PART 4 DECEMBER 1970

Transmitting transistors

Microwave devices

Field effect transistors

Dual transistors

Microminiature devices

Beam lead devices

Photo devices

Accessories

SEMICONDUCTORS AND INTEGRATED CIRCUITS

Part 4 **December 1970**

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. Where ratings or specifications quoted differ from those published in the preceding edition they will be pointed out by arrows. 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 pusblished 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.

January 1970

ELECTRON TUBES (BLUE SERIES)

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

Part 1 — **January 1970**

Transmitting tubes (Tetrodes, Pentodes)
Associated accessories

Part 2 — **February 1970**

Tubes for microwave equipment

Part 3 — **March 1970**

Special Quality tubes
Miscellaneous devices

Part 4 — **April 1970**

Receiving tubes

Part 5 — **May 1970**

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

Part 6 — **June 1970**

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

Part 7 — **July 1970**

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 1970**

T.V. Picture tubes

Part 9 — **December 1969**

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

SEMICONDUCTORS AND INTEGRATED CIRCUITS (RED SERIES)

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

Part 1 Diodes and Thyristors **September 1970**

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

Part 2 Low frequency; Deflection **October 1970**

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

Part 3 High frequency; Switching **November 1970**

General
High frequency transistors
Switching transistors
Accessories

Part 4 Special types **December 1970**

General
Transmitting transistors
Microwave devices
Field effect transistors
Dual transistors
Microminiature devices for thick- and thin-film circuits
Beam lead devices for thick- and thin-film circuits
Photo devices
Accessories

Part 5 Integrated Circuits **February 1970**

General
Digital integrated circuits
- FC family; standard temperature range
- FC family; extended temperature range
- FD family
- FJ family; standard temperature range

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 1970**

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, 61-Series
Circuit blocks 90-Series
Circuit blocks for ferrite core memory drive
Input/output devices

Part 2 Resistors, Capacitors **November 1969**

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

Part 3 Radio, Audio, Television **January 1970**

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

Part 4 Magnetic Materials, White Ceramics **March 1970**

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

Part 5 Memory Products, Magnetic Heads, Quartz Crystals, Microwave Devices, Variable Transformers, Electro-mechanical Components **June 1970**

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

[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 ($R_{th\ j\text{-}mb} > 15\ ^oC/W$)

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

E Tunnel diode

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

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 ($R_{th\ j\text{-}mb} \leq 15\ ^oC/W$)

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

P Radiation sensitive device [1)]

Q Radiation generating device

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

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

T Electrically, or by means of light, triggered controlling and switching power device having a breakdown characteristic ($R_{th\ j\text{-}mb} \leq 15\ ^oC/W$) [1)]

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

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

Y Rectifying diode, booster diode, efficiency diode [1)]

Z Voltage reference or voltage regulator diode [1)]

1) For the type designation of a range see page 4.

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.

TYPE DESIGNATION FOR A RANGE OF SEMICONDUCTOR DEVICES

The type designation of a range of variants of:

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

b) rectifying diodes (second letter Y)

c) thyristors (second letter T)

d) radiation detectors

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

The suffix part consists of:

a) for voltage reference or voltage regulator diodes

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

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

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

b) for rectifying diodes

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

c) for thyristors

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

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

d) for radiation detectors

a figure giving the depth of the depletion layer in μm and where appropriate a version letter if there are differences in resolution.

EXAMPLES

BZY88series	Range of silicon voltage regulator diodes for professional equipment
BZY88-C9V1	The particular type out of the range with a typical zener voltage of 9.1 V ± 5%
BYX13-1200	The particular normal polarity type out of the BYX13series with a maximum repetitive peak reverse voltage of 1200 V
BTX64-200R	The particular reverse polarity type out of the BTX64 thyristor range of which the lower maximum repetitive peak voltage is 200 V

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

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, o	=	As third subscript: The terminal not mentioned is open circuited
S, 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, 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.

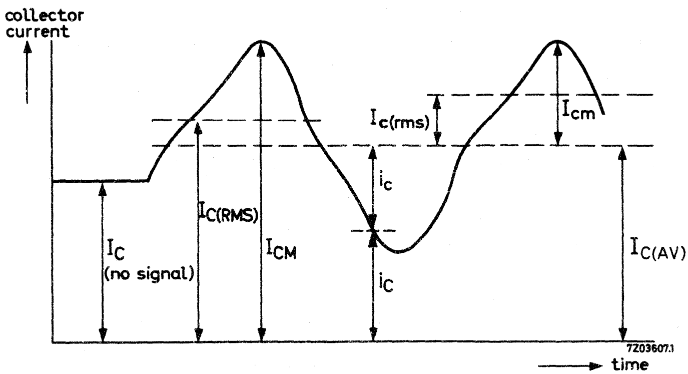


Fig.1

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	c = common collector
b = common base	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
$I_{B(AV)}$, $I_{C(AV)}$, $I_{E(AV)}$	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 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
$I_{F(AV)}$	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	Reverse recovery 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 **impedance**	

LETTER SYMBOLS
FOR RECTIFIER DIODES AND THYRISTORS

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

QUANTITY SYMBOLS

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

   Examples: i, v, p

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

   Examples: I, V, P

SUBSCRIPTS FOR QUANTITY SYMBOLS

1. Total values are indicated by upper case subscripts.
2. Values of varying components are indicated by lower case subscripts.
3. For power rectifier diodes and thyristors the terminals are not indicated in the subscripts, except for the gate-terminal of thyristors.
4. List of subscripts:

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

---

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

Transmitting transistors

RULES FOR MOUNTING QUARTER-INCH CAPSTAN HEADERS AS USED FOR R-F POWER TRANSISTORS

A 5 mm thick brass nut is supplied with each transistor for securing it to a heatsink. To ensure optimum heat transfer and avoid damage to the threaded stud of the transistor the following recommendations should be observed:

- Diameter of mounting hole in heatsink: 4.1 mm (+0.05, - 0.00)
- Heatsink to be at least 3 mm thick.
  Attachment to a thinner heatsink may damage the mounting stud.
- Heatsink surfaces at the mounting hole to be flat, parallel, and free of burrs or oxidation.
- Mounting nut torque: 8.0 kg cm (+0.05, - 0.0)
  If security against vibration is required, use a locking compound such as Lock-tite. Do not use washers; they impair the heat transfer.
- Recommend distance from the top surface of heatsink to surface of printed wiring board: 2.9 mm (+0.0, - 0.2)
  Tension in the transistor leads sets the limit on spacing between heatsink and printed wiring board; in general, the leads can withstand more pull in the downward than in the upward direction.
- Solder the leads to the connection pads with resin-cored lead-tin solder, using an iron of normal temperature. Soldering iron temperatures as high as 350 ^{o}C are safely tolerable; the transistor can withstand an interior temperature of 250 ^{o}C for about ten minutes.
  The leads may be tinned, if required, by dipping them into a solder bath at about 230 ^{o}C; each lead may be dipped up to its full length. A flux of the quality of Super-Safe is recommended; after tinning, surplus flux should be rinsed away in tap water.

GERMANIUM ALLOY DIFFUSED TRANSISTOR

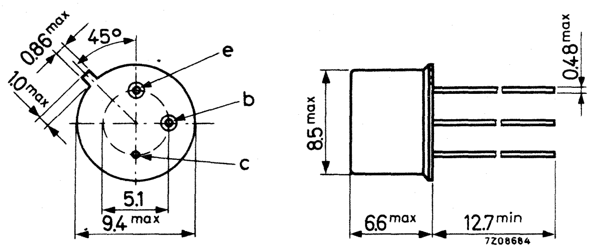
P-N-P transistor in a TO-39 metal envelope, primarily intended for use as a power amplifier in transmitting circuits up to frequencies of 180 MHz.

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

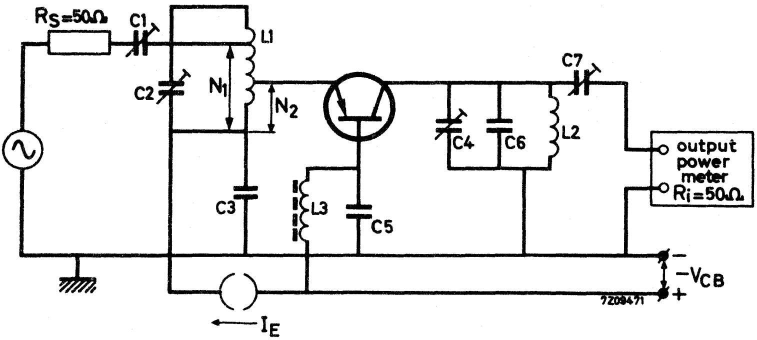
[1]) Limiting values according to the Absolute Maximum System as defined in IEC publication 134.

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

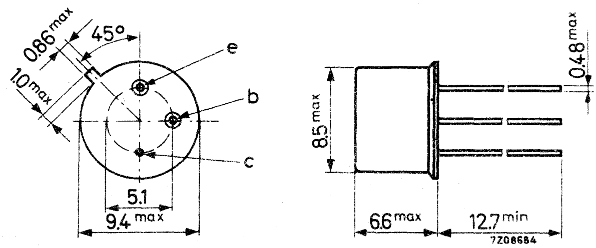
N-P-N transistors in a TO-39 metal envelope with the collector connected to the case. The BFY44 and BFY70 are primarily intended for use in v.h.f. medium power amplifiers or as output stage in small transmitters or as driver for transmitting tubes.

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 °C unless otherwise specified

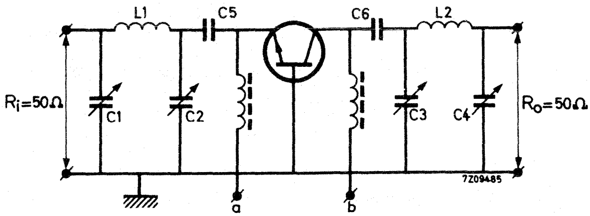
			BFY44	BFY70	
Collector cut-off current					
I_E = 0; V_{CB} = 40 V	I_{CBO}	typ.	3	-	nA
		<	500	-	nA
I_E = 0; V_{CB} = 28 V	I_{CBO}	typ.	-	3	nA
		<	-	500	nA
I_E = 0; V_{CB} = 40 V; T_j = 150 °C	I_{CBO}	typ.	1.5	-	μA
		<	50	-	μA
I_E = 0; V_{CB} = 28 V; T_j = 150 °C	I_{CBO}	typ.	-	1.5	μA
		<	-	50	μA
Emitter 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 Ω	$V_{CERsust}$	>	80	60	V
I_C = 0.5 mA; V_{BE} = 0	$V_{CESsust}$	>	80	60	V
Saturation voltages (both types)					
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

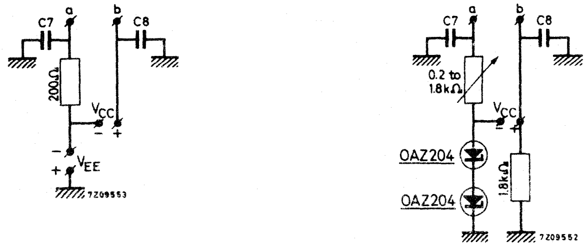
D.C. current gain				
I_C = 150 mA; V_{CE} = 10 V	h_{FE}	typ.	20	
I_C = 500 mA; V_{CE} = 5 V	h_{FE}	>	5	
		typ.	20	
Collector capacitance at f = 1 MHz				
$I_E = I_e = 0$ BFY44 : V_{CB} = 40 V	C_c	typ.	7	pF
		<	12	pF
$I_E = I_e = 0$ BFY70 : V_{CB} = 28 V	C_c	typ.	7	pF
		<	14	pF
Transition frequency				
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

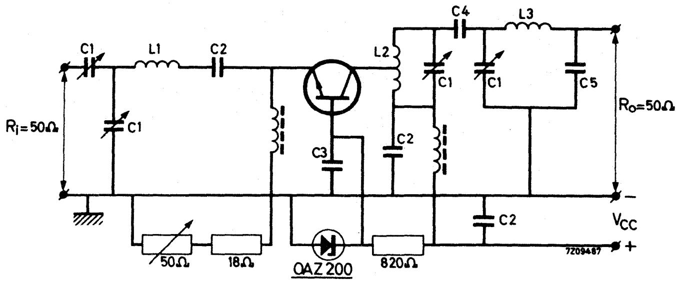
BFY44: V_{CE} = 40 V; P_i = 0.425 W

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)

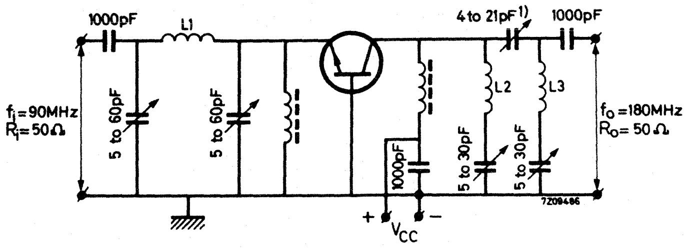
B. Amplifier circuit



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



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

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

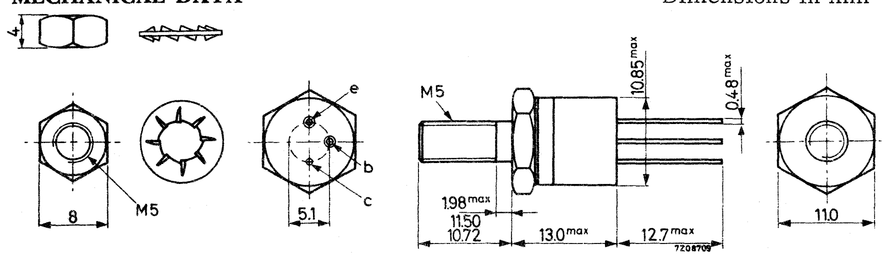
1) Variable ceramic capacitor
2) V_{CE} = 40 V is for BFY44 only

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	$R_{th\ j-mb}$	=	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

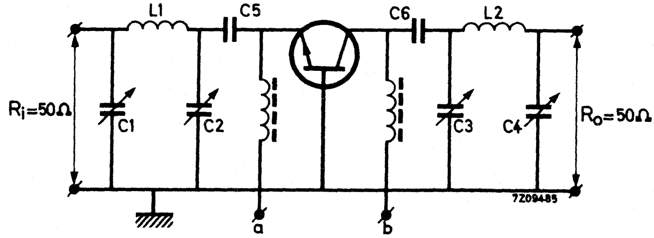
[1] Limiting values according to the Absolute Maximum System as defined in IEC publication 134.

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

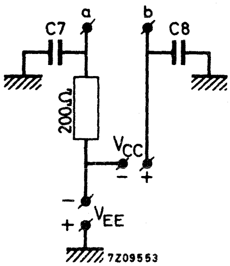
Saturation voltages				
I_C = 500 mA; I_B = 100 mA	V_{CEsat}	typ.	0.3	V
		<	0.7	V
	V_{BEsat}	typ.	1.1	V
		<	1.5	V
D.C. current gain				
$-I_E$ = 10 mA; V_{CB} = 10 V	h_{FE}	typ.	9	
$-I_E$ = 150 mA; V_{CB} = 10 V	h_{FE}	typ.	11	
$-I_E$ = 500 mA; V_{CB} = 10 V	h_{FE}	>	5	
		typ.	11	
Collector capacitance 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

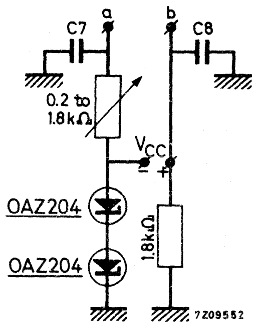
APPLICATION INFORMATION

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

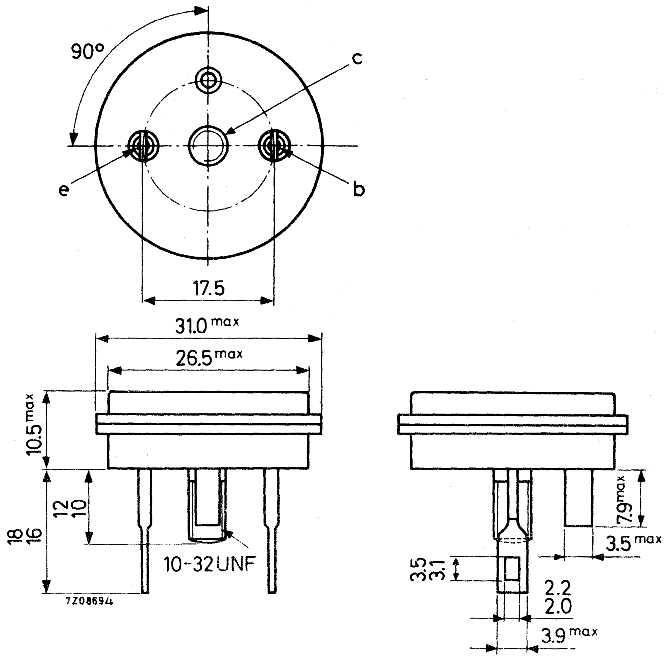
N-P-N triple diffused transistor in a TO-36 metal envelope.
The BLY17 is intended for high frequency and high power applications, primarily for use in the transmitting field.

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 $f \geq 0.5$ MHz	P_{tot}	max.	100	W
Storage temperature	T_{stg}		-65 to +175	°C
Junction temperature	T_j	max.	175	°C

THERMAL RESISTANCE

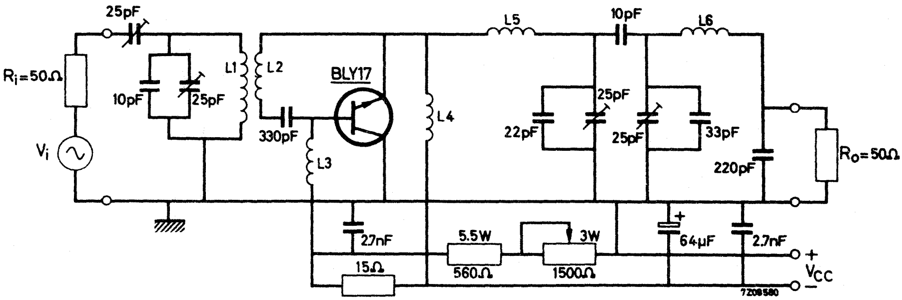
From junction to mounting base $R_{th\ j\text{-}mb}$ = 1.5 °C/W

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

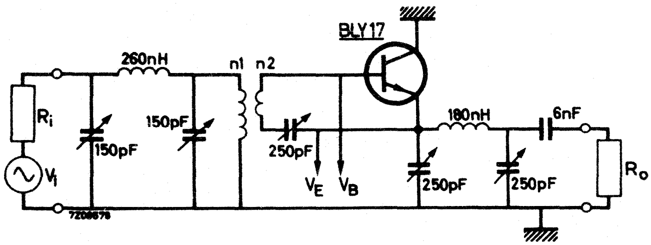
Peak envelope power		P.E.P.		20	W
Intermodulation distortion	of the third order	d_3	typ.	−32	dB
	of the fifth order	d_5	typ.	−32	dB
Power gain		G_p	typ.	8	dB
Collector current	without drive 1)	I_C		60	mA
	with full drive 2)	I_{CAV}	typ.	880	mA

1) Adjustable with the variable resistor.

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

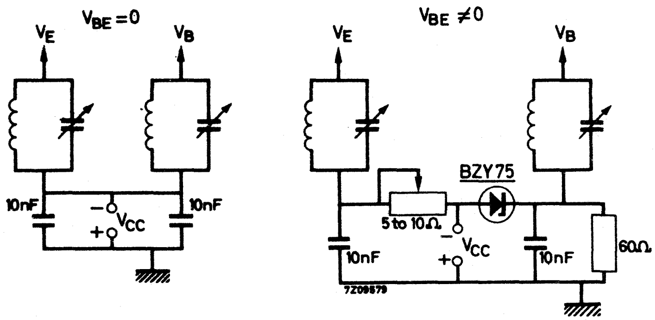
APPLICATION INFORMATION (continued)

Amplifier circuit



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

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

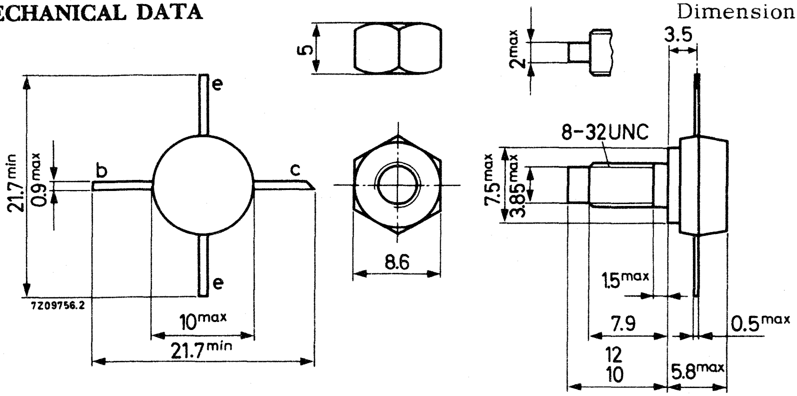
N-P-N silicon planar epitaxial transistors in a capstan envelope. The transistors are intended for battery operated f.m. transmitters with a supply voltage of up to 13.8 V for the BLY53 or up to 28 V for the BLY37.

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	°C
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

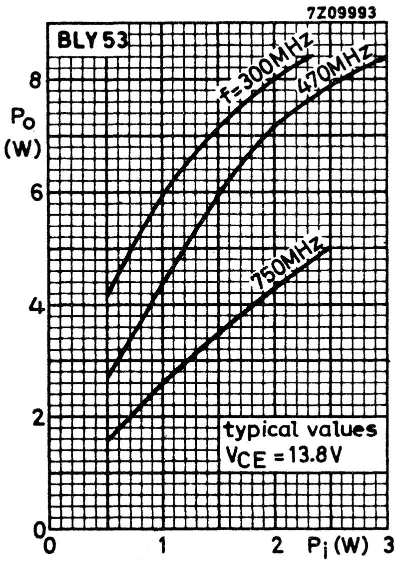
P_i	<	2	W
G_p	>	4.7	dB
η	>	60	%

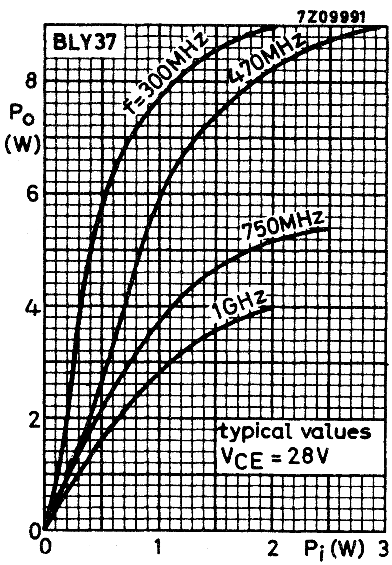
R.F. performance at f = 470 MHz (common emitter) of the BLY37

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

P_i	<	1.5	W
G_p	>	6	dB
η	>	60	%

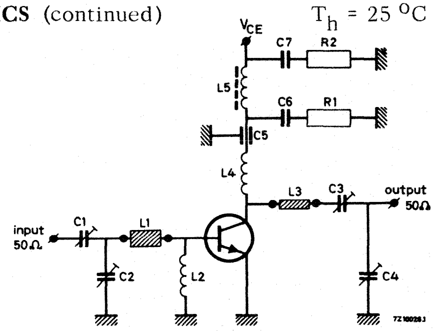
All transistors are tested with a V.S.W.R. of 50 varied through all phases.





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

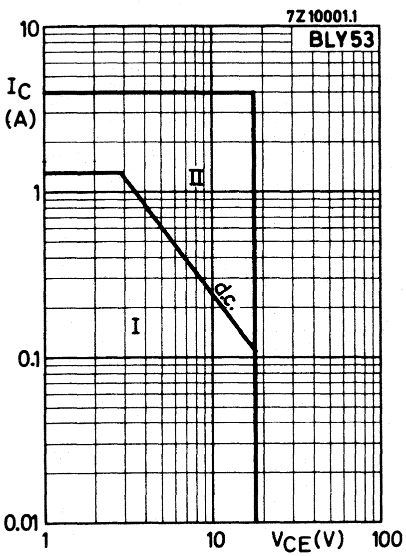
Test circuit:

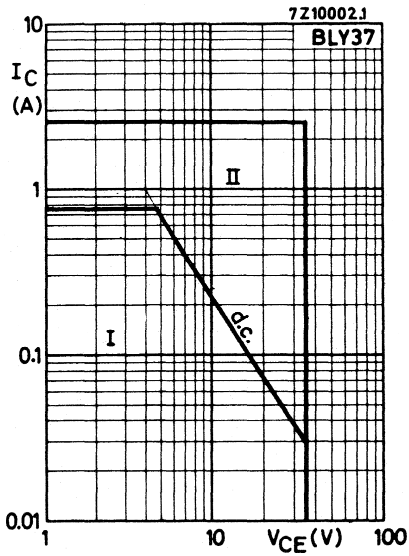


Components:

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	

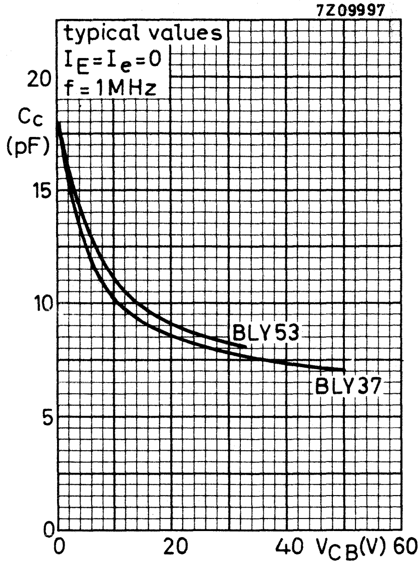
L1 = 35 mm x 6 mm straight Cu strip
L2 = 5 turns Cu wire (0.6 mm); internal diameter 8 mm
L3 = 25 mm straight Cu wire (1.5 mm)
L4 = 3 turns Cu wire (1.0 mm); internal diameter 3.5 mm; winding pitch 2 mm; leads 2x10 mm
L5 = FXC choke (codenumber 4312 020 36640)

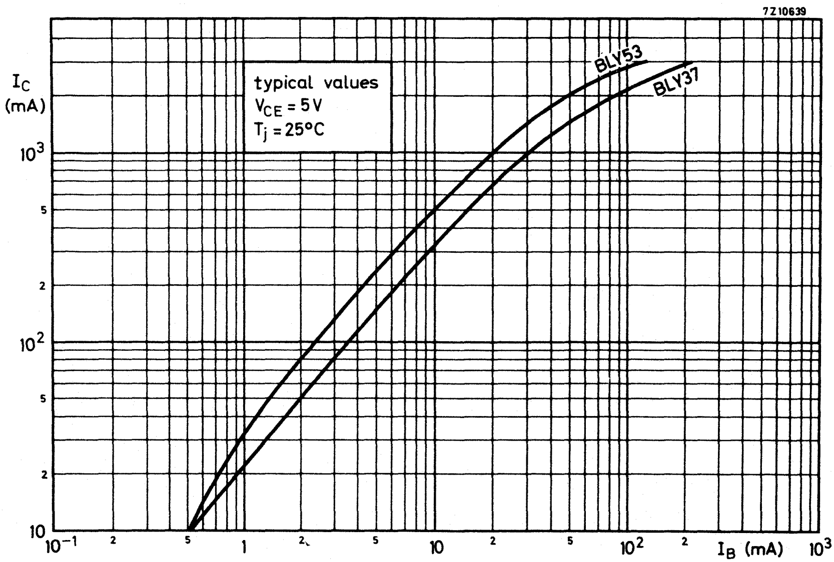


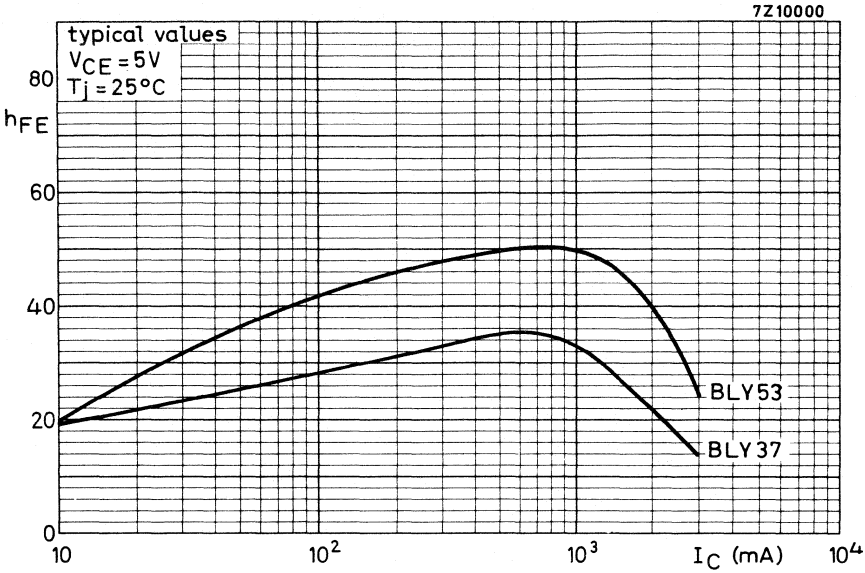


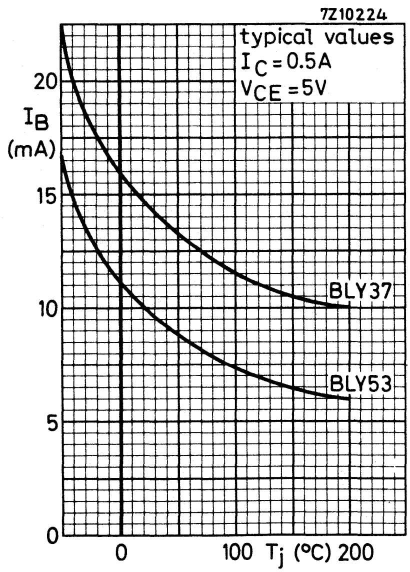
I Region of permissible operation under all base-emitter conditions and at all frequencies, including d.c.

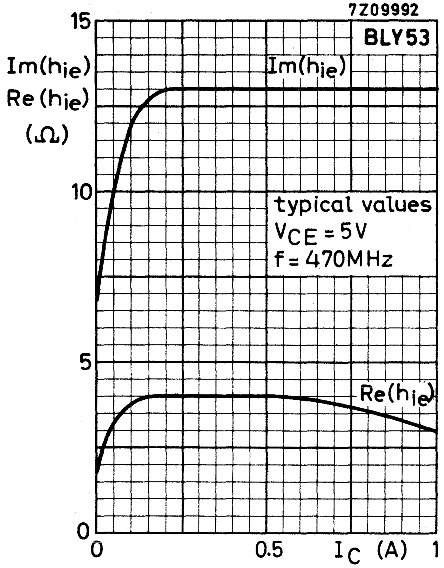
II Additional region of operation at f > 1 MHz.
Care must be taken to reduce the d.c. adjustment to region I before removing the a.c. signal. This may be achieved by an appropriate bias in class A, B or C

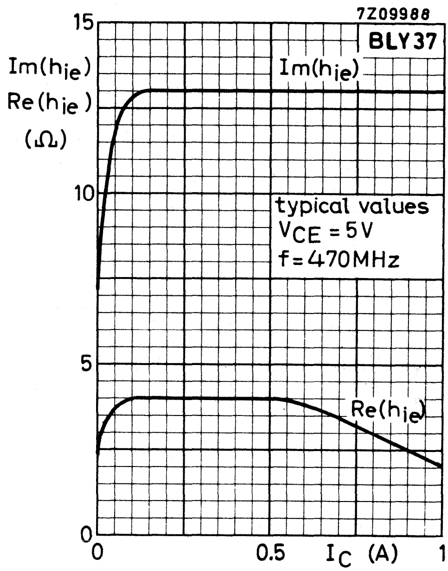

7Z09997
typical values
$I_E = I_e = 0$
f = 1 MHz
C_c (pF)
BLY53
BLY37
V_{CB}(V)

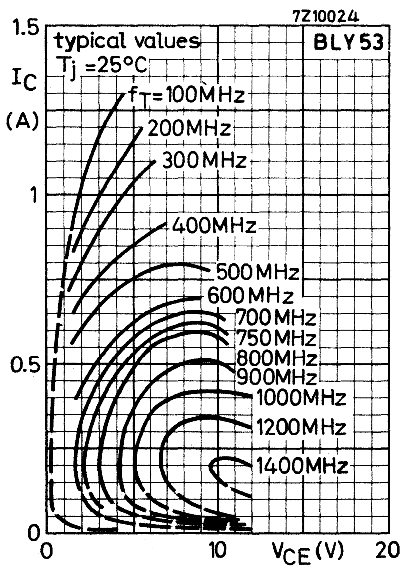

7Z10639
typical values
V_{CE} = 5 V
T_j = 25°C
I_C (mA)
BLY53
BLY37
I_B (mA)

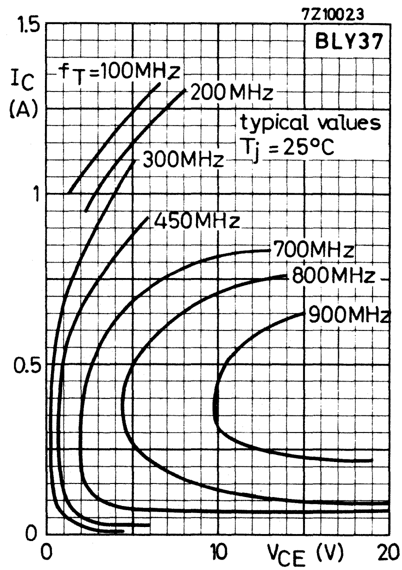

7Z10000
typical values
V_{CE} = 5V
T_j = 25°C
80
h_{FE}
60
40
20
0
10
10^2
10^3
I_C (mA)
10^4
BLY53
BLY37

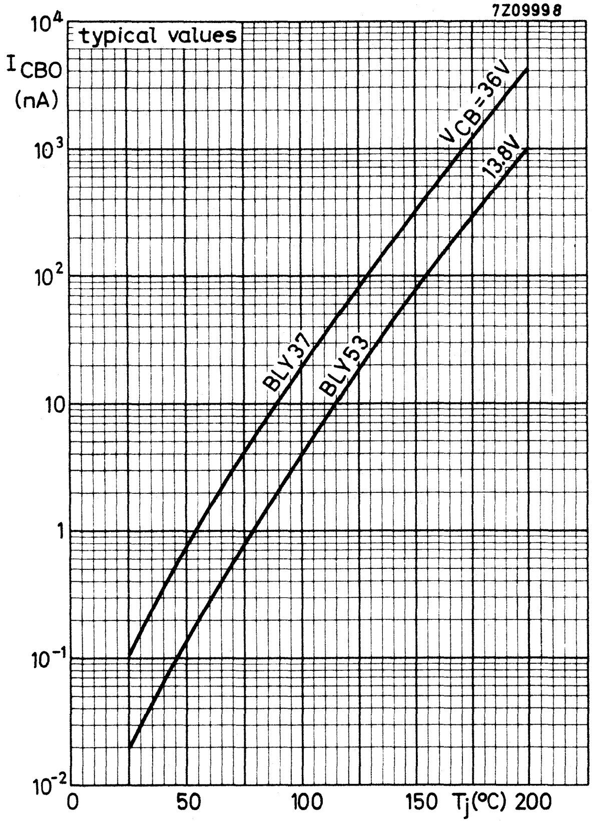

7Z10224
typical values
I_C = 0.5A
V_{CE} = 5V
20
I_B
(mA)
15
10
5
0
0
100 T_j (°C) 200
BLY37
BLY53


7Z09992
BLY53
Im(h_{ie})
Re(h_{ie})
(Ω)
15
10
5
0
Im(h_{ie})
typical values
V_{CE} = 5 V
f = 470 MHz
Re(h_{ie})
0
0.5
I_C (A)
1


7Z09988
BLY37
Im(h_{ie})
Re(h_{ie})
(Ω)
15
10
5
0
Im(h_{ie})
typical values
V_{CE} = 5 V
f = 470 MHz
Re(h_{ie})
0
0.5
I_C (A)
1

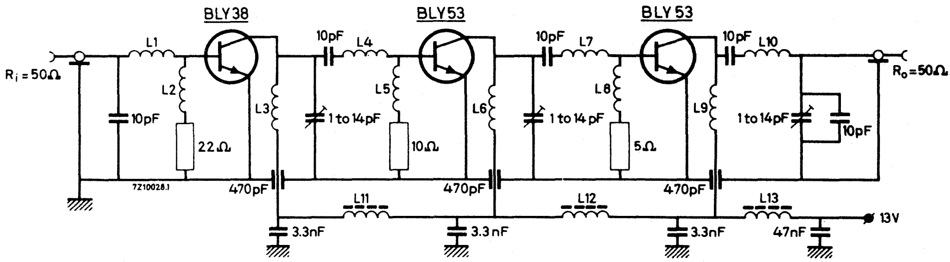

7Z10024
BLY53
typical values
T_j = 25 °C
I_C
(A)
1.5
1
0.5
0
f_T = 100 MHz
200 MHz
300 MHz
400 MHz
500 MHz
600 MHz
700 MHz
750 MHz
800 MHz
900 MHz
1000 MHz
1200 MHz
1400 MHz
0
10
V_{CE} (V)
20


7Z10023
BLY37
I_C
(A)
1.5
1
0.5
0
f_T = 100 MHz
200 MHz
300 MHz
450 MHz
700 MHz
800 MHz
900 MHz
typical values
T_j = 25 °C
0
10
V_{CE} (V)
20


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

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

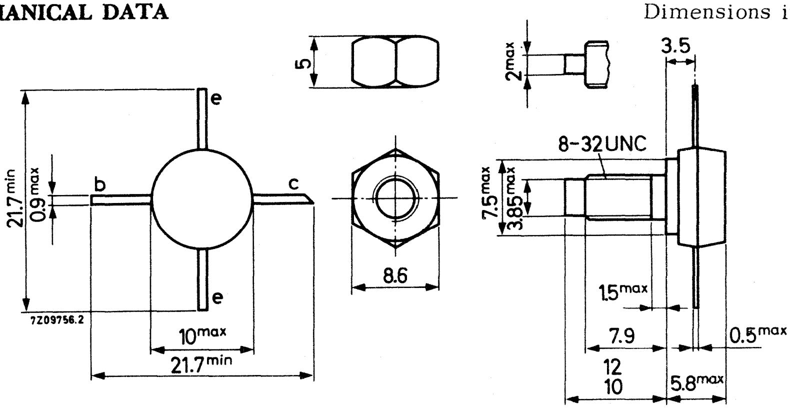
N-P-N silicon planar epitaxial transistors in a capstan envelope. The transistors are intended for battery operated f.m. transmitters with a supply voltage of up to 13.8 V for the BLY38 or up to 28 V for the BLY76.

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	^oC
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	
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.	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
Power dissipation					
Total power dissipation f > 1 MHz	P_{tot}	max.	5.5	4.0	W

Temperatures

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

THERMAL RESISTANCE

From junction to heatsink	$R_{th\ j\text{-}h}$	=	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

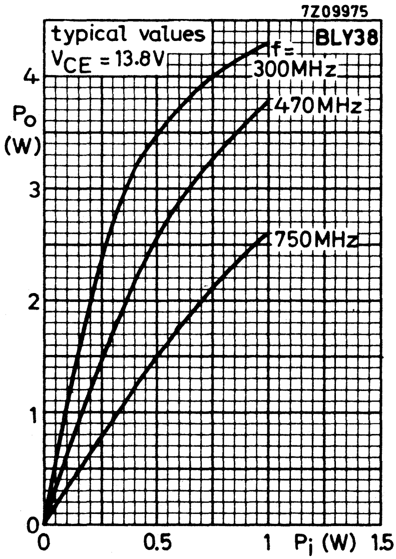
R.F. performance at f = 470 MHz (common emitter) of the BLY38

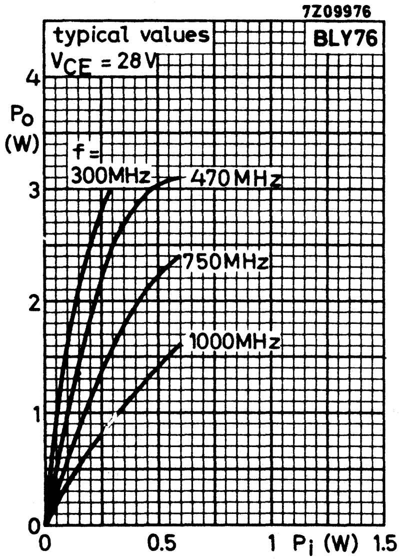
V_{CE} = 13.8 V; P_o = 2.0 W	P_i	<	0.5	W
	G_p	>	6.0	dB
	η	>	60	%

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	%

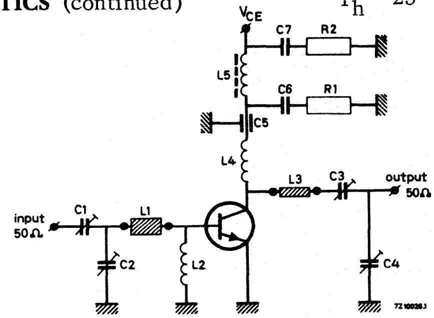
All transistors are tested with a V.S.W.R. of 50 varied through all phases.





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

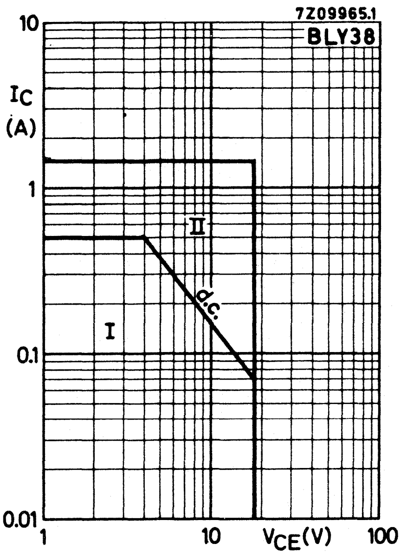
Test circuit:

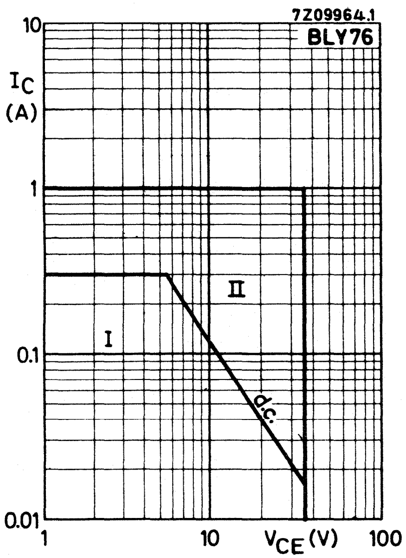


Components:

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	

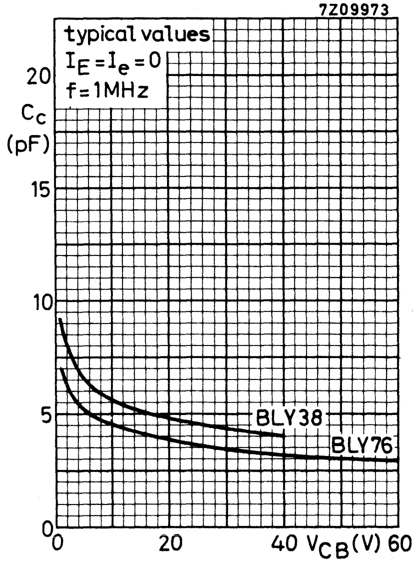
L1 = 35 mm x 6 mm straight Cu strip
L2 = 5 turns Cu wire (0.6 mm); internal diameter 8 mm
L3 = 25 mm straight Cu wire (1.5 mm)
L4 = 3 turns Cu wire (1.0 mm); internal diameter 3.5 mm; winding pitch 2 mm; leads 2x10 mm
L5 = FXC choke (code number 4312 020 36640)

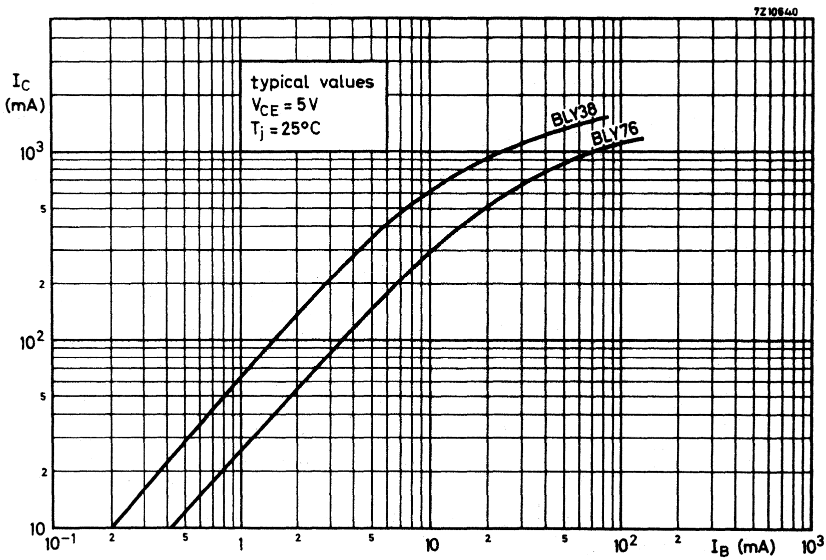


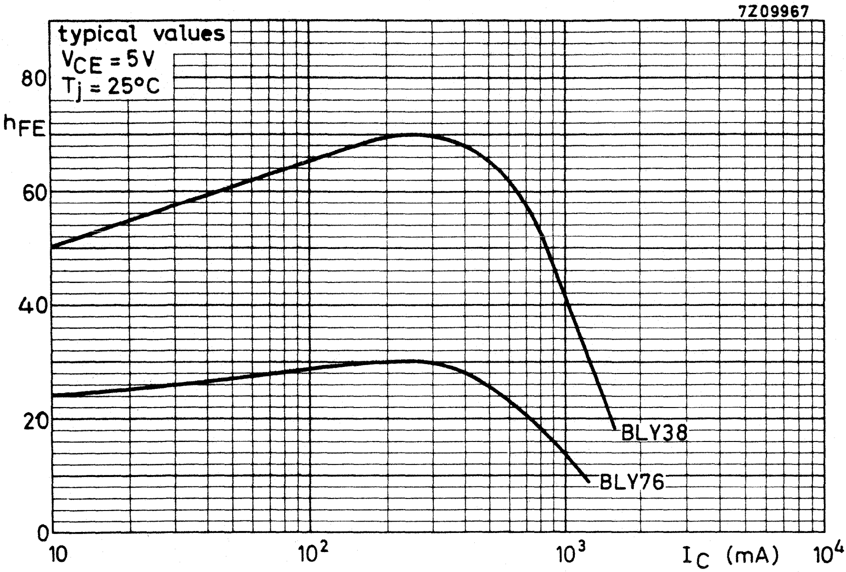


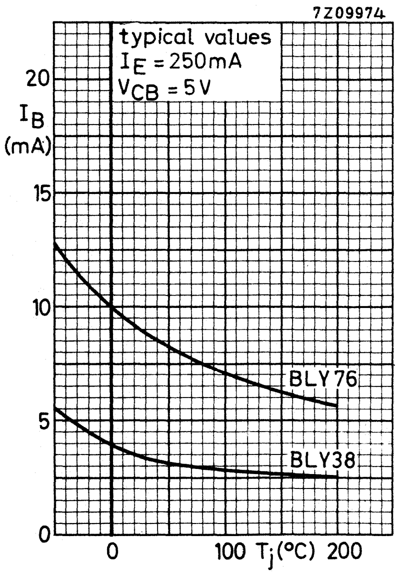
I Region of permissible operation under all base-emitter conditions and at all frequencies, including d.c.

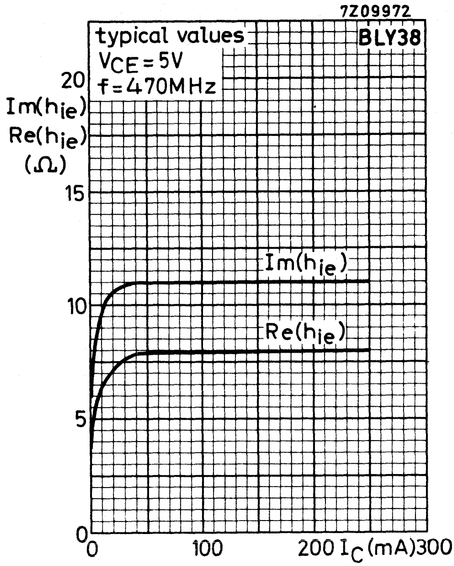
II Additional region of operation at f > 1 MHz.
Care must be taken to reduce the d.c. adjustment to region I before removing the a.c. signal. This may be achieved by an appropriate bias in class A, B or C

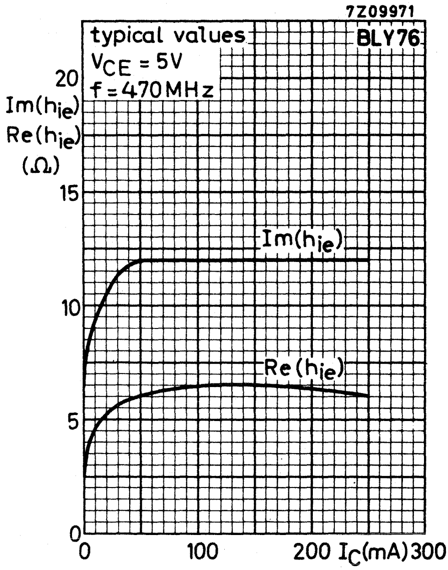

7Z09973
typical values
$I_E = I_e = 0$
f = 1 MHz
C_c (pF)
BLY38
BLY76
V_{CB} (V)

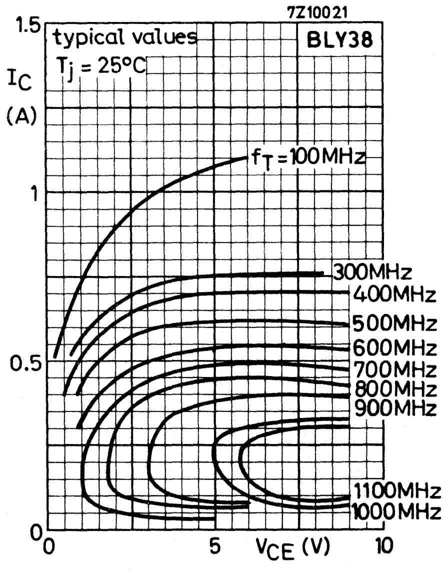

7Z10640
typical values
$V_{CE} = 5$ V
$T_j = 25$ °C
I_C (mA)
BLY38
BLY76
I_B (mA)

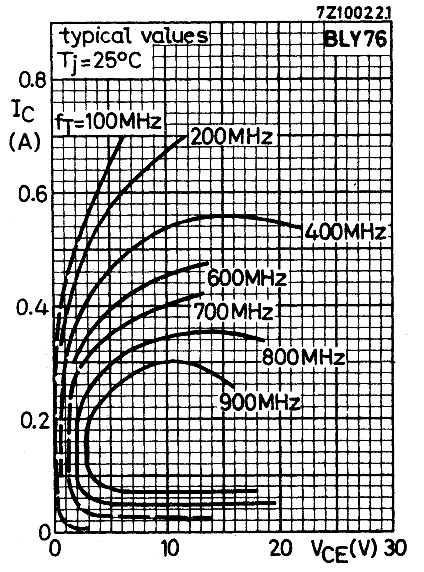

7Z09967
typical values
V_{CE} = 5 V
T_j = 25 °C
h_{FE}
80
60
40
20
0
BLY38
BLY76
10
10^2
10^3
I_C (mA)
10^4

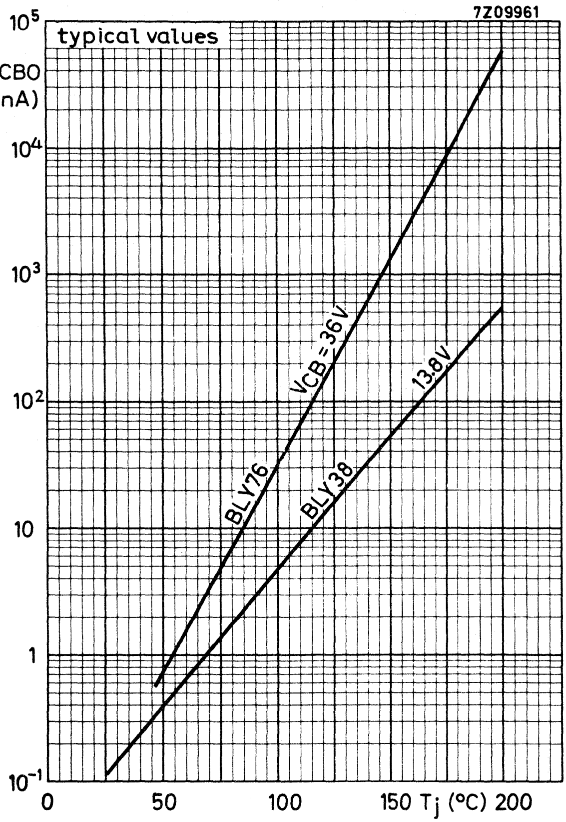

7Z09974
typical values
I_E = 250 mA
V_{CB} = 5 V
I_B
(mA)
20
15
10
5
0
BLY76
BLY38
0
100
T_j (°C)
200


7Z09972
typical values
V_{CE} = 5V
f = 470MHz
BLY38
Im(h_{ie})
Re(h_{ie})
(Ω)
20
15
10
5
0
Im(h_{ie})
Re(h_{ie})
0
100
200 I_C (mA) 300


7Z09971
typical values
V_{CE} = 5V
f = 470MHz
BLY76
Im(h_{ie})
Re(h_{ie})
(Ω)
20
15
10
5
0
Im(h_{ie})
Re(h_{ie})
0
100
200 I_C (mA) 300

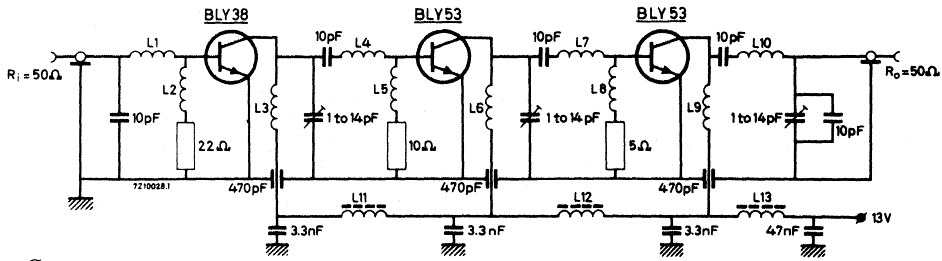

7Z10021
typical values
T_j = 25°C
BLY38
I_C
(A)
1.5
1
0.5
0
f_T = 100MHz
300MHz
400MHz
500MHz
600MHz
700MHz
800MHz
900MHz
1100MHz
1000MHz
0
5
V_{CE} (V)
10


7Z100221
typical values
T_j = 25°C
BLY76
I_C
(A)
0.8
0.6
0.4
0.2
0
f_T = 100MHz
200MHz
400MHz
600MHz
700MHz
800MHz
900MHz
0
10
20
V_{CE} (V) 30


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
V_{CB} = 36V
BLY76
13.8V
BLY38

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

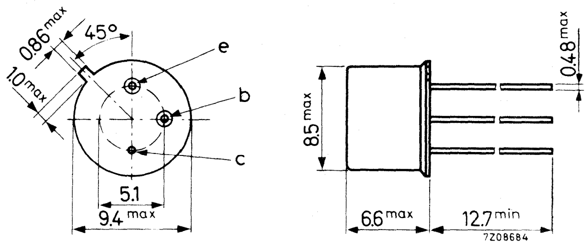
Type No.	T_{mb} (°C)	T_h (°C)	P_o (W)	P_i (W)	G_p (dB)	η (%)
BFS22	25		4	< 0.63	> 8	> 60
BLY87		25	8	< 1.0	> 9	> 70
BLY88		25	15	< 2.65	> 7.5	> 65
BLY89		25	23	< 5.75	> 6	> 70

MECHANICAL DATA see page 2

MECHANICAL DATA
BFS22

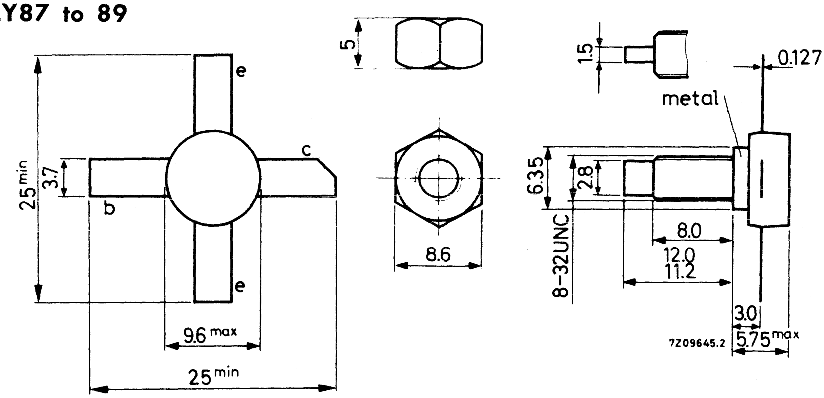
Dimensions in mm

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

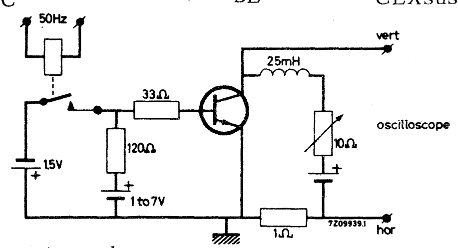
THERMAL RESISTANCE

			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	$R_{th\ mb\text{-}h}$	=	**2.5**				°C/W ←

CHARACTERISTICS

T_j = 25 °C unless otherwise specified

			BFS22	BLY87	BLY88	BLY89	
Collector cut-off current							
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

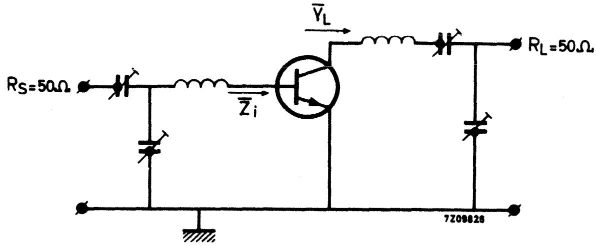
CHARACTERISTICS (continued) T_j = 25 °C unless otherwise specified

			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

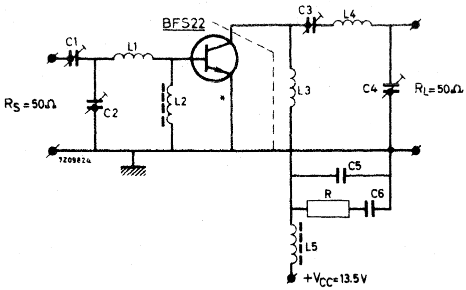
R.F. performance in common emitter configuration, class B (not neutralized) at f = 175 MHz; V_{CE} = 13.5 V						
Type No.	T_{mb} (°C)	T_h (°C)	P_o (W)	P_i (W)	G_p (dB)	η (%)
BFS22	25		4	< 0.63	> 8	> 60
BLY87		25	8	< 1.0	> 9	> 70
BLY88		25	15	< 2.65	> 7.5	> 65
BLY89		25	23	< 5.75	> 6	> 70

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)



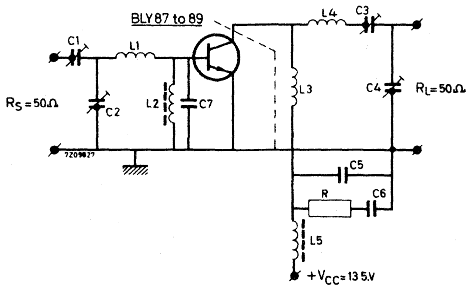
* The length of the external emitter wire is 0.5 mm.

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 **36640**
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

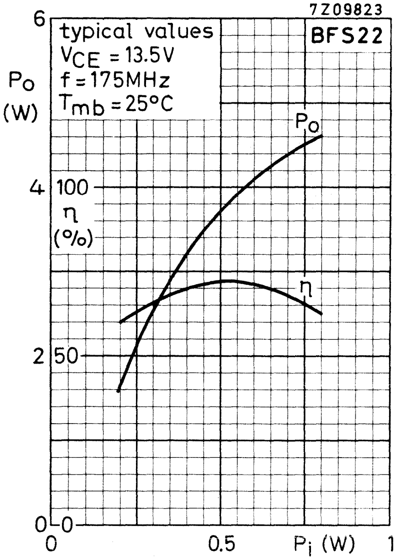
Test circuit for the BLY87; BLY88 and BLY89 at f = 175 MHz (common emitter)

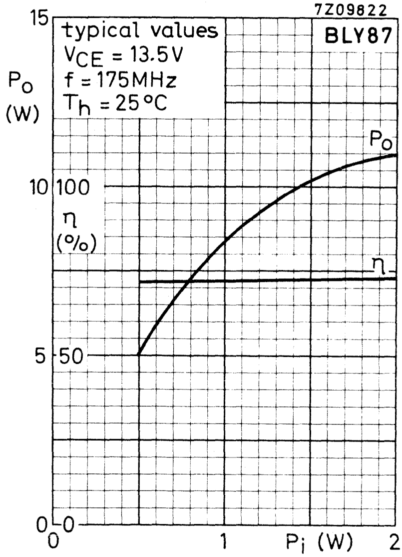


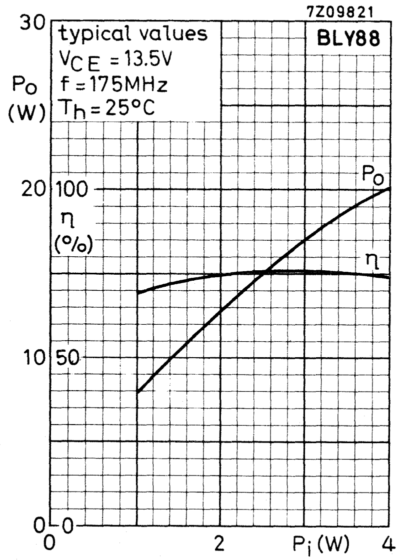
C1 = C2 = C3 = C4 = 4 to 29 pF air trimmer
C5 = 100 pF ceramic
C6 = 120 nF polyester
C7 = 47 pF ceramic
R = 10 Ω

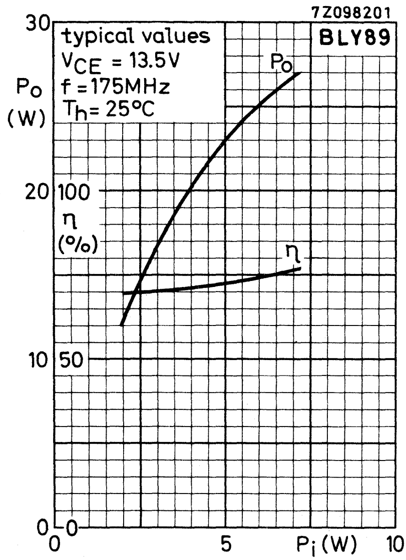
** For BLY87 L3 = 12 turns closely wound enamelled Cu wire (0.7 mm), int. diam. 4 mm

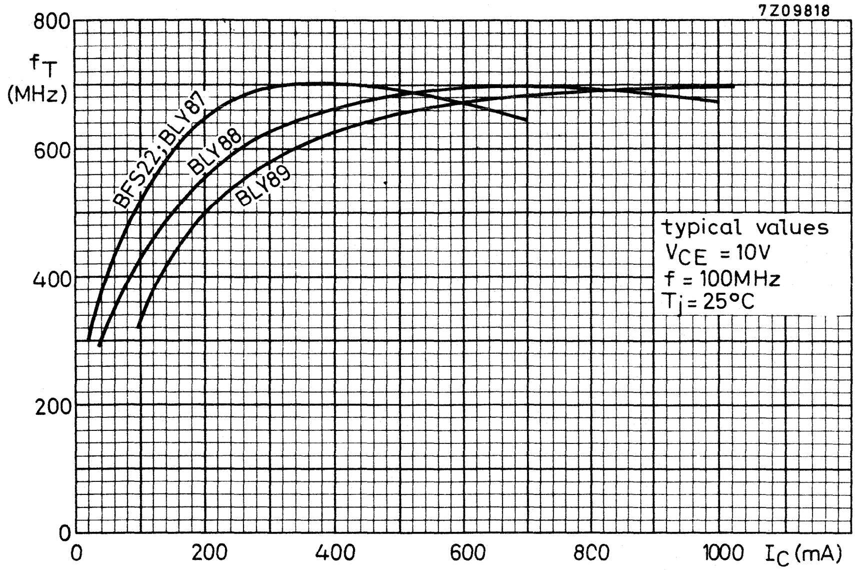
L1 = 1 turn Cu wire (1 mm), int. diam. 10 mm, leads 2x10 mm
L2 = L5 = ferroxcube choke coil.
Z (at f = 175 MHz) = 550 Ω ± 20%
Code number 4312 020 **36640**
** L3 = 2 turns Cu wire (1 mm), spaced 1 mm, int. diam. 5 mm, leads 2x15 mm
L4 = 2 turns closely wound enamelled Cu wire (1.5 mm), int. diam. 8.5 mm, leads 2x20 mm

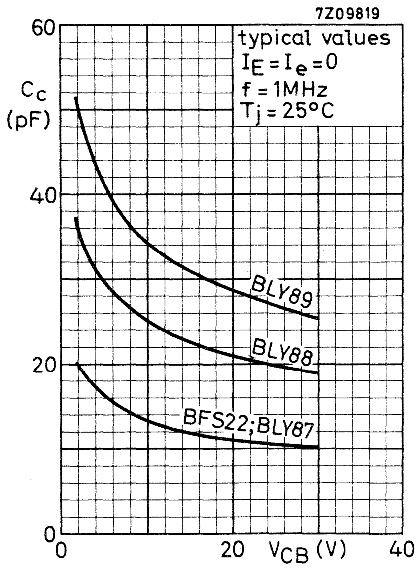

7Z09823
typical values
V_{CE} = 13.5V
f = 175MHz
T_{mb} = 25°C
BFS22
P_o (W)
η (%)
P_o
η
P_i (W)
0
0.5
1
2
4
6
50
100


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


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


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


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


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

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

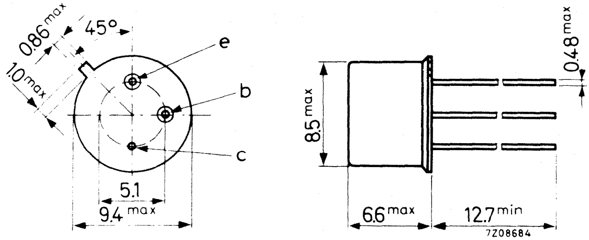
Type No.	T_{mb} (°C)	T_h (°C)	P_o (W)	P_i (W)	G_p (dB)	η (%)
BFS23	25		4	< 0.4	> 10	> 55
BLY91		25	8	< 0.5	> 12	> 50
BLY92		25	15	< 1.5	> 10	> 55
BLY93		25	23	< 2.9	> 9	> 60

MECHANICAL DATA see page 2.

MECHANICAL DATA Dimensions in mm

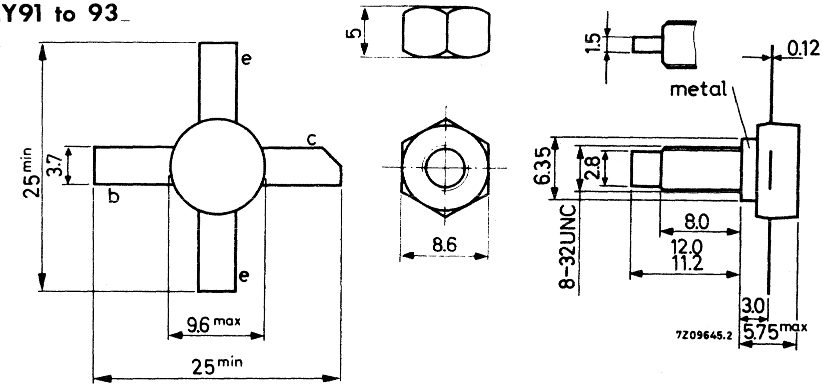
BFS23

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

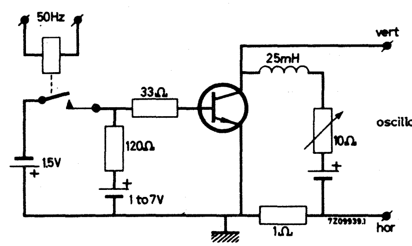
THERMAL RESISTANCE

			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	$R_{th\ mb\text{-}h}$	=	**2.5**				°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

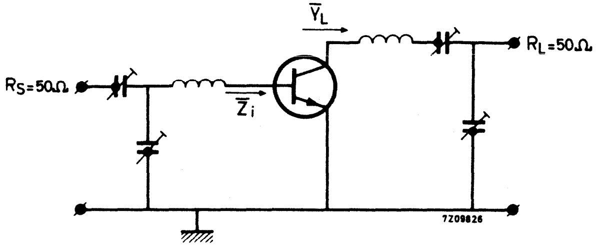
CHARACTERISTICS (continued) T_j = 25 °C unless otherwise specified

			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)	$\overline{Y}_L$ ($m\Omega^{-1}$)
BFS23 [1])	25		4	3.3 + j 1.4	10.7 − j 14.1
BLY91 [2])		25	8	2.8 + j 1.7	18.7 − j 18.4
BLY92 [2])		25	15	1.5 + j 2.2	36.9 − j 31.0
BLY93 [2])		25	23	1.4 + j 2.3	55.0 − j 39.6

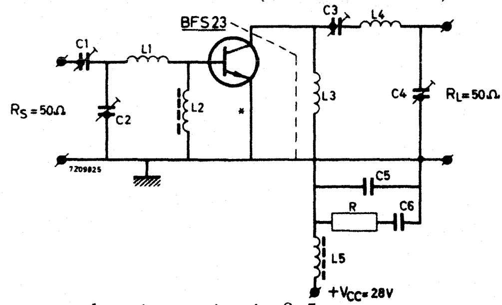
R.F. performance in common emitter configuration, class B (not neutralized) at f = 175 MHz; V_{CE} = 28 V						
Type No.	T_{mb} (°C)	T_h (°C)	P_o (W)	P_i (W)	G_p (dB)	η (%)
BFS23	25		4	< 0.4	> 10	> 55
BLY91		25	8	< 0.5	> 12	> 50
BLY92		25	15	< 1.5	> 10	> 55
BLY93		25	23	< 2.9	> 9	> 60

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)

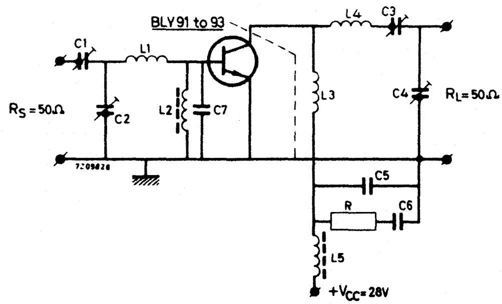


* The length of the external emitter wire is 0.5 mm.

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 **36640**
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

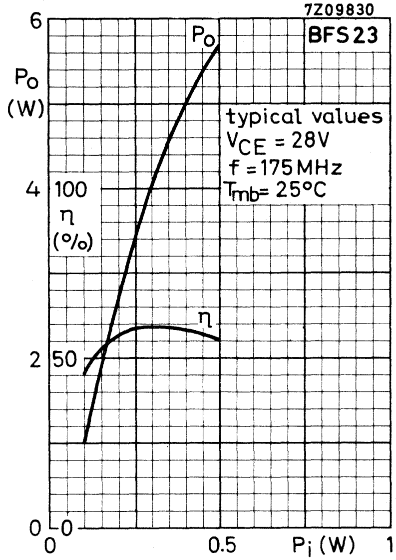
Test circuit for the BLY91; BLY92; BLY93 at f = 175 MHz (common emitter)

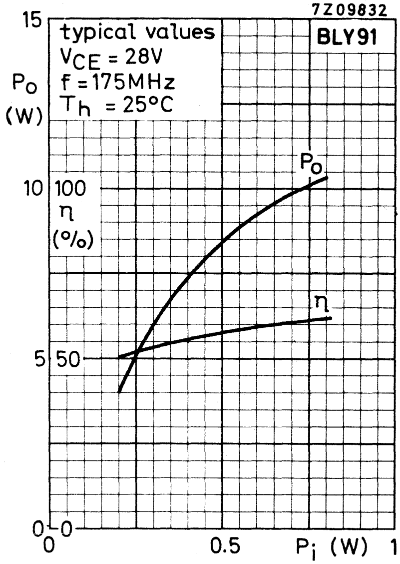


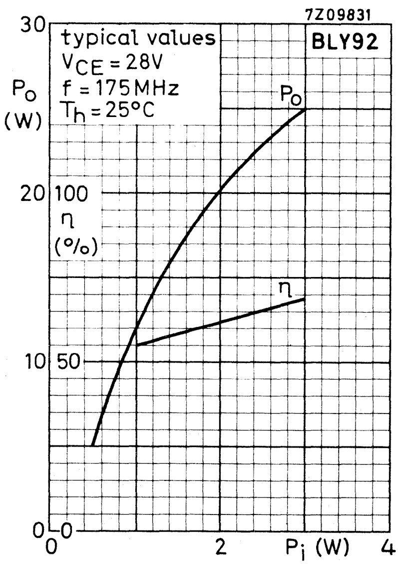
C1 = C2 = C3 = C4 = 4 to 29 pF air trimmer
C5 = 100 pF ceramic
C6 = 120 nF polyester
C7 = 47 pF ceramic
R = 10 Ω

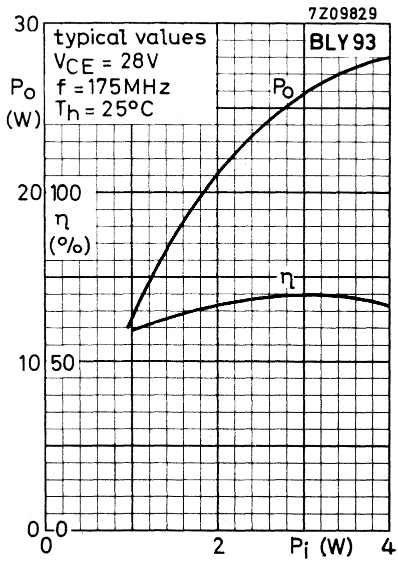
** For BLY91 L3 = 12 turns closely wound enamelled Cu wire (0.7 mm), int. diam. 4 mm

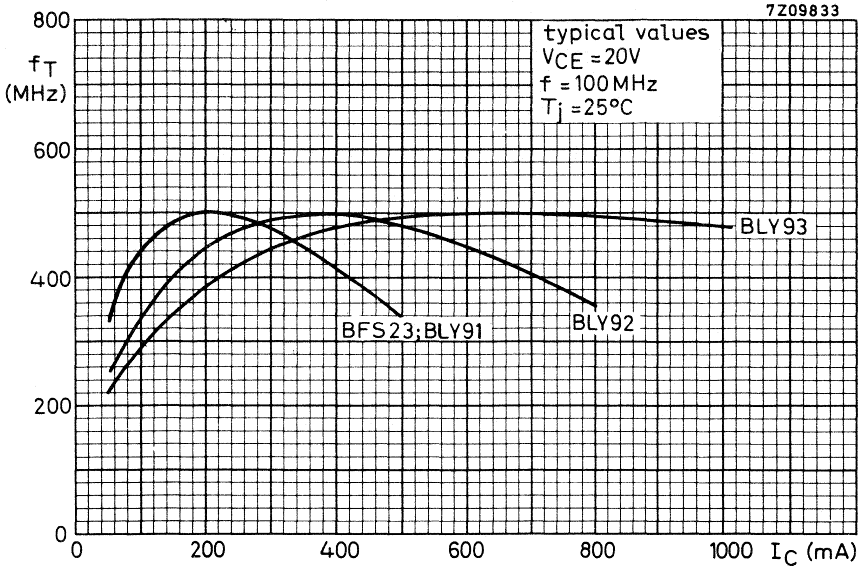
L1 = 1 turn Cu wire (1 mm), int. diam. 10 mm, leads 2x10 mm
L2 = L5 = ferroxcube choke coil.
Z (at f = 175 MHz) = 550 Ω ± 20%
Code number 4312 020 **36640**
** L3 = 2 turns Cu wire (1mm), spaced 1 mm, int. diam. 5 mm, leads 2 x 15 mm
L4 = 2 turns closely wound enamelled Cu wire (1.5 mm), int. diam. 8.5 mm, leads 2x20 mm

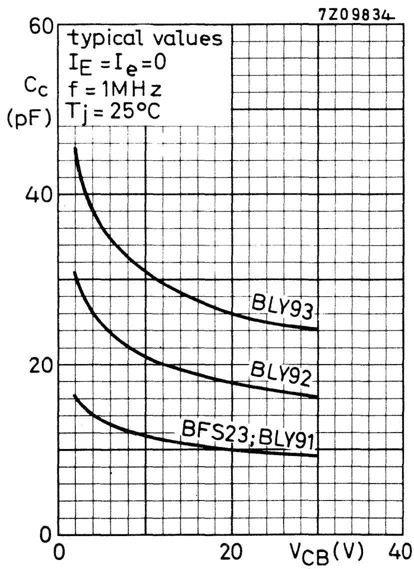

7Z09830
BFS23
typical values
V_{CE} = 28V
f = 175MHz
T_{mb} = 25°C
P_o (W)
η (%)
P_i (W)
6
4
2
0
100
50
0
0.5
1


7Z09832
BLY91
typical values
V_{CE} = 28V
f = 175MHz
T_h = 25°C
P_o (W)
η (%)
P_i (W)
15
10
5
0
100
50
0
0.5
1


7Z09831
BLY92
typical values
V_{CE} = 28V
f = 175MHz
T_h = 25°C
P_o (W)
η (%)
P_i (W)
30
20
10
0
100
50
0
2
4


7Z09829
BLY93
typical values
V_{CE} = 28V
f = 175MHz
T_h = 25°C
P_o (W)
η (%)
P_i (W)
30
20
10
0
100
50
0
2
4


7Z09833
typical values
V_{CE} = 20V
f = 100 MHz
T_j = 25°C
f_T
(MHz)
800
600
400
200
0
0
200
400
600
800
1000
I_C (mA)
BLY93
BFS23; BLY91
BLY92


7Z09834
typical values
$I_E = I_e = 0$
f = 1 MHz
T_j = 25°C
C_c
(pF)
60
40
20
0
0
20
V_{CB} (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

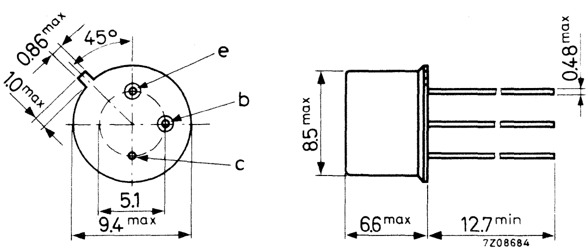
			2N3553	2N3375	2N3632	
Collector-emitter voltage $-V_{BE}$ = 1.5 V	V_{CEX}	max.	65	65	65	V
Collector-emitter voltage (open base)	V_{CEO}	max.	40	40	40	V
Collector current (peak value)	I_{CM}	max.	1.0	1.5	3.0	A
Total power dissipation up to T_{mb} = 25 °C	P_{tot}	max.	7	11.6	23	W
Junction temperature	T_j	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)

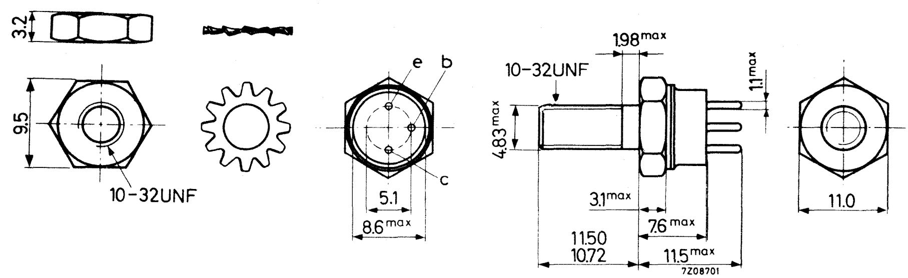
2N3375
2N3632

Dimensions in mm

TO-60
The top pins should not be bent

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	$R_{th\ mb\text{-}h}$ =	**2.5**			°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
$I_B = 0$ [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

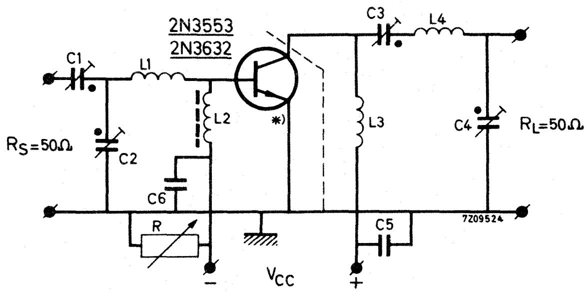
	f (MHz)	P_o (W)	P_i (W)	I_C (mA)	η %	Test circuit at page
2N3553	175	2.5	< 0.25	< 180	> 50	5
2N3375	100	7.5	< 1	< 410	> 65	6
2N3375	400	> 3	1	270	> 40	7
2N3632	175	> 13.5	3.5	690	> 70	5

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 **36640**) ←

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

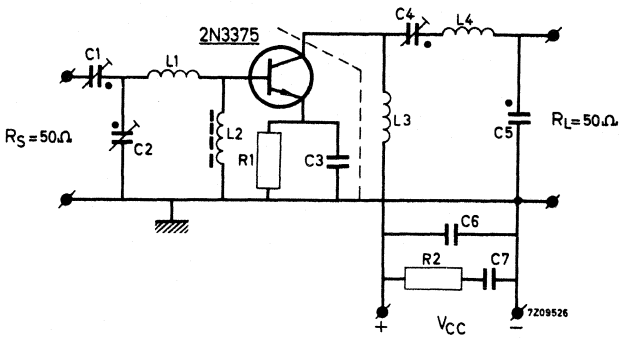
L4 = 3 turns closely wound enamelled Cu wire (1.5 mm); int. diam. 12 mm; leads 2 x 20 mm

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 **36640**)

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

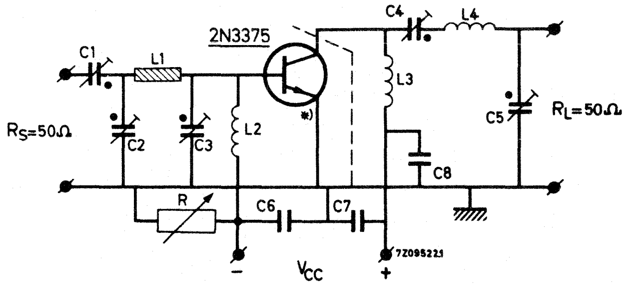
L4 = 5 turns closely wound enamelled Cu wire (1.5 mm); int. diam. 12 mm; leads 2 x 10 mm

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

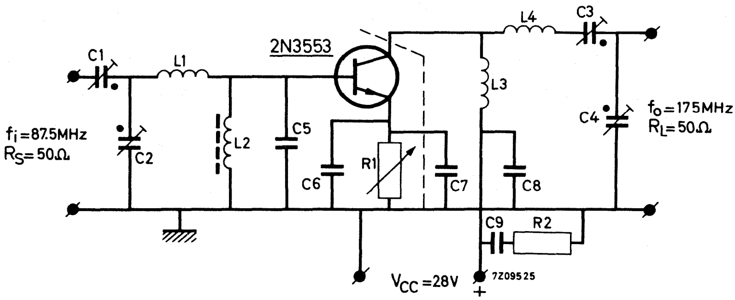
L3 = 7 turns closely wound enamelled Cu wire (0.5 mm); int. diam. 3 mm

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

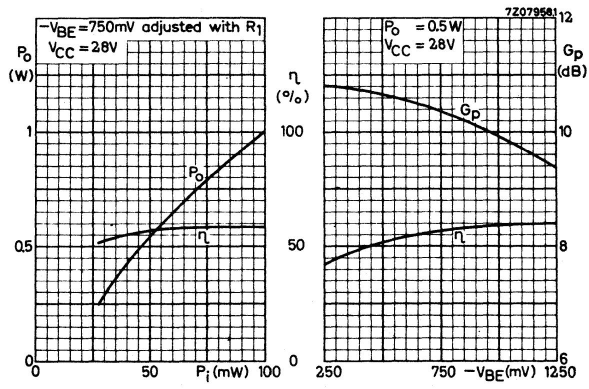
C1 = C2 = C3 =	4 to 29 pF	air trimmer	R_1 =	0 to 50 Ω	
C4 =	3.5 to 61.5 pF	air trimmer	R_2 =	10 Ω	carbon
C5 =	56 pF	ceramic			
C6 =	680 pF	ceramic			
C7 =	150 pF	ceramic			
C8 =	100 pF	ceramic			
C9 =	10 nF	polyester			

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 **36640**)

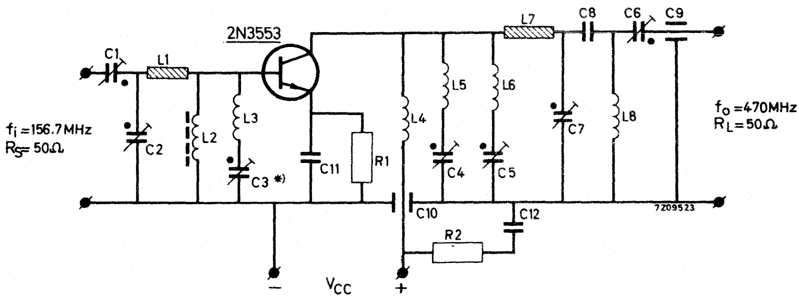
L3 = 15 turns closely wound enamelled Cu wire (0.7 mm); int. diam. 4 mm

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

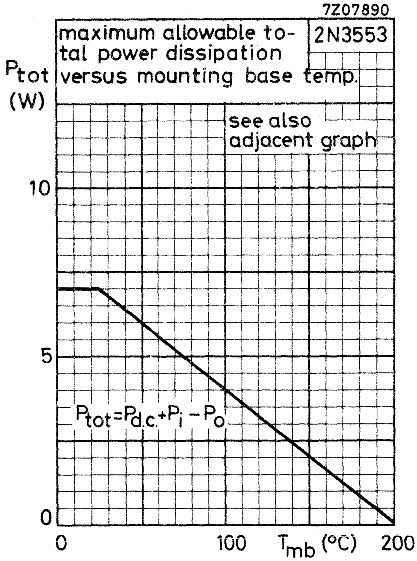
Components

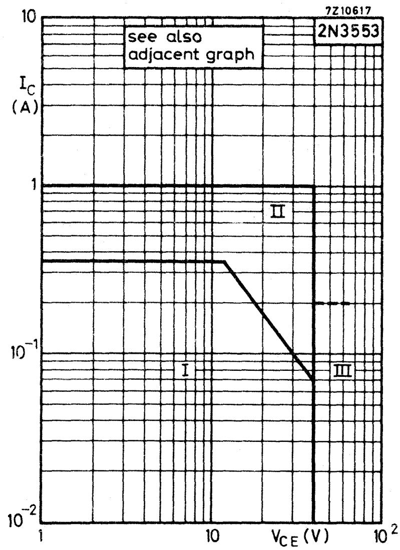
C1 = C2 = C3 = C4 =	4 to 29 pF	air trimmer	R_1 =	2.2 Ω	carbon
C5 = C6 = C7 =	4 to 10.4 pF	air trimmer	R_2 =	10 Ω	carbon
C8 =	1.0 pF	ceramic			
C9 =	12 pF	ceramic; feed through			
C10 =	100 pF	ceramic; feed through			
C11 =	1000 pF	ceramic			
C12 =	15 nF	polyester			

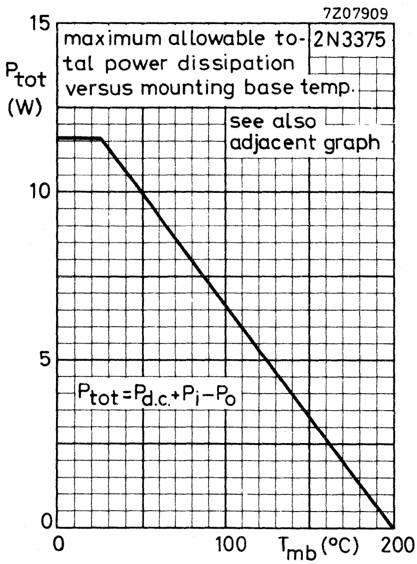
L1 = 35 mm straight Cu wire; diam. 1 mm; spaced 5.5 mm from chassis
L2 = Ferroxcube choke coil; Z (at f = 156.7 MHz) = 600 Ω ± 20%
(code number 4312 020 **36640**) ←
L3 = 18 mm straight Cu wire; diam. 1 mm; spaced 5.5. mm from chassis
L4 = 7 turns closely wound enamelled Cu wire (0.5 mm); int. diam. 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

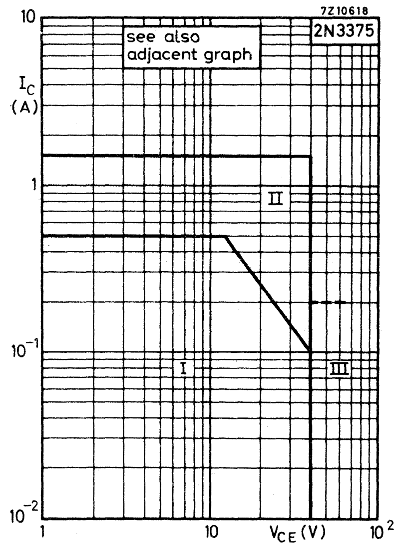
Typical performance at V_{CC} = 28 V

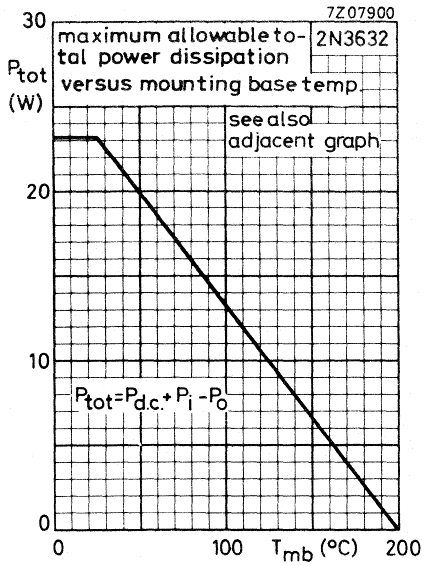
P_o (W)	P_i (W)	G_p (dB)	I_C (mA)	η %
1.5	0.27	7.5	125	43
2.0	0.39	7.1	156	46

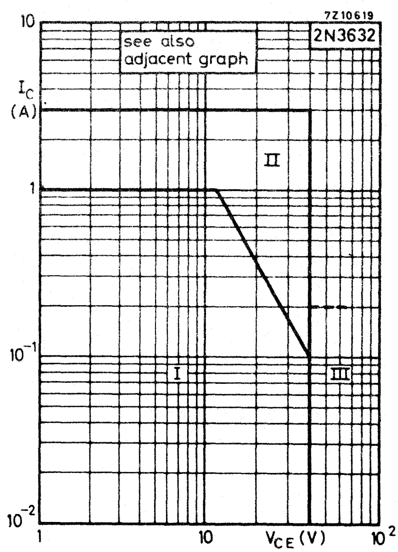

7Z07890
maximum allowable total power dissipation versus mounting base temp.
2N3553
Ptot (W)
see also adjacent graph
Ptot=Pd.c.+Pi−Po
10
5
0
0
100
Tmb (°C)
200


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


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

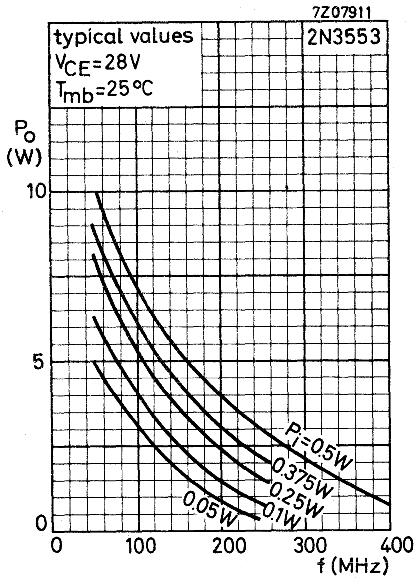


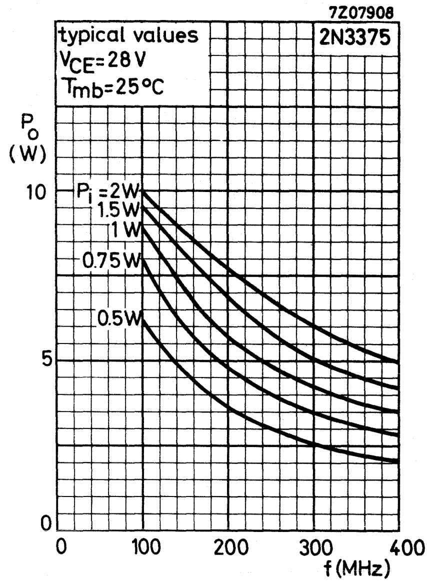


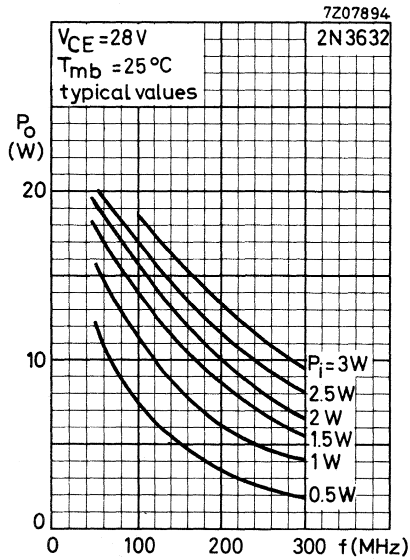
I Region of permissible operation under all base-emitter conditions and at all frequencies, including d.c.

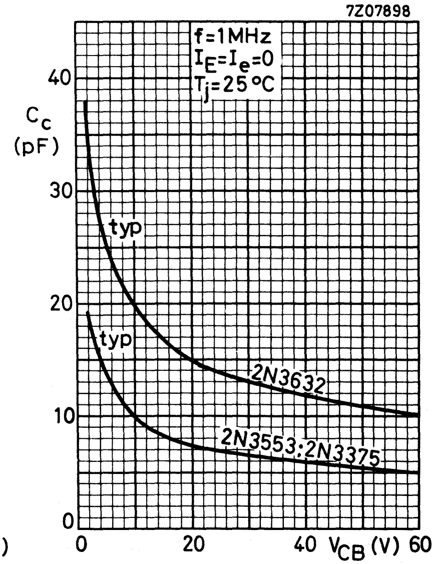
II Additional region of operation at $f \geq 1$ MHz.
Care must be taken to reduce the d.c. adjustment to region I before removing the a.c. signal. This may be achieved by an appropriate bias in class A, B or C.

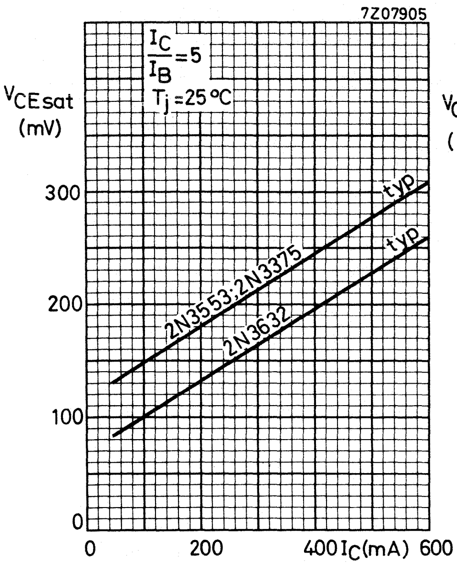
III Operating during switching off in this region is allowed, provided the transistor is cut-off with $-V_{BB} \leq 1.5$ V and $R_{BE} \geq 33\ \Omega$, $I_C \leq 200$ mA and the transient energy does not exceed 0.5 mWs.

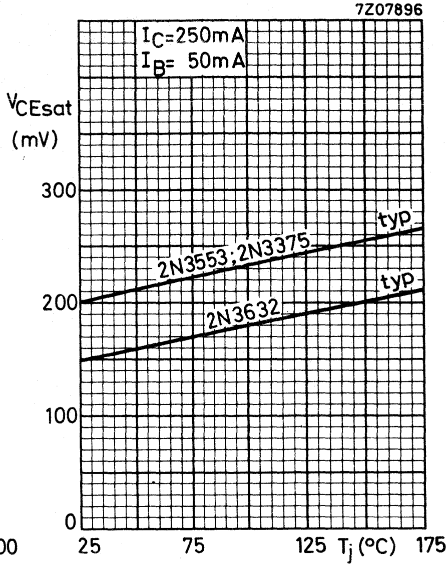

7Z07911
typical values
V_{CE}=28V
T_{mb}=25°C
2N3553
P_o
(W)
10
5
0
0
100
200
300
400
f (MHz)
P_i=0.5W
0.375W
0.25W
0.1W
0.05W

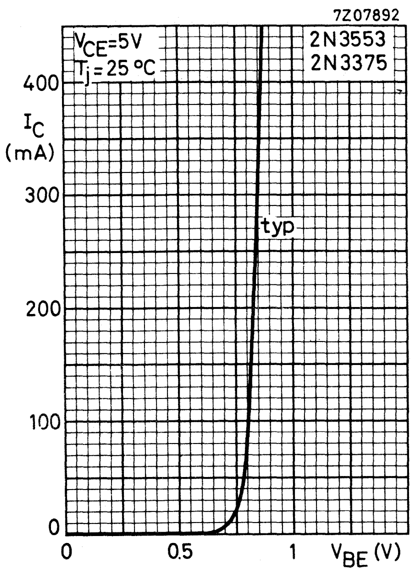

7Z07908
typical values
V_{CE}=28V
T_{mb}=25°C
2N3375
P_o
(W)
10
5
0
P_i=2W
1.5W
1W
0.75W
0.5W
0
100
200
300
400
f (MHz)

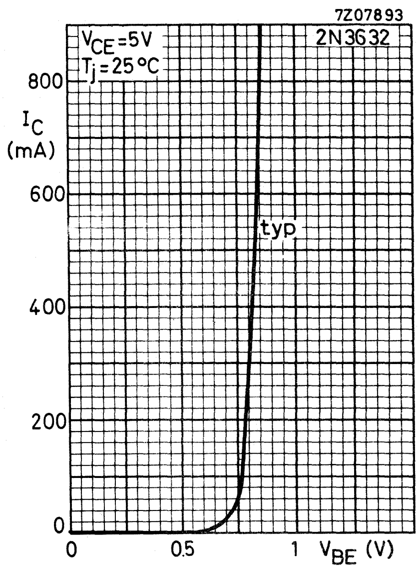

7Z07894
V_{CE}=28V
T_{mb}=25°C
typical values
2N3632
P_o
(W)
20
10
0
P_i=3W
2.5W
2 W
1.5W
1 W
0.5W
0
100
200
300
f (MHz)

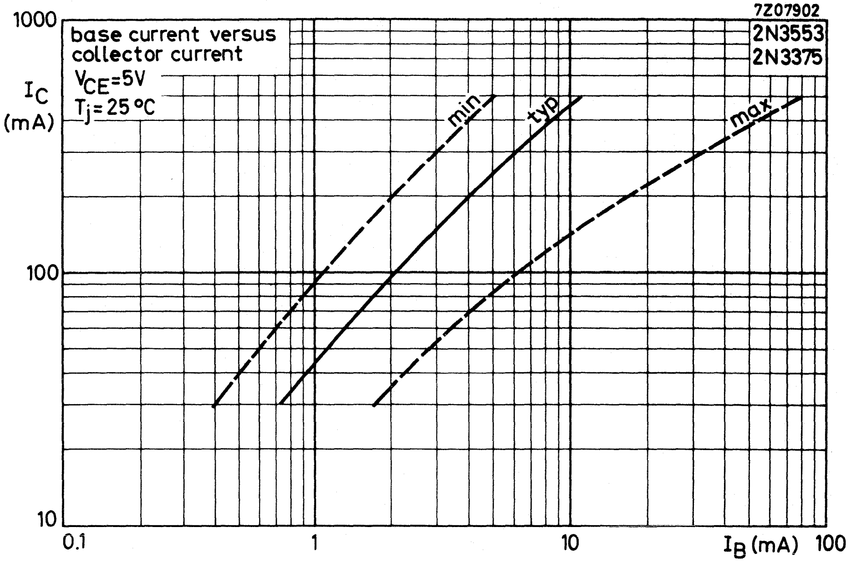

7Z07898
f=1MHz
I_E=I_e=0
T_j=25°C
C_c
(pF)
40
30
20
10
0
typ
typ
2N3632
2N3553;2N3375
0
20
40
V_{CB} (V)
60

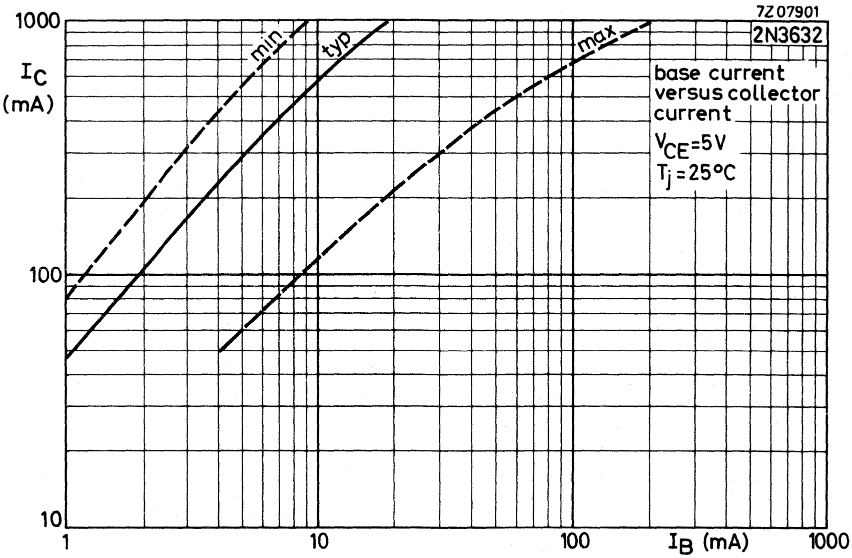

7Z07905
$\frac{I_C}{I_B}=5$
$T_j=25\,^{\circ}C$
V_{CEsat} (mV)
300
200
100
0
0
200
400
I_C (mA)
600
2N3553;2N3375
2N3632
typ
typ

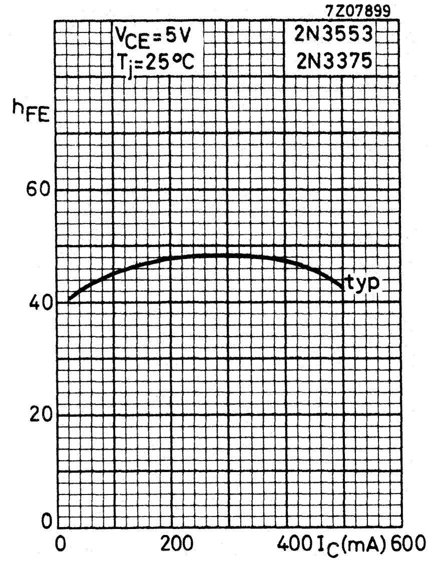

7Z07896
$I_C=250\,mA$
$I_B=50\,mA$
V_{CEsat} (mV)
300
200
100
0
25
75
125
T_j (°C)
175
2N3553;2N3375
2N3632
typ
typ

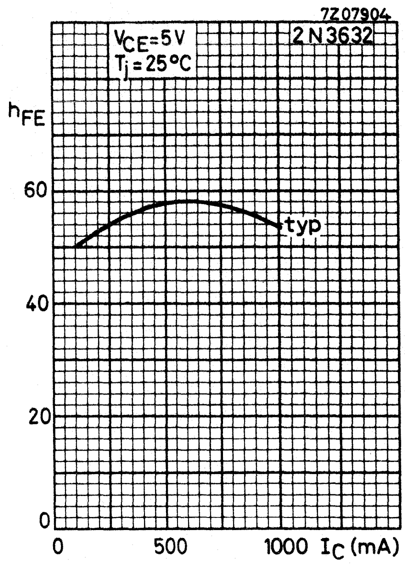

7Z07892
$V_{CE}=5\,V$
$T_j=25\,^{\circ}C$
2N3553
2N3375
I_C (mA)
400
300
200
100
0
0
0.5
1
V_{BE} (V)
typ

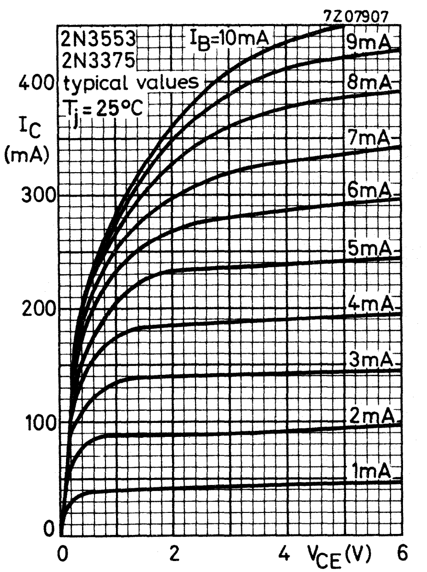

7Z07893
$V_{CE}=5\,V$
$T_j=25\,^{\circ}C$
2N3632
I_C (mA)
800
600
400
200
0
0
0.5
1
V_{BE} (V)
typ

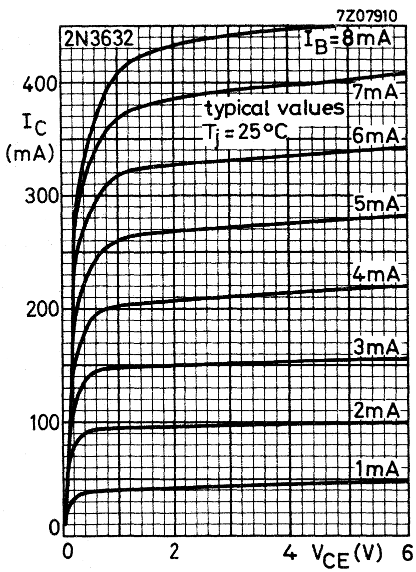

7Z07902
2N3553
2N3375
base current versus
collector current
VCE=5V
Tj=25 °C
IC
(mA)
1000
100
10
min
typ
max
0.1
1
10
IB (mA)
100

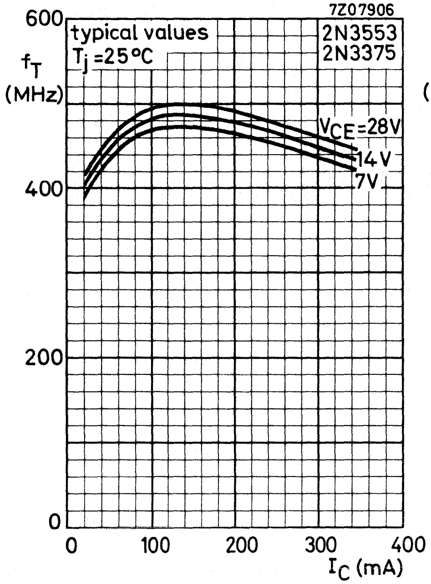

7Z07901
2N3632
base current
versus collector
current
VCE=5V
Tj=25°C
IC
(mA)
1000
100
10
min
typ
max
1
10
100
IB (mA)
1000

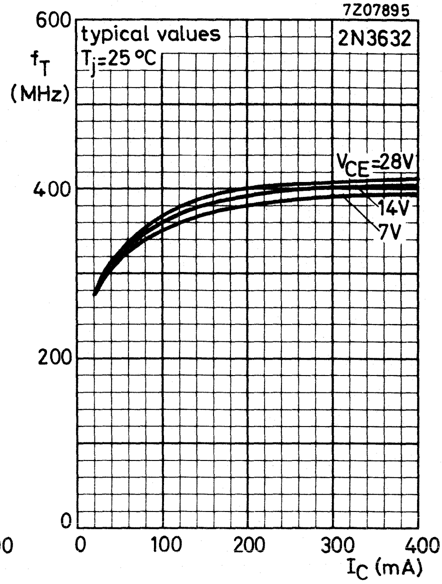

7Z07899
V_{CE} = 5 V
T_j = 25 °C
2N3553
2N3375
h_{FE}
60
40
20
0
typ
0
200
400
600
I_C (mA)

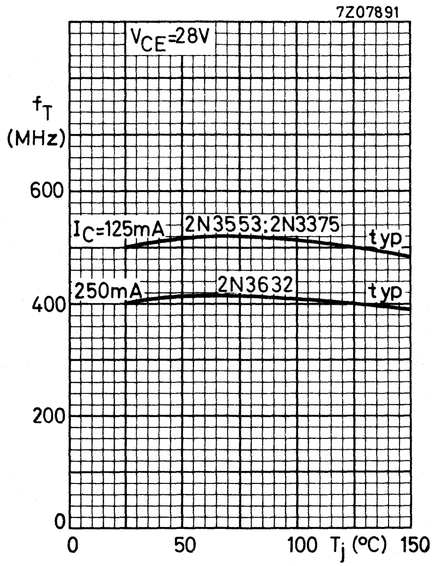

7Z07904
V_{CE} = 5 V
T_j = 25 °C
2N3632
h_{FE}
60
40
20
0
typ
0
500
1000
I_C (mA)

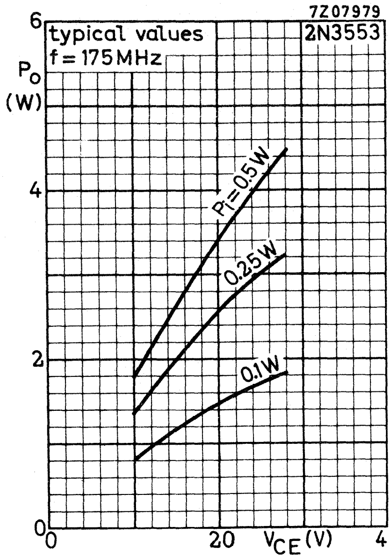

7Z07907
2N3553
2N3375
typical values
T_j = 25 °C
I_B = 10 mA
9 mA
8 mA
7 mA
6 mA
5 mA
4 mA
3 mA
2 mA
1 mA
I_C (mA)
400
300
200
100
0
0
2
4
6
V_{CE} (V)

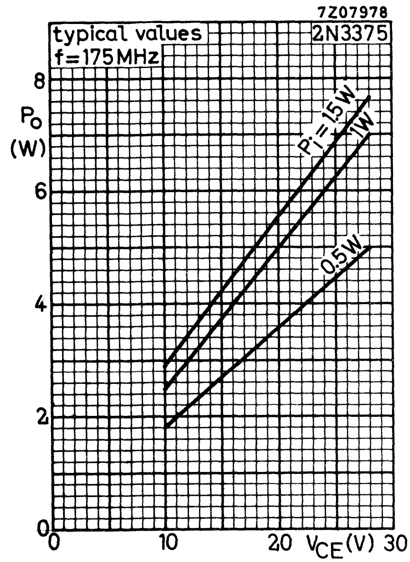

7Z07910
2N3632
typical values
T_j = 25 °C
I_B = 8 mA
7 mA
6 mA
5 mA
4 mA
3 mA
2 mA
1 mA
I_C (mA)
400
300
200
100
0
0
2
4
6
V_{CE} (V)

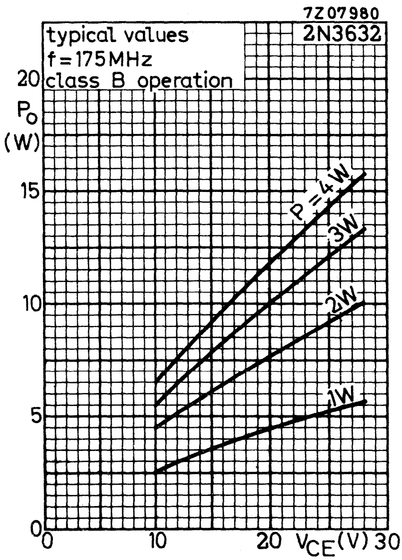

7Z07906
typical values
T_j = 25 °C
2N3553
2N3375
f_T
(MHz)
600
400
200
0
V_{CE} = 28V
14 V
7V
0
100
200
300
400
I_C (mA)


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
T_j (°C)
150


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


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


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

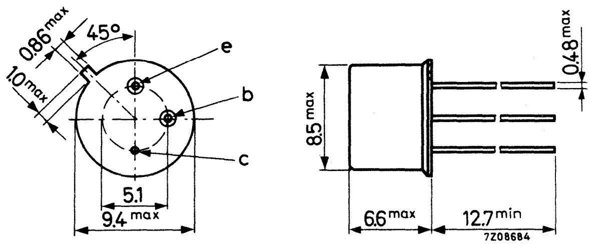
			2N3866	2N4427	
Collector-emitter voltage R_{BE} = 10 Ω	V_{CER}	max.	55	40	V
Collector-emitter voltage (open base)	V_{CEO}	max.	30	20	V
Collector current (d.c. or averaged over any 20 ms period)	I_C	max.	0.4	0.4	A
Total power dissipation up to T_{mb} = 25 °C	P_{tot}	max.	5	3.5	W
Junction temperature	T_j	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 in accordance with the Absolute Maximum System (IEC134)

Voltages [1]			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 [1]					
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 [1]					
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	$R_{th\ j-a}$	=	200	°C/W
From junction to mounting base	$R_{th\ j-mb}$	=	35	°C/W
From mounting base to heatsink mounted with top clamping washer of 56218	$R_{th\ mb-h}$	=	1.0	°C/W
top clamping washer of 56218 and a boron nitride washer for electrical insulation	$R_{th\ mb-h}$	=	**2.5**	°C/W

[1]) 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

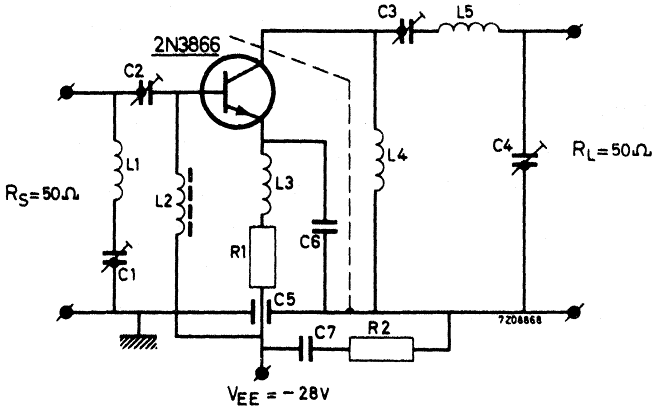
R.F. performance at T_{mb} = 25 °C

	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

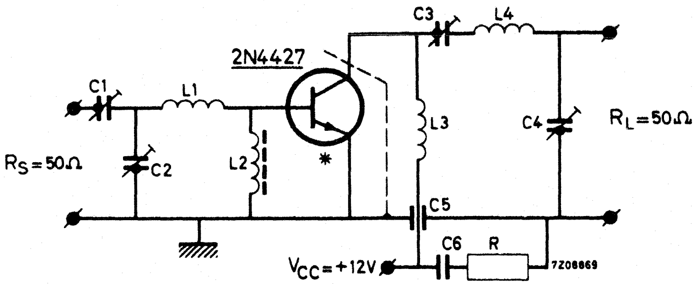
→ L2 = Ferroxcube choke coil; Z (at f = 250 MHz) = 450 Ω (code number 4312 020 36690)

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)

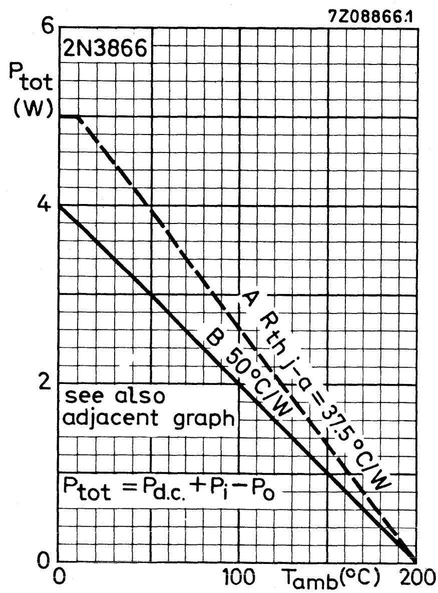
Test circuit with the 2N4427 at f = 175 MHz

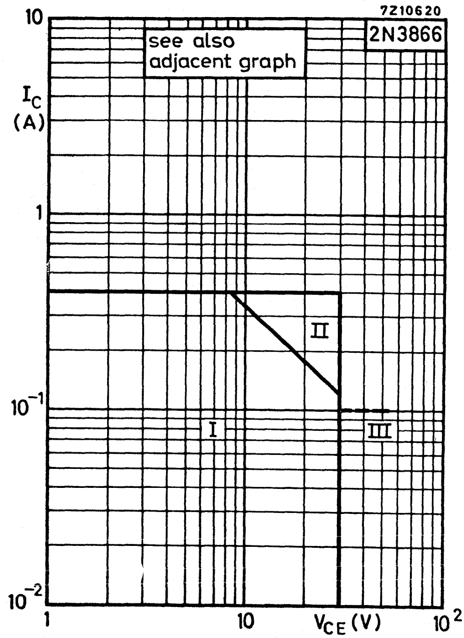


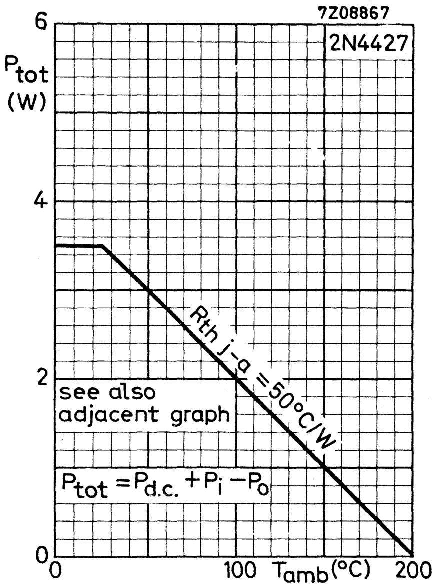
*) The length of the external emitter wire is 1.6 mm

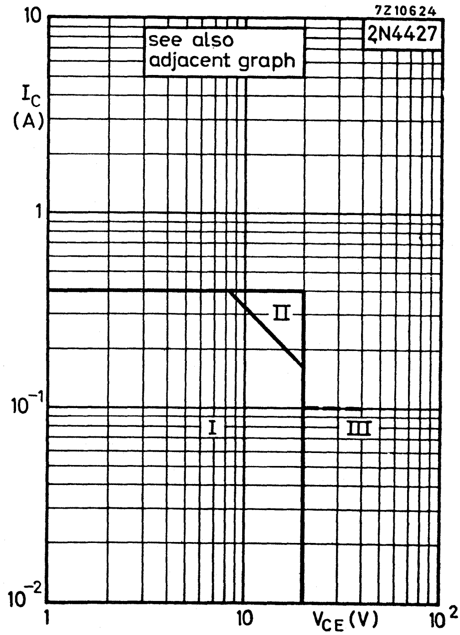
C1 = C2 = C3 = C4 =	4 to 29 pF	air trimmer
C5 =	1 nF	feed through
C6 =	12 nF	
R =	10 Ω	

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 36640) ←
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


7Z08866.1
2N3866
P_{tot} (W)
6
4
2
0
A $R_{th\ j-a}$ = 37,5 °C/W
B 50°C/W
see also adjacent graph
$P_{tot} = P_{d.c.} + P_i - P_o$
0
100
T_{amb} (°C)
200


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

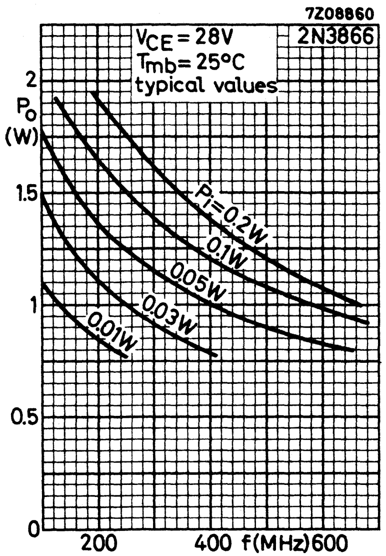

7Z08867
2N4427
P_{tot} (W)
6
4
2
0
$R_{th\ j-a}$ = 50°C/W
see also adjacent graph
$P_{tot} = P_{d.c.} + P_i - P_o$
0
100
T_{amb} (°C)
200

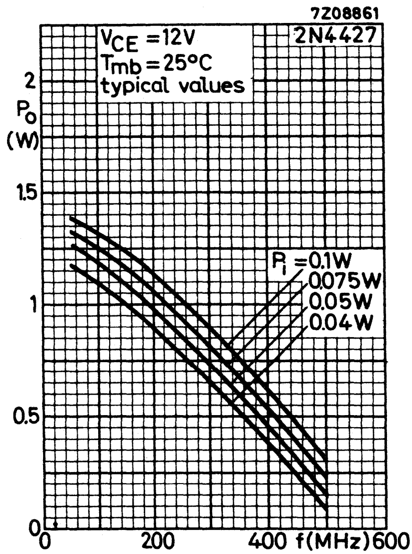

7Z10624
2N4427
see also adjacent graph
I_C (A)
10
1
10^{-1}
10^{-2}
I
II
III
1
10
V_{CE} (V)
10^2

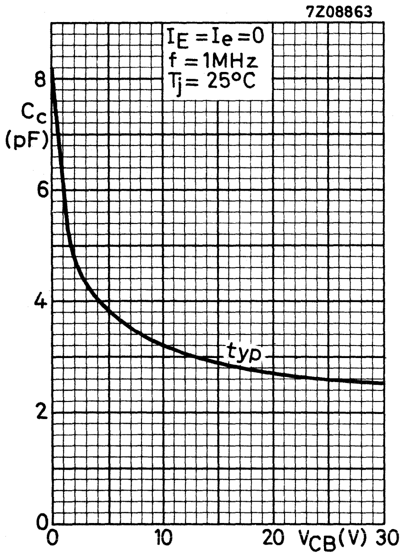
I Region of permissible operation under all base-emitter conditions and at all frequencies, including d.c.

