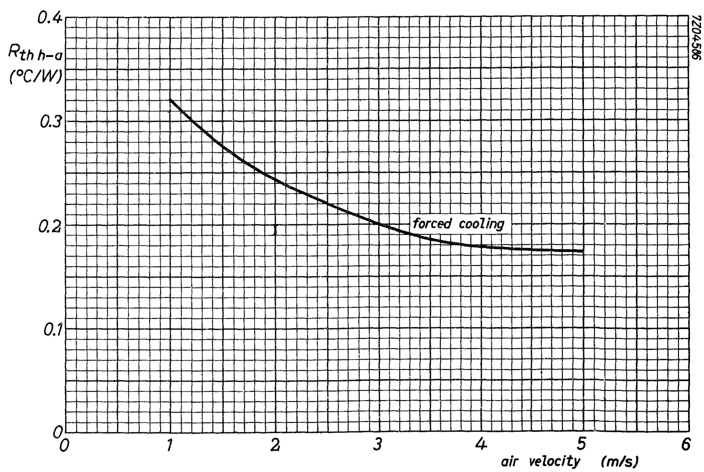


7Z3 0135

The graphs are valid for the combination of diode and heatsink.







7Z3 0136

HEATSINK EXTRUSIONS

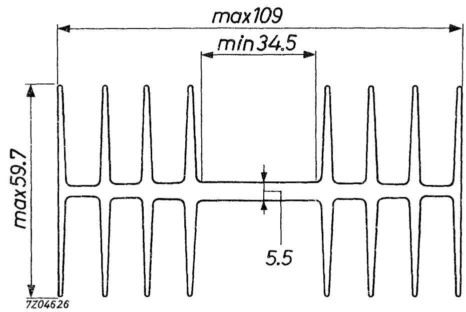
7Z3 0137

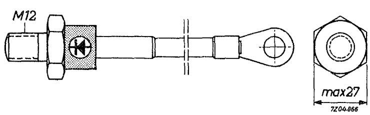
EXTRUDED ALUMINIUM HEATSINK

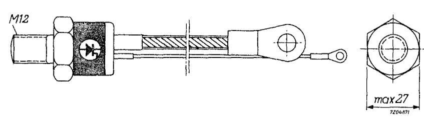
Extruded heatsink of aluminium alloy.
The extrusion is supplied unpainted, in lengths of 1.5 m.

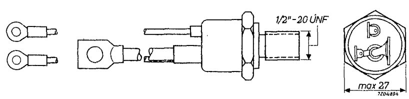
Weight: 4 kg per 1.5 m.

