PHILIPS

Data handbook

PHILIPS Electronic components and materials

Semiconductors and integrated circuits

Part 1a December 1972

Rectifier diodes

Voltage regulator diodes

Transient suppressor diodes

Thyristors, diacs, triacs

Ignistors

Rectifier stacks

SEMICONCUCTORS AND INTEGRATED CIRCUITS

Part 1a **December 1972**

Index and maintenance type list at the back

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DATA HANDBOOK SYSTEM

Our Data Handbook System is a comprehensive source of information on electronic components, subassemblies and materials; it is made up of three series of handbooks each comprising several parts.

ELECTRON TUBES	**BLUE**
SEMICONDUCTORS AND INTEGRATED CIRCUITS	**RED**
COMPONENTS AND MATERIALS	**GREEN**

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

Where ratings or specifications differ from those published in the preceding edition they are pointed out by arrows. Where application information is given it is advisory and does not form part of the product specification.

If you need confirmation that the published data about any of our products are the latest available, please contact our representative. He is at your service and will be glad to answer your inquiries.

ELECTRON TUBES (BLUE SERIES)

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

Part 1 Transmitting tubes (Tetrodes, Pentodes); Amplifier circuit assemblies — **January 1972**

Part 2 Tubes for microwave equipment — **February 1972**

Part 3 Special Quality tubes; Miscellaneous devices — **March 1972**

Part 4 Receiving tubes — **June 1972**

Part 5 Cathode-ray tubes; Photo tubes; Camera tubes — **July 1972**

Part 6 Devices for nuclear equipment — **September 1972**

Photomultiplier tubes
Channel electron multipliers
Scintillators
Photoscintillators
Radiation counter tubes
Semicinductor radiation detectors
Neutron generator tubes
Photo diodes

Part 7 Gas-filled tubes — **October 1972**

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

Part 8 T.V.Picture tubes — **November 1972**

Part 9 Transmitting tubes (Triodes) ; Tubes for r.f. heating (Triodes) — **December 1971**

SEMICONDUCTORS AND INTEGRATED CIRCUITS (RED SERIES)

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

Part 1a Rectifier diodes and thyristors — **December 1972**

Rectifier diodes
Voltage regulator diodes
Transient suppressor diodes
Thyristors, diacs, triacs
Ignistors
Rectifier stacks

Part 1b Diodes — **December 1972**

Small signal germanium diodes
Small signal silicon diodes
Special diodes
Voltage regulator diodes
Voltage reference diodes
Tuner diodes

Part 2 Low frequency and deflection transistors — **October 1971**

Part 3 High frequency and switching transistors — **November 1971**

Part 4 Special types — **December 1971**

Transmitting transistors
Microwave devices
Field effect transistors
Dual transistors
Microminiature devices for thick- and thin-film circuits
Photoconductive devices
Photodiodes
Phototransistors
Light emitting diodes
Infra-red sensitive devices

Part 5 Linear integrated circuits — **February 1972**

Part 6 Digital integrated circuits — **March 1972**

DTL (FC family)
DTL/HNIL (FZ family)
TTL (FJ family)
TTL (GJ family)
CML (GH family)
MOS (FD family)

COMPONENTS AND MATERIALS (GREEN SERIES)

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

Part 1 Circuit Blocks, Input/Output Devices, Electro-mechanical Components, Peripheral Devices — **October 1971**

Circuit blocks 40-Series
Counter modules 50-Series
Norbits 60-Series, 61- Series
Circuit blocks 90-Series
Input/output devices
Electro-mechanical components
Peripheral devices

Part 2 Resistors, Capacitors — **December 1971**

Fixed resistors
Variable resistors
Non-linear resistors
Ceramic capacitors
Paper capacitors and film capacitors
Electrolytic capacitors
Variable capacitors

Part 3 Radio, Audio, Television — **February 1972**

FM tuners
Coil assemblies
Piezoelectric ceramic resonators and filters
Loudspeakers
Audio and mains transformers
Television tuners, aerial input assemblies
Components for black and white television
Components for colour television
Deflection assemblies for camera tubes

Part 4 Magnetic Materials, Piezoelectric Ceramics, Ni Cd cells — **May 1972**

Ferrites for radio, audio and television
Small coils and assembling parts
Ferroxcube potcores and square cores
Ferroxcube transformer cores
Piezoelectric ceramics
Permanent magnet materials
Cylindrical nickel cadmium cells *)

Part 5 Memory Products, Magnetic Heads, Quartz Crystals, Microwave Devices, Variable Transformers — **August 1972**

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

Part 6 Electric Motors and Accessories, Timing and Control Devices — **October 1972**

Small synchronous motors
Stepper motors
D.C. motors
D.C. tachogenerators
Asynchronous motors
Indicators for built-in test equipment
Time indicators, timers, timing motors
Aircraft electronic clock system

Part 7 Circuit Blocks — **September 1971**

Circuit blocks 100 kHz Series
Circuit blocks 1-Series
Circuit blocks 10-Series
Circuit blocks for ferrite core memory drive

*) These items have been discontinued

General

Type designation

Rating systems

Letter symbols

PRO ELECTRON TYPE DESIGNATION CODE

FOR SEMICONDUCTOR DEVICES

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

The type designation consists of:

TWO LETTERS FOLLOWED BY A SERIAL NUMBER

The first letter gives an indication of the material

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

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

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

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

R Compound material as employed in Hall generators and photoconductive cells

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

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

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

A Detection diode, switching diode, mixer diode

B Variable capacitance diode

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

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

E Tunnel diode

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

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

H Magnetic sensitive diode; Field probe

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

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

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

→ N Photocoupler

P Radiation sensitive device [1]

Q Radiation generating device

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

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

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

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

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

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

Z Voltage reference or voltage regulator diode [1]

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

The serial number consists of:

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

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

VERSION LETTER

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

TYPE DESIGNATION FOR A RANGE OF SEMICONDUCTOR DEVICES

The type designation of a range of variants of:

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

b) rectifying diodes (second letter Y)

c) thyristors (second letter T)

d) radiation detectors

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

The suffix part consists of:

a) for voltage reference or voltage regulator diodes

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

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

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

b) for rectifying diodes

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

c) for thyristors

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

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

d) for radiation detectors

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

EXAMPLES

BZY88series	Range of silicon voltage regulator diodes for professional equipment
BZY88-C9V1	The particular type out of the range with a typical zener voltage of 9.1 V ± 5%
BYX13-1200	The particular normal polarity type out of the BYX13series with a maximum repetitive peak reverse voltage of 1200 V
BTW92-800R	The particular reverse polarity type out of the BTW92 thyristor range of which the lower maximum repetitive peak voltage is 800V

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.

RATING SYSTEMS

ACCORDING TO I.E.C. PUBLICATION 134

1. DEFINITIONS OF TERMS USED

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

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

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

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

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

Note: Limiting conditions may be either maxima or minima.

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

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

2. ABSOLUTE MAXIMUM RATING SYSTEM

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

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

p.t.o.

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

3. DESIGN MAXIMUM RATING SYSTEM

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

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

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

4. DESIGN CENTRE RATING SYSTEM

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

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

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

NOTE

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

Letter symbols

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

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

QUANTITY SYMBOLS

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

   Examples: i, v, p

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

   Examples: I, V, P

SUBSCRIPTS FOR QUANTITY SYMBOLS

1. Total values are indicated by upper case subscripts.

   Examples: I_C, I_{CM}, $I_{C(AV)}$, i_C, V_{EB}

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

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

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

   For maximum (peak) values : M or m

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

   For d.c. values : no additional subscript

   For root-mean-square values : (RMS) or (rms)

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

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

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

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

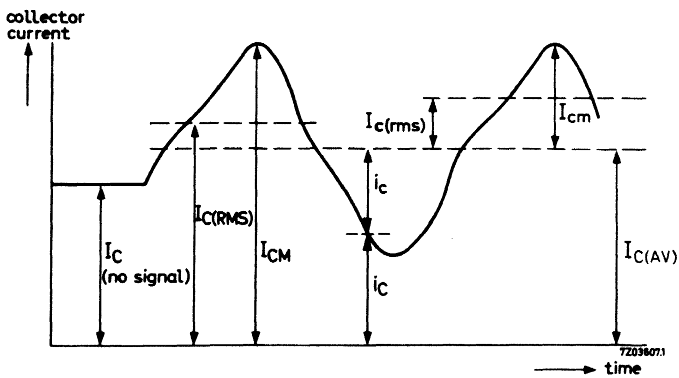

Fig.1

CONVENTIONS FOR SUBSCRIPT SEQUENCE

1. Currents

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

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

2. Voltages

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

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

3. Supply voltages

Supply voltages may be indicated by repeating the terminal subscript.

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

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

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

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

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

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

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

ELECTRICAL PARAMETER SYMBOLS

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

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

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

   Examples: H_i, Z_o, H_F, Y_R

SUBSCRIPTS FOR PARAMETER SYMBOLS

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

   Examples: h_{IB}, h_{FE}

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

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

   Examples: h_{ib}, z_{ob}

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

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

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

Notes 1) The voltage and current symbols in matrix notation are indicated by a single digit subscript.
The subscript 1 = input; the subscript 2 = output
2) The voltages and currents in these equations may be complex quantities.

4. The second subscript identifies the circuit configuration.

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

Examples: (common base)

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

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

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

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

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

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

LIST OF LETTER SYMBOLS IN ALPHABETICAL ORDER

Letter symbol	Definition
B	Bandwidth
b_{ib}, b_{ie}, b_{is}, b_{fb}, b_{fe}, b_{fs}, b_{ob}, b_{oe}, b_{os}, b_{rb}, b_{re}, b_{rs}	See y parameters
C_c 1)	Collector capacitance (emitter open-circuited to a.c. and d.c.)
C_d 1)	Diode capacitance
C_e 1)	Emitter capacitance (collector open-circuited to a.c. and d.c.)
C_{ib}, C_{ie}, C_{is}, C_{fb}, C_{fe}, C_{fs}, C_{ob}, C_{oe}, C_{os}, C_{rb}, C_{re}, C_{rs}	See y parameters
d	Distortion
F	Noise figure
f	Frequency
f_{hfb}, f_{hfe}, f_{yfe}	Cut-off frequency (frequency at which the parameter indicated by the subscript is 0.7 of its low frequency value)
f_T	Transition frequency (Gain-bandwidth product)
g_{ie}, g_{ib}, g_{oe}, g_{ob}	See y parameters
G_p	Power gain
G_S	Source conductance
G_{tr}	Transducer gain
G_{UM}	Maximum unilateralised power gain
G_v	Voltage gain

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

Letter symbol	Definition
h_{FB}, h_{FC}, h_{FE}	D.C. current gain (static value of the forward current transfer ratio; output voltage held constant)
h_{fb}, h_{fc}, h_{fe}	Small-signal current gain (small-signal value of the forward current transfer ratio; output short-circuited to a.c.)
h_{IB}, h_{IC}, h_{IE}	Static value of the input resistance (output voltage held constant)
h_{ib}, h_{ic}, h_{ie}	Small-signal value of the input impedance (output short-circuited to a.c.)
h_{OB}, h_{OC}, h_{OE}	Static value of the output conductance (input current held constant)
h_{ob}, h_{oc}, h_{oe}	Small-signal value of the output admittance (input open-circuited to a.c.)
h_{RB}, h_{RC}, h_{RE}	Static value of the reverse voltage transfer ratio (input current held constant)
h_{rb}, h_{rc}, h_{re}	Small-signal value of the reverse voltage transfer ratio (input open-circuited to a.c.)
I_B, I_C, I_D, I_E, I_G, I_S	Total d.c. (or average) current
I_b, I_c, I_d, I_e, I_g, I_s	Varying component of the current
i_B, i_C, i_D, i_E, i_G, i_S	Instantaneous total value of the current
i_b, i_c, i_d, i_e, i_g, i_s	Instantaneous value of the varying component of the current
$I_{B(AV)}$, $I_{C(AV)}$, $I_{E(AV)}$	Total average current (to distinguish between average and d.c. if necessary)
I_{BEX}, I_{CEX}	Total base, respectively collector current under specified conditions. These symbols are commonly used in case of a reverse biased emitter junction
I_{BM}, I_{CM}, I_{EM}	Maximum (peak) value of the total current
I_{bm}, I_{cm}, I_{em}	Maximum (peak) value of the varying component of the current
I_{CBO}	Collector cut-off current (open emitter)
I_{CEO}	Collector cut-off current (open base)
I_{CBS} or I_{CES}	Collector cut-off current (emitter short-circuited to base)

Letter symbol	Definition
I_{DSS}	Drain current (source short-circuited to gate)
I_{EBO}	Emitter cut-off current (open collector)
I_F	Total forward current of a diode (d.c. or average)
i_F	Instantaneous total value of the forward current of a diode
$I_{F(AV)}$	Total average forward current of a diode (to distinguish between average and d.c. if necessary)
I_{FM}	Peak forward current of a diode
I_{GSS}	Gate cut-off current (source short-circuited to drain)
I_i, I_o	Input, respectively output current of a specified circuit
I_R	Total reverse (cut-off) current of a diode
i_R	Instantaneous total value of the reverse current of a diode
I_{RRM}	Repetitive peak reverse current of a diode
I_{RSM}	Non-repetitive peak reverse current of a diode
I_{SDS}	Source cut-off current (drain short-circuited to gate)
I_Z	Zener current (d.c. or average)
I_{ZM}	Peak zener current
I_{ZS}	Non-repetitive zener current
P_i, P_o	Input, respectively output power of a specified circuit
P_{tot}	Total power dissipation in the device
P_Z	Zener power dissipation
P_{ZM}	Peak zener power dissipation
P_{ZSM}	Non-repetitive peak zener power dissipation
Q_s	Reverse recovery charge

Letter symbol	Definition
r_D	Diode (internal) series resistance
r_{DS}	Drain-source resistance
r_{GS}	Gate-source resistance
R_L	Load resistance
R_S	Source resistance
R_{th}	Thermal resistance
$R_{th\ j\text{-}a}$	Thermal resistance from junction to ambient
$R_{th\ j\text{-}mb}$	Thermal resistance from junction to mounting base
$R_{th\ j\text{-}c}$	Thermal resistance from junction to case
$R_{th\ mb\text{-}h}$	Thermal resistance from mounting base to heatsink (contact thermal resistance)
r_z	Dynamic-slope resistance of a zener diode
S_Z	Temperature coefficient of the operating voltage of a zener diode
T_{amb}	Ambient temperature
T_{case}	Case temperature
t_d ; t_f	Delay time; fall time
t_{fr}	Forward recovery time of a diode
T_j	Junction temperature
t_{off}	Turn-off time ($t_{off} = t_s + t_f$)
t_{on}	Turn-on time ($t_{on} = t_d + t_r$)
t_r	Rise time
t_{rr}	Reverse recovery time of a diode
t_s	Storage time
T_{stg}	Storage temperature
V_{BB}, V_{CC}, V_{EE}	Supply voltage
V_{BE}, V_{CB}, V_{CE}, V_{EB}	Total value of the voltage (d.c. or average)
V_{be}, V_{cb}, V_{ce}, V_{eb}	Varying component of the voltage
v_{BE}, v_{CB}, v_{CE}, v_{EB}	Instantaneous value of the total voltage
v_{be}, v_{cb}, v_{ce}, v_{eb}	Instantaneous value of the varying component of the voltage

Letter symbols	Definition
V_{BEfl}	Base-emitter floating voltage (open base)
V_{BEsat}	Saturation voltage at specified bottoming conditions
$V_{(BR)}$	Breakdown voltage
$V_{(BR)CBO}$, $V_{(BR)CEO}$, $V_{(BR)EBO}$	Breakdown voltage between the terminal indicated by the first subscript and the reference terminal (second subscript) when the third terminal is open circuited
$V_{(BR)CER}$	Collector-emitter breakdown voltage with a specified resistance between emitter and base
$V_{(BR)CES}$	Collector-emitter breakdown voltage with the emitter short circuited to the base
V_{CBO}, V_{CEO}, V_{DGO}, V_{EBO}, V_{GSO}	Voltage of the terminal indicated by the first subscript w.r.t. the reference terminal (second subscript) with the third terminal open circuited
V_{CBOM}, V_{CEOM}	Peak value of V_{CBO}, V_{CEO}
V_{CEK}	Knee voltage at specified conditions
V_{CER}	Collector-emitter voltage with a specified resistance between emitter and base
V_{CERM}	Peak value of V_{CER}
V_{CES}	Collector-emitter voltage with the emitter short circuited to the base
V_{CEsat}	Saturation voltage at specified bottoming conditions
$V_{CE,sust}$	Collector-emitter sustaining voltage under the condition, indicated by the third subscript
V_{CEX}	Collector-emitter voltage in a specified circuit. This symbol is commonly used to indicate a reverse biased emitter junction
V_{DSS}	Drain-source voltage with the source short-circuited to the gate
V_{EBfl}	Emitter-base floating voltage (open emitter)
V_F	Continuous forward voltage of a diode
V_{FM}	Peak forward voltage of a diode

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

LETTER SYMBOLS
FOR RECTIFIER DIODES AND THYRISTORS

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

QUANTITY SYMBOLS

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

   Examples: i, v, p

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

   Examples: I, V, P

SUBSCRIPTS FOR QUANTITY SYMBOLS

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

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

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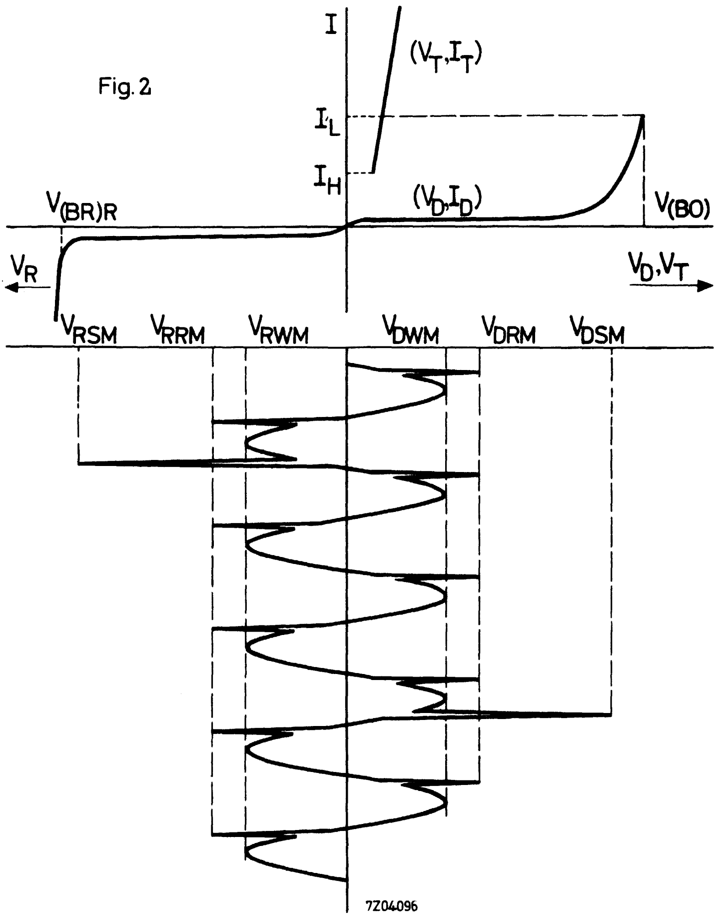
[1]) For the anode-cathode voltage of thyristors F is replaced either by D or by T, to distinguish between "off-state" (non triggered) and "on-state" (triggered).

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



LIST OF LETTER SYMBOLS IN ALPHABETICAL ORDER

for Rectifier Diodes (R) and Thyristors (T)

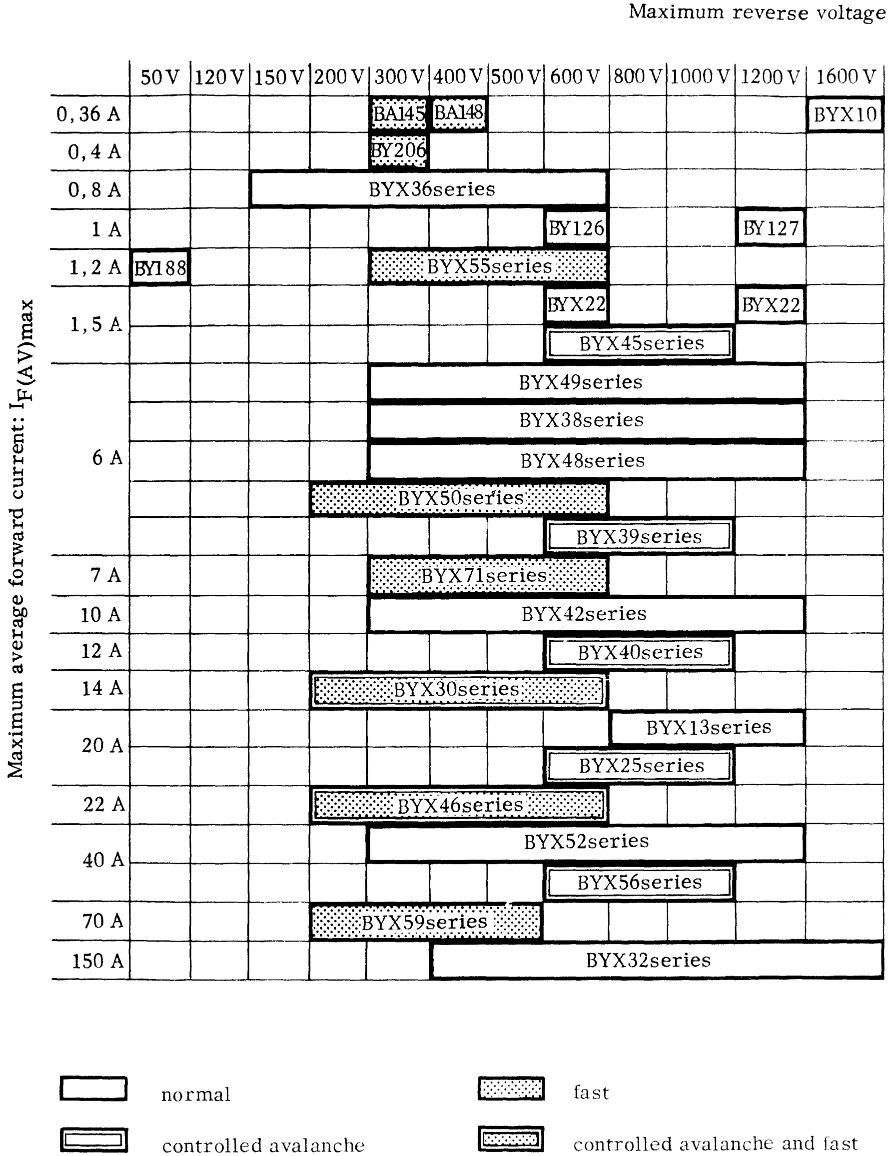
Instantaneous values (i, p, v) and a.c. components (lower case subscripts) have been omitted.

Letter symbol	R	T	Description
I_{DM}	-	T	Peak off-state current (d.c.)
I_F	R	-	Forward current (d.c. or average)
$I_{F(AV)}$	R	-	Total average forward current (to distinguish between average and d.c. if necessary)
I_{FGM}	-	T	Forward peak gate current
$I_{F(RMS)}$	R	-	R.M.S. value of the forward 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
I_L	-	T	Latching current (pick up current, Ip)
I_{RG}	-	T	Reverse gate current
I_{RM}	R	T	Peak reverse current (d.c.)
I_{RRM}	R	T	Repetitive peak reverse current
I^2t	R	T	I squared t for fusing
I_T	-	T	On-state current (d.c.)
$-dI/dt$	-	T	Rate of change of commutation current
dI_T/dt	-	T	Rate of rise of on-state current
$I_{T(AV)}$	-	T	Average on-state current
I_{TRM}	-	T	Repetitive peak on-state current
$I_{T(RMS)}$	-	T	R.M.S. value of the on-state current
I_{TSM}	-	T	Non-repetitive peak on-state current
$I_{TS(RMS)}$	-	T	R.M.S. value of the non-repetitive on-state current
$P_{G(AV)}$	-	T	Average gate power dissipation
P_{GM}	-	T	Peak gate power dissipation
$P_{R(AV)}$	R	T	Average reverse power dissipation

Letter symbol	R	T	Description
P_{RRM}	R	T	Repetitive peak reverse power dissipation
P_{RSM}	R	T	Non-repetitive peak reverse power dissipation
R_{th}	R	T	Thermal resistance
T_{amb}	R	T	Ambient temperature
T_{mb}	R	T	Mounting base temperature
t_d; t_f	R	T	Delay time; fall time
T_j	R	T	Junction temperature
t_{on}	R	T	Turn-on time ($t_{on} = t_d + t_r$)
t_q	R	T	Turn-off time
t_r	R	T	Rise time
T_{stg}	R	T	Storage temperature
$V_{(BO)}$	-	T	Forward breakover voltage
$V_{(BR)R}$	R	T	Reverse avalanche breakdown voltage
V_D	-	T	Continuous off-state voltage
$\frac{dV_D}{dt}$	-	T	Rate of rise of 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 that will not trigger any device
V_{GT}	-	T	Gate-cathode voltage that will trigger all devices
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 on-state voltage
Z_{th}	R	T	Transient thermal impedance

Rectifier diodes

TYPE SELECTION CHART



Maximum average forward current: $I_{F(AV)max}$	1,8 kV	12,5 kV	15 kV	35 kV	37,5 kV	75 kV to 150 kV
	Maximum reverse voltage					
2,0 mA	BY184					
2,5 mA		BY187	BY176	BY185		
50 mA					BYX35	BYX29series

Single phase bridge rectifier assemblies

Maximum imput voltage (r.m.s.)

