PHILIPS

DATA HANDBOOK

PHILIPS ELECTRON DEVICES
116 vanderhoof ave toronto 17, ontario

SEMICONDUCTORS AND INTEGRATED CIRCUITS

PART 1 SEPTEMBER 1968

Diodes and Thyristors

Rectifier Stacks

Accessories and Heatsinks

SEMICONDUCTORS AND INTEGRATED CIRCUITS

Part 1 **September 1968**

DATA HANDBOOK SYSTEM

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

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

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

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

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

SEMICONDUCTORS AND INTEGRATED CIRCUITS

This (red) series comprises the following volumes:

Part 1 September 1968

Former issue: August 1967

General section

Signal diodes

Variable capacitance diodes

Voltage regulator diodes

Rectifier diodes

Thyristors

Rectifier stacks

Accessories and heatsinks

Part 2 October 1968

Former issue: September 1967

General section

Germanium transistors

Photo devices

Accessories and heatsinks

Part 3/4 November 1968

General section

Silicon transistors

Accessories and heatsinks

Part 5 January 1969

General section

Digital integrated circuits

Linear integrated circuits

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

General section

Type designation
Colour codes
Rating systems
Letter symbols

TYPE DESIGNATION CODE

FOR SEMICONDUCTOR DEVICES

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

The type designation consists of:

TWO LETTERS FOLLOWED BY A SERIAL NUMBER

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

- A Devices with one or more junctions, using material with a band gap of 0.6 to 1.0 eV, such as germanium
- B Devices with one or more junctions, using material with a band gap of 1.0 to 1.3 eV, such as silicon
- C Devices with one or more junctions, using material with a band gap of 1.3 eV and more, such as gallium arsenide
- D Devices with one or more junctions, using material with a band gap of less than 0.6 eV, such as indium antimonide
- R Devices without junction, using materials such as those employed in Hall generators and photoconductive cells

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

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

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

A Detection diode, high speed diode, mixer diode

B Variable capacitance diode

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

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

E Tunnel diode

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

G Multiple of dissimilar devices (see note at page 1)

H Field probe

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

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

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

P Radiation sensitive device

Q Radiation generating device

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

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

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

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

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

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

Z Voltage reference or voltage regulator diode [1]

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

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<u>The serial number</u> consists of:

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

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

EXAMPLES

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

BYX27 Silicon rectifying diode intended primarily for "industrial" applications

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TYPE DESIGNATION FOR A RANGE OF SEMICONDUCTOR DEVICES

The type designation of a range of variants of:

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

b) rectifying diodes (second letter Y)

c) thyristors (second letter T)

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

The suffix part consists of:

a) for voltage reference or voltage regulator diodes

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

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

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

b) for rectifying diodes

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

c) for thyristors

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

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

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EXAMPLES

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

OLD SYSTEM

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

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

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

EXAMPLES

OA81	Semiconductor diode
OAZ200	Zener diode
OC72	Transistor

7Z3 0368

TYPE DESIGNATION FOR SEMICONDUCTOR RECTIFIER STACKS

The type designation consists of:

Three letters followed by a serial number

The first 2 letters indicate the type of stack:

OS Denotes a semiconductor rectifier diode stack

OT Denotes a semiconductor stack in which also thyristors are used

The third letter indicates the type of circuit:

A Single phase half wave

B Two phase half wave

C Three phase half wave (three phase star)

D Four phase half wave (four phase star)

E Six phase half wave (six phase star)

F Three phase double Y with interphase transformer

H Single phase full wave (single phase bridge)

J Single phase magnetic amplifier bridge

K Three phase full wave (three phase bridge)

L Four phase full wave (four phase bridge)

M Voltage doubler (half a single phase full wave)

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

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

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RATING SYSTEMS

ACCORDING TO I.E.C. PUBLICATION 134

1. DEFINITIONS OF TERMS USED

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

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

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

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

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

2. ABSOLUTE MAXIMUM RATING SYSTEM

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

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

p.t.o.

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

3. DESIGN MAXIMUM RATING SYSTEM

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

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

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

4. DESIGN CENTRE RATING SYSTEM

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

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

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

NOTE

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

LETTER SYMBOLS

LETTER SYMBOLS FOR SEMICONDUCTOR DEVICES
excluding power diodes and thyristors

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

QUANTITY SYMBOLS

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

   Examples: i, v, p

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

   Examples: I, V, P

SUBSCRIPTS FOR QUANTITY SYMBOLS

1. Total values are indicated by upper case subscripts.

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

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

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

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

   For maximum (peak) values : M or m

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

   For d.c. values : no additional subscript

   For root-mean-square values : (rms)

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

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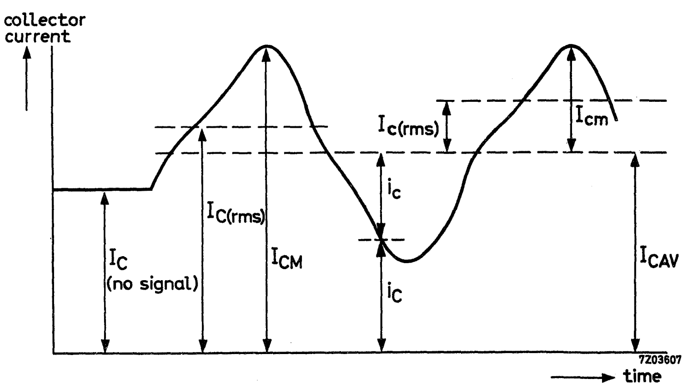
4. List of subscripts (examples, see figure 1)

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

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

Fig. 1



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CONVENTIONS FOR SUBSCRIPT SEQUENCE

1. Currents

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

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

2. Voltages

For transistors: normally, two subscripts are used to indicate the points between which the voltage is measured. The first subscript indicates one terminal point and the second the reference terminal.
Where there is no possibility of confusion, the second subscript may be omitted.

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

3. Supply voltages

Supply voltages may be indicated by repeating the terminal subscript.

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

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

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

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

Example: V_{B2-E} voltage between second base and emitter

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

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

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ELECTRICAL PARAMETER SYMBOLS

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

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

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

   Examples: H_i, Z_o, H_F, Y_R

SUBSCRIPTS FOR PARAMETER SYMBOLS

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

   Examples: h_{IB}, h_{FE}

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

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

   Examples: h_{ib}, z_{ob}

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

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

   Examples:
   $$V_1 = h_i I_1 + h_r V_2$$
   $$I_2 = h_f I_1 + h_o V_2$$

Notes 1) The voltage and current symbols in matrix notation are indicated by a single digit subscript.
The subscript 1 = input; the subscript 2 = output

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

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4. The second subscript identifies the circuit configuration.

e = common emitter
b = common base
c = common collector
j = common terminal, general

Examples: (common base)

$$I_1 = y_{ib} V_{1b} + y_{rb} V_{2b}$$
$$I_2 = y_{fb} V_{1b} + y_{ob} V_{2b}$$

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

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

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

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

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

[1]) As an exception to the general rule for electrical parameters capacitances are represented by the upper-case letter. 7Z3 0344

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

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

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

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

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

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LETTER SYMBOLS
FOR POWER DIODES AND THYRISTORS

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

QUANTITY SYMBOLS

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

   Examples: i, v, p

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

   Examples: I, V, P

SUBSCRIPTS FOR QUANTITY SYMBOLS

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

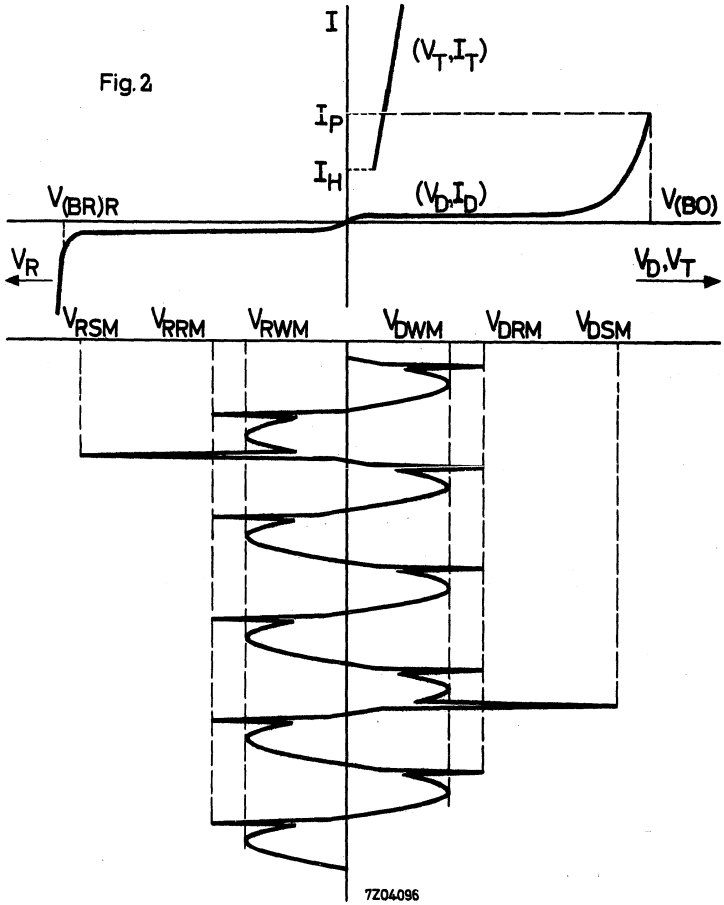
G, g	=	Gate terminal
F, f	=	Forward 1)
D, d	=	Forward off-state 1); non trigger (gate voltage or current)
T, t	=	Forward on-state 1); trigger (gate voltage or current)
R, r	=	As first subscript; Reverse As second subscript: Repetitive
AV, av	=	Average value
M, m	=	Maximum (peak or crest) value
(rms)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

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

7Z3 0350

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

Fig. 2



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

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

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

7Z3 0352

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

7Z3 0353

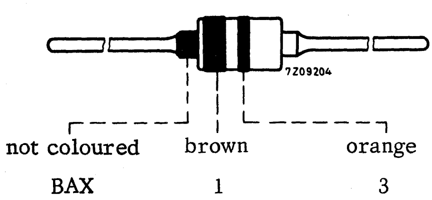
COLOUR CODES FOR WHISKERLESS DIODES

Indication of Pro-Electron type numbers

1. The colour of the cathode stud indicates the three letters.
2. The broadest band indicates the cathode side.
3. The colour of the broadest band indicates the first digit.
4. The colour of the second band indicates the second digit.

3 letters	digit	colour
BAX	–	not coloured
	0	black
BAW	1	brown
BAV	2	red
BAU	3	orange
BAT	4	yellow
BAS	5	green
	6	blue
	7	violet
	8	grey
	9	white

Example: BAX13



Indication of JEDEC assigned type numbers

(EIA-standard RS-236-A; January, 1963)

1. Prefix identification

The prefix identification consisting of a first number symbol and the letter "N" shall not be indicated in the coding.

2. Banding systems

The sequence number consisting of a two, three, or four digit number after the letter "N" may be coded as follows:

2.1 Two-digit sequence numbers shall consist of a first black band and the sequence number in second and third bands of the colours indicated in Table 1. If a suffix letter is required, it shall be indicated with a fourth band as indicated in Table 1.

2.2 Three-digit sequence numbers shall consist of the sequence number in first, second, and third bands of the colours indicated in Table 1. If a suffix letter is required, it shall be indicated with a fourth band as indicated in Table 1.

2.3 Four-digit sequence numbers shall consist of the sequence number in four bands of the colours indicated in Table 1 with a fifth black band. If a suffix letter is required it shall be indicated as the fifth band and shall replace the black band.

3. Cathode identification and reading sequence

3.1 A double-width band shall be used as the first band reading from cathode to anode ends.

3.2 An alternative method is provided where equal width bands may be used. The bands shall be clearly grouped toward the cathode end, and shall be read from cathode to anode ends.

3.3 Either of the above colour banding methods may be used in stead of the cathode designating symbol or other marking.

4. Colour bands

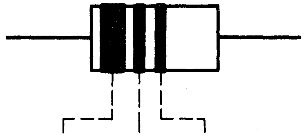
The sequence numbers of the type numbers and suffix letters shall be indicated by the colours in Table 1.

TABLE 1

NUMBER	COLOUR	SUFFIX LETTER
0	black	not applicable
1	brown	A
2	red	B
3	orange	C
4	yellow	D
5	green	E
6	blue	F
7	violet	G
8	grey	H
9	white	J

Examples

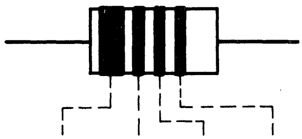
1N914



white brown yellow

1N 9 1 4

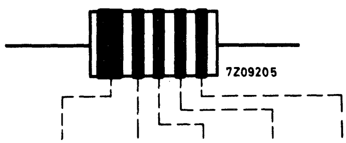
1N916B



white brown blue red

1N 9 1 6 B

1N4009



yellow black black white black

1N 4 0 0 9 -

Signal diodes

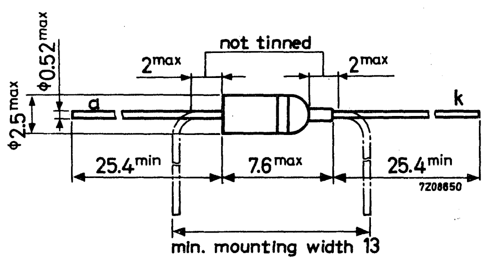
POINT CONTACT DIODE

Germanium point contact diode in a subminiature all glass DO-7 envelope primarily intended for use in a.m. detector and ratio detector circuits.

QUICK REFERENCE DATA				
Continuous reverse voltage	V_R	max.	30	V
Repetitive peak reverse voltage	V_{RRM}	max.	45	V
Forward current (d.c.)	I_F	max.	35	mA
Repetitive peak forward current	I_{FRM}	max.	100	mA
Operating ambient temperature	T_{amb}	max.	60	^oC
Forward voltage at I_F = 10 mA	V_F	<	2.2	V

MECHANICAL DATA Dimensions in mm

DO-7



The white band indicates the cathode side

7Z3 2066

RATINGS (Limiting values) [1]

Voltages

Continuous reverse voltage	V_R	max.	30	V
Repetitive peak reverse voltage	V_{RRM}	max.	45	V

Currents

Forward current (d.c.)	I_F	max.	35	mA
Average rectified forward current (averaged over any 50 ms period)	I_{FAV}	max.	35	mA
Repetitive peak forward current	I_{FRM}	max.	100	mA
Non repetitive peak forward current ($t < 1$ s)	I_{FSM}	max.	200	mA

Temperatures

Storage temperature	T_{stg}		−55 to +75	°C
Operating ambient temperature	T_{amb}	max.	60	°C

THERMAL RESISTANCE

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

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

7Z3 1181

CHARACTERISTICS

Forward voltage at T_{amb} = 25 °C

I_F = 0.1 mA	V_F	typ.	0.23	V
		<	0.30	V
I_F = 1 mA	V_F	typ.	0.56	V
		<	0.88	V
I_F = 10 mA	V_F	typ.	1.5	V
		<	2.2	V
I_F = 30 mA [1]	V_F	typ.	2.8	V
		<	4.0	V

Forward voltage at T_{amb} = 60 °C

I_F = 0.1 mA	V_F	typ.	0.16	V
		<	0.25	V
I_F = 1 mA	V_F	typ.	0.50	V
		<	0.80	V
I_F = 10 mA	V_F	typ.	1.4	V
		<	2.1	V
I_F = 30 mA [1]	V_F	typ.	2.6	V
		<	3.8	V

Reverse current at T_{amb} = 25 °C

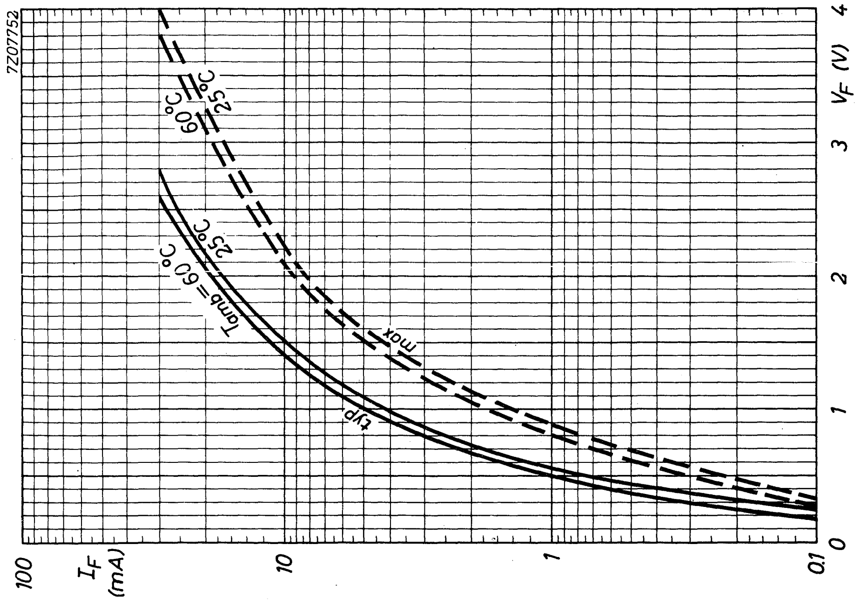
V_R = 0.1 V	I_R	typ.	0.35	µA
		<	1.0	µA
V_R = 1.5 V	I_R	typ.	0.8	µA
		<	2.8	µA
V_R = 10 v	I_R	typ.	4.5	µA
		<	18	µA
V_R = 30 V	I_R	typ.	35	µA
		<	150	µA
V_R = 45 V	I_R	typ.	90	µA
		<	350	µA

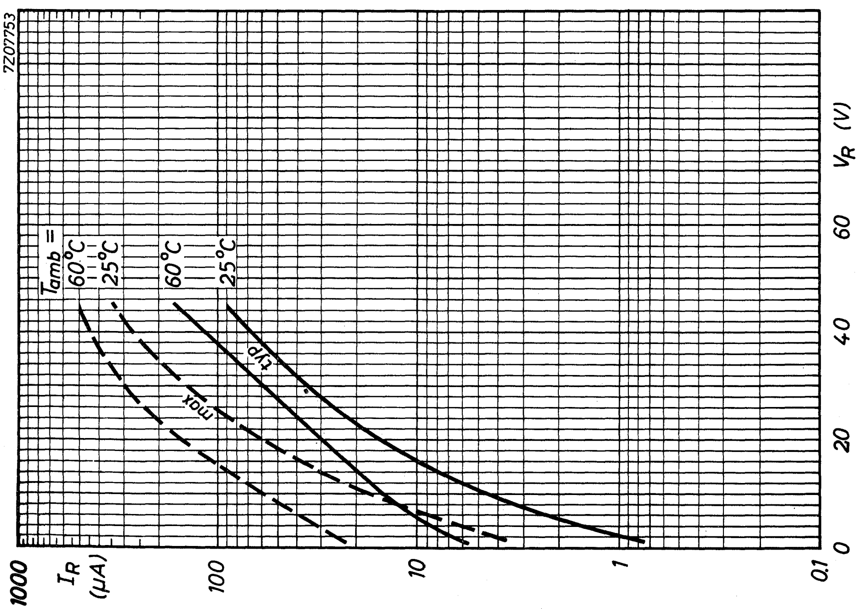
Reverse current at T_{amb} = 60 °C

V_R = 0.1 V	I_R	typ.	4.5	µA
		<	12	µA
V_R = 1.5 V	I_R	typ.	6	µA
		<	25	µA
V_R = 10 V	I_R	typ.	16	µA
		<	60	µA
V_R = 30 V	I_R	typ.	60	µA
		<	300	µA
V_R = 45 V	I_R	typ.	170	µA
		<	500	µA

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

7Z3 1182


7Z07752
I_F (mA)
100
10
1
0.1
V_F (V)
0
1
2
3
4
T_{amb} = 60 °C
25 °C
typ
60 °C
25 °C
max

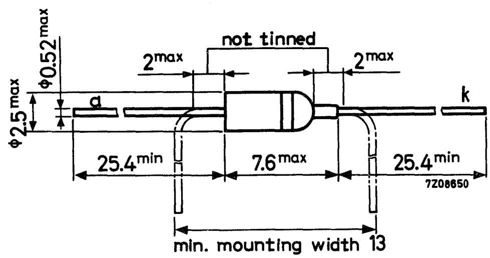

7Z07753
I_R (μA)
1000
100
10
1
0.1
V_R (V)
0
20
40
60
T_{amb} =
60 °C
25 °C
60 °C
25 °C
max
typ

POINT CONTACT DIODE

Germanium point contact diode in a subminiature all glass DO-7 envelope primarily intended for computer applications.

MECHANICAL DATA Dimensions in mm

DO-7



The coloured band indicates the cathode side

RATINGS (Limiting values according to the Absolute Maximum System as dened in IEC publication 134)

Voltages

Continuous reverse voltage	V_R	max.	60	V
Repetitive peak reverse voltage	V_{RRM}	max.	90	V

Currents

Forward current (d.c.)	I_F	max.	35	mA
Average rectified forward current (averaged over any 20 ms period)	I_{FAV}	max.	35	mA
Repetitive peak forward current	I_{FRM}	max.	150	mA
Non repetitive peak forward current	I_{FSM}	max.	200	mA

Temperatures

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

THERMAL RESISTANCE

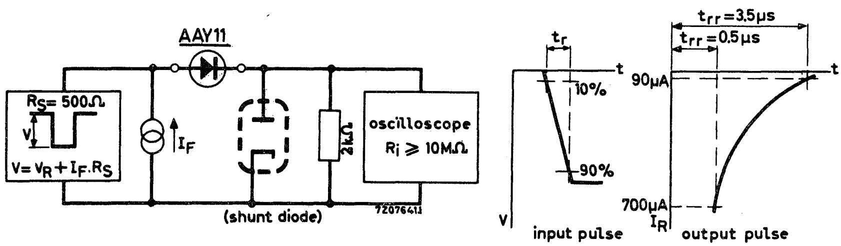
From junction to ambient in free air	$R_{th\ j\text{-}a}$	=	0.4	$^oC/mW$

CHARACTERISTICS

T_j = 25 °C unless otherwise specified

Forward voltage				
I_F = 5 mA	V_F	typ.	0.72	V
		<	1.0	V
I_F = 30 mA	V_F	typ.	2.1	V
		1.5 to	3.0	V
Reverse current				
V_R = 50 V	I_R	typ.	25	μA
		<	65	μA
V_R = 50 V; T_j = 60 °C	I_R	<	150	μA
V_R = 90 V	I_R	typ.	130	μA
		<	250	μA
Reverse recovery current when switched from I_F = 30 mA to V_R = 35 V; R_L = 2.5 kΩ				
measured at t_{rr} = 0.5 μs	I_R	typ.	200	μA
		<	700	μA
measured at t_{rr} = 3.5 μs	I_R	typ.	25	μA
		<	90	μA

Test circuit



Reverse pulse:

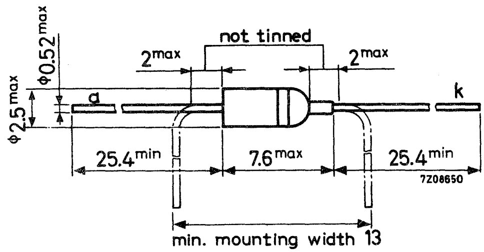
Rise time	$t_r \leq 0.1$	μs
Duty cycle	δ = 0.5	
Frequency	f = 50	kHz
Circuit capacitance	C ≤ 30	pF (C = Oscilloscope + parasitical capacitance)

POINT CONTACT DIODE

Germanium point contact diode in a subminiature all glass DO-7 envelope primarily intended for computer applications.

MECHANICAL DATA Dimensions in mm

DO-7



The coloured band indicates the cathode side

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

Voltage

Continuous reverse voltage	V_R	max.	15	V

Currents

Forward current (d.c.)	I_F	max.	20	mA
Peak forward current	I_{FM}	max.	50	mA

Temperatures

Storage temperature	T_{stg}	-65 to +75		^oC
Junction temperature	T_j	max.	75	^oC
Operating ambient temperature	T_{amb}	max.	60	^oC

THERMAL RESISTANCE

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

CHARACTERISTICS T_j = 25 °C unless otherwise specified

Forward voltage

I_F = 2 mA	V_F	0.25 to 0.45	V
I_F = 2 mA; T_j = 60 °C	V_F	0.19 to 0.39	V
I_F = 10 mA	V_F	0.40 to 0.80	V
I_F = 10 mA; T_j = 60 °C	V_F	0.34 to 0.74	V
I_F = 50 mA	V_F	0.60 to 1.5	V
I_F = 50 mA; T_j = 60 °C	V_F	0.54 to 1.44	V

Reverse current

V_R = 5 V; T_{amb} = 60 °C	I_R	<	30	μA
V_R = 5 V; T_{amb} = 25 °C	I_R	<	10	μA
V_R = 15 V; T_{amb} = 60 °C	I_R	<	100	μA
V_R = 15 V; T_{amb} = 25 °C	I_R	<	60	μA

Diode capacitance

V_R = 1 V; f = 0.5 MHz	C_d	<	1.2	pF

Reverse recovery current when switched from

I_F = 3 mA to V_R = 5 V; R_L = 0.5 kΩ measured at t_{rr} = 50 ns	I_R	<	0.5	mA

Reverse recovery time when switched from

I_D = 3 mA to V_R = 1 V; R_L = 100 Ω measured at I_R = 1 mA	t_{rr}	typ.	5	ns
		<	12	ns

GOLD BONDED DIODES

Gold bonded germanium diodes in subminiature all glass DO-7 envelope, intended for switching applications and general purposes.

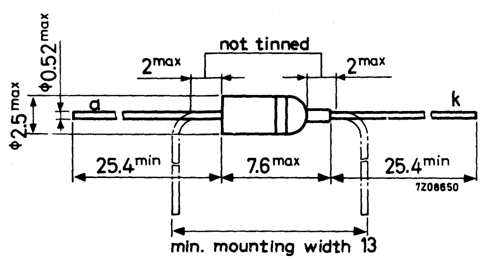
QUICK REFERENCE DATA

			AAY30	AAY32	
Continuous reverse voltage	V_R	max.	30	30	V
Repetitive peak reverse voltage	V_{RRM}	max.	50	30	V
Forward current (d.c.)	I_F	max.	110	110	mA
Repetitive peak forward current	I_{FRM}	max.	400	150	mA
Junction temperature	T_j	max.	75	85	^oC
Forward voltage at I_F = 150 mA	V_F	<	1.0	1.0	V
Recovered charge when switched from I_F = 10 mA to V_R = 10 V	Q_s	<	500	150	pC

MECHANICAL DATA

Dimensions in mm

DO-7



The coloured band indicates the cathode side

RATINGS (Limiting values) [1]

Voltages			AAY30	AAY32	
Continuous reverse voltage	V_R	max.	30	30	V
Repetitive peak reverse voltage	V_{RRM}	max.	50	30	V
Non repetitive peak reverse voltage ($t < 1$ s)	V_{RSM}	max.	50	30	V
Currents					
Forward current (d.c.)	I_F	max.	110	110	mA
Average rectified forward current (averaged over any 20 ms period)	I_{FAV}	max.	110	110	mA
Repetitive peak forward current	I_{FRM}	max.	400	150	mA
Non repetitive peak forward current ($t < 1$ s)	I_{FSM}	max.	500	200	mA

Temperatures

Storage temperature	AAY30	T_{stg}	-65 to +75	°C
	AAY32	T_{stg}	-65 to +85	°C
Junction temperature	AAY30	T_j	max. 75	°C
	AAY32	T_j	max. 85	°C

THERMAL RESISTANCE

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

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

CHARACTERISTICS

Forward voltage at T_j = 25 °C

I_F = 0.1 mA	V_F	<	0.20 V
I_F = 1.0 mA	V_F	<	0.31 V
I_F = 10 mA	V_F	<	0.45 V
I_F = 30 mA	V_F	<	0.60 V
I_F = 150 mA	V_F	<	1.0 V

Forward voltage at T_j = 60 °C

I_F = 0.1 mA	V_F	<	0.14 V
I_F = 1.0 mA	V_F	<	0.26 V
I_F = 10 mA	V_F	<	0.41 V
I_F = 30 mA	V_F	<	0.57 V
I_F = 150 mA	V_F	<	0.99 V

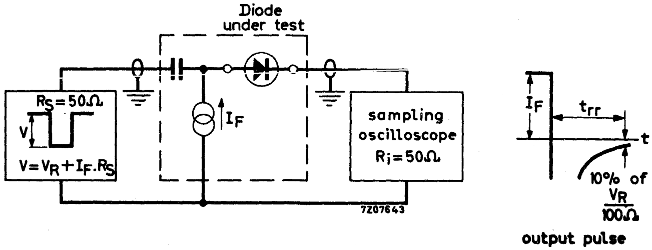
			AAY30	AAY32	
Reverse current at T_j = 25 °C					
V_R = 1.5 V	I_R	<	9	2.5	μA
V_R = 10 V	I_R	<	15	8	μA
V_R = 20 V	I_R	<	25	25	μA
V_R = 25 V	I_R	<	35	35	μA
V_R = 30 V	I_R	<	50	70	μA
V_R = 50 V	I_R	<	200	–	μA
Reverse current at T_j = 60 °C					
V_R = 1.5 V	I_R	<	40	15	μA
V_R = 10 V	I_R	<	60	30	μA
V_R = 20 V	I_R	<	120	60	μA
V_R = 25 V	I_R	<	150	100	μA
V_R = 30 V	I_R	<	200	200	μA
V_R = 50 V	I_R	<	500	–	μA
Diode capacitance					
V_R = 1 V; f = 1 MHz	C_d	<	1.0	1.5	pF

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

Reverse recovery time when switched
from $I_F = 10$ mA to $V_R = 1$ V; $R_L = 100\ \Omega$

Measured at $I_R = 10\ \%$ of $\frac{V_R}{R_L}$	AAY30	t_{rr}	<	150	ns
	AAY32	t_{rr}	<	50	ns

Test circuit:



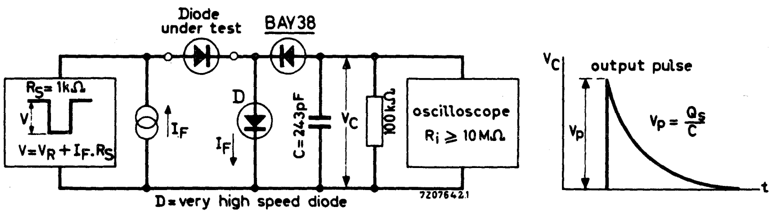
Reverse pulse:	Rise time	t_r =	0.6 ns
	Pulse duration	t_p =	100 ns
	Duty cycle	δ =	0.05

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

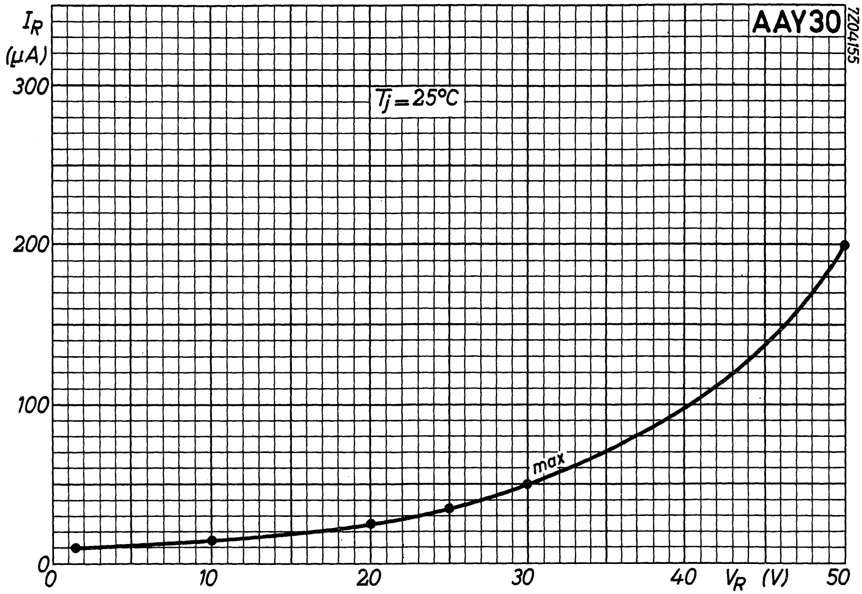
Recovered charge when switched
from $I_F = 10$ mA to $V_R = 10$ V; $R_L = 1\ k\Omega$

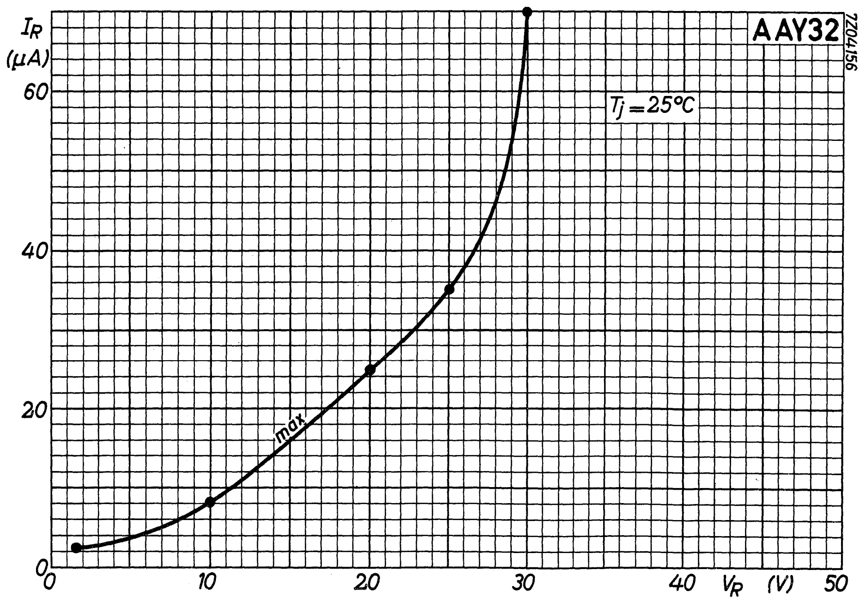
AAY30	Q_s	<	500	pC
AAY32	Q_s	<	150	pC

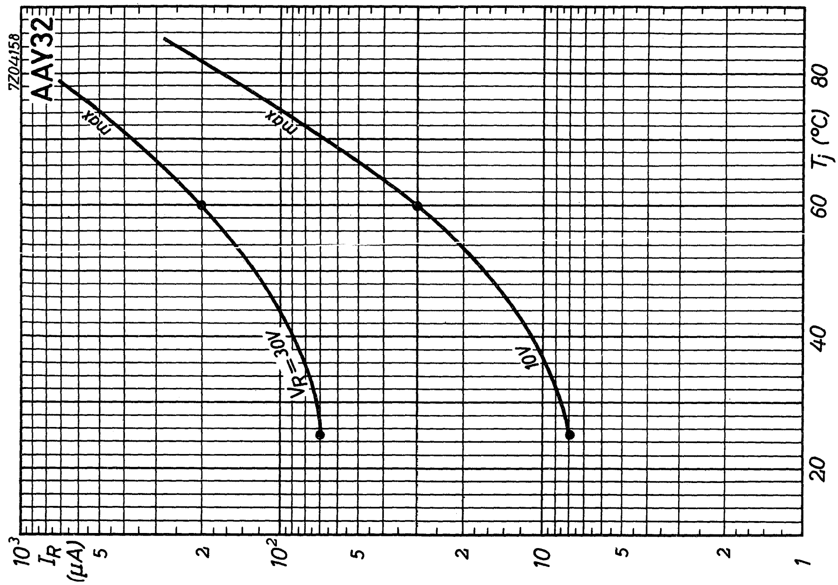
Test circuit:

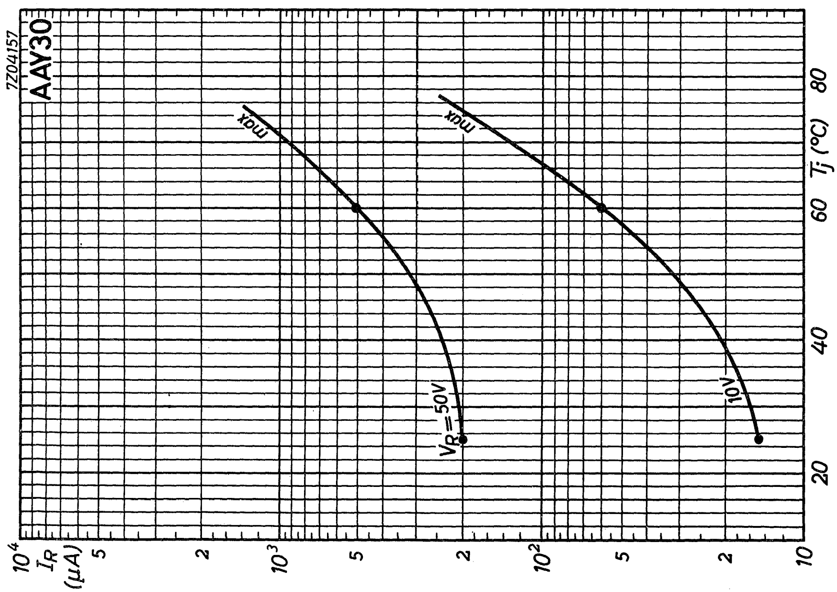


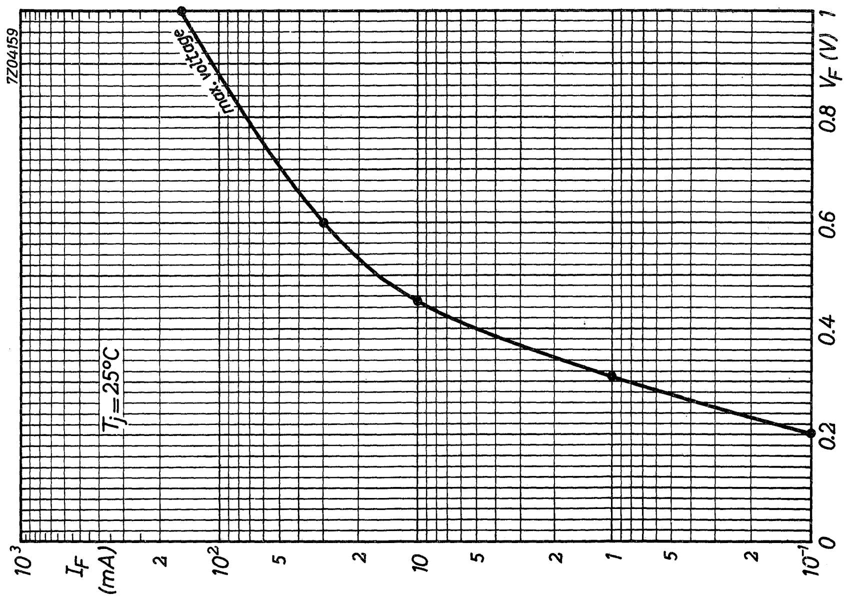
Reverse pulse:	Rise time	t_r =	2 ns
	Pulse duration	t_p =	0.4 μs
	Duty cycle	δ =	0.02

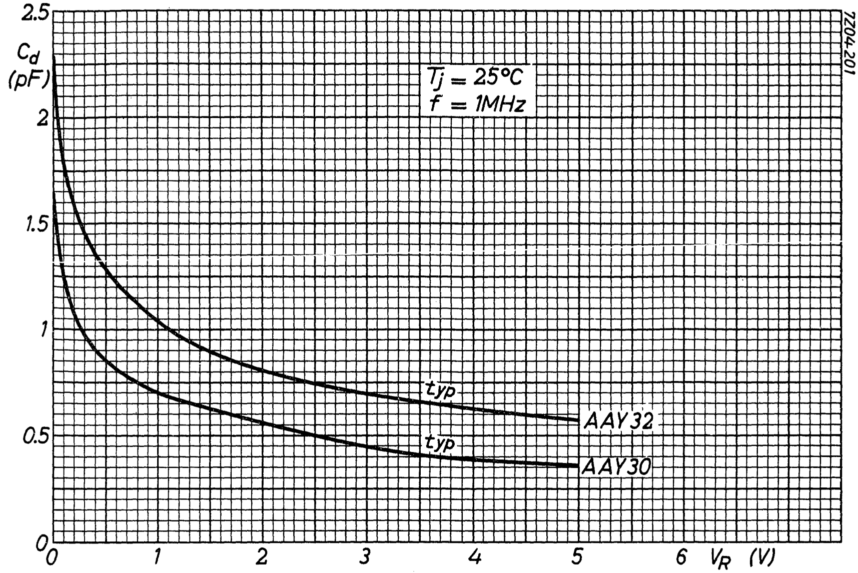

AAY30
7Z04155
I_R
(μA)
300
200
100
0
$T_j = 25°C$
max
0
10
20
30
40
V_R (V)
50

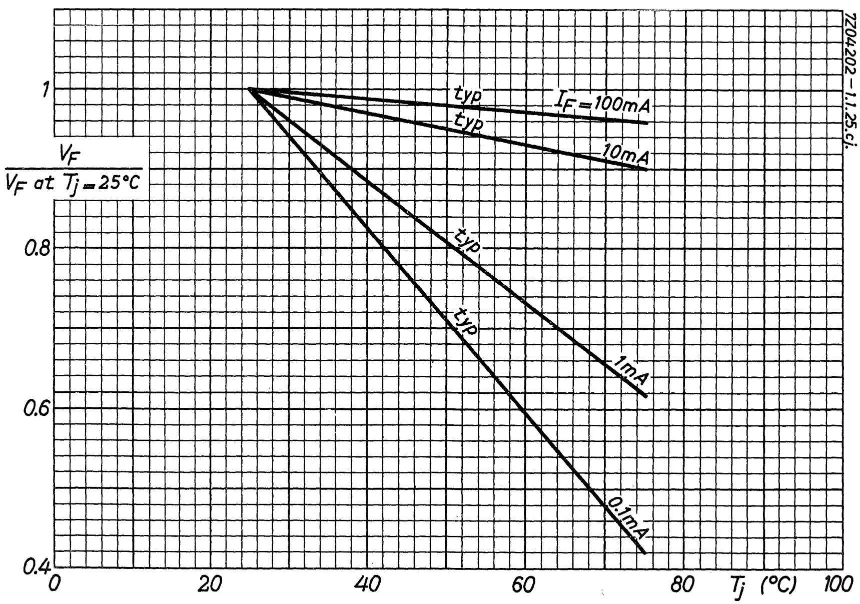

AAY32
7Z04156
I_R
(μA)
60
40
20
0
$T_j = 25°C$
max
0
10
20
30
40
V_R (V)
50

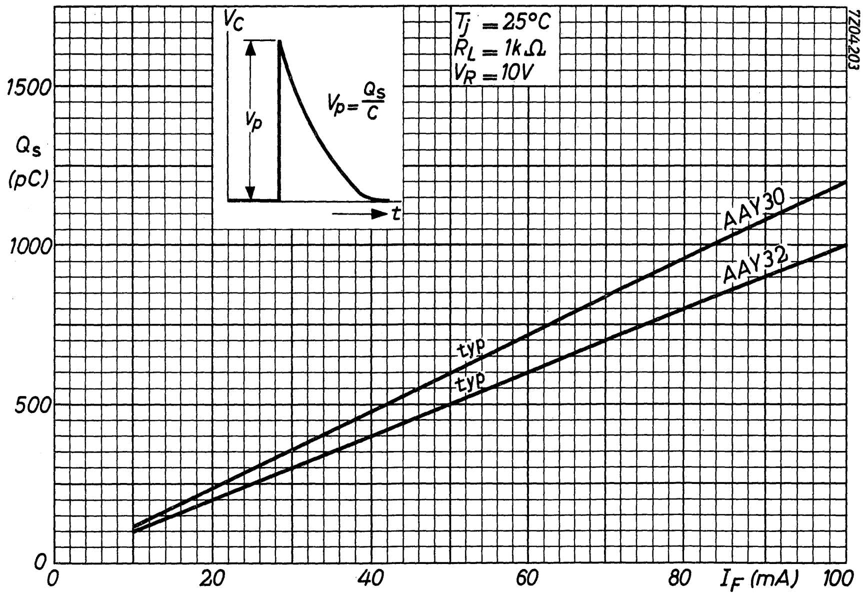

7Z04158
AAY32
max
max
$V_R = 30V$
10V
T_j (°C)
20
40
60
80
10^3
I_R (μA)
5
2
10^2
5
2
10
5
2
1

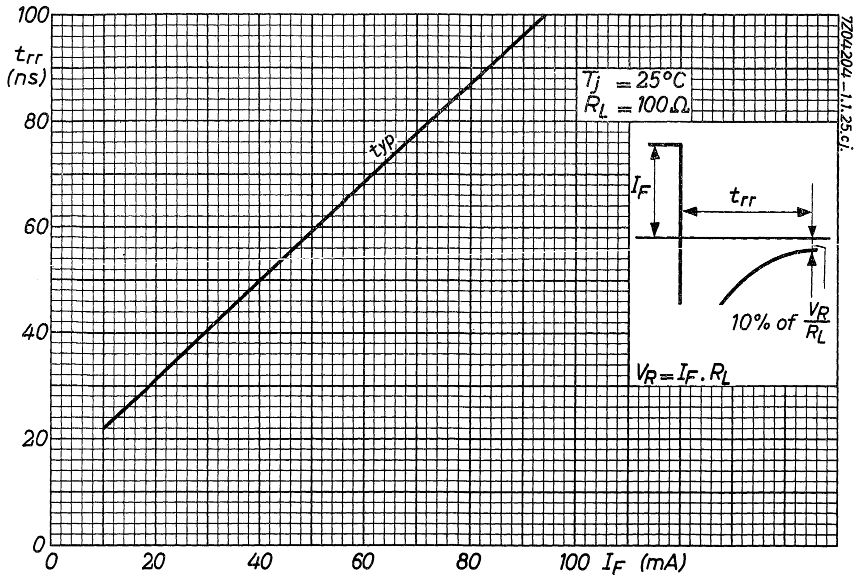

7Z04157
AAY30
max
max
$V_R = 50V$
10V
T_j (°C)
20
40
60
80
10^4
I_R (μA)
5
2
10^3
5
2
10^2
5
2
10

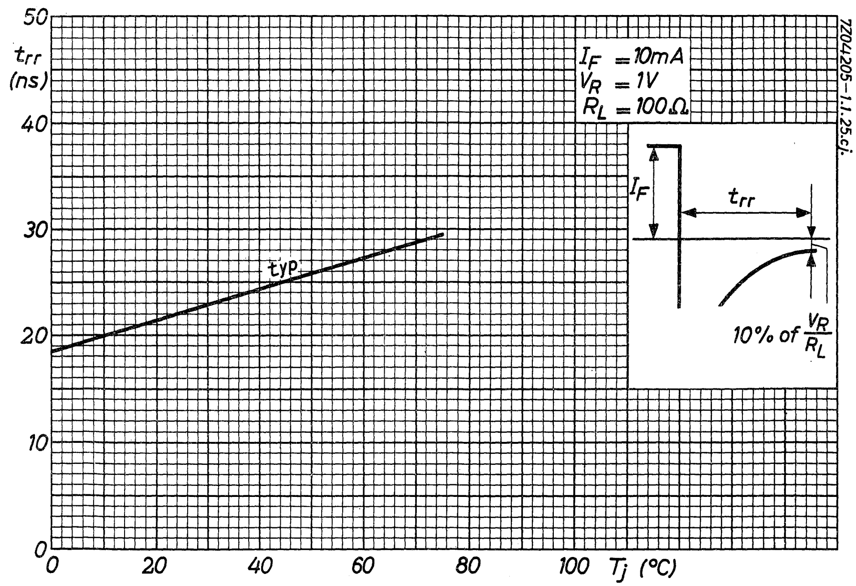

7Z04159
max. voltage
$T_j = 25^\circ C$
I_F (mA)
10^3
2
10^2
5
2
10
5
2
1
5
2
10^{-1}
0
0.2
0.4
0.6
0.8
1
V_F (V)


2.5
C_d
(pF)
2
1.5
1
0.5
0
0
1
2
3
4
5
6
V_R (V)
T_j = 25°C
f = 1MHz
typ
AAY32
typ
AAY30
7Z04201


1
$\frac{V_F}{V_F \text{ at } T_j = 25°C}$
0.8
0.6
0.4
0
20
40
60
80
100
T_j (°C)
typ
I_F = 100mA
typ
10mA
typ
1mA
typ
0.1mA
7Z04202-1.1.25.ci.


V_C
V_p
$V_p = \frac{Q_s}{C}$
t
$T_j = 25°C$
$R_L = 1k\Omega$
$V_R = 10V$
7Z04203
1500
Q_s
(pC)
1000
500
0
0
20
40
60
80
I_F (mA)
100
AAY30
AAY32
typ
typ

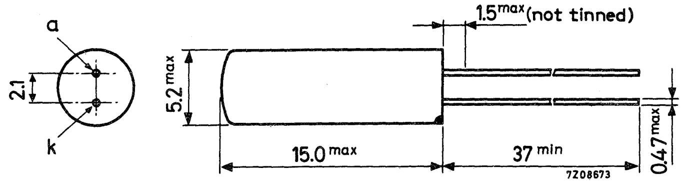

100
t_{rr}
(ns)
80
60
40
20
0
0
20
40
60
80
100 I_F (mA)
typ
T_j = 25°C
R_L = 100Ω
I_F
t_{rr}
10% of $\frac{V_R}{R_L}$
$V_R = I_F . R_L$
7Z04204-1.1.25.ci.


50
t_{rr}
(ns)
40
30
20
10
0
0
20
40
60
80
100 T_j (°C)
typ
I_F = 10mA
V_R = 1V
R_L = 100Ω
I_F
t_{rr}
10% of $\frac{V_R}{R_L}$
7Z04205-1.1.25.ci.

GERMANIUM DIODE FOR FAST SWITCHING

Germanium diode in single ended all glass construction, intended for high current low storage applications.

MECHANICAL DATA Dimensions in mm



The red dot indicates the cathode side

RATINGS (Limiting values) [1])

Voltage

Continuous reverse voltage	V_R	max.	30	V

Currents

Forward current (d.c. or average over any 50 ms period)	I_F	max.	220	mA
Repetitive peak forward current (t = 25 ms)				
T_{amb} = 25 °C	I_{FRM}	max.	1	A
T_{amb} = 60 °C	I_{FRM}	max.	0.5	A
Non repetitive peak forward current (t = 100 μs)	I_{FSM}	max.	4	A

Temperatures

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

THERMAL RESISTANCE

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

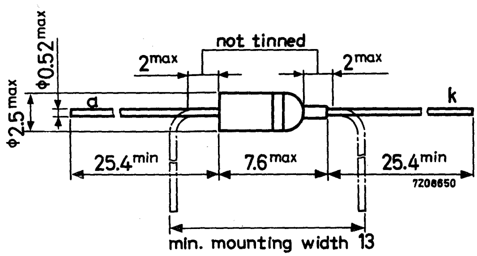
Forward voltage					
I_F = 0.3 mA	V_F	<	0.19		V
I_F = 30 mA	V_F	<	0.33		V
I_F = 100 mA	V_F	<	0.42		V
I_F = 1 A	V_F	<	0.70		V
Reverse current		T_{amb} =	25	60 °C	
V_R = 1.5 V	I_R	<	5	60	μA
V_R = 10 V	I_R	<	10	70	μA
V_R = 30 V	I_R	<	60	300	μA
Diode capacitance					
V_R = 3 V	C_d	typ.	7.3		pF
		<	12		pF
V_R = 0	C_d	typ.	27		pF
Forward recovery voltage					
I_F = 400 mA; t_r = 40 ns	V_{FM}	typ.	0.8		V
		<	2.0		V
Forward recovery time					
I_F = 400 mA; t_r = 40 ns measured at V_F = 0.8 V	t_{fr}	typ.	60		ns
Reverse recovery time when switched from					
I_F = 10 mA to V_R = 10 V; R_L = 1 kΩ measured at I_R = 1 mA	t_{rr}	typ.	50		ns
		<	120		ns
Recovered charge when switched from					
I_F = 10 mA to V_R = 10 V; R_L = 1 kΩ; t_f < 10 ns	Q_s	typ.	150		pC
		<	200		pC

GOLD BONDED DIODE

Gold bonded germanium diode in subminiature all glass DO-7 envelope, intended for high speed switching applications.

MECHANICAL DATA Dimensions in mm

DO 7



The coloured band indicates the cathode side

RATINGS (Limiting values) [1])

Voltage

Continuous reverse voltage	V_R	max.	8	V

Currents

Forward current (d.c. or average over any 50 ms period)	I_F	max.	30	mA
Repetitive peak forward current (t < 5ms)	I_{FRM}	max.	100	mA

Temperatures

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

THERMAL RESISTANCE

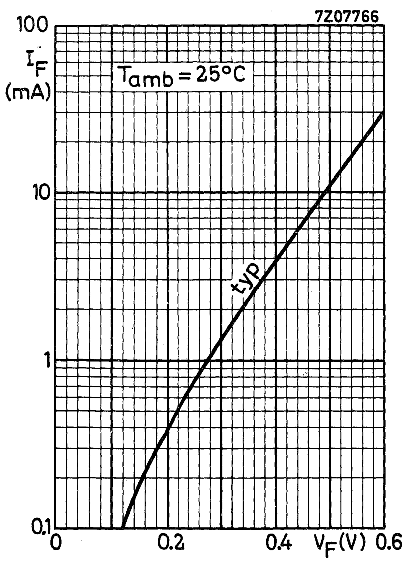
From junction to ambient in free air	$R_{th\ j-a}$	=	0.5	°C/mW

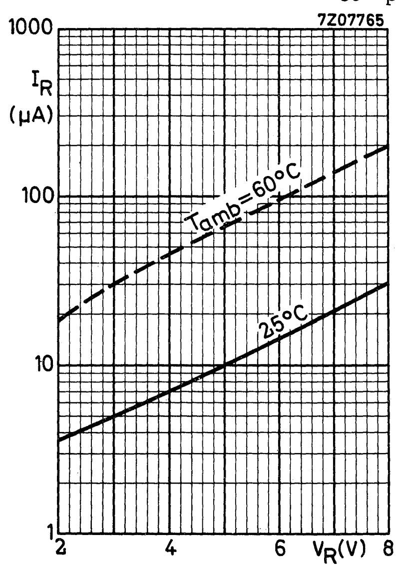
[1]) Limiting values according to the Absolute Maximum System as defined in IEC publication 134.

CHARACTERISTICS

T_{amb} = 25 °C unless otherwise specified

Condition	Symbol		T_{amb} = 25	60 °C	Unit
Forward voltage					
I_F = 1 mA	V_F	typ.	0.27		V
		<	0.32		V
I_F = 10 mA	V_F	typ.	0.50		V
		<	0.60		V
I_F = 30 mA	V_F	typ.	0.60		V
		<	1.00		V
Reverse current			T_{amb} = 25	60 °C	
V_R = 3 V	I_R	typ.	5	30	μA
		<	25	85	μA
V_R = 8 V	I_R	typ.	30	190	μA
		<	150		μA
Diode capacitance					
V_R = 1 V	C_d	typ.	3.3		pF
V_R = 3 V	C_d	typ.	1.3		pF
		<	2.0		pF
Forward recovery voltage					
I_F = 20 mA; t_r = 5 ns	V_{FM}	typ.	0.7		V
		<	1.5		V
Recovered charge when switched from I_F = 10 mA to V_R = 5 V; R_L = 0.5 kΩ; t_f = 5 ns	Q_s	typ.	20		pC
		<	30		pC





GOLD BONDED DIODES

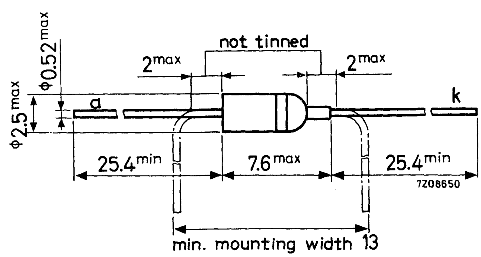
Gold bonded germanium diodes in subminiature all glass DO-7 envelope, intended for switching applications and general purposes.

QUICK REFERENCE DATA

			AAZ15	AAZ17	
Continuous reverse voltage	V_R	max.	75	50	V
Repetitive peak reverse voltage	V_{RRM}	max.	100	75	V
Forward current (d.c.)	I_F	max.	140	140	mA
Repetitive peak forward current	I_{FRM}	max.	250	250	mA
Junction temperature	T_j	max.	85	85	°C
Forward voltage at I_F = 250 mA	V_F	<	1.1	1.1	V
Recovered charge when switched from I_F = 10 mA to V_R = 10 V	Q_s	<	1800	900	pC

MECHANICAL DATA Dimensions in mm

DO-7



The coloured band indicates the cathode side

RATINGS (Limiting values) [1])

Voltages			AAZ15	AAZ17	
Continuous reverse voltage	V_R	max.	75	50	V
Repetitive peak reverse voltage	V_{RRM}	max.	100	75	V
Non repetitive peak reverse voltage ($t < 1$ s)	V_{RSM}	max.	115	75	V

Currents				
Forward current (d.c.)	I_F	max.	140	mA
Average rectified forward current (averaged over any 20 ms period)	I_{FAV}	max.	140	mA
Repetitive peak forward current	I_{FRM}	max.	250	mA
Non repetitive peak forward current ($t < 1$ s)	I_{FSM}	max.	500	mA

Temperatures				
Storage temperature	T_{stg}		−65 to +85	°C
Junction temperature	T_j	max.	85	°C

THERMAL RESISTANCE

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

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

CHARACTERISTICS

Forward voltage at T_j = 25 °C

I_F = 0.1 mA	V_F < 0.20	V
I_F = 10 mA	V_F < 0.45	V
I_F = 250 mA	V_F < 1.10	V

Forward voltage at T_j = 60 °C

I_F = 0.1 mA	V_F < 0.15	V
I_F = 10 mA	V_F < 0.40	V
I_F = 250 mA	V_F < 1.07	V

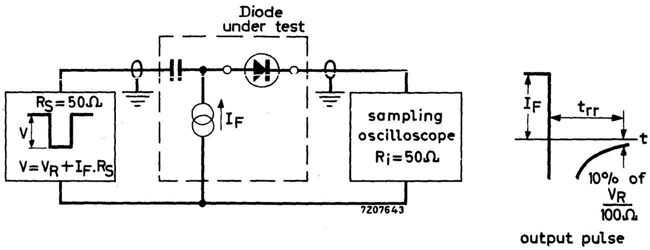
		AAZ15	AAZ17	
Reverse current at T_j = 25 °C				
V_R = 1.5 V	I_R <	2.5	2.5	µA
V_R = 10 V	I_R <	4	15	µA
V_R = 50 V	I_R <	15	150	µA
V_R = 75 V	I_R <	25	300	µA
V_R = 100 V	I_R <	100	–	µA
Reverse current at T_j = 60 °C				
V_R = 1.5 V	I_R <	30	30	µA
V_R = 10 V	I_R <	40	60	µA
V_R = 50 V	I_R <	80	300	µA
V_R = 75 V	I_R <	120	500	µA
V_R = 100 V	I_R <	300	–	µA
Diode capacitance				
V_R = 1 V; f = 1 MHz	C_d <	2	2	pF

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

Reverse recovery time when switched
from $I_F = 10$ mA to $V_R = 1$ V; $R_L = 100\ \Omega$

Measured at $I_R = 10\ \%$ of $\frac{V_R}{R_L}$	AAZ15	t_{rr}	typ.	350	ns
	AAZ17	t_{rr}	<	350	ns

Test circuit:



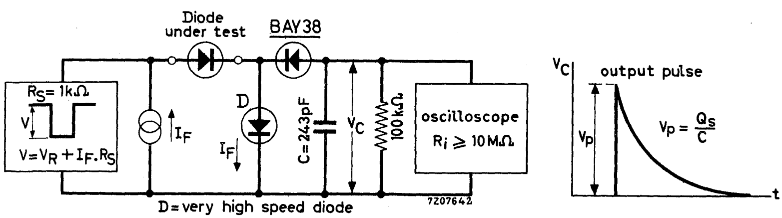
Reverse pulse:	Rise time	t_r	= 0.6	ns
	Pulse duration	t_p	= 100	ns
	Duty cycle	δ	= 0.05	

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

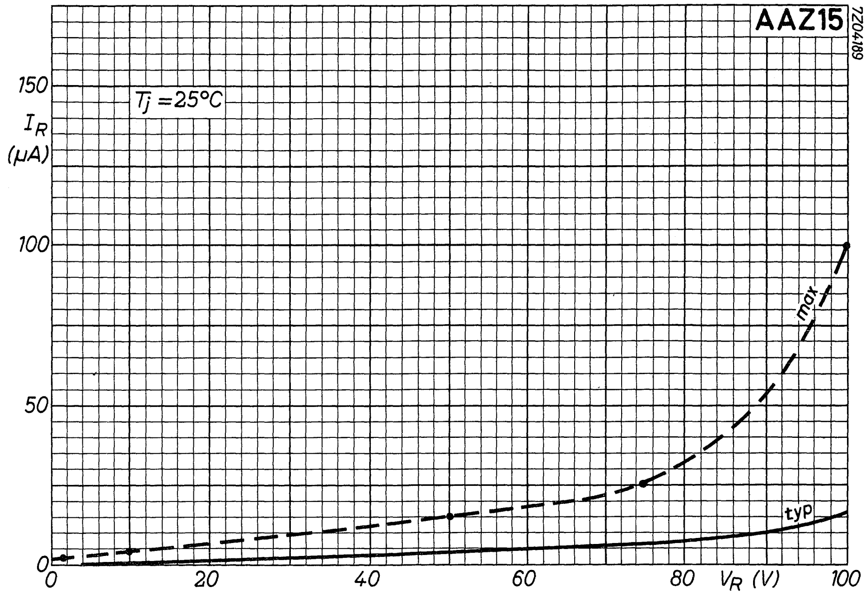
Recovered charge when switched
from $I_F = 10$ mA to $V_R = 10$ V; $R_L = 1\ k\Omega$

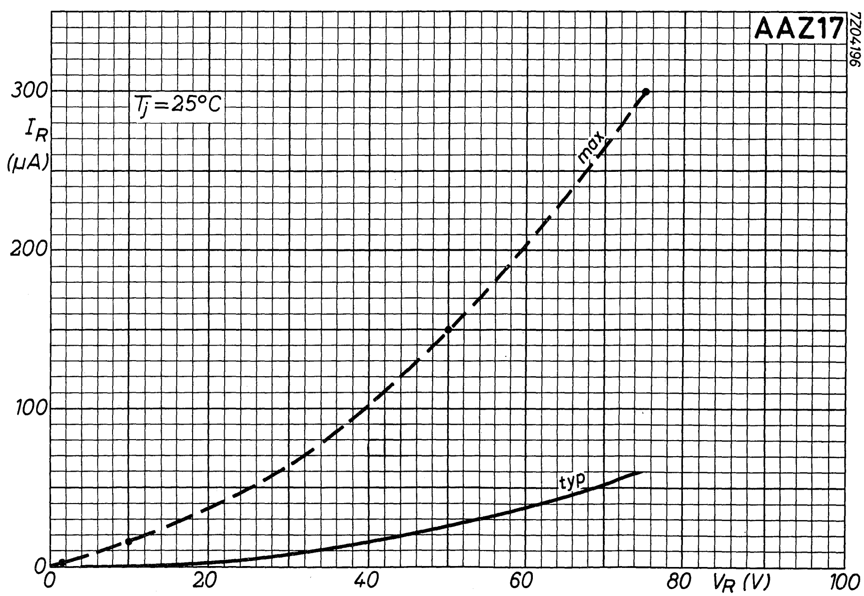
AAZ15	Q_s	<	1800	pC
AAZ17	Q_s	<	900	pC

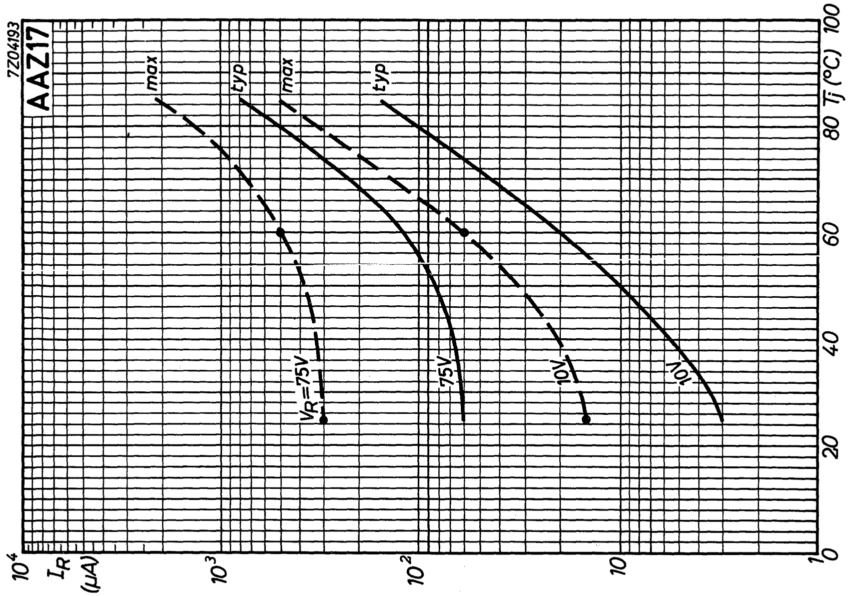
Test circuit:

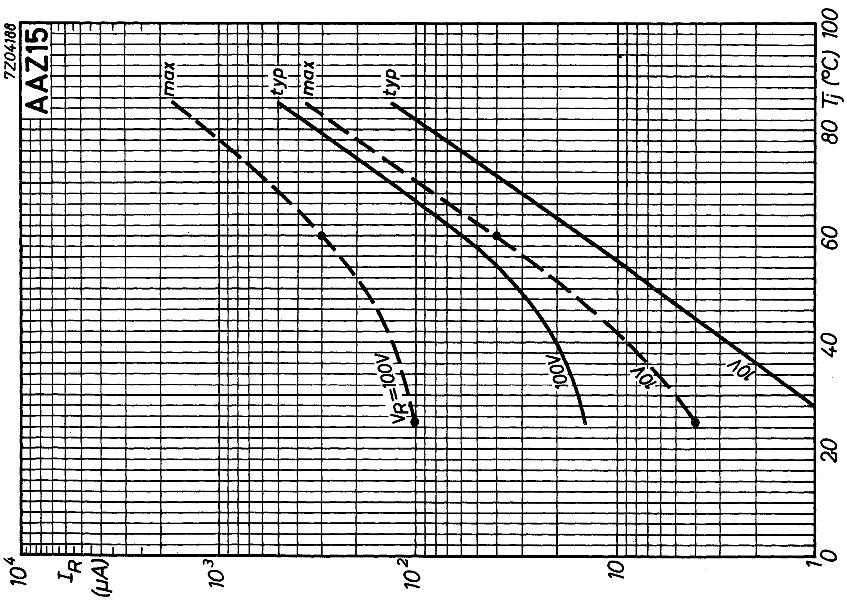


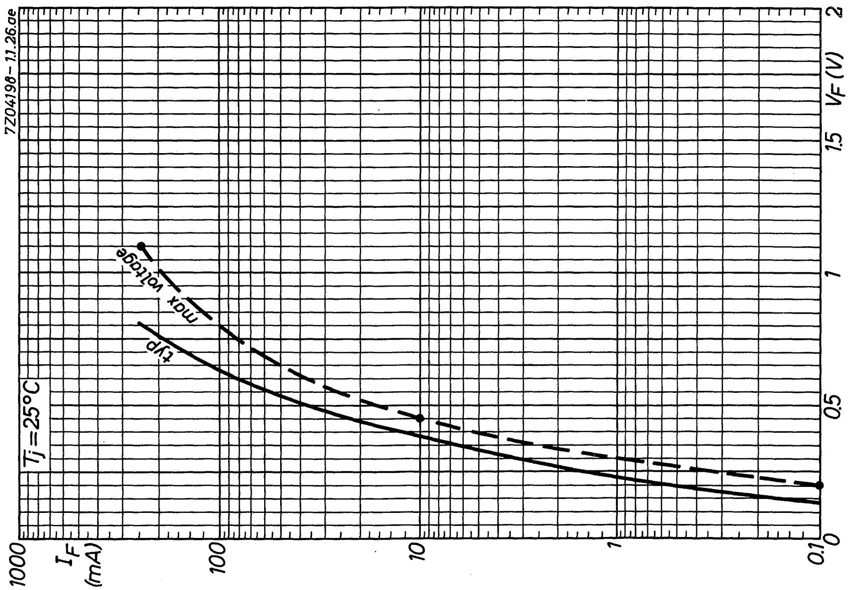
Reverse pulse:	Rise time	t_r	= 2	ns
	Pulse duration	t_p	= 0.4	μs
	Duty cycle	δ	= 0.02	

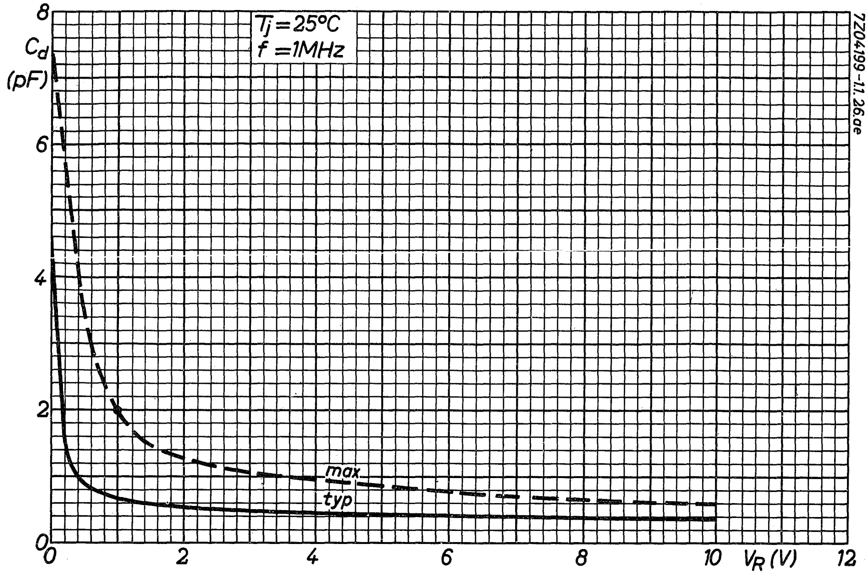

AAZ15
7Z04189
150
100
50
0
I_R
(μA)
$T_j = 25°C$
max
typ
0
20
40
60
80
V_R (V)
100

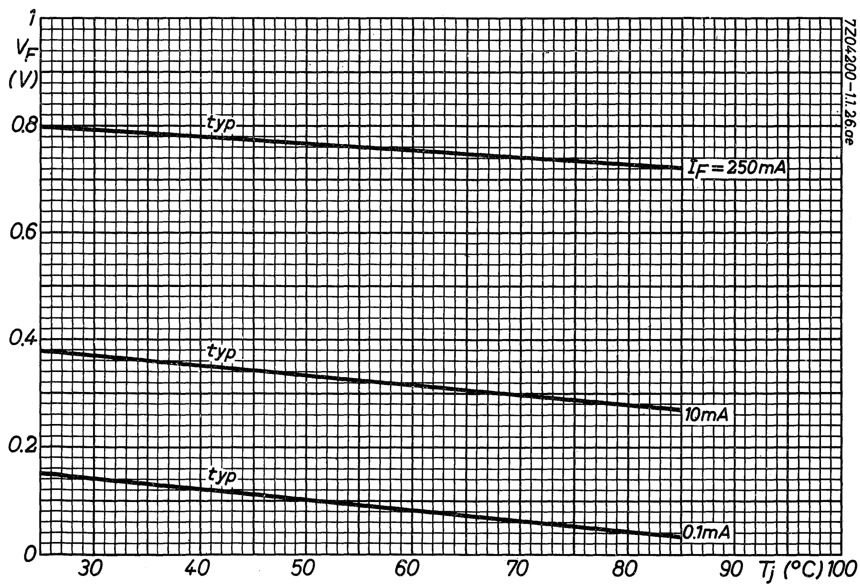

AAZ17
7Z04196
300
200
100
0
I_R
(μA)
$T_j = 25°C$
max
typ
0
20
40
60
80
V_R (V)
100

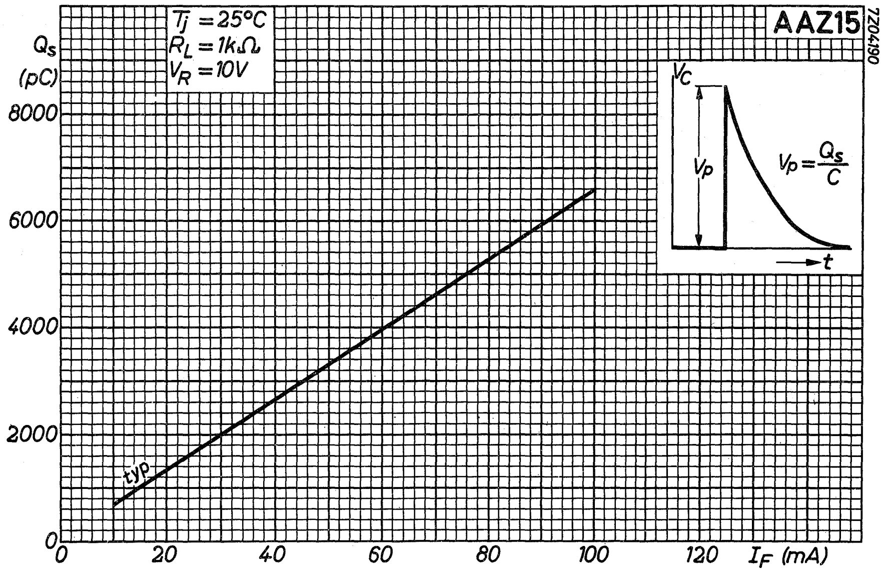

7Z04193
AAZ17
max
typ
max
typ
V_R=75V
75V
10V
10V
I_R (μA)
10^4
10^3
10^2
10
1
0
20
40
60
80
100
T_j (°C)

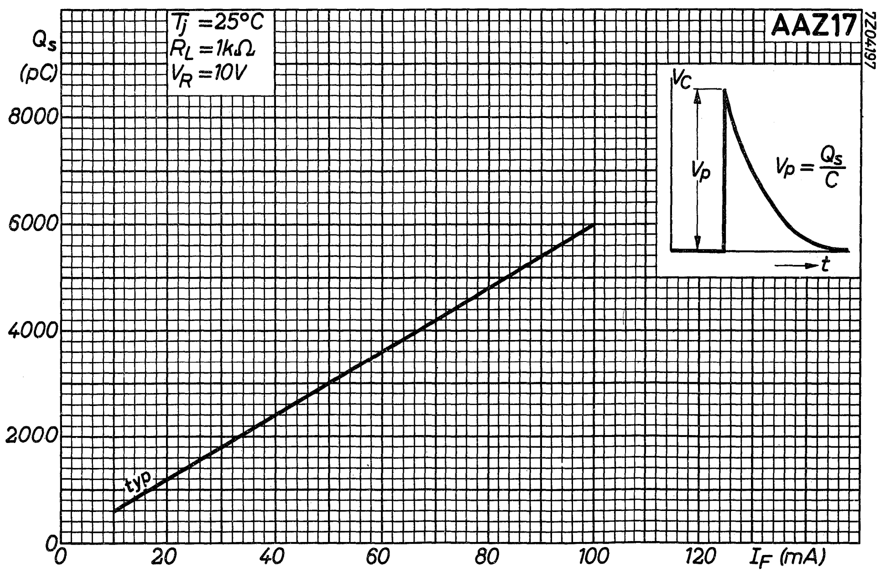

7Z04188
AAZ15
max
typ
max
typ
V_R=100V
100V
10V
10V
I_R (μA)
10^4
10^3
10^2
10
1
0
20
40
60
80
100
T_j (°C)

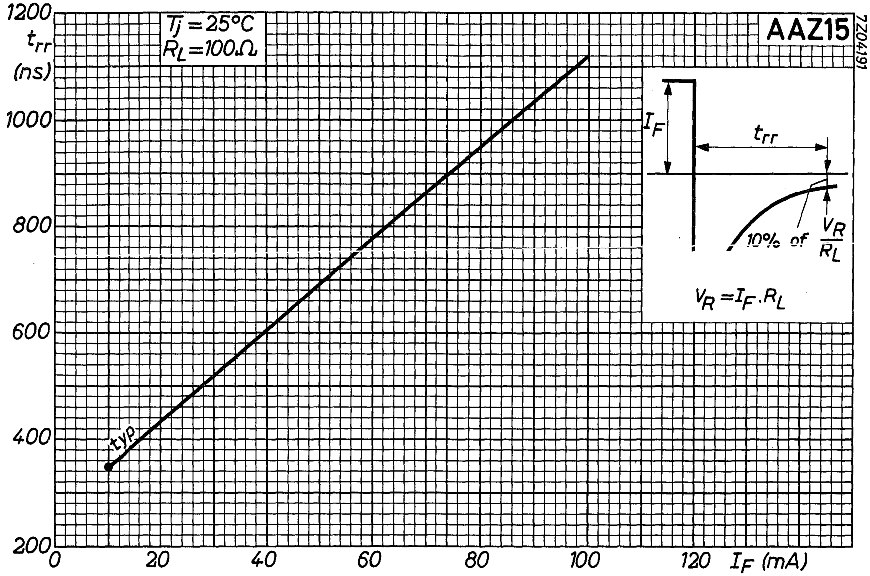

7Z04198-1.1.26.ae
$T_j = 25°C$
max voltage
typ
V_F (V)
I_F (mA)
1000
100
10
1
0.1
0
0.5
1
1.5
2

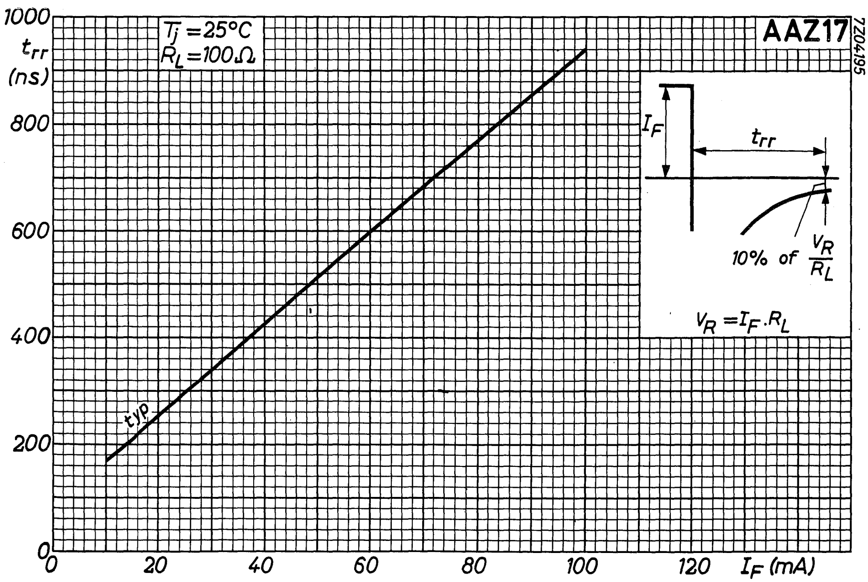

$T_j = 25°C$
$f = 1MHz$
C_d (pF)
max
typ
V_R (V)
7Z04199-1.1.26ae

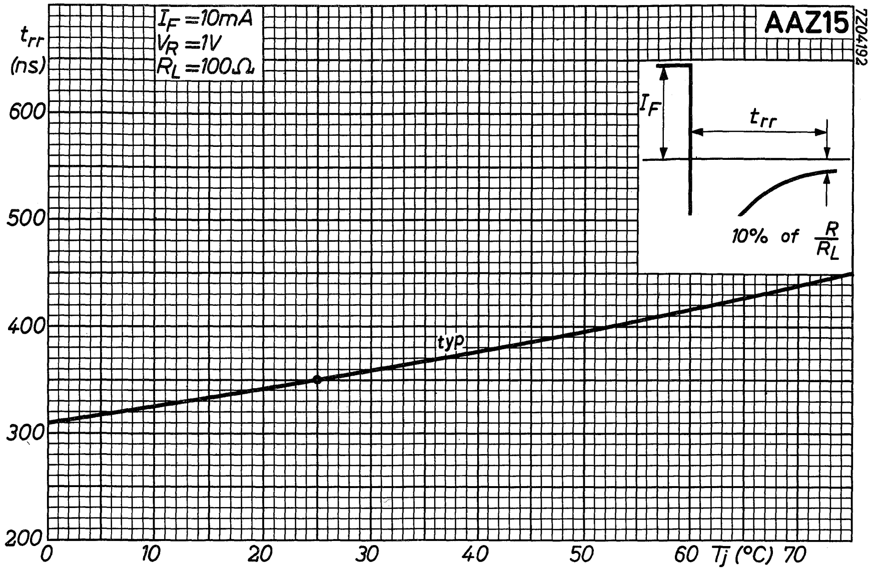

V_F (V)
typ
$I_F = 250mA$
10mA
0.1mA
T_j (°C)
7Z04200-1.1.26ae

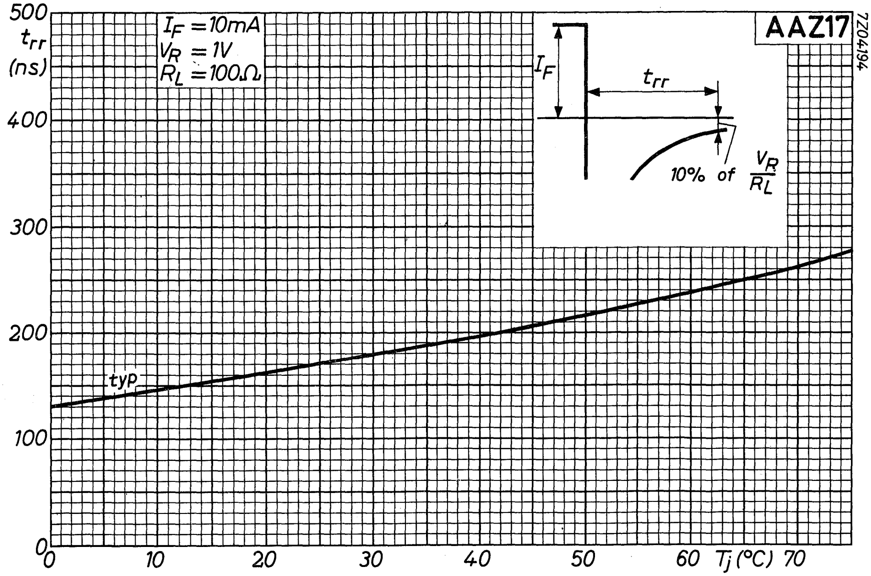

AAZ15
7Z04190
T_j = 25°C
R_L = 1kΩ
V_R = 10V
Q_s
(pC)
8000
6000
4000
2000
0
typ
0
20
40
60
80
100
120
I_F (mA)
V_C
V_p
$V_p = \frac{Q_s}{C}$
t


AAZ17
7Z04197
T_j = 25°C
R_L = 1kΩ
V_R = 10V
Q_s
(pC)
8000
6000
4000
2000
0
typ
0
20
40
60
80
100
120
I_F (mA)
V_C
V_p
$V_p = \frac{Q_s}{C}$
t


1200
t_{rr}
(ns)
1000
800
600
400
200
$T_j = 25°C$
$R_L = 100\Omega$
AAZ15
7Z04191
typ
I_F
t_{rr}
10% of $\frac{V_R}{R_L}$
$V_R = I_F . R_L$
0
20
40
60
80
100
120
I_F (mA)


1000
t_{rr}
(ns)
800
600
400
200
0
$T_j = 25°C$
$R_L = 100\Omega$
AAZ17
7Z04195
typ
I_F
t_{rr}
10% of $\frac{V_R}{R_L}$
$V_R = I_F . R_L$
0
20
40
60
80
100
120
I_F (mA)


t_{rr} (ns)
600
500
400
300
200
0
10
20
30
40
50
60
T_j (°C)
70
I_F = 10mA
V_R = 1V
R_L = 100Ω
AAZ15
7Z04192
I_F
t_{rr}
10% of $\frac{R}{R_L}$
typ


500
t_{rr} (ns)
400
300
200
100
0
0
10
20
30
40
50
60
T_j (°C)
70
I_F = 10mA
V_R = 1V
R_L = 100Ω
AAZ17
7Z04194
I_F
t_{rr}
10% of $\frac{V_R}{R_L}$
typ

GOLD BONDED DIODE

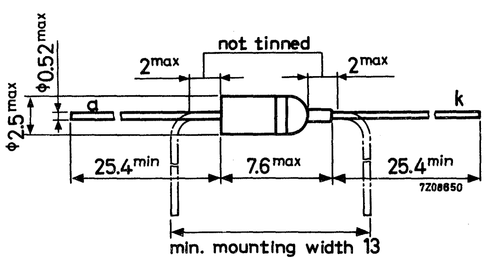
Gold bonded germanium diode in subminiature all glass DO-7 envelope, intended for switching applications and general purposes.

QUICK REFERENCE DATA				
Continuous reverse voltage	V_R	max.	20	V
Repetitive peak reverse voltage	V_{RRM}	max.	20	V
Forward current (d.c.)	I_F	max.	180	mA
Repetitive peak forward current	I_{FRM}	max.	300	mA
Junction temperature	T_j	max.	75	°C
Forward voltage at I_F = 300 mA	V_F	<	0.78	V
Recovered charge when switched from I_F = 10 mA to V_R = 10 V	Q_s	<	200	pC

MECHANICAL DATA

Dimensions in mm

DO-7



The coloured band indicates the cathode side

RATINGS (Limiting values) [1]

Voltages

Continuous reverse voltage	V_R	max.	20	V
Repetitive peak reverse voltage	V_{RRM}	max.	20	V
Non repetitive peak reverse voltage ($t < 1$ s)	V_{RSM}	max.	30	V

Currents

Forward current (d.c.)	I_F	max.	180	mA
Average rectified forward current (averaged over any 20 ms period)	I_{FAV}	max.	180	mA
Repetitive peak forward current	I_{FRM}	max.	300	mA
Non repetitive peak forward current ($t < 1$ s)	I_{FSM}	max.	400	mA

Temperatures

Storage temperature	T_{stg}	-65 to +75		^oC
Junction temperature	T_j	max.	75	^oC

THERMAL RESISTANCE

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

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

CHARACTERISTICS

Forward voltage at $T_j = 25\ ^oC$

I_F = 0.1 mA	V_F < 0.20 V
I_F = 1.0 mA	V_F < 0.30 V
I_F = 10 mA	V_F < 0.41 V
I_F = 30 mA	V_F < 0.49 V
I_F = 150 mA	V_F < 0.65 V
I_F = 300 mA [1]	V_F < 0.78 V

Forward voltage at $T_j = 60\ ^oC$

I_F = 0.1 mA	V_F < 0.14 V
I_F = 1.0 mA	V_F < 0.25 V
I_F = 10 mA	V_F < 0.36 V
I_F = 30 mA	V_F < 0.45 V
I_F = 150 mA	V_F < 0.62 V
I_F = 300 mA [1]	V_F < 0.76 V

Reverse current at $T_j = 25\ ^oC$

V_R = 1.5 V	I_R < 3.5 μA
V_R = 10 V	I_R < 15 μA
V_R = 20 V	I_R < 50 μA

Reverse current at $T_j = 60\ ^oC$

V_R = 1.5 V	I_R < 30 μA
V_R = 10 V	I_R < 45 μA
V_R = 20 V	I_R < 100 μA

Diode capacitance

V_R = 1 V; f = 1 MHz	C_d < 1.5 pF

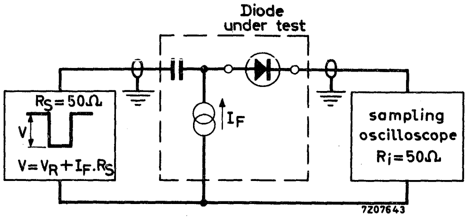
1) Measured under pulsed conditions to prevent excessive dissipation.

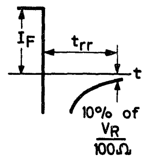
CHARACTERISTICS (continued) $T_j = 25\ ^oC$

Reverse recovery time when switched from $I_F = 10$ mA to $V_R = 1$ V; $R_L = 100\ \Omega$ — $t_{rr} < 70$ ns

Measured at $I_R = 10\ \%$ of $\frac{V_R}{R_L}$

Test circuit:





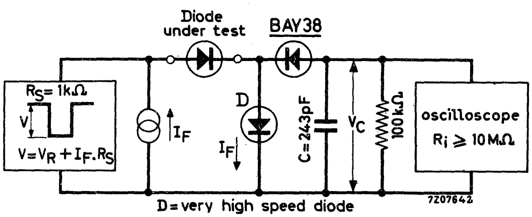
output pulse

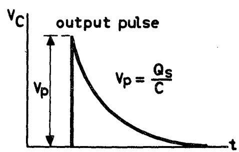
Reverse pulse:	Rise time	t_r	= 0.6	ns
	Pulse duration	t_p	= 100	ns
	Duty cycle	δ	= 0.05	

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

Recovered charge when switched from $I_F = 10$ mA to $V_R = 10$ V; $R_L = 1$ kΩ — $Q_s < 200$ pC

Test circuit:





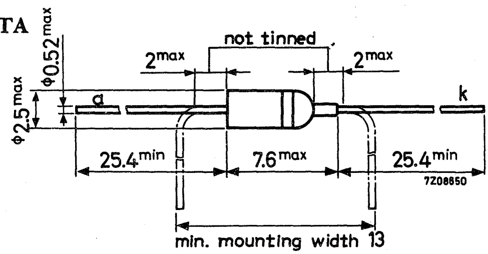
Reverse pulse:	Rise time	t_r	= 2	ns
	Pulse duration	t_p	= 0.4	μs
	Duty cycle	δ	= 0.02	

SILICON DIODE

General purpose silicon diode in a subminiature all glass DO-7 envelope.

MECHANICAL DATA Dimensions in mm

DO-7



The coloured band indicates the cathode side

RATINGS (Limiting values) [1])

Voltage

Continuous reverse voltage	V_R	max.	60	V

Currents

Forward current (d.c.)	I_F	max.	90	mA
Repetitive peak forward current	I_{FRM}	max.	100	mA
Non repetitive peak forward current ($t \leq 1$ s)	I_{FSM}	max.	200	mA

Temperatures

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

THERMAL RESISTANCE

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

CHARACTERISTICS

Forward voltage

		T_{amb} = 25 °C	T_{amb} = 60 °C	
I_F = 0.1 mA	V_F	typ. 0.55	typ. 0.5	V
		< 0.75		V
I_F = 1.0 mA	V_F	typ. 0.65	typ. 0.6	V
		0.5 to 1.0	0.4 to 0.9	V
I_F = 30 mA	V_F	typ. 0.9	typ. 0.85	V
		< 1.5	< 1.5	V

Reverse current

		T_{amb} = 60 °C	T_{amb} = 75 °C	
V_R = 10 V	I_R	typ. 5.0	< 10	μA
V_R = 60 V	I_R	typ. 10	< 20	μA

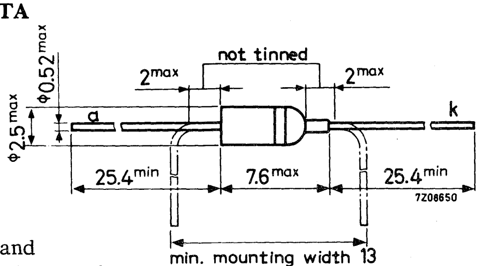
1) Limiting values according to the Absolute Maximum System as defined in IEC publication 134.

SILICON ALLOYED JUNCTION DIODE

Silicon alloyed junction diode in subminiature all-glass DO-7 envelope intended for use as low voltage stabilizer.

MECHANICAL DATA Dimensions in mm

DO-7



The coloured band indicates the cathode side

RATINGS (Limiting values) [1])

Current

Forward current (d.c.)	I_F	max.	20	mA

Temperatures

Storage temperature	T_{stg}	−55 to +90	°C
Operating ambient temperature	T_{amb}	−55 to +90	°C

THERMAL RESISTANCE

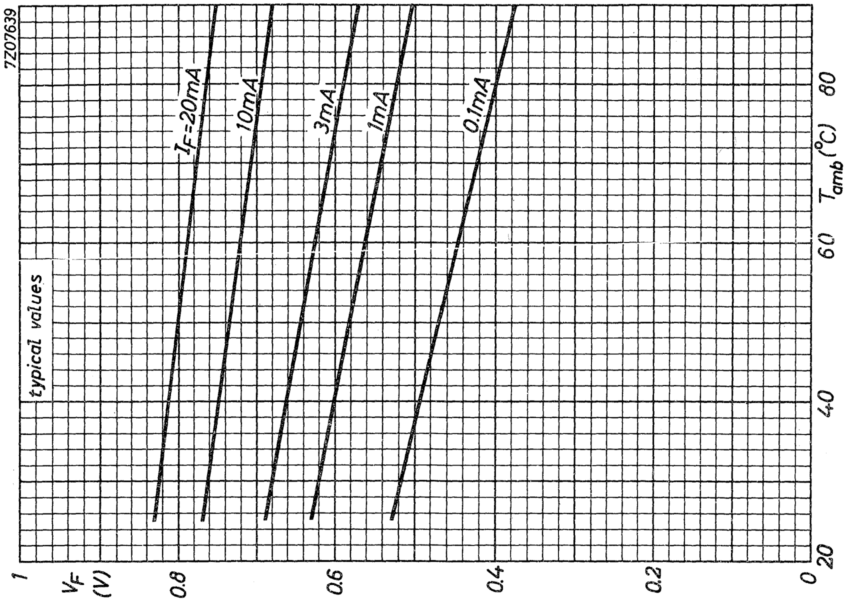
From junction to ambient in free air	$R_{th\,j\text{-}a}$	=	0.4	°C/mW

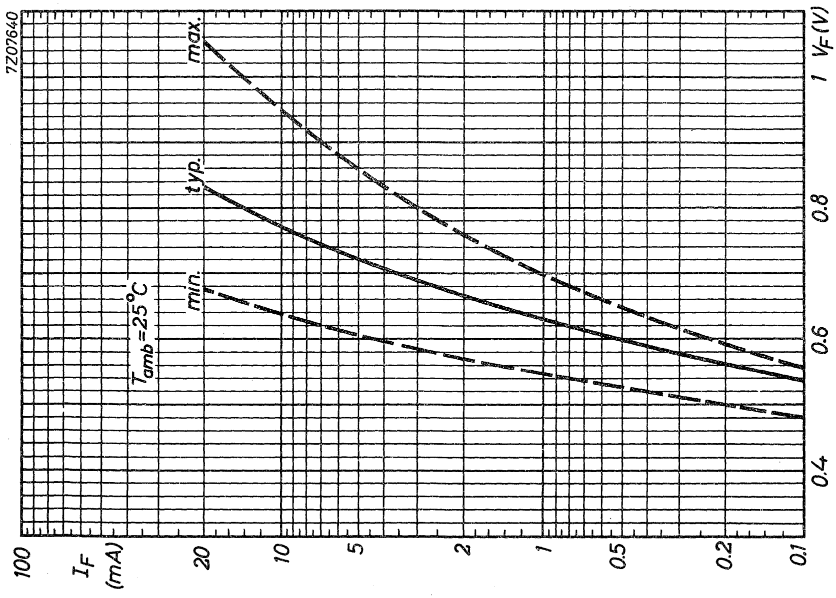
CHARACTERISTICS $T_{amb} = 25\ °C$

Forward voltage

$I_F = 0.2$ mA	V_F	>	0.5	V
$I_F = 3$ mA	V_F	<	0.8	V

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


7Z07639
typical values
I_F=20mA
10mA
3mA
1mA
0.1mA
V_F (V)
T_{amb} (°C)
1
0.8
0.6
0.4
0.2
0
20
40
60
80


7Z07640
T_{amb}=25°C
max.
typ.
min.
I_F (mA)
V_F (V)
100
20
10
5
2
1
0.5
0.2
0.1
1
0.8
0.6
0.4

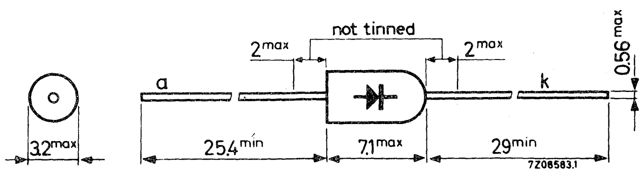
HIGH SPEED SILICON DIODE

Double diffused diode in a DO-14 plastic envelope primarily intended for use in clamp circuits of colour difference amplifiers in television receivers.

QUICK REFERENCE DATA				
Crest working reverse voltage	V_{RWM}	max.	300	V
Average forward current	I_{FAV}	max.	0.3	A
Non repetitive peak forward current half sine wave; t = 10 ms	I_{FSM}	max.	15	A
Junction temperature	T_j	max.	125	^oC
Thermal resistance from junction to ambient	$R_{th\ j\text{-}a}$	=	0.2	$^oC/mW$
Recovered charge when switched from I_F = 10 mA to V_R = 2 V with $-\frac{dI}{dt}$ = 5 mA/μs; T_j = 25 ^oC	Q_s	<	0.4	nC

MECHANICAL DATA Dimensions in mm

DO-14



The envelope fulfils the accelerated damp heat test described in IEC publication 68-2 (test D, severity IV, 6 cycles).

RATINGS (Limiting values) [1]

Voltages

Crest working reverse voltage	V_{RWM}	max.	300	V
Repetitive peak reverse voltage	V_{RRM}	max.	350	V
Non repetitive peak reverse voltage ($t < 1$ ms)	V_{RSM}	max.	350	V

→ Currents

Forward current (d.c.)	I_F	max.	0.3	A
Average forward current (averaged over any 20 ms period)	I_{FAV}	max.	0.3	A
Repetitive peak forward current	I_{FRM}	max.	2	A
Non repetitive peak forward current half sine wave; t = 10 ms	I_{FSM}	max.	15	A
Repetitive peak reverse current	I_{RRM}	max.	0.5	A

Temperatures

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

THERMAL RESISTANCE

From junction to ambient	$R_{th\ j-a}$	=	0.2	$^{o}C/mW$

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

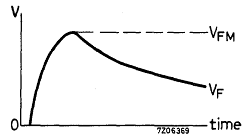
CHARACTERISTICS T_j = 25 °C unless otherwise specified

Forward voltage at I_F = 100 mA; T_j = 75 °C	V_F	<	1.0	V
Reverse current at V_R = 300 V; T_j = 75 °C	I_R	<	10	μA
Diode capacitance at f = 1 MHz				
V_R = 150 V; T_j = 25 °C to 125 °C	C_d	typ.	4.0	pF

Switching characteristics

Forward recovery voltage

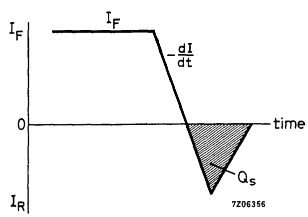
I_F = 100 mA; t_r = 50 ns	V_{FM}	<	3.0	V



Recovered charge when switched from

I_F = 10 mA to V_R = 2 V with

$-\frac{dI}{dt}$ = 5 mA/μs	Q_s	<	0.4	nC



MOUNTING INSTRUCTIONS

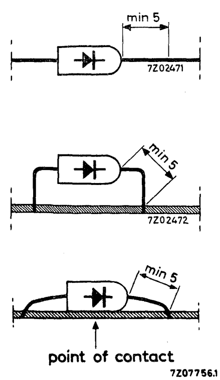
Iron soldering

At a max. iron temperature of 300 °C, the max. permissible soldering time is 3 s, provided the soldering spot is at least 5 mm from the seal.

Dip soldering

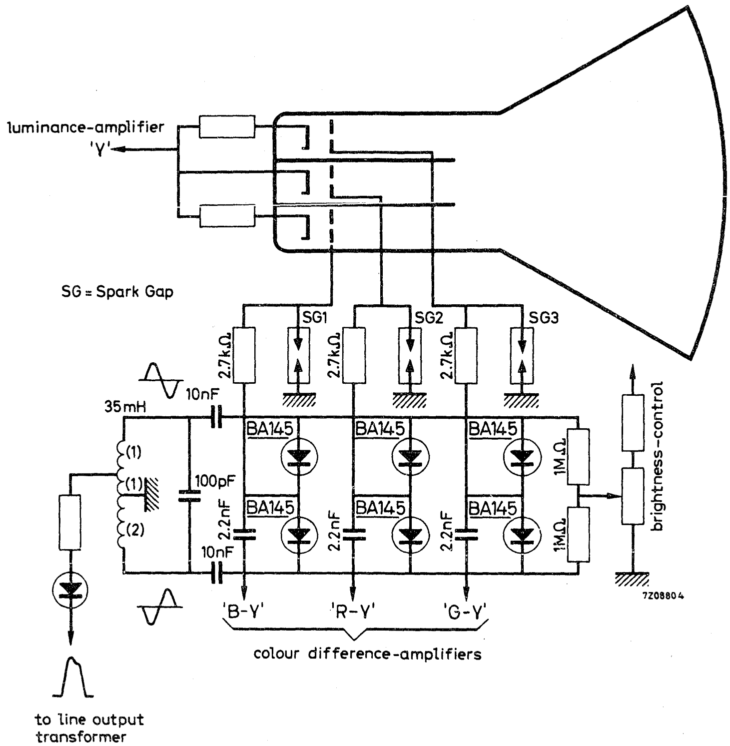
At a max. solder temperature of 300 °C, the max. permissible soldering time is 3 s, provided the soldering spot is at least 5 mm from the seal.

Note: If during soldering the diode is in contact with the printed board the maximum permissible temperature of the point of contact is 125 °C.



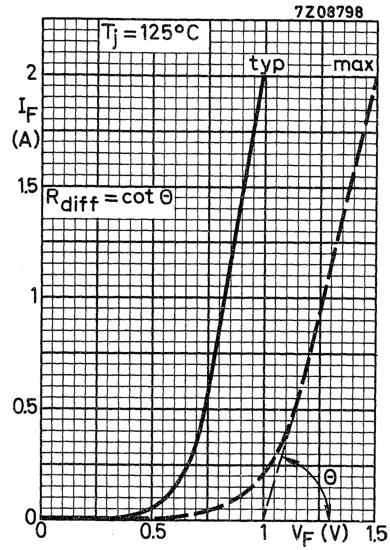
APPLICATION INFORMATION

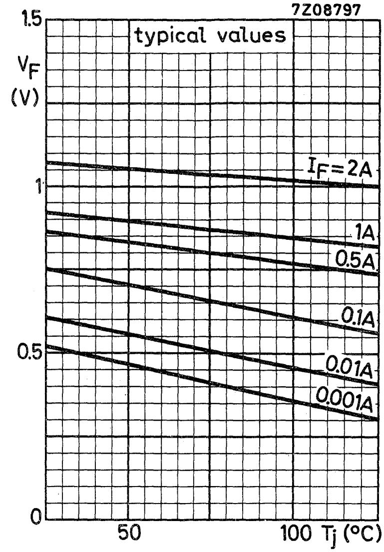
Clamp circuit for colour difference amplifiers in television receivers.

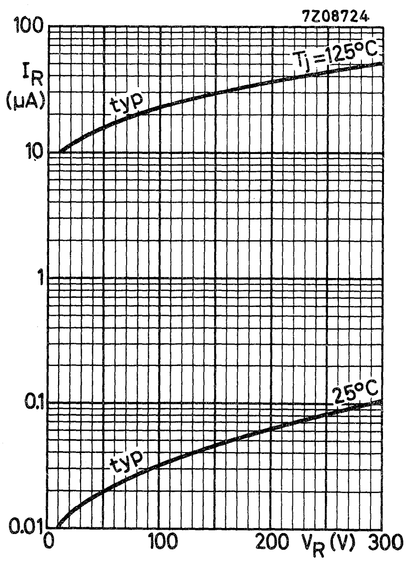


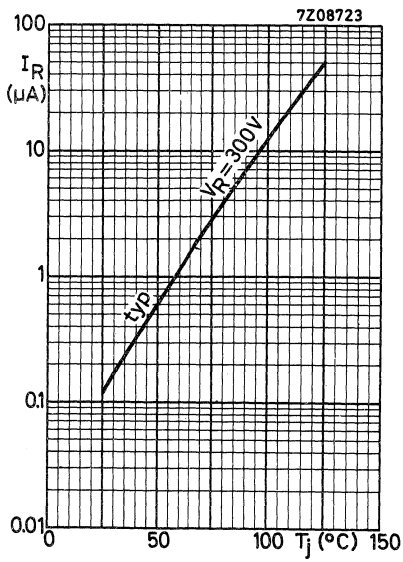
Up to $T_{amb} = 65^{o}C$ the differences in clamping levels in the circuit will be less than 1 V.

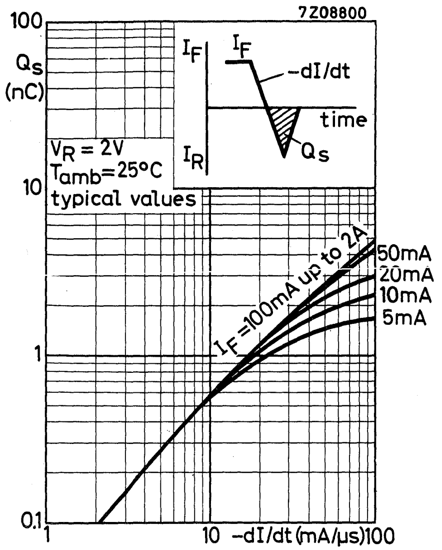
When in a picture tube flash-over occurs, it is possible that high voltage peaks appear at the control grid. These voltage peaks can damage the diodes in the clamp circuit. Protection of the diodes is obtained by means of a sparkgap with breakover voltage of < 3000 V and a resistor of 2.7 kΩ.

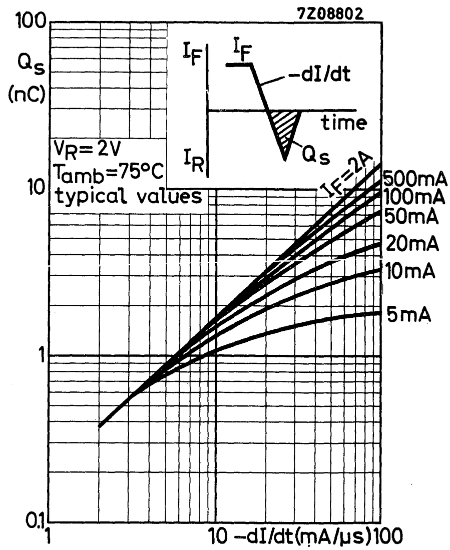

7Z08798
$T_j = 125°C$
typ
max
I_F (A)
$R_{diff} = \cot \Theta$
Θ
V_F (V)
0
0.5
1
1.5
2

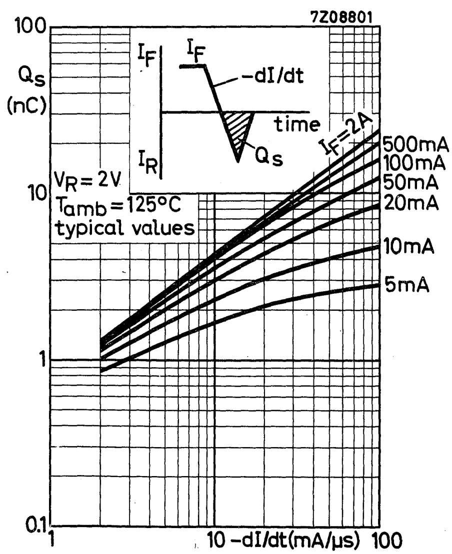

7Z08797
typical values
V_F (V)
$I_F = 2A$
1A
0.5A
0.1A
0.01A
0.001A
0
0.5
1
1.5
50
100 T_j (°C)

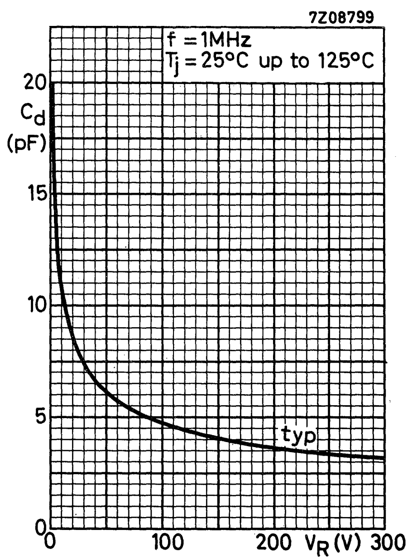

7Z08724
I_R (μA)
$T_j = 125°C$
typ
25°C
typ
0.01
0.1
1
10
100
0
100
200 V_R (V) 300


7Z08723
I_R (μA)
$V_R = 300V$
typ
0.01
0.1
1
10
100
0
50
100 T_j (°C) 150


7Z08800
100
Qs
(nC)
10
1
0.1
1
10 -dI/dt (mA/μs) 100
VR = 2V
Tamb = 25°C
typical values
IF
IF
-dI/dt
time
IR
Qs
IF = 100mA up to 2A
50mA
20mA
10mA
5mA


7Z08802
100
Qs
(nC)
10
1
0.1
1
10 -dI/dt (mA/μs) 100
VR = 2V
Tamb = 75°C
typical values
IF
IF
-dI/dt
time
IR
Qs
IF = 2A
500mA
100mA
50mA
20mA
10mA
5mA


7Z08801
100
Qs
(nC)
10
1
0.1
1
10 -dI/dt (mA/μs) 100
VR = 2V
Tamb = 125°C
typical values
IF
IF
-dI/dt
time
IR
Qs
IF = 2A
500mA
100mA
50mA
20mA
10mA
5mA


7Z08799
f = 1MHz
Tj = 25°C up to 125°C
20
Cd
(pF)
15
10
5
0
0
100
200 VR (V) 300
typ

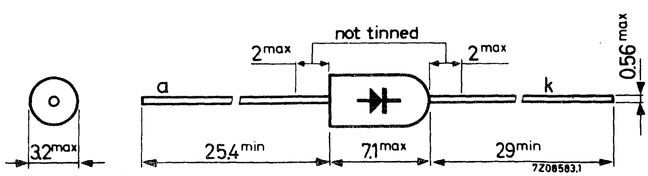
HIGH SPEED SILICON DIODE

Double diffused general purpose diode in a DO-14 plastic envelope for use as line phase detector, clamping diode, scan rectifier for the supply of the small signal parts in television receivers etc.

QUICK REFERENCE DATA				
Crest working reverse voltage	V_{RWM}	max.	300	V
Average forward current	I_{FAV}	max.	0.3	A
Non repetitive peak forward current half sine wave; t = 10 ms	I_{FSM}	max.	15	A
Junction temperature	T_j	max.	125	^oC
Thermal resistance from junction to ambient	$R_{th\ j\text{-}a}$	=	0.2	$^oC/mW$
Recovered charge when switched from I_F = 10 mA to V_R = 2 V with $-\frac{dI}{dt}$ = 5 mA/μs; T_j = 25 ^oC	Q_s	<	0.8	nC

MECHANICAL DATA Dimensions in mm

DO-14



The envelope fulfils the accelerated damp heat test described in IEC publication 68-2 (test D, severity IV, 6 cycles).

RATINGS (Limiting values) [1])

Voltages

Crest working reverse voltage	V_{RWM}	max.	300	V
Repetitive peak reverse voltage	V_{RRM}	max.	350	V
Non repetitive peak reverse voltage ($t < 10$ ms)	V_{RSM}	max.	350	V

Currents

Average forward current (averaged over any 20 ms period)	I_{FAV}	max.	0.3	A
Repetitive peak forward current	I_{FRM}	max.	2.0	A
Non repetitive peak forward current half sine wave; t = 10 ms	I_{FSM}	max.	15	A
Repetitive peak reverse current	I_{RRM}	max.	0.5	A

Temperatures

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

THERMAL RESISTANCE

From junction to ambient	$R_{th\ j-a}$	=	0.2	$^{o}C/mW$

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

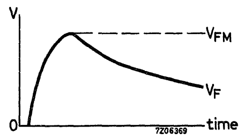
CHARACTERISTICS T_j = 25 °C unless otherwise specified

Forward voltage at I_F = 2 A; T_j = 125 °C	V_F	<	1.5	V
Reverse current at V_R = 300 V; T_j = 125 °C	I_R	<	200	μA
Diode capacitance at f = 1 MHz V_R = 150 V; T_j = 25 °C to 125 °C	C_d	typ.	4.0	pF

Switching characteristics

Forward recovery voltage

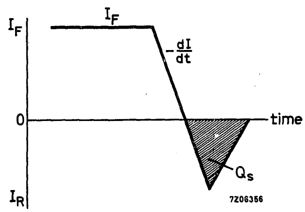
I_F = 100 mA; t_r = 50 ns — V_{FM} < 3.0 V



Recovered charge when switched from

I_F = 10 mA to V_R = 2 V with

$-\frac{dI}{dt}$ = 5 mA/μs — Q_s < 0.8 nC



MOUNTING INSTRUCTIONS

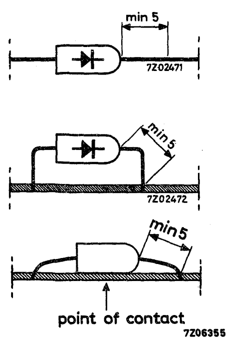
Iron soldering

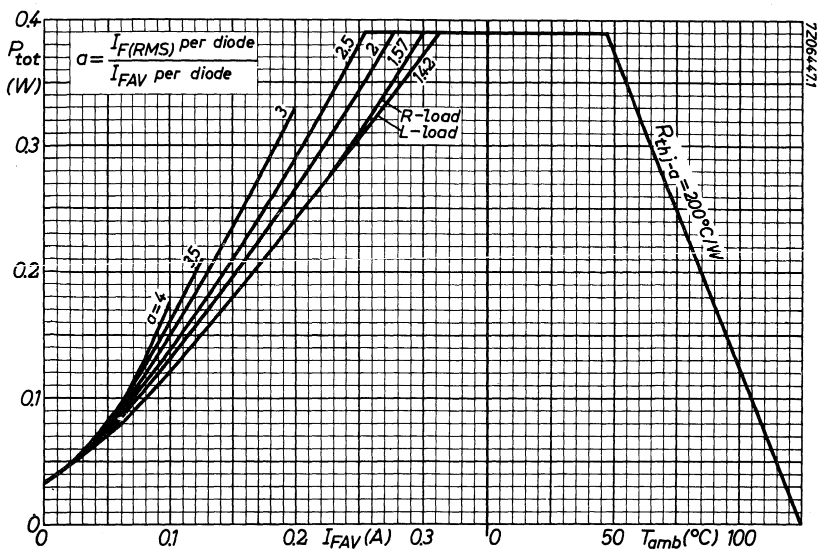
At a max. iron temperature of 300 °C, the max. permissible soldering time is 3 s, provided the soldering spot is at least 5 mm from the seal.

Dip soldering

At a max. solder temperature of 300 °C, the max. permissible soldering time is 3 s, provided the soldering spot is at least 5 mm from the seal.

Note: if during soldering the diode is in contact with the printed board the maximum permissible temperature of the point of contact is 125 °C.



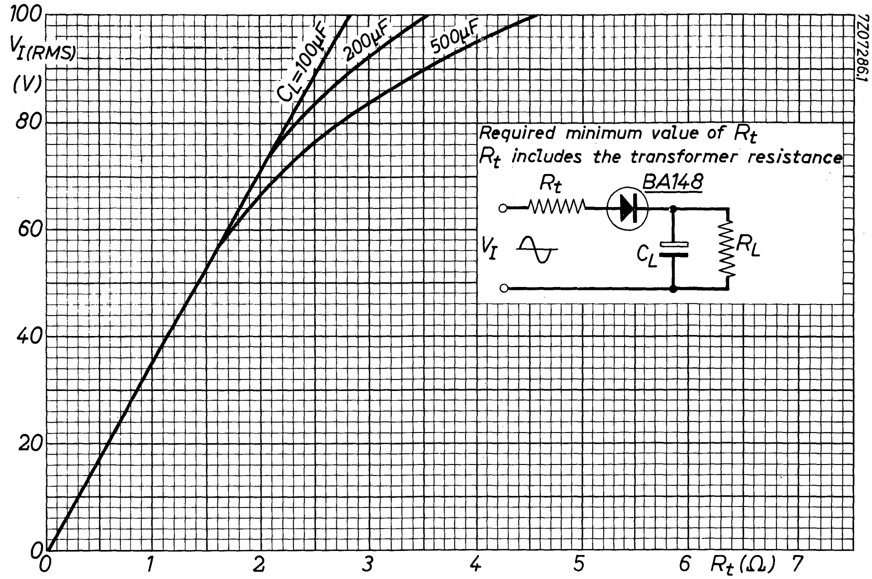


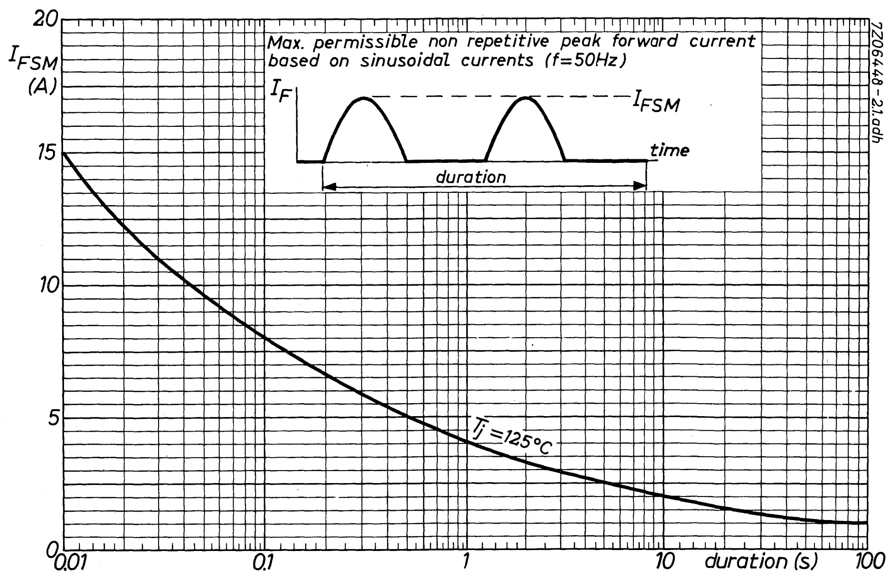
From the left hand graph the total power dissipation can be found as a function of the average forward current.

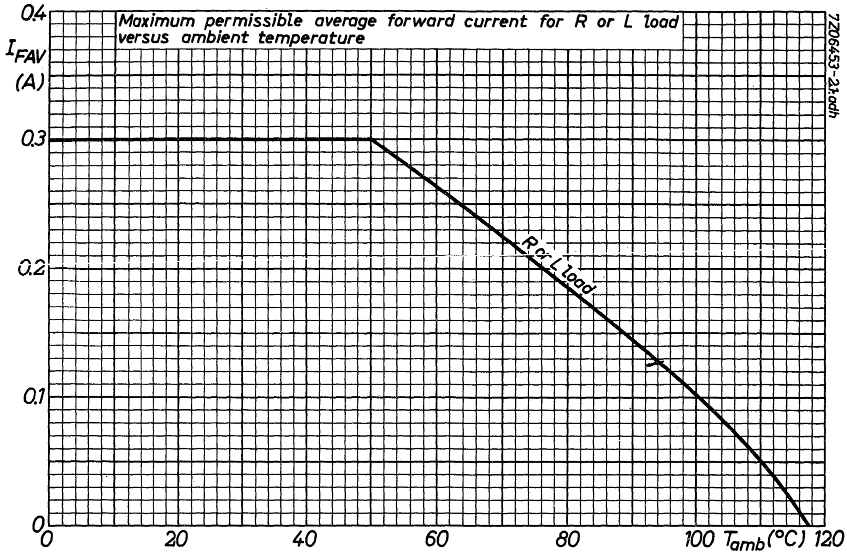
The parameter $a = \frac{I_{F(RMS)}\text{per diode}}{I_{FAV}\text{ per diode}}$ depends on $\omega R_L C_L$ and $\frac{R_t + r_{diff.}}{R_L}$ and can be found from existing graphs.

See for instance "Power rectification with silicon diodes".
Once the power dissipation is known, the max. permissible ambient temperature follows from the right hand graph.

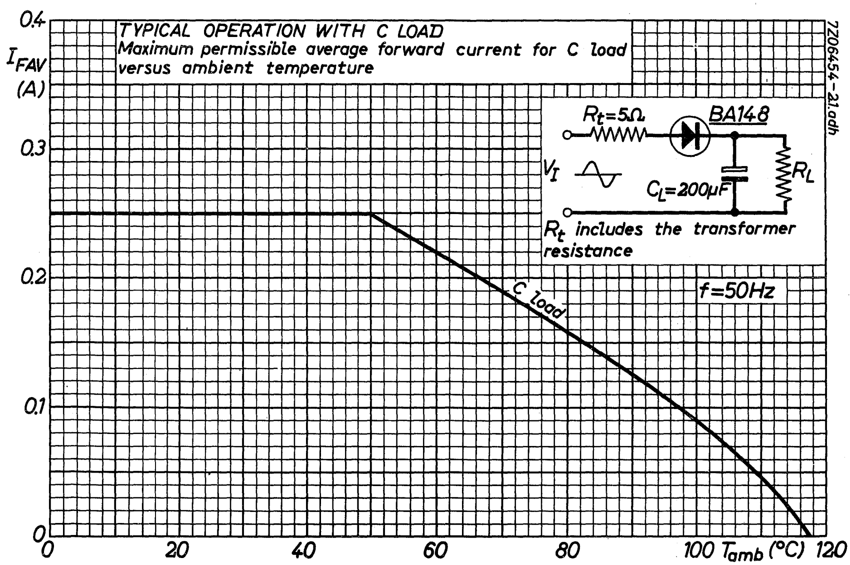
For the series resistance, added to limit the initial peak rectifier current, the required minimum value can be found from the upper graph at page 5.
$r_{diff.}$ is shown at page 10, upper figure.


100
$V_{I(RMS)}$
(V)
80
60
40
20
0
0
1
2
3
4
5
6
R_t (Ω)
7
C_L=100µF
200µF
500µF
7Z07286.1
Required minimum value of R_t
R_t includes the transformer resistance
R_t
BA148
V_I
C_L
R_L

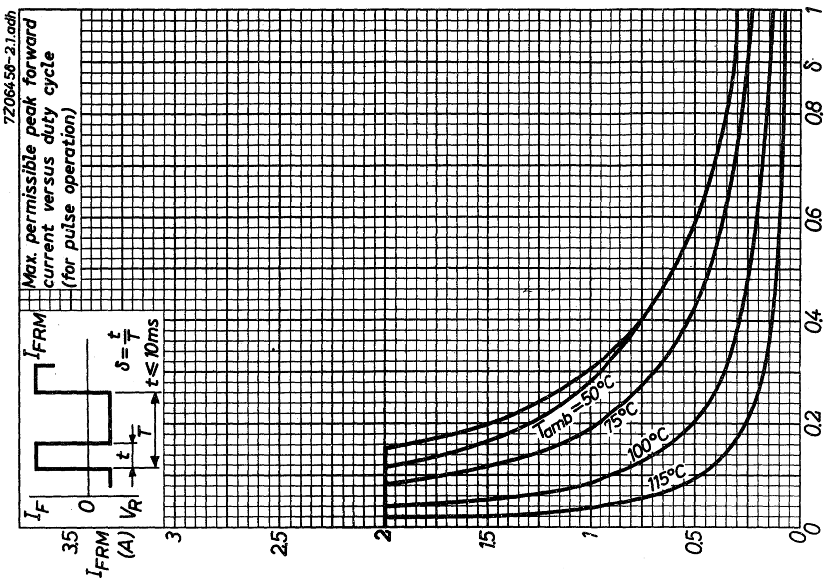

20
I_{FSM}
(A)
15
10
5
0
0.01
0.1
1
10
duration (s)
100
7Z06448-2.1.adh
Max. permissible non repetitive peak forward current
based on sinusoidal currents (f=50Hz)
I_F
I_{FSM}
time
duration
T_j=125°C

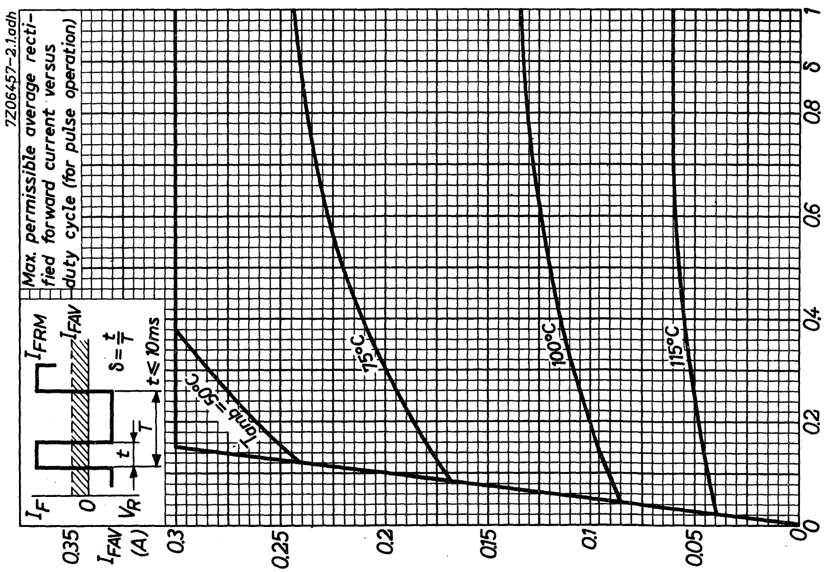


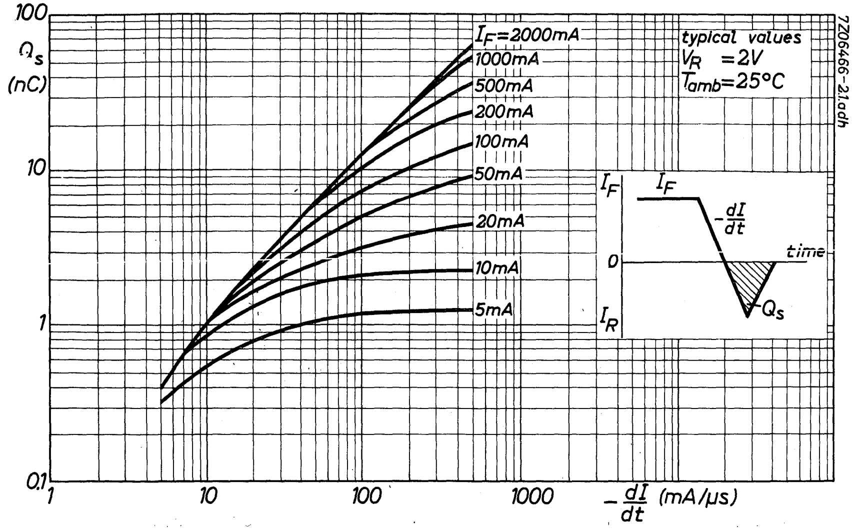
Maximum permissible average forward current for R or L load versus ambient temperature
7Z06453-2.1.adh
I_{FAV} (A)
0.4
0.3
0.2
0.1
0
0
20
40
60
80
100 T_{amb} (°C) 120
R or L load

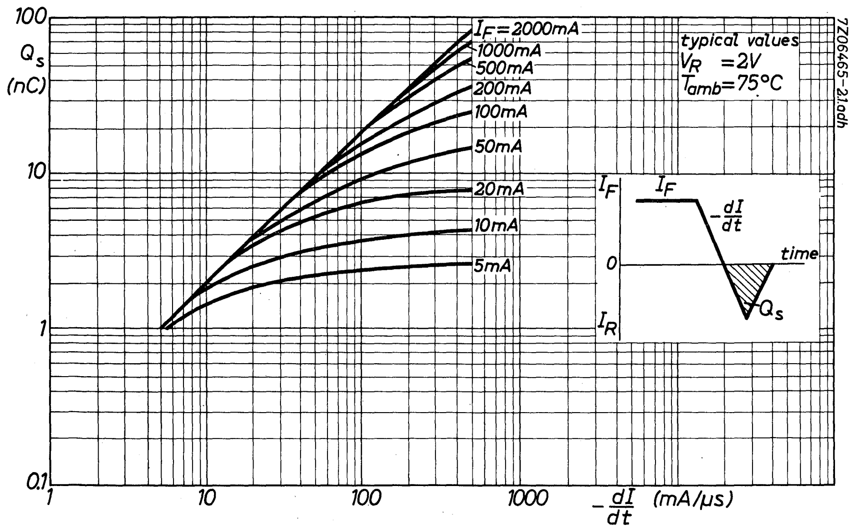


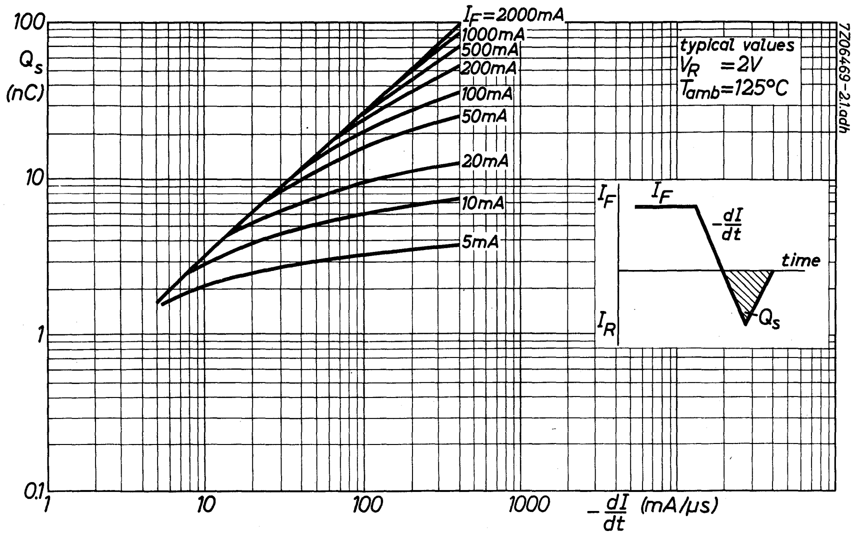
TYPICAL OPERATION WITH C LOAD
Maximum permissible average forward current for C load versus ambient temperature
7Z06454-2.1.adh
I_{FAV} (A)
0.4
0.3
0.2
0.1
0
0
20
40
60
80
100 T_{amb} (°C) 120
R_t=5Ω
BA148
V_I
C_L=200μF
R_L
R_t includes the transformer resistance
f=50Hz
C load

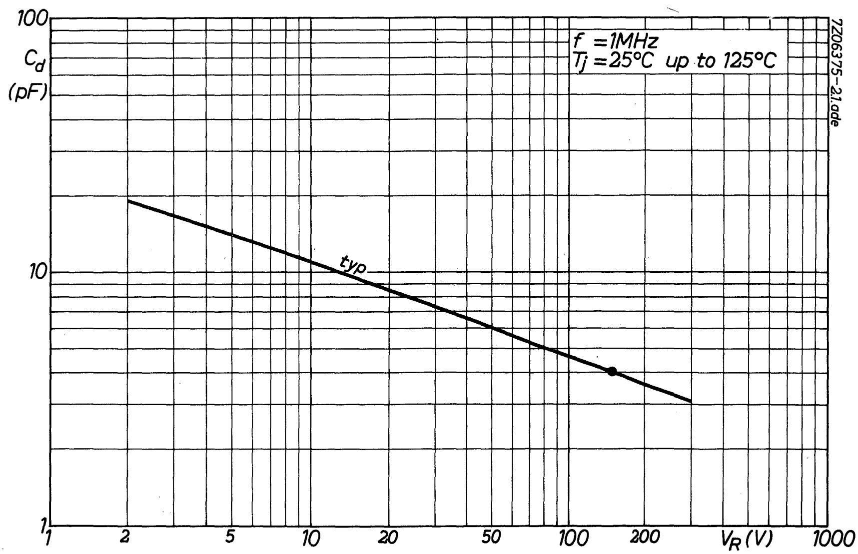

7Z06458-2.1.adh
Max. permissible peak forward current versus duty cycle (for pulse operation)
I_F
I_{FRM}
0
V_R
t
T
$\delta = \frac{t}{T}$
t ≤ 10ms
I_{FRM} (A)
T_{amb} = 50°C
75°C
100°C
115°C
δ
0
0.2
0.4
0.6
0.8
1
0.5
1.5
2
2.5
3
3.5

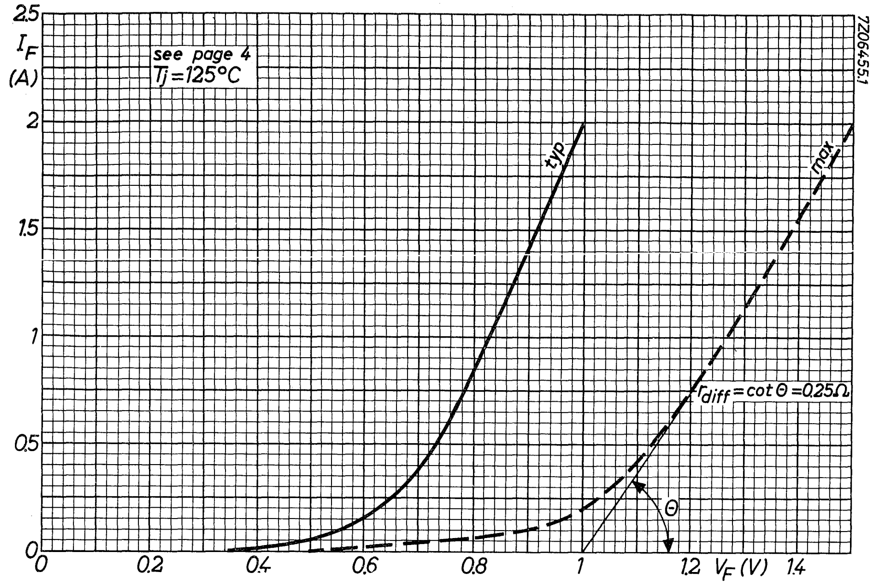

7Z06457-2.1.adh
Max. permissible average rectified forward current versus duty cycle (for pulse operation)
I_F
I_{FRM}
I_{FAV}
0
V_R
t
T
$\delta = \frac{t}{T}$
t ≤ 10ms
I_{FAV} (A)
T_{amb} = 50°C
75°C
100°C
115°C
δ
0
0.2
0.4
0.6
0.8
1
0.05
0.1
0.15
0.2
0.25
0.3
0.35

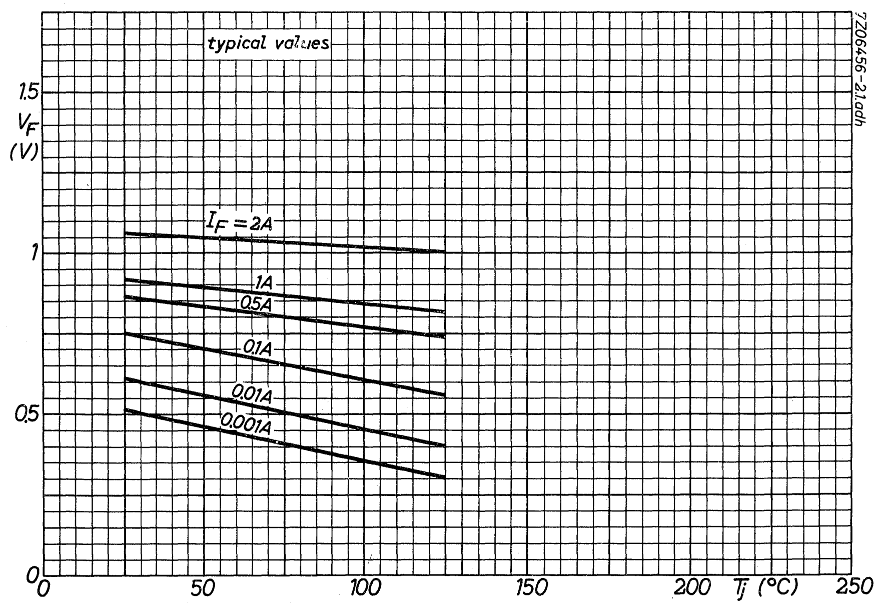

100
Q_s
(nC)
10
1
0.1
1
10
100
1000
$-\frac{dI}{dt}$ (mA/µs)
I_F=2000mA
1000mA
500mA
200mA
100mA
50mA
20mA
10mA
5mA
typical values
V_R =2V
T_{amb}=25°C
7Z06466-2.1adh
I_F
0
I_R
$-\frac{dI}{dt}$
time
Q_s

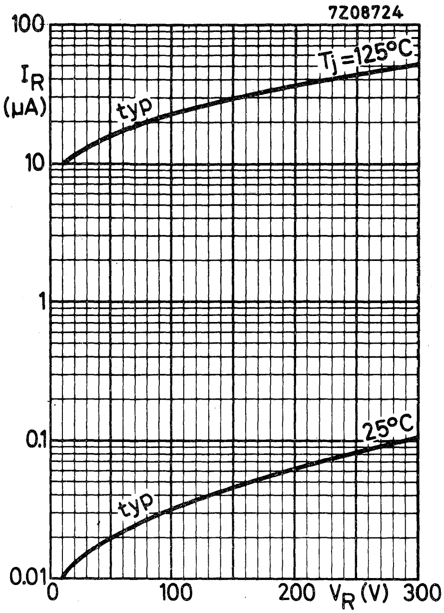

100
Q_s
(nC)
10
1
0.1
1
10
100
1000
$-\frac{dI}{dt}$ (mA/µs)
I_F=2000mA
1000mA
500mA
200mA
100mA
50mA
20mA
10mA
5mA
typical values
V_R =2V
T_{amb}=75°C
7Z06465-2.1adh
I_F
0
I_R
$-\frac{dI}{dt}$
time
Q_s

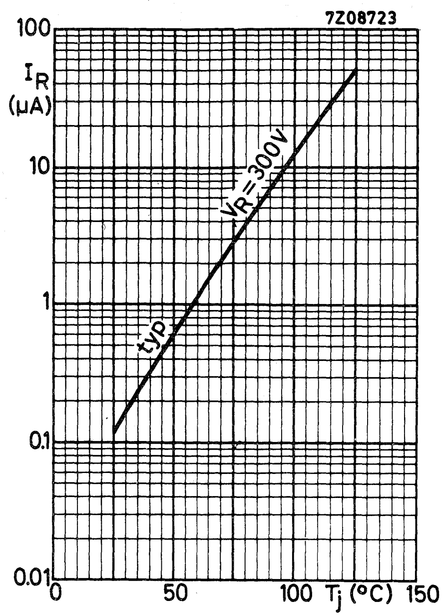

100
Q_s
(nC)
10
1
0.1
1
10
100
1000
$-\frac{dI}{dt}$ (mA/µs)
I_F=2000mA
1000mA
500mA
200mA
100mA
50mA
20mA
10mA
5mA
typical values
V_R =2V
T_{amb}=125°C
I_F
I_F
$-\frac{dI}{dt}$
time
I_R
Q_s
7Z06469-2.1.adh


100
C_d
(pF)
10
1
1
2
5
10
20
50
100
200
V_R(V)
1000
typ
f =1MHz
T_j =25°C up to 125°C
7Z06375-2.1.ade


2.5
I_F
(A)
see page 4
$T_j = 125\,°C$
2
1.5
1
0.5
0
typ
max
$r_{diff} = \cot\Theta = 0.25\,\Omega$
Θ
0
0.2
0.4
0.6
0.8
1
1.2
V_F (V)
1.4
7Z06455.1

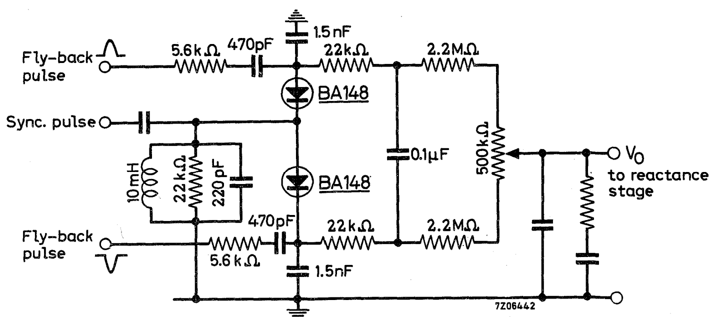

typical values
1.5
V_F
(V)
1
0.5
0
$I_F = 2A$
1A
0.5A
0.1A
0.01A
0.001A
0
50
100
150
200
T_j (°C)
250
7Z06456-2.1.adh





APPLICATION INFORMATION

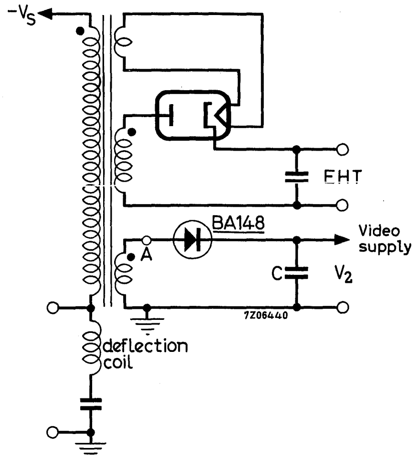
Self catching line phase detector

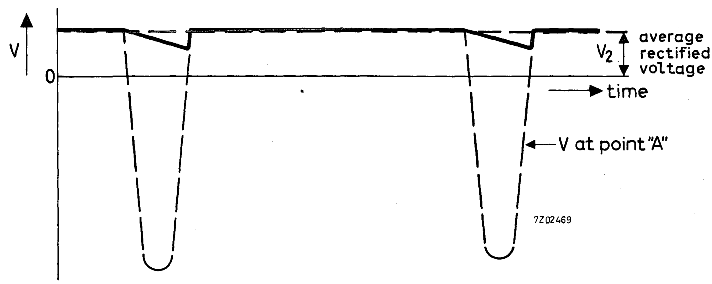


In the high impedance type of a line phase detector shown in the circuit diagram the BA148 is very well applicable owing to its high speed and low leakage properties.

APPLICATION INFORMATION (continued)

Low voltage power supply of the line output stage of a television receiver.





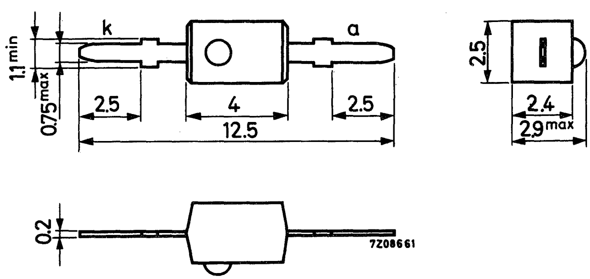
By means of an extra winding on the line output transformer and a BA148 a supply voltage up to 30 V can be obtained for the low voltage parts of a television receiver. The rectifier is conductive during the scan cycle, which facilitates an output voltage which is essentially stable and has a low source impedance.

SILICON PLANAR DIODE

The BA182 is a switching diode in a plastic envelope. It is intended for band switching in v.h.f. television tuners.

QUICK REFERENCE DATA				
Continuous reverse voltage	V_R	max.	35	V
Forward current (d.c.)	I_F	max.	100	mA
Junction temperature	T_j	max.	100	^oC
Diode capacitance at f = 1 MHz V_R = 20 V	C_d	typ. <	0.8 1	pF pF
Series resistance at f = 200 MHz I_F = 5 mA	r_D	typ. <	0.5 0.7	Ω Ω

MECHANICAL DATA Dimensions in mm



The dot indicates the cathode

The sealing of the plastic envelope withstands the accelerated damp heat test of IEC recommendation 68-2 (test D, severity IV, 6 cycles)

RATINGS (Limiting values) [1])

Voltage				
Continuous reverse voltage	V_R	max.	35	V
Current				
Forward current (d.c.)	I_F	max.	100	mA
Temperatures				
Storage temperature	T_{stg}	-55 to +100		°C
Junction temperature	T_j	max.	100	°C

THERMAL RESISTANCE

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

CHARACTERISTICS

Forward voltage at I_F = 100 mA	V_F	<	1.2	V
Reverse current				
V_R = 20 V	I_R	<	100	nA
V_R = 20 V; T_j = 60 °C	I_R	<	1	μA
Diode capacitance at f = 1 MHz				
V_R = 20 V	C_d	typ.	0.8	pF
		<	1	pF
Series resistance at f = 200 MHz				
I_F = 5 mA	r_D	typ.	0.5	Ω
		<	0.7	Ω

MOUNTING AND SOLDERING INSTRUCTIONS

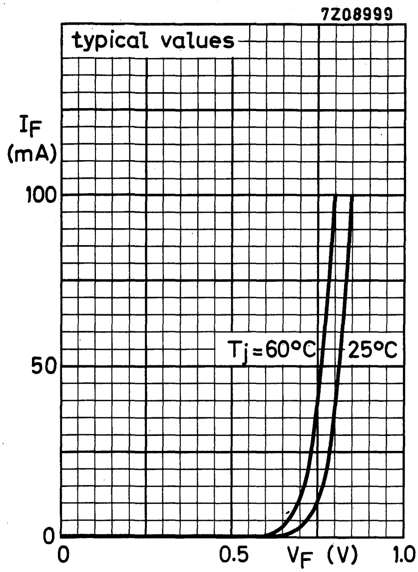
Mounting

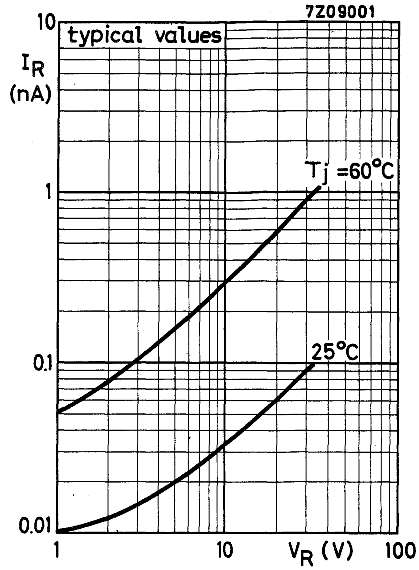
The leads must be bent with a radius of not less than 0.5 mm near the seal. (This can be done by hand if care is taken to exert no pulling force).

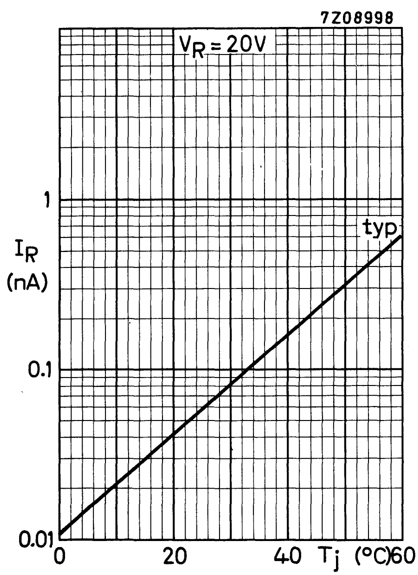
Soldering

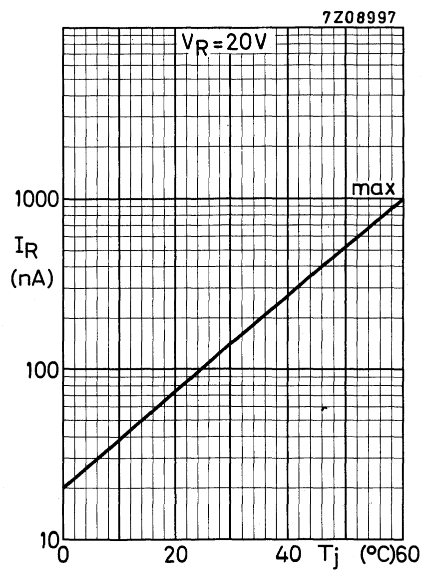
At a maximum iron or solder temperature of 300 °C, the maximum permissible soldering time is 3 seconds. The soldering spot may be at any distance from the seal. During soldering, care must be taken that the plastic body does not come into contact with any temperature higher than 125 °C.

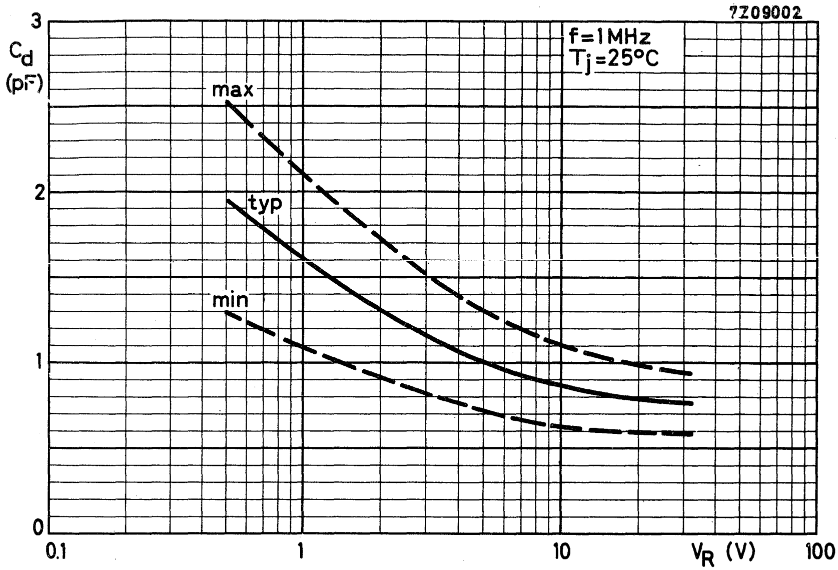
[1]) Limiting values according to the Absolute Maximum System as defined in IEC publication 134.

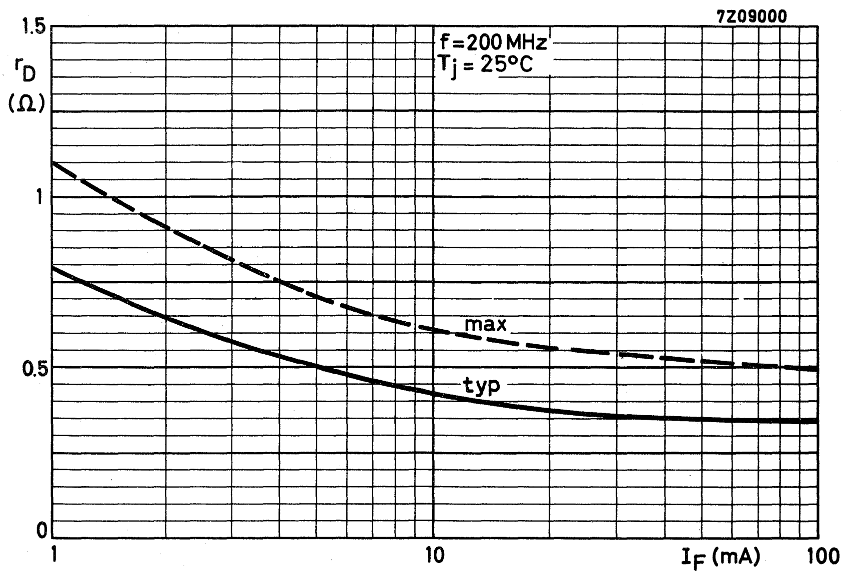

7Z08999
typical values
I_F
(mA)
100
50
0
0
0.5
V_F (V)
1.0
T_j = 60°C
25°C


7Z09001
typical values
10
I_R
(nA)
1
0.1
0.01
1
10
V_R (V)
100
T_j = 60°C
25°C


7Z08998
V_R = 20V
1
I_R
(nA)
0.1
0.01
0
20
40
T_j (°C)
60
typ


7Z08997
V_R = 20V
1000
I_R
(nA)
100
10
0
20
40
T_j (°C)
60
max


7Z09002
C_d
(pF)
3
2
1
0
max
typ
min
f=1MHz
T_j=25°C
0.1
1
10
V_R (V)
100

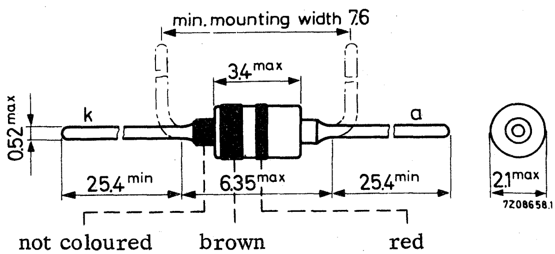

7Z09000
r_D
(Ω)
1.5
1
0.5
0
f=200 MHz
T_j = 25°C
max
typ
1
10
I_F (mA)
100

SILICON OXIDE PASSIVATED AVALANCHE DIODE

Whiskerless diffused diode in a molybdenum hard glass subminiature envelope, capable of absorbing transients repetitively. It is a fast high conductance diode, primarily intended for switching inductive loads in semi-electronic telephone exchanges.

QUICK REFERENCE DATA				
Repetitive peak forward current	I_{FRM}	max.	800	mA
Thermal resistance from junction to ambient	$R_{th\ j\text{-}a}$	=	0.3	°C/mW
Forward voltage at I_F = 200 mA	V_F	<	1.0	V
Reverse breakdown voltage I_R = 1 mA	$V_{(BR)R}$	120 to	175	V
Reverse recovery time when switched from I_F = 30 mA to V_R = 3 V; R_L = 100 Ω measured at I_R = 3 mA	t_{rr}	<	50	ns
Recovered charge when switched from I_F = 10 mA to V_R = 5 V R_L = 500 Ω	Q_s	<	0.5	nC

MECHANICAL DATA Dimensions in mm



RATINGS (Limiting values) [1])

Voltage

Continuous reverse voltage	V_R	max.	90	V [2])

Currents

Average rectified forward current (averaged over any 20 ms period)	I_{FAV}	max.	400	mA
Forward current (d.c.)	I_F	max.	400	mA
Repetitive peak forward current	I_{FRM}	max.	800	mA
Non repetitive peak forward current				
t = 1 μs	I_{FSM}	max.	6000	mA
t = 1 s	I_{FSM}	max.	1500	mA
Repetitive peak reverse current	I_{RRM}	max.	600	mA

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	$R_{th\ j-a}$	=	0.3	°C/mW

CHARACTERISTICS T_j = 25 °C unless otherwise specified

Forward voltage

I_F = 10 mA	V_F	<	0.75	V
I_F = 50 mA	V_F	<	0.84	V
I_F = 100 mA	V_F	<	0.90	V
I_F = 200 mA	V_F	<	1.0	V
I_F = 400 mA	V_F	<	1.25	V

Reverse breakdown voltage

I_R = 1 mA	$V_{BR(R)}$	120 to	175	V

Reverse current

V_R = 90 V; T_j = 150 °C	I_R	<	100	μA

Diode capacitance

V_R = 0; f = 1 MHz	C_d	typ.	25	pF
		<	35	pF

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

[2]) It is allowed to exceed this value as described on page 4. Care should be taken not to exceed the I_{RRM} rating.

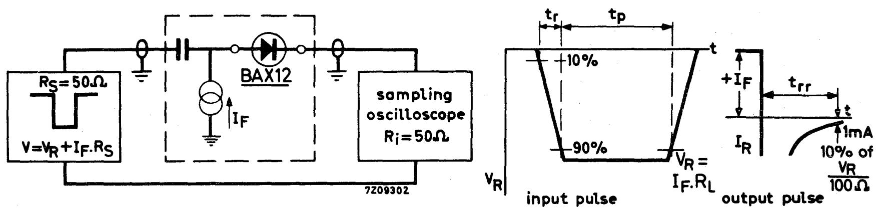
CHARACTERISTICS (continued) T_j = 25 °C unless otherwise specified

Reverse recovery time when switched from

I_F = 30 mA to V_R = 3 V; R_L = 100 Ω

measured at I_R = 1 mA	t_{rr}	typ.	37	ns
		<	60	ns
measured at I_R = 3 mA	t_{rr}	typ.	30	ns
		<	50	ns

Test circuit:



Reverse pulse: Rise time t_r = 0.6 ns

Pulse duration t_p = 100 ns

Duty cycle δ = 0.05

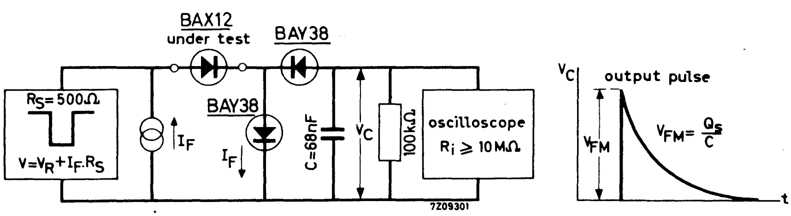
Oscilloscope: Rise time t_r = 0.35 ns

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

Recovered charge when switched from

I_F = 10 mA to V_R = 5 V; R_L = 500 Ω Q_s < 0.5 nC

Test circuit:

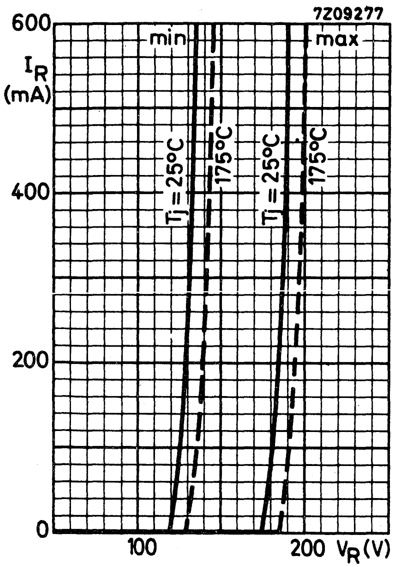


Reverse pulse: Rise time t_r = 15 ns

Pulse duration t_p = 35 μs

Frequency f = 25 kHz

Circuit capacitance C < 30 pF (C = Oscilloscope + parasitical capacitance)



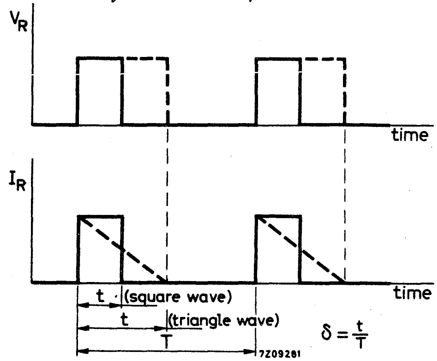
Reverse voltages higher than the V_R ratings are allowed, provided

a. the transient energy ≤ 5 mWs at $T_j = 25\,^oC$

b. $T \geq 50$ ms: $\delta \leq 0.01$ (square wave pulse)

$\delta \leq 0.02$ (triangle wave pulse)

With increasing temperature, the maximum allowable transient energy must be decreased by 0.015 mWs/°C.



EXAMPLE for calculating the maximum allowable drive current and the maximum turn off time in a practical circuit (see fig. 1)

1. Maximum allowable drive current

For the circuit shown it can be calculated with $E = \frac{1}{2} LI^2$

$$I_{drive\ max.} = \sqrt{\frac{5 \times 10^{-3}}{\frac{1}{2} \times 0.6}} = 130 \text{ mA}$$

2. Maximum turn off time

Immediately after opening switch S the reverse current of the diode is $I_R = I_{drive}$

The turn off time $t_{off} = \frac{E}{\frac{1}{2} \times I_R \times V_{(BR)R}}$. It will be maximum for devices with minmum breakdown voltage if the maximum drive current is applied.

$$\text{Hence } t_{off\ max.} = \frac{5 \times 10^{-3}}{\frac{1}{2} \times 130 \times 10^{-3} \times 120} = 0.6 \text{ ms}$$

$$\text{For } I_{drive} = 100 \text{ mA: } t_{off\ max} = \frac{\frac{1}{2} \times 0.6 \times 10^{-2}}{\frac{1}{2} \times 100 \times 10^{-3} \times 120} = 0.5 \text{ ms}$$

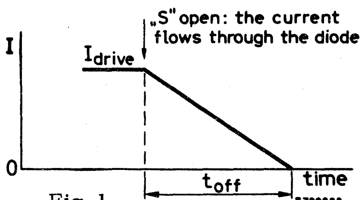


Fig. 1

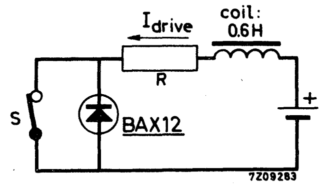
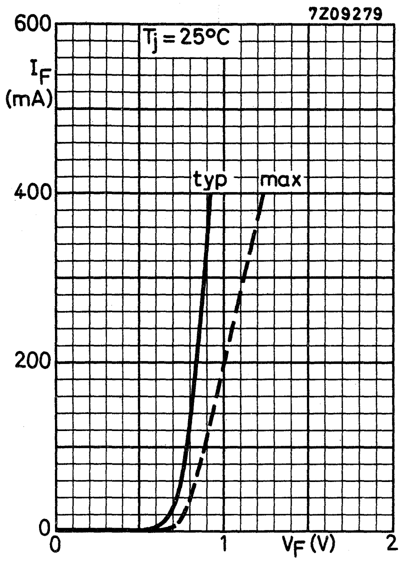
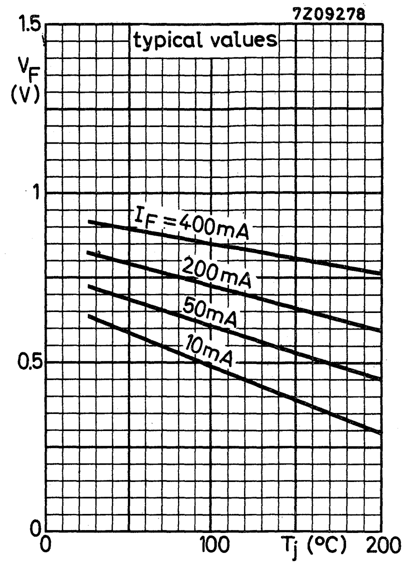
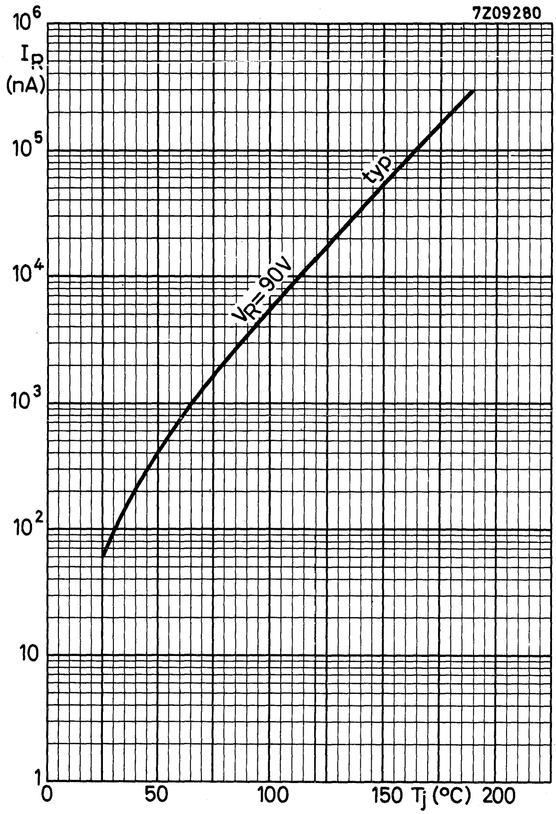


Fig. 2


7Z09279
$T_j = 25°C$
I_F (mA)
600
400
200
0
typ
max
0
1
V_F (V)
2


7Z09278
typical values
V_F (V)
1.5
1
0.5
0
I_F = 400mA
200mA
50mA
10mA
0
100
T_j (°C)
200


7Z09280
10^6
I_R
(nA)
10^5
10^4
10^3
10^2
10
1
0
50
100
150
T_j (°C)
200
typ.
V_R=90V

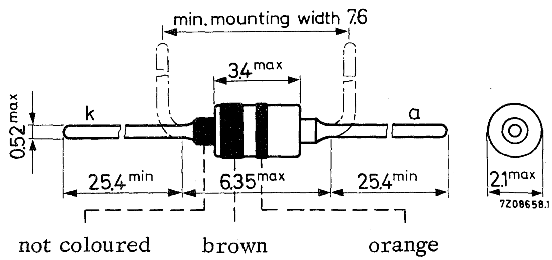
SILICON OXIDE PASSIVATED DIODE

Whiskerless diode in a molybdenum hardglass subminiature envelope. The BAX13 is primarily intended for fast logic applications.

QUICK REFERENCE DATA				
Continuous reverse voltage	V_R	max.	50	V
Repetitive peak reverse voltage	V_{RRM}	max.	50	V
Repetitive peak forward current	I_{FRM}	max.	150	mA
Thermal resistance from junction to ambient	$R_{th\ j\text{-}a}$	=	0.60	°C/mW
Forward voltage at I_F = 20 mA	V_F	<	1.0	V
Reverse recovery time when switched from I_F = 10 mA to V_R = 6 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	<	45	pC

MECHANICAL DATA

Dimensions in mm



RATINGS (Limiting values) [1])

Voltages

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

Currents

Average rectified forward current (averaged over any 20 ms period)	I_{FAV}	max.	75	mA [2])
Forward current (d.c.)	I_F	max.	75	mA
Repetitive peak forward current	I_{FRM}	max.	150	mA
Non repetitive peak forward current t = 1 μs	I_{FSM}	max.	2000	mA
t = 1 s	I_{FSM}	max.	500	mA

Temperatures

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

THERMAL RESISTANCE

From junction to ambient in free air	$R_{th\ j\text{-}a}$	=	0.60	°C/mW

CHARACTERISTICS T_j = 25 °C unless otherwise specified

Forward voltage

I_F = 2 mA	V_F	<	0.7	V
I_F = 10 mA; T_j = 100 °C	V_F	<	0.8	V
I_F = 20 mA	V_F	<	1.0	V [3])
I_F = 75 mA	V_F	<	1.53	V [3])

Reverse current

V_R = 10 V	I_R	<	25	nA
→ V_R = 10 V; T_j = 150 °C	I_R	<	10	μA
V_R = 25 V	I_R	<	50	nA
→ V_R = 50 V	I_R	<	200	nA
→ V_R = 50 V; T_j = 150 °C	I_R	<	25	μA

Diode capacitance (see also page 7)

V_R = 0; f = 1 MHz	C_d	<	3	pF

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

[2]) For sinusoidal operation see page 5.
For pulse operation see page 6.

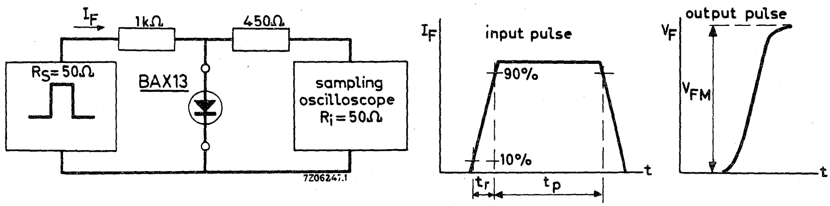
[3]) Measured under pulsed conditions to prevent excessive dissipation.

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

Forward recovery voltage (see also page 7)

At t_r > 20 ns, V_{FM} will not exceed V_F corresponding to I_F = 1 to 75 mA

Test circuit:



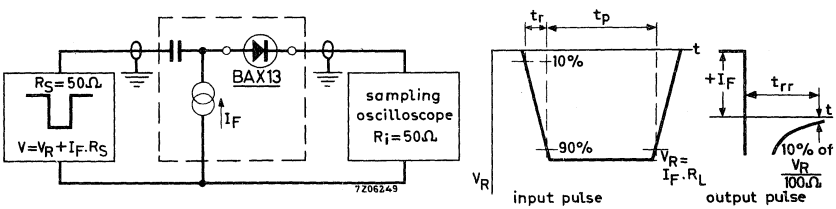
Current pulse: Rise time	t_r = 20 ns	Oscilloscope:		
Pulse duration	t_p = 120 ns	Rise time	t_r = 0.35 ns	
Duty cycle	δ = 0.01			

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

Reverse recovery time when switched from

I_F = 10 mA to V_R ; R_L = 100 Ω (see also page 8)
measured at I_R = 1 mA; switched to V_R = 1 V t_{rr} < 6 ns
V_R = 6 V t_{rr} < 4 ns

Test circuit:



Reverse pulse: Rise time	t_r = 0.6 ns	Oscilloscope:		
Pulse duration	t_p = 100 ns	Rise time	t_r = 0.35 ns	
Duty cycle	δ = 0.05			

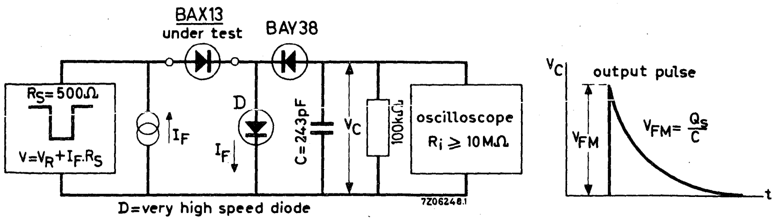
Circuit capacitance C ≤ 1 pF (C = Oscilloscope + parasitical capacitance)

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

Recovered charge when switched from

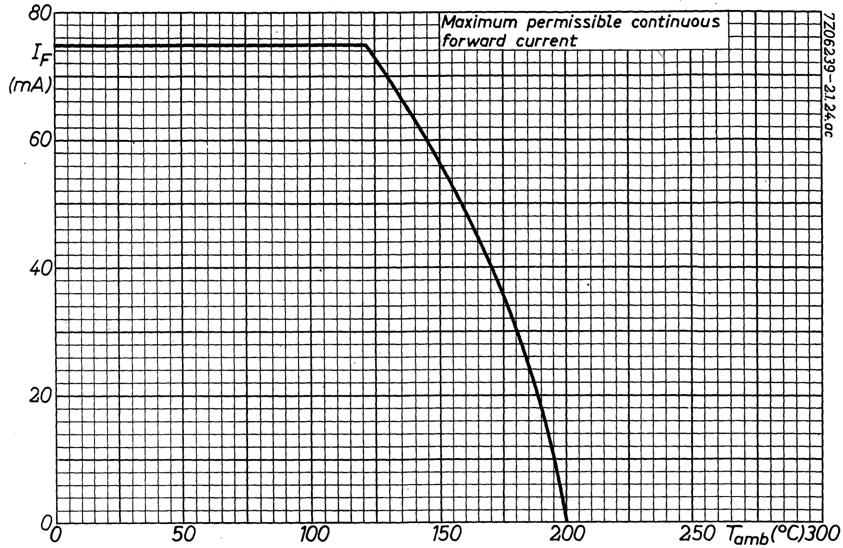
I_F = 10 mA to V_R = 5 V; R_L = 500 Ω | Q_s < 45 pC

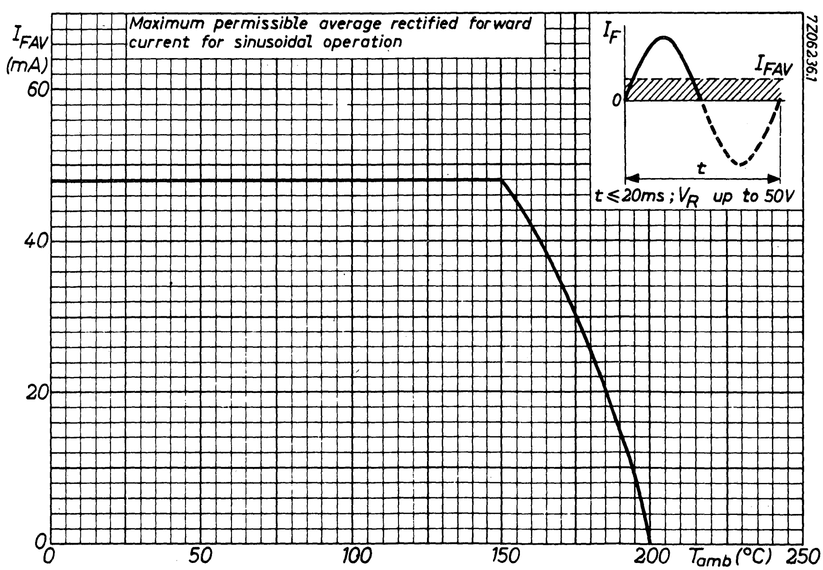
Test circuit:

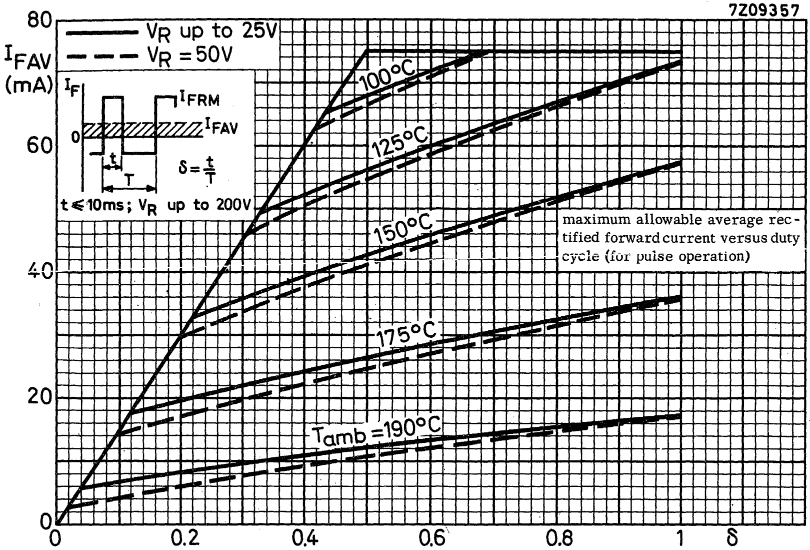


Reverse pulse:	Rise time	t_r	=	2 ns
	Pulse duration	t_p	=	400 ns
	Duty cycle	δ	=	0.02

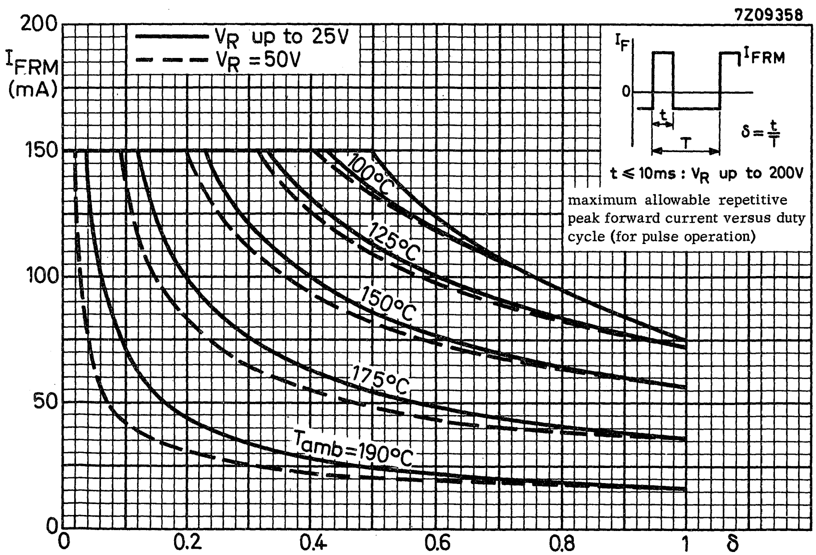
Circuit capacitance C < 7 pF (C = Oscilloscope + parasitical capacitance)


Maximum permissible continuous forward current
80
I_F
(mA)
60
40
20
0
0
50
100
150
200
250
T_{amb} (°C)
300
7Z06239-2.1.24.ac

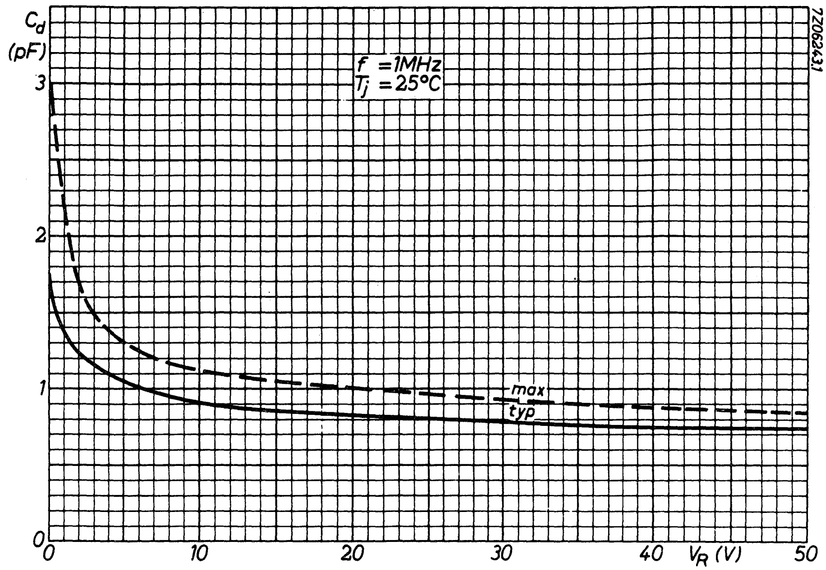

Maximum permissible average rectified forward current for sinusoidal operation
I_{FAV}
(mA)
60
40
20
0
0
50
100
150
200
T_{amb} (°C)
250
I_F
I_{FAV}
0
t
t ≤ 20ms ; V_R up to 50V
7Z06236.1

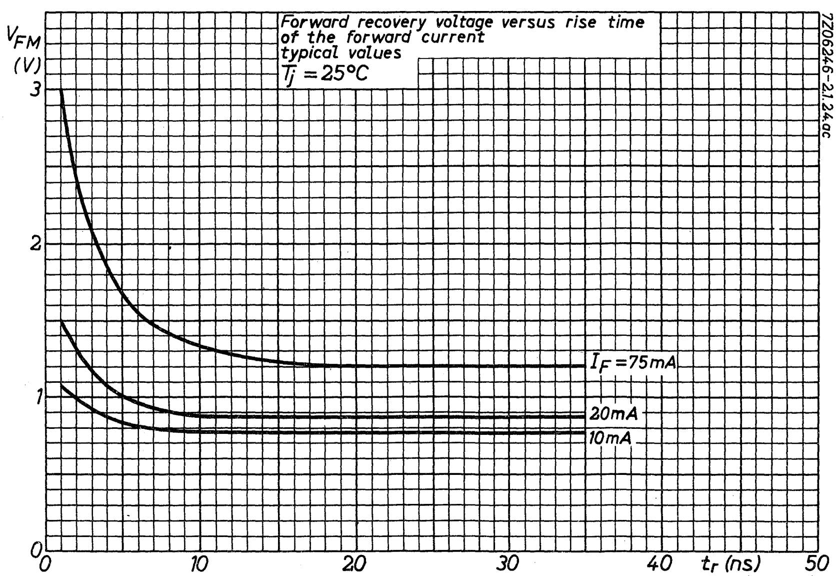


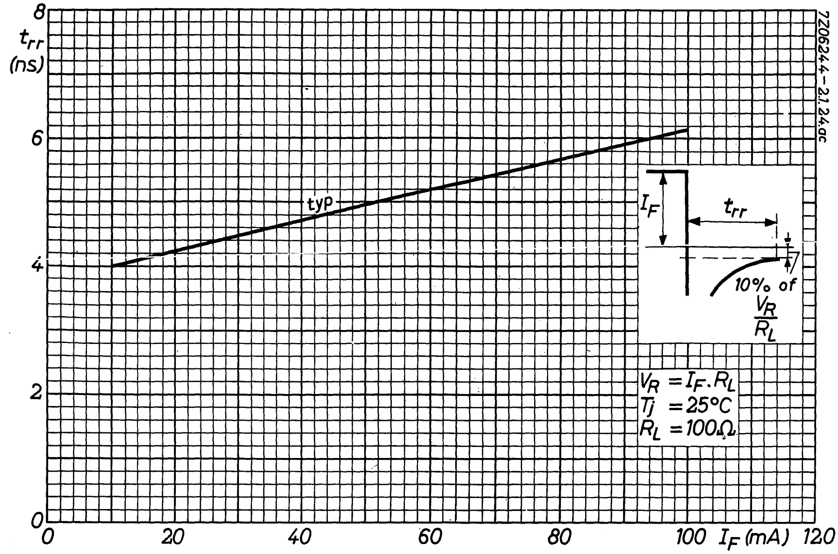
maximum allowable average rectified forward current versus duty cycle (for pulse operation)

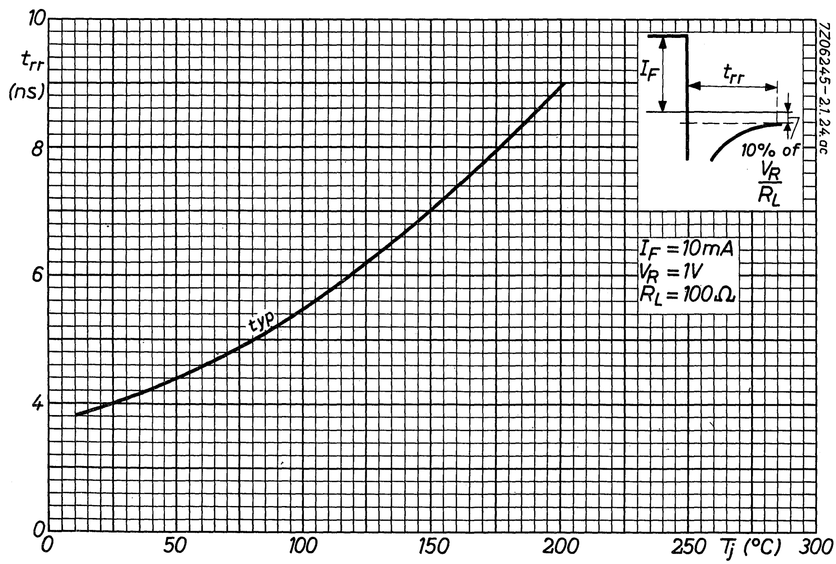


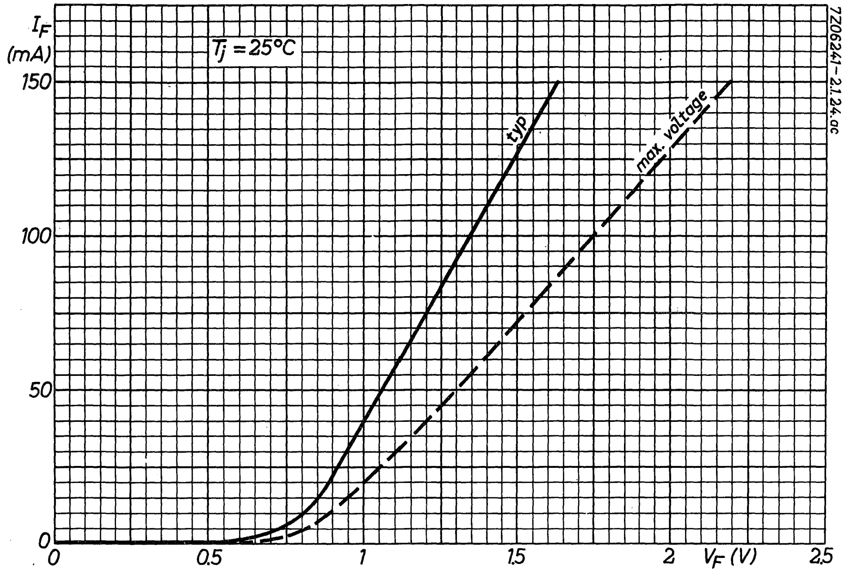
maximum allowable repetitive peak forward current versus duty cycle (for pulse operation)

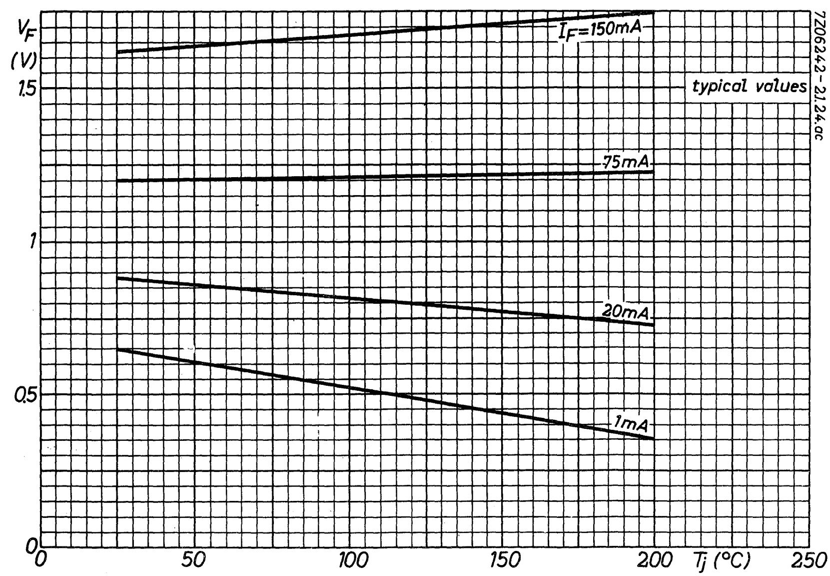

C_d (pF)
f = 1MHz
T_j = 25°C
max
typ
V_R (V)
0
10
20
30
40
50
1
2
3
7Z06243.1

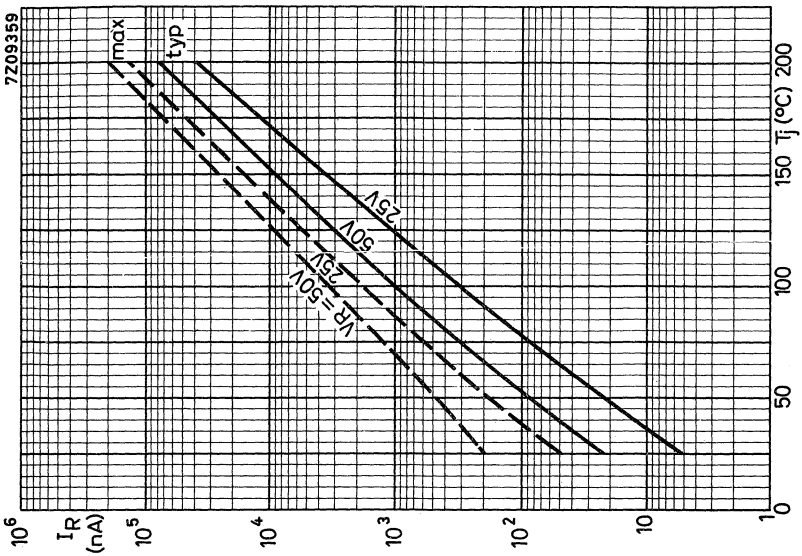

Forward recovery voltage versus rise time of the forward current
typical values
T_j = 25°C
V_{FM} (V)
I_F = 75mA
20mA
10mA
t_r (ns)
0
10
20
30
40
50
1
2
3
7Z06246-2.1.24.ac

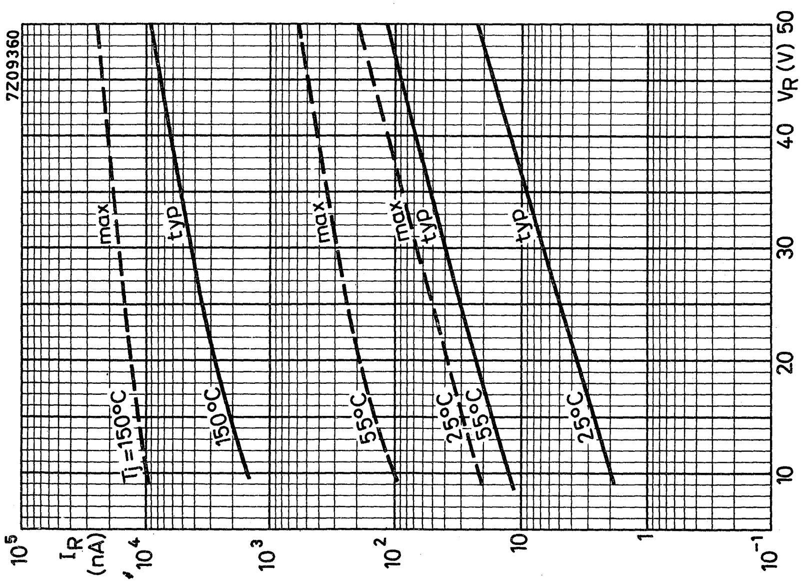

7Z06244-2.1.24.ac
t_{rr} (ns)
typ
I_F
t_{rr}
10% of $\frac{V_R}{R_L}$
$V_R = I_F . R_L$
$T_j = 25°C$
$R_L = 100\Omega$
I_F (mA)


7Z06245-2.1.24.ac
t_{rr} (ns)
typ
I_F
t_{rr}
10% of $\frac{V_R}{R_L}$
$I_F = 10mA$
$V_R = 1V$
$R_L = 100\Omega$
T_j (°C)


I_F
(mA)
150
100
50
0
$T_j = 25°C$
typ
max. voltage
0
0.5
1
1.5
2
V_F (V)
2.5
7Z06241-2.1.24.ac


V_F
(V)
1.5
1
0.5
0
I_F=150mA
typical values
75mA
20mA
1mA
0
50
100
150
200
T_j (°C)
250
7Z06242-2.1.24.ac


7Z09359
max
typ
25V
50V
25V
V_R = 50V
I_R (nA)
10^6
10^5
10^4
10^3
10^2
10
1
0
50
100
150
200
T_j (°C)


7Z09360
max
typ
T_j = 150°C
150°C
max
55°C
max
typ
25°C
55°C
typ
25°C
I_R (nA)
10^5
10^4
10^3
10^2
10
1
10^{-1}
10
20
30
40
50
V_R (V)

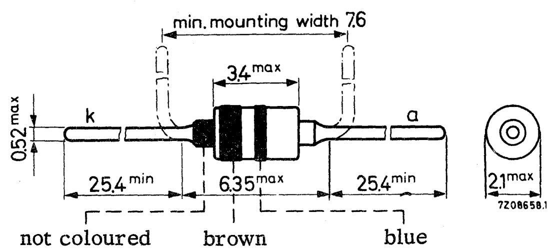
SILICON OXIDE PASSIVATED DIODE

Whiskerless diffused diode in a molybdenum hard glass subminature envelope. The BAX16 is primarily intended for general purpose industrial applications.

QUICK REFERENCE DATA				
Continuous reverse voltage	V_R	max.	150	V
Repetitive peak forward current	I_{FRM}	max.	300	mA
Thermal resistance from junction to ambient	$R_{th\ j\text{-}a}$	=	0.40	°C/mW
Forward voltage at I_F = 100 mA	V_F	<	1.3	V
Reverse recovery time when switched from I_F = 30 mA to V_R = 3 V; R_L = 100 Ω measured at I_R = 1 mA	t_{rr}	<	120	ns
Recovered charge when switched from I_F = 10 mA to V_R = 5 V R_L = 500 Ω	Q_s	<	0.7	nC

MECHANICAL DATA

Dimensions in mm



RATINGS (Limiting values) 1)

Voltages				
Continuous reverse voltage	V_R	max.	150	V 2)
Repetitive peak reverse voltage	V_{RRM}	max.	150	V
Currents				
Average rectified forward current (averaged over any 20 ms period)	I_{FAV}	max.	200	mA 3)
Forward current (d.c.)	I_F	max.	200	mA
Repetitive peak forward current	I_{FRM}	max.	300	mA
Non repetitive peak forward current t = 1 μs	I_{FSM}	max.	2500	mA
t = 1 s	I_{FSM}	max.	500	mA
Temperatures				
Storage temperature	T_{stg}		-65 to +200	°C
Junction temperature	T_j	max.	200	°C

THERMAL RESISTANCE

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

CHARACTERISTICS T_j = 25 °C unless otherwise specified

Forward voltage				
I_F = 1 mA	V_F	<	0.65	V
I_F = 10 mA; T_j = 100 °C	V_F	<	0.85	V
→ I_F = 100 mA	V_F	<	1.3	V 4)
→ I_F = 200 mA	V_F	<	1.5	V 4)
→ I_F = 200 mA; T_j = 175 °C	V_F	<	1.4	V 4)
Reverse current				
V_R = 50 V	I_R	<	25	nA
V_R = 50 V; T_j = 150 °C	I_R	<	25	μA
V_R = 150 V	I_R	<	100	nA
V_R = 150 V; T_j = 150 °C	I_R	<	100	μA
Diode capacitance (see also page 5)				
V_R = 0; f = 1 MHz	C_d	<	10	pF

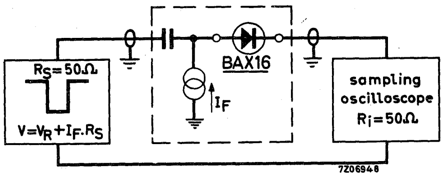
1) Limiting values according to the Absolute Maximum System as defined in IEC publication 134.
2) Measured at zero lifetime at I_R = 10 μA : V_R > 165 V.
3) For sinusoidal operation see page 5. For pulse operation see page 4.
4) Measured under pulsed conditions to prevent excessive dissipation.

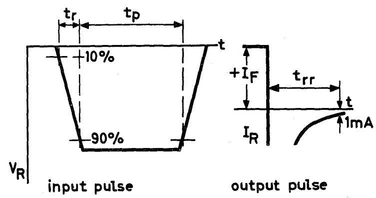
CHARACTERISTICS (continued) T_j = 25 °C unless otherwise specified

Reverse recovery time when switched from

I_F = 30 mA to V_R = 3 V; R_L = 100 Ω (see also page 6) measured at I_R = 1 mA — t_{rr} typ. 70 ns; < 120 ns

Test circuit:





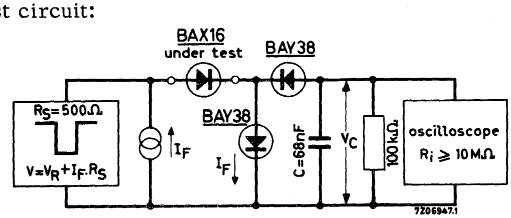
Reverse pulse:	Rise time	t_r = 0.6 ns	Oscilloscope:	
	Pulse duration	t_p = 100 ns	Rise time	t_r = 0.35 ns
	Duty cycle	δ = 0.05		

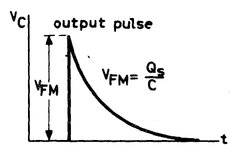
Circuit capacitance C ≤ 1 pF (C = Oscilloscope + parasitical capacitance)

Recovered charge when switched from

I_F = 10 mA to V_R = 5 V; R_L = 500 Ω — Q_s < 0.7 nC

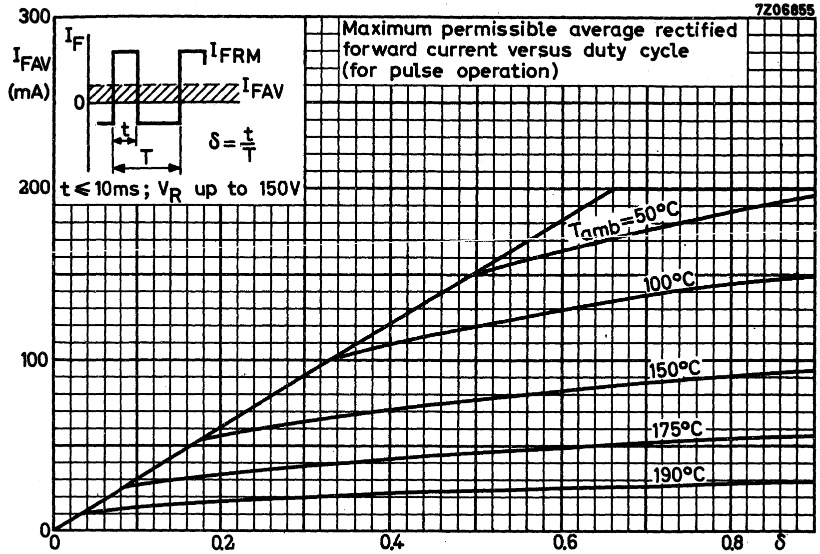
Test circuit:

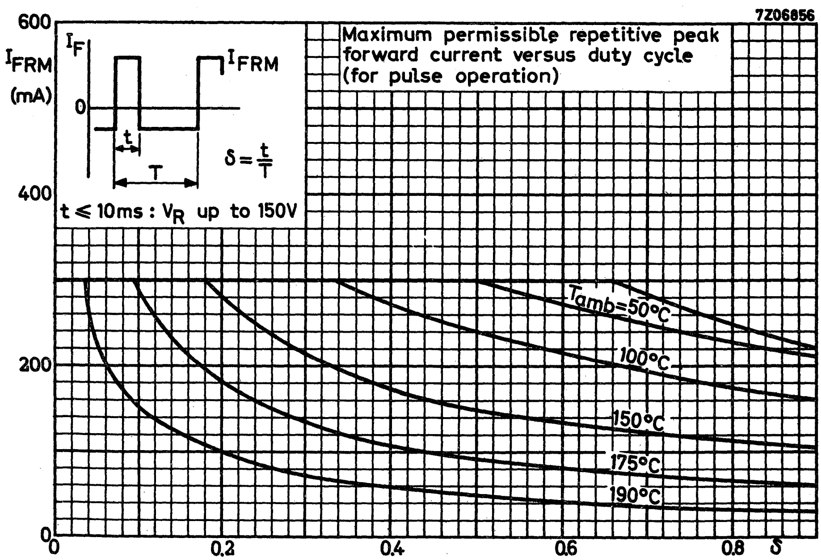


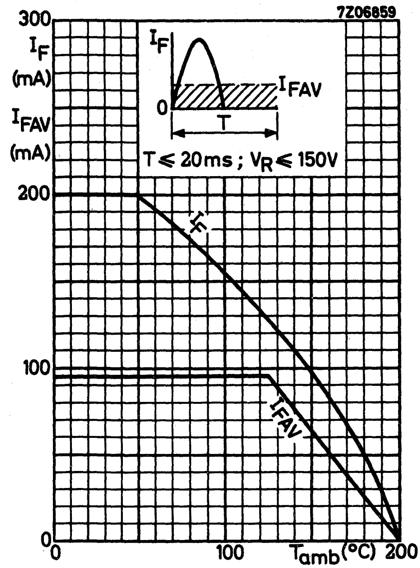


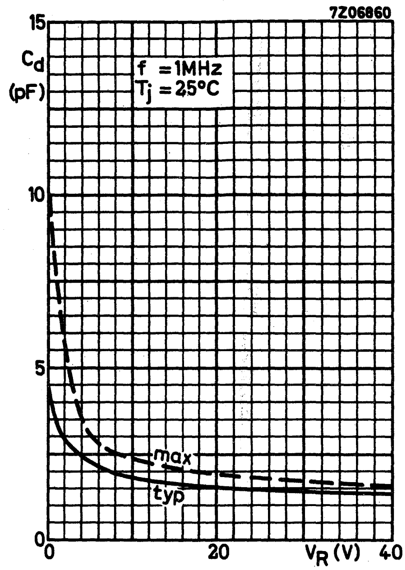
Reverse pulse:	Rise time	t_r = 15 ns
	Pulse duration	t_p = 35 μs
	Frequency	f = 25 kHz

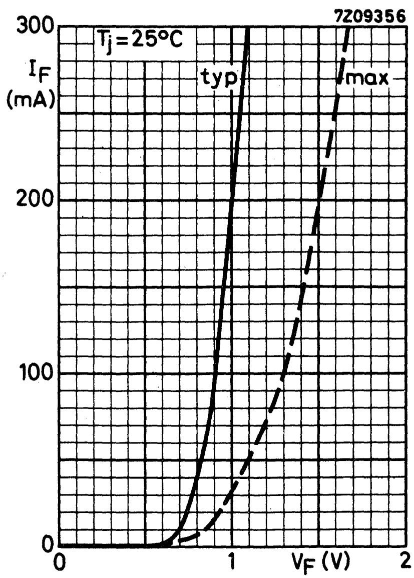
Circuit capacitance C < 30 pF (C = Oscilloscope + parasitical capacitance)

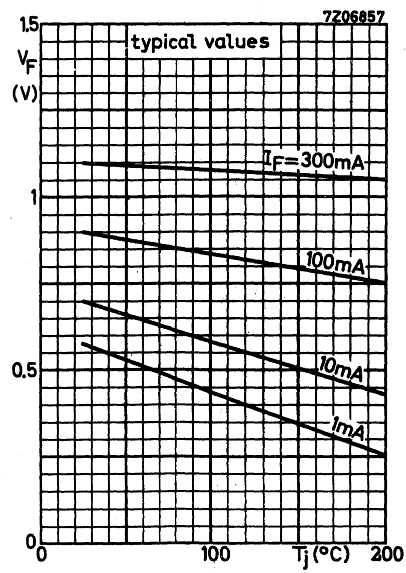

7Z06855
Maximum permissible average rectified forward current versus duty cycle (for pulse operation)
I_{FAV} (mA)
I_F
I_{FRM}
I_{FAV}
0
t
T
$\delta = \frac{t}{T}$
t ≤ 10ms; V_R up to 150V
300
200
100
0
0
0.2
0.4
0.6
0.8
δ
T_{amb}=50°C
100°C
150°C
175°C
190°C

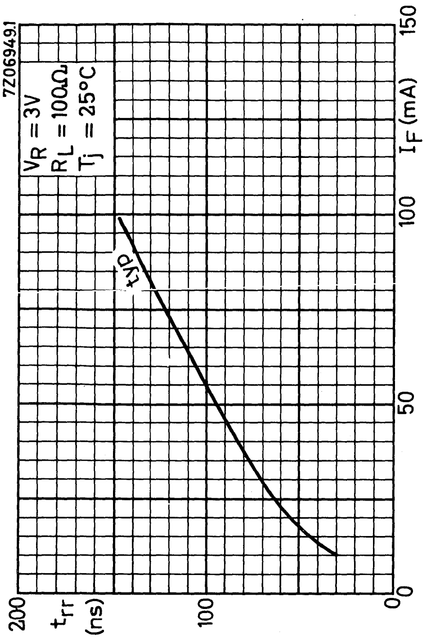

7Z06856
Maximum permissible repetitive peak forward current versus duty cycle (for pulse operation)
I_{FRM} (mA)
I_F
I_{FRM}
0
t
T
$\delta = \frac{t}{T}$
t ≤ 10ms : V_R up to 150V
600
400
200
0
0
0.2
0.4
0.6
0.8
δ
T_{amb}=50°C
100°C
150°C
175°C
190°C

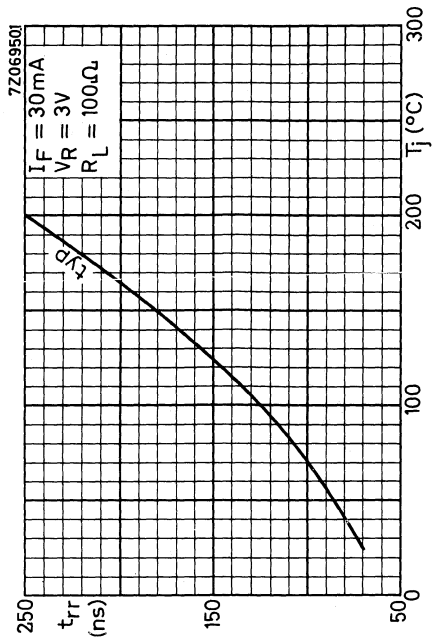

7Z06859
300
I_F (mA)
I_{FAV} (mA)
I_F
I_{FAV}
0
T
T ≤ 20 ms ; V_R ≤ 150 V
200
I_F
100
I_{FAV}
0
0
100
T_{amb} (°C)
200

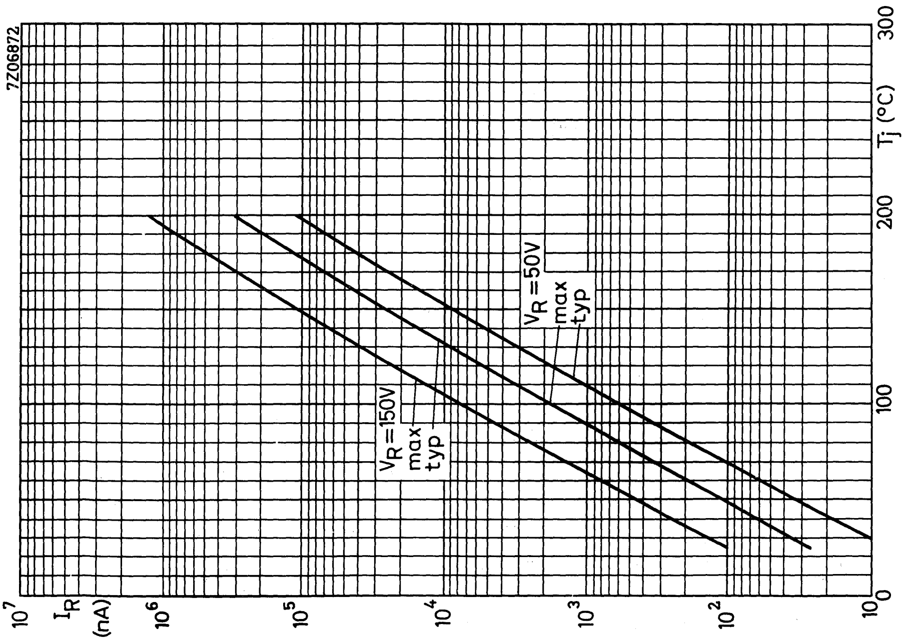

7Z06860
15
C_d (pF)
f = 1 MHz
T_j = 25 °C
10
5
max
typ
0
0
20
V_R (V)
40


7Z09356
300
I_F (mA)
T_j = 25 °C
typ
max
200
100
0
0
1
V_F (V)
2


7Z06857
1.5
V_F (V)
typical values
I_F = 300 mA
1
100 mA
0.5
10 mA
1 mA
0
0
100
T_j (°C)
200


7Z06949.1
VR = 3V
RL = 100Ω
Tj = 25°C
typ
trr (ns)
IF (mA)
200
100
0
0
50
100
150


7Z06950.1
IF = 30mA
VR = 3V
RL = 100Ω
typ
trr (ns)
Tj (°C)
250
150
50
0
100
200
300


7Z06872
IR (nA)
VR = 150V
max
typ
VR = 50V
max
typ
Tj (°C)
10^7
10^6
10^5
10^4
10^3
10^2
10
0
100
200
300

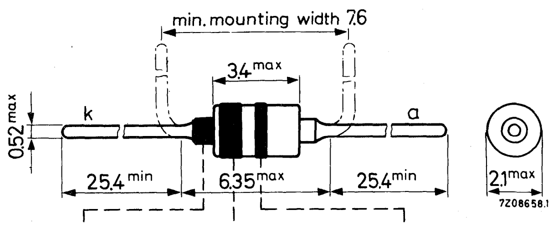
SILICON OXIDE PASSIVATED DIODE

Whiskerless diffused diode in a molybdenum hard glass subminiature envelope. The BAX17 is primarily intended for general purpose industrial applications.