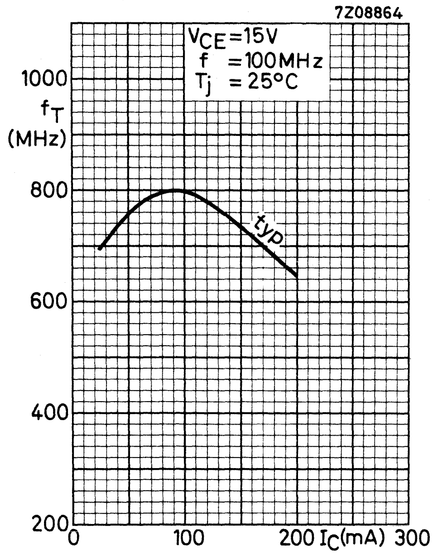
II Additional region of operation at f ≥ 1 MHz.
Care must be taken to reduce the d.c. adjustment to region I before removing the a.c. signal. This may be achieved by an appropriate bias in class A, B or C.

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
0
10
20
V_{CB}(V)
30
typ


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

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.

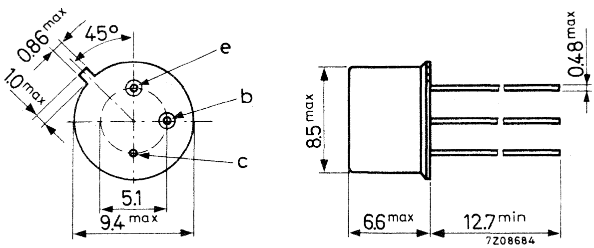
QUICK REFERENCE DATA

			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)

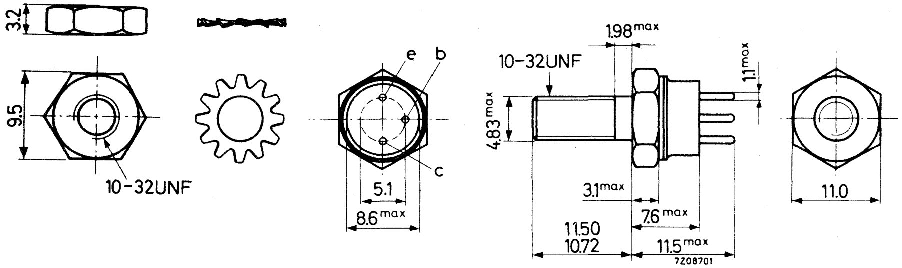
Dimensions in mm

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	$R_{th\ j-mb}$	=	25	15	7.5	$^{o}C/W$
From mounting base to heatsink	$R_{th\ mb-h}$	=		0.6	0.6	$^{o}C/W$
From mounting base to heatsink mounted with top clamping washer of 56218	$R_{th\ mb-h}$	=	1.0			$^{o}C/W$
top clamping washer of 56218 and a boron nitride washer for electrical insulation	$R_{th\ mb-h}$	=	**2.5**			$^{o}C/W$ ←

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; $T_j = 150\ ^{o}C$	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

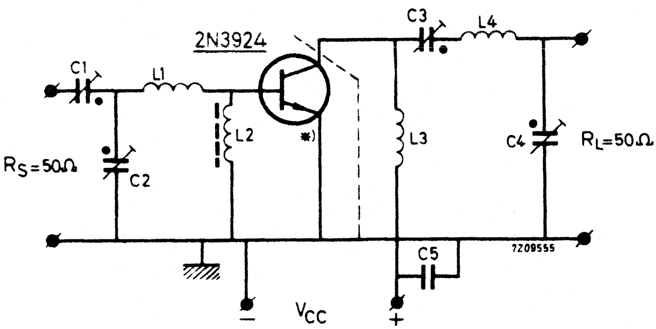
	P_o (W)	P_i (W)	I_C (mA)	η %	Test circuit at page
2N3924	4	< 1	< 420	> 70	5
2N3926	7	< 2	< 740	> 70	6
2N3927	12	< 4	< 1100	> 80	6

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

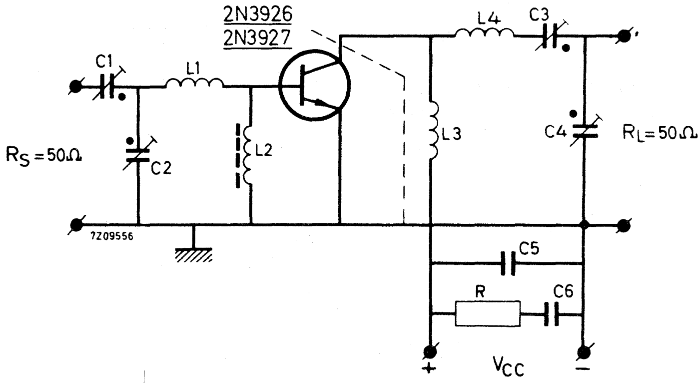
L2 = Ferroxcube choke coil. Z (at f = 175 MHz) = 550 Ω ± 20%
(code number 4312 020 **36640**) ←

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

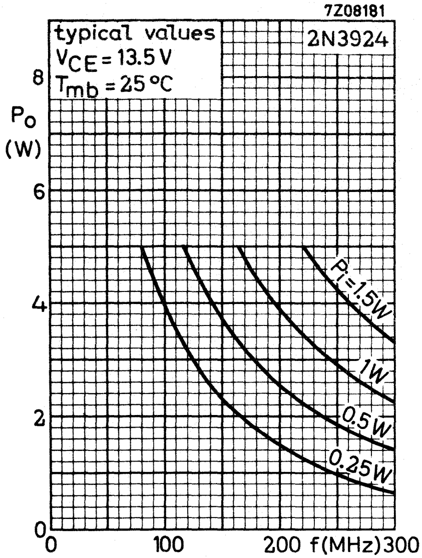
L1 = 1 turn Cu wire (1.0 mm); int. diam. 10 mm; leads 2 x 10 mm

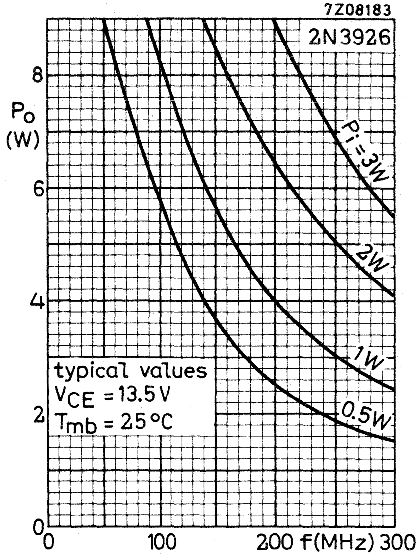
L2 = Ferroxcube choke coil. Z (at f = 175 MHz) = 550 Ω ± 20% (code number 4312 020 **36640)**

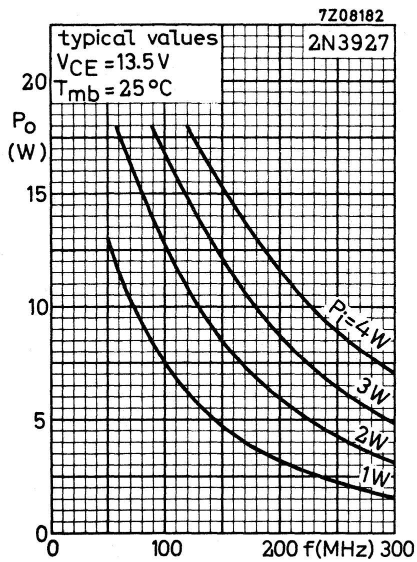
L3 = 15 turns closely wound enamelled Cu wire (0.7 mm); int. diam. 4 mm

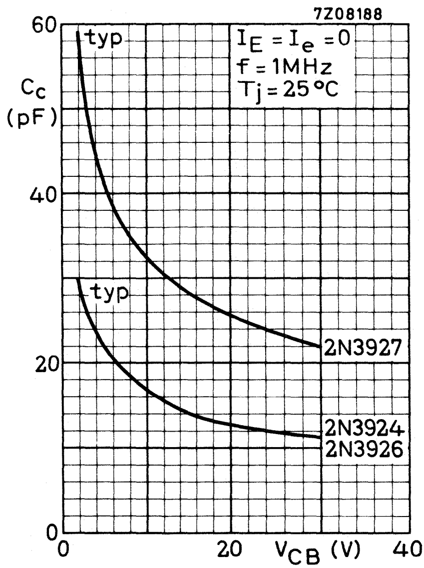
L4 = 2 turns closely wound enamelled Cu wire (1.5 mm); int. diam. 8.5 mm; leads 2 x 20 mm

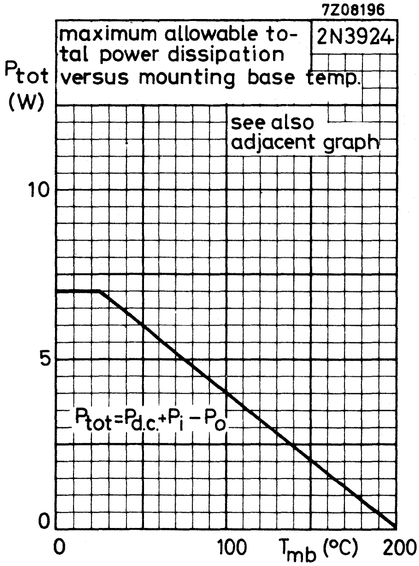
R = 10 Ω carbon

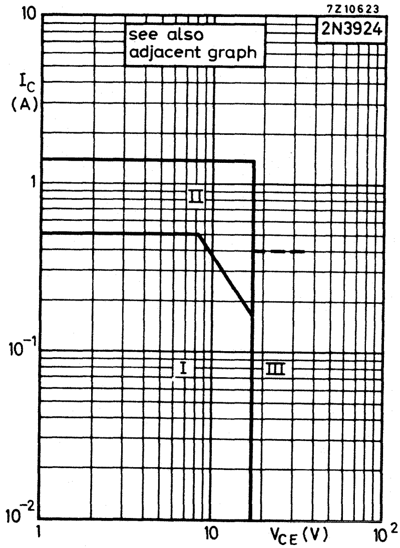

7Z08181
typical values
V_{CE} = 13.5 V
T_{mb} = 25 °C
2N3924
P_o (W)
P_i = 1.5 W
1 W
0.5 W
0.25 W
f (MHz)

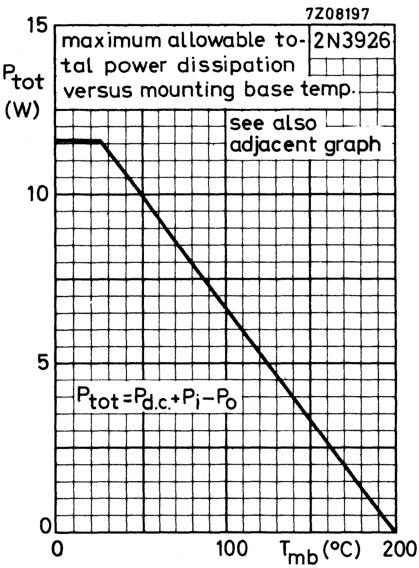

7Z08183
2N3926
P_o (W)
P_i = 3 W
2 W
1 W
0.5 W
typical values
V_{CE} = 13.5 V
T_{mb} = 25 °C
f (MHz)

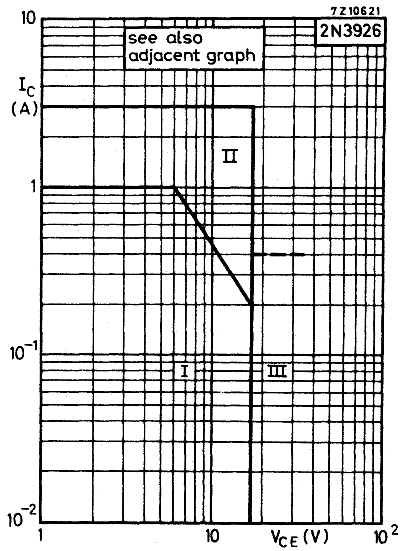

7Z08182
typical values
V_{CE} = 13.5 V
T_{mb} = 25 °C
2N3927
P_o (W)
P_i = 4 W
3 W
2 W
1 W
f (MHz)

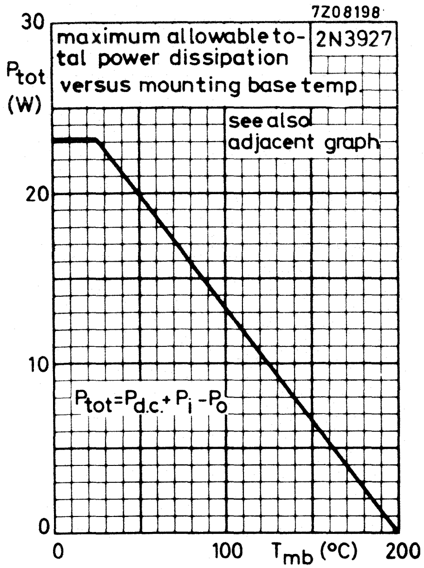

7Z08188
C_c (pF)
typ
$I_E = I_e = 0$
f = 1 MHz
T_j = 25 °C
2N3927
2N3924
2N3926
V_{CB} (V)

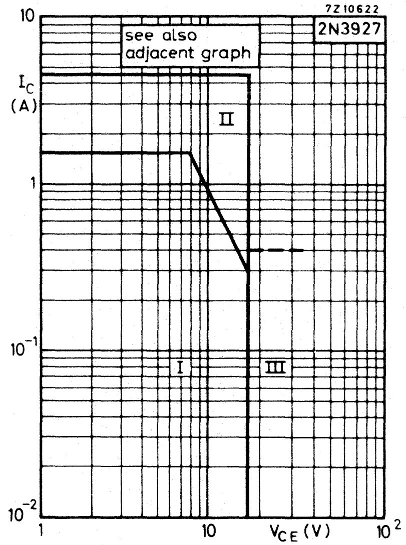

7Z08196
maximum allowable total power dissipation versus mounting base temp.
2N3924
P_{tot} (W)
see also adjacent graph
10
5
0
$P_{tot}=P_{d.c.}+P_i-P_o$
0
100
T_{mb} (°C)
200


7Z10623
2N3924
see also adjacent graph
10
I_C (A)
1
II
10^{-1}
I
III
10^{-2}
1
10
V_{CE} (V)
10^2


7Z08197
15
maximum allowable total power dissipation versus mounting base temp.
2N3926
P_{tot} (W)
see also adjacent graph
10
5
0
$P_{tot}=P_{d.c.}+P_i-P_o$
0
100
T_{mb} (°C)
200


7Z10621
2N3926
see also adjacent graph
10
I_C (A)
1
II
10^{-1}
I
III
10^{-2}
1
10
V_{CE} (V)
10^2

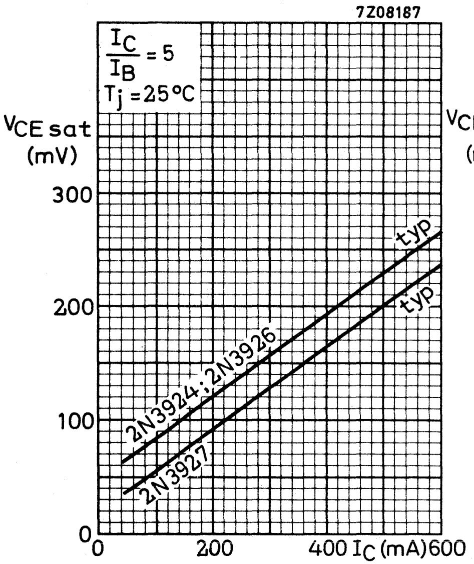


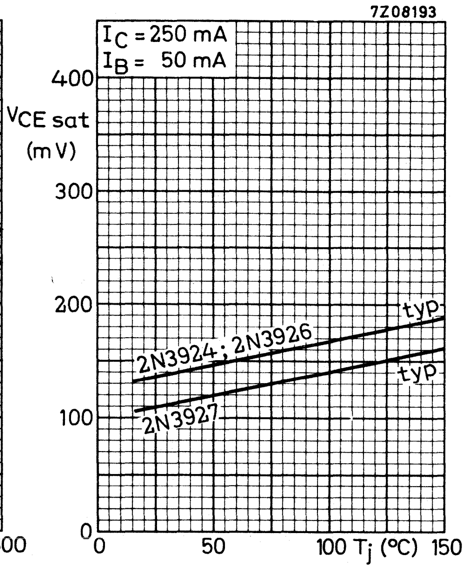


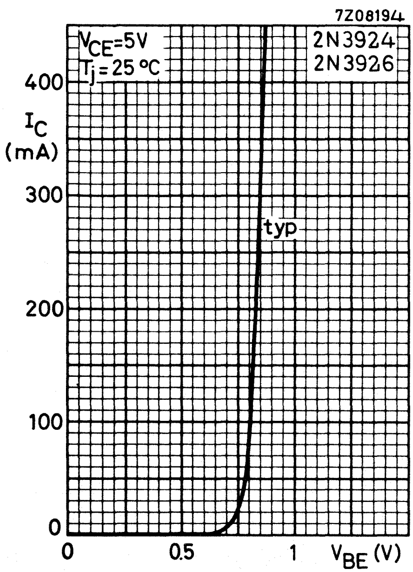
I Region of permissible operation under all base-emitter conditions and at all frequencies, including d.c.

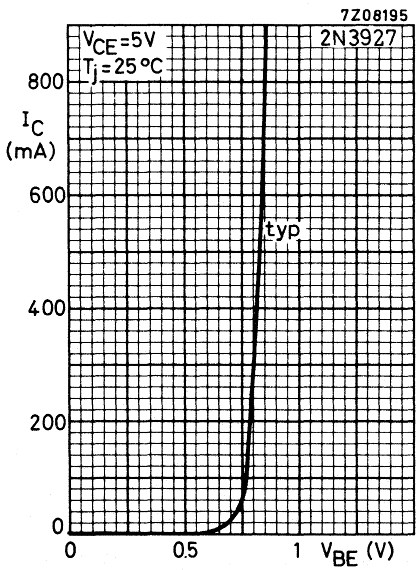
II Additional region of operation at f ≥ 1 MHz.
Care must be taken to reduce the d.c. adjustment to region I before removing the a.c. signal. This may be achieved by an appropriate bias in class A, B or C.

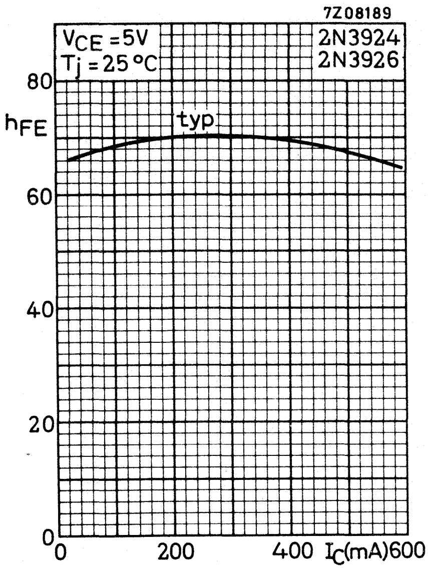
III Operating during switching off in this region is allowed, provided the transistor is cut-off with $-V_{BB} \leq 1.5$ V and $R_{BE} \geq 33\ \Omega$, $I_C \leq 400$ mA and the transient energy does not exceed 2 mWs.

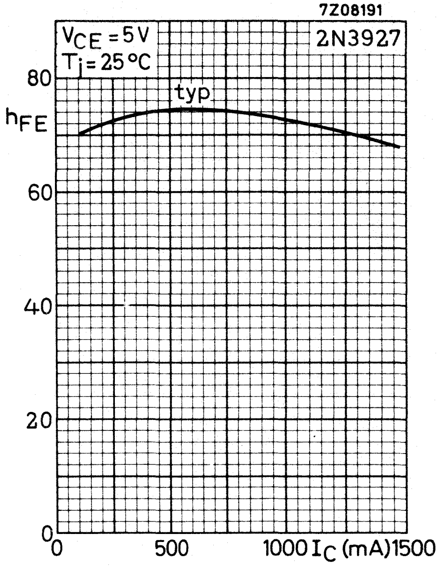

7Z08187
$\frac{I_C}{I_B} = 5$
$T_j = 25\,^{\circ}C$
$V_{CE\,sat}$ (mV)
typ
typ
2N3924; 2N3926
2N3927
0
100
200
300
0
200
400 I_C (mA) 600

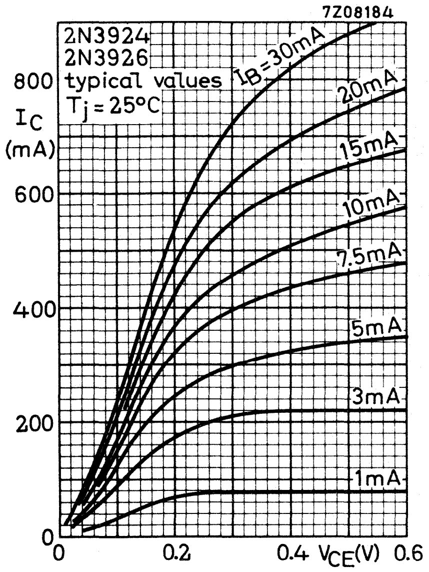

7Z08193
$I_C = 250$ mA
$I_B = 50$ mA
$V_{CE\,sat}$ (mV)
typ
typ
2N3924; 2N3926
2N3927
0
100
200
300
400
0
50
100 T_j (°C) 150

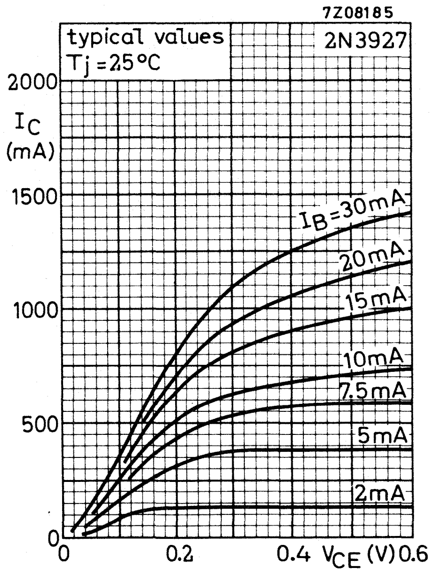

7Z08194
$V_{CE} = 5$ V
$T_j = 25\,^{\circ}C$
2N3924
2N3926
I_C (mA)
typ
0
100
200
300
400
0
0.5
1 V_{BE} (V)

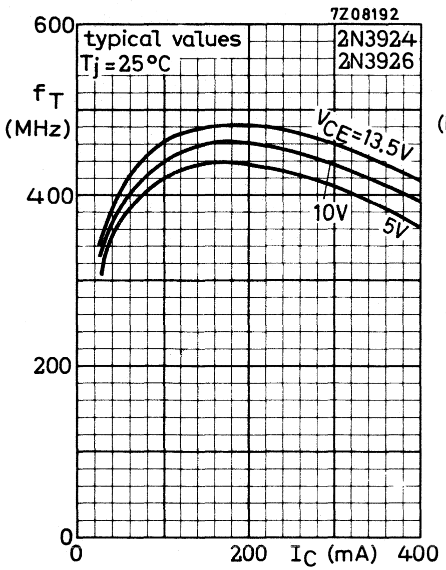

7Z08195
$V_{CE} = 5$ V
$T_j = 25\,^{\circ}C$
2N3927
I_C (mA)
typ
0
200
400
600
800
0
0.5
1 V_{BE} (V)

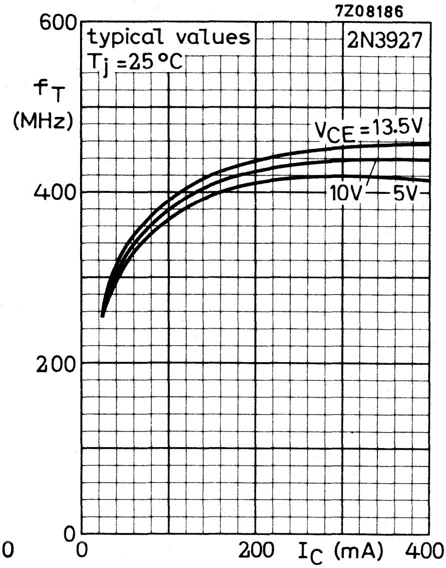

7Z08189
VCE = 5V
Tj = 25 °C
2N3924
2N3926
hFE
typ
IC (mA)
0
20
40
60
80
200
400
600

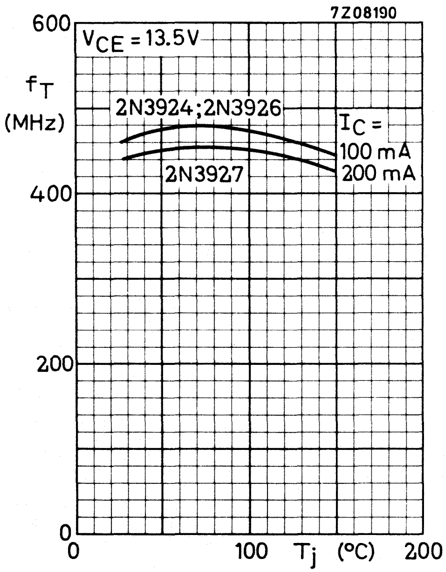

7Z08191
VCE = 5V
Tj = 25 °C
2N3927
hFE
typ
IC (mA)
0
20
40
60
80
500
1000
1500


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


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

Microwave devices

GERMANIUM TUNNEL DIODES

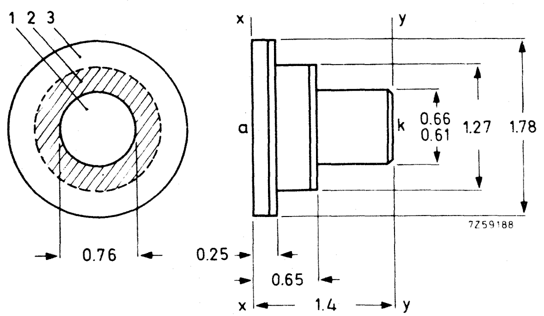
Germanium tunnel diodes for use as low noise microwave amplifiers in S-band. The device is mounted in a small ceramic-metal case with hermetic welded seal.

QUICK REFERENCE DATA

			AEY13	AEY15	AEY16	
Resistive cut-off frequency	f_r	>	6	8	10	GHz
Noise measure	N_S	typ.	1.3	1.3	1.3	
Peak point current	I_P	>	1.8	1.8	1.8	mA
Peak point voltage	V_P	typ.	50	50	50	mV
Valley point voltage	V_V	typ.	300	300	300	mV
Peak to valley point current ratio	I_P/I_V	typ.	10	10	10	

MECHANICAL DATA

Dimensions in mm



Compression force on mounting surfaces x-x and y-y: max. 2.45 N

1. Do not press on this area.
2. Preferred area of pressure.
3. Take care not to flex the flange.

Contact to the diode should be made by means of a resilient arrangement so that it is not possible to apply undue force. If for example, in a microwave circuit contact is made between a plunger and a flat surface then the plunger should be actuated through a spring.

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

Junction temperature	T_j	−40 to +70	°C

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

Peak point voltage	V_P	typ.	50	mV
Valley point voltage	V_V	typ.	300	mV
Peak point current	I_P		1.8 to 2.3	mA
Peak-valley current ratio	I_P/I_V	typ.	10	

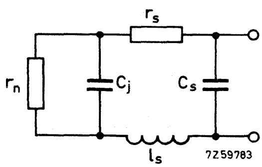
Resistive cut-off frequency

$$f_r = \frac{1}{2\pi . r_n . C_j}\sqrt{\frac{r_n}{r_s} - 1}$$

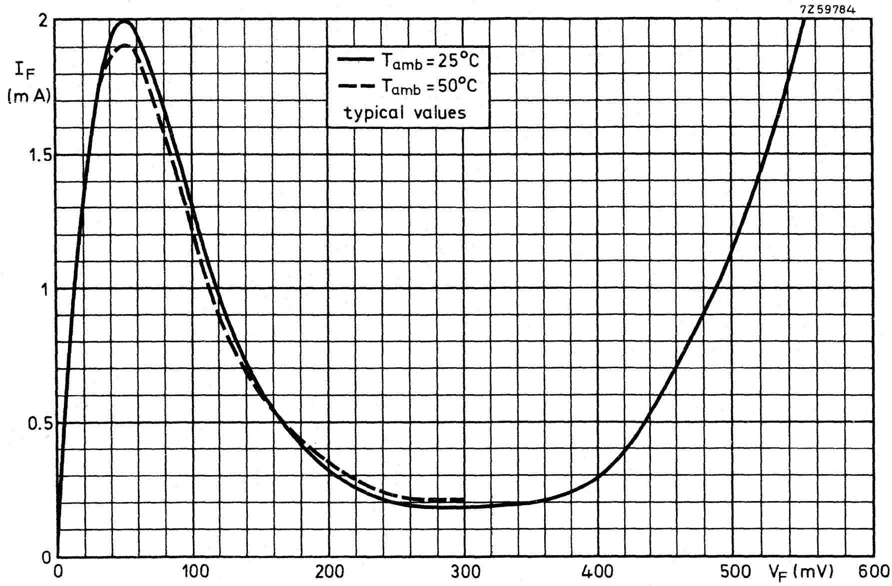
			AEY13	AEY15	AEY16	
	f_r	>	6	8	10	GHz
	f_r	typ.	7	9	11	GHz
	f_r	<	14	14	14	GHz
Junction capacitance at V_V	C_j	typ.	3.2	2.5	2.0	pF

Stray capacitance	C_s	typ.	0.3	pF
Series inductance	l_s	typ.	120	pH
Series resistance	r_s	typ.	1.0	Ω
		<	2.0	Ω
Negative resistance at inflexion point	r_n	typ.	50	Ω
Noise measure [1]	N_s	typ.	1.3	

EQUIVALENT CIRCUIT



[1] $N_s \approx 20\ I_F . r_n$ if biased in the negative resistance region.


7Z59784
I_F (mA)
2
1.5
1
0.5
0
T_{amb} = 25°C
T_{amb} = 50°C
typical values
0
100
200
300
400
500
V_F (mV)
600

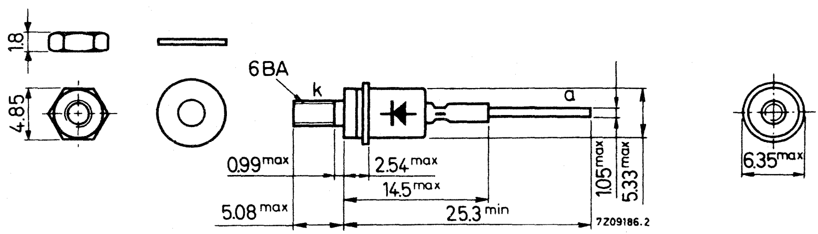
SILICON DOUBLE DIFFUSED VARACTOR DIODE

Varactor diode in a metal envelope primarily intended for use in frequency multiplier circuits with output frequencies up to 1000 MHz.

QUICK REFERENCE DATA				
Continuous reverse voltage	V_R	max.	100	V
Total power dissipation up to T_{mb} = 30 °C	P_{tot}	max.	12	W
Junction temperature	T_j	max.	150	°C
Total capacitance at f = 10 MHz V_R = 100 V	C_d		4.0 to 6.0	pF
Diode series resistance at f = 250 MHz V_R = 48 V	r_D	max.	1.3	Ω
Cut-off frequency $\frac{1}{2\pi r_D(C_d \text{ at } V_{Rmax})}$	f_{co}	> typ.	20 25	GHz GHz

MECHANICAL DATA Dimensions in mm

Supplied with the device: Nut and lock washer



Diameter of hole in heatsink: 2.87 mm

RATINGS (Limiting values) [1])

Voltage				
Continuous reverse voltage	V_R	max.	100	V
Current				
Repetitive peak forward current	I_{FRM}	max.	400	mA
Power dissipation				
Total power dissipation up to T_{mb} = 30 °C	P_{tot}	max.	12	W
T_{amb} = 30 °C	P_{tot}	max.	1	W
Temperatures				
Storage temperature	T_{stg}		−55 to +150	°C
Junction temperature	T_j	max.	150	°C

THERMAL RESISTANCE

From junction to ambient in free air	$R_{th\ j\text{-}a}$	=	120	°C/W
From junction to mounting base	$R_{th\ j\text{-}mb}$	=	10	°C/W

CHARACTERISTICS T_j = 25 °C unless otherwise specified

Reverse current (d.c.)				
V_R = 100 V	I_R	typ.	0.1	μA
		<	10	μA
V_R = 100 V; T_j = 150 °C	I_R	typ.	8	μA
		<	200	μA
Total capacitance at f = 10 MHz				
V_F = 0.5 V	C_d	typ.	65	pF
V_R = 0	C_d	typ.	25	pF
V_R = 100 V	C_d		4 to 6	pF
Stray capacitance	C_s	typ.	1.4	pF
Diode series inductance	L_d	typ.	13	nH
Diode series resistance at f = 250 MHz				
V_R = 48 V	r_D	typ.	1.3	Ω
		<	2.0	Ω
Cut-off frequency $\frac{1}{2\pi r_D(C_d \text{ at } V_{Rmax})}$	f_{co}	>	20	GHz
		typ.	25	GHz

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

SILICON PLANAR EPITAXIAL VARACTOR DIODE

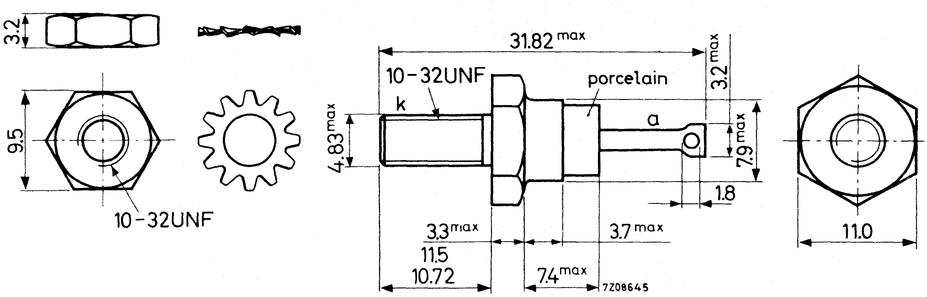
Varactor diode with a very low series resistance, in a low inductance, hermetically sealed, welded ceramic-metal DO-4 envelope.
The BAY96 is a high efficiency frequency multiplier designed for use in the v.h.f. and u.h.f. regions.
With the reverse voltage rating of 120 V, it can handle an input power up to 40 W.

QUICK REFERENCE DATA

Continuous reverse voltage	V_R	max.	120	V
Total power dissipation up to T_{mb} = 25 °C	P_{tot}	max.	20	W
Junction temperature	T_j	max.	175	°C
Total capacitance at f = 1 MHz				
V_R = 6 V	C_d		28 to 39	pF
Diode series resistance at f = 400 MHz				
V_R = 6 V	r_D	max.	1.2	Ω
Cut-off frequency $\frac{1}{2\pi r_D C_d}$ at V_R = 120 V	f_{co}	typ.	25	GHz

MECHANICAL DATA Dimensions in mm

DO-4



Diameter of hole in heatsink: max. 5.2 mm
Accessories available: 56295 (56262A)

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

RATINGS (Limiting values) [1])

Voltage

Continuous reverse voltage	V_R	max.	120	V

Power dissipation

Total power dissipation up to T_{mb} = 25 °C	P_{tot}	max.	20	W

Temperatures

Storage temperature	T_{stg}	-65 to +175		°C
Junction temperature	T_j	max.	175	°C

THERMAL RESISTANCE

From junction to mounting base	$R_{th\ j\text{-}mb}$	=	7.5	°C/W

CHARACTERISTICS

Total capacitance at f = 1 MHz				
V_R = 6 V	C_d	28 to	39	pF
Diode series resistance at f = 400 MHz				
V_R = 6 V	r_D	typ. <	0.9 1.2	Ω Ω
Cut-off frequency $\frac{1}{2\pi r_D C_d}$ at V_R = 120 V	f_{co}	typ.	25	GHz

APPLICATION INFORMATION

Frequency tripler 150 to 450 MHz

The tripler circuit at page 3 consists of a parallel connection of the varactor, the input and output circuits, and the idler circuits. This shunt configuration has two outstanding advantages for high power harmonic generation.

1. The varactor can be grounded on one side, thus utilizing the chassis as a heatsink.
2. The varactor, being a low impedance device, operates best in a circuit that requires a low impedance coupling element between input and output circuits.

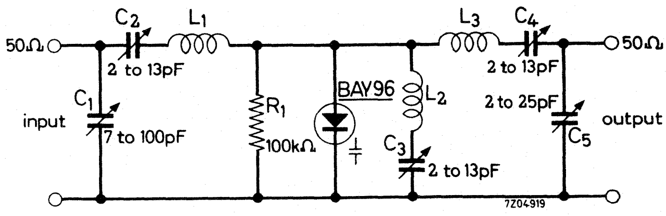
The function of the input and output networks is to provide impedance matching, and at the same time eliminate undesired r.f. current components, minimizing losses. A single tuned circuit is insufficient for the reduction of spurious response and therefore, a suitable output filter should follow the multiplier.

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

APPLICATION INFORMATION (continued)

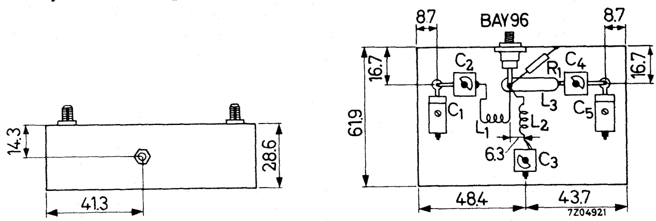
140 to 450 MHz tripler circuit

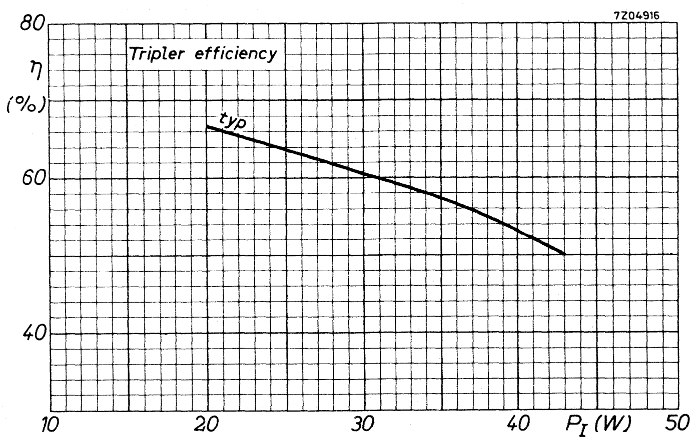
Efficiency at P_I = 25 W	η	>	60	%
		typ.	64	%

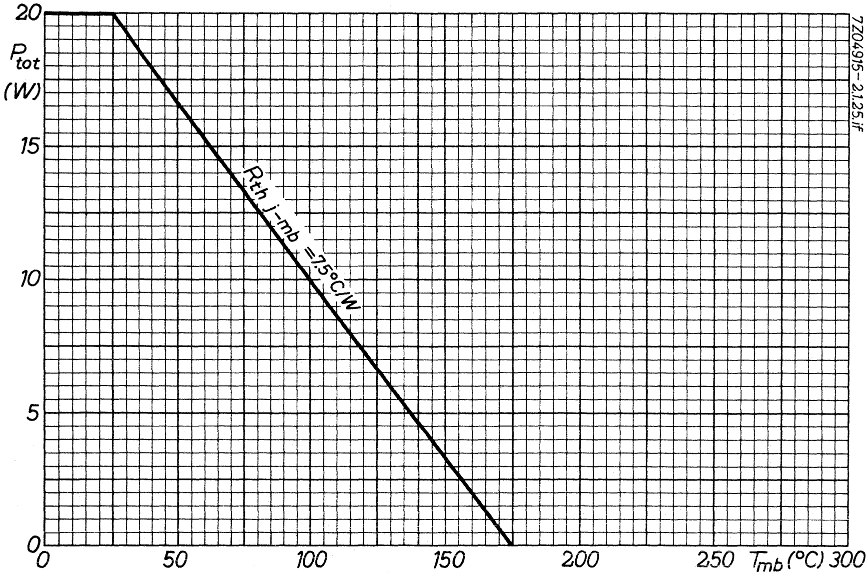


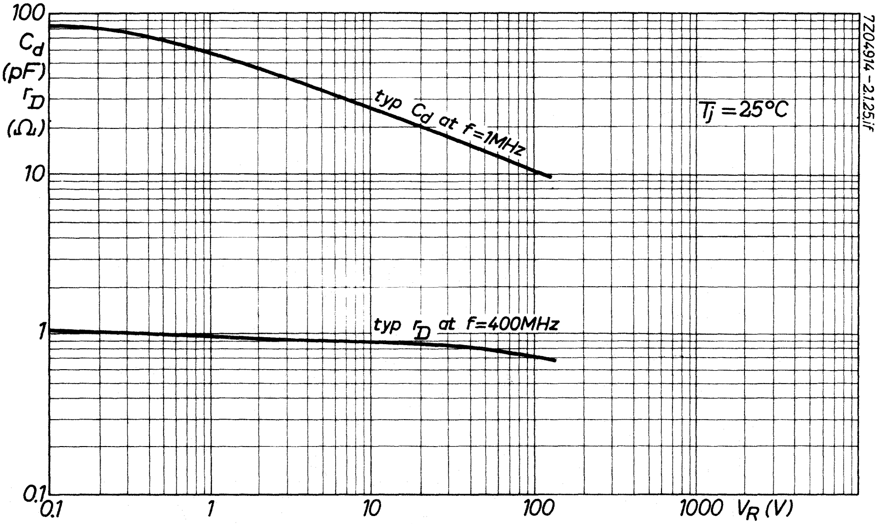
L_1 = 6.5 turns; d = 1.3 mm. Length of coil: 14.3 mm, inner diameter: 7.5 mm.
L_2 = 2 turns; d = 2 mm. Length of coil: 7.9 mm, inner diameter: 6.7 mm.
L_3 = copper strip, cross section 6.3 x 0.5 mm^2, length: 25.4 mm, height above chassis: 14.3 mm.

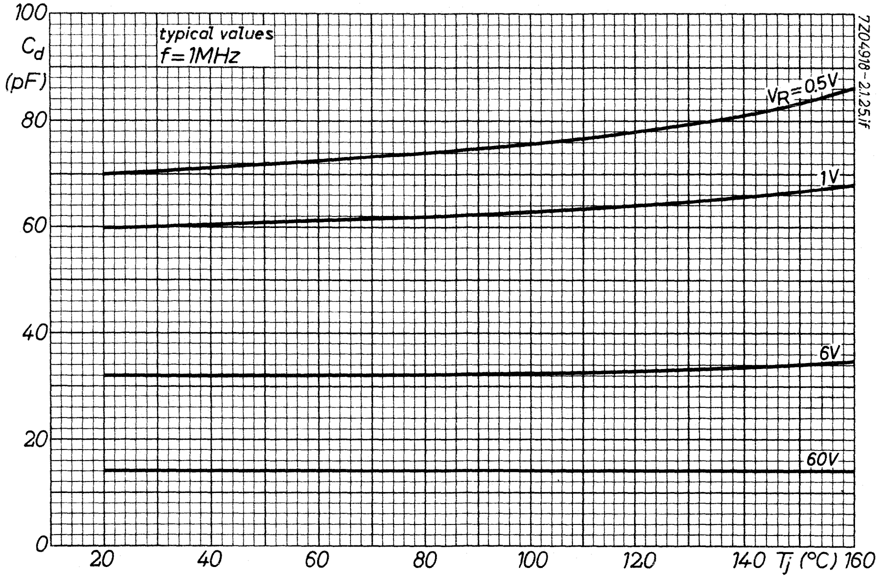
Component lay-out of tripler circuit: Dimensions in mm

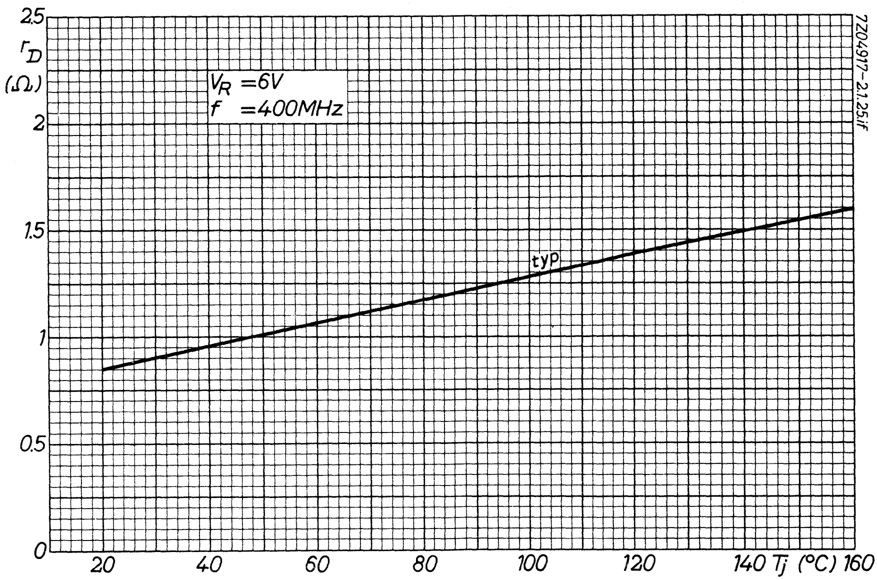





20
P_tot
(W)
15
10
5
0
0
50
100
150
200
250
T_mb (°C)
300
Rth j-mb = 7.5°C/W
7Z04915-2.1.25.if


100
C_d
(pF)
r_D
(Ω)
10
1
0.1
0.1
1
10
100
1000
V_R (V)
typ C_d at f=1MHz
typ r_D at f=400MHz
T_j = 25°C
7Z04914-2.1.25.if


typical values
f = 1MHz
C_d
(pF)
100
80
60
40
20
0
V_R = 0.5V
1V
6V
60V
20
40
60
80
100
120
140
160
T_j (°C)
7Z04918 - 2.1.25.if

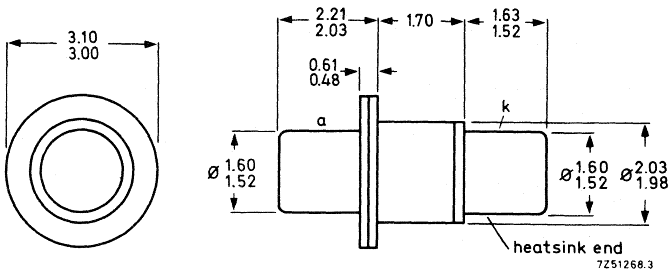

V_R = 6V
f = 400MHz
r_D
(Ω)
2.5
2
1.5
1
0.5
0
typ
20
40
60
80
100
120
140
160
T_j (°C)
7Z04917 - 2.1.25.if

SILICON VARACTOR DIODE

The BXY27 is a silicon planar epitaxial varactor diode exhibiting step recovery characteristics, especially suitable for use in frequency multiplier circuits up to S-band output frequency and 10 W input power.
The device is mounted in a small double ended ceramic-metal case with hermetic seal. The diode is packed in a container.

QUICK REFERENCE DATA				
Input power (doubler 1 to 2 GHz)	P_i	<	10	W
Output power (doubler 1 to 2 GHz)	P_o	>	5	W
Junction temperature	T_j	max.	175	°C
Cut-off frequency	f_c	typ.	100	GHz
Diode capacitance	C_d	typ.	4.5	pF

MECHANICAL DATA Dimensions in mm



Type marking on the container

The heat should be transferred via the cathode pin.

RATINGS (Limiting values) [1]

Reverse voltage	V_R	max.	55	V
Total power dissipation up to $T_{pin} = 95\,^oC$	P_{tot}	max.	4	W
Storage temperature	T_{stg}	-65 to +175		^oC
Junction temperature	T_j	max.	175	^oC

THERMAL RESISTANCE

From junction to pin	$R_{th\ j\text{-}pin}$	=	20	$^oC/W$

CHARACTERISTICS

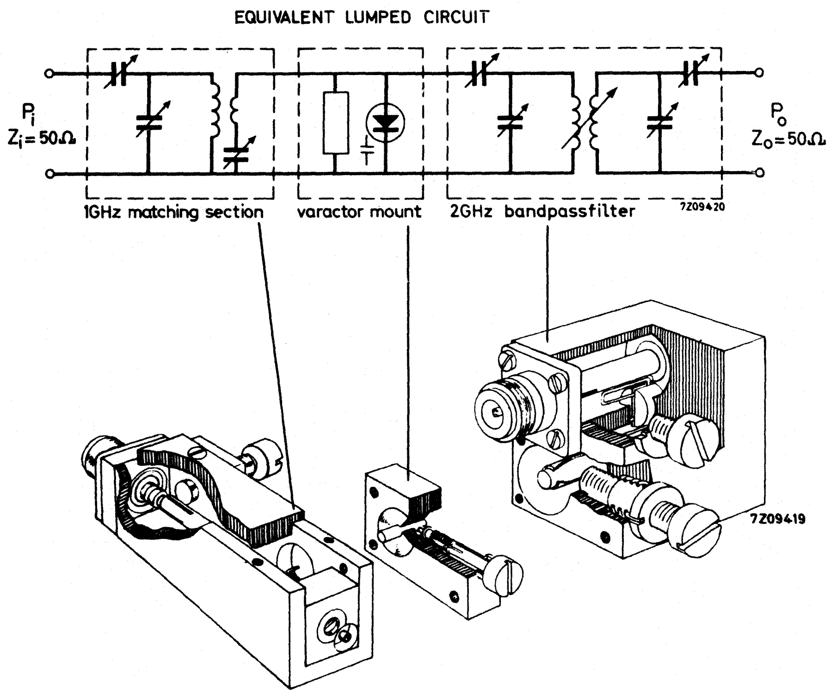
$T_{amb} = 25\,^oC$ unless otherwise specified

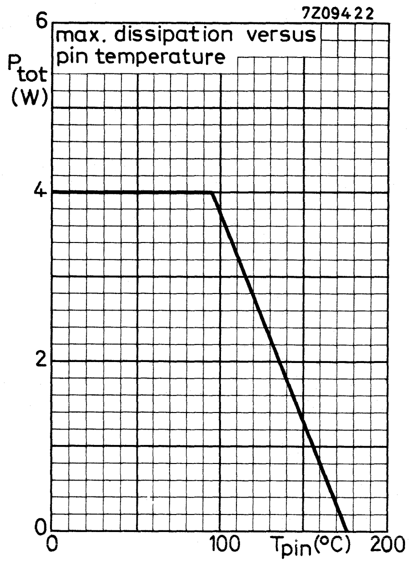
Reverse current at $V_R = 6$ V	I_R	typ.	1	nA
		<	1	μA
Cut-off frequency at $V_R = 6$ V				
$f_c = \frac{1}{2\pi r_d(C_d - C_{str})}$	f_c	>	50	GHz
		typ.	100	GHz
Diode capacitance at f = 1 MHz				
$V_R = 6$ V (C_d includes C_{str})	C_d	typ.	4.5	pF
		3.0 to 6.5		pF
Stray capacitance	C_{str}	typ.	0.25	pF
Diode series inductance	L_d	typ.	650	pH
Diode series resistance at f = 2 GHz				
$V_R = 6$ V	r_d	typ.	0.4	Ω
Overall efficiency in frequency doubler circuit on page 3				
$P_i = 10$ W: $f_i = 1$ GHz	η	>	50	%
		typ.	60	%
Overall efficiency in frequency tripler circuit				
$P_i = 10$ W: $f_i = 1$ GHz	η	typ.	40	%

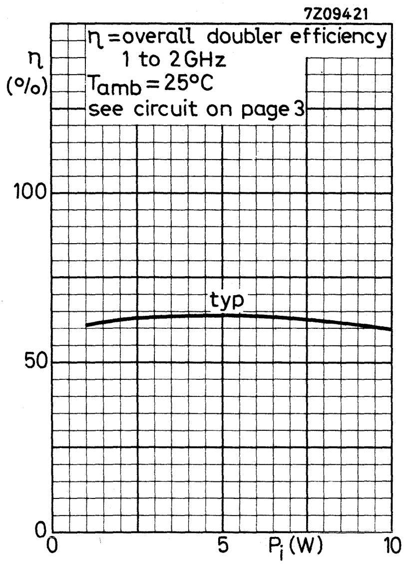
[1]) Limiting values according to the Absolute Maximum System as defined in IEC publication 134.

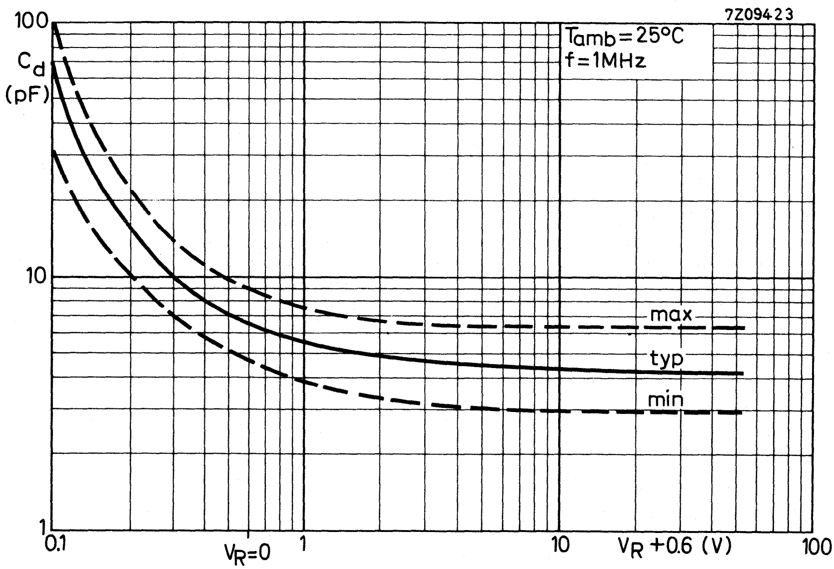
CHARACTERISTICS

Test circuit




7Z09422
max. dissipation versus
pin temperature
Ptot
(W)
6
4
2
0
0
100
Tpin(°C)
200


7Z09421
η = overall doubler efficiency
1 to 2 GHz
Tamb = 25°C
see circuit on page 3
η
(%)
100
50
0
typ
0
5
Pi (W)
10

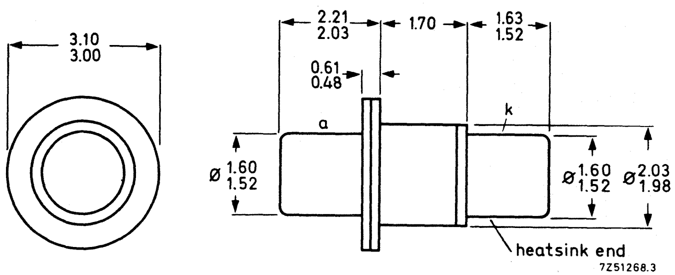

7Z09423
Tamb = 25°C
f = 1MHz
Cd
(pF)
100
10
1
max
typ
min
0.1
VR=0
1
10
VR +0.6 (V)
100

SILICON VARACTOR DIODE

The BXY28 is a silicon planar epitaxial varactor diode exhibiting step recovery characteristics, especially suitable for use in frequency multiplier circuits up to C-band output frequency and 7 W input power.
The device is mounted in a small double ended ceramic-metal case with hermetic seal. The diode is packed in a container.

QUICK REFERENCE DATA				
Input power (doubler 2 to 4 GHz)	P_i	<	7	W
Output power (doubler 2 to 4 GHz)	P_o	>	3.5	W
Junction temperature	T_j	max.	175	^oC
Cut-off frequency	f_c	typ.	100	GHz
Diode capacitance	C_d	typ.	1.5	pF

MECHANICAL DATA Dimensions in mm



Type marking on the container

The heat should be transferred via the cathode pin.

RATINGS (Limiting values) [1])

Reverse voltage	V_R	max.	45	V
Total power dissipation up to T_{pin} = 70 °C	P_{tot}	max.	3.5	W
Storage temperature	T_{stg}	−65 to +175		°C
Junction temperature	T_j	max.	175	°C

THERMAL RESISTANCE

From junction to pin	$R_{th\ j\text{-}pin}$	=	30	°C/W

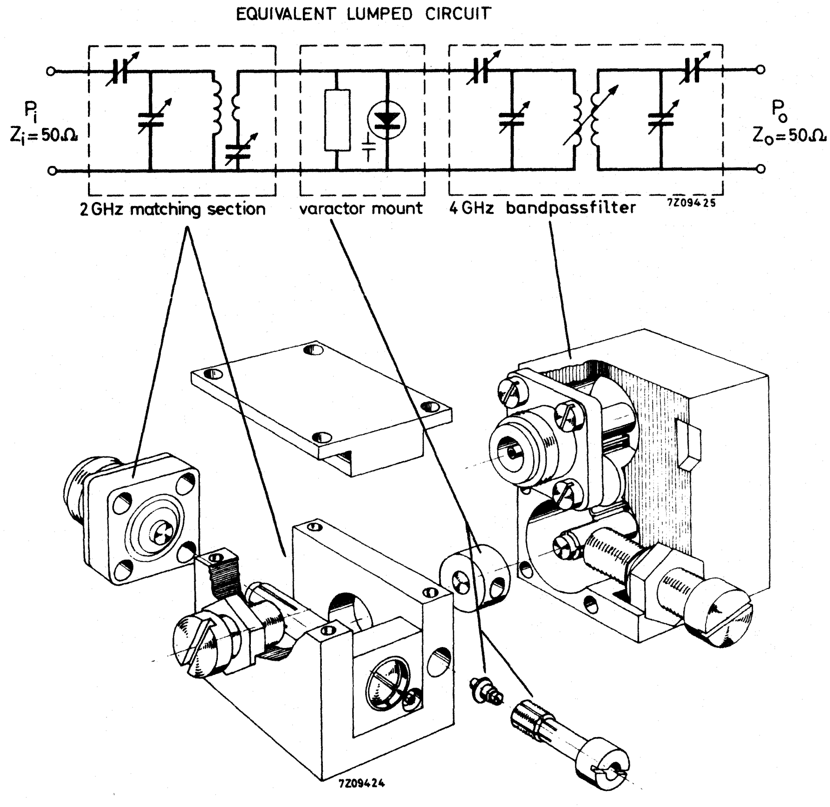
CHARACTERISTICS T_{amb} = 25 °C unless otherwise specified

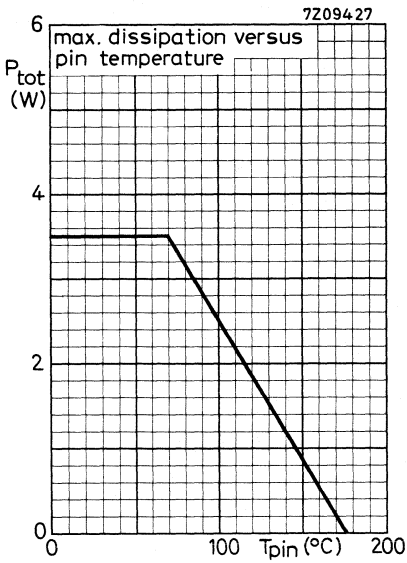
Reverse current at V_R = 6 V	I_R	typ.	1	nA
		<	1	µA
Cut-off frequency at V_R = 6 V				
$f_c = \frac{1}{2\pi r_d(C_d - C_{str})}$	f_c	>	80	GHz
		typ.	100	GHz
Diode capacitance at f = 1 MHz				
V_R = 6 V(C_d includes C_{str})	C_d	typ.	1.5	pF
		1.0 to	2.5	pF
Stray capacitance	C_{str}	typ.	0.25	pF
Diode series inductance	L_d	typ.	650	pH
Diode series resistance at f = 2 GHz				
V_R = 6 V	r_d	typ.	0.9	Ω
Overall efficiency in frequency doubler circuit of page 3				
P_i = 7 W; f_i = 2 GHz	η	>	50	%
		typ.	55	%
Overall efficiency in frequency quadrupler circuit				
P_i = 2 W; f_i = 0.56 GHz	η	typ.	40	%

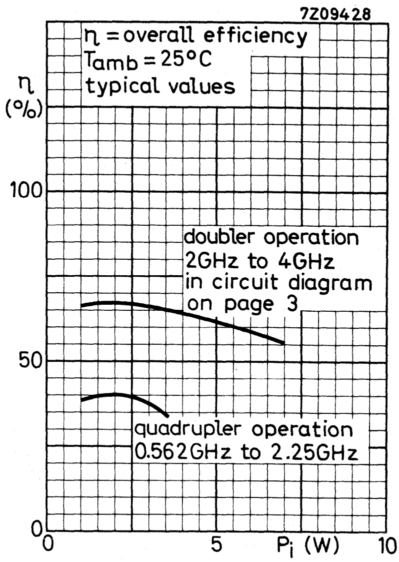
[1]) Limiting values according to the Absolute Maximum System as defined in IEC publication 134.

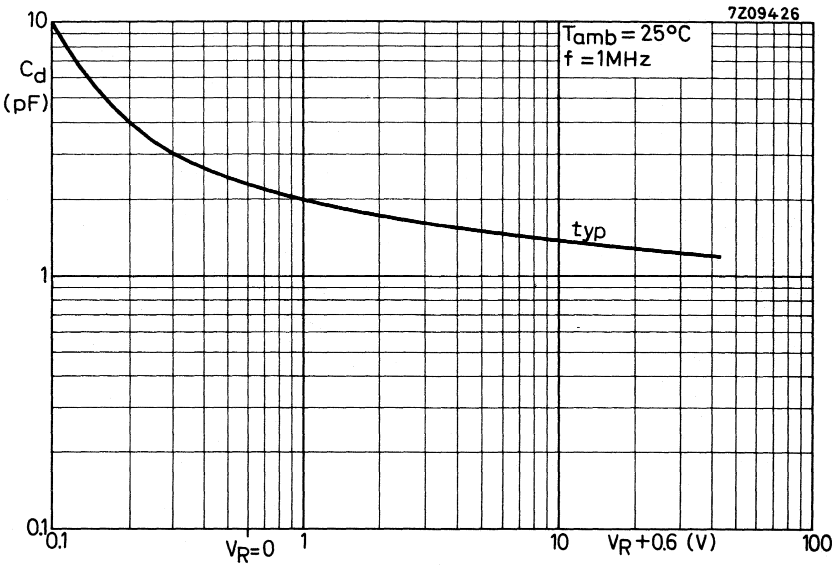
CHARACTERISTICS

Test circuit




7Z09427
max. dissipation versus
pin temperature
P_{tot}
(W)
6
4
2
0
0
100
T_{pin} (°C)
200


7Z09428
η = overall efficiency
T_{amb} = 25°C
typical values
η
(%)
100
50
0
doubler operation
2GHz to 4GHz
in circuit diagram
on page 3
quadrupler operation
0.562GHz to 2.25GHz
0
5
P_i (W)
10

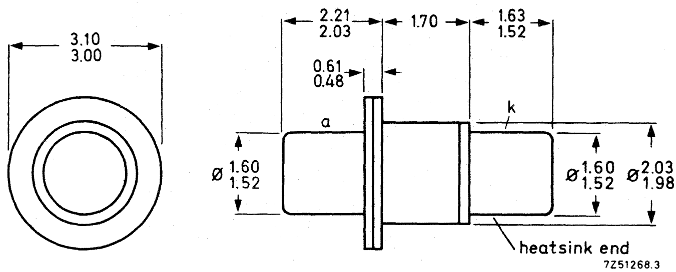

7Z09426
T_{amb} = 25°C
f = 1MHz
C_d
(pF)
10
1
0.1
typ
0.1
V_R=0
1
10
V_R + 0.6 (V)
100

SILICON VARACTOR DIODE

Silicon planar epitaxial varactor diode exhibiting step recovery characteristics, especially suitable for use in frequency multiplier circuits up to X-band output frequency.
The device is mounted in a small double ended ceramic-metal case with hermetic seal.

QUICK REFERENCE DATA				
Output power (quadrupler 2.25 to 9.0 GHz)				
at P_i = 1.0 W	P_o	>	0.3	W
Resistive cut-off frequency at V_R = 6 V	f_c	typ.	120	GHz
Diode capacitance at V_R = 6 V	C_d	typ.	1.0	pF
Junction temperature	T_j	max.	150	^oC

MECHANICAL DATA Dimensions in mm



Type marking on the container
The heat should be transferred via the cathode pin

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

Reverse voltage	V_R	max.	25	V
Total power dissipation up to T_{pin} = 70 °C	P_{tot}	max.	1	W
Storage temperature	T_{stg}		−55 to +150	°C
Junction temperature	T_j	max.	150	°C

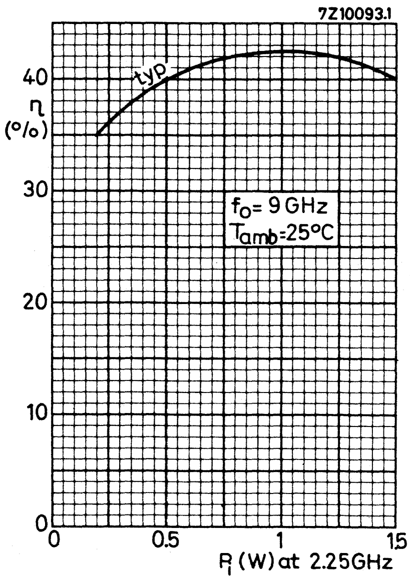
THERMAL RESISTANCE

From junction to pin	$R_{th\ j\text{-}pin}$	=	50	°C/W

CHARACTERISTICS

T_{amb} = 25 °C

Reverse current at V_R = 6 V	I_R	typ.	1.0	nA
		<	1.0	μA
Cut-off frequency at V_R = 6 V $f_c = \frac{1}{2\pi r_D(C_d - C_{str})}$	f_c	>	90	GHz
		typ.	120	GHz
Diode capacitance at V_R = 6 V; f = 1 MHz	C_d	typ.	1.0	pF
		0.8 to	1.5	pF
Stray capacitance	C_{str}	typ.	0.25	pF
Diode series inductance	L_d	typ.	650	pH
Overall efficiency in quadrupler circuit P_i = 1.0 W; f_i = 2.25 GHz	η	>	30	%

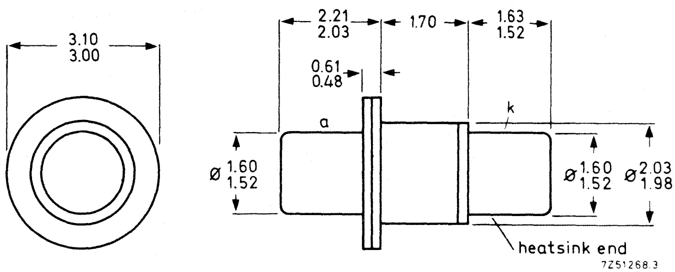


SILICON VARACTOR DIODE

Silicon planar epitaxial varactor diode exhibiting step recovery characteristics, especially suitable for use in high order frequency multiplier circuits up to X-band output frequency.
The device is mounted in a small double ended ceramic-metal case with hermetic seal.

QUICK REFERENCE DATA				
Output power (frequency multiplier 1 to 10 GHz)				
at P_i = 500 mW	P_o	typ.	20	mW
Resistive cut-off frequency at V_R = 6 V	f_c	typ.	150	GHz
Diode capacitance at V_R = 6 V	C_d	typ.	0.75	pF
Junction temperature	T_j	max.	150	^oC

MECHANICAL DATA Dimensions in mm



Type marking on container.
The heat should be transferred via the cathode pin.

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

Reverse voltage	V_R	max.	20	V
Total power dissipation up to T_{pin} = 70 °C	P_{tot}	max.	1	W
Storage temperature	T_{stg}		−55 to +150	°C
Junction temperature	T_j	max.	150	°C

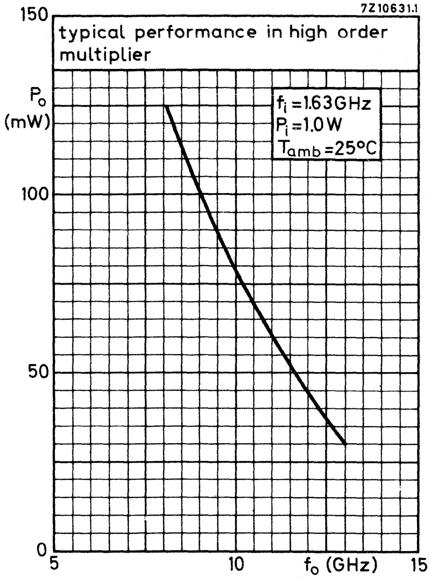
THERMAL RESISTANCE

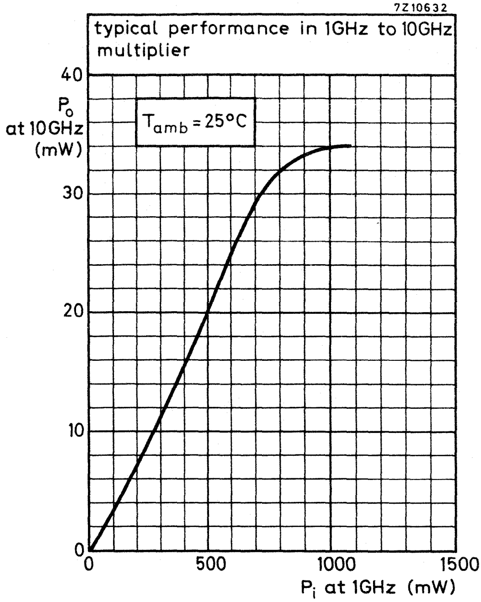
From junction to pin	$R_{th\ j\text{-}pin}$	=	50	°C/W

CHARACTERISTICS

T_{amb} = 25 °C

Reverse current at V_R = 6 V	I_R	typ.	1	nA
		<	1	μA
Cut-off frequency at V_R = 6 V $f_c = \frac{1}{2\pi r_D(C_d - C_{str})}$	f_c	>	100	GHz
		typ.	150	GHz
Diode capacitance at V_R = 6 V; f = 1 MHz	C_d	typ.	0.75	pF
		0.5 to	1	pF
Stray capacitance	C_{str}	typ.	0.25	pF
Diode series inductance	L_d	typ.	650	pH
Transition time	t_t	<	150	ps
Storage time	t_s	typ.	50	ns
Multiplier performance Output power at P_i = 500 mW (frequency multiplier 1 to 10 GHz)	P_o	>	15	mW
		typ.	20	mW


7Z10631.1
typical performance in high order multiplier
150
100
50
0
P
o
(mW)
f
i
=1.63GHz
P
i
=1.0W
T
amb
=25°C
5
10
f
o
(GHz)
15

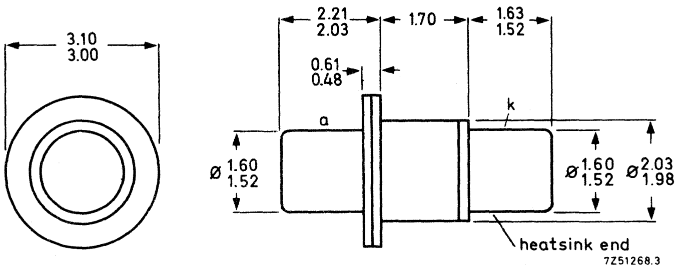

7Z10632
typical performance in 1GHz to 10GHz multiplier
40
30
20
10
0
P
o
at 10GHz
(mW)
T
amb
=25°C
0
500
1000
1500
P
i
at 1GHz (mW)

GALLIUM ARSENIDE VARACTOR DIODE

Diffused mesa varactor diode with a high cut-off frequency for use in parametric amplifiers, frequency multipliers and switches.
The device is mounted in a small double ended ceramic-metal case with hermetic seal.

QUICK REFERENCE DATA				
Reverse voltage	V_R	max.	6.0	V
Average forward current	I_{FAV}	max.	70	mA
Total power dissipation up to T_{pin} = 107 °C	P_{tot}	max.	50	mW
Operating ambient temperature	T_{amb}	−196 to +150		°C
Cut-off frequency; V_R = 6 V	f_c	typ.	240	GHz

MECHANICAL DATA Dimensions in mm



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

Voltage				
Continuous reverse voltage	V_R	max.	6.0	V
Current				
Average forward current	I_{FAV}	max.	70	mA
Power dissipation				
Total power dissipation up to T_{pin} = 107 °C	P_{tot}	max.	50	mW
Temperatures				
Storage temperature	T_{stg}	−196 to +150		°C
Junction temperature	T_j	max.	150	°C

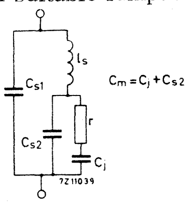
THERMAL RESISTANCE

From junction to pin	$R_{th\ j-pin}$	=	0.9	°C/mW

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

Reverse current				
V_R = 6.0 V	I_R	typ. <	0.1 1.0	μA μA
Forward voltage				
I_F = 1.0 μA	V_F	typ.	0.9	V
Effective diode capacitance [1] $C_m = \frac{1}{4\pi^2 f_{res}^2 l_s}$				
V_R = 0	C_m	typ. 0.3 to	0.4 0.5	pF pF
Stray capacitance [1]	Cs1	typ.	0.10	pF
	Cs2	typ.	0.15	pF
Series inductance [1]	l_s	typ.	625	pH
Cut-off frequency [2] at V_R = 0	f_{co}	> typ.	125 150	GHz GHz
V_R = 6 V	f_{co}	typ.	240	GHz
Capacitance variation coefficient [3]	γ	> typ.	0.12 0.15	
Series resonant frequency at V_R = 0 [2]	f_{res}	typ. 8.9 to	10 11.6	GHz GHz

[1] A suitable lumped circuit equivalent may be drawn as follows:



[2] Measurements at and about f_{res}, in a suitable waveguide holder, enable the values of f_{res} and the diode Q factor to be determined. The effective diode capacitance and the cut-off frequency can be calculated taking l_s to be the typical value. $f_{co} = Q_o f_{res}$ where Q_o is the Q factor at zero bias.

[3] $$\gamma = \frac{C_{m\,max} - C_{m\,min}}{2\,(C_{m\,max} + C_{m\,min})} = \frac{(1-V)^{-1/3} - 2^{-1/3}}{2\left\{(1-V)^{-1/3} + 2^{-1/3}\right\} + \frac{4\,C_{s2}}{C_j}}$$

where $C_{m\,max}$ = effective capacitance at I_F = 1.0 μA
$C_{m\,min}$ = effective capacitance at V_R = 1.0 V
$V = V_F$ at 1.0 μA
$C_j = C_m - C_{s2}$

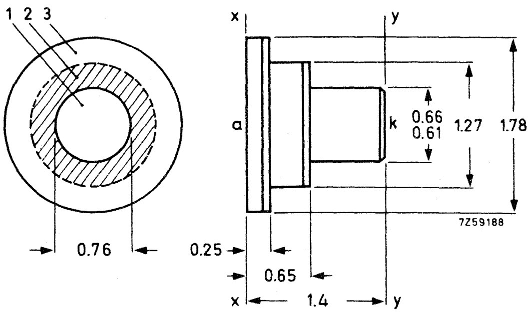
GALLIUM ARSENIDE DIFFUSED MESA VARACTOR DIODE

Varactor diode with a high cut-off frequency, primarily intended for use in microwave parametric amplifiers. The device is mounted in a small ceramic-metal case with hermetic welded seal.

QUICK REFERENCE DATA				
Continuous reverse voltage	V_R	max.	6	V
Total power dissipation up to T_{mb} = 25 °C	P_{tot}	max.	50	mW
Junction temperature	T_j		−196 to +135	°C
Cut-off frequency ; V_R = 0	f_{co}	typ.	350	GHz

MECHANICAL DATA

Dimensions in mm



Compression force on mounting surfaces x-x and y-y: max. 2.45 N

1. Do not press on this area.
2. Preferred area of pressure.
3. Take care not to flex the flange

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

Voltage				
Continuous reverse voltage	V_R	max.	6.0	V
Power dissipation				
Total power dissipation up to T_{mb} = 25 °C	P_{tot}	max.	50	mW
Temperatures				
Storage temperature	T_{stg}		−196 to +175	°C
Junction temperature	T_j	max.	135	°C

THERMAL RESISTANCE

From junction to mounting base	$R_{th\ j\text{-}mb}$	=	0.9	°C/mW

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

Reverse current				
V_R = 6.0 V	I_R	typ.	0.1	μA
		<	1.0	μA
Capacitance $\frac{1}{2\pi r_D f_{co}}$				
V_R = 0	C_d	typ.	0.2	pF
Stray capacitance	C_s	typ.	0.3	pF
Diode series resistance				
V_R = 0	r_D	typ.	2.25	Ω
		1 to	3.0	Ω
Series inductance $\frac{1}{4\pi^2 f_{res}^2 C_d}$	l_s	typ.	140	pH
Cut-off frequency ; V_R = 0	f_{co}	>	200	GHz
		typ.	350	GHz
Product of capacitance variation coefficient and cut-off frequency; V_R = 0 [1])	γf_{co}	>	35	GHz
		typ.	40	GHz
Series resonant frequency ; V_R = 0	f_{res}	typ.	30	GHz
		27 to	34	GHz

1)
$$\gamma = \frac{C_{d\,max} - C_{d\,min}}{2(C_{d\,max} + C_{d\,min})} = \frac{\frac{1}{f_{res\,min}^2} - \frac{1}{f_{res\,max}^2}}{2\left(\frac{1}{f_{res\,min}^2} + \frac{1}{f_{res\,max}^2}\right)}$$

where $C_{d\,max}$ = capacitance at I_F = 1.0 μA

$C_{d\,min}$ = capacitance at V_R = 1.0 V

$f_{res\,min}$ and $f_{res\,max}$ are the corresponding resonant frequencies assuming a constant inductance. Hence it is directly measurable in the transmission loss system.

Remark

The dynamic parameters are quoted using a holder which takes the form of a double four-section, wide band, low v.s.w.r. Q-band 26 to 40 GHz waveguide transformer to a reduced height of 0.25 mm. The transformer is step down followed by step up in order to use standard Q-band components on either side. A d.c. isolated choke system allows the diode to be inserted across the 0.25 mm reduced height section and to be biased.

Using a swept frequency transmission loss measuring system the f_{co}, the Q and γ of the diode-holder system can be measured ($f_{co} = Q \times f_{res}$).

Separately, by measuring the transmission loss past the diode at resonance, r_D can be found.

OPERATING NOTES

The CXY10 varactor diode will give excellent noise performance in a parametric amplifier of suitable design.

For instance, at a signal frequency of 8.5GHz in an amplifier having an over-coupled ratio of 4dB to 5dB with a pump frequency at 35GHz and an idler frequency of 26.5GHz, the effective input noise temperature of the amplifier less the contribution due to the circulator would be typically 200°K and a maximum of 250°K with the amplifier at room temperature. In cooled paramps, due to its low temperature working capability, the device would give appropriately lower effective input noise temperatures.

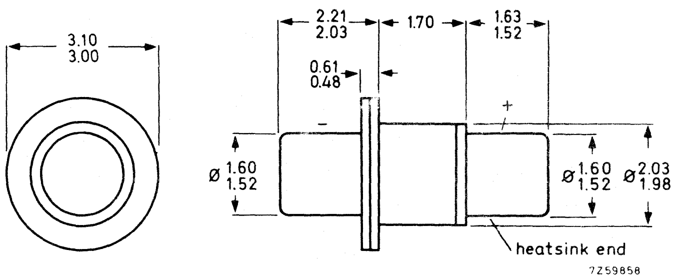
GUNN EFFECT DIODES

Gallium arsenide Gunn effect diodes for c.w. oscillations up to X-band frequencies. The devices are mounted in a small double ended ceramic-metal case with hermetic seal suitable for mounting in various types of cavity.
The main types CXY11A to C will oscillate throughout X-band, the actual frequency depending on the cavity used. The sub-types 8.5, 10.5 and 11.5 are only specified in a 1 GHz band centred on 8.5, 10.5 and 11.5 GHz respectively (see table 1 on page 2)

QUICK REFERENCE DATA

Operating voltage		V	typ.	7	V
Total power dissipation up to T_{pin} = 35 °C		P_{tot}	max.	1.0	W
Operating frequency			X-band		
Output power at f = 9.5 GHz	CXY11A	P_o	>	5	mW
	CXY11B	P_o	>	10	mW
	CXY11C	P_o	>	15	mW

MECHANICAL DATA Dimensions in mm



Type marking on the container

The heat should be transferred via the flangeless pin

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

Voltage [1]	V	max.	7.0	V
Total power dissipation up to T_{pin} = 35 °C	P_{tot}	max.	1.0	W
Storage temperature	T_{stg}	max.	175	°C

CHARACTERISTICS T_{pin} = 35 °C

Current at V = 7.0 V	I	typ.	140	mA
Operating frequency [2]	f		8.0 to 12	GHz
Output power [3]				
CXY11A	P_o	>	5	mW
		typ.	8	mW
CXY11B	P_o	>	10	mW
		typ.	12	mW
CXY11C	P_o	>	15	mW
		typ.	20	mW

[1] Bias must always be applied in such a way that the flanged end of the device is negative. Reversing polarity or exceeding maximum rating may cause permanent damage. Care should be taken not to exceed voltage transients of 8 V.

[2] The frequency is governed by the choise of cavity to which the device is coupled. For frequency coverage see table 1.

[3] P_o is measured in a coaxial cavity at the test frequency given in table 1.

Table 1.

	Test frequency and frequency coverage in GHz			
	8.5 8 to 9	9.5 8 to 12	10.5 10 to 11	11.5 11 to 12
P_o > 5 mW, typ. 8 mW	$CXY11A_{8.5}$	CXY11A	$CXY11A_{10.5}$	$CXY11A_{11.5}$
P_o > 10 mW, typ. 12 mW	$CXY11B_{8.5}$	CXY11B	$CXY11B_{10.5}$	$CXY11B_{11.5}$
P_o > 15 mW, typ. 20 mW	$CXY11C_{8.5}$	CXY11C	$CXY11C_{10.5}$	$CXY11C_{11.5}$

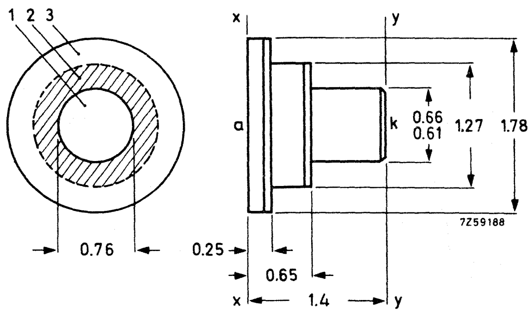
GALLIUM ARSENIDE DIFFUSED MESA VARACTOR DIODE

Diffused mesa varactor diode suitable for use in frequency multiplier circuits up to Q-band output frequency. The device is mounted in a small ceramic-metal case with hermetic welded seal.

QUICK REFERENCE DATA				
Output power (quadrupler 9.0 to 36 GHz) at P_i = 500 mW	P_o	>	50	mW
Resistive cut-off frequency at V_R = 6 V	f_c	typ.	500	GHz
Junction temperature	T_j	max.	175	°C

MECHANICAL DATA

Dimensions in mm



Compression force on mounting surfaces x-x and y-y: max. 2.45 N

1. Do not press on this area.
2. Preferred area of pressure.
3. Take care not to flex the flange.

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

Voltage				
Continuous reverse voltage	V_R	max.	10	V
Power dissipation				
Total power dissipation up to T_{mb} = 25 °C	P_{tot}	max.	300	mW
R.F. input power	P_i	max.	500	mW
Temperatures				
Storage temperature	T_{stg}	−55 to +175		°C
Junction temperature	T_j	max.	175	°C

THERMAL RESISTANCE

From junction to mounting base	$R_{th\ j\text{-}mb}$	=	0.5	°C/mW

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

Reverse current				
V_R = 6.0 V	I_R	typ.	0.001	μA
		<	1.0	μA
Capacitance $\frac{1}{2\pi r_D f_{co}}$				
V_R = 6.0 V	C_d	typ.	0.25	pF
Stray capacitance	C_s	typ.	0.3	pF
Diode series resistance				
V_R = 6.0 V	r_D	typ.	1.3	Ω
Series inductance $\frac{1}{4\pi^2 f_{res}^2 C_d}$	l_s	typ.	120	pH
Cut-off frequency ; V_R = 6.0 V	f_{co}	>	300	GHz
		typ.	500	GHz
Series resonant frequency ; V_R = 6.0 V	f_{res}	typ.	29	GHz
		27 to	35	GHz

Remark

The dynamic parameters are quoted using a holder which takes the form of a double four-section, wide band, low v.s.w.r. Q-band 26 to 40 GHz waveguide transformer to a reduced height of 0.25 mm. The transformer is step down followed by step up in order to use standard Q-band components on either side. A d.c. isolated choke system allows the diode to be inserted across the 0.25 mm reduced height section and to be biased.

Using a swept frequency transmission loss measuring system the f_{co}, the Q of the diode-holder system can be measured ($f_{co} = Q \times f_{res}$).

Separately, by measuring the transmission loss past the diode at resonance, r_D can be found.

Field effect transistors

MATCHED N-CHANNEL FET's

Matched pair of n-channel silicon epitaxial planar junction field effect transistors in TO-72 metal envelopes held together by a metal S-clip.
It is intended for low level differential amplifiers.

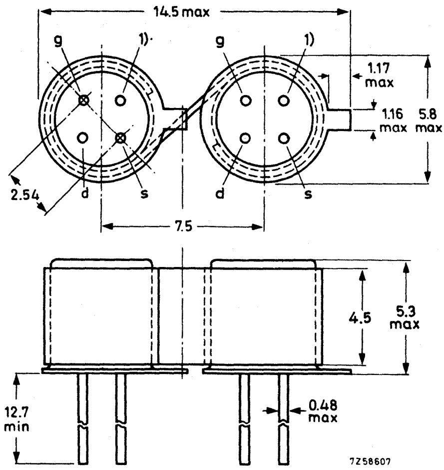
QUICK REFERENCE DATA

Characteristics T_{amb} = 25 °C; V_{DG} = 15 V; I_D = 0.5 mA			BFS21	BFS21A	
Gate cut-off current	I_G	<	0.5	0.5	nA
Gate-source voltage difference	$\lvert \Delta V_{GS} \rvert$	<	20	10	mV
Thermal drift of gate-source voltage difference	$\left\lvert \frac{d\, \Delta V_{GS}}{dT} \right\rvert$	<	75	40	µV/°C
Difference of penetration factor	$\left\lvert \Delta \frac{g_{os}}{g_{fs}} \right\rvert$	<	1	0.5	10^{-3}
Difference of transfer impedance	$\left\lvert \Delta \frac{1}{g_{fs}} \right\rvert$	<	15	7.5	Ω
Common mode rejection ratio	CMRR	>	60	66	dB

TOTAL DEVICE

Dimensions in mm

MECHANICAL DATA



1) = shield lead (connected to case)

max. lead diameter is guaranteed only for 12.7 mm

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

Voltage				
Voltage between any 2 terminals	V	max.	30	V
Currents				
Drain current	I_D	max.	4	mA
Gate current	I_G	max.	0.5	mA
Power dissipation				
Total power dissipation up to T_{amb} = 100 °C	P_{tot}	max.	30	mW
Temperature				
Operating ambient temperature	Tamb	-20 to + 100 °C		

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

		BFS21	BFS21A	
Drain current ratio				
V_{DG} = 15 V; V_{GS} = 0; T_j = 25 °C	$\frac{I_{D1-S1S}}{I_{D2-S2S}}$	> 0.95 < 1.05	0.95 1.05	
Gate-source voltage difference				
I_D = 500 μA; V_{DG} = 15 V	$\lvert\Delta V_{GS}\rvert$	< 20	10	mV
I_D = 100 μA; V_{DG} = 15 V	$\lvert\Delta V_{GS}\rvert$	< 20	10	mV
Thermal drift of gate-source voltage difference				
I_D = 500 μA; V_{DG} = 15 V	$\left\lvert\frac{d\ \Delta V_{GS}}{dT}\right\rvert$	< 75	40	μV/°C
I_D = 100 μA; V_{DG} = 15 V	$\left\lvert\frac{d\ \Delta V_{GS}}{dT}\right\rvert$	< 75	40	μV/°C
Change of gate-source voltage difference with ambient temperature				
T_{amb} = 25 to 100 °C				
I_D = 500 μA; V_{DG} = 15 V	$\lvert\Delta V_{GS}(T_{amb2}) - \Delta V_{GS}(T_{amb1})\rvert$	< 6	3	mV
I_D = 100 μA; V_{DG} = 15 V	$\lvert\Delta V_{GS}(T_{amb2}) - \Delta V_{GS}(T_{amb1})\rvert$	< 6	3	mV
Difference of penetration factors [1]				
I_D = 500 μA; V_{DG} = 15 V	$\left\lvert\Delta \frac{g_{os}}{g_{fs}}\right\rvert$	< 1	0.5	10^{-3}
I_D = 100 μA; V_{DG} = 15 V	$\left\lvert\Delta \frac{g_{os}}{g_{fs}}\right\rvert$	< 1	0.5	10^{-3}
Difference of transfer impedances [2]				
I_D = 500 μA; V_{DG} = 15 V	$\left\lvert\Delta \frac{1}{g_{fs}}\right\rvert$	< 15	7.5	Ω
I_D = 100 μA; V_{DG} = 15 V	$\left\lvert\Delta \frac{1}{g_{fs}}\right\rvert$	< 75	37.5	Ω

[1] The difference between the penetration factors is equal to the ratio of the change of the gate-source voltage difference to the change of drain-gate voltage, at constant drain current.

($\Delta \frac{g_{os}}{g_{fs}} = \frac{d\ \Delta V_{GS}}{d\ V_{DG}}$ at I_D = constant)

[2] The difference between the transfer impedances is equal to the ratio of the change of the gate-source voltage difference to the change of drain current, at constant drain-gate voltage.

($\Delta \frac{1}{g_{fs}} = \frac{d\ \Delta V_{GS}}{d\ I_D}$ at V_{DG} = constant)

CHARACTERISTICS (continued) (total device)

Common mode rejection ratio [1]

			BFS21	BFS21A	
I_D = 500 μA; V_{DG} = 15 V	CMRR	>	60	66	dB
I_D = 100 μA; V_{DG} = 15 V	CMRR	>	60	66	dB

INDIVIDUAL TRANSISTOR

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^o	P_{tot}	max.	300	mW
Temperatures				
Storage temperature	T_{stg}		−65 to +200	^{o}C
Junction temperature	T_j	max.	200	^{o}C

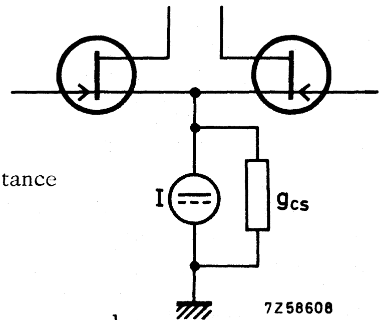
THERMAL RESISTANCE

From junction to ambient in free air (for individual transistor without S-clip) $R_{th\ j\text{-}a}$ = 0.59 ^{o}C/mW

[1]) Common mode rejection ratio

$$(CMRR)^{-1} = \Delta \frac{g_{os}}{g_{fs}} + \tfrac{1}{2} g_{cs} \Delta \frac{1}{g_{fs}}$$

where g_{cs} in this formula is the output conductance of the summing current source.



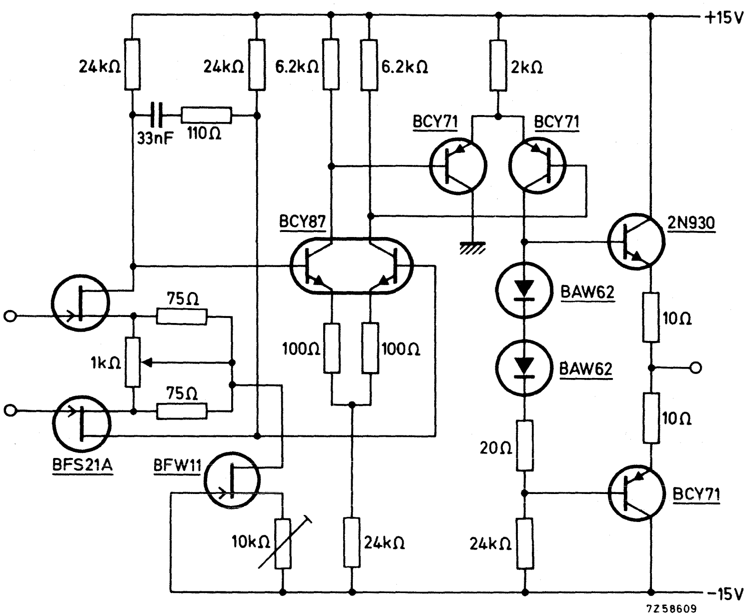
The guaranteed values of CMRR apply at g_{cs} = 0.1 $\mu\Omega^{-1}$

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

Gate cut-off current				
I_D = 500 μA; V_{DS} = 15 V	I_G	<	0.5	nA
I_D = 500 μA; V_{DS} = 15 V; T_{amb} = 100 °C	I_G	<	25	nA
Drain current				
V_{DS} = 15 V, V_{GS} = 0, T_j = 25 °C	I_{DSS}	>	1	mA
Gate-source cut-off voltage				
I_D = 0.5 nA, V_{DS} = 15 V	$-V_{(P)GS}$	<	6	V
Transfer conductance at f = 1 kHz				
I_D = 500 μA; V_{DS} = 15 V	g_{fs}	>	1.0	$m\Omega^{-1}$
Output conductance at f = 1 kHz				
I_D = 500 μA; V_{DS} = 15 V	g_{os}	<	15	$\mu\Omega^{-1}$
Input capacitance at f = 1 MHz				
I_D = 500 μA; V_{DS} = 15 V	C_{is}	<	5	pF
Feedback capacitance at f = 1 MHz				
I_D = 500 μA; V_{DS} = 15 V	C_{rs}	<	0.75	pF
Equivalent noise voltage				
f = 10 Hz				
I_D = 500 μA; V_{DS} = 15 V	$V_n/\sqrt{B}$	<	200	$nV/\sqrt{Hz}$
V_{DS} = 15 V, V_{GS} = 0	$V_n/\sqrt{B}$	<	75	$nV/\sqrt{Hz}$

APPLICATION INFORMATION

Operational amplifier



APPLICATION INFORMATION (continued)

Input voltages

Initial off-set voltage	<	10	mV
Differential off-set voltage change with temperature	<	40	μV/°C
Differential off-set voltage change with time	<	40	μV/day
Noise voltage (B = 100 kHz)	<	2	μV
Common mode rejection ratio	>	65	dB
Supply rejection ratio	<	500	10^{-6}
Input voltage range	±	10	V

Input currents

Input bias current; T_{amb} = 25 °C	typ.	50	pA
; T_{amb} = 100 °C	<	25	nA
Off-set current ; T_{amb} = 25 °C	typ.	20	pA
; T_{amb} = 100 °C	<	25	nA

Input impedance

Input resistance	typ.	100	GΩ
Input resistance (common mode)	typ.	100	GΩ
Input capacitance	typ.	3	pF
Input capacitance (common mode)	typ.	3	pF

Frequency response

Bandwidth (G_V = 1)	typ.	10	MHz
Slewing rate	typ.	10	V/μs

Output voltage range	±	10	V
Output current range	±	10	mA
Output resistance	typ.	300	Ω

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.