Average output current I_O	60 V	280 V
1 A		BY179
1,4 A	BY164	

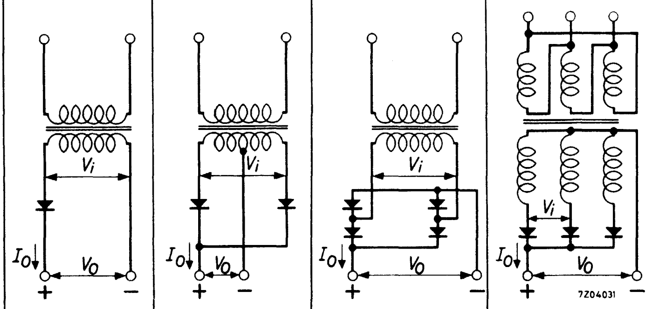
normal

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)
		$I_O = I_{F(AV)}$	$I_O = 2\ I_{F(AV)}$	$I_O = 2\ I_{F(AV)}$	$I_O = 3\ I_{F(AV)}$
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.

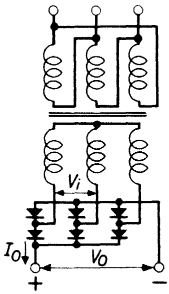
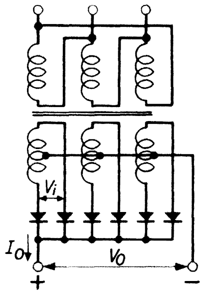
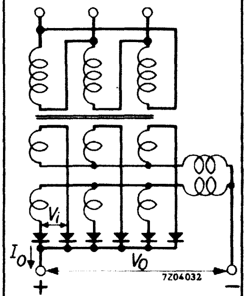
$V_{i(rms)}$ = transformer secondary r.m.s. voltage in V

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
				
		$I_O = 3\ I_{F(AV)}$	$I_O = 4.8\ I_{F(AV)}$	$I_O = 6\ I_{F(AV)}$
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.

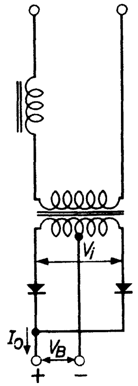
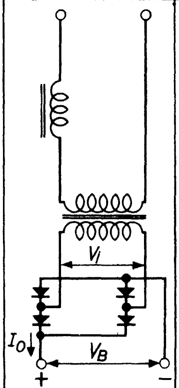
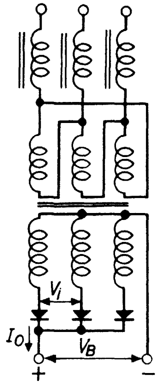
$V_{i(rms)}$ = transformer secondary r.m.s. voltage in V

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.

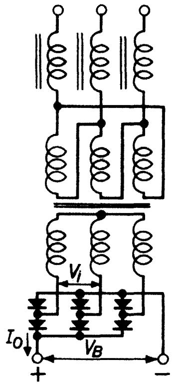
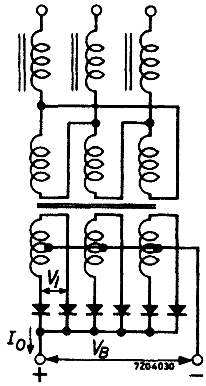
		Two phase half wave		Single phase full wave (Single phase bridge)		Three phase half wave (Three phase star)	
							
		$I_O = I_{F(AV)}$		$I_O = I_{F(AV)}$		$I_O = 1.5\ I_{F(AV)}$	
V_{RWMmax}	$V_{i(rms)}$	V_O	n	V_O	n	V_o	n
100	62	28	13	60	27	35	16
200	125	60	27	120	54	70	32
300	190	90	41	180	82	105	47
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 $I_{F(AV)}$		I_O = 3 $I_{F(AV)}$	
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)

OPERATING NOTES

When there is a possibility that transients, due to the energy stored in the transformer, will exceed the maximum permissible non-repetitive peak reverse voltage [1]), a damping circuit should be connected across the transformer.
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_{RSM} = the transient voltage peak produced by the transformer

V_{RWM} = the actually applied crest working reverse voltage

The capacitance values calculated from the above table are minimum values; to allow for circuit variations and component tolerances, larger values should be used.

[1]) For controlled avalanche types read: non-repetitive peak reverse power.

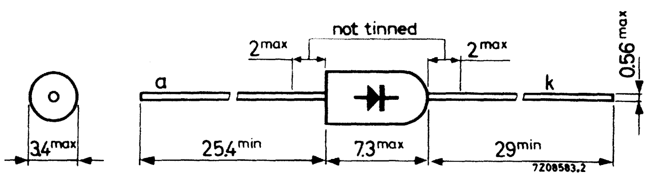
HIGH SPEED SILICON DIODE

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
Repetitive peak reverse voltage	V_{RRM}	max.	350	V
Average forward current with R load $V_{RWM} = V_{RWMmax}$	$I_{F(AV)}$	max.	0.3	A
Non-repetitive peak forward current t = 10 ms; T_j = 125 °C prior to surge	I_{FSM}	max.	15	A
Junction temperature	T_j	max.	125	°C
Reverse recovery charge when switched from I_F = 10 mA to V_R = 2 V with −dI/dt = 5 mA/μs; T_j = 25 °C	Q_s	<	0.4	nC

MECHANICAL DATA Dimensions in mm

DO-14



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 in accordance with the Absolute Maximum System (IEC 134)

Voltages

Crest working reverse voltage	V_{RWM}	max.	300	V
Repetitive peak reverse voltage ($\delta \leq 0.01$)	V_{RRM}	max.	350	V
Non-repetitive peak reverse voltage ($t \leq 1$ ms)	V_{RSM}	max.	350	V

Currents

Average forward current (averaged over any 20 ms period) with R load $V_{RWM} = V_{RWMmax}$	$I_{F(AV)}$	max.	0.3	A
Forward current d.c.	I_F	max.	0.3	A
Repetitive peak forward current	I_{FRM}	max.	2	A
Non-repetitive peak forward current ($t = 10$ ms; half sine wave) $T_j = 125\,^oC$ prior to surge	I_{FSM}	max.	15	A
Repetitive peak reverse current	I_{RRM}	max.	0.5	A

Temperatures

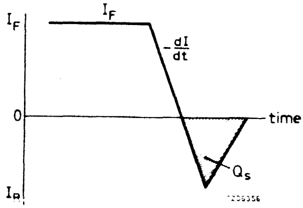
Storage temperature	T_{stg}	-65 to +125		^oC
Junction temperature	T_j	max.	125	^oC

THERMAL RESISTANCE

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

CHARACTERISTICS

Forward voltage I_F = 100 mA; T_j = 75 °C	V_F	<	1.0	V 1)
Reverse current V_R = 300 V; T_j = 75 °C	I_R	<	10	μA
V_R = 300 V; T_j = 25 °C	I_R	<	2	μA
Capacitance at f = 1 MHz V_R = 150 V; T_j = 25 to 125 °C	C_d	typ.	4.0	pF
Reverse recovery charge when switched from I_F = 10 mA to V_R = 2 V with $-dI/dt$ = 5 mA/μs; T_j = 25 °C	Q_s	<	0.4	nC



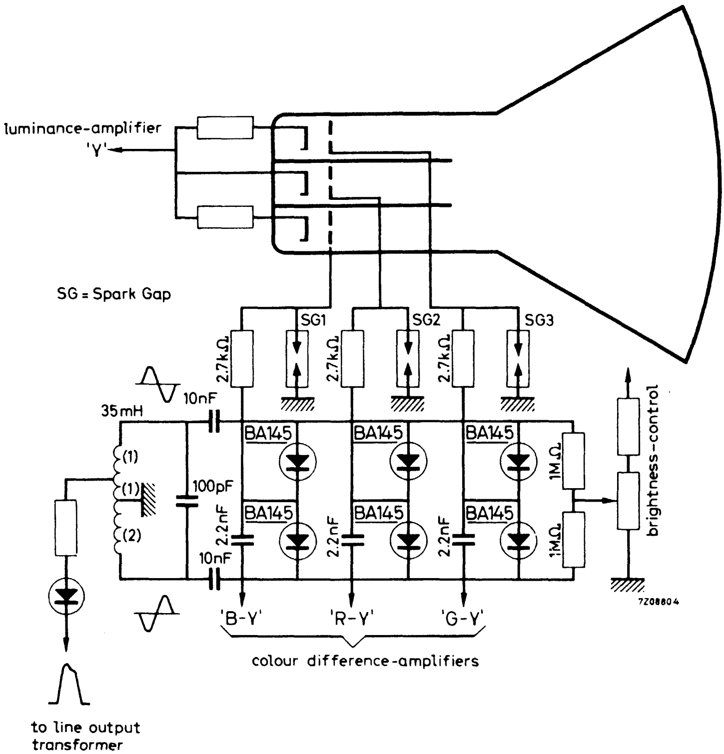
SOLDERING AND MOUNTING NOTES

1. Soldered joints must be at least 5 mm from the seal.
2. A soldering iron must not be in contact with the joint for more than 3 seconds.
3. The maximum permissible temperature of the soldering bath is 300 °C; it must not be in contact with the joint for more than 3 seconds.
4. Avoid hot spots due to handling or mounting; the body of the device must not come into contact with or be exposed to a temperature higher than 125 °C.

1) Measured under pulse conditions to avoid excessive dissipation.

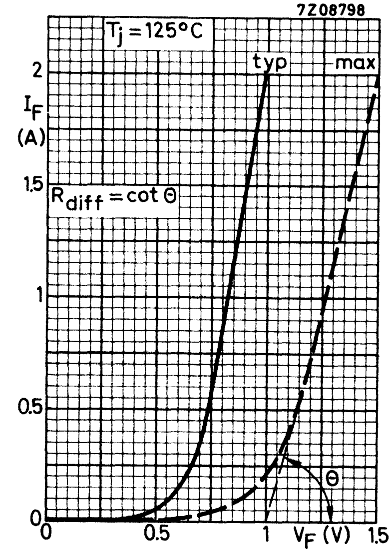
APPLICATION INFORMATION

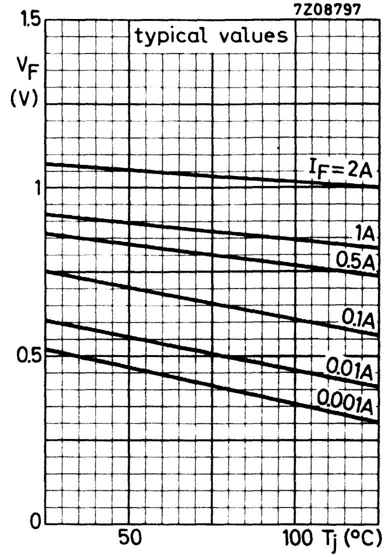
Clamp circuit for colour difference amplifiers in television receivers.

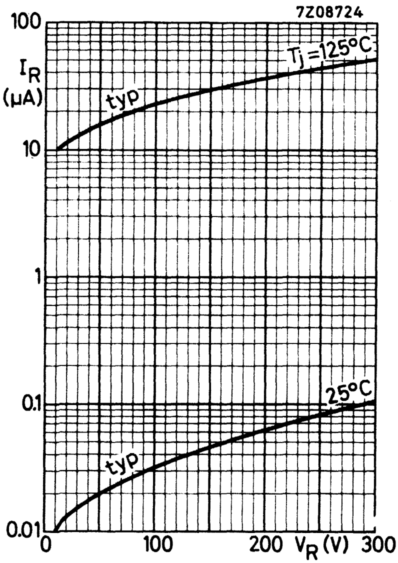


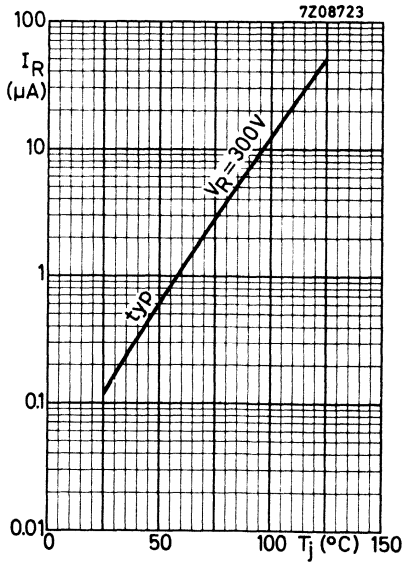
Up to $T_{amb} = 65^{o}C$ the differences in clamping levels in the circuit will be less than 1 V.

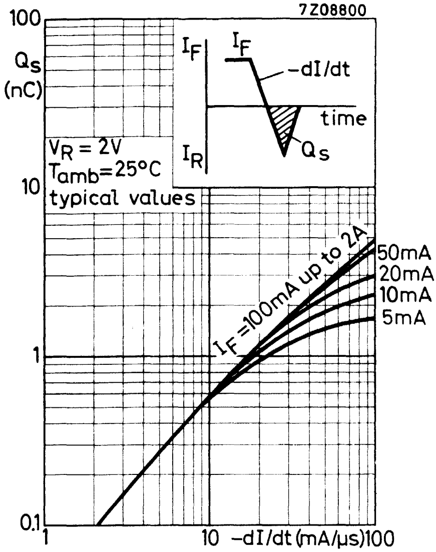
When in a picture tube flash-over occurs, it is possible that high voltage peaks appear at the control grid. These voltage peaks can damage the diodes in the clamp circuit. Protection of the diodes is obtained by means of a sparkgap with breakover voltage of < 3000 V and a resistor of 2.7 kΩ.

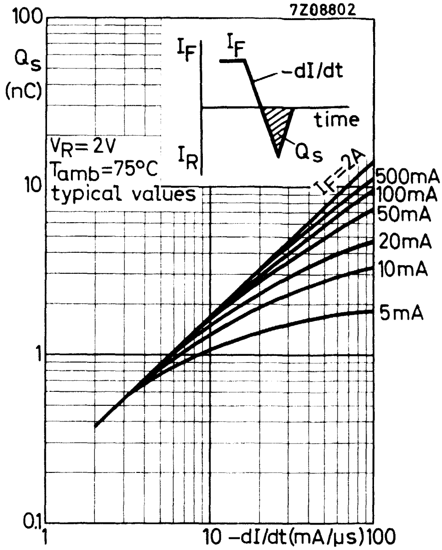

7Z08798
Tj = 125°C
typ
max
2
IF
(A)
1.5
Rdiff = cot Θ
1
0.5
0
Θ
0
0.5
1
VF (V)
1.5

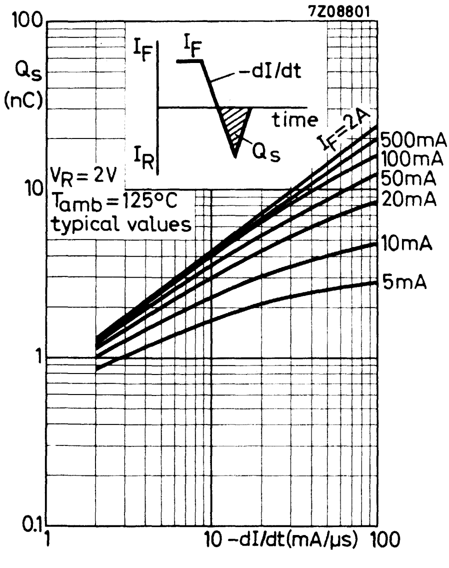

7Z08797
1.5
typical values
VF
(V)
IF = 2A
1
1A
0.5A
0.1A
0.5
0.01A
0.001A
0
50
100 Tj (°C)

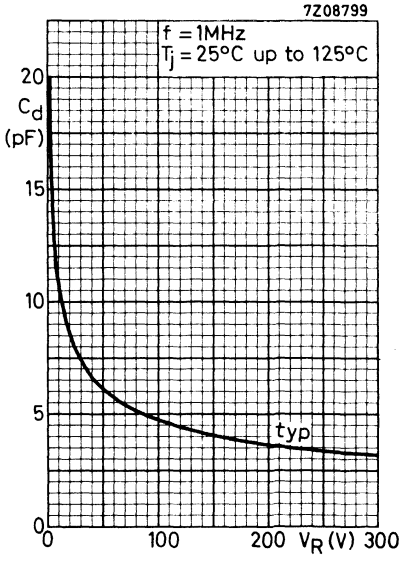

7Z08724
100
IR
(μA)
Tj = 125°C
typ
10
1
0.1
25°C
typ
0.01
0
100
200 VR (V) 300


7Z08723
100
IR
(μA)
10
VR = 300V
typ
1
0.1
0.01
0
50
100 Tj (°C) 150


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


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


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

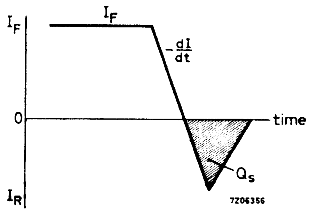

7Z08799
f = 1MHz
Tj = 25°C up to 125°C
Cd
(pF)
20
15
10
5
0
0
100
200
VR (V) 300
typ

CHARACTERISTICS (continued)

Reverse recovery charge when switched from.

I_F = 10 mA to V_R = 2 V with

$-\frac{dI}{dt}$ = 5 mA/μs; T_j = 25 °C — Q_s < 0.8 nC

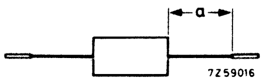


THERMAL RESISTANCE

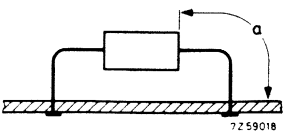
Effect of mounting on thermal resistance $R_{th\ j-a}$

The quoted values apply when no other leads run to the tie–points. If leads of other dissipating components share the same tie–points, the thermal resistance will be higher than that quoted.

1. Mounted to solder tags at a lead-length a = 10 mm. $R_{th\ j-a}$ = 150 °C/W

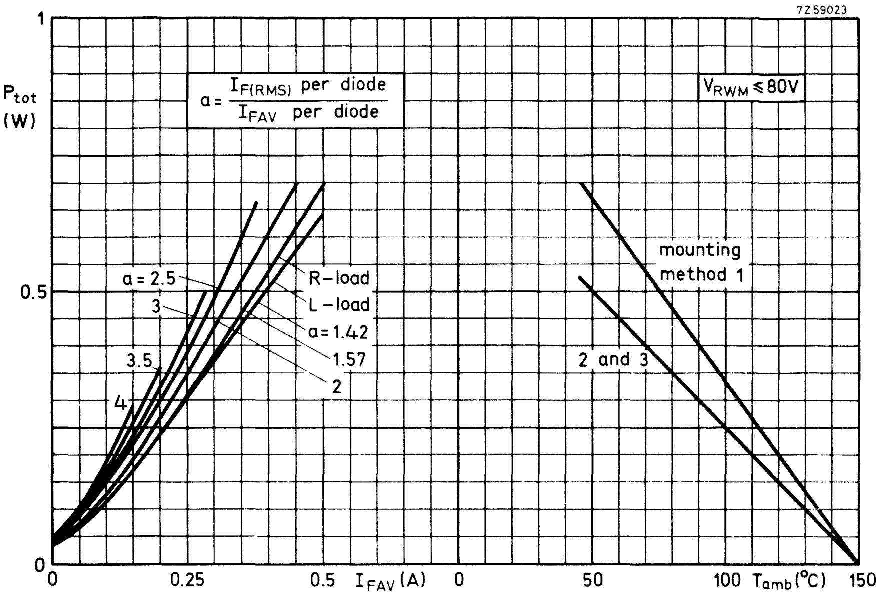


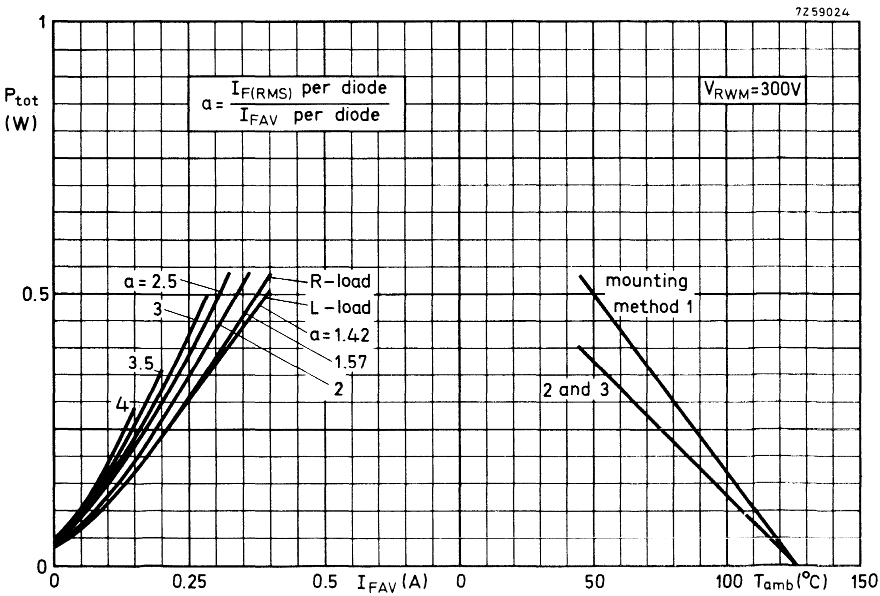
2. Mounted to solder tags at a = maximum lead-length. $R_{th\ j-a}$ = 200 °C/W
3. Mounted on printed-wiring board with a small area of copper at a lead-length a > 5 mm. $R_{th\ j-a}$ = 200 °C/W



SOLDERING AND MOUNTING NOTES

1. Soldered joints must be at least 5 mm from the seal.
2. The maximum permissible temperature of the soldering iron or bath is 300 °C; it must be in contact with the joint for no more than 3 seconds.
3. Avoid hot spots due to handling or mounting; the body of the device must not come into contact with or be exposed to a temperature higher than 125°C.


7Z59023
P_{tot} (W)
$a = \frac{I_{F(RMS)} \text{ per diode}}{I_{FAV} \text{ per diode}}$
$V_{RWM} \leq 80V$
a = 2.5
3
3.5
4
R-load
L-load
a = 1.42
1.57
2
mounting method 1
2 and 3
0
0.5
1
0
0.25
0.5
I_{FAV} (A)
0
50
100
T_{amb} (°C)
150


7Z59024
P_{tot} (W)
$a = \frac{I_{F(RMS)} \text{ per diode}}{I_{FAV} \text{ per diode}}$
$V_{RWM} = 300V$
a = 2.5
3
3.5
4
R-load
L-load
a = 1.42
1.57
2
mounting method 1
2 and 3
0
0.5
1
0
0.25
0.5
I_{FAV} (A)
0
50
100
T_{amb} (°C)
150

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

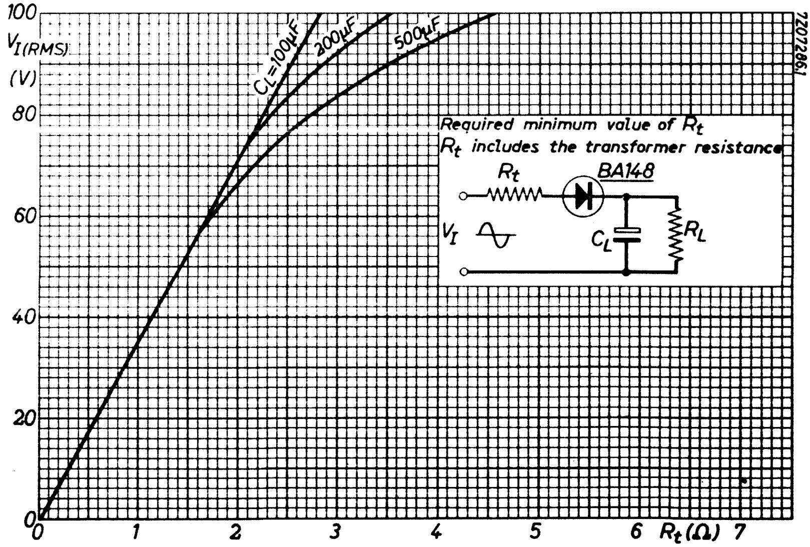
The parameter $a = \frac{I_{F(RMS)} \text{ per diode}}{I_{FAV} \text{ per diode}}$ depends on $\omega R_L C_L$ and $\frac{R_t + r_{diff.}}{R_L}$ and can be found from existing graphs.