QUICK REFERENCE DATA				
Continuous reverse voltage	V_R	max.	200	V
Repetitive peak forward current	I_{FRM}	max.	300	mA
Thermal resistance from junction to ambient	$R_{th\ j\text{-}a}$	=	0.40	°C/mW
Forward voltage at I_F = 200 mA	V_F	<	1.2	V
Reverse recovery time when switched from I_F = 30 mA to V_R = 3 V; R_L = 100 Ω measured at I_R = 1 mA	t_{rr}	<	120	ns
Recovered charge when switched from I_F = 10 mA to V_R = 5 V R_L = 500 Ω	Q_s	<	0.7	nC

MECHANICAL DATA

Dimensions in mm



RATINGS (Limiting values) [1])

Voltages

Continuous reverse voltage	V_R	max.	200	V [2])
Repetitive peak reverse voltage	V_{RRM}	max.	200	V

Currents

Average rectified forward current (averaged over any 20 ms period)	I_{FAV}	max.	200	mA [3])
Forward current (d.c.)	I_F	max.	200	mA
Repetitive peak forward current	I_{FRM}	max.	300	mA
Non repetitive peak forward current t = 1 μs	I_{FSM}	max.	2500	mA
t = 1 s	I_{FSM}	max.	500	mA

Temperatures

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

THERMAL RESISTANCE

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

CHARACTERISTICS T_j = 25 °C unless otherwise specified

Forward voltage

I_F = 1 mA	V_F	<	0.65	V
I_F = 10 mA; T_j = 100 °C	V_F	<	0.75	V
I_F = 100 mA	V_F	<	1.1	V [4])
I_F = 200 mA	V_F	<	1.2	V [4])
I_F = 200 mA; T_j = 175 °C	V_F	<	1.2	V [4])

Reverse current

V_R = 50 V	I_R	<	25	nA
V_R = 50 V; T_j = 150 °C	I_R	<	25	μA
V_R = 150 V	I_R	<	100	nA
V_R = 200 V; T_j = 150 °C	I_R	<	100	μA

Diode capacitance (see also page 5)

V_R = 0; f = 1 MHz	C_d	<	10	pF

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

2) Measured at zero lifetime at I_R = 10 μA : $V_R \geq$ 220 V.

3) For sinusoidal operation see page 5. For pulse operation see page 4.

4) Measured under pulsed conditions to prevent excessive dissipation.

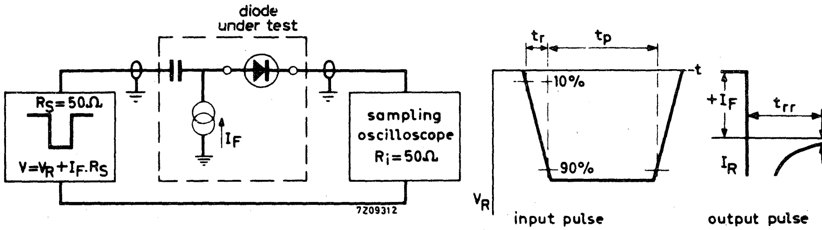
CHARACTERISTICS (continued) $T_j = 25\ ^{o}C$ unless otherwise specified

Reverse recovery time when switched from

$I_F = 30$ mA to $V_R = 3$ V; $R_L = 100\ \Omega$
(see also page 6) measured at $I_R = 1$ mA

t_{rr}	typ.	70	ns
	<	120	ns

Test circuit:



Reverse pulse: Rise time t_r = 0.6 ns

Pulse duration t_p = 100 ns

Duty cycle δ = 0.05

Oscilloscope:

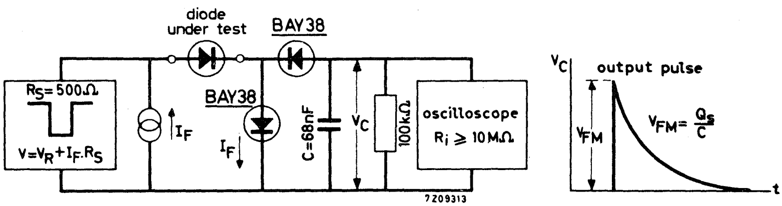
Rise time t_r = 0.35 ns

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

Recovered charge when switched from

$I_F = 10$ mA to $V_R = 5$ V; $R_L = 500\ \Omega$ Q_s < 0.7 nC

Test circuit.

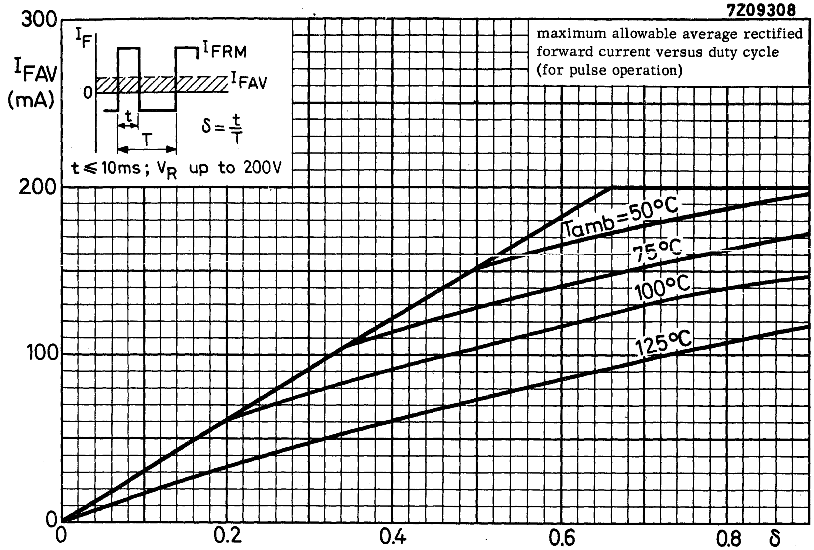


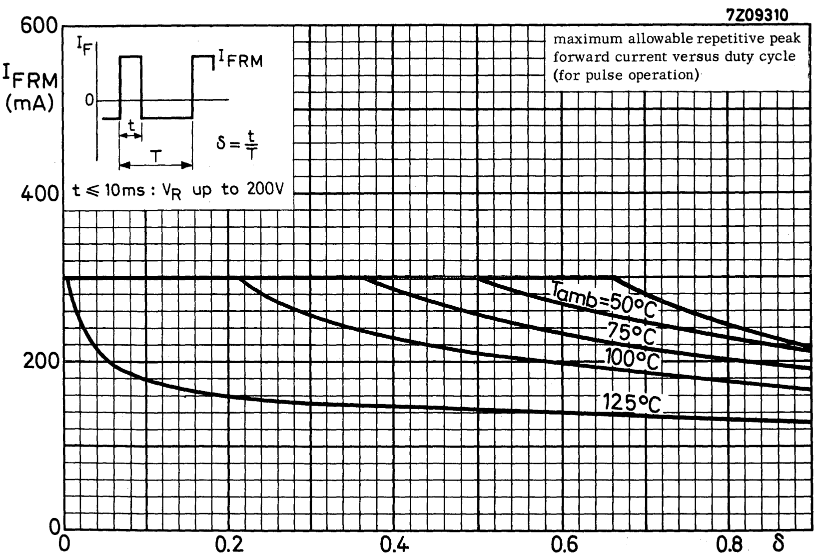
Reverse pulse: Rise time t_r = 15 ns

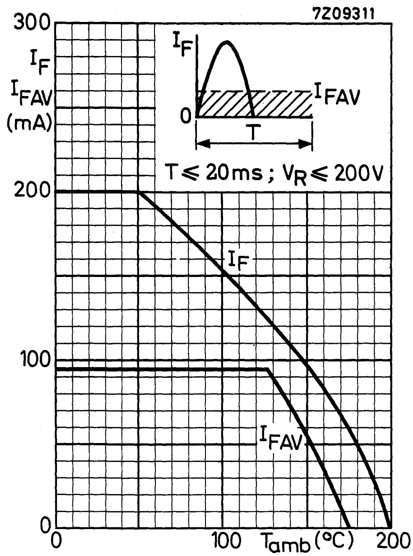
Pulse duration t_p = 35 μs

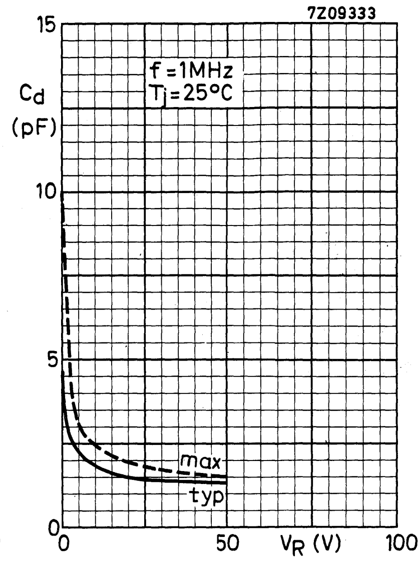
Frequency f = 25 kHz

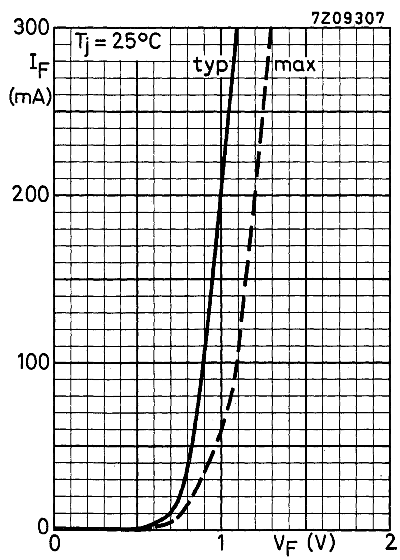
Circuit capacitance C < 30 pF (C = Oscilloscope + parasitical capacitance)

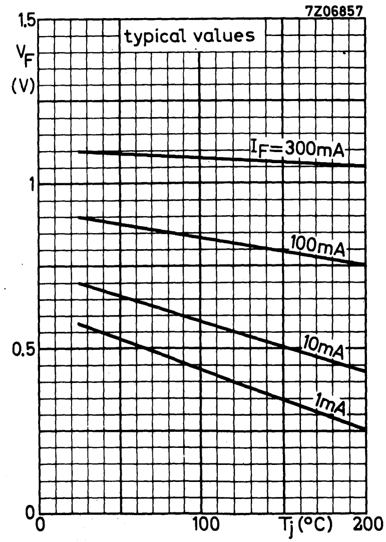

7Z09308
maximum allowable average rectified forward current versus duty cycle (for pulse operation)
I_{FAV} (mA)
I_F
I_{FRM}
I_{FAV}
$\delta = \frac{t}{T}$
t ≤ 10ms ; V_R up to 200V
Tamb=50°C
75°C
100°C
125°C
δ

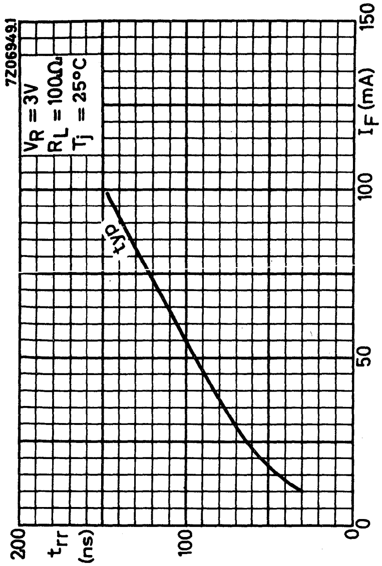

7Z09310
maximum allowable repetitive peak forward current versus duty cycle (for pulse operation)
I_{FRM} (mA)
I_F
I_{FRM}
$\delta = \frac{t}{T}$
t ≤ 10ms : V_R up to 200V
Tamb=50°C
75°C
100°C
125°C
δ

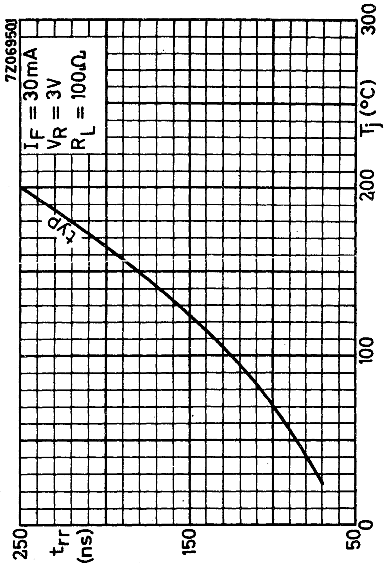

7Z09311
300
I_F
I_{FAV}
(mA)
200
100
0
I_F
I_{FAV}
0
T
T ≤ 20 ms ; V_R ≤ 200 V
I_F
I_{FAV}
0
100
T_{amb} (°C)
200

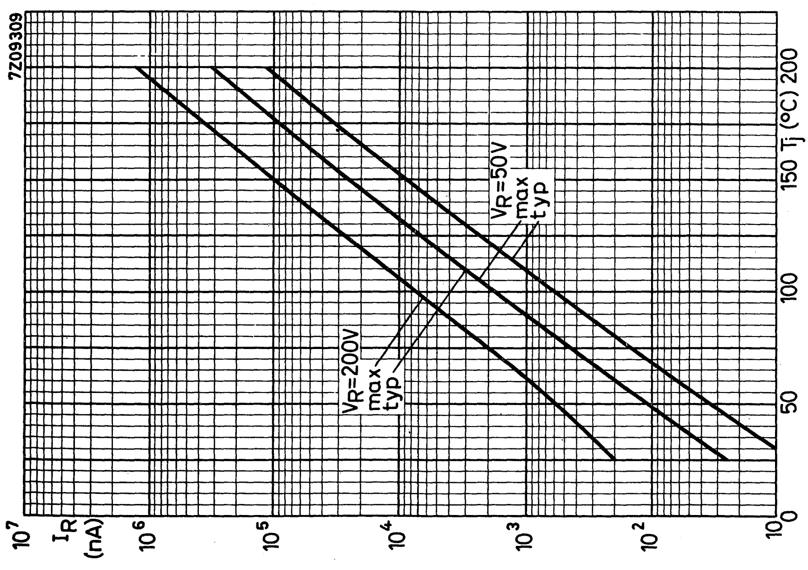

7Z09333
15
Cd
(pF)
10
5
0
f = 1MHz
T_j = 25 °C
max
typ
0
50
V_R (V)
100


7Z09307
300
I_F
(mA)
200
100
0
T_j = 25 °C
typ
max
0
1
V_F (V)
2


7Z06857
1.5
V_F
(V)
1
0.5
0
typical values
I_F=300mA
100mA
10mA
1mA
0
100
T_j (°C)
200


7Z06949.1
VR = 3V
RL = 100Ω
Tj = 25°C
typ
IF (mA)
0
50
100
150
trr (ns)
200
100
0


7Z06950.1
IF = 30mA
VR = 3V
RL = 100Ω
typ
Tj (°C)
0
100
200
300
trr (ns)
250
150
50


7Z09309
VR=200V
max
typ
VR=50V
max
typ
Tj (°C)
0
50
100
150
200
IR (nA)
10^7
10^6
10^5
10^4
10^3
10^2
10

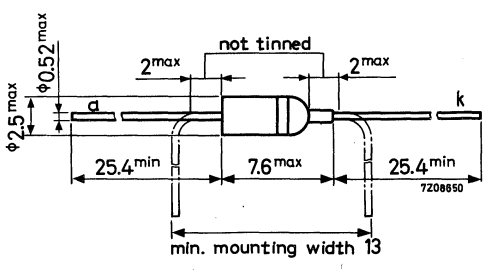
SILICON PLANAR EPITAXIAL DIODE

Silicon planar epitaxial diode in subminiature all glass DO-7 envelope.
The BAX78 is a diode, for very high speed high current applications, primarily intended for core gating in very fast memories.

QUICK REFERENCE DATA				
Continuous reverse voltage	V_R	max.	55	V
Repetitive peak forward current	I_{FRM}	max.	600	mA
Thermal resistance from junction to ambient in free air	$R_{th\ j\text{-}a}$	=	0.4	$^oC/mW$
Forward voltage at I_F = 500 mA	V_F	<	1.25	V
Reverse recovery time when switched from I_F = 400 mA to V_R = 40 V; R_L = 1 kΩ measured at I_R = 4 mA	t_{rr}	<	20	ns

MECHANICAL DATA Dimensions in mm

DO-7



The coloured band indicates the cathode side

RATINGS (Limiting values) [1]

Voltages

Continuous reverse voltage	V_R	max.	55	V [2]
Repetitive peak reverse voltage	V_{RRM}	max.	55	V

Currents

Average rectified forward current (averaged over any 20 ms period)	I_{FAV}	max.	300	mA
Forward current (d.c.)	I_F	max.	300	mA
Repetitive peak forward current	I_{FRM}	max.	600	mA
Non repetitive peak forward current $t = 1\ \mu s$	I_{FSM}	max.	2000	mA
$t = 1$ s	I_{FSM}	max.	600	mA

Temperatures

Storage temperature	T_{stg}		−65 to +200	°C
Junction temperature	T_j	max.	190	°C

THERMAL RESISTANCE

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

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

Forward voltage

$I_F = 1$ mA	V_F	0.55 to 0.65	V
$I_F = 10$ mA	V_F	0.65 to 0.75	V
$I_F = 100$ mA	V_F	0.85 to 0.95	V
$I_F = 500$ mA	V_F	1.00 to 1.25	V

Reverse current

$V_R = 55$ V	I_R	< 100	nA
$V_R = 55$ V; $T_j = 150\ ^oC$	I_R	< 100	μA

Diode capacitance

$V_R = 0$; $f = 1$ MHz	C_d	< 2	pF

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

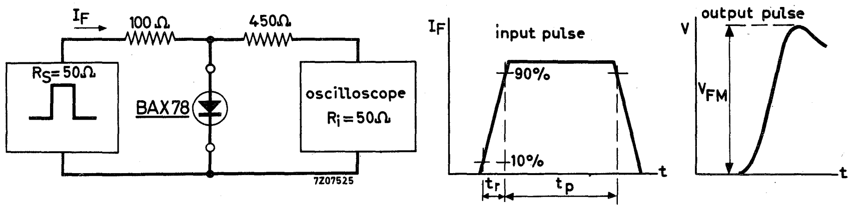
2) Measured at zero lifetime: $I_R = 5\ \mu A$; $V_R > 65$ V.

CHARACTERISTICS (continued) $T_j = 25\ ^oC$ unless otherwise specified

Forward recovery voltage

I_F = 400 mA; t_r = 30 ns	V_{FM}	<	2.0	V
I_F = 400 mA; t_r = 100 ns	V_{FM}	<	1.5	V

Test circuit:



Current pulse: Rise time t_r = 30 ns, resp. 100 ns

Pulse duration t_p = 300 ns

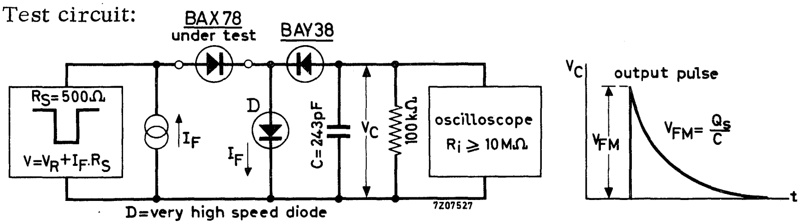
Duty cycle δ = 0.01

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

Recovered charge when switched from

I_F = 10 mA to V_R = 5 V; R_L = 500 Ω Q_s < 35 pC

Test circuit:



Reverse pulse: Rise time t_r = 2 ns

Pulse duration t_p = 400 ns

Duty cycle δ = 0.01

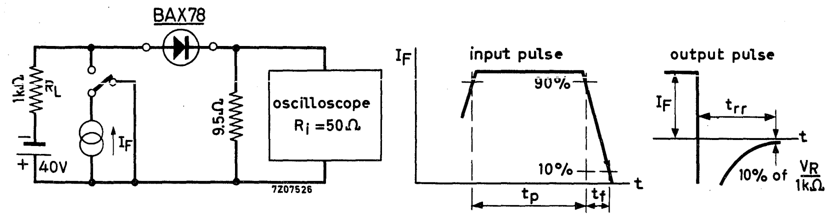
Circuit capacitance C < 7 pF (C = Oscilloscope + parasitical capacitance)

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

Reverse recovery time when switched from

I_F = 400 mA to V_R = 40 V; R_L = 1 kΩ
measured at I_R = 4 mA t_{rr} < 20 ns

Test circuit:

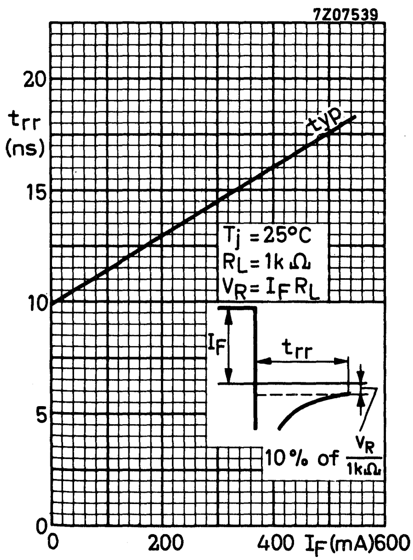


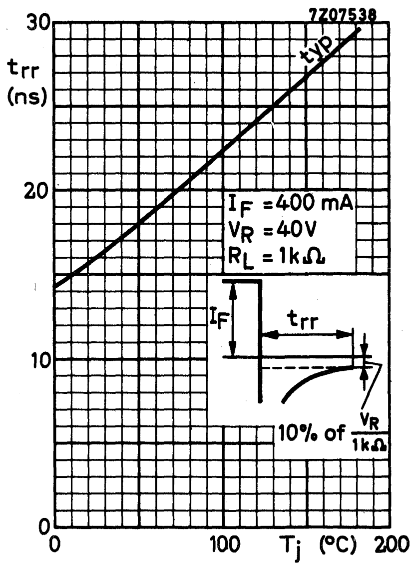
Current pulse: Fall time t_f = 5 ns

Pulse duration t_p = 1.5 μs

Duty cycle δ = 0.01

Circuit capacitance C ≤ 10 pF (C = Oscilloscope + parasitical capacitance)





SILICON PLANAR DIODES

These types have been superseded by the BAX16

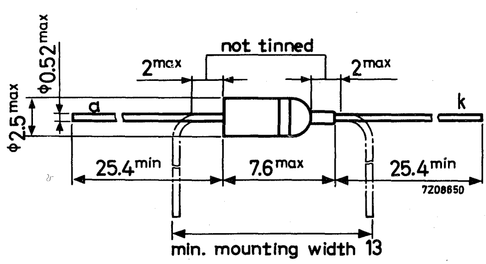
SILICON PLANAR EPITAXIAL DIODE

Silicon planar epitaxial diode in subminiature all glass DO-7 envelope.
The BAY38 is a very high speed general purpose diode, primarily intended for logic applications.

QUICK REFERENCE DATA				
Continuous reverse voltage	V_R	max.	50	V
Repetitive peak forward current	I_{FRM}	max.	225	mA
Thermal resistance from junction to ambient	$R_{th\ j-a}$	=	0.4	°C/mW
Forward voltage at I_F = 50 mA	V_F	<	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}	<	4	ns

MECHANICAL DATA Dimensions in mm

DO-7



The coloured band indicates the cathode side

RATINGS (Limiting values) [1])

Voltage

Continuous reverse voltage	V_R	max.	50	V

Currents

Average rectified forward current (averaged over any 20 ms period)	I_{FAV}	max.	115	mA
Forward current (d.c.)	I_F	max.	115	mA
Repetitive peak forward current	I_{FRM}	max.	225	mA
Non repetitive peak forward current $t = 1\ \mu s$	I_{FSM}	max.	2000	mA
$t = 1$ s	I_{FSM}	max.	500	mA

Temperatures

Storage temperature	T_{stg}	-65 to +200		^oC
Junction temperature	T_j	max.	190	^oC

THERMAL RESISTANCE

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

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

Forward voltage

$I_F = 50$ mA	V_F	<	1	V

Reverse current

$V_R = 50$ V;	I_R	<	50	nA
$V_R = 50$ V; $T_j = 150\ ^oC$	I_R	<	50	μA

Diode capacitance

$V_R = 0$; $f = 1$ MHz	C_d	<	2	pF

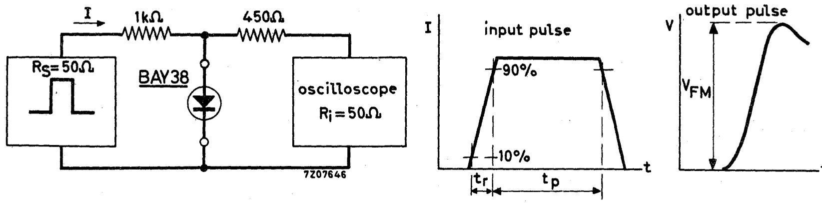
[1]) Limiting values according to the Absolute Maximum System as defined in IEC publication 134.

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

Forward recovery voltage

I_F = 10 mA; t_r = 20 ns	V_{FM}	<	1.75	V
I_F = 100 mA; t_r = 50 ns	V_{FM}	<	1.75	V

Test circuit:



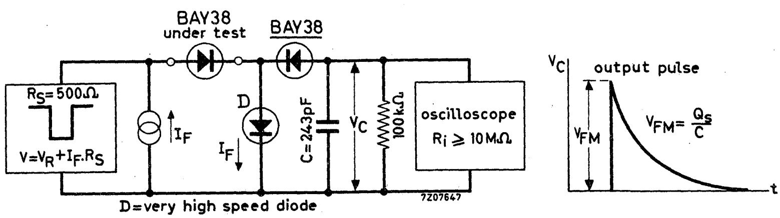
Current pulse:	Rise time (10 mA)	t_r	=	20 ns
	Rise time (100 mA)	t_r	=	50 ns
	Pulse duration	t_p	=	120 ns
	Duty cycle	δ	=	0.01

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

Recovered charge when switched from

I_F = 10 mA to V_R = 5 V; R_L = 500 Ω Q_s < 35 pC

Test circuit:



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

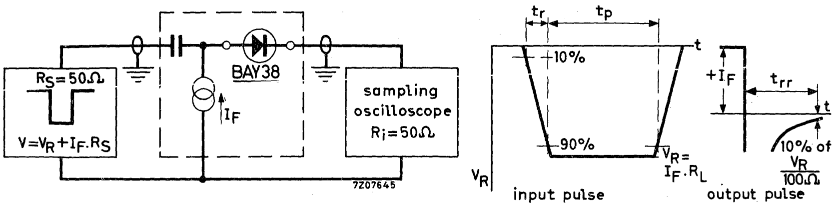
Circuit capacitance C < 7 pF (C = Oscilloscope + parasitical capacitance)

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

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} < 4 ns

Test circuit:

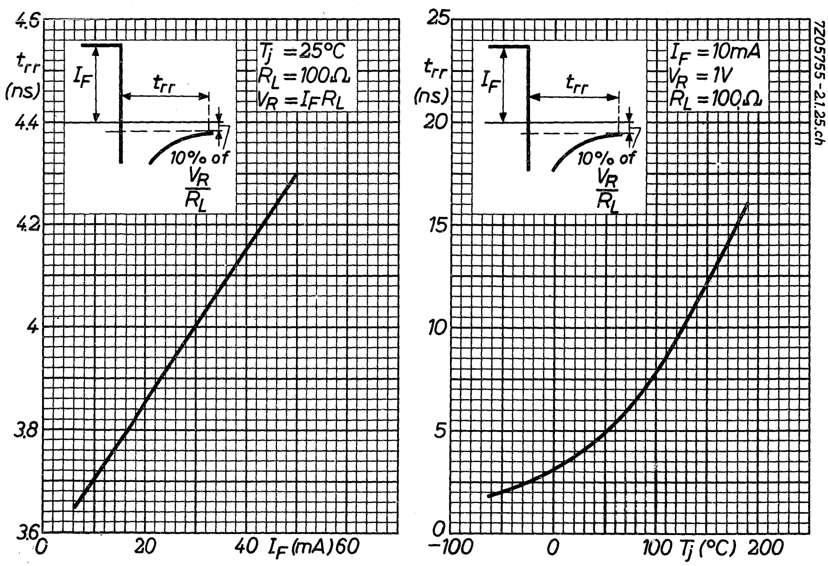


Reverse pulse: Rise time t_r = 0.6 ns

Pulse duration t_p = 100 ns

Duty cycle δ = 0.05

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



SILICON PLANAR EPITAXIAL DIODE

This type has been superseded by the BAX78

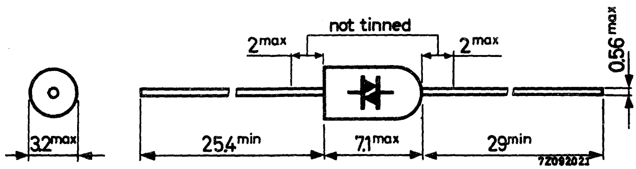
SILICON BI-DIRECTIONAL TRIGGER DEVICE

Silicon bi-directional trigger device in a DO-14 plastic envelope intended for use in triac and thyristor trigger circuits.

QUICK REFERENCE DATA			
Breakover voltage	$V_{(BO)}$	28 to 36	V
Breakback voltage at I_F = 10 mA	ΔV	> 6	V
Repetitive peak current (t ≤ 20 μs)	I_{FRM}	max. 2	A

MECHANICAL DATA Dimensions in mm

DO-14



The envelope fulfils the accelerated damp heat test described in I.E.C. publication 68.2 (test D, severity IV, 6 cycles).

RATINGS (Limiting values) [1]

Total power dissipation	P_{tot}	max.	150	mW
Repetitive peak current (t ≤ 20 μs)	I_{FRM}	max.	2	A
Storage temperature	T_{stg}		−65 to +100	°C
Junction temperature	T_j	max.	100	°C

THERMAL RESISTANCE

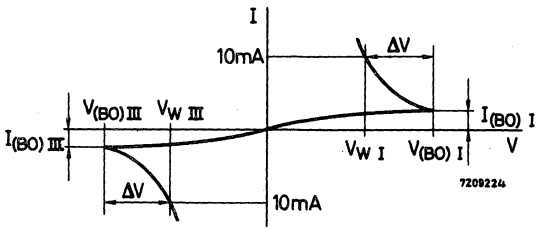
From junction to ambient in free air	$R_{th\ j\text{-}a}$	=	0.2	°C/mW

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

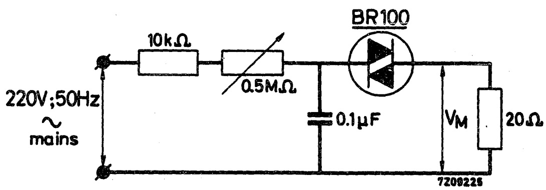
CHARACTERISTICS

T_j = 25 °C unless otherwise specified

Breakover voltage at $\frac{dV}{dt}$ = 10 V/ms	$V_{(BO)}$		28 to 36	V
Breakover voltage symmetry	$\lvert V_{(BO)I} - V_{(BO)III} \rvert$	<	3	V
Breakback voltage I_F = 10 mA; $\frac{dV}{dt}$ = 10 V/ms	$\Delta V = V_{(BO)} - V_W$	>	6	V
Breakover current	$I_{(BO)}$	<	100	μA



Test circuit for peak output voltage



V_M measured across a resistor of 20 Ω (instead of a thyristor) will be > 5 V.

GERMANIUM GOLD BONDED DIODE

Germanium gold bonded diode in single ended all glass construction.

RATINGS (Limiting values) [1])

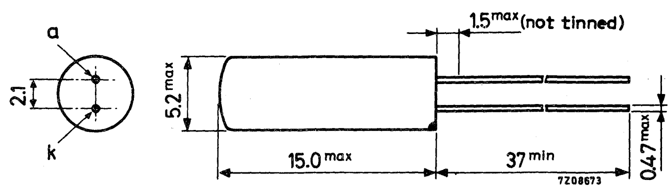
		T_{amb} = 25 °C		T_{amb} = 75 °C	
Continuous reverse voltage	V_R	max.	100	50	V
Repetitive peak reverse voltage	V_{RRM}	max.	100	50	V
Average forward current	I_{FAV}	max.	125	50	mA
Repetitive peak forward current	I_{FRM}	max.	350	350	mA
Non rep. peak forw. current; $t < 1$ s	I_{FSM}	max.	500		mA
$t < 1$ μs; $\delta = 0.01$	I_{FSM}	max.	1000		mA
Operating ambient temperature	T_{amb}	max.		75	°C
Storage temperature	T_{stg}			−55 to +90	°C

CHARACTERISTICS

		T_{amb} = 25 °C	T_{amb} = 60 °C	
Forward voltage				
I_F = 0.1 mA	V_F	0.10 to 0.25	0.03 to 0.20	V
I_F = 10 mA	V_F	0.25 to 0.55	0.20 to 0.50	V
I_F = 200 mA	V_F	0.50 to 1.0	0.48 to 1.0	V
I_F = 300 mA	V_F	0.55 to 1.25	0.55 to 1.25	V
Reverse current				
V_R = 1.5 V	I_R	0.2 to 5	5 to 26	μA
V_R = 10 V	I_R	0.3 to 6	5.5 to 30	μA
V_R = 50 V	I_R	0.45 to 9	7.5 to 60	μA
V_R = 100 V	I_R	0.7 to 30	10 to 120	μA

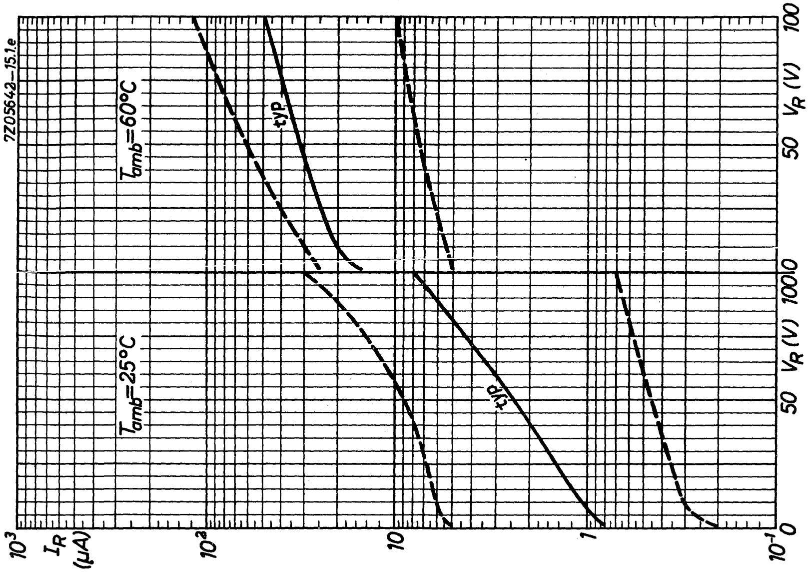
MECHANICAL DATA

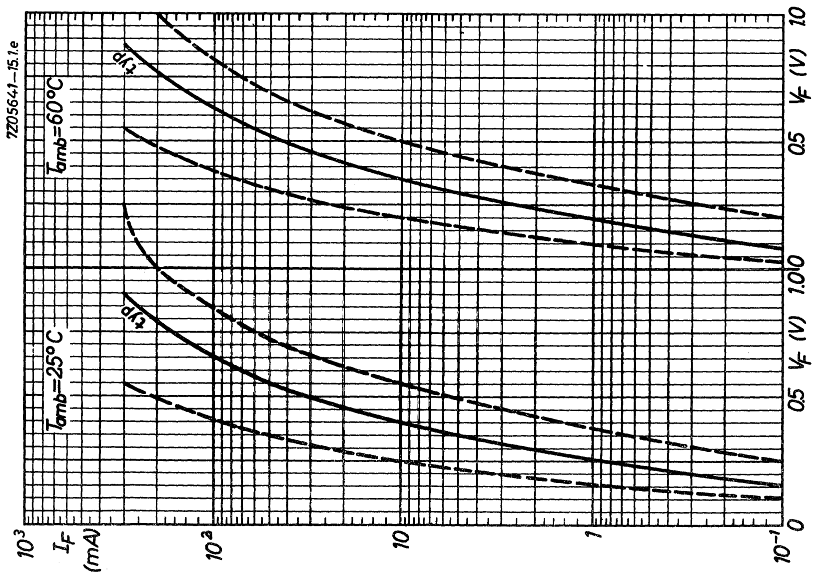
Dimensions in mm



The red dot indicates the cathode side

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


7Z05642–15.1.e
T_{amb}=60°C
T_{amb}=25°C
typ
typ
I_R (μA)
10^3
10^2
10
1
10^{-1}
0
50
V_R (V)
100
0
50
V_R (V)
100


7Z05641–15.1.e
T_{amb}=60°C
T_{amb}=25°C
typ
typ
I_F (mA)
10^3
10^2
10
1
10^{-1}
0
0.5
V_F (V)
1.0
0
0.5
V_F (V)
1.0

GERMANIUM GOLD BONDED DIODE

Germanium gold bonded diode in single ended all glass construction intended for switching applications.

RATINGS (Limiting values)

Continuous reverse voltage	V_R	max.	25	V
Repetitive peak reverse voltage	V_{RRM}	max.	25	V
Non repetitive peak reverse voltage ($t \leq 1$ s)	V_{RSM}	max.	30	V
Average forward current; T_{amb} = 25 °C	I_{FAV}	max.	80	mA
T_{amb} = 75 °C	I_{FAV}	max.	40	mA
Forward current (d.c.) T_{amb} = 25 °C	I_F	max.	140	mA
T_{amb} = 75 °C	I_F	max.	50	mA
Repetitive peak forward current	I_{FRM}	max.	250	mA
Non repetitive peak forward current ($t < 1$ s)	I_{FSM}	max.	400	mA
Operating ambient temperature	T_{amb}	max.	75	°C
Storage temperature	T_{stg}		-55 to +75	°C

THERMAL RESISTANCE

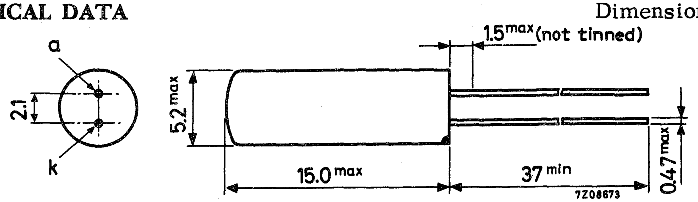
From junction to ambient $R_{th\ j\text{-}a}$ = 0.4 °C/mW

CHARACTERISTICS

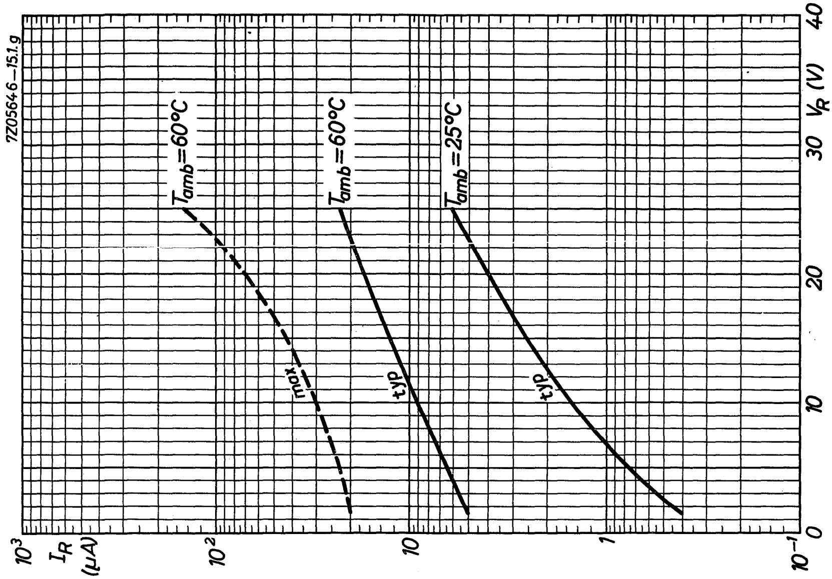
			T_{amb} = 25 °C	T_{amb} = 60 °C	
Forward voltage	I_F = 0.1 mA	V_F	0.12 to 0.26	0.06 to 0.19	V
	I_F = 10 mA	V_F	0.30 to 0.48	0.14 to 0.28	V
	I_F = 50 mA	V_F	0.40 to 0.78	0.37 to 0.75	V
	I_F = 250 mA	V_F	< 1.65		V
Reverse current	V_R = 1.5 V	I_R	typ. 0.4	< 20	μA
	V_R = 10 V	I_R	typ. 1.5	< 30	μA
	V_R = 25 V	I_R	typ. 6.0	< 150	μA

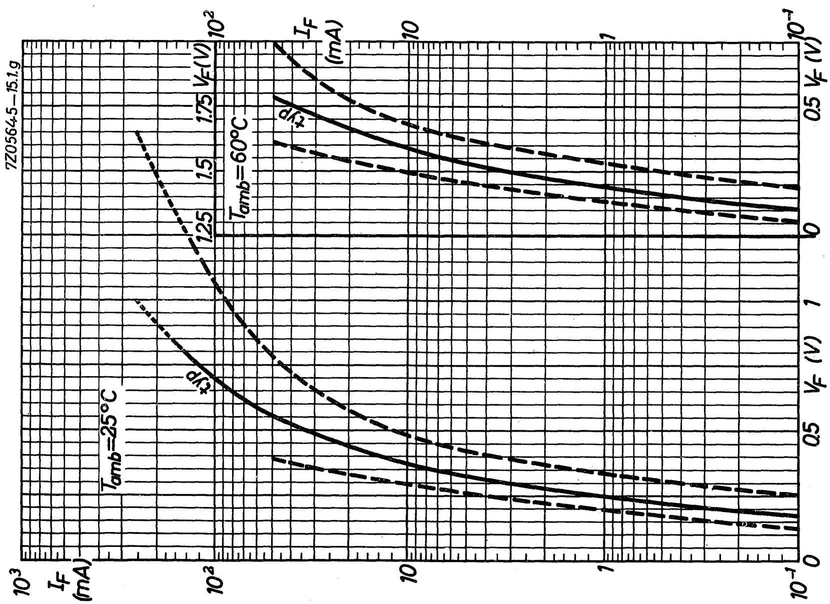
Reverse recovery current when switched
from I_F = 5 mA to V_R = 5 V; T_{amb} = 25 °C
measured at t_{rr} = 0.5 μs — I_R typ. 140 μA; < 250 μA

MECHANICAL DATA Dimensions in mm



The red dot indicates the cathode side


7Z05646-15.1.g
T_{amb}=60°C
T_{amb}=60°C
T_{amb}=25°C
max
typ
typ
I_R (μA)
10^3
10^2
10
1
10^{-1}
0
10
20
30
40
V_R (V)


7Z05645-15.1.g
T_{amb}=25°C
typ
T_{amb}=60°C
typ
I_F (mA)
10^3
10^2
10
1
10^{-1}
0
0.5
1
1.25
1.5
1.75
V_F (V)

GERMANIUM GOLD BONDED DIODE

Germanium gold bonded diode in single ended all glass construction intended for switching applications.

RATINGS (Limiting values)

Continuous reverse voltage	V_R	max.	25	V
Repetitive peak reverse voltage	V_{RRM}	max.	25	V
Non repetitive peak reverse voltage ($t \leq 1$ s)	V_{RSM}	max.	40	V
Average forward current: T_{amb} = 25 °C	I_{FAV}	max.	160	mA
T_{amb} = 75 °C	I_{FAV}	max.	70	mA
Forward current (d.c.) T_{amb} = 25 °C	I_F	max.	270	mA
T_{amb} = 75 °C	I_F	max.	90	mA
Repetitive peak forward current	I_{FRM}	max.	500	mA
Non repetitive peak forward current ($t < 1$ s)	I_{FSM}	max.	800	mA
Operating ambient temperature	T_{amb}	max.	75	°C
Storage temperature	T_{stg}		−55 to +90	°C

THERMAL RESISTANCE

From junction to ambient $R_{th\ j\text{-}a}$ = 0.35 °C/mW

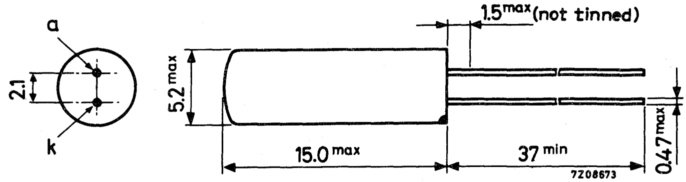
CHARACTERISTICS

			T_{amb} = 25 °C	T_{amb} = 60 °C	
Forward voltage	I_F = 0.1 mA	V_F	< 0.21	< 0.15	V
	I_F = 10 mA	V_F	< 0.41	< 0.35	V
	I_F = 500 mA	V_F	< 0.90		V
Reverse current	V_R = 1.5 V	I_R	< 3.5	< 20	µA
	V_R = 10 V	I_R	< 10	< 45	µA
	V_R = 25 V	I_R	< 50	< 100	µA

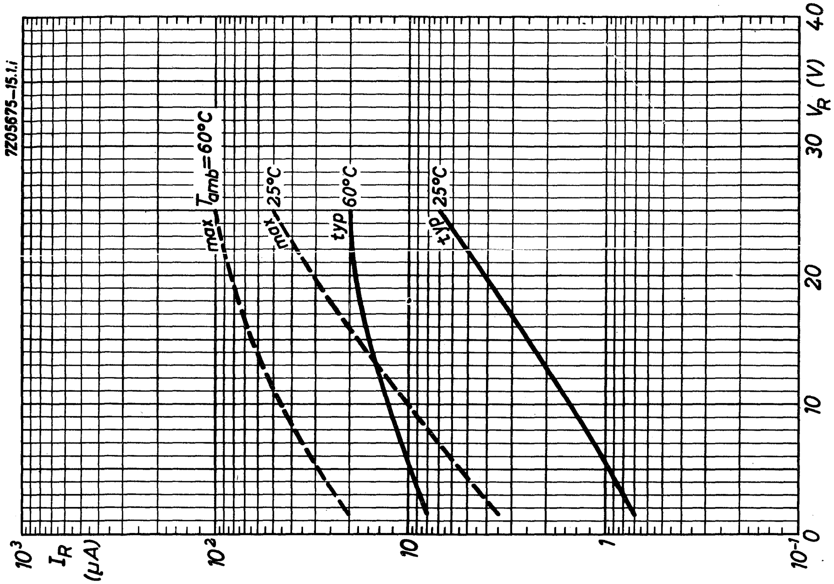
Reverse recovery current when switched from I_F = 400 mA to V_R = 10 V; T_{amb} = 25 °C measured at t_{rr} = 3.5 µs I_R < 150 µA

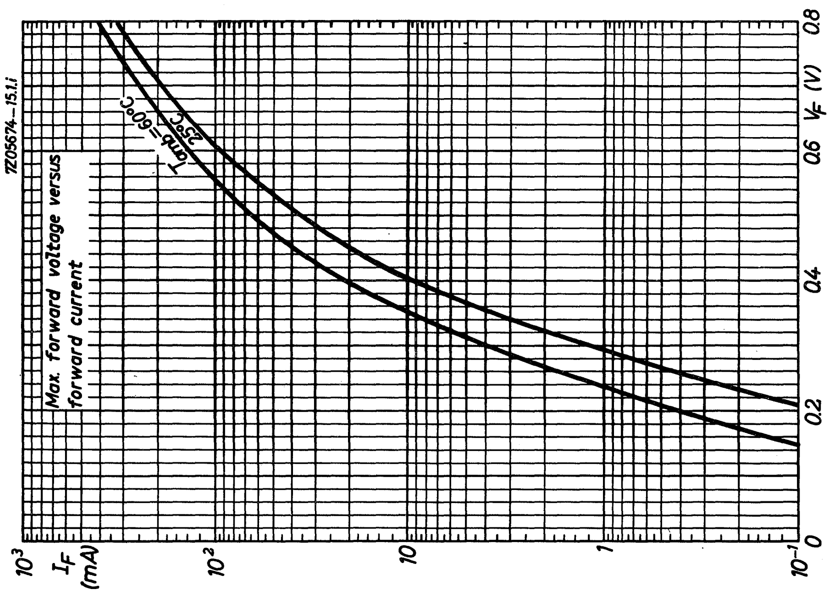
MECHANICAL DATA

Dimensions in mm



The red dot indicates the cathode side


7Z05675–15.1.i
max T_{amb}=60°C
max 25°C
typ 60°C
typ 25°C
V_R (V)
I_R (μA)
10^3
10^2
10
1
10^{-1}
0
10
20
30
40


7Z05674–15.1.i
Max. forward voltage versus forward current
T_{amb}=60°C
25°C
V_F (V)
I_F (mA)
10^3
10^2
10
1
10^{-1}
0
0.2
0.4
0.6
0.8

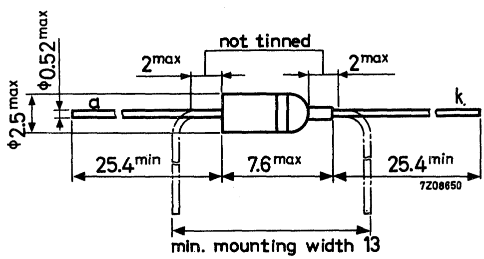
GOLD BONDED DIODE

Gold bonded germanium diode in subminiature all glass DO-7 envelope, intended for switching applications and general purposes.

QUICK REFERENCE DATA				
Continuous reverse voltage	V_R	max.	25	V
Repetitive peak reverse voltage	V_{RRM}	max.	25	V
Forward current (d.c.)	I_F	max.	110	mA
Repetitive peak forward current	I_{FRM}	max.	150	mA
Junction temperature	T_j	max.	75	°C
Forward voltage at I_F = 150 mA	V_F	<	1.1	V
Recovered charge when switched from I_F = 10 mA to V_R = 10 V	Q_s	<	600	pC

MECHANICAL DATA Dimensions in mm

DO-7



The coloured band indicates the cathode side

RATINGS (Limiting values) [1]

Voltages

Continuous reverse voltage	V_R	max.	25	V
Repetitive peak reverse voltage	V_{RRM}	max.	25	V
Non repetitive peak reverse voltage ($t < 1$ s)	V_{RSM}	max.	30	V

Currents

Forward current (d.c.)	I_F	max.	110	mA
Average rectified forward current (averaged over any 20 ms period)	I_{FAV}	max.	110	mA
Repetitive peak forward current	I_{FRM}	max.	150	mA
Non repetitive peak forward current ($t < 1$ s)	I_{FSM}	max.	200	mA

Temperatures

Storage temperature	T_{stg}		-65 to +75	^oC
Junction temperature	T_j	max.	75	^oC

THERMAL RESISTANCE

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

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

CHARACTERISTICS

Forward voltage at T_j = 25 °C

I_F = 0.1 mA	V_F < 0.20 V
I_F = 1.0 mA	V_F < 0.31 V
I_F = 10 mA	V_F < 0.45 V
I_F = 30 mA	V_F < 0.65 V
I_F = 150 mA	V_F < 1.10 V

Forward voltage at T_j = 60 °C

I_F = 0.1 mA	V_F < 0.14 V
I_F = 1.0 mA	V_F < 0.28 V
I_F = 10 mA	V_F < 0.43 V
I_F = 30 mA	V_F < 0.62 V
I_F = 150 mA	V_F < 1.10 V

Reverse current at T_j = 25 °C

V_R = 1.5 V	I_R < 3.5 μA
V_R = 10 V	I_R < 15 μA
V_R = 20 V	I_R < 50 μA
V_R = 25 V	I_R < 100 μA

Reverse current at T_j = 60 °C

V_R = 1.5 V	I_R < 20 μA
V_R = 10 V	I_R < 40 μA
V_R = 20 V	I_R < 90 μA
V_R = 25 V	I_R < 160 μA

Diode capacitance

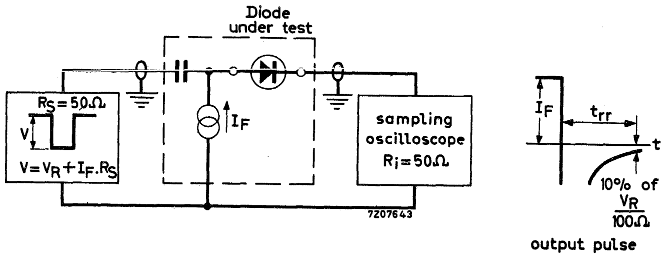
V_R = 1 V; f = 1 MHz	C_d < 3.5 pF

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

Reverse recovery time when switched
from I_F = 10 mA to V_R = 1 V; R_L = 100 Ω

Measured at I_R = 10 % of $\frac{V_R}{R_L}$ t_{rr} < 70 ns

Test circuit:

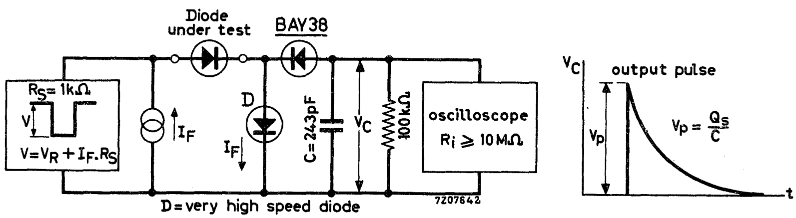


Reverse pulse:	Rise time	t_r	= 0.6	ns
	Pulse duration	t_p	= 100	ns
	Duty cycle	δ	= 0.05	

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

Recovered charge when switched
from I_F = 10 mA to V_R = 10 V; R_L = 1 kΩ Q_s < 600 pC

Test circuit:



Reverse pulse:	Rise time	t_r	= 2	ns
	Pulse duration	t_p	= 0.4	µs
	Duty cycle	δ	= 0.02	

GERMANIUM DIODE

Germanium diode in all glass construction for use in video detector circuits.

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

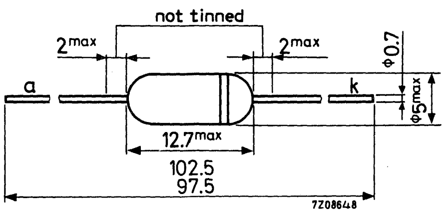
Voltages				
Continuous reverse voltage	V_R	max.	15	V
Repetitive peak reverse voltage	V_{RRM}	max.	22.5	V
Currents				
Forward current (d.c.)	I_F	max.	50	mA
Repetitive peak forward current	I_{FRM}	max.	150	mA
Non repetitive peak forward current ($t \leq 1$ s)	I_{FSM}	max.	400	mA
Temperature				
Operating ambient temperature	T_{amb}		-50 to +75	^oC

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

Forward voltage at $I_F = 0.1$ mA	V_F	0.1 to 0.25	V
Reverse current at $V_R = 1.5$ V	I_R	1 to 30	μA
Diode capacitance	C_d	typ. 1	pF

MECHANICAL DATA Dimensions in mm

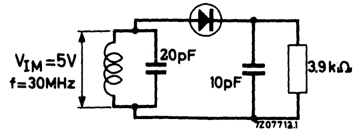
Net weight: 0.6 g



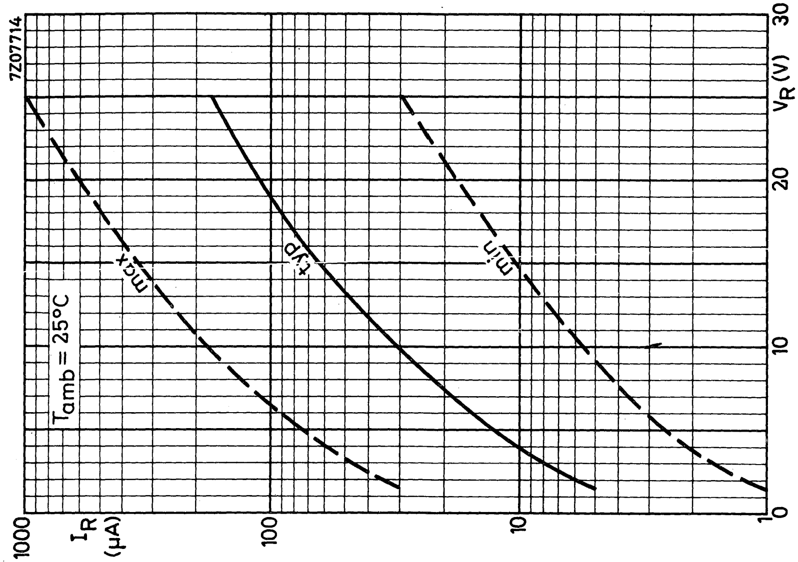
APPLICATION INFORMATION

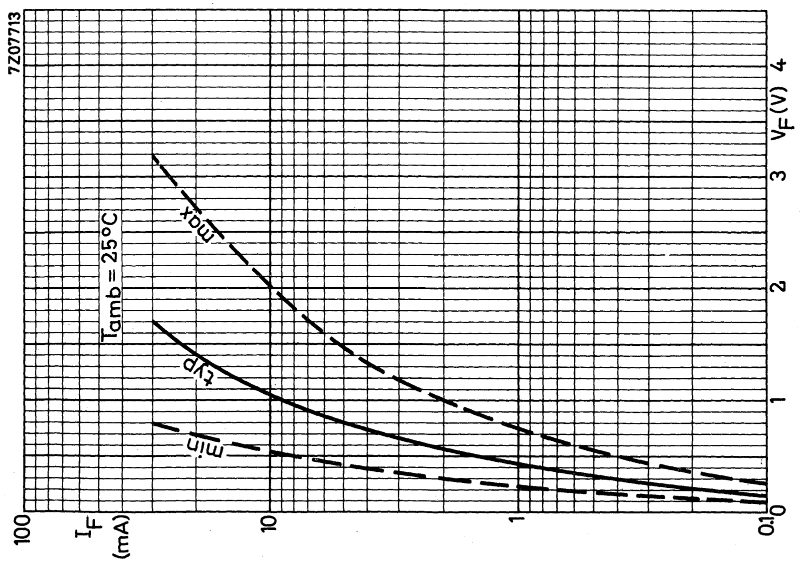
Diode in video detector circuit

Efficiency: $\eta = 62\%$
Damping resistance: 3 kΩ



FOR NEW DESIGN THE SUCCESSOR TYPE OA90 IS RECOMMENDED


7Z07714
T_{amb} = 25°C
max
typ
min
I_R (μA)
1000
100
10
1
V_R (V)
0
10
20
30


7Z07713
T_{amb} = 25°C
max
typ
min
I_F (mA)
100
10
1
0.1
V_F (V)
0
1
2
3
4

GERMANIUM DIODES

Germanium r.f. rectifier diode in all glass construction with high reverse resistance.
Type 2-OA72 consists of 2 diodes OA72 selected for operation in a ratio detector or similar circuits.

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

		T_{amb} = 25 °C	60 °C	
Reverse voltage	V_R	max. 30	30	V
Peak reverse voltage	V_{RM}	max. 45	45	V
Forward current (d.c.) at $V_{RM max.}$	I_F	max. 10	4	mA
Forward current (peak value)	I_{FM}	max. 100	100	mA
Non rep. peak forward current (t = 1 s)	I_{FSM}	max. 200	200	mA

CHARACTERISTICS T_{amb} = 25 °C

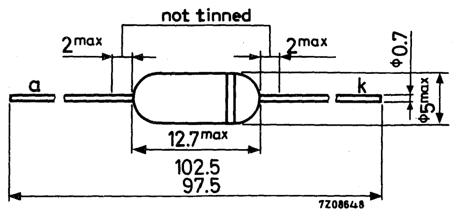
Forward voltage

I_F = 0.1 mA	V_F	typ. 0.2	V
I_F = 10 mA	V_F	typ. 1.4	V
I_F = 30 mA	V_F	typ. 2.4	V

Reverse current

V_R = 1.5 V	I_R	typ. 0.8	µA
V_R = 10 V	I_R	typ. 4.5	µA
V_R = 30 V	I_R	typ. 50	µA
V_R = 45 V	I_R	typ. 130	µA

MECHANICAL DATA Dimensions in mm



The coloured band indicates the cathode side

FOR NEW DESIGN THE SUCCESSOR TYPE AA119 IS RECOMMENDED

GERMANIUM DIODE

Germanium diode in all glass construction for use in video detector circuits.

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

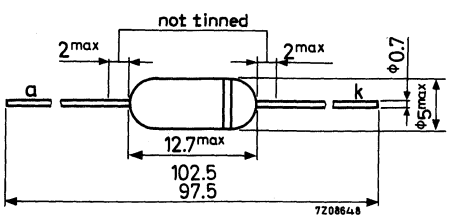
Continuous reverse voltage	V_R	max.	20	V
Peak reverse voltage	V_{RM}	max.	30	V
Forward current (d.c.)	I_F	max.	50	mA
Peak forward current	I_{FM}	max.	150	mA
Non repetitive peak forward current; t = 1 s	I_{FSM}	max.	400	mA
Operating ambient temperature	T_{amb}	-50 to +75		^oC

CHARACTERISTICS

Forward voltage at T_{amb} = 25 ^oC			
I_F = 0.1 mA	V_F	0.1 to 0.2	V
I_F = 8 mA	V_F	0.5 to 1.0	V
Reverse current at T_{amb} = 25 ^oC			
V_R = 1.5 V	I_R	1 to 18	μA
V_R = 10 V	I_R	8 to 100	μA
V_R = 20 V	I_R	25 to 400	μA
V_R = 30 V	I_R	45 to 1200	μA
Diode capacitance	C_d	typ. 1	pF

MECHANICAL DATA Dimensions in mm

Net weight: 0.6 g



The coloured band indicates the cathode side

FOR NEW DESIGN THE SUCCESSOR TYPE OA90 IS RECOMMENDED

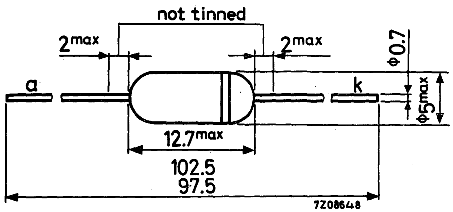
GERMANIUM DIODE

Germanium diode in all glass construction for use in a.m. detector circuits.
Type 2-OA79 consists of 2 diodes OA79 selected for operation in a ratio detector circuit.

MECHANICAL DATA

Dimensions in mm

The white band indicates the cathode side



RATINGS (Limiting values) [1]

Continuous reverse voltage	V_R	max.	30	V
Repetitive peak reverse voltage	V_{RRM}	max.	45	V
Forward current (d.c.)	I_F	max.	35	mA
Repetitive peak forward current	I_{FRM}	max.	100	mA
Non repetitive peak forward current ($t \leq 1$ s)	I_{FSM}	max.	200	mA
Operating ambient temperature	T_{amb}		-50 to +60	°C

CHARACTERISTICS

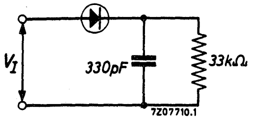
		T_{amb} = 25 °C	T_{amb} = 60 °C	
Forward voltage				
I_F = 0.1 mA	V_F	typ. 0.23	typ. 0.16	V
		0.15 to 0.30	0.1 to 0.25	V
I_F = 10 mA	V_F	typ. 1.5	typ. 1.4	V
		0.8 to 2.2	0.7 to 2.1	V
I_F = 30 mA	V_F	typ. 2.8	typ. 2.6	V
		1.4 to 4.0	1.2 to 3.8	V
Reverse current				
V_R = 0.1 V	I_R	typ. 0.35	typ. 4.5	µA
		< 1.0	< 12	µA
V_R = 1.5 V	I_R	typ. 0.8	typ. 6	µA
		0.1 to 2.8	0.8 to 25	µA
V_R = 10 V	I_R	typ. 4.5	typ. 16	µA
		0.4 to 18	2.5 to 60	µA
V_R = 30 V	I_R	typ. 35	typ. 60	µA
		1.5 to 150	60 to 300	µA
V_R = 45 V	I_R	typ. 90	typ. 170	µA
		4 to 350	15 to 500	µA

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

7Z3 1247

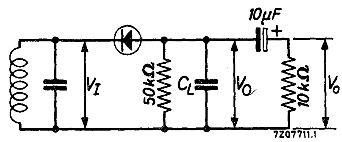
APPLICATION INFORMATION

Measuring circuit at T_{amb} = 25 °C



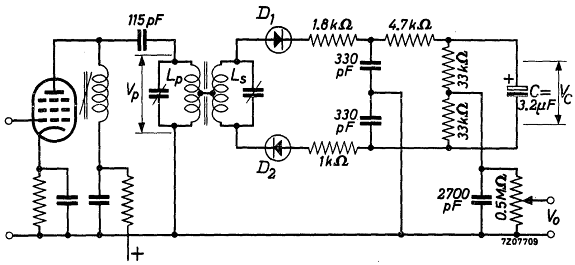
$V_{I(RMS)}$	= 3	V	η	typ.	85	%
f	= 10.7	MHz	R_d	typ.	15	kΩ
					13.5 to 19	kΩ

Diode in an a.m. detector circuit at T_{amb} = 25 °C



$V_{I(RMS)}$	= 0.1	V	V_O	typ.	55	mV
f	= 0.5	MHz	$V_{o(rms)}$	typ.	4.5	mV [1]
			R	typ.	40	kΩ [2]

Matched pair in a ratio detector circuit



L_p	=	7.4	μH
Q_0	=	80	unloaded
R	=	40	kΩ unloaded
Tap	=	0.5	
L_s	=	4.4	μH
Q_0	=	150	unloaded
R	=	45	kΩ unloaded
kQ	=	0.8 [3]	
f_0	=	10.7	MHz
Δf	=	15	kHz
m	=	0.3	

a.m. suppression factor at V_C = 2 to 20 V

$f = f_0$	α	≥ 30
$f = f_0 \pm 25$ kHz	α	≥ 15

For optimum a.m. suppression D_1 must be that diode of the matched pair which has the better dynamic forward characteristic.

For new design the successor types AA119; 2-AA119 are recommended

1) Modulation factor m = 0.3
2) Modulation factor m = 0
3) Measured in the circuit with V_p = 350 mV

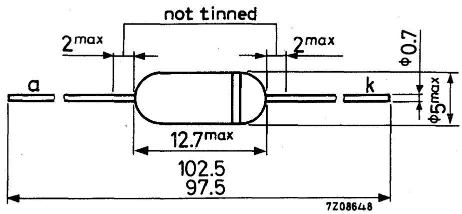
7Z3 1909

GERMANIUM DIODE

Germanium diode in all glass construction for general purposes.

MECHANICAL DATA

Dimensions in mm



The coloured band indicates the cathode side

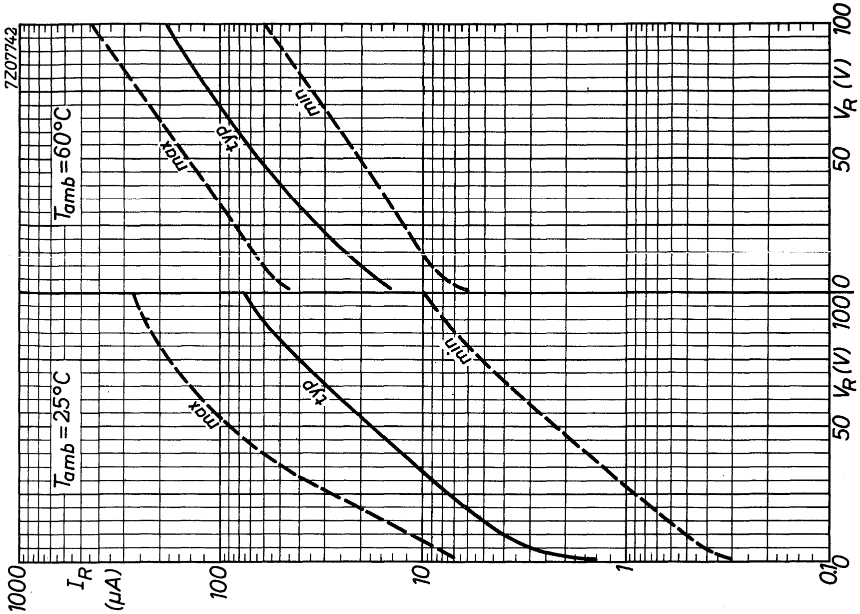
RATINGS (Limiting values according to the Absolute Maximum System as defined in IEC publication 134).

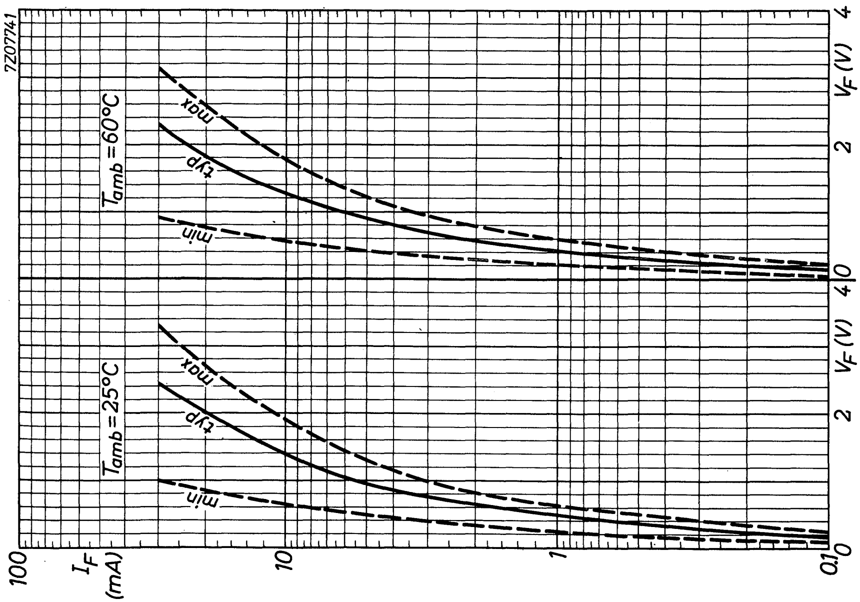
Average reverse voltage (averaged over any 50 ms period)	V_R	max.	90	V
Repetitive peak reverse voltage	V_{RRM}	max.	115	V
Average forward current (averaged over any 50 ms period)	I_F	max.	50	mA
Repetitive peak forward current	I_{FRM}	max.	150	mA
Non repetitive peak forward current ($t < 1$ s)	I_{FSM}	max.	500	mA
Operating ambient temperature	T_{amb}		−50 to +75	°C

CHARACTERISTICS

		T_{amb} = 25 °C	T_{amb} = 60 °C	
Forward voltage				
I_F = 0.1 mA	V_F	typ. 0.2	typ. 0.13	V
		0.1 to 0.25	0.05 to 0.2	V
I_F = 10 mA	V_F	typ. 1.4	typ. 1.3	V
		0.65 to 1.9	0.55 to 1.8	V
I_F = 30 mA	V_F	typ. 2.45	typ. 2.3	V
		1.0 to 3.3	0.9 to 3.15	V
Reverse current				
V_R = 1.5 V	I_R	typ. 1.5	typ. 15	μA
		0.3 to 7	6 to 45	μA
V_R = 10 V	I_R	typ. 4	typ. 20	μA
		0.5 to 11	9 to 60	μA
V_R = 75 V	I_R	typ. 40	typ. 115	μA
		5.5 to 180	35 to 260	μA
V_R = 100 V	I_R	typ. 75	typ. 190	μA
		10 to 275	60 to 450	μA

FOR NEW DESIGN THE SUCCESSOR TYPE OA91 IS RECOMMENDED

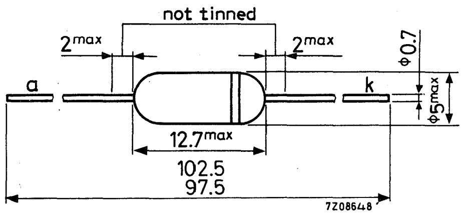

7Z07742
Tamb = 60°C
Tamb = 25°C
max
typ
min
I_R (μA)
V_R (V)
1000
100
10
1
0.1
0
50
100


7Z07741
Tamb = 60°C
Tamb = 25°C
max
typ
min
I_F (mA)
V_F (V)
100
10
1
0.1
0
2
4

GERMANIUM DIODE

Germanium diode in all glass construction for general purposes.

MECHANICAL DATA Dimensions in mm



The coloured band indicates the cathode side

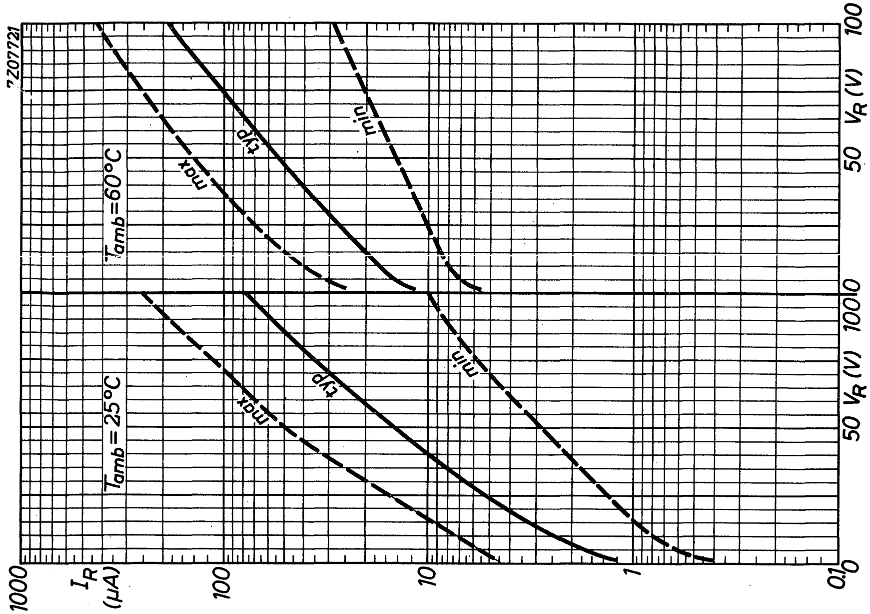
RATINGS (Limiting values according to the Absolute Maximum System as defined in IEC publication 134).

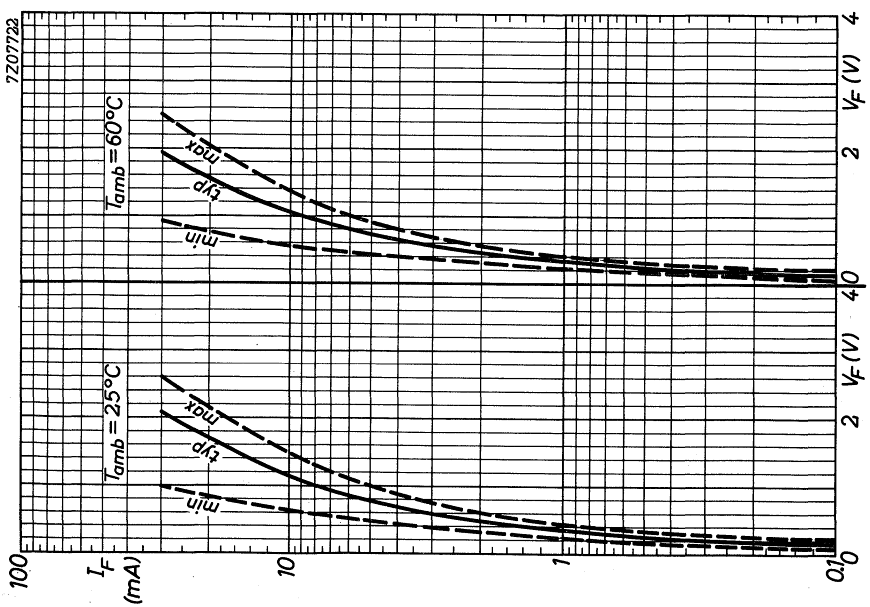
Average reverse voltage (averaged over any 50 ms period)	V_R	max.	90	V
Repetitive peak reverse voltage	V_{RRM}	max.	115	V
Average forward current (averaged over any 50 ms period)	I_F	max.	50	mA
Repetitive peak forward current	I_{FRM}	max.	150	mA
Non repetitive peak forward current ($t < 1$ s)	I_{FSM}	max.	500	mA
Operating ambient temperature	T_{amb}		−50 to +75	°C

CHARACTERISTICS

		T_{amb} = 25 °C	T_{amb} = 60 °C	
Forward voltage				
I_F = 0.1 mA	V_F	typ. 0.2	typ. 0.13	V
		0.1 to 0.25	0.05 to 0.2	V
I_F = 10 mA	V_F	typ. 1.15	typ. 1.05	V
		0.65 to 1.5	0.55 to 1.4	V
I_F = 30 mA	V_F	typ. 2.05	typ. 1.95	V
		1.0 to 2.6	0.9 to 2.5	V
Reverse current				
V_R = 1.5 V	I_R	typ. 1.2	typ. 12	μA
		0.4 to 4.5	5.5 to 26	μA
V_R = 10 V	I_R	typ. 2.5	typ. 17	μA
		0.8 to 7	8 to 40	μA
V_R = 75 V	I_R	typ. 35	typ. 100	μA
		5.7 to 110	20 to 250	μA
V_R = 100 V	I_R	typ. 75	typ. 190	μA
		10 to 250	30 to 430	μA

FOR NEW DESIGN THE SUCCESSOR TYPE OA95 IS RECOMMENDED


7Z07721
Tamb=60°C
Tamb=25°C
max
typ
min
IR (µA)
VR (V)
1000
100
10
1
0.1
0
50
100


7Z07722
Tamb=60°C
Tamb=25°C
max
typ
min
IF (mA)
VF (V)
100
10
1
0.1
0
2
4

GERMANIUM DIODES

Germanium diodes in all glass construction for use in computers.

RATINGS (Limiting values)

		T_{amb} = 25 °C	T_{amb} = 60 °C
Reverse voltage	V_R	max. 60 V	60 V
Peak reverse voltage	V_{RM}	max. 90 V	90 V
Forward current	I_F	max. 35 mA	15 mA
Peak forward current	I_{FM}	max. 150 mA	150 mA

CHARACTERISTICS

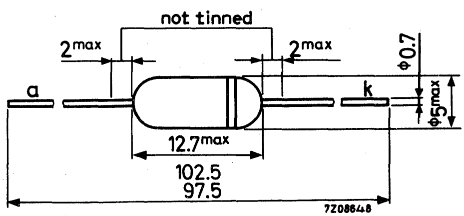
		T_{amb} = 25 °C	T_{amb} = 60 °C
Forward voltage			
I_F = 5 mA	V_F	typ 0.78 V	typ 0.72 V
		0.6 to 1 V	0.5 to 0.95 V
I_F = 30 mA	V_F	typ 2.15 V	typ 1.9 V
		1.5 to 3 V	1.3 to 2.8 V
Reverse current			
V_R = 10 V	I_R	typ 2.5 μA	typ 20 μA
		0.8 to 7 μA	6 to 40 μA
V_R = 60 V	I_R	typ 35 μA	typ 75 μA
		5.7 to 92 μA	25 to 200 μA

Reverse recovery time, when switched from I_F = 30 mA to V_R = 35 V

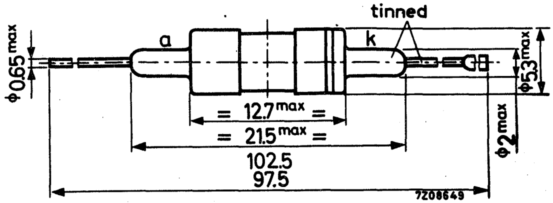
Measured at I_R = 700 μA t_{rr} < 0.5 μs

Measured at I_R = 87.5 μA t_{rr} < 3.5 μs

MECHANICAL DATA   Dimensions in mm



The coloured band indicates the cathode side



Clip-in execution (OA86C)

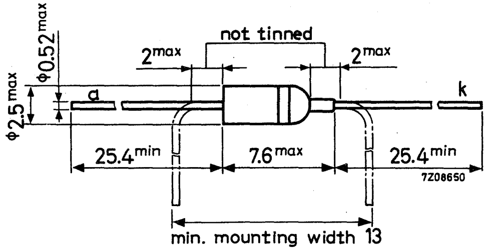
GERMANIUM DIODE

Germanium diode in subminiature all glass DO-7 construction for use as video detector.

MECHANICAL DATA

Dimensions in mm

DO-7



The coloured band indicates the cathode side

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

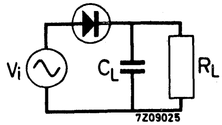
Average reverse voltage (averaged over any 50 ms period)	V_R	max.	20	V
Repetitive peak reverse voltage	V_{RRM}	max.	30	V
Non repetitive peak reverse voltage	V_{RSM}	max.	40	V
Average forward current (averaged over any 50 ms period)	I_F	max.	8	mA
Repetitive peak forward current	I_{FRM}	max.	45	mA
Non repetitive peak forward current ($t < 1$ s)	I_{FSM}	max.	200	mA
Storage temperature	T_{stg}		−55 to +90	°C
Operating ambient temperature	T_{amb}		−55 to +75	°C

CHARACTERISTICS

		T_{amb} = 25 °C	60 °C	
Forward voltage				
I_F = 0.1 mA	V_F	typ. 0.18	typ. 0.12	V
		0.1 to 0.25	< 0.20	V
I_F = 10 mA	V_F	typ. 1.0	typ. 0.95	V
		0.5 to 1.5	0.4 to 1.4	V
I_F = 30 mA	V_F	typ. 2.0	typ. 1.95	V
		1.1 to 3.2	1.0 to 3.1	V
Reverse current				
V_R = 1.5 V	I_R	typ. 2.4	typ. 11	µA
		< 10	< 40	µA
V_R = 10 V	I_R	typ. 20	typ. 45	µA
		< 135	< 270	µA
V_R = 20 V	I_R	typ. 90	typ. 140	µA
		< 450	< 650	µA
V_R = 30 V	I_R	typ. 300	typ. 400	µA
		< 1100	< 1500	µA

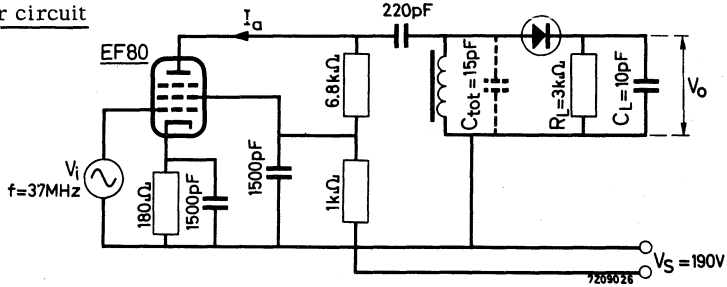
APPLICATION INFORMATION

Measuring circuit



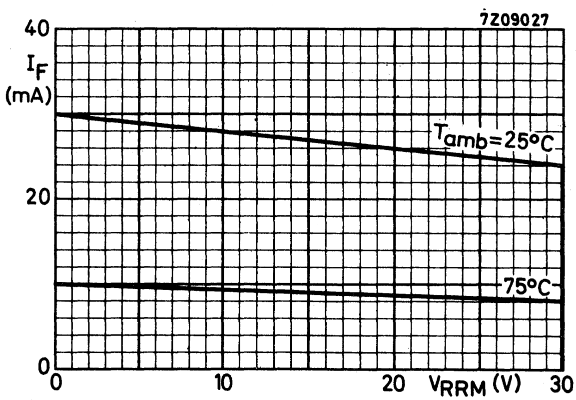
V_{im}	=	5	1.4	0.5	5	V
f	=	40	40	40	30	MHz
C_L	=	10	10	10	10	pF
R_L	=	3	3	3	3.9	kΩ
η	typ.	63	54	34	>60	%
R_d	typ.	2.4	2.8	3.7	>2.9	kΩ

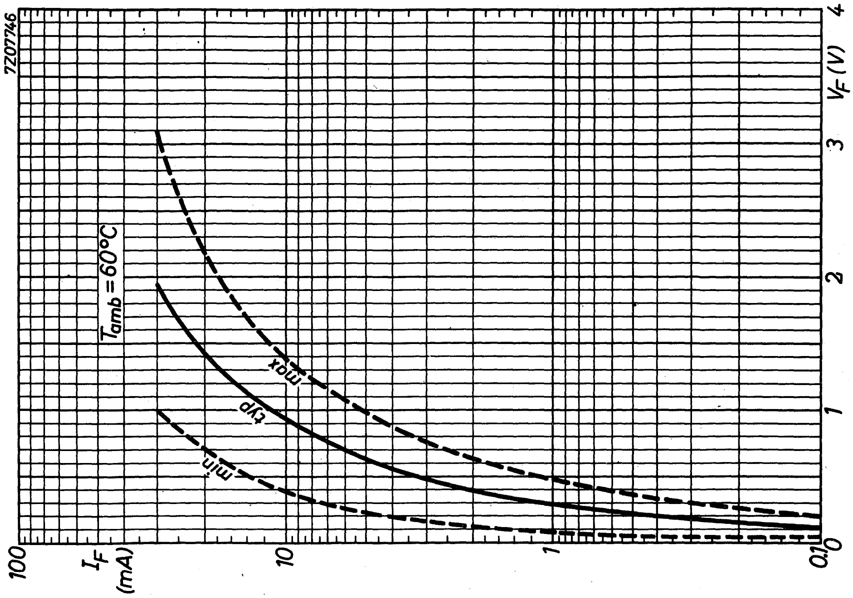
Video detector circuit

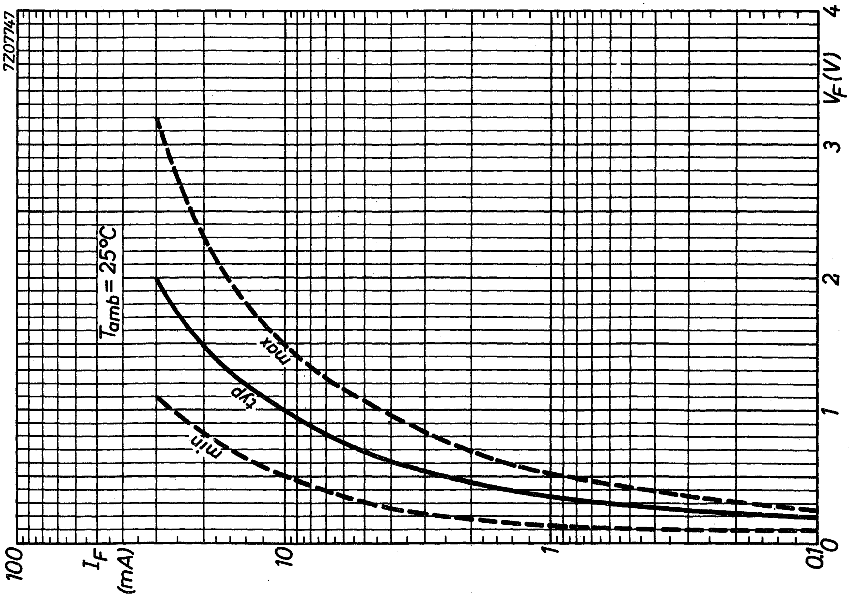


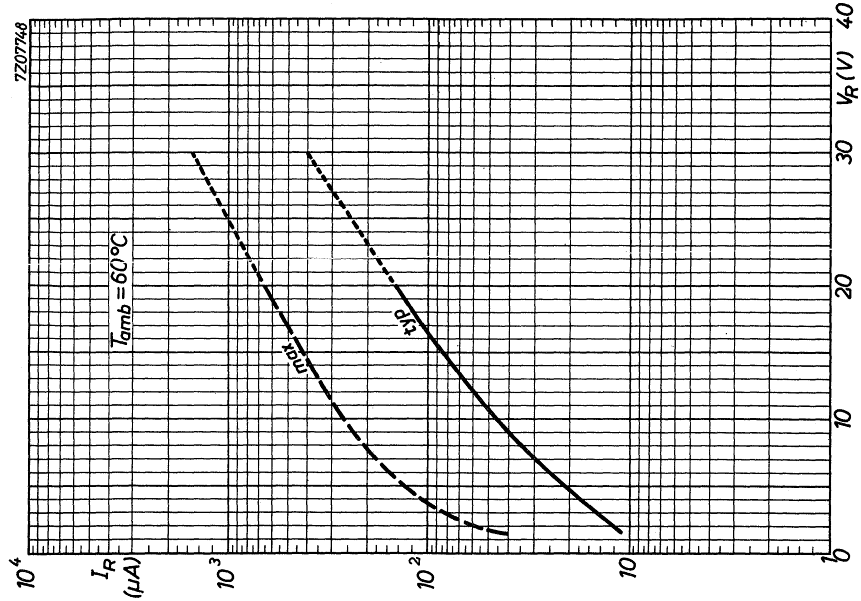
Q of the tuned circuit with removed diode: Q = 19

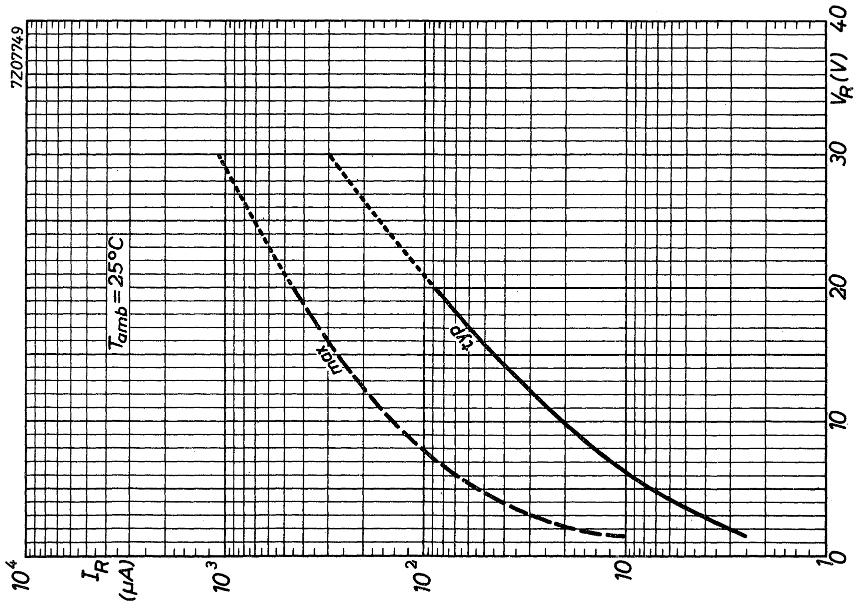
I_{am}	=	2.5	0.25	mA
B	=	4.7	4.1	MHz
V_o	typ.	2.7	0.20	V




7207746
$T_{amb} = 60°C$
max
typ
min
I_F (mA)
100
10
1
0.1
V_F (V)
0
1
2
3
4


7207747
$T_{amb} = 25°C$
max
typ
min
I_F (mA)
100
10
1
0.1
V_F (V)
0
1
2
3
4


7Z07748
T_{amb} = 60°C
max
typ
V_R (V)
40
30
20
10
0
10^4
I_R (μA)
10^3
10^2
10
1

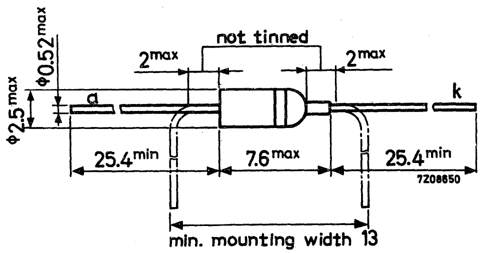

7Z07749
T_{amb} = 25°C
max
typ
V_R (V)
40
30
20
10
0
10^4
I_R (μA)
10^3
10^2
10
1

GERMANIUM DIODE

Germanium diode in subminiature all glass DO-7 construction for general purposes.

MECHANICAL DATA — Dimensions in mm

DO-7



The coloured band indicates the cathode side

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

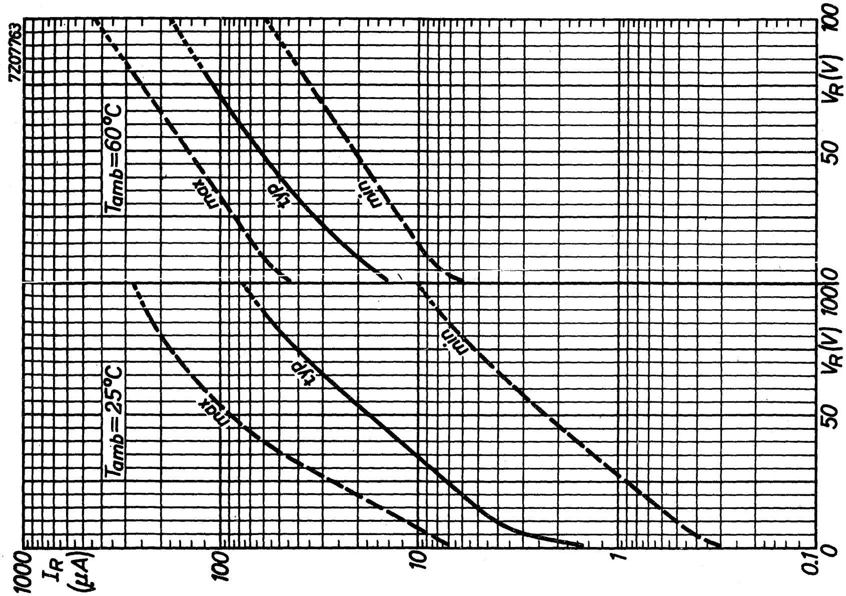
Average reverse voltage (averaged over any 50 ms period)	V_R	max.	90	V
Repetitive peak reverse voltage	V_{RRM}	max.	115	V
Average forward current (averaged over any 50 ms period)	I_F	max.	50	mA
Repetitive peak forward current	I_{FRM}	max.	150	mA
Non repetitive peak forward current ($t < 1$ s)	I_{FSM}	max.	500	mA
Storage temperature	T_{stg}		−55 to +75	°C
Operating ambient temperature	T_{amb}		−55 to +75	°C

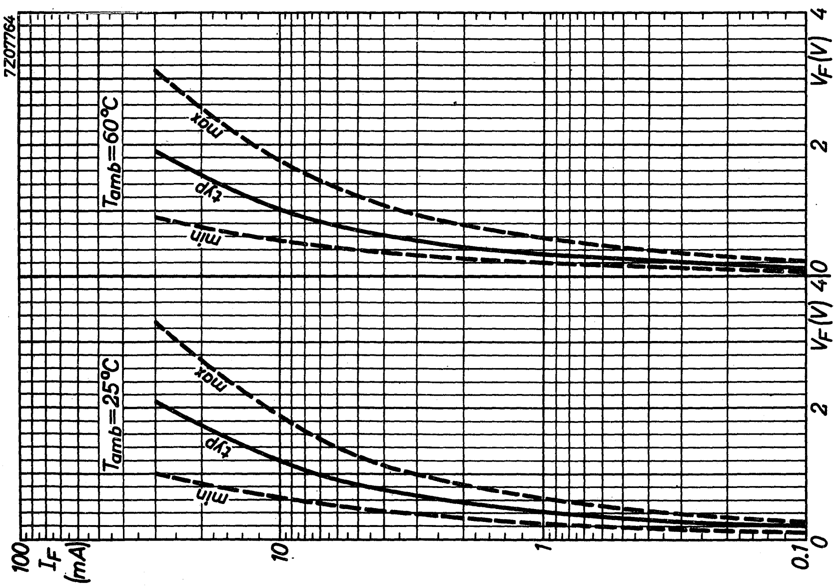
THERMAL RESISTANCE

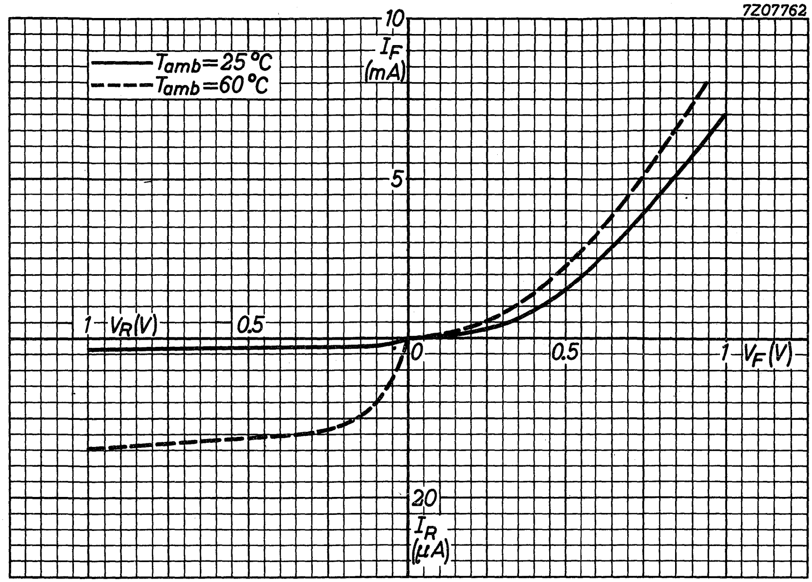
From junction to ambient in free air — $R_{th\ j\text{-}a}$ = 0.4 °C/mW

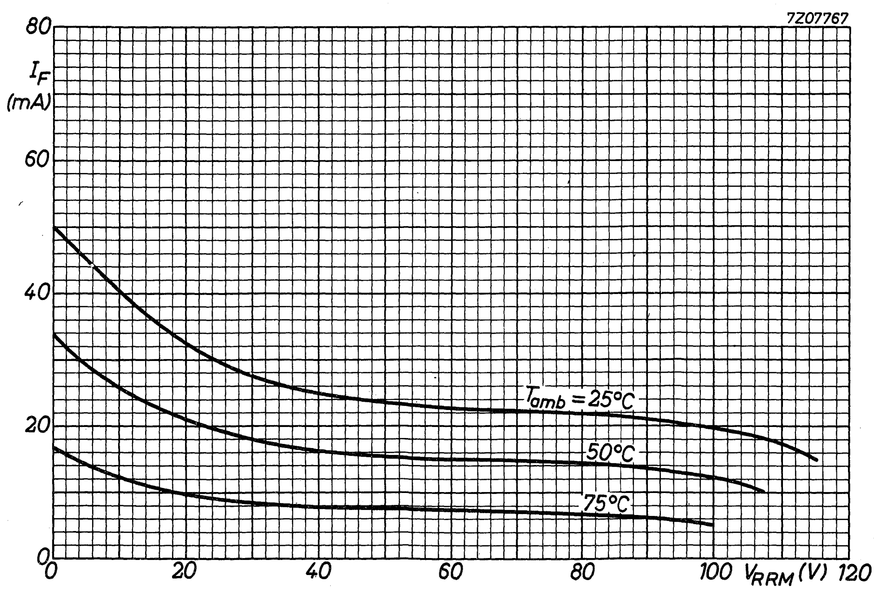
CHARACTERISTICS

		T_{amb} = 25 °C	T_{amb} = 60 °C	
Forward voltage				
I_F = 0.1 mA	V_F	typ. 0.18	typ. 0.1	V
		0.1 to 0.25	0.05 to 0.2	V
I_F = 10 mA	V_F	typ. 1.2	typ. 1.05	V
		0.65 to 1.9	0.55 to 1.8	V
I_F = 30 mA	V_F	typ. 2.1	typ. 1.9	V
		1.0 to 3.3	0.9 to 3.15	V
Reverse current				
V_R = 1.5 V	I_R	typ. 1.5	typ. 15	μA
		0.3 to 7	6 to 45	μA
V_R = 10 V	I_R	typ. 4	typ. 20	μA
		0.5 to 11	9 to 60	μA
V_R = 75 V	I_R	typ. 40	typ. 115	μA
		5.5 to 180	35 to 260	μA
V_R = 100 V	I_R	typ. 75	typ. 190	μA
		10 to 275	60 to 450	μA


7207763
T_{amb}=60°C
T_{amb}=25°C
max
typ
min
I_R (μA)
1000
100
10
1
0.1
V_R(V)
0
50
100


7207764
T_{amb}=60°C
T_{amb}=25°C
max
typ
min
I_F (mA)
100
10
1
0.1
V_F(V)
0
2
4


7Z07762
T_{amb}=25 °C
T_{amb}=60 °C
10
I_F (mA)
5
1 V_R(V)
0.5
0
0.5
1 V_F (V)
20
I_R (μA)


7Z07767
80
I_F (mA)
60
40
20
0
0
20
40
60
80
100
V_{RRM} (V)
120
T_{amb} = 25°C
50°C
75°C

GERMANIUM DIODE

Germanium diode in subminiature all glass DO-7 envelope, intended for switching applications.

RATINGS (Limiting values) T_{amb} = 75 °C

Continuous reverse voltage	V_R	max.	15	V
Repetitive peak reverse voltage	V_{RRM}	max.	15	V
Non repetitive peak reverse voltage ($t < 1$ s)	V_{RSM}	max.	20	V
Average forward current	I_{FAV}	max.	7	mA
Forward current (d.c.)	I_F	max.	10	mA
Repetitive peak forward current	I_{FRM}	max.	50	mA
Non repetitive peak forward current ($t < 1$ s)	I_{FSM}	max.	100	mA
Operating ambient temperature	T_{amb}	max.	75	°C
Storage temperature	T_{stg}	-55 to +90		°C

THERMAL RESISTANCE

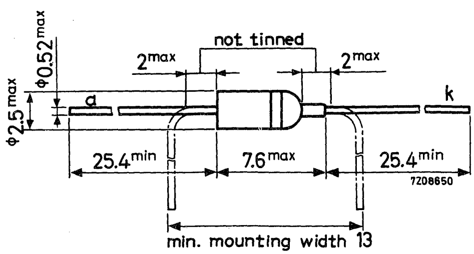
From junction to ambient	$R_{th\,j\text{-}a}$	=	0.55	°C/mW

CHARACTERISTICS

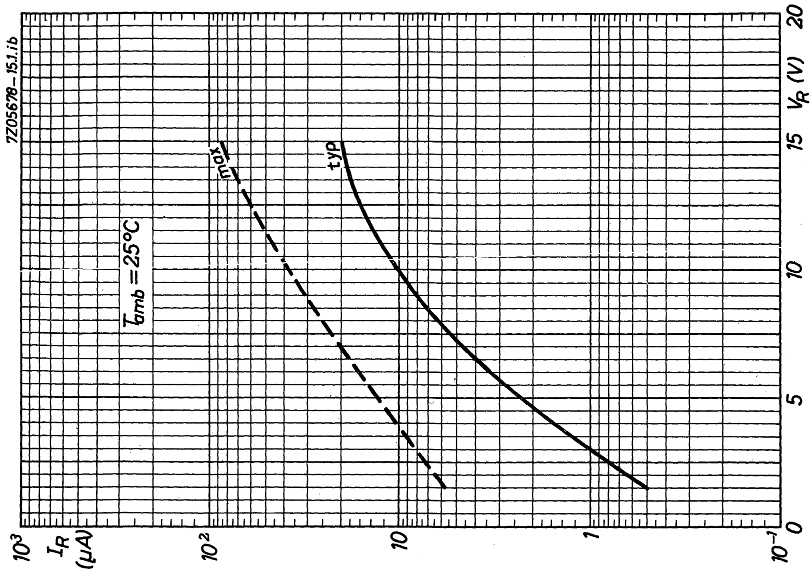
Forward voltage at T_{amb} = 25 °C				
I_F = 3 mA	V_F	typ.	0.55	V
		0.30 to 1.00		V
Reverse current at T_{amb} = 60 °C				
V_R = 15 V	I_R	typ.	40	μA
		<	155	μA
Reverse recovery current when switched from I_F = 5 mA to V_R = 5 V; T_{amb} = 25 °C				
measured at t_{rr} = 0.5 μs	I_R	typ.	80	μA
		<	300	μA
measured at t_{rr} = 3.5 μs	I_R	typ.	15	μA
		<	60	μA
Diode capacitance at f = 0.5 MHz				
V_R = 0.75 V; T_{amb} = 25 °C	C_d	<	0.5	pF

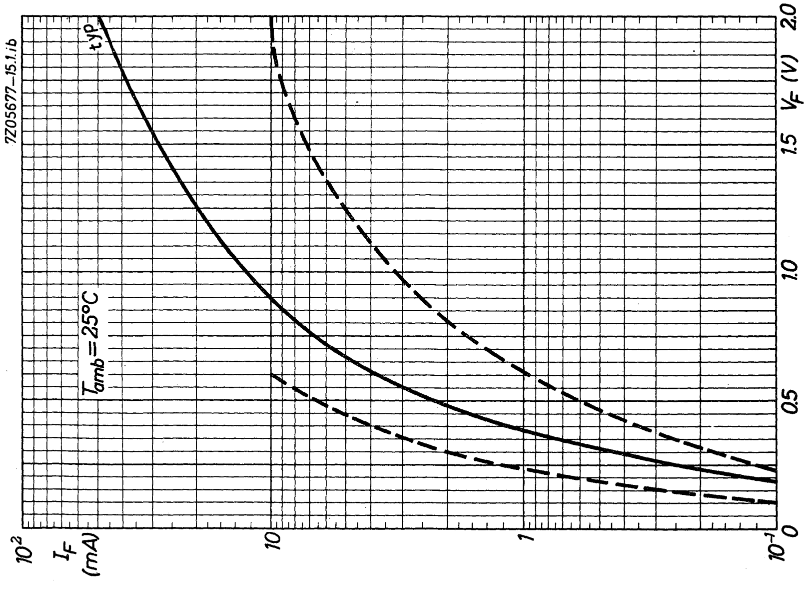
MECHANICAL DATA Dimensions in mm

DO-7



The coloured band indicates the cathode side


7Z05678–15.1.ib
Tamb = 25°C
max
typ
VR (V)
IR (μA)
10^3
10^2
10
1
10^-1
0
5
10
15
20

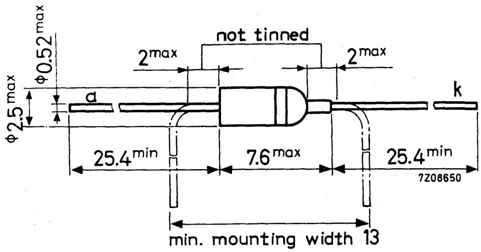

7Z05677–15.1.ib
Tamb = 25°C
typ
VF (V)
IF (mA)
10^2
10
1
10^-1
0
0.5
1.0
1.5
2.0

GERMANIUM DIODE

Germanium diode in subminiature all glass DO-7 construction for general purposes.

MECHANICAL DATA Dimensions in mm

DO-7



The coloured band indicates the cathode side

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

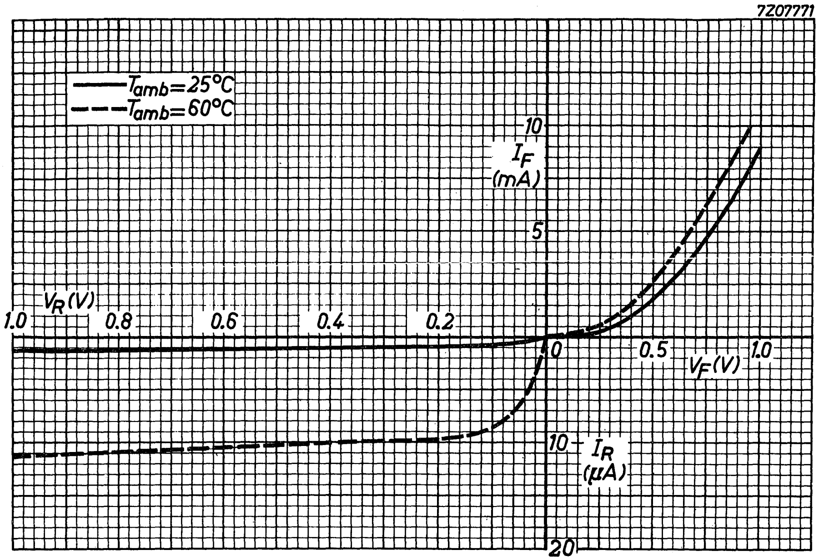
Average reverse voltage (averaged over any 50 ms period)	V_R	max.	90	V
Repetitive peak reverse voltage	V_{RRM}	max.	115	V
Average forward current (averaged over any 50 ms period)	I_F	max.	50	mA
Repetitive peak forward current	I_{FRM}	max.	150	mA
Non repetitive peak forward current ($t < 1$ s)	I_{FSM}	max.	500	mA
Storage temperature	T_{stg}		−55 to +75	°C
Operating ambient temperature	T_{amb}		−55 to +75	°C

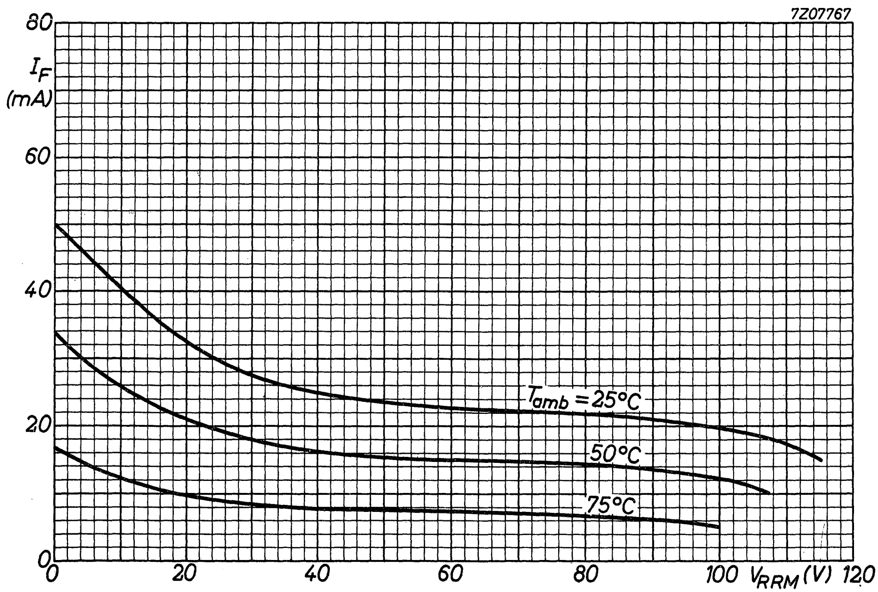
THERMAL RESISTANCE

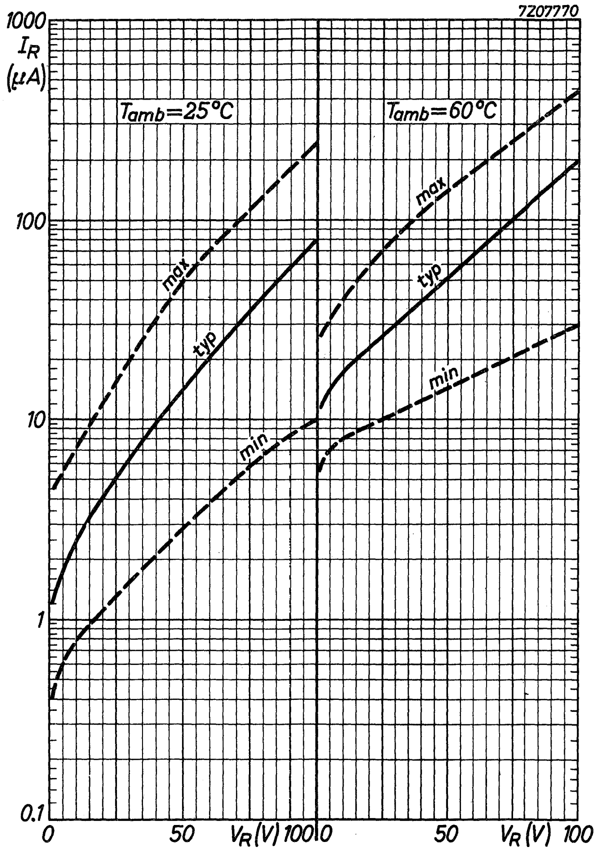
From junction to ambient in free air $R_{th\ j\text{-}a}$ = 0.4 °C/mW

CHARACTERISTICS

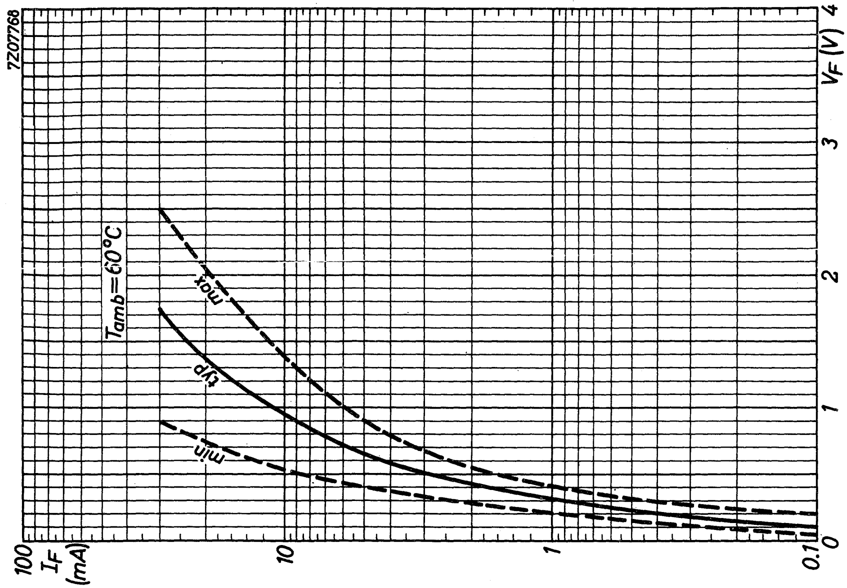
		T_{amb} = 25 °C	T_{amb} = 60 °C	
Forward voltage				
I_F = 0.1 mA	V_F	typ. 0.18	typ. 0.1	V
		0.1 to 0.25	0.05 to 0.2	V
I_F = 10 mA	V_F	typ. 1.05	typ. 0.95	V
		0.65 to 1.5	0.55 to 1.4	V
I_F = 30 mA	V_F	typ. 1.85	typ. 1.75	V
		1.0 to 2.6	0.9 to 2.5	V
Reverse current				
V_R = 1.5 V	I_R	typ. 1.2	typ. 12	μA
		0.4 to 4.5	5.5 to 26	μA
V_R = 10 V	I_R	typ. 2.5	typ. 17	μA
		0.8 to 7	8 to 40	μA
V_R = 75 V	I_R	typ. 35	typ. 100	μA
		5.7 to 110	20 to 250	μA
V_R = 100 V	I_R	typ. 80	typ. 200	μA
		10 to 250	30 to 430	μA

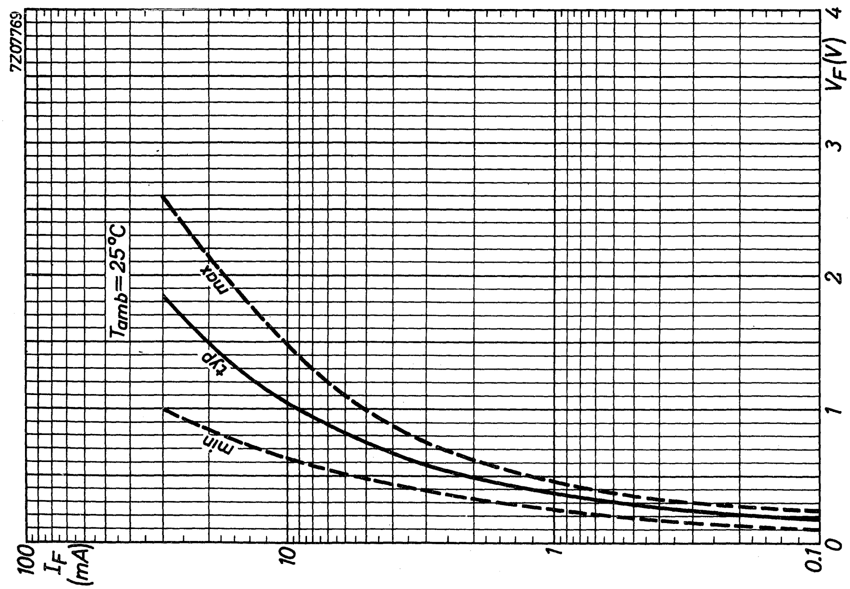

7Z07771
T_{amb}=25°C
T_{amb}=60°C
10
I_F
(mA)
5
V_R(V)
1.0
0.8
0.6
0.4
0.2
0
0.5
1.0
V_F(V)
10
I_R
(µA)
20


7Z07767
80
I_F
(mA)
60
40
20
0
T_{amb} = 25°C
50°C
75°C
0
20
40
60
80
100
V_{RRM}(V)
120



7Z07770
1000
I_R
(μA)
100
10
1
0.1
T_{amb}=25°C
T_{amb}=60°C
max
typ
min
max
typ
min
0
50
V_R(V) 100
0
50
V_R(V) 100


7Z07768
T_{amb}=60°C
max
typ
min
100
I_F (mA)
10
1
0.1
V_F (V)
0
1
2
3
4


7Z07769
T_{amb}=25°C
max
typ
min
100
I_F (mA)
10
1
0.1
V_F (V)
0
1
2
3
4

SILICON DIODES

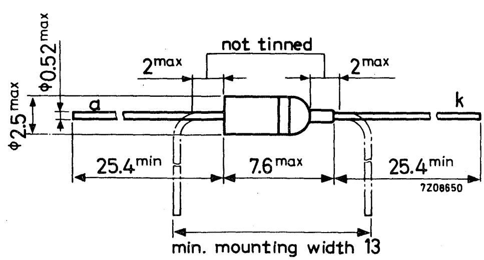
Silicon alloyed general purpose diodes in a subminiature all glass DO-7 envelope.

QUICK REFERENCE DATA

			OA200	OA202	
Continuous reverse voltage	V_R	max.	50	150	V
Repetitive peak forward current	I_{FRM}	max.	250		mA
Thermal resistance from junction to ambient	$R_{th\ j\text{-}a}$	=	0.4		$^oC/mW$
Forward voltage I_F = 30 mA; T_{amb} = 25 ^oC	V_F	typ.	0.9		V
Reverse recovery time when switched from I_F = 30 mA to V_R = 35 V; R_L = 2.5 kΩ measured at I_R = 4 mA	t_{rr}	typ.	3.5		μs

MECHANICAL DATA Dimensions in mm

DO-7



The coloured band indicates the cathode side

RATINGS (Limiting values) [1]

Voltage

Continuous reverse voltage	OA200	V_R	max.	50	V
	OA202	V_R	max.	150	V

Currents

		T_{amb} = 25 °C		T_{amb} = 125 °C	
Average rectified forward current (averaged over any 20 ms period)	I_{FAV}	max.	160	48	mA
Average forward current for sinusoidal operation	I_{FAV}	max.	80	40	mA
Forward current (d.c.; see page 4)	I_F	max.	160	48	mA
Repetitive peak forward current	I_{FRM}	max.	250	125	mA

Temperatures

Storage temperature	T_{stg}	-55 °C to +125		°C
Operating ambient	T_{amb}	max.	125	°C

THERMAL RESISTANCE

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

CHARACTERISTICS

				T_{amb} = 25 °C		T_{amb} = 125 °C	
Forward voltage							
I_F = 0.1 mA		V_F	typ.	0.52		–	V
			<	0.62		0.30	V
I_F = 10 mA		V_F	typ.	0.80		–	V
			<	0.96		0.65	V
I_F = 30 mA		V_F	typ.	0.90		–	V
			<	1.15		0.80	V
Reverse current							
$V_R = V_{Rmax}$	OA200	I_R	typ.	0.02		1	µA
			<	0.10		10	µA
	OA202	I_R	typ.	0.01		0.5	µA
			<	0.10		10	µA
Diode capacitance							
V_R = 0.75 V; f = 0.5 MHz		C_d	typ.		10		pF
			<		25		pF

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

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

Reverse recovery current when switched from

I_F = 5 mA to V_R = 5 V; R_L = 2 .5 kΩ

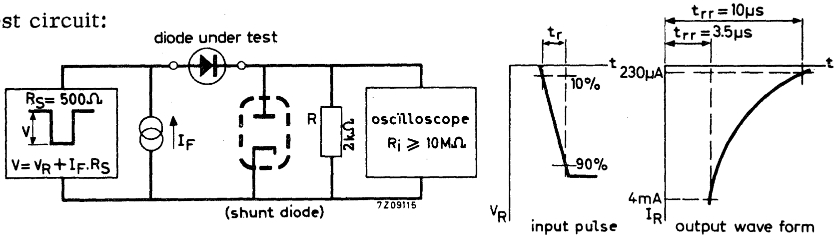
measured at t_{rr} = 3.5 μs	I_R	typ.	1.2	mA
t_{rr} = 10 μs	I_R	typ.	35	μA

Reverse recovery current when switched from

I_F = 30 mA to V_R = 35 V; R_L = 2.5 kΩ

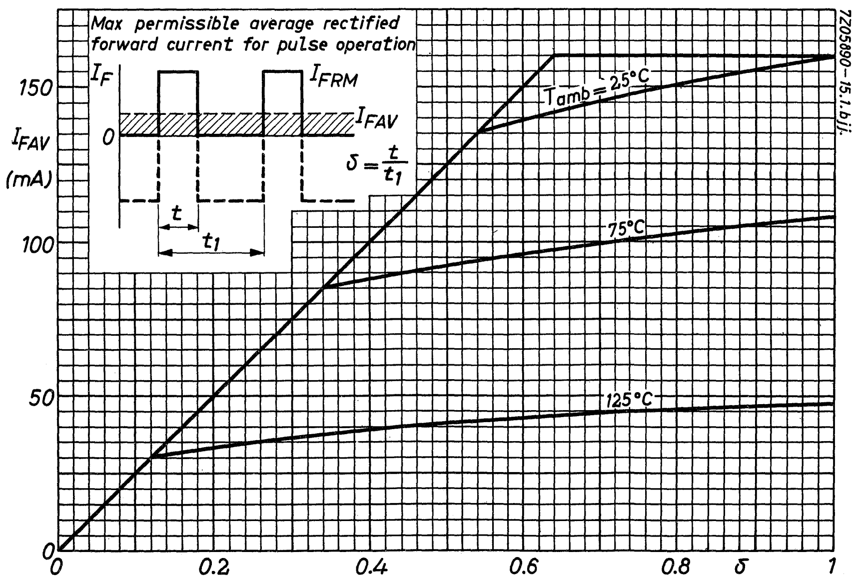
measured at t_{rr} = 3.5 μs	I_R	typ.	4	mA
t_{rr} = 10 μs	I_R	typ.	230	μA

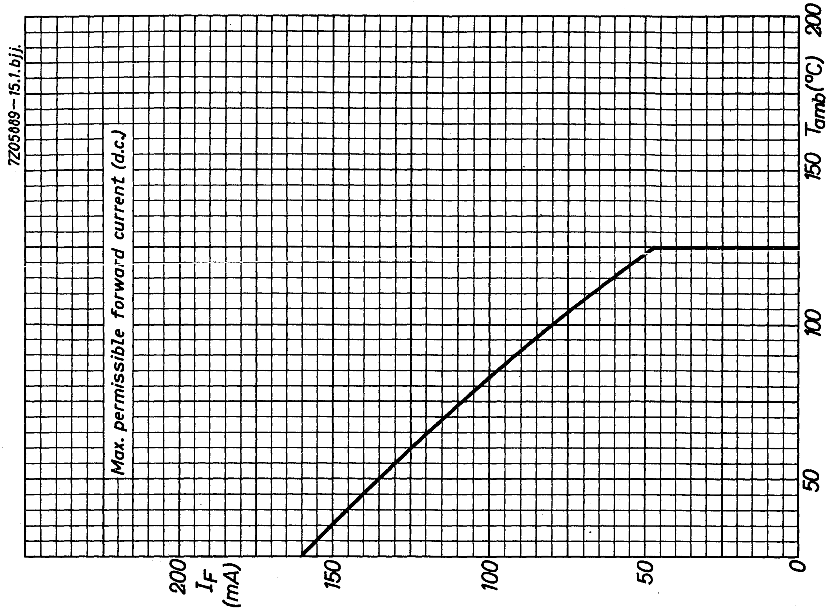
Test circuit:

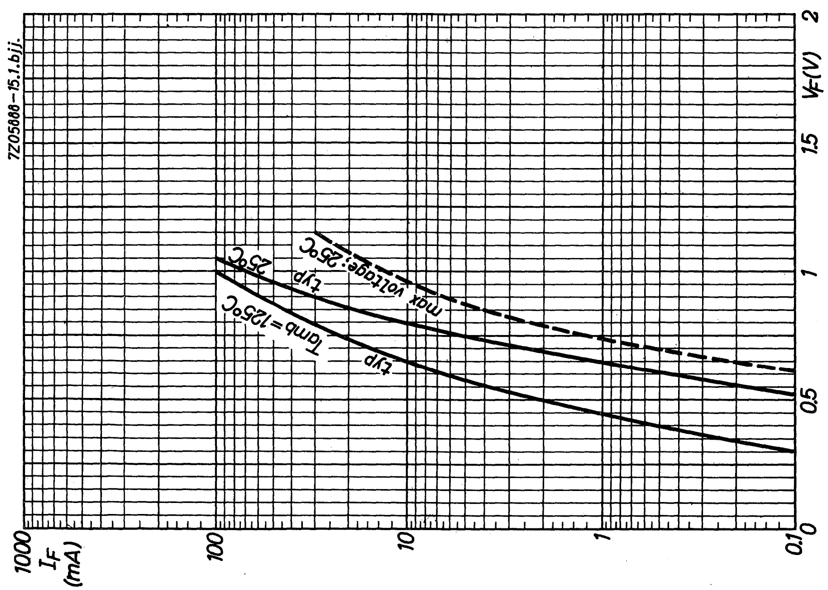


Reverse pulse: Rise time $t_r \leq 0.1$ μs
Duty cycle δ = 0.5
Frequency f = 50 kHz

Oscilloscope: Capacitance C = 40 pF
Rise time t_r = 25 ns




7Z05889-15.1.bjj.
Max. permissible forward current (d.c.)
200
I_F
(mA)
150
100
50
0
50
100
150
200
T_{amb}(°C)


7Z05888-15.1.bjj.
max voltage; 25°C
typ 25°C
Tamb=125°C
typ
1000
I_F
(mA)
100
10
1
0.1
0
0.5
1
1.5
2
V_F(V)

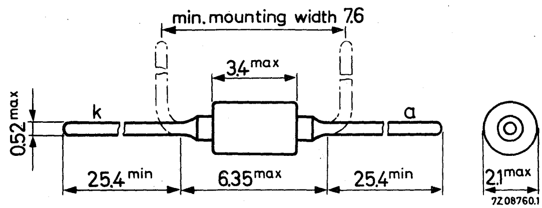
SILICON OXIDE PASSIVATED DIODES

Whiskerless diodes in a molybdenum hard glass subminiature envelope.
These high speed diodes are primarily intended for fast logic applications.

QUICK REFERENCE DATA				
Continuous reverse voltage	V_R	max.	75	V
Repetitive peak reverse voltage	V_{RRM}	max.	100	V
Repetitive peak forward current	I_{FRM}	max.	225	mA
Forward voltage				
1N914 : I_F = 10 mA 1N914A: I_F = 20 mA 1N914B: I_F = 100 mA	V_F	<	1	V
Reverse recovery time when switched from I_F = 10 mA to V_R = 6 V;				
R_L = 100 Ω				
measured at I_R = 1 mA	t_{rr}	<	4	ns

MECHANICAL DATA

Dimensions in mm



Colour code according to E.I.A.

RATINGS (Limiting values) [1]

Voltages

Continuous reverse voltage		V_R	max.	75	V
Repetitive peak reverse voltage		V_{RRM}	max.	100	V

Currents

Average rectified forward current (averaged over any 20 ms period)	T_{amb} = 25 °C	I_{FAV}	max.	75	mA
	T_{amb} = 150 °C	I_{FAV}	max.	10	mA
Forward current (d.c.)		I_F	max.	75	mA
Repetitive peak forward current		I_{FRM}	max.	225	mA
Non repetitive peak forward current (t = 1 s)		I_{FSM}	max.	500	mA
Total power dissipation		P_{tot}	max.	250	mW

Temperatures

Storage temperature	T_{stg}	-65 to +200	°C
Operating ambient temperature	T_{amb}	-65 to +175	°C

CHARACTERISTICS T_j = 25 °C unless otherwise specified

Forward voltages

1N914 : I_F = 10 mA 1N914A: I_F = 20 mA 1N914B: I_F = 100 mA	V_F	< 1	V
1N914B: I_F = 5 mA	V_F	0.62 to 0.72	V

Reverse breakdown voltage

I_R = 100 μA	$V_{(BR)R}$	>	100	V

Reverse currents

V_R = 20 V	I_R	<	25	nA
V_R = 75 V	I_R	<	5	μA
V_R = 20 V; T_j = 150 °C	I_R	<	50	μA
1N914B: V_R = 100 V	I_R	<	100	μA

Diode capacitance

V_R = 0; f = 1 MHz	C_d	<	4	pF

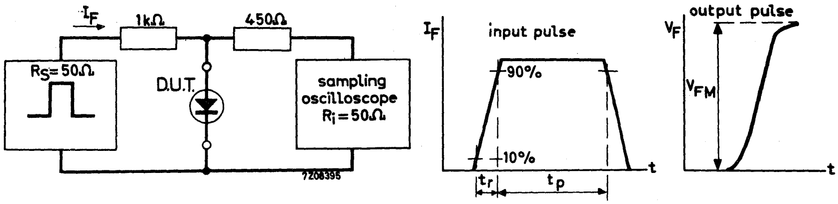
[1] Limiting values according to the Absolute Maximum System as defined in IEC publication 134.

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

Forward recovery voltage when switched to

I_F = 50 mA; t_r = 20 ns V_{FM} < 2.5 V

Test circuit:



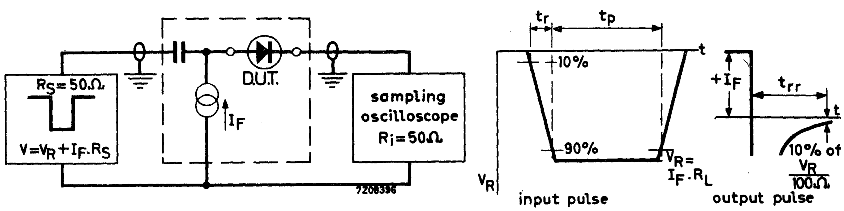
Current pulse: Rise time	t_r	=	20	ns	Oscilloscope:	
Pulse duration	t_p	=	120	ns	Rise time	t_r = 0.35 ns
Duty cycle	δ	=	0.01			

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

Reverse recovery time when switched from

I_F = 10 mA to V_R; R_L = 100 Ω
measured at I_R = 1 mA; switched to V_R = 1 V t_{rr} < 8 ns
V_R = 6 V t_{rr} < 4 ns

Test circuit:



Reverse pulse: Rise time	t_r	=	0.6	ns	Oscilloscope:	
Pulse duration	t_p	=	100	ns	Rise time	t_r = 0.35 ns
Duty cycle	δ	=	0.05			

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

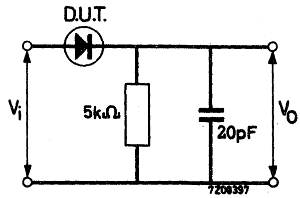
CHARACTERISTICS (continued) T_j = 25 °C unless otherwise specified

Rectifying efficiency

$$\eta = \frac{V_O}{V_{i(rms)}\sqrt{2}}$$

f = 100 MHz; $V_{i(rms)}$ = 2 V	η	>	45	%

Test circuit:



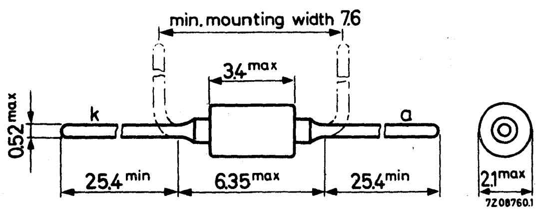
SILICON OXIDE PASSIVATED DIODES

Whiskerless diodes in a molybdenum hard glass subminiature envelope.
These high speed diodes are primarily intended for fast logic applications.

QUICK REFERENCE DATA

Continuous reverse voltage	V_R	max.	75	V
Repetitive peak reverse voltage	V_{RRM}	max.	100	V
Repetitive peak forward current	I_{FRM}	max.	225	mA
Forward voltage IN916 : I_F = 10 mA IN916A: I_F = 20 mA IN916B: I_F = 30 mA	V_F	<	1	V
Reverse recovery time when switched from I_F = 10 mA to V_R = 6 V; R_L = 100 Ω measured at I_R = 1 mA	t_{rr}	<	4	ns

MECHANICAL DATA Dimensions in mm



Colour code according to E.I.A.

RATINGS (Limiting values) [1])

Voltages

Continuous reverse voltage	V_R	max.	75	V
Repetitive peak reverse voltage	V_{RRM}	max.	100	V

Currents

Average rectified forward current (averaged over any 20 ms period) T_{amb} = 25 °C	I_{FAV}	max.	75	mA
T_{amb} = 150 °C	I_{FAV}	max.	10	mA
Forward current (d.c.)	I_F	max.	75	mA
Repetitive peak forward current	I_{FRM}	max.	225	mA
Non repetitive peak forward current (t = 1 s)	I_{FSM}	max.	500	mA
Total power dissipation	P_{tot}	max.	250	mW

Temperatures

Storage temperature	T_{stg}	-65 to +200	°C
Operating ambient temperature	T_{amb}	-65 to +175	°C

CHARACTERISTICS T_j = 25 °C unless otherwise specified

Forward voltages

IN916 : I_F = 10 mA; IN916A: I_F = 20 mA; IN916B: I_F = 30 mA	V_F	<	1	V
IN916B: I_F = 5 mA	V_F		0.63 to 0.73	V

Reverse breakdown voltage

I_R = 100 μA	$V_{(BR)R}$	>	100	V

Reverse currents

V_R = 20 V	I_R	<	25	nA
V_R = 75 V	I_R	<	5	μA
V_R = 20 V; T_j = 150 °C	I_R	<	50	μA

Diode capacitance

V_R = 0; f = 1 MHz	C_d	<	2	pF

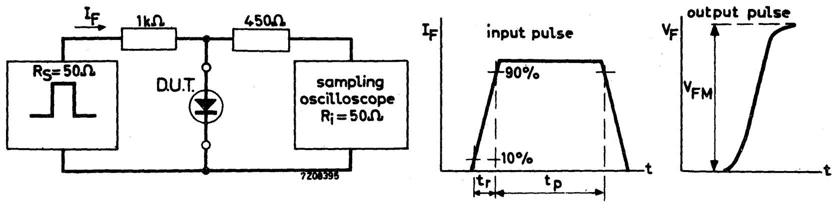
[1]) Limiting values according to the Absolute Maximum System as defined in IEC publication 134.

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

Forward recovery voltage when switched to

I_F = 50 mA; t_r = 20 ns V_{FM} < 2.5 V

Test circuit:



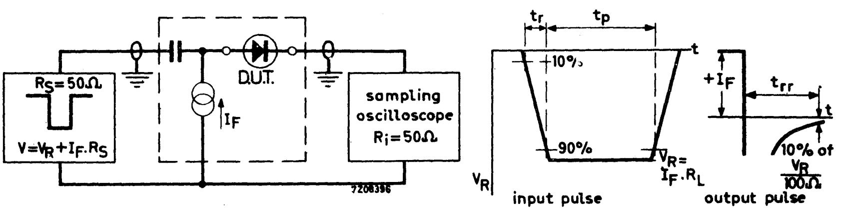
Current pulse:	Rise time	t_r = 20 ns	Oscilloscope:	
	Pulse duration	t_p = 120 ns	Rise time	t_r = 0.35 ns
	Duty cycle	δ = 0.01		

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

Reverse recovery time when switched from

I_F = 10 mA to V_R; R_L = 100 Ω
measured at I_R = 1 mA; switched to V_R = 6 V t_{rr} < 4 ns

Test circuit:



Reverse pulse:	Rise time	t_r = 0.6 ns	Oscilloscope:	
	Pulse duration	t_p = 100 ns	Rise time	t_r = 0.35 ns
	Duty cycle	δ = 0.05		

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

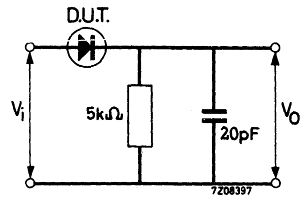
CHARACTERISTICS (continued) T_j = 25 °C unless otherwise specified

Rectifying efficiency

$$\eta = \frac{V_O}{V_{i(rms)} \sqrt{2}}$$

f = 100 MHz; $V_{i(rms)}$ = 2 V η > 45 %

Test circuit:



ULTRA HIGH SPEED SILICON DIODE

General purpose diode for military and industrial applications.

RATINGS (Limiting values) [1])

Voltage				
Continuous reverse voltage at T_{amb} = 25 °C	V_R	max.	25	V
Power dissipation				
Total power dissipation at T_{amb} = 25 °C	P_{tot}	max.	250	mW
Temperature				
Storage temperature	T_{stg}	-65 to +200		°C

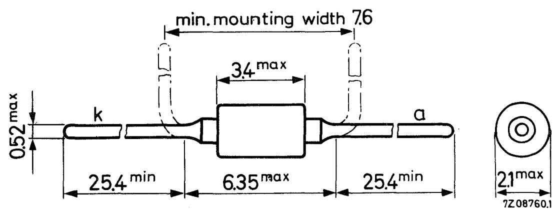
THERMAL RESISTANCE

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

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

Forward voltage				
I_F = 30 mA	V_F	<	1	V
Reverse breakdown voltage				
I_R = 5 μA	$V_{(BR)R}$	>	35	V
Reverse currents				
V_R = 25 V	I_R	<	0.1	μA
V_R = 25 V; T_{amb} = 150 °C	I_R	<	100	μA
Diode capacitance				
V_R = 0; f = 1 MHz	C_d	<	4	pF

MECHANICAL DATA Dimensions in mm



Colour code according to E.I.A.

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

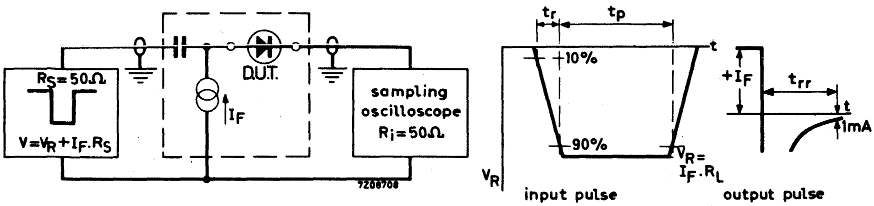
CHARACTERISTICS (continued) T_{amb} = 25 °C unless otherwise specified

Reverse recovery time when switched from

I_F = 10 mA to V_R; R_L = 100 Ω

measured at I_R = 1 mA; switched to V_R = 1 V	t_{rr}	<	4	ns
V_R = 6 V	t_{rr}	<	2	ns

Test circuit:



Reverse pulse:

Rise time t_r ≤ 0.5 ns

Oscilloscope:

Rise time t_r ≤ 0.6 ns

Variable capacitance diodes

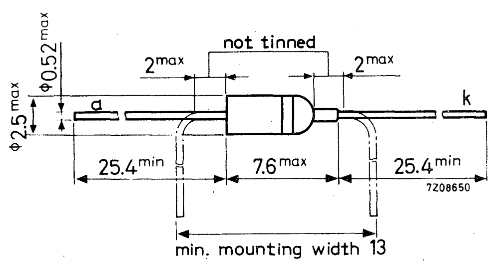
VOLTAGE DEPENDENT CAPACITOR

Silicon voltage dependent capacitor in subminiature all-glass DO-7 construction intended for automatic frequency control in television receivers.

QUICK REFERENCE DATA				
Continuous reverse voltage	V_R	max.	20	V
Reverse current (d.c.)	I_R	max.	100	μA
Junction temperature	T_j	max.	90	^oC
Capacitance ratio	$\frac{C_d (V_R = 10\ V)}{C_d (V_R = 4\ V)}$	<	0.7	

MECHANICAL DATA Dimensions in mm

DO-7



The coloured band indicates the cathode side

RATINGS (Limiting values) [1]

Continuous reverse voltage	V_R	max.	20	V
Reverse current (d.c.)	I_R	max.	100	μA
Junction temperature	T_j	max.	90	^oC
Storage temperature	T_{stg}		-55 to +90	^oC

THERMAL RESISTANCE

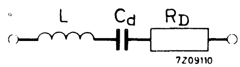
From junction to ambient in free air $R_{th\ j\text{-}a}$ = 0.4 $^oC/mW$

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

CHARACTERISTICS T_j = 25 °C unless otherwise specified

Reverse current at T_j = 80 °C; V_R = 20 V	I_R	<	5	μA
Diode capacitance; V_R = 4 V; f = 0.5 MHz	C_d		20 to 45	pF [1]
Capacitance ratio at f ≤ 300 MHz	$\frac{C_d\ (V_R = 10\ V)}{C_d\ (V_R = 4\ V)}$	<	0.7	
Series resistance at V_R = 4 V	r_D	typ.	1.7	Ω
		<	3	Ω

Simplified equivalent circuit



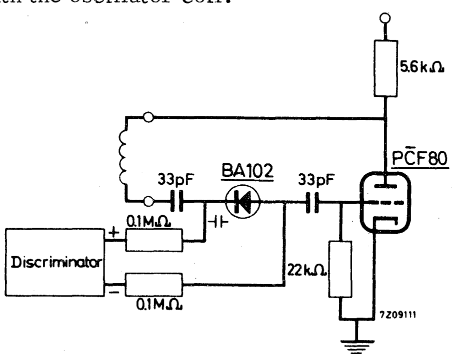
L = lead inductance ≈ 6 nH
r_D = series resistance
C_d = diode capacitance (see page 3)

} frequency independent up to f = 300 MHz

These data apply at a distance between the two measuring points of 10 mm.

APPLICATION INFORMATION

Basic circuit for automatic frequency control in television receivers using the BA102 in series with the oscillator coil.

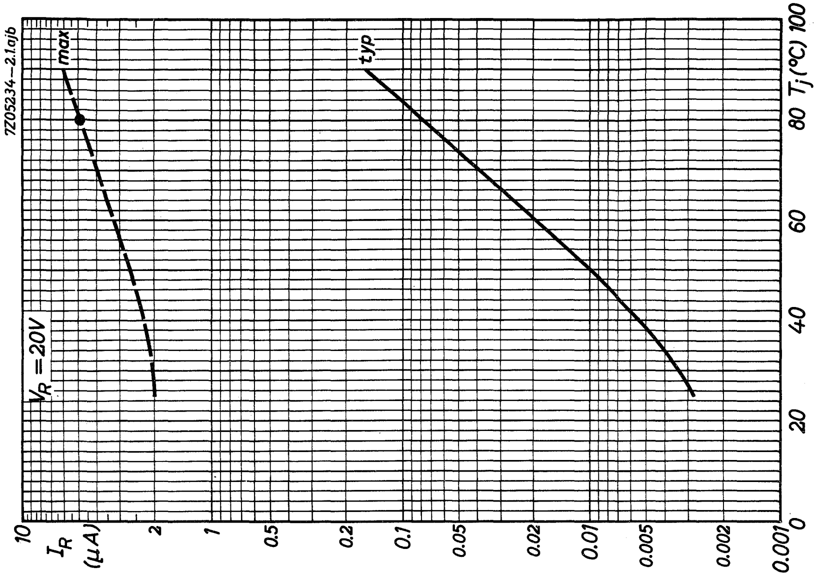


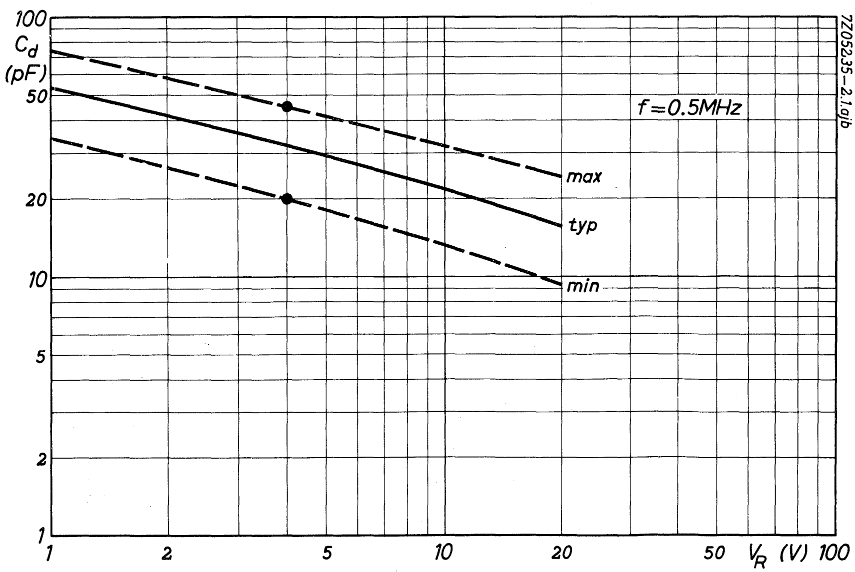
Sensitivity of the discriminator	:	25 V/MHz
Reduction of the frequency deviation Band I	:	1:10
Band III	:	1:25

[1]) For convenience reasons only the spread in the magnitude of C_d is indicated in more detail by means of coloured dots.

At V_R = 4 V; f = 0.5 MHz; T_j = 25 °C

white dot	: C_d	20 to 24	pF
yellow dot	: C_d	24 to 30	pF
blue dot	: C_d	30 to 37	pF
green dot	: C_d	37 to 45	pF


7Z05234-2.1.ajb
max
typ
VR = 20V
IR (μA)
Tj (°C)
10
2
1
0.5
0.2
0.1
0.05
0.02
0.01
0.005
0.002
0.001
0
20
40
60
80
100


Cd (pF)
100
50
20
10
5
2
1
f=0.5MHz
max
typ
min
7Z05235-2.1.ajb
1
2
5
10
20
50
VR (V)
100

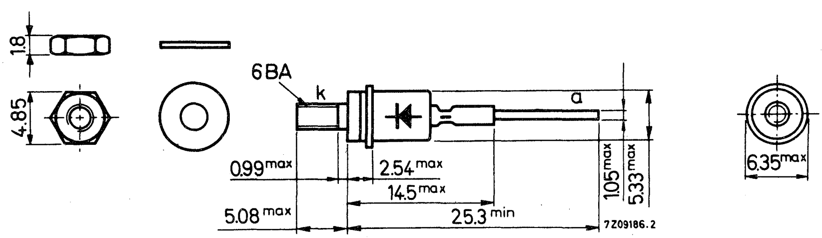
SILICON DOUBLE DIFFUSED VARACTOR DIODE

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

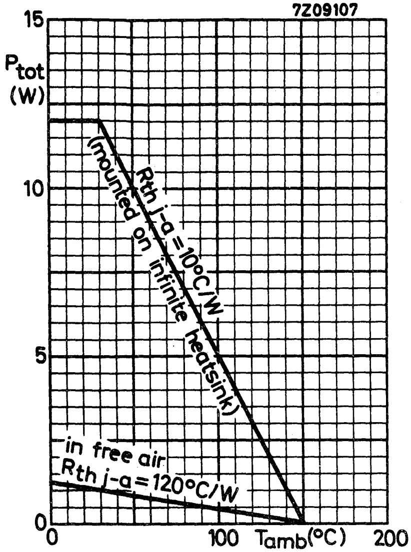
THERMAL RESISTANCE

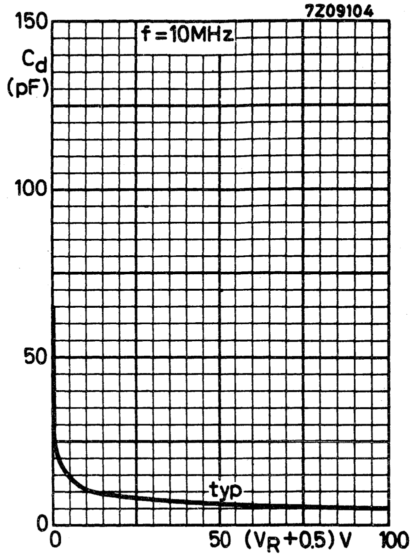
From junction to ambient in free air	$R_{th\ j\text{-}a}$	=	120	°C/W
From junction to mounting base	$R_{th\ j\text{-}mb}$	=	10	°C/W

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.

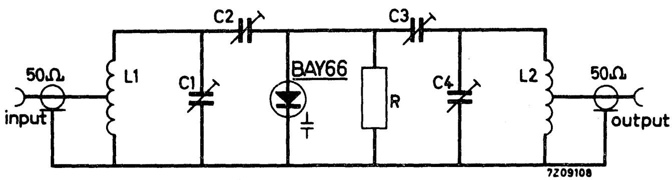




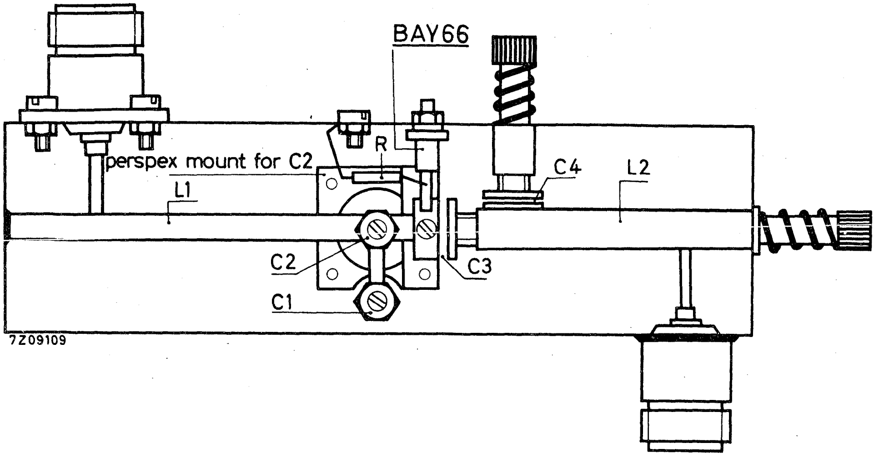
APPLICATION INFORMATION

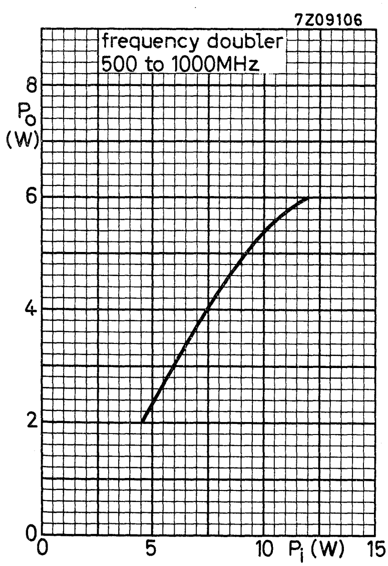
Frequency doubler 500 MHz to 1000 MHz.

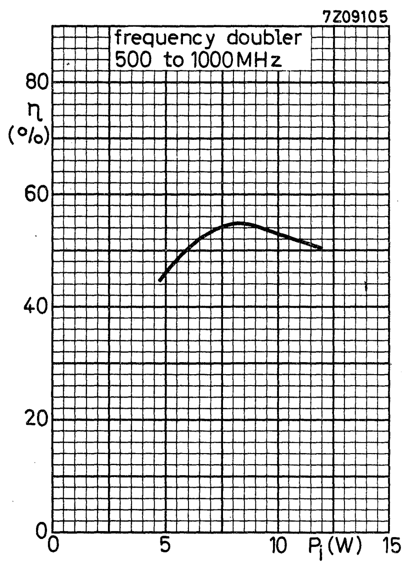
Overall efficiency η typ. 50 %



R = 100 kΩ
C1 = C2 = 3.5 pF (trimmer)
C3 = C4 = two disks of 10 mm diameter, with variable distance
L1 = silver plated brass strip; cross section 4 x 1.5 mm; length 59 mm, height above chassis 8 mm; tap at 14 mm from earth.
L2 = silver plated brass rod; diameter 7 mm; length 46 mm, centre height above chassis 14 mm; tap at 11 mm from earth.


BAY66
R
perspex mount for C2
L1
C4
L2
C2
C3
C1
7Z09109


7Z09106
frequency doubler
500 to 1000MHz
P_o
(W)
8
6
4
2
0
0
5
10
P_i (W)
15


7Z09105
frequency doubler
500 to 1000MHz
η
(%)
80
60
40
20
0
0
5
10
P_i (W)
15

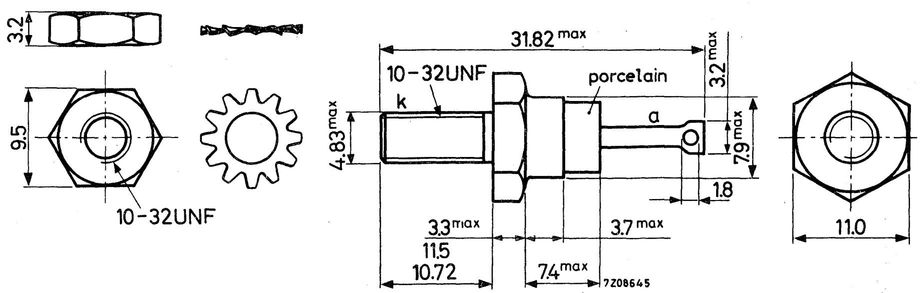
SILICON PLANAR EPITAXIAL VARACTOR DIODE

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	Ω
		<	1.2	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.

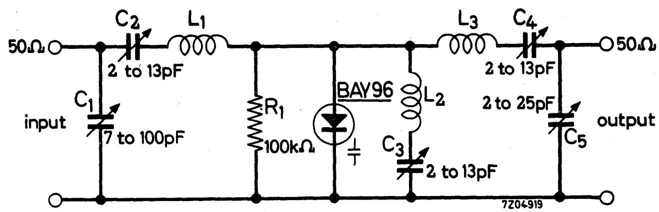
The function of the input and output networks is to provide impedance matching, and at the same time eliminate undesired r.f. current components, minimizing losses. A single tuned circuit is insufficient for the reduction of spurious response and therefore, a suitable output filter should follow the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

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

APPLICATION INFORMATION (continued)

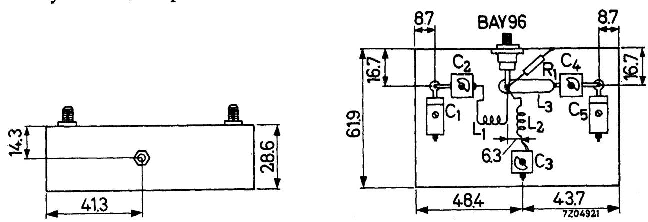
140 to 450 MHz tripler circuit

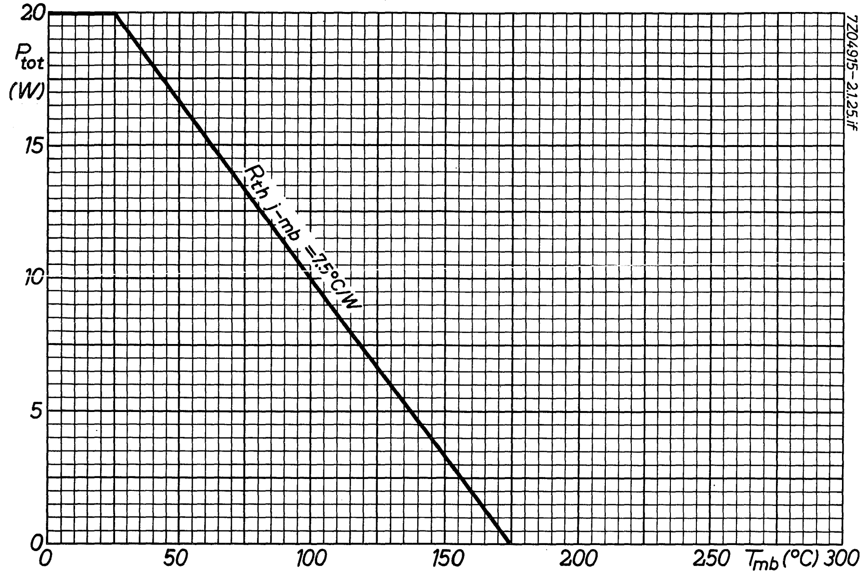
Efficiency at P_I = 25 W	η	>	60 %
		typ.	64 %

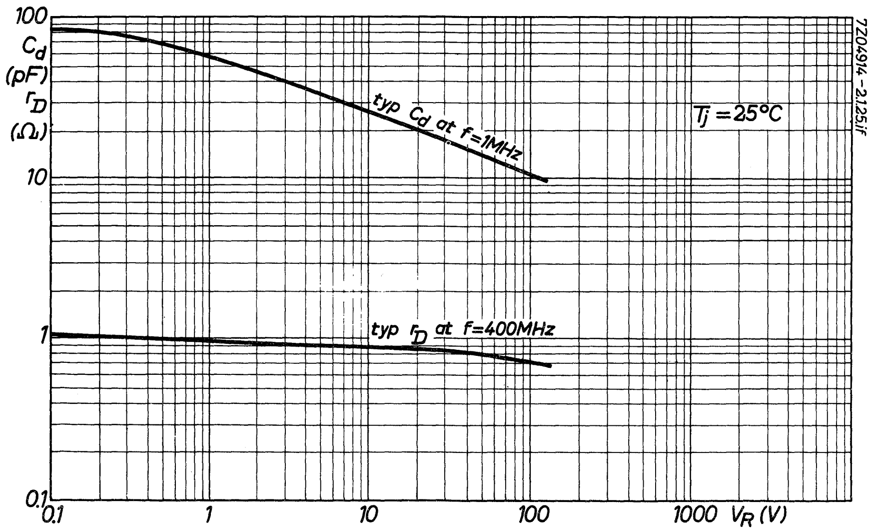


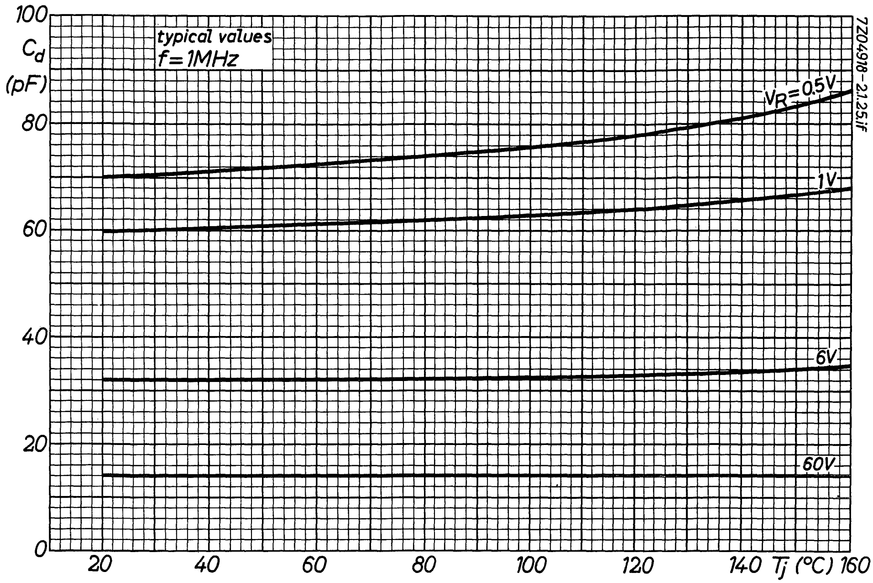
L_1 = 6.5 turns; d = 1.3 mm. Length of coil: 14.3 mm, inner diameter: 7.5 mm.
L_2 = 2 turns; d = 2 mm. Length of coil: 7.9 mm, inner diameter: 6.7 mm.
L_3 = copper strip, cross section 6.3 x 0.5 mm^2, length: 25.4 mm, height above chassis: 14.3 mm.

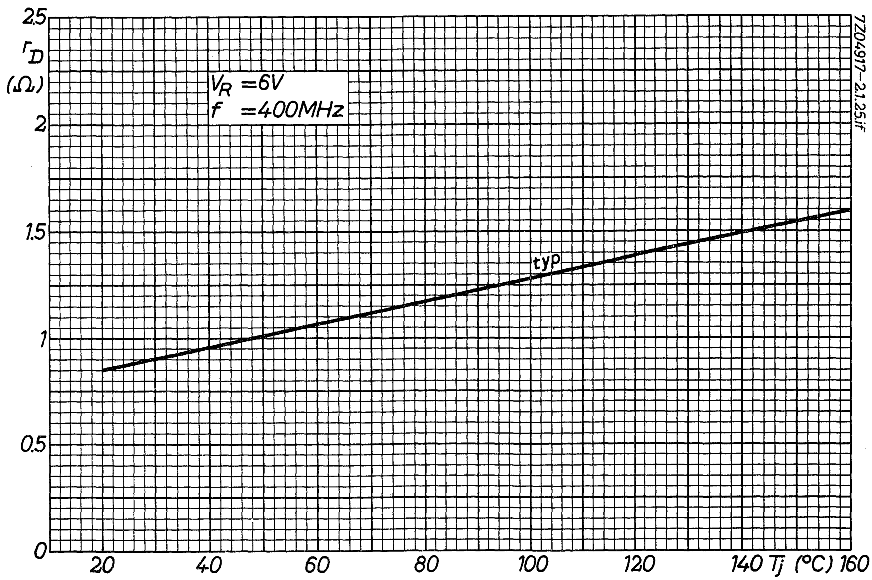
Component lay-out of tripler circuit: Dimensions in mm




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


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


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

SILICON PLANAR VARIABLE CAPACITANCE DIODES

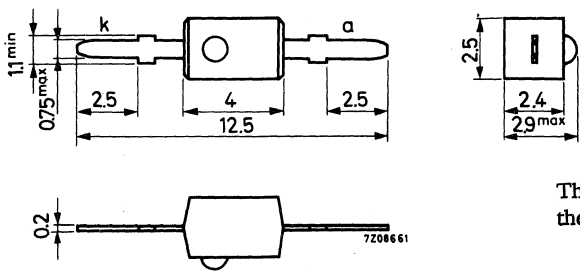
The BB105A is intended for use in u.h.f. tuners up to frequencies of 790 MHz.
The BB105B is meant for u.h.f. tuners up to frequencies of 860 MHz.
The BB105G is meant for v.h.f. tuners.
Twelve matched diodes are delivered together, thus containing 4 triplets or 3 quadruplets.
The capacitance difference between any two of the twelve diodes is less than 3% for the BB105A and BB105B and less than 6% for the BB105G over the voltage range from 0.5 to 28 V.

QUICK REFERENCE DATA

			BB105A	BB105B	BB105G	
Reverse voltage	V_R	max.	28			V
Reverse current at V_R = 28 V	I_R	<	100			nA
Diode capacitance at f = 1 MHz, V_R = 25 V	C_d	>	2.3	2.0	1.8	pF
		<	2.8	2.3	2.8	pF
Capacitance ratio at f = 1 MHz	$\frac{C_d(V_R = 3\ V)}{C_d(V_R = 25\ V)}$	>	4	4.5	4	
		<	5	6	6	
Series resistance at f = 470 MHz, V_R is that value at which C_d = 9 pF	r_D	typ.	0.6	0.7	0.9	Ω
		<	0.8	0.8	1.2	Ω

MECHANICAL DATA Dimensions in mm

12-BB105A and B: marked on packing
12-BB105G : green dot on the envelope



The dot indicates the cathode side

The sealing of the plastic envelope withstands the accelerated dampheat test of IEC recommendation 68-2 (test D, severity IV, 6 cycles).

RATINGS (Limiting values) [1]

Continuous reverse voltage	V_R	max.	28	V
Reverse voltage (peak value)	V_{RM}	max.	30	V
Forward current (d.c.)	I_F	max.	20	mA
Storage temperature	T_{stg}		−55 to +60	°C
Junction temperature	T_j	max.	60	°C

THERMAL RESISTANCE

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

CHARACTERISTICS T_j = 25 °C unless otherwise specified

			BB105A	BB105B	BB105G	
Reverse current						
V_R = 28 V	I_R	<	100	100	100	nA
V_R = 28 V; T_j = 60 °C	I_R	<	1	1	1	µA
Diode capacitance at f = 1 MHz						
V_R = 1 V	C_d	typ.	17	17.5	17.5	pF
V_R = 3 V	C_d	typ.	11.5	11.5	11.5	pF
V_R = 25 V	C_d	>	2.3	2.0	1.8	pF
		<	2.8	2.3	2.8	pF
Capacitance ratio at f = 1 MHz	$\frac{C_d(V_R = 3\ V)}{C_d(V_R = 25\ V)}$	>	4	4.5	4	
		<	5	6	6	
Series resistance at f = 470 MHz						
V_R is that value at which C_d = 9 pF	r_D	typ.	0.6	0.7	0.9	Ω
		<	0.8	0.8	1.2	Ω
I_F = 5 mA; f = 200 MHz	r_D	typ.	0.4	0.4	0.4	Ω

MOUNTING AND SOLDERING INSTRUCTIONS

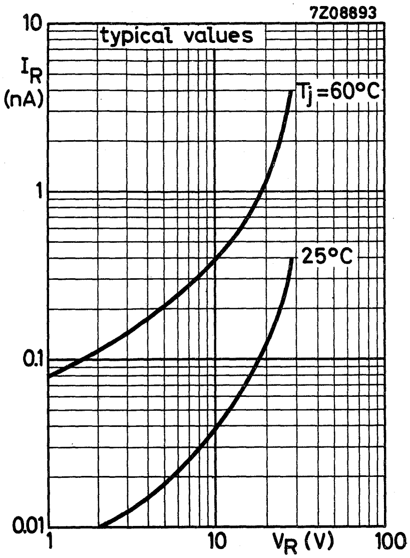
Mounting

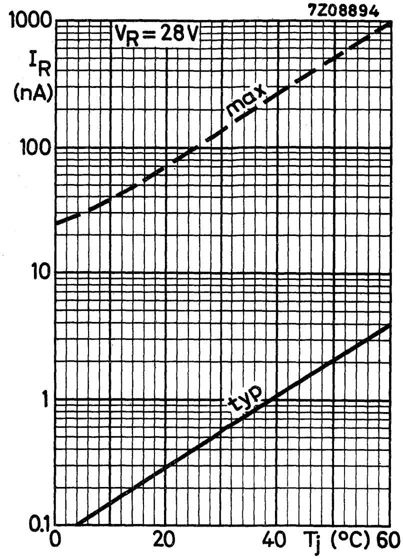
The leads must not be bent with a radius of less than 0.5 mm near the seal. (This can be done by hand if care is taken to exert no pulling force).

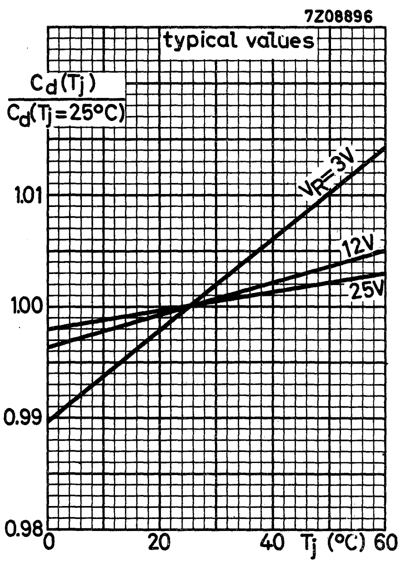
Soldering

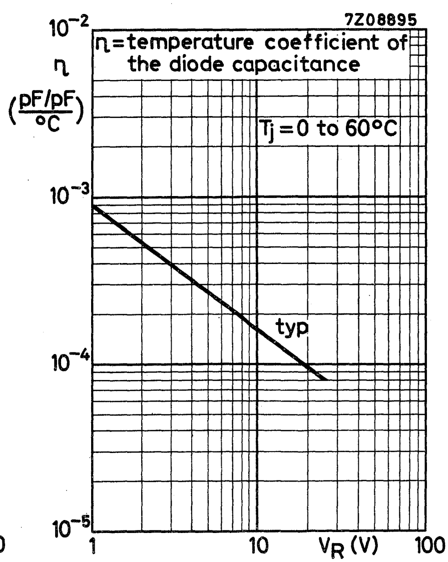
At a maximum iron or solder temperature of 300 °C, the maximum permissible soldering time is 3 seconds. The soldering spot may be at any distance from the seal. During soldering, care must be taken that the plastic body does not come into contact with any temperature higher than 125 °C.

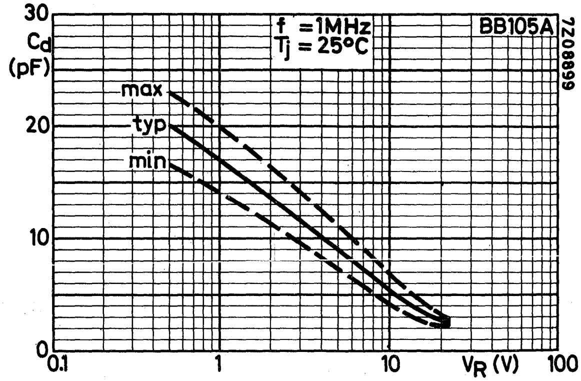
1) Limiting values according to the Absolute Maximum System as defined in IEC publication 134.

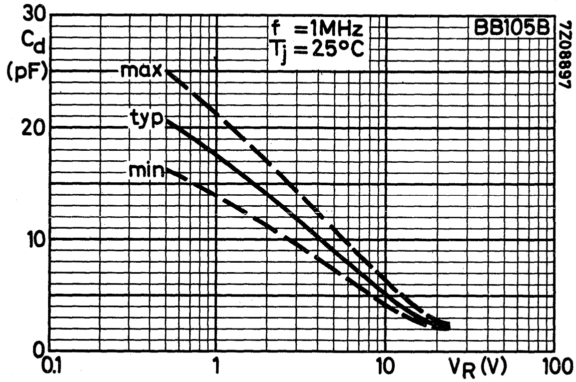

7Z08893
typical values
I_R (nA)
$T_j = 60°C$
25°C
V_R (V)
10
1
0.1
0.01
1
10
100

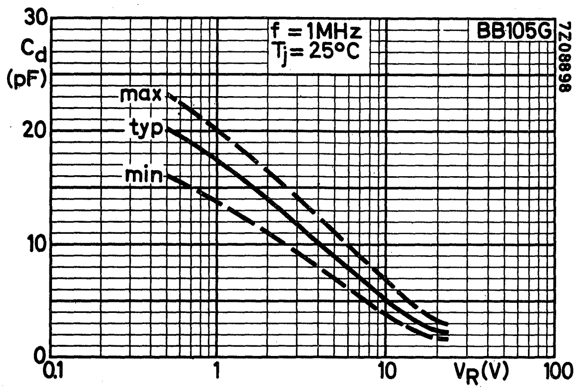

7Z08894
$V_R = 28V$
I_R (nA)
max
typ
T_j (°C)
1000
100
10
1
0.1
0
20
40
60


7Z08896
typical values
$\frac{C_d(T_j)}{C_d(T_j = 25°C)}$
$V_R = 3V$
12V
25V
T_j (°C)
1.01
1.00
0.99
0.98
0
20
40
60


7Z08895
η = temperature coefficient of the diode capacitance
η ($\frac{pF/pF}{°C}$)
$T_j = 0$ to 60°C
typ
V_R (V)
10^{-2}
10^{-3}
10^{-4}
10^{-5}
1
10
100


30
C_d
(pF)
20
10
0
0.1
1
10
100
V_R (V)
f = 1MHz
T_j = 25°C
BB105A
7Z08899
max
typ
min


30
C_d
(pF)
20
10
0
0.1
1
10
100
V_R (V)
f = 1MHz
T_j = 25°C
BB105B
7Z08897
max
typ
min


30
C_d
(pF)
20
10
0
0.1
1
10
100
V_R (V)
f = 1MHz
T_j = 25°C
BB105G
7Z08898
max
typ
min

Voltage regulator diodes

TYPE SELECTION CHART

Reference voltage ±5% V_Z (V)	400 mW DO-7	1.5 W DO-1	20 W DO-4	75 W DO-5
			Reverse polarity available	
3.3	BZY88-C3V3			
3.6	-C3V6			
3.9	-C3V9			
4.3	-C4V3			
4.7	-C4V7	BZY96-C4V7		
5.1	-C5V1	-C5V1		
5.6	-C5V6	-C5V6		
6.2	-C6V2	-C6V2		
6.8	-C6V8	-C6V8	BZY93-C6V8	
7.5	-C7V5	-C7V5	-C7V5	BZY91-C7V5
8.2	-C8V2	-C8V2	-C8V2	-C8V2
9.1	-C9V1	-C9V1	-C9V1	-C9V1
10	-C10	BZY95-C10	-C10	-C10
11	-C11	-C11	-C11	-C11
12	-C12	-C12	-C12	-C12
13	-C13	-C13	-C13	-C13
15	-C15	-C15	-C15	-C15
16	-C16	-C16	-C16	-C16
18	-C18	-C18	-C18	-C18
20	-C20	-C20	-C20	-C20
22	-C22	-C22	-C22	-C22
24	-C24	-C24	-C24	-C24
27	-C27	-C27	-C27	-C27
30	-C30	-C30	-C30	-C30
33	BZY94-C33	-C33	-C33	-C33
36	-C36	-C36	-C36	-C36
39	-C39	-C39	-C39	-C39
43	-C43	-C43	-C43	-C43
47	-C47	-C47	-C47	-C47
51	-C51	-C51	-C51	-C51
56	-C56	-C56	-C56	-C56
62	-C62	-C62	-C62	-C62
68	-C68	-C68	-C68	-C68
75	-C75	-C75	-C75	-C75

Diode with extremely low temperature coefficient

Type	Temperature coefficient S_Z (%/°C)	Reference voltage V_Z (V)	Envelope
BZY78	0.005	5.3	DO-7

LOW POWER VOLTAGE REGULATORS

Alloyed silicon diodes in a DO-7 envelope intended for use as low power voltage stabilisers or voltage references.
Zener voltage range from 4.7 to 9.1 V with a tolerance of ± 5%.

RATINGS (Limiting values) [1]

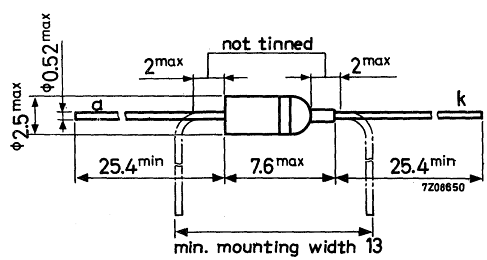
Forward current (d.c.)	I_F	max.	50	mA
Zener current (d.c.)	I_Z	max.	25	mA
Total power dissipation up to T_{amb} = 25 °C	P_{tot}	max.	280	mW
Storage temperature	T_{stg}		−55 to +150	°C
Junction temperature	T_j	max.	150	°C

THERMAL RESISTANCE

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

MECHANICAL DATA Dimensions in mm

DO-7



The coloured band indicates the cathode side

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

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

Forward voltage at I_F = 0.1 mA	V_F	typ.	0.61	V
I_F = 10 mA	V_F	typ.	0.76	V
Reverse current at V_R = 1.0 V; T_{amb} = 60 °C	I_R	typ.	4	nA

	Zener voltage at I_Z = 1 mA min.	nom.	max.	Temperature coefficient at I_Z = 1 mA typ.	Differential resistance at I_Z = 1 mA typ.
BZY56	4.4	4.7	5.0 V	−2.0 mV/°C	370 Ω
BZY57	4.8	5.1	5.4 V	−1.8 mV/°C	360 Ω
BZY58	5.3	5.6	6.0 V	−1.0 mV/°C	280 Ω
BZY59	5.8	6.2	6.6 V	+0.5 mV/°C	200 Ω
BZY60	6.4	6.8	7.2 V	+2.7 mV/°C	5.0 Ω
BZY61	7.1	7.5	7.9 V	+4.0 mV/°C	8.0 Ω
BZY62	7.7	8.2	8.7 V	+5.0 mV/°C	6.2 Ω
BZY63	8.6	9.1	9.6 V	+6.2 mV/°C	8.0 Ω

	Zener voltage at I_Z = 5 mA typ.	Temperature coefficient at I_Z = 5 mA typ.	Differential resistance at I_Z = 5 mA typ.
BZY56	5.2 V	−1.2 mV/°C	62 Ω
BZY57	5.6 V	−0.5 mV/°C	50 Ω
BZY58	6.0 V	+1.0 mV/°C	28 Ω
BZY59	6.3 V	+1.8 mV/°C	12 Ω
BZY60	6.9 V	+3.1 mV/°C	3.5 Ω
BZY61	7.6 V	+4.3 mV/°C	2.8 Ω
BZY62	8.25 V	+5.2 mV/°C	3.2 Ω
BZY63	9.2 V	+6.4 mV/°C	4.4 Ω

	Zener voltage at I_Z = 20 mA typ.	Temperature coefficient at I_Z = 20 mA typ.	Differential resistance at I_Z = 20 mA typ.
BZY56	5.6 V	0.0 mV/°C	9.5 Ω
BZY57	5.9 V	+1.0 mV/°C	6.0 Ω
BZY58	6.2 V	+2.0 mV/°C	3.2 Ω
BZY59	6.4 V	+2.5 mV/°C	2.0 Ω
BZY60	7.0 V	+3.6 mV/°C	1.5 Ω
BZY61	7.7 V	+4.6 mV/°C	1.7 Ω
BZY62	8.4 V	+5.5 mV/°C	2.0 Ω
BZY63	9.4 V	+6.6 mV/°C	2.7 Ω

LOW POWER VOLTAGE REGULATORS

Alloyed silicon diodes in a DO-7 envelope intended for use as low power voltage stabilisers or voltage references.
Zener voltage range from 4.3 to 12.0 V with a tolerance of ±15%.

RATINGS (Limiting values) [1])

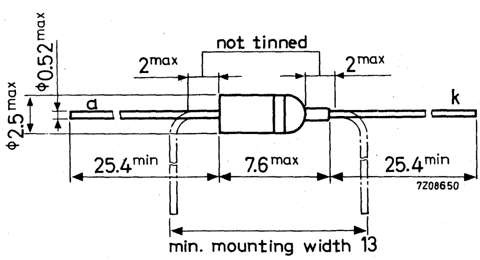
Forward current (d.c.)	I_F	max.	50	mA
Zener current (d.c.)	I_Z	max.	25	mA
Total power dissipation up to T_{amb} = 25 °C	P_{tot}	max.	280	mW
Storage temperature	T_{stg}	-55 to +150		°C
Junction temperature	T_j	max.	150	°C

THERMAL RESISTANCE

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

MECHANICAL DATA Dimensions in mm

DO-7



The coloured band indicates the cathode side

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

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

Forward voltage at I_F = 0.1 mA	V_F	typ.	0.61	V
I_F = 10 mA	V_F	typ.	0.76	V
Reverse current at V_R = 1.0 V; T_{amb} = 60 °C	I_R	typ.	4	nA

	Zener voltage at I_Z = 1 mA min.	nom.	max.	Temperature coefficient at I_Z = 1 mA typ.	Differential resistance at I_Z = 1 mA typ.
BZY64	3.3	4.3	5.0 V	−2.2 mV/°C	375 Ω
BZY65	4.4	5.1	6.0 V	−1.8 mV/°C	360 Ω
BZY66	5.3	6.2	7.2 V	+0.5 mV/°C	200 Ω
BZY67	6.4	7.5	8.7 V	+4.0 mV/°C	8.0 Ω
BZY68	7.7	9.1	10.6 V	+6.2 mV/°C	8.0 Ω
BZY69	9.4	12.0	15.0 V	+9.2 mV/°C	21 Ω

	at I_Z = 5 mA typ.	at I_Z = 5 mA typ.	at I_Z = 5 mA typ.
BZY64	4.9 V	−1.7 mV/°C	77 Ω
BZY65	5.6 V	−0.5 mV/°C	50 Ω
BZY66	6.3 V	+1.8 mV/°C	12 Ω
BZY67	7.6 V	+4.3 mV/°C	2.8 Ω
BZY68	9.2 V	+6.4 mV/°C	3.5 Ω
BZY69	12.2 V	+9.3 mV/°C	11 Ω

	at I_Z = 20 mA typ.	at I_Z = 20 mA typ.	at I_Z = 20 mA typ.
BZY64	5.3 V	−1.2 mV/°C	12 Ω
BZY65	5.9 V	+1.0 mV/°C	6.0 Ω
BZY66	6.4 V	+2.5 mV/°C	2.0 Ω
BZY67	7.7 V	+4.6 mV/°C	1.7 Ω
BZY68	9.4 V	+6.6 mV/°C	3.0 Ω
BZY69	12.5 V	+9.4 mV/°C	7.0 Ω

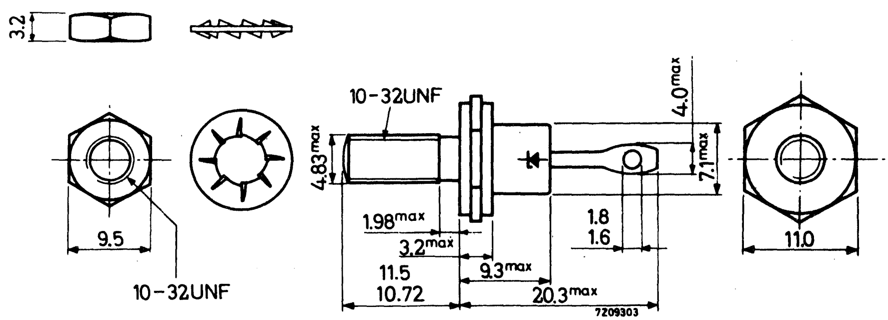
MEDIUM POWER VOLTAGE REGULATORS

Alloyed silicon diodes in a DO-4 metal envelope for use as medium power voltage stabilisers or voltage references.
Zener voltage range from 6.2 to 9.1 V with a tolerance of ±15%.

QUICK REFERENCE DATA				
Zener voltage range		nom.	6.2 to 9.1	V
Zener voltage tolerance			±15	%
Repetitive peak zener current	I_{ZRM}	max.	7	A
Total power dissipation up to T_{mb} = 50 °C	P_{tot}	max.	10	W
Non repetitive peak reverse power dissipation	P_{ZSM}	max.	45	W
Junction temperature	T_j	max.	150	°C
Thermal resistance from junction to mounting base	$R_{th\ j\text{-}mb}$	=	10	°C/W

MECHANICAL DATA Dimensions in mm

DO-4



Net weight : 4.3 g

With accessories: 6.5 g

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])

Currents

Average forward current (averaged over any 20 ms period)	I_{FAV}	max.	0.5	A
Repetitive peak forward current	I_{FRM}	max.	7	A
Repetitive peak zener current	I_{ZRM}	max.	7	A

Power dissipation

Total power dissipation up to T_{mb} = 50 °C	P_{tot}	max.	10	W
Non repetitive peak reverse power ($t < 100\ \mu s$)	P_{ZSM}	max.	45	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	$R_{th\ j\text{-}a}$	=	70	°C/W
From junction to mounting base	$R_{th\ j\text{-}mb}$	=	10	°C/W

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

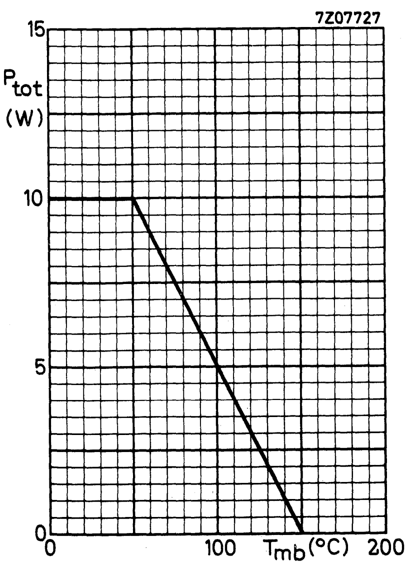
Forward voltage at I_F = 200 mA V_F < 1.0 V

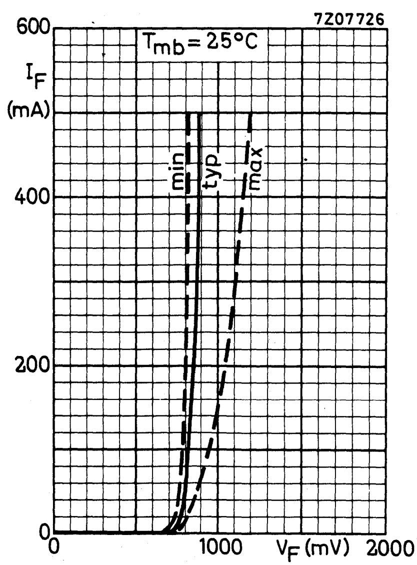
			BZY74	BZY75	BZY76	
Reverse current						
V_R = 2.0 V	I_R	<	50			μA
V_R = 3.0 V	I_R	<		50	50	μA
Diode capacitance						
V_R = 2.0 V	C_d	typ.		350	250	pF
V_R = 3.0 V	C_d	typ.	475			pF

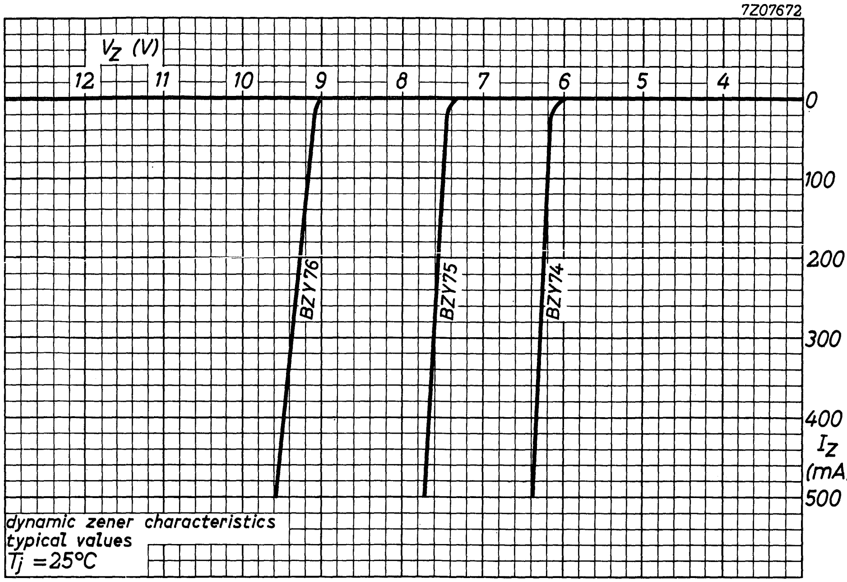
[1]) Limiting values according to the Absolute Maximum System as defined in IEC publication 134.

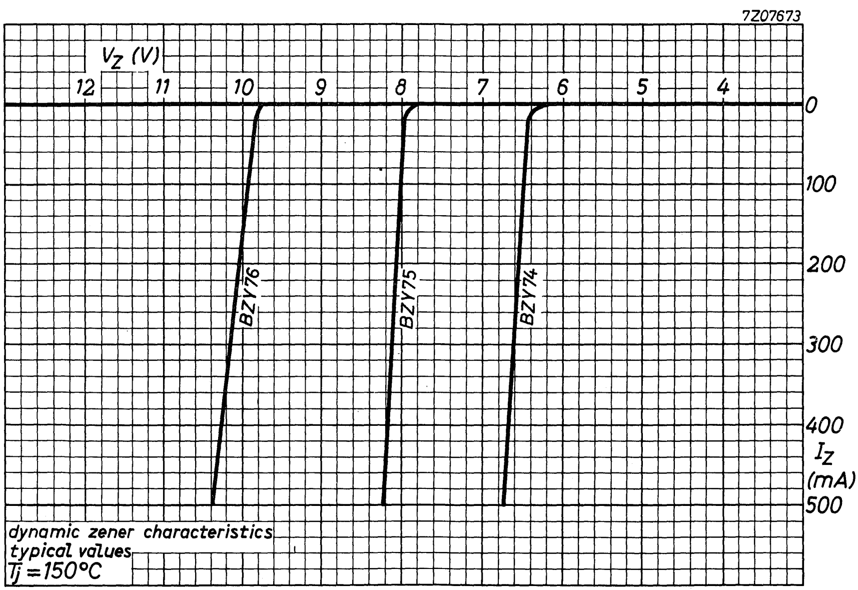
CHARACTERISTICS (continued) T_{mb} = 25 °C unless otherwise specified

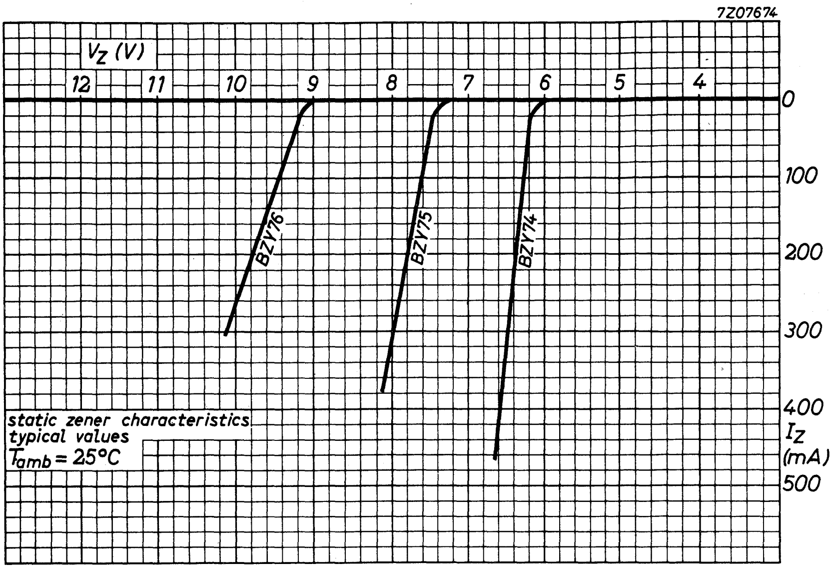
	Zener voltage at I_Z = 20 mA				Temperature coefficient at I_Z = 20 mA	Differential resistance at I_Z = 20 mA		
	min.	nom.	max.		typ.	typ.	max.	
BZY74	5.3	6.2	7.2	V	+2.1 mV/°C	2.2	5.0	Ω
BZY75	6.4	7.5	8.7	V	+3.8 mV/°C	2.3	10	Ω
BZY76	7.7	9.1	10.6	V	+5.8 mV/°C	3.7	17	Ω
	at I_Z = 100 mA				at I_Z = 100 mA	at I_Z = 100 mA		
	min.	nom.	max.		typ.	typ.	max.	
BZY74	5.5	6.3	7.4	V	+2.5 mV/°C	1.1	2.5	Ω
BZY75	6.4	7.6	9.0	V	+4.1 mV/°C	1.2	5.0	Ω
BZY76	7.8	9.3	11	V	+6.1 mV/°C	1.7	5.0	Ω

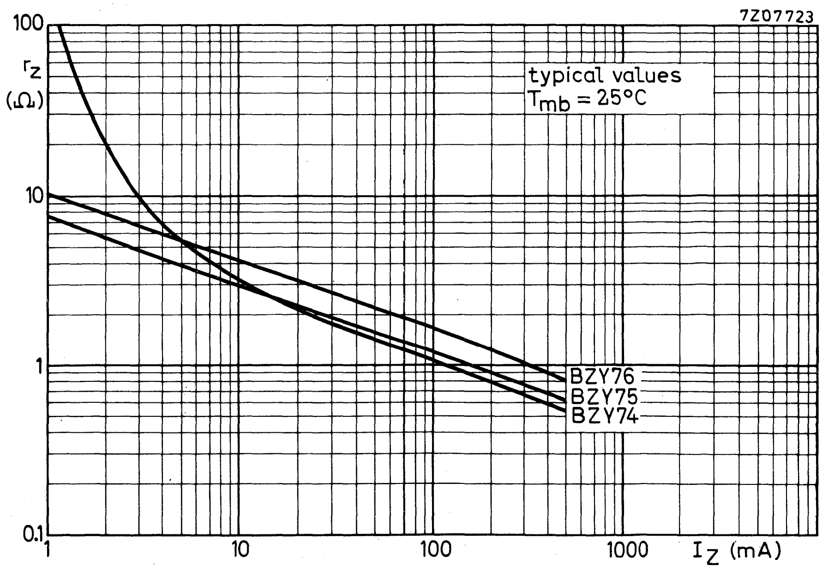


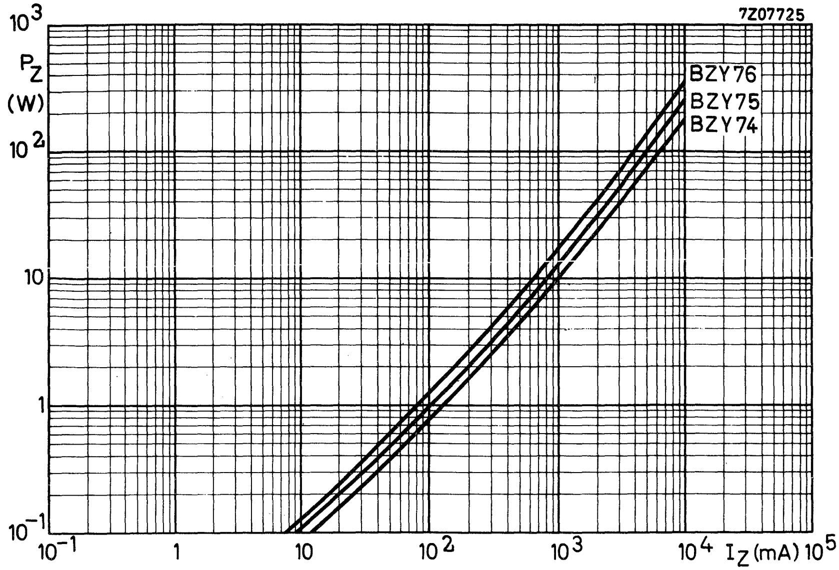


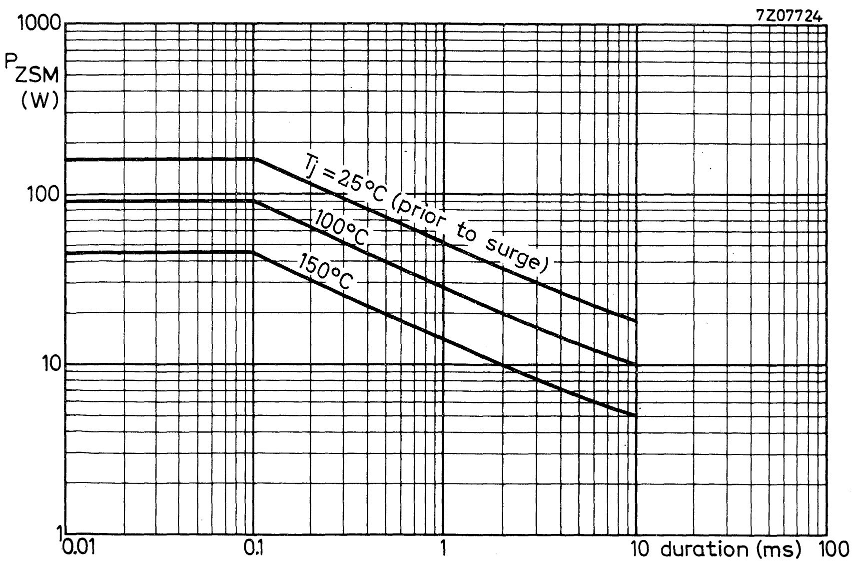

7Z07672
V_Z (V)
12
11
10
9
8
7
6
5
4
0
100
200
300
400
500
I_Z (mA)
BZY76
BZY75
BZY74
dynamic zener characteristics
typical values
T_j = 25°C


7Z07673
V_Z (V)
12
11
10
9
8
7
6
5
4
0
100
200
300
400
500
I_Z (mA)
BZY76
BZY75
BZY74
dynamic zener characteristics
typical values
T_j = 150°C


7Z07674
V_Z (V)
12
11
10
9
8
7
6
5
4
0
100
200
300
400
I_Z
(mA)
500
BZY76
BZY75
BZY74
static zener characteristics
typical values
T_{amb} = 25°C


7Z07723
100
r_Z
(Ω)
10
1
0.1
1
10
100
1000
I_Z (mA)
typical values
T_{mb} = 25°C
BZY76
BZY75
BZY74


7Z07725
P_Z
(W)
10^3
10^2
10
1
10^{-1}
BZY76
BZY75
BZY74
10^{-1}
1
10
10^2
10^3
10^4
I_Z (mA)
10^5


7Z07724
P_{ZSM}
(W)
1000
100
10
1
T_j = 25°C (prior to surge)
100°C
150°C
0.01
0.1
1
10
duration (ms)
100

VOLTAGE REFERENCE DIODE

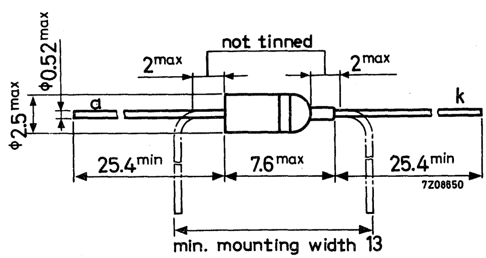
Silicon diode in a DO-7 envelope intended for use as a voltage reference diode in general industrial applications.
The BZY78 has an extremely high voltage stability ($\pm$1% at a zener current of 11.5 mA).

QUICK REFERENCE DATA

Zener voltage at I_Z = 11.5 mA	V_Z	nom.	5.3	V
			5.1 to 5.6	V
Voltage stability at T_{amb} from −50 to 100 °C, I_Z = 11.5 mA $\pm$10%	$\frac{\Delta V_Z}{V_Z}$		−1 to +1	%
Repetitive peak zener current	I_{ZRM}	max.	25	mA
Total power dissipation up to T_{amb} = 25 °C	P_{tot}	max.	280	mW
Junction temperature	T_j	max.	150	°C
Thermal resistance	$R_{th\,j\text{-}a}$	=	0.45	°C/mW

MECHANICAL DATA Dimensions in mm

DO-7



The coloured band indicates the cathode side

RATINGS (Limiting values) [1]

Currents

Average forward current (averaged over any 20 ms period)	I_{FAV}	max.	50	mA
Repetitive peak forward current	I_{FRM}	max.	50	mA
Zener current (d.c. or average over any 20 ms period)	I_Z	max.	25	mA
Repetitive peak zener current	I_{ZRM}	max.	25	mA

Power dissipation

Total power dissipation up to T_{amb} = 25 °C	P_{tot}	max.	280	mW

Temperatures

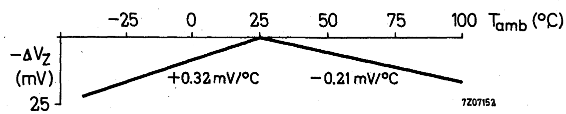
Storage temperature	T_{stg}	−55 to +150	°C
Junction temperature	T_j	max. 150	°C

THERMAL RESISTANCE

From junction to ambient	$R_{th\ j\text{-}a}$	=	0.45	°C/mW

CHARACTERISTICS T_j = 25 °C unless otherwise specified

Zener voltage at I_Z = 11.5 mA	V_Z	nom.	5.3	V
		5.1 to	5.6	V
Forward voltage at I_F = 1 mA	V_F	0.65 to	0.75	V
Reverse current at V_R = 2 V	I_R	<	1.0	μA
Temperature coefficient				
I_Z = 11.5 mA ±10%; T_j = −40 to +25 °C	S_Z	typ.	+0.32	mV/°C
T_j = +25 to +100 °C	S_Z	typ.	−0.21	mV/°C



Differential resistance at I_Z = 11.5 mA	r_z	typ.	18	Ω
		15 to	20	Ω
Voltage stability at T_{amb} = −50 to +100 °C, I_Z = 11.5 mA ±10%	$\frac{\Delta V_Z}{V_Z}$	−1 to	+1	%

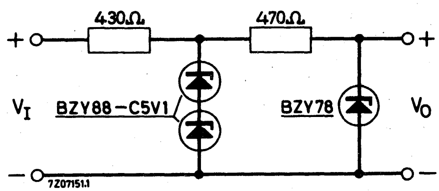
[1] Limiting values according to the Absolute Maximum System as defined in IEC publication 134.

MOUNTING INSTRUCTIONS

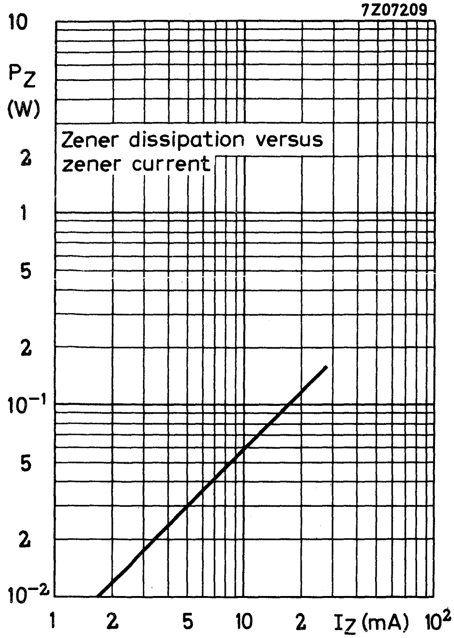
1. When using a soldering iron, the diode may be soldered directly into a circuit, but heat conducted to the junction should be kept to a minimum by use of a thermal shunt.
2. Diodes may be dip soldered at a solder temperature of 245 °C for a maximum soldering time of 5 seconds. The case temperature during dip soldering may exceed the maximum storage temperature for a period not greater than 2 minutes, provided that it at no time exceeds 115 °C. These recommendations apply to a diode with the anode end mounted flush on the board with punched-through holes or spaced at least 1.5 mm above a board with plated-through holes. For mounting the cathode end onto the board the diode must be spaced at least 5 mm from the underside of the printed circuit board in the case of punched-through holes or 5 mm from the top of the board for plated-through holes.
3. Care should be taken not to bend the leads nearer than 1.5 mm from the seals.