Dimensions in mm



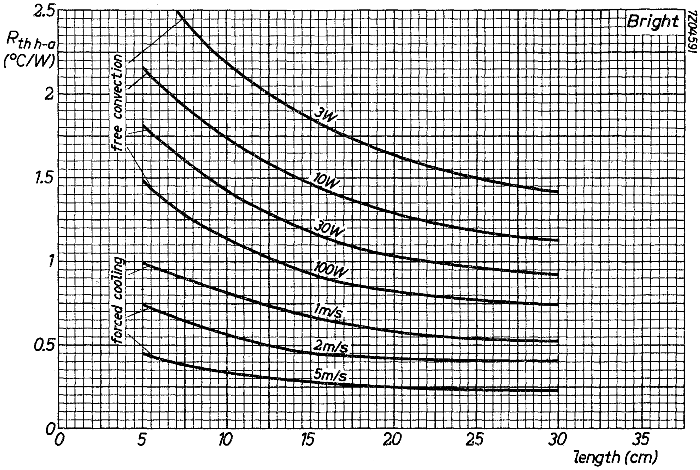


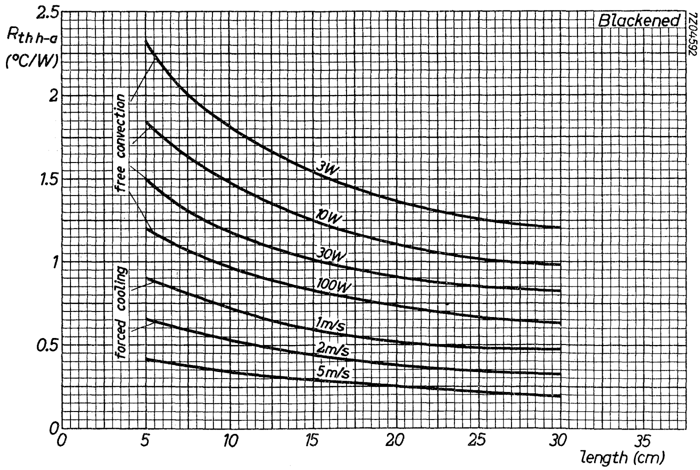




7Z3 0138

The graphs are valid for the combination of rectifier device and heatsink.





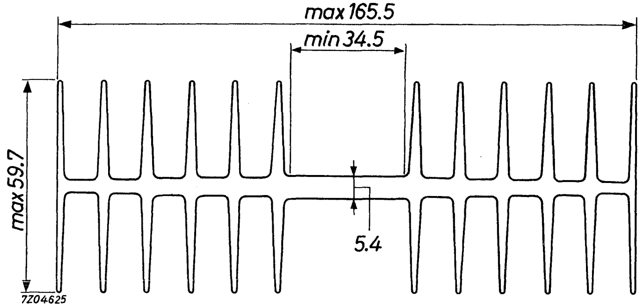
7Z3 0139

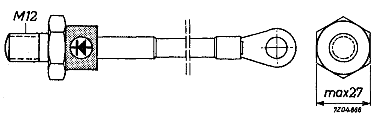
EXTRUDED ALUMINIUM HEATSINK

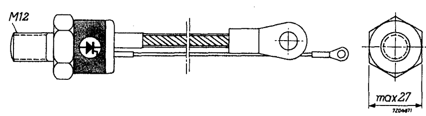
Extruded heatsink of aluminium alloy.
The extrusion is supplied unpainted, in lengths of 1.5 m.

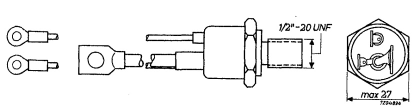
Weight: 6 kg per 1.5 m.

Dimensions in mm



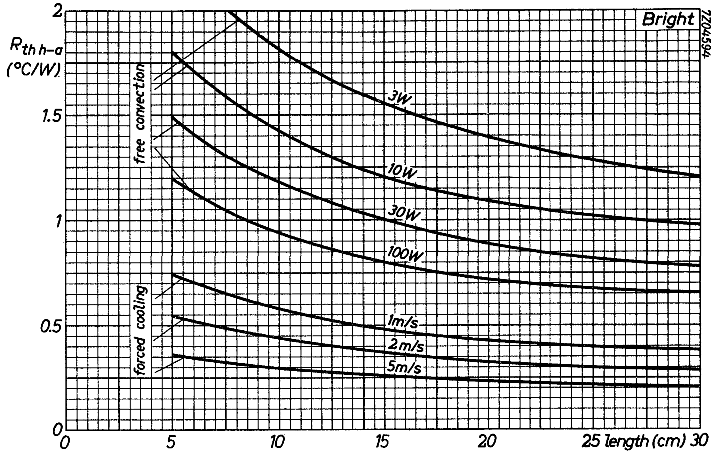


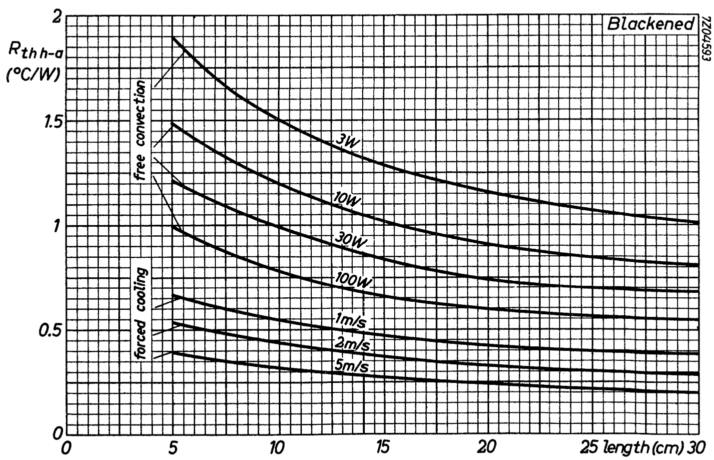




7Z3 0140

The graphs are valid for the combination of rectifier device and heatsink.