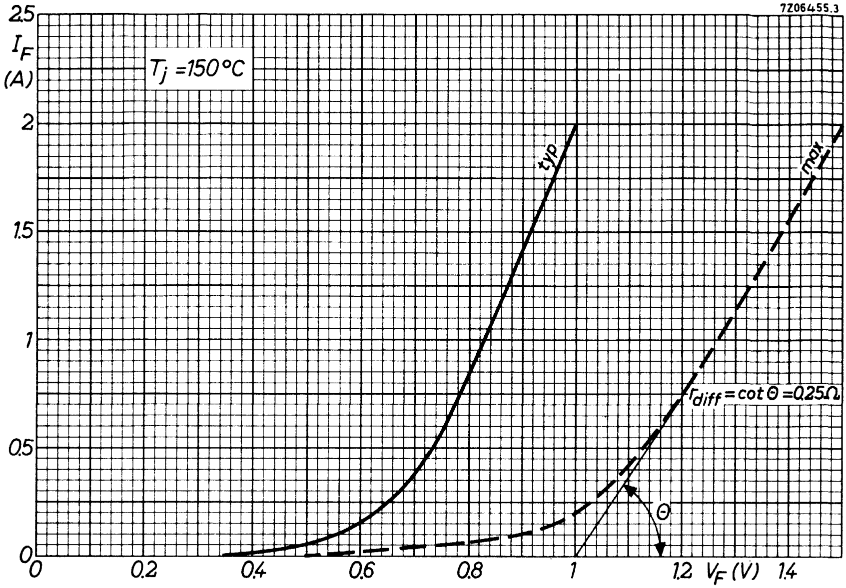
See Application Book: RECTIFIER DIODES

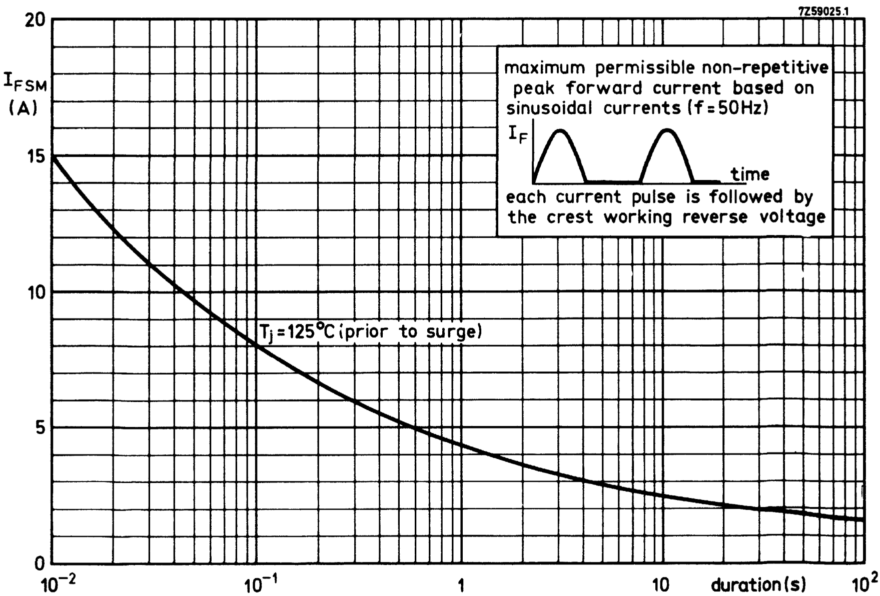
Once the power dissipation is known, the max. permissible ambient temperature follows from the right hand graph.

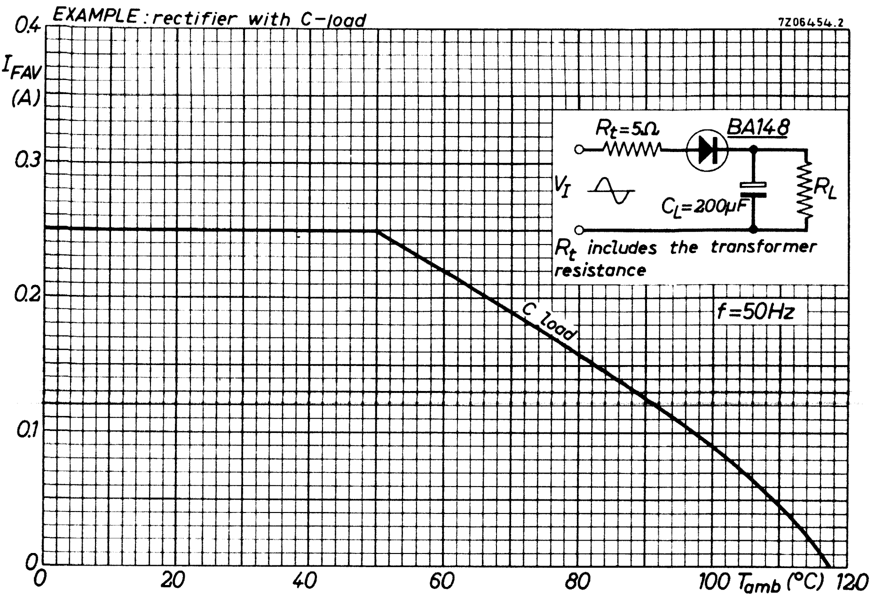
For the series resistance, added to limit the initial peak rectifier current, the required minimum value can be found from the graph below.

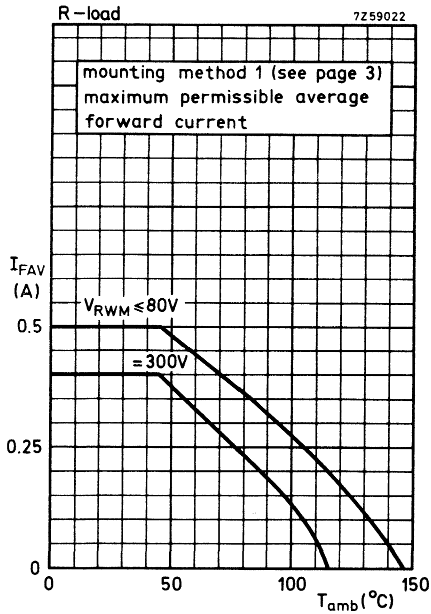
rdiff. is shown on page 6, upper figure.

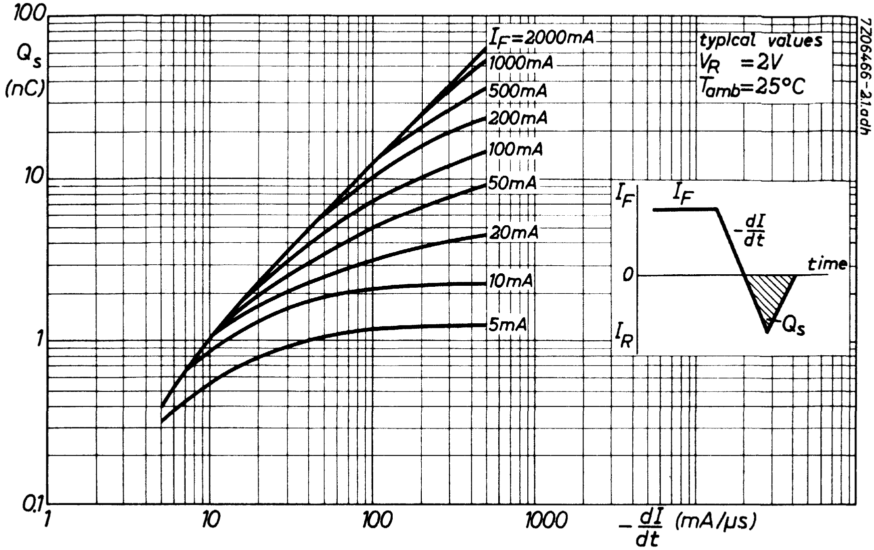


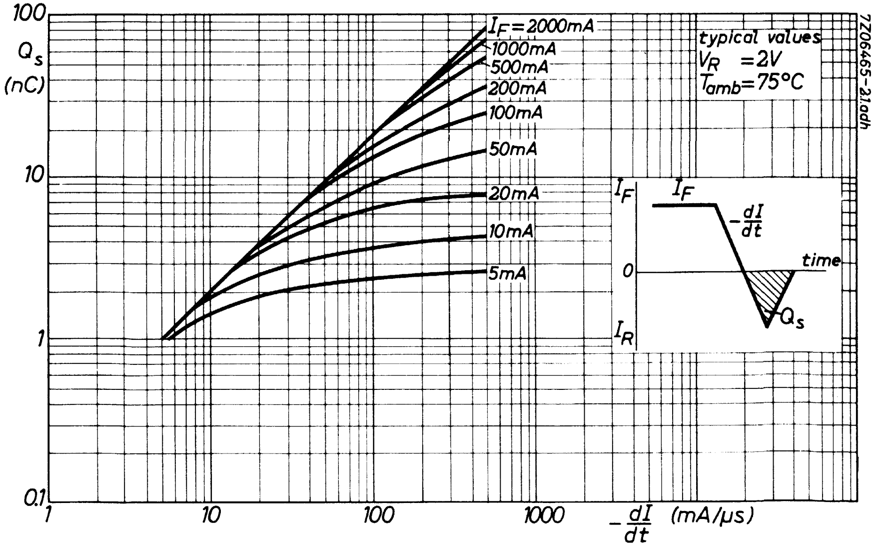

7Z06455.3
2.5
I_F
(A)
T_j =150 °C
2
1.5
1
0.5
0
typ
max
r_{diff} = cot Θ = 0.25 Ω
Θ
0
0.2
0.4
0.6
0.8
1
1.2
V_F (V)
1.4

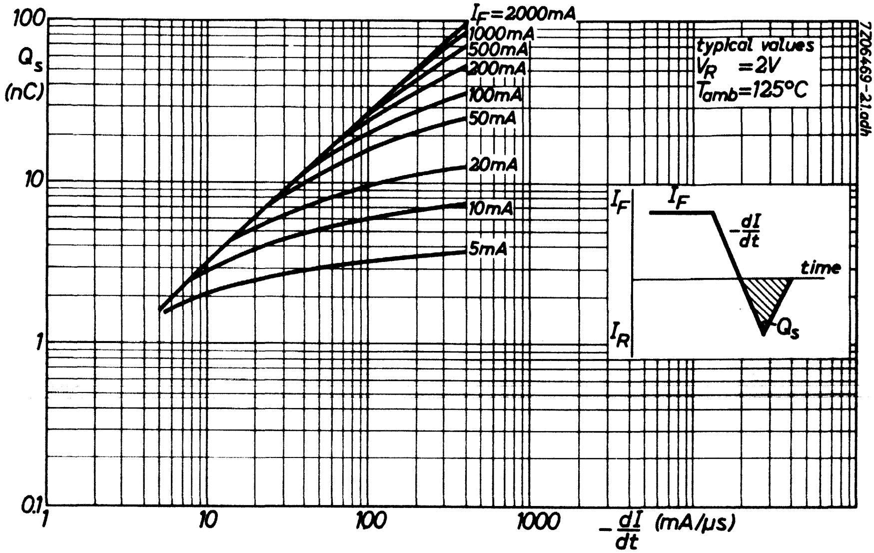

7Z59025.1
20
I_{FSM}
(A)
15
10
5
0
maximum permissible non-repetitive peak forward current based on sinusoidal currents (f = 50Hz)
I_F
time
each current pulse is followed by the crest working reverse voltage
T_j = 125 °C (prior to surge)
10^{-2}
10^{-1}
1
10
duration (s)
10^{2}

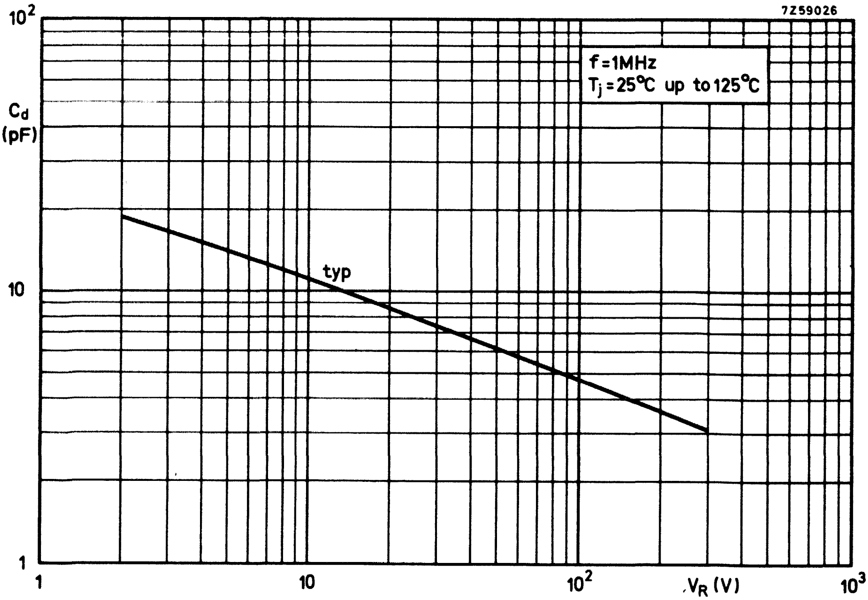

EXAMPLE : rectifier with C-load
7Z06454.2
I_{FAV} (A)
0.4
0.3
0.2
0.1
0
$R_t = 5\Omega$
BA148
V_I
$C_L = 200\mu F$
R_L
R_t includes the transformer resistance
f = 50Hz
C load
0
20
40
60
80
100
T_{amb} (°C)
120


R-load
7Z59022
mounting method 1 (see page 3)
maximum permissible average
forward current
I_{FAV} (A)
$V_{RWM} \leq 80V$
= 300V
0.5
0.25
0
0
50
100
150
T_{amb} (°C)


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
I_F
I_F
$-\frac{dI}{dt}$
0
time
I_R
Q_s
7Z06466-2.1.adh

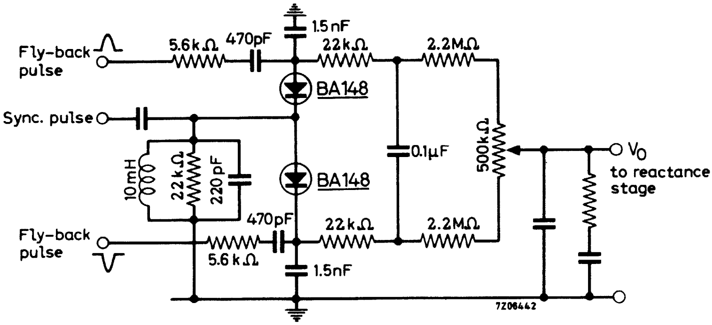

100
Q_s
(nC)
10
1
0.1
1
10
100
1000
$-\frac{dI}{dt}$ (mA/µs)
I_F=2000mA
1000mA
500mA
200mA
100mA
50mA
20mA
10mA
5mA
typical values
V_R =2V
T_{amb}=75°C
I_F
I_F
$-\frac{dI}{dt}$
0
time
I_R
Q_s
7Z06465-2.1.adh


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


7Z59026
f = 1MHz
T_j = 25°C up to 125°C
C_d
(pF)
10^2
10
1
typ
1
10
10^2
V_R (V)
10^3

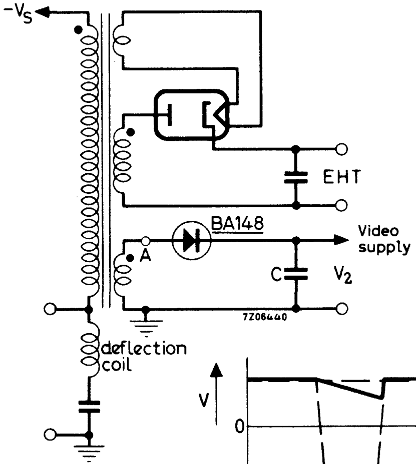
APPLICATION INFORMATION

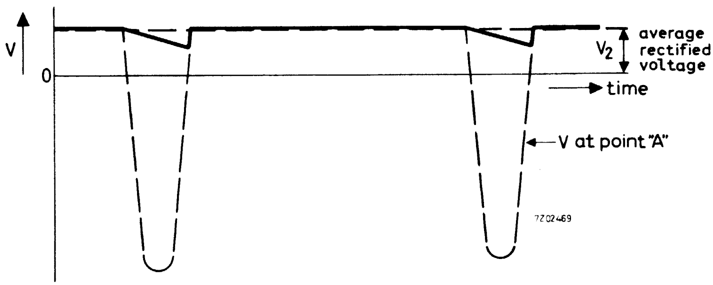
Self catching line phase detector



The high speed and low leakage current of the BA148 make it particularly useful in the type of line phase detector shown above.

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





An extra winding on the line output transformer in series with a BA148 can supply up to 30 V for the low voltage parts of a television receiver. Because the diode conducts during scan the source impedance is low and the output voltage stable.

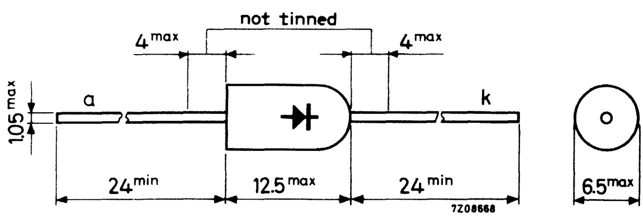
SILICON RECTIFIER DIODES

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 load; $V_{RWM} = V_{RWMmax}$	$I_{F(AV)}$	max.	1.0		A
$V_{RWM} = 60$ V	$I_{F(AV)}$	max.	1.2		A
Non-repetitive peak forward current $t = 10$ ms; $T_j = 150$ °C prior to surge	I_{FSM}	max.	40		A
Junction temperature	T_j	max.	150		°C

MECHANICAL DATA

Dimensions in mm



The rounded end 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).

All information applies to frequencies up to 400 Hz

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

Voltages			BY126	BY127	
Crest working reverse voltage	V_{RWM}	max.	450	800	V
Repetitive peak reverse voltage ($\delta \leq 0.01$)	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 page 4, 6, 7				
with R load; $V_{RWM} = V_{RWMmax}$	$I_{F(AV)}$	max.	1.0	A
$V_{RWM} = 60$ V	$I_{F(AV)}$	max.	1.2	A
Repetitive peak forward current	I_{FRM}	max.	10	A
Non-repetitive peak forward current ($t = 10$ ms; half sine wave) $T_j = 150\,^{o}C$ prior to surge	I_{FSM}	max.	40	A

Temperatures				
Storage temperature	T_{stg}		−65 to +150	^{o}C
Junction temperature	T_j	max.	150	^{o}C

THERMAL RESISTANCE See page 3

CHARACTERISTICS

Forward voltage				
$I_F = 5$ A; $T_j = 25\,^{o}C$	V_F	<	1.5	V [1]

Peak reverse current				
$V_{RM} = V_{RRMmax}$	I_{RM}	<	10	μA

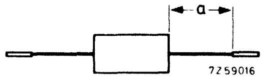
[1]) measured under pulsed conditions to avoid excessive dissipation

THERMAL RESISTANCE (influence of mounting method)

The quoted values apply when no other leads run to the tie-points. If leads of other dissipating components share the same tie-points, the thermal resistance will be higher than that quoted.

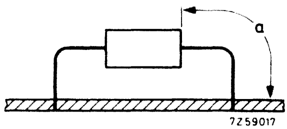
1. Mounted to solder tags at a lead-length a = 10 mm. $R_{th\ j\text{-}a}$ = 60 °C/W

2. Mounted to solder tags at a = maximum lead-length. $R_{th\ j\text{-}a}$ = 70 °C/W



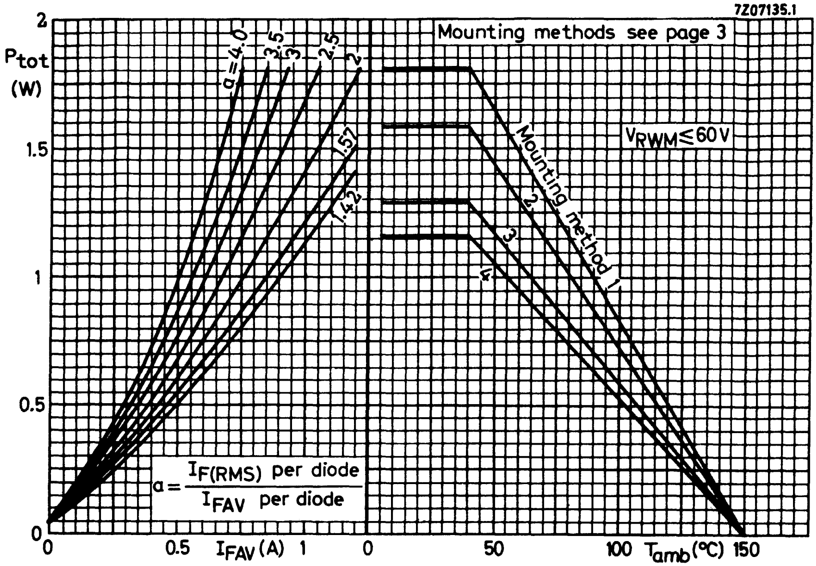
3. Mounted on printed-wiring board at a = maximum lead-length. $R_{th\ j\text{-}a}$ = 85 °C/W

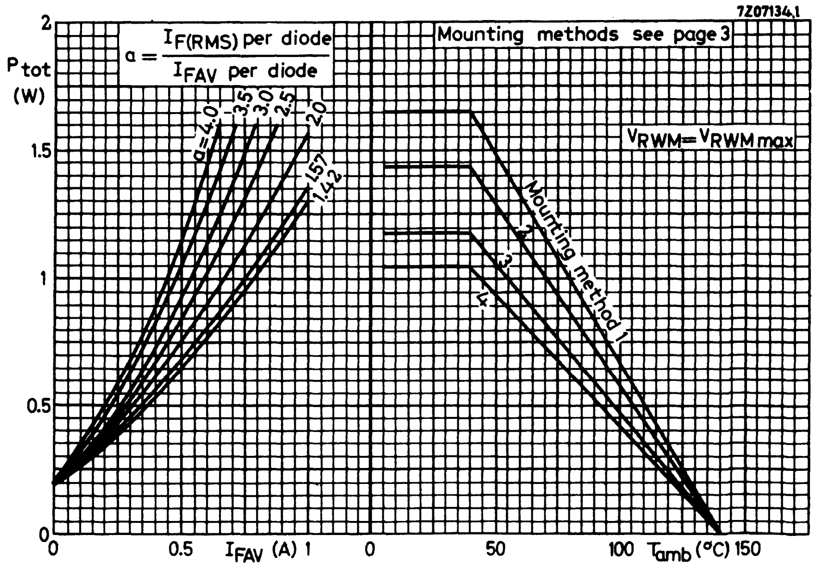
4. Mounted on printed-wiring board at a lead-length a = 10 mm. $R_{th\ j\text{-}a}$ = 95 °C/W

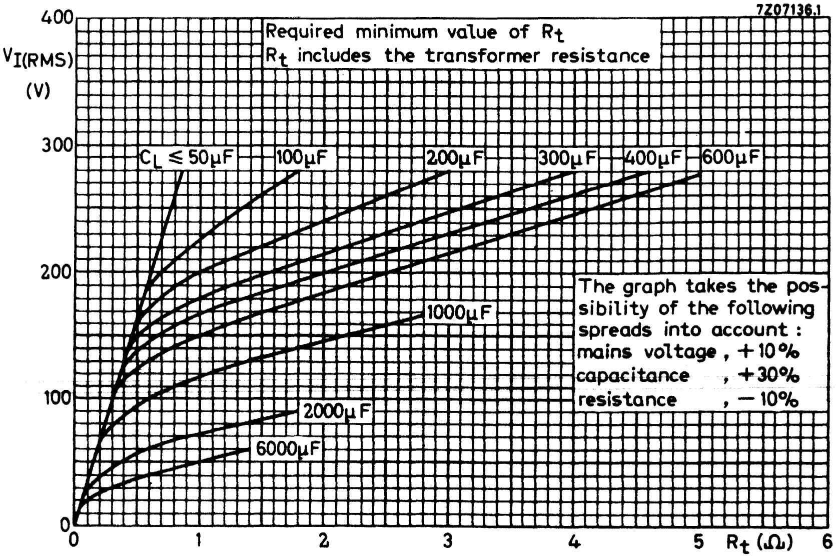


SOLDERING AND MOUNTING NOTES

1. Soldered joints must be at least 5 mm from the seal.
2. The maximum permissible temperature of the soldering iron or bath is 300 °C; it must be in contact with the joint for no more than 3 seconds.
3. Avoid hot spots due to handling or mounting; the body of the device must not come into contact with or be exposed to a temperature higher than 150 °C.


7Z07135.1
Mounting methods see page 3
Ptot (W)
2
1.5
1
0.5
0
a=4.0
3.5
3
2.5
2
1.57
1.42
$V_{RWM} \leq 60 V$
Mounting method 1
2
3
4
$a = \frac{I_{F(RMS)} \text{ per diode}}{I_{FAV} \text{ per diode}}$
0
0.5
IFAV (A)
1
0
50
100
Tamb (°C)
150


7Z07134.1
Mounting methods see page 3
Ptot (W)
2
1.5
1
0.5
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
$V_{RWM} = V_{RWM\,max}$
Mounting method 1
2
3
4
0
0.5
IFAV (A)
1
0
50
100
Tamb (°C)
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.

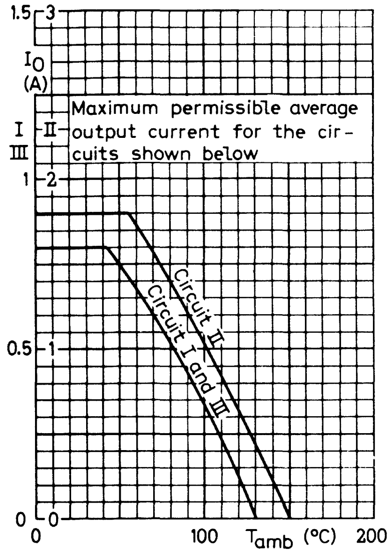
See **Application Book:** RECTIFIER DIODES

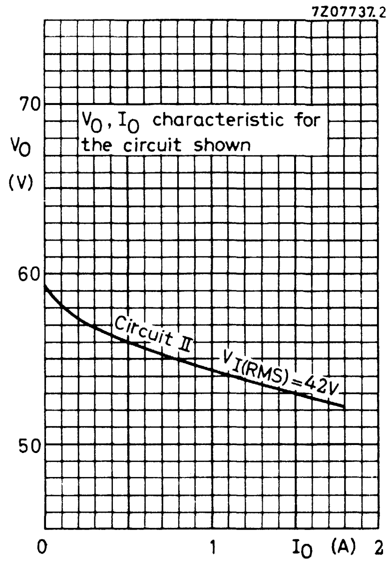
Once the power dissipation is known, the max. permissible ambient temperature follows from the right hand graph.