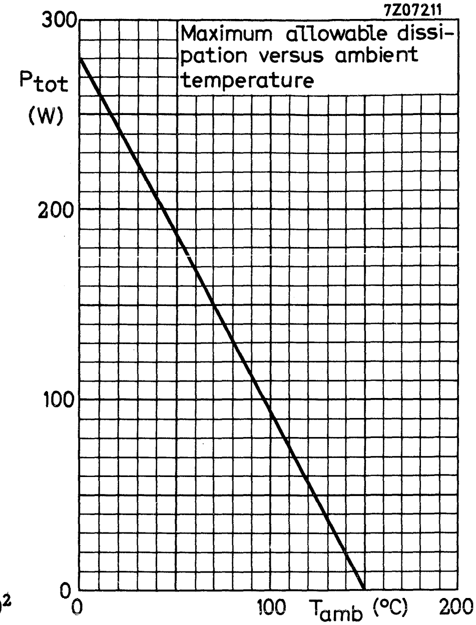
APPLICATION INFORMATION

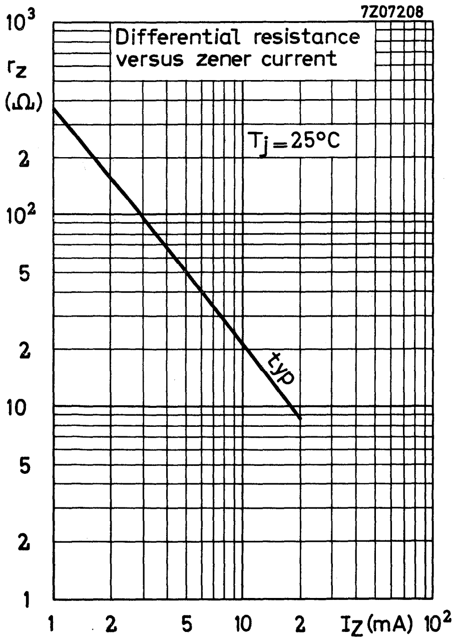
Typical reference-voltage circuit

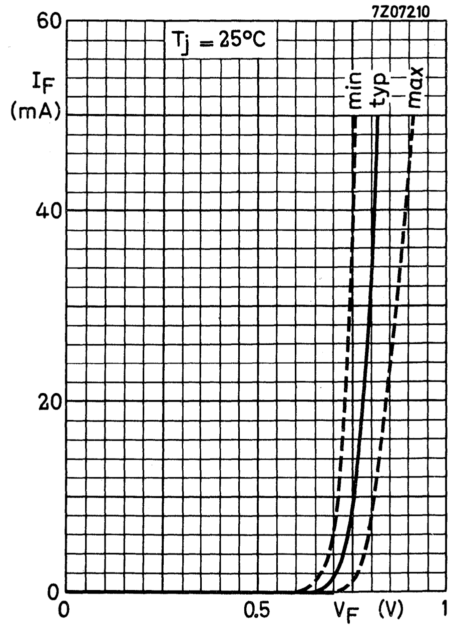


Temperature range	T_{amb}	0 to +50 °C	
Input voltage	V_I	24 V	± 10%
Output voltage	V_O	5.1 to 5.6 V	±0.3%


7Z07209
Zener dissipation versus zener current
P_Z (W)
10
2
1
5
2
10^{-1}
5
2
10^{-2}
1
2
5
10
2
I_Z (mA)
10^2


7Z07211
Maximum allowable dissipation versus ambient temperature
P_{tot} (W)
300
200
100
0
0
100
T_{amb} (°C)
200


7Z07208
Differential resistance versus zener current
r_Z (Ω)
$T_j = 25°C$
typ
10^3
2
10^2
5
2
10
5
2
1
1
2
5
10
2
I_Z (mA)
10^2


7Z07210
$T_j = 25°C$
I_F (mA)
min
typ
max
60
40
20
0
0
0.5
V_F (V)
1

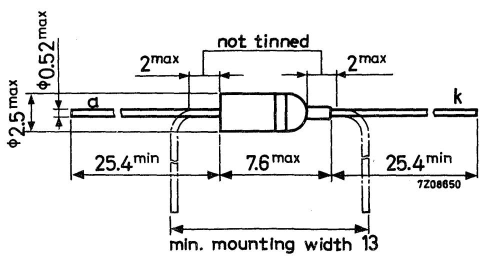
VOLTAGE REGULATOR DIODES

Silicon diodes in subminiature all glass DO-7 envelope for use as low current voltage stabilizers or voltage references.
The series consists of 24 types with nominal zener voltages ranging from 3.3 V to 30 V with a tolerance of ±5%.

QUICK REFERENCE DATA				
Zener voltage range		nom.	3.3 to 30	V
Zener voltage tolerance			±5	%
Repetitive peak zener current	I_{ZRM}	max.	250	mA
Total power dissipation up to T_{amb} = 50 °C	P_{tot}	max.	400	mW
Non repetitive peak reverse power T_j = 150 °C; t = 100 µs	P_{ZSM}	max.	15	W
Junction temperature	T_j	max.	175	°C
Thermal resistance from junction to ambient in free air	$R_{th\ j\text{-}a}$	=	0.31	°C/mW

MECHANICAL DATA Dimensions in mm

DO-7



The band indicates the cathode side

RATINGS (Limiting values) 1)

Currents

→ Forward current (d.c.)	I_F	max.	250	mA
Repetitive peak forward current	I_{FRM}	max.	250	mA
Repetitive peak zener current	I_{ZRM}	max.	250	mA

Power dissipation

→ Total power dissipation up to T_{amb} = 50 °C	P_{tot}	max.	400	mW
Non repetitive peak reverse power T_j = 150 °C; t = 100 μs	P_{ZSM}	max.	15	W

→ Temperatures

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

THERMAL RESISTANCE

From junction to ambient in free air	$R_{th\ j-a}$	=	0.31	°C/mW

→ **CHARACTERISTICS** T_j = 25 °C unless otherwise specified

Forward voltage

I_F = 10 mA	V_F	<	0.9	V

BZY88-...	Zener voltage V_Z at I_Z = 1 mA 2)				Temperature coefficient S_Z at I_Z = 1 mA				Differential resistance r_Z at I_Z = 1 mA			
	min.	nom.	max.		min.	typ.	max.		min.	typ.	max.	
C3V3	2.4	2.75	3.0	V	-4.5	-1.9	-0.5	mV/°C	380	410	440	Ω
C3V6	2.7	3.0	3.3	V	-4.5	-2.05	-0.5	mV/°C	380	410	430	Ω
C3V9	3.0	3.3	3.6	V	-3.5	-2.4	-0.5	mV/°C	380	410	430	Ω
C4V3	3.3	3.6	3.9	V	-2.7	-2.25	-0.5	mV/°C	340	410	430	Ω
C4V7	3.7	4.1	4.3	V	-2.5	-2.0	-0.3	mV/°C	360	390	420	Ω
C5V1	4.3	4.65	5.0	V	-2.1	-1.9	-0.3	mV/°C	300	340	370	Ω
C5V6	4.8	5.3	5.7	V	-1.8	-1.4	0	mV/°C	160	310	350	Ω
C6V2	5.7	5.9	6.5	V	0	+1.6	+3.0	mV/°C	10	100	250	Ω
C6V8	6.5	6.7	6.9	V	+ 2	+3.2	+3.7	mV/°C	5	15	70	Ω
C7V5	7.0	7.45	7.8	V	+ 3	+4.2	+5.9	mV/°C	4.0	8.6	20	Ω
C8V2	7.8	8.1	8.5	V	+4.3	+5.0	+6.0	mV/°C	4.0	10	20	Ω
C9V1	8.55	9.0	9.5	V	+4.5	+6.0	+7.0	mV/°C	7	12	24	Ω

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

2) C3V3 to C9V1 at T_{amb} = 25 °C.

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

BZY88-...	Zener voltage V_Z at I_Z = 5 mA 2)				Temperature coefficient S_Z at I_Z = 5 mA				Differential resistance r_Z at I_Z = 5 mA			
	min.	nom.	max.		min.	typ.	max.		min.	typ.	max.	
C3V3	3.1	3.3	3.5	V	-4.0	-2.3	-0.5	mV/°C	70	83.5	110	Ω
C3V6	3.4	3.6	3.8	V	-3.5	-2.0	-0.5	mV/°C	65	76	105	Ω
C3V9	3.7	3.9	4.1	V	-2.5	-2.05	-0.5	mV/°C	60	76	100	Ω
C4V3	4.0	4.3	4.5	V	-2.5	-1.8	-0.5	mV/°C	55	70	90	Ω
C4V7	4.4	4.7	5.0	V	-2.0	-1.55	0	mV/°C	49	62	85	Ω
C5V1	4.8	5.1	5.4	V	-1.75	-1.2	0	mV/°C	34	46	75	Ω
C5V6	5.3	5.6	6.0	V	-1.5	-0.2	+1.0	mV/°C	10	22	55	Ω
C6V2	5.8	6.2	6.6	V	+0.5	+2.0	+3.5	mV/°C	1	7	27	Ω
C6V8	6.4	6.8	7.2	V	+2.3	+3.2	+3.8	mV/°C	0.5	3.0	15	Ω
C7V5	7.1	7.5	7.9	V	+3.1	+4.2	+5.9	mV/°C	0.5	3.0	15	Ω
C8V2	7.8	8.2	8.7	V	+4.2	+5.0	+6.0	mV/°C	0.9	3.5	20	Ω
C9V1	8.6	9.1	9.6	V	+4.8	+6.0	+7.0	mV/°C	1.0	4.75	25	Ω
C10	9.4	10	10.6	V	–	+7.0	–	mV/°C	–	–	25	Ω
C11	10.4	11	11.6	V	–	+8.7	–	mV/°C	–	–	35	Ω
C12	11.4	12	12.6	V	–	+9.0	–	mV/°C	–	–	35	Ω
C13	12.4	13	14.1	V	–	+10.5	–	mV/°C	–	–	35	Ω
C15	13.9	15	15.6	V	–	+12.5	–	mV/°C	–	–	40	Ω
C16	15.4	16	17.1	V	–	+13	–	mV/°C	–	–	45	Ω
C18	16.9	18	19.1	V	–	+15	–	mV/°C	–	–	50	Ω
C20	18.9	20	21.2	V	–	+17	–	mV/°C	–	–	60	Ω
C22	20.8	22	23.3	V	–	+19	–	mV/°C	–	–	65	Ω
C24	22.7	24	25.9	V	–	+21	–	mV/°C	–	–	75	Ω
C27	25.1	27	28.9	V	–	+23.5	–	mV/°C	–	–	85	Ω
C30	28	30	32	V	–	+26	–	mV/°C	–	–	95	Ω

BZY88-...	at I_Z = 20 mA 2)				at I_Z = 20 mA				at I_Z = 20 mA			
	min.	nom.	typ.		min.	typ.	max.		min.	typ.	max.	
C3V3	3.5	4	4.2	V	-3.3	-2.4	-0.5	mV/°C	16.0	19.5	22	Ω
C3V6	3.9	4.2	4.4	V	-2.5	-1.55	-0.5	mV/°C	16	18	20	Ω
C3V9	4.2	4.45	4.65	V	-2.4	-1.55	-0.5	mV/°C	14	16	18	Ω
C4V3	4.45	4.7	4.95	V	-2.0	-1.5	-0.5	mV/°C	13	15	17	Ω
C4V7	4.9	5.1	5.3	V	-1.5	-0.85	0	mV/°C	12	15	17	Ω
C5V1	5.1	5.35	5.7	V	-1.5	-0.8	0	mV/°C	4	7	11	Ω
C5V6	5.45	5.75	6.1	V	-1.0	+1.0	+3.0	mV/°C	1.5	4.0	8.0	Ω
C6V2	5.95	6.4	6.7	V	+1.0	+2.2	+4.0	mV/°C	0.8	1.4	3.1	Ω
C6V8	6.6	6.9	7.25	V	+2.8	+3.2	+3.8	mV/°C	0.7	1.3	3.0	Ω
C7V5	7.2	7.65	7.95	V	+2.5	+4.2	+5.9	mV/°C	0.5	1.6	5.0	Ω
C8V2	7.9	8.4	8.75	V	+4	+5	+6	mV/°C	0.9	1.8	6.0	Ω
C9V1	8.7	9.4	9.7	V	+5	+6	+7	mV/°C	1.0	1.85	7.0	Ω

2) C3V3 to C9V1 at T_{amb} = 25 °C

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

BZY88-...	Diode capacitance C_d at V_R = 3 V (typ.)	Reverse current I_R at V_R =	typ.	max.	
C3V3	395 pF	1 V	0.54	3.0	μA
C3V6	370 pF	1 V	0.25	3.0	μA
C3V9	335 pF	1 V	0.11	3.0	μA
C4V3	270 pF	1 V	0.1	3.0	μA
C4V7	290 pF	2 V	0.25	3.0	μA
C5V1	275 pF	2 V	0.15	1.0	μA
C5V6	260 pF	2 V	0.6	1.0	μA
C6V2	240 pF	2 V	0.1	1.0	μA
C6V8	220 pF	3 V	0.025	1.0	μA
C7V5	190 pF	3 V	15	500	nA
C8V2	150 pF	3 V	11	400	nA
C9V1	140 pF	5 V	8	400	nA
C10 to C30	–	$\frac{2}{3} \cdot V_{Znom}$	–	2.5	μA

OPERATING NOTES

1. Dissipation and heatsink considerations

a. Steady-state conditions

The maximum allowable steady-state dissipation $P_{s\,max}$ is given by the relationship

$$P_{s\,max} = \frac{T_{j\,max} - T_{amb}}{R_{th\,j\text{-}a}}$$

where T_j max is the maximum permissible operating junction temperature,
T_{amb} is the ambient temperature,
$R_{th\,j\text{-}a}$ is the total thermal resistance from junction to ambient

b. Pulse conditions (see fig. next page)

The maximum allowable additional pulse power $P_{m\,max}$ is given by the formula

$$P_{m\,max} = \frac{(T_{j\,max} - T_{amb}) - (P_s \cdot R_{th\,j\text{-}a})}{R_{th\,t}}$$

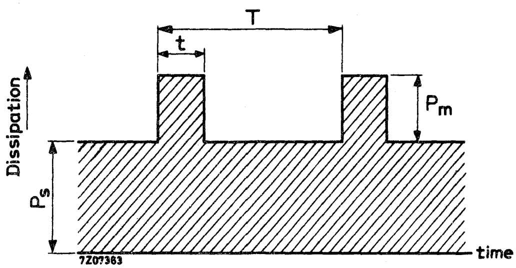
where P_s is the steady-state dissipation, excluding that in the pulses,

$R_{th\,t}$ is the effective transient thermal resistance of the device from junction to ambient. It is a function of the pulse duration t and duty cycle δ (see page 9, lower figure).

δ is the duty cycle and is equal to the pulse duration t divided by the period duration T.

OPERATING NOTES (continued)

The steady-state power P_s when biased in the zener direction at a given zener current can be found from page 13, upper figure. With the additional pulsed power dissipation $P_{m\ max}$ calculated from the above expression, the total repetitive peak zener power dissipation $P_{ZRM} = P_s + P_{m\ max}$. From page 13, upper figure the corresponding maximum repetitive peak zener current at P_{ZRM} can now be read. This repetitive peak zener current is subject to the absolute maximum rating. For pulse durations longer than the temperature stabilization time of the diode t_{stab}, the maximum allowable repetitive peak dissipation P_{ZRM} is equal to the maximum steady-state power $P_{s\ max}$. The temperature stabilization time for the BZY88series is 100 s (see page 9, lower figure).



Example

The following example illustrates how to calculate the maximum permissible repetitive peak zener current of a BZY88-C7V5 zener diode mounted in free air at a maximum ambient temperature of 60 °C. The steady-state zener current is 10 mA, the duty cycle $\delta = 0.1$ and the pulse duration t = 1 ms.

The steady-state dissipation P_s at a zener current of 10 mA (from page 13, upper figure) = 76 mW.
The thermal resistance from junction to ambient $R_{th\ j\text{-}a} = 0.31\ ^oC/mW$.
The transient thermal resistance $R_{th\ t}$ with a duty cycle $\delta = 0.1$ and a pulse duration t = 1 ms (from page 9, lower figure).

$$R_{th\ t} = 41.5\ ^oC/W$$

The maximum additional pulse power dissipation

$$P_{m\ max} = \frac{(T_{j\ max} - T_{amb}) - P_s \cdot R_{th\ j\text{-}a}}{R_{th\ t}}$$

If $P_s = 76$ mW, $R_{th\ t} = 41.5\ ^oC/W$,

$$P_{m\ max} = \frac{(175\text{-}60)\text{-}(0.076 \times 310)}{41.5} = 2.2\ W$$

therefore, the total repetitive peak power dissipation,

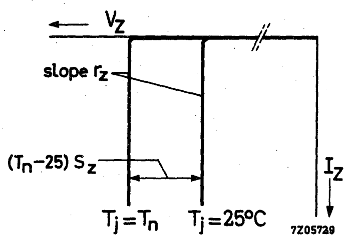
$$P_{ZRM} = 0.076 + 2.2 = 2.28\ W$$

From page 13, upper figure, the corresponding repetitive peak zener current is 250 mA. This is within the rating of the BZY88-C7V5 and is therefore permissible.

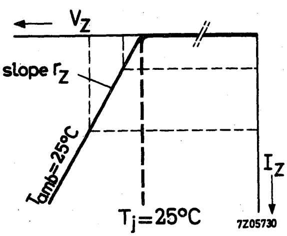
OPERATING NOTES (continued)

2. Zener characteristics

The basic characteristic of a zener diode is the dynamic zener characteristic, that is, the variation of zener voltage when a current pulse is applied in the reverse direction. The slope of this characteristic is r_z. Typical dynamic characteristics at T_j = 25 and 150 °C are given on pages 10 and 11 for each type of diode. Because of the temperature sensitivity of the zener characteristics, the dynamic characteristics at any other operating temperature will be displaced from those at T_j = 25 °C by a voltage corresponding to $S_Z \times (T_n - 25)$ °C, where S_Z is the temperature coefficient of the diode and T_n is a nominal operating temperature. This is illustrated below.



Dynamic characteristics



Static characteristic

The static characteristic of the diode is obtained by connecting the steady-state zener voltages at various direct zener currents and may, therefore, be used to determine the operating point at any zener current. This is shown above. The slope of the static characteristic will depend on

(1) the differential resistance, r_z

(2) the rise in junction temperature due to internal dissipation and the thermal resistance from junction to ambient, $V_Z . I_Z . R_{th\ j\text{-}a}$.

(3) the temperature coefficient of the diode, S_Z

From the above, the static slope resistance r_Z is found to be

$$r_Z = r_z + V_Z . R_{th\ j\text{-}a} . S_Z$$

where r_z is the differential resistance, V_Z is the steady-state zener voltage and is equal to

$$\frac{V_Z'}{1 - I_Z . R_{th\ j\text{-}a} . S_Z}$$

V_Z' being the zener voltage at $T_j = T_n$ at the working current I_Z.

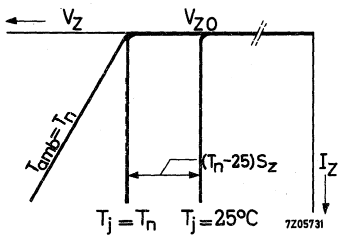
OPERATING NOTES (continued)

The position of this static characteristic in relation to the dynamic characteristic at T_j = 25 °C is dependent on the ambient temperature and the temperature coefficient, the low-current voltage being displaced by

$$S_Z \times (T_n - 25)^{\circ}C$$

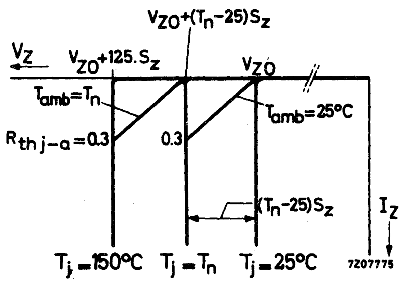
from the low current voltage, V_{ZO} on the dynamic characteristic at T_j = 25 °C (See figure below)

Example for positive S_Z



Next figure shows typical dynamic characteristics at T_j = 25, 150 and a nominal temperature, T_n °C. It also shows static characteristics at ambient temperatures of 25 and T_n °C.

Example for positive S_Z

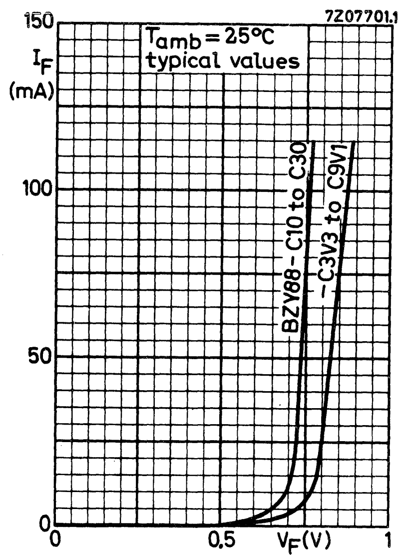


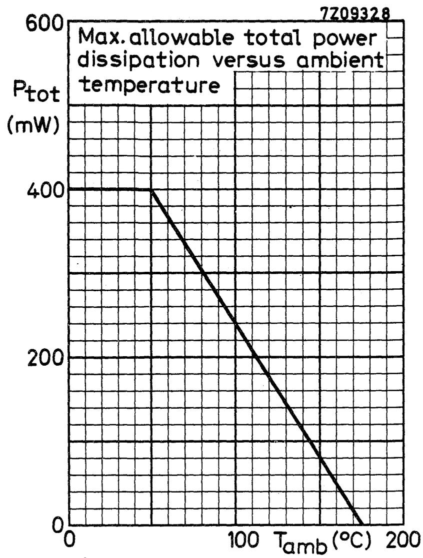
Typical static characteristics for each type of diode are given on page 12. These curves were obtained with the device mounted in free air at an ambient temperature of 25 °C.

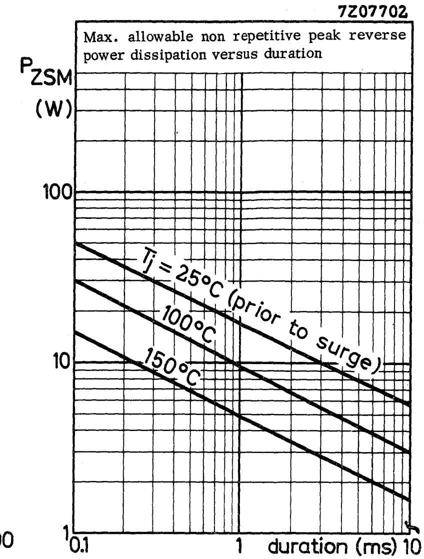
The slope resistance for pulse operation can be calculated by incorporating the transient thermal resistance $R_{th\ t}$ into the formula for r_Z. Curves of $R_{th\ t}$ plotted against pulse duration and duty cycle are given in the lower figure on page 9.

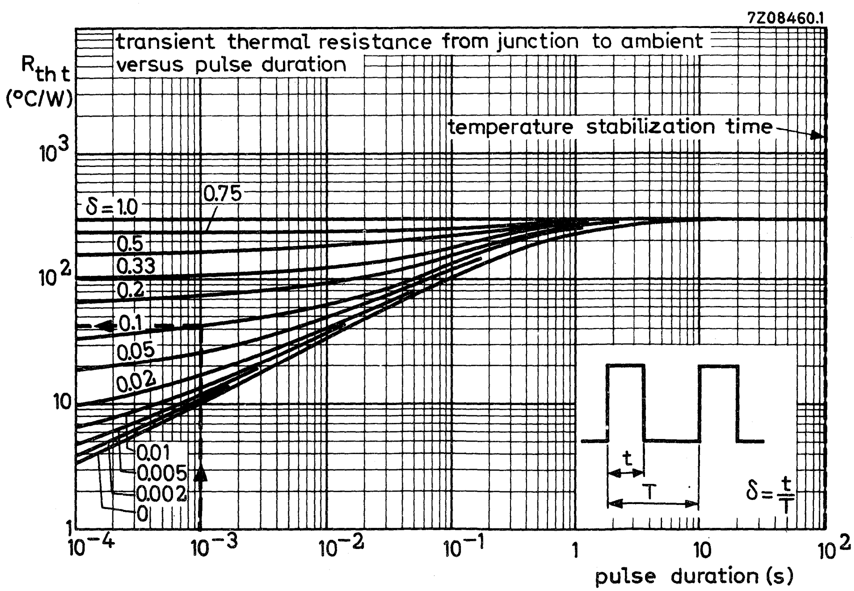
OPERATING NOTES (continued)

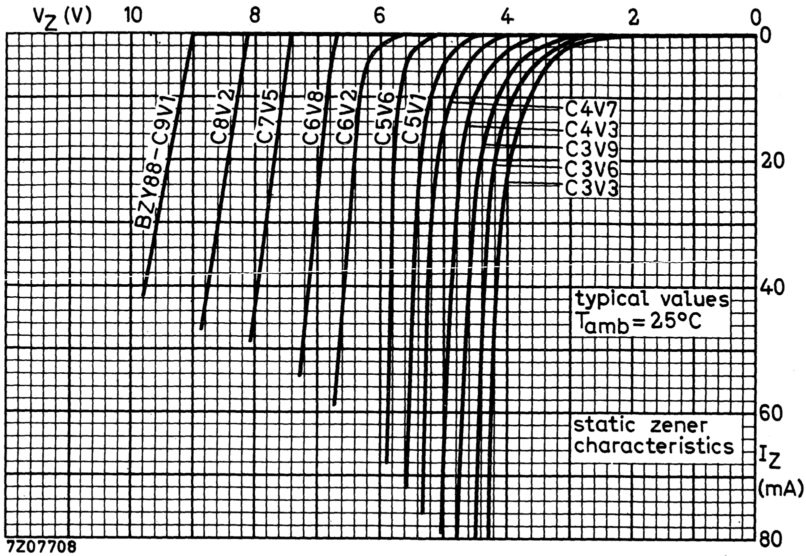
3. When using a soldering iron, the diode may be soldered directly into a circuit, but heat conducted to the junction should be kept to a minimum by use of a thermal shunt.
4. Diodes may be dip soldered at a solder temperature of 245 °C for a maximum soldering time of 5 seconds. The case temperature during dip soldering must not at any time exceed the maximum storage temperature. These recommendations apply to a diode with the anode end mounted flush on the board with punched-through holes. For mounting the cathode end onto the board the diode must be spaced 5 mm from the underside of the printed circuit board in the case of punched-through holes or 5 mm from the top of the board for plated-through holes.
5. Care should be taken not to bend the leads nearer than 1.5 mm from the seals.

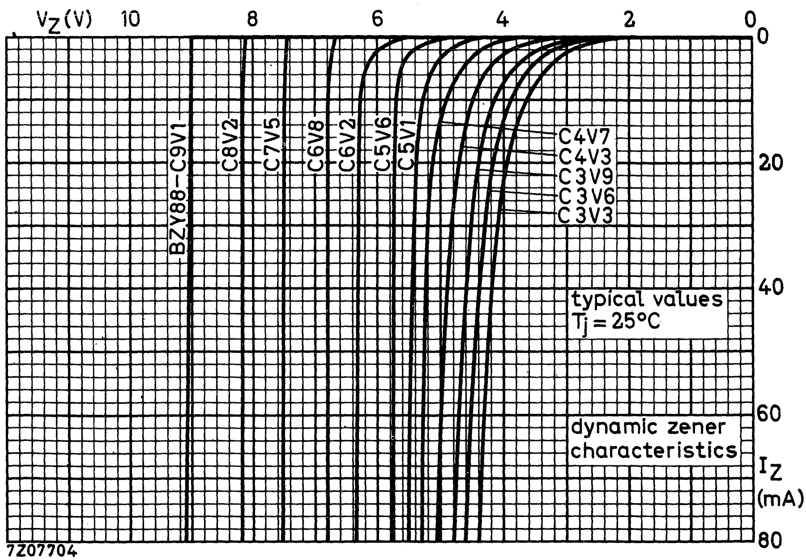


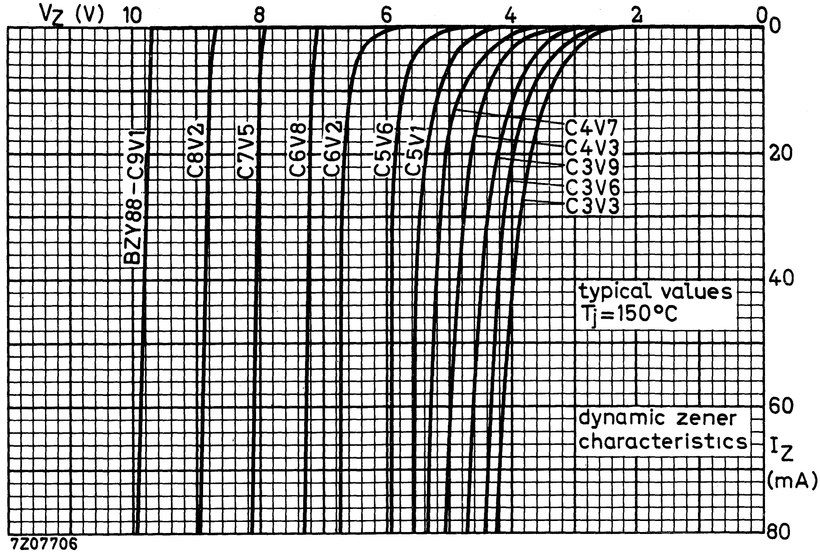

7Z09328
Max. allowable total power dissipation versus ambient temperature
Ptot (mW)
600
400
200
0
0
100
Tamb (°C)
200


7Z07702
Max. allowable non repetitive peak reverse power dissipation versus duration
PZSM (W)
100
10
1
Tj = 25°C (prior to surge)
100°C
150°C
0.1
1
duration (ms)
10

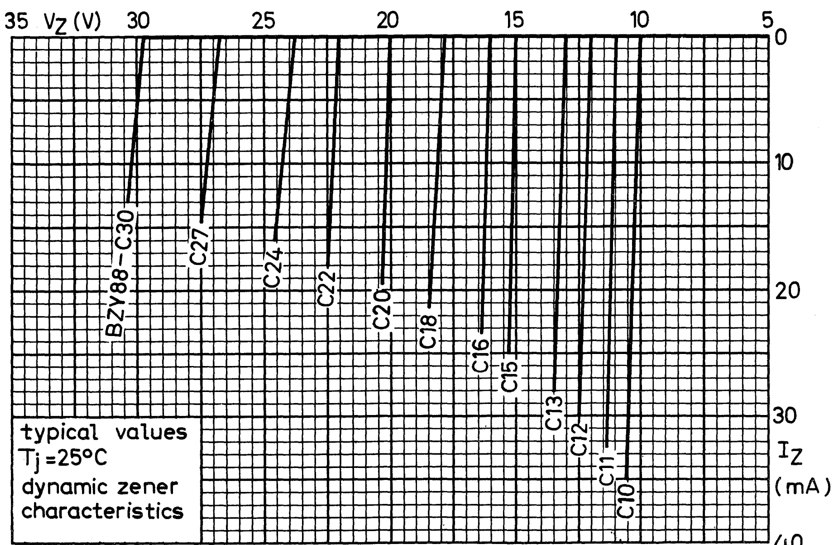

7Z08460.1
transient thermal resistance from junction to ambient versus pulse duration
Rth t (°C/W)
10^3
10^2
10
1
temperature stabilization time
δ = 1.0
0.75
0.5
0.33
0.2
0.1
0.05
0.02
0.01
0.005
0.002
0
t
T
δ = t/T
10^-4
10^-3
10^-2
10^-1
1
10
10^2
pulse duration (s)


VZ (V)
10
8
6
4
2
0
0
20
40
60
80
IZ
(mA)
BZY88–C9V1
C8V2
C7V5
C6V8
C6V2
C5V6
C5V1
C4V7
C4V3
C3V9
C3V6
C3V3
typical values
Tamb = 25°C
static zener characteristics
7Z07708

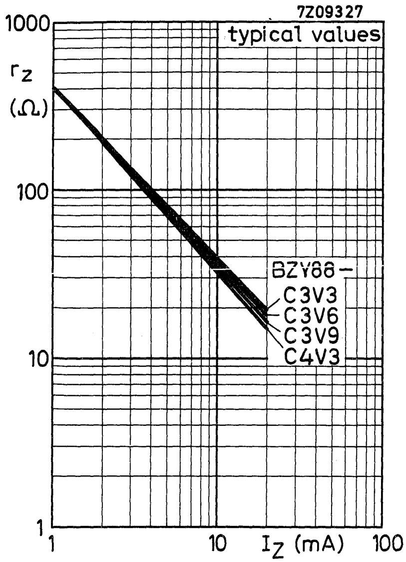

VZ (V)
10
8
6
4
2
0
0
20
40
60
80
IZ
(mA)
BZY88–C9V1
C8V2
C7V5
C6V8
C6V2
C5V6
C5V1
C4V7
C4V3
C3V9
C3V6
C3V3
typical values
Tj = 25°C
dynamic zener characteristics
7Z07704

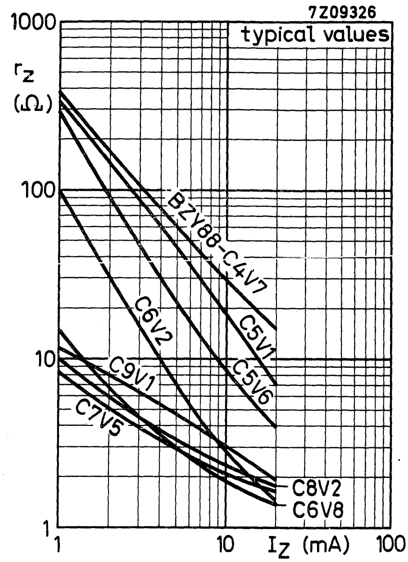


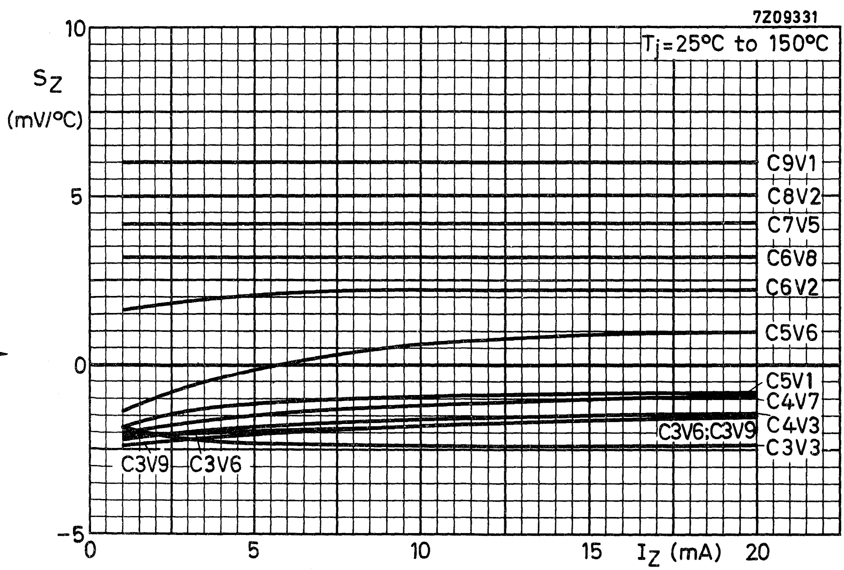
7Z07706

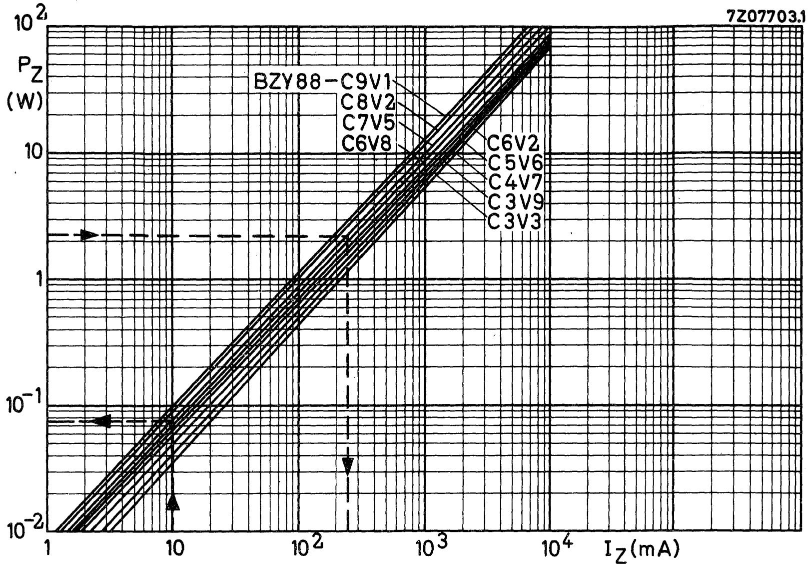


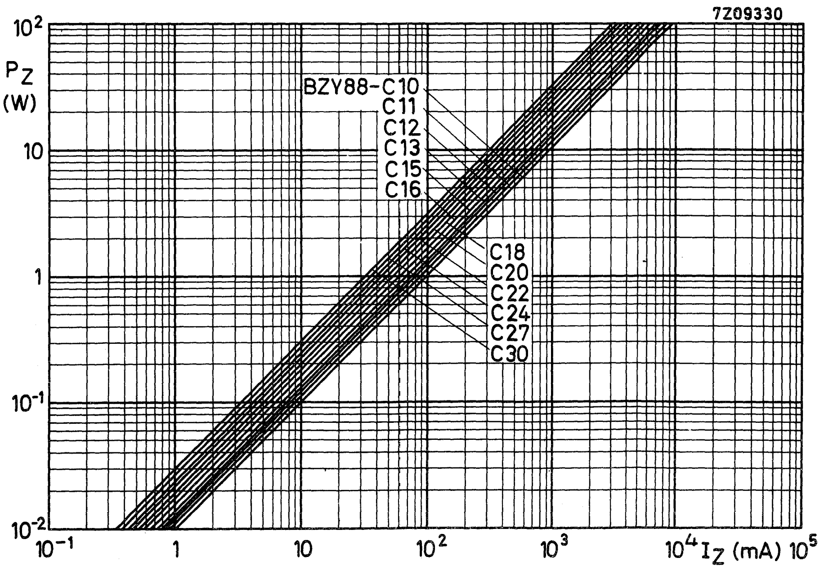
7Z09329


7Z09327
typical values
1000
r_Z
(Ω)
100
10
1
BZY88 –
C3V3
C3V6
C3V9
C4V3
1
10
I_Z (mA)
100


7Z09326
typical values
1000
r_Z
(Ω)
100
10
1
BZY88-C4V7
C5V1
C5V6
C6V2
C9V1
C7V5
C8V2
C6V8
1
10
I_Z (mA)
100


7Z09331
T_j=25°C to 150°C
10
S_Z
(mV/°C)
5
0
–5
C9V1
C8V2
C7V5
C6V8
C6V2
C5V6
C5V1
C4V7
C4V3
C3V3
C3V6;C3V9
C3V9
C3V6
0
5
10
15
I_Z (mA)
20


7Z07703.1
P_Z
(W)
BZY88-C9V1
C8V2
C7V5
C6V8
C6V2
C5V6
C4V7
C3V9
C3V3
10^2
10
1
10^{-1}
10^{-2}
1
10
10^2
10^3
10^4
I_Z (mA)


7Z09330
P_Z
(W)
BZY88-C10
C11
C12
C13
C15
C16
C18
C20
C22
C24
C27
C30
10^2
10
1
10^{-1}
10^{-2}
10^{-1}
1
10
10^2
10^3
10^4
I_Z (mA)
10^5

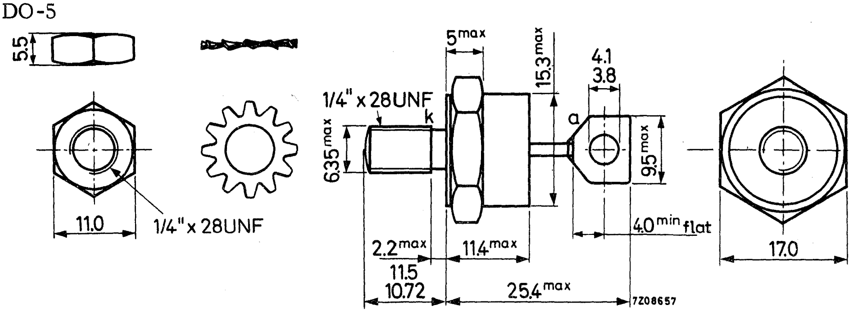
VOLTAGE REGULATOR DIODES

Diffused silicon diodes in a DO-5 envelope for use in power stabilisation and transient suppression circuits.
The series consists of 22 normal polarity types (stud cathode) and 22 reverse polarity types (stud anode) with nominal zener voltages ranging from 10 to 75 V with a tolerance of ±5%.

QUICK REFERENCE DATA				
Zener voltage range		nom.	10 to 75	V
Zener voltage tolerance			±5	%
Repetitive peak zener current	I_{ZRM}	max.	100	A
Total power dissipation up to T_{mb} = 65 °C	P_{tot}	max.	75	W
Non repetitive peak reverse power T_{mb} = 65 °C; t = 100 μs	P_{ZSM}	max.	4.4	kW
Junction temperature	T_j	max.	175	°C
Thermal resistance from junction to mounting base	$R_{th\ j\text{-}mb}$	=	1.47	°C/W

MECHANICAL DATA Dimensions in mm

DO-5



Polarity of connections: BZY91-C10 to C75 stud cathode
BZY91-C10R to C75R stud anode

Diameter of hole in heatsink: max. 6.5 mm
Accessories available: 56264A

Torque on nut: min. 17 cm kg
max. 35 cm kg

Net weight : 11 g
With accessories: 15 g

RATINGS (Limiting values) [1]

Currents

Average forward current (averaged over any 20 ms period)	I_{FAV}	max.	10	A
Repetitive peak forward current	I_{FRM}	max.	30	A
Repetitive peak zener current	I_{ZRM}	max.	100	A

Power dissipation

Total power dissipation up to $T_{mb} = 65\ ^{o}C$	P_{tot}	max.	75	W
Non repetitive peak reverse power at $T_{mb} = 65\ ^{o}C$; $\delta = 0$				
t = 100 μs	P_{ZSM}	max.	4.4	kW
t = 1 ms	P_{ZSM}	max.	1.48	kW
t = 10 ms	P_{ZSM}	max.	500	W
t = 100 ms	P_{ZSM}	max.	170	W

Temperatures

Storage temperature	T_{stg}	-55 to +175		^{o}C
Junction temperature	T_j	max.	175	^{o}C

THERMAL RESISTANCE

From junction to mounting base	$R_{th\ j\text{-}mb}$	=	1.47	$^{o}C/W$
From mounting base to heatsink	$R_{th\ mb\text{-}h}$	=	0.2	$^{o}C/W$

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

CHARACTERISTICS at T_{mb} = 25 °C

Forward voltage at I_F = 10 A — V_F < 1.5 V

Reverse current at $V_R = \frac{2}{3} \cdot V_{Znom}$ — I_R < 1 mA

BZY91-...	Zener voltage V_Z min.	nom.	max.	Differential resistance r_Z max.
	at I_Z = 2 A [1]			at I_Z = 2 A
C10(R)	9.4	10	10.6 V	0.4 Ω
C11(R)	10.4	11	11.6 V	0.4 Ω
C12(R)	11.4	12	12.6 V	0.5 Ω
C13(R)	12.4	13	14.1 V	0.5 Ω
C15(R)	13.9	15	15.6 V	0.6 Ω
C16(R)	15.4	16	17.1 V	0.6 Ω
C18(R)	16.9	18	19.1 V	0.7 Ω
	at I_Z = 1 A [1]			at I_Z = 1 A
	min.	nom.	max.	max.
C20(R)	18.9	20	21.2 V	0.8 Ω
C22(R)	20.8	22	23.3 V	0.8 Ω
C24(R)	22.7	24	25.9 V	0.9 Ω
C27(R)	25.1	27	28.9 V	1.0 Ω
C30(R)	28	30	32 V	1.1 Ω
C33(R)	31	33	35 V	1.2 Ω
C36(R)	34	36	38 V	1.3 Ω
	at I_Z = 0.5 A [1]			at I_Z = 0.5 A
	min.	nom.	max.	max.
C39(R)	37	39	41 V	1.4 Ω
C43(R)	40	43	45 V	1.5 Ω
C47(R)	44	47	50 V	1.7 Ω
C51(R)	48	51	54 V	1.8 Ω
C56(R)	53	56	60 V	2.0 Ω
C62(R)	58	62	66 V	2.2 Ω
C68(R)	64	68	72 V	2.4 Ω
C75(R)	71	75	79 V	2.6 Ω

[1]) The zener voltage is measured by a pulse method with $t_p \leq 100\ \mu s$, duty cycle $\delta \leq 0.001$ and $T_j \approx 25$ °C

OPERATING NOTES

1. Dissipation and heatsink considerations

   a. Steady-state conditions

   The maximum allowable steady-state dissipation P_s is given by the relationship

$$P_{s\ max.} = \frac{T_{j\ max.} - T_{amb}}{R_{th\ j-a}}$$

   where $T_{j\ max.}$ is the maximum permissible operating junction temperature,

   T_{amb} is the ambient temperature,

   $R_{th\ j-a}$ is the total thermal resistance from junction to ambient
   $R_{th\ j-a} = R_{th\ j-mb} + R_{th\ mb-h} + R_{th\ h-a}$,

   $R_{th\ mb-h}$ is the thermal resistance from mounting base to heatsink, that is 0.2 °C/W,

   $R_{th\ h-a}$ is the thermal resistance of the heatsink

   b. Pulse conditions (see fig. next page)

   The maximum allowable additional pulse power $P_{m\ max.}$ is given by the formula

$$P_{m\ max.} = \frac{(T_{j\ max.} - T_{amb}) - (P_s \cdot R_{th\ j-a})}{R_{th\ t} + \delta \cdot R_{th\ mb\ a}}$$

   where P_s is the steady-state dissipation, excluding that in the pulses,

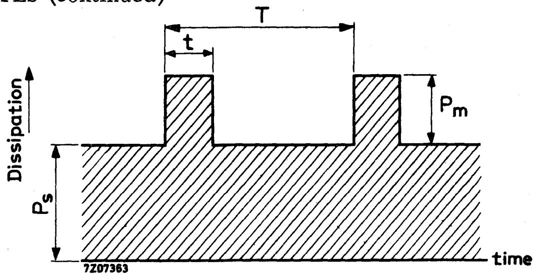
   $R_{th\ t}$, is the effective transient thermal resistance of the device from junction to mounting base. It is a function of the pulse duration t and duty cycle δ (see page 8),

   δ is the duty cycle and is equal to the pulse duration t divided by the period duration T,

   $R_{th\ mb-a}$ is the total thermal resistance from mounting base to ambient. $R_{th\ mb-a} = R_{th\ mb-h} + R_{th\ h-a}$.

The steady-state power P_s when biased in the zener direction at a given zener current can be found from page 9, upper figure. With the additional pulsed power dissipation P_m calculated from the above expression, the total repetitive peak zener power dissipation $P_{ZRM} = P_s + P_m$. From page 9, upper figure the corresponding maximum repetitive peak zener current at P_{ZRM} can now be read. This repetitive peak zener current is subject to the absolute maximum rating. For pulse durations longer than the temperature stabilisation time of the diode t_{stab}, the maximum allowable repetitive peak dissipation P_{ZRM} is equal to the maximum steady-state power $P_{s\ max.}$ The temperature stabilisation time for the BZY91series is 2 s (see page 8).

OPERATING NOTES (continued)



2. Care must be taken to ensure that the connecting lug is not bent or twisted.

Example

The following example illustrates how to calculate the maximum permissible repetitive peak zener current of a BZY91-C56 zener diode mounted on a heatsink with $R_{th\ h\text{-}a} = 2\ ^oC/W$ at a maximum ambient temperature of 50 ^oC. The steady-state zener current is 0.5 A, the duty cycle $\delta = 0.1$ and the pulse duration $t = 1$ ms.

The steady-state dissipation P_s at a zener current of 0.5 A (from page 9, upper figure) = 28 W.
The thermal resistance from junction to ambient $R_{th\ j\text{-}a} = R_{th\ j\text{-}mb} + R_{th\ mb\text{-}h} + R_{th\ h\text{-}a} = 1.47 + 0.2 + 2 = 3.67\ ^oC/W$.
The transient thermal resistance $R_{th\ t}$ with a duty cycle $\delta = 0.1$ and a pulse duration $t = 1$ ms (from page 8, lower figure)

$$R_{th\ t} = 0.23\ ^oC/W$$

The maximum additional pulse power dissipation

$$P_{m\ max.} = \frac{(T_{j\ max} - T_{amb}) - P_s \cdot R_{th\ j\text{-}a}}{R_{th\ t} + \delta \cdot R_{th\ mb\text{-}a}}$$

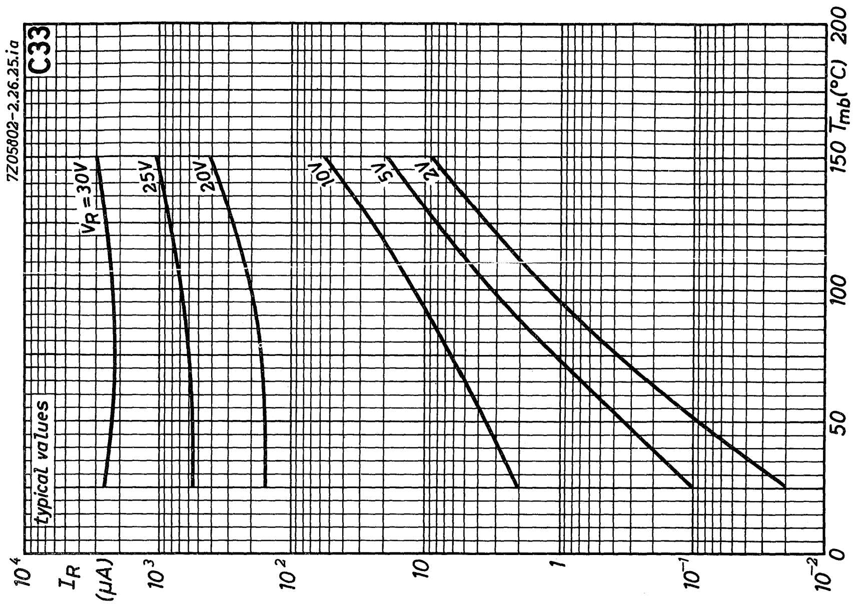
If $P_s = 28$ W, $R_{th\ t} = 0.23\ ^oC/W$,

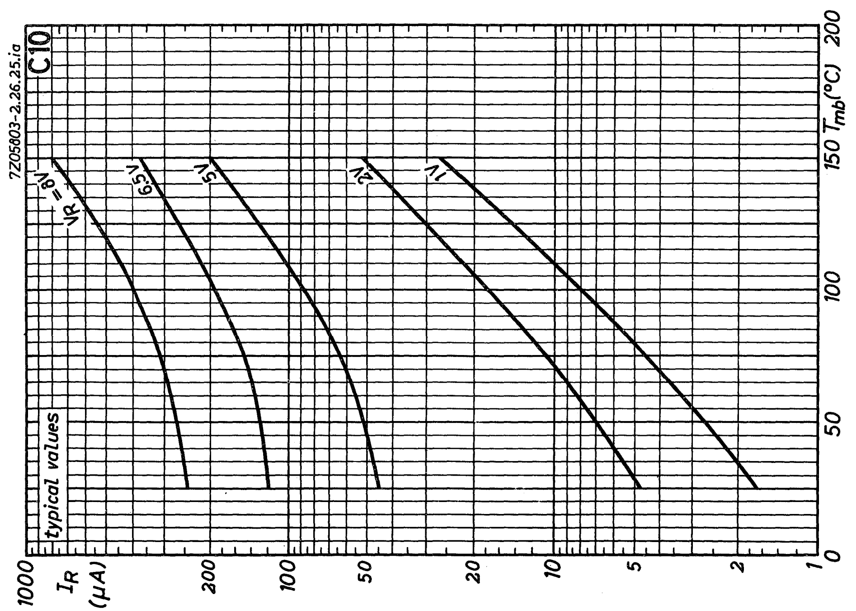
then $$P_{m\ max} = \frac{(175 - 50) - (28 \times 3.67)}{0.23 + 0.1 \times 2.2} = 49\ W$$

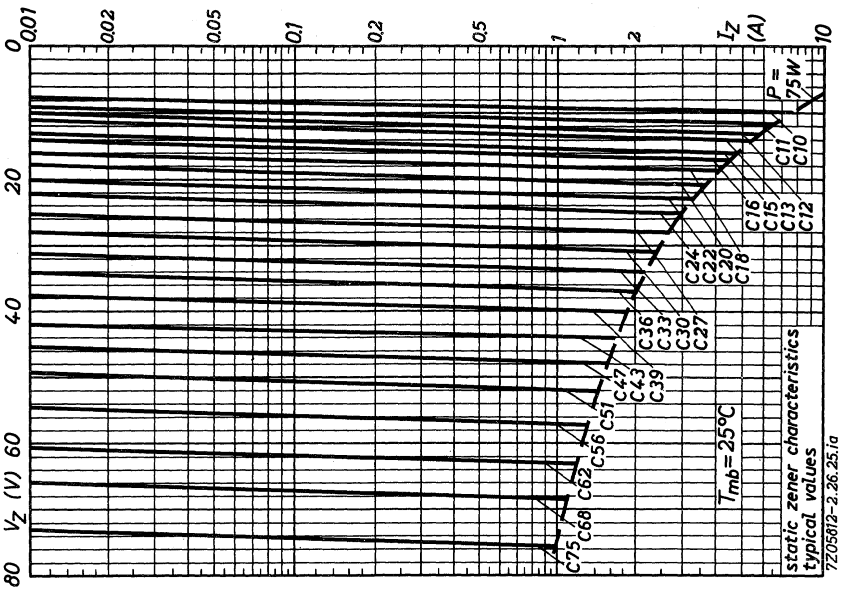
therefore, the total repetitive peak power dissipation,

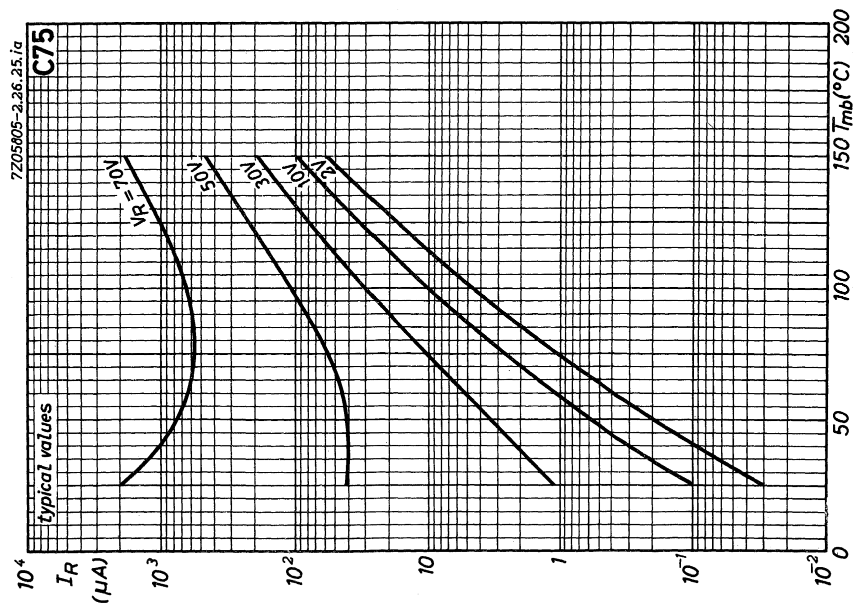
$$P_{ZRM} = (28\ W + 49\ W) = 77\ W$$

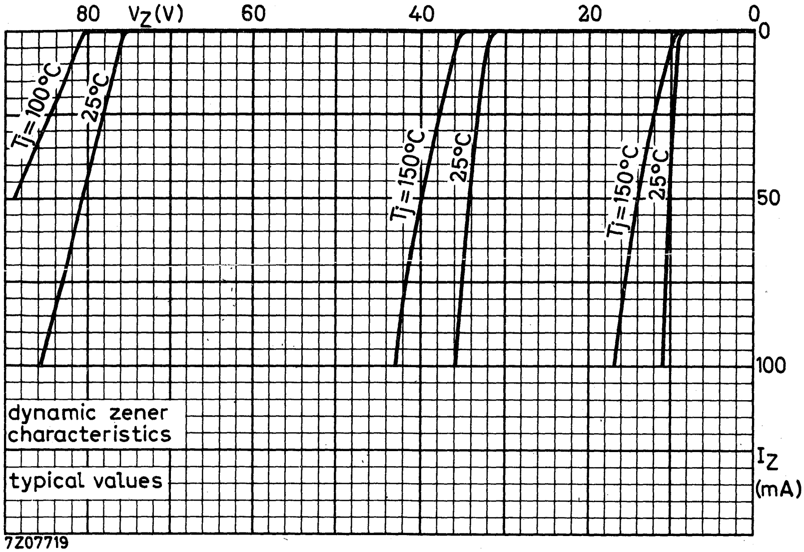
From page 9, upper figure, the corresponding repetitive peak zener current is 1.3 A. This is within the rating of the BZY91-C56 and is therefore permissible.

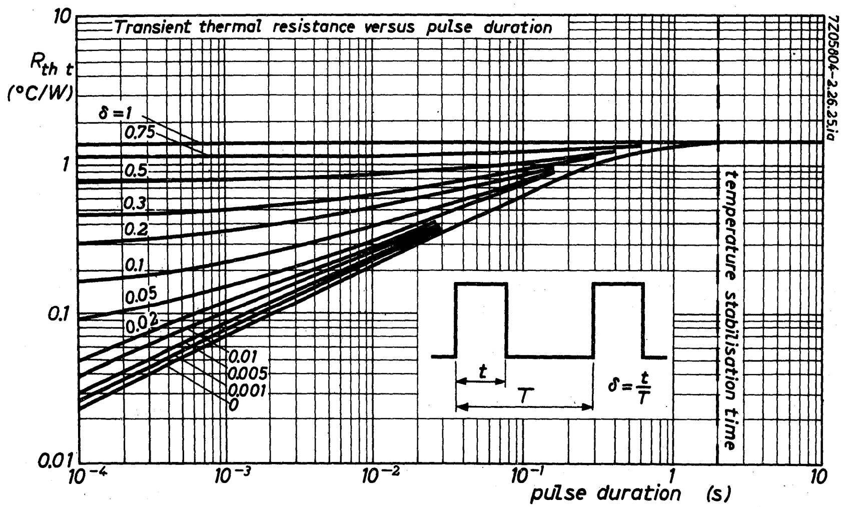

7Z05802-2.26.25.ia
C33
typical values
V_R = 30V
25V
20V
10V
5V
2V
I_R
(μA)
10^4
10^3
10^2
10
1
10^{-1}
10^{-2}
0
50
100
150
200
T_{mb}(°C)

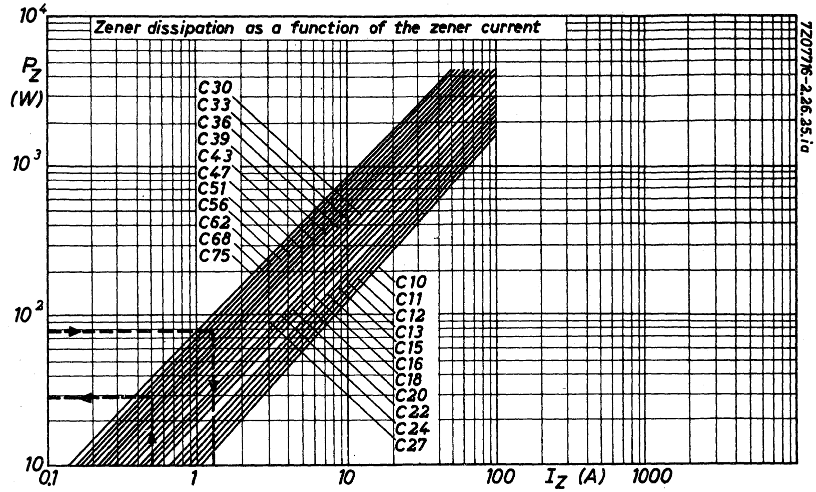

7Z05803-2.26.25.ia
C10
typical values
V_R = 8V
6.5V
5V
2V
1V
1000
I_R
(μA)
200
100
50
20
10
5
2
1
0
50
100
150
200
T_{mb}(°C)

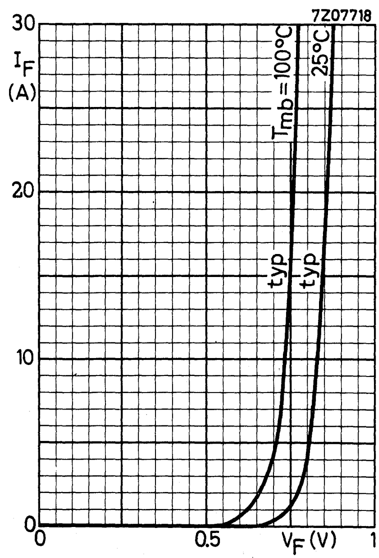

static zener characteristics
typical values
7Z05812-2.26.25.ia
Tmb=25°C
P = 75W
VZ (V)
IZ (A)
0.01
0.02
0.05
0.1
0.2
0.5
1
2
10
0
20
40
60
80
C10
C11
C12
C13
C15
C16
C18
C20
C22
C24
C27
C30
C33
C36
C39
C43
C47
C51
C56
C62
C68
C75

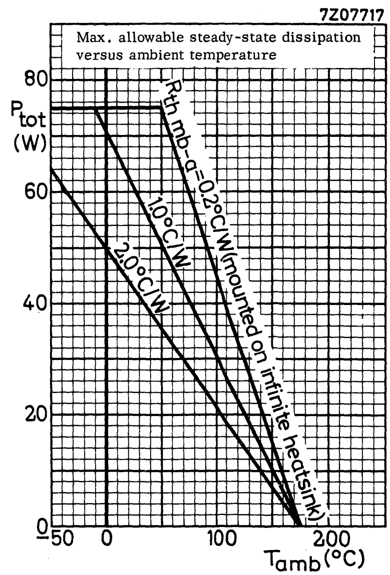

C75
7Z05805-2.26.25.ia
typical values
VR = 70V
50V
30V
10V
2V
IR (µA)
Tmb (°C)
0
50
100
150
200

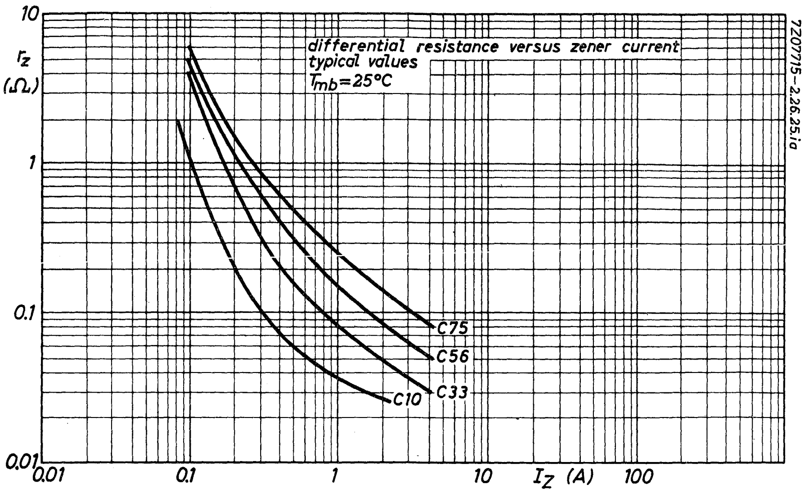

80
V_Z(V)
60
40
20
0
0
50
100
T_j=100°C
25°C
T_j=150°C
25°C
T_j=150°C
25°C
dynamic zener characteristics
typical values
I_Z (mA)
7Z07719

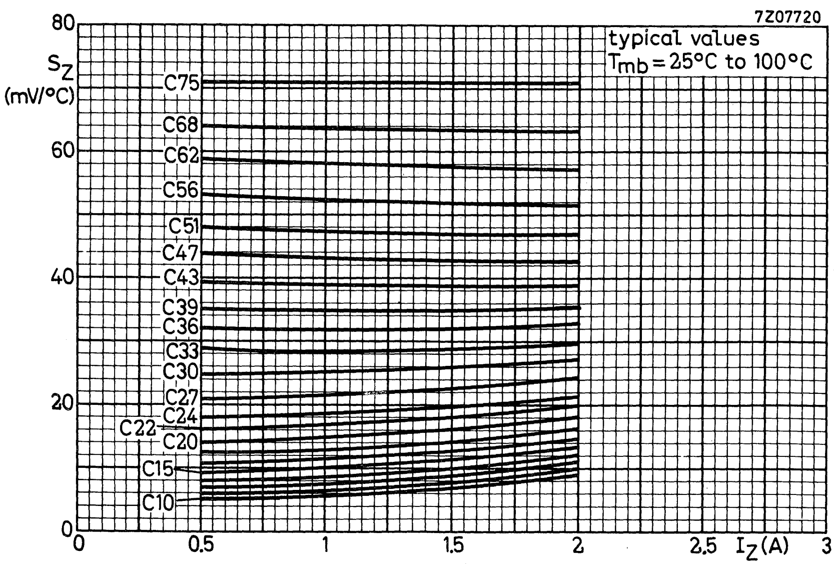

Transient thermal resistance versus pulse duration
$R_{th\ t}$ (°C/W)
10
1
0.1
0.01
δ = 1
0.75
0.5
0.3
0.2
0.1
0.05
0.02
0.01
0.005
0.001
0
t
T
δ = t/T
temperature stabilisation time
10^{-4}
10^{-3}
10^{-2}
10^{-1}
1
10
pulse duration (s)
7Z05804-2.26.25.ia


Zener dissipation as a function of the zener current
7Z07716-2.26.25.ia
P_Z (W)
10^4
10^3
10^2
10
C30
C33
C36
C39
C43
C47
C51
C56
C62
C68
C75
C10
C11
C12
C13
C15
C16
C18
C20
C22
C24
C27
0.1
1
10
100
1000
I_Z (A)


7Z07718
I_F (A)
30
20
10
0
0
0.5
V_F (V)
1
T_{mb} = 100°C
25°C
typ
typ


7Z07717
Max. allowable steady-state dissipation versus ambient temperature
P_{tot} (W)
80
60
40
20
0
−50
0
100
200
T_{amb} (°C)
$R_{th\ mb-a}$ = 0.2°C/W (mounted on infinite heatsink)
1.0°C/W
2.0°C/W


7Z07715-2.26.25.ia
differential resistance versus zener current
typical values
T_{mb}=25°C
r_Z
(Ω)
10
1
0.1
0.01
0.01
0.1
1
10
I_Z (A)
100
C75
C56
C33
C10


7Z07720
typical values
T_{mb}=25°C to 100°C
S_Z
(mV/°C)
80
60
40
20
0
C75
C68
C62
C56
C51
C47
C43
C39
C36
C33
C30
C27
C24
C22
C20
C15
C10
0
0.5
1
1.5
2
2.5
I_Z(A)
3

SILICON POWER VOLTAGE REGULATORS

Diffused silicon diodes in a DO-4 metal envelope intended for general purpose applications.
The series consists of 26 normal polarity types (stud cathode) and 26 reverse polarity types (stud anode) with nominal zener voltages ranging from 6.8 V to 75 V with a tolerance of ±5%.

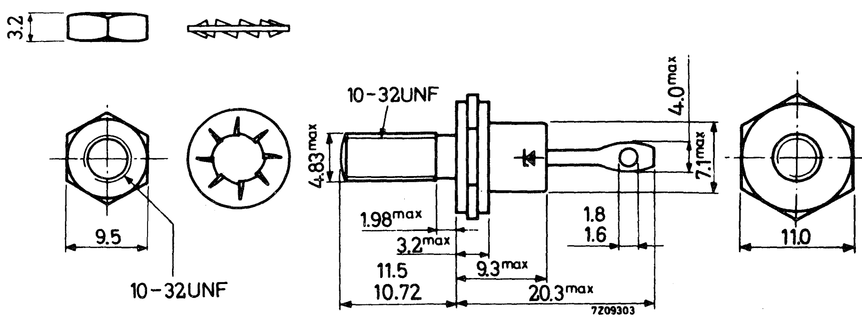
QUICK REFERENCE DATA

Zener voltage range		nom.	6.8 to 75	V
Zener voltage tolerance			±5	%
Repetitive peak zener current	I_{ZRM}	max.	20	A
Total power dissipation up to T_{mb} = 75 °C	P_{tot}	max.	20	W
Non repetitive peak reverse power dissipation T_j = 175 °C; t = 100 μs	P_{ZSM}	max.	500	W
Junction temperature	T_j	max.	175	°C
Thermal resistance from junction to mounting base	$R_{th\ j\text{-}mb}$	=	5.0	°C/W

MECHANICAL DATA

Dimensions in mm

DO-4



Net weight : 4.3 g
With accessories: 6.5 g
Diameter of hole in heatsink: max. 5.2 mm
Accessories available: 56295 (56262A)

Torque on nut: min. 8 cm kg
max. 17 cm kg
The mark shown applies to normal polarity types

RATINGS (Limiting values) [1]

Currents

Average forward current (averaged over any 20 ms period)	I_{FAV}	max.	5 A
Repetitive peak forward current	I_{FRM}	max.	15 A
Repetitive peak zener current	I_{ZRM}	max.	20 A

Power dissipation

Total power dissipation up to T_{mb} = 75 °C	P_{tot}	max.	20 W
Non repetitive peak reverse power dissipation, T_j = 175 °C; t = 100 μs	P_{ZSM}	max.	500 W

Temperatures

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

THERMAL RESISTANCE

From junction to mounting base	$R_{th\ j\text{-}mb}$	=	5.0 °C/W
From mounting base to heatsink	$R_{th\ mb\text{-}h}$	=	0.6 °C/W

CHARACTERISTICS T_j = 25 °C unless otherwise specified

Forward voltage at I_F = 5 A V_F < 1.5 V

Reverse current at			BZY93-C6V8(R)	C7V5(R)	C8V2(R)	C9V1(R) to C75(R)	
V_R = 2 V	I_R	<	100	100			μA
V_R = 5.6 V	I_R	<			100		μA
$V_R = \frac{2}{3} \cdot V_{Znom}$	I_R	<				50	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

BZY93-...	Zener voltage V_Z at I_Z = 2 A min.	nom.	max.	Temperature coefficient at I_Z = 2 A typ.	Differential resistance at I_Z = 2 A typ.	max.
C6V8(R)	6.4	6.8	7.2 V	2.5 mV/°C	0.04	0.2 Ω
C7V5(R)	7.1	7.5	7.9 V	3.0 mV/°C	0.04	0.3 Ω
C8V2(R)	7.7	8.2	8.7 V	4.0 mV/°C	0.05	0.3 Ω
	at I_Z = 1 A min.	nom.	max.	at I_Z = 1 A typ.	at I_Z = 1 A typ.	max.
C9V1(R)	8.6	9.1	9.6 V	5.0 mV/°C	0.07	0.5 Ω
C10(R)	9.4	10	10.6 V	7.0 mV/°C	0.07	0.5 Ω
C11(R)	10.4	11	11.6 V	7.5 mV/°C	0.08	1.0 Ω
C12(R)	11.4	12	12.6 V	8.0 mV/°C	0.08	1.0 Ω
C13(R)	12.4	13	14.1 V	8.5 mV/°C	0.08	1.0 Ω
C15(R)	13.9	15	15.6 V	10.0 mV/°C	0.10	1.2 Ω
	at I_Z = 0.5 A min.	nom.	max.	at I_Z = 0.5 A typ.	at I_Z = 0.5 A typ.	max.
C16(R)	15.4	16	17.1 V	11 mV/°C	0.18	1.2 Ω
C18(R)	16.9	18	19.1 V	12 mV/°C	0.20	1.5 Ω
C20(R)	18.9	20	21.2 V	14 mV/°C	0.20	1.5 Ω
C22(R)	20.8	22	23.3 V	16 mV/°C	0.21	1.8 Ω
C24(R)	22.7	24	25.9 V	18 mV/°C	0.22	2.0 Ω
C27(R)	25.1	27	28.9 V	21 mV/°C	0.25	2.0 Ω
C30(R)	28	30	32 V	25 mV/°C	0.30	2.5 Ω
C33(R)	31	33	35 V	30 mV/°C	0.32	3.0 Ω
	at I_Z = 0.2 A min.	nom.	max.	at I_Z = 0.2 A typ.	at I_Z = 0.2 A typ.	max.
C36(R)	34	36	38 V	32 mV/°C	0.75	4.0 Ω
C39(R)	37	39	41 V	35 mV/°C	0.85	5.0 Ω
C43(R)	40	43	45 V	40 mV/°C	0.90	6.5 Ω
C47(R)	44	47	50 V	45 mV/°C	1.0	7.0 Ω
C51(R)	48	51	54 V	50 mV/°C	1.2	7.5 Ω
C56(R)	53	56	60 V	55 mV/°C	1.3	8.0 Ω
C62(R)	58	62	66 V	60 mV/°C	1.5	9.0 Ω
C68(R)	64	68	72 V	65 mV/°C	1.8	10.0 Ω
C75(R)	71	75	79 V	70 mV/°C	2.0	10.5 Ω

OPERATING NOTES

1. Dissipation and heatsink considerations

a. Steady-state conditions

The maximum allowable steady-state dissipation $P_{s\,max}$ is given by the relationship

$$P_{s\,max} = \frac{T_{j\,max} - T_{amb}}{R_{th\,j-a}}$$

where $T_{j\,max}$ is the maximum permissible operating junction temperature.

T_{amb} is the ambient temperature,

$R_{th\,j-a}$ is the total thermal resistance from junction to ambient
$R_{th\,j-a} = R_{th\,j-mb} + R_{th\,mb-h} + R_{th\,h-a}$,

$R_{th\,mb-h}$ is the thermal resistance from mounting base to heatsink, that is 0.6 °C/W,

$R_{th\,h-a}$ is the thermal resistance of the heatsink

b. Pulse conditions (see fig. next page)

The maximum allowable additional pulse power $P_{m\,max}$ is given by the formula

$$P_{m\,max} = \frac{(T_{j\,max} - T_{amb}) - (P_s \,.\, R_{th\,j-a})}{R_{th\,t} + \delta \,.\, R_{th\,mb-a}}$$

where P_s is the steady-state dissipation, excluding that in the pulses,

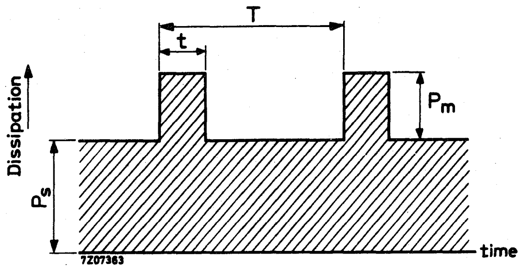
$R_{th\,t}$ is the effective transient thermal resistance of the device from junction to mounting base. It is a function of the pulse duration t and duty cycle δ (see page 6, upper figure).

δ is the duty cycle and is equal to the pulse duration t divided by the period duration T,

$R_{th\,mb-a}$ is the total thermal resistance from mounting base to ambient. $R_{th\,mb-a} = R_{th\,mb-h} + R_{th\,h-a}$.

The steady-state power P_s when biased in the zener direction at a given zener current can be found from page 8, upper figure. With the additional pulsed power dissipation $P_{m\,max}$ calculated from the above expression, the total repetitive peak zener power dissipation $P_{ZRM} = P_s + P_{m\,max}$. From page 8, upper figure the corresponding maximum repetitive peak zener current at P_{ZRM} can now be read. This repetitive peak zener current is subject to the absolute maximum rating. For pulse durations longer than the temperature stabilisation time of the diode t_{stab}, the maximum allowable repetitive peak dissipation P_{ZRM} is equal to the maximum steady-state power $P_{s\,max}$. The temperature stabilisation time for the BZY93series is 5 s (see page 6, upper figure).

OPERATING NOTES (continued)



2. Care must be taken to ensure that the connecting lug is not bent or twisted.

Example

The following example illustrates how to calculate the maximum permissible repetitive peak zener current of a BZY93-C12 zener diode mounted on a heatsink with $R_{th\ h\text{-}a} = 2\ ^oC/W$ at a maximum ambient temperature of 50 °C. The steady-state zener current is 0.5 A, the duty cycle $\delta = 0.1$ and the pulse duration t = 1 ms.

The steady-state dissipation P_S at a zener current of 0.5 A (from page 8, upper figure) = 7 W.
The thermal resistance from junction to ambient $R_{th\ j\text{-}a} = R_{th\ j\text{-}mb} + R_{th\ mb\text{-}h} + R_{th\ h\text{-}a} = 5 + 0.6 + 2 = 7.6\ ^oC/W$.
The transient thermal resistance $R_{th\ t}$ with a duty cycle $\delta = 0.1$ and a pulse duration t = 1 ms (from page 6, upper figure)

$$R_{th\ t} = 0.92\ ^oC/W$$

The maximum additional pulse power dissipation

$$P_{m\ max} = \frac{(T_{j\ max} - T_{amb}) - P_S\ .\ R_{th\ j\text{-}a}}{R_{th\ t} + \delta\ .\ R_{th\ mb\text{-}a}}$$

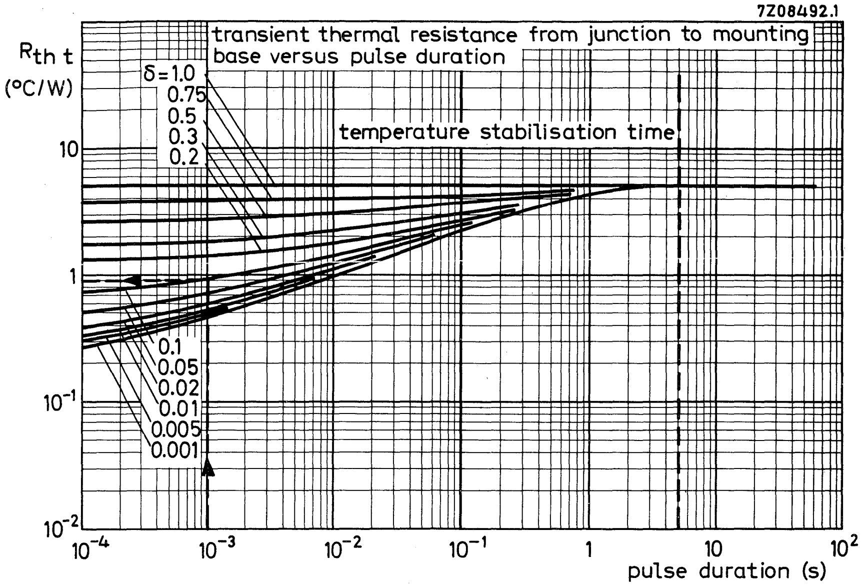
If $P_S = 7$ W, $R_{th\ t} = 0.92\ ^oC/W$,

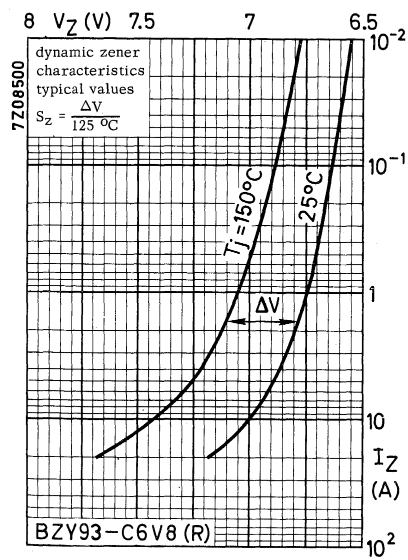
$$P_{m\ max} = \frac{(175 - 50) - (7 \times 7.6)}{0.92 + 0.1 \times 2.6} = 61\ W$$

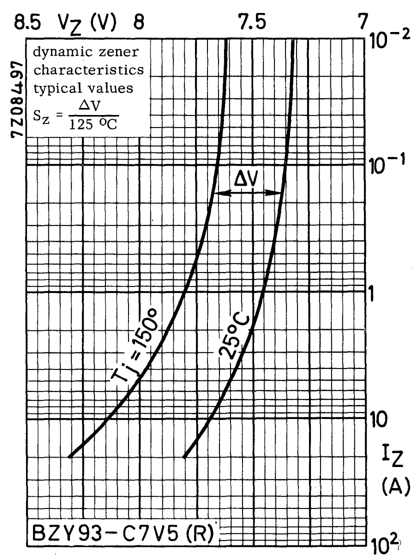
therefore, the total repetitive peak power dissipation,

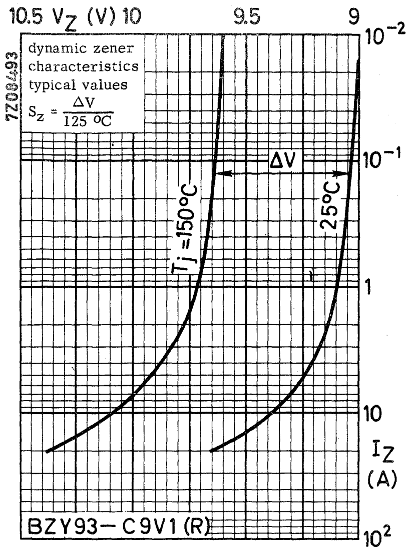
$$P_{ZRM} = (7 + 61) = 68\ W$$

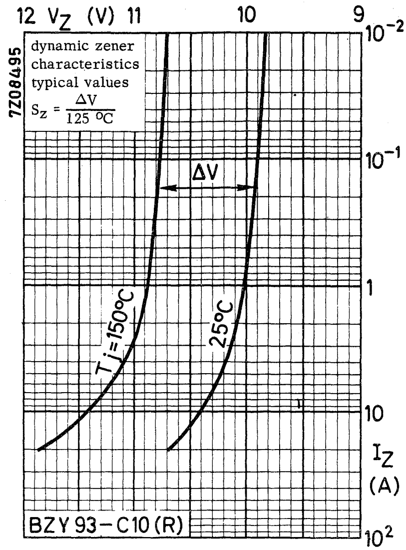
From page 8, upper figure, the corresponding repetitive peak zener current is 5 A. This is within the rating of the BZY93-C12 and is therefore permissible.

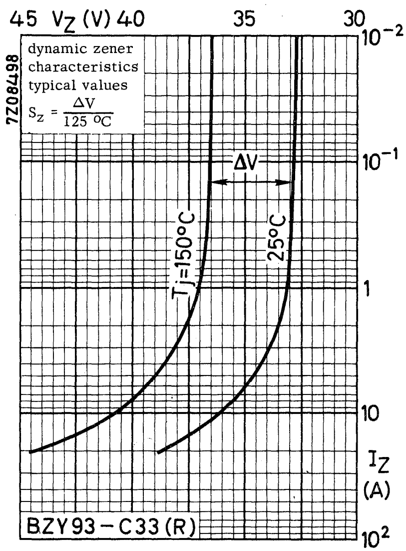

7Z08492.1
transient thermal resistance from junction to mounting base versus pulse duration
Rth t
(°C/W)
temperature stabilisation time
δ=1.0
0.75
0.5
0.3
0.2
0.1
0.05
0.02
0.01
0.005
0.001
10
1
10⁻¹
10⁻²
10⁻⁴
10⁻³
10⁻²
10⁻¹
1
10
10²
pulse duration (s)

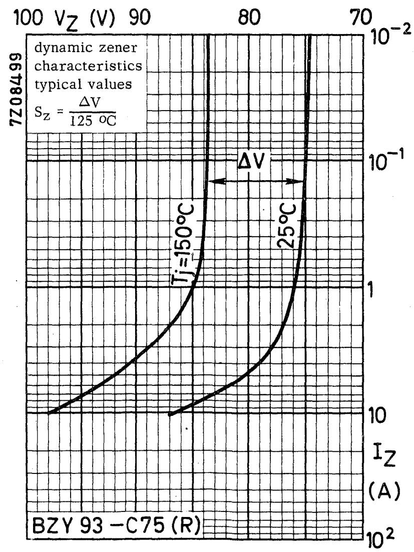

7Z08500
8 VZ (V) 7.5 7 6.5
dynamic zener characteristics typical values
SZ = ΔV / 125 °C
Tj =150°C
25°C
ΔV
10⁻²
10⁻¹
1
10
10²
IZ (A)
BZY93−C6V8 (R)

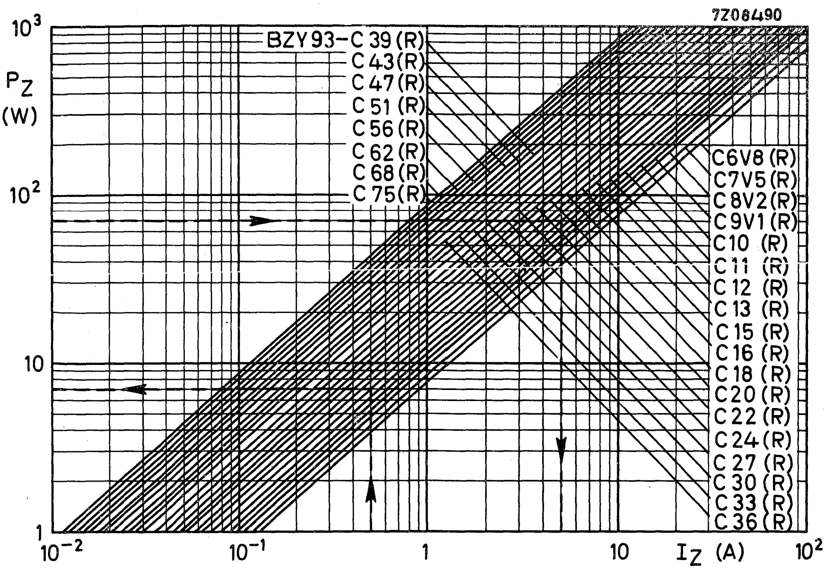

7Z08497
8.5 VZ (V) 8 7.5 7
dynamic zener characteristics typical values
SZ = ΔV / 125 °C
Tj =150°
25°C
ΔV
10⁻²
10⁻¹
1
10
10²
IZ (A)
BZY93−C7V5 (R)

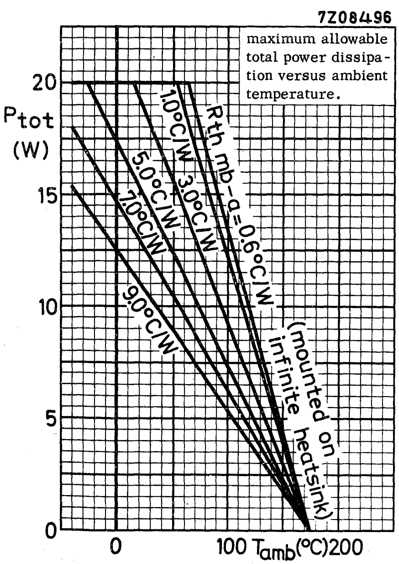

10.5 VZ (V) 10 9.5 9
7Z08493
dynamic zener characteristics typical values
Sz = ΔV / 125 °C
ΔV
Tj =150°C
25°C
10^-2
10^-1
1
10
IZ (A)
10^2
BZY93 – C9V1 (R)

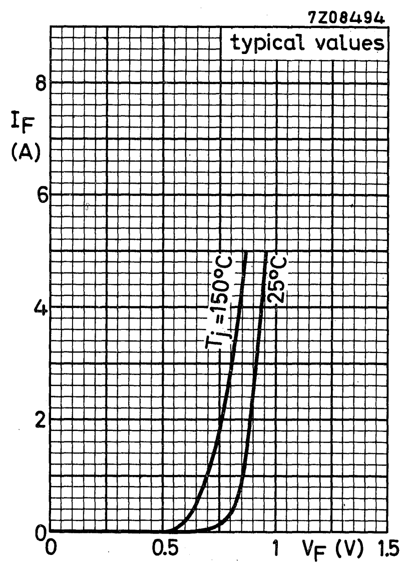

12 VZ (V) 11 10 9
7Z08495
dynamic zener characteristics typical values
Sz = ΔV / 125 °C
ΔV
Tj =150°C
25°C
10^-2
10^-1
1
10
IZ (A)
10^2
BZY 93 – C10 (R)

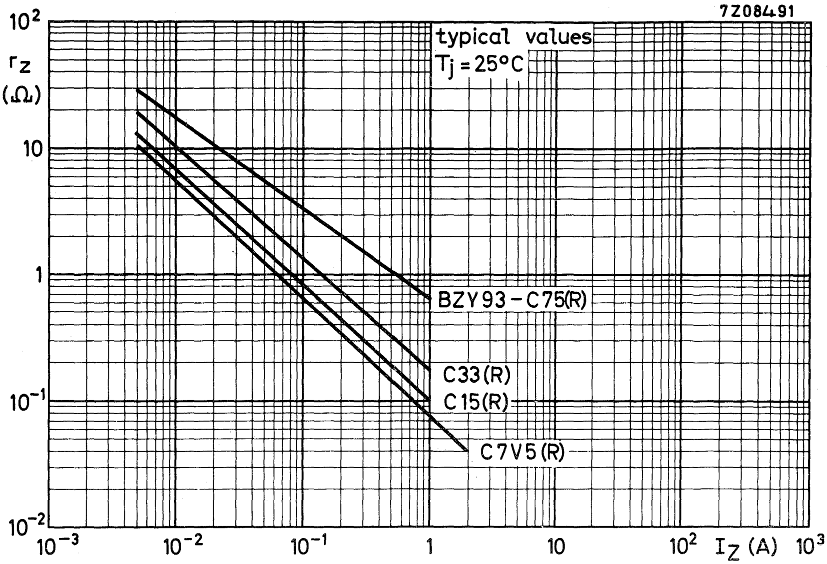

45 VZ (V) 40 35 30
7Z08498
dynamic zener characteristics typical values
Sz = ΔV / 125 °C
ΔV
Tj=150°C
25°C
10^-2
10^-1
1
10
IZ (A)
10^2
BZY93 – C33 (R)


100 VZ (V) 90 80 70
7Z08499
dynamic zener characteristics typical values
Sz = ΔV / 125 °C
ΔV
Tj=150°C
25°C
10^-2
10^-1
1
10
IZ (A)
10^2
BZY 93 – C75 (R)


7Z08490
BZY93-C 39 (R)
C 43 (R)
C 47 (R)
C 51 (R)
C 56 (R)
C 62 (R)
C 68 (R)
C 75 (R)
C6V8 (R)
C7V5 (R)
C 8V2 (R)
C 9V1 (R)
C10 (R)
C11 (R)
C 12 (R)
C 13 (R)
C 15 (R)
C 16 (R)
C 18 (R)
C 20 (R)
C 22 (R)
C 24 (R)
C 27 (R)
C 30 (R)
C 33 (R)
C 36 (R)
P_Z (W)
I_Z (A)
10^3
10^2
10
1
10^-2
10^-1
1
10
10^2


7Z08496
maximum allowable total power dissipation versus ambient temperature.
P_tot (W)
20
15
10
5
0
0
100 T_amb (°C) 200
R_th mb-a = 0.6°C/W (mounted on infinite heatsink)
1.0°C/W
3.0°C/W
5.0°C/W
7.0°C/W
9.0°C/W


7Z08494
typical values
I_F (A)
8
6
4
2
0
0
0.5
1
V_F (V)
1.5
T_j = 150°C
25°C


7Z08491
typical values
$T_j = 25°C$
r_Z
(Ω)
10^2
10
1
10^{-1}
10^{-2}
10^{-3}
10^{-2}
10^{-1}
1
10
10^2
I_Z (A)
10^3
BZY93-C75(R)
C33(R)
C15(R)
C7V5(R)

LOW POWER VOLTAGE REGULATORS

Diffused silicon diodes in a DO-7 subminiature envelope for use as low power voltage stabilisers or voltage references.
The series consists of 22 types with nominal zener voltages ranging from 10 V to 75 V with a tolerance of ±5%.

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

Currents

Average forward current (averaged over any 20 ms period)	I_{FAV}	max.	250	mA
Repetitive peak zener current	I_{ZRM}	max.	250	mA

Power dissipation

Total power dissipation up to T_{amb} = 50 °C	P_{tot}	max.	400	mW
Non repetitive peak reverse power dissipation, T_j = 150 °C	P_{ZSM}	max.	15	W

Temperatures

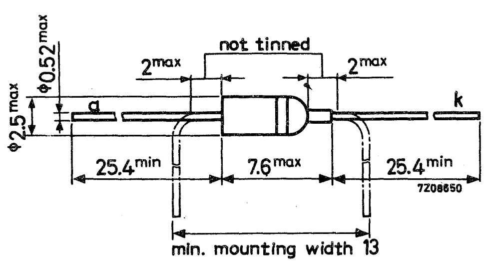
Storage temperature	T_{stg}		−65 to +175	°C
Junction temperature	T_j	max.	175	°C

THERMAL RESISTANCE

From junction to ambient in free air	$R_{th\ j\text{-}a}$	=	0.31	°C/mW

MECHANICAL DATA Dimensions in mm

DO-7



The coloured band indicates the cathode side

CHARACTERISTICS

T_j = 25 °C unless otherwise specified

Forward voltage at I_F = 10 mA — V_F < 0.9 V

Reverse current at $V_R = \frac{2}{3} \cdot V_{Znom}$ — I_R < 2.5 μA

BZY94-...	Zener voltage at I_Z = 5.0 mA min.	nom.	max.		Temperature coefficient at I_Z = 5.0 mA typ.	Differential resistance at I_Z = 5.0 mA max.
C10	9.4	10	10.6	V	7.0 mV/°C	25 Ω
C11	10.4	11	11.6	V	8.7 mV/°C	35 Ω
C12	11.4	12	12.6	V	9.0 mV/°C	35 Ω
C13	12.4	13	14.1	V	10.5 mV/°C	35 Ω
C15	13.9	15	15.6	V	12.5 mV/°C	40 Ω
C16	15.4	16	17.1	V	13.0 mV/°C	45 Ω
C18	16.9	18	19.1	V	15.0 mV/°C	50 Ω
C20	18.9	20	21.2	V	17.0 mV/°C	60 Ω
C22	20.8	22	23.3	V	19.0 mV/°C	65 Ω
C24	22.7	24	25.9	V	21.0 mV/°C	75 Ω
C27	25.1	27	28.9	V	23.5 mV/°C	85 Ω
C30	28	30	32	V	26 mV/°C	95 Ω
C33	31	33	35	V	29 mV/°C	110 Ω
C36	34	36	38	V	31 mV/°C	120 Ω

BZY94-...	at I_Z = 2.0 mA min.	nom.	max.		at I_Z = 2.0 mA typ.	at I_Z = 2.0 mA max.
C39	37	39	41	V	34 mV/°C	130 Ω
C43	40	43	45	V	37 mV/°C	150 Ω
C47	44	47	50	V	40 mV/°C	170 Ω
C51	48	51	54	V	44 mV/°C	180 Ω
C56	53	56	60	V	47 mV/°C	200 Ω
C62	58	62	66	V	51 mV/°C	215 Ω
C68	64	68	72	V	56 mV/°C	240 Ω
C75	71	75	79	V	60 mV/°C	255 Ω

MEDIUM POWER VOLTAGE REGULATORS

Diffused silicon diodes in a DO-1 metal case for use as medium power voltage stabilisers or voltage references.
The series consist of 22 normal polarity types (stud-cathode) with nominal zener voltages ranging from 10 V to 75 V with a tolerance of ± 5%.

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

Currents

Average forward current (averaged over any 20 ms period)	I_{FAV}	max.	1	A
Repetitive peak forward current	I_{FRM}	max.	3	A
Repetitive peak zener current	I_{ZRM}	max.	5	A

Power dissipation

Total power dissipation up to T_{amb} = 25 °C	P_{tot}	max.	1.5	W
Non repetitive peak reverse power	P_{ZSM}	max.	100	W

Temperatures

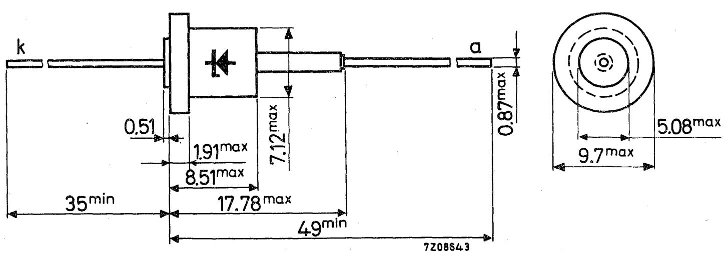
Storage temperature	T_{stg}		−65 to +175	°C
Junction temperature	T_j	max.	175	°C

THERMAL RESISTANCE

From junction to ambient in free air	$R_{th\ j\text{-}a}$	=	100	°C/W

MECHANICAL DATA Dimensions in mm

DO-1



CHARACTERISTICS T_j = 25 °C unless otherwise specified

Forward voltage at I_F = 1.0 A V_F < 1.5 V

Reverse current at $V_R = \frac{2}{3} \cdot V_{Z\,nom}$ I_R < 10 μA

BZY95-...	Zener voltage at I_Z = 50 mA			Temperature coefficient at I_Z = 50 mA	Differential resistance at I_Z = 50 mA	
	min.	nom.	max.	typ.	typ.	max.
C10	9.4	10	10.6 V	7.0 mV/°C	0.75	4.0 Ω
C11	10.4	11	11.6 V	7.5 mV/°C	0.80	4.5 Ω
C12	11.4	12	12.6 V	8.0 mV/°C	0.85	5.0 Ω
C13	12.4	13	14.1 V	8.5 mV/°C	0.90	6.0 Ω
C15	13.9	15	15.6 V	10.0 mV/°C	1.0	8.0 Ω
	at I_Z = 20 mA			at I_Z = 20 mA	at I_Z = 20 mA	
	min.	nom.	max.	typ.	typ.	max.
C16	15.4	16	17.1 V	11 mV/°C	2.4	9 Ω
C18	16.9	18	19.1 V	12 mV/°C	2.5	11 Ω
C20	18.9	20	21.2 V	14 mV/°C	2.8	12 Ω
C22	20.8	22	23.3 V	16 mV/°C	3.0	13 Ω
C24	22.7	24	25.9 V	18 mV/°C	3.4	14 Ω
C27	25.1	27	28.9 V	20 mV/°C	3.8	18 Ω
C30	28	30	32 V	25 mV/°C	4.5	22 Ω
C33	31	33	35 V	30 mV/°C	5.0	25 Ω
C36	34	36	38 V	32 mV/°C	5.5	30 Ω
	at I_Z = 10 mA			at I_Z = 10 mA	at I_Z = 10 mA	
	min.	nom.	max.	typ.	typ.	max.
C39	37	39	41 V	35 mV/°C	12	35 Ω
C43	40	43	45 V	40 mV/°C	13	40 Ω
C47	44	47	50 V	45 mV/°C	14	50 Ω
C51	48	51	54 V	50 mV/°C	15	55 Ω
C56	53	56	60 V	55 mV/°C	17	63 Ω
C62	58	62	66 V	60 mV/°C	18	75 Ω
C68	64	68	72 V	65 mV/°C	18	90 Ω
C75	71	75	79 V	70 mV/°C	20	100 Ω

MEDIUM POWER VOLTAGE REGULATORS

Alloyed silicon diodes in a DO-1 metal case for use as medium power voltage stabilisers or voltage references.
The series consists of 8 normal polarity types (stud-cathode) with nominal zener voltages ranging from 4.7 V to 9.1 V with a tolerance of ±5%.

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

Currents

Average forward current (averaged over any 20 ms period)	I_{FAV}	max.	1	A
Repetitive peak forward current	I_{FRM}	max.	3	A
Repetitive peak zener current	I_{ZRM}	max.	3.5	A

Power dissipation

Total power dissipation up to T_{amb} = 25 °C	P_{tot}	max.	1.5	W
Non repetitive peak reverse power	P_{ZSM}	max.	20	W

Temperatures

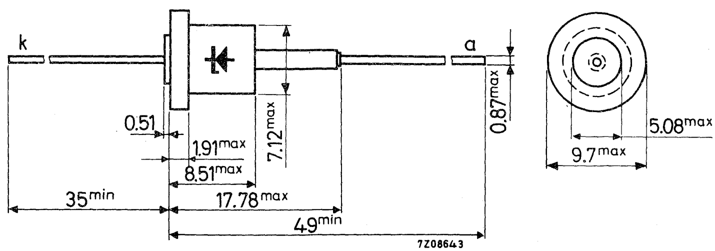
Storage temperature	T_{stg}		-65 to +175	°C
Junction temperature	T_j	max.	175	°C

THERMAL RESISTANCE

From junction to ambient in free air	$R_{th\ j\text{-}a}$	=	100	°C/W

MECHANICAL DATA Dimensions in mm

DO-1



CHARACTERISTICS

T_j = 25 °C unless otherwise specified

Forward voltage at I_F = 1.0 A — V_F < 1.5 V

Reverse current

BZY96-C4V7	V_R = 1.0 V	I_R	<	20	μA
C5V1	V_R = 1.0 V	I_R	<	20	μA
C5V6	V_R = 1.0 V	I_R	<	20	μA
C6V2	V_R = 2.0 V	I_R	<	20	μA
C6V8	V_R = 2.0 V	I_R	<	20	μA
C7V5	V_R = 3.0 V	I_R	<	20	μA
C8V2	V_R = 5.6 V	I_R	<	20	μA
C9V1	V_R = 6.2 V	I_R	<	20	μA

BZY96-...	Zener voltage at I_Z = 100 mA			Temperature coefficient at I_Z = 100 mA	Differential resistance at I_Z = 100 mA	
	min.	nom.	max.	typ.	typ.	max.
C4V7	4.4	4.7	5.0 V	−0.6 mV/°C	2.5	10 Ω
C5V1	4.8	5.1	5.4 V	+0.1 mV/°C	1.0	5.0 Ω
C5V6	5.3	5.6	6.0 V	+1.0 mV/°C	0.7	4.0 Ω
C6V2	5.8	6.2	6.6 V	+2.0 mV/°C	0.6	3.0 Ω
C6V8	6.4	6.8	7.2 V	+3.0 mV/°C	0.6	3.0 Ω
	at I_Z = 50 mA			at I_Z = 50 mA	at I_Z = 50 mA	
	min.	nom.	max.	typ.	typ.	max.
C7V5	7.1	7.5	7.9 V	+4.0 mV/°C	1.0	3.5 Ω
C8V2	7.7	8.2	8.7 V	+5.0 mV/°C	1.2	3.5 Ω
C9V1	8.6	9.1	9.6 V	+6.4 mV/°C	1.8	4.5 Ω

LOW POWER VOLTAGE REGULATORS

These types have been superseded by the BZY88-C6V2 to BZY88-C8V2

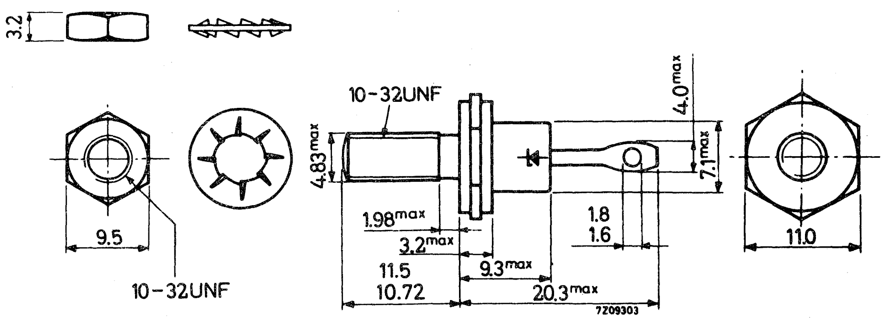
MEDIUM POWER VOLTAGE REGULATORS

Alloyed silicon diodes in a DO-4 metal envelope for use as medium-current voltage stabilisers or voltage references.
Zener voltage range from 5.6 to 24 V with a tolerance of ±5%.

QUICK REFERENCE DATA				
Zener voltage range (tolerance ±5%)		nom.	5.6 to 24	V
Repetitive peak zener current	I_{ZRM}	max.	7	A
Total power dissipation up to T_{mb} = 50 °C	P_{tot}	max.	10	W
Non repetitive peak reverse power dissipation	P_{ZSM}	max.	45	W
Junction temperature	T_j	max.	150	°C
Thermal resistance from junction to mounting base	$R_{th\ j\text{-}mb}$	=	10	°C/W

MECHANICAL DATA Dimensions in mm

DO-4



The mark shown applies to normal polarity types

Net weight 4.3 g
With accessories 6.5 g
Mounting torque: min. 8 cm kg
max. 17 cm kg
Diameter of hole in heatsink: max. 5.2 mm
Accessories available for insulated mounting: 56295 (56262A)

RATINGS (Limiting values) [1]

Currents

Average forward current (averaged over any 20 ms period)	I_{FAV}	max.	0.5	A
Repetitive peak forward current	I_{FRM}	max.	7	A
Repetitive peak zener current	I_{ZRM}	max.	7	A

Power dissipation

Total power dissipation up to T_{mb} = 50 °C	P_{tot}	max.	10	W
Non repetitive peak reverse power ($t < 100\ \mu s$)	P_{ZSM}	max.	45	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	$R_{th\ j\text{-}a}$	=	70	°C/W
From junction to mounting base	$R_{th\ j\text{-}mb}$	=	10	°C/W

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

Forward voltage

I_F = 200 mA	V_F	<	1.0	V

Reverse current

BZZ14	V_R = 2 V	I_R	<	500	nA
BZZ15	V_R = 2 V	I_R	<	500	nA
BZZ16	V_R = 3 V	I_R	<	500	nA
BZZ17	V_R = 3 V	I_R	<	500	nA
BZZ18	V_R = 3 V	I_R	<	400	nA
BZZ19	V_R = 5 V	I_R	<	400	nA
BZZ20	V_R = 5 V	I_R	<	400	nA
BZZ21 to 29	V_R = 5 V	I_R	<	50	nA

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

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

Diode capacitance

BZZ14	V_R = 3 V	C_d	typ.	575	pF
BZZ15	V_R = 3 V	C_d	typ.	475	pF
BZZ16	V_R = 3 V	C_d	typ.	375	pF
BZZ17	V_R = 2 V	C_d	typ.	350	pF
BZZ18	V_R = 2 V	C_d	typ.	300	pF
BZZ19	V_R = 2 V	C_d	typ.	250	pF
BZZ20	V_R = 2 V	C_d	typ.	250	pF
BZZ21	V_R = 3 V	C_d	typ.	340	pF
BZZ22	V_R = 3 V	C_d	typ.	280	pF
BZZ23	V_R = 3 V	C_d	typ.	260	pF
BZZ24	V_R = 3 V	C_d	typ.	240	pF
BZZ25	V_R = 3 V	C_d	typ.	210	pF
BZZ26	V_R = 3 V	C_d	typ.	200	pF
BZZ27	V_R = 3 V	C_d	typ.	155	pF
BZZ28	V_R = 3 V	C_d	typ.	135	pF
BZZ29	V_R = 3 V	C_d	typ.	130	pF

	Zener voltage V_Z (V) at I_Z = 20 mA			Temperature coefficient S_Z (mV/°C) at I_Z = 20 mA			Differential resistance r_z (Ω) at I_Z = 20 mA	
	min.	nom.	max.	min.	typ.	max.	typ.	max.
BZZ14	5.3	5.6	6.0	−0.4	+0.7	+2.5	4.5	15
BZZ15	5.8	6.2	6.6	+1.0	+2.1	+3.5	2.2	6.0
BZZ16	6.4	6.8	7.2	+2.0	+2.9	+4.0	2.07	5.0
BZZ17	7.1	7.5	7.9	+3.0	+3.75	+4.5	2.3	7.5
BZZ18	7.7	8.2	8.7	+4.0	+4.7	+6.0	2.6	10
BZZ19	8.6	9.1	9.6	+3.5	+5.8	+6.5	3.18	10
BZZ20	9.4	10	10.6	+6.0	+7.0	+8.0	3.8	17
BZZ21	10.4	11	11.6		+7.5		4.4	25
BZZ22	11.4	12	12.6		+8.8		5.25	28
BZZ23	12.4	13	14.1		+10		6.3	33
BZZ24	13.9	15	15.6		+12.6		8.9	39
BZZ25	15.4	16	17.1		+13.8		10.5	48
BZZ26	16.9	18	19.1		+16.4		14.5	54
BZZ27	18.9	20	21.2		+19		19.5	58
BZZ28	20.8	22	23.3		+21.6		26	63
BZZ29	22.7	24	25.9		+24.2		33.5	70

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

	Zener voltage V_Z (V)			Temperature coefficient S_Z (mV/°C)			Differential resistance r_Z (Ω)	
	at I_Z = 100 mA			at I_Z = 100 mA			at I_Z = 100 mA	
	min.	nom.	max.	min.	typ.	max.	typ.	max.
BZZ14	5.5	5.72	6.3	+0.5	+1.6	+3.0	1.47	4.0
BZZ15	5.8	6.3	6.8	+2.0	+2.45	+4.0	1.12	2.5
BZZ16	6.4	6.9	7.4	+2.5	+3.15	+4.0	1.1	2.5
BZZ17	7.2	7.6	8.2	+3.0	+4.05	+5.0	1.2	3.5
BZZ18	7.8	8.35	9.0	+3.0	+4.9	+6.1	1.38	5.0
BZZ19	8.8	9.3	10	+4.0	+6.1	+7.0	1.65	5.0
BZZ20	9.6	10.3	11	+3.0	+7.25	+11	2.05	5.0
BZZ21		11.3			+9.5		2.0	8.0
BZZ22		12.3			+11		2.5	10
BZZ23		13.4			+12		3.0	13
BZZ24		15.5			+14.8		4.2	16
BZZ25		16.7			+16		5.0	20
BZZ26		18.8			+18.7		7.0	20
BZZ27		21.5			+21.2		9.2	20
BZZ28		23.6			+23.8		12.2	25
BZZ29		26.1			+26.5		16	28

	at I_Z = 500 mA			at I_Z = 500 mA			at I_Z = 500 mA	
	min.	nom.	max.	min.	typ.	max.	typ.	max.
BZZ14	5.5	5.97	6.5	0	+2.15	+3.0	0.54	1.0
BZZ15	6.0	6.6	7.4	+1.5	+2.9	+4.0	0.53	2.0
BZZ16	6.6	7.12	7.9	+2.5	+3.7	+4.0	0.57	2.5
BZZ17	7.1	7.82	8.5	+3.0	+4.6	+7.0	0.62	3.0
BZZ18	8.0	8.57	9.5	+3.5	+5.5	+6.8	0.68	3.0
BZZ19	8.8	9.55	10.2	+4.5	+6.65	+7.5	0.81	3.0
BZZ20	10	10.72	11.6	+3.0	+7.8	+11	0.97	3.0

LOW POWER VOLTAGE REGULATORS

Alloyed silicon diodes in all-glass construction with external metal can for use as low power voltage stabilisers or voltage references.
OAZ200 to 207: zener voltage range from 4.7 to 9.1 V with a tolerance of ± 5%
OAZ208 to 213: zener voltage range from 4.3 to 12 V with a tolerance of ± 15%

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

Currents

Forward current (d.c. or averaged over any 20 ms period)	I_F	max.	100	mA
Repetitive peak forward current	I_{FRM}	max.	250	mA
Repetitive peak zener current	I_{ZRM}	max.	250	mA
Non repetitive peak zener current ($t \leq 100\ \mu s$)	I_{ZSM}	max.	10	A

Power dissipation

Total power dissipation up to $T_{amb} = 25\ ^oC$ with cooling clip 56210 on a heatsink 1.6 mm Al 3.5 cm x 3.5 cm	P_{tot}	max.	500	mW

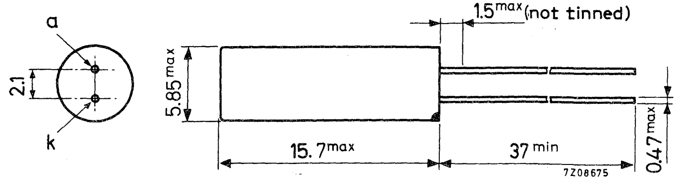
Temperatures

Storage temperature	T_{stg}	-55 to +150		^oC
Junction temperature	T_j	max.	150	^oC

THERMAL RESISTANCE

From junction to case	$R_{th\ j\text{-}c}$	=	0.15	$^oC/mW$
From junction to ambient in free air	$R_{th\ j\text{-}a}$	=	0.4	$^oC/mW$
From junction to ambient with cooling clip 56209	$R_{th\ j\text{-}a}$	=	0.3	$^oC/mW$
with cooling clip 56210	$R_{th\ j\text{-}a}$	=	0.25	$^oC/mW$

MECHANICAL DATA Dimensions in mm



The coloured dot indicates the cathode side

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

These types have been superseded by BZY88-C6V2 to BZY88-C9V1

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

Forward voltage

I_F = 10 mA	V_F	typ. 730	mV
		620 to 820	mV
I_F = 100 mA	V_F	typ. 800	mV
		700 to 920	mV

	Diode capacitance at V_R = 3 V			Reverse current		
	min.	typ.	max.	at V_R =	typ.	max.
OAZ200	200	420	650 pF	2 V	0.12	0.50 μA
OAZ201	100	400	650 pF	2 V	0.04	0.50 μA
OAZ202	100	360	600 pF	2 V	0.02	0.30 μA
OAZ203	100	300	500 pF	2 V	0.04	0.30 μA
OAZ204	100	300	450 pF	3 V	0.02	0.25 μA
OAZ205	100	250	400 pF	3 V	0.005	0.20 μA
OAZ206	50	220	350 pF	5 V	0.02	0.20 μA
OAZ207	50	170	300 pF	5 V	0.015	0.15 μA
OAZ208	200	420	700 pF	1.5 V	0.10	0.50 μA
OAZ209	100	400	650 pF	1.5 V	0.04	0.50 μA
OAZ210	100	300	600 pF	2 V	0.02	0.50 μA
OAZ211	50	300	450 pF	2 V	0.02	0.30 μA
OAZ212	50	170	350 pF	5 V	0.015	0.20 μA
OAZ213	50	150	250 pF	5 V	0.010	0.15 μA

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

	Zener voltage V_Z (V)			Temperature coefficient S_Z (mV/°C)			Differential resistance r_Z (Ω)		
	at I_Z = 1 mA			at I_Z = 1 mA			at I_Z = 1 mA		
	min.	nom.	max.	min.	typ.	max.	min.	typ.	max.
OAZ200	4.4	4.7	5.0	−2.75	−2.0	−1.25	320	350	400
OAZ201	4.8	5.1	5.4	−2.5	−1.8	−1.0	270	330	400
OAZ202	5.3	5.6	6.0	−2.5	−1.0	+1.5	50	275	380
OAZ203	5.8	6.2	6.6	−1.0	+0.5	+3.0	10	215	380
OAZ204	6.4	6.8	7.2	0.0	+2.5	+4.0	5.0	40	170
OAZ205	7.1	7.5	7.9	+2.0	+4.0	+5.0	3.0	8.6	35
OAZ206	7.7	8.2	8.7	+2.0	+5.0	+7.0	2.5	7.6	28
OAZ207	8.6	9.1	9.6	+4.0	+6.2	+7.0	2.5	9.6	45
	at I_Z = 5 mA			at I_Z = 5 mA			at I_Z = 5 mA		
	min.	nom.	max.	min.	typ.	max.	min.	typ.	max.
OAZ200	4.9	5.2	5.6	−1.75	−1.2	0.0	30	56	70
OAZ201	5.2	5.6	6.0	−1.5	−0.6	+1.0	12	45	75
OAZ202	5.6	6.0	6.3	−1.0	+0.8	+2.5	5.0	24	55
OAZ203	6.1	6.3	6.8	+0.5	+1.7	+3.5	2.5	9.5	25
OAZ204	6.4	6.9	7.3	+2.0	+3.0	+4.0	2.0	4.7	24
OAZ205	7.1	7.6	8.0	+2.0	+4.3	+5.0	1.0	3.7	17
OAZ206	7.7	8.2	8.8	+2.0	+5.2	+7.5	1.0	3.8	15
OAZ207	8.6	9.2	9.8	+4.0	+6.4	+7.0	1.5	4.9	25
	at I_Z = 20 mA			at I_Z = 20 mA			at I_Z = 20 mA		
	min.	nom.	max.	min.	typ.	max.	min.	typ.	max.
OAZ200	5.3	5.6	5.9	−1.5	+0.2	+1.5	3.0	9.0	15
OAZ201	5.6	5.9	6.2	−0.5	+1.0	+2.5	1.0	5.7	13
OAZ202	5.9	6.2	6.6	+0.5	+1.9	+3.5	1.0	3.2	6
OAZ203	6.1	6.4	6.9	+1.0	+2.6	+4.0	1.0	2.3	11
OAZ204	6.5	7.0	7.4	+2.0	+3.6	+5.0	0.5	2.0	8
OAZ205	7.1	7.7	8.2	+2.0	+4.6	+5.5	0.75	2.2	12
OAZ206	7.8	8.4	9.0	+2.0	+5.4	+7.5	1.0	2.4	10
OAZ207	8.8	9.4	10.0	+4.0	+6.6	+8.0	0.75	2.9	20

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

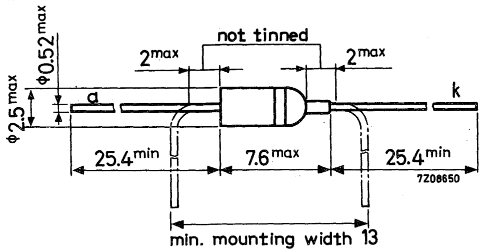
	Zener voltage V_Z (V)			Temperature coefficient S_Z (mV/°C)			Differential resistance r_Z (Ω)		
	at I_Z = 1 mA			at I_Z = 1 mA			at I_Z = 1 mA		
	min.	nom.	max.	min.	typ.	max.	min.	typ.	max.
OAZ208	3.3	4.3	5.0	−3.5	−2.0	−0.5	320	350	400
OAZ209	4.4	5.1	6.0	−2.75	−1.8	+1.5	50	330	400
OAZ210	5.3	6.2	7.2	−2.5	+0.5	+4.0	5.0	215	380
OAZ211	6.4	7.5	8.7	0.0	+4.0	+7.0	2.5	8.6	170
OAZ212	7.7	9.1	10.6	+2.5	+6.2	+8.5	2.5	9.6	45
OAZ213	9.4	12	15.0	+4.0	+9.2	+12	-	35	70
	at I_Z = 5 mA			at I_Z = 5 mA			at I_Z = 5 mA		
	min.	nom.	max.	min.	typ.	max.	min.	typ.	max.
OAZ208	3.8	4.9	5.6	−2.2	−1.4	0.0	30	62	80
OAZ209	4.9	5.6	6.3	−1.75	−0.6	+2.5	5.0	45	75
OAZ210	5.6	6.3	7.3	−1.0	+1.7	+4.0	2.0	9.5	55
OAZ211	6.4	7.6	8.8	+2.0	+4.3	+7.5	1.0	3.7	24
OAZ212	7.7	9.2	10.8	+2.5	+6.4	+8.5	1.0	4.9	25
OAZ213	9.4	12.2	15.3	+4.0	+9.3	+12	-	12	40
	at I_Z = 20 mA			at I_Z = 20 mA			at I_Z = 20 mA		
	min.	nom.	max.	min.	typ.	max.	min.	typ.	max.
OAZ208	4.3	5.3	5.9	−2.0	−0.5	+1.5	3.0	12	20
OAZ209	5.3	5.9	6.4	−1.5	+1.0	+3.5	1.0	5.7	15
OAZ210	5.9	6.4	7.4	+0.5	+2.6	+5.0	0.5	2.3	11
OAZ211	6.5	7.7	9.0	+2.0	+4.6	+7.5	0.5	2.2	12
OAZ212	7.8	9.4	11.1	+2.5	+6.6	+8.5	0.7	2.9	20
OAZ213	9.6	12.5	15.7	+4.0	+9.4	+12	-	5.6	16

VOLTAGE REGULATOR DIODES

Silicon alloyed diodes in subminiature all glass DO-7 envelope for use as low power voltage stabilisers or voltage references.
The series consists of 14 types with nominal zener voltages ranging from 3.3 to 12 V with a tolerance of ±5%.

MECHANICAL DATA Dimensions in mm

DO-7



The coloured band indicates the cathode side

RATINGS (Limiting values) [1])

Currents

Repetitive peak zener current	I_{ZRM}	max.	250	mA
Average forward current (averaged over any 20 ms period)	I_{FAV}	max.	250	mA

Power dissipation

Total power dissipation up to T_{amb} = 50 °C	P_{tot}	max.	400	mW

Temperatures

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

THERMAL RESISTANCE

From junction to ambient in free air	$R_{th\ j-a}$	=	0.31	°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

Forward voltage at I_F = 10 mA V_F < 900 mV

	Zener voltage [1] at I_Z = 20 mA			Temperature coefficient [1] at I_Z = 20 mA	Differential resistance [1] at I_Z = 20 mA	Reverse current at V_R = 1.0 V, T_{amb} =	
	min.	nom.	max.	typ.	max.	25 °C	150 °C
1N746A	3.135	3.3	3.465 V	-2.05 mV/°C	28 Ω	10	30 μA
1N747A	3.420	3.6	3.780 V	-2.05 mV/°C	24 Ω	10	30 μA
1N748A	3.705	3.9	4.095 V	-1.90 mV/°C	23 Ω	10	30 μA
1N749A	4.085	4.3	4.515 V	-1.55 mV/°C	22 Ω	2.0	30 μA
1N750A	4.465	4.7	4.935 V	-0.845 mV/°C	19 Ω	2.0	30 μA
1N751A	4.845	5.1	5.355 V	-0.405 mV/°C	17 Ω	1.0	20 μA
1N752A	5.320	5.6	5.880 V	+0.336 mV/°C	11 Ω	1.0	20 μA
1N753A	5.890	6.2	6.510 V	+1.36 mV/°C	7.0 Ω	0.1	20 μA
1N754A	6.460	6.8	7.140 V	+2.38 mV/°C	5.0 Ω	0.1	20 μA
1N755A	7.125	7.5	7.875 V	+3.37 mV/°C	6.0 Ω	0.1	20 μA
1N756A	7.790	8.2	8.610 V	+4.26 mV/°C	8.0 Ω	0.1	20 μA
1N757A	8.645	9.1	9.555 V	+5.10 mV/°C	10 Ω	0.1	20 μA
1N758A	9.500	10.0	10.500 V	+6.0 mV/°C	17 Ω	0.1	20 μA
1N759A	11.400	12.0	12.000 V	+7.2 mV/°C	30 Ω	0.1	20 μA

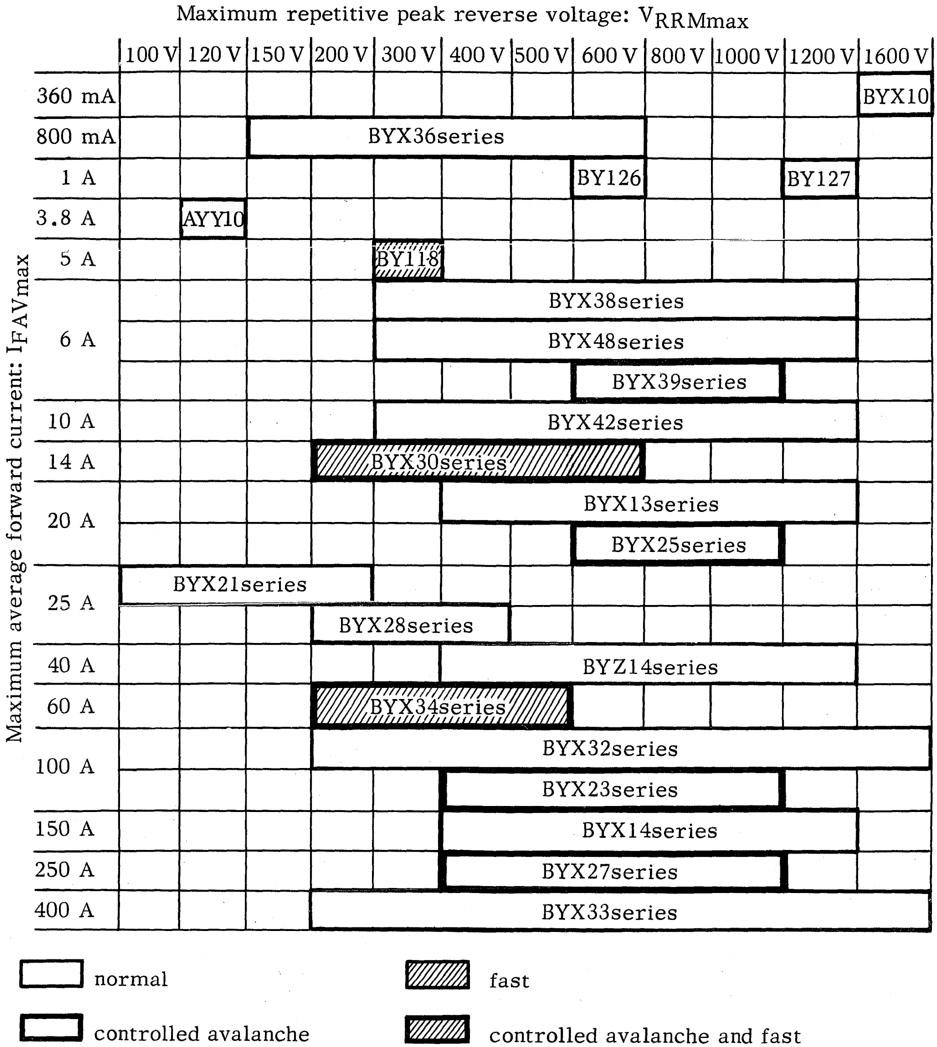
OPERATING NOTES

1. When using a soldering iron, the diodes may be soldered directly into a circuit, but heat conducted to the junction should be kept to a minimum by use of a thermal shunt.
2. Diodes may be dip soldered at a solder temperature of 245 °C for a maximum soldering time of 5 seconds. The case temperature during dip soldering must not at any time exceed the maximum storage temperature. These recommendations apply to a diode with the anode end mounted flush on the board with punched-through holes. For mounting the cathode end onto the board the diode must be spaced 5 mm from the underside of the printed circuit board in the case of punched-through holes or 5 mm from the top of the board for plated-through holes.
3. Care should be taken not to bend the leads nearer than 1.5 mm from the seals.

[1]) Measured by a pulse method with $t_p \leq 100\ \mu s$, $\delta = 0.001$, T_j = 25 °C.

Rectifier diodes

TYPE SELECTION CHART



Maximum repetitive peak reverse voltage: V_{RRMmax}

Maximum average forward current: I_{FAVmax}

	15 kV	37.5 kV	75 kV to 150 kV
2.5 mA	BY140		
50 mA		BYX35	BYX29series

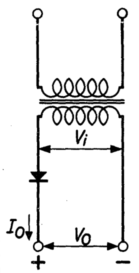
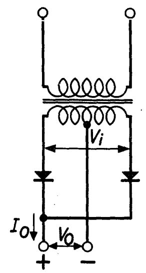
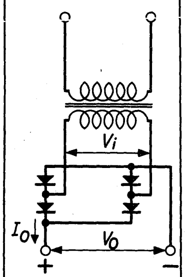
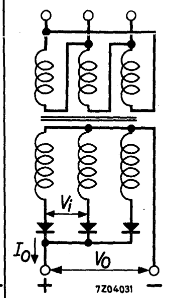
normal

controlled avalanche

fast

OPERATION AS RECTIFIER

Output voltages and currents of diodes in rectifier circuits based on the rated crest working reverse voltage and rated average forward current.

		Single phase half wave	Two phase half wave	Single phase full wave (Single phase bridge)	Three phase half wave (Three phase star)
					
		$I_O = I_{FAV}$	$I_O = 2(I_{FAV})$	$I_O = 2(I_{FAV})$	$I_O = 3(I_{FAV})$
V_{RWMmax}	$V_{i(rms)}$	V_O	V_O	V_O	V_O
100	70	30	30	62	47
200	140	60	60	125	95
300	210	90	90	185	140
400	280	125	125	250	190
500	350	155	155	310	235
600	420	185	185	375	280
800	560	250	250	500	380
1000	700	315	315	635	475
1200	840	375	375	750	560
1600	1120	500	500	1000	760

These V_i and I_O figures are absolute max. values for resistive or inductive load; no source impedance is assumed. The equipment designer has to determine an average design such that these values will not be exceeded.

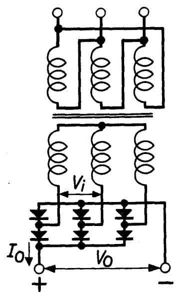
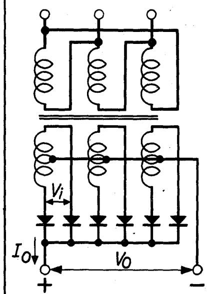
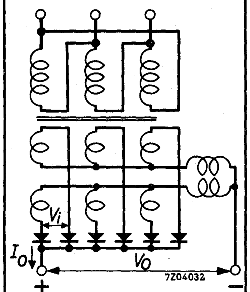
$V_{i(rms)}$ = transformer secondary r.m.s. voltage in V

I_O = average output current in A

V_O = average output voltage in V

OPERATION AS RECTIFIER

Output voltages and currents of diodes in rectifier circuits based on the rated crest working reverse voltage and rated average forward current.

		Three phase full wave (Three phase bridge)	Six phase half wave (Six phase star)	Three phase double Y with interphase transformer
				
		$I_O = 3(I_{FAV})$	$I_O = 4.8\ (I_{FAV})$	$I_O = 6(I_{FAV})$
V_{RWMmax}	$V_{i(rms)}$	V_O	V_O	V_O
100	70	94	47	40
200	140	185	95	80
300	210	280	140	120
400	280	375	190	160
500	350	470	235	200
600	420	565	280	240
800	560	750	380	320
1000	700	940	475	400
1200	840	1120	560	480
1600	1120	1510	760	640

These V_i and I_O figures are absolute max. values for resistive or inductive load; no source impedance is assumed. The equipment designer has to determine an average design such that these values will not be exceeded.

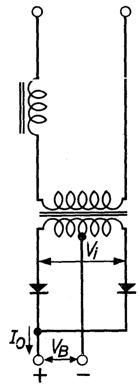
$V_{i(rms)}$ = transformer secondary r.m.s. voltage in V

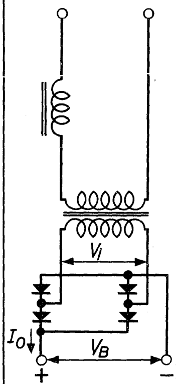
I_O = average output current in A

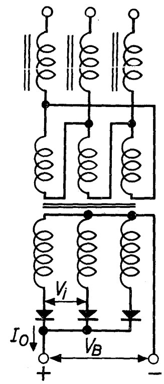
V_O = average output voltage in V

TYPICAL OPERATION FOR BATTERY CHARGING

Output voltages and currents of diodes in rectifier circuits based on the rated crest working reverse voltage and rated average forward current.







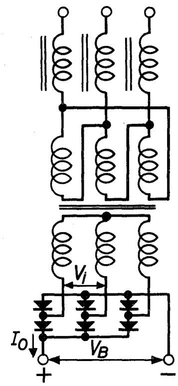
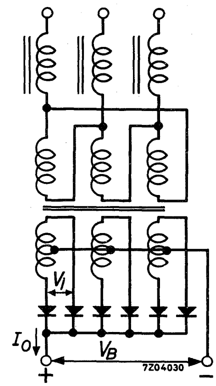
		Two phase half wave		Single phase full wave (Single phase bridge)		Three phase half wave (Three phase star)	
		$I_O = I_{FAV}$		$I_O = I_{FAV}$		$I_O = 1.5(I_{FAV})$	
V_{RWMmax}	$V_{i(rms)}$	V_O	n	V_O	n	V_o	n
100	62	28	13	60	27	35	16
200	125	60	27	120	54	70	32
300	190	90	41	180	82	105	47
400	255	120	54	240	109	140	64
500	315	150	68	300	136	170	77
600	380	180	82	360	164	210	95
800	510	240	109	480	217	270	122
1000	640	300	136	600	272	340	154
1200	750	360	164	720	328	420	190

The above data are nominal values with battery load. The possibility of mains voltage fluctuations of max. 10% has been taken into account. For current limiting use is made of inductors in series with the primary of the mains transformer.

$V_{i(rms)}$ = transformer secondary r.m.s. voltage in V
I_O = average output current in A
V_B = battery voltage in V
n = maximum number of Pb cells in series (nominal voltage per cell is 2.2 V)

TYPICAL OPERATION FOR BATTERY CHARGING

Output voltages and currents of diodes in rectifier circuits based on the rated crest working reverse voltage and rated average forward current.

		Three phase full wave (Three phase bridge)		Six phase half wave (Six phase star)	
					
		$I_O = 1.5(I_{FAV})$		$I_O = 3(I_{FAV})$	
V_{RWMmax}	$V_{i(rms)}$	V_O	n	V_O	n
100	62	60	27	30	13
200	125	120	54	60	27
300	190	180	82	90	41
400	255	240	109	120	54
500	315	300	136	150	68
600	380	360	164	180	82
800	510	480	217	240	109
1000	640	600	272	300	136
1200	750	720	328	360	164

The above data are nominal values with battery load. The possibility of mains voltage fluctuations of max. 10% has been taken into account. For current limiting use is made of inductors in series with the primary of the mains transformer.

$V_{i(rms)}$ = transformer secondary r.m.s. voltage in V
I_O = average output current in A
V_B = battery voltage in V
n = maximum number of Pb cells in series (nominal voltage per cell is 2.2 V)

GERMANIUM RECTIFIER DIODE

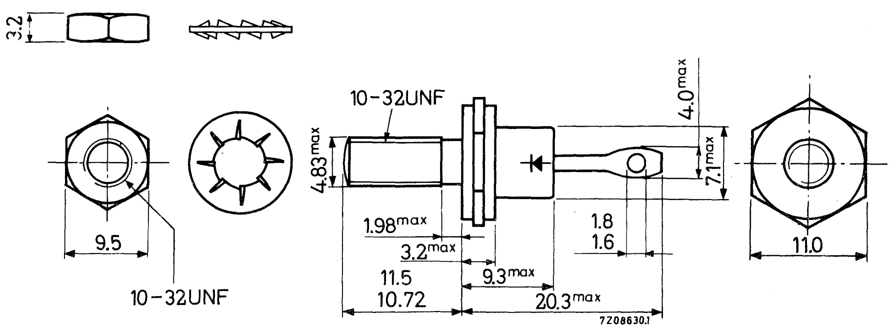
Germanium diode in a DO-4 metal envelope, primarily intended for medium-power rectifier applications.

QUICK REFERENCE DATA				
Crest working reverse voltage	V_{RWM}	max.	95	V
Repetitive peak reverse voltage	V_{RRM}	max.	120	V
Average forward current	I_{FAV}	max.	3.8	A
Non repetitive peak forward current (t < 10 ms)	I_{FSM}	max.	90	A
Junction temperature	T_j	max.	75	°C
Thermal resistance from junction to mounting base	$R_{th\ j\text{-}mb}$	=	5	°C/W

MECHANICAL DATA

Dimensions in mm

DO-4



Net weight : 4.3 g

With accessories : 6.5 g

Diameter of hole in heatsink : max. 5.2 mm

Accessories available : 56295 (56262A)

Torque on nut: min. 8 cm kg

max. 17 cm kg

All information applies to frequencies up to 1000 Hz

RATINGS (Limiting values) [1]

Voltages

Continuous reverse voltage	V_R	max.	85	V
Crest working reverse voltage	V_{RWM}	max.	95	V
Repetitive peak reverse voltage	V_{RRM}	max.	120	V
Non repetitive peak reverse voltage	V_{RSM}	max.	120	V

Currents

Average forward current (averaged over any 20 ms period)	I_{FAV}	max.	3.8	A
Forward current (d.c.)	I_F	max.	12	A
Repetitive peak forward current	I_{FRM}	max.	12	A
Non repetitive peak forward current $t < 10$ ms (See page 5)	I_{FSM}	max.	90	A

TEMPERATURES

Storage temperature	T_{stg}		-25 to +75	°C
Junction temperature	T_j	max.	75	°C

THERMAL RESISTANCE

From junction to ambient	$R_{th\ j\text{-}a}$	=	50	°C/W
From junction to mounting base	$R_{th\ j\text{-}mb}$	=	5	°C/W
From mounting base to heatsink	$R_{th\ mb\text{-}h}$	=	1	°C/W

CHARACTERISTICS

Voltages

Forward voltage at I_F = 12 A; T_j = 25 °C	V_F	<	0.70	V
T_j = 75 °C	V_F	<	0.65	V

Currents

Reverse current V_R = 85 V; T_j = 25 °C	I_R	<	100	μA
V_R = 85 V; T_j = 75 °C	I_R	<	4	mA

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

OPERATING NOTES

1. When there is a possibility that transient voltages, caused by the stored energy in the transformer core, will exceed the maximum permissible non repetitive peak reverse voltage, a damping circuit across the transformer should be applied.
   Either a series RC circuit or a voltage dependent resistor may be used. Suitable component values for an RC circuit across the transformer primary or secondary may be calculated as follows:

$\frac{V_{RSM}}{V_{RWM}}$	RC across primary of transformer		RC across secondary of transformer	
	C (μF)	R (Ω)	C (μF)	R (Ω)
2.0	$200\frac{I_{mag}}{V_1}$	$\frac{150}{C}$	$225\frac{I_{mag}T^2}{V_1}$	$\frac{200}{C}$
1.5	$400\frac{I_{mag}}{V_1}$	$\frac{225}{C}$	$450\frac{I_{mag}T^2}{V_1}$	$\frac{275}{C}$
1.25	$550\frac{I_{mag}}{V_1}$	$\frac{260}{C}$	$620\frac{I_{mag}T^2}{V_1}$	$\frac{310}{C}$

where I_{mag} = magnetising primary r.m.s. current (A)

V_1 = transformer primary r.m.s. voltage (V)

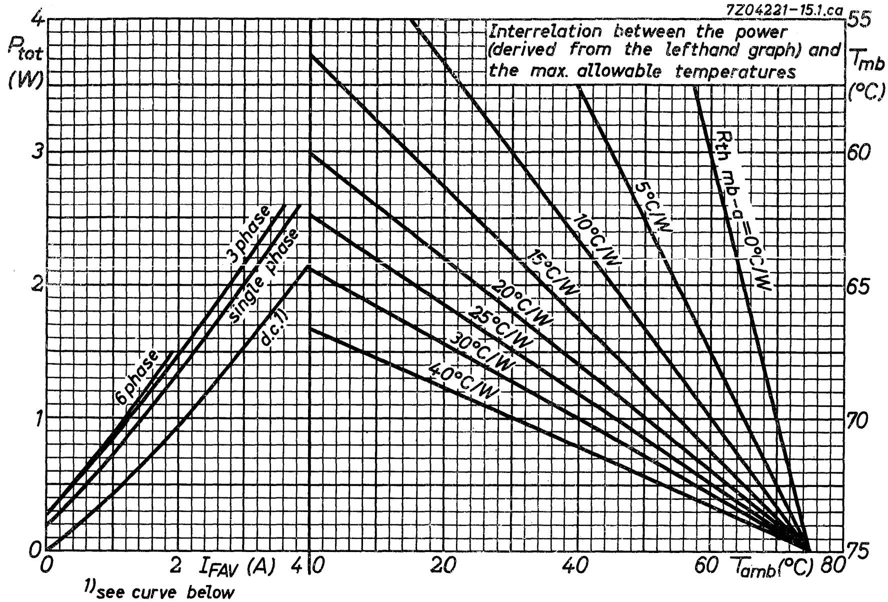
V_2 = transformer secondary r.m.s. voltage (V)

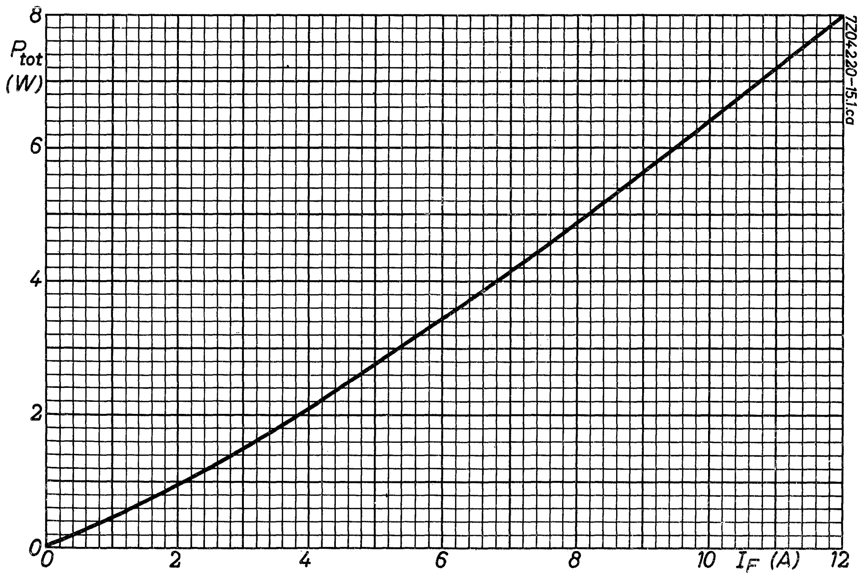
T = V_1/V_2

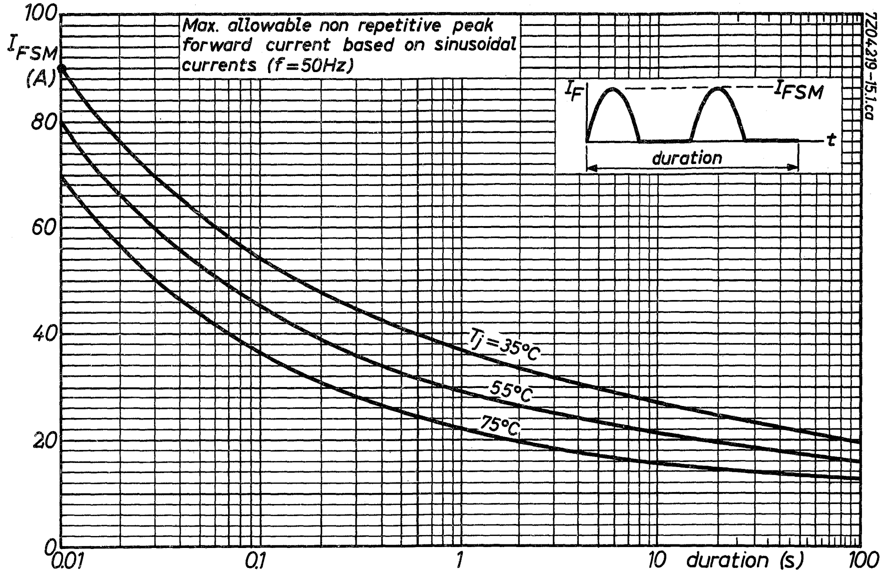
V_{RWM} stands for the actually applied crest working reverse voltage

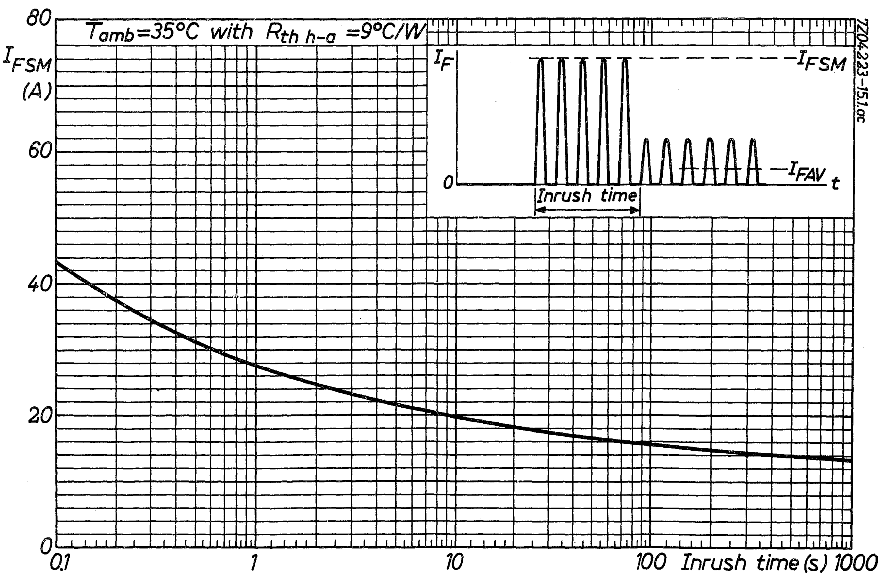
APPLICATION INFORMATION

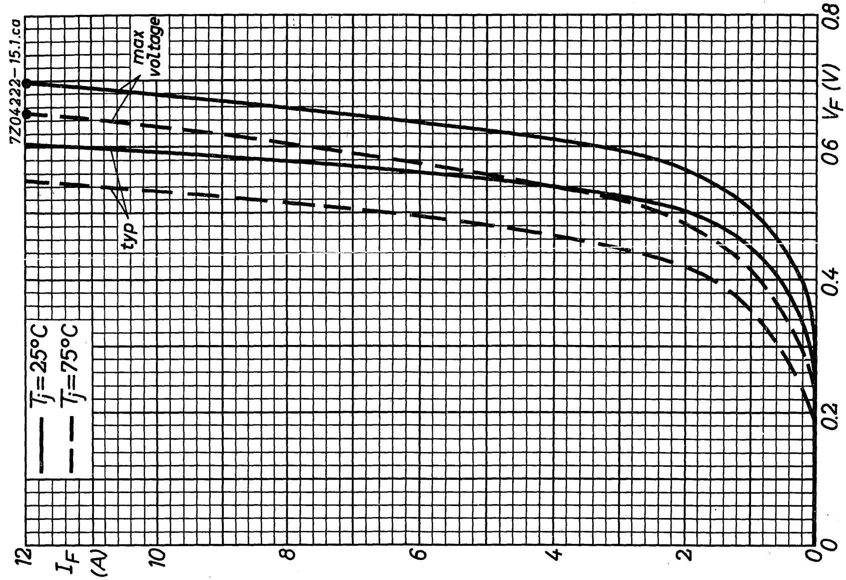
See general pages at the beginning of this section.

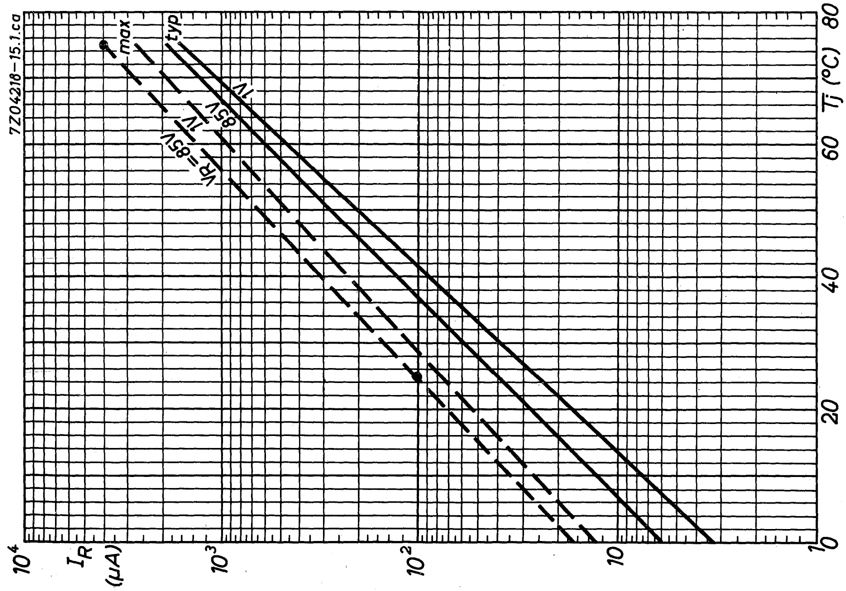

7Z04221-15.1.ca
Interrelation between the power (derived from the lefthand graph) and the max. allowable temperatures
Ptot (W)
Tmb (°C)
6 phase
3 phase
single phase
d.c.1)
Rth mb-a=0°C/W
5°C/W
10°C/W
15°C/W
20°C/W
25°C/W
30°C/W
40°C/W
IFAV (A)
Tamb (°C)
1)see curve below


Ptot (W)
7Z04220-15.1.ca
IF (A)


Max. allowable non repetitive peak forward current based on sinusoidal currents (f=50Hz)
7Z04219-15.1.ca
I_{FSM} (A)
100
80
60
40
20
0
0.01
0.1
1
10
duration (s)
100
I_F
I_{FSM}
t
duration
T_j=35°C
55°C
75°C


T_{amb}=35°C with $R_{th\ h-a}$ =9°C/W
7Z04223-15.1.ac
I_{FSM} (A)
80
60
40
20
0
0.1
1
10
100
Inrush time (s)
1000
I_F
I_{FSM}
I_{FAV}
t
Inrush time


7Z04222-15.1.ca
max voltage
typ
Tj=25°C
Tj=75°C
VF (V)
0
0.2
0.4
0.6
0.8
IF (A)
0
2
4
6
8
10
12


7Z04218-15.1.ca
max
typ
1V
85V
1V
VR=85V
Tj (°C)
0
20
40
60
80
IR (µA)
1
10
10^2
10^3
10^4

SILICON RECTIFIER DIODES

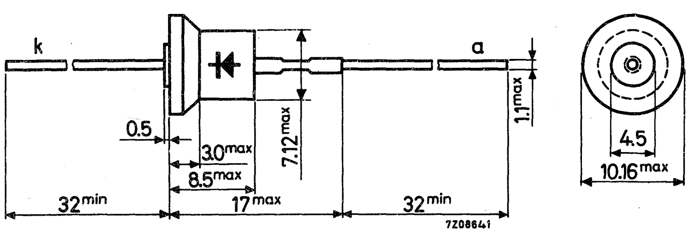
Silicon double diffused rectifier diodes in a DO-1 metal envelope. They are intended for mains rectifier applications in television receivers.

QUICK REFERENCE DATA

			BY100	BY114	
Crest working reverse voltage	V_{RWM}	max.	800	450	V
Repetitive peak reverse voltage	V_{RRM}	max.	1250	650	V
Average forward current with R and L load; $V_{RWM} = V_{RWMmax}$	I_{FAV}	max.	1.0		A
$V_{RWM} = 60$ V	I_{FAV}	max.	1.2		A
Non repetitive peak forward current t = 10 ms	I_{FSM}	max.	40		A
Junction temperature	T_j	max.	150		°C
Thermal resistance from junction to ambient	$R_{th\ j-a}$	=	60		°C/W

MECHANICAL DATA Dimensions in mm

DO-1



For new design the successor types BY126 and BY127 are recommended

All information applies to frequencies up to 400 Hz

RATINGS (Limiting values) [1]

Voltages			BY100	BY114	
Crest working reverse voltage	V_{RWM}	max.	800	450	V
Repetitive peak reverse voltage	V_{RRM}	max.	1250	650	V
Non repetitive peak reverse voltage ($t \leq 10$ ms)	V_{RSM}	max.	1250	650	V

Currents				
Average forward current (averaged over any 20 ms period) with R and L load; $V_{RWM} = V_{RWMmax}$	I_{FAV}	max.	1.0	A
$V_{RWM} = 60$ V	I_{FAV}	max.	1.2	A
Repetitive peak forward current	I_{FRM}	max.	10	A
Non repetitive peak forward current $t = 10$ ms; half sine wave	I_{FSM}	max.	40	A

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

THERMAL RESISTANCE

From junction to ambient in free air	$R_{th\ j\text{-}a}$	=	60	°C/W

CHARACTERISTICS at $T_j = 25$ °C

Voltage				
Forward voltage at $I_F = 5$ A	V_F	<	1.5	V

Current				
Reverse current at $V_R = V_{RRMmax}$	I_R	<	10	μA

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

SILICON DIODE

Silicon diffused rectifier diode in a metal envelope for use as efficiency diode in line deflection circuits of television receivers.

RATINGS (Limiting values) [1]

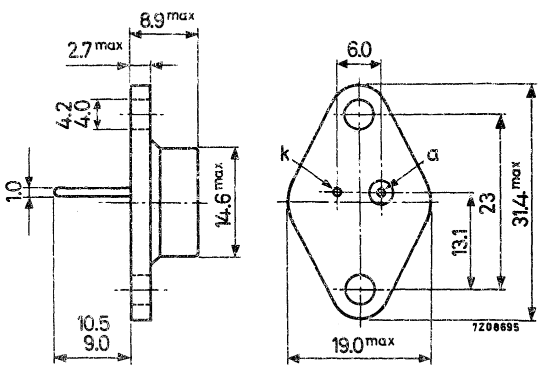
Voltage				
Repetitive peak reverse voltage	V_{RRM}	max.	300	V
Currents				
Forward current (d.c.)	I_F	max.	6	A
Average rectified forward current (averaged over any 20 ms period)	I_{FAV}	max.	5	A
Repetitive peak forward current	I_{FRM}	max.	14	A
Repetitive peak forward current (t = 3 μs)	I_{FRM}	max.	20	A
Temperatures				
Storage temperature	T_{stg}		−55 to +150	°C
Junction temperature	T_j	max.	150	°C

THERMAL RESISTANCE

From junction to mounting base	$R_{th\ j\text{-}mb}$	=	5	°C/W
From mounting base to heatsink	$R_{th\ mb\text{-}h}$	=	0.5	°C/W
From mounting base to heasink with mica washer	$R_{th\ mb\text{-}h}$	=	1.5	°C/W

MECHANICAL DATA Dimensions in mm

Cathode is connected to mounting base



Accessories available: 56203

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

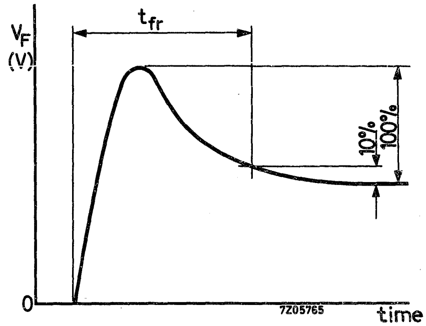
CHARACTERISTICS

T_j = 25 °C unless otherwise specified

Forward voltage at I_F = 14 A	V_F	< 1.2	V
Reverse current at V_R = 300 V	I_R	< 100	μA

Forward recovery time

I_F = 14 A; t_r = 0.25 μs T_j up to 150 °C	t_{fr}	< 1.0	μs

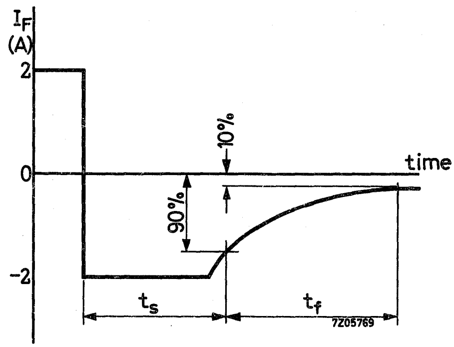


Forward output wave form

Reverse recovery time when switched from

I_F = 2 A to V_R = 30 V; I_R limited to 2 A;
t_r < 0.25 μs ; T_j up to 150 °C

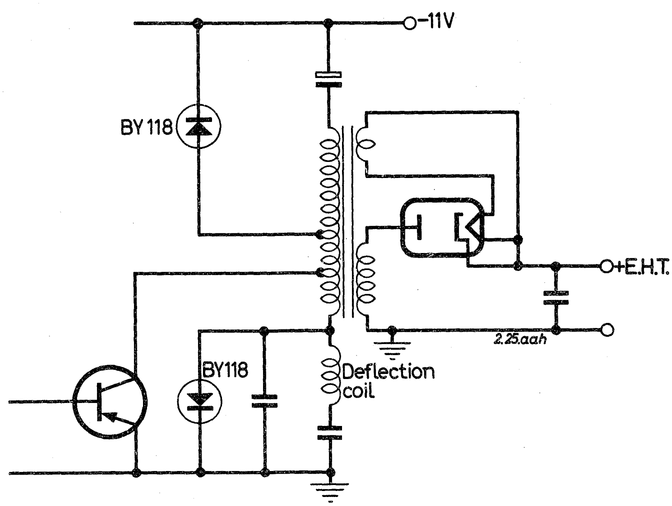
Storage time	t_s	< 3	μs
Fall time	t_f	< 1	μs

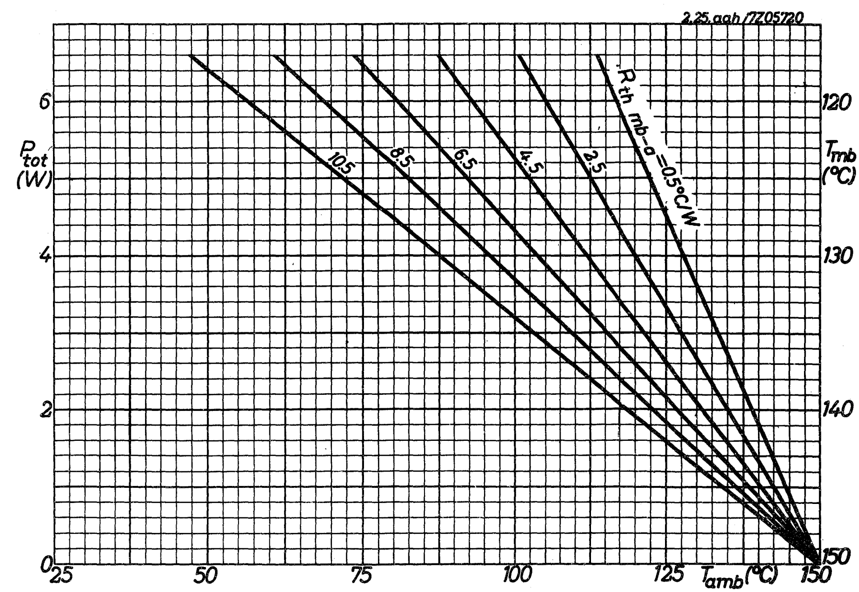


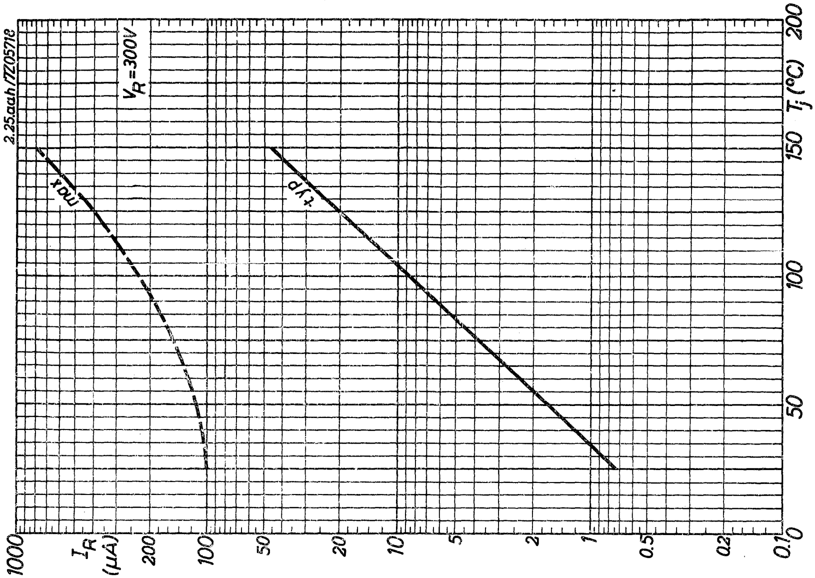
Reverse output wave form

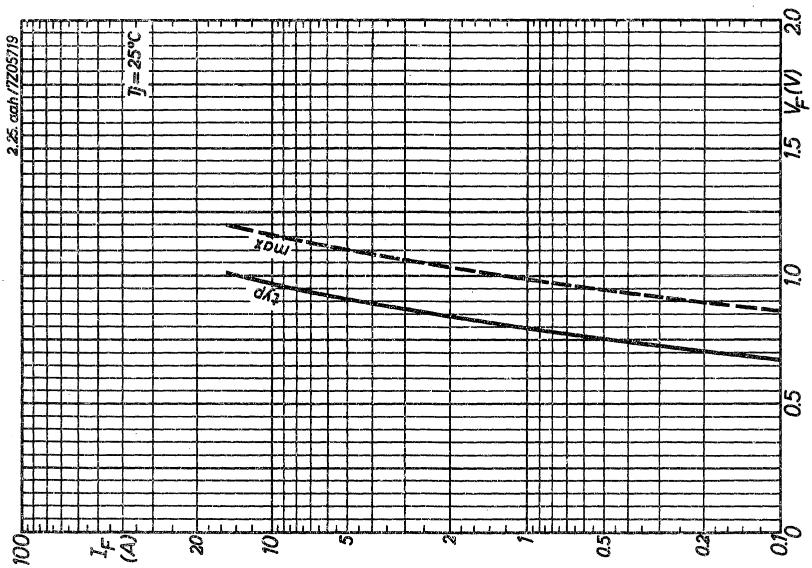
APPLICATION INFORMATION

Typical fundamental line deflection circuit with a series efficiency diode and a parallel efficiency diode.






2.25.aah/7Z05718
V_R = 300V
max
typ
I_R (µA)
1000
200
100
50
20
10
5
2
1
0.5
0.2
0.1
0
50
100
150
200
T_j (°C)


2.25.aah/7Z05719
T_j = 25°C
max
typ
I_F (A)
100
20
10
5
2
1
0.5
0.2
0.1
0
0.5
1.0
1.5
2.0
V_F (V)

BRIDGE RECTIFIER ASSEMBLY

Bridge rectifier assembly in a plastic envelope equipped with four silicon double diffused junction diodes.
It is primarily intended for transistorized equipment drawing its power from mains with frequencies up to 400 Hz.

QUICK REFERENCE DATA

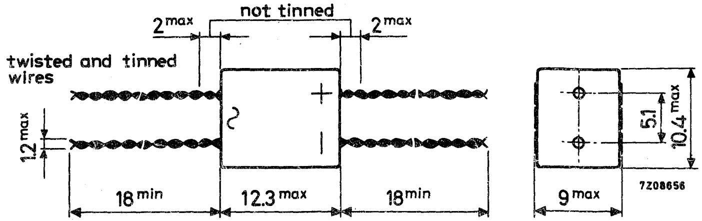
For meaning of symbols see page 2

Input				
R.M.S. voltage	$V_{I(RMS)}$	max.	42	V
Repetitive peak voltage	V_{IRM}	max.	120	V
Output				
Continuous voltage				
with C load	V_O		60	V
with R and L load	V_O		38	V
Average current with R and L load up to T_{amb} = 45 °C	I_O	max.	0.8	A
Repetitive peak current	I_{ORM}	max.	3	A
Thermal resistance from junction to ambient	$R_{th\ j\text{-}a}$	=	50	°C/W

MECHANICAL DATA

Dimensions in mm

Plastic envelope with polarity indications at both sides.



The sealing of the plastic envelope withstands the accelerated damp heat test of IEC recommendation 68-2 (test D, severity IV, 6 cycles)

All information applies to mains frequencies up to 400 Hz.

RATINGS (Limiting values) [1])

Input

R.M.S. voltage	$V_{I(RMS)}$	max.	42	V
Crest working voltage	V_{IWM}	max.	60	V
Repetitive peak voltage	V_{IRM}	max.	120	V
Non repetitive peak voltage; t < 10 ms	V_{ISM}	max.	120	V
Non repetitive peak current (See also page 5)	I_{ISM}	max.	15	A

Output

Average current with C load	See pages 4 and 6			
Average current with R and L load up to T_{amb} = 45 °C (See also page 4)	I_O	max.	0.8	A
Repetitive peak current	I_{ORM}	max.	3	A

Temperatures

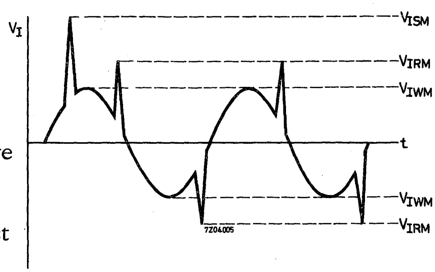
Storage temperature	T_{stg}		-65 to +150	°C
Junction temperature	T_j	max.	150	°C

THERMAL RESISTANCE (See also page 3)

From junction to ambient in free air	$R_{th\ j\text{-}a}$	=	50	°C/W

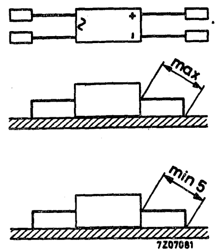
MEANING OF SYMBOL SUBSCRIPTS

First subscript	I	=	input
	O	=	output
Second subscript	R	=	repetitive
	S	=	non repetitive
	W	=	working
Third subscript	M	=	peak or crest



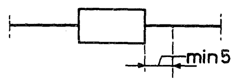
1) Limiting values according to the Absolute Maximum System as defined in IEC publication 134.

MOUNTING METHODS



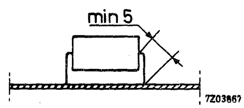
1. Mounted on soldering lips at any lead length. $R_{th\ j\text{-}a}$ = 50 $^{\circ}$C/W
2. Mounted on a printed board at a maximum lead length. $R_{th\ j\text{-}a}$ = 65 $^{\circ}$C/W
3. Mounted on a printed board at a lead length of 5 mm. $R_{th\ j\text{-}a}$ = 75 $^{\circ}$C/W

Iron soldering



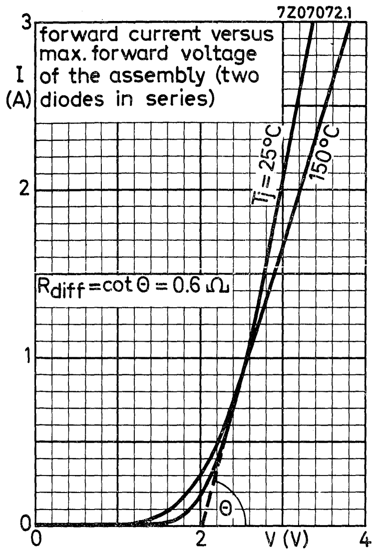
At a maximum iron temperature of 300 $^{\circ}$C, the maximum permissible soldering time is 3 seconds, provided the soldering spot is at least 5 mm from the seal.

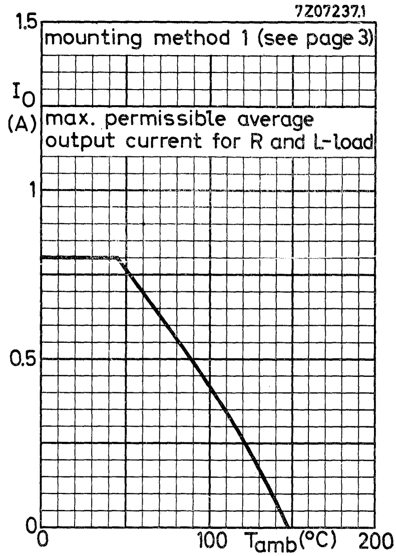
Dip soldering



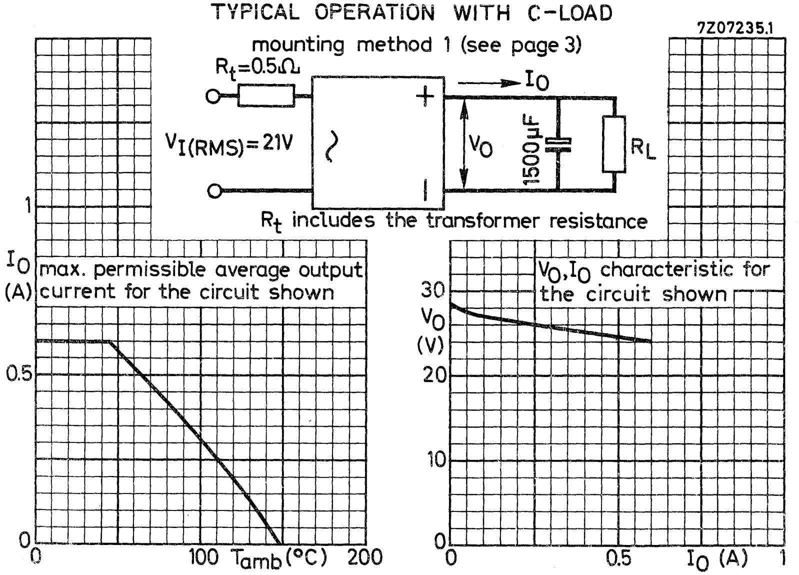
At a maximum solder temperature of 300 $^{\circ}$C, the maximum permissible soldering time is 3 seconds, provided the soldering spot is at least 5 mm from the seal.

Note: If during soldering the assembly is in contact with the printed board the maximum permissible temperature of the point of contact is 150 $^{\circ}$C.

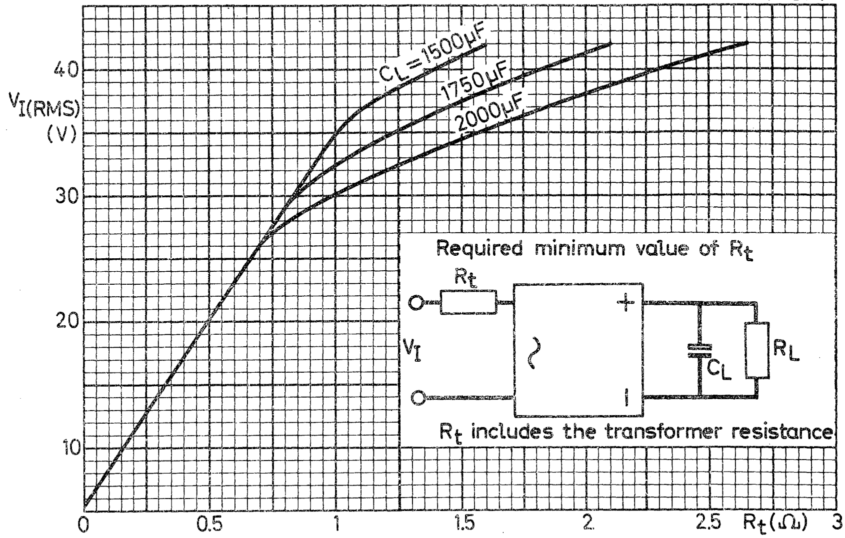




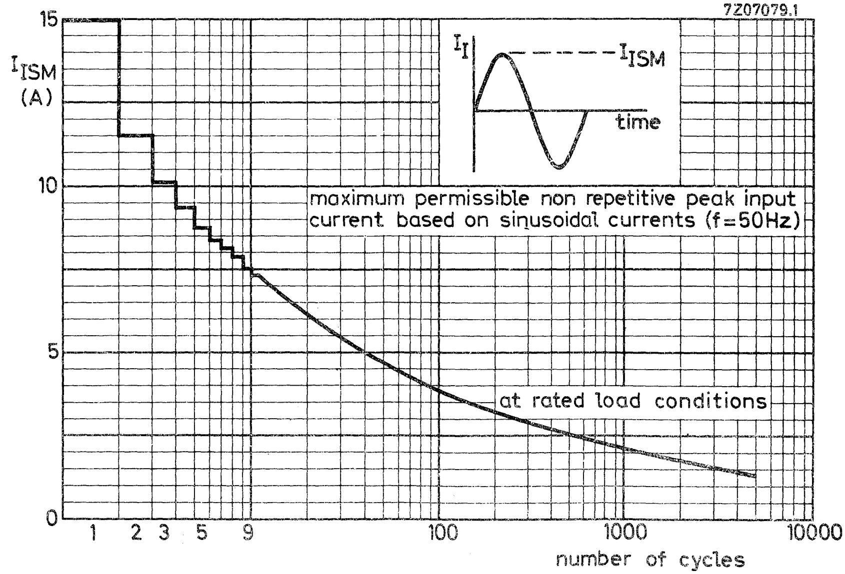
TYPICAL OPERATION WITH C-LOAD

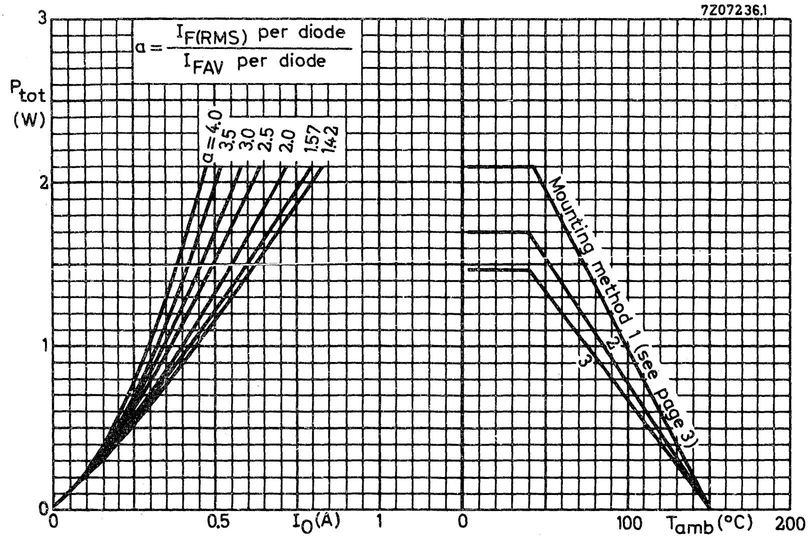


7Z07234.1



7Z07079.1





From the left hand graph the total power dissipation can be found as a function of the average output current.

The parameter $a = \frac{I_{F(RMS)} \text{per diode}}{I_{FAV} \text{ per diode}}$ depends on $\omega R_L C_L$ and $\frac{R_t + R_{diff}}{R_L}$ and can be found from existing graphs.

See for instance "Power rectification with silicon diodes".
Once the power dissipation is known, the max. permissible ambient temperature follows from the right hand graph.

For the series resistance, added to limit the initial peak rectifier current, the required minimum value can be found from the upper graph on page 5.
R_{diff} is shown on page 4, upper figure.

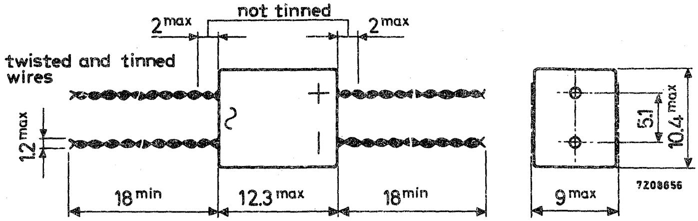
BRIDGE RECTIFIER ASSEMBLY

Bridge rectifier assembly in a plastic envelope equipped with four silicon double diffused junction diodes.
It is primarily intended for transistorized equipment drawing its power from mains with frequencies up to 400 Hz.

QUICK REFERENCE DATA				
For meaning of symbols see page 2				
Input				
R.M.S. voltage	$V_{I(RMS)}$	max.	280	V
Repetitive peak voltage	V_{IRM}	max.	800	V
Output				
Continuous voltage				
with C load	V_O		400	V
with R and L load	V_O		255	V
Average current with R and L load up to T_{amb} = 40 °C	I_O	max.	0.7	A
Repetitive peak current	I_{ORM}	max.	3	A
Thermal resistance from junction to ambient	$R_{th\ j\text{-}a}$	=	50	°C/W

MECHANICAL DATA Dimensions in mm

Plastic envelope with polarity indications at both sides



The sealing of the plastic envelope withstands the accelerated damp heat test of IEC recommendation 68-2 (test D, severity IV, 6 cycles)

All information applies to mains frequencies up to 400 Hz.

RATINGS (Limiting values) [1])

Input

R.M.S. voltage	$V_{I(RMS)}$	max.	280	V
Crest working voltage	V_{IWM}	max.	400	V
Repetitive peak voltage	V_{IRM}	max.	800	V
Non repetitive peak voltage; $t < 10$ ms	V_{ISM}	max.	800	V
Non repetitive peak current (See also page 5)	I_{ISM}	max.	15	A

Output

Average current with C load	See pages 4 and 6			
Average current with R and L load up to T_{amb} = 40 °C (See also page 4)	I_O	max.	0.7	A
Repetitive peak current	I_{ORM}	max.	3	A

Temperatures

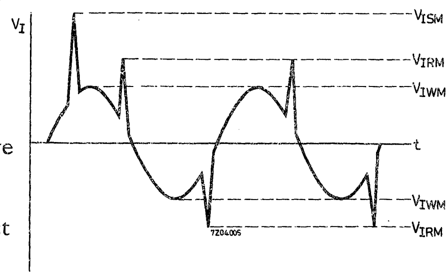
Storage temperature	T_{stg}		-65 to +125	°C
Junction temperature	T_j	max.	125	°C

THERMAL RESISTANCE

From junction to ambient in free air	$R_{th\ j\text{-}a}$	=	50	°C/W

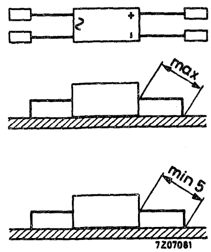
MEANING OF SYMBOL SUBSCRIPTS

First subscript	I	=	input
	O	=	output
Second subscript	R	=	repetitive
	S	=	non repetitive
	W	=	working
Third subscript	M	=	peak or crest



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

MOUNTING METHODS



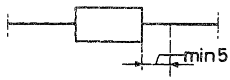
1. Mounted on soldering lips at any lead length. $R_{th\ j\text{-}a} = 50\ ^{o}C/W$

2. Mounted on a printed board at maximum lead length. $R_{th\ j\text{-}a} = 65\ ^{o}C/W$

3. Mounted on a printed board at a lead length of 5 mm. $R_{th\ j\text{-}a} = 75\ ^{o}C/W$

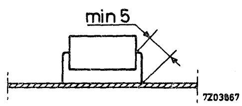
Iron soldering

At a maximum iron temperature of 300 ^{o}C, the maximum permissible soldering time is 3 seconds, provided the soldering spot is at least 5 mm from the seal.

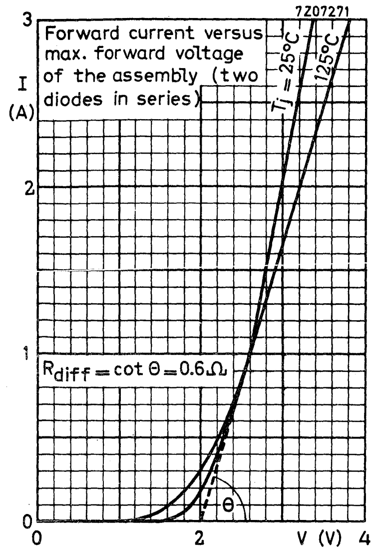


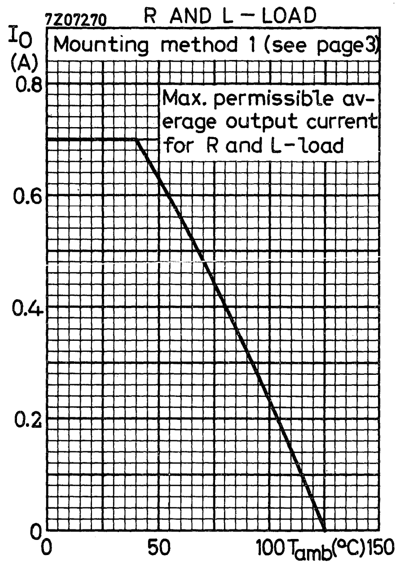
Dip soldering

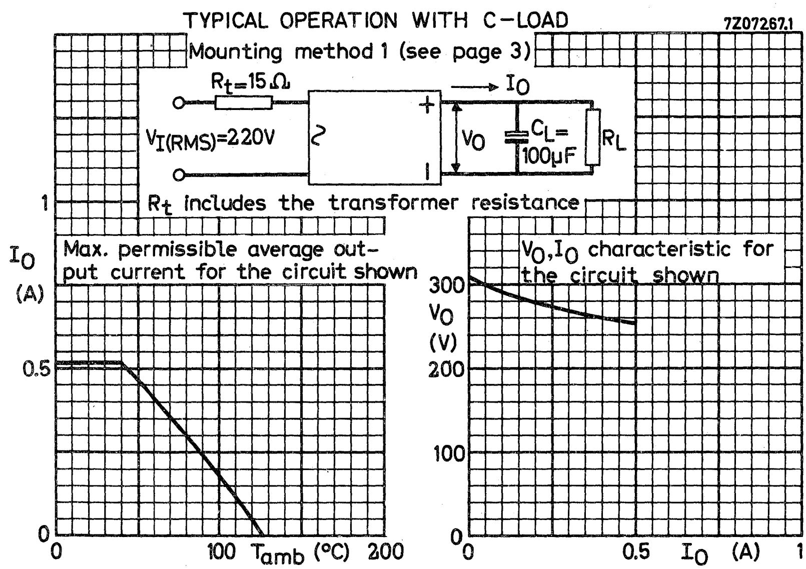
At a maximum solder temperature of 300 ^{o}C, the maximum permissible soldering time is 3 seconds, provided the soldering spot is at least 5 mm from the seal.

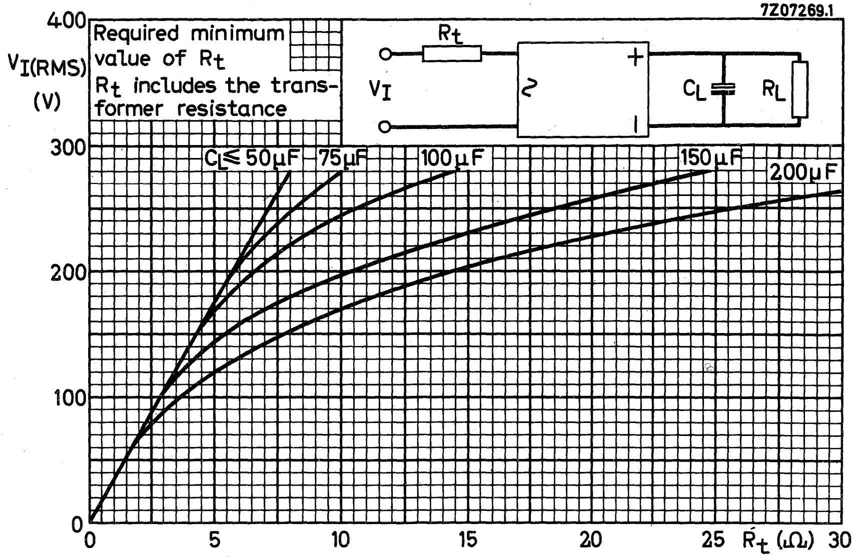


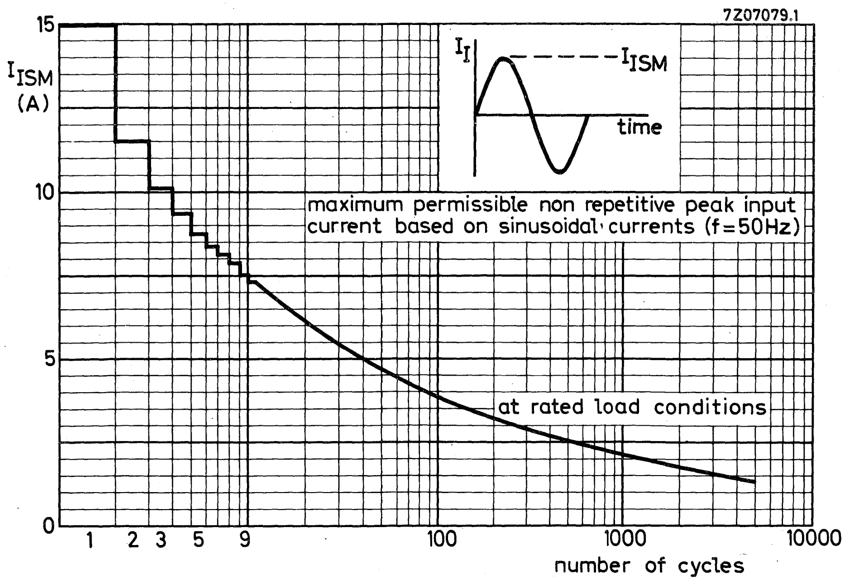
Note: If during soldering the assembly is in contact with the printed board the maximum permissible temperature of the point of contact is 150 ^{o}C.

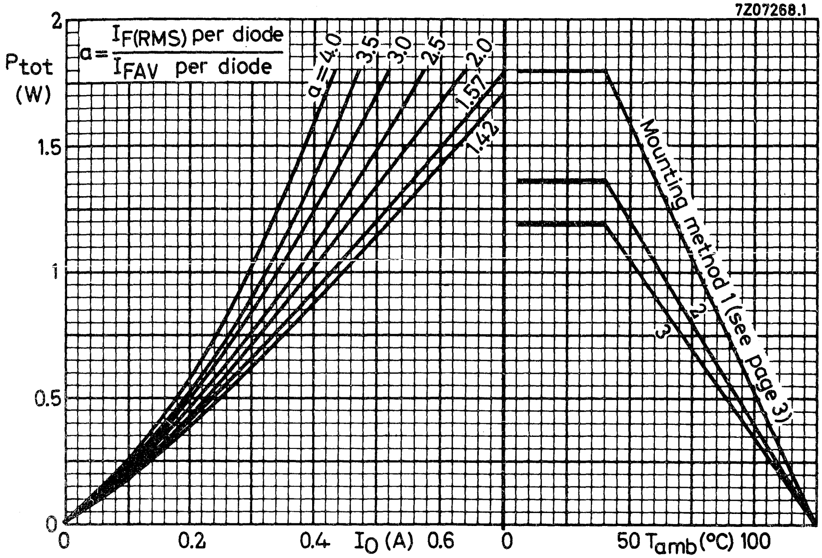

7Z07271
Forward current versus max. forward voltage of the assembly (two diodes in series)
I (A)
$T_j = 25°C$
125°C
$R_{diff} = \cot \Theta = 0.6 \Omega$
Θ
V (V)
0
1
2
3
0
2
4


7Z07270
R AND L – LOAD
Mounting method 1 (see page 3)
I_O (A)
Max. permissible average output current for R and L-load
0
0.2
0.4
0.6
0.8
0
50
100
T_{amb} (°C)
150


TYPICAL OPERATION WITH C–LOAD
7Z07267.1
Mounting method 1 (see page 3)
$R_t = 15 \Omega$
I_O
$V_{I(RMS)} = 220V$
V_O
$C_L = 100 \mu F$
R_L
R_t includes the transformer resistance
I_O (A)
Max. permissible average output current for the circuit shown
0
0.5
1
0
100
T_{amb} (°C)
200
V_O, I_O characteristic for the circuit shown
V_O (V)
0
100
200
300
0
0.5
I_O (A)
1


7Z07269.1
400
300
200
100
0
VI(RMS)
(V)
Required minimum
value of Rt
Rt includes the transformer resistance
Rt
VI
+
CL
RL
CL≤ 50μF
75μF
100μF
150μF
200μF
0
5
10
15
20
25
Rt (Ω)
30


7Z07079.1
15
IISM
(A)
10
5
0
II
IISM
time
maximum permissible non repetitive peak input current based on sinusoidal currents (f=50Hz)
at rated load conditions
1
2
3
5
9
100
1000
10000
number of cycles



From the left hand graph the total power dissipation can be found as a function of the average output current.

The parameter $a = \frac{I_{F(RMS)} \text{ per diode}}{I_{FAV} \text{ per diode}}$ depends on $\omega R_L C_L$ and $\frac{R_t + R_{diff}}{R_L}$ and can be found from existing graphs.

See for instance "Power rectification with silicon diodes".
Once the power dissipation is known, the max. permissible ambient temperature follows from the right hand graph.

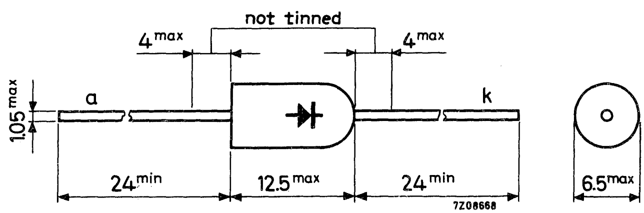
For the series resistance, added to limit the initial peak rectifier current, the required minimum value can be found from the upper graph at page 5.
R_{diff} is shown at page 4, upper figure.

SILICON RECTIFIER DIODES

Silicon double diffused rectifier diodes in a plastic envelope. They are intended for mains rectifier applications in television receivers.

QUICK REFERENCE DATA					
			BY126	BY127	
Crest working reverse voltage	V_{RWM}	max.	450	800	V
Repetitive peak reverse voltage	V_{RRM}	max.	650	1250	V
Average forward current with R and L load; $V_{RWM} = V_{RWMmax}$	I_{FAV}	max.	1.0		A
$V_{RWM} = 60$ V	I_{FAV}	max.	1.2		A
Non repetitive peak forward current t = 10 ms	I_{FSM}	max.	40		A
Junction temperature	T_j	max.	150		^oC
Thermal resistance from junction to ambient	$R_{th\ j\text{-}a}$	=	60		$^oC/W$

MECHANICAL DATA Dimensions in mm



The rounded end indicates the cathode side.

The envelope fulfils the accelerated damp heat test described in IEC publication 68-2 (test D, severity IV, 6 cycles).

MOUNTING METHODS see page 3.

All information applies to frequencies up to 400 Hz

RATINGS (Limiting values) [1]

Voltages			BY126	BY127	
Crest working reverse voltage	V_{RWM}	max.	450	800	V
Repetitive peak reverse voltage	V_{RRM}	max.	650	1250	V
Non repetitive peak reverse voltage ($t \leq 10$ ms)	V_{RSM}	max.	650	1250	V

Currents				
Average forward current (averaged over any 20 ms period), see also pages 4, 6, 7 with R and L load; $V_{RWM} = V_{RWMmax}$	I_{FAV}	max.	1.0	A
$V_{RWM} = 60$ V	I_{FAV}	max.	1.2	A
Repetitive peak forward current	I_{FRM}	max.	10	A
Non repetitive peak forward current $t = 10$ ms; half sine wave	I_{FSM}	max.	40	A

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

THERMAL RESISTANCE

From junction to ambient in free air	$R_{th\ j\text{-}a}$	=	60	°C/W

See also page 3

CHARACTERISTICS at $T_j = 25$ °C

Voltage				
Forward voltage at $I_F = 5$ A	V_F	<	1.5	V

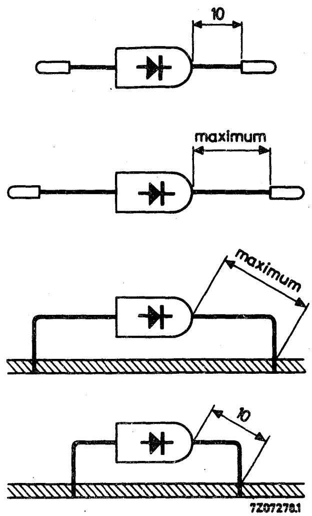
Current				
Reverse current at $V_R = V_{RRMmax}$	I_R	<	10	μA

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

MOUNTING METHODS

The thermal resistance values apply when the leads of the diodes are mounted separately. When at the tie-points other diodes (or dissipating resistors) are connected, the thermal resistance of the diode will increase.

1. Mounted on soldering lips at a lead-length of 10 mm. $R_{th\ j\text{-}a}$ = 60 °C/W
2. Mounted on soldering lips at maximum lead-length. $R_{th\ j\text{-}a}$ = 70 °C/W
3. Mounted on a printed board at maximum lead-length. $R_{th\ j\text{-}a}$ = 85 °C/W
4. Mounted on a printed board at a lead-length of 10 mm. $R_{th\ j\text{-}a}$ = 95 °C/W



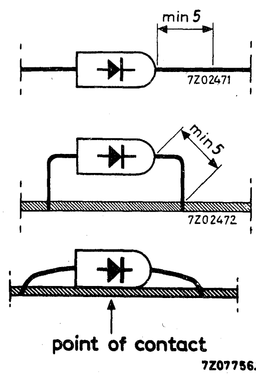
Iron soldering

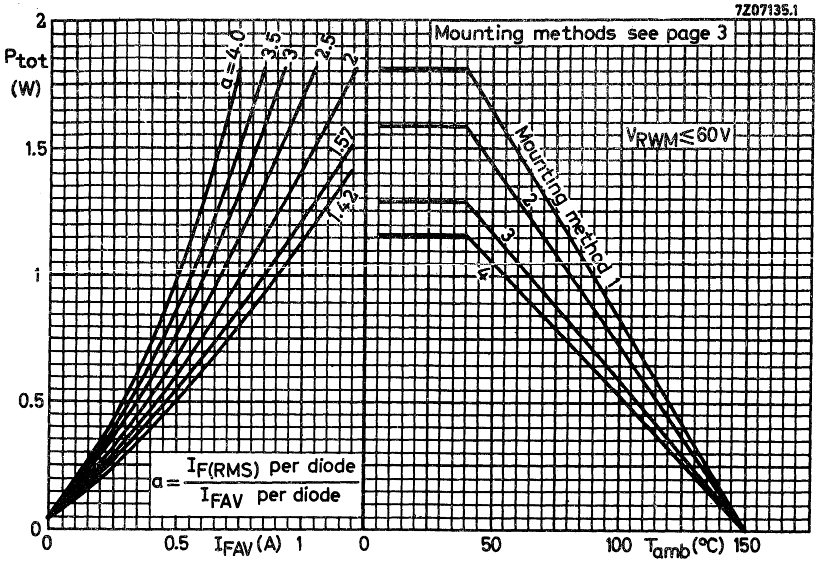
At a max. iron temperature of 300 °C, the max. permissible soldering time is 3 s, provided the soldering spot is at least 5 mm from the seal.

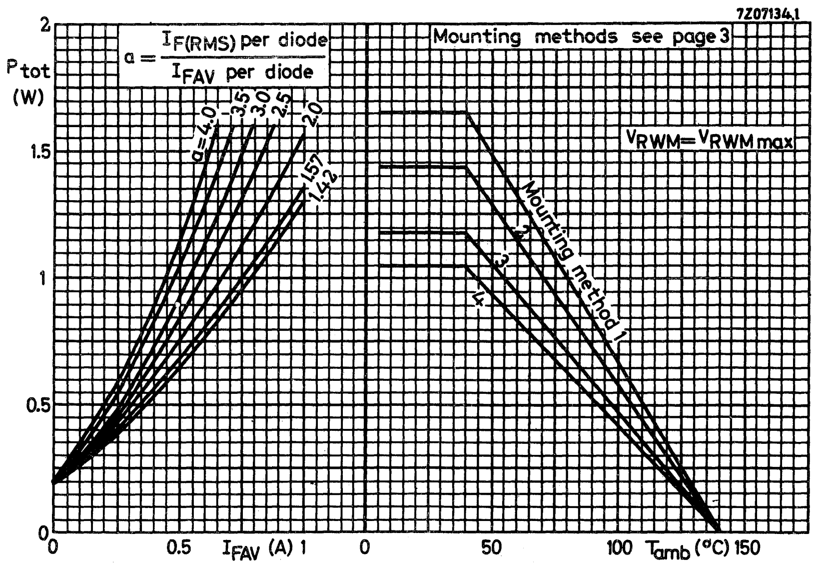
Dip soldering

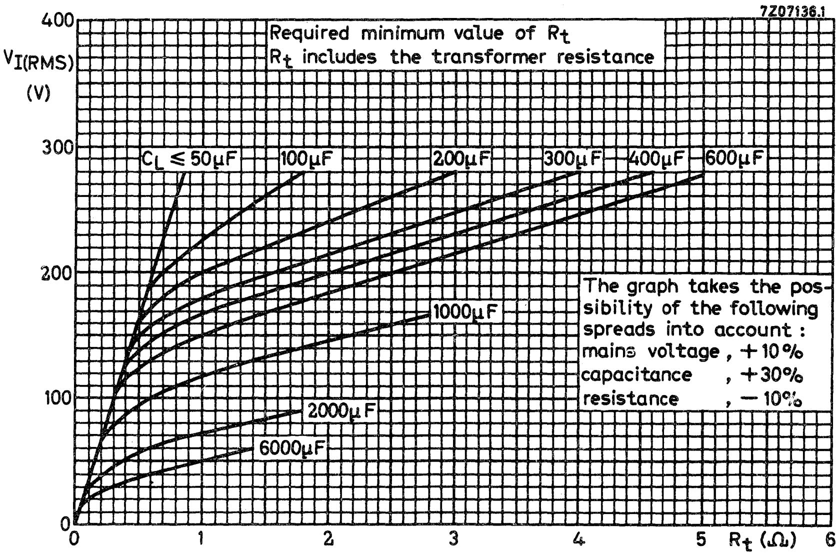
At a max. solder temperature of 300 °C, the max. permissible soldering time is 3 s, provided the soldering spot is at least 5 mm from the seal.

Note: If during soldering the diode is in contact with the printed board the maximum permissible temperature of the point of contact is 150 °C.




7Z07135.1
Mounting methods see page 3
P_{tot} (W)
a=4.0
3.5
3
2.5
2
1.57
1.42
$V_{RWM} \leq 60V$
Mounting method 1
2
3
4
$a = \frac{I_{F(RMS)} \text{ per diode}}{I_{FAV} \text{ per diode}}$
I_{FAV} (A)
T_{amb} (°C)
0
0.5
1
1.5
2
0
0.5
1
0
50
100
150


7Z07134.1
Mounting methods see page 3
P_{tot} (W)
$a = \frac{I_{F(RMS)} \text{ per diode}}{I_{FAV} \text{ per diode}}$
a=4.0
3.5
3.0
2.5
2.0
1.57
1.42
$V_{RWM} = V_{RWM\,max}$
Mounting method 1
2
3
4
I_{FAV} (A)
T_{amb} (°C)
0
0.5
1
1.5
2
0
0.5
1
0
50
100
150



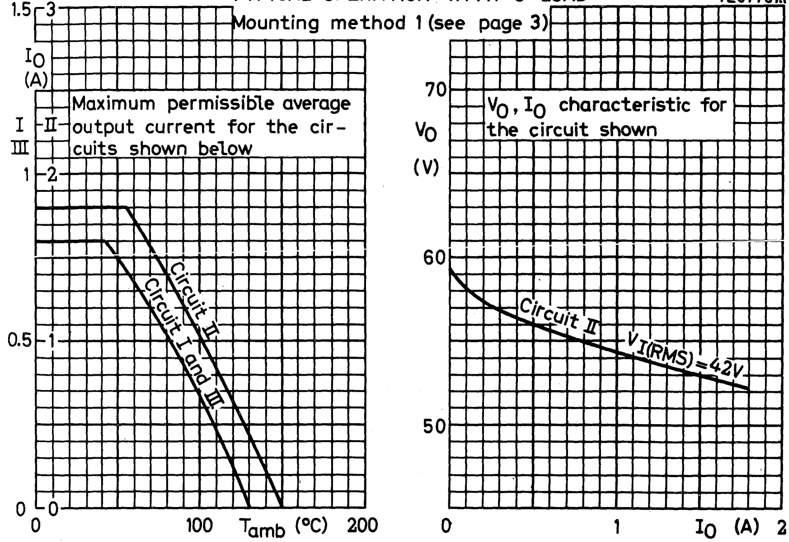
From the left hand graph on page 4 the total power dissipation can be found as a function of the average output current.

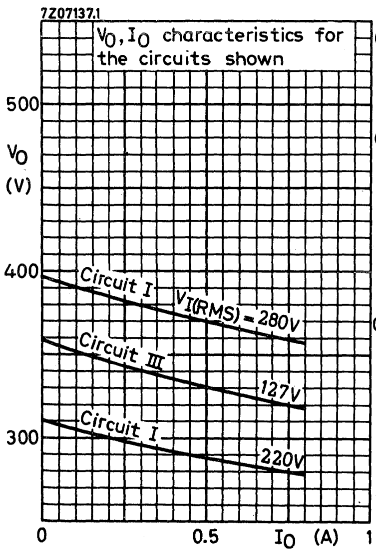
The parameter $a = \frac{I_{F(RMS)}\text{ per diode}}{I_{FAV}\text{ per diode}}$ depends on $n\omega R_L C_L$ and $\frac{R_t + R_{diff}}{nR_L}$ and can be found from existing graphs.

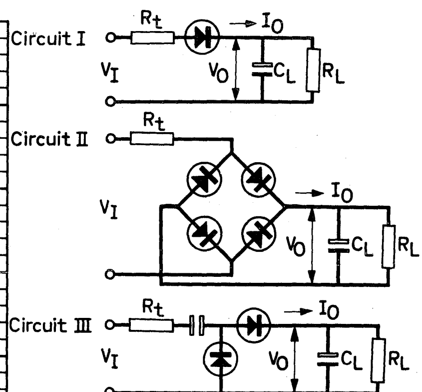
See for instance "Power rectification with silicon diodes".
Once the power dissipation is known, the max. permissible ambient temperature follows from the right hand graph.

For the series resistance, added to limit the initial peak rectifier current, the required minimum value can be found from the upper graph.
R_{diff} is shown on page 7.

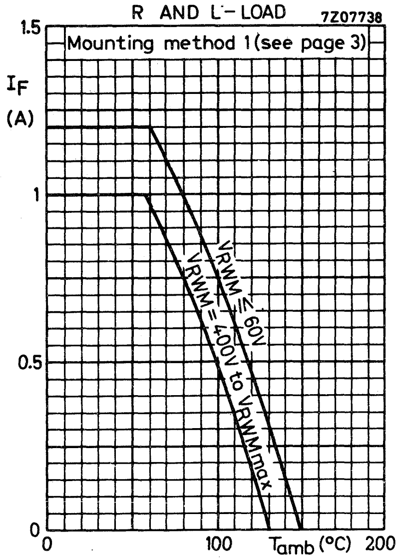
TYPICAL OPERATION WITH C-LOAD

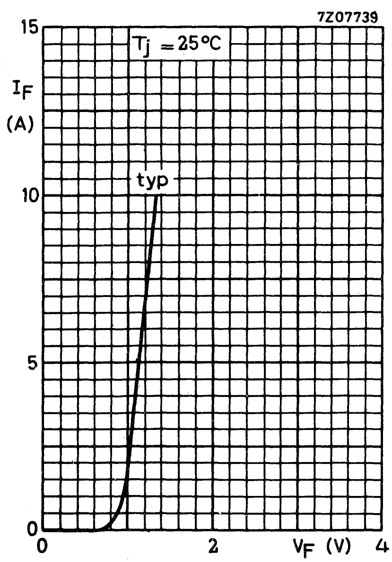


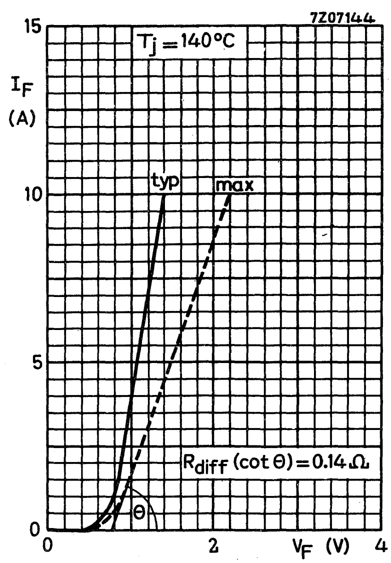


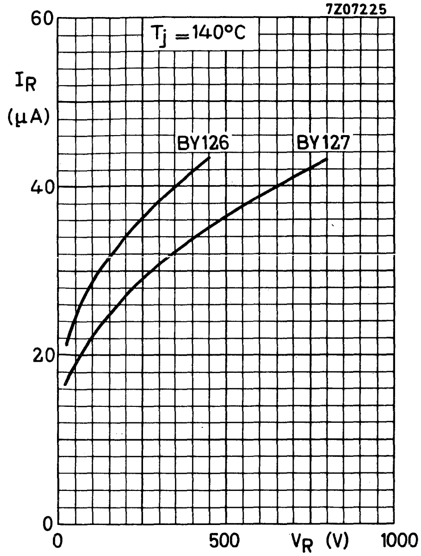


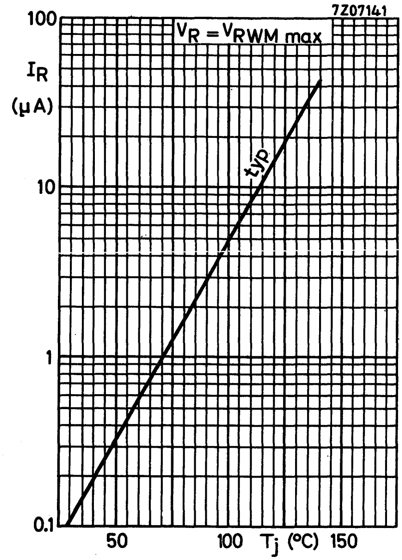
	$V_{I(RMS)}$	R_t	C_L
Circuit I	220V	1.4 Ω	200 µF
	280V	3.0 Ω	200 µF
Circuit II	42V	0.72 Ω	6000 µF
Circuit III	127V	0.4 Ω	400 µF

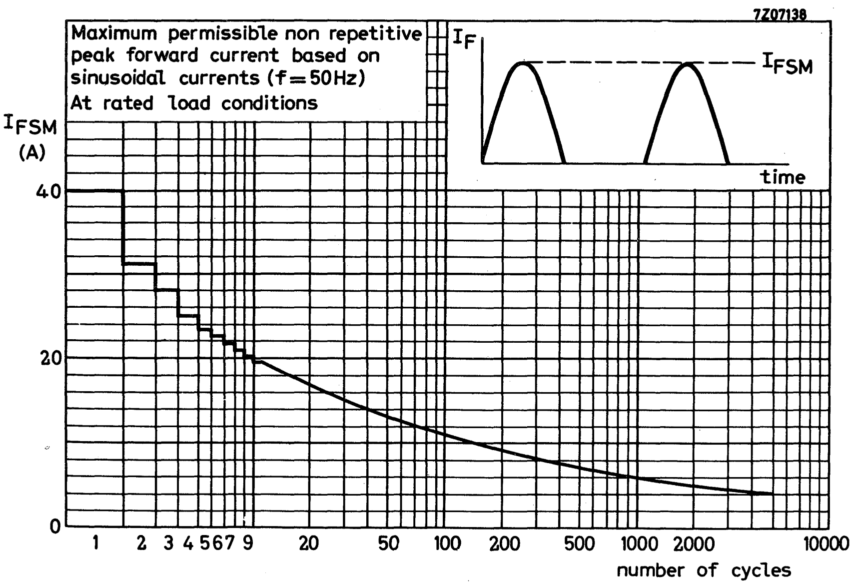

R AND L-LOAD
7Z07738
Mounting method 1 (see page 3)
IF
(A)
1.5
1
0.5
0
0
100
Tamb (°C)
200
VRWM ≦ 60V
VRWM = 400V to VRWMmax


7Z07739
Tj = 25°C
IF
(A)
15
10
5
0
typ
0
2
VF (V)
4


7Z07144
Tj = 140°C
IF
(A)
15
10
5
0
typ
max
Rdiff (cot Θ) = 0.14 Ω
Θ
0
2
VF (V)
4


7Z07225
T_j = 140°C
I_R (μA)
BY126
BY127
60
40
20
0
0
500
V_R (V)
1000


7Z07141
$V_R = V_{RWM\ max}$
I_R (μA)
typ
100
10
1
0.1
50
100
T_j (°C)
150

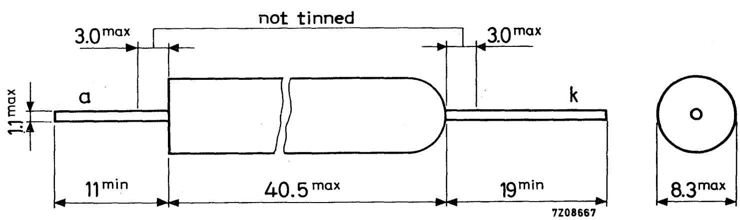

7Z07138
Maximum permissible non repetitive peak forward current based on sinusoidal currents (f = 50Hz)
At rated load conditions
I_{FSM} (A)
I_F
I_{FSM}
time
40
20
0
1
2
3
4
5
6
7
9
20
50
100
200
500
1000
2000
10000
number of cycles

HIGH SPEED HIGH VOLTAGE DIODE

High speed silicon diode in a plastic envelope. It is intended for high voltage rectifier circuits in line deflection circuits in colour and black and white television receivers.

