PHILIPS

DATA HANDBOOK

ELECTRONIC COMPONENTS AND MATERIALS DIVISION

SEMICONDUCTORS AND INTEGRATED CIRCUITS

PART 4 DECEMBER 1969

Transmitting transistors

Field effect transistors

Dual transistors

Microminiature devices for thick- and thin-film circuits

Photo devices

Accessories

SEMICONDUCTORS AND INTEGRATED CIRCUITS

Part 4 **December 1969**

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 (9 parts)	BLUE
SEMICONDUCTORS AND INTEGRATED CIRCUITS (5 parts)	RED
COMPONENTS AND MATERIALS (5 parts)	GREEN

The several parts contain all pertinent data available at the time of publication, and each is revised and reissued annually; the contents of each series are summarized on the following pages.
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, may we ask that you contact our representative. He is at your service and will be glad to answer your inquiries.

7Z2 9287

ELECTRON TUBES (BLUE SERIES)

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

Part 1 — **December 1968**

Transmitting tubes (Tetrodes, Pentodes)
Associated accessories

Part 2 — **February 1969**

Tubes for microwave equipment

Part 3 — **March 1969**

Special Quality tubes
Miscellaneous devices

Part 4 — **April 1969**

Receiving tubes

Part 5 — **May 1969**

Cathode-ray tubes
Photo tubes
Camera tubes
Photoconductive devices
Associated accessories

Part 6 — **June 1969**

Photomultiplier tubes
Scintillators
Photoscintillators
Radiation counter tubes
Semiconductor radiation detectors
Neutron generator tubes

Part 7 — **July 1969**

Voltage stabilizing and reference tubes
Counter, selector, and indicator tubes
Trigger tubes
Switching diodes
Thyratrons
Ignitrons
Industrial rectifying tubes
High-voltage rectifying tubes

Part 8 — **August 1969**

T.V. Picture tubes

Part 9 — **December 1968**

Transmitting tubes (Triodes)
Tubes for R.F. heating (Triodes)
Associated accessories

7Z2 9299

SEMICONDUCTORS AND INTEGRATED CIRCUITS (RED SERIES)

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

Part 1 Diodes and Thyristors — **September 1969**

General
Signal diodes
Variable capacitance diodes
Voltage regulator diodes
Rectifier diodes
Thyristors, diacs, triacs
Rectifier stacks
Accessories
Heatsinks

Part 2 Low frequency; Deflection — **October 1969**

General
Low frequency transistors (low power)
Low frequency power transistors
Deflection transistors
Accessories

Part 3 High frequency; Switching — **November 1969**

General
High frequency transistors
Switching transistors
Accessories

Part 4 Special types — **December 1969**

General
Transmitting transistors
Field effect transistors
Dual transistors
Diodes and transistors for thick-and thin-film circuits
Photo devices
Accessories

Part 5 Integrated Circuits — **January 1969**

General section
Digital integrated circuits
Linear integrated circuits

COMPONENTS AND MATERIALS (GREEN SERIES)

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

Part 1 Circuit Blocks, Input/Output Devices **September 1969**

Circuit blocks 100kHz Series
Circuit blocks 1-Series
Circuit blocks 10-Series
Circuit blocks 20-Series
Circuit blocks 40- Series
Counter modules 50-Series
Norbits 60-Series
Circuit blocks for ferrite core memory drive
Input/output devices

Part 2 Resistors, Capacitors **November 1968**

Fixed resistors
Variable resistors
Non-linear resistors
Ceramic capacitors
Polycarbonate, paper, mica, polystyrene capacitors
Electrolytic capacitors
Variable capacitors

Part 3 Radio, Audio, Television **January 1969**

FM tuners
Coils and resonators
Audio and mains transformers
Loudspeakers
Electronic organ assemblies
Television tuners
Components for black and white television
Components for colour television
Deflection assemblies for camera tubes

Part 4 Magnetic Materials, White Ceramics **March 1969**

Ferrites for radio, audio and television
Ferroxcube potcores
Microchokes
Ferroxcube transformer cores
Piezoxide
Insulating and dielectric materials
Permanent magnet materials

Part 5 Memory Products, Magnetic Heads, Quartz Crystals, Microwave Devices, Variable Transformers, Electro-mechanical Components **June 1969**

Ferrite memory cores
Matrix planes, matrix stacks
Complete memories
Magnetic heads
Quartz crystal units, crystal filters
Isolators, circulators
Variable mains transformers
Electro-mechanical components

General

Type designation
Rating systems
Letter symbols

PRO ELECTRON TYPE DESIGNATION CODE

FOR SEMICONDUCTOR DEVICES

This type designation code applies to discrete devices and to multiple devices [1])

The type designation consists of:

TWO LETTERS FOLLOWED BY A SERIAL NUMBER

The first letter gives an indication of the material

A Material with a band gap of 0.6 to 1.0 eV, such as germanium

B Material with a band gap of 1.0 to 1.3 eV, such as silicon

C Material with a band gap of 1.3 eV and more, such as gallium arsenide

D Material with a band gap of less than 0.6 eV, such as indium antimonide

R Compound material as employed in Hall generators and photoconductive cells

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

Multiples of similar devices as well as multiples consisting of a main device and an auxiliary device are designated according to the code for discrete devices described above.
Multiples of dissimilar devices of other nature are designated by the second letter G.

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

A Detection diode, switching diode, mixer diode

B Variable capacitance diode

C Transistor for a.f. applications ($R_{th\ j-mb} > 15\ ^oC/W$)

D Power transistor for a.f. applications ($R_{th\ j-mb} \leq 15\ ^oC/W$)

E Tunnel diode

F Transistor for h.f. applications ($R_{th\ j-mb} > 15\ ^oC/W$)

G Multiple of dissimilar devices (see note on page 1); Miscellaneous

H Magnetic sensitive diode; Field probe

K Hall generator in an open magnetic circuit, e.g. magnetogram or signal probe

L Power transistor for h.f. applications ($R_{th\ j-mb} \leq 15\ ^oC/W$)

M Hall generator in a closed electrically energised magnetic circuit, e.g. Hall modulator or multiplier

P Radiation sensitive device [1]

Q Radiation generating device

R Electrically triggered controlling and switching device having a breakdown characteristic ($R_{th\ j-mb} > 15\ ^oC/W$)

S Transistor for switching applications ($R_{th\ j-mb} > 15\ ^oC/W$)

T Electrically, or by means of light, triggered controlling and switching power device having a breakdown characteristic ($R_{th\ j-mb} \leq 15\ ^oC/W$)

U Power transistor for switching applications ($R_{th\ j-mb} \leq 15\ ^oC/W$)

X Multiplier diode, e.g. varactor, step recovery diode

Y Rectifying diode, booster diode, efficiency diode

Z Voltage reference or voltage regulator diode

[1] For the type designation of a range see page 3.

The serial number consists of:

Three figures for semiconductor devices designed primarily for use in domestic equipment

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

VERSION LETTER

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

EXAMPLES

AC187	Germanium low power a.f. transistor intended primarily for domestic equipment
BYX27	Silicon rectifying diode intended primarily for professional equipment

TYPE DESIGNATION FOR A RANGE OF RADIATION DETECTORS

The type designation of a range of variants of radiation detectors distinctly belonging to one basic type may be qualified by a suffix part which is clearly seperated 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 figure giving the depth of the depletion layer in μm and where appropriate a version letter if there are differences in resolution.

RATING SYSTEMS

ACCORDING TO I.E.C. PUBLICATION 134

1. DEFINITIONS OF TERMS USED

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

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

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

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

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

Note: Limiting conditions may be either maxima or minima.

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

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

2. ABSOLUTE MAXIMUM RATING SYSTEM

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

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

p.t.o.

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

3. DESIGN MAXIMUM RATING SYSTEM

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

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

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

4. DESIGN CENTRE RATING SYSTEM

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

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

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

NOTE

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

LETTER SYMBOLS

LETTER SYMBOLS FOR SEMICONDUCTOR DEVICES
excluding rectifier diodes, thyristors and integrated circuits

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) or (rms)

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

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

A, a	=	Anode terminal
K, k	=	Cathode terminal
E, e	=	Emitter terminal
B, b	=	Base terminal or Substrate for MOS devices
C, c	=	Collector terminal
D, d	=	Drain terminal
(BR)	=	Break-down
X, x	=	Specified circuit
M, m	=	Maximum (peak) value
AV, av	=	Average value
(RMS), (rms)	=	R.M.S. value
F, f	=	Forward
G, g	=	Gate terminal
R, r	=	As first subscript: Reverse. As second subscript: Repetitive
O	=	As third subscript: The terminal not mentioned is open circuited
S	=	As first or second subscript: Source terminal (for FETS only) As second subscript: Non repetitive (not for FETS) 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.

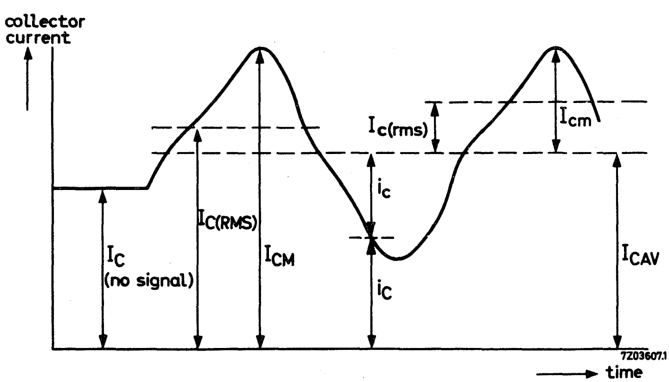


Fig.1

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.

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.

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

LIST OF LETTER SYMBOLS IN ALPHABETICAL ORDER

Letter symbol	Definition
B	Bandwidth
b_{ib}, b_{ie}, b_{is}, b_{fb}, b_{fe}, b_{fs}, b_{ob}, b_{oe}, b_{os}, b_{rb}, b_{re}, b_{rs}	See y parameters
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_{is}, C_{fb}, C_{fe}, C_{fs}, C_{ob}, C_{oe}, C_{os}, C_{rb}, C_{re}, C_{rs}	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
G_v	Voltage gain

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

Letter symbol	Definition
h_{FB}, h_{FC}, h_{FE}	D.C. current gain (static value of the forward current transfer ratio; output voltage held constant)
h_{fb}, h_{fc}, h_{fe}	Small-signal current gain (small-signal value of the forward current transfer ratio; 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.)
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_D, I_E, I_G, I_S	Total d.c. (or average) current
I_b, I_c, I_d, I_e, I_g, I_s	Varying component of the current
i_B, i_C, i_D, i_E, i_G, i_S	Instantaneous total value of the current
i_b, i_c, i_d, i_e, i_g, i_s	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)

Letter symbol	Definition
I_{DSS}	Drain cut-off current (source short-circuited to gate)
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
I_{GSS}	Gate cut-off current (source short-circuited to drain)
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_{SDS}	Source cut-off current (drain short-circuited to gate)
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

Letter symbol	Definition
r_D	Diode (internal) series resistance
r_{DS}	Drain-source resistance
r_{GS}	Gate-source resistance
R_L	Load resistance
R_S	Source resistance
R_{th}	Thermal resistance
$R_{th\ j\text{-}a}$	Thermal resistance from junction to ambient
$R_{th\ j\text{-}mb}$	Thermal resistance from junction to mounting base
$R_{th\ j\text{-}c}$	Thermal resistance from junction to case
$R_{th\ mb\text{-}h}$	Thermal resistance from mounting base to heatsink (contact thermal resistance)
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
t_d ; t_f	Delay time; 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

Letter symbols	Definition
V_{BEfl}	Base-emitter floating voltage (open base)
V_{BEsat}	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_{DGO}, V_{EBO}, V_{GSO}	Voltage of the terminal indicated by the first subscript w.r.t. the reference terminal (second subscript) with the third terminal open circuited
V_{CBOM}, V_{CEOM}	Peak value of V_{CBO}, V_{CEO}
V_{CEK}	Knee voltage at specified conditions
V_{CER}	Collector-emitter voltage with a specified resistance between emitter and base
V_{CERM}	Peak value of V_{CER}
V_{CES}	Collector-emitter voltage with the emitter short circuited to the base
V_{CEsat}	Saturation voltage at specified bottoming conditions
$V_{CE.sust}$	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_{DSS}	Drain-source voltage with the source short-circuited to the gate
V_{EBfl}	Emitter-base floating voltage (open emitter)
V_F	Continuous forward voltage of a diode
V_{FM}	Peak forward voltage of a diode

Letter symbol	Definition	
V_i, V_o	Input, respectively output voltage of a specified circuit	
$V_{(P)GS}$	Gate-source cut-off 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}, y_{is}	Input admittance	Output short circuited to a.c.
b_{ib}, b_{ie}, b_{is}		
g_{ib}, g_{ie}, g_{is}	Input conductance	
C_{ib}, C_{ie}, C_{is}	Input capacitance	
φ_{ib}, φ_{ie}, φ_{is}	Phase angle of input admittance	
y_{fb}, y_{fe}, y_{fs}	Transfer admittance	Output short circuited to a.c.
b_{fb}, b_{fe}, b_{fs}		
g_{fb}, g_{fe}, g_{fs}	Transfer conductance	
C_{fb}, C_{fe}, C_{fs}	Transfer capacitance	
φ_{fb}, φ_{fe}, φ_{fs}	Phase angle of transfer admittance	
y_{ob}, y_{oe}, y_{os}	Output admittance	Input short circuited to a.c.
b_{ob}, b_{oe}, b_{os}		
g_{ob}, g_{oe}, g_{os}	Output conductance	
C_{ob}, C_{oe}, C_{os}	Output capacitance	
φ_{ob}, φ_{oe}, φ_{os}	Phase angle of output admittance	
y_{rb}, y_{re}, y_{rs}	Feedback admittance	Input short circuited to a.c.
b_{rb}, b_{re}, b_{rs}		
g_{rb}, g_{re}, g_{rs}	Feedback conductance	
C_{rb}, C_{re}, C_{rs}	Feedback capacitance	
φ_{rb}, φ_{re}, φ_{rs}	Phase angle of feedback admittance	
Z_{th}	Transient thermal resistance or thermal impedance	

Transmitting transistors

GERMANIUM ALLOY DIFFUSED TRANSISTOR

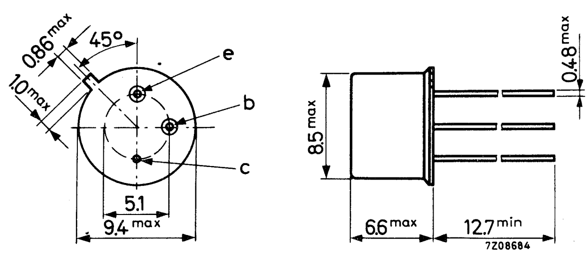
P-N-P transistor in a TO-39 metal envelope, primarily intended for use as a power amplifier in transmitting circuits up to frequencies of 180 MHz.

QUICK REFERENCE DATA				
Collector-base voltage (open emitter)	$-V_{CBO}$	max.	32	V
Collector-emitter voltage (V_{BE} = 0)	$-V_{CES}$	max.	32	V
Collector current (d.c.)	$-I_C$	max.	150	mA
Total power dissipation up to T_{case} = 65 °C	P_{tot}	max.	800	mW
Junction temperature	T_j	max.	90	°C
Transition frequency				
I_E = 100 mA; $-V_{CB}$ = 5 V	f_T	typ.	350	MHz

MECHANICAL DATA Dimensions in mm

TO-39

Collector connected to case



Accessories available: 56218, 56245, 56265

RATINGS (Limiting values) [1])

Voltages

Collector-base voltage (open emitter)	$-V_{CBO}$	max.	32	V
Collector-emitter voltage (V_{BE} = 0)	$-V_{CES}$	max.	32	V

Currents

Collector current (d.c.)	$-I_C$	max.	150	mA
Collector current (peak value)	$-I_{CM}$	max.	300	mA
Emitter current (d.c.)	I_E	max.	200	mA
Emitter current (peak value)	I_{EM}	max.	350	mA
Reverse emitter current (d.c.)	$-I_E$	max.	10	mA
Reverse emitter current (peak value)	$-I_{EM}$	max.	30	mA

Power dissipation

Total power dissipation up to T_{case} = 65 °C	P_{tot}	max.	800	mW

Temperatures

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

THERMAL RESISTANCE

From junction to ambient in free air	$R_{th\ j-a}$	=	0.25	°C/mW
on a heatsink of 12.5 cm^2	$R_{th\ j-a}$	=	0.08	°C/mW
From junction to case	$R_{th\ j-c}$	=	0.035	°C/mW

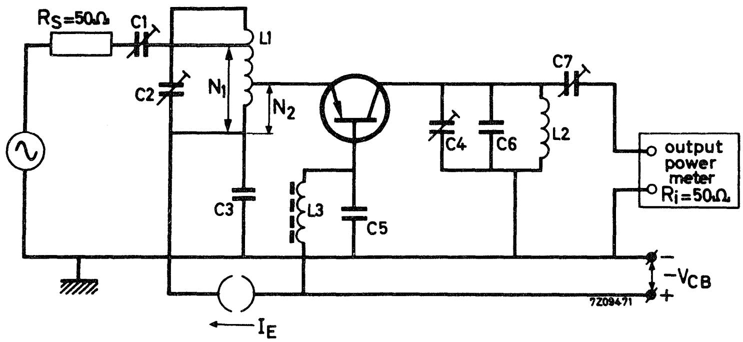
[1]) Limiting values according to the Absolute Maximum System as defined in IEC publication 134.

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

Collector cut-off current				
$I_E = 0$; $-V_{CB} = 10$ V	$-I_{CBO}$	<	10	μA
$I_E = 0$; $-V_{CB} = 32$ V	$-I_{CBO}$	<	1	mA
Emitter cut-off current				
$I_C = 0$; $-V_{EB} = 0.5$ V	$-I_{EBO}$	<	1	mA
Base current				
$I_E = 100$ mA; $-V_{CB} = 2$ V	$-I_B$	<	3	mA
$I_E = 80$ mA; $-V_{CB} = 12$ V	$-I_B$	typ.	1	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

APPLICATION INFORMATION

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



f	= 80	180 MHz
C1	= 50	15 pF
C2	= 50	15 pF
C3	= 10	1 nF
C4	= 50	15 pF
C5 [1]	= 10	0.12 nF
C6	= 82	0 pF
C7	= 100	15 pF

f	= 80	180 MHz
L1	= 0.1	0.08 μH
L2	= 0.03	0.02 μH
L3	= h.f. choke	
N_1/N_{tot}	= 1	0.5
N_2/N_{tot}	= 0.5	0.22
Q_1	> 150	200
Q_2	> 150	200

Performance in common base configuration

I_E = 80 mA; $-V_{CB}$ = 12 V

Output power at	f = 80 MHz	P_o	> 500	mW
	f = 180 MHz	P_o	> 400	mW
Power gain at	f = 80 MHz	G_p [2]	> 10	dB
	f = 180 MHz	G_p [2]	> 9	dB

Note

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

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

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

SILICON EMITTER GRID V.H.F. POWER TRANSISTORS

For data of the BFS22 please refer to types BLY87 to 89

For data of the BFS23 please refer to types BLY91 to 93

SILICON PLANAR EPITAXIAL TRANSISTORS

N-P-N transistors in a TO-39 metal envelope with the collector connected to the case. The BFY44 and BFY70 are primarily intended for use in v.h.f. medium power amplifiers or as output stage in small transmitters or as driver for transmitting tubes.

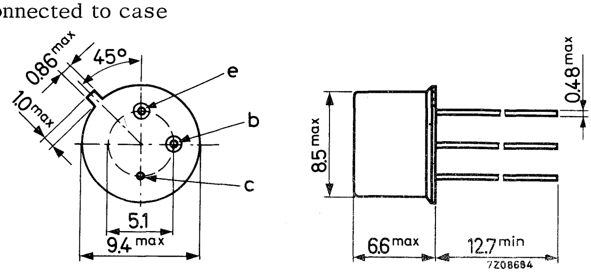
QUICK REFERENCE DATA

			BFY44	BFY70	
Collector-base voltage (open emitter)	V_{CBO}	max.	80	60	V
Collector-emitter voltage (open base)	V_{CEO}	max.	60	40	V
Emitter-base voltage (open collector)	V_{EBO}	max.	4	4	V
Collector current (d.c.)	I_C	max.	1	1	A
Total power dissipation up to T_{case} = 25 °C	P_{tot}	max.	5	5	W
Junction temperature	T_j	max.	200	200	°C
Saturation voltages I_C = 500 mA; I_B = 100 mA	V_{CEsat}	typ.	0.4	0.4	V
Transition frequency I_C = 100 mA; V_{CE} = 10 V	f_T	typ.	210	210	MHz
Performance in a specified circuit at f = 180 MHz					
Output power at V_{CE} = 40 V	P_o	typ.	2.1	-	W
Output power at V_{CE} = 28 V	P_o	typ.	-	1.5	W
Power gain	G_p	typ.	7	7	dB
Collector efficiency	η	typ.	50	50	%

MECHANICAL DATA

Dimensions in mm

Collector connected to case
TO-39



Accessories available: 56218, 56245, 56265

RATINGS (Limiting values) [1])

Voltages

			BFY44	BFY70	
Collector-base voltage (open emitter)	V_{CBO}	max.	80	60	V
Collector-emitter voltage (open base)	V_{CEO}	max.	60	40	V
Emitter-base voltage (open collector)	V_{EBO}	max.	4	4	V

Currents

Collector current (d.c.)	I_C	max.	1.0	A
Collector current (peak value)	I_{CM}	max.	1.0	A
Base current (d.c.)	I_B	max.	0.2	A
Base current (peak value)	I_{BM}	max.	0.2	A

Power dissipation

Total power dissipation up to $T_{case} = 25\,^{o}C$	P_{tot}	max.	5	W

Temperatures

Storage temperature	T_{stg}		-65 to +200	^{o}C
Junction temperature	T_j	max.	200	^{o}C

THERMAL RESISTANCE

From junction to case	$R_{th\ j\text{-}c}$	=	35	$^{o}C/W$

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

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

			BFY44	BFY70	
Collector cut-off current					
$I_E = 0$; $V_{CB} = 40$ V	I_{CBO}	typ.	3	-	nA
		<	500	-	nA
$I_E = 0$; $V_{CB} = 28$ V	I_{CBO}	typ.	-	3	nA
		<	-	500	nA
$I_E = 0$; $V_{CB} = 40$ V; $T_j = 150\ ^oC$	I_{CBO}	typ.	1.5	-	μA
		<	50	-	μA
$I_E = 0$; $V_{CB} = 28$ V; $T_j = 150\ ^oC$	I_{CBO}	typ.	-	1.5	μA
		<	-	50	μA
Emitter cut-off current					
$I_C = 0$; $V_{EB} = 1$ V	I_{EBO}	typ.	1	1	nA
		<	500	500	nA
$I_C = 0$; $V_{EB} = 4$ V	I_{EBO}	<	100	100	μA
Sustaining voltages					
$I_C = 10$ mA; $I_B = 0$	$V_{CEOsust}$	>	60	40	V
$I_C = 1$ mA; $R_{BE} = 10\ \Omega$	$V_{CERsust}$	>	80	60	V
$I_C = 0.5$ mA; $V_{BE} = 0$	$V_{CESsust}$	>	80	60	V

Saturation voltages (BFY44 and BFY70)

$I_C = 500$ mA; $I_B = 100$ mA	V_{CEsat}	typ.	0.4	V
		<	0.7	V
	V_{BEsat}	typ.	1.0	V
		<	1.5	V

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

D.C. current gain

I_C = 150 mA; V_{CE} = 10 V	h_{FE}	typ.	20	
I_C = 500 mA; V_{CE} = 5 V	h_{FE}	>	5	
		typ.	20	

Collector capacitance at f = 1 MHz

$I_E = I_e = 0$ BFY44 : V_{CB} = 40 V	C_c	typ.	7	pF
		<	12	pF
$I_E = I_e = 0$ BFY70 : V_{CB} = 28 V	C_c	typ.	7	pF
		<	14	pF

Transition frequency

I_C = 100 mA; V_{CE} = 10 V	f_T	typ.	210	MHz

Feedback time constant at f = 10.7 MHz

$-I_E$ = 30 mA; V_{CB} = 20 V	$\left\lvert \frac{h_{rb}}{\omega} \right\rvert$	typ.	18	ps
		<	35	ps

y parameters at f = 180 MHz (common base) T_{amb} = 25 °C

$-I_E$ = 150 mA; V_{CB} = 24 V

Input conductance	g_{ib}	typ.	48	$m\Omega^{-1}$
Input capacitance	$-C_{ib}$	typ.	120	pF
Transfer admittance	$\lvert y_{fb} \rvert$	typ.	98	$m\Omega^{-1}$
Phase angle of transfer admittance	φ_{fb}	typ.	62°	
Output conductance	g_{ob}	typ.	4.3	$m\Omega^{-1}$
Output capacitance	C_{ob}	typ.	13.5	pF

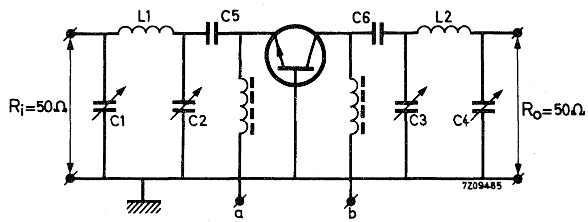
y parameters at f = 180 MHz (common emitter)

I_C = 150 mA; V_{CE} = 24 V

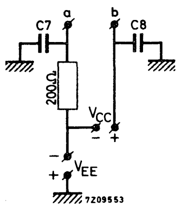
Input conductance	g_{ie}	typ.	96	$m\Omega^{-1}$
Input capacitance	$-C_{ie}$	typ.	32	pF

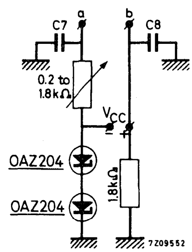
APPLICATION INFORMATION

A. Amplifier circuit



Different methods of biasing





Components	f = 100 MHz	f = 180 MHz
C1, C2, C4	25 pF variable air capacitor + 22 pF mica	25 pF variable air capacitor
C3	25 pF variable air capacitor	25 pF variable air capacitor
C5, C6, C7, C8	3.3 nF	1 nF
L1	2 turns Cu wire (1 mm); d = 12 mm	1 turn Cu wire (1.2 mm); d = 12 mm
L2	3.5 turns Cu wire (1 mm); d = 12 mm	2 turns Cu wire (1.2 mm); d = 12 mm

Performance in common base configuration

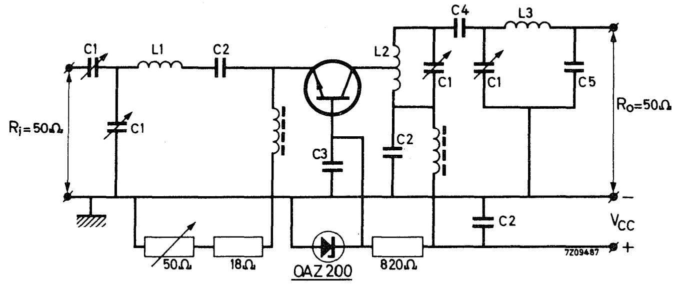
BFY44: V_{CE} = 40 V; P_i = 0.425 W

BFY70: V_{CE} = 28 V; P_i = 0.3 W

			BFY44	BFY70	
Output power	P_o	>	1.7	1.2	W
		typ.	2.1	1.5	W
Power gain	G_p	>	6.0		dB
		typ.	7.0		dB
Collector efficiency	η	>	40		%
		typ.	50		%

APPLICATION INFORMATION (continued)

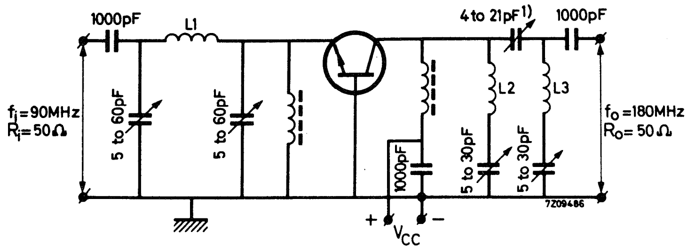
B. Amplifier circuit



Components	f = 80 MHz	f = 165 MHz
C1	60 pF	25 pF
C2	680 pF	100 pF
C3	680 pF	82 pF
C4	4.7 pF	2.2 pF
C5	82 pF	33 pF
L1	2 turns Cu wire (1 mm); d = 10 mm	straight Cu wire (1 mm); length 40 mm
L2	3 turns enamelled Cu wire (1.5 mm); d = 12 mm	2 turns Cu wire (1 mm); d = 10 mm
Tap	1.2 turn from cold side	0.8 turn from cold side
L3	3 turns enamelled Cu wire (1.5 mm); d = 12 mm	2 turns Cu wire (1 mm); d = 10 mm

APPLICATION INFORMATION (continued)

C. Frequency doubler 90-180 MHz



L1	≈	70 nH;	1.5 turns	Cu wire (1.2 mm); d = 12 mm
L2	≈	90 nH;	2 turns	
L3	≈	140 nH;	3 turns	

Typical performance

V_{CE} (V)	I_C (mA)	P_i = (mW) f_i = 90 MHz	P_o (mW) f_o = 180 MHz	G_p (dB)	η (%)
40 2)	110	130	920	8.5	21
30	94	110	700	8.0	25
20	82	110	460	6.2	28

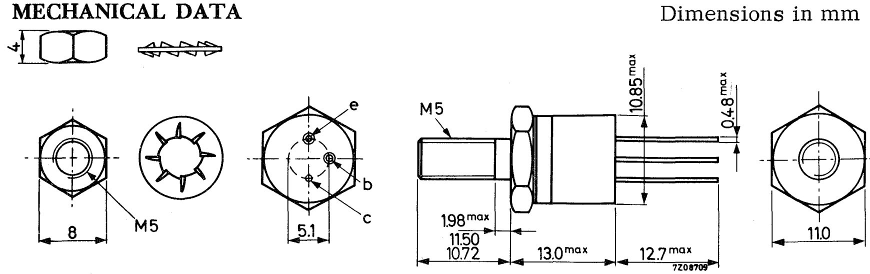
1) Variable ceramic capacitor
2) V_{CE} = 40 V is for BFY44 only

SILICON PLANAR EPITAXIAL TRANSISTOR

N-P-N transistor in a metal envelope. All electrodes are electrically insulated from the stud.
The BLY14 is intended for high frequency and high power applications, primarily for use in the transmitting field.

QUICK REFERENCE DATA				
Collector-base voltage (open emitter)	V_{CBO}	max.	80	V
Collector-emitter voltage (V_{BE} = 0)	V_{CES}	max.	80	V
Collector current (peak value)	I_{CM}	max.	1.0	A
Total power dissipation up to T_{mb} = 25 °C, f ≥ 1 MHz	P_{tot}	max.	8.75	W
Junction temperature	T_j	max.	200	°C
D.C. current gain at T_j = 25 °C; $-I_E$ = 500 mA; V_{CB} = 10 V	h_{FE}	typ.	11	
Transition frequency; I_C = 100 mA; V_{CE} = 10 V	f_T	typ.	190	MHz
Performance in a specified circuit; V_{CE} = 40 V; P_i = 0.625 W; f = 180 MHz				
Output power	P_o	>	3	W
Power gain	G_p	>	6.8	dB
Collector efficiency	η	>	40	%

MECHANICAL DATA Dimensions in mm



Collector is connected to the can (upper part of the envelope)
Torque on nut: max. 18 cm kg

RATINGS (Limiting values) [1])

Voltages

Collector-base voltage (open emitter)	V_{CBO}	max.	80	V
Collector-emitter voltage (V_{BE} = 0)	V_{CES}	max.	80	V
Collector-emitter voltage (open base)	V_{CEO}	max.	55	V
Emitter-base voltage (open collector)	V_{EBO}	max.	4	V

Currents

Collector current (d.c.)	I_C	max.	1.0	A
Collector current (peak value)	I_{CM}	max.	1.0	A
Base current (d.c.)	I_B	max.	0.2	A
Base current (peak value)	I_{BM}	max.	0.2	A

Power dissipation

Total power dissipation up to T_{mb} = 25 °C	P_{tot}	max.	8.75	W

Temperatures

Storage temperature	T_{stg}	-65 to +200		°C
Junction temperature	T_j	max.	200	°C

THERMAL RESISTANCE

From junction to mounting base	$R_{th\ j\text{-}mb}$	=	20	°C/W

CHARACTERISTICS T_j = 25 °C unless otherwise specified

Collector cut-off current

I_E = 0; V_{CB} = 40 V	I_{CBO}	typ.	1	nA
		<	500	nA
I_E = 0; V_{CB} = 40 V; T_j = 150 °C	I_{CBO}	typ.	0.8	μA
		<	50	μA
V_{CE} = 80 V; R_{BE} = 10 Ω	I_{CER}	<	1	mA
I_B = 0; V_{CE} = 55 V	I_{CEO}	<	10	mA

Emitter cut-off current

I_C = 0; V_{EB} = 1 V	I_{EBO}	typ.	2	nA
		<	500	nA
I_C = 0; V_{EB} = 4 V	I_{EBO}	<	100	μA

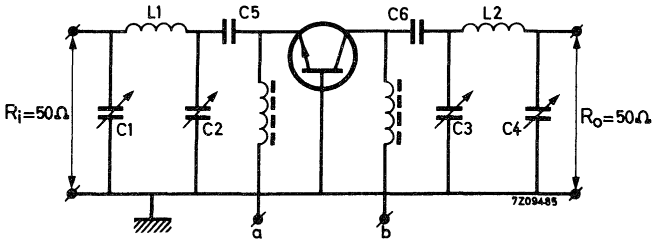
[1]) Limiting values according to the Absolute Maximum System as defined in IEC publication 134.

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

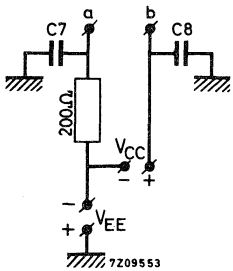
Saturation voltages				
I_C = 500 mA; I_B = 100 mA	V_{CEsat}	typ.	0.3	V
		<	0.7	V
	V_{BEsat}	typ.	1.1	V
		<	1.5	V
D.C. current gain				
$-I_E$ = 10 mA; V_{CB} = 10 V	h_{FE}	typ.	9	
$-I_E$ = 150 mA; V_{CB} = 10 V	h_{FE}	typ.	11	
$-I_E$ = 500 mA; V_{CB} = 10 V	h_{FE}	>	5	
		typ.	11	
Collector capacitance at f = 1 MHz				
$I_E = I_e$ = 0; V_{CB} = 40 V	C_c	typ.	7.5	pF
		<	10	pF
Capacitance between collector and stud		typ.	3.7	pF
		<	5	pF
Transition frequency				
I_C = 100 mA; V_{CE} = 10 V	f_T	typ.	190	MHz
Feedback time constant at f = 10 MHz				
$-I_E$ = 30 mA; V_{CB} = 40 V	$\left\lvert \frac{h_{rb}}{\omega} \right\rvert$	typ.	10.5	ps
		<	35	ps
y parameters in common base configuration				
$-I_E$ = 150 mA; V_{CB} = 24 V; f = 180 MHz				
Input conductance	g_{ib}	typ.	48	$m\Omega^{-1}$
Input capacitance	$-C_{ib}$	typ.	120	pF
Transfer admittance	$\lvert y_{fb} \rvert$	typ.	98	$m\Omega^{-1}$
Phase angle of transfer admittance	φ_{fb}	typ.	62°	
Output conductance	g_{ob}	typ.	4.3	$m\Omega^{-1}$
Output capacitance	C_{ob}	typ.	13.5	pF
y parameters in common emitter configuration				
I_C = 150 mA; V_{CE} = 24 V; f = 180 MHz				
Input conductance	g_{ie}	typ.	96	$m\Omega^{-1}$
Input capacitance	$-C_{ie}$	typ.	32	pF

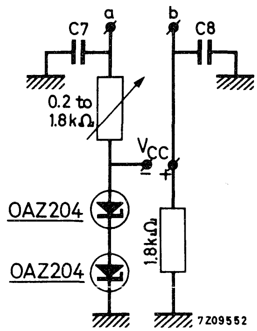
APPLICATION INFORMATION

Amplifier circuit



Different methods of biasing





Components	f = 100 MHz	f = 180 MHz
C1, C2, C3, C4	25 pF	25 pF
C5, C6, C7, C8	3.3 nF	1 nF
L1	2 turns Cu wire (1 mm); d = 12 mm	1 turn Cu wire (1.2 mm); d = 12 mm
L2	3.5 turns Cu wire (1 mm); d = 12 mm	2 turns Cu wire (1.2 mm); d = 12 mm

Performance in common base configuration

V_{CE} = 40 V; P_i = 0.625 W

f = 180 MHz; T_{mb} = 25 °C

Output power	P_o	>	3.0	W
		typ.	3.6	W
Power gain	G_p	>	6.8	dB
		typ.	7.6	dB
Collector efficiency	η	>	40	%
		typ.	48	%

TRIPLE DIFFUSED SILICON PLANAR TRANSISTOR

N-P-N triple diffused transistor in a TO-36 metal envelope.
The BLY17 is intended for high frequency and high power applications, primarily for use in the transmitting field.

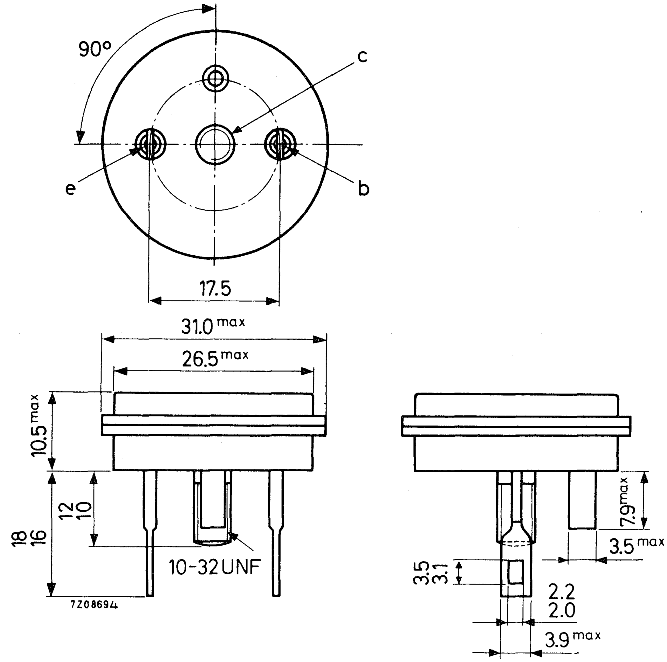
QUICK REFERENCE DATA

Collector-base voltage (open emitter)	V_{CBO}	max.	100	V
Collector-emitter voltage ($R_{BE} \leq 10\ \Omega$)	V_{CER}	max.	100	V
Collector current (peak value)	I_{CM}	max.	10	A
Total power dissipation up to T_{mb} = 25 °C, $f \geq 0.5$ MHz	P_{tot}	max.	100	W
Junction temperature	T_j	max.	175	°C
D.C. current gain at T_j = 25 °C; $-I_E$ = 1 A; V_{CB} = 0	h_{FE}	typ.	25	
Transition frequency; I_C = 1.5 A; V_{CE} = 10 V	f_T	typ.	70	MHz
Performance in a specified circuit at f = 30 MHz; V_{CE} = 40 V; V_{BE} = 0; P_i = 7.5 W				
Output power	P_o	>	30	W
Power gain	G_p	>	6	dB
Collector efficiency	η	>	40	%

MECHANICAL DATA See page 2

MECHANICAL DATA Dimensions in mm

TO-36



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

Torque on nut: min. 8 cm kg
max. 17 cm kg

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

Collector-base voltage (open emitter)	V_{CBO}	max.	100	V
Collector-emitter voltage ($R_{BE} \leq 10\ \Omega$)	V_{CER}	max.	100	V
Emitter-base voltage (open collector)	V_{EBO}	max.	4	V
Collector current (d.c.)	I_C	max.	10	A
Collector current (peak value)	I_{CM}	max.	10	A
Base current (d.c. or average over any 20 ms period)	I_B	max.	2	A
Total power dissipation up to T_{mb} = 25 °C f ≥ 0.5 MHz	P_{tot}	max.	100	W
Storage temperature	T_{stg}		−65 to +175	°C
Junction temperature	T_j	max.	175	°C

THERMAL RESISTANCE

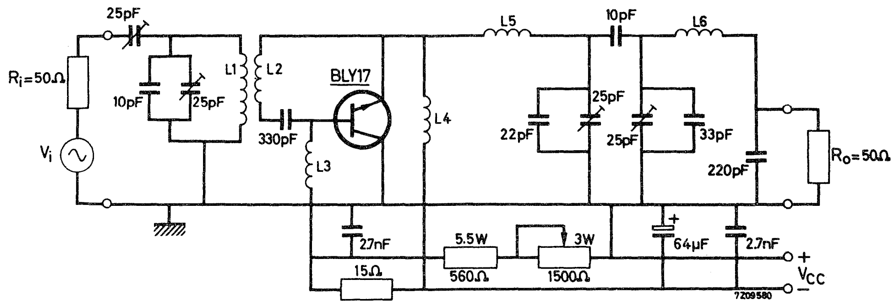
From junction to mounting base $R_{th\ j\text{-}mb}$ = 1.5 °C/W

CHARACTERISTICS T_j = 25 °C unless otherwise specified

Collector cut-off current				
I_E = 0; V_{CB} = 40 V	I_{CBO}	typ.	0.1	mA
		<	10	mA
I_E = 0; V_{CB} = 40 V; T_j = 150 °C	I_{CBO}	typ.	0.2	mA
		<	50	mA
I_E = 0; V_{CB} = 100 V	I_{CBO}	typ.	0.6	mA
		<	20	mA
I_E = 0; V_{CB} = 100 V; T_j = 150 °C	I_{CBO}	typ.	1	mA
		<	80	mA
V_{CE} = 80 V; R_{BE} = 10 Ω	I_{CER}	typ.	0.3	mA
		<	50	mA
V_{CE} = 80 V; R_{BE} = 10 Ω; T_j = 150 °C	I_{CER}	typ.	1	mA
		<	100	mA
Emitter cut-off current				
I_C = 0; V_{EB} = 4 V	I_{EBO}	typ.	0.03	mA
		<	100	mA
Saturation voltages				
I_C = 10 A; I_B = 2 A	V_{CEsat}	typ.	0.5	V
		<	2.0	V
	V_{BEsat}	typ.	1.2	V
		<	3.0	V
D.C. current gain				
$-I_E$ = 1 A; V_{CB} = 0	h_{FE}	>	5	
		typ.	25	
$-I_E$ = 5 A; V_{CB} = 0	h_{FE}	>	5	
		typ.	13	
$-I_E$ = 10 A; V_{CB} = 0	h_{FE}	>	5	
		typ.	9	
Collector capacitance at f = 1 MHz				
I_E = I_e = 0; V_{CB} = 40 V	C_c	typ.	100	pF
		<	150	pF
Transition frequency				
I_C = 1.5 A; V_{CE} = 10 V	f_T	>	50	MHz
		typ.	70	MHz
Feedback time constant at f = 10 MHz				
$-I_E$ = 1.5 A; V_{CB} = 10 V	$\left\lvert \frac{h_{rb}}{\omega} \right\rvert$	typ.	140	ps

APPLICATION INFORMATION

Linear amplifier circuit for 'single side band'



COIL DATA

L1 = 8 turns enamelled Cu wire (1.2 mm); d = 12 mm

L2 = 2 turns enamelled Cu wire (1.2 mm); d = 12 mm
L_2 is coupled to the 'cold' side of L_1.

L3 = 40 turns enamelled Cu wire (0.3 mm); d = 6 mm

L4 = 27 turns enamelled Cu wire (0.45 mm); d = 6 mm

L5 = 10 turns enamelled Cu wire (1.2 mm); d = 12 mm

L6 = 9 turns enamelled Cu wire (1.2 mm); d = 12 mm

PERFORMANCE V_{CE} = 40 V; f = 28 MHz; T_{mb} = 25 °C

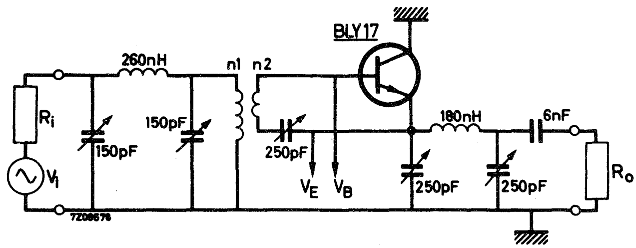
Peak envelope power		P.E.P.		20	W
Intermodulation distortion	of the third order	d_3	typ.	−32	dB
	of the fifth order	d_5	typ.	−32	dB
Power gain		G_p	typ.	8	dB
Collector current	without drive [1]	I_C		60	mA
	with full drive [2]	I_{CAV}	typ.	880	mA

[1]) Adjustable with the variable resistor.

[2]) Corresponding with a P.E.P. of 20 W.

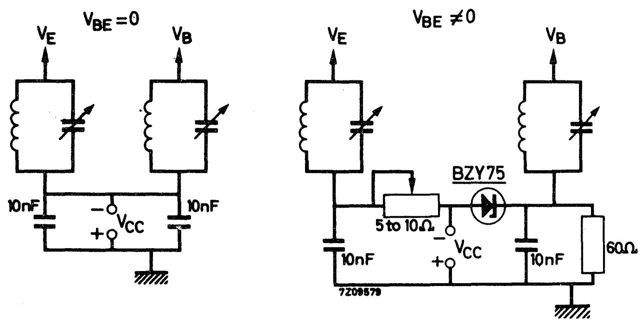
APPLICATION INFORMATION (continued)

Amplifier circuit



n1 = 6 turns (2 mm); d = 20 mm } closely coupled
n2 = 2 turns (2 mm); d = 20 mm

Alternative methods of biasing



PERFORMANCE in common emitter configuration

V_{CE} = 40 V ; V_{BE} = 0

P_i = 7.5 W; f = 30 MHz; T_{mb} = 25 °C

Output power	P_o	>	30	W
		typ.	40	W
Power gain	G_p	>	6	dB
		typ.	7.5	dB
Collector efficiency	η	>	40	%
		typ.	55	%

U.H.F. TRANSMITTING TRANSISTORS

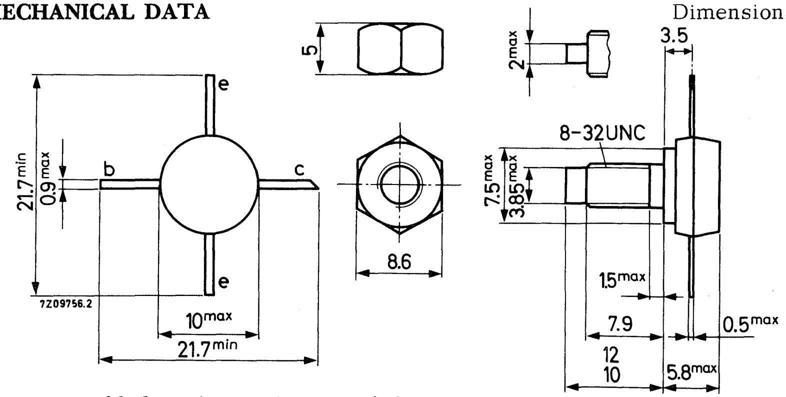
N-P-N silicon planar epitaxial transistors in a capstan envelope. The transistors are intended for battery operated f.m. transmitters with a supply voltage of up to 13.8 V for the BLY53 or up to 28 V for the BLY37.

QUICK REFERENCE DATA

			BLY53	BLY37	
Collector-base voltage (peak value)	V_{CBOM}	max.	36	65	V
Collector-emitter voltage (open base)	V_{CEO}	max.	18	36	V
Collector current (peak value)	I_{CM}	max.	4	2.5	A
Total power dissipation f > 1 MHz	P_{tot}	max.	15	10	W
Junction temperature	T_j	max.	200	200	^oC
Transition frequency at f = 100 MHz I_C = 0.5 A; V_{CE} = 5 V	f_T	typ.	800	800	MHz
Output power at f = 470 MHz P_i = 2.0 W; V_{CE} = 13.8 V	P_o	>	6		W
P_i = 1.5 W; V_{CE} = 28 V	P_o	>		6	W

MECHANICAL DATA

Dimensions in mm



Diameter of hole in heatsink: max. 4.17 mm

Torque on nut: min. 7.5 cm kg
max. 8.5 cm kg

When locking is required, an adhesive instead of a lock washer is preferred.

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

			BLY53	BLY37	
Voltages					
Collector-base voltage (open emitter) peak value; I_C = 10 mA	V_{CBOM}	max.	36	65	V
Collector-emitter voltage (open base) I_C = 10 mA	V_{CEO}	max.	18	36	V
Emitter-base voltage (open collector) I_E = 10 mA	V_{EBO}	max.	4	4	V
Currents					
Collector current (average)	I_{CAV}	max.	1.3	0.75	A
Collector current (peak value)	I_{CM}	max.	4	2.5	A
Emitter current (peak value)	I_{EM}	max.	4	2.5	A
Power dissipation					
Total power dissipation f > 1 MHz	P_{tot}	max.	15	10	W

Temperatures

Storage temperature	T_{stg}		−30 to +200	°C
Junction temperature	T_j	max.	200	°C

THERMAL RESISTANCE

From junction to heatsink	$R_{th\ j\text{-}h}$	=	12.5	°C/W

CHARACTERISTICS T_j = 25 °C unless otherwise specified

			BLY53	BLY37	
Base-emitter voltage [1]					
I_C = 0.5 A; V_{CE} = 5 V	V_{BE}	<	1.5	1.5	V
Saturation voltage					
I_C = 0.5 A; I_B = 0.1 A	V_{CEsat}	<	0.5	0.5	V
D.C. current gain					
I_C = 0.5 A; V_{CE} = 5 V	h_{FE}	typ.	50	35	
Transition frequency at f = 100 MHz					
I_C = 0.5 A; V_{CE} = 5 V	f_T	typ.	800	800	MHz
Collector capacitance at f = 1 MHz					
$I_E = I_e = 0$; V_{CB} = 13.8 V	C_c	typ.	10		pF
$I_E = I_e = 0$; V_{CB} = 28 V	C_c	typ.		8	pF
Collector-stud capacitance		typ.	2	2	pF
h parameters at f = 470 MHz					
I_C = 0.5 A; V_{CE} = 5 V					
Input resistance	$Re(h_{ie})$	typ.	4	4	Ω
Input reactance	$Im(h_{ie})$	typ.	13	13	Ω

[1] V_{BE} decreases by about 1.5 mV/°C with increasing temperature.

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

R.F. performance at f = 470 MHz (common emitter) of the BLY53

V_{CE} = 13.8 V; P_o = 6 W

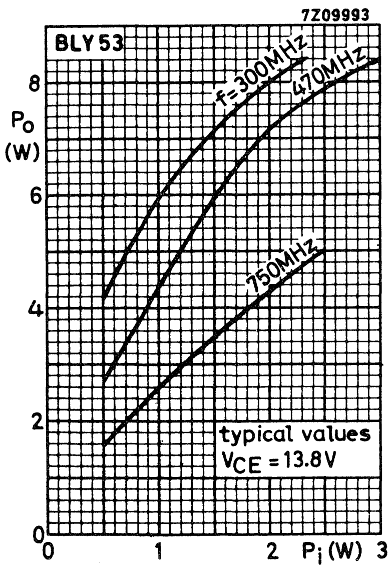
P_i	<	2	W
G_p	>	4.7	dB
η	>	60	%

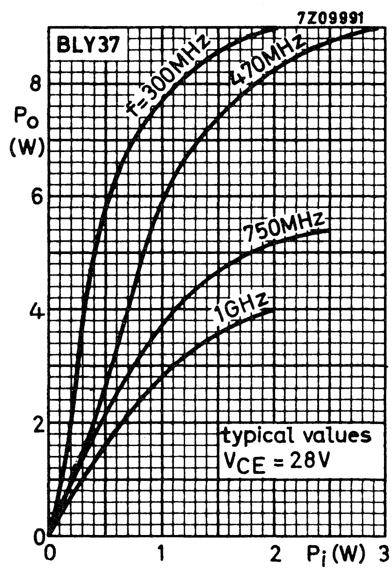
R.F. performance at f = 470 MHz (common emitter) of the BLY37

V_{CE} = 28 V; P_o = 6 W

P_i	<	1.5	W
G_p	>	6	dB
η	>	60	%

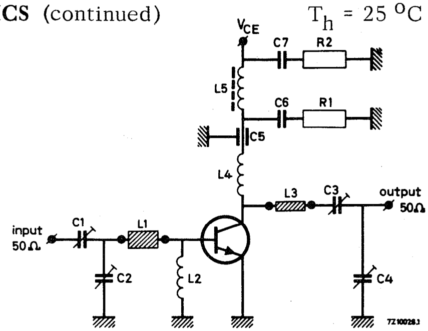
All transistors are tested with a V.S.W.R. of 50 varied through all phases.





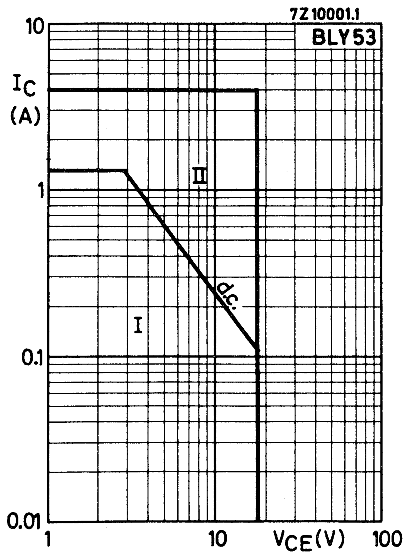
CHARACTERISTICS (continued) T_h = 25 °C unless otherwise specified

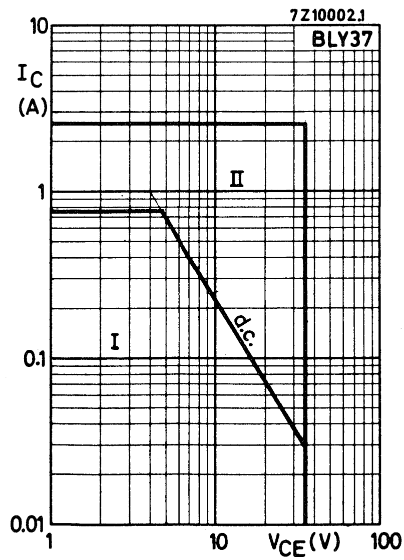
Test circuit:



Components:

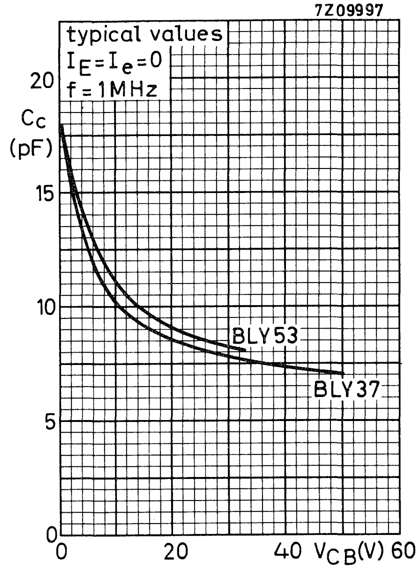
C1 = C2 = C3 = C4 = 1 to 17 pF air trimmer
C5 = 100 pF disk ceramic by-pass
C6 = C7 = 10 nF paper
R1 = R2 = 10 Ω
L1 = 35 mm x 6 mm straight Cu strip
L2 = 5 turns Cu wire (0.6 mm); internal diameter 8 mm
L3 = 25 mm straight Cu wire (1.5 mm)
L4 = 3 turns Cu wire (1.0 mm); internal diameter 3.5 mm; winding pitch 2 mm; leads 2x10 mm
L5 = FXC choke (codenumber 4312 020 36640)

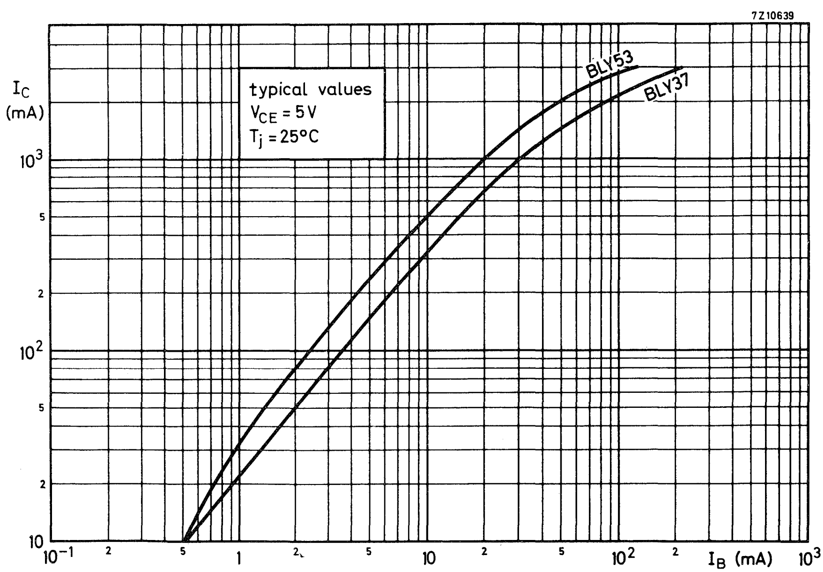


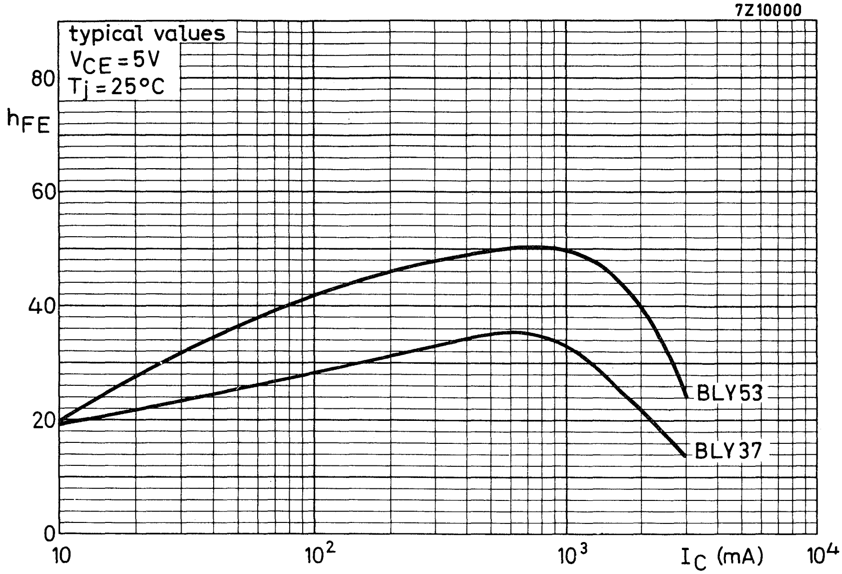


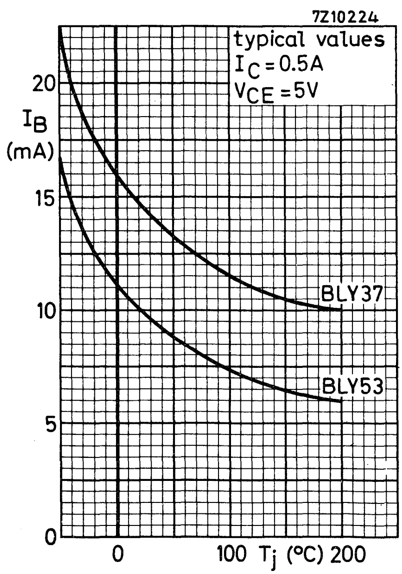
I Region of permissible operation under all base-emitter conditions and at all frequencies, including d.c.

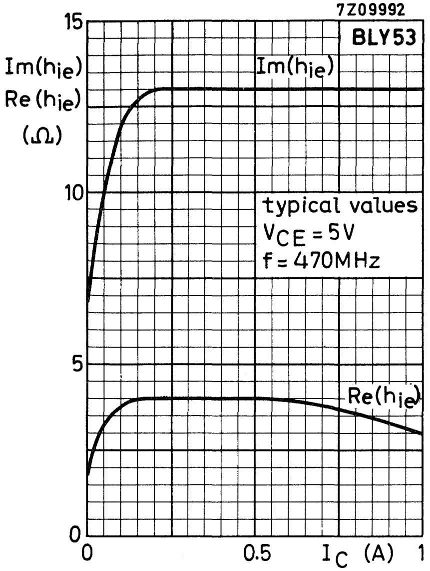
II Additional region of operation at f > 1 MHz.
Care must be taken to reduce the d.c. adjustment to region I before removing the a.c. signal. This may be achieved by an appropriate bias in class A, B or C

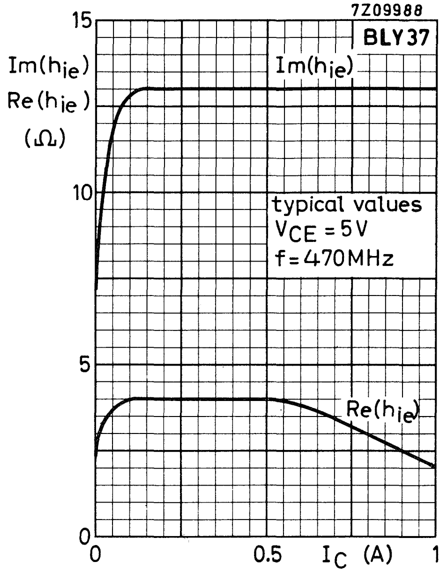

7Z09997
typical values
$I_E = I_e = 0$
f = 1 MHz
C_c (pF)
20
15
10
5
0
0
20
40
V_{CB}(V) 60
BLY53
BLY37

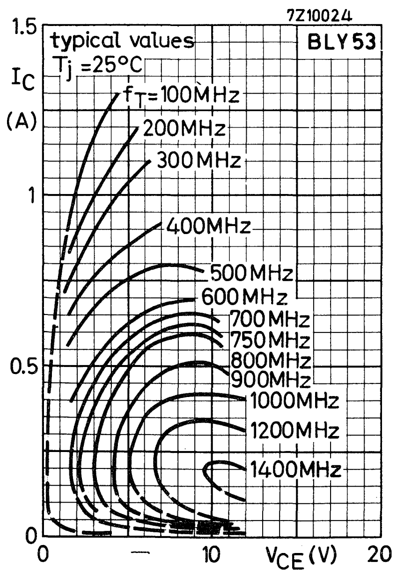

7Z10639
I_C (mA)
typical values
$V_{CE} = 5\,V$
$T_j = 25°C$
BLY53
BLY37
10^3
5
2
10^2
5
2
10
10^{-1}
2
5
1
2
5
10
2
5
10^2
2
I_B (mA)
10^3

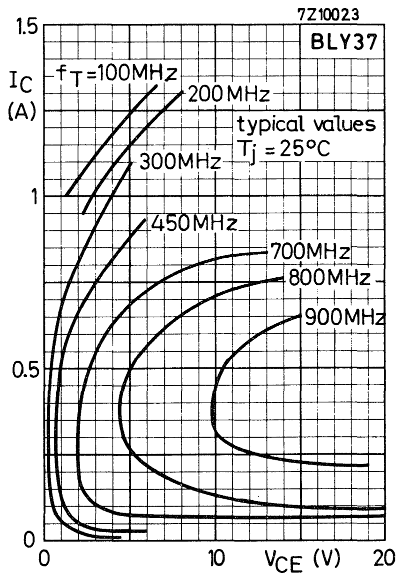

7Z10000
typical values
$V_{CE} = 5V$
$T_j = 25°C$
h_{FE}
80
60
40
20
0
10
10^2
10^3
I_C (mA)
10^4
BLY53
BLY37

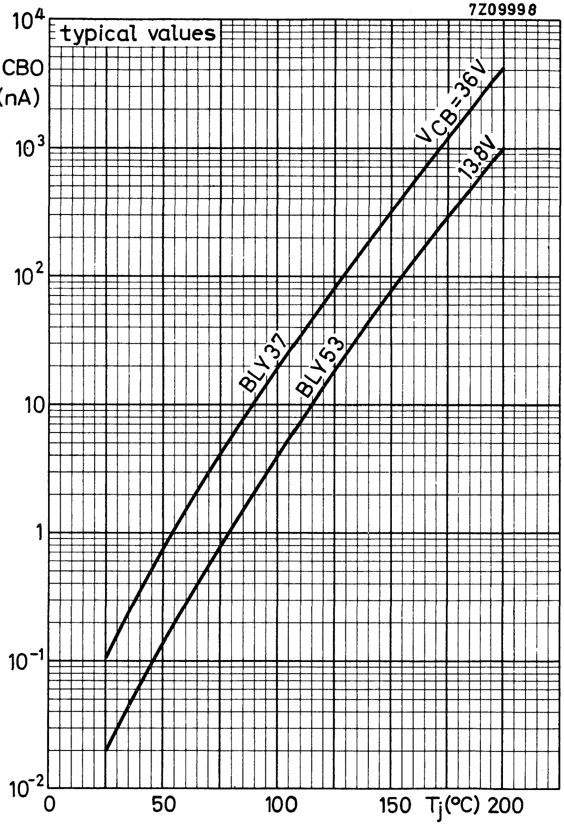

7Z10224
typical values
$I_C = 0.5A$
$V_{CE} = 5V$
I_B (mA)
20
15
10
5
0
0
100 T_j (°C) 200
BLY37
BLY53


7Z09992
BLY53
Im(hie)
Re(hie)
(Ω)
typical values
VCE = 5V
f = 470MHz
Re(hie)
IC (A)


7Z09988
BLY37
Im(hie)
Re(hie)
(Ω)
typical values
VCE = 5V
f = 470MHz
Re(hie)
IC (A)

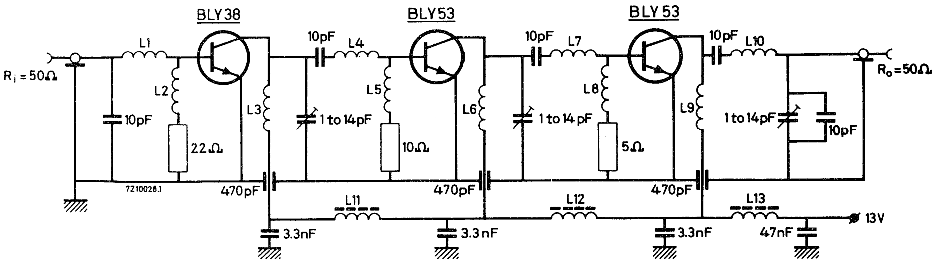

7Z10024
BLY53
typical values
Tj = 25°C
IC
(A)
fT = 100MHz
200MHz
300MHz
400MHz
500MHz
600MHz
700MHz
750MHz
800MHz
900MHz
1000MHz
1200MHz
1400MHz
VCE (V)


7Z10023
BLY37
IC
(A)
fT = 100MHz
200MHz
typical values
Tj = 25°C
300MHz
450MHz
700MHz
800MHz
900MHz
VCE (V)


7Z09998
typical values
I_{CBO} (nA)
10^4
10^3
10^2
10
1
10^{-1}
10^{-2}
V_{CB}=36V
13.8V
BLY37
BLY53
0
50
100
150
T_j(°C)
200

APPLICATION INFORMATION

3-stage v.h.f. amplifier with two BLY53 transistors operating at f = 470 MHz.