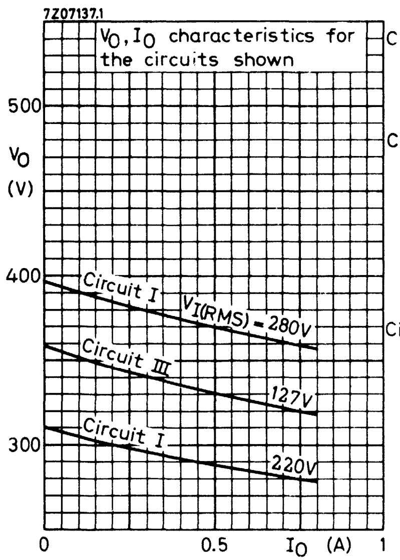
For the series resistance, added to limit the initial peak rectifier current, the required minimum value can be found from the upper graph.

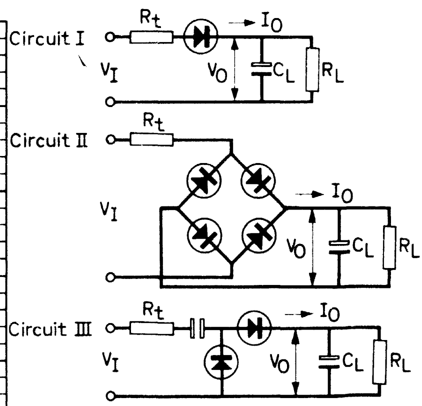
R_{diff} is shown on page 7.

EXAMPLE: Rectifier with C-load
mounting method 1 (see page 3)

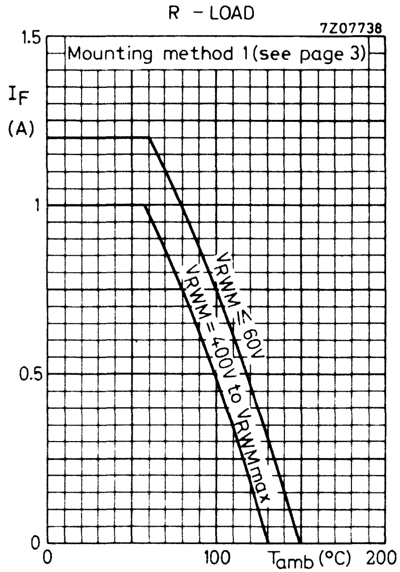


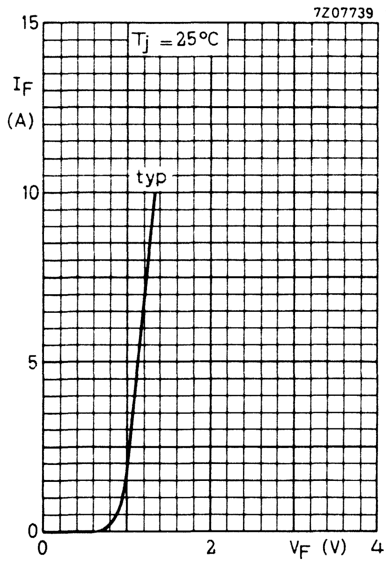


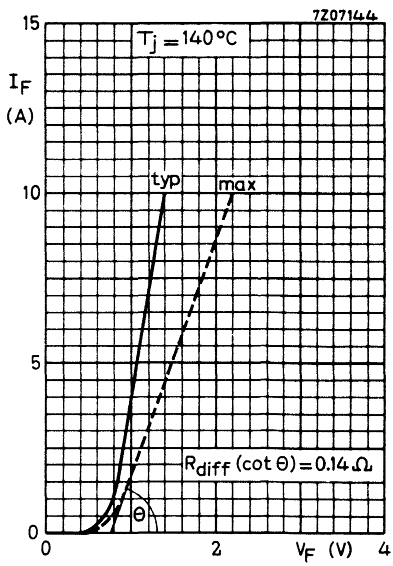


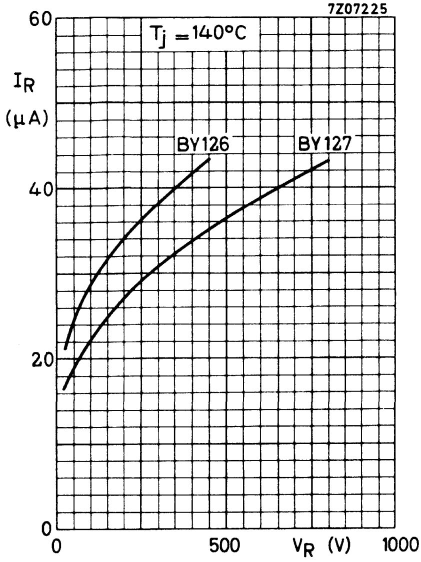


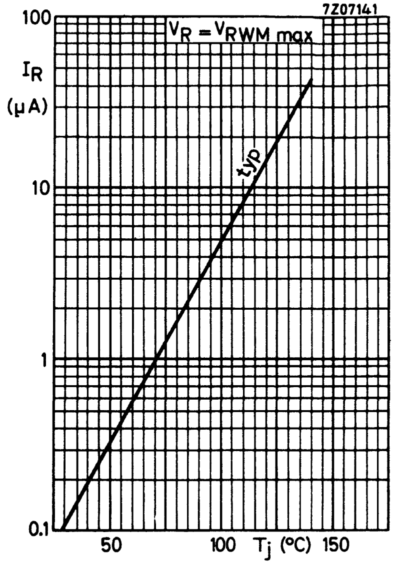
	$V_{I(RMS)}$	R_t	C_L
Circuit I	220V 280V	1.4 Ω 3.0 Ω	200 μF 200 μF
Circuit II	42V	0.72 Ω	6000 μF
Circuit III	127V	0.4 Ω	400 μF

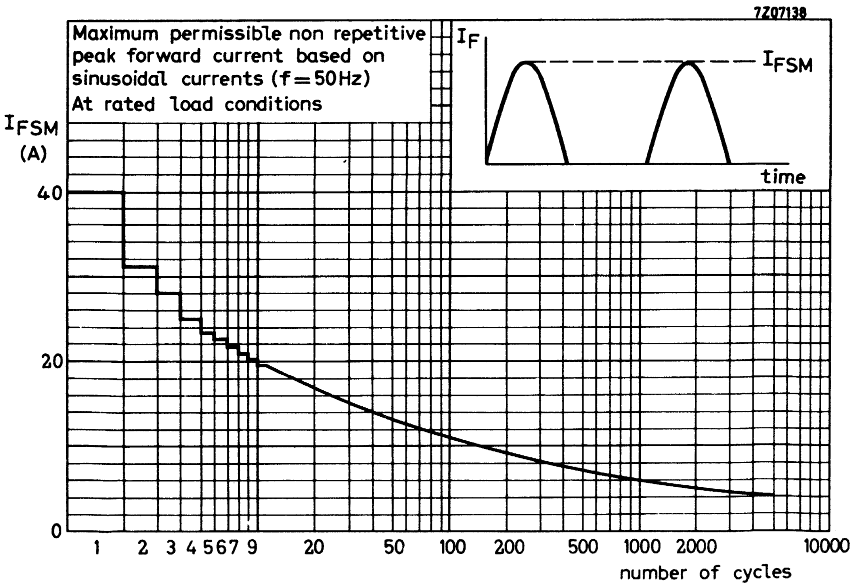

R - LOAD
7Z07738
Mounting method 1(see page 3)
IF
(A)
1.5
1
0.5
0
0
100
200
Tamb (°C)
VRWM ≤ 60V
VRWM = 400V to VRWMmax


7Z07739
Tj = 25°C
IF
(A)
15
10
5
0
typ
0
2
4
VF (V)


7Z07144
Tj = 140°C
IF
(A)
15
10
5
0
typ
max
Rdiff (cot Θ) = 0.14 Ω
Θ
0
2
4
VF (V)


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

BRIDGE RECTIFIER ASSEMBLY

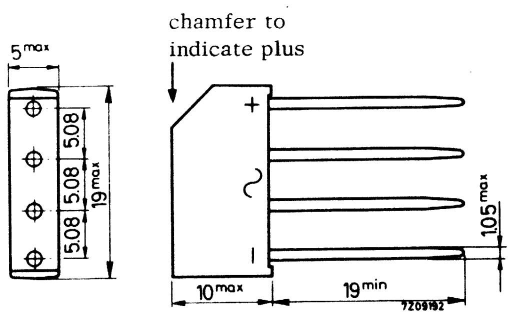
Plastic encapsulated bridge rectifier assembly comprising four silicon double diffused diodes.
It is primarily intended for use in the power supplies of many types of transistorized equipment operating at frequencies up to 400 Hz.

QUICK REFERENCE DATA

Input				
R.M.S. voltage	$V_{I(RMS)}$	max.	60	V
Repetitive peak voltage	V_{IRM}	max.	120	V
Output				
Continuous voltage				
with C load	V_O		85	V
with R load	V_O		54	V
Average current with				
with R load $V_{I(RMS)} \leq 60$ V	I_O	max.	1.2	A
$V_{I(RMS)} \leq 42$ V	I_O	max.	1.4	A
Repetitive peak current	I_{ORM}	max.	5	A

MECHANICAL DATA

Dimensions in mm



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 in accordance with the Absolute Maximum System (IEC 134)

Input

R.M.S. voltage	$V_{I(RMS)}$	max.	60	V
Crest working voltage	V_{IWM}	max.	85	V
Repetitive peak voltage	V_{IRM}	max.	120	V
Non repetitive peak voltage; $t \leq 10$ ms	V_{ISM}	max.	120	V
Non repetitive peak current (see also page 6)	I_{ISM}	max.	25	A

Output

Average current with C load	See pages 3, 4 and 5			
Average current with R and L load (see also page 6)				
$V_{I(RMS)} \leq 60$ V	I_O	max.	1.2	A
$V_{I(RMS)} \leq 42$ V	I_O	max.	1.4	A
Repetitive peak current	I_{ORM}	max.	5	A

Temperatures

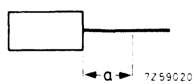
Storage temperature	T_{stg}		−55 to +125	°C
Junction temperature	T_j	max.	150	°C

THERMAL RESISTANCE

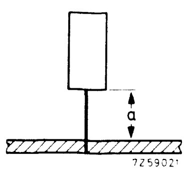
Effect of mounting on thermal resistance $R_{th\ j\text{-}a}$

The quoted values apply when no other leads run to the tie-points. If leads of other dissipating components share the same tie-points, the thermal resistance will be higher than that quoted.

1. Mounted to solder tags at a lead-length a > 5 mm. $R_{th\ j\text{-}a}$ = 40 °C/W



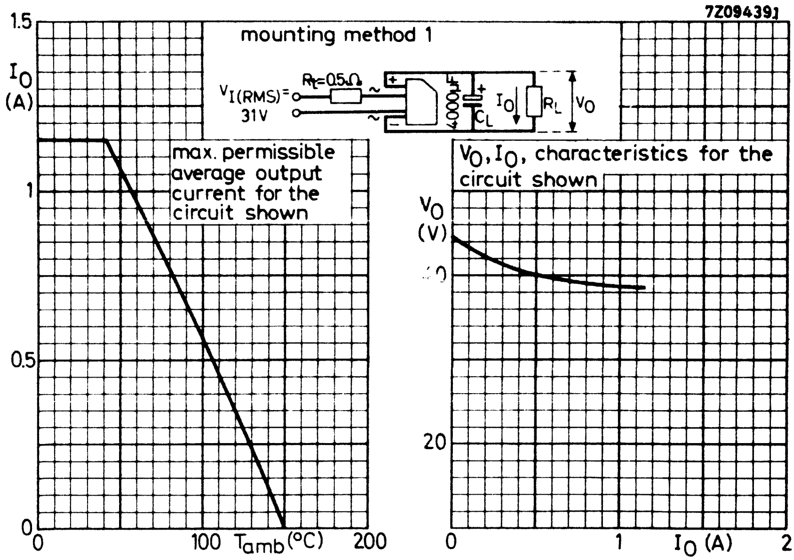
2. Mounted on printed-wiring board at a = maximum lead-length. $R_{th\ j\text{-}a}$ = 50 °C/W
3. Mounted on printed-wiring board at a lead-length a = 5 mm. $R_{th\ j\text{-}a}$ = 55 °C/W
4. Mounted on printed-wiring board at a lead-length a = 1.5 mm. $R_{th\ j\text{-}a}$ = 60 °C/W
(distance -a- is including printed-wiring board thickness)

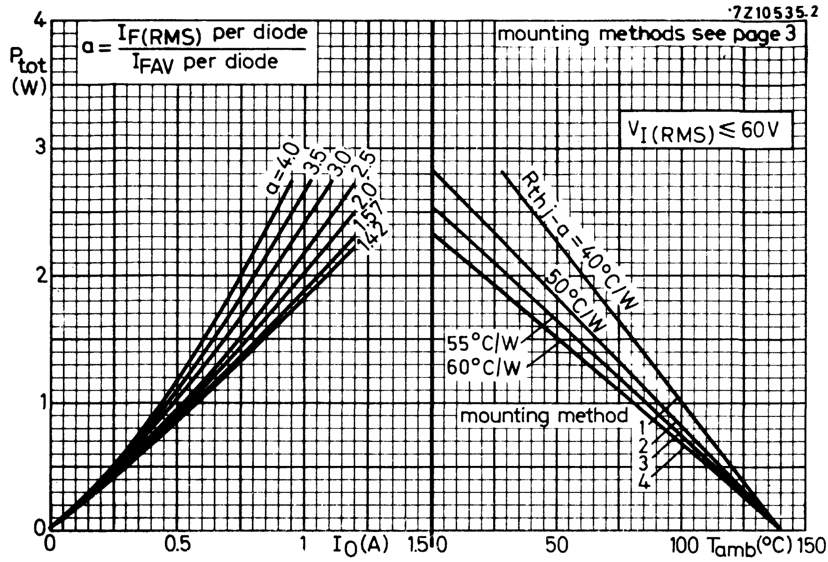


SOLDERING AND MOUNTING NOTES

1. The maximum permissible contact time for the soldering iron or bath is 3 seconds.
2. If the soldered joints are at least 5 mm from the seal, the maximum permissible temperature of the soldering iron or bath is 270 °C. If the joints are between 1.5 mm (min) and 5 mm from the seal, the maximum permissible temperature is 250 °C.
3. Avoid hot spots due to handling or mounting; the body of the device must not come into contact with or be exposed to a temperature higher than 150 °C.

EXAMPLE: Rectifier with C load





From the lefthand graph the total power dissipation can be found as a function of the average output current.

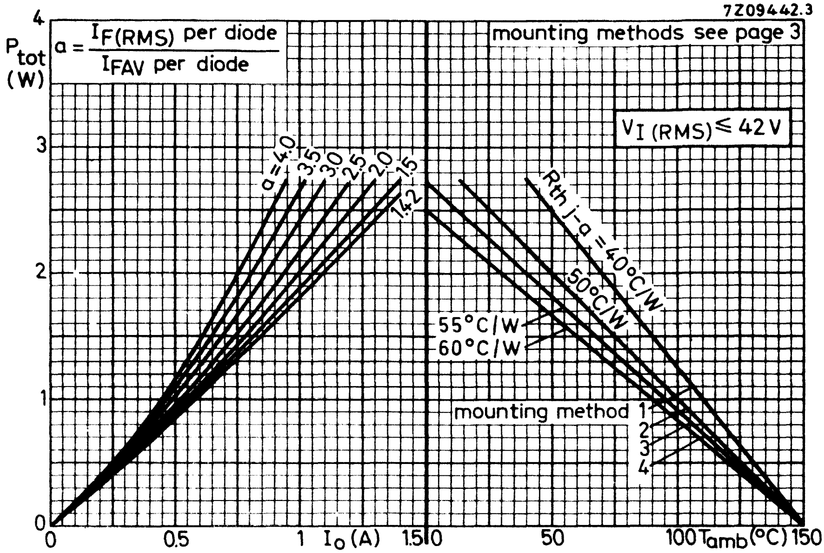
The parameter $a = \frac{I_{F(RMS)}\text{ per diode}}{I_{FAV}\text{ per diode}}$ depends on $\omega R_L C_L$ and $\frac{R_t + R_{diff}}{R_L}$ and can be found from existing graphs.

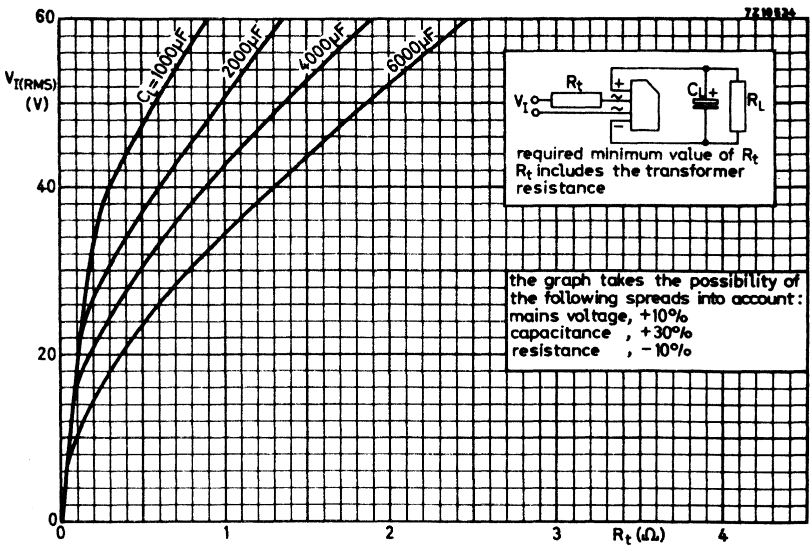
See Application Book: RECTIFIER DIODES.

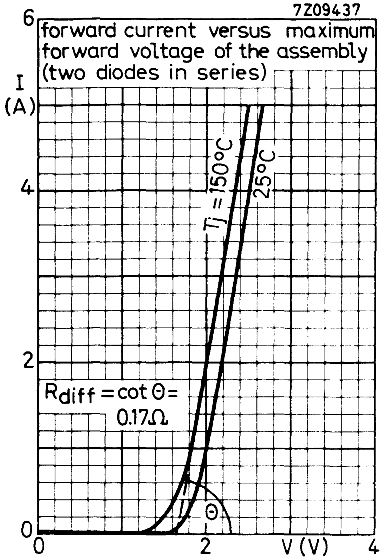
Once the power dissipation is known, the max. permissible ambient temperature follows from the right hand graph.

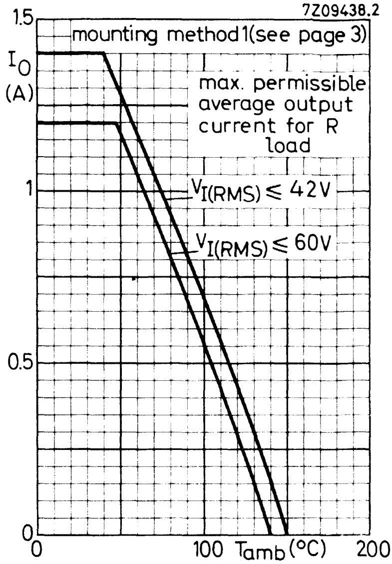
For the series resistance, added to limit the initial peak rectifier current, the required minimum value can be found from the lower graph on page 5.

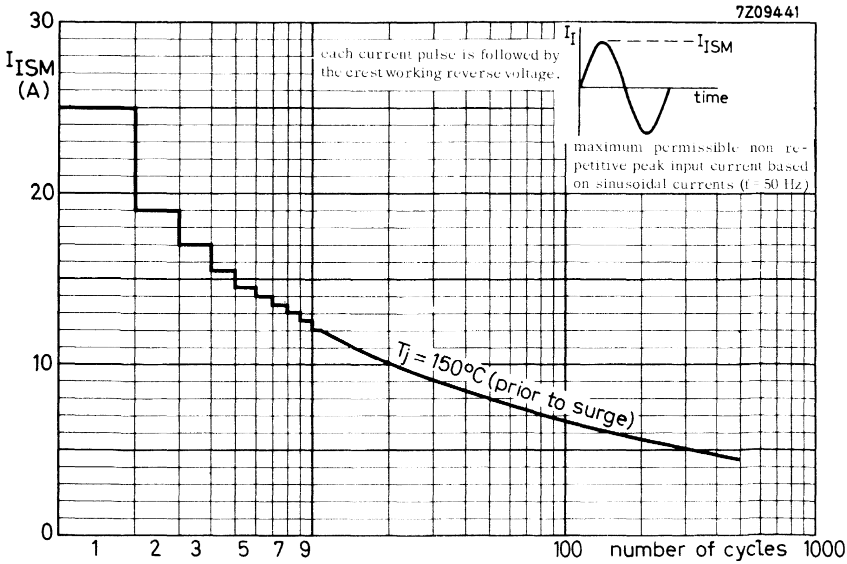
R_{diff} is shown on page 6, left hand upper figure.


7Z09442.3
P_{tot} (W)
$a = \frac{I_{F(RMS)} \text{ per diode}}{I_{FAV} \text{ per diode}}$
mounting methods see page 3
$V_{I\ (RMS)} \leq 42$ V
a = 4.0
3.5
3.0
2.5
2.0
1.5
1.42
$R_{th\ j-a}$ = 40 °C/W
50 °C/W
55 °C/W
60 °C/W
mounting method 1
2
3
4
I_o (A)
T_{amb} (°C)
0
0.5
1
1.5
50
100
150
2
3
4


$V_{I(RMS)}$ (V)
C_L = 1000 µF
2000 µF
4000 µF
6000 µF
R_t
V_I
C_L
R_L
required minimum value of R_t
R_t includes the transformer resistance
the graph takes the possibility of the following spreads into account:
mains voltage, +10%
capacitance , +30%
resistance , −10%
R_t (Ω)
0
1
2
3
4
20
40
60


7Z09437
forward current versus maximum forward voltage of the assembly (two diodes in series)
I (A)
6
4
2
0
$T_j = 150°C$
25°C
$R_{diff} = \cot \Theta = 0.17 \Omega$
Θ
0
2
V (V)
4


7Z09438.2
mounting method 1(see page 3)
I_O (A)
1.5
1
0.5
0
max. permissible average output current for R load
$V_{I(RMS)} \leq 42V$
$V_{I(RMS)} \leq 60V$
0
100
T_{amb} (°C)
200

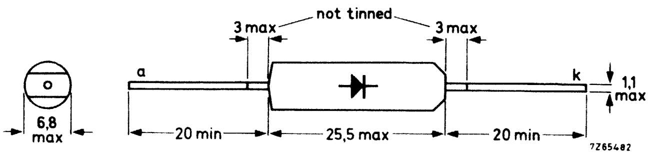

7Z09441
I_{ISM} (A)
30
20
10
0
each current pulse is followed by the crest working reverse voltage.
I_I
I_{ISM}
time
maximum permissible non repetitive peak input current based on sinusoidal currents (f = 50 Hz)
$T_j = 150°C$ (prior to surge)
1
2
3
5
7
9
100
number of cycles
1000

SILICON E.H.T. RECTIFIER DIODE

Silicon e.h.t. rectifier diode in a plastic envelope intended for tripler circuits, tiny-vision receivers and as focus rectifiers in colour 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
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.	5	nC

MECHANICAL DATA Dimensions in mm



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

Voltages [1]

Crest working reverse voltage	V_{RWM}	max.	15	kV	
Repetitive peak reverse voltage	V_{RRM}	max.	15	kV	
Non repetitive peak reverse voltage (t ≤ 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	[2]
Repetitive peak reverse current during switching off	I_{RRM}	max.	150	mA	

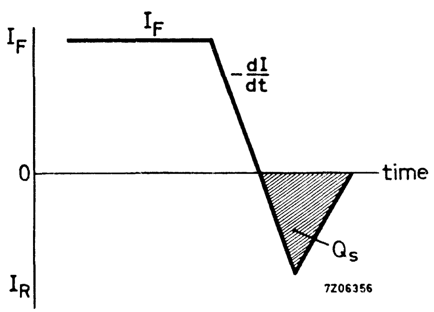
Temperatures

Storage temperature	T_{stg}	-55 to +100		°C
Junction temperature	T_j	max.	95	°C

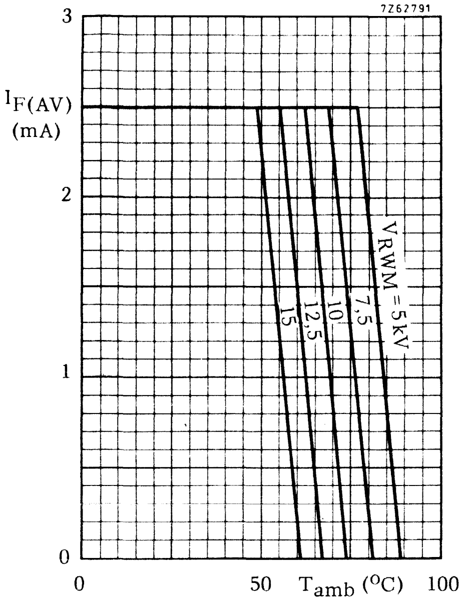
→ **THERMAL RESISTANCE** from junction to ambient $R_{th\ j\text{-}amb}$ = 175 °C/W

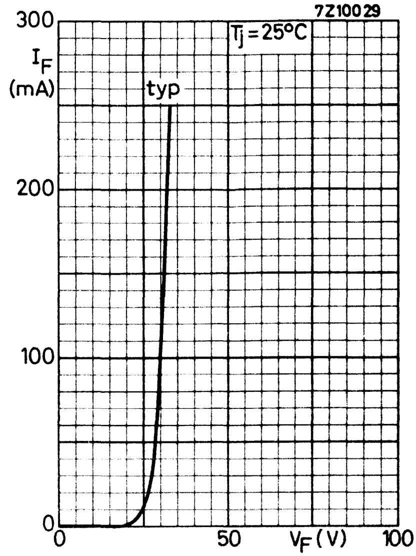
CHARACTERISTICS

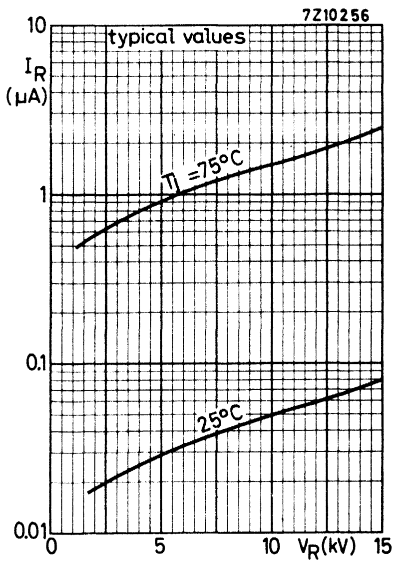
Forward voltage at I_F = 100 mA; T_j = 95 °C	V_F	<	35	V
→ Reverse current at V_R = 15 kV; T_j = 75 °C	I_R	<	4	μA
Recoverd charge when switched from I_F = 200 mA to V_R = 100 V with $-\frac{dI}{dt}$ = 200 mA/μs; T_j = 25 °C	Q_s	typ.	5	nC

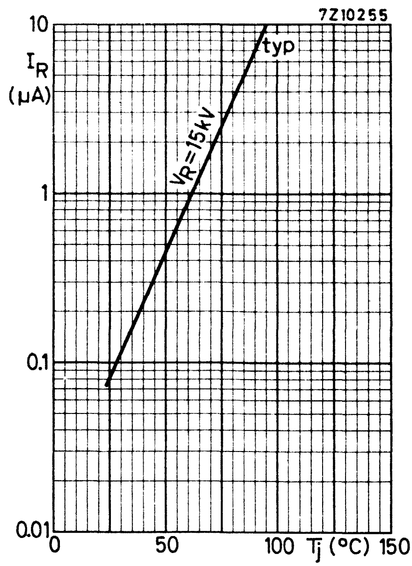


1) During initial line-up a reverse voltage of 17 kV is allowed at T_{amb} = 40 °C.
2) The rectifier can withstand flash-over currents in the picture tube.