QUICK REFERENCE DATA				
Crest working reverse voltage	V_{RWM}	max.	15	kV
Repetitive peak reverse voltage	V_{RRM}	max.	15	kV
Average forward current	I_{FAV}	max.	2.5	mA
Non repetitive peak forward current	I_{FSM}	max.	1000	mA
Junction temperature	T_j	max.	95	°C
Recovered charge when switched from I_F = 200 mA to V_R = 100 V with $-\frac{dI}{dt}$ = 200 mA/μs	Q_s	typ.	30	nC

MECHANICAL DATA Dimensions in mm



The rounded end indicates the cathode side

RATINGS (Limiting values) [1])

Voltages

Crest working reverse voltage	V_{RWM}	max.	15	kV
Repetitive peak reverse voltage	V_{RRM}	max.	15	kV
Non repetitive peak reverse voltage ($t \leq 10$ ms)	V_{RSM}	max.	15	kV

Currents

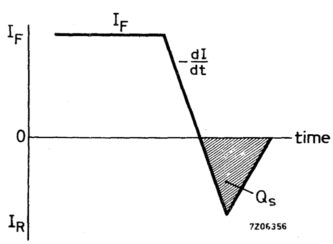
Average forward current (averaged over any 20 ms period)	I_{FAV}	max.	2.5	mA
Repetitive peak forward current	I_{FRM}	max.	250	mA
Non repetitive peak forward current ($t \leq 10$ ms)	I_{FSM}	max.	1000	mA
Repetitive peak reverse current during switching off	I_{RRM}	max.	150	mA

Temperatures

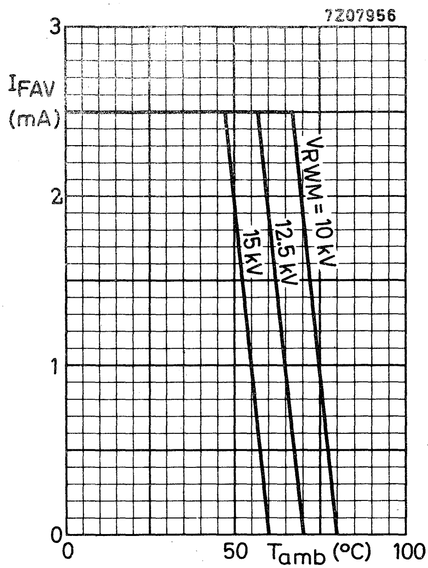
Storage temperature	T_{stg}	-55 to +100		°C
Junction temperature	T_j	max.	95	°C

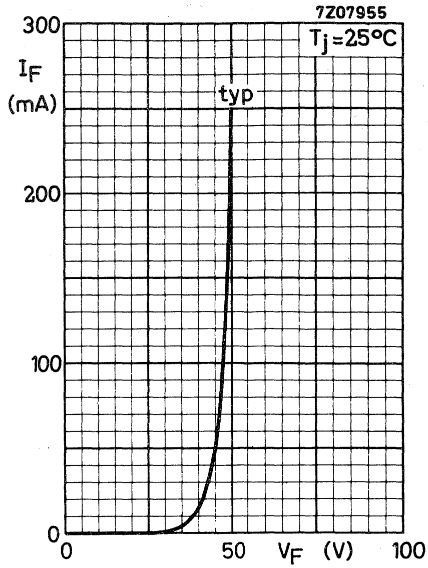
CHARACTERISTICS

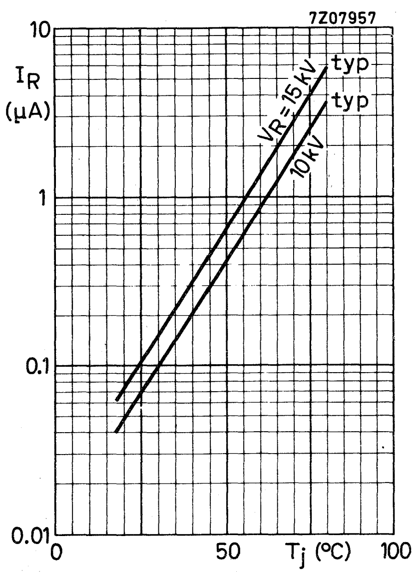
Forward voltage at $I_F = 100$ mA; $T_j = 100$ °C	V_F	<	50	V
Reverse current at $V_R = 15$ kV; $T_j = 75$ °C	I_R	<	10	μA
Recovered charge when switched from $I_F = 200$ mA to $V_R = 100$ V with $-\frac{dI}{dt} = 200$ mA/μs; $T_j = 25$ °C	Q_s	typ.	30	nC



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


7Z07956
I_{FAV}
(mA)
3
2
1
0
0
50
T_{amb} (°C)
100
V_{RWM} = 10 kV
12.5 kV
15 kV

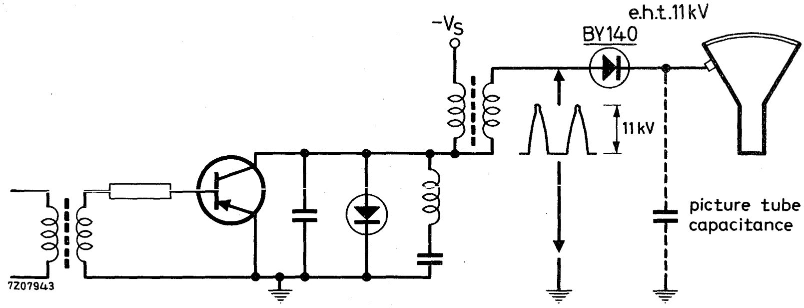

7Z07955
T_j = 25°C
I_F
(mA)
300
200
100
0
typ
0
50
V_F (V)
100


7Z07957
I_R
(μA)
10
1
0.1
0.01
typ
typ
V_R = 15 kV
10 kV
0
50
T_j (°C)
100

APPLICATION INFORMATION

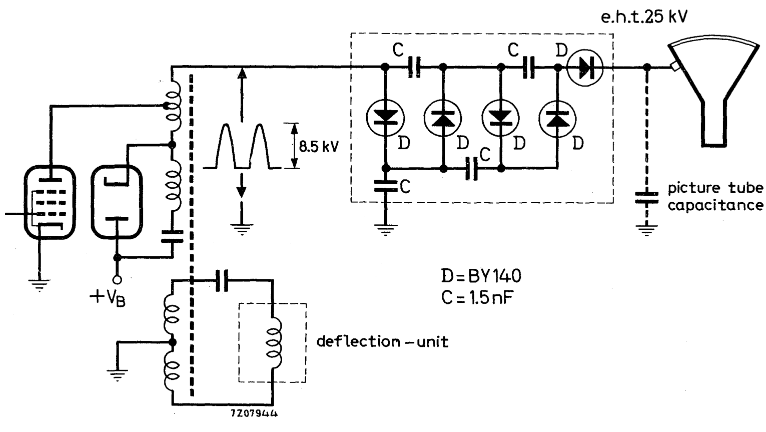
E.H.T. rectifier circuits

A.



Typical deflection circuit for small screen television receivers employing the BY140 as an e.h.t. rectifier. Proper operation of the BY140 is ensured up to an ambient temperature of 60 °C.
The contribution of the BY140 to the overall e.h.t. regulation of the circuit is negligibly small.

B.



E.H.T. supply for colour television receivers by means of a tripler circuit employing BY140 diodes. Proper operation of the BY140 diodes is ensured up to an ambient temperature of 70 °C.
Contribution to the regulation of the complete horizontal deflection output circuit due to the tripler system (inside the dashed-lines): 600 kΩ.

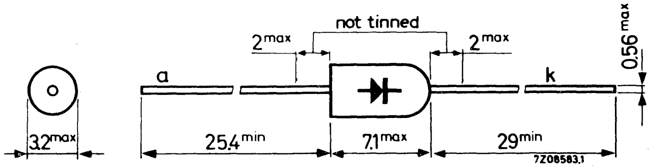
SILICON RECTIFIER DIODE

Double diffused silicon diode in a DO-14 plastic envelope for low current rectifier applications.

QUICK REFERENCE DATA				
Crest working reverse voltage	V_{RWM}	max.	800	V
Repetitive peak reverse voltage	V_{RRM}	max.	1600	V
Average forward current				
R and L load; $V_{RWM} = V_{RWMmax}$	I_{FAV}	max.	0.36	A
$V_{RWM} = 60$ V	I_{FAV}	max.	0.5	A
Non repetitive peak forward current (t = 10 ms)	I_{FSM}	max.	15	A
Junction temperature	T_j	max.	150	°C

MECHANICAL DATA Dimensions in mm

DO-14



The envelope fulfils the accelerated damp heat test described in I.E.C. publication 68.2 (test D, severity IV, 6 cycles).

MOUNTING METHODS see page 3.

→ All information applies to frequencies up to 400 Hz.

RATINGS (Limiting values) [1])

Voltages

Crest working reverse voltage	V_{RWM}	max.	800	V
→ Repetitive peak reverse voltage	V_{RRM}	max.	1600	V
Non repetitive peak reverse voltage (t<10 ms)	V_{RSM}	max.	1600	V

Currents

→ Average forward current (averaged over any 20 ms period)				
for R and L load; $V_{RWM} = V_{RWMmax}$	I_{FAV}	max.	0.36	A
V_{RWM} = 60 V	I_{FAV}	max.	0.5	A
for capacitive load		see page 4		
→ Repetitive peak forward current	I_{FRM}	max.	3	A
Non repetitive peak forward current (t = 10 ms; half-sine wave)	I_{FSM}	max.	15	A

Temperatures

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

THERMAL RESISTANCE

→ From junction to ambient (see also page 3)	$R_{th\ j\text{-}a}$	=	150	°C/W

CHARACTERISTICS

→ Forward voltage at I_F = 2 A; T_j = 25 °C	V_F	<	1.6	V [2])
→ Reverse current at V_R = 800 V; T_j = 125 °C	I_R	<	50	μA

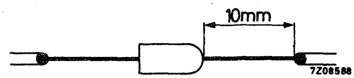
[1]) Limiting values according to the Absolute Maximum System as defined in IEC publication 134.

[2]) Measured under pulsed condition to prevent excessive dissipation.

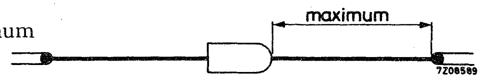
MOUNTING METHODS

The thermal resistance values apply when the leads of the diodes are mounted separately. When at the tie-points other diodes (or dissipating resistors) are connected, the thermal resistance of the diode will increase.

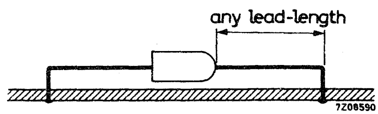
1. Mounted on soldering lips at a lead-length of 10 mm. $R_{th\ j\text{-}a} = 150\ ^{o}C/W$



2. Mounted on soldering lips at maximum lead-length. $R_{th\ j\text{-}a} = 200\ ^{o}C/W$

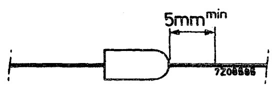


3. Mounted on a printed board with a small area of copper at any lead-length. $R_{th\ j\text{-}a} = 200\ ^{o}C/W$



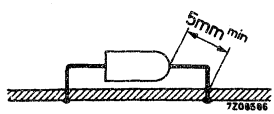
Iron soldering

At a max. iron temperature of 300 ^{o}C, the max. permissible soldering time is 3 s, provided the soldering spot is at least 5 mm from the seal.

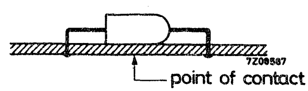


Dip soldering

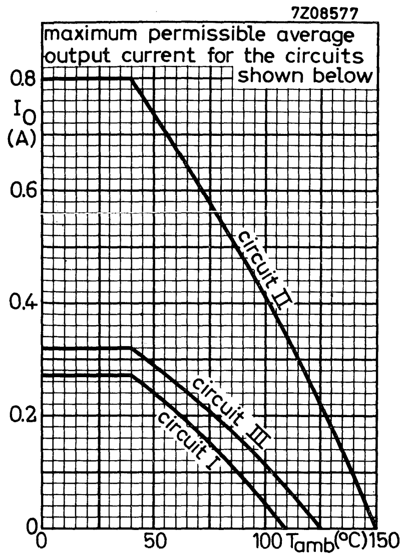
At a max. solder temperature of 300 ^{o}C, the max. permissible soldering time is 3 s, provided the soldering spot is at least 5 mm from the seal.

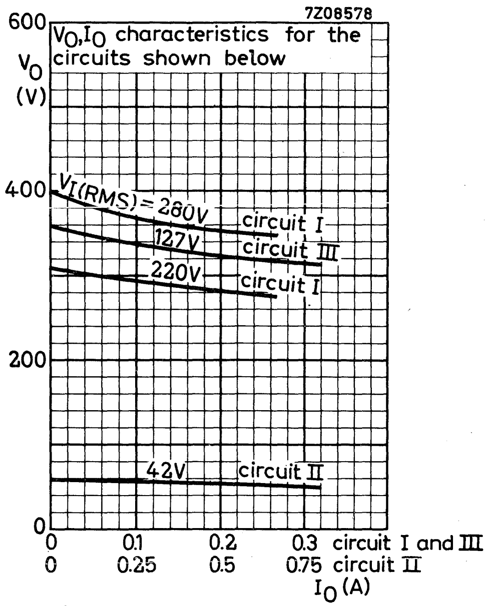


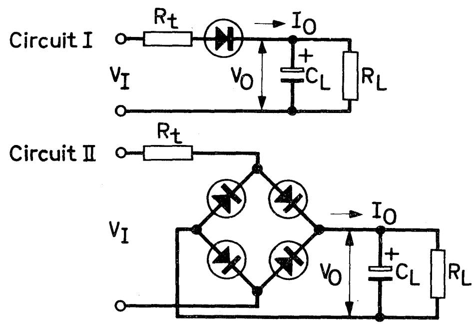
Note: If during soldering the diode is in contact with the printed board the maximum permissible temperature of the point of contact is 150 ^{o}C.

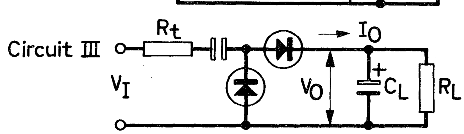


TYPICAL OPERATION WITH C-LOAD
mounting method 1 (see page 3)





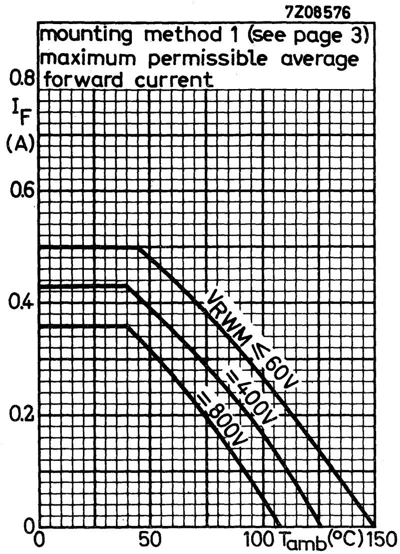


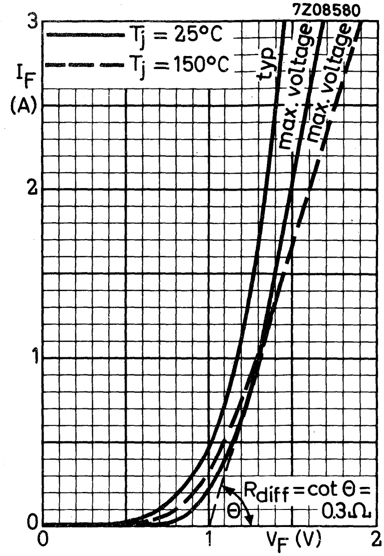


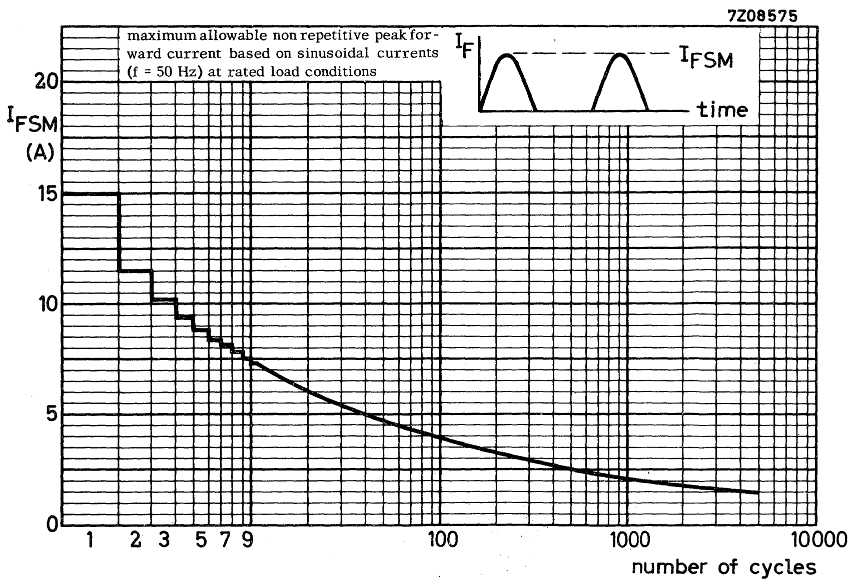
	$V_{I(RMS)}$	R_t	C_L
Circuit I	220V	8.2 Ω	100 μF
	280V	15 Ω	100 μF
Circuit II	42V	1.5 Ω	1500 μF
Circuit III	127V	5.6 Ω	200 μF

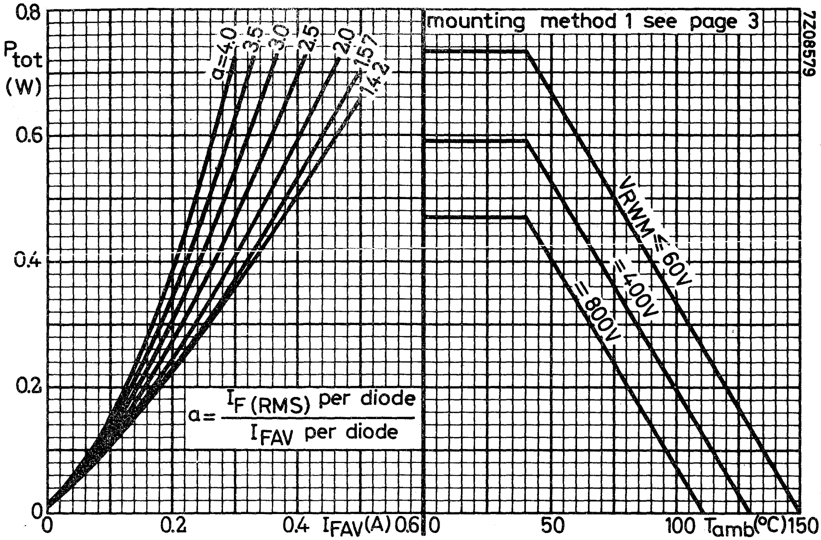
7Z08584

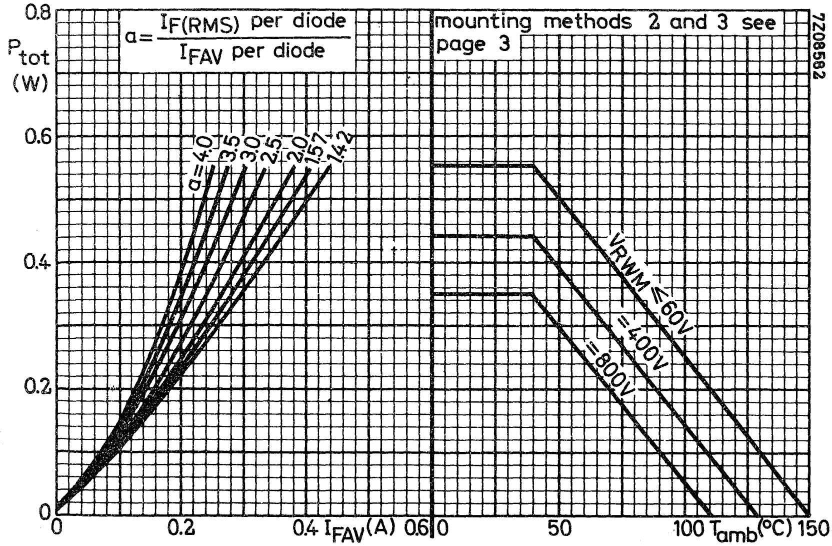
R AND L-LOAD

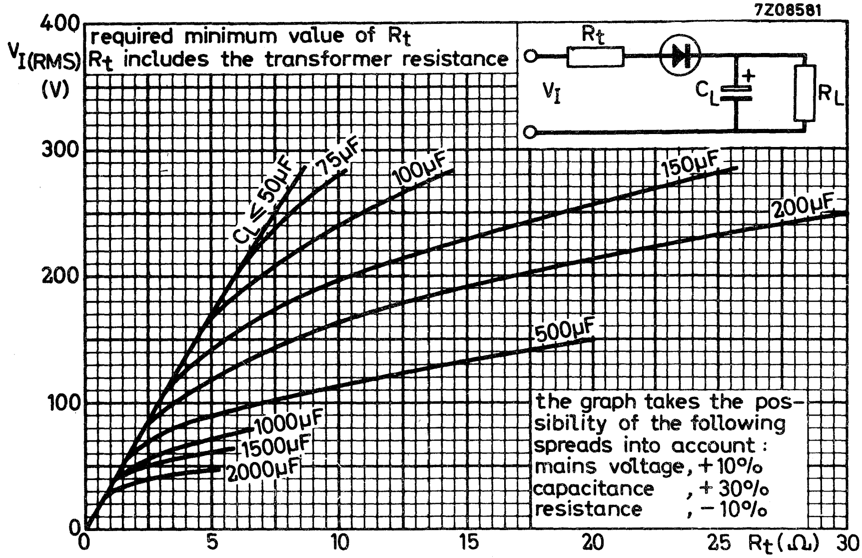

7Z08576
mounting method 1 (see page 3)
maximum permissible average
forward current
I_F
(A)
0.8
0.6
0.4
0.2
0
V_RWM ≤ 60V
= 400V
= 800V
0
50
100
T_amb (°C)
150


7Z08580
T_j = 25°C
T_j = 150°C
typ
max. voltage
max. voltage
I_F
(A)
3
2
1
0
R_diff = cot Θ = 0.3Ω
Θ
0
1
V_F (V)
2


7Z08575
maximum allowable non repetitive peak forward current based on sinusoidal currents (f = 50 Hz) at rated load conditions
I_F
I_FSM
time
I_FSM
(A)
20
15
10
5
0
1
2
3
5
7
9
100
1000
10000
number of cycles


7Z08579
mounting method 1 see page 3
P_{tot} (W)
0.8
0.6
0.4
0.2
0
a=4.0
3.5
3.0
2.5
2.0
1.57
1.42
$a = \frac{I_{F(RMS)} \text{ per diode}}{I_{FAV} \text{ per diode}}$
$V_{RWM} \leq 60V$
= 400V
= 800V
0
0.2
0.4
I_{FAV}(A)
0.6
0
50
100
T_{amb}(°C)
150


7Z08582
mounting methods 2 and 3 see page 3
P_{tot} (W)
0.8
0.6
0.4
0.2
0
$a = \frac{I_{F(RMS)} \text{ per diode}}{I_{FAV} \text{ per diode}}$
a=4.0
3.5
3.0
2.5
2.0
1.57
1.42
$V_{RWM} \leq 60V$
= 400V
= 800V
0
0.2
0.4
I_{FAV}(A)
0.6
0
50
100
T_{amb}(°C)
150



From the left hand graph on page 6 the total power dissipation can be found as a function of the average output current.

The parameter $a = \frac{I_{F(RMS)} \text{ per diode}}{I_{FAV} \text{ per diode}}$ depends on $n\omega R_L C_L$ and $\frac{R_t + R_{diff}}{nR_L}$ and can be found from existing graphs.

See for instance "Power rectification with silicon diodes"
Once the power dissipation is known, the max. permissible ambient temperature follows from the right hand graph.

For the series resistance, added to limit the initial peak rectifier current, the required minimum value can be found from the upper graph.
R_{diff} is shown on page 5 upper figure.

SILICON RECTIFIER DIODES

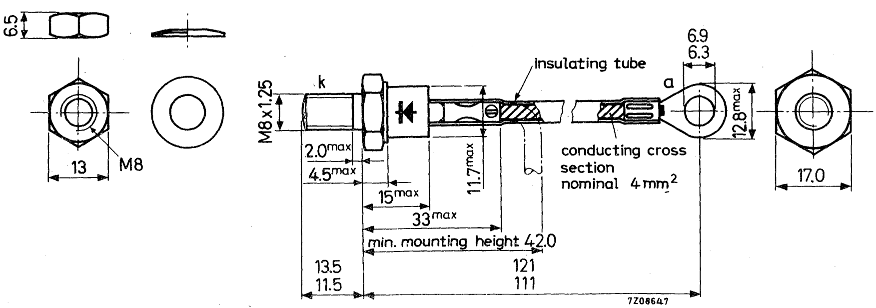
Double diffused silicon diodes in metal envelopes, intended for power rectifier applications.
The series consists of the following types:
Normal polarity (stud cathode):
BYX13-400; BYX13-600; BYX13-800; BYX13-1000; BYX13-1200
Reverse polarity (stud anode):
BYX13-400R; BYX13-600R; BYX13-800R; BYX13-1000R; BYX13-1200R

QUICK REFERENCE DATA

			BYX13-400(R)	600(R)	800(R)	1000(R)	1200(R)	
Crest working reverse voltage	V_{RWM}	max.	200	300	400	500	600	V
Repetitive peak reverse voltage	V_{RRM}	max.	400	600	800	1000	1200	V

Average forward current	I_{FAV}	max.	20	A
Non repetitive peak forward current $t = 10$ ms; $T_{mb} = 125$ °C	I_{FSM}	max.	400	A
Junction temperature	T_j	max.	150	°C
Thermal resistance from junction to mounting base	$R_{th\ j\text{-}mb}$	=	1.1	°C/W

MECHANICAL DATA Dimensions in mm



The mark shown applies to normal polarity types and blue cables.

Reverse polarity types: reversed symbol and red cable

Net weight : 25 g
With accessories : 35 g

Torque on nut: min. 40 cm kg
max. 60 cm kg

Diameter of hole in heatsink: max. 8.5 mm.

RATINGS (Limiting values) [1]

Voltages		BYX13-400(R)	600(R)	800(R)	1000(R)	1200(R)	
Continuous reverse voltage	V_R	max. 200	300	400	500	600	V
Crest working reverse voltage	V_{RWM}	max. 200	300	400	500	600	V
Repetitive peak reverse voltage	V_{RRM}	max. 400	600	800	1000	1200	V
Non repetitive peak reverse voltage ($t < 10$ ms)	V_{RSM}	max. 400	600	800	1000	1200	V

Currents

Average forward current (averaged over any 20 ms period)	I_{FAV}	max.	20	A
Repetitive peak forward current	I_{FRM}	max.	100	A
Non repetitive peak forward current $t = 10$ ms; $T_{mb} = 125$ °C (See page 8)	I_{FSM}	max.	400	A
I squared t, for fusing ($t = 10$ ms)	I^2t	max.	570	A^2s

Temperatures

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

THERMAL RESISTANCE

From junction to mounting base	$R_{th\ j\text{-}mb}$	=	1.1	°C/W
From mounting base to heatsink	$R_{th\ mb\text{-}h}$	=	0.3	°C/W

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

CHARACTERISTICS

Forward voltage at T_{mb} = 25 °C

I_F = 1 A	V_F	<	0.9	V
I_F = 100 A	V_F	<	2.0	V [1]

Reverse current at T_{mb} = 125 °C

			BYX13-400(R)	600(R)	800(R)	1000(R)	1200(R)	
V_R = 200 V	I_R	<	2.0					mA
V_R = 300 V	I_R	<		2.0				mA
V_R = 400 V	I_R	<			2.0			mA
V_R = 500 V	I_R	<				1.7		mA
V_R = 600 V	I_R	<					1.4	mA

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

OPERATING NOTES

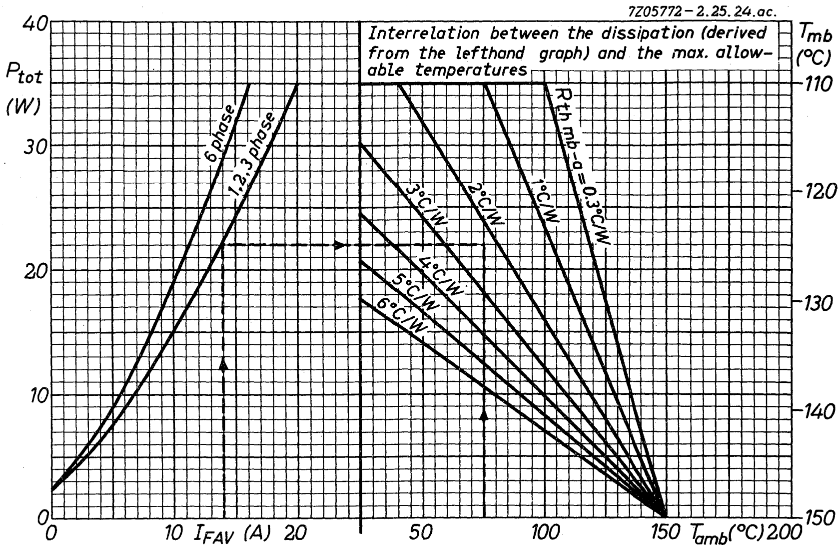
1. When there is a possibility that transient voltages, caused by the stored energy in the transformer core, will exceed the maximum permissible non repetitive peak reverse voltage, a damping circuit across the transformer should be applied.
   Either a series RC circuit or a voltage dependent resistor may be used. Suitable component values for an RC circuit across the transformer primary or secondary may be calculated as follows:

RC across primary of transformer	
C (μF)	R (Ω)
$200\frac{I_{mag}}{V_1}$	$\frac{150}{C}$

RC across secondary of transformer	
C (μF)	R (Ω)
$225\frac{I_{mag}T^2}{V_1}$	$\frac{200}{C}$

   where I_{mag} = magnetising primary r.m.s. current (A)
   V_1 = transformer primary r.m.s. voltage (V)
   V_2 = transformer secondary r.m.s. voltage (V)
   T = V_1/V_2

2. In order to prevent the diodes from being damaged by surge currents higher than those mentioned in the curves at page 8 a fast fuse is recommended.



Determination of the heatsink thermal resistance.

Example:

Assume a diode, used in a three phase full wave rectifier circuit.

frequency	f	= 50 Hz
average forward current	I_{FAV}	= 14 A (per diode)
ambient temperature	T_{amb}	= 75 °C

From the left hand part of the graph above it follows that at I_{FAV} = 14 A and in a three phase rectifier circuit the average forward power + average leakage power = 22 W per diode.

From the right hand part of the graph above follows the thermal resistance, required for P_{tot} = 22 W at T_{amb} = 75 °C

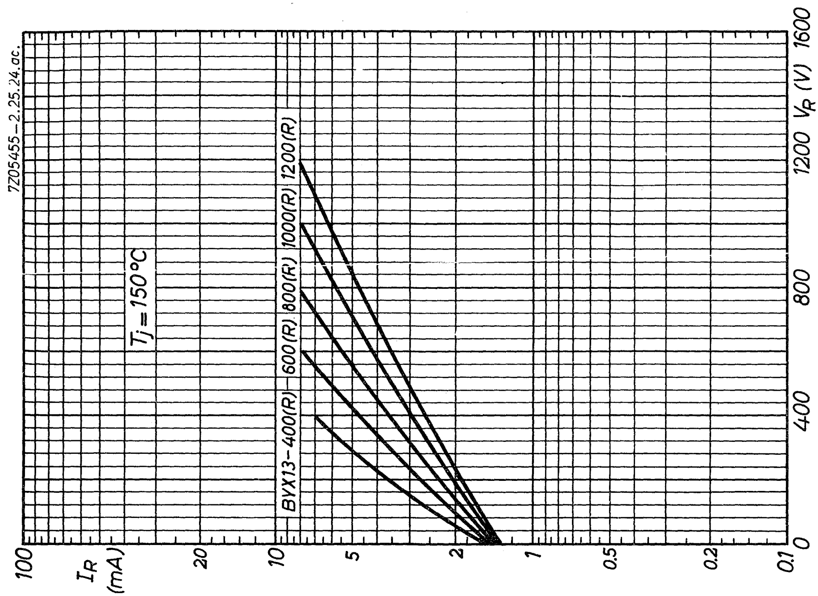
$$R_{th\ mb-a} \approx 2.3\ ^{o}C/W$$

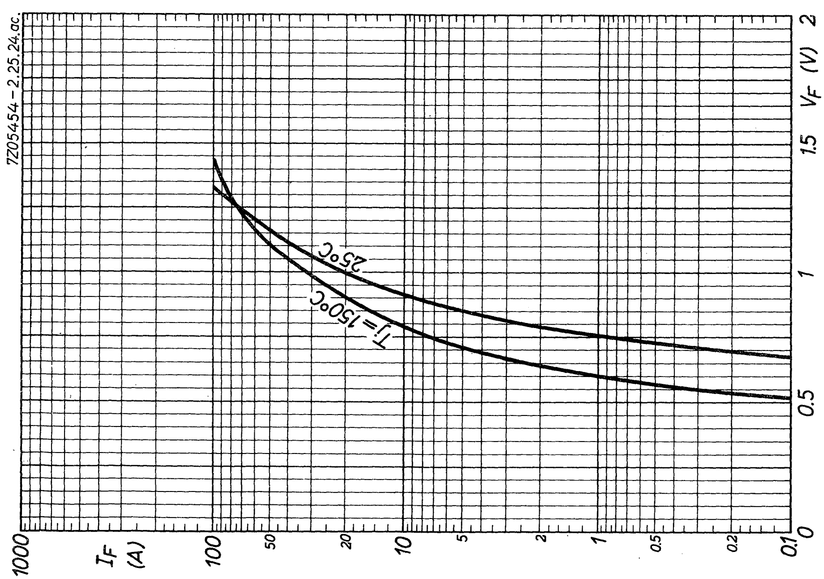
The contact thermal resistance $R_{th\ mb-h} = 0.3\ ^{o}C/W$

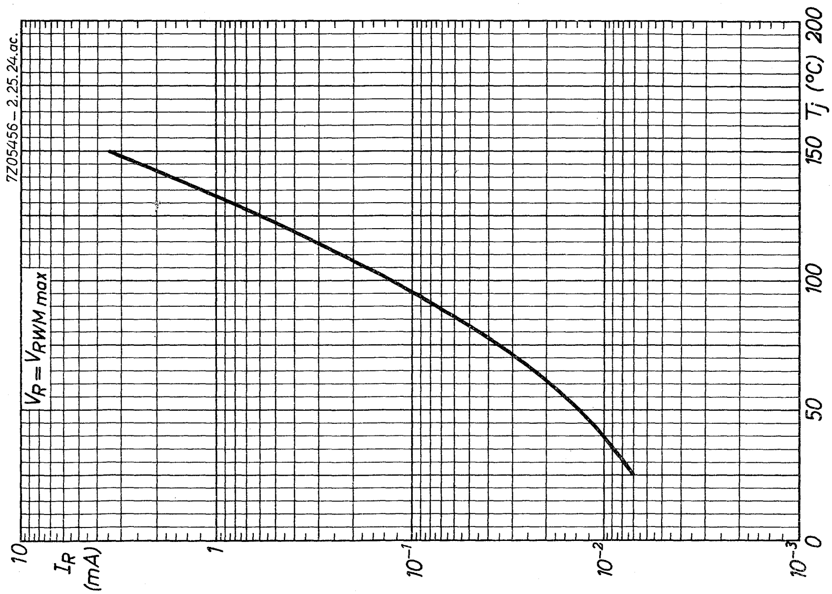
Hence the heatsink thermal resistance should be:

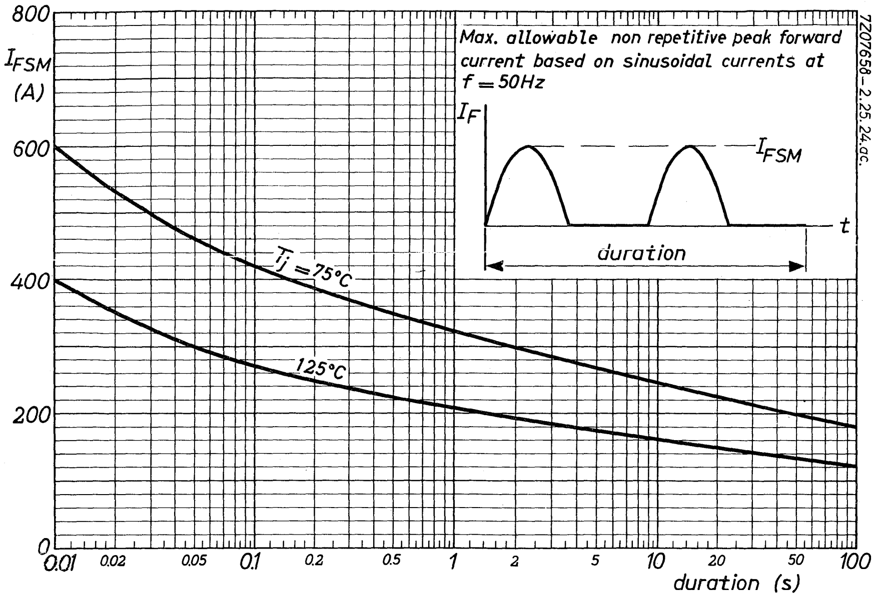
$$R_{th\ h-a} = R_{th\ mb-a} - R_{th\ mb-h} = (2.3 - 0.3)\ ^{o}C/W = 2.0\ ^{o}C/W$$

The applicable heatsink(s) may then be found in the Section ACCESSORIES and HEATSINKS.


7Z05455-2.25.24.ac.
$T_j = 150\,°C$
BYX13-400(R)
600(R)
800(R)
1000(R)
1200(R)
V_R (V)
0
400
800
1200
1600
I_R (mA)
100
20
10
5
2
1
0.5
0.2
0.1


7Z05454-2.25.24.ac.
$T_j = 150\,°C$
25 °C
V_F (V)
0
0.5
1
1.5
2
I_F (A)
1000
100
50
20
10
5
2
1
0.5
0.2
0.1


7Z05456 - 2.25.24.ac.
$V_R = V_{RWM\,max}$
I_R (mA)
10
1
10^{-1}
10^{-2}
10^{-3}
T_j (°C)
0
50
100
150
200



APPLICATION INFORMATION

See general pages at the beginning of this section.

SILICON RECTIFIER DIODES

Double diffused silicon diodes in metal envelopes, intended for power rectifier applications.
The series consists of the following types:
Normal polarity (stud cathode):
BYX14-400; BYX14-600; BYX14-800; BYX14-1000; BYX14-1200
Reverse polarity (stud anode):
BYX14-400R; BYX14-600R; BYX14-800R; BYX14-1000R; BYX14-1200R.

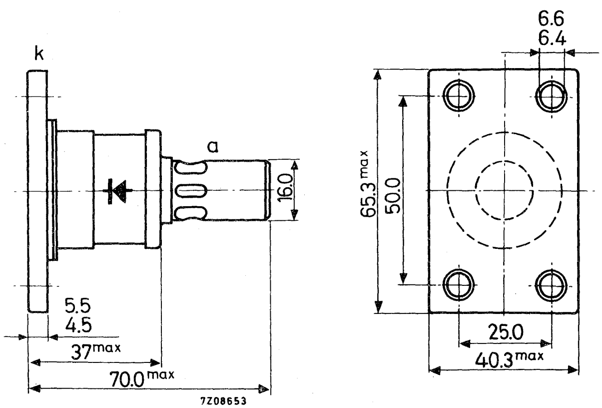
QUICK REFERENCE DATA

			BYX14-400(R)	600(R)	800(R)	1000(R)	1200(R)	
Crest working reverse voltage	V_{RWM}	max.	200	300	400	500	600	V
Repetitive peak reverse voltage	V_{RRM}	max.	400	600	800	1000	1200	V

Average forward current	I_{FAV}	max.	150	A
Non repetitive peak forward current (t = 10 ms)	I_{FSM}	max.	3000	A
Junction temperature	T_j	max.	190	^oC
Thermal resistance from junction to mounting base	$R_{th\ j\text{-}mb}$	=	0.28	$^oC/W$

MECHANICAL DATA

Dimensions in mm



Net weight: 230 g
Accessories and mounting instructions: see page 3.

RATINGS (Limiting values) [1]

Voltages			BYX14-400(R)	600(R)	800(R)	1000(R)	1200(R)	
Continuous reverse voltage	V_R	max.	200	300	400	500	600	V
Crest working reverse voltage	V_{RWM}	max.	200	300	400	500	600	V
Repetitive peak reverse voltage	V_{RRM}	max.	400	600	800	1000	1200	V
Non repetitive peak reverse voltage ($t < 10$ ms)	V_{RSM}	max.	400	600	800	1000	1200	V

Currents

Average forward current (averaged over any 20 ms period) [2]	I_{FAV}	max.	150	A
Repetitive peak forward current	I_{FRM}	max.	750	A
Non repetitive peak forward current $t = 10$ ms; $T_j = 150$ °C; see page 8	I_{FSM}	max.	3000	A
I squared t, for fusing ($t < 10$ ms)	I^2t	max.	32000	A^2s

Temperatures

Storage temperature	T_{stg}		-65 to +190	°C
Junction temperature	T_j	max.	190	°C

THERMAL RESISTANCE

From junction to mounting base	$R_{th\ j\text{-}mb}$	=	0.28	°C/W
From mounting base to heatsink	$R_{th\ mb\text{-}h}$	=	0.07	°C/W

---

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

2) If the applied crest working reverse voltage does not exceed 200 V, an average forward current I_{FAV} = 200 A is allowed.
For six-phase circuits or capacitive load:
I_{FAVmax} = 120 A when $V_{RWM} \geq$ 200 V
and I_{FAVmax} = 160 A when $V_{RWM} \leq$ 200 V

CHARACTERISTICS

Forward voltage at T_{mb} = 175 °C

I_F = 750 A	V_F	<	1.8	V [1]

Reverse current at T_{mb} = 175 °C

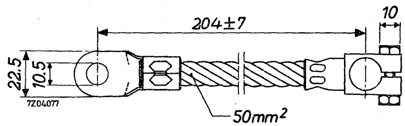
$V_R = V_{RWMmax}$	I_R	<	15	mA

ACCESSORIES AND MOUNTING INSTRUCTIONS

Dimensions in mm

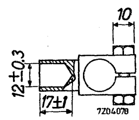
Flexible top lead

Type number 56243
Weight ≈ 170 g



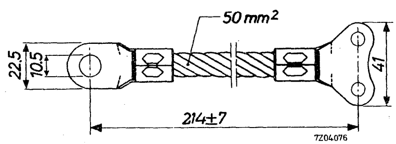
Clamp

Type number 56244
Weight ≈ 70 g



Flexible base lead

Type number 56247
Weight ≈ 130 g



1. These accessories are available on request.
2. For mounting of the flexible top lead it is recommended to use two spanners to avoid damage.
   Torque on nut: min. 30 cm kg for good thermal contact; max. 60 cm kg.
3. For mounting the diode on a heatsink use steel bolts.
   Min. torque for good thermal and electrical contact: 30 cm kg
   Max. torque : 60 cm kg

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

OPERATING NOTES

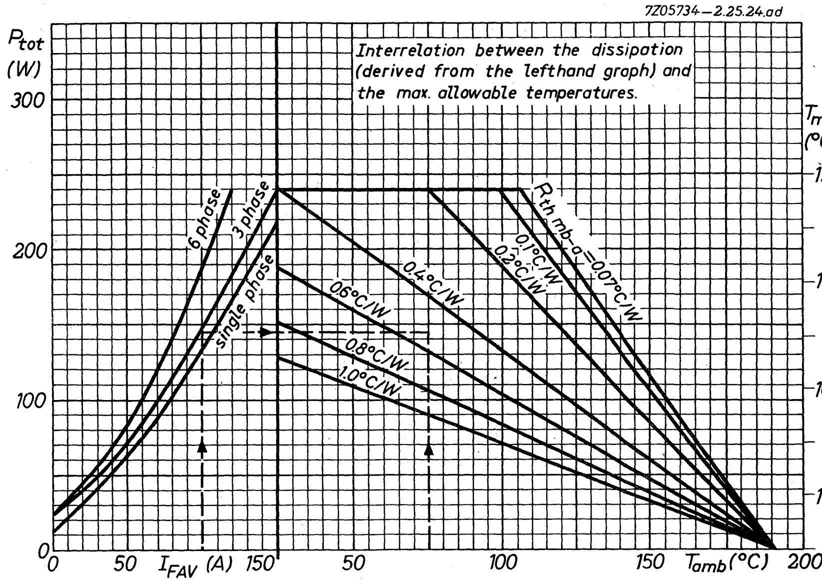
1. When there is a possibility that transient voltages, caused by the stored energy in the transformer core, will exceed the maximum permissible non repetitive peak reverse vo 'age, a damping circuit across the transformer should be applied.
   Either a series RC circuit or a voltage dependent resistor may be used. Suitable component values for an RC circuit across the transformer primary or secondary may be calculated as follows:

RC across primary of transformer	
C (μF)	R (Ω)
$200\frac{I_{mag}}{V_1}$	$\frac{150}{C}$

RC across secondary of transformer	
C (μF)	R (Ω)
$225\frac{I_{mag}T^2}{V_1}$	$\frac{200}{C}$

   where I_{mag} = magnetising primary r.m.s. current (A)
   V_1 = transformer primary r.m.s. voltage (V)
   V_2 = transformer secondary r.m.s. voltage (V)
   T = V_1/V_2

2. In order to prevent the diodes from being damaged by surge currents higher than those mentioned in the curve at page 8, a fast fuse is recommended.



Determination of the heatsink thermal resistance.

Example:

Assume a diode, used in a 3 phase full wave rectifier circuit.

frequency	f	= 50 Hz
average forward current	I_{FAV}	= 100 A (per diode)
ambient temperature	T_{amb}	= 75 °C

From the left hand part of the graph above it follows that at I_{FAV} = 100 A in a three phase rectifier circuit the average forward power + average leakage power = 145 W per diode.

From the right hand part of the graph above follows the thermal resistance, required for P_{tot} = 145 W at T_{amb} = 75 °C

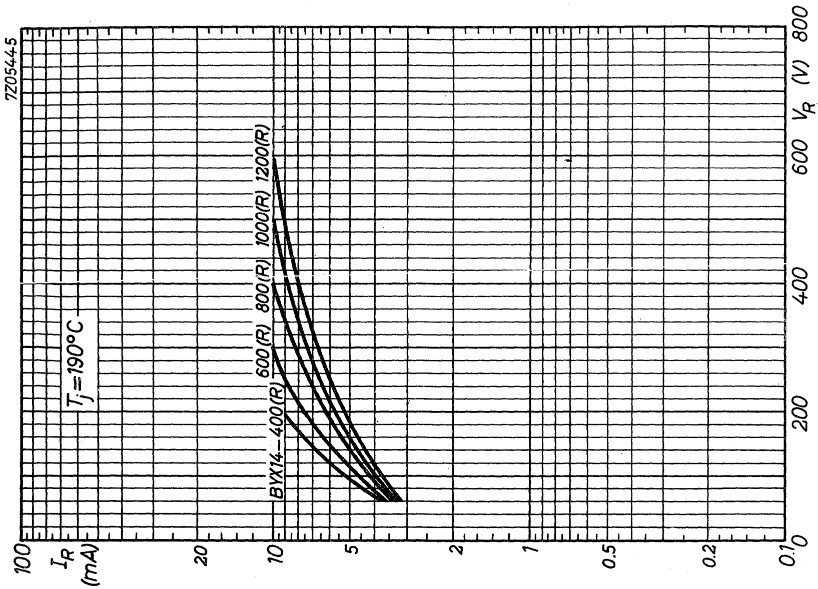
$$R_{th\ mb\text{-}a} \approx 0.52\ ^{o}C/W$$

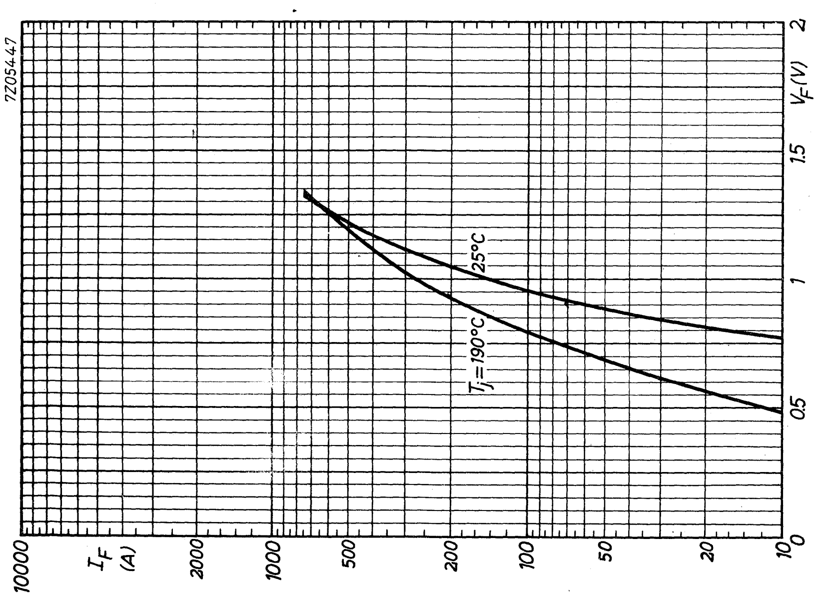
The contact thermal resistance $R_{th\ mb\text{-}h}$ = 0.07 °C/W

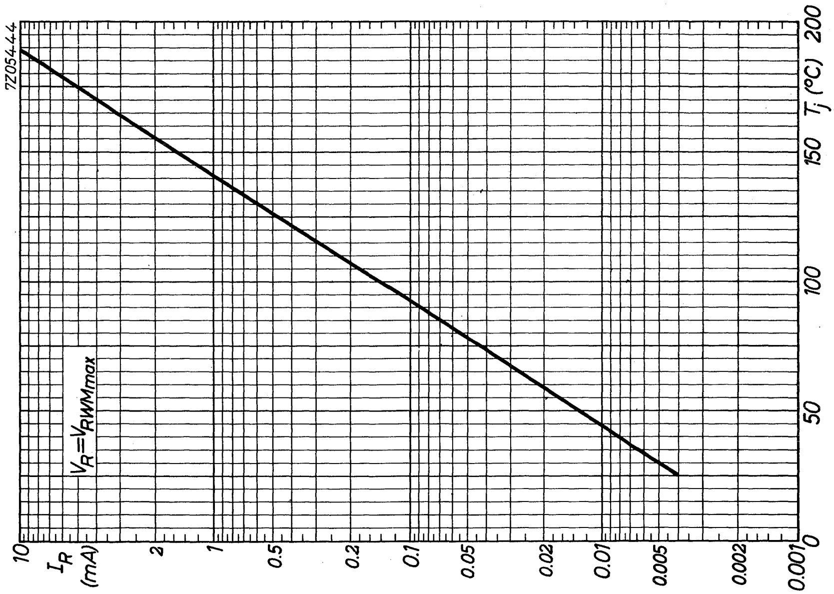
Hence the heatsink thermal resistance should be:

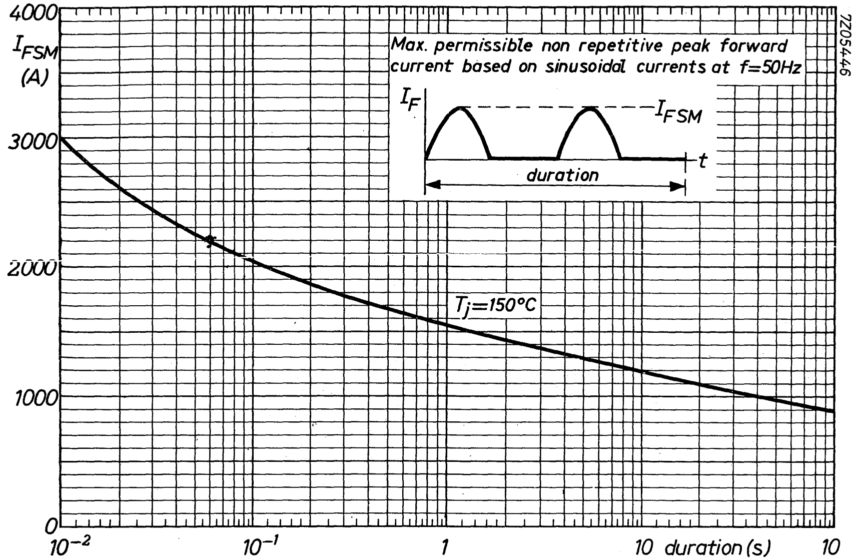
$$R_{th\ h\text{-}a} = R_{th\ mb\text{-}a} - R_{th\ mb\text{-}h} = (0.52 - 0.07)\ ^{o}C/W = 0.45\ ^{o}C/W$$

The applicable heatsink(s) may then be found in the Section ACCESSORIES and HEATSINKS.


7Z05445
$T_j = 190°C$
BYX14-400(R)
600(R)
800(R)
1000(R)
1200(R)
I_R (mA)
100
20
10
5
2
1
0.5
0.2
0.1
0
200
400
600
800
V_R (V)


7Z05447
$T_j = 190°C$
25°C
I_F (A)
10000
2000
1000
500
200
100
50
20
10
0
0.5
1
1.5
2
V_F (V)


7Z05444
V_R=V_RWMmax
I_R
(mA)
10
2
1
0.5
0.2
0.1
0.05
0.02
0.01
0.005
0.002
0.001
T_j (°C)
0
50
100
150
200



APPLICATION INFORMATION

See general pages at the beginning of this section.

SILICON RECTIFIER DIODES

These types have been superseded by the BYX21 and BYX28series

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SILICON RECTIFIER DIODES

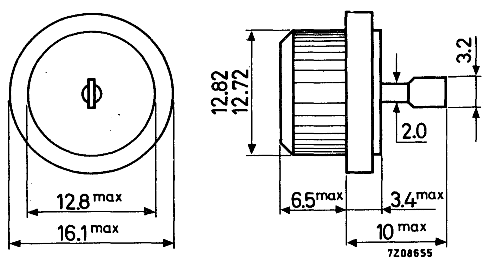
Silicon diodes in a metal envelope, primarily intended as rectifiers in generating systems of motor cars.
The diodes can be press-mounted or soldered
The series consists of the following types:
Normal polarity (stud cathode): BYX21-100 and BYX21-200.
Reverse polarity (stud anode) : BYX21-100R and BYX21-200R.

QUICK REFERENCE DATA

			BYX21-100(R)	200(R)	
Crest working reverse voltage	V_{RWM}	max.	50	100	V
Average forward current	I_{FAV}	max.	25		A
Non repetitive peak forward current t = 10 ms	I_{FSM}	max.	250		A
Junction temperature	T_j	max.	175		^oC
Thermal resistance from junction to case	$R_{th\ j-c}$	=	1.5		$^oC/W$

MECHANICAL DATA Dimensions in mm

Accessories available: 56232



Marked in red: Cathode connected to case BYX21-100 and BYX21-200

Marked in blue: Anode connected to case BYX21-100R and BYX21-200R

For mounting instructions see page 3

Force to seat the diode for good heat transfer: 350 kg

Maximum force : 900 kg

7Z3 1940

All information applies to frequencies up to 1000 Hz

RATINGS (Limiting values) [1]

Voltages			BYX21-100(R)	200(R)	
Continuous reverse voltage	V_R	max.	45	90	V
Crest working reverse voltage	V_{RWM}	max.	50	100	V
Repetitive peak reverse voltage	V_{RRM}	max.	100	200	V
Non repetitive peak reverse voltage ($t < 10$ ms)	V_{RSM}	max.	100	200	V

Currents				
Forward current (d.c.)	I_F	max.	25	A
Average forward current (averaged over any 20 ms period)	I_{FAV}	max.	25	A
Repetitive peak forward current	I_{FRM}	max.	80	A
Non repetitive peak forward current $t = 10$ ms	I_{FSM}	max.	250	A

Temperatures				
Storage temperature	T_{stg}		-65 to +175	^oC
Junction temperature	T_j	max.	175	^oC

THERMAL RESISTANCE

From junction to case	$R_{th\ j-c}$	=	1.5	$^oC/W$
From case to heatsink				
press mounted	$R_{th\ c-h}$	=	0.5	$^oC/W$
soldered	$R_{th\ c-h}$	=	0.2	$^oC/W$

CHARACTERISTICS

Forward voltage at $T_j = 25\ ^oC$				
$I_F = 80$ A	V_F	<	1.60	V [2]
Reverse current at $T_j = 125\ ^oC$				
$V_R = 45$ V; BYX21-100(R)	I_R	<	6	mA
$V_R = 90$ V; BYX21-200(R)	I_R	<	3	mA

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

[2] Measured under pulsed conditions to prevent excessive dissipation.

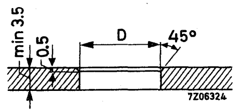
7Z3 1941

MOUNTING INSTRUCTIONS Dimensions in mm

PRESS MOUNTING

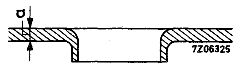
A. Flat heatsink without raised border

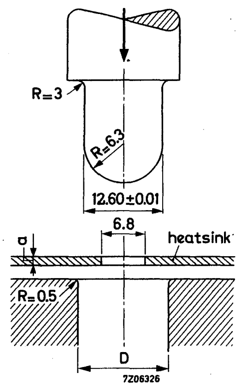
Diameter of hole in heatsink: from 12.61 to 12.66 mm
(Diameter required depends on hardness of heatsink material)
Thermal resistance from case to heatsink: $R_{th\ c\text{-}h} = 0.5\ ^{o}C/W$



B. Flat heatsink with raised border (Copper or aluminium)

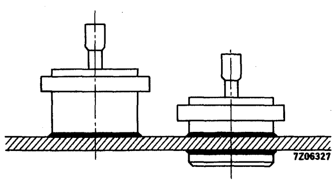
a (mm)	D (mm)	$R_{th\ c\text{-}h}$ ($^{o}C/W$)
3.00	17.50 ± 0.03	0.25
2.00	15.50 ± 0.03	0.35
1.50	14.50 ± 0.03	0.45



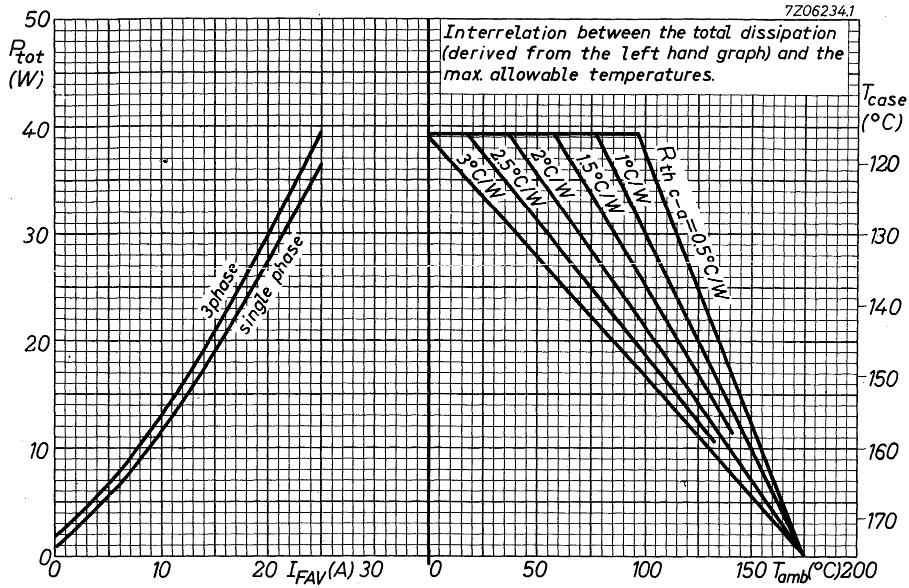


MOUNTING BY SOLDERING

Soldering temperature	T	max.	235	^{o}C
Soldering time	t	max.	30	s
Thermal resistance from case to heatsink	$R_{th\ c\text{-}h}$	=	0.2	$^{o}C/W$



7Z3 1942


7Z06234.1
Interrelation between the total dissipation (derived from the left hand graph) and the max. allowable temperatures.
P_{tot} (W)
50
40
30
20
10
0
0
10
20
I_{FAV}(A)
30
3phase
single phase
T_{case} (°C)
120
130
140
150
160
170
0
50
100
150
T_{amb}(°C)
200
3°C/W
2.5°C/W
2°C/W
1.5°C/W
1°C/W
$R_{th\ c-a}$=0.5°C/W

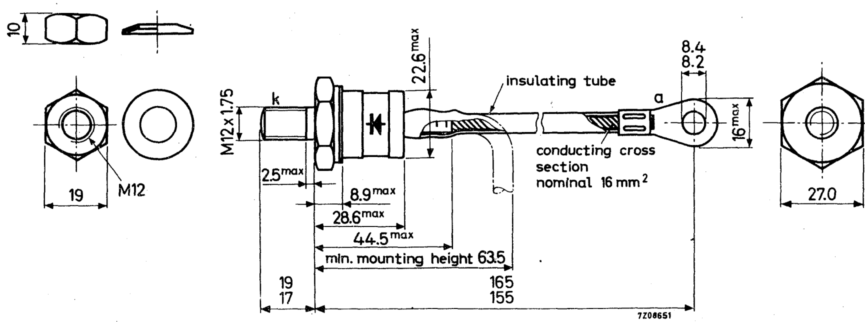
CONTROLLED AVALANCHE RECTIFIER DIODES

Diffused silicon diodes in metal envelopes with ceramic insulation, capable of absorbing transients and intended for power rectifier application.
The series consists of the following types: BYX23-400, BYX23-600, BYX23-800 and BYX23-1000.

QUICK REFERENCE DATA

			BYX23- 400	600	800	1000	
Crest working reverse voltage	V_{RWM}	max.	400	600	800	1000	V
Average forward current	I_{FAV}	max.	100				A
Non repetitive peak forward current (t = 10 ms)	I_{FSM}	max.	1600				A
Repetitive peak reverse power (t = 10 μs) T_j = 190 °C	P_{RRM}	max.	8				kW
Non repetitive peak reverse power (t = 10 μs) T_j = 25 °C	P_{RSM}	max.	30				kW
Junction temperature	T_j	max.	190				°C
Thermal resistance from junction to mounting base	$R_{th\ j\text{-}mb}$	=	0.4				°C/W

MECHANICAL DATA Dimensions in mm



Net weight : 95 g
Accessories: 115 g
Diameter of hole in heatsink: max. 13.0 mm

Torque on nut: min. 100 cm kg
max. 250 cm kg

RATINGS (Limiting values) [1]

Voltages [2]

			BYX23- 400	600	800	1000	
Continuous reverse voltage	V_R	max.	400	600	800	1000	V
Crest working reverse voltage	V_{RWM}	max.	400	600	800	1000	V

Currents

Average forward current (averaged over any 20 ms period)	I_{FAV}	max.	100	A
Forward current (d.c.)	I_F	max.	130	A
Repetitive peak forward current	I_{FRM}	max.	500	A
Non repetitive peak forward current t = 10 ms (See page 6)	I_{FSM}	max.	1600	A

Reverse power dissipation

Average reverse power (averaged over any 20 ms period) T_j = 190 °C	P_{RAV}	max.	30	W
Repetitive peak reverse power; t = 10 μs (square wave; f = 50 Hz) T_j = 190 °C	P_{RRM}	max.	8	kW
Non repetitive peak reverse power t = 10 μs; T_j = 25 °C (See page 6)	P_{RSM}	max.	30	kW
Non repetitive peak reverse power t = 10 μs; T_j = 190 °C (See page 6)	P_{RSM}	max.	15	kW

Temperatures

Storage temperature	T_{stg}		−55 to +200	°C
Junction temperature	T_j	max.	190	°C

THERMAL RESISTANCE

From junction to mounting base	$R_{th\ j\text{-}mb}$	=	0.4	°C/W
From mounting base to heatsink without heatsink compound	$R_{th\ mb\text{-}h}$	=	0.1	°C/W
From mounting base to heatsink with heatsink compound (Dow Corning 340)	$R_{th\ mb\text{-}h}$	=	0.04	°C/W

1) Limiting values according to the Absolute Maximum System as defined in IEC publication 134.
2) These ratings apply at $R_{th\ j\text{-}a} \leq 1.7$ °C/W (d.c.) or ≤ 3.3 °C/W (a.c.)

CHARACTERISTICS

Forward voltage at I_F = 500 A; T_j = 190 °C	V_F	<	1.7	V
Reverse breakdown voltage				
I_R = 10 mA; T_j = 25 °C				
BYX23-400	$V_{(BR)R}$		500 to 800	V
BYX23-600	$V_{(BR)R}$		750 to 1050	V
BYX23-800	$V_{(BR)R}$		1000 to 1320	V
BYX23-1000	$V_{(BR)R}$		1250 to 1600	V
(See also reverse characteristics on page 9)				
Reverse current at T_j = 175 °C				
BYX23-400 : V_R = 400 V	I_R	<	20	mA
BYX23-600 : V_R = 600 V	I_R	<	17	mA
BYX23-800 : V_R = 800 V	I_R	<	13	mA
BYX23-1000: V_R = 1000 V	I_R	<	10	mA

OPERATING NOTES

1. Voltage sharing of series connected controlled avalanche diodes.

   When diodes with avalanche characteristics are connected in series, the usual R and C elements for voltage sharing can be omitted.

2. Switching transients for controlled avalanche diodes.

   In an unloaded rectifier circuit, when the transformer is switched off, energy is released.
   When, as a result, no diode rating is exceeded, special provisions are not needed. If, however, the rated non repetitive peak power dissipation per device could be exceeded, damping across the transformer is necessary in order to protect the device.

   The duration of the transformer's energy release can be found in first approximation from the empirical formula:

$$t = \frac{V_{RWM}}{V_{(BR)R\,min}}\ ;\ \text{(milliseconds)}$$

where V_{RWM} = actually applied crest working voltage

$V_{(BR)R\,min}$ = minimum reverse breakdown voltage

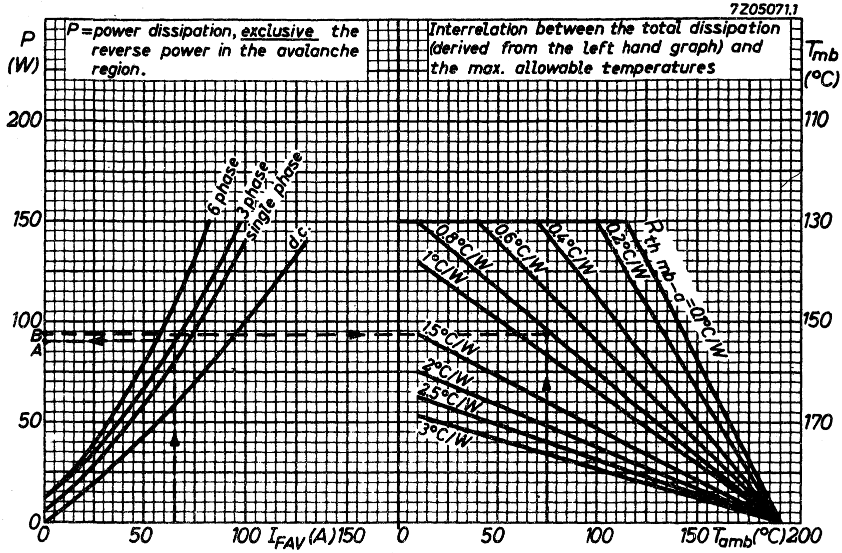
The non repetitive peak power that can be absorbed by a single device during t ms can be derived from the graph on page 6. Multiplying that amount with the time in which it is released results in the energy absorbed by one diode. (E_D).
A series string of n diodes can absorb n times as much. ($n.E_D$)

The difference between the energy released by the transformer and that absorbed by the n diodes should be absorbed by series connected R and C elements across the secondary winding of the transformer.
The magnitudes of R and C have to be derived from the following formulae:

$$C = \frac{E_T - n.E_D}{(n.V_{(BR)R\,min})^2} \cdot 10^6 \quad (\mu F) \qquad R = \frac{310}{C} \quad (\Omega)$$

where C = capacitance in μF
E_T = energy released by the transformer in Ws
n = number of diodes in series
E_D = energy absorbed by one diode in Ws
$V_{(BR)R\,min}$ = minimum reverse breakdown voltage of one diode in V
R = resistance in Ω

7Z05071.1



Determination of the heatsink thermal resistance

Example:

Assume a diode, used in a three phase rectifier circuit.

frequency	f	=	50	Hz
average forward current	I_{FAV}	=	65	A (per diode)
ambient temperature	T_{amb}	=	75	°C
repetitive peak reverse power dissipation in the avalanche region	P_{RRM}	=	6	kW (per diode)
duration of P_{RRM}	t	=	10	μs

From the left hand part of the graph above it follows that at $I_{FAV} = 65$ A in a three-phase rectifier the average forward power + average leakage power = 90W per diode (point A). The average reverse power in the avalanche region, averaged over any cycle, follows from:

$$P_{RAV} = \delta \times P_{RRM}, \text{ where the duty cycle } \delta = \frac{10\ \mu s}{20\ ms} = 0.0005$$

Thus: $P_{RAV} = 0.0005 \times 6\ kW = 3\ W$.

Therefore the total device power dissipation $P_{tot} = (90 + 3)\ W = 93\ W$ (point B).

From the right hand part of the graph above follows the thermal resistance, required for $P_{tot} = 93$ W at $T_{amb} = 75$ °C.

$$R_{th\ mb\text{-}a} \approx 0.8\ °C/W$$

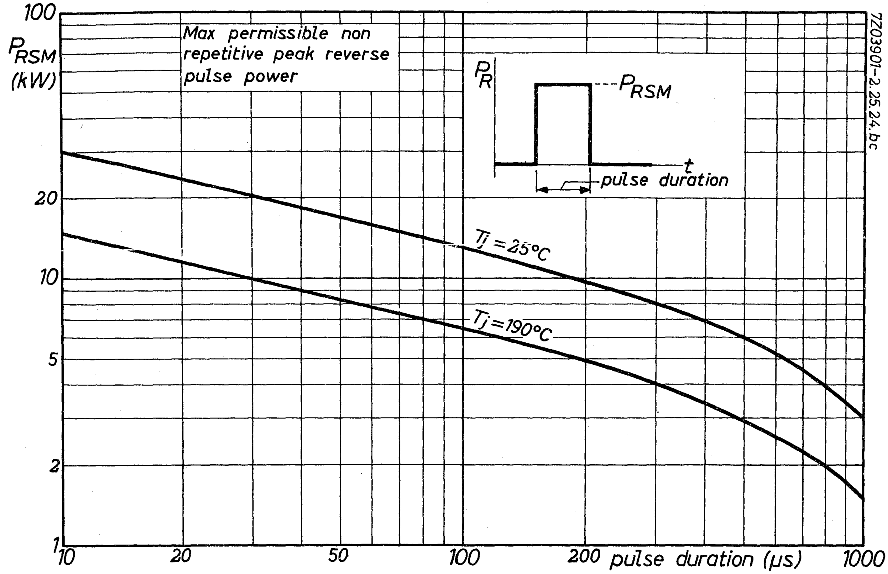
The contact thermal resistance $R_{th\ mb\text{-}h} = 0.1$ °C/W.

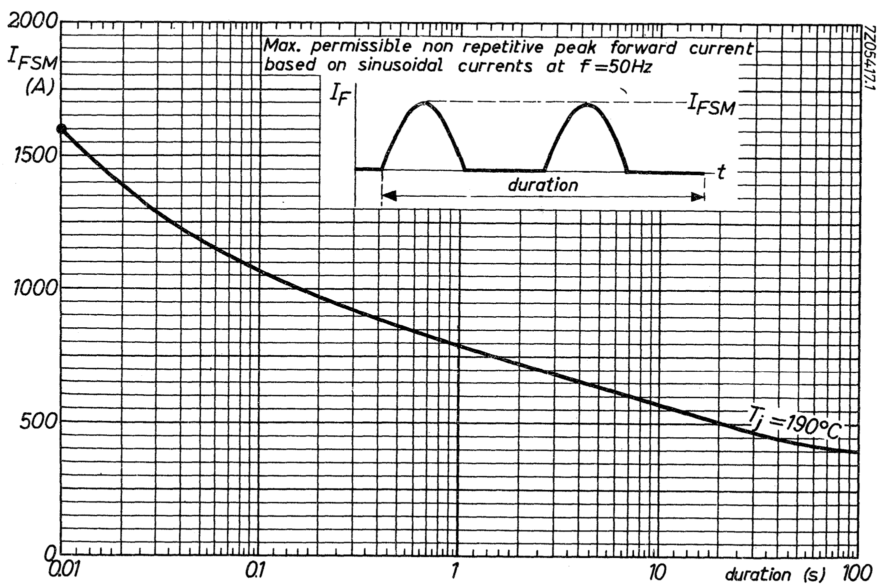
Hence the heatsink thermal resistance should be:

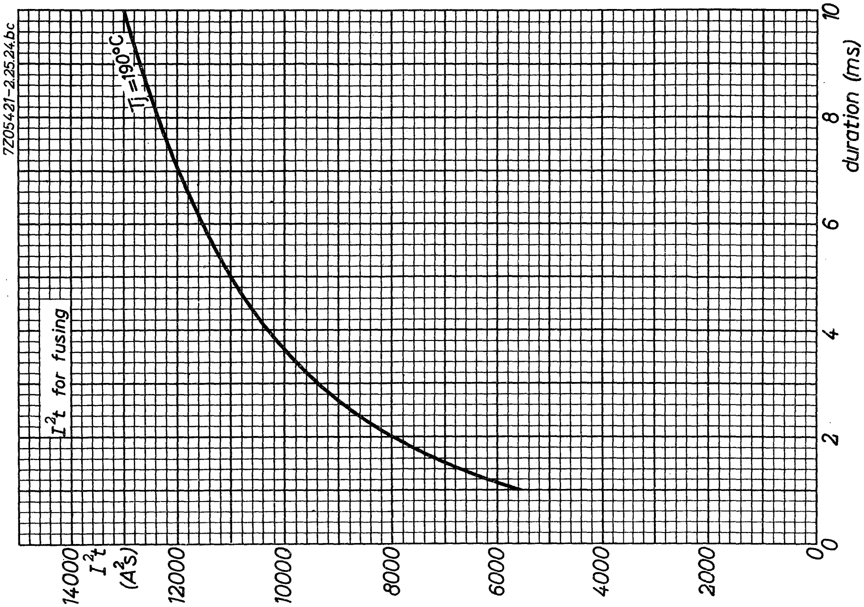
$$R_{th\ h\text{-}a} = R_{th\ mb\text{-}a} - R_{th\ mb\text{-}h} = (0.8 - 0.1)\ °C/W = 0.7\ °C/W.$$

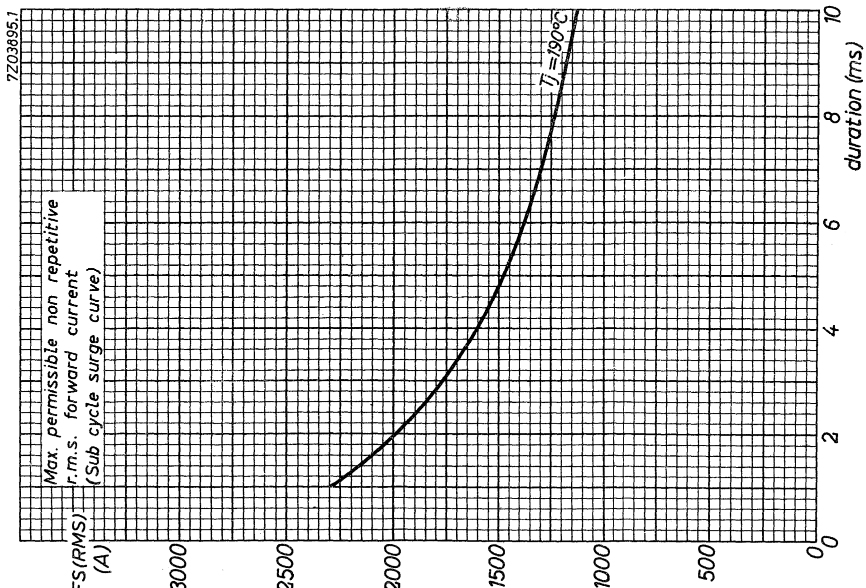
The applicable heatsink(s) may then be found in the Section ACCESSORIES and HEATSINKS.

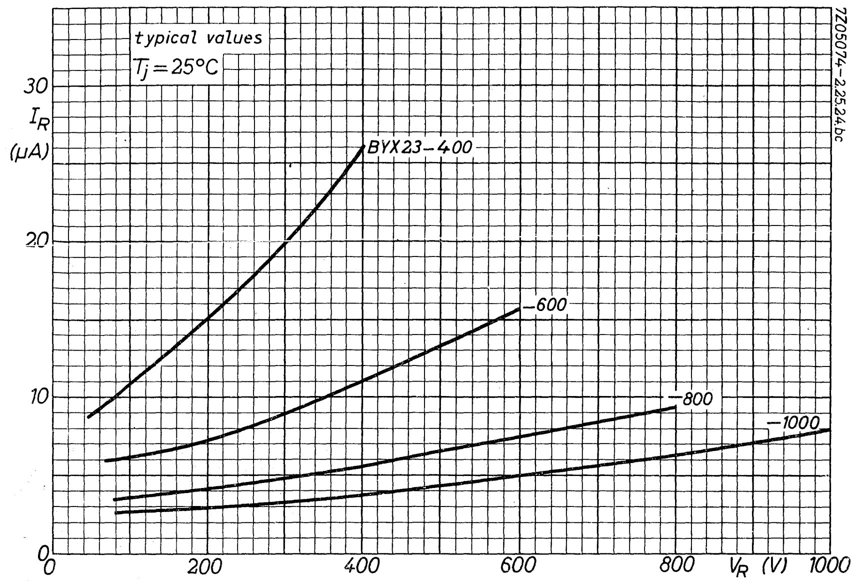
7Z3 1951

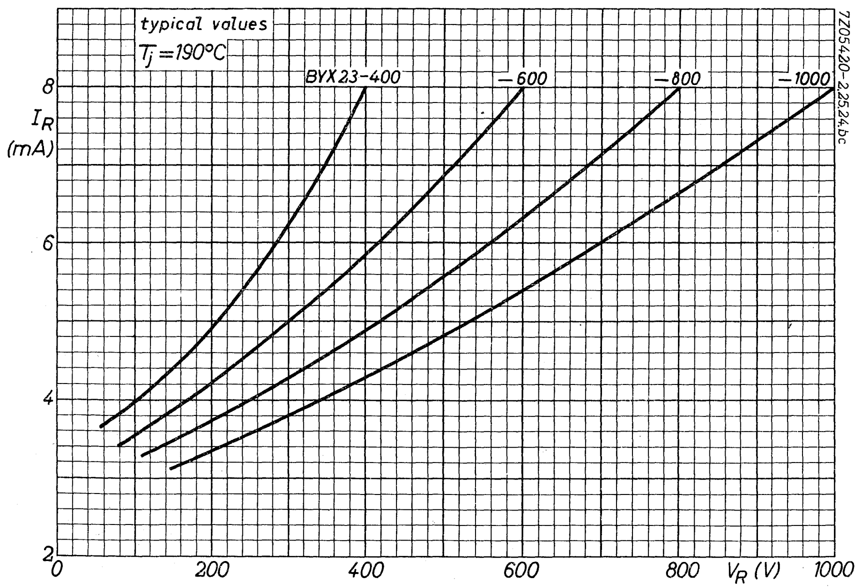

100
P_{RSM}
(kW)
Max permissible non repetitive peak reverse pulse power
P_R
P_{RSM}
t
pulse duration
$T_j = 25°C$
$T_j = 190°C$
20
10
5
2
1
10
20
50
100
200
pulse duration (μs)
1000
7Z03901-2.25.24.bc

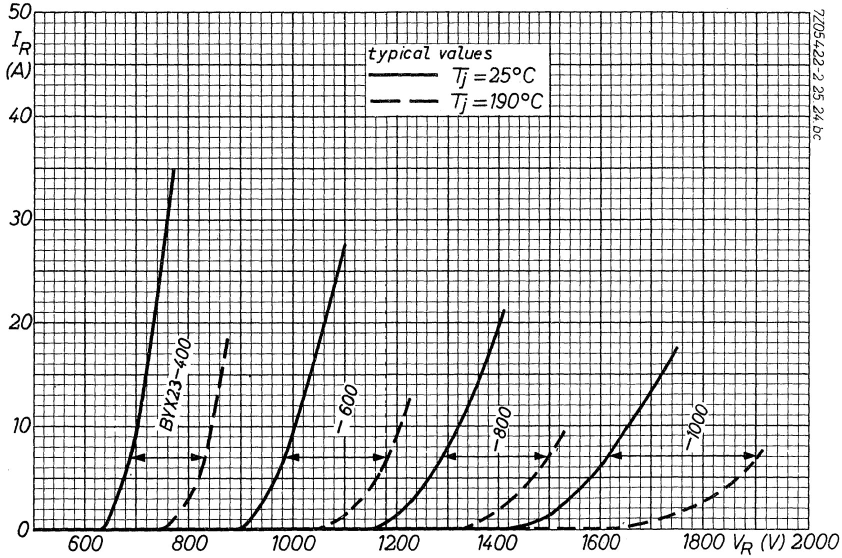

2000
I_{FSM}
(A)
Max. permissible non repetitive peak forward current based on sinusoidal currents at f = 50Hz
I_F
I_{FSM}
t
duration
1500
1000
500
0
0.01
0.1
1
10
duration (s)
100
$T_j = 190°C$
7Z05417.1

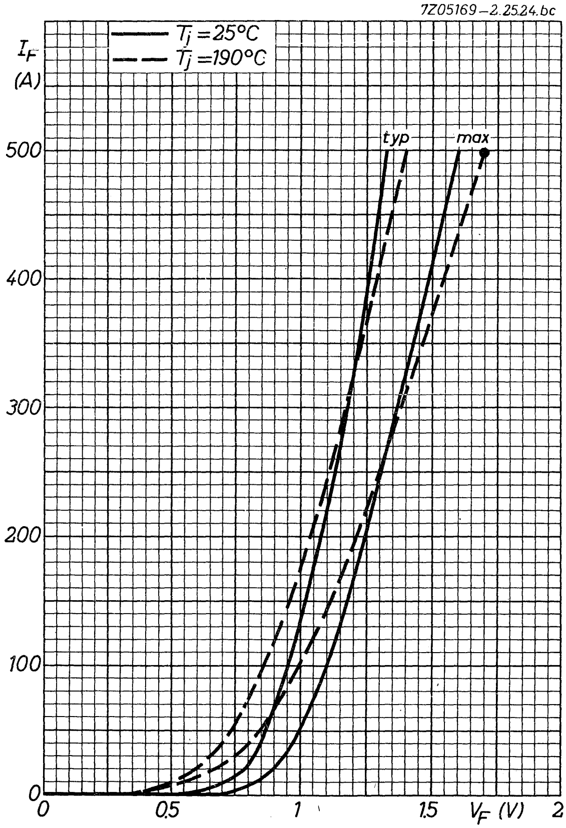

7Z05421-2.25.24.bc
I²t for fusing
Tj =190°C
I²t (A²s)
14000
12000
10000
8000
6000
4000
2000
0
duration (ms)
0
2
4
6
8
10


7Z03895.1
Max. permissible non repetitive r.m.s. forward current (Sub cycle surge curve)
Tj =190°C
IFS(RMS) (A)
3000
2500
2000
1500
1000
500
0
duration (ms)
0
2
4
6
8
10


typical values
$T_j = 25°C$
30
I_R
(μA)
20
10
0
BYX23-400
-600
-800
-1000
0
200
400
600
800
V_R (V)
1000
7Z05074-2.25.24.bc


typical values
$T_j = 190°C$
8
I_R
(mA)
6
4
2
BYX23-400
-600
-800
-1000
0
200
400
600
800
V_R (V)
1000
7Z05420-2.25.24.bc


50
I_R
(A)
40
30
20
10
0
typical values
T_j = 25°C
T_j = 190°C
BYX23-400
-600
-800
-1000
600
800
1000
1200
1400
1600
1800 V_R (V) 2000
7Z05422-2 25.24.bc



APPLICATION INFORMATION

See general pages at the beginning of this section

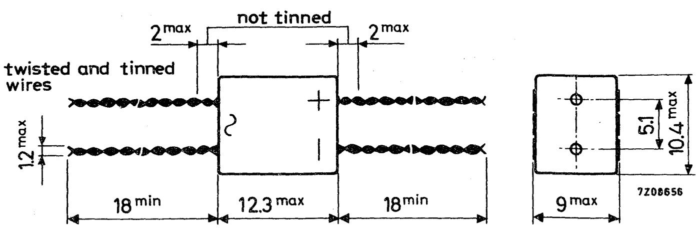
BRIDGE RECTIFIER ASSEMBLY

Bridge rectifier assembly in a plastic envelope equipped with four silicon double diffused junction diodes.
It is primarily intended for general and industrial applications such as rectifiers in transistorized equipment drawing its power from mains with frequencies up to 400 Hz.

QUICK REFERENCE DATA				
For meaning of symbols see page 2				
Input				
R.M.S. voltage	$V_{I(RMS)}$	max.	565	V
Repetitive peak voltage	V_{IRM}	max.	1600	V
Output				
Continuous voltage				
with C load	V_O		800	V
with R and L load	V_O		510	V
Average current with R and L load				
up to T_{amb} = 40 °C; $V_{I(RMS)}$ = 42 V	I_O	max.	0.8	A
$V_{I(RMS)}$ = 565 V	I_O	max.	0.55	A
Repetitive peak current	I_{ORM}	max.	3.0	A
Thermal resistance from junction to ambient in free air	$R_{th\ j-a}$	=	50	°C/W

MECHANICAL DATA Dimensions in mm

Plastic envelope with polarity indications at both sides



The sealing of the plastic envelope withstands the accelerated damp heat test of IEC recommendation 68-2 (test D, severity IV, 6 cycles).

MOUNTING METHODS see page 3

7Z3 1952

All information applies to mains frequencies up to 400 Hz.

RATINGS (Limiting values) [1])

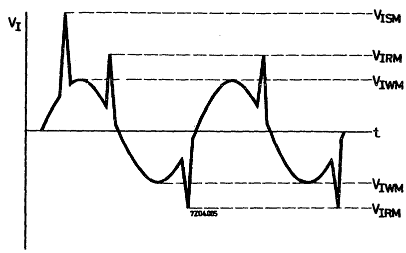
Input				
R.M.S. voltage	$V_{I(RMS)}$	max.	565	V
Crest working voltage	V_{IWM}	max.	800	V
Repetitive peak voltage	V_{IRM}	max.	1600	V
Non repetitive peak voltage; $t < 10$ ms	V_{ISM}	max.	1600	V
Non repetitive peak current (See also page 8)	I_{ISM}	max.	15	A
Output				
Average current with C load	See pages 4, 6 and 7			
Average current with R and L load up to T_{amb} = 40 °C (See also pp. 5, 6 and 7)				
$V_{I(RMS)}$ = 42 V	I_O	max.	0.8	A
$V_{I(RMS)}$ = 565 V	I_O	max.	0.55	A
Repetitive peak current	I_{ORM}	max.	3.0	A
Temperatures				
Storage temperature	T_{stg}		-65 to +150	°C
Junction temperature	T_j	max.	150	°C

THERMAL RESISTANCE

From junction to ambient in free air — $R_{th\ j-a}$ = 50 °C/W
See also page 3

MEANING OF SYMBOL SUBSCRIPTS

First subscript	I	= input
	O	= output
Second subscript	R	= repetitive
	S	= non repetitive
	W	= working
Third subscript	M	= peak or crest



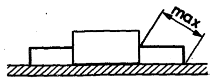
1) Limiting values according to the Absolute Maximum System as defined in IEC publication 134.

7Z3 1953

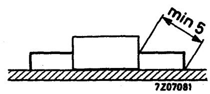
MOUNTING METHODS

1. Mounted on soldering lips at any lead length. $R_{th\ j\text{-}a}$ = 50 °C/W

2. Mounted on a printed board at maximum lead length. $R_{th\ j\text{-}a}$ = 65 °C/W

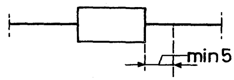


3. Mounted on a printed board at a lead length of 5 mm. $R_{th\ j\text{-}a}$ = 75 °C/W



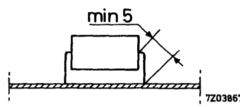
Iron soldering

At a maximum iron temperature of 300 °C, the maximum permissible soldering time is 3 seconds, provided the soldering spot is at least 5 mm from the seal.



Dip soldering

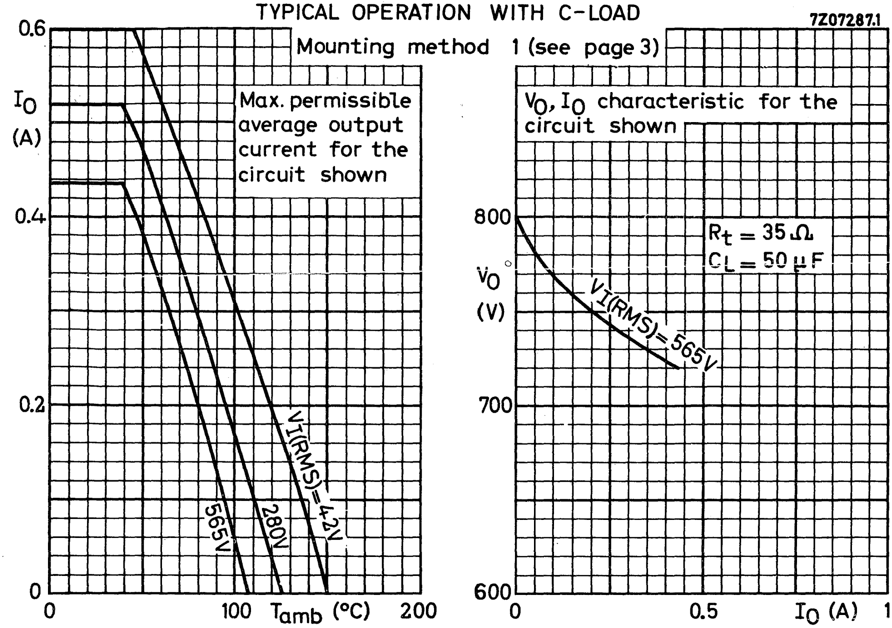
At a maximum solder temperature of 300 °C, the maximum permissible soldering time is 3 seconds, provided the soldering spot is at least 5 mm from the seal.

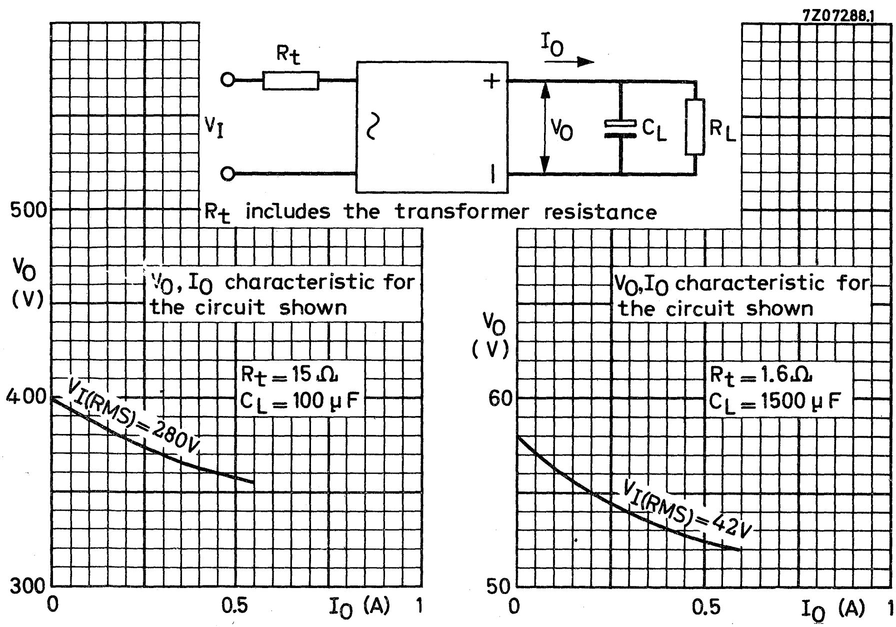


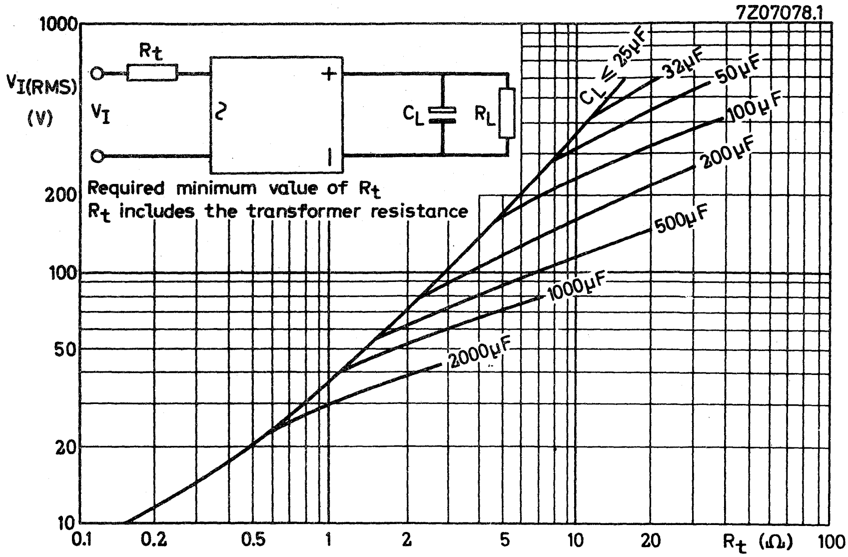
Note: If during soldering the assembly is in contact with the printed board the maximum permissible temperature of the point of contact is 150 °C.

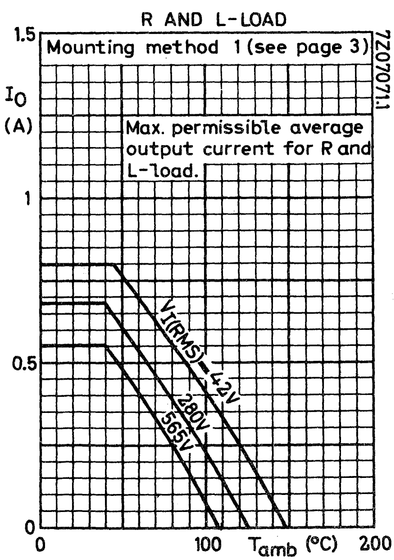
7Z3 1954

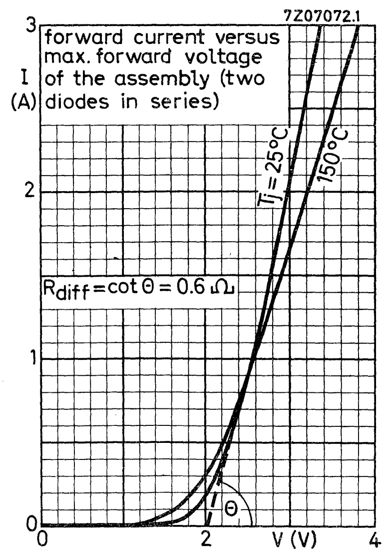
TYPICAL OPERATION WITH C-LOAD

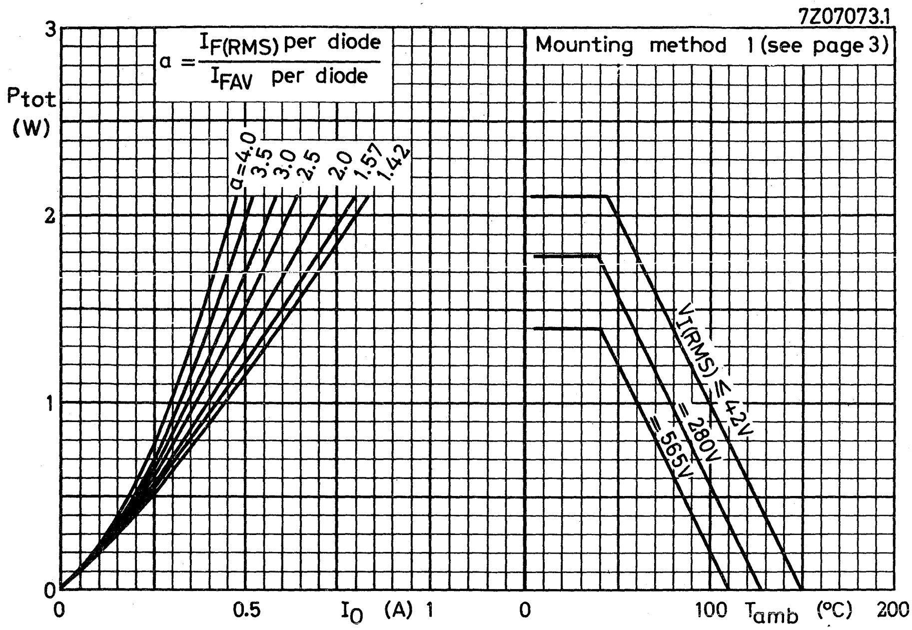


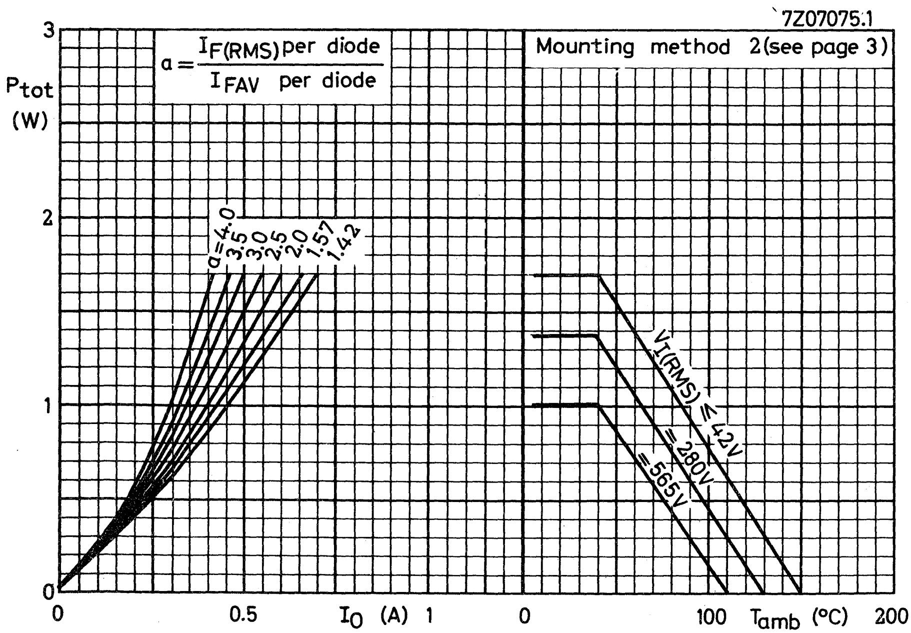


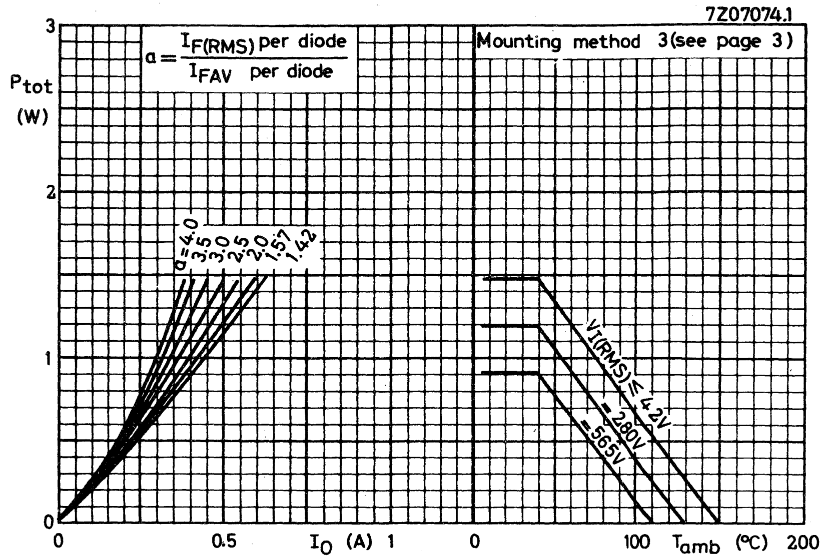

7Z07078.1
$V_{I(RMS)}$ (V)
1000
200
100
50
20
10
R_t
V_I
+
~
−
C_L
R_L
Required minimum value of R_t
R_t includes the transformer resistance
$C_L \leq 25\mu F$
32µF
50µF
100µF
200µF
500µF
1000µF
2000µF
0.1
0.2
0.5
1
2
5
10
20
R_t (Ω)
100


R AND L-LOAD
7Z07071.1
Mounting method 1 (see page 3)
I_O (A)
Max. permissible average output current for R and L-load.
$V_{I(RMS)} = 42V$
280V
565V
1.5
1
0.5
0
0
100
T_{amb} (°C)
200


7Z07072.1
forward current versus max. forward voltage of the assembly (two diodes in series)
I (A)
$R_{diff} = \cot\Theta = 0.6\ \Omega$
$T_j = 25°C$
150°C
Θ
3
2
1
0
0
2
V (V)
4


7Z07073.1
Mounting method 1 (see page 3)
a = IF(RMS) per diode / IFAV per diode
Ptot (W)
a=4.0 3.5 3.0 2.5 2.0 1.57 1.42
VI(RMS) ≤ 42V
= 280V
= 565V
IO (A)
Tamb (°C)
0
0.5
1
100
200
2
3


7Z07075.1
Mounting method 2 (see page 3)
a = IF(RMS) per diode / IFAV per diode
Ptot (W)
a=4.0 3.5 3.0 2.5 2.0 1.57 1.42
VI(RMS) ≤ 42V
= 280V
= 565V
IO (A)
Tamb (°C)
0
0.5
1
100
200
2
3



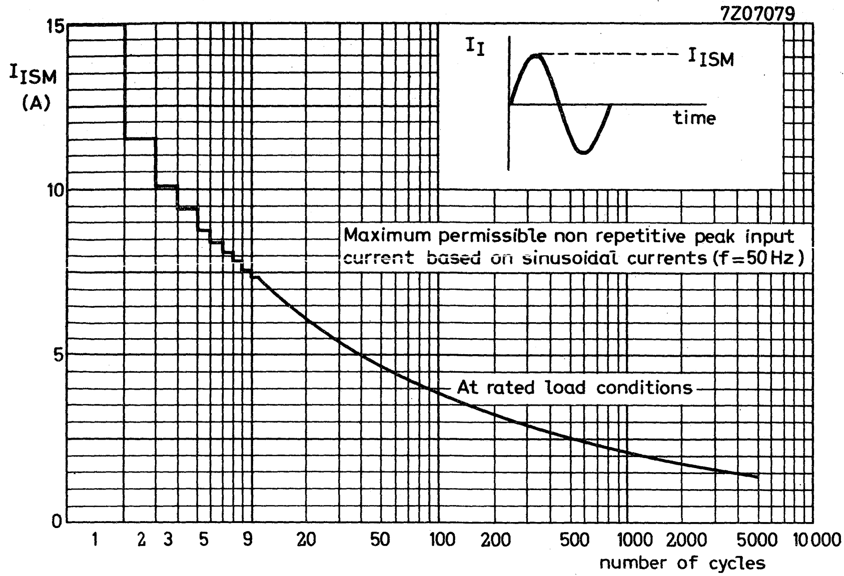
From the lefthand graphs the total power dissipation can be found as a function of the average output current.

The parameter $a = \frac{I_{F(RMS)} \text{per diode}}{I_{FAV} \text{ per diode}}$ depends on $n\omega R_L C_L$ and $\frac{R_t + R_{diff}}{nR_L}$ and can be found from existing graphs. (For single phase full wave: n = 2)

See for instance "Power rectification with silicon diodes".
Once the power dissipation is known, the max. permissible ambient temperature follows from the right hand graph.

For the series resistance, added to limit the initial peak rectifier current, the required minimum value can be found from the upper graph at page 5.
R_{diff} is shown at page 5 also.

7Z3 1957


7Z07079
I_{ISM} (A)
15
10
5
0
I_I
I_{ISM}
time
Maximum permissible non repetitive peak input current based on sinusoidal currents (f = 50 Hz)
At rated load conditions
1
2
3
5
9
20
50
100
200
500
1000
2000
5000
10 000
number of cycles

CONTROLLED AVALANCHE RECTIFIER DIODES

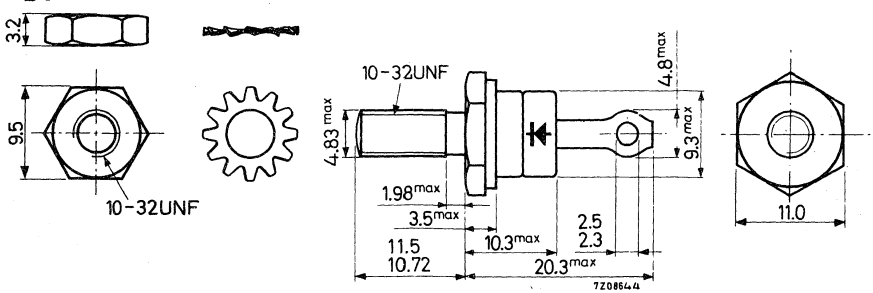
Diffused silicon diodes in a DO-4 metal envelope, capable of absorbing transients and intended for power rectifier applications.
The series consists of the following types:
Normal polarity (stud cathode): BYX25-600, BYX25-800, BYX25-1000.
Reverse polarity (stud anode): BYX25-600R, BYX25-800R, BYX25-1000R.

QUICK REFERENCE DATA

			BYX25-600(R)	800(R)	1000(R)	
Crest working reverse voltage	V_{RWM}	max.	600	800	1000	V
Average forward current	I_{FAV}	max.		20		A
Non repetitive peak forward current t = 10 ms	I_{FSM}	max.		360		A
Repetitive peak reverse power t = 10 μs; T_j = 175 °C	P_{RRM}	max.		3.0		kW
Non repetitive peak reverse power t = 10 μs; T_j = 25 °C	P_{RSM}	max.		18		kW
Junction temperature	T_j	max.		175		°C
Thermal resistance from junction to mounting base	$R_{th\ j\text{-}mb}$	=		1.3		°C/W

MECHANICAL DATA Dimensions in mm

DO-4



Net weight : 5.6 g
With accessories: 7.6 g
Diameter of hole in heatsink: max. 5.2 mm
Accessories available: 56295, (56262A)

Torque on nut: min. 8 cm kg
max. 17 cm kg
The mark shown applies to normal polarity types.

All information applies to frequencies up to 400 Hz

RATINGS (Limiting values) [1]

Voltages [2]			BYX25-600(R)	800(R)	1000(R)	
Continuous reverse voltage	V_R	max.	600	800	1000	V
Crest working reverse voltage	V_{RWM}	max.	600	800	1000	V

Currents				
Average forward current (averaged over any 20 ms period)	I_{FAV}	max.	20	A
Forward current (d.c.)	I_F	max.	25	A
Repetitive peak forward current	I_{FRM}	max.	440	A
Non repetitive peak forward current t = 10 ms (see also page 7)	I_{FSM}	max.	360	A

Reverse power dissipation				
Reverse power (d.c. or average over any 20 ms period)	P_R	max.	38	W
Repetitive peak reverse power (square wave) f = 50 Hz; T_j = 175 °C; t = 10 μs	P_{RRM}	max.	3.0	kW
Non repetitive peak reverse power (square wave) (see also page 6) T_j = 25 °C; t = 10 μs	P_{RSM}	max.	18	kW
T_j = 175 °C; t = 10 μs	P_{RSM}	max.	3.0	kW

Temperatures				
Storage temperature	T_{stg}		−55 to +175	°C
Junction temperature	T_j	max.	175	°C

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

[2] To ensure thermal stability: $R_{th\ j\text{-}a}$ < 2.5 °C/W (d.c.) or < 5 °C/W (a.c.)
For smaller heatsinks T_j max. should be derated. For a.c. see page 5).
For d.c.: if $R_{th\ j\text{-}a}$ = 5 °C/W, then T_j max. = 135 °C,
if $R_{th\ j\text{-}a}$ = 10 °C/W, then T_j max. = 120 °C.

THERMAL RESISTANCE

From junction to ambient in free air	$R_{th\ j-a}$	=	50	°C/W
From junction to mounting base	$R_{th\ j-mb}$	=	1.3	°C/W
From mounting base to heatsink	$R_{th\ mb-h}$	=	0.5	°C/W

CHARACTERISTICS

			BYX25-600(R)	800(R)	1000(R)	
Voltages						
Forward voltage at						
I_F = 50 A; T_j = 25 °C	V_F	<	1.8	1.8	1.8	V [1]
Reverse breakdown voltage (see also page 8)						
I_R = 5 mA; T_j = 25 °C	$V_{(BR)R}$	>	750	1000	1250	V
		<	1050	1320	1600	V
Currents						
Reverse current at T_j = 125 °C						
V_R = 600 V	I_R	<	1.0			mA
V_R = 800 V	I_R	<		0.8		mA
V_R = 1000 V	I_R	<			0.6	mA

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

OPERATING NOTES

1. Voltage sharing of series connected controlled avalanche diodes.
   If diodes with avalanche characteristics are connected in series, the usual R and C elements for voltage sharing can be omitted.
2. The top connector should not be bent; it should be soldered into the circuit so there is no strain on it.
   During soldering the heat conduction to the junction should be kept to a minimum by using a thermal shunt.

Determination of the heatsink thermal resistance.

Example:

Assume a diode, used in a three phase rectifier circuit.

frequency	f	= 50 Hz
average forward current	I_{FAV}	= 10 A (per diode)
ambient temperature	T_{amb}	= 40 °C
repetitive peak reverse power dissipation in the avalanche region	P_{RRM}	= 2 kW (per diode)
duration of P_{RRM}	t	= 40 μs

From the left hand part of the upper graph on page 5 it follows that at I_{FAV} = 10 A in a three phase rectifier circuit the average forward power + average leakage power = 19.5 W per diode (point A). The average reverse power in the avalanche region, averaged over any cycle, follows from:

$$P_{RAV} = \delta \times P_{RRM}, \text{ where the duty cycle } \delta = \frac{40\ \mu s}{20\ ms} = 0.002$$

Thus: $P_{RAV} = 0.002 \times 2\ kW = 4\ W$

Therefore the total device power dissipation $P_{tot} = (19.5 + 4)\ W = 23.5\ W$ (point B).
From the graph follows a maximum allowable mounting base temperature T_{mb} = 144 °C (point C).

However, to avoid excessive peak junction temperatures resulting from the pulse character of the repetitive peak reverse power in the avalanche region, this value of the mounting base temperature should be decreased as follows: If the repetitive peak reverse power in the avalanche region is 2 kW; t = 40 μs; f = 50 Hz, the maximum allowable junction temperature should be 163 °C instead of 175 °C (see the lower graph on page 5).
Therefore the mounting base temperature should be decreased with (175 - 163) °C = 12 °C as well.

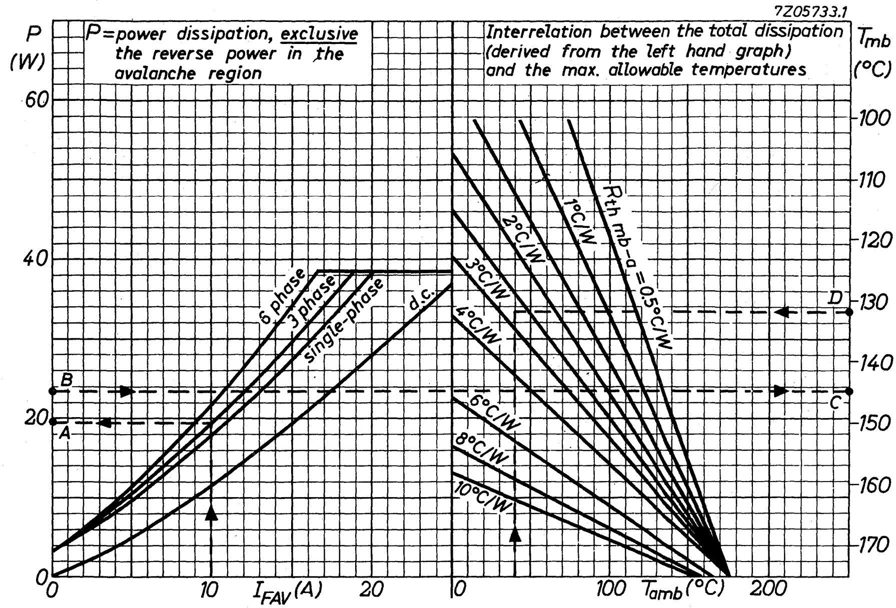
So the maximum allowable mounting base temperature is (144 - 12) °C = 132 °C (point D).
From the right hand part of the upper graph on page 5 follows the thermal resistance, required for T_{mb} = 132 °C at T_{amb} = 40 °C

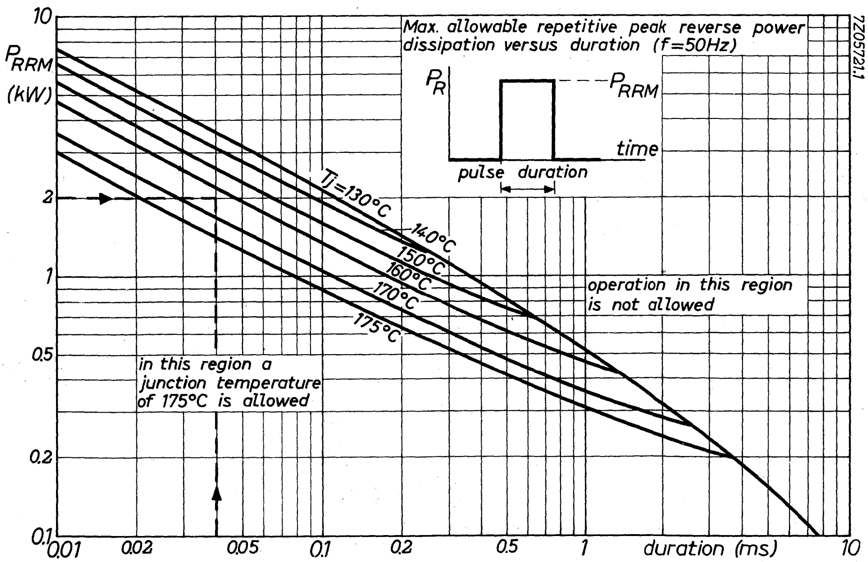
$$R_{th\ mb\text{-}a} \approx 2.8\ ^{o}C/W$$

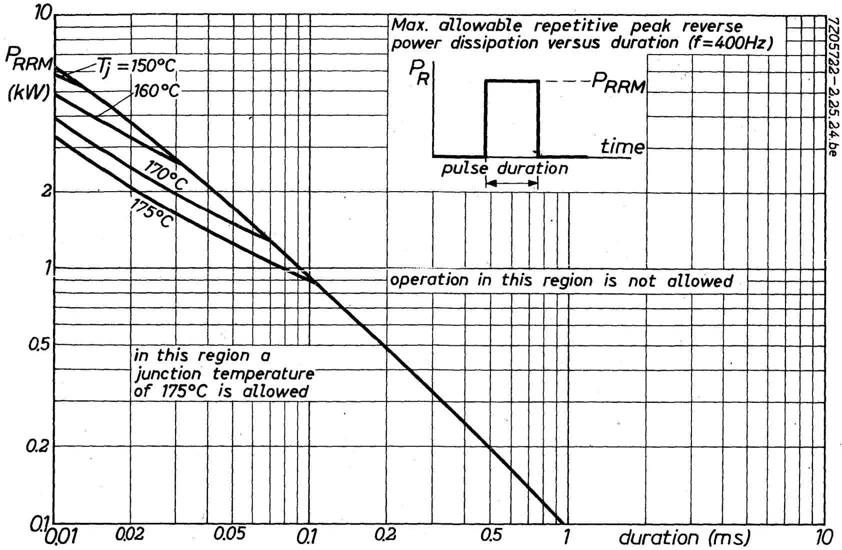
The contact thermal resistance $R_{th\ mb\text{-}h} = 0.5\ ^{o}C/W$
Hence the heatsink thermal resistance should be:

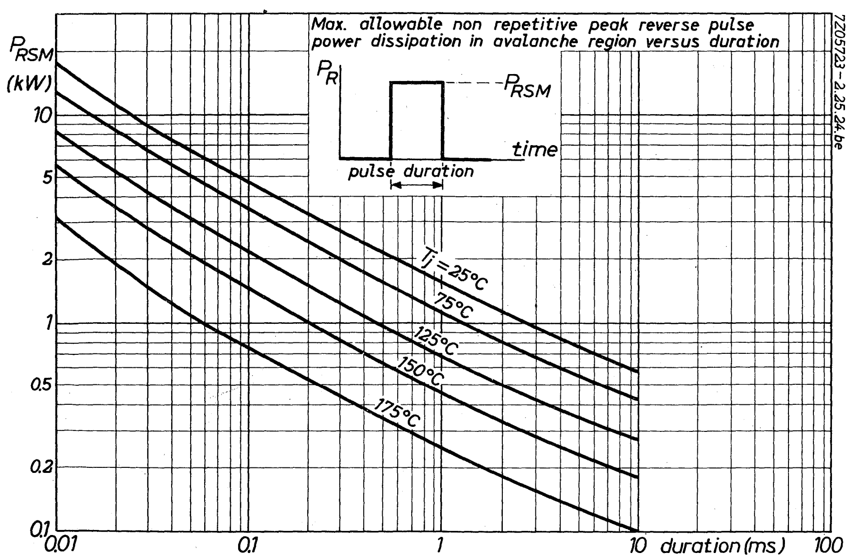
$$R_{th\ h\text{-}a} = R_{th\ mb\text{-}a} - R_{th\ mb\text{-}h} = (2.8 - 0.5)\ ^{o}C/W = 2.3\ ^{o}C/W$$

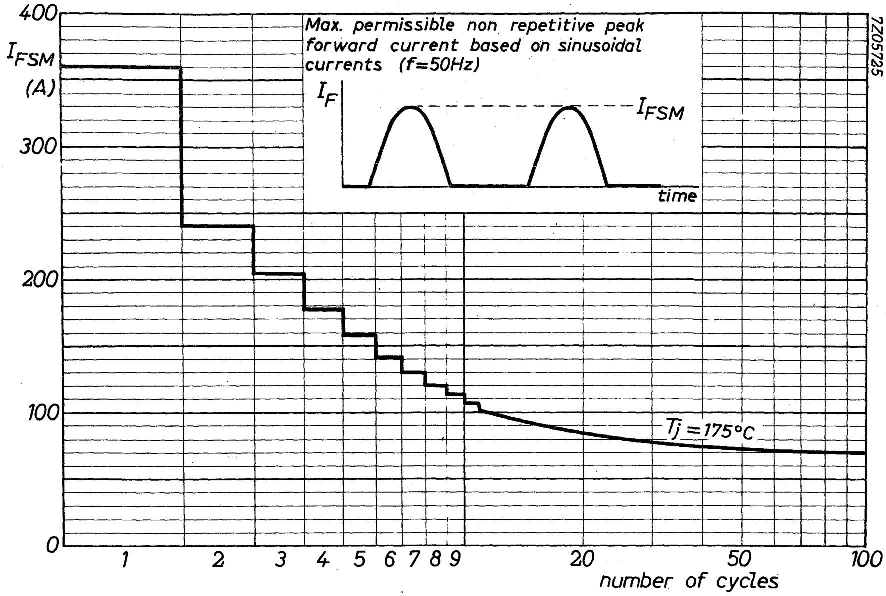
The applicable heatsink(s) may then be found in the Section ACCESSORIES and HEATSINKS.

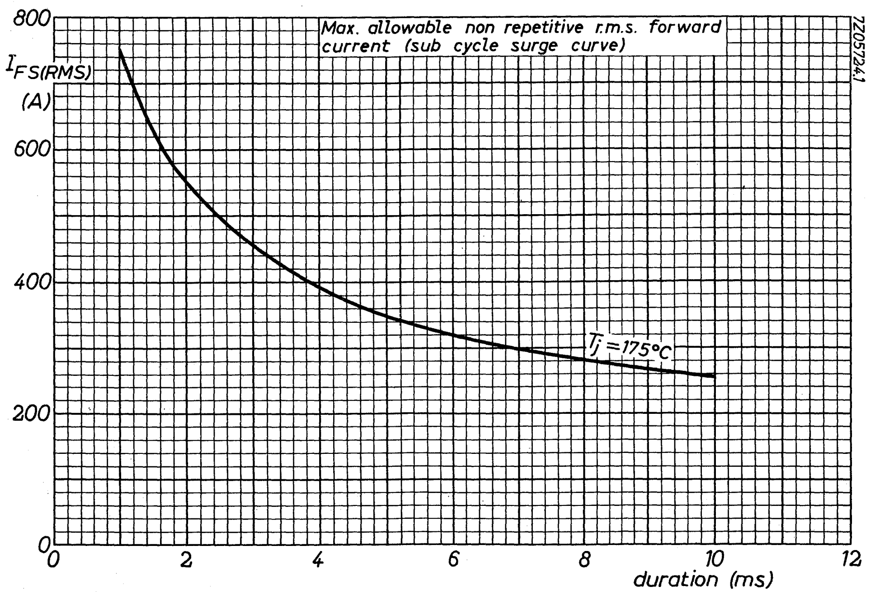

7Z05733.1
P (W)
P=power dissipation, exclusive the reverse power in the avalanche region
Interrelation between the total dissipation (derived from the left hand graph) and the max. allowable temperatures
Tmb (°C)
6 phase
3 phase
single-phase
d.c.
A
B
C
D
Rth mb-a = 0.5°C/W
1°C/W
2°C/W
3°C/W
4°C/W
6°C/W
8°C/W
10°C/W
IFAV (A)
Tamb (°C)
0
10
20
40
60
100
200
110
120
130
140
150
160
170

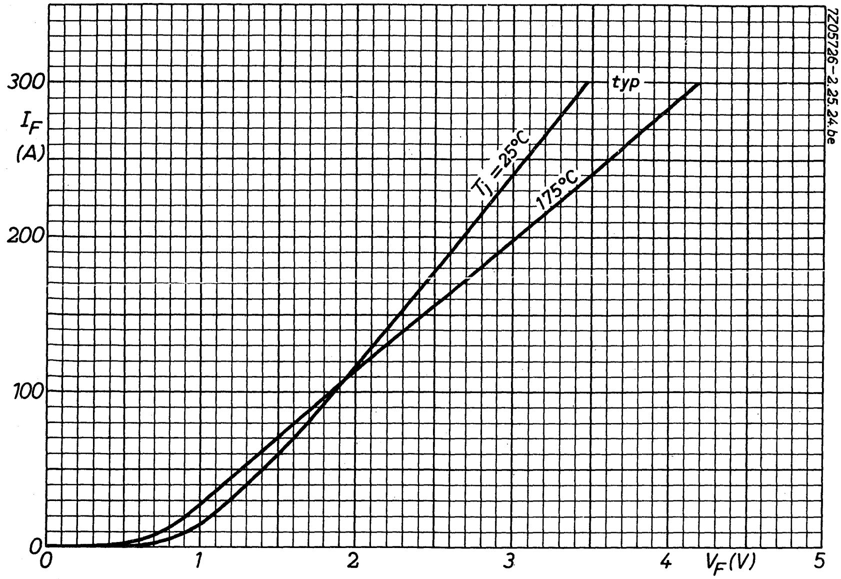

7Z05721.1
PRRM (kW)
Max. allowable repetitive peak reverse power dissipation versus duration (f=50Hz)
PR
PRRM
time
pulse duration
Tj=130°C
140°C
150°C
160°C
170°C
175°C
operation in this region is not allowed
in this region a junction temperature of 175°C is allowed
duration (ms)
10
2
1
0.5
0.2
0.1
0.01
0.02
0.05
0.1
0.2
0.5
1
10

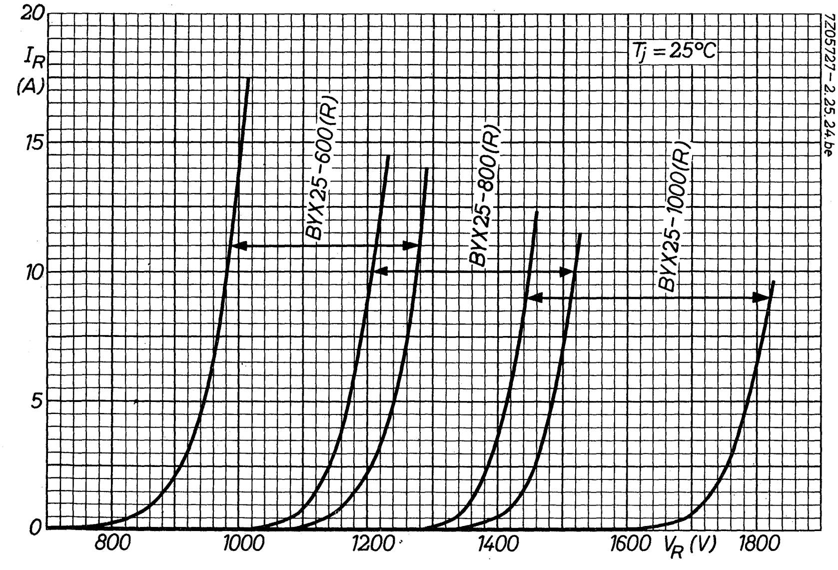

Max. allowable repetitive peak reverse power dissipation versus duration (f=400Hz)
P_{RRM} (kW)
T_j = 150°C
160°C
170°C
175°C
P_R
P_{RRM}
time
pulse duration
operation in this region is not allowed
in this region a junction temperature of 175°C is allowed
duration (ms)
10
2
1
0.5
0.2
0.1
0.01
0.02
0.05
0.1
0.2
0.5
1
10
7Z05722 - 2.25.24.be


Max. allowable non repetitive peak reverse pulse power dissipation in avalanche region versus duration
P_{RSM} (kW)
P_R
P_{RSM}
time
pulse duration
T_j = 25°C
75°C
125°C
150°C
175°C
duration (ms)
10
5
2
1
0.5
0.2
0.1
0.01
0.1
1
10
100
7Z05723 - 2.25.24.be


400
I_{FSM}
(A)
300
200
100
0
Max. permissible non repetitive peak forward current based on sinusoidal currents (f=50Hz)
I_F
I_{FSM}
time
7Z05725
T_j =175°C
1
2
3
4
5
6
7
8
9
20
50
100
number of cycles


800
$I_{FS(RMS)}$
(A)
600
400
200
0
Max. allowable non repetitive r.m.s. forward current (sub cycle surge curve)
7Z05724.1
T_j =175°C
0
2
4
6
8
10
12
duration (ms)





APPLICATION INFORMATION

See general pages at the beginning of this section

CONTROLLED AVALANCHE RECTIFIER DIODES

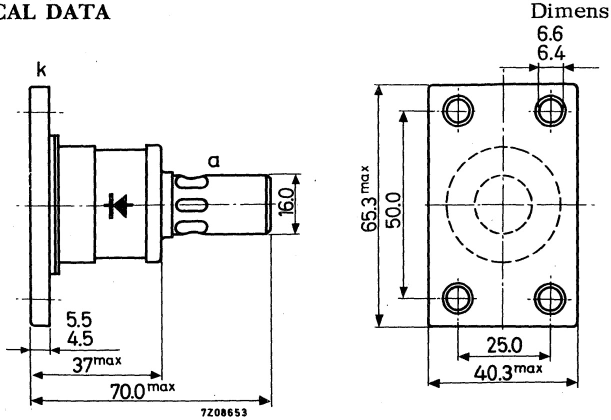
Diffused silicon diodes in metal envelopes with ceramic insulation, capable of absorbing transients and intended for power rectifier application.
The series consists of the following types: BYX27-400, BYX27-600, BYX27-800 and BYX27-1000.

QUICK REFERENCE DATA

			BYX27- 400	600	800	1000	
Crest working reverse voltage	V_{RWM}	max.	400	600	800	1000	V
Average forward current	I_{FAV}	max.	250				A
Non repetitive peak forward current t = 10 ms	I_{FSM}	max.	4000				A
Repetitive peak reverse power t = 10 μs; T_j = 190 °C	P_{RRM}	max.	20				kW
Non repetitive peak reverse power t = 10 μs; T_j = 25 °C	P_{RSM}	max.	80				kW
Junction temperature	T_j	max.	190				°C
Thermal resistance from junction to mounting base	$R_{th\,j\text{-}mb}$	=	0.2				°C/W

MECHANICAL DATA

Dimensions in mm



Net weight ≈ 230 g
Accessories and mounting instructions: see page 3.

RATINGS (Limiting values) [1]

Voltages [2]		BYX27-	400	600	800	1000	
Continuous reverse voltage	V_R	max.	400	600	800	1000	V
Crest working reverse voltage	V_{RWM}	max.	400	600	800	1000	V

Currents

Average forward current (averaged over any 20 ms period)	I_{FAV}	max.	250	A
Forward current (d.c.)	I_F	max.	325	A
Repetitive peak forward current	I_{FRM}	max.	1250	A
Non repetitive peak forward current t = 10 ms (See page 6)	I_{FSM}	max.	4000	A

Reverse power dissipation

Average reverse power at T_j = 190 °C (averaged over any 20 ms period)	P_{RAV}	max.	80	W
Repetitive peak reverse power; t = 10 μs (square wave; f = 50 Hz) T_j = 190 °C	P_{RRM}	max.	20	kW
Non repetitive peak reverse power t = 10 μs; T_j = 25 °C (See page 6)	P_{RSM}	max.	80	kW
Non repetitive peak reverse power t = 10 μs; T_j = 190 °C (See page 6)	P_{RSM}	max.	40	kW

Temperatures

Storage temperature	T_{stg}		-55 to +200	°C
Junction temperature	T_j	max.	190	°C

THERMAL RESISTANCE

From junction to mounting base	$R_{th\,j\text{-}mb}$	=	0.2	°C/W
From mounting base to heatsink without heatsink compound	$R_{th\,mb\text{-}h}$	=	0.07	°C/W
From mounting base to heatsink with heatsink compound (Dow corning 340)	$R_{th\,mb\text{-}h}$	=	0.03	°C/W

---

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

[2]) These ratings apply at $R_{th\,j\text{-}a} \leqq 0.7$ °C/W (d.c.) or $\leqq 1.3$ °C/W (a.c.).

CHARACTERISTICS

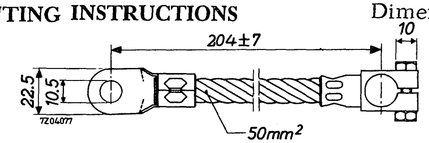
Forward voltage at I_F = 1250 A; T_j = 190 °C	V_F	<	1.8	V
Reverse breakdown voltage				
I_R = 25 mA; T_j = 25 °C				
BYX27-400	$V_{(BR)R}$	500 to 800		V
BYX27-600	$V_{(BR)R}$	750 to 1050		V
BYX27-800	$V_{(BR)R}$	1000 to 1320		V
BYX27-1000	$V_{(BR)R}$	1250 to 1600		V
(See also reverse characteristics on page 9)				
Reverse current at T_j = 175 °C				
BYX27-400 : V_R = 400 V	I_R	<	50	mA
BYX27-600 : V_R = 600 V	I_R	<	42	mA
BYX27-800 : V_R = 800 V	I_R	<	32	mA
BYX27-1000: V_R = 1000 V	I_R	<	25	mA

ACCESSORIES AND MOUNTING INSTRUCTIONS

Dimensions in mm

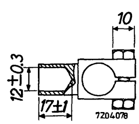
Flexible top lead

Type number 56243
Weight ≈ 170 g



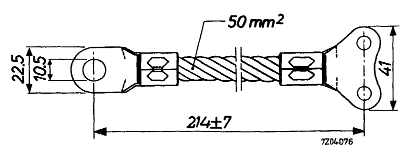
Clamp

Type number 56244
Weight ≈ 70 g



Flexible base lead

Type number 56247
Weight ≈ 135 g



1. These accessories are available on request.
2. For mounting of the flexible top lead it is recommended to use two spanners to avoid damage.
   Torque on nut: min. 30 cm kg; max. 60 cm kg.
3. For mounting the diode on a heatsink use steel bolts.
   Min. torque for good thermal and electrical contact : 30 cm kg
   Max. torque : 60 cm kg

OPERATING NOTES

1. Voltage sharing of series connected controlled avalanche diodes.

   When diodes with avalanche characteristics are connected in series, the usual R and C elements for voltage sharing can be omitted.

2. Switching transients for controlled avalanche diodes.

   In an unloaded rectifier circuit, when the transformer is switched off, energy is released.
   When, as a result, no diode rating is exceeded, special provisions are not needed. If, however, the rated non repetitive peak power dissipation per device could be exceeded, damping across the transformer is necessary in order to protect the device.

   The duration of the transformer's energy release can be found in first approximation from the empirical formula:

$$t = \frac{V_{RWM}}{V_{(BR)R\,min}}\text{; (milliseconds)}$$

where V_{RWM} = actually applied crest working voltage

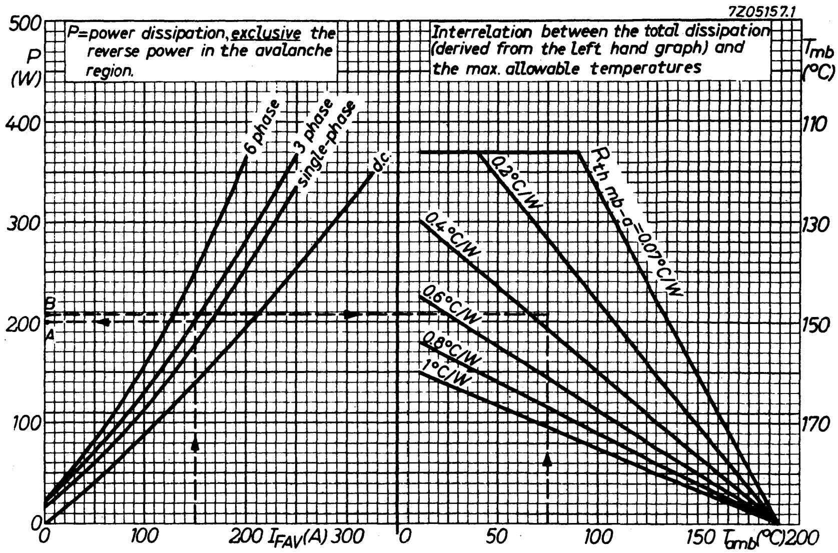
$V_{(BR)R\,min}$ = minimum reverse breakdown voltage

The non repetitive peak power that can be absorbed by a single device during t ms can be derived from the graph on page 6. Multiplying that amount with the time in which it is released results in the energy absorbed by one diode. (E_D).
A series string of n diodes can absorb n times as much. ($n.E_D$)

The difference between the energy released by the transformer and that absorbed by the n diodes should be absorbed by series connected R and C elements across the secondary winding of the transformer.
The magnitudes of R and C have to be derived from the following formulae:

$$C = \frac{E_T - n.E_D}{(n.V_{(BR)R\,min})^2}\cdot 10^6 \quad (\mu F) \qquad R = \frac{310}{C} \quad (\Omega)$$

where C = capacitance in μF
E_T = energy released by the transformer in Ws
n = number of diodes in series
E_D = energy absorbed by one diode in Ws
$V_{(BR)R\,min}$ = minimum reverse breakdown voltage of one diode in V
R = resistance in Ω



Determination of the heatsink thermal resistance.

Example:

Assume a diode, used in a three phase rectifier circuit.

frequency	f	= 50 Hz
average forward current	I_{FAV}	= 150 A (per diode)
ambient temperature	T_{amb}	= 75 °C
repetitive peak reverse power dissipation in the avalanche region	P_{RRM}	= 16 kW(per diode)
duration of P_{RRM}	t	= 10 µs

From the left hand part of the graph above it follows that at I_{FAV} = 150 A in a three phase rectifier circuit the average forward power + average leakage power = 200 W per diode (point A). The average reverse power in the avalanche region, averaged over any cycle, follows from:

$$P_{RAV} = \delta \times P_{RRM}, \text{ where the duty cycle } \delta = \frac{10\ \mu s}{20\ ms} = 0.0005$$

Thus: P_{RAV} = 0.0005 x 16 kW = 8 W

Therefore the total device power dissipation P_{tot} = (200 + 8) W = 208 W (point B).

From the right hand part of the graph above follows the thermal resistance, required for P_{tot} = 208 W at T_{amb} = 75 °C

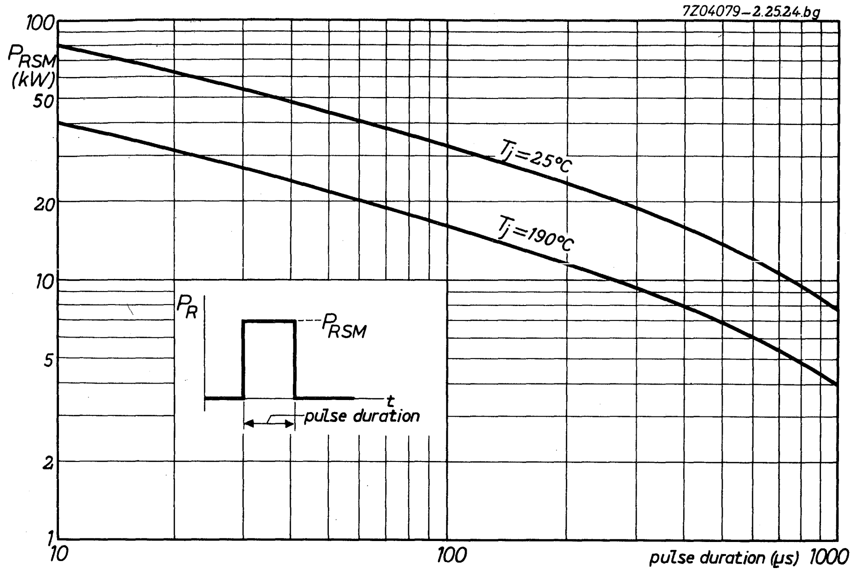
$$R_{th\ mb-a} \approx 0.35\ °C/W$$

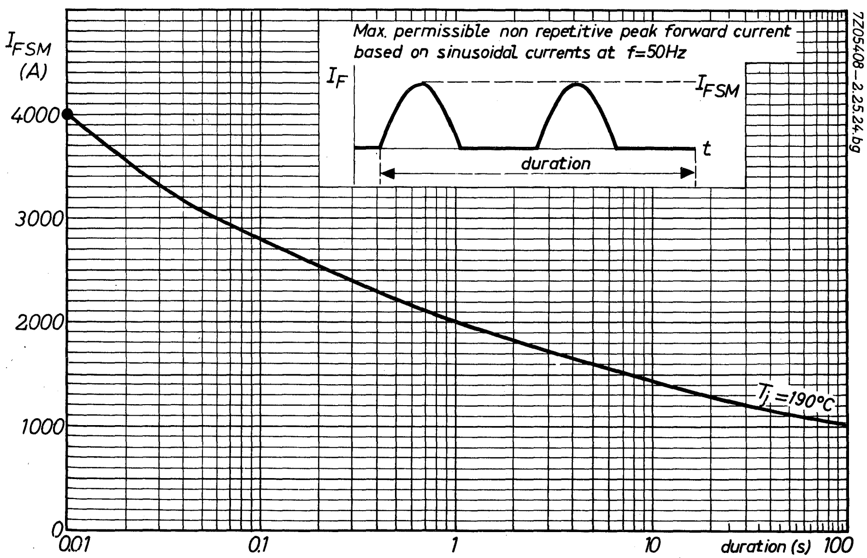
The contact thermal resistance $R_{th\ mb-h}$ = 0.07 °C/W

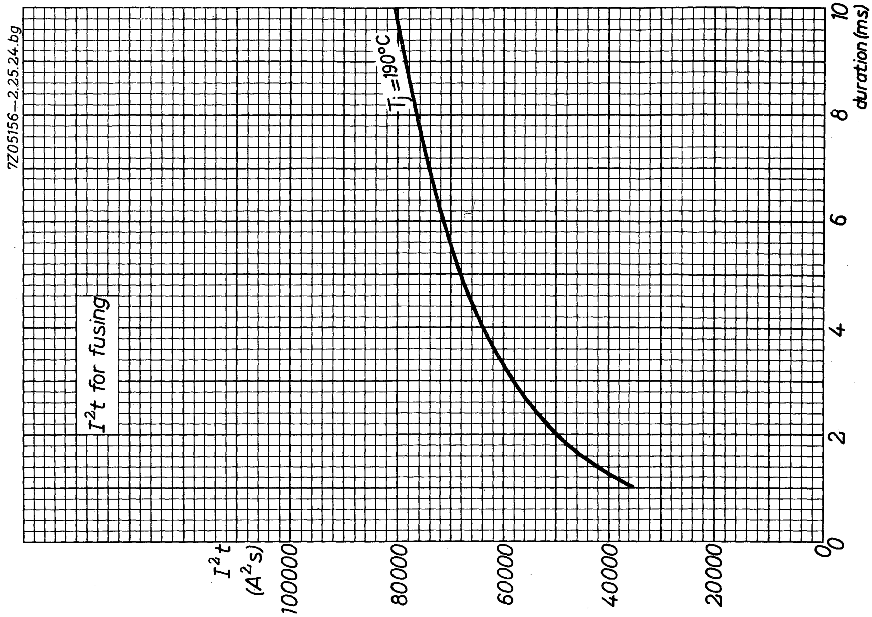
Hence the heatsink thermal resistance should be :

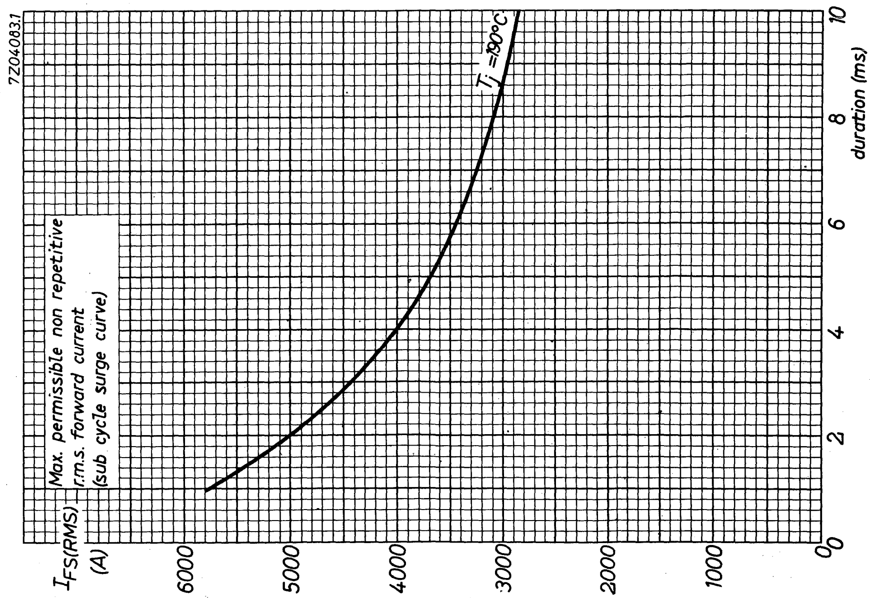
$$R_{th\ h-a} = R_{th\ mb-a} - R_{th\ mb-h} = (0.35 - 0.07)\ °C/W = 0.28\ °C/W$$

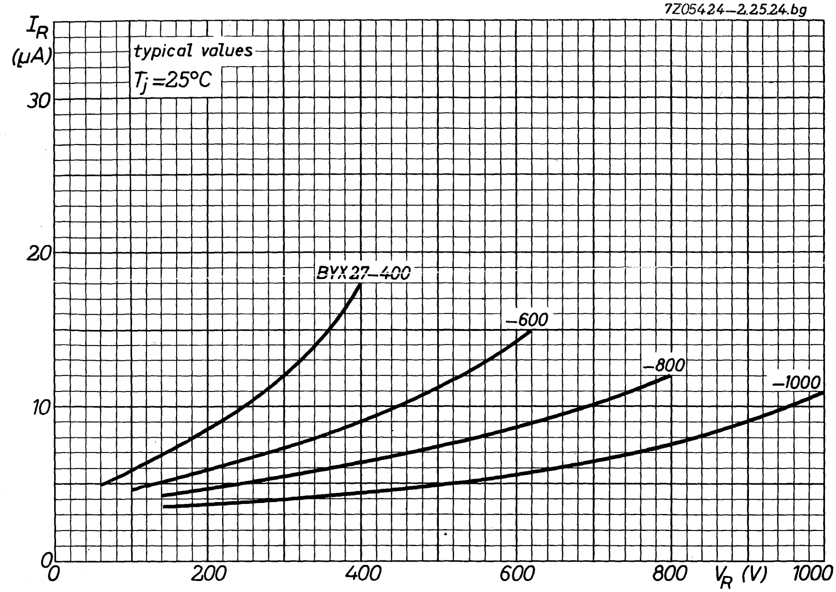
The applicable heatsink(s) may then be found in the Section ACCESSORIES and HEATSINKS.

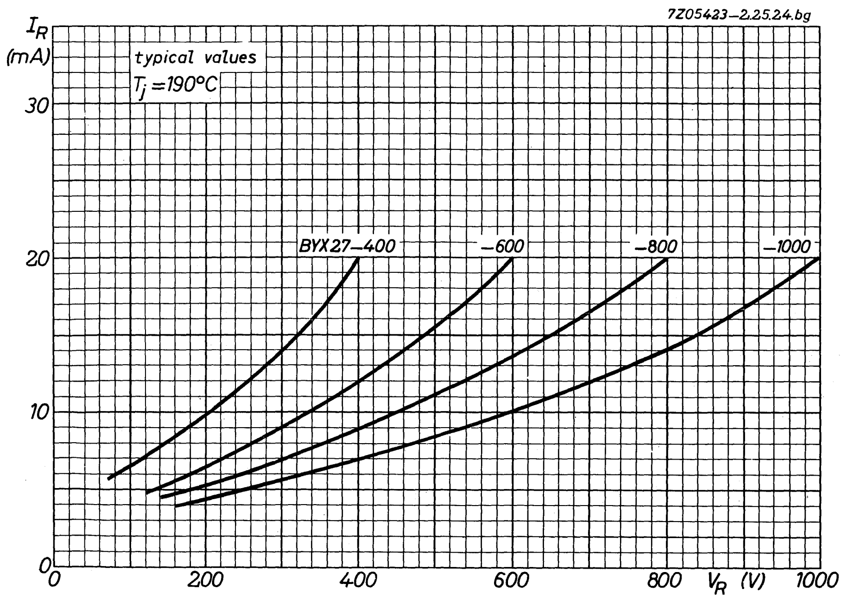

7Z04079–2.25.24.bg
100
P_{RSM}
(kW)
50
20
10
5
2
1
10
100
pulse duration (µs) 1000
T_j=25°C
T_j=190°C
P_R
P_{RSM}
t
pulse duration

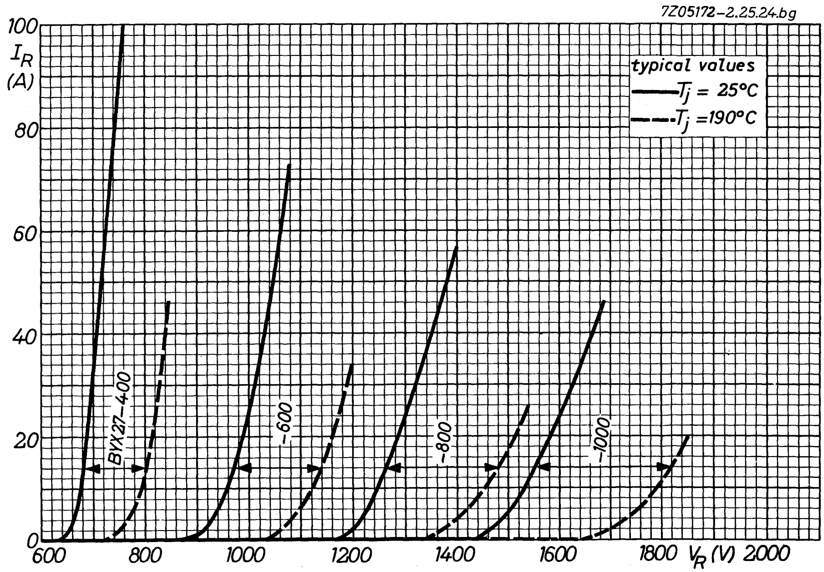

I_{FSM}
(A)
4000
3000
2000
1000
0
0.01
0.1
1
10
duration (s) 100
Max. permissible non repetitive peak forward current
based on sinusoidal currents at f=50Hz
I_F
I_{FSM}
t
duration
T_j=190°C
7Z05408–2.25.24.bg

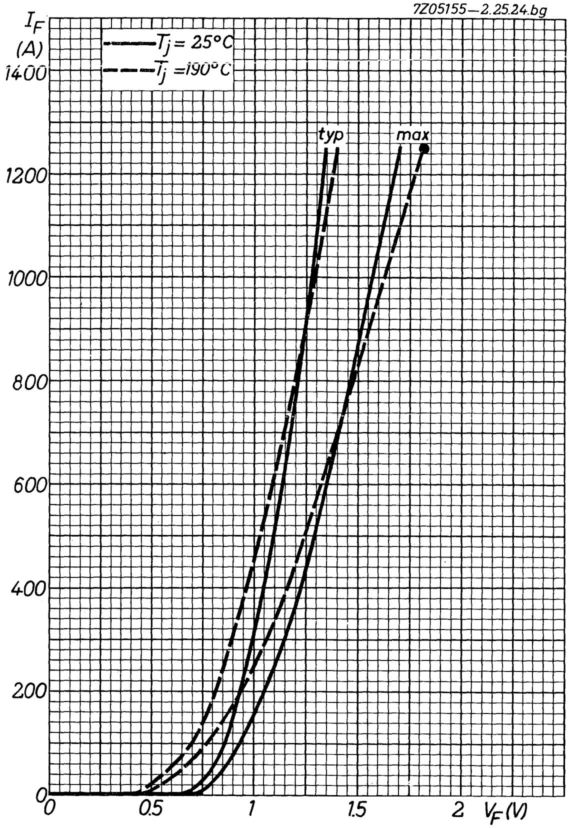

7Z05156—2.25.24.bg
I^2t for fusing
T_j=190°C
I^2t (A^2s)
100000
80000
60000
40000
20000
0
0
2
4
6
8
10
duration (ms)


7Z04083.1
Max. permissible non repetitive
r.m.s. forward current
(sub cycle surge curve)
T_j =190°C
$I_{FS(RMS)}$
(A)
6000
5000
4000
3000
2000
1000
0
0
2
4
6
8
10
duration (ms)


7Z05424–2.25.24.bg
I_R (μA)
typical values
T_j = 25°C
BYX27–400
–600
–800
–1000
0
10
20
30
0
200
400
600
800
V_R (V)
1000


7Z05423–2.25.24.bg
I_R (mA)
typical values
T_j = 190°C
BYX27–400
–600
–800
–1000
0
10
20
30
0
200
400
600
800
V_R (V)
1000


7Z05172-2.25.24.bg
100
I_R
(A)
80
60
40
20
0
600
800
1000
1200
1400
1600
1800
V_R (V)
2000
typical values
T_j = 25°C
T_j =190°C
BYX27-400
-600
-800
-1000



APPLICATION INFORMATION

See general pages at the beginning of this section

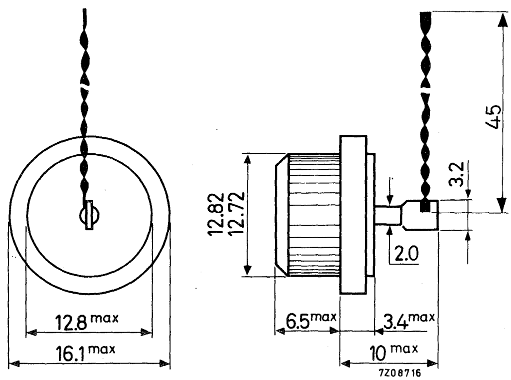
SILICON RECTIFIER DIODES

Silicon diodes in a metal envelope for rectifier applications.
The diodes can be press-mounted, soldered at the bottom or mounted with an adaptor.
The series consists of the following types:
Normal polarity (stud cathode): BYX28-200 and BYX28-400.
Reverse polarity (stud anode) : BYX28-200R and BYX28-400R.

QUICK REFERENCE DATA

			BYX28-200(R)	400(R)	
Crest working reverse voltage	V_{RWM}	max.	100	200	V
Average forward current	I_{FAV}	max.	25		A
Non repetitive peak forward current t = 10 ms	I_{FSM}	max.	300		A
Junction temperature	T_j	max.	175		^oC
Thermal resistance from junction to case	$R_{th\ j-c}$	=	1.5		$^oC/W$

MECHANICAL DATA Dimensions in mm



Marked in red : Cathode connected to case BYX28-200 and BYX28-400
Marked in blue: Anode connected to case BYX28-200R and BYX28-400R
For mounting instructions see pages 3 and 4
Force to seat the diode for good heat transfer: 350 kg
Maximum force : 900 kg
Not delivered with the device: Mounting adaptor 56232

All information applies to frequencies up to 1000 Hz

RATINGS (Limiting values) [1]

Voltages			BYX28-200(R)	400(R)	
Continuous reverse voltage	V_R	max.	90	180	V
Crest working reverse voltage	V_{RWM}	max.	100	200	V
Repetitive peak reverse voltage	V_{RRM}	max.	200	400	V
Non repetitive peak reverse voltage ($t < 10$ ms)	V_{RSM}	max.	200	400	V

Currents

Forward current (d.c.)	I_F	max.	25	A
Average forward current (averaged over any 20 ms period)	I_{FAV}	max.	25	A
Repetitive peak forward current	I_{FRM}	max.	80	A
Non repetitive peak forward current $t = 10$ ms; see page 6	I_{FSM}	max.	300	A

Temperatures

Storage temperature	T_{stg}		-65 to +175	^oC
Junction temperature	T_j	max.	175	^oC

THERMAL RESISTANCE

From junction to case	$R_{th\ j-c}$	=	1.5	$^oC/W$
From case to heatsink				
press mounted	$R_{th\ c-h}$	=	0.5	$^oC/W$
soldered	$R_{th\ c-h}$	=	0.2	$^oC/W$
mounted with adaptor 56232	$R_{th\ c-h}$	=	1.1	$^oC/W$

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

Forward voltage at $I_F = 80$ A	V_F	<	1.45	V [2]
Reverse current at $T_j = 125\ ^oC$				
$V_R = 90$ V; BYX28-200(R)	I_R	<	3.0	mA
$V_R = 180$ V; BYX28-400(R)	I_R	<	1.5	mA

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

[2] Measured under pulsed conditions to prevent excessive dissipation.

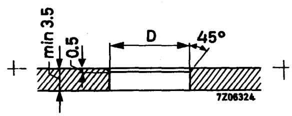
MOUNTING INSTRUCTIONS

Dimensions in mm

PRESS MOUNTING

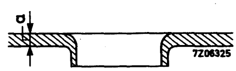
A. Flat heatsink without raised border

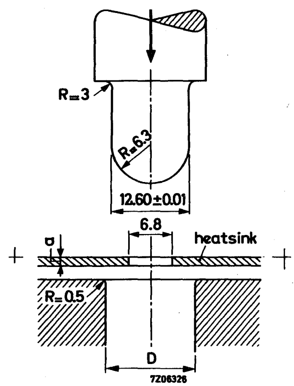
Diameter of hole in heatsink: from 12.61 to 12.66 mm
(Diameter required depends on hardness of heatsink material)
Thermal resistance from case to heatsink: $R_{th\ c\text{-}h} = 0.5\ ^{\circ}C/W$



B. Flat heatsink with raised border (Copper or aluminium)

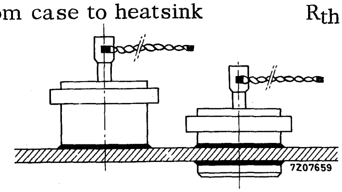
a (mm)	D (mm)	$R_{th\ c\text{-}h}$ (°C/W)
3.00	17.50 ± 0.03	0.25
2.00	15.50 ± 0.03	0.35
1.50	14.50 ± 0.03	0.45





MOUNTING BY SOLDERING

Soldering temperature	T	max.	235	°C
Soldering time	t	max.	30	s
Thermal resistance from case to heatsink	$R_{th\ c\text{-}h}$	=	0.2	°C/W



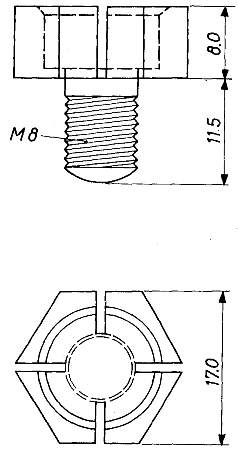
MOUNTING INSTRUCTIONS (continued)

Dimensions in mm

Mounting adaptor 56232

Type 56232 consists of a body, a spring washer and a nut.

Thermal resistance from case to heatsink: $R_{th\ c\text{-}h}$ = 1.1 °C/W



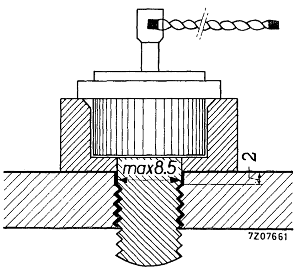
Mounting method 1

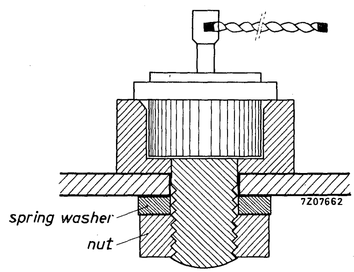
Torque on nut: min. 80 cm kg
max. 130 cm kg

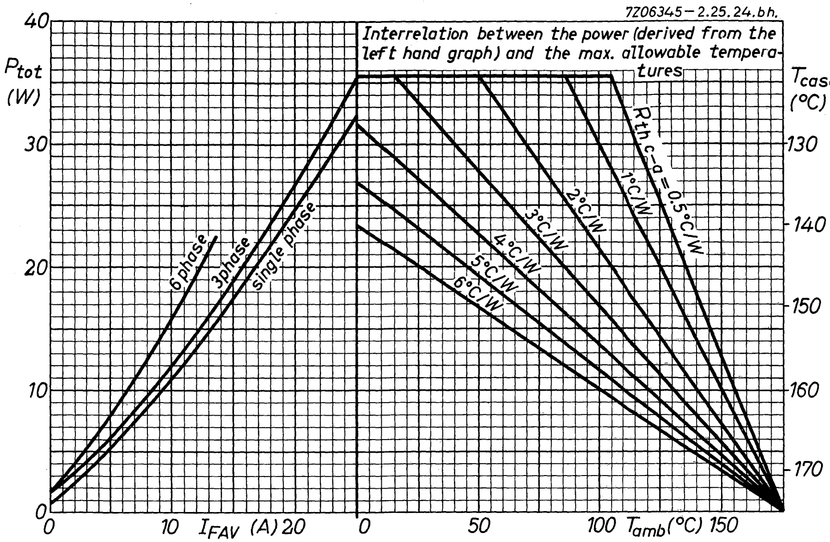
Mounting method 2

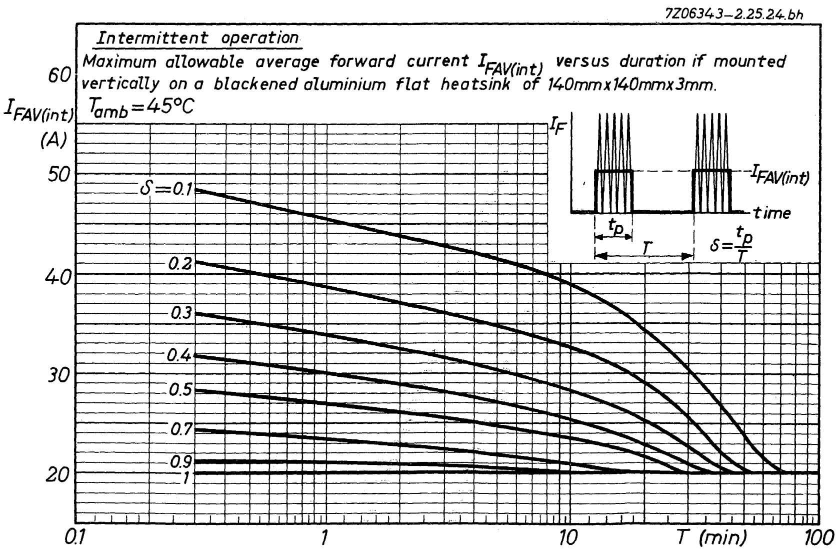
Diameter of hole in heatsink: max. 8.5 mm

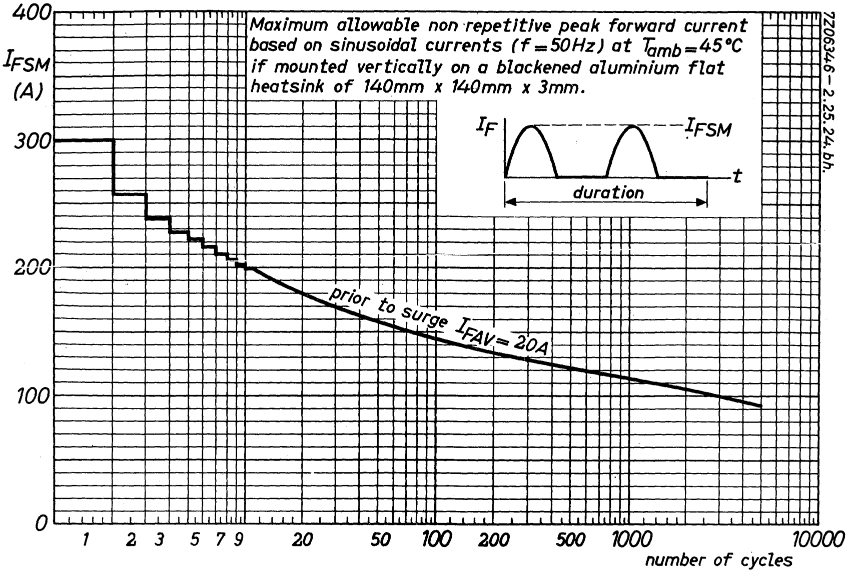
Torque on nut : min. 60 cm kg
max. 100 cm kg

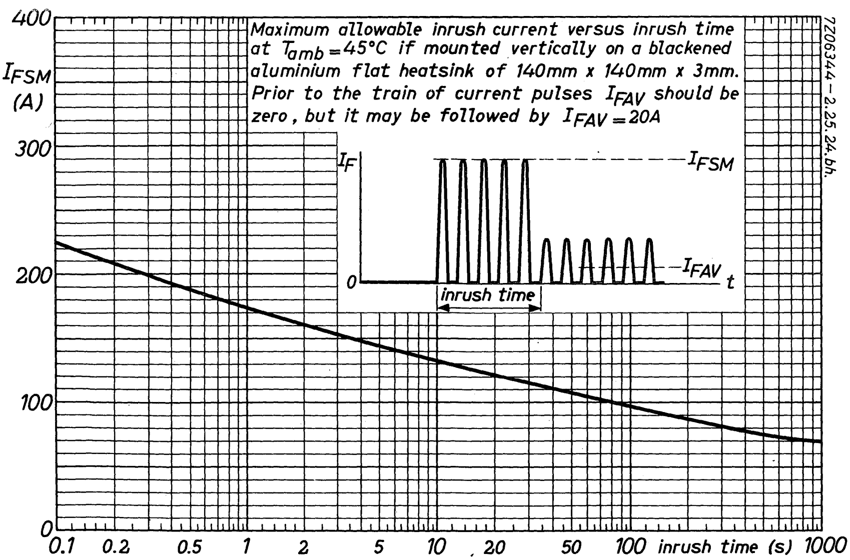


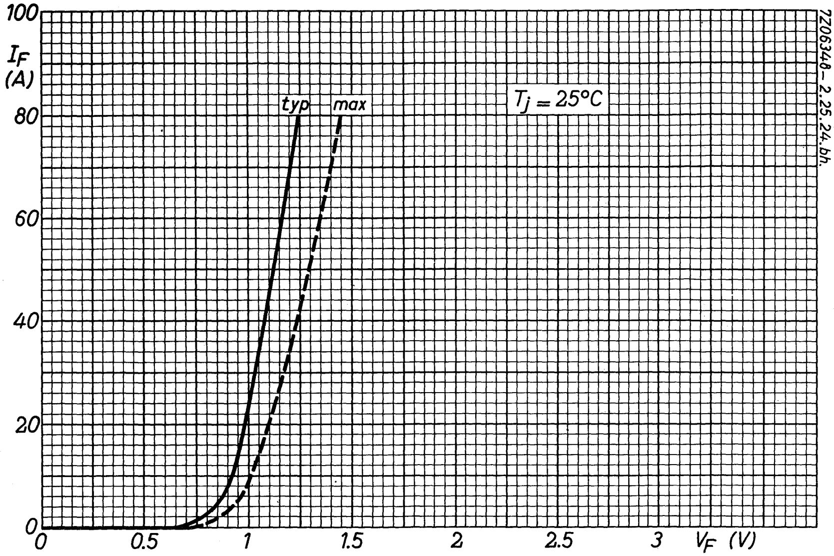


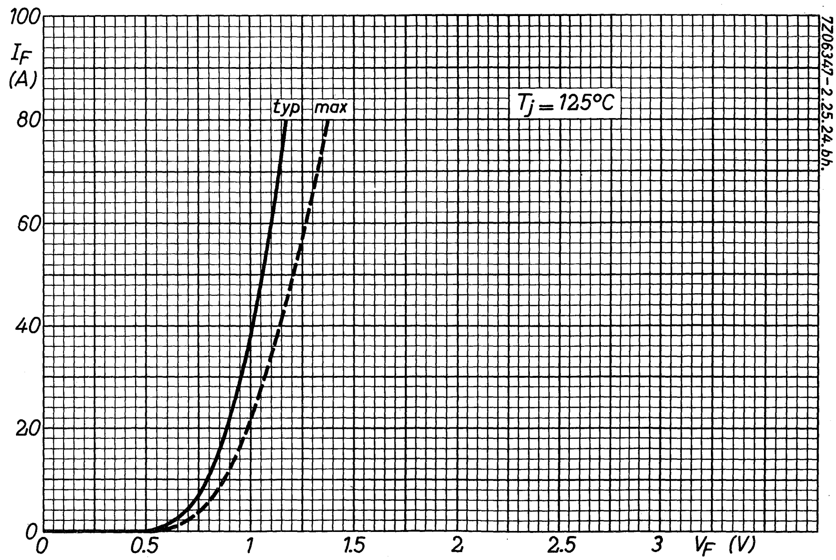

7Z06345–2.25.24.bh.
Interrelation between the power (derived from the left hand graph) and the max. allowable temperatures
P_{tot} (W)
T_{case} (°C)
40
30
20
10
0
130
140
150
160
170
6 phase
3phase
single phase
Rth c–a = 0.5°C/W
1°C/W
2°C/W
3°C/W
4°C/W
5°C/W
6°C/W
0
10
I_{FAV} (A) 20
0
50
100
T_{amb} (°C) 150

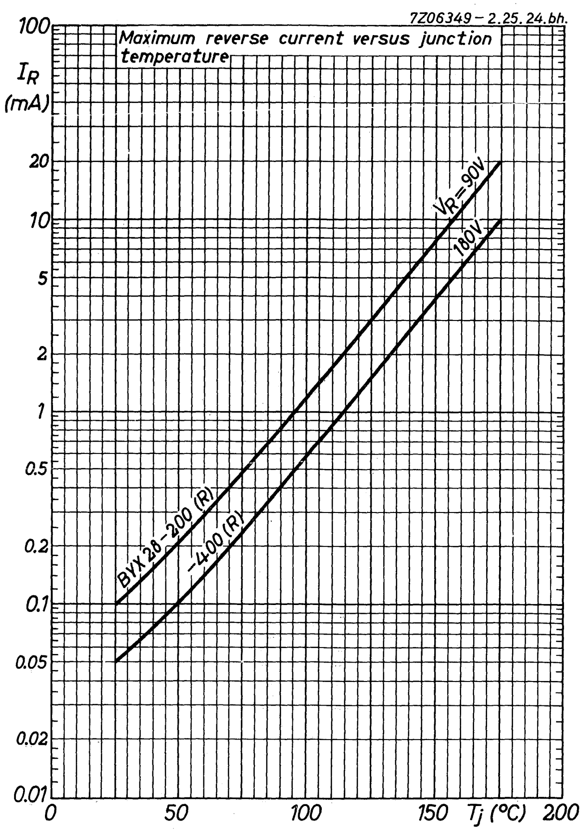

7Z06343–2.25.24.bh
Intermittent operation
Maximum allowable average forward current $I_{FAV(int)}$ versus duration if mounted vertically on a blackened aluminium flat heatsink of 140mm x 140mm x 3mm.
T_{amb} = 45°C
$I_{FAV(int)}$ (A)
60
50
40
30
20
δ = 0.1
0.2
0.3
0.4
0.5
0.7
0.9
1
I_F
$I_{FAV(int)}$
time
t_p
T
$\delta = \frac{t_p}{T}$
0.1
1
10
T (min)
100


Maximum allowable non repetitive peak forward current based on sinusoidal currents (f = 50Hz) at T_{amb} = 45°C if mounted vertically on a blackened aluminium flat heatsink of 140mm x 140mm x 3mm.
I_F
I_{FSM}
t
duration
prior to surge I_{FAV} = 20A
400
I_{FSM}
(A)
300
200
100
0
1
2
3
5
7
9
20
50
100
200
500
1000
10000
number of cycles
7Z06346 − 2.25.24.bh.


Maximum allowable inrush current versus inrush time at T_{amb} = 45°C if mounted vertically on a blackened aluminium flat heatsink of 140mm x 140mm x 3mm. Prior to the train of current pulses I_{FAV} should be zero, but it may be followed by I_{FAV} = 20A
I_F
I_{FSM}
I_{FAV}
0
t
inrush time
400
I_{FSM}
(A)
300
200
100
0
0.1
0.2
0.5
1
2
5
10
20
50
100
inrush time (s)
1000
7Z06344 − 2.25.24.bh.


100
I_F
(A)
80
60
40
20
0
typ
max
$T_j = 25°C$
0
0.5
1
1.5
2
2.5
3
V_F (V)
7Z06348-2.25.24.bh.


100
I_F
(A)
80
60
40
20
0
typ
max
$T_j = 125°C$
0
0.5
1
1.5
2
2.5
3
V_F (V)
7Z06347-2.25.24.bh.


7Z06349 – 2.25.24.bh.
Maximum reverse current versus junction temperature
I_R (mA)
100
20
10
5
2
1
0.5
0.2
0.1
0.05
0.02
0.01
0
50
100
150
T_j (°C)
200
V_R=90V
180V
BYX 28-200 (R)
-400 (R)

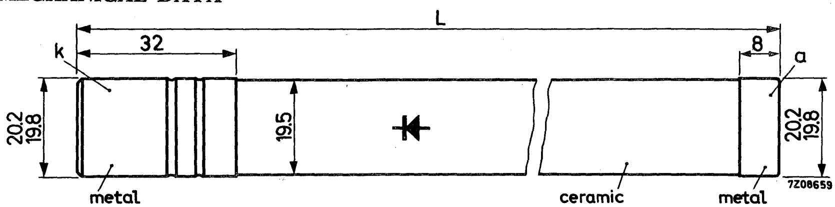
CONTROLLED AVALANCHE HIGH VOLTAGE DIODES

Silicon diodes in a ceramic envelope with metal connectors capable of absorbing transients and primarily intended for high voltage rectifier circuits in X-ray applications.
The series consists of the following types:
BYX29-75000, BYX29-100000, BYX29-125000 and BYX29-150000.

QUICK REFERENCE DATA

			BYX29-75000	100000	125000	150000	
Crest working reverse voltage	V_{RWM}	max.	75	100	125	150	kV
Average forward current	I_{FAV}	max.	50	50	50	50	mA
Non repetitive peak forward current; t = 10 ms	I_{FSM}	max.	5000	5000	5000	5000	mA
Junction temperature	T_j	max.	125	125	125	125	°C
Thermal resistance from junction to cooling oil	$R_{th\ j-o}$	=	3.2	2.7	1.6	1.6	°C/W

MECHANICAL DATA Dimensions in mm



BYX29- 75000	L : 141 to 143 mm	Weight: 135 g
BYX29-100000	L : 169 to 171 mm	Weight: 165 g
BYX29-125000	L : 229 to 231 mm	Weight: 225 g
BYX29-150000	L : 229 to 231 mm	Weight: 225 g

All information applies to frequencies up to 400 Hz

RATINGS (Limiting values) [1]

Voltages		BYX29-75000	100000	125000	150000	
Crest working reverse voltage	V_{RWM}	max. 75	100	125	150	kV

Currents

Average forward current (averaged over any 20 ms period)

continuous operation	I_{FAV}	max.	50	mA
intermittent operation ($t \leq 1$ s, once every 20 s)	I_{FAV}	max.	750	mA

Repetitive peak forward current

continuous operation	I_{FRM}	max.	250	mA
intermittent operation (at an average forward current I_{FAV} = 750 mA; $t \leq 1$ s, once every 20 s)	I_{FRM}	max.	2500	mA
Non repetitive peak forward current (t = 10 ms)	I_{FSM}	max.	5000	mA

Non repetitive peak reverse current

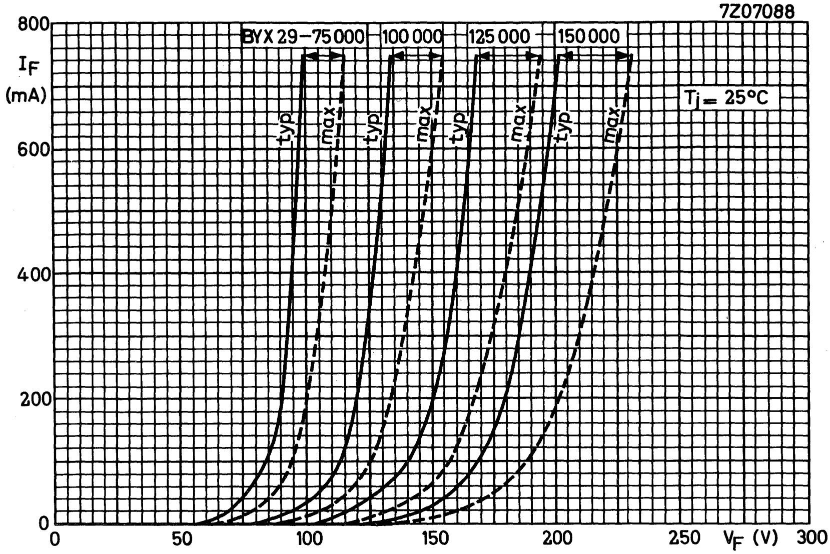
$t < 10\ \mu s$; T_j = 25 °C	I_{RSM}	max.	500	mA
T_j = 125 °C	I_{RSM}	max.	400	mA

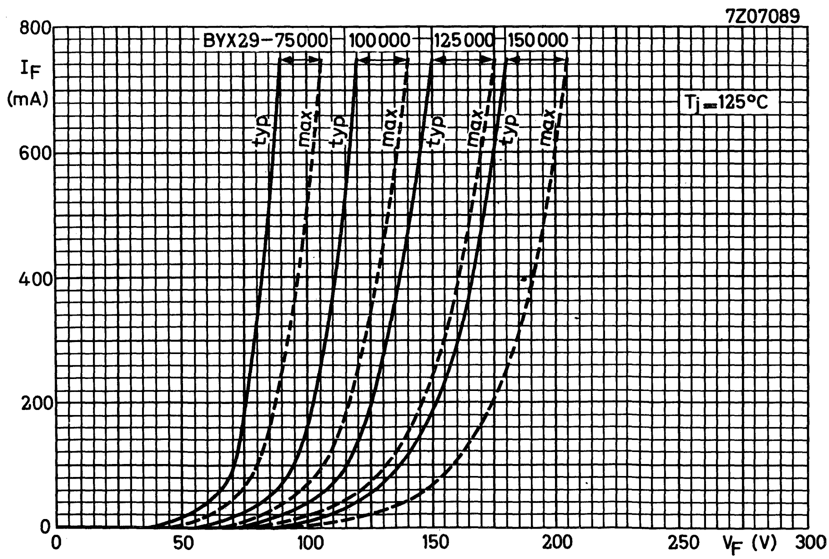
Temperatures

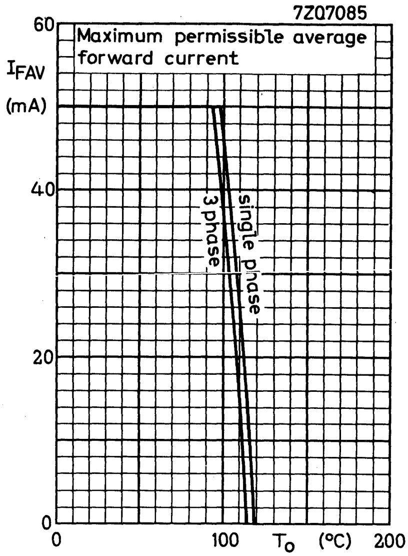
Storage temperature	T_{stg}	−30 to +125	°C
Junction temperature	T_j	max. 125	°C

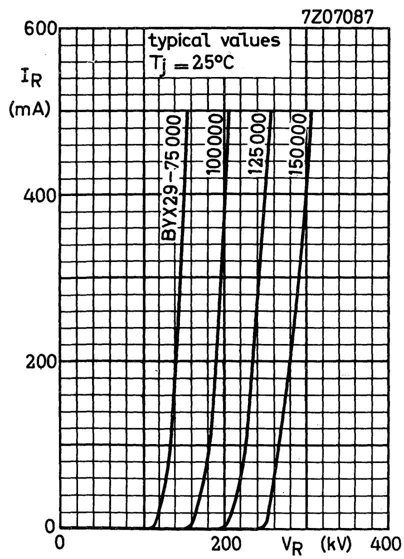
THERMAL RESISTANCE		BYX29-75000	100000	125000	150000	
From junction to cooling oil	$R_{th\ j-o}$ =	3.2	2.7	1.6	1.6	°C/W
CHARACTERISTICS						
Voltages at T_j = 25 °C						
Forward voltage at I_F = 50 mA	V_F	< 88	116	145	175	V
Reverse breakdown voltage						
I_R = 1 mA	$V_{(BR)R}$	> 100	135	165	200	kV
Currents at T_j = 125 °C						
Reverse current at $V_R = V_{RWMmax}$	I_R	< 33	33	33	33	µA

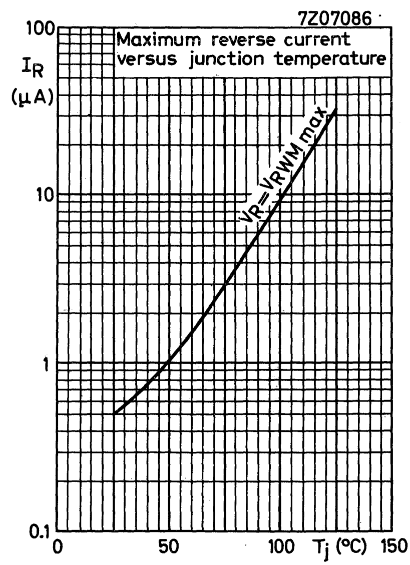
[1]) Limiting values according to the Absolute Maximum System as defined in IEC publication 134.


7Z07088
BYX 29−75000
100 000
125 000
150 000
typ
max
T_j = 25°C
I_F (mA)
800
600
400
200
0
0
50
100
150
200
250
V_F (V)
300


7Z07089
BYX29−75000
100000
125000
150000
typ
max
T_j = 125°C
I_F (mA)
800
600
400
200
0
0
50
100
150
200
250
V_F (V)
300


7Z07085
Maximum permissible average forward current
I_{FAV} (mA)
60
40
20
0
3 phase
single phase
0
100
T_o (°C)
200


7Z07087
typical values
$T_j = 25°C$
I_R (mA)
600
400
200
0
BYX29-75000
100000
125000
150000
0
200
V_R (kV)
400


7Z07086
Maximum reverse current versus junction temperature
I_R (μA)
100
10
1
0.1
$V_R = V_{RWM}$ max
0
50
100
T_j (°C)
150

HIGH SPEED RECTIFIER DIODES WITH CONTROLLED AVALANCHE

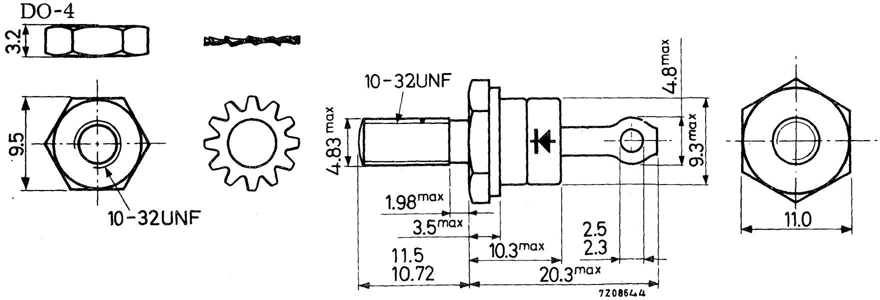
Diffused silicon diodes in a DO-4 metal envelope, capable of absorbing transients. They are primarily intended for use in high frequency power supplies, thyristor inverters and multi-phase power rectifier applications.
The series consists of the following types:
Normal polarity (stud cathode): BYX30-200 to BYX30-600.
Reverse polarity (stud anode) : BYX30-200R to BYX30-600R.

QUICK REFERENCE DATA

		BYX30-200(R)	300(R)	400(R)	500(R)	600(R)	
Crest working reverse voltage	V_{RWM}	max. 200	300	400	500	600	V
Average forward current	I_{FAV}	max. 14					A
Non repetitive peak forward current; t = 10 ms	I_{FSM}	max. 250					A
Repetitive peak reverse power t = 10 μs; T_j = 150 °C	P_{RRM}	max. 5.5					kW
Non repetitive peak reverse power; t = 10 μs; T_j = 25 °C	P_{RSM}	max. 18					kW
Junction temperature	T_j	max. 150					°C
Thermal resistance from junction to mounting base	$R_{th\ j\text{-}mb}$	= 1.3					°C/W
Recovered charge $I_F = I_R = 2$ A	Q_s	< 0.70					μC

MECHANICAL DATA Dimensions in mm

DO-4



Net weight : 5.6 g
With accessories: 7.6 g
Diameter of hole in heatsink: max. 5.2 mm
Accessories available: 56295, (56262A)

Torque on nut: min. 8 cm kg
max. 17 cm kg
The mark shown applies to normal polarity types.

All information applies to frequencies up to 50 kHz

RATINGS (Limiting values) [1]

Voltages [2]			BYX30-200(R)	300(R)	400(R)	500(R)	600(R)	
→ Continuous reverse voltage	V_R	max.	200	300	400	500	600	V
→ Crest working reverse voltage	V_{RWM}	max.	200	300	400	500	600	V

Currents				
Average forward current (averaged over any 20 ms period)	I_{FAV}	max.	14	A
Forward current (d.c.)	I_F	max.	17	A
Repetitive peak forward current	I_{FRM}	max.	310	A
Non repetitive peak forward current t = 10 ms (see also page 7)	I_{FSM}	max.	250	A
Repetitive peak reverse current (during turn-off)	I_{RRM}	max.	20	A
Reverse power dissipation				
Reverse power (d.c. or average over any 20 ms period) See also page 6	P_R	max.	30	W
Repetitive peak reverse power at f = 50 Hz square wave; t = 10 μs; T_j = 150 °C	P_{RRM}	max.	5.5	kW
Non repetitive peak reverse power (square wave) See also page 6 t = 10 μs; T_j = 25 °C	P_{RSM}	max.	18	kW
T_j = 150 °C	P_{RSM}	max.	5.5	kW
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	$R_{th\ j-a}$	=	50	°C/W
From junction to mounting base	$R_{th\ j-mb}$	=	1.3	°C/W
From mounting base to heatsink	$R_{th\ mb-h}$	=	0.5	°C/W

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

[2]) To ensure thermal stability: $R_{th\ j-a} < 2.5$ °C/W (d.c.) or < 5 °C/W (a.c.) For smaller heatsinks $T_{j\ max.}$ should be derated. For a.c. see page 5.
For d.c.: if $R_{th\ j-a}$ = 5 °C/W, then $T_{j\ max.}$ = 135 °C,
if $R_{th\ j-a}$ = 10 °C/W, then $T_{j\ max.}$ = 120 °C.

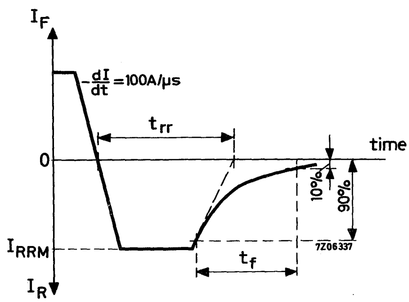
CHARACTERISTICS T_j = 25 °C unless otherwise specified

		BYX30-200(R)	300(R)	400(R)	500(R)	600(R)	
Forward voltage at I_F = 50 A [1]	V_F	< 3.2	3.2	3.2	3.2	3.2	V
Reverse breakdown voltage I_R = 5 mA; see page 8	$V_{(BR)R}$	> 250	375	500	625	750	V
		< 1050	1050	1050	1050	1050	V
Reverse current at T_j = 125 °C $V_R = V_{RWMmax}$.	I_R	< 4.0	4.0	4.0	4.0	4.0	mA

Recovered charge when switched from I_F = 2 A to V_R = 30 V; I_R limited to I_{RRM} = 2 A; $-\frac{dI}{dt}$ = 100 A/μs — Q_s < 0.70 μC

Reverse recovery time when switched from I_F = 2 A to V_R = 30 V; I_R limited to I_{RRM} = 2 A; $-\frac{dI}{dt}$ = 100 A/μs — t_{rr} < 0.35 μs

Fall time under all conditions — t_f < 0.30 μs



OPERATING NOTES FOR REPETITIVE CONDITIONS

1. Square wave operation
When I_F has been flowing sufficiently long for the steady state to be established, there will be a charge due to minority carriers present. Before the device can block in the reverse direction this charge must be extracted. This extraction takes the form of a reverse transient (see figure above). The majority of the power dissipation due to the reverse transient occurs during t_f as the rectifier gradually becomes reverse biased, and the mean power will be proportional to the operating frequency. The mean value of this power loss can be derived from the graphs on page 10.

p.t.o.

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

OPERATING NOTES FOR REPETITIVE CONDITIONS (continued)

2. Sine wave operation
   Power loss in sine wave operation will be considerably less owing to the much slower rate of change of the applied voltage (and consequently lower values of I_{RRM}), so that power loss due to reverse recovery may be safely ignored for frequencies up to 50 kHz.

Determination of the heatsink thermal resistance.

Example:
Assume a diode, used in a single phase rectifier circuit.

frequency	f	=	50	Hz
average forward current	I_{FAV}	=	6	A (per diode)
ambient temperature	T_{amb}	=	40	^oC
repetitive peak reverse power dissipation in the avalanche region	P_{RRM}	=	3	kW (per diode)
duration of P_{RRM}	t	=	40	μs

From the left hand part of the upper graph on page 5 it follows that at I_{FAV} = 6 A in a single-phase rectifier circuit the average forward power + average leakage power = 15 W per diode (point A). The average reverse power in the avalanche region, averaged over any cycle, follows from:

$$P_{RAV} = \delta \times P_{RRM}, \text{ where the duty cycle } \delta = \frac{40\ \mu s}{20\ ms} = 0.002$$

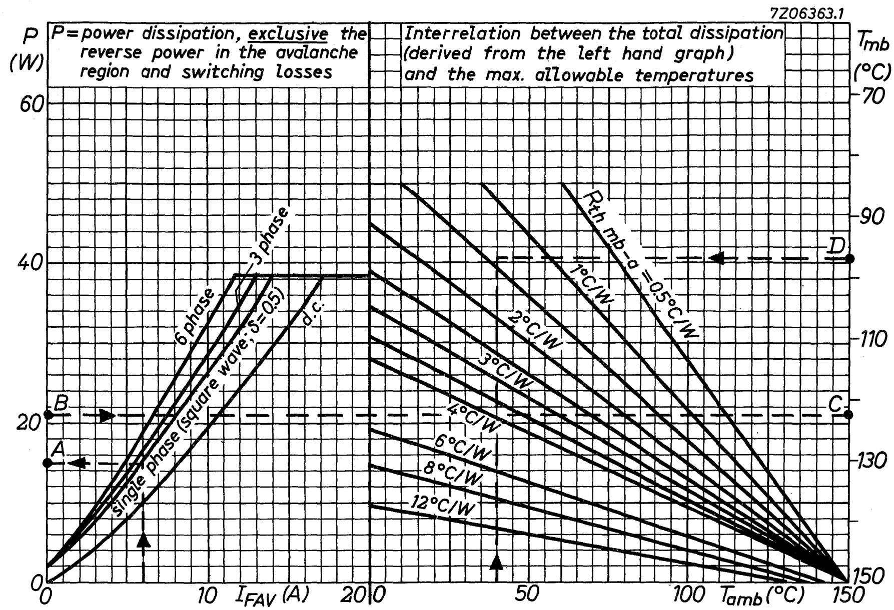
Thus: P_{RAV} = 0.002 x 3 kW = 6 W. According to operating note 2 the power losses due to reverse recovery may be neglected.
Therefore the total device power dissipation P_{tot} = (15+6) W = 21 W (point B). From the graph follows a maximum allowable mounting base temperature T_{mb} = 123 ^oC (point C).
However, to avoid excessive peak junction temperatures resulting from the pulse character of the repetitive peak reverse power in the avalanche region, this value of the mounting base temperature should be decreased as follows: If the repetitive peak reverse power in the avalanche region is 3 kW; t = 40 μs; f = 50 Hz, the maximum allowable junction temperature should be 124 ^oC instead of 150 ^oC (see the lower graph on page 5).
Therefore the mounting base temperature should be decreased with (150-124) ^oC = 26 ^oC as well.
So the maximum allowable mounting base temperature is (123-26) ^oC = 97 ^oC (point D).
From the right hand part of the upper graph on page 5 follows the thermal resistance, required for T_{mb} = 97 ^oC at T_{amb} = 40 ^oC.

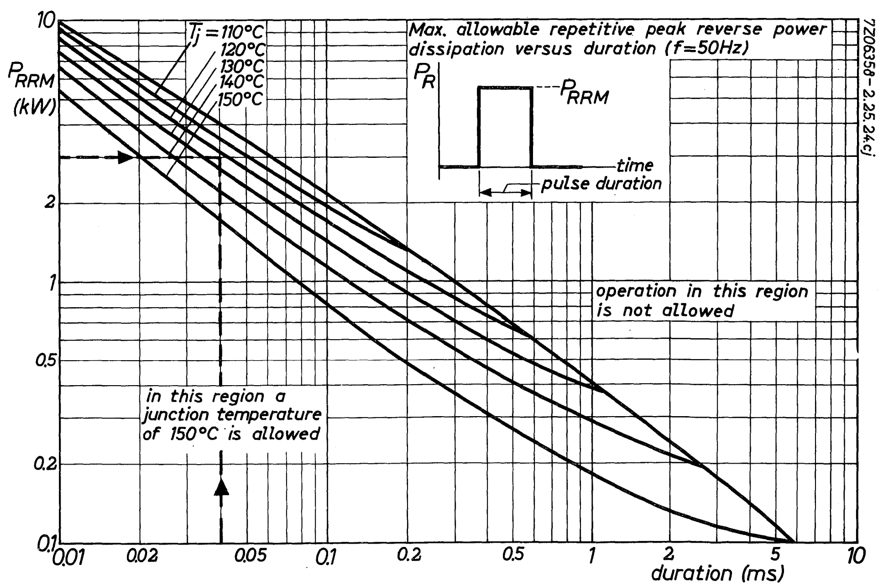
$$R_{th\ mb\text{-}a} \approx 1.4\ ^oC/W$$

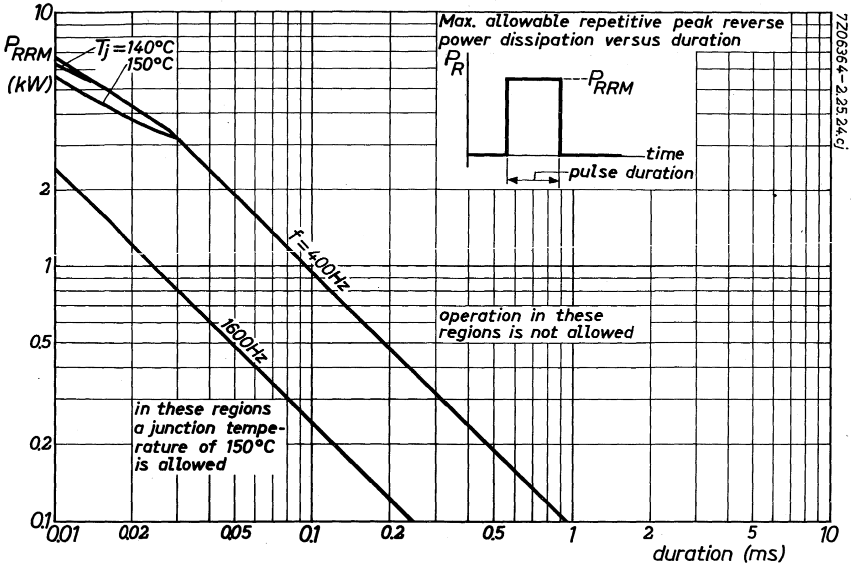
The contact thermal resistance $R_{th\ mb\text{-}h}$ = 0.5 $^oC/W$.
Hence the heatsink thermal resistance should be:

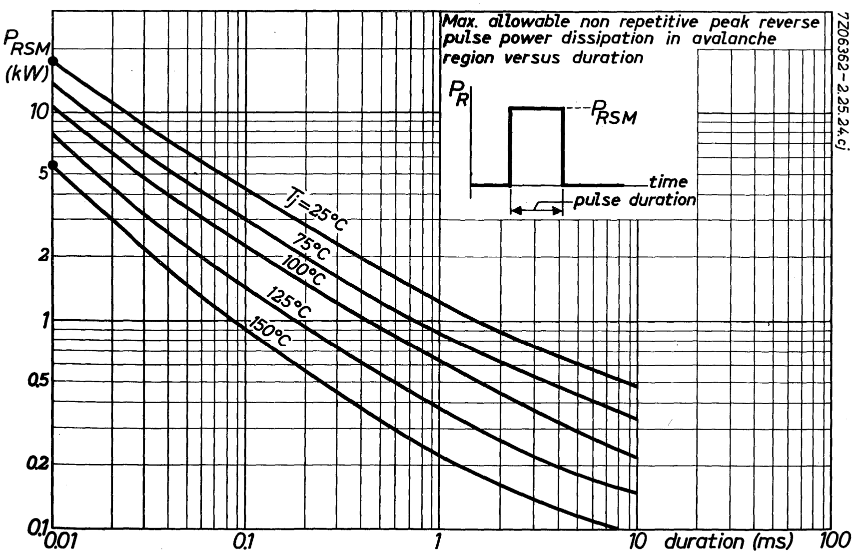
$$R_{th\ h\text{-}a} = R_{th\ mb\text{-}a} - R_{th\ mb\text{-}h} = (1.4 - 0.5)\ ^oC/W = 0.9\ ^oC/W.$$

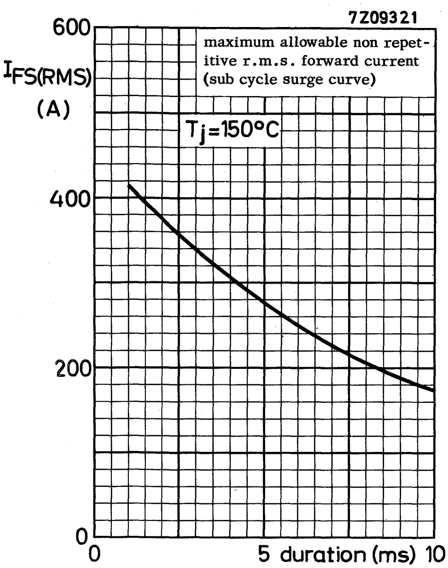
The applicable heatsink(s) may then be found in the Section ACCESSORIES and HEATSINKS.