Components

L1 = 30 nH
L2 = L3 = L5 = 3 turns enamelled Cu wire (0.5 mm); int. diam. 4 mm
L4 = 25 nH
L6 = L8 = L9 = 4 turns enamelled Cu wire (0.5 mm); int. diam. 4 mm
L7 = 18 nH
L10 = 8 nH
L11 = L12 = L13 = Ferroxcube choke coil (code number 4312 020 36700)

Performance

Output power at f = 470 MHz
V_{CC} = 13 V; P_i = 0.3 W — P_o typ. 8 W
η typ. 47 %

U.H.F. TRANSMITTING TRANSISTORS

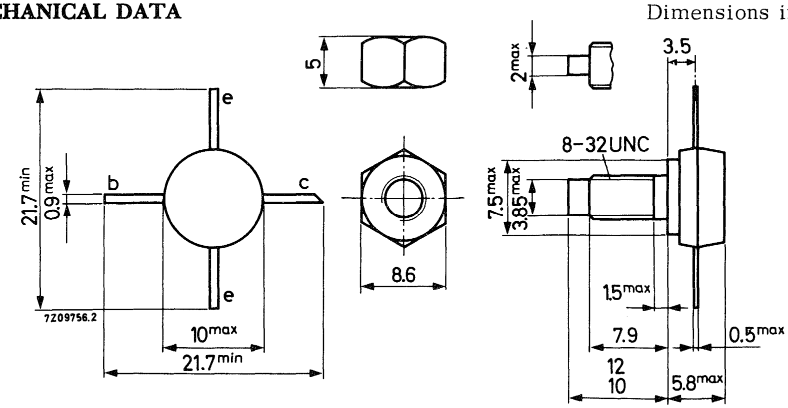
N-P-N silicon planar epitaxial transistors in a capstan envelope. The transistors are intended for battery operated f.m. transmitters with a supply voltage of up to 13.8 V for the BLY38 or up to 28 V for the BLY76.

QUICK REFERENCE DATA

			BLY38	BLY76	
Collector-base voltage (peak value)	V_{CBOM}	max.	36	65	V
Collector-emitter voltage (open base)	V_{CEO}	max.	18	36	V
Collector current (peak value)	I_{CM}	max.	1.5	1.0	A
Total power dissipation f > 1 MHz	P_{tot}	max.	5.5	4.0	W
Junction temperature	T_j	max.	200	200	°C
Transition frequency at f = 100 MHz I_C = 0.25 A; V_{CE} = 5 V	f_T	typ.	1000	900	MHz
Output power at f = 470 MHz P_i = 0.5 W; V_{CE} = 13.8 V	P_o	>	2.0		W
P_i = 0.4 W; V_{CE} = 28 V	P_o	>		2.0	W

MECHANICAL DATA

Dimensions in mm



Diameter of hole in heatsink: max. 4.17 mm

Torque on nut: min. 7.5 cm kg
max. 8.5 cm kg

When locking is required, an adhesive instead of a lock washer is preferred.

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

			BLY38	BLY76	
<u>Voltages</u>					
Collector-base voltage (open emitter) peak value; I_C = 10 mA	V_{CBOM}	max.	36	65	V
Collector-emitter voltage (open base) I_C = 10 mA	V_{CEO}	max.	18	36	V
Emitter-base voltage (open collector) I_E = 10 mA	V_{EBO}	max.	4	4	V
<u>Currents</u>					
Collector current (average)	I_{CAV}	max.	0.5	0.3	A
Collector current (peak value)	I_{CM}	max.	1.5	1.0	A
Emitter current (peak value)	I_{EM}	max.	1.5	1.0	A
<u>Power dissipation</u>					
Total power dissipation f > 1 MHz	P_{tot}	max.	5.5	4.0	W

<u>Temperatures</u>

Storage temperature	T_{stg}		−30 to +200	°C
Junction temperature	T_j	max.	200	°C

THERMAL RESISTANCE

From junction to heatsink	$R_{th\ j\text{-}h}$	=	31	°C/W

CHARACTERISTICS

T_j = 25 °C unless otherwise specified

			BLY38	BLY76	
Base-emitter voltage[1]					
I_C = 0.25 A; V_{CE} = 5 V	V_{BE}	<	1.5	1.5	V
Saturation voltage					
I_C = 0.25 A; I_B = 50 mA	V_{CEsat}	<	0.5	0.5	V
D.C. current gain					
I_C = 0.25 A; V_{CE} = 5 V	h_{FE}	typ.	70	30	
Transition frequency at f = 100 MHz					
I_C = 0.25 A; V_{CE} = 5 V	f_T	typ.	1000	900	MHz
Collector capacitance at f = 1 MHz					
I_E = I_e = 0; V_{CB} = 13.8 V	C_c	typ.	5.5		pF
I_E = I_e = 0; V_{CB} = 28 V	C_c	typ.		3.5	pF
Collector-stud capacitance		typ.	2	2	pF
h parameters at f = 470 MHz					
I_C = 0.25 A; V_{CE} = 5 V					
Input resistance	Re(hie)	typ.	8	6	Ω
Input reactance	Im(hie)	typ.	11	12	Ω

[1] V_{BE} decreases by about 1.5 mV/°C with increasing temperature.

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

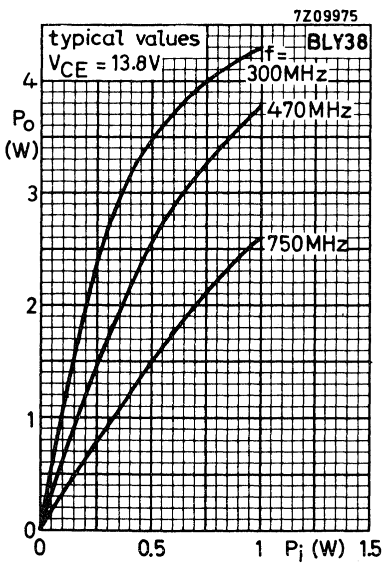
R.F. performance at f = 470 MHz (common emitter) of the BLY38

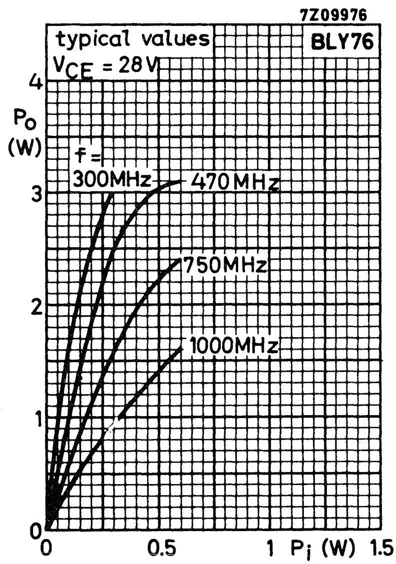
V_{CE} = 13.8 V; P_o = 2.0 W	P_i	<	0.5	W
	G_p	>	6.0	dB
	η	>	60	%

R.F. performance at f = 470 MHz (common emitter) of the BLY76

V_{CE} = 28 V; P_o = 2.0 W	P_i	<	0.4	W
	G_p	>	7.0	dB
	η	>	60	%

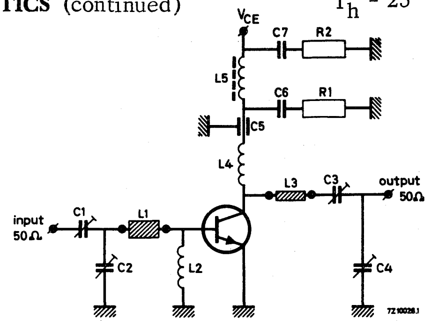
All transistors are tested with a V.S.W.R. of 50 varied through all phases.





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

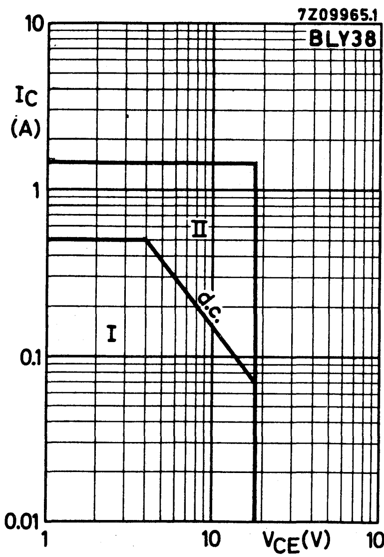
Test circuit:

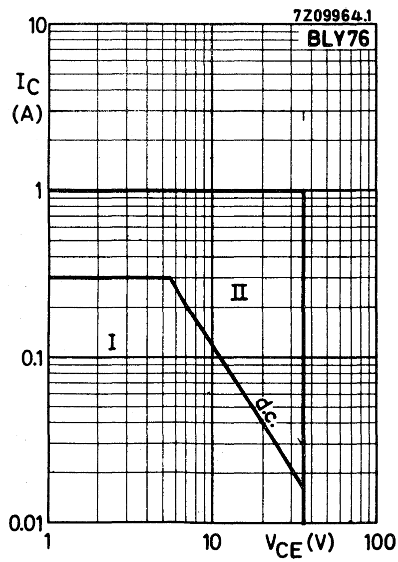


Components:

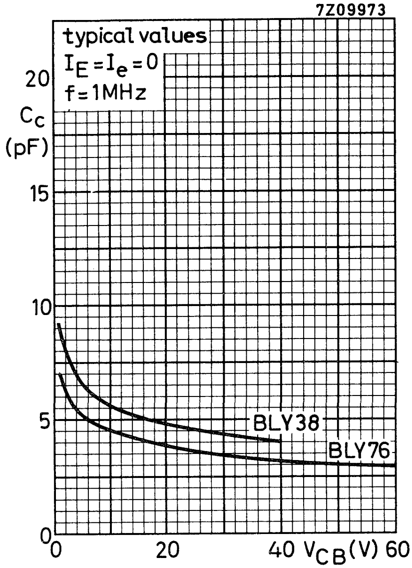
C1 = C2 = C3 = C4 =	1 to 17 pF	air trimmer
C5 =	100 pF	disk ceramic by-pass
C6 = C7 =	10 nF	paper
R1 = R2 =	10 Ω	

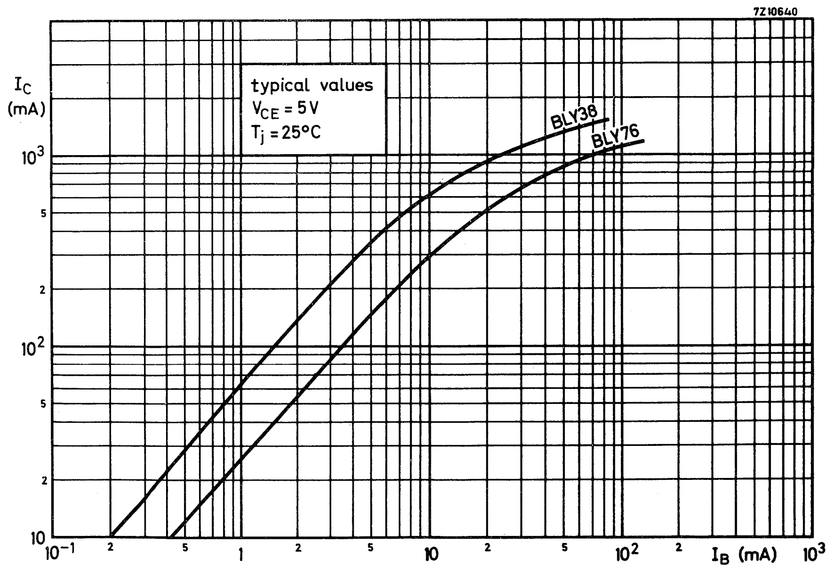
L1 = 35 mm x 6 mm straight Cu strip
L2 = 5 turns Cu wire (0.6 mm); internal diameter 8 mm
L3 = 25 mm straight Cu wire (1.5 mm)
L4 = 3 turns Cu wire (1.0 mm); internal diameter 3.5 mm; winding pitch 2 mm; leads 2x10 mm
L5 = FXC choke (code number 4312 020 36640)

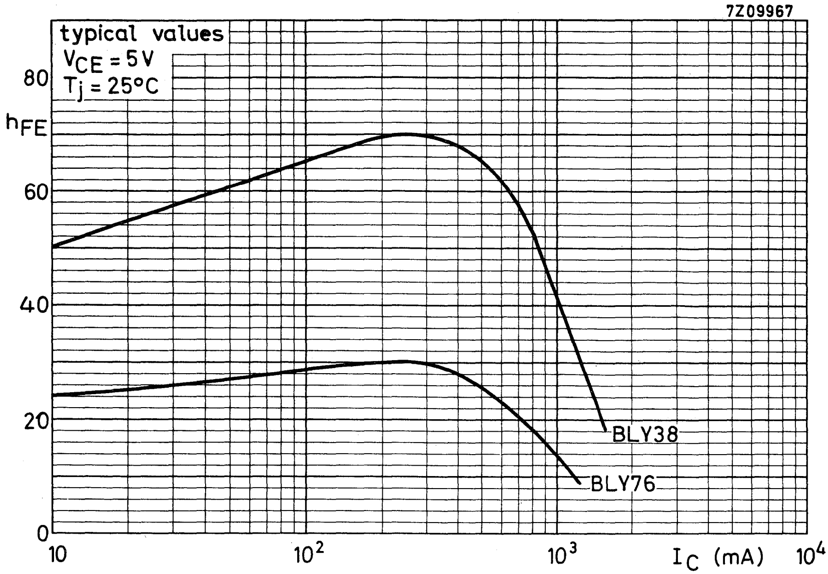


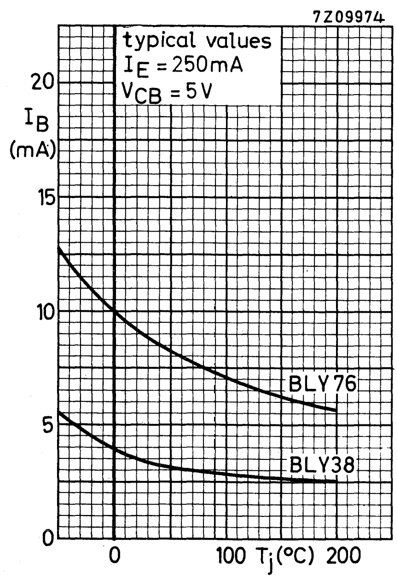


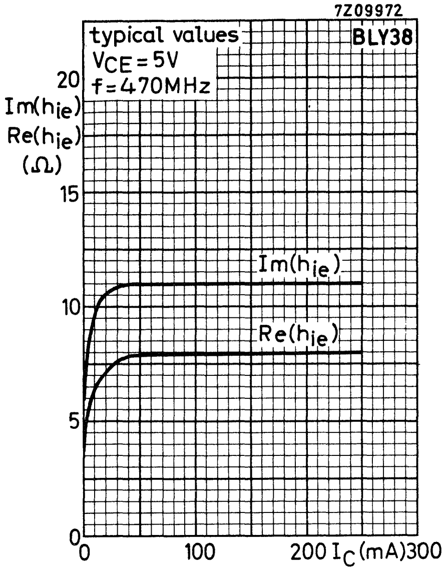
I Region of permissible operation under all base-emitter conditions and at all frequencies, including d.c.
II Additional region of operation at f > 1 MHz.
Care must be taken to reduce the d.c. adjustment to region I before removing the a.c. signal. This may be achieved by an appropriate bias in class A, B or C

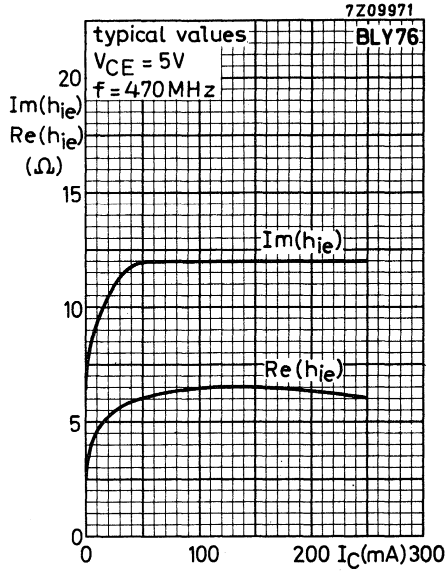

7Z09973
typical values
$I_E = I_e = 0$
f = 1MHz
20
C_c
(pF)
15
10
5
0
0
20
40
V_{CB} (V)
60
BLY38
BLY76

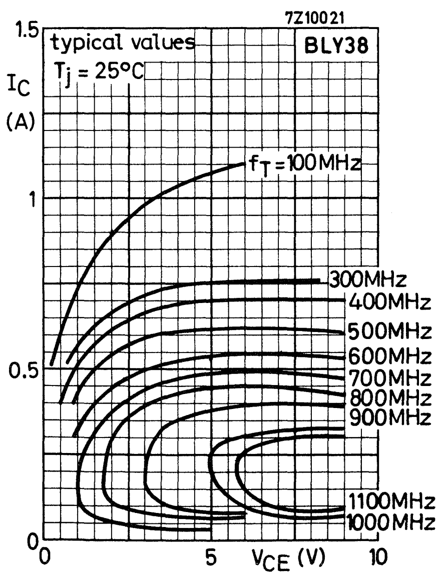

7Z10640
typical values
$V_{CE} = 5$ V
$T_j = 25$°C
I_C
(mA)
10^3
5
2
10^2
5
2
10
10^{-1}
2
5
1
2
5
10
2
5
10^2
2
I_B (mA)
10^3
BLY38
BLY76

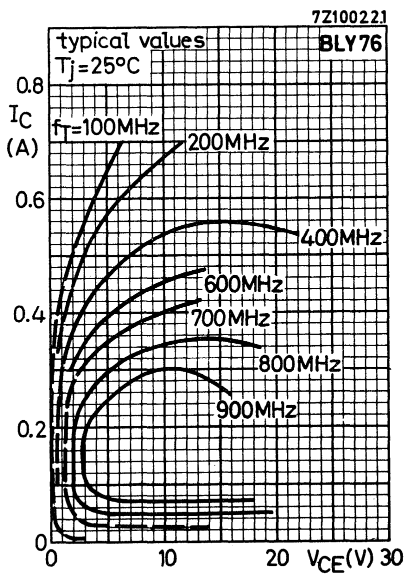

7Z09967
typical values
V_{CE} = 5 V
T_j = 25°C
h_{FE}
80
60
40
20
0
10
10^2
10^3
I_C (mA)
10^4
BLY38
BLY76

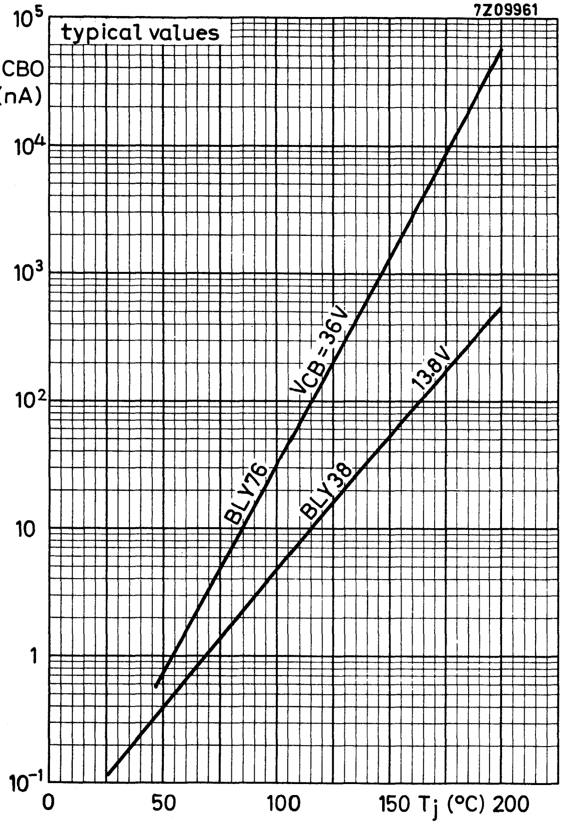

7Z09974
typical values
I_E = 250 mA
V_{CB} = 5 V
I_B
(mA)
20
15
10
5
0
0
100
T_j(°C)
200
BLY76
BLY38


7Z09972
typical values
V_{CE} = 5V
f = 470MHz
BLY38
Im(h_{ie})
Re(h_{ie})
(Ω)
I_C (mA)


7Z09971
typical values
V_{CE} = 5V
f = 470MHz
BLY76
Im(h_{ie})
Re(h_{ie})
(Ω)
I_C(mA)

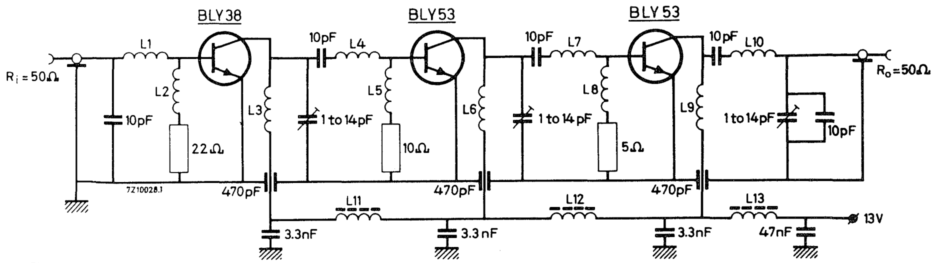

7Z10021
typical values
T_j = 25°C
BLY38
I_C
(A)
f_T = 100MHz
300MHz
400MHz
500MHz
600MHz
700MHz
800MHz
900MHz
1100MHz
1000MHz
V_{CE} (V)


7Z10022.1
typical values
T_j = 25°C
BLY76
I_C
(A)
f_T = 100MHz
200MHz
400MHz
600MHz
700MHz
800MHz
900MHz
V_{CE}(V)


7Z09961
typical values
I_{CBO} (nA)
10^5
10^4
10^3
10^2
10
1
10^{-1}
0
50
100
150 T_j (°C) 200
BLY76
V_{CB} = 36 V
BLY38
13.8 V

APPLICATION INFORMATION

3-stage v.h.f. amplifier with the BLY38 in the driver stage operating at f = 470 MHz



Components

L1 = 30 nH
L2 = L3 = L5 = 3 turns enamelled Cu wire (0.5 mm); int. diam. 4 mm
L4 = 25 nH
L6 = L8 = L9 = 4 turns enamelled Cu wire (0.5 mm); int. diam. 4 mm
L7 = 18 nH
L10 = 8 nH
L11 = L12 = L13 = Ferroxcube choke coil (code number 4312 020 36700)

Performance

Output power at f = 470 MHz

V_{CC} = 13 V; P_i = 0.3 W	P_o	typ.	8 W
	η	typ.	47 %

SILICON EMITTER GRID V.H.F. POWER TRANSISTORS

N-P-N epitaxial planar transistors primarily intended for v.h.f. transmitting applications with a supply voltage of 13.5 V in class B and C in mobile industrial and military equipment.
The transistors are resistance stabilized and are tested under severe load mismatch conditions.
The BFS22 has a TO-39 metal envelope with the collector connected to the case.
The BLY87 to 89 have a $\frac{1}{4}$" capstan envelope with a moulded cap. The leads are insulated from the stud.

QUICK REFERENCE DATA

			BFS22	BLY87	BLY88	BLY89	
Collector-base voltage (peak value)	V_{CBOM}	max.	36	36	36	36	V
Collector-emitter voltage (open base)	V_{CEO}	max.	18	18	18	18	V
Collector current (peak value)	I_{CM}	max.	2.25	3.75	7.5	10	A
Total power dissipation at f > 1 MHz							
T_{mb} = 25 °C	P_{tot}	max.	8				W
T_h = 25 °C	P_{tot}	max.		16	29	44	W
Junction temperature	T_j	max.	200	200	200	200	°C
Transition frequency at f = 100 MHz							
I_C = 350 mA; V_{CE} = 10 V	f_T	typ.	700	700			MHz
I_C = 700 mA; V_{CE} = 10 V	f_T	typ.			700		MHz
I_C = 1000 mA; V_{CE} = 10 V	f_T	typ.				700	MHz

R.F. performance at f = 175 MHz; V_{CE} = 13.5 V

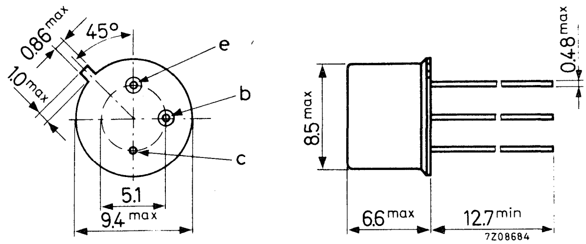
Type No.	T_{mb} (°C)	T_h (°C)	P_o (W)	P_i (W)	G_p (dB)	η (%)
BFS22	25		4	< 0.63	> 8	> 60
BLY87		25	8	< 1.0	> 9	> 70
BLY88		25	15	< 2.65	> 7.5	> 65
BLY89		25	23	< 5.75	> 6	> 70

MECHANICAL DATA see page 2

MECHANICAL DATA Dimensions in mm

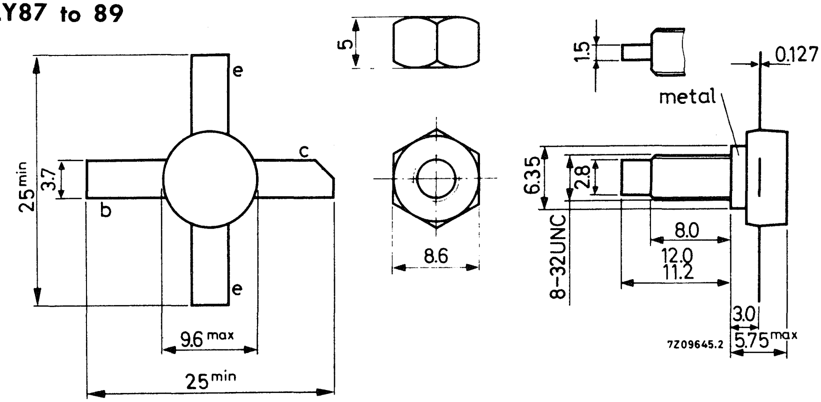
BFS22

TO-39
Collector connected
to case



Accessories available: 56218; 56245; 56265

BLY87 to 89



Diameter of hole in heatsink: max. 4.17 mm

Torque on nut: min. 7.5 cmkg
max. 8.5 cmkg

When locking is required, an adhesive instead of a lock washer is preferred.

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

Voltages			BFS22	BLY87	BLY88	BLY89	
Collector-base voltage (peak value)							
$I_E = 0$; $I_C = 1$ mA	V_{CBOM}	max.	36	36			V
$I_E = 0$; $I_C = 3$ mA	V_{CBOM}	max.			36	36	V
Collector-emitter voltage (open base)							
$I_B = 0$; $I_C = 10$ mA	V_{CEO}	max.	18	18			V
$I_B = 0$; $I_C = 25$ mA	V_{CEO}	max.			18	18	V
Emitter-base voltage (open collector)							
$I_C = 0$; $I_E = 1$ mA	V_{EBO}	max.	4	4			V
$I_C = 0$; $I_E = 3$ mA	V_{EBO}	max.			4	4	V

RATINGS (continued)

Currents			BFS22	BLY87	BLY88	BLY89	
Collector current (average)	I_{CAV}	max.	0.75	1.25	2.5	3.5	A
Collector current (peak value)	I_{CM}	max.	2.25	3.75	7.5	10	A
Power dissipation							
Total power dissipation at f > 1 MHz							
T_{mb} = 25 °C	P_{tot}	max.	8				W
T_h = 25 °C	P_{tot}	max.		16	29	44	W
Temperature							
Storage temperature	T_{stg}		−65 to +200	−30 to +200			°C
Junction temperature	T_j	max.	200	200	200	200	°C

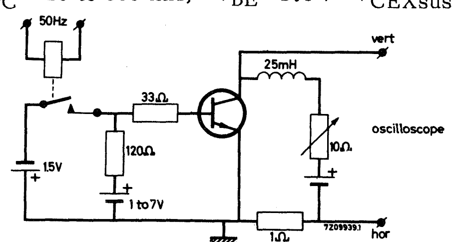
THERMAL RESISTANCE

			BFS22	BLY87	BLY88	BLY89	
From junction to mounting base	$R_{th\ j\text{-}mb}$	=	22				°C/W
From junction to heatsink	$R_{th\ j\text{-}h}$	=		11	6	4	°C/W
From mounting base to heatsink with a boron nitride washer for electrical insulation	$R_{th\ mb\text{-}h}$	=	1.2				°C/W

CHARACTERISTICS

T_j = 25 °C unless otherwise specified

Collector cut-off current			BFS22	BLY87	BLY88	BLY89	
I_B = 0; V_{CE} = 14 V	I_{CEO}	<	5	5	10	10	mA
Sustaining voltages							
I_C = 10 to 200 mA; $-V_{BE}$ = 1.5 V	$V_{CEXsust}$	>	36	36			V
I_C = 10 to 600 mA; $-V_{BE}$ = 1.5 V	$V_{CEXsust}$	>			36		V
I_C = 10 to 800 mA; $-V_{BE}$ = 1.5 V	$V_{CEXsust}$	>				36	V



Saturation voltage			BFS22	BLY87	BLY88	BLY89	
I_C = 500 mA; I_B = 100 mA	V_{CEsat}	<	0.5	0.5	0.3	0.3	V

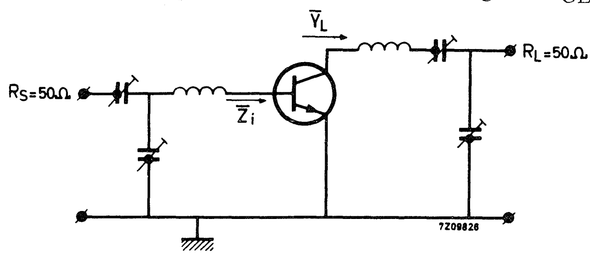
CHARACTERISTICS (continued) T_j = 25 °C unless otherwise specified

			BFS22	BLY87	BLY88	BLY89	
D.C. current gain							
I_C = 500 mA; V_{CE} = 5 V	h_{FE}	>	5	5	5	5	
Transition frequency at f = 100 MHz							
I_C = 350 mA; V_{CE} = 10 V	f_T	typ.	700	700			MHz
I_C = 700 mA; V_{CE} = 10 V	f_T	typ.			700		MHz
I_C = 1000 mA; V_{CE} = 10 V	f_T	typ.				700	MHz
Collector capacitance at f = 1 MHz							
$I_E = I_e = 0$; V_{CB} = 15 V	C_c	<	15	15	30	45	pF

Input- and load impedance at f = 175 MHz

Simplified circuit diagram

Typical values for minimum input reflection and maximum gain. V_{CE} = 13.5 V.



Type No.	T_{mb} (°C)	T_h (°C)	P_o (W)	$\overline{Z}_i$ (Ω)	$\overline{Y}_L$ ($m\Omega^{-1}$)
BFS22 [1])	25		4	3.8 + j2.1	39.7 - j25.8
BLY87 [2])		25	8	2.6 + j2.6	64.5 - j32.9
BLY88 [2])		25	15	1.5 + j2.9	131 - j29.0
BLY89 [2])		25	23	1.3 + j2.8	190 - j19.6

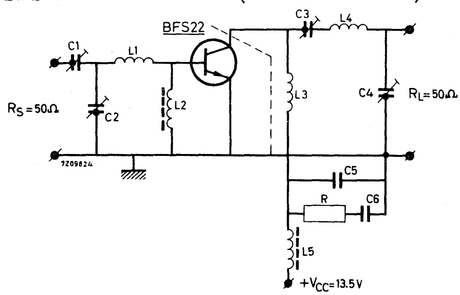
R.F. performance in common emitter configuration, class B (not neutralized) at f = 175 MHz; V_{CE} = 13.5 V						
Type No.	T_{mb} (°C)	T_h (°C)	P_o (W)	P_i (W)	G_p (dB)	η (%)
BFS22	25		4	< 0.63	> 8	> 60
BLY87		25	8	< 1.0	> 9	> 70
BLY88		25	15	< 2.65	> 7.5	> 65
BLY89		25	23	< 5.75	> 6	> 70

All transistors are tested with a V.S.W.R. of 50 varied through all phases.

1) Length of external leads 1.6 mm. 2) Length of external leads 1.0 mm.

CHARACTERISTICS (continued)

Test circuit for the BFS22 at f = 175 MHz (common emitter)

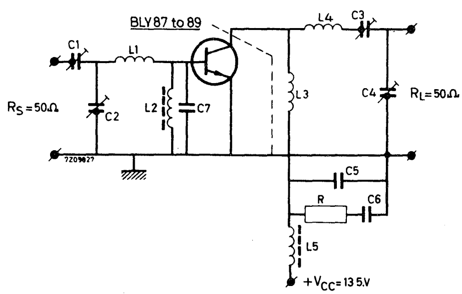


* The length of the external emitter wire is 0.5 mm.

C1 = C2 = C3 = C4 = 4 to 29 pF air trimmer
C5 = 100 pF ceramic
C6 = 120 nF polyester
R = 10 Ω

L1 = 1 turn Cu wire (1 mm), int. diam. 10 mm, leads 2x10 mm
L2 = L5 = ferroxcube choke coil. Z (at f = 175 MHz) = 550 Ω ± 20% Code number 4312 020 36641
L3 = 15 turns closely wound enamelled Cu wire (0.7 mm), int. diam. 4 mm
L4 = 3 turns closely wound enamelled Cu wire (1.5 mm), int. diam. 12 mm, leads 2x20 mm

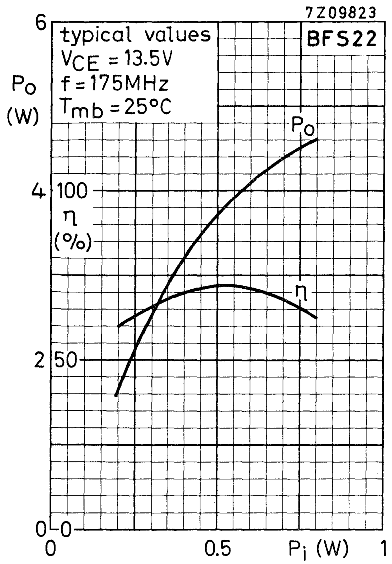
Test circuit for the BLY87; BLY88 and BLY89 at f = 175 MHz (common emitter)

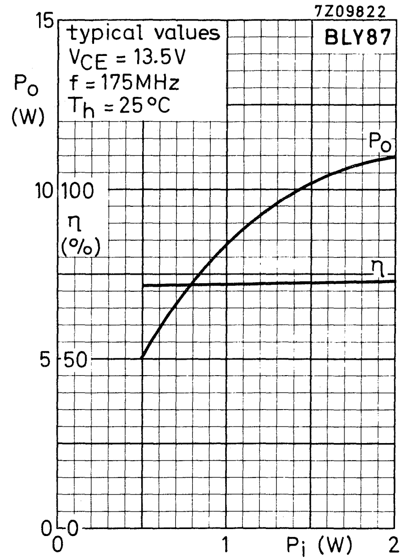


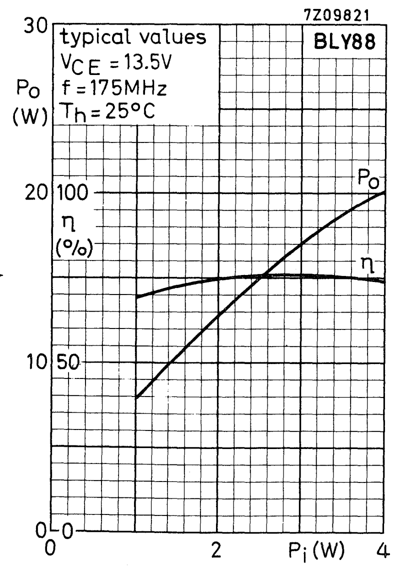
C1 = C2 = C3 = C4 = 4 to 29 pF air trimmer
C5 = 100 pF ceramic
C6 = 120 nF polyester
C7 = 47 pF ceramic
R = 10 Ω

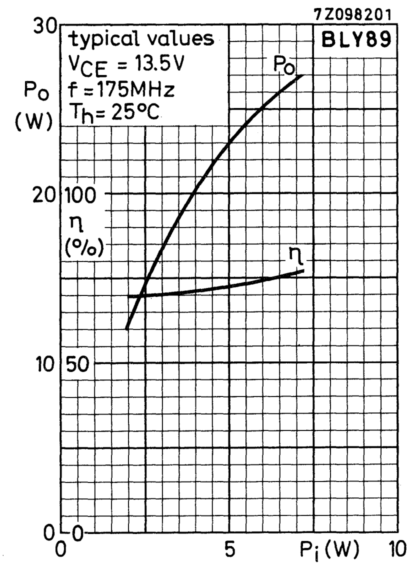
** For BLY87 L3 = 12 turns closely wound enamelled Cu wire (0.7 mm), int. diam. 4 mm

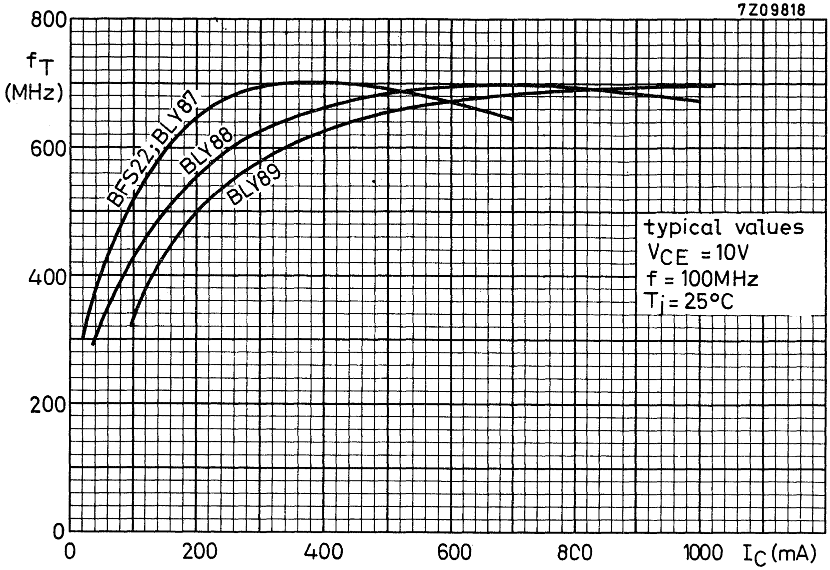
L1 = 1 turn Cu wire (1 mm), int. diam. 10 mm, leads 2x10 mm
L2 = L5 = ferroxcube choke coil. Z (at f = 175 MHz) = 550 Ω ± 20% Code number 4312 020 36641
* L3 = 2 turns Cu wire (1 mm), spaced 1 mm, int. diam. 5 mm, leads 2x15 mm
L4 = 2 turns closely wound enamelled Cu wire (1.5 mm), int. diam. 8.5 mm, leads 2x20 mm

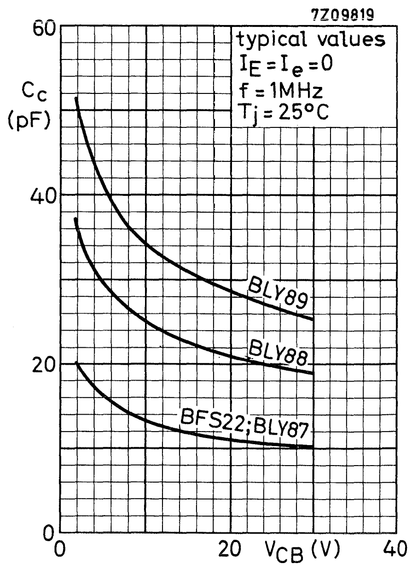

7Z09823
typical values
V_{CE} = 13.5V
f = 175MHz
T_{mb} = 25°C
BFS22
P_o
(W)
η
(%)
6
4
2
0
100
50
0
0
0.5
1
P_i (W)
P_o
η


7Z09822
typical values
V_{CE} = 13.5V
f = 175MHz
T_h = 25°C
BLY87
P_o
(W)
η
(%)
15
10
5
0
100
50
0
0
1
2
P_i (W)
P_o
η


7Z09821
typical values
V_{CE} = 13.5V
f = 175MHz
T_h = 25°C
BLY88
P_o
(W)
η
(%)
30
20
10
0
100
50
0
0
2
4
P_i (W)
P_o
η


7Z098201
typical values
V_{CE} = 13.5V
f = 175MHz
T_h = 25°C
BLY89
P_o
(W)
η
(%)
30
20
10
0
100
50
0
0
5
10
P_i (W)
P_o
η


7Z09818
800
f_T
(MHz)
600
400
200
0
BFS22; BLY87
BLY88
BLY89
typical values
V_{CE} = 10V
f = 100MHz
T_j = 25°C
0
200
400
600
800
1000
I_C (mA)


7Z09819
60
C_c
(pF)
40
20
0
typical values
$I_E = I_e = 0$
f = 1MHz
T_j = 25°C
BLY89
BLY88
BFS22; BLY87
0
20
V_{CB} (V)
40

APPLICATION NOTE

The specified power output and gain are as measured in a metal chassis mounted circuit at a heatsink temperature of 25 °C. In a printed circuit, the gain at the specified power output may be 0.5 dB lower.*
Also, at temperatures up to 75 °C the power output relative to that at 25 °C is diminished by the following factors:

BLY87	typ.	−15 mW/°C
BLY88	typ.	−20 mW/°C
BLY89	typ.	−40 mW/°C

* Details on the printed circuit boards are available on request.

SILICON EMITTER GRID V.H.F. POWER TRANSISTORS

N-P-N epitaxial planar transistors primarily intended for v.h.f. transmitting applications with a supply voltage of 28 V in class B and C in mobile industrial and military equipment.
The transistors are resistance stabilized and are tested under severe load mismatch conditions.
The BFS23 has a TO-39 metal envelope with the collector connected to the case.
The BLY91 to 93 have a $\frac{1}{4}$" capstan envelope with a moulded cap. The leads are insulated from the stud.

QUICK REFERENCE DATA

			BFS23	BLY91	BLY92	BLY93	
Collector-base voltage (peak value)	V_{CBOM}	max.	65	65	65	65	V
Collector-emitter voltage (open base)	V_{CEO}	max.	36	36	36	36	V
Collector current (peak value)	I_{CM}	max.	1.5	2.25	4.5	6	A
Total power dissipation at f > 1 MHz							
T_{mb} = 25 °C	P_{tot}	max.	8				W
T_h = 25 °C	P_{tot}	max.		16	29	44	W
Junction temperature	T_j	max.	200	200	200	200	°C
Transition frequency at f = 100 MHz							
I_C = 200 mA; V_{CE} = 20 V	f_T	typ.	500	500			MHz
I_C = 400 mA; V_{CE} = 20 V	f_T	typ.			500		MHz
I_C = 600 mA; V_{CE} = 20 V	f_T	typ.				500	MHz

R.F. performance at f = 175 MHz; V_{CE} = 28 V

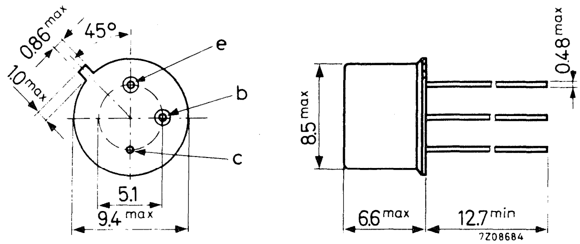
Type No.	T_{mb} (°C)	T_h (°C)	P_o (W)	P_i (W)	G_p (dB)	η (%)
BFS23	25		4	< 0.4	> 10	> 55
BLY91		25	8	< 0.5	> 12	> 50
BLY92		25	15	< 1.5	> 10	> 55
BLY93		25	23	< 2.9	> 9	> 60

MECHANICAL DATA see page 2.

MECHANICAL DATA Dimensions in mm

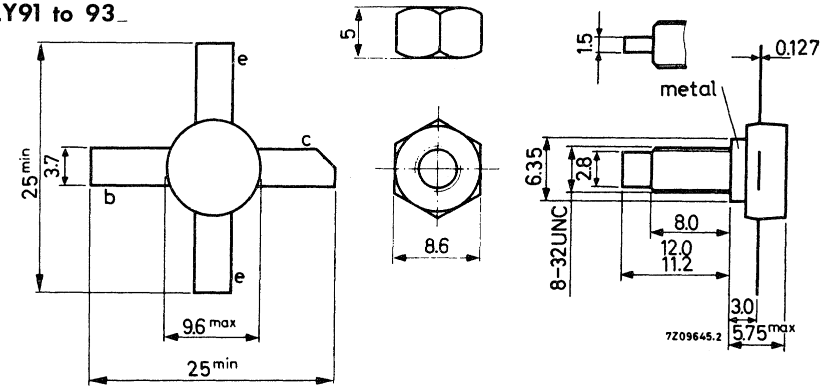
BFS23

TO-39
Collector connected to case



Accessories available: 56218; 56245; 56265

BLY91 to 93



Diameter of hole in heatsink: max. 4.17 mm

Torque on nut: min. 7.5 cmkg
max. 8.5 cmkg

When locking is required, an adhesive instead of a lock washer is preferred.

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

Voltages			BFS23	BLY91	BLY92	BLY93	
Collector-base voltage (peak value)							
$I_E = 0$; $I_C = 1$ mA	V_{CBOM}	max.	65	65			V
$I_E = 0$; $I_C = 3$ mA	V_{CBOM}	max.			65	65	V
Collector-emitter voltage (open base)							
$I_B = 0$; $I_C = 10$ mA	V_{CEO}	max.	36	36			V
$I_B = 0$; $I_C = 25$ mA	V_{CEO}	max.			36	36	V
Emitter-base voltage (open collector)							
$I_C = 0$; $I_E = 1$ mA	V_{EBO}	max.	4	4			V
$I_C = 0$; $I_E = 3$ mA	V_{EBO}	max.			4	4	V

RATINGS (continued)

			BFS23	BLY91	BLY92	BLY93	
Currents							
Collector current (average)	I_{CAV}	max.	0.5	0.75	1.5	2.0	A
Collector current (peak value)	I_{CM}	max.	1.5	2.25	4.5	6.0	A
Power dissipation							
Total power dissipation at f > 1 MHz							
T_{mb} = 25 °C	P_{tot}	max.	8				W
T_h = 25 °C	P_{tot}	max.		16	29	44	W
Temperature							
Storage temperature	T_{stg}		−65 to +200	−30 to +200			°C
Junction temperature	T_j	max.	200	200	200	200	°C

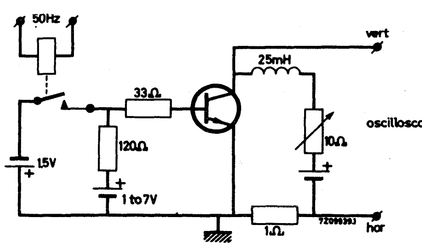
THERMAL RESISTANCE

			BFS23	BLY91	BLY92	BLY93	
From junction to mounting base	$R_{th\ j\text{-}mb}$	=	22				°C/W
From junction to heatsink	$R_{th\ j\text{-}h}$	=		11	6	4	°C/W
From mounting base to heatsink with a boron nitride washer for electrical insulation	$R_{th\ mb\text{-}h}$	=	1.2				°C/W

CHARACTERISTICS

T_j = 25 °C unless otherwise specified

			BFS23	BLY91	BLY92	BLY93	
Collector cut-off current							
I_B = 0; V_{CE} = 28 V	I_{CEO}	<	5	5	10	10	mA
Sustaining voltages							
I_C = 10 to 200 mA; $-V_{BE}$ = 1.5 V	$V_{CEXsust}$	>	65	65			V
I_C = 10 to 600 mA; $-V_{BE}$ = 1.5 V	$V_{CEXsust}$	>			65		V
I_C = 10 to 800 mA; $-V_{BE}$ = 1.5 V	$V_{CEXsust}$	>				65	V



			BFS23	BLY91	BLY92	BLY93	
Saturation voltage							
I_C = 500 mA; I_B = 100 mA	V_{CEsat}	<	0.5	0.5	0.3	0.3	V

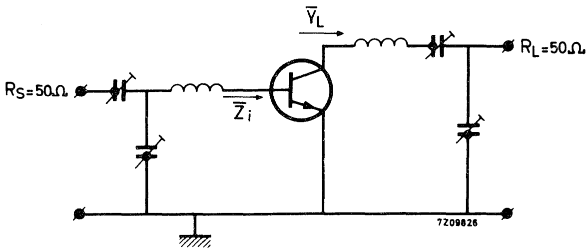
CHARACTERISTICS (continued) T_j = 25 °C unless otherwise specified

			BFS23	BLY91	BLY92	BLY93	
D.C. current gain							
I_C = 500 mA; V_{CE} = 5 V	h_{FE}	>	5	5	5	5	
Transition frequency at f = 100 MHz							
I_C = 200 mA; V_{CE} = 20 V	f_T	typ.	500	500			MHz
I_C = 400 mA; V_{CE} = 20 V	f_T	typ.			500		MHz
I_C = 600 mA; V_{CE} = 20 V	f_T	typ.				500	MHz
Collector capacitance at f = 1 MHz							
$I_E = I_e = 0$; V_{CB} = 30 V	C_c	<	10	10	20	30	pF

Input- and load impedance at f = 175 MHz

Simplified circuit diagram

Typical values for minimum input reflection and maximum gain at V_{CE} = 28 V



Type No.	T_{mb} (°C)	T_h (°C)	P_o (W)	$\overline{Z}_i$ (Ω)	$\overline{Y}_L$ (mΩ^{-1})
BFS23 [1]	25		4	3.3 + j1.4	10.7 − j14.1
BLY91 [2]		25	8	2.8 + j1.7	18.7 − j18.4
BLY92 [2]		25	15	1.5 + j2.2	36.9 − j31.0
BLY93 [2]		25	23	1.4 + j2.3	55.0 − j39.6

R.F. performance in common emitter configuration, class B (not neutralized) at f = 175 MHz; V_{CE} = 28 V

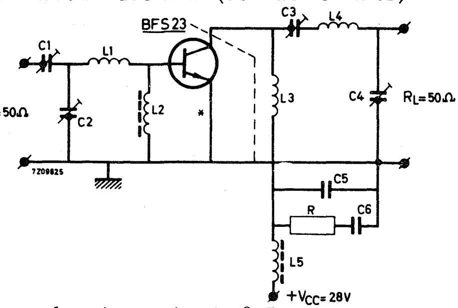
Type No.	T_{mb} (°C)	T_h (°C)	P_o (W)	P_i (W)	G_p (dB)	η (%)
BFS23	25		4	< 0.4	> 10	> 55
BLY91		25	8	< 0.5	> 12	> 50
BLY92		25	15	< 1.5	> 10	> 55
BLY93		25	23	< 2.9	> 9	> 60

All transistors are tested with a V.S.W.R. of 50 varied through all phases.

[1]) Length of external leads 1.6 mm. [2]) Length of external leads 1.0 mm.

CHARACTERISTICS (continued)

Test circuit for the BFS23 at f = 175 MHz (common emitter)

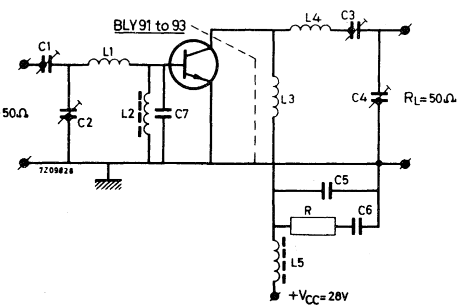


* The length of the external emitter wire is 0.5 mm.

C1 = C2 = C3 = C4 = 4 to 29 pF air trimmer
C5 = 100 pF ceramic
C6 = 120 nF polyester
R = 10 Ω

L1 = 1 turn Cu wire (1 mm), int. diam. 10 mm, leads 2x10 mm
L2 = L5 = ferroxcube choke coil. Z (at f = 175 MHz) = 550 Ω ± 20% Code number 4312 020 36641
L3 = 15 turns closely wound enamelled Cu wire (0.7 mm), int. diam. 4 mm
L4 = 3 turns closely wound enamelled Cu wire (1.5 mm), int. diam. 12 mm, leads 2x20 mm

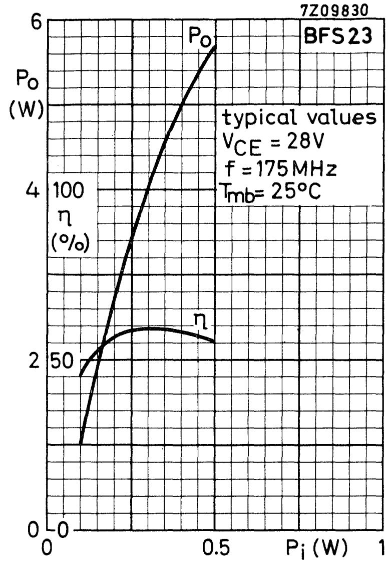
Test circuit for the BLY91; BLY92; BLY93 at f = 175 MHz (common emitter)

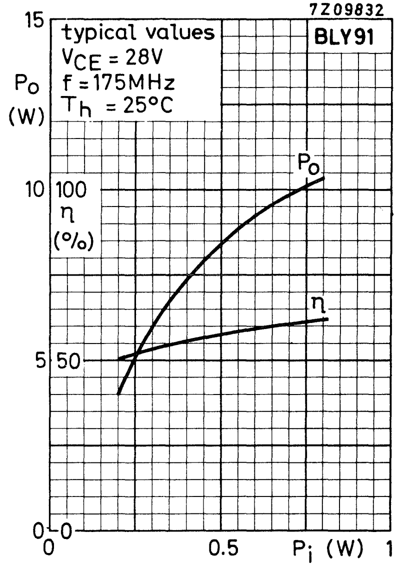


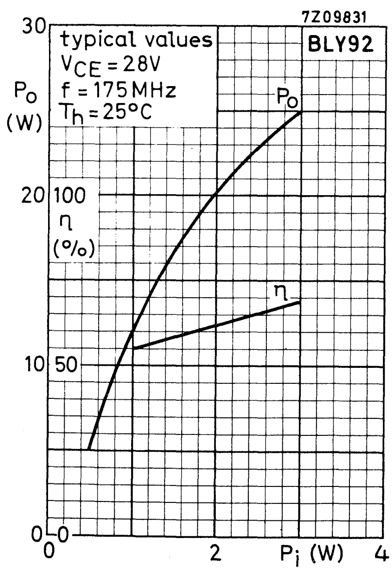
C1 = C2 = C3 = C4 = 4 to 29 pF air trimmer
C5 = 100 pF ceramic
C6 = 120 nF polyester
C7 = 47 pF ceramic
R = 10 Ω

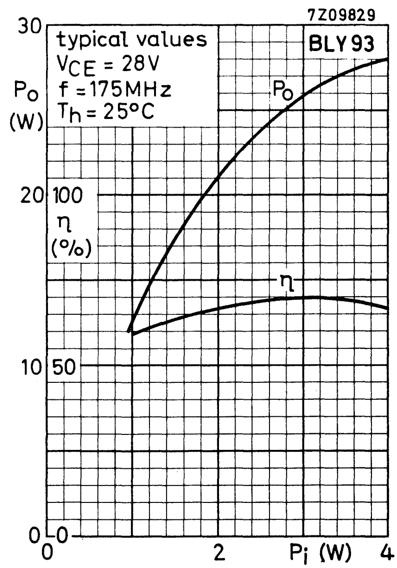
** For BLY91 L3 = 12 turns closely wound enamelled Cu wire (0.7 mm), int. diam. 4 mm

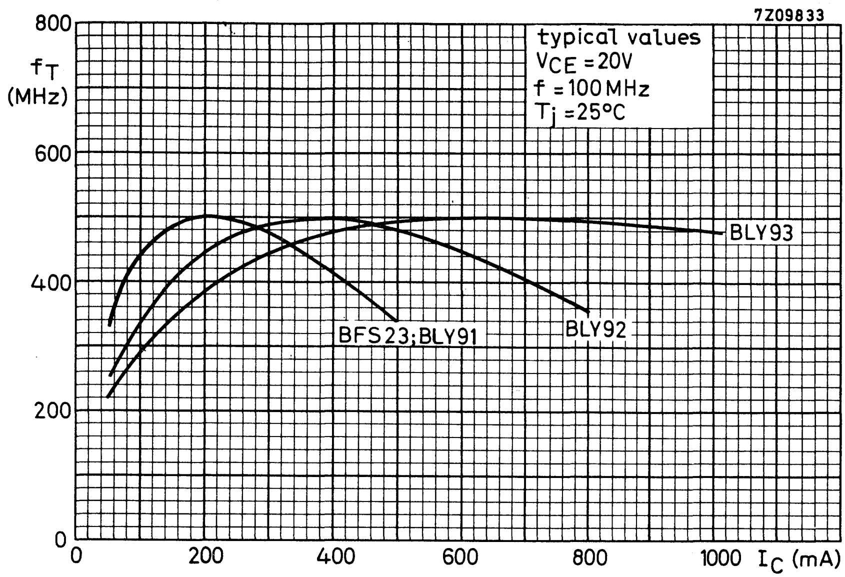
L1 = 1 turn Cu wire (1 mm), int. diam. 10 mm, leads 2x10 mm
L2 = L5 = ferroxcube choke coil. Z (at f = 175 MHz) = 550 Ω ± 20% Code number 4312 020 36641
** L3 = 2 turns Cu wire (1mm), spaced 1 mm, int. diam. 5 mm, leads 2 x 15 mm
L4 = 2 turns closely wound enamelled Cu wire (1.5 mm), int. diam. 8.5 mm, leads 2x20 mm

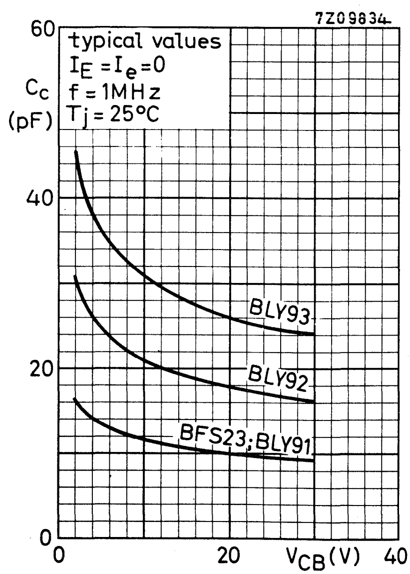

7Z09830
BFS23
typical values
VCE = 28V
f = 175 MHz
Tmb = 25°C
Po
(W)
η
(%)
Po
η
6
4
2
0
100
50
0
0
0.5
Pi (W)
1


7Z09832
BLY91
typical values
VCE = 28V
f = 175 MHz
Th = 25°C
Po
(W)
η
(%)
Po
η
15
10
5
0
100
50
0
0
0.5
Pi (W)
1


7Z09831
BLY92
typical values
VCE = 28V
f = 175 MHz
Th = 25°C
Po
(W)
η
(%)
Po
η
30
20
10
0
100
50
0
0
2
Pi (W)
4


7Z09829
BLY93
typical values
VCE = 28V
f = 175 MHz
Th = 25°C
Po
(W)
η
(%)
Po
η
30
20
10
0
100
50
0
0
2
Pi (W)
4


7Z09833
typical values
VCE = 20V
f = 100 MHz
Tj = 25°C
fT
(MHz)
800
600
400
200
0
0
200
400
600
800
1000
IC (mA)
BLY93
BFS23; BLY91
BLY92


7Z09834
typical values
IE = Ie = 0
f = 1MHz
Tj = 25°C
Cc
(pF)
60
40
20
0
0
20
VCB (V)
40
BLY93
BLY92
BFS23; BLY91

→ APPLICATION NOTE

The specified power output and gain are as measured in a metal chassis mounted circuit at a heatsink temperature of 25 °C. In a printed circuit, the gain at the specified power output may be 0.7 dB lower.*
Also, at temperatures up to 75 °C the power output relative to that at 25 °C is diminished by the following factors:

BLY91	typ.	-15 mW/°C
BLY92	typ.	-20 mW/°C
BLY93	typ.	-40 mW/°C

* Details on the printed circuit boards are available on request.

SILICON EPITAXIAL PLANAR OVERLAY TRANSISTORS

The 2N3553 is a n-p-n overlay transistor in a TO-39 metal envelope with the collector connected to the case.
The 2N3375 and the 2N3632 are n-p-n overlay transistors in TO-60 metal envelopes with the electrodes insulated from the studs.
The 2N3553 and the 2N3375 are intended for v.h.f./u.h.f. and the 2N3632 for v.h.f. transmitting applications.

QUICK REFERENCE DATA

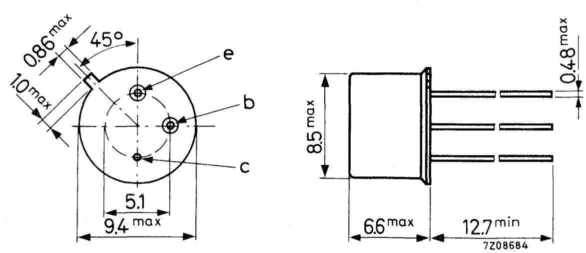
			2N3553	2N3375	2N3632	
Collector-emitter voltage $-V_{BE}$ = 1.5 V	V_{CEX}	max.	65	65	65	V
Collector-emitter voltage (open base)	V_{CEO}	max.	40	40	40	V
Collector current (peak value)	I_{CM}	max.	1.0	1.5	3.0	A
Total power dissipation up to T_{mb} = 25 °C	P_{tot}	max.	7	11.6	23	W
Junction temperature	T_j	max.	200	200	200	°C
Transition frequency						
I_C = 125 mA; V_{CE} = 28 V	f_T	typ.	500	500		MHz
I_C = 250 mA; V_{CE} = 28 V	f_T	typ.			400	MHz

R.F. performance at V_{CE} = 28 V

	f (MHz)	P_o (W)	P_i (W)	η (%)
2N3553	175	2.5	< 0.25	> 50
2N3375	100	7.5	< 1	> 65
2N3375	400	> 3	1	> 40
2N3632	175	> 13.5	3.5	> 70

MECHANICAL DATA Dimensions in mm

2N3553
Collector connected to case
TO-39



Accessories available: 56218, 56245, 56265.

MECHANICAL DATA (continued)

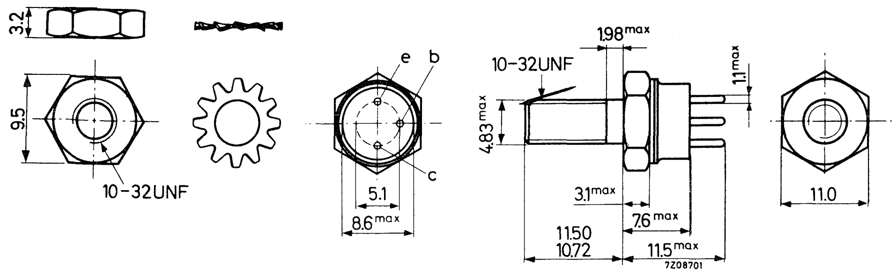
2N3375
2N3632

TO-60
The top pins should not be bent

Dimensions in mm

Torque on nut: min. 8 cm kg
max. 17 cm kg

Diameter of hole in heatsink: 4.8 to 5.2 mm



RATINGS (Limiting values) [1])

Voltages [2])

Collector-base voltage (open emitter)	V_{CBO}	max.	65	V
Collector-emitter voltage I_C up to 200 mA; $-V_{BE}$ = 1.5 V	V_{CEX}	max.	65	V
Collector-emitter voltage (open base) I_C up to 200 mA	V_{CEO}	max.	40	V
Emitter-base voltage (open collector)	V_{EBO}	max.	4	V

Currents [2])

			2N3553	2N3375	2N3632	
Collector current (d.c.)	I_C	max.	0.35	0.5	1	A
Collector current (peak value)	I_{CM}	max.	1.0	1.5	3	A

Power dissipation [2])

Total power dissipation up to T_{mb} = 25 °C	P_{tot}	max.	7	11.6	23	W

Temperatures

Storage temperature	T_{stg}		-65 to +200	°C
Junction temperature	T_j	max.	200	°C

[1]) Limiting values according to the Absolute Maximum System as defined in IEC publication 134.
[2]) See also areas of permissible operation at pages 10 and 11.

THERMAL RESISTANCE

		2N3553	2N3375	2N3632	
From junction to mounting base	$R_{th\ j\text{-}mb}$ =	25	15	7.5	°C/W
From mounting base to heatsink	$R_{th\ mb\text{-}h}$ =		0.6	0.6	°C/W
From mounting base to heatsink mounted with top clamping washer of 56218	$R_{th\ mb\text{-}h}$ =	1.0			°C/W
top clamping washer of 56218 and a boron nitride washer for electrical insulation	$R_{th\ mb\text{-}h}$ =	1.2			°C/W

CHARACTERISTICS

T_j = 25 °C unless otherwise specified

			2N3553	2N3375	2N3632	
Collector cut-off current						
$I_B = 0$; $V_{CE} = 30$ V	I_{CEO}	<	100	100	250	μA
Breakdown voltages						
$I_E = 0$; $I_C = 250$ μA	$V_{(BR)CBO}$	>	65	65	65	V
I_C up to 200 mA; $-V_{BE} = 1.5$ V; $R_B = 33\ \Omega$ [1]	$V_{(BR)CEX}$	>	65	65	65	V
I_C up to 200 mA; $I_B = 0$ [1]	$V_{(BR)CEO}$	>	40	40	40	V
$I_C = 0$; $I_E = 250$ μA	$V_{(BR)EBO}$	>	4	4	4	V
Base-emitter voltage						
I_C = 250 mA; V_{CE} = 5 V	V_{BE}	<	1.5			V
I_C = 500 mA; V_{CE} = 5 V	V_{BE}	<		1.5		V
I_C = 1000 mA; V_{CE} = 5 V	V_{BE}	<			1.5	V
Saturation voltage						
I_C = 250 mA; I_B = 50 mA	V_{CEsat}	<	1.0			V
I_C = 500 mA; I_B = 100 mA	V_{CEsat}	<		1.0		V
I_C = 1000 mA; I_B = 200 mA	V_{CEsat}	<			1.0	V

[1]) Pulsed through an inductor of 25 mH; $\delta = 0.5$; f = 50 Hz

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

			2N3553	2N3375	2N3632	
D.C. current gain						
I_C = 125 mA; V_{CE} = 5 V	h_{FE}	>	15	15		
		<	200	200		
I_C = 250 mA; V_{CE} = 5 V	h_{FE}	>	10	10	10	
		<	100	100	150	
I_C = 1000 mA; V_{CE} = 5 V	h_{FE}	>			5	
		<			110	
Collector capacitance at f = 1 MHz						
$I_E = I_e = 0$; V_{CB} = 28 V	C_c	<	10	10	20	pF
Collector-case capacitance		<		6	6	pF
Transition frequency						
I_C = 125 mA; V_{CE} = 28 V	f_T	typ.	500	500		MHz
I_C = 250 mA; V_{CE} = 28 V	f_T	typ.			400	MHz
Real part of input impedance at f = 200 MHz						
I_C = 125 mA; V_{CE} = 28 V	$Re(h_{ie})$	<	20	20		Ω
I_C = 250 mA; V_{CE} = 28 V	$Re(h_{ie})$	<			20	Ω

R.F. performance at V_{CE} = 28 V

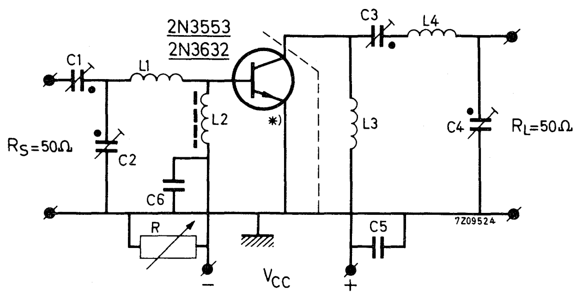
	f (MHz)	P_o (W)	P_i (W)	I_C (mA)	η %	Test circuit at page
2N3553	175	2.5	< 0.25	< 180	> 50	5
2N3375	100	7.5	< 1	< 410	> 65	6
2N3375	400	> 3	1	270	> 40	7
2N3632	175	> 13.5	3.5	690	> 70	5

NOTE

The transistors can withstand an output V.S.W.R. of 3 : 1 varied through all phases under conditions mentioned in the table above.

CHARACTERISTICS (continued)

Test circuit with the 2N3553 or the 2N3632 at f = 175 MHz



*) The length of the external emitter wire of the 2N3553 is 1.6 mm.
The emitter of the 2N3632 should be connected to the case as short as possible.