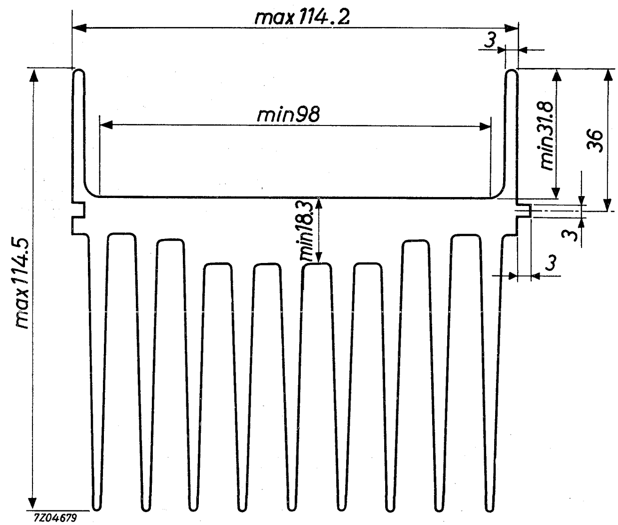
7Z3 0141

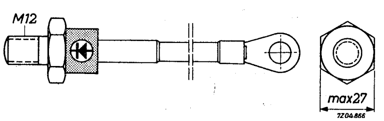
EXTRUDED ALUMINIUM HEATSINK

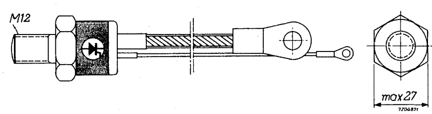
Extruded heatsink of aluminium alloy.
The extrusion is supplied unpainted, in lengths of 1.0 m.

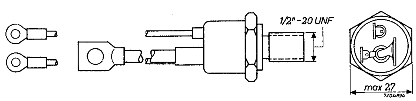
Weight: 10.8 kg per 1.0 m.