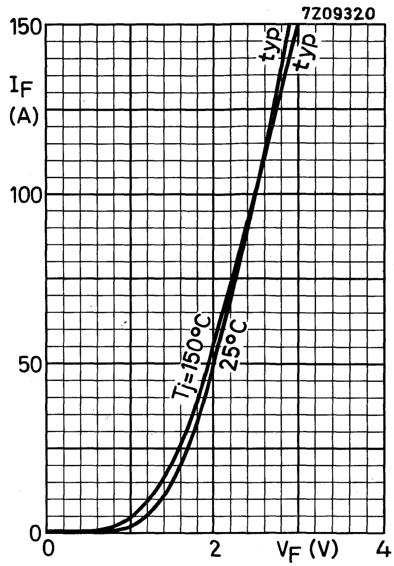

7Z06363.1
P (W)
P = power dissipation, exclusive the reverse power in the avalanche region and switching losses
Interrelation between the total dissipation (derived from the left hand graph) and the max. allowable temperatures
T_{mb} (°C)
6 phase
3 phase
single phase (square wave; δ=0.5)
d.c.
$R_{th\ mb-a}$ = 0.5°C/W
1°C/W
2°C/W
3°C/W
4°C/W
6°C/W
8°C/W
12°C/W
A
B
C
D
I_{FAV} (A)
T_{amb} (°C)

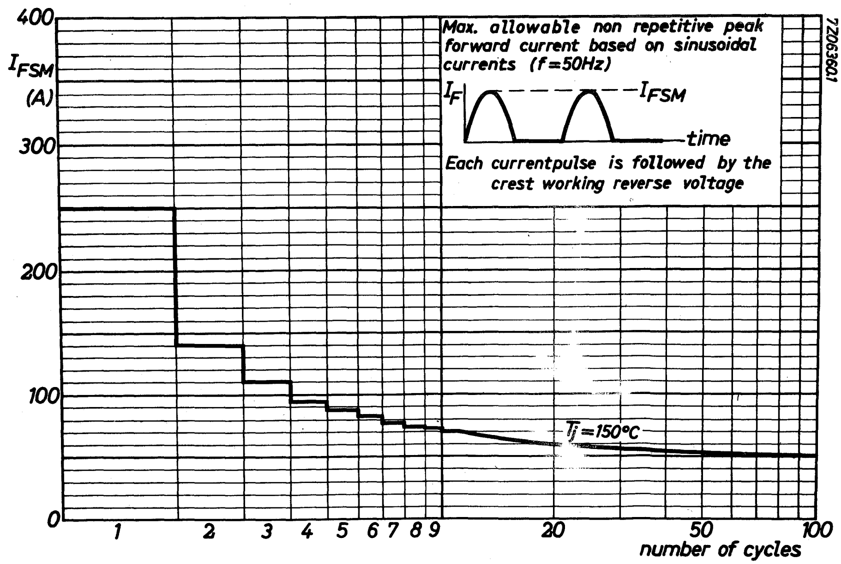

P_{RRM} (kW)
T_j = 110°C
120°C
130°C
140°C
150°C
Max. allowable repetitive peak reverse power dissipation versus duration (f=50Hz)
P_R
P_{RRM}
time
pulse duration
operation in this region is not allowed
in this region a junction temperature of 150°C is allowed
duration (ms)
7Z06358-2.25.24.c)

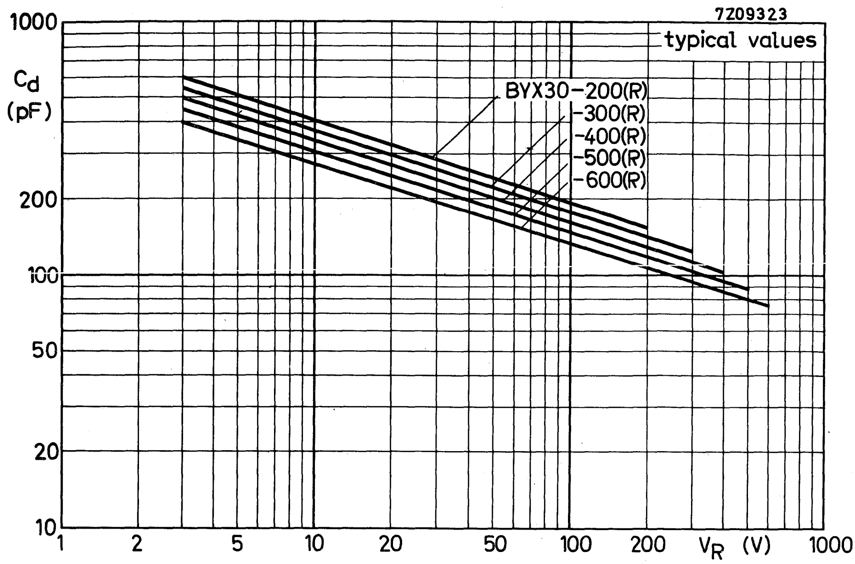

Max. allowable repetitive peak reverse power dissipation versus duration
P_{RRM} (kW)
T_j=140°C
150°C
P_R
P_{RRM}
time
pulse duration
f=400Hz
1600Hz
operation in these regions is not allowed
in these regions a junction temperature of 150°C is allowed
duration (ms)
7Z06364-2.25.24.cj

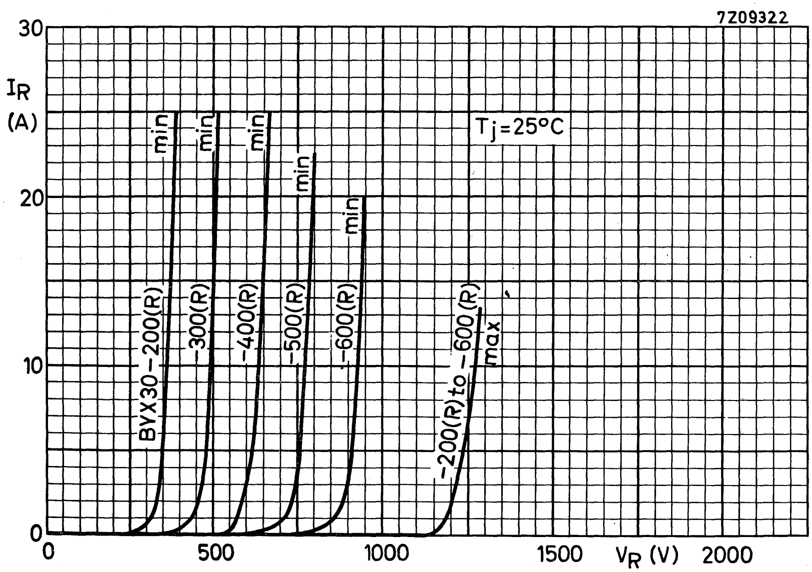

Max. allowable non repetitive peak reverse pulse power dissipation in avalanche region versus duration
P_{RSM} (kW)
P_R
P_{RSM}
time
pulse duration
T_j=25°C
75°C
100°C
125°C
150°C
duration (ms)
7Z06362-2.25.24.cj

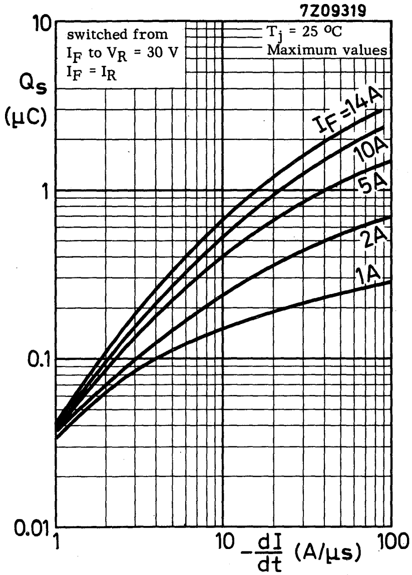

7Z09321
maximum allowable non repetitive r.m.s. forward current (sub cycle surge curve)
T_j=150°C
$I_{FS(RMS)}$ (A)
600
400
200
0
0
5 duration (ms) 10

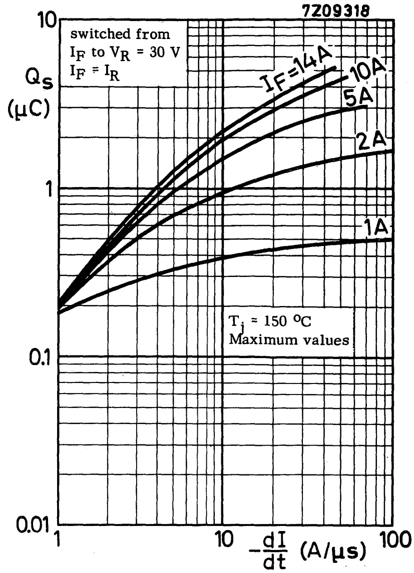

7Z09320
I_F (A)
150
100
50
0
typ
typ
T_j=150°C
25°C
0
2
V_F (V)
4

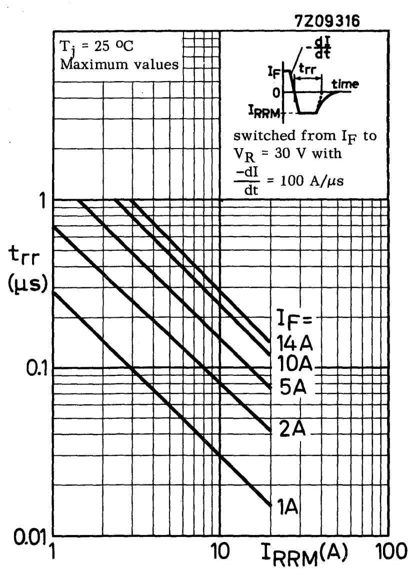

7Z63601
Max. allowable non repetitive peak forward current based on sinusoidal currents (f=50Hz)
I_F
I_{FSM}
time
Each currentpulse is followed by the crest working reverse voltage
I_{FSM} (A)
400
300
200
100
0
T_j=150°C
1
2
3
4
5
6
7
8
9
20
50
100
number of cycles

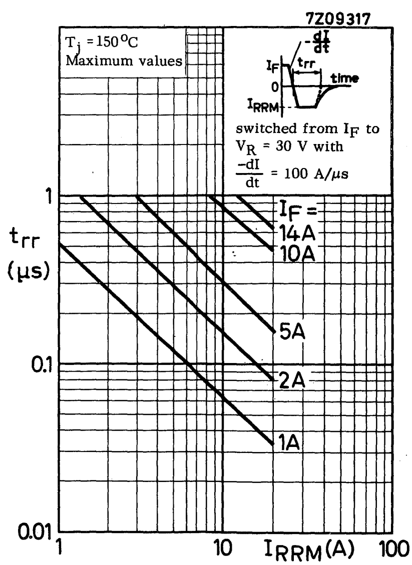

7Z09323
typical values
C_d
(pF)
BYX30−200(R)
−300(R)
−400(R)
−500(R)
−600(R)
1000
200
100
50
20
10
1
2
5
10
20
50
100
200
V_R (V)
1000

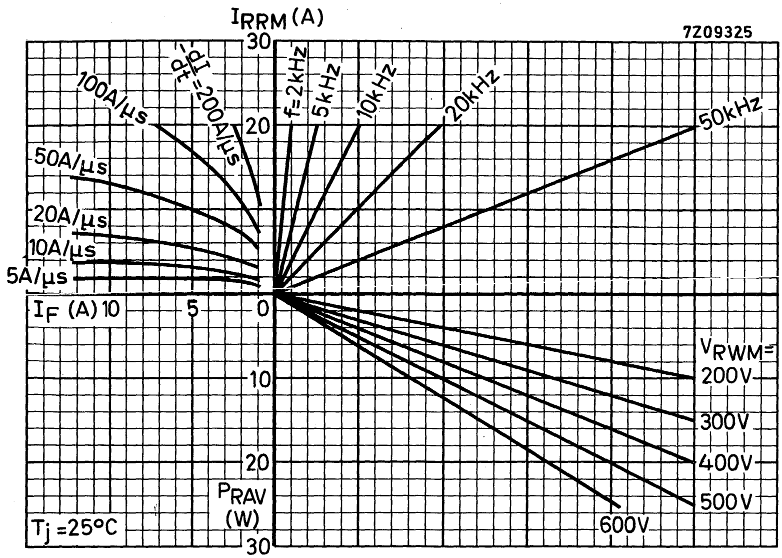

7Z09322
I_R
(A)
T_j=25°C
min
min
min
min
min
BYX30−200(R)
−300(R)
−400(R)
−500(R)
−600(R)
−200(R) to −600(R)
max
30
20
10
0
0
500
1000
1500
V_R (V)
2000

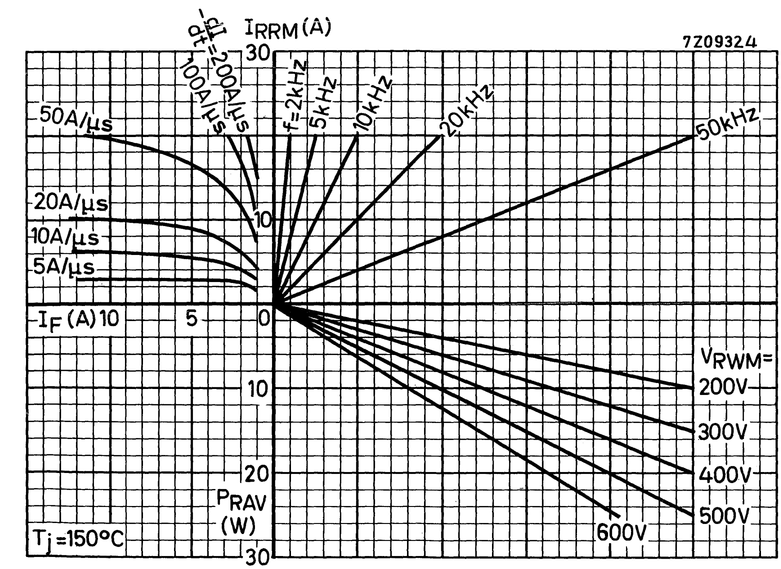

7Z09319
switched from
I_F to V_R = 30 V
I_F = I_R
T_j = 25 °C
Maximum values
Q_s
(µC)
I_F =14A
10A
5A
2A
1A
10
1
0.1
0.01
1
10
100
$-\frac{dI}{dt}$ (A/µs)


7Z09318
switched from
I_F to V_R = 30 V
I_F = I_R
Q_s
(µC)
I_F =14A
10A
5A
2A
1A
T_j = 150 °C
Maximum values
10
1
0.1
0.01
1
10
100
$-\frac{dI}{dt}$ (A/µs)


7Z09316
T_j = 25 °C
Maximum values
$-\frac{dI}{dt}$
I_F
t_{rr}
time
0
I_{RRM}
switched from I_F to
V_R = 30 V with
$\frac{-dI}{dt}$ = 100 A/µs
t_{rr}
(µs)
I_F =
14A
10A
5A
2A
1A
1
0.1
0.01
1
10
100
I_{RRM}(A)


7Z09317
T_j =150°C
Maximum values
$-\frac{dI}{dt}$
I_F
t_{rr}
time
0
I_{RRM}
switched from I_F to
V_R = 30 V with
$\frac{-dI}{dt}$ = 100 A/µs
t_{rr}
(µs)
I_F =
14A
10A
5A
2A
1A
1
0.1
0.01
1
10
100
I_{RRM}(A)





Nomogram: Power loss P_{RAV} due to switching only (square wave operation)

SILICON RECTIFIER DIODES

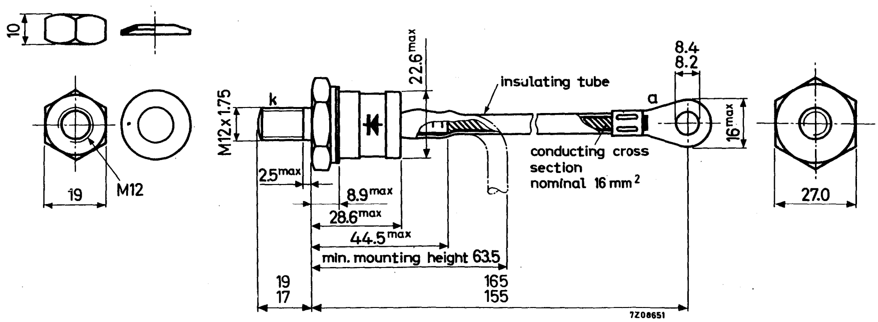
Diffused silicon diodes in metal envelopes with ceramic insulation, intended for power rectifier application. The series consists of the following types:
Normal polarity (stud cathode):
BYX32-200; -400; -600; -800; -1000; -1200 and BYX32-1600.
Reverse polarity (stud anode):
BYX32-200R; -400R; -600R; -800R; -1000R; -1200R and BYX32-1600R.

QUICK REFERENCE DATA

	BYX32-	200 200R	400 400R	600 600R	800 800R	1000 1000R	1200 1200R	1600 1600R	
Crest working reverse voltage	V_{RWM} max.	200	400	600	800	1000	1200	1200	V
Repetitive peak reverse voltage	V_{RRM} max.	200	400	600	800	1000	1200	1600	V

Average forward current	I_{FAV}	max.	100	A
Non repetitive peak forward current (t = 10 ms)	I_{FSM}	max.	1600	A
Junction temperature	T_j	max.	190	^{o}C
Thermal resistance from junction to mounting base	$R_{th\,j\text{-}mb}$	=	0.4	$^{o}C/W$

MECHANICAL DATA Dimensions in mm



Normal polarity (→|←): blue cable. Reverse polarity (→|←): red cable.

Net weight : 95 g
With accessories : 115 g
Diameter of hole in heatsink: max. 13 mm.

Torque on nut: min. 100 cm kg
max. 250 cm kg

All information applies to frequencies up to 400 Hz.

RATINGS (Limiting values) [1])

Voltages [2])	BYX32-	200 200R	400 400R	600 600R	800 800R	1000 1000R	1200 1200R	1600 1600R	
Continuous reverse voltage	V_R max.	200	400	600	800	1000	1200	1200	V
Crest working reverse voltage	V_{RWM} max.	200	400	600	800	1000	1200	1200	V
Repetitive peak reverse voltage	V_{RRM} max.	200	400	600	800	1000	1200	1600	V
Non repetitive peak reverse voltage ($t < 10$ ms)	V_{RSM} max.	225	450	650	900	1100	1300	1600	V

Currents

Average forward current (averaged over any 20 ms period)	I_{FAV}	max.	100	A
Forward current (d.c.)	I_F	max.	130	A
Repetitive peak forward current	I_{FRM}	max.	500	A
Non repetitive peak forward current t = 10 ms (See page 6)	I_{FSM}	max.	1600	A

Temperatures

Storage temperature	T_{stg}		−55 to +200	^{o}C
Junction temperature	T_j	max.	190	^{o}C

THERMAL RESISTANCE

From junction to mounting base	$R_{th\,j\text{-}mb}$	=	0.4	^{o}C/W
From mounting base to heatsink without heatsink compound	$R_{th\,mb\text{-}h}$	=	0.1	^{o}C/W
From mounting base to heatsink with heatsink compound (Dow Corning 340)	$R_{th\,mb\text{-}h}$	=	0.04	^{o}C/W

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

[2]) To ensure thermal stability: $R_{th\,j\text{-}a} < 1.7\,^{o}C/W$ (d.c.) or $< 3.3\,^{o}C/W$ (a.c.).

CHARACTERISTICS

Forward voltage at I_F = 500 A; T_j = 190 °C	V_F	<	1.7	V [1]
Reverse current at T_j = 175 °C				
BYX32-200(R) : V_R = 200 V	I_R	<	20	mA
BYX32-400(R) : V_R = 400 V	I_R	<	20	mA
BYX32-600(R) : V_R = 600 V	I_R	<	17	mA
BYX32-800(R) : V_R = 800 V	I_R	<	13	mA
BYX32-1000(R) : V_R = 1000 V	I_R	<	10	mA
BYX32-1200(R) : V_R = 1200 V	I_R	<	8	mA
BYX32-1600(R) : V_R = 1200 V	I_R	<	8	mA

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

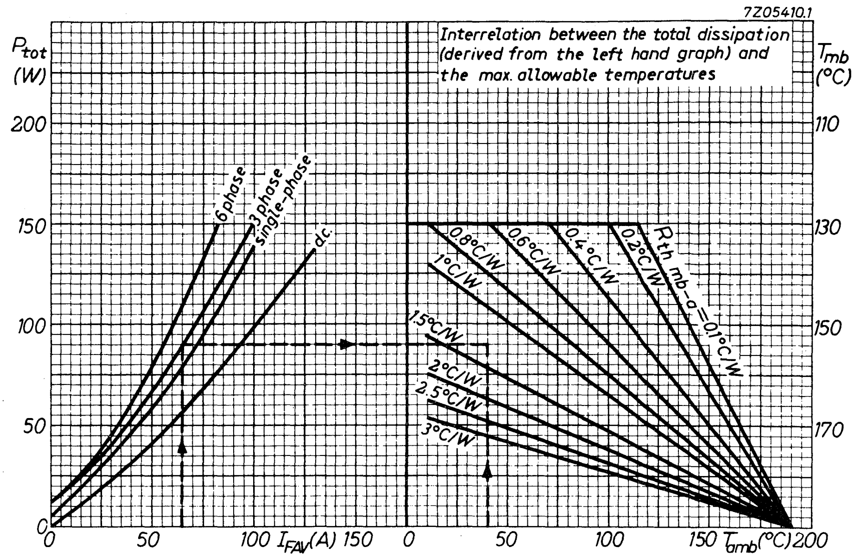
OPERATING NOTES

1. When there is a possibility that transient voltages, caused by the stored energy in the transformer core, will exceed the maximum permissible non repetitive peak reverse voltage, a damping circuit across the transformer should be applied.
Either a series RC circuit or a voltage dependent resistor may be used. Suitable component values for an RC circuit across the transformer primary or secondary may be calculated as follows:

$\frac{V_{RSM}}{V_{RWM}}$	RC across primary of transformer		RC across secondary of transformer	
	C (μF)	R (Ω)	C (μF)	R (Ω)
2.0	$200\frac{I_{mag}}{V_1}$	$\frac{150}{C}$	$225\frac{I_{mag}T^2}{V_1}$	$\frac{200}{C}$
1.5	$400\frac{I_{mag}}{V_1}$	$\frac{225}{C}$	$450\frac{I_{mag}T^2}{V_1}$	$\frac{275}{C}$
1.25	$550\frac{I_{mag}}{V_1}$	$\frac{260}{C}$	$620\frac{I_{mag}T^2}{V_1}$	$\frac{310}{C}$
1.0	$800\frac{I_{mag}}{V_1}$	$\frac{300}{C}$	$900\frac{I_{mag}T^2}{V_1}$	$\frac{350}{C}$

where I_{mag} = magnetising primary r.m.s. current (A)
V_1 = transformer primary r.m.s. voltage (V)
V_2 = transformer secondary r.m.s. voltage (V)
T = V_1/V_2
V_{RWM} stands for the actually applied crest working reverse voltage

2. In order to prevent the diodes from being damaged by surge currents higher than those mentioned in the curves at pages 6 and 7 a fast fuse is recommended.



Determination of the heatsink thermal resistance.

Example:

Assume a diode, used in a three phase rectifier circuit.

frequency	f	= 50 Hz
average forward current	I_{FAV}	= 65 A(per diode)
ambient temperature	T_{amb}	= 40 °C

From the left hand part of the graph above it follows that at I_{FAV} = 65 A in a three phase rectifier circuit the average forward power + average leakage power = 90 W per diode.

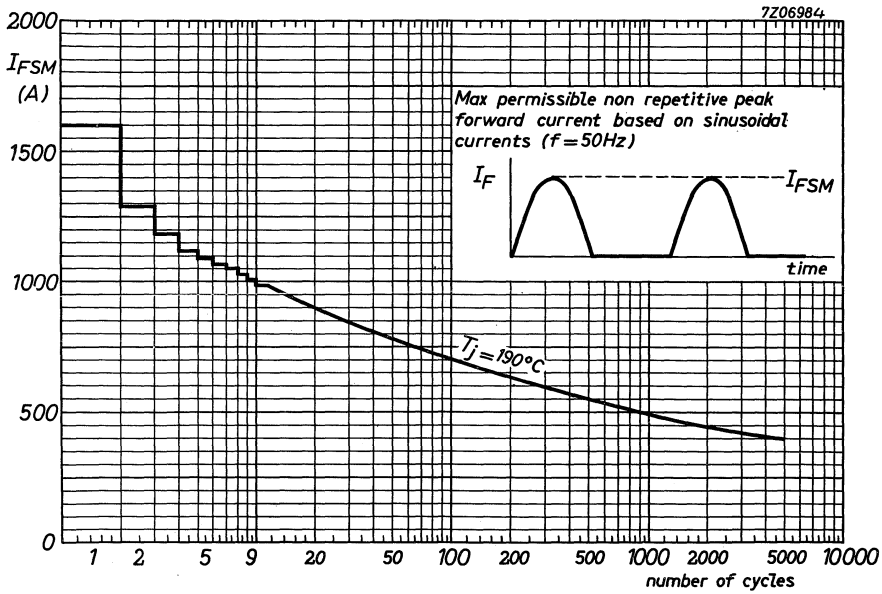
From the right hand part of the graph above follows the thermal resistance, required for P_{tot} = 90 W at T_{amb} = 40 °C

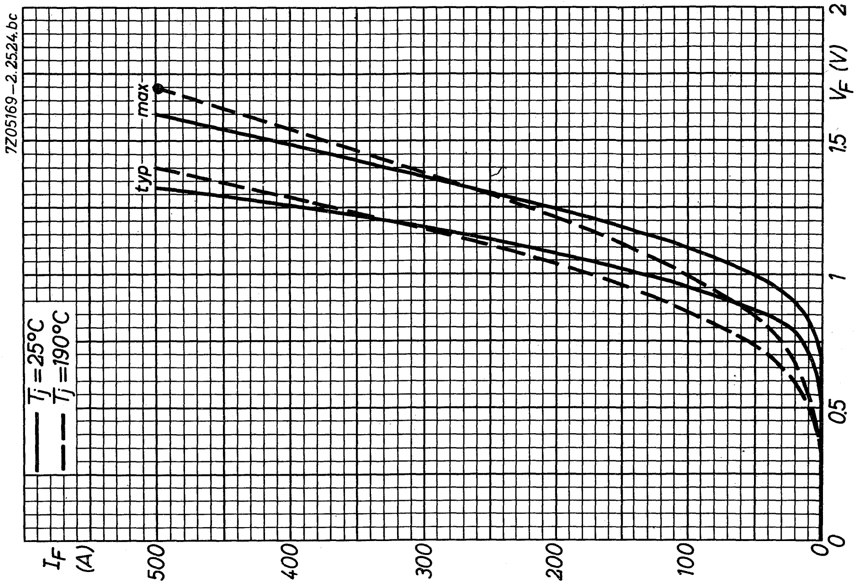
$$R_{th\ mb\text{-}a} \approx 1.3\ ^{o}C/W$$

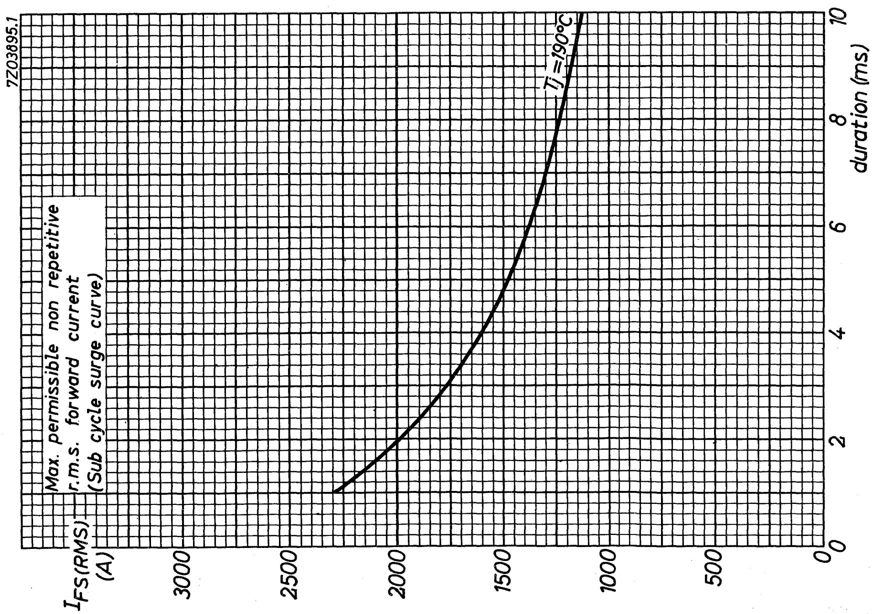
The contact thermal resistance $R_{th\ mb\text{-}h}$ = 0.1 °C/W
Hence the heatsink thermal resistance should be:

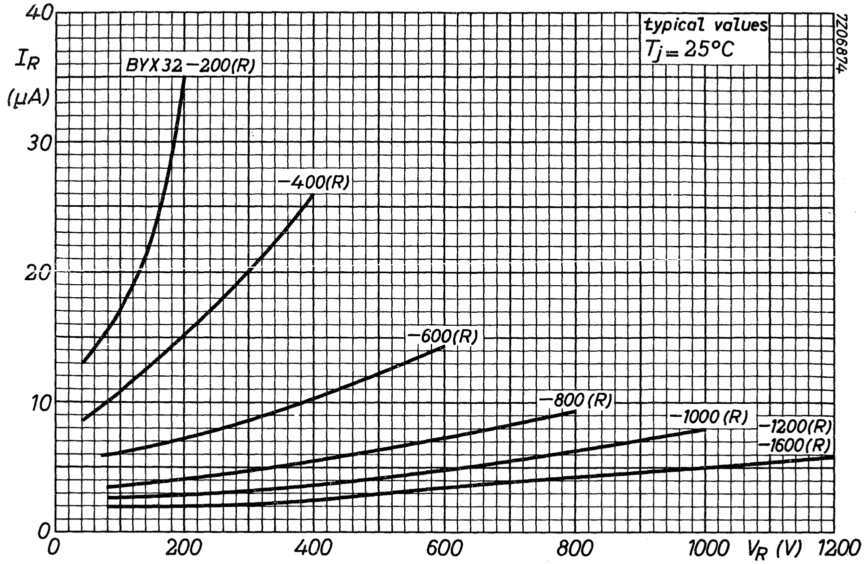
$$R_{th\ h\text{-}a} = R_{th\ mb\text{-}a} - R_{th\ mb\text{-}h} = (1.3 - 0.1)\ ^{o}C/W = 1.2\ ^{o}C/W$$

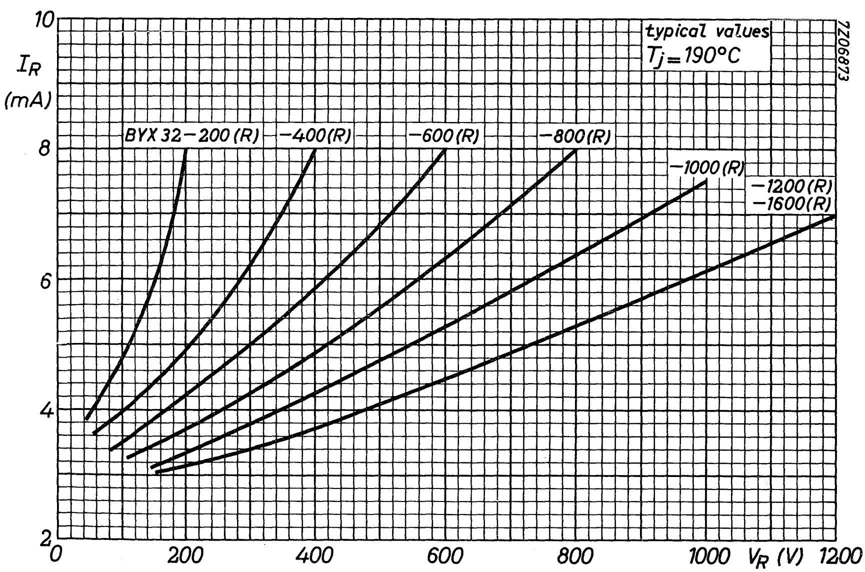
The applicable heatsink(s) may then be found in the Section ACCESSORIES and HEATSINKS.


7Z06984
2000
I_{FSM}
(A)
1500
1000
500
0
1
2
5
9
20
50
100
200
500
1000
2000
5000
10000
number of cycles
Max permissible non repetitive peak forward current based on sinusoidal currents (f = 50Hz)
I_F
I_{FSM}
time
$T_j = 190°C$


7Z05169-2.2524.bc
$T_j = 25°C$
$T_j = 190°C$
max
typ
I_F (A)
V_F (V)
0
100
200
300
400
500
0.5
1
1.5
2


7Z03895.1
Max. permissible non repetitive
r.m.s. forward current
(Sub cycle surge curve)
$T_j = 190°C$
$I_{FS(RMS)}$ (A)
duration (ms)
0
500
1000
1500
2000
2500
3000
2
4
6
8
10





APPLICATION INFORMATION

See general pages at the beginning of this section

SILICON RECTIFIER DIODES

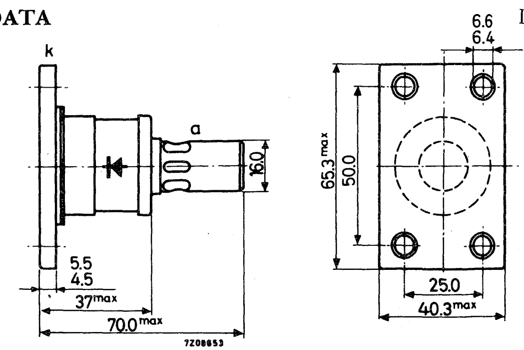
Diffused silicon diodes in metal envelopes with ceramic insulation, intended for power rectifier application. The series consists of the following types:
Normal polarity (stud cathode):
BYX33-200; -400; -600; -800; -1000; -1200 and BYX33-1600.
Reverse polarity (stud anode):
BYX33-200R; -400R; -600R; -800R; -1000R; -1200R; and BYX33-1600R.

QUICK REFERENCE DATA

	BYX33-	200 200R	400 400R	600 600R	800 800R	1000 1000R	1200 1200R	1600 1600R	
Crest working reverse voltage	V_{RWM} max.	200	400	600	800	1000	1200	1200	V
Repetitive peak reverse voltage	V_{RRM} max.	200	400	600	800	1000	1200	1600	V

Average forward current up to T_{mb} = 120 °C	I_{FAV}	max.	250	A
water cooled up to T_{mb} = 55 °C	I_{FAV}	max.	400	A
Non repetitive peak forward current (t = 10 ms)	I_{FSM}	max.	4000	A
Junction temperature	T_j	max.	190	°C
Thermal resistance from junction to mounting base	$R_{th\ j\text{-}mb}$	=	0.2	°C/W

MECHANICAL DATA Dimensions in mm



Net weight: 230 g
Normal polarity (stud cathode, ⯇): blue circle on top.
Reverse polarity (stud anode, ⯈): red circle on top.
Accessories and mounting instructions: see page 3.

All information applies to frequencies up to 400 Hz.

RATINGS (Limiting values) [1]

Voltages [2]	BYX33-	200 200R	400 400R	600 600R	800 800R	1000 1000R	1200 1200R	1600 1600R	
Continuous reverse voltage	V_R max.	200	400	600	800	1000	1200	1200	V
Crest working reverse voltage	V_{RWM} max.	200	400	600	800	1000	1200	1200	V
Repetitive peak reverse voltage	V_{RRM} max.	200	400	600	800	1000	1200	1600	V
Non repetitive peak reverse voltage ($t < 10$ ms)	V_{RSM} max.	225	450	650	900	1100	1300	1600	V

Currents

→ Average forward current (averaged over any 20 ms period) up to T_{mb} = 120 °C	I_{FAV}	max.	250	A
water cooled up to T_{mb} = 55 °C	I_{FAV}	max.	400	A
→ Forward current (d.c.)	I_F	max.	400	A
→ Repetitive peak forward current	I_{FRM}	max.	2000	A
Non repetitive peak forward current t = 10 ms (See page 6)	I_{FSM}	max.	4000	A
→ I squared t for fusing (t = 10 ms) (See page 6)	I^2t	max.	80 000	A^2s

Temperatures

Storage temperature	T_{stg}		-55 to +200	°C
Junction temperature	T_j	max.	190	°C

THERMAL RESISTANCE

From junction to mounting base	$R_{th\ j\text{-}mb}$	=	0.2	°C/W
From mounting base to heatsink without heatsink compound	$R_{th\ mb\text{-}h}$	=	0.07	°C/W
From mounting base to heatsink with heatsink compound (Dow Corning 340)	$R_{th\ mb\text{-}h}$	=	0.03	°C/W

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

[2] To ensure thermal stability: $R_{th\ j\text{-}a} \leq 0.7$ °C/W (d.c.) or ≤ 1.3 °C/W (a.c.)

CHARACTERISTICS

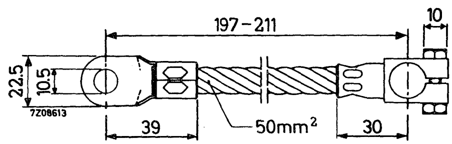
Forward voltage at I_F = 1250 A; T_j = 190 °C	V_F	<	1.8	V [1])
Reverse current at T_j = 175 °C				
BYX33-200(R) : V_R = 200 V	I_R	<	50	mA
BYX33-400(R) : V_R = 400 V	I_R	<	50	mA
BYX33-600(R) : V_R = 600 V	I_R	<	42	mA
BYX33-800(R) : V_R = 800 V	I_R	<	32	mA
BYX33-1000(R) : V_R = 1000 V	I_R	<	25	mA
BYX33-1200(R) : V_R = 1200 V	I_R	<	20	mA
BYX33-1600(R) : V_R = 1200 V	I_R	<	20	mA

ACCESSORIES AND MOUNTING INSTRUCTIONS

Dimensions in mm

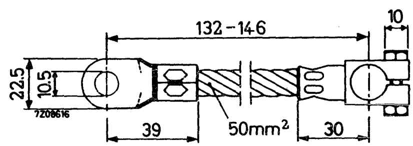
Flexible top lead

Type number 56243
Weight: 170 g



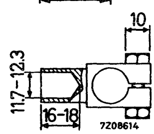
Flexible top lead

Type number 56243A
Weight: 140 g



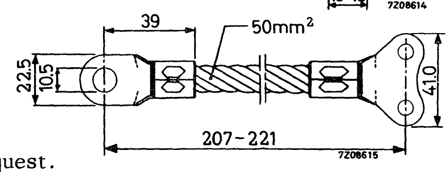
Clamp

Type number 56244
Weight: 70 g



Flexible base lead

Type number 56247
Weight: 135 g



1. These accessories are available on request.
2. For mounting of the flexible top lead it is recommended to use two spanners to avoid damage.
   Torque on nut: min. 30 cm kg; max. 60 cm kg.
3. For mounting the diode on a heatsink use steel bolts.
   Min. torque for good thermal and electrical contact: 30 cm kg
   Max. torque : 60 cm kg
4. Top lead 56243 should only be used for $I_{F(RMS)} \leq$ 400 A.
   Top lead 56243A is necessary for $I_{F(RMS)} >$ 400 A to prevent excessive temperature of the top connection.

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

OPERATING NOTES

1. When there is a possibility that transient voltages, caused by the stored energy in the transformer core, will exceed the maximum permissible non repetitive peak reverse voltage, a damping circuit across the transformer should be applied.
   Either a series RC circuit or a voltage dependent resistor may be used. Suitable component values for an RC circuit across the transformer primary or secondary may be calculated as follows:

$\frac{V_{RSM}}{V_{RWM}}$	RC across primary of transformer		RC across secondary of transformer	
	C (μF)	R (Ω)	C (μF)	R (Ω)
2.0	$200\frac{I_{mag}}{V_1}$	$\frac{150}{C}$	$225\frac{I_{mag}T^2}{V_1}$	$\frac{200}{C}$
1.5	$400\frac{I_{mag}}{V_1}$	$\frac{225}{C}$	$450\frac{I_{mag}T^2}{V_1}$	$\frac{275}{C}$
1.25	$550\frac{I_{mag}}{V_1}$	$\frac{260}{C}$	$620\frac{I_{mag}T^2}{V_1}$	$\frac{310}{C}$
1.0	$800\frac{I_{mag}}{V_1}$	$\frac{300}{C}$	$900\frac{I_{mag}T^2}{V_1}$	$\frac{350}{C}$

where I_{mag} = magnetising primary r.m.s. current (A)

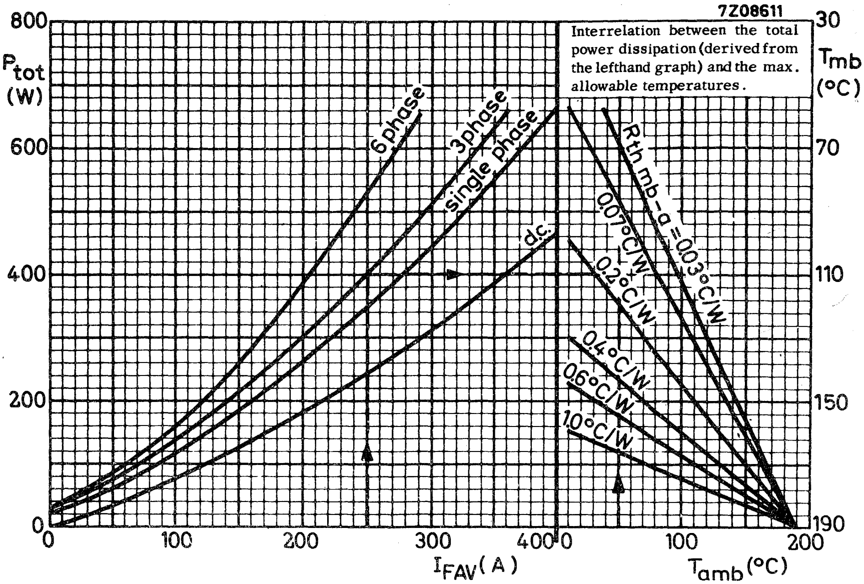
V_1 = transformer primary r.m.s. voltage (V)

V_2 = transformer secondary r.m.s. voltage (V)

T = V_1/V_2

V_{RWM} stands for the actually applied crest working reverse voltage

2. In order to prevent the diodes from being damaged by surge currents higher than those mentioned in the curves on page 6 a fast fuse is recommended.



Determination of the heatsink thermal resistance

Example:

Assume a diode, used in a three phase rectifier circuit.

frequency	f	=	50 Hz
ambient temperature	T_{amb}	=	50 °C
average forward current	I_{FAV}	=	250 A (per diode)

From the left hand part of the graph above it follows, that at I_{FAV} = 250 A the average forward power + average leakage power = 400 W per diode.
From the right hand part follows the thermal resistance, required for P_{tot} = 400 W at T_{amb} = 50 °C:

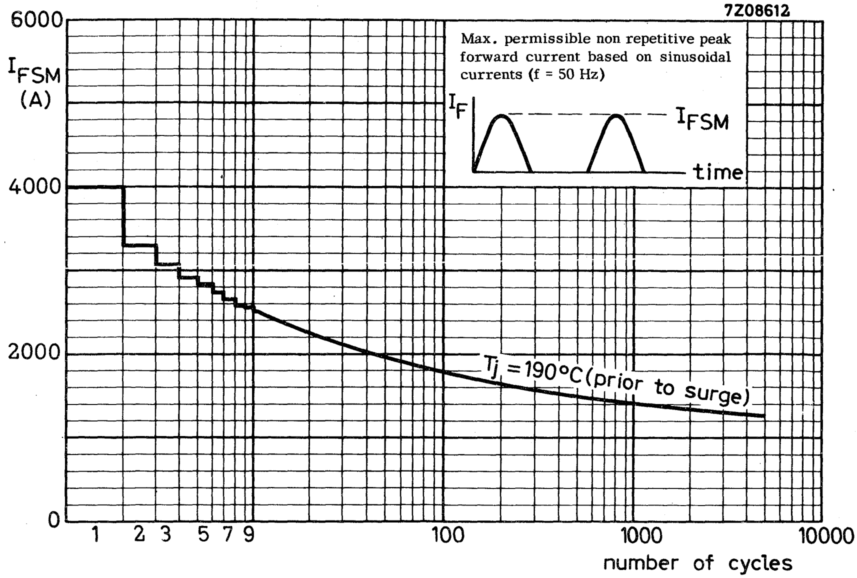
$$R_{th\ mb-a} \approx 0.15\ ^{o}C/W$$

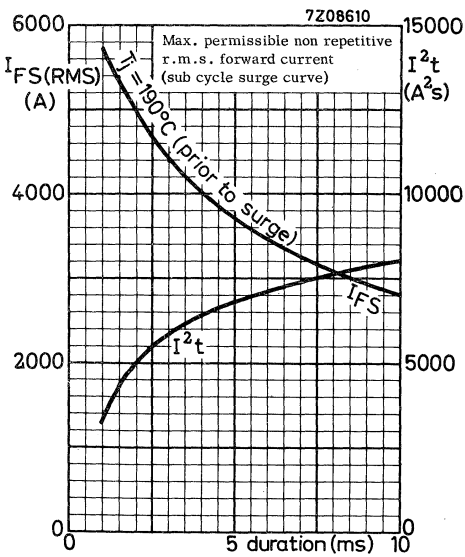
The contact thermal resistance $R_{th\ mb-h}$ = 0.03 °C/W

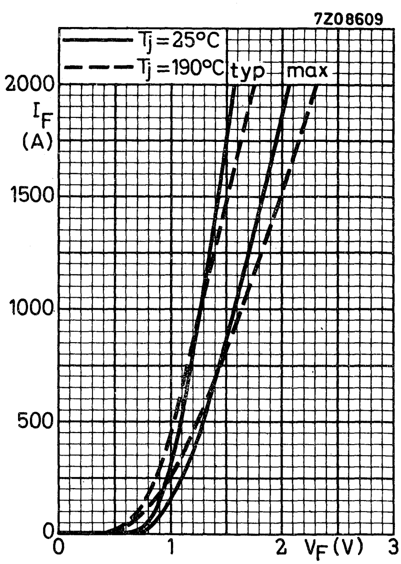
Hence the heatsink thermal resistance should be:

$$R_{th\ h-a} = R_{th\ mb-a} - R_{th\ mb-h} = (0.15 - 0.03)\ ^{o}C/W = 0.12\ ^{o}C/W.$$

The applicable heatsink(s) may than be found in the Section ACCESSORIES and HEATSINKS.


7Z08612
Max. permissible non repetitive peak forward current based on sinusoidal currents (f = 50 Hz)
I_F
I_{FSM}
time
6000
I_{FSM} (A)
4000
2000
0
T_j = 190°C (prior to surge)
1
2
3
5
7
9
100
1000
10000
number of cycles


7Z08610
Max. permissible non repetitive r.m.s. forward current (sub cycle surge curve)
6000
$I_{FS(RMS)}$ (A)
4000
2000
0
15000
I^2t (A^2s)
10000
5000
0
T_j = 190°C (prior to surge)
I_{FS}
I^2t
0
5 duration (ms)
10


7Z08609
T_j = 25°C
T_j = 190°C
typ
max
2000
I_F (A)
1500
1000
500
0
0
1
2
V_F (V)
3

HIGH SPEED RECTIFIER DIODES WITH CONTROLLED AVALANCHE

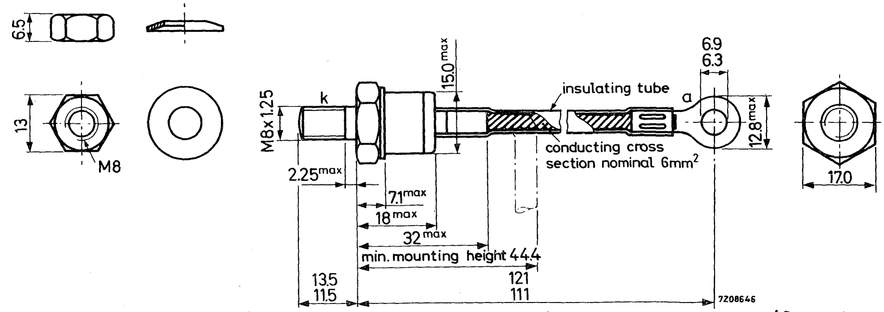
Diffused silicon diodes in a metal envelope, capable of absorbing transients. They are primarily intended for use in high frequency power supplies, inverters, choppers, sonar power supplies and ultra sonic systems.
The series consists of the following types:
Normal polarity (stud cathode): BYX34-200, -300, -400 and BYX34-500.

QUICK REFERENCE DATA

			BYX34-200	300	400	500	
Crest working reverse voltage	V_{RWM}	max.	200	300	400	500	V
Average forward current	I_{FAV}	max.	60				A
Non repetitive peak forward current t = 10 ms	I_{FSM}	max.	1200				A
Repetitive peak reverse power t = 10 μs; T_j = 150 °C	P_{RRM}	max.	8				kW
Non repetitive peak reverse power t = 10 μs; T_j = 25 °C	P_{RSM}	max.	30				kW
Junction temperature	T_j	max.	150				°C
Thermal resistance from junction to mounting base	$R_{th\ j\text{-}mb}$	=	0.4				°C/W
Recovered charge when switched from I_F = 50 A; -dI/dt = 50 A/μs; T_j = 25 °C	Q_s	<	7.5				μC

MECHANICAL DATA

Dimensions in mm



Net weight : 36 g
With accessories: 42 g
Diameter of hole in heatsink: max. 8.5 mm

Torque on nut: min. 40 cm kg
max. 60 cm kg

RATINGS (Limiting values) [1]

Voltages [2]

			BYX34-200	300	400	500	
Continuous reverse voltage	V_R	max.	200	300	400	500	V
Crest working reverse voltage	V_{RWM}	max.	200	300	400	500	V

Currents

Average forward current (averaged over any 20 ms period)	I_{FAV}	max.	60	A
Forward current (d.c.)	I_F	max.	75	A
R.M.S. forward current	$I_{F(RMS)}$	max.	120	A
Repetitive peak forward current	I_{FRM}	max.	1000	A
Non repetitive peak forward current t = 10 ms; see also page 7	I_{FSM}	max.	1200	A
Repetitive peak reverse current (during turn-off)	I_{RRM}	max.	100	A

Reverse power dissipation

Reverse power (d.c. or averaged over any 20 ms period)	P_R	max.	30	W
Repetitive peak reverse power at f = 50 Hz square wave; t = 10 μs; T_j = 150 °C	P_{RRM}	max.	8.0	kW
Non repetitive peak reverse power square wave; see also page 6 t = 10 μs; T_j = 25 °C	P_{RSM}	max.	30	kW
T_j = 150 °C	P_{RSM}	max.	15	kW

Temperatures

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

THERMAL RESISTANCE

From junction to mounting base	$R_{th\ j\text{-}mb}$	=	0.4	°C/W
From mounting base to heatsink with heatsink compound (e.g. Dow Corning 340)	$R_{th\ mb\text{-}h}$	=	0.2	°C/W

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

2) To ensure thermal stability: $R_{th\ j\text{-}a} < 1.25$ °C/W (d.c.) or < 2.5 °C/W (a.c.)

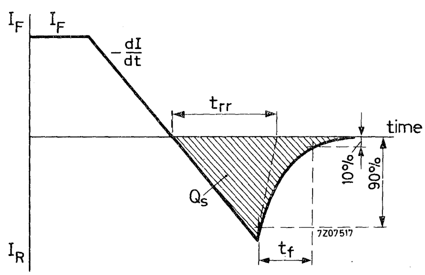
CHARACTERISTICS T_j = 25 °C unless otherwise specified

			BYX34-200	300	400	500	
Forward voltage							
I_F = 300 A; T_j = 150 °C	V_F	<	1.85	1.85	1.85	1.85	V 1)
Reverse breakdown voltage							
I_R = 10 mA; see also page 9	$V_{(BR)R}$	>	250	375	500	625	V
		<	515	640	770	900	V
Reverse current at T_j = 125 °C							
$V_R = V_{RWMmax}$	I_R	<	25	17	12.5	10.0	mA

Recovered charge when switched from I_F = 50 A to a reverse voltage with $-\frac{dI}{dt}$ = 50 A/μs — Q_s < 7.5 μC

Reverse recovery time when switched from I_F = 50 A to a reverse voltage with $-\frac{dI}{dt}$ = 50 A/μs; — t_{rr} < 0.6 μs

Fall time under all conditions — t_f < 0.3 μs



OPERATING NOTES

1. Square wave operation
When I_F has been flowing sufficiently long for steady state to be established, there will be a charge due to minority carriers present. Before the device can block in the reverse direction this charge must be extracted. This extraction takes the form of a reverse transient (see figure above). The majority of the power dissipation due to the reverse transient occurs during t_f as the rectifier gradually becomes reverse biased, and the mean power will be proportional to the operating frequency. The mean value of this power loss can be derived from the graphs at pages 5 and 6.

1) Measured under pulsed conditions to avoid excessive dissipation.

OPERATING NOTES (continued)

2. Sine wave operation

Power loss in sine wave operation will be considerably less owing to the much slower rate of change of the applied voltage (and consequently lower values of I_{RRM}), so that power loss due to reverse recovery may be safely ignored for frequencies up to 20 kHz.

3. Determination of the heatsink thermal resistance

Example:

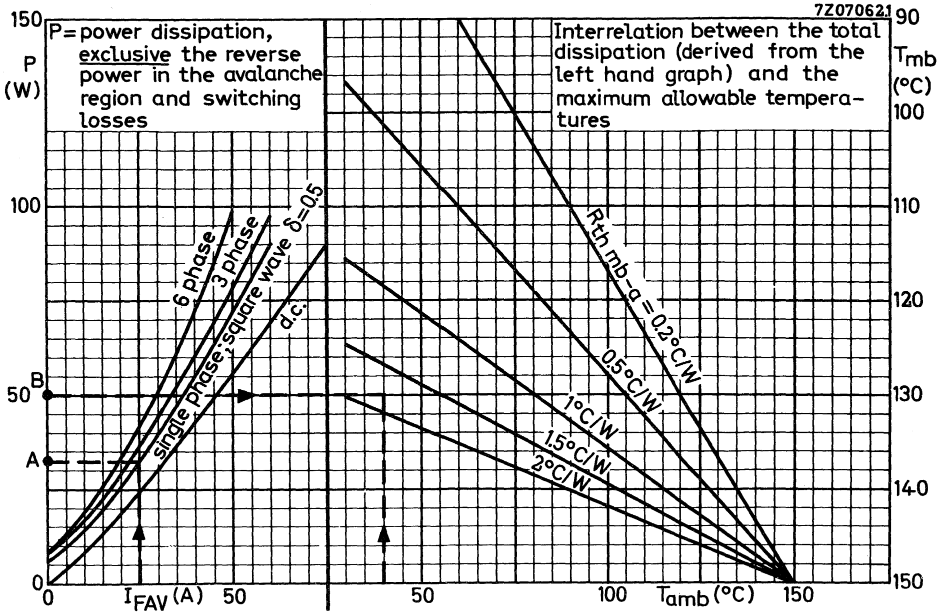
Assume a diode, used in an inverter.

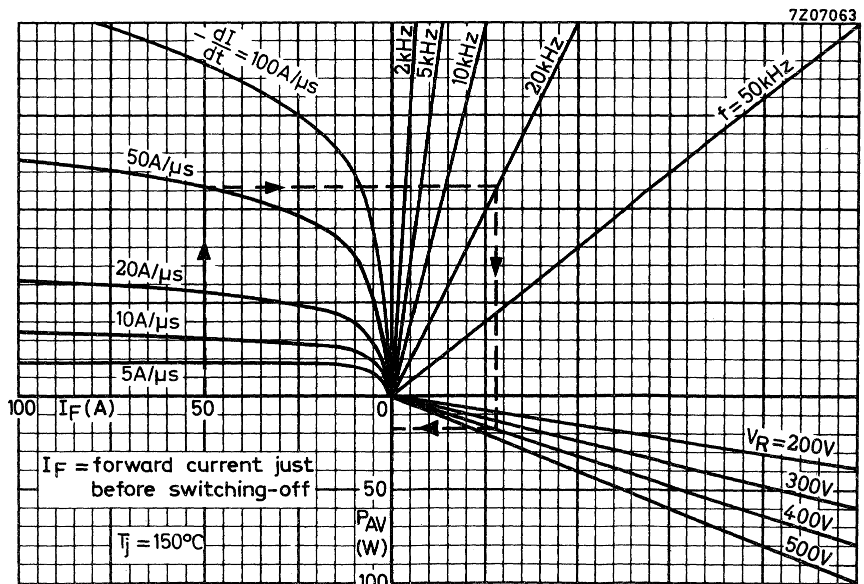
frequency	f	=	20 kHz
duty cycle	δ	=	0.5
ambient temperature	T_{amb}	=	40 °C
switched from	I_F	=	50 A
to	V_R	=	400 V
at a rate	$-\frac{dI}{dt}$	=	50 A/µs

At a duty cycle $\delta = 0.5$ the average forward current $I_{FAV} = 25$ A.
From the upper graph at page 5 it follows, that at $I_{FAV} = 25$ A the average forward power + average leakage power = 32 W (point A).
The additional power losses due to switching-off can be read from the nomogram at page 5 (the example being based on optimum use, i.e. $T_j = 150$ °C).
Starting from $I_F = 50$ A on the horizontal scale trace upwards until the appropriate line $-\frac{dI}{dt} = 50$ A/µs. From the intersection trace horizontally to the right until the line for f = 20 kHz. Then trace downwards to the line $V_R = 400$ V and ultimately trace horizontally to the left and on the vertical axis read the additional average power dissipation $P_{AV} = 18$ W.
Therefore the total power dissipation $P_{tot} = 32 \text{ W} + 18 \text{ W} = 50$ W (point B of the upper graph at page 5). It follows that at $T_{amb} = 40$ °C the required thermal resistance $R_{th\ mb\text{-}a} \simeq 1.8$ °C/W.
Hence the thermal resistance should be:

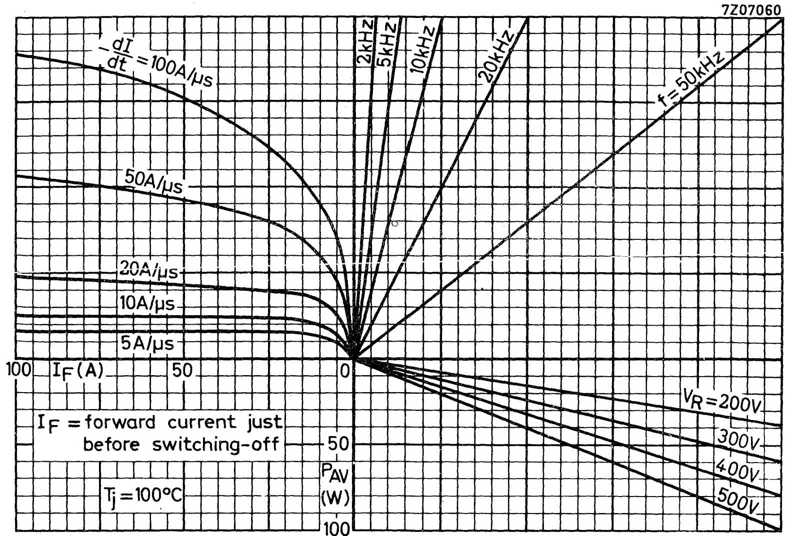
$$R_{th\ h\text{-}a} = R_{th\ mb\text{-}a} - R_{th\ mb\text{-}h} = (1.8 - 0.2)\ ^{o}C/W = 1.6\ ^{o}C/W.$$

The applicable heatsink(s) may then be found in the Section ACCESSORIES and HEATSINKS.

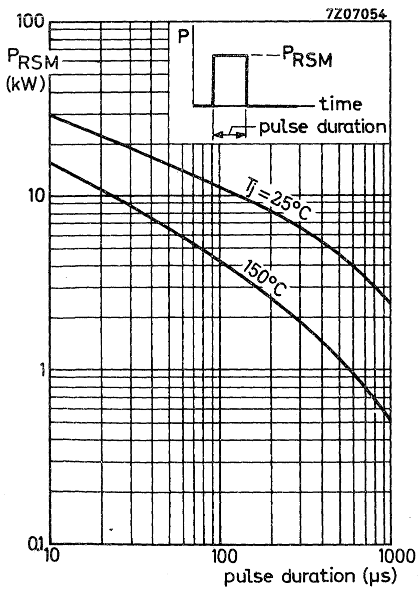


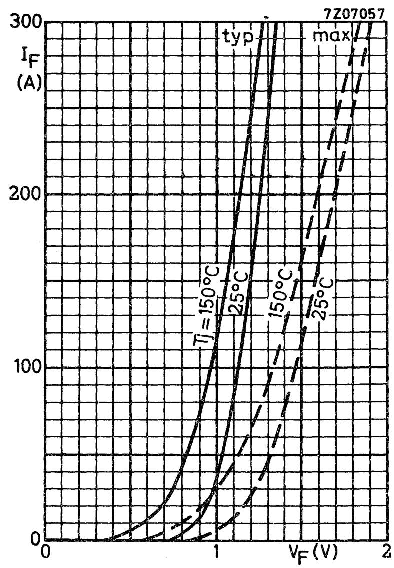


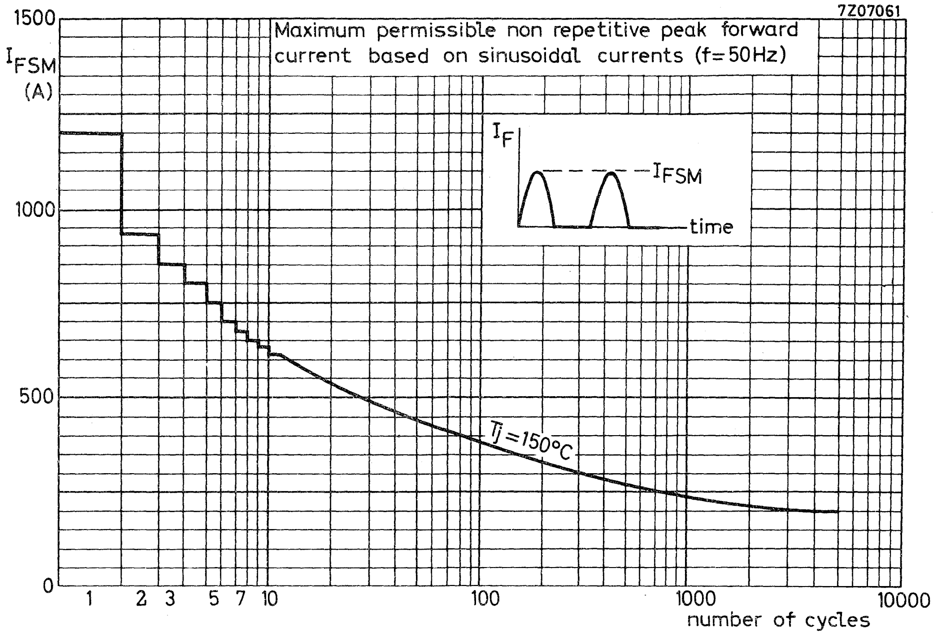
Nomogram: Power loss P_{AV} due to switching only (square wave operation)

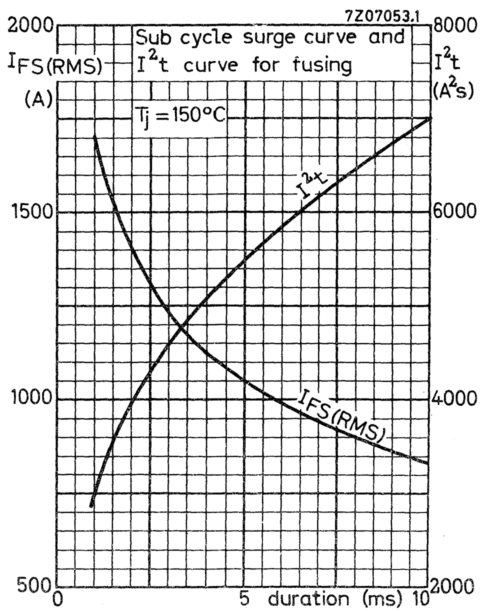


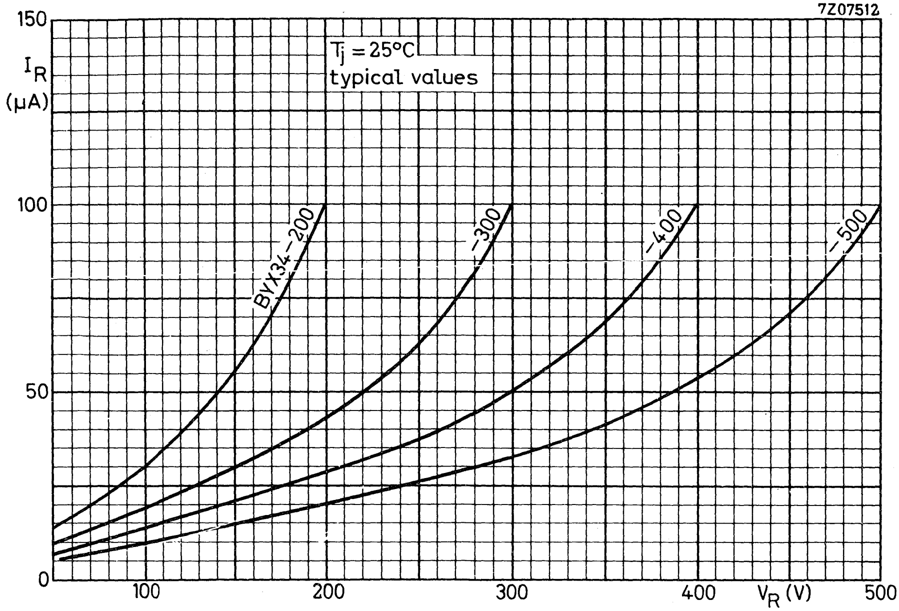
Nomogram: Power loss P_{AV} due to switching only (square wave operation)

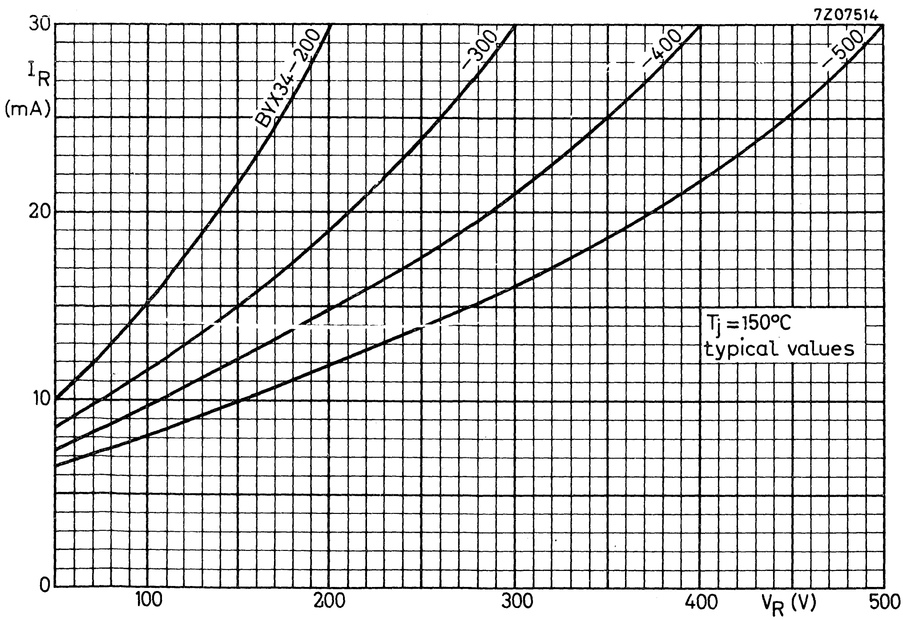


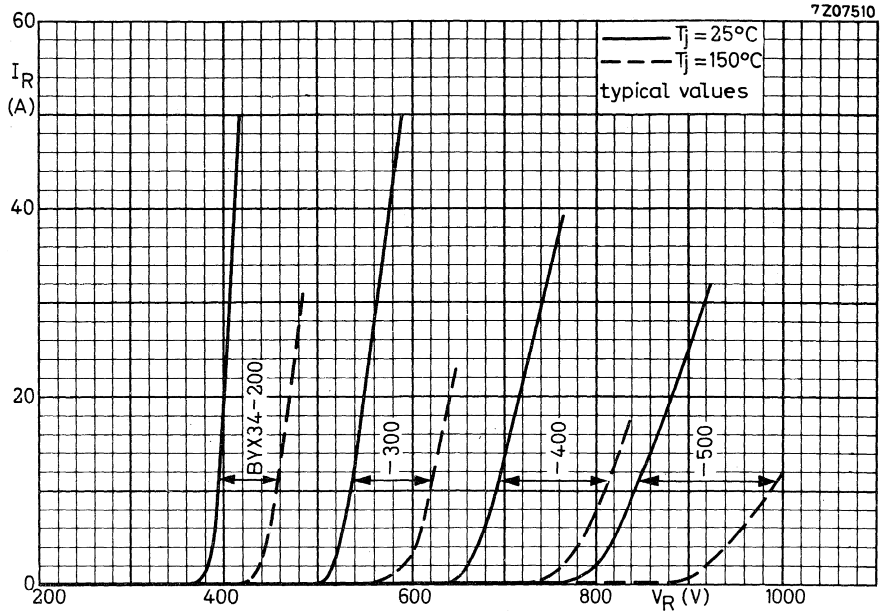


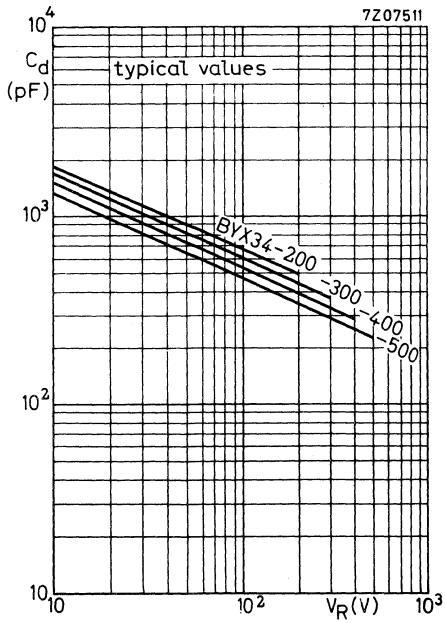

7Z07061
Maximum permissible non repetitive peak forward current based on sinusoidal currents (f=50Hz)
1500
I FSM
(A)
1000
500
0
1
2
3
5
7
10
100
1000
10000
number of cycles
Tj=150°C
IF
IFSM
time

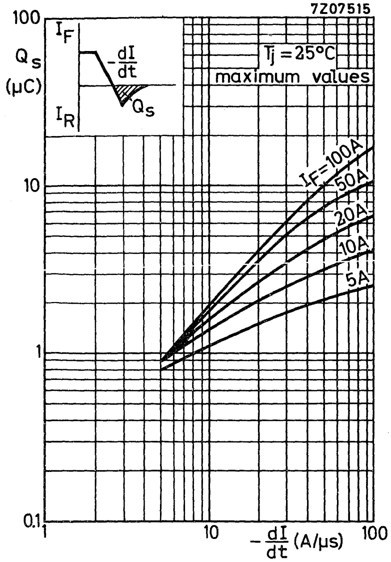

7Z07053.1
Sub cycle surge curve and I²t curve for fusing
2000
IFS(RMS)
(A)
1500
1000
500
8000
I²t
(A²s)
6000
4000
2000
Tj=150°C
I²t
IFS(RMS)
0
5
duration (ms)
10

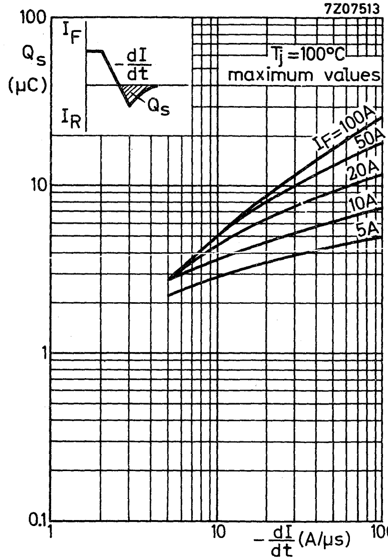

7Z07512
150
I_R
(μA)
100
50
0
100
200
300
400
500
V_R (V)
T_j = 25°C
typical values
BYX34–200
–300
–400
–500

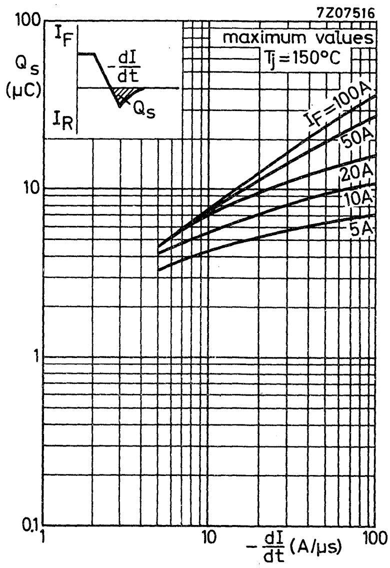

7Z07514
30
I_R
(mA)
20
10
0
100
200
300
400
500
V_R (V)
T_j = 150°C
typical values
BYX34–200
–300
–400
–500


7Z07510
I_R
(A)
60
40
20
0
200
400
600
800
1000
V_R (V)
T_j = 25°C
T_j = 150°C
typical values
BYX34−200
−300
−400
−500


7Z07511
C_d
(pF)
10^4
10^3
10^2
10
10
10^2
V_R (V)
10^3
typical values
BYX34−200
−300
−400
−500


7Z07515
100
10
1
0.1
Q_s (μC)
I_F
I_R
$-\frac{dI}{dt}$
Q_s
$T_j = 25°C$
maximum values
I_F=100A
50A
20A
10A
5A
1
10
100
$-\frac{dI}{dt}$ (A/μs)


7Z07513
100
10
1
0.1
Q_s (μC)
I_F
I_R
$-\frac{dI}{dt}$
Q_s
$T_j = 100°C$
maximum values
I_F=100A
50A
20A
10A
5A
1
10
100
$-\frac{dI}{dt}$ (A/μs)

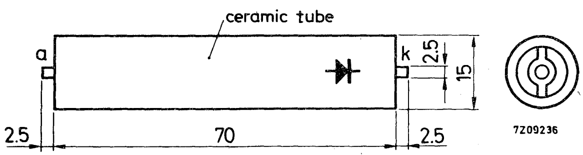

7Z07516
100
10
1
0.1
Q_s (μC)
I_F
I_R
$-\frac{dI}{dt}$
Q_s
maximum values
$T_j = 150°C$
I_F=100A
50A
20A
10A
5A
1
10
100
$-\frac{dI}{dt}$ (A/μs)

SILICON HIGH VOLTAGE DIODE

The BYX35 is primarily intended for the high voltage power supply of X-ray, electron microscope and LASER equipment.
The device is in a ceramic tube and must be immersed in oil for cooling and insulating.
The diodes can be connected in series, without voltage equalizing elements, for higher voltage applications.

QUICK REFERENCE DATA				
Crest working reverse voltage	V_{RWM}	max.	25	kV
Repetitive peak reverse voltage	V_{RRM}	max.	37.5	kV
Average forward current	I_{FAV}	max.	0.05	A
Non repetitive peak forward current t = 10 ms	I_{FSM}	max.	15	A

MECHANICAL DATA Dimensions in mm



Net weight : 42 g
With accessories: 44 g

For mounting instructions see page 3.

All information applies to frequencies from 40 up to 400 Hz.

RATINGS (Limiting values) [1])

Voltages

Crest working reverse voltage	V_{RWM}	max.	25	kV
Repetitive peak reverse voltage	V_{RRM}	max.	37.5	kV
Non repetitive peak reverse voltage ($t \leq 10$ ms)	V_{RSM}	max.	40	kV

Currents

Continuous operation				
Average forward current (averaged over any 20 ms period) $T_{oil} \leq 50\,^{o}C$	I_{FAV}	max.	0.05	A
Repetitive peak forward current	I_{FRM}	max.	0.16	A
Non repetitive peak forward current ($t = 10$ ms)	I_{FSM}	max.	15	A
Intermittent operation				
Average forward current (averaged over any 20 ms period) $T_{oil} \leq 50\,^{o}C$ ($t \leq 0.5$ s once every 18 s)	I_{FAV}	max.	0.5	A
Repetitive peak forward current ($t \leq 0.5$ s once every 18 s)	I_{FRM}	max.	1.6	A

Temperatures

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

THERMAL RESISTANCE

From junction to cooling oil	$R_{th\ j\text{-}o}$	=	8	$^{o}C/W$

CHARACTERISTICS

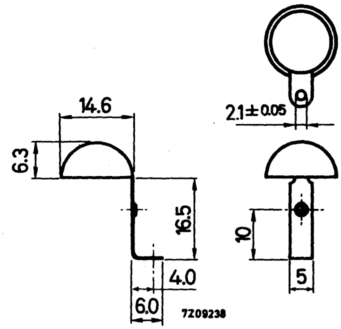
Forward voltage at $I_F = 10$ mA; $T_j = 25\,^{o}C$	V_F	typ.	25	V
Diode capacitance at $T_j = 25\,^{o}C$	C_d	typ.	45	pF

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

MOUNTING INSTRUCTIONS

Dimensions in mm

Each diode is supplied with 2 anti-corona caps.

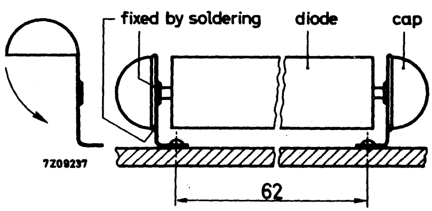


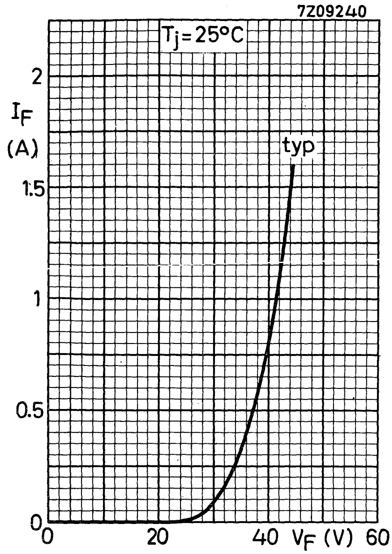
1. Mount clip on board.
2. Solder diode into fixing hole.
3. Bend anti-corona cap down in direction of arrow and solder into position.

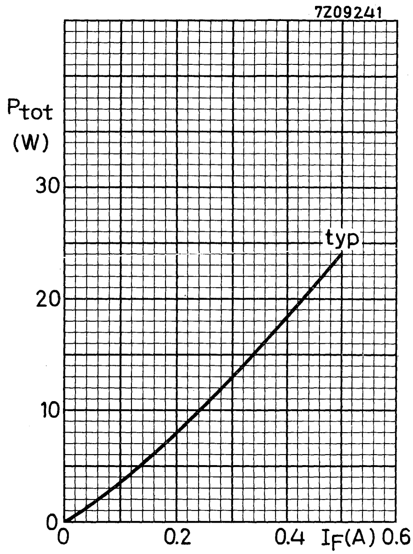
Notes:

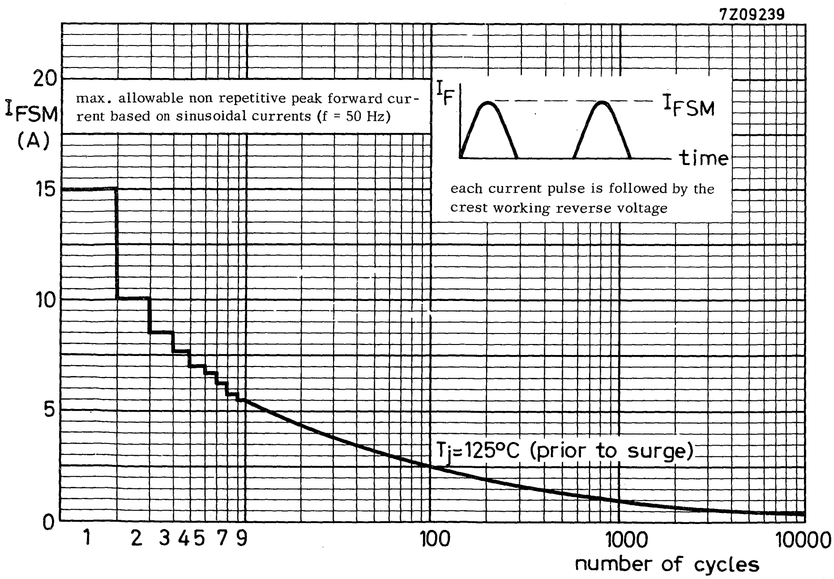
a. For good heat transfer and insulation, the devices must be immersed in oil.

b. Any mounting position can be used.




7Z09240
$T_j = 25°C$
I_F (A)
typ
V_F (V)
0
0.5
1
1.5
2
0
20
40
60


7Z09241
P_{tot} (W)
typ
I_F(A)
0
10
20
30
0
0.2
0.4
0.6


7Z09239
I_{FSM} (A)
max. allowable non repetitive peak forward current based on sinusoidal currents (f = 50 Hz)
I_F
I_{FSM}
time
each current pulse is followed by the crest working reverse voltage
T_j=125°C (prior to surge)
0
5
10
15
20
1
2
3
4
5
7
9
100
1000
10000
number of cycles

SILICON RECTIFIER DIODES

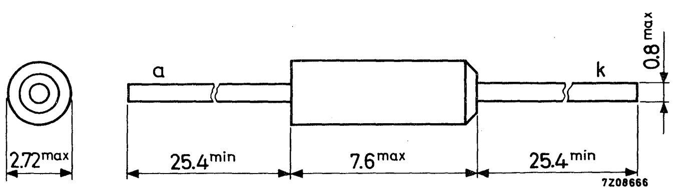
Diffused silicon rectifier diodes in a DO-15 plastic envelope for general purposes. The series consists of the following types: BYX36-150, BYX36-300, BYX36-600.

QUICK REFERENCE DATA

			BYX36-			
			150	300	600	
Crest working reverse voltage	V_{RWM}	max.	100	200	400	V
Repetitive peak reverse voltage	V_{RRM}	max.	150	300	600	V
Average forward current with R-load up to T_{amb} = 40 °C	I_{FAV}	max.		0.8		A
Junction temperature	T_j	max.		125		°C

MECHANICAL DATA Dimensions in mm

DO-15



The coned end indicates the cathode side

RATINGS (Limiting values) [1]

Voltages			BYX36-150	300	600	
Continuous reverse voltage	V_R	max.	100	200	400	V
Crest working reverse voltage	V_{RWM}	max.	100	200	400	V
Repetitive peak reverse voltage	V_{RRM}	max.	150	300	600	V
Non repetitive peak reverse voltage ($t \leq 10$ ms)	V_{RSM}	max.	150	300	600	V

Currents				
Average forward current (averaged over any 20 ms period) for R-load up to T_{amb} = 40 °C	I_{FAV}	max.	0.8	A
Forward current (d.c.) up to T_{amb} = 40 °C	I_F	max.	0.9	A
Repetitive peak forward current	I_{FRM}	max.	5	A
Non repetitive peak forward current t = 10 ms; half sine wave	I_{FSM}	max.	30	A

Temperatures				
Storage temperature	T_{stg}		−55 to +125	°C
Junction temperature	T_j	max.	125	°C

THERMAL RESISTANCE

From junction to ambient — $R_{th\ j-a}$ — see page 3

CHARACTERISTICS — T_j = 25 °C unless otherwise specified

Forward voltage at I_F = 1 A [2]	V_F	typ.	0.9	V
		<	1.2	V
I_F = 5 A [2]	V_F	typ.	1.1	V
Reverse current				
$V_R = V_{RWMmax}$; T_j = 125 °C	I_R	<	120	μA

[1] Limiting values according to the Absolute Maximum System as defined in IEC publication 134.
[2] Measured under pulsed conditions to prevent excessive dissipation.

7Z3 1890

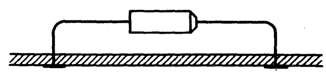
MOUNTING METHODS

The thermal resistance values apply when the leads of the diodes are mounted separately. When at the tie-points other diodes (or dissipating resistors) are connected, the thermal resistance of the diode will increase.

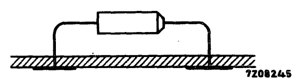
1. Mounted on soldering lips at a lead-length of 5 mm. $R_{th\ j-a} = 110\ ^{o}C/W$

2. Mounted on soldering lips at maximum lead-length. $R_{th\ j-a} = 135\ ^{o}C/W$

3. Mounted on a printed board with a small area of copper ($< 0.25\ cm^2$), at any lead length. $R_{th\ j-a} = 150\ ^{o}C/W$

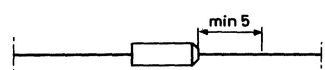


4. Mounted on a printed board with a large area of copper ($\geq 1.5\ cm^2$), at any lead length. $R_{th\ j-a} = 90\ ^{o}C/W$



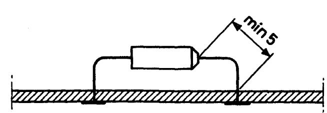
Iron soldering

At a max. iron temperature of 300 ^{o}C. the max. permissible soldering time is 3 s, provided the soldering spot is at least 5 mm from the seal.

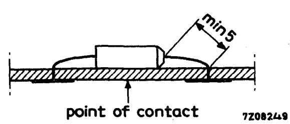


Dip soldering

At a max. solder temperature of 300 ^{o}C, the max. permissible soldering time is 3 s, provided the soldering spot is at least 5 mm from the seal.



Note: If during soldering the diode is in contact with the printed board the maximum permissible temperature of the point of contact is 125 ^{o}C.



OPERATING NOTES (determination of the required mounting method)

It is always desirable to run semiconductor devices at as low a junction temperature as possible, and mounting conditions should be chosen to ensure this.

The mounting used for the BYX36series of diodes will depend on the current rating required. From the known current and ambient temperature requirements a thermal resistance can be determined from the rating curve on page 5, upper figure.

At page 3 some mounting methods are given with their corresponding thermal resistances.

These values can only be regarded as a guide, as local conditions such as the proximity of many dissipating components or large masses of cool metal can alter these values considerably.

If possible, the running conditions should be checked using a thermocouple to measure the temperature of the lead at its tie-point.
This can be referred to the curve on page 5, lower figure.

EXAMPLE

A rectifier is required to supply 0.55 A maximum from a 100 V a.c. supply with capacitive smoothing and a maximum ambient temperature of 60 ^{o}C, f = 50 Hz.

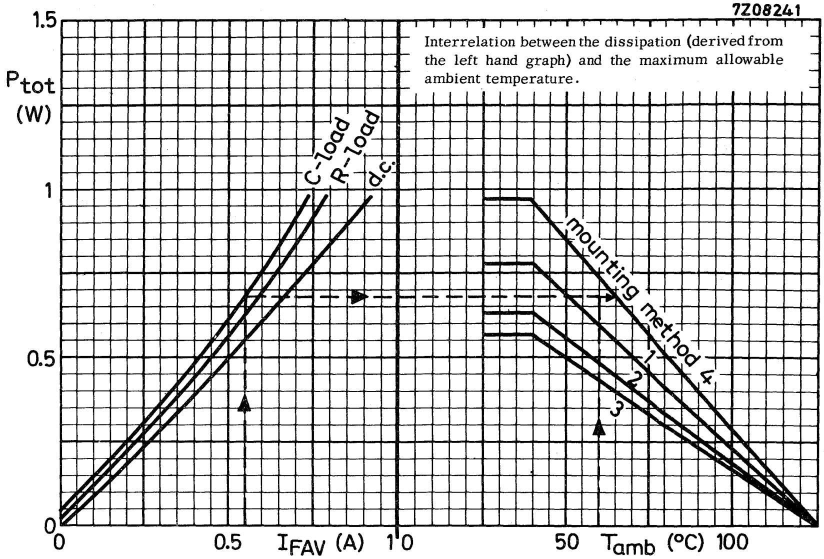
Solution.

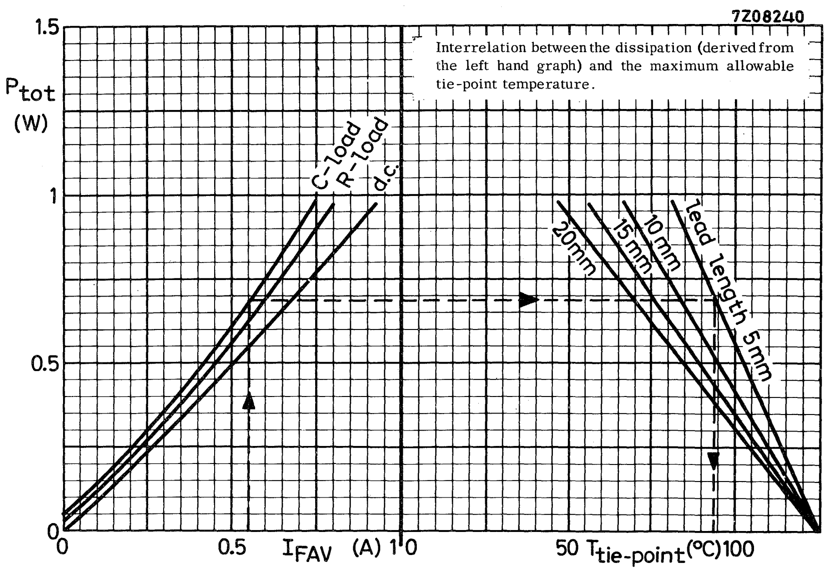
a) For this example it is assumed that a printed wiring board is designed with ample copper around each connection at a hole spacing of one inch.
From the upper graph on page 5 it follows that at I_{FAV} = 0.55 A and C-load the average forward power + average leakage power = 0.68 W.

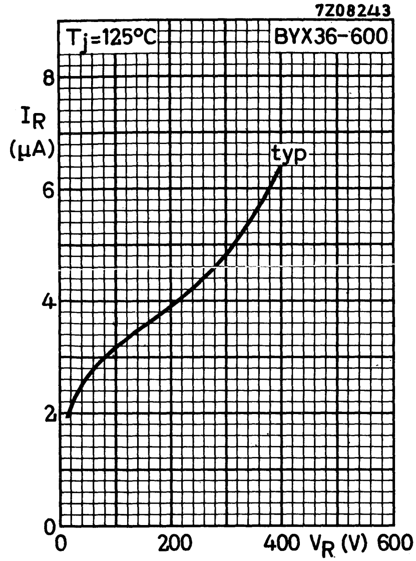
From the graph it follows that at T_{amb} = 60 ^{o}C, mounting method 4 has to be used (i.e. mounting on a printed wiring board with large copper area).

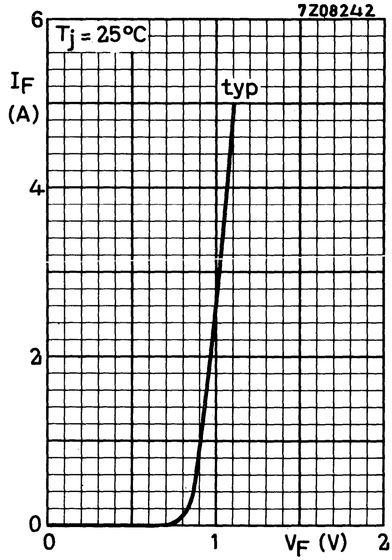
b) When for the same rectifier a more precise printed board design is desirable, the temperature of the lead/printed wiring board join (tie-point) has to be measured.
From the lower graph on page 5 it follows that at I_{FAV} = 0.55 A and C-load the average forward power + average leakage power = 0.68 W.
From the graph it follows that at a lead length of 5 mm the maximum tie-point temperature is 94 ^{o}C. At this lead length an area of copper has to be chosen around the tie points, such that this temperature will never be exceeded.

7Z3 1892


7Z08241
Interrelation between the dissipation (derived from the left hand graph) and the maximum allowable ambient temperature.
1.5
Ptot
(W)
1
0.5
0
0
0.5
IFAV (A)
1
0
50
Tamb (°C)
100
C-load
R-load
d.c.
mounting method 4
1
2
3


7Z08240
Interrelation between the dissipation (derived from the left hand graph) and the maximum allowable tie-point temperature.
1.5
Ptot
(W)
1
0.5
0
0
0.5
IFAV (A)
1
0
50
Ttie-point (°C)
100
C-load
R-load
d.c.
20mm
15mm
10mm
lead length 5mm


7Z08243
Tj=125°C
BYX36-600
IR
(μA)
typ
0
2
4
6
8
0
200
400
VR (V)
600


7Z08242
Tj = 25°C
IF
(A)
typ
0
2
4
6
0
1
VF (V)
2

SILICON RECTIFIER DIODES

Diffused silicon rectifier diodes in a DO-4 metal envelope intended for power rectifier applications. The series consists of the following types.
Normal polarity (stud cathode): BYX38-300; BYX38-600; BYX38-900; BYX38-1200.
Reverse polarity (stud anode): BYX38-300R; BYX38-600R; BYX38-900R; BYX38-1200R

QUICK REFERENCE DATA

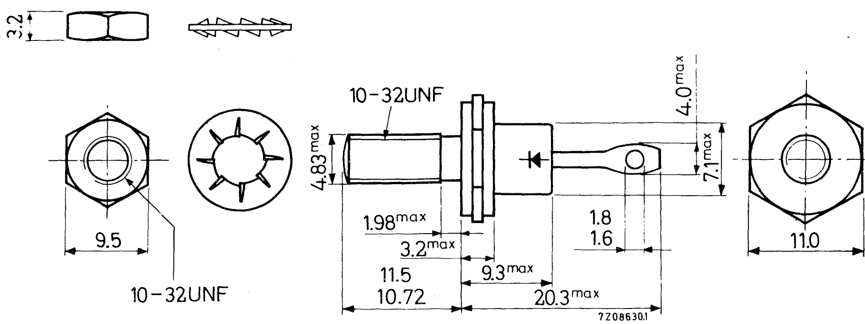
			BYX38-300(R)	600(R)	900(R)	1200(R)	
Crest working reverse voltage	V_{RWM}	max.	200	400	600	800	V
Repetitive peak reverse voltage	V_{RRM}	max.	300	600	900	1200	V

Average forward current up to T_{mb} = 75 °C	I_{FAV}	max.	6	A
Junction temperature	T_j	max.	150	°C
Thermal resistance from junction to mounting base	$R_{th\ j\text{-}mb}$	=	5	°C/W

MECHANICAL DATA

Dimensions in mm

DO-4



Net weight : 4.3 g
With accessories: 6.5 g
Diameter of hole in heatsink: max. 5.2 mm
Accessories available: 56295 (56262A)

Torque on nut: min. 8 cmkg
max. 17 cmkg
The mark shown applies to normal polarity types

All information applies to the frequency range 50 to 400 Hz

RATINGS (Limiting values) [1]

Voltages			BYX38-300(R)	600(R)	900(R)	1200(R)	
Crest working reverse voltage	V_{RWM}	max.	200	400	600	800	V
Repetitive peak reverse voltage	V_{RRM}	max.	300	600	900	1200	V
Non repetitive peak reverse voltage ($t \leq 10$ ms)	V_{RSM}	max.	300	600	900	1200	V

Currents

Average forward current (averaged over any 20 ms period) T_{mb} = 75 °C	I_{FAV}	max.	6.0	A
T_{mb} = 125 °C	I_{FAV}	max.	2.5	A
Forward current (d.c.) T_{mb} = 90 °C	I_F	max.	6.0	A
T_{mb} = 125 °C	I_F	max.	3.0	A
Repetitive peak forward current	I_{FRM}	max.	20	A
Non repetitive peak forward current t = 10 ms (see also page A) T_j = 125 °C	I_{FSM}	max.	38	A
I squared t for fusing (t = 10 ms)	I^2t	max.	7.3	A^2s

Temperatures

Storage temperature	T_{stg}		-55 to +150	°C
Junction temperature	T_j	max.	150	°C

THERMAL RESISTANCE

From junction to mounting base	$R_{th\ j\text{-}mb}$	=	5	°C/W
From mounting base to heatsink	$R_{th\ mb\text{-}h}$	=	0.6	°C/W

CHARACTERISTICS T_j = 25 °C unless otherwise specified

Forward voltage	at I_F = 5 A [2]	V_F	<	1.7	V
	I_F = 15 A [2]	V_F	<	2.1	V
Reverse current	$V_R = V_{RWMmax}$	I_R	<	10	μA
	$V_R = V_{RWMmax}$; T_j = 125 °C	I_R	<	200	μA

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

[2] Measured under pulsed conditions to prevent excessive dissipation.

OPERATING NOTES

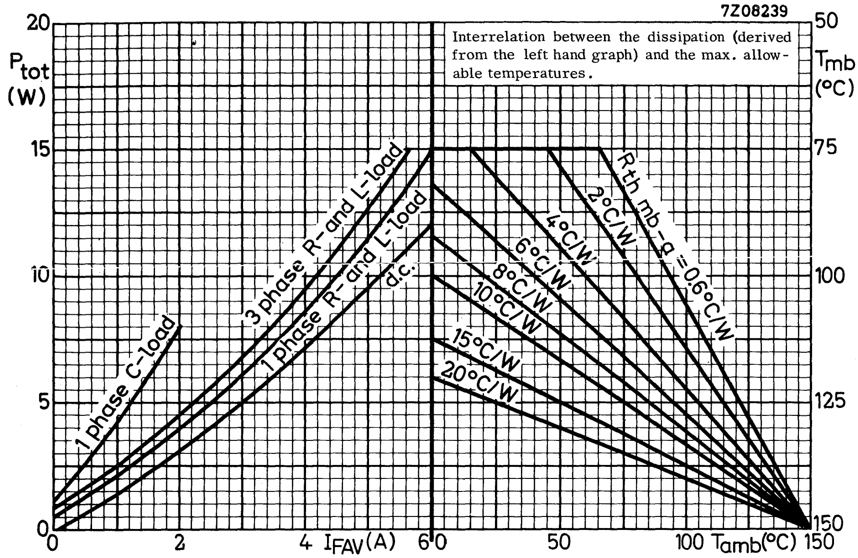
1. Where there is a possibility that transient voltages, caused by the stored energy in the transformer core, will exceed the maximum permissible non repetitive peak reverse voltage, a damping circuit across the transformer should be applied.
   Either a series RC circuit or a voltage dependent resistor may be used.
   Suitable component values for an RC circuit across the transformer primary or secondary may be calculated as follows:

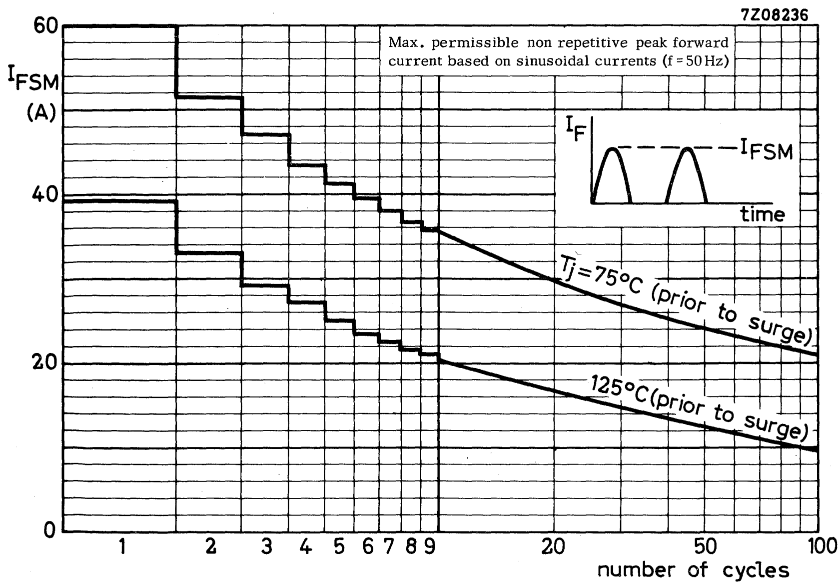
$\frac{V_{RSM}}{V_{RWM}}$	RC across primary of transformer		RC across secondary of transformer	
	C (μF)	R (Ω)	C (μF)	R (Ω)
2.0	$200\frac{I_{mag}}{V_1}$	$\frac{150}{C}$	$225\frac{I_{mag}T^2}{V_1}$	$\frac{200}{C}$
1.5	$400\frac{I_{mag}}{V_1}$	$\frac{225}{C}$	$450\frac{I_{mag}T^2}{V_1}$	$\frac{275}{C}$

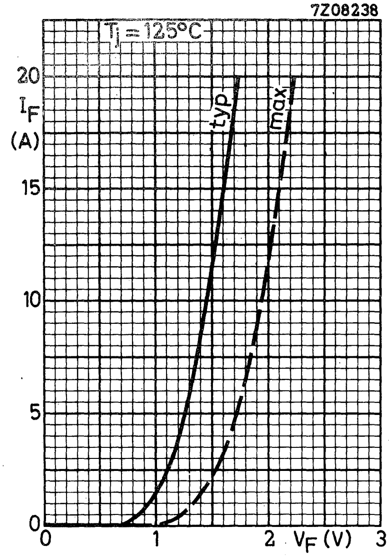
where I_{mag} = magnetising primary r.m.s. current (A)
V_1 = transformer primary r.m.s. voltage (V)
V_2 = transformer secondary r.m.s. voltage (V)
T = V_1/V_2
V_{RWM} stands for the actually applied crest working voltage

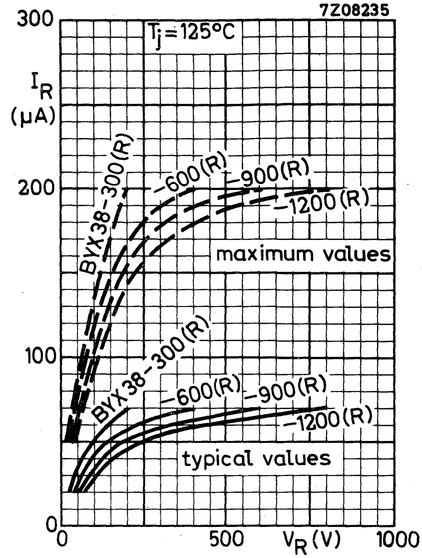
2. In order to prevent the diodes from being damaged by surge currents higher than those mentioned in the curves at page 4 a fast fuse is recommended.

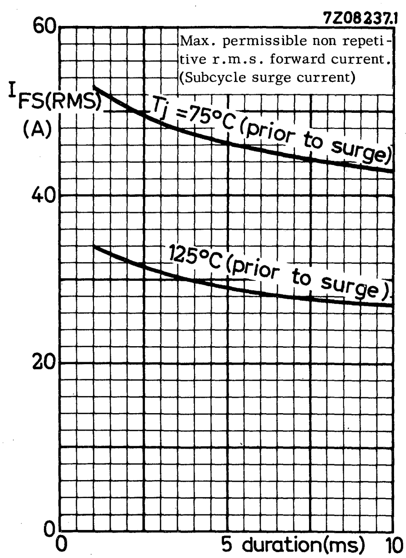
3. The top connector should neither be bent nor twisted; it should be soldered into the circuit so there is no strain on it.
   During soldering the heat conduction to the junction should be kept to a minimum by using a thermal shunt.


7Z08239
Interrelation between the dissipation (derived from the left hand graph) and the max. allowable temperatures.
P_{tot} (W)
T_{mb} (°C)
1 phase C-load
3 phase R- and L-load
1 phase R- and L-load
d.c.
Rth mb-a = 0.6°C/W
2°C/W
4°C/W
6°C/W
8°C/W
10°C/W
15°C/W
20°C/W
I_{FAV} (A)
T_{amb} (°C)
0
2
4
6
50
100
150
5
10
15
20
75
125


7Z08236
Max. permissible non repetitive peak forward current based on sinusoidal currents (f = 50 Hz)
I_{FSM} (A)
I_F
I_{FSM}
time
Tj = 75°C (prior to surge)
125°C (prior to surge)
number of cycles
0
20
40
60
1
2
3
4
5
6
7
8
9
20
50
100


7Z08238
T_j = 125°C
I_F (A)
typ
max
V_F (V)
0
1
2
3
5
10
15
20


7Z08235
T_j = 125°C
I_R (μA)
BYX38-300(R)
-600(R)
-900(R)
-1200(R)
maximum values
typical values
V_R (V)
0
100
200
300
500
1000

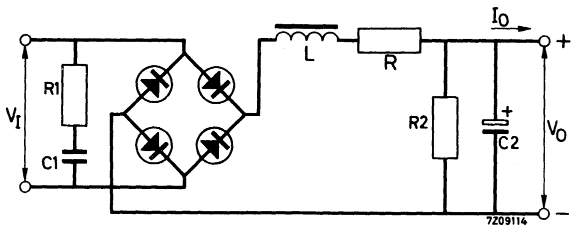

7Z08237.1
Max. permissible non repetitive r.m.s. forward current. (Subcycle surge current)
$I_{FS(RMS)}$ (A)
T_j = 75°C (prior to surge)
125°C (prior to surge)
duration(ms)
0
5
10
20
40
60

APPLICATION INFORMATION

Full wave rectifier circuit with choke input filter

Operating ambient temperature T_{amb} up to 50 °C

		BYX38-600(R)	900(R)	1200(R)	
R.M.S. input voltage	$V_{I(RMS)}$	130	200	250	V
Average output voltage	V_O	100	150	200	V
Average output current	I_O	0 to 4	0 to 4	0 to 4	A
Maximum ripple		0.5	0.5	0.5	%



Each diode is mounted on a 6 cm x 6 cm blackened aluminium cooling fin.
Thickness 1.6 mm

Table of circuit components

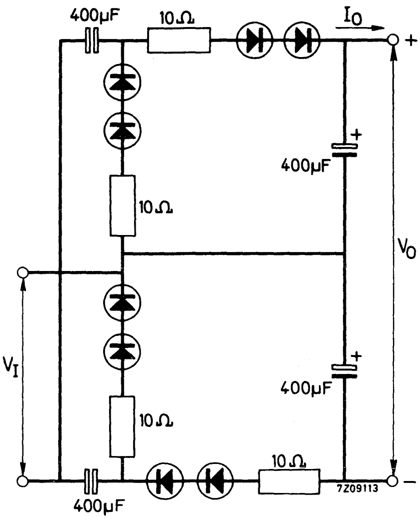
	BYX38-600(R)	900(R)	1200(R)	
R1	220	220	390	Ω [1]
C1	1.0	1.0	0.5	μF [1]
L	0.5	1.0	1.0	H
	(R = 3)	(R = 5)	(R = 5)	Ω
R2	200	300	400	Ω
	(50)	(75)	(100)	W
C2	500	250	250	μF

[1]) RC damping circuit; see operating notes on page 3.

APPLICATION INFORMATION (continued)

Voltage quadrupler circuit with BYX38-1200(R)

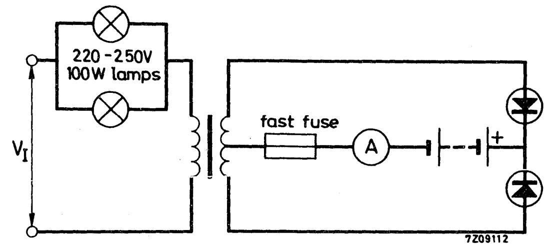
Operating ambient temperature	T_{amb}	up to	50	°C
R.M.S. input voltage	$V_{I(RMS)}$		220	V
Average output voltage	V_O		910	V
Average output current	I_O		840	mA



Each diode is mounted on a 4.5 cm x 4.5 cm blackened aluminimum cooling fin. Thickness 1.6 mm.

APPLICATION INFORMATION (continued)

Protected battery charger with BYX38-300



Both rectifier diodes are mounted on a 15 cm x 15 cm vertically mounted blackened aluminium flat heatsink. Thickness 1.6 mm.

$V_{I(RMS)}$	Mean charging current for a battery voltage of:	
	6 V	12 V
220 V	5.6 A	3.4 A
250 V	5.0 A	3.4 A

Transformer data:

n (primary to half secondary)	0.094	
$V_{T(RMS)}$	150	V
$I_{primary}$ (rms)	0.75	A
$I_{secondary}$ (rms)	4.5	A
$I_{primary}$ (off-load saturation current with two 100 W lamps in parallel, connected in series with primary)	0.6	A

CONTROLLED AVALANCHE RECTIFIER DIODES

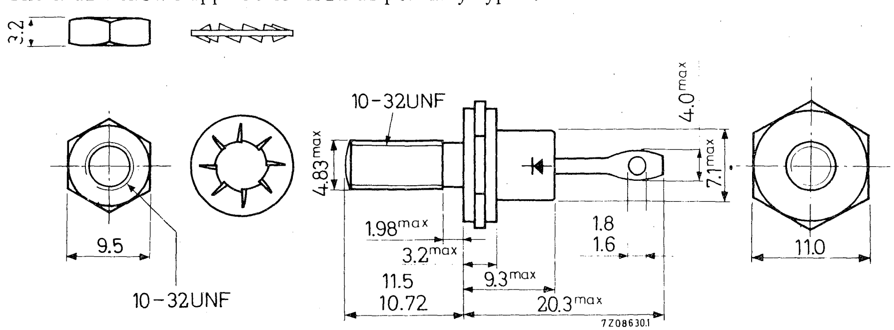
Silicon diodes in a DO-4 metal envelope, capable of absorbing transients and intended for power rectifier application.
The series consists of the following types:
Normal polarity (stud cathode): BYX39-600; BYX39-800; BYX39-1000
Reverse polarity (stud anode): BYX39-600R; BYX39-800R; BYX39-1000R

QUICK REFERENCE DATA

			BYX39-600(R)	800(R)	1000(R)	
Crest working reverse voltage	V_{RWM}	max.	600	800	1000	V
Average forward current	I_{FAV}	max.	6			A
Non repetitive peak forward current; t = 10 ms; T_j = 125 °C	I_{FSM}	max.	100			A
Repetitive peak reverse power t = 10 μs; T_j = 125 °C	P_{RRM}	max.	2			kW
Non repetitive peak reverse power t = 10 μs; T_j = 25 °C	P_{RSM}	max.	4			kW
Junction temperature	T_j	max.	175			°C

MECHANICAL DATA

DO-4
The mark shown applies to normal polarity types.



Net weight : 4.3 g
With accessories: 6.5 g
Diameter of hole in heatsink: max. 5.2 mm
Accessories available: 56295 (56262A)

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

7Z3 2068

All information applies to frequencies up to 400 Hz

RATINGS (Limiting values) [1]

Voltages [2]			BYX39-600(R)	800(R)	1000(R)	
Crest working reverse voltage	V_{RWM}	max.	600	800	1000	V

Currents

Average forward current (averaged over any 20 ms period)	I_{FAV}	max.	6.0	A
Forward current (d.c.)	I_F	max.	6.8	A
R.M.S. forward current	$I_{F(RMS)}$	max.	9.5	A
Repetitive peak forward current	I_{FRM}	max.	120	A
Non repetitive peak forward current t = 10 ms; T_j = 125 °C; see also page 7	I_{FSM}	max.	100	A
I squared t for fusing	See curves at page 7			

Reverse power dissipation

Reverse power (averaged over any 20 ms period)	P_{RAV}	max.	10	W
Repetitive peak reverse power at f = 50 Hz square wave; t = 10 μs; T_j = 125 °C (see also pages 5 and 6)	P_{RRM}	max.	2	kW
Non repetitive peak reverse power square wave; see also page 6 t = 10 μs; T_j = 25 °C	P_{RSM}	max.	4	kW
T_j = 175 °C	P_{RSM}	max.	0.8	kW

Temperatures

Storage temperature	T_{stg}		−55 to +175	°C
Junction temperature	T_j	max.	175	°C

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

[2] To ensure thermal stability: $R_{th\ j\text{-}a} < 20$ °C/W (a.c.)
For smaller heatsinks T_j max. should be derated.
(see also page 5)

7Z3 1870

THERMAL RESISTANCE

From junction to ambient in free air	$R_{th\ j-a}$	=	50 °C/W
From junction to mounting base	$R_{th\ j-mb}$	=	4.5 °C/W
From mounting base to heatsink	$R_{th\ mb-h}$	=	0.5 °C/W

CHARACTERISTICS

Voltages		BYX39-600(R)	800(R)	1000(R)	
Forward voltage at					
I_F = 20 A; T_j = 25 °C	V_F	< 2.0	2.0	2.0	V [1]
Reverse breakdown voltage (see also page 8)					
I_R = 5 mA; T_j = 25 °C	$V_{(BR)R}$	> 750	1000	1250	V
		< 1600	1600	1600	V
Currents					
Reverse current at T_j = 125 °C					
V_R = 600 V	I_R	< 150			μA
V_R = 800 V	I_R	<	150		μA
V_R = 1000 V	I_R	<		150	μA

OPERATING NOTES

1. Voltage sharing of series connected controlled avalanche diodes.

   If diodes with avalanche characteristics are connected in series, the usual R and C elements for voltage sharing can be omitted.

2. In order to prevent the diodes from being damaged by surge currents higher than those mentioned in the curves at page 7 a fast fuse is recommended.

3. The top connector should neither be bent nor twisted; it should be soldered into the circuit so there is no strain on it.
   During soldering the heat conduction to the junction should be kept to a minimum by using a thermal shunt.

---

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

7Z3 1871

Determination of the heatsink thermal resistance.

Example:

Assume a diode, used in a single phase rectifier circuit.

frequency	f	=	50	Hz
average forward current	I_{FAV}	=	3	A (per diode)
ambient temperature	T_{amb}	=	70	°C
repetitive peak reverse power dissipation in the avalanche region	P_{RRM}	=	0.5	kW (per diode)
duration of P_{RRM}	t	=	70	µs

From the left hand part of the upper graph on page 5 it follows that at I_{FAV} = 3 A in a single phase rectifier circuit the average forward power + average leakage power = 4.9 W per diode (point A). The average reverse power in the avalanche region, averaged over any cycle, follows from:

$$P_{RAV} = \delta \times P_{RRM}, \text{ where the duty cycle } \delta = \frac{70\ \mu s}{20\ ms} = 0.0035$$

Thus: $P_{RAV} = 0.0035 \times 0.5\ kW = 1.75\ W$.

Therefore the total device power dissipation $P_{tot} = (4.9 + 1.75)\ W = 6.65\ W$ (point B). From the graph follows a maximum allowable mounting base temperature T_{mb} = 145 °C (point C).

However, to avoid excessive peak junction temperatures resulting from the pulse character of the repetitive peak reverse power in the avalanche region, this value of the mounting base temperature should be decreased as follows: If the repetitive peak reverse power in the avalanche region is 0.5 kW; t = 70 µs; f = 50 Hz, the maximum allowable junction temperature should be 167 °C instead of 175 °C (see the lower graph on page 5).
Therefore the mounting base temperature should be decreased with 175 - 167 = 8 °C as well.

So the maximum allowable mounting base temperature is 145 - 8 = 137 °C (point D).

From the right hand part of the upper graph on page 5 follows the thermal resistance, required for P_{tot} = 6.65 W at T_{amb} = 70 °C.

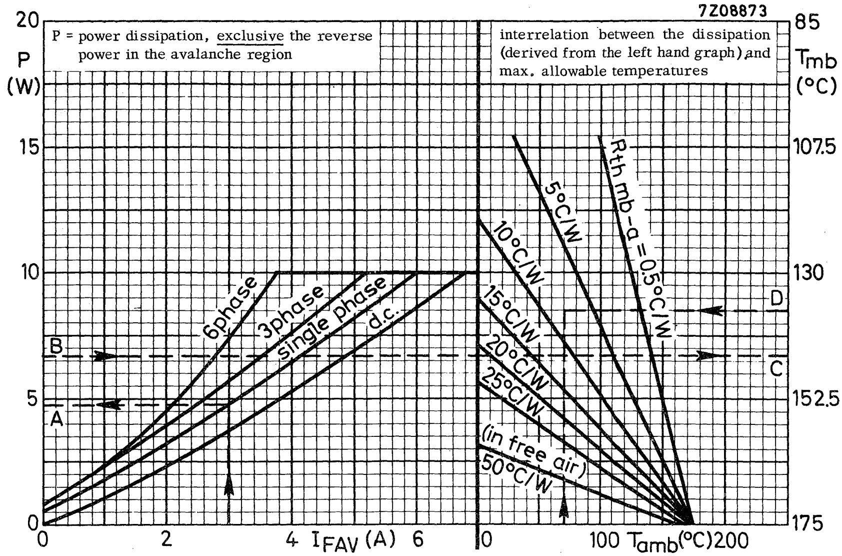
$$R_{th\ mb\text{-}a} \approx 8\ ^{o}C/W$$

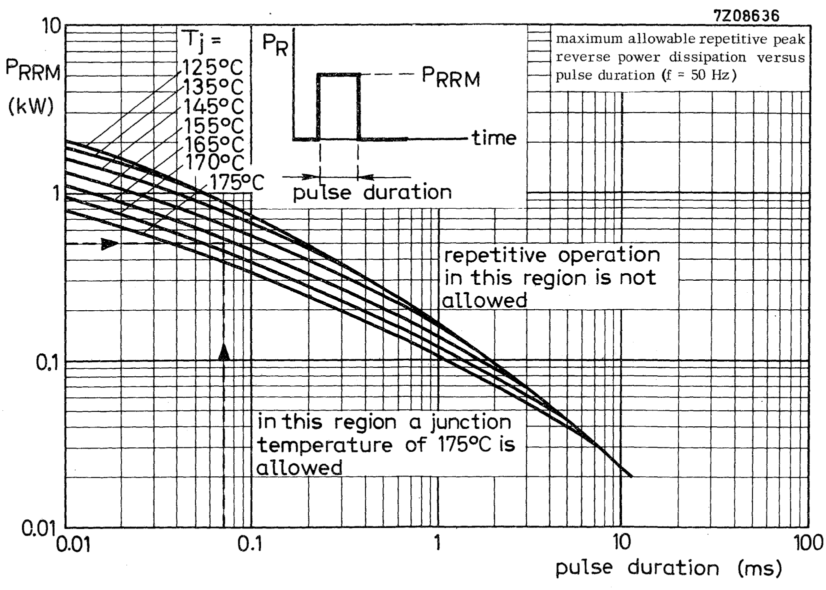
The contact thermal resistance $R_{th\ mb\text{-}h}$ = 0.5 °C/W
Hence the heatsink thermal resistance should be:

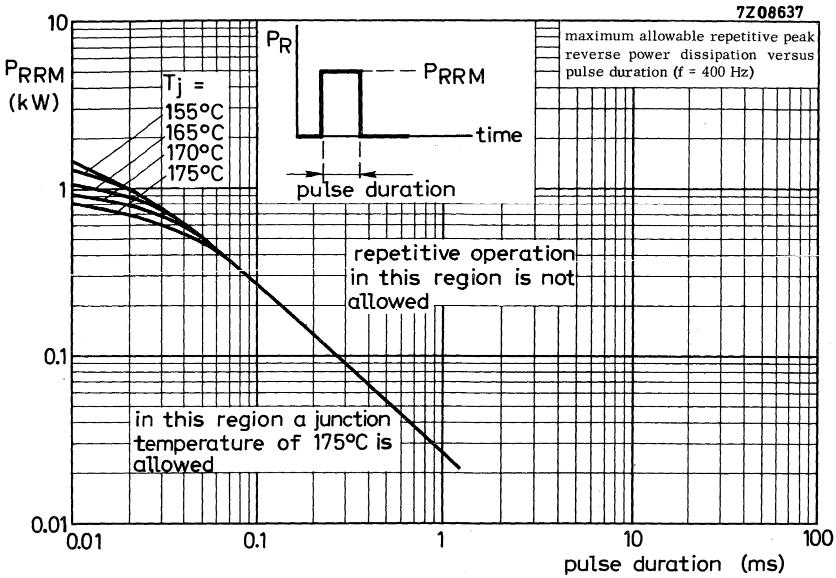
$$R_{th\ h\text{-}a} = R_{th\ mb\text{-}a} - R_{th\ mb\text{-}h} = (8 - 0.5)\ ^{o}C/W = 7.5\ ^{o}C/W.$$

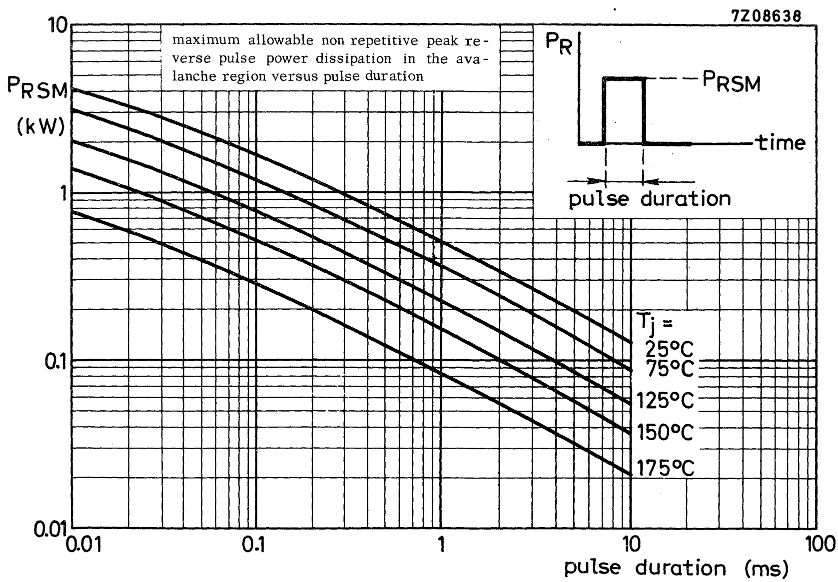
The applicable heatsink(s) may then be found in the Section ACCESSORIES and HEATSINKS.

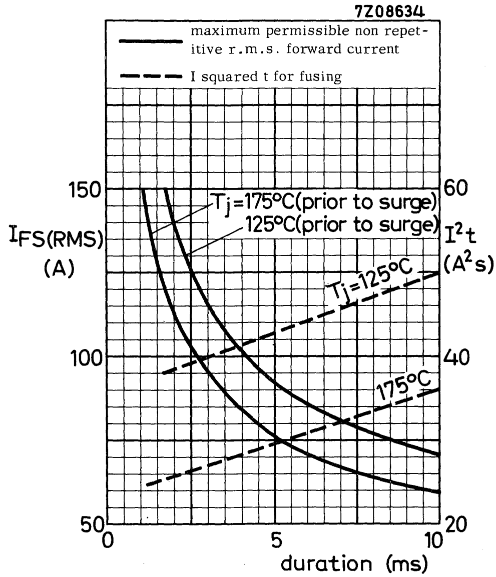
7Z3 1872

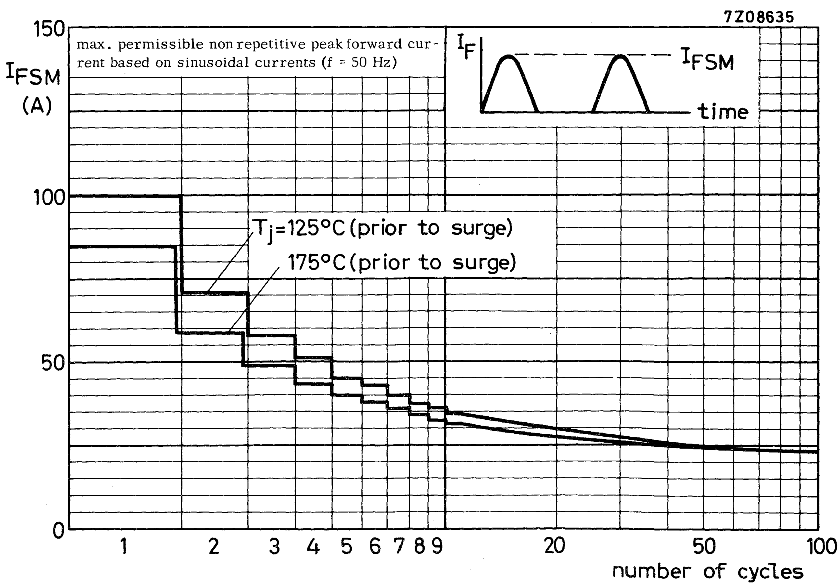

7Z08873
P = power dissipation, exclusive the reverse power in the avalanche region
interrelation between the dissipation (derived from the left hand graph) and max. allowable temperatures
P (W)
Tmb (°C)
6phase
3phase
single phase
d.c.
5°C/W
10°C/W
15°C/W
20°C/W
25°C/W
(in free air)
50°C/W
Rth mb-a = 0.5°C/W
A
B
C
D
IFAV (A)
Tamb (°C)

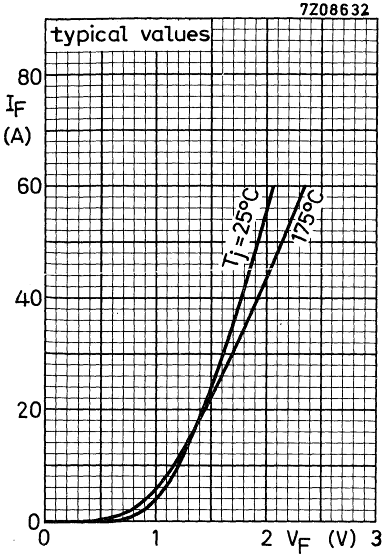

7Z08636
maximum allowable repetitive peak reverse power dissipation versus pulse duration (f = 50 Hz)
PRRM (kW)
Tj =
125°C
135°C
145°C
155°C
165°C
170°C
175°C
PR
PRRM
time
pulse duration
repetitive operation in this region is not allowed
in this region a junction temperature of 175°C is allowed
pulse duration (ms)

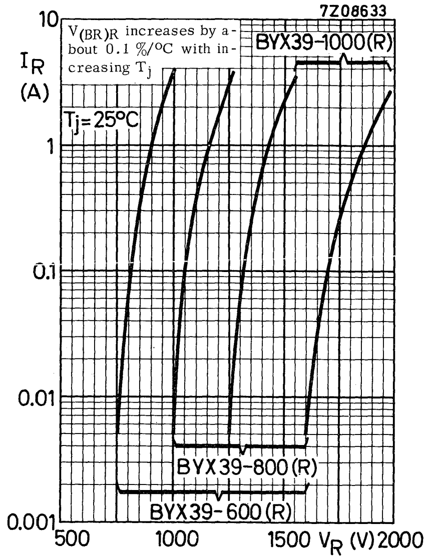

7Z08637
maximum allowable repetitive peak reverse power dissipation versus pulse duration (f = 400 Hz)
P_{RRM} (kW)
T_j =
155°C
165°C
170°C
175°C
P_R
P_{RRM}
time
pulse duration
repetitive operation in this region is not allowed
in this region a junction temperature of 175°C is allowed
10
1
0.1
0.01
0.01
0.1
1
10
100
pulse duration (ms)


7Z08638
maximum allowable non repetitive peak reverse pulse power dissipation in the avalanche region versus pulse duration
P_{RSM} (kW)
P_R
P_{RSM}
time
pulse duration
T_j =
25°C
75°C
125°C
150°C
175°C
10
1
0.1
0.01
0.01
0.1
1
10
100
pulse duration (ms)


7Z08634
maximum permissible non repetitive r.m.s. forward current
I squared t for fusing
150
100
50
$I_{FS(RMS)}$ (A)
60
40
20
I^2t (A^2s)
T_j=175°C(prior to surge)
125°C(prior to surge)
T_j=125°C
175°C
0
5
10
duration (ms)


7Z08635
max. permissible non repetitive peak forward current based on sinusoidal currents (f = 50 Hz)
I_F
I_{FSM}
time
150
100
50
0
I_{FSM} (A)
T_j=125°C (prior to surge)
175°C (prior to surge)
1
2
3
4
5
6
7
8
9
20
50
100
number of cycles


7Z08632
typical values
I_F
(A)
80
60
40
20
0
0
1
2
3
V_F (V)
T_j = 25°C
175°C


7Z08633
$V_{(BR)R}$ increases by about 0.1 %/°C with increasing T_j
T_j = 25°C
I_R
(A)
10
1
0.1
0.01
0.001
500
1000
1500
2000
V_R (V)
BYX39-1000(R)
BYX39-800(R)
BYX39-600(R)

SILICON RECTIFIER DIODES

Diffused silicon rectifier diodes in a DO-4 metal envelope intended for power rectifier applications. The series consists of the following types.
Normal polarity (stud cathode): BYX42-300; BYX42-600; BYX42-900; BYX42-1200.
Reverse polarity (stud anode): BYX42-300R; BYX42-600R; BYX42-900R; BYX42-1200R.

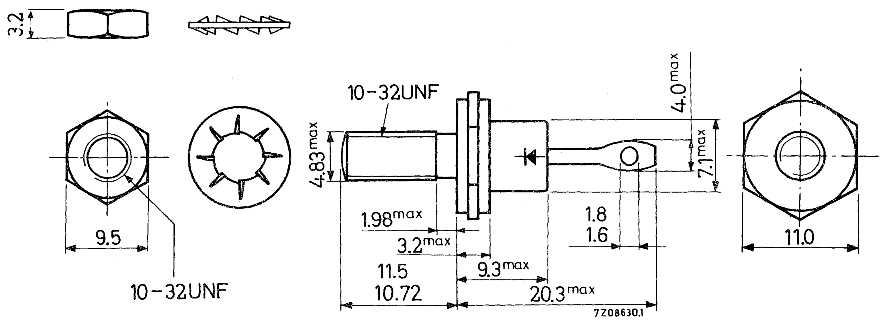
QUICK REFERENCE DATA

			BYX42-300(R)	600(R)	900(R)	1200(R)	
Crest working reverse voltage	V_{RWM}	max.	200	400	600	800	V
Repetitive peak reverse voltage	V_{RRM}	max.	300	600	900	1200	V
Average forward current up to T_{mb} = 130 °C	I_{FAV}	max.	10				A
Junction temperature	T_j	max.	175				°C

MECHANICAL DATA

Dimensions in mm

DO-4



Net weight: 4.3 g
With accessories: 6.5 g
Diameter of hole in heatsink: max. 5.2 mm
Accessories available: 56295 (56262A)

Torque on nut: min. 8 cmkg
max. 17 cmkg
The mark shown applies to normal polarity types

All information applies to frequencies up to 400 Hz

RATINGS (Limiting values) [1]

Voltages		BYX42-300(R)	600(R)	900(R)	1200(R)	
Crest working reverse voltage	V_{RWM}	max. 200	400	600	800	V
Repetitive peak reverse voltage	V_{RRM}	max. 300	600	900	1200	V
Non repetitive peak reverse voltage ($t \leq 10$ ms)	V_{RSM}	max. 300	600	900	1200	V

Currents				
Average forward current (averaged over any 20 ms period) T_{mb} = 130 °C	I_{FAV}	max.	10	A
Forward current (d.c.)	I_F	max.	16	A
Repetitive peak forward current	I_{FRM}	max.	60	A
Non repetitive peak forward current t = 10 ms (see page 3)	I_{FSM}	max.	125	A

Temperatures				
Storage temperature	T_{stg}		−55 to +175	°C
Junction temperature	T_j	max.	175	°C

THERMAL RESISTANCE

From junction to ambient in free air	$R_{th\ j\text{-}a}$	=	50	°C/W
From junction to mounting base	$R_{th\ j\text{-}mb}$	=	3.0	°C/W
From mounting base to heatsink	$R_{th\ mb\text{-}h}$	=	0.5	°C/W

CHARACTERISTICS

Forward voltage at I_F = 15 A; T_j = 25 to 175 °C [2]	V_F	<	1.4	V
Reverse current at V_R = V_{RWMmax}; T_j = 125 °C	I_R	<	200	μA

OPERATING NOTES

1. When there is a possibility that transient voltages, caused by the stored energy in the transformer core, will exceed the maximum permissible non repetitive peak reverse voltage, a damping circuit across the transformer should be applied. Either a series RC circuit or a voltage dependent resistor may be used. Suitable component values for an RC circuit across the transformer primary or secondary may be calculated as follows:

[1] Limiting values according to the Absolute Maximum System as defined in IEC publication 134.
[2] Measured under pulsed conditions to prevent excessive dissipation.

OPERATING NOTES (continued)

$\frac{V_{RSM}}{V_{RWM}}$	RC across primary of transformer		RC across secondary of transformer	
	C (μF)	R (Ω)	C (μF)	R (Ω)
2.0	$200\frac{I_{mag}}{V_1}$	$\frac{150}{C}$	$225\frac{I_{mag}T^2}{V_1}$	$\frac{200}{C}$
1.5	$400\frac{I_{mag}}{V_1}$	$\frac{225}{C}$	$450\frac{I_{mag}T^2}{V_1}$	$\frac{275}{C}$

where I_{mag} = magnetising primary r.m.s. current (A)

V_1 = transformer primary r.m.s. voltage

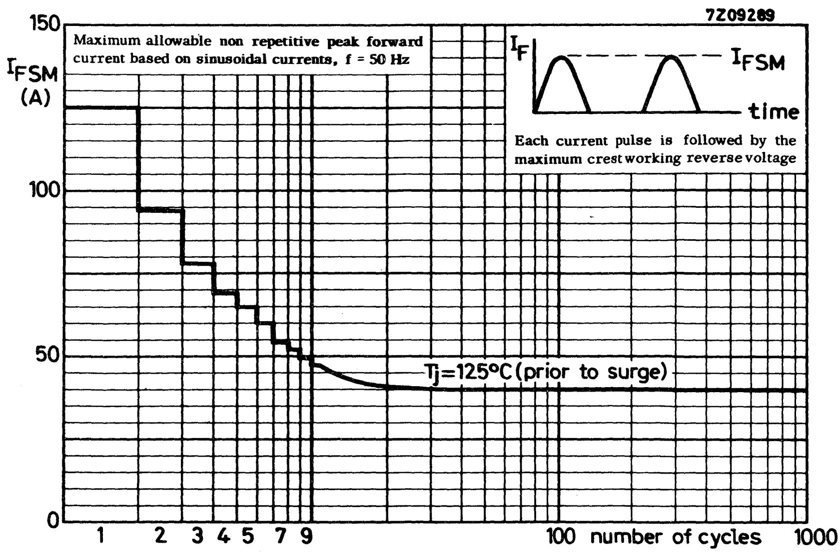
V_2 = transformer secondary r.m.s. voltage (V)

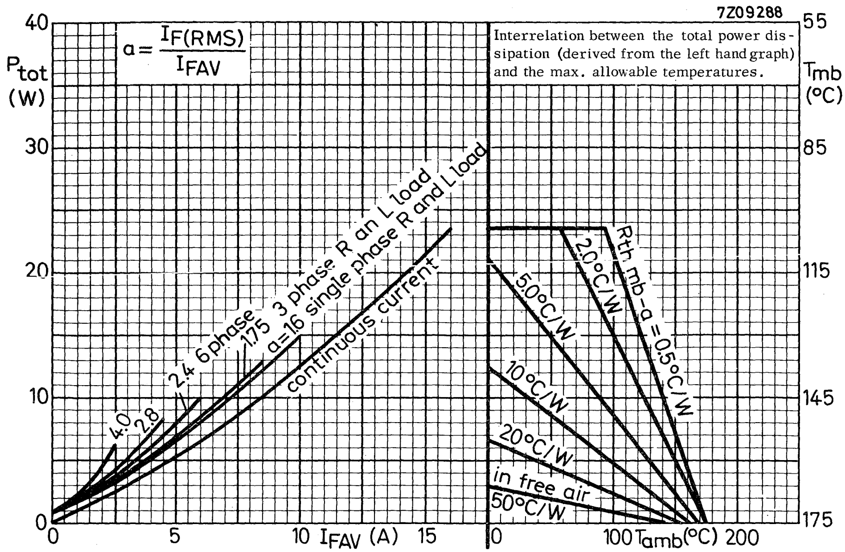
T = V_1/V_2

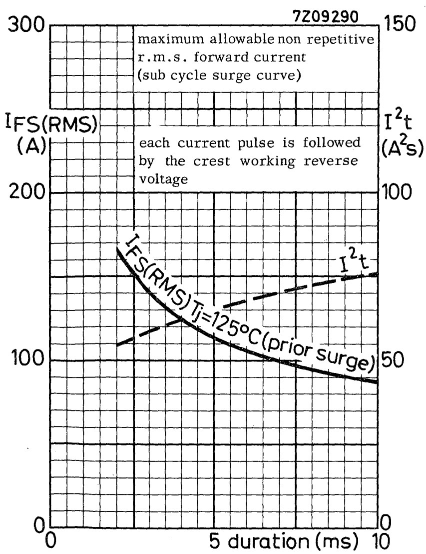
V_{RWM} stands for the actually applied crest working reverse voltage

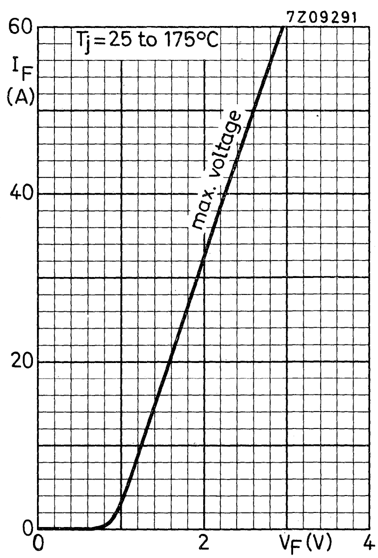
2. In order to prevent the diodes from being damaged by surge currents higher than those mentioned in the curve on page 4 a fast fuse is recommended.

3. The top connector should neither be bent nor twisted; it should be soldered into the circuit so there is no strain on it.
During soldering the heat conduction to the junction should be kept to a minimum by using a thermal shunt.




7Z09288
$a = \frac{I_{F(RMS)}}{I_{FAV}}$
Interrelation between the total power dissipation (derived from the left hand graph) and the max. allowable temperatures.
P_{tot} (W)
T_{mb} (°C)
4.0
2.8
2.4 6 phase
1.75 3 phase R an L load
a=1.6 single phase R and L load
continuous current
$R_{th\ mb-a}$ = 0.5°C/W
2.0°C/W
5.0°C/W
10°C/W
20°C/W
in free air
50°C/W
I_{FAV} (A)
T_{amb}(°C)


7Z09290
maximum allowable non repetitive r.m.s. forward current (sub cycle surge curve)
each current pulse is followed by the crest working reverse voltage
$I_{FS(RMS)}$ (A)
I^2t (A^2s)
$I_{FS(RMS)}$ T_j=125°C (prior surge)
I^2t
duration (ms)


7Z09291
T_j=25 to 175°C
I_F (A)
max. voltage
V_F (V)

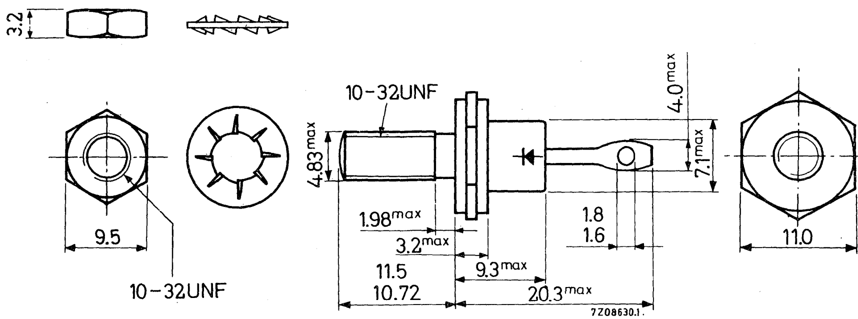
SILICON RECTIFIER DIODES

Diffused silicon rectifier diodes in a DO-4 metal envelope intended for power rectifier applications. The series consists of the following types.
Normal polarity (stud cathode): BYX48-300; BYX48-600; BYX48-900; BYX48-1200.
Reverse polarity (stud anode): BYX48-300R; BYX48-600R; BYX48-900R; BYX48-1200R.

QUICK REFERENCE DATA							
			BYX48-300(R)	600(R)	900(R)	1200(R)	
Crest working reverse voltage	V_{RWM}	max.	200	400	600	800	V
Repetitive peak reverse voltage	V_{RRM}	max.	300	600	900	1200	V
Average forward current up to T_{mb} = 130 °C	I_{FAV}	max.	6.0				A
Junction temperature	T_j	max.	175				°C

MECHANICAL DATA Dimensions in mm

DO-4



Net weight : 4.3 g
With accessories: 6.5 g
Diameter of hole in heatsink: max. 5.2 mm
Accessories available: 56295 (56262A)

Torque on nut: min. 8 cmkg
max. 17 cmkg
The mark shown applies to normal polarity types

All information applies to frequencies up to 400 Hz

RATINGS (Limiting values) [1]

Voltages		BYX48-300(R)	600(R)	900(R)	1200(R)	
Crest working reverse voltage	V_{RWM}	max. 200	400	600	800	V
Repetitive peak reverse voltage	V_{RRM}	max. 300	600	900	1200	V
Non repetitive peak reverse voltage ($t \leq 10$ ms)	V_{RSM}	max. 300	600	900	1200	V

Currents

Average forward current (averaged over any 20 ms period) T_{mb} = 130 °C	I_{FAV}	max.	6.0	A
Forward current (d.c.)	I_F	max.	9.5	A
Repetitive peak forward current	I_{FRM}	max.	36	A
Non repetitive peak forward current t = 10 ms (see page 3)	I_{FSM}	max.	90	A

Temperatures

Storage temperature	T_{stg}		-55 to +175	°C
Junction temperature	T_j	max.	175	°C

THERMAL RESISTANCE

From junction to ambient in free air	$R_{th\ j-a}$	=	50	°C/W
From junction to mounting base	$R_{th\ j-mb}$	=	4.5	°C/W
From mounting base to heatsink	$R_{th\ mb-h}$	=	0.5	°C/W

CHARACTERISTICS

Forward voltage at I_F = 15 A; T_j = 25 to 175 °C [2]	V_F	< 1.8	V
Reverse current at $V_R = V_{RWMmax}$; T_j = 125 °C	I_R	< 200	μA

OPERATING NOTES

1. When there is a possibility that transient voltages, caused by the stored energy in the transformer core, will exceed the maximum permissible non repetitive peak reverse voltage, a damping circuit across the transformer should be applied. Either a series RC circuit or a voltage dependent resistor may be used. Suitable component values for an RC circuit across the transformer primary or secondary may be calculated as follows:

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

[2] Measured under pulsed conditions to prevent excessive dissipation.

OPERATING NOTES (continued)

$\frac{V_{RSM}}{V_{RWM}}$	RC across primary of transformer		RC across secondary of transformer	
	C (μF)	R (Ω)	C (μF)	R (Ω)
2.0	$200\frac{I_{mag}}{V_1}$	$\frac{150}{C}$	$225\frac{I_{mag}T^2}{V_1}$	$\frac{200}{C}$
1.5	$400\frac{I_{mag}}{V_1}$	$\frac{225}{C}$	$450\frac{I_{mag}T^2}{V_1}$	$\frac{275}{C}$

where I_{mag} = magnetising primary r.m.s. current (A)

V_1 = transformer primary r.m.s. voltage (V)

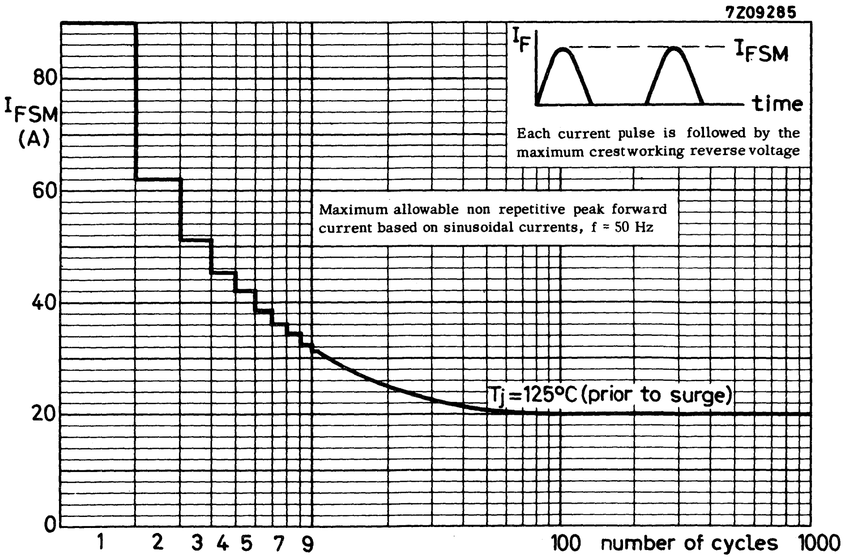
V_2 = transformer secondary r.m.s. voltage (V)

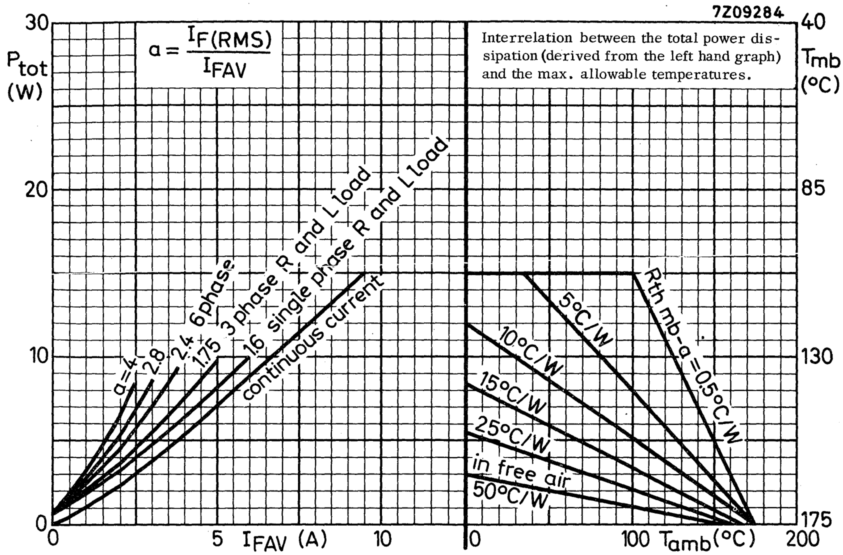
T = V_1/V_2

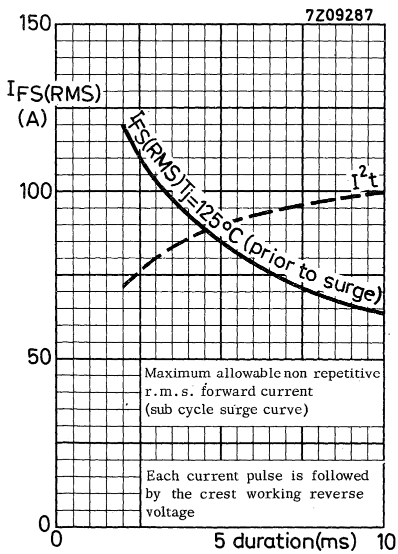
V_{RWM} stands for the actually applied crest working reverse voltage

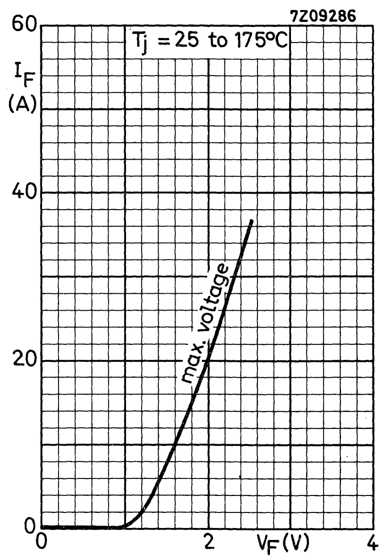
2. In order to prevent the diodes from being damaged by surge currents higher than those mentioned in the curves on page 4 a fast fuse is recommended.

3. The top connector should neither be bent nor twisted; it should be soldered into the circuit so there is no strain on it.
During soldering the heat conduction to the junction should be kept to a minimum by using a thermal shunt.




7Z09284
$a = \frac{I_{F(RMS)}}{I_{FAV}}$
Interrelation between the total power dissipation (derived from the left hand graph) and the max. allowable temperatures.
P_{tot} (W)
T_{mb} (°C)
a=4
2.8
2.4 6phase
1.75 3 phase R and L load
1.6 single phase R and L load
continuous current
5°C/W
10°C/W
15°C/W
25°C/W
in free air
50°C/W
$R_{th\ mb-a}$ = 0.5°C/W
I_{FAV} (A)
T_{amb} (°C)


7Z09287
$I_{FS(RMS)}$ (A)
$I_{FS(RMS)}$ T_j=125°C (prior to surge)
I^2t
Maximum allowable non repetitive r.m.s. forward current (sub cycle surge curve)
Each current pulse is followed by the crest working reverse voltage
duration(ms)


7Z09286
T_j = 25 to 175°C
I_F (A)
max. voltage
V_F (V)

SILICON RECTIFIER DIODES

For data of these diodes please refer to the BYZ14series

7Z3 2029

SILICON RECTIFIER DIODES

These types have been superseded by the BYX21 and BYX28series

SILICON RECTIFIER DIODES

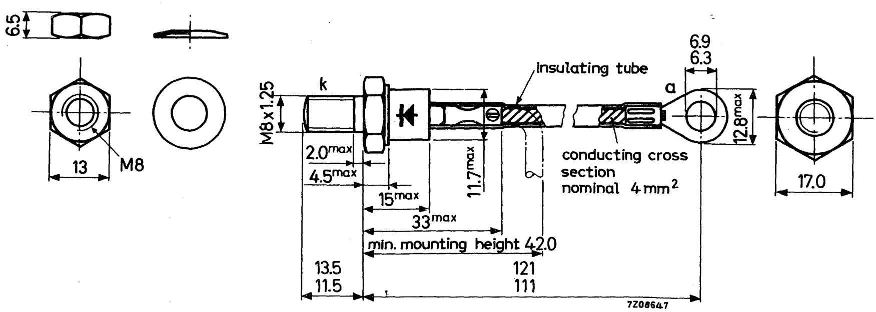
Double diffused silicon diodes in metal envelopes intended for power rectifier applications.
The series consists of the following types:
Normal polarity (stud cathode): BYY22; BYY67; BYY24.
Reverse polarity (stud anode) : BYY23; BYY68; BYY25.

QUICK REFERENCE DATA

		BYY22 BYY23	BYY67 BYY68	BYY24 BYY25	
Crest working reverse voltage	V_{RWM}	max. 200	300	400	V
Repetitive peak reverse voltage	V_{RRM}	max. 400	600	800	V
Average forward current	I_{FAV}	max. 10			A
Non repetitive peak forward current t = 10 ms; T_{mb} = 125 °C	I_{FSM}	max. 200			A
Junction temperature	T_j	max. 150			°C
Thermal resistance from junction to mounting base	$R_{th\ j\text{-}mb}$	= 1.1			°C/W

MECHANICAL DATA

Dimensions in mm



The mark shown applies to normal polarity types and blue cables.

Reverse polarity types: reversed symbol and red cable

Net weight ≈ 25 g
With accessories ≈ 35 g

Torque on nut: min. 40 cm kg
max. 60 cm kg

Diameter of hole in heatsink: max. 8.5 mm

RATINGS (Limiting values) [1]

Voltages		BYY22 BYY23	BYY67 BYY68	BYY24 BYY25	
Continuous reverse voltage	V_R	max. 200	300	400	V
Crest working reverse voltage	V_{RWM}	max. 200	300	400	V
Repetitive peak reverse voltage	V_{RRM}	max. 400	600	800	V
Non repetitive peak reverse voltage ($t < 10$ ms)	V_{RSM}	max. 400	600	800	V

Currents

Average forward current (averaged over any 20 ms period)	I_{FAV}	max.	10	A
Repetitive peak forward current	I_{FRM}	max.	50	A
Non repetitive peak forward current $t = 10$ ms; $T_{mb} = 125$ °C (see page 3)	I_{FSM}	max.	200	A

Temperatures

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

THERMAL RESISTANCE

From junction to mounting base	$R_{th\ j\text{-}mb}$	=	1.1	°C/W
From mounting base to heatsink	$R_{th\ mb\text{-}h}$	=	0.3	°C/W

CHARACTERISTICS

Forward voltage at $T_{mb} = 25$ °C

$I_F = 1$ A	V_F	<	0.9	V
$I_F = 50$ A	V_F	<	1.5	V [2]

Reverse current at $T_{mb} = 125$ °C

BYY22 BYY23	$V_R = 200$ V	I_R	<	2	mA
BYY67 BYY68	$V_R = 300$ V	I_R	<	2	mA
BYY24 BYY25	$V_R = 400$ V	I_R	<	2	mA

[1]) Limiting values according to the Absolute Maximum System as defined in IEC publication 134.
[2]) Measured under pulsed conditions to prevent excessive dissipation.

OPERATING NOTES

1. When there is a possibility that transient voltages, caused by the stored energy in the transformer core, will exceed the maximum permissible non repetitive peak reverse voltage, a damping circuit across the transformer should be applied.
   Either a series RC circuit or a voltage dependent resistor may be used. Suitable component values for an RC circuit across the transformer primary or secondary may be calculated as follows:

RC across primary of transformer		RC across secondary of transformer	
C (μF)	R (Ω)	C (μF)	R (Ω)
$200 \frac{I_{mag}}{V_1}$	$\frac{150}{C}$	$225 \frac{I_{mag} T^2}{V_1}$	$\frac{200}{C}$

   where:

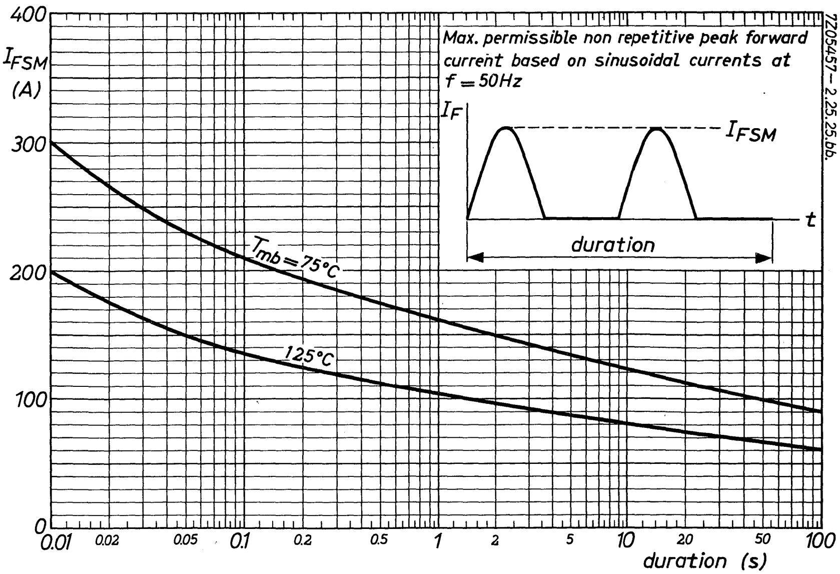
   I_{mag} = magnetising primary r.m.s. current (A)

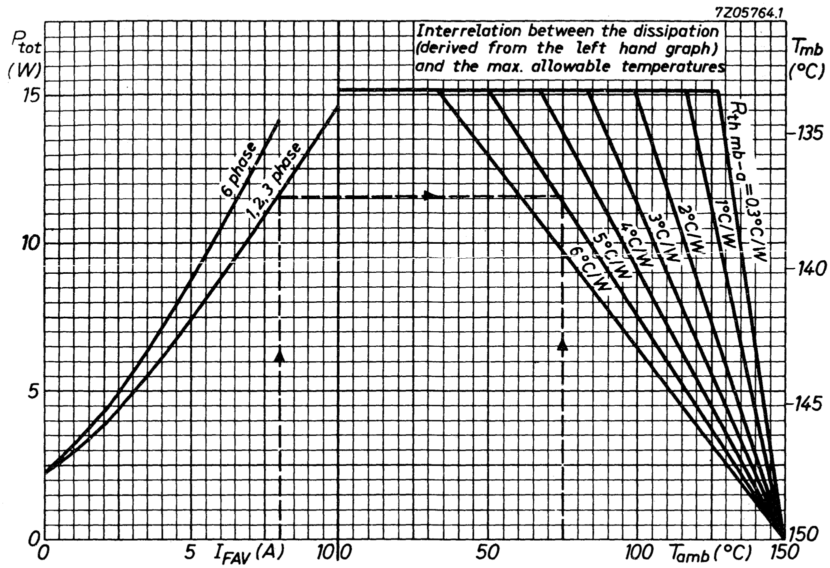
   V_1 = transformer primary r.m.s. voltage (V)

   V_2 = transformer secondary r.m.s. voltage (V)

   T = V_1/V_2

2. In order to prevent the diodes from being damaged by surge currents higher than those mentioned in the curve below a fast fuse is recommended.





Determination of the heatsink thermal resistance.

Example:

Assume a diode, used in a three phase full wave rectifier circuit.

frequency	f	= 50	Hz
average forward current	I_{FAV}	= 8	A (per diode)
ambient temperature	T_{amb}	= 75	^{o}C

From the left hand part of the graph above it follows that at I_{FAV} = 8 A in a three phase rectifier circuit the average forward power + average leakage power = 11.6 W per diode.

From the right hand part of the graph above follows the thermal resistance, required for P_{tot} = 11.6 W at T_{amb} = 75 ^{o}C

$$R_{th\ mb-a} \approx 4.9\ ^{o}C/W$$

The contact thermal resistance $R_{th\ mb-h}$ = 0.3 ^{o}C/W
Hence the heatsink thermal resistance should be:

$$R_{th\ h-a} = R_{th\ mb-a} - R_{th\ mb-h} = (4.9 - 0.3)\ ^{o}C/W = 4.6\ ^{o}C/W$$

The applicable heatsink(s) may then be found in the Section ACCESSORIES and HEATSINKS.

SILICON RECTIFIER DIODES

For data of these diodes please refer to the BYY22series

7Z3 2030

SILICON RECTIFIER DIODES

For data of these diodes please refer to the BYZ14series

7Z3 2031

SILICON RECTIFIER DIODES

These types have been superseded by the BYX38series

SILICON RECTIFIER DIODES

Double diffused silicon diodes in metal envelopes intended for power rectifier applications.
The series consists of the following types:
Normal polarity (stud cathode): BYZ14; BYY73; BYY15; BYY75; BYY77.
Reverse polarity (stud anode) : BYZ15; BYY74; BYY16; BYY76; BYY78.

QUICK REFERENCE DATA

			BYZ14 BYZ15	BYY73 BYY74	BYY15 BYY16	BYY75 BYY76	BYY77 BYY78	
Crest working reverse voltage	V_{RWM}	max.	200	300	400	500	600	V
Repetitive peak reverse voltage	V_{RRM}	max.	400	600	800	1000	1200	V

Average forward current	I_{FAV}	max.	40	A
Non repetitive peak forward current t = 10 ms	I_{FSM}	max.	800	A
Junction temperature	T_j	max.	150	^oC
Thermal resistance from junction to mounting base	$R_{th\ j\text{-}mb}$	=	1.0	$^oC/W$

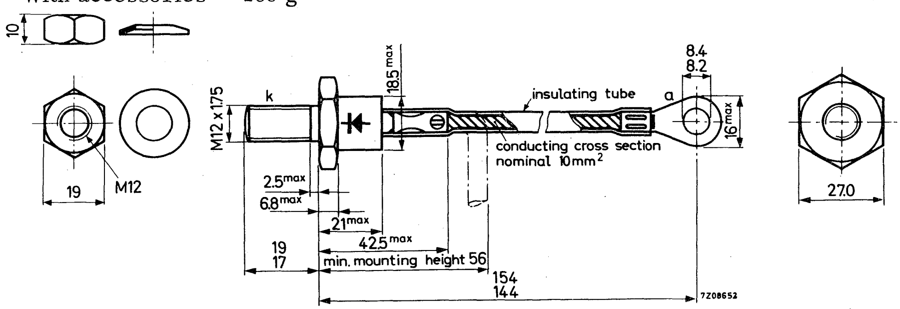
MECHANICAL DATA

Dimensions in mm

Net weight ≈ 80 g

With accessories ≈ 100 g

The mark shown applies to normal polarity diodes



Diameter of hole in heatsink: max. 13.0 mm
Torque on nut: min. 100 cm kg
max. 250 cm kg

7Z3 1992

RATINGS (Limiting values) [1]

Voltages

			BYZ14 BYZ15	BYY73 BYY74	BYY15 BYY16	BYY75 BYY76	BYY77 BYY78	
Continuous reverse voltage	V_R	max.	200	300	400	500	600	V
Crest working reverse voltage	V_{RWM}	max.	200	300	400	500	600	V
Repetitive peak reverse voltage	V_{RRM}	max.	400	600	800	1000	1200	V
Non repetitive peak reverse voltage ($t < 10$ ms)	V_{RSM}	max.	400	600	800	1000	1200	V

Currents

Average forward current (averaged any 20 ms period)	I_{FAV}	max.	40	A
Repetitive peak forward current	I_{FRM}	max.	200	A
Non repetitive peak forward current t = 10 ms; See page 8	I_{FSM}	max.	800	A
I squared t for fusing (t = 10 ms)	I^2t	max.	2250	A^2s

Temperatures

Storage temperature	T_{stg}		-65 to +150	^oC
Junction temperature	T_j	max.	150	^oC

THERMAL RESISTANCE

From junction to mounting base	$R_{th\ j\text{-}mb}$	=	1.0	$^oC/W$
From mounting base to heatsink	$R_{th\ mb\text{-}h}$	=	0.15	$^oC/W$

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

CHARACTERISTICS

Forward voltage at T_j = 25 °C

I_F = 1 A	V_F	< 0.9	V
I_F = 200 A	V_F	< 1.8	V [1]

Reverse current at T_j = 125 °C

		BYZ14 BYZ15	BYY73 BYY74	BYY15 BYY16	BYY75 BYY76	BYY77 BYY78	
V_R = 200 V	I_R	< 2					mA
V_R = 300 V	I_R		<2				mA
V_R = 400 V	I_R			< 2			mA
V_R = 500 V	I_R				< 1.7		mA
V_R = 600 V	I_R					< 1.4	mA

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

7Z3 1994

OPERATING NOTES

[1]) When there is a possibility that transient voltages, caused by the stored energy in the transformer core, will exceed the maximum permissible non repetitive peak reverse voltage, a damping circuit across the transformer should be applied.
Either a series RC circuit or a voltage dependent resistor may be used. Suitable component values for an RC circuit across the transformer primary or secondary may be calculated as follows:

RC across primary of transformer	
C (μF)	R (Ω)
$200 \frac{I_{mag}}{V_1}$	$\frac{150}{C}$

RC across secondary of transformer	
C (μF)	R (Ω)
$225 \frac{I_{mag} T^2}{V_1}$	$\frac{200}{C}$

where:

I_{mag} = magnetising primary r.m.s. current (A)

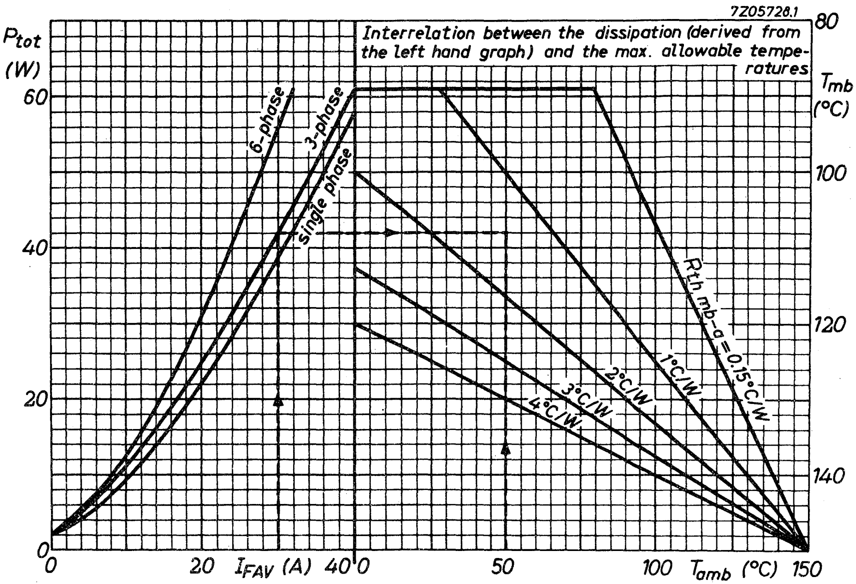
V_1 = transformer primary r.m.s. voltage (V)

V_2 = transformer secondary r.m.s. voltage (V)

T = V_1/V_2

[2]) In order to prevent the diodes from being damaged by surge currents higher than those mentioned in the curves at page 8 a fast fuse is recommended.

7Z3 1999



Determination of the heatsink thermal resistance.

Example:

Assume a diode, used in a three phase full wave rectifier circuit with a total output current of 90 A.

frequency	f	=	50	Hz
average forward current	I_{FAV}	=	30	A (per diode)
ambient temperature	T_{amb}	=	50	^{o}C

From the left hand part of the graph above it follows that at I_{FAV} = 30 A in a three phase rectifier circuit the average forward power + average leakage power = 42 W per diode.

From the right hand part of the graph above follows the thermal resistance, required for P_{tot} = 42 W at T_{amb} = 50 ^{o}C.

$$R_{th\ mb\text{-}a} \approx 1.4\ ^{o}C/W$$

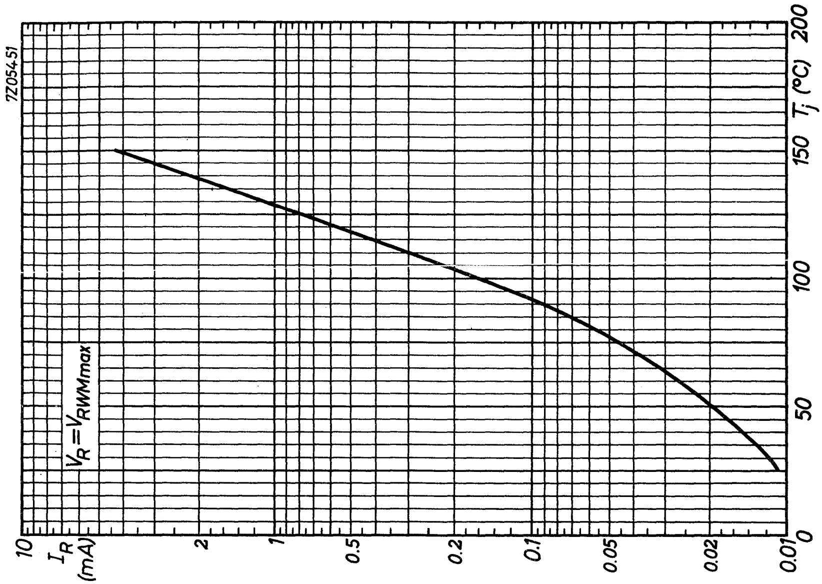
The contact thermal resistance $R_{th\ mb\text{-}h}$ = 0.15 ^{o}C/W.

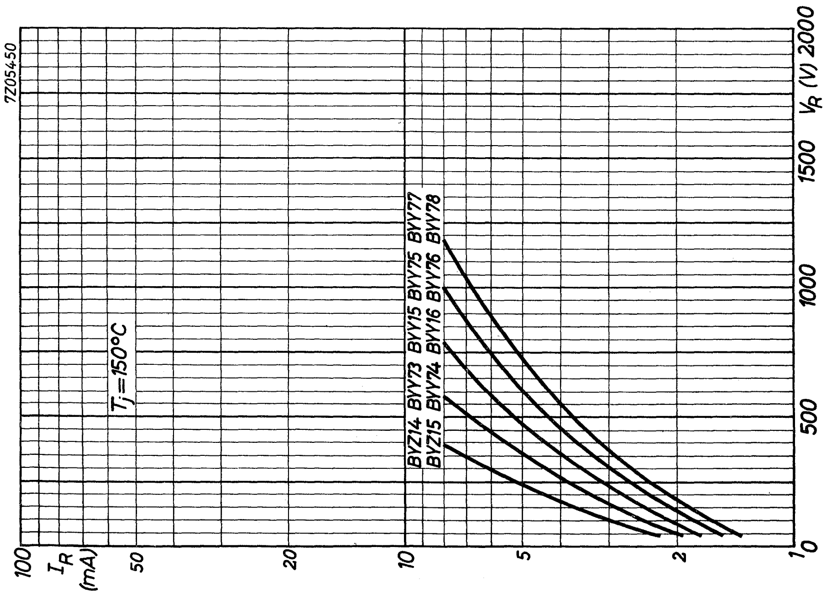
Hence the heatsink thermal resistance should be:

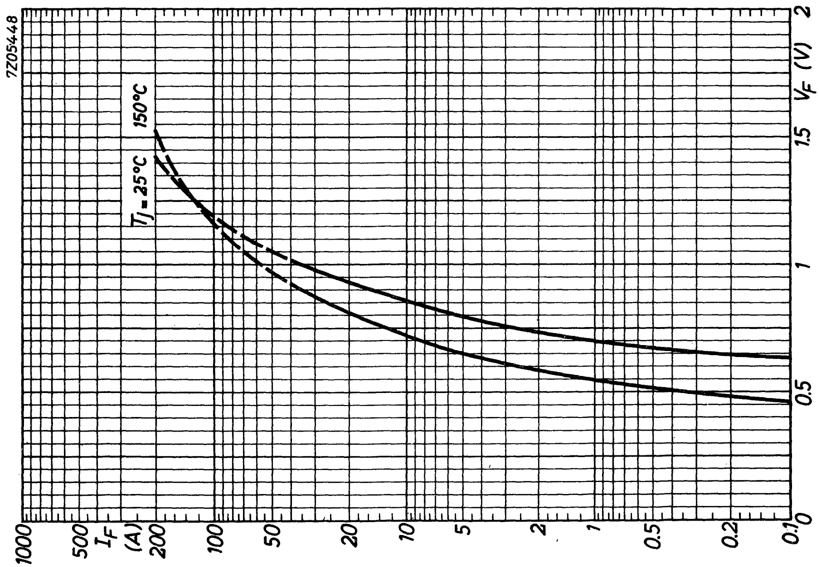
$$R_{th\ h\text{-}a} = R_{th\ mb\text{-}a} - R_{th\ mb\text{-}h} = (1.4-0.15)\ ^{o}C/W = 1.25\ ^{o}C/W.$$

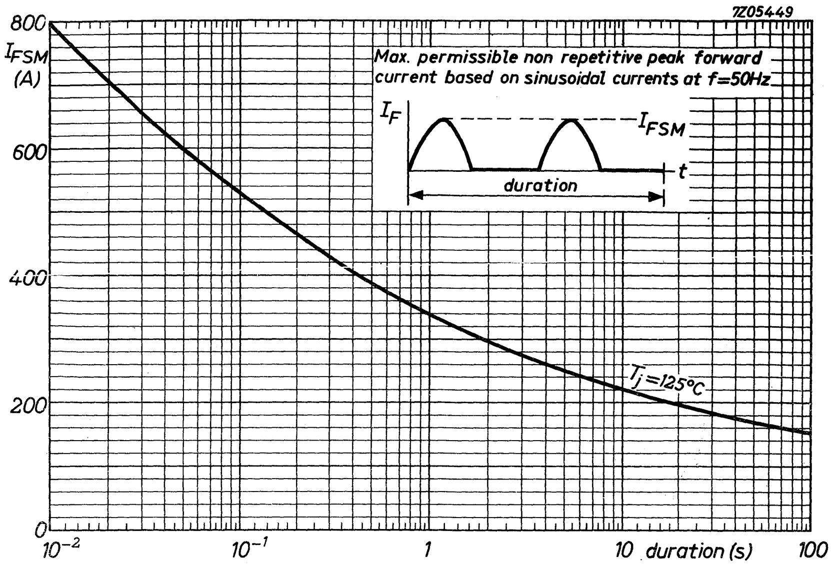
The applicable heatsink(s) may then be found in the Section ACCESSORIES and HEATSINKS.

7Z3 2000


7Z05451
V_R=V_RWMmax
T_j (°C)
0
50
100
150
200
I_R (mA)
10
2
1
0.5
0.2
0.1
0.05
0.02
0.01


7Z05450
T_j=150°C
BYZ14 BYY73 BYY15 BYY75 BYY77
BYZ15 BYY74 BYY16 BYY76 BYY78
V_R (V)
0
500
1000
1500
2000
I_R (mA)
100
50
20
10
5
2
1


7Z05448
Tj = 25°C
150°C
VF (V)
0
0.5
1
1.5
2
IF (A)
1000
500
200
100
50
20
10
5
2
1
0.5
0.2
0.1



APPLICATION INFORMATION

See general pages at the beginning of this section

SILICON RECTIFIER DIODES

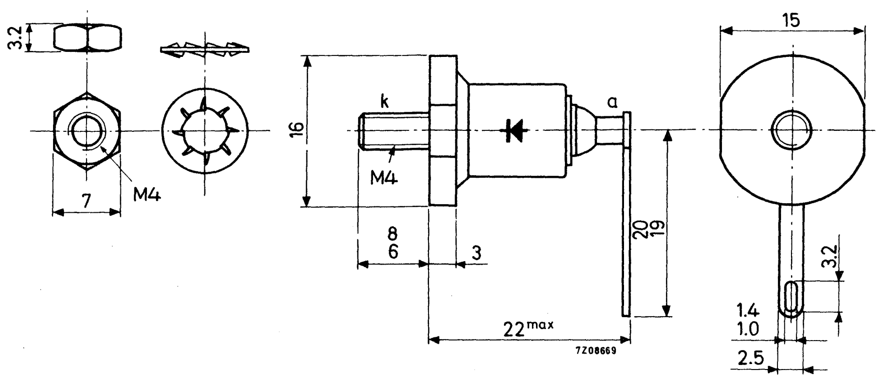
These types have been superseded by the BYX38series

GERMANIUM RECTIFIER DIODE

Germanium diode in a metal envelope, primarily intended for medium-power rectifier applications.

QUICK REFERENCE DATA				
Crest working reverse voltage	V_{RWM}	max.	95	V
Repetitive peak reverse voltage	V_{RRM}	max.	120	V
Average forward current	I_{FAV}	max.	3.8	A
Non repetitive peak forward current (t < 10 ms)	I_{FSM}	max.	90	A
Junction temperature	T_j	max.	75	^oC
Thermal resistance from junction to mounting base	$R_{th\,j\text{-}mb}$	=	5	$^oC/W$

MECHANICAL DATA Dimensions in mm



Torque on nut: 3 cm kg

All information applies to frequencies up to 1000 Hz

RATINGS (Limiting values) [1])

Voltages

Continuous reverse voltage	V_R	max.	85	V
Crest working reverse voltage	V_{RWM}	max.	95	V
Repetitive peak reverse voltage	V_{RRM}	max.	120	V
Non repetitive peak reverse voltage	V_{RSM}	max.	120	V

Currents

Average forward current (averaged over any 20 ms period)	I_{FAV}	max.	3.8	A
Forward current (d.c.)	I_F	max.	12	A
Repetitive peak forward current	I_{FRM}	max.	12	A
Non repetitive peak forward current $t < 10$ ms	I_{FSM}	max.	90	A

TEMPERATURES

Storage temperature	T_{stg}		−25 to +75	^oC
Junction temperature	T_j	max.	75	^oC

THERMAL RESISTANCE

From junction to ambient	$R_{th\,j\text{-}a}$	=	50	$^oC/W$
From junction to mounting base	$R_{th\,j\text{-}mb}$	=	5	$^oC/W$
From mounting base to heatsink	$R_{th\,mb\text{-}h}$	=	1	$^oC/W$

CHARACTERISTICS

Forward voltage at I_F = 12 A; T_j = 25 ^oC	V_F	<	0.70	V
T_j = 75 ^oC	V_F	<	0.65	V
Reverse current at V_R = 85 V; T_j = 25 ^oC	I_R	<	100	μA
V_R = 85 V; T_j = 75 ^oC	I_R	<	4	mA

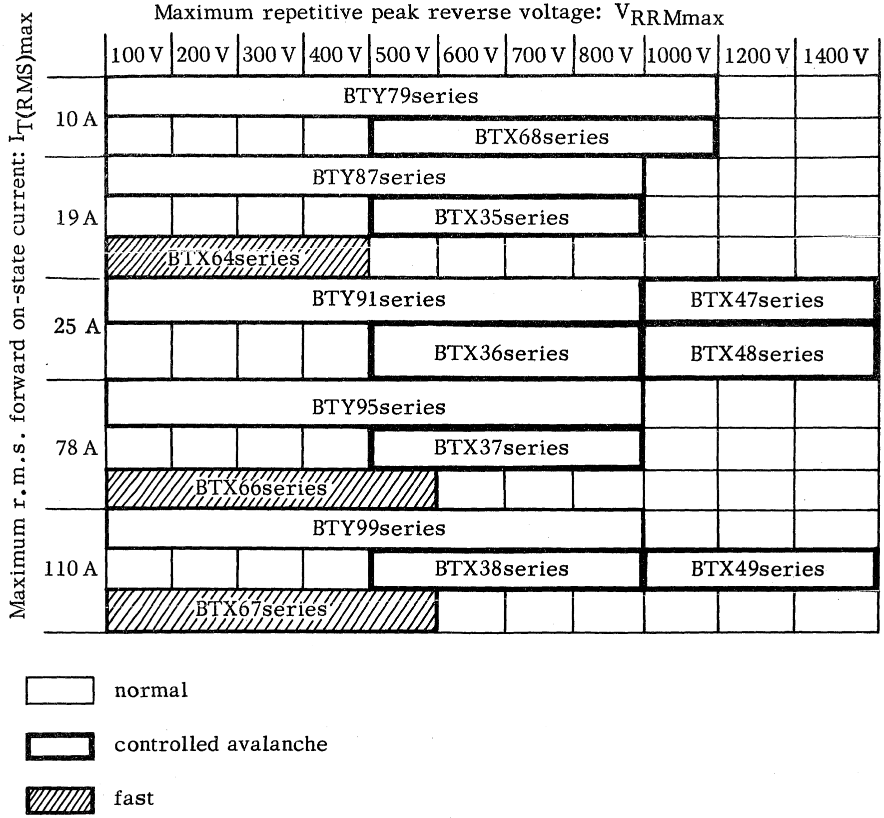
FOR NEW DESIGN THE SUCCESSOR TYPE AYY10-120
IS RECOMMENDED

SILICON DIODES

The OA210 has been superseded by the BY126
The OA211 and OA214 have been superseded by the BY127

Thyristors

TYPE SELECTION CHART



SILICON CONTROLLED SWITCH

The BRY39 is a planar p-n-p-n switch in a TO-72 metal envelope, intended as driver for numerical indicator tubes and other switching applications.
It is an integrated pnp-npn transistor pair of which all electrodes are accessible. The collector of the n-p-n transistor is connected to the case.

QUICK REFERENCE DATA

P-N-P transistor				
Emitter-base voltage (open collector)	$-V_{EBO}$	max.	70	V
N-P-N transistor				
Collector-base voltage (open emitter)	V_{CBO}	max.	70	V
Emitter current (peak value	$-I_{EM}$	max.	500	mA
Total power dissipation up to T_{amb} = 25 °C	P_{tot}	max.	250	mW
Junction temperature	T_j	max.	150	°C
Forward on-state voltage				
I_A = 50 mA; I_C = 0; R_{BE} = 10 kΩ	V_{AE}	<	1.4	V
Holding current				
I_C = 10 mA; $-V_{BB}$ = 2 V; R_{BE} = 10 kΩ	I_H	<	1.0	mA
Turn on time	t_{on}	<	0.25	µs
Turn off time	t_q	<	5.0	µs

For further data please refer
to BRY39 in section Transistors

7Z3 1868

P-GATE SILICON THYRISTORS

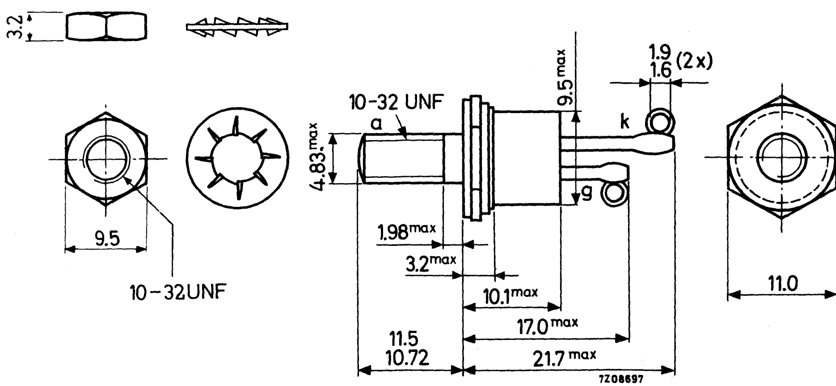
P-gate silicon thyristors in a TO-64 metal envelope, intended for use in domestic applications. The series consist of the reverse polarity types (stud-anode) BT101-300R; BT101-500R; BT102-300R and BT102-500R.
The BT101series has a higher triggering sensitivity.

QUICK REFERENCE DATA

			BT101; BT102-300R	500R	
Crest working reverse voltage	V_{RWM}	max.	200	400	V
Crest working off-state voltage	V_{DWM}	max.	200	400	V
Average forward current (T_{mb} = 85 °C)	I_{TAV}	max.	6.4		A
R.M.S. forward current	$I_{T(RMS)}$	max.	15		A
Non repetitive peak forward current (t=10 ms)	I_{TSM}	max.	55		A
Junction temperature	T_j	max.	125		°C
Current to trigger all devices V_D = 6 V; T_j = 25 °C	BT101 I_{GT}	>	10		mA
	BT102 I_{GT}	>	50		mA

MECHANICAL DATA Dimensions in mm

TO-64



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

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

All information applies to frequencies up to 400 Hz.

RATINGS (Limiting values)[1])

ANODE TO CATHODE

Voltages [2])			BT101; BT102-300R	500R	
Crest working reverse voltage	V_{RWM}	max.	200	400	V
Repetitive peak reverse voltage ($\delta \leq 0.01$)	V_{RRM}	max.	300	500	V
Non repetitive peak reverse voltage ($t \leq 10$ ms)	V_{RSM}	max.	300	500	V
Crest working off-state voltage	V_{DWM}	max.	200	400	V
Repetitive peak off-state voltage ($\delta \leq 0.01$)	V_{DRM}	max.	300	500	V
Non repetitive peak off-state voltage ($t \leq 10$ ms)	V_{DSM}	max.	300	500	V

Currents

Average forward current (averaged over any 20 ms period) T_{mb} = 85 °C	I_{TAV}	max.	6.4	A
R.M.S. forward current	$I_{T(RMS)}$	max.	15	A
Repetitive peak forward current	I_{TRM}	max.	50	A
Non repetitive peak forward current (t=10 ms) (see also page 7)	I_{TSM}	max.	55	A
Fusing conditions	see page 7			

GATE TO CATHODE

Voltages

Forward peak voltage	V_{FGM}	max.	10	V
Reverse peak voltage	V_{RGM}	max.	5	V

Current

Forward peak current	I_{FGM}	max.	2	A

Power dissipation

Average power dissipation	P_{GAV}	max.	0.5	W
Peak power dissipation	P_{GM}	max.	5	W

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

2) These ratings apply to a gate voltage range of −5 to +0.25 V.
To ensure thermal stability: $R_{th\ j\text{-}a} \leq 20$ °C/W (d.c.) or ≤ 40 °C/W (a.c.).
For smaller heatsinks T_{jmax} should be derated. (see page 5)

RATINGS (continued)

Temperatures

Storage temperature	T_{stg}	−55 to +125	°C
Junction temperature	T_j	max. 125	°C

THERMAL RESISTANCE

From junction to mounting base	$R_{th\ j\text{-}mb}$	= 3	°C/W
From mounting base to heatsink	$R_{th\ mb\text{-}h}$	= 0.5	°C/W

CHARACTERISTICS T_j = 125 °C unless otherwise specified

ANODE TO CATHODE

Voltage

Forward on-state voltage			
I_T = 20 A; T_j = 25 °C	V_T	< 2.3	V [1]

Currents

Reverse current			
$V_R = V_{RWM}$ max	I_R	< 1.5	mA
Off-state current			
$V_D = V_{DWM}$ max	I_D	< 1.5	mA

GATE TO CATHODE

Voltages

Voltage to trigger all devices			
V_D = 6 V; T_j = 25 °C	BT101 V_{GT}	> 2	V
	BT102 V_{GT}	> 2.5	V
Voltage not to trigger any device	V_{GD}	< 0.25	V

Current

Current to trigger all devices			
V_D = 6 V; T_j = 25 °C	BT101 I_{GT}	> 10	mA
	BT102 I_{GT}	> 50	mA

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

OPERATING NOTES

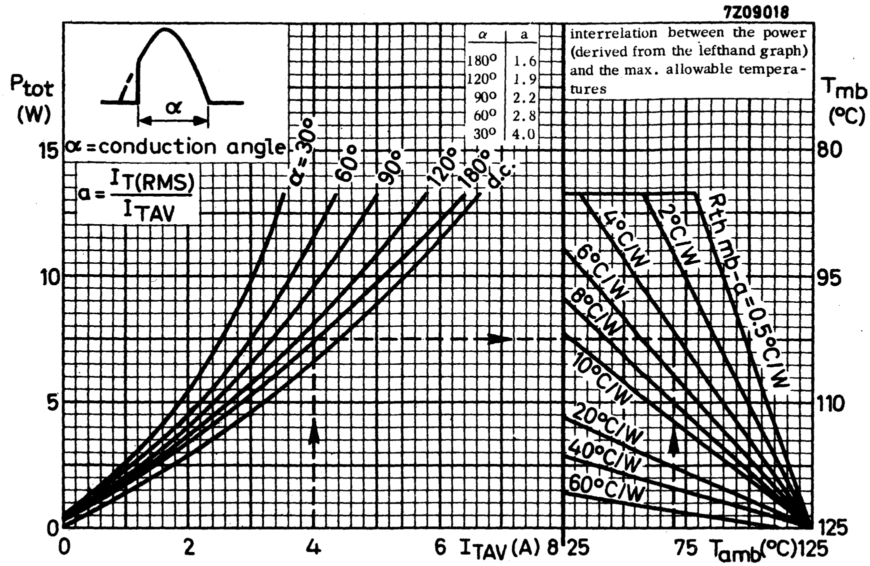
1. When there is a possibility that transient voltages, caused by the stored energy in the transformer core, will exceed the maximum permissible non repetitive peak reverse voltage, a damping circuit across the transformer should be applied.
   Either a series RC circuit or a voltage dependent resistor may be used. Suitable component values for an RC circuit across the transformer primary or secondary may be calculated as follows:

$\frac{V_{RSM}}{V_{RWM}}$	RC across primary of transformer		RC across secondary of transformer	
	C (μF)	R (Ω)	C (μF)	R (Ω)
2.0	$200\frac{I_{mag}}{V_1}$	$\frac{150}{C}$	$225\frac{I_{mag}T^2}{V_1}$	$\frac{200}{C}$
1.5	$400\frac{I_{mag}}{V_1}$	$\frac{225}{C}$	$450\frac{I_{mag}T^2}{V_1}$	$\frac{275}{C}$
1.25	$550\frac{I_{mag}}{V_1}$	$\frac{260}{C}$	$620\frac{I_{mag}T^2}{V_1}$	$\frac{310}{C}$
1.0	$800\frac{I_{mag}}{V_1}$	$\frac{300}{C}$	$900\frac{I_{mag}T^2}{V_1}$	$\frac{350}{C}$

   where I_{mag} = magnetising primary r.m.s. current (A)
   V_1 = transformer primary r.m.s. voltage (V)
   V_2 = transformer secondary r.m.s. voltage (V)
   T = V_1/V_2
   V_{RWM} stands for the actually applied crest working reverse voltage.

2. In order to prevent the thyristors from being damaged by surge currents higher than those mentioned in the curve at page 7 a fast fuse is recommended.

3. The gate and cathode connectors should not be bent or twisted; they should be soldered into the circuit so there is no strain on them.
   During soldering the heat conduction to the junction should be kept to a minimum by using a thermal shunt.



Determination of the heatsink thermal resistance.

Example:

Assume a thyristor, used in a single phase full wave rectifier circuit.

frequency	f	= 50	Hz
conduction angle	α	= 180°	
average forward current	I_{TAV}	= 4	A (per thyristor)
ambient temperature	T_{amb}	= 70	°C

From the left hand part of the graph above it follows that at $I_{TAV} = 4$ A and $\alpha = 180°$ in a single phase rectifier circuit the average forward power + average leakage power = 7.5 W per thyristor.

From the right hand part of the graph above follows the thermal resistance, required for $P_{tot} = 7.5$ W at $T_{amb} = 70$ °C

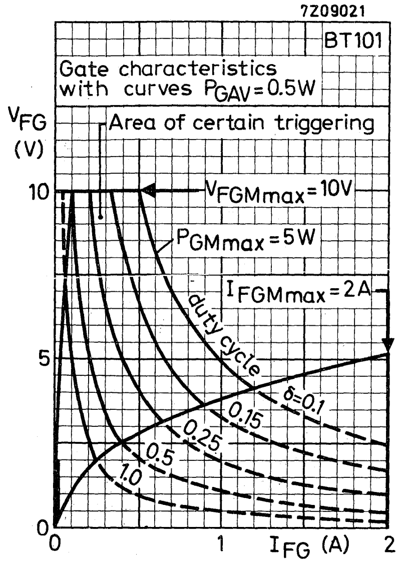
$$R_{th\ mb\text{-}a} \approx 4.3\ °C/W$$

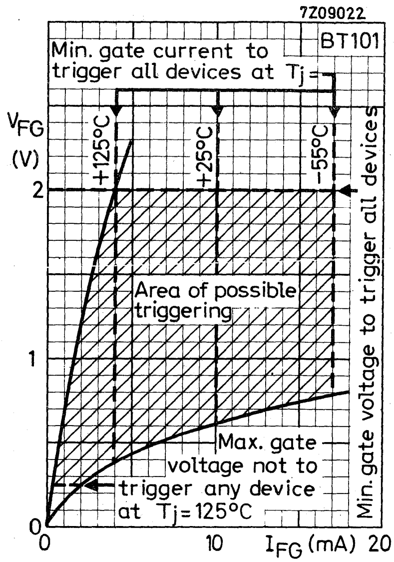
The contact thermal resistance $R_{th\ mb\text{-}h} = 0.5$ °C/W

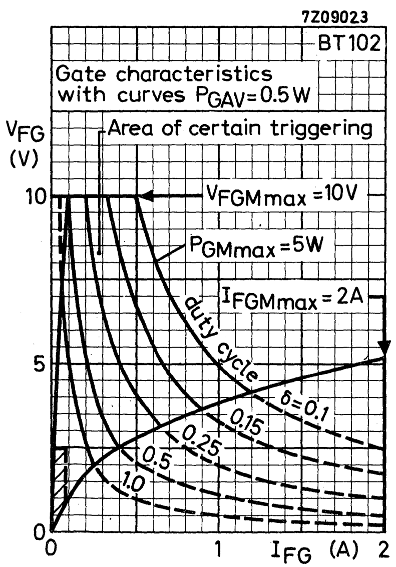
Hence the heatsink thermal resistance should be:

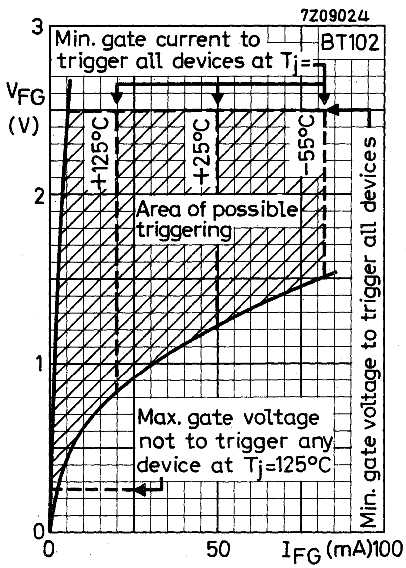
$$R_{th\ h\text{-}a} = R_{th\ mb\text{-}a} - R_{th\ mb\text{-}h} = (4.3 - 0.5)\ °C/W = 3.8\ °C/W$$

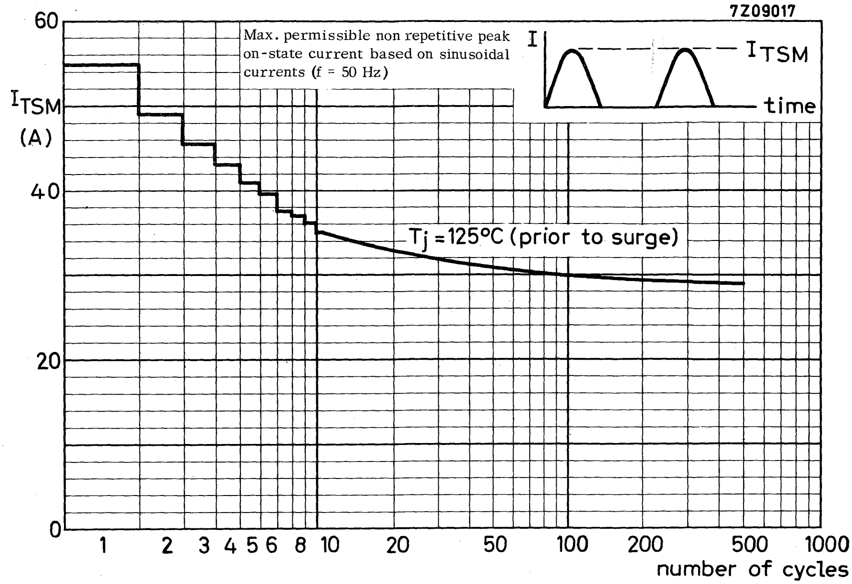
The applicable heatsink(s) may then be found in the section ACCESSORIES and HEATSINKS.

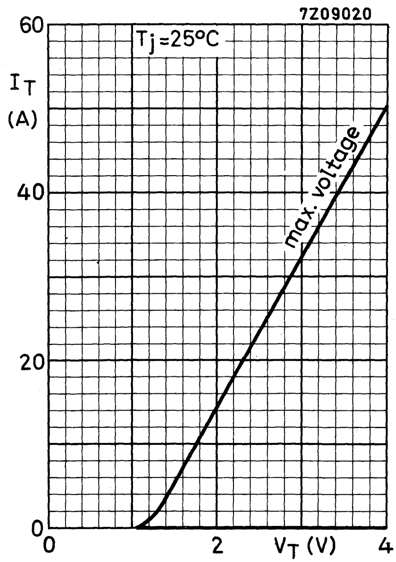

7Z09021
BT101
Gate characteristics
with curves PGAV=0.5W
VFG
(V)
Area of certain triggering
VFGMmax=10V
PGMmax=5W
IFGMmax=2A
duty cycle
δ=0.1
0.15
0.25
0.5
1.0
10
5
0
0
1
IFG (A)
2

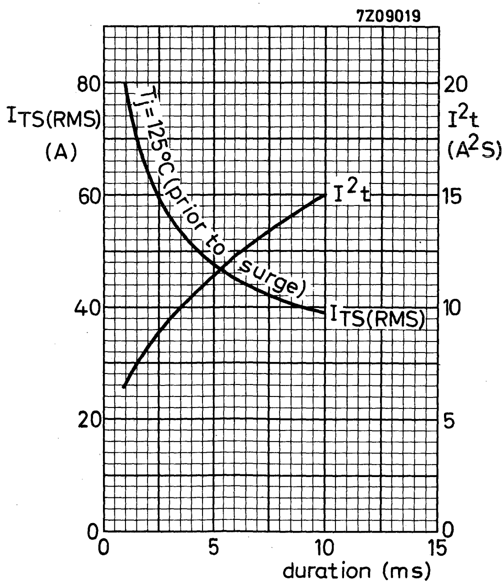

7Z09022
BT101
Min. gate current to
trigger all devices at Tj=
VFG
(V)
+125°C
+25°C
−55°C
Min. gate voltage to trigger all devices
Area of possible
triggering
Max. gate
voltage not to
trigger any device
at Tj=125°C
2
1
0
0
10
IFG (mA)
20


7Z09023
BT102
Gate characteristics
with curves PGAV=0.5W
VFG
(V)
Area of certain triggering
VFGMmax=10V
PGMmax=5W
IFGMmax=2A
duty cycle
δ=0.1
0.15
0.25
0.5
1.0
10
5
0
0
1
IFG (A)
2


7Z09024
BT102
Min. gate current to
trigger all devices at Tj=
VFG
(V)
+125°C
+25°C
−55°C
Min. gate voltage to trigger all devices
Area of possible
triggering
Max. gate voltage
not to trigger any
device at Tj=125°C
3
2
1
0
0
50
IFG (mA)100


7Z09017
Max. permissible non repetitive peak on-state current based on sinusoidal currents (f = 50 Hz)
I
ITSM
time
60
40
20
0
ITSM
(A)
Tj =125°C (prior to surge)
1
2
3
4
5
6
8
10
20
50
100
200
500
1000
number of cycles


7Z09020
Tj =25°C
60
40
20
0
IT
(A)
max. voltage
0
2
VT (V)
4


7Z09019
80
60
40
20
0
ITS(RMS)
(A)
Tj = 125°C (prior to surge)
I2t
ITS(RMS)
20
15
10
5
0
I2t
(A2S)
0
5
10
15
duration (ms)

P-GATE SILICON THYRISTORS

P-gate all diffused silicon thyristors in a metal case for power control and power switching applications.
The series consists of the reverse polarity types (stud-anode): BTX12-100R, BTX12-200R, BTX12-300R, BTX12-400R, BTX12-500R, BTX12-600R.

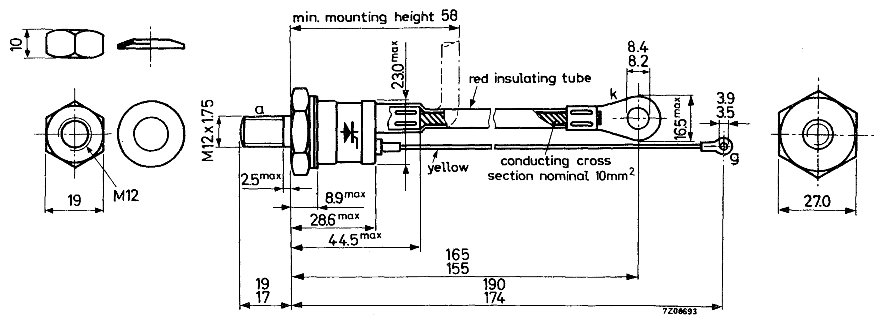
QUICK REFERENCE DATA

			BTX12-100R	200R	300R	400R	500R	600R	
Crest working reverse voltage	V_{RWM}	max.	100	200	300	400	500	600	V
Crest working off-state voltage	V_{DWM}	max.	100	200	300	400	500	600	V

Average forward current	I_{TAV}	max.	20	A
Non repetitive peak forward current t = 10 ms	I_{TSM}	max.	250	A
Junction temperature	T_j	max.	125	°C
Thermal resistance from junction to mounting base	$R_{th\ j\text{-}mb}$	=	1.45	°C/W

MECHANICAL DATA

Dimensions in mm



Net weight : 95 g
With accessories: 115 g
Diameter of hole in heatsink: max. 13.0 mm

Torque on nut: min. 100 cm kg
max. 250 cm kg

FOR NEW DESIGN THE SUCCESSOR TYPE BTX81 IS RECOMMENDED

All information applies to frequencies up to 400 Hz

RATINGS (Limiting values) [1])

ANODE TO CATHODE

Voltages [2])			BTX12-100R	200R	300R	400R	500R	600R	
Crest working reverse voltage	V_{RWM}	max.	100	200	300	400	500	600	V
Repetitive peak reverse voltage	V_{RRM}	max.	400	400	500	500	600	600	V
Non repetitive peak reverse voltage $t \leqq 10$ ms	V_{RSM}	max.	400	400	500	500	700	700	V
Crest working off-state voltage	V_{DWM}	max.	100	200	300	400	500	600	V
Repetitive peak off-state voltage	V_{DRM}	max.	100	200	300	400	500	600	V
Non repetitive peak off-state voltage [3])	V_{DSM}	max.	500	500	500	500	700	700	V

Currents

Average forward current (averaged over any 20 ms period)	I_{TAV}	max.	20	A
R.M.S. forward current	$I_{T(RMS)}$	max.	31	A
Repetitive peak forward current	I_{TRM}	max.	175	A
Non repetitive peak forward current t = 10 ms	I_{TSM}	max.	250	A
I squared t for fusing	I^2t	max.	250	A^2s
Rate of rise of forward current	$\frac{dI_T}{dt}$	max.	5	A/μs
Repetitive peak reverse current (during commutation or turn-off)	I_{RRM}	max.	20	A

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

[2]) These ratings apply to a gate voltage range of −5 to +0.25 V. To ensure thermal stability: $R_{th\ j\text{-}a} \leqq 7$ °C/W.

[3]) This voltage may be applied without damage but the thyristor may switch into the on-state. Care should be taken that no current ratings are exceeded.

RATINGS (Limiting values) (continued)

GATE TO CATHODE

Voltages

Forward peak voltage	V_{FGM}	max.	10	V
Reverse peak voltage	V_{RGM}	max.	5	V

Current

Forward peak current	I_{FGM}	max.	2	A

Power dissipation

Average power dissipation (averaged over any 20 ms period)	P_{GAV}	max.	0.5	W
Peak power dissipation	P_{GM}	max.	5	W

TEMPERATURES

Storage temperature	T_{stg}		-55 to +125	°C
Junction temperature	T_j	max.	125	°C

THERMAL RESISTANCE

From junction to mounting base	$R_{th\ j\text{-}mb}$	=	1.45	°C/W
From mounting base to heatsink	$R_{th\ mb\text{-}h}$	=	0.15	°C/W

CHARACTERISTICS T_j = 125 °C unless otherwise specified

ANODE TO CATHODE

Voltages

			BTX12-100R	200R	300R	400R	500R	600R	
Forward on-state voltage; I_T = 175 A	V_T	<	3.5	3.5	3.5	3.5	3.5	3.5	V [1]
Forward breakover voltage	$V_{(BO)}$	>	100	200	300	400	500	600	V
Rate of rise of forward voltage not to trigger any device	$\frac{dV_D}{dt}$	<	20	20	20	20	20	20	V/µs

Currents

Reverse current $V_R = V_{RRM}$ max	I_R	<	8	8	5	5	5	5	mA
Off-state current $V_D = V_{DRM}$ max	I_D	<	8	8	5	5	5	5	mA

Holding current	I_H	typ.	40	mA

GATE TO CATHODE

Voltages

Voltage to trigger all devices V_D = 6 V; T_j = 25 °C	V_{GT}	>	3	V
Voltage not to trigger any device	V_{GD}	<	0.25	V

Current

Current to trigger all devices T_j = 25 °C	I_{GT}	>	50	mA

SWITCHING CHARACTERISTICS

Turn on time ($t_d + t_r$)	t_{on}	typ.	4	µs
delay time	t_d	typ.	1.3	µs
rise time	t_r	typ.	2.7	µs
Turn off time	t_q	typ.	6	µs

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

P-GATE SILICON THYRISTORS

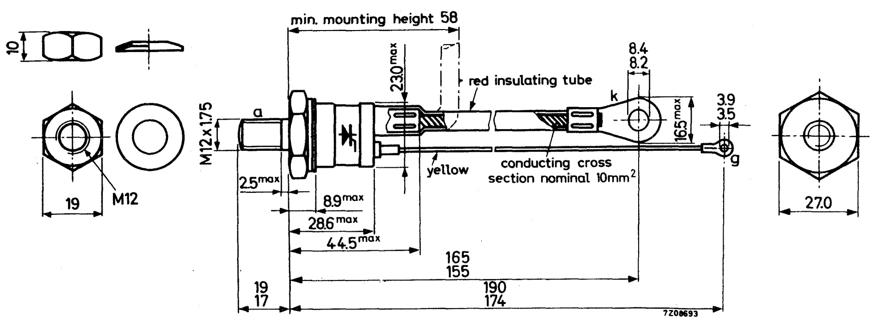
P-gate all diffused silicon thyristors in a metal case for power control and power switching applications.
The series consists of the reverse polarity types (stud-anode): BTX13-100R, BTX13-200R, BTX13-300R, BTX13-400R, BTX13-500R and BTX13-600R.

QUICK REFERENCE DATA

			BTX13-100R	200R	300R	400R	500R	600R	
Crest working reverse voltage	V_{RWM}	max.	100	200	300	400	500	600	V
Crest working off-state voltage	V_{DWM}	max.	100	200	300	400	500	600	V

Average forward current	I_{TAV}	max.	30	A
Non repetitive peak forward current t = 10 ms	I_{TSM}	max.	250	A
Junction temperature	T_j	max.	125	^oC
Thermal resistance from junction to mounting base	$R_{th\ j\text{-}mb}$	=	0.90	$^oC/W$

MECHANICAL DATA Dimensions in mm



Net weight : 95 g
With accessories: 115 g
Diameter of hole in heatsink: max. 13.0 mm

Torque on nut: min. 100 cm kg
max. 250 cm kg

FOR NEW DESIGN THE SUCCESSOR TYPE BTX82 IS RECOMMENDED

All information applies to frequencies up to 400 Hz

RATINGS (Limiting values) [1]

ANODE TO CATHODE

Voltages [2]			BTX13-100R	200R	300R	400R	500R	600R	
Crest working reverse voltage	V_{RWM}	max.	100	200	300	400	500	600	V
Repetitive peak reverse voltage	V_{RRM}	max.	400	400	500	500	600	600	V
Non repetitive peak reverse voltage $t \leqq 10$ ms	V_{RSM}	max.	400	400	500	500	700	700	V
Crest working off-state voltage	V_{DWM}	max.	100	200	300	400	500	600	V
Repetitive peak off-state voltage	V_{DRM}	max.	100	200	300	400	500	600	V
Non repetitive peak off-state voltage [3]	V_{DSM}	max.	500	500	500	500	700	700	V

Currents

Average forward current (averaged over any 20 ms period)	I_{TAV}	max.	30	A
R.M.S. forward current	$I_{T(RMS)}$	max.	47	A
Repetitive peak forward current	I_{TRM}	max.	250	A
Non repetitive peak forward current t = 10 ms	I_{TSM}	max.	300	A
I squared t for fusing	I^2t	max.	300	A^2s
Rate of rise of forward current	$\frac{dI_T}{dt}$	max.	5	A/μs
Repetitive peak reverse current (during commutation or turn-off)	I_{RRM}	max.	20	A

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

[2] These ratings apply to a gate voltage range of −5 to +0.25 V.
To ensure thermal stability: $R_{th\ j-a} \leqq 7$ °C/W.

[3] This voltage may be applied without damage but the thyristor may switch into the on-state. Care should be taken that no current ratings are exceeded.

RATINGS (Limiting values) (continued)

GATE TO CATHODE

Forward peak voltage	V_{FGM}	max.	10	V
Reverse peak voltage	V_{RGM}	max.	5	V

Current

Forward peak current	I_{FGM}	max.	2	A

Power dissipation

Average power dissipation (averaged over any 20 ms period)	P_{GAV}	max.	0.5	W
Peak power dissipation	P_{GM}	max.	5	W

TEMPERATURES

Storage temperature	T_{stg}		-55 to +125	^oC
Junction temperature	T_j	max.	125	^oC

THERMAL RESISTANCE

From junction to mounting base	$R_{th\ j\text{-}mb}$	=	0.90	$^oC/W$
From mounting base to heatsink	$R_{th\ mb\text{-}h}$	=	0.15	$^oC/W$

CHARACTERISTICS T_j = 125 °C unless otherwise specified

ANODE TO CATHODE

Voltages			BTX13-100R	200R	300R	400R	500R	600R	
Forward on-state voltage; I_T = 250 A	V_T	<	3.5	3.5	3.5	3.5	3.5	3.5	V [1]
Forward breakover voltage	$V_{(BO)}$	>	100	200	300	400	500	600	V
Rate of rise of forward voltage not to trigger any device	$\frac{dV_D}{dt}$	<	20	20	20	20	20	20	V/μs
Currents									
Reverse current $V_R = V_{RRM\,max}$	I_R	<	8	8	5	5	5	5	mA
Off-state current $V_D = V_{DRM\,max}$	I_D	<	8	8	5	5	5	5	mA

Holding current	I_H	typ.	40	mA
GATE TO CATHODE				
Voltages				
Voltage to trigger all devices V_D = 6 V; T_j = 25 °C	V_{GT}	>	3	V
Voltage not to trigger any device	V_{GD}	<	0.25	V
Current				
Current to trigger all devices T_j = 25 °C	I_{GT}	>	50	mA
SWITCHING CHARACTERISTICS				
Turn on time ($t_d + t_r$)	t_{on}	typ.	4	μs
delay time	t_d	typ.	1.3	μs
rise time	t_r	typ.	2.7	μs
Turn off time	t_q	typ.	6	μs

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

CONTROLLED AVALANCHE THYRISTORS

P-gate silicon thyristors in a TO-48 metal envelope, capable of absorbing transients and intended for power control and power switching applications. The series consists of the following reverse polarity types (stud anode):
BTX35-500R; BTX35-600R; BTX35-700R and BTX35-800R.