7Z62791
3
2
1
0
$I_{F(AV)}$ (mA)
0
50
T_{amb} (°C)
100
V_{RWM} = 5 kV
7,5
10
12,5
15


7Z10029
300
200
100
0
I_F (mA)
T_j = 25°C
typ
0
50
V_F (V)
100

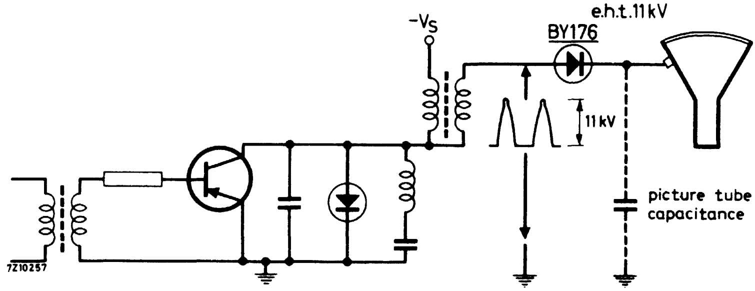

7Z10256
10
1
0.1
0.01
I_R (μA)
typical values
T_j = 75°C
25°C
0
5
10
V_R(kV)
15


7Z10255
10
1
0.1
0.01
I_R (μA)
typ
V_R = 15 kV
0
50
100
T_j (°C)
150

APPLICATION INFORMATION

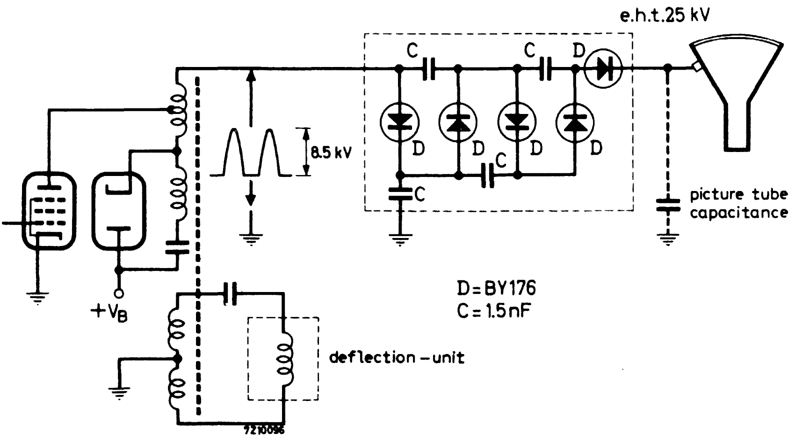
E.H.T. rectifier circuits

A.



Typical deflection circuit for small screen television receivers employing the BY176 an an e.h.t. rectifier. Proper operation of the BY176 is ensured up to an ambient temperature of 60 °C.
The contribution of the BY176 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 BY176 diodes. Proper operation of the BY176 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.

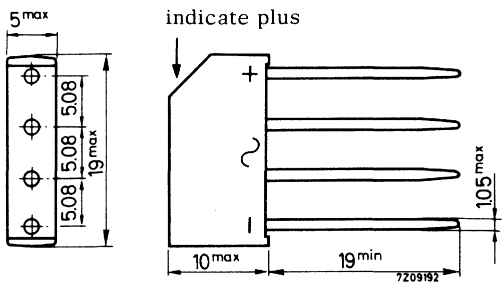
BRIDGE RECTIFIER ASSEMBLY

Plastic encapsulated bridge rectifier assembly comprising four silicon double diffused diodes.
It is primarily intended for equipment drawing its power from mains with frequencies up to 400 Hz.

QUICK REFERENCE DATA				
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 load	V_O		255	V
Average current				
with R load up to T_{amb} = 40 °C	I_O	max.	1	A
Repetitive peak current	I_{ORM}	max.	5	A

MECHANICAL DATA

Dimensions in mm



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 in accordance with the Absolute Maximum System (IEC 134)

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; $t \leq 10$ ms	V_{ISM}	max.	800	V
Non repetitive peak current (see also page 6)	I_{ISM}	max.	25	A

Output

Average current with C load	See pages 4 and 5			
Average current with R and L load up to T_{amb} = 40 °C (see also page 5)	I_O	max.	1	A
Repetitive peak current	I_{ORM}	max.	5	A

Temperatures

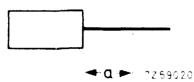
Storage temperature	T_{stg}	-55 to +125		°C
Junction temperature	T_j	max.	125	°C

THERMAL RESISTANCE

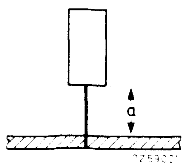
Effect of mounting on thermal resistance $R_{th\ j-a}$

The quoted values apply when no other leads run to the tie-points. If leads of other dissipating components share the same tie-points, the thermal resistance will be higher than that quoted.

1. Mounted to solder tags at a lead-length a > 5 mm. $R_{th\ j-a}$ = 40 °C/W

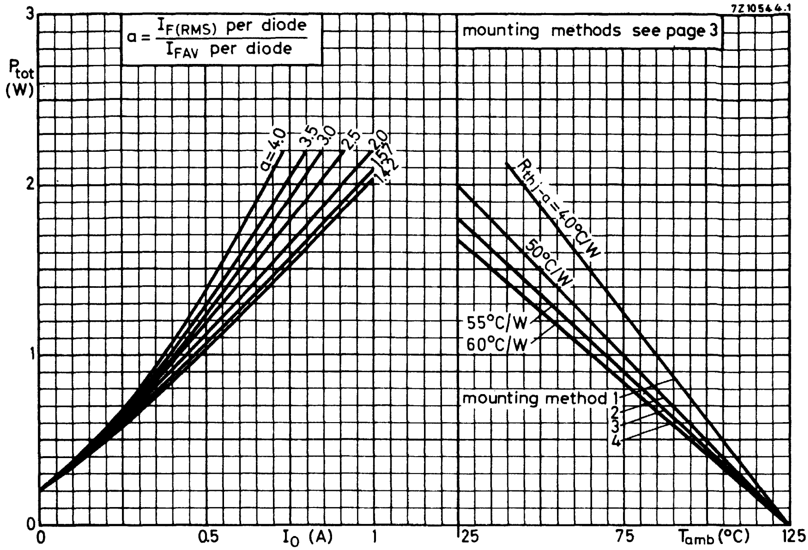


2. Mounted on printed-wiring board at a = maximum lead-length. $R_{th\ j-a}$ = 50 °C/W
3. Mounted on printed-wiring board at a lead-length a = 5 mm. $R_{th\ j-a}$ = 55 °C/W
4. Mounted on printed-wiring board at a lead length a = 1.5 mm. $R_{th\ j-a}$ = 60 °C/W (distance -a- including printed-wiring board thickness)



SOLDERING AND MOUNTING NOTES

1. The maximum permissible contact time for the soldering iron or bath is 3 seconds.
2. If the soldered joints are at least 5 mm from the seal, the maximum permissible temperature of the soldering iron or bath is 270 °C. If the joints are between 1.5 mm (min) and 5 mm from the seal, the maximum permissible temperature is 250 °C.
3. Avoid hot spots due to handling or mounting; the body of the device must not come into contact with or be exposed to a temperature higher than 150 °C.

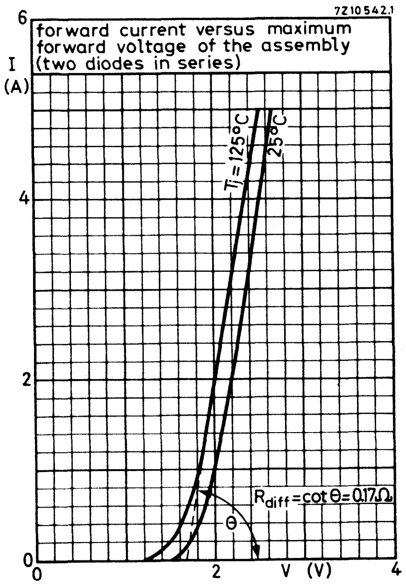


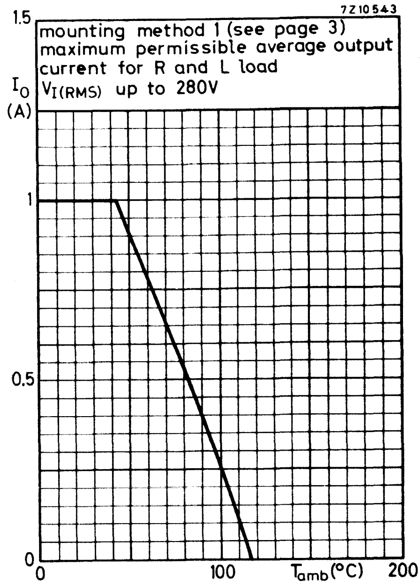
From the lefthand graph the total power dissipation can be found as a function of the average output current.

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.

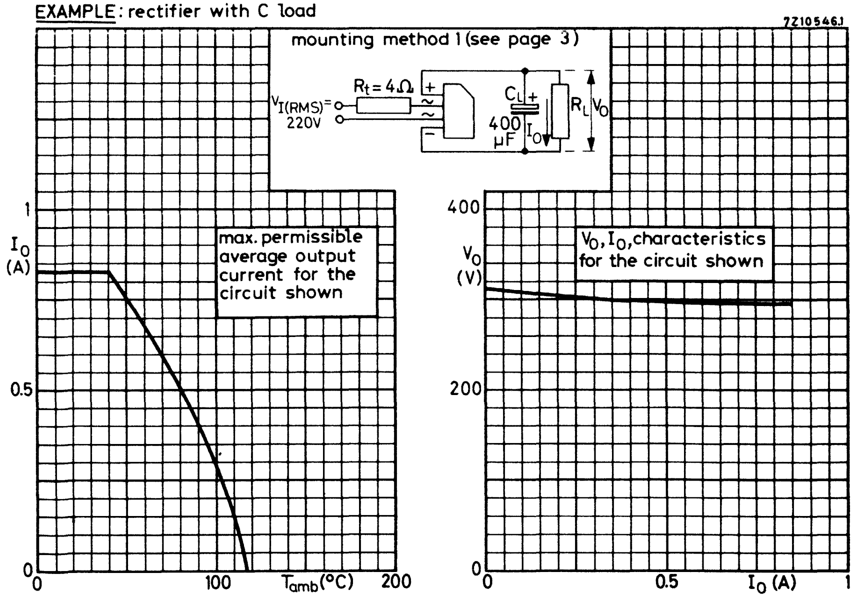
See Application Book: RECTIFIER DIODES.
Once the power dissipation is known, the max. permissible ambient temperature follows from the right hand graph.

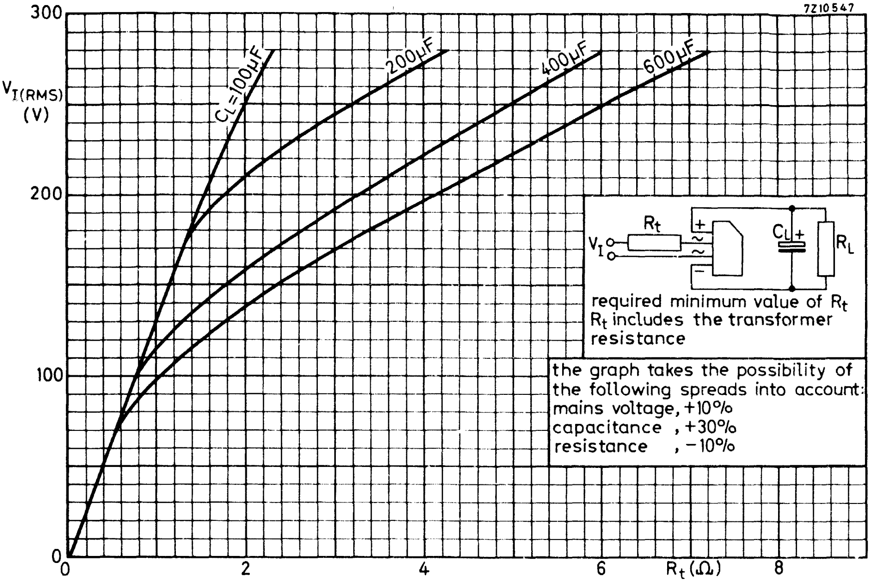
For the series resistance, added to limit the initial peak rectifier current, the required minimum value can be found from the upper graph on page 6.
R_{diff} is shown on page 5, left hand upper graph.

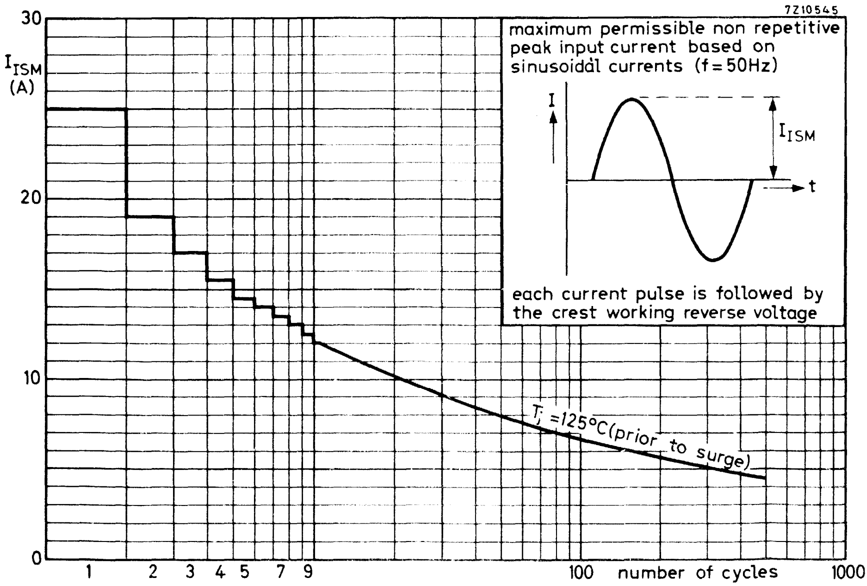




EXAMPLE: rectifier with C load




7Z10547
300
200
100
0
$V_{I(RMS)}$ (V)
C_L=100μF
200μF
400μF
600μF
0
2
4
6
R_t (Ω)
8
R_t
V_I
C_L
R_L
required minimum value of R_t
R_t includes the transformer resistance
the graph takes the possibility of the following spreads into account:
mains voltage, +10%
capacitance , +30%
resistance , −10%


7Z10545
30
20
10
0
I_{ISM} (A)
maximum permissible non repetitive peak input current based on sinusoidal currents (f = 50Hz)
I
I_{ISM}
t
each current pulse is followed by the crest working reverse voltage
T_j = 125°C (prior to surge)
1
2
3
4
5
7
9
100
number of cycles
1000

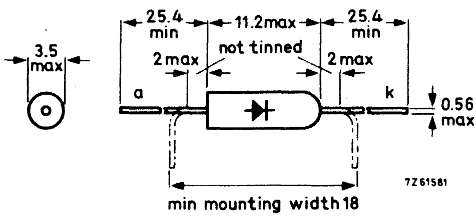
SILICON HIGH VOLTAGE DIODE

Diode in a plastic envelope intended for use as V_{g2} supply in colour television receivers.

QUICK REFERENCE DATA				
Crest working reverse voltage	V_{RWM}	max.	1500	V
Repetitive peak reverse voltage	V_{RRM}	max.	1800	V
Average forward current	$I_{F(AV)}$	max.	2.0	mA
Repetitive peak forward current	I_{FRM}	max.	100	mA
Junction temperature	T_j	max.	85	^oC
Recovered charge when switched from I_F = 10 mA to V_R = 2 V with $-\frac{dI}{dt}$ = 5 mA/μs	Q_s	typ.	1	nC

MECHANICAL DATA

Dimensions in mm



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 in accordance with the Absolute Maximum System (IEC 134)

Voltages

Crest working reverse voltage	V_{RWM}	max.	1500	V
Repetitive peak reverse voltage	V_{RRM}	max.	1800	V
Non repetitive peak reverse voltage ($t \leq 10$ ms)	V_{RSM}	max.	1800	V

Currents

Average forward current (averaged over any 20 ms period)	$I_{F(AV)}$	max.	2.0	mA
Repetitive peak forward current	I_{FRM}	max.	100	mA
Non repetitive peak forward current ($t \leq 10$ ms)	I_{FSM}	max.	1000	mA

Temperatures

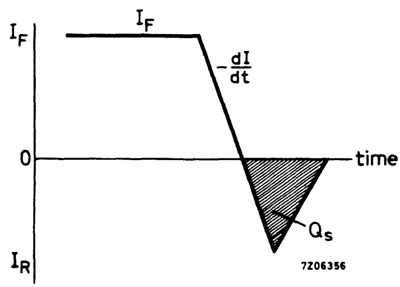
Storage temperature	T_{stg}		−65 to +100	°C
→ Junction temperature	T_j	max.	85	°C

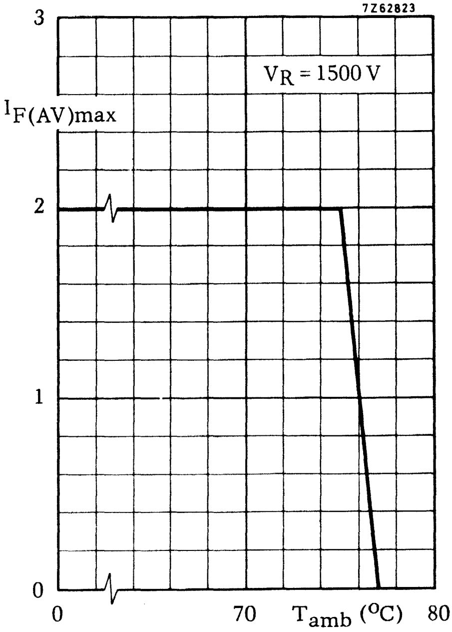
THERMAL RESISTANCE

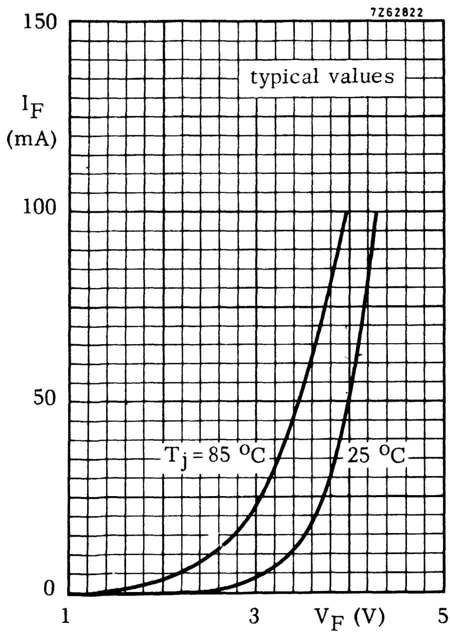
From junction to ambient in free air	$R_{th\ j\text{-}a}$	=	175	°C/W

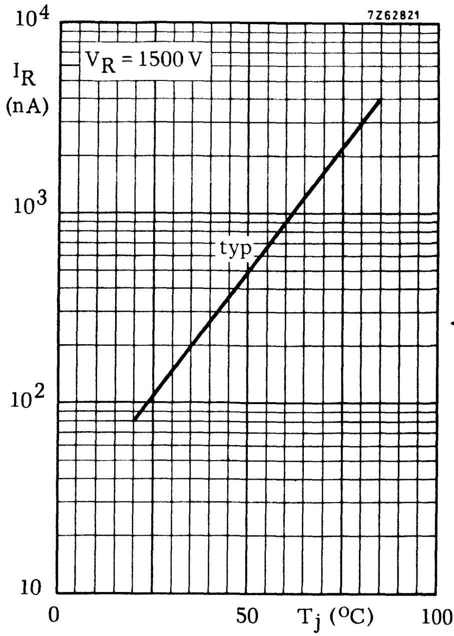
CHARACTERISTICS

Forward voltage at I_F = 100 mA; T_j = 75 °C	V_F	<	5	V
Reverse current at V_R = 1500 V; T_j = 75 °C	I_R	<	10	µA
Recovered charge when switched from I_F = 10 mA to V_R = 2 V with $-\frac{dI}{dt}$ = 5 mA/µs; T_j = 25 °C	Q_s	typ.	1	nC




7Z62823
3
2
1
0
$I_{F(AV)max}$
V_R = 1500 V
0
70
T_{amb} (°C)
80

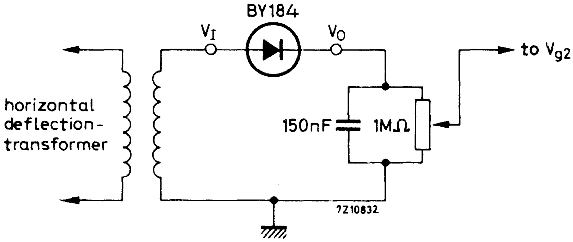

7Z62822
150
100
50
0
I_F
(mA)
typical values
T_j = 85 °C
25 °C
1
3
V_F (V)
5

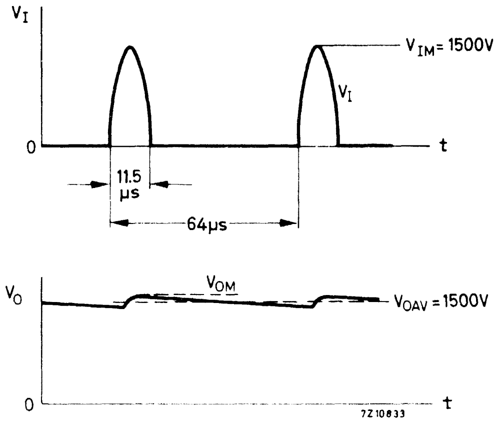

7Z62821
10^4
10^3
10^2
10
I_R
(nA)
V_R = 1500 V
typ
0
50
T_j (°C)
100

APPLICATION INFORMATION

Basic circuit for V_{g2} supply in colour television receivers.

Stable continuous operation is ensured at an ambient temperature up to 70 °C



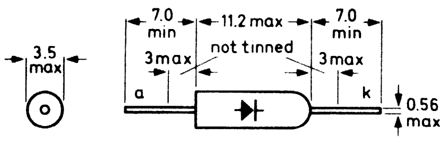


SILICON E.H.T. RECTIFIER DIODE

E.H.T. rectifier diode in a plastic envelope intended for tripler circuits and as focus rectifiers in colour television receivers.
Because of the smallness of the envelope, the diode should be potted when used at voltages above 6 kV, see sheet 4.