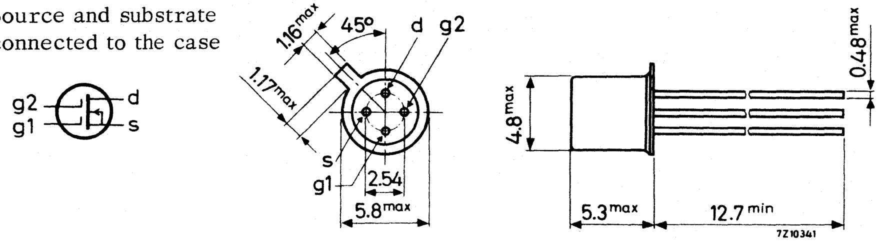
QUICK REFERENCE DATA

Drain-source voltage	V_{DSX}	max.	20	V
Gate 1-source voltage	$\pm V_{G1\text{-}S}$	max.	8	V
Gate 2-source voltage	$\pm V_{G2\text{-}S}$	max.	8	V
Drain current	I_D	max.	20	mA
Total power dissipation up to $T_{amb} = 25\,^{o}C$	P_{tot}	max.	200	mW
Junction temperature	T_j	max.	135	^{o}C
Transfer admittance at f = 1 kHz I_D = 10 mA; V_{DS} = 13 V; $+V_{G2\text{-}S}$ = 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; $+V_{G2\text{-}S}$ = 4 V	$-C_{rs}$	typ.	25	fF
Transducer gain at f = 200 MHz I_D = 10 mA; V_{DS} = 13 V; $+V_{G2\text{-}S}$ = 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; $+V_{G2\text{-}S}$ = 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)

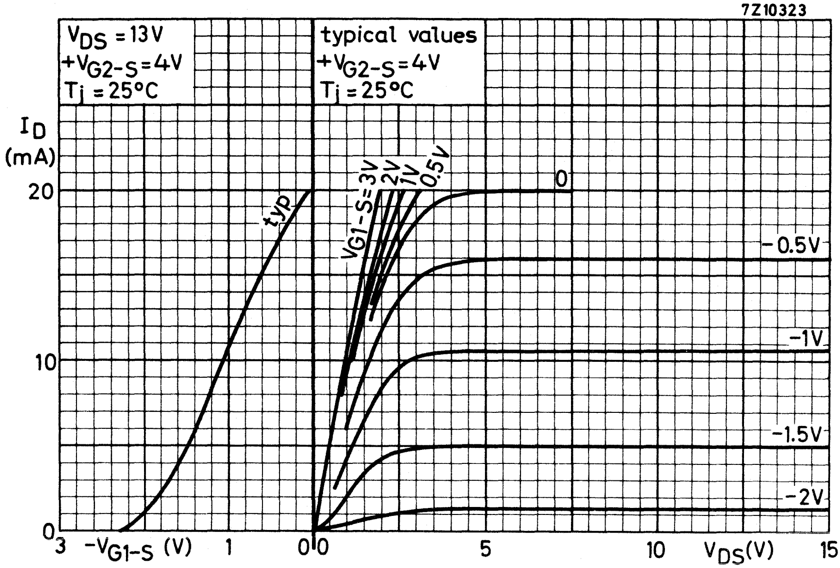
Voltages				
Drain-source voltage	V_{DSX}	max.	20	V
Gate 1-source voltage	$\pm V_{G1-S}$	max.	8	V
Gate 2-source voltage	$\pm V_{G2-S}$	max.	8	V
Non repetitive peak voltage ($t \leq 10$ ms)				
gate 1-source voltage	$\pm V_{G1-SM}$	max.	50	V
gate 2-source voltage	$\pm V_{G2-SM}$	max.	50	V
Current				
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

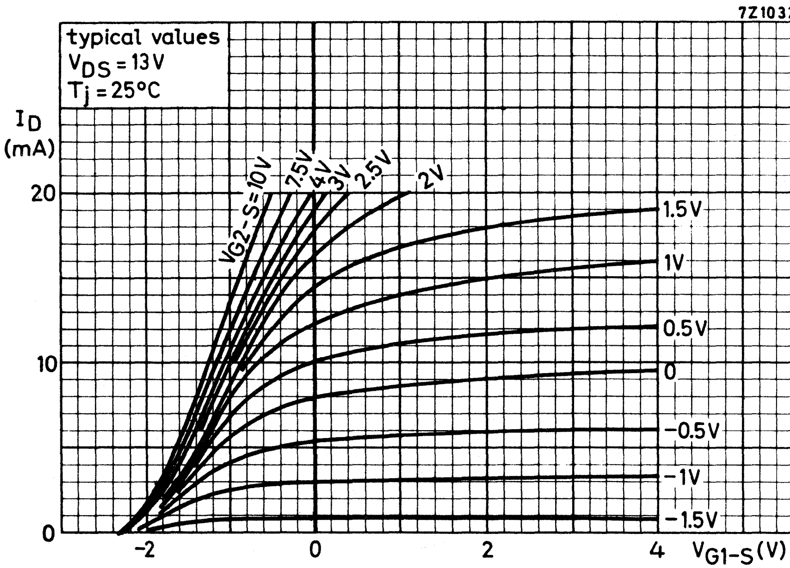
THERMAL RESISTANCE

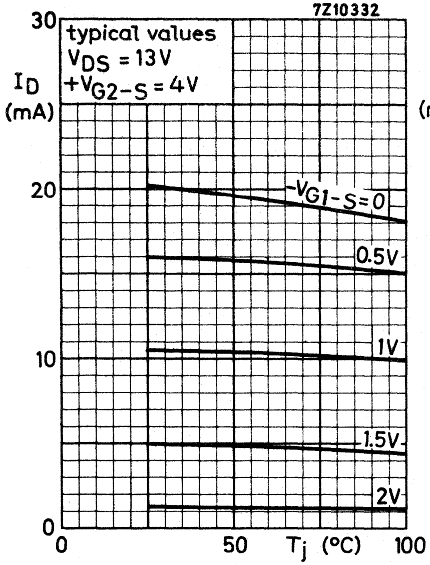
From junction to ambient in free air	$R_{th\ j-a}$	=	0.55	$^oC/mW$

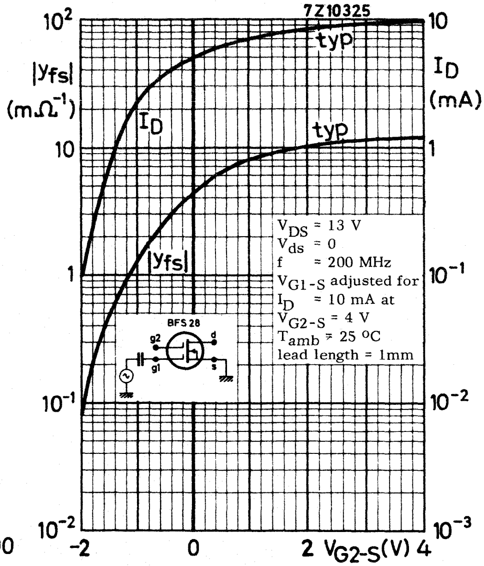
CHARACTERISTICS $T_j = 25\ ^{o}C$ unless otherwise specified

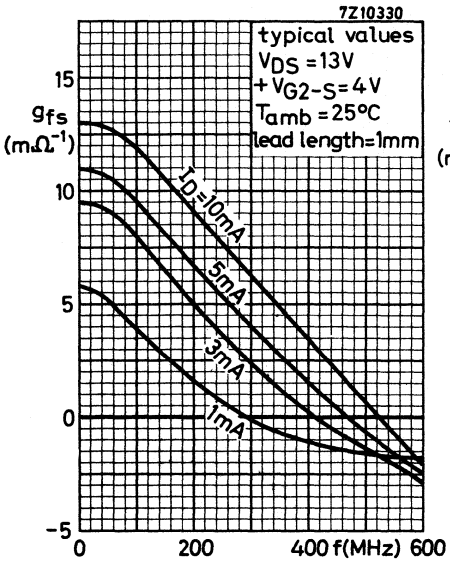
Gate 1 cut-off current				
$\pm V_{G1\text{-}S} = 8$ V; $V_{G2\text{-}S} = 0$; $V_{DS} = 0$; $T_j = 135\ ^{o}C$	$\pm I_{G1\text{-}SS}$	<	1	nA
Gate 2 cut-off current				
$\pm V_{G2\text{-}S} = 8$ V; $V_{G1\text{-}S} = 0$; $V_{DS} = 0$; $T_j = 135\ ^{o}C$	$\pm I_{G2\text{-}SS}$	<	1	nA
Gate 1-source voltage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

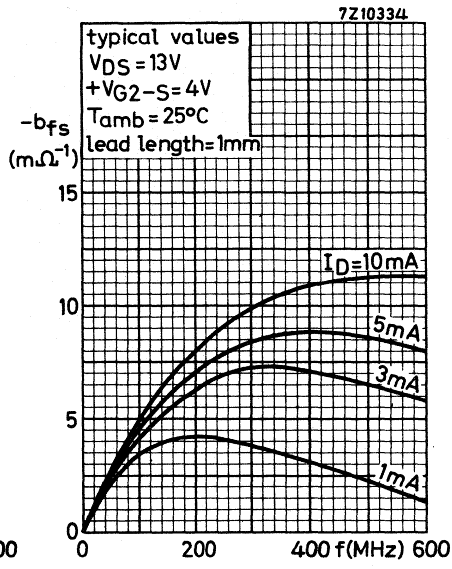

7Z10323
V_{DS} = 13 V
+V_{G2-S} = 4 V
T_j = 25 °C
typical values
+V_{G2-S} = 4 V
T_j = 25 °C
I_D (mA)
20
10
0
typ
V_{G1-S} = 3 V
2 V
1 V
0.5 V
0
−0.5 V
−1 V
−1.5 V
−2 V
3
$-V_{G1-S}$ (V)
1
0
0
5
10
V_{DS} (V)
15

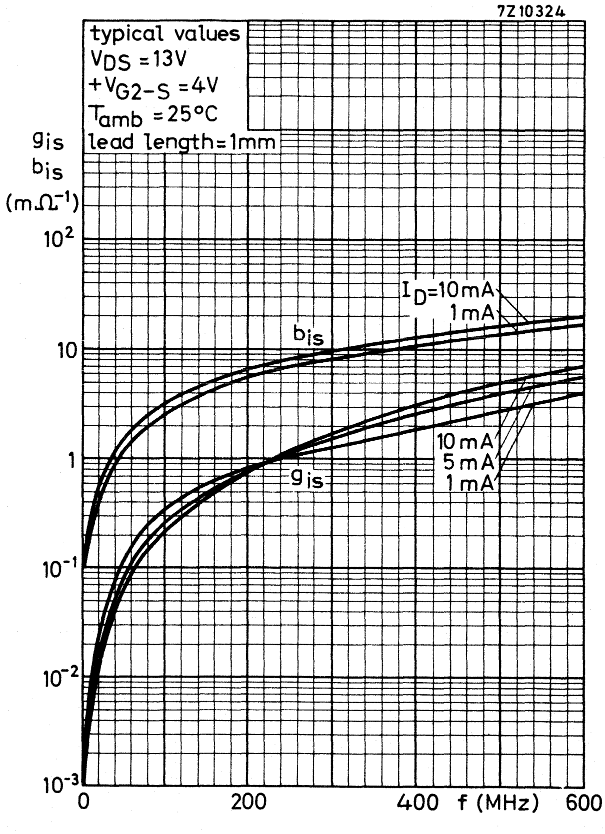

7Z10329
typical values
V_{DS} = 13 V
T_j = 25 °C
I_D (mA)
20
10
0
V_{G2-S} = 10 V
7.5 V
4 V
3 V
2.5 V
2 V
1.5 V
1 V
0.5 V
0
−0.5 V
−1 V
−1.5 V
−2
0
2
4
V_{G1-S} (V)

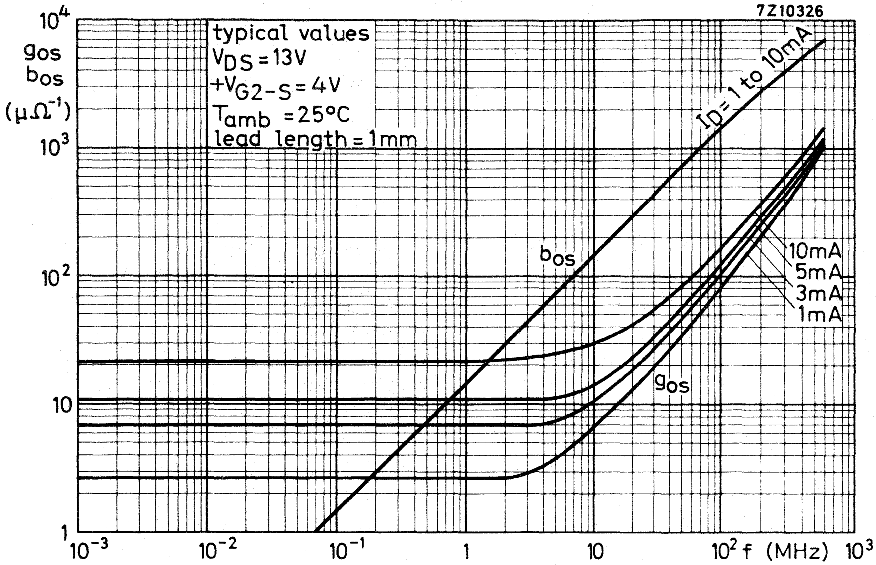

7Z10332
typical values
V_{DS} = 13 V
$+V_{G2-S}$ = 4 V
I_D (mA)
$-V_{G1-S}$ = 0
0.5V
1V
1.5V
2V
T_j (°C)

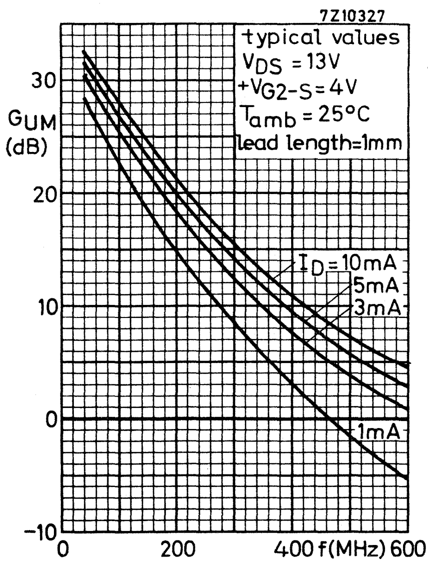

7Z10325
$|y_{fs}|$ (mΩ⁻¹)
I_D (mA)
typ
I_D
$|y_{fs}|$
V_{DS} = 13 V
V_{ds} = 0
f = 200 MHz
V_{G1-S} adjusted for
I_D = 10 mA at
V_{G2-S} = 4 V
T_{amb} = 25 °C
lead length = 1mm
BFS 28
V_{G2-S}(V)

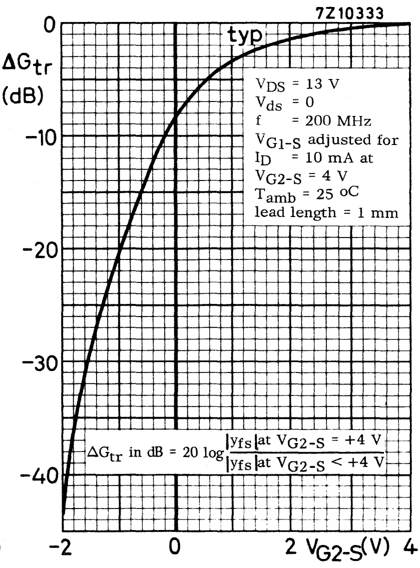

7Z10330
typical values
V_{DS} = 13V
$+V_{G2-S}$ = 4V
T_{amb} = 25°C
lead length=1mm
g_{fs} (mΩ⁻¹)
I_D=10mA
5mA
3mA
1mA
f(MHz)

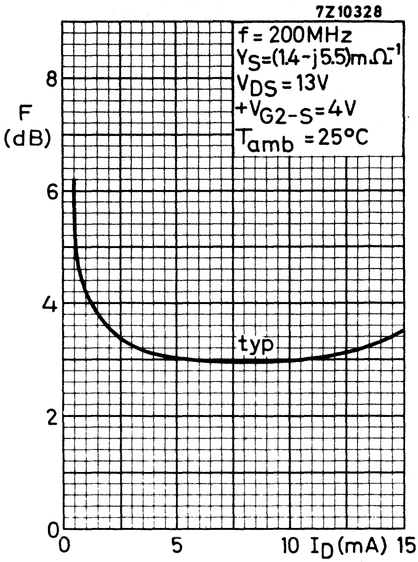

7Z10334
typical values
V_{DS} = 13V
$+V_{G2-S}$ = 4V
T_{amb} = 25°C
lead length=1mm
$-b_{fs}$ (mΩ⁻¹)
I_D=10mA
5mA
3mA
1mA
f(MHz)

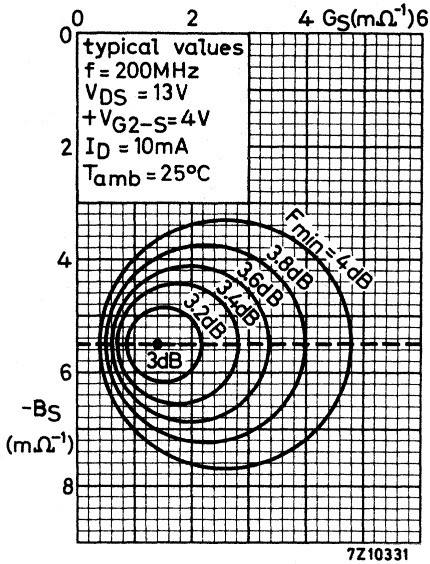

7Z10324
typical values
V_{DS} = 13V
$+V_{G2-S}$ = 4V
T_{amb} = 25°C
lead length = 1mm
g_{is}
b_{is}
$(m\Omega^{-1})$
10^2
10
1
10^{-1}
10^{-2}
10^{-3}
I_D = 10 mA
1 mA
b_{is}
10 mA
5 mA
1 mA
g_{is}
0
200
400
f (MHz)
600


7Z10326
typical values
$V_{DS} = 13V$
$+V_{G2-S} = 4V$
$T_{amb} = 25°C$
lead length = 1mm
g_{os}
b_{os}
$(\mu\Omega^{-1})$
10^4
10^3
10^2
10
1
$I_D = 1$ to 10mA
b_{os}
g_{os}
10mA
5mA
3mA
1mA
10^{-3}
10^{-2}
10^{-1}
1
10
10^2 f (MHz)
10^3


7Z10327
typical values
$V_{DS} = 13V$
$+V_{G2-S} = 4V$
$T_{amb} = 25°C$
lead length=1mm
G_{UM}
(dB)
30
20
10
0
−10
$I_D = 10mA$
5mA
3mA
1mA
0
200
400 f(MHz) 600


7Z10333
ΔG_{tr}
(dB)
0
−10
−20
−30
−40
typ
$V_{DS} = 13$ V
$V_{ds} = 0$
f = 200 MHz
V_{G1-S} adjusted for
$I_D = 10$ mA at
$V_{G2-S} = 4$ V
$T_{amb} = 25$ oC
lead length = 1 mm
ΔG_{tr} in dB = $20 \log \frac{|y_{fs}| \text{at } V_{G2-S} = +4\text{ V}}{|y_{fs}| \text{at } V_{G2-S} < +4\text{ V}}$
−2
0
2 V_{G2-S}(V) 4


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


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

N-CHANNEL SILICON FIELD EFFECT TRANSISTORS

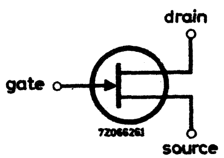
N-channel silicon epitaxial planar junction field effect transistors in a TO-72 metal envelope with the shield lead connected to the case.
The transistors are designed for broad band amplifiers (0 to 300 MHz).
Their very low noise at low frequencies makes these devices very suitable for differential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

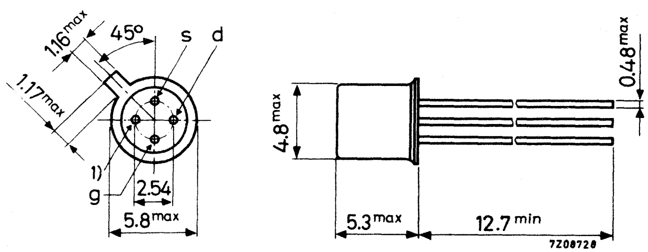
QUICK REFERENCE DATA

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 °C	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	$\lvert y_{fs} \rvert$	>	3.2	3.2	$m\Omega^{-1}$
Noise figure at V_{DS} = 15 V; V_{GS} = 0 f = 100 MHz; R_G = 1 kΩ	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

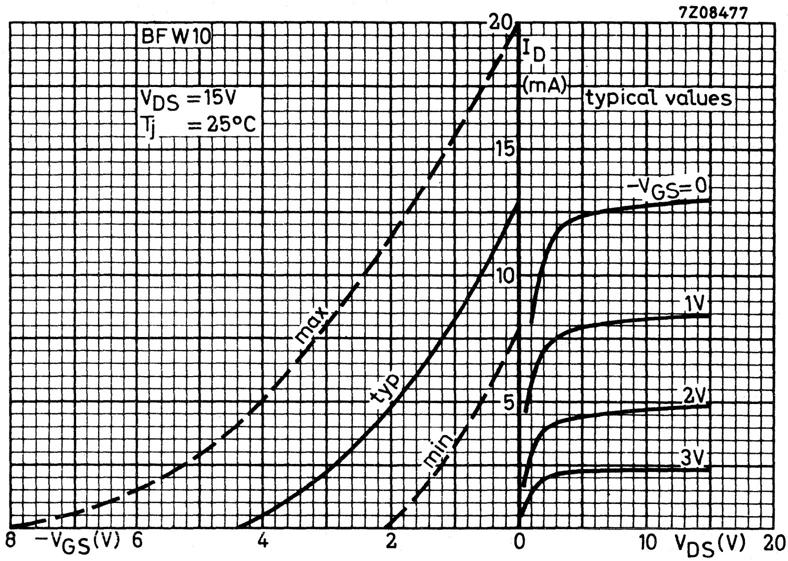
THERMAL RESISTANCE

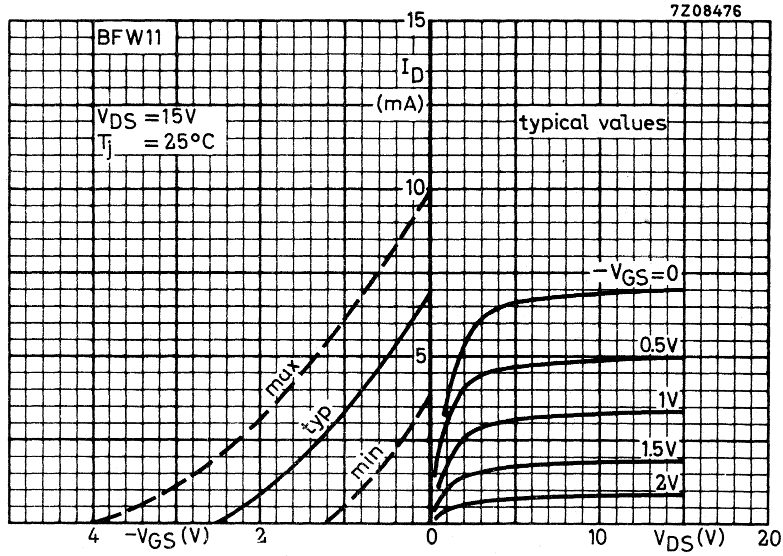
From junction to ambient	$R_{th\ j-a}$	=	0.59	°C/mW

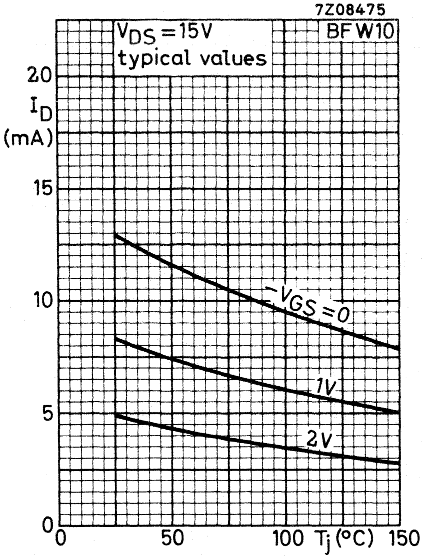
CHARACTERISTICS T_j = 25 °C unless otherwise specified

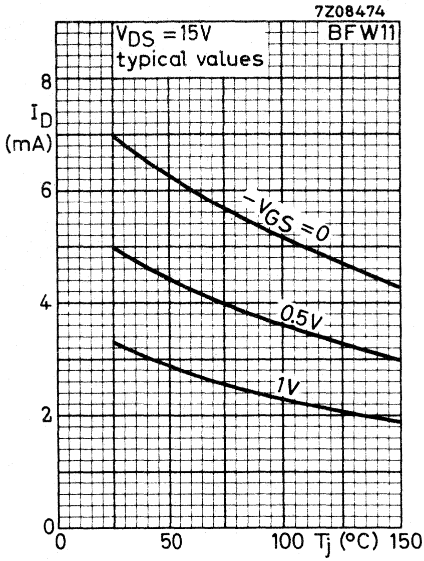
			BFW10	BFW11	
Gate cut-off current					
$-V_{GS}$ = 20 V; V_{DS} = 0	$-I_{GSS}$	<	0.5	0.5	nA
$-V_{GS}$ = 20 V; V_{DS} = 0; T_j = 150 °C	$-I_{GSS}$	<	0.5	0.5	μA
Drain current [1]					
V_{DS} = 15 V; V_{GS} = 0	I_{DSS}	>	8	4	mA
		<	20	10	mA
Gate-source voltage					
I_D = 400 μA; V_{DS} = 15 V	$-V_{GS}$	>	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
20
15
10
5
$-V_{GS}$=0
1V
2V
3V
max
typ
min
8
$-V_{GS}$(V)
6
4
2
0
10
V_{DS}(V)
20

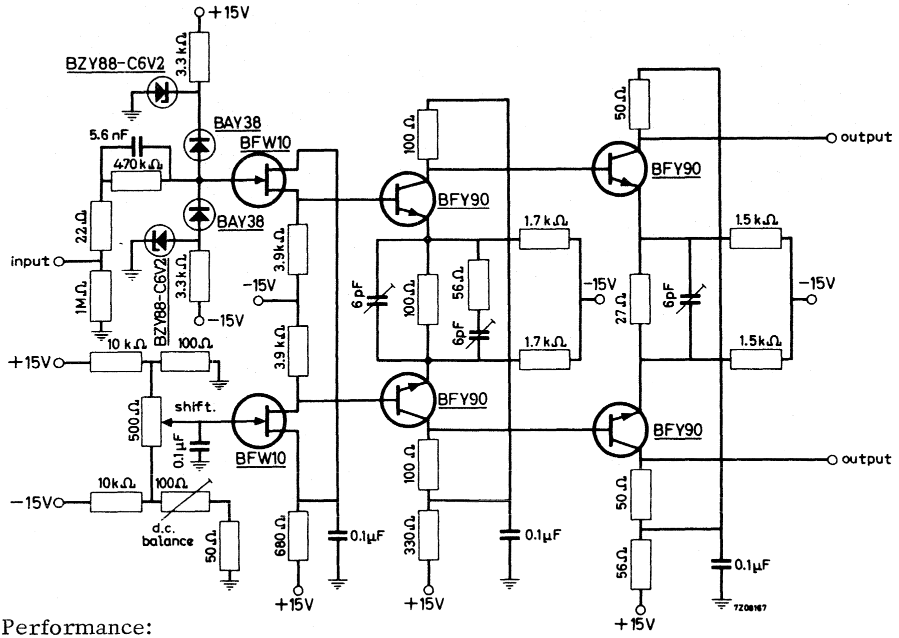

7Z08476
BFW11
V_{DS} = 15V
T_j = 25°C
I_D
(mA)
typical values
15
10
5
$-V_{GS}$=0
0.5V
1V
1.5V
2V
max
typ
min
4
$-V_{GS}$(V)
2
0
10
V_{DS}(V)
20


7Z08475
V_{DS} = 15 V
typical values
BFW10
20
15
10
5
0
I_D (mA)
$-V_{GS}$ = 0
1V
2V
0
50
100
150
T_j (°C)


7Z08474
V_{DS} = 15 V
typical values
BFW11
8
6
4
2
0
I_D (mA)
$-V_{GS}$ = 0
0.5V
1V
0
50
100
150
T_j (°C)

APPLICATION INFORMATION (continued)

Input amplifier circuit for an oscilloscope.

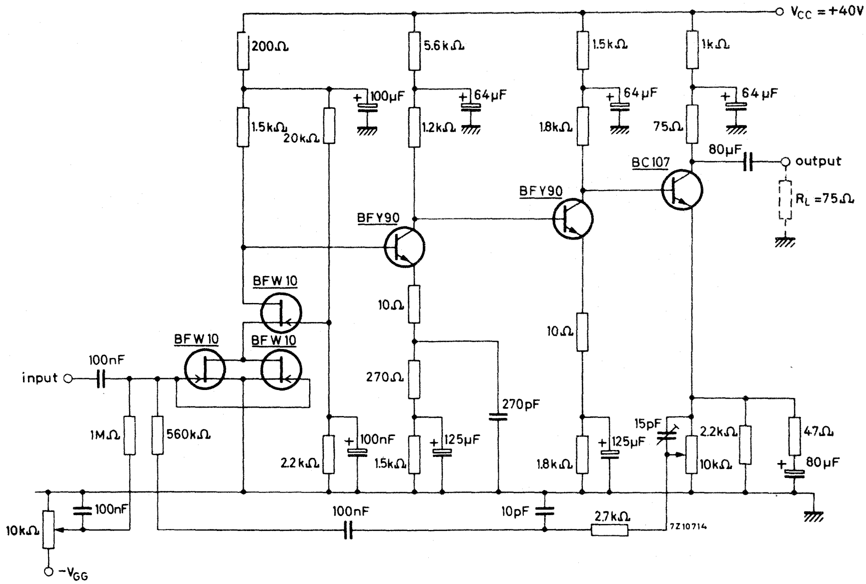


Performance:

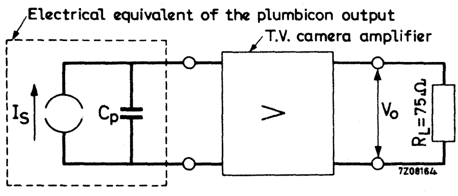
Input resistance	1 MΩ
Input capacitance	7.5 pF
Bandwidth	From d.c. to 300 MHz
Rise time	< 1 ns
Voltage gain	3.6
R.M.S. noise voltage (B = 300 MHz)	≤ 0.2 mV (input short-circuited)
Input sensitivity	This input amplifier is intended for an oscilloscope with a maximum input sensitivity of 5 or 10 mV/cm 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) ($d \leq 5\%$)	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

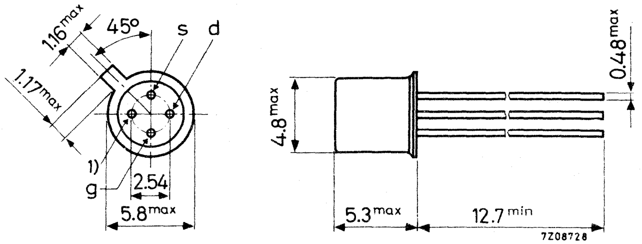
N-CHANNEL SILICON FIELD EFFECT TRANSISTOR

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	$\pm V_{DS}$	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	$\lvert y_{fs} \rvert$	>	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 in accordance with the Absolute Maximum System (IEC134)

Voltages				
→ Drain-source voltage	$\pm V_{DS}$	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 °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

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 °C	$-I_{GSS}$	<	1.0	μA
Drain current [1]				
V_{DS} = 15 V; V_{GS} = 0	I_{DSS}	2 to	20	mA
Gate-source voltage				
I_D = 200 μA; 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	$\vert y_{fs} \vert$	2.0 to	6.5	$m\Omega^{-1}$
Output admittance	$\vert y_{os} \vert$	<	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	$\vert y_{fs} \vert$	>	1.6	$m\Omega^{-1}$

[1]) Measured under pulsed conditions.

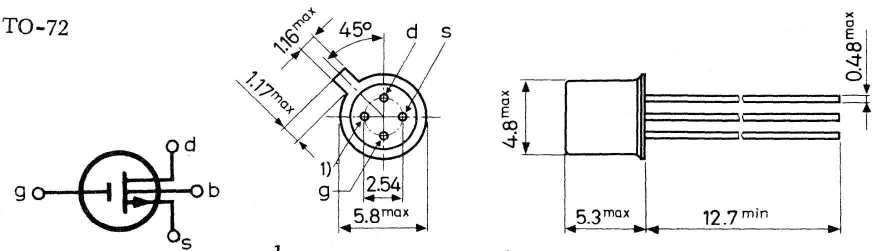
N-CHANNEL INSULATED GATE FIELD EFFECT TRANSISTOR

Depletion type insulated gate field effect transistor in a TO-72 metal envelope with the substrate connected to the case.
It is intended for chopper and other special switching applications, e.g. timing circuits, multiplex circuits, etc. The features are a very low drain-source 'on' resistance, a very high drain-source 'off' resistance and low feedback capacitances.

QUICK REFERENCE DATA				
Drain-source resistance (on) at f = 1 kHz				
V_{DS} = 0 ; V_{GS} = 5 V; V_{BS} = 0	$r_{ds\,on}$	<	50	Ω
Drain-source resistance (off)				
V_{DS} = 10 V; $-V_{GS}$ = 5 V; V_{BS} = 0	r_{DSoff}	>	10	GΩ
Feedback capacitances at f = 1 MHz				
$-V_{GS}$ = 5 V; V_{DS} = 0; I_B = 0	$-C_{rs}$	<	0.5	pF
$-V_{GD}$ = 5 V; V_{SD} = 0; I_B = 0	$-C_{rd}$	<	1.2	pF

MECHANICAL DATA Dimensions in mm

TO-72



1) Substrate connected to case

Note: To safeguard the gates against damage duo 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-substrate voltage	V_{DB}	max.	30	V
Source-substrate voltage	V_{SB}	max.	30	V
Gate-substrate voltage (continuous)	V_{GB}	max.	10	V
		min.	−10	V
Repetitive peak gate to all other terminals voltage $V_{SB} = V_{DB} = 0$; $f > 100$ Hz	V_{G-N}	max.	15	V
		min.	−15	V
Non repetitive peak gate to all other terminals voltage $V_{SB} = V_{DB} = 0$; $t < 10$ ms	V_{G-N}	max.	50	V
		min.	−50	V

Currents

Drain current (peak value) $t_r = 20$ ms; d = 0.1	I_{DM}	max.	50	mA
Source current (peak value) $t_r = 20$ ms; d = 0.1	I_{SM}	max.	50	mA

Power dissipation

Total power dissipation up to $T_{amb} = 25$ °C	P_{tot}	max.	200	mW

Temperatures

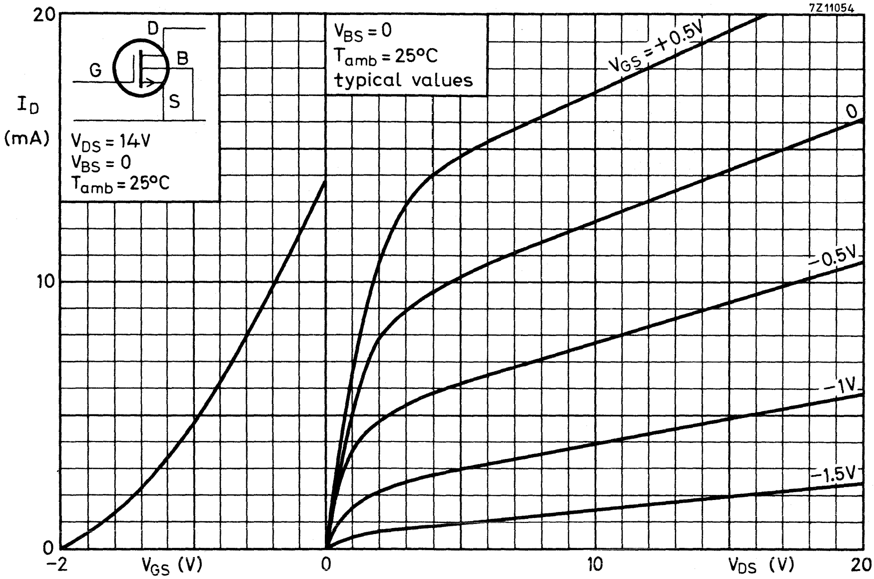
Storage temperature	T_{stg}		−65 to +125	°C
Junction temperature	T_j	max.	125	°C

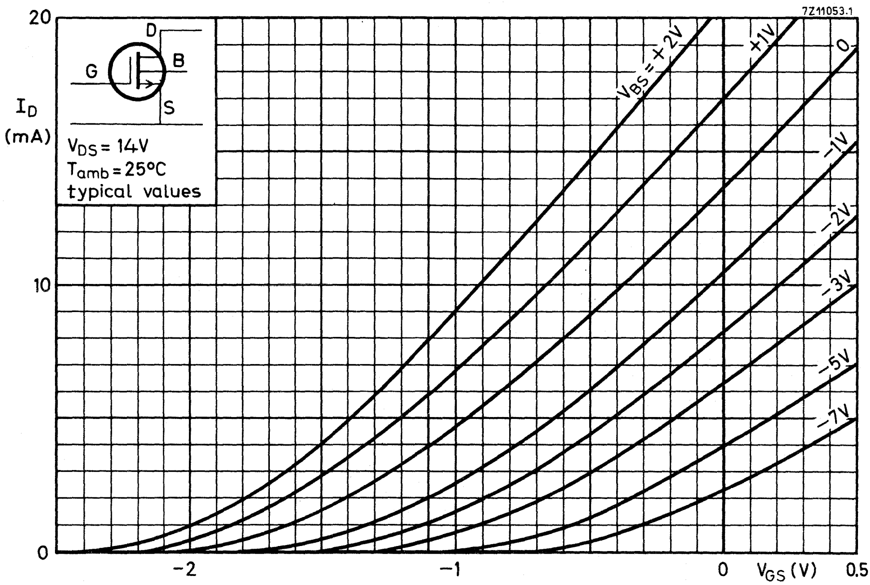
THERMAL RESISTANCE

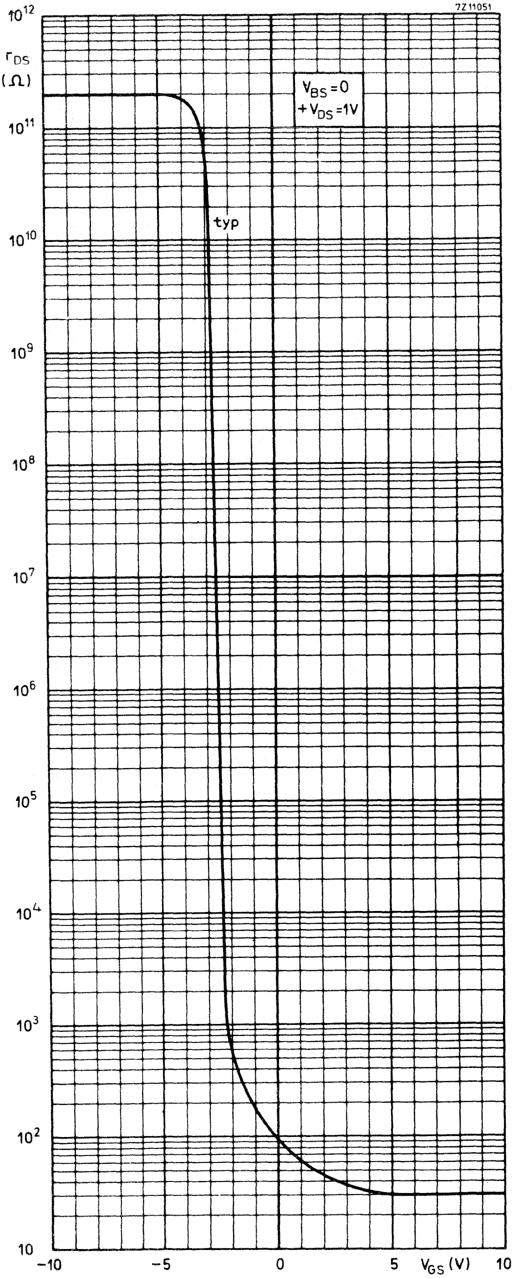
From junction to ambient in free air	$R_{th\ j-a}$	=	0.5	°C/mW

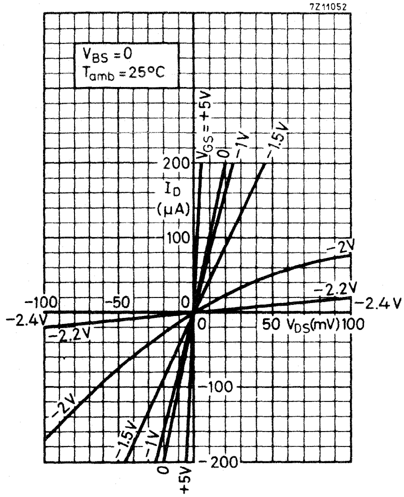
CHARACTERISTICS T_j = 25 °C unless otherwise specified

Drain cut-off currents; V_{BS} = 0				
V_{DS} = 10 V; $-V_{GS}$ = 5 V	I_{DSX}	<	1	nA
V_{DS} = 10 V; $-V_{GS}$ = 5 V; T_j = 125 °C	I_{DSX}	<	1	µA
Source cut-off currents; V_{BD} = 0				
V_{SD} = 10 V; $-V_{GD}$ = 5 V	I_{SDX}	<	1	nA
V_{SD} = 10 V; $-V_{GD}$ = 5 V; T_j = 125 °C	I_{SDX}	<	1	µA
Gate currents; V_{BS} = 0				
$-V_{GS}$ = 10 V; V_{DS} = 0	$-I_{GSS}$	<	10	pA
V_{GS} = 10 V; V_{DS} = 0	I_{GSS}	<	10	pA
$-V_{GS}$ = 10 V; V_{DS} = 0; T_j = 125 °C	$-I_{GSS}$	<	200	pA
V_{GS} = 10 V; V_{DS} = 0; T_j = 125 °C	I_{GSS}	<	200	pA
Bulk currents; V_{GB} = 0				
$-V_{BD}$ = 30 V; I_S = 0	$-I_{BDO}$	<	10	µA
$-V_{BS}$ = 30 V; I_D = 0	$-I_{BSO}$	<	10	µA
Drain-source resistance (on) at f = 1 kHz; V_{BS} = 0				
V_{GS} = 0 ; V_{DS} = 0	r_{dson}	<	100	Ω
V_{GS} = 0 ; V_{DS} = 0; T_j = 125 °C	r_{dson}	<	150	Ω
$+V_{GS}$ = 5 V; V_{DS} = 0	r_{dson}	<	50	Ω
Drain-source resistance (off)				
$-V_{GS}$ = 5 V; V_{DS} = 10 V; V_{BS} = 0	r_{DSoff}	>	10	GΩ
Feedback capacitances at f = 1 MHz				
$-V_{GS}$ = 5 V; V_{DS} = 0; I_B = 0	C_{rs}	<	0.5	pF
$-V_{GD}$ = 5 V; V_{SD} = 0; I_B = 0	C_{rd}	<	1.2	pF
Gate to all other terminals capacitance at f = 1 MHz				
$-V_{GB}$ = 5 V; V_{SB} = V_{DB} = 0	C_{g-n}	<	5	pF


7Z11054
D
G
B
S
I_D
(mA)
V_{DS} = 14V
V_{BS} = 0
T_{amb} = 25°C
V_{BS} = 0
T_{amb} = 25°C
typical values
V_{GS} = +0.5V
0
−0.5V
−1V
−1.5V
20
10
0
−2
V_{GS} (V)
0
10
V_{DS} (V)
20


7Z11053.1
D
G
B
S
I_D
(mA)
V_{DS} = 14V
T_{amb} = 25°C
typical values
V_{BS} = +2V
+1V
0
−1V
−2V
−3V
−5V
−7V
20
10
0
−2
−1
0
V_{GS} (V)
0.5


7Z11051
r_{DS} (Ω)
10^{12}
10^{11}
10^{10}
10^{9}
10^{8}
10^{7}
10^{6}
10^{5}
10^{4}
10^{3}
10^{2}
10
$V_{BS} = 0$
$+V_{DS} = 1V$
typ
−10
−5
0
5
V_{GS} (V)
10


7Z11052
$V_{BS} = 0$
$T_{amb} = 25°C$
$V_{GS} = +5V$
0
−1V
−1.5V
200
I_D (μA)
100
−2V
−2.2V
−2.4V
−100
−50
0
50
V_{DS}(mV)
100
−100
−200
+5V

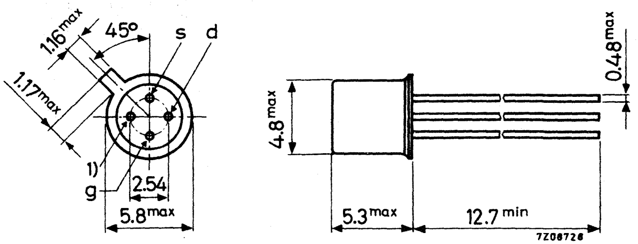
N-CHANNEL SILICON FIELD EFFECT TRANSISTOR

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	$\lvert y_{fs}\rvert$	>	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 $\delta \leq 0.1$

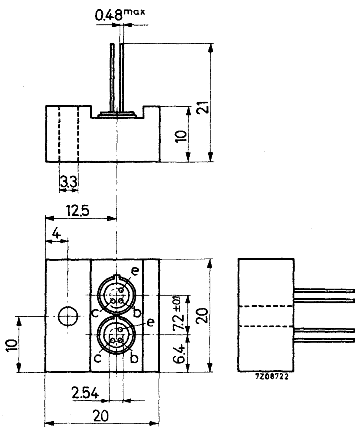
Dual transistors

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 $\lvert I_{1E} + I_{2E} \rvert \leq 200\ \mu A$ $V_{1C-1E} = V_{2C-2E} \leq 20\ V$ $\lvert V_{1B-1E} - V_{2B-2E} \rvert \leq 100\ \mu V$ T_{amb}: -20 to $+90\ ^{o}C$	$\left\lvert \frac{\Delta V}{\Delta T} \right\rvert$	typ. <	1 $\mu V/^{o}C$ 3 $\mu V/^{o}C$
Equivalent differential current change referred to the input $I_{1C} + I_{2C} = 100\ \mu A$ T_{amb}: -20 to $+90\ ^{o}C$	$\left\lvert \frac{\Delta I}{\Delta T} \right\rvert$	typ. <	0.5 $nA/^{o}C$ 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 15000 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

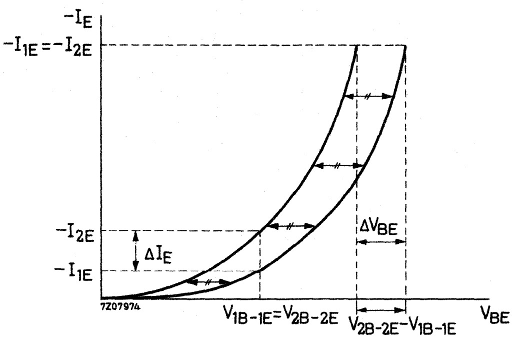
$\frac{I_{1C}}{I_{2C}}$ 0.85 to 1; typ. 0.93

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:



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

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

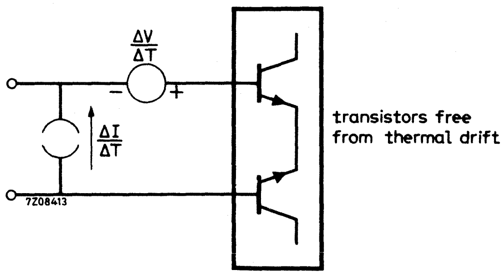
ΔV_{BE} measured at $\frac{I_{2E}}{I_{1E}} = 1$

CHARACTERISTICS of the complete device (continued)

Equivalent circuit for drift

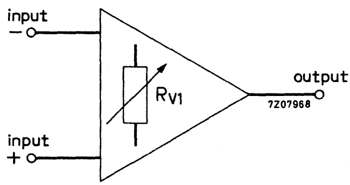
In the equivalent circuit the transistors are considered to be drift free.
All temperature coefficients are concentrated in the voltage source $\frac{\Delta V}{\Delta T}$ and in the current source $\frac{\Delta I}{\Delta T}$.

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

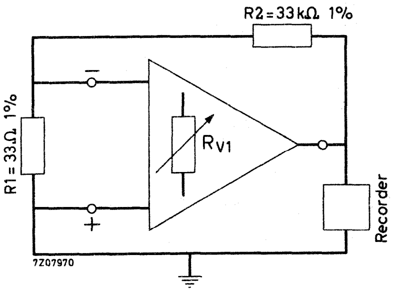
BCY55 unit (wires included) mounted in a small metal or plastic box for shielding against direct heat radiation. $\left|\frac{\Delta V}{\Delta T}\right|$ typ. 1 μV/°C; < 3 μV/°C

Equivalent differential current change with temperature referred to the input.

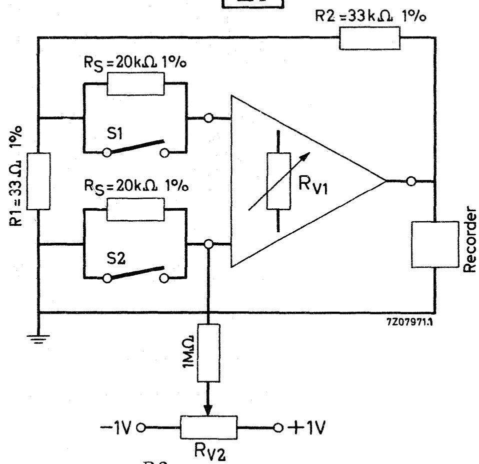
$I_{1C} + I_{2C} = 100\ \mu A$ $\frac{\Delta I}{\Delta T}$ typ. 0.5 nA/°C; < 1.5 nA/°C

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.

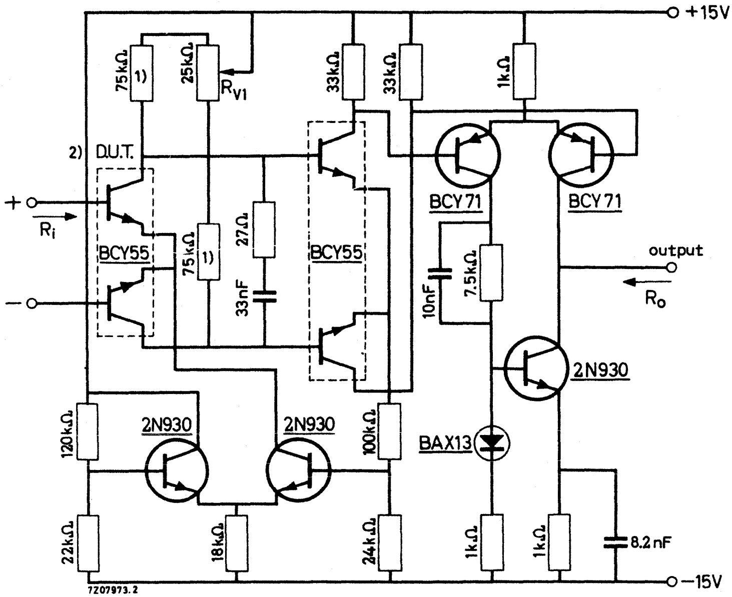
Then: $\frac{\Delta V}{\Delta T} = \frac{V_{T2} - V_{T1}}{T_2 - T_1} \cdot \frac{R1}{R2}$ or $\frac{\Delta I}{\Delta T} = \frac{V_{T2} - V_{T1}}{T_2 - T_1} \cdot \frac{R1}{R2} \cdot \frac{1}{2R_S}$

[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.

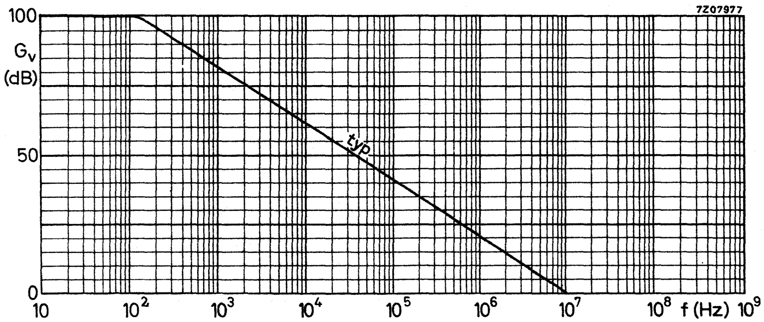


1) Relative temperature coefficient < $10^{-5}/^{o}C$

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



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.

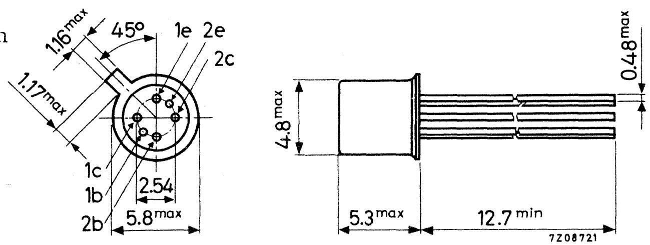
			BCY87	BCY88	BCY89	
Ratio of collector currents at $V_{1B-1E} = V_{2B-2E}$	I_{1C}/I_{2C}		0.9-1.11	0.8-1.25	0.67-1.5	
Base current difference at $V_{1B-1E} = V_{2B-2E}$	$\lvert I_{1B}-I_{2B}\rvert$	<	25	80	300	nA
Equivalent differential voltage change with temperature	$\left\lvert\frac{\Delta V}{\Delta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

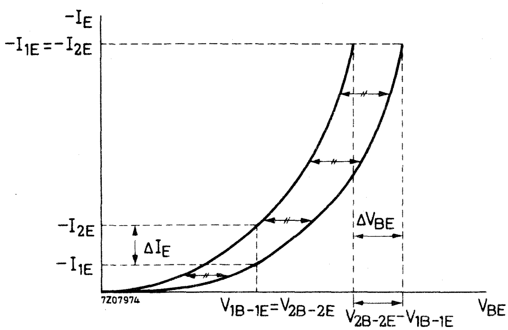
a. Collector-base voltage of both transistors not exceeding 10 V ($V_{1C-1B} = V_{2C-2B} \leq 10$ V)

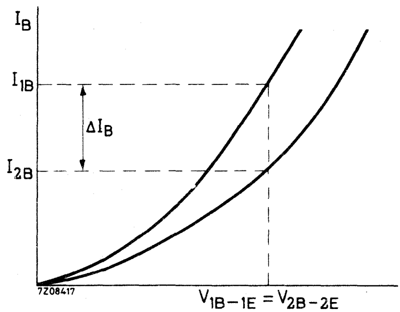
b. Sum of the emitter currents from 10 to 100 μA
$-(I_{1E} + I_{2E}) = 10$ to 100 μA

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						
$I_{1C} = I_{2C}$	$\|V_{1B-1E} - V_{2B-2E}\|$	<	3	6	10	mV
Difference between base currents						
$V_{1B-1E} = V_{2B-2E}$	$\|I_{1B} - I_{2B}\|$	<	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 $\Delta V_{BE} = 0$

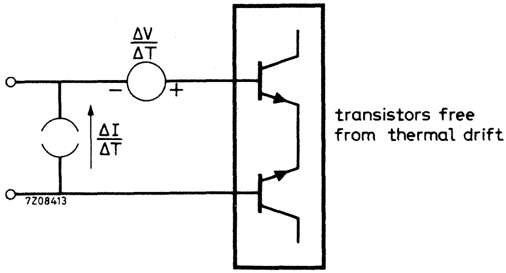
ΔV_{BE} measured at $\frac{I_{2E}}{I_{1E}} = 1$

CHARACTERISTICS of the complete device (continued)

Equivalent circuit for drift

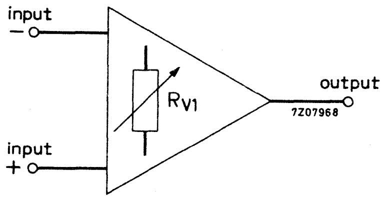
In the equivalent circuit the transistors are considered to be drift free.
All temperature coefficients are concentrated in the voltage source $\frac{\Delta V}{\Delta T}$ and in the current source $\frac{\Delta I}{\Delta T}$.

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

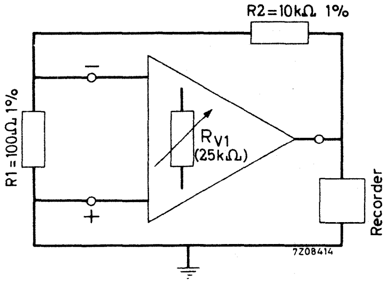
			BCY87	BCY88	BCY89	
T_{amb} = −20 to +90 °C	$\left\|\frac{\Delta V}{\Delta T}\right\|$	typ.	1	2	4	μV/°C
		<	3	6	10	μV/°C

Equivalent differential current change with temperature

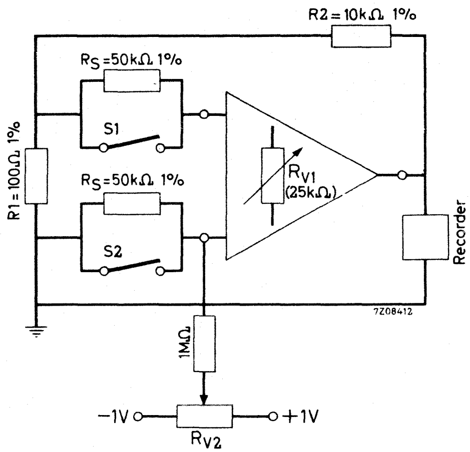
			BCY87	BCY88	BCY89	
T_{amb} = −20 to +90 °C	$\left\|\frac{\Delta I}{\Delta T}\right\|$	<	0.5	2	10	nA/°C

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.

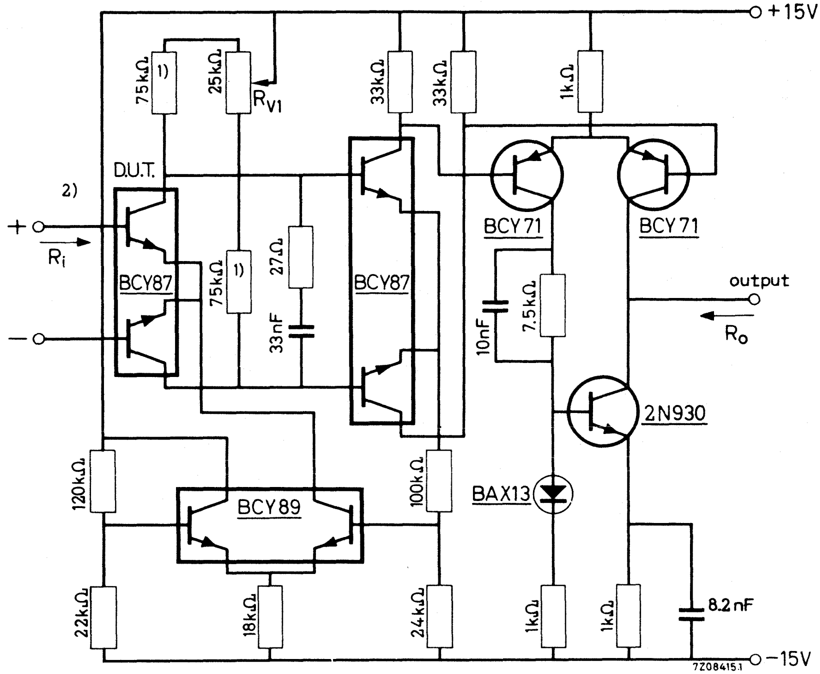
Then: $\frac{\Delta V}{\Delta T} = \frac{V_{T2} - V_{T1}}{T_2 - T_1} \cdot \frac{R1}{R2}$ or $\frac{\Delta I}{\Delta T} = \frac{V_{T2} - V_{T1}}{T_2 - T_1} \cdot \frac{R1}{R2} \cdot \frac{1}{2R_S}$

[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.

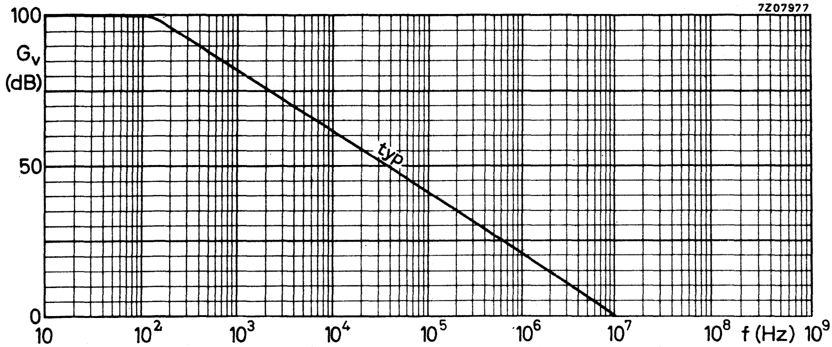


1) Relative temperature coefficient < $10^{-5}/^{o}C$

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	$R_{th\ j-a}$	=	1	°C/mW

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

MATCHED N-CHANNEL FET's

Matched pair of n-channel silicon epitaxial planar junction field effect transistors in TO-72 metal envelopes held together by a metal S-clip.
It is intended for low level differential amplifiers.

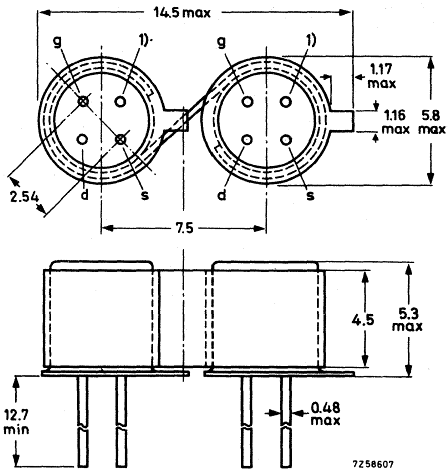
QUICK REFERENCE DATA

Characteristics $T_{amb} = 25\ ^oC$; $V_{DG} = 15$ V; $I_D = 0.5$ mA			BFS21	BFS21A	
Gate cut-off current	I_G	<	0.5	0.5	nA
Gate-source voltage difference	$\|\Delta V_{GS}\|$	<	20	10	mV
Thermal drift of gate-source voltage difference	$\left\|\frac{d\ \Delta V_{GS}}{dT}\right\|$	<	75	40	$\mu V/^oC$
Difference of penetration factor	$\left\|\Delta \frac{g_{os}}{g_{fs}}\right\|$	<	1	0.5	10^{-3}
Difference of transfer impedance	$\left\|\Delta \frac{1}{g_{fs}}\right\|$	<	15	7.5	Ω
Common mode rejection ratio	CMRR	>	60	66	dB

TOTAL DEVICE

Dimensions in mm

MECHANICAL DATA



1) = shield lead (connected to case)

max. lead diameter is guaranteed only for 12.7 mm

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

Voltage

Voltage between any 2 terminals	V	max.	30	V

Currents

Drain current	I_D	max.	4	mA
Gate current	I_G	max.	0.5	mA

Power dissipation

Total power dissipation up to T_{amb} = 100 °C	P_{tot}	max.	30	mW

Temperature

Operating ambient temperature	Tamb	-20 to + 100 °C

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

			BFS21	BFS21A	
Drain current ratio					
V_{DG} = 15 V; V_{GS} = 0; T_j = 25 °C	$\frac{I_{D1-S1S}}{I_{D2-S2S}}$	>	0.95	0.95	
		<	1.05	1.05	
Gate-source voltage difference					
I_D = 500 μA; V_{DG} = 15 V	$\lvert\Delta V_{GS}\rvert$	<	20	10	mV
I_D = 100 μA; V_{DG} = 15 V	$\lvert\Delta V_{GS}\rvert$	<	20	10	mV
Thermal drift of gate-source voltage difference					
I_D = 500 μA; V_{DG} = 15 V	$\left\lvert\frac{d\ \Delta V_{GS}}{dT}\right\rvert$	<	75	40	μV/°C
I_D = 100 μA; V_{DG} = 15 V	$\left\lvert\frac{d\ \Delta V_{GS}}{dT}\right\rvert$	<	75	40	μV/°C
Change of gate-source voltage difference with ambient temperature					
T_{amb} = 25 to 100 °C					
I_D = 500 μA; V_{DG} = 15 V	$\lvert\Delta V_{GS}(T_{amb2}) - \Delta V_{GS}(T_{amb1})\rvert$	<	6	3	mV
I_D = 100 μA; V_{DG} = 15 V	$\lvert\Delta V_{GS}(T_{amb2}) - \Delta V_{GS}(T_{amb1})\rvert$	<	6	3	mV
Difference of penetration factors [1]					
I_D = 500 μA; V_{DG} = 15 V	$\left\lvert\Delta \frac{g_{os}}{g_{fs}}\right\rvert$	<	1	0.5	10^{-3}
I_D = 100 μA; V_{DG} = 15 V	$\left\lvert\Delta \frac{g_{os}}{g_{fs}}\right\rvert$	<	1	0.5	10^{-3}
Difference of transfer impedances [2]					
I_D = 500 μA; V_{DG} = 15 V	$\left\lvert\Delta \frac{1}{g_{fs}}\right\rvert$	<	15	7.5	Ω
I_D = 100 μA; V_{DG} = 15 V	$\left\lvert\Delta \frac{1}{g_{fs}}\right\rvert$	<	75	37.5	Ω

[1] The difference between the penetration factors is equal to the ratio of the change of the gate-source voltage difference to the change of drain-gate voltage, at constant drain current.

$$\left(\Delta \frac{g_{os}}{g_{fs}} = \frac{d\ \Delta V_{GS}}{d\ V_{DG}} \text{ at } I_D = \text{constant}\right)$$

[2] The difference between the transfer impedances is equal to the ratio of the change of the gate-source voltage difference to the change of drain current, at constant drain-gate voltage.

$$\left(\Delta \frac{1}{g_{fs}} = \frac{d\ \Delta V_{GS}}{d\ I_D} \text{ at } V_{DG} = \text{constant}\right)$$

CHARACTERISTICS (continued) (total device)

Common mode rejection ratio [1]			BFS21	BFS21A	
I_D = 500 μA; V_{DG} = 15 V	CMRR	>	60	66	dB
I_D = 100 μA; V_{DG} = 15 V	CMRR	>	60	66	dB

INDIVIDUAL TRANSISTOR

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 $T_{amb} = 25^o$	P_{tot}	max.	**300**	mW
Temperatures				
Storage temperature	T_{stg}		-65 to +200	^oC
Junction temperature	T_j	max.	200	^oC

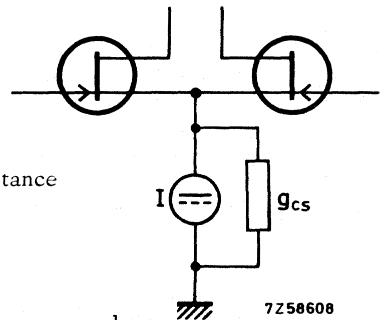
THERMAL RESISTANCE

From junction to ambient in free air (for individual transistor without S-clip) $R_{th\ j-a}$ = 0.59 $^oC/mW$

[1]) Common mode rejection ratio

$$(CMRR)^{-1} = \Delta\frac{g_{os}}{g_{fs}} + \frac{1}{2} g_{cs}\, \Delta\frac{1}{g_{fs}}$$

where g_{cs} in this formula is the output conductance of the summing current source.



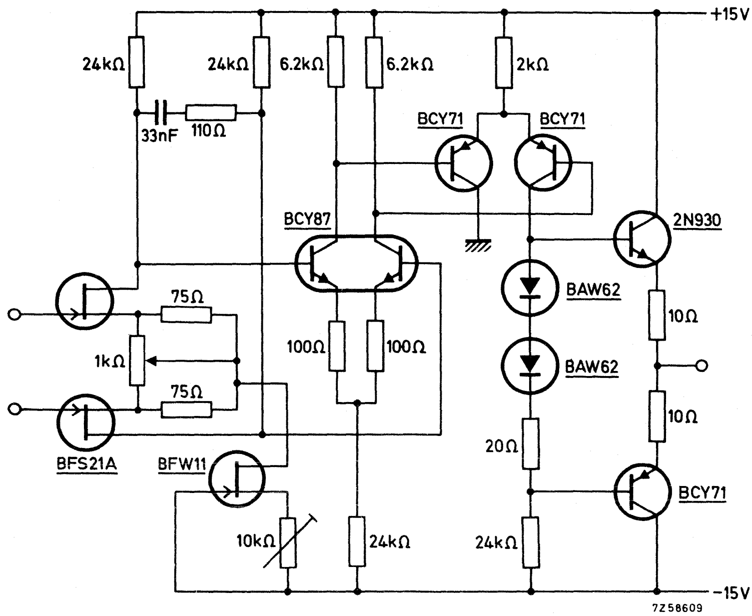
The guaranteed values of CMRR apply at $g_{cs} = 0.1\ \mu\Omega^{-1}$

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

Gate cut-off current				
I_D = 500 µA; V_{DS} = 15 V	I_G	<	0.5	nA
I_D = 500 µA; V_{DS} = 15 V; T_{amb} = 100 °C	I_G	<	25	nA
Drain current				
V_{DS} = 15 V, V_{GS} = 0, T_j = 25 °C	I_{DSS}	>	1	mA
Gate-source cut-off voltage				
I_D = 0.5 nA, V_{DS} = 15 V	$-V_{(P)GS}$	<	6	V
Transfer conductance at f = 1 kHz				
I_D = 500 µA; V_{DS} = 15 V	g_{fs}	>	1.0	$m\Omega^{-1}$
Output conductance at f = 1 kHz				
I_D = 500 µA; V_{DS} = 15 V	g_{os}	<	15	$\mu\Omega^{-1}$
Input capacitance at f = 1 MHz				
I_D = 500 µA; V_{DS} = 15 V	C_{is}	<	5	pF
Feedback capacitance at f = 1 MHz				
I_D = 500 µA; V_{DS} = 15 V	C_{rs}	<	0.75	pF
Equivalent noise voltage				
f = 10 Hz				
I_D = 500 µA; V_{DS} = 15 V	$V_n/\sqrt{B}$	<	200	nV/$\sqrt{Hz}$
V_{DS} = 15 V, V_{GS} = 0	$V_n/\sqrt{B}$	<	75	nV/$\sqrt{Hz}$

APPLICATION INFORMATION

Operational amplifier



APPLICATION INFORMATION (continued)

Input voltages			
Initial off-set voltage	<	10	mV
Differential off-set voltage change with temperature	<	40	μV/°C
Differential off-set voltage change with time	<	40	μV/day
Noise voltage (B = 100 kHz)	<	2	μV
Common mode rejection ratio	>	65	dB
Supply rejection ratio	<	500	10^{-6}
Input voltage range	±	10	V
Input currents			
Input bias current; T_{amb} = 25 °C	typ.	50	pA
; T_{amb} = 100 °C	<	25	nA
Off-set current ; T_{amb} = 25 °C	typ.	20	pA
; T_{amb} = 100 °C	<	25	nA
Input impedance			
Input resistance	typ.	100	GΩ
Input resistance (common mode)	typ.	100	GΩ
Input capacitance	typ.	3	pF
Input capacitance (common mode)	typ.	3	pF
Frequency response			
Bandwidth (G_V = 1)	typ.	10	MHz
Slewing rate	typ.	10	V/μs
Output voltage range	±	10	V
Output current range	±	10	mA
Output resistance	typ.	300	Ω

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:

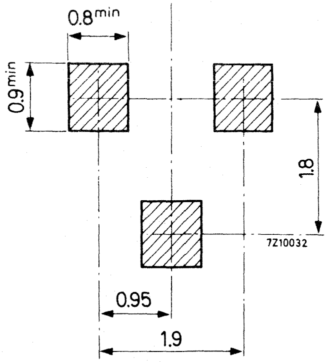
1. The maximum solder temperature and the proper flux are important. The flux must not affect the resistors, and its residue must be easy to remove. Use only rosin flux, which can be easily removed with butylacetate or xylene.
2. The temperature change during soldering must not be so severe as to strain 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.

The transistors in this chapter are also available with the base and emitter connections interchanged. These types are indicated by the letter R following the type number: e.g. BCW29R.

Type No.	Marking code
BAW56	A1
BCW29	C1
BCW30	C2
BCW31	D1
BCW32	D2
BCW33	D3
BCW69	H1
BCW70	H2
BCW71	K1
BCW72	K2
BFS17	E1
BFS18	F1
BFS19	F2
BFS20	G1
BSV52	B2
BZX84-C4V7	Z1
BZX84-C5V1	Z2
BZX84-C5V6	Z3
BZX84-C6V2	Z4
BZX84-C6V8	Z5
BZX84-C7V5	Z6
BZX84-C8V2	Z7
BZX84-C9V1	Z8
BZX84-C10	Z9
BZX84-C11	Y1
BZX84-C12	Y2

Type No.	Marking code
BCW29R	C4
BCW30R	C5
BCW31R	D4
BCW32R	D5
BCW33R	D6
BCW69R	H4
BCW70R	H5
BCW71R	K4
BCW72R	K5
BFS17R	E4
BFS18R	F4
BFS19R	F5
BFS20R	G4
BSV52R	B4

SILICON PLANAR EPITAXIAL HIGH SPEED DIODES

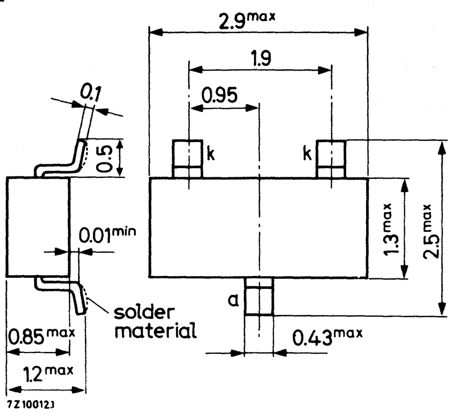
The BAW56 consists of two diodes in a micro miniature plastic envelope. The anodes are commoned and the unit is intended for high speed switching in thick and thin film circuits.

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		°C
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



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	°C
Junction temperature	T_j	max.	125	°C [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	$R_{th\ j\text{-}a}$	=	**1.4**	°C/mW
one diode loaded	$R_{th\ j\text{-}a}$	=	**0.9**	°C/mW

mounted on a **ceramic substrate of 7 mm x 5 mm x 0.5 mm**

both diodes loaded simultaneously	$R_{th\ j\text{-}a}$	=	**1.1**	°C/mW
one diode loaded	$R_{th\ j\text{-}a}$	=	**0.67**	°C/mW

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

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

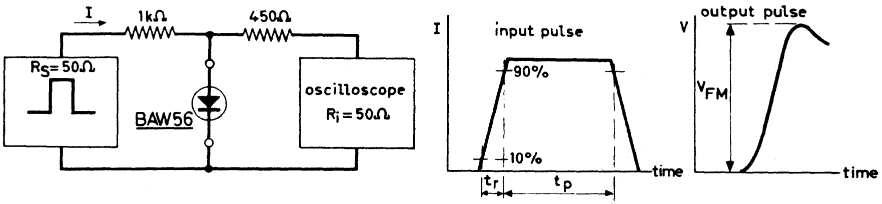
V_R = 10 V; T_j = 125 °C	I_R	<	8	μA
V_R = 25 V	I_R	<	30	nA
V_R = 25 V; T_j = 125 °C	I_R	<	10	μA

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

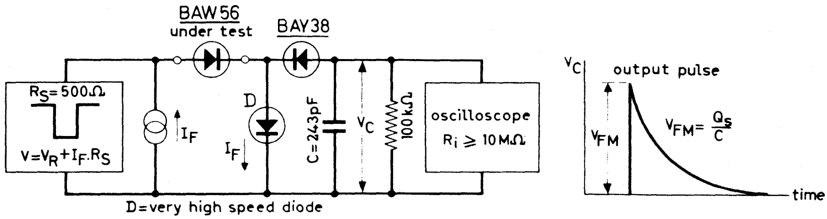
Circuit capacitance C < 1 pF (C = Oscilloscope + parasitical capacitance)

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

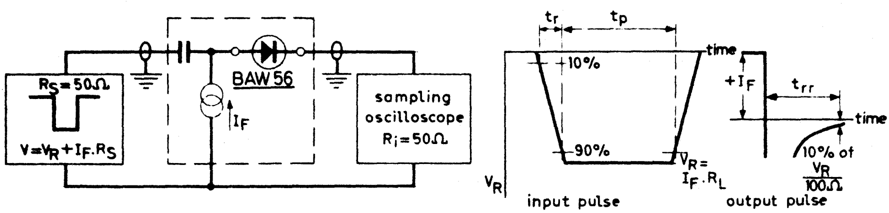
Circuit capacitance C < 7 pF (C = Oscilloscope + parasitical capacitance)

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:

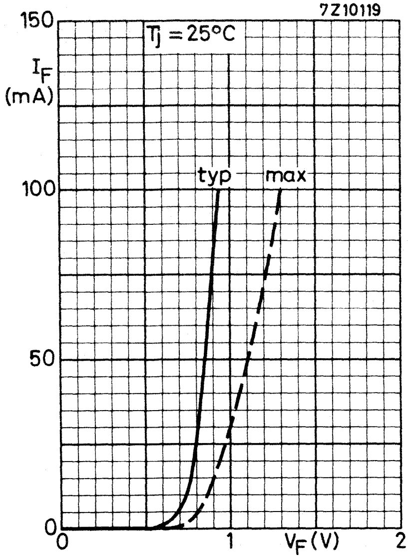


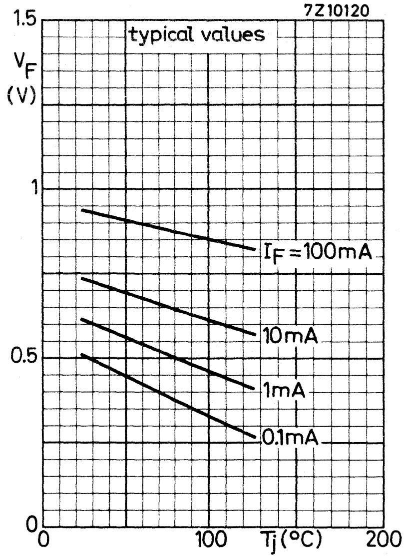
Reverse pulse: Rise time t_r = 0.6 ns Oscilloscope: Rise time t_r = 0.35 ns

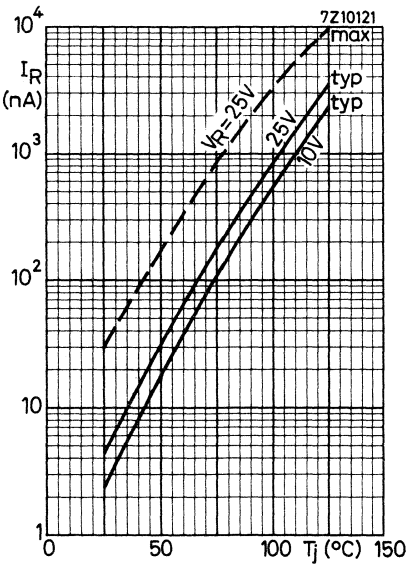
Pulse duration t_p = 100 ns

Duty cycle δ = 0.05

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


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
1mA
0.1mA
0.5
0
0
100
T_j (°C)
200


7Z10121
10^4
I_R
(nA)
max
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.

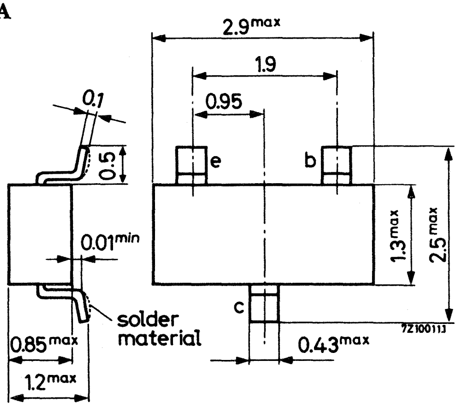
QUICK REFERENCE DATA

			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.	150	150	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



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 **ceramic substrate of 7 mm x 5 mm x 0.5 mm**	P_{tot}	max.	150	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 **ceramic substrate of 7 mm x 5 mm x 0.5 mm**	$R_{th\ j\text{-}a}$	=	0.67	°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

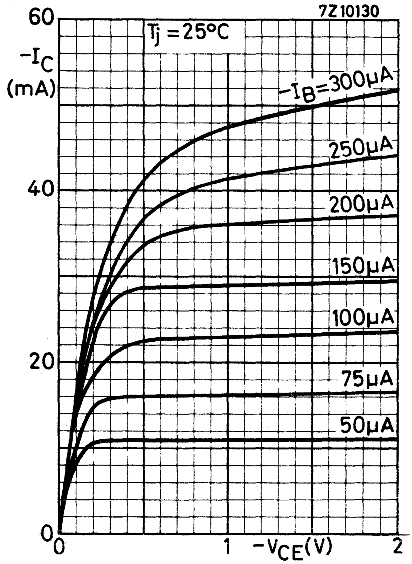
Saturation voltages				
$-I_C$ = 10 mA; $-I_B$ = 0.5 mA	$-V_{CEsat}$	typ.	80	mV
		<	300	mV
	$-V_{BEsat}$	typ.	720	mV
$-I_C$ = 50 mA; $-I_B$ = 2.5 mA	$-V_{CEsat}$	typ.	180	mV
	$-V_{BEsat}$	typ.	810	mV

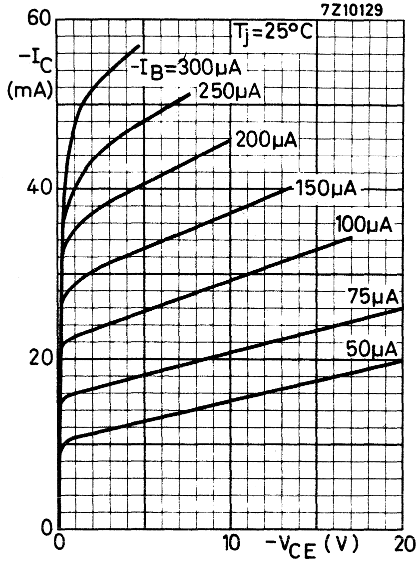
D.C. current gain			BCW29	BCW30
$-I_C$ = 10 μA; $-V_{CE}$ = 5 V	h_{FE}	typ.	90	150
$-I_C$ = 2 mA; $-V_{CE}$ = 5 V	h_{FE}	>	120	215
		<	260	500

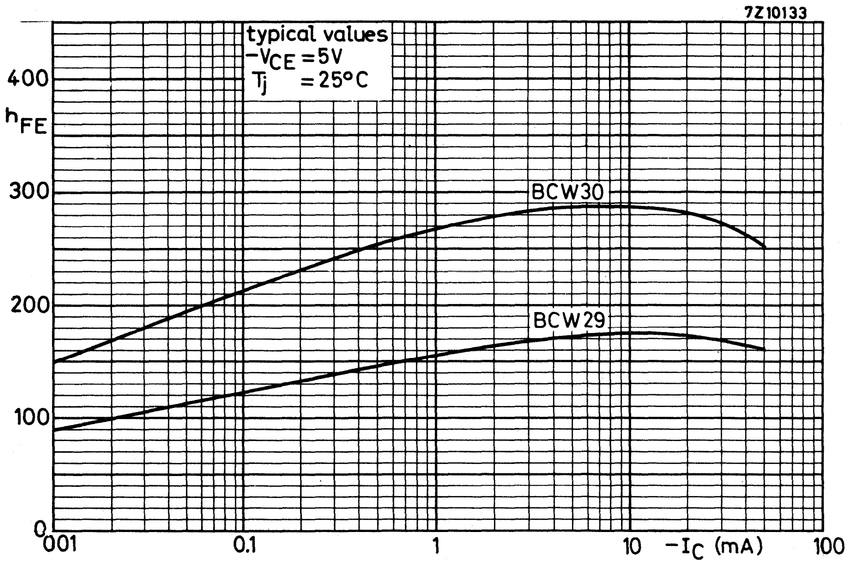
Collector capacitance at f = 1 MHz				
$I_E = I_e$ = 0; $-V_{CB}$ = 10 V	C_c	<	7.0	pF ←
Transition frequency at f = 35 MHz				
$-I_C$ = 10 mA; $-V_{CE}$ = 5 V	f_T	typ.	150	MHz
Noise figure at R_S = 2 kΩ				
$-I_C$ = 200 μA; $-V_{CE}$ = 5 V; f = 1 kHz; B = 200 Hz	F	<	10	dB[1]

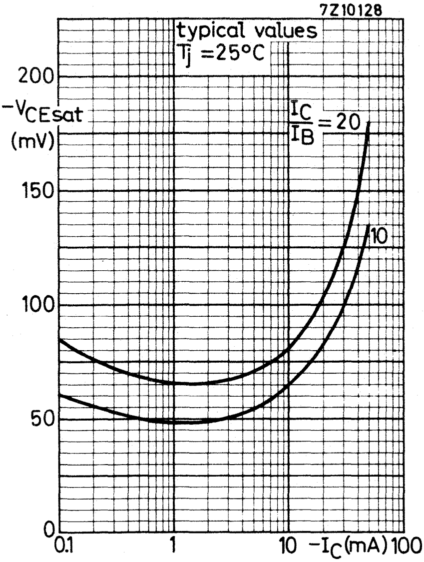
[1]) Crystal mounted in a BC177 envelope.

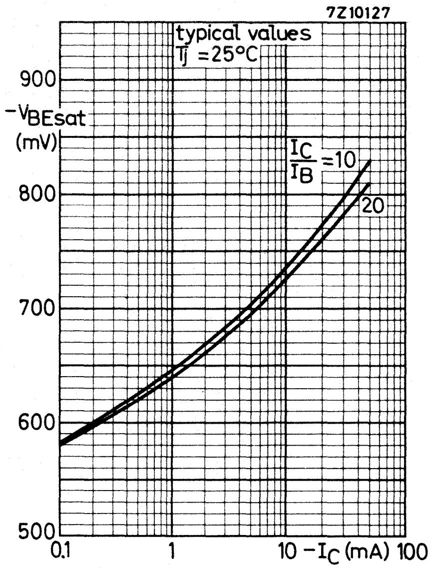
Typical behaviour of collector current versus collector-emitter voltage

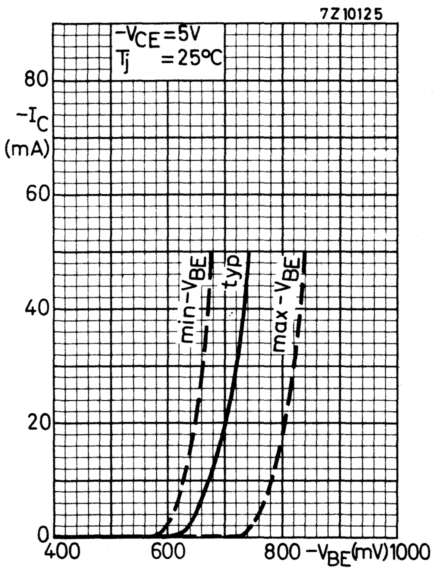


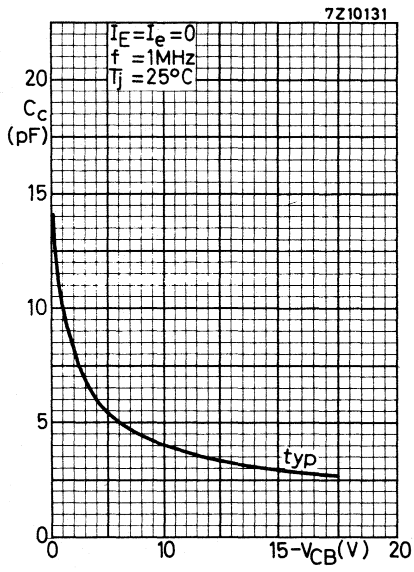


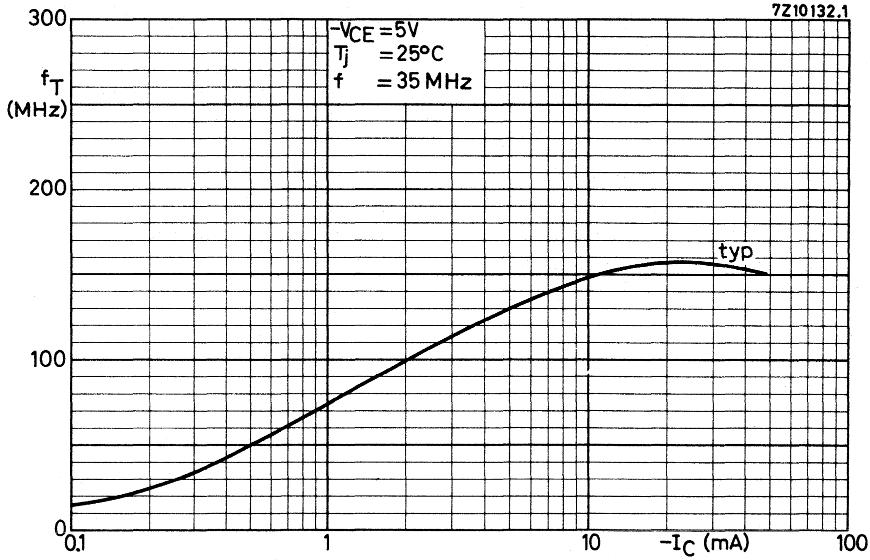


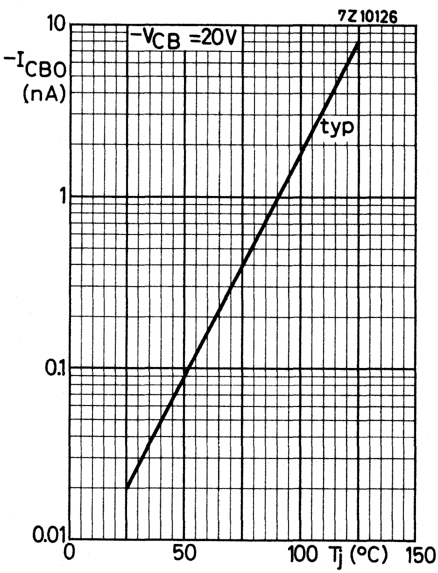

7Z10128
typical values
T_j = 25°C
$-V_{CEsat}$ (mV)
$\frac{I_C}{I_B}$ = 20
10
$-I_C$ (mA)


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.

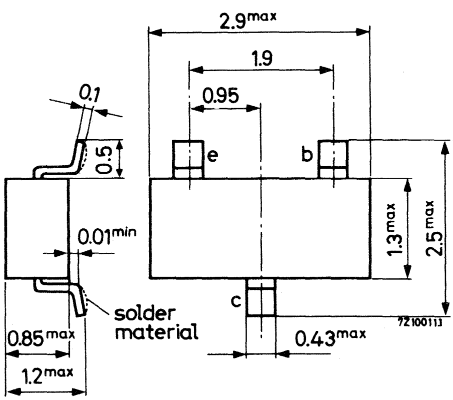
QUICK REFERENCE DATA

			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.	150	150	150	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



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 **ceramic substrate of 7 mm x 5 mm x 0.5 mm**	P_{tot}	max.	**150**	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 **ceramic substrate of 7 mm x 5 mm x 0.5 mm**	$R_{th\ j\text{-}a}$	=	0.67	°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

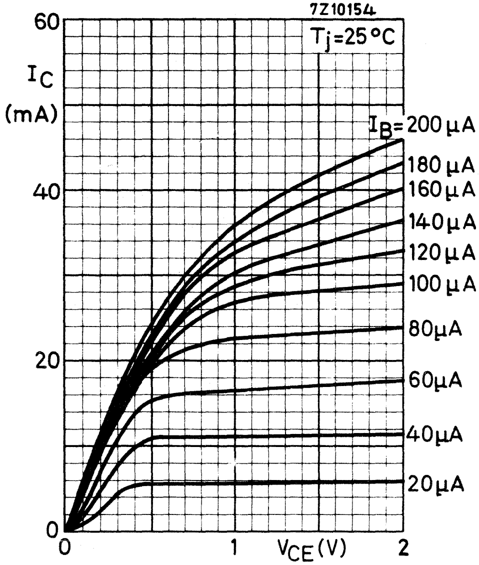
I_C = 10 mA; V_{CE} = 5 V	f_T	typ.	300	MHz

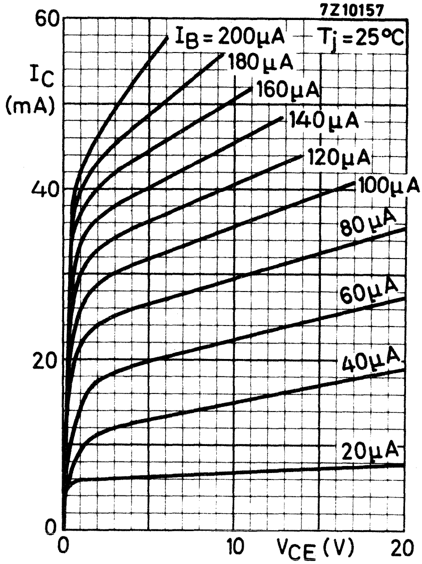
Noise figure at R_S = 2 kΩ

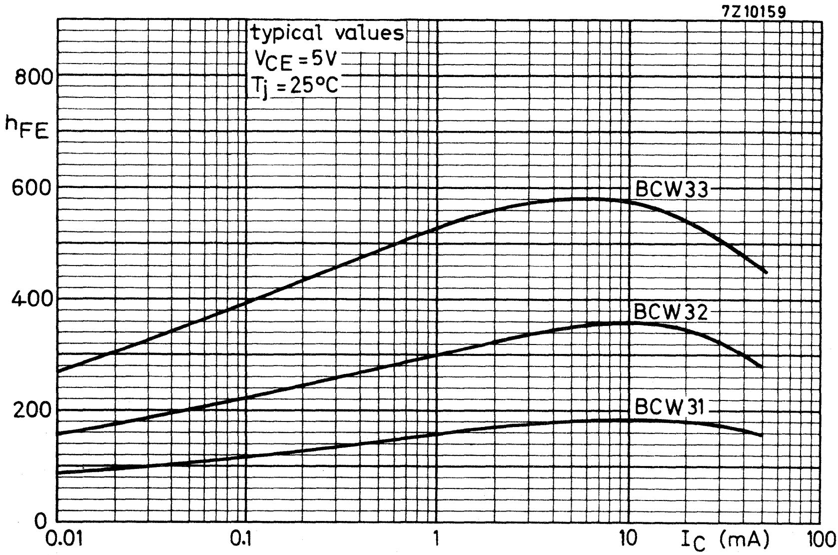
I_C = 200 μA; V_{CE} = 5 V f = 1 kHz; B = 200 Hz	F	<	10	dB [1])

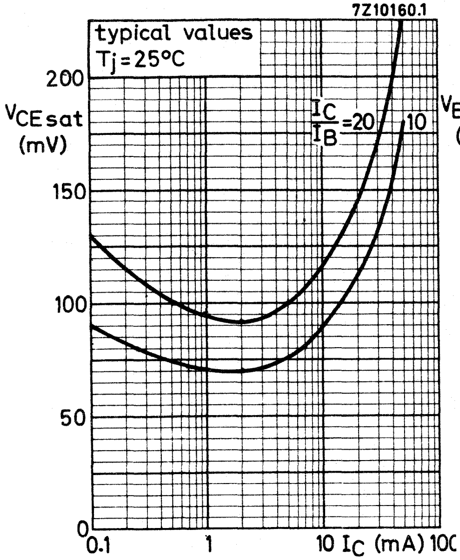
[1]) Crystal mounted in a BC107 envelope.

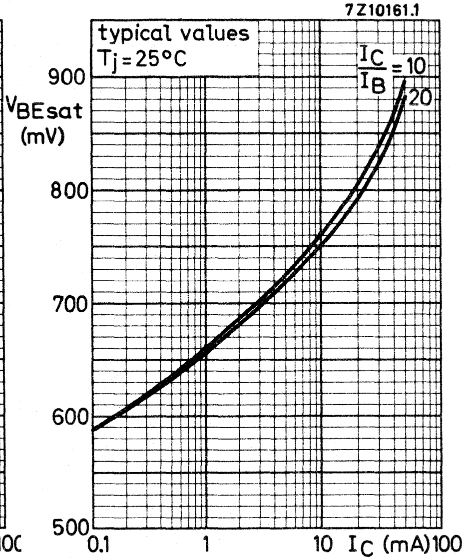
Typical behaviour of collector current versus collector-emitter voltage

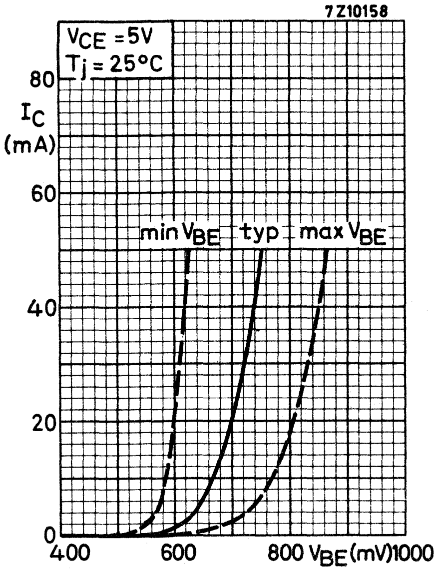


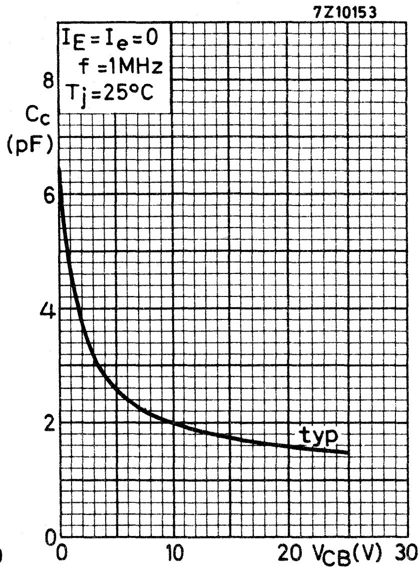


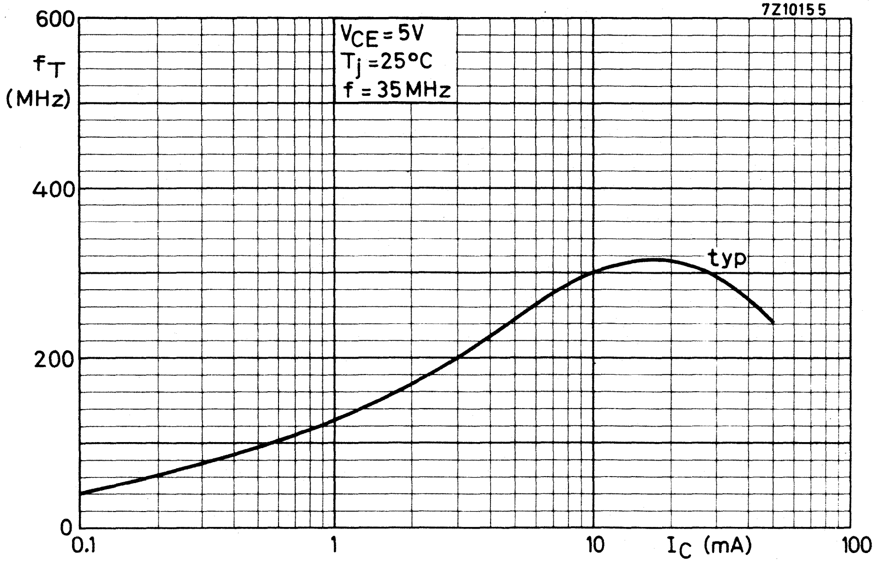


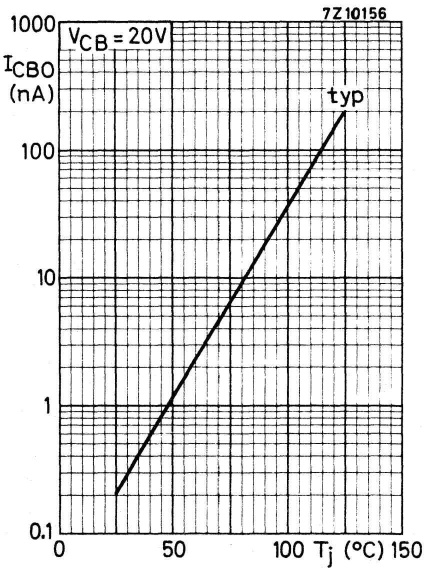

7Z10160.1
typical values
Tj = 25°C
200
150
100
50
0
VCEsat
(mV)
IC/IB = 20
10
0.1
1
10 IC (mA) 100


7Z10161.1
typical values
Tj = 25°C
IC/IB = 10
20
900
800
700
600
500
VBEsat
(mV)
0.1
1
10 IC (mA) 100


7Z10158
VCE = 5V
Tj = 25°C
80
60
40
20
0
IC
(mA)
min VBE
typ
max VBE
400
600
800 VBE (mV) 1000


7Z10153
IE = Ie = 0
f = 1MHz
Tj = 25°C
8
6
4
2
0
Cc
(pF)
typ
0
10
20 VCB (V) 30


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


7Z10156
1000
100
10
1
0.1
I_{CBO}
(nA)
V_{CB} = 20V
typ
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.

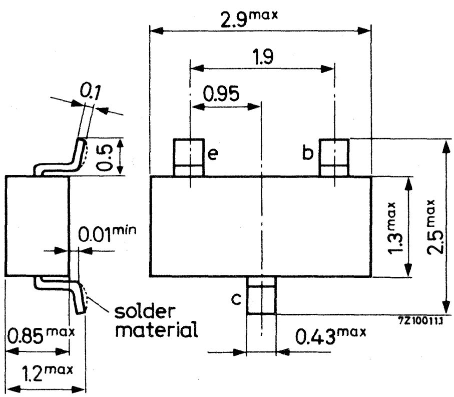
QUICK REFERENCE DATA

			BCW69	BCW70	
Collector-base voltage (open emitter)	$-V_{CBO}$	max.	50	50	V
Collector-emitter voltage (open base)	$-V_{CEO}$	max.	45	45	V
Collector current (peak value)	$-I_{CM}$	max.	200	200	mA
Total power dissipation up to T_{amb} = 25 °C	P_{tot}	max.	150	150	mW
Junction temperature	T_j	max.	125	125	°C
D.C. current gain at T_j = 25 °C $-I_C$ = 2 mA; $-V_{CE}$ = 5 V	h_{FE}	> <	120 260	215 500	
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 kΩ $-I_C$ = 200 μA; $-V_{CE}$ = 5 V f = 1 kHz; B = 200 Hz	F	<	10	10	dB

MECHANICAL DATA

Dimensions in mm

Code:
BCW69 H1
BCW70 H2



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

Voltages

Collector-base voltage (open emitter)	$-V_{CBO}$	max.	50	V
Collector-emitter voltage (V_{BE} = 0)	$-V_{CES}$	max.	50	V
Collector-emitter voltage (open base) $-I_C$ = 2 mA	$-V_{CEO}$	max.	45	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 ceramic substrate of 7 mm x 5 mm x 0.5 mm	P_{tot}	max.	150	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 ceramic substrate of 7 mm x 5 mm x 0.5 mm	$R_{th\ j-a}$	=	0.67	°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

			BCW69	BCW70
$-I_C$ = 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	<	7.0	pF ←

Transition frequency at f = 35 MHz

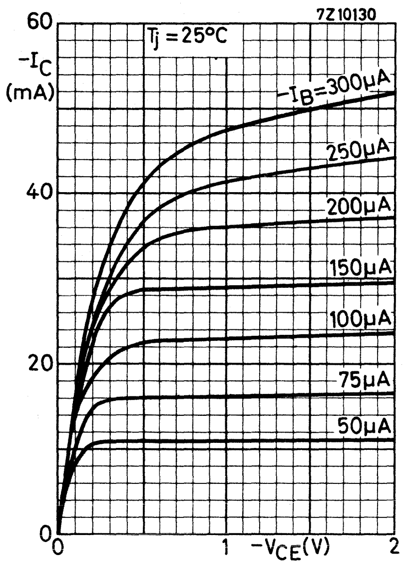
$-I_C$ = 10 mA; $-V_{CE}$ = 5 V	f_T	typ.	150	MHz

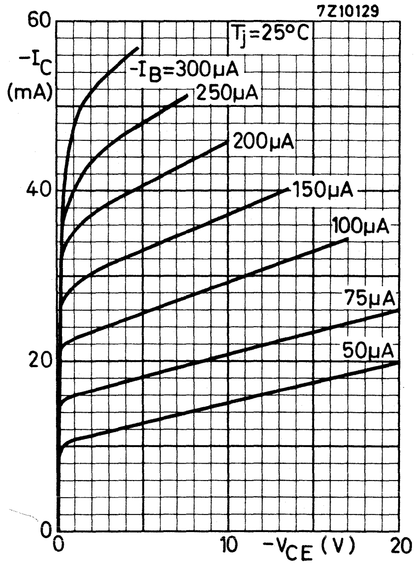
Noise figure at R_S = 2 kΩ

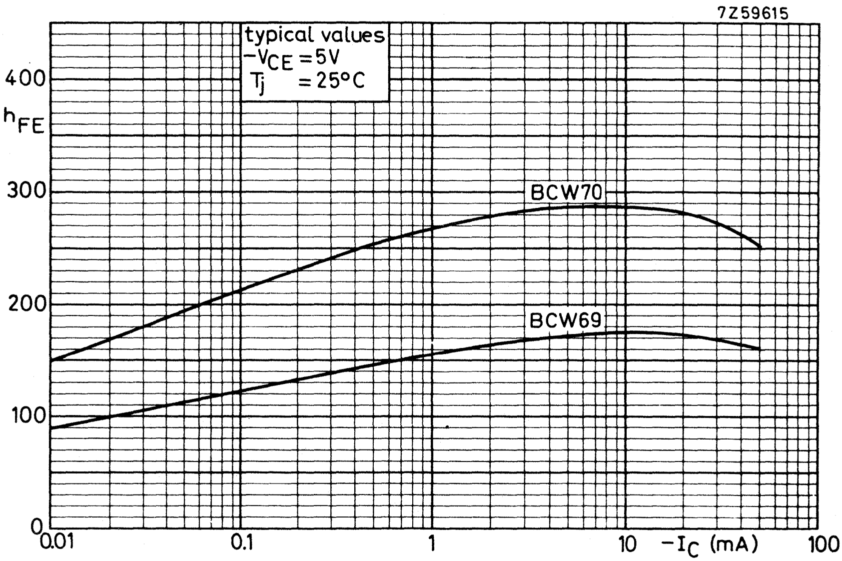
$-I_C$ = 200 μA; $-V_{CE}$ = 5 V f = 1 kHz; B = 200 Hz	F	<	10	dB[1]

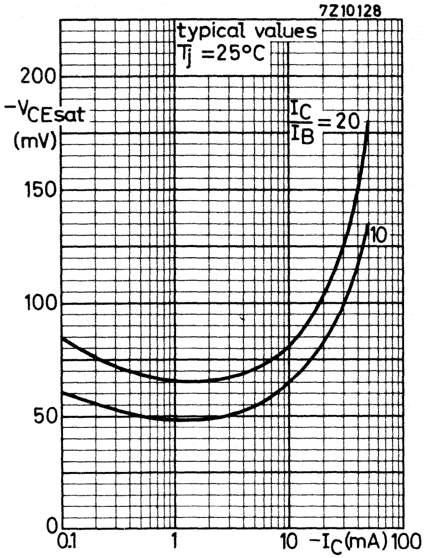
[1]) Crystal mounted in a BC177 envelope.

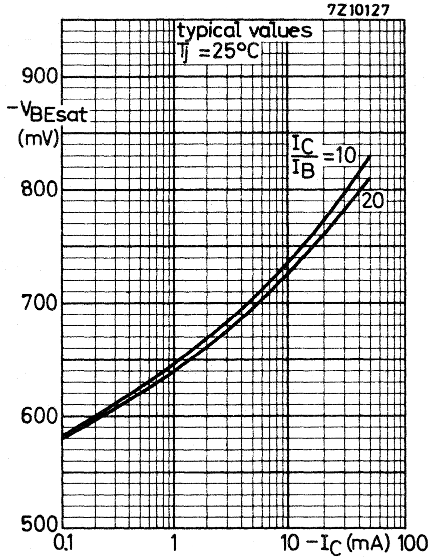
Typical behaviour of collector current versus collector-emitter voltage

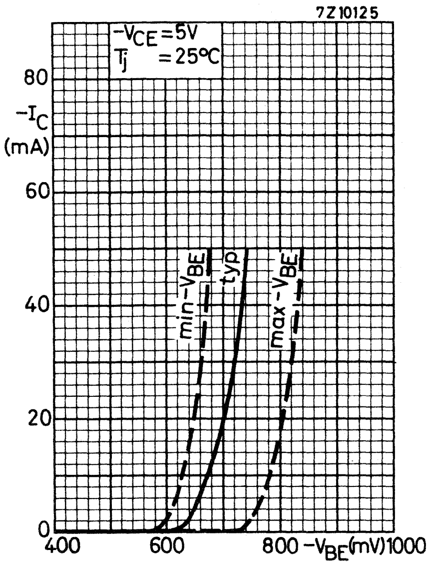


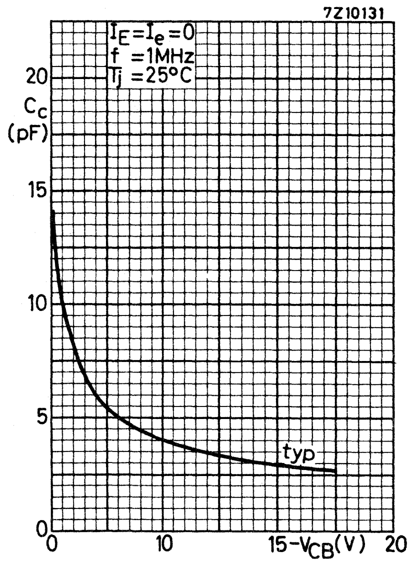


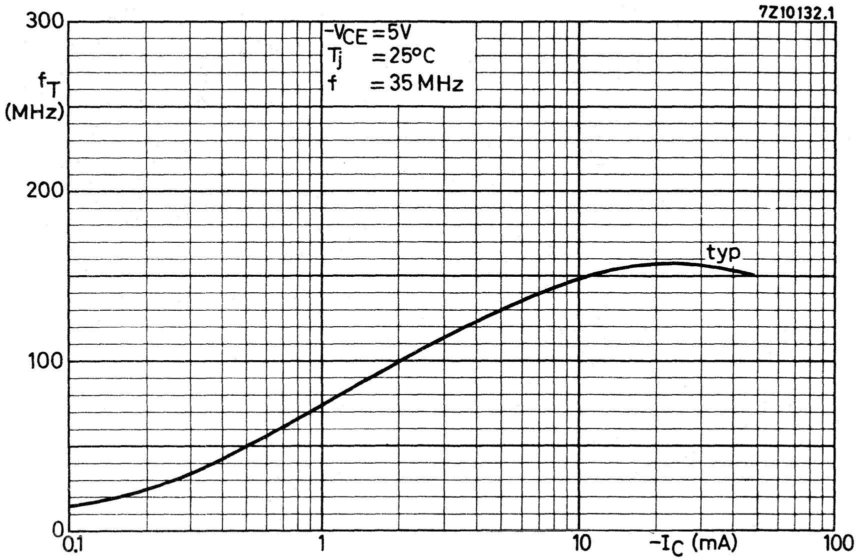


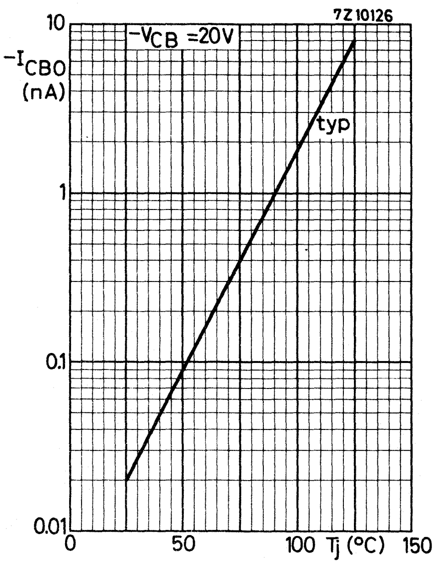

7Z10128
typical values
Tj =25°C
200
150
100
50
0
−VCEsat
(mV)
IC/IB = 20
10
0.1
1
10
−IC (mA)
100


7Z10127
typical values
Tj =25°C
900
800
700
600
500
−VBEsat
(mV)
IC/IB = 10
20
0.1
1
10
−IC (mA)
100


7Z10125
−VCE = 5V
Tj = 25°C
80
60
40
20
0
−IC
(mA)
min −VBE
typ
max −VBE
400
600
800
−VBE (mV)
1000


7Z10131
IE = Ie = 0
f = 1MHz
Tj = 25°C
20
15
10
5
0
Cc
(pF)
typ
0
10
15
−VCB (V)
20


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.