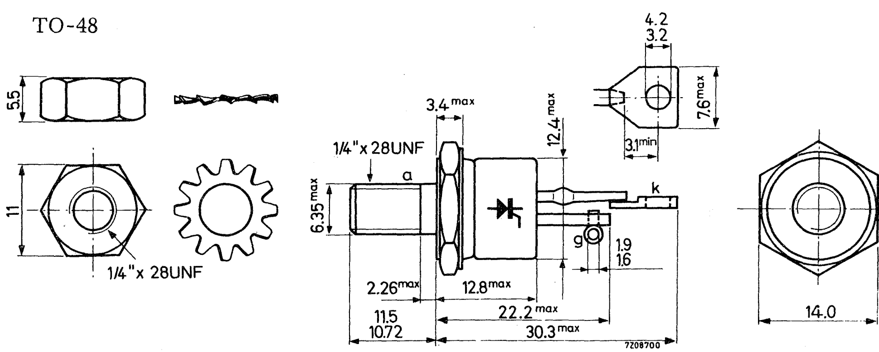
QUICK REFERENCE DATA

			BTX35-500R	600R	700R	800R	
Crest working reverse voltage	V_{RWM}	max.	500	600	700	800	V
Crest working off-state voltage	V_{DWM}	max.	500	600	700	800	V
Average forward current	I_{TAV}	max.	12				A
Non repetitive peak forward current $t = 10$ ms	I_{TSM}	max.	140				A
Non repetitive peak reverse dissipation $t = 10\ \mu s$; $T_j = 25\ ^oC$	P_{RSM}	max.	18				kW
Junction temperature	T_j	max.	125				^oC
Thermal resistance from junction to mounting base	$R_{th\ j\text{-}mb}$	=	2.0				$^oC/W$

MECHANICAL DATA

Dimensions in mm

TO-48



Net weight : 10 g
With accessories: 15 g

Torque on nut: min. 17 cm kg
max. 35 cm kg

Diameter of hole in heatsink: max. 6.5 mm
Accessories available: 56264A

All information applies to frequencies up to 400 Hz

RATINGS (Limiting values) [1]

ANODE TO CATHODE

Voltages [2]			BTX35-500R	600R	700R	800R	
Continuous reverse voltage	V_R	max.	500	600	700	800	V
Crest working reverse voltage	V_{RWM}	max.	500	600	700	800	V
Continuous off-state voltage	V_D	max.	500	600	700	800	V
Crest working off-state voltage	V_{DWM}	max.	500	600	700	800	V [3]

Currents

Average forward current (averaged over any 20 ms period)	I_{TAV}	max.	12	A
Forward current (d.c.)	I_T	max.	15	A
R.M.S. forward current	$I_{T(RMS)}$	max.	19	A
Repetitive peak forward current	I_{TRM}	max.	140	A
Non repetitive peak forward current t = 10 ms (See also page 7)	I_{TSM}	max.	140	A
I squared t for fusing (t = 1.5 to 10 ms)	I^2t	max.	100	A^2s
Rate of rise of forward current	$\frac{dI_T}{dt}$	max.	20	A/μs
Repetitive peak reverse current (during turn-off)	I_{RRM}	max.	20	A

Power dissipation

Non repetitive peak reverse dissipation (See also page 7) t = 10 μs; T_j = 25 °C	P_{RSM}	max.	18	kW
t = 10 μs; T_j = 125 °C	P_{RSM}	max.	7.5	kW

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

[2] These ratings apply to a gate voltage range of −5 to +0.25 V
To ensure thermal stability: $R_{th\ j-a} \leq 4.5$ °C/W (d.c.) or ≤ 9 °C/W (a.c.)

[3] Off-state voltages higher than V_{DWMmax} are allowed, but at voltages higher than the forward breakover voltage (see page 4) the device may switch into the on-state.

RATINGS (Limiting values) (continued)

GATE TO CATHODE

Voltages

Forward peak voltage	V_{FGM}	max.	10	V
Reverse peak voltage	V_{RGM}	max.	5	V

Current

Forward peak current	I_{FGM}	max.	2	A

Power dissipation

Average power dissipation (averaged over any 20 ms period)	P_{GAV}	max.	0.5	W
Peak power dissipation	P_{GM}	max.	5	W

TEMPERATURES

Storage temperature	T_{stg}		−55 to +125	^{o}C
Junction temperature	T_j	max.	125	^{o}C

THERMAL RESISTANCE

From junction to mounting base	$R_{th\ j\text{-}mb}$	=	2.0	$^{o}C/W$
From mounting base to heatsink	$R_{th\ mb\text{-}h}$	=	0.2	$^{o}C/W$
From mounting base to heatsink with mica washer	$R_{th\ mb\text{-}h}$	=	4.0	$^{o}C/W$

CHARACTERISTICS

T_j = 125 °C unless otherwise specified

ANODE TO CATHODE

Voltages

			BTX35-500R	600R	700R	800R	
Forward on-state voltage I_T = 50 A; T_j = 25 °C	V_T	<	3.0	3.0	3.0	3.0	V [1])
Reverse breakdown voltage in avalanche region	$V_{(BR)R}$	>	550	660	770	880	V
Forward breakover voltage	$V_{(BO)}$	>	550	660	770	880	V
Rate of rise of forward voltage not to trigger the device	$\frac{dV_D}{dt}$	typ.	100	100	100	100	V/µs
Rate of rise of forward voltage not to trigger any device	$\frac{dV_D}{dt}$	<	20	20	20	20	V/µs

Currents

			BTX35-500R	600R	700R	800R	
Reverse current $V_R = V_{RWMmax}$	I_R	<	6.0	5.0	4.5	4.0	mA [2])
Off-state current $V_D = V_{DWMmax}$	I_D	<	6.0	5.0	4.5	4.0	mA
Pick up current	I_P	typ.	20				mA
Holding current	I_H	typ.	10				mA

GATE TO CATHODE

Voltages

Voltage to trigger all devices V_D = 6 V; T_j = 25 °C	V_{GT}	>	3.5	V
Voltage not to trigger any device	V_{GD}	<	0.25	V

Current

Current to trigger all devices V_D = 6 V; T_j = 25 °C	I_{GT}	>	65	mA

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

[2]) These I_R values apply to a gate voltage range of −5 to +0.25 V.

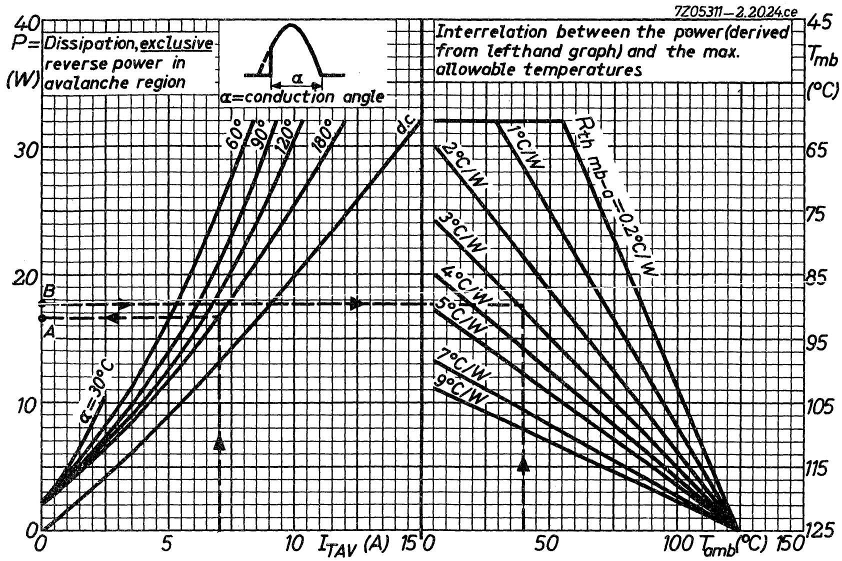
SWITCHING CHARACTERISTICS (See also page 10)

Turn on time when switched from V_D = 400 V to I_T = 50 A				
Gate source 5 V, 25 Ω, T_j = 125 °C	t_{on}	typ.	2.0	μs
Turn off time when switched from I_T = 10 A to I_R between 5 and 20 A				
dV_D/dt = 20 V/μs T_j = 125 °C	t_q	typ.	15	μs
T_j = 25 °C	t_q	typ.	7.5	μs

OPERATING NOTES

1. In order to prevent the thyristors from being damaged by surge currents higher than those mentioned in the curves at page 7 a fast fuse is recommended.

2. The gate and cathode connectors should not be bent; they should be soldered into the circuit so there is no strain on them.
   During soldering the heat conduction to the junction should be kept to a minimum by using a thermal shunt.



Determination of the heatsink thermal resistance

Example:

Assume a thyristor, used in a single phase full wave rectifier circuit.

frequency	f	=	50 Hz
conduction angle	α	=	180^o
average forward current	I_{TAV}	=	7 A (per thyristor)
ambient temperature	T_{amb}	=	40 ^oC
repetitive peak reverse power dissipation in the avalanche region	P_{RRM}	=	2 kW (per thyristor)
duration of P_{RRM}	t	=	10 μs

From the left hand part of the graph above it follows that at $I_{TAV} = 7$ A and $\alpha = 180^o$ the average forward power + average leakage power = 16.6 W per thyristor (point A). The average reverse power in the avalanche region, averaged over any cycle, follows from:

$$P_{RAV} = \delta \times P_{RRM}, \text{ where the duty cycle } \delta = \frac{10\ \mu s}{20\ ms} = 0.0005$$

Thus: $P_{RAV} = 0.0005 \times 2\ kW = 1\ W$.

Therefore the total device power dissipation $P_{tot} = (16.6 + 1)\ W = 17.6\ W$ (point B).

From the right hand part of the graph above follows the thermal resistance, required for $P_{tot} = 17.6$ W at $T_{amb} = 40\ ^oC$.

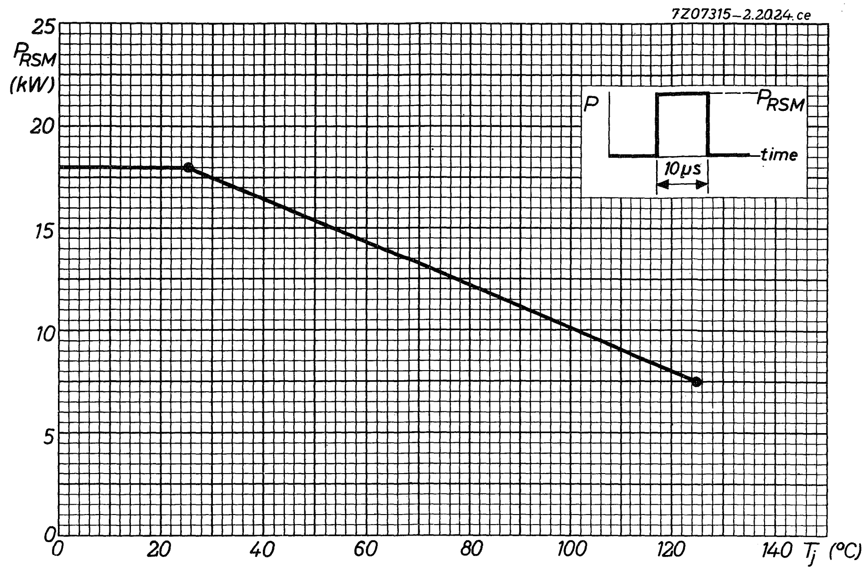
$$R_{th\ mb\text{-}a} \approx 2.9\ ^oC/W$$

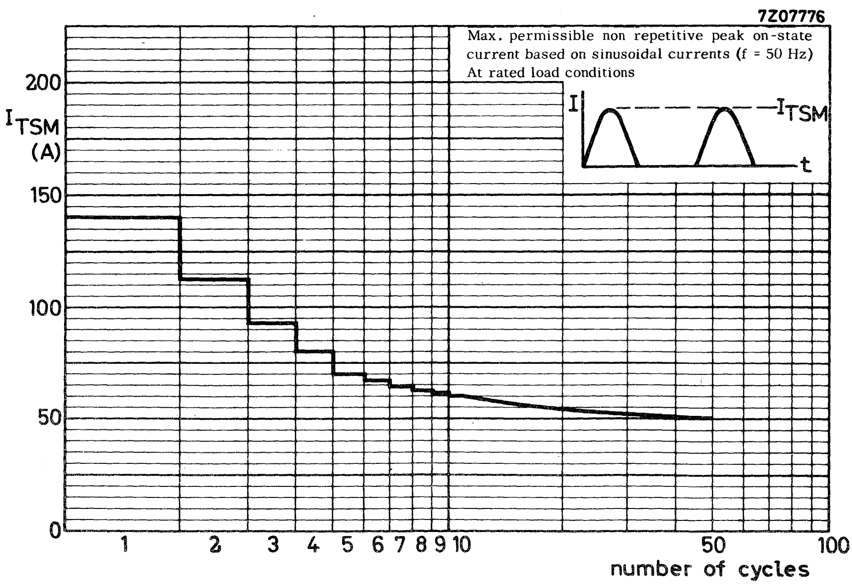
The contact thermal resistance $R_{th\ mb\text{-}h} = 0.2\ ^oC/W$

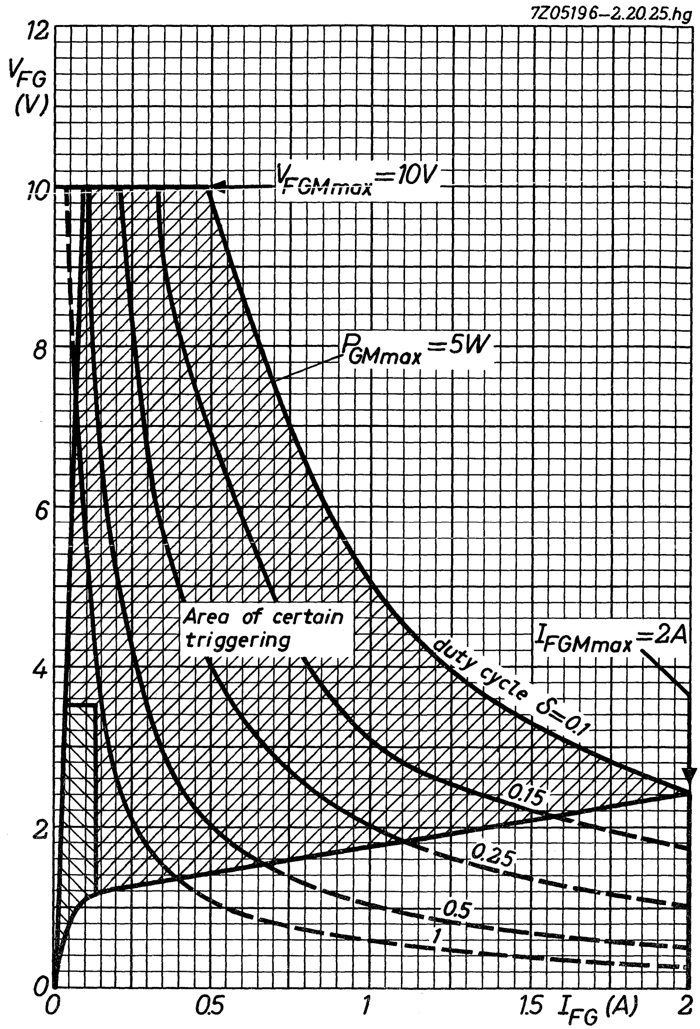
Hence the heatsink thermal resistance should be:

$$R_{th\ h\text{-}a} = R_{th\ mb\text{-}a} - R_{th\ mb\text{-}h} = (2.9 - 0.2)\ ^oC/W = 2.7\ ^oC/W.$$

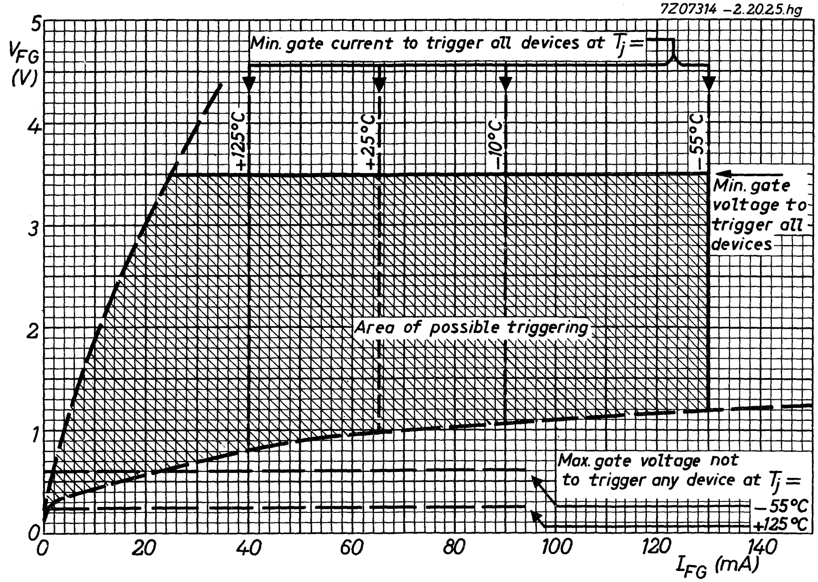
The applicable heatsink(s) may then be found in the Section ACCESSORIES and HEATSINKS.

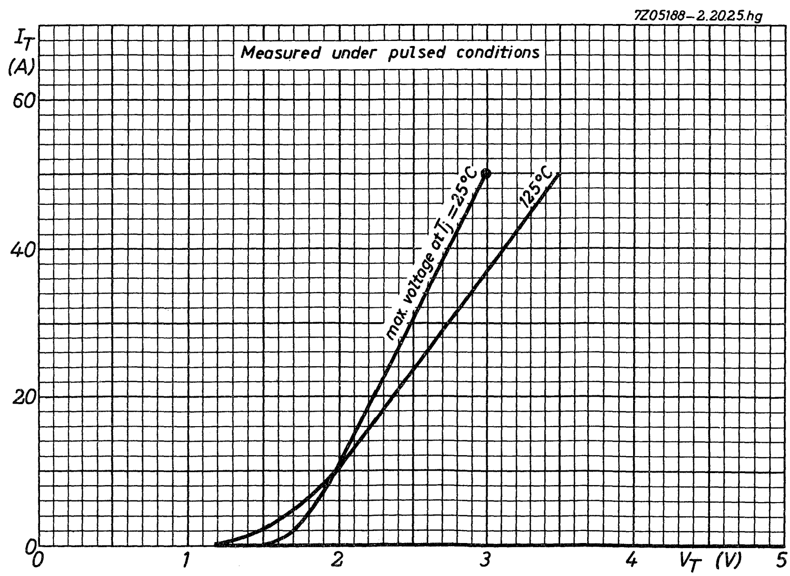

7Z07315-2.2024.ce
25
P_{RSM}
(kW)
20
15
10
5
0
P
P_{RSM}
time
10 μs
0
20
40
60
80
100
120
140 T_j (°C)

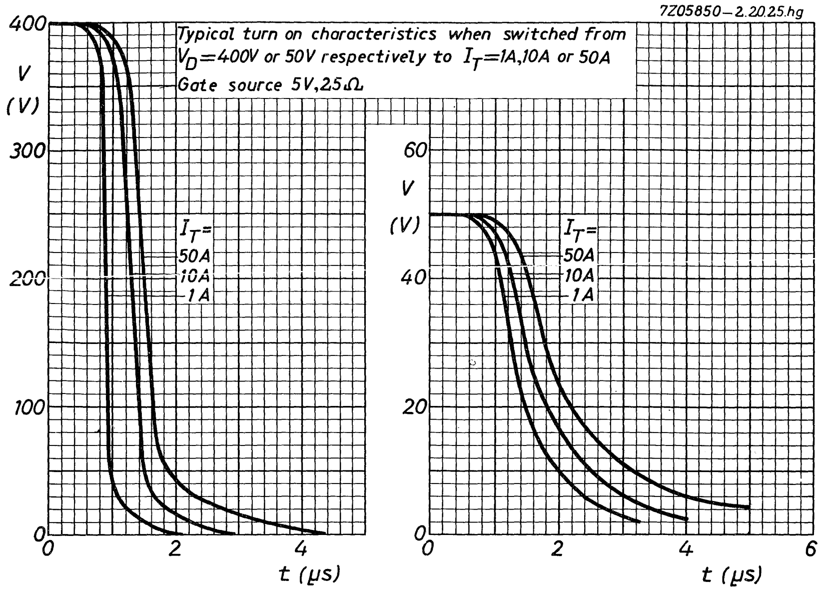

7Z07776
Max. permissible non repetitive peak on-state current based on sinusoidal currents (f = 50 Hz)
At rated load conditions
200
I_{TSM}
(A)
150
100
50
0
I
I_{TSM}
t
1
2
3
4
5
6
7
8
9
10
50
100
number of cycles

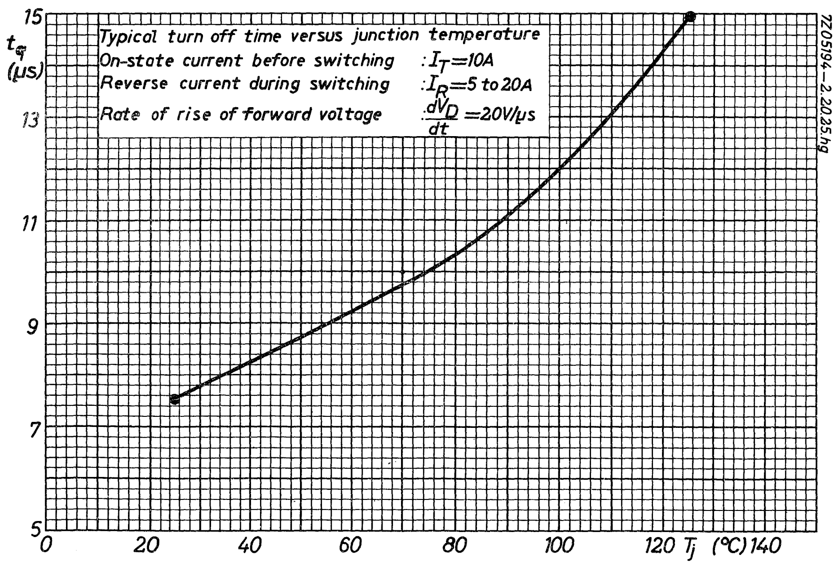


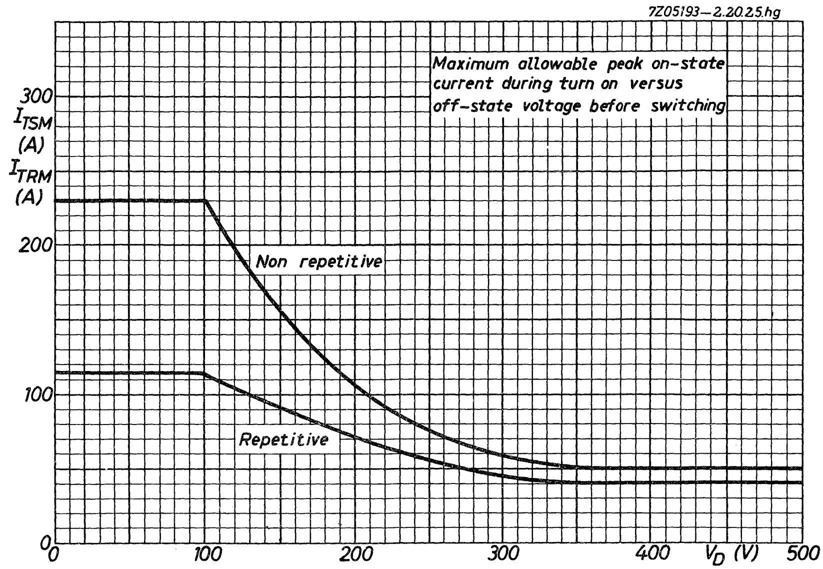
Gate characteristics with curves $P_{GAV}=0.5W$

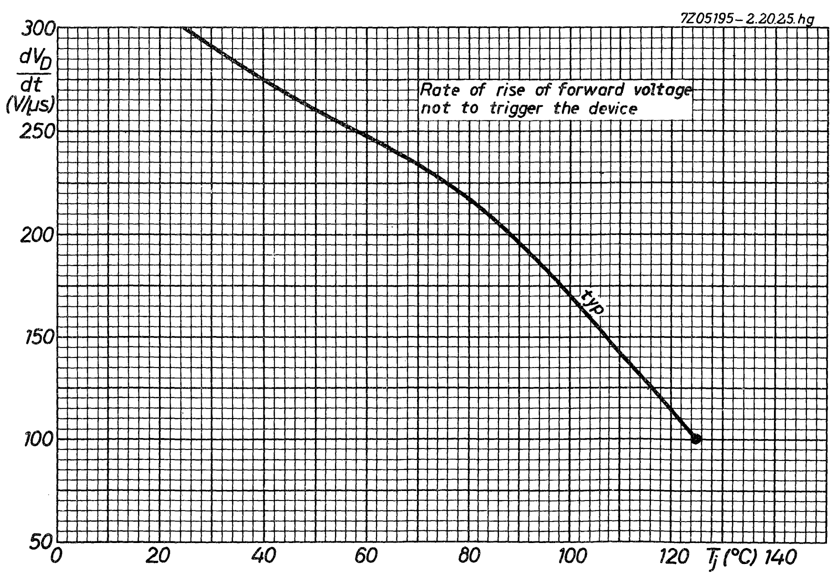

7Z07314 –2.20.25.hg
V_{FG} (V)
Min. gate current to trigger all devices at T_j =
+125°C
+25°C
–10°C
–55°C
Min. gate voltage to trigger all devices
Area of possible triggering
Max. gate voltage not to trigger any device at T_j =
– 55°C
+125°C
I_{FG} (mA)
0
20
40
60
80
100
120
140
1
2
3
4
5


7Z05188–2.20.25.hg
I_T (A)
Measured under pulsed conditions
max. voltage at T_j = 25°C
125°C
V_T (V)
0
20
40
60
1
2
3
4
5


7Z05850–2.20.25.hg
Typical turn on characteristics when switched from
V_D=400V or 50V respectively to I_T=1A,10A or 50A
Gate source 5V,25Ω
400
V
(V)
300
200
100
0
I_T=
50A
10A
1A
0
2
4
t (µs)
60
V
(V)
40
20
0
I_T=
50A
10A
1A
0
2
4
6
t (µs)


7Z05194–2.20.25.hg
Typical turn off time versus junction temperature
On-state current before switching : I_T=10A
Reverse current during switching : I_R=5 to 20A
Rate of rise of forward voltage : $\frac{dV_D}{dt}$=20V/µs
15
t_q
(µs)
13
11
9
7
5
0
20
40
60
80
100
120 T_j (°C) 140


7Z05193–2.20.25.hg
Maximum allowable peak on-state current during turn on versus off-state voltage before switching
I_{TSM} (A)
I_{TRM} (A)
300
200
100
0
Non repetitive
Repetitive
0
100
200
300
400
V_D (V)
500


7Z05195–2.20.25.hg
Rate of rise of forward voltage not to trigger the device
$\frac{dV_D}{dt}$ (V/μs)
300
250
200
150
100
50
typ
0
20
40
60
80
100
120
T_j (°C)
140

CONTROLLED AVALANCHE THYRISTORS

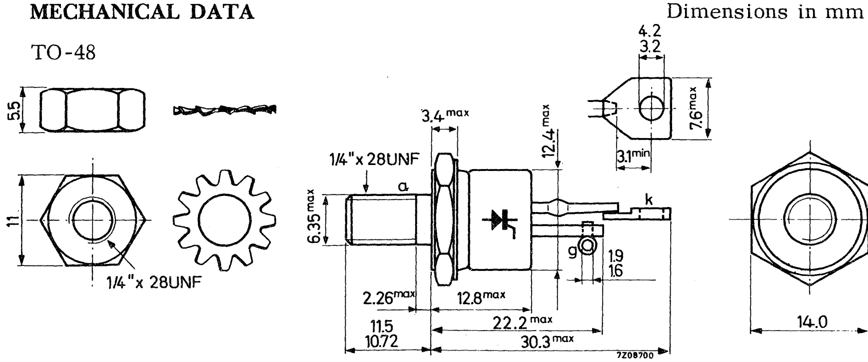
P-gate silicon thyristors in a TO-48 metal envelope, capable of absorbing transients and intended for power control and power switching applications. The series consists of the following reverse polarity types (stud anode):
BTX36-500R; BTX36-600R; BTX36-700R and BTX36-800R.

QUICK REFERENCE DATA

			BTX36-500R	600R	700R	800R	
Crest working reverse voltage	V_{RWM}	max.	500	600	700	800	V
Crest working off-state voltage	V_{DWM}	max.	500	600	700	800	V
Average forward current	I_{TAV}	max.	16				A
Non repetitive peak forward current $t = 10$ ms	I_{TSM}	max.	200				A
Non repetitive peak reverse dissipation $t = 10\ \mu s$; $T_j = 25\ ^oC$	P_{RSM}	max.	18				kW
Junction temperature	T_j	max.	125				^oC
Thermal resistance from junction to mounting base	$R_{th\ j-mb}$	=	2.0				$^oC/W$

MECHANICAL DATA Dimensions in mm

TO-48



Net weight : 10 g
With accessories: 15 g

Torque on nut: min. 17 cm kg
max. 35 cm kg

Diameter of hole in heatsink: max. 6.5 mm

Accessories available: 56264A

All information applies to frequencies up to 400 Hz

RATINGS (Limiting values) [1]

ANODE TO CATHODE

Voltages [2]

			BTX36-500R	600R	700R	800R	
Continuous reverse voltage	V_R	max.	500	600	700	800	V
Crest working reverse voltage	V_{RWM}	max.	500	600	700	800	V
Continuous off-state voltage	V_D	max.	500	600	700	800	V
Crest working off-state voltage	V_{DWM}	max.	500	600	700	800	V [3]

Currents

Average forward current (averaged over any 20 ms period)	I_{TAV}	max.	16	A
Forward current (d.c.)	I_T	max.	19	A
R.M.S. forward current	$I_{T(RMS)}$	max.	25	A
Repetitive peak forward current	I_{TRM}	max.	150	A
Non repetitive peak forward current t = 10 ms (See also page 7)	I_{TSM}	max.	200	A
I squared t for fusing (t = 1.5 to 10 ms)	I^2t	max.	200	A^2s
Rate of rise of forward current	$\frac{dI_T}{dt}$	max.	20	A/μs
Repetitive peak reverse current (during turn-off)	I_{RRM}	max.	20	A

Power dissipation

Non repetitive peak reverse dissipation (See also page 7)				
t = 10 μs; T_j = 25 °C	P_{RSM}	max.	18	kW
t = 10 μs; T_j = 125 °C	P_{RSM}	max.	7.5	kW

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

2) These ratings apply to a gate voltage range of −5 to +0.25 V. To ensure thermal stability: $R_{th\ j\text{-}a} \leq 4.5$ °C/W (d.c.) or ≤ 9 °C/W (a.c.)

3) Off-state voltages higher than V_{DWMmax} are allowed, but at voltages higher than the forward breakover voltage (see page 4) the device may switch into the on-state.

RATINGS (Limiting values) (continued)

GATE TO CATHODE

Voltages

Forward peak voltage	V_{FGM}	max.	10	V
Reverse peak voltage	V_{RGM}	max.	5	V

Current

Forward peak current	I_{FGM}	max.	2	A

Power dissipation

Average power dissipation (averaged over any 20 ms period)	P_{GAV}	max.	0.5	W
Peak power dissipation	P_{GM}	max.	5	W

TEMPERATURES

Storage temperature	T_{stg}		−55 to +125	^oC
Junction temperature	T_j	max.	125	^oC

THERMAL RESISTANCE

From junction to mounting base	$R_{th\ j\text{-}mb}$	=	2.0	$^oC/W$
From mounting base to heatsink	$R_{th\ mb\text{-}h}$	=	0.2	$^oC/W$
From mounting base to heatsink with mica washer	$R_{th\ mb\text{-}h}$	=	4.0	$^oC/W$

CHARACTERISTICS $T_j = 125\ ^oC$ unless otherwise specified

ANODE TO CATHODE

Voltages

			BTX36-500R	600R	700R	800R	
Forward on-state voltage $I_T = 50$ A; $T_j = 25\ ^oC$	V_T	<	2.0	2.0	2.0	2.0	V 1)
Reverse breakdown voltage in avalanche region	$V_{(BR)R}$	>	550	660	770	880	V
Forward breakover voltage	$V_{(BO)}$	>	550	660	770	880	V
Rate of rise of forward voltage not to trigger the device	$\frac{dV_D}{dt}$	typ.	100	100	100	100	V/μs
Rate of rise of forward voltage not to trigger any device	$\frac{dV_D}{dt}$	<	20	20	20	20	V/μs

Currents

			BTX36-500R	600R	700R	800R	
Reverse current $V_R = V_{RWMmax}$	I_R	<	6.0	5.0	4.5	4.0	mA 2)
Off-state current $V_D = V_{DWMmax}$	I_D	<	6.0	5.0	4.5	4.0	mA
Pick up current	I_P	typ.	20 (all types)				mA
Holding current	I_H	typ.	10 (all types)				mA

GATE TO CATHODE

Voltages

Voltage to trigger all devices $V_D = 6$ V; $T_j = 25\ ^oC$	V_{GT}	>	3.0	V
Voltage not to trigger any device	V_{GD}	<	0.25	V

Current

Current to trigger all devices $V_D = 6$ V; $T_j = 25\ ^oC$	I_{GT}	>	40	mA

1) Measured under pulsed conditions to prevent excessive dissipation.

2) These I_R values apply to a gate voltage range of −5 to +0.25 V.

SWITCHING CHARACTERISTICS (See also page 10)

Turn on time when switched from
V_D = 400 V to I_T = 50 A

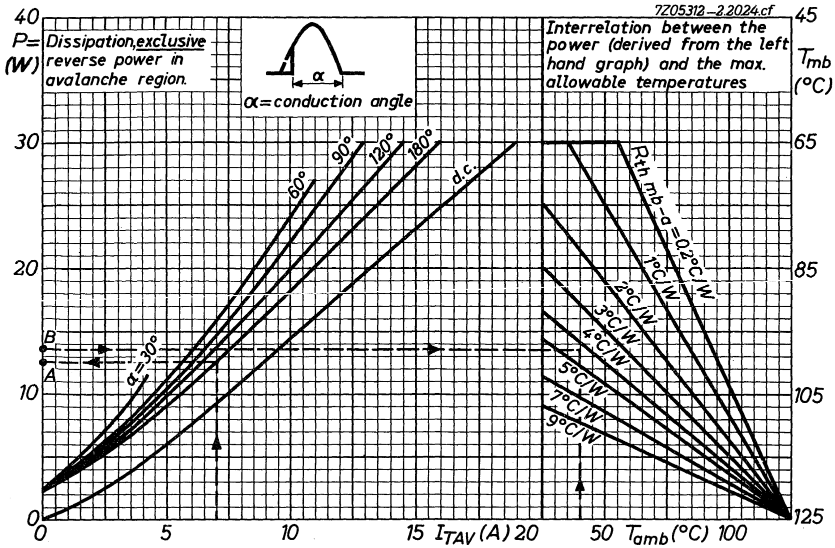
Gate source 5 V, 25 Ω, T_j = 125 °C	t_{on}	typ.	2.0	μs

Turn off time when switched from
I_T = 10 A to I_R between 5 and 20 A

dV_D/dt = 20 V/μs	T_j = 125 °C	t_q	typ.	20	μs
	T_j = 25 °C	t_q	typ.	10	μs

OPERATING NOTES

1. In order to prevent the thyristors from being damaged by surge currents higher than those mentioned in the curves at page 7 a fast fuse is recommended.
2. The gate and cathode connectors should not be bent; they should be soldered into the circuit so there is no strain on them.
   During soldering the heat conduction to the junction should be kept to a minimum by using a thermal shunt.



Determination of the heatsink thermal resistance.

Example:

Assume a thyristor, used in a single phase full wave rectifier circuit.

frequency	f	=	50 Hz
conduction angle	α	=	180°
average forward current	I_{TAV}	=	7 A (per thyristor)
ambient temperature	T_{amb}	=	40 °C
repetitive peak reverse power dissipation in the avalanche region	P_{RRM}	=	2 kW (per thyristor)
duration of P_{RRM}	t	=	10 μs

From the left hand part of the graph above it follows that at I_{TAV} = 7 A and α = 180° the average forward power + average leakage power = 12.5 W per thyristor (point A). The average reverse power in the avalanche region, averaged over any cycle, follows from:

$$P_{RAV} = \delta \times P_{RRM}, \text{ where the duty cycle } \delta = \frac{10\ \mu s}{20\ ms} = 0.0005$$

Thus: P_{RAV} = 0.0005 x 2 kW = 1 W.

Therefore the total device power dissipation P_{tot} = (12.5 + 1) W = 13.5 W (point B).

From the right hand part of the graph above follows the thermal resistance, required for P_{tot} = 13.5 W at T_{amb} = 40 °C

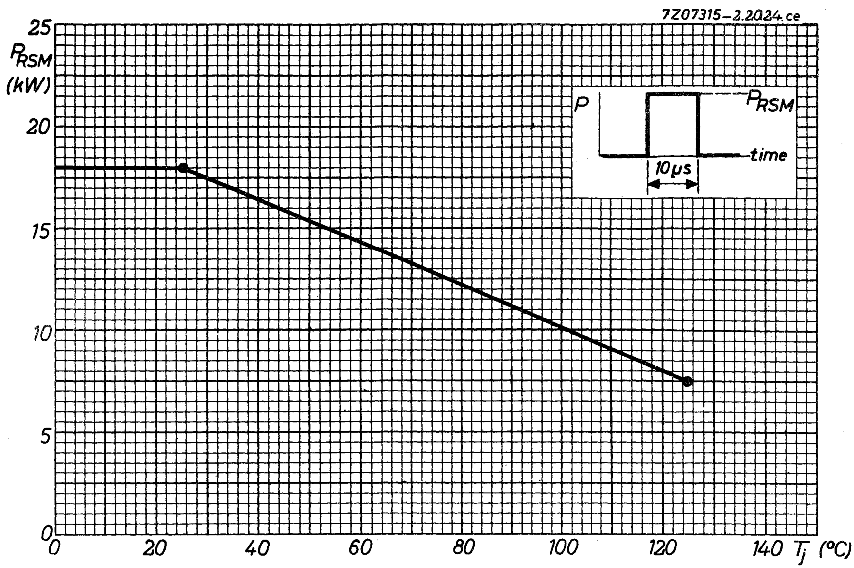
$$R_{th\ mb-a} \approx 4.4\ ^{o}C/W$$

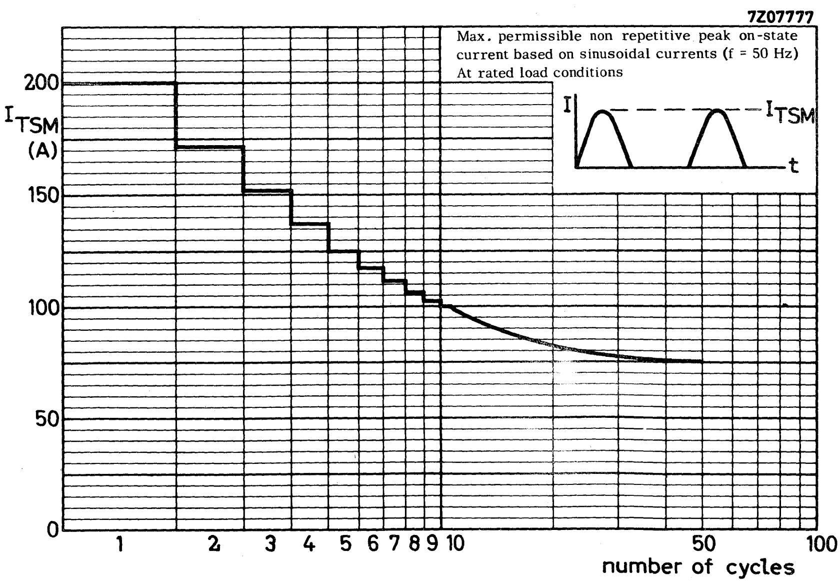
The contact thermal resistance $R_{th\ mb-h}$ = 0.2 °C/W.

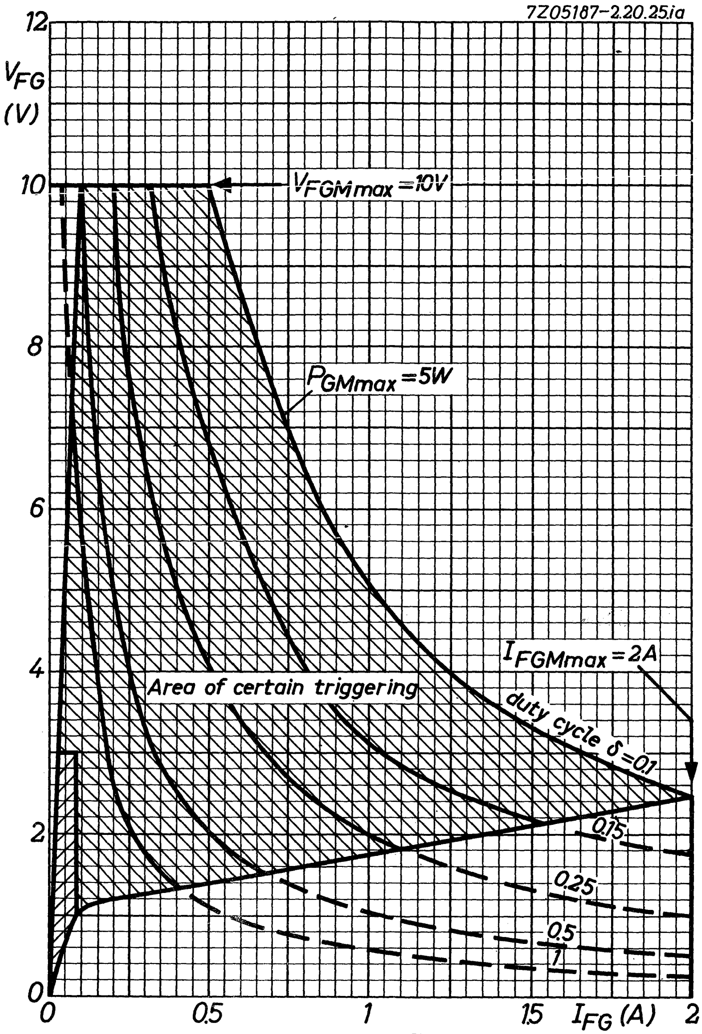
Hence the heatsink thermal resistance should be:

$$R_{th\ h-a} = R_{th\ mb-a} - R_{th\ mb-h} = (4.4 - 0.2)\ ^{o}C/W = 4.2\ ^{o}C/W.$$

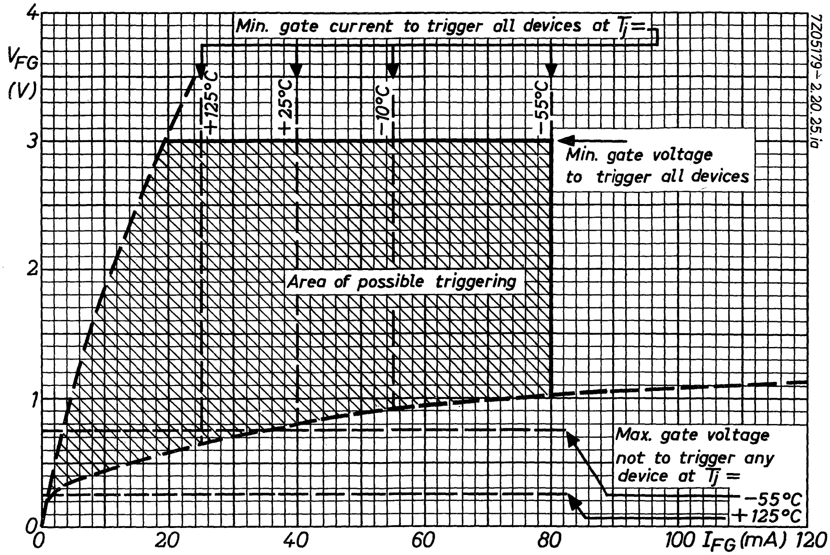
The applicable heatsink(s) may then be found in the Section ACCESSORIES and HEATSINKS.

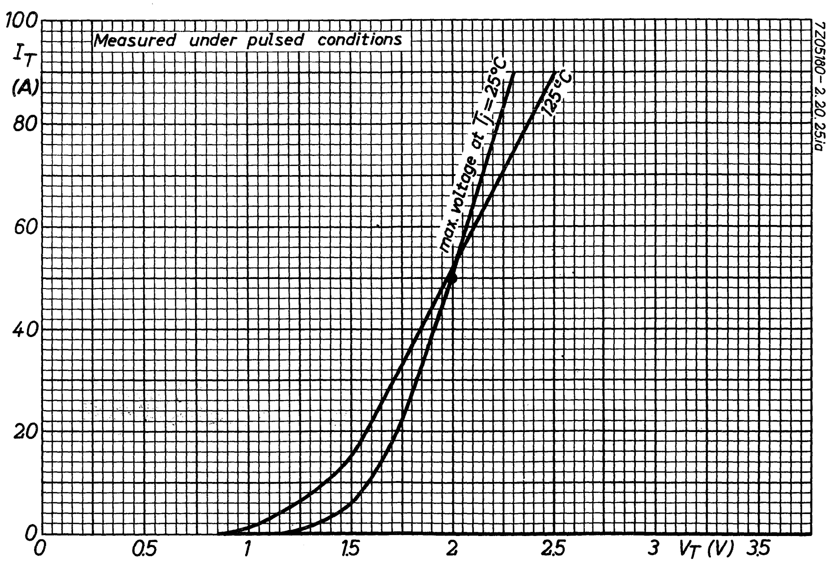

7Z07315–2.2024.ce
25
P_{RSM}
(kW)
20
15
10
5
0
0
20
40
60
80
100
120
140 T_j (°C)
P
P_{RSM}
time
10 µs

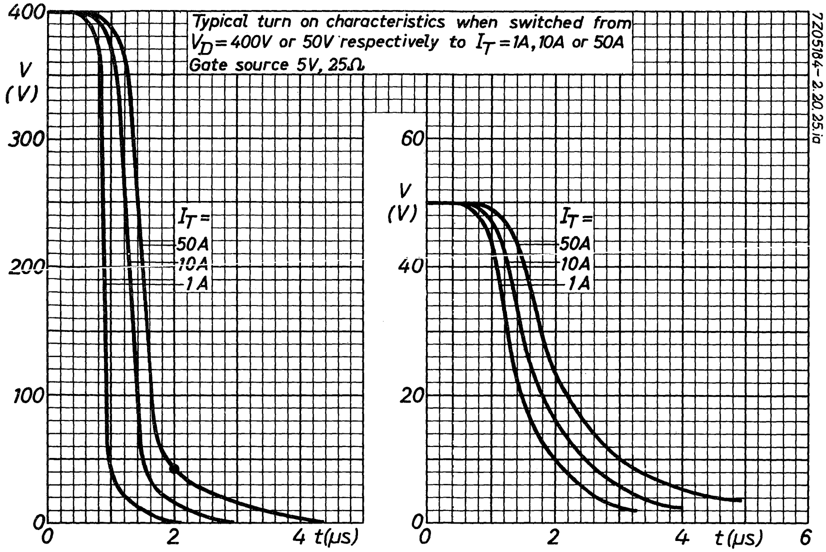

7Z07777
Max. permissible non repetitive peak on-state current based on sinusoidal currents (f = 50 Hz)
At rated load conditions
200
I_{TSM}
(A)
150
100
50
0
I
I_{TSM}
t
1
2
3
4
5
6
7
8
9
10
50
100
number of cycles

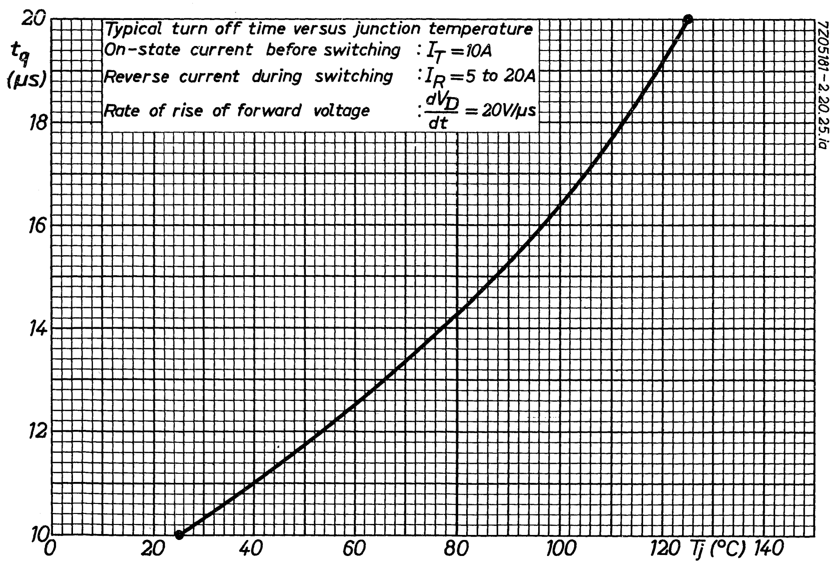


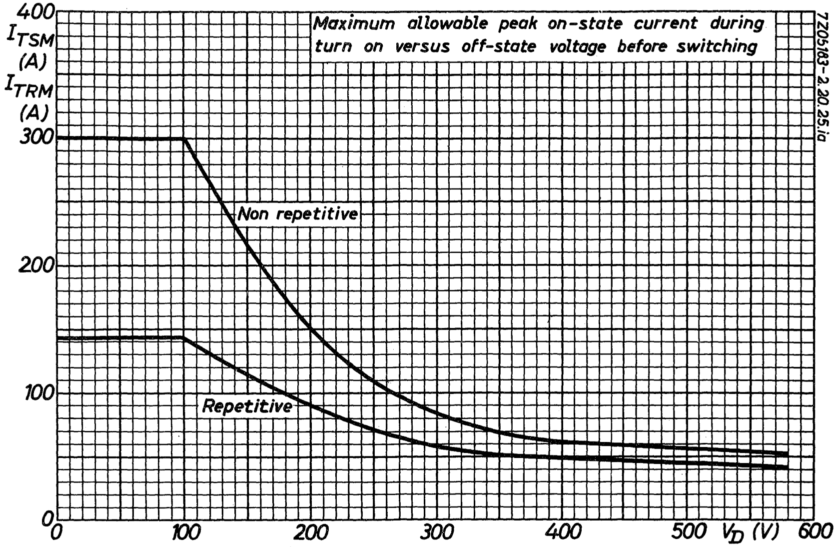
Gate characteristics with curves $P_{GAV} = 0.5W$

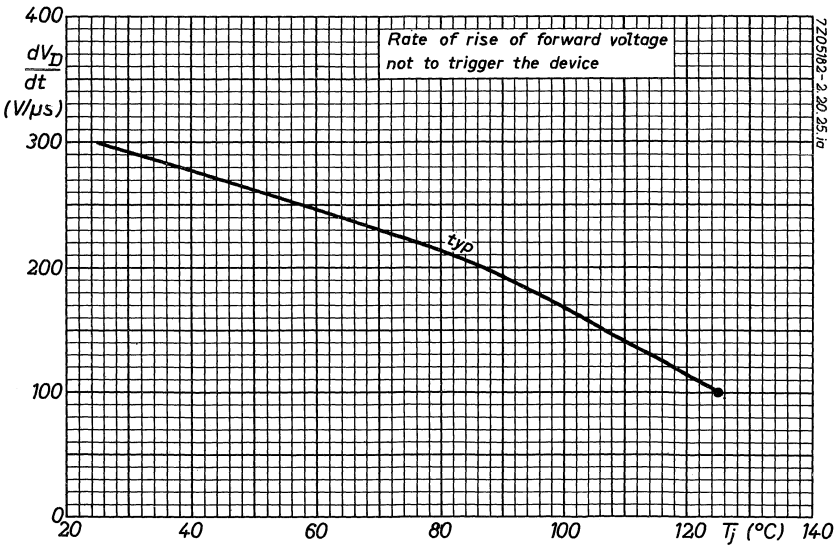

Min. gate current to trigger all devices at T_j =
+125°C
+25°C
−10°C
−55°C
Min. gate voltage to trigger all devices
Area of possible triggering
Max. gate voltage not to trigger any device at T_j =
−55°C
+125°C
V_{FG} (V)
I_{FG} (mA)
0
1
2
3
4
20
40
60
80
100
120
7Z05179−2.20.25.ia


Measured under pulsed conditions
max. voltage at T_j = 25°C
125°C
I_T (A)
V_T (V)
0
20
40
60
80
100
0.5
1
1.5
2
2.5
3
3.5
7Z05180−2.20.25ia


Typical turn on characteristics when switched from V_D=400V or 50V respectively to I_T=1A,10A or 50A
Gate source 5V, 25Ω
V (V)
400
300
200
100
0
I_T =
50A
10A
1A
0
2
4 t(μs)
60
40
20
0
0
2
4
t(μs)
6
7Z05184-2.20.25.ia


Typical turn off time versus junction temperature
On-state current before switching : I_T =10A
Reverse current during switching : I_R =5 to 20A
Rate of rise of forward voltage : $\frac{dV_D}{dt}$ = 20V/μs
t_q (μs)
20
18
16
14
12
10
0
20
40
60
80
100
120
T_j (°C)
140
7Z05181-2.20.25.ia


Maximum allowable peak on-state current during turn on versus off-state voltage before switching
7Z05183-2.20.25.ia
I_{TSM} (A)
I_{TRM} (A)
400
300
200
100
0
Non repetitive
Repetitive
0
100
200
300
400
500
V_D (V)
600


Rate of rise of forward voltage not to trigger the device
7Z05182-2.20.25.ia
$\frac{dV_D}{dt}$ (V/μs)
400
300
200
100
0
typ
20
40
60
80
100
120
T_j (°C)
140

CONTROLLED AVALANCHE THYRISTORS

P-gate silicon thyristors in a metal envelope with ceramic insulation. They are capable of absorbing transients and intended for power control and power switching applications. The series consists of the following reverse polarity types (stud anode):

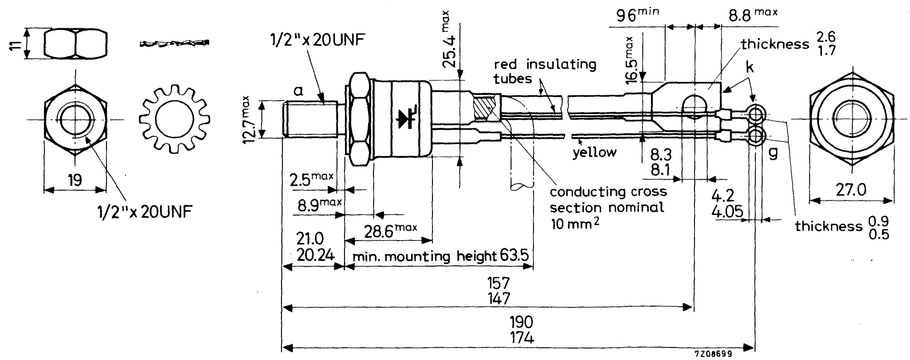
BTX37-500R; BTX37-600R; BTX37-700R and BTX37-800R.

QUICK REFERENCE DATA

			BTX37–500R	600R	700R	800R	
Crest working reverse voltage	V_{RWM}	max.	500	600	700	800	V
Crest working off-state voltage	V_{DWM}	max.	500	600	700	800	V
Average forward current	I_{TAV}	max.	50				A
Non repetitive peak forward current t = 10 ms	I_{TSM}	max.	680				A
Non repetitive peak reverse dissipation t = 10 μs; T_j = 25 °C	P_{RSM}	max.	40				kW
Junction temperature	T_j	max.	125				°C
Thermal resistance from junction to mounting base	$R_{th\,j\text{-}mb}$	=	0.6				°C/W

MECHANICAL DATA

Dimensions in mm



Net weight : 80 g
With accessories: 108 g

Torque on nut: min. 90 cm kg
max. 175 cm kg

Diameter of hole in heatsink: max. 13 mm

All information applies to frequencies up to 400 Hz.

RATINGS (Limiting values) [1])

ANODE TO CATHODE

Voltages [2])			BTX37-500R	600R	700R	800R	
Continuous reverse voltage	V_R	max.	500	600	700	800	V
Crest working reverse voltage	V_{RWM}	max.	500	600	700	800	V
Continuous off-state voltage	V_D	max.	500	600	700	800	V
Crest-working off-state voltage	V_{DWM}	max.	500	600	700	800	V [3])

Currents

Average forward current (averaged over any 20 ms period)	I_{TAV}	max.	50	A
Forward current (d.c.)	I_T	max.	75	A
R.M.S. forward current	$I_{T(RMS)}$	max.	78	A
Repetitive peak forward current	I_{TRM}	max.	700	A
Non repetitive peak forward current t = 10 ms (See also page 7)	I_{TSM}	max.	680	A
I squared t for fusing (t = 1.5 to 10 ms)	I^2t	max.	2000	A^2s
Rate of rise of forward current	$\frac{dI_T}{dt}$	max.	20	A/μs
Repetitive peak reverse current (during turn-off)	I_{RRM}	max.	30	A

Power dissipation

Non repetitive peak reverse dissipation (See also page 7) t = 10 μs; T_j = 25 °C	P_{RSM}	max.	40	kW
t = 10 μs; T_j = 125 °C	P_{RSM}	max.	18	kW

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

[2]) These ratings apply to a gate voltage range of −5 to +0.25 V
To ensure thermal stability: $R_{th\ j\text{-}a} \leq 1.5$ °C/W (d.c.) or ≤ 3 °C/W (a.c.)

[3]) Off-state voltages higher than V_{DWMmax} are allowed, but at voltages higher than the forward breakover voltage (see page 4) the device may switch into the on-state.

RATINGS (Limiting values) (continued)

GATE TO CATHODE

Voltages

Forward peak voltage	V_{FGM}	max.	10	V
Reverse peak voltage	V_{RGM}	max.	5	V

Current

Forward peak current	I_{FGM}	max.	2	A

Power dissipation

Average power dissipation (averaged over any 20 ms period)	P_{GAV}	max.	0.5	W
Peak power dissipation	P_{GM}	max.	5	W

TEMPERATURES

Storage temperature	T_{stg}		−55 to +125	°C
Junction temperature	T_j	max.	125	°C

THERMAL RESISTANCE

From junction to mounting base	$R_{th\ j\text{-}mb}$	=	0.6	°C/W
From mounting base to heatsink	$R_{th\ mb\text{-}h}$	=	0.1	°C/W

CHARACTERISTICS T_j = 125 °C unless otherwise specified

ANODE TO CATHODE

Voltages

			BTX37-500R	600R	700R	800R	
Forward on-state voltage I_T = 500 A; T_j = 25 °C	V_T	<	3.3	3.3	3.3	3.3	V 1)
Reverse breakdown voltage in avalanche region	$V_{(BR)R}$	>	550	660	770	880	V
Forward breakover voltage	$V_{(BO)}$	>	550	660	770	880	V
Rate of rise of forward voltage not to trigger the device	$\frac{dV_D}{dt}$	typ.	10	10	10	10	V/µs

Currents

			BTX37-500R	600R	700R	800R	
Reverse current $V_R = V_{RWMmax}$	I_R	<	12	12	12	10	mA 2)
Off-state current $V_D = V_{DWMmax}$	I_D	<	12	12	12	10	mA
Pick up current	I_P	typ.	20				mA
Holding current	I_H	typ.	10				mA

GATE TO CATHODE

Voltages

Voltage to trigger all devices V_D = 6 V; T_j = 25 °C	V_{GT}	>	3	V
Voltage not to trigger any device	V_{GD}	<	0.25	V

Current

Current to trigger all devices V_D = 6 V; T_j = 25 °C	I_{GT}	>	80	mA

1) Measured under pulsed conditions to prevent excessive dissipation.

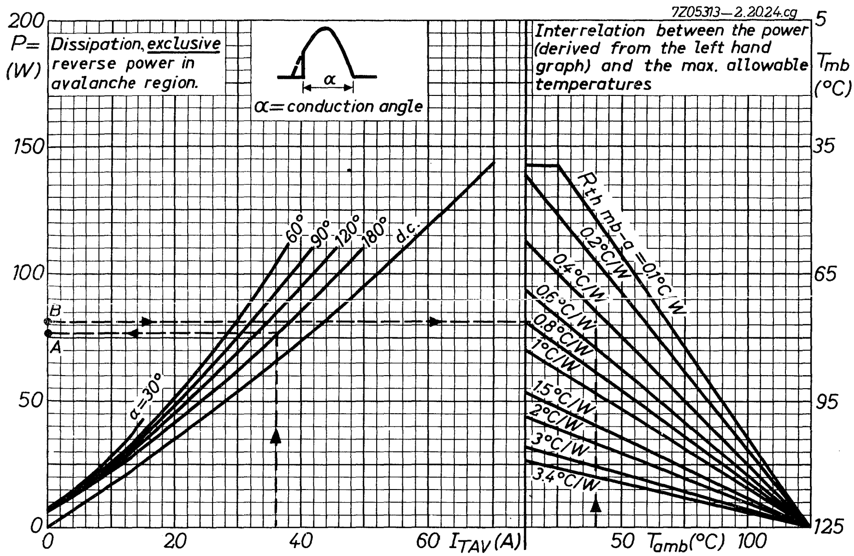
2) The I_R values apply to a gate voltage range of −5 to +0.25 V.

SWITCHING CHARACTERISTICS (See also page 10)

Turn on time when switched from V_D = 400 V to I_T = 50 A				
Gate source 5 V, 25 Ω, T_j = 125 °C	t_{on}	typ.	3.0	μs
Turn off time when switched from I_T = 50 A to I_R between 10 and 30 A				
dV_D/dt = 5 V/μs T_j = 125 °C	t_q	typ.	20	μs
T_j = 25 °C	t_q	typ.	10	μs

OPERATING NOTE

In order to prevent the thyristors from being damaged by surge currents higher than those mentioned in the curves at page 7 a fast fuse is recommended.



Determination of the heatsink thermal resistance

Example:

Assume a thyristor, used in a single phase full wave rectifier circuit.

frequency	f	=	50	Hz
conduction angle	α	=	180°	
average forward current	I_{TAV}	=	36	A (per thyristor)
ambient temperature	T_{amb}	=	40	°C
repetitive peak reverse power dissipation in the avalanche region	P_{RRM}	=	8	kW (per thyristor)
duration of P_{RRM}	t	=	10	μs

From the left hand part of the graph above it follows that at $I_{TAV} = 36$ A and $\alpha = 180°$ the average forward power + average leakage power = 77 W per thyristor (point A). The average reverse power in the avalanche region, averaged over any cycle, follows from:

$$P_{RAV} = \delta \times P_{RRM}, \text{ where the duty cycle } \delta = \frac{10\ \mu s}{20\ ms} = 0.0005$$

Thus: $P_{RAV} = 0.0005 \times 8\ kW = 4\ W$.

Therefore the total device power dissipation $P_{tot} = (77 + 4)\ W = 81\ W$ (point B).

From the right hand part of the graph above follows the thermal resistance, required for $P_{tot} = 81$ W at $T_{amb} = 40$ °C.

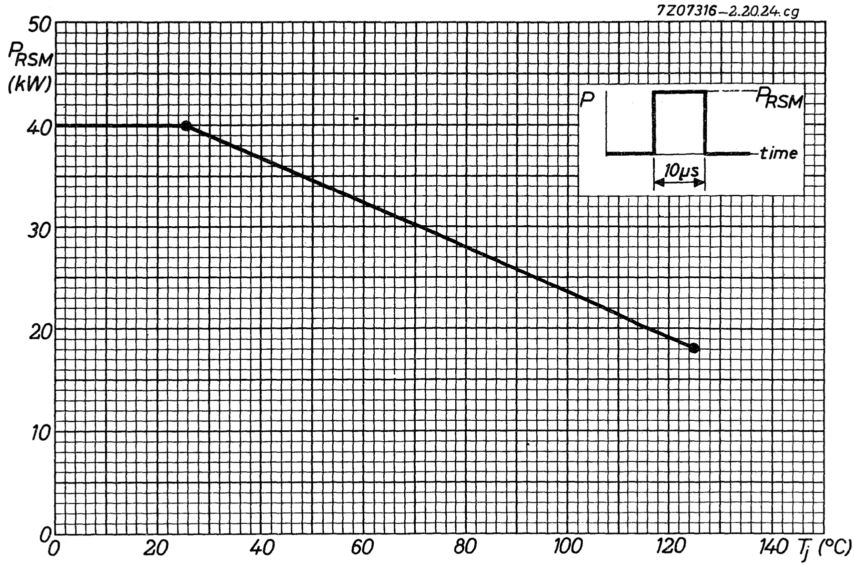
$$R_{th\ mb\text{-}a} \approx 0.47\ °C/W$$

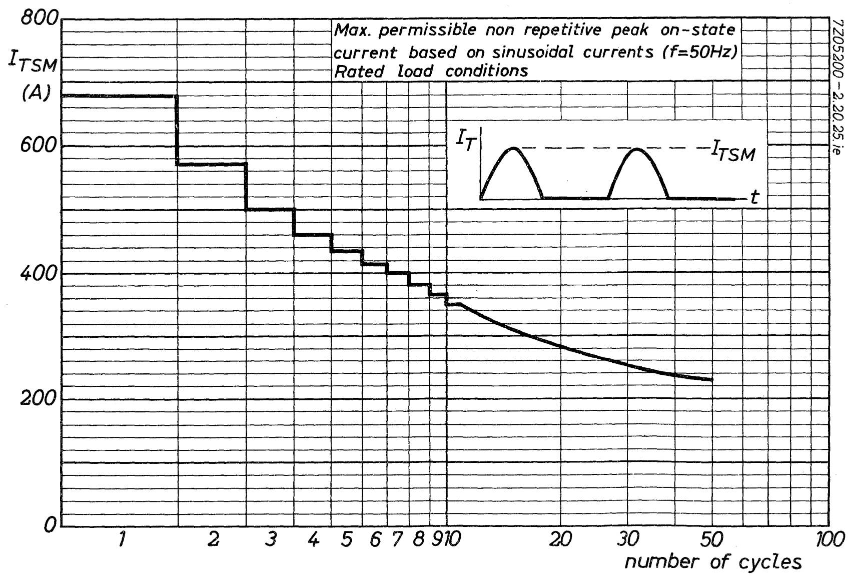
The contact thermal resistance $R_{th\ mb\text{-}h} = 0.1$ °C/W.

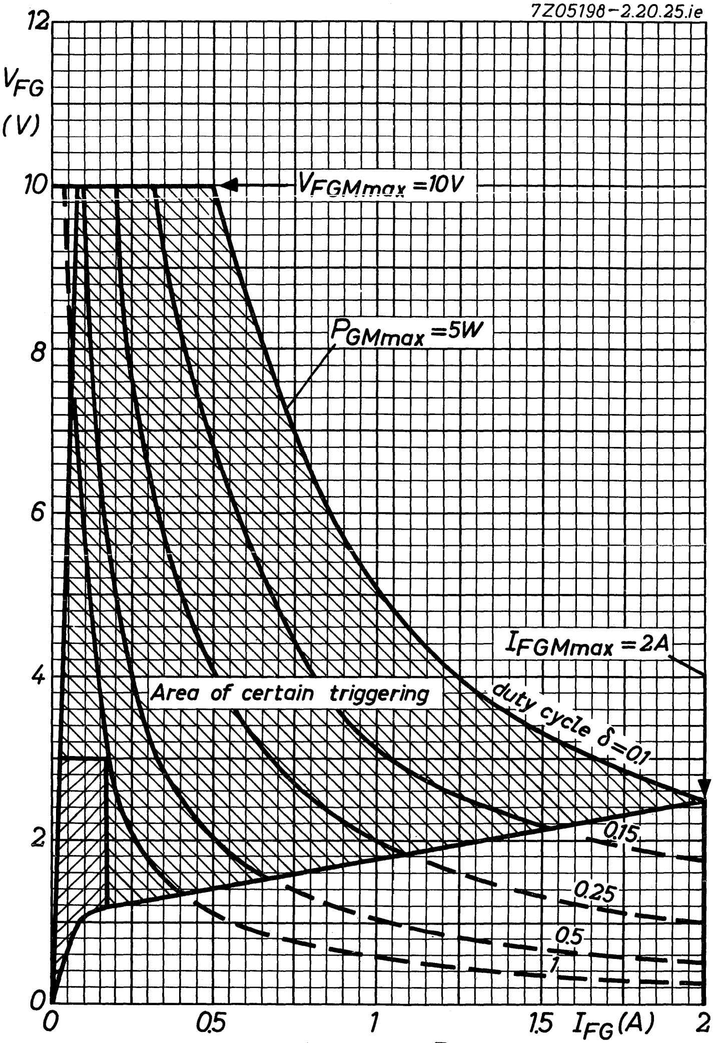
Hence the heatsink thermal resistance should be:

$$R_{th\ h\text{-}a} = R_{th\ mb\text{-}a} - R_{th\ mb\text{-}h} = (0.47 - 0.1)\ °C/W = 0.37\ °C/W.$$

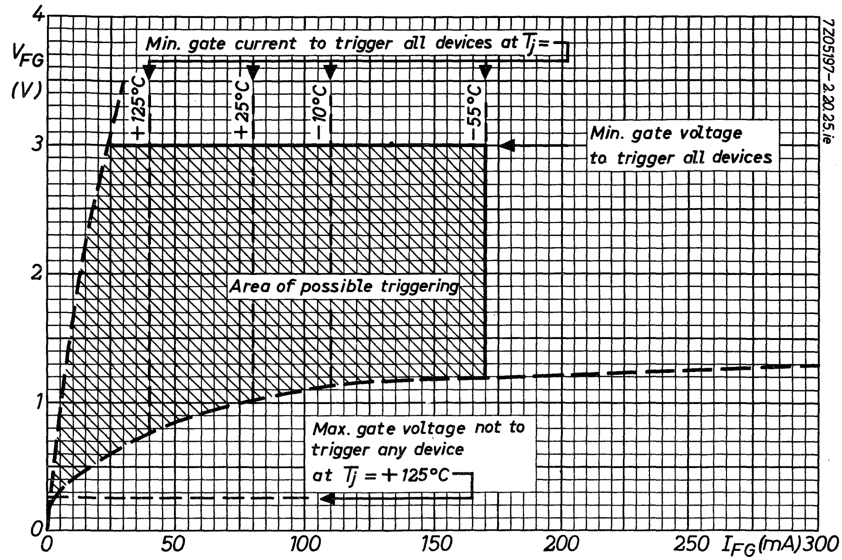
The applicable heatsink(s) may then be found in the Section ACCESSORIES and HEATSINKS.

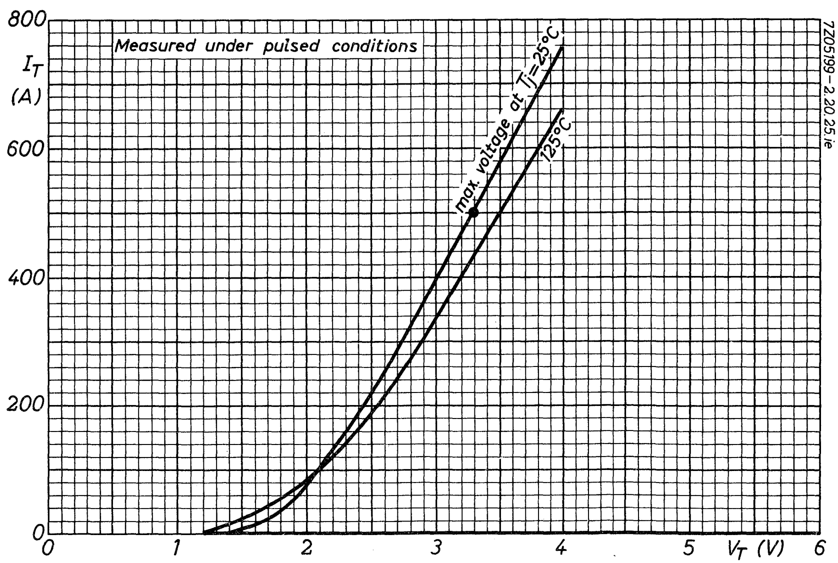

7Z07316−2.20.24.cg
50
P_{RSM}
(kW)
40
30
20
10
0
P
P_{RSM}
time
10μs
0
20
40
60
80
100
120
140 T_j (°C)

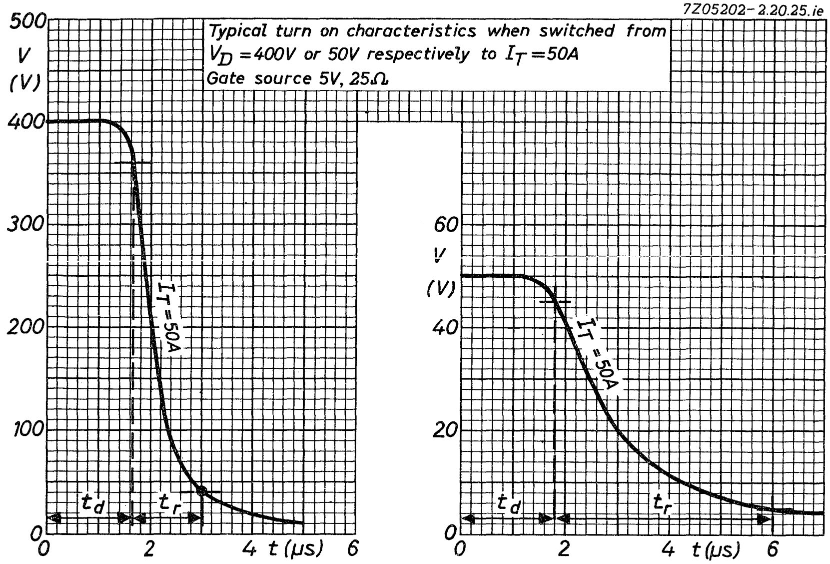

800
I_{TSM}
(A)
600
400
200
0
Max. permissible non repetitive peak on-state current based on sinusoidal currents (f=50Hz)
Rated load conditions
7Z05200−2.20.25.ie
I_T
I_{TSM}
t
1
2
3
4
5
6
7
8
9
10
20
30
50
100
number of cycles

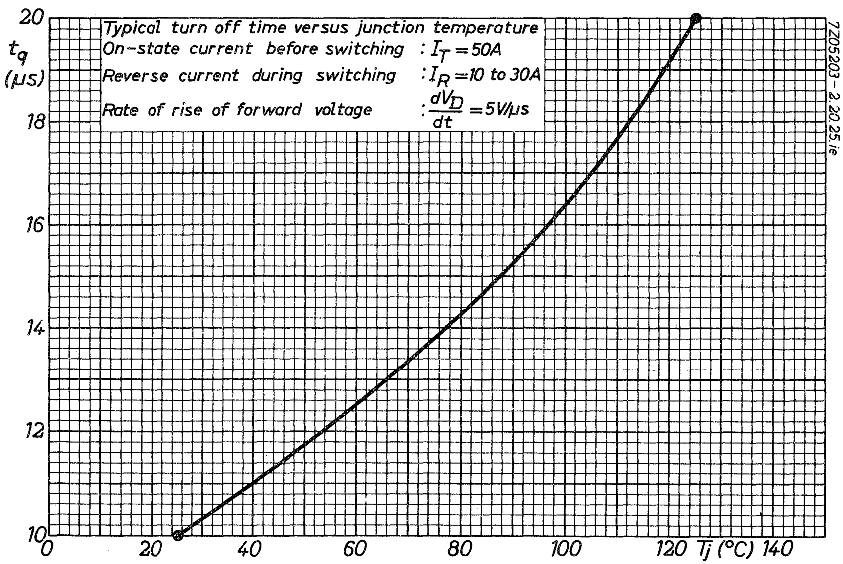


Gate characteristics with curves $P_{GAV} = 0.5W$


4
V_{FG}
(V)
3
2
1
0
Min. gate current to trigger all devices at T_j =
+125°C
+25°C
−10°C
−55°C
Min. gate voltage to trigger all devices
Area of possible triggering
Max. gate voltage not to trigger any device at T_j = +125°C
0
50
100
150
200
250
I_{FG} (mA) 300
7Z05197−2.20.25.ie


800
I_T
(A)
600
400
200
0
Measured under pulsed conditions
max. voltage at T_j = 25°C
125°C
0
1
2
3
4
5
V_T (V)
6
7Z05199−2.20.25.ie


7Z05202-2.20.25.ie
Typical turn on characteristics when switched from
V_D =400V or 50V respectively to I_T =50A
Gate source 5V, 25Ω
500
V
(V)
400
300
200
100
0
I_T =50A
t_d
t_r
0
2
4 t (μs)
6
60
V
(V)
40
20
0
I_T =50A
t_d
t_r
0
2
4 t (μs)
6


Typical turn off time versus junction temperature
On-state current before switching : I_T =50A
Reverse current during switching : I_R =10 to 30A
Rate of rise of forward voltage : $\frac{dV_D}{dt}$ =5V/μs
20
t_q
(μs)
18
16
14
12
10
0
20
40
60
80
100
120 T_j (°C) 140
7Z05203-2.20.25.ie

CONTROLLED AVALANCHE THYRISTORS

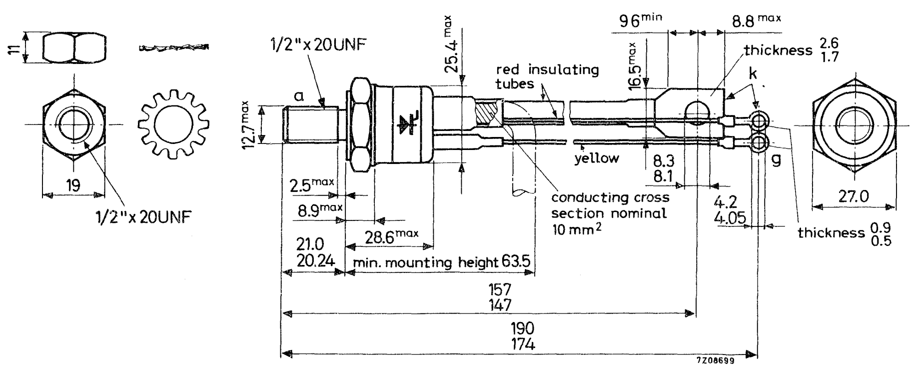
P-gate silicon thyristors in a metal envelope with ceramic insulation. They are capable of absorbing transients and intended for power control and power switching applications. The series consists of the following reverse polarity types (stud anode):

BTX38-500R; BTX38-600R; BTX38-700R and BTX38-800R.

QUICK REFERENCE DATA

			BTX38-500R	600R	700R	800R	
Crest working reverse voltage	V_{RWM}	max.	500	600	700	800	V
Crest working off-state voltage	V_{DWM}	max.	500	600	700	800	V
Average forward current	I_{TAV}	max.	70				A
Non repetitive peak forward current t = 10 ms	I_{TSM}	max.	900				A
Non repetitive peak reverse dissipation t = 10 μs; T_j = 25 °C	P_{RSM}	max.	40				kW
Junction temperature	T_j	max.	125				°C
Thermal resistance from junction to mounting base	$R_{th\ j\text{-}mb}$	=	0.4				°C/W

MECHANICAL DATA Dimensions in mm



Net weight : 80 g
With accessories: 108 g

Torque on nut: min. 90 cm kg
max. 175 cm kg

Diameter of hole in heatsink: max. 13 mm

All information applies to frequencies up to 400 Hz

RATINGS (Limiting values) [1])

ANODE TO CATHODE

Voltages [2])			BTX38-500R	600R	700R	800R
Continuous reverse voltage	V_R	max.	500	600	700	800 V
Crest working reverse voltage	V_{RWM}	max.	500	600	700	800 V
Continuous off-state voltage	V_D	max.	500	600	700	800 V
Crest working off-state voltage	V_{DWM}	max.	500	600	700	800 V [3])

Currents

Average forward current (averaged over any 20 ms period)	I_{TAV}	max.	70	A
Forward current (d.c.)	I_T	max.	100	A
R.M.S. forward current	$I_{T(RMS)}$	max.	110	A
Repetitive peak forward current	I_{TRM}	max.	1000	A
Non repetitive peak forward current t = 10 ms (See also page 7)	I_{TSM}	max.	900	A
I squared t for fusing (t = 1.5 to 10 ms)	I^2t	max.	4000	A^2s
Rate of rise of forward current	$\frac{dI_T}{dt}$	max.	20	A/μs
Repetitive peak reverse current (during turn-off)	I_{RRM}	max.	30	A

Power dissipation

Non repetitive peak reverse dissipation (See also page 7) t = 10 μs; T_j = 25 °C	P_{RSM}	max.	40	kW
t = 10 μs; T_j = 125 °C	P_{RSM}	max.	18	kW

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

2) These ratings apply to a gate voltage range of −5 to +0.25 V
To ensure thermal stability: $R_{th\ j-a} \leq 1.5$ °C/W (d.c.) or ≤ 3 °C/W (a.c.)

3) Off-state voltages higher than V_{DWMmax} are allowed, but at voltages higher than the forward breakover voltage (see page 4) the device may switch into the on-state.

RATINGS (Limiting values) (continued)

GATE TO CATHODE

Voltages

Forward peak voltage	V_{FGM}	max.	10	V
Reverse peak voltage	V_{RGM}	max.	5	V

Currents

Forward peak current	I_{FGM}	max.	2	A

Power dissipation

Average power dissipation (averaged over any 20 ms period)	P_{GAV}	max.	0.5	W
Peak power dissipation	P_{GM}	max.	5	W

TEMPERATURES

Storage temperature	T_{stg}		-55 to +125	^oC
Junction temperature	T_j	max.	125	^oC

THERMAL RESISTANCE

From junction to mounting base	$R_{th\ j\text{-}mb}$	=	0.4	$^oC/W$
From mounting base to heatsink	$R_{th\ mb\text{-}h}$	=	0.1	$^oC/W$

CHARACTERISTICS T_j = 125 °C unless otherwise specified

ANODE TO CATHODE

Voltages			BTX38-500R	600R	700R	800R	
Forward on-state voltage I_T = 500 A; T_j = 25 °C	V_T	<	2.5	2.5	2.5	2.5	V [1]
Reverse breakdown voltage in avalanche region	$V_{(BR)R}$	>	550	660	770	880	V
Forward breakover voltage	$V_{(BO)}$	>	550	660	770	880	V
Rate of rise of forward voltage not to trigger the device	$\frac{dV_D}{dt}$	typ.	10	10	10	10	V/µs
Currents							
Reverse current $V_R = V_{RWMmax}$	I_R	<	12	12	12	10	mA [2]
Off-state current $V_D = V_{DWMmax}$	I_D	<	12	12	12	10	mA
Pick up current	I_P	typ.	20				mA
Holding current	I_H	typ.	10				mA

GATE TO CATHODE

Voltages				
Voltage to trigger all devices V_D = 6 V; T_j = 25 °C	V_{GT}	>	3.0	V
Voltage not to trigger any device	V_{GD}	<	0.25	V
Current				
Current to trigger all devices V_D = 6 V; T_j = 25 °C	I_{GT}	>	70	mA

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

[2]) These I_R values apply to a gate voltage range of −5 to +0.25 V.

SWITCHING CHARACTERISTICS (See also page 10)

Turn on time when switched from
V_D = 400 V to I_T = 50 A

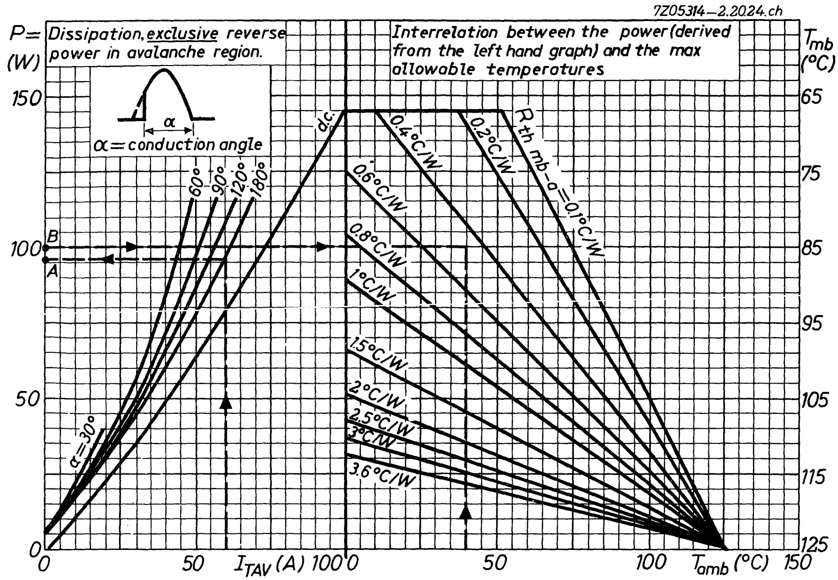
Gate source 5 V, 25 Ω, T_j = 125 °C	t_{on}	typ.	3.0	μs

Turn off time when switched from
I_T = 50 A to I_R between 10 and 30 A

dV_D/dt = 5 V/μs; T_j = 125 °C	t_q	typ.	20	μs
T_j = 25 °C	t_q	typ.	10	μs

OPERATING NOTE

In order to prevent the thyristors from being damaged by surge currents higher than those mentioned in the curves at page 7 a fast fuse is recommended.



Determination of the heatsink thermal resistance

Example:

Assume a thyristor, used in a single phase full wave rectifier circuit.

frequency	f	=	50	Hz
conduction angle	α	=	180°	
average forward current	I_{TAV}	=	60	A (per thyristor)
ambient temperature	T_{amb}	=	40	°C
repetitive peak reverse power dissipation in the avalanche region	P_{RRM}	=	8	kW (per thyristor)
duration of P_{RRM}	t	=	10	μs

From the left hand part of the graph above it follows that at I_{TAV} = 60 A and α = 180° the average forward power + average leakage power = 96 W per thyristor (point A). The average reverse power in the avalanche region, averaged over any cycle, follows from:

$$P_{RAV} = \delta \times P_{RRM}, \text{ where the duty cycle } \delta = \frac{10\ \mu s}{20\ ms} = 0.0005$$

Thus: $P_{RAV} = 0.0005 \times 8\ kW = 4\ W$.

Therefore the total device power dissipation P_{tot} = (96 + 4) W = 100 W (point B).

From the right hand part of the graph above follows the thermal resistance, required for P_{tot} = 100 W at T_{amb} = 40 °C.

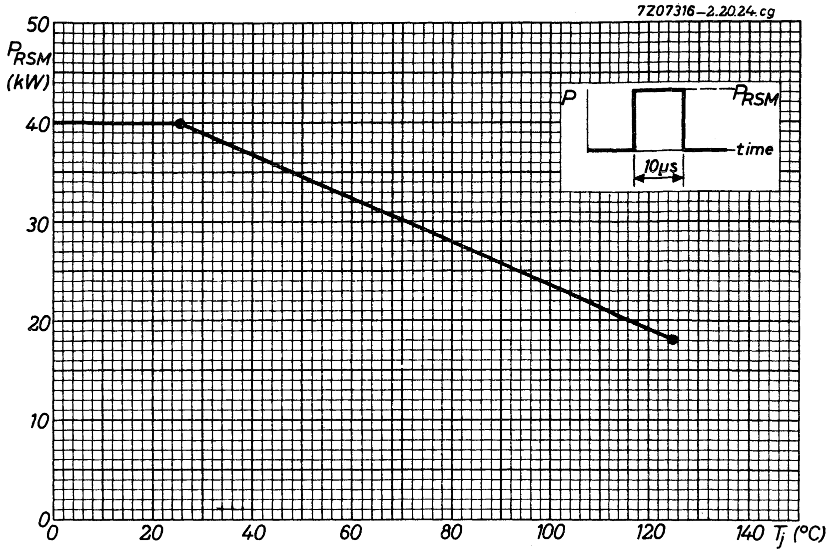
$$R_{th\ mb\text{-}a} \approx 0.45\ ^{o}C/W.$$

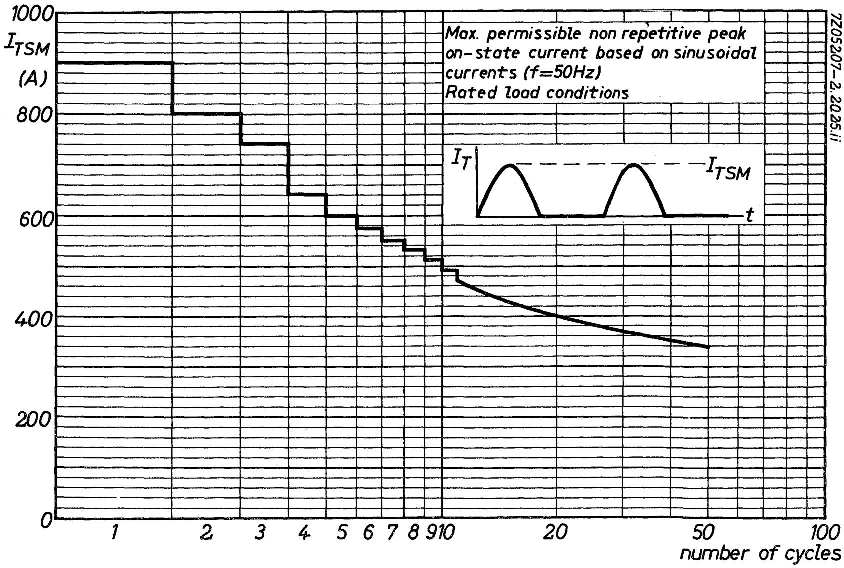
The contact thermal resistance $R_{th\ mb\text{-}h}$ = 0.1 °C/W.

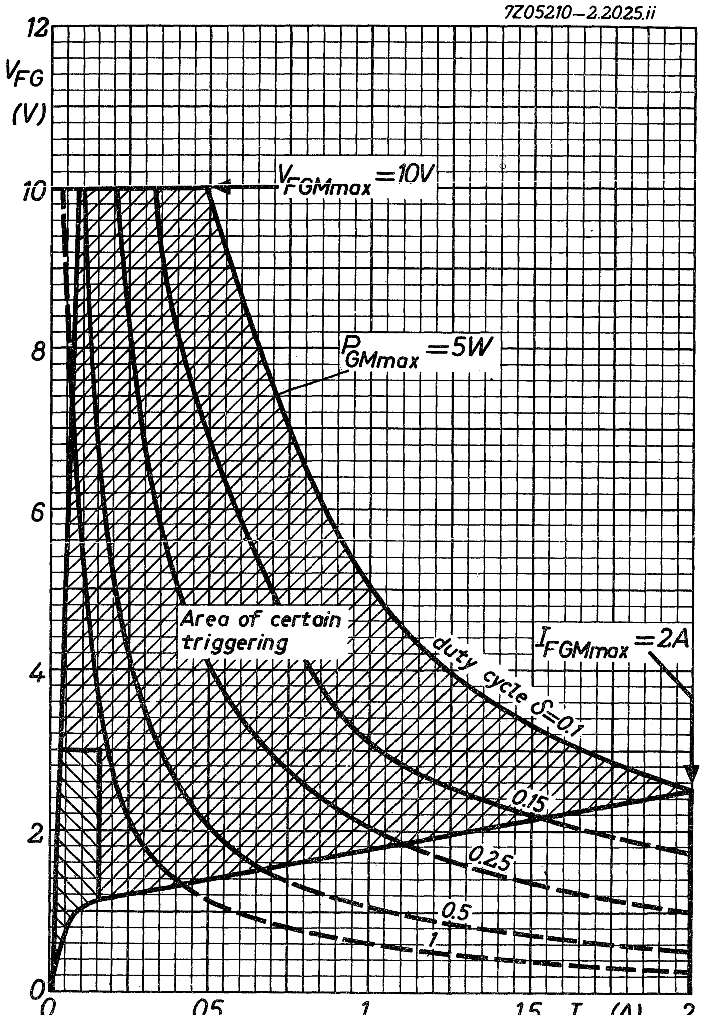
Hence the heatsink thermal resistance should be:

$$R_{th\ h\text{-}a} = R_{th\ mb\text{-}a} - R_{th\ mb\text{-}h} = (0.45 - 0.1)\ ^{o}C/W = 0.35\ ^{o}C/W.$$

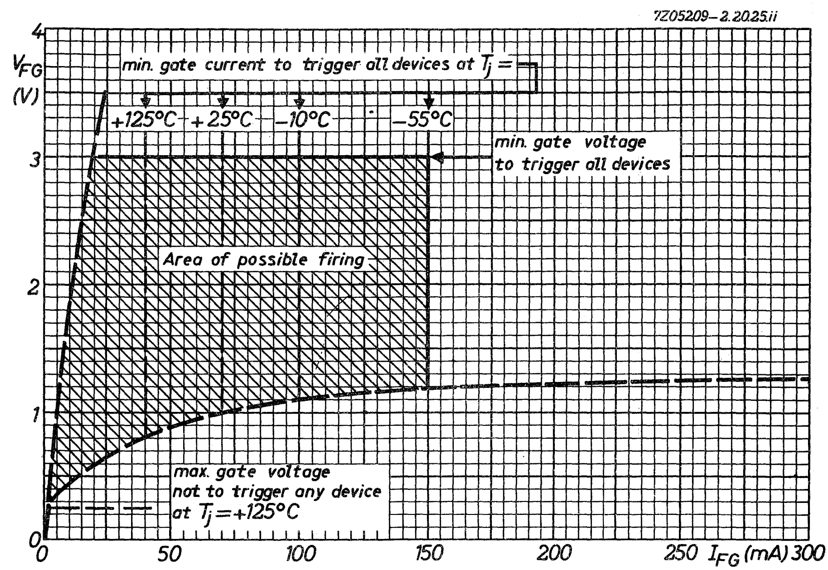
The applicable heatsink(s) may then be found in the Section ACCESSORIES and HEATSINKS.

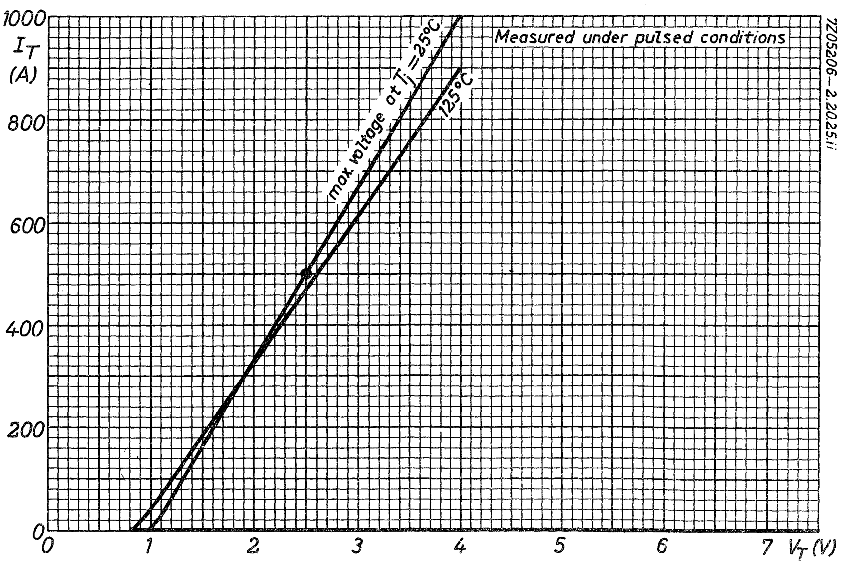

7Z07316–2.20.24.cg
50
P_{RSM}
(kW)
40
30
20
10
0
0
20
40
60
80
100
120
140 T_j (°C)
P
P_{RSM}
time
10µs

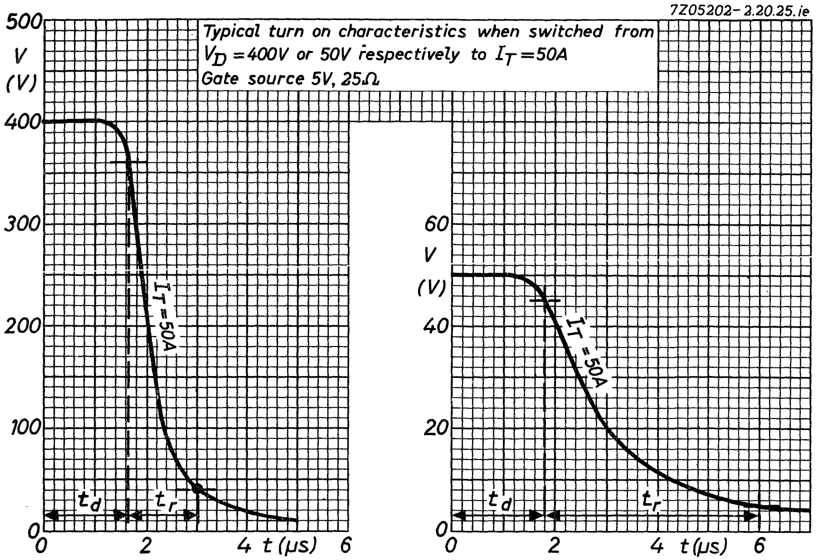

1000
I_{TSM}
(A)
800
600
400
200
0
1
2
3
4
5 6 7 8 9 10
20
50
100
number of cycles
Max. permissible non repetitive peak
on-state current based on sinusoidal
currents (f=50Hz)
Rated load conditions
I_T
I_{TSM}
t
7Z05207–2.20.25.ii

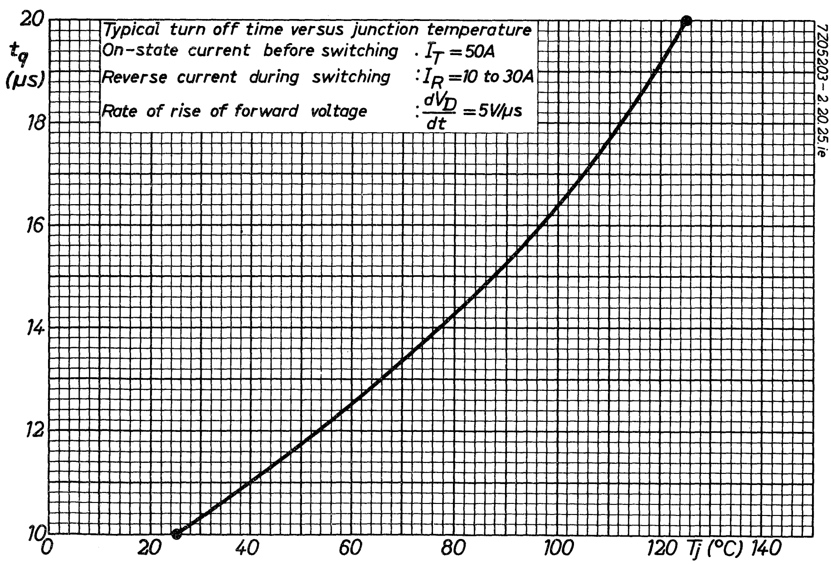


Gate characteristics with curves $P_{GAV} = 0.5W$


7Z05209–2.20.25.ii
V_{FG} (V)
min. gate current to trigger all devices at T_j =
+125°C
+25°C
–10°C
–55°C
min. gate voltage to trigger all devices
Area of possible firing
max. gate voltage not to trigger any device at T_j = +125°C
I_{FG} (mA)
0
50
100
150
200
250
300
1
2
3
4


I_T (A)
Measured under pulsed conditions
7Z05206–2.20.25.ii
max. voltage at T_j = 25°C
125°C
V_T (V)
0
1
2
3
4
5
6
7
200
400
600
800
1000


7Z05202-2.20.25.ie
Typical turn on characteristics when switched from
V_D = 400V or 50V respectively to I_T = 50A
Gate source 5V, 25Ω
500
V
(V)
400
300
200
100
0
I_T = 50A
t_d
t_r
0
2
4 t (μs) 6
60
V
(V)
40
20
0
I_T = 50A
t_d
t_r
0
2
4 t (μs)
6


Typical turn off time versus junction temperature
On-state current before switching : I_T = 50A
Reverse current during switching : I_R = 10 to 30A
Rate of rise of forward voltage : $\frac{dV_D}{dt}$ = 5V/μs
7Z05203-2.20.25.ie
20
t_q
(μs)
18
16
14
12
10
0
20
40
60
80
100
120 T_j (°C) 140

CONTROLLED AVALANCHE THYRISTORS

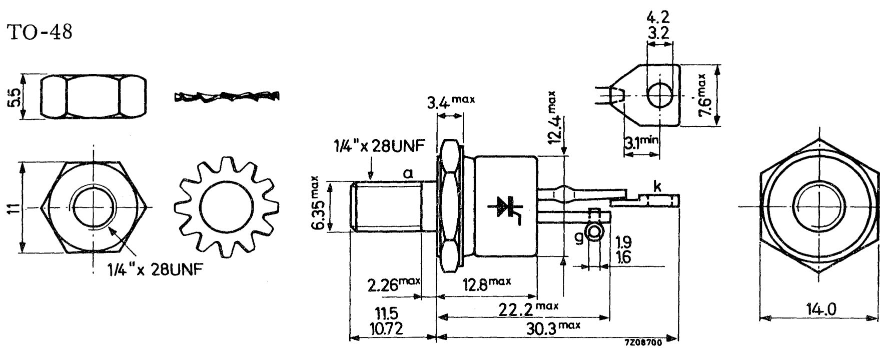
P-gate silicon thyristors in a TO-48 metal envelope, capable of absorbing transients and intended for power control and power switching applications (d.c. motor speed control, furnaces and lighting). The series consists of the following reverse polarity types (stud anode): BTX47-1000R; BTX47-1200R and BTX47-1400R.

QUICK REFERENCE DATA

			BTX47-1000R	1200R	1400R	
Crest working reverse voltage	V_{RWM}	max.	800	800	800	V
Crest working off-state voltage	V_{DWM}	max.	800	800	800	V
Reverse breakdown voltage in the avalanche region	$V_{(BR)R}$	>	1000	1200	1400	V
Forward breakover voltage	$V_{(BO)}$	>	900	1100	1300	V
Average forward current at T_{mb} = 67 °C	I_{TAV}	max.	16			A
T_{mb} = 85 °C	I_{TAV}	max.	12			A
Non repetitive peak forward current t = 10 ms	I_{TSM}	max.	155			A
Non repetitive peak reverse dissipation t = 10 μs; T_j = 25 °C	P_{RSM}	max.	18			kW
Junction temperature	T_j	max.	125			°C

MECHANICAL DATA Dimensions in mm

TO-48



Net weight : 10 g
With accessories: 15 g
Diameter of hole in heatsink: max. 6.5 mm
Accessories available: 56264A

Torque on nut: min. 17 cm kg
max. 35 cm kg

All information applies to frequencies up to 400 Hz

RATINGS (Limiting values) [1]

ANODE TO CATHODE

Voltages [2]

			BTX47-1000R	1200R	1400R	
Continuous reverse voltage	V_R	max.	800	800	800	V
Crest working reverse voltage	V_{RWM}	max.	800	800	800	V
Repetitive peak reverse voltage (δ = 0.01; f = 50 Hz)	V_{RRM}	max.	1000	1200	1400	V
Non repetitive peak reverse voltage (t ≤ 10 ms)	V_{RSM}	max.	1000	1200	1400	V
Continuous off-state voltage	V_D	max.	800	800	800	V
Crest working off-state voltage	V_{DWM}	max.	800	800	800	V [3]
Repetitive peak off-state voltage (δ = 0.01; f = 50 Hz)	V_{DRM}	max.	900	1100	1300	V

Currents

Average forward current (averaged over any 20 ms period) T_{mb} = 67 °C	I_{TAV}	max.	16	A
T_{mb} = 85 °C	I_{TAV}	max.	12	A
Forward current (d.c.)	I_T	max.	20	A
R.M.S. forward current	$I_{T(RMS)}$	max.	25	A
Repetitive peak forward current	I_{TRM}	max.	160	A
Non repetitive peak forward current (t = 10 ms); see also page 9	I_{TSM}	max.	155	A
I squared t for fusing (t = 1 to 10 ms)	I^2t	max.	125	A^2s
Rate of rise of forward current	$\frac{dI_T}{dt}$	max.	50	A/μs
Repetitive peak reverse current (during turn-off)	I_{RRM}	max.	20	A

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

[2]) These ratings apply to a gate voltage range of −5 to +0.25 V.
To ensure thermal stability: $R_{th\ j-a} \leqq 3.0$ °C/W (d.c.) or $\leqq 6.0$ °C/W (a.c.)

[3]) Off-state voltages higher than V_{DWMmax} are allowed, but at voltages higher than the forward breakover voltage (see page 4) the device may switch into the on-state.

RATINGS (Limiting values) (continued)

ANODE TO CATHODE

Power dissipation

Non repetitive peak reverse dissipation				
$t = 10\ \mu s$; $T_j = 25\ ^oC$	P_{RSM}	max.	18	kW
$t = 10\ \mu s$; $T_j = 125\ ^oC$	P_{RSM}	max.	7.5	kW

GATE TO CATHODE

Voltages

Forward peak voltage	V_{FGM}	max.	10	V
Reverse peak voltage	V_{RGM}	max.	5	V

Current

Forward peak current	I_{FGM}	max.	2	A

Power dissipation

Average power dissipation (averaged over any 20 ms period)	P_{GAV}	max.	0.5	W
Peak power dissipation	P_{GM}	max.	5	W

TEMPERATURES

Storage temperature	T_{stg}	-55 to	+125	^oC
Junction temperature	T_j	max.	125	^oC

THERMAL RESISTANCE

From junction to mounting base	$R_{th\ j\text{-}mb}$	=	1.0	$^oC/W$
From mounting base to heatsink	$R_{th\ mb\text{-}h}$	=	0.2	$^oC/W$
Transient thermal resistance (t = 1 ms)	$R_{th\ t}$	=	0.05	$^oC/W$

CHARACTERISTICS

T_j = 125 °C unless otherwise specified

ANODE TO CATHODE

Voltages			BTX47-1000R	1200R	1400R	
Forward on-state voltage I_T = 50 A; T_j = 25 °C	V_T	<	4.0	4.0	4.0	V [1]
Reverse breakdown voltage in the avalanche region	$V_{(BR)R}$	>	1000	1200	1400	V
Forward breakover voltage	$V_{(BO)}$	>	900	1100	1300	V

Currents

Reverse current $V_R = V_{RWMmax}$	I_R	<	5	mA
Off-state current $V_D = V_{DWMmax}$	I_D	<	5	mA
Pick up current	I_P	typ.	20	mA
Holding current	I_H	typ.	10	mA

GATE TO CATHODE

Voltages

Voltage to trigger all devices V_D = 6 V; T_j = 25 °C	V_{GT}	>	3.5	V
Voltage not to trigger any device	V_{GD}	<	0.25	V

Current

Current to trigger all devices V_D = 6 V; T_j = 25 °C	I_{GT}	>	65	mA

SWITCHING CHARACTERISTICS

Turn on time when switched from $V_D = V_{DWMmax}$ to I_T = 10 A; Gate source 5 V, 25 Ω	t_{on}	typ.	5.0	μs
Turn off time when switched from I_T = 10 A to I_R = 10 A; T_j = 125 °C	t_q	typ.	50	μs
T_j = 25 °C	t_q	typ.	25	μs

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

OPERATING NOTES

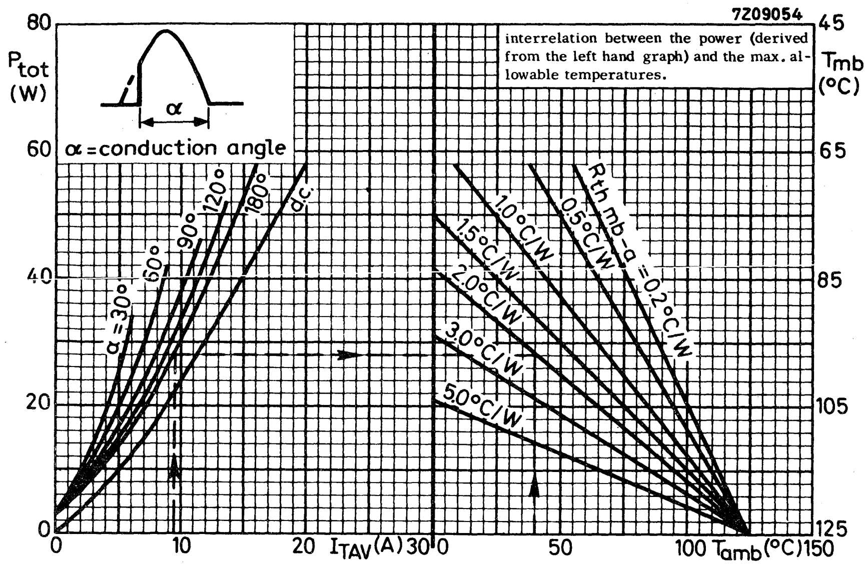
1. When there is a possibility that transient voltages, caused by the stored energy in the transformer core, will exceed the maximum permissible non repetitive peak reverse voltage, a damping circuit across the transformer should be applied.
   Either a series RC circuit or a voltage dependent resistor may be used. Suitable component values for an RC circuit across the transformer primary or secondary may be calculated as follows:

$\frac{V_{RSM}}{V_{RWM}}$	RC across primary of transformer		RC across secondary of transformer	
	C (μF)	R (Ω)	C (μF)	R (Ω)
2.0	$200\frac{I_{mag}}{V_1}$	$\frac{150}{C}$	$225\frac{I_{mag}T^2}{V_1}$	$\frac{200}{C}$
1.5	$400\frac{I_{mag}}{V_1}$	$\frac{225}{C}$	$450\frac{I_{mag}T^2}{V_1}$	$\frac{275}{C}$
1.25	$550\frac{I_{mag}}{V_1}$	$\frac{260}{C}$	$620\frac{I_{mag}T^2}{V_1}$	$\frac{310}{C}$
1.0	$800\frac{I_{mag}}{V_1}$	$\frac{300}{C}$	$900\frac{I_{mag}T^2}{V_1}$	$\frac{350}{C}$

   where I_{mag} = magnetising primary r.m.s. current (A)
   V_1 = transformer primary r.m.s. voltage (V)
   V_2 = transformer secondary r.m.s. voltage (V)
   T = V_1/V_2
   V_{RWM} stands for the actually applied crest working reverse voltage.

2. In order to prevent the thyristors from being damaged by surge currents higher than those mentioned in the curves on page 9 a fast fuse is recommended.

3. The gate and cathode connectors should not be bent or twisted; they should be soldered into the circuit so there is no strain on them.
   During soldering the heat conduction to the junction should be kept to a minimum by using a thermal shunt.



Determination of the heatsink thermal resistance.

Example:

Assume a thyristor, used in a single phase full-wave rectifier circuit.

frequency	f	= 50 Hz
conduction angle	α	= 180°
average forward current	I_{TAV}	= 9.5 A (per thyristor)
ambient temperature	T_{amb}	= 40 °C

From the left hand part of the graph above it follows that at I_{TAV} = 9.5 A and α = 180° the average forward power + average leakage power = 28 W per thyristor.

From the right hand part of the graph above follows the thermal resistance, required for P_{tot} = 28 W at T_{amb} = 40 °C

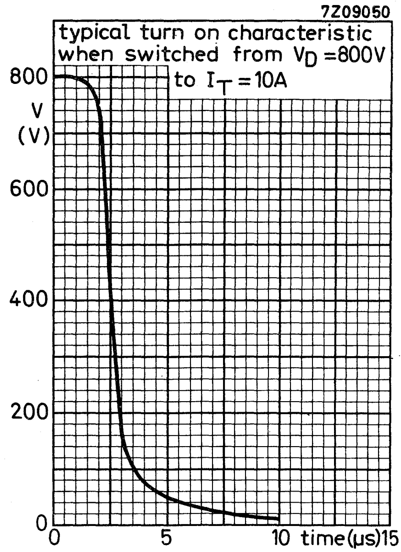
$$R_{th\ mb-a} \approx 2.0\ ^{\circ}C/W$$

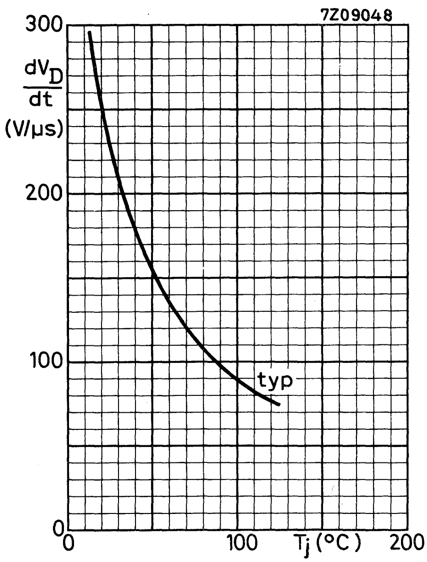
The contact thermal resistance $R_{th\ mb-h}$ = 0.2 °C/W

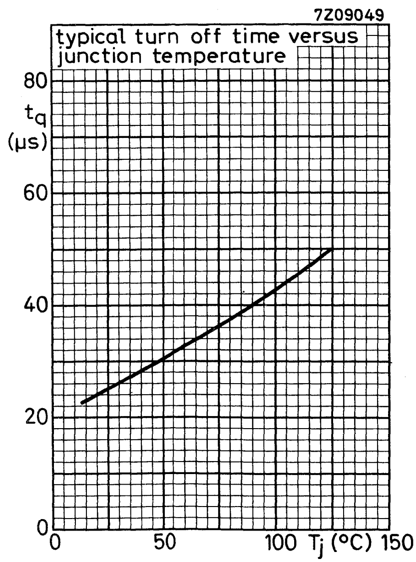
Hence the heatsink thermal resistance should be:

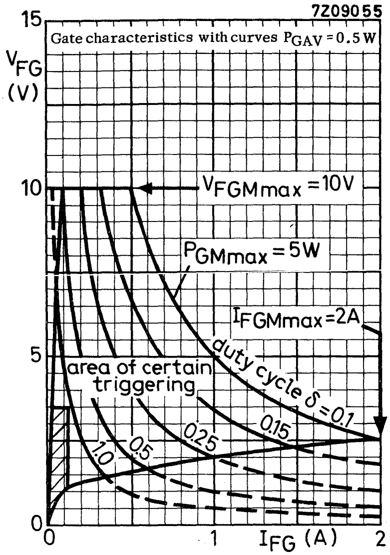
$$R_{th\ h-a} = R_{th\ mb-a} - R_{th\ mb-h} = (2.0 - 0.2)\ ^{\circ}C/W = 1.8\ ^{\circ}C/W$$

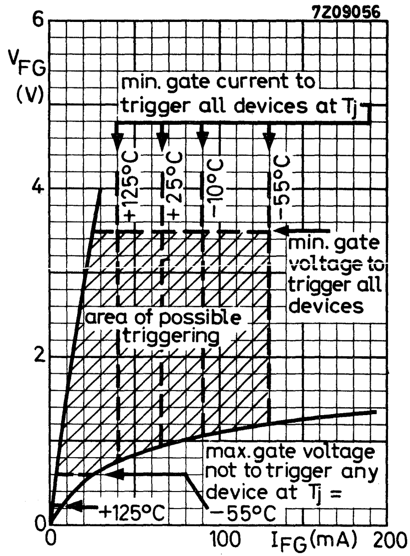
The applicable heatsink(s) may then be found in the Section ACCESSORIES and HEATSINKS.

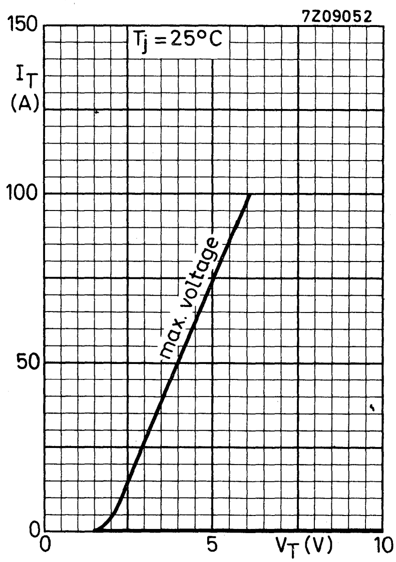

7Z09050
typical turn on characteristic
when switched from V_D = 800V
to I_T = 10A
800
V
(V)
600
400
200
0
0
5
10
time (μs)
15

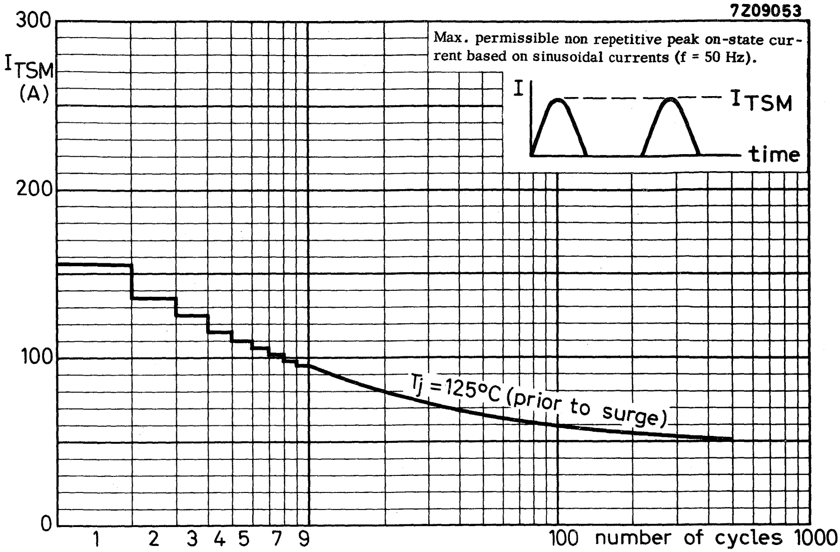

7Z09048
300
$\frac{dV_D}{dt}$
(V/μs)
200
100
0
0
100
T_j (°C)
200
typ

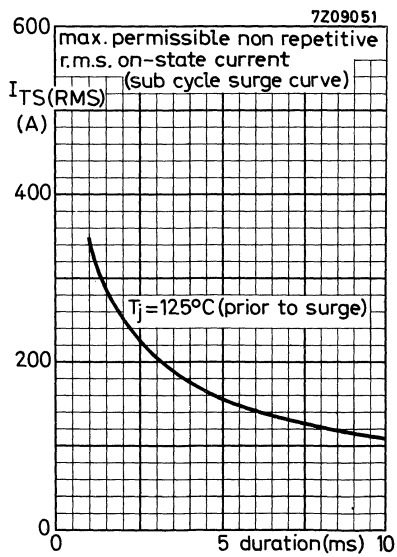

7Z09049
typical turn off time versus
junction temperature
80
t_q
(μs)
60
40
20
0
0
50
100
T_j (°C)
150

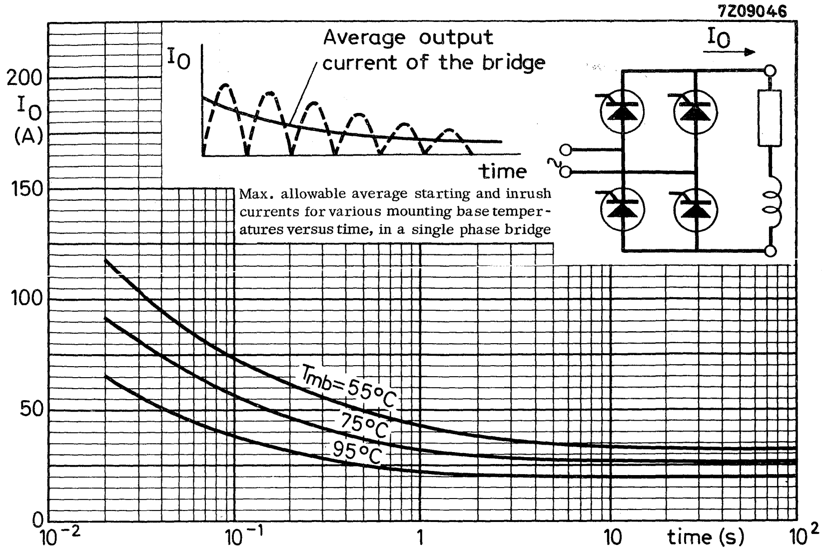

7Z09055
Gate characteristics with curves $P_{GAV} = 0.5$ W
V_{FG} (V)
$V_{FGMmax} = 10V$
$P_{GMmax} = 5W$
$I_{FGMmax} = 2A$
duty cycle $\delta = 0.1$
0.15
0.25
0.5
1.0
area of certain triggering
I_{FG} (A)
15
10
5
0
0
1
2


7Z09056
V_{FG} (V)
min. gate current to trigger all devices at T_j
+125°C
+25°C
−10°C
−55°C
min. gate voltage to trigger all devices
area of possible triggering
max. gate voltage not to trigger any device at T_j = −55°C
+125°C
I_{FG}(mA)
6
4
2
0
0
100
200

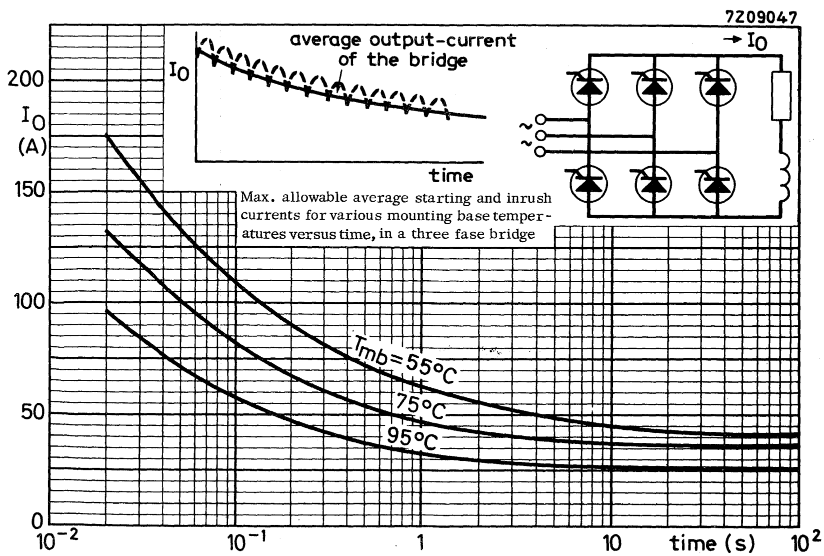

7Z09052
$T_j = 25°C$
I_T (A)
max. voltage
V_T (V)
150
100
50
0
0
5
10


7Z09053
Max. permissible non repetitive peak on-state current based on sinusoidal currents (f = 50 Hz).
I
ITSM
time
300
ITSM
(A)
200
100
0
1
2
3
4
5
7
9
100
number of cycles
1000
Tj = 125°C (prior to surge)


7Z09051
max. permissible non repetitive r.m.s. on-state current
(sub cycle surge curve)
600
ITS(RMS)
(A)
400
200
0
0
5
duration(ms)
10
Tj=125°C (prior to surge)



Max. allowable average starting and inrush currents for various mounting base temperatures versus time, in a single phase bridge



Max. allowable average starting and inrush currents for various mounting base temperatures versus time, in a three fase bridge

CONTROLLED AVALANCHE THYRISTORS

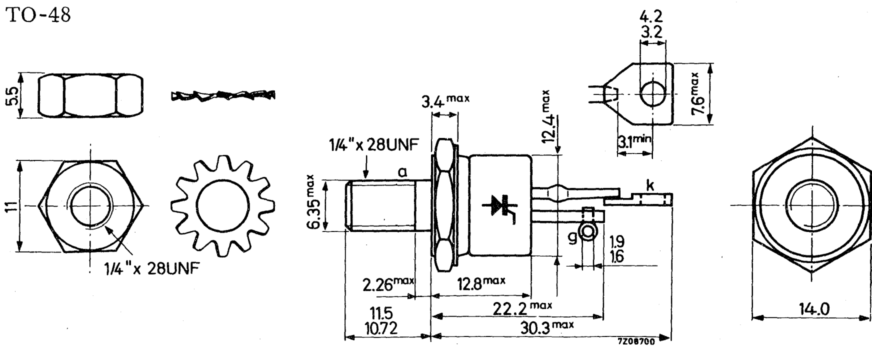
P-gate silicon thyristors in a TO-48 metal envelope, capable of absorbing transients and intended for power control and power switching applications (d.c. motor speed control, furnaces and lighting). The series consists of the following reverse polarity types (stud anode): BTX48-1000R; BTX48-1200R; BTX48-1400R;

QUICK REFERENCE DATA

			BTX48-1000R	1200R	1400R	
Crest working reverse voltage	V_{RWM}	max.	800	800	800	V
Crest working off-state voltage	V_{DWM}	max.	800	800	800	V
Reverse breakdown voltage in the avalanche region	$V_{(BR)R}$	>	1000	1200	1400	V
Forward breakover voltage	$V_{(BO)}$	>	900	1100	1300	V
Average forward current at T_{mb} = 85 °C	I_{TAV}	max.	16			A
Non repetitive peak forward current t = 10 ms	I_{TSM}	max.	200			A
Non repetitive peak reverse dissipation t = 10 μs; T_j = 25 °C	P_{RSM}	max.	18			kW
Junction temperature	T_j	max.	125			°C

MECHANICAL DATA Dimensions in mm

TO-48



Net weight : 10 g
With accessories: 15 g
Diameter of hole in heatsink: max. 6.5 mm
Accessories available: 56264A

Torque on nut: min. 17 cm kg
max. 35 cm kg

All information applies to frequencies up to 400 Hz

RATINGS (Limiting values) [1])

ANODE TO CATHODE

Voltages [2])			BTX48-1000R	1200R	1400R	
Continuous reverse voltage	V_R	max.	800	800	800	V
Crest working reverse voltage	V_{RWM}	max.	800	800	800	V
Repetitive peak reverse voltage (δ = 0.01; f = 50 Hz)	V_{RRM}	max.	1000	1200	1400	V
Non repetitive peak reverse voltage ($t \leq 10$ ms)	V_{RSM}	max.	1000	1200	1400	V
Continuous off-state voltage	V_D	max.	800	800	800	V
Crest working off-state voltage	V_{DWM}	max.	800	800	800	V [3])
Repetitive peak off-state voltage (δ = 0.01; f = 50 Hz)	V_{DRM}	max.	900	1100	1300	V

Currents

Average forward current (averaged over any 20 ms period) T_{mb} = 85 °C	I_{TAV}	max.	16	A
Forward current (d.c.)	I_T	max.	20	A
R.M.S. forward current	$I_{T(RMS)}$	max.	25	A
Repetitive peak forward current	I_{TRM}	max.	200	A
Non repetitive peak forward current (t = 10 ms) see also page 9	I_{TSM}	max.	200	A
I squared t for fusing (t = 1 to 10 ms)	I^2t	max.	200	A^2s
Rate of rise of forward current	$\frac{dI_T}{dt}$	max.	50	A/μs
Repetitive peak reverse current (during turn-off)	I_{RRM}	max.	20	A

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

[2]) These ratings apply to a gate voltage range of −5 to +0.25 V.
To ensure thermal stability: $R_{th\ j\text{-}a} \leq 3.0$ °C/W (d.c.) or ≤ 6.0 °C/W (a.c.)

[3]) Off-state voltages higher than V_{DWMmax} are allowed, but at voltages higher than the forward breakover voltage (see page 4) the device may switch into the on-state.

RATINGS (Limiting values) (continued)

ANODE TO CATHODE

Power dissipation

Non repetitive peak reverse dissipation $t = 10\ \mu s$; $T_j = 25\ ^oC$	P_{RSM}	max.	18	kW
$t = 10\ \mu s$; $T_j = 125\ ^oC$	P_{RSM}	max.	7.5	kW

GATE TO CATHODE

Voltages

Forward peak voltage	V_{FGM}	max.	10	V
Reverse peak voltage	V_{RGM}	max.	5	V

Current

Forward peak current	I_{FGM}	max.	2	A

Power dissipation

Average power dissipation (averaged over any 20 ms period)	P_{GAV}	max.	0.5	W
Peak power dissipation	P_{GM}	max.	5	W

TEMPERATURES

Storage temperature	T_{stg}		−55 to +125	^oC
Junction temperature	T_j	max.	125	^oC

THERMAL RESISTANCE

From junction to mounting base	$R_{th\ j\text{-}mb}$	=	1.0	$^oC/W$
From mounting base to heatsink	$R_{th\ mb\text{-}h}$	=	0.2	$^oC/W$
Transient thermal resistance (t = 1 ms)	$R_{th\ t}$	=	0.05	$^oC/W$

CHARACTERISTICS

T_j = 125 °C unless otherwise specified

ANODE TO CATHODE

Voltages

			BTX48-1000R	1200R	1400R	
Forward on-state voltage I_T = 50 A; T_j = 25 °C	V_T	<	2.7	2.7	2.7	V [1]
Reverse breakdown voltage in the avalanche region	$V_{(BR)R}$	>	1000	1200	1400	V
Forward breakover voltage	$V_{(BO)}$	>	900	1100	1300	V

Currents

Reverse current $V_R = V_{RWMmax}$	I_R	<	5	mA
Off-state current $V_D = V_{DWMmax}$	I_D	<	5	mA
Pick up current	I_P	typ.	20	mA
Holding current	I_H	typ.	10	mA

GATE TO CATHODE

Voltages

Voltage to trigger all devices V_D = 6 V; T_j = 25 °C	V_{GT}	>	3.5	V
Voltage not to trigger any device	V_{GD}	<	0.25	V

Current

Current to trigger all devices V_D = 6 V; T_j = 25 °C	I_{GT}	>	65	mA

SWITCHING CHARACTERISTICS

Turn on time when switched from $V_D = V_{DWMmax}$ to I_T = 10 A; Gate source 5 V, 25 Ω	t_{on}	typ.	5.0	µs
Turn off time when switched from I_T = 10 A to I_R = 10 A; T_j = 125 °C	t_q	typ.	50	µs
T_j = 25 °C	t_q	typ.	25	µs

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

OPERATING NOTES

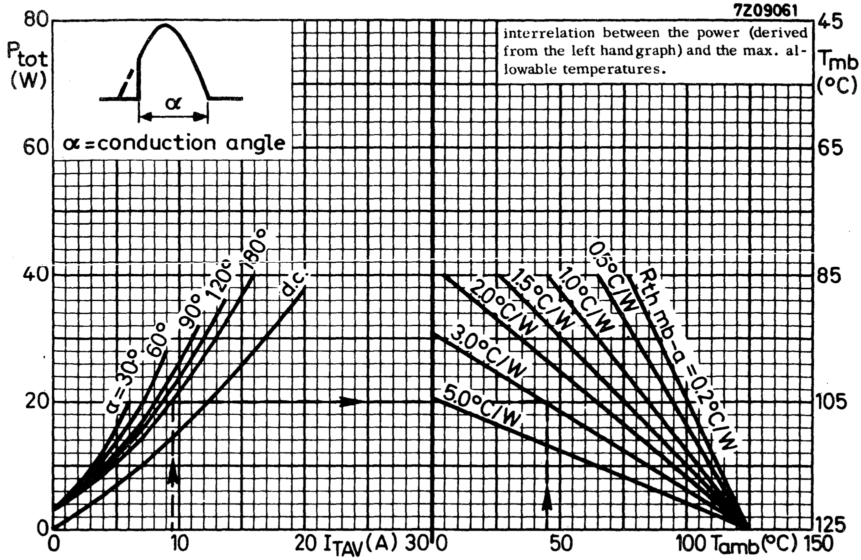
1. When there is a possibility that transient voltages, caused by the stored energy in the transformer core, will exceed the maximum permissible non repetitive peak reverse voltage, a damping circuit across the transformer should be applied.
   Either a series RC circuit or a voltage dependent resistor may be used. Suitable component values for an RC circuit across the transformer primary or secondary may be calculated as follows:

$\frac{V_{RSM}}{V_{RWM}}$	RC across primary of transformer		RC across secondary of transformer	
	C (μF)	R (Ω)	C (μF)	R (Ω)
2.0	$200\frac{I_{mag}}{V_1}$	$\frac{150}{C}$	$225\frac{I_{mag}T^2}{V_1}$	$\frac{200}{C}$
1.5	$400\frac{I_{mag}}{V_1}$	$\frac{225}{C}$	$450\frac{I_{mag}T^2}{V_1}$	$\frac{275}{C}$
1.25	$550\frac{I_{mag}}{V_1}$	$\frac{260}{C}$	$620\frac{I_{mag}T^2}{V_1}$	$\frac{310}{C}$
1.0	$800\frac{I_{mag}}{V_1}$	$\frac{300}{C}$	$900\frac{I_{mag}T^2}{V_1}$	$\frac{350}{C}$

   where I_{mag} = magnetising primary r.m.s. current (A)
   V_1 = transformer primary r.m.s. voltage (V)
   V_2 = transformer secondary r.m.s. voltage (V)
   T = V_1/V_2
   V_{RWM} stands for the actually applied crest working reverse voltage

2. In order to prevent the thyristors from being damaged by surge currents higher than those mentioned in the curves on page 9 a fast fuse is recommended.

3. The gate and cathode connectors should not be bent or twisted; they should be soldered into the circuit so there is no strain on them.
   During soldering the heat conduction to the junction should be kept to a minimum by using a thermal shunt.



Determination of the heatsink thermal resistance

Example:

Assume a thyristor, used in a single phase full-wave rectifier circuit.

frequency	f	=	50	Hz
conduction angle	α	=	180°	
average forward current	I_{TAV}	=	9.5	A (per thyristor)
ambient temperature	T_{amb}	=	45	°C

From the left hand part of the graph above it follows that at $I_{TAV} = 9.5$ A and $\alpha = 180°$ the average forward power + average leakage power = 20 W per thyristor.

From the right hand part of the graph above follows the thermal resistance, required for P_{tot} = 20 W at T_{amb} = 45 °C

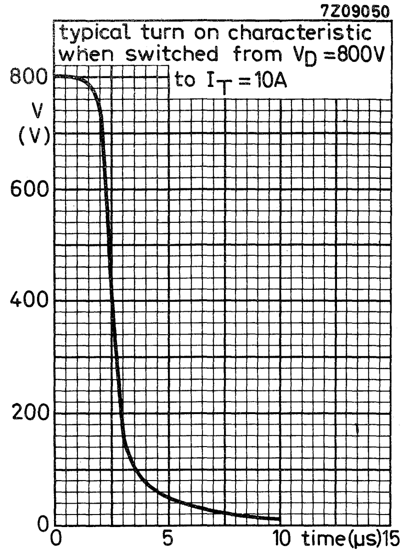
$$R_{th\ mb\text{-}a} \approx 3.0\ ^{\circ}C/W$$

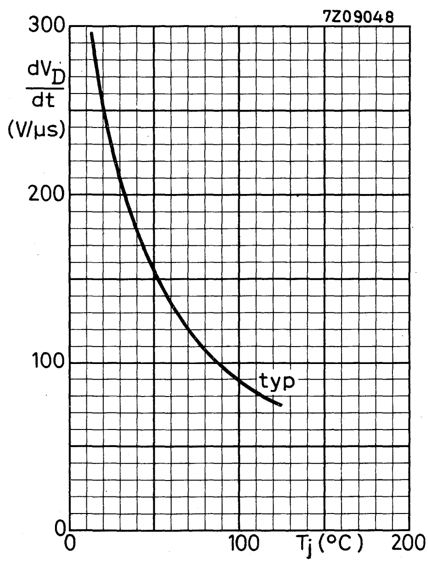
The contact thermal resistance $R_{th\ mb\text{-}h}$ = 0.2 °C/W

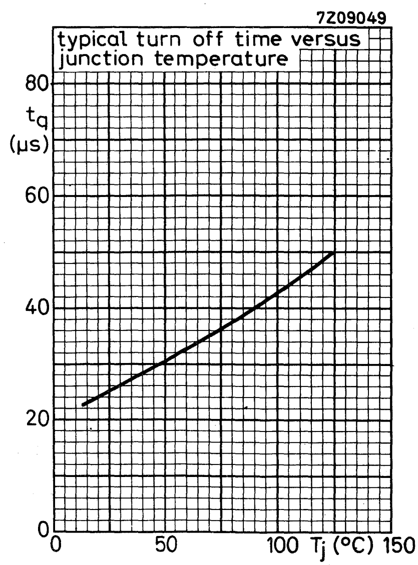
Hence the heatsink thermal resistance should be:

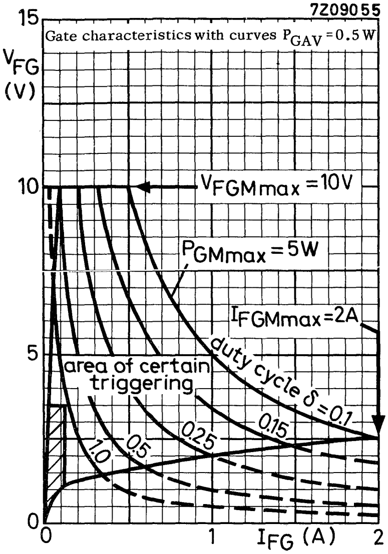
$$R_{th\ h\text{-}a} = R_{th\ mb\text{-}a} - R_{th\ mb\text{-}h} = (3.0 - 0.2)\ ^{\circ}C/W = 2.8\ ^{\circ}C/W$$

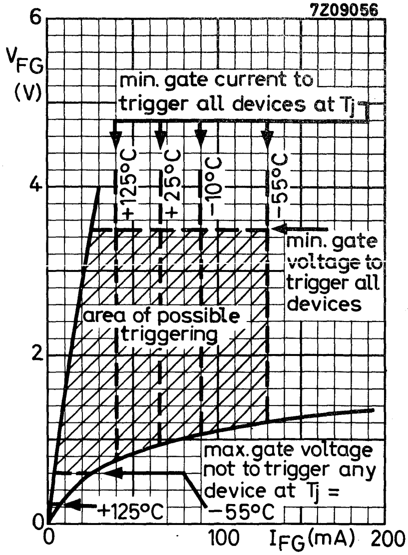
The applicable heatsink(s) may then be found in the Section ACCESSORIES and HEATSINKS.

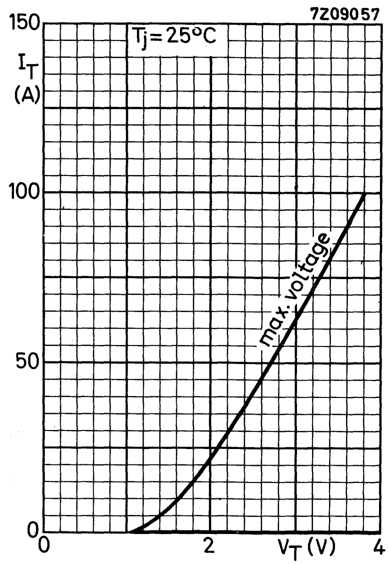

7Z09050
typical turn on characteristic
when switched from V_D =800V
to I_T =10A
800
V
(V)
600
400
200
0
0
5
10 time(μs)15

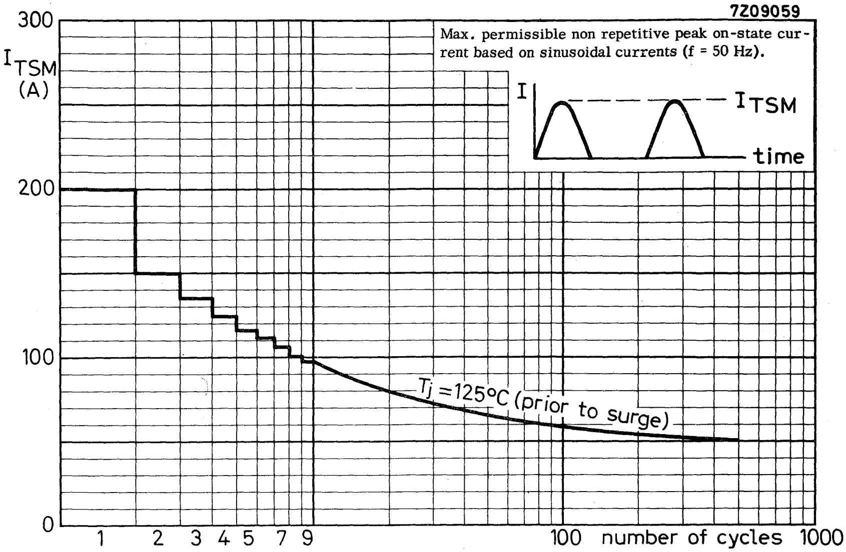

7Z09048
300
$\frac{dV_D}{dt}$
(V/μs)
200
100
typ
0
0
100 T_j (°C) 200

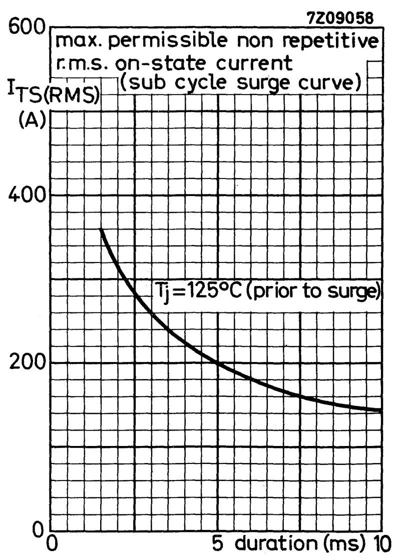

7Z09049
typical turn off time versus
junction temperature
80
t_q
(μs)
60
40
20
0
0
50
100 T_j (°C) 150

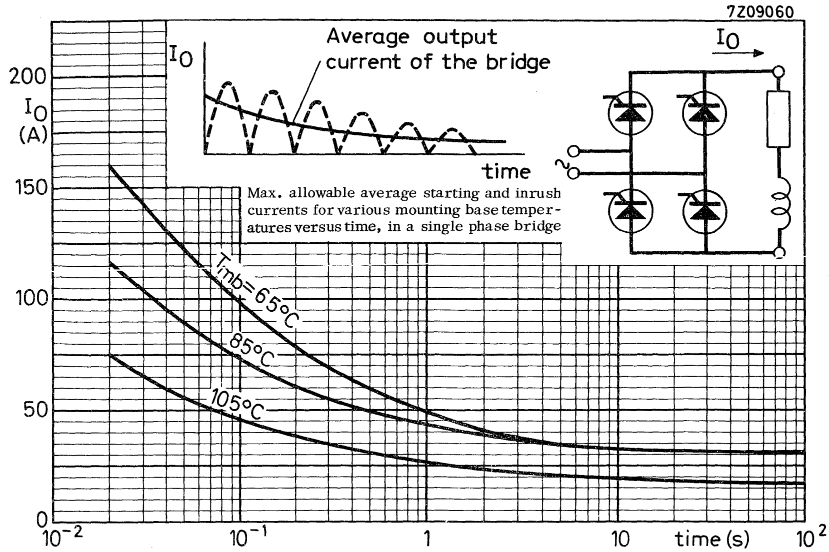

7Z09055
Gate characteristics with curves P_{GAV} = 0.5 W
V_{FG} (V)
V_{FGMmax} = 10V
P_{GMmax} = 5W
I_{FGMmax}=2A
duty cycle δ = 0.1
0.15
0.25
0.5
1.0
area of certain triggering
I_{FG} (A)
15
10
5
0
0
1
2

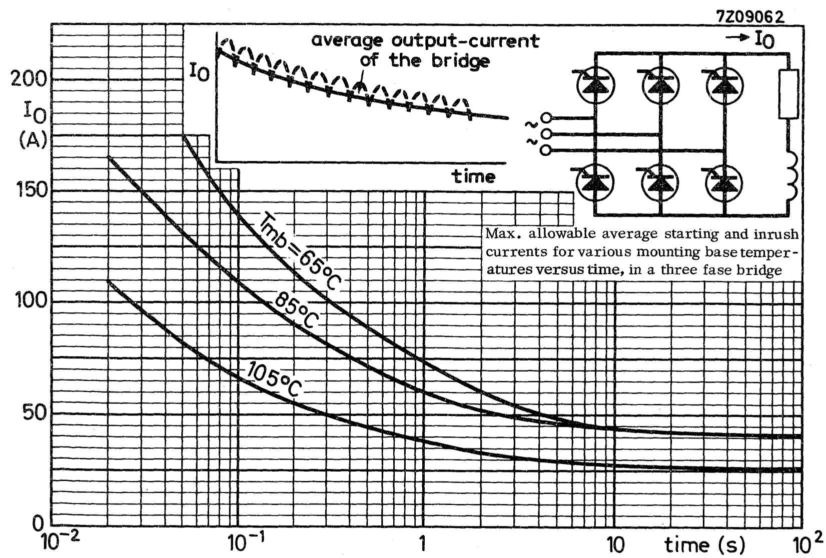

7Z09056
V_{FG} (V)
min. gate current to trigger all devices at Tj
+125°C
+25°C
−10°C
−55°C
min. gate voltage to trigger all devices
area of possible triggering
max. gate voltage not to trigger any device at Tj = −55°C
+125°C
I_{FG} (mA)
6
4
2
0
0
100
200


7Z09057
T_j = 25°C
I_T (A)
max. voltage
V_T (V)
150
100
50
0
0
2
4


7Z09059
Max. permissible non repetitive peak on-state current based on sinusoidal currents (f = 50 Hz).
I
ITSM
time
300
ITSM
(A)
200
100
0
1
2
3 4 5
7 9
100
number of cycles
1000
Tj =125°C (prior to surge)


7Z09058
max. permissible non repetitive
r.m.s. on-state current
(sub cycle surge curve)
ITS(RMS)
(A)
600
400
200
0
0
5
duration (ms)
10
Tj=125°C (prior to surge)


7Z09060
Average output
current of the bridge
I₀
time
Max. allowable average starting and inrush currents for various mounting base temperatures versus time, in a single phase bridge
200
150
100
50
0
I₀
(A)
Tmb=65°C
85°C
105°C
10⁻²
10⁻¹
1
10
time (s)
10²


7Z09062
average output-current
of the bridge
I₀
time
Max. allowable average starting and inrush currents for various mounting base temperatures versus time, in a three fase bridge
200
150
100
50
0
I₀
(A)
Tmb=65°C
85°C
105°C
10⁻²
10⁻¹
1
10
time (s)
10²

CONTROLLED AVALANCHE THYRISTORS

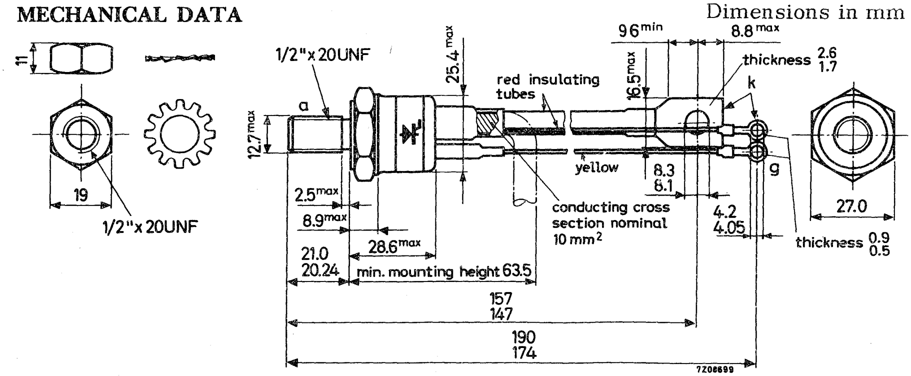
P-gate silicon thyristors in a metal envelope with ceramic insulation. They are capable of absorbing transients and intended for power control and power switching applications (d.c. motor speed control, furnaces and lighting). The series consists of the following reverse polarity types (stud anode): BTX49-1000R; BTX49-1200R and BTX49-1400R.

QUICK REFERENCE DATA

			BTX49-1000R	1200R	1400R	
Crest working reverse voltage	V_{RWM}	max.	800	800	800	V
Crest working off-state voltage	V_{DWM}	max.	800	800	800	V
Reverse breakdown voltage in in the avalanche region	$V_{(BR)R}$	>	1000	1200	1400	V
Forward breakover voltage	$V_{(BO)}$	>	900	1100	1300	V
Average forward current at T_{mb} = 75 °C	I_{TAV}	max.	70			A
T_{mb} = 85 °C	I_{TAV}	max.	60			A
Non repetitive peak forward current t = 10 ms	I_{TSM}	max.	1050			A
Non repetitive peak reverse dissipation t = 10 μs; T_j = 25 °C	P_{RSM}	max.	40			kW
Junction temperature	T_j	max.	125			°C

MECHANICAL DATA

Dimensions in mm



Net weight : 80 g
With accessories: 108 g

Torque on nut: min. 90 cm kg
max. 175 cm kg

Diameter of hole in heatsink: max. 13 mm

All information applies to frequencies up to 400 Hz

RATINGS (Limiting values) [1])

ANODE TO CATHODE

Voltages [2])			BTX49-1000R	1200R	1400R	
Continuous reverse voltage	V_R	max.	800	800	800	V
Crest working reverse voltage	V_{RWM}	max.	800	800	800	V
Repetitive peak reverse voltage (δ = 0.01; f = 50 Hz)	V_{RRM}	max.	1000	1200	1400	V
Non repetitive peak reverse voltage ($t \leq 10$ ms)	V_{RSM}	max.	1000	1200	1400	V
Continuous off-state voltage	V_D	max.	800	800	800	V
Crest working off-state voltage	V_{DWM}	max.	800	800	800	V [3])
Repetitive peak off-state voltage (δ = 0.01; f = 50 Hz)	V_{DRM}	max.	900	900	900	V

Currents

Average forward current (averaged over any 20 ms period) T_{mb} = 75 °C	I_{TAV}	max.	70	A
T_{mb} = 85 °C	I_{TAV}	max.	60	A
Forward current (d.c.)	I_T	max.	80	A
R.M.S. forward current	$I_{T(RMS)}$	max.	110	A
Repetitive peak forward current	I_{TRM}	max.	1000	A
Non repetitive peak forward current (t = 10 ms) see also page 9	I_{TSM}	max.	1050	A
I squared t for fusing (t = 1 to 10 ms)	I^2t	max.	5600	A^2s
Rate of rise of forward current	$\frac{dI_T}{dt}$	max.	50	A/μs
Repetitive peak reverse current (during turn-off)	I_{RRM}	max.	30	A

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

2) These ratings apply to a gate voltage range of −5 to +0.25 V. To ensure thermal stability: $R_{th\ j-a} \leq 1.5$ °C/W (d.c.) or 3.0 °C/W (a.c.)

3) Off-state voltages higher than V_{DWMmax} are allowed, but at voltages higher than the forward breakover voltage (see page 4) the device may switch into the on-state.

RATINGS (Limiting values) (continued)

ANODE TO CATHODE

Power dissipation

Non repetitive peak reverse dissipation				
t = 10 μs; T_j = 25 ^oC	P_{RSM}	max.	40	kW
t = 10 μs; T_j = 125 ^oC	P_{RSM}	max.	18	kW

GATE TO CATHODE

Voltages

Forward peak voltage	V_{FGM}	max.	10	V
Reverse peak voltage	V_{RGM}	max.	5	V

Current

Forward peak current	I_{FGM}	max.	2	A

Power dissipation

Average power dissipation (averaged over any 20 ms period)	P_{GAV}	max.	0.5	W
Peak power dissipation	P_{GM}	max.	5	W

TEMPERATURES

Storage temperature	T_{stg}	-55 to +125		^oC
Junction temperature	T_j	max.	125	^oC

THERMAL RESISTANCE

From junction to mounting base	$R_{th\ j\text{-}mb}$	=	0.3	$^oC/W$
From mounting base to heatsink	$R_{th\ mb\text{-}h}$	=	0.1	$^oC/W$
Transient thermal resistance (t = 1 ms)	$R_{th\ t}$	=	0.015	$^oC/W$

CHARACTERISTICS T_j = 125 °C unless otherwise specified

ANODE TO CATHODE

Voltages

		BTX49-1000R	1200R	1400R	
Forward on-state voltage I_T = 500 A; T_j = 25 °C	V_T	< 3.5	3.5	3.5	V [1]
Reverse breakdown voltage in the avalanche region	$V_{(BR)R}$	> 1000	1200	1400	V
Forward breakover voltage	$V_{(BO)}$	> 900	1100	1300	V

Currents

Reverse current $V_R = V_{RWMmax}$	I_R	<	10	mA
Off-state current $V_D = V_{DWMmax}$	I_D	<	10	mA
Pick up current	I_P	typ.	20	mA
Holding current	I_H	typ.	10	mA

GATE TO CATHODE

Voltages

Voltage to trigger all devices V_D = 6 V; T_j = 25 °C	V_{GT}	>	3.0	V
Voltage not to trigger any device	V_{GD}	<	0.25	V

Current

Current to trigger all devices V_D = 6 V; T_j = 25 °C	I_{GT}	>	80	mA

SWITCHING CHARACTERISTICS

Turn on time when switched from $V_D = V_{DWMmax}$ to I_T = 10 A; Gate source 5 V, 25 Ω	t_{on}	typ.	5.0	μs
Turn off time when switched from I_T = 50 A to I_R = 30 A; T_j = 125 °C	t_q	typ.	50	μs
T_j = 25 °C	t_q	typ.	25	μs

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

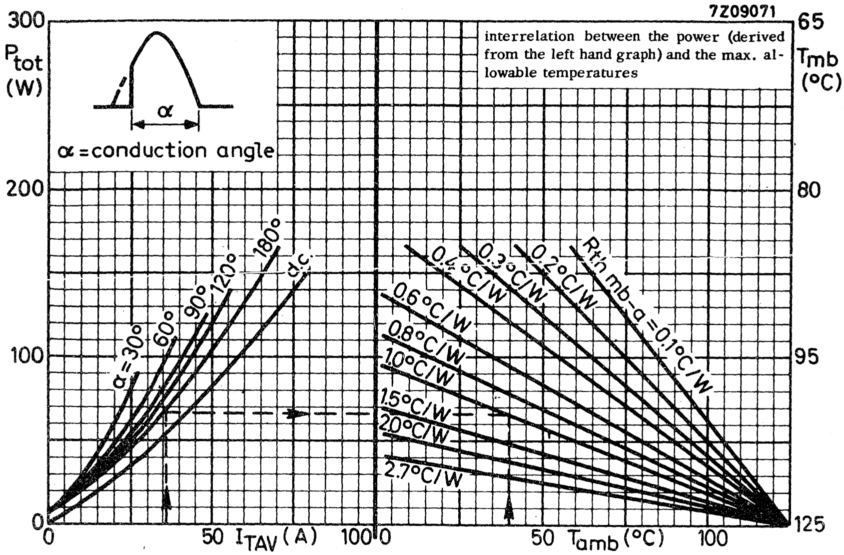
OPERATING NOTES

1. When there is a possibility that transient voltages, caused by the stored energy in the transformer core, will exceed the maximum permissible non repetitive peak reverse voltage, a damping circuit across the transformer should be applied.
Either a series RC circuit or a voltage dependent resistor may be used. Suitable component values for an RC circuit across the transformer primary or secondary may be calculated as follows:

$\frac{V_{RSM}}{V_{RWM}}$	RC across primary of transformer		RC across secondary of transformer	
	C (μF)	R (Ω)	C (μF)	R (Ω)
2.0	$200\frac{I_{mag}}{V_1}$	$\frac{150}{C}$	$225\frac{I_{mag}T^2}{V_1}$	$\frac{200}{C}$
1.5	$400\frac{I_{mag}}{V_1}$	$\frac{225}{C}$	$450\frac{I_{mag}T^2}{V_1}$	$\frac{275}{C}$
1.25	$550\frac{I_{mag}}{V_1}$	$\frac{260}{C}$	$620\frac{I_{mag}T^2}{V_1}$	$\frac{310}{C}$
1.0	$800\frac{I_{mag}}{V_1}$	$\frac{300}{C}$	$900\frac{I_{mag}T^2}{V_1}$	$\frac{350}{C}$

where I_{mag} = magnetising primary r.m.s. current (A)
V_1 = transformer primary r.m.s. voltage (V)
V_2 = transformer secondary r.m.s. voltage (V)
T = V_1/V_2
V_{RWM} stands for the actually applied crest working reverse voltage

2. In order to prevent the thyristors from being damaged by surge currents higher than those mentioned in the curves on page 9 a fast fuse is recommended.



Determination of the heatsink thermal resistance.

Example:

Assume a thyristor, used in a single phase full-wave rectifier circuit.

frequency	f	=	50 Hz
conduction angle	α	=	180°
average forward current	I_{TAV}	=	36 A (per thyristor)
ambient temperature	T_{amb}	=	40 °C

From the left hand part of the graph above it follows that at I_{TAV} = 36 A and α = 180° the average forward power + average leakage power = 68 W per thyristor.

From the right hand part of the graph above follows the thermal resistance, required for P_{tot} = 68 W at T_{amb} = 40 °C

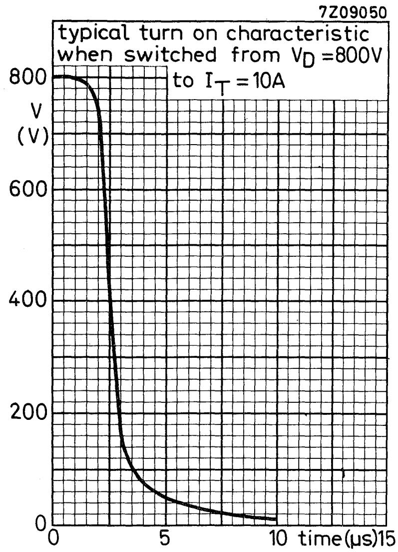
$$R_{th\ mb\text{-}a} \approx 1.0\ ^{\circ}C/W$$

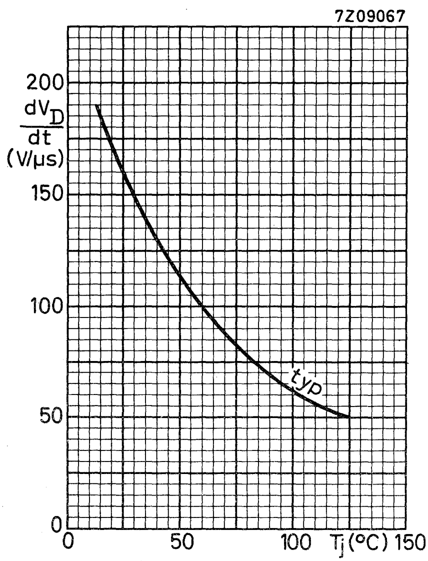
The contact thermal resistance $R_{th\ mb\text{-}h} = 0.1\ ^{\circ}C/W$

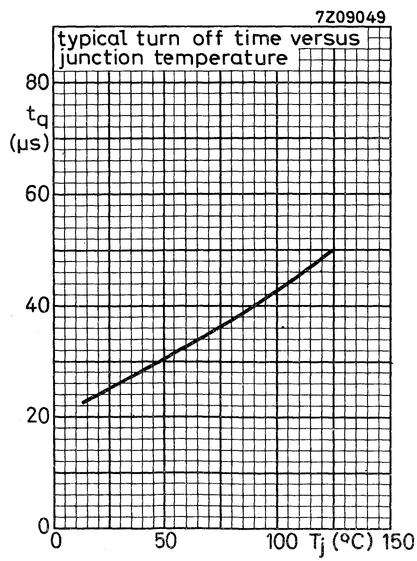
Hence the heatsink thermal resistance should be:

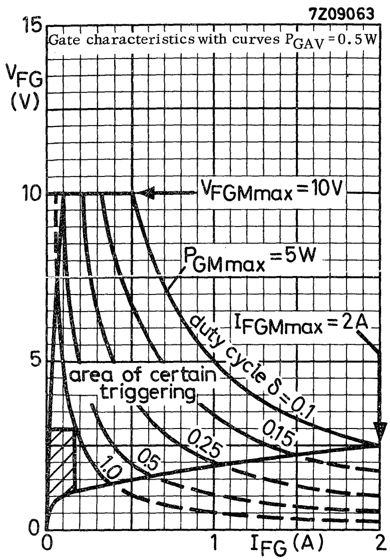
$$R_{th\ h\text{-}a} = R_{th\ mb\text{-}a} - R_{th\ mb\text{-}h} = (1.0 - 0.1)\ ^{\circ}C/W = 0.9\ ^{\circ}C/W$$

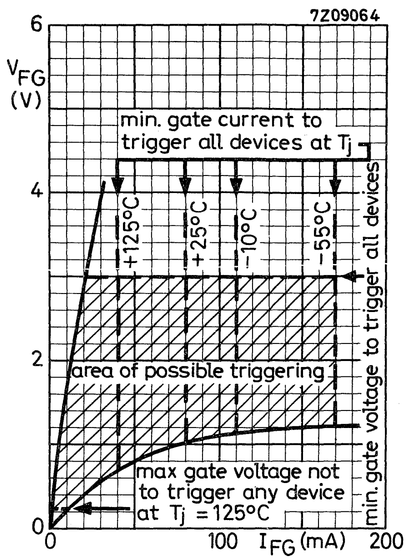
The applicable heatsink(s) may then be found in the Section ACCESSORIES and HEATSINKS.

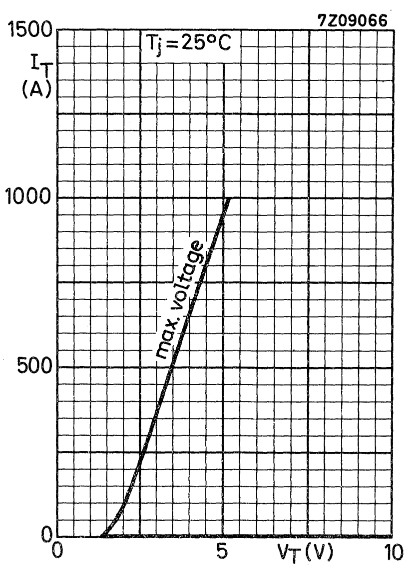

7Z09050
typical turn on characteristic
when switched from V_D =800V
to I_T =10A
800
V
(V)
600
400
200
0
0
5
10
time(μs)15

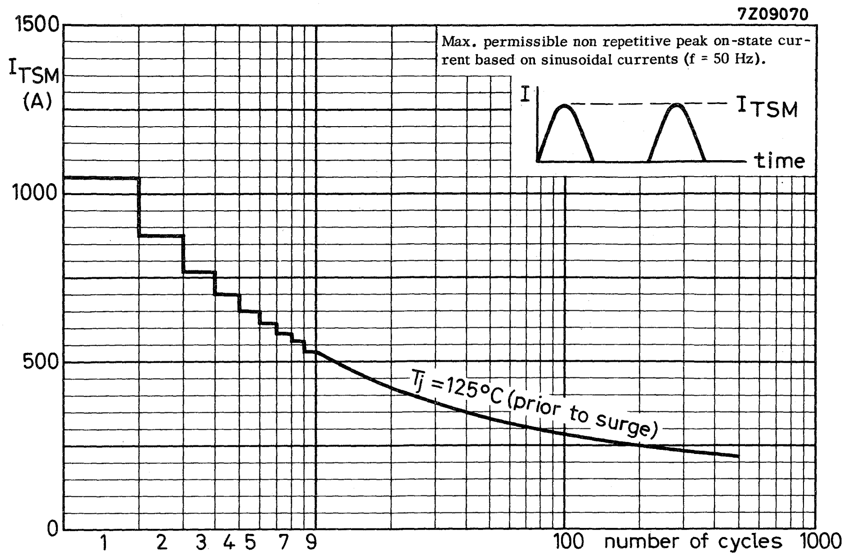

7Z09067
200
$\frac{dV_D}{dt}$
(V/μs)
150
100
50
0
typ
0
50
100
T_j(°C) 150

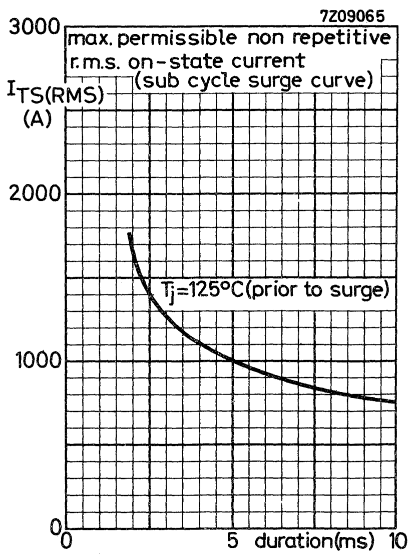

7Z09049
typical turn off time versus
junction temperature
80
t_q
(μs)
60
40
20
0
0
50
100
T_j (°C) 150

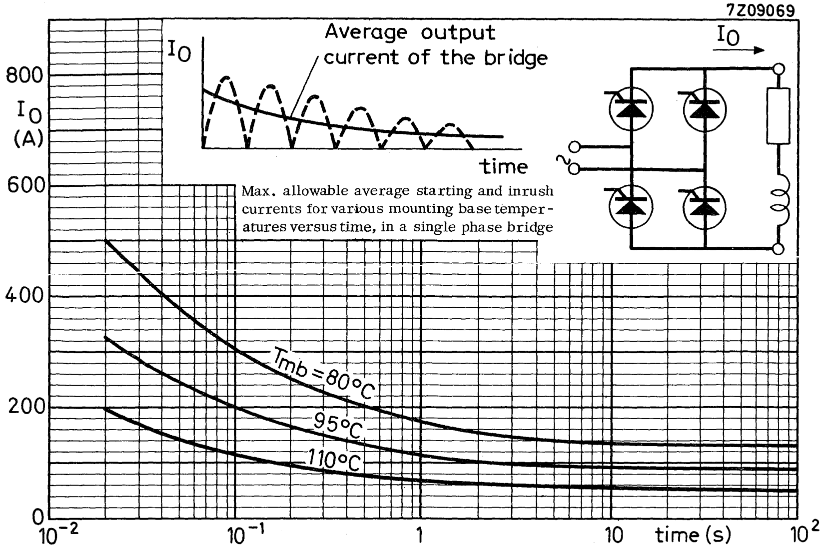

7Z09063
Gate characteristics with curves P_{GAV} = 0.5 W
V_{FG} (V)
V_{FGMmax} = 10 V
P_{GMmax} = 5 W
I_{FGMmax} = 2 A
duty cycle δ = 0.1
0.15
0.25
0.5
1.0
area of certain triggering
I_{FG} (A)


7Z09064
V_{FG} (V)
min. gate current to trigger all devices at T_j
+125°C
+25°C
−10°C
−55°C
min. gate voltage to trigger all devices
area of possible triggering
max gate voltage not to trigger any device at T_j = 125°C
I_{FG} (mA)

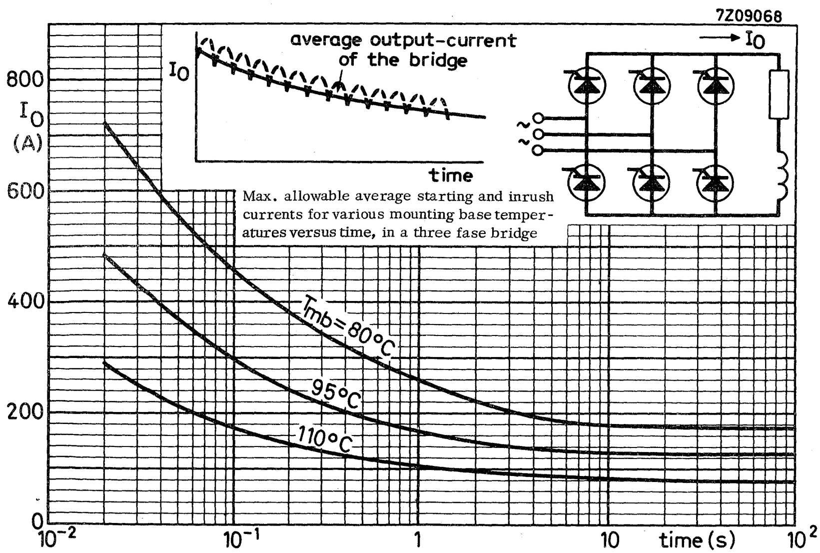

7Z09066
T_j = 25°C
I_T (A)
max. voltage
V_T (V)


7Z09070
Max. permissible non repetitive peak on-state current based on sinusoidal currents (f = 50 Hz).
I
ITSM
time
1500
ITSM
(A)
1000
500
0
1
2
3
4
5
7
9
100
number of cycles
1000
Tj =125°C (prior to surge)


7Z09065
max. permissible non repetitive
r.m.s. on-state current
(sub cycle surge curve)
3000
ITS(RMS)
(A)
2000
1000
0
0
5
duration(ms)
10
Tj=125°C(prior to surge)



Max. allowable average starting and inrush currents for various mounting base temperatures versus time, in a single phase bridge



Max. allowable average starting and inrush currents for various mounting base temperatures versus time, in a three fase bridge

P-GATE SILICON THYRISTORS

P-gate fast thyristors in a TO-48 metal envelope intended for use in power control circuits where low switching times are required, a.o. for invertors, a.c. motor-speed control, emergency power supplies and pulse generators up to 20 kHz.
The series consists of the following reverse polarity types (stud anode):
BTX64-100R, BTX64-200R, BTX64-300R, BTX64-400R and BTX64-500R.

QUICK REFERENCE DATA

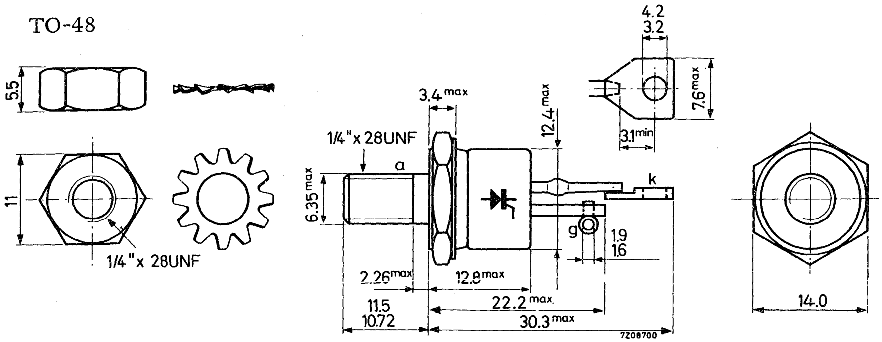
			BTX64-100R	200R	300R	400R	500R	
Crest working reverse voltage	V_{RWM}	max.	100	200	300	400	500	V
Crest working off-state voltage	V_{DWM}	max.	100	200	300	400	500	V

Average forward current				
$T_{mb} = 35\ ^oC$	I_{TAV}	max.	16	A
$T_{mb} = 65\ ^oC$	I_{TAV}	max.	12	A
Non repetitive peak forward current t = 10 ms	I_{TSM}	max.	140	A
Junction temperature	T_j	max.	125	^oC
Thermal resistance from junction to mounting base	$R_{th\ j-mb}$	=	2.0	$^oC/W$
Turn off time when switched from $I_T = 10$ A to $I_R = 10$ A at max. dV_D/dt; $T_j = 125\ ^oC$	t_q	<	10	μs

MECHANICAL DATA (see page 2)

MECHANICAL DATA Dimensions in mm

TO-48



Net weight : 10 g
With accessories: 15 g

Torque on nut: min. 17 cm kg
max. 35 cm kg

Diameter of hole in heatsink: max. 6.5 mm

Accessories available: 56264A

All information applies to frequencies up to 20 kHz.

RATINGS (limiting values) [1]

ANODE TO CATHODE

Voltages [2]			BTX64-100R	200R	300R	400R	500R	
Continuous reverse voltage	V_R	max.	100	200	300	400	500	V
Crest working reverse voltage	V_{RWM}	max.	100	200	300	400	500	V
Repetitive peak reverse voltage	V_{RRM}	max.	100	200	300	400	500	V
Non repetitive peak reverse voltage ($t < 5$ ms)	V_{RSM}	max.	150	300	400	500	600	V
Continuous off-state voltage	V_D	max.	100	200	300	400	500	V
Crest working off-state voltage	V_{DWM}	max.	100	200	300	400	500	V
Repetitive peak off-state voltage	V_{DRM}	max.	100	200	300	400	500	V
Non rep. peak off-state voltage	V_{DSM}		max. 500 V [3]					

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

2) These ratings apply to a gate voltage range of −5 to +0.25 V.
To ensure thermal stability: $R_{th\,j\text{-}a} \leq 4.5\ ^{\circ}C/W$ (d.c.) or $\leq 9\ ^{\circ}C/W$ (a.c.)

3) This voltage may be applied without damage, but the thyristor may switch into the on-state. Care should be taken that no current ratings are exceeded.

RATINGS (Limiting values) (continued)

ANODE TO CATHODE

Currents

Average forward current (averaged over any 20 ms period); T_{mb} = 35 °C	I_{TAV}	max.	16	A
T_{mb} = 65 °C	I_{TAV}	max.	12	A
Forward current (d.c.)	I_T	max.	19	A
R.M.S. forward current	$I_{T(RMS)}$	max.	19	A
Repetitive peak forward current	I_{TRM}	max.	140	A
Non repetitive peak forward current (t = 10 ms); see also page 10	I_{TSM}	max.	140	A
I squared t for fusing (t $\leq$ 10 ms)	I^2t	max.	100	A^2s
Rate of rise of forward current	$\frac{dI_T}{dt}$	max.	100	A/μs
Repetitive peak reverse current (during turn off)	I_{RRM}	max.	20	A

GATE TO CATHODE

Voltages

Forward peak voltage	V_{FGM}	max.	20	V
Reverse peak voltage	V_{RGM}	max.	5	V

Current

Forward peak current	I_{FGM}	max.	2	A

Power dissipation

Average power dissipation	P_{GAV}	max.	0.5	W
Peak power dissipation	P_{GM}	max.	5	W

TEMPERATURES

Storage temperature	T_{stg}		-55 to +125	°C
Junction temperature	T_j	max.	125	°C

THERMAL RESISTANCE

From junction to mounting base	$R_{th\,j\text{-}mb}$	=	2.0	°C/W
From mounting base to heatsink	$R_{th\,mb\text{-}h}$	=	0.2	°C/W

CHARACTERISTICS T_j = 125 °C unless otherwise specified

ANODE TO CATHODE

Voltages

			BTX64-100R	200R	300R	400R	500R	
Forward on-state voltage I_T = 50 A; T_j = 25 °C	V_T	<	3.0	3.0	3.0	3.0	3.0	V [1]
Forward breakover voltage	$V_{(BO)}$	>	100	200	300	400	500	V
Rate of rise of forward voltage not to trigger any device	$\frac{dV_D}{dt}$	<	10	20	30	40	50	V/μs

Currents

			BTX64-100R	200R	300R	400R	500R	
Reverse current $V_R = V_{RWM max}$	I_R	<	13	12	10	8.0	6.0	mA [2]
Off-state current $V_D = V_{DWM max}$	I_D	<	13	12	10	8.0	6.0	mA

Pick-up current	I_P	typ. 20	mA
Holding current	I_H	typ. 10	mA

GATE TO CATHODE

Voltages

Voltage to trigger all devices V_D = 6 V; T_j = 25 °C	V_{GT}	>	3.5	V
Voltage not to trigger any device	V_{GD}	<	0.25	V

Current

Current to trigger all devices V_D = 6 V; T_j = 25 °C	I_{GT}	>	65	mA

SWITCHING CHARACTERISTICS (See also page 7)

Turn on time when switched from $V_D = V_{DWM max}$ to I_T = 10 A, Gate source 20 V, 20 Ω	t_{on}	typ.	0.4	μs
Turn off time when switched from I_T = 10 A to I_R = 10 A at max. dV_D/dt; T_j = 125 °C	t_q	<	10	μs
T_j = 25 °C	t_q	<	5	μs

[1]) Measured under pulsed conditions to prevent excessive dissipation.
[2]) These I_R values apply to a gate voltage range of −5 to +0.25 V.

OPERATING NOTES

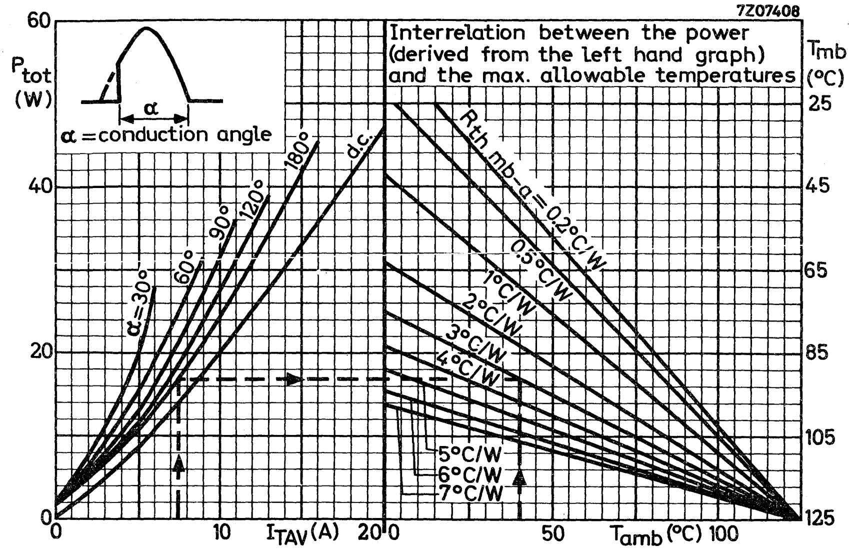
1. When there is a possibility that transient voltages, caused by the stored energy in the transformer core, will exceed the maximum permissible non repetitive peak reverse voltage, a damping circuit across the transformer should be applied.
   Either a series RC circuit or a voltage dependent resistor may be used. Suitable component values for an RC circuit across the transformer primary or secondary may be calculated as follows:

$\frac{V_{RSM}}{V_{RWM}}$	RC across primary of transformer		RC across secondary of transformer	
	C (μF)	R (Ω)	C (μF)	R (Ω)
2.0	$200 \frac{I_{mag}}{V_1}$	$\frac{150}{C}$	$225 \frac{I_{mag} T^2}{V_1}$	$\frac{200}{C}$
1.5	$400 \frac{I_{mag}}{V_1}$	$\frac{225}{C}$	$450 \frac{I_{mag} T^2}{V_1}$	$\frac{275}{C}$
1.25	$550 \frac{I_{mag}}{V_1}$	$\frac{260}{C}$	$620 \frac{I_{mag} T^2}{V_1}$	$\frac{310}{C}$
1.0	$800 \frac{I_{mag}}{V_1}$	$\frac{300}{C}$	$900 \frac{I_{mag} T^2}{V_1}$	$\frac{350}{C}$

   where I_{mag} = magnetising primary r.m.s. current (A)
   V_1 = transformer primary r.m.s. voltage (V)
   V_2 = transformer secondary r.m.s. voltage (V)
   T = V_1/V_2
   V_{RWM} stands for the actually applied crest working reverse voltage.

2. In order to prevent the thyristors from being damaged by surge currents higher than those mentioned in the curve at page 10 a fast fuse is recommended.

3. The gate and cathode connectors should not be bent; they should be soldered into the circuit so there is no strain on them.
   During soldering the heat conduction to the junction should be kept to a minimum by using a thermal shunt.



Determination of the heatsink thermal resistance.

Example:

Assume a thyristor, used in a rectifier circuit.

frequency	f	=	1	kHz
conduction angle	α	=	180°	
ambient temperature	T_{amb}	=	40	°C
average forward current	I_{TAV}	=	7.5	A

From the left hand part of the graph above it follows, that at $I_{TAV} = 7.5$ A and $\alpha = 180^{\circ}$ the average forward power + average leakage power = 17 W per thyristor.
From the right hand part follows the thermal resistance, required for P_{tot} = 17 W at $T_{amb} = 40$ °C:

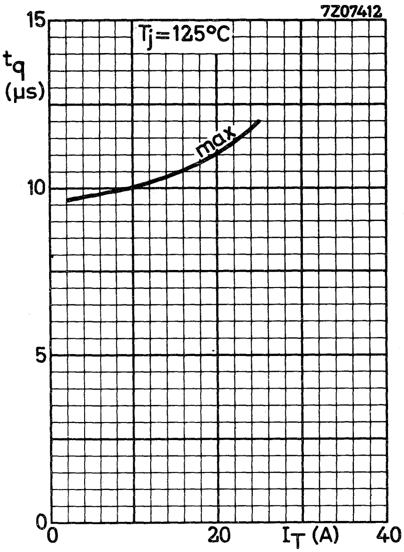
$$R_{th\,mb\text{-}a} \approx 3.0\ ^{\circ}\mathrm{C/W}$$

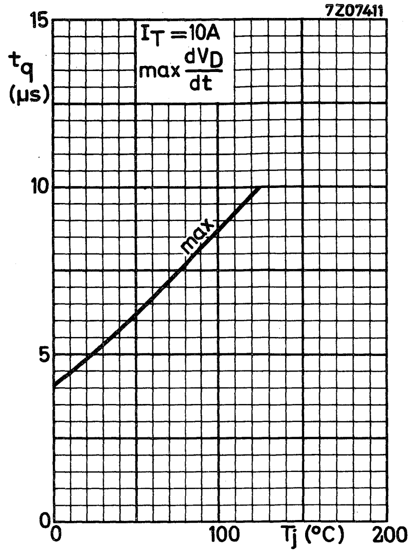
The contact thermal resistance $R_{th\,mb\text{-}h} = 0.2$ °C/W

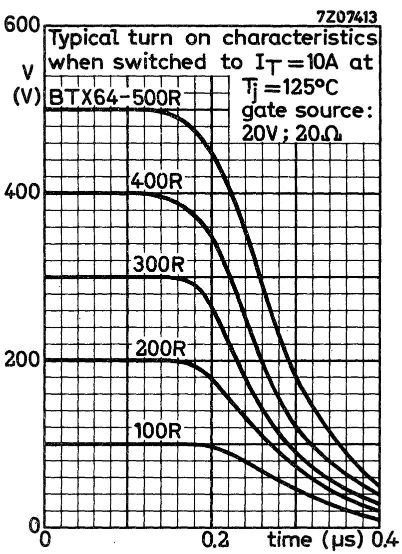
Hence the heatsink thermal resistance should be:

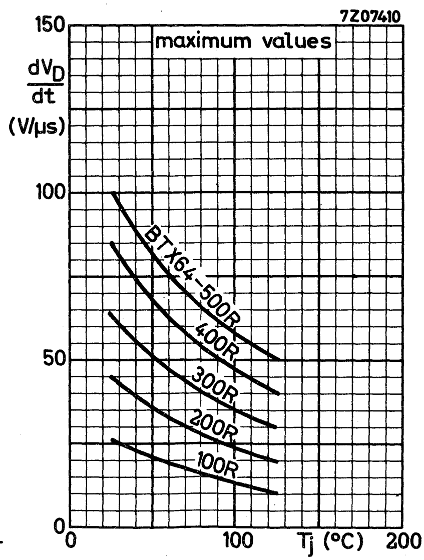
$$R_{th\,h\text{-}a} = R_{th\,mb\text{-}a} - R_{th\,mb\text{-}h} = (3.0 - 0.2)\ ^{\circ}\mathrm{C/W} = 2.8\ ^{\circ}\mathrm{C/W}.$$

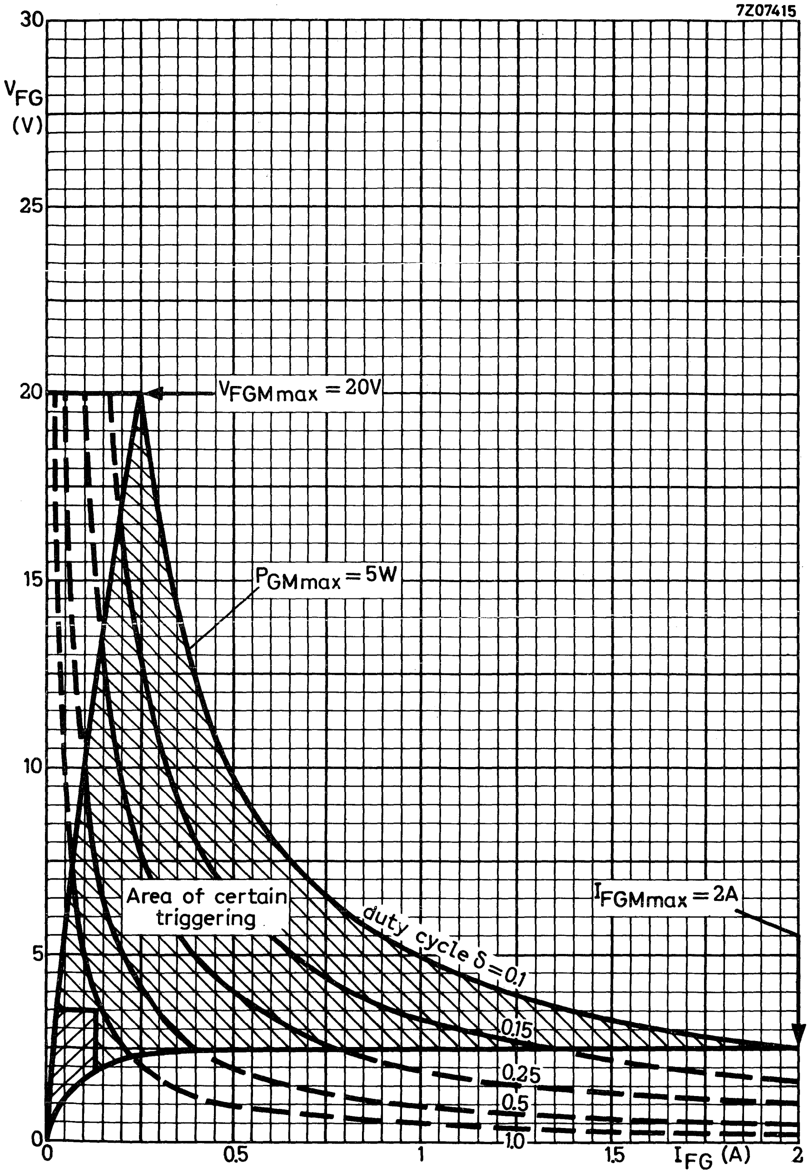
The applicable heatsink(s) may then be found in the Section ACCESSORIES and HEATSINKS


7Z07412
15
t_q
(μs)
T_j=125°C
max
10
5
0
0
20
I_T (A)
40

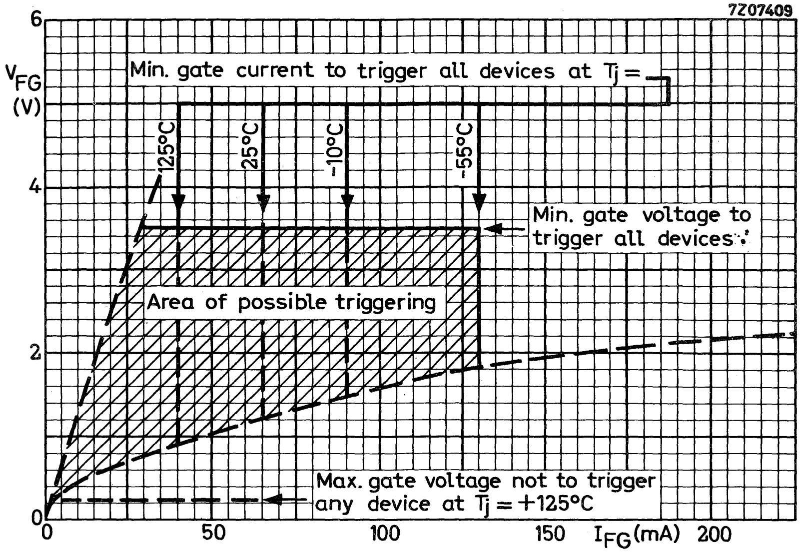

7Z07411
15
t_q
(μs)
I_T =10A
max $\frac{dV_D}{dt}$
max
10
5
0
0
100
T_j (°C)
200

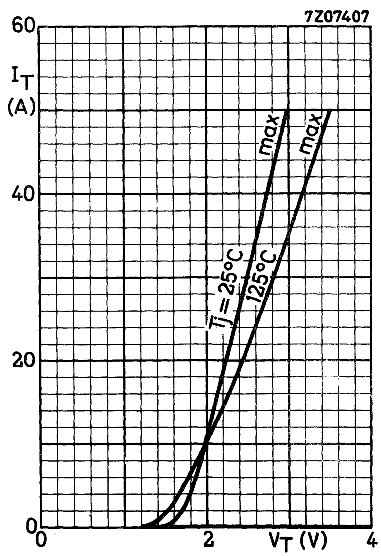

7Z07413
600
V
(V)
Typical turn on characteristics
when switched to I_T=10A at
T_j=125°C
gate source:
20V; 20Ω
BTX64-500R
400R
300R
200R
100R
400
200
0
0
0.2
time (μs) 0.4


7Z07410
150
$\frac{dV_D}{dt}$
(V/μs)
maximum values
BTX64-500R
400R
300R
200R
100R
100
50
0
0
100
T_j (°C)
200

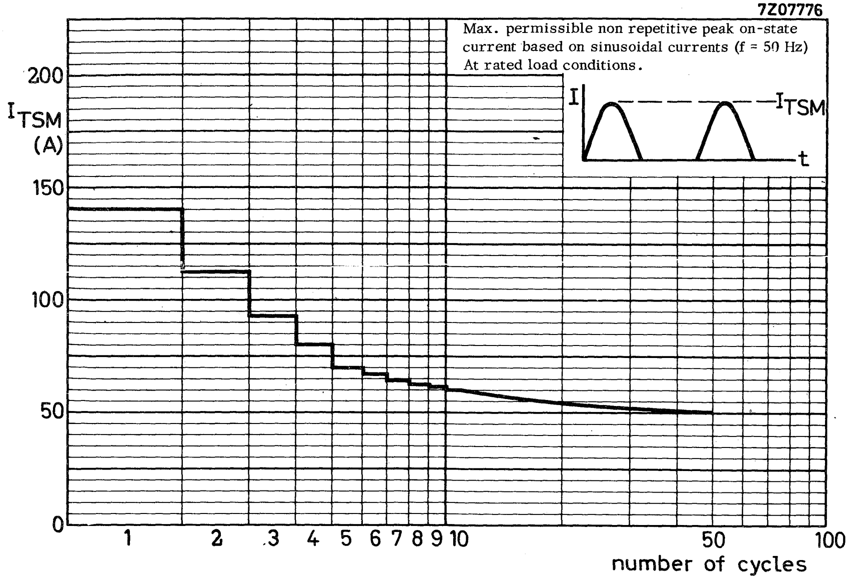


Gate characteristics with curves $P_{GAV} = 0.5W$


7Z07409
V_{FG} (V)
Min. gate current to trigger all devices at Tj =
125°C
25°C
-10°C
-55°C
Min. gate voltage to trigger all devices
Area of possible triggering
Max. gate voltage not to trigger any device at Tj = +125°C
I_{FG} (mA)
0
2
4
6
0
50
100
150
200


7Z07407
I_T (A)
max
max
Tj = 25°C
125°C
V_T (V)
0
20
40
60
0
2
4

7Z07776


Max. permissible non repetitive peak on-state current based on sinusoidal currents (f = 50 Hz)
At rated load conditions.
I
I_{TSM}
t
200
I_{TSM}
(A)
150
100
50
0
1
2
3
4
5
6
7
8
9
10
50
100
number of cycles

P-GATE SILICON THYRISTORS

P-gate fast thyristors in a metal envelope with ceramic insulation intended for use in power control circuits where low switching times are required, a.o. for invertors, a.c. motor-speed control, emergency power supplies and pulse generators up to 13 kHz.
The series consists of the following reverse polarity types (stud anode): BTX66-100R, BTX66-200R, BTX66-300R, BTX66-400R and BTX66-500R.

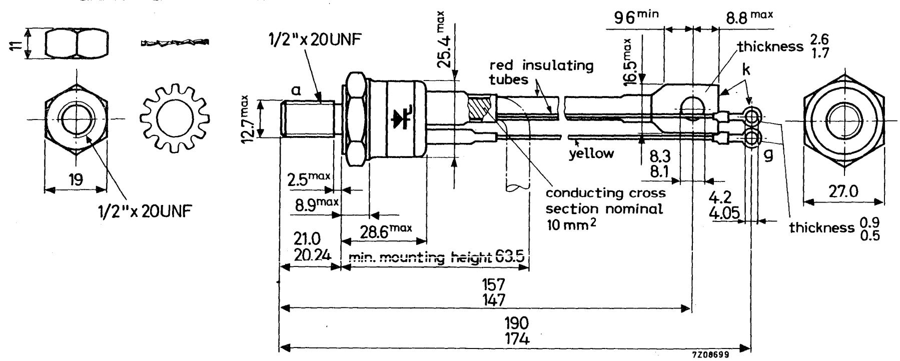
QUICK REFERENCE DATA

			BTX66-100R	200R	300R	400R	500R	
Crest working reverse voltage	V_{RWM}	max.	100	200	300	400	500	V
Crest working off-state voltage	V_{DWM}	max.	100	200	300	400	500	V

Average forward current				
T_{mb} = 25 °C	I_{TAV}	max.	70	A
T_{mb} = 60 °C	I_{TAV}	max.	50	A
Non repetitive peak forward current t = 10 ms	I_{TSM}	max.	680	A
Junction temperature	T_j	max.	125	°C
Thermal resistance from junction to mounting base	$R_{th\,j\text{-}mb}$	=	0.6	°C/W
Turn off time when switched from I_T = 50 A to I_R = 20 A at max. dV_D/dt; T_j = 125 °C	t_q	<	15	μs

MECHANICAL DATA (see page 2)

MECHANICAL DATA Dimensions in mm



Diameter of hole in heatsink: max. 13 mm

Net weight : 80 g

With accessories: 108 g

Torque on nut: min. 90 cm kg; max. 175 cm kg

All information applies to frequencies up to 13 kHz

RATINGS (Limiting values) 1)

ANODE TO CATHODE

Voltages 2)			BTX66-100R	200R	300R	400R	500R	
Continuous reverse voltage	V_R	max.	100	200	300	400	500	V
Crest working reverse voltage	V_{RWM}	max.	100	200	300	400	500	V
Repetitive peak reverse voltage	V_{RRM}	max.	100	200	300	400	500	V
Non repetitive peak reverse voltage (t < 5 ms)	V_{RSM}	max.	150	300	400	500	600	V
Continuous off-state voltage	V_D	max.	100	200	300	400	500	V
Crest working off-state voltage	V_{DWM}	max.	100	200	300	400	500	V
Repetitive peak off-state voltage	V_{DRM}	max.	100	200	300	400	500	V
Non rep. peak off-state voltage	V_{DSM}		max. 500 V 3)					

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

2) These ratings apply to a gate voltage range of −5 to +0.25 V.
To ensure thermal stability: $R_{th\,j\text{-}a} \leq 1.5\ ^{o}C/W$ (d.c.) or $\leq 3.0\ ^{o}C/W$ (a.c.)

3) This voltage may be applied without damage, but the thyristor may switch into the on-state. Care should be taken that no current ratings are exceeded.

RATINGS (Limiting values) (continued)

ANODE TO CATHODE

Currents

Average forward current (averaged over any 20 ms period) T_{mb} = 25 °C	I_{TAV}	max.	70	A
T_{mb} = 60 °C	I_{TAV}	max.	50	A
Forward current (d.c.)	I_T	max.	78	A
R.M.S. forward current	$I_{T(RMS)}$	max.	110	A
Repetitive peak forward current	I_{TRM}	max.	700	A
Non repetitive peak forward current (t = 10 ms); see also page 10	I_{TSM}	max.	680	A
I squared t for fusing (t $\leq$ 10 ms)	I^2t	max.	2000	A^2s
Rate of rise of forward current	$\frac{dI_T}{dt}$	max.	100	A/µs
Repetitive peak reverse current (during turn-off)	I_{RRM}	max.	20	A

GATE TO CATHODE

Voltages

Forward peak voltage	V_{FGM}	max.	20	V
Reverse peak voltage	V_{RGM}	max.	5	V

Current

Forward peak current	I_{FGM}	max.	2	A

Power dissipation

Average power dissipation	P_{GAV}	max.	1.0	W
Peak power dissipation	P_{GM}	max.	5	W

TEMPERATURES

Storage temperature	T_{stg}	−55 to +125		°C
Junction temperature	T_j	max.	125	°C

THERMAL RESISTANCE

From junction to mounting base	$R_{th\,j\text{-}mb}$	=	0.6	°C/W
From mounting base to heatsink	$R_{th\,mb\text{-}h}$	=	0.1	°C/W

CHARACTERISTICS T_j = 125 °C unless otherwise specified

ANODE TO CATHODE

Voltages

			BTX66-100R	200R	300R	400R	500R	
Forward on-state voltage I_T = 500 A; T_j = 25 °C	V_T	<	3.3	3.3	3.3	3.3	3.3	V [1]
Forward breakover voltage	$V_{(BO)}$	>	100	200	300	400	500	V
Rate of rise of forward voltage not to trigger any device	$\frac{dV_D}{dt}$	<	7	13	20	27	33	V/µs
Currents								
Reverse current $V_R = V_{RWM\,max}$	I_R	<	13	12	10	8.0	12	mA [2]
Off-state current $V_D = V_{DWM\,max}$	I_D	<	13	12	10	8.0	12	mA

Pick-up current I_P typ. 20 mA

Holding current I_H typ. 10 mA

GATE TO CATHODE

Voltages

Voltage to trigger all devices
V_D = 6 V; T_j = 25 °C V_{GT} > 3.0 V

Voltage not to trigger any device V_{GD} < 0.25 V

Current

Current to trigger all devices
V_D = 6 V; T_j = 25 °C I_{GT} > 80 mA

SWITCHING CHARACTERISTICS (See also page 7)

Turn on time when switched from
$V_D = V_{DWM\,max}$ to I_T = 50 A
Gate source 20 V, 20 Ω t_{on} typ. 0.5 µs

Turn off time when switched from
I_T = 50 A to I_R = 20 A
at max. dV_D/dt; T_j = 125 °C t_q < 15 µs
T_j = 25 °C t_q < 7.5 µs

[1]) Measured under pulsed conditions to prevent excessive dissipation.
[2]) These I_R values apply to a gate voltage range of −5 to +0.25 V.

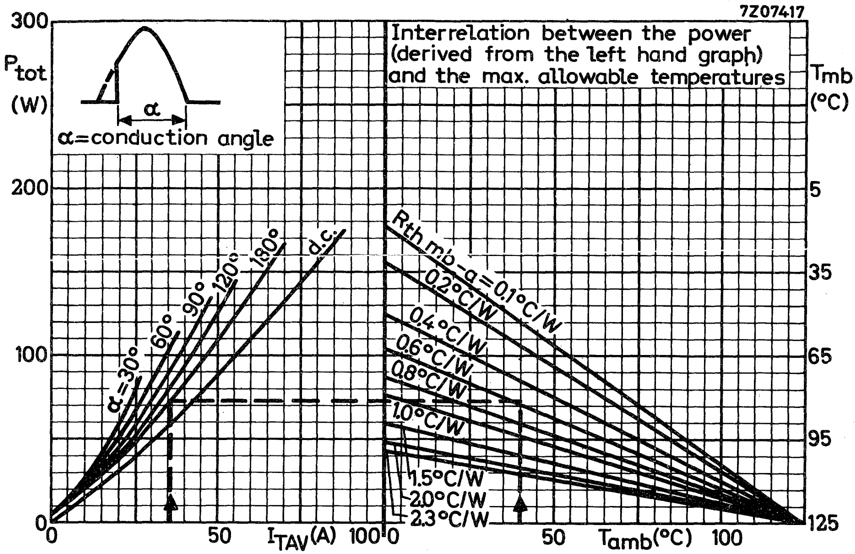
OPERATING NOTES

1. When there is a possibility that transient voltages, caused by the stored energy in the transformer core, will exceed the maximum permissible non repetitive peak reverse voltage, a damping circuit across the transformer should be applied.
   Either a series RC circuit or a voltage dependent resistor may be used. Suitable component values for an RC circuit across the transformer primary or secondary may be calculated as follows:

$\frac{V_{RSM}}{V_{RWM}}$	RC across primary of transformer		RC across secondary of transformer	
	C (μF)	R (Ω)	C (μF)	R (Ω)
2.0	$200\frac{I_{mag}}{V_1}$	$\frac{150}{C}$	$225\frac{I_{mag}T^2}{V_1}$	$\frac{200}{C}$
1.5	$400\frac{I_{mag}}{V_1}$	$\frac{225}{C}$	$450\frac{I_{mag}T^2}{V_1}$	$\frac{275}{C}$
1.25	$550\frac{I_{mag}}{V_1}$	$\frac{260}{C}$	$620\frac{I_{mag}T^2}{V_1}$	$\frac{310}{C}$
1.0	$800\frac{I_{mag}}{V_1}$	$\frac{300}{C}$	$900\frac{I_{mag}T^2}{V_1}$	$\frac{350}{C}$

   where I_{mag} = magnetising primary r.m.s. current (A)
   V_1 = transformer primary r.m.s. voltage (V)
   V_2 = transformer secondary r.m.s. voltage (V)
   T = V_1/V_2
   V_{RWM} stands for the actually applied crest working reverse voltage.

2. In order to prevent the thyristors from being damaged by surge currents higher than those mentioned in the curve at page 10 a fast fuse is recommended.



Determination of the heatsink thermal resistance.

Example:

Assume a thyristor, used in a rectifier circuit.

frequency	f	=	1	kHz
conduction angle	α	=	180°	
ambient temperature	T_{amb}	=	40	$^{\circ}$C
average forward current	I_{TAV}	=	36	A

From the left hand part of the graph above it follows, that at I_{TAV} = 36 A and α = 180° the average forward power + average leakage power = 73 W per thyristor.