Components

C1 = C2 = C3 = C4 =	4 to 29 pF	air trimmer
C5 =	10 nF	polyester
C6 =	100 pF	ceramic

L1 = 1 turn Cu wire (1.0 mm); int. diam. 10 mm; leads 2 x 10 mm

L2 = Ferroxcube choke coil. Z (at f = 175 MHz) = 550 Ω ± 20%
(code number 4312 020 36641)

L3 = 15 turns closely wound enamelled Cu wire (0.7 mm); int. diam. 4 mm

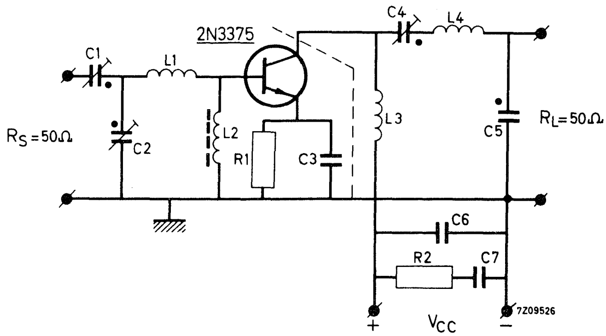
L4 = 3 turns closely wound enamelled Cu wire (1.5 mm); int. diam. 12 mm; leads 2 x 20 mm

R = 0 for the 2N3553

R = 0 to 2 Ω for the 2N3632

CHARACTERISTICS (continued)

Test circuit with the 2N3375 at f = 100 MHz



Components

C1 = C2 = 3.5 to 61.5 pF		air trimmer
C3 =	10 nF	polyester
C4 = C5 = 4 to	29 pF	air trimmer
C6 =	330 pF	ceramic
C7 =	10 nF	polyester

L1 = 2 turns closely wound enamelled Cu wire (1.5 mm); int. diam. 10 mm; leads 2 x 10 mm

L2 = Ferroxcube choke coil. Z (at f = 100 MHz) = 700 Ω ± 20% (code number 4312 020 36641)

L3 = 23 turns closely wound enamelled Cu wire (0.7 mm); int. diam. 6 mm

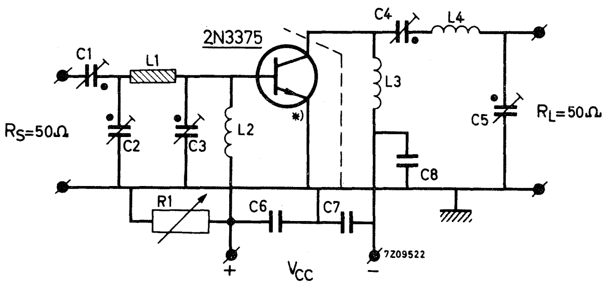
L4 = 5 turns closely wound enamelled Cu wire (1.5 mm); int. diam. 12 mm; leads 2 x 10 mm

R1 = 1.35 Ω carbon

R2 = 10 Ω carbon

CHARACTERISTICS (continued)

Test circuit with the 2N3375 at f = 400 MHz



*) The emitter should be connected to the case as short as possible.

Components

C1 = C2 =	0.7 to 6.7 pF	ceramic trimmer
C3 =	0.5 to 3.5 pF	ceramic trimmer
C4 = C5 =	3 to 19 pF	air trimmer
C6 = C7 =	15 pF	ceramic
C8 =	4700 pF	ceramic

L1 = 20 mm straight Cu wire; diam. 1.5 mm; spaced 8 mm from chassis

L2 = 17 turns closely wound enamelled Cu wire (0.5 mm); int. diam. 3 mm

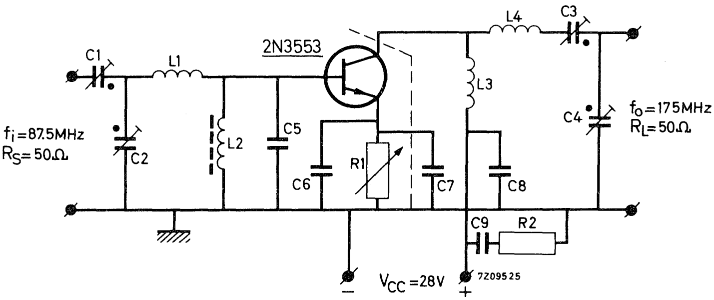
L3 = 7 turns closely wound enamelled Cu wire (0.5 mm); int. diam. 3 mm

L4 = 1 turn Cu wire (1.5 mm); int. diam. 10 mm; leads 2 x 5 mm

R = 0 to 5 Ω

APPLICATION INFORMATION

The 2N3553 used in a frequency doubler circuit 87.5 - 175 MHz



Components

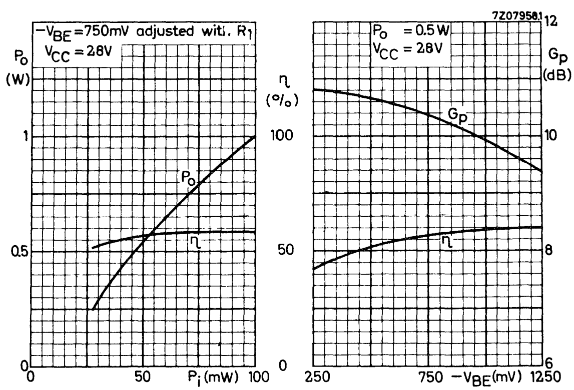
C1 = C2 = C3 =	4 to 29 pF	air trimmer	R_1 =	0 to 50 Ω	
C4 =	3.5 to 61.5 pF	air trimmer	R_2 =	10 Ω	carbon
C5 =	56 pF	ceramic			
C6 =	680 pF	ceramic			
C7 =	150 pF	ceramic			
C8 =	100 pF	ceramic			
C9 =	10 nF	polyester			

L1 = 5 turns Cu wire (1 mm); winding pitch 1.5 mm; int. diam. 6 mm; leads 2 x 12 mm

L2 = Ferroxcube choke coil; Z (at f = 87.5 MHz) = 750 Ω ± 20% (code number 4312 020 36641)

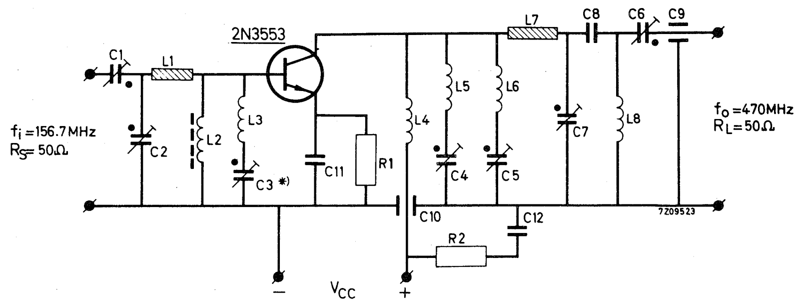
L3 = 15 turns closely wound enamelled Cu wire (0.7 mm); int. diam. 4 mm

L4 = 6 turns Cu wire (1 mm); winding pitch 1.5 mm; int. diam. 6 mm; leads 2 x 12 mm



APPLICATION INFORMATION (continued)

The 2N3553 used in a parametric frequency tripler 156.7 - 470 MHz



*) C3 tuned to second harmonic frequency

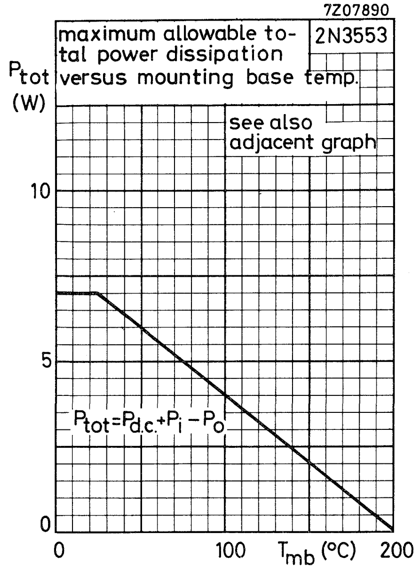
Components

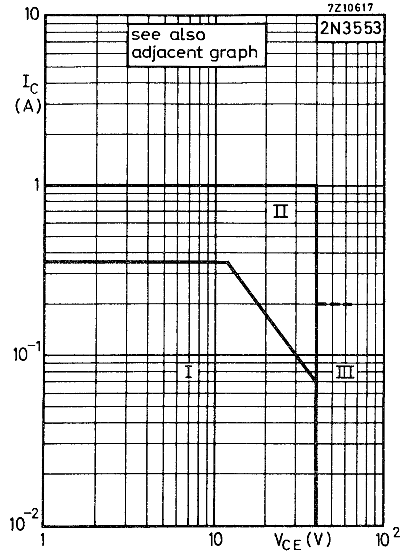
C1 = C2 = C3 = C4 = 4 to 29 pF	air trimmer	R_1 = 2.2 Ω	carbon
C5 = C6 = C7 = 4 to 10.4 pF	air trimmer	R_2 = 10 Ω	carbon
C8 = 1.0 pF	ceramic		
C9 = 12 pF	ceramic; feed through		
C10 = 100 pF	ceramic; feed through		
C11 = 1000 pF	ceramic		
C12 = 15 nF	polyester		

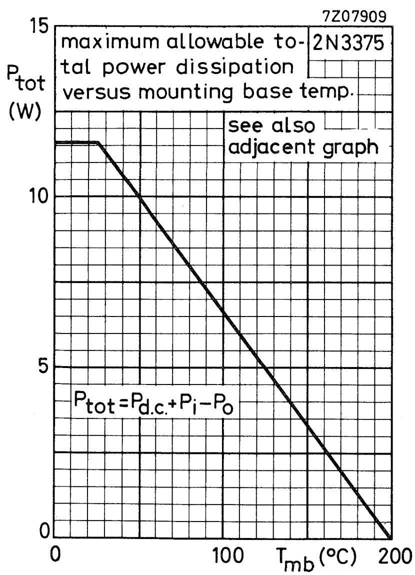
L1 = 35 mm straight Cu wire; diam. 1 mm; spaced 5.5 mm from chassis
L2 = Ferroxcube choke coil; Z (at f = 156.7 MHz) = 600 Ω ± 20%
(code number 4312 020 36641)
L3 = 18 mm straight Cu wire; diam. 1 mm; spaced 5.5. mm from chassis
L4 = 7 turns closely wound enamelled Cu wire (0.5 mm); int. diam. 3.5 mm
L5 = 3 turns Cu wire (1 mm); winding pitch 1.7 mm; int. diam. 8.5 mm; leads 2 x 10 mm
L6 = 2 turns Cu wire (1 mm); winding pitch 1.7 mm; int. diam. 7 mm; leads 2 x 10 mm
L7 = 40 mm straight Cu wire; diam. 1.5 mm; spaced 5.5 mm from chassis
L8 = 1 turn Cu wire; int. diam. 7 mm; leads 2 x 5 mm

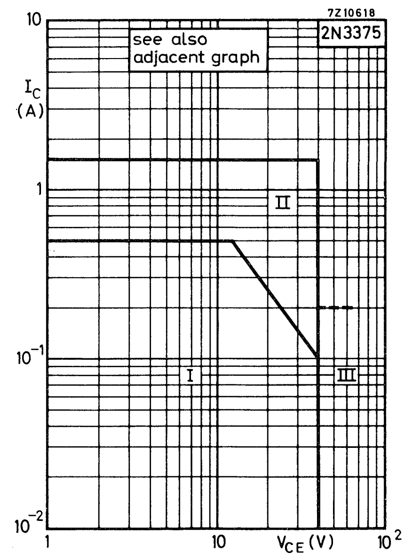
Typical performance at V_{CC} = 28 V

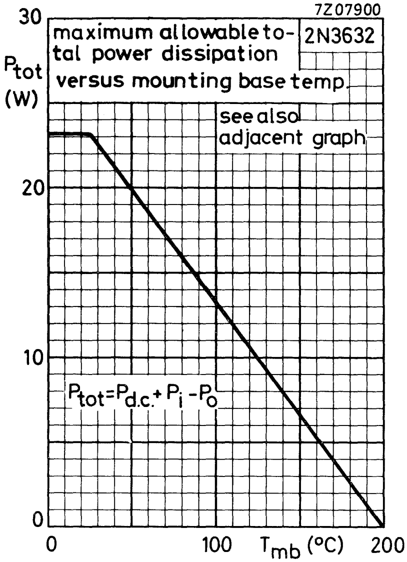
P_o (W)	P_i (W)	G_p (dB)	I_C (mA)	η %
1.5	0.27	7.5	125	43
2.0	0.39	7.1	156	46

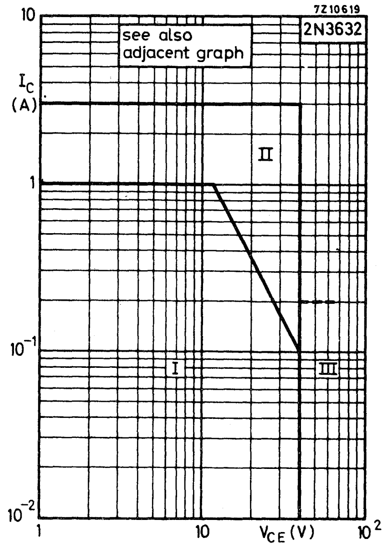

7Z07890
maximum allowable total power dissipation versus mounting base temp.
2N3553
Ptot (W)
see also adjacent graph
Ptot=Pd.c.+Pi − Po
0
5
10
0
100
Tmb (°C)
200


7Z10617
2N3553
see also adjacent graph
IC (A)
10
1
10⁻¹
10⁻²
II
I
III
1
10
VCE (V)
10²


7Z07909
maximum allowable total power dissipation versus mounting base temp.
2N3375
Ptot (W)
see also adjacent graph
Ptot=Pd.c.+Pi−Po
15
10
5
0
0
100
Tmb (°C)
200


7Z10618
2N3375
see also adjacent graph
IC (A)
10
1
10⁻¹
10⁻²
II
I
III
1
10
VCE (V)
10²

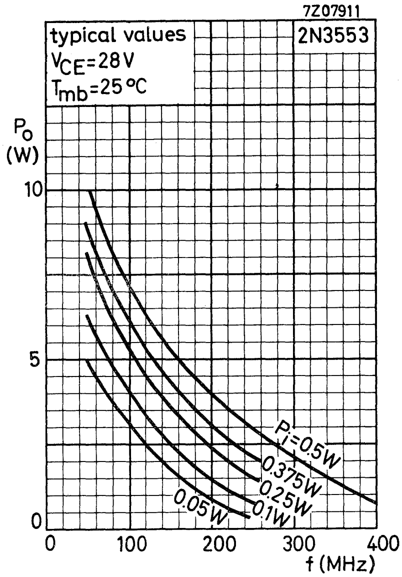


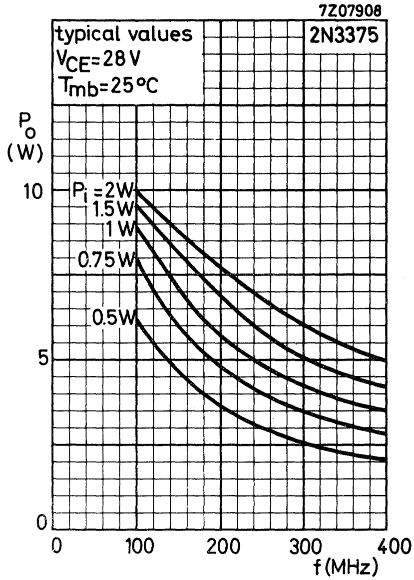


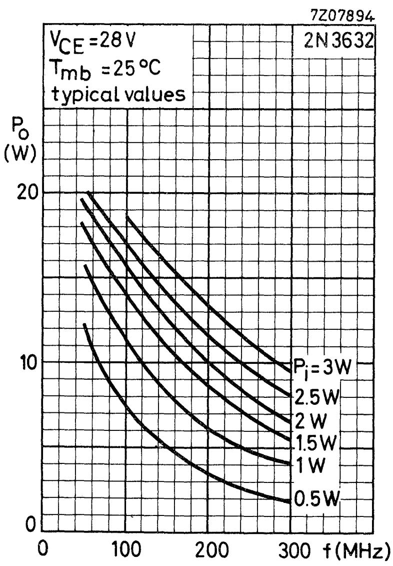
I Region of permissible operation under all base-emitter conditions and at all frequencies, including d.c.

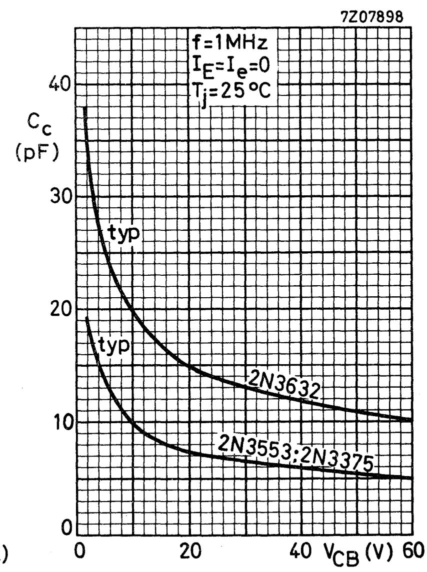
II Additional region of operation at f $\geq$ 1 MHz.
Care must be taken to reduce the d.c. adjustment to region I before removing the a.c. signal. This may be achieved by an appropriate bias in class A, B or C.

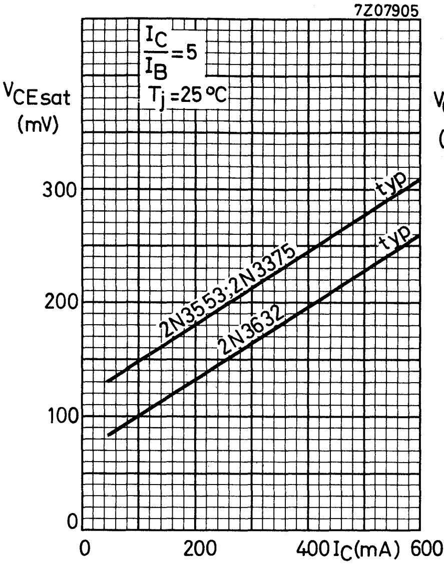
III Operating during switching off in this region is allowed, provided the transistor is cut-off with $-V_{BB} \leq 1.5$ V and $R_{BE} \geq 33\ \Omega$, $I_C \leq 200$ mA and the transient energy does not exceed 0.5 mWs.

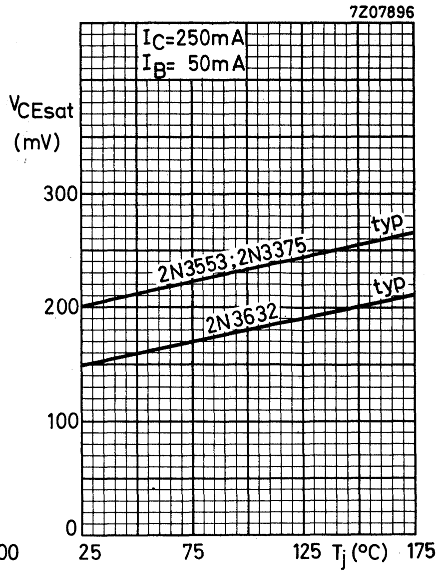

7Z07911
typical values
V_{CE}=28 V
T_{mb}=25 °C
2N3553
P_o (W)
10
5
0
P_i=0.5W
0.375W
0.25W
0.1W
0.05W
0
100
200
300
400
f (MHz)

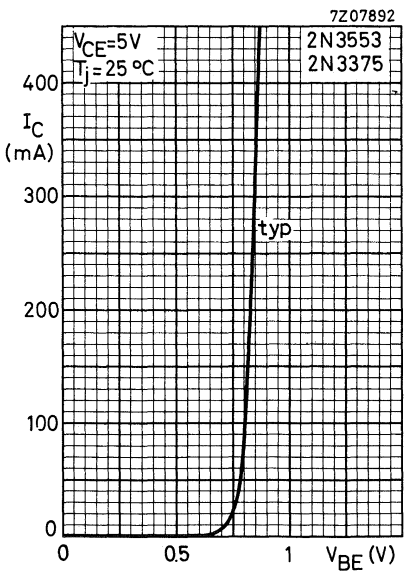

7Z07908
typical values
V_{CE}=28 V
T_{mb}=25 °C
2N3375
P_o (W)
10
5
0
P_i =2W
1.5W
1 W
0.75W
0.5W
0
100
200
300
400
f (MHz)

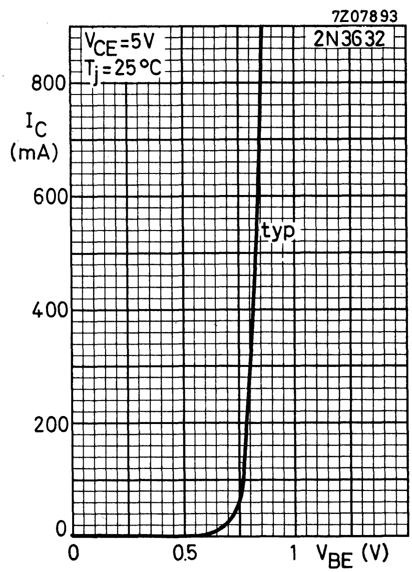

7Z07894
V_{CE} =28 V
T_{mb} =25 °C
typical values
2N3632
P_o (W)
20
10
0
P_i=3W
2.5W
2 W
1.5W
1 W
0.5W
0
100
200
300
f (MHz)

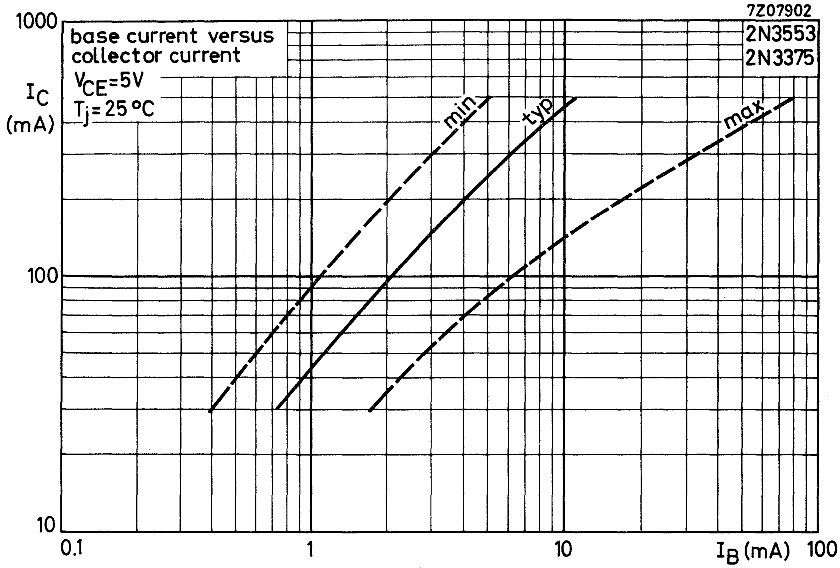

7Z07898
f=1 MHz
I_E=I_e=0
T_j=25 °C
C_c (pF)
40
30
20
10
0
typ
typ
2N3632
2N3553;2N3375
0
20
40
V_{CB} (V)
60

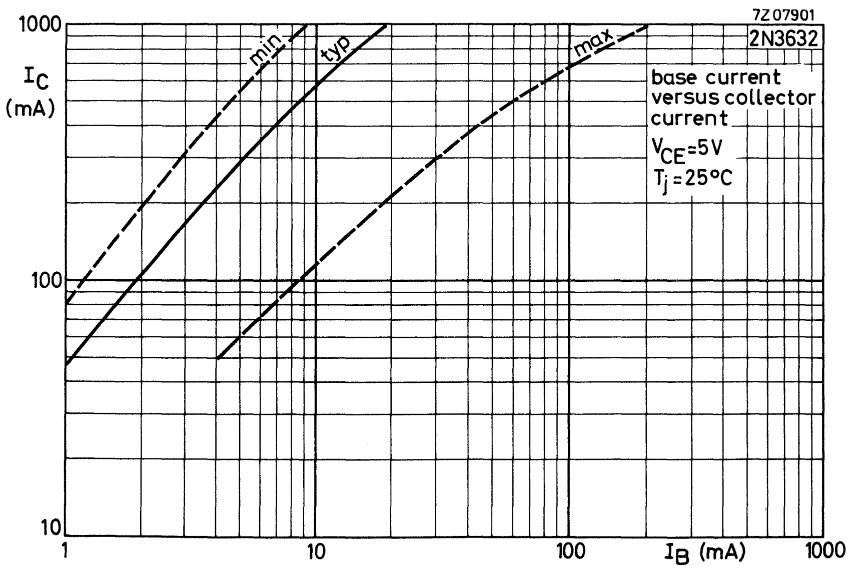

7Z07905
$\frac{I_C}{I_B} = 5$
$T_j = 25$ °C
V_{CEsat} (mV)
300
200
100
0
0
200
400
600
I_C (mA)
typ
typ
2N3553;2N3375
2N3632

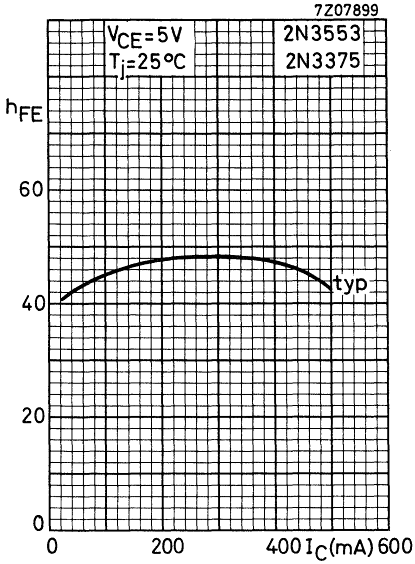

7Z07896
$I_C = 250$ mA
$I_B = 50$ mA
V_{CEsat} (mV)
300
200
100
0
25
75
125
175
T_j (°C)
typ
typ
2N3553;2N3375
2N3632

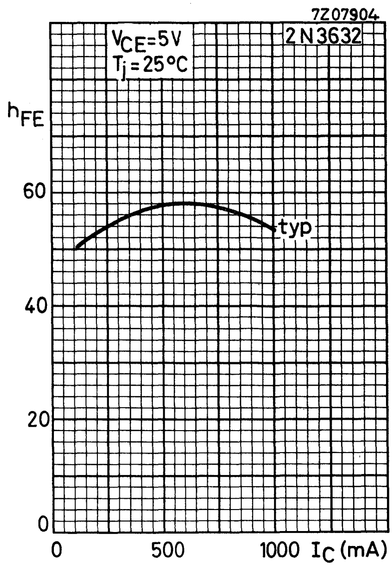

7Z07892
$V_{CE} = 5$ V
$T_j = 25$ °C
2N3553
2N3375
I_C (mA)
400
300
200
100
0
0
0.5
1
V_{BE} (V)
typ

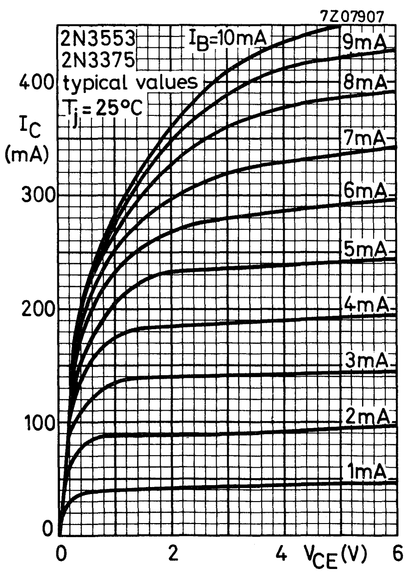

7Z07893
$V_{CE} = 5$ V
$T_j = 25$ °C
2N3632
I_C (mA)
800
600
400
200
0
0
0.5
1
V_{BE} (V)
typ

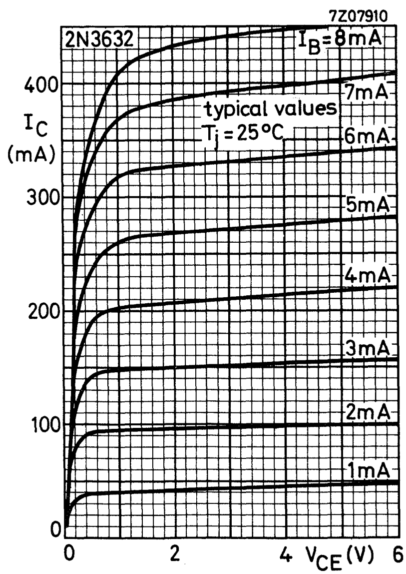

7Z07902
2N3553
2N3375
base current versus
collector current
VCE=5V
Tj=25 °C
IC
(mA)
1000
100
10
min
typ
max
0.1
1
10
IB (mA)
100

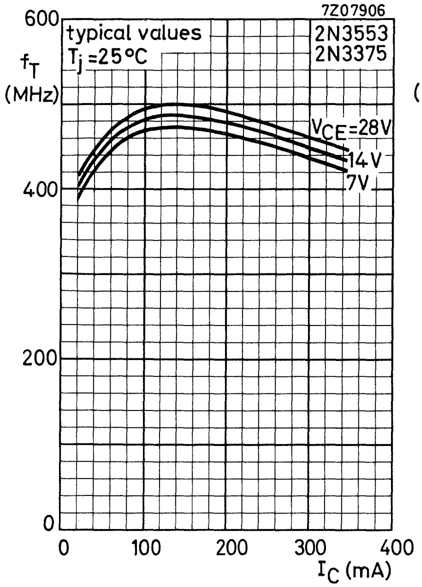

7Z07901
2N3632
base current
versus collector
current
VCE=5V
Tj=25 °C
IC
(mA)
1000
100
10
min
typ
max
1
10
100
IB (mA)
1000

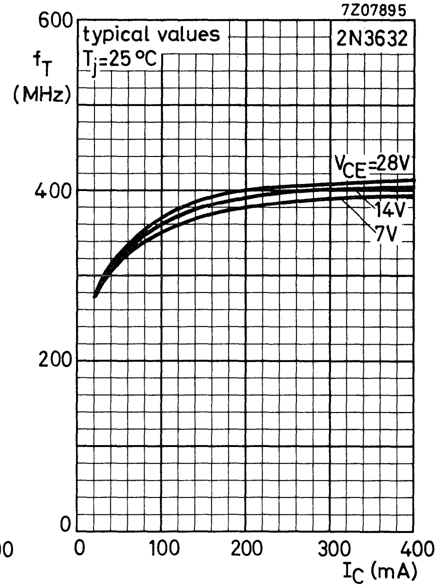

7Z07899
V_{CE}=5V
T_j=25°C
2N3553
2N3375
h_{FE}
60
40
20
0
typ
0
200
400
I_C(mA)
600

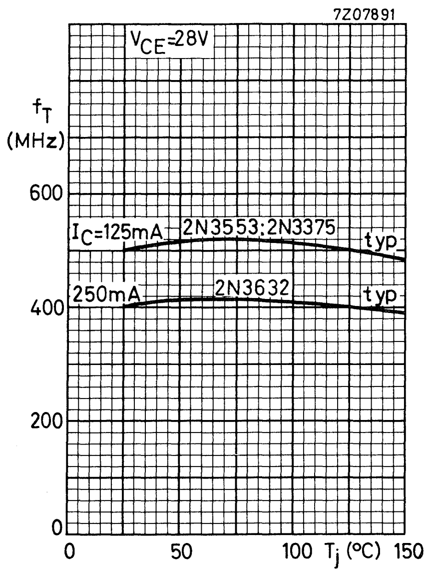

7Z07904
V_{CE}=5V
T_j=25°C
2N3632
h_{FE}
60
40
20
0
typ
0
500
1000
I_C (mA)

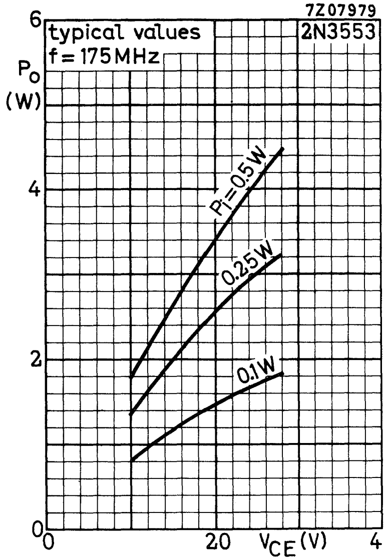

7Z07907
2N3553
2N3375
typical values
T_j=25°C
I_B=10mA
9mA
8mA
7mA
6mA
5mA
4mA
3mA
2mA
1mA
I_C
(mA)
400
300
200
100
0
0
2
4
V_{CE}(V)
6

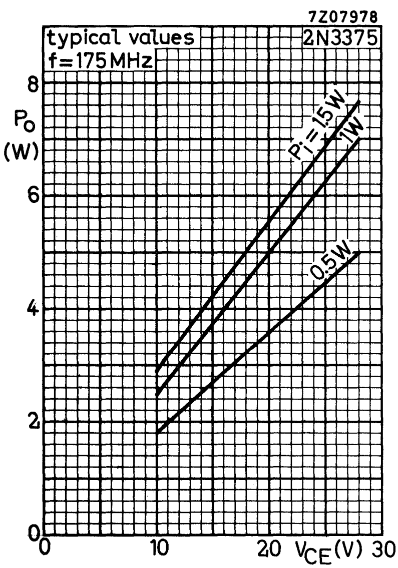

7Z07910
2N3632
I_B=8mA
7mA
typical values
T_j=25°C
6mA
5mA
4mA
3mA
2mA
1mA
I_C
(mA)
400
300
200
100
0
0
2
4
V_{CE}(V)
6

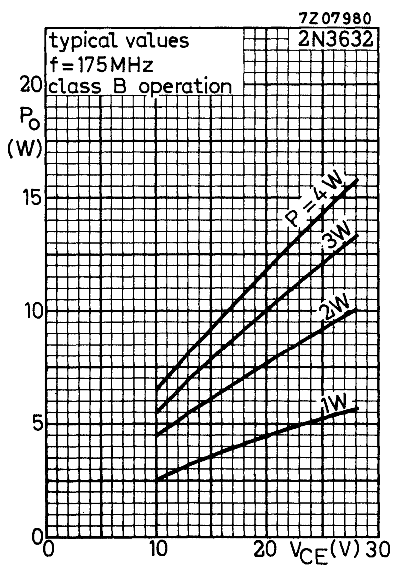

7Z07906
typical values
T_j = 25 °C
2N3553
2N3375
f_T (MHz)
600
400
200
0
V_{CE} = 28V
14 V
7V
0
100
200
300
400
I_C (mA)


7Z07895
typical values
T_j = 25 °C
2N3632
f_T (MHz)
600
400
200
0
V_{CE} = 28V
14V
7V
0
100
200
300
400
I_C (mA)


7Z07891
V_{CE} = 28V
f_T (MHz)
600
400
200
0
I_C = 125mA
2N3553;2N3375
typ
250mA
2N3632
typ
0
50
100
150
T_j (°C)


7Z07979
typical values
f = 175 MHz
2N3553
P_o (W)
P_i = 0.5 W
0.25 W
0.1 W
0
2
4
6
0
20
V_{CE} (V)
4


7Z07978
typical values
f = 175 MHz
2N3375
P_o (W)
P_i = 1.5 W
1 W
0.5 W
0
2
4
6
8
0
10
20
V_{CE} (V)
30


7Z07980
typical values
f = 175 MHz
class B operation
2N3632
P_o (W)
P_i = 4 W
3 W
2 W
1 W
0
5
10
15
20
0
10
20
V_{CE} (V)
30

SILICON EPITAXIAL PLANAR OVERLAY TRANSISTORS

N-P-N overlay transistors in a TO-39 metal envelope with the collector connected to the case. The devices are primarily intended for class A, B or C amplifiers, frequency multiplier- and oscillator circuits.
The transistors are suitable in output, driver or pre-driver stages in v.h.f. and u.h.f. equipment.

QUICK REFERENCE DATA

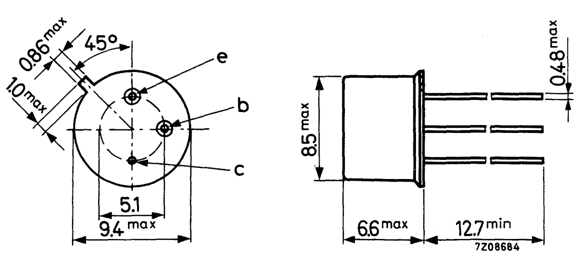
			2N3866	2N4427	
Collector-emitter voltage R_{BE} = 10 Ω	V_{CER}	max.	55	40	V
Collector-emitter voltage (open base)	V_{CEO}	max.	30	20	V
Collector current (d.c. or averaged over any 20 ms period)	I_C	max.	0.4	0.4	A
Total power dissipation up to T_{mb} = 25 °C	P_{tot}	max.	5	3.5	W
Junction temperature	T_j	max.	200	200	°C
Transition frequency I_C = 25 mA; V_{CE} = 15 V; f = 100 MHz	f_T	typ.	700		MHz
I_C = 25 mA; V_{CE} = 10 V; f = 100 MHz	f_T	typ.		700	MHz

R.F. performance

Type	f (MHz)	V_{CE} (V)	P_o (W)	P_i (W)	η (%)
2N3866	400	28	1	< 0.1	> 45
2N4427	175	12	1	< 0.1	> 50

MECHANICAL DATA Dimensions in mm

Collector connected to case
TO-39



Accessories available: 56218; 56245; 56265

RATINGS (Limiting values) [1])

Voltages [2])			2N3866	2N4427	
Collector-base voltage (open emitter)	V_{CBO}	max.	55	40	V
Collector-emitter voltage R_{BE} = 10 Ω	V_{CER}	max.	55	40	V
Collector-emitter voltage (open base)	V_{CEO}	max.	30	20	V
Emitter-base voltage (open collector)	V_{EBO}	max.	3.5	2.0	V
Currents [2])					
Collector current (d.c. or averaged over any 20 ms period)	I_C	max.	0.4	0.4	A
Collector current (peak value)	I_{CM}	max.	0.4	0.4	A
Power dissipation [2])					
Total power dissipation up to T_{mb} = 25 °C	P_{tot}	max.	5	3.5	W

Temperatures

Storage temperature	T_{stg}		−65 to +200	°C
Junction temperature	T_j	max.	200	°C

THERMAL RESISTANCE

From junction to ambient in free air	$R_{th\ j\text{-}a}$	=	200	°C/W
From junction to mounting base	$R_{th\ j\text{-}mb}$	=	35	°C/W
From mounting base to heatsink mounted with top clamping washer of 56218	$R_{th\ mb\text{-}h}$	=	1.0	°C/W
top clamping washer of 56218 and a boron nitride washer for electrical insulation	$R_{th\ mb\text{-}h}$	=	1.2	°C/W

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

2) See also areas of permissible operation on page 6 .

CHARACTERISTICS T_j = 25 °C unless otherwise specified

			2N3866	2N4427	
Collector cut-off current					
I_B = 0; V_{CE} = 28 V	I_{CEO}	<	20		μA
I_B = 0; V_{CE} = 12 V	I_{CEO}	<		20	μA
Breakdown voltages					
I_E = 0; I_C = 100 μA	$V_{(BR)CBO}$	>	55	40	V
I_C = 5 mA; R_{BE} = 10 Ω	$V_{(BR)CER}$	>	55	40	V
I_B = 0; I_C = 5 mA	$V_{(BR)CEO}$	>	30	20	V
I_C = 0; I_E = 100 μA	$V_{(BR)EBO}$	>	3.5	2	V
Collector-emitter saturation voltage					
I_C = 100 mA; I_B = 20 mA	V_{CEsat}	<	1.0	0.5	V
D.C. current gain					
I_C = 50 mA; V_{CE} = 5 V	h_{FE}		10 to 200		
I_C = 100 mA; V_{CE} = 5 V	h_{FE}			10 to 200	
I_C = 360 mA; V_{CE} = 5 V	h_{FE}	>	5	5	
Transition frequency					
I_C = 25 mA; V_{CE} = 15 V; f = 100 MHz	f_T	typ.	700		MHz
I_C = 25 mA; V_{CE} = 10 V; f = 100 MHz	f_T	typ.		700	MHz
Collector capacitance					
V_{CB} = 28 V; I_E = I_e = 0; f = 1 MHz	C_c	<	3		pF
V_{CB} = 12 V; I_E = I_e = 0; f = 1 MHz	C_c	<		4	pF

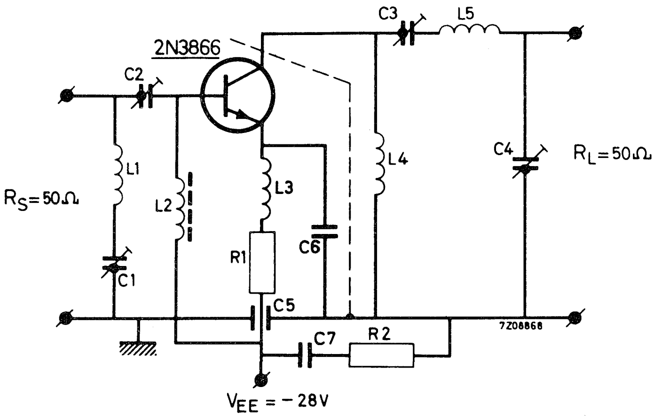
R.F. performance at T_{mb} = 25 °C

	f (MHz)	V_{CE} (V)	P_o (W)	P_i (W)	I_C (mA)	η (%)	Test circuit on page
2N3866	100	28	1.8	0.05	< 107	> 60	
2N3866	250	28	1.5	0.1	< 107	> 50	
2N3866	400	28	1.0	< 0.1	< 79	> 45	4 *
2N4427	175	12	1.0	< 0.1	< 167	> 50	5 *
2N4427	470	12	0.4	0.1	67	50	

*) The transistor can withstand an output V.S.W.R. of 3 : 1 varied through all phases for conditions, mentioned in the table above.

CHARACTERISTICS (continued)

Test circuit with the 2N3866 at f = 400 MHz

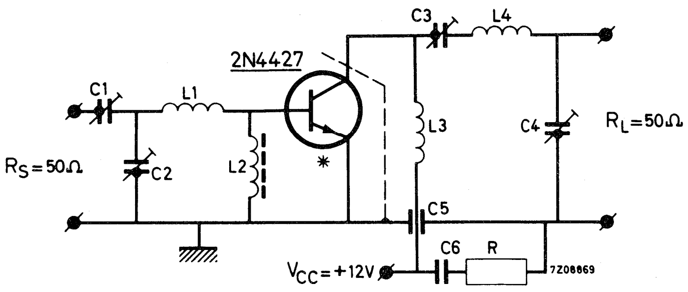


C1 = C2 = C3 =	4 to 29 pF	air trimmer
C4 =	4 to 14 pF	air trimmer
C5 =	1 nF	feed through
C6 =	12 pF	
C7 =	12 nF	
R1 =	5.6 Ω	
R2 =	10 Ω	

L1 = 2 turns Cu wire (1 mm); int. diam. 6 mm; winding pitch 3 mm
L2 = Ferroxcube choke coil; Z (at f = 250 MHz) = 450 Ω (code number 4312 020 36691)
L3 = L4 = 6 turns enamelled Cu wire (0.5 mm); int. diam. 3.5 mm (100 nH)
L5 = 2 turns Cu wire (1 mm); int. diam. 7 mm; winding pitch 2.5 mm; leads 2x15 mm.

CHARACTERISTICS (continued)

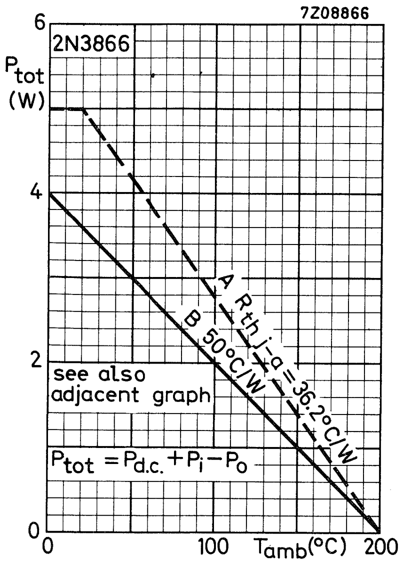
Test circuit with the 2N4427 at f = 175 MHz

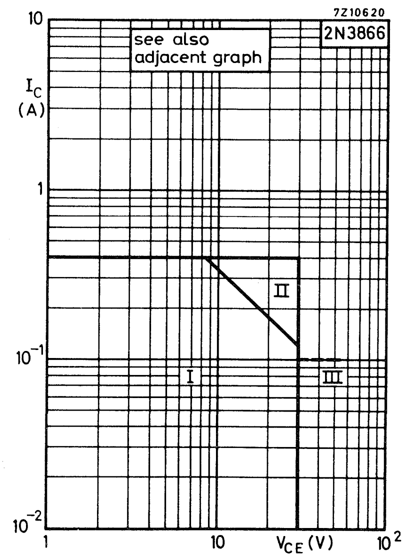


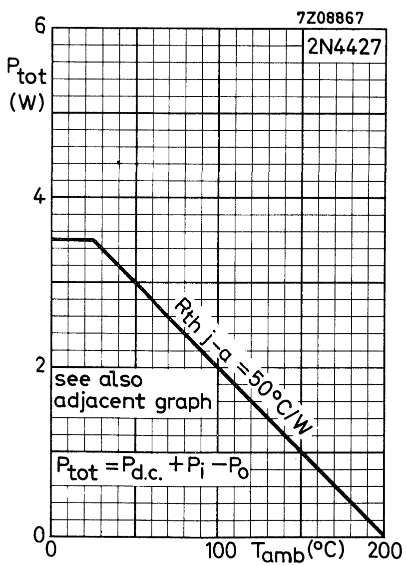
*) The length of the external emitter wire is 1.6 mm

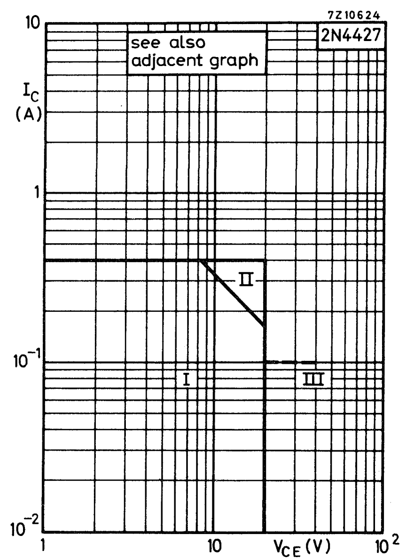
C1 = C2 = C3 = C4 =	4 to 29 pF	air trimmer
C5 =	1 nF	feed through
C6 =	12 nF	
R =	10 Ω	

L1 = 2 turns Cu wire (1 mm); int. diam. 6 mm; winding pitch 2 mm; leads 2x10 mm
L2 = Ferroxcube choke coil; Z (at f = 175 MHz) = 550 Ω (code number 4312 020 36641)
L3 = 2 turns Cu wire (1 mm); int. diam. 5 mm; winding pitch 2 mm; leads 2x10 mm
L4 = 3 turns Cu wire (1.5 mm); int. diam. 10 mm; winding pitch 2 mm; leads 2x15 mm


7Z08866
2N3866
P_{tot} (W)
A $R_{th\ j-a}$ = 36.2 °C/W
B 50 °C/W
see also adjacent graph
$P_{tot} = P_{d.c.} + P_i - P_o$
T_{amb} (°C)
0
100
200
2
4
6


7Z10620
2N3866
see also adjacent graph
I_C (A)
V_{CE} (V)
I
II
III
10
1
10^{-1}
10^{-2}
1
10
10^2

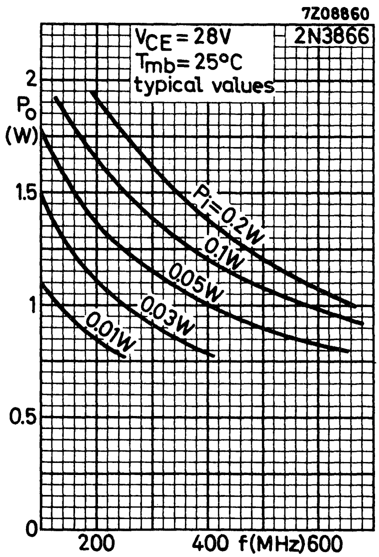

7Z08867
2N4427
P_{tot} (W)
$R_{th\ j-a}$ = 50 °C/W
see also adjacent graph
$P_{tot} = P_{d.c.} + P_i - P_o$
T_{amb} (°C)
0
100
200
2
4
6

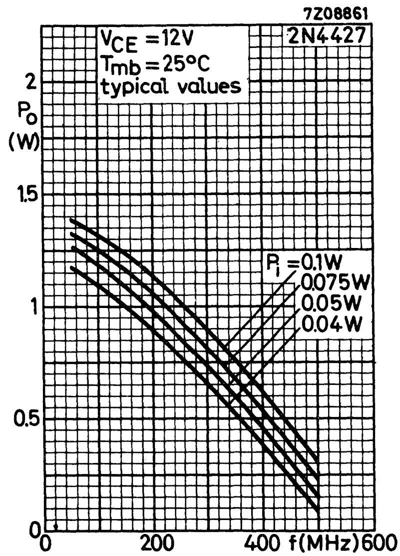

7Z10624
2N4427
see also adjacent graph
I_C (A)
V_{CE} (V)
I
II
III
10
1
10^{-1}
10^{-2}
1
10
10^2

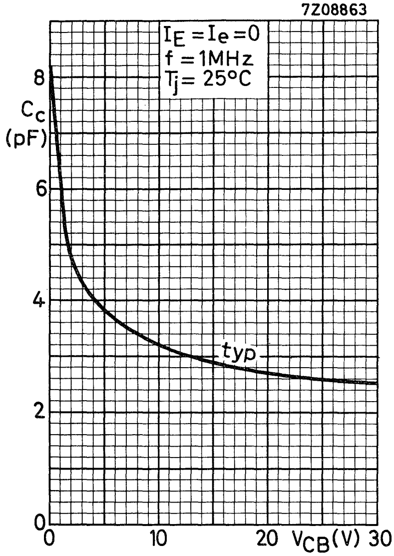
I Region of permissible operation under all base-emitter conditions and at all frequencies, including d.c.

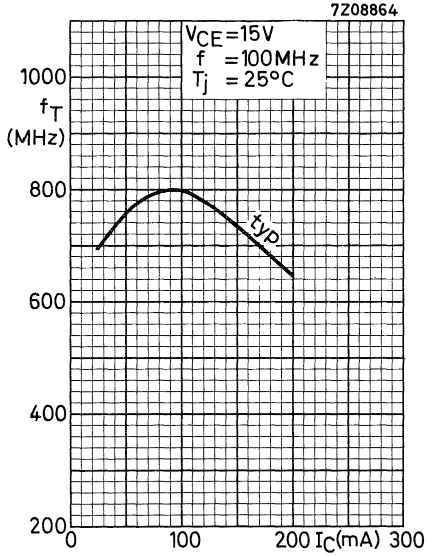
II Additional region of operation at f ≥ 1 MHz.
Care must be taken to reduce the d.c. adjustment to region I before removing the a.c. signal. This may be achieved by an appropriate bias in class A, B or C.

III Operating during switching off in this region is allowed, provided the transistor is cut-off with $-V_{BB} \leq 1.5$ V and $R_{BE} \geq 33\ \Omega$, $I_C \leq 100$ mA and the transient energy does not exceed 0.125 mWs.






7Z08863
$I_E = I_e = 0$
f = 1MHz
T_j = 25°C
C_c
(pF)
8
6
4
2
0
typ
0
10
20
V_{CB}(V)
30


7Z08864
V_{CE}=15V
f = 100MHz
T_j = 25°C
f_T
(MHz)
1000
800
600
400
200
typ
0
100
200
I_C(mA)
300

SILICON EPITAXIAL PLANAR OVERLAY TRANSISTORS

The 2N3924 is a n-p-n overlay transistor in a TO-39 metal envelope with the collector connected to the case.
The 2N3926 and the 2N3927 are n-p-n overlay transistors in TO-60 metal envelopes with the emitter connected to the case.
The transistors are intended for v.h.f. transmitting applications.

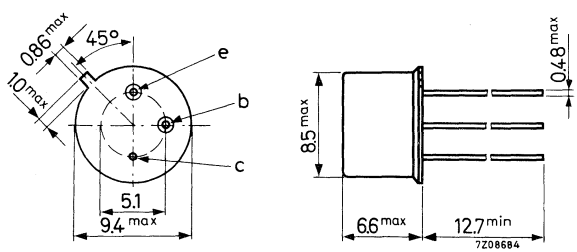
QUICK REFERENCE DATA

			2N3924	2N3926	2N3927	
Collector-emitter voltage $-V_{BE}$ = 1.5 V	V_{CEX}	max.	36	36	36	V
Collector-emitter voltage (open base)	V_{CEO}	max.	18	18	18	V
Collector current (peak value)	I_{CM}	max.	1.5	3.0	4.5	A
Total power dissipation up to T_{mb} = 25 °C	P_{tot}	max.	7	11.6	23	W
Junction temperature	T_j	max.	200	200	200	°C
Transition frequency						
I_C = 100 mA; V_{CE} = 13.5 V	f_T	>	250	250		MHz
I_C = 200 mA; V_{CE} = 13.5 V	f_T	>			200	MHz

R.F. performance at V_{CE} = 13.5 V; f = 175 MHz			
	P_o (W)	P_i (W)	η (%)
2N3924	4	< 1	> 70
2N3926	7	< 2	> 70
2N3927	12	< 4	> 80

MECHANICAL DATA Dimensions in mm

2N3924
Collector connected to case
TO-39



Accessories available: 56218, 56245, 56265.

MECHANICAL DATA (continued)

Dimensions in mm

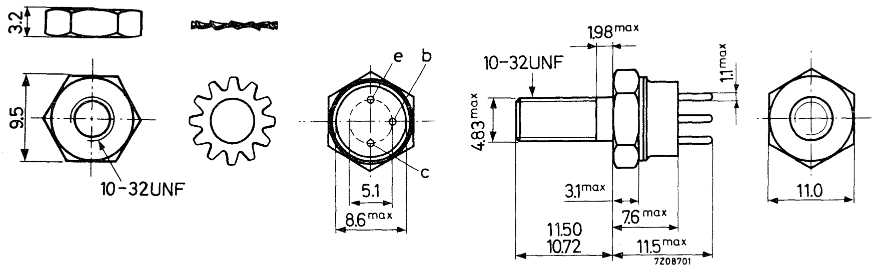
2N3926
2N3927

TO-60

The emitter connected to the case
The top pins should not be bent

Diameter of hole in heatsink: 4.8 to 5.2 mm
The device is supplied with nut and lock washer

Torque on nut: min. 8 cm kg
max. 17 cm kg



RATINGS (Limiting values) [1]

Voltages [2]

Collector-base voltage (open emitter)	V_{CBO}	max.	36	V
Collector-emitter voltage I_C up to 400 mA; $-V_{BE}$ = 1.5 V	V_{CEX}	max.	36	V
Collector-emitter voltage (open base) I_C up to 400 mA	V_{CEO}	max.	18	V
Emitter-base voltage (open collector)	V_{EBO}	max.	4	V

Currents [2]

			2N3924	2N3926	2N3927	
Collector current (d.c.)	I_C	max.	0.5	1.0	1.5	A
Collector current (peak value)	I_{CM}	max.	1.5	3.0	4.5	A

Power dissipation [2]

			2N3924	2N3926	2N3927	
Total power dissipation up to T_{mb} = 25 °C	P_{tot}	max.	7	11.6	23	W

Temperatures

Storage temperature	T_{stg}		-65 to +200	°C
Junction temperature	T_j	max.	200	°C

[1] Limiting values according to the Absolute Maximum System as defined in IEC publication 134.
[2] See also areas of permissible operation at pages 8 and 9.

THERMAL RESISTANCE

			2N3924	2N3926	2N3927	
From junction to mounting base	$R_{th\ j\text{-}mb}$	=	25	15	7.5	°C/W
From mounting base to heatsink	$R_{th\ mb\text{-}h}$	=		0.6	0.6	°C/W
From mounting base to heatsink mounted with top clamping washer of 56218	$R_{th\ mb\text{-}h}$	=	1.0			°C/W
top clamping washer of 56218 and a boron nitride washer for electrical insulation	$R_{th\ mb\text{-}h}$	=	1.2			°C/W

CHARACTERISTICS

T_j = 25 °C unless otherwise specified

			2N3924	2N3926	2N3927	
Collector cut-off current						
$I_B = 0$; $V_{CE} = 15$ V	I_{CEO}	<	100	100	250	μA
$I_B = 0$; $V_{CE} = 15$ V; $T_j = 150$ °C	I_{CEO}	<	5	5	5	mA
Breakdown voltages						
$I_E = 0$; $I_C = 250$ μA	$V_{(BR)CBO}$	>	36	36	36	V
I_C up to 400 mA, $-V_{BE} = 1.5$ V; $R_B = 33\ \Omega$ [1]	$V_{(BR)CEX}$	>	36	36	36	V
I_C up to 400 mA, $I_B = 0$ [1]	$V_{(BR)CEO}$	>	18	18	18	V
$I_C = 0$; $I_E = 250$ μA	$V_{(BR)EBO}$	>	4	4	4	V
Base-emitter voltage						
$I_C = 250$ mA; $V_{CE} = 5$ V	V_{BE}	<	1.5			V
$I_C = 500$ mA; $V_{CE} = 5$ V	V_{BE}	<		1.5		V
$I_C = 1000$ mA; $V_{CE} = 5$ V	V_{BE}	<			1.5	V
Saturation voltage						
$I_C = 250$ mA; $I_B = 50$ mA	V_{CEsat}	<	0.75			V
$I_C = 500$ mA; $I_B = 100$ mA	V_{CEsat}	<		0.75		V
$I_C = 1000$ mA; $I_B = 200$ mA	V_{CEsat}	<			1.0	V

[1] Pulsed through an inductor of 25 mH; $\delta = 0.5$; f = 50 Hz

CHARACTERISTICS (continued)

T_j = 25 °C unless otherwise specified

			2N3924	2N3926	2N3927	
D.C. current gain						
I_C = 250 mA; V_{CE} = 5 V	h_{FE}	>	10			
		<	150			
I_C = 500 mA; V_{CE} = 5 V	h_{FE}	>		5		
		<		150		
I_C = 1000 mA; V_{CE} = 5 V	h_{FE}	>			5	
		<			150	
Collector capacitance at f = 1 MHz						
$I_E = I_e = 0$; V_{CB} = 13.5 V	C_c	<	20	20	45	pF
Transition frequency						
I_C = 100 mA; V_{CE} = 13.5 V	f_T	>	250	250		MHz
I_C = 200 mA; V_{CE} = 13.5 V	f_T	>			200	MHz
Real part of input impedance at f = 200 MHz						
I_C = 100 mA; V_{CE} = 13.5 V	$Re(h_{ie})$	<	20	20		Ω
I_C = 200 mA; V_{CE} = 13.5 V	$Re(h_{ie})$	<			20	Ω

R.F. performance at V_{CE} = 28 V; f = 175 MHz

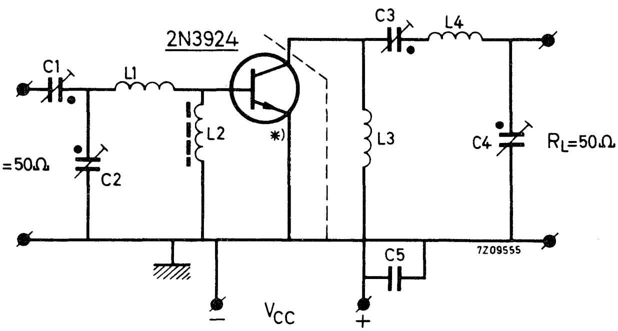
	P_o (W)	P_i (W)	I_C (mA)	η %	Test circuit at page
2N3924	4	< 1	< 420	> 70	5
2N3926	7	< 2	< 740	> 70	6
2N3927	12	< 4	< 1100	> 80	6

NOTE

The transistors can withstand an output V.S.W.R. of 3:1 varied through all phases under conditions mentioned in the table above.

CHARACTERISTICS (continued)

Test circuit with the 2N3924 at f = 175 MHz



*) The length of the external emitter wire of the 2N3924 is 1.6 mm.

Components

C1 = C2 = C3 = C4 = 4 to 29 pF air trimmer

C5 = 10 nF polyester

L1 = 1 turn Cu wire (1.0 mm); int. diam. 10 mm; leads 2 x 10 mm

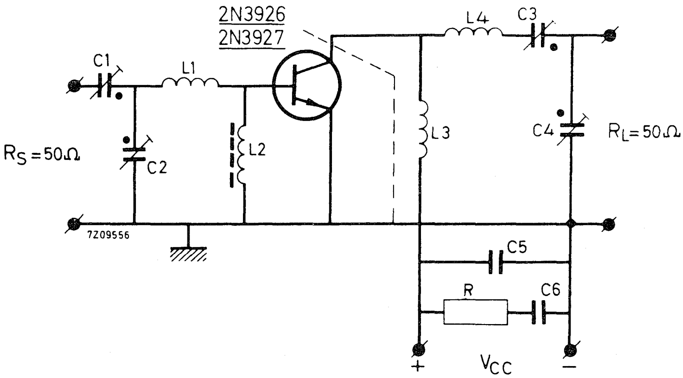
L2 = Ferroxcube choke coil. Z (at f = 175 MHz) = 550 Ω ± 20% (code number 4312 020 36641)

L3 = 15 turns closely wound enamelled Cu wire (0.7 mm); int. diam. 4 mm

L4 = 3 turns closely wound enamelled Cu wire (1.5 mm); int. diam. 12 mm; leads 2 x 20 mm

CHARACTERISTICS (continued)

Test circuit with the 2N3926 or 2N3927 at f = 175 MHz



Components

C1 = C2 = C3 = C4 = 4 to 29 pF air trimmer

C5 = 100 pF ceramic

C6 = 10 nF polyester

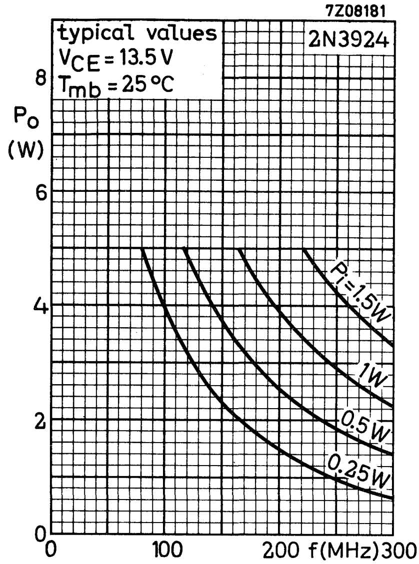
L1 = 1 turn Cu wire (1.0 mm); int. diam. 10 mm; leads 2 x 10 mm

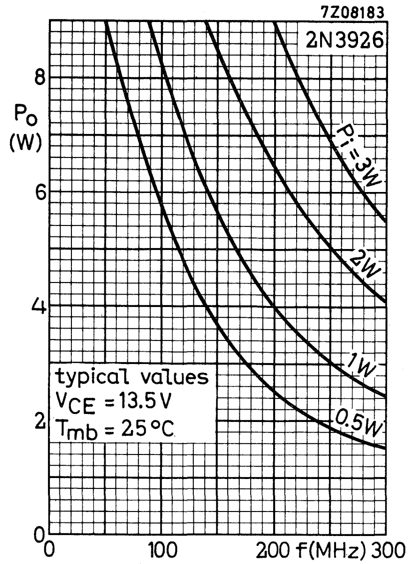
L2 = Ferroxcube choke coil. Z (at f = 175 MHz) = 550 Ω ± 20%
(code number 4312 020 36641)

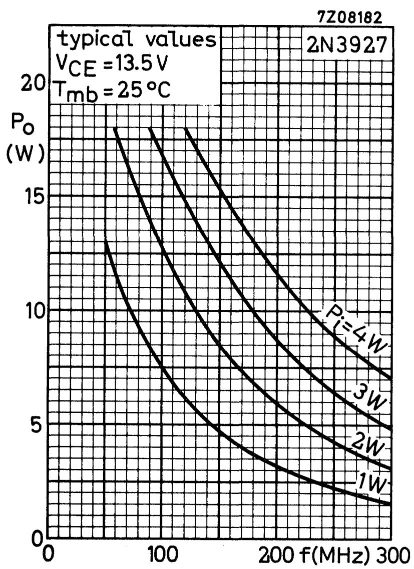
L3 = 15 turns closely wound enamelled Cu wire (0.7 mm); int. diam. 4 mm

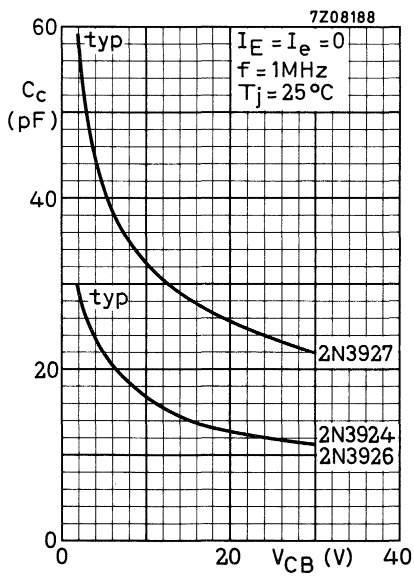
L4 = 2 turns closely wound enamelled Cu wire (1.5 mm); int. diam. 8.5 mm; leads 2 x 20 mm

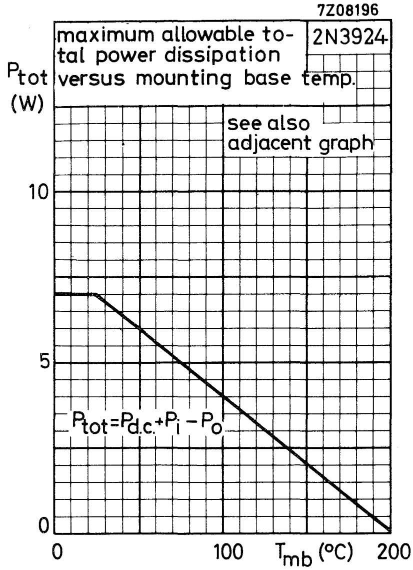
R = 10 Ω carbon

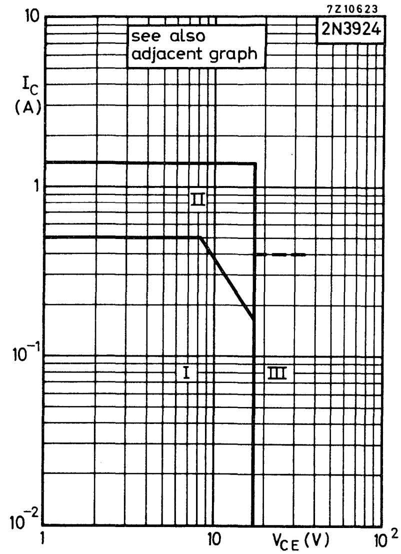

7Z08181
typical values
V_{CE} = 13.5 V
T_{mb} = 25 °C
2N3924
P_o (W)
8
6
4
2
0
0
100
200
f(MHz)
300
P_i = 1.5W
1W
0.5 W
0.25W

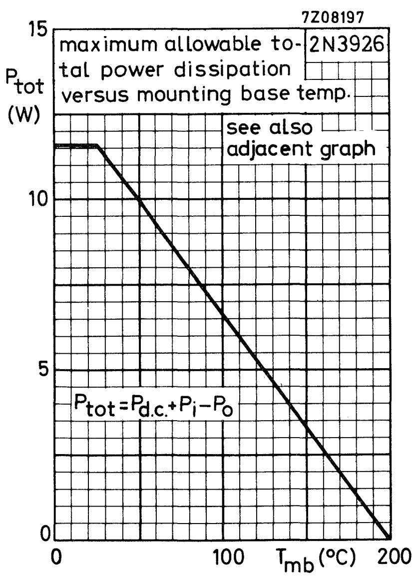

7Z08183
2N3926
P_o (W)
8
6
4
2
0
0
100
200
f(MHz)
300
P_i = 3W
2W
1W
0.5W
typical values
V_{CE} = 13.5 V
T_{mb} = 25 °C

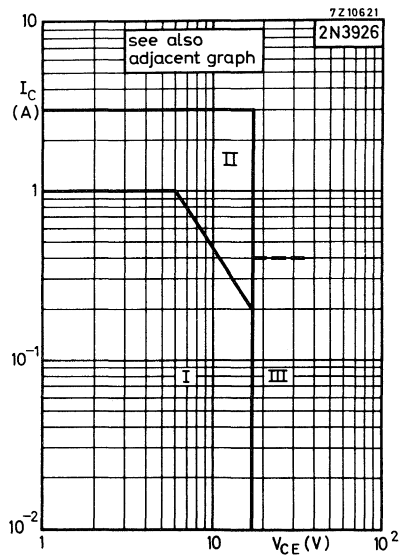

7Z08182
typical values
V_{CE} = 13.5 V
T_{mb} = 25 °C
2N3927
P_o (W)
20
15
10
5
0
0
100
200
f(MHz)
300
P_i = 4W
3W
2W
1W

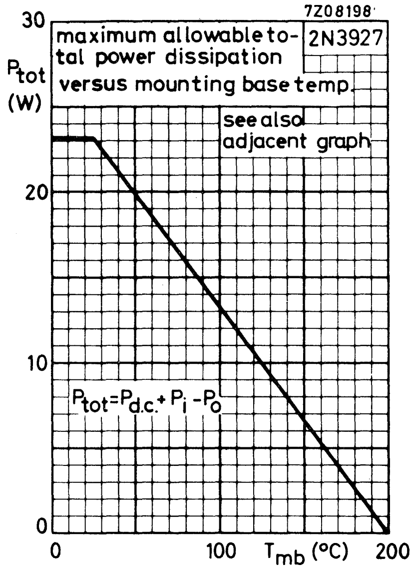

7Z08188
C_c (pF)
60
40
20
0
typ
typ
$I_E = I_e = 0$
f = 1 MHz
T_j = 25 °C
2N3927
2N3924
2N3926
0
20
V_{CB} (V)
40

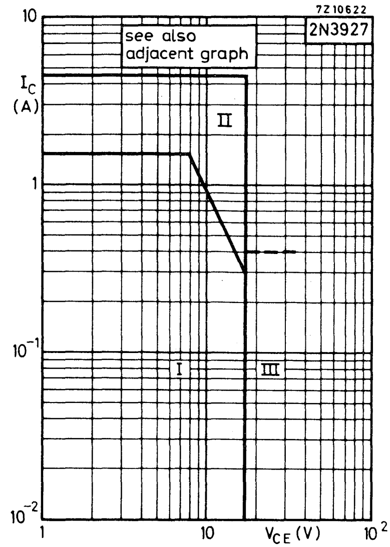

7Z08196
maximum allowable total power dissipation versus mounting base temp.
2N3924
see also adjacent graph
Ptot (W)
10
5
0
Ptot=Pd.c.+Pi−Po
0
100
Tmb (°C)
200


7Z10623
2N3924
see also adjacent graph
IC (A)
10
1
10−1
10−2
II
I
III
1
10
VCE (V)
10 2


7Z08197
maximum allowable total power dissipation versus mounting base temp.
2N3926
see also adjacent graph
Ptot (W)
15
10
5
0
Ptot=Pd.c.+Pi−Po
0
100
Tmb (°C)
200


7Z10621
2N3926
see also adjacent graph
IC (A)
10
1
10−1
10−2
II
I
III
1
10
VCE (V)
10 2

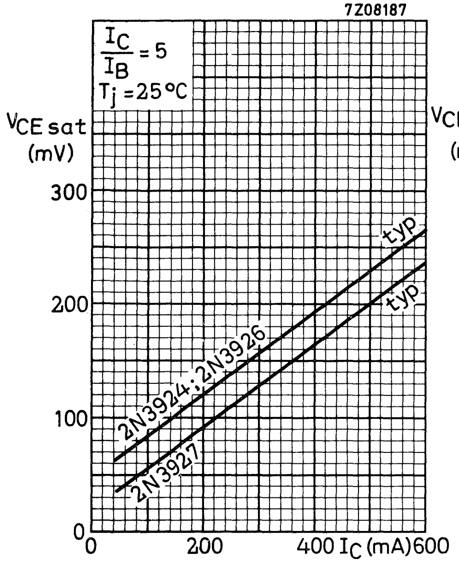


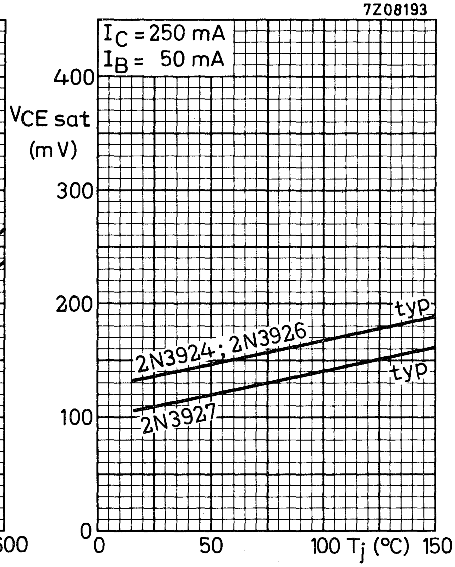


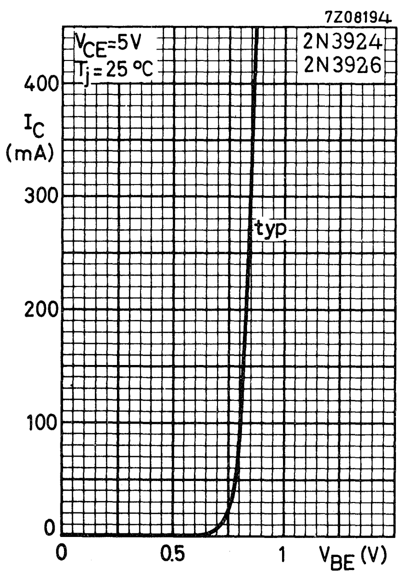
I Region of permissible operation under all base-emitter conditions and at all frequencies, including d.c.