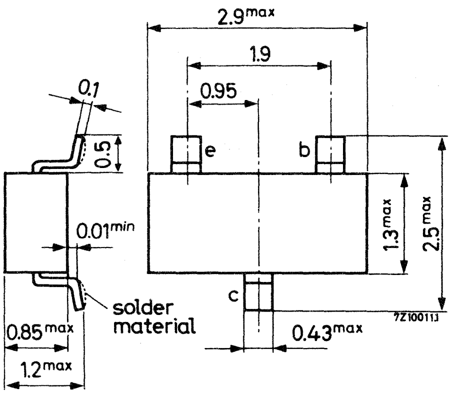
QUICK REFERENCE DATA

			BCW71	BCW72	
Collector-base voltage (open emitter)	V_{CBO}	max.	50	50	V
Collector-emitter voltage (open base)	V_{CEO}	max.	45	45	V
Collector current (peak value)	I_{CM}	max.	200	200	mA
Total power dissipation up to T_{amb} = 25 °C	P_{tot}	max.	150	150	mW
Junction temperature	T_j	max.	125	125	°C
D.C. current gain at T_j = 25 °C I_C = 2 mA; V_{CE} = 5 V	h_{FE}	> <	110 220	200 450	
Transition frequency at f = 35 MHz I_C = 10 mA; V_{CE} = 5 V	f_T	typ.	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	dB

MECHANICAL DATA

Dimensions in mm

Code:
BCW71 K1
BCW72 K2



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

Voltages

Collector-base voltage (open emitter)	V_{CBO}	max.	50	V
Collector-emitter voltage (open base) I_C = 2 mA	V_{CEO}	max.	45	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 **ceramic substrate of 7 mm x 5 mm x 0.5 mm**	P_{tot}	max.	150	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 ceramic substrate of **7 mm x 5 mm x 0.5 mm**	$R_{th\ j-a}$	=	0.67	°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) $T_j = 25\,^{o}C$ 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

			BCW71	BCW72
$I_C = 10$ μA; $V_{CE} = 5$ V	h_{FE}	typ.	90	150
$I_C = 2$ mA; $V_{CE} = 5$ V	h_{FE}	>	110	200
		<	220	450

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

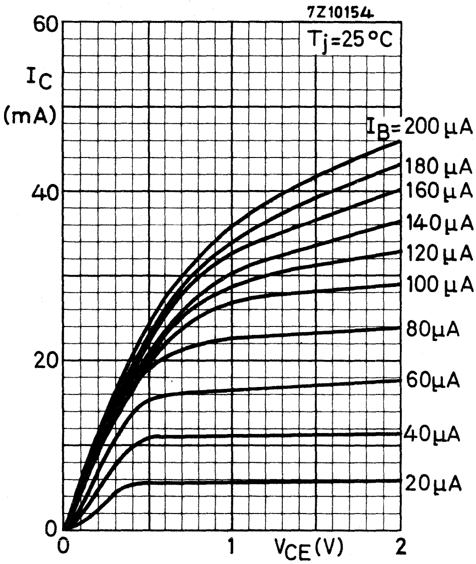
$I_C = 10$ mA; $V_{CE} = 5$ V	f_T	typ.	300	MHz

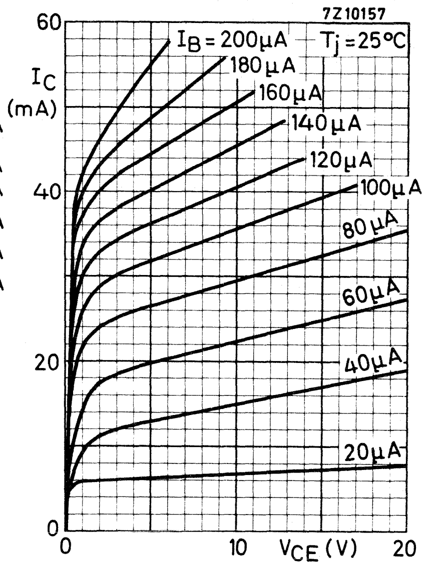
Noise figure at $R_S = 2$ kΩ

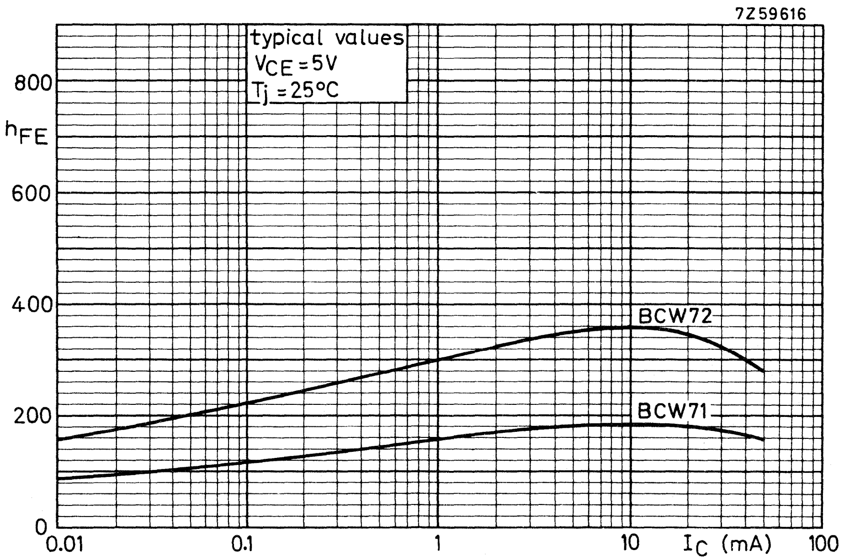
$I_C = 200$ μA; $V_{CE} = 5$ V f = 1 kHz; B = 200 Hz	F	<	10	dB [1]

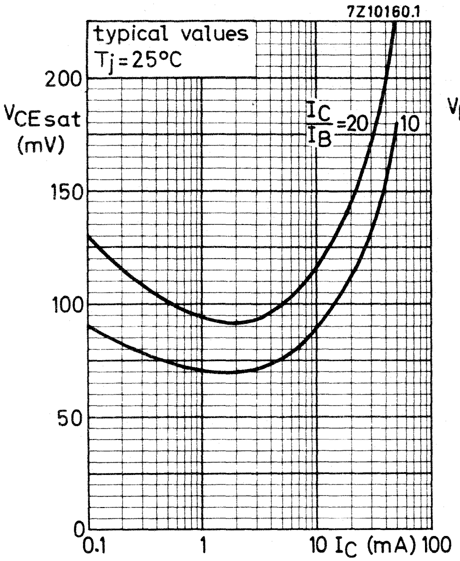
[1]) Crystal mounted in a BC107 envelope.

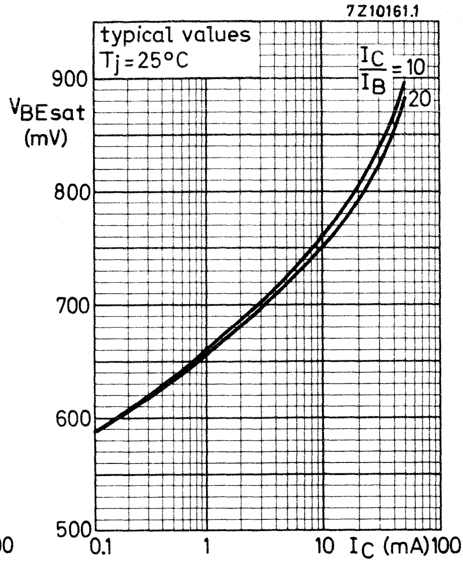
Typical behaviour of collector current versus collector-emitter voltage

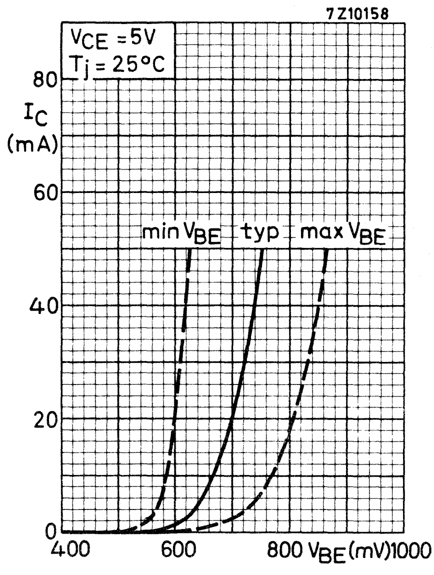


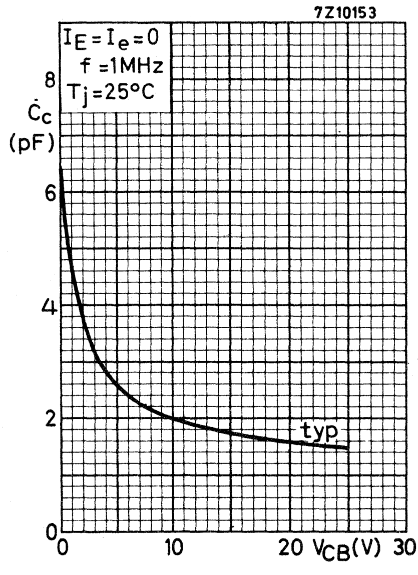


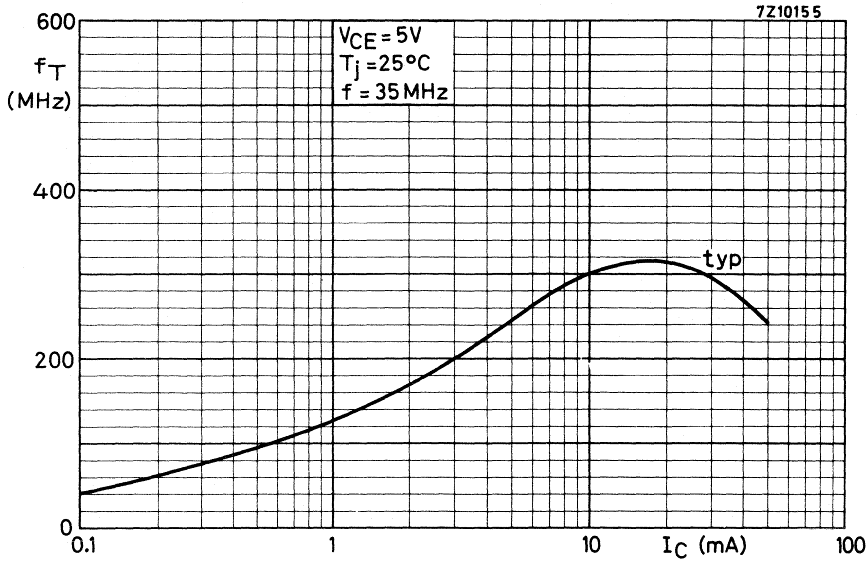


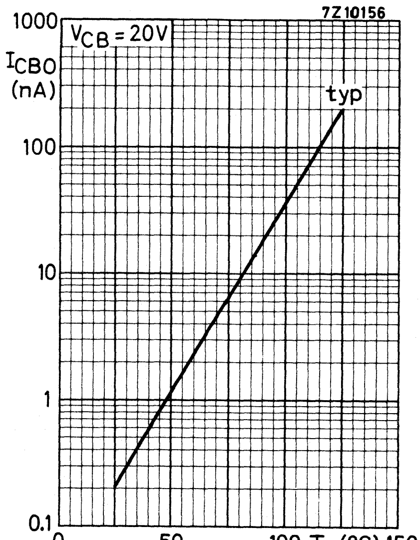

7Z10160.1
typical values
Tj = 25°C
VCEsat (mV)
IC/IB = 20
10
IC (mA)


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


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


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


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


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

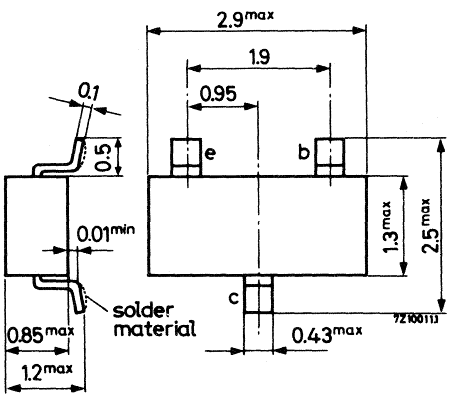
SILICON PLANAR EPITAXIAL TRANSISTOR

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 °C	P_{tot}	max.	**150**	mW
Junction temperature	T_j	max.	125	°C
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 Ω; f = 500 MHz	F	typ.	4.5	dB

MECHANICAL DATA Dimensions in mm

Code: E1



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 **ceramic substrate of 7 mm x 5 mm x 0.5 mm**	P_{tot}	max.	**150**	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 **ceramic substrate of 7 mm x 5 mm x 0.5 mm**	$R_{th\ j\text{-}a}$	=	**0.67**	°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

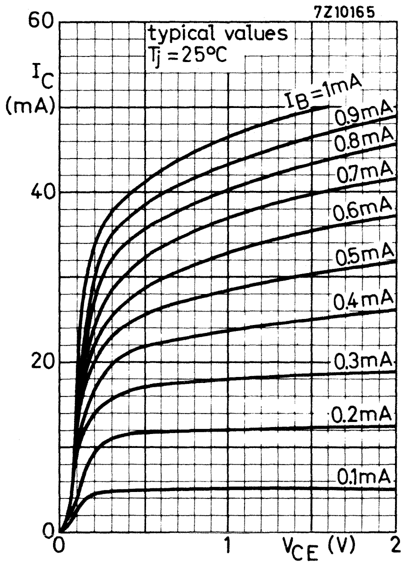
I_C = 2 mA; V_{CE} = 1 V	h_{FE}	20 to	150
I_C = 25 mA; V_{CE} = 1 V	h_{FE}	>	20

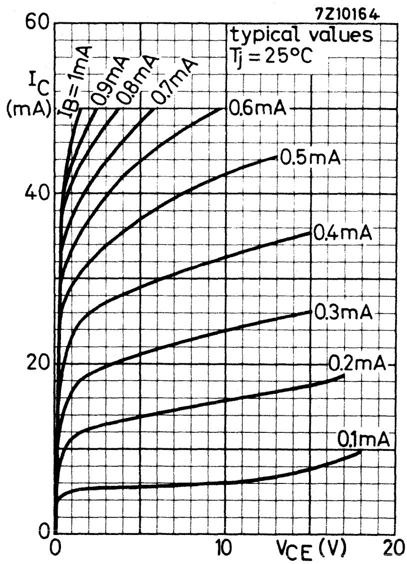
[1]) For highly professional applications it is advisable not to exceed a maximum junction temperature of 100 °C.

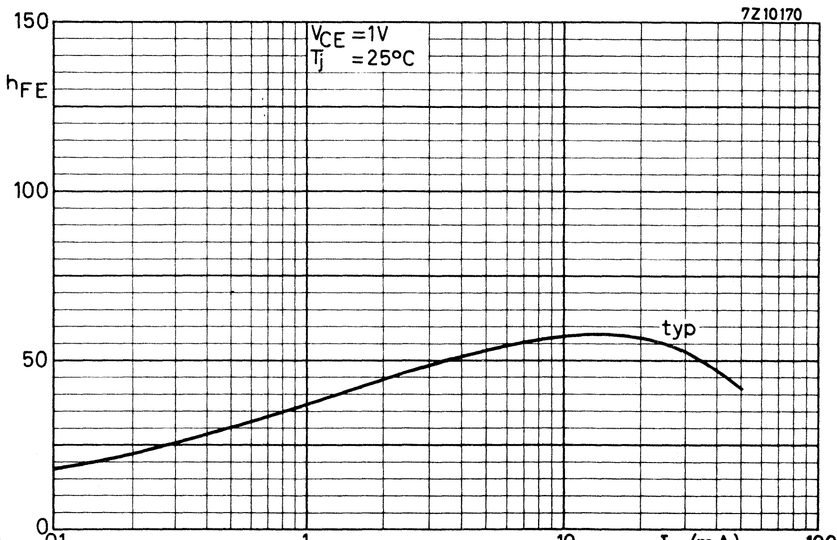
CHARACTERISTICS (continued) T_j = 25 °C unless otherwise specified

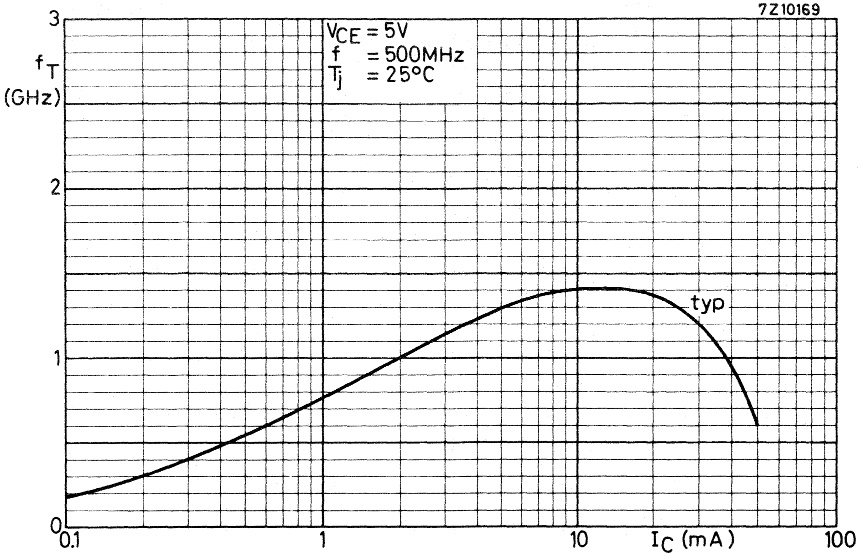
Transition frequency				
I_C = 2 mA; V_{CE} = 5 V; f = 500 MHz	f_T	typ.	1.0	GHz
I_C = 25 mA; V_{CE} = 5 V; f = 500 MHz	f_T	typ.	1.3	GHz
Collector capacitance at f = 1 MHz				
$I_E = I_e = 0$; V_{CB} = 10 V	C_c	<	1.5	pF
Emitter capacitance at f = 1 MHz				
$I_C = I_c = 0$; V_{EB} = 0.5 V	C_e	<	2.0	pF
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

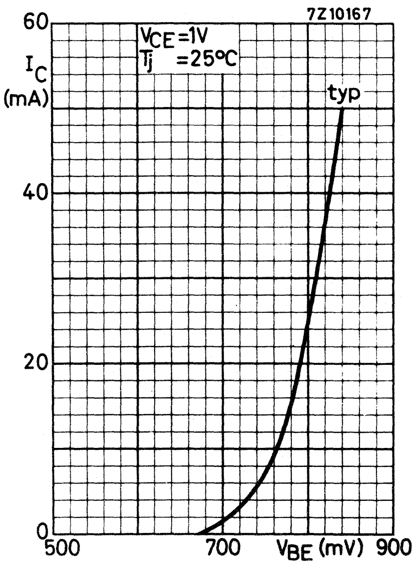
[1]) Crystal mounted in a BFY90 envelope.

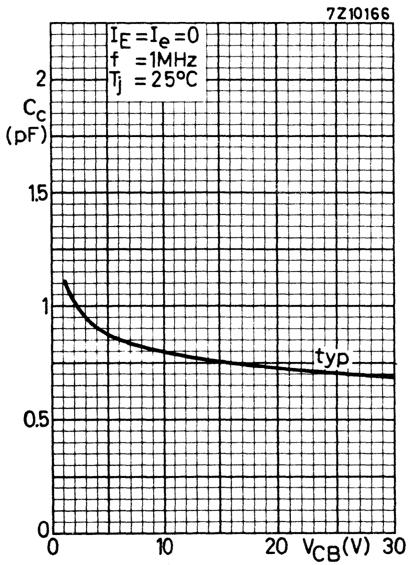

7Z10165
typical values
$T_j = 25^oC$
I_C (mA)
I_B=1mA
0.9mA
0.8mA
0.7mA
0.6mA
0.5mA
0.4mA
0.3mA
0.2mA
0.1mA
V_{CE} (V)
0
1
2
20
40
60

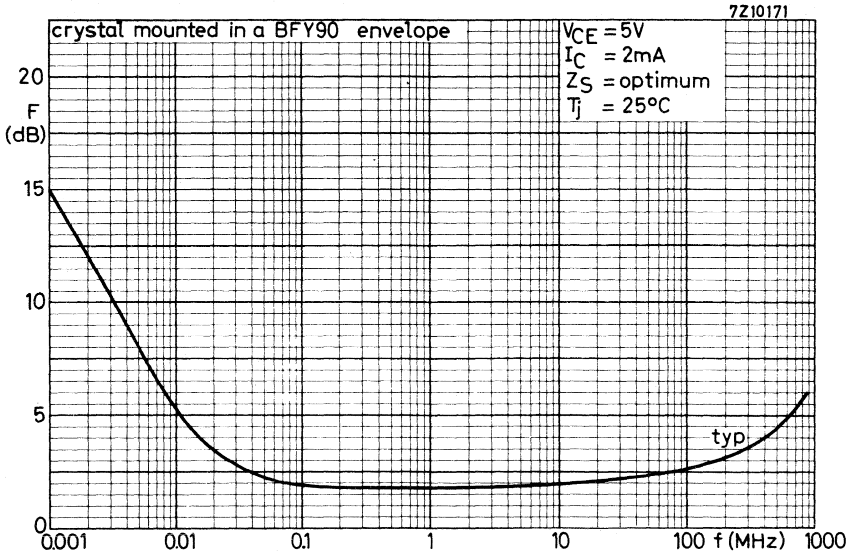

7Z10164
typical values
$T_j = 25^oC$
I_C (mA)
I_B=1mA
0.9mA
0.8mA
0.7mA
0.6mA
0.5mA
0.4mA
0.3mA
0.2mA
0.1mA
V_{CE} (V)
0
10
20
40
60

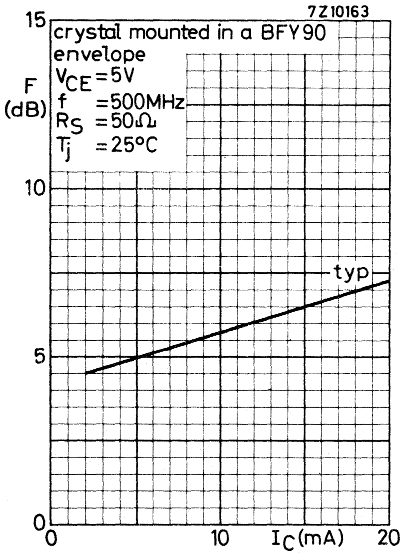

7Z10170
V_{CE} = 1V
T_j = 25°C
h_{FE}
typ
I_C (mA)
0.1
1
10
100
0
50
100
150

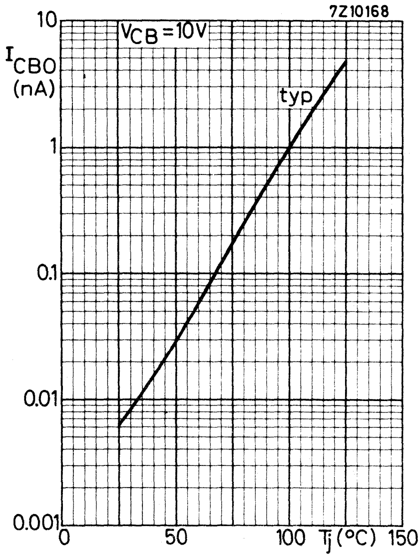

7Z10169
V_{CE} = 5V
f = 500MHz
T_j = 25°C
f_T
(GHz)
3
2
1
0
0.1
1
10
100
I_C (mA)
typ


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


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


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

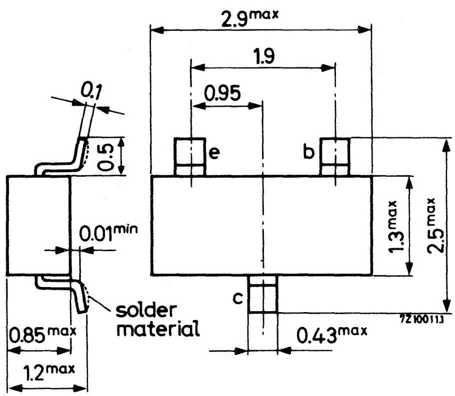
SILICON PLANAR EPITAXIAL TRANSISTORS

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.	**150**	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 **ceramic substrate of 7 mm x 5 mm x 0.5 mm**	P_{tot}	max.	**150**	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 **ceramic substrate of 7 mm x 5 mm x 0.5 mm**	$R_{th\ j\text{-}a}$	=	**0.67**	°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

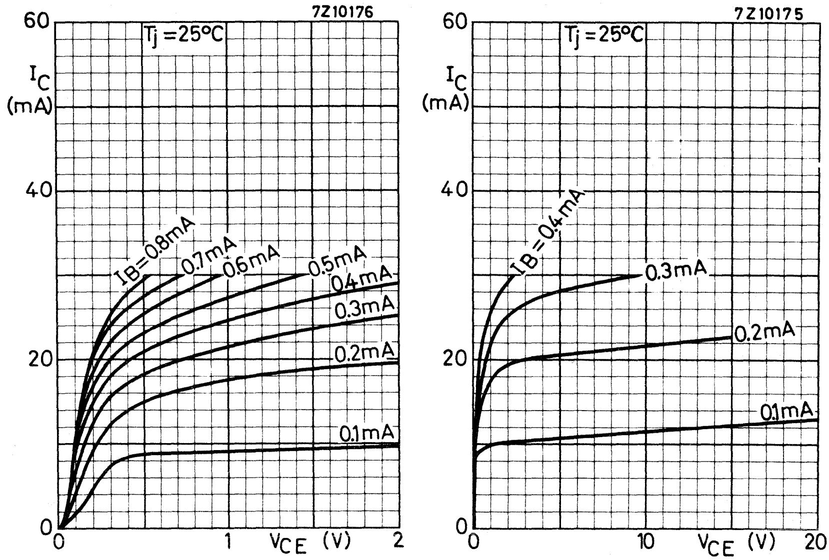
1) For highly professional applications it is advisable not to exceed a maximum junction temperature of 100 °C.

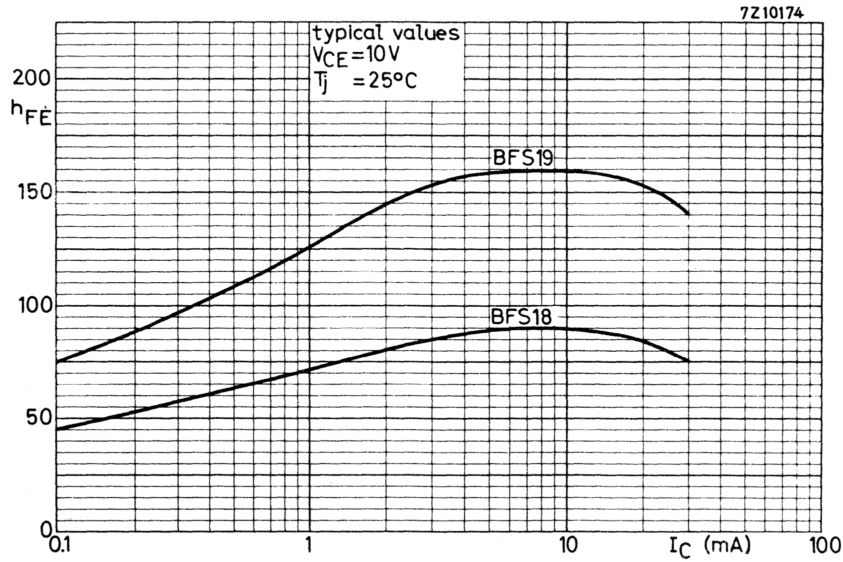
CHARACTERISTICS (continued) T_j = 25 °C unless otherwise specified

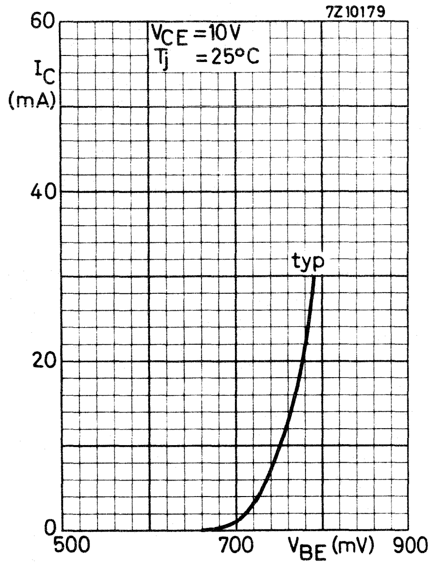
			BFS18	BFS19	
D.C. current gain					
I_C = 1 mA; V_{CE} = 10 V	h_{FE}		35 to 125	65 to 225	
Transition frequency at f = 100 MHz					
I_C = 1 mA; V_{CE} = 10 V	f_T	typ.	200	260	MHz
Collector capacitance at f = 1 MHz					
$I_E = I_e = 0$; V_{CB} = 10 V	C_c	typ.	1		pF
Feedback capacitance at f = 1 MHz		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

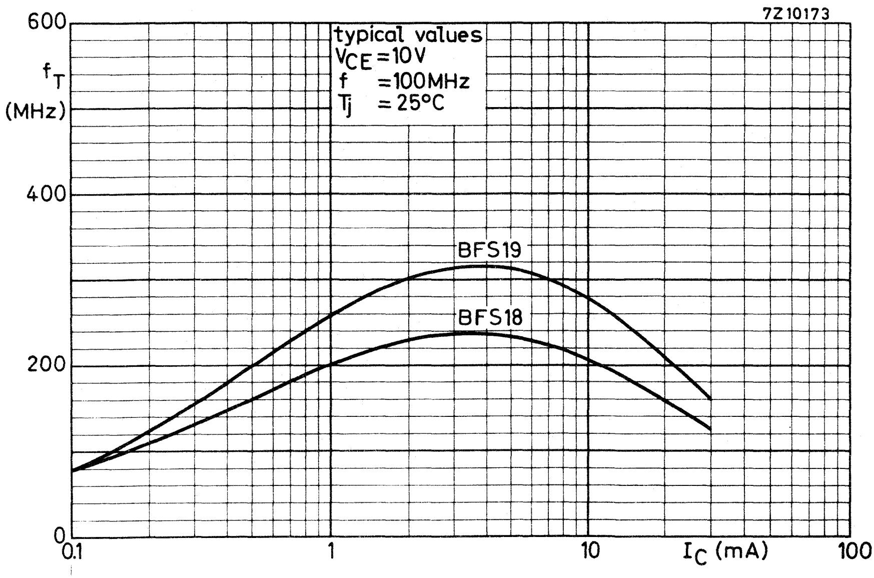
[1] Crystal mounted in a BF115 envelope.

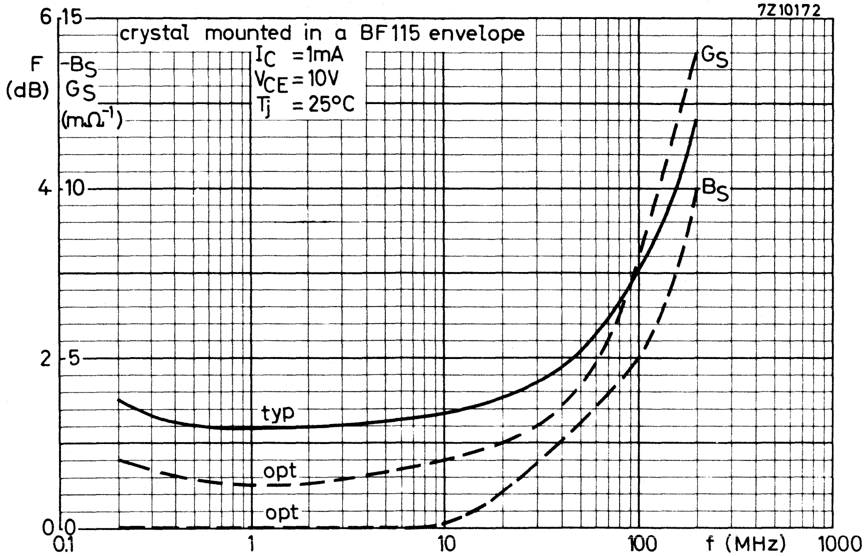
Typical behaviour of collector current versus collector-emitter voltage

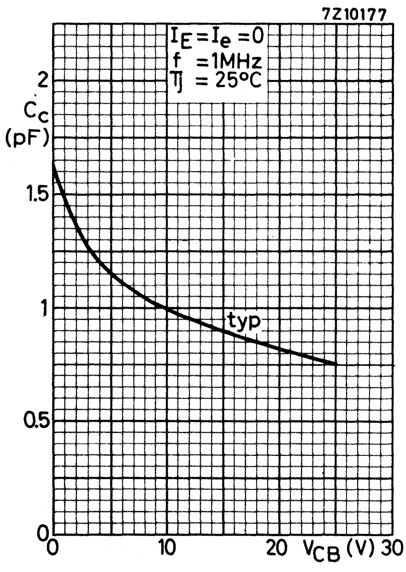


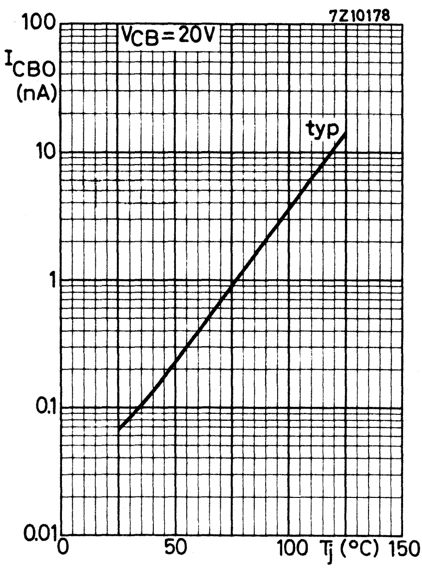



7Z10179
V_{CE} = 10 V
T_j = 25°C
I_C
(mA)
60
40
20
0
typ
500
700
V_{BE} (mV)
900


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
$(m\Omega^{-1})$
G_S
B_S
typ
opt
opt
f (MHz)
0.1
1
10
100
1000
0
2
4
6
0
5
10
15


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


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

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.

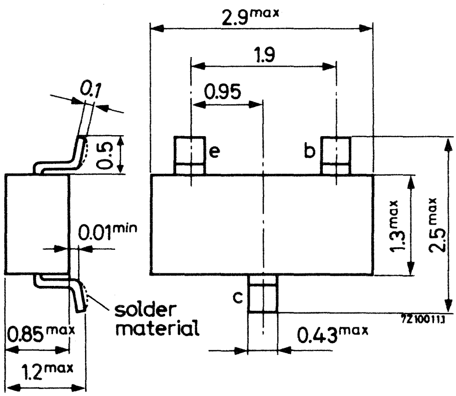
QUICK REFERENCE DATA

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.	**150**	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



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 **ceramic substrate of 7 mm x 5 mm x 0.5 mm**	P_{tot}	max.	**150**	mW

Temperatures

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

→ **THERMAL RESISTANCE**

From junction to ambient

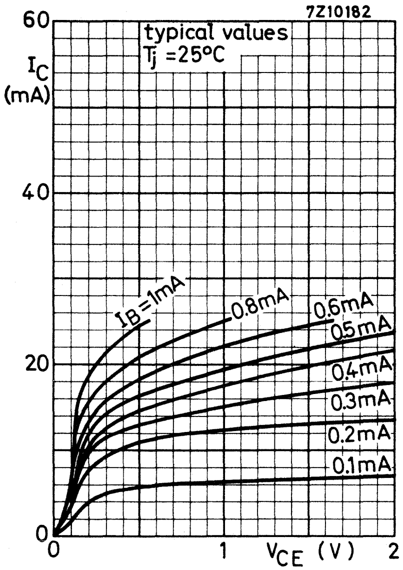
mounted on a glass substrate of 5 mm x 5 mm x 1 mm	$R_{th\ j\text{-}a}$	=	0.9	°C/mW
mounted on a **ceramic substrate of 7 mm x 5 mm x 0.5 mm**	$R_{th\ j\text{-}a}$	=	**0.67**	°C/mW

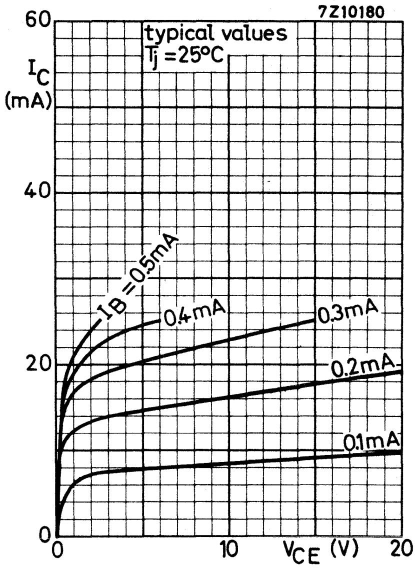
[1]) For highly professional applications it is advisable not to exceed a maximum junction temperature of 100 °C

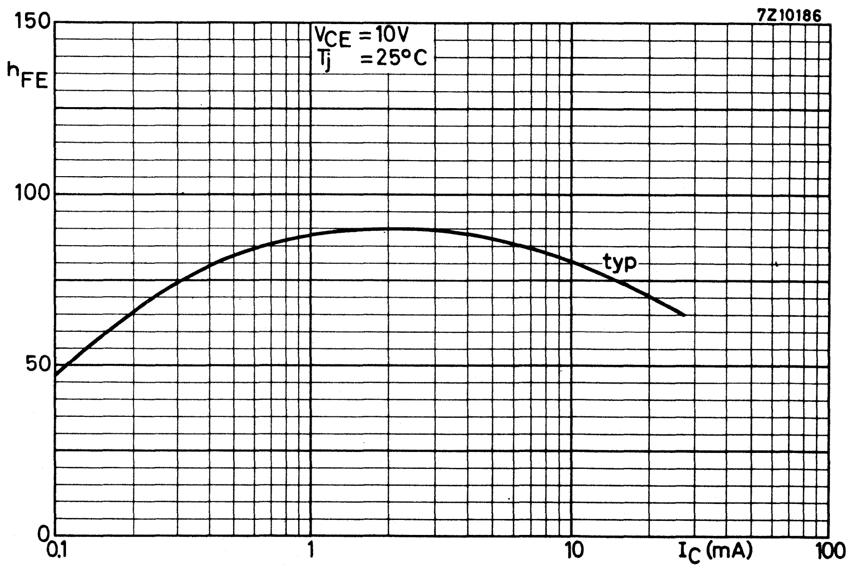
CHARACTERISTICS

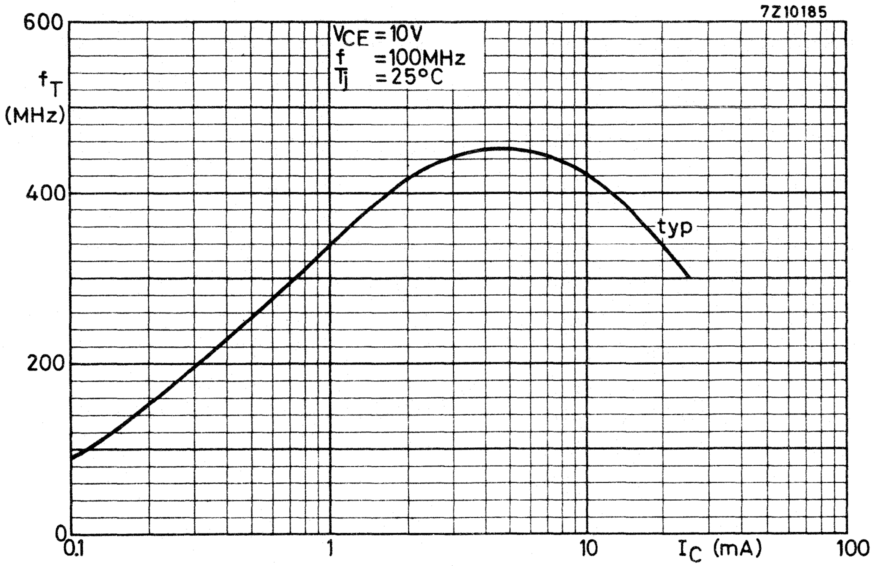
T_j = 25 °C unless otherwise specified

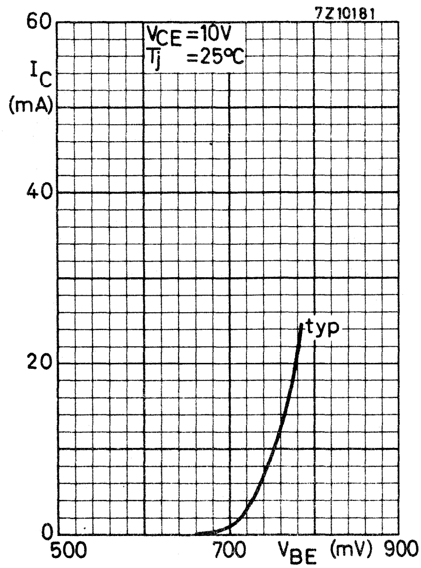
Collector cut-off current				
$I_E = 0$; $V_{CB} = 20$ V	I_{CBO}	<	100	nA
$I_E = 0$; $V_{CB} = 20$ V; $T_j = 100$ °C	I_{CBO}	<	10	μA
Base-emitter voltage				
$I_C = 7$ mA; $V_{CE} = 10$ V	V_{BE}	typ.	740	mV
		<	900	mV
D.C. current gain				
$I_C = 7$ mA; $V_{CE} = 10$ V	h_{FE}	>	40	
		typ.	85	
Transition 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

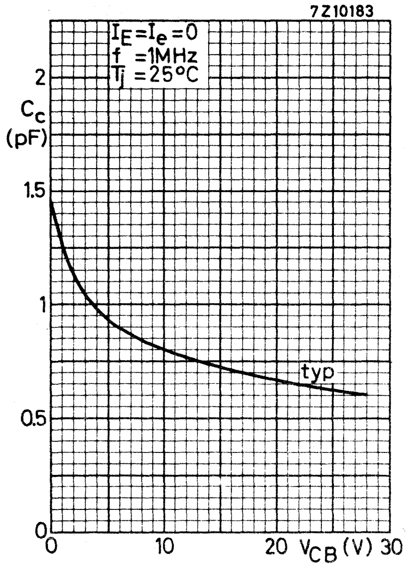

7Z10182
typical values
T_j = 25°C
I_C (mA)
60
40
20
0
I_B = 1mA
0.8mA
0.6mA
0.5mA
0.4mA
0.3mA
0.2mA
0.1mA
0
1
V_{CE} (V)
2

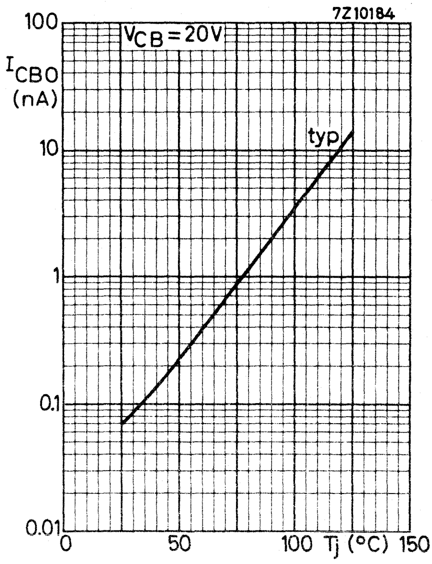

7Z10180
typical values
T_j = 25°C
I_C (mA)
60
40
20
0
I_B = 0.5mA
0.4mA
0.3mA
0.2mA
0.1mA
0
10
V_{CE} (V)
20


7Z10186
V_{CE} = 10V
T_j = 25°C
h_{FE}
150
100
50
0
typ
0.1
1
10
I_C (mA)
100


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


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


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


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

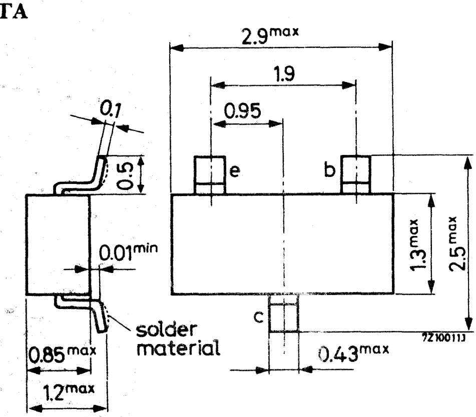
SILICON PLANAR EPITAXIAL HIGH SPEED SWITCHING TRANSISTOR

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.	**150**	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



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 **ceramic substrate of 7 mm x 5 mm x 0.5 mm**	P_{tot}	max.	**150**	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 **ceramic substrate of 7 mm x 5 mm x 0.5 mm**m	$R_{th\ j\text{-}a}$	=	**0.67**	°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

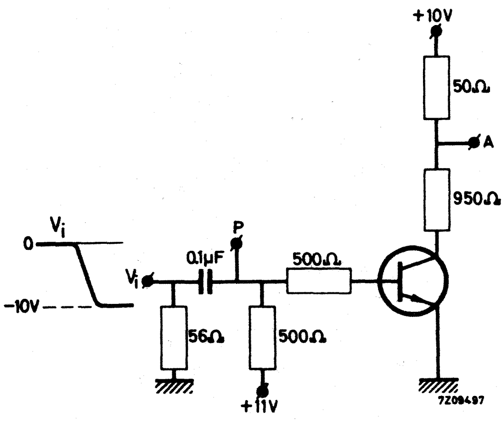
Emitter capacitance at f = 1 MHz

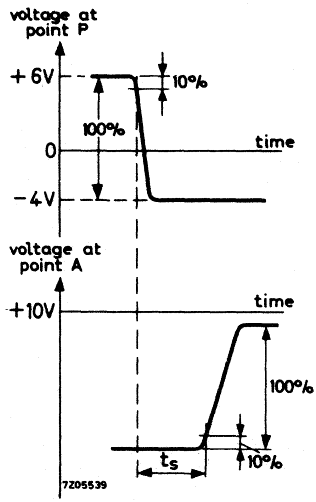
$I_C = I_c = 0$; V_{EB} = 1 V	C_e	<	4.5	pF

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

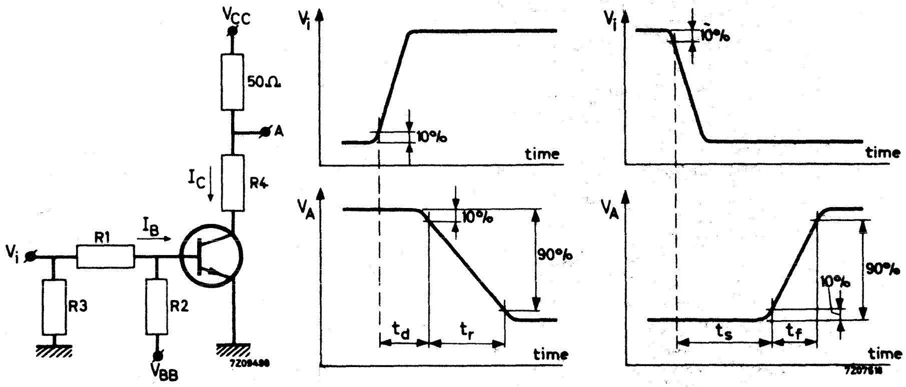
CHARACTERISTICS (continued) T_j = 25 °C unless otherwise specified

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

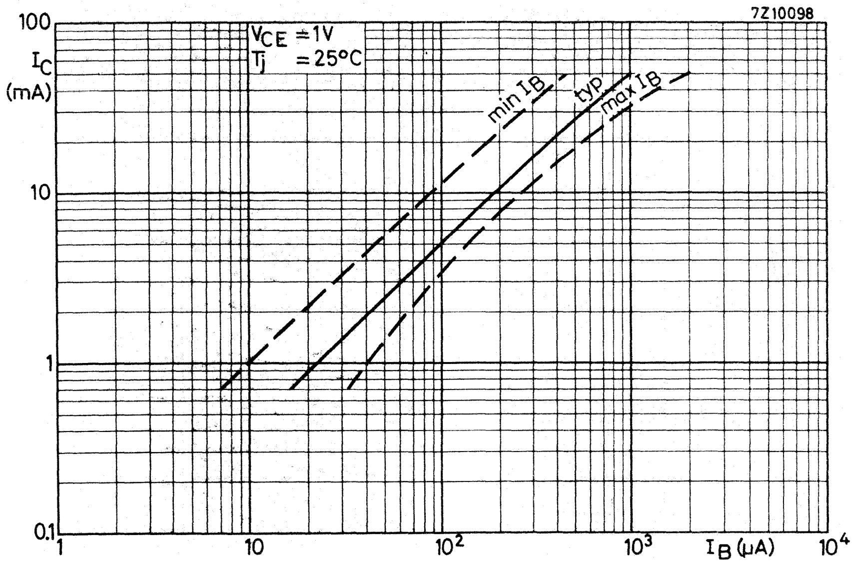
Oscilloscope:

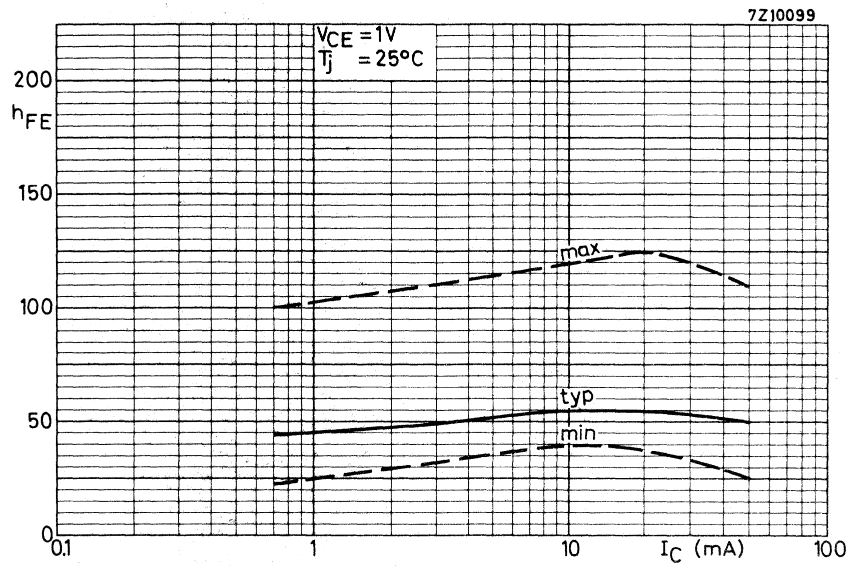
Input impedance	R_i	=	50 Ω
Rise time	t_r	<	1 ns

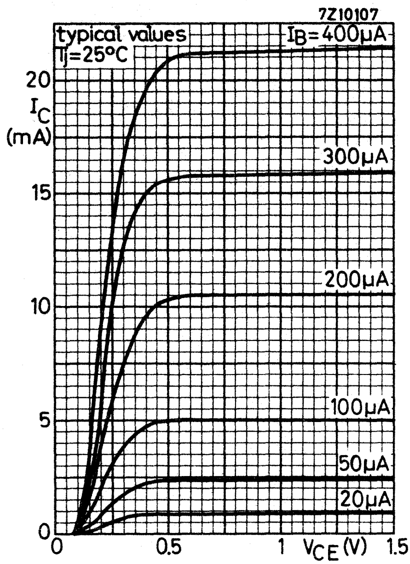
							turn on time			turn off time	
I_C (mA)	I_B (mA)	$-I_{BM}$ (mA)	V_{CC} (V)	$R_1;R_2$ (kΩ)	R_3 (Ω)	R_4 (Ω)	$-V_{BB}$ (V)	$-V_{BE}$ (V)	V_i (V)	V_{BB} (V)	$-V_i$ (V)
10	3	1.5	3	3.3	50	220	3.0	1.5	15	12.0	15

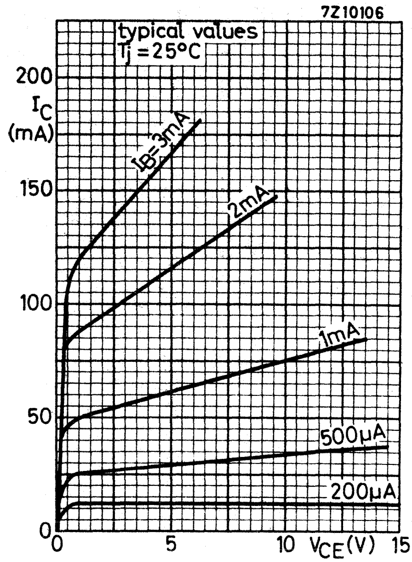
Note

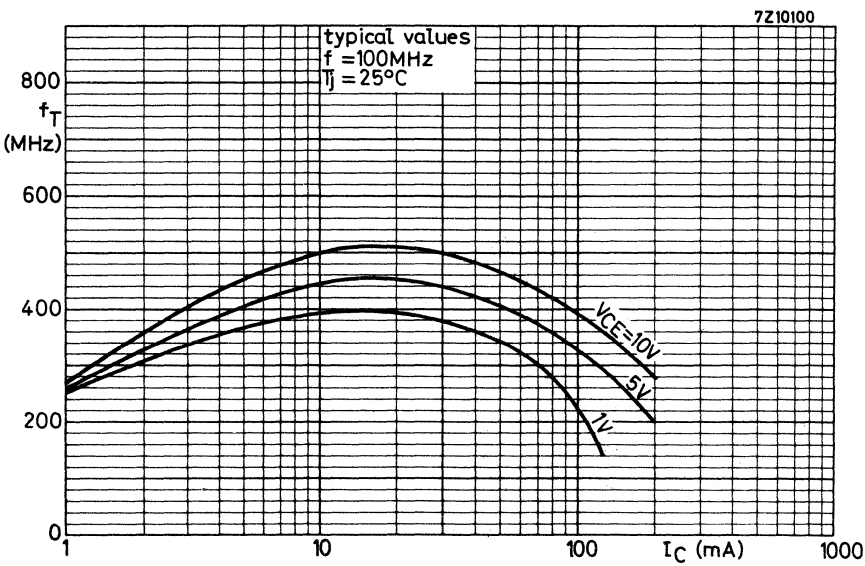
$-I_{BM}$ is the reverse current that can flow during switching off. The indicated $-I_{BM}$ is determined and limited by the applied cut-off voltage and series resistance.

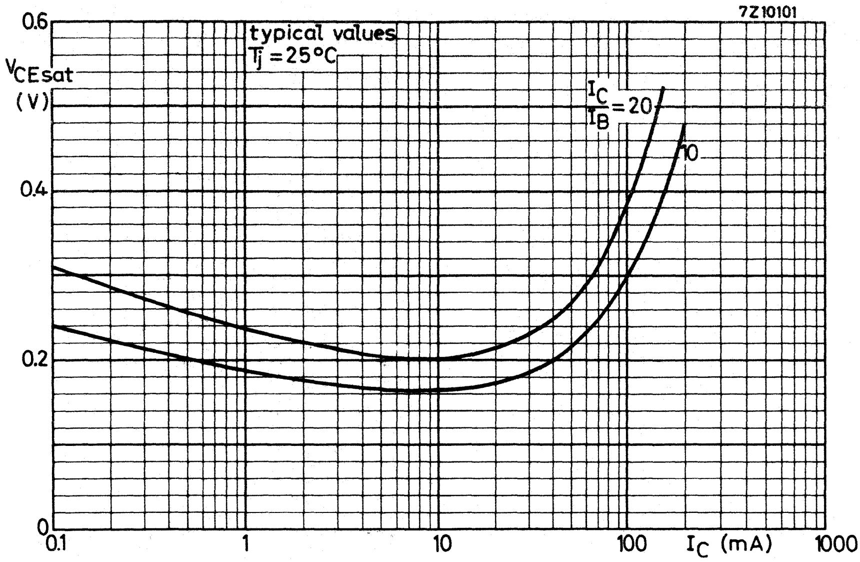

7Z10098
V_{CE} = 1V
T_j = 25°C
100
I_C
(mA)
10
1
0.1
min I_B
typ
max I_B
1
10
10^2
10^3
I_B (μA)
10^4

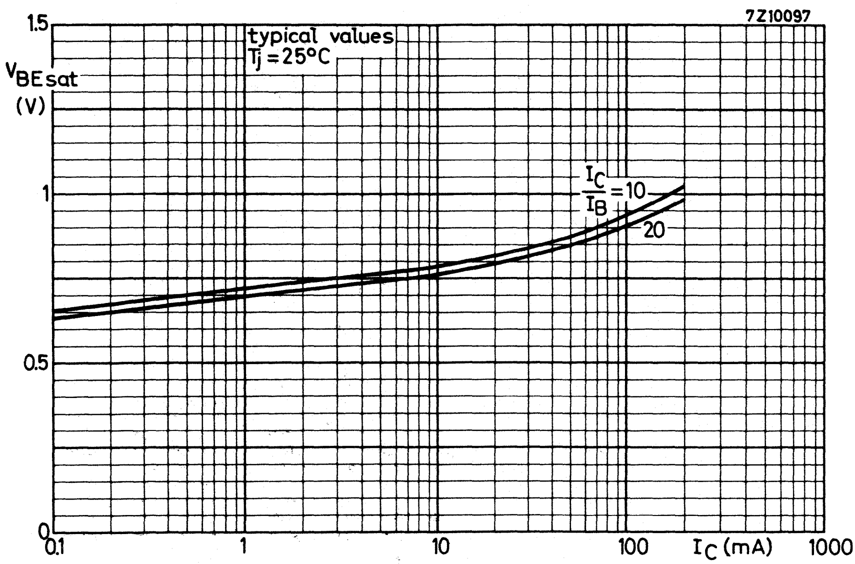

7Z10099
V_{CE} = 1V
T_j = 25°C
200
h_{FE}
150
100
50
0
max
typ
min
0.1
1
10
I_C (mA)
100

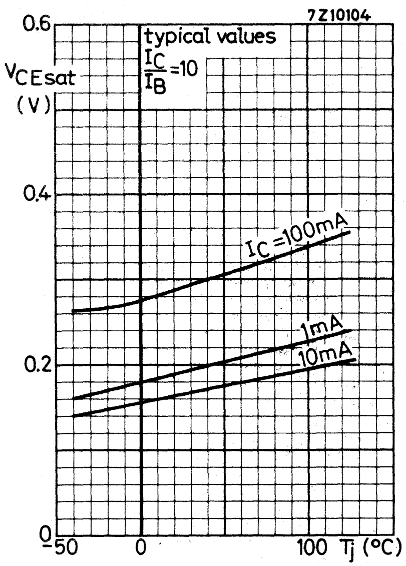

7Z10107
typical values
Tj=25°C
IB=400μA
IC
(mA)
300μA
200μA
100μA
50μA
20μA
0
5
10
15
20
0
0.5
1
VCE (V)
1.5

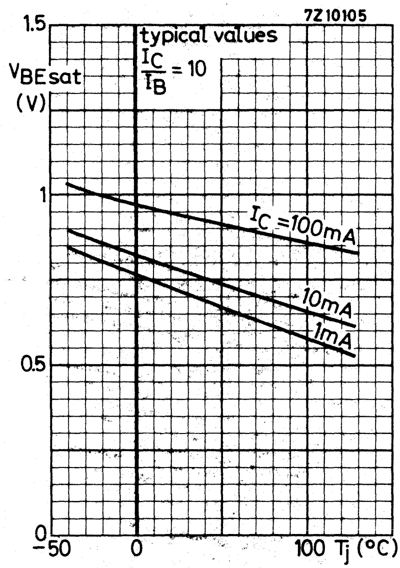

7Z10106
typical values
Tj=25°C
IC
(mA)
IB=3mA
2mA
1mA
500μA
200μA
0
50
100
150
200
0
5
10
VCE (V)
15

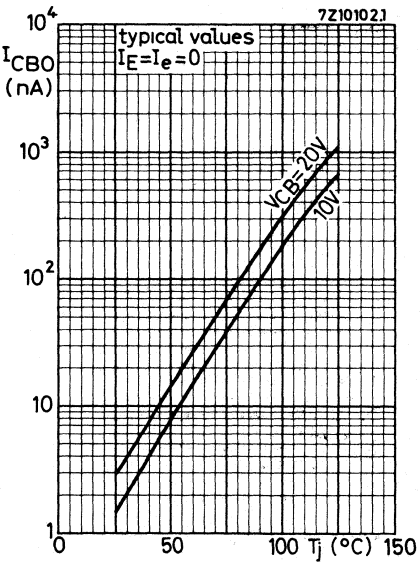

7Z10100
typical values
f =100MHz
Tj =25°C
fT
(MHz)
0
200
400
600
800
VCE=10V
5V
1V
1
10
100
IC (mA)
1000

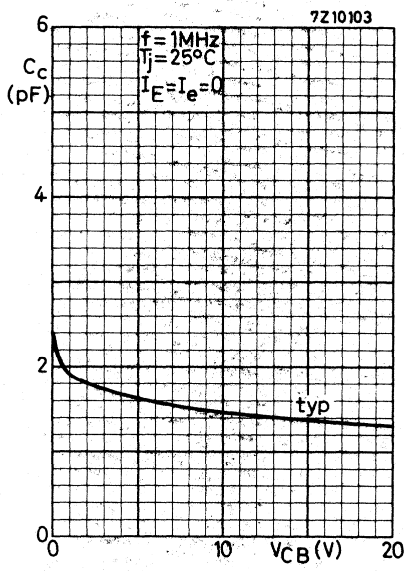

7Z10101
typical values
$T_j = 25\,^{\circ}C$
V_{CEsat} (V)
$\frac{I_C}{I_B} = 20$
10
0.6
0.4
0.2
0
0.1
1
10
100
I_C (mA)
1000


7Z10097
typical values
$T_j = 25\,^{\circ}C$
V_{BEsat} (V)
$\frac{I_C}{I_B} = 10$
20
1.5
1
0.5
0
0.1
1
10
100
I_C (mA)
1000


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
V_{CB}=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

SILICON PLANAR VOLTAGE REFERENCE DIODES

Low power general purpose voltage reference diodes in a micro miniature plastic envelope intended for application in thick- and thin-film circuits.
The series covers the whole normalized range of nominal zener voltages from 4.7 V to 12 V with a tolerance of ± 5%.

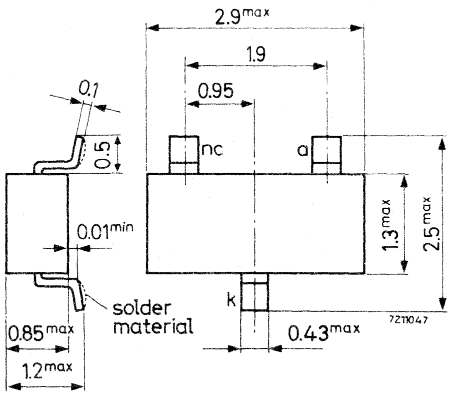
QUICK REFERENCE DATA			
Zener voltage range		nom.	4.7 to 12 V
Zener voltage tolerance			± 5 %
Total power dissipation up to T_{amb} = 25 °C	P_{tot}	max.	150 mW
Junction temperature	T_j	max.	125 °C

MECHANICAL DATA

Dimensions in mm

Code:

BZX84-C4V7	Z1
BZX84-C5V1	Z2
BZX84-C5V6	Z3
BZX84-C6V2	Z4
BZX84-C6V8	Z5
BZX84-C7V5	Z6
BZX84-C8V2	Z7
BZX84-C9V1	Z8
BZX84-C10	Z9
BZX84-C11	Y1
BZX84-C12	Y2



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

Currents

Repetitive peak forward current	I_{FRM}	max.	100	mA
Repetitive peak zener current	I_{ZRM}	max.	100	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
mounted on a ceramic substrate of 7 mm x 5 mm x 0.5 mm	P_{tot}	max.	150	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 ceramic substrate 7 mm x 5 mm x 0.5 mm	$R_{th\ j\text{-}a}$	=	0.67	°C/mW

CHARACTERISTICS T_j = 25 °C unless otherwise specified

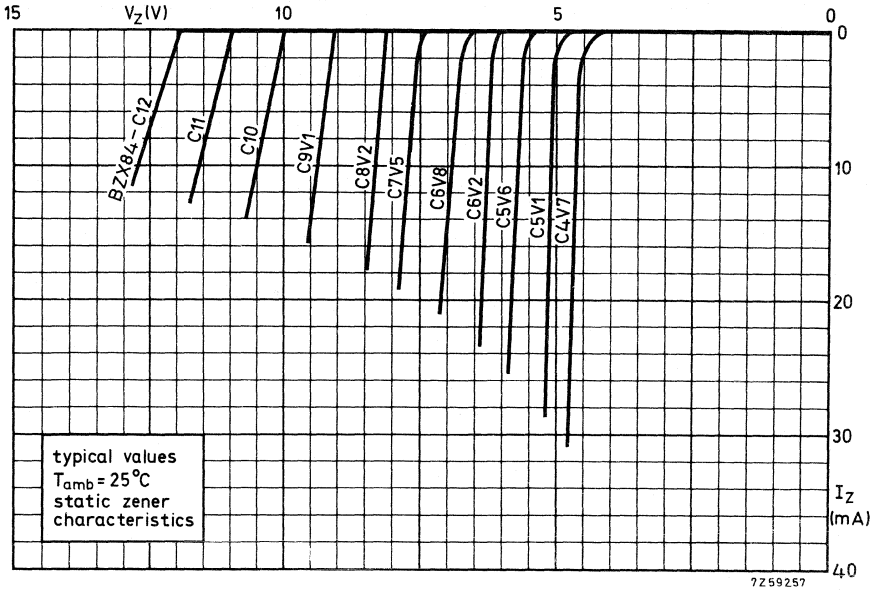
Forward voltage at I_F = 10 mA V_F < 0.9 V

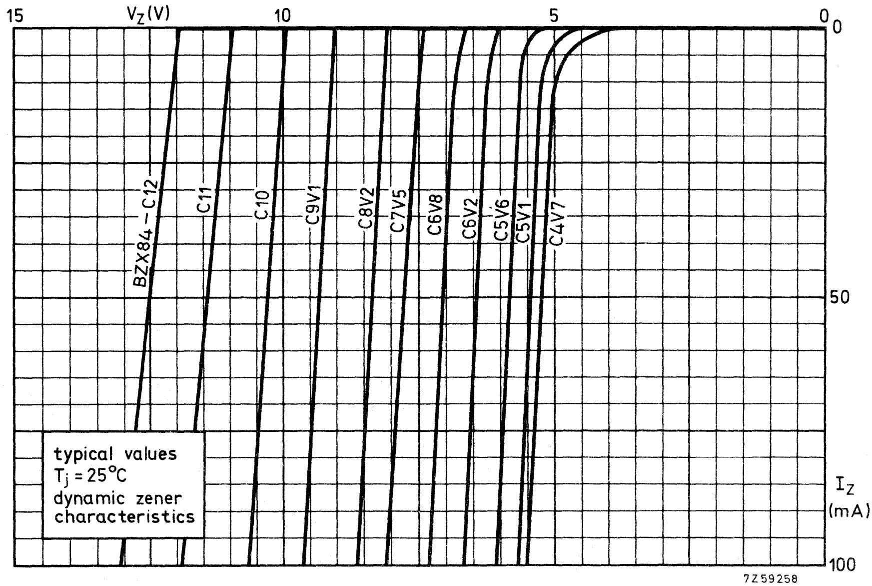
Reverse current		BZX84-	C4V7 to C5V1	C5V6	C6V2	C6V8 to C8V2	C9V1	C10 C11	C12	
V_R = 2 V	I_R	<	3000	2000	500					nA
V_R = 3 V	I_R	<				100				nA
V_R = 5 V	I_R	<					100			nA
V_R = 7 V	I_R	<						100		nA
V_R = 8 V	I_R	<							100	nA

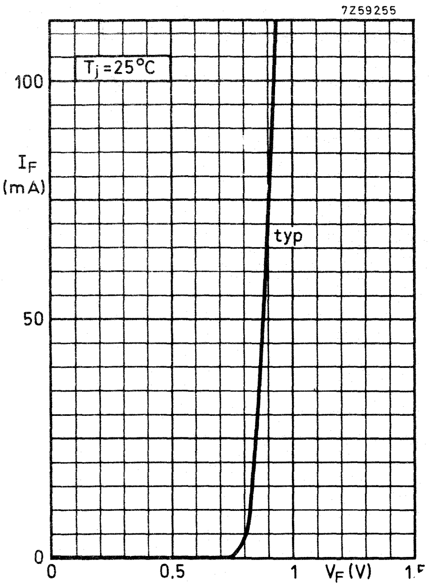
1) For highly professional applications it is advisable not to exceed a maximum junction temperature of 100 °C.

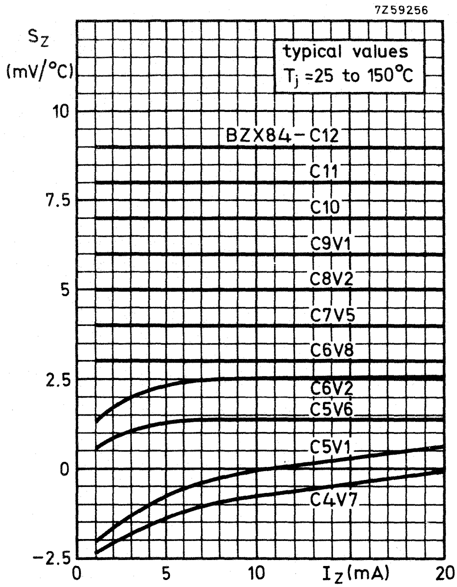
CHARACTERISTICS (continued) T_j = 25 °C unless otherwise specified

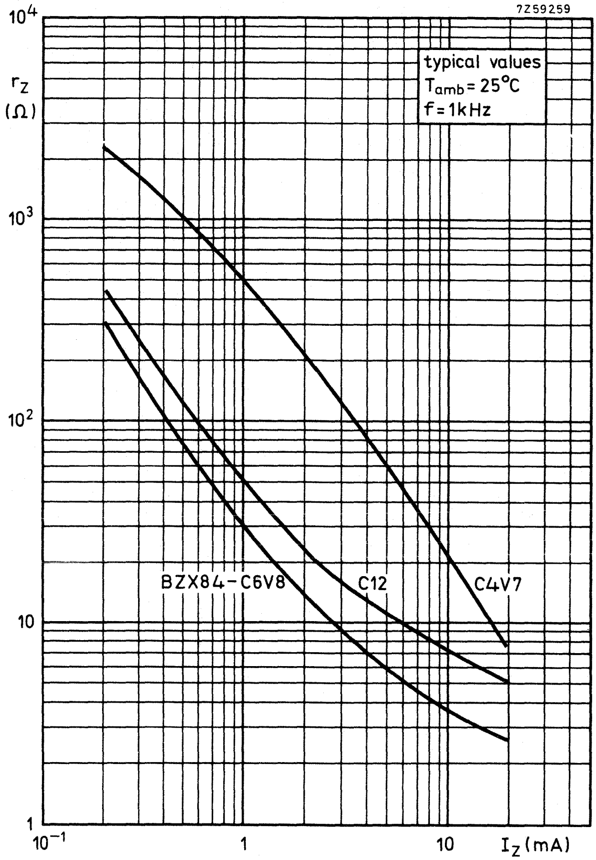
BZX84-...	Zener voltage V_Z at I_Z = 5 mA			Temperature coefficient S_Z at I_Z = 5 mA	Differential resistance r_Z at I_Z = 5 mA f = 1kHz; T_{amb} = 25 °C
	min.	nom.	max.	typ.	max.
C4V7	4.4	4.7	5.0 V	−1.4 mV/°C	80 Ω
C5V1	4.8	5.1	5.4 V	−0.8 mV/°C	70 Ω
C5V6	5.3	5.6	6.0 V	+1.2 mV/°C	40 Ω
C6V2	5.8	6.2	6.6 V	+2.3 mV/°C	20 Ω
C6V8	6.4	6.8	7.2 V	+3 mV/°C	20 Ω
C7V5	7.1	7.5	7.9 V	+4 mV/°C	20 Ω
C8V2	7.8	8.2	8.7 V	+5 mV/°C	20 Ω
C9V1	8.6	9.1	9.6 V	+6 mV/°C	20 Ω
C10	9.4	10	10.6 V	+7 mV/°C	25 Ω
C11	10.4	11	11.6 V	+8 mV/°C	30 Ω
C12	11.4	12	12.6 V	+9 mV/°C	30 Ω


15
V_Z(V)
10
5
0
0
10
20
30
40
I_Z
(mA)
BZX84−C12
C11
C10
C9V1
C8V2
C7V5
C6V8
C6V2
C5V6
C5V1
C4V7
typical values
T_{amb} = 25 °C
static zener
characteristics
7Z59257


15
V_Z(V)
10
5
0
0
50
100
I_Z
(mA)
BZX84−C12
C11
C10
C9V1
C8V2
C7V5
C6V8
C6V2
C5V6
C5V1
C4V7
typical values
T_j = 25 °C
dynamic zener
characteristics
7Z59258


7Z59255
T_j = 25 °C
100
I_F
(mA)
typ
50
0
0
0.5
1
V_F (V)

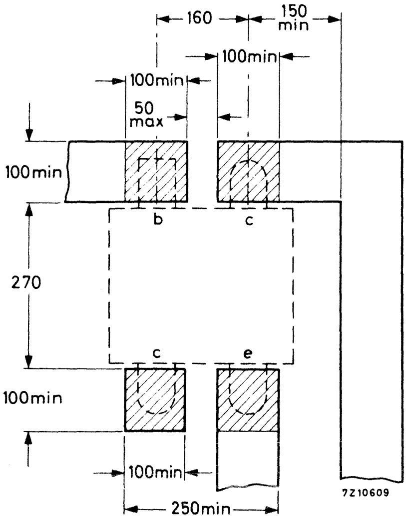

7Z59256
S_Z
(mV/°C)
typical values
T_j = 25 to 150 °C
10
BZX84-C12
C11
7.5
C10
C9V1
5
C8V2
C7V5
C6V8
2.5
C6V2
C5V6
C5V1
0
C4V7
−2.5
0
5
10
I_Z (mA)
20


7Z59259
r_Z
(Ω)
typical values
T_{amb} = 25°C
f = 1 kHz
BZX84-C6V8
C12
C4V7
I_Z (mA)
10^4
10^3
10^2
10
1
10^{-1}
1
10

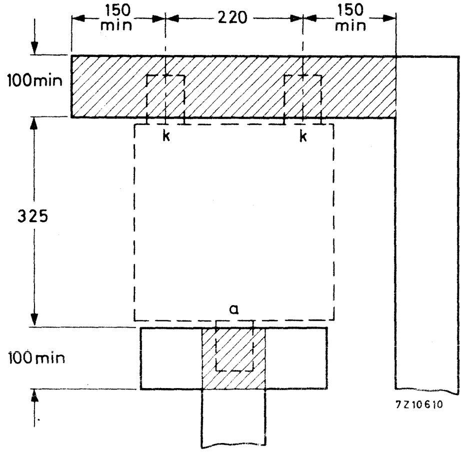
Beam lead devices for thick- and thin-film circuits

Recommended dimensions of conductors on film substrates (in μm)

TRANSISTOR



DIODE



Note: All beam leads should be bonded, even if unused.

Mounting instructions

The devices should be ultrasonicaly bonded, preferably to aluminium but other metals such as gold can also be used.

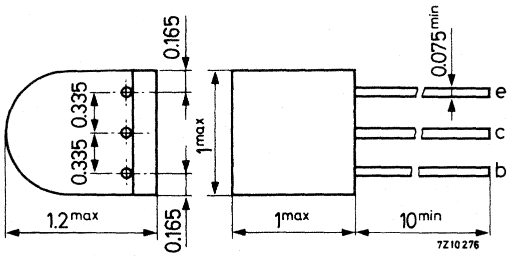
The usual sequence is as follows:
- put a droplet of glue on the substrate where the crystal is to be mounted, keeping clear of the conductors. Use a glue that will not contaminate the crystal and will be easy to remove.
- using a vacuum needle, accurately position the crystal
- bond the crystal to the metal film
  typical bonding conditions:
  bonding tool : hemispherical tip of 75 μm radius
  force applied : ± 10 g
  power setting: ± 75 mW, during 250 ms
  frequency : 60 kHz
- remove glue.

We can supply the necessary machines and accessories.
A phenolformaldehyde plastic can be used to protect the device.
Further details are available on request.

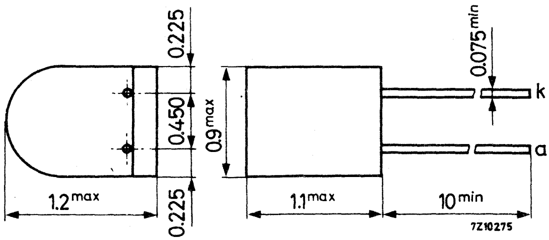
These devices are also available on request (for bread-boarding, etc.) mounted on a glass substrate, plastic encapsulated, with gold wire leads.

Dimensions in mm

TRANSISTOR



DIODE



VERY HIGH-SPEED SWITCHING DIODE WITH ALUMINIUM BEAM LEADS

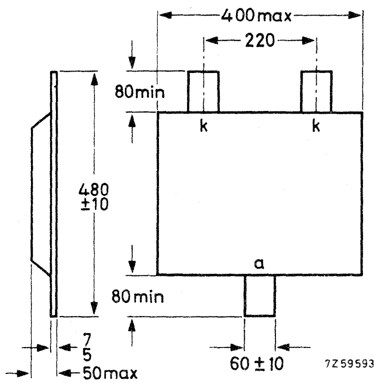
Diodes for hybrid integrated circuits, etc, supplied as a bare crystal with three aluminium beam leads.
Silicon planar epitaxial diode for very high-speed switching

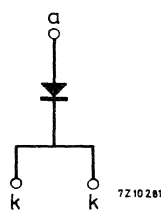
QUICK REFERENCE DATA				
Continuous reverse voltage	V_R	max.	25	V
Repetitive peak reverse voltage	V_{RRM}	max.	38	V
Junction temperature	T_j	max.	125	^oC
Forward voltage at I_F = 50 mA	V_F	<	1.1	V
Reverse recovery time when switched from I_F = 10 mA to V_R = 3 V; R_L = 100 Ω measured at I_R = 1 mA	t_{rr}	<	4	ns
Recovered charge when switched from I_F = 10 mA to V_R = 5 V R_L = 500 Ω	Q_s	<	35	pC

MECHANICAL DATA

Dimensions in μm

Bare crystal with three aluminium beam leads





RATINGS 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.	38	V

Currents

Forward current (d.c.)	I_F	max.	50	mA
Repetitive peak forward current	I_{FRM}	max.	100	mA

Temperatures

Storage temperature	T_{stg}		−40 to +125	°C
Junction temperature	T_j	max.	125	°C

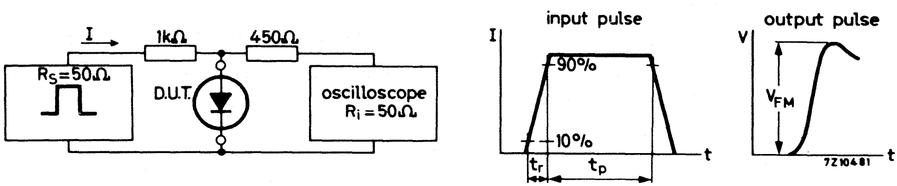
THERMAL RESISTANCE

From junction to ambient
mounted on a glass thin film (10 mm x 10 mm x 0.8 mm)
with plastic encapsulation $R_{th\ j-a}$ = 1.25 °C/mW

CHARACTERISTICS T_j = 25 °C unless otherwise specified

Forward voltage				
I_F = 50 mA	V_F	<	1.1	V
Reverse current				
V_R = 25 V	I_R	<	100	nA
V_R = 25 V; T_j = 125 °C	I_R	<	20	μA
Diode capacitance				
V_R = 0; f = 1 MHz	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

Pulse duration t_p = 120 ns

Duty cycle δ = 0.01

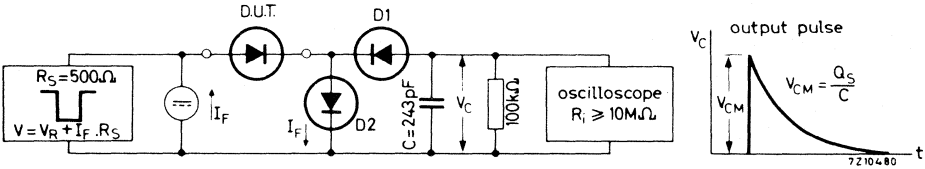
Circuit capacitance $C < 1$ pF (C = Oscilloscope + parasitical capacitance)

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 < 35 pC

Test circuit:



D1 = BAW62
D2 = BAW62

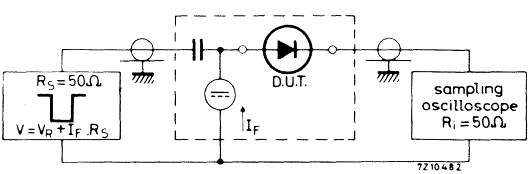
Reverse pulse: Rise time t_r = 2 ns
Pulse duration t_p = 400 ns
Duty cycle δ = 0.02

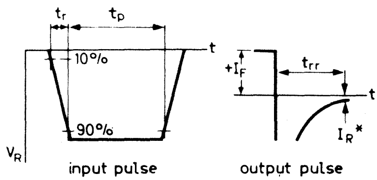
Circuit capacitance C < 7 pF (C = Oscilloscope + parasitical capacitance)

Reverse recovery time when switched from

I_F = 10 mA to V_R = 3 V; R_L = 100 Ω
measured at I_R = 1 mA t_{rr} < 4 ns

Test circuit:

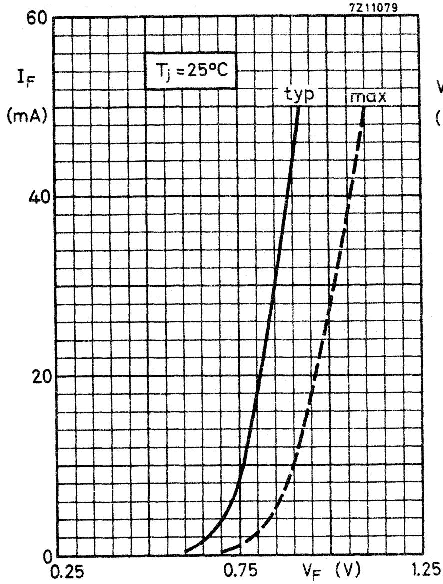


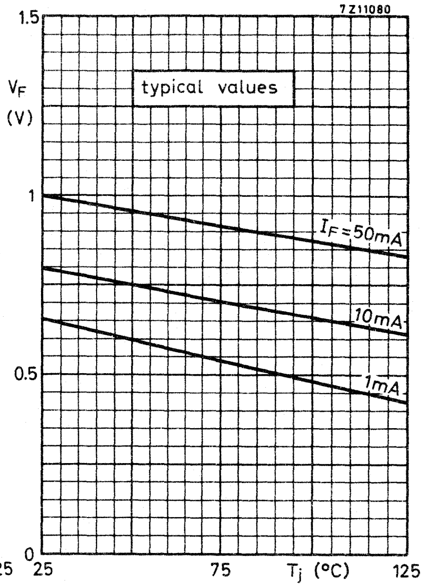


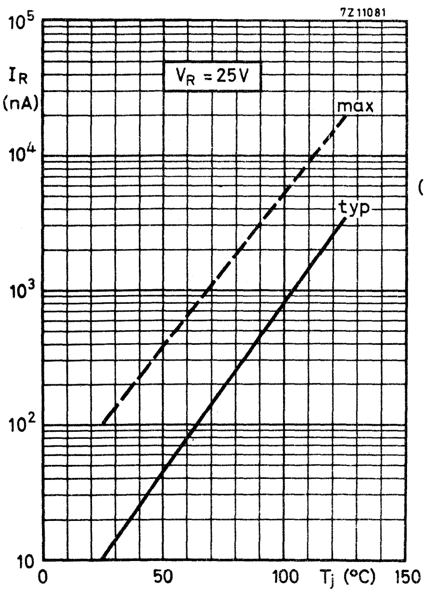
* I_R = 1 mA

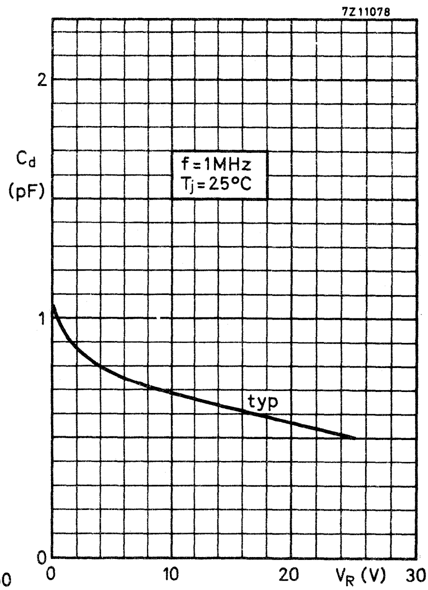
Reverse pulse: Rise time t_r = 0.6 ns
Pulse duration t_p = 100 ns
Duty cycle δ = 0.05

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


7Z11079
$T_j = 25°C$
I_F
(mA)
typ
max
60
40
20
0
0.25
0.75
V_F (V)
1.25


7Z11080
typical values
V_F
(V)
1.5
1
0.5
0
$I_F = 50mA$
10mA
1mA
25
75
T_j (°C)
125


7Z11081
$V_R = 25V$
I_R
(nA)
max
typ
10^5
10^4
10^3
10^2
10
0
50
100
T_j (°C)
150


7Z11078
C_d
(pF)
f = 1MHz
$T_j = 25°C$
typ
2
1
0
0
10
20
V_R (V)
30

GENERAL PURPOSE TRANSISTORS WITH ALUMINIUM BEAM LEADS

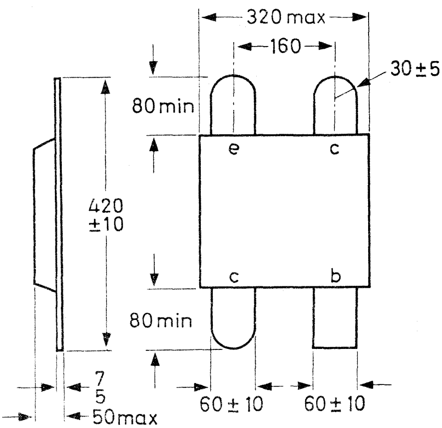
Transistors for hybrid integrated circuits, etc., supplied as bare crystals with four aluminium beam leads.
N-P-N silicon planar epitaxial transistors intended for general purpose and h.f. applications in thick- and thin-film circuits.

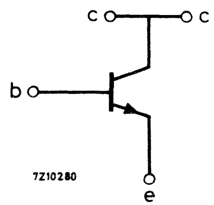
QUICK REFERENCE DATA					
Collector-base voltage (open emitter)	V_{CBO}	max.		30	V
Collector-emitter voltage (open base)	V_{CEO}	max.		20	V
Collector current (d.c.)	I_C	max.		30	mA
Total power dissipation up to $T_{amb} = 25\ ^oC$	P_{tot}	max.		80	mW
Junction temperature	T_j	max.		125	^oC
D.C. current gain at $T_j = 25\ ^oC$			BFX75	BFX76	
$I_C = 1$ mA; $V_{CE} = 10$ V	h_{FE}		70 to 280	33 to 110	
Transition frequency at f = 35 MHz					
$I_C = 1$ mA; $V_{CE} = 10$ V	f_T	typ.	330	260	MHz

MECHANICAL DATA

Dimensions in μm

Bare crystal with four aluminium beam leads





For orientation the base beam lead has a different form from the others.

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

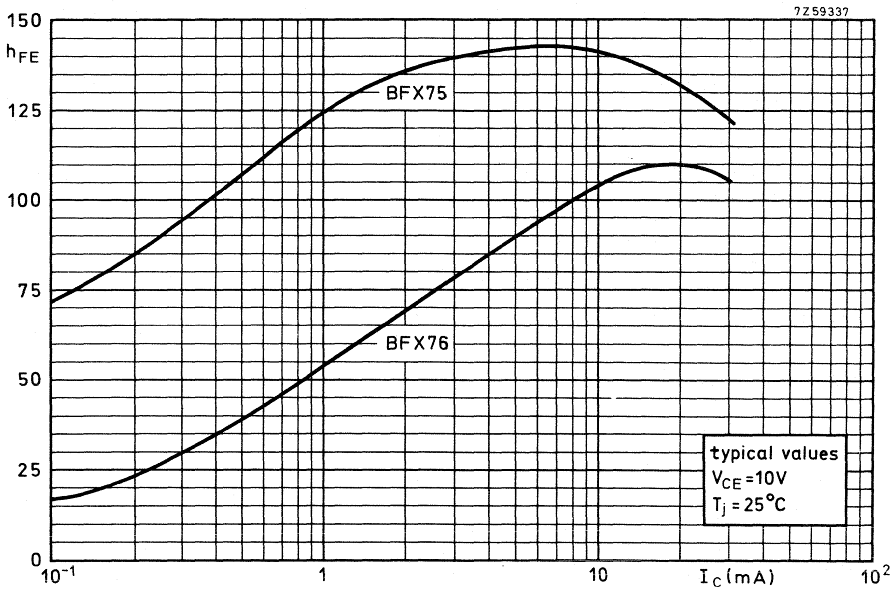
Voltages				
Collector-base voltage (open emitter)	V_{CBO}	max.	30	V
Collector-emitter voltage (open base)	V_{CEO}	max.	20	V
Emitter-base voltage (open collector)	V_{EBO}	max.	5	V
Currents				
Collector current (d.c.)	I_C	max.	30	mA
Collector current (peak value)	I_{CM}	max.	30	mA
Power dissipation				
Total power dissipation up to T_{amb} = 25 °C mounted on a glass thin film (10 mm x 10 mm x 0.8 mm) with plastic encapsulation	P_{tot}	max.	80	mW
Temperatures				
Storage temperature	T_{stg}	-40 to +125		°C
Junction temperature	T_j	max.	125	°C

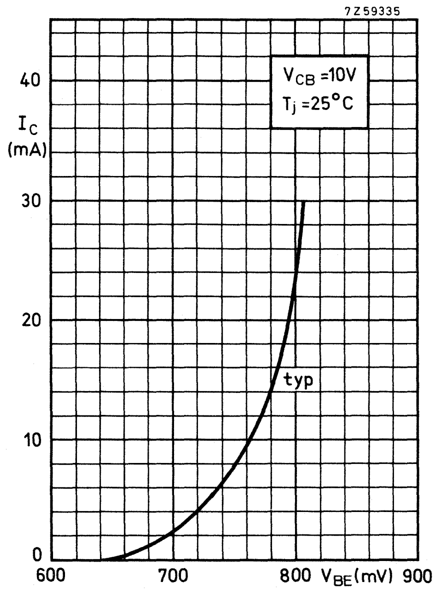
THERMAL RESISTANCE

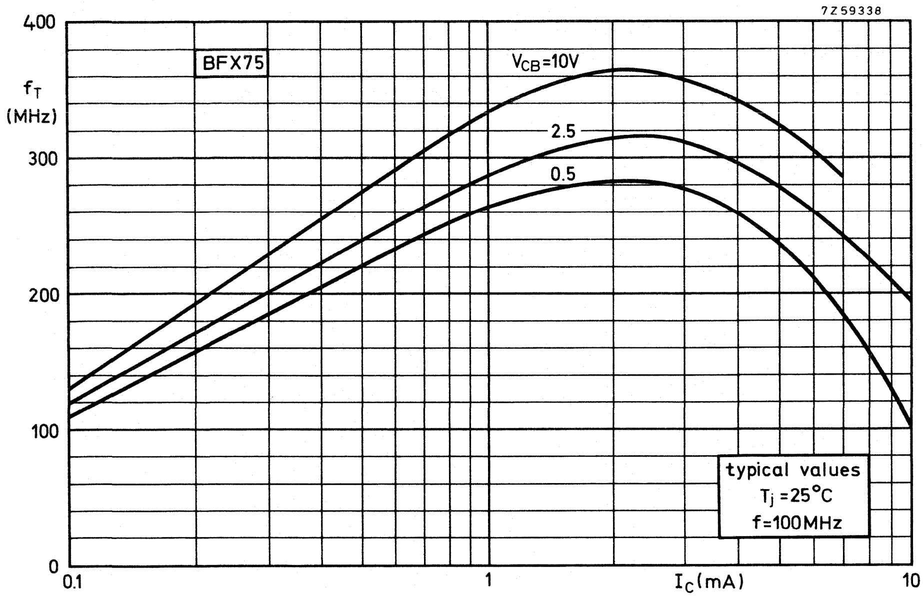
From junction to ambient mounted on a glass thin film (10 mm x 10 mm x 0.8 mm) with plastic encapsulation	$R_{th\ j-a}$	=	1.25	°C/mW

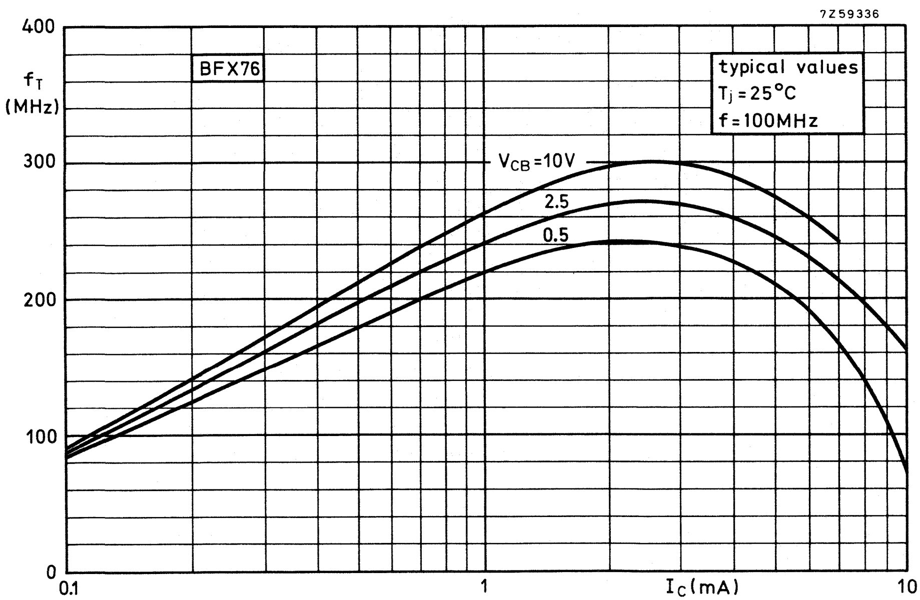
CHARACTERISTICS $T_j = 25\ ^oC$ unless otherwise specified

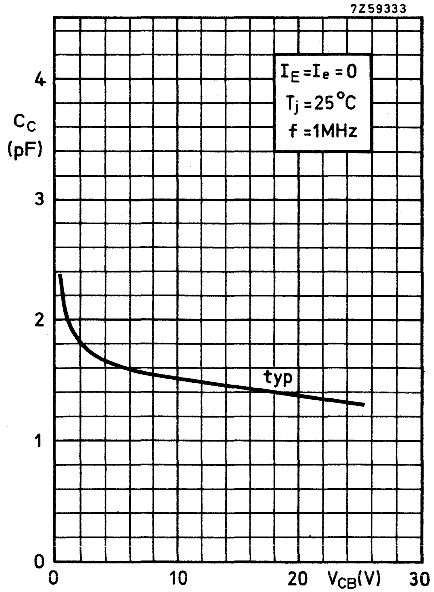
Collector or cut-off current					
$I_E = 0$; $V_{CB} = 10$ V	I_{CBO}	<		100	nA
$I_E = 0$; $V_{CB} = 10$ V; $T_j = 125\ ^oC$	I_{CBO}	<		1	μA
Base-emitter voltage					
$I_C = 1$ mA; $V_{CE} = 10$ V	V_{BE}		0.60 to 0.70		V
Feedback capacitance at f = 10.7 MHz					
$I_C = 1$ mA; $V_{CE} = 10$ V	$-C_{re}$	typ.		0.65	pF
Collector capacitance at f = 1 MHz					
$I_E = I_e = 0$; $V_{CB} = 10$ V	C_c	typ.		1.5	pF
D.C. current gain			BFX75	BFX76	
$I_C = 1$ mA; $V_{CE} = 10$ V	h_{FE}		70 to 280	33 to 110	
Transition frequency at f = 35 MHz					
$I_C = 1$ mA; $V_{CE} = 10$ V	f_T	typ.	330	260	MHz
Noise figure					
$I_C = 1$ mA; $V_{CE} = 10$ V					
f = 5 MHz; $G_S = 100\ m\Omega^{-1}$	F	typ.	3	3	dB

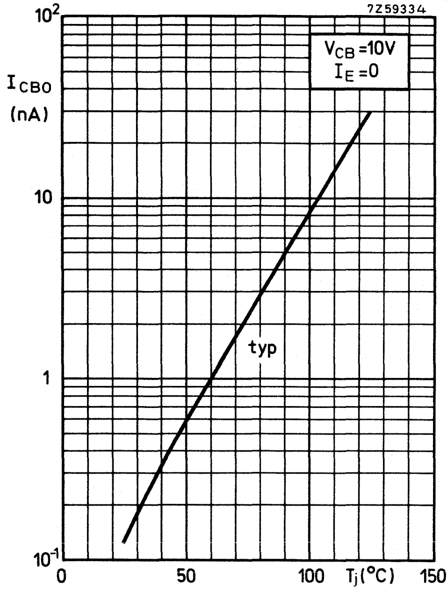

7Z59337
150
h_{FE}
125
100
75
50
25
0
10^{-1}
1
10
I_C (mA)
10^2
BFX75
BFX76
typical values
V_{CE} = 10V
T_j = 25°C

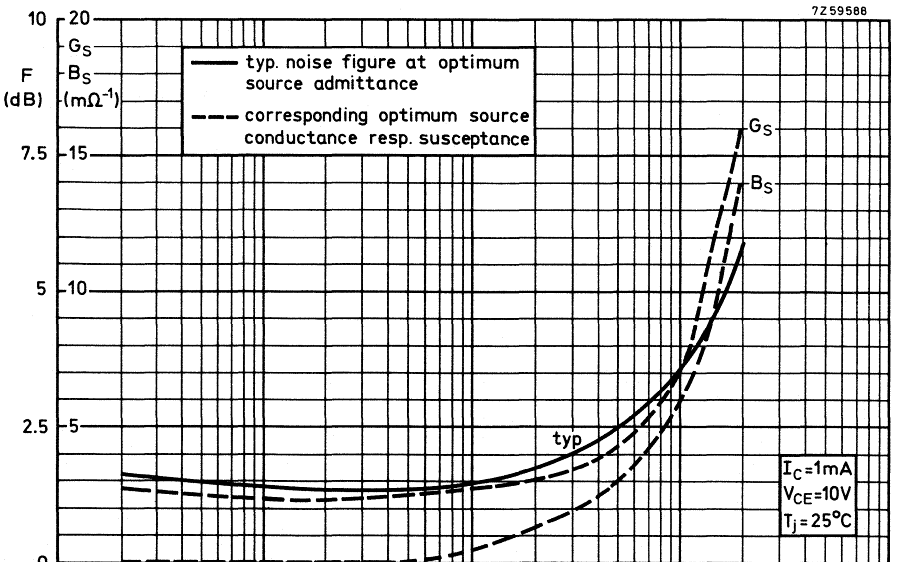

7Z59335
40
I_C
(mA)
30
20
10
0
600
700
800
V_{BE} (mV)
900
V_{CB} = 10V
T_j = 25°C
typ


7Z59338
BFX75
f_T (MHz)
400
300
200
100
0
V_{CB}=10V
2.5
0.5
typical values
T_j = 25 °C
f = 100 MHz
0.1
1
10
I_C (mA)


7Z59336
BFX76
f_T (MHz)
400
300
200
100
0
typical values
T_j = 25 °C
f = 100 MHz
V_{CB}=10V
2.5
0.5
0.1
1
10
I_C (mA)


7Z59333
$I_E = I_e = 0$
$T_j = 25\,^{\circ}C$
f = 1MHz
C_c
(pF)
4
3
2
1
0
typ
0
10
20
V_{CB}(V)
30


7Z59334
V_{CB} = 10V
I_E = 0
I_{CBO}
(nA)
10^2
10
1
10^{-1}
typ
0
50
100
T_j(°C)
150


7Z59588
F
(dB)
G_S
B_S
(mΩ^{-1})
10
7.5
5
2.5
0
20
15
10
5
typ. noise figure at optimum source admittance
corresponding optimum source conductance resp. susceptance
G_S
B_S
typ
I_C=1mA
V_{CE}=10V
T_j=25°C
10^{-1}
1
10
10^2
f (MHz)
10^3

HIGH-SPEED SWITCHING TRANSISTORS WITH ALUMINIUM BEAM LEADS

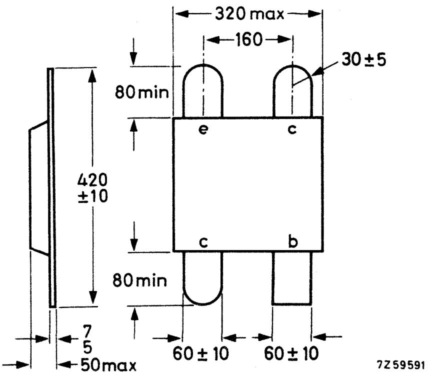
Transistors for hybrid integrated circuits, etc., supplied as bare crystals with four aluminium beam leads.
N-P-N silicon planar epitaxial transistors for high-speed saturated switching.
Also available (for bread-boarding, etc.) mounted on a glass substrate, plastic encapsulated, with gold wire leads.

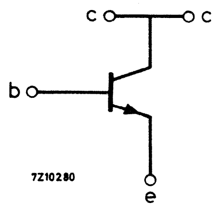
QUICK REFERENCE DATA						
			BSV61	BSV62	BSV63	
Collector-base voltage (open emitter)	V_{CBO}	max.	20	20	20	V
Collector-emitter voltage (open base)	V_{CEO}	max.	9	12	12	V
Collector current (peak value)	I_{CM}	max.	50	50	50	mA
Total power dissipation up to T_{amb} = 25 °C	P_{tot}	max.	80	80	80	mW
Junction temperature	T_j	max.	125	125	125	°C
D.C. current gain at T_j = 25 °C; I_C = 1 mA; V_{CE} = 1 V	h_{FE}	>	80	17	30	
		<	300	50	120	
Transition frequency at f = 100 MHz; I_C = 5 mA; V_{CE} = 2 V	f_T	typ.	640	510	560	MHz

MECHANICAL DATA

Dimensions in μm

Bare crystal with four aluminium beam leads





For orientation the base beam lead has a different form from the others.

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 (open base)	BSV61	V_{CEO}	max.	9	V
	BSV62; BSV63	V_{CEO}	max.	12	V
Emitter-base voltage (open collector)		V_{EBO}	max.	4.5	V

Currents

Collector current (d.c.)	I_C	max.	50	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 thin film (10 mm x 10 mm x 0.8 mm) with plastic encapsulation	P_{tot}	max.	80	mW

Temperatures

Storage temperature	T_{stg}	−40 to +125		°C
Junction temperature	T_j	max.	125	°C

THERMAL RESISTANCE

From junction to ambient mounted on a glass thin film (10 mm x 10 mm x 0.8 mm) with plastic encapsulation	$R_{th\ j\text{-}a}$	=	1.25	°C/mW

CHARACTERISTICS T_j = 25 °C unless otherwise specified

Collector cut-off current

I_E = 0; V_{CB} = 20 V; T_j = 125 °C	I_{CBO}	<	10	μA
I_E = 0; V_{CB} = 20 V; T_j = 25 °C	I_{CBO}	<	100	nA

Emitter cut-off current

I_C = 0; V_{EB} = 2 V; T_j = 125 °C	I_{EBO}	<	2	μA

Sustaining voltages

			BSV61	BSV62 BSV63	
I_C = 10 mA; I_B = 0	$V_{CEOsust}$	>	9	12	V

Saturation voltages

I_C = 10 mA; I_B = 1 mA	V_{CEsat}	<	0.25	V
	V_{BEsat}		0.70 to 0.85	V

Collector capacitance at f = 1 MHz

$I_E = I_e$ = 0; V_{CB} = 5 V	C_c	<	4.0	pF

Emitter capacitance at f = 1 MHz

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

D.C. current gain

			BSV61	BSV62	BSV63	
I_C = 1 mA; V_{CE} = 1 V	h_{FE}	>	80	17	30	
		<	300	50	120	
I_C = 1 mA; V_{CE} = 1 V; T_j = −40 °C	h_{FE}	typ.	70	18	37	
I_C = 10 mA; V_{CE} = 1 V	h_{FE}	typ.	160	70	95	

Transition frequency at f = 100 MHz

			BSV61	BSV62	BSV63	
I_C = 5 mA; V_{CE} = 2 V	f_T	typ.	640	510	560	MHz

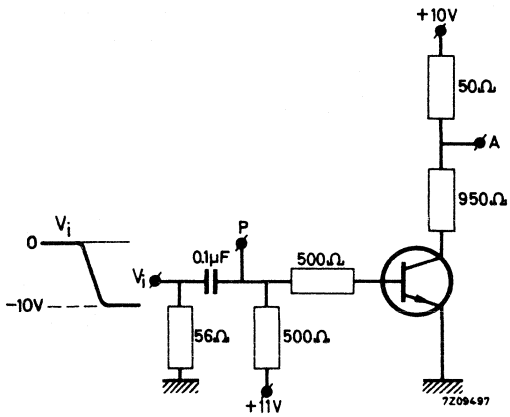
CHARACTERISTICS (continued) T_j = 25 °C unless otherwise specified

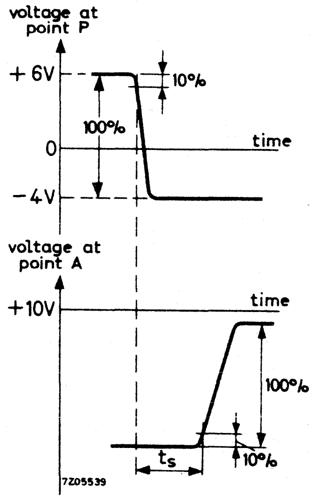
Switching times

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

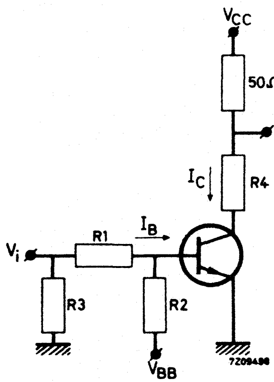
CHARACTERISTICS (continued) T_j = 25 °C unless otherwise spceified

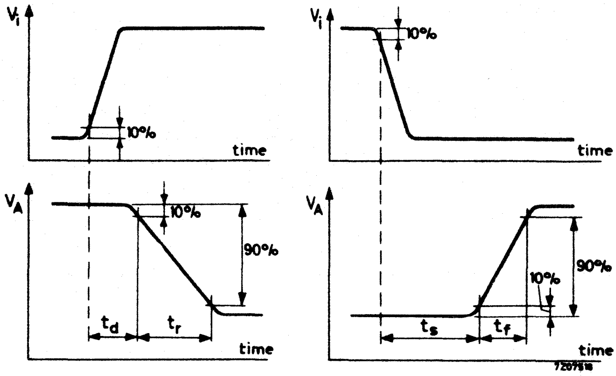
Switching times

Turn on time when switched from
$-V_{BE}$ = 1.5 V to I_C = 10 mA; I_B = 3 mA — t_{on} typ. 9 ns; < 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} typ. 15 ns; < 22 ns

Test circuit:





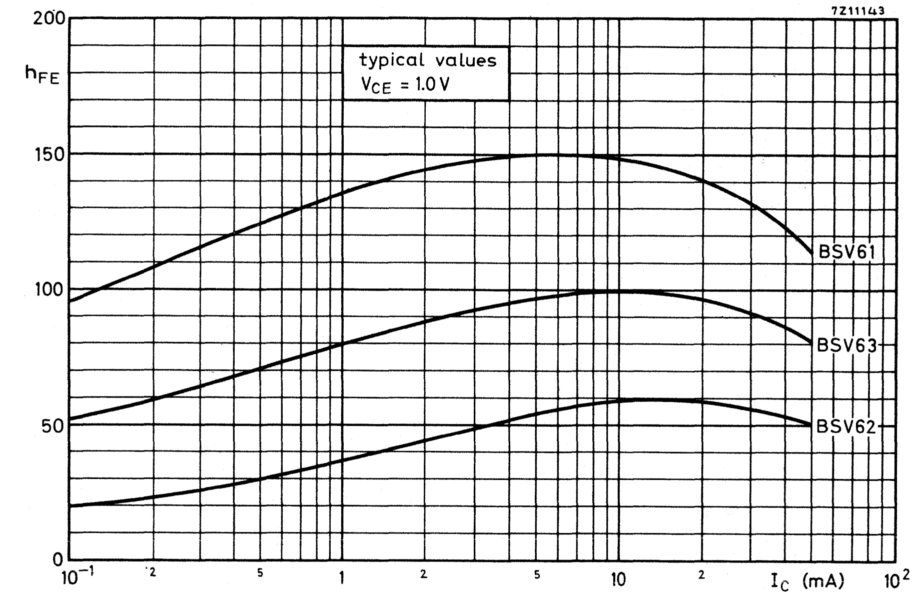
Pulse generator:				
Rise time	t_r	<	1	ns
Pulse duration	t	>	300	ns
Duty cycle	δ	<	0.02	
Source impedance	R_S	=	50	Ω

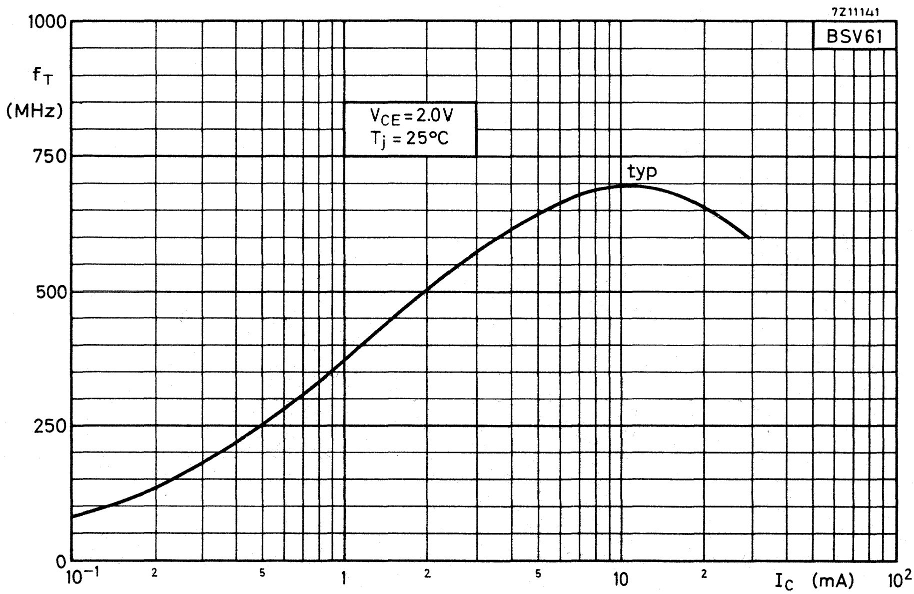
Oscilloscope:				
Input impedance	R_i	=	50	Ω
Rise time	t_r	<	1	ns

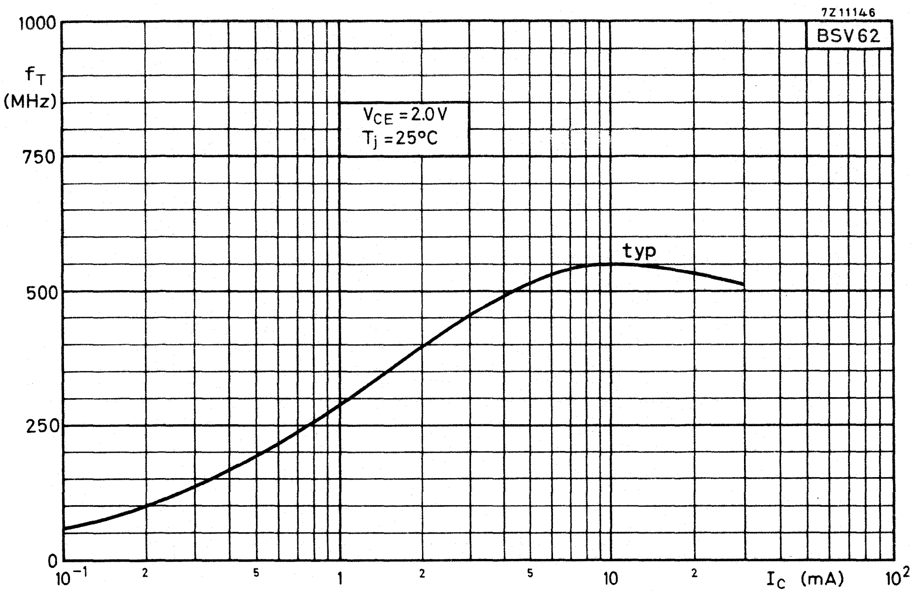
							turn on time			turn off time	
I_C (mA)	I_B (mA)	$-I_{BM}$ (mA)	V_{CC} (V)	R1;R2 (kΩ)	R3 (Ω)	R4 (Ω)	$-V_{BB}$ (V)	$-V_{BE}$ (V)	V_i (V)	V_{BB} (V)	$-V_i$ (V)
10	3	1.5	3	3.3	50	220	3.0	1.5	15	12.0	15

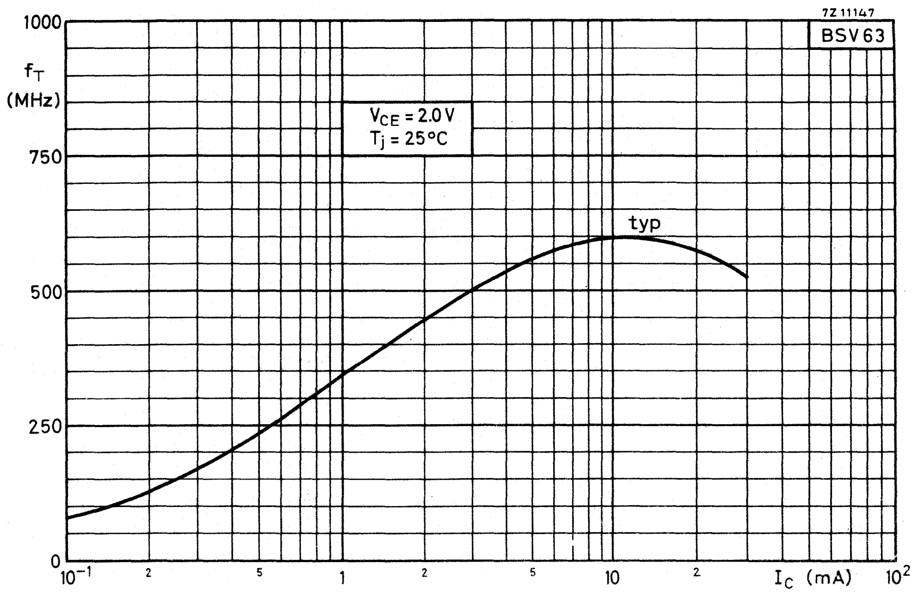
Note

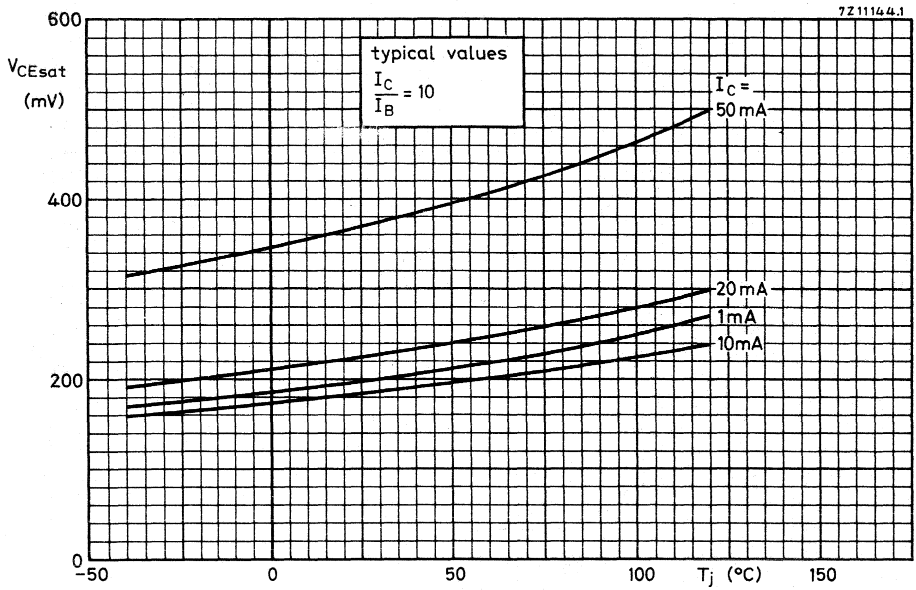
$-I_{BM}$ is the reverse current that can flow during switching off. The indicated $-I_{BM}$ is determined and limited by the applied cut-off voltage and series resistance.