From the right hand part follows the thermal resistance, required for P_{tot} = 73 W at T_{amb} = 40 $^{\circ}$C:

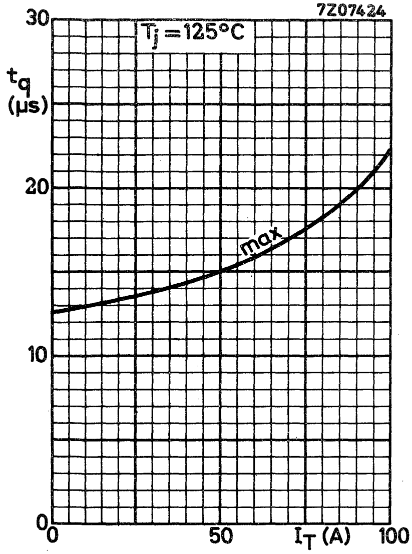
$$R_{th\,mb-a} \approx 0.55\ ^{\circ}\mathrm{C/W}$$

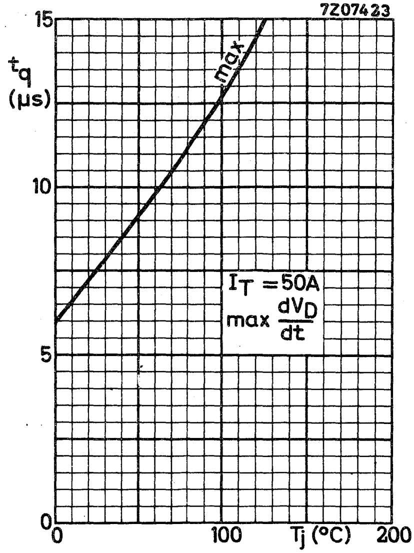
The contact thermal resistance $R_{th\,mb-h}$ = 0.1 $^{\circ}$C/W

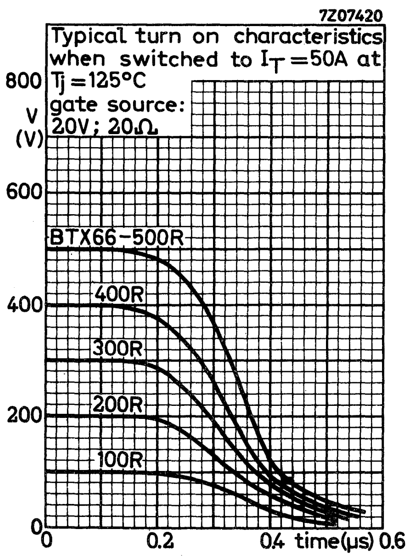
Hence the heatsink thermal resistance should be:

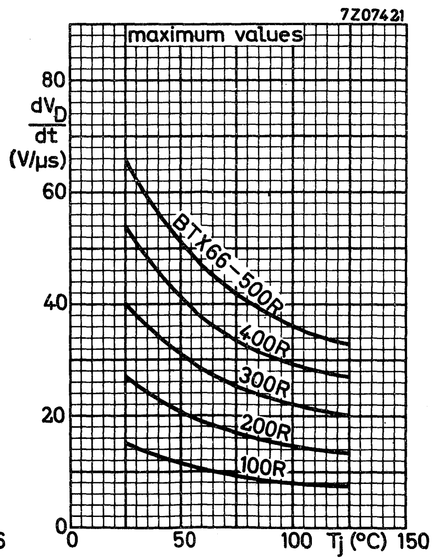
$$R_{th\,h-a} = R_{th\,mb-a} - R_{th\,mb-h} = (0.55 - 0.1)\ ^{\circ}\mathrm{C/W} = 0.45\ ^{\circ}\mathrm{C/W}$$

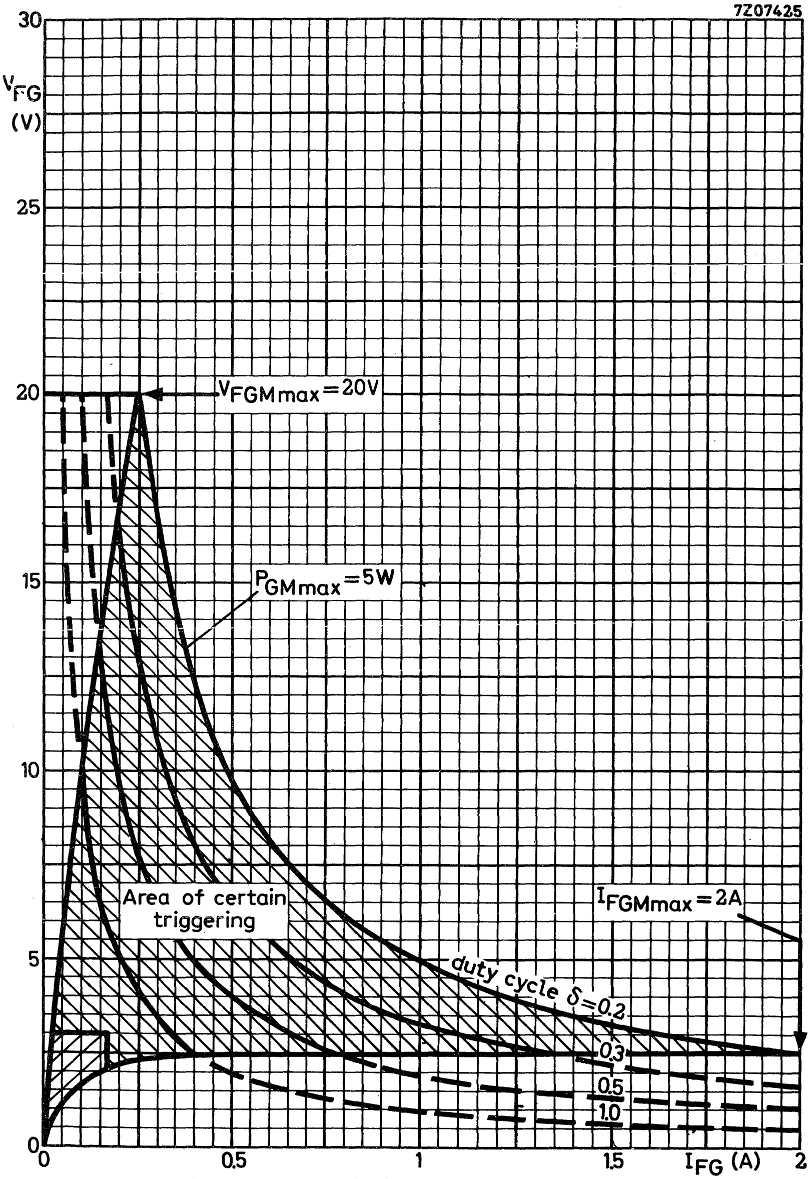
The applicable heatsink(s) may then be found in the Section ACCESSORIES and HEATSINKS


7Z07424
$T_j = 125°C$
t_q (μs)
max
30
20
10
0
0
50
I_T (A)
100

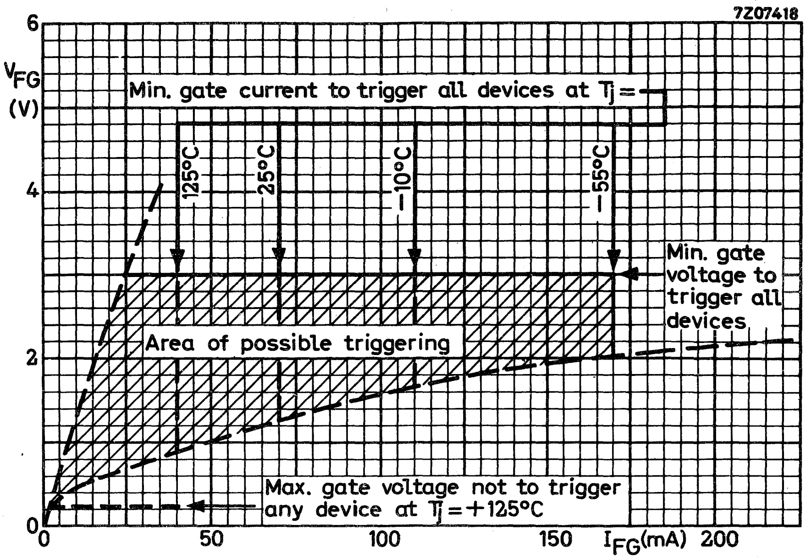

7Z07423
t_q (μs)
max
$I_T = 50A$
max $\frac{dV_D}{dt}$
15
10
5
0
0
100
T_j (°C)
200

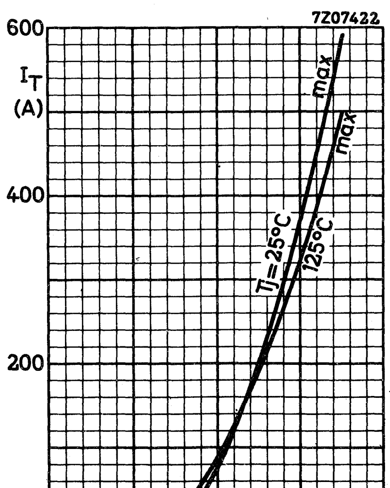

7Z07420
Typical turn on characteristics when switched to $I_T = 50A$ at $T_j = 125°C$
gate source: 20V; 20Ω
V (V)
BTX66-500R
400R
300R
200R
100R
800
600
400
200
0
0
0.2
0.4
time(μs)
0.6

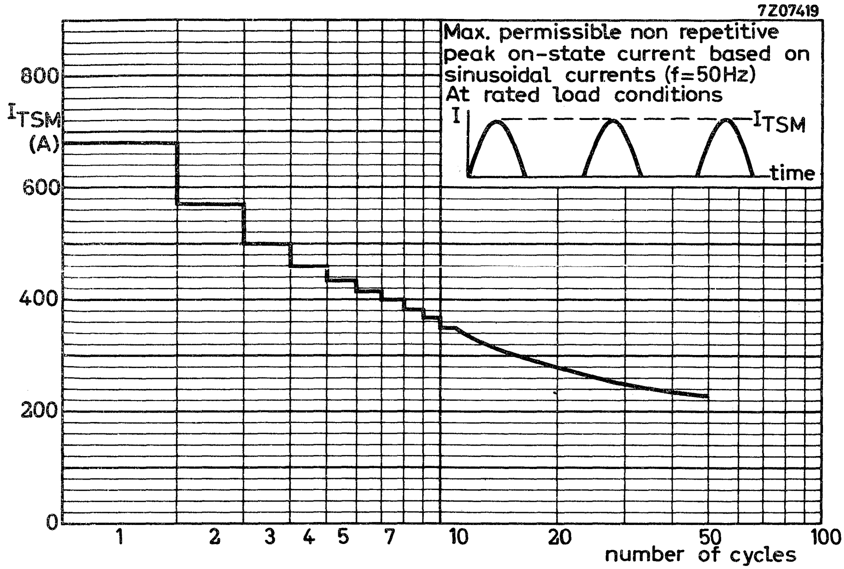

7Z07421
maximum values
$\frac{dV_D}{dt}$ (V/μs)
BTX66-500R
400R
300R
200R
100R
80
60
40
20
0
0
50
100
T_j (°C)
150



Gate characteristics with curves P_{GAV}=1.0W


7Z07418
V_{FG} (V)
Min. gate current to trigger all devices at T_j =
125°C
25°C
−10°C
−55°C
Min. gate voltage to trigger all devices
Area of possible triggering
Max. gate voltage not to trigger any device at T_j = +125°C
I_{FG} (mA)
0
2
4
6
0
50
100
150
200


7Z07422
I_T (A)
max
max
T_j = 25°C
125°C
V_T (V)
0
200
400
600
0
2
4


7Z07419
Max. permissible non repetitive peak on-state current based on sinusoidal currents (f=50Hz)
At rated load conditions
I
ITSM
time
800
ITSM
(A)
600
400
200
0
1
2
3
4
5
7
10
20
50
100
number of cycles

P-GATE SILICON THYRISTORS

P-gate fast thyristors in a metal envelope with ceramic insulation intended for use in power control circuits where low switching times are required, a.o. for invertors, a.c. motor-speed control, emergency power supplies and pulse generators up to 13 kHz.
The series consists of the following reverse polarity types (stud anode):
BTX67-100R, BTX67-200R, BTX67-300R, BTX67-400R, BTX67-500R

QUICK REFERENCE DATA

			BTX67-100R	200R	300R	400R	500R	
Crest working reverse voltage	V_{RWM}	max.	100	200	300	400	500	V
Crest working off-state voltage	V_{DWM}	max.	100	200	300	400	500	V

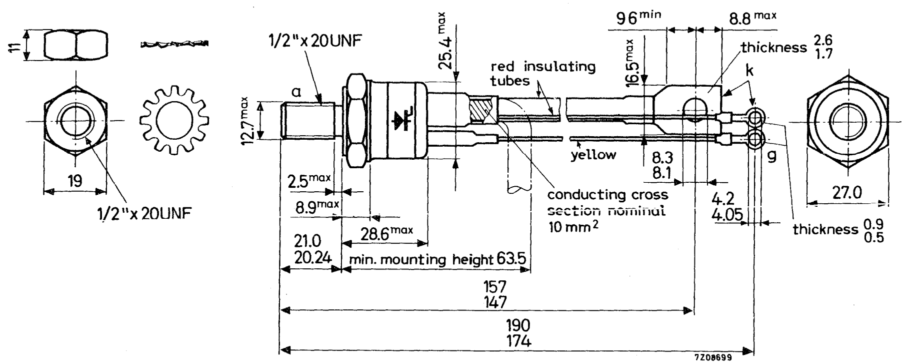
Average forward current				
T_{mb} = 77 °C	I_{TAV}	max.	70	A
T_{mb} = 85 °C	I_{TAV}	max.	62	A
Non repetitive peak forward current t = 10 ms	I_{TSM}	max.	900	A
Junction temperature	T_j	max.	125	°C
Thermal resistance from junction to mounting base	$R_{th\ j\text{-}mb}$	=	0.4	°C/W
Turn off time when switched from I_T = 50 A to I_R = 20 A; R_{GK} = 100 Ω at max. dV_D/dt; T_j = 125 °C	t_q	<	15	µs

MECHANICAL DATA (see page 2)

7Z3 1733

MECHANICAL DATA

Dimensions in mm



Diameter of hole in heatsink: max. 13 mm
Net weight : 88 g
With accessories: 108 g

Torque on nut: min. 90 cm kg
max. 175 cm kg

All information applies to frequencies up to 13 kHz

RATINGS (Limiting values) [1]

ANODE TO CATHODE

Voltages [2]			BTX67-100R	200R	300R	400R	500R	
Continuous reverse voltage	V_R	max.	100	200	300	400	500	V
Crest working reverse voltage	V_{RWM}	max.	100	200	300	400	500	V
Repetitive peak reverse voltage	V_{RRM}	max.	100	200	300	400	500	V
Non repetitive peak reverse voltage ($t < 5$ ms)	V_{RSM}	max.	150	300	400	500	600	V
Continuous off-state voltage	V_D	max.	100	200	300	400	500	V
Crest working off-state voltage	V_{DWM}	max.	100	200	300	400	500	V
Repetitive peak off-state voltage	V_{DRM}	max.	100	200	300	400	500	V
Non rep. peak off-state voltage	V_{DSM}	max.	600	600	600	600	600	V 3)

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

[2]) These ratings apply to a gate voltage range of −5 to +0.25 V.
To ensure thermal stability: $R_{th\ j\text{-}a} \leq 1.5$ °C/W (d.c.) or ≤ 3.0 °C/W (a.c.)

[3]) This voltage may be applied without damage, but the thyristor may switch into the on-state. Care should be taken that no current ratings are exceeded. 7Z3 1734

RATINGS (Limiting values) (continued)

ANODE TO CATHODE

Currents

Average forward current (averaged over any 20 ms period) T_{mb} = 77 °C	I_{TAV}	max.	70	A
T_{mb} = 85 °C	I_{TAV}	max.	62	A
Forward current (d.c.)	I_T	max.	110	A
R.M.S. forward current	$I_{T(RMS)}$	max.	110	A
Repetitive peak forward current	I_{TRM}	max.	1000	A
Non repetitive peak forward current (t = 10 ms); see also page 10	I_{TSM}	max.	900	A
I squared t for fusing (t < 10 ms)	I^2t	max.	4000	A^2s
Rate of rise of forward current	$\frac{dI_T}{dt}$	max.	100	A/µs
Repetitive peak reverse current (during turn-off)	I_{RRM}	max.	20	A

GATE TO CATHODE

Voltages

Forward peak voltage	V_{FGM}	max.	20	V
Reverse peak voltage	V_{RGM}	max.	5	V

Current

Forward peak current	I_{FGM}	max.	2	A

Power dissipation

Average power dissipation	P_{GAV}	max.	1.0	W
Peak power dissipation	P_{GM}	max.	5	W

TEMPERATURES

Storage temperature	T_{stg}		−55 to + 125	°C
Junction temperature	T_j	max.	125	°C

THERMAL RESISTANCE

From junction to mounting base	$R_{th\ j\text{-}mb}$	=	0.4	°C/W
From mounting base to heatsink	$R_{th\ mb\text{-}h}$	=	0.1	°C/W

7Z3 1735

CHARACTERISTICS T_j = 125 °C unless otherwise specified

ANODE TO CATHODE

Voltages

		BTX67-100R	200R	300R	400R	500R	
Forward on-state voltage I_T = 500 A; T_j = 25 °C	V_T	< 2.5	2.5	2.5	2.5	2.5	V 1)
Forward breakover voltage	$V_{(BO)}$	> 100	200	300	400	500	V
Rate of rise of forward voltage not to trigger any device; R_{GK} = 100 Ω	$\frac{dV_D}{dt}$	< 7	13	20	27	33	V/μs
Currents							
Reverse current $V_R = V_{RWMmax}$	I_R	< 13	12	10	8.0	12	mA 2)
Off-state current $V_D = V_{DWMmax}$	I_D	< 13	12	10	8.0	12	mA

Pick-up current I_P typ. 20 mA

Holding current I_H typ. 10 mA

GATE TO CATHODE

Voltages

Voltage to trigger all devices
V_D = 6 V; T_j = 25 °C V_{GT} > 3.0 V

Voltage not to trigger any device V_{GD} < 0.25 V

Current

Current to trigger all devices
V_D = 6 V; T_j = 25 °C I_{GT} > 80 mA

SWITCHING CHARACTERISTICS (See also page 7)

Turn on time when switched from
$V_D = V_{DWMmax}$ to I_T = 50 A

Gate source 20 V, 20 Ω t_{on} typ. 0.5 μs

Turn off time when switched from
I_T = 50 A to I_R = 20 A; R_{GK} = 100 Ω

at max. dV_D/dt; T_j = 125 °C t_q < 15 μs

T_j = 25 °C t_q < 7.5 μs

1) Measured under pulsed conditions to prevent excessive dissipation.
2) These I_R values apply to a gate voltage range of −5 to +0.25 V.

7Z3 1736

OPERATING NOTES

1. When there is a possibility that transient voltages, caused by the stored energy in the transformer core, will exceed the maximum permissible non repetitive peak reverse voltage, a damping circuit across the transformer should be applied.
Either a series RC circuit or a voltage dependent resistor may be used. Suitable component values for an RC circuit across the transformer primary or secondary may be calculated as follows:

$\frac{V_{RSM}}{V_{RWM}}$	RC across primary of transformer		RC across secondary of transformer	
	C (μF)	R (Ω)	C (μF)	R (Ω)
2.0	$200\,\frac{I_{mag}}{V_1}$	$\frac{150}{C}$	$225\,\frac{I_{mag}T^2}{V_1}$	$\frac{200}{C}$
1.5	$400\,\frac{I_{mag}}{V_1}$	$\frac{225}{C}$	$450\,\frac{I_{mag}T^2}{V_1}$	$\frac{275}{C}$
1.25	$550\,\frac{I_{mag}}{V_1}$	$\frac{260}{C}$	$620\,\frac{I_{mag}T^2}{V_1}$	$\frac{310}{C}$
1.0	$800\,\frac{I_{mag}}{V_1}$	$\frac{300}{C}$	$900\,\frac{I_{mag}T^2}{V_1}$	$\frac{350}{C}$

where I_{mag} = magnetising primary r.m.s. current (A)

V_1 = transformer primary r.m.s. voltage (V)

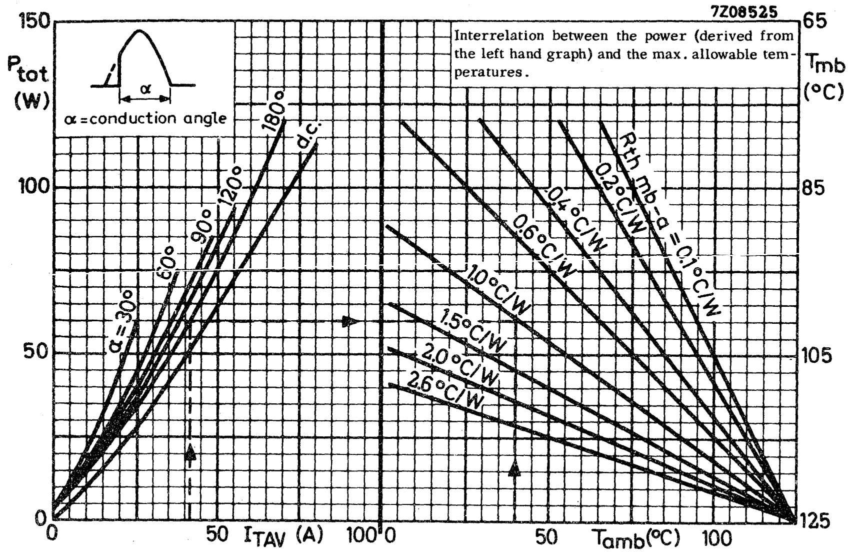
V_2 = transformer secondary r.m.s. voltage (V)

T = V_1/V_2

V_{RWM} stands for the actually applied crest working reverse voltage.

2. In order to prevent the thyristors from being damaged by surge currents higher than those mentioned in the curve at page 10 a fast fuse is recommended.

7Z3 1737



Determination of the heatsink thermal resistance.

Example:

Assume a thyristor, used in a rectifier circuit.

frequency	f	=	1 kHz
conduction angle	α	=	180°
ambient temperature	T_{amb}	=	40 °C
average forward current	I_{TAV}	=	42 A

From the left hand part of the graph above it follows, that at I_{TAV} = 42 A and α = 180° the average forward power + average leakage power = 60 W per thyristor. From the right hand part follows the thermal resistance, required for P_{tot} = 60 W at T_{amb} = 40 °C:

$$R_{th\ mb\text{-}a} \approx 1.0\ ^{\circ}C/W$$

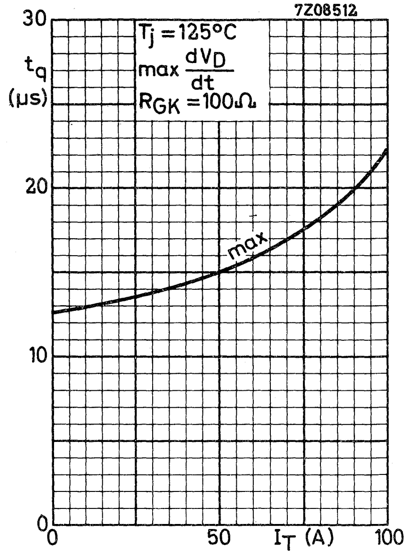
The contact thermal resistance $R_{th\ mb\text{-}h}$ = 0.1 °C/W

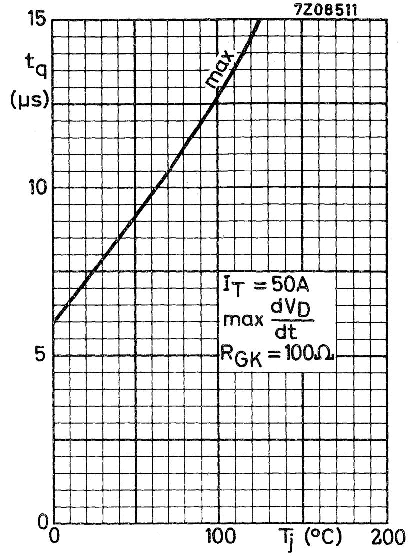
Hence the heatsink thermal resistance should be:

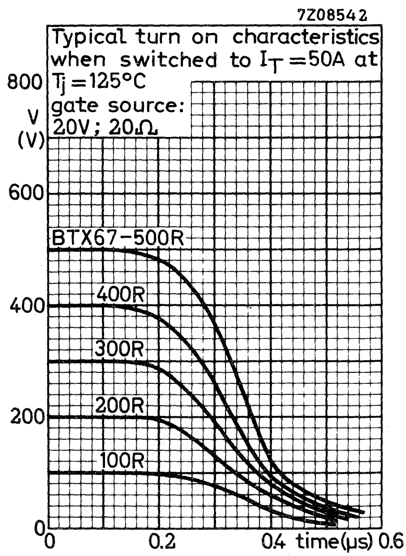
$$R_{th\ h\text{-}a} = R_{th\ mb\text{-}a} - R_{th\ mb\text{-}h} = (1.0 - 0.1)\ ^{\circ}C/W = 0.9\ ^{\circ}C/W$$

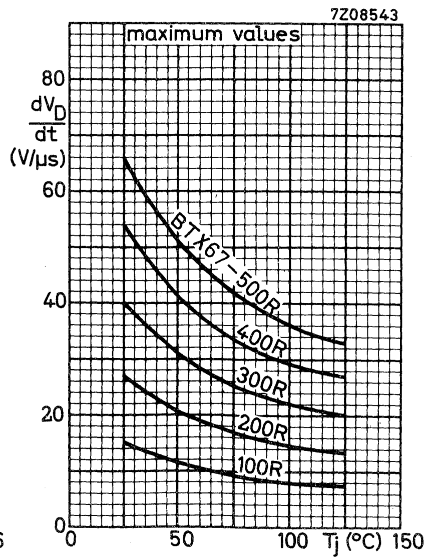
The applicable heatsink(s) may then be found in the Section ACCESSORIES and HEATSINKS.

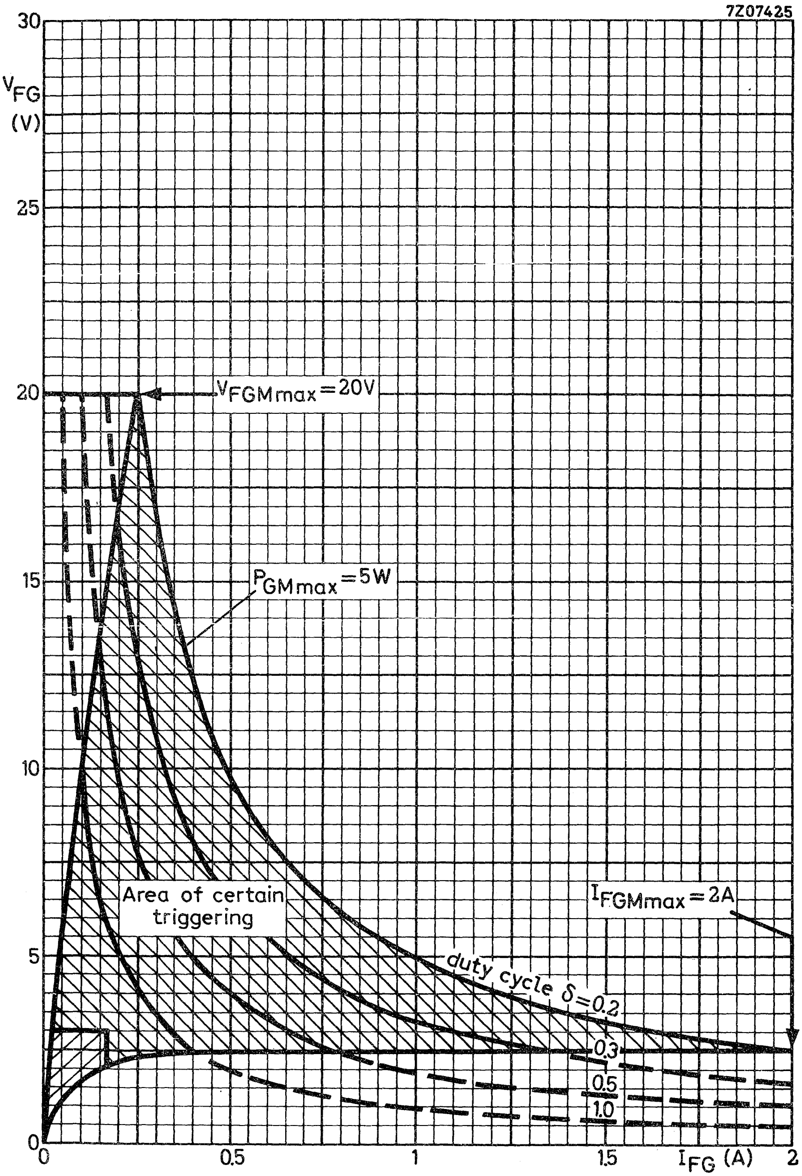
7Z3 1738


7Z08512
30
tq
(µs)
20
10
0
Tj = 125°C
max dVD/dt
RGK = 100Ω
max
0
50
IT (A)
100

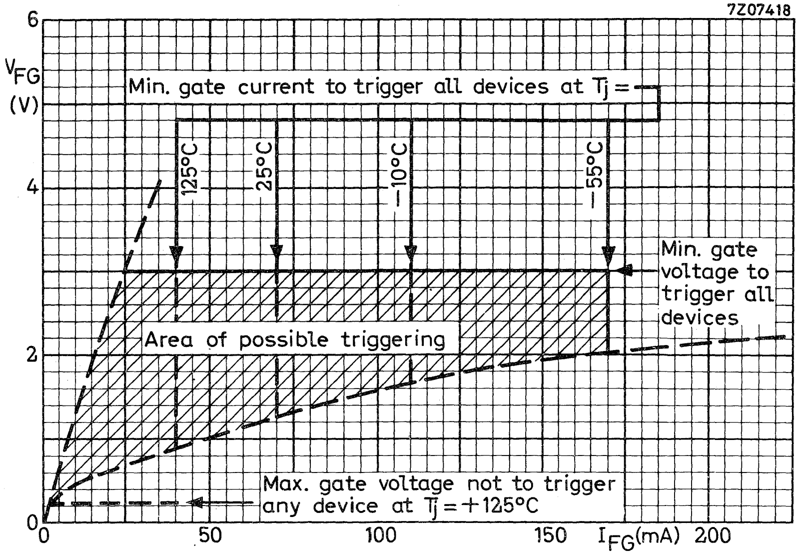

7Z08511
15
tq
(µs)
10
5
0
max
IT = 50A
max dVD/dt
RGK = 100Ω
0
100
Tj (°C)
200

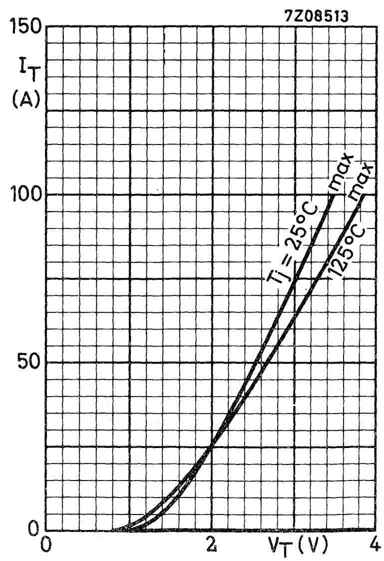

7Z08542
Typical turn on characteristics when switched to IT = 50A at Tj = 125°C
gate source: 20V; 20Ω
800
V
(V)
600
400
200
0
BTX67-500R
400R
300R
200R
100R
0
0.2
0.4
time(µs)
0.6

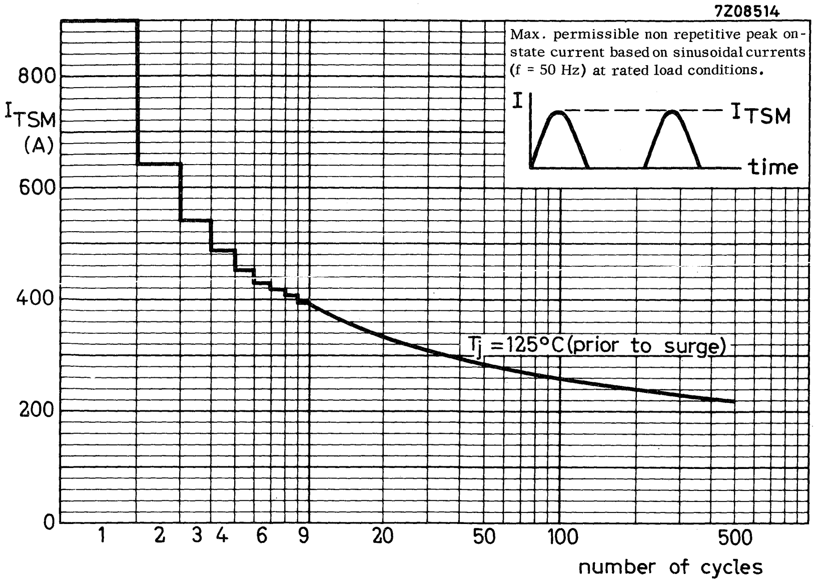

7Z08543
maximum values
80
dVD/dt
(V/µs)
60
40
20
0
BTX67-500R
400R
300R
200R
100R
0
50
100
Tj (°C)
150



Gate characteristics with curves $P_{GAV} = 1.0W$


7Z07418
V_{FG} (V)
Min. gate current to trigger all devices at Tj =
125°C
25°C
−10°C
−55°C
Min. gate voltage to trigger all devices
Area of possible triggering
Max. gate voltage not to trigger any device at Tj = +125°C
I_{FG}(mA)
0
50
100
150
200
2
4
6


7Z08513
I_T (A)
Tj = 25°C max
125°C max
V_T (V)
0
2
4
50
100
150


7Z08514
Max. permissible non repetitive peak on-state current based on sinusoidal currents (f = 50 Hz) at rated load conditions.
I
ITSM
time
800
ITSM
(A)
600
400
200
0
1
2
3
4
6
9
20
50
100
500
number of cycles
Tj = 125°C (prior to surge)

CONTROLLED AVALANCHE THYRISTORS

P-gate silicon thyristors in a TO-64 metal envelope, capable of absorbing transients and intended for power control and power switching applications. The series consists of the following reverse polarity types (stud anode):
BTX68-500R; BTX68-600R; BTX68-700R; BTX68-800R and BTX68-1000R.

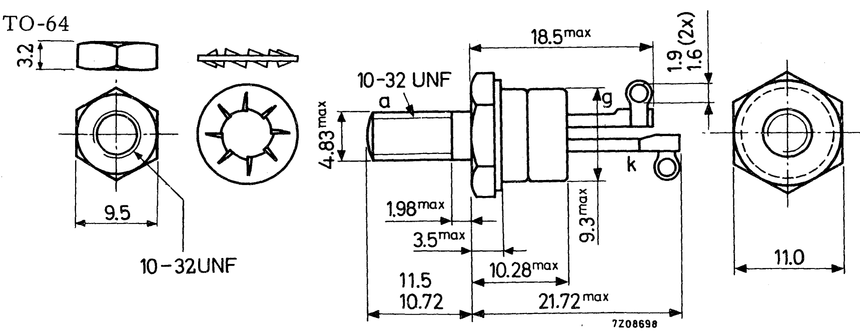
QUICK REFERENCE DATA

			BTX68-500R	600R	700R	800R	1000R	
Crest working reverse voltage	V_{RWM}	max.	500	600	700	800	1000	V
Crest working off-state voltage	V_{DWM}	max.	500	600	700	800	1000	V

Average forward current; T_{mb} = 85 °C	I_{TAV}	max.	6.4	A
Non repetitive peak forward current t = 10 ms	I_{TSM}	max.	80	A
Non repetitive peak reverse power dissipation t = 10 μs; T_j = 25 °C	P_{RSM}	max.	12	kW
Junction temperature	T_j	max.	125	°C
Thermal resistance from junction to mounting base	$R_{th\ j\text{-}mb}$	=	3.0	°C/W

MECHANICAL DATA Dimensions in mm

TO-64



Net weight : 5.6 g
With accessories: 7.5 g

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

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

7Z3 1797

All information applies to frequencies up to 400 Hz

RATINGS (Limiting values) [1]

ANODE TO CATHODE

Voltages [2]			BTX68-500R	600R	700R	800R	1000R	
Continuous reverse voltage	V_R	max.	500	600	700	800	1000	V
Crest working reverse voltage	V_{RWM}	max.	500	600	700	800	1000	V
Continuous off-state voltage	V_D	max.	500	600	700	800	1000	V
Crest working off-state voltage	V_{DWM}	max.	500	600	700	800	1000	V [3]

Currents

Average forward current (averaged over any 20 ms period) $T_{amb} = 85\ ^oC$	I_{TAV}	max.	6.4	A
Forward current (d.c.)	I_T	max.	10	A
Repetitive peak forward current	I_{TRM}	max.	60	A
Non repetitive peak forward current t = 10 ms (See also page 7)	I_{TSM}	max.	80	A
I squared t for fusing (t < 10 ms)	I^2t	max.	32	A^2s
Rate of rise of forward current	$\frac{dI_T}{dt}$	max.	20	A/μs
Repetitive peak reverse current (during turn-off)	I_{RRM}	max.	5	A

Power dissipation

Non repetitive peak reverse dissipation

t = 10 μs; T_j = 25 ^oC	P_{RSM}	max.	12	kW
t = 10 μs; T_j = 125 ^oC	P_{RSM}	max.	4	kW

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

[2] These ratings apply to a gate voltage range of −5 to +0.25 V. To ensure thermal stability: $R_{th\ j-a} \leqq 6.0\ ^oC/W$ (d.c.) or $\leqq 12\ ^oC/W$ (a.c.).

[3] Off-state voltages higher than V_{DWMmax} are allowed, but at voltages higher than the forward breakover voltage (see page 4) the device may switch into the on-state.

7Z3 1798

RATINGS (Limiting values) (continued)

GATE TO CATHODE

Voltages

Forward peak voltage	V_{FGM}	max.	10	V
Reverse peak voltage	V_{RGM}	max.	5	V

Current

Forward peak current	I_{FGM}	max.	2	A

Power dissipation

Average power dissipation (averaged over any 20 ms period)	P_{GAV}	max.	0.5	W
Peak power dissipation	P_{GM}	max.	5	W

TEMPERATURES

Storage temperature	T_{stg}		−55 to +125	^oC
Junction temperature	T_j	max.	125	^oC

THERMAL RESISTANCE

From junction to mounting base	$R_{th\ j\text{-}mb}$	=	3.0	$^oC/W$
From mounting base to heatsink	$R_{th\ mb\text{-}h}$	=	0.5	$^oC/W$
From mounting base to heatsink mounted with 56295	$R_{th\ mb\text{-}h}$	=	4.0	$^oC/W$

7Z3 1799

CHARACTERISTICS

T_j = 125 °C unless otherwise specified

ANODE TO CATHODE

Voltages

			BTX68-500R	600R	700R	800R	1000R	
Forward on-state voltage I_T = 20 A; T_j = 25 °C	V_T	<	2.3	2.3	2.3	2.3	2.3	V[1]
Reverse breakdown voltage in avalanche region	$V_{(BR)R}$	>	550	660	770	880	1000	V
Forward breakover voltage	$V_{(BO)}$	>	550	660	770	880	1000	V
Rate of rise of forward voltage not to trigger the device	$\frac{dV_D}{dt}$	typ.	100					V/µs
Rate of rise of forward voltage not to trigger any device	$\frac{dV_D}{dt}$	<	20					V/µs

Currents

Reverse current $V_R = V_{RWMmax}$	I_R	<	2.5	mA [2]
Off-state current $V_D = V_{DWMmax}$	I_D	<	2.5	mA
Pick up current	I_P	typ.	20	mA
Holding current	I_H	typ.	10	mA

GATE TO CATHODE

Voltages

Voltage to trigger all devices V_D = 6 V; T_j = 25 °C	V_{GT}	>	3.0	V
Voltage not to trigger any device	V_{GD}	<	0.25	V

Current

Current to trigger all devices V_D = 6 V; T_j = 25 °C	I_{GT}	>	30	mA

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

[2]) These I_R values apply to a gate voltage range of −5 to +0.25 V.

7Z3 1800

SWITCHING CHARACTERISTICS

Turn on time when switched from
V_D = 50 V to I_T = 10 A

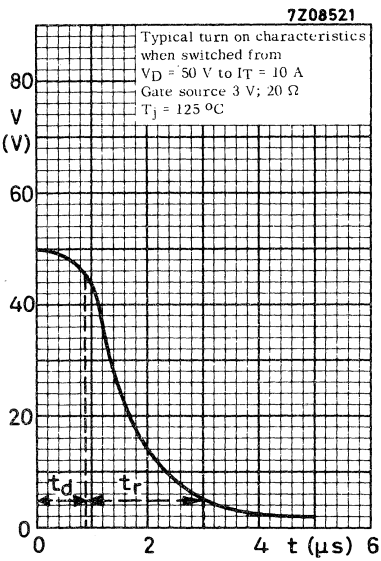
Gate source 3 V, 20 Ω, T_j = 125 °C — t_{on} typ. 3.0 μs

Turn off time when switched from
I_T = 10 A to I_R = 5 A

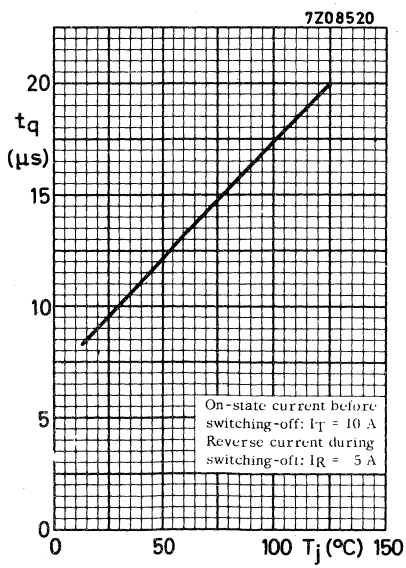
dV_D/dt = 20 V/μs T_j = 125 °C — t_q typ. 20 μs

OPERATING NOTES

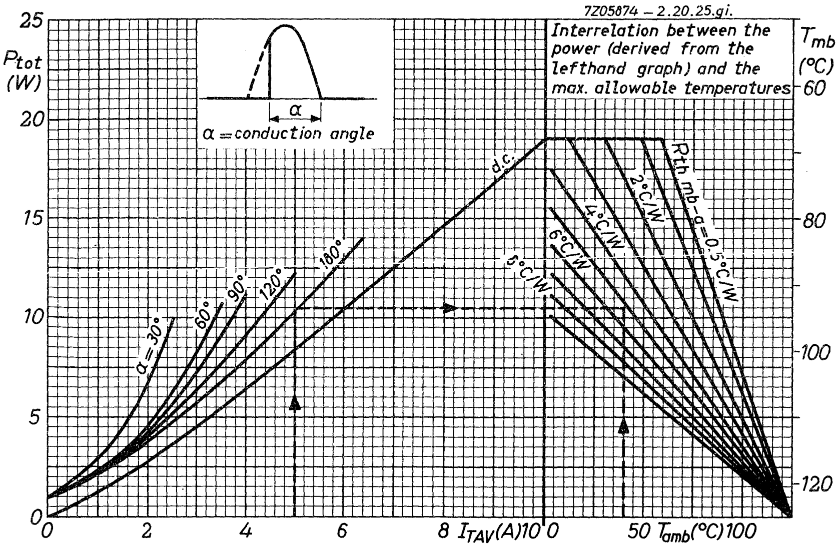
1. In order to prevent the thyristors from being damaged by surge currents higher than those mentioned in the curve at page 7 a fast fuse is recommended.
2. The gate and cathode connectors should not be bent or twisted: they should be soldered into the circuit so there is no strain on them.
   During soldering the heat conduction to the junction should be kept to a minimum by using a thermal shunt.



Typical turn off time versus junction temperature



7Z3 1801



EXAMPLE (Determination of the heatsink thermal resistance)

Assume the thyristor used in a 50 Hz single phase full wave rectifier circuit (conduction angle α = 180°) at T_{amb} = 40 °C.
The average forward current (per thyristor) I_{TAV} = 5 A.

From the left hand part of the graph above it follows that at I_{TAV} = 5 A and α = 180° the average forward power + average leakage power = 10.5 W per thyristor.

From the right hand part follows the thermal resistance, required for P_{tot} = 10.5 W at T_{amb} = 40 °C.

$$R_{th\ mb-a} \approx 5.2\ °C/W$$

The contact thermal resistance $R_{th\ mb-h}$ = 0.5 °C/W

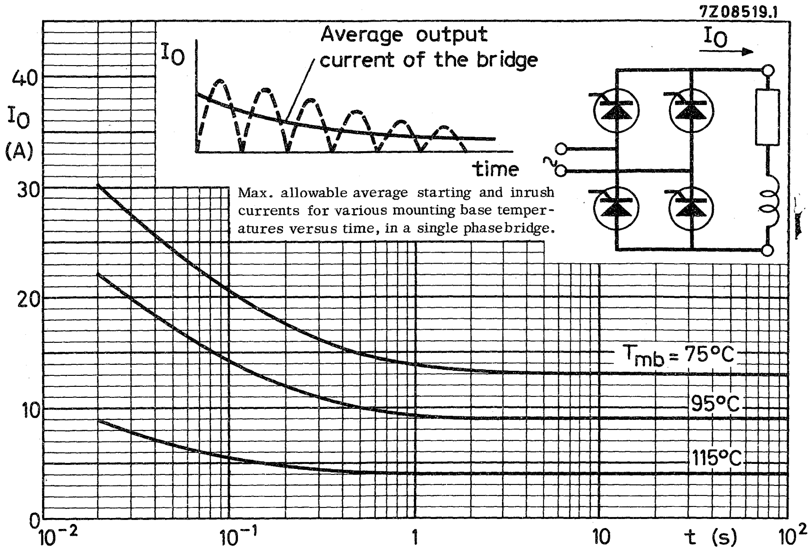
Hence the heatsink thermal resistance should be:

$$R_{th\ h-a} = R_{th\ mb-a} - R_{th\ mb-h} = (5.2 - 0.5)\ °C/W = 4.7\ °C/W$$

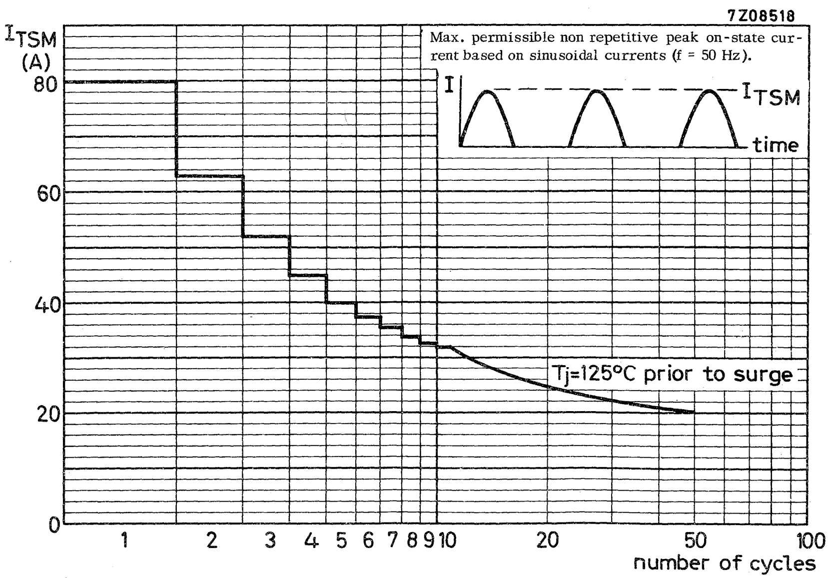
The applicable heatsink(s) may then be found in the Section ACCESSORIES and HEATSINKS.

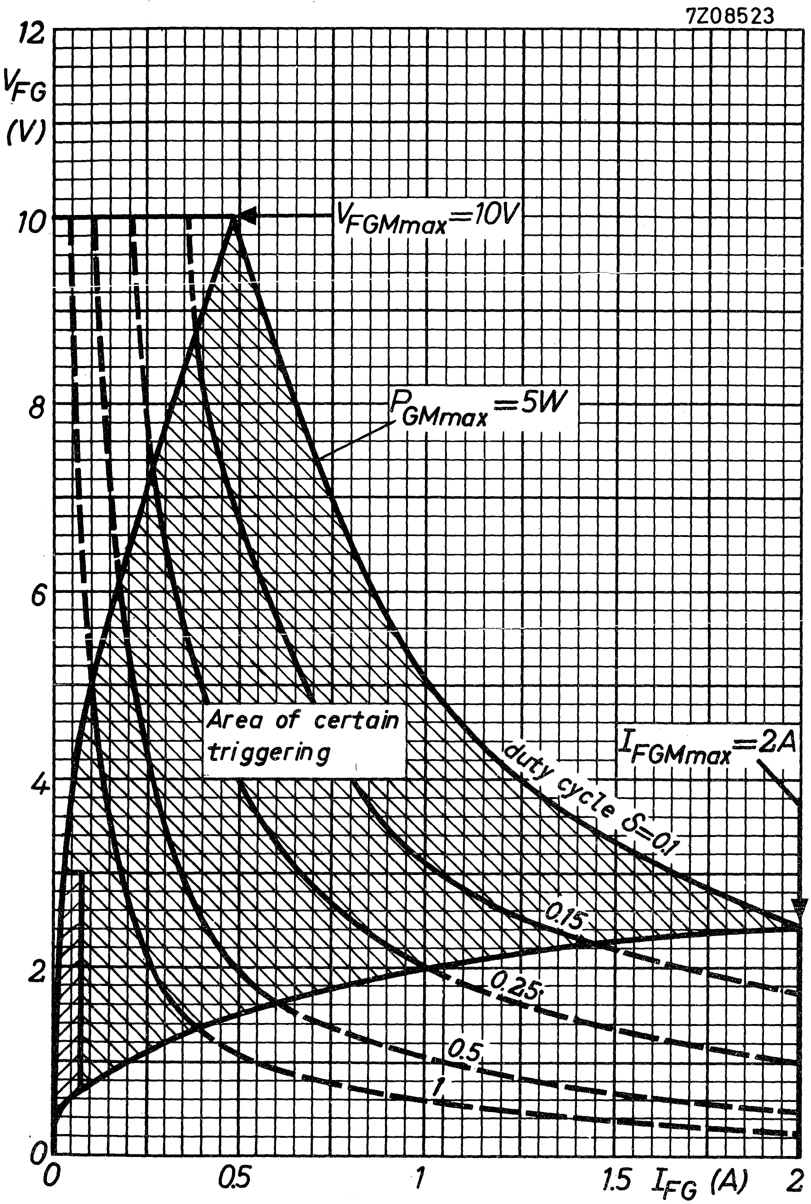
7Z3 1802

7Z08519.1

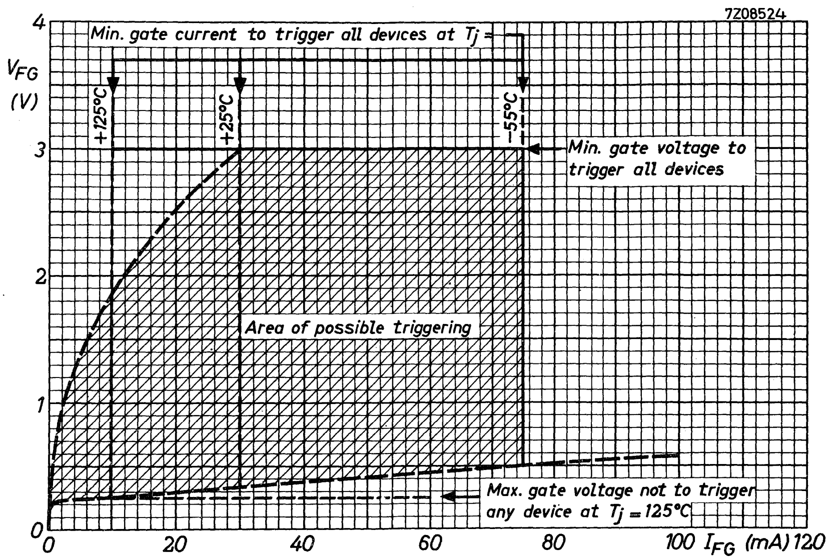


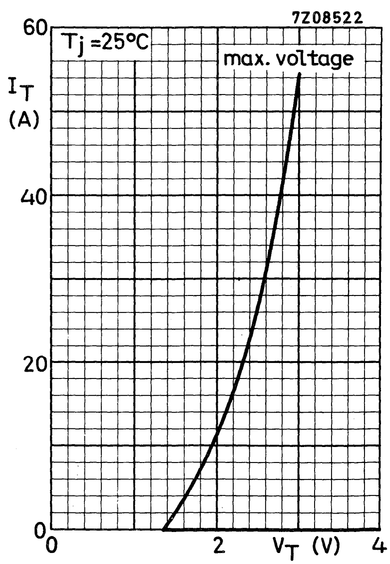
7Z08518





Gate characteristics with curves P_{GAV}=0.5W


7Z08524
Min. gate current to trigger all devices at Tj =
+125°C
+25°C
−55°C
Min. gate voltage to trigger all devices
Area of possible triggering
Max. gate voltage not to trigger any device at Tj = 125°C
VFG (V)
IFG (mA)
0
1
2
3
4
20
40
60
80
100
120


7Z08522
Tj =25°C
max. voltage
IT (A)
VT (V)
0
20
40
60
2
4

P-GATE SILICON THYRISTORS

P-gate thyristors in a TO-64 metal envelope. They are intended for power control and power switching applications.
The series consists of the following reverse polarity types (stud anode):
BTY79-100R, BTY79-200R, BTY79-300R, BTY79-400R, BTY79-500R, BTY79-600R, BTY79-700R, BTY79-800R and BTY79-1000R.

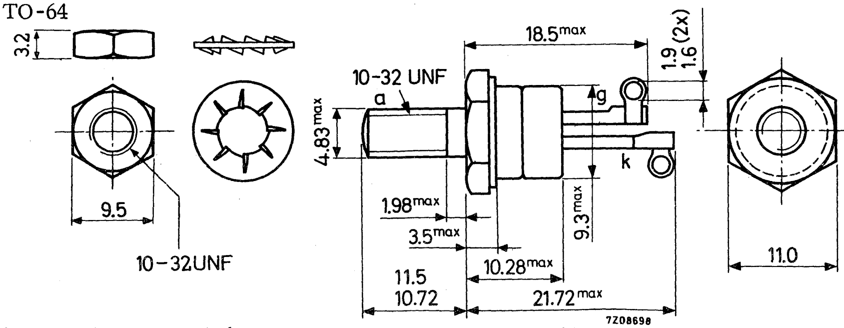
QUICK REFERENCE DATA

		BTY79-100R	200R	300R	400R	500R	600R	700R	800R	1000R	
Crest working reverse voltage	V_{RWM} max.	100	200	300	400	500	600	700	800	1000	V
Crest working off-state voltage	V_{DWM} max.	100	200	300	400	500	600	700	800	1000	V

Average forward current	I_{TAV}	max.	6.4	A
Non repetitive peak forward current (t = 10 ms)	I_{TSM}	max.	80	A
Junction temperature	T_j	max.	125	°C
Thermal resistance from junction to mounting base	$R_{th\ j\text{-}mb}$	=	3.0	°C/W

MECHANICAL DATA Dimensions in mm

TO-64



Net weight : 5.6 g
With accessories: 7.5 g

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

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

7Z3 1811

All information applies to frequencies up to 400 Hz.

RATINGS (Limiting values) [1]

ANODE TO CATHODE

Voltages [2]		BTY79-100R	200R	300R	400R	500R	600R	700R	800R	1000R	
V_R	max.	100	200	300	400	500	600	700	800	1000	V
V_{RWM}	max.	100	200	300	400	500	600	700	800	1000	V
V_{RRM}	max.	100	200	300	400	500	600	700	800	1000	V
V_{RSM} [2]	max.	150	300	400	500	600	720	850	960	1100	V
V_D	max.	100	200	300	400	500	600	700	800	1000	V
V_{DWM}	max.	100	200	300	400	500	600	700	800	1000	V
V_{DRM}	max.	100	200	300	400	500	600	700	800	1000	V
V_{DSM}	max.	500	500	500	500	1100	1100	1100	1100	1100	V [4]

Currents

Average forward current (averaged over any 20 ms period)	I_{TAV}	max.	6.4	A
Forward current (d.c.)	I_T	max.	10	A
R.M.S. forward current	$I_{T(RMS)}$	max.	10	A
Repetitive peak forward current	I_{TRM}	max.	57	A
Non repetitive peak forward current (t = 10 ms) See page 10	I_{TSM}	max.	80	A
I squared for fusing (t ≤ 10 ms)	I^2t	max.	32	A^2s
Rate of rise of forward current	$\frac{dI_T}{dt}$	max.	20	A/μs
Repetitive peak reverse current (during turn-off)	I_{RRM}	max.	5	A

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

[2] These ratings apply to a gate voltage range of −5 to +0.25 V.
To ensure thermal stability: $R_{th\ j-a} \leq 6$ °C/W (d.c.) or ≤ 12 °C/W (a.c.).

[3] t < 5 ms.

[4] This voltage may be applied without damage but the thyristor may switch into the on-state. Care should be taken that no current ratings are exceeded.

7Z3 1812

RATINGS (Limiting values) (continued)

GATE TO CATHODE

Voltages

Forward peak voltage	V_{FGM}	max.	10	V
Reverse peak voltage	V_{RGM}	max.	5	V

Current

Forward peak current	I_{FGM}	max.	2	A

Power dissipation

Average power dissipation (averaged over any 20 ms period)	P_{GAV}	max.	0.5	W
Peak power dissipation	P_{GM}	max.	5	W

TEMPERATURES

Storage temperature	T_{stg}		−55 to +125	^oC
Junction temperature	T_j	max.	125	^oC

THERMAL RESISTANCE

From junction to mounting base	$R_{th\ j\text{-}mb}$	=	3.0	$^oC/W$
From mounting base to heatsink	$R_{th\ mb\text{-}h}$	=	0.5	$^oC/W$
From mounting base to heatsink with mica washer	$R_{th\ mb\text{-}h}$	=	4.0	$^oC/W$

7Z3 1813

CHARACTERISTICS T_j = 125 °C unless otherwise specified

ANODE TO CATHODE

Voltages			BTY79-100R	200R	300R	400R	500R	600R	700R	800R	1000R
I_T = 20 A [1]) T_j = 25 °C	V_T	<	2.3	2.3	2.3	2.3	2.3	2.3	2.3	2.3	2.3 V
	$V_{(BO)}$	>	100	200	300	400	500	600	700	800	1000 V
not to trigger the device	$\frac{dV_D}{dt}$	typ.	100	100	100	100	100	100	100	100	100 V/µs
not to trigger any device	$\frac{dV_D}{dt}$	<	20	20	20	20	20	20	20	20	20 V/µs
Currents											
V_R = V_{RWMmax}. 2)	I_R	<	5	5	5	5	2.5	2.5	2.5	2.5	2.5 mA
V_D = V_{DWMmax}.	I_D	<	5	5	5	5	2.5	2.5	2.5	2.5	2.5 mA

Holding current I_H typ. 10 mA

GATE TO CATHODE

Voltages

Voltage to trigger all devices
V_D = 6 V; T_j = 25 °C V_{GT} > 2.5 V

Voltage not to trigger any device V_{GD} < 0.25 V

Current

Current to trigger all devices
V_D = 6 V; T_j = 25 °C I_{GT} > 25 mA

1) Measured under pulsed conditions to prevent excessive dissipation.

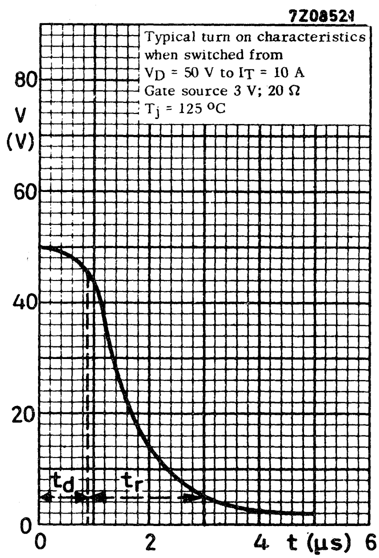
2) These I_R values apply to a gate voltage range of −5 to +0.25 V.

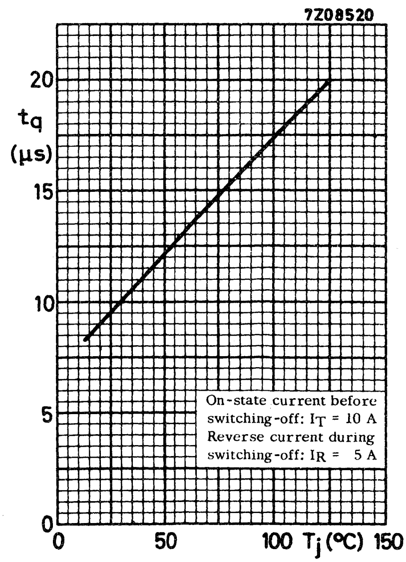
7Z3 1014

SWITCHING CHARACTERISTICS

Turn on time when switched from V_D = 50 V to I_T = 10 A			
Gate source 3 V, 20 Ω, T_j = 125 °C	t_{on}	typ.	3.0 μs
Turn off time when switched from I_T = 10 A to I_R = 5 A			
dV_D/dt = 20 V/μs; T_j = 125 °C	t_q	typ.	15 μs
		<	25 μs

Typical turn off time versus junction temperature





7Z3 1815

OPERATING NOTES

1. When there is a possibility that transient voltages, caused by the stored energy in the transformer core, will exceed the maximum permissible non repetitive peak reverse voltage, a damping circuit across the transformer should be applied.
   Either a series RC circuit or a voltage dependent resistor may be used. Suitable component values for an RC circuit across the transformer primary or secondary may be calculated as follows:

$\frac{V_{RSM}}{V_{RWM}}$	RC across primary of transformer		RC across secondary of transformer	
	C (µF)	R (Ω)	C (µF)	R (Ω)
2.0	$200\frac{I_{mag}}{V_1}$	$\frac{150}{C}$	$225\frac{I_{mag}T^2}{V_1}$	$\frac{200}{C}$
1.5	$400\frac{I_{mag}}{V_1}$	$\frac{225}{C}$	$450\frac{I_{mag}T^2}{V_1}$	$\frac{275}{C}$
1.25	$550\frac{I_{mag}}{V_1}$	$\frac{260}{C}$	$620\frac{I_{mag}T^2}{V_1}$	$\frac{310}{C}$
1.0	$800\frac{I_{mag}}{V_1}$	$\frac{300}{C}$	$900\frac{I_{mag}T^2}{V_1}$	$\frac{350}{C}$

where I_{mag} = magnetising primary r.m.s. current (A)

V_1 = transformer primary r.m.s. voltage (V)

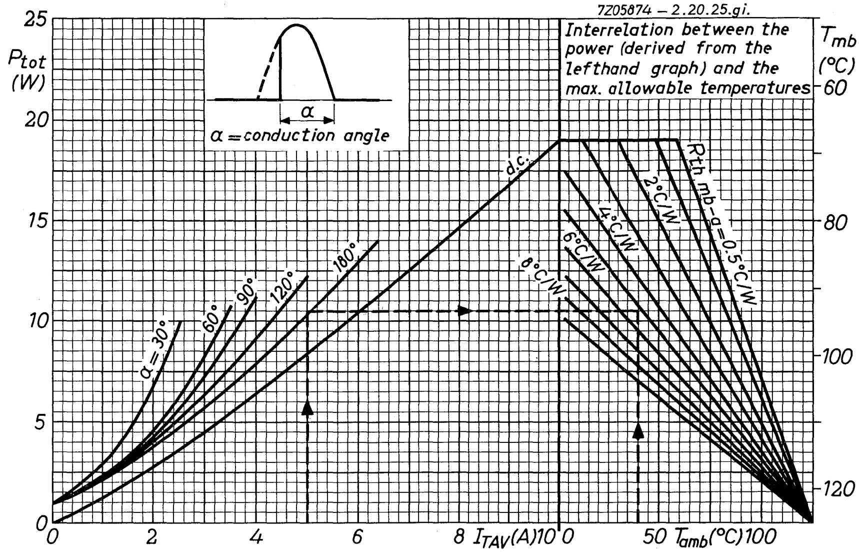
V_2 = transformer secondary r.m.s. voltage (V)

T = V_1/V_2

V_{RWM} stands for the actually applied crest working reverse voltage.

2. In order to prevent the thyristors from being damaged by surge currents higher than those mentioned in the curve at page 10 a fast fuse is recommended.

3. The gate and cathode connectors should not be bent or twisted; they should be soldered into the circuit so there is no strain on them.
   During soldering the heat conduction to the junction should be kept to a minimum by using a thermal shunt.



EXAMPLE (Determination of the heatsink thermal resistance)

Assume the thyristor used in a 50 Hz single phase full wave rectifier circuit (conduction angle α = 180°) at T_{amb} = 40 °C.
The average forward current (per thyristor) I_{TAV} = 5 A.

From the left hand part of the graph above it follows that at I_{TAV} = 5 A and α = 180° the average forward power + average leakage power = 10.5 W per thyristor.

From the right hand part follows the thermal resistance, required for P_{tot} = 10.5 W at T_{amb} = 40 °C.

$$R_{th\ mb\text{-}a} \approx 5.2\ ^{\circ}C/W$$

The contact thermal resistance $R_{th\ mb\text{-}h}$ = 0.5 °C/W

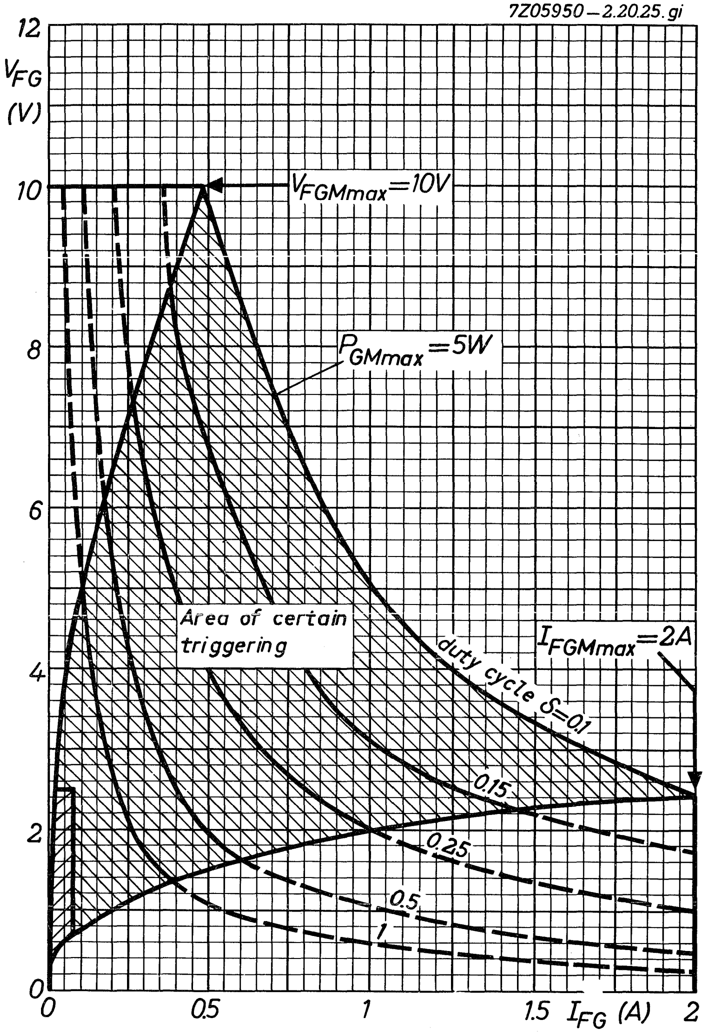
Hence the heatsink thermal resistance should be:

$$R_{th\ h\text{-}a} = R_{th\ mb\text{-}a} - R_{th\ mb\text{-}h} = (5.2 - 0.5)\ ^{\circ}C/W = 4.7\ ^{\circ}C/W$$

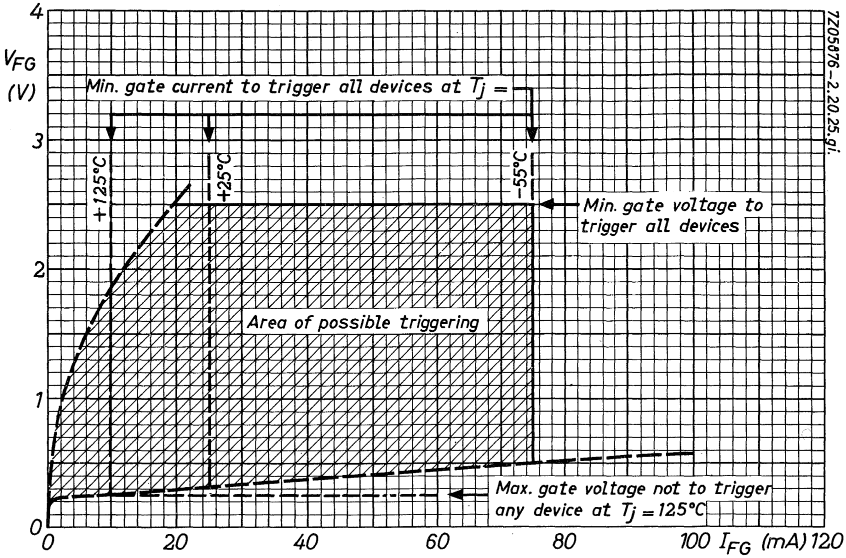
The applicable heatsink(s) may then be found in the section ACCESSORIES and HEATSINKS.

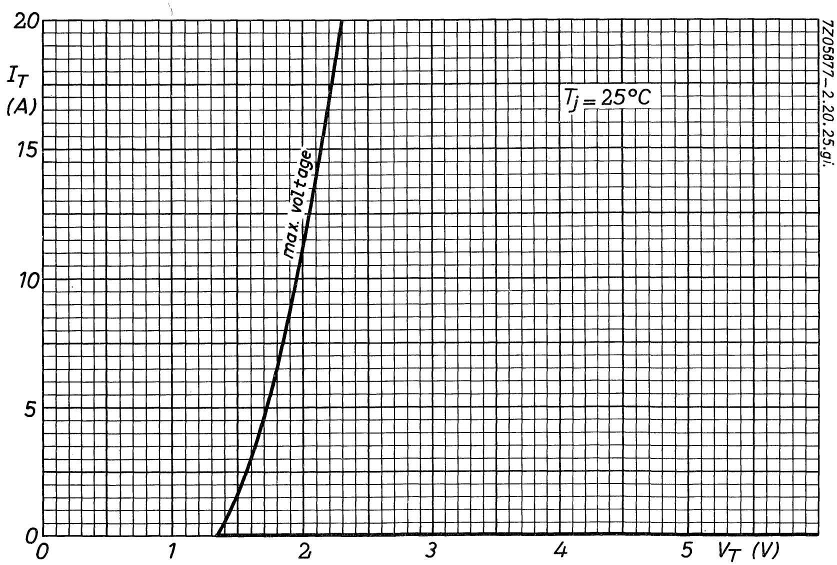
7Z3 1817

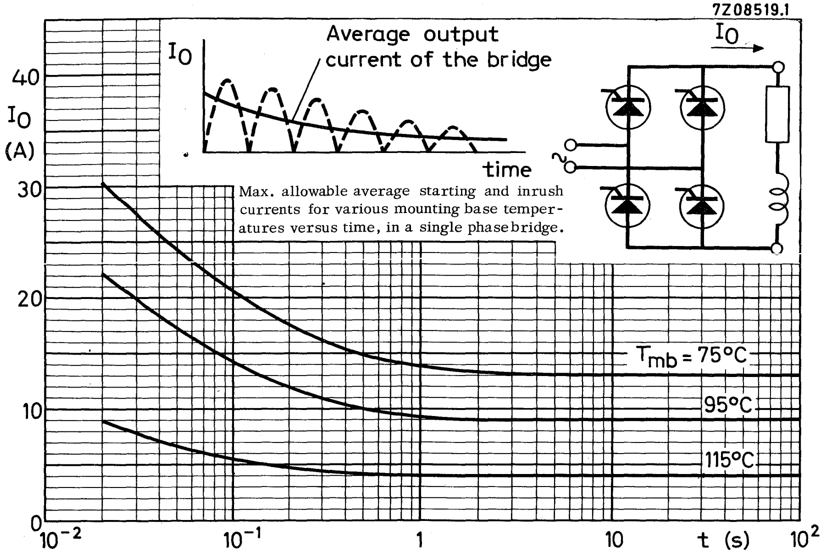
7Z05950—2.20.25.gi

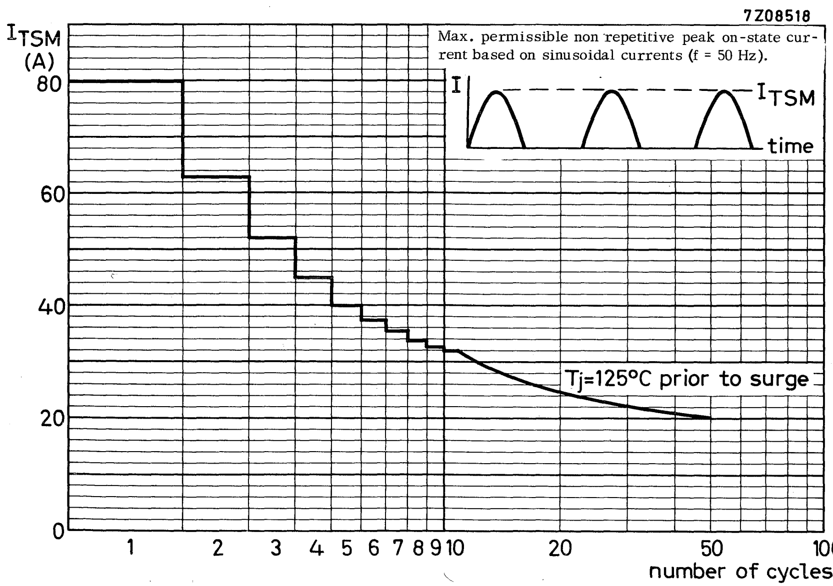


Gate characteristics with curves P_{GAV}=0.5W


7Z05876–2.20.25.gi.
V_{FG} (V)
4
3
2
1
0
0
20
40
60
80
100 I_{FG} (mA) 120
Min. gate current to trigger all devices at T_j =
+125°C
+25°C
−55°C
Min. gate voltage to trigger all devices
Area of possible triggering
Max. gate voltage not to trigger any device at T_j = 125°C


7Z05877–2.20.25.gi.
I_T (A)
20
15
10
5
0
0
1
2
3
4
5 V_T (V)
T_j = 25°C
max. voltage


7Z08519.1
Average output current of the bridge
I_O
time
Max. allowable average starting and inrush currents for various mounting base temperatures versus time, in a single phasebridge.
40
I_O (A)
30
20
10
0
T_{mb} = 75°C
95°C
115°C
10^{-2}
10^{-1}
1
10
t (s)
10^2


7Z08518
Max. permissible non repetitive peak on-state current based on sinusoidal currents (f = 50 Hz).
I
I_{TSM}
time
I_{TSM} (A)
80
60
40
20
0
Tj=125°C prior to surge
1
2
3
4
5
6
7
8
9
10
20
50
100
number of cycles

P-GATE SILICON THYRISTORS

These types have been superseeded by the BTY79series

P-GATE SILICON THYRISTORS

P-gate thyristors in a TO-48 metal envelope. They are intended for power control and power switching applications.
The series consists of the following reverse polarity types (stud anode):
BTY87-100R, BTY87-200R, BTY87-300R, BTY87-400R,
BTY87-500R, BTY87-600R, BTY87-700R and BTY87-800R.

QUICK REFERENCE DATA

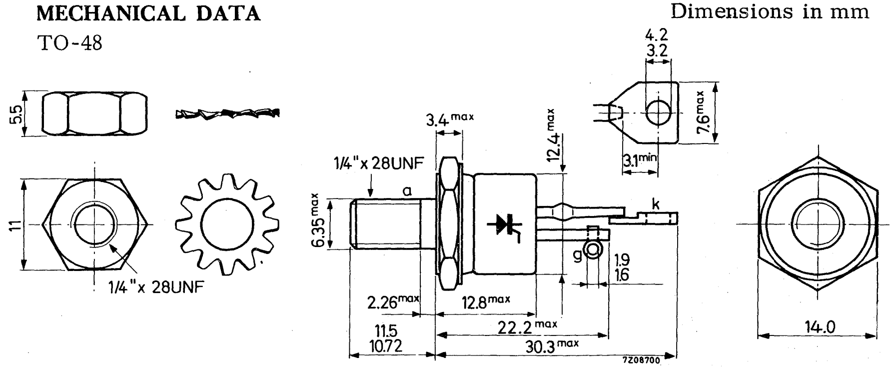
		BTY87-100R	200R	300R	400R	500R	600R	700R	800R	
Crest working reverse voltage	V_{RWM} max.	100	200	300	400	500	600	700	800	V
Crest working off-state voltage	V_{DWM} max.	100	200	300	400	500	600	700	800	V

Average forward current	I_{TAV}	max.	12	A
Non repetitive peak forward current (t = 10 ms)	I_{TSM}	max.	140	A
Junction temperature	T_j	max.	125	°C
Thermal resistance from junction to mounting base	$R_{th\ j\text{-}mb}$	=	1.6	°C/W

MECHANICAL DATA

Dimensions in mm

TO-48



Net weight : 10 g
With accessories : 15 g

Torque on nut: min. 17 cm kg
max. 35 cm kg

Diameter of hole in heatsink: max. 6.5 mm

Accessories available: 56264A

All information applies to frequencies up to 400 Hz.

RATINGS (Limiting values) [1]

ANODE TO CATHODE

Voltages [2]

		BTY87-100R	200R	300R	400R	500R	600R	700R	800R	
Crest working reverse voltage	V_{RWM} max.	100	200	300	400	500	600	700	800	V
Repetitive peak reverse voltage	V_{RRM} max.	100	200	300	400	500	600	700	800	V
Non repetitive peak reverse voltage (t < 5 ms)	V_{RSM} max.	150	300	400	500	600	720	850	960	V
Crest working off-state voltage	V_{DWM} max.	100	200	300	400	500	600	700	800	V
Repetitive peak off-state voltage	V_{DRM} max.	100	200	300	400	500	600	700	800	V
Non rep. peak off-state voltage	V_{DSM} max.	500	500	500	500	850	850	850	850	V[3]

Currents

Average forward current (averaged over any 20 ms period)	I_{TAV}	max.	12	A
→ Forward current (d.c.)	I_T	max.	19	A
R.M.S. forward current	$I_{T(RMS)}$	max.	19	A
Repetitive peak forward current	I_{TRM}	max.	140	A
Non repetitive peak forward current (t = 10 ms) See page 12	I_{TSM}	max.	140	A
I squared t, for fusing (t = 1.5 to 10 ms)	I^2t	max.	100	A^2s
Rate of rise of forward current	$\frac{dI_T}{dt}$	max.	20	A/µs
Repetitive peak reverse current (during turn-off)	I_{RRM}	max.	20	A

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

[2] These ratings apply to a gate voltage range of −5 to +0.25 V
To ensure thermal stability: $R_{th\ j-a} \leq 4.5\ ^oC/W$ (d.c.) or $< 9\ ^oC/W$ (a.c.)

[3] This voltage may be applied without damage but the thyristor may switch into the on-state. Care should be taken that no current ratings are exceeded.

RATINGS (Limiting values) (continued)

GATE TO CATHODE

Voltages

Forward peak voltage	V_{FGM}	max.	10	V
Reverse peak voltage	V_{RGM}	max.	5	V

Current

Forward peak current	I_{FGM}	max.	2	A

Power dissipation

Average power dissipation (averaged over any 20 ms period)	P_{GAV}	max.	0.5	W
Peak power dissipation	P_{GM}	max.	5	W

TEMPERATURES

Storage temperature	T_{stg}	−55 to +125		^{o}C
Junction temperature	T_j	max.	125	^{o}C

THERMAL RESISTANCE

From junction to mounting base	$R_{th\ j\text{-}mb}$	=	1.6	$^{o}C/W$ ←
From mounting base to heatsink	$R_{th\ mb\text{-}h}$	=	0.2	$^{o}C/W$
From mounting base to heatsink with mica washer	$R_{th\ mb\text{-}h}$	=	4.0	$^{o}C/W$

CHARACTERISTICS T_j = 125 °C unless otherwise specified

ANODE TO CATHODE

Voltages			BTY87-100R	200R	300R	400R	500R	600R	700R	800R	
Forward on-state voltage I_T = 50 A; T_j = 25 °C	V_T	<	3.0	3.0	3.0	3.0	3.0	3.0	3.0	3.0	V [1]
Forward breakover voltage	$V_{(BO)}$	>	100	200	300	400	500	600	700	800	V
Rate of rise of forward voltage not to trigger the device	$\frac{dV_D}{dt}$	typ.	100	100	100	100	100	100	100	100	V/µs
Rate of rise of forward voltage not to trigger any device	$\frac{dV_D}{dt}$	<	20	20	20	20	20	20	20	20	V/µs
Currents											
Reverse current $V_R = V_{RWMmax.}$	I_R	<	13	12	10	8.0	6.0	5.0	4.5	4.0	mA [2]
Off-state current $V_D = V_{DWMmax.}$	I_D	<	13	12	10	8.0	6.0	5.0	4.5	4.0	mA

Pick up current	I_P	typ.	20	mA
Holding current	I_H	typ.	10	mA

GATE TO CATHODE

Voltages

Voltage to trigger all devices V_D = 6 V; T_j = 25 °C	V_{GT}	>	3.5	V
Voltage not to trigger any device	V_{GD}	<	0.25	V

Current

Current to trigger all devices V_D = 6 V; T_j = 25 °C	I_{GT}	>	65	mA

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

[2]) These I_R values apply to a gate voltage range of −5 to +0.25 V.

SWITCHING CHARACTERISTICS (See also page 10)

Turn on time when switched from

V_D = 400 V to I_T = 50 A				
Gate source 5 V, 25 Ω; T_j = 125 °C	t_{on}	typ.	2.0	μs

Turn off time when switched from

I_T = 10 A to I_R between 5 and 20 A					
$\frac{dV_D}{dt}$ = 20 V/μs; T_j = 125 °C	t_q	typ.	20	μs	←
T_j = 25 °C	t_q	typ.	10	μs	←

OPERATING NOTES

1. When there is a possibility that transient voltages, caused by the stored energy in the transformer core, will exceed the maximum permissible non repetitive peak reverse voltage, a damping circuit across the transformer should be applied.
   Either a series RC circuit or a voltage dependent resistor may be used. Suitable component values for an RC circuit across the transformer primary or secondary may be calculated as follows:

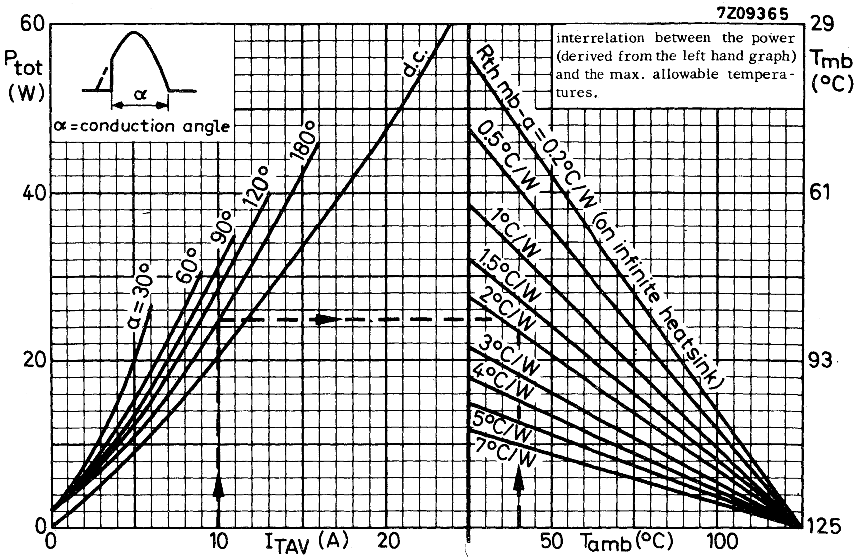
$\frac{V_{RSM}}{V_{RWM}}$	RC across primary of transformer		RC across secondary of transformer	
	C (μF)	R (Ω)	C (μF)	R (Ω)
2.0	$200\frac{I_{mag}}{V_1}$	$\frac{150}{C}$	$225\frac{I_{mag}T^2}{V_1}$	$\frac{200}{C}$
1.5	$400\frac{I_{mag}}{V_1}$	$\frac{225}{C}$	$450\frac{I_{mag}T^2}{V_1}$	$\frac{275}{C}$
1.25	$550\frac{I_{mag}}{V_1}$	$\frac{260}{C}$	$620\frac{I_{mag}T^2}{V_1}$	$\frac{310}{C}$
1.0	$800\frac{I_{mag}}{V_1}$	$\frac{300}{C}$	$900\frac{I_{mag}T^2}{V_1}$	$\frac{350}{C}$

   where I_{mag} = magnetising primary r.m.s. current (A)
   V_1 = transformer primary r.m.s. voltage (V)
   V_2 = transformer secondary r.m.s. voltage (V)
   T = V_1/V_2

   V_{RWM} stands for the actually applied crest working reverse voltage

2. In order to prevent the thyristors from being damaged by surge currents higher than those mentioned in the curves at pages 11 and 12 a fast fuse is recommended.

3. The gate and cathode connectors should not be bent; they should be soldered into the circuit so there is no strain on them.
   During soldering the heat conduction to the junction should be kept to a minimum by using a thermal shunt.



Determination of the heatsink thermal resistance

Example:

Assume a thyristor, used in a single phase full wave rectifier circuit.

frequency	f	=	50	Hz
conduction angle	α	=	180°	
average forward current	I_{TAV}	=	10	A (per thyristor)
ambient temperature	T_{amb}	=	40	°C

From the left hand part of the graph above it follows that at I_{TAV} = 10 A and α = 180° the average forward power + average leakage power = 25 W per thyristor.

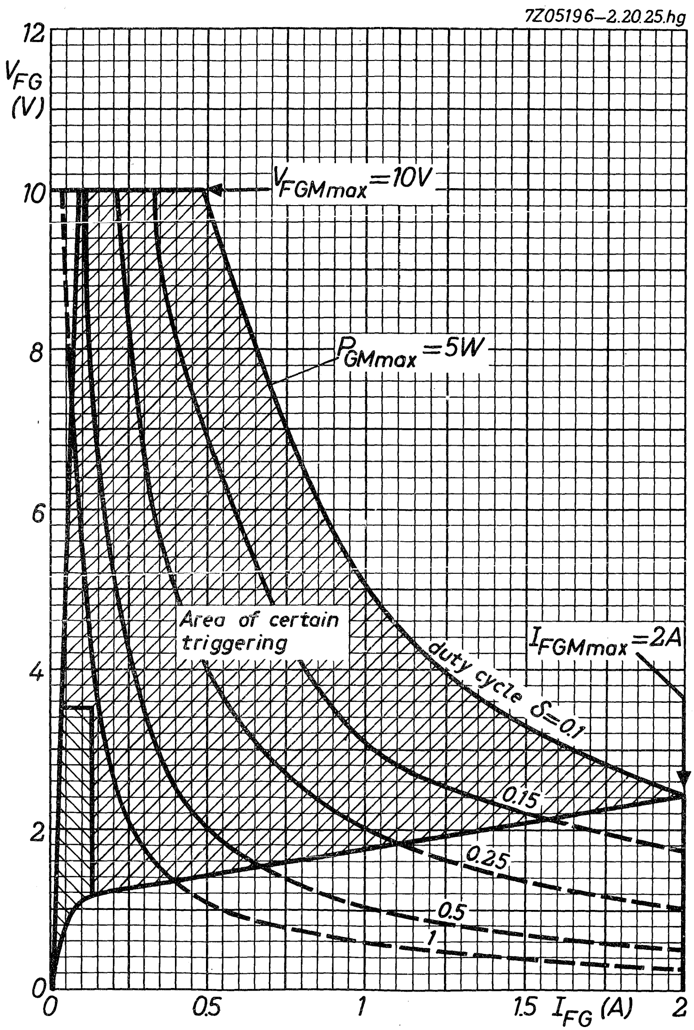
From the right hand part of the graph above follows the thermal resistance, required for P_{tot} = 25 W at T_{amb} = 40 °C

$$R_{th\ mb\text{-}a} \approx 1.8\ ^{o}C/W$$

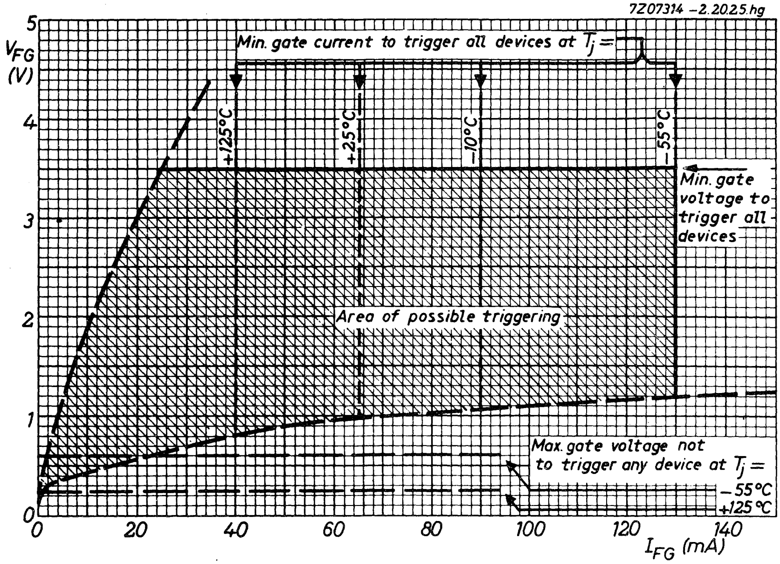
The contact thermal resistance $R_{th\ mb\text{-}h}$ = 0.2 °C/W.
Hence the heatsink thermal resistance should be:

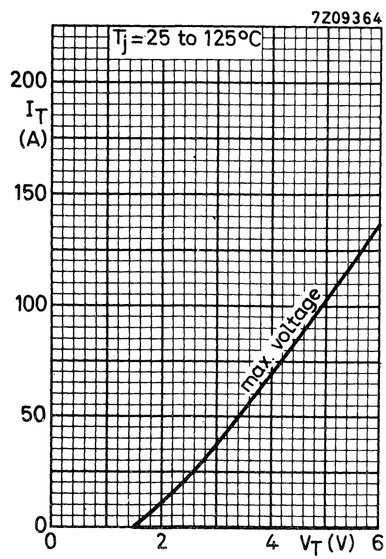
$$R_{th\ h\text{-}a} = R_{th\ mb\text{-}a} - R_{th\ mb\text{-}h} = (1.8 - 0.2)\ ^{o}C/W = 1.6\ ^{o}C/W.$$

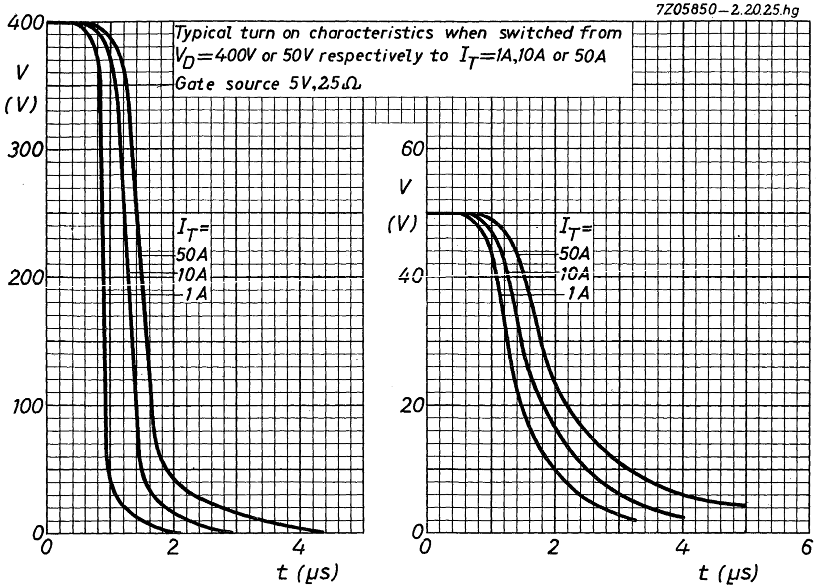
The appropriate heatsink(s) will be found in the Section ACCESSORIES and HEATSINKS.

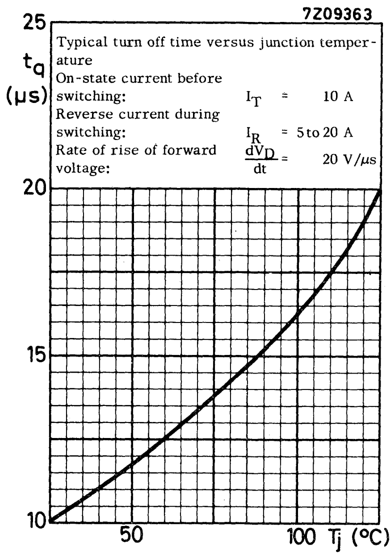


Gate characteristics with curves P_{GAV}=0.5W


7Z07314 –2.20.25.hg
V_{FG} (V)
Min. gate current to trigger all devices at T_j =
+125°C
+25°C
–10°C
–55°C
Min. gate voltage to trigger all devices
Area of possible triggering
Max. gate voltage not to trigger any device at T_j =
–55°C
+125°C
I_{FG} (mA)

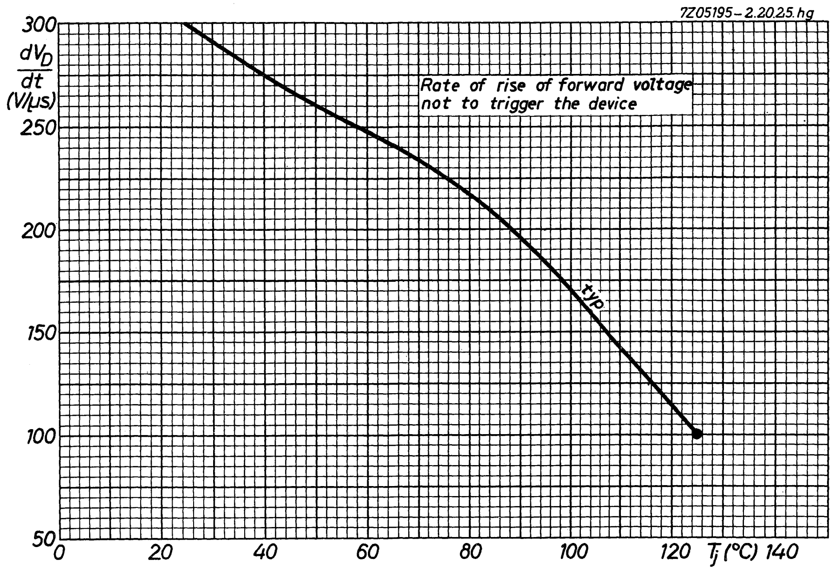

7Z09364
T_j = 25 to 125°C
I_T (A)
max. voltage
V_T (V)

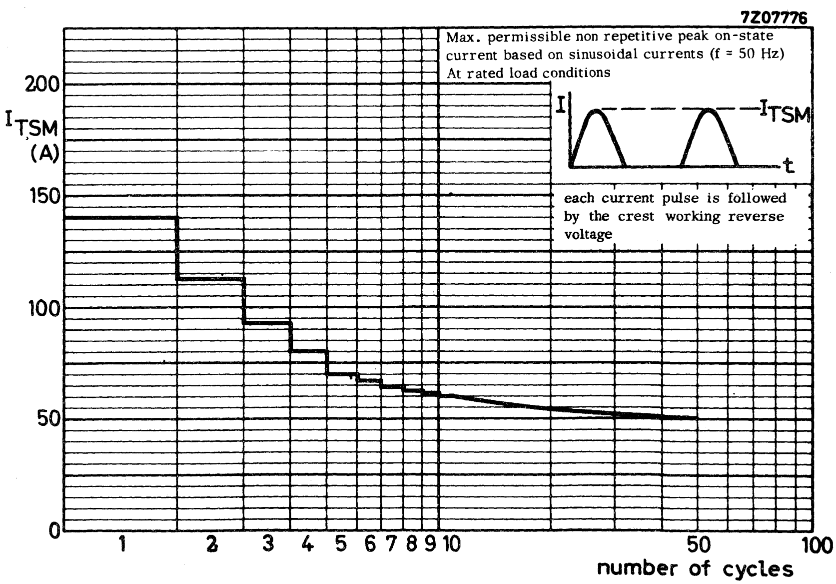


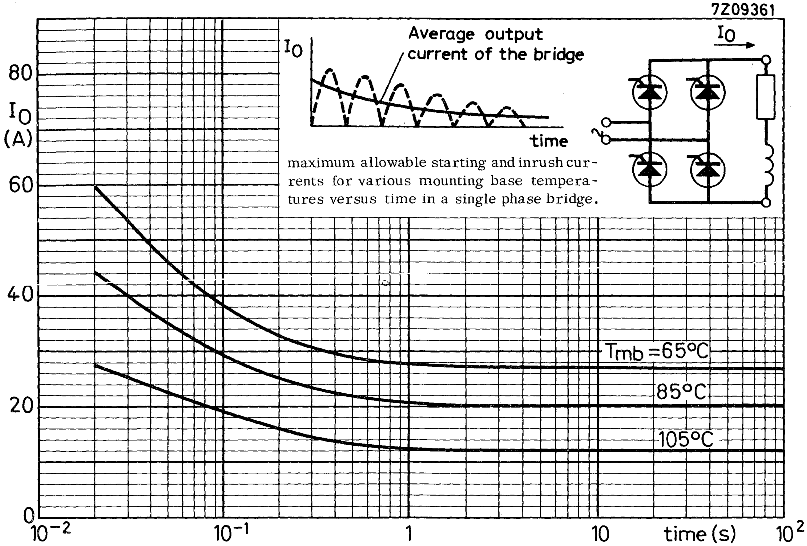


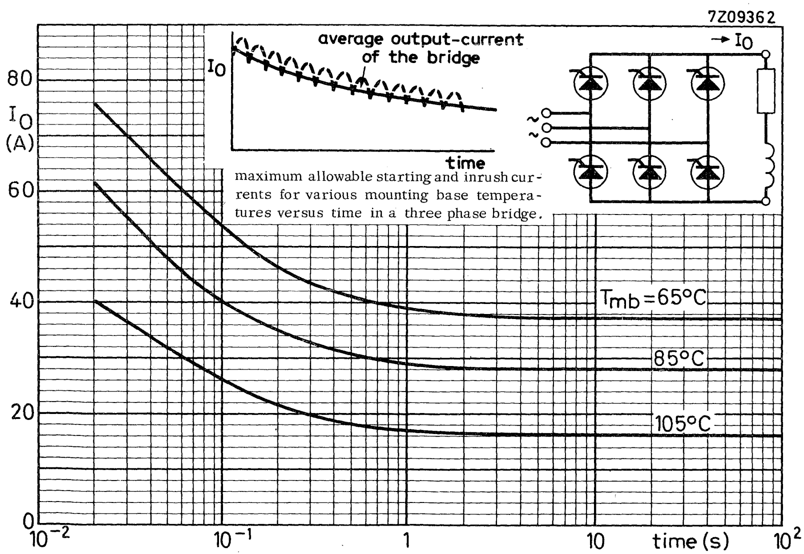
Typical turn off time versus junction temperature

On-state current before switching:	I_T	=	10 A
Reverse current during switching:	I_R	=	5 to 20 A
Rate of rise of forward voltage:	$\frac{dV_D}{dt}$	=	20 V/μs


7Z05195-2.20.25.hg
300
250
200
150
100
50
dVD/dt (V/µs)
Rate of rise of forward voltage not to trigger the device
typ
0
20
40
60
80
100
120
140
Tj (°C)


7Z07776
Max. permissible non repetitive peak on-state current based on sinusoidal currents (f = 50 Hz)
At rated load conditions
I
ITSM
t
each current pulse is followed by the crest working reverse voltage
200
150
100
50
0
ITSM (A)
1
2
3
4
5
6
7
8
9
10
50
100
number of cycles


7Z09361
80
I_O
(A)
60
40
20
0
10^{-2}
10^{-1}
1
10
time (s)
10^2
I_O
Average output
current of the bridge
time
maximum allowable starting and inrush currents for various mounting base temperatures versus time in a single phase bridge.
T_{mb} =65°C
85°C
105°C


7Z09362
80
I_O
(A)
60
40
20
0
10^{-2}
10^{-1}
1
10
time (s)
10^2
I_O
average output-current
of the bridge
time
maximum allowable starting and inrush currents for various mounting base temperatures versus time in a three phase bridge.
T_{mb} =65°C
85°C
105°C

P-GATE SILICON THYRISTORS

P-gate thyristors in a TO-48 metal envelope. They are intended for power control and power switching applications.
The series consists of the following reverse polarity types (stud anode):
BTY91-100R, BTY91-200R, BTY91-300R, BTY91-400R,
BTY91-500R, BTY91-600R, BTY91-700R and BTY91-800R.

QUICK REFERENCE DATA

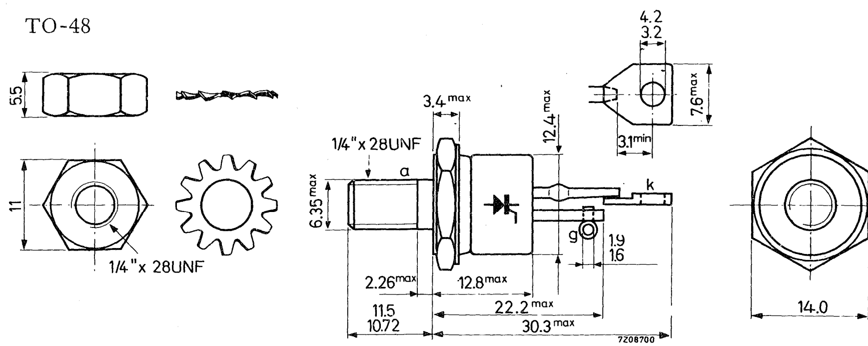
		BTY91-100R	200R	300R	400R	500R	600R	700R	800R	
Crest working reverse voltage	V_{RWM} max.	100	200	300	400	500	600	700	800	V
Crest working off-state voltage	V_{DWM} max.	100	200	300	400	500	600	700	800	V

Average forward current	I_{TAV}	max.	16	A
Non repetitive peak forward current (t = 10 ms)	I_{TSM}	max.	200	A
Junction temperature	T_j	max.	125	^{o}C
Thermal resistance from junction to mounting base	$R_{th\ j\text{-}mb}$	=	1.6	$^{o}C/W$

MECHANICAL DATA

Dimensions in mm

TO-48



Net weight: : 10 g

With accessories: 15 g

Torque on nut: min. 17 cm kg
max. 35 cm kg

Diameter of hole in heatsink: max. 6.5 mm

Accessories available: 56264A

All information applies to frequencies up to 400 Hz.

RATINGS (Limiting values) [1]

ANODE TO CATHODE

Voltages [2]		BTY91-100R	200R	300R	400R	500R	600R	700R	800R	
Crest working reverse voltage	V_{RWM} max.	100	200	300	400	500	600	700	800	V
Repetitive peak reverse voltage	V_{RRM} max.	100	200	300	400	500	600	700	800	V
Non repetitive peak reverse voltage ($t < 5$ ms)	V_{RSM} max.	150	300	400	500	600	720	850	960	V
Crest working off-state voltage	V_{DWM} max.	100	200	300	400	500	600	700	800	V
Repetitive peak off-state voltage	V_{DRM} max.	100	200	300	400	500	600	700	800	V
Non rep. peak off-state voltage	V_{DSM} max.	500	500	500	500	850	850	850	850	V [3]

Currents

Average forward current (averaged over any 20 ms period)	I_{TAV}	max.	16	A
→ Forward current (d.c.)	I_T	max.	25	A
R.M.S. forward current	$I_{T(RMS)}$	max.	25	A
→ Repetitive peak forward current	I_{TRM}	max.	200	A
Non repetitive peak forward current ($t = 10$ ms) See page 12	I_{TSM}	max.	200	A
I squared t, for fusing ($t = 1.5$ to 10 ms)	I^2t	max.	200	A^2s
Rate of rise of forward current	$\frac{dI_T}{dt}$	max.	20	A/μs
Repetitive peak reverse current (during turn-off)	I_{RRM}	max.	20	A

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

[2] These ratings apply at a gate voltage range of -5 to $+0.25$ V
To ensure thermal stability: $R_{th\ j-a} \leq 4.5$ °C/W (d.c.) or ≤ 9 °C/W (a.c.)

[3] This voltage may be applied without damage but the thyristor may switch into the on-state. Care should be taken that no current ratings are exceeded.

RATINGS (Limiting values) (continued)

GATE TO CATHODE

Voltages

Forward peak voltage	V_{FGM}	max.	10	V
Reverse peak voltage	V_{RGM}	max.	5	V

Current

Forward peak current	I_{FGM}	max.	2	A

Power dissipation

Average power dissipation (averaged over any 20 ms period)	P_{GAV}	max.	0.5	W
Peak power dissipation	P_{GM}	max.	5	W

TEMPERATURES

Storage temperature	T_{stg}	−55 to +125	°C
Junction temperature	T_j	max. 125	°C

THERMAL RESISTANCE

From junction to mounting base	$R_{th\ j\text{-}mb}$	=	1.6	°C/W ←
From mounting base to heatsink	$R_{th\ mb\text{-}h}$	=	0.2	°C/W
From mounting base to heatsink with mica washer	$R_{th\ mb\text{-}h}$	=	4.0	°C/W

CHARACTERISTICS

T_j = 125 °C unless otherwise specified

ANODE TO CATHODE

Voltages			BTY91-100R	200R	300R	400R	500R	600R	700R	800R	
Forward on-state voltage I_T = 50 A; T_j = 25 °C	V_T	<	2.0	2.0	2.0	2.0	2.0	2.0	2.0	2.0	V [1]
Forward breakover voltage	$V_{(BO)}$	>	100	200	300	400	500	600	700	800	V
Rate of rise of forward voltage not to trigger the device	$\frac{dV_D}{dt}$	typ.	100	100	100	100	100	100	100	100	V/μs
Rate of rise of forward voltage not to trigger any device	$\frac{dV_D}{dt}$	<	20	20	20	20	20	20	20	20	V/μs
Currents											
Reverse current $V_R = V_{RWMmax.}$	I_R	<	13	12	10	8.0	6.0	5.0	4.5	4.0	mA [2]
Off-state current $V_D = V_{DWMmax.}$	I_D	<	13	12	10	8.0	6.0	5.0	4.5	4.0	mA

Pick up current	I_P	typ.	20	mA
Holding current	I_H	typ.	10	mA

GATE TO CATHODE

Voltages

Voltage to trigger all devices V_D = 6 V; T_j = 25 °C	V_{GT}	>	3.0	V
Voltage not to trigger any device	V_{GD}	<	0.25	V

Current

Current to trigger all devices V_D = 6 V; T_j = 25 °C	I_{GT}	>	40	mA

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

[2] These I_R values apply to a gate voltage range of −5 to +0.25 V.

SWITCHING CHARACTERISTICS (See also page 10)

Turn on time when switched from

V_D = 400 V to I_T = 50 A

Gate source 5 V, 25 Ω; T_j = 125 °C — t_{on} typ. 2.0 μs

Turn off time when switched from

I_T = 10 A to I_R between 5 and 20 A

$\frac{dV_D}{dt}$ = 20 V/μs; T_j = 125 °C	t_q	typ.	20	μs
T_j = 25 °C	t_q	typ.	10	μs

OPERATING NOTES

1. When there is a possibility that transient voltages, caused by the stored energy in the transformer core, will exceed the maximum permissible non repetitive peak reverse voltage, a damping circuit across the transformer should be applied.
   Either a series RC circuit or a voltage dependent resistor may be used. Suitable component values for an RC circuit across the transformer primary or secondary may be calculated as follows:

$\frac{V_{RSM}}{V_{RWM}}$	RC across primary of transformer		RC across secondary of transformer	
	C (μF)	R (Ω)	C (μF)	R (Ω)
2.0	$200\frac{I_{mag}}{V_1}$	$\frac{150}{C}$	$225\frac{I_{mag}T^2}{V_1}$	$\frac{200}{C}$
1.5	$400\frac{I_{mag}}{V_1}$	$\frac{225}{C}$	$450\frac{I_{mag}T^2}{V_1}$	$\frac{275}{C}$
1.25	$550\frac{I_{mag}}{V_1}$	$\frac{260}{C}$	$620\frac{I_{mag}T^2}{V_1}$	$\frac{310}{C}$
1.0	$800\frac{I_{mag}}{V_1}$	$\frac{300}{C}$	$900\frac{I_{mag}T^2}{V_1}$	$\frac{350}{C}$

where I_{mag} = magnetising primary r.m.s. current (A)

V_1 = transformer primary r.m.s. voltage (V)

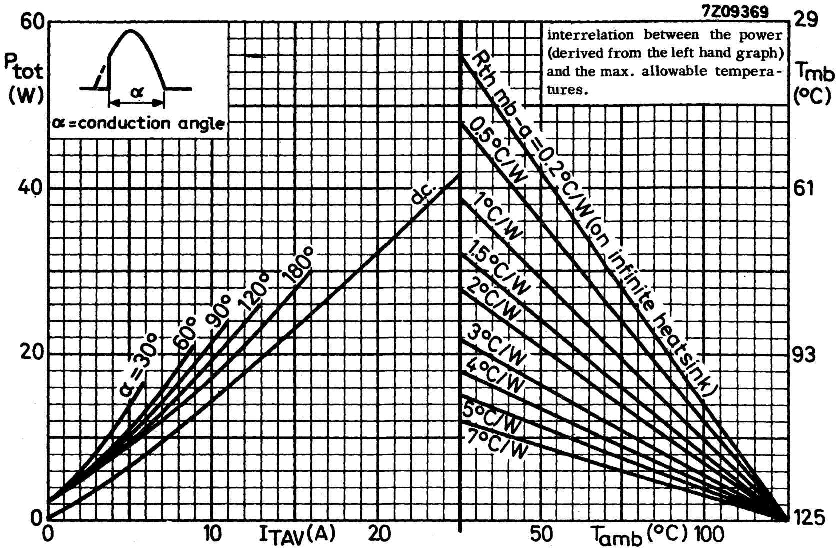
V_2 = transformer secondary r.m.s. voltage (V)

T = V_1/V_2

V_{RWM} stands for the actually applied crest working reverse voltage

2. In order to prevent the thyristors from being damaged by surge currents higher than those mentioned in the curves at pages 11 and 12 a fast fuse is recommended.

3. The gate and cathode connectors should not be bent; they should be soldered into the circuit so there is no strain on them.
   During soldering the heat conduction to the junction should be kept to a minimum by using a thermal shunt.



Determination of the heatsink thermal resistance

Example:

Assume a thyristor, used in a single phase full wave rectifier circuit.

frequency	f	=	50	Hz
conduction angle	α	=	180^{o}	
average forward current	I_{TAV}	=	10	A (per thyristor)
ambient temperature	T_{amb}	=	40	^{o}C

From the left hand part of the graph above it follows that at I_{TAV} = 10 A and α = 180^{o} the average forward power + average leakage power = 17 W per thyristor.

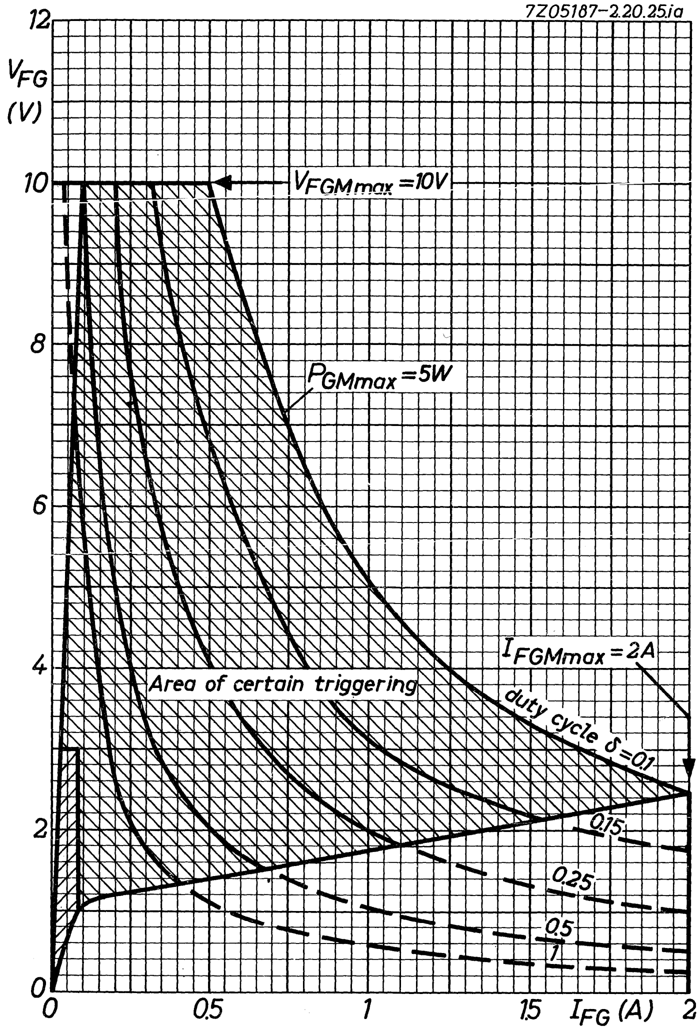
From the right hand part of the graph above follows the thermal resistance, required for P_{tot} = 17 W at T_{amb} = 40 ^{o}C

$$R_{th\ mb\text{-}a} \approx 3.5\ ^{o}C/W$$

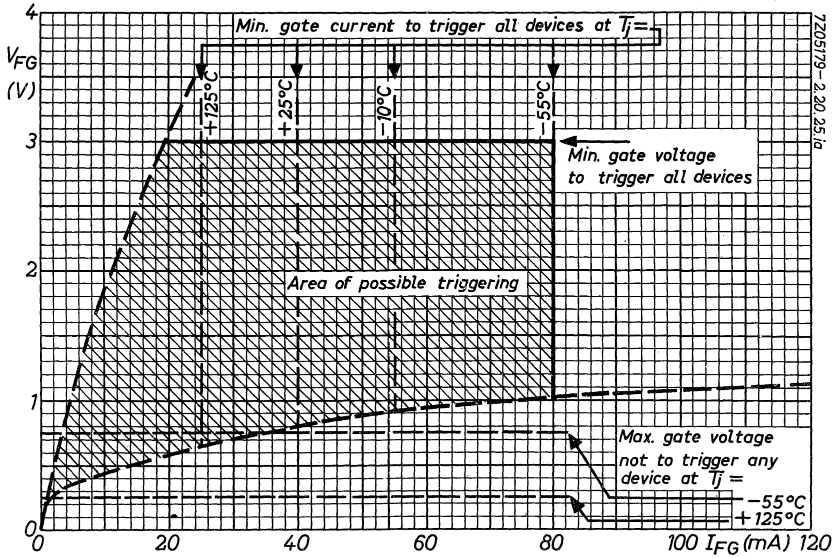
The contact thermal resistance $R_{th\ mb\text{-}h}$ = 0.2 ^{o}C/W.
Hence the heatsink thermal resistance should be:

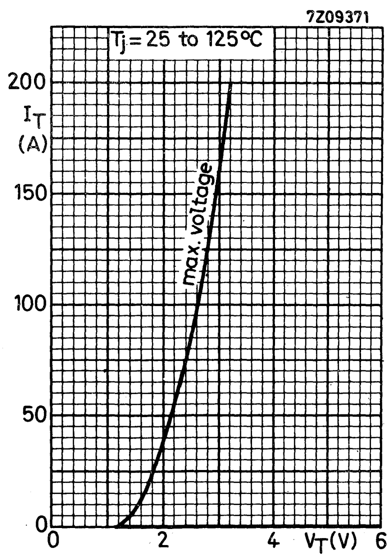
$$R_{th\ h\text{-}a} = R_{th\ mb\text{-}a} - R_{th\ mb\text{-}h} = (3.5 - 0.2)\ ^{o}C/W = 3.3\ ^{o}C/W.$$

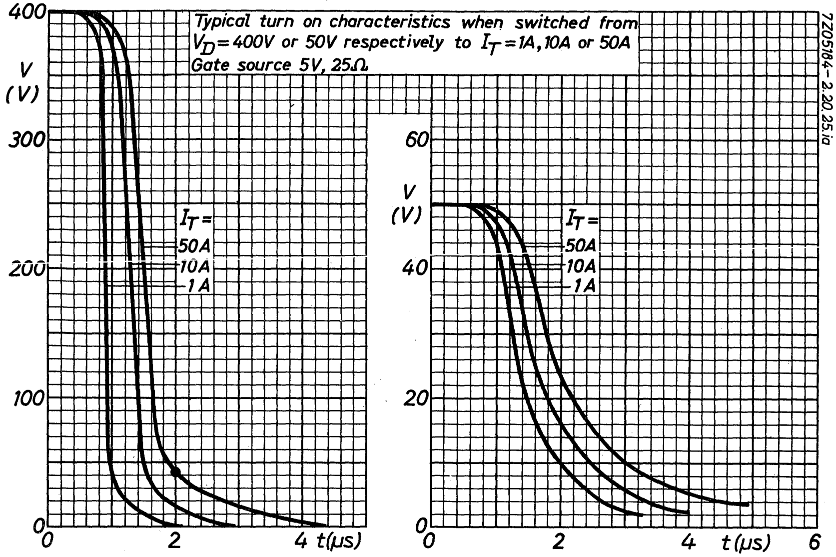
The appropriate heatsink(s) will be found in the Section ACCESSORIES and HEATSINKS.

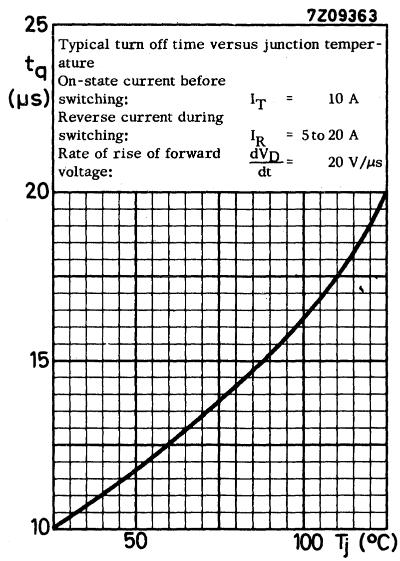


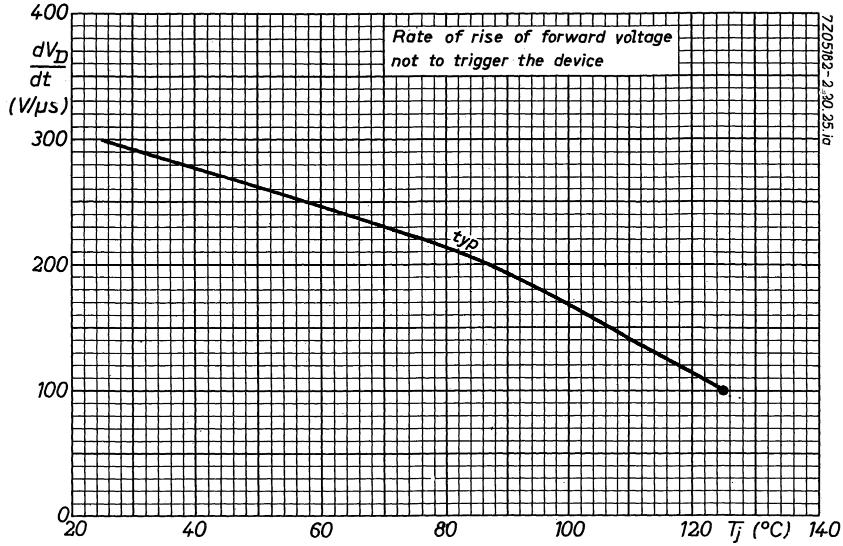
Gate characteristics with curves $P_{GAV} = 0.5 W$

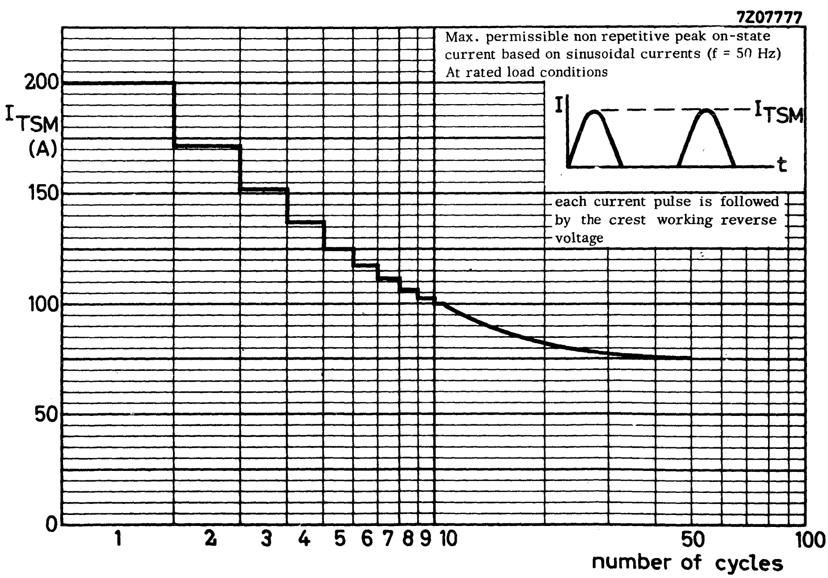

7Z05179−2.20.25.ia
V_{FG} (V)
Min. gate current to trigger all devices at T_j =
+125°C
+25°C
−10°C
−55°C
Min. gate voltage to trigger all devices
Area of possible triggering
Max. gate voltage not to trigger any device at T_j =
−55°C
+125°C
I_{FG} (mA)
0
20
40
60
80
100
120
1
2
3
4

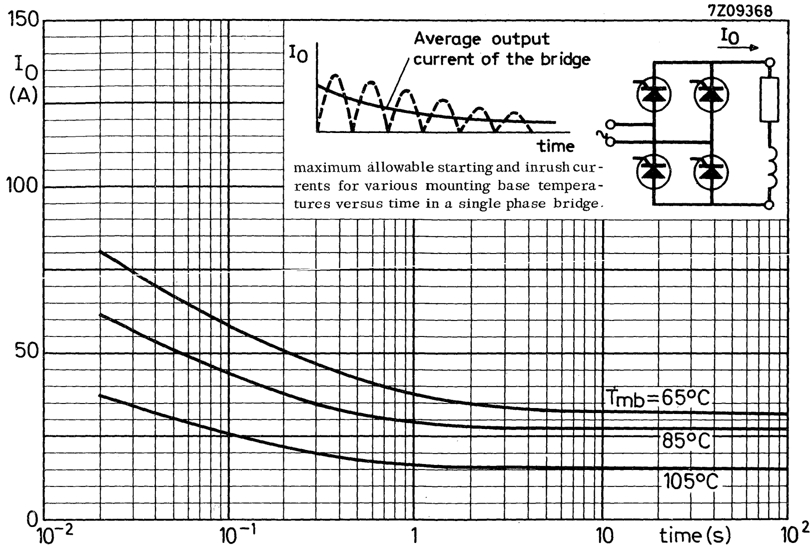

7Z09371
T_j = 25 to 125°C
I_T (A)
max. voltage
V_T (V)
0
50
100
150
200
0
2
4
6


Typical turn on characteristics when switched from
V_D = 400V or 50V respectively to I_T = 1A, 10A or 50A
Gate source 5V, 25Ω
7Z05184 - 2.20.25.ia
V
(V)
400
300
200
100
0
I_T =
50A
10A
1A
0
2
4 t(μs)
60
40
20
0
0
2
4 t(μs) 6

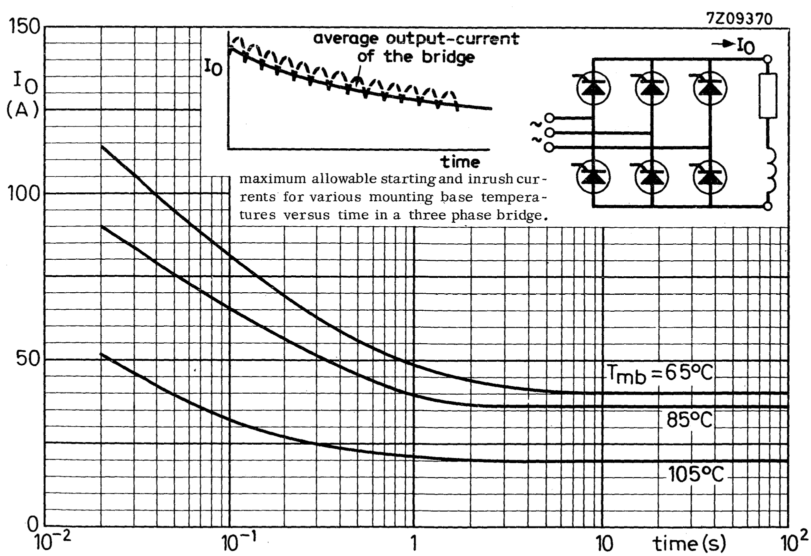

7Z09363
Typical turn off time versus junction temperature
On-state current before switching: I_T = 10 A
Reverse current during switching: I_R = 5 to 20 A
Rate of rise of forward voltage: $\frac{dV_D}{dt}$ = 20 V/μs
t_q
(μs)
25
20
15
10
50
100 T_j (°C)


400
$\frac{dV_D}{dt}$
(V/μs)
300
200
100
0
20
40
60
80
100
120
T_j (°C)
140
Rate of rise of forward voltage not to trigger the device
typ
7Z05182-2.30.25.ia


7Z07777
Max. permissible non repetitive peak on-state current based on sinusoidal currents (f = 50 Hz)
At rated load conditions
I
I_{TSM}
t
each current pulse is followed by the crest working reverse voltage
200
I_{TSM}
(A)
150
100
50
0
1
2
3
4
5
6
7
8
9
10
50
100
number of cycles



maximum allowable starting and inrush currents for various mounting base temperatures versus time in a single phase bridge.



maximum allowable starting and inrush currents for various mounting base temperatures versus time in a three phase bridge.

P-GATE SILICON THYRISTORS

P-gate thyristors in a metal envelope with ceramic insulation. They are intended for power control and power switching applications.
The series consists of the following reverse polarity types (stud anode):
BTY95-100R, BTY95-200R, BTY95-300R, BTY95-400R,
BTY95-500R, BTY95-600R, BTY95-700R and BTY95-800R.

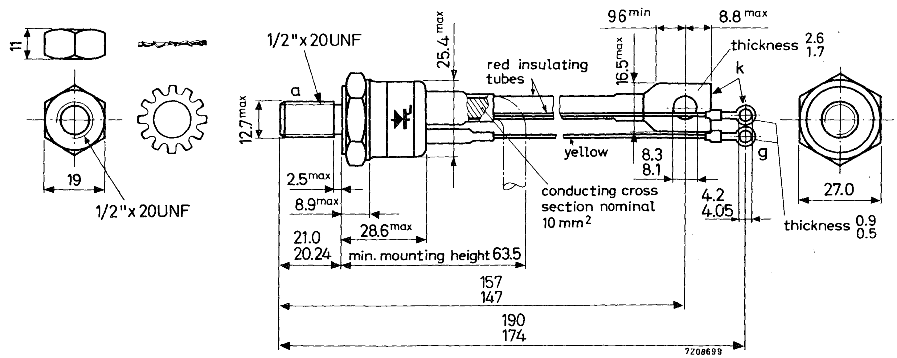
QUICK REFERENCE DATA

		BTY95-100R	200R	300R	400R	500R	600R	700R	800R	
Crest working reverse voltage	V_{RWM} max.	100	200	300	400	500	600	700	800	V
Crest working off-state voltage	V_{DWM} max.	100	200	300	400	500	600	700	800	V

Average forward current	I_{TAV}	max.	50	A
Non repetitive peak forward current (t = 10 ms)	I_{TSM}	max.	680	A
Junction temperature	T_j	max.	125	°C
Thermal resistance from junction to mounting base	$R_{th\ j\text{-}mb}$	=	0.6	°C/W

MECHANICAL DATA

Dimensions in mm



Net weight : 80 g
With accessories: 108 g
Diameter of hole in heatsink: max. 13 mm

Torque on nut: min. 90 cm kg
max. 175 cm kg

All information applies to frequencies up to 400 Hz.

RATINGS (Limiting values) [1]

ANODE TO CATHODE

Voltages [2]		BTY95-100R	200R	300R	400R	500R	600R	700R	800R	
Crest working reverse voltage	V_{RWM} max.	100	200	300	400	500	600	700	800	V
Repetitive peak reverse voltage	V_{RRM} max.	100	200	300	400	500	600	700	800	V
Non repetitive peak reverse voltage ($t < 5$ ms)	V_{RSM} max.	150	300	400	500	600	720	850	960	V
Crest working off-state voltage	V_{DWM} max.	100	200	300	400	500	600	700	800	V
Repetitive peak off-state voltage	V_{DRM} max.	100	200	300	400	500	600	700	800	V
Non repetitive peak off-state voltage	V_{DSM} max.	850	850	850	850	850	850	850	850	V [3]

Currents

Average forward current (averaged over any 20 ms period)	I_{TAV}	max.	50	A
Forward current (d.c.)	I_T	max.	75	A
R.M.S. forward current	$I_{T(RMS)}$	max.	78	A
Repetitive peak forward current	I_{TRM}	max.	700	A
Non repetitive peak forward current ($t = 10$ ms) See page 11	I_{TSM}	max.	680	A
I squared t, for fusing ($t = 1.5$ to 10 ms)	I^2t	max.	2000	A^2s
Rate of rise of forward current	$\frac{dI_T}{dt}$	max.	20	A/µs
Repetitive peak reverse current (during turn-off)	I_{RRM}	max.	30	A

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

[2] These ratings apply to a gate voltage range of −5 to +0.25 V. For thermal stability: $R_{th\ j\text{-}a} \leqq 4.5$ °C/W (d.c.) or $\leqq 9$ °C/W (a.c.) for −100 to −400 types,
$R_{th\ j\text{-}a} \leqq 1.5$ °C/W (d.c.) or $\leqq 3$ °C/W (a.c.) for −500 to −800 types.

[3] This voltage may be applied without damage but the thyristor may switch into the on-state. Care should be taken that no current ratings are exceeded

RATINGS (Limiting values) (continued)

GATE TO CATHODE

Voltages

Forward peak voltage	V_{FGM}	max.	10	V
Reverse peak voltage	V_{RGM}	max.	5	V

Current

Forward peak current	I_{FGM}	max.	2	A

Power dissipation

Average power dissipation (averaged over any 20 ms period)	P_{GAV}	max.	0.5	W
Peak power dissipation	P_{GM}	max.	5	W

TEMPERATURES

Storage temperature	T_{stg}		−55 to +125	^{o}C
Junction temperature	T_j	max.	125	^{o}C

THERMAL RESISTANCE

From junction to mounting base	$R_{th\ j\text{-}mb}$	=	0.6	$^{o}C/W$
From mounting base to heatsink	$R_{th\ mb\text{-}h}$	=	0.1	$^{o}C/W$

CHARACTERISTICS

T_j = 125 °C unless otherwise specified

ANODE TO CATHODE

Voltages			BTY95-100R	200R	300R	400R	500R	600R	700R	800R	
Forward on-state voltage I_T = 500 A; T_j = 25 °C	V_T	<	3.3	3.3	3.3	3.3	3.3	3.3	3.3	3.3	V [1]
Forward breakover voltage	$V_{(BO)}$	>	100	200	300	400	500	600	700	800	V
Rate of rise of forward voltage not to trigger the device	$\frac{dV_D}{dt}$	typ.	10	10	10	10	10	10	10	10	V/μs
Currents											
Reverse current $V_R = V_{RWMmax}$	I_R	<	13	12	10	8.0	12	12	12	10	mA [2]
Off-state current $V_D = V_{DWMmax}$	I_D	<	13	12	10	8.0	12	12	12	10	mA

Pick up current	I_P	typ.	20	mA
Holding current	I_H	typ.	10	mA

GATE TO CATHODE

Voltages

Voltage to trigger all devices V_D = 6 V; T_j = 25 °C	V_{GT}	>	3.0	V
Voltage not to trigger any device	V_{GD}	<	0.25	V

Current

Current to trigger all devices V_D = 6 V; T_j = 25 °C	I_{GT}	>	80	mA

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

[2]) These I_R values apply to a gate voltage range of −5 to +0.25 V.

SWITCHING CHARACTERISTICS (See also page 10)

Turn on time when switched from V_D = 400 V to I_T = 50 A; Gate source 5 V, 25 Ω, T_j = 125 °C	t_{on}	typ.	3.0	μs
Turn off time when switched from I_T = 50 A to I_R between 10 and 30 A; $\frac{dV_D}{dt}$ = 5 V/μs ; T_j = 125 °C	t_q	typ.	20	μs
T_j = 25 °C	t_q	typ.	10	μs

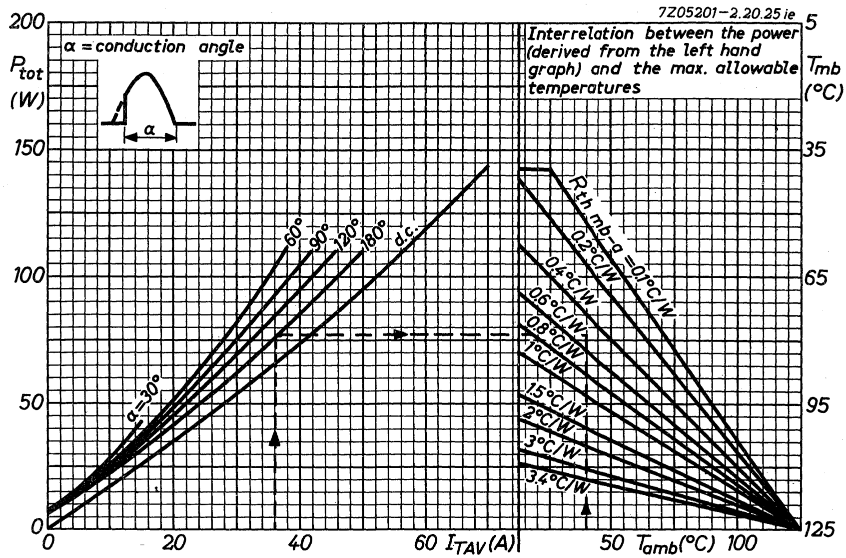
OPERATING NOTES

1. When there is a possibility that transient voltages, caused by the stored energy in the transformer core, will exceed the maximum permissible non repetitive peak reverse voltage, a damping circuit across the transformer should be applied.
Either a series RC circuit or a voltage dependent resistor may be used. Suitable component values for an RC circuit across the transformer primary or secondary may be calculated as follows:

$\frac{V_{RSM}}{V_{RWM}}$	RC across primary of transformer		RC across secondary of transformer	
	C (µF)	R (Ω)	C (µF)	R (Ω)
2.0	$200\frac{I_{mag}}{V_1}$	$\frac{150}{C}$	$225\frac{I_{mag}T^2}{V_1}$	$\frac{200}{C}$
1.5	$400\frac{I_{mag}}{V_1}$	$\frac{225}{C}$	$450\frac{I_{mag}T^2}{V_1}$	$\frac{275}{C}$
1.25	$550\frac{I_{mag}}{V_1}$	$\frac{260}{C}$	$620\frac{I_{mag}T^2}{V_1}$	$\frac{310}{C}$
1.0	$800\frac{I_{mag}}{V_1}$	$\frac{300}{C}$	$900\frac{I_{mag}T^2}{V_1}$	$\frac{350}{C}$

where I_{mag} = magnetising primary r.m.s. current (A)
V_1 = transfomer primary r.m.s. voltage (V)
V_2 = transformer secondary r.m.s. voltage (V)
T = V_1/V_2
V_{RWM} stands for the actually applied crest working reverse voltage.

2. In order to prevent the thyristors from being damaged by surge currents higher than those mentioned in the curves at page 11 a fast fuse is recommended.



Determination of the heatsink thermal resistance

Example:

Assume a thyristor, used in a single phase full wave rectifier circuit.

frequency	f	=	50 Hz
conduction angle	α	=	180°
average forward current	I_{TAV}	=	36 A (per thyristor)
ambient temperature	T_{amb}	=	40 °C

From the left hand part of the graph above it follows that at I_{TAV} = 36 A and α = 180° the average forward power + average leakage power = 77 W per thyristor.

From the right hand part of the graph above follows the thermal resistance, required for P_{tot} = 77 W at T_{amb} = 40 °C

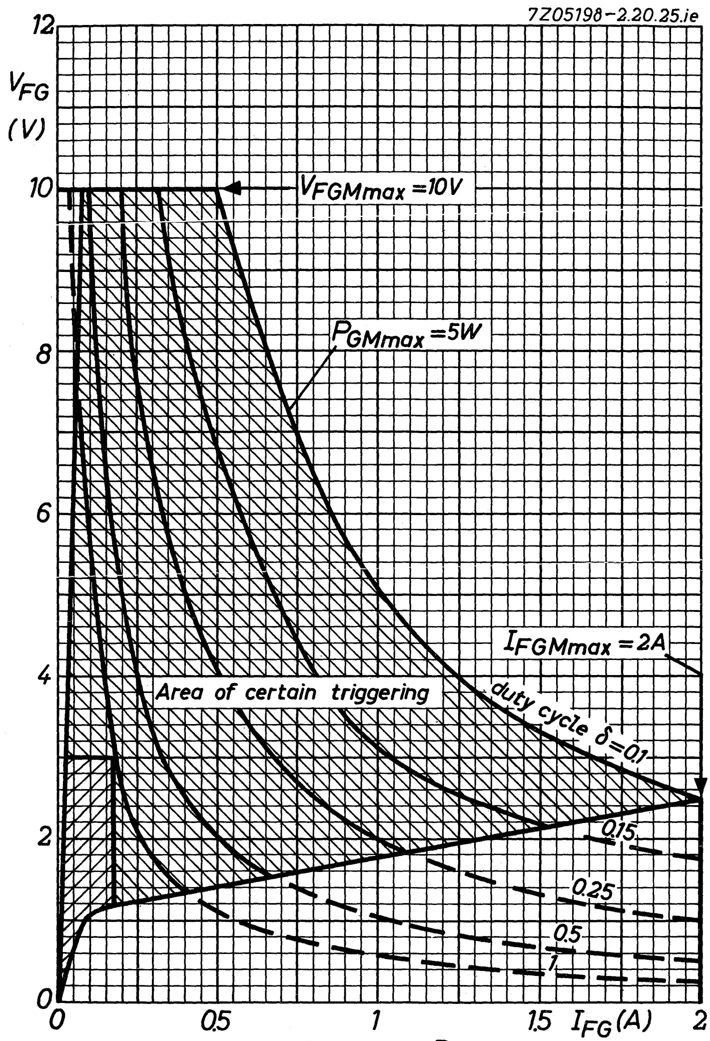
$$R_{th\ mb-a} \approx 0.52\ ^{\circ}C/W$$

The contact thermal resistance $R_{th\ mb-h}$ = 0.1 °C/W.

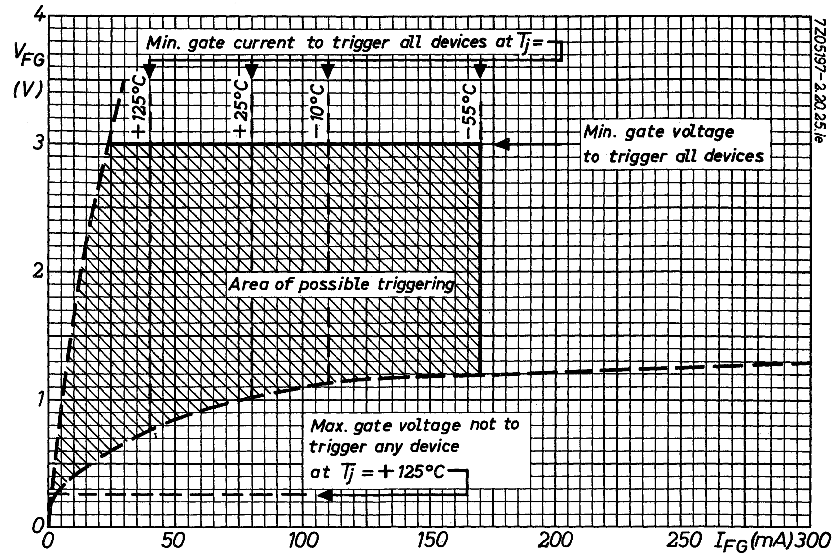
Hence the heatsink thermal resistance should be:

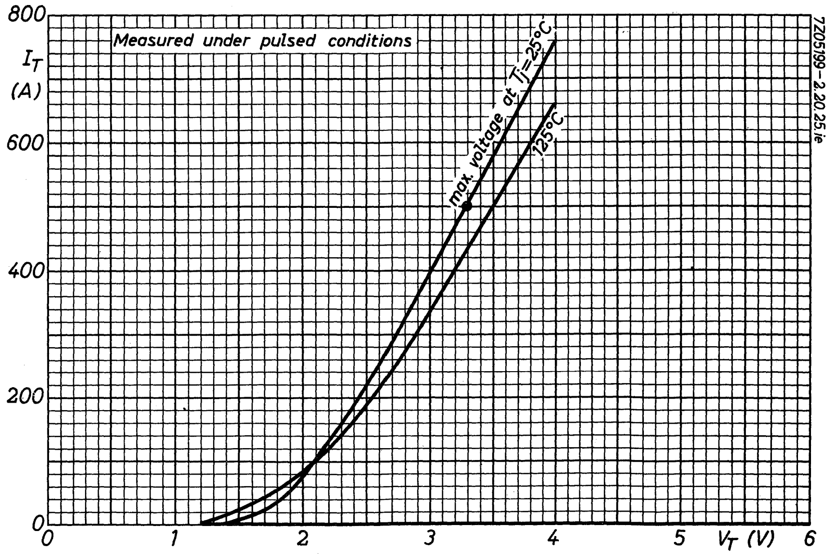
$$R_{th\ h-a} = R_{th\ mb-a} - R_{th\ mb-h} = (0.52 - 0.1)\ ^{\circ}C/W = 0.42\ ^{\circ}C/W.$$

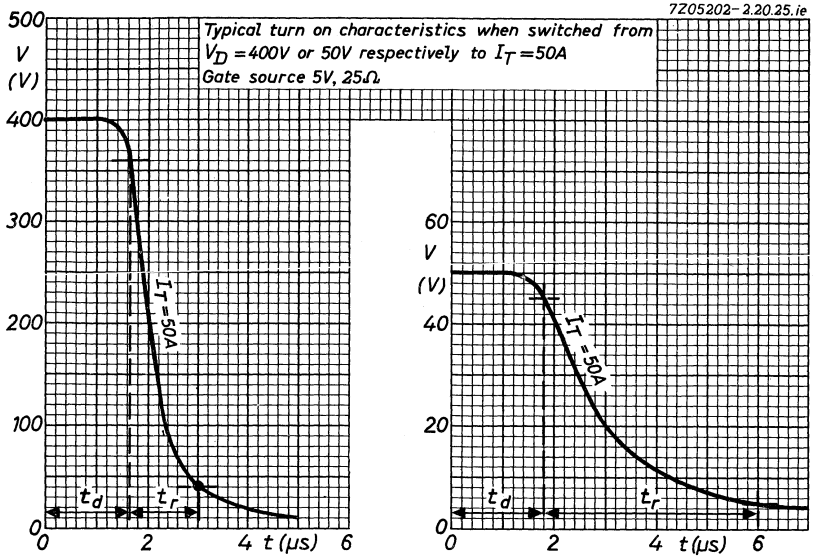
The applicable heatsink(s) may then be found in the Section ACCESSORIES and HEATSINKS.

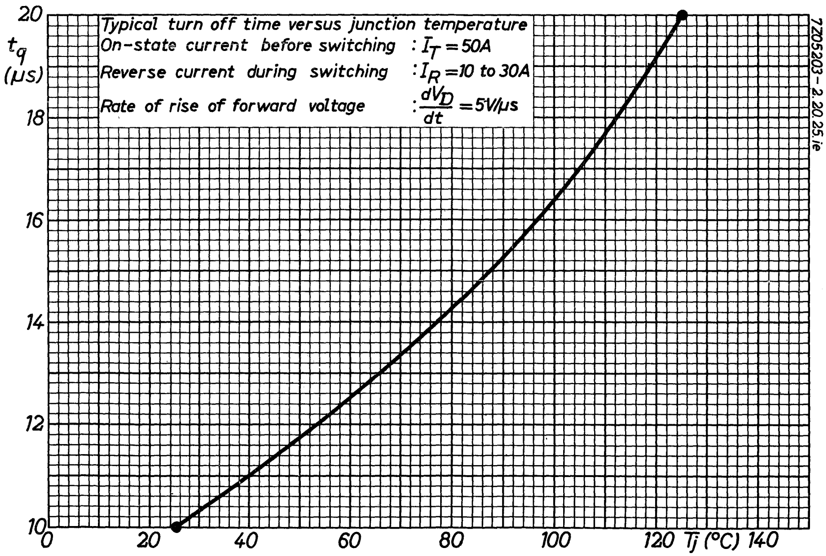


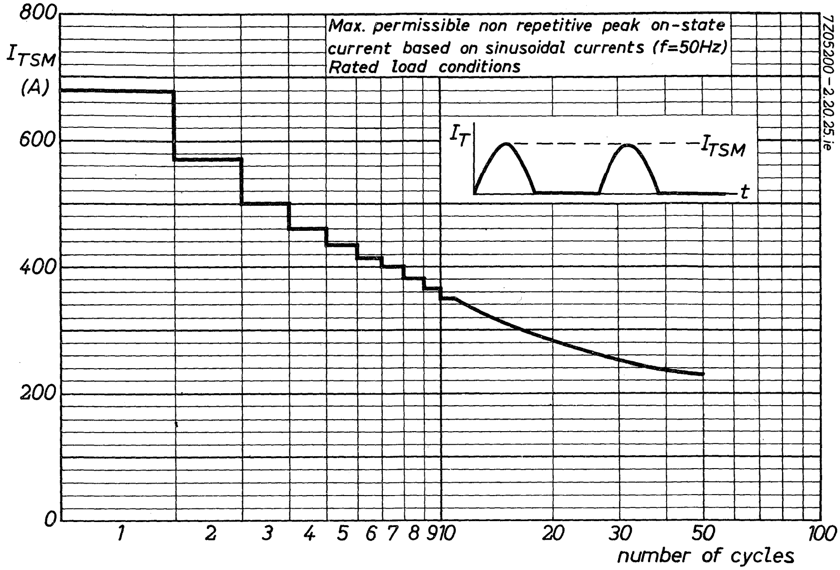
Gate characteristics with curves P_{GAV} =0.5W


4
V_{FG}
(V)
3
2
1
0
Min. gate current to trigger all devices at T_j =
+125°C
+25°C
−10°C
−55°C
Min. gate voltage
to trigger all devices
Area of possible triggering
Max. gate voltage not to
trigger any device
at T_j = +125°C
0
50
100
150
200
250
I_{FG} (mA) 300
7Z05197-2.20.25.ie


800
I_T
(A)
600
400
200
0
Measured under pulsed conditions
max. voltage at T_j = 25°C
125°C
0
1
2
3
4
5
V_T (V)
6
7Z05199-2.20.25.ie


7Z05202-2.20.25.ie
Typical turn on characteristics when switched from
V_D =400V or 50V respectively to I_T =50A
Gate source 5V, 25Ω
500
V
(V)
400
300
200
100
0
I_T =50A
t_d
t_r
0
2
4 t (μs) 6
60
V
(V)
40
20
0
I_T =50A
t_d
t_r
0
2
4 t (μs) 6


Typical turn off time versus junction temperature
On-state current before switching : I_T = 50A
Reverse current during switching : I_R =10 to 30A
Rate of rise of forward voltage : $\frac{dV_D}{dt}$ = 5V/μs
7Z05203-2.20.25.ie
20
t_q
(μs)
18
16
14
12
10
0
20
40
60
80
100
120 Tj (°C) 140


800
600
400
200
0
I_{TSM}
(A)
Max. permissible non repetitive peak on-state
current based on sinusoidal currents (f=50Hz)
Rated load conditions
I_T
I_{TSM}
t
7205200-2.20.25.ie
1
2
3
4
5
6
7
8
9
10
20
30
50
100
number of cycles

P-GATE SILICON THYRISTORS

P-gate thyristors in a metal envelope with ceramic insulation. They are intended for power control and power switching applications.
The series consists of the following reverse polarity types (stud anode):
BTY99-100R, BTY99-200R, BTY99-300R, BTY99-400R,
BTY99-500R, BTY99-600R, BTY99-700R and BTY99-800R.

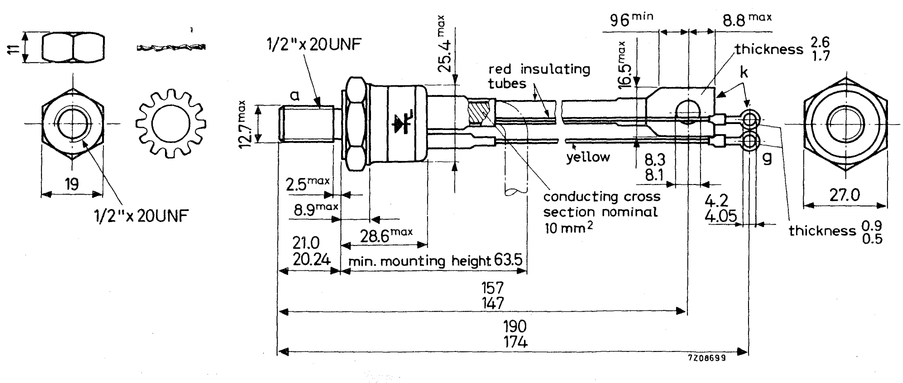
QUICK REFERENCE DATA

		BTY99-100R	200R	300R	400R	500R	600R	700R	800R	
Crest working reverse voltage	V_{RWM} max.	100	200	300	400	500	600	700	800	V
Crest working off-state voltage	V_{DWM} max.	100	200	300	400	500	600	700	800	V

Average forward current	I_{TAV}	max.	70	A
Non repetitive peak forward current (t = 10 ms)	I_{TSM}	max.	900	A
Junction temperature	T_j	max.	125	°C
Thermal resistance from junction to mounting base	$R_{th\ j\text{-}mb}$	=	0.4	°C/W

MECHANICAL DATA

Dimensions in mm



Net weight : 80 g
With accessories: 108 g
Diameter of hole in heatsink: max. 13 mm

Torque on nut: min. 90 cm kg
max. 175 cm kg

All information applies to frequencies up to 400 Hz.

RATINGS (Limiting values) [1])

ANODE TO CATHODE

Voltages [2])		BTY99-100R	200R	300R	400R	500R	600R	700R	800R	
Crest working reverse voltage	V_{RWM} max.	100	200	300	400	500	600	700	800	V
Repetitive peak reverse voltage	V_{RRM} max.	100	200	300	400	500	600	700	800	V
Non repetitive peak reverse voltage ($t < 5$ ms)	V_{RSM} max.	150	300	400	500	600	720	850	960	V
Crest working off-state voltage	V_{DWM} max.	100	200	300	400	500	600	700	800	V
Repetitive peak off-state voltage	V_{DRM} max.	100	200	300	400	500	600	700	800	V
Non repetitive peak off-state voltage	V_{DSM} max.	850	850	850	850	850	850	850	850	V[3])

Currents

Average forward current (averaged over any 20 ms period)	I_{TAV}	max.	70	A
Forward current (d.c.)	I_T	max.	100	A
R.M.S. forward current	$I_{T(RMS)}$	max.	110	A
Repetitive peak forward current	I_{TRM}	max.	1000	A
Non repetitive peak forward current ($t = 10$ ms) See page 11	I_{TSM}	max.	900	A
I squared t, for fusing ($t = 1.5$ to 10 ms)	I^2t	max.	4000	A^2s
Rate of rise of forward current	$\frac{dI_T}{dt}$	max.	20	A/μs
Repetitive peak reverse current (during turn-off)	I_{RRM}	max.	30	A

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

[2]) These ratings apply to a gate voltage range of -5 to $+0.25$ V. For thermal stability: $R_{th\ j\text{-}a} \leqq 4.5\ ^{o}C/W$ (d.c.) or $\leqq 9\ ^{o}C/W$ (a.c.) for -100 to -400 types, $R_{th\ j\text{-}a} \leqq 1.5\ ^{o}C/W$ (d.c.) or $\leqq 3\ ^{o}C/W$ (a.c.) for -500 to -800 types.

[3]) This voltage may be applied without damage but the thyristor may switch into the on-state. Care should be taken that no current ratings are exceeded.

RATINGS (Limiting values) (continued)

GATE TO CATHODE

Voltages

Forward peak voltage	V_{FGM}	max.	10	V
Reverse peak voltage	V_{RGM}	max.	5	V

Currents

Forward peak current	I_{FGM}	max.	2	A

Power dissipation

Average power dissipation (averaged over any 20 ms period)	P_{GAV}	max.	0.5	W
Peak power dissipation	P_{GM}	max.	5	W

TEMPERATURES

Storage temperature	T_{stg}		−55 to +125	°C
Junction temperature	T_j	max.	125	°C

THERMAL RESISTANCE

From junction to mounting base	$R_{th\ j\text{-}mb}$	=	0.4	°C/W
From mounting base to heatsink	$R_{th\ mb\text{-}h}$	=	0.1	°C/W

CHARACTERISTICS

T_j = 125 °C unless otherwise specified

ANODE TO CATHODE

Voltages

			BTY99–100R	200R	300R	400R	500R	600R	700R	800R	
Forward on-state voltage I_T = 500 A; T_j = 25 °C	V_T	<	2.5	2.5	2.5	2.5	2.5	2.5	2.5	2.5	V [1]
Forward breakover voltage	$V_{(BO)}$	>	100	200	300	400	500	600	700	800	V
Rate of rise of forward voltage not to trigger the device	$\frac{dV_D}{dt}$	typ.	10	10	10	10	10	10	10	10	V/μs

Currents

			BTY99–100R	200R	300R	400R	500R	600R	700R	800R	
Reverse current $V_R = V_{RWMmax}$	I_R	<	13	12	10	8.0	12	12	12	10	mA [2]
Off-state current $V_D = V_{DWMmax}$	I_D	<	13	12	10	8.0	12	12	12	10	mA

Pick up current	I_P	typ.	20	mA
Holding current	I_H	typ.	10	mA

GATE TO CATHODE

Voltages

Voltage to trigger all devices V_D = 6 V; T_j = 25 °C	V_{GT}	>	3.0	V
Voltage not to trigger any device	V_{GD}	<	0.25	V

Current

Current to trigger all devices V_D = 6 V	I_{GT}	>	70	mA

---

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

[2]) These I_R values apply to a gate voltage range of −5 to +0.25 V.

SWITCHING CHARACTERISTICS (See also page 10)

Turn on time when switched from V_D = 400 V to I_T = 50 A Gate source 5 V, 25 Ω, T_j = 125 °C	t_{on}	typ.	3.0	μs
Turn off time when switched from I_T = 50 A to I_R between 10 and 30 A $\frac{dV_D}{dt}$ = 5 V/μs ; T_j = 125 °C	t_q	typ.	20	μs
T_j = 25 °C	t_q	typ.	10	μs

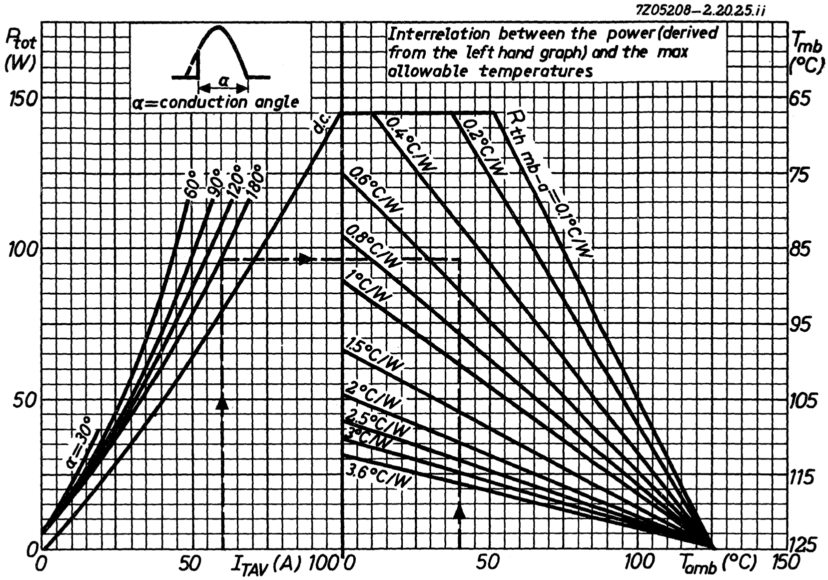
OPERATING NOTES

1. When there is a possibility that transient voltages, caused by the stored energy in the transformer core, will exceed the maximum permissible non repetitive peak reverse voltage, a damping circuit across the transformer should be applied.
   Either a series RC circuit or a voltage dependent resistor may be used. Suitable component values for an RC circuit across the transformer primary or secondary may be calculated as follows:

$\frac{V_{RSM}}{V_{RWM}}$	RC across primary of transformer		RC across secondary of transformer	
	C (μF)	R (Ω)	C (μF)	R (Ω)
2.0	$200\frac{I_{mag}}{V_1}$	$\frac{150}{C}$	$225\frac{I_{mag}T^2}{V_1}$	$\frac{200}{C}$
1.5	$400\frac{I_{mag}}{V_1}$	$\frac{225}{C}$	$450\frac{I_{mag}T^2}{V_1}$	$\frac{275}{C}$
1.25	$550\frac{I_{mag}}{V_1}$	$\frac{260}{C}$	$620\frac{I_{mag}T^2}{V_1}$	$\frac{310}{C}$
1.0	$800\frac{I_{mag}}{V_1}$	$\frac{300}{C}$	$900\frac{I_{mag}T^2}{V_1}$	$\frac{350}{C}$

   where I_{mag} = magnetising primary r.m.s. current (A)
   V_1 = transfomer primary r.m.s. voltage (V)
   V_2 = transformer secondary r.m.s. voltage (V)
   T = V_1/V_2
   V_{RWM} stands for the actually applied crest working reverse voltage.

2. In order to prevent the thyristors from being damaged by surge currents higher than those mentioned in the curves at page 11 a fast fuse is recommended.



Determination of the heatsink thermal resistance

Example:
Assume a thyristor, used in a single phase full wave rectifier circuit.

frequency	f	=	50 Hz
conduction angle	α	=	180°
average forward current	I_{TAV}	=	60 A (per thyristor)
ambient temperature	T_{amb}	=	40 °C

From the left hand part of the graph above it follows that at I_{TAV} = 60 A and α = 180° the average forward power + average leakage power = 96 W per thyristor.

From the right hand part of the graph above follows the thermal resistance, required for P_{tot} = 96 W at T_{amb} = 40 °C

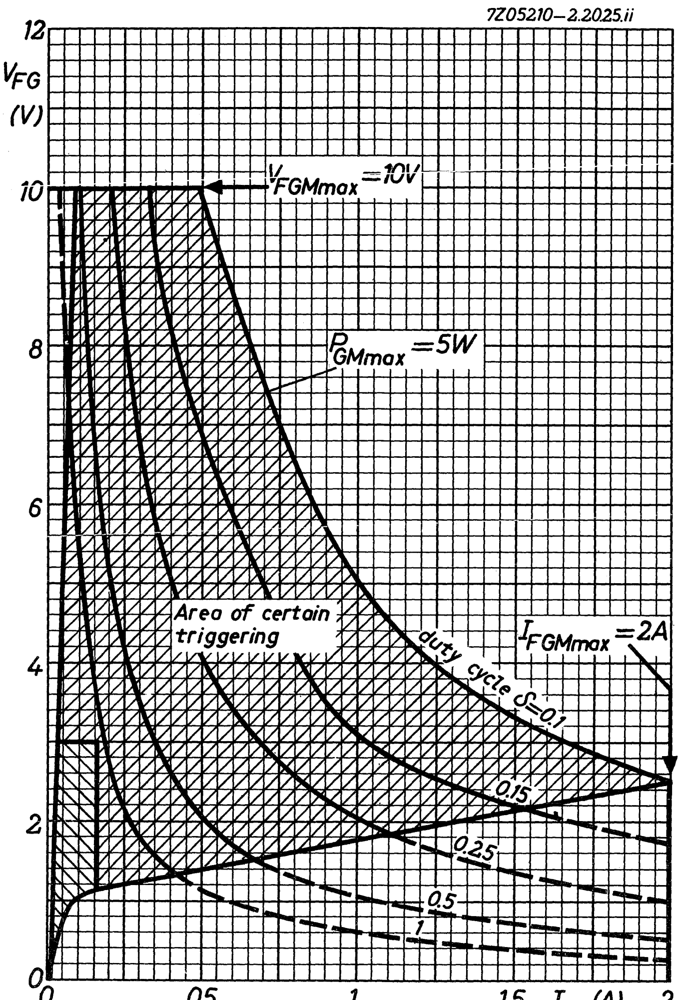
$$R_{th\ mb\text{-}a} \approx 0.5\ ^{o}C/W$$

The contact thermal resistance $R_{th\ mb\text{-}h}$ = 0.1 °C/W.

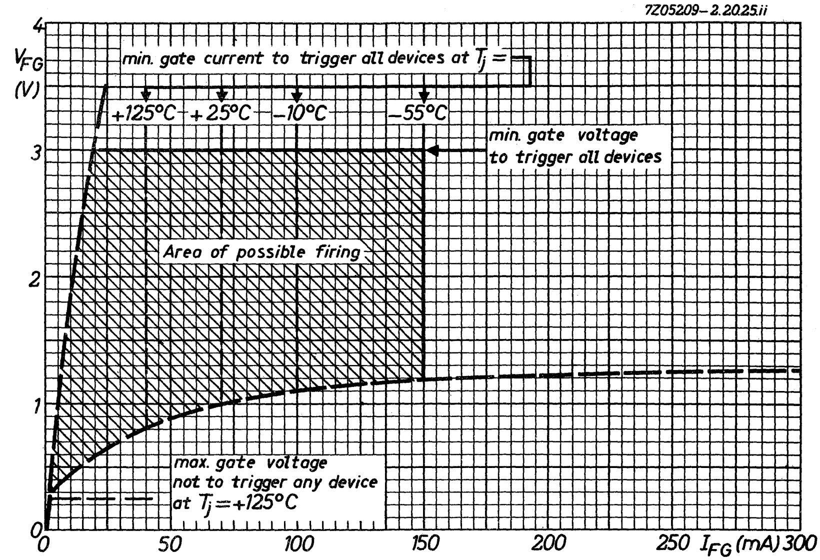
Hence the heatsink thermal resistance should be:

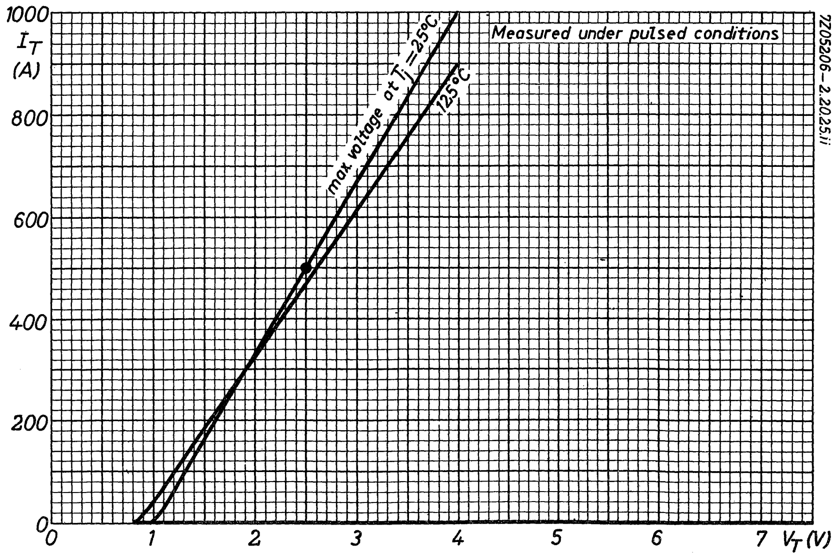
$$R_{th\ h\text{-}a} = R_{th\ mb\text{-}a} - R_{th\ mb\text{-}h} = (0.5 - 0.1)\ ^{o}C/W = 0.4\ ^{o}C/W.$$

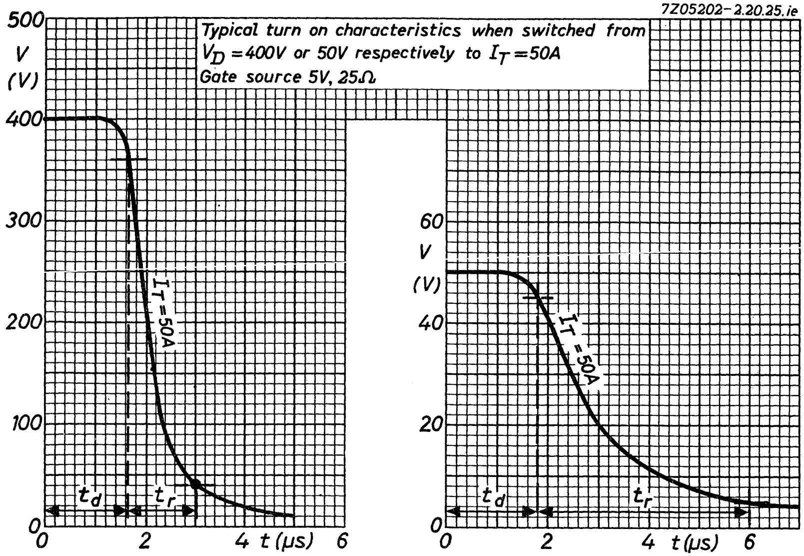
The applicable heatsink(s) may then be found in the Section ACCESSORIES and HEATSINKS.

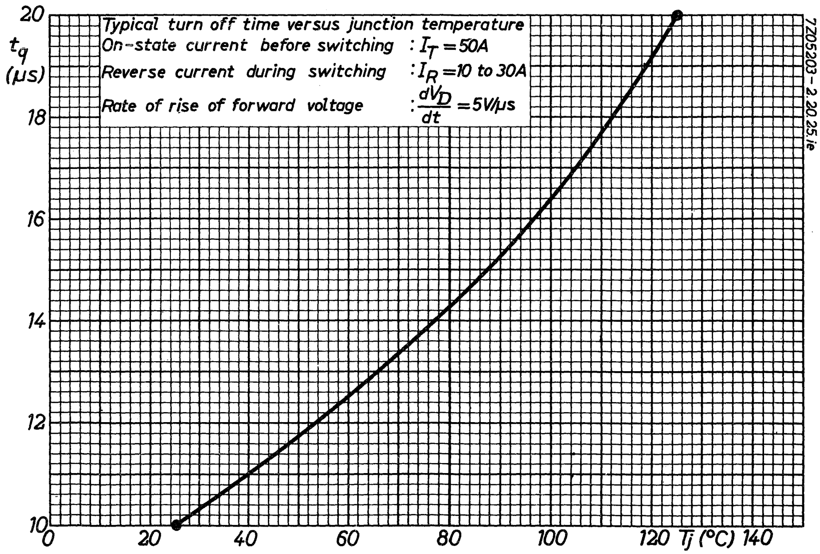


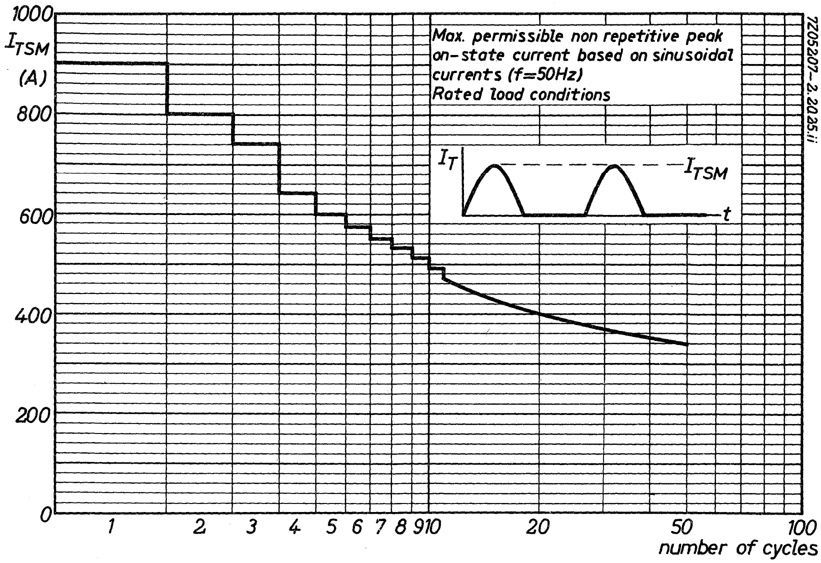
Gate characteristics with curves $P_{GAV} = 0.5W$


7Z05209–2.20.25.ii
V_{FG} (V)
min. gate current to trigger all devices at T_j =
+125°C
+25°C
–10°C
–55°C
min. gate voltage to trigger all devices
Area of possible firing
max. gate voltage not to trigger any device at T_j = +125°C
I_{FG} (mA)
0
50
100
150
200
250
300
1
2
3
4


I_T (A)
Measured under pulsed conditions
max. voltage at T_j = 25°C
125°C
7Z05206–2.20.25.ii
V_T (V)
0
200
400
600
800
1000
1
2
3
4
5
6
7


7Z05202-2.20.25.ie
Typical turn on characteristics when switched from
V_D =400V or 50V respectively to I_T =50A
Gate source 5V, 25Ω
500
V
(V)
400
300
200
100
0
I_T =50A
t_d
t_r
0
2
4 t (μs)
6
60
V
(V)
40
20
0
I_T =50A
t_d
t_r
0
2
4 t (μs)
6


7Z05203-2.20.25.ie
Typical turn off time versus junction temperature
On-state current before switching : I_T =50A
Reverse current during switching : I_R =10 to 30A
Rate of rise of forward voltage : $\frac{dV_D}{dt}$ =5V/μs
20
t_q
(μs)
18
16
14
12
10
0
20
40
60
80
100
120 T_j (°C) 140


1000
I_{TSM}
(A)
800
600
400
200
0
Max. permissible non repetitive peak on-state current based on sinusoidal currents (f=50Hz)
Rated load conditions
I_T
I_{TSM}
t
1
2
3
4
5
6
7
8
9
10
20
50
100
number of cycles
7Z05207-2.2025.ii

Rectifier stacks

HIGH VOLTAGE RECTIFIER STACKS

The OSB9110series is a range of high voltage rectifier units, incorporating BYX39-1000 and BYX39-1000R controlled avalanche diodes, mounted on a fireproof triangular former. The series is intended for application in two phase halve wave rectifier circuits.
The assemblies are supplied with $\frac{1}{4}$" U.N.F. studs or with standard valve bases and with a centre tap (8-32UNC).
The maximum crest working voltages for which single units can be supplied cover the range from 2 to 15 kV in steps of 1 kV.

QUICK REFERENCE DATA

Input		OSB9110-4	-6	...	-28	-30	
Crest working voltage	V_{IWM}	max. 2	3	...	14	15	kV
Output							
Average output current with R and L load (averaged over any 20 ms period)							
in free air at T_{amb} = 35 °C	I_O	max. 7 A					
in oil at T_{oil} = 100 °C	I_O	max. 12 A					

MECHANICAL DATA

See pages 4 and 5

All information applies to frequencies up to 400 Hz

RATINGS (Limiting values) [1])

Input voltage (see figure below)

		OSB9110-4	-6	...	-28	-30	
Crest working input voltage	V_{IWM}	max. 2	3	...	14	15	kV
R.M.S. input voltage	$V_{I(RMS)}$	max. 1.4	2.1	...	9.8	10.5	kV

Input current

Non repetitive peak input current
half sine wave; t = 10 ms — I_{ISM} max. 85 A

Output current (see figure below)

Average output current with R and L load (averaged over any 20 ms period)

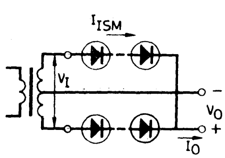
in free air at T_{amb} = 35 °C	I_O	max.	7	A
in oil at T_{oil} = 100 °C	I_O	max.	12	A
Repetitive peak output current	I_{ORM}	max.	120	A

Power dissipation in the avalanche region

		OSB9110-4	-6	...	-28	-30	
Repetitive peak power t = 10 μs; square wave; f = 50 Hz; T_j = 125 °C	P_{IRM}	max. 3	4.5	...	21	22.5	kW
Non repetitive peak power t = 10 μs; square wave; T_j = 25 °C	P_{ISM}	max. 6	9	...	42	45	kW

Temperatures

Storage temperature	T_{stg}	-55 to +175		°C
Junction temperature	T_j	max.	175	°C



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

CHARACTERISTICS (See note 1) $T_j = 25^{o}C$ unless otherwise specified

Forward voltage

		OSB9110-4	-6	...	-28	-30	
$I_F = 50$ A	V_F	< 4	6	...	28	30	V

Reverse breakdown voltage

$I_R = 5$ mA	$V_{(BR)R}$	> 2.5	3.75	...	17.5	18.75	kV
		< 3.2	4.8	...	22.4	24	kV

The breakdown voltage increases by approximately 0.1% per ^{o}C with increasing junction temperature

Reverse current

$V_I = V_{IWMmax}$; $T_j = 125\ ^{o}C$ I_R < 0.6 mA

NOTES

1. The characteristics given apply from centre tap to end.
2. Type number suffix

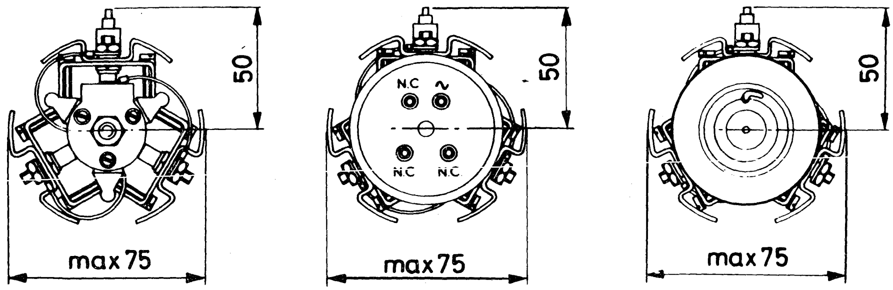
   The suffix consists of a figure indicating the total number of diodes, followed by either A, B or C.
   A = $\frac{1}{4}$" U.N.F. studs at the ends
   B = 4 pin base B4D
   C = Goliath Edison Screw cap.
2. Operating position

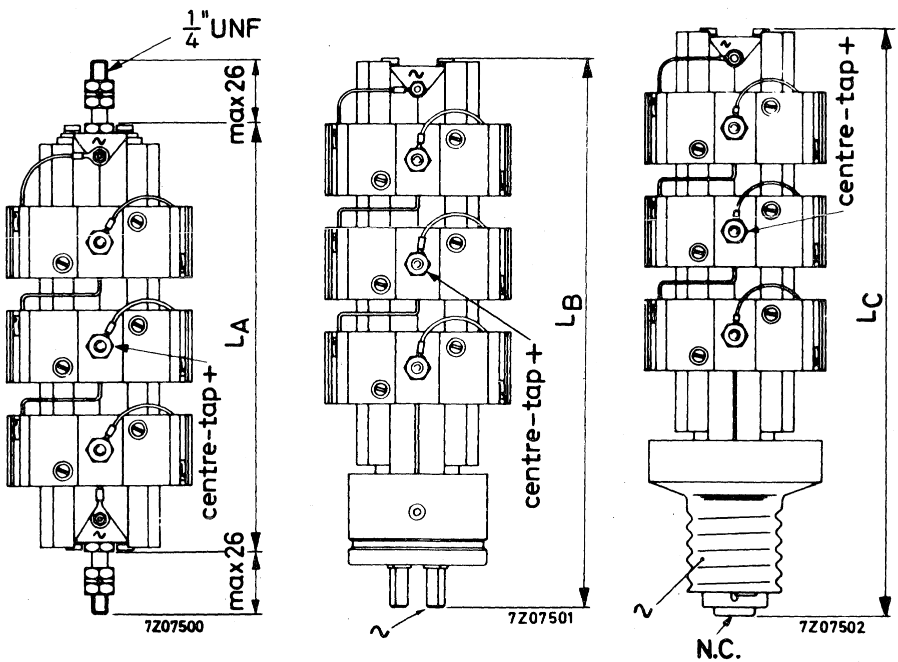
   The rectifier units can be operated at their maximum ratings when mounted in any position.

MECHANICAL DATA Dimensions in mm

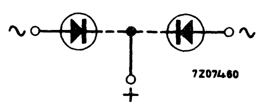
n = total number of diodes

OSB9110-nA OSB9110-nB OSB9110-nC





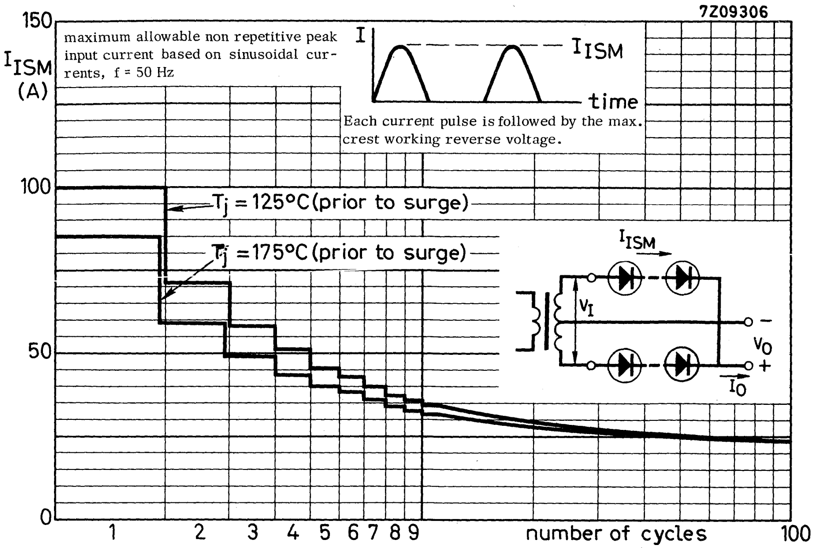
CIRCUIT OSB9110

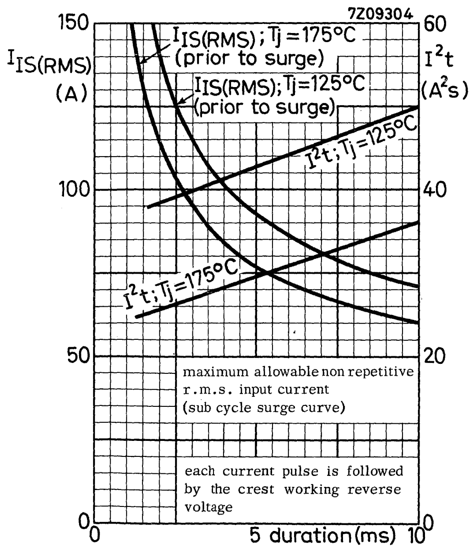


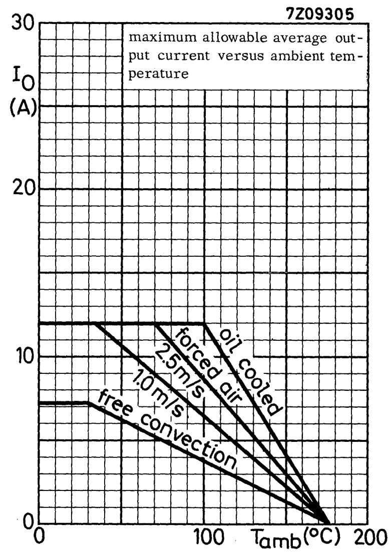
For lengths and weights see table on page 5.

Table of lengths and weights (mm and g)

		4 ; 6	8	10 ; 12	14	16 ; 18	20	22 ; 24	26	28 ; 30
number of diodes	n	4 ; 6	8	10 ; 12	14	16 ; 18	20	22 ; 24	26	28 ; 30
maximum lengths	L_A	132	172	212	253	293	333	374	414	454
	L_B	162	202	242	283	323	363	404	444	484
	L_C	199	239	279	320	360	400	441	481	521
weight	W_A	286	419	552	685	818	951	1084	1217	1350
	$W_B = W_C$	351	484	617	750	883	1016	1149	1282	1415


7Z09306
150
I_{ISM} (A)
maximum allowable non repetitive peak input current based on sinusoidal currents, f = 50 Hz
I
I_{ISM}
time
Each current pulse is followed by the max. crest working reverse voltage.
100
T_j = 125°C (prior to surge)
T_j = 175°C (prior to surge)
I_{ISM}
V_I
V_O
I_O
50
0
1
2
3
4
5
6
7
8
9
number of cycles
100


7Z09304
150
$I_{IS(RMS)}$ (A)
60
I^2t (A^2s)
$I_{IS(RMS)}$; T_j = 175°C (prior to surge)
$I_{IS(RMS)}$; T_j = 125°C (prior to surge)
I^2t; T_j = 125°C
100
40
I^2t; T_j = 175°C
50
20
maximum allowable non repetitive r.m.s. input current (sub cycle surge curve)
each current pulse is followed by the crest working reverse voltage
0
0
5 duration (ms) 10
0


7Z09305
30
I_O (A)
maximum allowable average output current versus ambient temperature
20
10
oil cooled
forced air
2.5 m/s
1.0 m/s
free convection
0
0
100
T_{amb} (°C)
200

HIGH VOLTAGE RECTIFIER STACKS

The OSB9210series is a range of high voltage rectifier units, incorporating BYX25-1000 and BYX25-1000R controlled avalanche diodes, mounted on a fire-proof triangular former. The series is intended for application in two phase halve wave rectifier circuits.
The assemblies are supplied with ¼" U.N.F. studs or with standard valve bases and with a centre tap (8-32UNC).
The maximum crest working voltages for which single units can be supplied cover the range from 2 to 15 kV in steps of 1 kV.

QUICK REFERENCE DATA

Input		OSB9210-4	-6	...	-28	-30	
Crest working voltage	V_{IWM}	max. 2	3	...	14	15	kV
Output							
Average output current with R and L load (averaged over any 20 ms period)							
in free air at T_{amb} = 35 °C	I_O	max. 10					A
in oil at T_{oil} = 30 °C	I_O	max. 40					A

MECHANICAL DATA

See pages 4 and 5

All information applies to frequencies up to 400 Hz

RATINGS (Limiting values) [1])

Input voltage (see figure below)

			OSB9210-4	-6	...	-28	-30
Crest working input voltage	V_{IWM}	max.	2	3	...	14	15 kV
R.M.S. input voltage	$V_{I(RMS)}$	max.	1.4	2.1	...	9.8	10.5 kV

Input current

Non repetitive peak input current half sine wave; t = 10 ms	I_{ISM}	max.	360	A
I squared t for fusing $t \leq 10$ ms	I^2t	max.	625	A^2s

Output current (see figure below)

Average output current with R and L load (averaged over any 20 ms period)

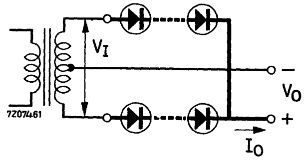
in free air at T_{amb} = 35 °C	I_O	max.	10	A
in oil at T_{oil} = 30 °C	I_O	max.	40	A
Repetitive peak output current	I_{ORM}	max.	440	A

Power dissipation in the avalanche region

			OSB9210-4	-6	...	-28	-30
Repetitive peak power t = 10 μs; square wave; f = 50 Hz; T_j = 125 °C	P_{IRM}	max.	10	15	...	70	75 kW
Non repetitive peak power t = 10 μs; square wave; T_j = 25 °C	P_{ISM}	max.	26	39	...	182	195 kW

Temperatures

Storage temperature	T_{stg}		-55 to +175	°C
Junction temperature	T_j	max.	175	°C



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

CHARACTERISTICS (See note 1) T_j = 25 °C unless otherwise specified

		OSB9210-4	-6	...	-28	-30	
Forward voltage							
I_F = 50 A	V_F	< 3.8	5.7	...	26.6	28.5	V
Reverse breakdown voltage							
I_R = 5 mA	$V_{(BR)R}$	> 2.5	3.75	...	17.5	18.75	kV
		< 3.2	4.8	...	22.4	24	kV

The breakdown voltage increases by approximately 0.1% per °C with increasing junction temperature

Reverse current

V_I = V_{IWMmax}; T_j = 125 °C I_R < 0.6 mA

NOTES

1. The characteristics given apply from centre tap to end.
2. Type number suffix

   The suffix consists of a figure indicating the total number of diodes, followed by either A, B or C.
   A = $\frac{1}{4}$" U.N.F. studs at the ends
   B = 4 pin base B4D
   C = Goliath Edison Screw cap.

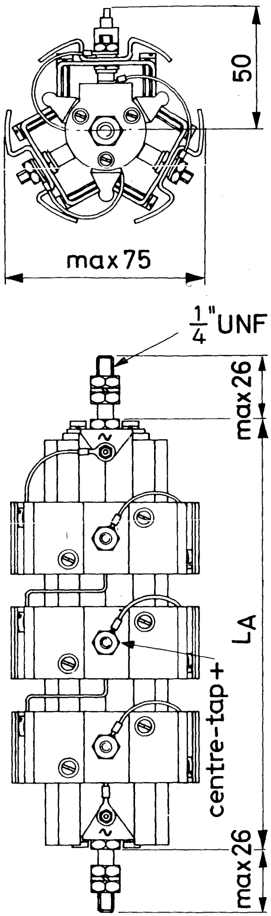
2. Operating position

   The rectifier units can be operated at their maximum ratings when mounted in any position.

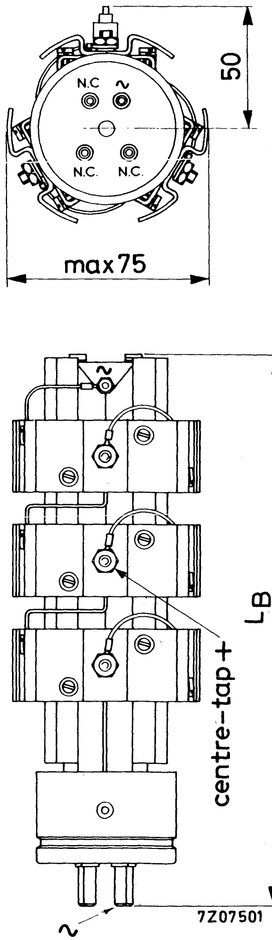
MECHANICAL DATA Dimensions in mm

n = total number of diodes

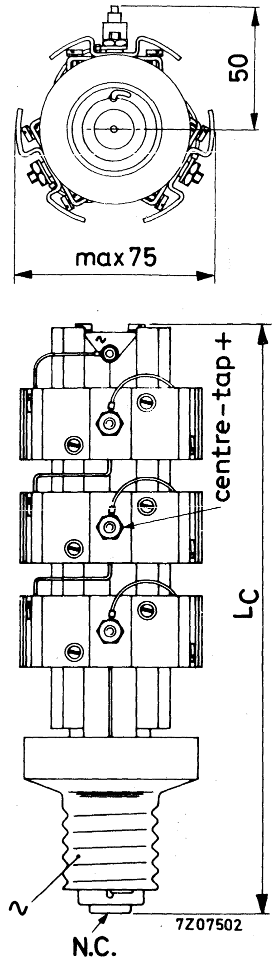
OSB9210-nA



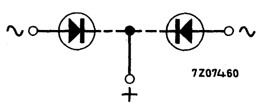
OSB9210-nB



OSB9210-nC



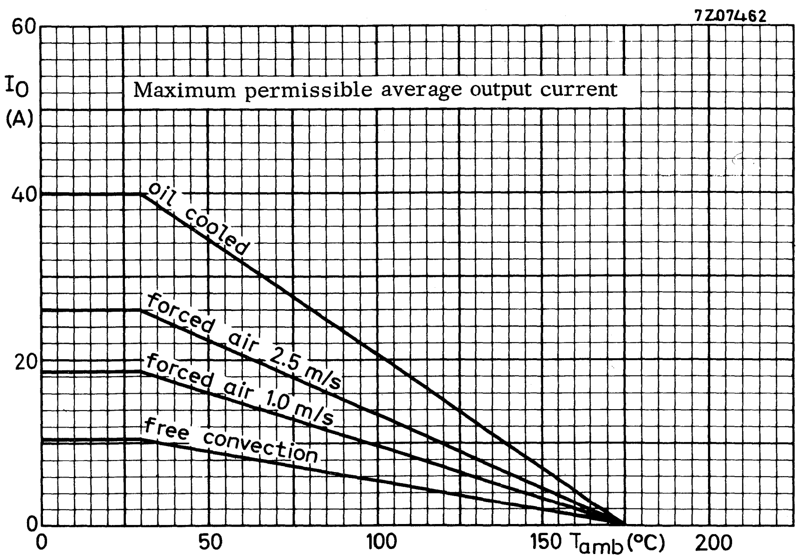
CIRCUIT OSB9210

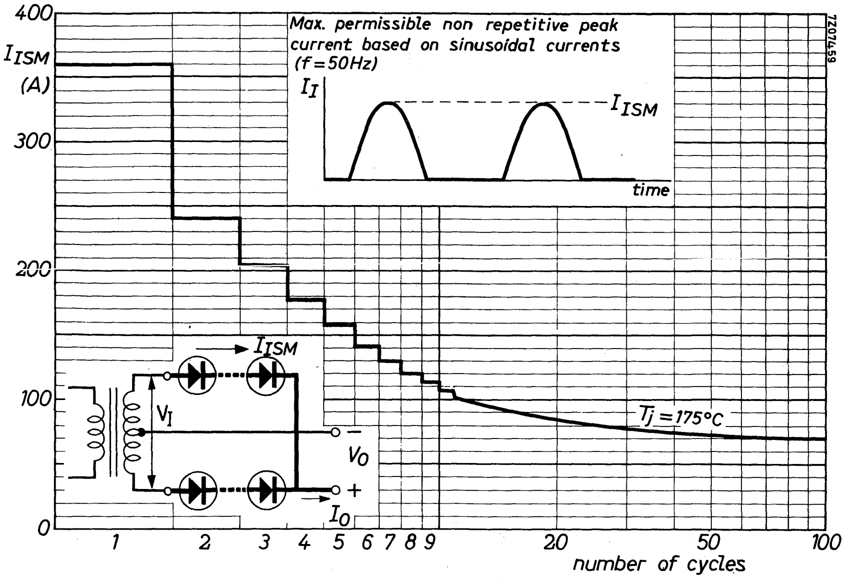


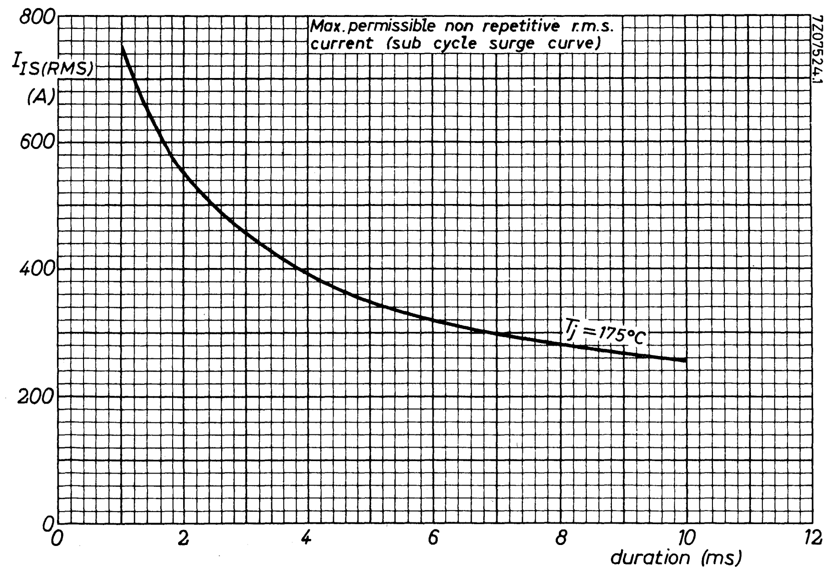
For lengths and weights see table on page 5.

Table of lengths and weights (mm and g)

number of diodes	n	4;6	8	10;12	14	16;18	20	22;24	26	28;30
maximum lengths	L_A	132	172	212	253	293	333	374	414	454
	L_B	162	202	242	283	323	363	404	444	484
	L_C	199	239	279	320	360	400	441	481	521
weight	W_A	286	419	552	685	818	951	1084	1217	1350
	$W_B = W_C$	351	484	617	750	883	1016	1149	1282	1415




400
I_{ISM}
(A)
300
200
100
0
Max. permissible non repetitive peak current based on sinusoidal currents (f=50Hz)
I_I
I_{ISM}
time
7Z07459
I_{ISM}
V_I
V_O
I_O
T_j = 175°C
1
2
3
4
5
6
7
8
9
20
50
100
number of cycles

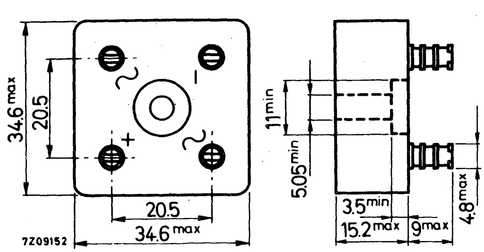

800
$I_{IS(RMS)}$
(A)
600
400
200
0
Max.permissible non repetitive r.m.s. current (sub cycle surge curve)
7Z07524.1
T_j = 175°C
0
2
4
6
8
10
12
duration (ms)

SINGLE PHASE FULL WAVE RECTIFIER MODULES

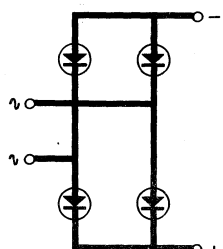
The OSH02series are single phase full wave rectifier modules which can be mounted on a heatsink.
The series consists of the types OSH02-200, OSH02-400 and OSH02-800.

QUICK REFERENCE DATA						
			OSH02-200	400	800	
Input						
R.M.S. voltage	$V_{I(RMS)}$	max.	140	280	560	V
Repetitive peak voltage	V_{IRM}	max.	300	600	1200	V
Output						
Average voltage with R and L load	V_O	max.	125	250	500	V
Average current with R and L load T_{amb} = 35 °C in free air	I_O	max.	1.9	1.9	1.9	A

MECHANICAL DATA Dimensions in mm



7Z09152



7Z05062

Weight: 40 g

All information applies to frequencies up to 400 Hz.

RATINGS (Limiting values) [1]

Input			OSH02-200	400	800	
R.M.S. voltage	$V_{I(RMS)}$	max.	140	280	560	V
Crest working voltage	V_{IWM}	max.	200	400	800	V
Repetitive peak voltage	V_{IRM}	max.	300	600	1200	V
Non repetitive peak voltage (t < 10 ms)	V_{ISM}	max.	300	600	1200	V
Non repetitive peak current (t = 20 ms; see page 4)	I_{ISM}	max.	18.5 (all types)			A

Output

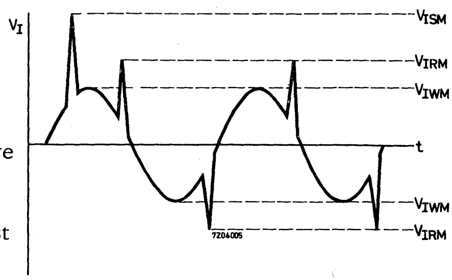
Average current with R and L load				
T_{amb} = 35 °C in free air	I_O	max.	1.9	A
T_{case} = 85 °C mounted on a heatsink	I_O	max.	2.0	A
Repetitive peak current				
T_{amb} = 25 °C	I_{ORM}	max.	15	A
T_{amb} = 100 °C	I_{ORM}	max.	5.0	A

Temperatures

Storage temperature	T_{stg}	max.	150	°C

MEANING OF SYMBOL SUBSCRIPTS

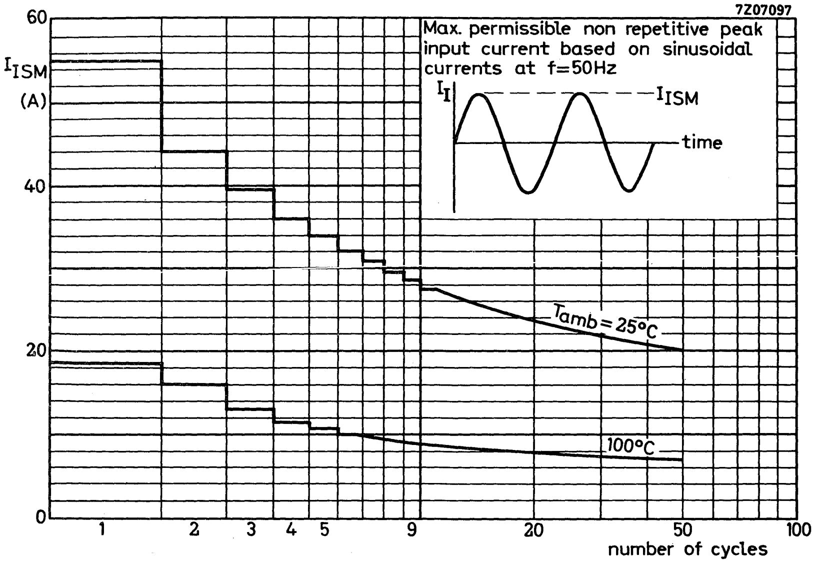
First subscript I = input
O = output
Second subscript R = repetitive
S = non repetitive
W = working
Third subscript M = peak or crest

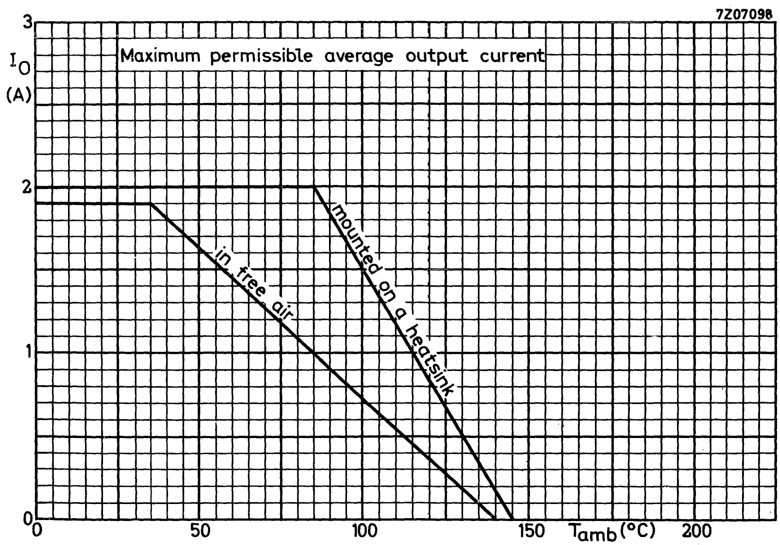


1) Limiting values according to the Absolute Maximum System as defined in IEC publication 134.

OPERATING NOTES

1. The modules have been designed so that they can withstand 5 kV(rms) between all electrical terminals connected together and chassis.
2. Care should be taken to ensure good thermal contact between device and heatsink. It is recommended to smear both surfaces with silicon grease.
3. The device may be mounted in any position with unrestricted airflow over the device.


7Z07097
Max. permissible non repetitive peak input current based on sinusoidal currents at f=50Hz
I_I
I_{ISM}
time
I_{ISM} (A)
60
40
20
0
T_{amb} = 25°C
100°C
1
2
3
4
5
9
20
50
100
number of cycles


7Z07098
Maximum permissible average output current
I_O (A)
3
2
1
0
in free air
mounted on a heatsink
0
50
100
150
T_{amb} (°C)
200

SINGLE PHASE FULL WAVE RECTIFIER STACKS

Single phase full wave rectifier stacks (bridge connected) incorporating four double diffused silicon diodes. The stacks may be used either with forced air or free convection cooling.

QUICK REFERENCE DATA

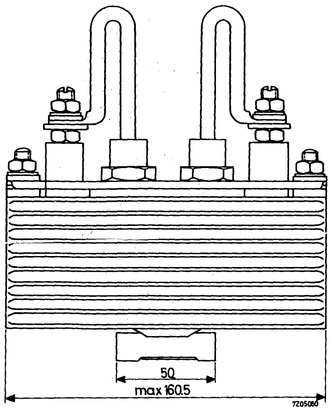
		OSH2504	OSH4502	OSH4503	
Input					
R.M.S. voltage	$V_{I(RMS)}$	max. 140	280	420	V
Repetitive peak voltage	V_{IRM}	max. 400	800	1200	V
Output					
Average voltage with R and L load	V_O	max. 125	250	375	V
Average current with R and L load					
free convection; T_{amb} = 50 °C	I_O	max. 47	47	47	A
forced cooling; T_{amb} = 40 °C	I_O	max. 80	80	80	A

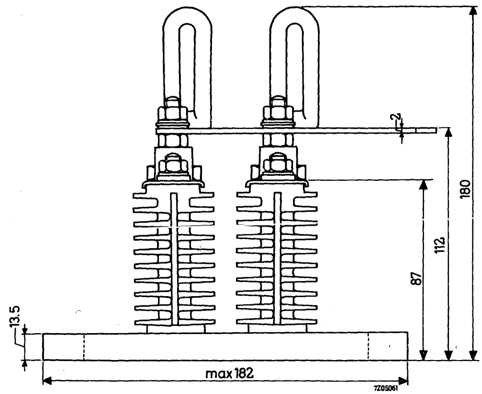
MECHANICAL DATA

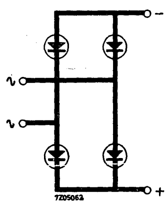
See page 2

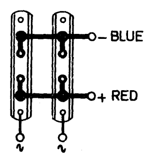
MECHANICAL DATA

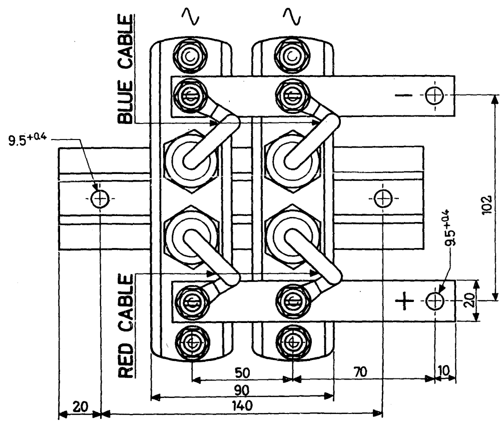
Dimensions in mm











All information applies to mains frequencies up to 400 Hz.

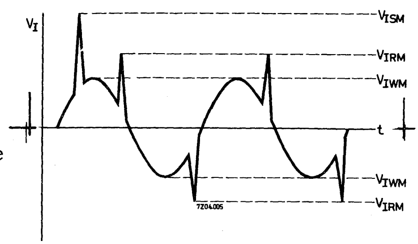
RATINGS (Limiting values) [1]

Input		OSH2504	OSH4502	OSH4503	
R.M.S. voltage	$V_{I(RMS)}$	max. 140	280	420	V
Crest working voltage	V_{IWM}	max. 200	400	600	V
Repetitive peak voltage	V_{IRM}	max. 400	800	1200	V
Non repetitive peak voltage (t < 10 ms)	V_{ISM}	max. 400	800	1200	V

Non repetitive peak current (t = 10 ms; see page 6)	I_{ISM}	max.	800	A
Output				
Average current with R and L load				
free convection; T_{amb} = 50 °C	I_O	max.	47	A
forced cooling 3 m/s; T_{amb} = 40 °C	I_O	max.	80	A
Repetitive peak current	I_{ORM}	max.	200	A
Temperatures				
Storage temperature	T_{stg}		−65 to +150	°C

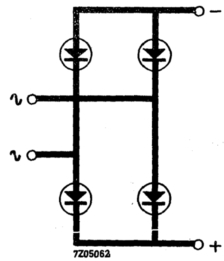
MEANING OF SYMBOL SUBSCRIPTS

First subscript	I	= input
	O	= output
Second subscript	R	= repetitive
	S	= non repetitive
	W	= working
Third subscript	M	= peak or crest



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

MAXIMUM OPERATING CONDITIONS[1])



		OSH2504	OSH4502	OSH4503	
Input					
R.M.S. voltage	$V_{I(RMS)}$	140	280	420	V
R.M.S. current					
free convection					
T_{amb} = 50 °C; R load	$I_{I(RMS)}$	52	52	52	A
L load	$I_{I(RMS)}$	47	47	47	A
forced cooling 3 m/s					
T_{amb} = 40 °C; R load	$I_{I(RMS)}$	88	88	88	A
L load	$I_{I(RMS)}$	80	80	80	A
Output					
Average voltage with R and L load	V_O	125	250	375	V
Average current with R and L load					
free convection; T_{amb} = 50 °C	I_O	47	47	47	A
forced cooling 3 m/s; T_{amb} = 40 °C	I_O	80	80	80	A

Required transformer volt amperes: 1.11 x average output power.

[1]) The V_I and I_O figures are absolute maximum values for resistive or inductive load; no source impedance is assumed.
The equipment designer has to determine an average design such that these values will not be exceeded.

OPERATING NOTES

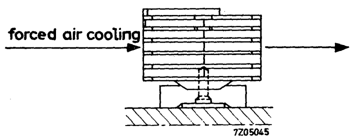
1. When there is a possibility that transient voltages, caused by the stored energy in the transformer core, will exceed the maximum permissible non repetitive peak reverse voltage, a damping circuit across the transformer should be applied.
   Either a series RC circuit or a voltage dependent resistor may be used. Suitable component values for an RC circuit across the transformer primary or secondary may be calculated as follows:

RC across primary of transformer	
C (μF)	R (Ω)
$200 \frac{I_{mag}}{V_1}$	$\frac{150}{C}$

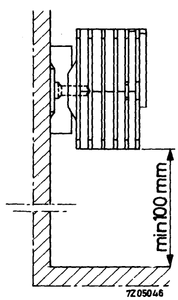
RC across secondary of transformer	
C (μF)	R (Ω)
$225 \frac{I_{mag}T^2}{V_1}$	$\frac{200}{C}$

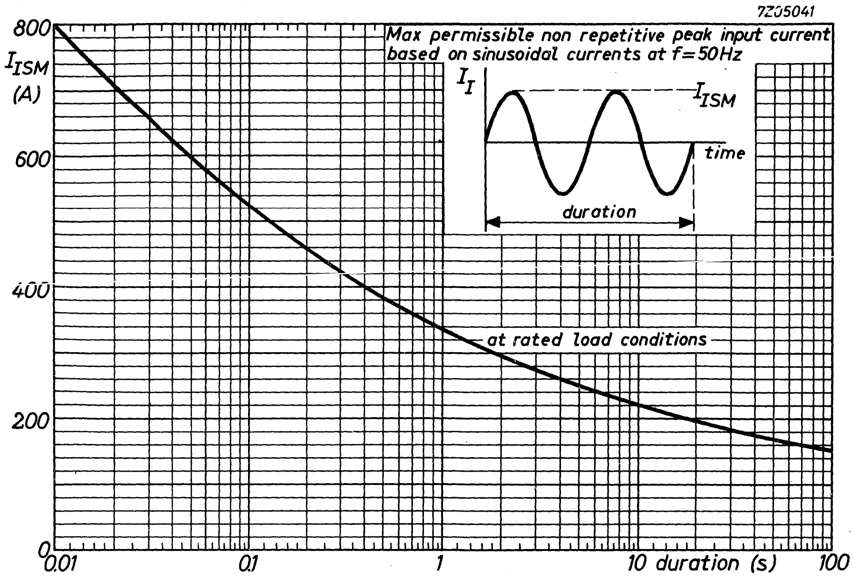
where:
I_{mag} = magnetising primary r.m.s. current (A)
V_1 = transformer primary r.m.s. voltage (V)
V_2 = transformer secondary r.m.s. voltage (V)
T = V_1/V_2

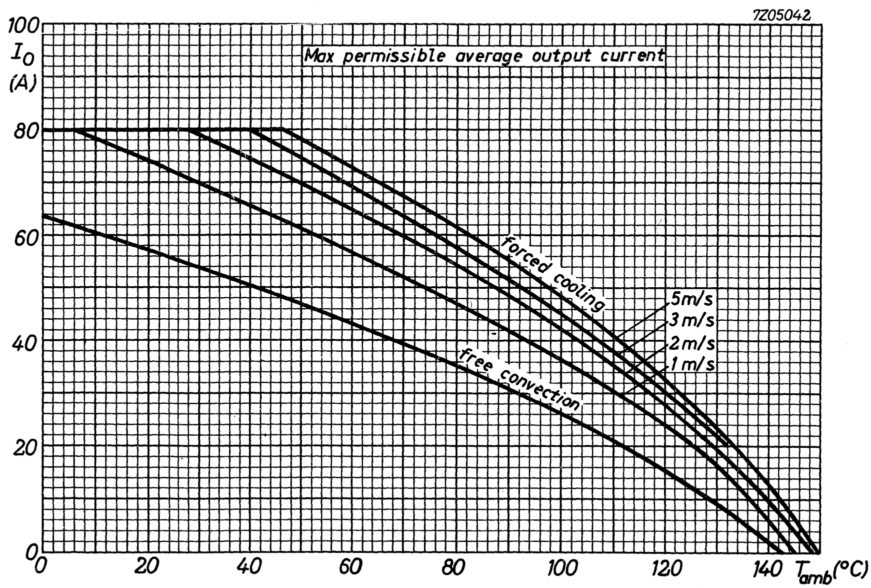
2. With forced air cooling at more than 0.5 m/s the stack may be mounted in any position, provided the air flow is parallel to the cooling fins.