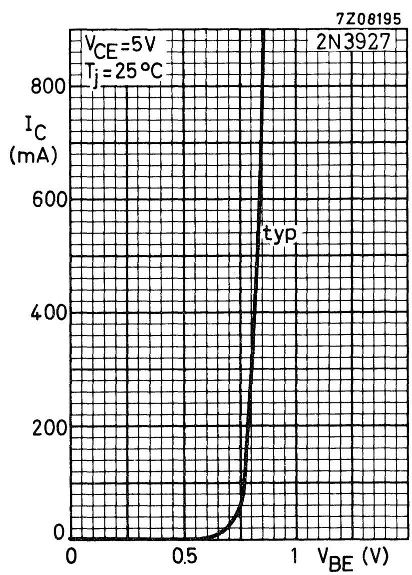
II Additional region of operation at $f \geq 1$ MHz.
Care must be taken to reduce the d.c. adjustment to region I before removing the a.c. signal. This may be achieved by an appropriate bias in class A, B or C.

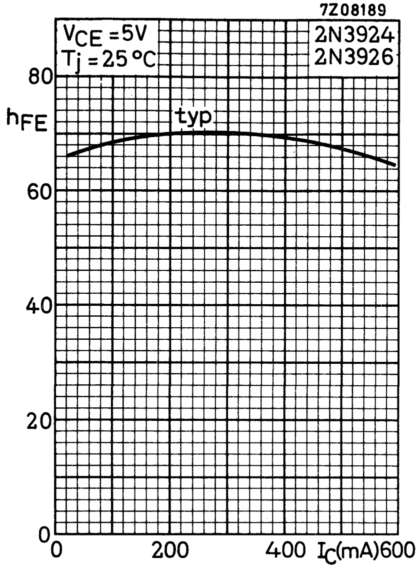
III Operating during switching off in this region is allowed, provided the transistor is cut-off with $-V_{BB} \leq 1.5$ V and $R_{BE} \geq 33\ \Omega$, $I_C \leq 400$ mA and the transient energy does not exceed 2 mWs.

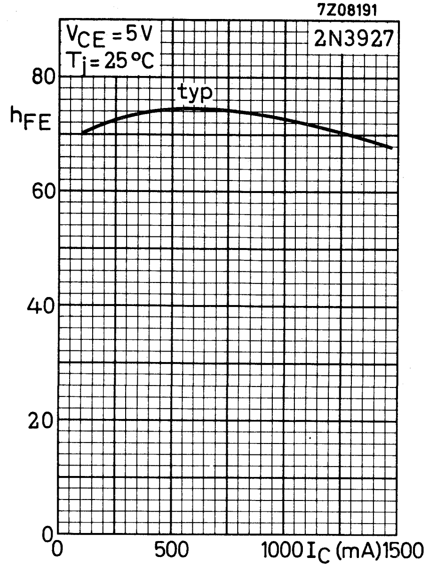

7Z08187
$\frac{I_C}{I_B} = 5$
$T_j = 25\,^{\circ}C$
$V_{CE\,sat}$ (mV)
300
200
100
0
0
200
400
I_C (mA)
600
typ
typ
2N3924; 2N3926
2N3927

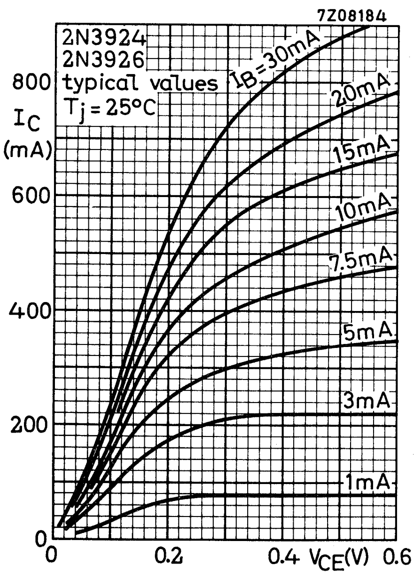

7Z08193
$I_C = 250$ mA
$I_B = 50$ mA
$V_{CE\,sat}$ (mV)
400
300
200
100
0
0
50
100
T_j (°C)
150
typ
typ
2N3924; 2N3926
2N3927

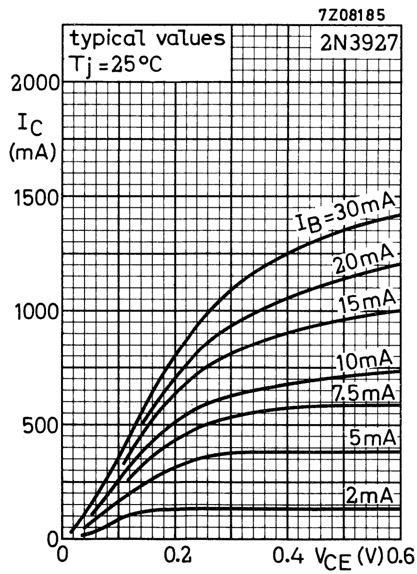

7Z08194
$V_{CE} = 5$ V
$T_j = 25\,^{\circ}C$
2N3924
2N3926
I_C (mA)
400
300
200
100
0
0
0.5
1
V_{BE} (V)
typ

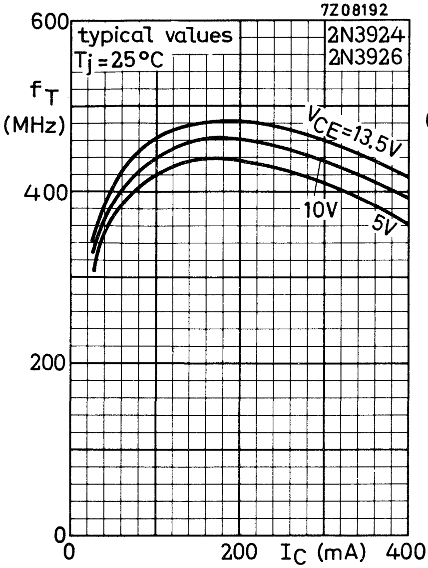

7Z08195
$V_{CE} = 5$ V
$T_j = 25\,^{\circ}C$
2N3927
I_C (mA)
800
600
400
200
0
0
0.5
1
V_{BE} (V)
typ

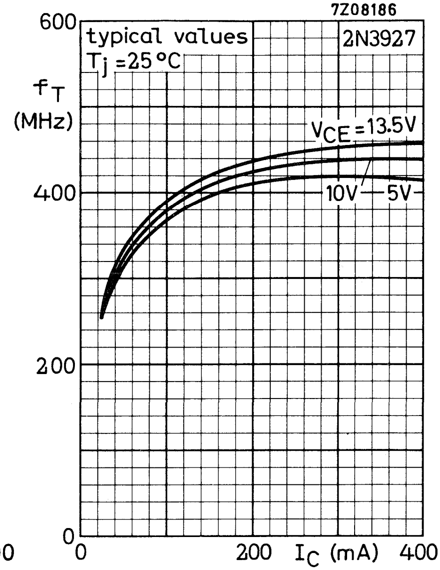

7Z08189
VCE = 5V
Tj = 25 °C
2N3924
2N3926
hFE
typ
80
60
40
20
0
0
200
400
IC(mA)600

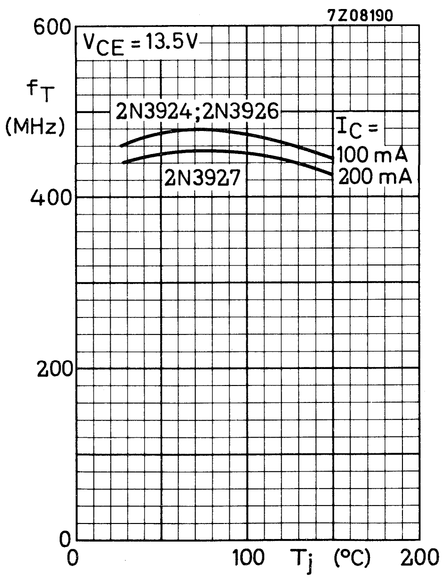

7Z08191
VCE = 5 V
Tj = 25 °C
2N3927
hFE
typ
80
60
40
20
0
0
500
1000 IC (mA)1500


7Z08184
2N3924
2N3926
typical values
Tj = 25°C
IC
(mA)
IB=30mA
20mA
15mA
10mA
7.5mA
5mA
3mA
1mA
800
600
400
200
0
0
0.2
0.4 VCE(V) 0.6


7Z08185
typical values
Tj = 25 °C
2N3927
IC
(mA)
IB=30mA
20mA
15mA
10mA
7.5mA
5mA
2mA
2000
1500
1000
500
0
0
0.2
0.4 VCE (V) 0.6


7Z08192
typical values
Tj = 25 °C
2N3924
2N3926
fT
(MHz)
VCE = 13.5V
10V
5V
600
400
200
0
0
200
IC (mA)
400


7Z08186
typical values
Tj = 25 °C
2N3927
fT
(MHz)
VCE = 13.5V
10V
5V
600
400
200
0
0
200
IC (mA)
400


7Z08190
VCE = 13.5V
fT
(MHz)
2N3924;2N3926
2N3927
IC =
100 mA
200 mA
600
400
200
0
0
100
Tj (°C)
200

SILICON EPITAXIAL PLANAR OVERLAY TRANSISTOR

For data of this transistor please refer to type 2N3866

Field effect transistors

SILICON N-CHANNEL DUAL INSULATED GATE FIELD EFFECT TRANSISTOR

Depletion type field effect transistor in a TO-72 metal envelope with source and substrate connected to the case.
This M.O.S.-tetrode is intended for a wide range of applications in communication, instrumentation and control.
The tetrode configuration, a series arrangement of two gate controlled channels offers:

a. very low feedback capacitance providing the possibility of more than 40 dB gain control in r.f. amplifiers requiring negligible a.g.c. power.
b. excellent signal handling capability over the entire gain control range.
c. low noise figure combined with high gain.

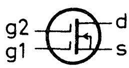
QUICK REFERENCE DATA

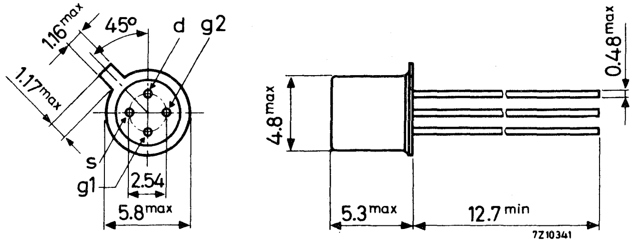
Drain-source voltage	V_{DSX}	max.	20	V
Gate 1-source voltage	$\pm V_{G1-S}$	max.	8	V
Gate 2-source voltage	$\pm V_{G2-S}$	max.	8	V
Drain current	I_D	max.	20	mA
Total power dissipation up to $T_{amb} = 25\,^oC$	P_{tot}	max.	200	mW
Junction temperature	T_j	max.	135	^oC
Transfer admittance at f = 1 kHz I_D = 10 mA; V_{DS} = 13 V; $+V_{G2-S}$ = 4 V	$\lvert y_{fs} \rvert$	> typ.	8 13	$m\Omega^{-1}$ $m\Omega^{-1}$
Feedback capacitance at f = 10 MHz I_D = 10 mA; V_{DS} = 13 V; $+V_{G2-S}$ = 4 V	$-C_{rs}$	typ.	25	fF
Transducer gain at f = 200 MHz I_D = 10 mA; V_{DS} = 13 V; $+V_{G2-S}$ = 4 V B_S and B_L tuned for maximum gain	G_{tr}	typ.	18	dB
Noise figure at optimum source admittance I_D = 10 mA; V_{DS} = 13 V; $+V_{G2-S}$ = 4 V; f = 200 MHz	F_{min}	typ. <	3 4	dB dB

MECHANICAL DATA see page 2.

MECHANICAL DATA Dimensions in mm

TO-72
Source and substrate connected to the case





Accessories available: 56246, 56263

Note: To safeguard the gates against damage due to accumulation of static charge during transport or handling, the leads are encircled by a ring of conductive rubber which should be removed just after the transistor is soldered into the circuit.

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

Voltages				
Drain-source voltage	V_{DSX}	max.	20	V
Gate 1-source voltage	$\pm V_{G1-S}$	max.	8	V
Gate 2-source voltage	$\pm V_{G2-S}$	max.	8	V
Non repetitive peak voltage ($t \leq 10$ ms)				
gate 1-source voltage	$\pm V_{G1-SM}$	max.	50	V
gate 2-source voltage	$\pm V_{G2-SM}$	max.	50	V
Current				
Drain current	I_D	max.	20	mA
Power dissipation				
Total power dissipation up to $T_{amb} = 25\,^oC$	P_{tot}	max.	200	mW
Temperatures				
Storage temperature	T_{stg}		-65 to +135	^oC
Junction temperature	T_j	max.	135	^oC

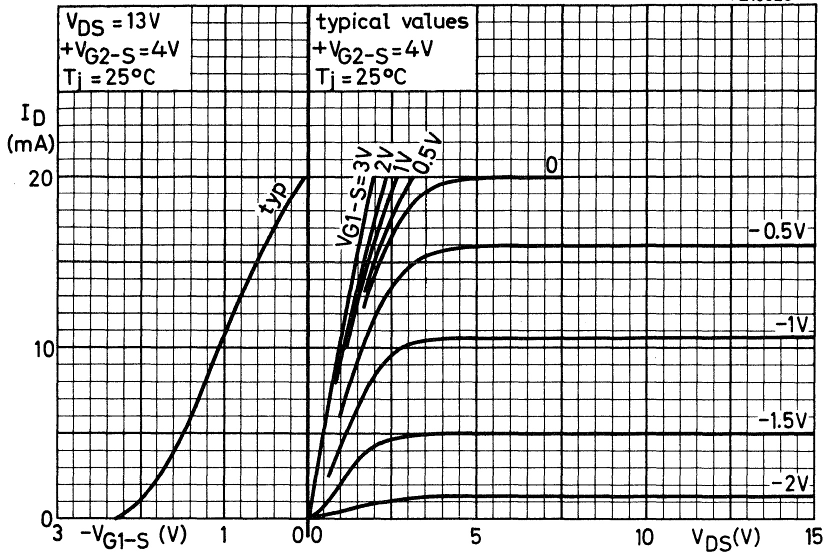
THERMAL RESISTANCE

From junction to ambient in free air	$R_{th\ j-a}$	=	0.55	^oC/mW

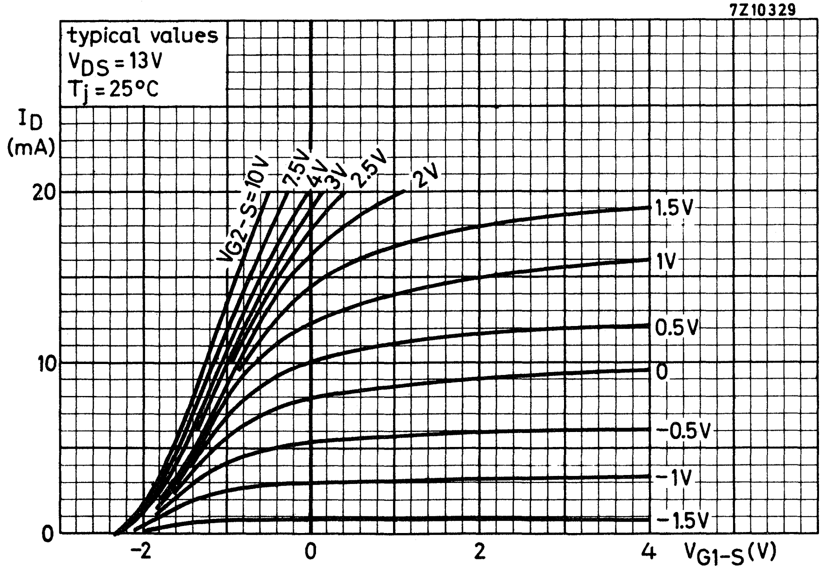
CHARACTERISTICS T_j = 25 °C unless otherwise specified

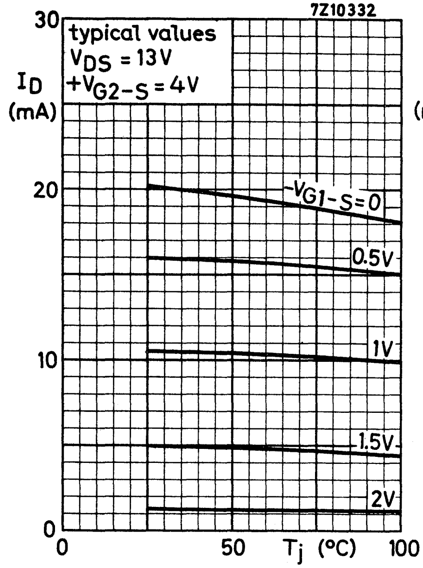
Gate 1 cut-off current			
$\pm V_{G1-S}$ = 8 V; V_{G2-S} = 0; V_{DS} = 0; T_j = 135 °C	$\pm I_{G1-SS}$	<	1 nA
Gate 2 cut-off current			
$\pm V_{G2-S}$ = 8 V; V_{G1-S} = 0; V_{DS} = 0; T_j = 135 °C	$\pm I_{G2-SS}$	<	1 nA
Gate 1-source voltage			
I_D = 10 mA; V_{DS} = 13 V; $+V_{G2-S}$ = 4 V	$-V_{G1-S}$		0.6 to 2.8 V
Gate 1-source cut-off voltage			
I_D = 100 μA; V_{DS} = 20 V; $+V_{G2-S}$ = 4 V	$-V_{G1-S}$	<	5 V
Gate 2-source cut-off voltage			
I_D = 50 μA; V_{DS} = 20 V; V_{G1-S} = 0	$-V_{G2-S}$	<	4 V
y-parameters (common source)			
I_D = 10 mA; V_{DS} = 13 V; $+V_{G2-S}$ = 4 V; T_{amb} = 25 °C			
Transfer admittance f = 1 kHz	$\|y_{fs}\|$	>	8 $m\Omega^{-1}$
		typ.	13 $m\Omega^{-1}$
f = 200 MHz	$\|y_{fs}\|$	typ.	12.1 $m\Omega^{-1}$
f = 500 MHz	$\|y_{fs}\|$	typ.	11.2 $m\Omega^{-1}$
Feedback capacitance f = 10 MHz	$-C_{rs}$	typ.	25 fF
Transducer gain at f = 200 MHz			
I_D = 10 mA; V_{DS} = 13 V; $+V_{G2-S}$ = 4 V			
G_S = 1.3 $m\Omega^{-1}$; G_L = 1 $m\Omega^{-1}$; T_{amb} = 25 °C			
B_S and B_L tuned for maximum gain	G_{tr}	typ.	18 dB
Maximum unilateralised power gain at T_{amb} = 25 °C			
G_{UM} in dB = $10 \log \frac{\|y_{fs}\|^2}{4 g_{is} g_{os}}$			
I_D = 10 mA; V_{DS} = 13 V; $+V_{G2-S}$ = 4 V; f = 200 MHz	G_{UM}	typ.	21.3 dB
f = 500 MHz	G_{UM}	typ.	7.3 dB
Noise figure at optimum source admittance at f = 200 MHz			
I_D = 10 mA; V_{DS} = 13 V; $+V_{G2-S}$ = 4 V			
G_{Sopt} = 1.4 $m\Omega^{-1}$; B_{Sopt} = 5.5 $m\Omega^{-1}$; T_{amb} = 25 °C	F_{min}	typ.	3 dB
		<	4 dB

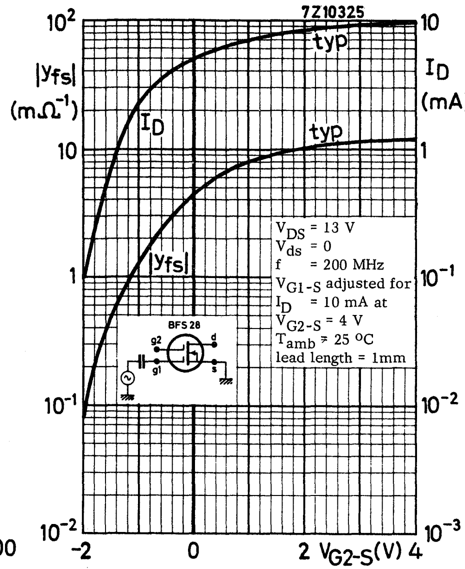
7Z10323

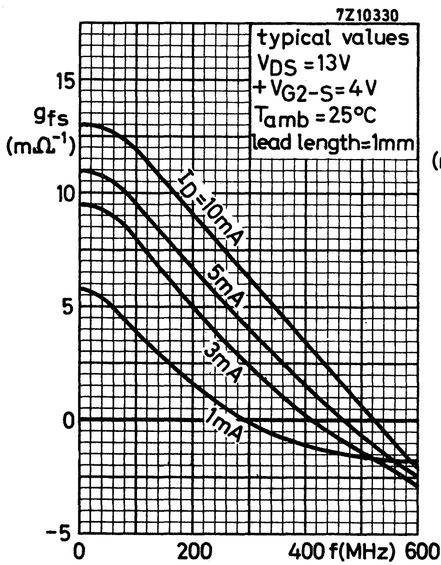


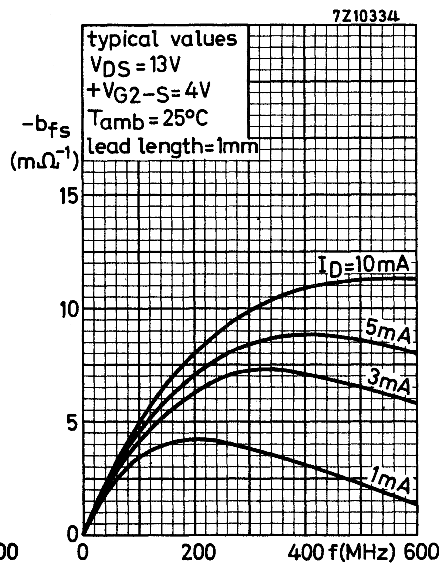
7Z10329

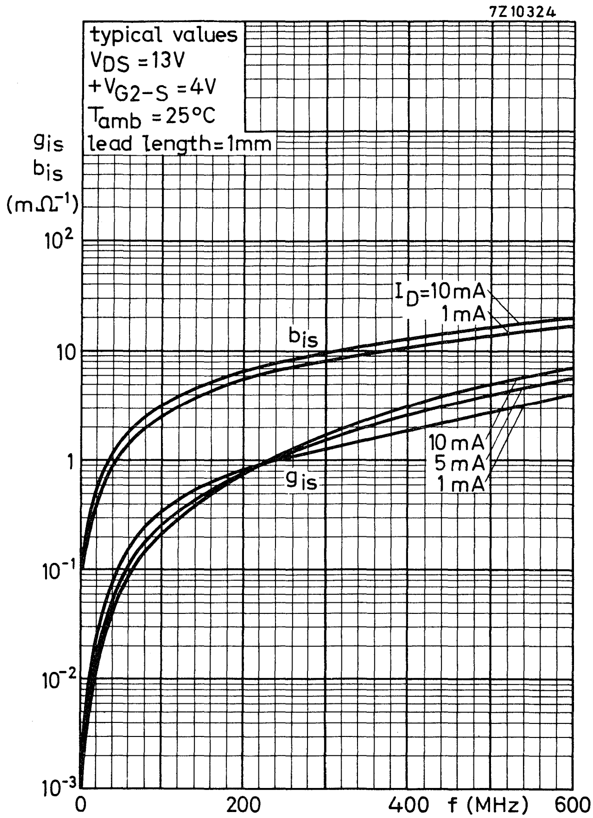


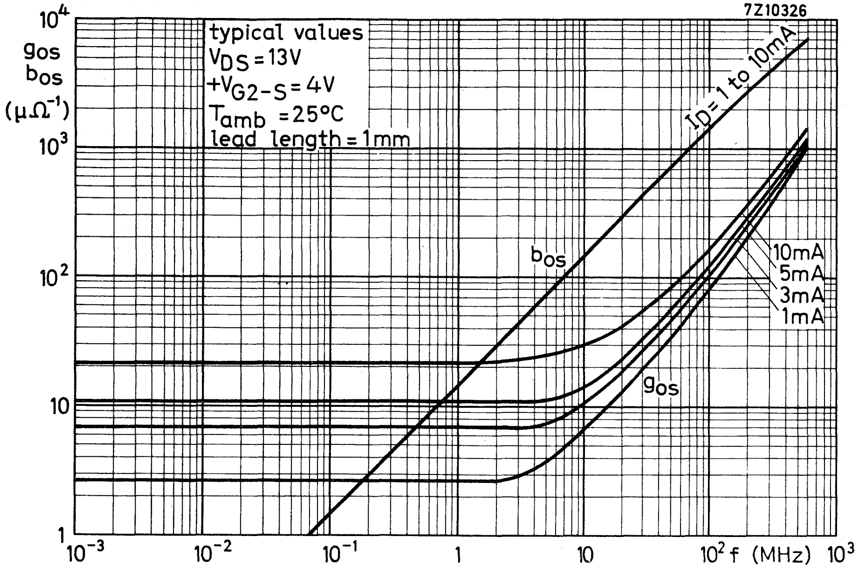

7Z10332
typical values
V_{DS} = 13V
$+V_{G2-S}$ = 4V
I_D (mA)
$-V_{G1-S}$=0
0.5V
1V
1.5V
2V
T_j (°C)
0
50
100
10
20
30

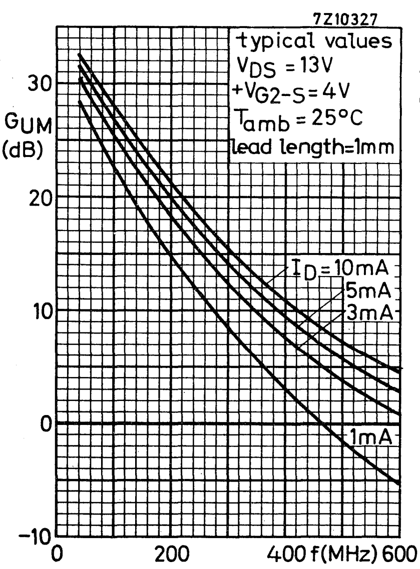

7Z10325
$|y_{fs}|$ (mΩ^{-1})
I_D (mA)
typ
I_D
$|y_{fs}|$
V_{DS} = 13 V
V_{ds} = 0
f = 200 MHz
V_{G1-S} adjusted for
I_D = 10 mA at
V_{G2-S} = 4 V
T_{amb} = 25 °C
lead length = 1mm
BFS 28
g2
g1
d
s
V_{G2-S}(V)
-2
0
2
4

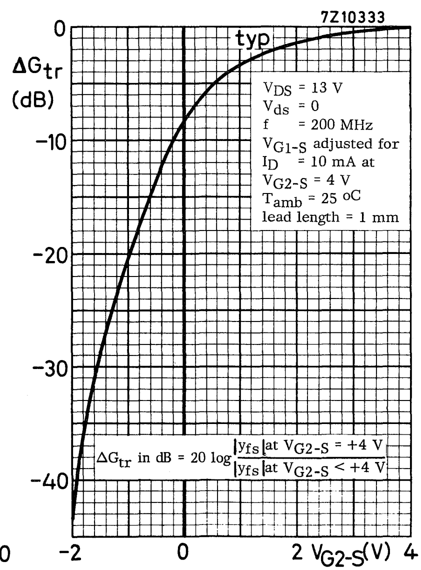

7Z10330
typical values
V_{DS} =13V
$+V_{G2-S}$=4V
T_{amb} =25°C
lead length=1mm
g_{fs} (mΩ^{-1})
I_D=10mA
5mA
3mA
1mA
f(MHz)
0
200
400
600
-5
5
10
15

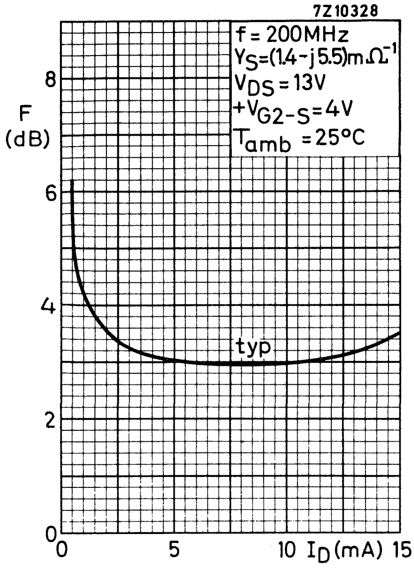

7Z10334
typical values
V_{DS} =13V
$+V_{G2-S}$=4V
T_{amb} =25°C
lead length=1mm
$-b_{fs}$ (mΩ^{-1})
I_D=10mA
5mA
3mA
1mA
f(MHz)
0
200
400
600
5
10
15

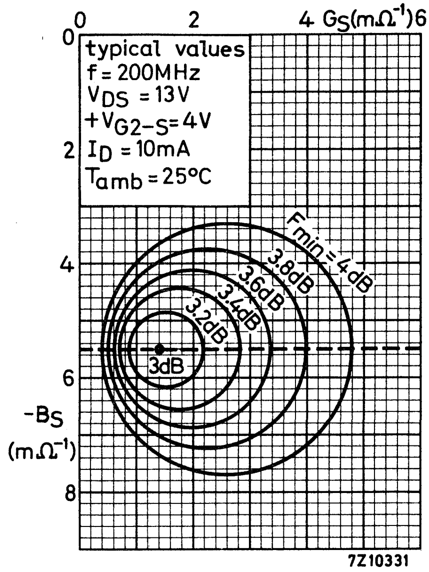

7Z10324
typical values
V_{DS} = 13V
+V_{G2-S} = 4V
T_{amb} = 25°C
lead length = 1mm
g_{is}
b_{is}
(mΩ⁻¹)
10^2
10
1
10^{-1}
10^{-2}
10^{-3}
I_D=10 mA
1 mA
b_{is}
10 mA
5 mA
1 mA
g_{is}
0
200
400
f (MHz)
600


7Z10326
typical values
VDS = 13V
+VG2-S = 4V
Tamb = 25°C
lead length = 1mm
gos
bos
(μΩ⁻¹)
ID = 1 to 10mA
bos
gos
10mA
5mA
3mA
1mA
f (MHz)


7Z10327
typical values
VDS = 13V
+VG2-S = 4V
Tamb = 25°C
lead length=1mm
GUM
(dB)
ID = 10mA
5mA
3mA
1mA
f(MHz)


7Z10333
typ
ΔGtr
(dB)
VDS = 13 V
Vds = 0
f = 200 MHz
VG1-S adjusted for
ID = 10 mA at
VG2-S = 4 V
Tamb = 25 oC
lead length = 1 mm
ΔGtr in dB = 20 log |yfs| at VG2-S = +4 V / |yfs| at VG2-S < +4 V
VG2-S(V)


7Z10328
f = 200MHz
YS=(1.4-j5.5)mΩ-1
VDS = 13V
+VG2-S=4V
Tamb = 25°C
F
(dB)
typ
ID (mA)
0
2
4
6
8
0
5
10
15


typical values
f = 200MHz
VDS = 13V
+VG2-S=4V
ID = 10mA
Tamb = 25°C
Gs(mΩ-1)
-BS
(mΩ-1)
Fmin = 4dB
3.8dB
3.6dB
3.4dB
3.2dB
3dB
7Z10331
0
2
4
6
8

N-CHANNEL SILICON FIELD EFFECT TRANSISTORS

N-channel silicon epitaxial planar junction field effect transistors in a TO-72 metal envelope with the shield lead connected to the case.
The transistors are designed for broad band amplifiers (0 to 300 MHz).
Their very low noise at low frequencies makes these devices very suitable for differential amplifiers, electro-medical and nuclear detector pre-amplifiers.

QUICK REFERENCE DATA

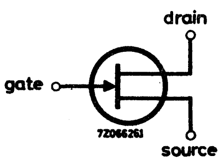
Drain-source voltage	$\pm V_{DS}$	max.	30	V
Gate-source voltage (open drain)	$-V_{GSO}$	max.	30	V
Total power dissipation up to $T_{amb} = 25\ ^oC$	P_{tot}	max.	300	mW

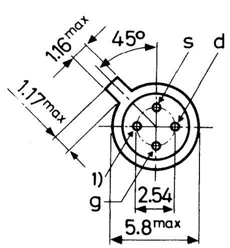
			BFW10	BFW11	
Drain current $V_{DS} = 15$ V; $V_{GS} = 0$	I_{DSS}	>	8	4	mA
		<	20	10	mA
Gate-source cut-off voltage $I_D = 0.5$ nA; $V_{DS} = 15$ V	$-V_{(P)GS}$	<	8	6	V
Feedback capacitance at f = 1 MHz $V_{DS} = 15$ V; $V_{GS} = 0$	$-C_{rs}$	<	0.75	0.75	pF
Transfer admittance (common source) $V_{DS} = 15$ V; $V_{GS} = 0$; f = 200 MHz	$\|y_{fs}\|$	>	3.2	3.2	$m\Omega^{-1}$
Noise figure at $V_{DS} = 15$ V; $V_{GS} = 0$ f = 100 MHz; $R_G = 1\ k\Omega$	F	<	2.5	2.5	dB
Equivalent noise voltage f = 10 Hz	$V_n/\sqrt{B}$	<	75	75	$nV/\sqrt{Hz}$

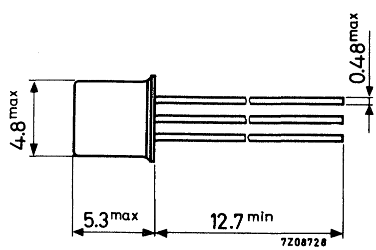
MECHANICAL DATA

Dimensions in mm

TO-72
Insulated electrodes







1) = shield lead (connected to case)

Accessories available: 56246, 56263.

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

Voltages

Drain-source voltage	$\pm V_{DS}$	max.	30	V
Drain-gate voltage (open source)	V_{DGO}	max.	30	V
Gate-source voltage (open drain)	$-V_{GSO}$	max.	30	V

Currents

Drain current	I_D	max.	20	mA
Gate current	I_G	max.	10	mA

Power dissipation

Total power dissipation up to T_{amb} = 25 °C	P_{tot}	max.	300	mW

Temperatures

Storage temperature	T_{stg}	-65 to +200		°C
Junction temperature	T_j	max.	200	°C

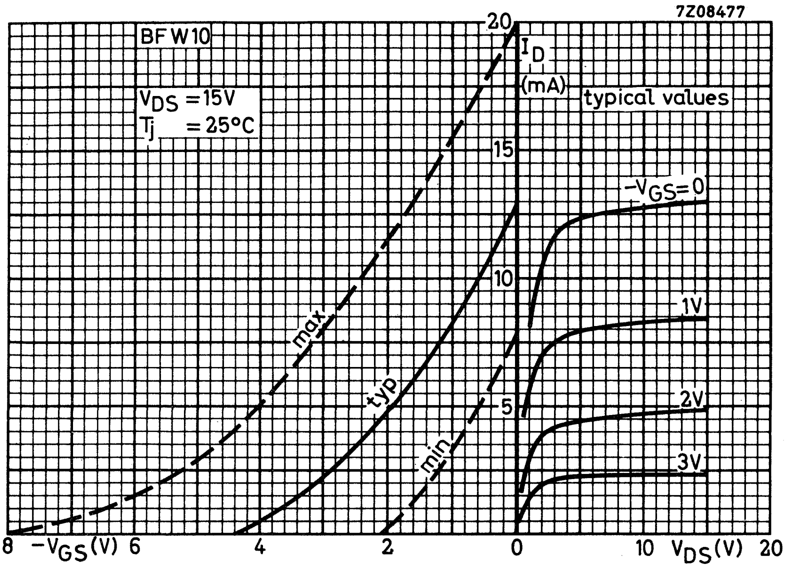
THERMAL RESISTANCE

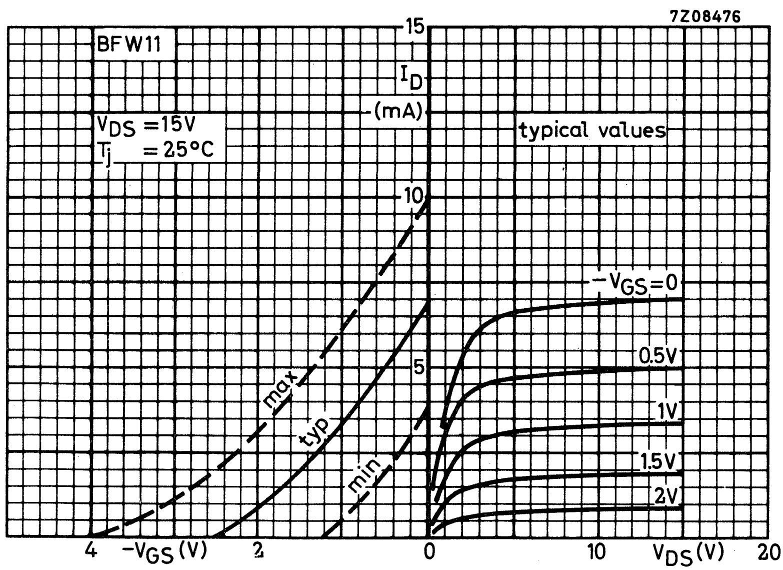
From junction to ambient	$R_{th\ j-a}$	=	0.59	°C/mW

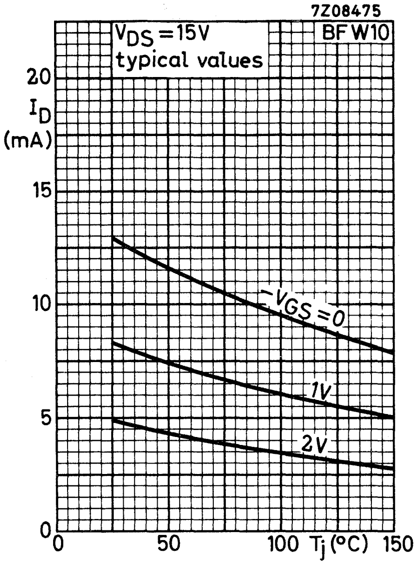
CHARACTERISTICS T_j = 25 °C unless otherwise specified

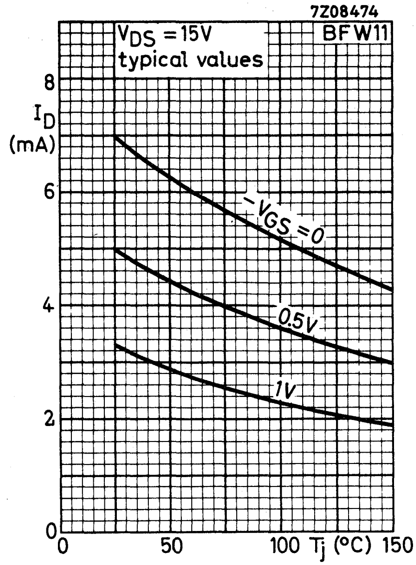
			BFW10	BFW11	
Gate cut-off current					
$-V_{GS}$ = 20 V; V_{DS} = 0	$-I_{GSS}$	<	0.5	0.5	nA
$-V_{GS}$ = 20 V; V_{DS} = 0; T_j = 150 °C	$-I_{GSS}$	<	0.5	0.5	μA
Drain current [1]					
V_{DS} = 15 V; V_{GS} = 0	I_{DSS}	>	8	4	mA
		<	20	10	mA
Gate-source voltage					
I_D = 400 μA; V_{DS} = 15 V	$-V_{GS}$	>	2.0		V
		<	7.5		V
I_D = 50 μA; V_{DS} = 15 V	$-V_{GS}$	>		1.25	V
		<		4.0	V
Gate-source cut-off voltage					
I_D = 0.5 nA; V_{DS} = 15 V	$-V_{(P)GS}$	<	8	6	V
y parameters					
V_{DS} = 15 V; V_{GS} = 0; T_{amb} = 25 °C					
f = 1 kHz Transfer admittance	$\|y_{fs}\|$	>	3.5	3.0	$m\Omega^{-1}$
		<	6.5	6.5	$m\Omega^{-1}$
Output admittance	$\|y_{os}\|$	<	85	50	$\mu\Omega^{-1}$
f = 1 MHz Input capacitance	C_{is}	typ.	4	4	pF
		<	5	5	pF
Feedback capacitance	$-C_{rs}$	typ.	0.6	0.6	pF
		<	0.75	0.75	pF
f = 200 MHz Transfer admittance	$\|y_{fs}\|$	>	3.2	3.2	$m\Omega^{-1}$
Input conductance	g_{is}	<	800	800	$\mu\Omega^{-1}$
Output conductance	g_{os}	<	200	100	$\mu\Omega^{-1}$
Noise figure at f = 100 MHz; R_G = 1 kΩ					
V_{DS} = 15 V; V_{GS} = 0; T_{amb} = 25 °C, input tuned to minimum noise	F	<	2.5	2.5	dB
Equivalent noise voltage					
V_{DS} = 15 V; V_{GS} = 0; T_{amb} = 25 °C					
f = 10 Hz	$V_n/\sqrt{B}$	<	75	75	$nV/\sqrt{Hz}$

[1] Measured under pulsed conditions.


7Z08477
BFW10
V_{DS} = 15V
T_j = 25°C
I_D (mA)
typical values
$-V_{GS}$=0
1V
2V
3V
max
typ
min
20
15
10
5
8
$-V_{GS}$(V)
6
4
2
0
10
V_{DS}(V)
20

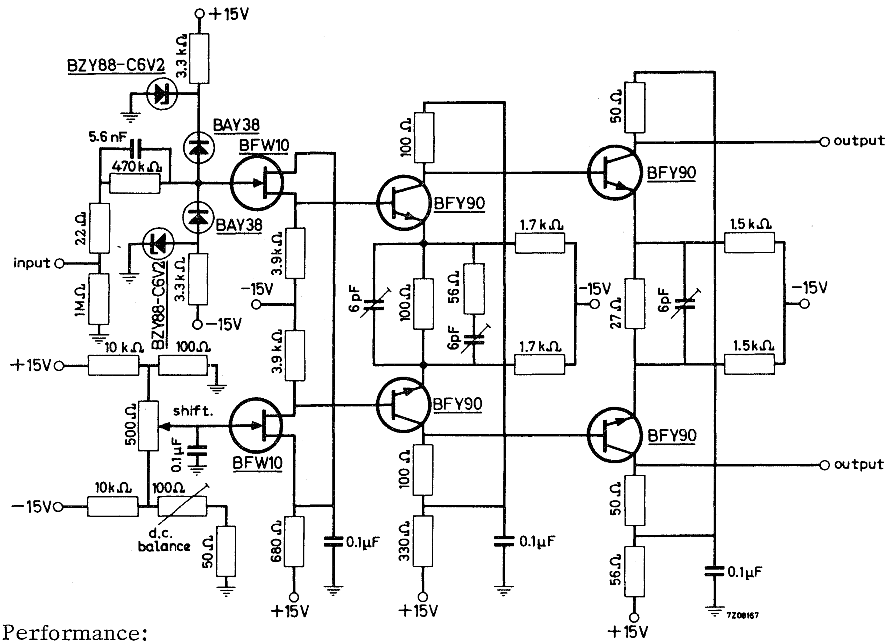

7Z08476
BFW11
V_{DS} = 15V
T_j = 25°C
I_D (mA)
typical values
$-V_{GS}$=0
0.5V
1V
1.5V
2V
max
typ
min
15
10
5
4
$-V_{GS}$(V)
2
0
10
V_{DS}(V)
20


7Z08475
V_{DS} = 15V
typical values
BFW10
I_D (mA)
−V_{GS} = 0
1V
2V
T_j (°C)


7Z08474
V_{DS} = 15V
typical values
BFW11
I_D (mA)
−V_{GS} = 0
0.5V
1V
T_j (°C)

APPLICATION INFORMATION (continued)

Input amplifier circuit for an oscilloscope.

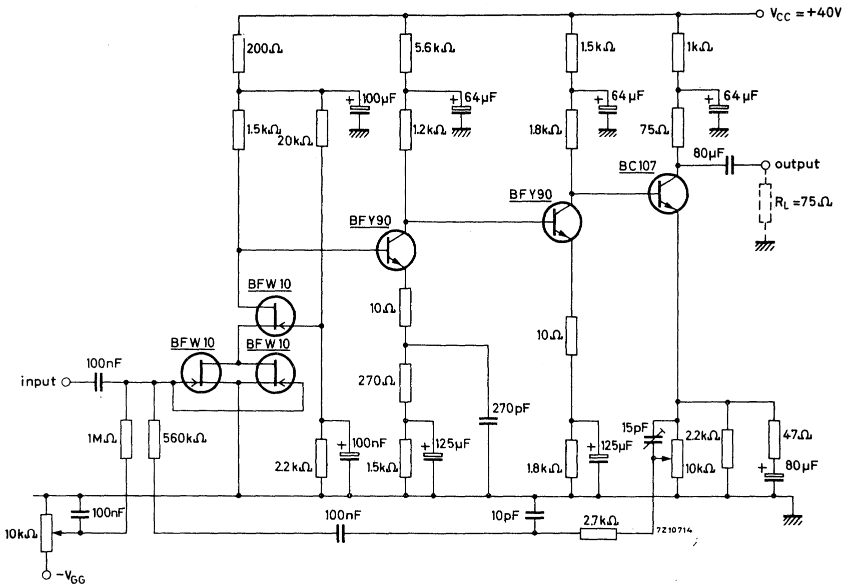


Performance:

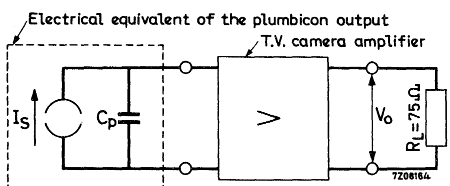
Input resistance	1 MΩ
Input capacitance	7.5 pF
Bandwidth	From d.c. to 300 MHz
Rise time	< 1 ns
Voltage gain	3.6
R.M.S. noise voltage (B = 300 MHz)	≤ 0.2 mV (input short-circuited)
Input sensitivity	This input amplifier is intended for an oscilloscope with a maximum input sensitivity of 5 or 10 mV/cm and a total bandwidth of 150 MHz
Input voltage	Max. permissible input voltage: peak to peak 600 V d.c. 300 V

APPLICATION INFORMATION (continued)

→ Television camera amplifier with BFW10



The circuit is designed for the Plumbicon Television Camera tube No. 55876. The electrical behaviour of this tube can be described as consisting of a current source I_S, shunted by a capacitance C_p ($C_p \approx 12$ pF).



Performance:

Transfer impedance (40 Hz to 5 MHz)	$\frac{V_O}{I_S}$	=	10^6 V/A
Output resistance	R_o	=	75 Ω
Output voltage (peak to peak) (d ≤ 5%)	V_O	<	1.3 V
Signal-noise ratio			
Ratio of V_O p-p (at I_S p-p = 0.3 µA) and the effective output noise voltage V_n (f from 40 Hz to 5 MHz)	$\frac{V_{O\,p\text{-}p}}{V_n}$	=	46 dB

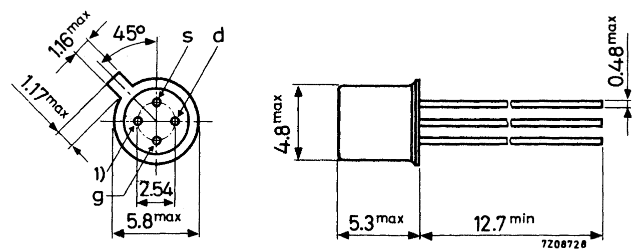
N-CHANNEL SILICON FIELD EFFECT TRANSISTOR

N-channel silicon epitaxial planar junction field effect transistor in a TO-72 metal envelope with the shield lead connected to the case.
The transistor is designed for general purpose amplifiers.

QUICK REFERENCE DATA				
Drain-source voltage (V_{GS} = 0)	$\pm V_{DSS}$	max.	25	V
Gate-source voltage (open drain)	$-V_{GSO}$	max.	25	V
Total power dissipation up to T_{amb} = 25 °C	P_{tot}	max.	300	mW
Drain current V_{DS} = 15 V; V_{GS} = 0	I_{DSS}		2 to 20	mA
Gate-source cut-off voltage I_D = 1.0 nA; V_{DS} = 15 V	$-V_{(P)GS}$	<	8	V
Feedback capacitance at f = 1 MHz V_{DS} = 15 V; V_{GS} = 0	$-C_{rs}$	<	2.0	pF
Transfer admittance (common source) V_{DS} = 15 V; V_{GS} = 0; f = 10 MHz	$\|y_{fs}\|$	>	1.6	$m\Omega^{-1}$

MECHANICAL DATA Dimensions in mm

TO-72



1) = shield lead (connected to case)

Accessories available: 56246, 56263.

RATINGS (Limiting values) [1])

Voltages

Drain-source voltage ($V_{GS} = 0$)	$\pm V_{DSS}$	max.	25	V
Drain-gate voltage (open source)	V_{DGO}	max.	25	V
Gate-source voltage (open drain)	$-V_{GSO}$	max.	25	V

Currents

Drain current	I_D	max.	20	mA
Gate current	I_G	max.	10	mA

Power dissipation

Total power dissipation up to $T_{amb} = 25\ ^oC$	P_{tot}	max.	300	mW

Temperatures

Storage temperature	T_{stg}	-65 to	+200	^oC
Junction temperature	T_j	max.	200	^oC

THERMAL RESISTANCE

From junction to ambient	$R_{th\ j-a}$	=	0.59	^oC/mW

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

Gate cut-off current

$-V_{GS} = 20$ V; $V_{DS} = 0$	$-I_{GSS}$	<	1.0	nA
$-V_{GS} = 20$ V; $V_{DS} = 0$; $T_j = 150\ ^oC$	$-I_{GSS}$	<	1.0	μA

Drain current [2])

$V_{DS} = 15$ V; $V_{GS} = 0$	I_{DSS}	2 to	20	mA

Gate-source voltage

$I_D = 200\ \mu A$; $V_{DS} = 15$ V	$-V_{GS}$	0.5 to	7.5	V

Gate-source cut-off voltage

$I_D = 1.0$ nA; $V_{DS} = 15$ V	$-V_{(P)GS}$	<	8	V

y parameters (common source)

$V_{DS} = 15$ V; $V_{GS} = 0$

f = 1 kHz Transfer admittance	$\lvert y_{fs} \rvert$	2.0 to	6.5	$m\Omega^{-1}$
Output admittance	$\lvert y_{os} \rvert$	<	85	$\mu\Omega^{-1}$
f = 1 MHz Input capacitance	C_{is}	<	6	pF
Feedback capacitance	$-C_{rs}$	<	2.0	pF
f = 10 MHz Transfer admittance	$\lvert y_{fs} \rvert$	>	1.6	$m\Omega^{-1}$

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

[2]) Measured under pulsed conditions.

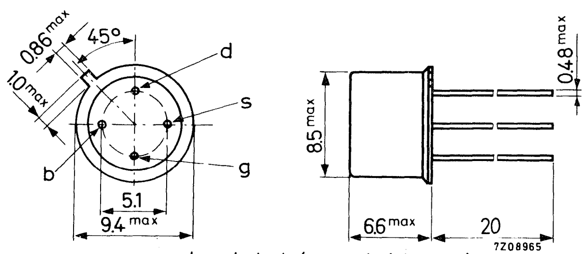
N-CHANNEL METAL OXIDE SEMICONDUCTOR TRANSISTOR

Silicon N-channel depletion type insulated gate field effect transistor, primarily intended for use in amplifiers, e.g. impedance converters.
The device has a TO-12 metal envelope, with the substrate connected to the envelope.

QUICK REFERENCE DATA				
Gate-substrate voltage (peak value)	$\pm V_{GBM}$	max.	15	V
Gate-source voltage (peak value)	$-V_{GSM}$	max.	30	V
Drain-source voltage (peak value)	$\pm V_{DSM}$	max.	30	V
Drain current	$\pm I_D$	max.	50	mA
Total power dissipation up to T_{amb} = 25 °C	P_{tot}	max.	250	mW
Gate-source cut-off voltage				
I_D = 20 μA; V_{DS} = 20 V	$-V_{(P)GS}$		0 to 4.5	V
Transfer admittance				
I_D = 5 mA; V_{DS} = 20 V	$\|y_{fs}\|$	>	1.3	$m\Omega^{-1}$

MECHANICAL DATA Dimensions in mm

TO-12



b = substrate (connected to case)

Accessories available: 56245, 56265

RATINGS (Limiting values) [1])

Voltages

Gate-substrate voltage (peak value)	$\pm V_{GBM}$	max.	15	V
Gate-drain voltage (peak value)	$-V_{GDM}$	max.	30	V
Gate-source voltage (peak value)	$-V_{GSM}$	max.	30	V
Drain-substrate voltage (peak value)	$+V_{DBM}$	max.	30	V
Source-substrate voltage (peak value)	$+V_{SBM}$	max.	30	V
Drain-source voltage (peak value)	$\pm V_{DSM}$	max.	30	V

Currents

Drain current	$\pm I_D$	max.	50	mA
Source current	$\pm I_S$	max.	50	mA

Power dissipation

Total power dissipation up to T_{amb} = 25 °C	P_{tot}	max.	250	mW

Temperatures

Storage temperature	T_{stg}		−65 to +150	°C
Junction temperature	T_j	max.	125	°C

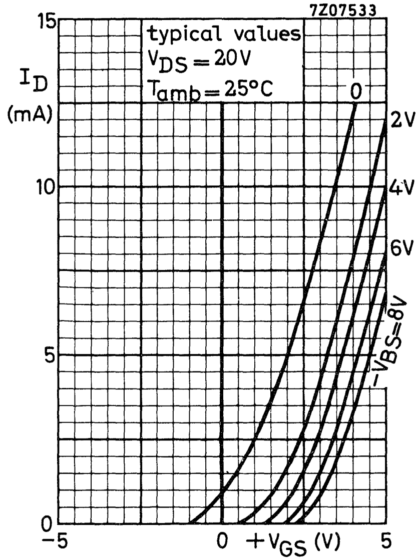
THERMAL RESISTANCE

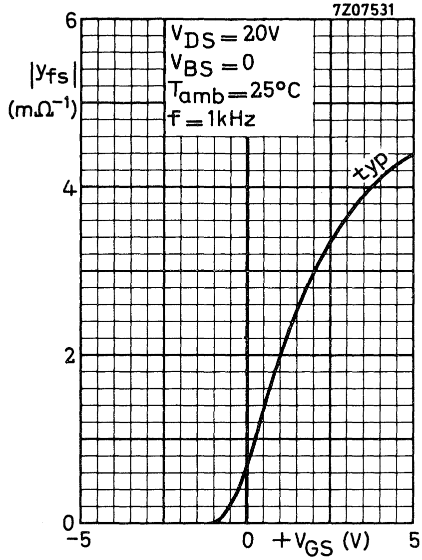
From junction to ambient in free air	$R_{th\ j\text{-}a}$	=	0.4	°C/mW

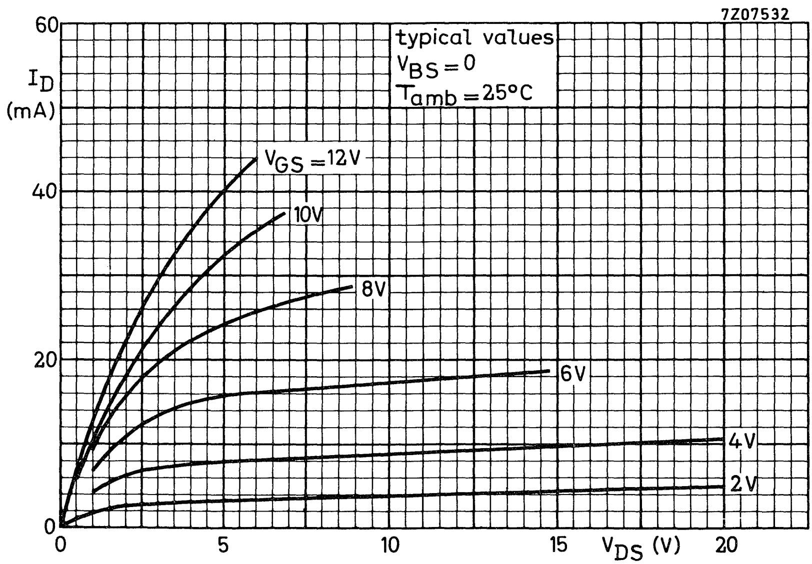
[1]) Limiting values according to the Absolute Maximum System as defined in IEC publication 134.

CHARACTERISTICS $V_{BS} = 0$, $T_j = 25\ ^oC$ unless otherwise specified

Drain cut-off current				
$V_{DS} = 15$ V; $-V_{GS} = 15$ V	I_{DSX}	typ.	1	nA
		<	50	nA
$V_{DS} = 15$ V; $-V_{GS} = 15$ V; $T_j = 125\ ^oC$	I_{DSX}	typ.	0.05	μA
		<	5	μA
Drain current				
$V_{DS} = 30$ V; $V_{GS} = V_{BS} = 0$	I_{DSS}	typ.	2	mA
		<	30	mA
Source current				
$V_{SD} = 30$ V; $V_{GD} = V_{BD} = 0$	I_{SDS}	typ.	2	mA
		<	30	mA
Gate-source cut-off voltage				
$I_D = 20$ μA; $V_{DS} = 20$ V	$-V_{(P)GS}$	typ.	1.5	V
			0 to 4.5	V
Gate-source voltage				
$I_D = 5$ mA; $V_{DS} = 20$ V	V_{GS}	typ.	+2	V
			−1 to +6.5	V
Gate-source resistance				
$V_{GS} = 15$ V; $V_{DS} = 0$	r_{GS}	>	100	GΩ
Transfer admittance				
$I_D = 5$ mA; $V_{DS} = 20$ V; f = 1 kHz	$\|y_{fs}\|$	>	1.3	$m\Omega^{-1}$
		typ.	2.5	$m\Omega^{-1}$
y parameters at f = 1 MHz (common source)				
$I_D = 1$ mA; $V_{DS} = 20$ V				
Input capacitance	C_{is}	<	5	pF
Feedback capacitance	$-C_{rs}$	<	0.75	pF
Output resistance	r_{os}	>	30	kΩ
		typ.	65	kΩ
Output capacitance	C_{os}	<	4	pF

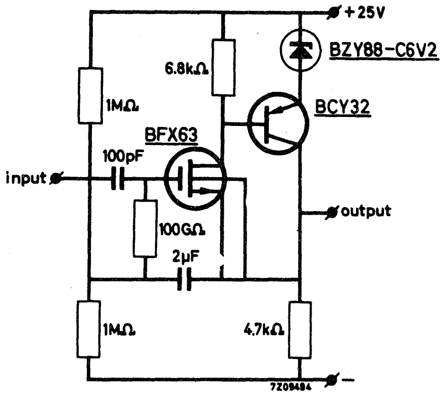

7Z07533
typical values
$V_{DS} = 20V$
$T_{amb} = 25°C$
I_D
(mA)
15
10
5
0
−5
0
$+V_{GS}$ (V)
5
0
2V
4V
6V
$-V_{BS} = 8V$


7Z07531
$V_{DS} = 20V$
$V_{BS} = 0$
$T_{amb} = 25°C$
f = 1kHz
$|y_{fs}|$
(mΩ⁻¹)
6
4
2
0
−5
0
$+V_{GS}$ (V)
5
typ


7Z07532
typical values
$V_{BS} = 0$
$T_{amb} = 25°C$
I_D
(mA)
60
40
20
0
0
5
10
15
V_{DS} (V)
20
$V_{GS} = 12V$
10V
8V
6V
4V
2V

APPLICATION INFORMATION

The transistor used in an impedance converter circuit.



Performance up to T_{amb} = 100 °C

Input resistance	10^{12} Ω
Output resistance	50 Ω
Gain	0.97

NOTE

To exclude the possibility of damage to the gate oxide layer by an electrostatic charge building up on the high resistance gate electrode, the base of the device has been packed with aluminium foil to short circuit the leads. The foil has been arranged so that it need not be removed until the device has been mounted in the circuit.

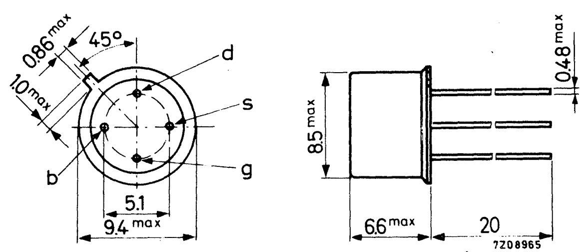
N-CHANNEL METAL OXIDE SEMICONDUCTOR TRANSISTOR

Silicon N-channel depletion type insulated gate field effect transistor, primarily intended for use as a chopper in low level d.c. amplifiers.
The device has a metal envelope, with the substrate connected to the case.

QUICK REFERENCE DATA				
Gate-substrate voltage (peak value)	$\pm V_{GBM}$	max.	15	V
Gate-source voltage (peak value)	$-V_{GSM}$	max.	30	V
Drain-source voltage (peak value)	$\pm V_{DSM}$	max.	30	V
Drain current	$\pm I_D$	max.	50	mA
Total power dissipation up to T_{amb} = 25 °C	P_{tot}	max.	250	mW
Drain-source resistance (on)				
I_D = 10 μA; V_{GS} = 5 V	r_{DS}	<	200	Ω

MECHANICAL DATA Dimensions in mm

TO-12



b = substrate (connected to case)

Accessories available: 56245, 56265

RATINGS (Limiting values) [1]

Voltages

Gate-substrate voltage (peak value)	$\pm V_{GBM}$	max.	15	V
Gate-drain voltage (peak value)	$-V_{GDM}$	max.	30	V
Gate-source voltage (peak value)	$-V_{GSM}$	max.	30	V
Drain-substrate voltage (peak value)	$+V_{DBM}$	max.	30	V
Source-substrate voltage (peak value)	$+V_{SBM}$	max.	30	V
Drain-source voltage (peak value)	$\pm V_{DSM}$	max.	30	V

Currents

Drain current	$\pm I_D$	max.	50	mA
Source current	$\pm I_S$	max.	50	mA

Power dissipation

Total power dissipation up to T_{amb} = 25 °C	P_{tot}	max.	250	mW

Temperatures

Storage temperature	T_{stg}	-65 to +150		°C
Junction temperature	T_j	max.	125	°C

THERMAL RESISTANCE

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

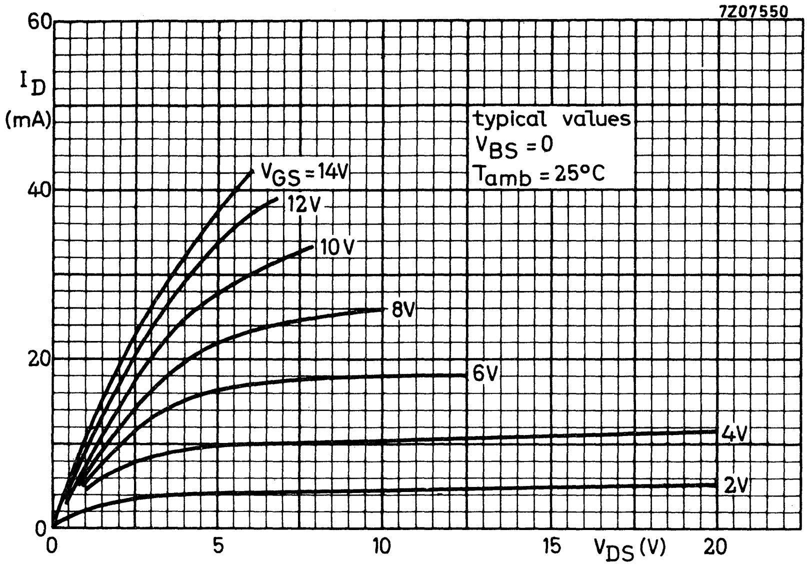
[1]) Limiting values according to the Absolute Maximum System as defined in IEC publication 134.