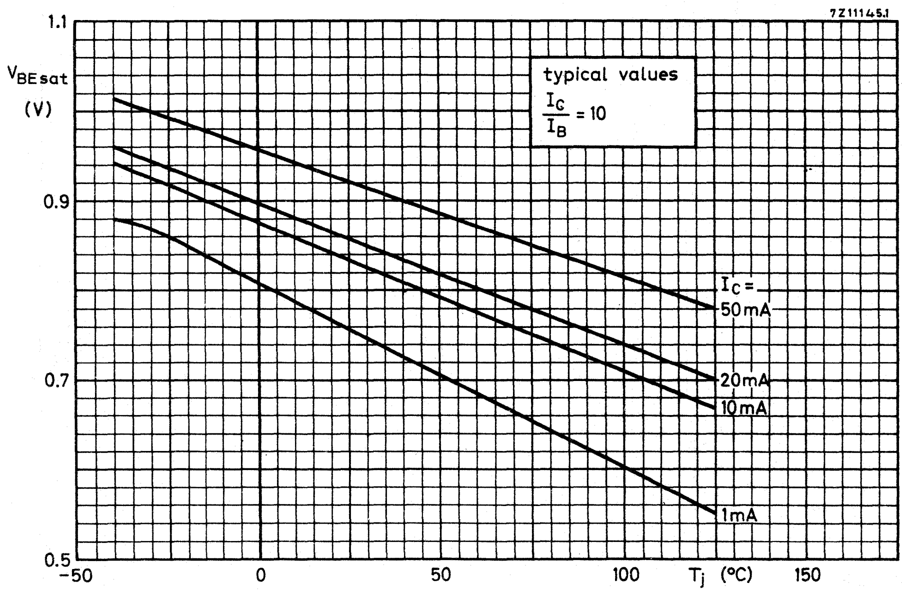

7Z11143
typical values
V_{CE} = 1.0 V
h_{FE}
200
150
100
50
0
BSV61
BSV63
BSV62
10^{-1}
2
5
1
2
5
10
2
I_C (mA)
10^2

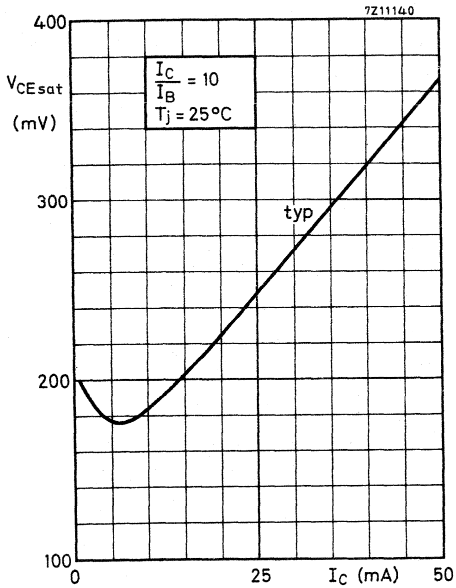

7Z11141
BSV61
f_T
(MHz)
V_{CE} = 2.0 V
T_j = 25 °C
1000
750
500
250
0
typ
10^{-1}
2
5
1
2
5
10
2
I_C (mA)
10^2

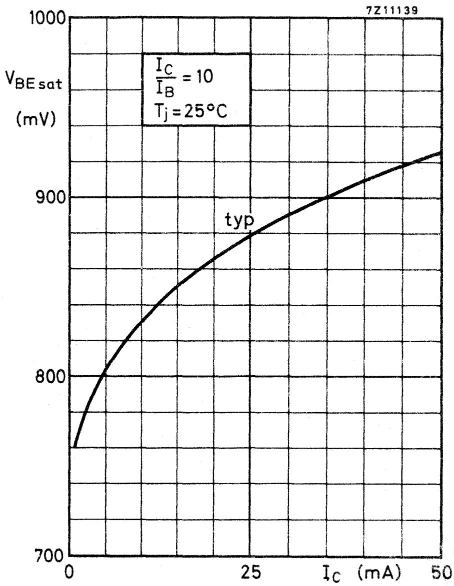

7Z11146
BSV62
1000
f_T
(MHz)
750
500
250
0
V_{CE} = 2.0 V
T_j = 25 °C
typ
10^{-1}
2
5
1
2
5
10
2
I_C (mA)
10^2

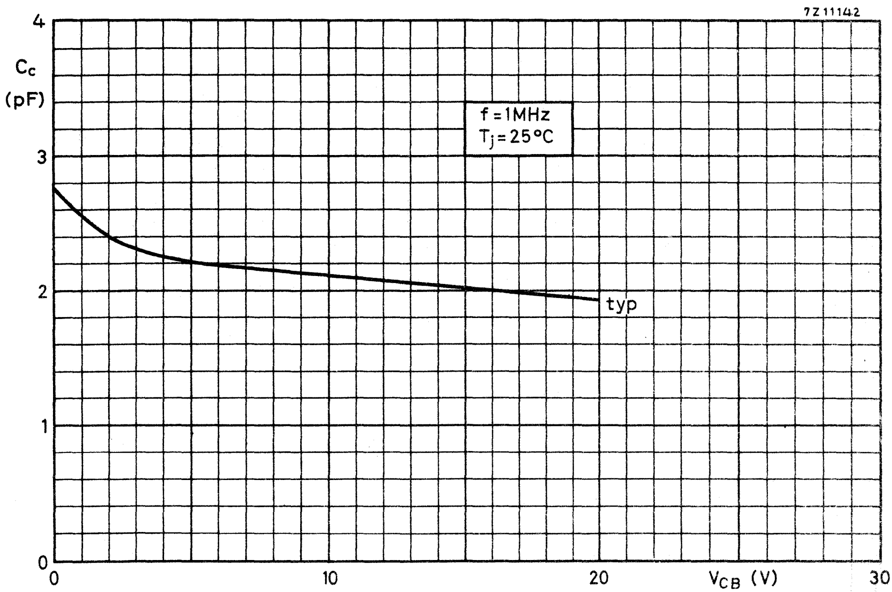

7Z11147
BSV63
1000
f_T
(MHz)
750
500
250
0
V_{CE} = 2.0 V
T_j = 25 °C
typ
10^{-1}
2
5
1
2
5
10
2
I_C (mA)
10^2


7Z11144.1
600
400
200
0
V_{CEsat}
(mV)
typical values
$\frac{I_C}{I_B} = 10$
$I_C =$
50 mA
20 mA
1 mA
10 mA
−50
0
50
100
T_j (°C)
150


7Z11145.1
1.1
0.9
0.7
0.5
V_{BEsat}
(V)
typical values
$\frac{I_C}{I_B} = 10$
$I_C =$
50 mA
20 mA
10 mA
1 mA
−50
0
50
100
T_j (°C)
150


7Z11140
400
300
200
100
VCEsat
(mV)
IC/IB = 10
Tj = 25°C
typ
0
25
IC (mA)
50


7Z11139
1000
900
800
700
VBE sat
(mV)
IC/IB = 10
Tj = 25°C
typ
0
25
IC (mA)
50


7Z11142
4
3
2
1
0
Cc
(pF)
f = 1MHz
Tj = 25°C
typ
0
10
20
VCB (V)
30

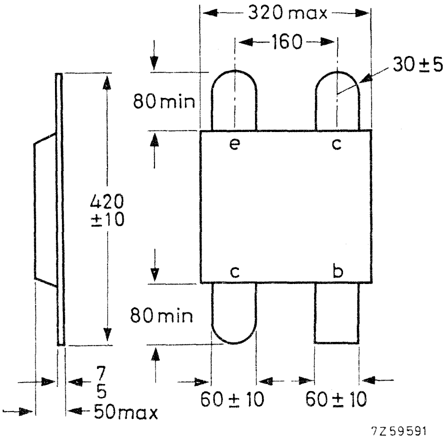
VERY HIGH-SPEED SWITCHING TRANSISTOR WITH ALUMINIUM BEAM LEADS

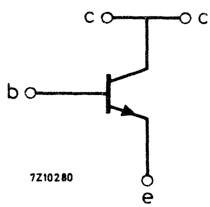
Transistor for hybrid integrated circuits, etc., supplied as a bare crystal with four aluminium beam leads.
N-P-N silicon planar epitaxial transistor for very high-speed saturated switching.

QUICK REFERENCE DATA				
Collector-base voltage (open emitter)	V_{CBO}	max.	15	V
Collector-emitter voltage (open base)	V_{CEO}	max.	6	V
Collector current (d.c.)	I_C	max.	50	mA
Total power dissipation up to T_{amb} = 25 °C	P_{tot}	max.	80	mW
Junction temperature	T_j	max.	125	°C
D.C. current gain at T_j = 25 °C I_C = 10 mA; V_{CE} = 0.5 V	h_{FE}		20 to 120	
Transition frequency at f = 100 MHz I_C = 5 mA; V_{CE} = 5.5 V	f_T	typ.	675	MHz

MECHANICAL DATA Dimensions in μm

Bare crystal with four aluminium beam leads





For orientation the base beam lead has a different form from the others.

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

Voltages

Collector-base voltage (open emitter)	V_{CBO}	max.	15	V
Collector-emitter voltage (open base)	V_{CEO}	max.	6	V
Emitter-base voltage (open collector)	V_{EBO}	max.	4	V

Currents

Collector current (d.c)	I_C	max.	50	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 thin film (10 mm x 10 mm x 0.8 mm) with plastic encapsulation	P_{tot}	max.	80	mW

Temperatures

Storage temperature	T_{stg}		−40 to +125	°C
Junction temperature	T_j	max.	125	°C

THERMAL RESISTANCE

From junction to ambient

mounted on a glass thin film (10 mm x 10 mm x 0.8 mm) with plastic encapsulation	$R_{th\ j-a}$	=	1.25	°C/mW

CHARACTERISTICS

T_j = 25 °C unless otherwise specified

Collector cut-off currents				
$I_E = 0$; $V_{CB} = 5$ V; $T_j = 125$ °C	I_{CBO}	<	5	µA
$I_E = 0$; $V_{CB} = 15$ V; $T_j = 125$ °C	I_{CBO}	<	10	µA
Emitter cut-off currents				
$I_C = 0$; $V_{EB} = 1$ V; $T_j = 125$ °C	I_{EBO}	<	5	µA
$I_C = 0$; $V_{EB} = 4$ V; $T_j = 125$ °C	I_{EBO}	<	10	µA
Sustaining voltage				
$I_C = 10$ mA; $I_B = 0$	$V_{CEOsust}$	>	6	V
Saturation voltages				
$I_C = 3$ mA; $I_B = 0.15$ mA	V_{CEsat}	<	300	mV
$I_C = 30$ mA; $I_B = 3$ mA	V_{CEsat}	<	450	mV
D.C. current gain				
$I_C = 1$ mA; $V_{CE} = 1$ V	h_{FE}	>	20	
		typ.	40	
$I_C = 10$ mA; $V_{CE} = 500$ mV	h_{FE}	20 to	120	
Collector capacitance at f = 1 MHz				
$I_E = I_e = 0$; $V_{CB} = 5$ V	C_c	<	3	pF
Emitter capacitance at f = 1 MHz				
$I_C = I_c = 0$; $V_{EB} = 0.5$ V	C_e	<	2.5	pF
Transition frequency at f = 100 MHz				
$I_C = 5$ mA; $V_{CE} = 5.5$ V	f_T	typ.	675	MHz

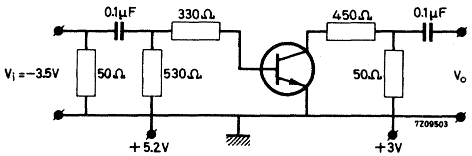
CHARACTERISTICS (continued) T_j = 25 °C unless otherwise specified

Switching times

Storage time

$I_C = I_B = -I_{BM} = 5$ mA	t_s	typ. 3.8	ns
		< 6	ns

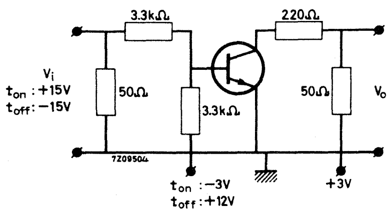
Test circuit:

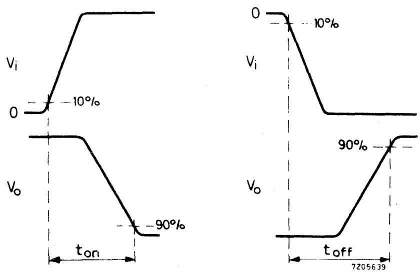


Pulse generator:					Oscilloscope:				
Pulse duration	t	>	300	ns	Input impedance	R_i	=	50	Ω
Rise time	t_r	<	1	ns	Rise time	t_r	<	1	ns
Duty cycle	δ	<	0.02						
Output resistance	R_o	=	50	Ω					

Turn on time when switched from $-V_{BE}$ = 1.5 V to I_C = 10 mA; I_B = 3 mA	t_{on}	typ. 7	ns
Turn off time when switched from I_C = 10 mA; I_B = 3 mA to cut-off with $-I_{BM}$ = 1.5 mA [1]	t_{off}	typ. 9	ns

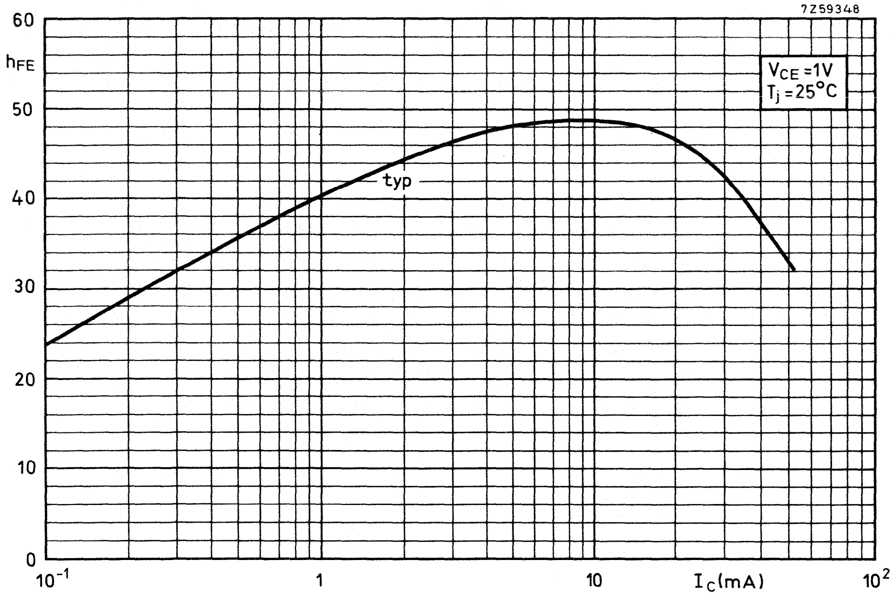
Test circuit:

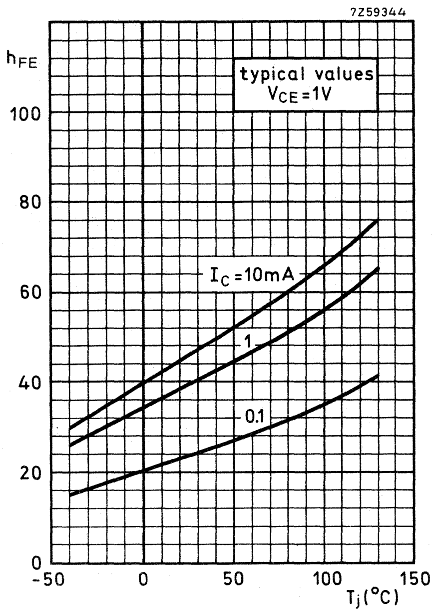


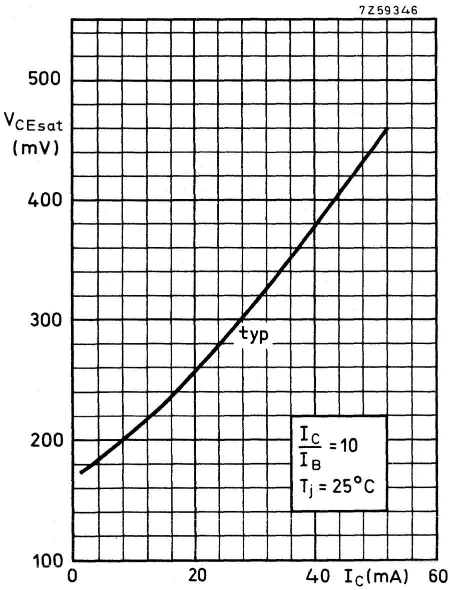


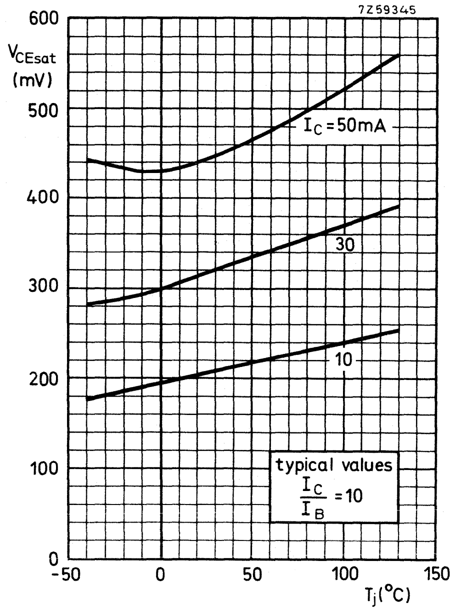
Pulse generator:					Oscilloscope:				
Pulse duration	t	>	300	ns	Input impedance	R_i	=	50	Ω
Rise time	t_r	<	1	ns	Rise time	t_r	<	1	ns
Duty cycle	δ	<	0.02						
Output impedance	R_o	=	50	Ω					

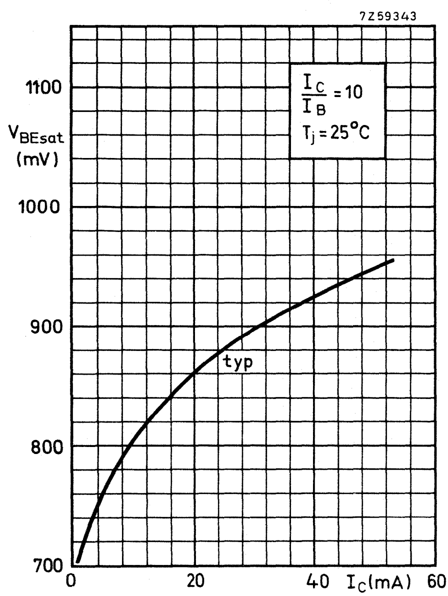
1) $-I_{BM}$ is the reverse current that can flow during switching off. The indicated $-I_{BM}$ is determined and limited by the applied cut-off voltage and the series resistance.

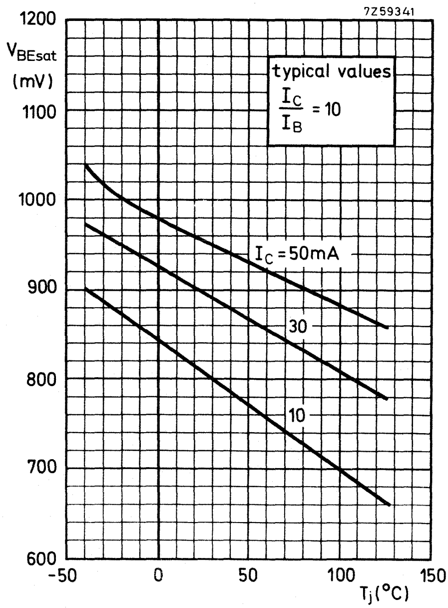

7Z59348
60
hFE
50
40
30
20
10
0
V_{CE} = 1V
T_j = 25°C
typ
10^{-1}
1
10
I_C(mA)
10^2

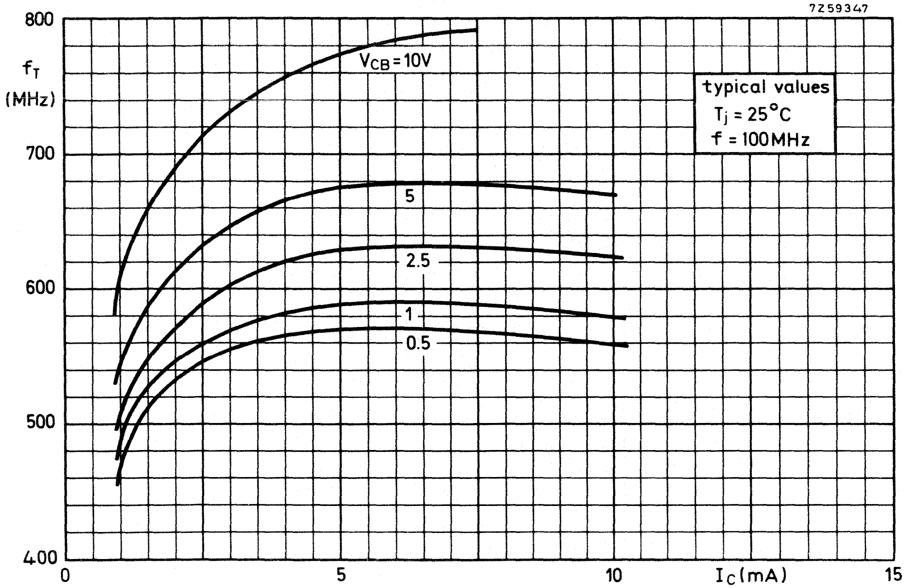

7Z59344
hFE
100
80
60
40
20
0
typical values
V_{CE} = 1V
I_C = 10mA
1
0.1
−50
0
50
100
150
T_j(°C)

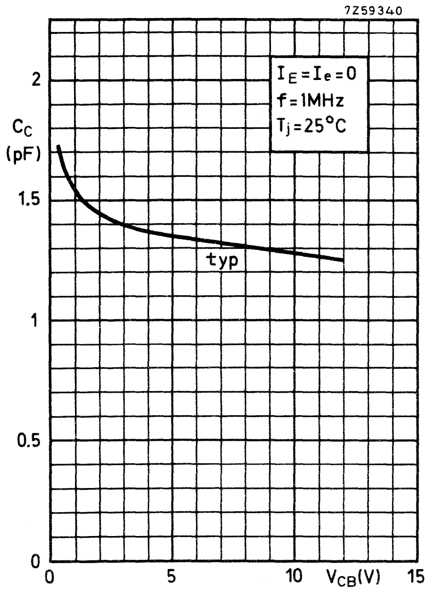

7Z59346
500
400
300
200
100
V_{CEsat} (mV)
typ
$\frac{I_C}{I_B} = 10$
$T_j = 25\,^{\circ}C$
0
20
40
60
I_C (mA)

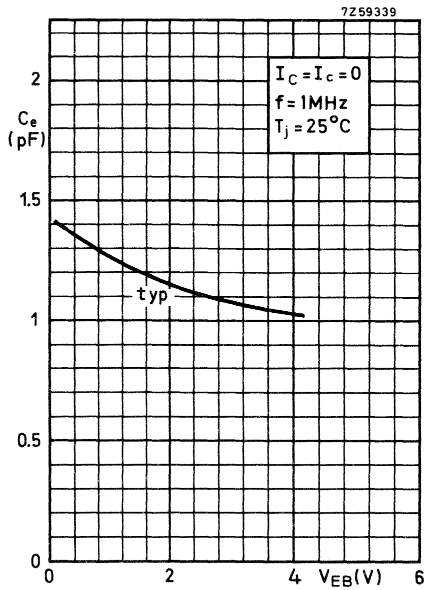

7Z59345
600
500
400
300
200
100
0
V_{CEsat} (mV)
$I_C = 50\,mA$
30
10
typical values
$\frac{I_C}{I_B} = 10$
−50
0
50
100
150
T_j (°C)


7Z59343
1100
1000
900
800
700
V_{BEsat} (mV)
$\frac{I_C}{I_B} = 10$
$T_j = 25\,^{\circ}C$
typ
0
20
40
60
I_C (mA)


7Z59341
1200
1100
1000
900
800
700
600
V_{BEsat} (mV)
typical values
$\frac{I_C}{I_B} = 10$
$I_C = 50\,mA$
30
10
−50
0
50
100
150
T_j (°C)


7Z59347
800
700
600
500
400
f_T (MHz)
V_{CB} = 10V
5
2.5
1
0.5
typical values
T_j = 25°C
f = 100MHz
0
5
10
I_C(mA)
15


7Z59340
C_c (pF)
2
1.5
1
0.5
0
$I_E = I_e = 0$
f = 1MHz
T_j = 25°C
typ
0
5
10
V_{CB}(V)
15


7Z59339
C_e (pF)
2
1.5
1
0.5
0
$I_C = I_c = 0$
f = 1MHz
T_j = 25°C
typ
0
2
4
V_{EB}(V)
6

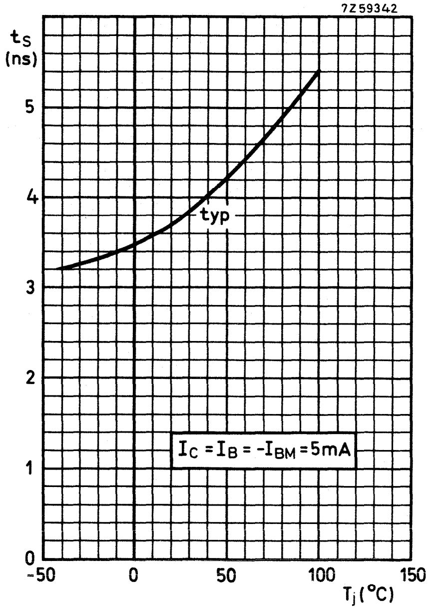

7Z59342
t_s (ns)
5
4
3
2
1
0
typ
$I_C = I_B = -I_{BM} = 5mA$
-50
0
50
100
150
T_j (°C)

Photo devices

CADMIUM SULPHIDE PHOTOCONDUCTIVE DEVICES

LIST OF SYMBOLS

Cell voltage	V
Cell current	I
Illumination current	I_l
Initial illumination current	I_{lo}
Equilibrium illumination current	I_{le}
Dark current	I_d
Initial dark current	I_{do}
Equilibrium dark current	I_{de}
Illumination resistance	r_l
Initial illumination resistance	r_{lo}
Equilibrium illumination resistance	r_{le}
Dark resistance	r_d
Initial dark resistance	r_{do}
Equilibrium dark resistance	r_{de}
Current rise time	t_{ri}
Current decay time	t_{fi}
Resistance rise time	t_{rr}
Resistance decay time	t_{fr}
Pulse time	t_{imp}
Averaging time	t_{av}
Pulse repetition rate	p_{rr}

Illumination sensitivity	N
Illumination response	γ
Voltage response	α
Ambient temperature	T_{amb}
Thermal resistance	K
Temperature of CdS tablet	T_{tablet}
Colour temperature	T_K
Dissipation	P
Illumination	E
Initial drift	D_o

GENERAL OPERATIONAL RECOMMENDATIONS PHOTOCONDUCTIVE DEVICES

1. GENERAL

1.1 These application directions are valid for all types of photoconductive cells, unless otherwise stated on the individual technical data sheets.

1.2 A photoconductive device is a light-sensitive device whose resistance varies with the illumination on the device.

1.3 Where the term illumination is used in the following sections it shall be taken to mean the radiant energy which is normally used to excite the device.

1.4 Also in the following sections, history is taken to mean the duration of the specified conditions plus a sufficient description of previous conditions.

2. OPERATING CHARACTERISTICS

2.1 The data given on the individual technical data sheets are based on the devices being uniformly illuminated.

2.2 The illumination resistance is the ratio of the voltage across the device to the current through the device when illumination is applied to the device.

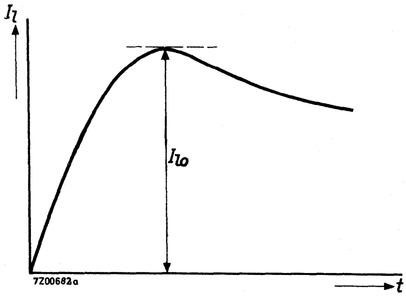
2.2.1 For a particular set of conditions the equilibrium illumination resistance is the illumination resistance after such a time under these conditions that the rate of change of the illumination resistance is less than 1% per 5 minutes.

2.2.2 For a particular set of conditions the initial illumination resistance is the first virtually constant value of the illumination resistance after a period of storage or other operating conditions.
The initial illumination resistance usually occurs after a few seconds under the specified conditions.

2.3 The illumination current is the current which passes when a voltage and illumination are applied to the device.

2.3.1 For a particular set of conditions the equilibrium illumination current is the illumination current after such a time under these conditions that the rate of change of the illumination current is less than 1% per 5 minutes.

2.3.2 For a particular set of conditions the initial illumination current is the first virtually constant value of the illumination current after a period of storage or other operating conditions.
The initial illumination current usually occurs after a few seconds under the specified conditions.



2.4 The dark resistance is the resistance of the device in the absence of illumination.

2.4.1 For a particular set of conditions the equilibrium dark resistance is the dark resistance after such a time under these conditions that the rate of change of the dark resistance is less than 2% per 5 minutes.

2.4.2 For a particular set of conditions the initial dark resistance is the dark resistance after a specified time under these conditions following a specified history.

2.5 The dark current is the current which passes when a voltage is applied to the device in the absence of illumination.

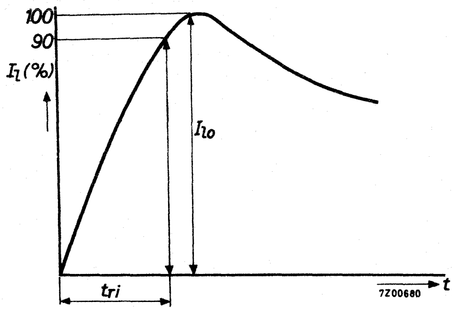
2.5.1 For a particular set of conditions the equilibrium dark current is the dark current after such a time under these conditions that the rate of change of the dark current is less than 2% per 5 minutes.

2.5.2 For a particular set of conditions the initial dark current is the dark current after a specified time under these conditions immediately following a specified history.

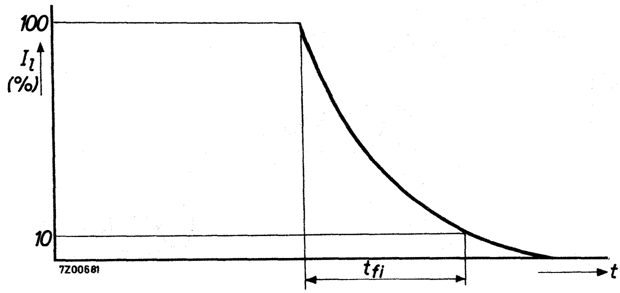
2.6.1 For a particular set of conditions and history the resistance decay time is the time taken for the resistance of the device to fall to a specified value measured from the instant of starting the illumination.

2.6.2 For a particular set of conditions and history the resistance rise time is the time taken for the resistance of the device to rise to a specified value measured from the instant of stopping the illumination.

2.7.1 For a particular set of conditions and history the current rise time is the time taken for the current through the device to rise to 90% ot its initial illumination current measured from the instant of starting the illumination.



2.7.2 For a particular set of conditions and history the current decay time is the time taken for the current through the device to fall to 10% of its value at the instant of stopping the illumination, measured from that instant.



2.8 The illumination sensitivity is the quotient of illumination current by the incident illumination.

2.9 The illumination resistance (current) temperature response is the relationship between the illumination resistance (current) and the ambient temperature of the device under constant illumination and voltage conditions.

2.10 For a particular set of conditions the initial drift is the difference between the equilibrium and initial illumination current, expressed as a percentage of the initial illumination current.

2.11 The illumination response is the relationship between the initial illumination resistance and the illumination, defined as $\frac{\Delta \log r_{lo}}{\Delta \log E}$

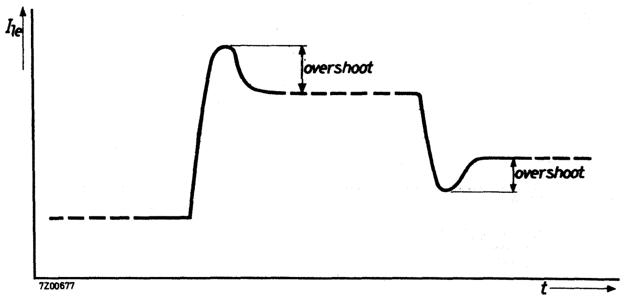
3. THERMAL DATA

3.1 Ambient temperature. The ambient temperature of a device is the temperature of the surrounding air of that device in its practical situation, which means that other elements in the same space or apparatus must have their normal maximum dissipation and that the same apparatus envelope must be used. This ambient temperature can normally be measured by using a mercury thermometer the mercury container of which has been blackened, placed at a distance of 5 mm from the envelope in the horizontal plane through the centre of the effective area of the CdS tablet.
It shall be exposed to substantially the same radiant energy as that incident on the CdS tablet.

3.2 The thermal resistance of a device is defined as the temperature difference between the hottest point of the device and the dissipating medium, divided by the power dissipated in the device.

4. OPERATIONAL NOTES

4.1 When a photoconductive device is subjected to a change of operating conditions there may be a transient change of current in excess of that due to the difference between the equilibrium illumination currents. This transient change is called overshoot.



4.2 Direct sunlight irradiation should be avoided.

5. MOUNTING

5.1 If no restrictions are made on the individual published data sheets, the device may be mounted in any position.

5.2 Most of the photoconductive devices may be soldered directly into the circuit, which is indicated on the individual published data sheets. However, the heat conducted to the seal of the device should be kept to a minimum by the use of a thermal shunt. If not otherwise indicated, the device may be dip-soldered at a solder temperature of 240 °C for a maximum of 10 seconds up to a point 5 mm from the seals.

6. **STORAGE**

It is recommended that the devices be stored in the dark. At any rate direct sunlight irradiation should be avoided.

7. **LIMITING VALUES**

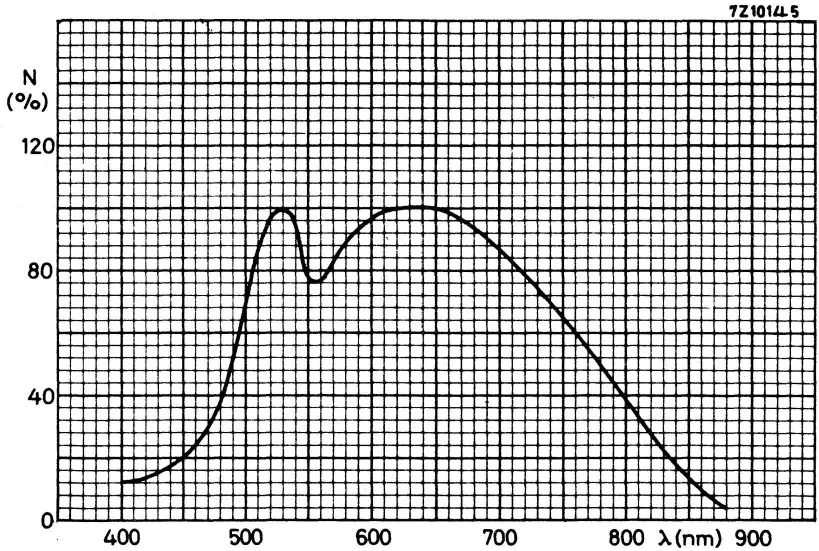
The limiting values of photoconductive devices are given in the absolute maximum rating system.

8. **OUTLINE DIMENSIONS**

The outline dimensions are given in mm.

9. **SHOCK AND VIBRATION**

The conditions for shock and vibration given on the individual data sheets are intended only to give an indication of the mechanical quality of the device. It is not advisable to subject the device to such conditions.



TYPE D

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.

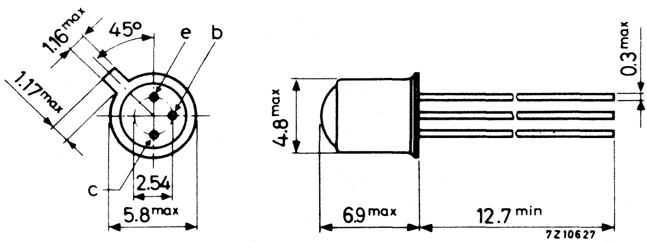
QUICK REFERENCE DATA				
Collector-emitter voltage (open base)	V_{CEO}	max.	32	V
Collector current (peak value)	I_{CM}	max.	50	mA
Junction temperature	T_j	max.	150	^oC
Collector-emitter dark cut-off current $I_B = 0$; $V_{CE} = 24$ V	$I_{CEO(D)}$	<	1.0	μA
			BPX25 | BPX29	
Collector-emitter light cut-off current $I_B = 0$; $V_{CE} = 24$ V; at 1000 lux	$I_{CEO(L)}$	typ.	8.0 | 0.8	mA
Peak spectral response	λ_m	typ.	0.8	μm

MECHANICAL DATA

Dimensions in mm

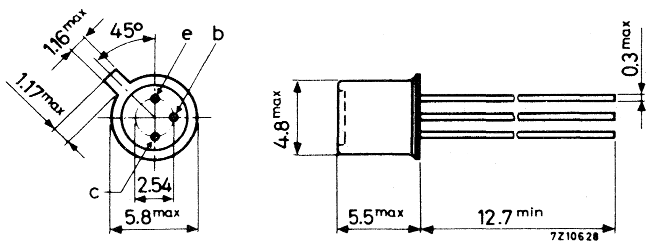
BPX25

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 °C	P_{tot}	max.	300	mW

Temperatures

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

THERMAL RESISTANCE

From junction to ambient	$R_{th\ j\text{-}a}$	=	0.4	°C/mW
From junction to case	$R_{th\ j\text{-}c}$	=	0.15	°C/mW

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

Collector-emitter dark cut-off current

$I_B = 0$; $V_{CE} = 24$ V	$I_{CEO(D)}$	typ.	0.2	μA
		<	1.0	μA
$I_B = 0$; $V_{CE} = 24$ V; $T_{amb} = 100$ °C	$I_{CEO(D)}$	typ.	30	μA
		<	500	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 °K (7.7 mW/cm²)	$I_{CEO(L)}$	>	2.5	0.25	mA
		typ.	8.0	0.8	mA
GaAs source; 15 mW/cm²	$I_{CEO(L)}$	typ.	13	1.3	mA

D.C. current gain

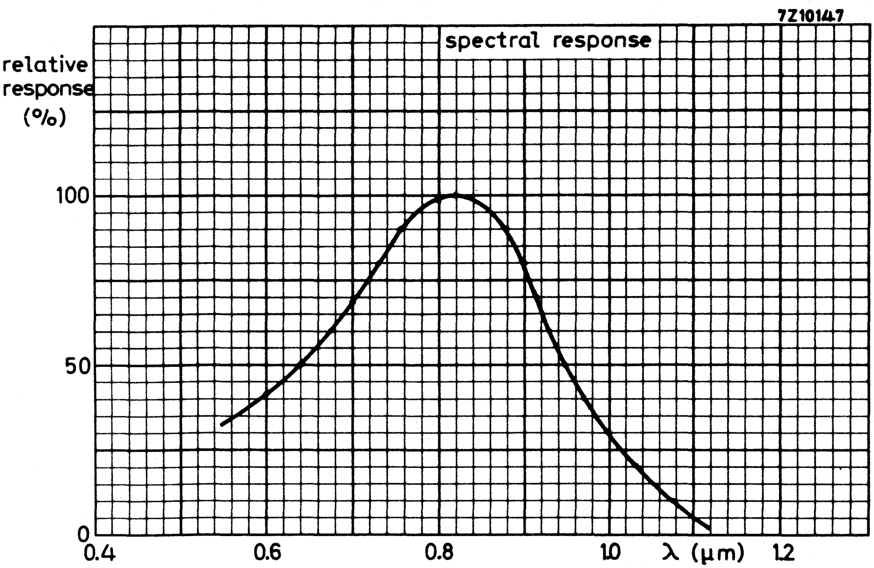
$I_C = 2$ mA; $V_{CE} = 5$ V	h_{FE}	typ.	250	250	

Cut-off frequency

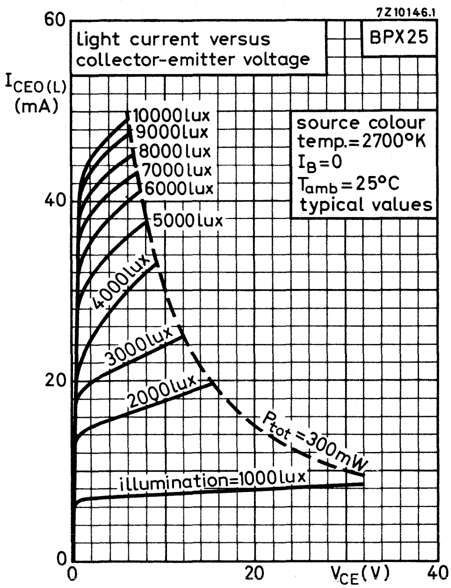
Source: modulated GaAs; 0.4 mW/cm² Load : optimum (50 Ω)	f_{co}	typ.	200	150	kHz

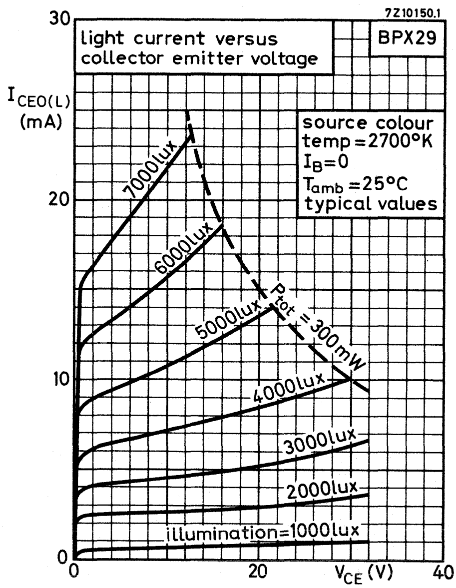
CHARACTERISTICS (continued)

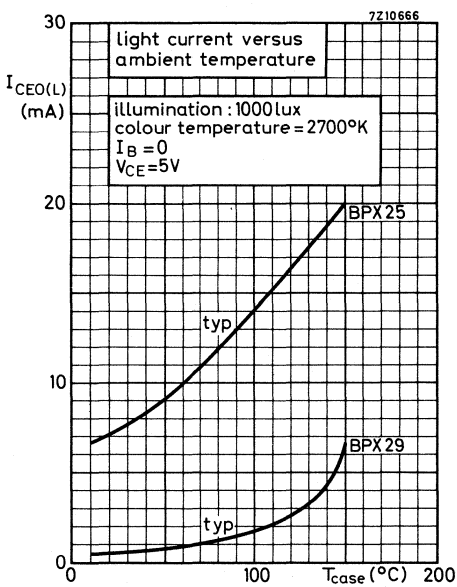
			BPX25	BPX29	
Rise time 1)	t_r	typ.	1.8	2.4	µs
Fall time 1)	t_f	typ.	1.8	2.4	µs
Peak spectral response	λ_m	typ.	0.8	0.8	µm
Equivalent noise illumination at f = 800 Hz 2)					
V_{CE} = 5 V; illumination: 1000 lux		typ.	0.5	1.5	$\frac{mlux}{\sqrt{Hz}}$

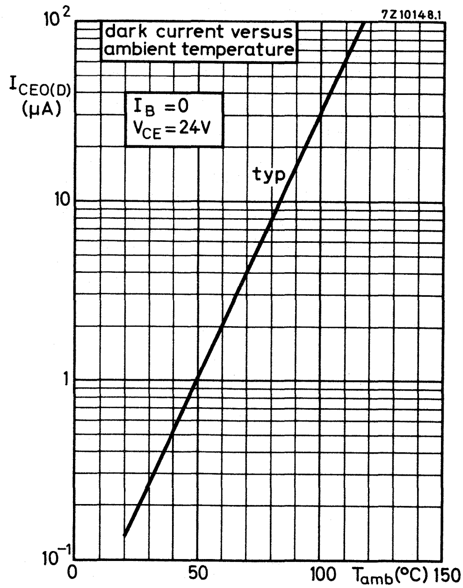


1) Source: modulated GaAs: 0.4 mW/cm^2
Load : optimum (50 Ω)
2) At this and lower frequencies, $\frac{1}{f}$ noise predominates.

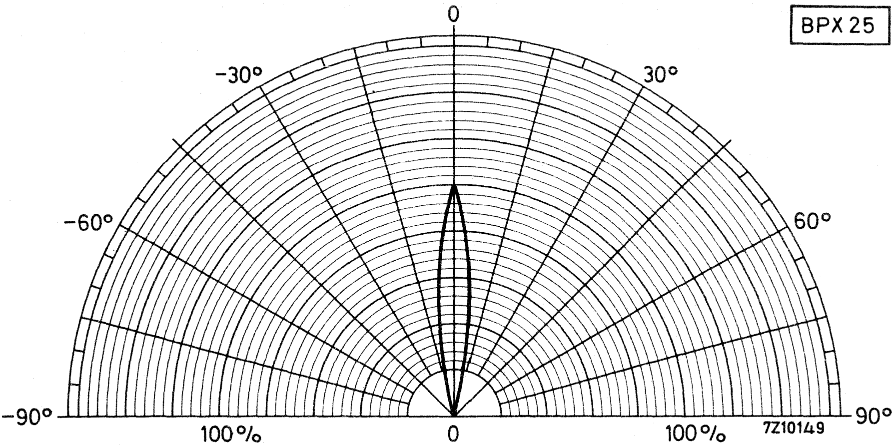

7Z10146.1
light current versus collector-emitter voltage
BPX25
$I_{CEO(L)}$ (mA)
source colour temp.=2700°K
I_B=0
T_{amb}=25°C
typical values
10000 lux
9000 lux
8000 lux
7000 lux
6000 lux
5000 lux
4000 lux
3000 lux
2000 lux
illumination=1000 lux
P_{tot}=300 mW
V_{CE} (V)
60
40
20
0
0
20
40


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}=300 mW
V_{CE} (V)
30
20
10
0
0
20
40

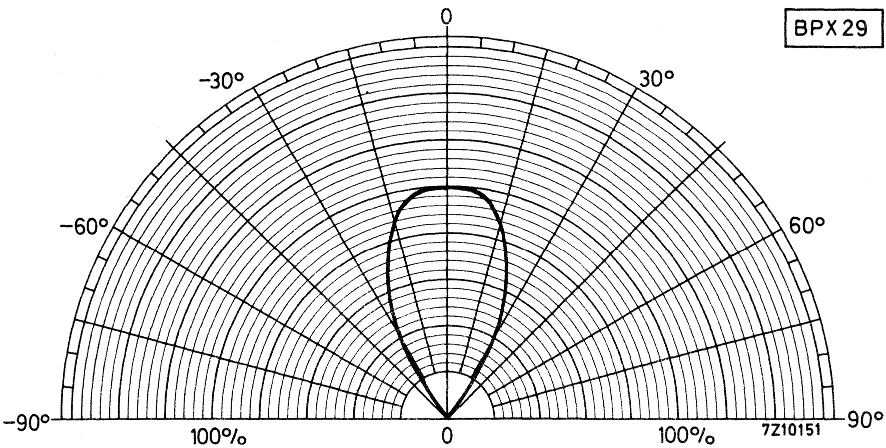

7Z10666
light current versus ambient temperature
$I_{CEO(L)}$ (mA)
illumination : 1000 lux
colour temperature=2700°K
I_B=0
V_{CE}=5V
BPX25
typ
BPX29
typ
T_{case} (°C)
30
20
10
0
0
100
200


7Z10148.1
dark current versus ambient temperature
$I_{CEO(D)}$ (μA)
I_B=0
V_{CE}=24V
typ
T_{amb}(°C)
10^2
10
1
10^{-1}
0
50
100
150

polar response of relative sensitivity



polar response of relative sensitivity



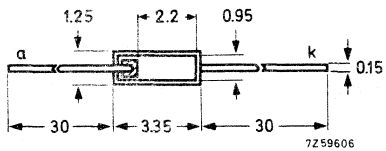
SILICON PLANAR PHOTO-DIODE

Unencapsulated photo-diode for general purpose applications.

QUICK REFERENCE DATA				
Reverse voltage	V_R	max.	18	V
Light sensitivity V_R = 15 V; E = 1000 lx	N	typ.	10	nA/lx
Dark reverse current at V_R = 15 V	I_d	<	0.5	µA
Peak spectral response	λ_m	typ.	800	nm

MECHANICAL DATA

Dimensions in mm



Slice thickness 0.27 mm

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

Voltage

Reverse voltage	V_R	max.	18	V

Currents

Forward current	I_F	max.	5	mA
Dark reverse current	I_R	max.	2	mA

Temperatures

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

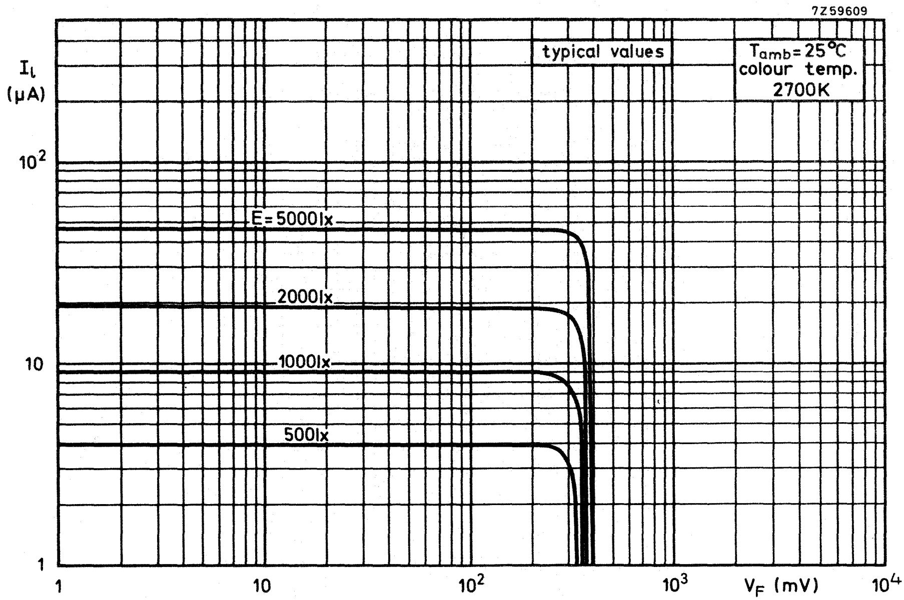
THERMAL RESISTANCE

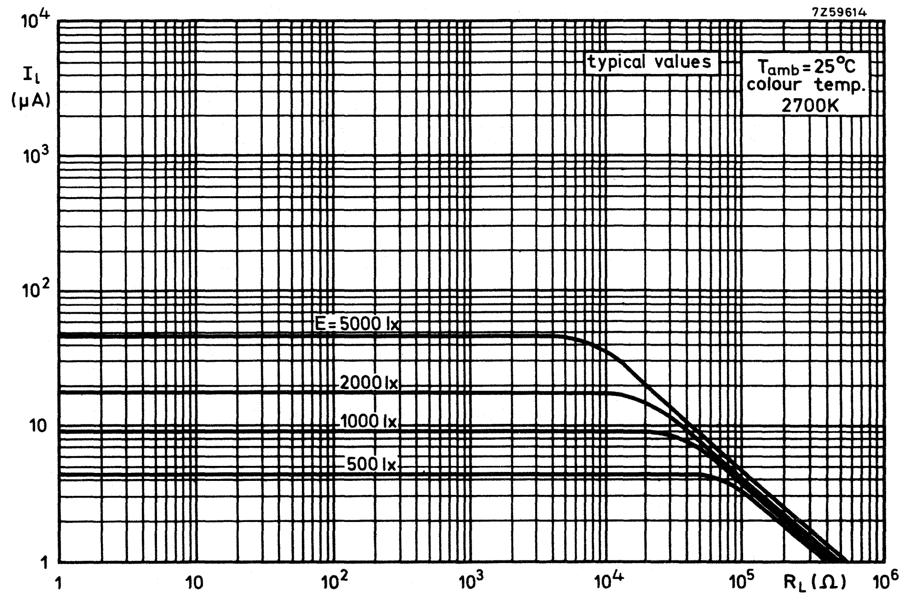
From junction to ambient in free air	$R_{th\ j-a}$	=	0.5	$^oC/mW$

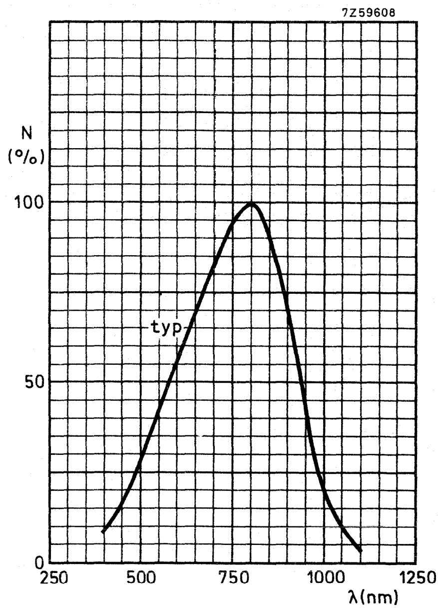
CHARACTERISTICS T_{amb} = 25 ^oC unless otherwise specified

Dark reverse current				
V_R = 15 V	I_d	typ.	0.01	μA
		<	0.5	μA
V_R = 15 V; T_{amb} = 100 ^oC	I_d	typ.	0.6	μA
		<	10	μA
Light reverse current; V = 0				
E = 1000 lx; colour temperature = 2700 K	I_l	>	7.5	μA
		typ.	9	μA
Forward voltage; I = 0				
E = 1000 lx; colour temperature = 2700 K	V_F	>	330	mV
		typ.	350	mV
Light sensitivity [1]				
V_R = 15 V; E = 1000 lx; colour temperature = 2700 K	N	>	8.5	nA/lx
		typ.	10	nA/lx
Peak spectral response	λ_m	typ.	800	nm
Diode capacitance; f = 500 kHz				
V_R = 15 V	C_d	typ.	90	pF
V_R = 0	C_d	typ.	300	pF

[1]) The value of light current increases with temperature equal to the increase in dark current.


7Z59609
typical values
Tamb = 25 °C
colour temp.
2700K
IL (μA)
10^2
10
1
E = 5000 lx
2000 lx
1000 lx
500 lx
1
10
10^2
10^3
VF (mV)
10^4


7Z59614
typical values
Tamb = 25 °C
colour temp.
2700K
IL (μA)
10^4
10^3
10^2
10
1
E = 5000 lx
2000 lx
1000 lx
500 lx
1
10
10^2
10^3
10^4
10^5
RL (Ω)
10^6


7Z59608
N
(%)
100
50
0
250
500
750
1000
1250
λ(nm)
typ

SILICON PLANAR PHOTO-DIODE

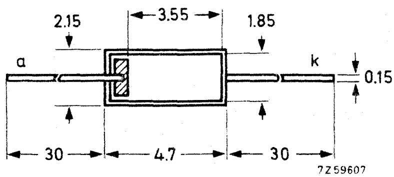
Unencapsulated photo-diode for general purpose applications.

QUICK REFERENCE DATA

Reverse voltage	V_R	max.	18	V
Light sensitivity V_R = 15 V; E = 1000 lx	N	typ.	30	nA/lx
Dark reverse current at V_R = 15 V	I_d	<	1.0	μA
Peak spectral response	λ_m	typ.	800	nm

MECHANICAL DATA

Dimensions in mm



Slice thickness 0.27 mm

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

Voltage				
Reverse voltage	V_R	max.	18	V
Currents				
Forward current	I_F	max.	10	mA
Dark reverse current	I_R	max.	5	mA
Temperatures				
Storage temperature	T_{stg}	−65 to	+125	°C
Junction temperature	T_j	max.	125	°C

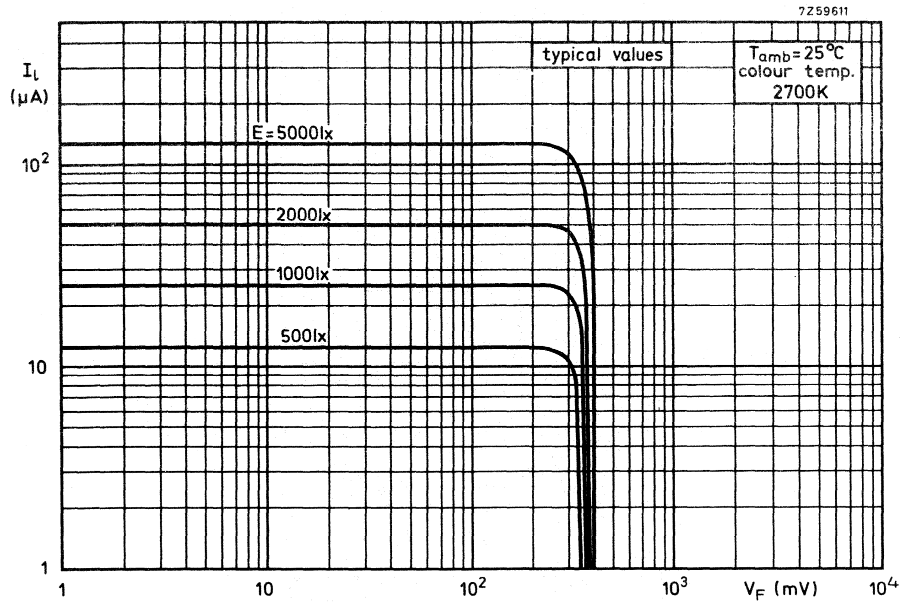
THERMAL RESISTANCE

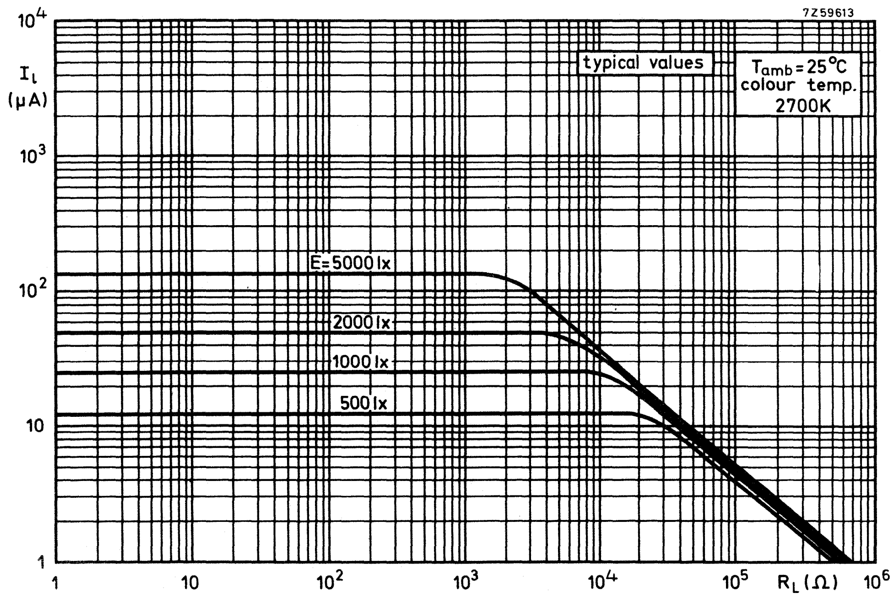
From junction to ambient in free air	$R_{th\ j-a}$	=	0.5	°C/mW

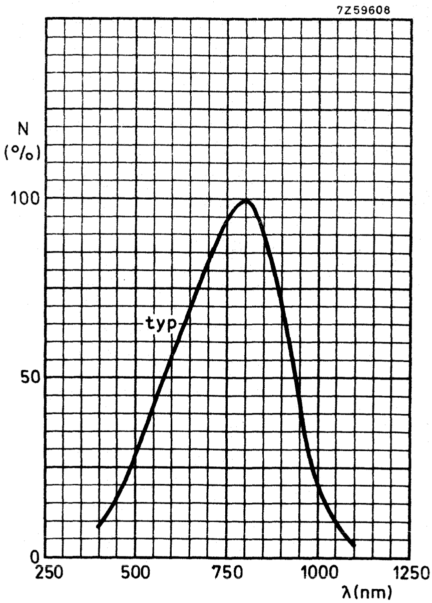
CHARACTERISTICS T_{amb} = 25 °C unless otherwise specified

Dark reverse current				
V_R = 15 V	I_d	typ. <	0.02 1.0	µA µA
V_R = 15 V; T_{amb} = 100 °C	I_d	typ. <	1.2 20	µA µA
Light reverse current; V = 0				
E = 1000 lx; colour temperature = 2700 K	I_l	> typ.	20 25	µA µA
Forward voltage; I = 0				
E = 1000 lx; colour temperature = 2700 K	V_F	> typ.	330 350	mV mV
Light sensitivity [1]				
V_R = 15 V; E = 1000 lx colour temperature = 2700 K	N	> typ.	25 30	nA/lx nA/lx
Peak spectral response	λ_m	typ.	800	nm
Diode capacitance; f = 500 kHz				
V_R = 15 V	C_d	typ.	250	pF
V_R = 0	C_d	typ.	800	pF

[1]) The value of light current increases with temperature equal to the increase in dark current.


7Z59611
typical values
T_{amb} = 25 °C
colour temp.
2700K
I_L
(μA)
E = 5000 lx
2000 lx
1000 lx
500 lx
10^2
10
1
1
10
10^2
10^3
V_F (mV)
10^4


7Z59613
typical values
T_{amb} = 25 °C
colour temp.
2700K
I_L
(μA)
E = 5000 lx
2000 lx
1000 lx
500 lx
10^4
10^3
10^2
10
1
1
10
10^2
10^3
10^4
10^5
R_L (Ω)
10^6

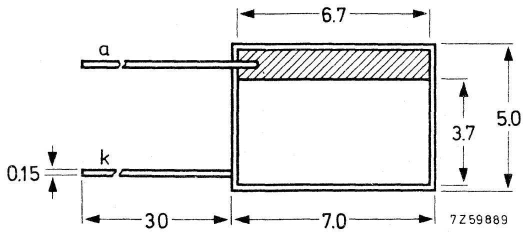

7Z59608
N
(%)
100
50
0
typ
250
500
750
1000
1250
λ(nm)

SILICON PLANAR PHOTO-DIODE

Unencapsulated photo-diode for general purpose applications.

QUICK REFERENCE DATA				
Reverse voltage	V_R	max.	12	V
Light sensitivity V_R = 10 V; E = 1000 lx	N	typ.	**120**	nA/lx
Dark reverse current at V_R = 10 V	I_d	<	5	µA
Peak spectral response	λ_m	typ.	800	nm

MECHANICAL DATA Dimensions in mm



Slice thickness 0.27 mm

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

Voltage				
Reverse voltage	V_R	max.	12	V
Currents				
Forward current	I_F	max.	50	mA
Dark reverse current	I_R	max.	20	mA
Temperatures				
Storage temperature	T_{stg}	−65 to +125		^{o}C
Junction temperature	T_j	max.	125	^{o}C

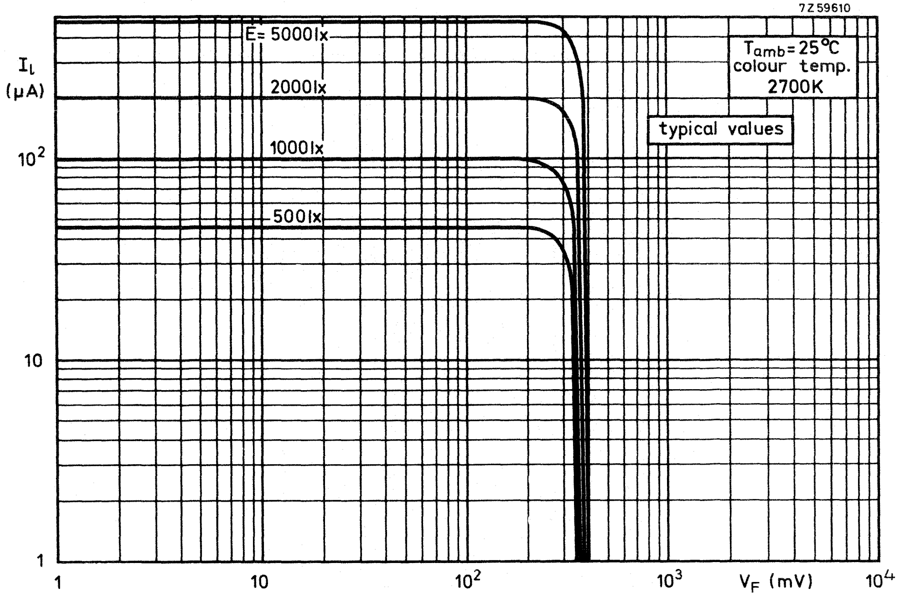
THERMAL RESISTANCE

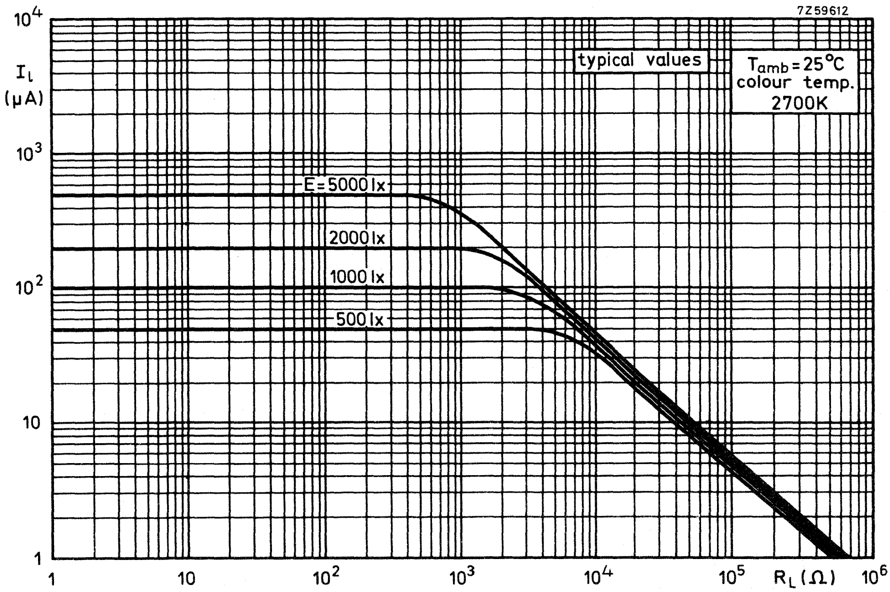
From junction to ambient in free air	$R_{th\ j\text{-}a}$	=	0.3	$^{o}C/mW$

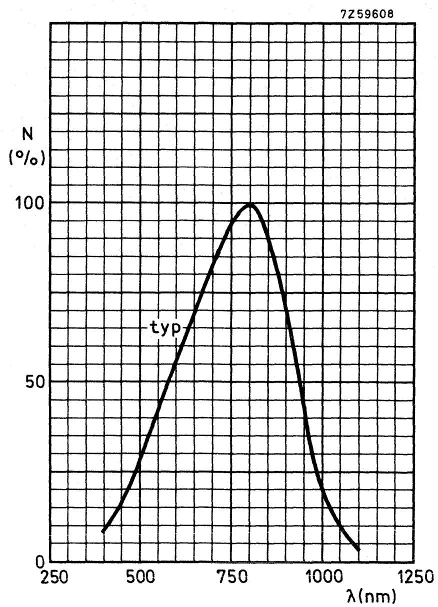
CHARACTERISTICS T_{amb} = 25 ^{o}C unless otherwise specified

Dark reverse current				
V_R = 10 V	I_d	typ.	0.1	µA
		$<$	5.0	µA
V_R = 10 V; T_{amb} = 100 ^{o}C	I_d	typ.	6.0	µA
		$<$	100	µA
Light reverse current; V = 0				
E = 1000 lx; colour temperature = 2700 K	I_l	$>$	80	µA
		typ.	100	µA
Forward voltage; I = 0				
E = 1000 lx; colour temperature = 2700 K	V_F	$>$	330	mV
		typ.	350	mV
Light sensitivity [1]				
V_R = 10 V; E = 1000 lx; colour temperature = 2700 K	N	$>$	100	nA/lx
		typ.	120	nA/lx
Peak spectral response	λ_m	typ.	800	nm
Diode capacitance; f = 500 kHz				
V_R = 10 V	C_d	typ.	1000	pF
V_R = 0	C_d	typ.	3000	pF

[1]) The value of light current increases with temperature equal to the increase in dark current.


7Z59610
I_L
(μA)
10^2
10
1
1
10
10^2
10^3
V_F (mV)
10^4
E= 5000 lx
2000 lx
1000 lx
500 lx
T_{amb} = 25 °C
colour temp.
2700K
typical values


7Z59612
10^4
I_L
(μA)
10^3
10^2
10
1
1
10
10^2
10^3
10^4
10^5
R_L (Ω)
10^6
typical values
T_{amb} = 25 °C
colour temp.
2700K
E= 5000 lx
2000 lx
1000 lx
500 lx


7Z59608
N
(%)
100
50
0
typ
250
500
750
1000
1250
λ(nm)

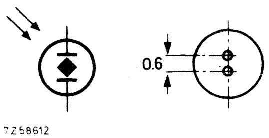
SILICON DUO PHOTO DIODE

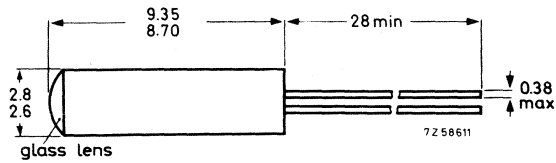
Silicon diffused photo-diode in a 2.8 mm diameter envelope with a glass lens.
The duo-diode construction makes this device independent of voltage polarity.

QUICK REFERENCE DATA				
Diode voltage (bidirectional)	V	max.	100	V
Dark current at V = 50 V; T_j = 25 °C	I_d	<	50	nA
Sensitivity at V = 50 V	N	typ.	0.2	µA/lx
Current rise time	t_{ri}	typ.	11	µs
Peak spectral response	λ_m	typ.	980	nm

MECHANICAL DATA

Dimensions in mm





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

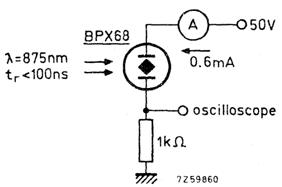
Voltage				
Diode voltage (bidirectional)	V	max.	100	V
Power dissipation				
Total power dissipation up to T_{amb} = 25 °C	P_{tot}	max.	80	mW
Temperatures				
Storage temperature	T_{stg}	−65 to	+125	°C
Junction temperature	T_j	max.	125	°C

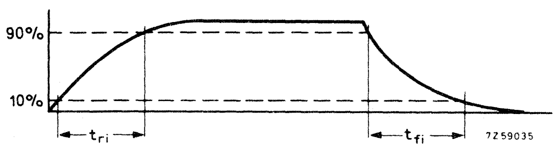
THERMAL RESISTANCE

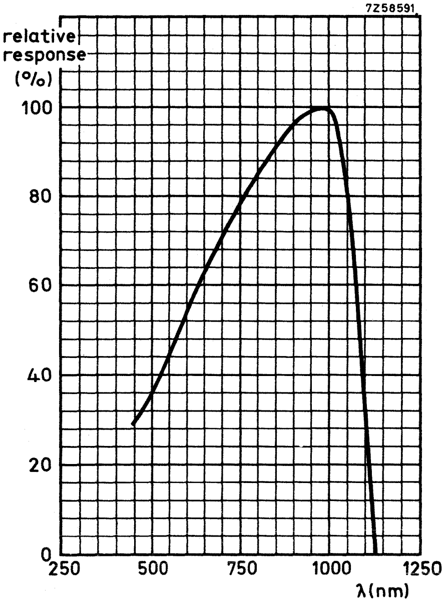
From junction to ambient	$R_{th\ j-a}$	=	1.25	°C/mW
From junction to case	$R_{th\ j-c}$	=	0.40	°C/mW

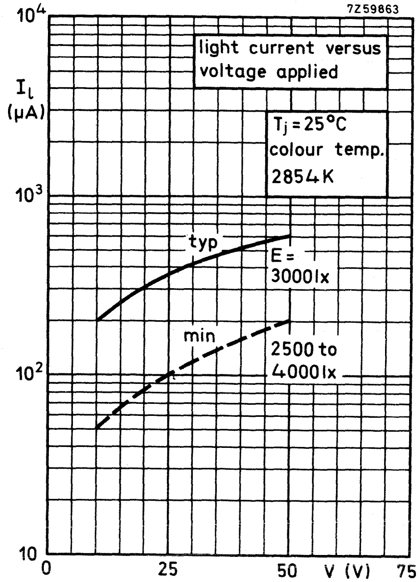
CHARACTERISTICS T_j = 25 °C unless otherwise specified

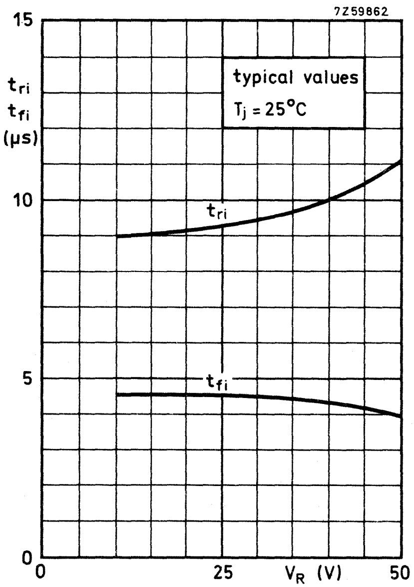
Dark current				
V = 100 V	I_d	typ.	18	nA
		<	10	µA
V = 50 V	I_d	typ.	7	nA
		<	50	nA
V = 50 V; T_j = 100 °C	I_d	typ.	10	µA
		<	100	µA
V = 50 V; T_j = 125 °C	I_d	typ.	100	µA
Light current				
V = 50 V; colour temperature = 2854 K				
E = 2500 to 4000 lx	I_l	>	0.2	mA
E = 3000 lx	I_l	typ.	0.6	mA
Capacitance				
V = 0	C	typ.	12	pF
V = 50 V	C	typ.	3.5	pF
Sensitivity				
V = 50 V; colour temperature = 2854 K				
E = 2500 to 4000 lx	N	>	0.08	µA/lx
E = 3000 lx	N	typ.	0.20	µA/lx
Current rise time see drawings below				
V = 50 V	t_{ri}	typ.	11	µs
Current fall time see drawings below				
V = 50 V	t_{fi}	typ.	4	µs

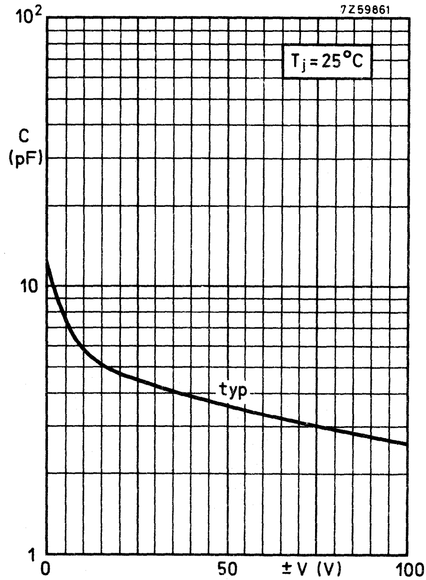


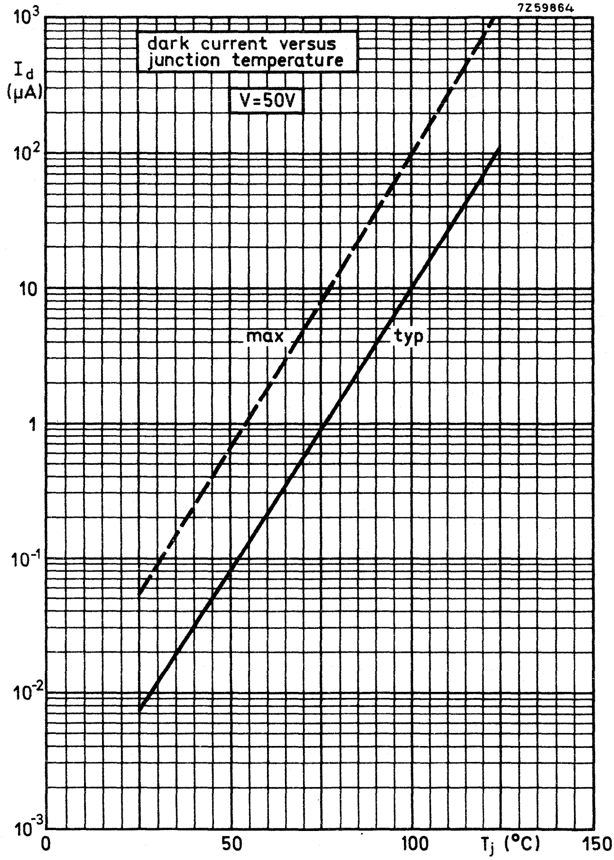



7Z58591
relative response (%)
100
80
60
40
20
0
250
500
750
1000
1250
λ(nm)


7Z59863
10^4
I_l (μA)
light current versus voltage applied
$T_j = 25°C$
colour temp. 2854 K
10^3
typ
E = 3000 lx
min
2500 to 4000 lx
10^2
10
0
25
50
V (V)
75


7Z59862
15
t_{ri}
t_{fi}
(μs)
typical values
$T_j = 25°C$
10
t_{ri}
5
t_{fi}
0
0
25
V_R (V)
50


7Z59861
10^2
C (pF)
$T_j = 25°C$
10
typ
1
0
50
±V (V)
100


7Z59864
dark current versus
junction temperature
V=50V
I_d
(μA)
10^3
10^2
10
1
10^{-1}
10^{-2}
10^{-3}
max
typ
0
50
100
T_j (°C)
150

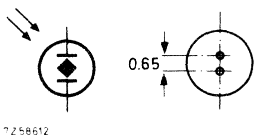
SILICON DUO PHOTO-DIODE

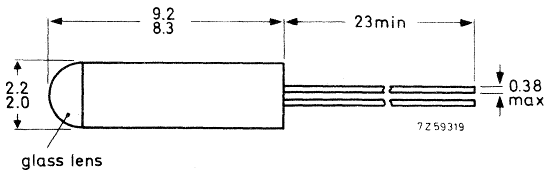
Silicon diffused photo-diode in a 2.2 mm diameter envelope with a glass lens.
The duo-diode construction makes this device independent of voltage polarity.

QUICK REFERENCE DATA				
Diode voltage (bidirectional)	V	max.	100	V
Dark current at V = 50 V; T_j = 25 °C	I_d	<	50	nA
Sensitivity at V = 50 V	N	typ.	0.28	µA/lx
Current rise time	t_{ri}	typ.	13	µs
Peak spectral response	λ_m	typ.	980	nm

MECHANICAL DATA

Dimensions in mm





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

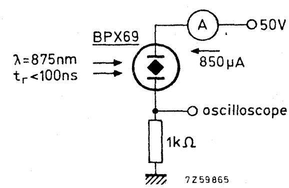
Voltage				
Diode voltage (bidirectional)	V	max.	100	V
Power dissipation				
Total power dissipation up to T_{amb} = 25 °C	P_{tot}	max.	80	mW
Temperatures				
Storage temperature	T_{stg}	−65 to	+125	°C
Junction temperature	T_j	max.	125	°C

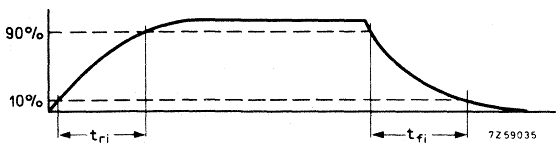
THERMAL RESISTANCE

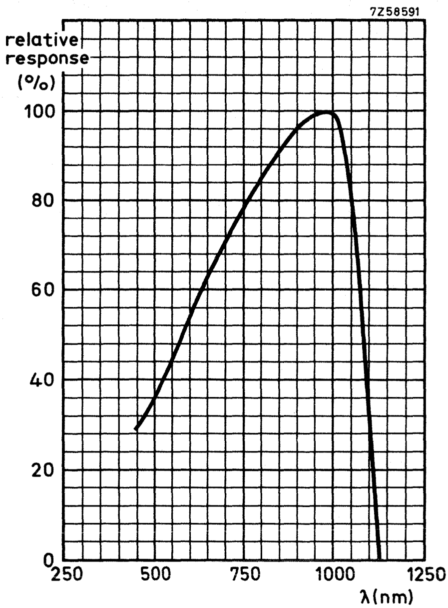
From junction to ambient	$R_{th\ j-a}$	=	1.25	°C/mW
From junction to case	$R_{th\ j-c}$	=	0.40	°C/mW

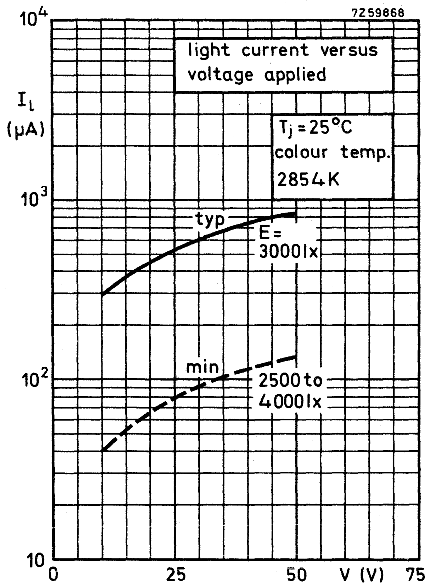
CHARACTERISTICS T_j = 25 °C unless otherwise specified

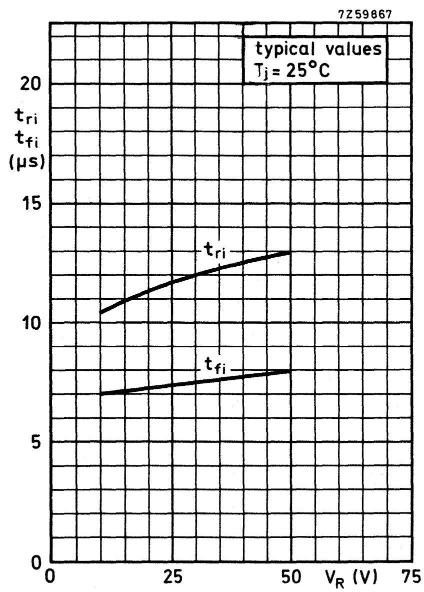
Dark current				
V = 100 V	I_d	typ.	10	nA
		<	10	µA
V = 50 V	I_d	typ.	4	nA
		<	50	nA
V = 50 V; T_j = 100 °C	I_d	typ.	11	µA
		<	100	µA
V = 50 V; T_j = 125 °C	I_d	typ.	110	µA
Light current				
V = 50 V; colour temperature = 2854 K				
E = 2500 to 4000 lx	I_l	>	125	µA
E = 3000 lx	I_l	typ.	850	µA
Capacitance				
V = 0	C	typ.	11.5	pF
V = 50 V	C	typ.	3.6	pF
Sensitivity				
V = 50 V; colour temperature = 2854 K				
E = 2500 to 4000 lx	N	>	0.05	µA/lx
E = 3000 lx	N	typ.	0.28	µA/lx
Current rise time see drawings below				
V = 50 V	t_{ri}	typ.	13	µs
Current fall time see drawings below				
V = 50 V	t_{fi}	typ.	8	µs

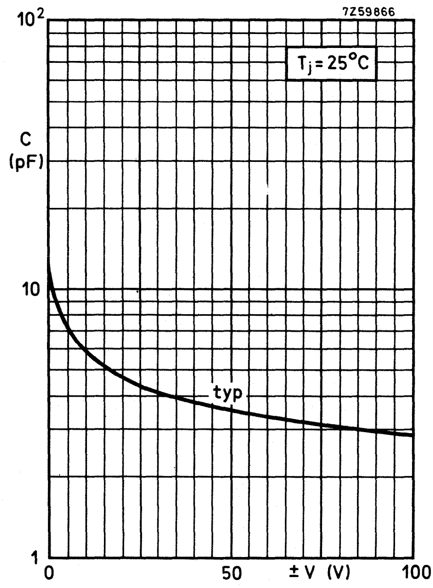


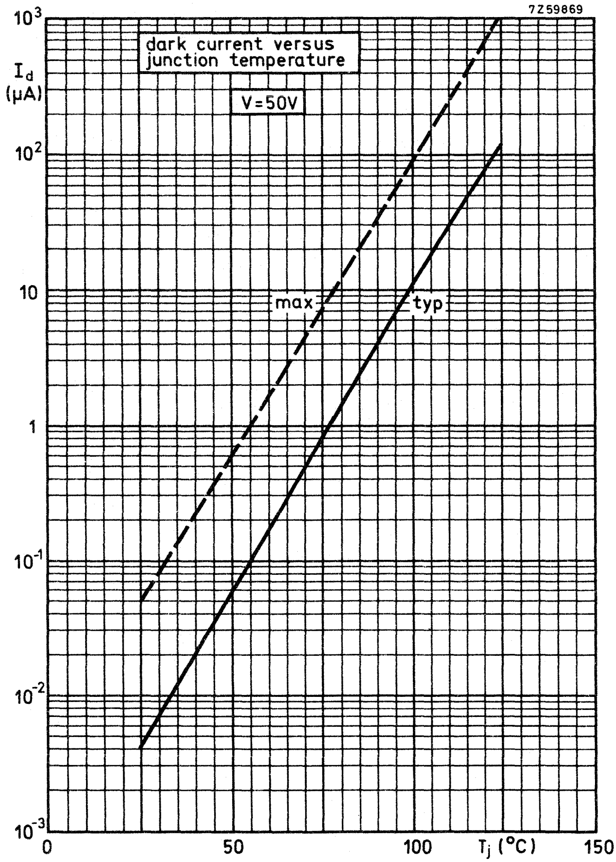



7Z58591
relative response (%)
100
80
60
40
20
0
250
500
750
1000
1250
λ(nm)


7Z59868
light current versus voltage applied
T_j = 25°C
colour temp.
2854K
I_L (μA)
typ
E = 3000lx
min
2500 to 4000lx
V (V)


7Z59867
typical values
T_j = 25°C
t_{ri}
t_{fi}
(μs)
V_R (V)


7Z59866
T_j = 25°C
C (pF)
typ
± V (V)

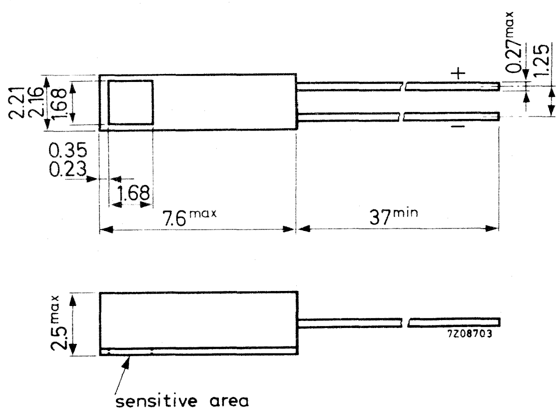

7Z59869
dark current versus
junction temperature
V=50V
I_d
(μA)
10^3
10^2
10
1
10^{-1}
10^{-2}
10^{-3}
max
typ
0
50
100
T_j (°C)
150

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



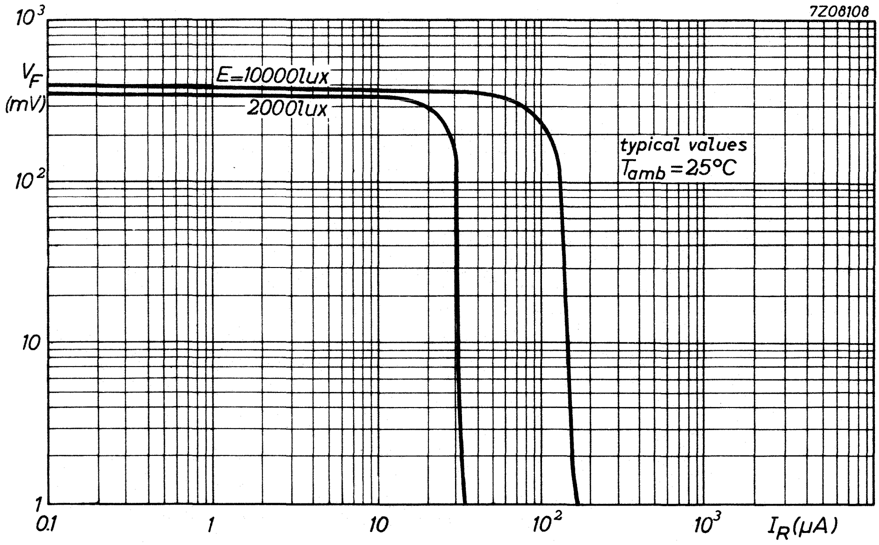
RATINGS (Limiting values) [1])

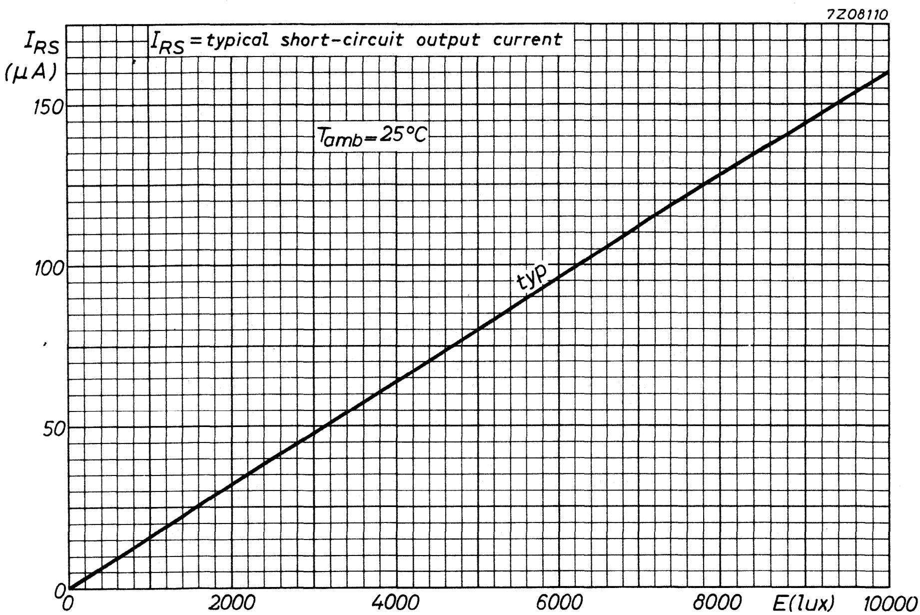
Reverse voltage	V_R	max.	1	V
Forward current	I_F	max.	10	mA
Temperatures				
Storage temperature	T_{stg}	−20 to +100		°C
Junction temperature	T_j	max.	100	°C

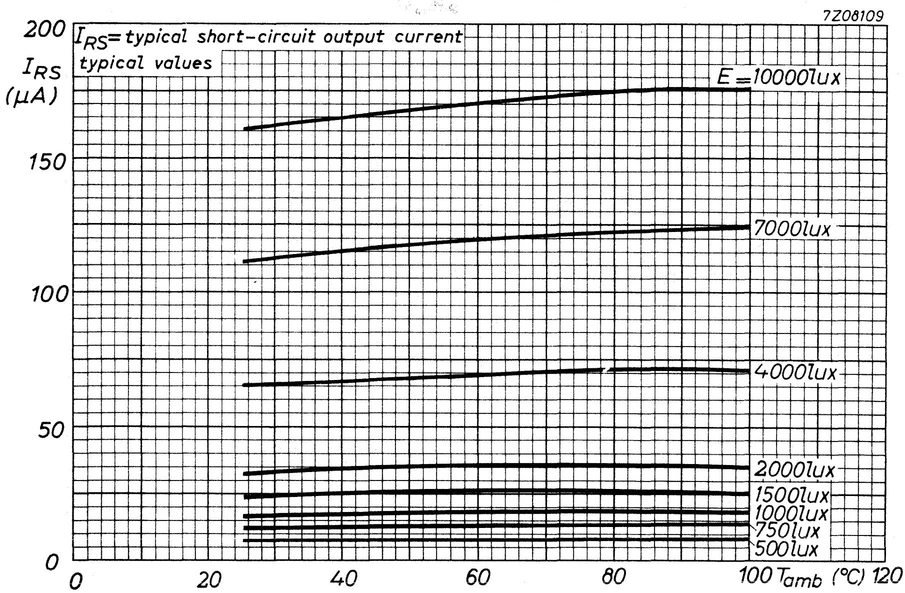
CHARACTERISTICS T_{amb} = 25 °C unless otherwise specified

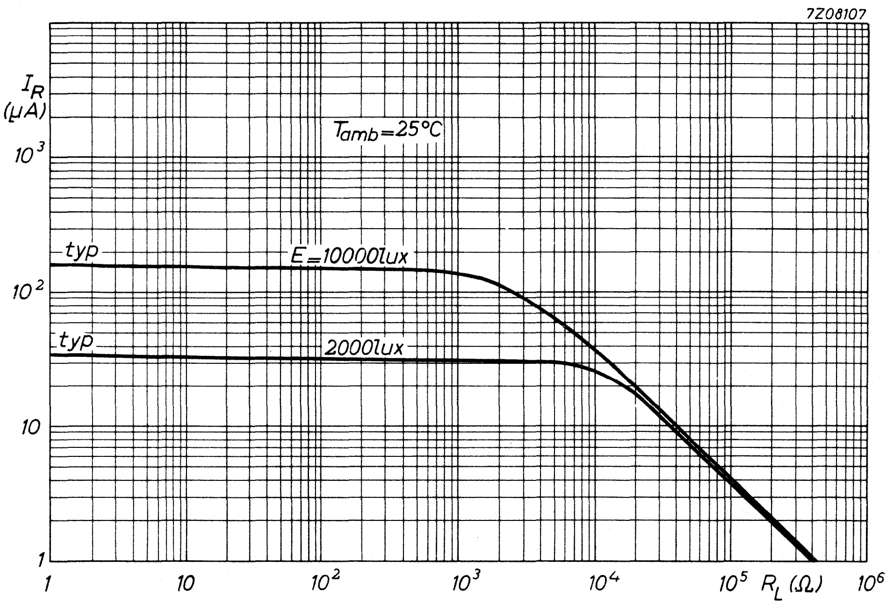
Dark reverse current				
V_R = 1 V	I_R	typ.	0.35	μA
		<	10	μA
V_R = 1 V; T_{amb} = 75 °C	I_R	<	30	μA
Short circuit current				
Colour temperature 2700 °K				
E = 2 000 lux	I_{RS}	typ.	32	μA
		15 to	50	μA
E = 10 000 lux	I_{RS}	typ.	160	μA
Peak spectral response	λ_m	typ.	0.8	μm
Sensitive area		typ.	2.8	mm^2
Diode capacitance at V = 0	C_d	<	1000	pF

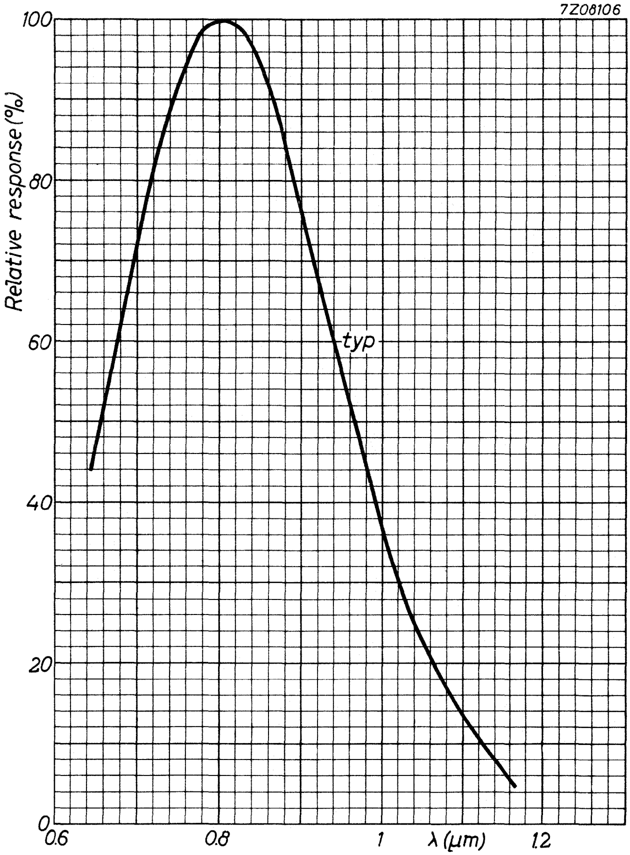
[1]) Limiting values according to the Absolute Maximum System as defined in IEC publication 134.

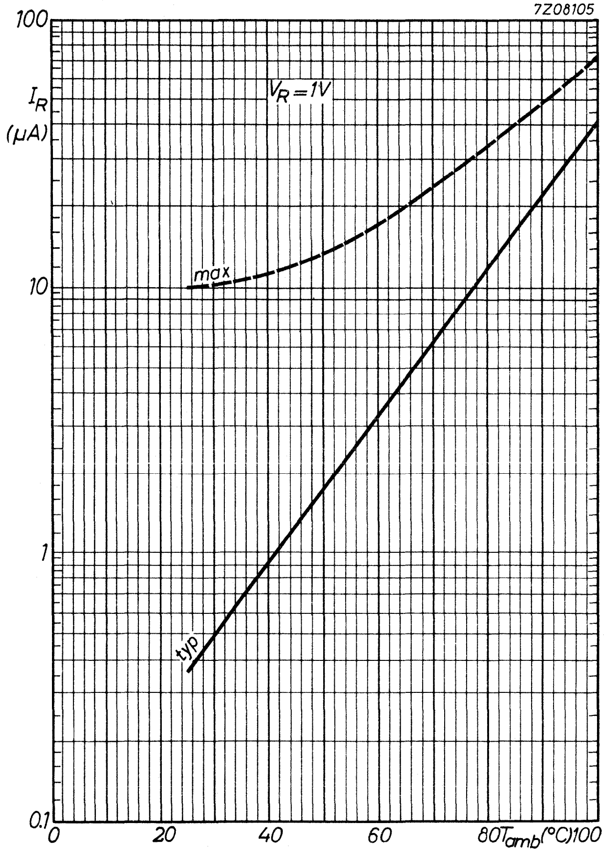

7Z08108
V_F (mV)
E=10000lux
2000lux
typical values
T_{amb} = 25°C
I_R (μA)


7Z08110
I_{RS} (μA)
I_{RS} = typical short-circuit output current
T_{amb} = 25°C
typ
E(lux)


7Z08109
I_{RS} = typical short-circuit output current
typical values
I_{RS} (μA)
200
150
100
50
0
E = 10000 lux
7000 lux
4000 lux
2000 lux
1500 lux
1000 lux
750 lux
500 lux
0
20
40
60
80
100
120
T_{amb} (°C)


7Z08107
I_R (μA)
T_{amb} = 25 °C
10^3
10^2
10
1
typ
E = 10000 lux
typ
2000 lux
1
10
10^2
10^3
10^4
10^5
R_L (Ω)
10^6


7Z08106
Relative response (%)
100
80
60
40
20
0
typ
0.6
0.8
1
λ (μm)
1.2


7Z08105
100
I_R
(μA)
$V_R = 1V$
max
10
1
typ
0.1
0
20
40
60
80
T_{amb} (°C)
100

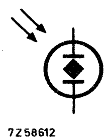
SILICON DUO PHOTO-DIODE

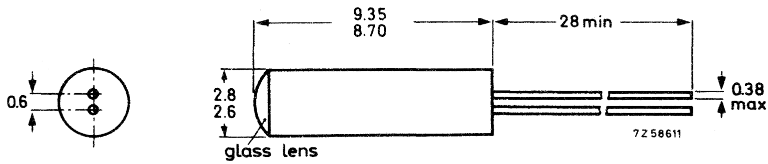
Silicon diffused photo-diode in a 2.8 mm diameter envelope with a glass lens. The duo-diode construction makes this device independent of voltage polarity.

QUICK REFERENCE DATA				
Diode voltage (bidirectional)	V	max.	60	V
Dark current at V = 50 V; T_j = 25 °C	I_d	<	50	nA
Sensitivity at V = 50 V	N	typ.	0.5	μA/lx
Current rise time	t_{ri}	typ.	17	μs
Peak spectral response	λ_m	typ.	980	nm

MECHANICAL DATA

Dimensions in mm





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

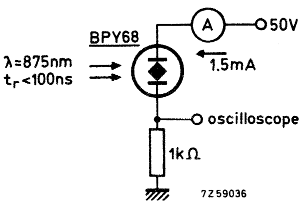
Voltage				
Diode voltage (bidirectional)	V	max.	60	V
Power dissipation				
Total power dissipation up to T_{amb} = 25 ^oC	P_{tot}	max.	80	mW
Temperatures				
Storage temperature	T_{stg}	-65 to +125		^oC
Junction temperature	T_j	max.	125	^oC

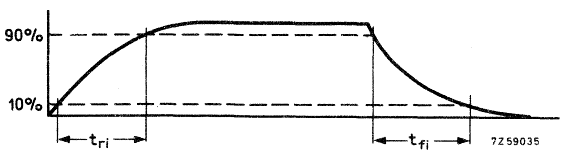
THERMAL RESISTANCE

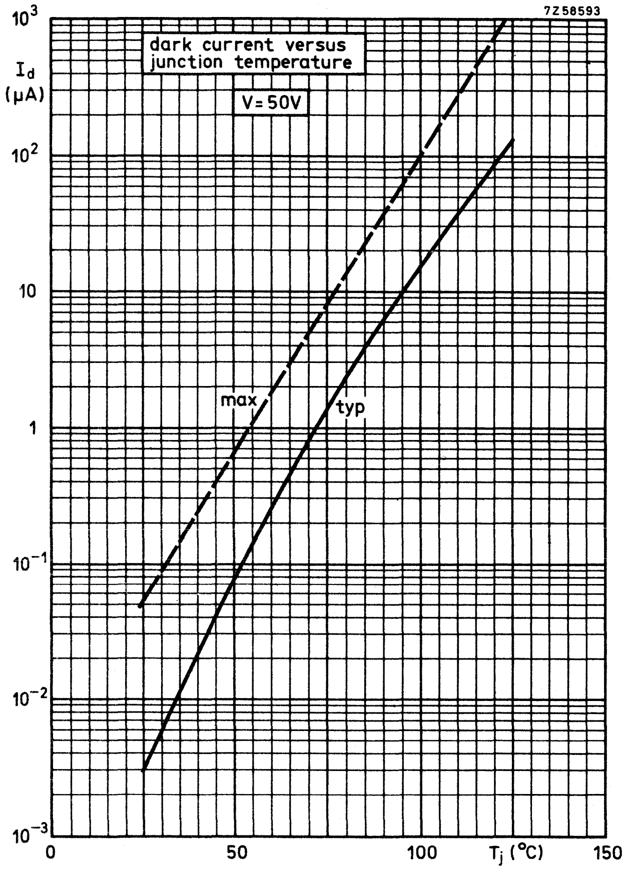
From junction to ambient	$R_{th\ j-a}$	=	1.25	$^oC/mW$
From junction to case	$R_{th\ j-c}$	=	0.40	$^oC/mW$

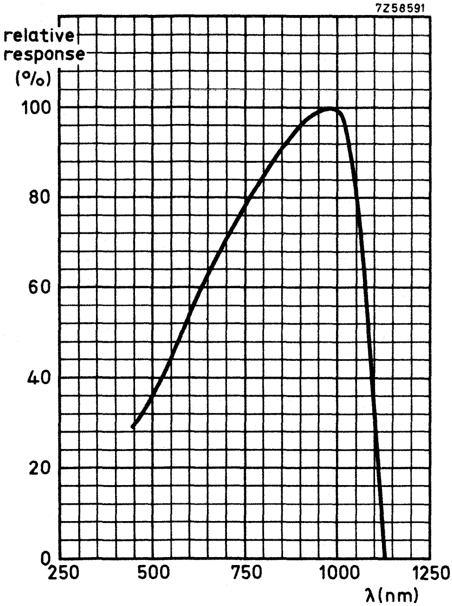
CHARACTERISTICS T_j = 25 °C unless otherwise specified

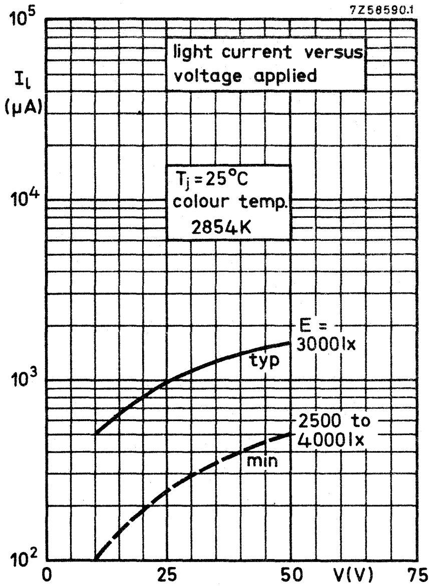
Dark current				
V = 60 V	I_d	typ.	3.5	nA
		<	10	µA
V = 50 V	I_d	typ.	3	nA
		<	50	nA
V = 50 V; T_j = 100 °C	I_d	typ.	15	µA
		<	100	µA
V = 50 V; T_j = 125 °C	I_d	typ.	120	µA
Light current				
V = 50 V; colour temperature = 2854 K				
E = 2500 to 4000 lx	I_l	>	0.5	mA
E = 3000 lx	I_l	typ.	1.5	mA
Capacitance				
V = 0	C	typ.	12	pF
V = 50 V	C	typ.	3.5	pF
Sensitivity				
V = 50 V; colour temperature = 2854 K				
E = 2500 to 4000 lx	N	>	0.20	µA/lx
E = 3000 lx	N	typ.	0.50	µA/lx
Current rise time see drawings below				
V = 50 V	t_{ri}	typ.	17	µs
Current fall time see drawings below				
V = 50 V	t_{fi}	typ.	10	µs

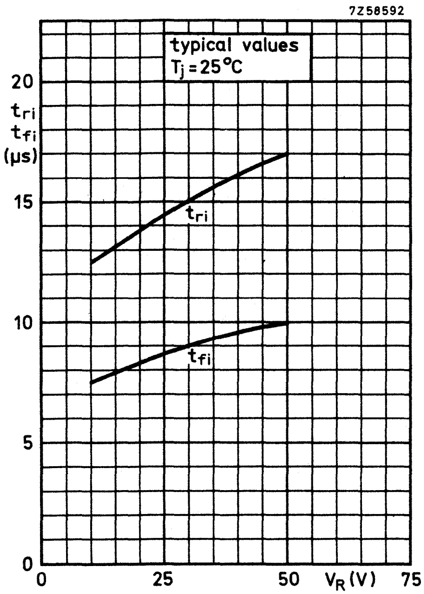


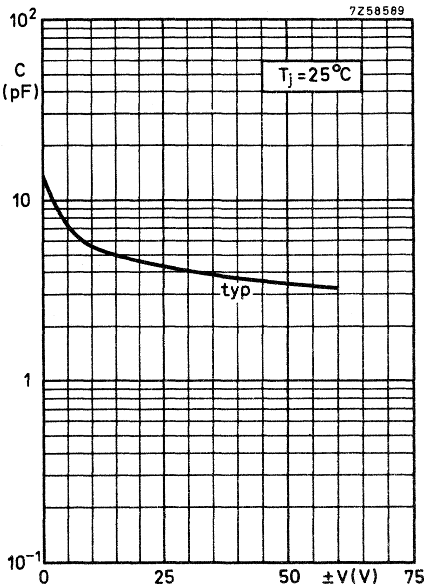



7Z58593
dark current versus
junction temperature
V = 50V
I_d
(μA)
10^3
10^2
10
1
10^{-1}
10^{-2}
10^{-3}
max
typ
0
50
100
T_j (°C)
150


7Z58591
relative response (%)
100
80
60
40
20
0
250
500
750
1000
1250
λ(nm)


7Z58590.1
10^5
I_L (µA)
light current versus voltage applied
$T_j = 25°C$ colour temp. 2854K
10^4
10^3
10^2
E = 3000 lx
typ
2500 to 4000 lx
min
0
25
50
V(V)
75


7Z58592
typical values $T_j = 25°C$
20
t_{ri} t_{fi} (µs)
15
10
5
0
t_{ri}
t_{fi}
0
25
50
V_R (V)
75


7Z58589
10^2
C (pF)
$T_j = 25°C$
10
typ
1
10^{-1}
0
25
50
±V(V)
75

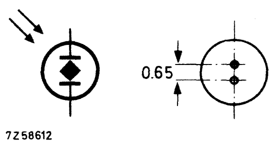
SILICON DUO PHOTO-DIODE

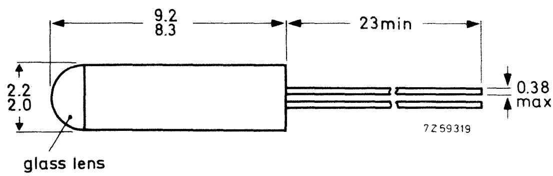
Silicon diffused photo-diode in a 2.2 mm diameter envelope with a glass lens.
The duo-diode construction makes this device independent of voltage polarity.