With forced air cooling at less than 0.5 m/s and in the case of free convection, the stack should be mounted with a minimum clearance of 100 mm above the chassis, as shown below.




7Z05041
Max permissible non repetitive peak input current based on sinusoidal currents at f=50Hz
800
600
400
200
0
I_{ISM} (A)
I_I
I_{ISM}
time
duration
at rated load conditions
0.01
0.1
1
10 duration (s)
100


7Z05042
Max permissible average output current
100
80
60
40
20
0
I_O (A)
forced cooling
5m/s
3 m/s
2 m/s
1 m/s
free convection
0
20
40
60
80
100
120
140 T_{amb}(°C)

THREE PHASE FULL WAVE RECTIFIER STACKS

Three phase full wave rectifier stacks (bridge connected) incorporating six double diffused silicon diodes. The stacks may be used either with forced air or free convection cooling.

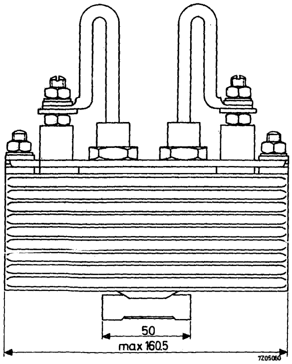
QUICK REFERENCE DATA

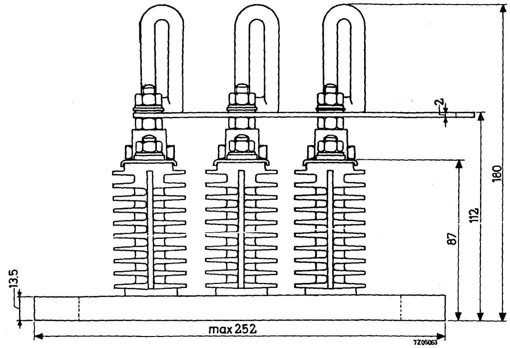
		OSK2503	OSK4509	OSK4510	
Input					
R.M.S. voltage	$V_{I(RMS)}$	max.140	280	420	V
Repetitive peak voltage	V_{IRM}	max.400	800	1200	V
Output					
Average voltage with R and L load	V_O	max.185	375	565	V
Average current with R and L load					
free convection; T_{amb} = 50 °C	I_O	max. 63	63	63	A
forced cooling ; T_{amb} = 40 °C	I_O	max.120	120	120	A

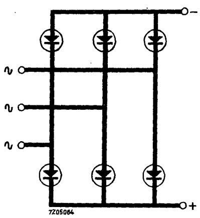
MECHANICAL DATA

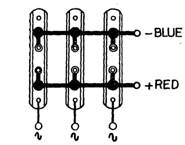
See page 2

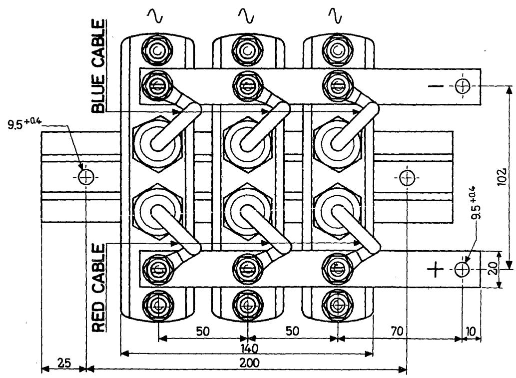
MECHANICAL DATA Dimensions in mm











All information applies to mains frequencies up to 400 Hz.

RATINGS (Limiting values) [1])

Input		OSK2503	OSK4509	OSK4510	
R.M.S. voltage	$V_{I(RMS)}$	max.140	280	420	V
Crest working voltage	V_{IWM}	max.200	400	600	V
Repetitive peak voltage	V_{IRM}	max.400	800	1200	V
Non repetitive peak voltage (t < 10 ms)	V_{ISM}	max.400	800	1200	V
Non repetitive peak current (t = 10 ms; see page 6)	I_{ISM}	max. 800 A			

Output

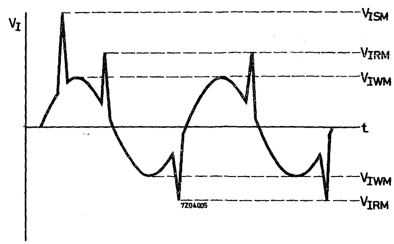
Average current with R and L load				
free convection; T_{amb} = 50 °C	I_O	max.	63	A
forced cooling 5 m/s; T_{amb} = 40 °C	I_O	max.	120	A
Repetitive peak current	I_{ORM}	max.	200	A

Temperatures

Storage temperature	T_{stg}	-65 to +150	°C

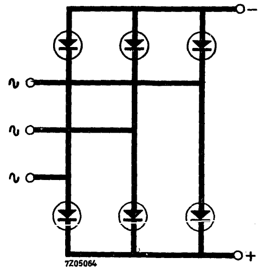
MEANING OF SYMBOL SUBSCRIPTS

First subscript	I	= input
	O	= output
Second subscript	R	= repetitive
	S	= non repetitive
	W	= working
Third subscript	M	= peak or crest



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

MAXIMUM OPERATING CONDITIONS [1])



		OSK2503	OSK4509	OSK4510	
Input					
R.M.S. voltage (line to line)	$V_{I(RMS)}$	140	280	420	V
R.M.S. current					
free convection					
T_{amb} = 50 C; R load L load	$I_{I(RMS)}$	52	52	52	A
forced cooling 5 m/s					
T_{amb} = 40 °C; R load L load	$I_{I(RMS)}$	98	98	98	A
Output					
Average voltage with R and L load	V_O	185	375	565	V
Average current with R and L load					
free convection; T_{amb} = 50 °C	I_O	63	63	63	A
forced cooling 5 m/s; T_{amb} = 40 °C	I_O	120	120	120	A

Required transformer volt amperes: 1.05 x average output power

[1]) The V_I and I_O figures are absolute maximum values for resistive or inductive load; no source impedance is assumed.
The equipment designer has to determine an average design such that these values will not be exceeded.

OPERATING NOTES

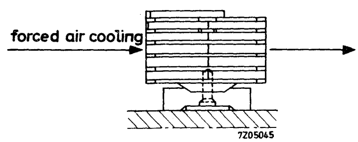
1. When there is a possibility that transient voltages, caused by the stored energy in the transformer core, will exceed the maximum permissible non repetitive peak reverse voltage, a damping circuit across the transformer should be applied.
   Either a series RC circuit or a voltage dependent resistor may be used. Suitable component values for an RC circuit across the transformer primary or secondary may be calculated as follows:

RC across primary of transformer		RC across secondary of transformer	
C (μF)	R (Ω)	C (μF)	R (Ω)
$200 \frac{I_{mag}}{V_1}$	$\frac{150}{C}$	$225 \frac{I_{mag}T^2}{V_1}$	$\frac{200}{C}$

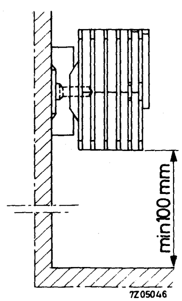
where:

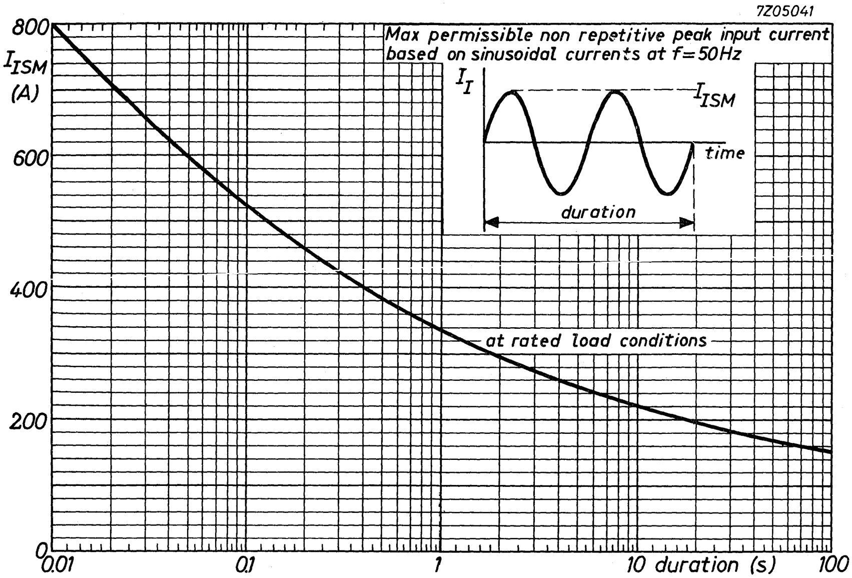
I_{mag} = magnetising primary r.m.s. current (A)
V_1 = transformer primary r.m.s. voltage (V)
V_2 = transformer secondary r.m.s. voltage (V)
T = V_1/V_2

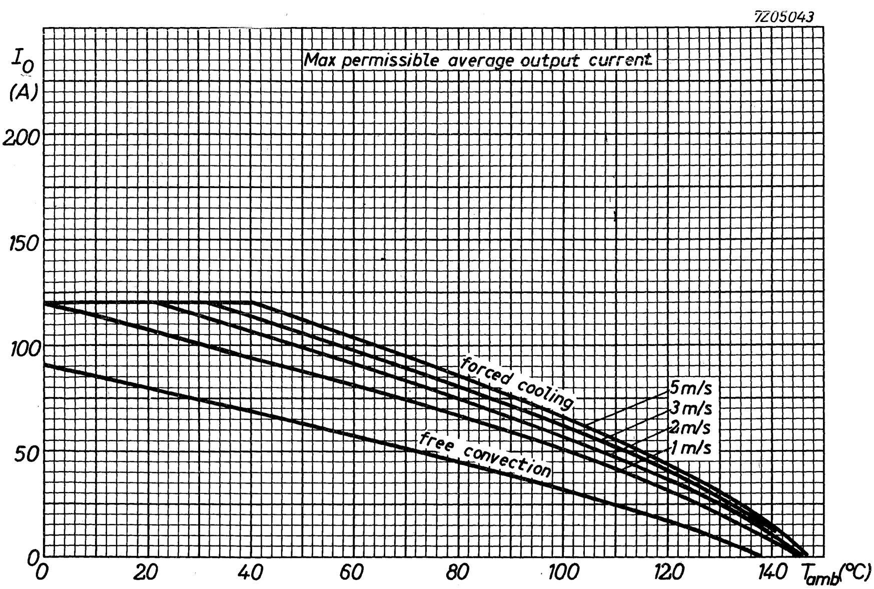
2. With forced air cooling at more than 0.5 m/s the stack may be mounted in any position, provided the air flow is parallel to the cooling fins.



   With forced air cooling at less than 0.5 m/s and in the case of free convection, the stack should be mounted with a minimum clearance of 100 mm above the chassis, as shown below.




7Z05041
Max permissible non repetitive peak input current based on sinusoidal currents at f=50Hz
I_{ISM} (A)
800
600
400
200
0
I_I
I_{ISM}
time
duration
at rated load conditions
0.01
0.1
1
10 duration (s)
100


7Z05043
Max permissible average output current
I_O (A)
200
150
100
50
0
forced cooling
5 m/s
3 m/s
2 m/s
1 m/s
free convection
0
20
40
60
80
100
120
140
T_{amb}(°C)

HIGH VOLTAGE RECTIFIER STACKS

The OSM9110series is a range of high voltage rectifier units, incorporating BYX39-1000R controlled avalanche diodes, connected in series and mounted on a fire-proof triangular former. The series is intended for application in single phase or three phase bridges or in voltage doubler circuits.
The assemblies are supplied with $\frac{1}{4}$" U.N.F. studs or with standard valve bases and with a centre tap (8-32UNC).
The maximum crest working voltages for which single units can be supplied cover the range from 2 to 15 kV in steps of 1 kV.

QUICK REFERENCE DATA

			OSM9110-4	-6	...	-28	-30	
Crest working reverse voltage from centre tap to end	V_{RWM}	max.	2	3	...	14	15	kV
Average forward current (averaged over any 20 ms period)								
in free air at T_{amb} = 35 °C	I_{FAV}	max.			3.5			A
in oil at T_{oil} = 100 °C	I_{FAV}	max.			6			A

MECHANICAL DATA

See pages 4 and 5

All information applies to frequencies up to 400 Hz

RATINGS (Limiting values) [1])

Voltage (see figures below)

		OSM9110-4	-6	...	-28	-30	
Crest working reverse voltage	V_{RWM}	max. 2	3	...	14	15	kV

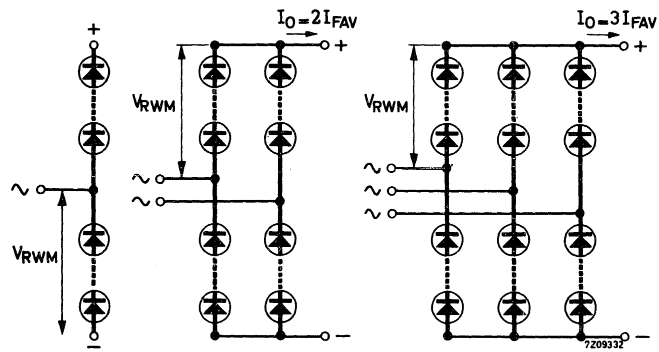
Currents

Average forward current (averaged over any 20 ms period)

in free air at T_{amb} = 35 °C	I_{FAV}	max.	3.5	A
in oil at T_{oil} = 100 °C	I_{FAV}	max.	6	A
Repetitive peak forward current	I_{FRM}	max.	120	A
Non repetitive peak forward current t = 10 ms; half sine wave	I_{FSM}	max.	85	A

Reverse power dissipation

		OSM9110-4	-6	...	-28	-30	
Repetitive peak reverse power t = 10 μs; square wave; f = 50 Hz; T_j = 125 °C	P_{RRM}	max. 3	4.5	...	21	22.5	kW
Non repetitive peak reverse power t = 10 μs; square wave; T_j = 25 °C	P_{RSM}	max. 6	9	...	42	45	kW



voltage doubler
1 x OSM9110

rectifier circuits with respectively
2 x OSM9110 and 3 x OSM9110

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

RATINGS (continued)

Temperatures

Storage temperature	T_{stg}	−55 to +175	°C
Junction temperature	T_j	max. 175	°C.

CHARACTERISTICS (See note 1) T_j = 25 °C unless otherwise specified

			OSM9110-4	-6	...	-28	-30	
Forward voltage								
I_F = 50 A	V_F	<	4	6	...	28	30	V
Reverse breakdown voltage								
I_R = 5 mA	$V_{(BR)R}$	>	2.5	3.75	...	17.5	18.75	kV
		<	3.2	4.8	...	22.4	24	kV

The breakdown voltage increases by approximately 0.1% per °C with increasing junction temperature

Reverse current

$V_R = V_{RWMmax}$; T_j = 125 °C I_R < 0.6 mA

NOTES

1. The characteristics given apply from centre tap to end.

2. Type number suffix

   The suffix consists of a figure indicating the total number of diodes, followed by either A, B or C.
   A = $\frac{1}{4}$" U.N.F. studs at the ends.
   B = 4 pin base B4D.
   C = Goliath Edison Screw cap.

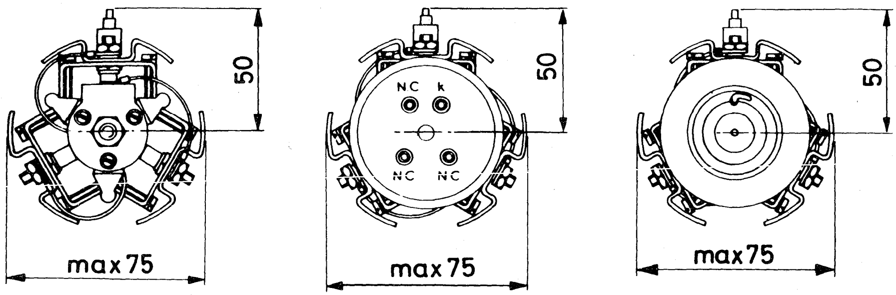
2. Operating position

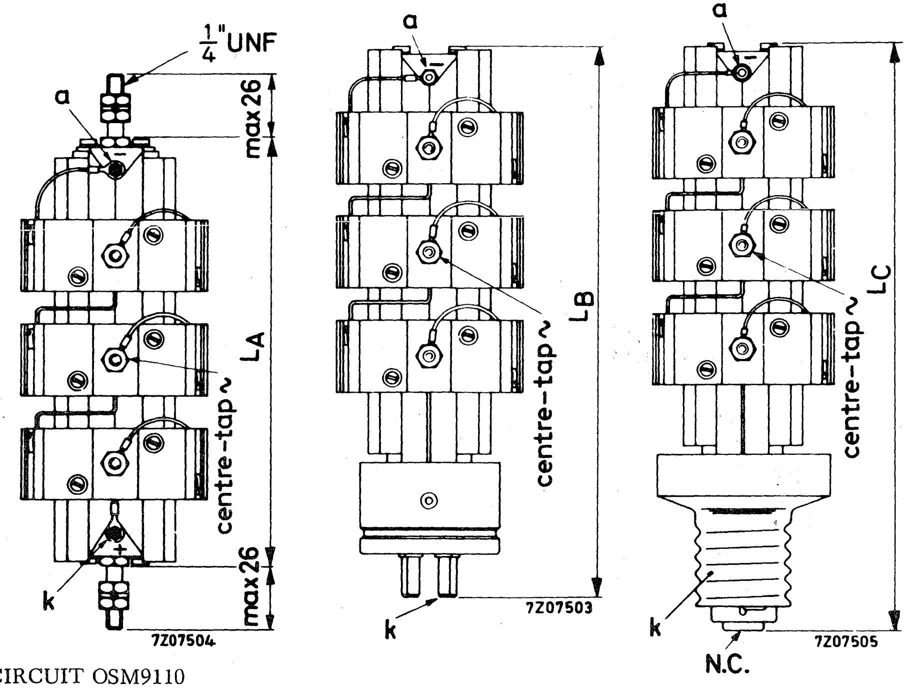
   The rectifier units can be operated at their maximum ratings when mounted in any position.

MECHANICAL DATA Dimensions in mm

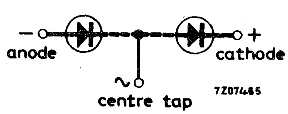
n = total number of diodes

OSM9110-nA OSM9110-nB OSM9110-nC





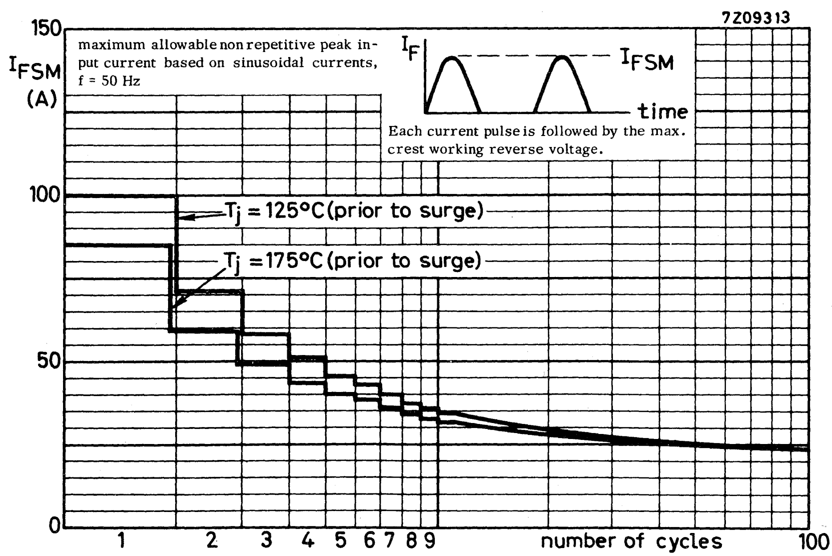
CIRCUIT OSM9110

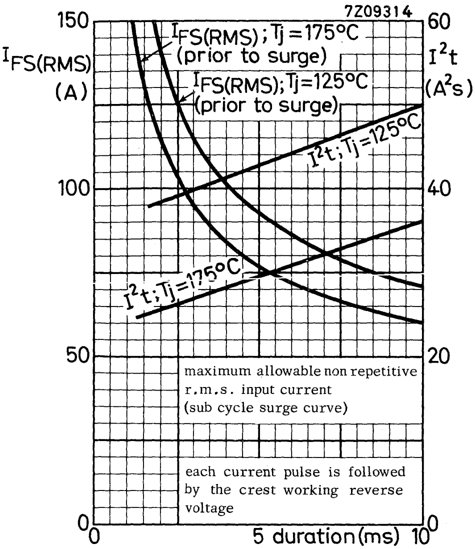


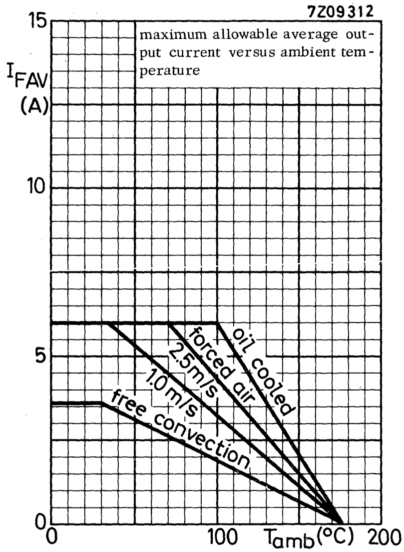
For lengths and weights see table on page 5.

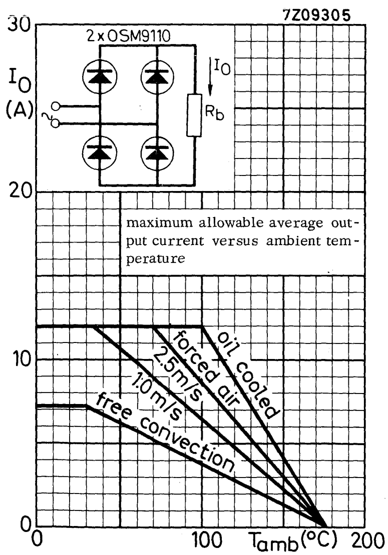
Table of lengths and weights (mm and g)

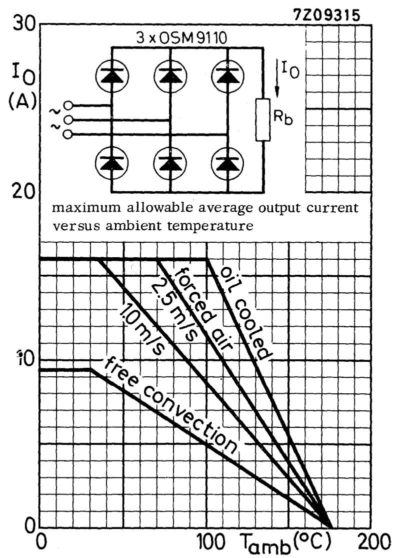
		4 ; 6	8	10 ; 12	14	16 ; 18	20	22 ; 24	26	28 ; 30
number of diodes	n	4 ; 6	8	10 ; 12	14	16 ; 18	20	22 ; 24	26	28 ; 30
maximum lengths	L_A	132	172	212	253	293	333	374	414	454
	L_B	162	202	242	283	323	363	404	444	484
	L_C	199	239	279	320	360	400	441	481	521
weight	W_A	286	419	552	685	818	951	1084	1217	1350
	$W_B = W_C$	351	484	617	750	883	1016	1149	1282	1415




7Z09314
150
100
50
0
$I_{FS(RMS)}$ (A)
60
40
20
0
I^2t (A^2s)
$I_{FS(RMS)}$; Tj = 175°C (prior to surge)
$I_{FS(RMS)}$; Tj = 125°C (prior to surge)
I^2t; Tj = 125°C
I^2t; Tj = 175°C
maximum allowable non repetitive r.m.s. input current (sub cycle surge curve)
each current pulse is followed by the crest working reverse voltage
0
5
10
duration (ms)


7Z09312
15
10
5
0
I_{FAV} (A)
maximum allowable average output current versus ambient temperature
oil cooled
forced air
2.5 m/s
1.0 m/s
free convection
0
100
200
T_{amb} (°C)


7Z09305
30
20
10
0
I_O (A)
2 x OSM9110
I_O
R_b
maximum allowable average output current versus ambient temperature
oil cooled
forced air
2.5 m/s
1.0 m/s
free convection
0
100
200
T_{amb} (°C)


7Z09315
30
20
10
0
I_O (A)
3 x OSM 9110
I_O
R_b
maximum allowable average output current versus ambient temperature
oil cooled
forced air
2.5 m/s
1.0 m/s
free convection
0
100
200
T_{amb} (°C)

HIGH VOLTAGE RECTIFIER STACKS

The OSM9210series is a range of high voltage rectifier units, incorporating BYX25-1000R controlled avalanche diodes, connected in series and mounted on a fire-proof triangular former. The series is intended for application in single phase or three phase bridges or in voltage doubler circuits.
The assemblies are supplied with $\frac{1}{4}$" U.N.F. studs or with standard valve bases and with a centre tap (8-32UNC).
The maximum crest working voltages for which single units can be supplied cover the range from 2 to 15 kV in steps of 1 kV.

QUICK REFERENCE DATA

			OSM9210-4	-6	...	-28	-30	
Crest working reverse voltage from centre tap to end	V_{RWM}	max.	2	3	...	14	15	kV
Average forward current (averaged over any 20 ms period)								
in free air at T_{amb} = 35 °C	I_{FAV}	max.			5			A
in oil at T_{oil} = 30 °C	I_{FAV}	max.			20			A

MECHANICAL DATA

See pages 4 and 5

All information applies to frequencies up to 400 Hz

RATINGS (Limiting values) [1]

The ratings apply from centre tap to end

Voltage (see figures below)

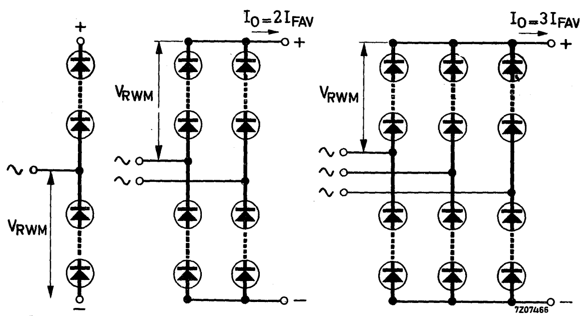
			OSM9210-4	-6	...	-28	-30	
Crest working reverse voltage	V_{RWM}	max.	2	3	...	14	15	kV

Currents

Average forward current (averaged over any 20 ms period)				
in free air at T_{amb} = 35 °C	I_{FAV}	max.	5	A
in oil at T_{oil} = 30 °C	I_{FAV}	max.	20	A
Repetitive peak forward current	I_{FRM}	max.	440	A
Non repetitive peak forward current t = 10 ms; half sine wave	I_{FSM}	max.	360	A
I squared t for fusing (t ≤ 10 ms)	I^2t	max.	625	A^2s

Reverse power dissipation

			OSM9210-4	-6	...	-28	-30	
Repetitive peak reverse power t = 10 μs; square wave; f = 50 Hz; T_j = 125 °C	P_{RRM}	max.	10	15	...	70	75	kW
Non repetitive peak reverse power t = 10 μs; square wave; T_j = 25 °C	P_{RSM}	max.	26	39	...	182	195	kW



voltage doubler
1 x OSM 9210

rectifier circuits with respectively
2 x OSM 9210 and 3 x OSM 9210

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

RATINGS (continued)

Temperatures

Storage temperature	T_{stg}	−55 to +175	°C
Junction temperature	T_j	max. 175	°C

CHARACTERISTICS (See note 1) T_j = 25 °C unless otherwise specified

			OSM9210-4	-6	...	-28	-30	
Forward voltage								
I_F = 50 A	V_F	<	3.8	5.7	...	26.6	28.5	V
Reverse breakdown voltage								
I_R = 5 mA	$V_{(BR)R}$	>	2.5	3.75	...	17.5	18.75	kV
		<	3.2	4.8	...	22.4	24	kV

The breakdown voltage increases by approximately 0.1% per °C with increasing junction temperature

Reverse current

$V_R = V_{RWM}$ max; T_j = 125 °C I_R < 0.6 mA

NOTES

1. The characteristics given apply from centre tap to end.
2. Type number suffix

   The suffix consists of a figure indicating the total number of diodes, followed by either A, B or C.
   A = ¼" U.N.F. studs at the ends.
   B = 4 pin base B4D
   C = Goliath Edison Screw cap.

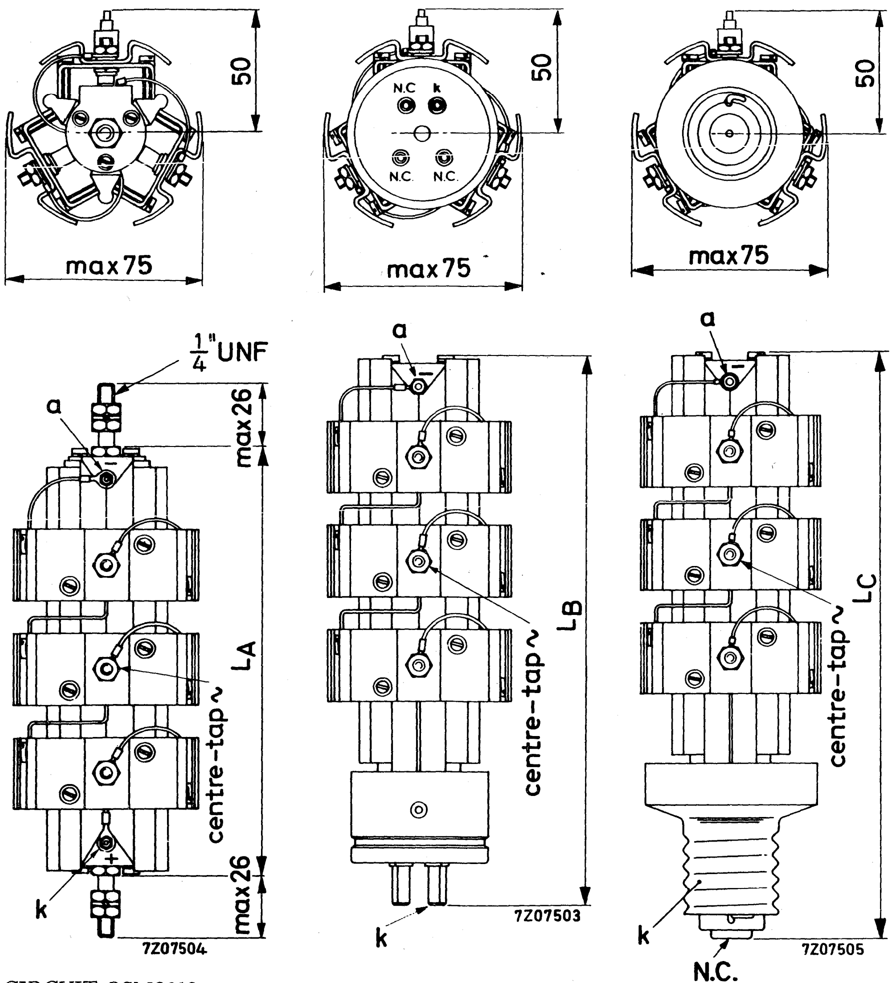
2. Operating position

   The rectifier units can be operated at their maximum ratings when mounted in any position.

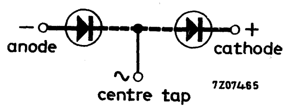
MECHANICAL DATA Dimensions in mm

n = total number of diodes

OSM9210-nA OSM9210-nB OSM9210-nC



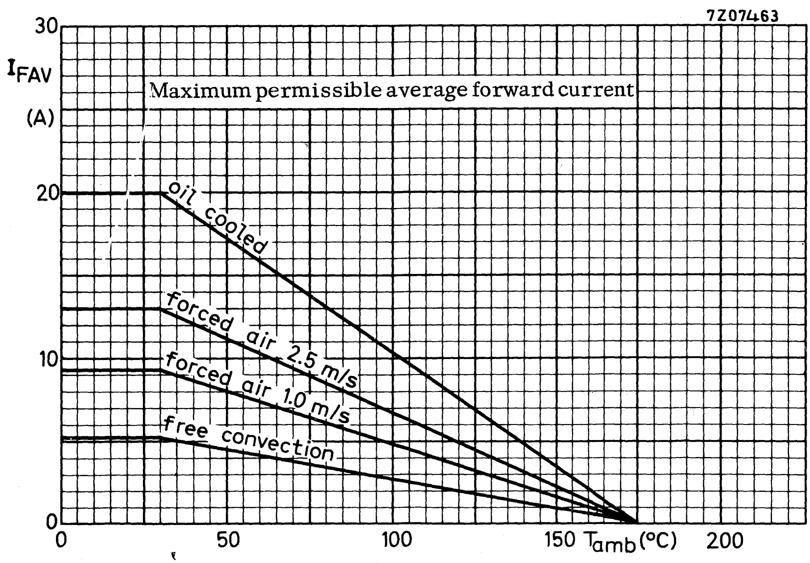
CIRCUIT OSM9210

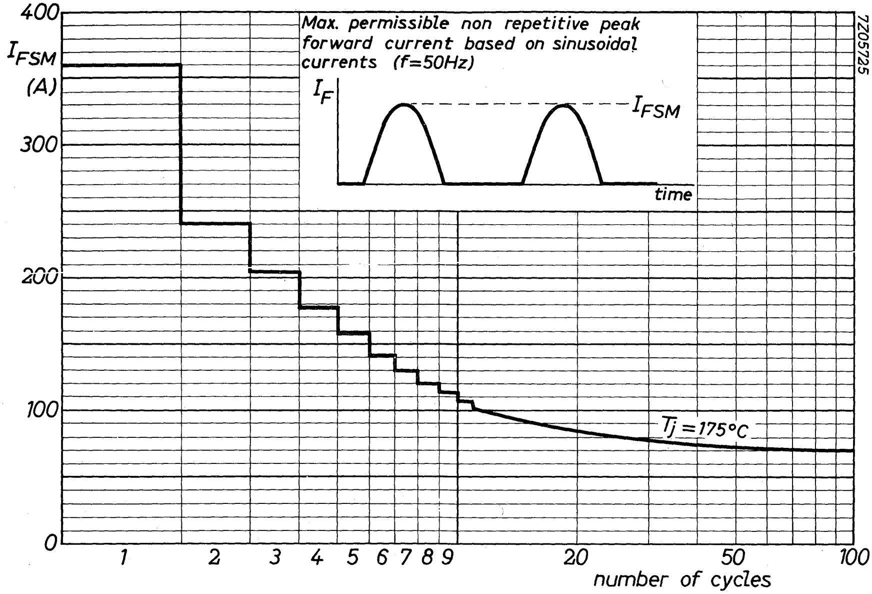


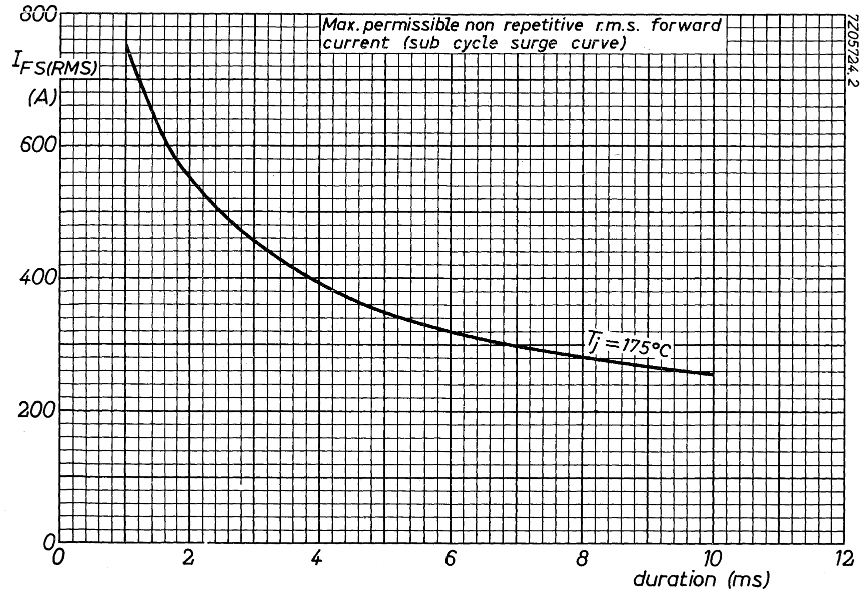
For lengths and weights see table on page 5.

Table of lengths and weights (mm and g)

number of diodes n	4;6	8	10;12	14	16;18	20	22;24	26	28;30
maximum lengths L_A	132	172	212	253	293	333	374	414	454
L_B	162	202	242	283	323	363	404	444	484
L_C	199	239	279	320	360	400	441	481	521
weight W_A	286	419	552	685	818	951	1084	1217	1350
$W_B = W_C$	351	484	617	750	883	1016	1149	1282	1415




Max. permissible non repetitive peak forward current based on sinusoidal currents (f=50Hz)
I_F
I_{FSM}
time
400
I_{FSM}
(A)
300
200
100
0
1
2
3
4
5
6
7
8
9
20
50
100
number of cycles
$T_j = 175°C$
7Z05725


Max. permissible non repetitive r.m.s. forward current (sub cycle surge curve)
800
$I_{FS(RMS)}$
(A)
600
400
200
0
0
2
4
6
8
10
12
duration (ms)
$T_j = 175°C$
7Z05724.2

HIGH VOLTAGE RECTIFIER STACKS

The OSS9110series is a range of high voltage rectifier units, incorporating BYX39-1000R controlled avalanche diodes, connected in series and mounted on a fire-proof triangular former.
The assemblies are supplied with $\frac{1}{4}$" U.N.F. studs or with standard valve bases.
The maximum crest working voltages for which single units can be supplied cover the range from 3 to 30 kV in steps of 1 kV.
Units can be connected in series for higher voltage applications.

QUICK REFERENCE DATA

		OSS9110-3	-4	...	-29	-30	
Crest working reverse voltage	V_{RWM}	max. 3	4	...	29	30	kV
Average forward current with R and L load (averaged over any 20 ms period)							
in free air at T_{amb} = 35 °C	I_{FAV}	max. 3.5					A
in oil at T_{oil} = 100 °C	I_{FAV}	max. 6					A

MECHANICAL DATA

See pages 4 and 5

All information applies to frequencies up to 400 Hz

RATINGS (Limiting values) [1])

Voltages

		OSS9110-3	-4	...	-29	-30	
Crest working reverse voltage	V_{RWM}	max. 3	4	...	29	30	kV

Currents

Average forward current with R and L load (averaged over any 20 ms period)

in free air at T_{amb} = 35 °C	I_{FAV}	max.	3.5	A
in oil at T_{oil} = 100 °C	I_{FAV}	max.	6	A
Repetitive peak forward current	I_{FRM}	max.	120	A
Non repetitive peak forward current; half sine wave t = 10 ms	I_{FSM}	max.	85	A

Reverse power dissipation

		OSS9110-3	-4	...	-29	-30	
Repetitive peak reverse power t = 10 μs; square wave; f = 50 Hz; T_j = 125 °C	P_{RRM}	max. 4.5	6	...	43.5	45	kW
Non repetitive peak reverse power t = 10 μs; square wave T_j = 25 °C	P_{RSM}	max. 9	12	...	87	90	kW

Temperatures

Storage temperature	T_{stg}		-55 to +175	°C
Junction temperature	T_j	max.	175	°C

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

CHARACTERISTICS

T_j = 25 °C unless otherwise specified

		OSS9110-3	-4	...	-29	-30	
Forward voltage							
I_F = 50 A	V_F	< 6	8	...	58	60	V
Reverse breakdown voltage							
I_R = 5 mA	$V_{(BR)R}$	> 3.75	5.0	...	36.25	37.5	kV
		< 4.8	6.4	...	46.6	48	kV

The breakdown voltage increases by approximately 0.1% per °C with increasing junction temperature

Reverse current

$V_R = V_{RWMmax}$; T_j = 125 °C I_R < 0.6 mA

NOTES

1. Type number suffix

   The suffix consists of a figure indicating the total number of diodes, followed by either A, B or C
   A = $\frac{1}{4}$" U.N.F. studs at the ends
   B = 4 pin base B4D
   C = Goliath Edison Screw cap.

2. Operating position

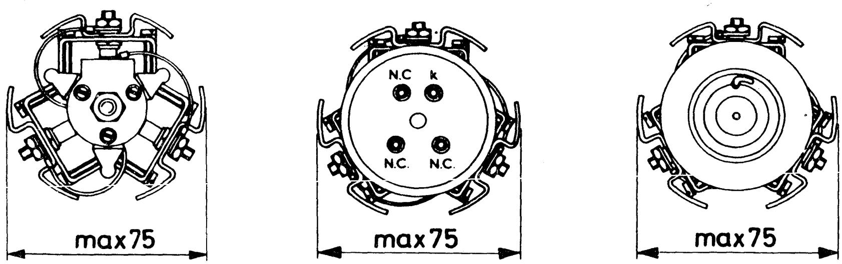
   The rectifier units can be operated at their maximum ratings when mounted in any position.

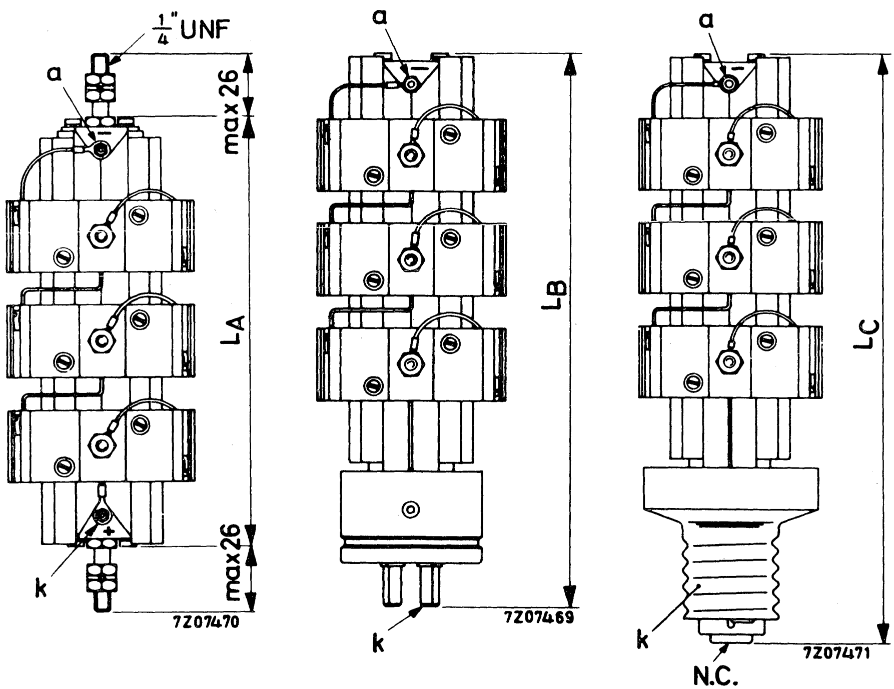
MECHANICAL DATA

Dimensions in mm

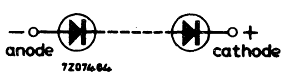
n = total number of diodes

OSS9110-nA OSS9110-nB OSS9110-nC





CIRCUIT OSS9110

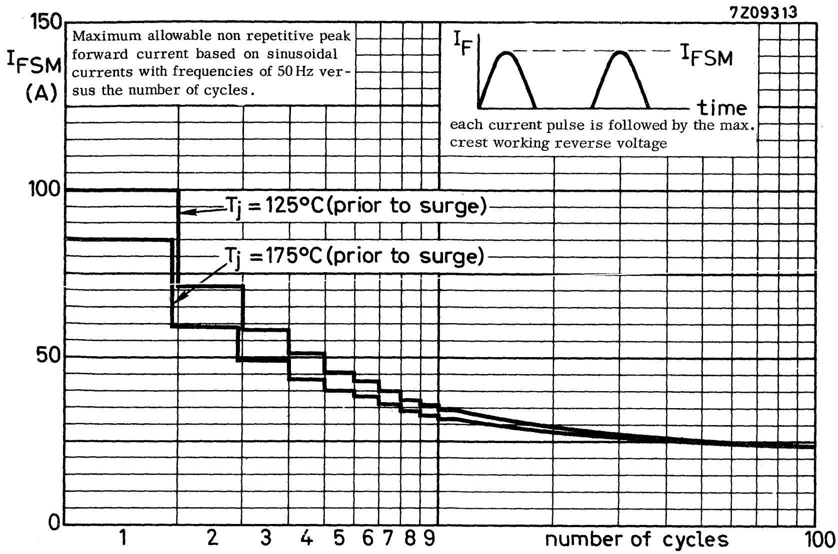


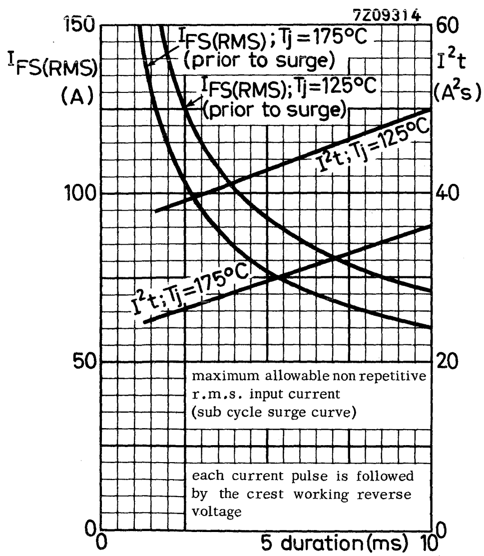
For lengths and weights see table on page 5.

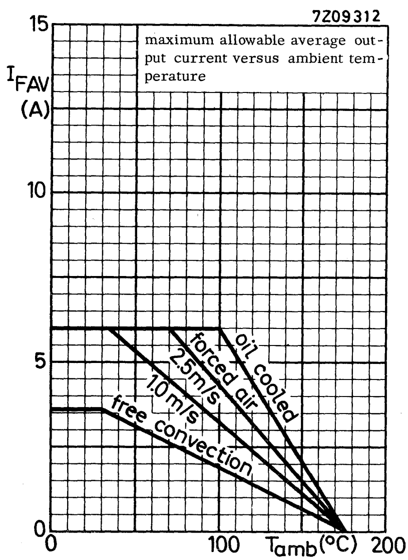
Table of lengths and weights (mm and g)

number of diodes	n	3	4 to 6	7 to 9	10 to 12	13 to 15
maximum lengths	L_A	91	132	172	212	253
	L_B	121	162	202	242	283
	L_C	159	199	239	279	320
weight	W_A	153	286	419	552	685
	$W_B = W_C$	218	351	484	617	750

number of diodes	n	16 to 18	19 to 21	22 to 24	25 to 27	28 to 30
maximum lengths	L_A	293	333	374	414	454
	L_B	323	363	404	444	484
	L_C	360	400	441	481	521
weight	W_A	818	951	1084	1217	1350
	$W_B = W_C$	883	1016	1149	1282	1415


7Z09313
150
IFSM
(A)
Maximum allowable non repetitive peak forward current based on sinusoidal currents with frequencies of 50 Hz versus the number of cycles.
IF
IFSM
time
each current pulse is followed by the max. crest working reverse voltage
100
Tj = 125°C (prior to surge)
Tj = 175°C (prior to surge)
50
0
1 2 3 4 5 6 7 8 9
number of cycles
100


7Z09314
150
IFS(RMS)
(A)
IFS(RMS); Tj = 175°C (prior to surge)
IFS(RMS); Tj = 125°C (prior to surge)
60
I²t
(A²s)
I²t; Tj = 125°C
I²t; Tj = 175°C
100
40
50
20
maximum allowable non repetitive r.m.s. input current (sub cycle surge curve)
each current pulse is followed by the crest working reverse voltage
0
0
5 duration (ms) 10
0


7Z09312
15
IFAV
(A)
maximum allowable average output current versus ambient temperature
10
5
oil cooled
forced air
2.5 m/s
1.0 m/s
free convection
0
0
100
Tamb (°C)
200

HIGH VOLTAGE RECTIFIER STACKS

The OSS9210series is a range of high voltage rectifier units, incorporating BYX25-1000R controlled avalanche diodes, connected in series and mounted on a fire-proof triangular former.
The assemblies are supplied with $\frac{1}{4}$" U.N.F. studs or with standard valve bases. The maximum crest working voltages for which single units can be supplied cover the range from 3 to 30 kV in steps of 1 kV.
Units can be connected in series for higher voltage applications.

QUICK REFERENCE DATA

			OSS9210-3	-4	...	-29	-30	
Crest working reverse voltage	V_{RWM}	max.	3	4	...	29	30	kV
Average forward current with R and L load (averaged over any 20 ms period)								
in free air at T_{amb} = 35 °C	I_{FAV}	max.			5			A
in oil at T_{oil} = 30 °C	I_{FAV}	max.			20			A

MECHANICAL DATA

See pages 4 and 5

All information applies to frequencies up to 400 Hz

RATINGS (Limiting values) [1]

Voltages		OSS9210-3	-4	...	-29	-30	
Crest working reverse voltage	V_{RWM}	max. 3	4	...	29	30	kV

Currents

Average forward current with R and L load (averaged over any 20 ms period) in free air at T_{amb} = 35 °C	I_{FAV}	max.	5	A
in oil at T_{oil} = 30 °C	I_{FAV}	max.	20	A
Repetitive peak forward current	I_{FRM}	max.	440	A
Non repetitive peak forward current; half sine wave t = 10 ms; T_j = 175 °C	I_{FSM}	max.	360	A
I squared t for fusing t = 1 to 10 ms	I^2t	max.	625	A^2s

Reverse power dissipation		OSS9210-3	-4	...	-29	-30	
Repetitive peak reverse power t = 10 µs; square wave; f = 50 Hz; T_j = 125 °C	P_{RRM}	max. 15	20	...	145	150	kW
Non repetitive peak reverse power t = 10 µs; square wave T_j = 25 °C	P_{RSM}	max. 39	52	...	377	390	kW

Temperatures

Storage temperature	T_{stg}	-55 to +175		°C
Junction temperature	T_j	max.	175	°C

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

CHARACTERISTICS

T_j = 25 °C unless otherwise specified

			OSS9210-3	-4	...	-29	-30	
Forward voltage								
I_F = 50 A	V_F	<	5.7	7.6	...	55.1	57	V
Reverse breakdown voltage								
I_R = 5 mA	$V_{(BR)R}$	>	3.75	5.0	...	36.25	37.5	kV
		<	4.8	6.4	...	46.6	48	kV

The breakdown voltage increases by approximately 0.1% per °C with increasing junction temperature

Reverse current

$V_R = V_{RWMmax}$; T_j = 125 °C I_R < 0.6 mA

NOTES

1. Type number suffix

   The suffix consists of a figure indicating the total number of diodes, followed by either A, B or C
   A = ¼" U.N.F. studs at the ends
   B = 4 pin base B4D
   C = Goliath Edison Screw cap.

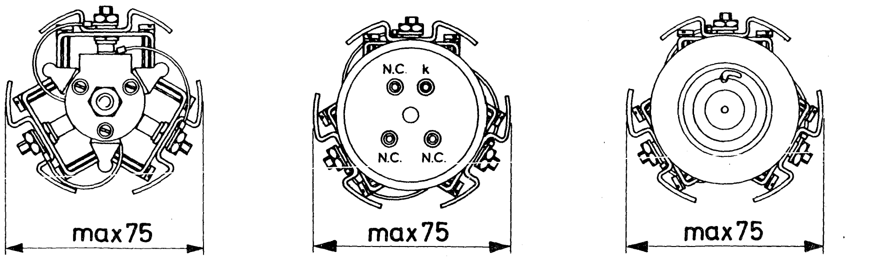
2. Operating position

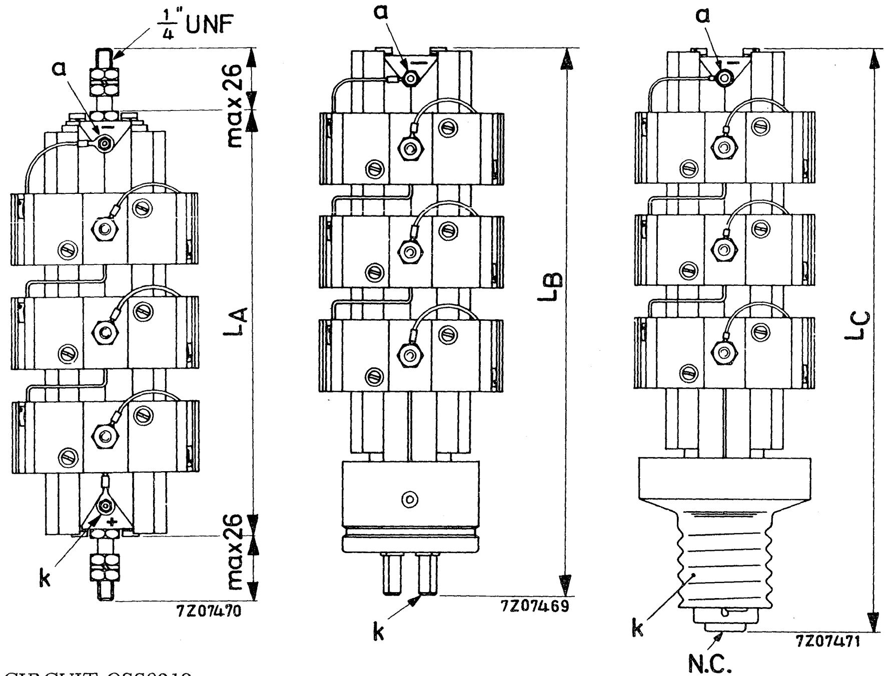
   The rectifier units can be operated at their maximum ratings when mounted in any position.

MECHANICAL DATA Dimensions in mm

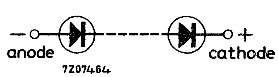
n = total number of diodes

OSS9210-nA OSS9210-nB OSS9210-nC





CIRCUIT OSS9210

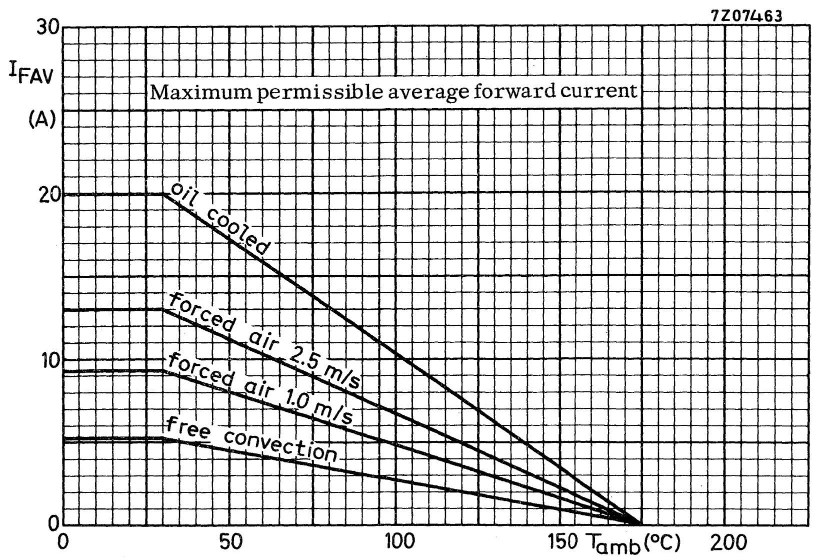


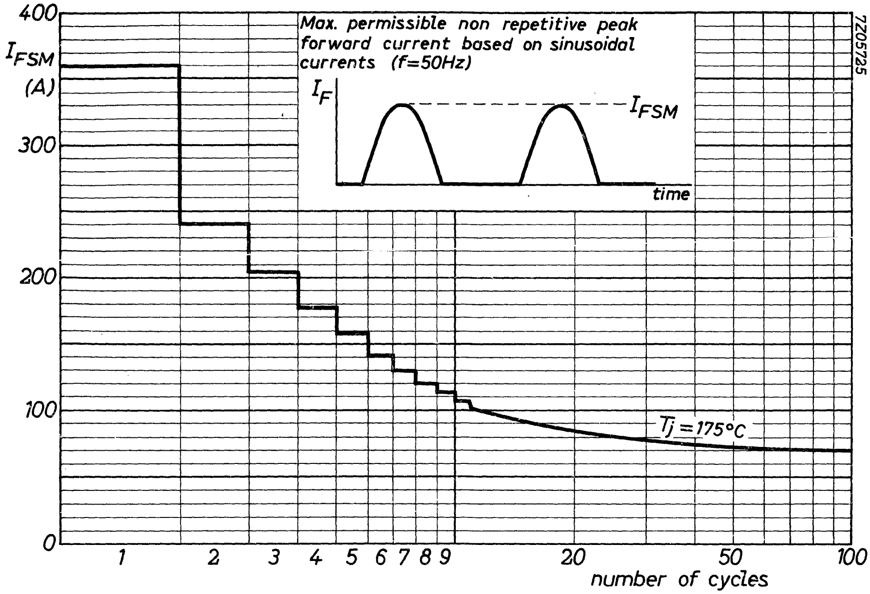
For lengths and weights see table on page 5.

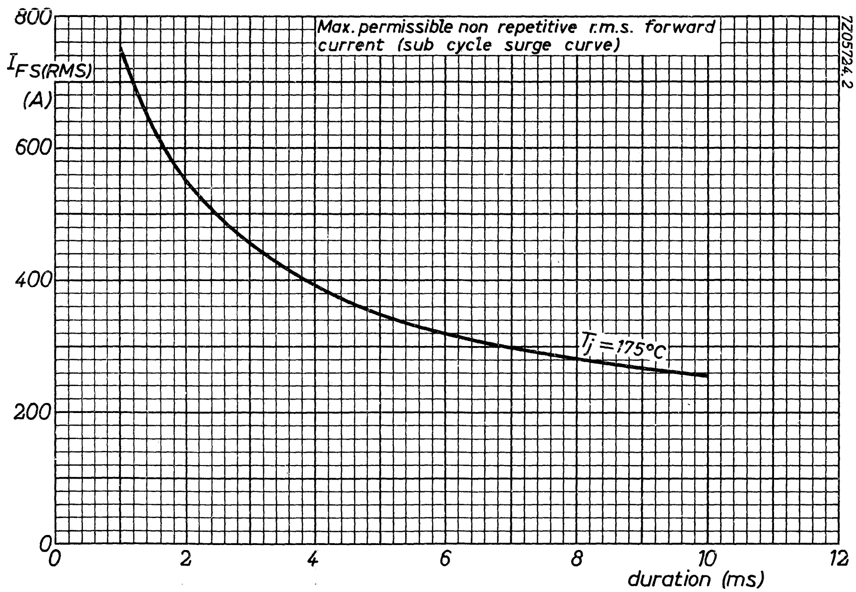
Table of lengths and weights (mm and g)

number of diodes	n	3	4 to 6	7 to 9	10 to 12	13 to 15
maximum lengths	L_A	91	132	172	212	253
	L_B	121	162	202	242	283
	L_C	159	199	239	279	320
weight	W_A	153	286	419	552	685
	$W_B = W_C$	218	351	484	617	750

number of diodes	n	16 to 18	19 to 21	22 to 24	25 to 27	28 to 30
maximum lengths	L_A	293	333	374	414	454
	L_B	323	363	404	444	484
	L_C	360	400	441	481	521
weight	W_A	818	951	1084	1217	1350
	$W_B = W_C$	883	1016	1149	1282	1415




400
I_{FSM}
(A)
300
200
100
0
Max. permissible non repetitive peak forward current based on sinusoidal currents (f=50Hz)
I_F
I_{FSM}
time
7Z05725
$T_j = 175°C$
1
2
3
4
5
6
7
8
9
20
50
100
number of cycles


800
$I_{FS(RMS)}$
(A)
600
400
200
0
Max. permissible non repetitive r.m.s. forward current (sub cycle surge curve)
7Z05724.2
$T_j = 175°C$
0
2
4
6
8
10
12
duration (ms)

Accessories and heatsinks

TABLE OF CONTENTS

INDEX OF TYPE NUMBERS

Introduction

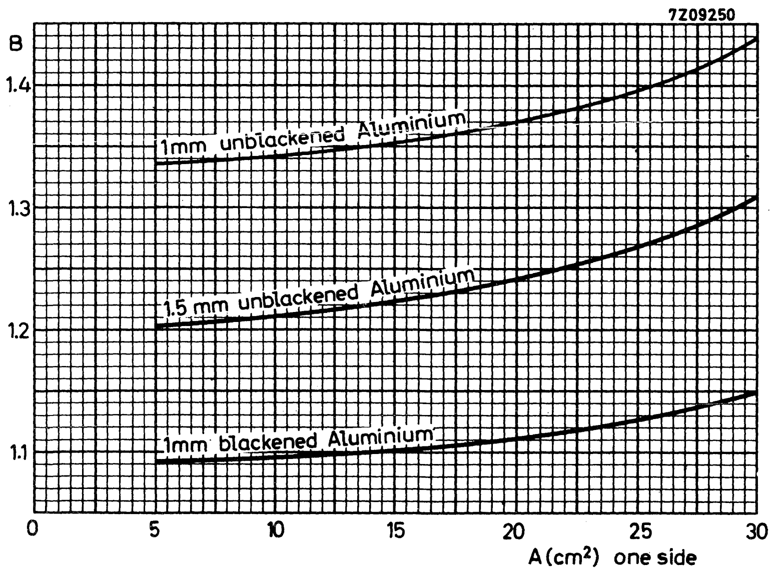
All information on thermal resistances of the accessories combined with flat heatsinks is valid for square heatsinks of blackened aluminium.
For a few variations the thermal resistance may be derived as follows:

a. Rectangular heatsinks (sides a and 2a)

When mounted with long side horizontal, multiply by 0.95.
When mounted with short side horizontal, multiply by 1.10.

b. Unblackened or thicker heatsinks

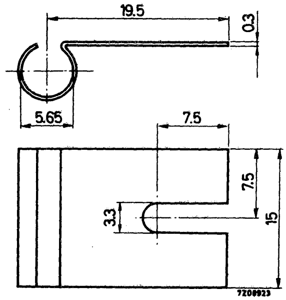
Multiply by the factor B given below as a function of the heatsink size A.



COOLING FIN

MECHANICAL DATA

Dimensions in mm

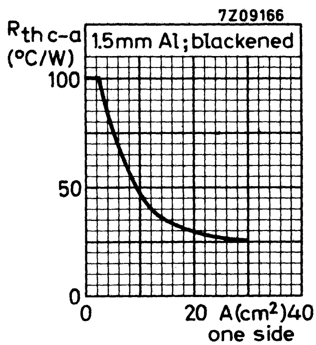


Fin material: brass, nickel plated

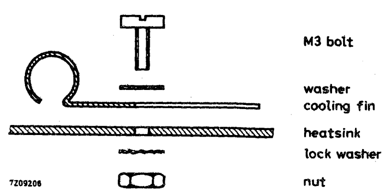
THERMAL RESISTANCE

From case to ambient with cooling fin only $R_{th\,c\text{-}a}$ = 100 °C/W

with heatsink see graph



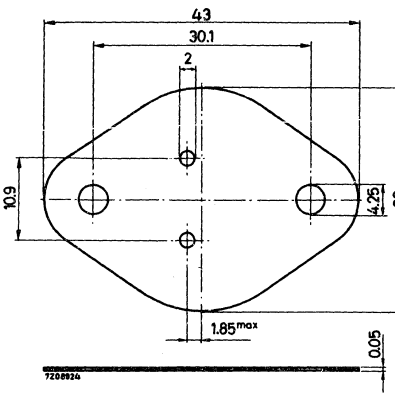
MOUNTING INSTRUCTIONS

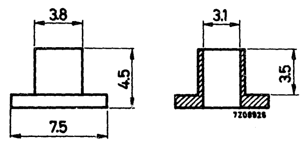


Torque on nut for good heat transfer: 5 cm kg

56201a MICA WASHER AND 2 INSULATING BUSHES

MECHANICAL DATA Dimensions in mm



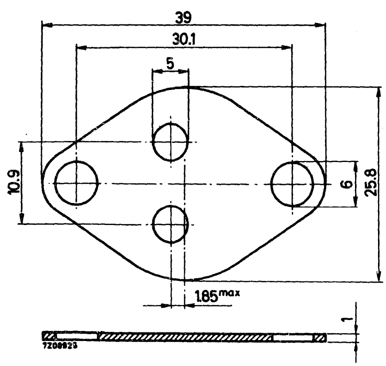


THERMAL RESISTANCE

From mounting base to heatsink $R_{th\ mb\text{-}h}$ = 1.0 °C/W

56201b LEAD WASHER

MECHANICAL DATA Dimensions in mm



MOUNTING ACCESSORIES

56201e consists of 56201a and 56201b

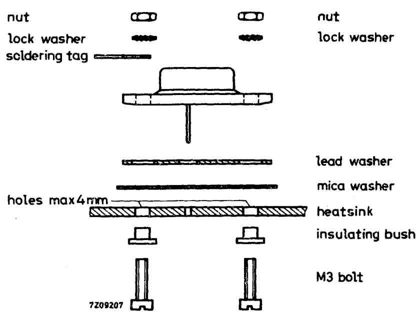
THERMAL RESISTANCE

From mounting base to heatsink
with mica washer and lead washer $R_{th\ mb\text{-}h}$ = 0.75 $^{o}C/W$

TEMPERATURE

Maximum allowable temperature T_{max} = 150 ^{o}C

MOUNTING INSTRUCTIONS

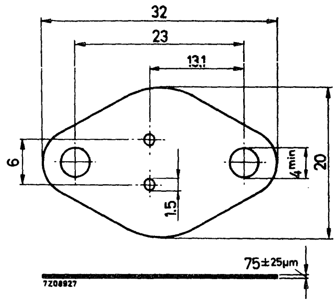


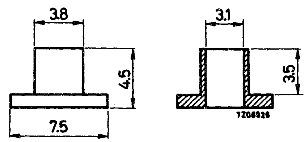
Torque on nut for good heat transfer: 5 cmkg

MICA WASHER AND 2 INSULATING BUSHES

MECHANICAL DATA

Dimensions in mm





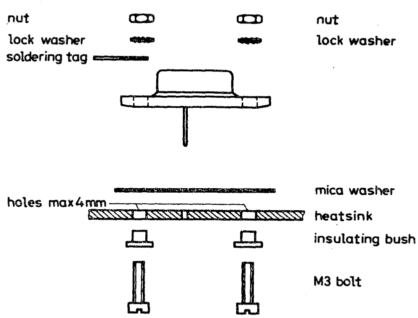
THERMAL RESISTANCE

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

TEMPERATURE

Maximum allowable temperature T_{max} = 150 °C

MOUNTING INSTRUCTIONS

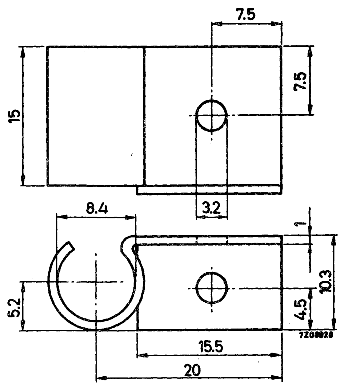


Torque on nut for good heat transfer: 5 cm kg

COOLING FIN

MECHANICAL DATA

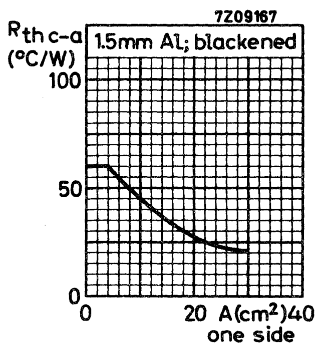
Dimensions in mm



Fin material: aluminium, blackened

THERMAL RESISTANCE

From case to ambient with cooling fin only	$R_{th\ c\text{-}a}$	= 60 °C/W
with heatsink		see graph



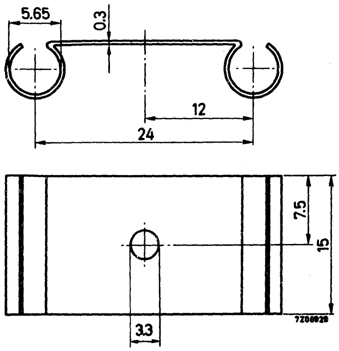
MOUNTING INSTRUCTIONS

Torque on M3 bolts for good heat transfer: 5 cmkg

COOLING FIN

MECHANICAL DATA

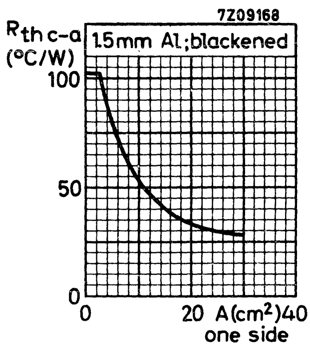
Dimensions in mm



Fin material: brass, nickel plated

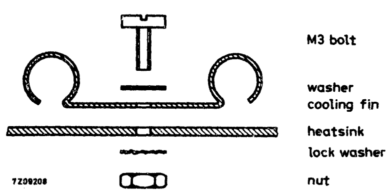
THERMAL RESISTANCE

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

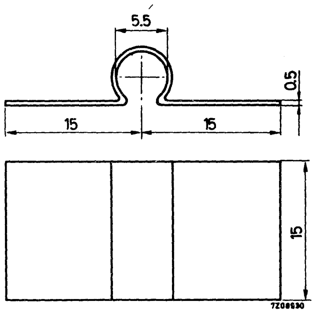


Torque on nut for good heat transfer: 5 cm kg

COOLING FIN

MECHANICAL DATA

Dimensions in mm



Fin material: brass, nickel plated

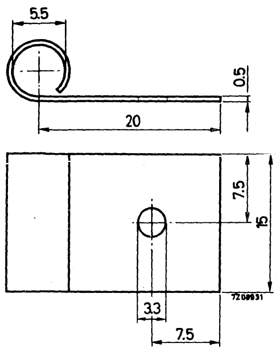
THERMAL RESISTANCE

From case to ambient with cooling fin only $R_{th\ c-a}$ = 75 °C/W

COOLING FIN

MECHANICAL DATA

Dimensions in mm

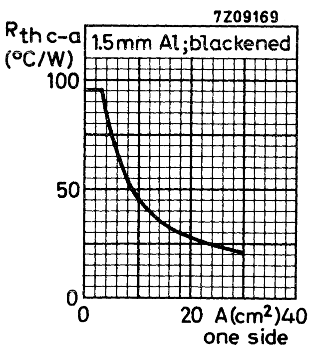


Fin material: brass, nickel plated

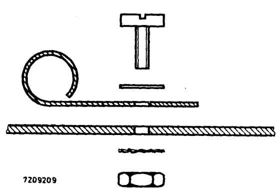
THERMAL RESISTANCE

From case to ambient with cooling fin only — $R_{th\ c\text{-}a}$ = 95 °C/W

with heatsink — see graph



MOUNTING INSTRUCTIONS

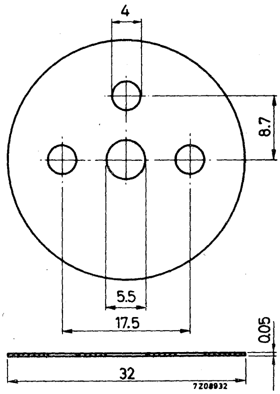


Torque on nut for good heat transfer: 5 cmkg

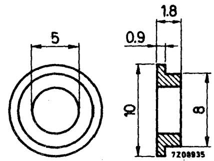
MOUNTING ACCESSORIES

MECHANICAL DATA

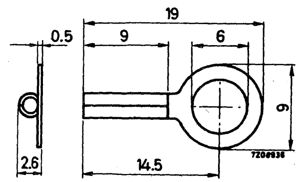
Dimensions in mm



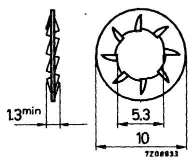
mica washer



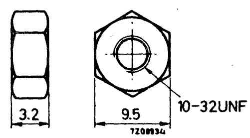
insulating ring



cable lug
material: brass, nickel plated



lock washer internal teeth
material: steel, nickel plated



hexagon nut
material: brass, nickel plated

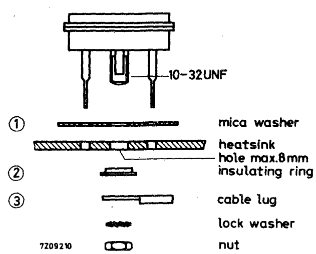
THERMAL RESISTANCE

From mounting base to heatsink $R_{th\ mb-h}$ = 1 $^{o}C/W$

TEMPERATURE

Maximum allowable temperature T_{max} = 125 ^{o}C

MOUNTING INSTRUCTIONS



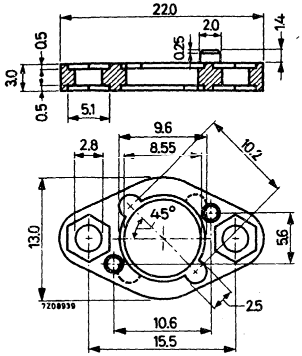
Torque on nut for good heat transfer: 20 cm

Non insulated mounting; without items 1, 2 and 3. (3 if necessary)

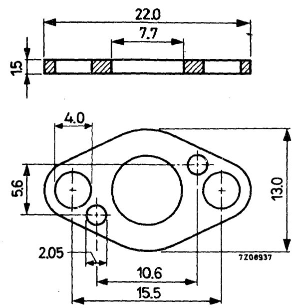
MOUNTING ACCESSORIES

MECHANICAL DATA

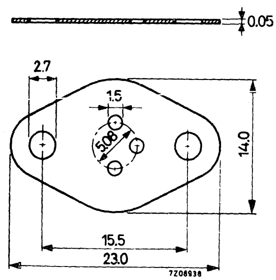
Dimensions in mm



top clamping washer
of insulating material



bottom clamping washer
material: brass, tin plated



mylar washer

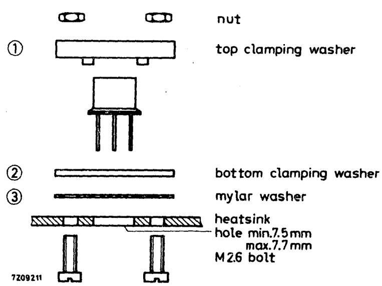
THERMAL RESISTANCE

From mounting base to heatsink non insulated mounting	$R_{th\ mb-h}$	=	1	$^{o}C/W$
insulated mounting	$R_{th\ mb-h}$	=	6	$^{o}C/W$

TEMPERATURE

Maximum allowable temperature	T_{max}	=	100	^{o}C

MOUNTING INSTRUCTIONS

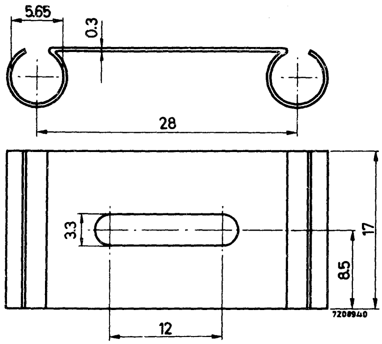


Non insulated mounting; without items 2 and 3. (Note: item 1 must than be mounted up-side down)

COOLING FIN

MECHANICAL DATA

Dimensions in mm

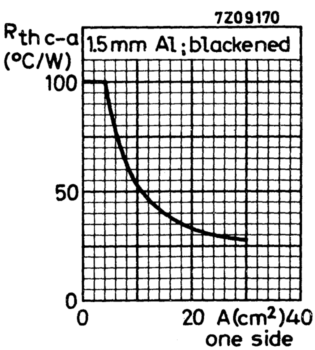


Fin material: brass, nickel plated

THERMAL RESISTANCE

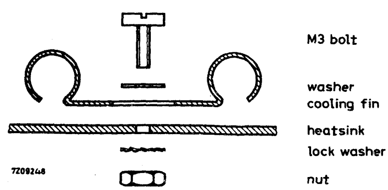
From case to ambient with cooling fin only — $R_{th\ c\text{-}a}$ = 100 °C/W

with heatsink — see graph



R_{th} values apply to each transistor, provided the two transistors have been mounted so that the heat flow from each is equal.

MOUNTING INSTRUCTIONS

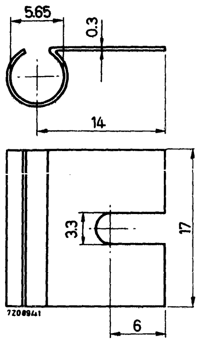


Torque on nut for good heat transfer: 5 cmkg

COOLING FIN

MECHANICAL DATA

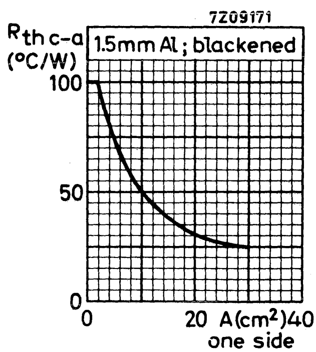
Dimensions in mm



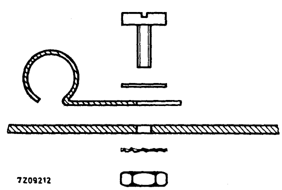
Fin material: brass, nickel plated

THERMAL RESISTANCE

From case to ambient with cooling fin only	$R_{th\ c-a}$	= 100 °C/W
with heatsink		see graph



MOUNTING INSTRUCTIONS

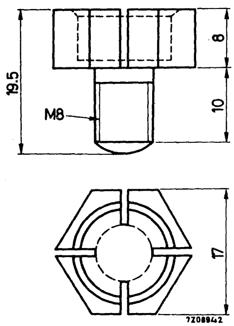


Torque on nut for good heat transfer: 5 cmkg

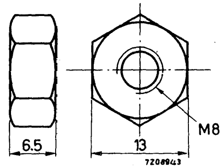
MOUNTING ADAPTOR

MECHANICAL DATA

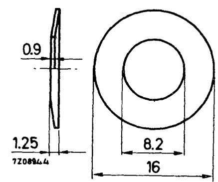
Dimensions in mm



mounting adaptor



hexagon nut
material: brass, nickel plated



dish spring
material: steel

THERMAL RESISTANCE

From diode case to heatsink $R_{th\ c\text{-}h}$ = 1.1 ^{o}C/W

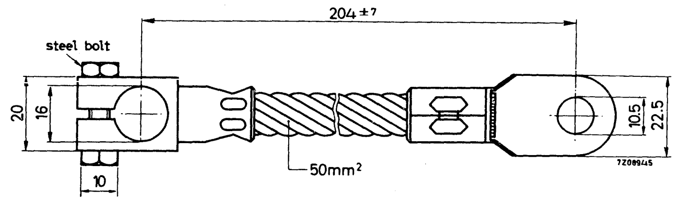
MOUNTING INSTRUCTIONS

Torque for mounting in a screw hole:	min.	80	cmkg
	max.	130	cmkg
on a heatsink	min.	60	cmkg
	max.	100	cmkg

FLEXIBLE TOP LEADS

56243

MECHANICAL DATA Dimensions in mm

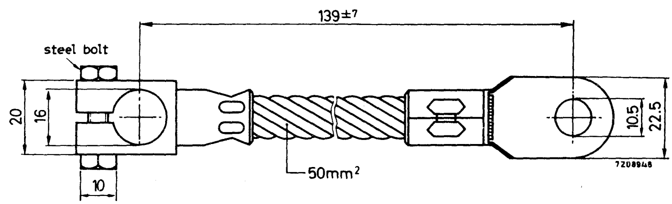


Weight: 170 g

Top lead 56243 should be used only for $I_{F\,(RMS)} \leq 400$ A.

56243A

MECHANICAL DATA Dimensions in mm



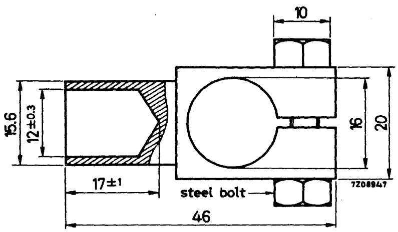
Weight: 140 g

For $I_{F\,(RMS)} > 400$ A, top lead 56243A must be used.
This prevents the temperature of the top connection becoming too high.

CLAMP

56244

MECHANICAL DATA — Dimensions in mm

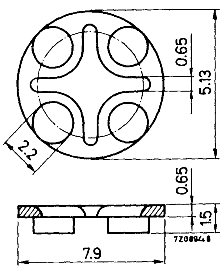


MOUNTING INSTRUCTIONS

The steel bolt ensures that sufficient torque can be applied to obtain good electrical contact.

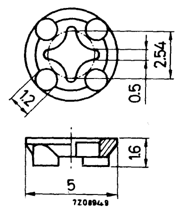
DISTANCE DISKS

56245



Insulating material

56246



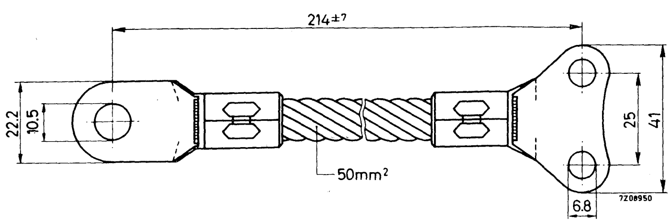
Insulating material

TEMPERATURE

Maximum allowable temperature T_{max} = 100 °C/W

56247 FLEXIBLE BASE LEAD

MECHANICAL DATA — Dimensions in mm

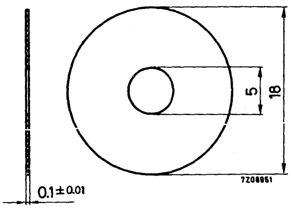


Weight: 130 g

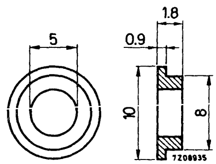
MOUNTING ACCESSORIES

MECHANICAL DATA

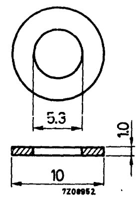
Dimensions in mm



mica washer



insulating ring



plain washer
material: brass, nickel plated

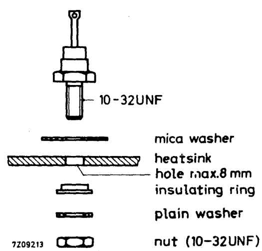
THERMAL RESISTANCE

From mounting base to heatsink (with mica washer) $R_{th\ mb\text{-}h}$ = 1.7 °C/W

TEMPERATURE

Maximum allowable temperature T_{max} = 125 °C

MOUNTING INSTRUCTIONS

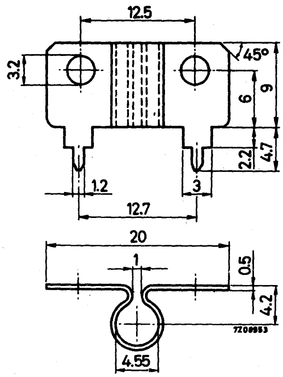


Notes: When using a tag for electrical contact insert tag between nut and plain washer or replace plain washer by tag.

COOLING FIN

MECHANICAL DATA

Dimensions in mm



Fin material: copper, tin plated

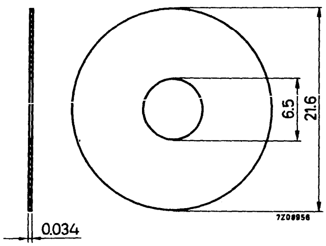
THERMAL RESISTANCE

From case to ambient $R_{th\ c-a}$ = 100 °C/W

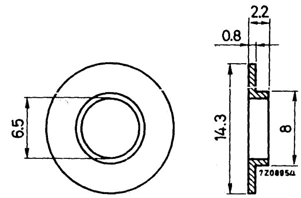
MOUNTING ACCESSORIES

MECHANICAL DATA

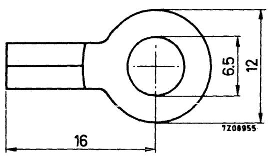
Dimensions in mm



Mica washer



Insulating ring



Soldering tag

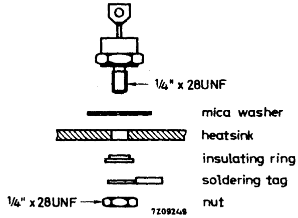
THERMAL RESISTANCE

From mounting base to heatsink with mica washer — $R_{th\ mb\text{-}h}$ = 4 $^{o}C/W$

TEMPERATURE

Maximum allowable temperature — T_{max} = 175 ^{o}C

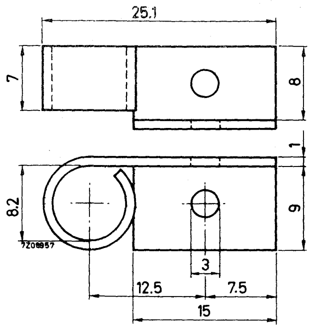
MOUNTING INSTRUCTIONS



COOLING FIN

MECHANICAL DATA

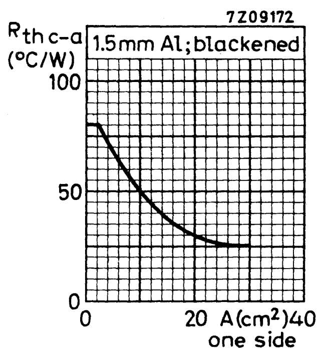
Dimensions in mm



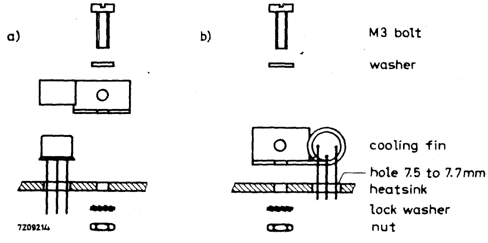
Fin material: aluminium, blackened

THERMAL RESISTANCE

From case to ambient with cooling fin only	$R_{th\ c\text{-}a}$	= 80 °C/W
with heatsink		see graph



MOUNTING INSTRUCTIONS

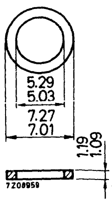


Torque on nut for good heat transfer: 5 cm kg

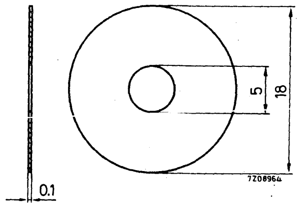
MOUNTING ACCESSORIES

MECHANICAL DATA

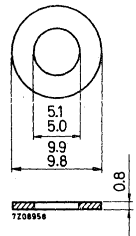
Dimensions in mm



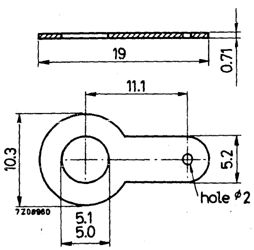
PTFE bush



2 mica washers



plain washer



terminal tag

THERMAL RESISTANCE

From mounting base to heatsink

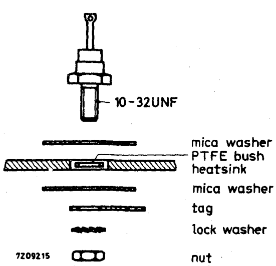
$R_{th\ mb\text{-}h} = 4\ ^{o}C/W$

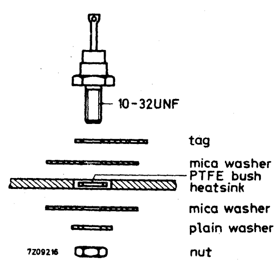
TEMPERATURE

Maximum allowable temperature

$T_{max} = 175\ ^{o}C$

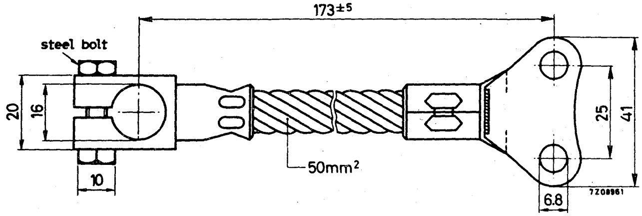
MOUNTING INSTRUCTIONS



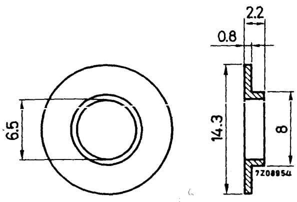


FLEXIBLE LEAD FOR SERIES CONNECTION

MECHANICAL DATA Dimensions in mm



INSULATING RING



Accessory 56299 is the insulating ring of 56264A.

Maximum operating temperature T_{max} = 175 °C

HEATSINKS

GENERAL

INTRODUCTION

Semiconductor rectifier diodes, thyristors and zener diodes for medium and high power have power losses which cannot be sufficiently transferred to the ambient air by these devices themselves. To prevent excessive junction temperatures the heat transfer capacity has to be improved.
This is achieved by heatsinks, which transfer the dissipated heat from the semiconductor junction to the ambient air by convection and radiation.

A flat metal plate is the simplest form of a heat transfer medium, but it is not the most efficient form for all conditions. In most cases a more complex form of heatsink will have advantages with regard to cost, size and weight.

This chapter offers, apart from information on heat transfer and the mechanical construction of assemblies, useful indications on how to take advantage of reverse-polarity diodes, etc., and, finally, the technical data on three types of heatsink with examples of calculation.

HEAT TRANSFER PATH

In a silicon rectifier the heat is generated inside the silicon wafer. From there the heat flows mainly to the base of the device and then via the heatsink to the surrounding air. The heat flow through heat conductors is analogous to the flow of electric current through electrical conductors. In this analogy the thermal resistance (R_{th} in $^oC/W$) corresponds with the electrical resistance (R in Ω).

Fig.1 shows the heat path from the junction to the ambient air as a series connection of three thermal resistances:

$R_{th\ j-mb}$: The thermal resistance from junction to mounting base. Its value can be found in the data sheets of the relevant semiconductor device.

$R_{th\ mb-h}$: The contact thermal resistance. This is the thermal resistance from mounting base to heatsink, resulting from the contact area being limited and the contact itself being imperfect. Its value can also be found in the data sheets.

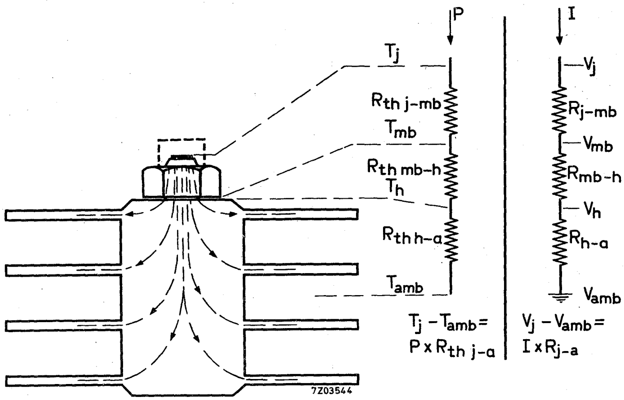
$R_{th\ h-a}$: The thermal resistance of the heatsink. This is the thermal resistance between the contact surface and the ambient air.

Once the heat has been transferred from heatsink to ambient, cool air must replace the heated air.

According to fig.1 the following formula can be used in heatsink calculations:

$$T_j - T_{amb} = P \times (R_{th\ j-mb} + R_{th\ mb-h} + R_{th\ h-a})$$

Fig.1 Analogy between heat conduction and electric conduction



MEANS TO IMPROVE HEAT TRANSFER

The contact thermal resistance can be made as small as possible by using:

1. a large contact area
2. plane contact surfaces by proper machining, grinding, etc. Heatsinks should be blanked or made burr-free after punching or drilling holes
3. sufficient pressure by applying at least the rated minimum torque. Use a torque spanner
4. silicon grease to fill up air pockets. A thin layer of air has a much higher resistance to heat flow than a thin film of grease (e.g. Dow Corning 340)

The thermal resistance of the heatsink can be reduced by:

1. painting or anodising the surface, which improves heat transfer by radiation
2. higher speed of the cooling air
3. larger size of the heatsink

The air flow can be obtained in the simplest way by natural convection. Any obstruction should be avoided. Therefore fins should be placed vertically, air intake and outlet apertures should be as large as possible. Ample spacing between heatsinks and adjacent structures and provisions to obtain a chimney effect also improve the air flow.

If free convection is not sufficient to remove the heat, a blower or a fan must be used. Forced air cooling also permits a substantially smaller heatsink.

INSULATED MOUNTING

In bridge rectifiers it may be desirable to insulate a diode electrically from its heatsink by means of a mica or teflon wahser. As a consequence the contact thermal resistance will be about 10 times that of the case without insulation. Since the total thermal resistance has a fixed maximum value for given values of P and T_{amb} (see previous section), the increase of $R_{th\ mb-h}$ has to be compensated by a considerable reduction of $R_{th\ h-a}$ (e.g. by using a much larger heatsink).

Furthermore, the creepage distances along the insulator may be too small for the high voltages occurring between diode and heatsink. In fig.2 the creepage distances A and B can be made sufficiently large; but C and D will always be small.

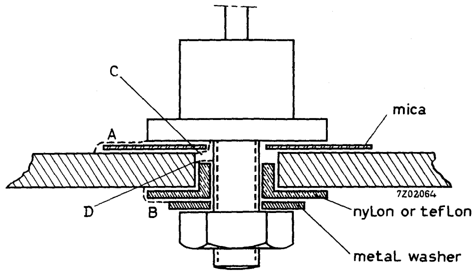


Fig.2 Creepage distances at an insulated diode
(C and D are the critical ones)

CONSTRUCTION OF ASSEMBLIES

In the previous sections some details have been given regarding the proper way of connecting a diode to a heatsink, positioning of heatsinks, etc.

For better current sharing of parallel-connected diodes a good thermal coupling of the devices is needed, which reduces differences in the forward characteristics. Two series-connected diodes should have a good thermal coupling in view of the reverse characteristics.

Thermal coupling can be obtained by mounting two diodes on one heatsink. On a plain cooling fin the two diodes should be mounted according to fig.3, on an extruded aluminium heatsink according to fig.4. A distance between the two diodes equal to one third of the heatsink length provides sufficient thermal coupling. For the electrical connection it is preferred to use a copper strip with a thickness of 1 mm. Mounting two diodes on one heatsink also saves mounting cost.

A flat plate with two diodes should have twice the area necessary for a separately mounted diode.
An extruded aluminium heatsink with two diodes should have twice the length necessary for a separately mounted diode.

An electrical series connection of two diodes mounted on one heatsink can be obtained by using diodes of different polarity. Figs. 5, 6, 7 and 8 show how the combination of normal and reverse-polarity diodes simplifies the assembly of single phase and three phase bridge rectifiers.

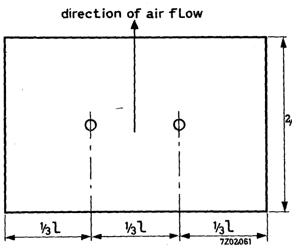


Fig.3. Dimensioning of a plain cooling fin with two diodes

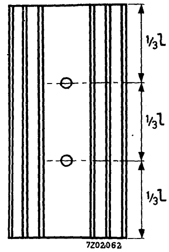


Fig.4. Extruded aluminium heatsink with two diodes

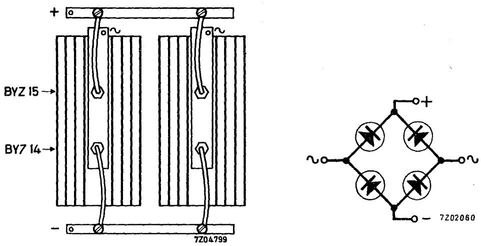


Fig.5. Single phase full wave rectifier with diodes of different polarity on extruded aluminium heatsinks

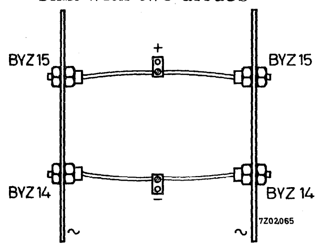


Fig.6. Single phase full wave rectifier with diodes of different polarity on plain cooling fins (Top view)

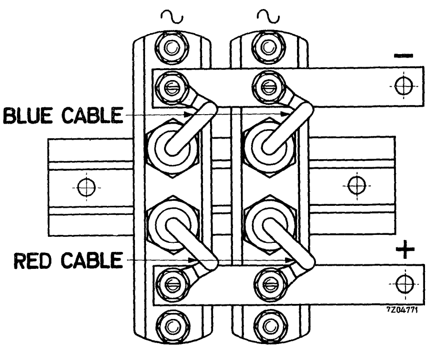


Fig.8. Single phase full wave rectifier with diodes of different polarity (red cable: reverse polarity; blue cable: normal polarity) on two double heatsinks 56250

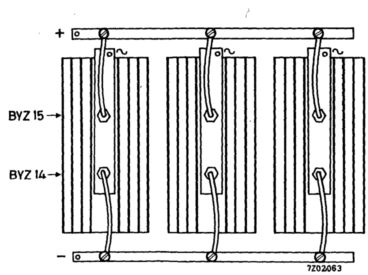
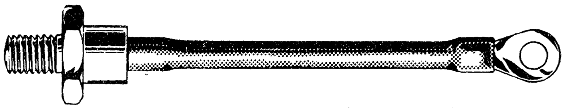


Fig.7. Three phase full wave rectifier with diodes of different polarity on extruded aluminium heatsinks

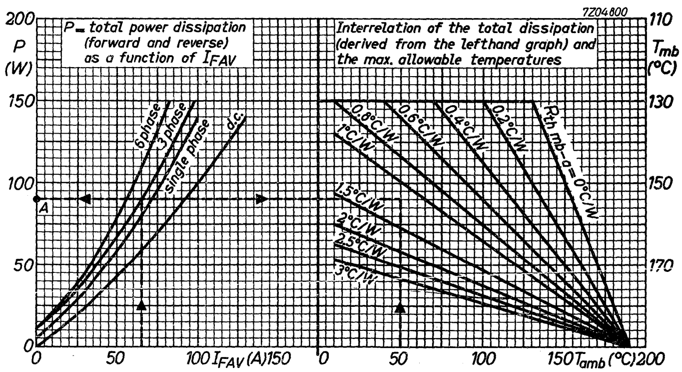
EXAMPLES OF HEATSINK CALCULATION

1. Devices without controlled avalanche properties.
Assume that the diode of which the outlines are shown, is used in a three phase 50 Hz rectifier circuit at T_{amb} = 50 °C. Further assume: average forward current per diode I_{FAV} = 65 A; contact thermal resistance $R_{th\ mb\text{-}h}$ = 0.1 °C/W



Stud: M12
Mounting base, across the flats: max. 27 mm

From the data of the diode the graph to be used is shown below.



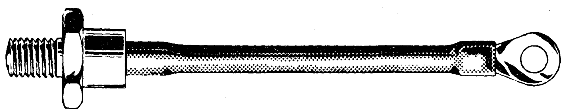
From the lefthand graph it follows that P_{tot} = 90 W per diode (point A).
From the righthand graph it follows that $R_{th\ mb\text{-}a} \approx$ 1.2 °C/W.
Thus $R_{th\ h\text{-}a} = R_{th\ mb\text{-}a} - R_{th\ mb\text{-}h}$ = (1.2 - 0.1) °C/W = 1.1 °C/W.
This may be achieved by different types of heatsinks as shown below.

Type	Free convection	Forced cooling
flat, blackened	–	125 cm^2; 2 m/s or 300 cm^2; 1 m/s
bright	–	175 cm^2; 2 m/s
diecast 56274	–	≈ 1.5 m/s
56280	applicable	
extrusion		
56230 bright	l = 12 cm	l = 5 cm 1); 1 m/s
blackened	l = 8 cm	l = 5 cm 1); 1 m/s
56231 bright	l = 7 cm	
blackened	l = 5 cm 1)	

1) Practical minimum length

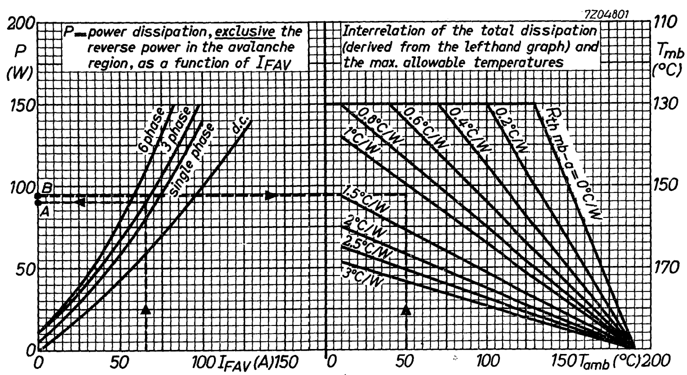
2. Devices with controlled avalanche proporties

Assume that the diode of which the outlines are shown, is used in a three phase 50 Hz rectifier circuit at T_{amb} = 50 °C. Further assume: average forward current per diode I_{FAV} = 65 A; contact thermal resistance $R_{th\ mb-h}$ = 0.1 °C/W; repetitive peak reverse power in the avalanche region (t = 10 μs) P_{RRM} = 8 kW (per diode).



Stud: M12
Mounting base, across the flats: max. 27 mm

From the data of this diode the graph to be used is shown below.



From the lefthand graph it follows that P_{tot} = 90 W per diode (point A).
The average reverse power in the avalanche region, averaged over any cycle, follows from $P_{RAV} = \delta \times P_{RRM}$, where the duty cycle $\delta = \frac{10\ \mu s}{20\ ms} = 0.0005$.

Thus P_{RAV} = 0.0005 x 8 kW = 4 W.

Therefore the total device power dissipation P_{tot} = 90 + 4 = 94 W (point B).
From the righthand graph it follows that $R_{th\ mb-a} \approx 1.1$ °C/W.
Hence the heatsink thermal resistance should be:

$$R_{th\ h-a} = R_{th\ mb-a} - R_{th\ mb-h} = (1.1 - 0.1)\ °C/W = 1\ °C/W.$$

A table of applicable heatsinks, similar to that on the foregoing page, can be derived for this case.

SELECTION GUIDE FOR DIODES

To simplify the selection of heatsinks, the table below indicates for each diecast heatsink the diodes for which is may be used.
For extruded heatsinks the most suitable combinations are given.
As an additional guide, the outlines of the appropriate diodes are shown beside the heatsink data.

	BYX38 BYX39	BYX25 BYX30 BYX42 BYX48	BYX13 BYY22	BYX21 BYX28 1)	BYZ14	BYX34	BYX23 BYX32	BYX14 BYX27 BYX33
Diecast 56250					●		●	
56268	●							
56271			●	●		●		
56274					●		●	
56277			●	●				
56280					●		●	
56283								●
Extrusions 56230 56231		●	●	●	●	●		
56259 56293					●	●	●	●
56290	●	●	●	●				

1) With adaptor 56232

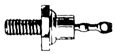
SELECTION GUIDE FOR THYRISTORS

To simplify the selection of heatsinks, the table below indicates for each diecast heatsink the thyristors for which it may be used.
For extruded heatsinks the most suitable combinations are given.
As an additional guide, the outlines of the appropriate thyristors are shown beside the heatsink data.

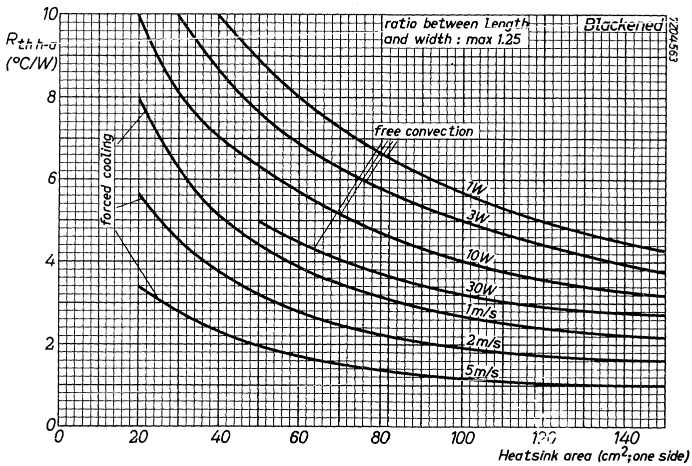
	BT101;102 BTX68 BTY79	BTX35 BTX64 BTY87	BTX36 BTX47 BTX48 BTY91	BTX81 BTX82	BTX37 BTX66 BTY95	BTX38 BTX49 BTX67 BTY99
Diecast 56253		●	●	●		
56256	●					
56279					●	●
56286					●	●
Extrusions 56230 56231		●	●	●	●	●
56259 56293					●	●
56290	●	●	●	●		

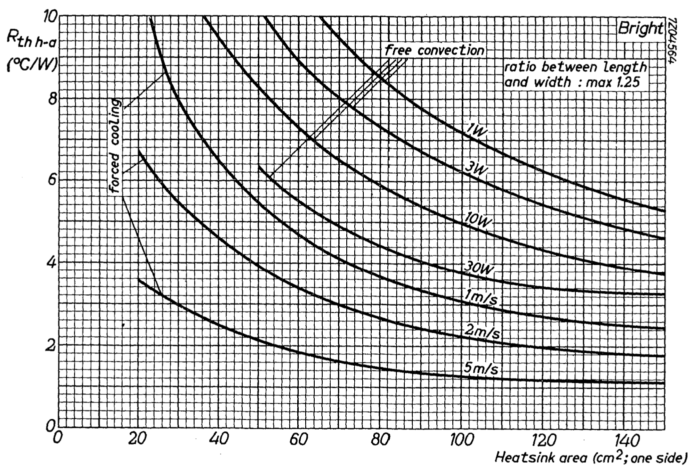
FLAT HEATSINKS

Thermal resistance of flat heatsinks of 2 mm copper or 3 mm aluminium.
The graphs are valid for the combination of device and heatsink.

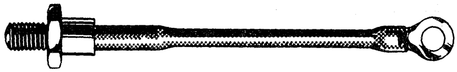


Studs: 10-32UNF
Mounting bases, across the flats: max. 11.0 mm

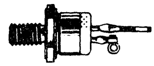




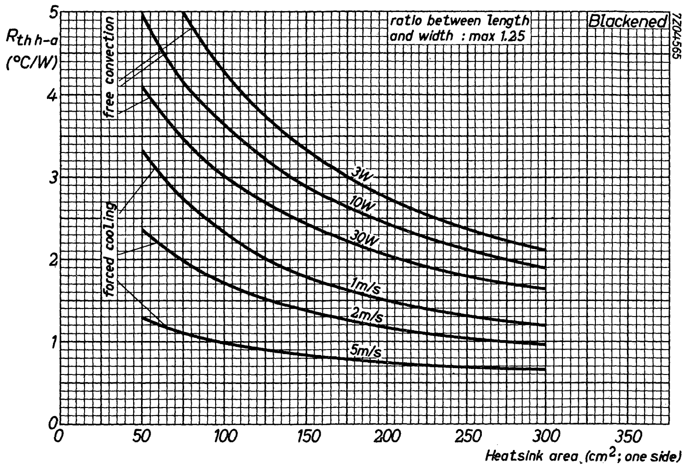
Thermal resistance of flat heatsinks of 2 mm copper or 3 mm aluminium.
The graphs are valid for the combination of device and heatsink.

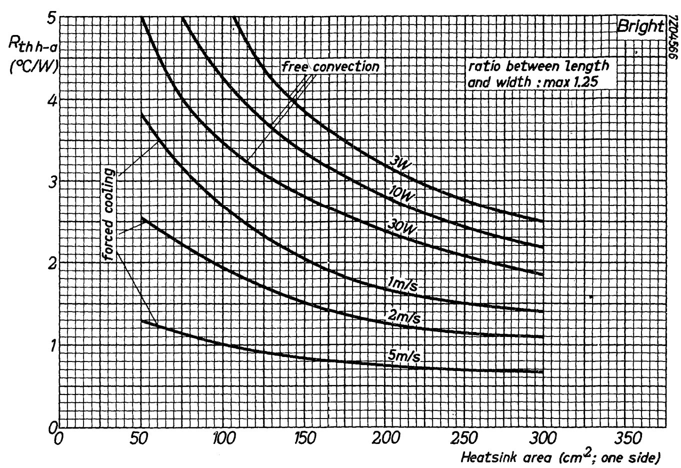


Stud: M8
Mounting base, across the flats: max. 17 mm

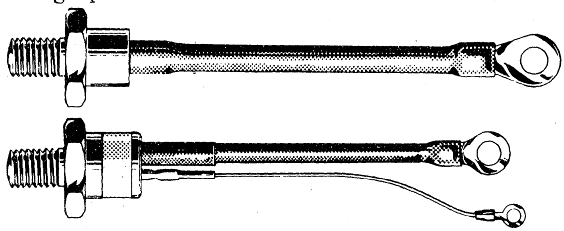


Stud: $\frac{1}{4}$" x 28 UNF
Mounting base, across the flats: max. 14.3 mm

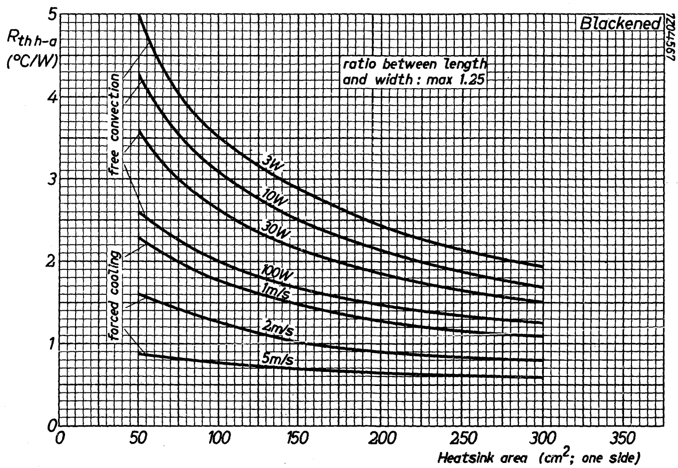


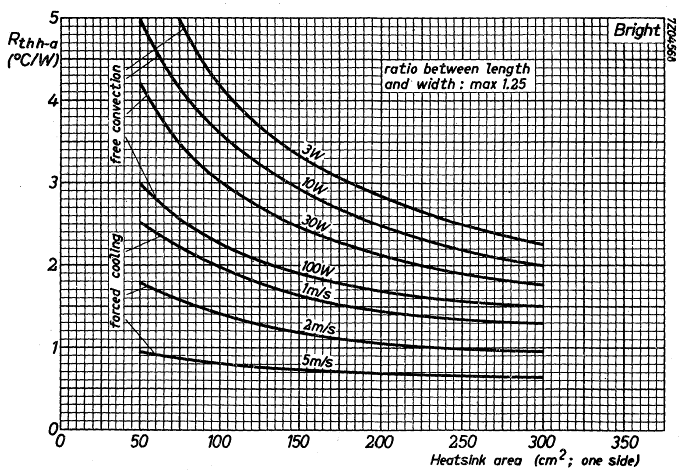


Thermal resistance of flat heatsinks of 2 mm copper or 3 mm aluminium.
The graphs are valid for the combination of device and heatsink.



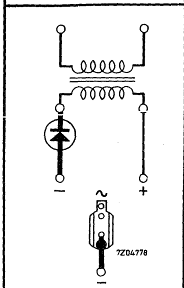
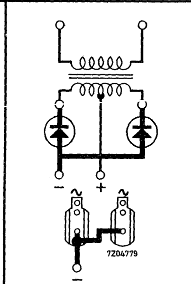
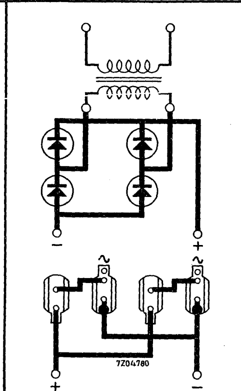
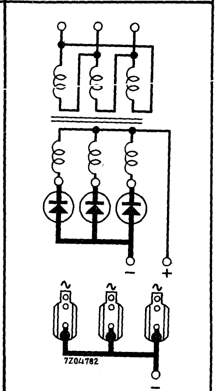
Studs: M12
Mounting bases, across the flats: max. 27 mm

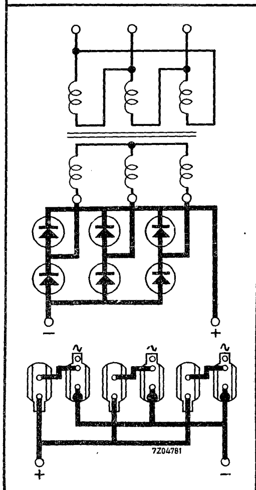
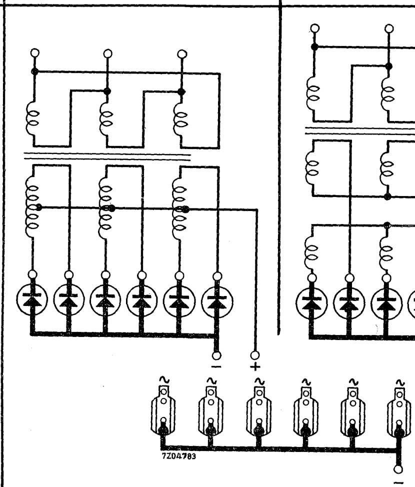
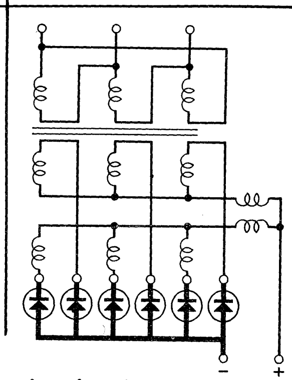


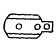


DIECAST HEATSINKS

RECTIFIER CIRCUITS ON SINGLE HEATSINKS

Single phase half wave	Two phase half wave	Single phase full wave (Single phase bridge)	Three phase half wave (Three phase star)
			

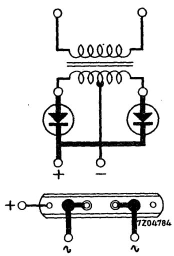
Three phase full wave (Three phase bridge)	Six phase half wave (Six phase star)	Three phase double Y with interphase transformer
		

Diecast heatsink without insulator 

Diecast heatsink with insulator 

RECTIFIER CIRCUITS ON DOUBLE HEATSINKS

<table>
<tr><th>Two phase
half wave</th><th>Single phase
full wave
(Single phase bridge)</th><th>Three phase
full wave
(Three phase bridge)</th></tr>
<tr><td>



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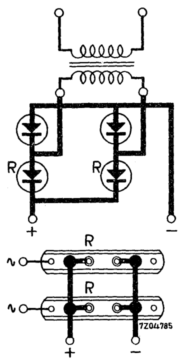

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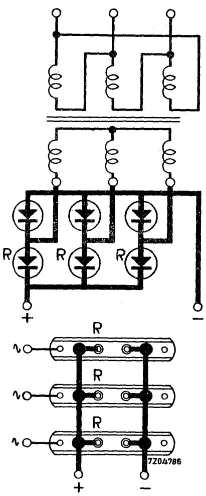


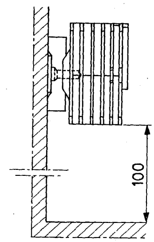
</td></tr>
</table>

R = Reverse polarity diode

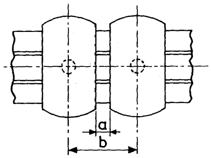
Diecast heatsink 56250 

MOUNTING INSTRUCTION FOR DIECAST HEATSINKS

1. At free convection cooling or forced air flow <0.5 m/s the heatsinks should be mounted with the fins vertical and with a distance to the chassis bottom > 100 mm.

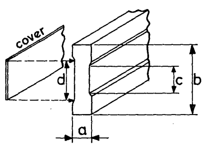


2. At forced air flow > 0.5 m/s the heatsinks may be mounted in any position.
3. Minimum distance between heatsinks in a row.



Heatsink	Distance (mm) a	Distance (mm) b
56256/68	> 5.0	>25.0
56277	> 5.0	>40.0
56250/53	>10.0	>50.0
56258/71/74	>10.0	>50.0

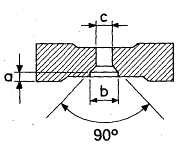
4. The rectifier devices should be fixed to their heatsinks with the torques specified in the relevant published data. Use a torque spanner.
5. For insulated mounting of heatsinks two sizes of mounting strips made of insulating material are available.



Strip	Dimensions (mm)				Weight (g)
	a	b	c	d	(with cover)
56233	10.0	36	14.1	22	330
56234	13.5	50	20.1	28	615

Length 750 mm

6. Mounting holes to be made in the strips:



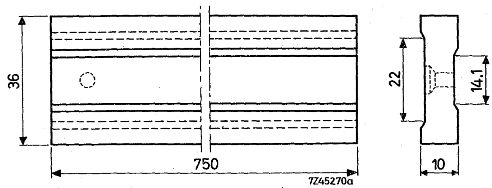
Heatsink	Strip	Dimensions in mm		
		a	b	c
56256/68	56233	< 1.5	7.5	4.3
56253/58/71	56234	< 1.3	10.2	6.3
56274/77	56234	< 1.3	10.2	6.3
56250	56234	< 1.8	13.8	8.3

MOUNTING STRIPS

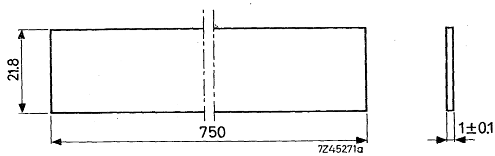
Type 56233 consists of the following components (1 to 2) — Dimensions in mm

1.
1 mounting strip of insulating material

Weight with cover:
330 g



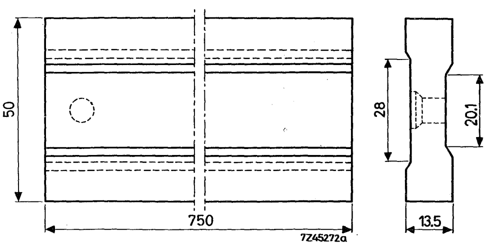
2.
1 insulating plate

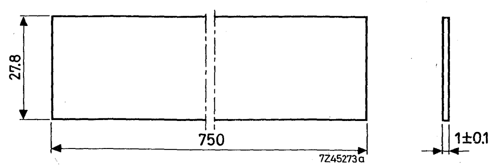


Type 56234 consists of the following components (1 to 2) — Dimensions in mm

1.
1 mounting strip of insulating material

Weight with cover:
615 g



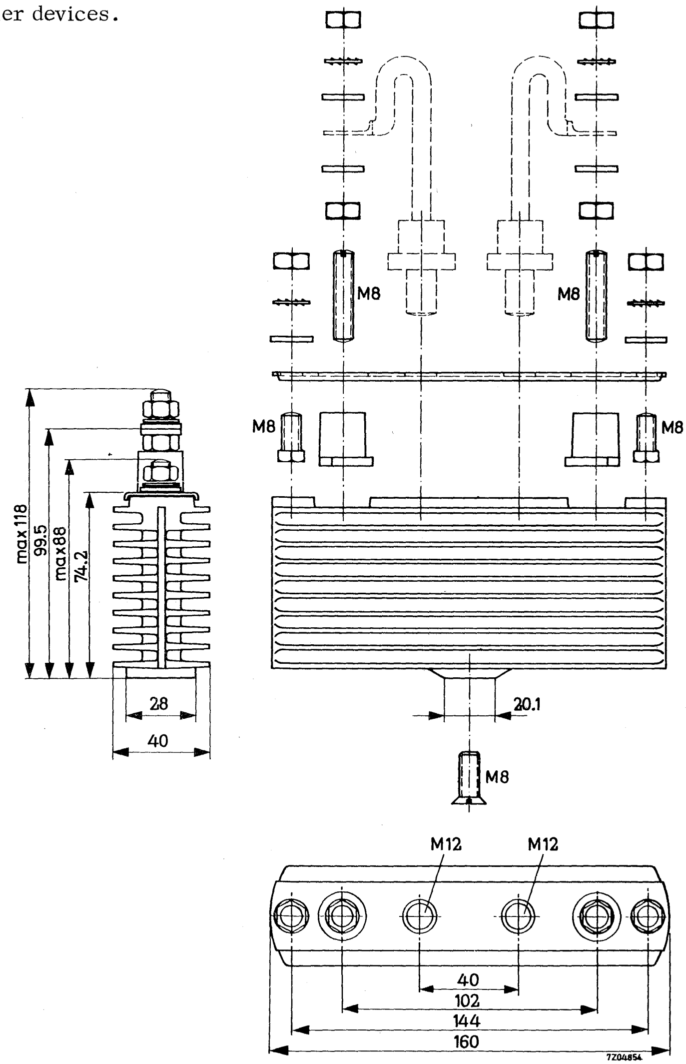


2.
1 insulating plate

DIECAST HEATSINK FOR TWO DEVICES

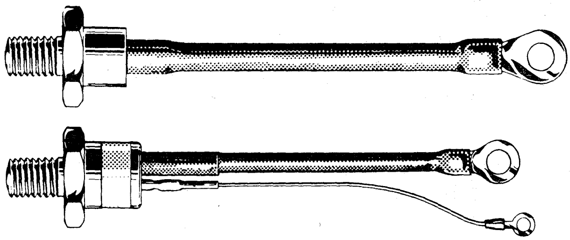
Diecast heatsink of aluminium alloy, painted black, with two M12 tap holes for two rectifier devices.

Dimensions in mm

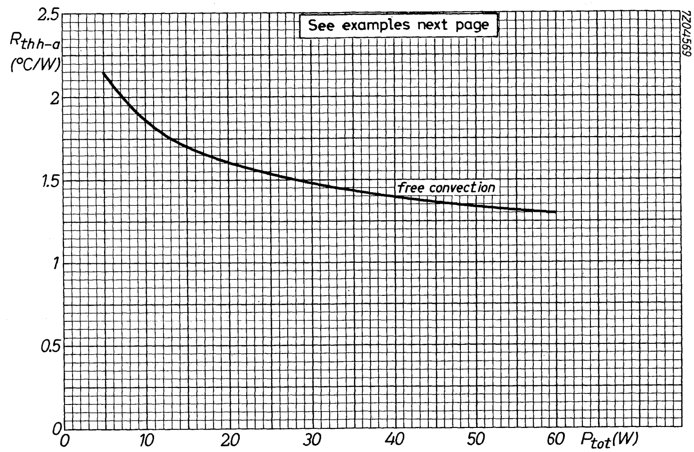


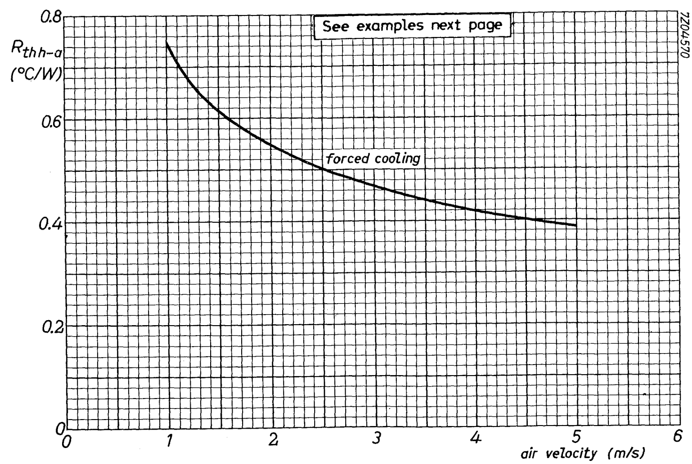
Weight 730 g

The graphs are valid for the combination of device and heatsink.



Studs: M12
Mounting base, across the flats: 27.0 mm





Calculations for the double heatsink 56250

For equal devices at equal conditions the maximum allowable mounting base temperature shall be calculated. After subtraction of the temperature drop caused by the contact thermal resistance the required heatsink thermal resistance can be determined.

For two different devices (with different $T_{j\ max}$, power dissipation and contact thermal resistance) the lower of the two maximum allowable mounting base temperatures shall be taken, after which the same procedure is followed.

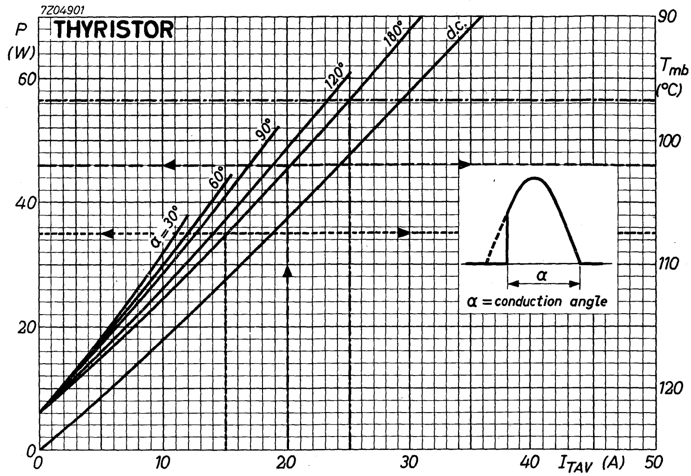
Examples

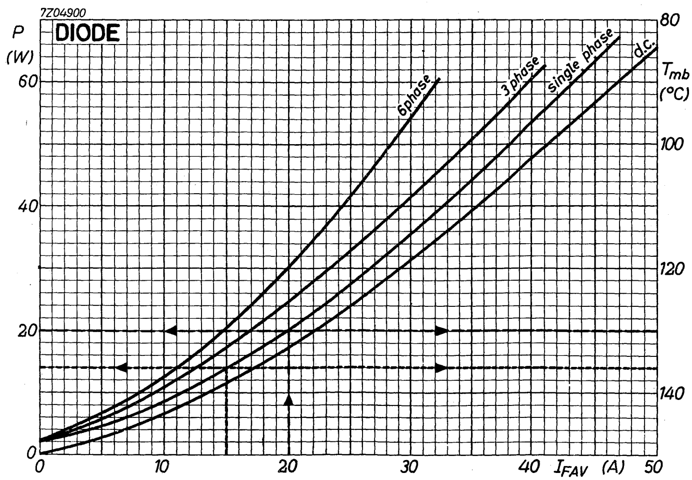
Consider a thyristor T and a diode D, used in single phase application ($\alpha = 180^o$), of which the curves to be used are shown on the next page. For all examples the contact thermal resistance $R_{th\ mb\text{-}h} = 0.1\ ^oC/W$.
In the table below, three different examples have been worked out.

	$T_1 + D_2$	$T_1 + D_2$	$T_1 + T_2$
Given: T_{amb} I_{AV}	30 °C 15 A	50 °C 20 A	45 °C 25 A
From next page			
P_1	35 W	46 W	56.5 W
P_2	14 W	20 W	56.5 W
$P_{tot} = P_1 + P_2$	49 W	66 W	113 W
$T_{mb\ 1}$ max.	107.5 °C	102 °C	96.5 °C
$T_{mb\ 2}$ max.	136 °C	130 °C	96.5 °C
$P_1 \times R_{th\ mb\text{-}h} = \Delta T_{mb\text{-}h}$	3.5 °C	4.6 °C	5.7 °C
Maximum T_h	104 °C	97.4 °C	90.8 °C
T_{amb}	30 °C	50 °C	45 °C
Max. $\Delta T_{h\text{-}a}$	74 °C	47.4 °C	45.8 °C
$\frac{\text{Max. } \Delta T_{h\text{-}a}}{P_{tot}} =$	$\frac{74}{49} =$	$\frac{47.4}{66} =$	$\frac{45.8}{113} =$
Max. $R_{th\ h\text{-}a}$	1.5 °C/W	0.72 °C/W	0.4 °C/W
From graphs on foregoing page follows:	Possible with free convection. 50 W: 1.35 °C/W	Only with forced cooling. At least 1.1 m/s	Only with forced cooling. At least 4.5 m/s

Calculations for the double heatsink 56250 (continued)

The two graphs below give the power dissipation and the maximum allowable mounting base temperature versus the average forward current, for the thyristor T and the diode D, respectively.

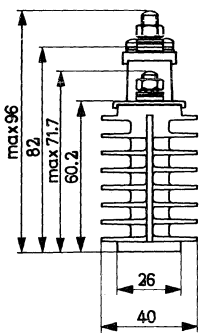


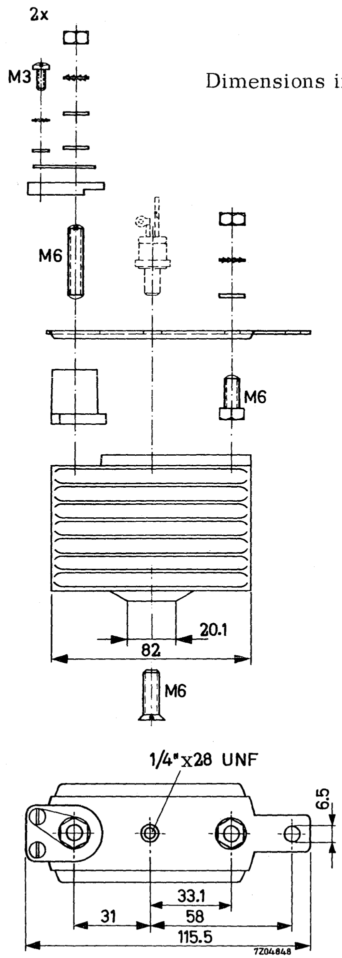


DIECAST HEATSINK

Diecast heatsink of aluminium alloy, painted black, with 1/4"x28 UNF tap hole for rectifier device.

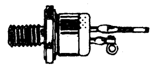
Dimensions in mm



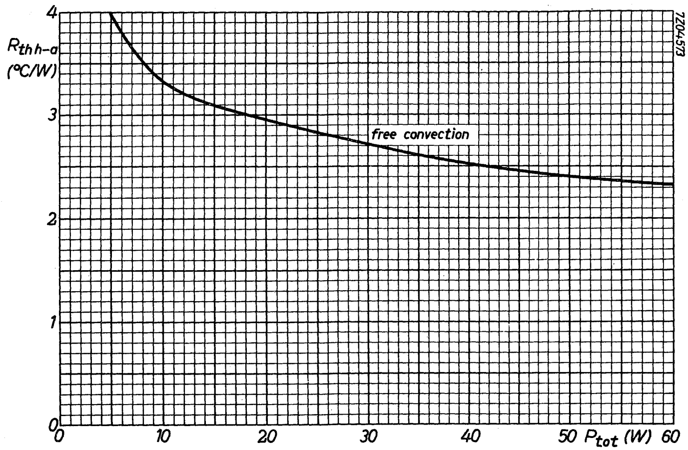


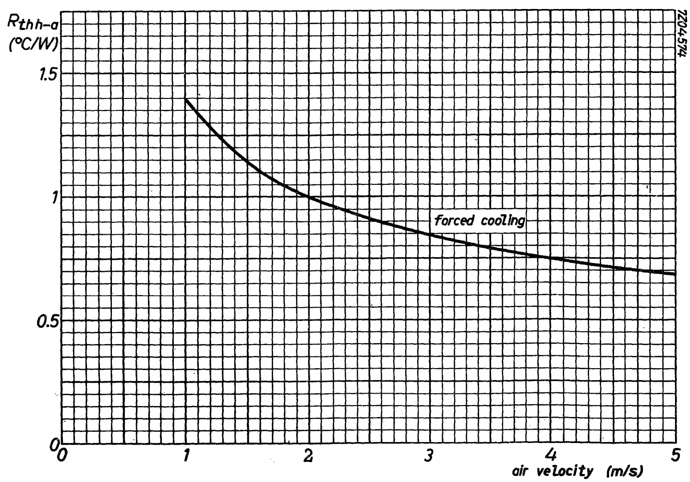
Weight 305 g

The graphs are valid for the combination of thyristor and heatsink.



Stud: $\frac{1}{4}$" x 28UNF
Mounting base, across the flats: max. 14.0 mm



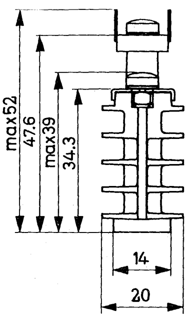


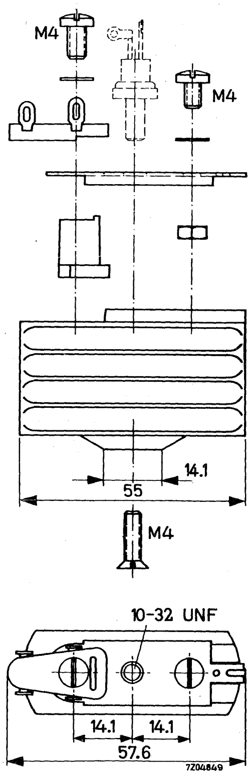
DIECAST HEATSINK

Diecast heatsink of aluminium alloy, painted black, with 10-32 UNF tap hole for rectifier device.

Dimensions in mm

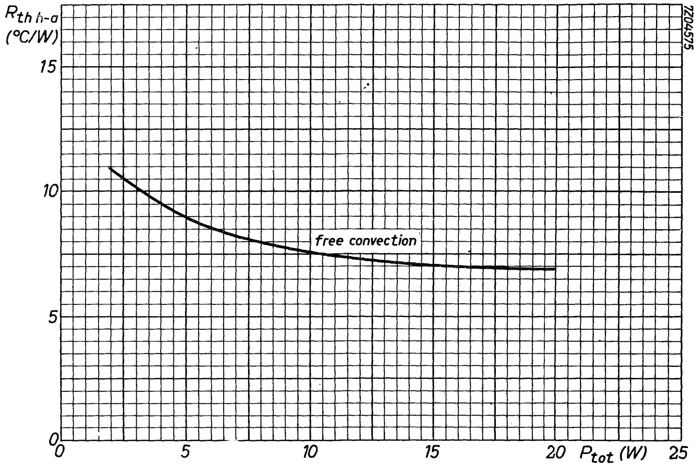
Weight: 55 g

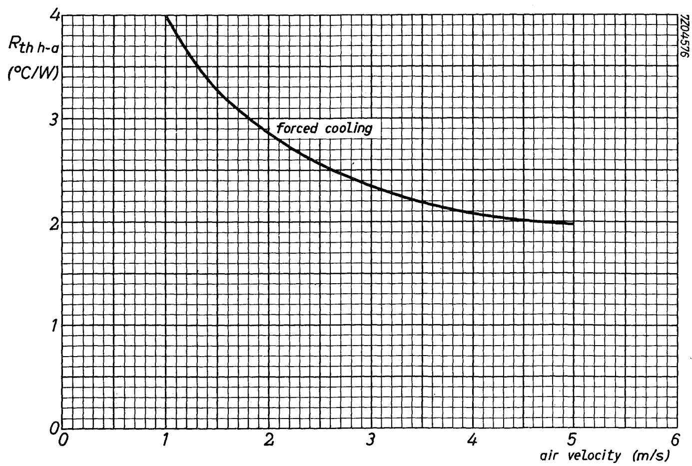




The graphs are valid for the combination of thyristor and heatsink.

Stud: 10 - 32UNF
Mounting base, across the flats: 11.0 mm



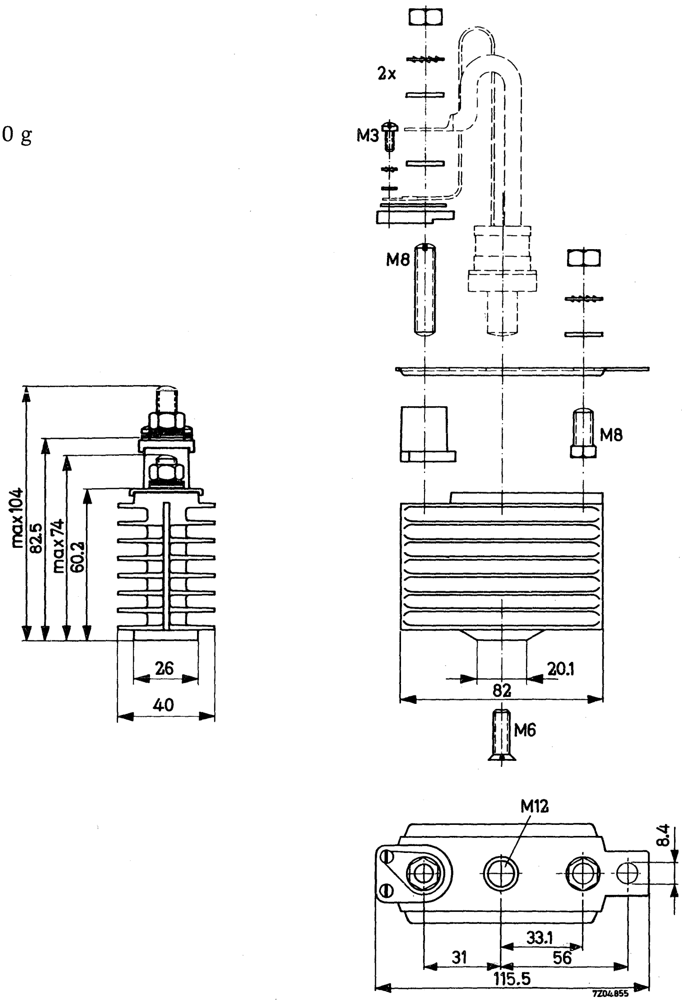


DIECAST HEATSINK

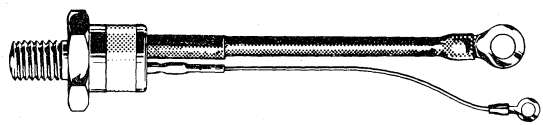
Diecast heatsink of aluminium alloy, painted black, with M12 tap hole for rectifier device.

Dimensions in mm

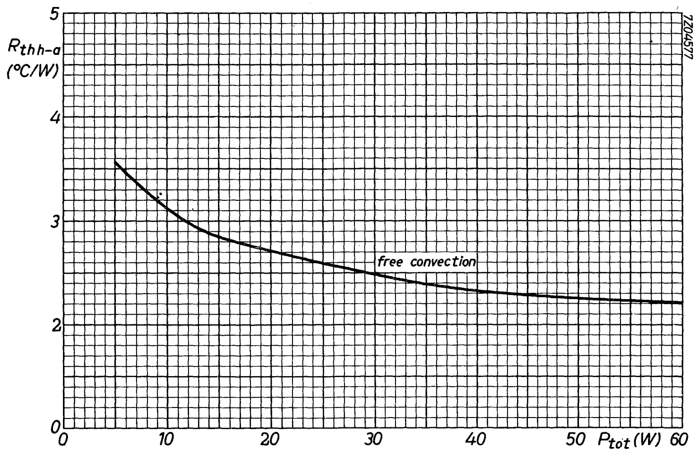
Weight 290 g



The graphs are valid for the combination of thyristor and heatsink.



Stud: M12
mounting base, across the flats: 27.0 mm

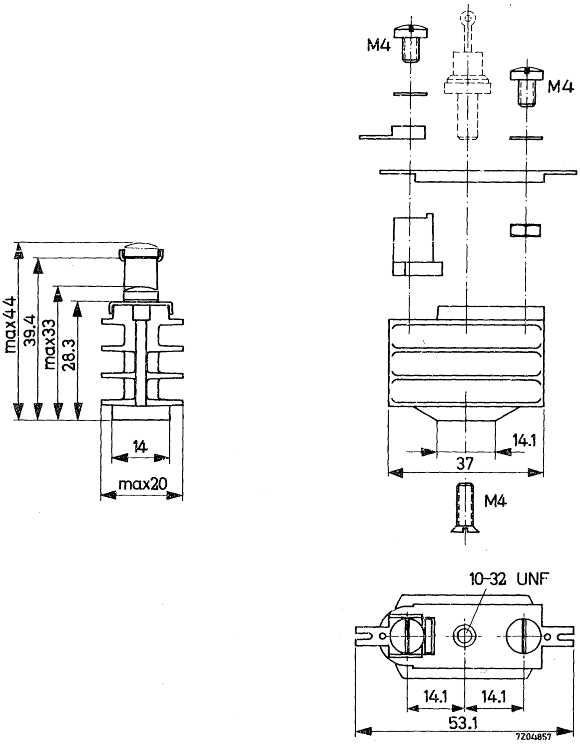


DIECAST HEATSINK

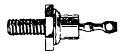
Diecast heatsink of aluminium alloy, painted black, with 10-32 UNF tap hole for rectifier device.

Dimensions in mm

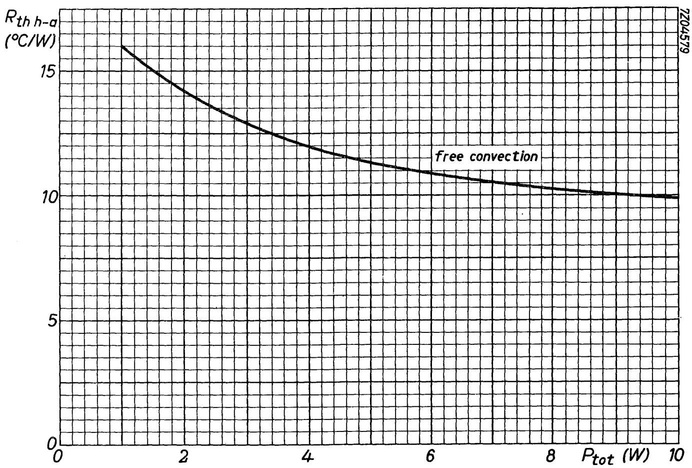
Weight 33 g

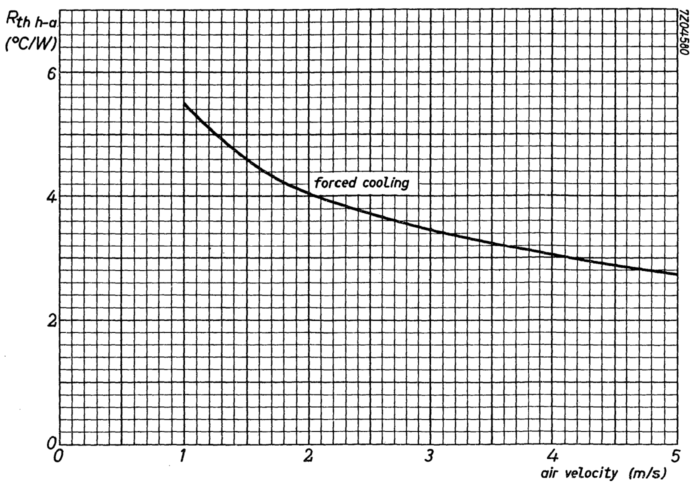


The graphs are valid for the combination of diode and heatsink.



Stud: 10 - 32UNF
Mounting base, across the flats: 11,0 mm



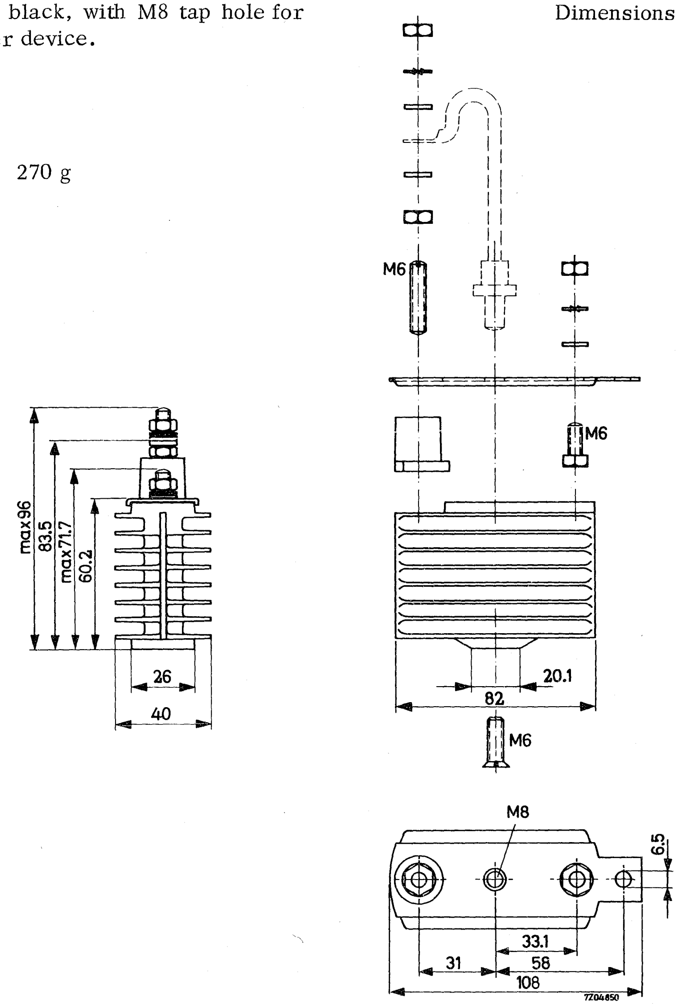


DIECAST HEATSINK

Diecast heatsink of aluminium alloy, painted black, with M8 tap hole for rectifier device.

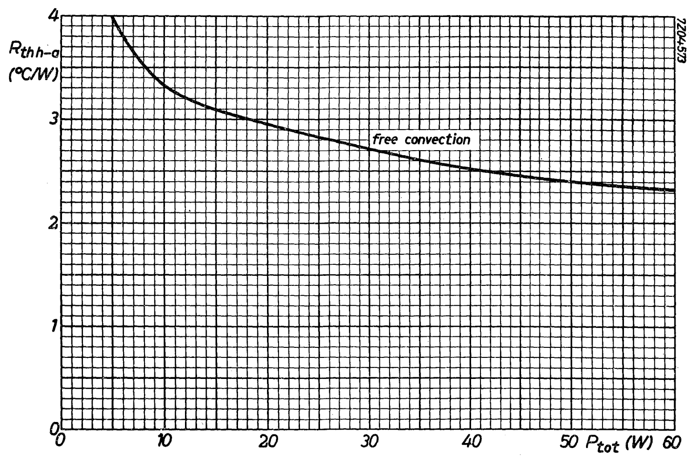
Dimensions in mm

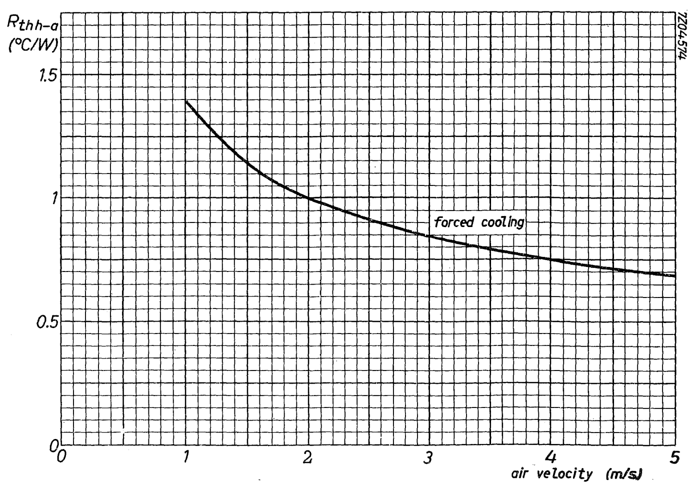
Weight 270 g



The graphs are valid for the combination of diode and heatsink.

Stud: M8
Mounting base, across the flats: 17.0 mm



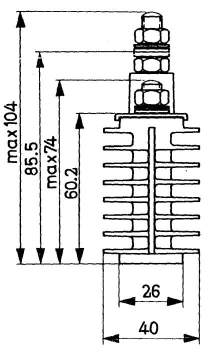


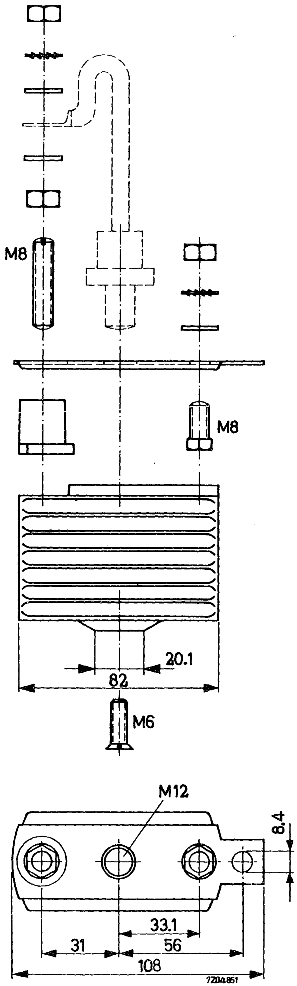
DIECAST HEATSINK

Diecast heatsink of aluminium alloy, painted black, with M12 tap hole for rectifier device.

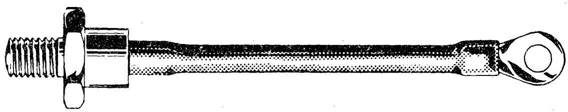
Dimensions in mm

Weight 295 g

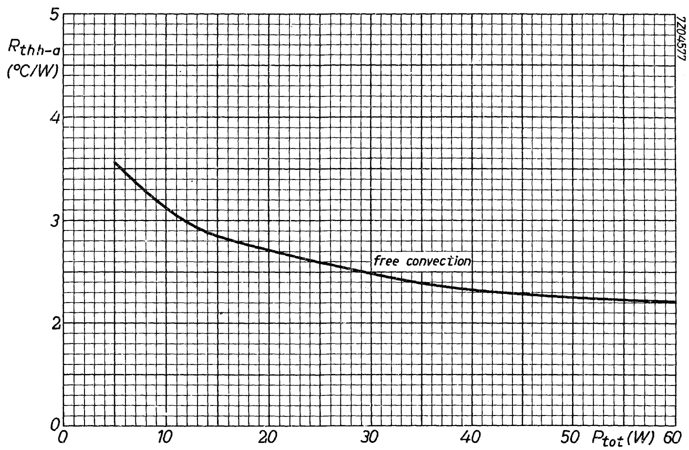


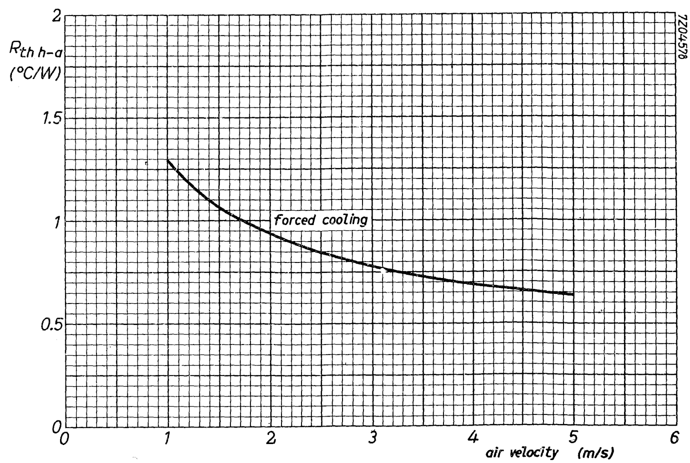


The graphs are valid for the combination of diode and heatsink.



Stud: M12
Mounting base, across the flats: 27.0 mm



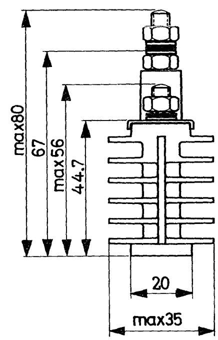


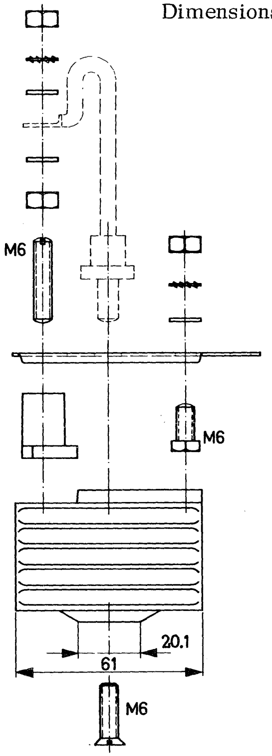
DIECAST HEATSINK

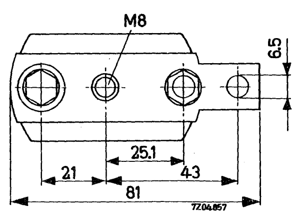
Diecast heatsink of aluminium alloy, painted black, with M8 tap hole for rectifier device.

Dimensions in mm

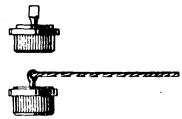
Weight 135 g

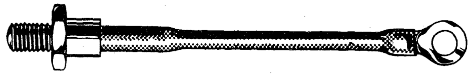




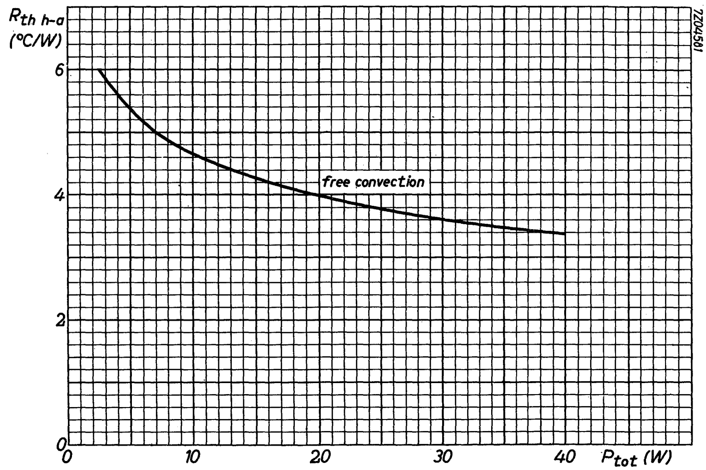


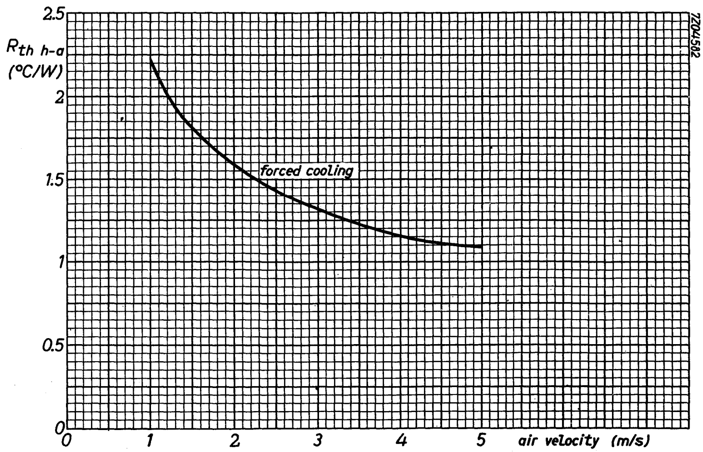
The graphs are valid for the combination of diode and heatsink.





Stud: M8
Mounting base, across the flats: 17.0 mm



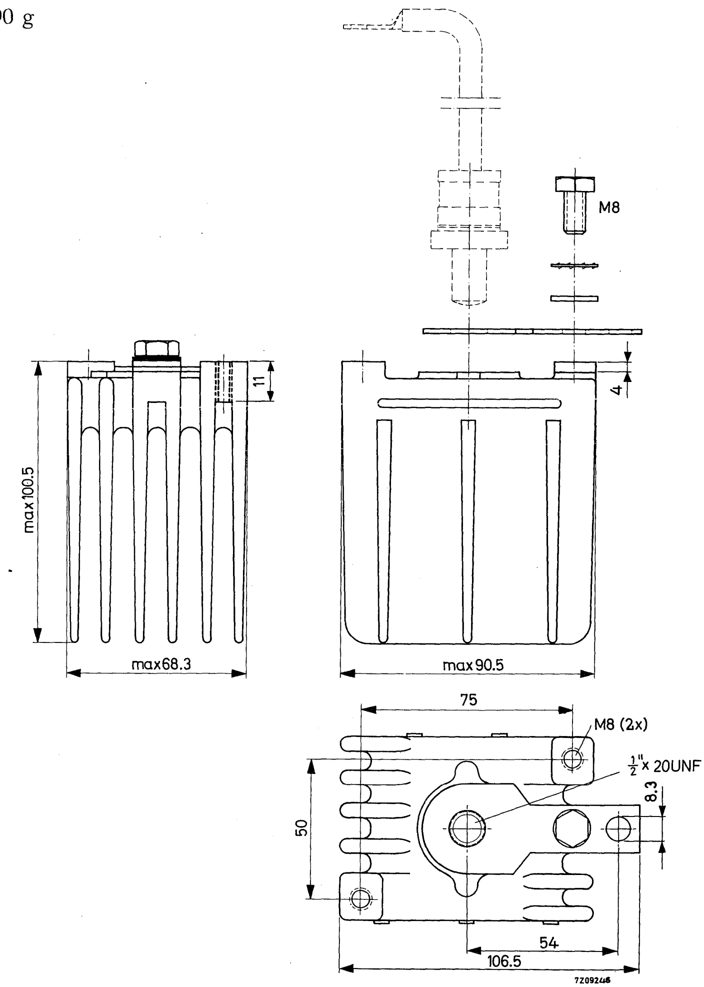


DIECAST HEATSINK

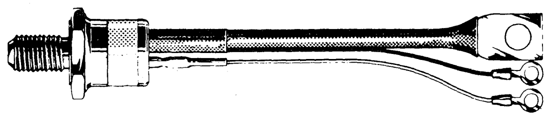
Diecast heatsink of aluminium alloy, painted black, with $\frac{1}{2}''$ x 20UNF tap hole for rectifier device.

Dimensions in mm

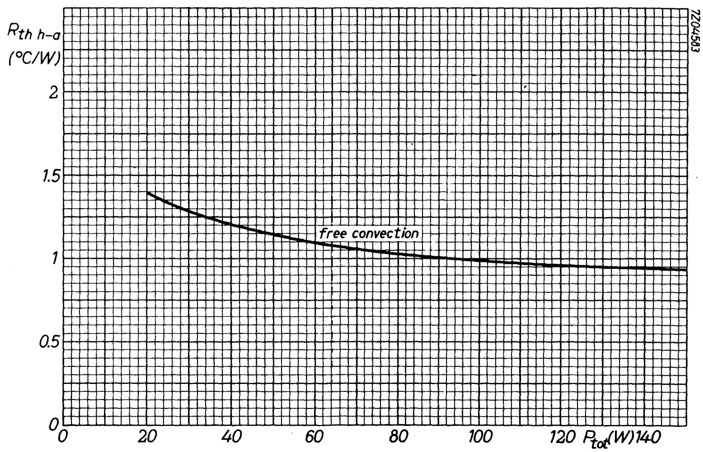
Weight: 690 g

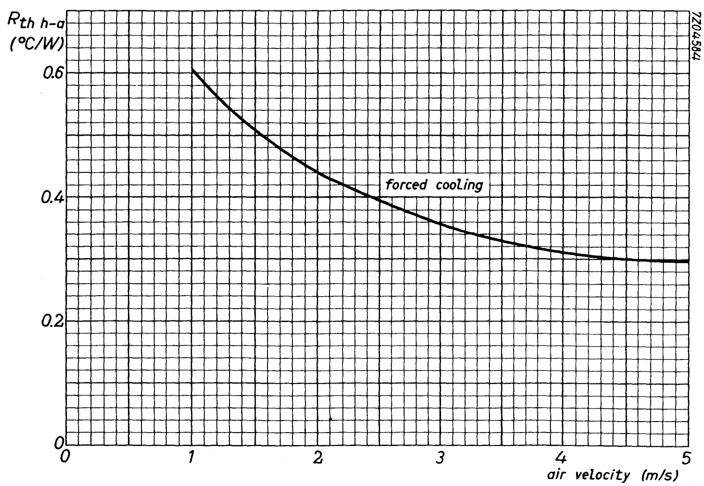


The graphs are valid for the combination of thyristor and heatsink.



Stud: $\frac{1}{2}$" x 20UNF
Mounting base, across the flats: 27.0 mm



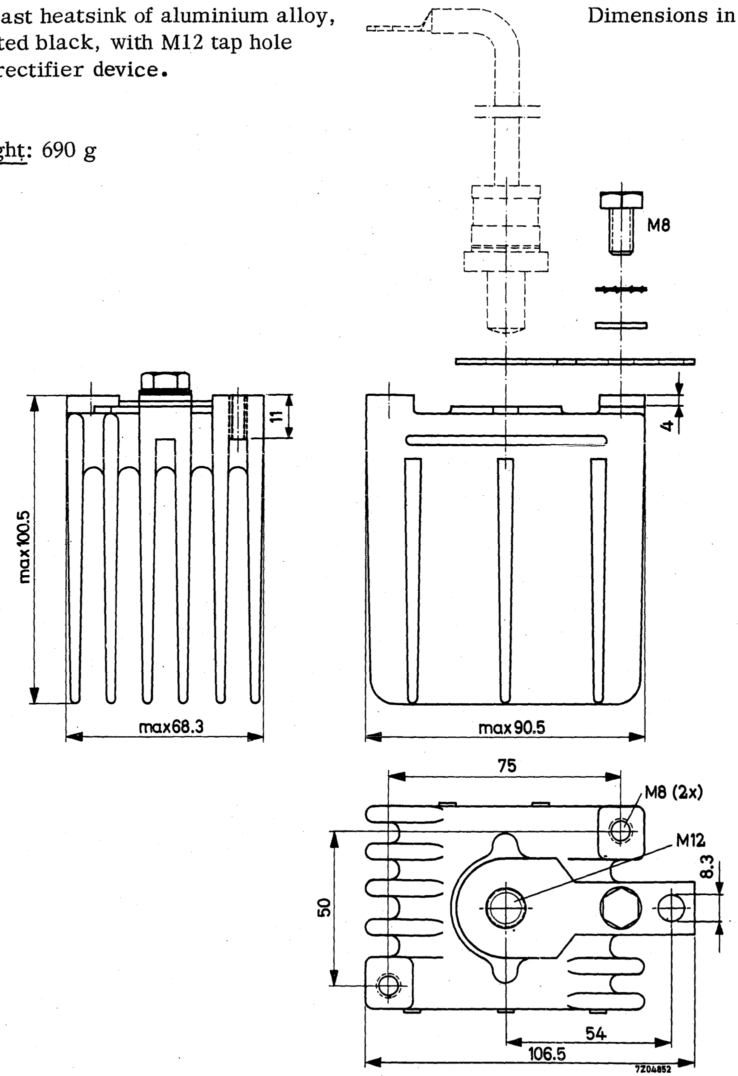


DIECAST HEATSINK

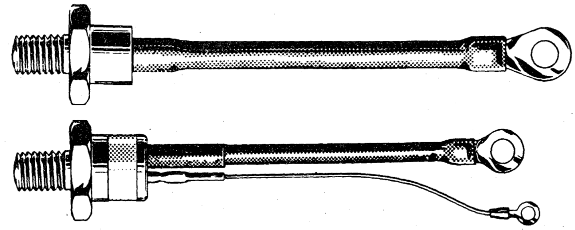
Diecast heatsink of aluminium alloy, painted black, with M12 tap hole for rectifier device.

Weight: 690 g

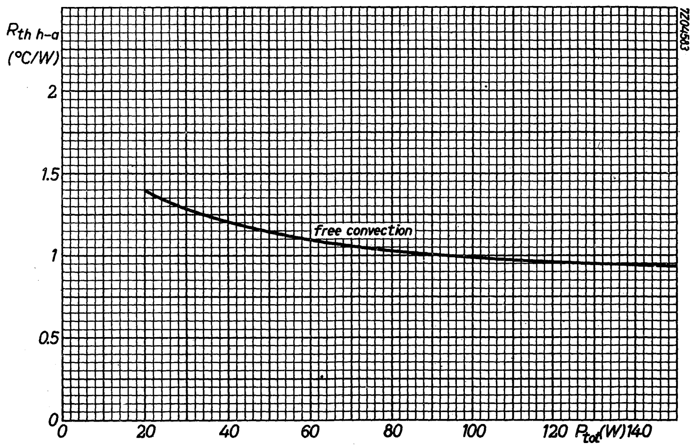
Dimensions in mm

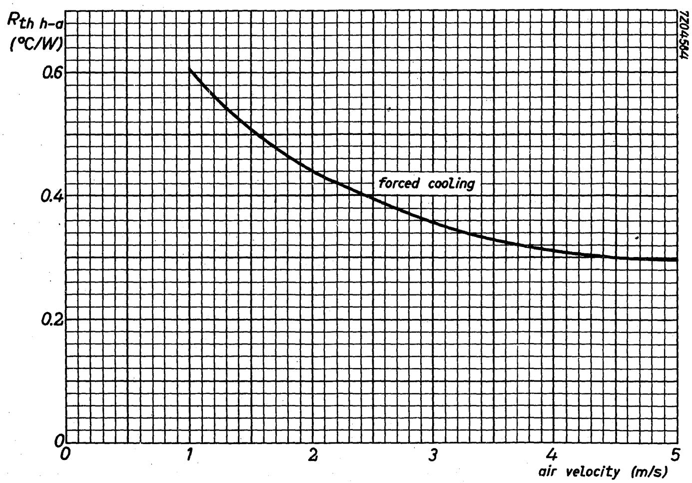


The graphs are valid for the combination of device and heatsink.



Stud: M12
Mounting base, across the flats: 27.0 mm



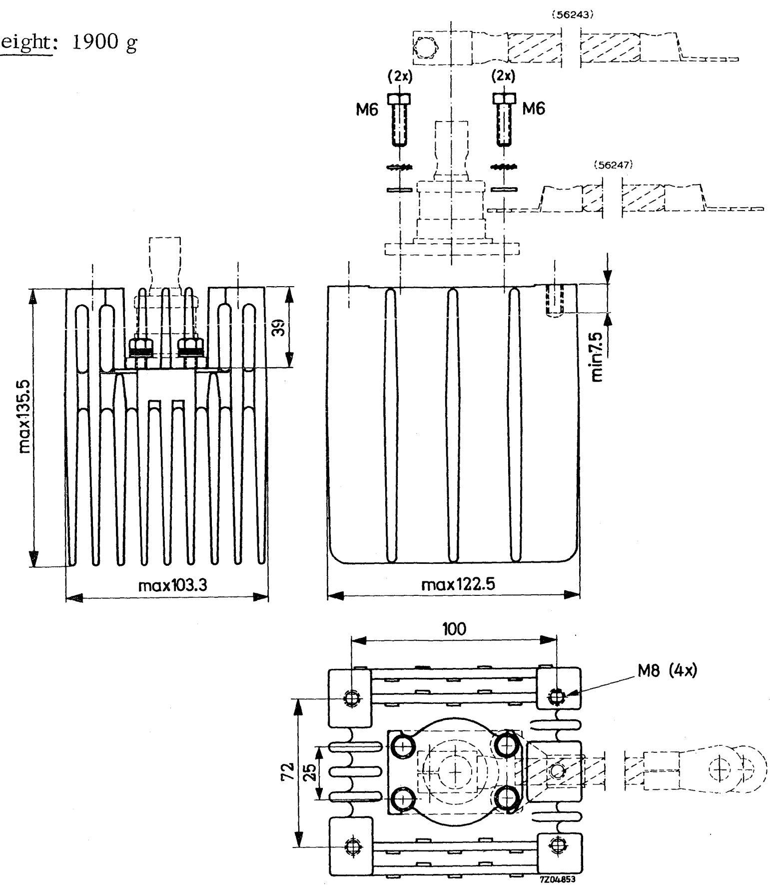


DIECAST HEATSINK

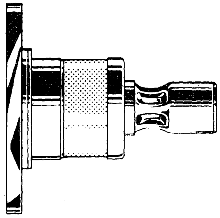
Diecast heatsink of aluminium alloy, painted black, intended for devices with flat mounting base.

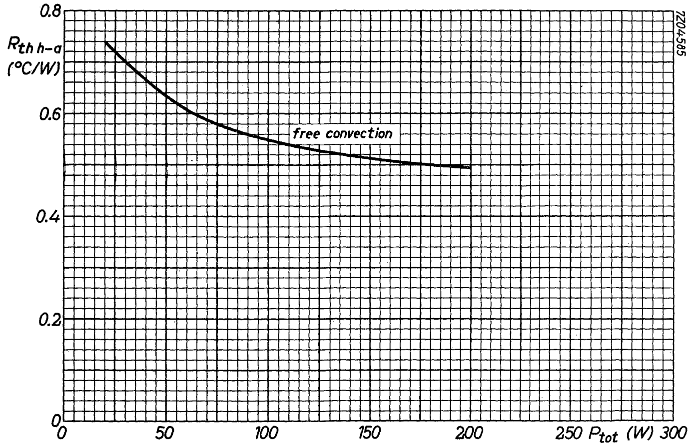
Dimensions in mm

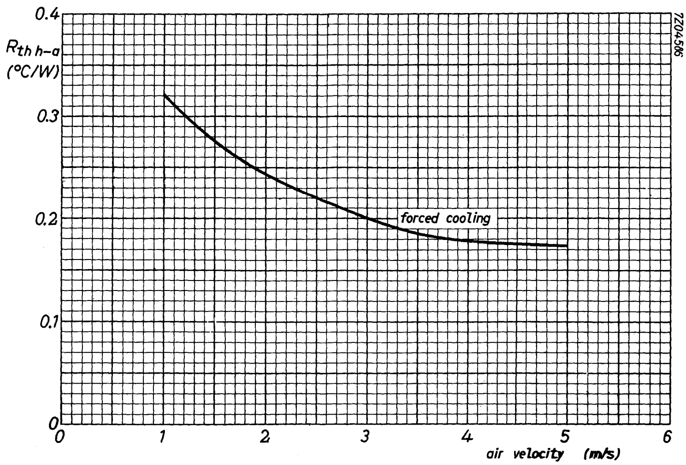
Weight: 1900 g



The graphs are valid for the combination of diode and heatsink.





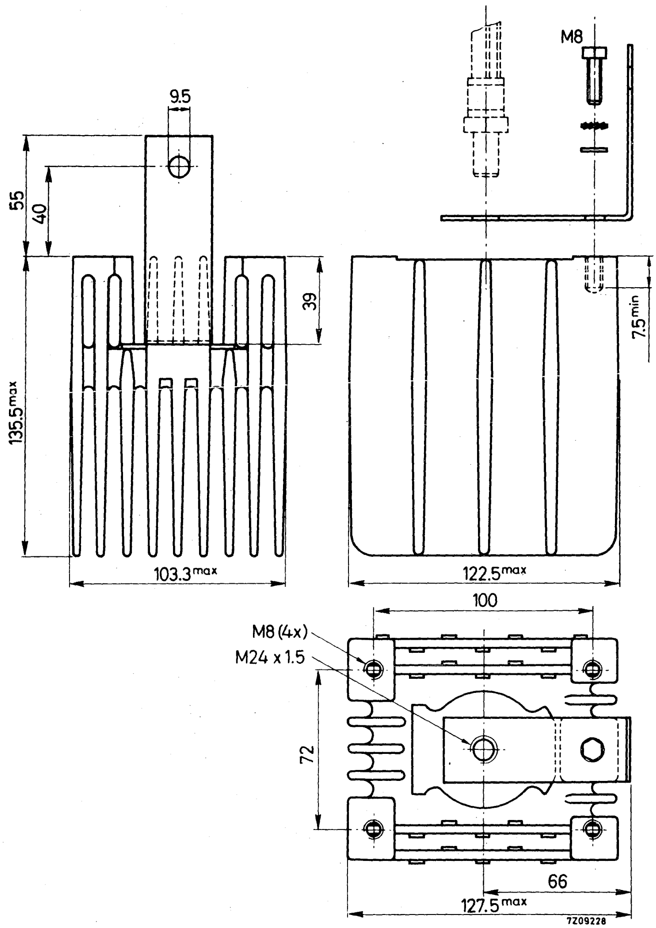


DIECAST HEATSINK

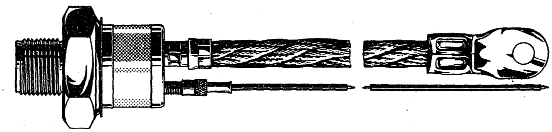
Diecast heatsink of aluminium alloy, painted black, with M24 x 1.5 tap hole for rectifier device.

Dimensions in mm

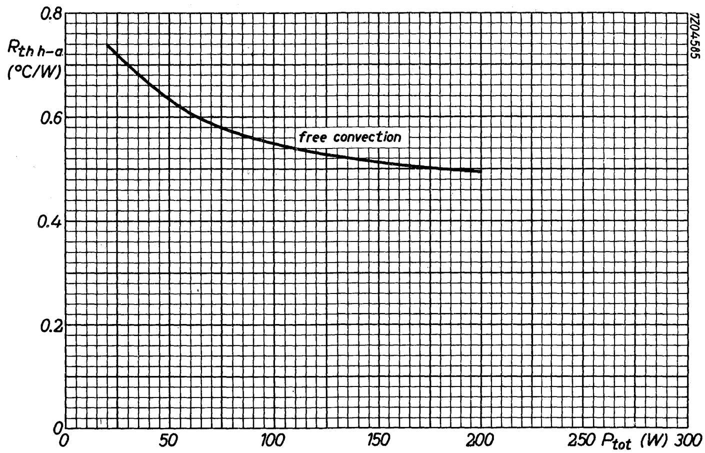
Weight: 1900 g

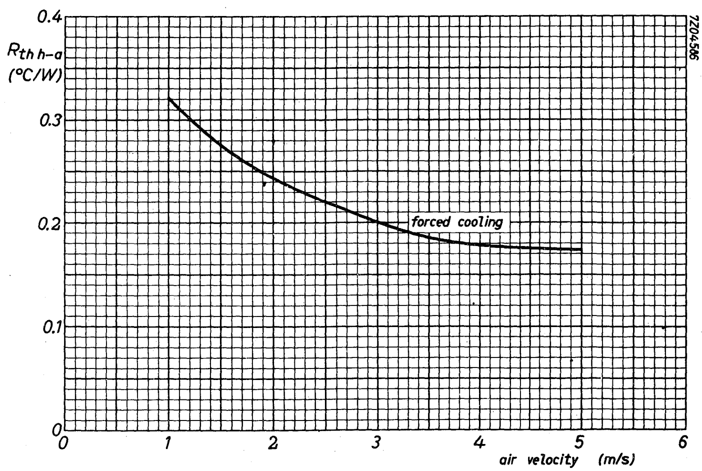


The graphs are valid for the combination of thyristor and heatsink.



Stud: M24 x 1.5
Mounting base, across the flats: 46 mm



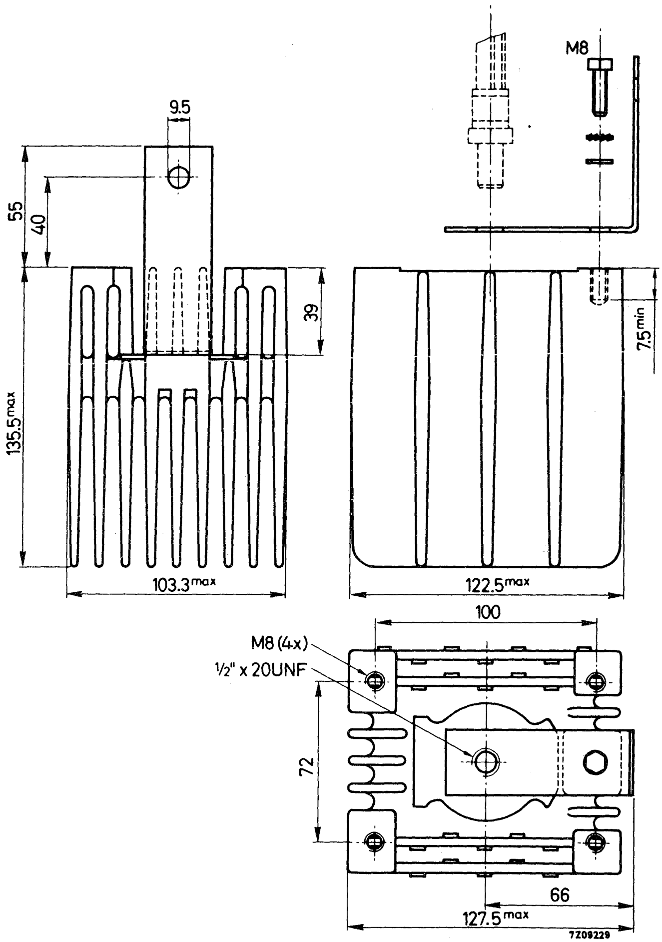


DIECAST HEATSINK

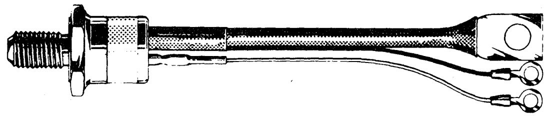
Diecast heatsink of aluminium alloy, painted black, with $\frac{1}{2}$" x 20UNF tap hole for rectifier device.

Dimensions in mm

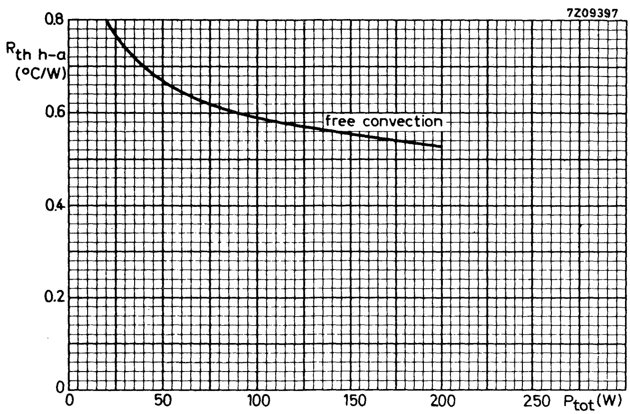
Weight: 1900 g

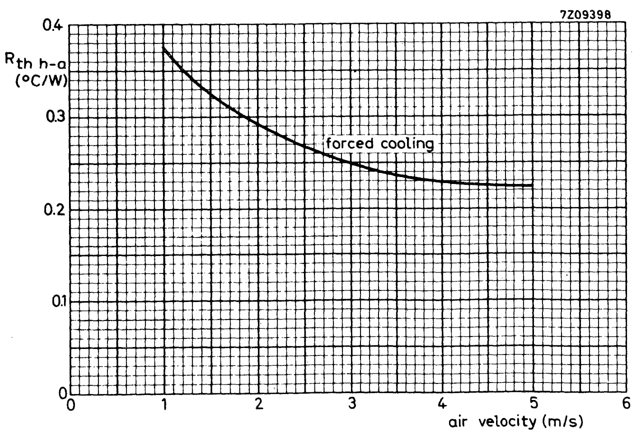


The graphs are valid for the combination of thyristor and heatsink.



Stud: $\frac{1}{2}$" x 20 UNF
Mounting base, across the flats: 27.0 mm





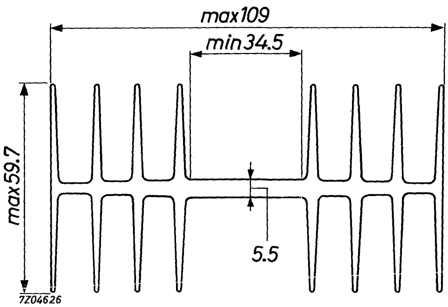
HEATSINK EXTRUSIONS

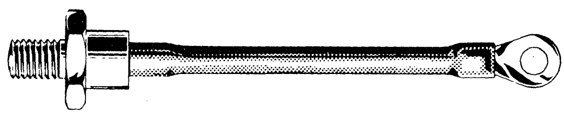
EXTRUDED ALUMINIUM HEATSINK

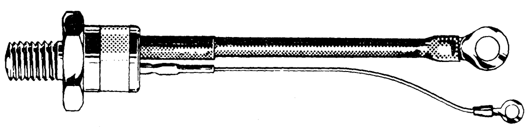
Extruded heatsink of aluminium alloy.
The extrusion is supplied unpainted, in lengths of 1.5 m.

Weight: 4 kg per 1.5 m.

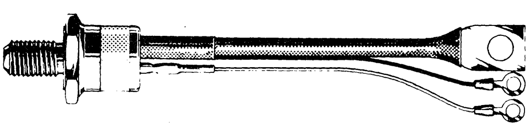
Dimensions in mm





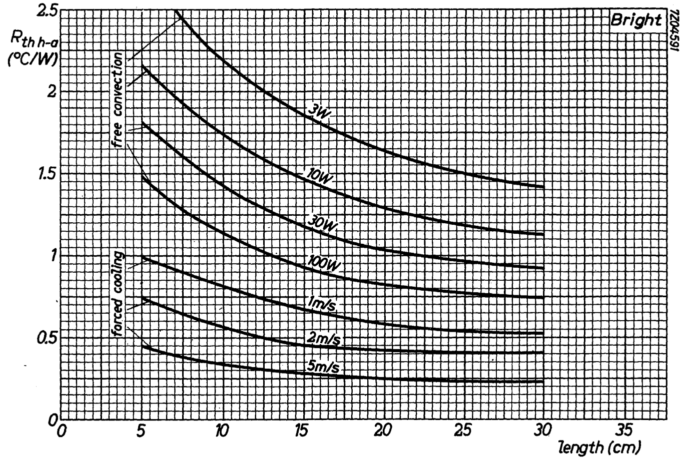


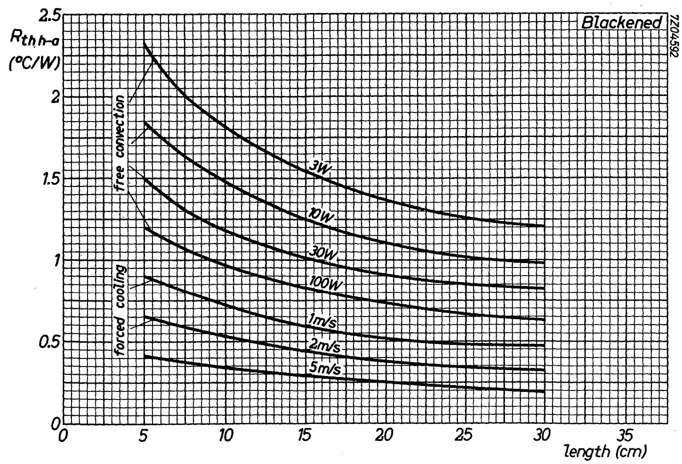
Studs: M12
Mounting bases, across the flats: 27.0 mm



Stud: $\frac{1}{2}$" x 20UNF
Mounting base, across the flats: 27.0 mm

The graphs are valid for the combination of rectifier device and heatsink.



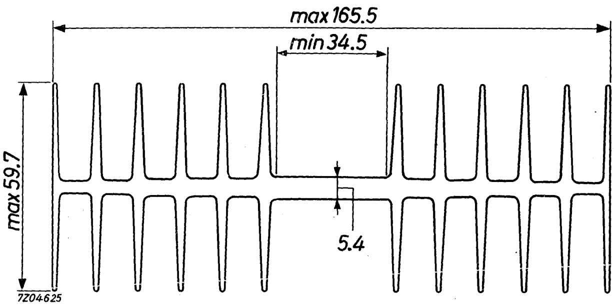


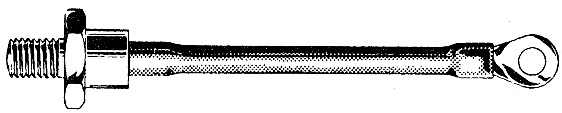
EXTRUDED ALUMINIUM HEATSINK

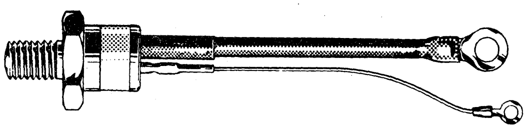
Extruded heatsink of aluminium alloy.
The extrusion is supplied unpainted, in lengths of 1.5 m.

Weight: 6 kg per 1.5 m.

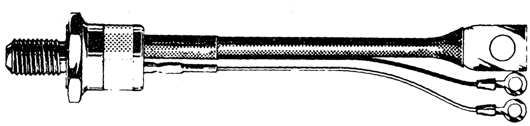
Dimensions in mm





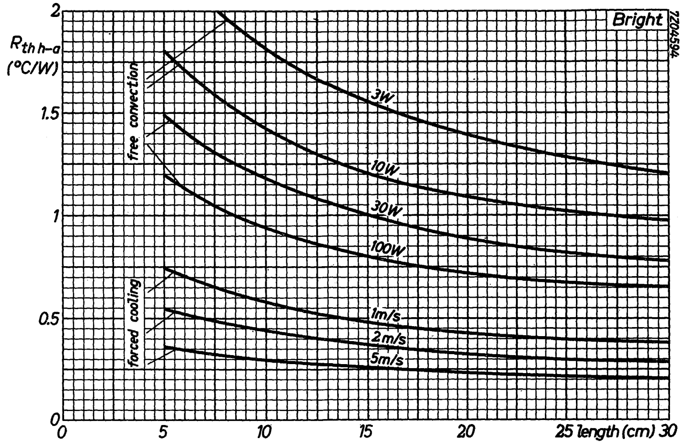


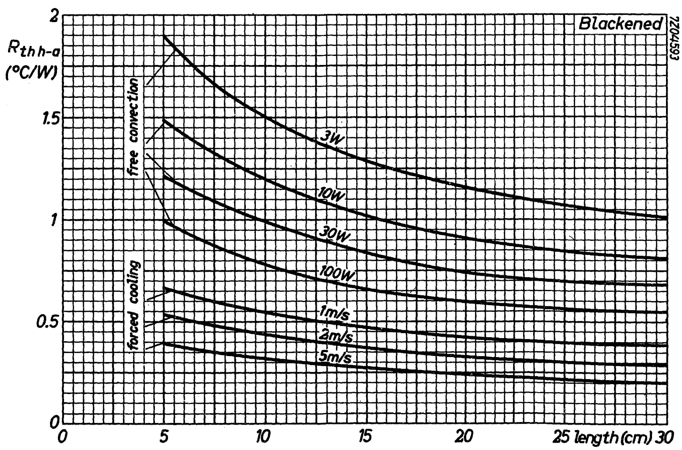
Studs: M12
Mounting bases, across the flats: 27.0 mm



Studs: $\frac{1}{2}$" x 20UNF
Mounting base, across the flats: 27.0 mm

The graphs are valid for the combination of rectifier device and heatsink



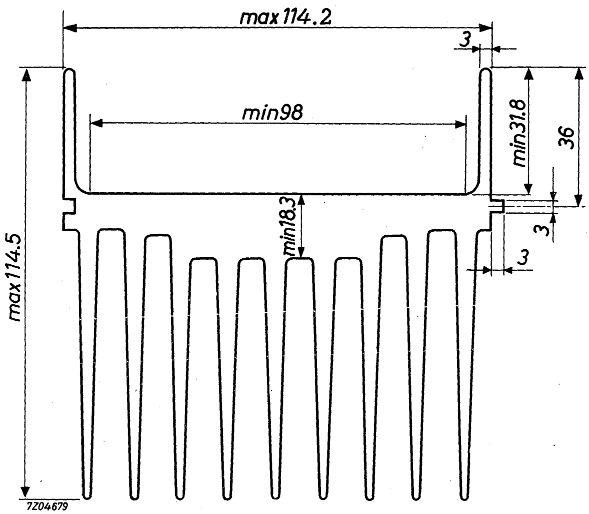


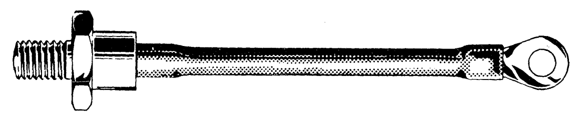
EXTRUDED ALUMINIUM HEATSINK

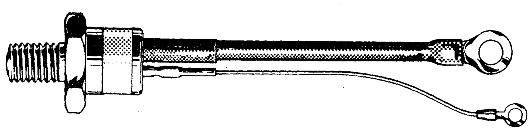
Extruded heatsink of aluminium alloy.
The extrusion is supplied unpainted, in lengths of 1.0 m.

Weight: 10.8 kg per 1.0 m.

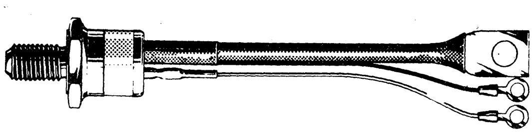
Dimensions in mm





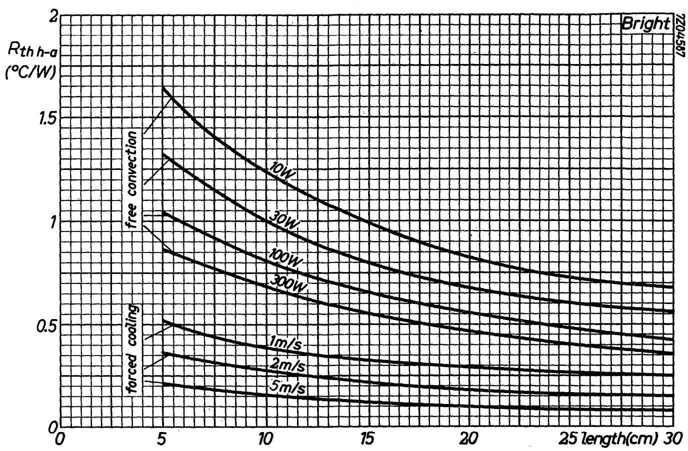


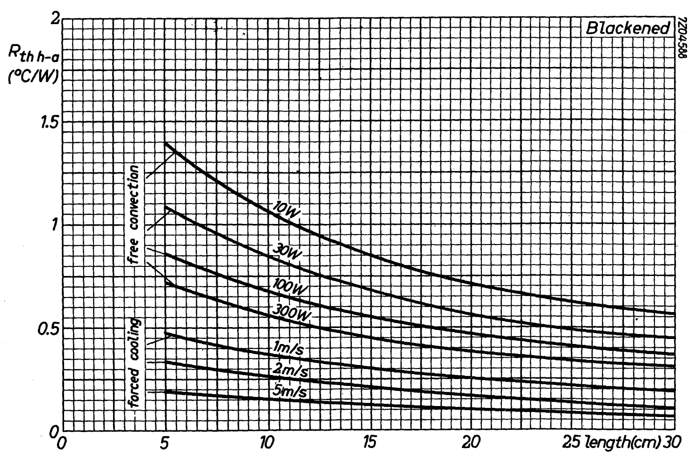
Studs: M12
Mounting bases, across the flats: 27.0 mm



Studs: $\frac{1}{2}$" x 20UNF
Mounting base, across the flats: 27.0 mm

The graphs are valid for the combination of rectifier device and heatsink.
For devices with a flat base see over.



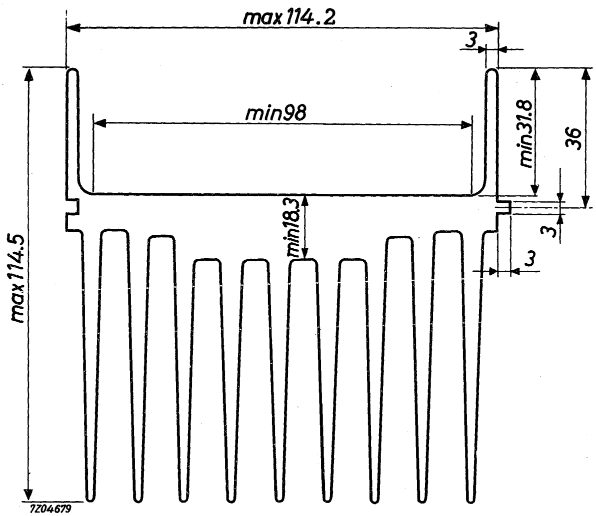


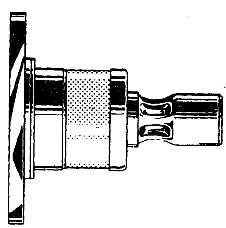
EXTRUDED ALUMINIUM HEATSINK

Extruded heatsink of aluminium alloy.
The extrusion is supplied unpainted, in lengths of 1.0 m.

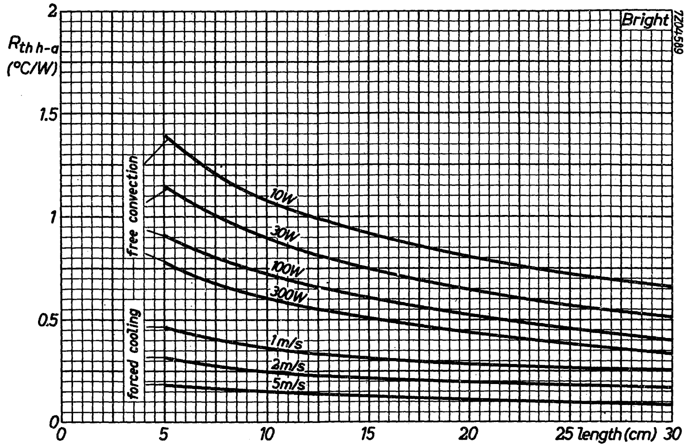
Weight: 10.8 kg per 1.0 m.

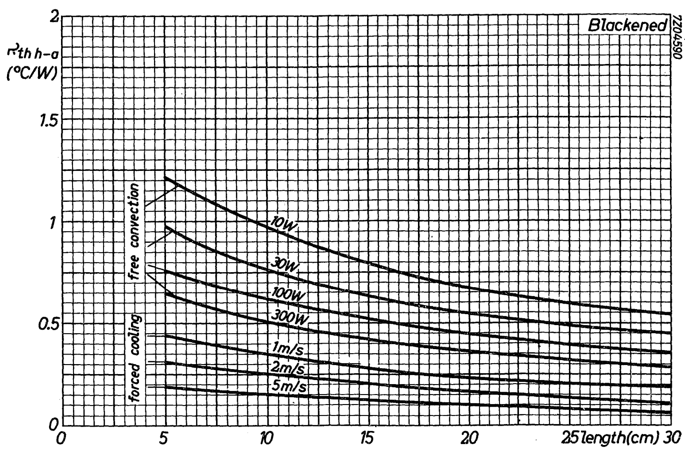
Dimensions in mm





The graphs are valid for the combination of rectifier device and heatsink.
For devices with threaded studs turn back one page.

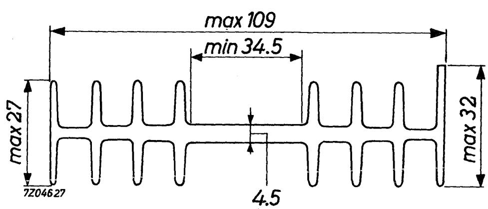


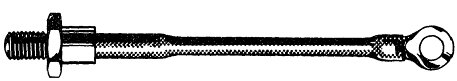


EXTRUDED ALUMINIUM HEATSINK

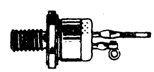
Extruded heatsink of aluminium alloy.
The extrusion is supplied unpainted, in lengths of 1.5 m.

Weight: 2.4 kg per 1.5 m. Dimensions in mm



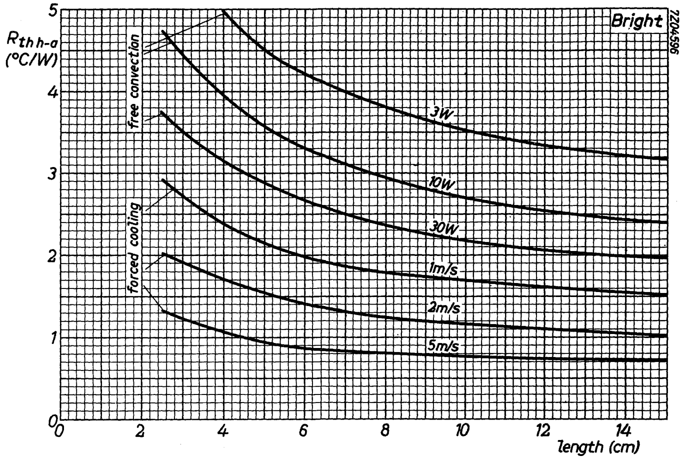


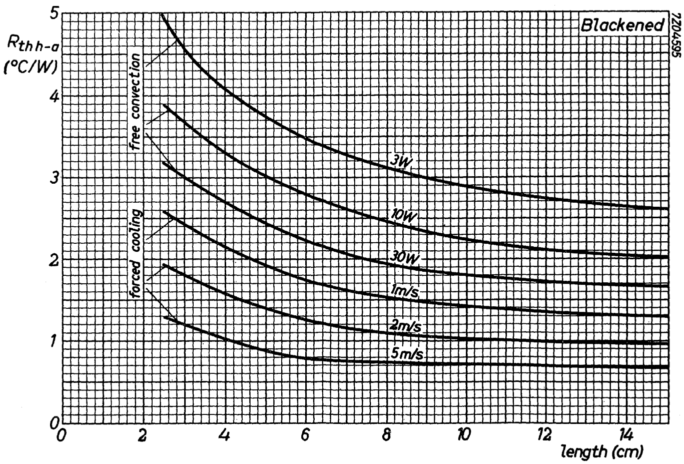
Stud: M8
Mounting base, across the flats: 17.0 mm



Stud: $\frac{1}{4}$" x 28UNF
Mounting base, across the flats: 14.3 mm

The graphs valid for the combination of rectifier device and heatsinks.



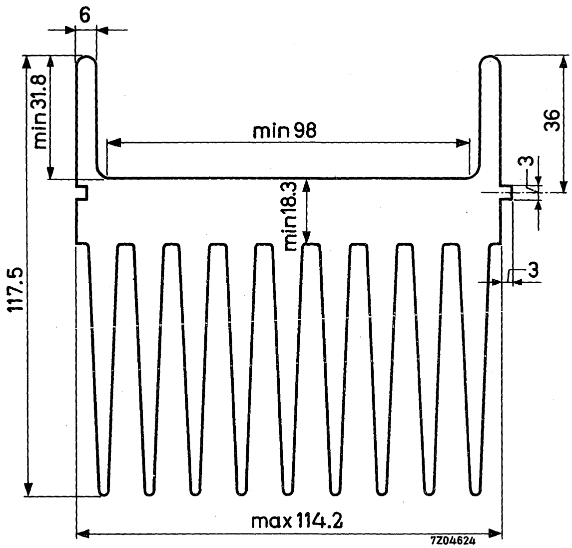


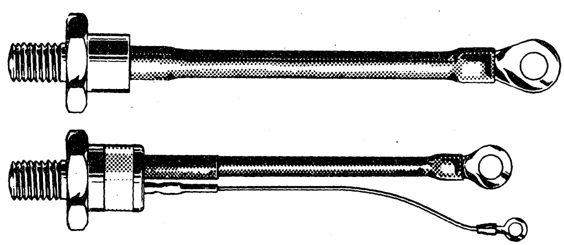
EXTRUDED ALUMINIUM HEATSINK

Extruded heatsink of aluminium alloy.
The extrusion is supplied unpainted, in lengths of 1.5 m.

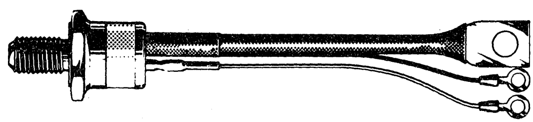
Weight: 16.2 kg per 1.5 m.

Dimensions in mm



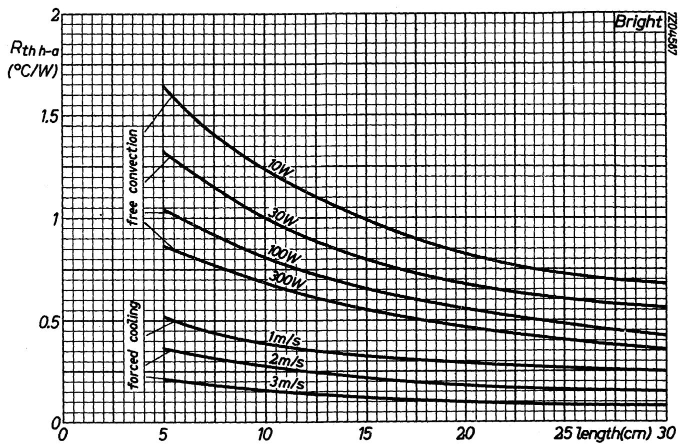


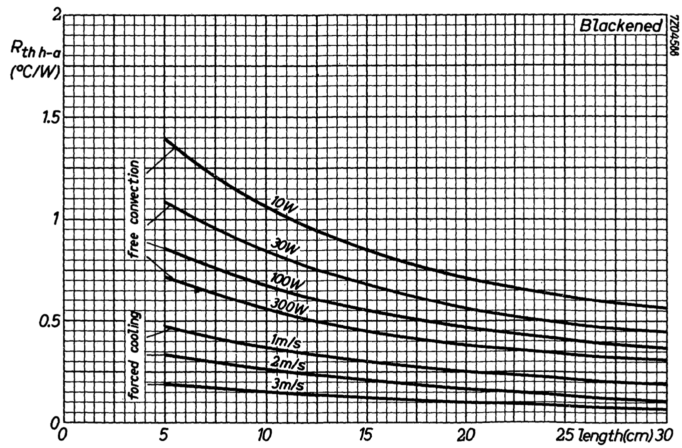
Studs: M12
Mounting bases, across the flats: 27.0 mm



Stud: $\frac{1}{2}$" x 20UNF
Mounting base, across the flats: 27.0 mm

The graphs are valid for the combination of rectifier device and heatsink.
For devices with a flat base see over.



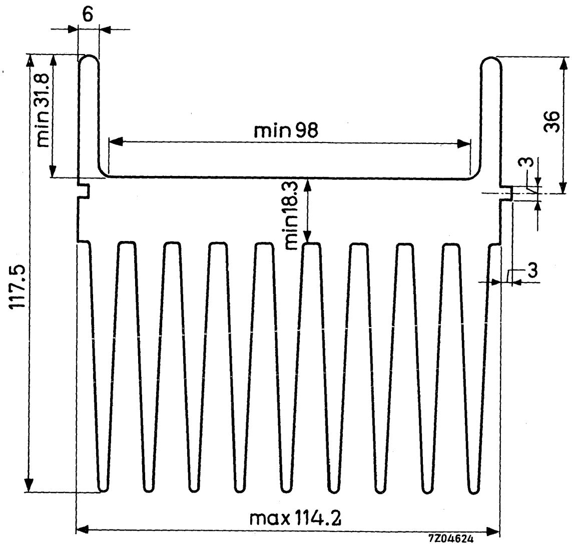


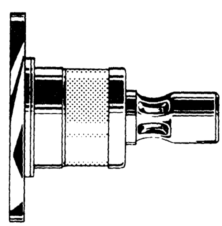
EXTRUDED ALUMINIUM HEATSINK

Extruded heatsink of aluminium alloy.
The extrusion is supplied unpainted, in lengths of 1.5 m.

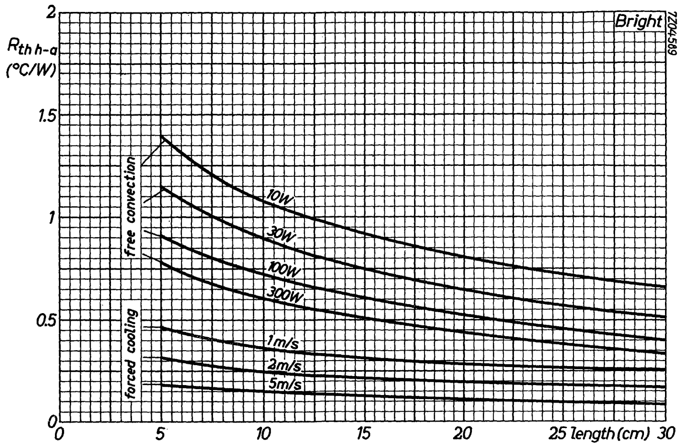
Weight: 16.2 kg per 1.5 m.

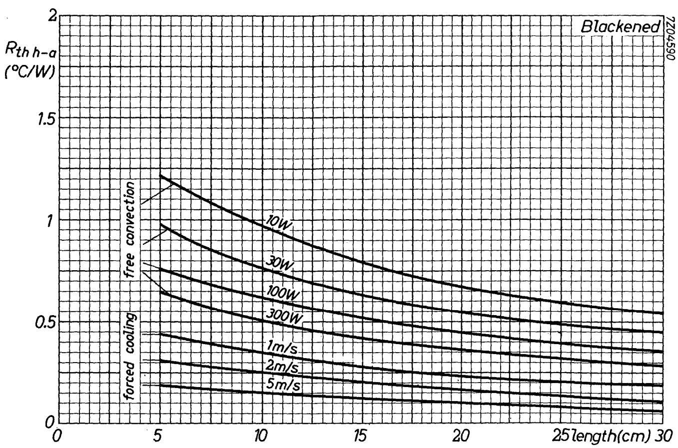
Dimensions in mm





The graphs are valid for the combination of rectifier device and heatsink.
For devices with threaded studs turn back one page.





INDEX OF TYPE NUMBERS

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

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Var = Variable capacitance diodes
Z = Voltage regulator diodes
R = Rectifier diodes
Thyr = Thyristors
St = Rectifier stacks

INDEX

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For Accessories and Heatsinks refer to the separate index, in the relevant section.

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