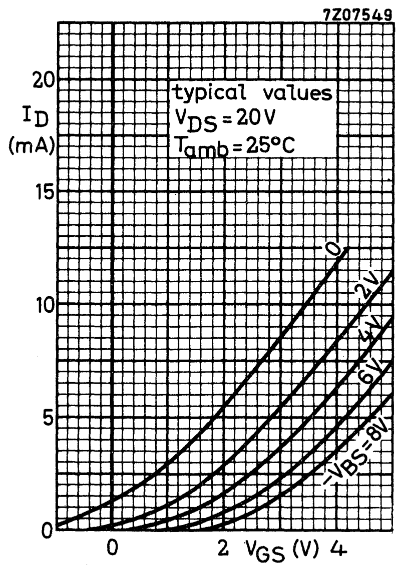
CHARACTERISTICS $V_{BS} = 0$, $T_j = 25\,^{o}C$ unless otherwise specified

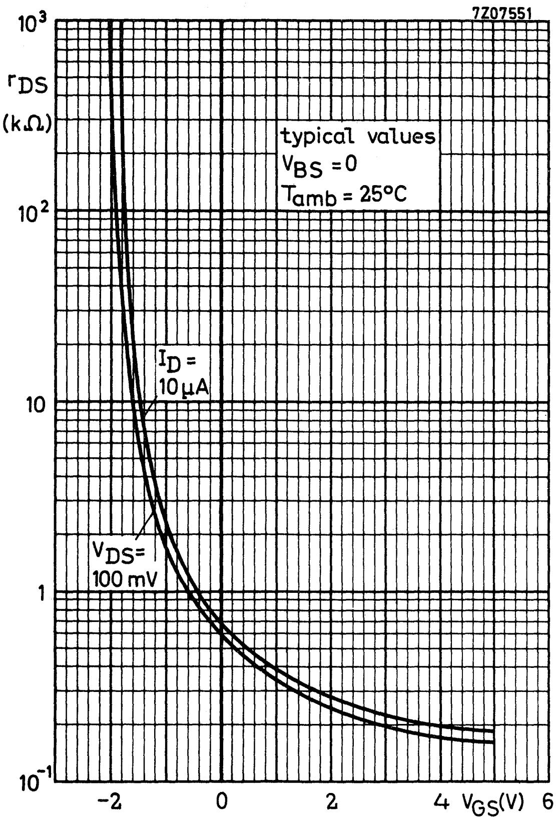
Drain cut-off current				
$V_{DS} = 15$ V; $-V_{GS} = 15$ V	I_{DSX}	typ.	1	nA
		<	50	nA
$V_{DS} = 15$ V; $-V_{GS} = 15$ V; $T_j = 125\,^{o}C$	I_{DSX}	typ.	0.05	µA
		<	5	µA
Drain current				
$V_{DS} = 30$ V; $V_{GS} = V_{BS} = 0$	I_{DSS}	typ.	2	mA
		<	30	mA
Source current				
$V_{SD} = 30$ V; $V_{GD} = V_{BD} = 0$	I_{SDS}	typ.	2	mA
		<	30	mA
Drain-source resistance (on)				
$I_D = 10\ \mu A$; $V_{GS} = 5$ V	r_{DS}	<	200	Ω
Drain-source resistance (off)				
$V_{DS} = 100$ mV; $-V_{GS} = 5$ V	r_{DS}	>	20	MΩ
Gate-source resistance				
$V_{GS} = 15$ V; $V_{DS} = 0$	r_{GS}	>	100	GΩ
y parameters at f = 1 MHz (common source)				
$I_D = 1$ mA; $V_{DS} = 20$ V				
Input capacitance	C_{is}	<	5	pF
Feedback capacitance	$-C_{rs}$	<	0.75	pF
Output capacitance	C_{os}	<	4	pF

NOTE

To exclude the possibility of damage to the gate oxide layer by an electrostatic charge building up on the high resistance gate electrode, the base of the device has been packed with aluminium foil to short circuit the leads. The foil has been arranged so that it need not be removed until the device has been mounted in the circuit.

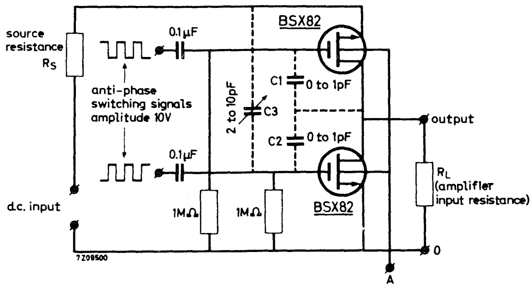

7Z07550
I_D (mA)
typical values
$V_{BS} = 0$
$T_{amb} = 25°C$
$V_{GS} = 14V$
12V
10V
8V
6V
4V
2V
V_{DS} (V)
0
5
10
15
20
20
40
60


7Z07549
I_D (mA)
typical values
$V_{DS} = 20V$
$T_{amb} = 25°C$
0
2V
4V
6V
$-V_{BS} = 8V$
V_{GS} (V)
0
2
4
5
10
15
20


7Z07551
10^3
r_{DS}
(kΩ)
typical values
V_{BS} = 0
T_{amb} = 25°C
10^2
I_D =
10 µA
10
V_{DS}=
100 mV
1
10^{-1}
−2
0
2
4
V_{GS}(V)
6

APPLICATION INFORMATION

The transistor used in a series-shunt chopper circuit.

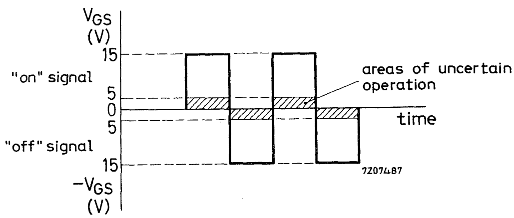


Connect point A to negative voltage supply equal to the maximum negative d.c. input to be chopped.
If the maximum negative d.c. input is less than 100 mV, than point A should be connected to 0.

Adjust trimmer capacitor C1 or C2 for minimum spike feedthrough. Trimmer capacitor C3 also required if R_S is greater than 1 kΩ.

Typical chopping efficiency: $\frac{R_L}{R_L + R_S + 180}$

Allowable chopper signals between gate and source.

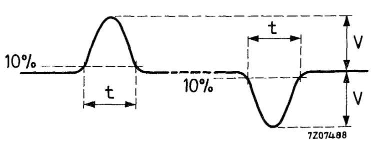


For good chopper performance

V_{GS} resp. $-V_{GS}$: 5 to 15 V

Spike feedthrough

Feedthrough voltage wave form at f = 5 kHz; R_S = 2 kΩ



Rise time of shopping signal (ns)	t (ns)	V (mV)
200	1000	20
20	120	120

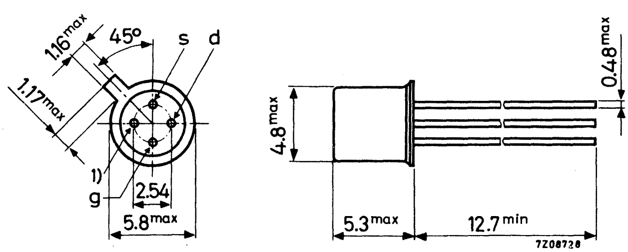
N-CHANNEL SILICON FIELD EFFECT TRANSISTOR

Silicon N-channel depletion type junction-triode field effect transistor in a TO-72 metal envelope, primarily intended for depletion mode operation in low power i.f.-r.f. amplifiers for industrial applications.

QUICK REFERENCE DATA				
Drain-source voltage	V_{DS}	max.	30	V
Gate-source voltage	$-V_{GS}$	max.	30	V
Total power dissipation up to T_{amb} = 25 °C	P_{tot}	max.	300	mW
Gate cut-off current $-V_{GS}$ = 20 V; V_{DS} = 0	$-I_{GSS}$	<	0.5	nA
Feedback capacitance at f = 1 MHz V_{DS} = 15 V; V_{GS} = 0	$-C_{rs}$	<	2	pF
Transfer admittance (common source) V_{DS} = 15 V; V_{GS} = 0; f = 200 MHz T_{amb} = 25 °C	$\|y_{fs}\|$	>	3.2	$m\Omega^{-1}$

MECHANICAL DATA Dimensions in mm

TO-72



1) = shield lead (connected to case)

Accessories available: 56246; 56263

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

Voltages

Drain-source voltage	V_{DS}	max.	30	V
Drain-gate voltage	V_{DG}	max.	30	V
Gate-source voltage	$-V_{GS}$	max.	30	V

Current

Gate current	I_G	max.	10	mA

Power dissipation

Total power dissipation up to T_{amb} = 25 °C	P_{tot}	max.	300	mW
Linear derating factor			2	mW/°C

Temperatures

Storage temperature	T_{stg}		−65 to +200	°C
Junction temperature	T_j	max.	200	°C

CHARACTERISTICS T_j = 25 °C unless otherwise specified

Gate cut-off current				
$-V_{GS}$ = 20 V; V_{DS} = 0	$-I_{GSS}$	<	0.5	nA
$-V_{GS}$ = 20 V; V_{DS} = 0; T_j = 150 °C	$-I_{GSS}$	<	0.5	μA
Drain current [1]				
V_{DS} = 15 V; V_{GS} = 0	I_{DSS}	4 to	20	mA
Gate-source voltage				
I_D = 400 μA; V_{DS} = 15 V	$-V_{GS}$	1 to	7.5	V
Gate-source cut-off voltage				
I_D = 0.5 nA; V_{DS} = 15 V	$-V_{(P)GS}$	<	8	V
Gate-source breakdown voltage				
$-I_G$ = 1 μA; V_{DS} = 0	$-V_{(BR)GSS}$	>	30	V

[1]) Measured under pulsed conditions; pulse duration t = 100 ms; duty cycle $\delta \leq 0.1$.

CHARACTERISTICS (continued)

y parameters (common source)

V_{DS} = 15 V; V_{GS} = 0 T_{amb} = 25 °C

f = 1 kHz	Transfer admittance [1]	$\|y_{fs}\|$		3.5 to 6.5	$m\Omega^{-1}$
	Output admittance [1]	$\|y_{os}\|$	<	35	$\mu\Omega^{-1}$
f = 1 MHz	Input capacitance	C_{is}	<	6	pF
	Feedback capacitance	$-C_{rs}$	<	2	pF
f = 200 MHz	Transfer admittance	$\|y_{fs}\|$	>	3.2	$m\Omega^{-1}$
	Real part of input conductance	$R_e(y_{is})$	<	0.8	$m\Omega^{-1}$
	Real part of output conductance	$R_e(y_{os})$	<	0.2	$m\Omega^{-1}$

Noise figure at f = 100 MHz T_{amb} = 25 °C

V_{DS} = 15 V; V_{GS} = 0; R_G = 1 kΩ input tuned to minimum noise	F	<	2.5	dB

1) Measured under pulsed conditions; Pulse duration t = 100 ms; duty cycle $\delta \leqslant 0.1$

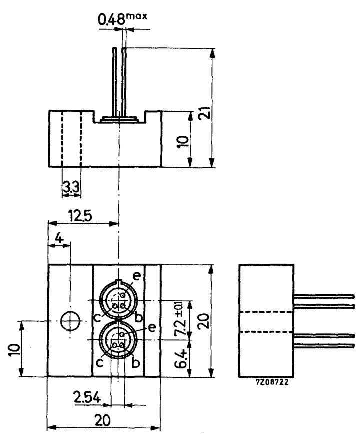
Dual transistors

N-P-N SILICON PLANAR LOW-LEVEL DUAL TRANSISTORS FOR DIFFERENTIAL AMPLIFIERS

Two special matched transistors in a TO-18 metal envelope, housed together in an aluminium cube.
The BCY55 is intended for very low level, low noise and low drift differential amplifiers.

QUICK REFERENCE DATA				
Equivalent differential voltage change referred to the input				
$\lvert I_{1E} + I_{2E} \rvert \leq 200\ \mu A$				
$V_{1C-1E} = V_{2C-2E} \leq 20$ V	$\left\lvert \frac{\Delta V}{\Delta T} \right\rvert$	typ.	1	$\mu V/^{o}C$
$\lvert V_{1B-1E} - V_{2B-2E} \rvert \leq 100\ \mu V$		<	3	$\mu V/^{o}C$
T_{amb}: −20 to +90 °C				
Equivalent differential current change referred to the input				
$I_{1C} + I_{2C} = 100\ \mu A$	$\left\lvert \frac{\Delta I}{\Delta T} \right\rvert$	typ.	0.5	$nA/^{o}C$
T_{amb}: −20 to +90 °C		<	1.5	$nA/^{o}C$

MECHANICAL DATA Dimensions in mm



CHARACTERISTICS of the individual transistors — T_j = 25 °C unless otherwise specified

Collector cut-off current				
$I_E = 0$; $V_{CB} = 45$ V	I_{CBO}	<	10	nA
$I_E = 0$; $V_{CB} = 20$ V; $T_{amb} = 90$ °C	I_{CBO}	<	5	nA
Emitter cut-off current				
$I_C = 0$; $V_{EB} = 5$ V	I_{EBO}	<	10	nA
Emitter-base voltage				
$-I_E = 0.5$ mA; $V_{CB} = 5$ V	$-V_{EB}$		600 to 800	mV
Saturation voltages				
$I_C = 10$ mA; $I_B = 0.5$ mA	V_{CEsat}	<	1.0	V
	V_{BEsat}		0.6 to 1.0	V
D.C. current gain				
$I_C = 10$ μA; $V_{CE} = 5$ V	h_{FE}		100 to 300	
$I_C = 10$ mA; $V_{CE} = 5$ V	h_{FE}		200 to 600	
Collector capacitance at f = 1 MHz				
$I_E = I_e = 0$; $V_{CB} = 5$ V	C_c	<	8	pF
Transition frequency				
$I_C = 0.5$ mA; $V_{CE} = 5$ V	f_T	>	50	MHz
		typ.	80	MHz
Cut-off frequency				
$I_C = 0.5$ mA; $V_{CE} = 5$ V	f_{hfe}	>	100	kHz
h parameters at f = 1 kHz				
$I_C = 1$ mA; $V_{CE} = 5$ V				
Input impedance	h_{ie}	typ.	10.0	kΩ
Reverse voltage transfer ratio	h_{re}	typ.	5.5	10^{-4}
Small signal current gain	h_{fe}	typ.	350	
			150 to 600	
Output admittance	h_{oe}	typ.	25	$\mu\Omega^{-1}$
Noise figure				
$I_C = 10$ μA; $V_{CE} = 5$ V; $R_S = 10$ kΩ; B = 10 to 15 000 Hz	F	typ.	2	dB
		<	3	dB

CHARACTERISTICS of the complete device

Ratio of collector currents

$V_{1B-1E} = V_{2B-2E}$
Emitter currents of each transistor up to 100 μA

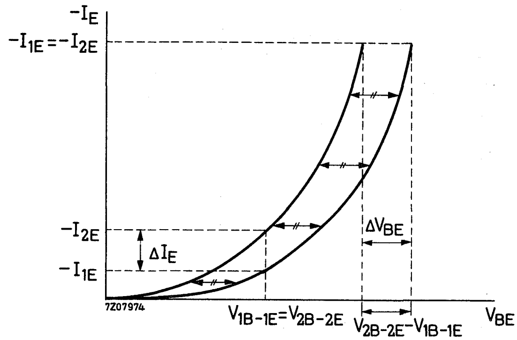
$\frac{I_{1C}}{I_{2C}}$	0.85 to 1	
	typ. 0.93	

Difference of base-emitter voltages

$-I_{1E} = -I_{2E}$ up to 100 μA
T_{amb}: −20 to +90 °C

$\lvert V_{1B-1E} - V_{2B-2E} \rvert$	typ.	2	mV
	<	4	mV

Illustration of matching characteristics:



$$\frac{I_{2E}}{I_{1E}} = \exp.\ \frac{q}{kT}\ .\ \Delta V_{BE}$$

$\frac{I_{2E}}{I_{1E}}$ measured at $\Delta V_{BE} = 0$

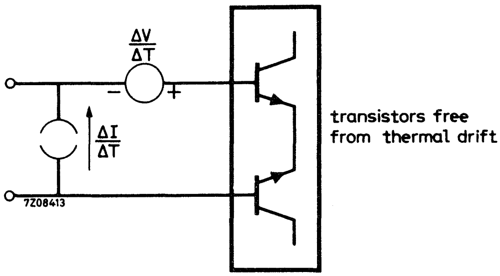
ΔV_{BE} measured at $\frac{I_{2E}}{I_{1E}} = 1$

CHARACTERISTICS of the complete device (continued)

Equivalent circuit for drift

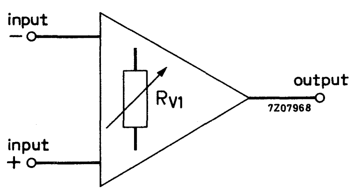
In the equivalent circuit the transistors are considered to be drift free.
All temperature coefficients are concentrated in the voltage source $\frac{\Delta V}{\Delta T}$ and in the current source $\frac{\Delta I}{\Delta T}$.

It should be noted that the differential current change given is only valid when the source resistances are almost equal; the differential voltage change only when the base-emitter voltages are almost equal.



Block symbol of test amplifier

The test amplifier, used in the tests on page 5, is described on pages 6 and 7. It is represented by the following amplifier symbol:



CHARACTERISTICS of the complete device (continued)

Equivalent differential voltage change with temperature referred to the input.

$|I_{1E} + I_{2E}| \leq 200\ \mu A$; $V_{1C-1E} = V_{2C-2E} \leq 20$ V

$|V_{1B-1E} - V_{2B-2E}| \leq 100\ \mu V$; T_j: −20 to +90 °C

BCY55 unit (wires included) mounted in a small metal or plastic box for shielding against direct heat radiation.

$\left\|\frac{\Delta V}{\Delta T}\right\|$	typ.	1	μV/°C
	<	3	μV/°C

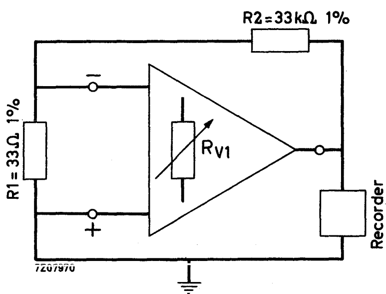
Equivalent differential current change with temperature referred to the input.

$I_{1C} + I_{2C} = 100\ \mu A$

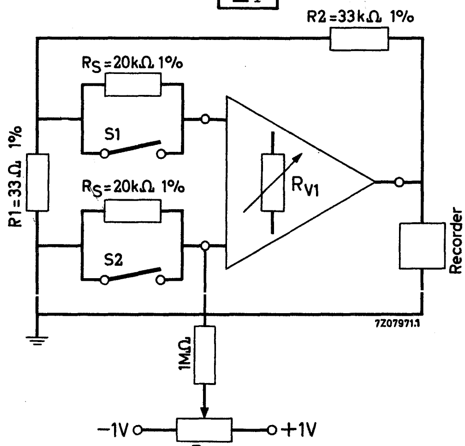
$\frac{\Delta I}{\Delta T}$	typ.	0.5	nA/°C
	<	1.5	nA/°C

Test methods

$\frac{\Delta V}{\Delta T}$



$\frac{\Delta I}{\Delta T}$



NOTE
To prevent contact potentials, connections should be soldered.

Amplification factor determined by feedback circuit: $\frac{R2}{R1} = 1000$

Output voltage against time is recorded.

The temperature of the amplifier is adjusted to T_1 between −20 and +90 °C. When it has stabilized, the output voltage is brought to zero ($|V_{T1}| < 100$ mV)[1]. The amplifier temperature is then adjusted to T_2 between −20 and +90 °C. When it has stabilized the output voltage can be read off.

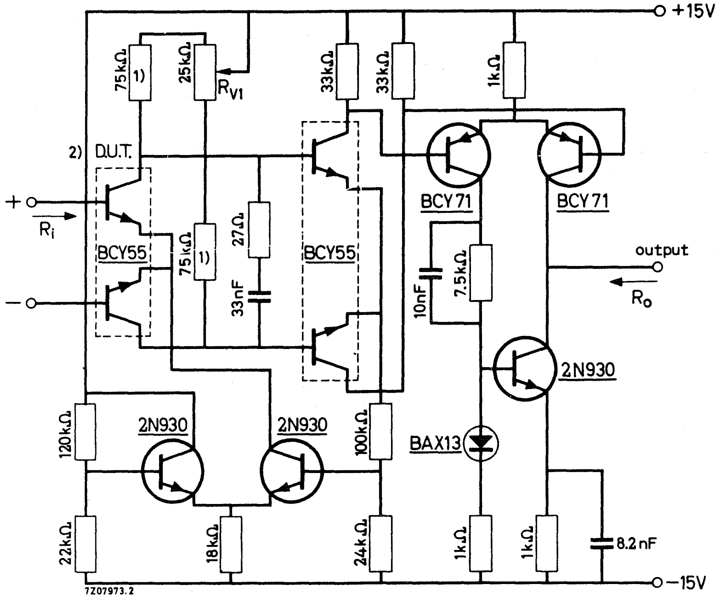
Then: $\frac{\Delta V}{\Delta T} = \frac{V_{T2} - V_{T1}}{T_2 - T_1} \cdot \frac{R1}{R2}$ or $\frac{\Delta I}{\Delta T} = \frac{V_{T2} - V_{T1}}{T_2 - T_1} \cdot \frac{R1}{R2} \cdot \frac{1}{2R_S}$

[1]) For $\frac{\Delta V}{\Delta T}$: adjusted by R_{V1}

For $\frac{\Delta I}{\Delta T}$: first by R_{V1} with S1 and S2 closed, then by R_{V2} with the switches open.

Differential test-amplifier

The test amplifier (including feedback resistors, source-resistors and biasing-resistors) should be mounted in a small box to ensure a uniform temperature throughout.

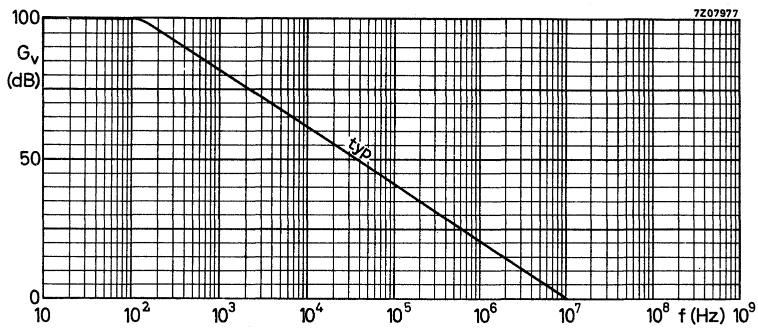


1) Relative temperature coefficient < $10^{-5}/^oC$

2) The device at the input is the device under test

Performance of the test amplifier

Open loop voltage gain (Z_L = 10 kΩ)	G_V	typ.	10^5	
Frequency at which G_V = 1	f_1	typ.	10	MHz
Max. common mode input voltage range			±10	V
Max. output current			±2.5	mA
Max. output voltage			±10	V
Input resistance	R_i	≥	100	kΩ
Output resistance	R_o	typ.	20	kΩ



RATINGS of the individual transistors (Limiting values) [1]

Voltages

Collector-base voltage (open emitter)	V_{CBO}	max.	45	V
Collector-emitter voltage (open base)	V_{CEO}	max.	45	V
Collector-emitter voltage with $V_{BE} = 0$	V_{CES}	max.	45	V
Emitter-base voltage (open collector)	V_{EBO}	max.	5	V

Currents

Collector currents (d.c. or average over any 50 ms period)	I_C	max.	30	mA
Collector current (peak value)	I_{CM}	max.	60	mA

Power dissipation

Total power dissipation up to $T_{amb} = 25\ ^oC$	P_{tot}	max.	300	mW

Temperatures

Storage temperature	T_{stg}		−50 to +125	^oC
Junction temperature	T_j	max.	125	^oC

THERMAL RESISTANCE

From junction to ambient in free air	$R_{th\ j\text{-}a}$	=	0.33	$^oC/mW$

(This value applies to one transistor at equal dissipation or difference in dissipation < 20% in both transistors of the unit)

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

N-P-N SILICON PLANAR DUAL TRANSISTORS FOR DIFFERENTIAL AMPLIFIERS

Matched dual n-p-n transistors in a TO-71 metal envelope with all leads insulated from the case. They are primarily intended for differential amplifier applications in general industrial service; e.g. instrumentation and control.
The product is divided in three types according to their matching accuracy.
The BCY87 and BCY88 are intended for applications in prestages of differential amplifiers where low offset, drift and noise are of prime importance. The BCY89 is for second stages, long tail pairs and more general purposes.

QUICK REFERENCE DATA

Ratings

Collector-base voltage (open emitter)	V_{CBO}	max.	45	V
Collector-emitter voltage (open base)	V_{CEO}	max.	40	V
Total power dissipation up to T_{amb} = 25 °C	P_{tot}	max.	150	mW
Junction temperature	T_j	max.	175	°C

Characteristics of the complete device with collector-base voltage of 10 V and sum of emitter currents from 10 to 100 μA.

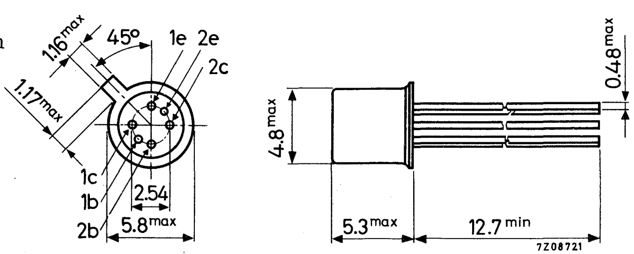
			BCY87	BCY88	BCY89	
Ratio of collector currents at $V_{1B-1E} = V_{2B-2E}$	I_{1C}/I_{2C}		0.9-1.11	0.8-1.25	0.67-1.5	
Base current difference at $V_{1B-1E} = V_{2B-2E}$	$\lvert I_{1B}-I_{2B} \rvert$	<	25	80	300	nA
Equivalent differential voltage change with temperature	$\left\lvert \frac{\Delta V}{\Delta T} \right\rvert$ 1)	<	3	6	10	μV/°C
Equivalent differential current change with temperature	$\left\lvert \frac{\Delta I}{\Delta T} \right\rvert$ 1)	<	0.5	2	10	nA/°C

MECHANICAL DATA

Dimensions in mm

TO-71
All leads insulated from the case

Accessories available:
56263



1) T_{amb} = −20 to +90 °C

RATINGS see page 7

CHARACTERISTICS of the individual transistors

T_{amb} = 25 °C unless otherwise specified

			BCY87	BCY88	BCY89	
Collector cut-off currents						
I_E = 0; V_{CB} = 20 V; T_{amb} = 90 °C	I_{CBO}	<	5	20	–	nA
I_E = 0; V_{CB} = 20 V	I_{CBO}	<	–	–	10	nA
D.C. current gain						
I_C = 5 μA; V_{CB} = 10 V	h_{FE}	>	80	–	–	
I_C = 50 μA; V_{CB} = 10 V	h_{FE}	>	100	100	100	
		<	450	450	450	
I_C = 500 μA; V_{CB} = 10 V	h_{FE}	>	–	120	–	
		<	–	600	–	
I_C = 10 mA; V_{CB} = 10 V	h_{FE}	>	–	–	100	
		<	–	–	600	
Transition frequency						
$-I_E$ = 50 μA; V_{CB} = 10 V	f_T	>	10	10	10	MHz
$-I_E$ = 500 μA; V_{CB} = 10 V	f_T	>	50	50	50	MHz
Collector capacitance at f = 1 MHz						
I_E = I_e = 0; V_{CB} = 10 V	C_c	<	3.5	3.5	3.5	pF
Noise figures						
I_C = 50 μA; V_{CE} = 5 V; R_S = 10 kΩ Bandwidth 10 Hz to 15 kHz	F	<	3	4	4	dB
1 kHz spot noise figure I_C = 50 μA; V_{CE} = 5 V; R_S = opt. Bandwidth = 200 Hz	F	<	4	5	5	dB

CHARACTERISTICS of the complete device.

These characteristics are valid under the following conditions:

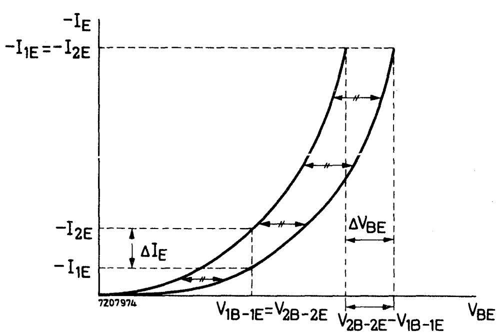
a. Collector-base voltage of both transistors not exceeding 10 V ($V_{1C-1B} = V_{2C-2B} \leq 10$ V)

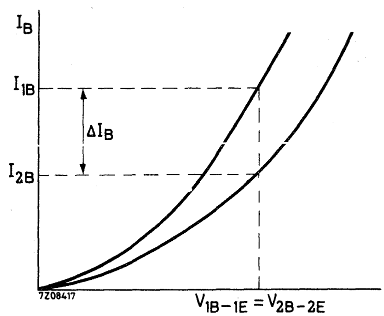
b. Sum of the emitter currents from 10 to 100 μA
$-(I_{1E} + I_{2E}) = 10$ to 100 μA

MATCHING CHARACTERISTICS

			BCY87	BCY88	BCY89	
Ratio of collector currents						
$V_{1B-1E} = V_{2B-2E}$	I_{1C}/I_{2C}		0.9-1.11	0.8-1.25	0.67-1.5	
Difference between base-emitter voltages						
$I_{1C} = I_{2C}$	$\lvert V_{1B-1E} - V_{2B-2E} \rvert$	<	3	6	10	mV
Difference between base currents						
$V_{1B-1E} = V_{2B-2E}$	$\lvert I_{1B} - I_{2B} \rvert$	<	25	80	300	nA

Illustration of matching characteristics:





$$\frac{I_{2E}}{I_{1E}} = \exp. \frac{q}{KT} \quad \Delta V_{BE}$$

$\frac{I_{2E}}{I_{1E}}$ measured at $\Delta V_{BE} = 0$

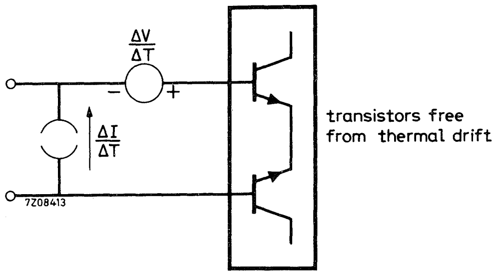
ΔV_{BE} measured at $\frac{I_{2E}}{I_{1E}} = 1$

CHARACTERISTICS of the complete device (continued)

Equivalent circuit for drift

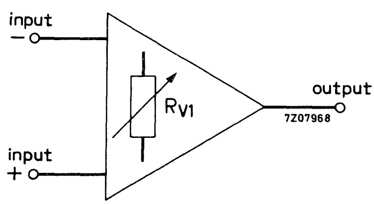
In the equivalent circuit the transistors are considered to be drift free.
All temperature coefficients are concentrated in the voltage source $\frac{\Delta V}{\Delta T}$ and in the current source $\frac{\Delta I}{\Delta T}$.

It should be noted that the differential current change given is only valid when the source resistances are almost equal; the differential voltage change only when the base-emitter voltages are almost equal.



Block symbol of test amplifier

The test amplifier, used in the tests on page 5, is described on pages 6 and 7. It is represented by the following amplifier symbol:



CHARACTERISTICS of the complete device (continued)

Equivalent differential voltage change with temperature

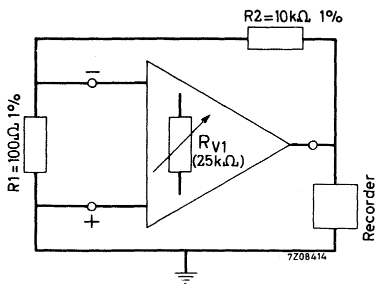
			BCY87	BCY88	BCY89	
$T_{amb} = -20$ to $+90$ °C	$\left\|\frac{\Delta V}{\Delta T}\right\|$	typ.	1	2	4	μV/°C
		<	3	6	10	μV/°C

Equivalent differential current change with temperature

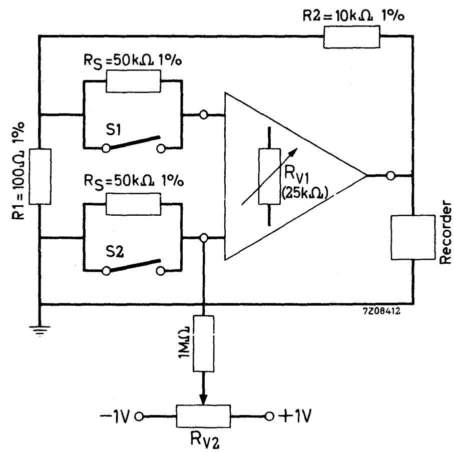
			BCY87	BCY88	BCY89	
$T_{amb} = -20$ to $+90$ °C	$\left\|\frac{\Delta I}{\Delta T}\right\|$	<	0.5	2	10	nA/°C

Test methods

$\frac{\Delta V}{\Delta T}$



$\frac{\Delta I}{\Delta T}$



NOTE

To prevent contact potentials, connections should be soldered.

Amplification factor determined by feedback circuit: $\frac{R2}{R1} = 100$

Output voltage against time is recorded.

The temperature of the amplifier is adjusted to T_1 between −20 and +90 °C. When it has stabilized, the output voltage is brought to zero ($|V_{T1}| < 1$ mV)[1]. The amplifier temperature is then adjusted to T_2 between −20 and +90 °C. When it has stabilized the output voltage can be read off.

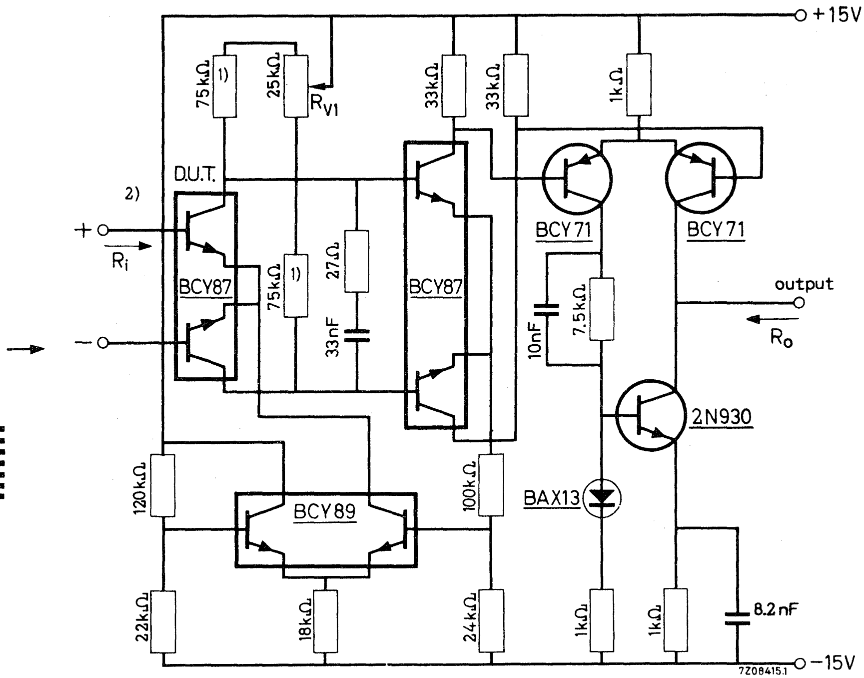
Then: $\frac{\Delta V}{\Delta T} = \frac{V_{T2} - V_{T1}}{T_2 - T_1} \cdot \frac{R1}{R2}$ or $\frac{\Delta I}{\Delta T} = \frac{V_{T2} - V_{T1}}{T_2 - T_1} \cdot \frac{R1}{R2} \cdot \frac{1}{2R_S}$

1) For $\frac{\Delta V}{\Delta T}$: adjusted by R_{V1}

For $\frac{\Delta I}{\Delta T}$: first by R_{V1} with S1 and S2 closed, then by R_{V2} with the switches open.

Differential test-amplifier

The test amplifier (including feedback resistors, source-resistors and biasing-resistors) should be mounted in a small box to ensure a uniform temperature throughout.

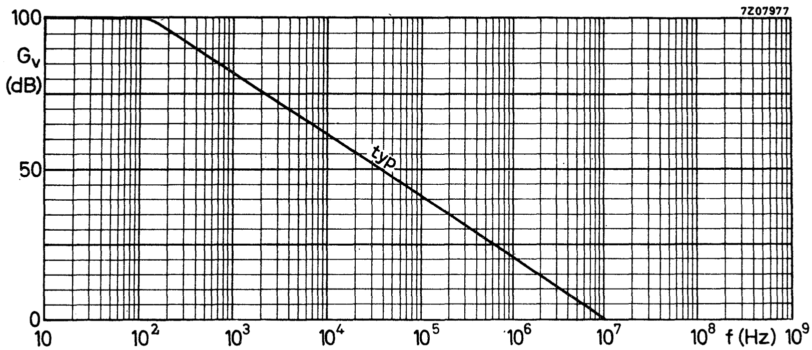


¹) Relative temperature coefficient < $10^{-5}/^{o}C$

²) The device at the input is the device under test

Performance of the test amplifier

Open loop voltage gain (Z_L = 10 kΩ)	G_v	typ.	10^5	
Frequency at which G_v = 1	f_1	typ.	10	MHz
Max. common mode input voltage range			±10	V
Max. output current			±2.5	mA
Max. output voltage			±10	V
Input resistance	R_i		100	kΩ
Output resistance	R_o	typ.	20	kΩ
Common mode rejection ratio			10^5	



RATINGS (Limiting values) [1])

Voltages (each transistor)

Collector-base voltage (open emitter)	V_{CBO}	max.	45	V
Collector-emitter voltage (open base) I_C = 10 mA	V_{CEO}	max.	40	V
Emitter-base voltage (open collector)	V_{EBO}	max.	5	V

Currents (each transistor)

Collector current (d.c.)	I_C	max.	30	mA
Total power dissipation up to T_{amb} = 25 °C	P_{tot}	max.	150	mW

Temperatures

Storage temperature	T_{stg}	max.	175	°C
Junction temperature	T_j	max.	175	°C

THERMAL RESISTANCE

From junction to ambient	$R_{th\ j\text{-}a}$	=	1	°C/mW

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

Microminiature devices for thick- and thin-film circuits

SOLDERING RECOMMENDATIONS

The gold-plated fernico tags are pre-tinned with a solder that melts at 185 °C. The following recommendations are for soldering the semiconductors to glass substrates having vapour deposited resistors and tin-lead covered conductive patterns. To get reliable connections, keep the following points in mind:

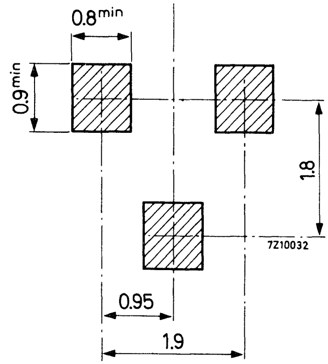
1. The maximum solder temperature and the proper flux are important. The flux must not affect the resistors, and its residue must be easy to remove. Use only rosin flux, which can be easily removed with butylacetate or xylene.
2. The temperature change during soldering must not be so severe as to strain the substrate.
3. The semiconductors must be accurately positioned on the substrate. The soldering tags must coincide exactly with the deposited conductors to avoid cracking the glass at high spots where the heated tags come in contact with it.
4. The softening point of the plastic encapsulation is 150 °C; take care to avoid damaging it during the soldering procedure.
5. Use micro-soldering irons of 18-8 stainless steel. They should be designed so as to concentrate heat at the tip.
6. With the tags at the maximum permissible temperature (250 °C) the maximum permissible soldering time is 10 s. The maximum permissible rate of temperature change is 25 °C/s.

Procedure

Pre-heat the substrate to 100 °C (on a heating table). Pick up the semiconductor with a vacuum needle. Using a magnifier and a micromanupilator position it exactly in the required place and alignment, and deposit it on the substrate. Bring the three micro-soldering irons into contact with the soldering tags and press them down firmly to ensure good heat transfer. Apply 20 W to each iron for 8 seconds.
This is sufficient to make the solder fluid for 3 seconds and assure good electrical contact; the junction temperature reaches 250 °C. To cool the solder below its melting point, allow a 3 to 5 second pause before removing the soldering irons.

With this method the encapsulation gets no hotter that the heating table (100 °C) and, if the soldering time is not less than 8 seconds, there is little risk of damage to the substrate. The method is also recommended for replacing semiconductors.

Minimum required dimensions of metal connection pads on thick-and thin-film substrates



Hand soldering

It is possible to replace semiconductors with a hand-held miniature soldering iron, but the procedure has the following disadvantages:

- It is expensive and time consuming.
- The semiconductors cannot be positioned accurately, and therefore the connecting tags may come into contact with the substrate and damage it.
- There is a high risk of breaking either the substrate or the connections inside the encapsulation; the encapsulation may also be damaged by the iron.

SILICON PLANAR EPITAXIAL HIGH SPEED DIODES

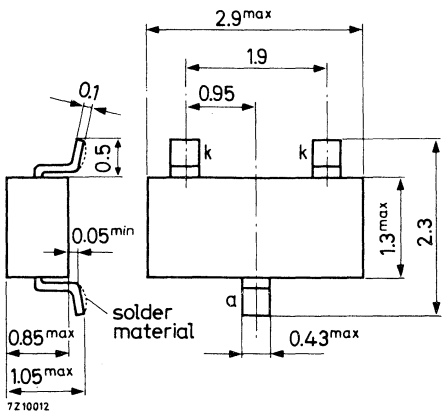
The BAW56 consists of two diodes in a micro miniature plastic envelope. The anodes are commoned and the unit is intended for high speed switching in thick and thin film circuits.

QUICK REFERENCE DATA (per diode)				
Continuous reverse voltage	V_R	max.	25	V
Repetitive peak reverse voltage	V_{RRM}	max.	50	V
Repetitive peak forward current	I_{FRM}	max.	100	mA
Junction temperature	T_j	-65 to +125		^oC
Forward voltage at I_F = 50 mA	V_F	<	1.1	V
Reverse recovery time when switched from I_F = 10 mA to V_R = 1 V; R_L = 100 Ω measured at I_R = 1 mA	t_{rr}	<	6	ns
Recovered charge when switched from I_F = 10 mA to V_R = 5 V; R_L = 500 Ω	Q_s	<	45	pC

MECHANICAL DATA

Dimensions in mm

Code: A1



MOUNTING METHODS see page 5.

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

Voltages

Continuous reverse voltage	V_R	max.	25	V
Repetitive peak reverse voltage	V_{RRM}	max.	50	V

Currents

Averaged rectified forward current (averaged over any 20 ms period)	I_{FAV}	max.	50	mA
Forward current (d.c.)	I_F	max.	50	mA
Repetitive peak forward current	I_{FRM}	max.	100	mA

Temperatures

Storage temperature	T_{stg}	-65 to +125		^oC
Junction temperature	T_j	max.	125	^oC [1]

THERMAL RESISTANCE (per diode)

From junction to ambient

mounted on a glass substrate of 5 mm x 5 mm x 1 mm

both diodes loaded simultaneously	$R_{th\ j-a}$	=	1.1	$^oC/mW$
one diode loaded	$R_{th\ j-a}$	=	0.6	$^oC/mW$

mounted on a glass fibre print of 24 mm x 12 mm x 1.5 mm

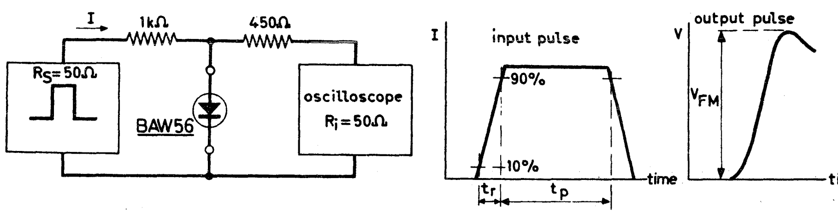
both diodes loaded simultaneously	$R_{th\ j-a}$	=	0.7	$^oC/mW$
one diode loaded	$R_{th\ j-a}$	=	0.4	$^oC/mW$

[1]) For highly professional applications it is advisable not to exceed a max. junction temperature of 100 ^oC.

CHARACTERISTICS (per diode) T_j = 25 °C unless otherwise specified

Forward voltage				
I_F = 1 mA	V_F	<	715	mV
I_F = 10 mA	V_F	<	855	mV
I_F = 50 mA	V_F	<	1100	mV
I_F = 100 mA	V_F	<	1300	mV
Reverse current				
V_R = 10 V; T_j = 125 °C	I_R	<	8	μA
V_R = 25 V	I_R	<	30	nA
V_R = 25 V; T_j = 125 °C	I_R	<	10	μA
Diode capacitance at f = 1 MHz; V_R = 0	C_d	<	2	pF
Forward recovery voltage				
I_F = 10 mA; t_r = 20 ns	V_{FM}	<	1.75	V

Test circuit:



Current pulse: Rise time t_r = 20 ns Oscilloscope: Rise time t_r = 0.35 ns

Pulse duration t_p = 120 ns

Duty cycle δ = 0.01

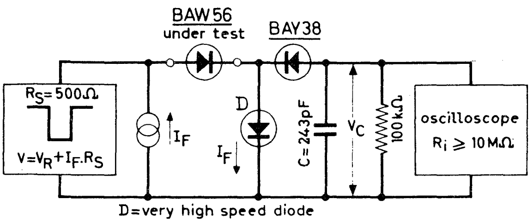
Circuit capacitance C < 1 pF (C = Oscilloscope + parasitical capacitance)

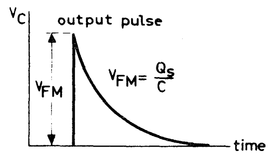
CHARACTERISTICS (continued) T_j = 25 °C unless otherwise specified

Recovered charge when switched from

I_F = 10 mA to V_R = 5 V; R_L = 500 Ω | Q_s < 45 pC

Test circuit:





Reverse pulse: Rise time t_r = 2 ns

Pulse duration t_p = 400 ns

Duty cycle δ = 0.02

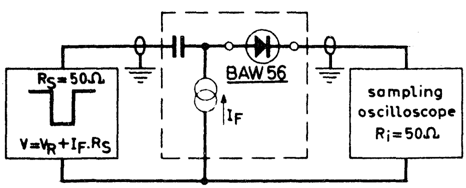
Circuit capacitance C < 7 pF (C = Oscilloscope + parasitical capacitance)

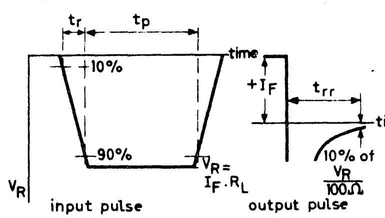
Reverse recovery time when switched from

I_F = 10 mA to V_R = 1 V; R_L = 100 Ω

measured at I_R = 1 mA | t_{rr} < 6 ns

Test circuit:





Reverse pulse: Rise time t_r = 0.6 ns Oscilloscope: Rise time t_r = 0.35 ns

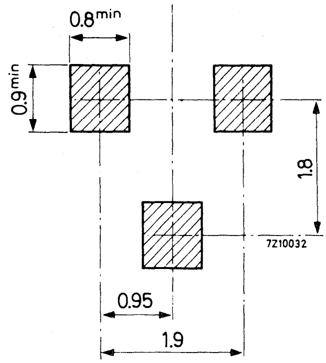
Pulse duration t_p = 100 ns

Duty cycle δ = 0.05

Circuit capacitance C < 1 pF (C = Oscilloscope + parasitical capacitance)

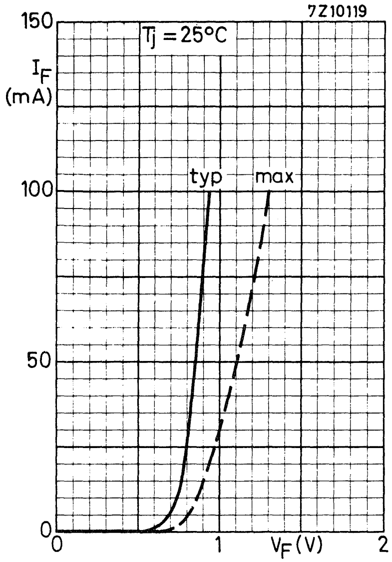
MOUNTING METHODS

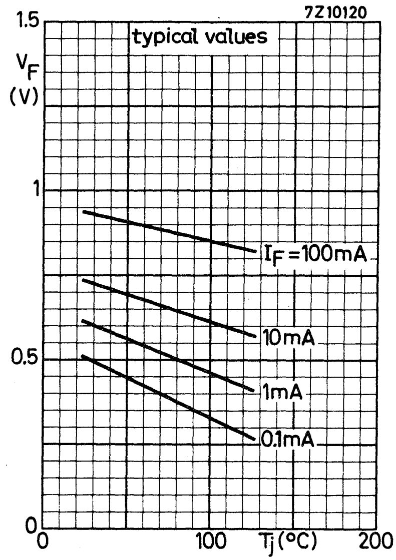
Minimum required dimensions of metal connection pads on thick and thin film substrates

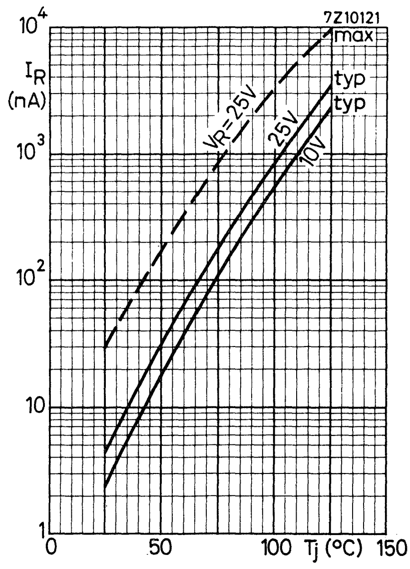


Soldering

The leads are covered with a solder material of which the melting point is 185 °C. At a maximum lead temperature of 250 °C, the maximum permissible soldering time is 10 s.
The maximum temperature gradient is 25 °C/s.


7Z10119
150
I_F
(mA)
$T_j = 25°C$
typ
max
100
50
0
0
1
V_F (V)
2


7Z10120
1.5
V_F
(V)
typical values
1
I_F =100mA
10mA
0.5
1mA
0.1mA
0
0
100
T_j (°C)
200


7Z10121
10^4
max
I_R
(nA)
typ
typ
V_R=25V
25V
10V
10^3
10^2
10
1
0
50
100
T_j (°C)
150

A.F. SILICON PLANAR EPITAXIAL TRANSISTORS

P-N-P transistors in a micro miniature plastic envelope.
They are intended for low level general purpose applications in thick and thin film circuits.

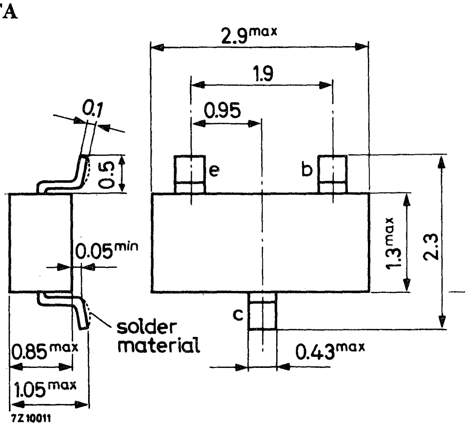
QUICK REFERENCE DATA

			BCW29	BCW30	
Collector-base voltage (open emitter)	$-V_{CBO}$	max.	30	30	V
Collector-emitter voltage (open base)	$-V_{CEO}$	max.	20	20	V
Collector current (peak value)	$-I_{CM}$	max.	200	200	mA
Total power dissipation up to $T_{amb} = 25\ ^oC$	P_{tot}	max.	110	110	mW
Junction temperature	T_j	max.	125	125	^oC
D.C. current gain at $T_j = 25\ ^oC$; $-I_C = 2$ mA; $-V_{CE} = 5$ V	h_{FE}	>	120	215	
		<	260	500	
Transition frequency at f = 35 MHz; $-I_C = 10$ mA; $-V_{CE} = 5$ V	f_T	typ.	150	150	MHz
Noise figure at $R_S = 2\ k\Omega$; $-I_C = 200\ \mu A$; $-V_{CE} = 5$ V; f = 1 kHz; B = 200 Hz	F	<	10	10	dB

MECHANICAL DATA

Dimensions in mm

Code:
BCW29 C1
BCW30 C2



MOUNTING METHODS see page 3.

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

Voltages

Collector-base voltage (open emitter)	$-V_{CBO}$	max.	30	V
Collector-emitter voltage (V_{BE} = 0)	$-V_{CES}$	max.	30	V
Collector-emitter voltage (open base) $-I_C$ = 2 mA	$-V_{CEO}$	max.	20	V
Emitter-base voltage (open collector)	$-V_{EBO}$	max.	5	V

Currents

Collector current (d.c.)	$-I_C$	max.	50	mA
Collector current (peak value)	$-I_{CM}$	max.	200	mA

Power dissipation

Total power dissipation up to T_{amb} = 25 °C mounted on a glass substrate of 5 mm x 5 mm x 1 mm	P_{tot}	max.	110	mW

Temperatures

Storage temperature	T_{stg}		-65 to +125	°C
Junction temperature	T_j	max.	125	°C [1])

THERMAL RESISTANCE

From junction to ambient mounted on a glass substrate of 5 mm x 5 mm x 1 mm	$R_{th\ j\text{-}a}$	=	0.9	°C/mW
mounted on a glass fibre print of 24 mm x 12 mm x 1.5 mm	$R_{th\ j\text{-}a}$	=	0.5	°C/mW

CHARACTERISTICS

Collector cut-off current

I_E = 0; $-V_{CB}$ = 20 V; T_j = 25 °C	$-I_{CBO}$	<	100	nA
T_j = 100 °C	$-I_{CBO}$	<	10	μA

Base-emitter voltage

$-I_C$ = 2 mA; $-V_{CE}$ = 5 V; T_j = 25 °C	$-V_{BE}$	600 to 750	mV

[1]) For highly professional applications it is advisable not to exceed a maximum junction temperature of 100 °C.

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

Saturation voltages

$-I_C$ = 10 mA; $-I_B$ = 0.5 mA	$-V_{CEsat}$	typ.	80	mV
		<	300	mV
	$-V_{BEsat}$	typ.	720	mV
$-I_C$ = 50 mA; $-I_B$ = 2.5 mA	$-V_{CEsat}$	typ.	180	mV
	$-V_{BEsat}$	typ.	810	mV

D.C. current gain

			BCW29	BCW30
$-I_C$ = 10 μA; $-V_{CE}$ = 5 V	h_{FE}	typ.	90	150
$-I_C$ = 2 mA; $-V_{CE}$ = 5 V	h_{FE}	>	120	215
		<	260	500

Collector capacitance at f = 1 MHz

$I_E = I_e = 0$; $-V_{CB}$ = 10 V	C_c	typ.	7.0	pF

Transition frequency at f = 35 MHz

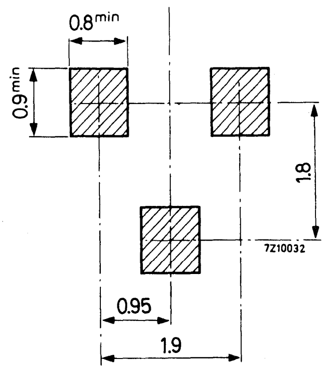
$-I_C$ = 10 mA; $-V_{CE}$ = 5 V	f_T	typ.	150	MHz

Noise figure at R_S = 2 kΩ

$-I_C$ = 200 μA; $-V_{CE}$ = 5 V f = 1 kHz; B = 200 Hz	F	<	10	dB[1]

MOUNTING METHODS

Minimum required dimensions of metal connection pads on thick and thin film substrates.

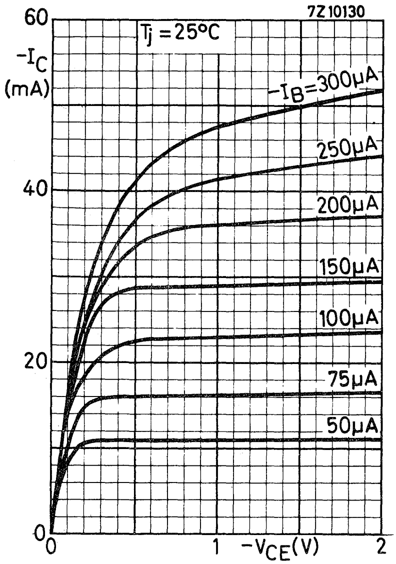


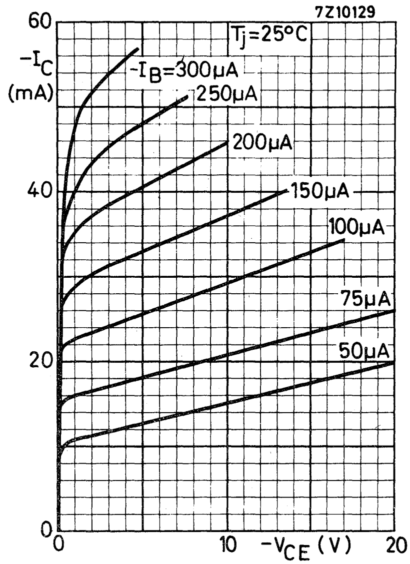
Soldering

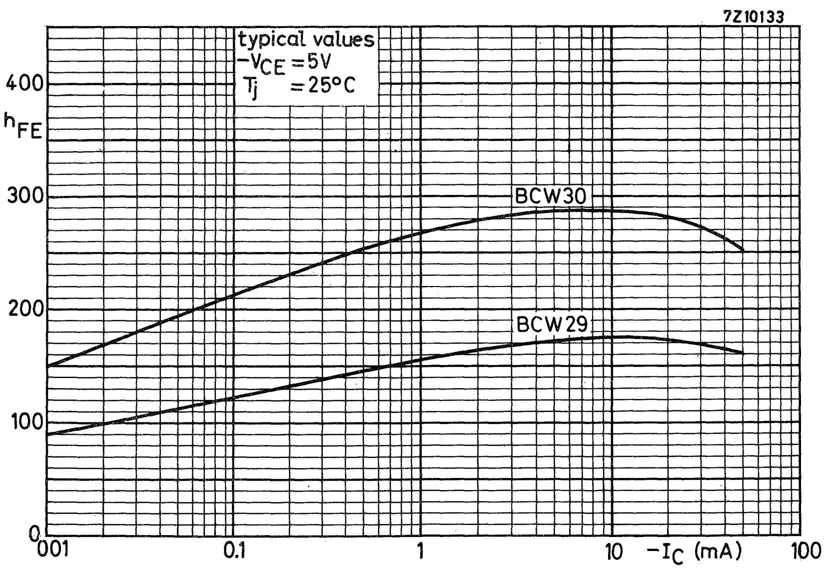
The leads are covered with a solder material of which the melting point is 185 °C. At a maximum lead temperature of 250 °C, the maximum permissible soldering time is 10 s.
The maximum temperature gradient is 25 °C/s.

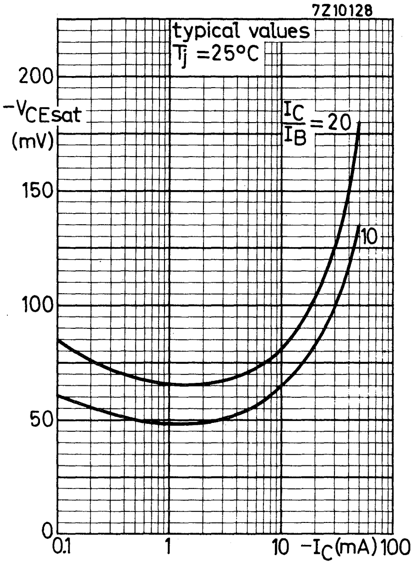
[1]) Crystal mounted in a BC177 envelope

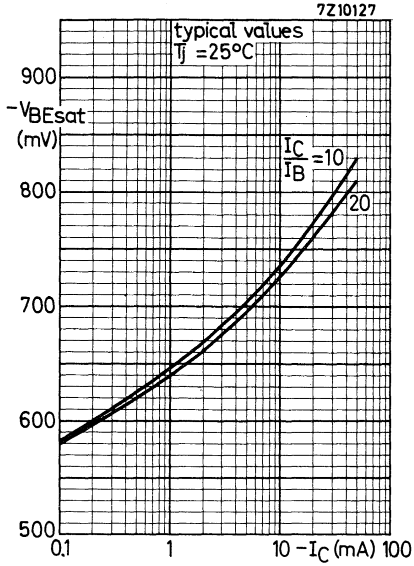
Typical behaviour of collector current versus collector-emitter voltage

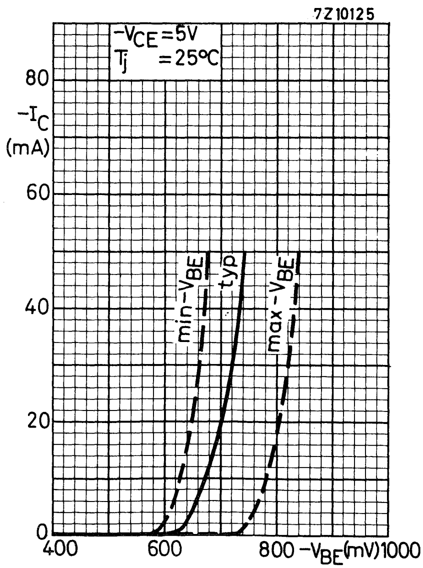


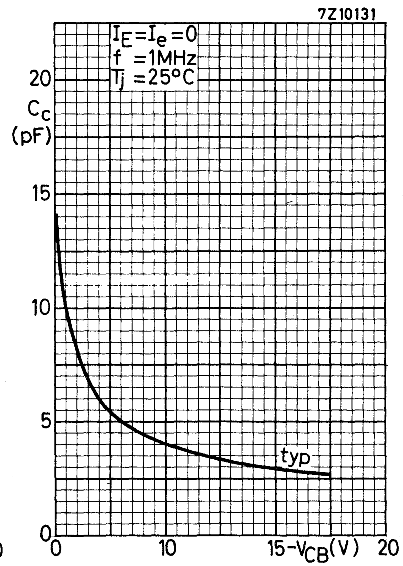


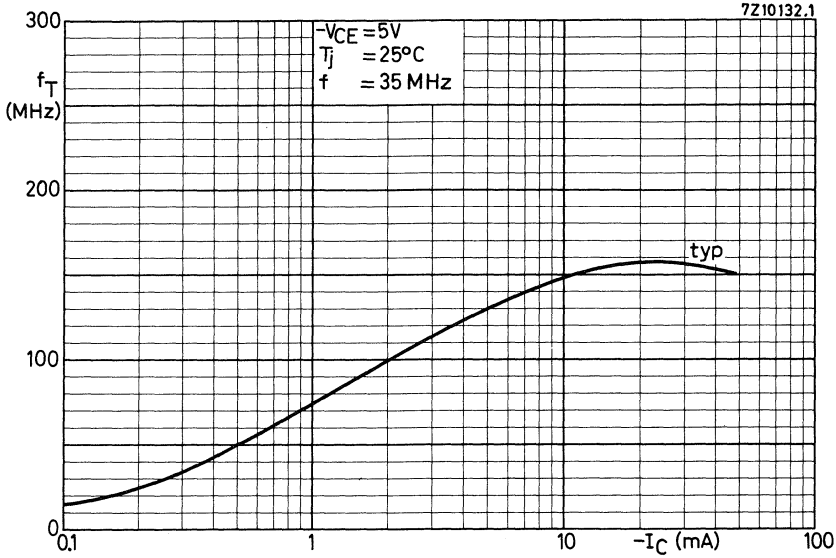


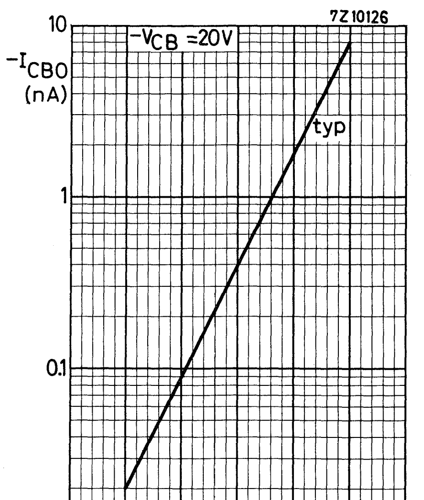

7Z10128
typical values
T_j = 25°C
$-V_{CEsat}$ (mV)
$\frac{I_C}{I_B}$ = 20
10
$-I_C$ (mA)


7Z10127
typical values
T_j = 25°C
$-V_{BEsat}$ (mV)
$\frac{I_C}{I_B}$ = 10
20
$-I_C$ (mA)


7Z10125
$-V_{CE}$ = 5V
T_j = 25°C
$-I_C$ (mA)
min-V_{BE}
typ
max-V_{BE}
$-V_{BE}$ (mV)


7Z10131
$I_E = I_e = 0$
f = 1MHz
T_j = 25°C
C_c (pF)
typ
$-V_{CB}$ (V)


7Z10132.1
$-V_{CE}$ = 5V
T_j = 25°C
f = 35 MHz
f_T (MHz)
300
200
100
0
typ
0.1
1
10
$-I_C$ (mA)
100


7Z10126
$-V_{CB}$ = 20V
$-I_{CBO}$ (nA)
10
1
0.1
0.01
typ
0
50
100
T_j (°C)
150

A.F. SILICON PLANAR EPITAXIAL TRANSISTORS

N-P-N transistors in a micro miniature plastic envelope.
They are intended for low level general purpose applications in thick and thin film circuits.

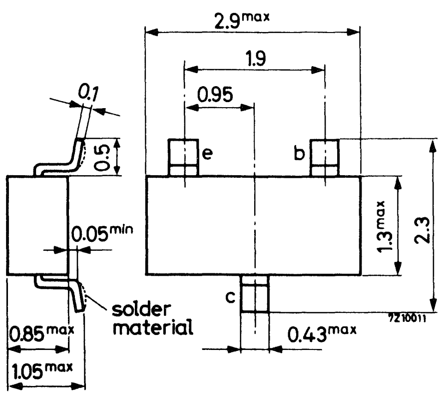
QUICK REFERENCE DATA

			BCW31	BCW32	BCW33	
Collector-base voltage (open emitter)	V_{CBO}	max.	30	30	30	V
Collector-emitter voltage (open base)	V_{CEO}	max.	20	20	20	V
Collector current (peak value)	I_{CM}	max.	200	200	200	mA
Total power dissipation up to T_{amb} = 25 °C	P_{tot}	max.	110	110	110	mW
Junction temperature	T_j	max.	125	125	125	°C
D.C. current gain at T_j = 25 °C; I_C = 2 mA; V_{CE} = 5 V	h_{FE}	>	110	200	420	
		<	220	450	800	
Transition frequency at f = 35 MHz; I_C = 10 mA; V_{CE} = 5 V	f_T	typ.	300	300	300	MHz
Noise figure at R_S = 2 kΩ; I_C = 200 μA; V_{CE} = 5 V; f = 1 kHz; B = 200 Hz	F	<	10	10	10	dB

MECHANICAL DATA

Dimensions in mm

Code:
BCW31 D1
BCW32 D2
BCW33 D3



MOUNTING METHODS see page 3.