QUICK REFERENCE DATA				
Diode voltage (bidirectional)	V	max.	60	V
Dark current at V = 50 V; T_j = 25 °C	I_d	<	50	nA
Sensitivity at V = 50 V	N	typ.	0.37	μA/lx
Current rise time	t_{ri}	typ.	16	μs
Peak spectral response	λ_m	typ.	980	nm

MECHANICAL DATA

Dimensions in mm





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

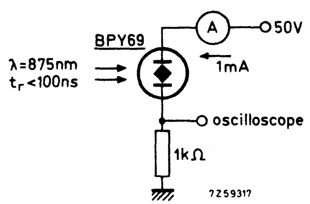
Voltage				
Diode voltage (bidirectional)	V	max.	60	V
Power dissipation				
Total power dissipation up to T_{amb} = 25 °C	P_{tot}	max	80	mW
Temperatures				
Storage temperature	T_{stg}	−65 to +125		°C
Junction temperature	T_j	max.	125	°C

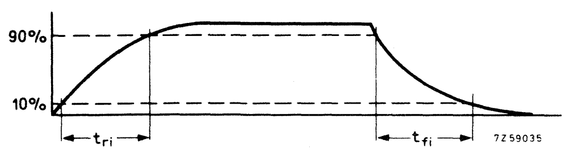
THERMAL RESISTANCE

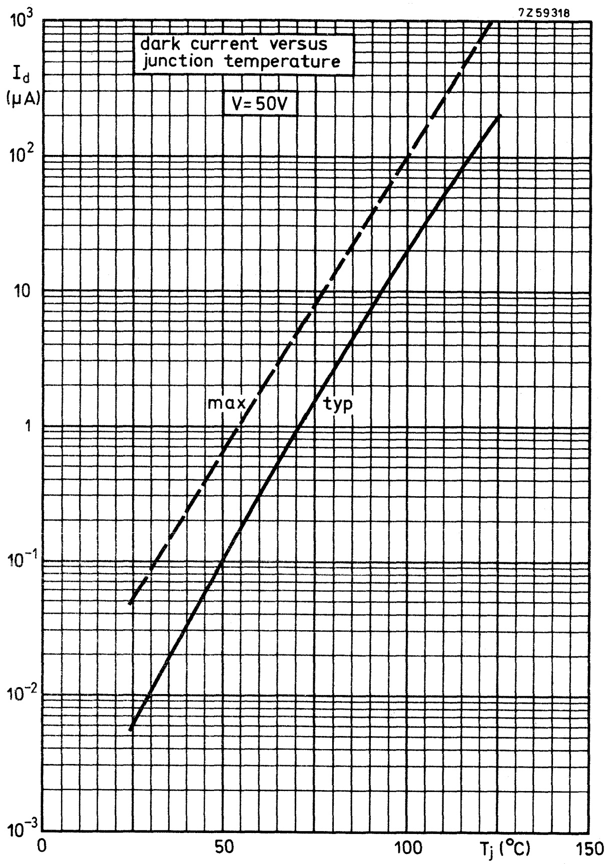
From junction to ambient	$R_{th\ j-a}$	=	1.25	°C/mW
From junction to case	$R_{th\ j-c}$	=	0.40	°C/mW

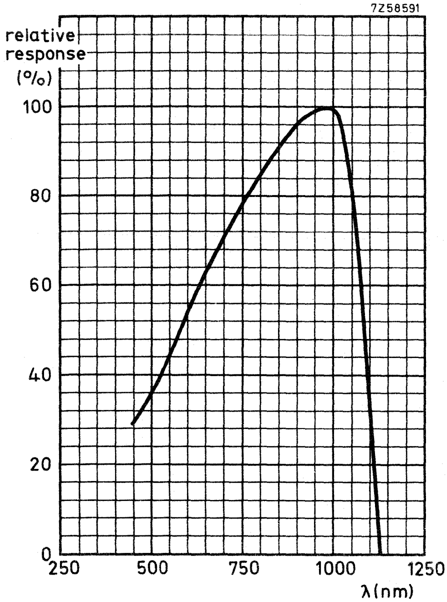
CHARACTERISTICS T_j = 25 °C unless otherwise specified

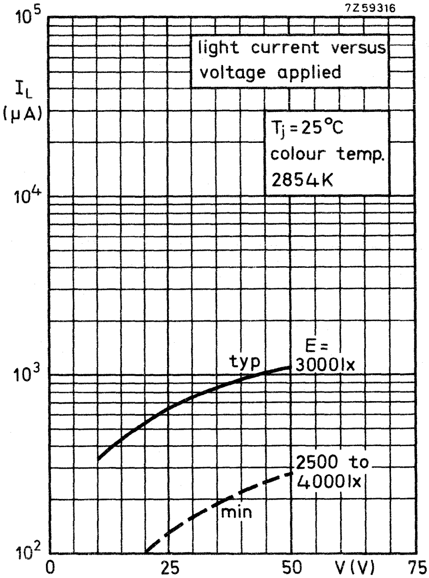
Dark current				
V = 60 V	I_d	typ.	7	nA
		<	10	µA
V = 50 V	I_d	typ.	6	nA
		<	50	nA
V = 50 V; T_j = 100 °C	I_d	typ.	20	µA
		<	100	µA
V = 50 V; T_j = 125 °C	I_d	typ.	200	µA
Light current				
V = 50 V; colour temperature = 2854 K				
E = 2500 to 4000 lx	I_l	>	275	µA
E = 3000 lx	I_l	typ.	1.1	mA
Capacitance				
V = 0	C	typ.	11.5	pF
V = 50 V	C	typ.	3.6	pF
Sensitivity				
V = 50 V; colour temperature = 2854 K				
E = 2500 to 4000 lx	N	>	0.11	µA/lx
E = 3000 lx	N	typ.	0.37	µA/lx
Current rise time see drawings below				
V = 50 V	t_{ri}	typ.	16	µs
Current fall time see drawings below				
V = 50 V	t_{fi}	typ.	10	µs

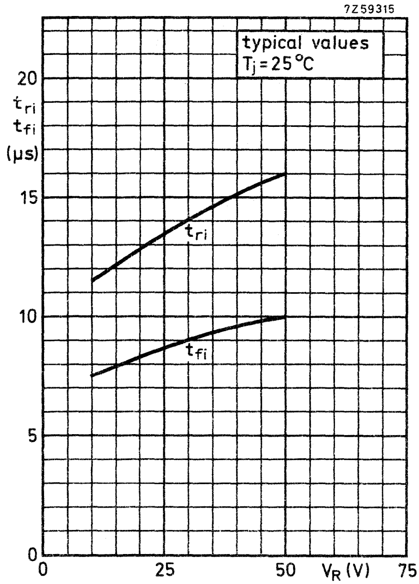


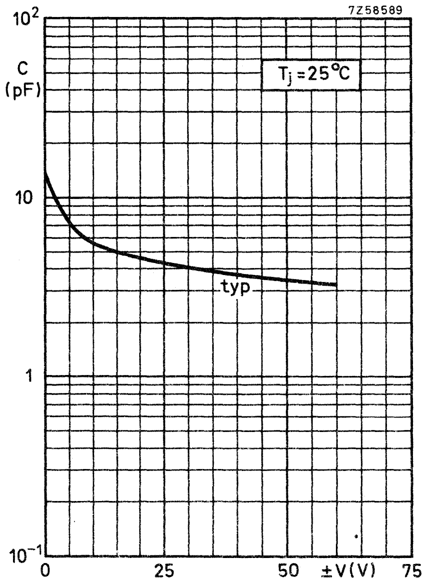



7Z59318
dark current versus
junction temperature
I_d
(μA)
V = 50V
max
typ
10^3
10^2
10
1
10^{-1}
10^{-2}
10^{-3}
0
50
100
T_j (°C)
150


7Z58591
relative response (%)
100
80
60
40
20
0
250
500
750
1000
1250
λ(nm)


7Z59316
light current versus voltage applied
T_j = 25 °C
colour temp. 2854K
I_L (μA)
10^5
10^4
10^3
10^2
typ
E = 3000 lx
2500 to 4000 lx
min
0
25
50
V (V)
75


7Z59315
typical values
T_j = 25 °C
t_{ri}
t_{fi}
(μs)
20
15
10
5
0
t_{ri}
t_{fi}
0
25
50
V_R (V)
75


7Z58589
T_j = 25 °C
C (pF)
10^2
10
1
10^{-1}
typ
0
25
50
±V (V)
75

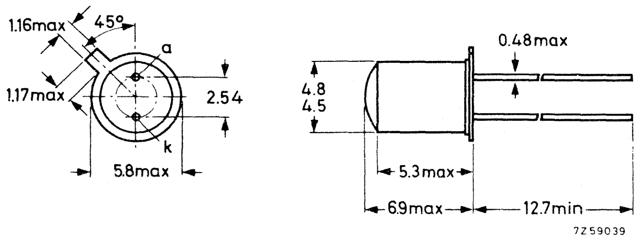
SILICON PHOTO-DIODE

Photo-diode sensitive to visible and infra-red radiation. It is intended for applications up to 1 GHz. The diode is provided with a glass lens.

QUICK REFERENCE DATA				
Reverse voltage	V_R	max.	100	V
Total power dissipation up to T_{case} = 25 °C	P_{tot}	max.	0.5	W
Light current at V_R = 10 V incident radiation: E = 1 mW/cm^2 λ = 770 nm	I_l	typ.	7.5	μA
Dark reverse current at V_R = 10 V	I_d	<	2.0	nA
Current rise time	t_{ri}	typ.	0.5	ns

MECHANICAL DATA

Dimensions in mm



max. lead diameter is guaranteed only for 12.7 mm

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

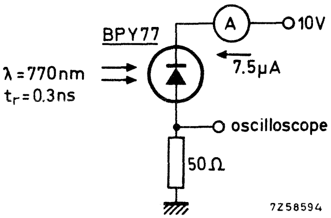
Reverse voltage	V_R	max.	100	V
Total power dissipation up to T_{case} = 25 °C	P_{tot}	max.	0.5	W
Temperatures				
Storage temperature	T_{stg}		−55 to +200	°C
Junction temperature	T_j	max.	200	°C

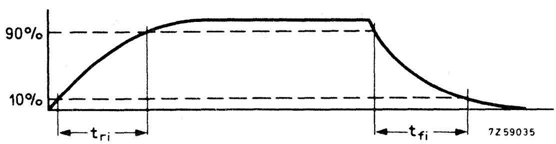
THERMAL RESISTANCE

From junction to ambient in free air	$R_{th\ j-a}$	=	700	°C/W
From junction to case	$R_{th\ j-c}$	=	350	°C/W

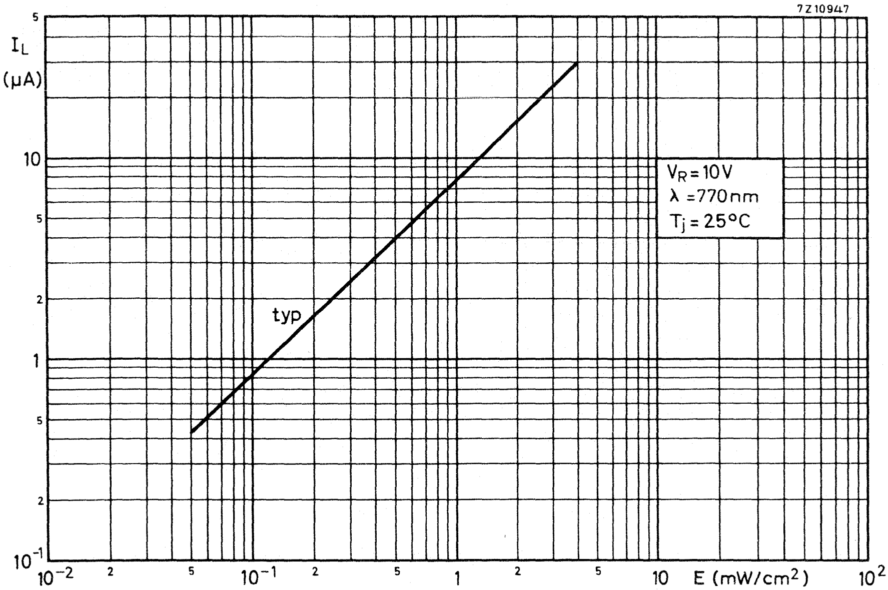
CHARACTERISTICS T_j = 25 °C unless otherwise specified

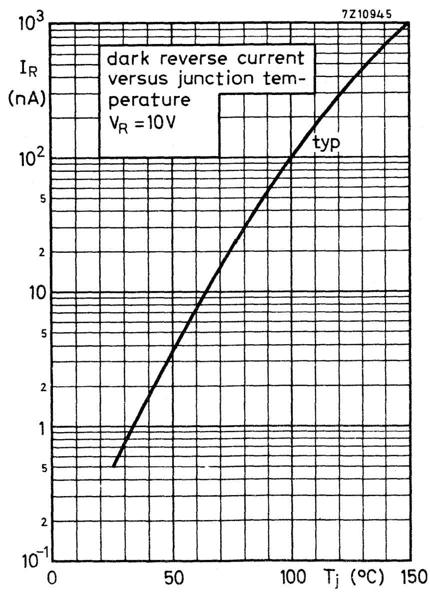
Forward voltage at I_F = 25 mA	V_F	typ.	0.75	V
		<	1.0	V
Dark reverse current at V_R = 10 V	I_d	typ.	0.5	nA
		<	2.0	nA
Light reverse current at V_R = 10 V incident radiation: E = 1 mW/cm^2; λ = 770 nm	I_l	>	1.0	μA
		typ.	7.5	μA
Current rise time see circuit below	t_{ri}	typ.	0.5	ns
Current fall time see circuit below	t_{fi}	typ.	0.6	ns

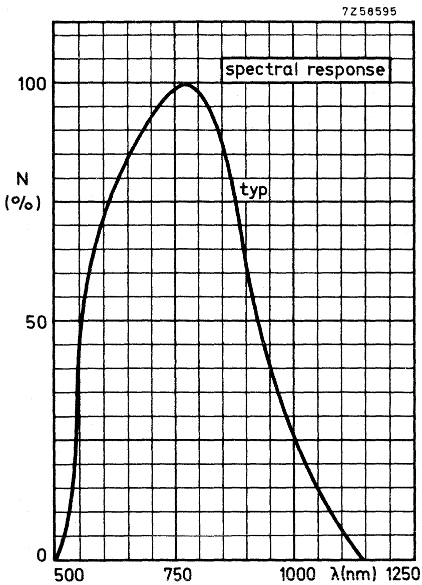


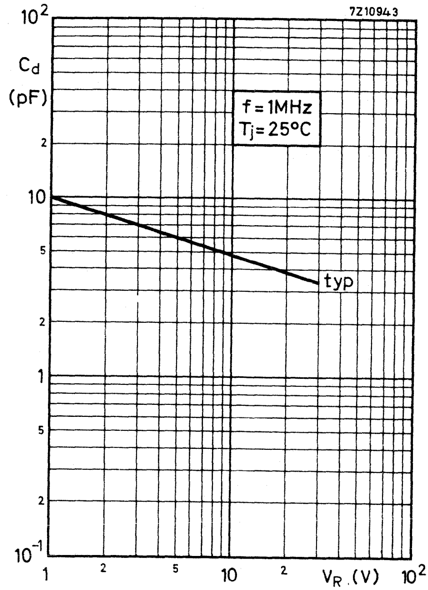


Peak spectral response	λ_m	typ.	770	nm
Diode capacitance at V_R = 10 V; f = 1 MHz	C_d	typ.	4.8	pF


7Z10947
I_L
(μA)
$V_R = 10V$
λ = 770 nm
$T_j = 25°C$
typ
E (mW/cm²)
10
1
5
2
10^{-1}
10^{-2}
10^{-1}
10
10^2


7Z10945
10^3
I_R
(nA)
dark reverse current
versus junction temperature
$V_R = 10V$
typ
10^2
10
1
10^{-1}
0
50
100
T_j (°C)
150


7Z58595
spectral response
100
N
(%)
50
0
typ
500
750
1000
λ(nm)
1250


7Z10943
10^2
C_d
(pF)
f = 1MHz
T_j = 25°C
10
typ
1
10^{-1}
1
10
V_R (V)
10^2

GALLIUM ARSENIDE LIGHT EMITTING DIODE

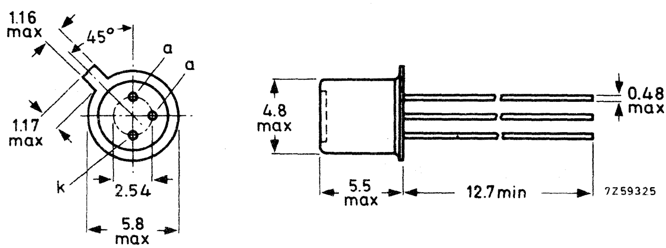
GaAs diode which emit radiation of a narrow spectral band in the near infrared region when forward biased. The device is intended for applications in optical transmission of information in opto-electronic couplers, etc. The diode is provided with a flat glass window.

QUICK REFERENCE DATA				
Forward current (d.c.)	I_F	max.	30	mA
Forward current (peak value)	I_{FM}	max.	0.5	A
Radiation output power per unit current	$\frac{P}{I}$	>	2	mW/A
Rise time of output signal	t_r	typ.	1	ns
Emitted wavelength	λ	typ.	875	nm

MECHANICAL DATA

TO-18, except for window

Dimensions in mm



max. lead diameter is guaranteed only for 12.7 mm.

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

Voltage				
Reverse voltage	V_R	max.	2	V
Currents				
Forward curent (d.c.)	I_F	max.	30	mA
Forward current (peak value)	I_{FM}	max.	0.5	A
Temperatures				
Storage temperature	T_{stg}		−196 to +200	^oC
Junction temperature	T_j		−196 to +200	^oC

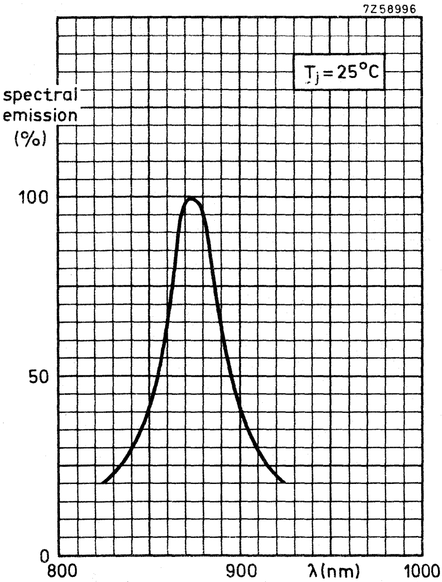
THERMAL RESISTANCE

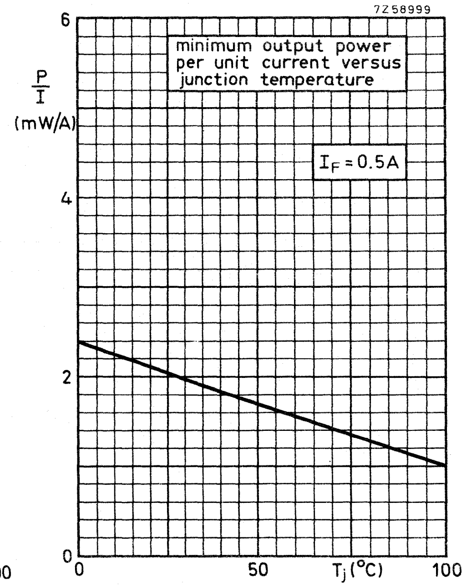
From junction to ambient	$R_{th\ j-a}$	=	570	$^oC/W$
From junction to case	$R_{th\ j-c}$	=	220	$^oC/W$

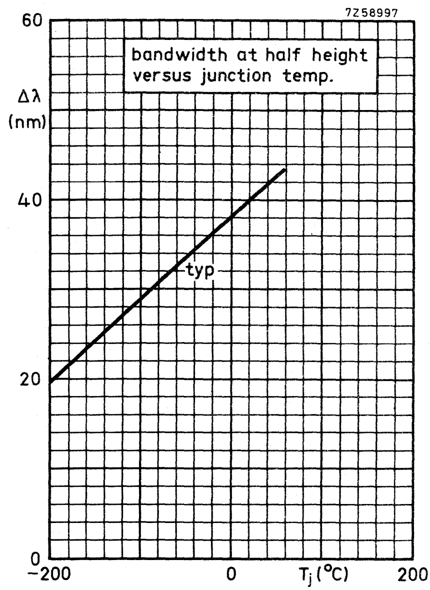
CHARACTERISTICS T_{case} = 25 ^oC unless otherwise specified

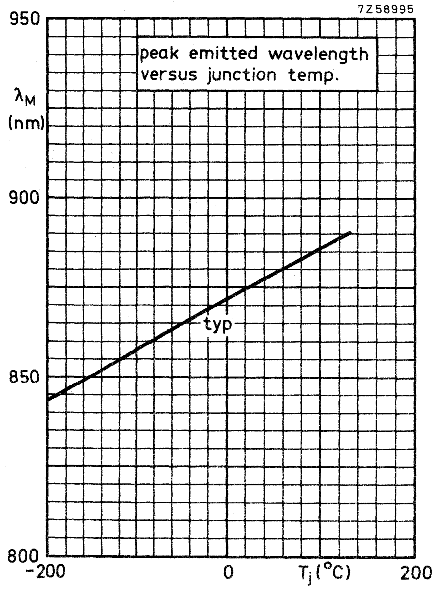
Forward voltage (single pulse < 10 ms)				
I_F = 30 mA	V_F	typ.	1.2	V
		<	1.4	V
I_F = 0.5 A	V_F	typ.	1.5	V
		<	3.0	V
Rise time of output signal	t_r	typ.	1	ns
Emitted wavelength	λ	typ.	875	nm
Bandwidth at half height	$\Delta\lambda$	typ.	40	nm
Radiation output power per unit current [1]				
I_F = 0.5 A	$\frac{P}{I}$	>	2	mW/A
		typ.	3.5	mW/A
Brightness of crystal at I_F = 30 mA		>	300	mW/cm^2
		typ.	450	mW/cm^2
Aperture angle at half height		typ.	20	^{o}
Emissive area of crystal		typ.	10^{-4}	cm^2

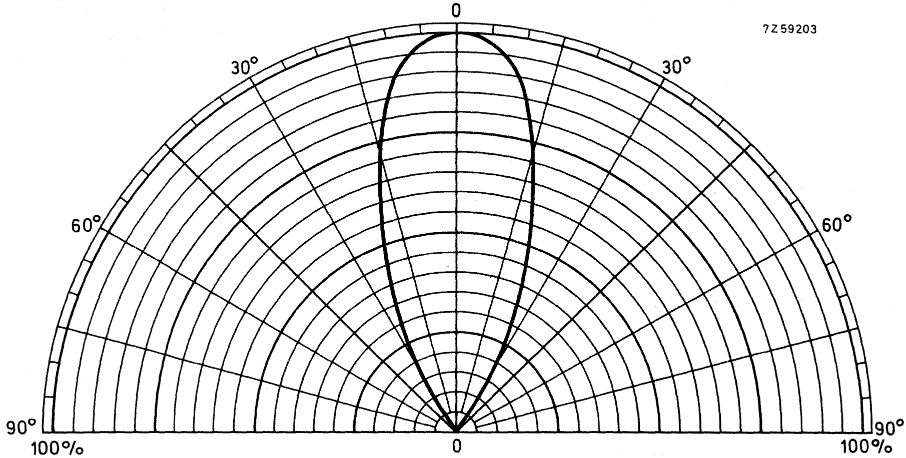
[1]) Measured under pulsed conditions, t_p = 10 μs; δ = 0.01

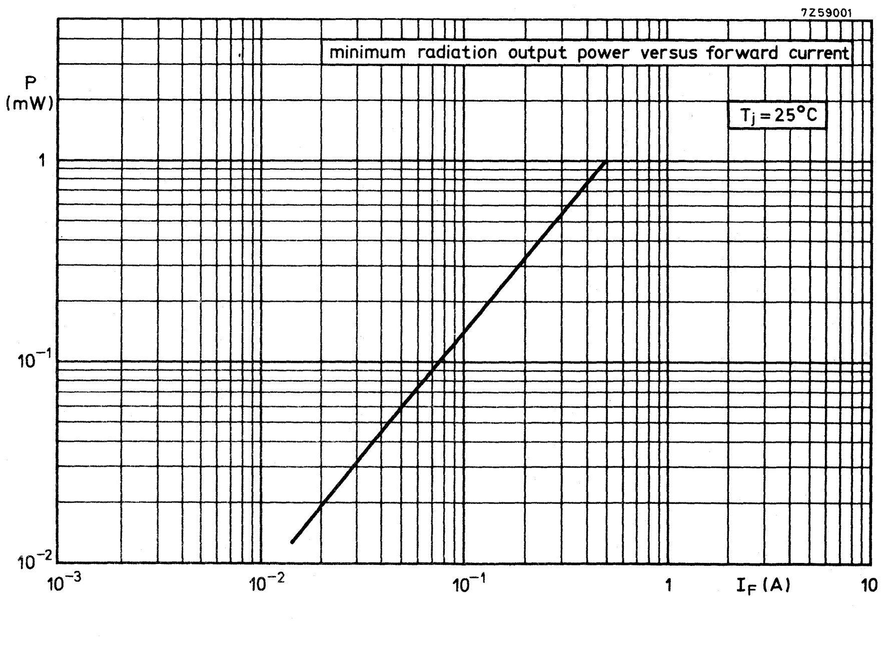

7Z58996
Tj = 25°C
spectral emission (%)
100
50
0
800
900
λ (nm)
1000


7Z58999
minimum output power per unit current versus junction temperature
P/I (mW/A)
IF = 0.5A
6
4
2
0
0
50
Tj (°C)
100


7Z58997
bandwidth at half height versus junction temp.
Δλ (nm)
typ
60
40
20
0
−200
0
Tj (°C)
200


7Z58995
peak emitted wavelength versus junction temp.
λM (nm)
typ
950
900
850
800
−200
0
Tj (°C)
200


0
7Z59203
30°
30°
60°
60°
90°
90°
100%
0
100%


7Z59001
minimum radiation output power versus forward current
P
(mW)
Tj = 25°C
1
10⁻¹
10⁻²
10⁻³
10⁻²
10⁻¹
1
IF (A)
10

Dissipation and heatsink considerations

The graph on page 6 can be used to determine the peak power dissipation and the thermal resistance of the heatsink required under pulse operation of the diode, when the peak pulse current, duty cycle, pulse duration and permissible temperature rise are known.

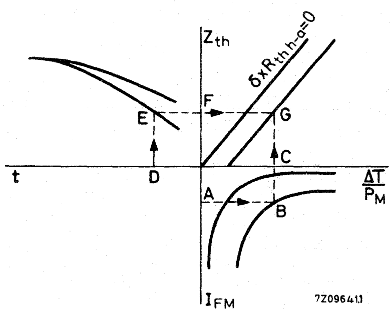


Fig. 1

The thermal relationship under pulse conditions is:

$$\frac{\Delta T}{P_M} = Z_{th} + \delta . R_{th\ h-a}$$

where ΔT = permissible temperature rise = $T_{j\ max.} - T_{amb}$

P_M = peak power dissipation

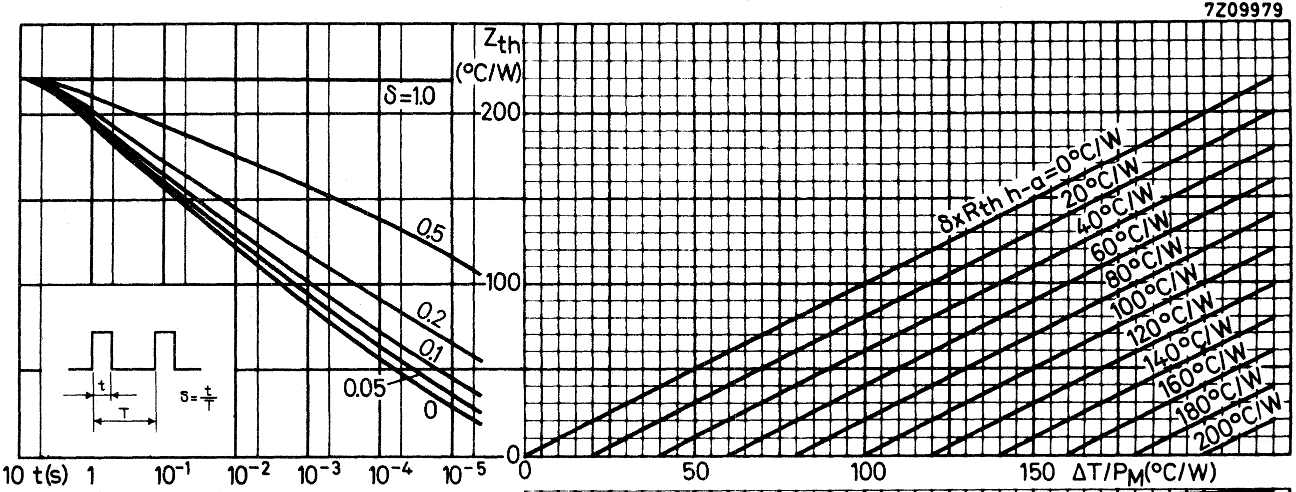
Z_{th} = thermal impedance

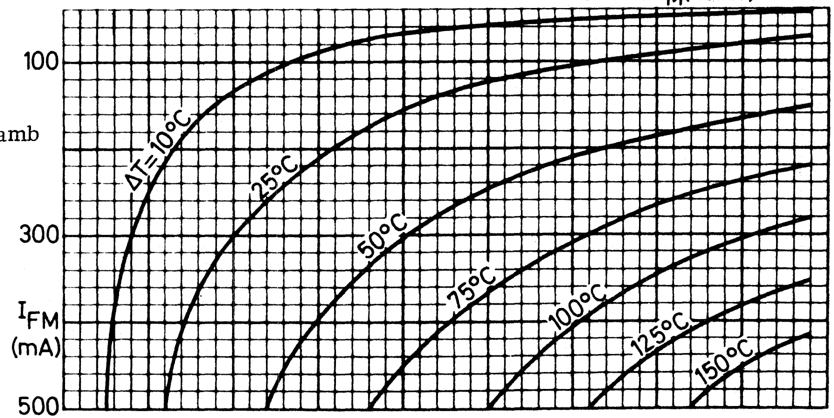
$R_{th\ h-a}$ = heatsink thermal resistance

δ = duty cycle

Fig. 1 is used to illustrate how the graph on page 6 should be used.

1. Starting at a point A in Fig. 1 on the I_{FM} axis trace horizontally until the appropriate ΔT curve is reached at point B.
2. Trace upwards to meet $\Delta T/P_M$ axis at a point C. From this value a maximum permissible peak power dissipation can be calculated.
3. Starting at a point D, on the t axis, trace upwards until the appropriate duty cycle curve is met at a point E.
4. From point E trace horizontally until Z_{th} axis is reached at a point F. This determines the thermal impedance.
5. Finally, produce the lines BC and EF until they cross at a point G, which determines the value of $\delta . R_{th\ h-a}$. From this the required value of thermal resistance of the heatsink can be calculated.
   The line $\delta . R_{th\ h-a} = 0$ can provide the maximum performance you can expect if $R_{th\ h-a} = 0$ (infinite heatsink) or $\delta = 0$ (one pulse only).





$\frac{\Delta T}{P_M} = Z_{th} + \delta . R_{th\ h\text{-}a}$ $\Delta T = T_{j\ max} - T_{amb}$

Z_{th} = thermal impedance
$R_{th\ h\text{-}a}$ = heatsink thermal resistance
t = pulse duration
T = cycle time
P_M = peak power dissipation

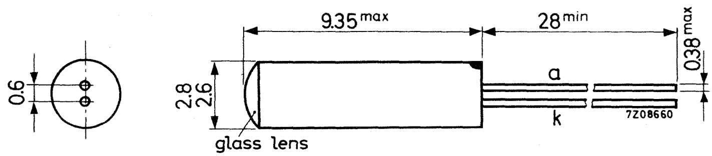
I_{FM} = peak current of the pulse

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	°C
Peak spectral response	λ_m	typ.	1.55	µm

MECHANICAL DATA Dimensions in mm



The coloured dot indicates the anode

RATINGS (Limiting values) [1])

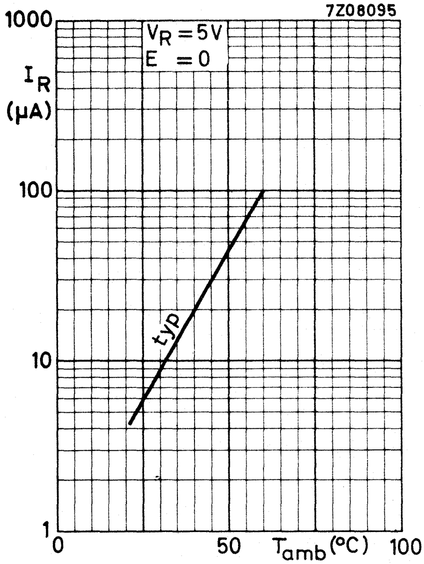
Reverse voltage	V_R	max.	30	V
Reverse current	I_R	max.	3	mA
Total power dissipation	P_{tot}	max.	30	mW

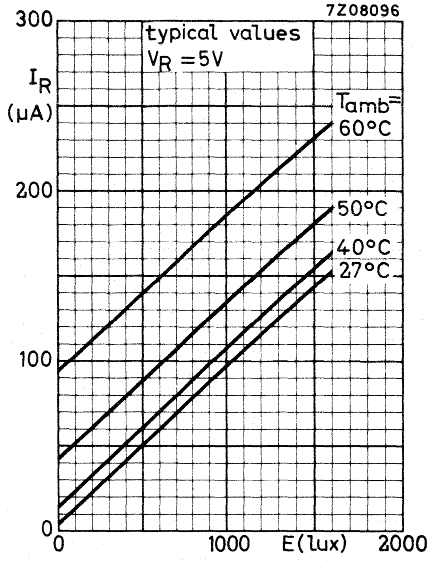
CHARACTERISTICS — T_{amb} = 25 °C and using a lamp of colour temperature 2500 °K

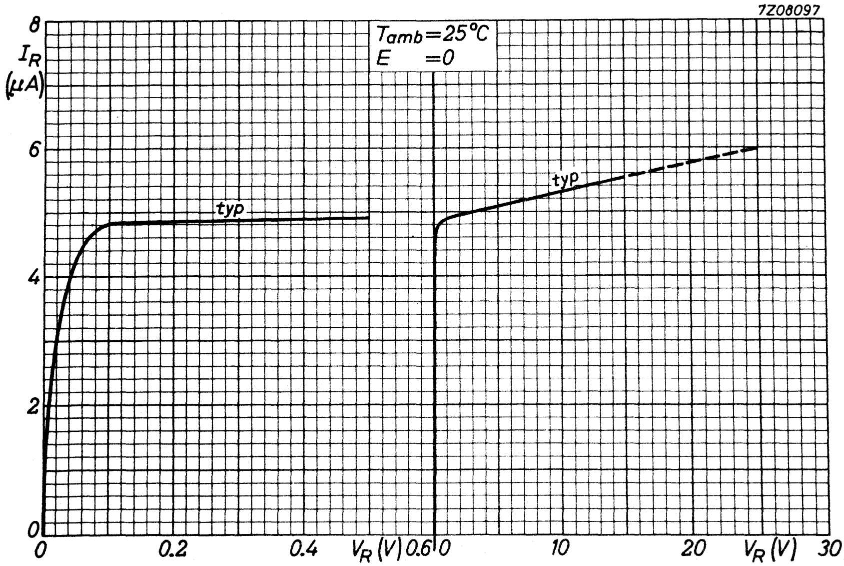
Dark reverse current at V_R = 10 V	I_R	<	15	μA
Noise of the dark current (r.m.s. value) V_R = 10 V; f = 10 kHz; B = 1 Hz		<	3	pA
Diode resistance (V_R = 0.5 to 30 V)	r_D	>	3	MΩ
Cut-off frequency at V_R = 10 V [2])	f_c	typ.	50	kHz
Peak spectral response	λ_m	typ.	1.55	μm
Zero spectral response	λ_0	typ.	2.0	μm
Sensitive area			1	mm^2
Light sensitivity			0.05	μA/lux

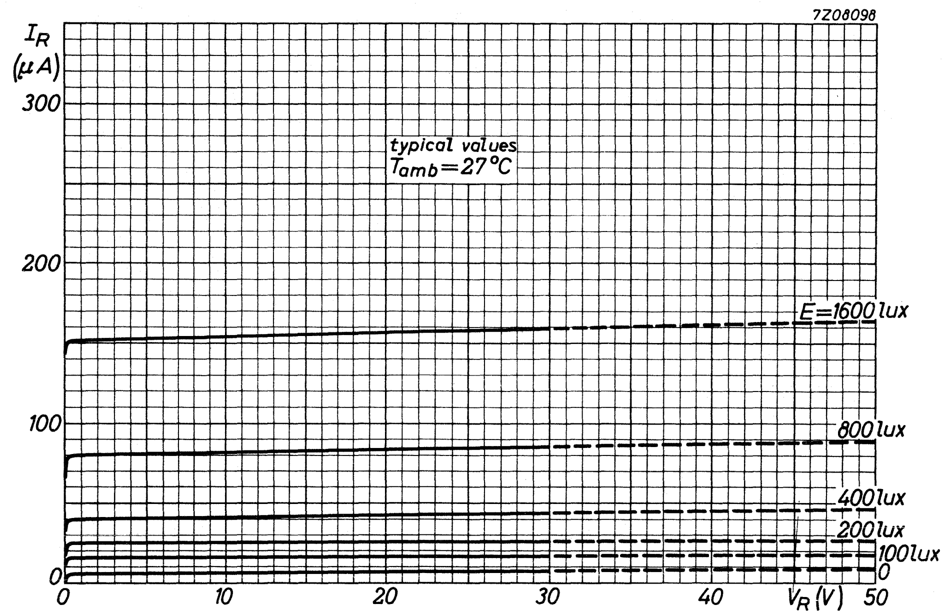
1) Limiting values according to the Absolute Maximum System as defined in IEC publication 134.

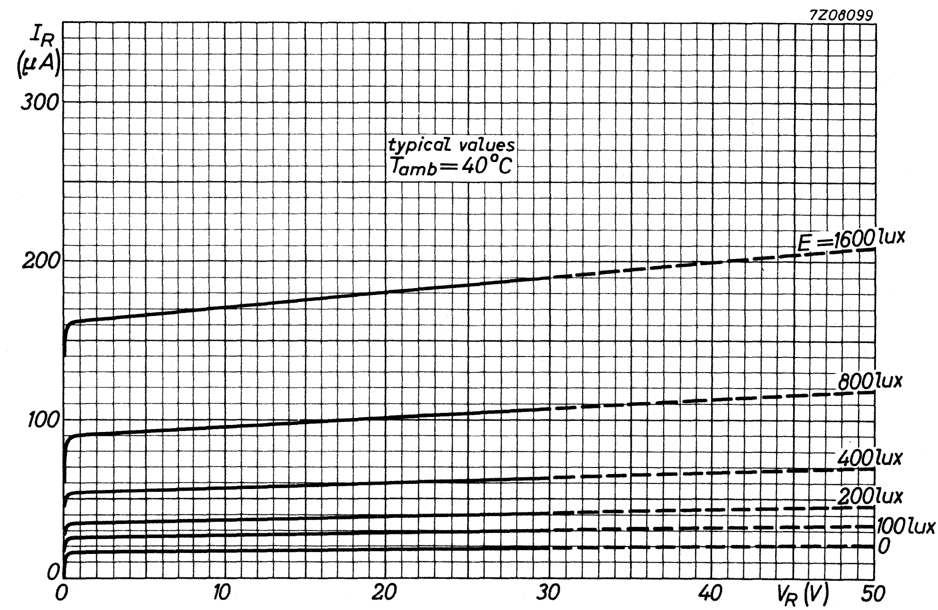
2) Frequency at which the sensitivity is 3 dB below the reference sensitivity, the latter being measured at V_R = 10 V; f = 1 kHz; T_{amb} = 20 °C.

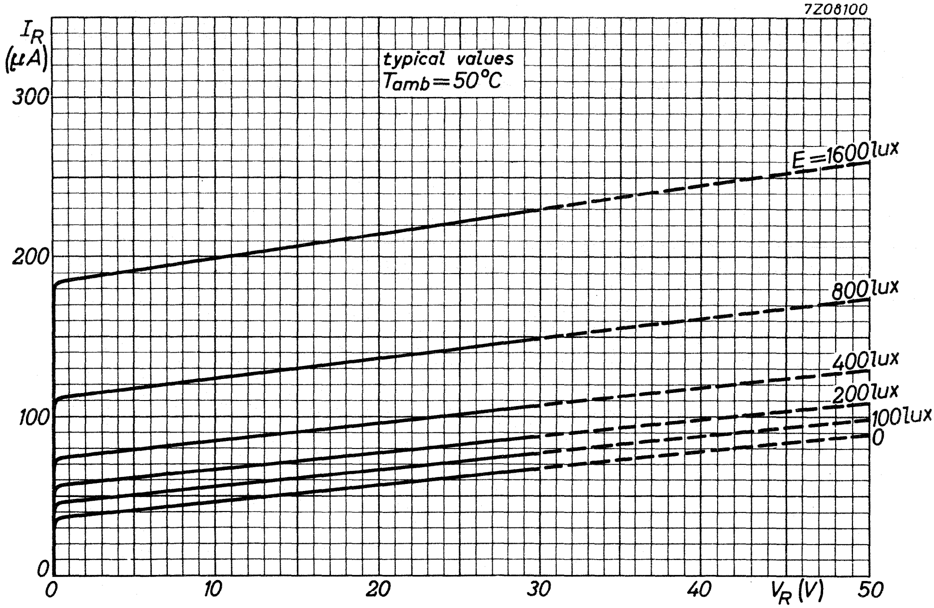

7Z08095
1000
I_R
(μA)
100
10
1
0
50
T_{amb} (°C)
100
V_R = 5 V
E = 0
typ

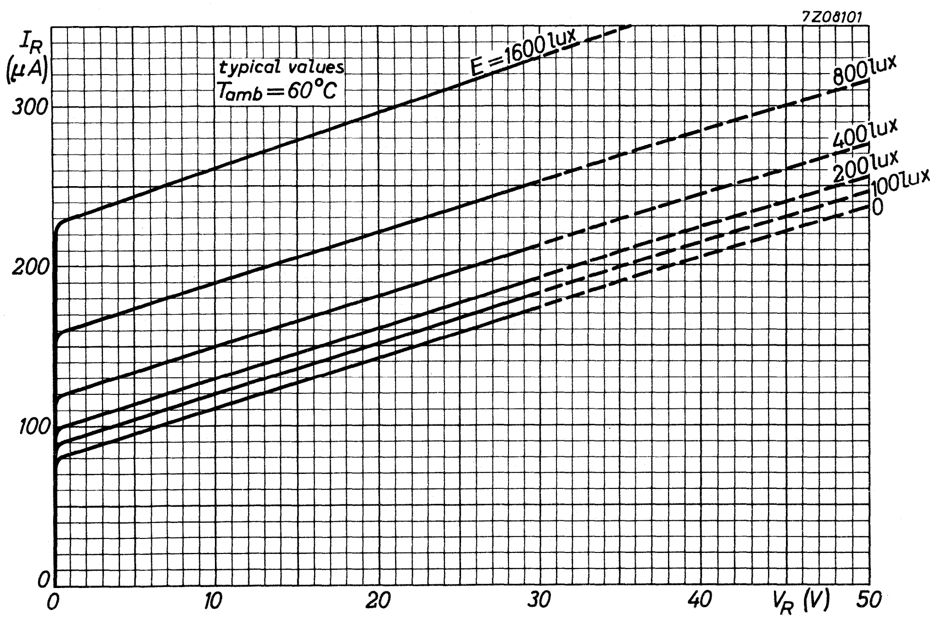

7Z08096
300
I_R
(μA)
200
100
0
0
1000
E(lux)
2000
typical values
V_R = 5 V
T_{amb}=
60°C
50°C
40°C
27°C

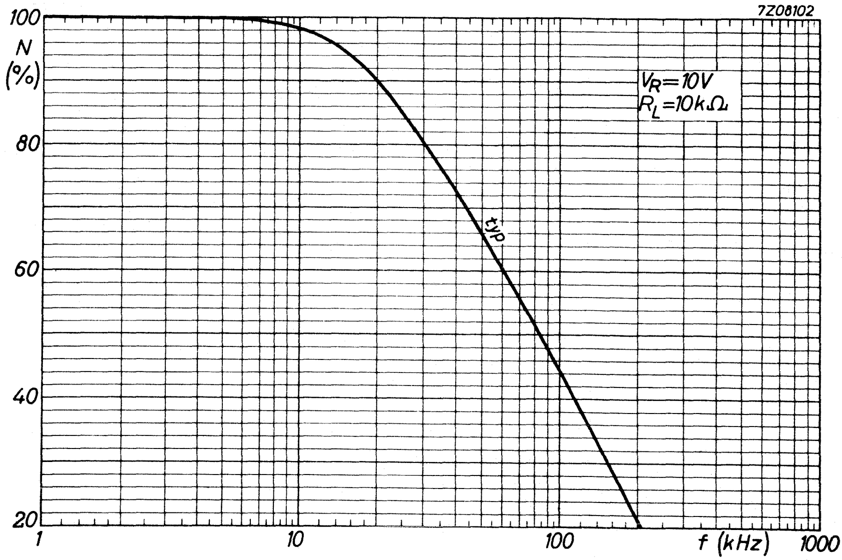

7Z08097
8
I_R
(μA)
6
4
2
0
0
0.2
0.4
V_R (V)
0.6
0
10
20
V_R (V)
30
T_{amb} = 25°C
E = 0
typ
typ

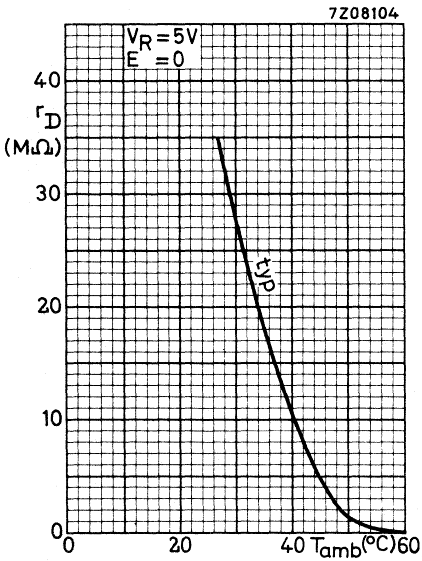

7Z08098
I_R (μA)
300
200
100
0
typical values
T_{amb}=27°C
E=1600 lux
800 lux
400 lux
200 lux
100 lux
0
0
10
20
30
40
V_R (V)
50

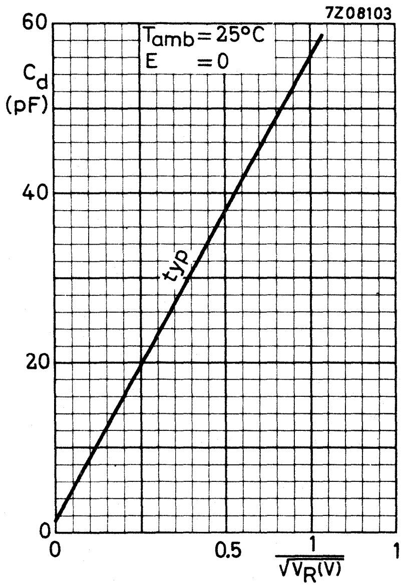

7Z08099
I_R (μA)
300
200
100
0
typical values
T_{amb}=40°C
E=1600 lux
800 lux
400 lux
200 lux
100 lux
0
0
10
20
30
40
V_R (V)
50


7Z08100
I_R (μA)
typical values
T_{amb} = 50°C
E = 1600 lux
800 lux
400 lux
200 lux
100 lux
0
300
200
100
0
0
10
20
30
40
V_R (V)
50


7Z08101
I_R (μA)
typical values
T_{amb} = 60°C
E = 1600 lux
800 lux
400 lux
200 lux
100 lux
0
300
200
100
0
0
10
20
30
40
V_R (V)
50


7Z08102
100
N
(%)
80
60
40
20
1
10
100
1000
f (kHz)
$V_R = 10V$
$R_L = 10k\Omega$
typ


7Z08104
$V_R = 5V$
E = 0
40
r_D
(MΩ)
30
20
10
0
0
20
40 T_{amb}(°C) 60
typ

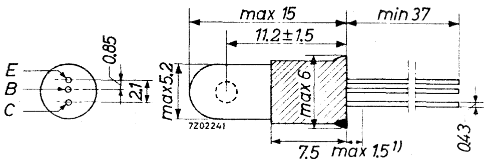

7Z08103
$T_{amb} = 25°C$
E = 0
60
C_d
(pF)
40
20
0
0
0.5
$\frac{1}{\sqrt{V_R(V)}}$
1
typ

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 in accordance with the Absolute Maximum System (IEC 134)

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 mm^2)	N	>	130	mA/lumen
Peak spectral response	λ_m	typ.	1.43	μm
Zero spectral response	λ_0	typ.	1.9	μm

CHARACTERISTICS (continued)

Circuit diagram

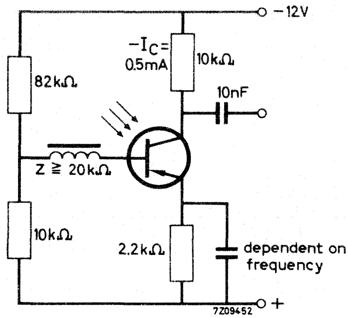
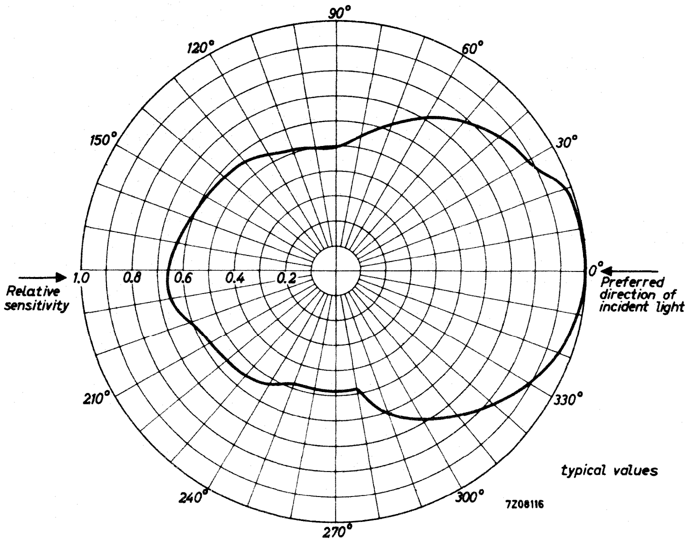
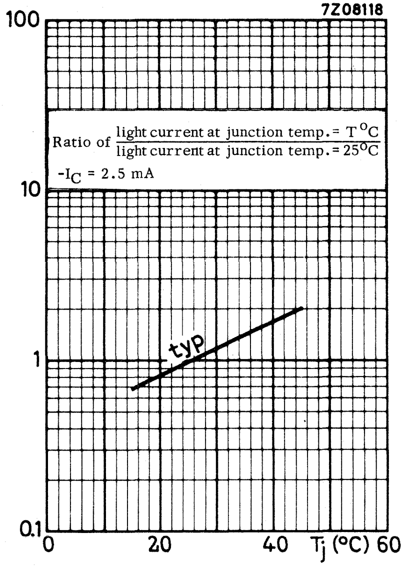
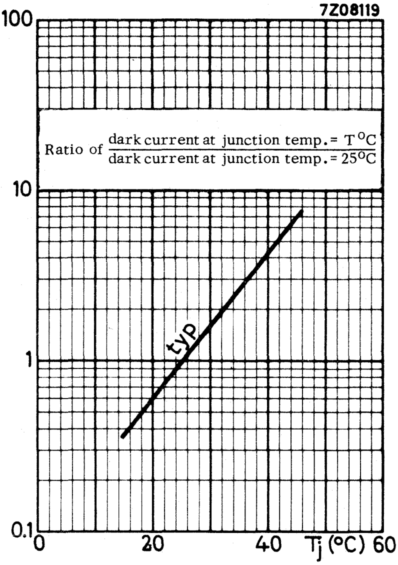
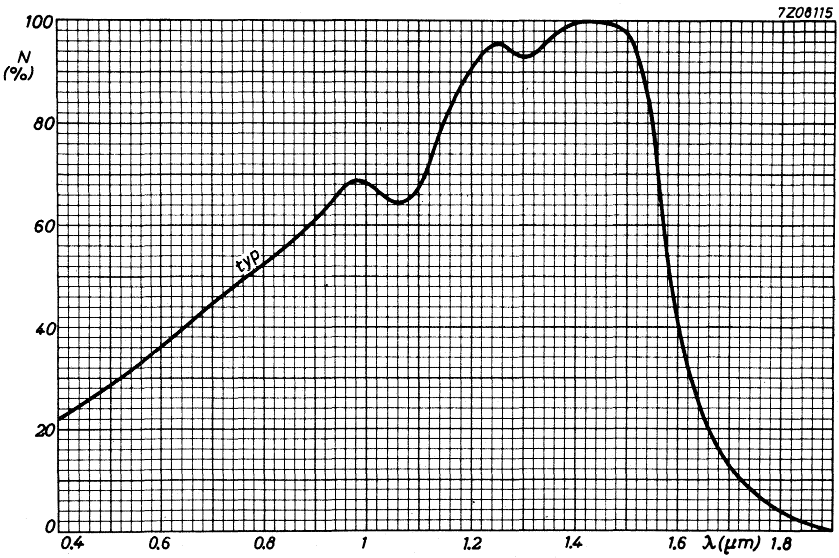


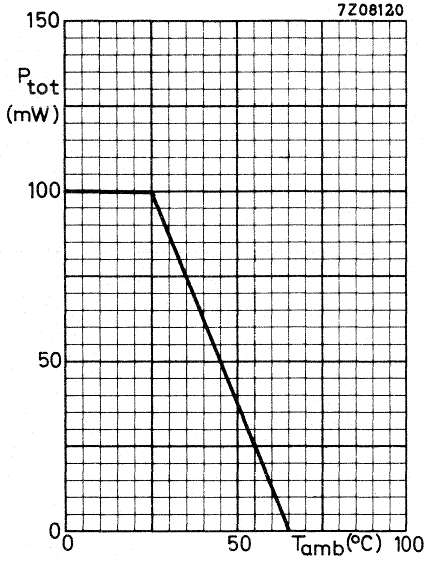
Photo-transistors are inherently sensitive to temperature variations, which result in variations of the output current which cannot be distinguished from the light signal. This is particularly so with an open circuit base connection, when thermal runaway is most likely to occur; for operation at elevated voltage and temperature the use of an external base emitter resistance is essential.
The function of this is to improve the light to dark current ratio by causing a much greater proportional decrease in dark current. It is recommended that for this purpose an NTC type resistor is used, the value required depending on the maximum ambient temperature and light level.

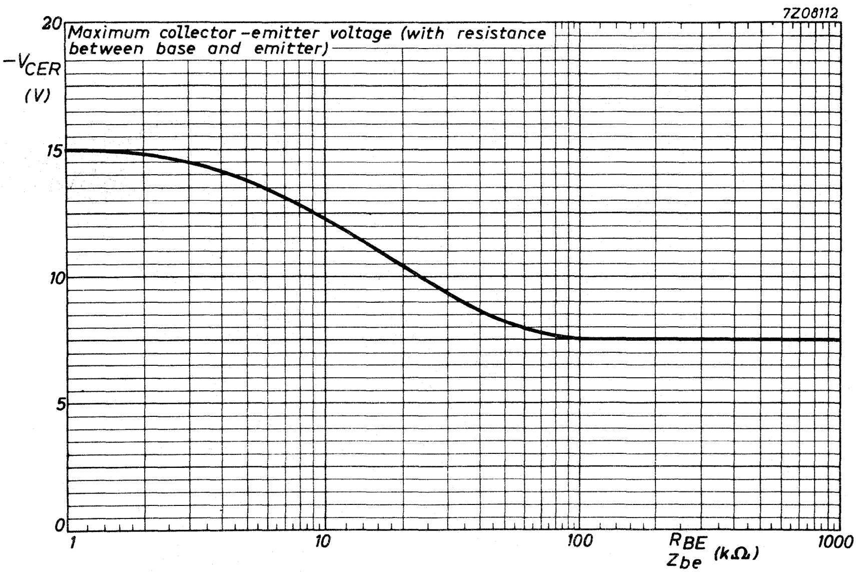


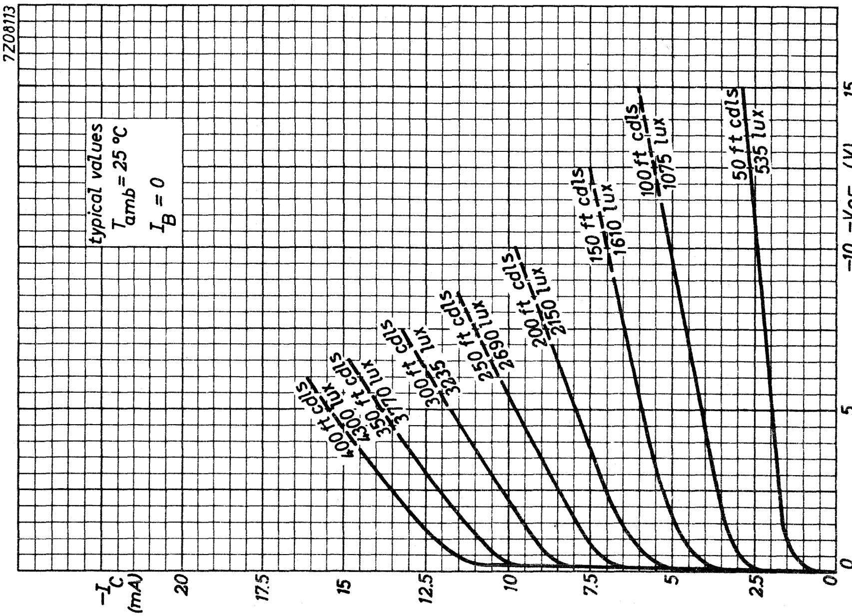

7Z08118
Ratio of light current at junction temp. = T °C / light current at junction temp. = 25 °C
-I_C = 2.5 mA
typ
100
10
1
0.1
0
20
40
Tj (°C) 60

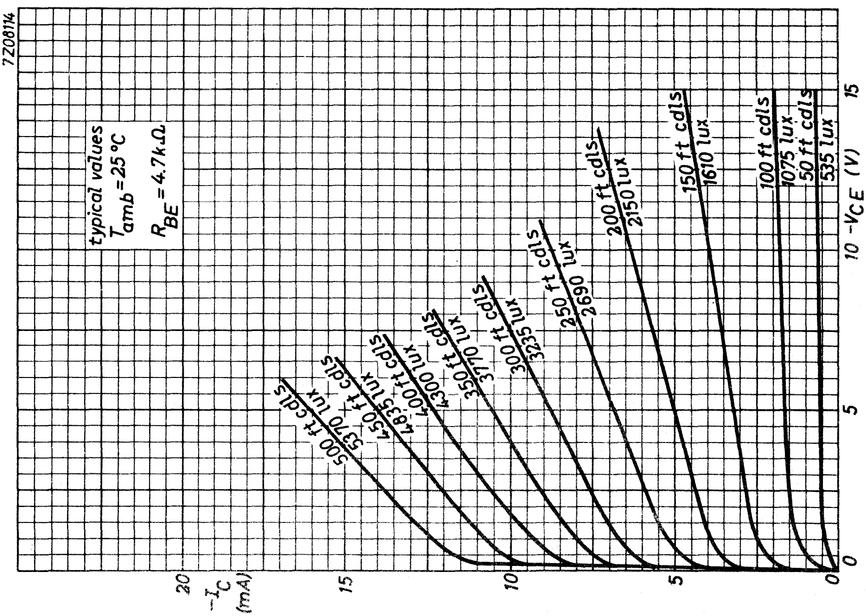

7Z08119
Ratio of dark current at junction temp. = T °C / dark current at junction temp. = 25 °C
typ
100
10
1
0.1
0
20
40
Tj (°C) 60


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
R_{BE}
Z_{be} (kΩ)
1000


7Z08113
typical values
$T_{amb} = 25\ °C$
$I_B = 0$
400 ft cdls
4300 lux
350 ft cdls
3770 lux
300 ft cdls
3235 lux
250 ft cdls
2690 lux
200 ft cdls
2150 lux
150 ft cdls
1610 lux
100 ft cdls
1075 lux
50 ft cdls
535 lux
$-I_C$ (mA)
20
17.5
15
12.5
10
7.5
5
2.5
0
0
5
−10
15
$-V_{CE}$ (V)


7Z08114
typical values
$T_{amb} = 25\ °C$
$R_{BE} = 4.7\ k\Omega$
500 ft cdls
5370 lux
450 ft cdls
4835 lux
400 ft cdls
4300 lux
350 ft cdls
3770 lux
300 ft cdls
3235 lux
250 ft cdls
2690 lux
200 ft cdls
2150 lux
150 ft cdls
1610 lux
100 ft cdls
1075 lux
50 ft cdls
535 lux
$-I_C$ (mA)
20
15
10
5
0
0
5
10
15
$-V_{CE}$ (V)

PHOTOCONDUCTIVE CELL

Indium antimonide photoconductive element mounted on a copper heatsink, recommended for operation at a temperature of 20 °C.
Sensitive to infra-red radiation extending to 7.5 μm and intended for use with mod-modulated or pulsed radiation.

RATINGS (Limiting values) [1])

Bias current at T_{amb} = 20 °C	I	max.	100	mA
Temperatures				
Operating ambient temperature	T_{amb}	max.	70	°C
Storage temperature	T_{stg}		- 50 to + 70	°C

CHARACTERISTICS T_{amb} = 20 °C unless otherwise specified

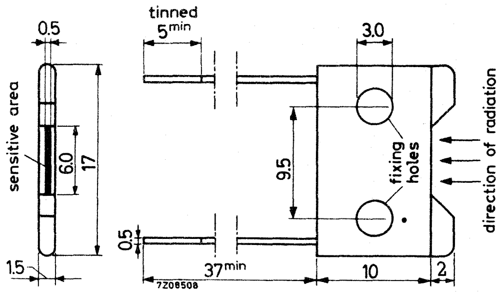
Peak spectral response	λ		6.0 to 6.3	μm
Spectral response range	from visible to		7.5	μm
Cell resistance	r_1		30 to 120	Ω
Time constant			0.1	μs
Sensitive area			6.0 x 0.5	mm^2
Sensitivity (6.0 μm radiation)		>	0.4	μV/μW
		typ.	1.0	μV/μW
(500 °K radiation)		typ.	0.3	μV/μW
D^* (6.0 μm, 800 Hz, 1 Hz)	see notes 1 and 2	>	8.5×10^7	$cm\sqrt{Hz}/W$
		typ.	2.0×10^8	$cm\sqrt{Hz}/W$
(500 °K, 800 Hz, 1 Hz)	see notes 1 and 2	typ.	6.0×10^7	$cm\sqrt{Hz}/W$
Noise equivalent power (N.E.P.)				
(6.0 μm, 800 Hz, 1 Hz)	see notes 1 and 2	typ.	8.6×10^{-10}	W
		<	2.0×10^{-9}	W
(500 °K, 800 Hz, 1 Hz)	see notes 1 and 2	typ.	2.5×10^{-9}	W

MECHANICAL DATA (see page 2)

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

MECHANICAL DATA

Dimensions in mm



NOTES

1. Measuring conditions.

The detector is attached to a heatsink which is maintained at a temperature of 20 °C and a bias current of 50 mA is applied. A parallel beam of monochromatic radiation of wavelength 4.4 μm, which would produce a steady irradiance of 68 $\mu W/cm^2$ at the sensitive element, is chopped at 800 Hz, giving an actual r.m.s. power at the element which amounts to

$$\frac{68}{2.2} = 31 \ \mu W/cm^2$$

Measurements of the detector output are made with an amplifier tuned to 800 Hz and with a bandwidth of 50 Hz, and are referred to open circuit conditions i.e. correction is made for the shunting effects of the bias supply impedance and the amplifier input impedance. Under these test conditions, the ORP10 will exhibit a minimum signal-to-noise ratio of 45 and typical of 105. The sensitivities quoted at the wavelength of peak response and under black body conditions are calculated from these measurements, assuming the detector to have a typical response curve.

2. D* and N.E.P.

These are figures of merit for the materials of detectors.
D* is defined in the expression:

$$D^* = \frac{\frac{V_s}{V_n} \times \sqrt{A(\Delta f)}}{W}$$

where: V_s = signal voltage across detector terminals
V_n = noise voltage across detector terminals
A = detector area
(Δf) = bandwidth of measuring amplifier
W = radiation power incident on detector sensitive element in watts.

NOTES (continued)

The figures in brackets which follow D* refer to the measuring conditions e.g. D* (5.3 μm, 800 Hz, 1 Hz) denotes monochromatic radiation incident on the detector of wavelength 5.3 μm, chopping frequency 800 Hz, bandwidth 1 Hz.

The Noise Equivalent Power (N.E.P.) is related to D* by the expression:

$$\text{N.E.P.} = \frac{\sqrt{A}}{D^*}.$$

3. Variation of performance with bias current.

Both signal and noise vary with bias current. Typical curves are shown on page 5. At high currents the noise increases more rapidly than the signal, and therefore the signal-to-noise ratio has a peak value at some optimum current, which will vary slightly from cell to cell. A typical value is 50 mA. In addition the ohmic heating caused by bias currents above 60 mA causes the temperature of the element to become significantly greater than the substrate so that the signal decreases as described in note 4.

4. Variation of performance with element temperature.

As with all semiconductor photocells, the performance depends on the temperature of the sensitive element. In the case of the ORP10 this is influenced by the ambient temperature and ohmic heating caused by the d.c. bias current. To minimise fluctuations, the element is mounted on a copper base from which it is insulated by a layer of aluminium oxide, and can readily be attached to a large heatsink.

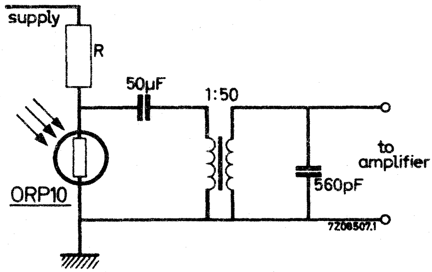
A typical variation of performance with temperature is given on page 5. The curve on page 5 shows the decrease in signal caused by the high current raising the temperature of the element.

On cooling, indium antimonide exhibits improved sensitivity and increased resistance. Below 15 ^{o}C this is impractical with the ORP10 unless special precautions are taken to prevent condensation and icing on the exposed element.

5. Warning.

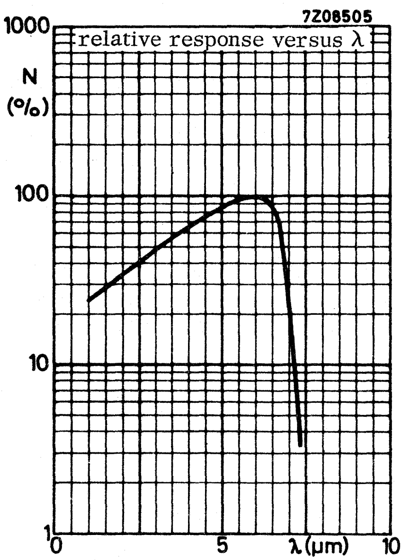
The sensitive surface is unprotected and should not be touched. It is stable in normal atmospheres but should not be exposed to high concentrations of the vapours of organic solvents. Care should be taken to avoid strain when attaching cells to heatsinks.

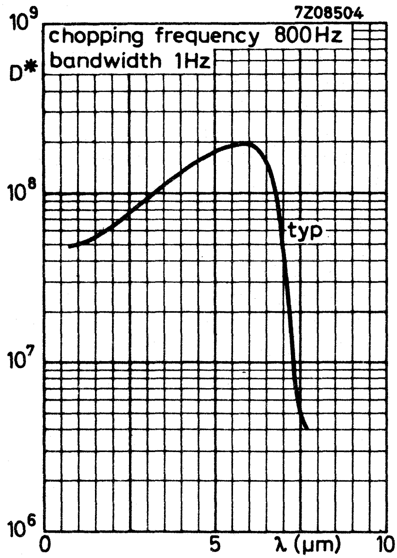
Recommended circuit for use with radiation chopped at 800 Hz.

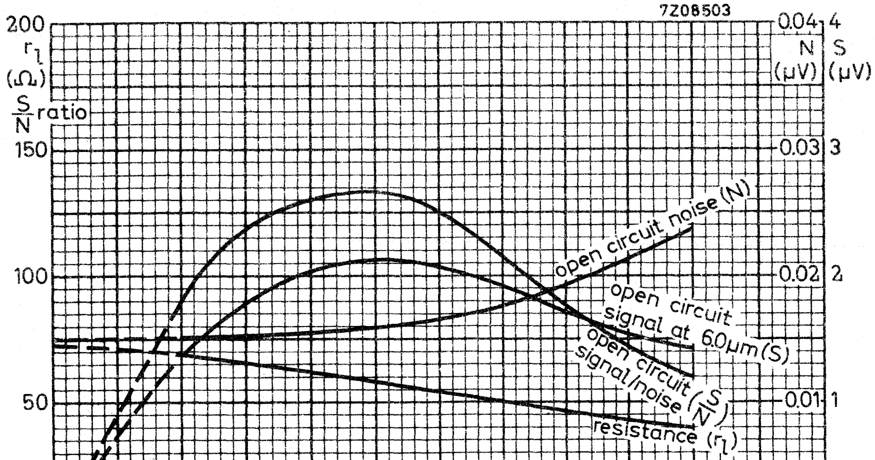


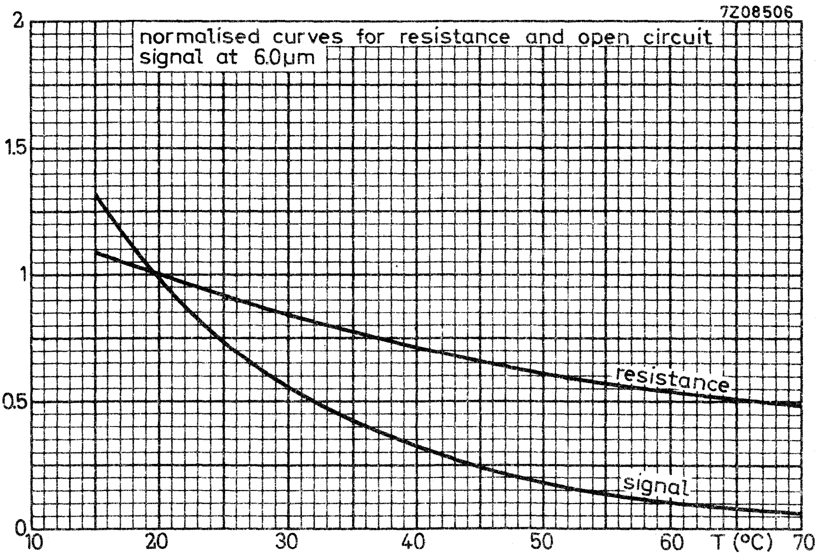
CIRCUIT NOTES

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)
S/N ratio
150
100
50
0
0.04
N (µV)
S (µV)
0.03
0.02
0.01
0
4
3
2
1
0
0
20
40
60
80
100
I (mA)
open circuit noise (N)
open circuit signal at 6.0µm (S)
open circuit signal/noise (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
70
T (°C)
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

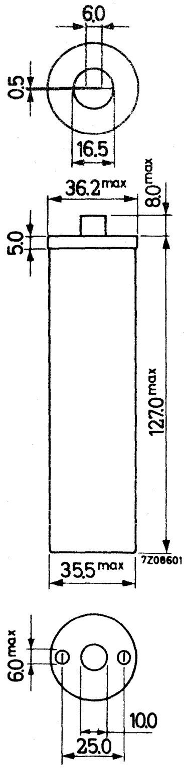
Peak spectral response		λ	5.3	μm
Spectral response range		from visible to	5.6	μm
Cell resistance		r_1	20 to 60	kΩ
Time constant			5	μs
Sensitive area			6.0 x 0.5	mm^2
Dwell time of liquid nitrogen		>	40	min.
Sensitivity (5.3 μm radiation)		>	12	mV/μW
		typ.	24	mV/μW
(500 °K radiation)		typ.	4.5	mV/μW
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)		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)		typ.	2.2×10^{-11}	W

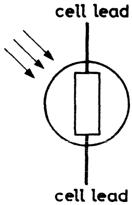
MECHANICAL DATA (see page 2)

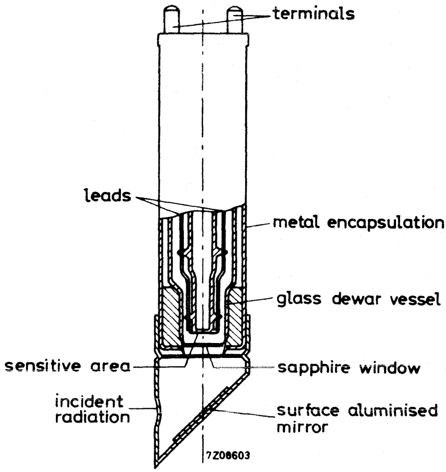
1) Limiting values according to the Absolute Maximum System as defined in IEC publication 134.

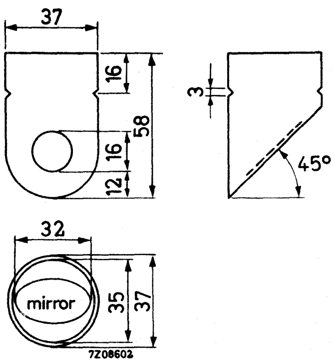
MECHANICAL DATA

Dimensions in mm









NOTES

1. Measuring conditions.

The detector is cooled to 77 °K by filling the dewar with liquid nitrogen and a bias current of 250 μA is applied. A parallel beam of monochromatic radiation of wavelength 4.4 μm, which would produce a steady irradiance of 7.6 $\mu W/cm^2$ 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.

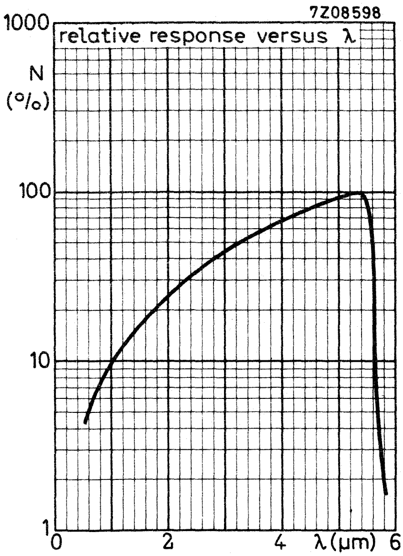
NOTES (continued)

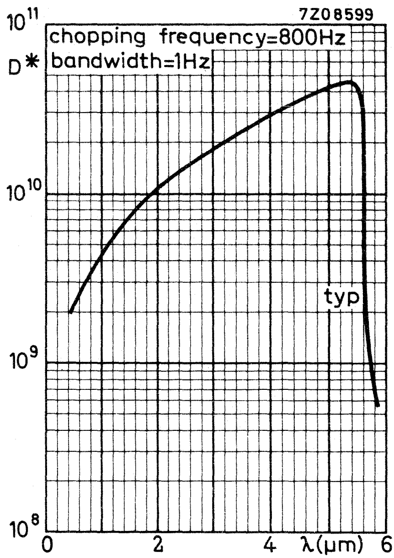
4. Effect of ambient radiation.

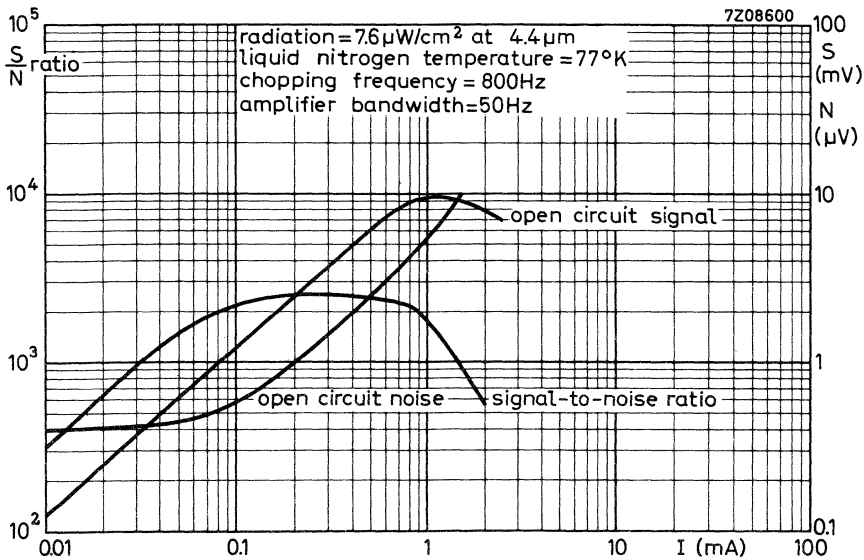
   Care should be taken to avoid the incidence on the cell of appreciable radiation in the visible range. Such radiation will cause a decrease in the cell resistance and signal as long as the cell is kept cool. Normal daylight can cause this effect if seen for more than a few minutes. Precautions should 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 = 7.6 μW/cm² at 4.4 μm
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

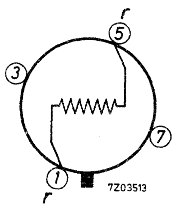
CADMIUM SULPHIDE PHOTOCONDUCTIVE CELL

Cadmium sulphide photoconductive cell with top sensitivity intended for use in flame control, smoke detection and industrial on-off switching applications.

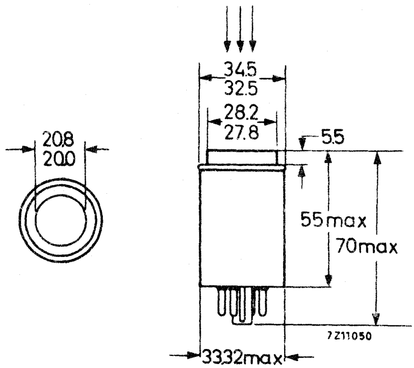
QUICK REFERENCE DATA				
Power dissipation at $T_{amb} = 25\,^{o}C$	P	max.	1.5	W
Cell voltage, d.c. and repetitive peak	V	max.	350	V
Cell resistance at 50 lux, 2700 ^{o}K colour temperature	$r_{\ell o}$		330	Ω
Spectral response curve		type D		
Outline dimensions		max. 34.5 dia. x 70		mm

MECHANICAL DATA

Dimensions in mm



Base: Octal



ELECTRICAL DATA

General

The electrical properties of CdS cells are dependent on many factors such as illumination, colour temperature of the light source, voltage, current, temperature, total time of operation in the circuit and time of operation during the last 24 hours prior to the measurement. The following basic characteristics are therefore only checkpoints of the electrical properties of these devices measured with defined values of the various conditions and at delivery.

Basic characteristics at T_{amb} = 25 °C, illumination with colour temperature of 2700 °K and at delivery

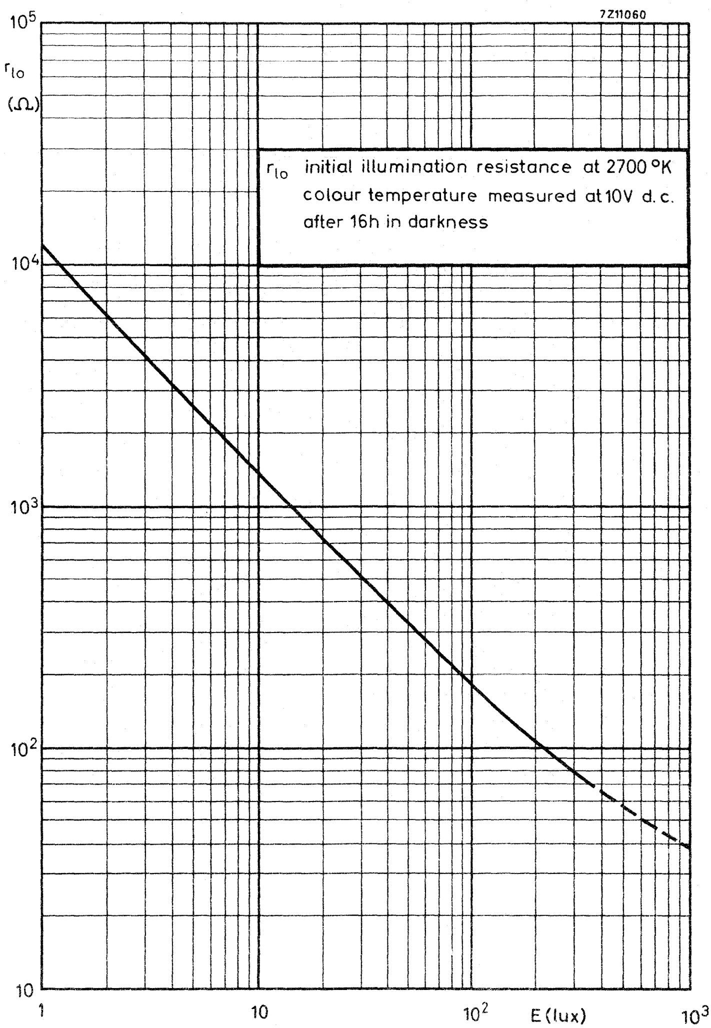
	symbol	min.	typical	max.	unit
Equilibrium dark current measured with 300 V d.c. applied via 1 MΩ, 30 minutes after switching off the illumination	I_{de}			6	μA
Initial illumination current measured at 10 V d.c. and illumination = 50 lux, after 16 hrs in darkness [1]	I_{lo}	11	30	47	mA
Initial illumination current measured at 10 V d.c. illumination = 50 lux and colour temperature = 1500 °K, after 16 hrs in darkness	I_{lo}	24	60	96	mA
Sensitivity at 50 lux, with 10 V d.c. applied	N		0.6		mA/lux

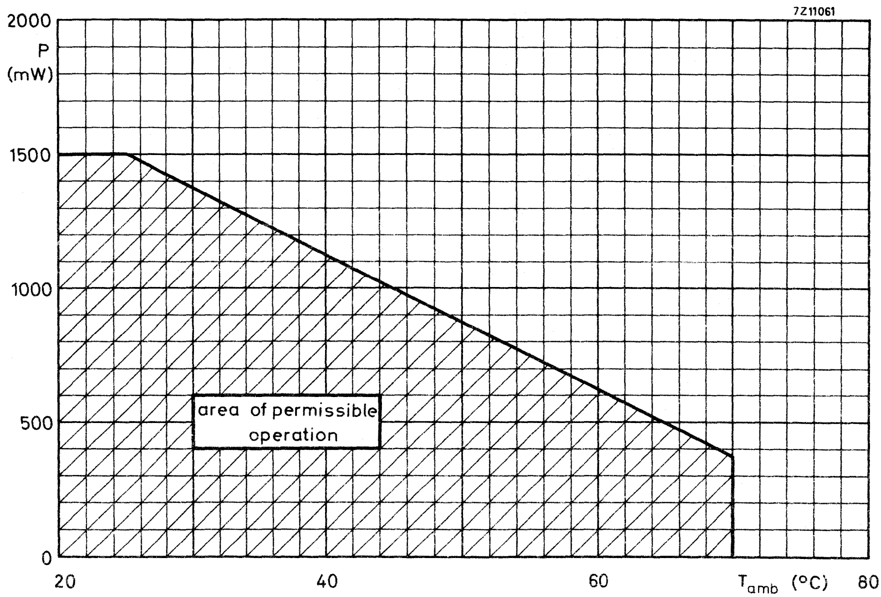
LIMITING VALUES (Absolute max.rating system)

Cell voltage, d.c. and repetitive peak		V	max.	350	V
Power dissipation			see page 4		
Ambient temperature,	storage and operating	T_{amb}	min.	-40	°C
	storage	T_{amb}	max.	+50	°C [2]
	operating	T_{amb}	max.	+70	°C

[1]) After 16 hours in darkness changes in the CdS material are still occurring, but have only insignificant effect on the illumination resistance and on the resistance decay time.

[2]) Operation of the cell counteracts the deteriorating effect of long periods at high temperature. The maximum operating temperature is therefore higher than the maximum storage temperature.


7Z11060
r_{lo} (Ω)
r_{lo} initial illumination resistance at 2700 °K colour temperature measured at 10V d.c. after 16h in darkness
10^5
10^4
10^3
10^2
10
1
10
10^2
E (lux)
10^3


7Z11061
2000
P
(mW)
1500
1000
500
0
20
40
60
80
T_{amb} (°C)
area of permissible operation

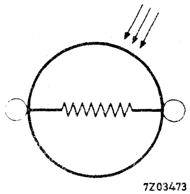
CADMIUM SULPHIDE PHOTOCONDUCTIVE CELL

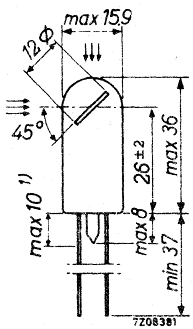
Cadmium sulphide photoconductive cell with top and side sensitivity.

QUICK REFERENCE DATA				
Power dissipation at T_{amb} = 25 °C	P	max.	0.4	W
Cell voltage, d.c. and repetitive peak	V	max.	300	V
Cell resistance at 50 lux, 2700 °K colour temperature	r_{lo}		2700	Ω
Spectral response curve		type D		
Outline dimensions		max. 15.9 dia. x 44		mm

MECHANICAL DATA

Dimensions in mm





Soldering

The cell may be soldered directly into the circuit but heat conducted to the seal should be kept to a minimum by the use of a thermal shunt. The cell may be dip-soldered at a solder temperature of 240 °C for a maximum of 10 s up to a point 10 mm from the seals.

1) Not tin plated

ELECTRICAL DATA

General

The electrical properties of CdS cells are dependent on many factors such as illumination, colour temperature of the light source, voltage, current, temperature, total time of operation in the circuit and time of operation during the last 24 hours prior to the measurement. The following basic characteristics are therefore only checkpoints of the electrical properties of these devices measured with defined values of the various conditions and at delivery.

Basic characteristics at T_{amb} = 25 °C, illumination with colour temperature of 2700 °K and at delivery.

	symbol	min.	typical	max.	unit
Equilibrium dark resistance measured with 300 V d.c. applied via 1 MΩ, 30 minutes after switching off the illumination	r_{de}	8			MΩ
Initial illumination resistance measured at 20 V d.c. and illumination = 50 lux, after 16 hrs in darkness [1])	r_{lo}	1300	2700	6200	Ω
Equilibrium illumination resistance measured at 20 V d.c. and illumination = 50 lux, after 15 minutes under the measuring conditions	r_{le}		3400		Ω
Resistance decay time Time to reach 7 kΩ measured from the instant of starting the illumination of 50 lux, after 16 hrs in darkness	t_{fr}		350		ms
Resistance rise time Time to reach 25 kΩ measured from the instant of stopping the illumination, after 15 minutes or longer illumination of 50 lux	t_{rr}		75		ms

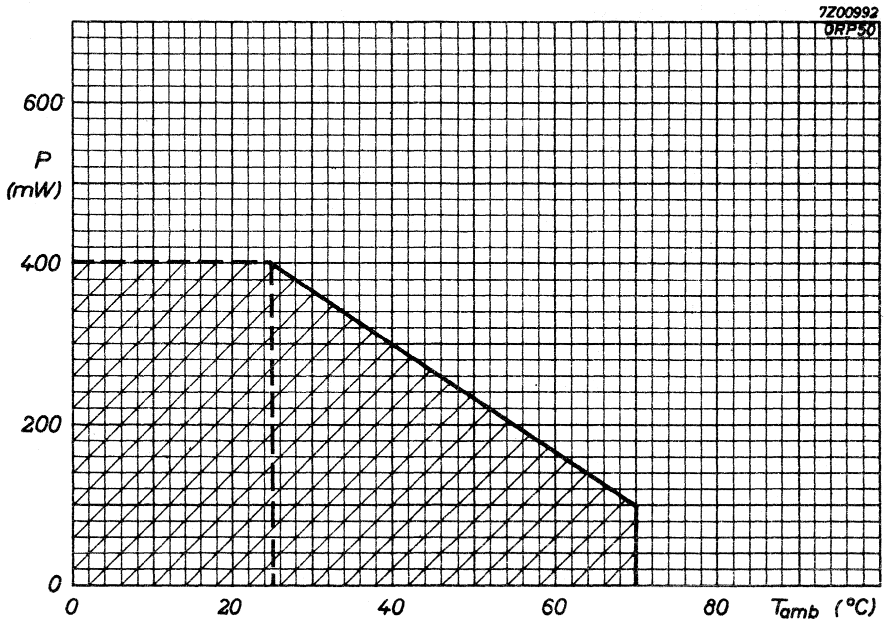
[1]) After 16 hours in darkness changes in the CdS material are still occurring, but have only insignificant effect on the illumination resistance and on the resistance decay time.

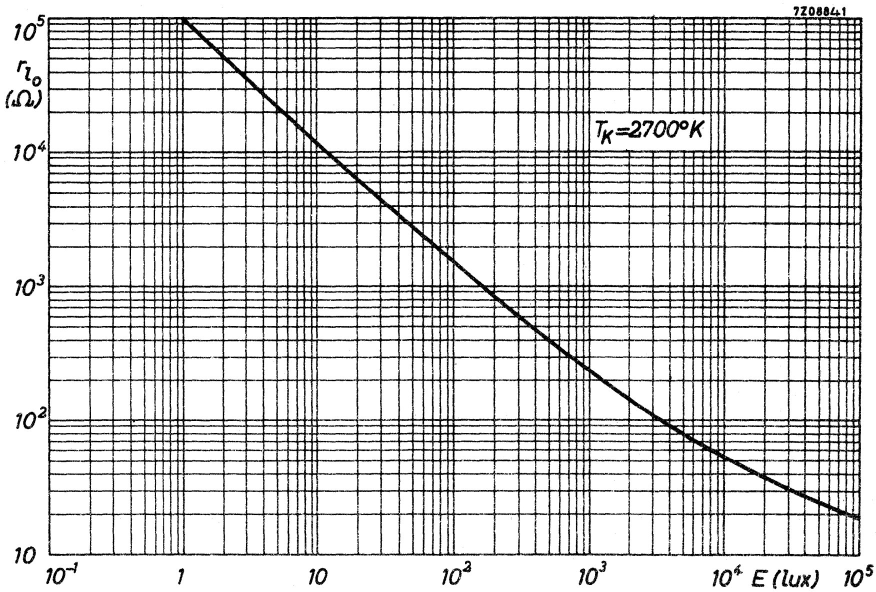
DESIGN CONSIDERATIONS

Apparatus with CdS devices should be designed so that changes in resistance values of the CdS cells during life from −30% to +70% do not impair the circuit performance. Direct sunlight irradiation should be avoided.

LIMITING VALUES (Absolute max. rating system)

Cell voltage, d.c. and repetitive peak		V	max.	300	V
Power dissipation at T_{amb} = 25 °C	See also sheet 4	P	max.	0.4	W
Power dissipation at T_{amb} = 70 °C		P	max.	0.1	W
Ambient temperature, storage and operating		T_{amb}	min.	−40	°C
storage		T_{amb}	max.	+50	°C
operating (< 1 lux)		T_{amb}	max.	+50	°C
operating (≥ 1 lux)		T_{amb}	max.	+70	°C


7Z00992
ORP50
600
P
(mW)
400
200
0
0
20
40
60
80
Tamb (°C)


7Z08841
10^5
r_{l_0}
(Ω)
10^4
10^3
10^2
10
T_K=2700°K
10^{-1}
1
10
10^2
10^3
10^4
E (lux)
10^5

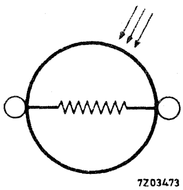
CADMIUM SULPHIDE PHOTOCONDUCTIVE CELL

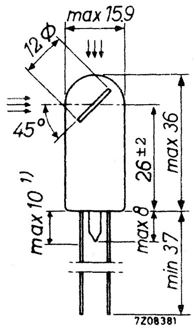
Cadmium sulphide photoconductive cell with top and side sensitivity intended for use in industrial on-off applications such as flame failure equipment. The cell is tropic proof, shock and vibration resistant.

QUICK REFERENCE DATA				
Power dissipation at T_{amb} = 25 °C	P	max.	400	mW
Cell voltage, d.c. and repetitive peak	V	max.	200	V
Cell resistance at 50 lux, 2700 °K colour temperature	rl_o		1200	Ω
Spectral response curve		type D		
Outline dimensions		max. 15.9 dia x 44		mm

MECHANICAL DATA

Dimensions in mm





Soldering

The cell may be soldered directly into the circuit but heat conducted to the seal should be kept to a minimum by the use of a thermal shunt. The cell may be dip-soldered at a solder temperature of 240 °C for a maximum of 10 s up to a point 10 mm from the seals.

1) Not tinned.

ELECTRICAL DATA

General

The electrical properties of CdS cells are dependent on many factors such as illumination, colour temperature of the light source, voltage, current, temperature, total time of operation in the circuit and time of operation during the last 24 hours prior to the measurement. The following basic characteristics are therefore only checkpoints of the electrical properties of these devices measured with defined values of the various conditions and at delivery.

Basic characteristics at T_{amb} = 25 °C, illumination with colour temperature of 2700 °K and at delivery

	symbol	min.	typical	max.	unit
Initial dark resistance measured with 200 V d.c. applied via 1 MΩ, 20 s after switching off the illumination	r_{do}	4		1)	MΩ
Equilibrium dark resistance measured with 200 V d.c. applied via 1 MΩ, 30 minutes after switching off the illumination	r_{de}	100		1)	MΩ
Initial illumination resistance measured at 10 V d.c., illumination = 50 lux, after 16 hours in darkness 2)	r_{lo}	750	1200	3000	Ω
Equilibrium illumination resistance measured at 10 V d.c., illumination = 50 lux, after 15 minutes under the measuring conditions	r_{le}	750	1500	4100	Ω
Current rise time Time to reach 90% of the max. value, measured from the instant of starting the illumination of 50 lux, at 10 V d.c. after 16 hours in darkness	t_{ri}			2	s

1) The spread of the dark resistance is large and values higher than 100 MΩ and 10 000 MΩ are possible for the initial dark resistance and the equilibrium dark resistance respectively.

2) After 16 hours in darkness changes in the CdS material are still occurring, but have only insignificant effect on the illumination resistance and on the resistance decay time.

Basic characteristics at T_{amb} = 25 ^{o}C, illumination with colour temperature of 2700 ^{o}K and at delivery (continued)

	symbol	min.	typical	max.	unit
Current decay time Time to reach 10% of the max. value, measured from the instant of stopping the illumination after 16 hours darkness and 10 sec. illumination of 50 lux, at 10 V d.c.	t_{f_i}			0.2	s
Sensitivity at 50 lux, with 10 V d.c. applied	N		0.17		mA/lux
Negative temperature response of illumination resistance	$\Delta r1/\Delta T$		0.2	0.5	%/^{o}C
Voltage response $\frac{\text{r at 0.5 V}}{\text{r at 10 V}}$	α		1.05		

THERMAL DATA

Continuous temperature of CdS tablet	T_{tablet}	max.	+85	^{o}C
Thermal resistance from CdS tablet to ambient, device free in air	K		150	^{o}C/W

DESIGN CONSIDERATIONS

Apparatus with CdS cells should be designed so that changes in resistance values of the cells during life from −30% to +70% do not impair the circuit performance. Direct sunlight irradiation should be avoided.

SHOCK AND VIBRATION

An indication for the ruggedness of the cell is the following:
Samples taken from normal production are submitted to shock and vibration tests mentioned below. More than 95% of the devices pass these tests without perceptible damage.

Shock

25 g_{peak}, 10 000 shocks in one of the three positions of the cell.

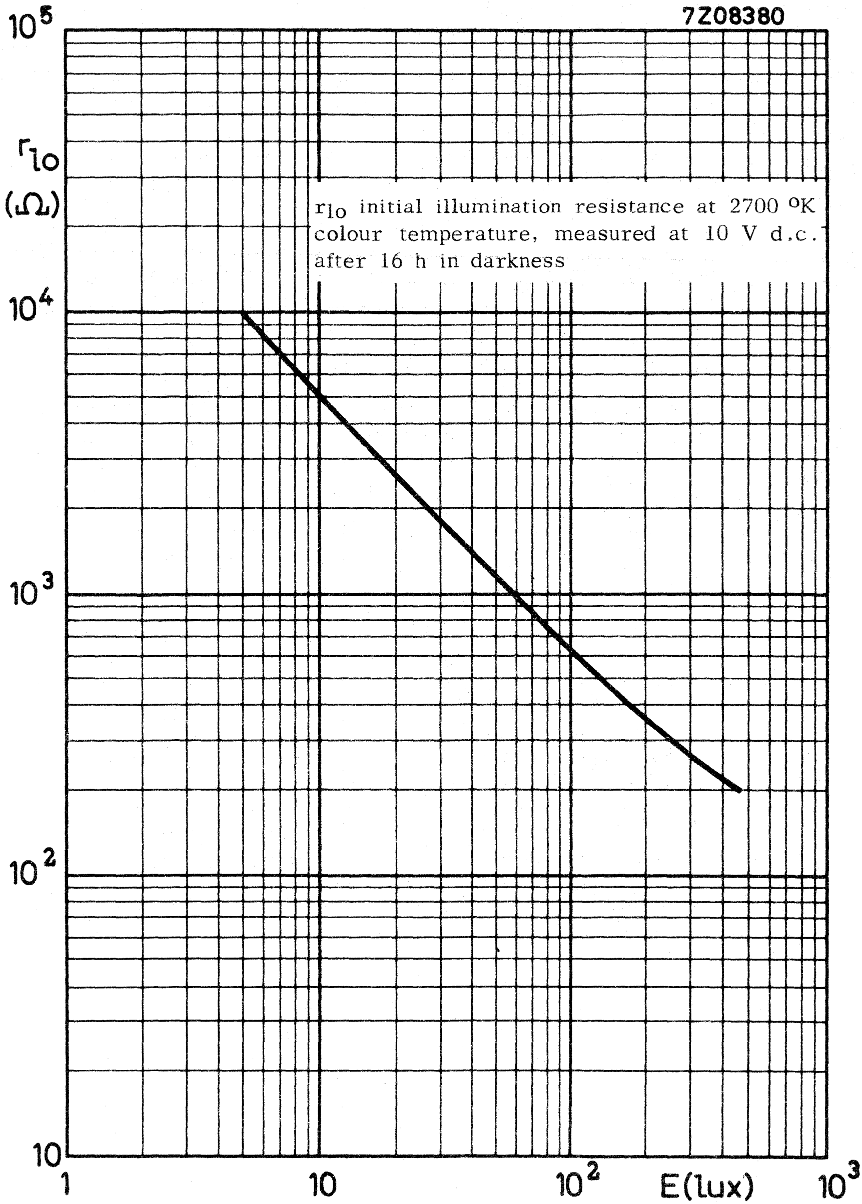
Vibration

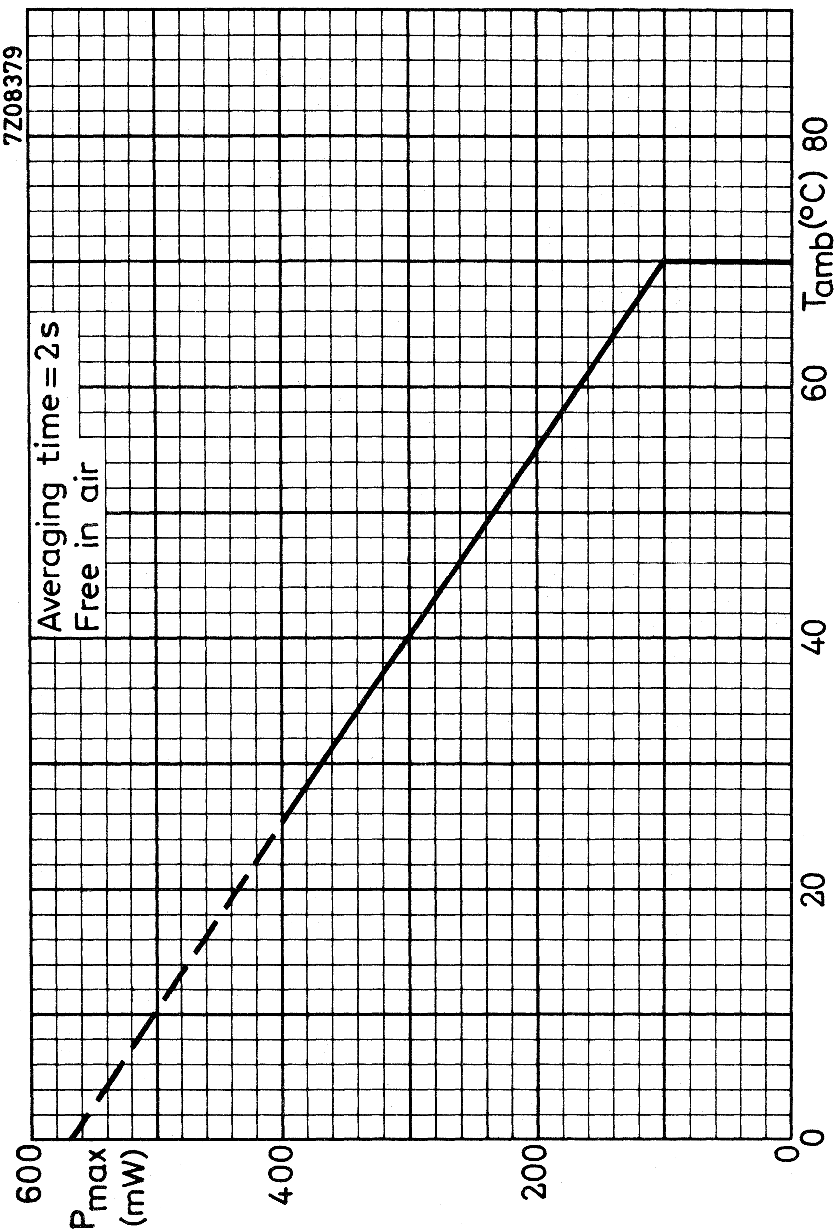
2.5 g_{peak}, 50 Hz, during 32 hours in each of the three positions of the cell.

LIMITING VALUES (Absolute max. rating system)

Cell voltage, d.c. and repetitive peak	V	max.	200	V
Cell voltage, pulse, t_{imp} = max. 5 ms p.r.r. = max. once per minute	V_p	max.	500	V
Power dissipation, t_{av} = 2 s	P	See sheet 6		
Power dissipation, pulse	P_p	max.	5xP	
Cell current, d.c. and repetitive peak	I	max.	100	mA
Illumination	E	max.	50 000	lux
Temperature CdS tablet, operating	T_{tablet}	max.	85	°C
Ambient temperature, storage and operating	T_{amb}	min.	−40	°C
storage	T_{amb}	max.	+50	°C [1]
operating	T_{amb}	max.	+70	°C

[1] Operation of the cell counteracts the deteriorating effect of long periods at high temperature. The maximum operating temperature is therefore higher than the maximum storage temperature.


7Z08380
10^5
r_{lo} (Ω)
r_{lo} initial illumination resistance at 2700 °K colour temperature, measured at 10 V d.c. after 16 h in darkness
10^4
10^3
10^2
10
1
10
10^2
E(lux)
10^3

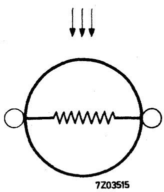

7Z08379
Averaging time = 2 s
Free in air
P_{max} (mW)
600
400
200
0
T_{amb} (°C)
0
20
40
60
80

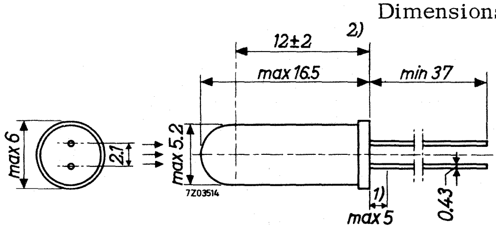
CADMIUM SULPHIDE PHOTOCONDUCTIVE CELL

Cadmium sulphide photoconductive cell with top sensitivity intended for use in flame control and other industrial applications as well as for automatic brightness and contrast control in TV receivers.
The cell is shock and vibration resistant.

QUICK REFERENCE DATA				
Power dissipation at T_{amb} = 25 °C	P	max.	70	mW
Cell voltage, d.c. and repetitive peak	V	max.	350	V
Cell resistance at 50 lux, 2700 °K colour temperature	r_{lo}		60	kΩ
Spectral response curve		type D		
Outline dimensions		max. 6 dia. x 16.5		mm

MECHANICAL DATA Dimensions in mm





Sensitive area 0.25 mm^2

Soldering

The cell may be soldered directly into the circuit but heat conducted to the seal should be kept to a minimum by the use of a thermal shunt. The cell may be dip-soldered at a solder temperature of 240 °C for a maximum of 10 s up to a point 5 mm from the seals.

[1]) Not tin plated

[2]) Centre of sensitive area

ELECTRICAL DATA

General

The electrical properties of CdS cells are dependent on many factors such as illumination, colour temperature of the light source, voltage, current, temperature, total time of operation in the circuit and time of operation during the last 24 hours prior to the measurement. The following basic characteristics are therefore only checkpoints of the electrical properties of these devices measured with defined values of the various conditions and at delivery.

Basic characteristics at T_{amb} = 25 °C, illumination with colour temperature of 2700 °K and at delivery

	symbol	min.	typical	max.	unit
Initial dark current measured at 300 V d.c. applied via 1 MΩ, 20 s after switching off the illumination	I_{do}			1.5	µA
Initial illumination current measured at 30 V d.c. and illumination = 50 lux, after 16 hrs in darkness [1])	I_{lo}	200	500	800	µA
Sensitivity at 50 lux, with 30 V d.c. applied	N		10		µA/lux

End of life characteristics at T_{amb} = 25 °C

Life test conditions: Illumination 50 to 100 lux, colour temperature about 2500 °K, P = 60 mW, T_{amb} = 35 °C

None of the end of life values stated under this heading are expected to be reached before 2500 operating hours under the following conditions:

Initial dark current measured at 300 V d.c., 20 s after switching off the illumination	I_{do}	max. 3	µA
Change of initial illumination current during life measured at 30 V d.c., illumination = 50 lux and colour temperature = 2700 °K, after 16 hrs in darkness	ΔI_{lo}	max. 60	%

[1]) After 16 hours in darkness changes in the CdS material are still occurring, but have only insignificant effect on the illumination resistance and on the resistance decay time.

SHOCK AND VIBRATION

An indication for the ruggedness of the device is the following:
Samples taken from normal production are submitted to shock and vibration tests mentioned below. More than 95% of the devices pass these tests without perceptible damage.

Shock

25 g_{peak}, 3000 shock in one of the three positions of the cell.

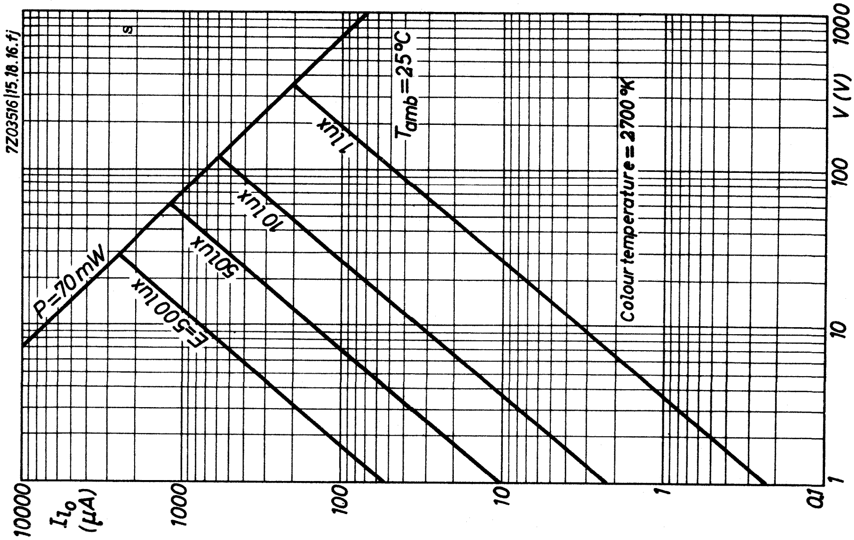
Vibration

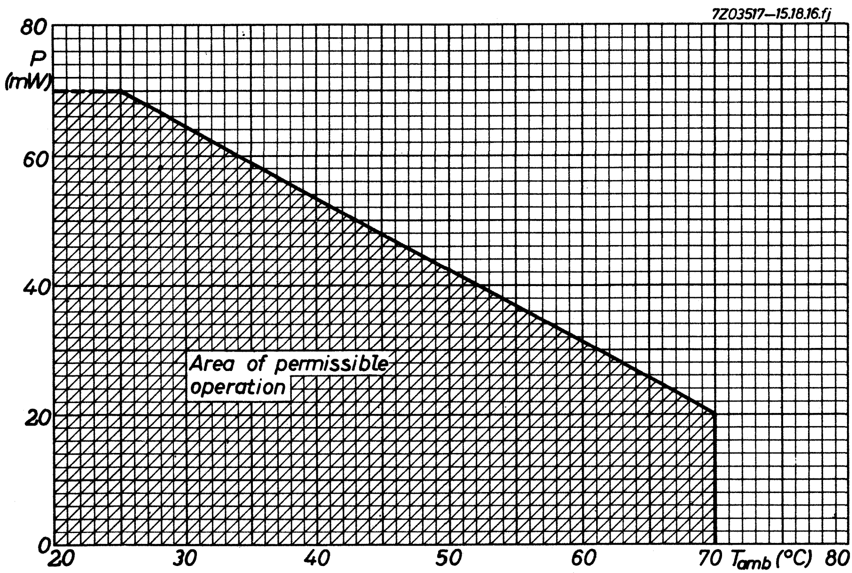
2.5 g_{peak}, 50 Hz during 32 hours in each of the three positions of the cell.