QUICK REFERENCE DATA				
Working reverse voltage	V_{RW}	max.	11.5	kV
Repetitive peak reverse voltage	V_{RRM}	max.	12.5	kV
Average forward current	$I_{F(AV)}$	max.	2.5	mA
Junction temperature	T_j	max.	85	°C
Reverse recovery:				
Recovered charge	Q_s	typ.	5	nC
Recovery time	t_{rr}	typ.	300	ns

MECHANICAL DATA Dimensions in mm



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

Voltages

Working reverse voltage	V_{RW}	max.	11.5	kV
Repetitive peak reverse voltage	V_{RRM}	max.	12.5	kV
Non-repetitive peak reverse voltage (t < 10 ms)	V_{RSM}	max.	12.5	kV

Currents

Average forward current (averaged over any 20 ms period)	$I_{F(AV)}$	max.	2.5	mA
Repetitive peak forward current	I_{FRM}	max.	200	mA [1]
Repetitive peak forward current during 20% of vertical deflection period time	I_{FRM}	max.	500	mA [1]
Repetitive peak reverse current during switching off	I_{RRM}	max.	150	mA

Temperatures

Storage temperature	T_{stg}	−55 to +85		°C
Junction temperature	T_j	max.	85	°C

CHARACTERISTICS

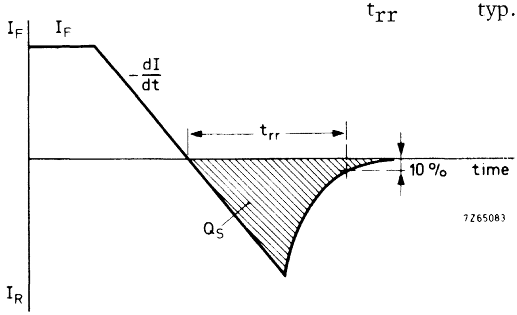
Forward voltage at I_F = 100 mA; T_j = 75 °C	V_F	<	26	V
Reverse current at V_R = 10 kV; T_j = 75 °C	I_R	<	4.0	μA

Reverse recovery: When switched from

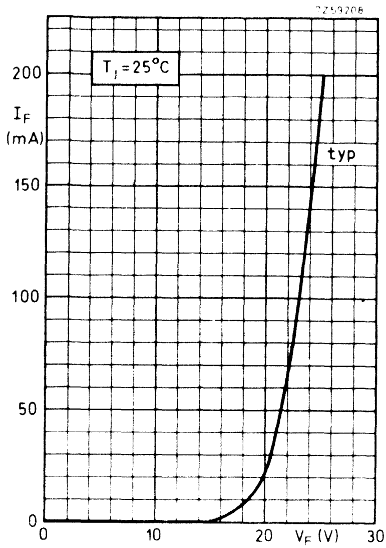
I_F = 200 mA to V_R = 100 V with

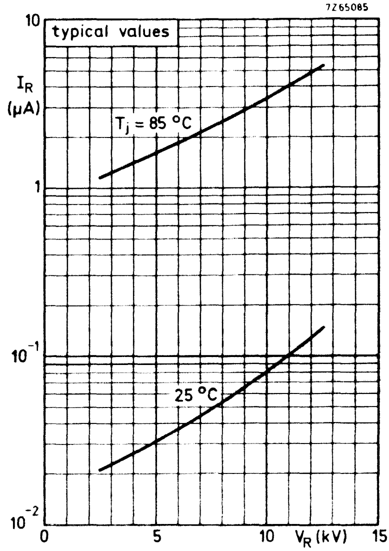
$-\frac{dI}{dt}$ = 200 mA/μs; T_j = 25 °C

Recovered charge	Q_s	typ.	5	nC
Recovery time	t_{rr}	typ.	300	ns

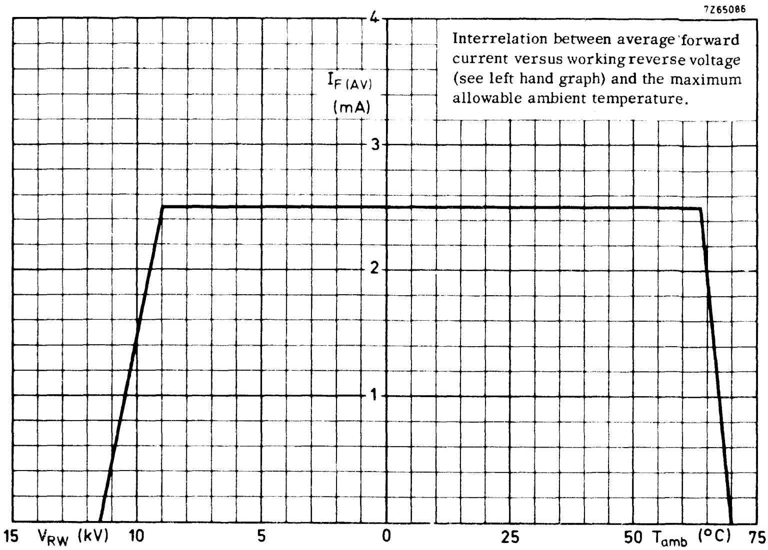


[1]) The rectifier can withstand flash-over currents in the picture tube.


7Z59208
$T_j = 25°C$
200
I_F
(mA)
150
100
50
0
typ
0
10
20
V_F (V)
30

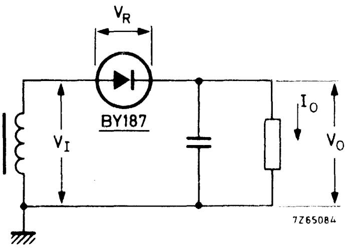

7Z65085
typical values
10
I_R
(µA)
1
10^{-1}
10^{-2}
$T_j = 85$ °C
25 °C
0
5
10
V_R (kV)
15

APPLICATION INFORMATION

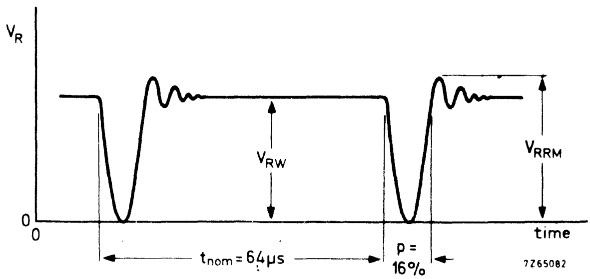


When used at voltages above 6 kV the diode should be potted in such a way that $R_{th\ j\text{-}a}$ is less than 120 °C/W.

Typical operating circuit



Typical applied voltage



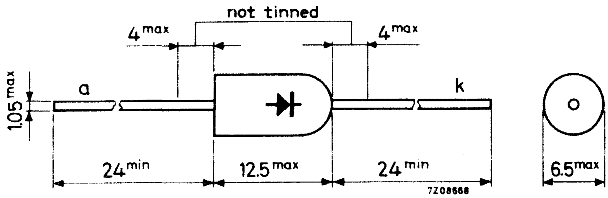
SILICON DIODE

Silicon double diffused diodes in a plastic envelope and intended for use as efficiency diode in horizontal deflection circuits between base and emitter terminals of the output transistor.

QUICK REFERENCE DATA					
Continuous reverse voltage	V_R	max.	25		V
Repetitive peak reverse voltage	V_{RRM}	max.	50		V
Average forward current with R load $V_R = V_{Rmax}$	$I_{F(AV)}$	max.	1,2		A
Repetitive peak forward current	I_{FRM}	max.	10		A
Junction temperature	T_j	max.	150		^oC
			BY188A	BY188B	
Forward conduction delay	t_d	>	0	0,7	μs

MECHANICAL DATA

Dimensions in mm



The rounded end indicates the cathode

The sealing of the plastic envelope withstands the accellerated damp heat test of IEC recommendation 68-2 (test D, severity 1 V, 6 cycles)

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

Voltages

Continuous reverse voltage	V_R	max.	25	V
Repetitive peak reverse voltage ($\delta \leq 0,01$)	V_{RRM}	max.	50	V
Non-repetitive peak reverse voltage ($t \leq 10$ ms)	V_{RSM}	max.	75	V

Currents

Average forward current (averaged over any 20 ms period)	$I_{F(AV)}$	max.	1,2	A
Repetitive peak forward current	I_{FRM}	max.	10	A
Non-repetitive peak forward current (t = 10 ms; half sine wave) T_j = 150 °C prior to surge	I_{FSM}	max.	40	A

Temperatures

Storage temperature	T_{stg}		-40 to +150	°C
Junction temperature	T_j	max.	150	°C

THERMAL RESISTANCE See page 3

CHARACTERISTICS

Forward voltage

I_F = 5 A; T_j = 25 °C	V_F	<	1,5	V [1]

Forward conduction delay at T_j = 150 °C

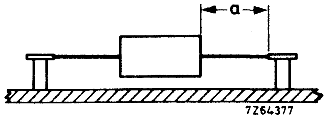
		BY188A	BY188B	
V_F = 6 V; See also page 5	t_d	> 0	0,7	µs

[1] Measured under pulse conditions to avoid excessive dissipation.

THERMAL RESISTANCE (influence of mounting method)

The quoted values of $R_{th\ j\text{-}a}$ should be used only when no other leads run to the tie-points (see upper graph on page 4).

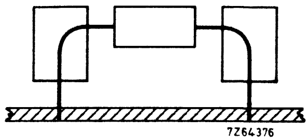
1. Mounted to ceramic solder tags at a lead-length a = 10 mm. $R_{th\ j\text{-}a}$ = 60 °C/W



2. Mounted on printed-wiring board at a = maximum lead length and heatsinks (0, 3 mm Cu) on leads.

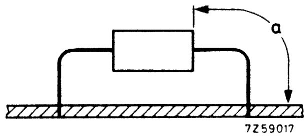
   Heatsink size 2 cm² (per side) $R_{th\ j\text{-}a}$ = 60 °C/W

   Heatsink size 1 cm² (per side) $R_{th\ j\text{-}a}$ = 70 °C/W



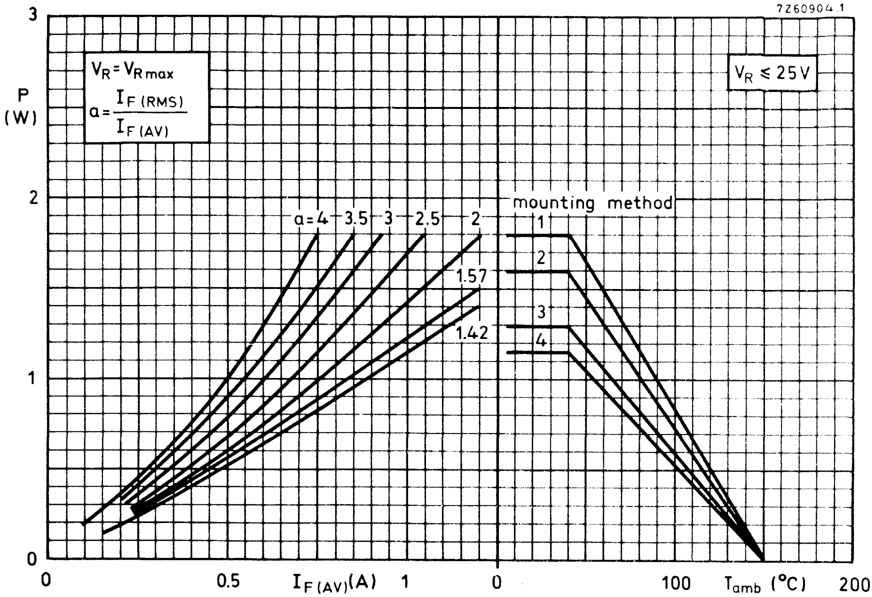
3. Mounted on printed-wiring board at a = maximum lead-length. $R_{th\ j\text{-}a}$ = 85 °C/W

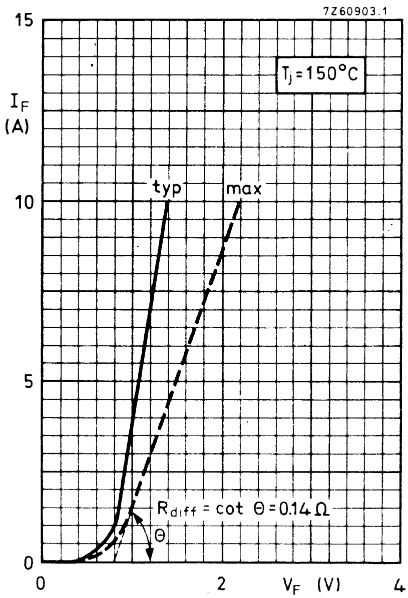
4. Mounted on printed-wiring board at a lead-length a= 10 mm. $R_{th\ j\text{-}a}$ = 95 °C/W



SOLDERING AND MOUNTING NOTES

1. Soldered joints must be at least 5 mm from the seal.
2. The maximum permissible temperature of the soldering bath is 300 °C; it must not be in contact with the joint for more than 3 seconds.
3. Avoid hot spots due to handling or mounting; the body and the device must not come into contact with or be exposed to a temperature higher than 150 °C.
4. Leads should not be bent less than 2 mm from the seal; exert no axial pull when bending.


7Z60904.1
P
(W)
$V_R = V_{R\,max}$
$a = \frac{I_{F\,(RMS)}}{I_{F\,(AV)}}$
$V_R \leq 25\,V$
a=4
3.5
3
2.5
2
1.57
1.42
mounting method
1
2
3
4
0
1
2
3
0
0.5
$I_{F\,(AV)}$(A)
1
0
100
T_{amb} (°C)
200

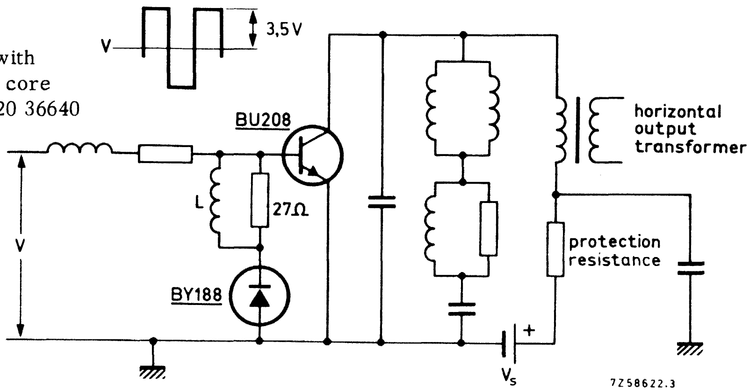

7Z60903.1
$T_j = 150\,°C$
I_F
(A)
typ
max
$R_{diff} = \cot\,\Theta = 0.14\,\Omega$
Θ
0
5
10
15
0
2
V_F (V)
4

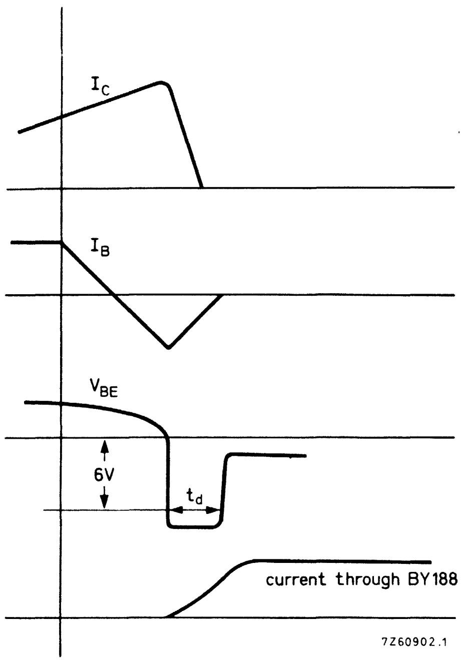
APPLICATION INFORMATION

In the horizontal deflection circuit shown below, the BY188 and the collector-base diode of the BU208 output transistor together fulfil the function of a parallel efficiency diode. During the forward conduction delay t_d of the BY188 (see waveforms below), the reverse bias between the base and emitter of the BU208 ensures fast turn-off of the collector current. The BU208 requires a delay time of minimum 1,5 μs, provided by the combined effects of the BY188 and coil L.

BY188A:
L = choke with ferrite core 4312 020 36640

BY188B:
L = 10 μH





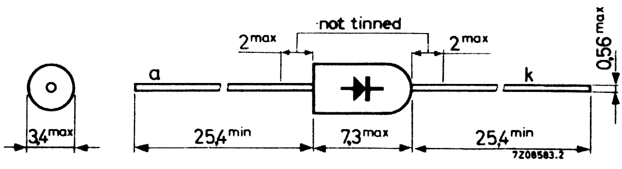
Waveforms in the above circuit during current turn-off.

FAST SOFT-RECOVERY RECTIFIER DIODE

Silicon double diffused rectifier diode in a plastic envelope. It is intended for use as top level detector, scan rectifier for the supply of small signal parts in television and other h.f. power supplies. The device features non snap-off characteristics.

QUICK REFERENCE DATA				
Working reverse voltage	V_{RW}	max.	300	V
Repetitive peak reverse voltage	V_{RRM}	max.	350	V
Average forward current with R load				
$V_{RW} = V_{RWmax}$	$I_{F(AV)}$	max.	0,4	A
V_{RW} = 80 V	$I_{F(AV)}$	max.	0,5	A
Non-repetitive peak forward current				
t = 10 ms; T_j = 125 °C prior to surge	I_{FSM}	max.	15	A
Junction temperature	T_j	max.	150	°C
Reverse recovery charge when switched				
from I_F = 400 mA to $V_R \geq 50$ V				
with $-dI/dt$ = 400 mA/μs; T_j = 25 °C	Q_s	<	60	nC

MECHANICAL DATA Dimensions in mm



The rounded end indicates the cathode side

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 in accordance with the Absolute Maximum System (IEC134)

Voltages

Continuous reverse voltage	V_R	max.	300	V
Working reverse voltage	V_{RW}	max.	300	V
Repetitive peak reverse voltage ($t \leq 10 \mu s$)	V_{RRM}	max.	350	V
Non-repetitive peak reverse voltage ($t \leq 10$ ms)	V_{RSM}	max.	350	V

Currents

Average forward current (averaged over any 20 ms period), with R load				
$V_{RW} = V_{RWmax}$	$I_{F(AV)}$	max.	0,4	A
$V_{RW} = 80$ V	$I_{F(AV)}$	max.	0,5	A
Repetitive peak forward current	I_{FRM}	max.	3,0	A
Repetitive peak forward current ($\delta \leq 0,03$; $f \geq 15$ kHz)	I_{FRM}	max.	5,0	A
Non-repetitive peak forward current (t = 10 ms; half sine wave) $T_j = 125$ °C prior to surge	I_{FSM}	max.	15	A

Temperatures

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

THERMAL RESISTANCE See page 3

CHARACTERISTICS

Forward voltage				
$I_F = 2$ A; $T_j = 150$ °C	V_F	<	1,5	V [1]
Reverse current at $V_R = 300$ V: $T_j = 125$ °C	I_R	<	200	µA
$T_j = 25$ °C	I_R	<	2	µA
Capacitance at f = 1 MHz				
$V_R = 150$ V; $T_j = 25$ to 125 °C	C_d	typ.	4,0	pF
Reverse recovery when switched from $I_F = 400$ mA to $V_R \geq 50$ V with $-dI/dt = 400$ mA/µs; $T_j = 25$ °C				
Recovery charge	Q_s	<	60	nC
Recovery time	t_{rr}	<	1,0	µs
Fall time	t_f	>	0,1	µs

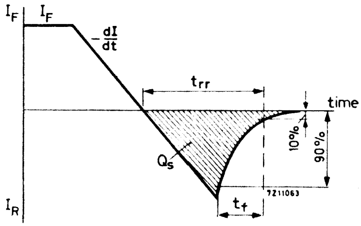
[1]) Measured under pulse conditions to avoid excessive dissipation.

CHARACTERISTICS (continued)

Reverse recovery when switched from

I_F = 10 mA to V_R ≥ 50 V with
−dI/dt = 0,5 A/μs; T_j = 25 °C

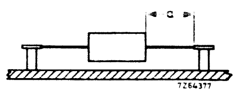
Recovery time	t_{rr}	<	300	ns



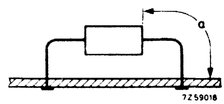
THERMAL RESISTANCE (influence of mounting method)

The quoted values of $R_{th\ j\text{-}a}$ should be used only when no other leads run to the tie-points. If leads of other dissipating components share the same tie-points, the thermal resistance will be higher than that quoted.

1. Mounted to solder tags at a lead-length a = 10 mm — $R_{th\ j\text{-}a}$ = 150 °C/W
2. Mounted to solder tags at a = maximum lead-length — $R_{th\ j\text{-}a}$ = 200 °C/W

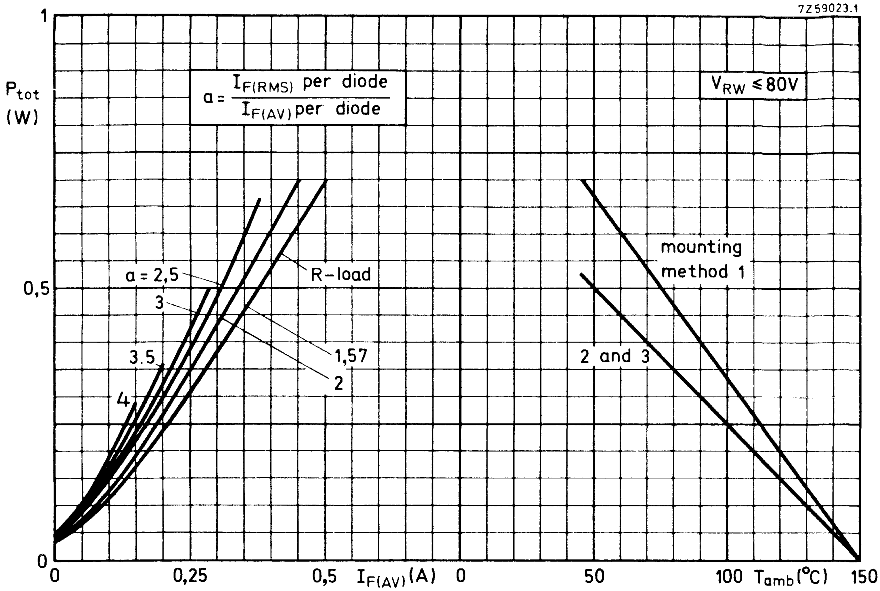


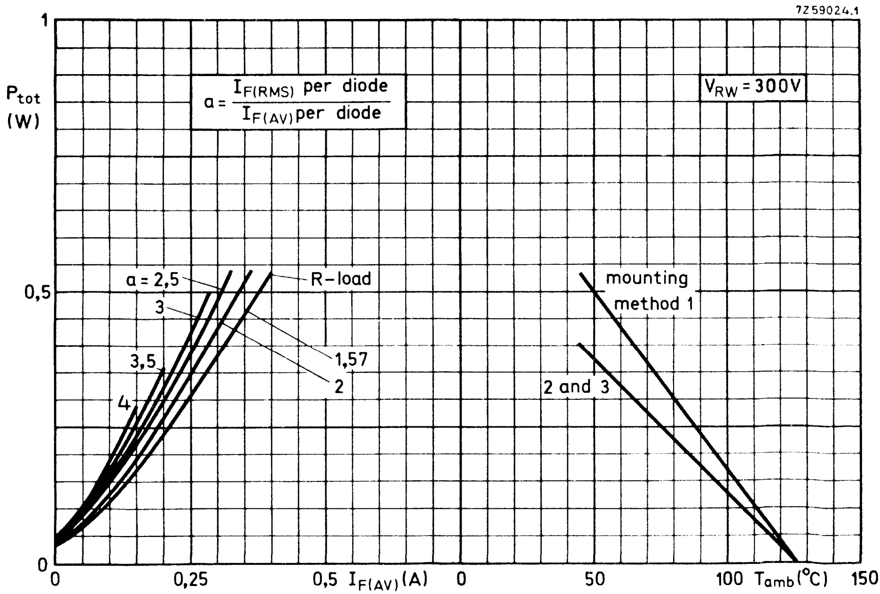
3. Mounted on printed-wiring board with a small area of copper at a lead-length a > 5 mm — $R_{th\ j\text{-}a}$ = 200 °C/W

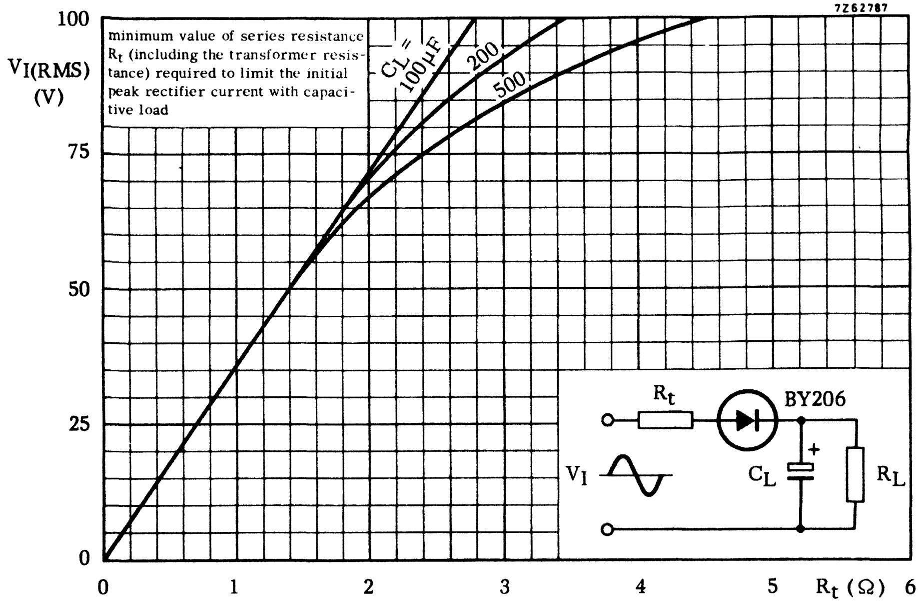


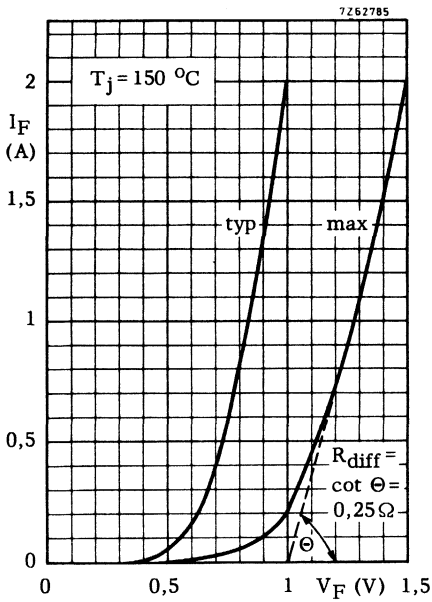
SOLDERING AND MOUNTING NOTES

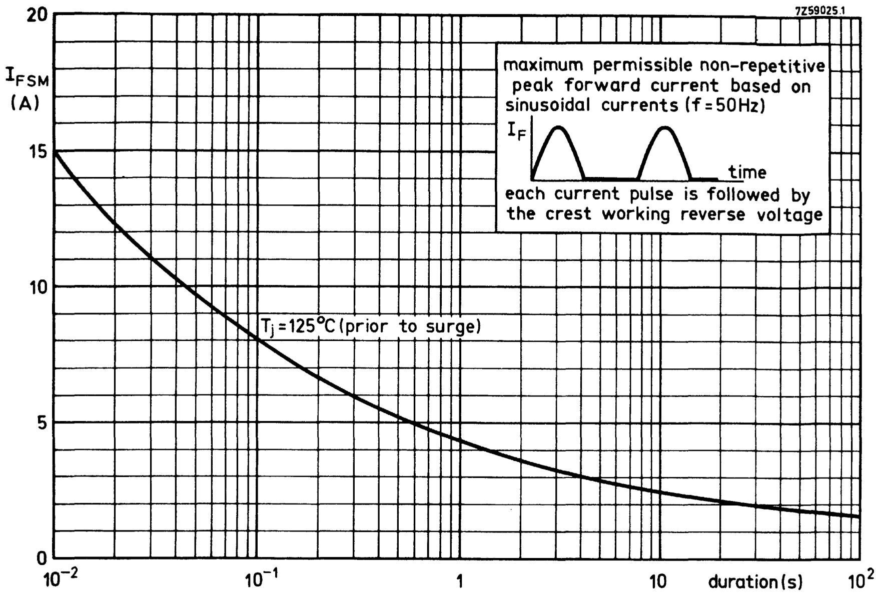
1. Soldered joints must be at least 5 mm from the seal.
2. The maximum permissible temperature of the soldering bath is 300 °C; it must not be in contact with the joint for more than 3 seconds.
3. Avoid hot spots due to handling or mounting; the body of the device must not come into contact with or be exposed to a temperature higher than 125 °C.