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

Voltages

Collector-base voltage (open emitter)	V_{CBO}	max.	30	V
Collector-emitter voltage (open base) I_C = 2 mA	V_{CEO}	max.	20	V
Emitter-base voltage (open collector)	V_{EBO}	max.	5	V

Currents

Collector current (d.c.)	I_C	max.	50	mA
Collector current (peak value)	I_{CM}	max.	200	mA

Power dissipation

Total power dissipation up to T_{amb} = 25 °C mounted on a glass substrate of 5 mm x 5 mm x 1 mm	P_{tot}	max.	110	mW

Temperatures

Storage temperature	T_{stg}	-65 to +125		°C
Junction temperature	T_j	max.	125	°C [1]

THERMAL RESISTANCE

From junction to ambient

mounted on a glass substrate of 5 mm x 5 mm x 1 mm	$R_{th\ j\text{-}a}$	=	0.9	°C/mW
mounted on a glass fibre print of 24 mm x 12 mm x 1.5 mm	$R_{th\ j\text{-}a}$	=	0.5	°C/mW

CHARACTERISTICS T_j = 25 °C unless otherwise specified

Collector cut-off current

I_E = 0; V_{CB} = 20 V	I_{CBO}	<	100	nA
I_E = 0; V_{CB} = 20 V; T_j = 100 °C	I_{CBO}	<	10	μA

Base-emitter voltage

I_C = 2 mA; V_{CE} = 5 V	V_{BE}	550 to	700	mV

[1]) For highly professional applications it is advisable not to exceed a maximum junction temperature of 100 °C.

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

Saturation voltages

I_C = 10 mA; I_B = 0.5 mA	V_{CEsat}	typ.	120	mV
		<	250	mV
	V_{BEsat}	typ.	750	mV
I_C = 50 mA; I_B = 2.5 mA	V_{CEsat}	typ.	230	mV
	V_{BEsat}	typ.	870	mV

D.C. current gain

			BCW31	BCW32	BCW33
I_C = 10 μA; V_{CE} = 5 V	h_{FE}	typ.	90	150	270
I_C = 2 mA; V_{CE} = 5 V	h_{FE}	>	110	200	420
		<	220	450	800

Collector capacitance at f = 1 MHz

$I_E = I_e$ = 0; V_{CB} = 10 V	C_c	<	4.0	pF

Transition frequency at f = 35 MHz

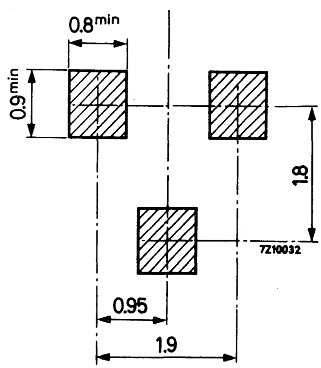
I_C = 10 mA; V_{CE} = 5 V	f_T	typ.	300	MHz

Noise figure at R_S = 2 kΩ

I_C = 200 μA; V_{CE} = 5 V f = 1 kHz; B = 200 Hz	F	<	10	dB [1])

MOUNTING METHODS

Minimum required dimensions of metal connection pads on thick and thin film substrates.

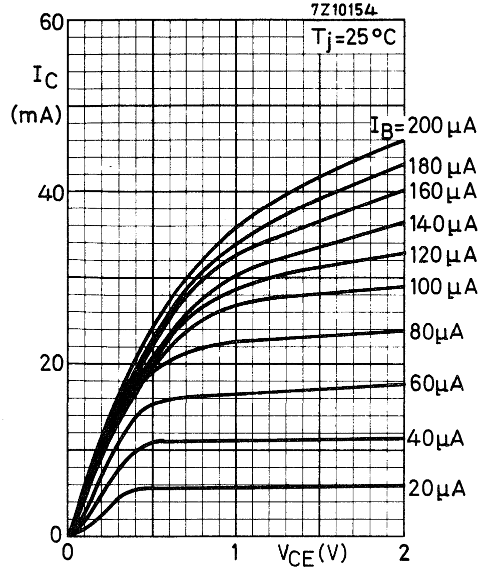


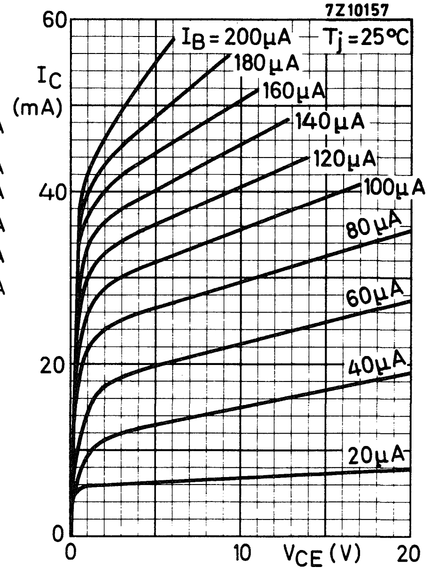
Soldering

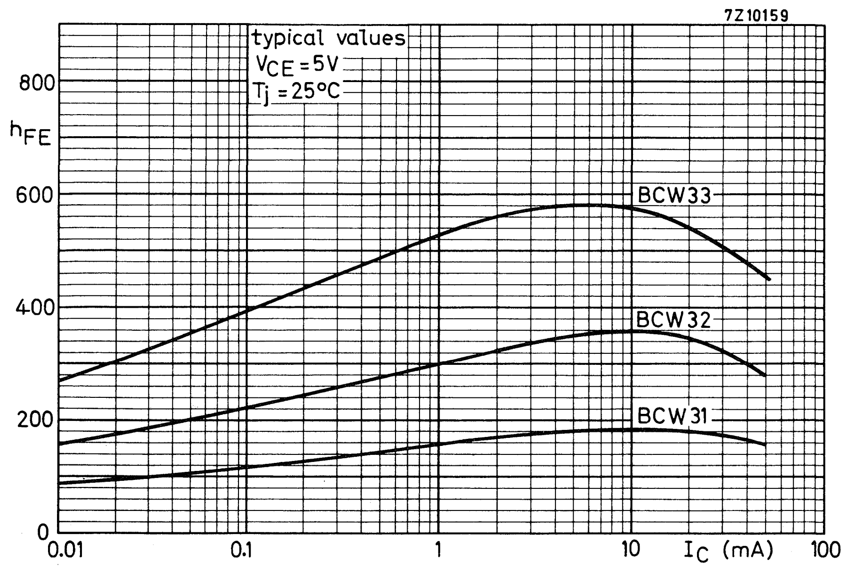
The leads are covered with a solder material of which the melting point is 185 °C. At a maximum lead temperature of 250 °C, the maximum permissible soldering time is 10 s.
The maximum temperature gradient is 25 °C/s.

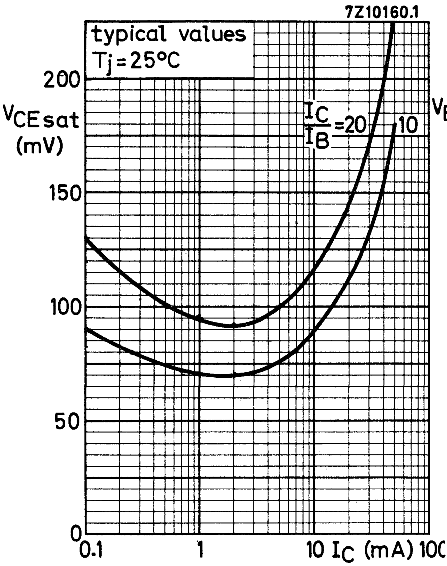
[1]) Crystal mounted in a BC107 envelope.

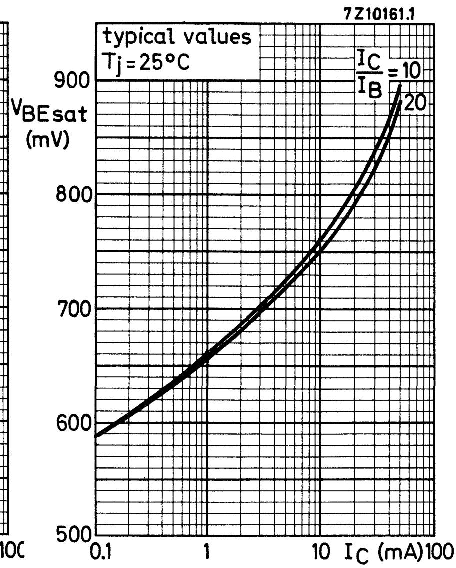
Typical behaviour of collector current versus collector-emitter voltage

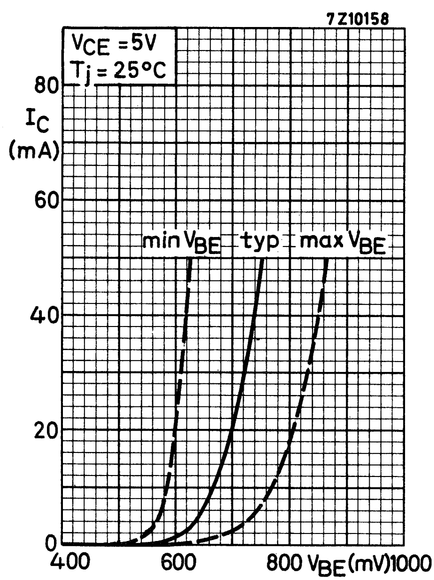


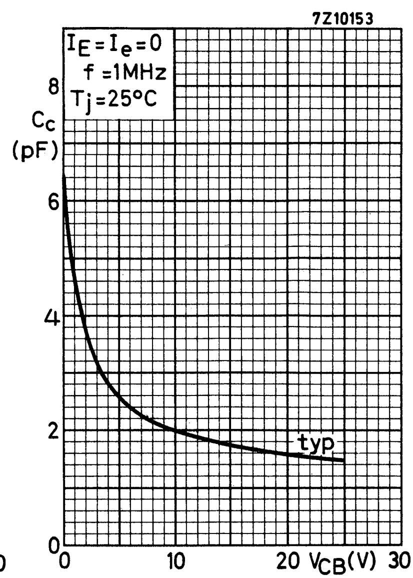


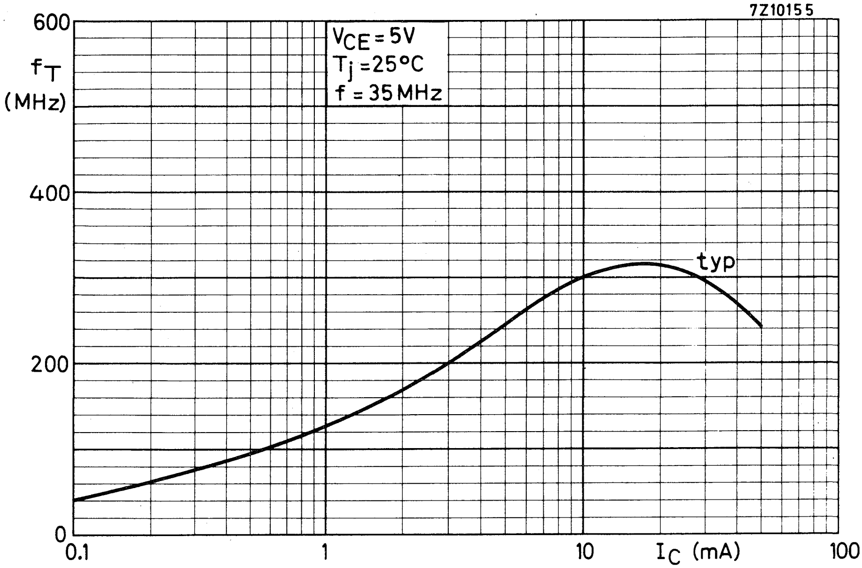


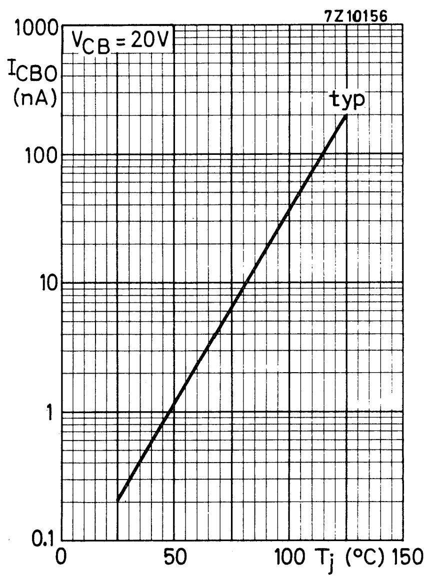

7Z10160.1
typical values
Tj=25°C
VCEsat (mV)
IC/IB=20
10
0.1
1
10 IC (mA) 100


7Z10161.1
typical values
Tj=25°C
VBEsat (mV)
IC/IB=10
20
0.1
1
10 IC (mA) 100


7Z10158
VCE=5V
Tj=25°C
IC (mA)
min VBE
typ
max VBE
400
600
800 VBE (mV) 1000


7Z10153
IE=Ie=0
f=1MHz
Tj=25°C
Cc (pF)
typ
0
10
20 VCB (V) 30


7Z10155
V_{CE} = 5V
T_j = 25°C
f = 35 MHz
600
f_T
(MHz)
400
200
0
typ
0.1
1
10
I_C (mA)
100


7Z10156
V_{CB} = 20V
1000
I_{CBO}
(nA)
100
10
1
0.1
typ
0
50
100
T_j (°C)
150

SILICON PLANAR EPITAXIAL TRANSISTOR

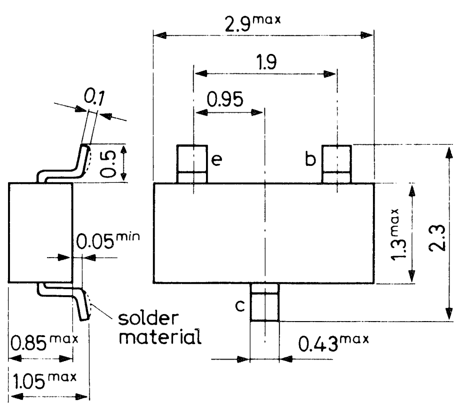
N-P-N transistor in a micro miniature plastic envelope.
It is intended for a wide range of v.h.f. and u.h.f. applications in thick and thin film circuits.

QUICK REFERENCE DATA

Collector-base voltage (open emitter; peak value)	V_{CBOM}	max.	25	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 $T_{amb} = 25\,^oC$	P_{tot}	max.	110	mW
Junction temperature	T_j	max.	125	^oC
D.C. current gain $I_C = 2$ mA; $V_{CE} = 1$ V	h_{FE}		20 to 150	
Transition frequency $I_C = 25$ mA; $V_{CE} = 5$ V; f = 500 MHz	f_T	typ.	1.3	GHz
Noise figure $I_C = 2$ mA; $V_{CE} = 5$ V $R_S = 50\ \Omega$; f = 500 MHz	F	typ.	4.5	dB

MECHANICAL DATA Dimensions in mm

Code: E1



MOUNTING METHODS see page 3.

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

Voltages

Collector-base voltage (open emitter; peak value)	V_{CBOM}	max.	25	V
Collector-emitter voltage (open base) I_C = 10 mA	V_{CEO}	max.	15	V
Emitter-base voltage (open collector)	V_{EBO}	max.	2.5	V

Currents

Collector current (d.c.)	I_C	max.	25	mA
Collector current (peak value)	I_{CM}	max.	50	mA

Power dissipation

Total power dissipation up to T_{amb} = 25 °C mounted on a glass substrate of 5 mm x 5 mm x 1 mm	P_{tot}	max.	110	mW

Temperatures

Storage temperature	T_{stg}		−65 to +125	°C
Junction temperature	T_j	max.	125	°C [1]

THERMAL RESISTANCE

From junction to ambient mounted on a glass substrate of 5 mm x 5 mm x 1 mm	$R_{th\ j\text{-}a}$	=	0.9	°C/mW
mounted on a glass fibre print of 24 mm x 12 mm x 1.5 mm	$R_{th\ j\text{-}a}$	=	0.5	°C/mW

CHARACTERISTICS T_j = 25 °C unless otherwise specified

Collector cut-off current

$I_E = 0$; $V_{CB} = 10$ V	I_{CBO}	<	10	nA
$I_E = 0$; $V_{CB} = 10$ V; $T_j = 100$ °C	I_{CBO}	<	10	μA

D.C. current gain

I_C = 2 mA; V_{CE} = 1 V	h_{FE}	20 to	150
I_C = 25 mA; V_{CE} = 1 V	h_{FE}	>	20

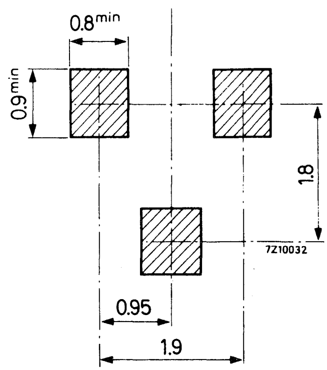
[1]) For highly professional applications it is advisable not to exceed a maximum junction temperature of 100 °C.

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

Transition frequency				
I_C = 2 mA; V_{CE} = 5 V; f = 500 MHz	f_T	typ.	1.0	GHz
I_C = 25 mA; V_{CE} = 5 V; f = 500 MHz	f_T	typ.	1.3	GHz
Collector capacitance at f = 1 MHz				
$I_E = I_e = 0$; V_{CB} = 10 V	C_c	<	1.5	pF
Emitter capacitance at f = 1 MHz				
$I_C = I_c = 0$; V_{EB} = 0.5 V	C_e	<	2.0	pF
Feedback capacitance at f = 1 MHz				
I_C = 2 mA; V_{CE} = 5 V	$-C_{re}$	typ.	0.65	pF
Noise figure				
I_C = 2 mA; V_{CE} = 5 V f = 500 MHz; R_S = 50 Ω	F	typ.	4.5	dB[1]
Intermodulation distortion				
I_C = 10 mA; V_{CE} = 6 V; R_L = 37.5 Ω; T_{amb} = 25 °C V_o = 100 mV at f_p = 183 MHz V_o = 100 mV at f_q = 200 MHz measured at $f_{(2q-p)}$ = 217 MHz	d_{im}	typ.	-45	dB

MOUNTING METHODS

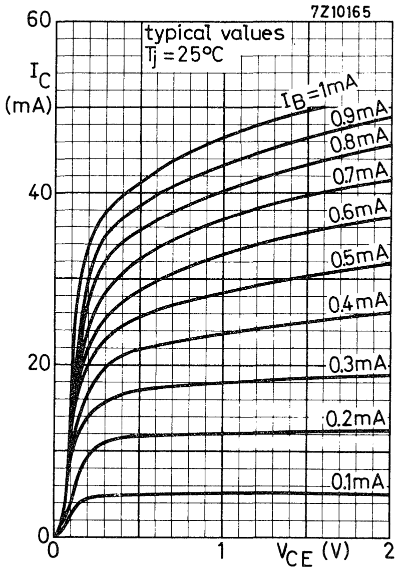
Minimum required dimensions of metal connection pads on thick and thin film substrates.

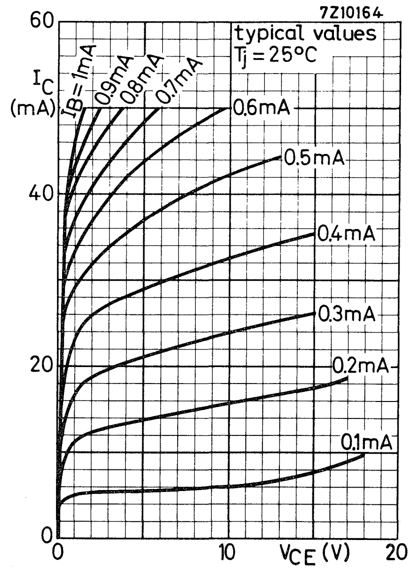


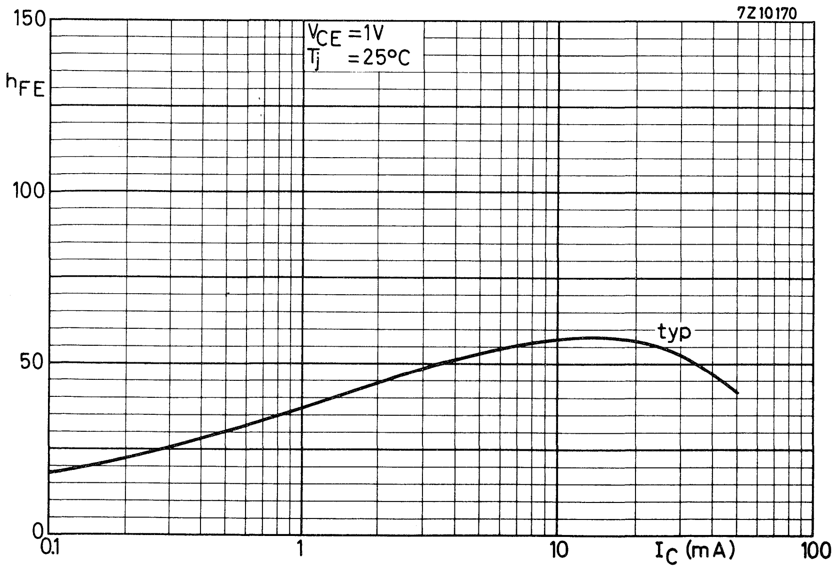
Soldering

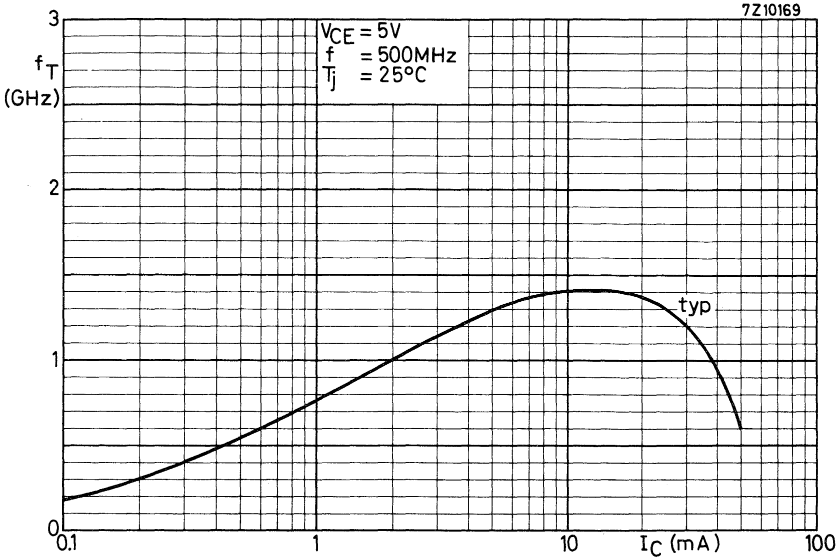
The leads are covered with a solder material of which the melting point is 185 °C. At a maximum lead temperature of 250 °C, the maximum permissible soldering time is 10 s.
The maximum temperature gradient is 25 °C/s.

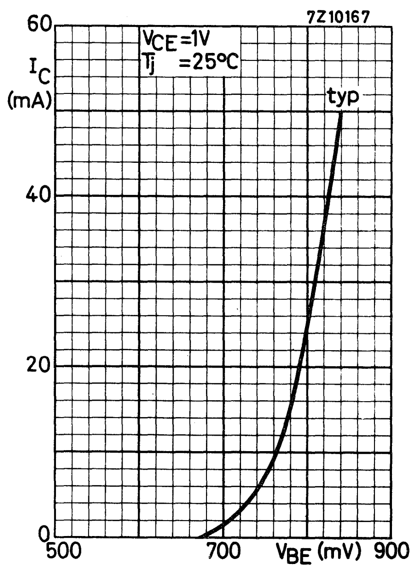
[1]) Crystal mounted in a BFY90 envelope.

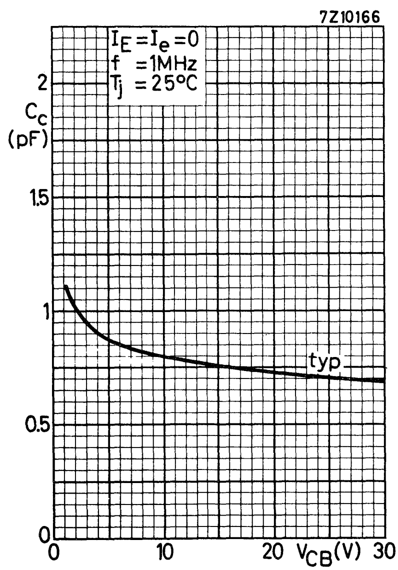

7Z10165
typical values
Tj = 25°C
IC (mA)
IB = 1mA
0.9mA
0.8mA
0.7mA
0.6mA
0.5mA
0.4mA
0.3mA
0.2mA
0.1mA
VCE (V)

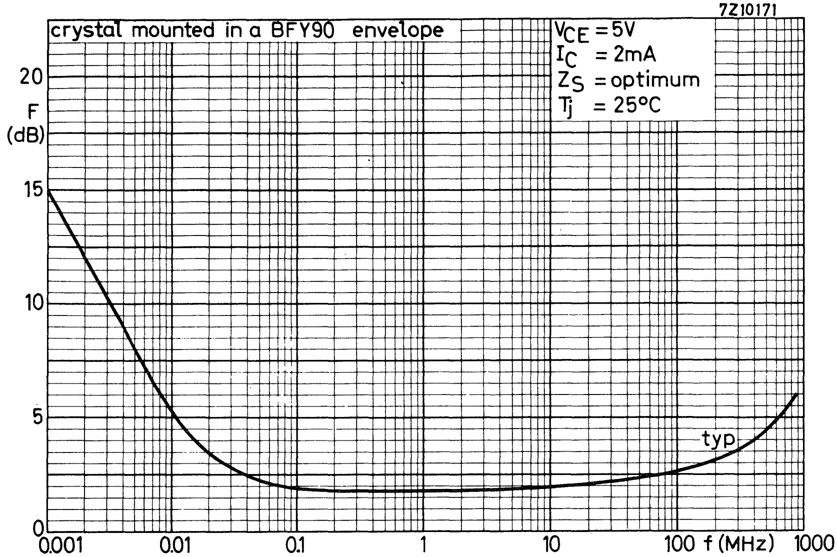

7Z10164
typical values
Tj = 25°C
IC (mA)
IB = 1mA
0.9mA
0.8mA
0.7mA
0.6mA
0.5mA
0.4mA
0.3mA
0.2mA
0.1mA
VCE (V)

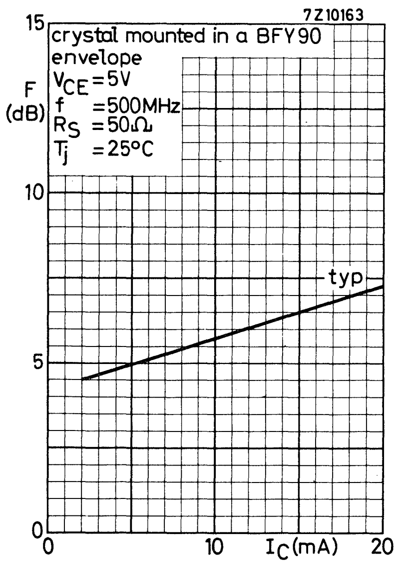

7Z10170
VCE = 1V
Tj = 25°C
hFE
typ
IC (mA)

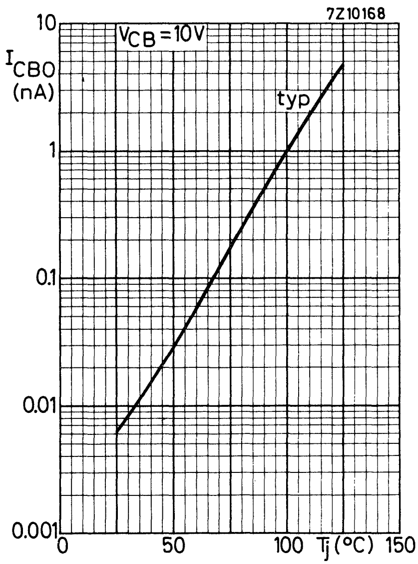

7Z10169
3
f_T
(GHz)
2
1
0
V_{CE} = 5V
f = 500MHz
T_j = 25°C
typ
0.1
1
10
I_C (mA)
100


7Z10167
60
I_C
(mA)
40
20
0
V_{CE} =1V
T_j =25°C
typ
500
700
V_{BE} (mV)
900


7Z10166
$I_E = I_e = 0$
f =1MHz
T_j = 25°C
2
C_c
(pF)
1.5
1
0.5
0
typ
0
10
20
V_{CB}(V)
30


7Z10171
crystal mounted in a BFY90 envelope
V_{CE} = 5V
I_C = 2mA
Z_S = optimum
T_j = 25°C
F (dB)
0
5
10
15
20
typ
0.001
0.01
0.1
1
10
100
f (MHz)
1000


7Z10163
crystal mounted in a BFY90 envelope
V_{CE} = 5V
f = 500MHz
R_S = 50Ω
T_j = 25°C
F (dB)
0
5
10
15
typ
0
10
I_C (mA)
20


7Z10168
V_{CB} = 10V
I_{CBO} (nA)
0.001
0.01
0.1
1
10
typ
0
50
100
T_j (°C)
150

SILICON PLANAR EPITAXIAL TRANSISTORS

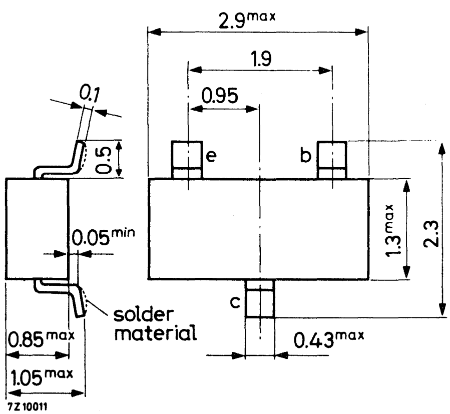
N-P-N transistors in a micro miniature plastic envelope.
They are intended for general purpose and h.f. applications in thick and thin film circuits.

QUICK REFERENCE DATA					
Collector-base voltage (open emitter)	V_{CBO}	max.	30		V
Collector-emitter voltage (open base)	V_{CEO}	max.	20		V
Collector current (d.c.)	I_C	max.	30		mA
Total power dissipation up to T_{amb} = 25 °C	P_{tot}	max.	110		mW
Junction temperature	T_j	max.	125		°C
D.C. current gain			BFS18	BFS19	
I_C = 1 mA; V_{CE} = 10 V	h_{FE}		35 to 125	65 to 225	
Transition frequency at f = 100 MHz					
I_C = 1 mA; V_{CE} = 10 V	f_T	typ.	200	260	MHz
Noise figure at f = 100 MHz					
I_C = 1 mA; V_{CE} = 10 V; G_S = 10 mΩ^{-1}	F	typ.	4		dB

MECHANICAL DATA

Dimensions in mm

Code:
BFS18 F1
BFS19 F2



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

Voltages

Collector-base voltage (open emitter)	V_{CBO}	max.	30	V
Collector-emitter voltage (open base) I_C = 2 mA	V_{CEO}	max.	20	V
Emitter-base voltage (open collector)	V_{EBO}	max.	5	V

Currents

Collector current (d.c.)	I_C	max.	30	mA
Colector current (peak value)	I_{CM}	max.	30	mA

Power dissipation

Total power dissipation up to T_{amb} = 25 °C mounted on a glass substrate of 5 mm x 5 mm x 1 mm	P_{tot}	max.	110	mW

Temperatures

Storage temperature	T_{stg}		-65 to +125	°C
Junction temperature	T_j	max.	125	°C 1)

THERMAL RESISTANCE

From junction to ambient mounted on a glass substrate of 5 mm x 5 mm x 1 mm	$R_{th\ j\text{-}a}$	=	0.9	°C/mW
mounted on a glass fibre print of 24 mm x 12 mm x 1.5 mm	$R_{th\ j\text{-}a}$	=	0.5	°C/mW

CHARACTERISTICS T_j = 25 °C unless otherwise specified

Collector cut-off current

$I_E = 0$; V_{CB} = 20 V	I_{CBO}	<	100	nA
$I_E = 0$; V_{CB} = 20 V; T_j = 100 °C	I_{CBO}	<	10	μA

Base-emitter voltage

I_C = 1 mA; V_{CE} = 10 V	V_{BE}	0.65 to 0.74	V

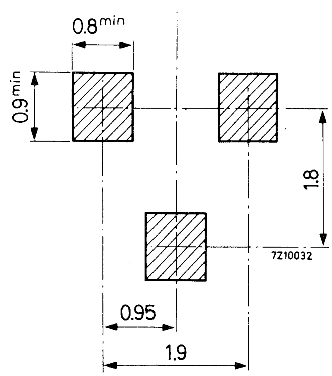
1) For highly professional applications it is advisable not to exceed a maximum junction temperature of 100 °C.

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

			BFS18	BFS19	
D.C. current gain					
I_C = 1 mA; V_{CE} = 10 V	h_{FE}		35 to 125	65 to 225	
Transition frequency at f = 100 MHz					
I_C = 1 mA; V_{CE} = 10 V	f_T	typ.	200	260	MHz
Collector capacitance at f = 1 MHz					
$I_E = I_e$ = 0; V_{CB} = 10 V	C_c	typ.	1		pF
Feedback capacitance at f = 1 MHz					
I_C = 1 mA; V_{CE} = 10 V	$-C_{re}$	typ.	0.85		pF
Noise figure					
I_C = 1 mA; V_{CE} = 10 V G_S = 10 mΩ^{-1}; f = 100 MHz	F	typ.	4		dB [1]

MOUNTING METHODS

Minimum required dimensions of metal connection pads on thick and thin film substrates.

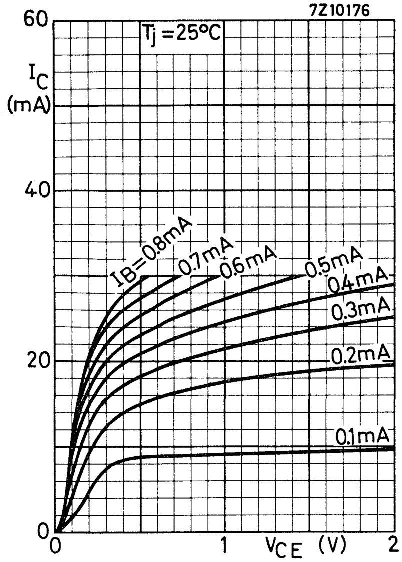


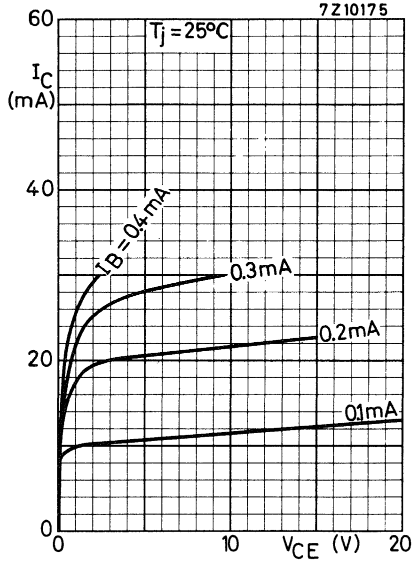
Soldering

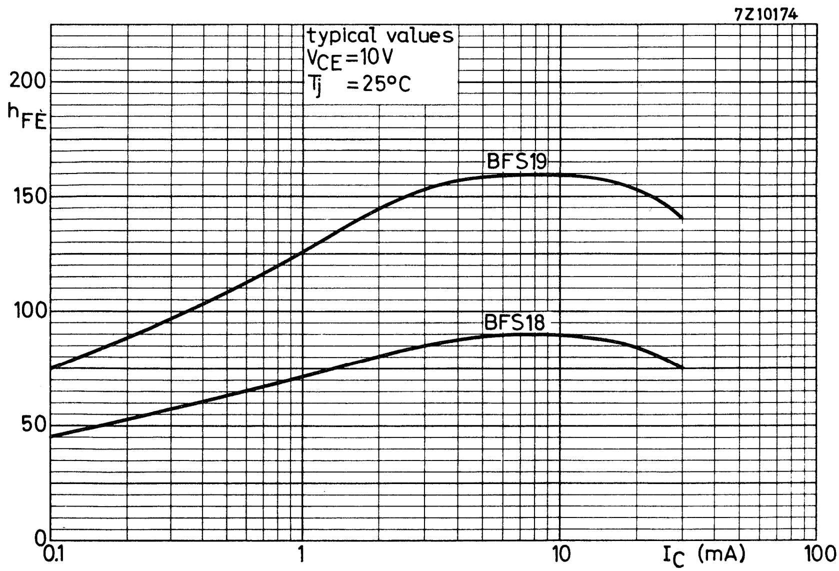
The leads are covered with a solder material of which the melting point is 185 °C. At a maximum lead temperature of 250 °C, the maximum permissible soldering time is 10 s.
The maximum temperature gradient is 25 °C/s.

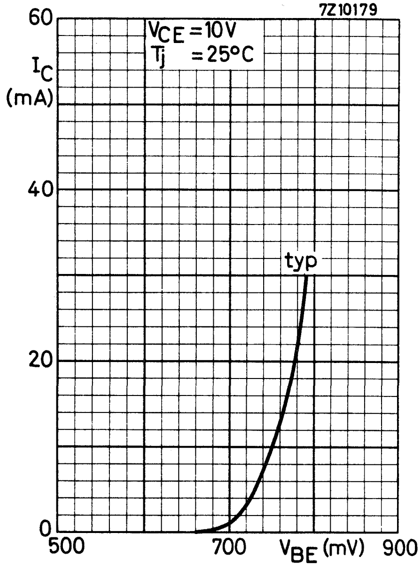
[1] Crystal mounted in a BF115 envelope.

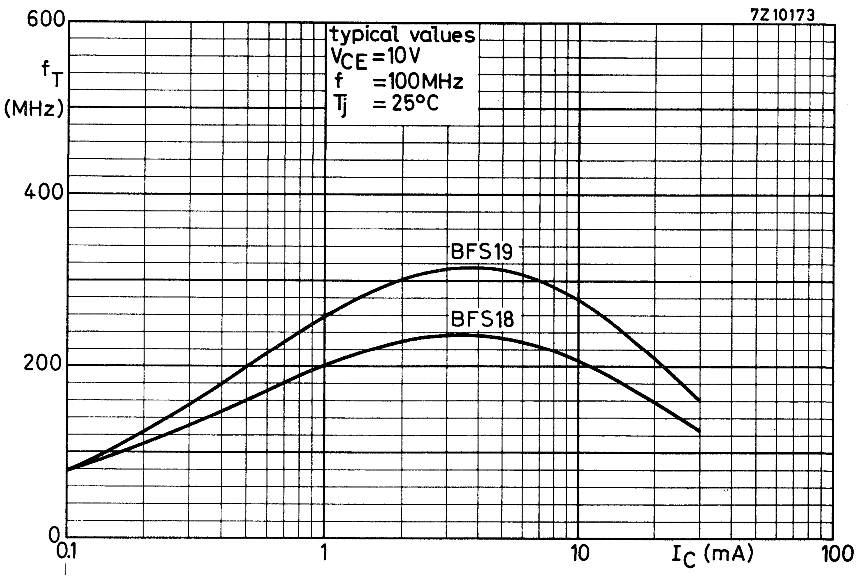
Typical behaviour of collector current versus collector-emitter voltage

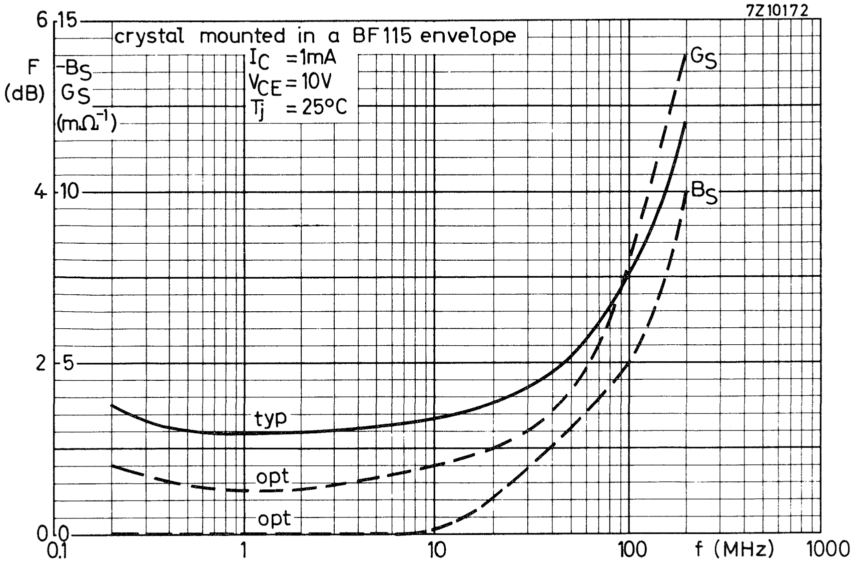


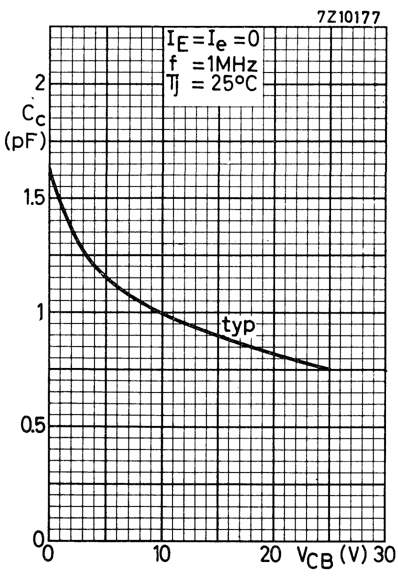


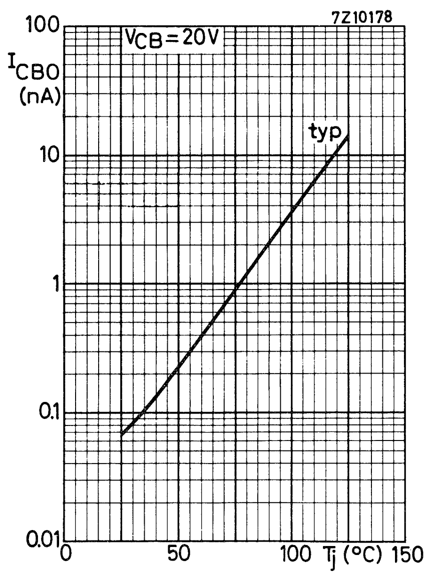



7Z10179
V_{CE} = 10 V
T_j = 25 °C
I_C (mA)
60
40
20
0
typ
500
700
V_{BE} (mV)
900


7Z10173
typical values
V_{CE} = 10 V
f = 100 MHz
T_j = 25 °C
f_T (MHz)
600
400
200
0
BFS19
BFS18
0.1
1
10
I_C (mA)
100


7Z10172
crystal mounted in a BF115 envelope
I_C = 1mA
V_{CE} = 10V
T_j = 25°C
F
(dB)
$-B_S$
G_S
(mΩ^{-1})
6
15
4
10
2
5
0
0
0.1
1
10
100
f (MHz)
1000
G_S
B_S
typ
opt
opt


7Z10177
$I_E = I_e = 0$
f = 1MHz
T_j = 25°C
C_c
(pF)
2
1.5
1
0.5
0
0
10
20
V_{CB} (V)
30
typ


7Z10178
V_{CB} = 20V
I_{CBO}
(nA)
100
10
1
0.1
0.01
0
50
100
T_j (°C)
150
typ

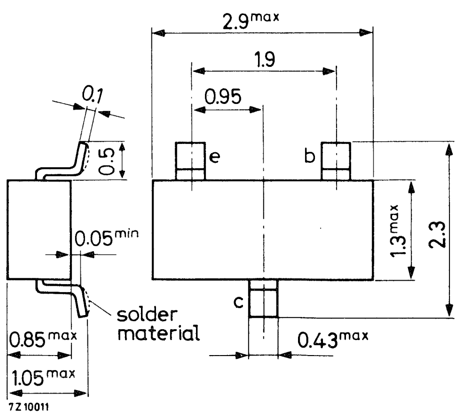
SILICON PLANAR EPITAXIAL TRANSISTOR

N-P-N transistor in a micro miniature plastic envelope.
It has a very low feedback capacitance and is intended for i.f. and v.h.f. applications in thick and thin film circuit.

QUICK REFERENCE DATA				
Collector-base voltage (open emitter)	V_{CBO}	max.	30	V
Collector-emitter voltage (open base)	V_{CEO}	max.	20	V
Collector current (d.c.)	I_C	max.	25	mA
Total power dissipation up to T_{amb} = 25 °C	P_{tot}	max.	110	mW
Junction temperature	T_j	max.	125	°C
D.C. current gain I_C = 7 mA; V_{CE} = 10 V	h_{FE}	>	40	
Transition frequency at f = 100 MHz I_C = 5 mA; V_{CE} = 5 V	f_T	typ.	450	MHz
Feedback capacitance at f = 1 MHz I_C = 1 mA; V_{CE} = 10 V	$-C_{re}$	typ.	400	fF

MECHANICAL DATA Dimensions in mm

Code: G1



MOUNTING METHODS see page 3.

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

Voltages

Collector-base voltage (open emitter)	V_{CBO}	max.	30	V
Collector-emitter voltage (open base) I_C = 2 mA	V_{CEO}	max.	20	V
Emitter-base voltage (open collector)	V_{EBO}	max.	4	V

Currents

Collector current (d.c.)	I_C	max.	25	mA
Collector current (peak value)	I_{CM}	max.	25	mA

Power dissipation

Total power dissipation up to T_{amb} = 25 °C mounted on a glass substrate of 5 mm x 5 mm x 1 mm	P_{tot}	max.	110	mW

Temperatures

Storage temperature	T_{stg}	−65 to +125		°C
Junction temperature	T_j	max.	125	°C [1])

THERMAL RESISTANCE

From junction to ambient

mounted on a glass substrate of 5 mm x 5 mm x 1 mm	$R_{th\ j-a}$	=	0.9	°C/mW
mounted on a glass fibre print of 24 mm x 12 mm x 1.5 mm	$R_{th\ j-a}$	=	0.5	°C/mW

1) For highly professional applications it is advisable not to exceed a maximum junction temperature of 100 °C

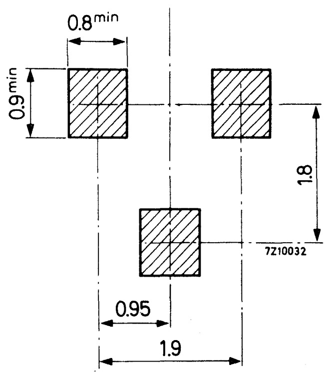
CHARACTERISTICS

T_j = 25 °C unless otherwise specified

Collector cut-off current				
I_E = 0; V_{CB} = 20 V	I_{CBO}	<	100	nA
I_E = 0; V_{CB} = 20 V; T_j = 100 °C	I_{CBO}	<	10	μA
Base-emitter voltage				
I_C = 7 mA; V_{CE} = 10 V	V_{BE}	typ.	740	mV
		<	900	mV
D.C. current gain				
I_C = 7 mA; V_{CE} = 10 V	h_{FE}	>	40	
		typ.	85	
Transition frequency at f = 100 MHz				
I_C = 5 mA; V_{CE} = 10 V	f_T	>	275	MHz
		typ.	450	MHz
Collector capacitance at f = 1 MHz				
I_E = I_e = 0; V_{CB} = 10 V	C_c	typ.	0.8	pF
Feedback capacitance at f = 1 MHz				
I_C = 1 mA; V_{CE} = 10 V	$-C_{re}$	typ.	350	fF

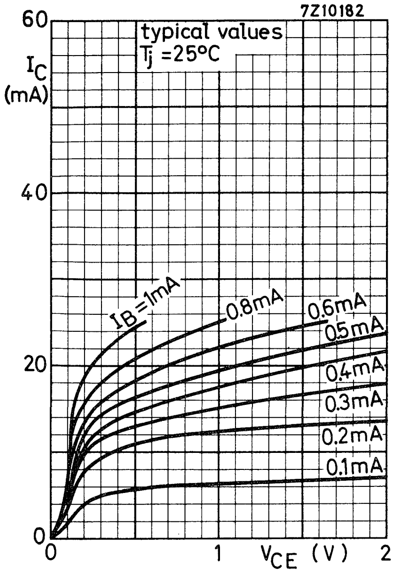
MOUNTING METHODS

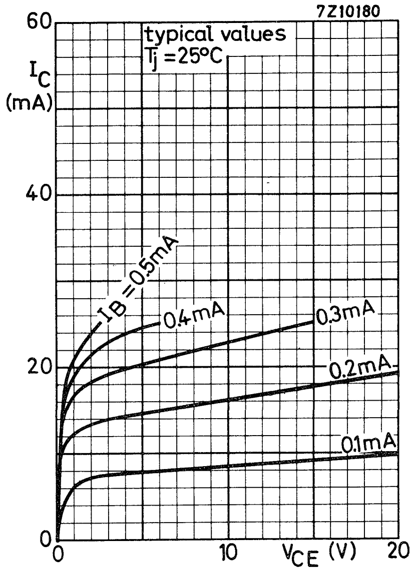
Minimum required dimensions of metal connection pads on thick and thin film substrates.

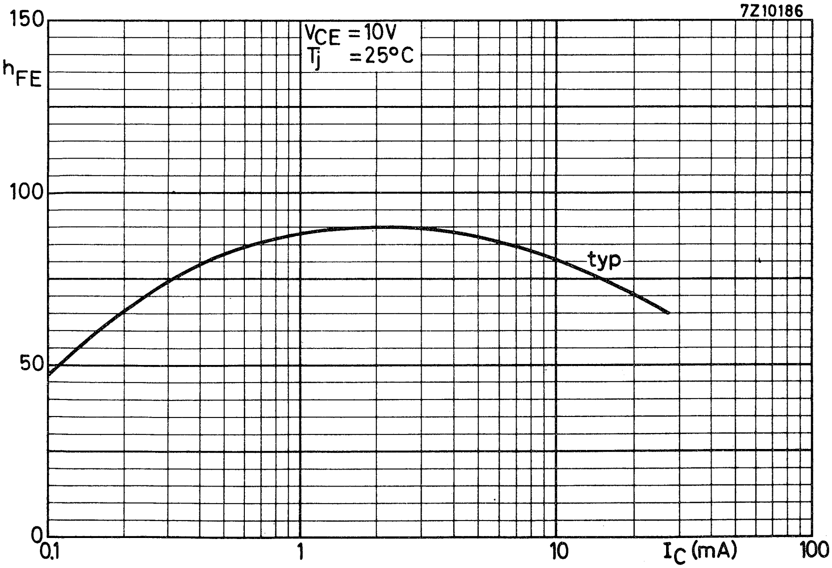


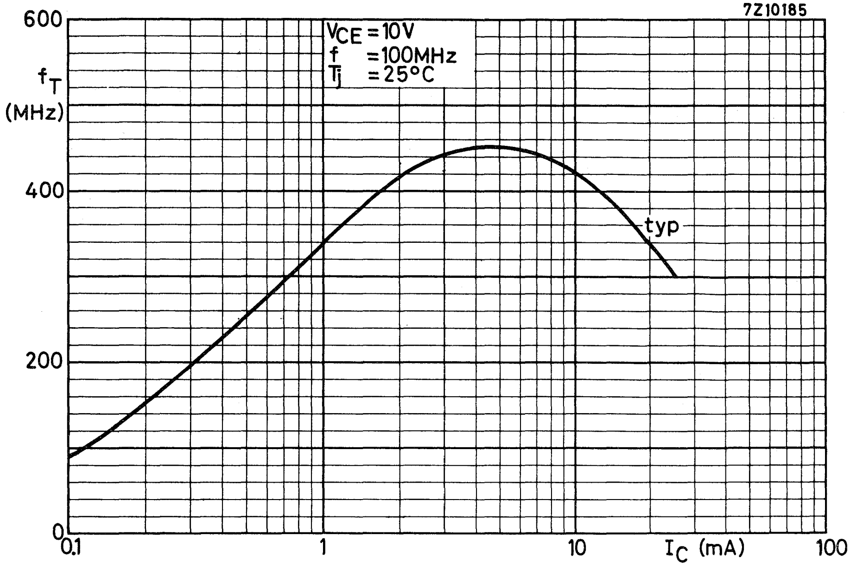
Soldering

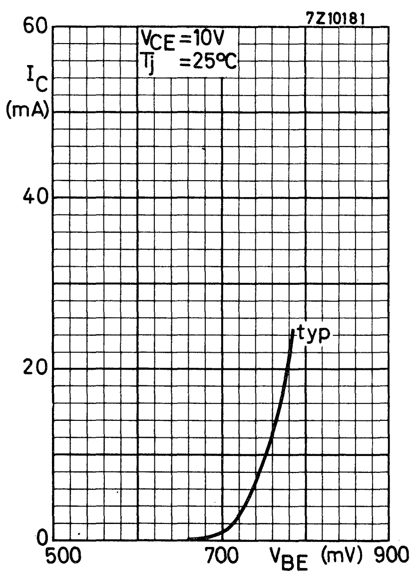
The leads are covered with a solder material of which the melting point is 185 °C. At a maximum lead temperature of 250 °C, the maximum permissible soldering time is 10 s.
The maximum temperature gradient is 25 °C/s.

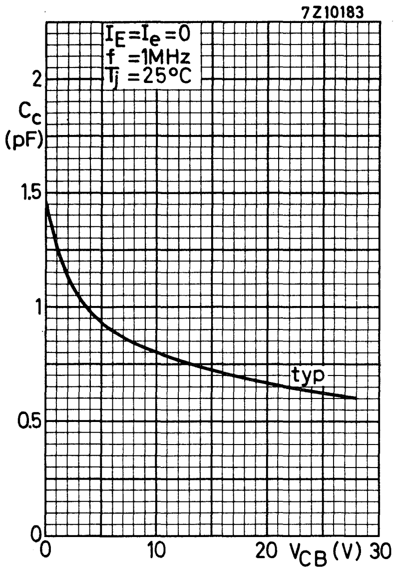

7Z10182
typical values
Tj =25°C
IC (mA)
IB=1mA
0.8mA
0.6mA
0.5mA
0.4mA
0.3mA
0.2mA
0.1mA
VCE (V)

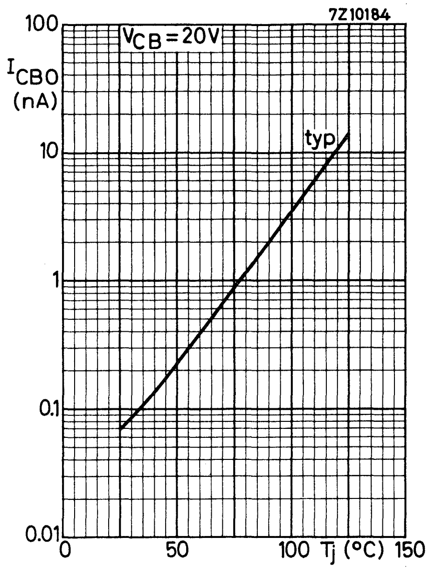

7Z10180
typical values
Tj =25°C
IC (mA)
IB=0.5mA
0.4mA
0.3mA
0.2mA
0.1mA
VCE (V)


7Z10186
VCE =10V
Tj =25°C
hFE
typ
IC (mA)


7Z10185
V_{CE} = 10 V
f = 100 MHz
T_j = 25 °C
f_T (MHz)
600
400
200
0
0.1
1
10
100
I_C (mA)
typ


7Z10181
V_{CE} = 10 V
T_j = 25 °C
I_C (mA)
60
40
20
0
500
700
900
V_{BE} (mV)
typ


7Z10183
$I_E = I_e = 0$
f = 1MHz
T_j = 25°C
C_c
(pF)
2
1.5
1
0.5
0
0
10
20
V_{CB} (V)
30
typ


7Z10184
V_{CB} = 20V
I_{CBO}
(nA)
100
10
1
0.1
0.01
0
50
100
T_j (°C)
150
typ

SILICON PLANAR EPITAXIAL HIGH SPEED SWITCHING TRANSISTOR

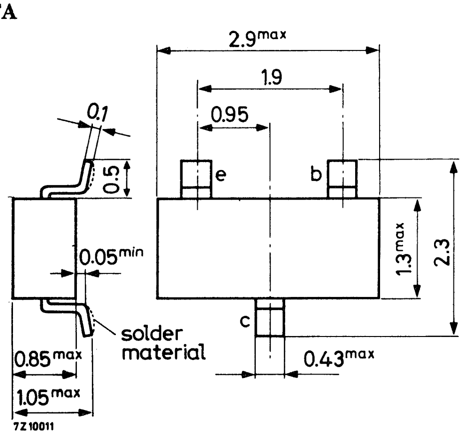
N-P-N transistor in a microminiature plastic envelope. It is intended for very high-speed saturated switching in thick and thin film circuits.

QUICK REFERENCE DATA				
Collector-base voltage (open emitter)	V_{CBO}	max.	20	V
Collector-emitter voltage (V_{BE} = 0)	V_{CES}	max.	20	V
Collector-emitter voltage (open base)	V_{CEO}	max.	12	V
Collector current (peak value)	I_{CM}	max.	200	mA
Total power dissipation up to T_{amb} = 25 °C	P_{tot}	max.	110	mW
Junction temperature	T_j	-65 to	+125	°C
D.C. current gain				
I_C = 10 mA; V_{CE} = 1 V	h_{FE}	40 to	120	
I_C = 50 mA; V_{CE} = 1 V	h_{FE}	>	25	
Transition frequency at f = 100 MHz				
I_C = 10 mA; V_{CE} = 10 V	f_T	>	400	MHz
		typ.	500	MHz
Storage time				
$I_C = I_B = -I_{BM}$ = 10 mA	t_s	<	13	ns

MECHANICAL DATA

Dimensions in mm

Code: B2



MOUNTING METHODS see page 5

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

Voltages

Collector-base voltage (open emitter)	V_{CBO}	max.	20	V
Collector-emitter voltage (V_{BE} = 0)	V_{CES}	max.	20	V
Collector-emitter voltage (open base) I_C = 10 mA	V_{CEO}	max.	12	V
Emitter-base voltage (open collector)	V_{EBO}	max.	5	V

Currents

Collector current (d.c.)	I_C	max.	50	mA
Collector current (peak value)	I_{CM}	max.	200	mA

Power dissipation

Total power dissipation up to T_{amb} = 25 °C mounted on a glass substrate of 5 mm x 5 mm x 1 mm	P_{tot}	max.	110	mW

Temperatures

Storage temperature	T_{stg}		−65 to +125	°C
Junction temperature	T_j	max.	125	°C 1)

THERMAL RESISTANCE

From junction to ambient

mounted on a glass substrate of 5 mm x 5 mm x 1 mm	$R_{th\ j\text{-}a}$	=	0.9	°C/mW
mounted on a glass fibre print of 24 mm x 12 mm x 1.5 mm	$R_{th\ j\text{-}a}$	=	0.5	°C/mW

CHARACTERISTICS T_j = 25 °C unless otherwise specified

Collector cut-off current

I_E = 0; V_{CB} = 10 V	I_{CBO}	<	100	nA
I_E = 0; V_{CB} = 10 V; T_j = 125 °C	I_{CBO}	<	5	μA

Saturation voltages

I_C = 10 mA; I_B = 300 μA	V_{CEsat}	<	300	mV
I_C = 10 mA; I_B = 1 mA	V_{CEsat}	<	250	mV
	V_{BEsat}		700 to 850	mV
I_C = 50 mA; I_B = 5 mA	V_{CEsat}	<	400	mV
	V_{BEsat}	<	1200	mV

1) For highly professional applications it is advisable not to exceed a max. junction temperature of 100 °C.

CHARACTERISTICS (continued)

D.C. current gain

I_C = 1 mA; V_{CE} = 1 V	h_{FE}	>	25	
I_C = 10 mA; V_{CE} = 1 V	h_{FE}		40 to 120	
I_C = 50 mA; V_{CE} = 1 V	h_{FE}	>	25	

Transition frequency at f = 100 MHz

I_C = 10 mA; V_{CE} = 10 V	f_T	>	400	MHz
		typ.	500	MHz

Collector capacitance at f = 1 MHz

$I_E = I_e = 0$; V_{CB} = 5 V	C_c	<	4	pF

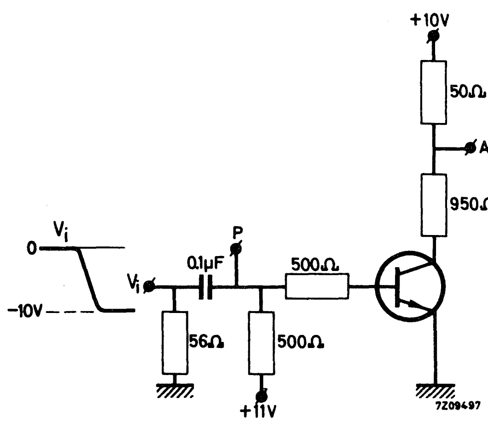
Emitter capacitance at f = 1 MHz

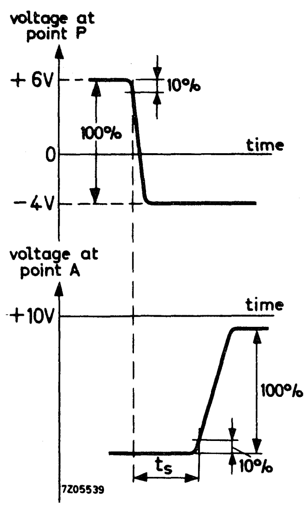
$I_C = I_c = 0$; V_{EB} = 1 V	C_e	<	4.5	pF

Switching times

Storage time $I_C = I_B = -I_{BM}$ = 10 mA	t_s	<	13	ns

Test circuit:





Pulse generator:

Rise time	t_r	<	1 ns
Pulse duration	t	>	300 ns
Duty cycle	δ	<	0.02
Source impedance	R_S	=	50 Ω

Oscilloscope:

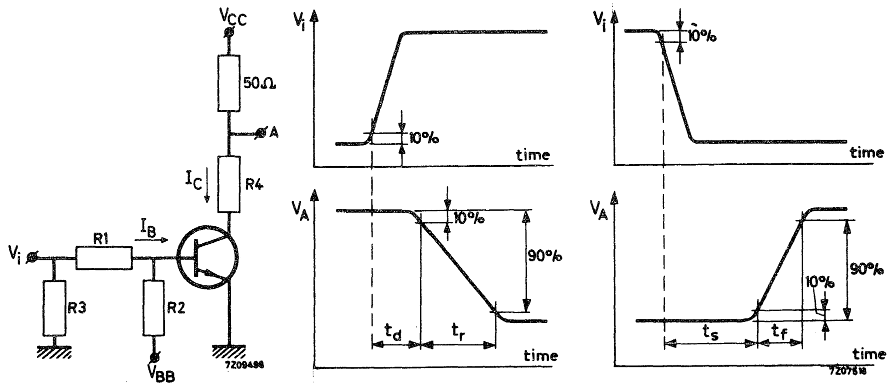
Input impedance	R_i	=	50 Ω
Rise time	t_r	<	1 ns

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

Switching times

Turn on time when switched from $-V_{BE}$ = 1.5 V to I_C = 10 mA; I_B = 3 mA	t_{on}	<	12	ns
Turn off time when switched from I_C = 10 mA; I_B = 3 mA to cut-off with $-I_{BM}$ = 1.5 mA	t_{off}	<	18	ns

Test circuit:



Pulse generator:

Rise time	t_r	<	1 ns
Pulse duration	t	>	300 ns
Duty cycle	δ	<	0.02
Source impedance	R_S	=	50 Ω

Oscilloscope:

Input impedance	R_i	=	50 Ω
Rise time	t_r	<	1 ns

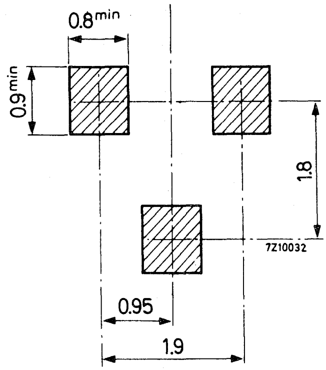
							turn on time			turn off time	
I_C (mA)	I_B (mA)	$-I_{BM}$ (mA)	V_{CC} (V)	$R_1;R_2$ (kΩ)	R_3 (Ω)	R_4 (Ω)	$-V_{BB}$ (V)	$-V_{BE}$ (V)	V_i (V)	V_{BB} (V)	$-V_i$ (V)
10	3	1.5	3	3.3	50	220	3.0	1.5	15	12.0	15

Note

$-I_{BM}$ is the reverse current that can flow during switching off. The indicated $-I_{BM}$ is determined and limited by the applied cut-off voltage and series resistance.

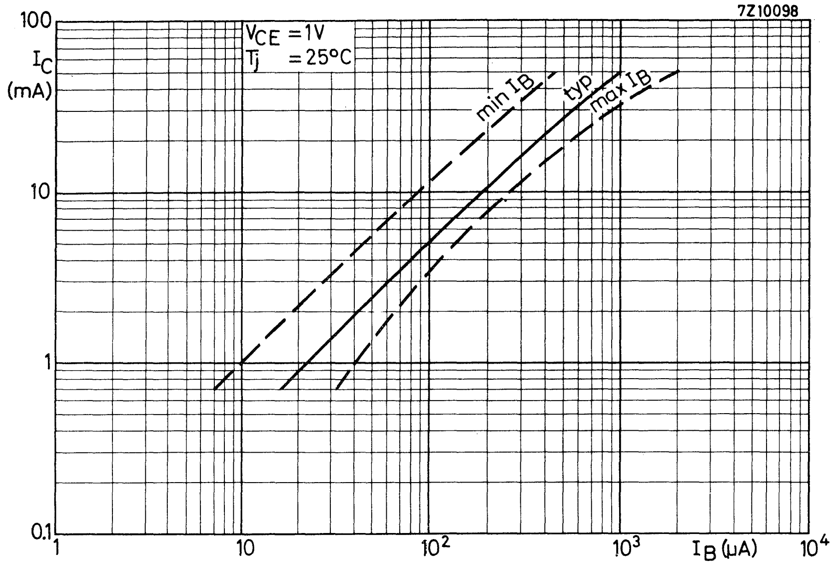
MOUNTING METHODS

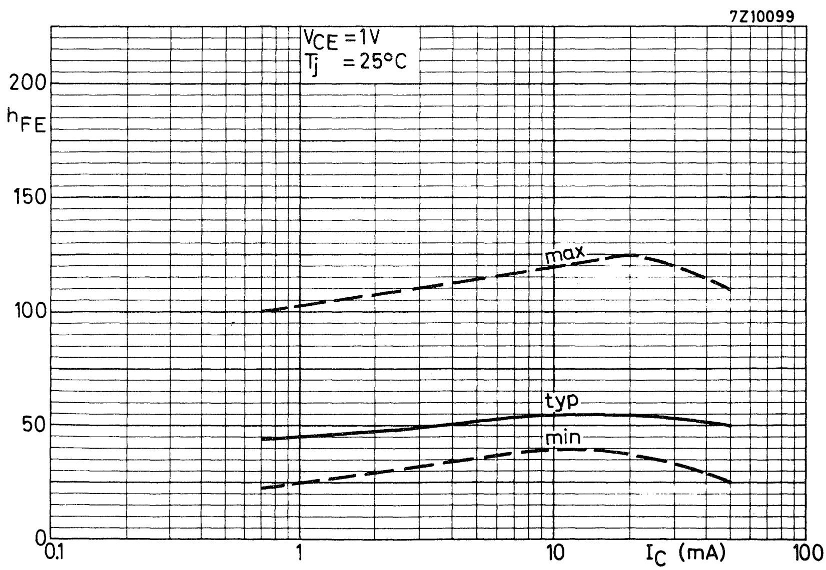
Minimum required dimensions of metal connection pads on thick and thin film substrates

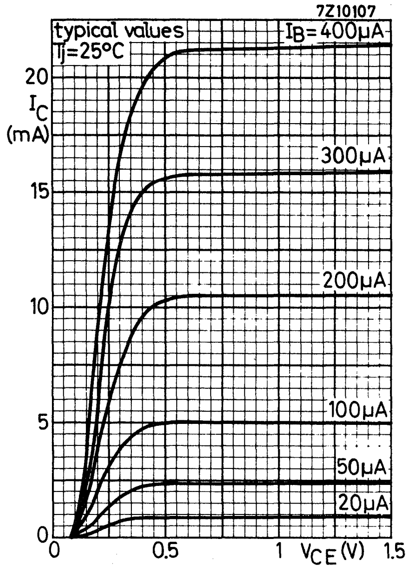


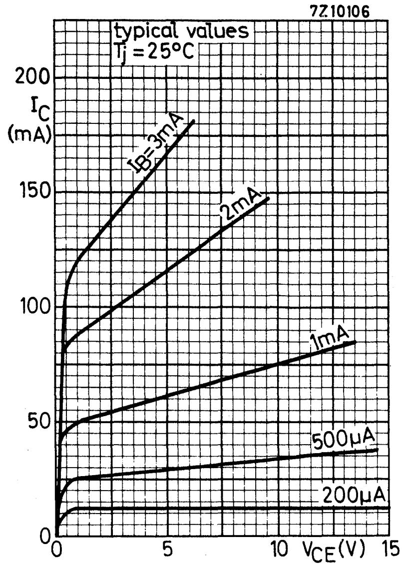
Soldering

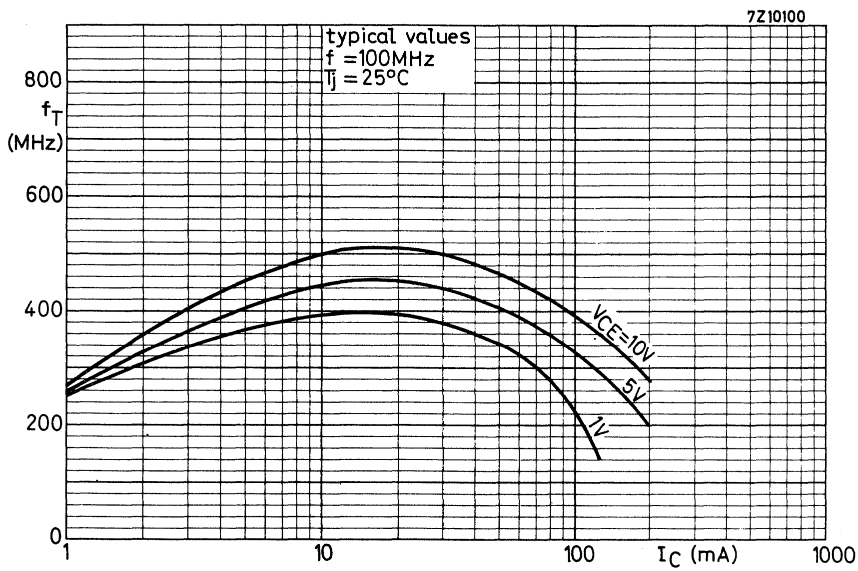
The leads are covered with a solder material of which the melting point is 185 °C. At a maximum lead temperature of 250 °C, the maximum permissible soldering time is 10 s.
The maximum temperature gradient is 25 °C/s.