Dimensions in mm



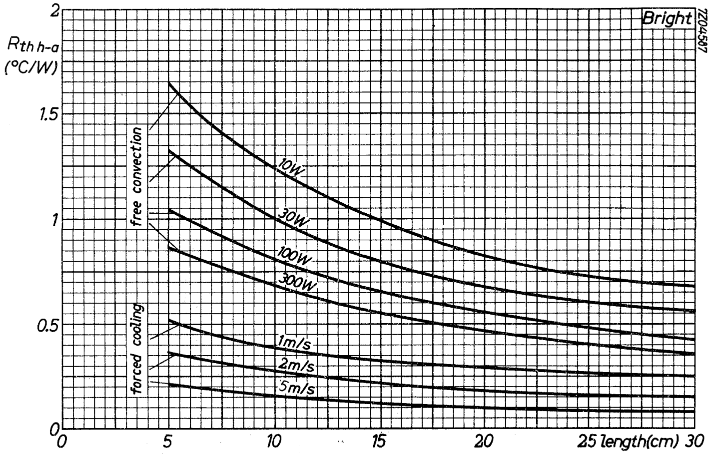


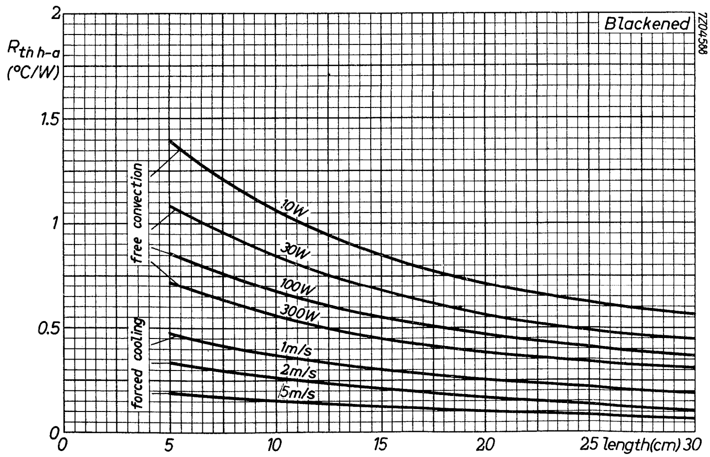




7Z3 0142

The graphs are valid for the combination of rectifier device and heatsink.
For devices with a flat base see page 71.



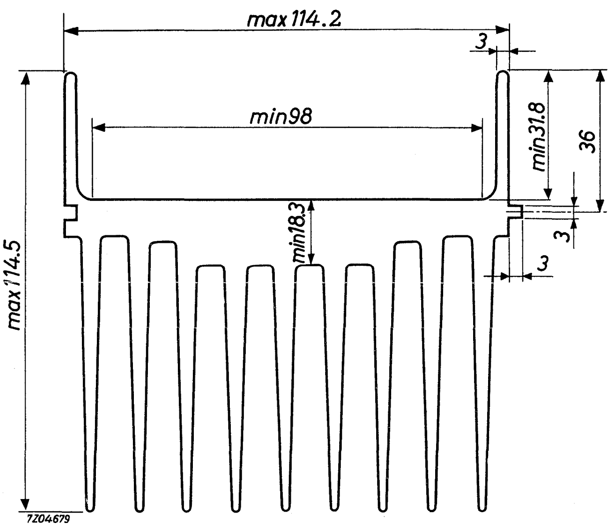


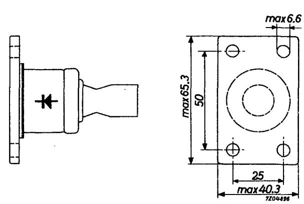
7Z3 1290

EXTRUDED ALUMINIUM HEATSINK

Extruded heatsink of aluminium alloy.
The extrusion is supplied unpainted, in lengths of 1.0 m.

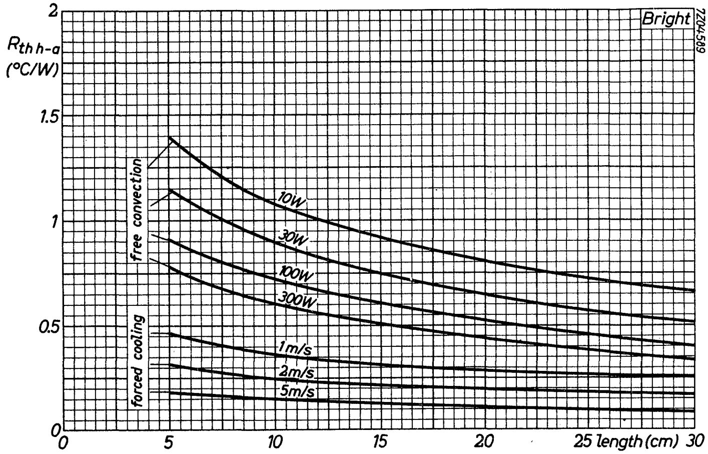
Weight: 10.8 kg per 1.0 m. Dimensions in mm

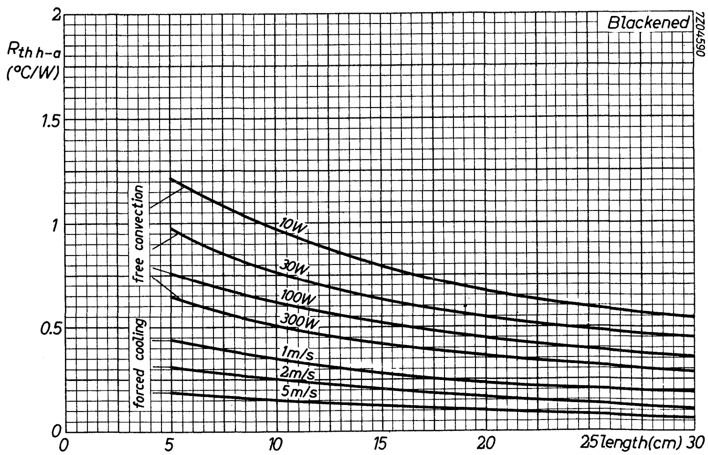




7Z3 0144

The graphs are valid for the combination of rectifier device and heatsink.
For devices with threaded studs see page 69.