LIMITING VALUES (Absolute max. rating system)

Cell voltage, d.c. and repetitive peak		V	max.	350	V
Power dissipation at T_{amb} = 25 °C	See also sheet 4	P	max.	70	mW
Power dissipation at T_{amb} = 70 °C	See also sheet 4	P	max.	20	mW
Cell current, d.c. and repetitive peak		I	max.	7.5	mA
Ambient temperature, storage and operating		T_{amb}	min.	−40	°C
storage		T_{amb}	max.	+50	°C [1]
operating		T_{amb}	max.	+70	°C

[1]) Operation of the cell counteracts the deteriorating effect of long periods at high temperature. The maximum operating temperature is therefore higher than the maximum storage temperature.


7Z03516|15.18.16.fj
T_{amb}=25°C
Colour temperature = 2700 °K
1 lux
10 lux
50 lux
E=500 lux
P=70 mW
V (V)
1000
100
10
1
I_{Lo} (μA)
10000
1000
100
10
1
0.1


7Z03517–15.18.16.fj
P (mW)
80
60
40
20
0
Area of permissible operation
20
30
40
50
60
70
T_{amb} (°C)
80

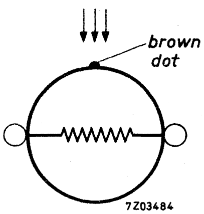
CADMIUM SULPHIDE PHOTOCONDUCTIVE CELL

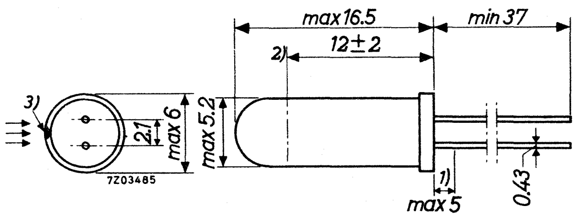
Cadmium sulphide photoconductive cell with side sensitivity intended for use in flame control and other industrial applications as well as for automatic brightness and contrast control in TV receivers.
The cell is shock and vibration resistant.

QUICK REFERENCE DATA				
Power dissipation at T_{amb} = 25 °C	P	max.	70	mW
Cell voltage, d.c. and repetitive peak	V	max.	350	V
Cell resistance at 50 lux, 2700 °K colour temperature	r_{lo}		60	kΩ
Spectral response curve		type D		
Outline dimensions		max. 6 dia. x 16.5		mm

MECHANICAL DATA

Dimensions in mm





Sensitive area 0.25 mm^2

Soldering

The cell may be soldered directly into the circuit but heat conducted to the seal should be kept to a minimum by the use of a thermal shunt. The cell may be dip-soldered at a solder temperature of 240 °C for a maximum of 10 s up to a point 5 mm from the seals.

1) Not tin plated

2) Centre of sensitive area

3) Brown dot

ELECTRICAL DATA

General

The electrical properties of CdS cells are dependent on many factors such as illumination, colour temperature of the light source, voltage, current, temperature, total time of operation in the circuit and time of operation during the last 24 hours prior to the measurement. The following basic characteristics are therefore only checkpoints of the electrical properties of these devices measured with defined values of the various conditions and at delivery.

Basic characteristics at T_{amb} = 25 °C, illumination with colour temperature of 2700 °K and at delivery

	symbol	min.	typical	max.	unit
Initial dark current measured at 300 V d.c. applied via 1 MΩ, 20 s after switching off the illumination	I_{do}			1.5	μA
Initial illumination current measured at 30 V d.c. and illumination = 50 lux, after 16 hrs in darkness [1])	I_{lo}	200	500	800	μA
Sensitivity at 50 lux, with 30 V d.c. applied	N		10		μA/lux

End of life characteristics at T_{amb} = 25 °C

Life test conditions: Illumination 50 to 100 lux, colour temperature about 2500 °K, P = 60 mW, T_{amb} = 35 °C

None of the end of life values stated under this heading are expected to be reached before 2500 operating hours under the following conditions:

Initial dark current measured at 300 V d.c., 20 s after switching off the illumination	I_{do}	max. 3	μA
Change of initial illumination current during life measured at 30 V d.c., illumination = 50 lux and colour temperature = 2700 °K, after 16 hrs in darkness	ΔI_{lo}	max. 60	%

[1]) After 16 hours in darkness changes in the CdS material are still occurring, but have only insignificant effect on the illumination resistance and on the resistance decay time.

SHOCK AND VIBRATION

An indication for the ruggedness of the device is the following:
Samples taken from normal production are submitted to shock and vibration tests mentioned below. More than 95% of the devices pass these tests without perceptible damage.

Shock

25 g_{peak}, 3000 shocks in one of the three positions of the cell.

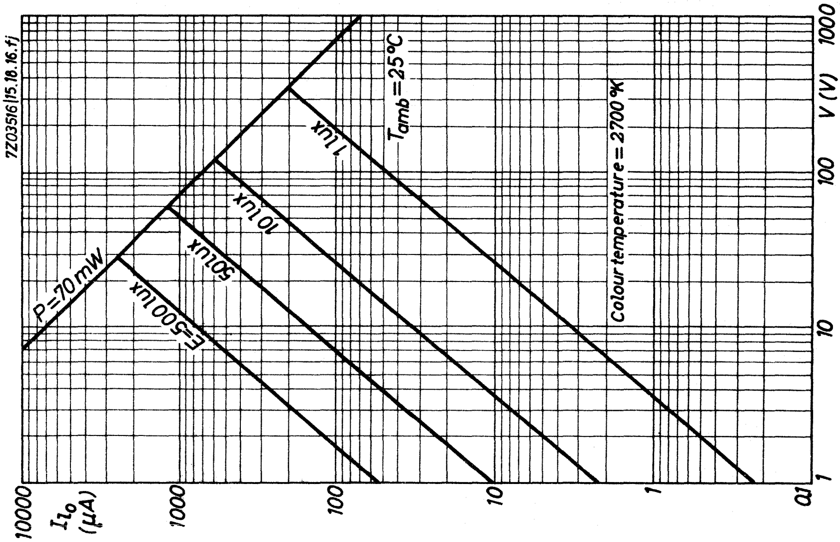
Vibration

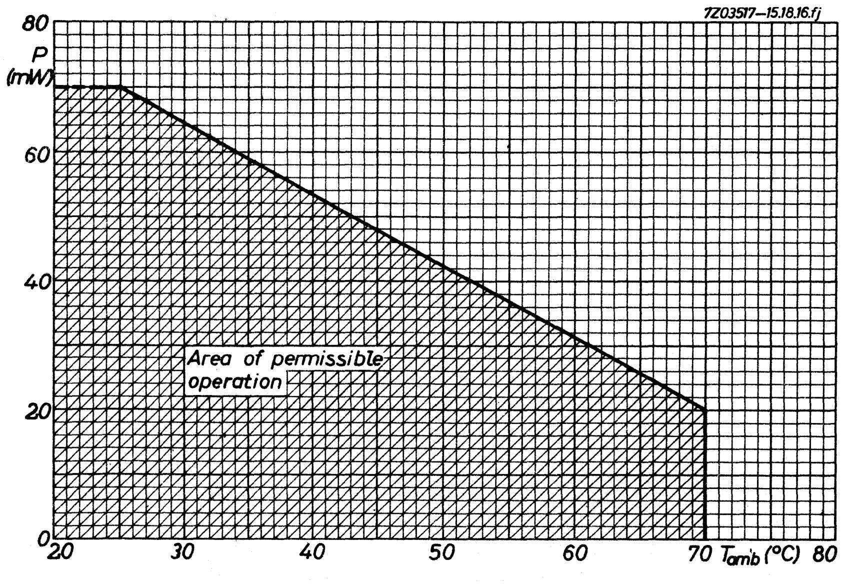
2.5 g_{peak}, 50 Hz during 32 hours in each of the three positions of the cell.

LIMITING VALUES (Absolute max. rating system)

Cell voltage, d.c. and repetitive peak		V	max. 350	V
Power dissipation at T_{amb} = 25 °C	See also sheet 4	P	max. 70	mW
Power dissipation at T_{amb} = 70 °C	See also sheet 4	P	max. 20	mW
Cell current, d.c. and repetitive peak		I	max. 7.5	mA
Ambient temperature,	storage and operating	T_{amb}	min. −40	°C
	storage	T_{amb}	max. +50	°C [1]
	operating	T_{amb}	max. +70	°C

[1] Operation of the cell counteracts the deteriorating effect of long periods at high temperature. The maximum operating temperature is therefore higher than the maximum storage temperature.


7Z03516|15.18.16.fj
T_amb = 25°C
Colour temperature = 2700 °K
P = 70 mW
1 lux
10 lux
50 lux
E = 5000 lux
V (V)
1000
100
10
1
I_lo (µA)
10000
1000
100
10
1
0.1

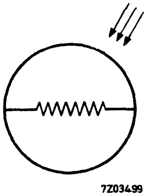

7Z03517–15.18.16.fj
80
P (mW)
60
40
20
0
Area of permissible operation
20
30
40
50
60
70
T_amb (°C)
80

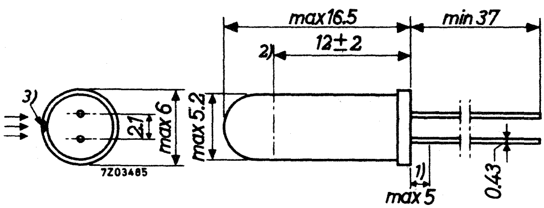
CADMIUM SULPHIDE PHOTOCONDUCTIVE CELL

Cadmium sulphide photoconductive cell with side sensitivity intended for use in industrial on-off applications such as flame failure circuits.
The cell is tropic proof, shock and vibration resistant.

QUICK REFERENCE DATA				
Power dissipation at T_{amb} = 25 °C	P	max.	100	mW
Cell voltage, d.c. and repetitive peak	V	max.	350	V
Cell resistance at 50 lux, 2700 °K colour temperature	r_{l_0}		45	kΩ
Spectral response curve		type D		
Outline dimensions		max. 6 dia x 16.5		mm

MECHANICAL DATA Dimensions in mm





Soldering

The cell may be soldered directly into the circuit but heat conducted to the seal should be kept to a minimum by the use of a thermal shunt. The cell may be dip-soldered at a solder temperature of 240 °C for a maximum of 10 s up to a point 5 mm from the seals.

1) Not tinned

2) Centre of sensitive area

3) Red dot

ELECTRICAL DATA

General

The electrical properties of CdS cells are dependent on many factors such as illumination, colour temperature of the light source, voltage, current, temperature, total time of operation in the circuit and time of operation during the last 24 hours prior to the measurement. The following basic characteristics are therefore only checkpoints of the electrical properties of these devices measured with defined values of the various conditions and at delivery.

Basic characteristics at T_{amb} = 25 °C, illumination with colour temperature of 2700 °K and at delivery.

	symbol	min.	typical	max.	unit
Initial dark resistance measured with 300 V d.c. applied via 1 MΩ, 20 s after switching off the illumination	r_{d_o}	150		1)	MΩ
Initial illumination resistance measured at 30 V d.c., illumination 50 lux, after 16 h in darkness 2)	r_{l_o}	30	45	100	kΩ
Equilibrium illumination resistance measured at 30 V d.c., illumination 50 lux, after 15 min. under the measuring conditions	r_{l_e}	30	60	170	kΩ
Current rise time	t_{r_i}		see page 6		
Current decay time	t_{f_i}		see page 7		
Sensitivity at 50 lux, with 30 V d.c. applied	N		13		μA/lux
Negative temperature response of illumination resistance	$\Delta r_l/\Delta T$		0.2	0.5	%/°C
Voltage respons $\frac{\text{r at 0.5 V d.c.}}{\text{r at 30 V d.c.}}$			1.4		

1) The spread of the dark resistance is large and values higher than 1000 MΩ are possible for the initial dark resistance.

2) After 16 hours in darkness changes in the CdS material are still occurring, but have only insignificant effect on the illumination resistance and on the current rise time.

THERMAL DATA

Continuous temperature of CdS tablet	T_{tablet}	max. + 85	°C
Thermal resistance from CdS tablet to ambient, device free in air	K	600	°C/W

DESIGN CONSIDERATIONS

Apparatus with CdS cells should be designed so that changes in resistance values of the cells during life from −30 % to + 70 % do not impair the circuit performance. Direct sunlight irradiation should be avoided.

SHOCK AND VIBRATION

An indication for the ruggedness of the cell is the following:
Samples taken from normal production are submitted to shock and vibration tests mentioned below. More than 95% of the devices pass these tests without perceptible damage.

Shock

25 g_{peak}, 10000 shocks in one of the three positions of the cell.

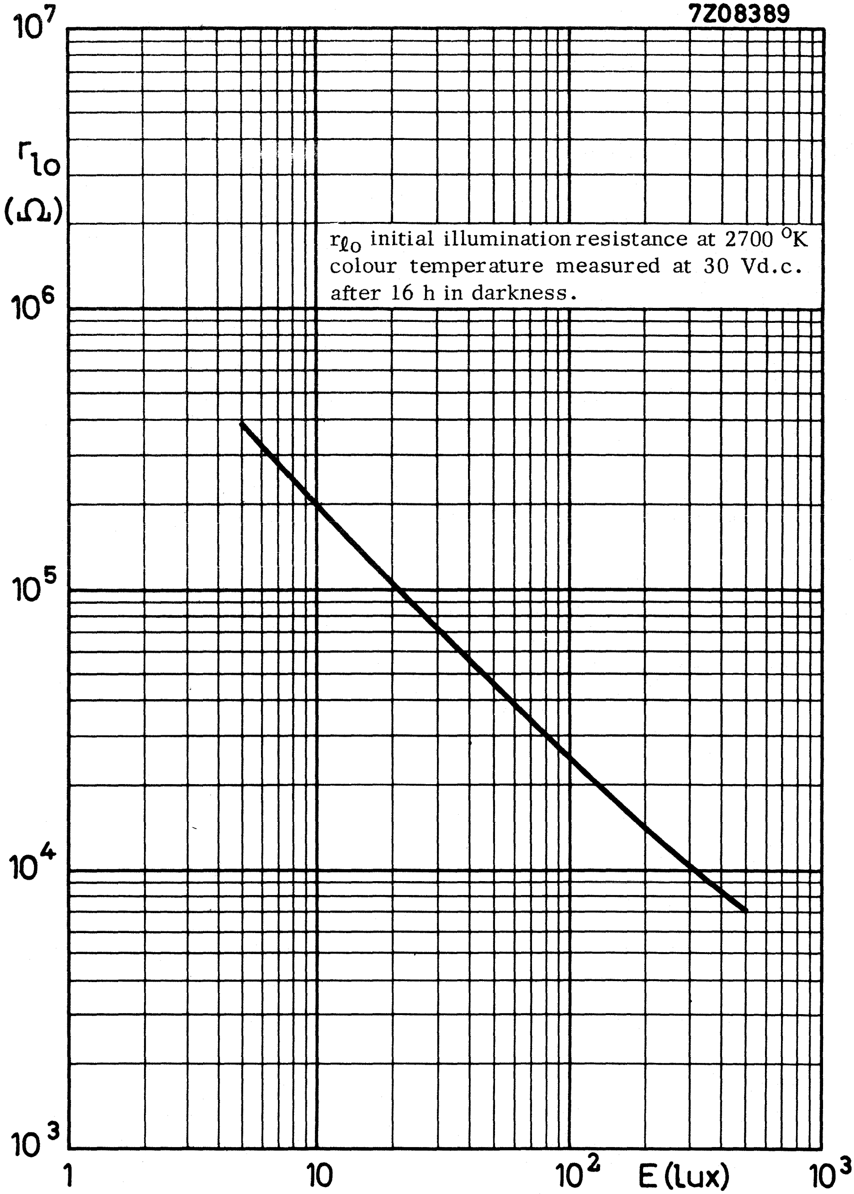
Vibration

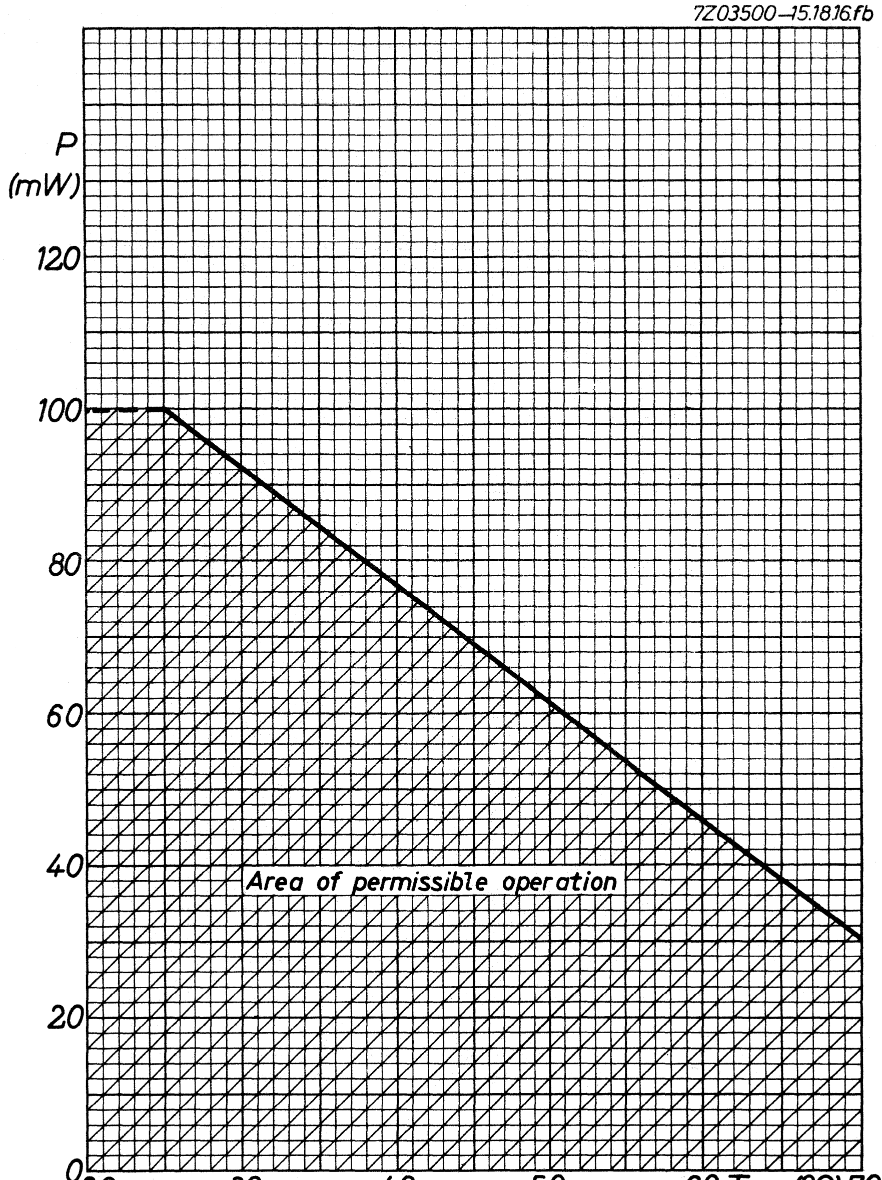
2.5 g_{peak}, 50 Hz, during 32 hours in each of the three positions of the cell.

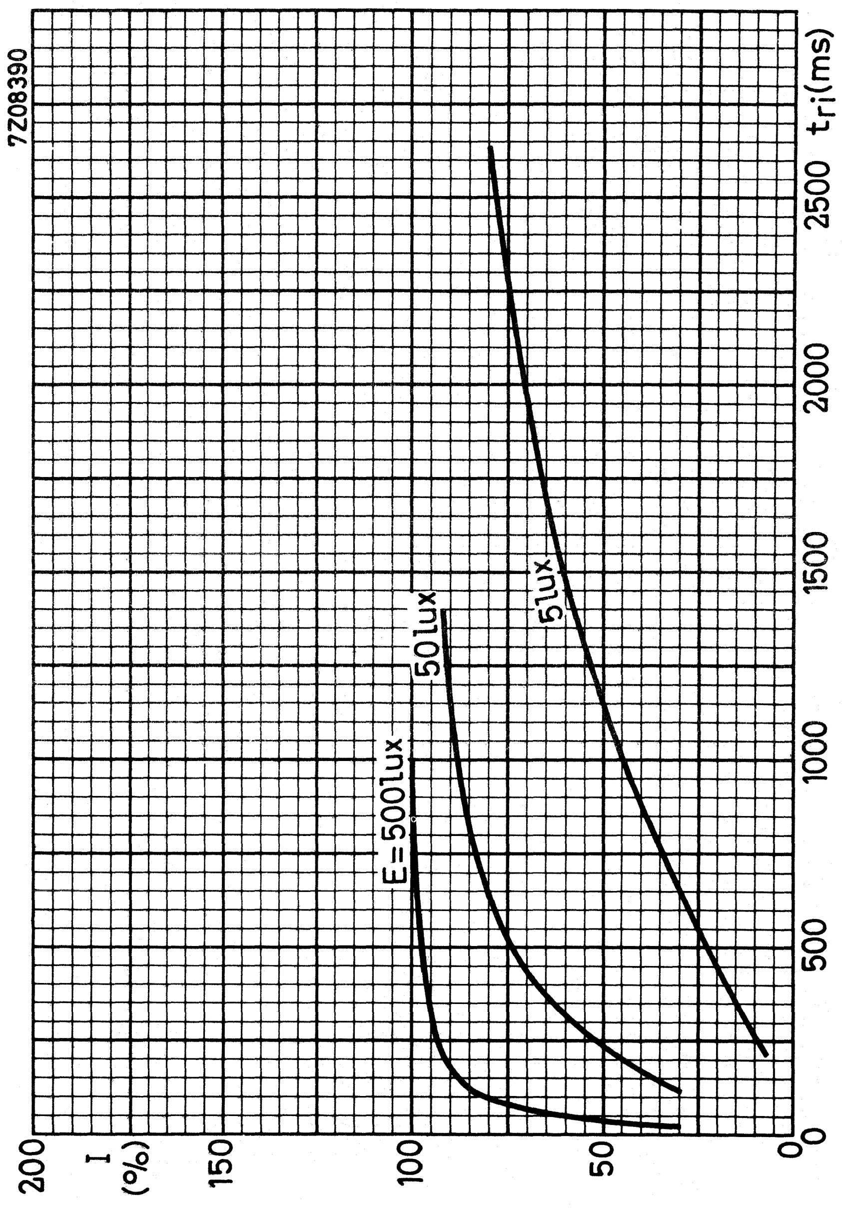
LIMITING VALUES (Absolute max. rating system)

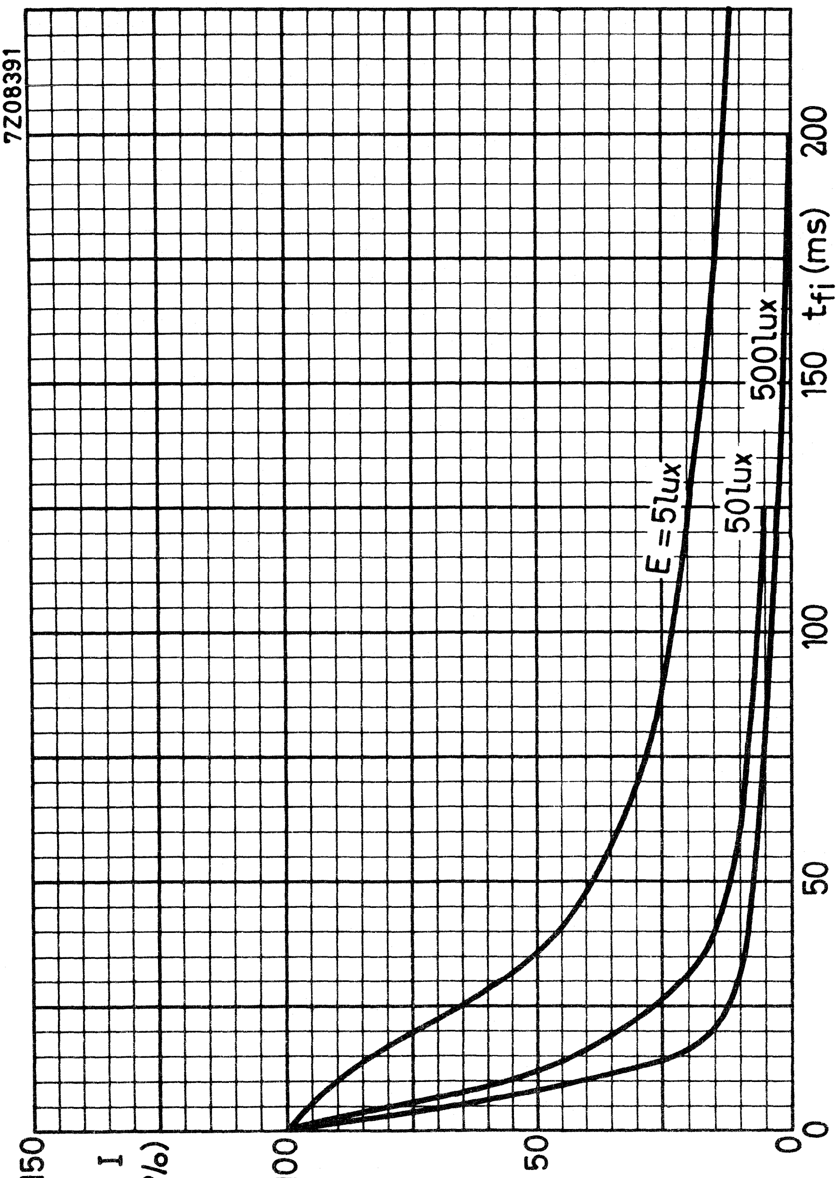
Cell voltage, d.c. and repetitive peak	V	max. 350	V
Cell voltage, pulse, t_{imp} = max. 5 ms p.r.r. max. once per minute	V_p	max. 1000	V
Power dissipation, t_{av} = 2 s	P	see page 5	
Power dissipation, pulse	P_p	max. 5 x P	
Temperature CdS tablet, operating	T_{tablet}	max. 85	°C
Ambient temperature, storage and operating	T_{amb}	min. −40	°C
storage	T_{amb}	max. +50	°C 1)
operating	T_{amb}	max. +70	°C

1) Operation of the cell counteracts the deteriorating effect of long periods at high temperature. The maximum operating temperature is therefore higher than the maximum storage temperature.


7Z08389
10^7
r_{lo}
(Ω)
$r_{\ell o}$ initial illumination resistance at 2700 °K colour temperature measured at 30 Vd.c. after 16 h in darkness.
10^6
10^5
10^4
10^3
1
10
10^2
E (lux)
10^3


7Z03500–15.18.16.fb
P
(mW)
120
100
80
60
40
20
0
Area of permissible operation
20
30
40
50
60
T_{amb} (°C)
70


7Z08390
t_ri (ms)
2500
2000
1500
1000
500
0
200
I
(%)
150
100
50
E = 500lux
50lux
5lux


7Z08391
E = 5lux
50lux
500lux
t_fi (ms)
I (%)
0
50
100
150
200

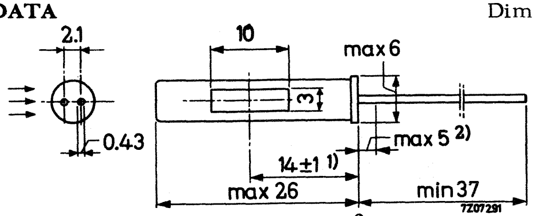
CADMIUM SULPHIDE PHOTOCONDUCTIVE CELL

Cadmium sulphide photoconductive cell with side sensitivity.
The cell is tropic proof, shock- and vibration resistant.

QUICK REFERENCE DATA				
Power dissipation	P	max.	75	mW
Cell voltage, d.c. and repetitive peak	V	max.	100	V
Cell resistance at 50 lux, 2700 °K colour temperature	r_{lo}		1600	Ω
Spectral response		type D		
Outline dimensions			6 dia. x 26	mm

MECHANICAL DATA

Dimensions in mm



Total area to be illuminated 0.3 cm^2

Sensitive part of this area 0.15 cm^2

Soldering

The cell may be soldered directly into the circuit but heat conducted to the seal should be kept to a minimum by the use of a thermal shunt. The cell may be dip-soldered at a solder temperature of 240 °C for a maximum of 10 s up to a point 5 mm from the seal.

1) Centre of sensitive area.

2) Not tin plated.
Care should be taken not to bend the leads nearer than 1.5 mm to the seal.

ELECTRICAL DATA

General

The electrical properties of CdS cells are dependent on many factors such as illumination, colour temperature of the light source, voltage, current, temperature, total time of operation in the circuit and time of operation during the last 24 hours prior to the measurement. The following basic characteristics are therefore only checkpoints of the electrical properties of these devices measured with defined values of the various conditions and at delivery.

Basic characteristics at T_{amb} = 25 °C, illumination with colour temperature = 2700 °K and at delivery

	Symbol	min.	typical	max.	unit
Initial dark resistance measured with 100 V d.c. applied via 1 MΩ 20 s after switching off the illumination	r_{do}	9		[1]	MΩ
Equilibrium dark resistance measured with 100 V d.c. applied via 1 MΩ, 30 min. after switching off the illumination	r_{de}	250		[1]	MΩ
Initial illumination resistance measured at V = 10 V, illumination 50 lux, after 16 hours in darkness [2]	r_{lo}	750	1600	2500	Ω
Equilibrium illumination resistance measured at V = 10 V, illumination 50 lux, after 15 minutes under the measuring conditions	r_{le}	750	1920	3250	Ω
Current rise time Time to reach 90% of its initial illumination current, measured from the instant of starting the illumination of 50 lux, at V = 10 V, after 16 hours in darkness	t_{ri}		1000		ms

[1] The spread of the dark resistance is large and values higher than 30 MΩ and 2000 MΩ are possible for the initial dark resistance and the equilibrium dark resistance respectively.

[2] After 16 hours in darkness changes in the CdS material are still occurring, but have only insignificant effect on the illumination resistance and on the resistance decay time.

ELECTRICAL DATA (continued)

	Symbol	min.	typical	max.	unit
Current decay time Time to reach 10% of its initial illumination current, measured from the instant of stopping the illumination of 50 lux, at V = 10 V, after 16 hours in darkness	t_{fi}		75		ms
Sensitivity at 50 lux, with V = 10 V d.c. applied	N		0.15		mA/lux
Negative temperature response of the illumination resistance			0.2	0.5	%/°C
Voltage response $\frac{\text{r at 0.5 V}}{\text{r at 10 V}}$	α		1.5		

DESIGN CONSIDERATIONS

It should be noted that this cell is designed for very high typical sensitivity with respect to its sensitive area, but that it may be expected that a high sensitivity will only be maintained if the dissipation averaged over 2 s is kept below 20 mW at 25 °C. Higher dissipations will accelerate the aging process which lowers sensitivity.

SHOCK AND VIBRATION

An indication for the ruggedness of the cell is the following:
Samples taken from normal production are submitted to shock and vibration tests mentioned below: More than 95% of the devices pass these tests without perceptible damage.

Shock

25 g_{peak}, 10000 shocks in one of the three positions of the cell.

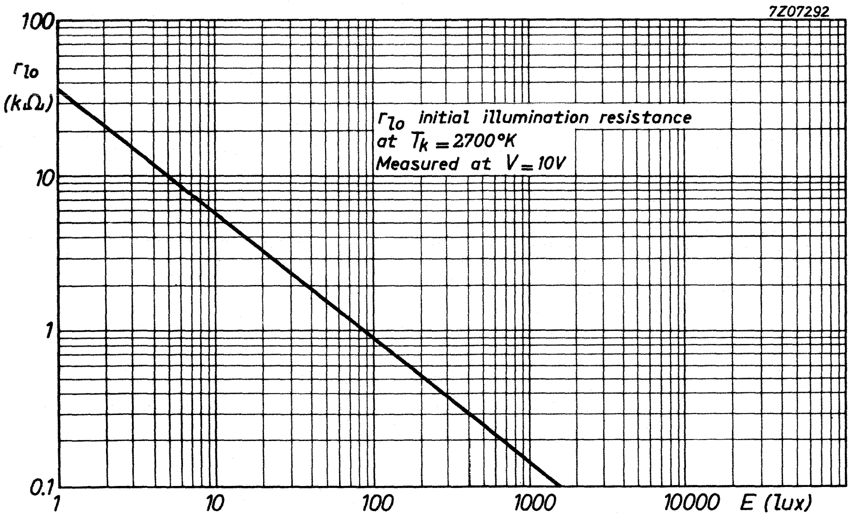
Vibration

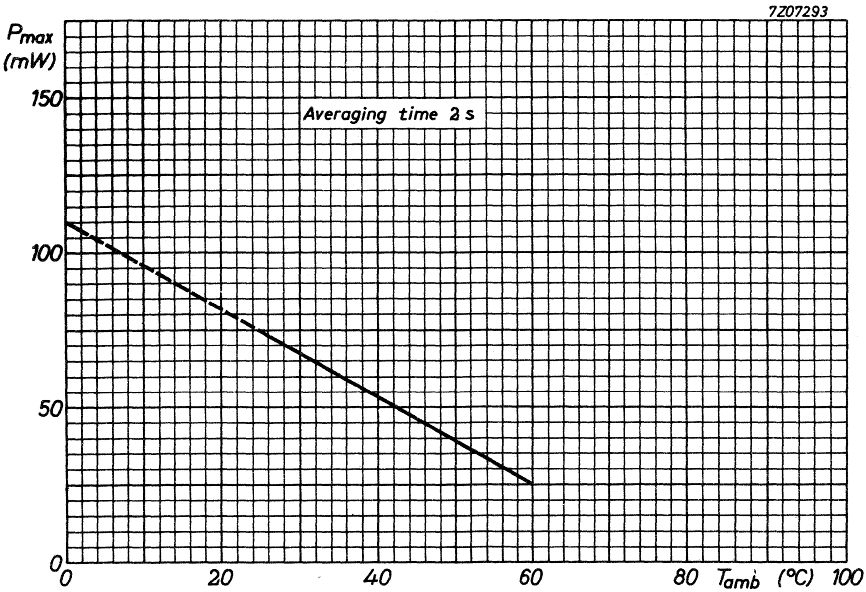
2.5 g_{peak}, 50 Hz, during 32 hours in each of the three positions of the cell.

LIMITING VALUES (Absolute max. rating system)

Cell voltage, d.c. and repetitive peak		V	max.	100	V
Power dissipation, t_{av} = 2 s		P	see sheet 5		
Ambient temperature,	storage and operating	T_{amb}	min.	−40	°C
	Storage	T_{amb}	max.	+40	°C [1])
	Operating	T_{amb}	max.	+70	°C

1) Operation of the cell counteracts the deteriorating effect of long periods at the high temperature. The maximum operating temperature is therefore higher than the maximum storage temperature.


7Z07292
100
r_{lo}
(kΩ)
10
1
0.1
1
10
100
1000
10000
E (lux)
r_{lo} initial illumination resistance
at $T_k = 2700$°K
Measured at V = 10V

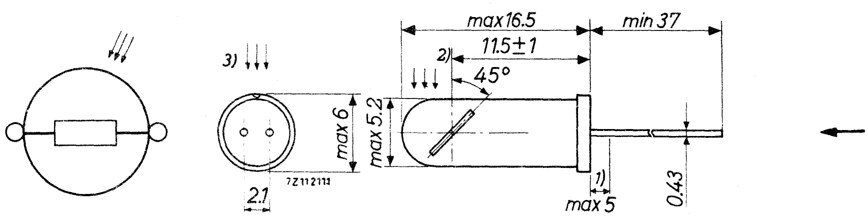

7Z07293
P_{max}
(mW)
150
100
50
0
0
20
40
60
80
T_{amb} (°C)
100
Averaging time 2 s

CADMIUM SULPHIDE PHOTOCONDUCTIVE CELL

Cadmium sulphide photoconductive cell with side and top sensitivity for use in flame control and other industrial on off applications.
The cell is tropic proff, shock and vibration resistant.

QUICK REFERENCE DATA				
Power dissipation at T_{amb} = + 25 °C	P	max.	100	mW
Cell voltage, d.c. and repetitive peak	V	max.	350	V
Cell resistance top sensitivity at 50 lux, 2700 °K colour temperature	r_{lo}		30	kΩ
Spectral response curve		type D		
Outline dimensions		max. 6 dia x 16.5		mm

MECHANICAL DATA Dimensions in mm



Soldering

The cell may be soldered directly into the circuit but heat conducted to the seal should be kept to a minimum by the use of a thermal shunt. The cell may be dip-soldered at a solder temperature of 240 °C for a maximum of 10 s up to a point 5 mm from the seals.

1) Not tin plated
2) Centre of sensitive area
3) White dot

ELECTRICAL DATA

General

The electrical properties of CdS cells are dependent on many factors such as illumination, colour temperature of the light source, voltage, current, temperature, total time of operation in the circuit and time of operation during the last 24 hours prior to the measurement. The following basic characteristics are therefore only checkpoints of the electrical properties of these devices measured with defined values of the various conditions and at delivery.

Basic characteristics at T_{amb} = 25 °C, illumination with colour temperature of 2700 °K and at delivery

	symbol	min.	typical	max.	unit
Initial dark resistance measured with 300 V d.c. applied via 1 MΩ, 20 s after switching off the illumination	r_{do}	100		[1])	MΩ
Initial illumination resistance measured at 30 V d.c., illumination = 50 lux, after 16 hours in darkness 2) 3)	r_{lo}	20	30	60	kΩ
Ratio side/top sensitivity	r_{le}side/top	0.7	1.0	1.8	
Equilibrium illumination resistance measured at 30 V d.c. illumination = 50 lux, after 15 minutes under the measuring conditions 3)	r_{le}	27	46	115	kΩ
Current rise time	t_{ri}	see	sheet 7		
Current decay time	t_{fi}	see	sheet 8		

[1]) The spread of the dark resistance is large and values higher than 1000 MΩ are possible for the initial dark resistance.

[2]) After 16 hours in darkness changes in the CdS material are still occurring, but have only insignificant effect on the illumination resistance and on the resistance decay time.

[3]) Measured at top sensitivity.

Basic characteristics at T_{amb} = 25 °C , illumination with colour temperature of 2700 °K and at delivery (continued)

	symbol	min.	typical	max.	unit
Sensitivity at 50 lux, with 30 V d.c. applied 3)	N		17		μA/lux
Negative temperature response of illumination resistance	$\Delta r_l/\Delta T$		0.2	0.5	%/ °C
Voltage response $\frac{\text{r at 0.5 V d.c.}}{\text{r at 30 V d.c.}}$	α		1.4		

THERMAL DATA

Continous temperature of CdS tablet	T_{tablet}	max. + 85 °C
Thermal resistance from CdS tablet to ambient, device free in air	K	600 °C/W

DESIGN CONSIDERATIONS

Apparatus with CdS cells should be designed so that changes in resistance values of the cells during life from −30% to +100% do not impair the circuit performance. Direct sunlight irradiation should be avoided.

SHOCK AND VIBRATION

An indication for the ruggedness of the cell is the following:
Samples taken from normal production are submitted to shock and vibration tests mentioned below. More than 95% of the devices pass these tests without perceptible damage.

Shock

25 g_{peak}, 10 000 shocks in one of the three positions of the cell.

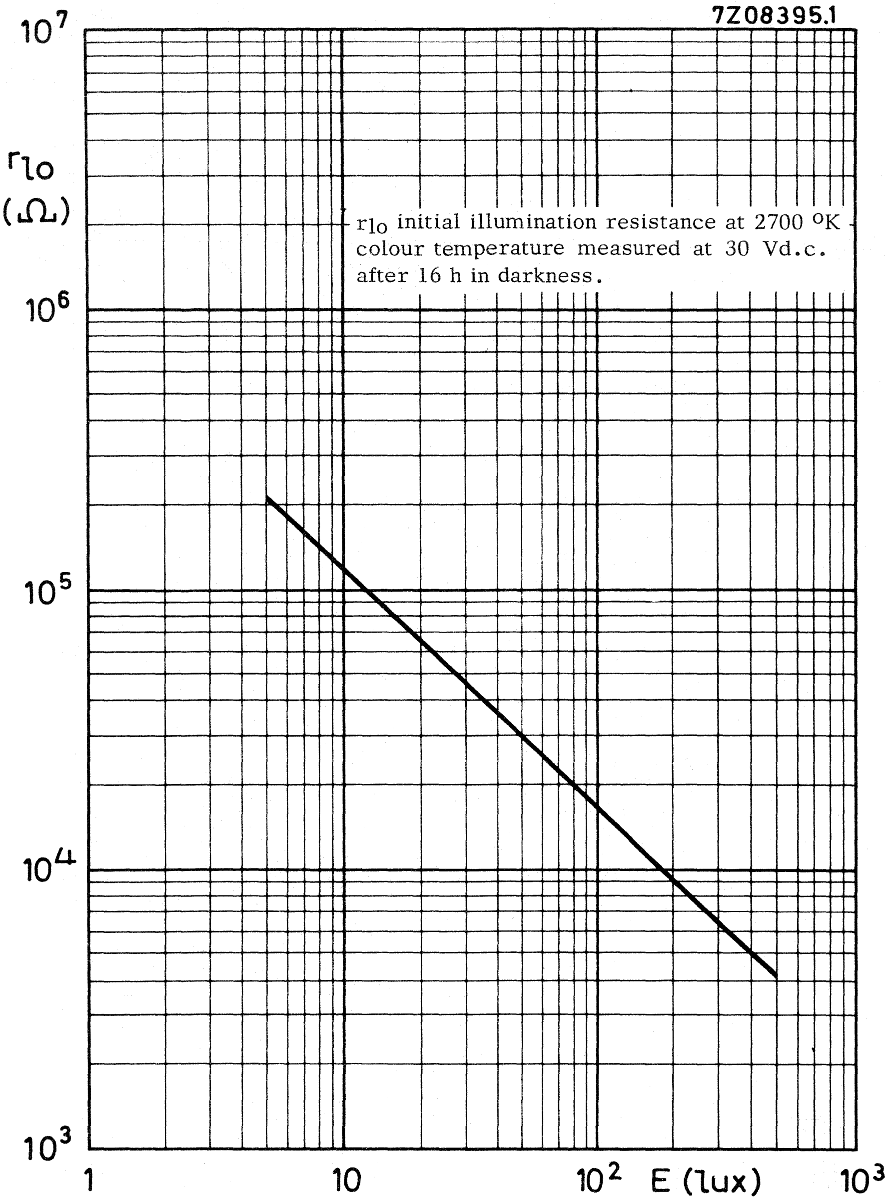
Vibration

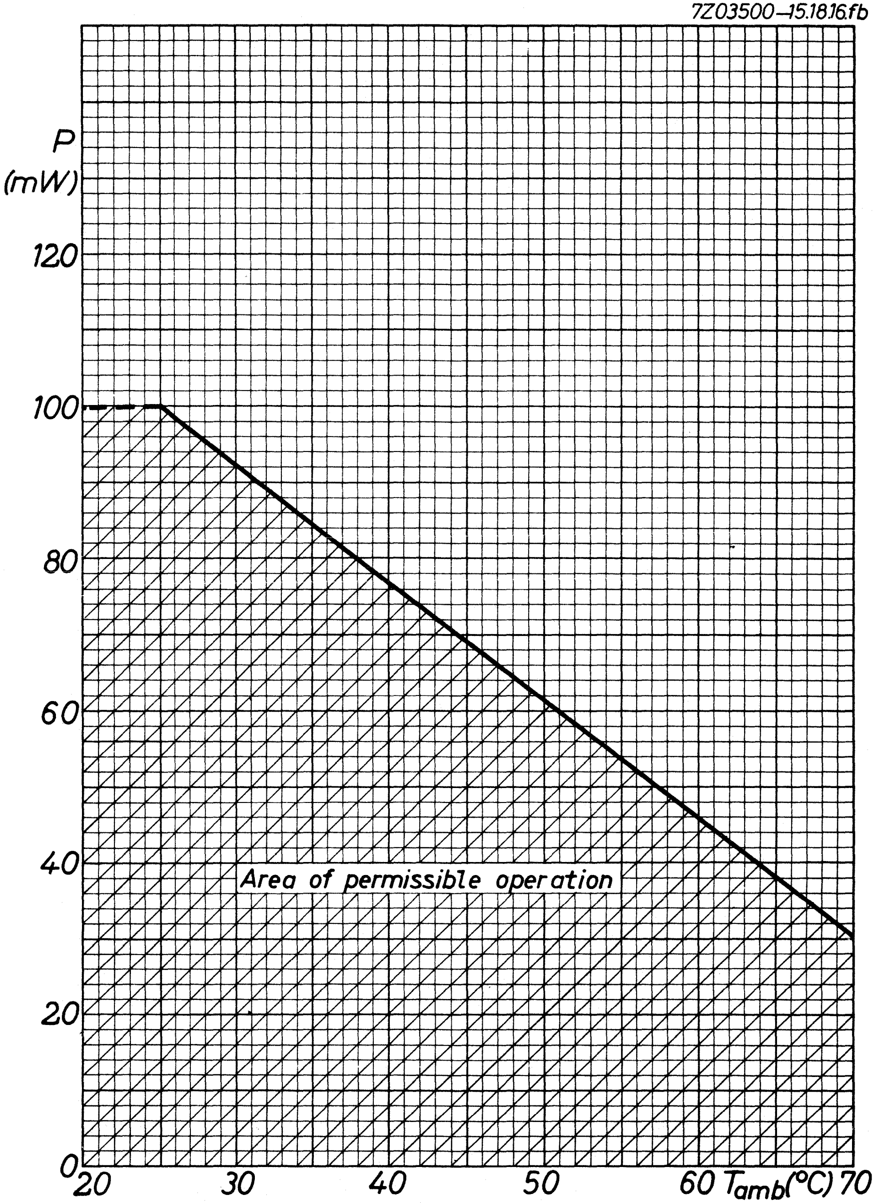
2.5 g_{peak}, 50 Hz, during 32 hours in each of the three positions of the cell.

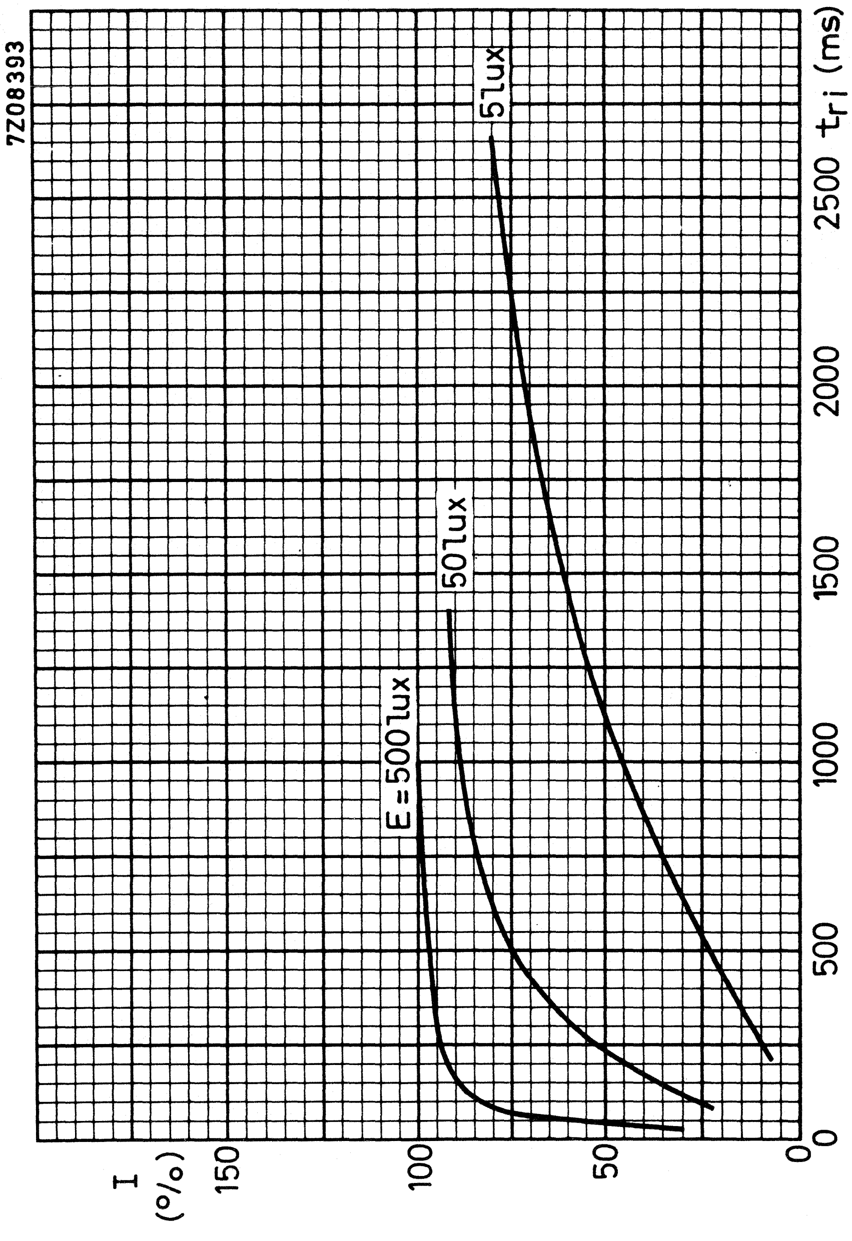
LIMITING VALUES Absolute max. rating system)

Cell voltage, d.c. and repetitive peak	V	max.	350	V
Cell voltage, pulse, t_{imp} = max. 5 ms p.r.r. = max. once per minute	V_p	max.	700	V
Power dissipation, t_{av} = 2 s	P	See sheet 6		
Power dissipation, pulse	P_p	max.	5xP	
Temperature CdS tablet, operating	T_{tablet}	max.	+85	°C
Ambient temperature, storage and operating	T_{amb}	min.	-40	°C
storage	T_{amb}	max.	+50	°C 1)
operating	T_{amb}	max.	+70	°C

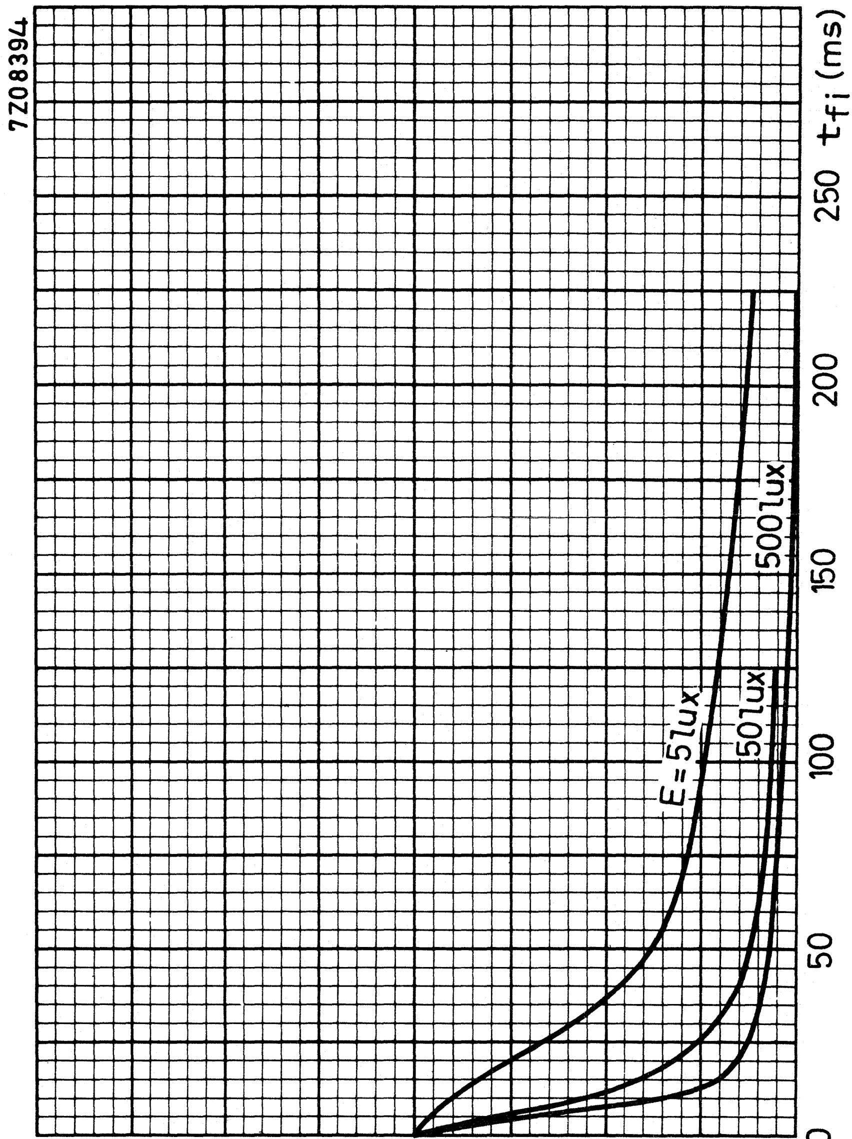
[1]) Operation of the cell counteracts the deteriorating effect of long periods at high temperature. The maximum operating temperature is therefore higher than the maximum storage temperature.


7Z08395.1
r_{lo} (Ω)
10^7
10^6
10^5
10^4
10^3
r_{lo} initial illumination resistance at 2700 °K colour temperature measured at 30 Vd.c. after 16 h in darkness.
1
10
10^2
E (lux)
10^3


7Z03500–15.18.16.fb
P
(mW)
120
100
80
60
40
20
0
20
30
40
50
60
T_{amb}(°C)
70
Area of permissible operation



7Z08393
t_ri (ms)
0
500
1000
1500
2000
2500
I
(%)
150
100
50
0
E = 500 lux
50 lux
5 lux

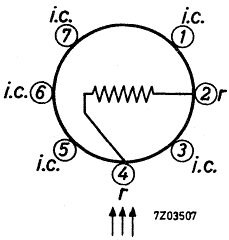

7Z08394
t_fi (ms)
250
200
150
100
50
0
I
(%)
150
100
50
0
E = 5 lux
50 lux
500 lux

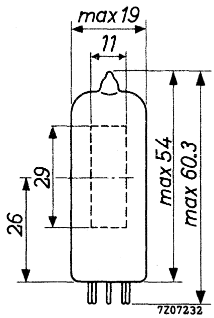
CADMIUM SULPHIDE PHOTOCONDUCTIVE CELL

Cadmium sulphide photoconductive cell with side sensitivity intended for use in flame control, smoke detector or industrial on-off switching applications. The cell is shock and vibration resistant.

QUICK REFERENCE DATA				
Power dissipation at T_{amb} = 25 °C	P	max.	1	W
Cell voltage, d.c. and repetitive peak	V	max.	350	V
Cell resistance at 50 lux, 2700 °K colour temperature	r		1000	Ω
Spectral response curve		type D		
Outline dimensions		max. 19 dia. x 60.3		mm

MECHANICAL DATA Dimensions in mm





Base: 7 p. miniature

Total area to be illuminated 1.1 x 2.9 cm^2

ELECTRICAL DATA

General

The electrical properties of CdS cells are dependent on many factors such as illumination, colour temperature of the light source, voltage current, temperature, total time of operation in the circuit and time of operation during the last 24 hours prior to the measurement. The following basic characteristics are therefore only checkpoints of the electrical properties of these devices measured with defined values of the various conditions and at delivery.

Basic characteristics at T_{amb} = 25 ^{o}C, illumination with colour temperature of 2700 ^{o}K and at delivery.

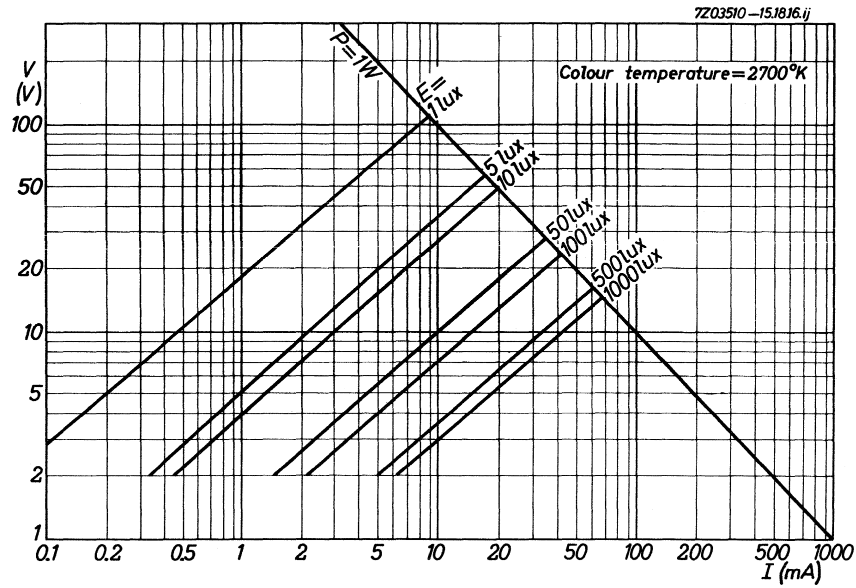
	symbol	min.	typical	max.	unit
Initial dark current measured with 300 V d.c. applied via 1 MΩ, 20 s after switching off the illumination	I_{do}			70	μA
Equilibrium dark current measured with 300 V d.c. applied via 1 MΩ, 15 minutes after switching off the illumination	I_{do}			2.5	μA
Initial illumination current measured at 10 V d.c. and illumination = 50 lux, after 16 hrs in darkness [1])	I_{lo}	3	10	15	mA
Initial illumination current measured at 10 V d.c., illumination = 50 lux and colour temperature = 1500 ^{o}K, after 16 hrs in darkness	I_{lo}	6	20	31	mA
Sensitivity at 50 lux, with 10 V d.c. applied	N		0.2		mA/lux
Current rise time	t_{ri}		see sheet 5		
Current decay time	t_{fi}		see sheet 5		

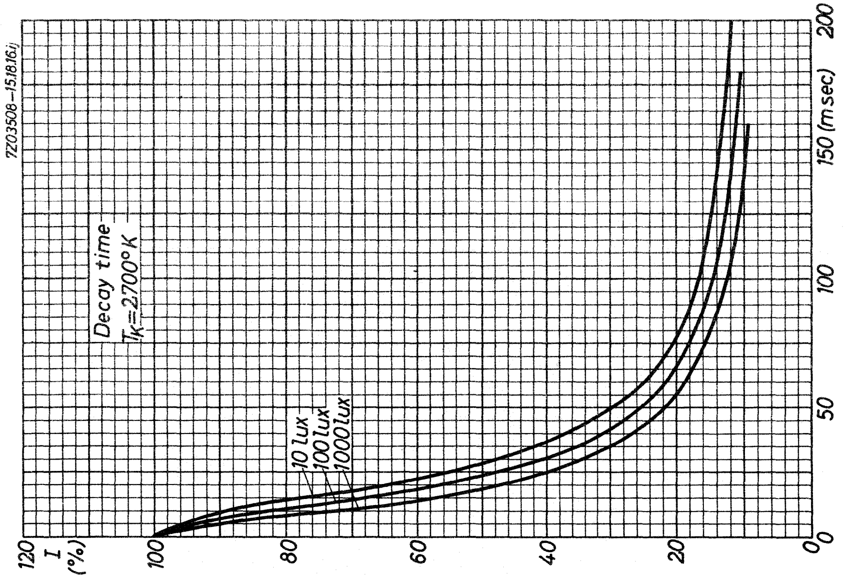
[1]) After 16 hours in darkness changes in the CdS material are still occurring, but have only insignificant effect on the illumination resistance and on the resistance decay time.

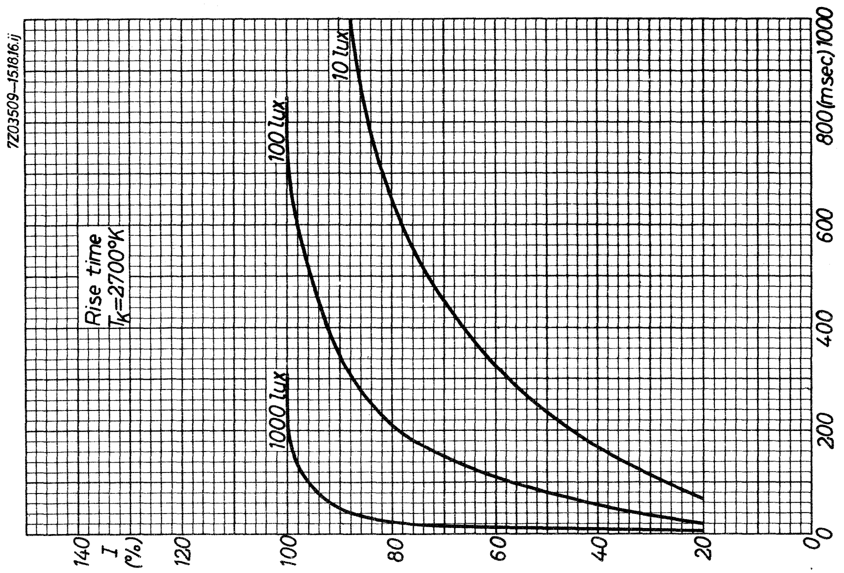
LIMITING VALUES (Absolute max. rating system)

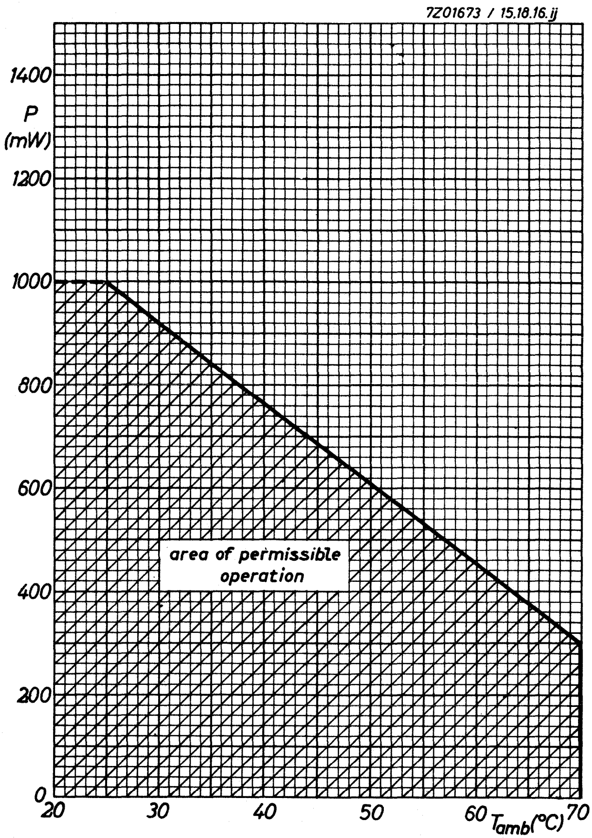
Cell voltage, d.c. and repetitive peak		V	max.	350	V
Power dissipation at T_{amb} = 25 °C	See also sheet 6	P	max.	1.0	W
Power dissipation at T_{amb} = 70 °C		P	max.	0.3	W
Ambient temperature, storage and operating		T_{amb}	min.	−40	°C
storage		T_{amb}	max.	+50	°C [1]
operating		T_{amb}	max.	+70	°C

[1] Operation of the cell counteracts the deteriorating effect of long periods at high temperature. The maximum operating temperature is therefore higher than the maximum storage temperature.


7Z03510 –15.1816.ij
V
(V)
100
50
20
10
5
2
1
0.1
0.2
0.5
1
2
5
10
20
50
100
200
500
1000
I (mA)
P=1W
E=
1lux
5lux
10lux
50lux
100lux
500lux
1000lux
Colour temperature=2700°K


7Z03508-15.18.16.ij
Decay time
T_K=2700°K
10 lux
100 lux
1000 lux
I
(%)
120
100
80
60
40
20
0
0
50
100
150 (msec)
200


7Z03509-15.18.16.ij
Rise time
T_K=2700°K
1000 lux
100 lux
10 lux
140
I
(%)
120
100
80
60
40
20
0
0
200
400
600
800 (msec) 1000


7Z01673 / 15.18.16.ij
1400
P
(mW)
1200
1000
800
600
400
200
0
area of permissible operation
20
30
40
50
60
T_{amb}(°C)
70

LAMP CdS CELLS-COMBINATION

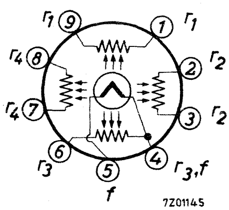
Combination of four cadmium sulphide photoconductive cells and a small incandescent lamp in a Noval envelope for use in relais circuits with low output resistance, control circuits and logic circuits.

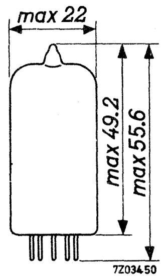
QUICK REFERENCE DATA				
Power dissipation, each cell, at T_{amb} = 25 °C	P	max.	150	mW
Cell voltage, d.c. and repetitive peak	V	max.	200	V
Cell resistance	r		15	Ω
Outline dimensions		max. 22 dia. x 55.6		mm

MECHANICAL DATA

Dimensions in mm

Base: Noval





ELECTRICAL DATA

Basic characteristics at T_{amb} = 25 °C, and at delivery

	symbol	min.	typical	max.	unit
Lamp filament voltage	V_f		24		V 2)
Lamp filament current at V_f = 24 V	I_f	54	60	66	mA
Initial dark current measured in the circuit of fig.1	I_{do}			15	μA

Basic characteristics at T_{amb} = 25 °C, and at delivery (continued)

	symbol	min.	typical	max.	unit
Initial illumination resistance measured in the circuit of fig.1 after 16 hrs in darkness [1])	r_{lo}		15	25	Ω
Resistance decay time Time to reach 400 Ω in circuit of fig.2, measured from the instant of starting the illumination after 16 hrs in darkness	t_{fr}		20		ms
Resistance rise time Time to reach 300 kΩ in circuit of fig.2, measured from the instant of stopping the illumination after 5 minutes or longer illumination	t_{rr}			1.7	s
Insulation resistance between two cells or between cell and filament measured at 300 V d.c.	r_{ins}	200			MΩ

CAPACITANCES measured at filament voltage V_f = 0 V

Between the terminals of each cell	C_r		9.5	pF
Between any cell terminal and the filament (except pins 4 and 6)	C_{rf}	max.	1	pF

REMARK

Shock and vibration should be avoided.

LIMITING VALUES (Absolute max. rating system)

Filament voltage (d.c. or r.m.s.)	V_f	max.	25.2	V	[2])
Cell voltage, d.c. and repetitive peak	V	max.	200	V	
Power dissipation of each cell at T_{amb} = 25 °C	P	max.	150	mW	[3])
Power dissipation of each cell at T_{amb} = 55 °C	P	max.	85	mW	[3])
Voltage between any pair of cells	V_{ri}-V_{rj}	max.	350	V	
Ambient temperature, operating	T_{amb}	min.	-40	°C	
		max.	+55	°C	[3])

Measuring circuit for r_{lo} and I_{do}

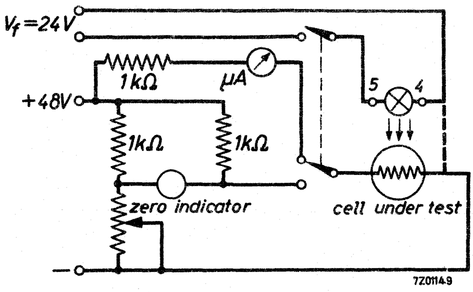


Fig.1

Measuring circuit t_{fr} and t_{rr}

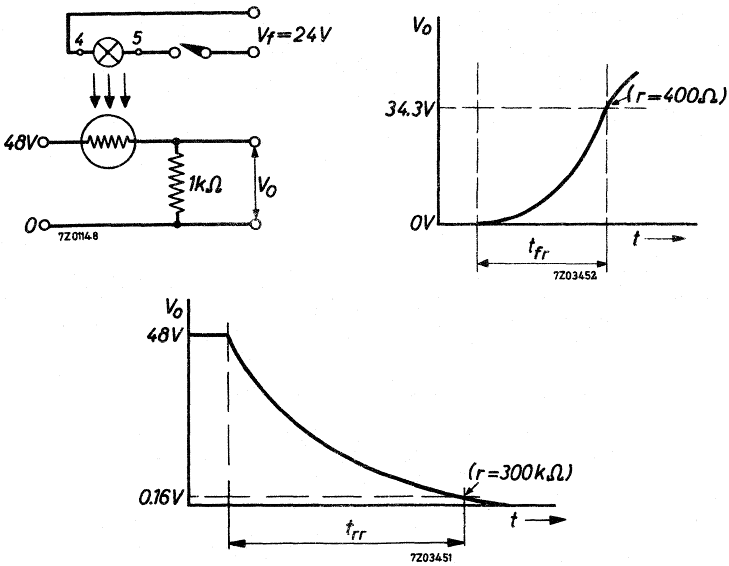
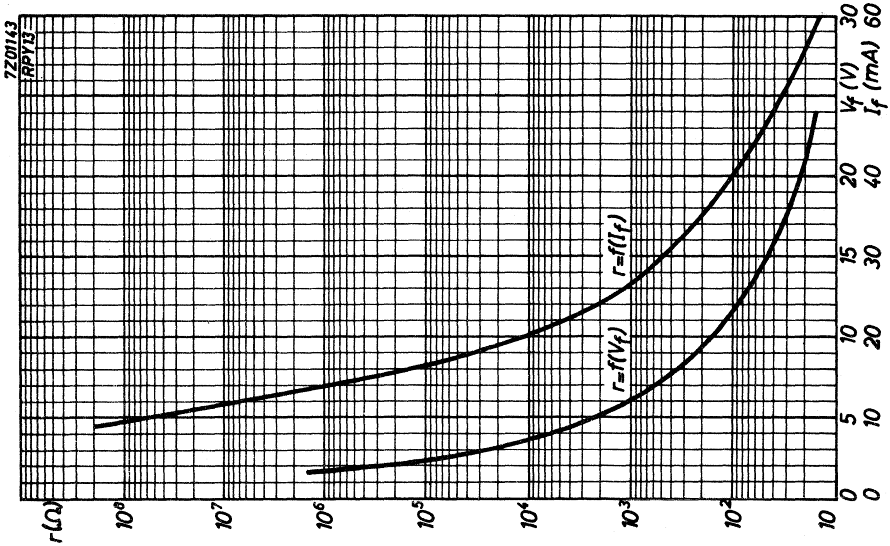


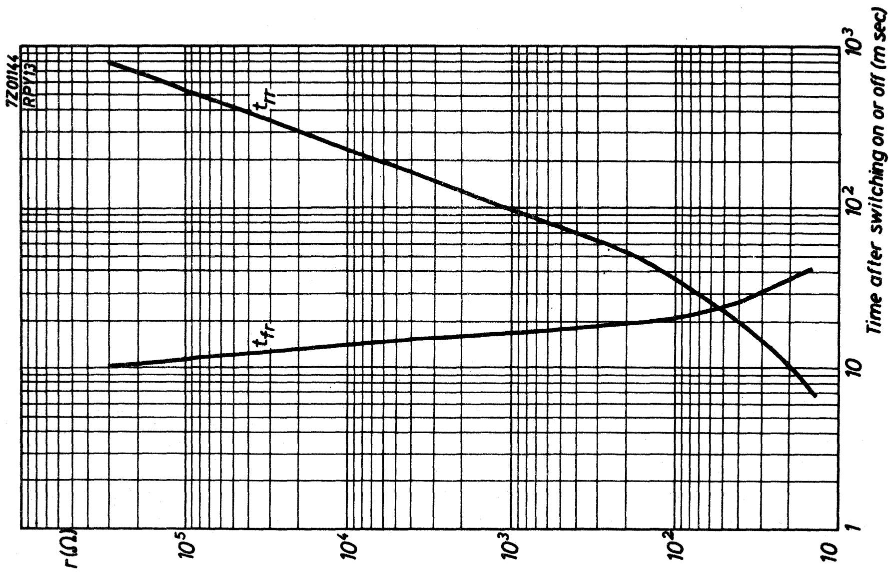
Fig.2

1) After 16 hours in darkness changes in the CdS material are still occurring, but have only insignificant effect on the illumination resistance and on the resistance decay time.

2) The life expectancy is considerably longer with lower values of V_f. In this respect it is recommended to apply a voltage not higher than 20 V.

3) For V_f = 24 V.


7Z01143
RPY13
r(Ω)
10^8
10^7
10^6
10^5
10^4
10^3
10^2
10
$r=f(I_f)$
$r=f(V_f)$
V_f (V)
I_f (mA)
0 5 10 15 20 30
0 10 20 30 40 60

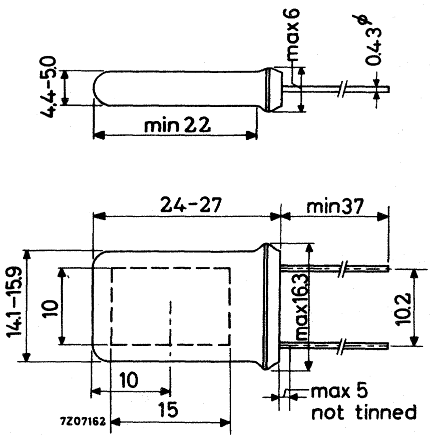

7Z01144
RPY13
t_{rr}
t_{fr}
r(Ω)
10^5
10^4
10^3
10^2
10
Time after switching on or off (m sec)
1
10
10^2
10^3

CADMIUM SULPHIDE PHOTOCONDUCTIVE CELL

Cadmium sulphide photoconductive cell with side sensitivity intended for use in general control circuits. The cell is tropic proof, shock and vibration resistant.

QUICK REFERENCE DATA				
Power dissipation at T_{amb} = 25 °C	P	max.	0.5	W
Power dissipation, with a heatsink with K = 5 °C/W and T_{amb} = 25 °C	P	max.	2	W
Cell voltage, d.c. and repetitive peak	V	max.	100	V
Cell resistance at 5000 lux, 2700 °K colour temperature	r		25	Ω
Spectral response curve		type	D	
Outline dimensions		max.	27 x 16.3 x 6	mm

MECHANICAL DATA Dimensions in mm



The centre distance of the leads is compatible with the IEC standard raster for printed wiring (0.1 inch).

Soldering

The cell may be soldered directly into the circuit but heat conducted to the seal should be kept to a minimum by the use of a thermal shunt. The cell may be dip-soldered at a solder temperature of 240 °C for a maximum of 10 s up to a point 5 mm from the seals.

ELECTRICAL DATA

General

The electrical properties of CdS cells are dependent on many factors such as illumination, colour temperature of the light source, voltage, current, temperature, total time of operation in the circuit and time of operation during the last 24 hours prior to the measurement. The following basic characteristics are therefore only checkpoints of the electrical properties of these devices measured with defined values of the various conditions and at delivery.

Basic characteristics at T_{amb} = 25 °C, illumination with colour temperature of 2700 °K and at delivery.

	symbol	min.	typical	max.	unit
Initial dark resistance measured with 100 V d.c. applied via 1 MΩ, 20 s after switching off the illumination	r_{do}	5.6		[1]	MΩ
Equilibrium dark resistance measured with 100 V d.c. applied via 1 MΩ, 30 minutes after switching off the illumination	r_{de}	50		[1]	MΩ
Initial illumination resistance (1) measured at 10 V d.c., illumination = 50 lux, after 16 hrs in darkness. [2]	r_{lo} (1)	235	400	1200	Ω
Initial illumination resistance (2) measured at 1 V d.c., illumination = 5000 lux, after 16 hrs in darkness [2][3]	r_{lo} (2)		25	35	Ω

[1] The spread of the dark resistance is large and values higher than 15 MΩ and 2000 MΩ are possible for the initial dark resistance and the equilibrium dark resistance respectively.

[2] After 16 hours in darkness changes in the CdS material are still occurring, but have only insignificant effect on the illumination resistance and on the resistance decay time.

[3] Maximum during life 40 Ω.

DESIGN CONSIDERATIONS

Apparatus with CdS cells should be designed so that changes in resistance values of the cells during life from -30% to +70% do not impair the circuit performance. Direct sunlight irradiation should be avoided.

SHOCK AND VIBRATION

An indication for the ruggedness of the cell is the following:
Samples taken from normal production are submitted to shock and vibration tests mentioned below. More than 95% of the devices pass these tests without perceptible damage.

Shock

25 g_{peak}, 10 000 shocks in one of the three positions of the cell.

Vibration

2,5 g_{peak}, 50 Hz, during 32 hours in each of the three positions of the cell.

N.B. These conditions are used solely to assess the mechanical quality of the cell. It is not advisable to subject the cell to such conditions.

LIMITING VALUES (Absolute max. rating system)

Cell voltage, d.c. and repetitive peak	V	max.	100	V
Cell voltage, pulse, t_{imp} = max. 5 ms; prr = max. once per minute	V_p	max.	250	V
Power dissipation, t_{av} = 2 s	P	see sheet C		
Power dissipation, pulse	P_p	max.	5 x P	
Cell current, d.c. and repetitive peak	I	max.	250	mA
Illumination	E	max.	50000	lux
Temperature CdS tablet, operating	T_{tablet}	max.	+85	°C [1]
Ambient temperature, storage and operating	T_{amb}	min.	-40	°C
storage	T_{amb}	max.	+50	°C [2]
operating	T_{amb}	max.	+70	°C

[1] If no forced air cooling is used, the envelope temperature opposite the centre of the sensitive area is about 83 °C when the CdS tablet temperature is 85 °C. This temperature can be determined e.g. with a thermocouple fastened on the envelope.

[2] Operation of the cell counteracts the deteriorating effect of long periods at high temperature. The maximum operating temperature is therefore higher than the maximum storage temperature.

Basic characteristics at T_{amb} = 25 °C, illumination with colour temperature of 2700 °K and at delivery. (continued)

	symbol	min.	typical	max.	unit
Equilibrium illumination resistance (1) measured at 10 V d.c., illumination = 50 lux, after 15 minutes under the measuring conditions	r_{le} (1)	235	480	1560	Ω
Equilibrium illumination resistance (2) measured at 1 V d.c., illumination = 5000 lux, after 15 minutes under the measuring conditions. [2]	r_{le} (2)			35	Ω
Resistance decay time Time to reach 50 Ω, measured from the instant of starting the illumination of 5000 lux, after 16 hrs in darkness. [1]	t_{fr}		5	25	ms
Resistance rise time Time to reach 2 kΩ, measured from the instant of stopping the illumination after 5 minutes or longer illumination of 5000 lux	t_{rr}		40	200	ms
Sensitivity at 50 lux, with 10 V d.c. applied	N		0.5		mA/lux
Negative temperature response of illumination resistance			0.2	0.5	%/°C
Voltage response $\frac{\text{r at 0.5 V d.c.}}{\text{r at 10 V d.c.}}$	α		1.1		

THERMAL DATA

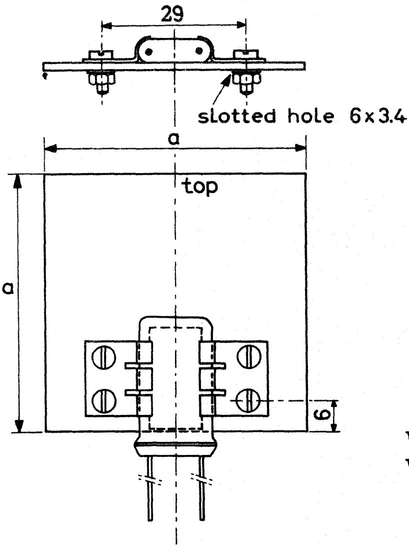
Continuous temperature of CdS tablet	T_{tablet}	max. +85	°C
Thermal resistance from CdS tablet to ambient, device free in air	K	120	°C/W
Thermal resistance from CdS tablet to heatsink (temperature of heatsink measured near the centre of the cell), when the cell is properly clamped on a heatsink as described on sheet 5	K	25	°C/W

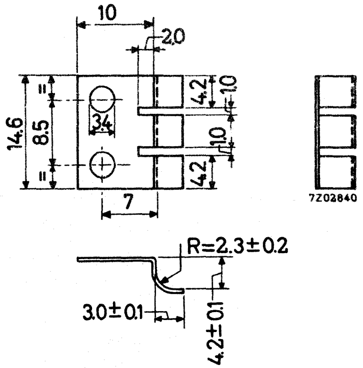
[1]) After 16 hours in darkness changes in the CdS material are still occurring, but have only insignificant effect on the illumination resistance and on the resistance decay time.

[2]) Maximum during life 40 Ω.

MECHANICAL DATA (continued) Dimensions in mm

RPY18 MOUNTED ON HEATSINK



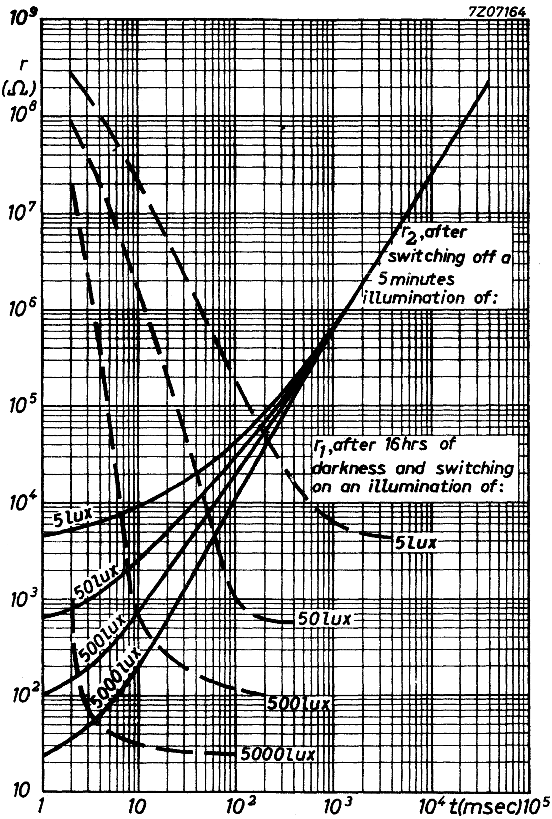


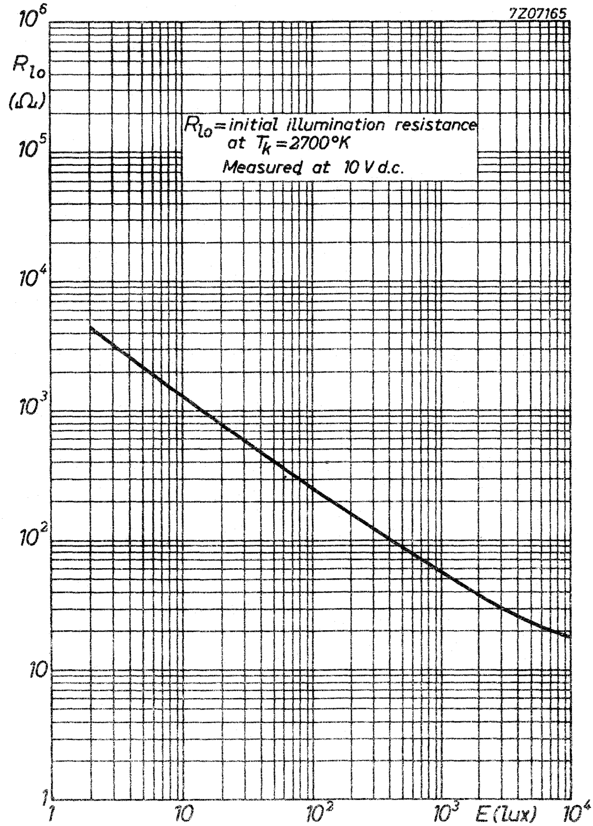
Detail: Clamping strip
tombac 0.3 mm

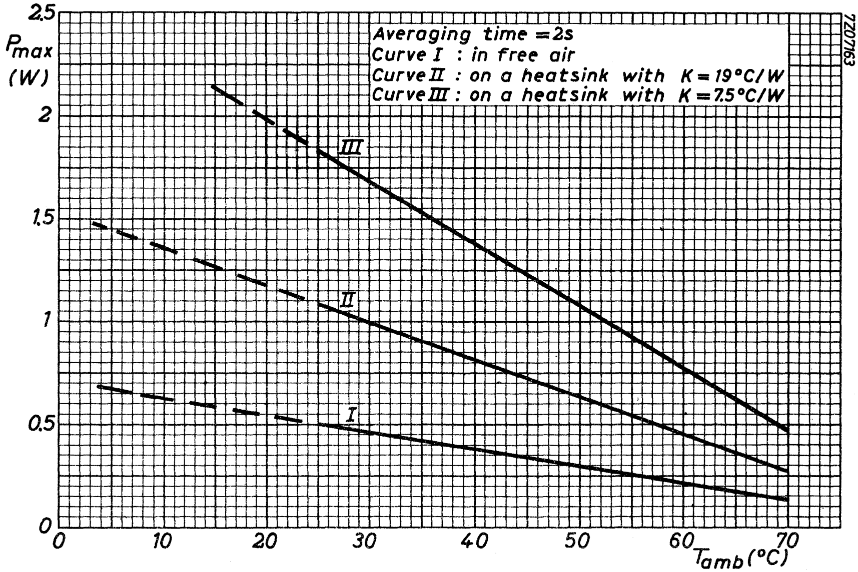
With a	=	50	mm	K	=	19	$^{o}C/W$
With a	=	100	mm	K	=	7.5	$^{o}C/W$

Mounting instructions

1. Mount one clamp on the heatsink, using the side with round holes.
2. Push the RPY18 under than clamp.
3. Press the second clamp firmly against the RPY18, using the slot holes.


7Z07164
r
(Ω)
10⁹
10⁸
10⁷
10⁶
10⁵
10⁴
10³
10²
10
1
10
10²
10³
10⁴
t(msec)
10⁵
r₂, after switching off a 5 minutes illumination of:
r₁, after 16hrs of darkness and switching on an illumination of:
5lux
50lux
500lux
5000lux
5lux
50lux
500lux
5000lux


7Z07165
10^6
R_{lo}
(Ω)
R_{lo} = initial illumination resistance
at T_k = 2700°K
Measured at 10 V d.c.
10^5
10^4
10^3
10^2
10
1
1
10
10^2
10^3
E (lux)
10^4


Averaging time = 2s
Curve I : in free air
Curve II : on a heatsink with K = 19°C/W
Curve III : on a heatsink with K = 7.5°C/W
7Z07163
Pmax
(W)
2.5
2
1.5
1
0.5
0
10
20
30
40
50
60
70
Tamb (°C)
I
II
III

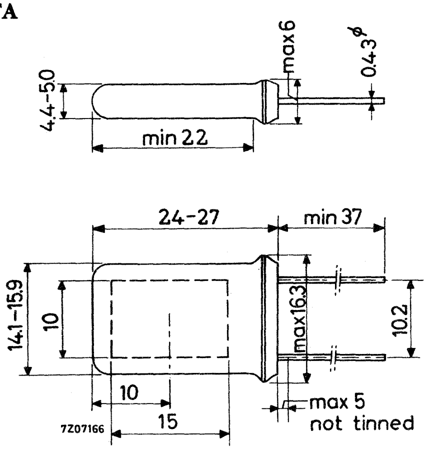
CADMIUM SULPHIDE PHOTOCONDUCTIVE CELL

Cadmium sulphide photoconductive cell with side sensitivity intended for use in general control circuits.
The cell is tropic proof, shock and vibration resistant.

QUICK REFERENCE DATA				
Power dissipation at T_{amb} = 25 °C	P	max.	0.5	W
Power dissipation, with a heatsink with K = 5 °C/W and T_{amb} = 25 °C	P	max.	2	W
Cell voltage, d.c. and repetitive peak	V	max.	400	V
Cell resistance at 50 lux, 2700 °K colour temperature	r		3000	Ω
Spectral response curve		type D		
Outline dimensions		max. 27 x 16.3 x 6		mm

MECHANICAL DATA

Dimensions in mm



Soldering

The cell may be soldered directly into the circuit but heat conducted to the seal should be kept to a minimum by the use of a thermal shunt. The cell may be dip-soldered at a solder temperature of 240 °C for a maximum of 10 s up to a point 5 mm from the seals.

ELECTRICAL DATA

General

The electrical properties of CdS cells are dependent on many factors such as illumination, colour temperature of the light source, voltage, current, temperature, total time of operation in the circuit and time of operation during the last 24 hours prior to the measurement. The following basic characteristics are therefore only checkpoints of the electrical properties of these devices measured with defined values of the various conditions and at delivery.

Basic characteristics at T_{amb} = 25 °C, illumination with colour temperature of 2700 °K and at delivery

	symbol	min.	typical	max.	unit
Initial dark resistance measured with 300 V d.c. applied via 1 MΩ, 20 s after switching off the illumination	r_{do}	10		1)	MΩ
Equilibrium dark resistance measured with 300 V d.c. applied via 1 MΩ, 30 minutes after switching off the illumination	r_{de}	200		1)	MΩ
Initial illumination resistance measured at 10 V d.c. illumination = 50 lux, after 16 hrs in darkness 2)	r_{lo}	1400	3000	6600	Ω
Equilibrium illumination resistance measured at 10 V d.c. illumination = 50 lux, after 15 minutes under the measuring conditions	r_{le}	1400	3800	9000	Ω
Resistance decay time Time to reach 20 kΩ, measured from the instant of starting the illumination of 50 lux, at 10 V d.c. after 16 hours in darkness	t_{fr}			0.2	s

1) The spread of the dark resistance is large and values higher than 100 MΩ and 10 000 MΩ are possible for the initial dark resistance and the equilibrium dark resistance respectively.

2) After 16 hours in darkness changes in the CdS material are still occurring, but have only insignificant effect on the illumination resistance and on the resistance decay time.

Basic characteristics at T_{amb} = 25 °C, illumination with colour temperature of 2700 °K and at delivery (continued)

	symbol	min.	typical	max.	unit
Resistance rise time Time to reach 1 MΩ, measured from the instant of stopping the illumination after 5 minutes or longer illumination of 50 lux, at 10 V d.c.	t_{rr}		0.6	1.25	s
Sensitivity	N		0.07		mA/lux
Negative temperature response of illumination resistance			0.2	0.5	%/°C
Voltage response $\frac{\text{r at 0.5 V d.c.}}{\text{r at 10 V d.c.}}$	α		1.1		

THERMAL DATA

Continuous temperature of CdS tablet	T_{tablet}	max. +85	°C
Thermal resistance from CdS tablet to ambient, device free in air	K	120	°C/W
Thermal resistance from CdS tablet to heatsink (temperature of heatsink measured near the centre of the cell), when the cell is properly clamped on a heatsink as described on sheet 5	K	25	°C/W

DESIGN CONSIDERATIONS

Apparatus with CdS cells should be designed so that changes in resistance values of the cells during life from −30% to +70% do not impair the circuit performance. Direct sunlight irradiation should be avoided.

SHOCK AND VIBRATION

An indication for the ruggedness of the cell is the following:
Samples taken from normal production are submitted to shock and vibration tests mentioned below. More than 95% of the devices pass these tests without perceptible damage.

Shock

25 g_{peak}, 10 000 shocks in one of the three positions of the cell.

Vibration

2.5 g_{peak}, 50 Hz, during 32 hours in each of the three positions of the cell.

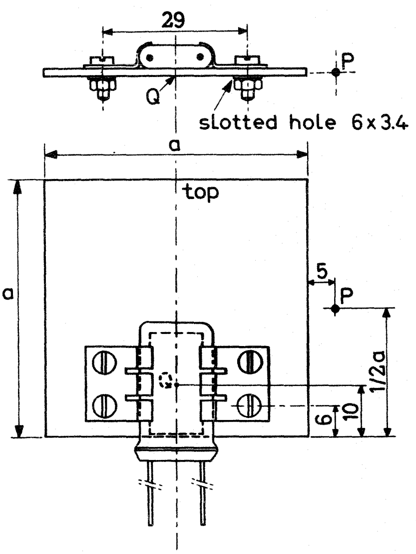
LIMITING VALUES (Absolute max. rating system)

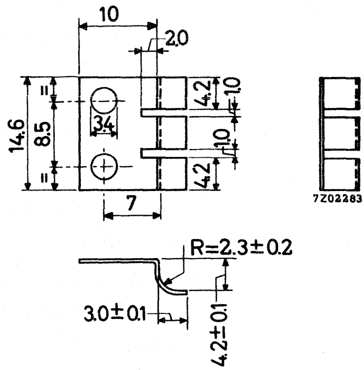
Cell voltage, d.c. and repetitive peak	V	max.	400	V
Cell voltage, pulse, T_{imp} = max. 5 ms p_{rr} = max. once per minute	V_p	max.	1000	V
Power dissipation, t_{av} = 1 s	P	See sheet 8		
Power dissipation, pulse	P_p	max.	5xP	
Cell current, d.c. and repetitive peak	I	max.	250	mA
Illumination	E	max.	50000	lux
Temperature CdS tablet, operating	T_{tablet}	max.	+85	°C [1]
Ambient temperature, storage and operating	T_{amb}	min.	−40	°C
storage	T_{amb}	max.	+50	°C [2]
operating	T_{amb}	max.	+70	°C

[1] If no forced air cooling is used, the envelope temperature opposite the centre of the sensitive area is about 83 °C when the CdS tablet temperature is 85 °C. This temperature can be determined e.g. with a thermocouple fastened on the envelope.

[2] Operation of the cell counteracts the deteriorating effect of long periods at high temperature. The maximum operating temperature is therefore higher than the maximum storage temperature.

RPY19 MOUNTED ON HEATSINK





Detail: Clamping strip
tombac 0.3 mm

The heat resistance K of the heatsink is defined as the temperature difference between the point Q at the backside of the heatsink, and ambient at point P, per Watt dissipation in the device, the heatsink being placed in an enclosure as given below.

Enclosure: cubical with internal edges 5 x a mm.
Place : point Q in the centre of the cubic, plane of heatsink vertical, top upside.

Determined according to the above rules a heatsink as given in the drawing has a heat resistance K = 19 ^{o}C/W when a = 50 mm and a K = 7.5 ^{o}C/W when a = 100 mm.

With smaller enclosure dimensions a higher value for K may be expected.

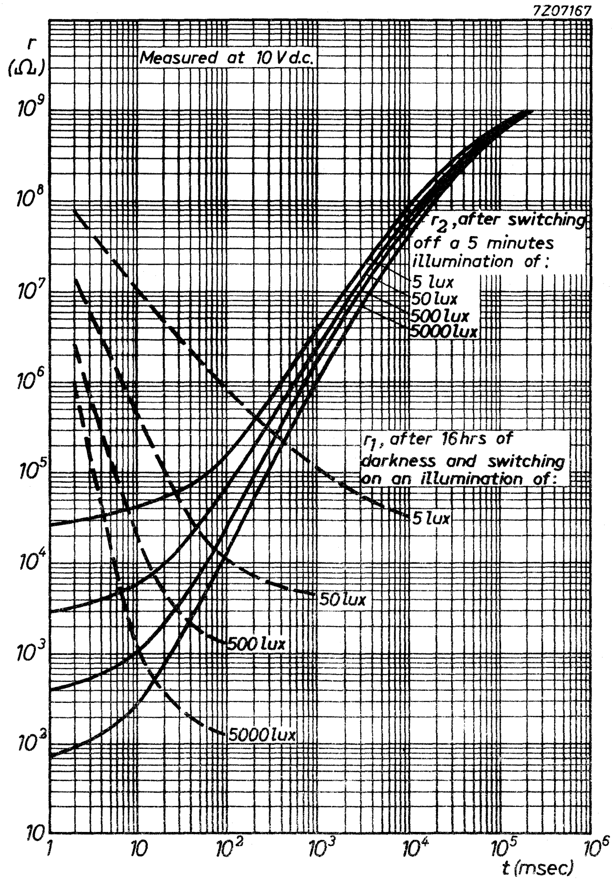
Mounting instructions

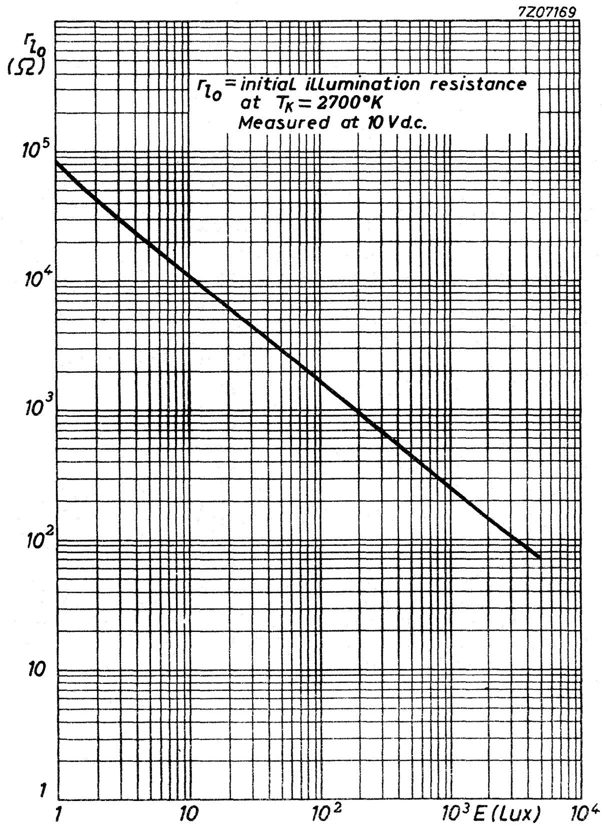
To reach the above mentioned K values it is essential that the RPY19 be installed in the following manner:

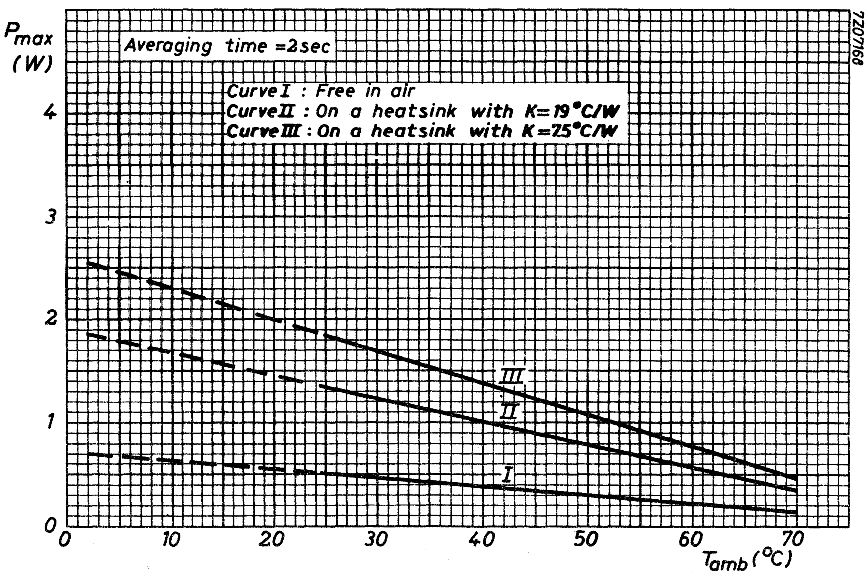
1. Mount one clamp on the heatsink, using the side with round holes.

2. Push the RPY19 under that clamp.

3. Press the second clamp firmly against the RPY19, using the slot holes.


7Z07167
r
(Ω)
Measured at 10 V d.c.
r2, after switching off a 5 minutes illumination of:
5 lux
50 lux
500 lux
5000 lux
r1, after 16 hrs of darkness and switching on an illumination of:
5 lux
50 lux
500 lux
5000 lux
t (msec)


7Z07169
r_{l_0} (Ω)
r_{l_0} = initial illumination resistance at T_K = 2700°K Measured at 10 Vd.c.
10^5
10^4
10^3
10^2
10
1
1
10
10^2
10^3 E (Lux)
10^4

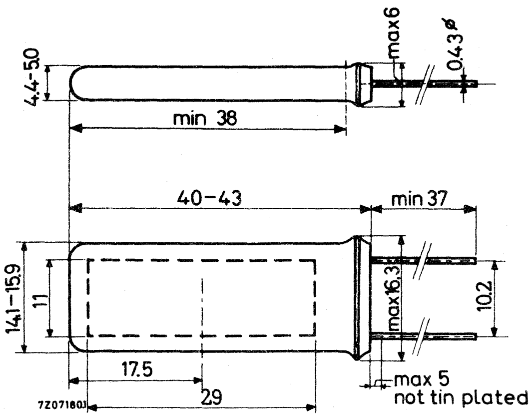

P_{max} (W)
Averaging time =2sec
Curve I : Free in air
Curve II : On a heatsink with K=19°C/W
Curve III : On a heatsink with K=7.5°C/W
7Z07168
0
1
2
3
4
0
10
20
30
40
50
60
70
T_{amb} (°C)
I
II
III

CADMIUM SULPHIDE PHOTOCONDUCTIVE CELL

Cadmium sulphide photoconductive cell with side sensitivity intended for use in general control circuits such as twilight switches and flame failure equipment. The cell is tropic proof, shock and vibration resistant.

QUICK REFERENCE DATA				
Power dissipation at T_{amb} = 25 °C	P	max.	1	W
Power dissipation, with a heatsink with K = 5 °C/W and T_{amb} = 25 °C	P	max.	3	W
Cell voltage, d.c. and repetitive peak	V	max.	400	V
Cell resistance at 50 lux, 2700 °K colour temperature	r		1500	Ω
Spectral response curve		type D		
Outline dimensions		max. 43 x 16.3 x 6		mm

MECHANICAL DATA Dimensions in mm



The centre distance of the leads is compatible with the standard raster for printed wiring (0.1 inch)

Soldering

The cell may be soldered directly into the circuit but heat conducted to the tablet should be kept to a minimum by the use of a thermal shunt. The cell may be dip-soldered at a solder temperature of 240 °C for a maximum of 10 s up to a point 5 mm from the seals.

ELECTRICAL DATA

General

The electrical properties of CdS cells are dependent on many factors such as illumination, colour temperature of the light source, voltage, current, temperature, total time of operation in the circuit and time of operation during the last 24 hours prior to the measurement. The following basic characteristics are therefore only checkpoints of the electrical properties of these devices measured with defined values of the various conditions and at delivery.

Basic characteristics at T_{amb} = 25 °C, illumination with colour temperature of 2700 °K and at delivery

	symbol	min.	typical	max.	unit
Initial dark resistance measured with 300 V d.c. applied via 1 MΩ, 20 s after switching off the illumination	r_{do}	6.5		1)	MΩ
Equilibrium dark resistance measured with 300 V d.c. applied via 1 MΩ, 30 minutes after switching off the illumination	r_{de}	120		1)	MΩ
Initial illumination resistance measured at 10 V, d.c. illumination = 50 lux, after 16 hrs in darkness 2)	r_{lo}	700	1500	3300	Ω
Equilibrium illumination resistance measured at 10 V, d.c. illumination = 50 lux, after 15 minutes under the measuring conditions	r_{le}	700	1900	4500	Ω

1) The spread of the dark resistance is large and values higher than 100 MΩ and 10 000 MΩ are possible for the initial dark resistance and the equilibrium dark resistance respectively.

2) After 16 hours in darkness changes in the CdS material are still occurring, but have only insignificant effect on the illumination resistance and on the resistance decay time.

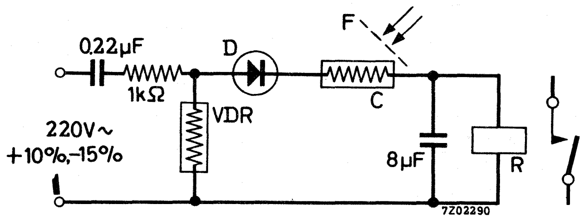
Basic characteristics at T_{amb} = 25 °C, illumination with colour temperature of 2700 °K and at delivery (continued)

	symbol	min.	typical	max.	unit
Resistance decay time Time to reach 10 kΩ, measured from the instant of starting the illumination of 50 lux, at 10 V d.c. after 16 hours in darkness 2)	t_{fr}			0.2	s
Resistance rise time Time to reach 1 MΩ, measured from the instant of stopping the illumination after 5 minutes or longer illumination of 50 lux, at 10 V d.c.	t_{rr}		0.9	1.5	s
Sensitivity at 50 lux, with 10 V d.c. applied	N		0.15		mA/lux
Negative temperature response of illumination resistance			0.2	0.5	%/°C
Voltage response $\frac{\text{r at 0.5 V d.c.}}{\text{r at 10 V d.c.}}$	α		1.05		

THERMAL DATA

Continuous temperature of CdS tablet	T_{tablet}	max.	+85	°C
Thermal resistance from CdS tablet to ambient, device free in air	K		60	°C/W
Thermal resistance from CdS tablet to heatsink (temperature of heatsink measured near the centre of the cell), when the cell is properly clamped on a heatsink as described on sheet 6.	K		15	°C/W

OPERATING CONDITIONS in a typical twilight switching circuit.



C = CdS cell RPY20

R = D.C. Relay 20 kΩ with I_e < 2.7 e.g. energizing current I_e of 2 mA and release current I_r of 0.8 mA.

VDR = voltage dependent resistor 10 mA at 180 V, 2 W e.g. type E299DG/P248

F = Absorption filter to be used to correct spread of the circuit and to adjust the switching level (10 to 70 lux).
Light transmission 5 to 20 %.

D = Diode V_{inv_p} > 500 V

DESIGN CONSIDERATIONS

Apparatus with CdS cells should be designed so that changes in resistance values of the cells during life from −30 % to +70 % do not impair the circuit performance. Direct sunlight irradiation should be avoided.

SHOCK AND VIBRATION

An indication for the ruggedness of the cell is the following:
Samples taken from normal production are submitted to shock and vibration tests mentioned below. More than 95 % of the devices pass these tests without perceptible damage.

Shock

25 g_{peak}, 10 000 shocks in one of the three positions of the cell.

Vibration

2.5 g_{peak}, 50 Hz, during 32 hours in each of the three positions of the cell.

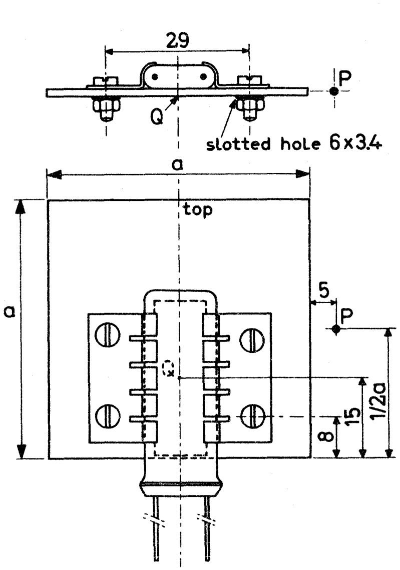
LIMITING VALUES (Absolute max. rating system)

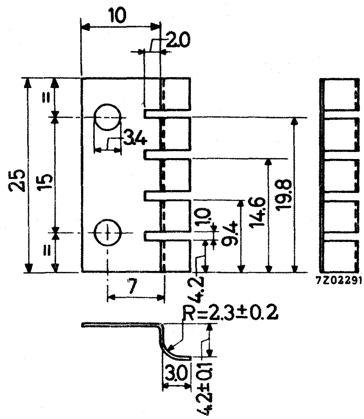
Cell voltage, d.c. and repetitive peak	V	max.	400	V
Cell voltage, pulse, t_{imp} = max. 5 ms p_{rr} = max. once per minute	V_p	max.	1000	V
Power dissipation, t_{av} = 2 s	P	See sheet 8		
Power dissipation, pulse	P_p	max.	5xP	
Cell current, d.c. and repetitive peak	I	max.	500	mA
Illumination	E	max.	50 000	lux
Temperature CdS tablet, operating	T_{tablet}	max.	+85	°C [1]
Ambient temperature, storage and operating	T_{amb}	min.	−40	°C
storage	T_{amb}	max.	+50	°C [2]
operating	T_{amb}	max.	+70	°C

[1] If no forced air cooling is used, the envelope temperature opposite the centre of the sensitive area is about 83 °C when the CdS tablet temperature is 85 °C. This temperature can be determined e.g. with a thermocouple fastened on the envelope.

[2] Operation of the cell counteracts the deteriorating effect of long periods at high temperature. The maximum operating temperature is therefore higher than the maximum storage temperature.

RPY20 MOUNTED ON HEATSINK





Detail: clamping strip
tombac 0.3 mm

The heat resistance K of the heatsink is defined as the temperature difference between the point Q at the backside of the heatsink, and ambient at point P, per Watt dissipation in the device, the heatsink being placed in an enclosure as given below.

Enclosure: cubical with internal edges 5 x a mm
Place : point Q in the centre of the enclosure, plane of heatsink vertical, "top" up

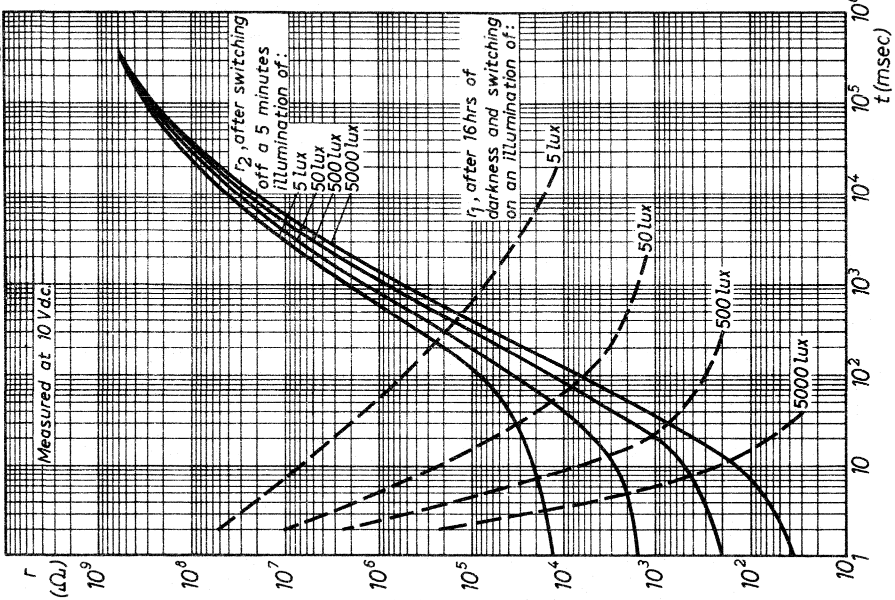
Determined according to the above rules a heatsink as given in the drawing has a heat resistance K = 19 ^{o}C/W when a = 50 mm and K = 7.5 ^{o}C/W when a = 100 mm.