7Z59023.1
1
P_{tot}
(W)
0,5
0
$a = \frac{I_{F(RMS)} \text{ per diode}}{I_{F(AV)} \text{ per diode}}$
$V_{RW} \leq 80V$
a = 2,5
3
3.5
4
R-load
1,57
2
mounting
method 1
2 and 3
0
0,25
0,5
$I_{F(AV)}$ (A)
0
50
100
T_{amb} (°C)
150

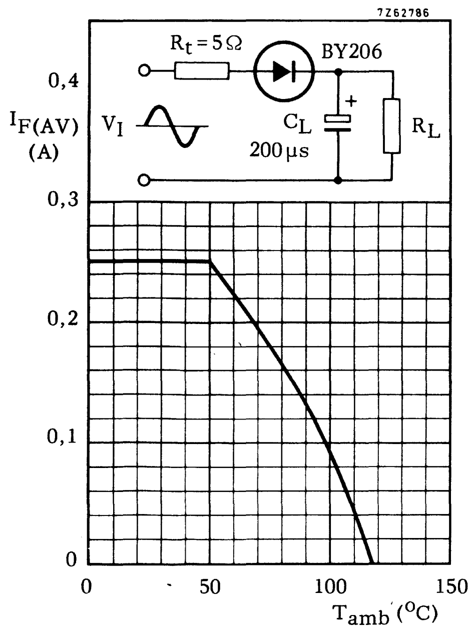

7Z59024.1
1
P_{tot}
(W)
0,5
0
$a = \frac{I_{F(RMS)} \text{ per diode}}{I_{F(AV)} \text{ per diode}}$
$V_{RW} = 300V$
a = 2,5
3
3,5
4
R-load
1,57
2
mounting
method 1
2 and 3
0
0,25
0,5
$I_{F(AV)}$ (A)
0
50
100
T_{amb} (°C)
150

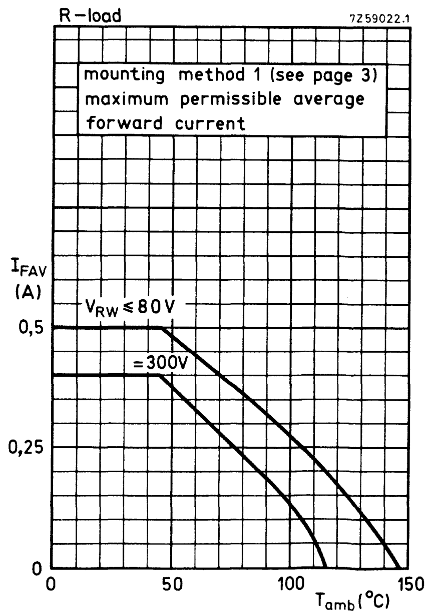

7Z62787
minimum value of series resistance R_t (including the transformer resistance) required to limit the initial peak rectifier current with capacitive load
$V_{I(RMS)}$ (V)
C_L = 100 μF
200
500
R_t
BY206
V_I
C_L
R_L
R_t (Ω)
0
25
50
75
100
0
1
2
3
4
5
6

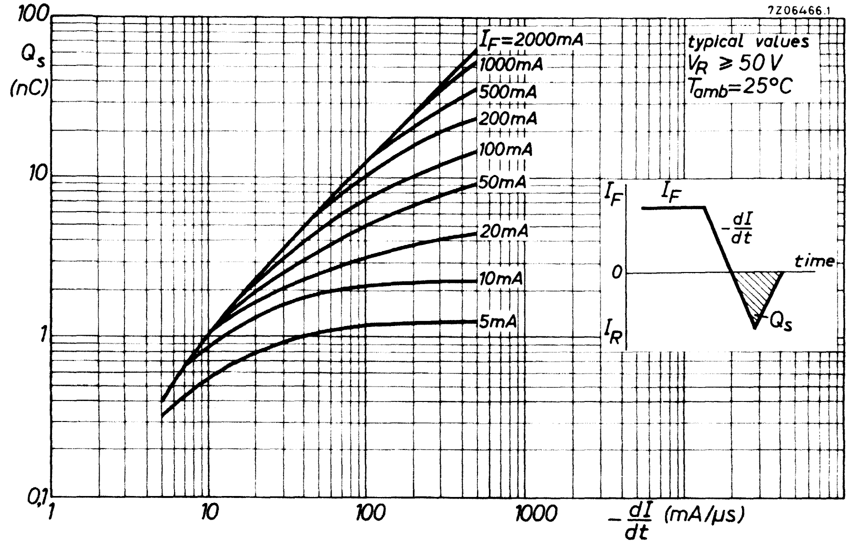

7Z62785
T_j = 150 °C
I_F (A)
typ
max
R_{diff} = cot Θ = 0,25 Ω
Θ
V_F (V)
0
0,5
1
1,5
2
0
0,5
1
1,5

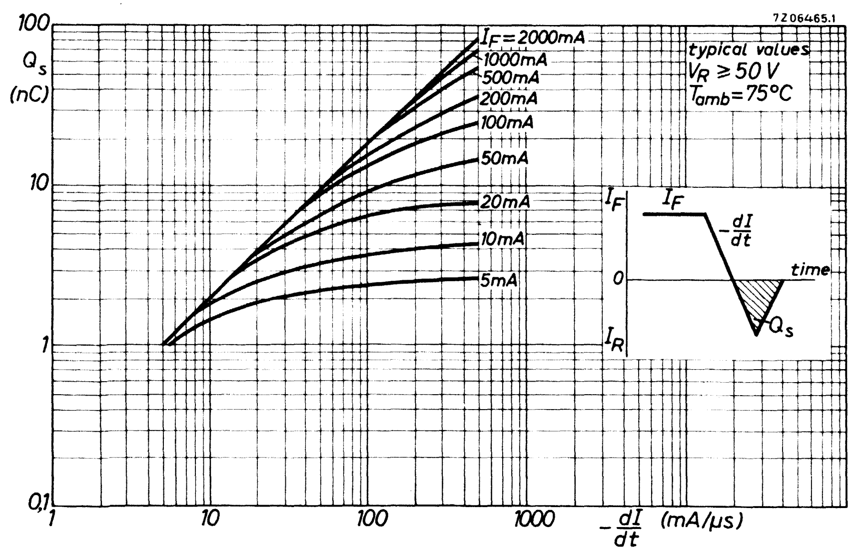


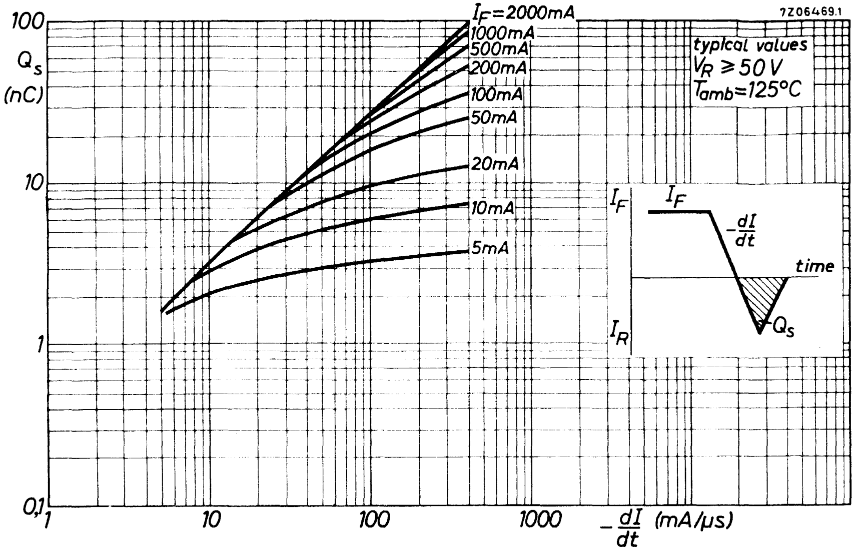
EXAMPLE OF OPERATION WITH C-LOAD

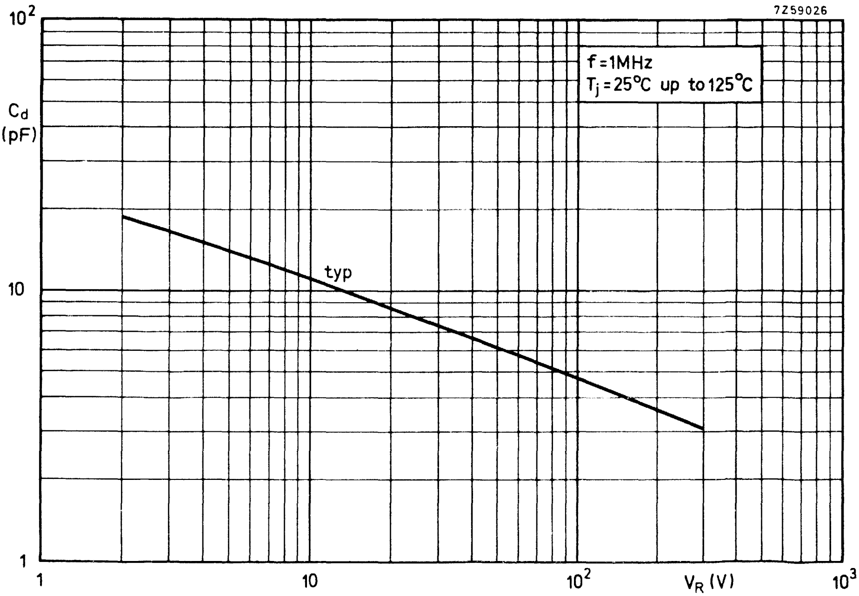





7Z06466.1
100
10
1
0,1
Qs
(nC)
1
10
100
1000
$-\frac{dI}{dt}$ (mA/µs)
I_F=2000mA
1000mA
500mA
200mA
100mA
50mA
20mA
10mA
5mA
typical values
$V_R \geq 50$ V
T_{amb}=25°C
I_F
I_F
$-\frac{dI}{dt}$
0
time
I_R
Q_s


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

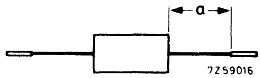

7Z06469.1
100
Q_s
(nC)
10
1
0,1
1
10
100
1000
$-\frac{dI}{dt}$ (mA/μs)
I_F=2000mA
1000mA
500mA
200mA
100mA
50mA
20mA
10mA
5mA
typical values
$V_R \geq 50$ V
T_{amb}=125°C
I_F
I_F
$-\frac{dI}{dt}$
time
I_R
Q_s


7Z59026
10^2
C_d
(pF)
10
1
1
10
10^2
V_R (V)
10^3
f = 1MHz
T_j = 25°C up to 125°C
typ

THERMAL RESISTANCE (influence of mounting method)

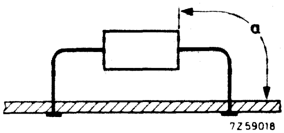
The quoted values apply when no other leads run to the tie-points. If leads of other dissipating components share the same tie-points, the thermal resistance will be higher than that quoted.

1. Mounted to solder tags at a lead-length a = 10 mm. $R_{th\ j-a}$ = 150 °C/W



2. Mounted to solder tags at a = maximum lead-length. $R_{th\ j-a}$ = 200 °C/W

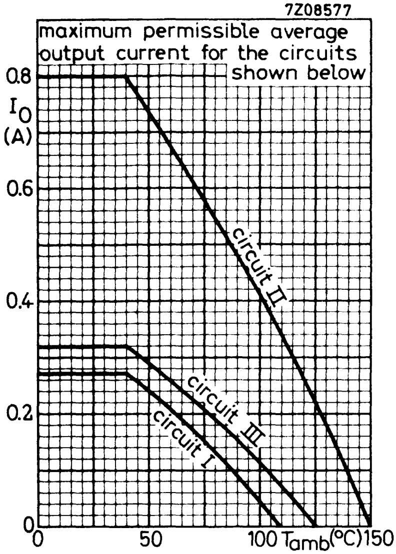
3. Mounted on printed-wiring with a small area of copper at any lead-length a. $R_{th\ j-a}$ = 200 °C/W

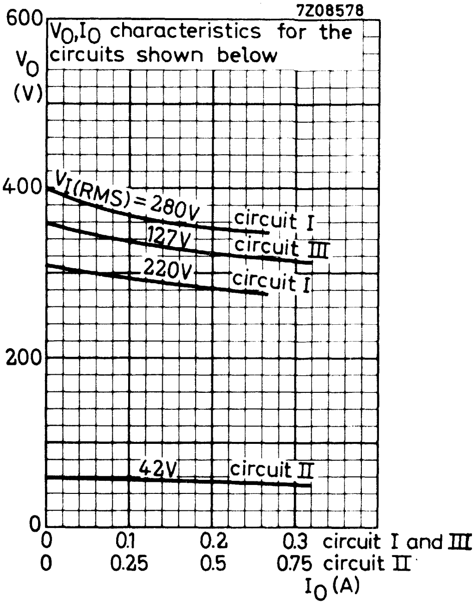


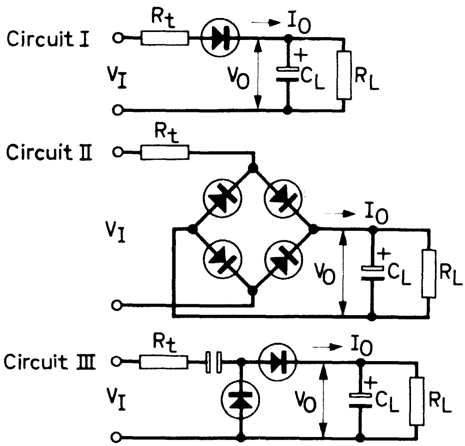
SOLDERING AND MOUNTING NOTES

1. Soldered joints must be at least 5 mm from the seal.
2. The maximum permissible temperature of the soldering iron or bath is 300 °C; it must be in contact with the joint for no more than 3 seconds.
3. Avoid hot spots due to handling or mounting; the body of the device must not come into contact with or be exposed to a temperature higher than 150 °C.

EXAMPLE: Rectifier with C-load
mounting method 1 (see page 3)



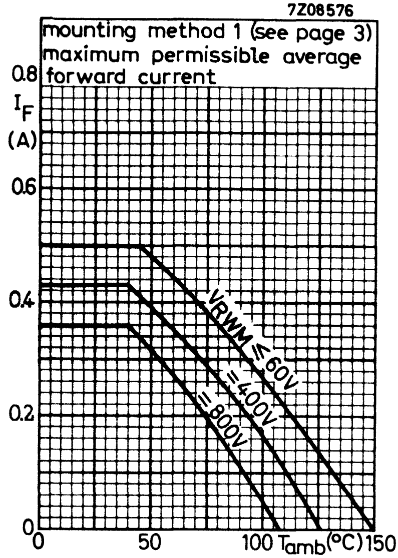


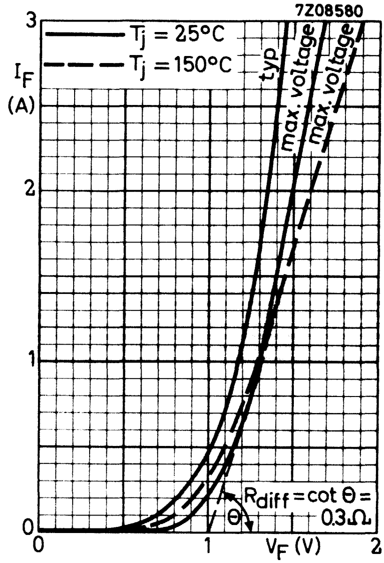


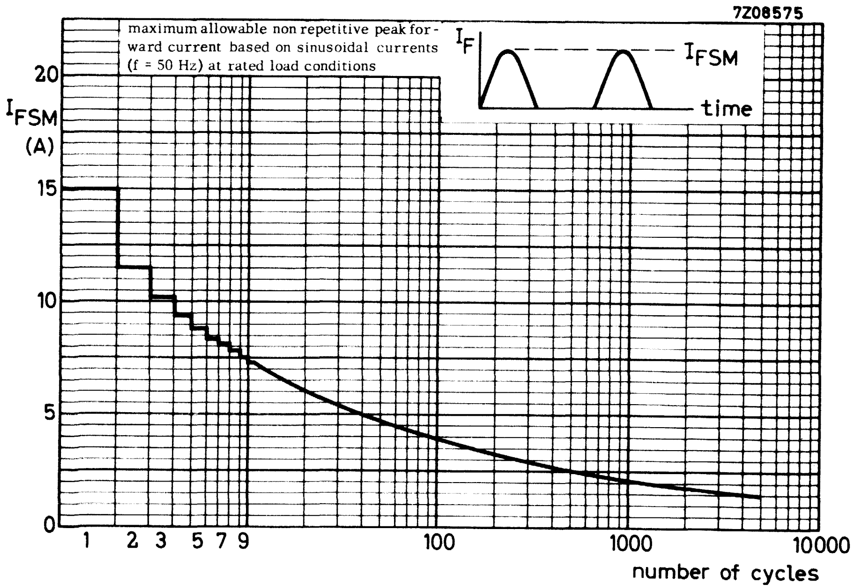
	$V_{I(RMS)}$	R_t	C_L
Circuit I	220V	8.2 Ω	100 µF
	280V	15 Ω	100 µF
Circuit II	42V	1.5 Ω	1500 µF
Circuit III	127V	5.6 Ω	200 µF

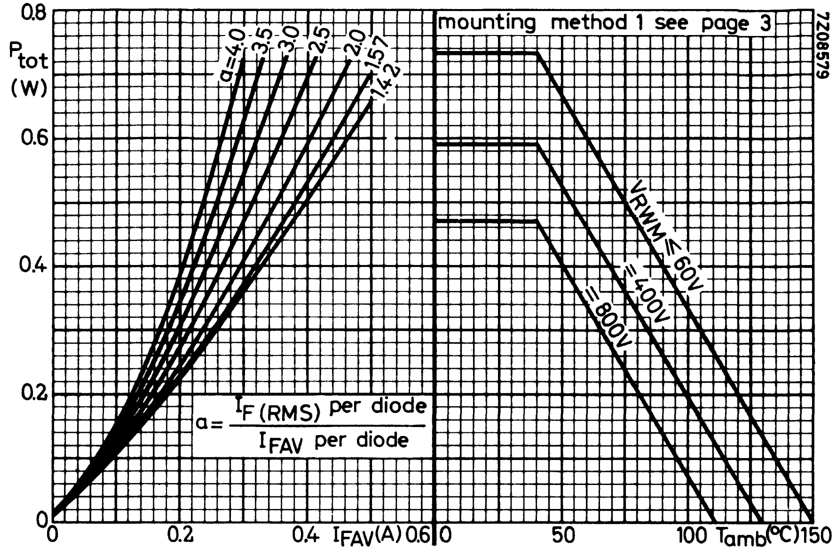
7Z08584

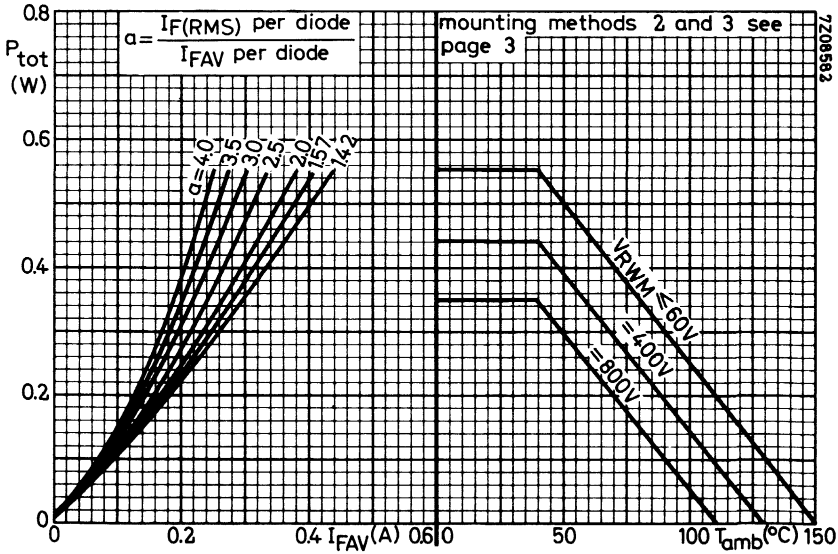
R AND L-LOAD

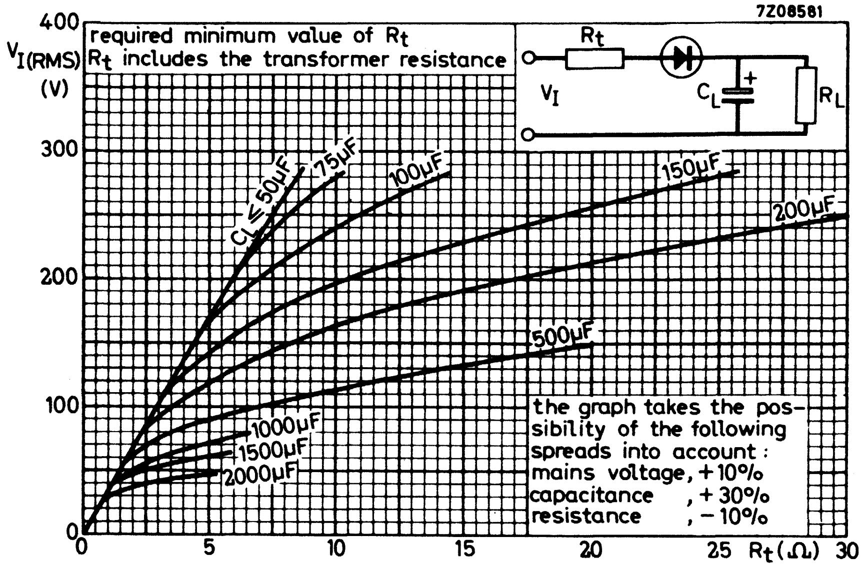

7Z08576
mounting method 1 (see page 3)
maximum permissible average
forward current
0.8
I_F
(A)
0.6
0.4
0.2
0
$V_{RWM} \leq 60V$
$\leq 400V$
$\leq 800V$
0
50
100
T_{amb} (°C)
150


7Z08580
3
I_F
(A)
2
1
0
$T_j = 25°C$
$T_j = 150°C$
typ
max. voltage
max. voltage
$R_{diff} = \cot \Theta = 0.3 \Omega$
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
20
I_{FSM}
(A)
15
10
5
0
1
2
3
5
7
9
100
1000
10000
number of cycles


0.8
P_{tot}
(W)
0.6
0.4
0.2
0
a=4.0
3.5
3.0
2.5
2.0
1.57
1.42
a = $I_{F(RMS)}$ per diode / I_{FAV} per diode
0
0.2
0.4 I_{FAV}(A) 0.6
mounting method 1 see page 3
$V_{RWM} \leq$ 60V
= 400V
= 800V
0
50
100 T_{amb}(°C) 150
7Z08579


0.8
P_{tot}
(W)
0.6
0.4
0.2
0
a = $I_{F(RMS)}$ per diode / I_{FAV} per diode
a=4.0
3.5
3.0
2.5
2.0
1.57
1.42
0
0.2
0.4 I_{FAV}(A) 0.6
mounting methods 2 and 3 see page 3
$V_{RWM} \leq$ 60V
= 400V
= 800V
0
50
100 T_{amb}(°C) 150
7Z08582



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 Application Book: RECTIFIER 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

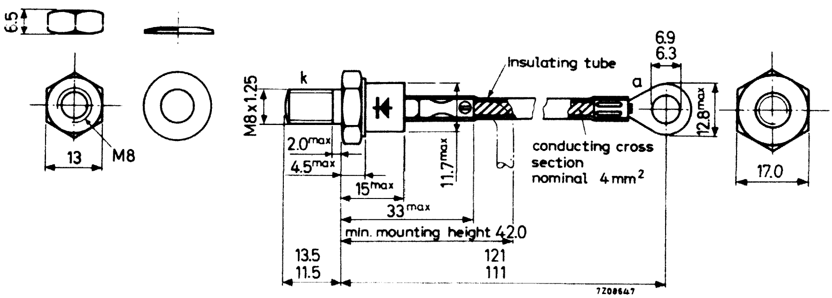
Double diffused silicon diodes in metal envelopes, intended for power rectifier applications.
The series consists of the following types:
Normal polarity (cathode to stud) BYX13-800 to 1200
Reverse polarity (anode to stud) BYX13-800R to 1200 R

QUICK REFERENCE DATA

			BYX13-800(R)	1000(R)	1200(R)	
Crest working reverse voltage	V_{RWM}	max.	400	500	600	V
Repetitive peak reverse voltage	V_{RRM}	max.	800	1000	1200	V
Average forward current up to $T_{mb} = 110\,^{o}C$	$I_{F(AV)}$			max.	20	A
at $T_{mb} = 125\,^{o}C$	$I_{F(AV)}$			max.	14	A
Non-repetitive peak forward current $t = 10$ ms; $T_j = 125\,^{o}C$ prior to surge	I_{FSM}			max.	400	A
Junction temperature	T_j			max.	150	^{o}C

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: 35 g
Diameter of clearance hole: max. 8.5 mm

Torque on nut: min. 4 Nm
(40 kg cm)
max. 6 Nm
(60 kg cm)

APPLICATION INFORMATION AND OPERATING NOTES

See general pages at the beginning of this section.