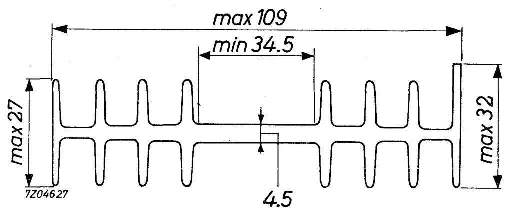
7Z3 1291

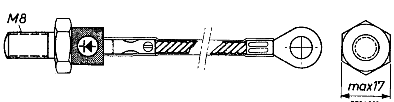
EXTRUDED ALUMINIUM HEATSINK

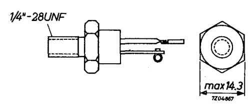
Extruded heatsink of aluminium alloy.
The extrusion is supplied unpainted, in lengths of 1.5 m.

Weight: 2.4 kg per 1.5 m.

Dimensions in mm

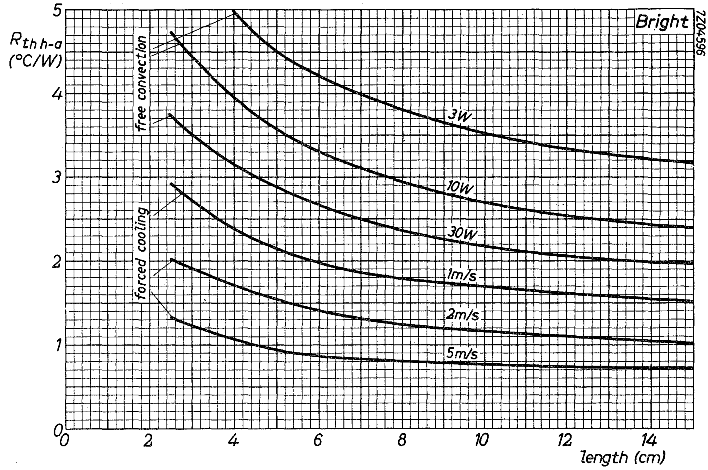


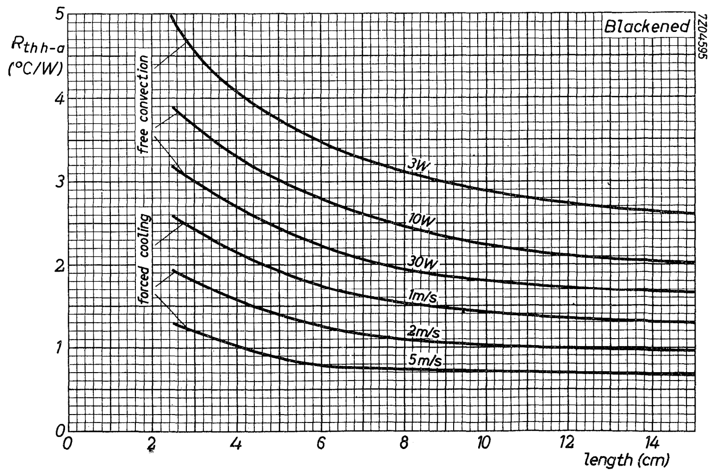




7Z3 0146

The graphs valid for the combination of rectifier device and heatsinks.