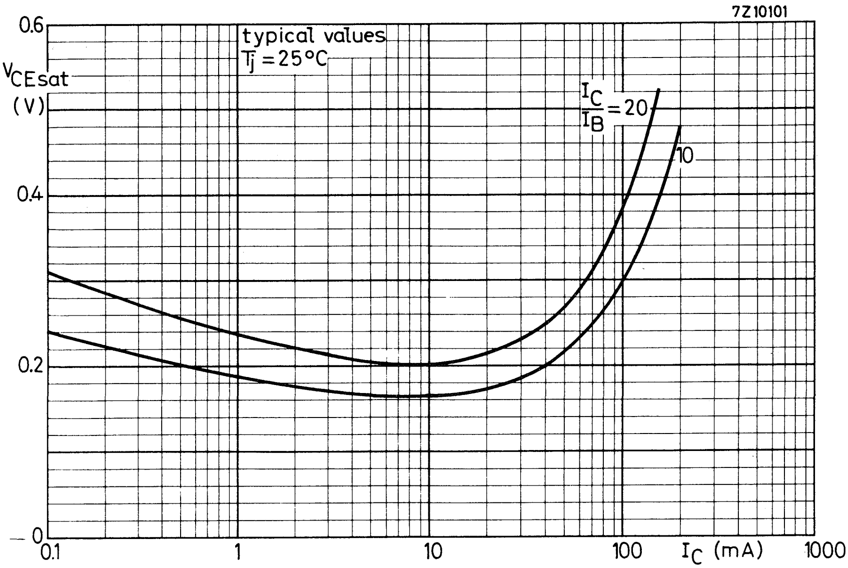

7Z10098
V_{CE} = 1V
T_j = 25°C
I_C (mA)
I_B (μA)
min I_B
typ
max I_B
100
10
1
0.1
1
10
10^2
10^3
10^4

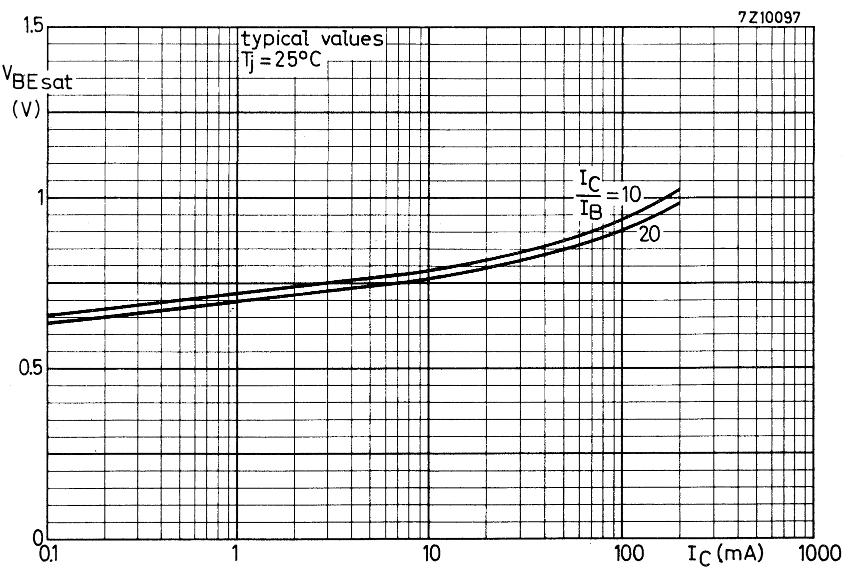

7Z10099
V_{CE} = 1V
T_j = 25°C
h_{FE}
I_C (mA)
max
typ
min
200
150
100
50
0
0.1
1
10
100

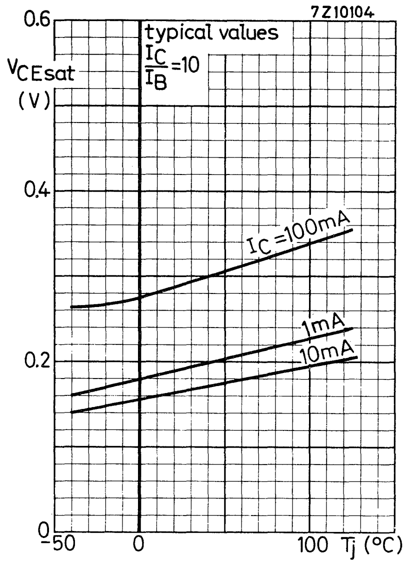

7Z10107
typical values
Tj=25°C
IB=400μA
300μA
200μA
100μA
50μA
20μA
IC (mA)
VCE (V)
0
5
10
15
20
0.5
1
1.5

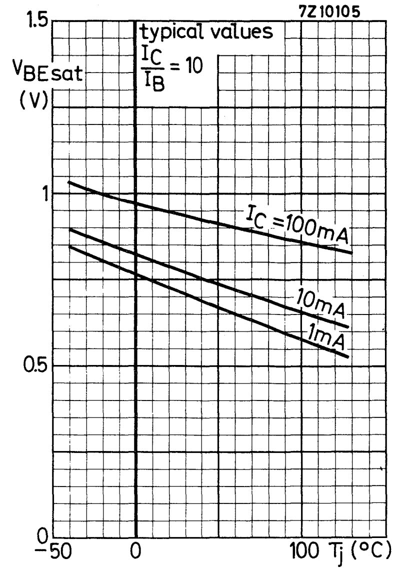

7Z10106
typical values
Tj=25°C
IB=3mA
2mA
1mA
500μA
200μA
IC (mA)
VCE (V)
0
50
100
150
200
5
10
15

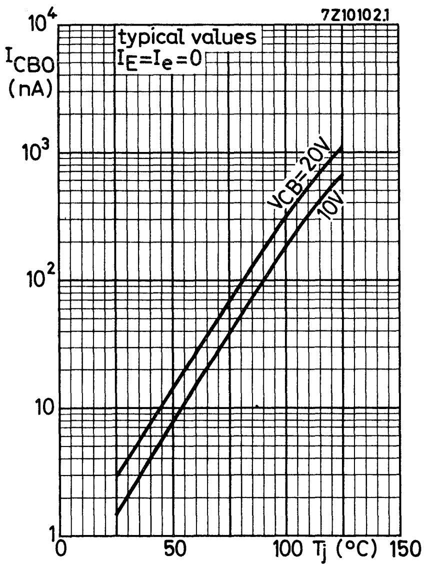

7Z10100
typical values
f =100MHz
Tj =25°C
fT (MHz)
VCE=10V
5V
1V
IC (mA)
0
200
400
600
800
1
10
100
1000


7Z10101
typical values
Tj = 25°C
VCEsat
(V)
0.6
0.4
0.2
0
IC/IB = 20
10
0.1
1
10
100
1000
IC (mA)


7Z10097
typical values
Tj = 25°C
VBEsat
(V)
1.5
1
0.5
0
IC/IB = 10
20
0.1
1
10
100
1000
IC (mA)


7Z10104
typical values
$\frac{I_C}{I_B}$=10
V_{CEsat} (V)
0.6
0.4
0.2
0
I_C =100mA
1mA
10mA
−50
0
100
T_j (°C)


7Z10105
typical values
$\frac{I_C}{I_B}$ = 10
V_{BEsat} (V)
1.5
1
0.5
0
I_C =100mA
10mA
1mA
−50
0
100
T_j (°C)


7Z10102.1
typical values
I_E=I_e=0
I_{CBO} (nA)
10^4
10^3
10^2
10
1
VCB=20V
10V
0
50
100
T_j (°C)
150

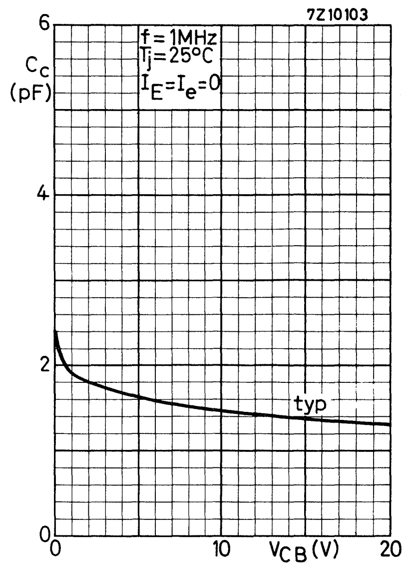

7Z10103
f = 1MHz
T_j=25°C
I_E=I_e=0
C_c (pF)
6
4
2
0
typ
0
10
V_{CB} (V)
20

Photo devices

SILICON PLANAR EPITAXIAL PHOTO-TRANSISTORS

General purpose n-p-n silicon photo-transistors in TO-18.
The window of the BPX25 is a lens, that of the BPX29 is plane.

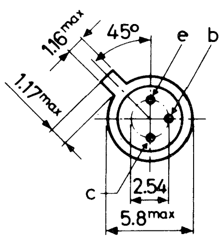
QUICK REFERENCE DATA				
Collector-emitter voltage (open base)	V_{CEO}	max.	32	V
Collector current (peak value)	I_{CM}	max.	50	mA
Junction temperature	T_j	max.	150	^oC
Collector-emitter dark cut-off current $I_B = 0$; $V_{CE} = 24$ V	$I_{CEO(D)}$	<	1.0	μA
Collector-emitter light cut-off current $I_B = 0$; $V_{CE} = 24$ V; at 1000 lux	$I_{CEO(L)}$	typ.	BPX25: 8.0 / BPX29: 0.8	mA
Peak spectral response	λ_m	typ.	0.8	μm

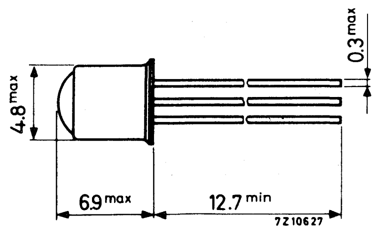
MECHANICAL DATA

Dimensions in mm

BPX25

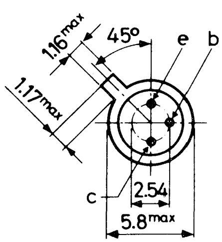
TO-18, except for lens
Collector connected to case

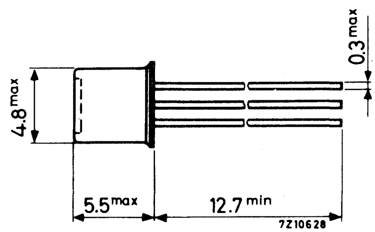




BPX29

TO-18, except for window
Collector connected to case





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

Voltages

Collector-base voltage (open emitter)	V_{CBO}	max.	32	V
Collector-emitter voltage (open base)	V_{CEO}	max.	32	V
Emitter-base voltage (open collector)	V_{EBO}	max.	5	V

Current

Collector current (peak value)	I_{CM}	max.	50	mA

Power dissipation

Total power dissipation up to $T_{amb} = 25^oC$	P_{tot}	max.	300	mW

Temperatures

Storage temperature	T_{stg}	-65 to	+150	^oC
Junction temperature	T_j	max.	150	^oC

THERMAL RESISTANCE

From junction to ambient	$R_{th\ j-a}$	=	0.4	$^oC/mW$
From junction to case	$R_{th\ j-c}$	=	0.15	$^oC/mW$

CHARACTERISTICS $T_{amb} = 25\ ^oC$ unless otherwise specified

Collector-emitter dark cut-off current

$I_B = 0$; $V_{CE} = 24$ V	$I_{CEO(D)}$	typ. <	0.2 1.0	μA μA
$I_B = 0$; $V_{CE} = 24$ V; $T_{amb} = 100\ ^oC$	$I_{CEO(D)}$	typ. <	30 500	μA μA

Collector-emitter light cut-off current

			BPX25	BPX29	
$I_B = 0$; $V_{CE} = 24$ V; illumination: 1000 lux tungsten filament lamp source with colour temperature 2700 ^oK (7.7 mW/cm^2)	$I_{CEO(L)}$	> typ.	2.5 8.0	0.25 0.8	mA mA
GaAs source; 15 mW/cm^2	$I_{CEO(L)}$	typ.	13	1.3	mA

D.C. current gain

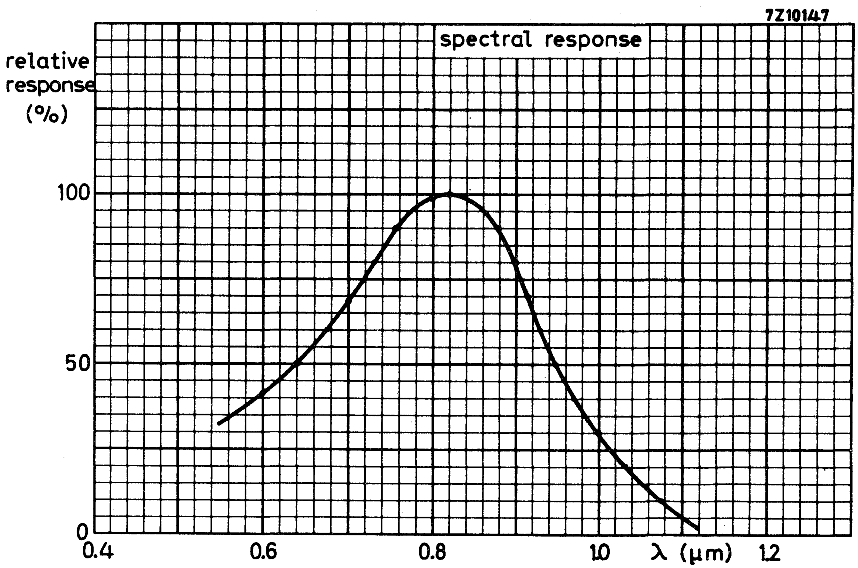
$I_C = 2$ mA; $V_{CE} = 5$ V	h_{FE}	typ.	250	250	

Cut-off frequency

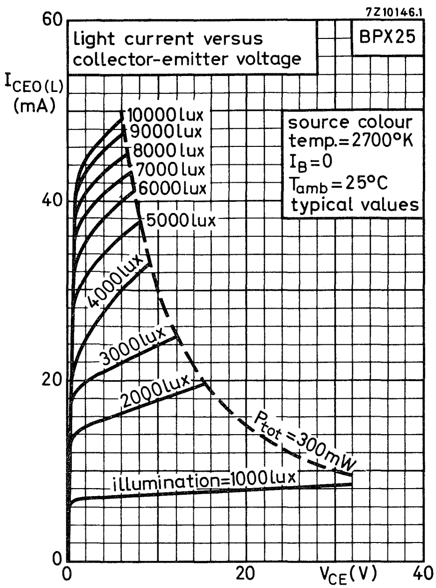
Source: modulated GaAs; 0.4 mW/cm^2 Load : optimum (50 Ω)	f_{co}	typ.	200	150	kHz

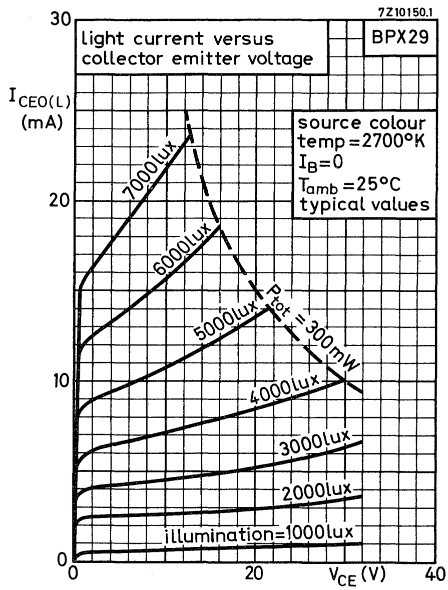
CHARACTERISTICS (continued)

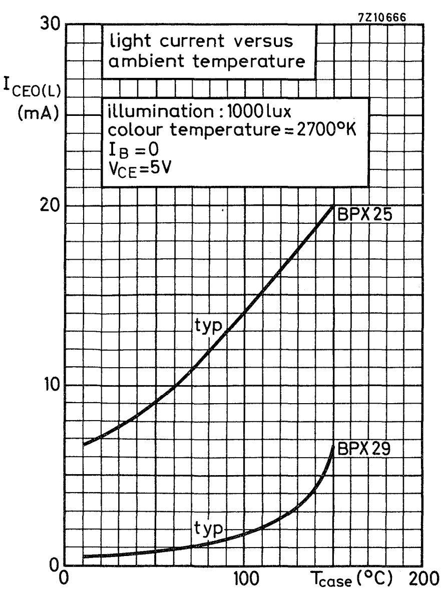
			BPX25	BPX29	
Rise time 1)	t_r	typ.	1.8	2.4	μs
Fall time 1)	t_f	typ.	1.8	2.4	μs
Peak spectral response	λ_m	typ.	0.8	0.8	μm
Equivalent noise illumination at f = 800 Hz 2)					
V_{CE} = 5 V; illumination: 1000 lux		typ.	0.5	1.5	$\frac{\text{mlux}}{\sqrt{\text{Hz}}}$

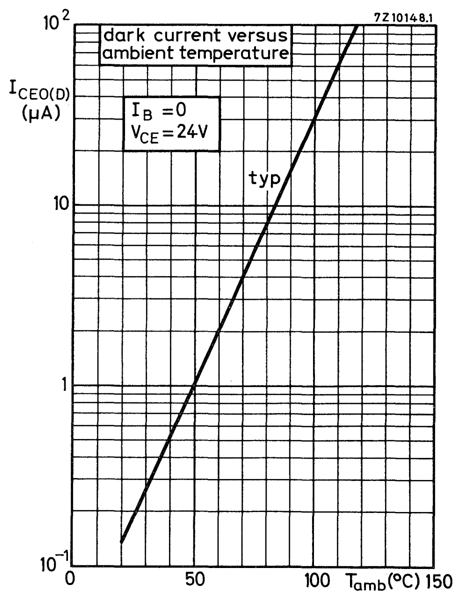


1) Source: modulated GaAs: 0.4 mW/cm^2
Load : optimum (50 Ω)
2) At this and lower frequencies, $\frac{1}{f}$ noise predominates.

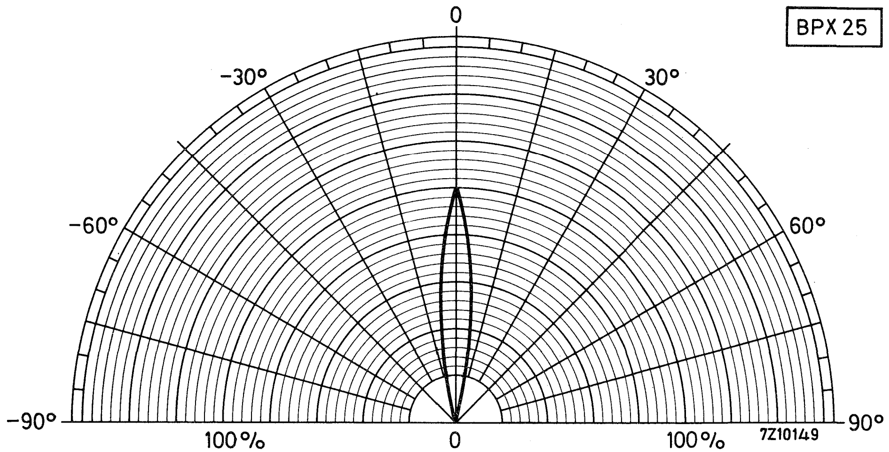

7Z10146.1
light current versus
collector-emitter voltage
BPX25
$I_{CEO(L)}$
(mA)
source colour
temp.=2700°K
I_B=0
T_{amb}=25°C
typical values
10000 lux
9000 lux
8000 lux
7000 lux
6000 lux
5000 lux
4000 lux
3000 lux
2000 lux
illumination=1000 lux
P_{tot}=300mW
V_{CE}(V)


7Z10150.1
light current versus
collector emitter voltage
BPX29
$I_{CEO(L)}$
(mA)
source colour
temp=2700°K
I_B=0
T_{amb}=25°C
typical values
7000 lux
6000 lux
5000 lux
4000 lux
3000 lux
2000 lux
illumination=1000 lux
P_{tot}=300mW
V_{CE}(V)

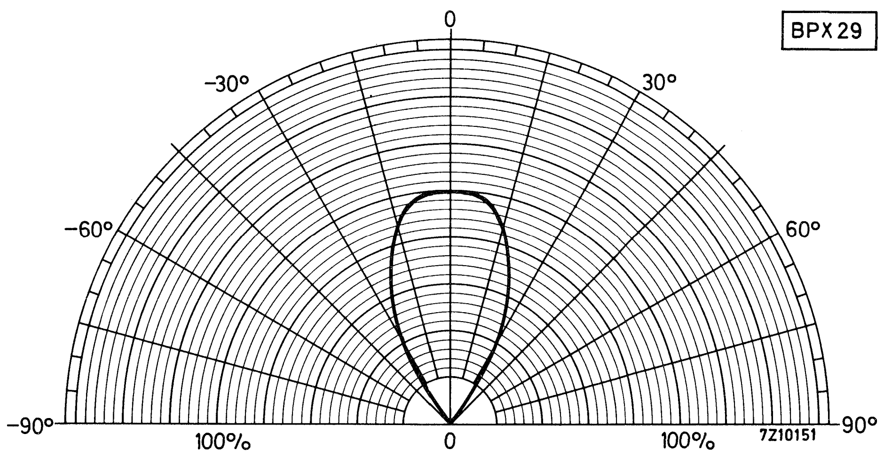

7Z10666
light current versus
ambient temperature
$I_{CEO(L)}$
(mA)
illumination: 1000 lux
colour temperature=2700°K
I_B=0
V_{CE}=5V
BPX25
typ
BPX29
typ
T_{case}(°C)


7Z10148.1
dark current versus
ambient temperature
$I_{CEO(D)}$
(μA)
I_B=0
V_{CE}=24V
typ
T_{amb}(°C)

polar response of relative sensitivity



polar response of relative sensitivity

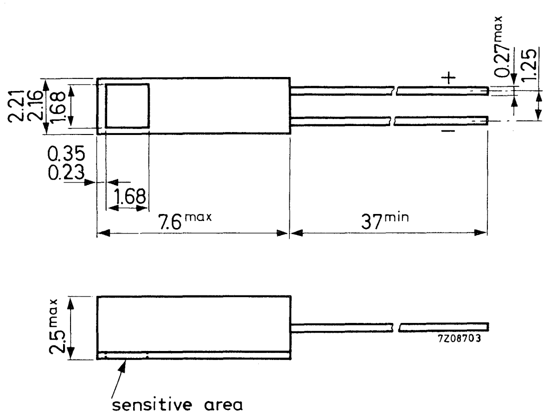


SILICON PHOTOVOLTAIC CELL

Silicon photovoltaic cell for use in tape and card readers.

QUICK REFERENCE DATA				
Sensitive area			2.8	mm^2
Light sensitivity at E = 2000 lux		typ.	32	μA
Ambient temperature	T_{amb}	max.	100	^oC
Peak spectral response	λ_m	typ.	0.8	μm

MECHANICAL DATA Dimensions in mm



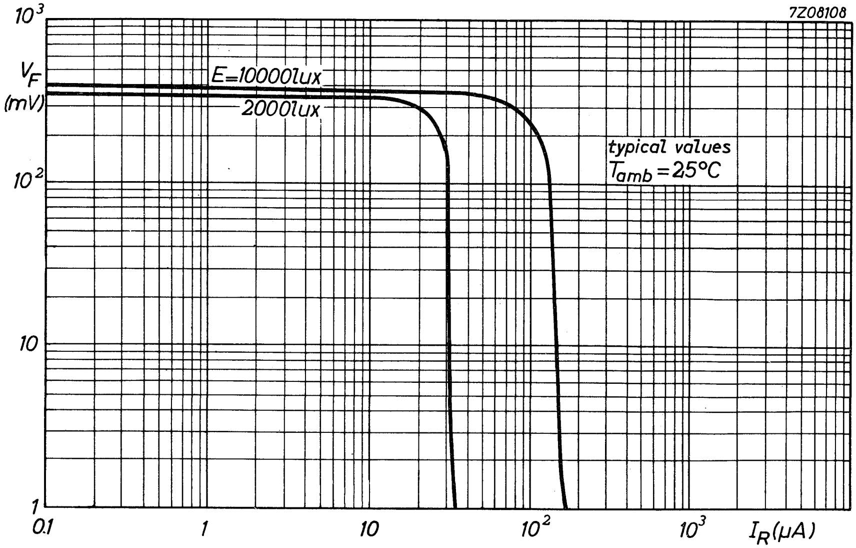
RATINGS (Limiting values) [1]

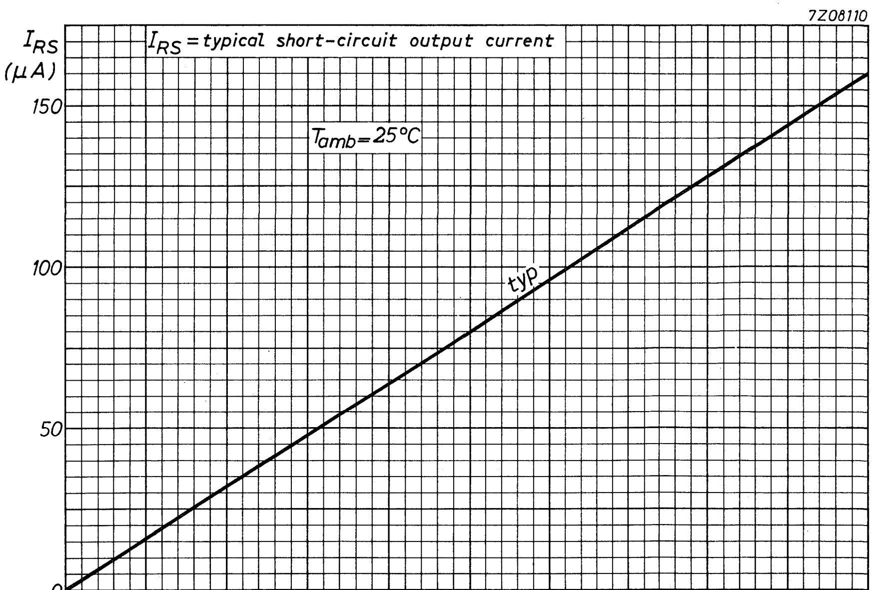
Reverse voltage	V_R	max.	1	V
Forward current	I_F	max.	10	mA
Temperatures				
Storage temperature	T_{stg}	-20 to +100		°C
Junction temperature	T_j	max.	100	°C

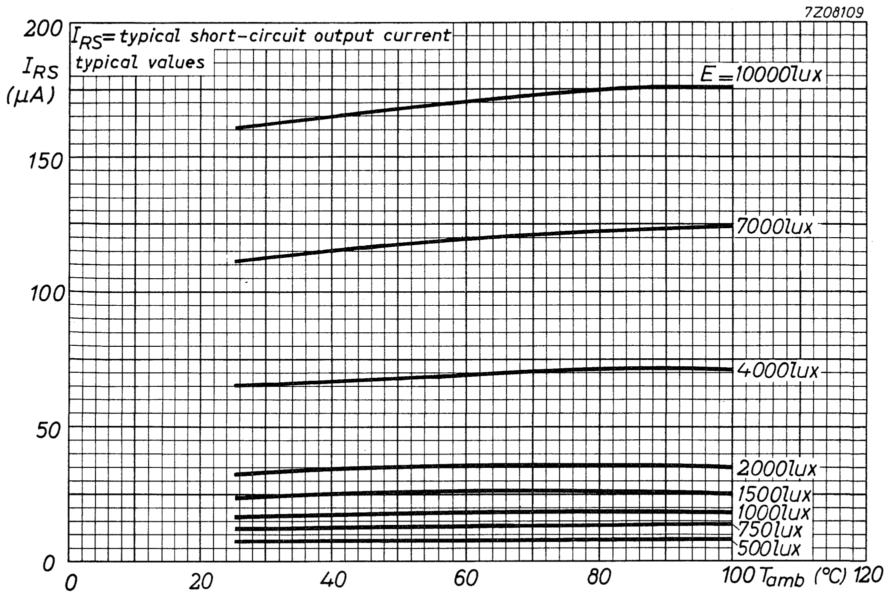
CHARACTERISTICS T_{amb} = 25 °C unless otherwise specified

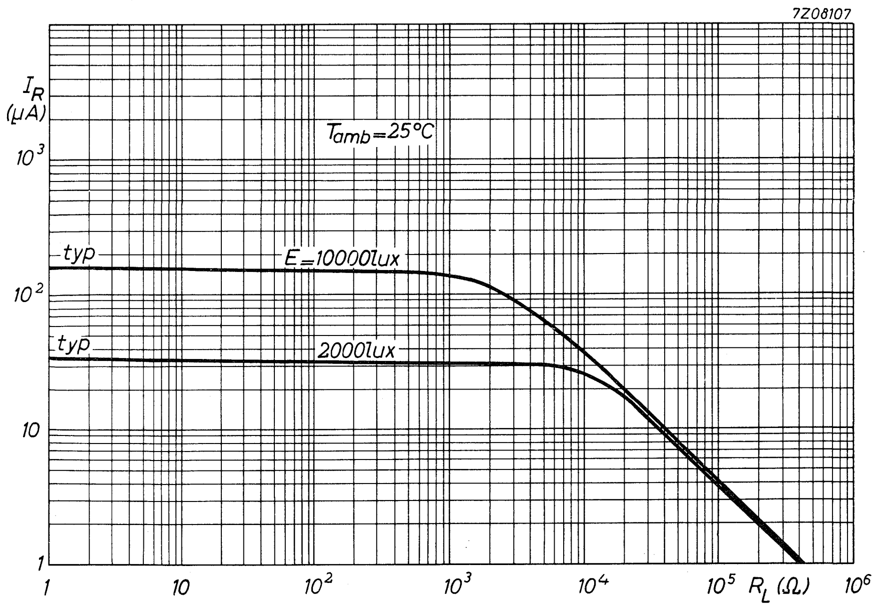
Dark reverse current				
V_R = 1 V	I_R	typ.	0.35	μA
		<	10	μA
V_R = 1 V; T_{amb} = 75 °C	I_R	<	30	μA
Short circuit current				
Colour temperature 2700 °K				
E = 2 000 lux	I_{RS}	typ.	32	μA
		15 to	50	μA
E = 10 000 lux	I_{RS}	typ.	160	μA
Peak spectral response	λ_m	typ.	0.8	μm
Sensitive area		typ.	2.8	mm^2
Diode capacitance at V = 0	C_d	<	1000	pF

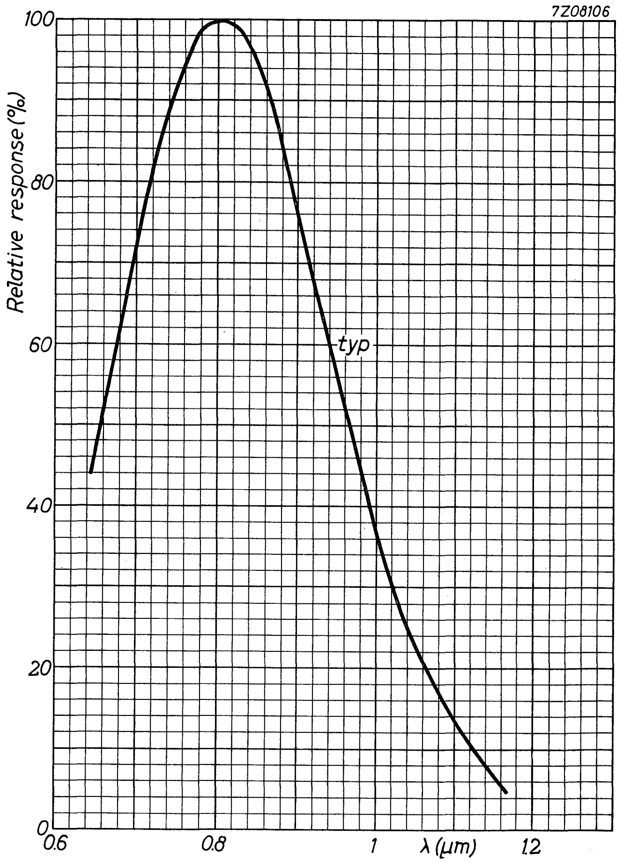
[1] Limiting values according to the Absolute Maximum System as defined in IEC publication 134.

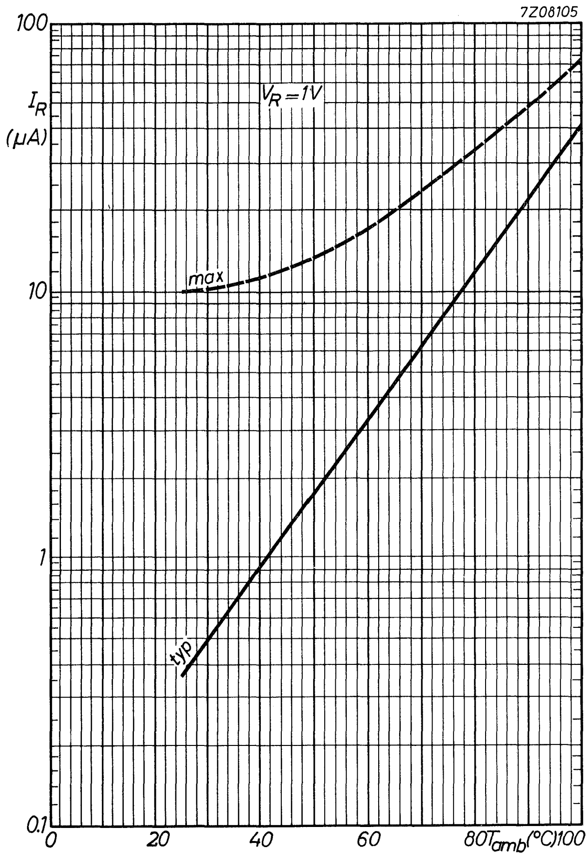

7Z08108
V_F
(mV)
10^3
10^2
10
1
E=10000lux
2000lux
typical values
T_{amb} = 25°C
0.1
1
10
10^2
10^3
I_R(μA)


7Z08110
I_{RS}
(μA)
I_{RS} = typical short-circuit output current
T_{amb}=25°C
typ
150
100
50
0
0
2000
4000
6000
8000
10000
E(lux)


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
typ
E=10000lux
10^2
typ
2000lux
10
1
1
10
10^2
10^3
10^4
10^5
R_L (Ω)
10^6


7Z08106
Relative response (%)
100
80
60
40
20
0
0.6
0.8
1
λ (μm)
1.2
typ

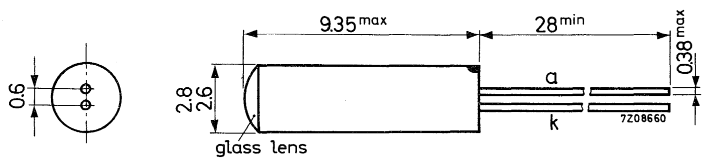

7Z08105
100
10
1
0.1
I_R
(μA)
$V_R = 1V$
max
typ
0
20
40
60
80
100
T_{amb} (°C)

GERMANIUM PHOTO-DIODE

Germanium general purpose photo-diode in a metal envelope.

QUICK REFERENCE DATA				
Sensitive area			1	mm^2
Light sensitivity			0.05	μA/lux
Ambient temperature	T_{amb}	max.	60	^oC
Peak spectral response	λ_m	typ.	1.55	μm

MECHANICAL DATA Dimensions in mm



The coloured dot indicates the anode

RATINGS (Limiting values) [1]

Reverse voltage	V_R	max.	30	V
Reverse current	I_R	max.	3	mA
Total power dissipation	P_{tot}	max.	30	mW

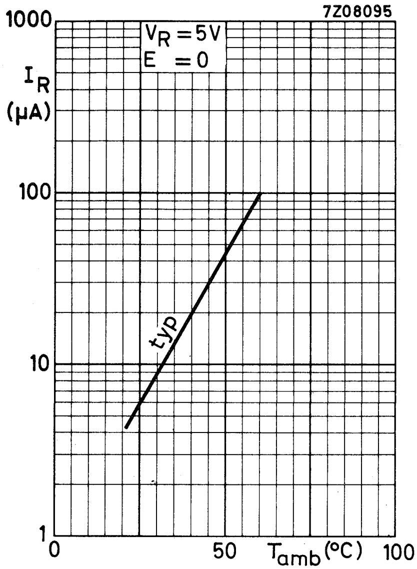
CHARACTERISTICS

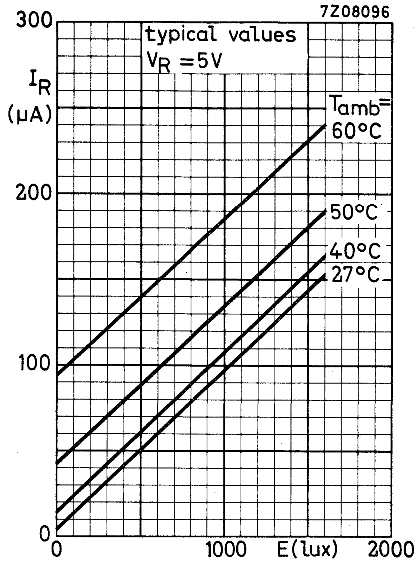
T_{amb} = 25 °C and using a lamp of colour temperature 2500 °K

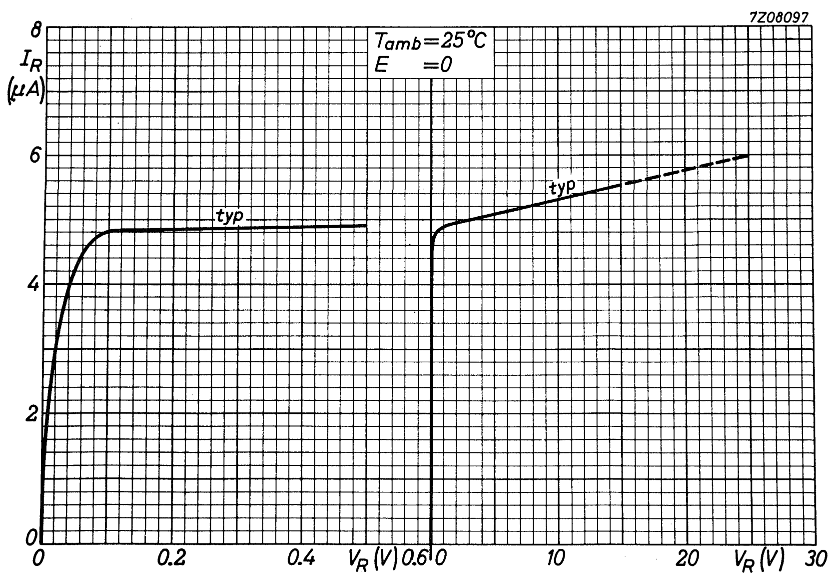
Dark reverse current at V_R = 10 V	I_R	<	15	μA
Noise of the dark current (r.m.s. value) V_R = 10 V; f = 10 kHz; B = 1 Hz		<	3	pA
Diode resistance (V_R = 0.5 to 30 V)	r_D	>	3	MΩ
Cut-off frequency at V_R = 10 V [2]	f_c	typ.	50	kHz
Peak spectral response	λ_m	typ.	1.55	μm
Zero spectral response	λ_0	typ.	2.0	μm
Sensitive area			1	mm^2
Light sensitivity			0.05	μA/lux

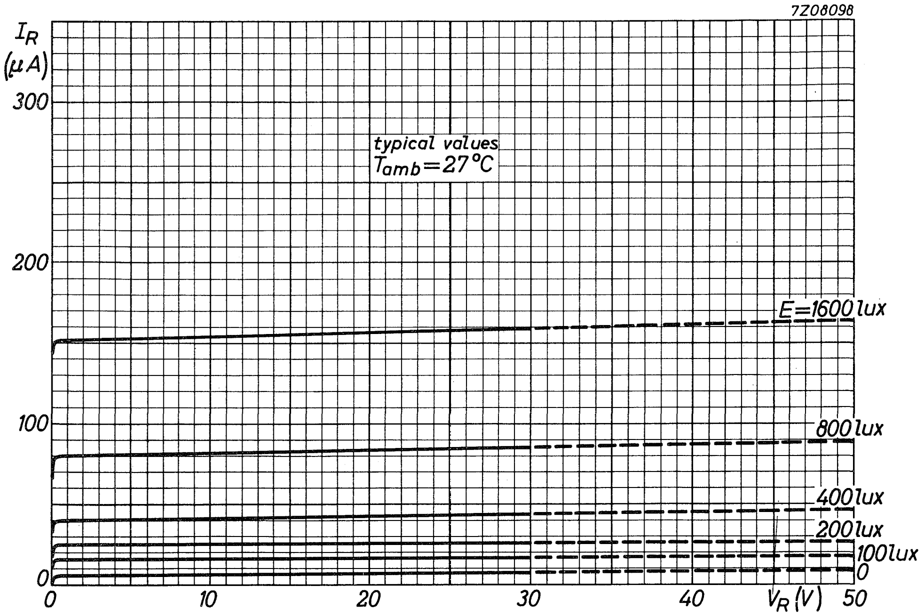
[1] Limiting values according to the Absolute Maximum System as defined in IEC publication 134.

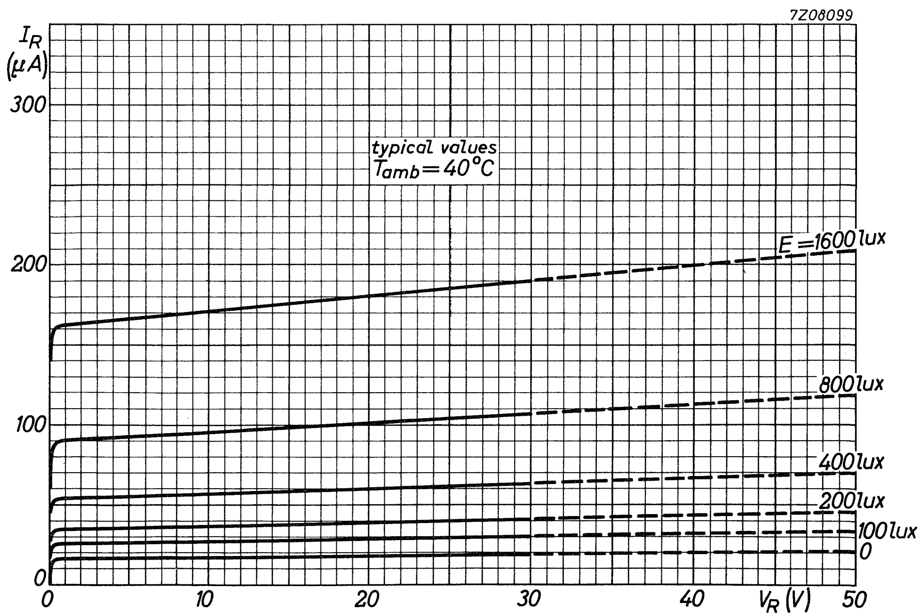
[2] Frequency at which the sensitivity is 3 dB below the reference sensitivity, the latter being measured at V_R = 10 V; f = 1 kHz; T_{amb} = 20 °C.

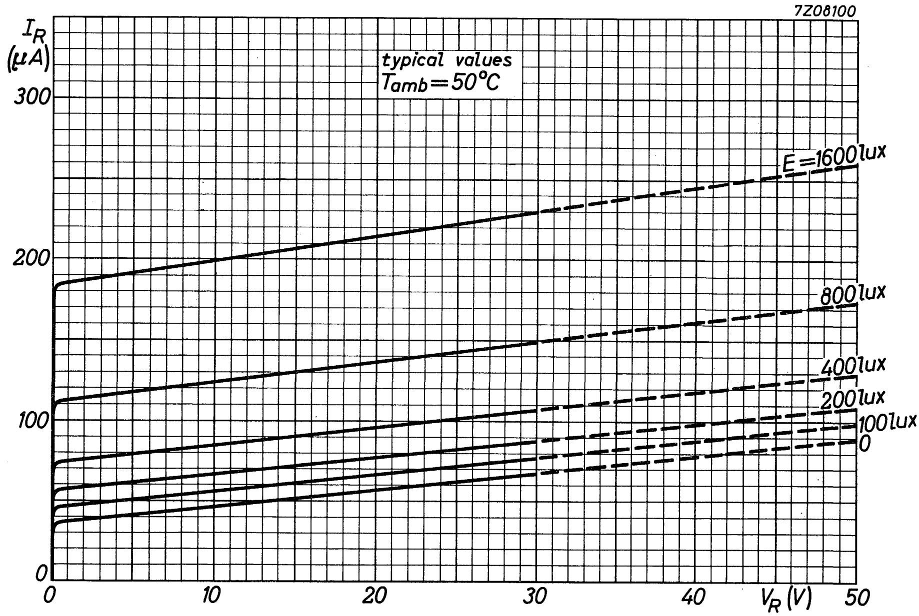

7Z08095
1000
100
10
1
I_R (µA)
V_R = 5V
E = 0
typ
0
50
T_{amb} (°C)
100

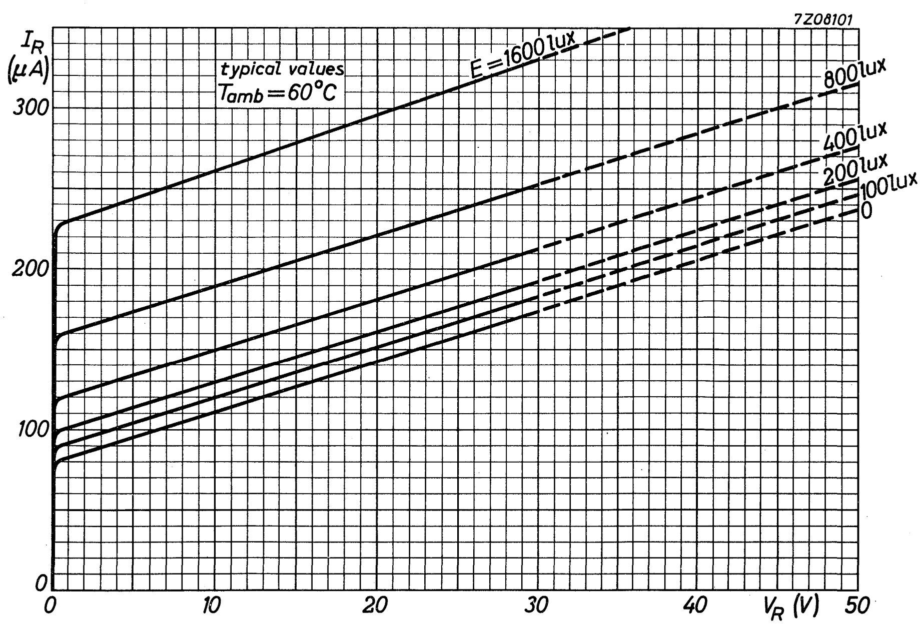

7Z08096
300
200
100
0
I_R (µA)
typical values
V_R = 5V
T_{amb}=
60°C
50°C
40°C
27°C
1000
E(lux)
2000

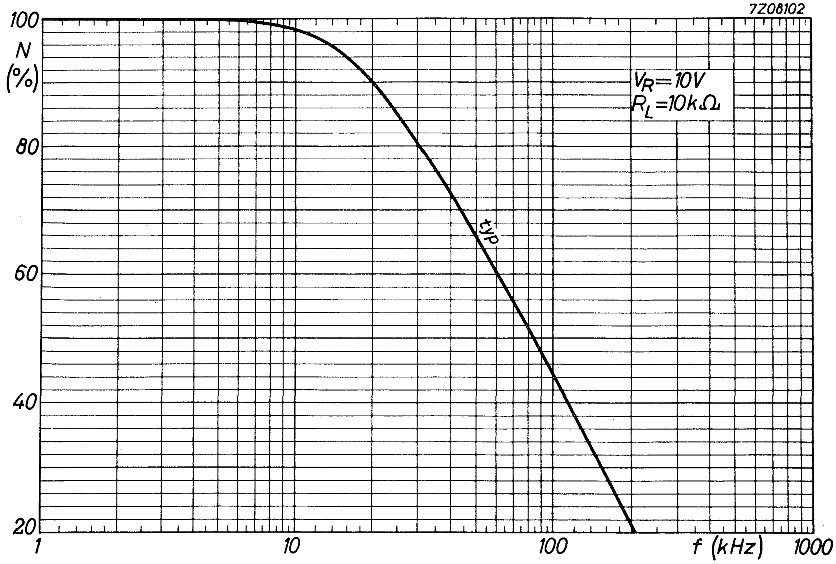

7Z08097
8
6
4
2
0
I_R (µA)
T_{amb} = 25°C
E = 0
typ
typ
0.2
0.4
V_R (V)
0.6
10
20
V_R (V)
30

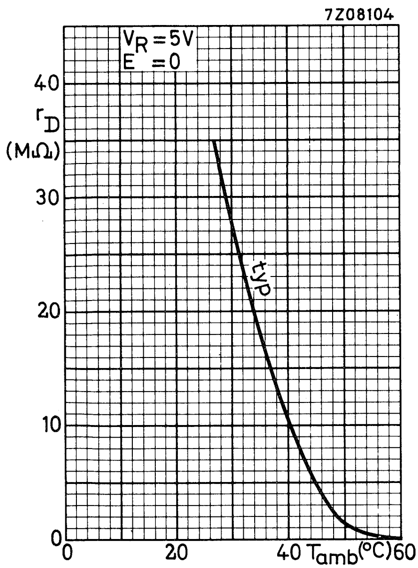

7Z08098
I_R
(μA)
300
200
100
0
typical values
T_{amb} = 27 °C
E = 1600 lux
800 lux
400 lux
200 lux
100 lux
0
0
10
20
30
40
V_R (V)
50

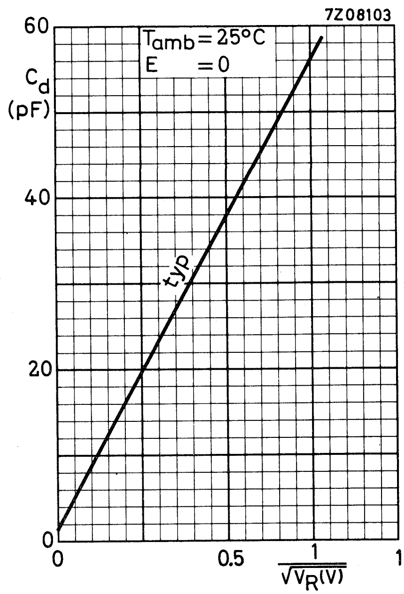

7Z08099
I_R
(μA)
300
200
100
0
typical values
T_{amb} = 40 °C
E = 1600 lux
800 lux
400 lux
200 lux
100 lux
0
0
10
20
30
40
V_R (V)
50


7Z08100
I_R (μA)
300
200
100
0
typical values
T_{amb} = 50°C
E = 1600 lux
800 lux
400 lux
200 lux
100 lux
0
0
10
20
30
40
V_R (V)
50


7Z08101
I_R (μA)
300
200
100
0
typical values
T_{amb} = 60°C
E = 1600 lux
800 lux
400 lux
200 lux
100 lux
0
0
10
20
30
40
V_R (V)
50


7Z08102
100
N
(%)
80
60
40
20
1
10
100
1000
f (kHz)
V_R=10V
R_L=10kΩ
typ


7Z08104
V_R = 5V
E = 0
r_D
(MΩ)
40
30
20
10
0
0
20
40
60
T_{amb}(°C)
typ

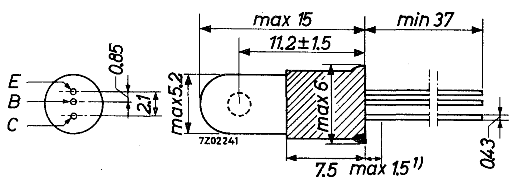

7Z08103
T_{amb} = 25°C
E = 0
C_d
(pF)
60
40
20
0
0
0.5
1
$\frac{1}{\sqrt{V_R(V)}}$
typ

GERMANIUM PHOTO-TRANSISTOR

P-N-P germanium photo-transistor intended for general purposes.

QUICK REFERENCE DATA				
Collector-base voltage (open emitter)	$-V_{CBO}$	max.	15	V
Collector-emitter voltage ($R_{BE} \leq 1$ kΩ)	$-V_{CER}$	max.	15	V
Collector current (d.c. or average)	$-I_C$	max.	20	mA
Total power dissipation up to $T_{amb} = 25$ °C	P_{tot}	max.	100	mW
Junction temperature	T_j	max.	65	°C
Light sensitivity (area 7 mm^2)	N	>	130	mA/lumen
Peak spectral response	λ_m	typ.	1.43	μm

MECHANICAL DATA Dimensions in mm



The coloured dot indicates the collector

The preferred direction of incident light is perpendicular to the plane of the leads, and is on the side of the bulb bearing the type number.

1) Not tinned.

RATINGS (Limiting values) [1])

Voltages

Collector-base voltage (open emitter)	$-V_{CBO}$	max.	15	V
Collector-base voltage (peak value)	$-V_{CBM}$	max.	15	V
Collector-emitter voltage ($R_{BE} \leq 1$ kΩ)	$-V_{CER}$	max.	15	V
Collector-emitter voltage (open base)	$-V_{CEO}$	max.	7.5	V
Collector-emitter voltage (peak value)	$-V_{CEM}$	max.	7.5	V

Currents

Collector current (d.c. or average)	$-I_C$	max.	20	mA
Collector current (peak value)	$-I_{CM}$	max.	20	mA

Power dissipation

Total power dissipation up to T_{amb} = 25 °C	P_{tot}	max.	100	mW

Temperatures

Storage temperature	T_{stg}	max.	65	°C
Junction temperature	T_j	max.	65	°C

THERMAL RESISTANCE

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

CHARACTERISTICS

Collector-emitter dark cut-off current				
$I_B = 0$; $-V_{CE} = 4.5$ V	$-I_{CEO}$	<	325	μA
Cut-off frequency for modulated light	f_c	>	3	kHz
Collector current				
$-V_{CE} = 2$ V with uniform illumination of 75 ft. candle (807 lux) with preferred direction of incident light, colour temperature of the light source 2700 °K	$-I_C$	>	750	μA
Light sensitivity (area 7 mm²)	N	>	130	mA/lumen
Peak spectral response	λ_m	typ.	1.43	μm
Zero spectral response	λ_0	typ.	1.9	μm

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

CHARACTERISTICS (continued)

Circuit diagram

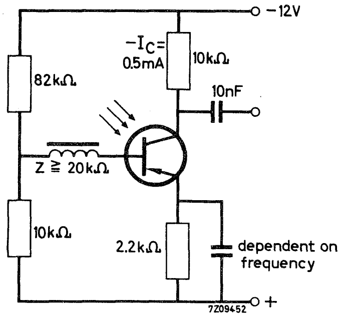
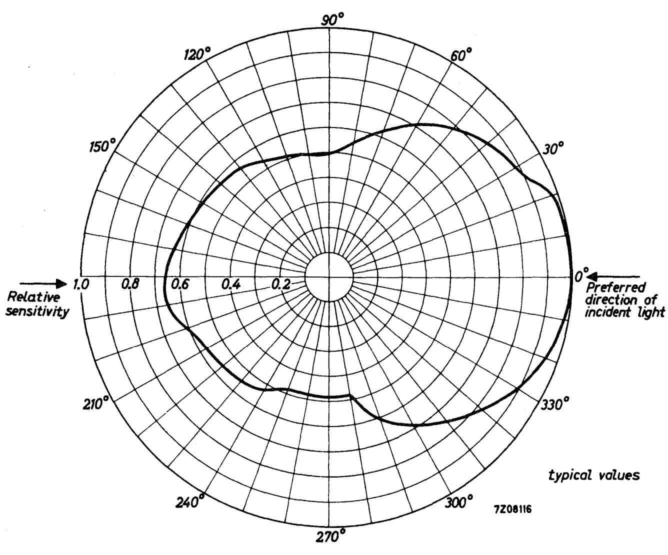
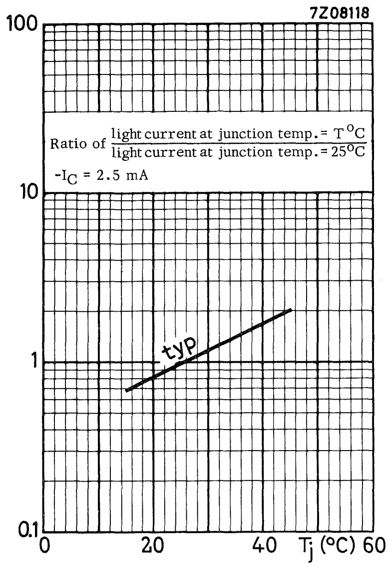
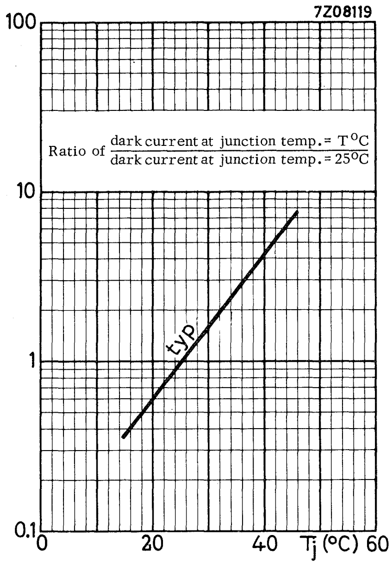
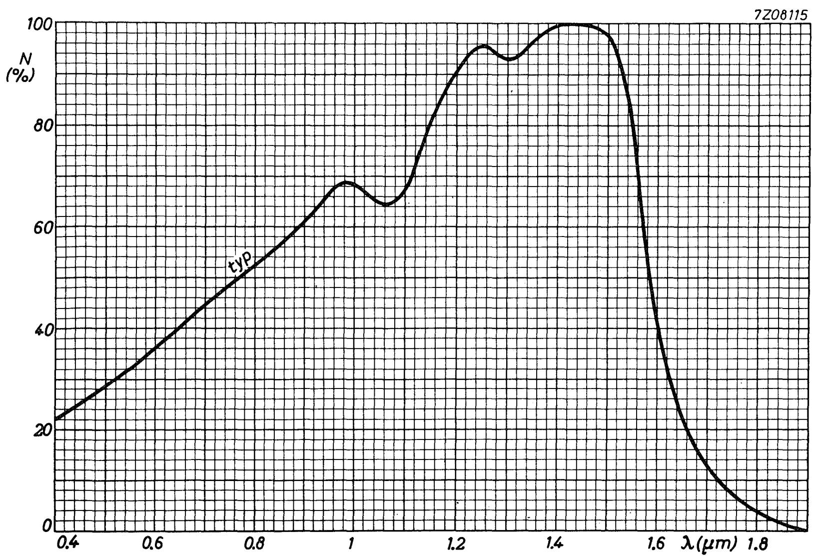


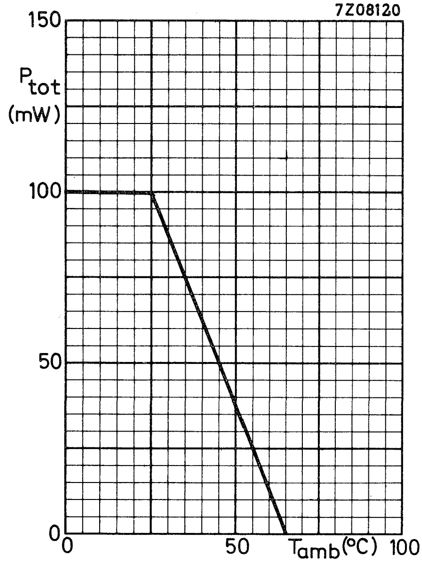
Photo-transistors are inherently sensitive to temperature variations, which result in variations of the output current which cannot be distinguished from the light signal. This is particularly so with an open circuit base connection, when thermal runaway is most likely to occur; for operation at elevated voltage and temperature the use of an external base emitter resistance is essential.
The function of this is to improve the light to dark current ratio by causing a much greater proportional decrease in dark current. It is recommended that for this purpose an NTC type resistor is used, the value required depending on the maximum ambient temperature and light level.

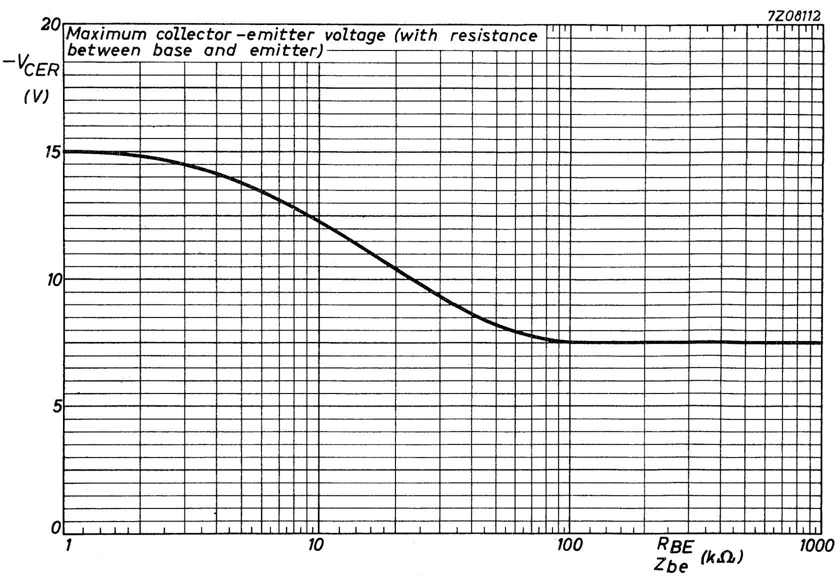


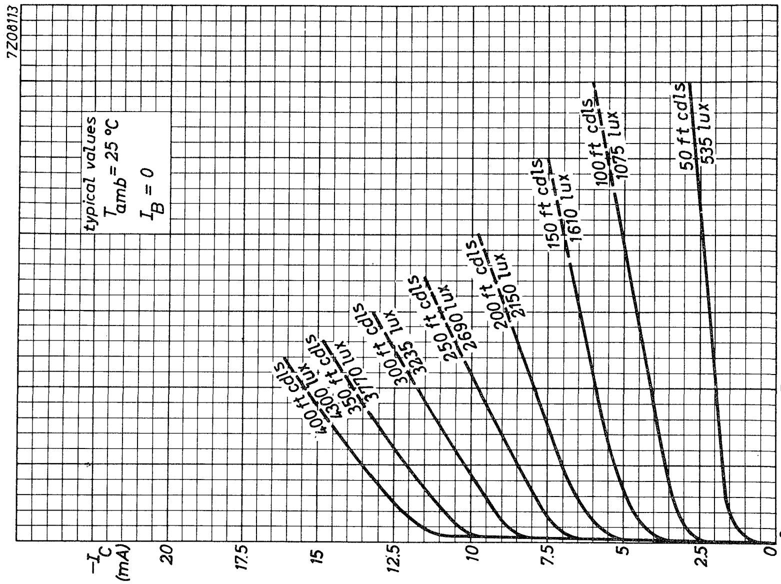

7Z08118
Ratio of $\frac{\text{light current at junction temp.} = T\ ^{o}C}{\text{light current at junction temp.} = 25^{o}C}$
$-I_C$ = 2.5 mA
typ
100
10
1
0.1
0
20
40
T_j (°C) 60

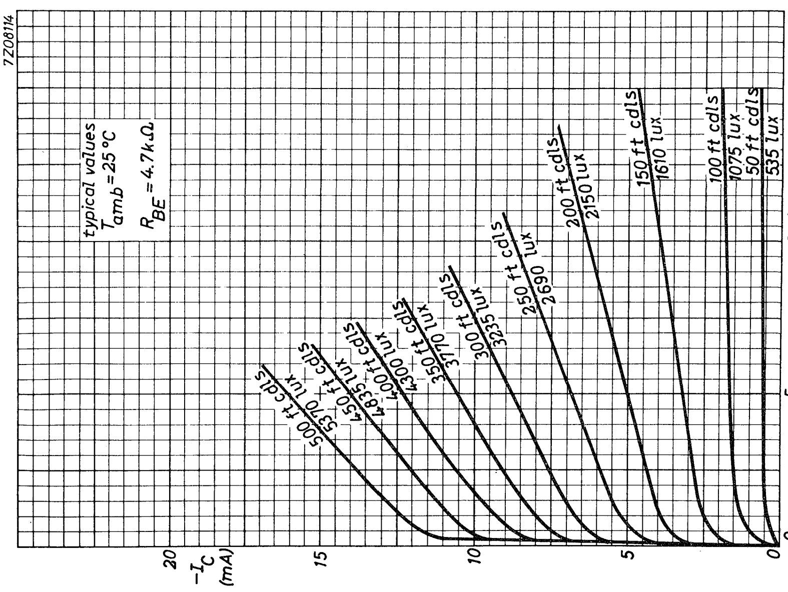

7Z08119
Ratio of $\frac{\text{dark current at junction temp.} = T\ ^{o}C}{\text{dark current at junction temp.} = 25^{o}C}$
typ
100
10
1
0.1
0
20
40
T_j (°C) 60


7Z08115
N (%)
100
80
60
40
20
0
typ
0.4
0.6
0.8
1
1.2
1.4
1.6
λ(μm)
1.8


7Z08120
150
P_{tot}
(mW)
100
50
0
0
50
T_{amb} (°C)
100


7Z08112
Maximum collector-emitter voltage (with resistance between base and emitter)
20
$-V_{CER}$
(V)
15
10
5
0
1
10
100
1000
R_{BE}
Z_{be} (kΩ)


7Z08113
typical values
T_{amb} = 25 °C
I_B = 0
50 ft cdls
535 lux
100 ft cdls
1075 lux
150 ft cdls
1610 lux
200 ft cdls
2150 lux
250 ft cdls
2690 lux
300 ft cdls
3235 lux
350 ft cdls
3770 lux
400 ft cdls
4300 lux
$-I_C$ (mA)
$-V_{CE}$ (V)
0
2.5
5
7.5
10
12.5
15
17.5
20
0
5
10
15


7Z08114
typical values
T_{amb} = 25 °C
R_{BE} = 4.7 kΩ
50 ft cdls
535 lux
100 ft cdls
1075 lux
150 ft cdls
1610 lux
200 ft cdls
2150 lux
250 ft cdls
2690
300 ft cdls
3235
350 ft cdls
3770 lux
400 ft cdls
4300 lux
450 ft cdls
4835
500 ft cdls
5370 lux
$-I_C$ (mA)
$-V_{CE}$ (V)
0
5
10
15
20
0
5
10
15

PHOTOCONDUCTIVE CELL

Indium antimonide photoconductive element mounted on a copper heatsink, recommended for operation at a temperature of 20 °C.
Sensitive to infra-red radiation extending to 7.5 μm and intended for use with modmodulated or pulsed radiation.