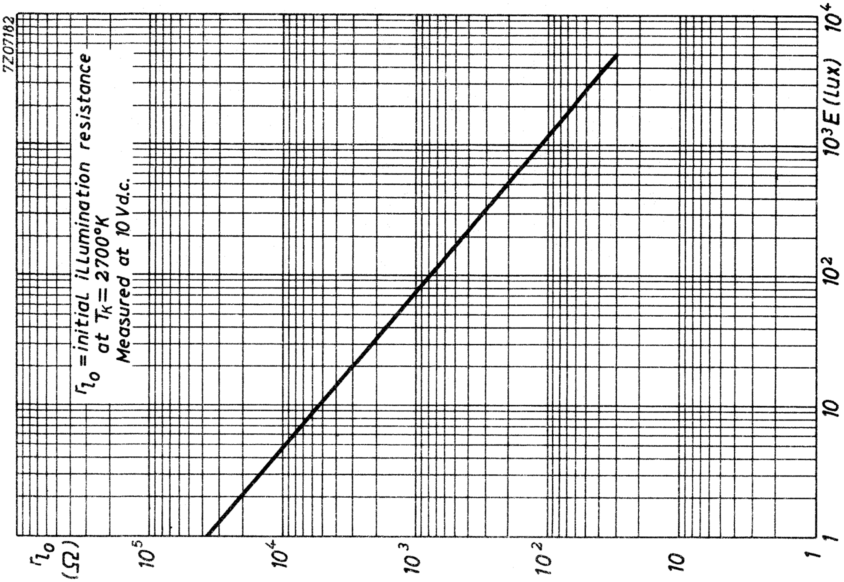
With smaller enclosure dimensions a higher value for K may be expected.

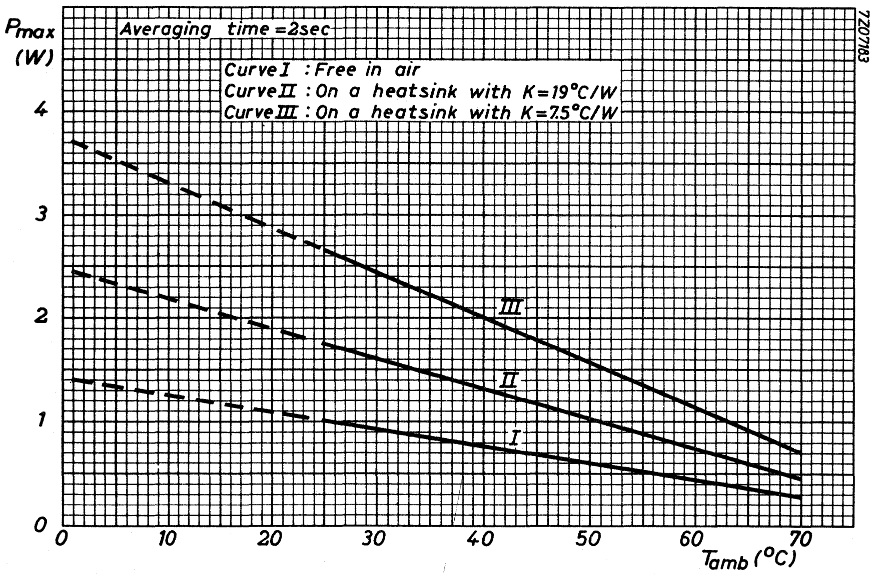
Mounting instructions

To reach the above mentioned K values it is essential that the RPY20 be installed in the following manner:

1. Mount one clamp on the heatsink, using the side with round holes.
2. Push the RPY20 under that clamp.
3. Press the second clamp firmly against the RPY20, using the slot holes.


7Z07181
Measured at 10 V d.c.
r_2, after switching off a 5 minutes illumination of:
5 lux
50 lux
500 lux
5000 lux
r_1, after 16 hrs of darkness and switching on an illumination of:
5 lux
50 lux
500 lux
5000 lux
r (Ω)
t (msec)
10^9
10^8
10^7
10^6
10^5
10^4
10^3
10^2
10
1
10
10^2
10^3
10^4
10^5
10^6


7Z07182
r_{lo} = initial illumination resistance at T_K = 2700°K
Measured at 10 V d.c.
r_{lo} (Ω)
E (lux)
10^5
10^4
10^3
10^2
10
1
1
10
10^2
10^3
10^4



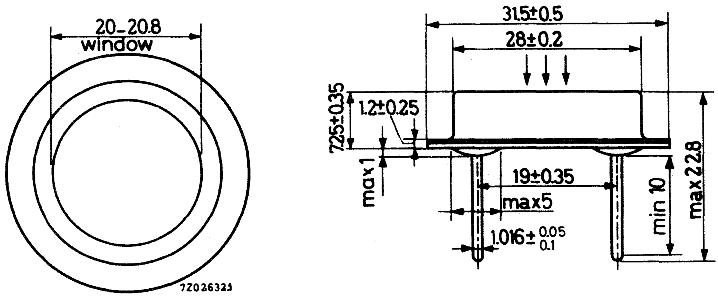
Pmax (W)
Averaging time = 2sec
Curve I : Free in air
Curve II : On a heatsink with K=19°C/W
Curve III : On a heatsink with K=7.5°C/W
7Z07183
4
3
2
1
0
0
10
20
30
40
50
60
70
Tamb (°C)
III
II
I

CADMIUM SULPHIDE PHOTOCONDUCTIVE CELL

Cadmium sulphide photoconductive cell with top sensitivity intended for use in general control circuits such as twilight switches and flame failure equipment. The cell is tropic proof, shock and vibration resistant.

QUICK REFERENCE DATA				
Power dissipation at T_{amb} = 25 °C	P	max.	1	W
Cell voltage, d.c. and repetitive peak	V	max.	400	V
Cell resistance at 50 lux, 2700 °K colour temperature	r		650	Ω
Spectral response curve		type D		
Outline dimensions		max. 32 dia.	x 7.6	mm

MECHANICAL DATA



Accessories

Contact springs type 55561

ELECTRICAL DATA

General

The electrical properties of CdS cells are dependent on many factors such as illumination, colour temperature of the light source, voltage, current, temperature, total time of operation in the circuit and time of operation during the last 24 hours prior to the measurement. The following basic characteristics are therefore only checkpoints of the electrical properties of these devices measured with defined values of the various conditions and at delivery.

Basic characteristics at T_{amb} = 25 °C, illumination with colour temperature of 2700 °K and at delivery

	symbol	min.	typical	max.	unit
Initial dark resistance measured with 400 V d.c. applied via 1 MΩ, 20 s after switching off the illumination	r_{do}	6.0		1)	MΩ
Equilibrium dark resistance measured with 400 V d.c. applied via 1 MΩ, 30 minutes after switching of the illumination	r_{de}	100		1)	MΩ
Initial illumination resistance measured at 10 V d.c. after 16 hrs in darkness 2) illumination 50 lux	r_{lo}	380	650	1900	Ω
Equilibrium illumination resistance measured at 10 V d.c. after 15 minutes under the measuring conditions illumination 50 lux	r_{le}	380	820	2600	Ω

1) The spread of the dark resistance is large and values higher than 100 MΩ and 10 000 MΩ are possible for the initial dark resistance and the equilibrium dark resistance respectively.

2) After 16 hours in darkness changes in the CdS material are still occurring, but have only insignificant effect on the illumination resistance and on the resistance decay time.

Basic characteristics at T_{amb} = 25 °C, illumination with colour temperature of 2700 °K and at delivery (continued)

	symbol	min.	typical	max.	unit
Resistance decay time Time to reach 10 kΩ, measured from the instant of starting the illumination of 50 lux, at 10 V d.c. after 16 hours in darkness [2])	t_{fr}			0.2	s
Resistance rise time Time to reach 1 MΩ, measured from the instant of stopping the illumination after 5 minutes or longer illumination with 50 lux, at 10 V d.c.	t_{rr}		1.0	1.5	s
Sensitivity at 50 lux, with 10 V d.c. applied	N		0.3		mA/lux
Negative temperature response of illumination resistance			0.2	0.5	%/°C
Voltage response $\frac{\text{r at 0.5 V d.c.}}{\text{r at 10 V d.c.}}$	α		1.05		

THERMAL DATA

Continuous temperature of CdS tablet	T_{tablet}	max.	+85	°C
Thermal resistance from CdS tablet to ambient, device free in air	K		60	°C/W

DESIGN CONSIDERATIONS

Apparatus with CdS cells should be designed so that changes in resistance values of the cells during life from −30 % to +70 % do not impair the circuit performance. Direct sunlight irradiation should be avoided.

SHOCK AND VIBRATION

An indication for the ruggedness of the cell is the following:
Samples taken from normal production are submitted to shock and vibration tests mentioned below. More than 95 % of the devices pass these tests without perceptible damage.

Shock

25 g_{peak}, 10 000 shocks in one of the three positions of the cell.

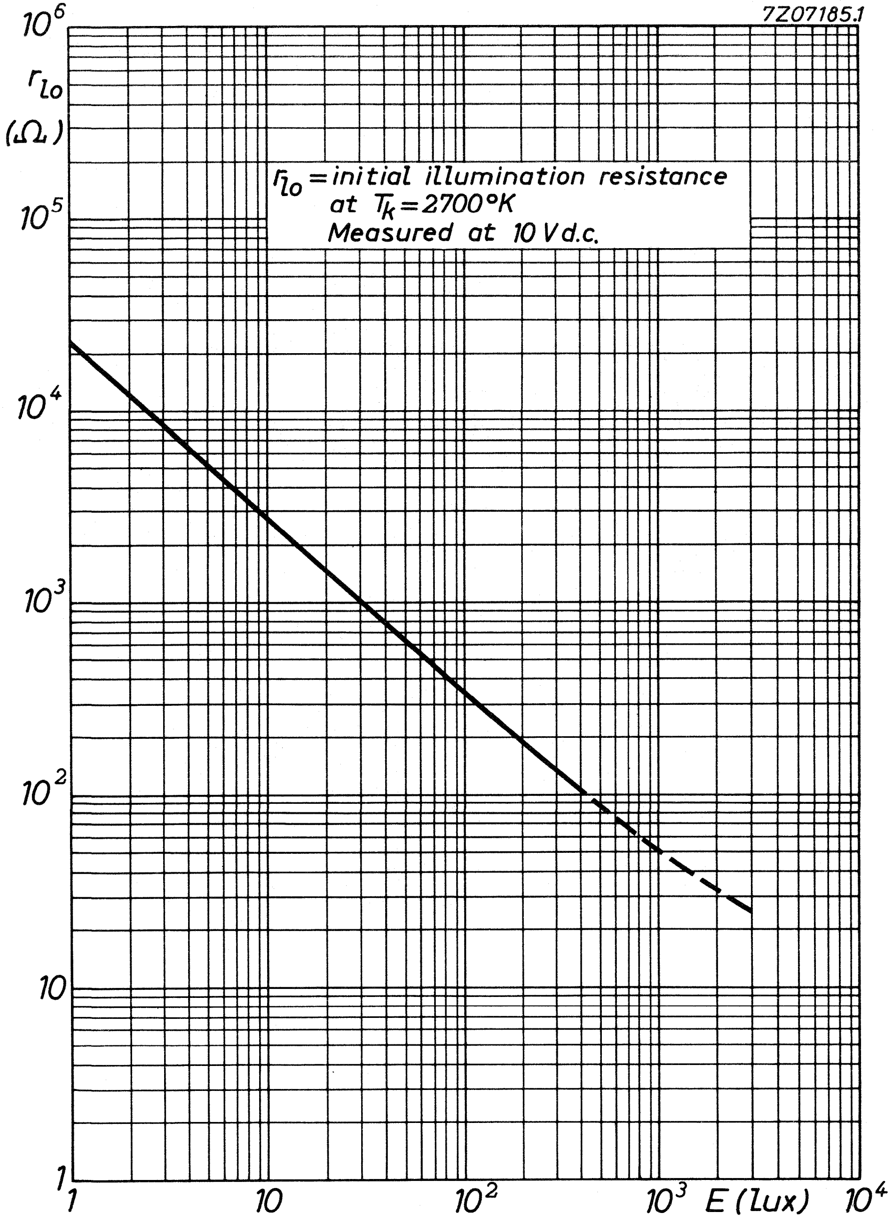
Vibration

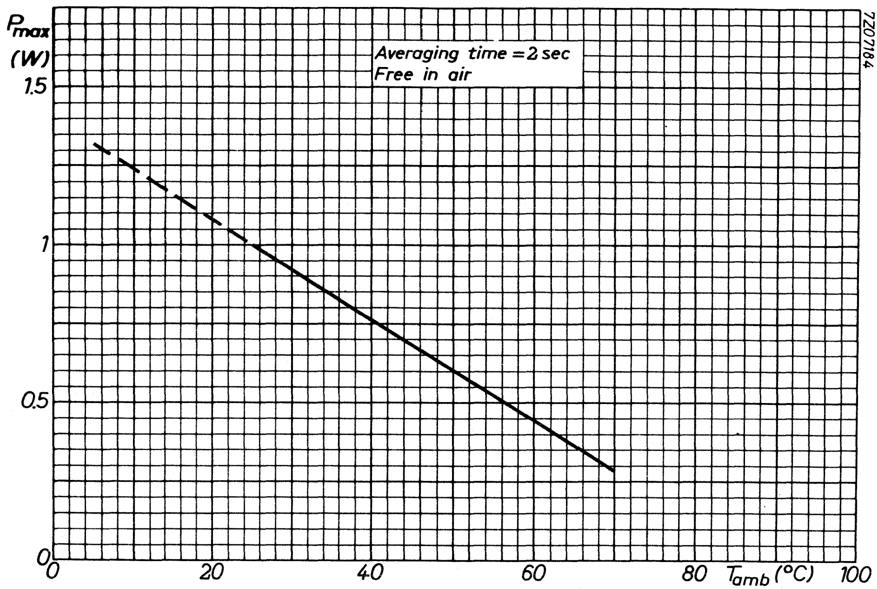
2.5 g_{peak}, 50 Hz, during 32 hours in each of the three positions of the cell.

LIMITING VALUES (Absolute max. rating system)

Cell voltage, d.c. and repetitive peak	V	max.	400	V
Cell voltage, pulse, t_{imp} = max. 5 ms p_{rr} = max. once per minute	V_p	max.	1000	V
Power dissipation, t_{av} = 2 s	P	See sheet 6		
Power dissipation, pulse	P_p	max.	5xP	
Cell current, d.c. and repetitive peak	I	max.	250	mA
Illumination	E	max.	50 000	lux
Temperature CdS tablet, operating	T_{tablet}	max.	+85	°C
Ambient temperature, storage and operating	T_{amb}	min.	−40	°C
storage	T_{amb}	max.	+50	°C [1]
operating	T_{amb}	max.	+70	°C

[1] Operation of the cell counteracts the deteriorating effect of long periods at high temperature. The maximum operating temperature is therefore higher than the maximum storage temperature.


7Z07185.1
10^6
r_{lo}
(Ω)
r_{lo} = initial illumination resistance at T_k = 2700°K Measured at 10 V d.c.
10^5
10^4
10^3
10^2
10
1
1
10
10^2
10^3
E (lux)
10^4

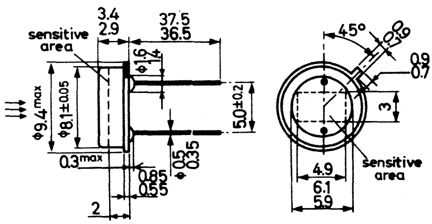

Pmax
(W)
1.5
1
0.5
0
Averaging time = 2 sec
Free in air
7Z07184
0
20
40
60
80
Tamb (°C)
100

CADMIUM SULPHO-SELENIDE PHOTOCONDUCTIVE CELL

Cadmium sulpho-selenide photoconductive device with top sensitivity intended for use in exposure meters, light-control equipment and for general industrial use. The device is tropic proof, shock and vibration resistant. The envelope is hermetically sealed and has a plane glass window.

QUICK REFERENCE DATA				
Power dissipation, as measuring device	P	max.	10	mW
for general use	P	max.	75	mW
Cell voltage, d.c. and repetitive peak	V	max.	50	V
Outline dimensions	max. 3.4 xdia 9.4			mm
Light sensitive area	4.9 mm x 3 mm			

MECHANICAL DATA Dimensions in mm



Soldering

The device may be soldered direct into the circuit but heat conducted to the seals should be kept at a minimum by the use of a thermal shunt. Dipsoldering at a solder temperature of 245 °C may be employed for a maximum of 10 s up to a point 5 mm from the seals of for maximum 3 s up to a point 1.5 mm from the seals. At a solder temperature between 245 °C and 400 °C the soldering time is maximum 5 s up to a point 5 mm from the seals.
The leads should not be bent less than 1.5 mm from the seals.

Data based on pre-production.

ELECTRICAL DATA

Basic characteristics at T_{amb} = 25 °C

Pre-conditioning > 1 h illumination with 300 lx (fluorescent light)

	symbol	min.	typical	max.	unit
Initial dark resistance measured at 50 $V_{d.c.}$, 20 s after stopping the illumination of 25.6 lx	r_{do}	100			kΩ
→ Initial illumination resistance measured at 1 $V_{d.c.}$, illumination 25.6 lx, colour temperature **4700 °K**	r_{lo}	**1.65**		**5.1**	kΩ
Current decay time: time to reach 10% of the current at the instant of stopping the illumination of 5 lx	t_{fi}		3		s
→ Gamma between E_1 = 0.4 lx and E_2 = 25.6 lx [1]	γ	**0.60**	0.75	**0.84**	
Shift in illumination current, measured with E = 50 lx, t = 10 min				10	
Pre-conditioning factor [2]		0.9		1.2	
Actinism $\frac{\text{Illumination at 2700 °K}}{\text{Illumination at 4700 °K}}$ (referred to the same cell current)			0.9		

---

[1] $\gamma = \dfrac{\log r1 - \log r2}{\log E_2 - \log E_1}$

[2] Pre-conditioning factor = $\dfrac{\text{Cell current at 0.4 lx, after 3 days in darkness}}{\text{Cell current at 0.4 lx after 1 h pre-conditioning at 300 lx (fluorescent light)}}$

SHOCK AND VIBRATION

An indication of the ruggedness of the device is the following:
Samples taken from normal production are submitted to shock and vibration tests mentioned below. More than 95% of the devices pass these tests without perceptible damage.

Shock

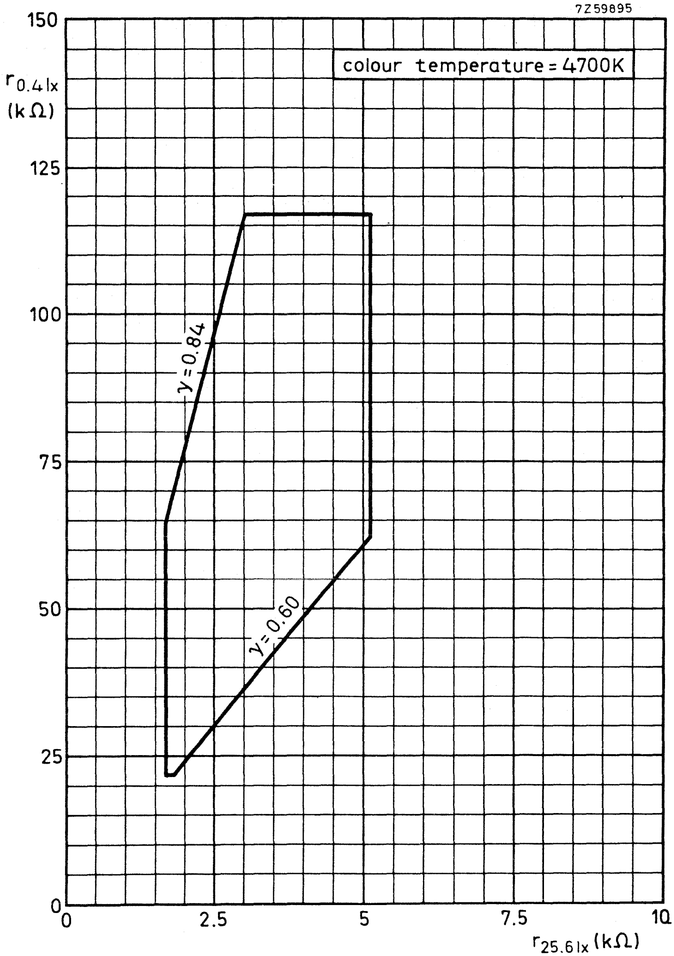
50 g_{peak}, 5 shocks in each of the four positions of the device.

Vibration

2.5 g_{peak}, 50 Hz, during 32 hours in each of the three positions of the device.

LIMITING VALUES (Absolute max. rating system)

Cell voltage, d.c. and repetitive peak	V	max.	50	V
Power dissipation, for use as measuring device	P	max.	10	mW
for general use	P	max.	75	mW
Ambient temperature	T_{amb}	max.	+60	^{o}C
	T_{amb}	min.	-40	^{o}C



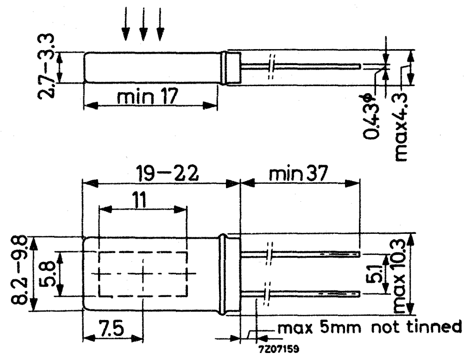
Area of illumination resistance ratio

CADMIUM SULPHIDE PHOTOCONDUCTIVE CELL

Cadmium sulphide photoconductive cell with side sensitivity intended for use in general control circuits.
The cell is tropic proof, shock and vibration resistant.

QUICK REFERENCE DATA				
Power dissipation at T_{amb} = 25 °C	P	max.	225	mW
Cell voltage, d.c. and repetitive peak	V	max.	100	V
Cell resistance at 50 lux, 2700 °K colour temperature	r_{lo}		1.6	kΩ
Spectral response curve		type D		
Outline dimensions		max.22x10.3x4.3		mm

MECHANICAL DATA — Dimensions in mm



Soldering

The cell may be soldered directly into the circuit but heat conducted to the seal should be kept to a minimum by the use of a thermal shunt. The cell maybe dip-soldered at a solder temperature of 240 °C for a maximum of 10 s up to a point 5 mm from the seals.

ELECTRICAL DATA

General

The electrical properties of CdS cells are dependent on many factors such as illumination, colour temperature of the light source, voltage current, temperature, total time of operation in the circuit and time of operation during the last 24 hours prior to the measurement. The following basic characteristics are therefore only checkpoints of the electrical properties of these devices measured with defined values of the various conditions and at delivery.

Basic characteristics at T_{amb} = 25 °C, illumination with colour temperature of 2700 °K and at delivery

	symbol	min.	typical	max.	unit
Initial dark resistance measured with 100 V d.c. applied via 1 MΩ, 20 s after switching off the illumination	r_{do}	9		1)	MΩ
Equilibrium dark resistance measured with 100 V d.c. applied via 1 MΩ, 30 minutes after switching off the illumination	r_{de}	100		1)	MΩ
Initial illumination resistance measured at V = 10 V d.c., illumination 50 lux, after 16 hours in darkness 2)	r_{lo}	950	1600	4800	Ω
Equilibrium illumination resistance measured at V = 10 V d.c., illumination 50 lux, after 15 minutes under the measuring conditions	r_{le}	950	1900	6200	Ω
Resistance decay time Time to reach 20 kΩ at V = 10 V d.c. measured from the instant of starting the illumination of 50 lux, after 16 hours in darkness. 2)	t_{fr}			0.2	s
Resistance rise time Time to reach 1 MΩ at V = 10 V d.c. measured after 5 minutes or longer illumination of 50 lux	t_{rr}		1.0	1.5	s
Sensitivity, at V = 10 V d.c. and 50 lux	N		0.12		mA/lux
Negative temperature response of illumination resistance			0.2	0.5	%/°C
Voltage response $\frac{r \text{ at } 0.5 \text{ V d.c.}}{r \text{ at } 10 \text{ V d.c.}}$	α		1.1		

1)2) See page 4

THERMAL DATA

Continuous temperature of CdS tablet	T_{tablet}	+85	°C
Thermal resistance from CdS tablet to ambient, device free in air	K	265	°C/W

DESIGN CONSIDERATIONS

Apparatus with CdS cells should be designed so that changes in resistance values of the CdS cells during life from −30% to +70% do not impair the circuit performance. Direct sunlight irradiation should be avoided.

SHOCK AND VIBRATION

An indication for the ruggedness of the cell is the following:
Samples taken from normal production are submitted to shock and vibration tests mentioned below. More than 95% of the devices pass these tests without perceptible damage.

Shock

25 g_{peak}, 10000 shocks in one of the three positions of the cell.

Vibration

2.5 g_{peak}, 50 Hz, during 32 hours in each of the three positions of the cell.

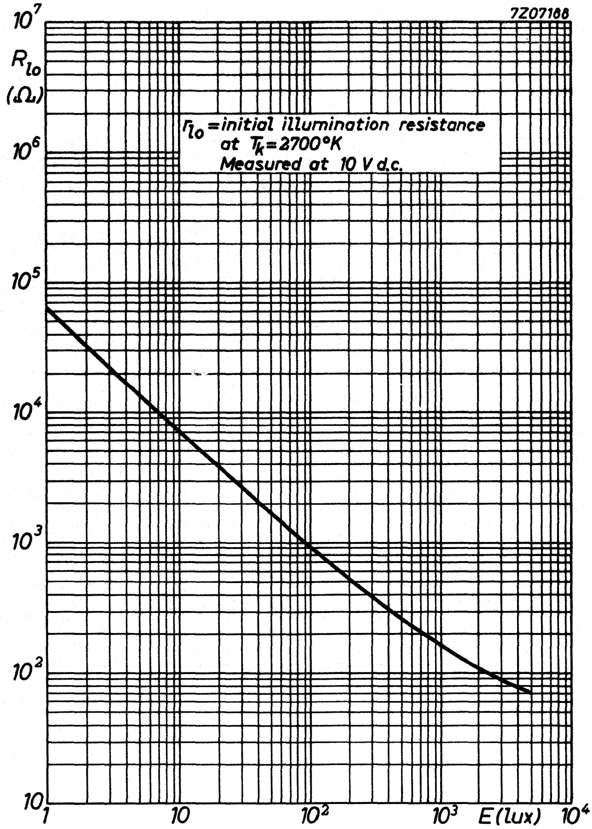
LIMITING VALUES (Absolute max. rating system)

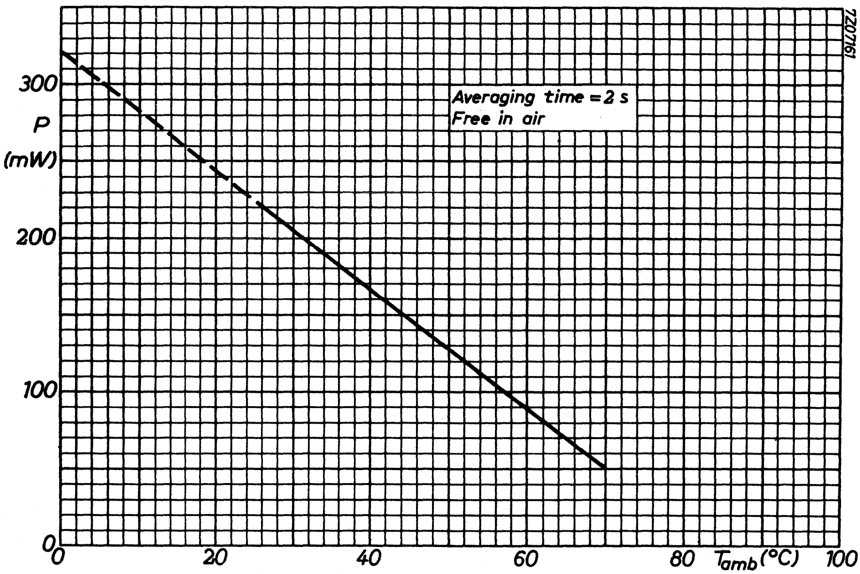
Cell voltage, d.c. and repetitive peak	V	max.	100	V
Cell voltage, pulse, T_{imp} = max. 5 ms, P_{rr} = max. once per minute	V_p	max.	250	V
Power dissipation, t_{av} = 2 s	P	See sheet 6		
Power dissipation, pulse	P_p	max.	5 x P	W
Cell current, d.c. and repetitive peak	I	max.	100	mA
Illumination	E	max.	50000	lux
Temperature CdS tablet, operating	T_{tablet}	max.	+85	°C [3]
Ambient temperature, storage and operating	T_{amb}	min.	−40	°C
Ambient temperature, storage	T_{amb}	max.	+50	°C [4]
Ambient temperature, operating	T_{amb}	max.	+70	°C

[3][4] See page 4.

NOTES

1. The spread of the dark resistance is large and values higher than 30 MΩ and 2000 MΩ are possible for the initial dark resistance and the equilibrium dark resistance respectively.
2. After 16 hours in darkness changes in the CdS material are still occurring, but have only insignificant effect on the illumination resistance and on the resistance decay time.
3. If no forced air cooling is used, the envelope temperature opposite the centre of the sensitive area is about 83 °C when the CdS tablet temperature is 85 °C. This temperature can be determined e.g. with a thermocouple fastened on the envelope.
4. Operation of the cell counteracts the deteriorating effect of long periods at high temperature. The maximum operating temperature is therefore higher than the maximum storage temperature.


7Z07188
10^7
R_{lo}
(Ω)
r_{lo} = initial illumination resistance
at T_k = 2700°K
Measured at 10 V d.c.
10^6
10^5
10^4
10^3
10^2
10
1
10
10^2
10^3
E (lux)
10^4

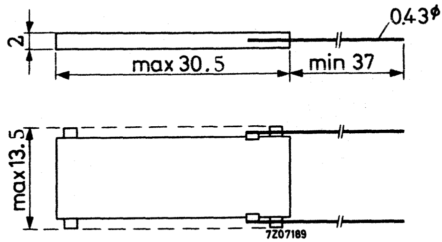

7Z07161
Averaging time = 2 s
Free in air
300
P
(mW)
200
100
0
0
20
40
60
80
T_{amb} (°C)
100

CADMIUM SULPHIDE PHOTOCONDUCTIVE CELL

Cadmium sulphide photoconductive cell with side sensitivity.
The device satisfies Test C: Damp heat test (long term exposure), severity IV (56 days exposure) of Publication 68-2 of the International Electrotechnical Commission (IEC).

QUICK REFERENCE DATA				
Power dissipation at T_{amb} = 25 °C	P	max.	0.75	W
Cell voltage, d.c. and repetitive peak	V	max.	400	V
Cell resistance at 50 lux, 2700 °K colour temperature	r		1500	Ω
Spectral response curve		type D		
Outline dimensions		max.	30.5x13.5x2	mm

MECHANICAL DATA Dimensions in mm



Soldering

The cell may be soldered directly into the circuit but heat conducted to the tablet should be kept to a minimum by the use of a thermal shunt. The cell may be dip-soldered at a solder temperature of 240 °C for a maximum of 10 s up to a point 5 mm from the seal.

Mounting

The cell is not insulated electrically and should be mounted accordingly.

Warning

To avoid damaging the cell, ask us for special instructions before attempting to encapsulate it in epoxy resin.

ELECTRICAL DATA

General

The electrical properties of CdS cells are dependent on many factors such as illumination, colour temperature of the light source, voltage, current, temperature, total time of operation in the circuit and time of operation during the last 24 hours prior to the measurement. The following basic characteristics are therefore only checkpoints of the electrical properties of these devices measured with defined values of the various conditions and at delivery.

Basic characteristics at T_{amb} = 25 °C, illumination with colour temperature of 2700 °K and at delivery

	symbol	min.	typical	max.	unit
Initial dark resistance measured with 300 V d.c. applied via 1 MΩ, 20 s after switching off the illumination	r_{do}	10		[1]	MΩ
Equilibrium dark resistance measured with 400 V d.c. applied via 1 MΩ, 30 minutes after switching off the illumination	r_{de}	200		[1]	MΩ
Initial illumination resistance measured at 10 V d.c. illumination = 50 lux, after 16 hrs in darkness [2]	r_{lo}	700	1500	3300	Ω
Equilibrium illumination resistance measured at 10 V d.c. illumination = 50 lux, after 15 minutes under the measuring conditions	r_{le}	700	1900	4500	Ω

[1] The spread of the dark resistance is large and values higher than 100 MΩ and 10 000 MΩ are possible for the intial dark resistance and the equilibrium dark resistance respectively.

[2] After 16 hours in darkness changes in the CdS material are still occurring, but have only insignificant effect on the illumination resistance and on the resistance decay time.

Basic characteristics at T_{amb} = 25 °C, illumination with colour temperature of 2700 °K and at delivery (continued)

	symbol	min.	typical	max.	unit
Resistance decay time Time to reach 10 kΩ, measured from the instant of starting the illumination of 50 lux at 10 V d.c. after 16 hrs in darkness [2]	t_{fr}			0.2	s
Resistance rise time Time to reach 1 MΩ, measured from the instant of stopping the illumination after 5 minutes or longer illumination of 50 lux, at 10 V d.c.	t_{rr}		0.9	1.5	s
Sensitivity at 50 lux, with 10 V d.c. applied	N		0.15		mA/lux
Negative temperature response of illumination resistance			0.2	0.5	%/°C
Voltage response $\frac{\text{r at 0.5 V d.c.}}{\text{r at 10 V d.c.}}$	α		1.05		

THERMAL DATA

Continuous temperature of CdS tablet T_{tablet} +85 °C

CLIMATIC DATA

The device satisfies test C: Damp heat test (long term exposure), severity IV (56 days at 40 ± 2 °C, 90 to 95% humidity) of Publication 68-2 of the International Electrotechnical Commission (IEC).

2) After 16 hours in darkness changes in the CdS material are still occurring, but have only insignificant effect on the illumination resistance and on the resistance decay time.

LIMITING VALUES (Absolute maximum rating system)

Cell voltage, d.c. and repetitive peak	V	max.	400	V
Cell voltage, pulse, t_{imp} = max. 5 ms p_{rr} = max. once per minute	V_p	max.	1000	V
Power dissipation, t_{av} = 2 s	P	see sheet 6		
Power dissipation, pulse	P_p	max.	5xP	
Cell current, d.c. and repetitive peak	I	max.	500	mA
Illumination	E	max.	50 000	lux
Temperature CdS tablet, operating	T_{tablet}	max.	+85	°C
Ambient temperature, storage and operating	T_{amb}	min.	−40	°C
storage	T_{amb}	max.	+50	°C [1])
operating	T_{amb}	max.	+70	°C

DESIGN CONSIDERATIONS

Apparatus with CdS cells should be designed so that changes in resistance values of the cells during life from −30% to +70% do not impair the circuit performance. Direct sunlight irradiation should be avoided.

SHOCK AND VIBRATION

An indication for the ruggedness of the cell is the following:
Samples taken from normal production are submitted to shock and vibration tests mentioned below. More than 95% of the devices pass these tests without perceptible damage.

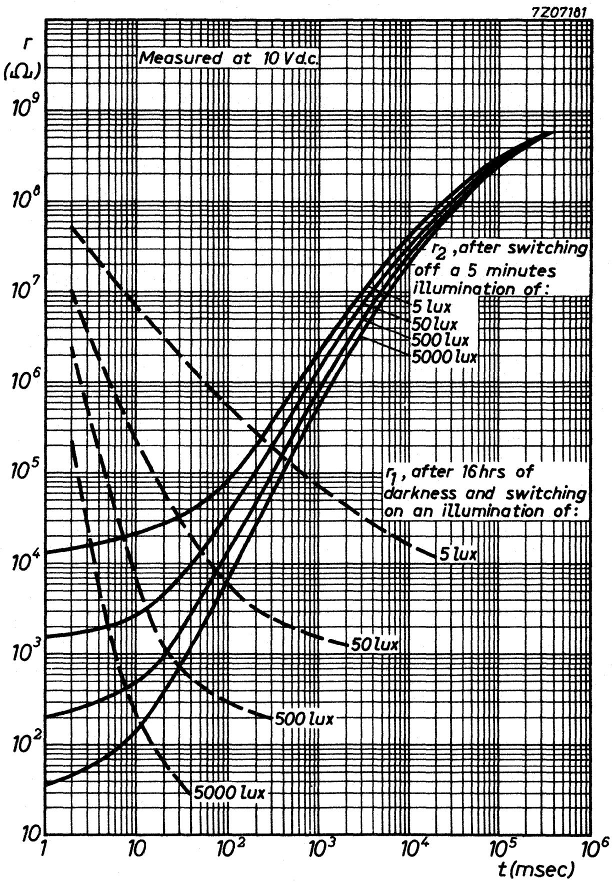
Shock

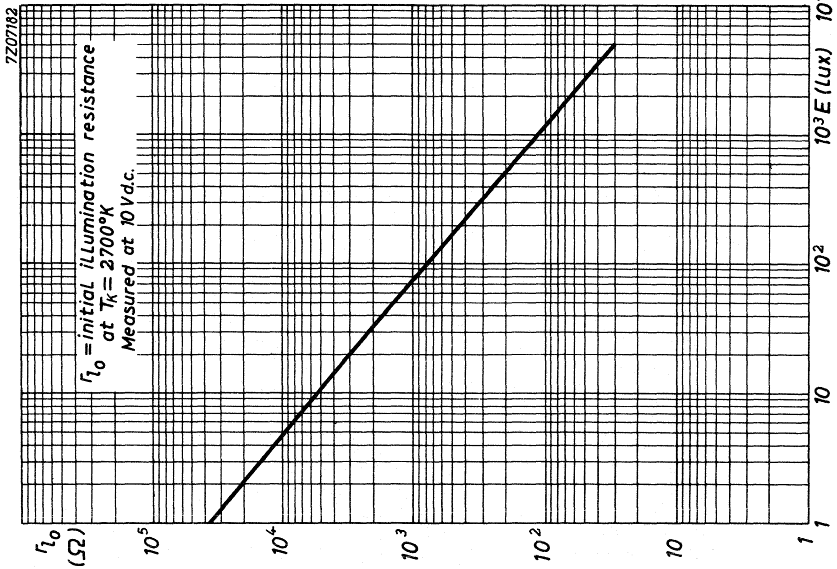
25 g_{peak}, 10 000 shocks in one of the three positions of the cell.

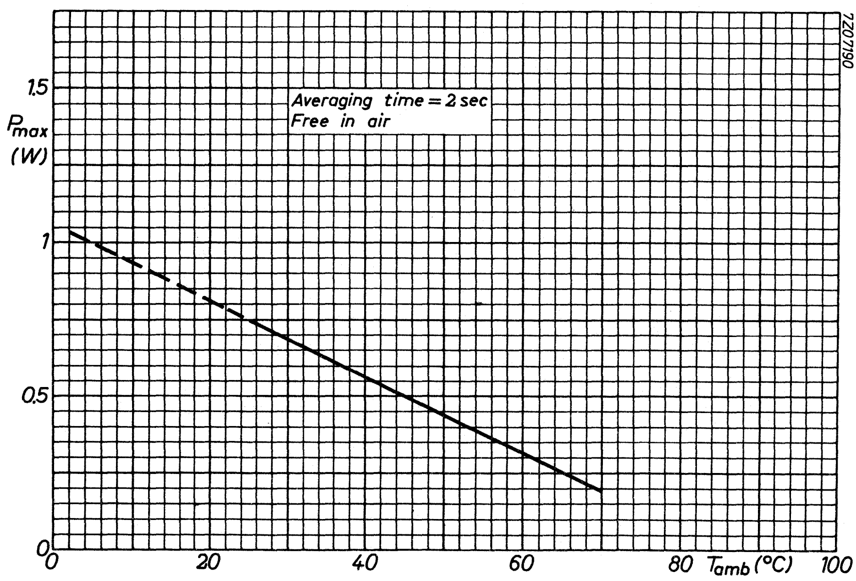
Vibration

2.5 g_{peak}, 50 Hz, during 32 hours in each of the three positions of the cell.

[1]) Operating of the cell counteracts the deteriorating effect of long periods at high temperature. The maximum operating temperature is therefore higher than the maximum storage temperature


7Z07181
r
(Ω)
Measured at 10 V d.c.
10^9
10^8
10^7
10^6
10^5
10^4
10^3
10^2
10
1
10
10^2
10^3
10^4
10^5
10^6
t (msec)
r_2, after switching off a 5 minutes illumination of:
5 lux
50 lux
500 lux
5000 lux
r_1, after 16 hrs of darkness and switching on an illumination of:
5 lux
50 lux
500 lux
5000 lux


7Z07182
r_{l_o} = initial illumination resistance
at T_K = 2700°K
Measured at 10 Vd.c.
r_{l_o} (Ω)
10^5
10^4
10^3
10^2
10
1
E (lux)
10^4
10^3
10^2
10
1


7Z07190
Averaging time = 2 sec
Free in air
P_{max} (W)
1.5
1
0.5
0
0
20
40
60
80
T_{amb} (°C)
100

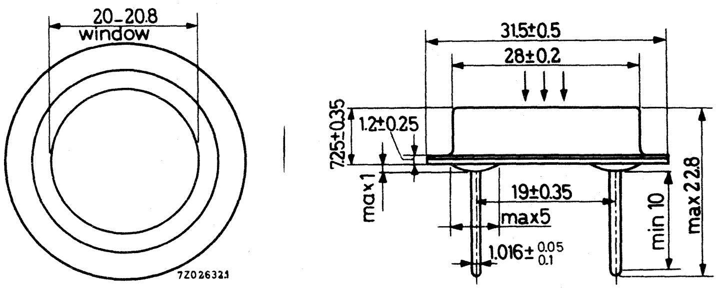
CADMIUM SULPHIDE PHOTOCONDUCTIVE CELL

Cadmium sulphide photoconductive cell with top sensitivity intended for use in general control circuits such as twilight switches and flame failure equipment.
The cell is tropic proof, shock and vibration resistant.

QUICK REFERENCE DATA					
Power dissipation at T_{amb} = 25 °C	P	max.		1	W
Cell voltage, d.c. and repetitive peak	V	max.		200	V
Cell resistance at 50 lux, 2700 °K c.t.	r_{lo}			420	Ω
Spectral response curve			type D		
Outline dimensions		max.	32	dia x 7.6	mm

MECHANICAL DATA

Dimensions in mm



Accessories

Contact springs type 55561

ELECTRICAL DATA

General

The electrical properties of CdS cells are dependent on many factors such as illumination colour temperature of the light source, voltage, current, temperature, total time of operation in the circuit and time of operation during the last 24 hours prior to the measurement. The following basic characteristics are therefore only checkpoints of the electrical properties of these devices measured with defined values of the various conditions and at delivery.

Basic characteristics at T_{amb} = 25 °C, illumination with colour temperature of 2700 °K and at delivery

	symbol	min.	typical	max.	unit
Initial dark resistance measured with 200 Vd.c. applied via 1 MΩ, 20 s after switching off the illumination	r_{do}	3		1)	MΩ
Equilibrium dark resistance measured with 200 Vd.c. applied via 1 MΩ, 30 min. after switching off the illumination	r_{de}	50		1)	MΩ
Initial illumination resistance measured at 10 Vd.c., illumination 50 lux, after 16 h in darkness 2)	r_{lo}	250	420	1250	Ω
Wquilibrium illumination resistance measured at 10 Vd.c., illumination 50 lux, after 15 min. under the measuring conditions	r_{le}	250	530	1700	Ω
Resistance decay time Time to reach 5 kΩ, measured from the instant of starting the illumination of 50 lux, at 10 Vd.c. after 16 h in darkness 2)	t_{fr}			0.3	s

1) the spread of the dark resistance is large and values higher than 50 MΩ and 5000 MΩ are possible for the initial dark resistance and the equilibrium dark resistance respectively.

2) After 16 h in darkness changes in the CdS material are still occurring, but have only insignificant effect on the illumination resistance and on the resistance decay time.

Basic characteristics at T_{amb} = 25 °C, illumination with colour temperature of 2700 °K and at delivery.

	symbol	min.	typical	max.	unit
Resistance rise time Time to reach 1 MΩ, measured from the instant of stopping the illumination, after 5 min. or longer illumination of 50 lux at 10 Vd.c.	t_{rr}			2	s
Sensitivity at 50 lux, with 10 Vd.c. applied	N		0.5		mA/lux
Negative temperature response of illumination resistance	$\Delta r_l/\Delta T$		0.2	0.5	% / °C
Voltage response $\frac{r \text{ at } 0.5\ V}{r \text{ at } 10\ V}$			1.05		

THERMAL DATA

Continuous temperature of CdS tablet	T_{tablet}	max.	+ 85	°C
Thermal resistance from CdS tablet to ambient, device free in air	K		60	°C/W

DESIGN CONSIDERATIONS

Apparatus with CdS cells should be designed so that changes in resistance values of the cells during life from - 30 % to + 70 % do not impair the circuit performance. Direct sunlight irradiation should be avoided.

SHOCK AND VIBRATION

An indication for the ruggedness of the cell is the following:
Samples taken from normal production are submitted to shock and vibration tests More than 95 % of the devices pass these tests without perceptible damage.

Shock

25 g_{peak}, 10000 shocks in one of the three positions of the cell.

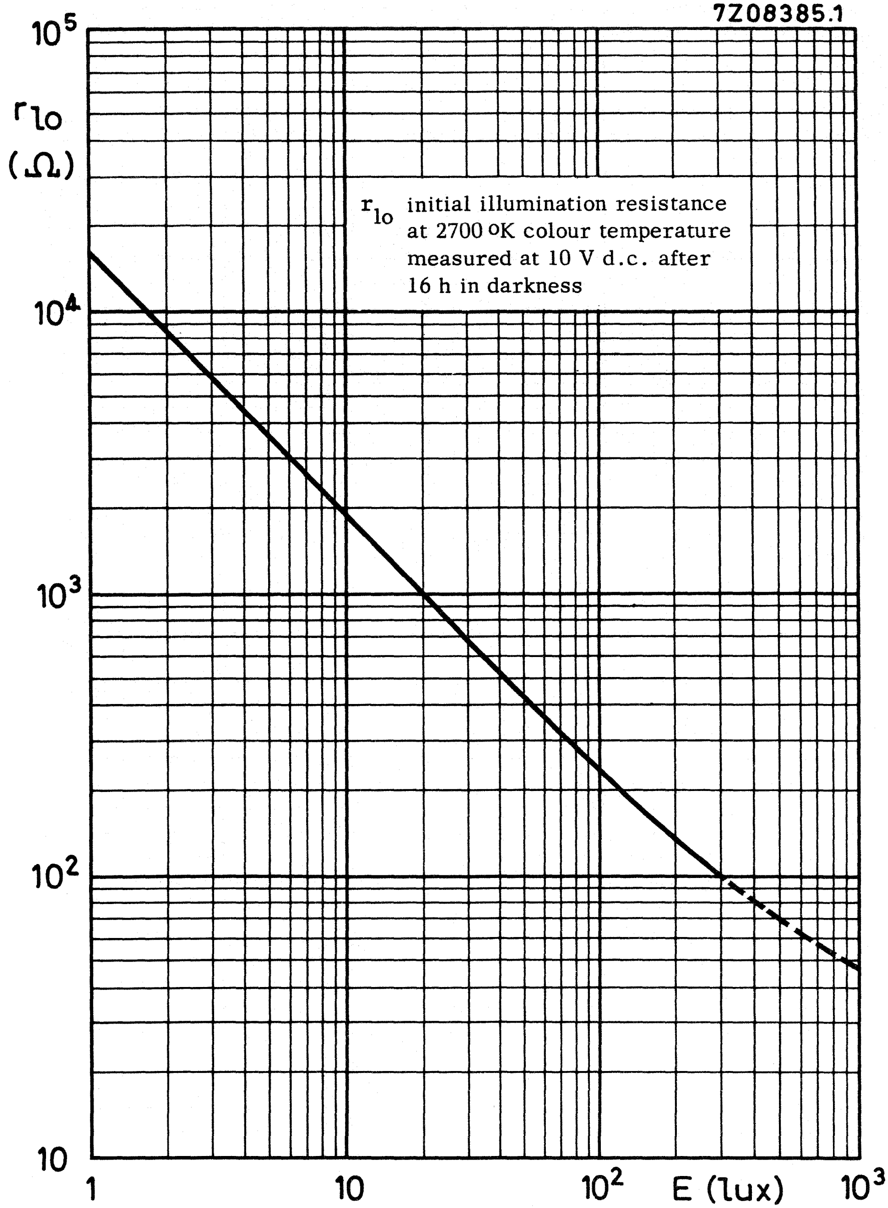
Vibration

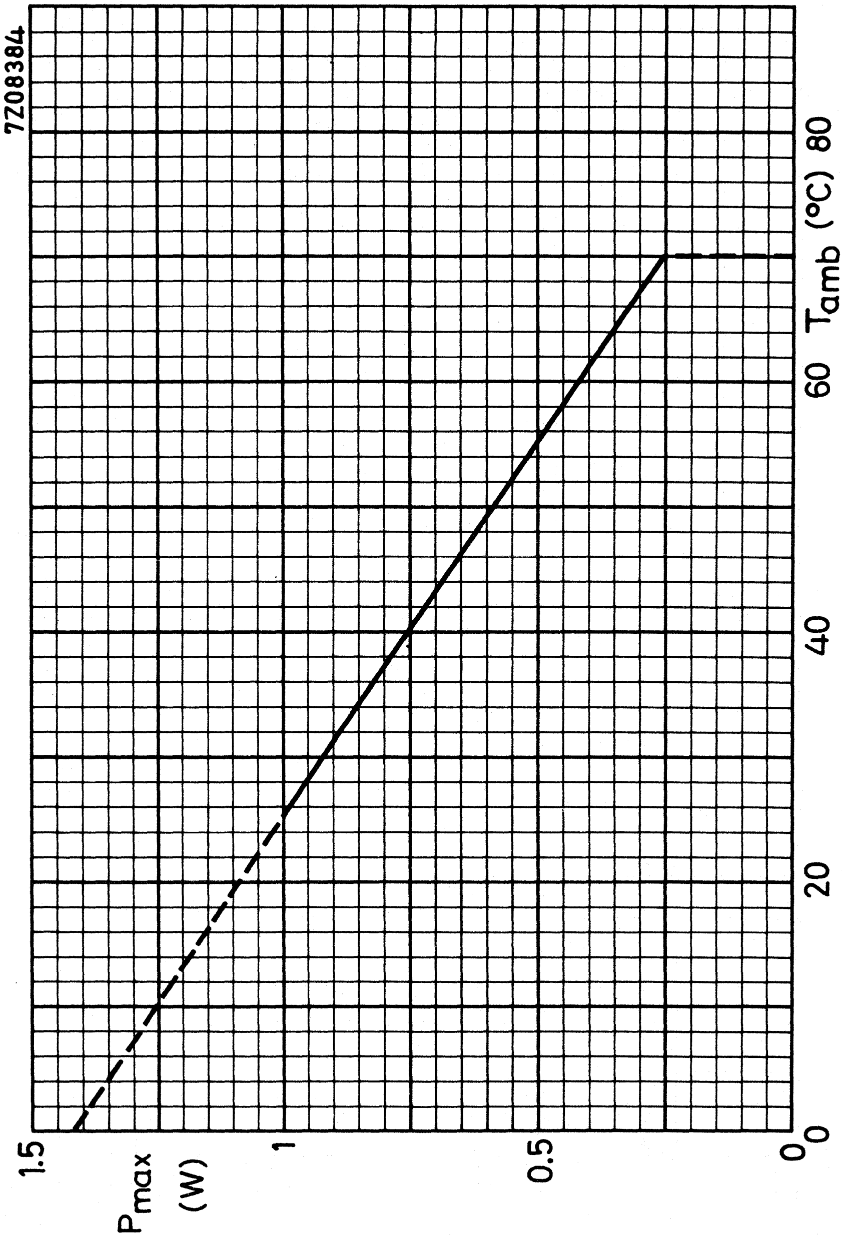
2.5 g_{peak}, 50 Hz, during 32 hours in each of the three positions of the cell.

LIMITING VALUES (Absolute max. rating system)

Cell voltage, d.c. and repetitive peak	V	max.	200	V
Cell voltage, pulse, t_{imp}=max. 5 ms p.r.r. = max. once per minute	V_P	max.	500	V
Power dissipation, t_{av} = 2 s	P	See	page	6
Power dissipation, pulse	P_p	max.	5 x	P
Cell current, d.c. and repetitive peak	I	max.	250	mA
Illumination	E	max.	50000	lux
Temperature Cds tablet, operating	T_{tablet}	max.	85	^oC
Ambient temperature, storage and operating	T_{amb}	min.	- 40	^oC
storage	T_{amb}	max.	+ 50	^oC 1)
operating	T_{amb}	max.	+ 70	^oC

1) Operation of the cell counteracts the deteriorating effect of long periods at high temperature. The maximum operating temperature is therefore higher than the maximum storage temperature.


7Z08385.1
10^5
r_{lo}
(Ω)
r_{lo} initial illumination resistance
at 2700 °K colour temperature
measured at 10 V d.c. after
16 h in darkness
10^4
10^3
10^2
10
1
10
10^2
E (lux)
10^3

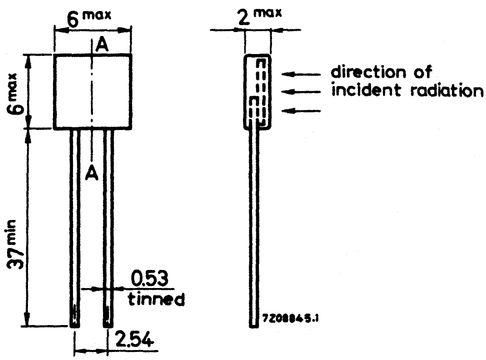

7Z08384
T_{amb} (°C)
0
20
40
60
80
P_{max} (W)
0
0.5
1
1.5

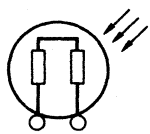
CADMIUM SULPHIDE PHOTOCONDUCTIVE DEVICE

Cadmium sulphide photoconductive device with side sensitivity in plastic encapsulation. The device consists of two cells connected in series and is intended for general applications.

QUICK REFERENCE DATA				
Power dissipation at T_{amb} = 40 °C [1]	P		200	mW
Voltage, d.c. and repetitive peak	V	max.	50	V
Resistance at 50 lux, 2700 °K colour temperature	r_{l_0}		600	Ω
Spectral response curve		see page 4		
Outline dimensions		max.	6 x 6 x 2	mm

MECHANICAL DATA Dimensions in mm





Soldering

The device may be soldered direct into the circuit but heat conducted to the tablet should be kept to a minimum by the use of a thermal shunt.
It may be dip-soldered at a solder temperature of 270 °C for a maximum of 2 s up to a point 6 mm from the envelope.

[1]) See Operating Note 2

ELECTRICAL DATA

Preconditioning > 1 h illumination with 300 lx (fluorescent light)

	symbol	min.	typical	max.	unit
Initial dark resistance, measured with 50 $V_{d.c.}$ applied via 1 MΩ, 20 s after switching off the illumination	r_{do}	200			kΩ
Initial illumination resistance measured at 1 $V_{d.c.}$, illumination 50 lux	r_{lo}	0.35	0.6	1.4	kΩ
Initial drift	D_o		0		%
F_{4700} (= $\frac{r_l \text{ at } 4700\ ^oK}{r_l \text{ at } 2700\ ^oK}$ at constant illumination)			1.2		

THERMAL DATA

Cell temperature	T_{cell}	max.	60	^oC
Thermal resistance from cell to a point on the leads 2 mm from the cell	K		35	$^oC/W$

LIMITING VALUES (Absolute max. rating system)

Cell voltage, d.c. and repetitive peak pulse, t_{imp} = max. 5 ms p r r = max. once per minute	V	max.	50	V
Power dissipation, t_{av} = 0.5 s	P	max.	300	mW
Cell current, d.c. and r.m.s.	I	max.	25	mA
Ambient temperature, storage and operating	T_{amb}	min.	−40	^oC
storage	T_{amb}	max.	+50	^oC
Cell temperature	T_{cell}	max.	+60	^oC

OPERATING NOTES

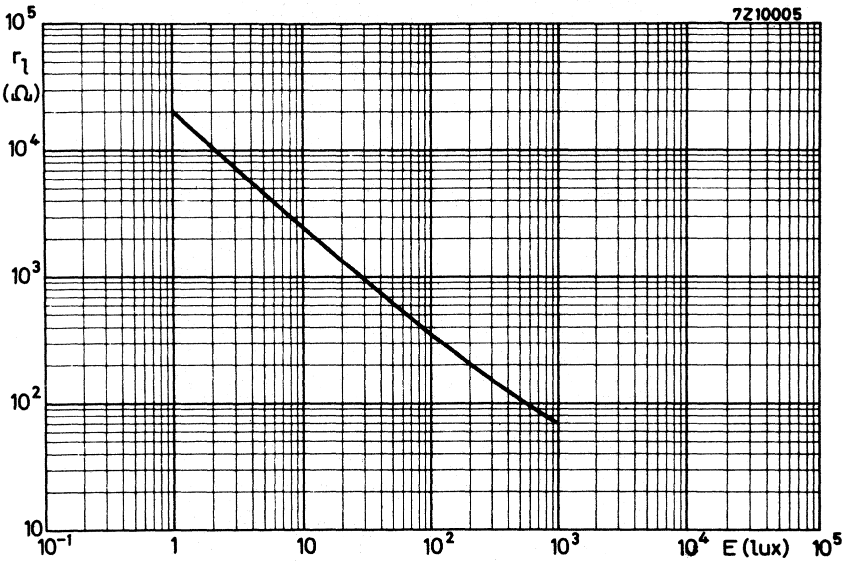
1. The device consists of two photoconductive cells connected in series. The resistance of the device is mainly governed by the resistance of that cell receiving the lowest luminous flux.
   If it is essential for the application that the device is partly shaded off, the shadow line should be perpendicular to the axis A-A of the device.

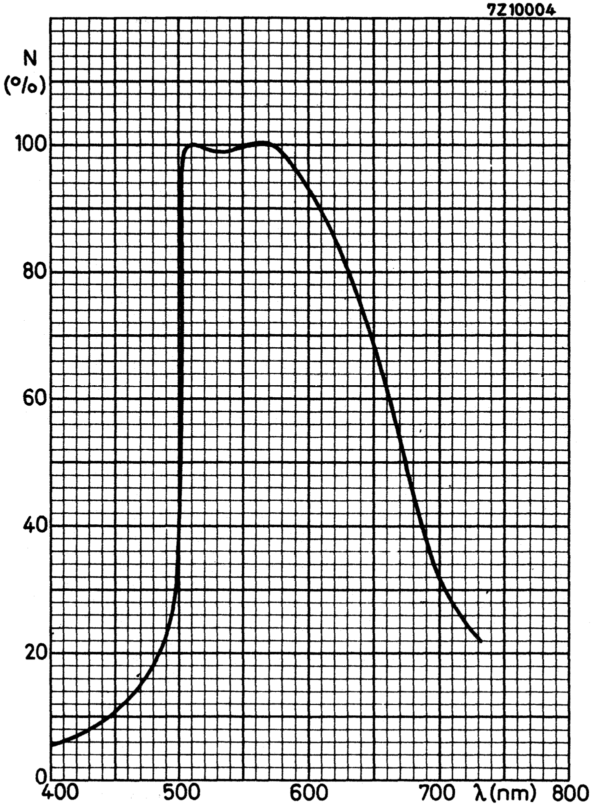
2. By clamping the leads at 2 mm from the body of the device, and making sure that the thermal resistance between clamping point and ambient is 50 $^oC/W$, one obtains an allowable dissipation of 200 mW at an ambient temperature of 40 ^oC; the temperature difference between clamping point and ambient then is 10 ^oC and the cell temperature 60 ^oC.

CLIMATIC DATA

After exposure to test C: Damp heat test (long term exposure):
temperature 40 °C ± 2 °C; relative humidity between 90% and 95%, severity VII of Publication 68-2 of the International Electrotechnical Commission (IEC) the changes in illumination resistance are within +50% and −30%.

A high humidity does not harm the cell. Yet care should be taken not to put the cell into operation when wet. Four hours under normal room conditions make it sufficiently dry, also after it has been exposed to high humidity conditions for a long time.



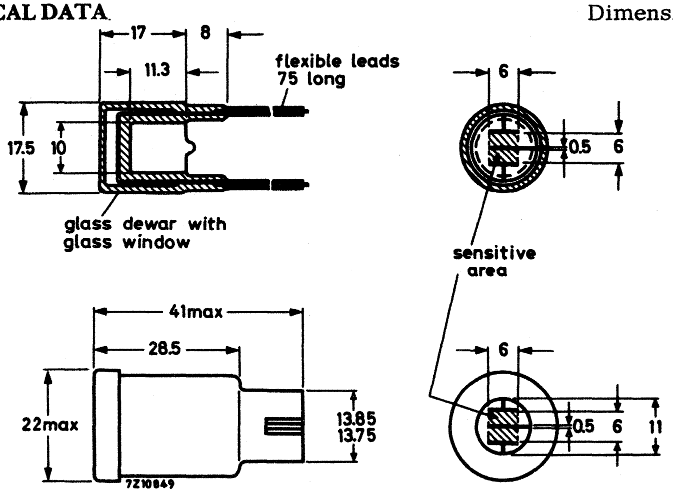

7Z10004
N
(%)
100
80
60
40
20
0
400
500
600
700
λ (nm)
800

PHOTOCONDUCTIVE CELLS

Evaporated lead sulphide photoconductive cells with sensitive element mounted in a glass dewar, encapsulated in a metal envelope for room temperature operation. Also available without metal envelope for cooled operation.
The cells are intended for use with pulsed or modulated radiation.

QUICK REFERENCE DATA				
Peak spectral response	λ_m		2.2	μm
Spectral response range	$\Delta\lambda$		0.3 to 3.5	μm
Internal resistance	r_i	typ.	1.5	MΩ
Responsivity (radiation 2.0 μm)		typ.	80	mV/μW
D^* (2.0 μm, 800 Hz, 1 Hz)		typ.	4×10^{10}	cm $\sqrt{Hz}$/W
Time constant		typ.	100	μs
Sensitive area			6.0 x 6.0	mm^2

MECHANICAL DATA Dimensions in mm



Accessory: socket for encapsulated version: Belling-Lee type 789/CS.

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

Voltage (bidirectional)		V	max. 250	V
Current (bidirectional)		I	max. 0.5	mA
Temperatures				
Storage temperature	encapsulated version	T_{stg}	−55 to +60	°C
	cooled version	T_{stg}	−80 to +60	°C
Operating ambient temperature		T_{amb}	max. 60	°C

CHARACTERISTICS at T_{amb} = 20 °C (see note 1 on page 3)

Peak spectral response	λ_m	2.2	μm
Spectral response range	$\Delta\lambda$	0.3 to 3.5	μm
Internal resistance	r_i	typ. 1.5	MΩ
		1.0 to 4.0	MΩ
Time constant		typ. 100	μs
Noise voltage		typ. 8.5	μV

Performance

1. Black body source
   colour temperature : 500 K
   chopping frequency : 800 Hz
   bandwidth : 1 Hz

→ Responsivity	> **0.2**	mV/μW
	typ. 1.3	mV/μW
→ D^*	> **2.0** x 10^8	cm $\sqrt{Hz}$/W
	typ. 6.5 x 10^8	cm $\sqrt{Hz}$/W
→ N.E.P.	typ. 0.92	nW
	< **3.0**	nW

2. Monochromatic source
   radiation : 2.0 μm
   chopping frequency: 800 Hz
   bandwidth : 1 Hz

Responsivity	typ. 80	mV/μW
D^*	typ. 4 x 10^{10}	cm $\sqrt{Hz}$/W
N.E.P.	typ. 15	pW

NOTES

1. Test conditions

The characteristics are measured with the cell biased from a 200 V d.c. supply in series with a 1.0 MΩ load resistor. No correction is made for the loading effect of the 1.0 MΩ resistor, i.e. open circuit characteristics are not given.

The sensitive element is situated at a distance of 264 mm a black body source limited by an aperture of 3 mm. The radiation path is interrupted at 800 Hz by a chopper blade at ambient temperature. Under these conditions the r.m.s. power at the element (chopping factor 2.2) is 4.5 $\mu W/cm^2$.

Measurements of the detector output are made with an amplifier tuned to 800 Hz with a bandwidth of 50 Hz.

2. D^* and N.E.P.

These are figures of merit for the materials of detectors.

The detectivity 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 Noise Equivalent Power (N.E.P.) is related to D^* by the expression:

$$\text{N.E.P.} = \frac{\sqrt{A}}{D^*}$$

3. Time constant

Detector time constant figures are based on the response to a step function in the incident radiation. Quoted times indicate the interval between the moment the radiation is cut off and the output falling to 63% of its peak value.

4. Variation of performance with bias current.

Both signal and noise vary with current in this type of cell. 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.

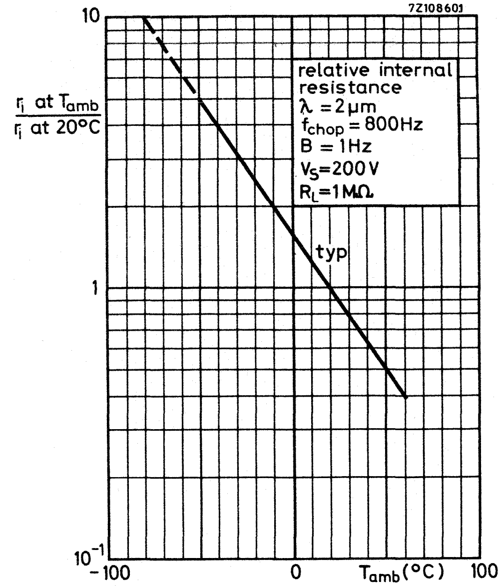
NOTES (continued)

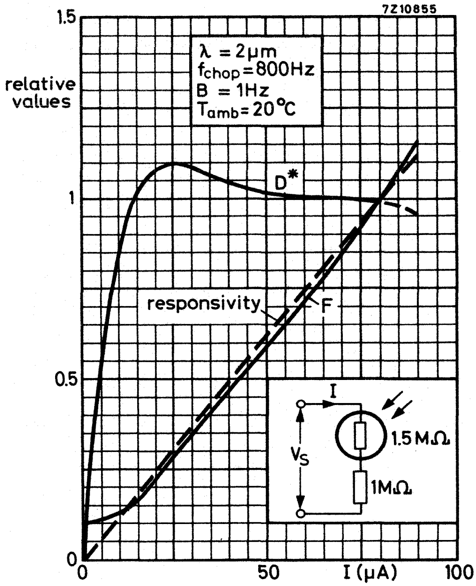
5. Effect of ambient radiation

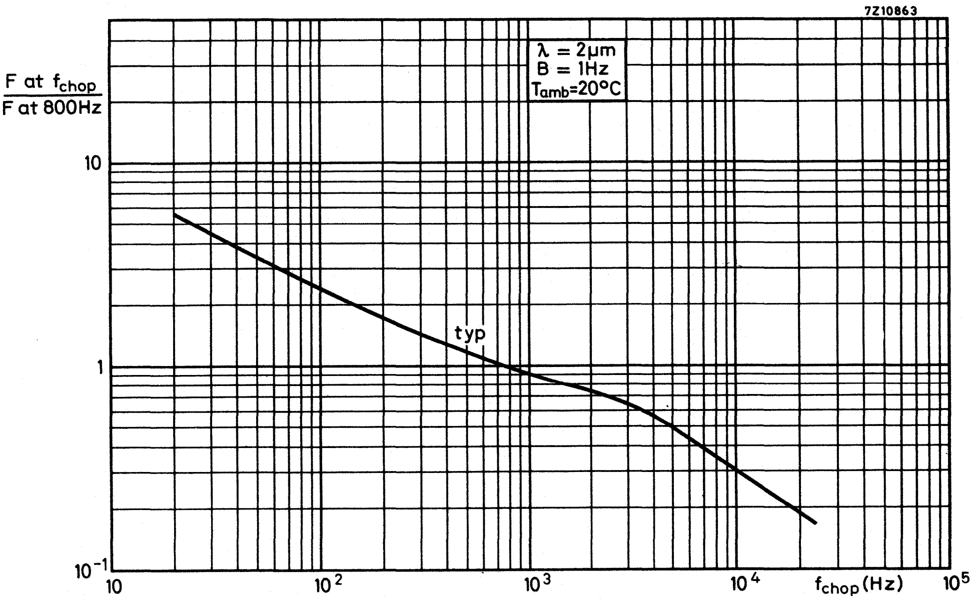
Care should be taken to avoid the incidence on the cell of appreciable radiation in the visible range. Such radiation will cause a decrease in the cell resistance and signal as long as the cell is kept cool. Normal daylight can cause this effect if seen for more than a few minutes. Precautions should be taken to prevent visible light reaching the sensitive element via the liquid nitrogen compartment.

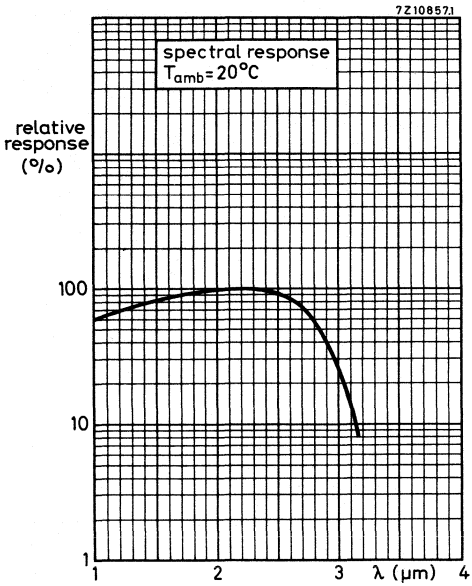
6. Warning

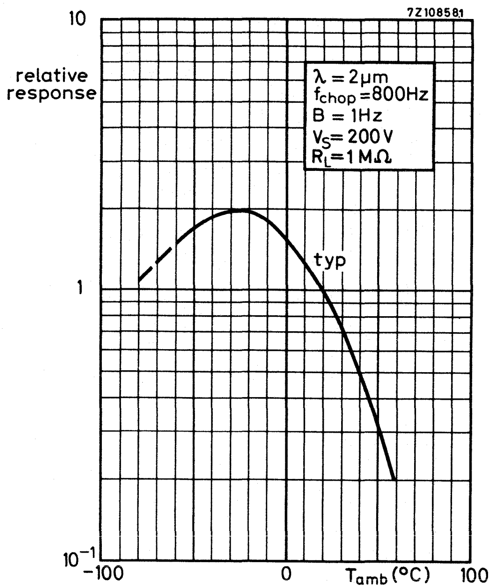
Care should be taken to ensure that the device is not allowed to reach room temperature while still biased.
The dewar vessel must always be completely dry before being refilled with liquid nitrogen. In very humid conditions, water vapour may condense at the top of the dewar vessel. Should this occur, the remaining liquid nitrogen should be allowed to boil off, the ice should be removed and precautions taken to avoid a recurrence.

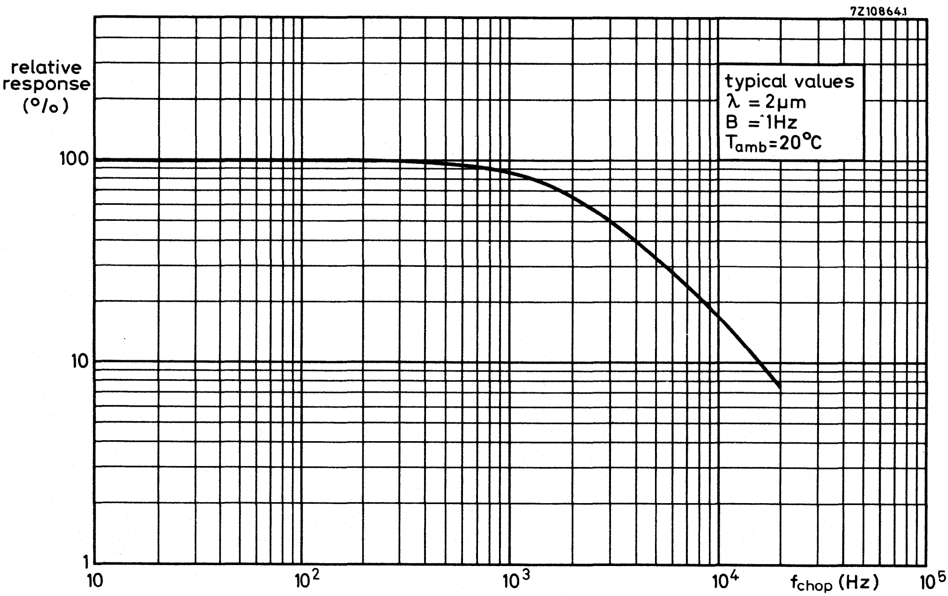

7Z108601
$\frac{r_i \text{ at } T_{amb}}{r_i \text{ at } 20°C}$
relative internal resistance
λ = 2 μm
f_{chop} = 800Hz
B = 1Hz
V_S = 200 V
R_L = 1 MΩ
typ
10
1
10^{-1}
−100
0
T_{amb} (°C)
100

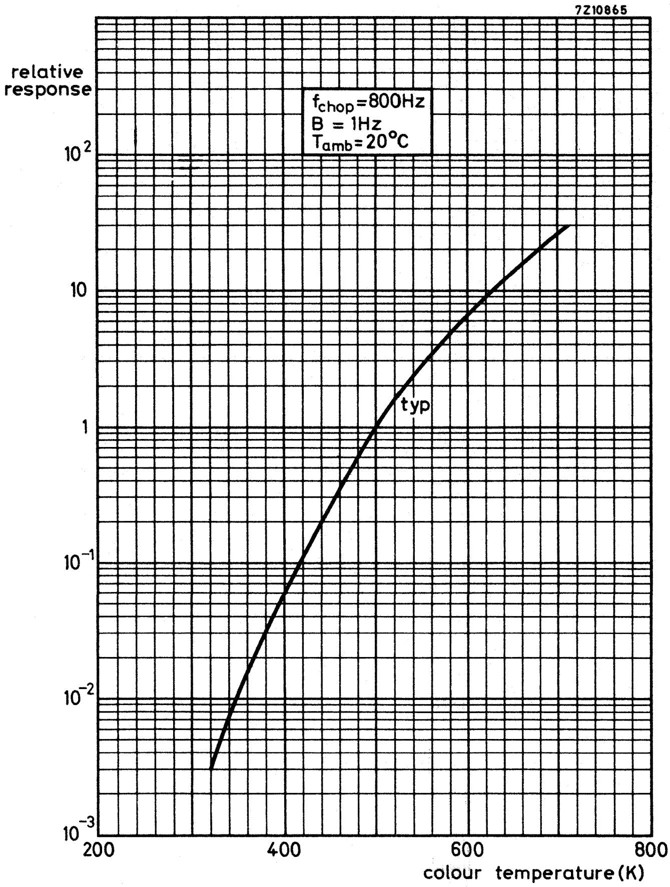

7Z10855
relative values
λ = 2 μm
f_{chop} = 800Hz
B = 1Hz
T_{amb} = 20 °C
D*
responsivity
F
I
V_S
1.5 MΩ
1MΩ
1.5
1
0.5
0
0
50
I (μA)
100

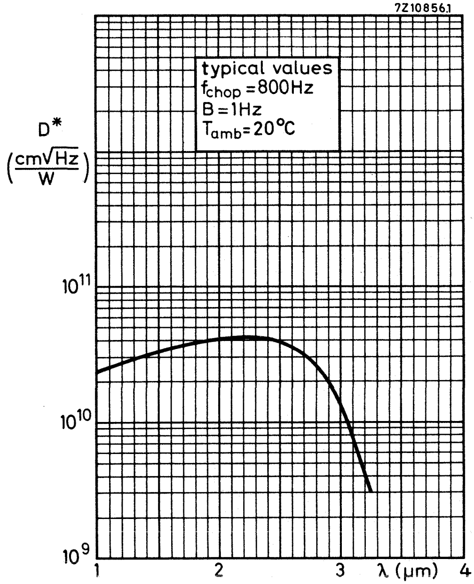

7Z10863
$\frac{F \text{ at } f_{chop}}{F \text{ at } 800Hz}$
λ = 2 μm
B = 1Hz
T_{amb} = 20°C
typ
10
1
10^{-1}
10
10^2
10^3
10^4
f_{chop} (Hz)
10^5

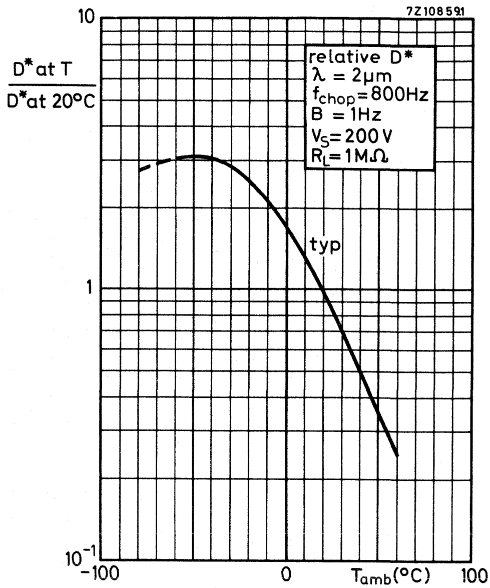

7Z10857.1
spectral response
Tamb=20°C
relative
response
(%)
100
10
1
1
2
3
λ (μm)
4

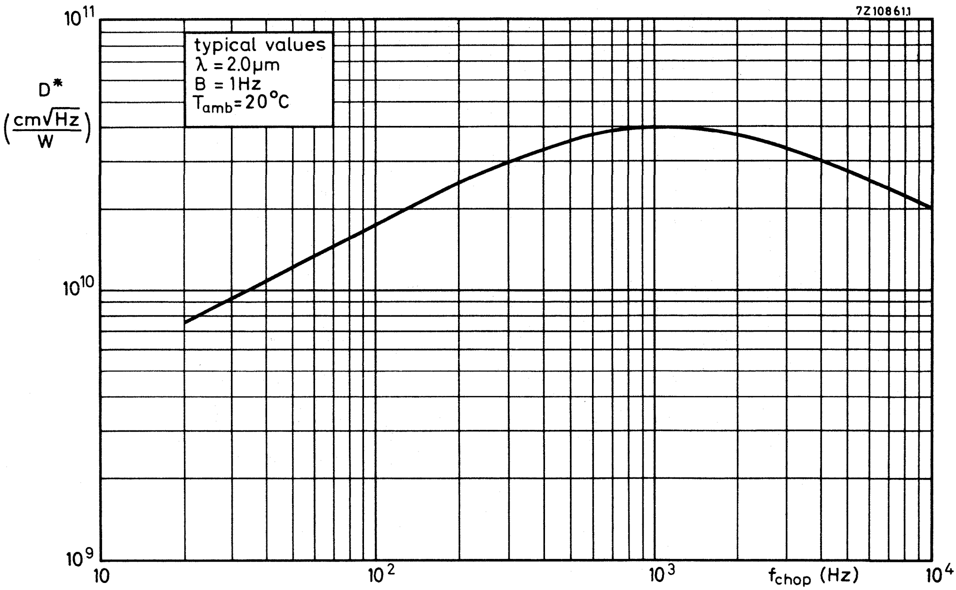

7Z10858.1
10
relative
response
λ = 2μm
fchop = 800Hz
B = 1Hz
VS = 200 V
RL = 1 MΩ
typ
1
10⁻¹
−100
0
Tamb (°C)
100

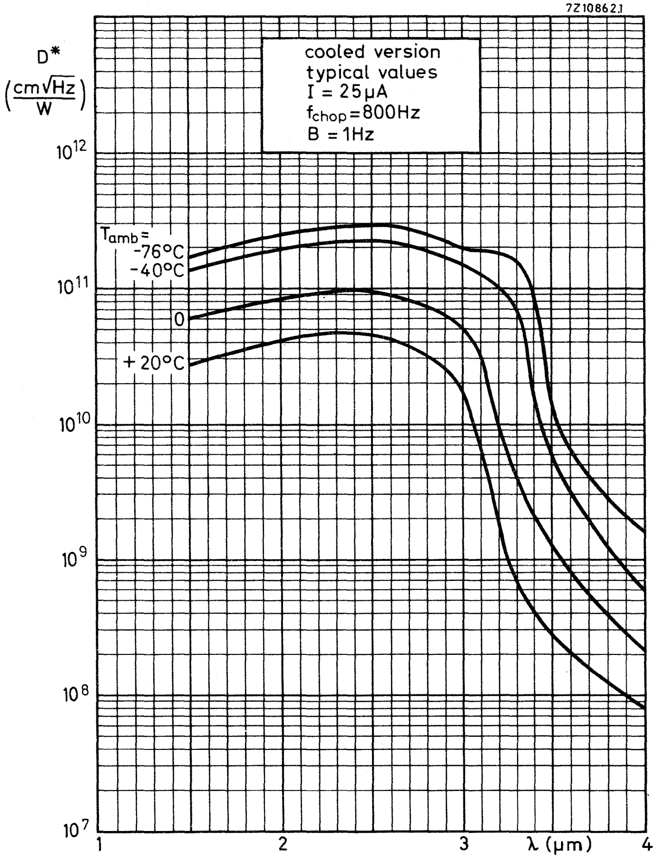

7Z10864.1
relative
response
(%)
typical values
λ = 2μm
B = 1Hz
Tamb=20°C
100
10
1
10
10²
10³
10⁴
fchop (Hz)
10⁵


7Z10865
relative response
f_{chop} = 800Hz
B = 1Hz
T_{amb} = 20°C
10^2
10
1
10^{-1}
10^{-2}
10^{-3}
typ
200
400
600
800
colour temperature (K)


7Z10856.1
typical values
f_{chop} = 800Hz
B = 1Hz
T_{amb} = 20°C
D*
(cm√Hz / W)
10^{11}
10^{10}
10^{9}
1
2
3
λ (μm)
4


7Z10859.1
10
D* at T / D* at 20°C
relative D*
λ = 2μm
f_{chop} = 800Hz
B = 1Hz
V_S = 200 V
R_L = 1MΩ
typ
1
10^{-1}
−100
0
T_{amb}(°C)
100


7Z10861.1
10^{11}
typical values
λ = 2.0μm
B = 1Hz
T_{amb} = 20°C
D*
(cm√Hz / W)
10^{10}
10^{9}
10
10^{2}
10^{3}
f_{chop} (Hz)
10^{4}


7Z10862.1
cooled version
typical values
I = 25 μA
f_chop = 800Hz
B = 1Hz
D*
(cm√Hz / W)
T_amb =
-76°C
-40°C
0
+20°C
10^12
10^11
10^10
10^9
10^8
10^7
1
2
3
λ (μm)
4

Accessories

Introduction

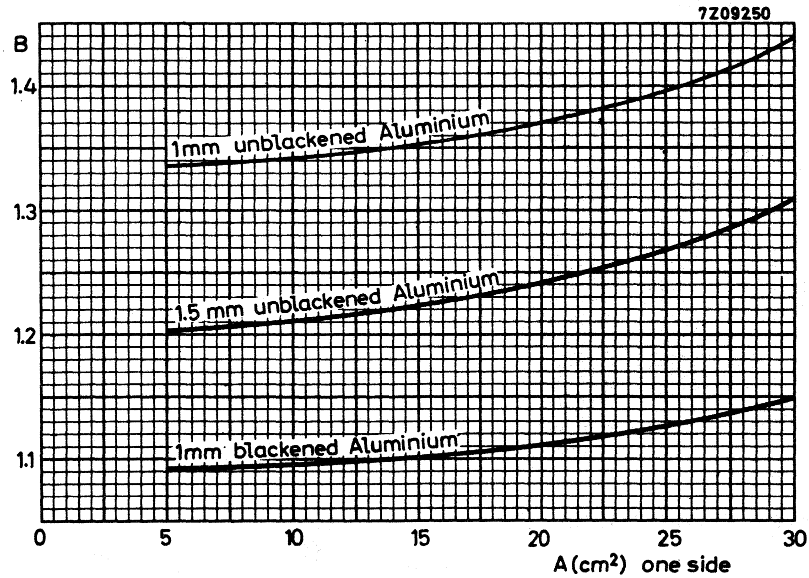
All information on thermal resistances of the accessories combined with flat heatsinks is valid for square heatsinks of 1.5 mm blackened aluminium.
For a few variations the thermal resistance may be derived as follows:

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

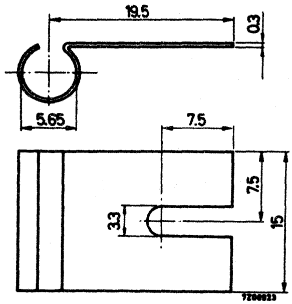
Multiply by the factor B given below as a function of the heatsink size A.



COOLING FIN

MECHANICAL DATA

Dimensions in mm

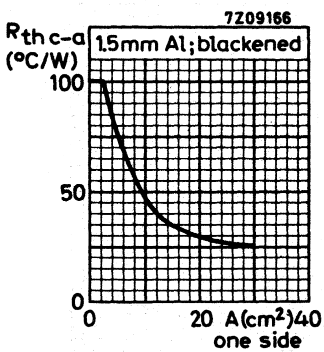


Fin material: brass, nickel plated

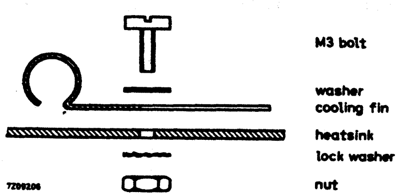
THERMAL RESISTANCE

From case to ambient with cooling fin only — $R_{th\ c\text{-}a}$ = 100 °C/W

with heatsink — see graph



MOUNTING INSTRUCTIONS

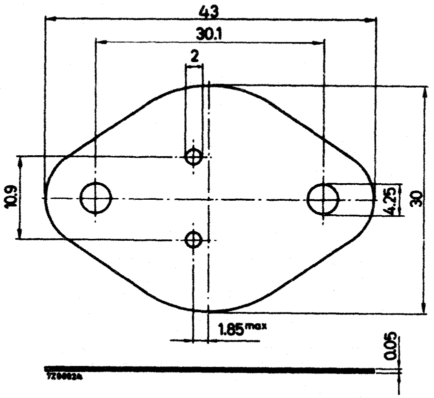


Torque on nut for good heat transfer: 5 cm kg

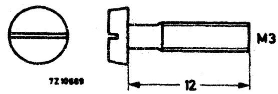
MOUNTING ACCESSORIES

MECHANICAL DATA

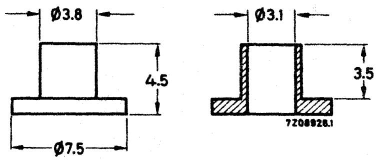
Dimensions in mm



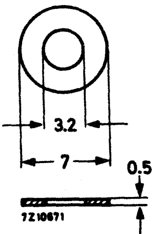
mica washer



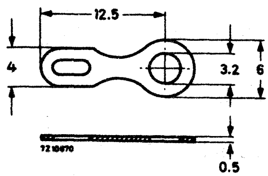
2 cheese head screws, slotted
material: brass, nickel plated



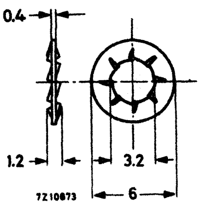
2 insulating bushes



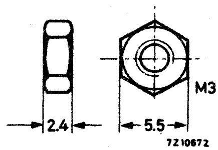
3 plain washers
material: brass, nickel plated



soldering tag



2 lock washers, internal teeth
material: steel, nickel plated



2 hexagon nuts
material: brass, nickel plated

THERMAL RESISTANCE

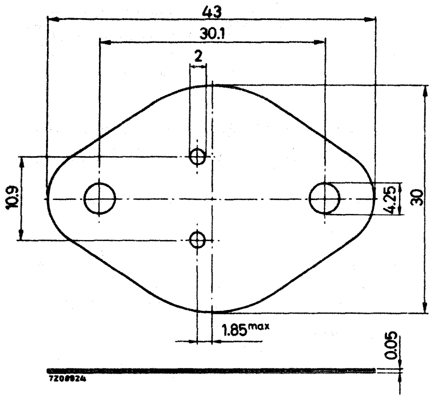
From mounting base to heatsink with mica washer $R_{th\ mb-h}$ = 1.0 °C/W

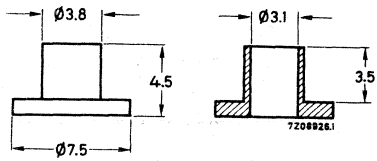
TEMPERATURES

Maximum allowable temperature T_{max} = 150 °C

56201a MICA WASHER AND 2 INSULATING BUSHES

MECHANICAL DATA Dimensions in mm



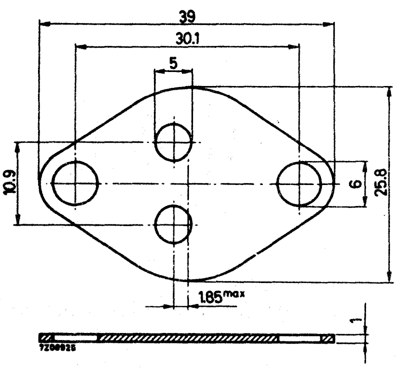


THERMAL RESISTANCE

From mounting base to heatsink $R_{th\ mb-h}$ = 1.0 °C/W

56201b LEAD WASHER

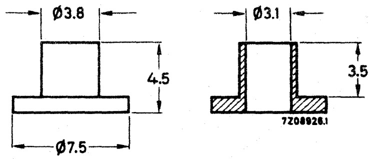
MECHANICAL DATA Dimensions in mm



56201c INSULATING BUSH

MECHANICAL DATA

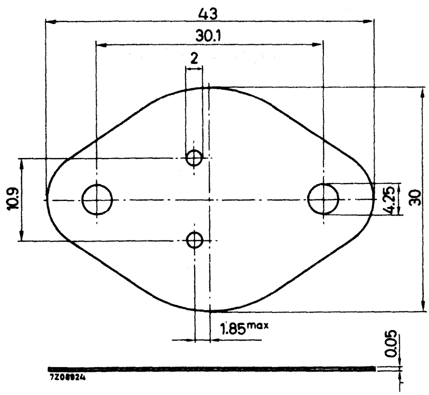
Dimensions in mm



56201d MICA WASHER

MECHANICAL DATA

Dimensions in mm



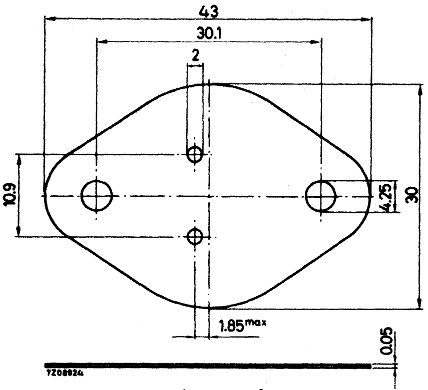
THERMAL RESISTANCE

From mounting base to heatsink $R_{th\ mb-h}$ = 1.0 °C/W

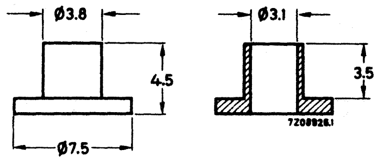
MOUNTING ACCESSORIES

MECHANICAL DATA

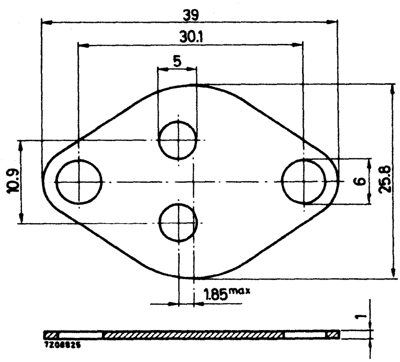
Dimensions in mm



mica washer



2 insulating bushes



lead washer

THERMAL RESISTANCE

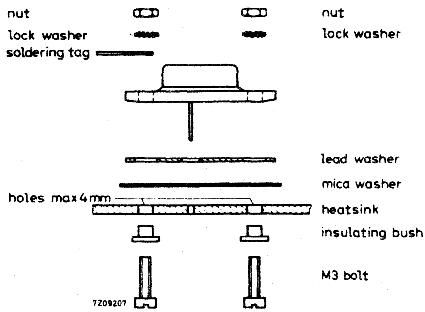
From mounting base to heatsink

with mica washer only	$R_{th\ mb-h}$	= 1.0	°C/W
with mica washer and lead washer	$R_{th\ mb-h}$	= 0.75	°C/W

TEMPERATURE

Maximum allowable temperature	T_{max}	= 150	°C

MOUNTING INSTRUCTIONS

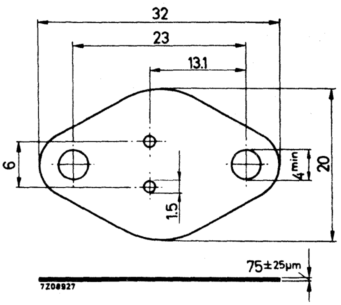


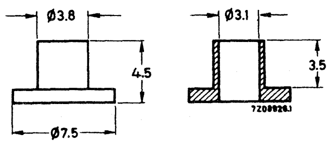
Torque on nut for good heat transfer : 5 cm kg

MICA WASHER AND 2 INSULATING BUSHES

MECHANICAL DATA

Dimensions in mm





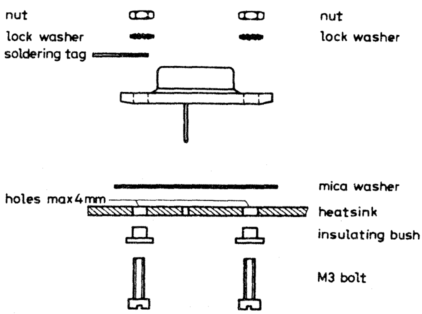
THERMAL RESISTANCE

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

TEMPERATURE

Maximum allowable temperature T_{max} = 150 °C

MOUNTING INSTRUCTIONS

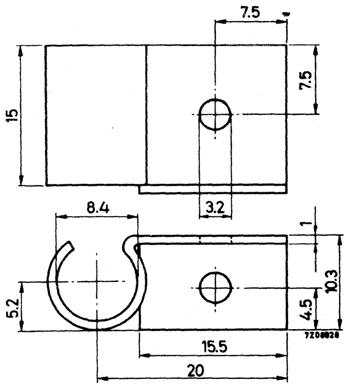


Torque on nut for good heat transfer: 5 cm kg

COOLING FIN

MECHANICAL DATA

Dimensions in mm

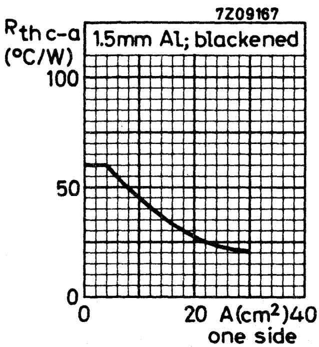


Fin material: aluminium, blackened

THERMAL RESISTANCE

From case to ambient with cooling fin only $R_{th\ c\text{-}a}$ = 60 °C/W

with heatsink see graph



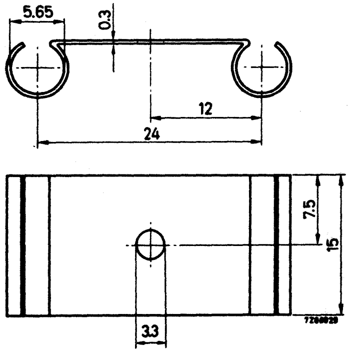
MOUNTING INSTRUCTIONS

Torque on M3 bolts for good heat transfer: 5 cmkg

COOLING FIN

MECHANICAL DATA

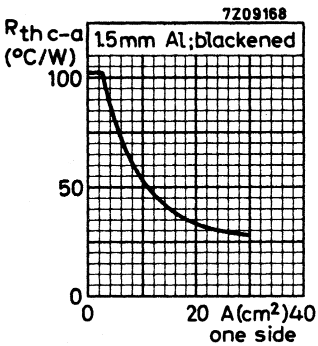
Dimensions in mm



Fin material: brass, nickel plated

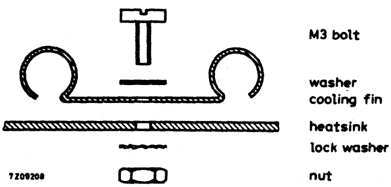
THERMAL RESISTANCE

From case to ambient with cooling fin only	$R_{th\ c\text{-}a}$	= 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

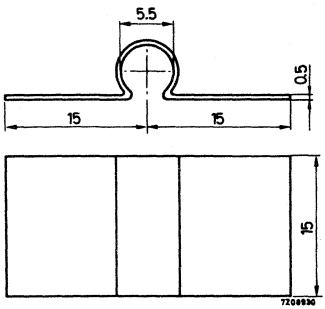


Torque on nut for good heat transfer: 5 cmkg

COOLING FIN

MECHANICAL DATA

Dimensions in mm



Fin material: brass, nickel plated

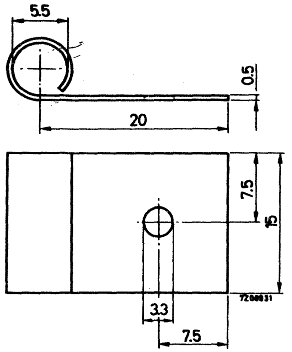
THERMAL RESISTANCE

From case to ambient with cooling fin only $R_{th\ c\text{-}a}$ = 75 °C/W

COOLING FIN

MECHANICAL DATA

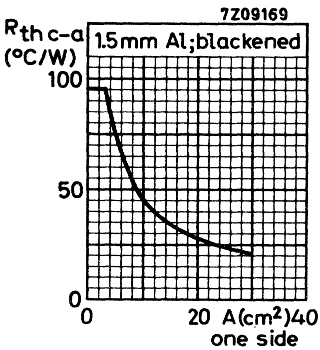
Dimensions in mm



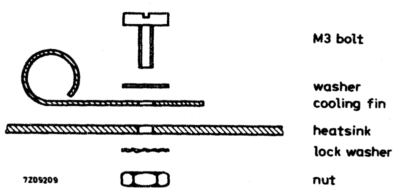
Fin material: brass, nickel plated

THERMAL RESISTANCE

From case to ambient with cooling fin only $R_{th\ c-a}$ = 95 $^{o}C/W$
with heatsink see graph



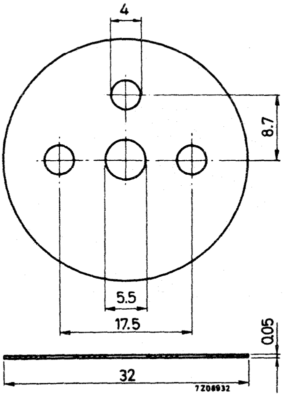
MOUNTING INSTRUCTIONS



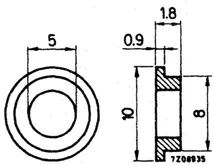
Torque on nut for good heat transfer: 5 cm kg

MOUNTING ACCESSORIES

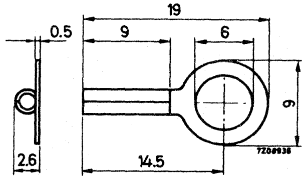
MECHANICAL DATA Dimensions in mm



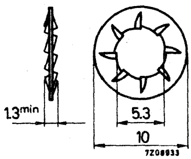
mica washer



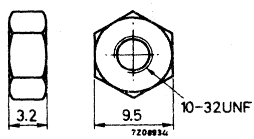
insulating ring



cable lug
material: brass, nickel plated



lock washer internal teeth
material: steel, nickel plated



hexagon nut
material: brass, nickel plated

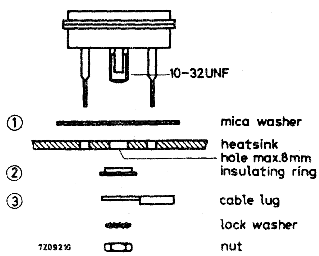
THERMAL RESISTANCE

From mounting base to heatsink $R_{th\ mb\text{-}h}$ = 1 °C/W

TEMPERATURE

Maximum allowable temperature T_{max} = 125 °C

MOUNTING INSTRUCTIONS



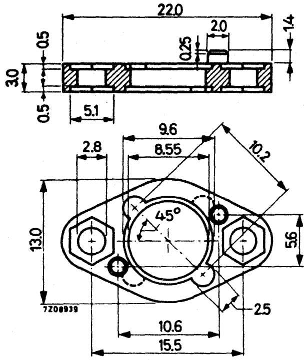
Torque on nut for good heat transfer: 20 cm

Non insulated mounting; without items 1, 2 and 3. (3 if necessary)

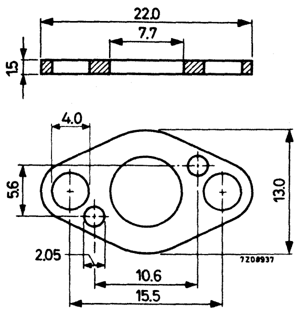
MOUNTING ACCESSORIES

MECHANICAL DATA

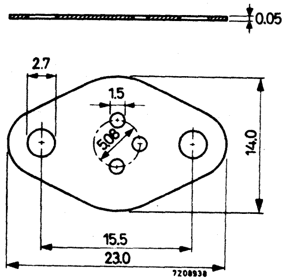
Dimensions in mm



top clamping washer
of insulating material



bottom clamping washer
material: brass, tin plated



mylar washer

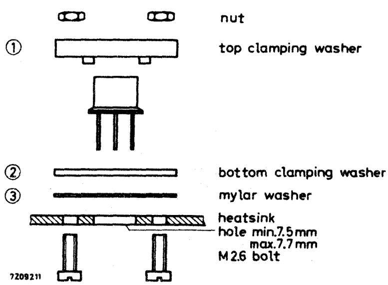
THERMAL RESISTANCE

From mounting base to heatsink	non insulated mounting	$R_{th\ mb\text{-}h}$ = 3 °C/W
	insulated mounting	$R_{th\ mb\text{-}h}$ = 6 °C/W

TEMPERATURE

Maximum allowable temperature T_{max} = 100 °C

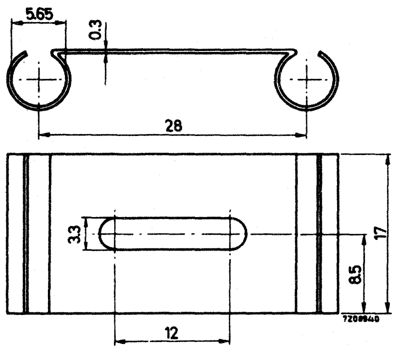
MOUNTING INSTRUCTIONS



Non insulated mounting; without items 2 and 3. (Note: item 1 must than be mounted up-side down)

COOLING FIN

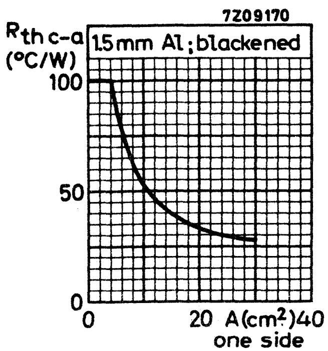
MECHANICAL DATA Dimensions in mm



Fin material: brass, nickel plated

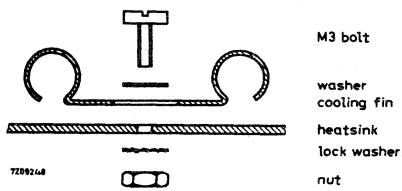
THERMAL RESISTANCE

From case to ambient with cooling fin only $R_{th\ c-a}$ = 100 °C/W
with heatsink see graph



R_{th} values apply to each transistor, provided the two transistors have been mounted so that the heat flow from each is equal.

MOUNTING INSTRUCTIONS

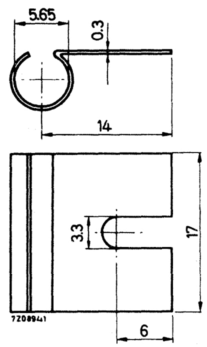


Torque on nut for good heat transfer: 5 cmkg

COOLING FIN

MECHANICAL DATA

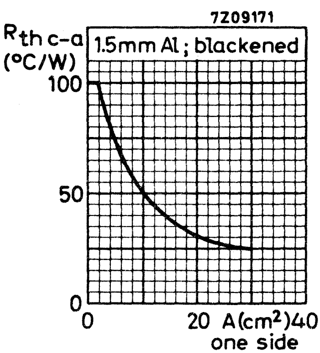
Dimensions in mm



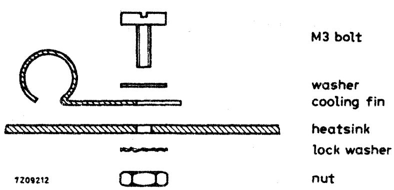
Fin material: brass, nickel plated

THERMAL RESISTANCE

From case to ambient with cooling fin only	$R_{th\ c-a}$	= 100 °C/W
with heatsink		see graph



MOUNTING INSTRUCTIONS

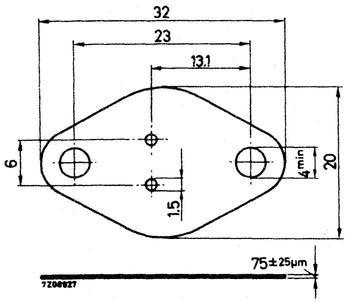


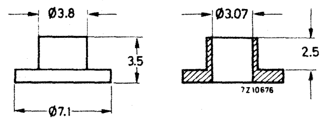
Torque on nut for good heat transfer: 5 cm kg

MICA WASHER AND 2 INSULATING BUSHES

56239

MECHANICAL DATA Dimensions in mm





THERMAL RESISTANCE

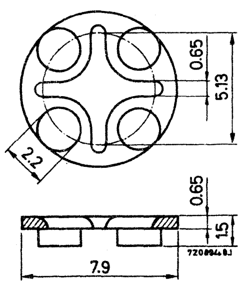
From mounting base to heatsink $R_{th\ mb\text{-}h}$ = 1.5 $^{o}C/W$

TEMPERATURE

Maximum allowable temperature T_{max} = 150 ^{o}C

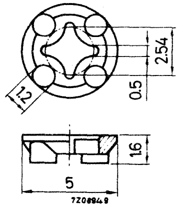
DISTANCE DISCS

56245



Insulating material

56246



Insulating material

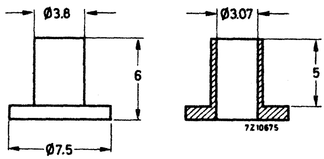
TEMPERATURE

Maximum allowable temperature T_{max} = 100 ^{o}C

2 INSULATING BUSHES

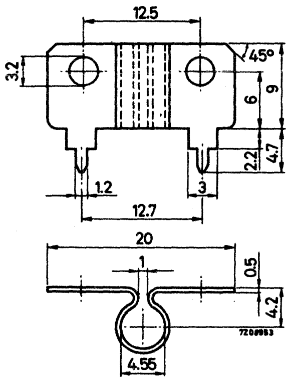
56261

MECHANICAL DATA Dimensions in mm



56263 COOLING FIN

MECHANICAL DATA Dimensions in mm



Fin material: copper, tin plated

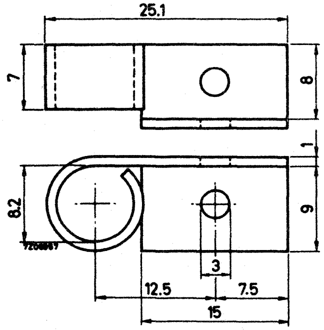
THERMAL RESISTANCE

From case to ambient $R_{th\,c-a}$ = 100 °C/W

COOLING FIN

MECHANICAL DATA

Dimensions in mm

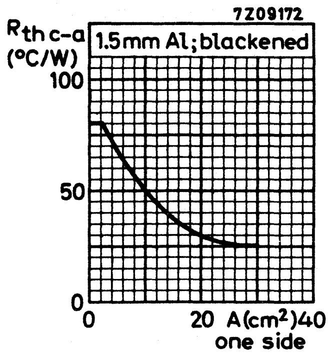


Fin material: aluminium, blackened

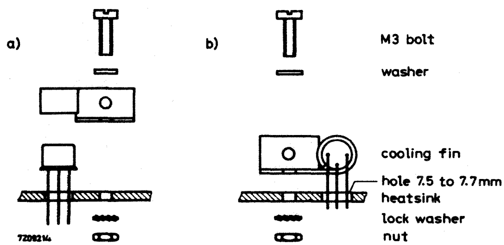
THERMAL RESISTANCE

From case to ambient with cooling fin only — $R_{th\ c\text{-}a}$ = 80 °C/W

with heatsink — see graph



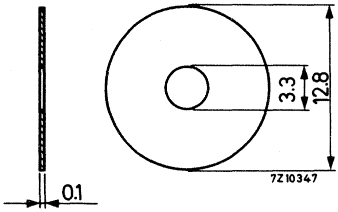
MOUNTING INSTRUCTIONS



Torque on nut for good heat transfer: 5 cm kg

56302 MICA WASHER

MECHANICAL DATA Dimensions in mm

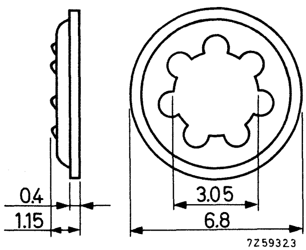


THERMAL RESISTANCE

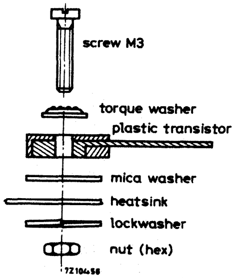
From mounting base to heatsink $R_{th\ mb\text{-}h}$ = 6 °C/W

56303 TORQUE WASHER

MECHANICAL DATA Dimensions in mm



MOUNTING INSTRUCTIONS



Torque on nut: min. 8 cm kg
max. 9 cm kg

INDEX OF TYPE NUMBERS

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

B = Beam lead devices for thick- and thin-film circuits
HF = High frequency transistors
LF = Low frequency transistors
Mm = Microminiature devices for thick- and thin-film circuits
Mw = Microwave devices
P = Lowfrequency power transistors
Sw = Switching transistors
Tr = Transmitting transistors

Defl = Deflection transistors
Dual = Dual transistors
FET = Field effect transistors
HF = High frequency transistors
LF = Low frequency transistors
Mm = Microminiature devices for thick- and thin-film circuits
P = Low frequency power transistors
Tr = Transmitting transistors

B = Beam lead devices for thick- and thin-film circuits
Defl = Deflection transistors
FET = Field effect transistors
HF = High frequency transistors
LF = Low frequency transistors
Mm = Microminiature devices for thick- and thin-film circuits
Mw = Microwave devices
P = Low frequency power transistors
Ph = Photo devices
Sw = Switching transistors
Tr = Transmitting transistors

FET = Field effect transistors
HF = High frequency transistors
LF = Low frequency transistors
P = Low frequency power transistors
Ph = Photo devices
Sw = Switching transistors
Tr = Transmitting transistors

A = Accessories
HF = High frequency transistors
LF = Low frequency transistors
Ph = Photo devices
Tr = Transmitting transistors

Printed in The Netherlands 9399 251 14701