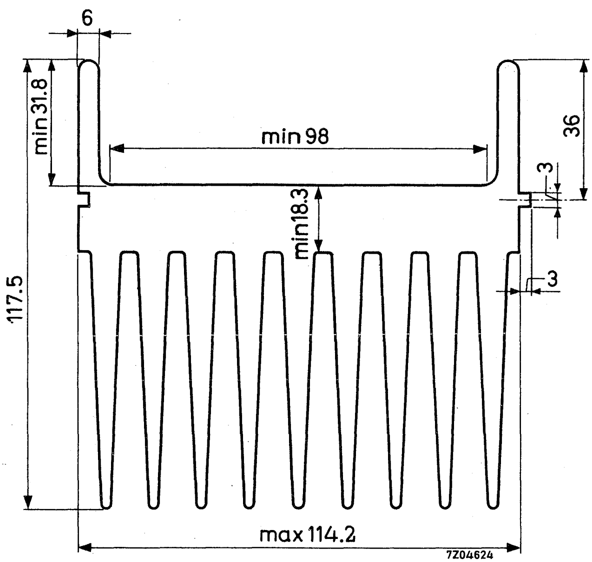


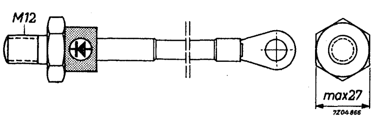
7Z3 0147

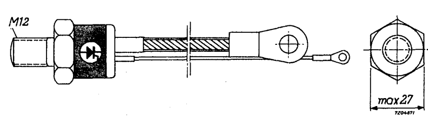
EXTRUDED ALUMINIUM HEATSINK

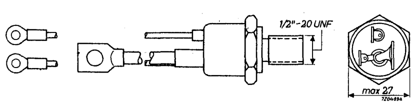
Extruded heatsink of aluminium alloy.
The extrusion is supplied unpainted, in lengths of 1.5 m.

Weight: 16.2 kg per 1.5 m.   Dimensions in mm



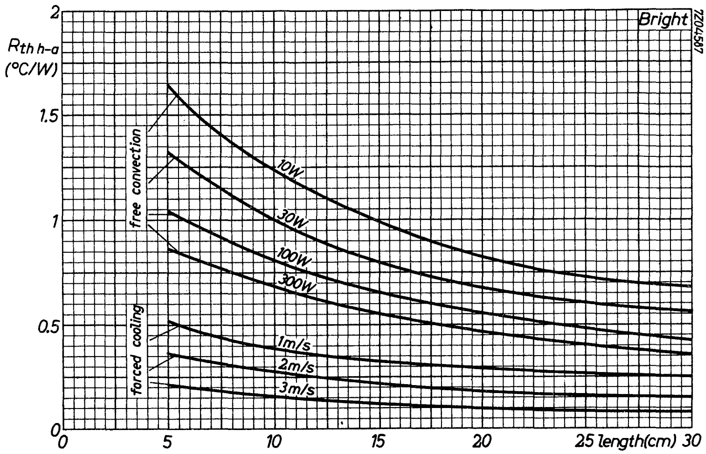


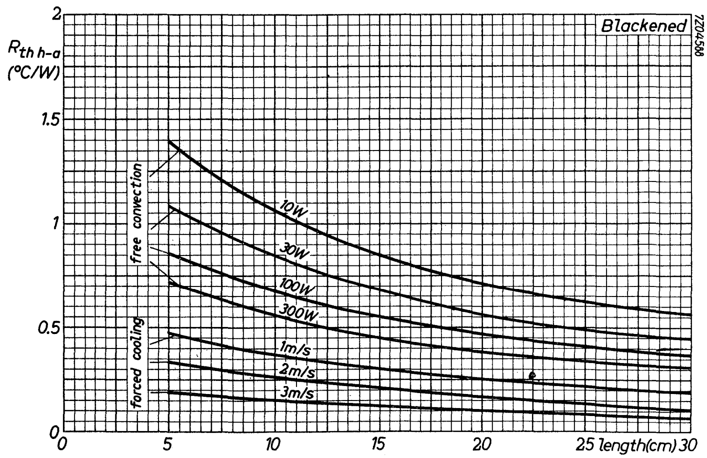




7Z3 0148

The graphs are valid for the combination of rectifier device and heatsink.
For devices with a flat base see page 77.