RATINGS (Limiting values) [1])

Bias current at T_{amb} = 20 °C	I	max.	100	mA
Temperatures				
Operating ambient temperature	T_{amb}	max.	70	°C
Storage temperature	T_{stg}		- 50 to + 70	°C

CHARACTERISTICS T_{amb} = 20 °C unless otherwise specified

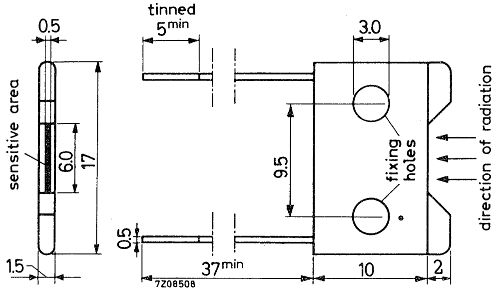
Peak spectral response	λ		6.0 to 6.3	μm
Spectral response range	from visible to		7.5	μm
Cell resistance	r_1		30 to 120	Ω
Time constant			0.1	μs
Sensitive area			6.0 x 0.5	mm^2
Sensitivity (6.0 μm radiation)		>	0.4	μV/μW
		typ.	1.0	μV/μW
(500 °K radiation)		typ.	0.3	μV/μW
D* (6.0 μm, 800 Hz, 1 Hz)	see notes 1 and 2	>	8.5×10^7	$cm\sqrt{Hz}/W$
		typ.	2.0×10^8	$cm\sqrt{Hz}/W$
(500 °K, 800 Hz, 1 Hz)	see notes 1 and 2	typ.	6.0×10^7	$cm\sqrt{Hz}/W$
Noise equivalent power (N.E.P.)				
(6.0 μm, 800 Hz, 1 Hz)	see notes 1 and 2	typ.	8.6×10^{-10}	W
		<	2.0×10^{-9}	W
(500 °K, 800 Hz, 1 Hz)	see notes 1 and 2	typ.	2.5×10^{-9}	W

MECHANICAL DATA (see page 2)

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

MECHANICAL DATA

Dimensions in mm



NOTES

1. Measuring conditions.

The detector is attached to a heatsink which is maintained at a temperature of 20 °C and a bias current of 50 mA is applied. A parallel beam of monochromatic radiation of wavelength 4.4 μm, which would produce a steady irradiance of 68 $\mu W/cm^2$ at the sensitive element, is chopped at 800 Hz, giving an actual r.m.s. power at the element which amounts to

$$\frac{68}{2.2} = 31\ \mu W/cm^2$$

Measurements of the detector output are made with an amplifier tuned to 800 Hz and with a bandwidth of 50 Hz, and are referred to open circuit conditions i.e. correction is made for the shunting effects of the bias supply impedance and the amplifier input impedance. Under these test conditions, the ORP10 will exhibit a minimum signal-to-noise ratio of 45 and typical of 105. The sensitivities quoted at the wavelength of peak response and under black body conditions are calculated from these measurements, assuming the detector to have a typical response curve.

2. D* and N.E.P.

These are figures of merit for the materials of detectors.
D* is defined in the expression:

$$D^* = \frac{\frac{V_s}{V_n} \times \sqrt{A(\Delta f)}}{W}$$

where: V_s = signal voltage across detector terminals
V_n = noise voltage across detector terminals
A = detector area
(Δf) = bandwidth of measuring amplifier
W = radiation power incident on detector sensitive element in watts.

NOTES (continued)

The figures in brackets which follow D* refer to the measuring conditions e.g. D* (5.3 μm, 800 Hz, 1 Hz) denotes monochromatic radiation incident on the detector of wavelength 5.3 μm, chopping frequency 800 Hz, bandwidth 1 Hz.

The Noise Equivalent Power (N.E.P.) is related to D* by the expression:

$$N.E.P. = \frac{\sqrt{A}}{D^*}.$$

3. Variation of performance with bias current.

Both signal and noise vary with bias current. Typical curves are shown on page 5. At high currents the noise increases more rapidly than the signal, and therefore the signal-to-noise ratio has a peak value at some optimum current, which will vary slightly from cell to cell. A typical value is 50 mA. In addition the ohmic heating caused by bias currents above 60 mA causes the temperature of the element to become significantly greater than the substrate so that the signal decreases as described in note 4.

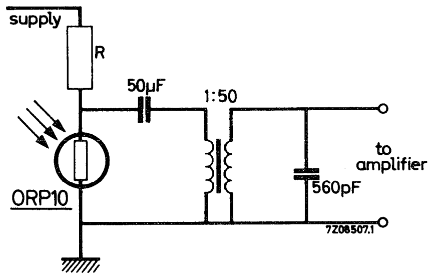
4. Variation of performance with element temperature.

As with all semiconductor photocells, the performance depends on the temperature of the sensitive element. In the case of the ORP10 this is influenced by the ambient temperature and ohmic heating caused by the d.c. bias current. To minimise fluctuations, the element is mounted on a copper base from which it is insulated by a layer of aluminium oxide, and can readily be attached to a large heatsink.
A typical variation of performance with temperature is given on page 5. The curve on page 5 shows the decrease in signal caused by the high current raising the temperature of the element.
On cooling, indium antimonide exhibits improved sensitivity and increased resistance. Below 15 ^{o}C this is impractical with the ORP10 unless special precautions are taken to prevent condensation and icing on the exposed element.

5. Warning.

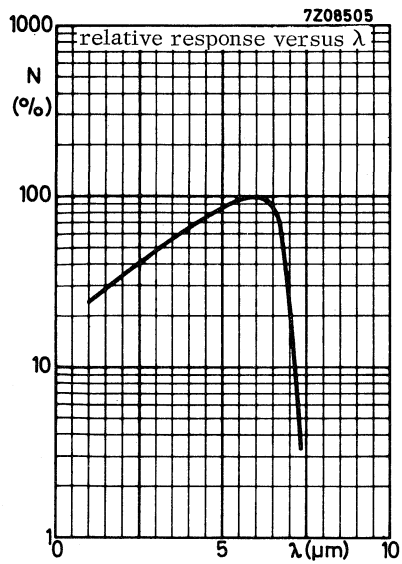
The sensitive surface is unprotected and should not be touched. It is stable in normal atmospheres but should not be exposed to high concentrations of the vapours of organic solvents. Care should be taken to avoid strain when attaching cells to heatsinks.

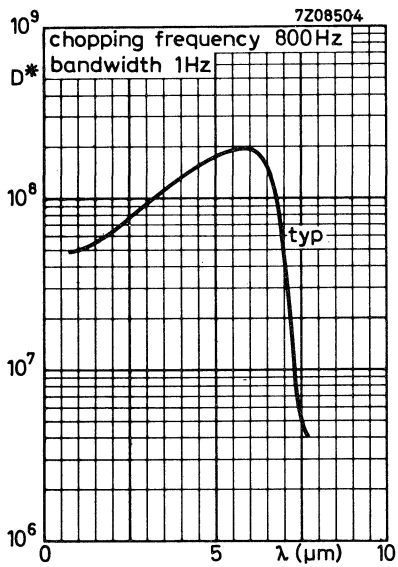
Recommended circuit for use with radiation chopped at 800 Hz.

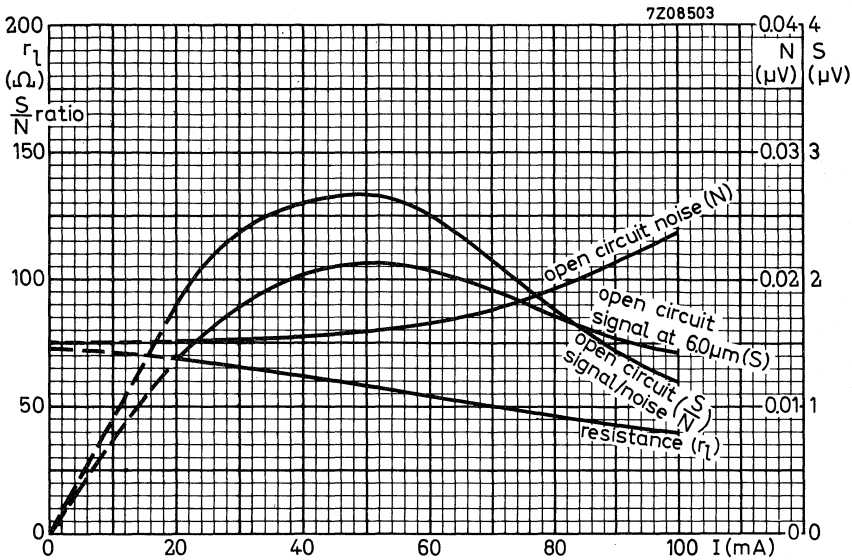


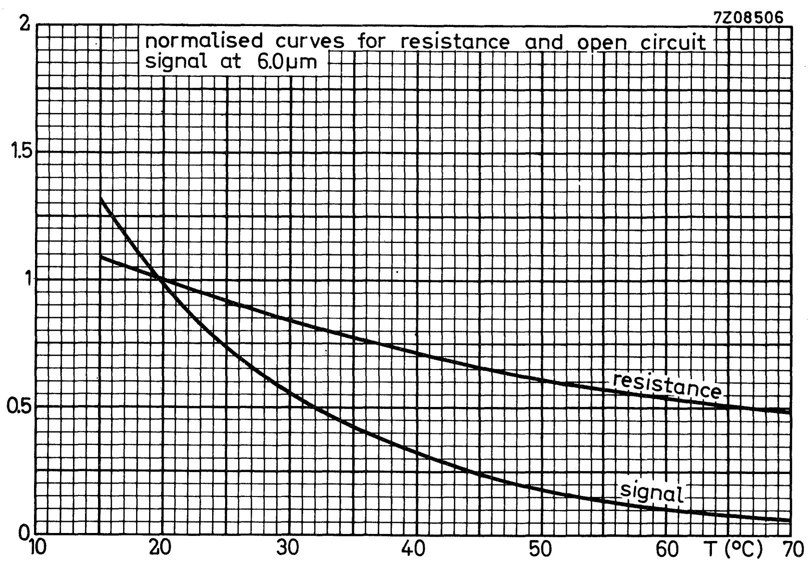
CIRCUIT NOTES

The transformer should be adequately screened to prevent stray pick-up.
The resistor R should be wire wound to minimise noise. It must be substantially larger than the cell resistance and its actual value will depend upon the supply voltage and the cell currents required. The 560 pF capacitor tunes the secondary to 800 Hz.






7Z08503
200
r_l
(Ω)
$\frac{S}{N}$ ratio
150
100
50
0
0
20
40
60
80
100
I (mA)
0.04
N
(µV)
0.03
0.02
0.01
0
4
S
(µV)
3
2
1
0
open circuit noise (N)
open circuit signal at 6.0µm (S)
open circuit signal/noise ($\frac{S}{N}$)
resistance (r_l)


7Z08506
normalised curves for resistance and open circuit signal at 6.0µm
2
1.5
1
0.5
0
10
20
30
40
50
60
T (°C)
70
resistance
signal

PHOTOCONDUCTIVE CELL

Indium antimonide photoconductive element mounted in a glass dewar vessel and cooled by liquid nitrogen. Sensitive to infra-red radiation extending to 5.6 μm and intended for use with modulated or pulsed radiation.

RATINGS (Limiting values) [1)]

Bias current at T_{amb} = 77 °K		5.0	mA
Temperatures			
Operating temperature	T	77	°K
Storage temperature	T_{stg}	- 55 to + 55	°C

CHARACTERISTICS T = 77 °K

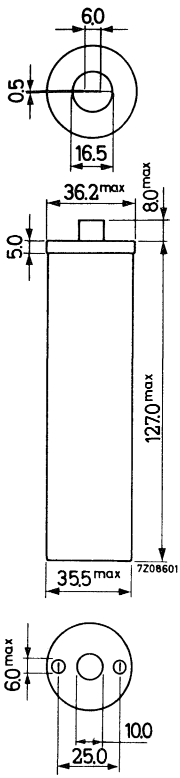
Peak spectral response	λ	5.3	μm
Spectral response range	from visible to	5.6	μm
Cell resistance	r_1	20 to 60	kΩ
Time constant		5	μs
Sensitive area		6.0 x 0.5	mm^2
Dwell time of liquid nitrogen	>	40	min.
Sensitivity (5.3 μm radiation)	>	12	mV/μW
	typ.	24	mV/μW
(500 °K radiation)	typ.	4.5	mV/μW
D* (5.3 μm, 800 Hz, 1 Hz) see notes 1 and 2	>	2.6×10^{10}	$cm\sqrt{Hz}/W$
	typ.	4.5×10^{10}	$cm\sqrt{Hz}/W$
(500 °K, 800 Hz, 1 Hz) see notes 1 and 2	typ.	8.0×10^{9}	$cm\sqrt{Hz}/W$
Noise equivalent power (N.E.P.)			
(5.3 μm, 800 Hz, 1 Hz) see notes 1 and 2	typ.	3.8×10^{-12}	W
	<	6.6×10^{-12}	W
(500 °K, 800 Hz, 1 Hz) see notes 1 and 2	typ.	2.2×10^{-11}	W

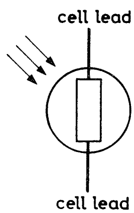
MECHANICAL DATA (see page 2)

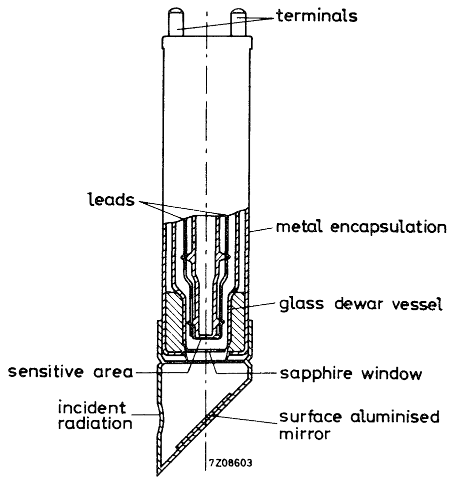
1) Limiting values according to the Absolute Maximum System as defined in IEC publication 134.

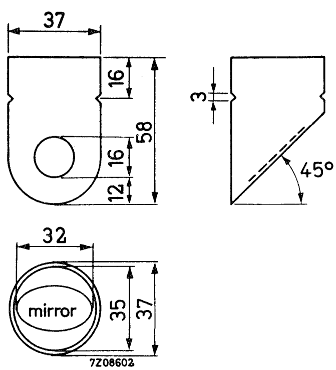
MECHANICAL DATA

Dimensions in mm









NOTES

1. Measuring conditions.

The detector is cooled to 77 ^{o}K by filling the dewar with liquid nitrogen and a bias current of 250 μA is applied. A parallel beam of monochromatic radiation of wavelength 4.4 μm, which would produce a steady irradiance of 7.6 $\mu W/cm^2$ at the sensitive element, is chopped at 800 Hz, giving an actual r.m.s. power at the element which amounts to

$$\frac{7.6}{2.2} = 3.45\ \mu W/cm^2$$

Measurements of the detector output are made with an amplifier tuned to 800 Hz and with a bandwidth of 50 Hz, and are referred to open circuit conditions i.e. correction is made for the shunting effects of the bias supply impedance and the amplifier input impedance. Under these test conditions, the ORP13 will exhibit a minimum signal-to-noise ratio of 1650 and typical of 3270. The sensitivities quoted at the wavelength of peak response and under black body conditions are calculated from these measurements, assuming the detector to have a typical response curve.

2. D* and N.E.P.

These are figures of merit for the materials of detectors.
D* is defined in the expression:

$$D^* = \frac{\frac{V_S}{V_n}\sqrt{A\,(\Delta f)}}{W}$$

where: V_S = signal voltage across detector terminals
V_n = noise voltage across detector terminals
A = detector area
(Δf) = bandwidth of measuring amplifier
W = radiation power incident on detector sensitive element in r.m.s. watts.

The figures in brackets which follow D* refer to the measuring conditions e.g. D* (5.3 μm, 800 Hz, 1 Hz) denotes monochromatic radiation incident on the detector of wavelength 5.3 μm, chopping frequency 800 Hz, bandwidth 1 Hz.

The Noise Equivalent Power (N.E.P.) is related to D* by the expression:

$$N.E.P. = \frac{\sqrt{A}}{D^*}$$

3. Variation of performance with bias current.

Both signal and noise vary with current in this type of cell. Typical curves are shown on page 5. At high currents the noise increases more rapidly than the signal, and therefore the signal-to-noise ratio has a peak value at some optimum current, which will vary slightly from cell to cell. A typical value is 250 μA.

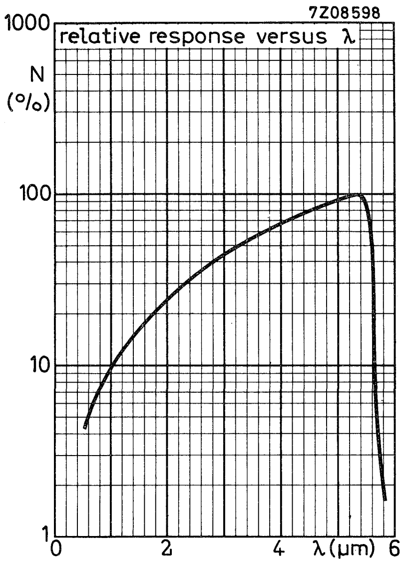
NOTES (continued)

4. Effect of ambient radiation.

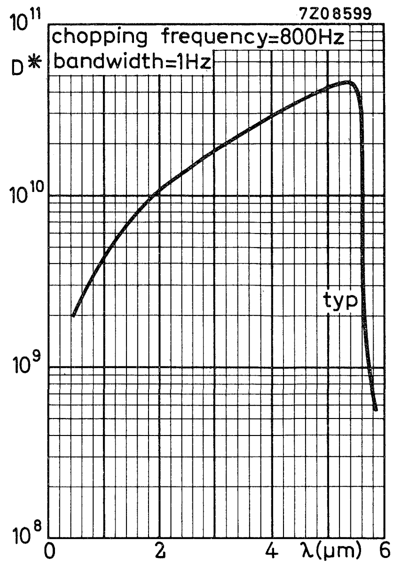
Care should be taken to avoid the incidence on the cell of appreciable radiation in the visible range. Such radiation will cause a decrease in the cell resistance and signal as long as the cell is kept cool. Normal daylight can cause this effect if seen for more than a few minutes. Precautions should be taken to prevent visible light reaching the sensitive element via the liquid nitrogen compartment.

5. Warning.

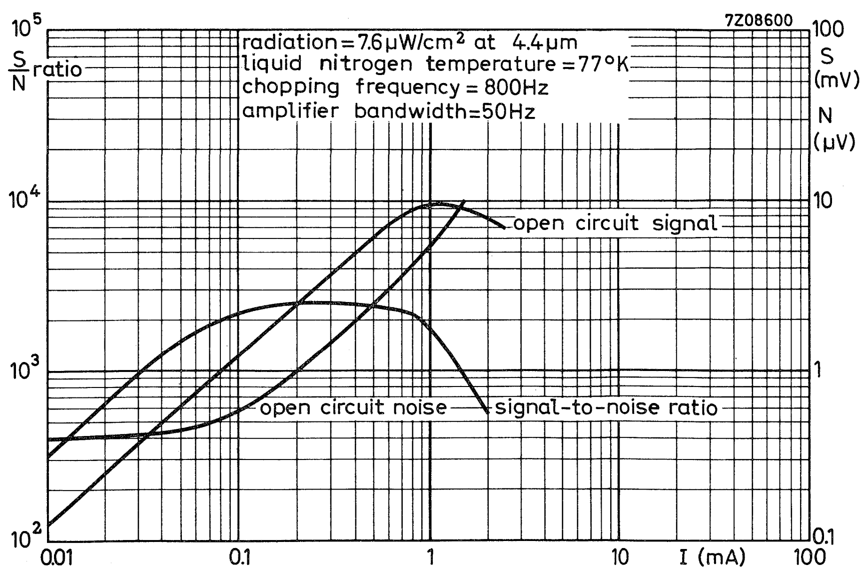
Care should be taken to ensure that the device is not allowed to reach room temperature while still biased.
The dewar vessel must always be completely dry before being refilled with liquid nitrogen. In very humid conditions, water vapour may condense at the top of the dewar vessel. Should this occur, the remaining liquid nitrogen should be allowed to boil off, the ice should be removed and precautions taken to avoid a recurrence.



7Z08598
relative response versus λ
N (%)
1000
100
10
1
0
2
4
λ(μm)
6



7Z08599
chopping frequency=800Hz
bandwidth=1Hz
D*
10^11
10^10
10^9
10^8
typ
0
2
4
λ(μm)
6



7Z08600
radiation=7.6μW/cm² at 4.4μm
liquid nitrogen temperature=77°K
chopping frequency=800Hz
amplifier bandwidth=50Hz
S/N ratio
10^5
10^4
10^3
10^2
S (mV)
N (μV)
100
10
1
0.1
open circuit signal
open circuit noise
signal-to-noise ratio
0.01
0.1
1
10
I (mA)
100

PHOTOCONDUCTIVE CELL

Uncooled lead sulphide photoconductive cell intended for use with chopped or pulsating radiation, having a high infra-red sensitivity at normal room temperatures.

RATINGS (Limiting values) [1])

Applied voltage	V	max.	250	V
Bias current	I	max.	0.5	mA
Temperatures				
Ambient temperature (see note 3 at page 3)	T_{amb}	max.	60	°C
Storage temperature	T_{stg}	max.	60	°C

CHARACTERISTICS

Peak spectral response	λ	2.5	μm
Spectral response range	$\Delta\lambda$	0.3 to 3.5	μm
Sensitivity (See note 1 at page 2)			
Sources: black body at 200 °C (r.m.s. voltage over peak power)		180	μV/μW
tungsten lamp [2]) (peak current per lumen)		3	mA/lumen
Signal-to-noise ratio with black body at 200 °C	$\frac{S}{N}$	150	
Noise equivalent power (N.E.P.)			
Sources: black body at 200 °C (bandwidth 1 Hz)[3])		5.0×10^{-9}	W
tungsten lamp (2 ± 0.05 μm)		5.5×10^{-11}	W
Cell resistance (typical production spread) (See note 3 at page 3)		1 to 4	MΩ

---

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

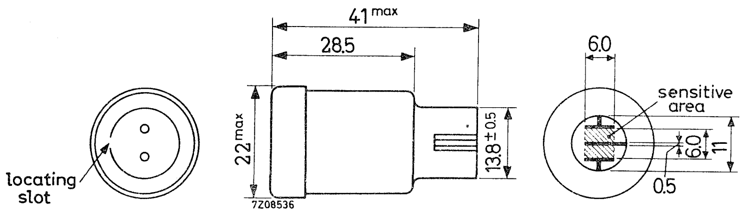
[2]) Chopped light, 0.05 lumen from a lamp at colour temperature 2700 °K falling on the cell area and with 200 V applied to the cell.

[3]) 4.9 μW of radiation falling on the cell area with 200 V applied to the cell and with a 1.0 MΩ load resistor. The chopping frequency of the radiation is 800 Hz and the measuring amplifier has a bandwidth of 50 Hz.

CHARACTERISTICS (continued)

Time constant (see note 2 at page 3)	75	μs
Variation of dark current with ambient temperature	−2	%/°C
Sensitive area (outer electrodes being 6.0 mm long and 6.0 mm apart)	36	mm^2

MECHANICAL DATA Dimensions in mm



NOTES

1. Sensitivity

The 61SV differs from vacuum photoemissive cells in that the signal for a given irradiation energy is linearly proportional to the applied voltage.
At low or normal radiation levels the cell current changes linearly with illumination. At very high levels of illumination the current varies as the square root of the illumination.
The sensitivity of photoemissive cells is normally defined in units of μA/lumen, the energising light source being a tungsten lamp operated at 2700 °K. The 61SV has a high infra-red sensitivity, and its performance is usually defined in terms of volts across the cell load divided by radiation source in watts, when subjected to chopped radiation from a black body at some specified temperature.
As a limiting measure of cell sensitivity the signal-to-noise ratio for a given amount of chopped radiation from a black body is usually given, or what is the same thing, the noise equivalent power, i.e., the radiation falling on the cell which will produce a signal equal to the cell noise with a test amplifier bandwidth of 1 Hz.
For any applied cell voltage there is a definite noise output, and the radiation source energy required to produce a signal output just equal to this noise output is referred to as the noise equivalent power.
The sensitivity increases rapidly with the radiation source temperature. This is illustrated by the fact that if the source temperature changes from 200 to 500 °C the sensitivity increases by over 100 times.

NOTES (continued)

2. Frequency response

As contrasted with the virtually inertialess vacuum photoemissive cells, the 61SV has a time constant in the region of 75 μs. This represents the time for the signal to drop to e^{-1} of its value after the radiation on the cell has been cut-off. Because of this the sensitivity varies with the frequency of interruption of the radiation in accordance with the following relationship.

$$S = \frac{S_o}{\sqrt{1 + 4\pi^2 f^2 \tau^2}}$$

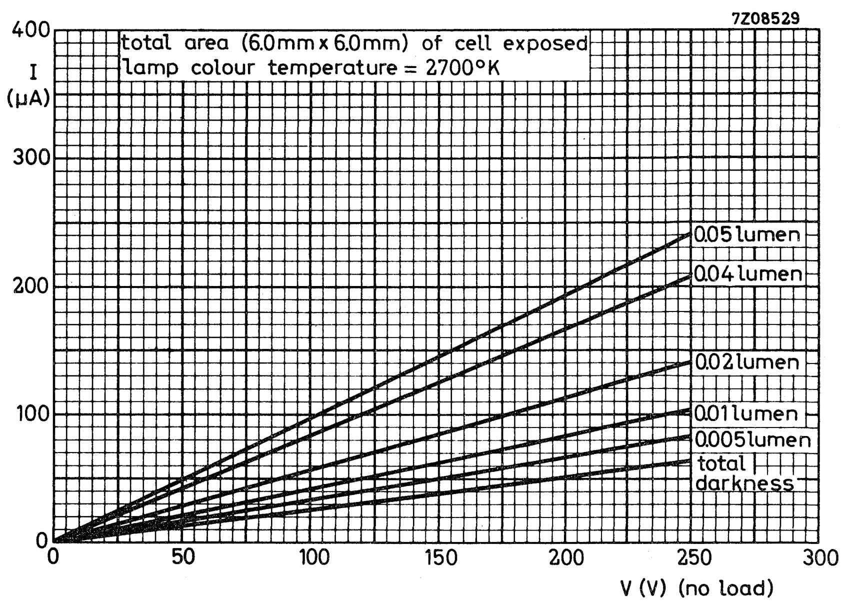
where S and S_o are the sensitivities at frequencies f and zero respectively and τ is the time constant.

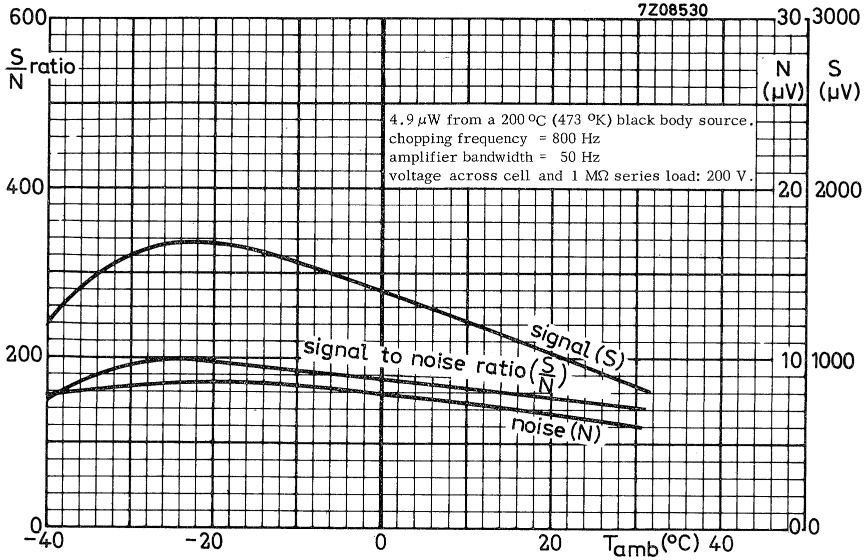
3. Ambient temperature

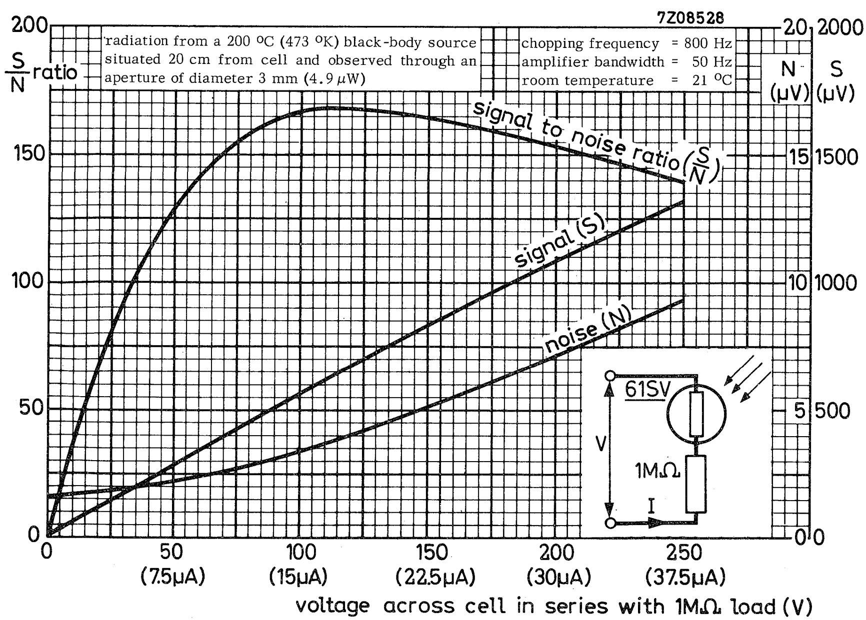
The sensitivity is susceptible to changes in ambient temperature. The change in signal sensitivity with ambient temperature for a black body source having a temperature of 200 ^oC can be expressed in the following manner over the temperature range −10 ^oC to +50 ^oC.

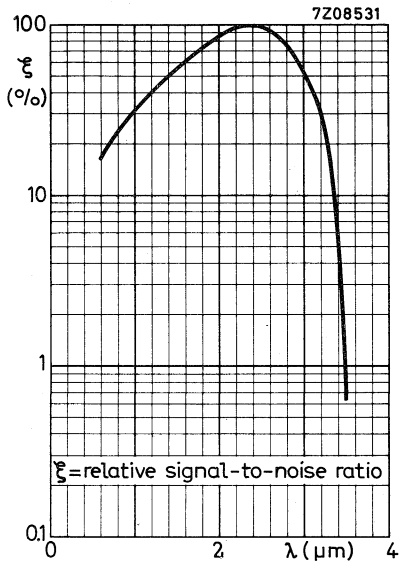
$$\frac{S_T}{S_{20}} = 1.4 - \frac{T}{50} \text{ or } \Delta\frac{S_T}{S_{20}} = -\frac{\Delta T}{50}$$

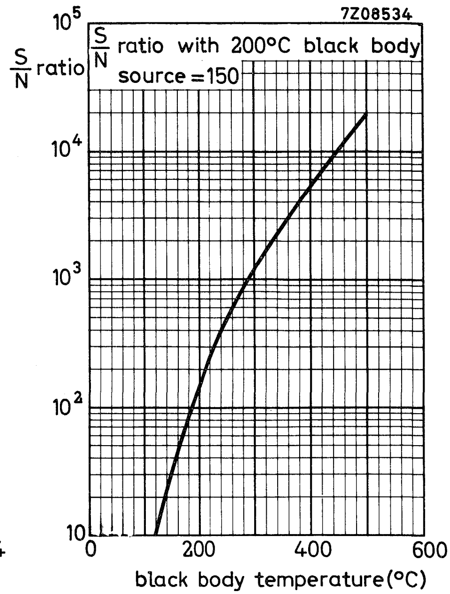
where S_T and S_{20} are the sensitivities at T ^oC and 20 ^oC respectively. The sensitivity changes 2% for each ^oC change of its value at 20 ^oC.

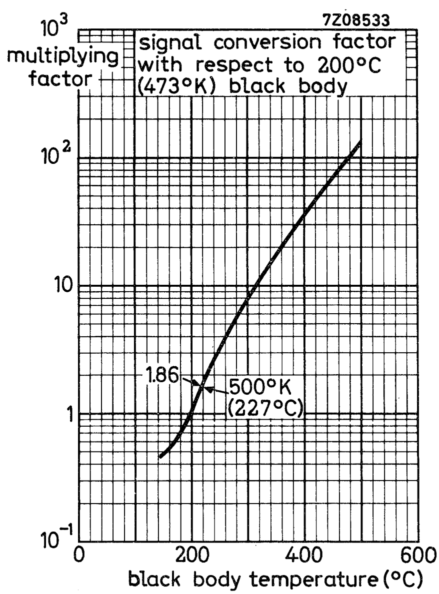


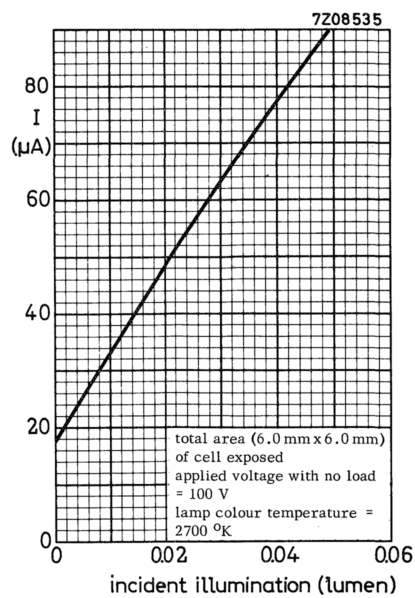

7Z08530
600
400
200
0
S/N ratio
30
20
10
0
N (μV)
3000
2000
1000
0
S (μV)
4.9 μW from a 200 °C (473 °K) black body source.
chopping frequency = 800 Hz
amplifier bandwidth = 50 Hz
voltage across cell and 1 MΩ series load: 200 V.
signal (S)
signal to noise ratio (S/N)
noise (N)
−40
−20
0
20
40
Tamb (°C)

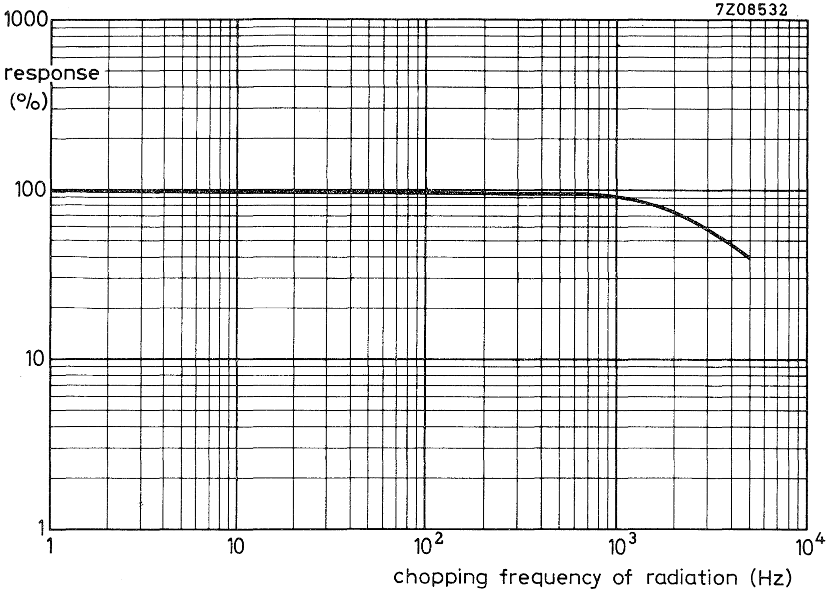

7Z08528
200
150
100
50
0
S/N ratio
20
15
10
5
0
N (μV)
2000
1500
1000
500
0
S (μV)
radiation from a 200 °C (473 °K) black-body source situated 20 cm from cell and observed through an aperture of diameter 3 mm (4.9 μW)
chopping frequency = 800 Hz
amplifier bandwidth = 50 Hz
room temperature = 21 °C
signal to noise ratio (S/N)
signal (S)
noise (N)
61SV
V
1MΩ
I
0
50 (7.5μA)
100 (15μA)
150 (22.5μA)
200 (30μA)
250 (37.5μA)
voltage across cell in series with 1MΩ load (V)


7Z08531
100
ξ
(%)
10
1
0.1
0
2
λ (μm)
4
ξ = relative signal-to-noise ratio


7Z08534
10^5
S/N ratio
S/N ratio with 200°C black body source = 150
10^4
10^3
10^2
10
0
200
400
600
black body temperature (°C)


7Z08533
10^3
multiplying factor
signal conversion factor with respect to 200°C (473°K) black body
10^2
10
1.86
500°K (227°C)
1
10^{-1}
0
200
400
600
black body temperature (°C)


7Z08535
80
I
(μA)
60
40
20
0
0
0.02
0.04
0.06
incident illumination (lumen)
total area (6.0 mm x 6.0 mm) of cell exposed
applied voltage with no load = 100 V
lamp colour temperature = 2700 °K


7Z08532
1000
response
(%)
100
10
1
1
10
10^2
10^3
10^4
chopping frequency of radiation (Hz)

Accessories

Introduction

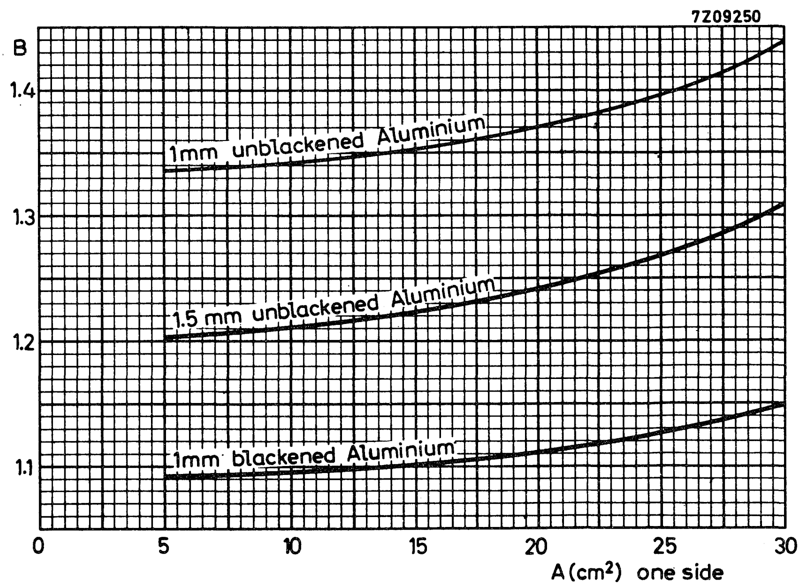
All information on thermal resistances of the accessories combined with flat heatsinks is valid for square heatsinks of 1.5 mm blackened aluminium.
For a few variations the thermal resistance may be derived as follows:

a. Rectangular heatsinks (sides a and 2a)

When mounted with long side horizontal, multiply by 0.95.
When mounted with short side horizontal, multiply by 1.10.

b. Unblackened or thicker heatsinks

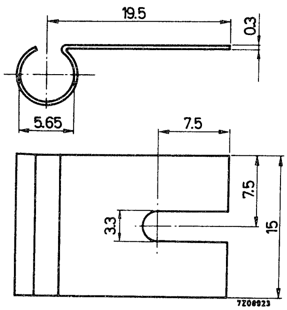
Multiply by the factor B given below as a function of the heatsink size A.



COOLING FIN

MECHANICAL DATA

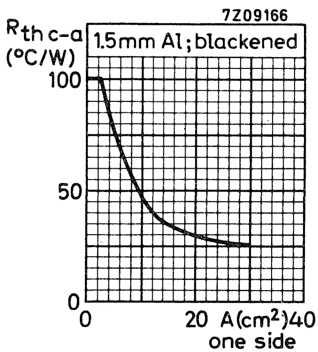
Dimensions in mm



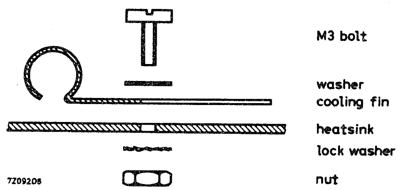
Fin material: brass, nickel plated

THERMAL RESISTANCE

From case to ambient with cooling fin only	$R_{th\ c-a}$ =	100 °C/W
with heatsink		see graph



MOUNTING INSTRUCTIONS

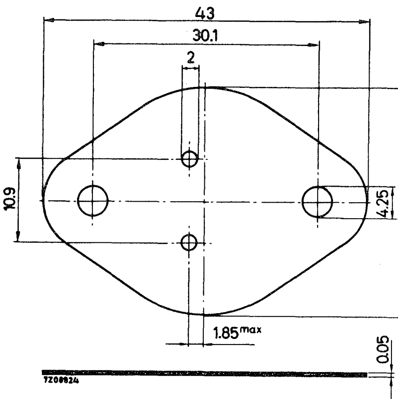


Torque on nut for good heat transfer: 5 cm kg

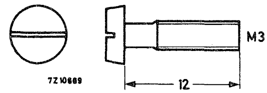
MOUNTING ACCESSORIES

MECHANICAL DATA

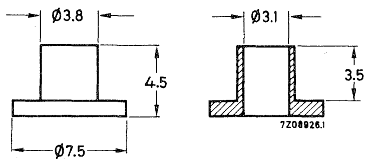
Dimensions in mm



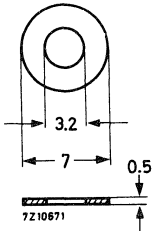
mica washer



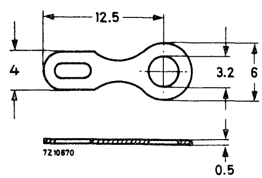
2 cheese head screws, slotted
material: brass, nickel plated



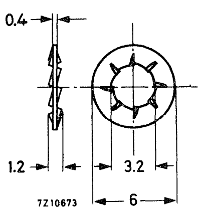
2 insulating bushes



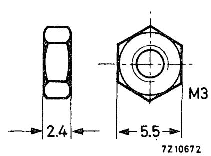
3 plain washers
material: brass, nickel plated



soldering tag



2 lock washers, internal teeth
material: steel, nickel plated



2 hexagon nuts
material: brass, nickel plated

THERMAL RESISTANCE

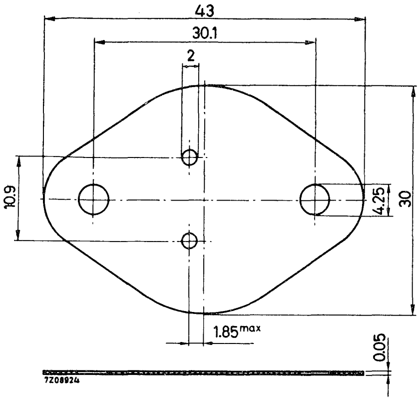
From mounting base to heatsink with mica washer $R_{th\ mb-h}$ = 1.0 °C/W

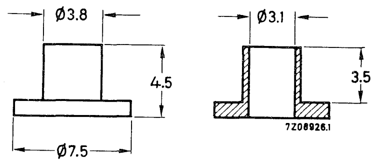
TEMPERATURES

Maximum allowable temperature T_{max} = 150 °C

56201a MICA WASHER AND 2 INSULATING BUSHES

MECHANICAL DATA Dimensions in mm



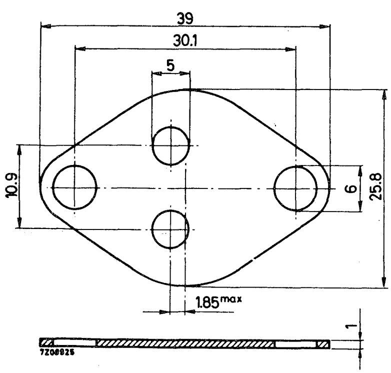


THERMAL RESISTANCE

From mounting base to heatsink $R_{th\ mb-h}$ = 1.0 °C/W

56201b LEAD WASHER

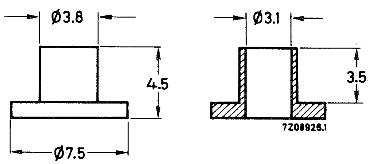
MECHANICAL DATA Dimensions in mm



56201c INSULATING BUSH

MECHANICAL DATA

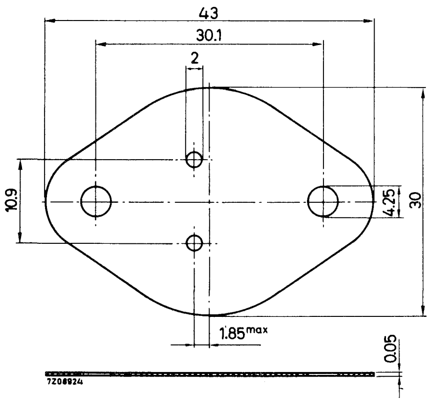
Dimensions in mm



56201d MICA WASHER

MECHANICAL DATA

Dimensions in mm



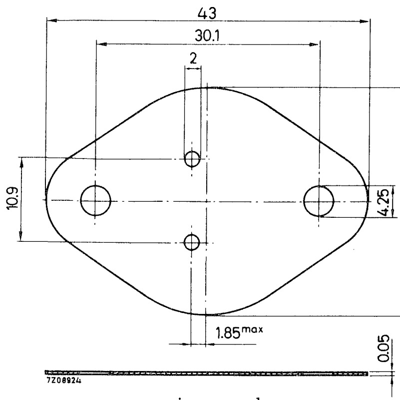
THERMAL RESISTANCE

From mounting base to heatsink $R_{th\ mb-h}$ = 1.0 °C/W

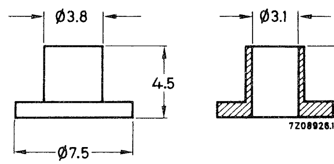
MOUNTING ACCESSORIES

MECHANICAL DATA

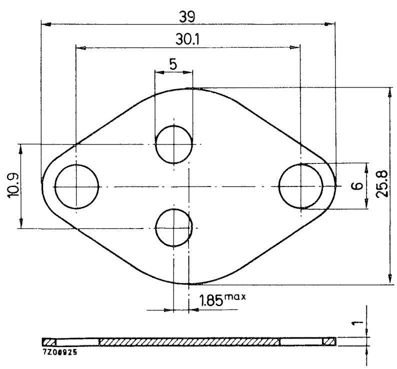
Dimensions in mm



mica washer

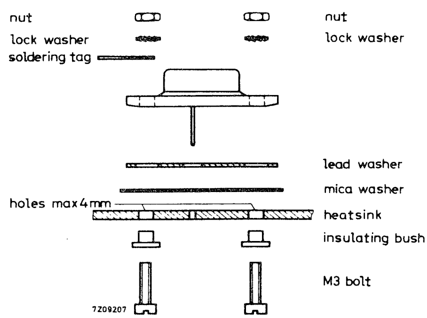


2 insulating bushes



lead washer

MOUNTING INSTRUCTIONS



Torque on nut for good heat transfer: 5 cm kg

THERMAL RESISTANCE

From mounting base to heatsink

with mica washer only	$R_{th\ mb\text{-}h}$	= 1.0	$^{o}C/W$
with mica washer and lead washer	$R_{th\ mb\text{-}h}$	= 0.75	$^{o}C/W$

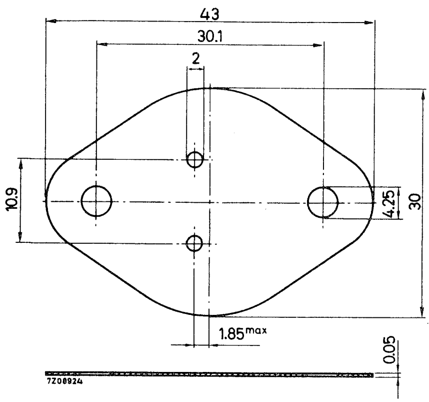
TEMPERATURE

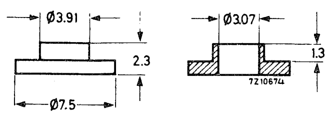
Maximum allowable temperature T_{max} = 150 ^{o}C

MICA WASHER AND 2 INSULATING BUSHES

56201f

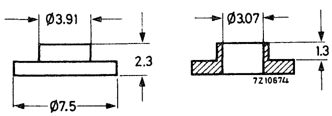
MECHANICAL DATA Dimensions in mm





56201g INSULATING BUSH

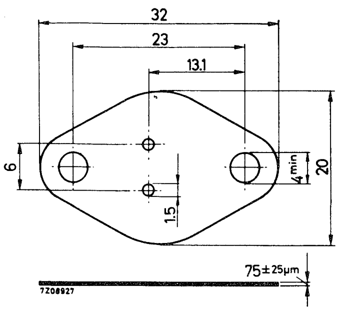
MECHANICAL DATA Dimensions in mm

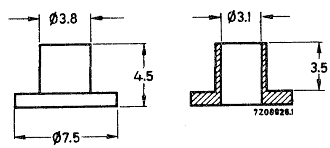


MICA WASHER AND 2 INSULATING BUSHES

MECHANICAL DATA

Dimensions in mm





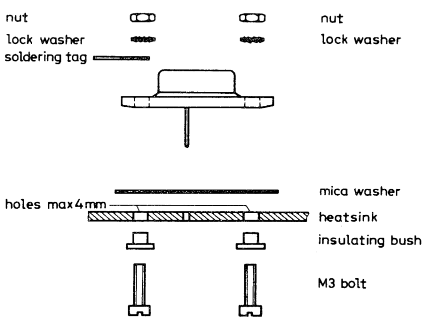
THERMAL RESISTANCE

From mounting base to heatsink $R_{th\ mb\text{-}h}$ = 1.5 $^{o}C/W$

TEMPERATURE

Maximum allowable temperature T_{max} = 150 ^{o}C

MOUNTING INSTRUCTIONS

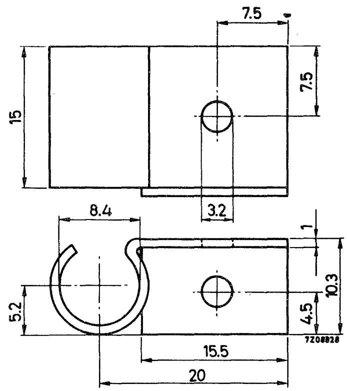


Torque on nut for good heat transfer: 5 cm kg

COOLING FIN

MECHANICAL DATA

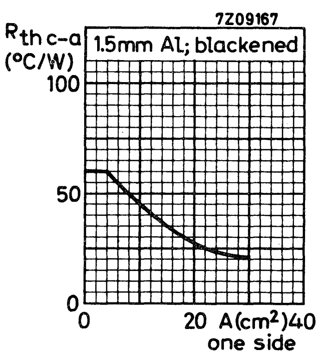
Dimensions in mm



Fin material: aluminium, blackened

THERMAL RESISTANCE

From case to ambient with cooling fin only	$R_{th\ c-a}$ =	60 °C/W
with heatsink		see graph



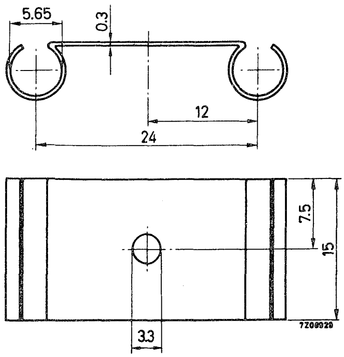
MOUNTING INSTRUCTIONS

Torque on M3 bolts for good heat transfer: 5 cmkg

COOLING FIN

MECHANICAL DATA

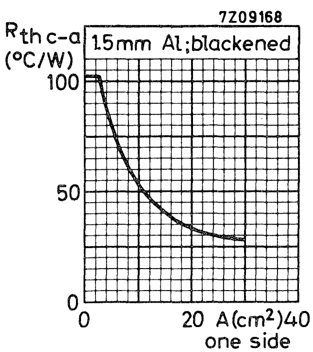
Dimensions in mm



Fin material: brass, nickel plated

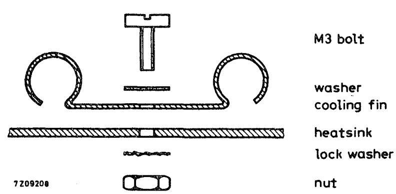
THERMAL RESISTANCE

From case to ambient with cooling fin only	$R_{th\ c-a}$	= 102 °C/W
with heatsink		see graph



R_{th} values apply to each transistor, provided the two transistors have been mounted so that the heat flow from each is equal.

MOUNTING INSTRUCTIONS

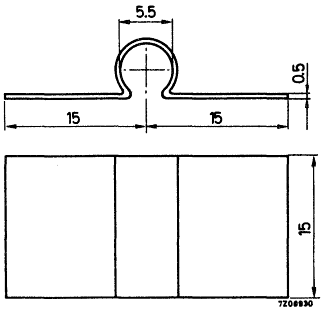


Torque on nut for good heat transfer: 5 cm kg

COOLING FIN

MECHANICAL DATA

Dimensions in mm



Fin material: brass, nickel plated

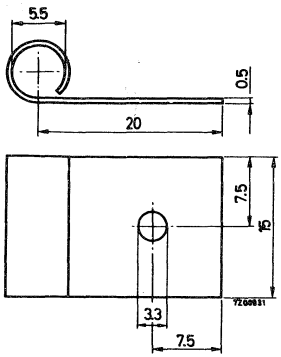
THERMAL RESISTANCE

From case to ambient with cooling fin only $R_{th\ c-a}$ = 75 °C/W

COOLING FIN

MECHANICAL DATA

Dimensions in mm

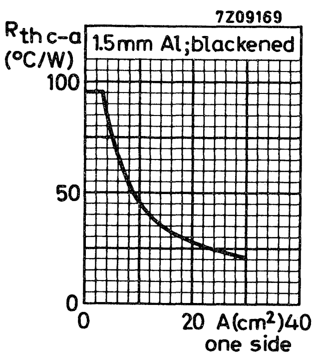


Fin material: brass, nickel plated

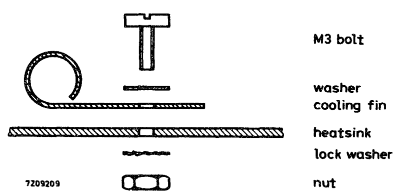
THERMAL RESISTANCE

From case to ambient with cooling fin only — $R_{th\ c\text{-}a}$ = 95 °C/W

with heatsink — see graph



MOUNTING INSTRUCTIONS

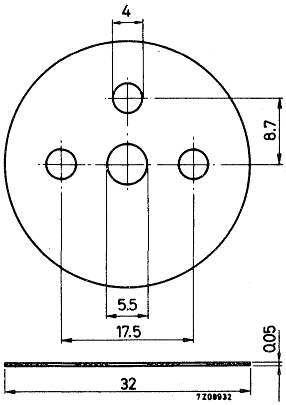


Torque on nut for good heat transfer: 5 cm kg

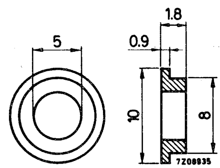
MOUNTING ACCESSORIES

MECHANICAL DATA

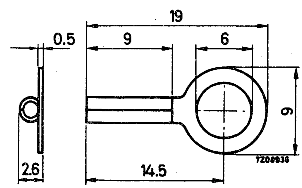
Dimensions in mm



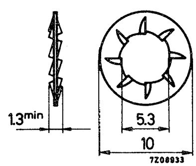
mica washer



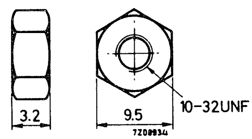
insulating ring



cable lug
material: brass, nickel plated



lock washer internal teeth
material: steel, nickel plated



hexagon nut
material: brass, nickel plated

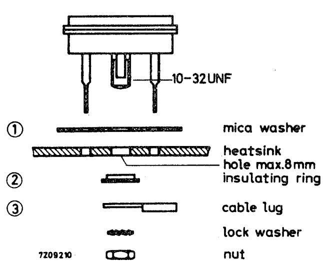
THERMAL RESISTANCE

From mounting base to heatsink $R_{th\ mb\text{-}h}$ = 1 $^oC/W$

TEMPERATURE

Maximum allowable temperature T_{max} = 125 ^oC

MOUNTING INSTRUCTIONS



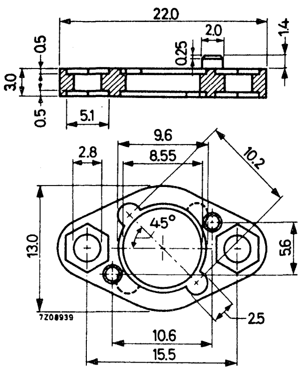
Torque on nut for good heat transfer: 20 cm

Non insulated mounting; without items 1, 2 and 3. (3 if necessary)

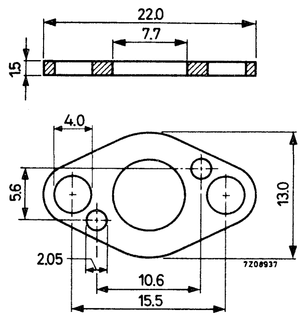
MOUNTING ACCESSORIES

MECHANICAL DATA

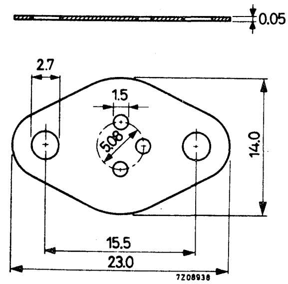
Dimensions in mm



top clamping washer
of insulating material



bottom clamping washer
material: brass, tin plated



mylar washer

THERMAL RESISTANCE

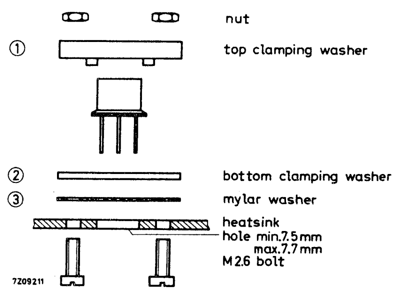
→ From mounting base to heatsink non insulated mounting $R_{th\ mb-h} = 3$ °C/W

insulated mounting $R_{th\ mb-h} = 6$ °C/W

TEMPERATURE

Maximum allowable temperature $T_{max} = 100$ °C

MOUNTING INSTRUCTIONS

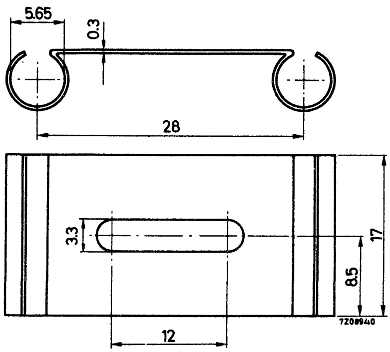


Non insulated mounting; without items 2 and 3. (Note: item 1 must than be mounted up-side down)

COOLING FIN

MECHANICAL DATA

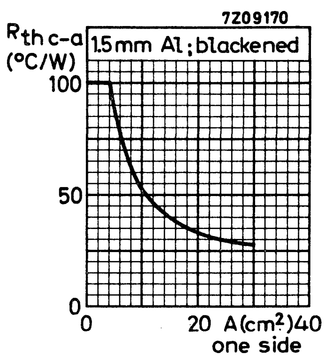
Dimensions in mm



Fin material: brass, nickel plated

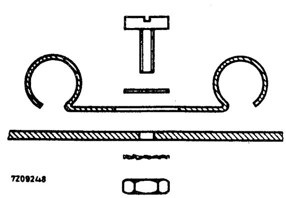
THERMAL RESISTANCE

From case to ambient with cooling fin only $R_{th\ c\text{-}a}$ = 100 °C/W
with heatsink see graph



R_{th} values apply to each transistor, provided the two transistors have been mounted so that the heat flow from each is equal.

MOUNTING INSTRUCTIONS

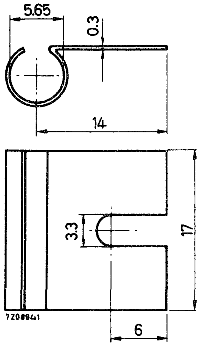


Torque on nut for good heat transfer: 5 cmkg

COOLING FIN

MECHANICAL DATA

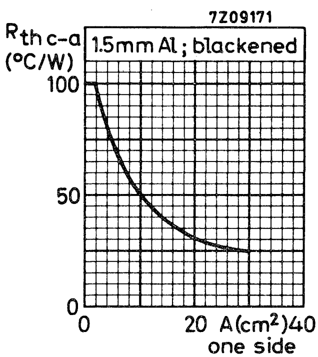
Dimensions in mm



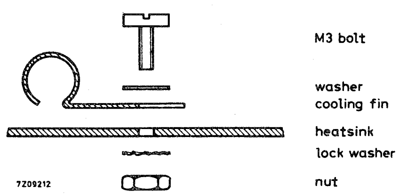
Fin material: brass, nickel plated

THERMAL RESISTANCE

From case to ambient with cooling fin only	$R_{th\ c-a}$	=	100 °C/W
with heatsink			see graph



MOUNTING INSTRUCTIONS



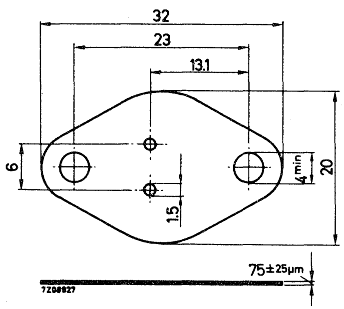
Torque on nut for good heat transfer: 5 cm kg

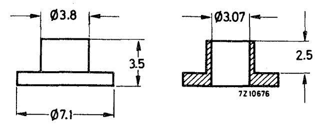
MICA WASHER AND 2 INSULATING BUSHES

56239

MECHANICAL DATA

Dimensions in mm





THERMAL RESISTANCE

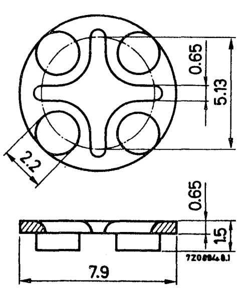
From mounting base to heatsink $R_{th\ mb-h}$ = 1.5 °C/W

TEMPERATURE

Maximum allowable temperature T_{max} = 150 °C

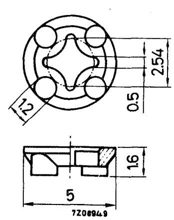
DISTANCE DISCS

56245



Insulating material

56246



Insulating material

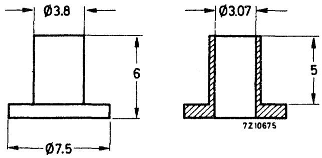
TEMPERATURE

Maximum allowable temperature T_{max} = 100 °C

2 INSULATING BUSHES

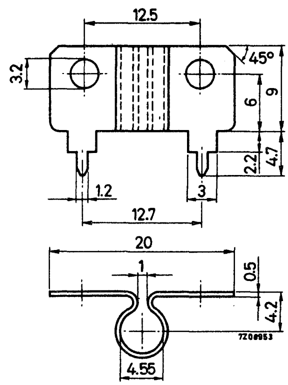
56261

MECHANICAL DATA Dimensions in mm



56263 COOLING FIN

MECHANICAL DATA Dimensions in mm



Fin material: copper, tin plated

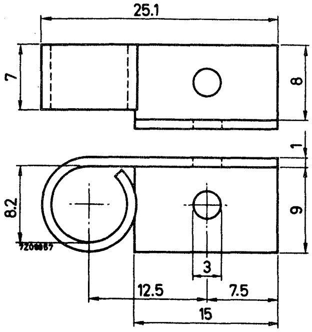
THERMAL RESISTANCE

From case to ambient $R_{th\ c-a}$ = 100 °C/W

COOLING FIN

MECHANICAL DATA

Dimensions in mm

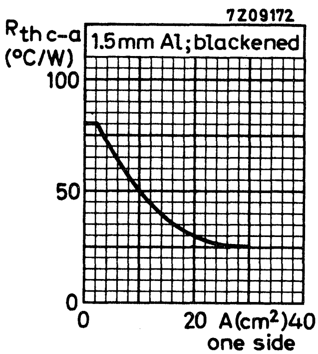


Fin material: aluminium, blackened

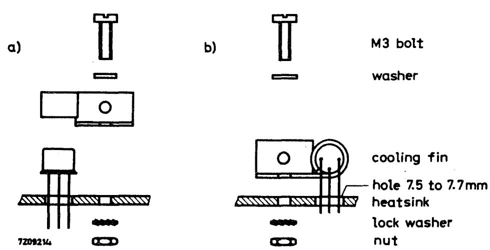
THERMAL RESISTANCE

From case to ambient with cooling fin only $R_{th\ c-a}$ = 80 °C/W

with heatsink see graph



MOUNTING INSTRUCTIONS

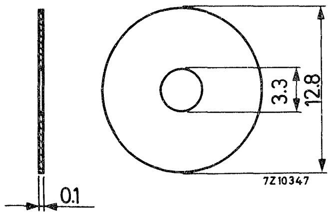


Torque on nut for good heat transfer: 5 cm kg

56302 MICA WASHER

MECHANICAL DATA

Dimensions in mm



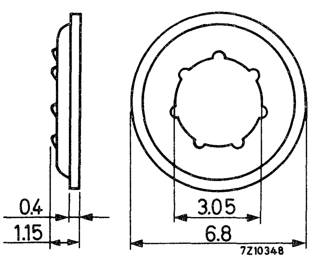
THERMAL RESISTANCE

From mounting base to heatsink $R_{th\ mb\text{-}h}$ = 6 °C/W

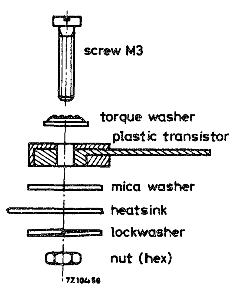
56303 TORQUE WASHER

MECHANICAL DATA

Dimensions in mm



MOUNTING INSTRUCTIONS



Torque on nut: min. 8 cm kg
max. 9 cm kg

INDEX OF TYPENUMBERS

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

Type No.	Section	Type No.	Section	Type No.	Section
AFY19	Tr	BLY87	Tr	56201d	A
BAW56	Micr	BLY88	Tr	56201e	A
BCW29	Micr	BLY89	Tr	56201f	A
BCW30	Micr	BLY91	Tr	56201g	A
BCW31	Micr	BLY92	Tr	56203	A
BCW32	Micr	BLY93	Tr	56207	A
BCW33	Micr	BPX25	Ph	56208	A
BCY55	Dual	BPX29	Ph	56209	A
BCY87	Dual	BPY10	Ph	56210	A
BCY88	Dual	BSV52	Micr	56213	A
BCY89	Dual	BSX82	FET	56218	A
BFS17	Micr	OAP12	Ph	56226	A
BFS18	Micr	OCP70	Ph	56227	A
BFS19	Micr	ORP10	Ph	56239	A
BFS20	Micr	ORP13	Ph	56245	A
BFS22	Tr	2N3375	Tr	56246	A
BFS23	Tr	2N3553	Tr	56261	A
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BFY70	Tr	2N4427	Tr		
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BLY17	Tr	56200	A		
BLY37	Tr	56201	A		
BLY38	Tr	56201a	A		
BLY53	Tr	56201b	A		
BLY76	Tr	56201c	A		

Tr = Transmitting transistors
FET = Field effect transistors
Dual = Dual transistors
Micr = Microminiature devices for thick- and thin-film circuits
Ph = Photo devices
A = Accessories

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