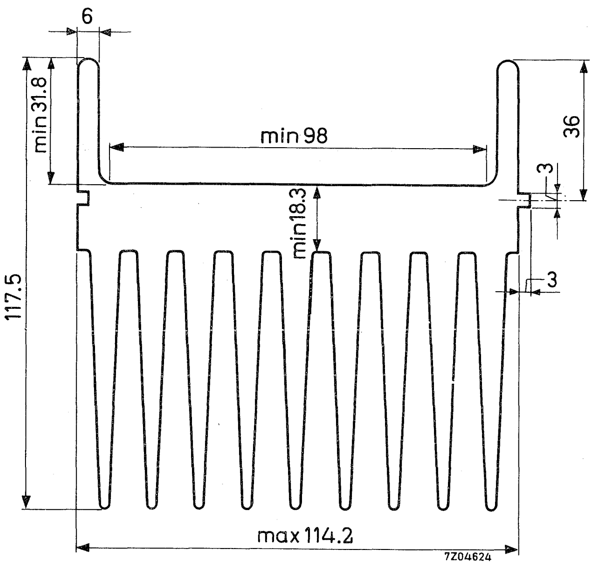


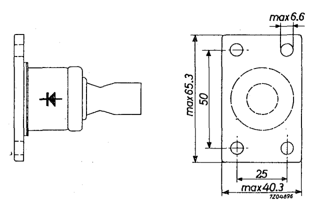
7Z3 1292

EXTRUDED ALUMINIUM HEATSINK

Extruded heatsink of aluminium alloy.
The extrusion is supplied unpainted, in lengths of 1.5 m.

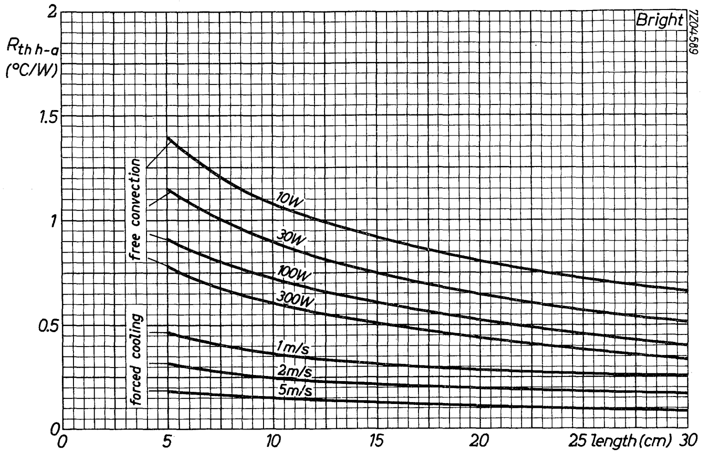
Weight: 16.2 kg per 1.5 m. Dimensions in mm

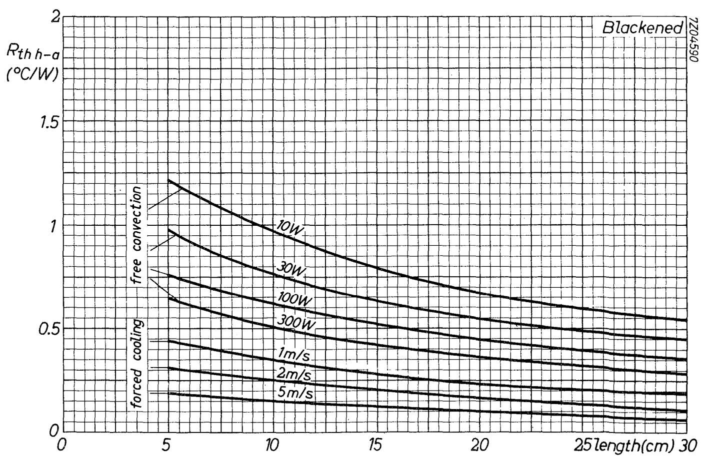




7Z3 0162

The graphs are valid for the combination of rectifier device and heatsink.
For devices with threaded studs see page 75.





7Z3 1293

Printed in Holland

9399 251 02001