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

Voltages

			BYX13-800(R)	1000(R)	1200(R)	
Continuous reverse voltage	V_R	max.	400	500	600	V
Crest working reverse voltage	V_{RWM}	max.	400	500	600	V
Repetitive peak reverse voltage ($\delta \leq 0.01$)	V_{RRM}	max.	800	1000	1200	V
Non-repetitive peak reverse voltage ($t < 10$ ms)	V_{RSM}	max.	800	1000	1200	V

Currents

Average forward current (averaged over any 20 ms period) up to T_{mb} = 110 °C	$I_{F(AV)}$	max.	20	A
at T_{mb} = 125 °C	$I_{F(AV)}$	max.	14	A
Repetitive peak forward current	I_{FRM}	max.	100	A
Non-repetitive peak forward current (t = 10 ms; half sine wave) T_j = 125 °C prior to surge	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

CHARACTERISTICS

Forward voltage at T_j = 25 °C

I_F = 1 A	V_F	<	0.9	V
I_F = 100 A	V_F	<	2.0	V [1]

Peak reverse current

			BYX13-800(R)	1000(R)	1200(R)
$V_{RM} = V_{RWMmax}$; T_j = 125 °C	I_{RM}	<	2.0	1.7	1.4 mA

[1]) Measured under pulse conditions to avoid excessive dissipation.

SILICON RECTIFIER DIODES

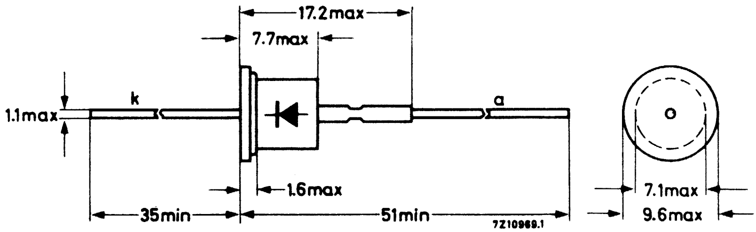
The BYX22-600 and BYX22-1200 are silicon diodes in a metal DO-1 envelope, intended for power rectifier applications up to 1.4 A.

QUICK REFERENCE DATA

		BYX22-600	1200	
Crest working reverse voltage	V_{RWM}	max. 400	800	V
Repetitive peak reverse voltage	V_{RRM}	max. 600	1200	V
Average forward current	I_{FAV}	max. 1.4		A
Non-repetitive peak forward current $t = 10$ ms; $T_j = 150\,^{o}C$	I_{FSM}	max. 40		A
Junction temperature	T_j	max. 150		^{o}C
Thermal resistance from junction to ambient	$R_{th\ j\text{-}a}$	= 60		$^{o}C/W$

MECHANICAL DATA Dimensions in mm

DO-1



MOUNTING METHODS see page 3

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

All information applies to frequencies up to 400Hz

Voltages

		BYX22-600	1200	
Crest working reverse voltage	V_{RWM}	max. 400	800	V
Repetitive peak reverse voltage ($d \leq 1\%$)	V_{RRM}	max. 600	1200	V
Non repetitive peak reverse voltage ($t \leq 10$ ms)	V_{RSM}	max. 600	1200	V

Currents

Average forward current (averaged over any 20 ms period) for R-load up to $T_{amb} = 30\,^{o}C$	I_{FAV}	max.	1.4	A
Forward current (d.c.) up to $T_{amb} = 30\,^{o}C$	I_F	max.	1.6	A
Repetitive peak forward current	I_{FRM}	max.	15	A
Non repetitive peak forward current $t = 10$ ms; $T_j = 150\,^{o}C$ (see page 6)	I_{FSM}	max.	40	A

Temperatures

Storage temperature	T_{stg}	-65 to +150		^{o}C
Ambient temperature	T_{amb}	max.	150	^{o}C

THERMAL RESISTANCE

From junction to ambient	$R_{th\ j-a}$	See page 3

CHARACTERISTICS

Forward voltage at $I_F = 5A$; $T_{amb} = 25\,^{o}C$	V_F	<	1.5	V [1]
Reverse current at $V_R = V_{RWMmax}$; $T_{amb} = 125\,^{o}C$	I_R	<	120	μA

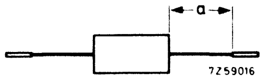
[1]) Measured under pulsed conditions to avoid excessive dissipation.

THERMAL RESISTANCE

Effect of mounting on thermal resistance $R_{th\ j-a}$

The quoted values apply when no other leads run to the tie-points. If leads of other dissipating components share the same tie-points, the thermal resistance will be higher than that quoted.

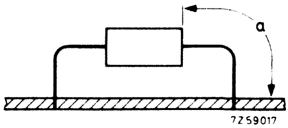
1. Mounted to solder tags at a lead-length a = 10 mm. $R_{th\ j-a}$ = 60 °C/W



2. Mounted to solder tags at a = maximum lead-length. $R_{th\ j-a}$ = 70 °C/W

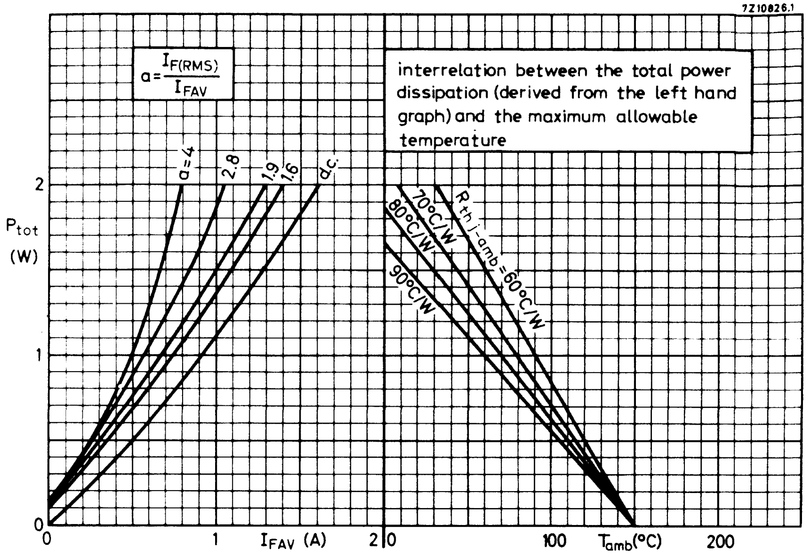
3. Mounted on printed-wiring board at a = maximum lead-length. $R_{th\ j-a}$ = 80 °C/W

4. Mounted on printed-wiring board at a lead-length a = 10 mm. $R_{th\ j-a}$ = 90 °C/W



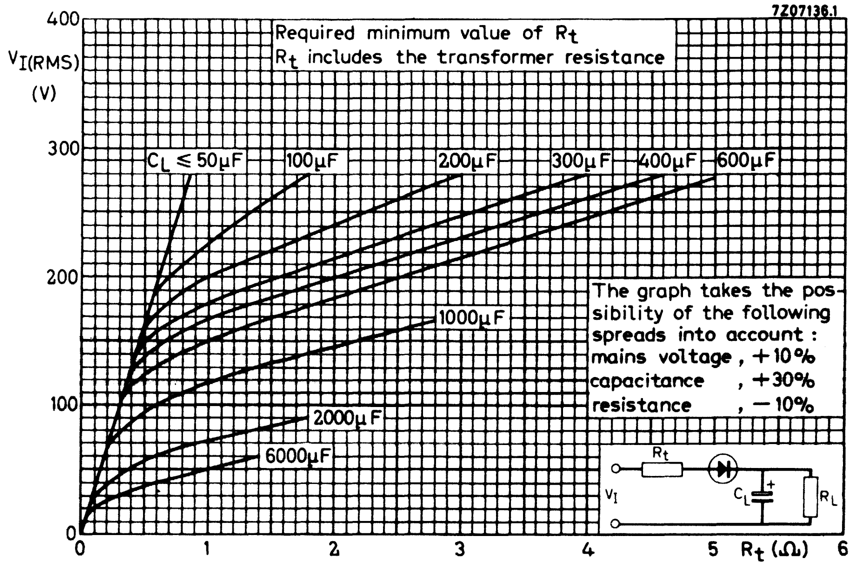
SOLDERING AND MOUNTING NOTES

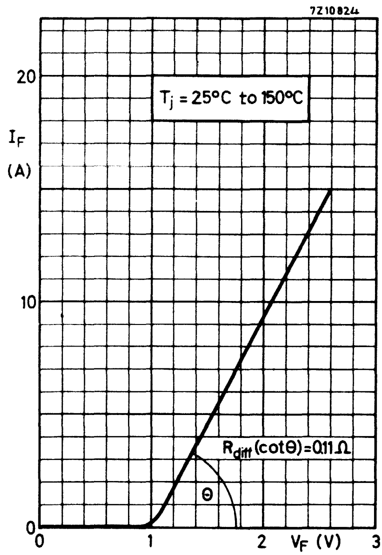
1. At a soldering iron or bath temperature of up to 245 °C, the maximum permissible soldering time is 10 s if the joint is 5 mm from the seal, 3 s if it is 1.5 mm from the seal.
2. At a temperature between 245 °C and 400 °C (max.), the joint must be more than 5 mm from the seal and soldering time must not exceed 5 s.
3. Leads should not be bent less than 1.5 mm from the seal; excert no axial pull when bending.

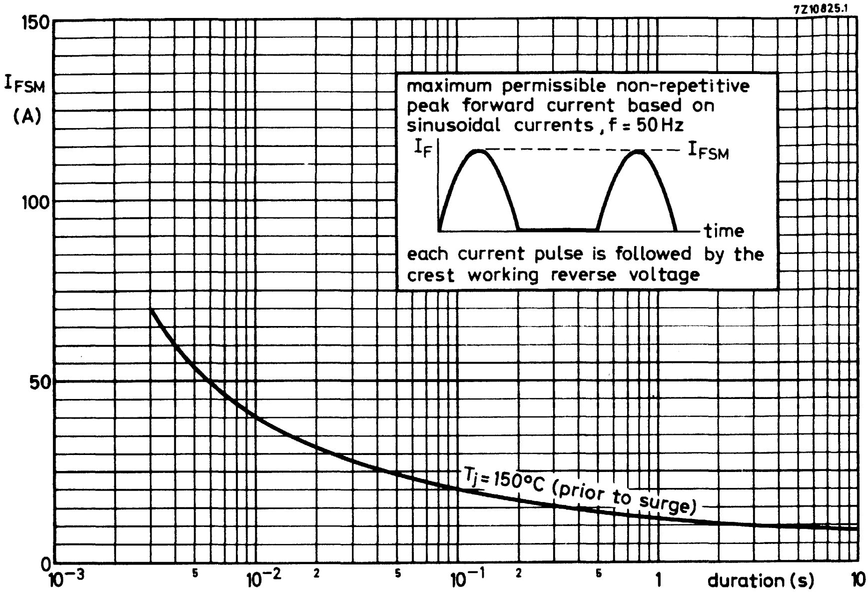


The form factor a = $\frac{I_{F(RMS)} \text{ per diode}}{I_{FAV} \text{ per diode}}$ depends on $n\omega R_L C_L$ and $\frac{R_t + R_{diff}}{nR_L}$ and can be found from existing graphs.

See Application Book: RECTIFIER DIODES.


7Z07136.1
Required minimum value of Rt
Rt includes the transformer resistance
VI(RMS) (V)
CL ≤ 50µF
100µF
200µF
300µF
400µF
600µF
1000µF
2000µF
6000µF
The graph takes the possibility of the following spreads into account :
mains voltage , +10%
capacitance , +30%
resistance , −10%
Rt
VI
CL
RL
Rt (Ω)


7Z10824
Tj = 25°C to 150°C
IF (A)
Rdiff (cotΘ)=0.11Ω
Θ
VF (V)


7Z10825.1
150
I_{FSM}
(A)
100
50
0
10^{-3}
5
10^{-2}
2
5
10^{-1}
2
5
1
duration (s)
10
maximum permissible 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 = 150°C (prior to surge)

CONTROLLED AVALANCHE RECTIFIER DIODES

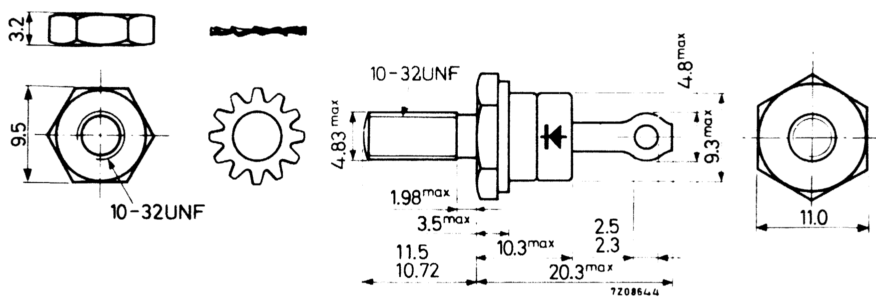
Diffused silicon diodes in a DO-4 metal envelope, capable of absorbing transients and intended for power rectifier applications.
The series consists of the following types:
Normal polarity (cathode to stud): BYX25-600 to 1000.
Reverse polarity (anode to stud): BYX25-600R to 1000R.

QUICK REFERENCE DATA

			BYX25-600(R)	800(R)	1000(R)	
Crest working reverse voltage	V_{RWM}	max.	600	800	1000	V
Reverse avalanche breakdown voltage	$V_{(BR)R}$	>	750	1000	1250	V
Average forward current	$I_{F(AV)}$	max.		20		A
Non-repetitive peak forward current $t = 10\,ms$; $T_j = 175\,^oC$ prior to surge	I_{FSM}	max.		360		A
Non-repetitive peak reverse power dissipation ($t = 10\,\mu s$; $T_j = 25\,^oC$)	P_{RSM}	max.		18		kW
Junction temperature	T_j	max.		175		^oC

MECHANICAL DATA Dimensions in mm

DO-4



Net weight: 7.6 g
Diameter of clearance hole: max. 5.2 mm
Accessories supplied on request: 56295, (56262A)
The mark shown applies to the normal polarity types

Torque on nut: min. 8 kgcm
(0.8 Newton-metres)
max. 17 kgcm
(1.7 Newton-metres)

All information applies to frequencies up to 400 Hz

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

Voltages [1]			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)	$I_{F(AV)}$	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; half sine wave) T_j = 175 °C prior to surge	I_{FSM}	max.	360	A

Reverse power dissipation

Average reverse power dissipation (averaged over any 20 ms period) T_j = 175 °C	$P_{R(AV)}$	max.	38	W
Repetitive peak reverse power dissipation t = 10 μs (square wave; f = 50 Hz) T_j = 175 °C	P_{RRM}	max.	3.0	kW
Non-repetitive peak reverse power dissipation t = 10 μs (square wave) T_j = 25 °C prior to surge	P_{RSM}	max.	18	kW
T_j = 175 °C prior to surge	P_{RSM}	max.	3.0	kW

Temperatures

Storage temperature	T_{stg}		−55 to +175	°C
Junction temperature	T_j	max.	175	°C

[1]) 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 $T_{j\ max.}$ = 129 °C.

THERMAL RESISTANCE

From junction to ambient in free air	$R_{th\ j\text{-}a}$	=	50	°C/W
From junction to mounting base	$R_{th\ j\text{-}mb}$	=	1.3	°C/W
From mounting base to heatsink	$R_{th\ mb\text{-}h}$	=	0.5	°C/W

CHARACTERISTICS

			BYX25-600(R)	800(R)	1000(R)	
Forward voltage						
I_F = 50 A; T_j = 25 °C	V_F	<	1.8	1.8	1.8	V [1]
Reverse avalanche breakdown voltage						
I_R = 5 mA; T_j = 25 °C	$V_{(BR)R}$	>	750	1000	1250	V
		<	2000	2000	2000	V
Peak reverse current						
V_{RM} = $V_{RWM\,max}$; T_j = 125 °C	I_{RM}	<	1.0	0.8	0.6	mA

APPLICATION INFORMATION

See general pages at the beginning of this section

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

OPERATING NOTES (See also general pages at the beginning of this section.)

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 that 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). In order to avoid excessive peak junction temperatures resulting from the pulse character of the repetitive peak reverse power in the avalanche region, the value of the maximum junction temperature should be reduced. 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, thus 12 °C lower (see the lower graph on page 5).

Allowance can be made for this by assuming an ambient temperature 12 °C higher than before, in this case 52 °C instead of 40 °C.

Using this in the curve leads to a thermal resistance

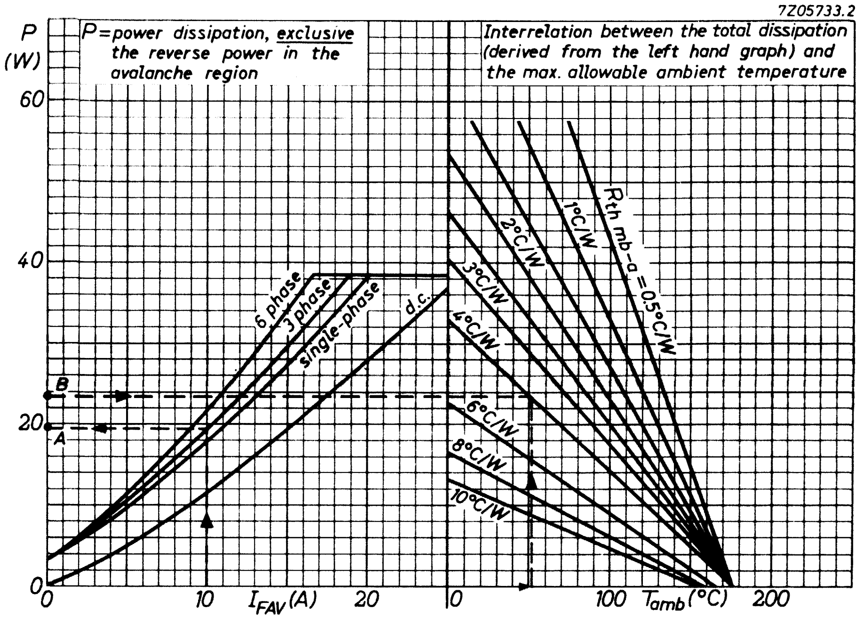
$$R_{th\ mb-a} \approx 4\ ^{o}C/W$$

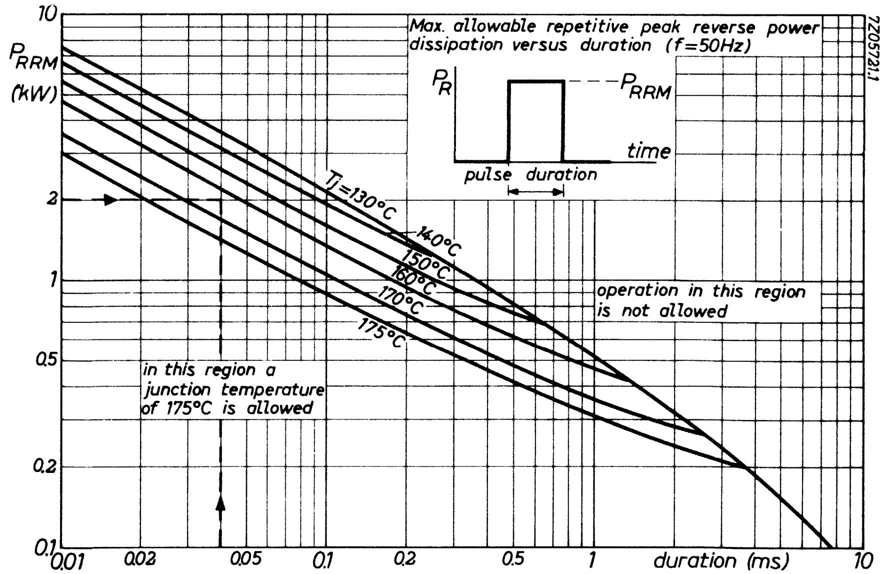
The contact thermal resistance $R_{th\ mb-h} = 0.5\ ^{o}C/W$

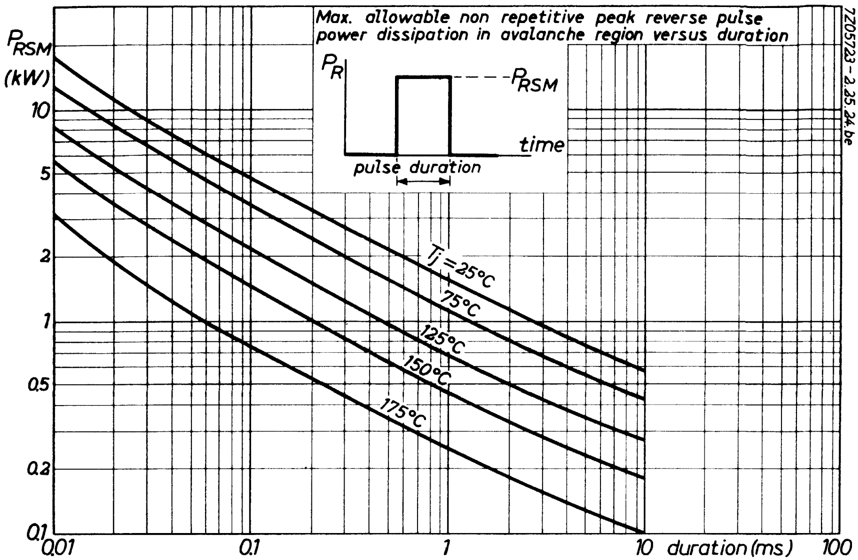
Hence the heatsink thermal resistance should be:

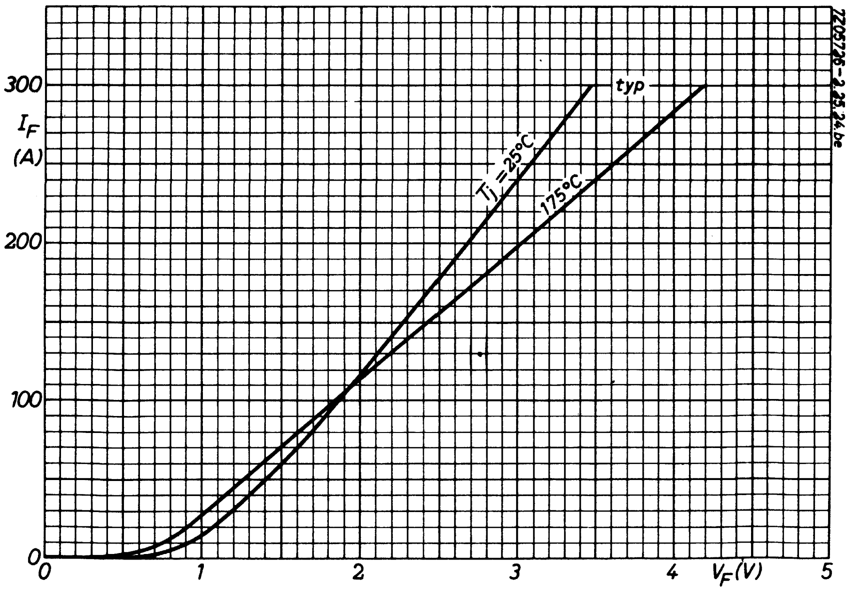
$$R_{th\ h-a} = R_{th\ mb-a} - R_{th\ mb-h} = (4 - 0.5)\ ^{o}C/W = 3.5\ ^{o}C/W$$

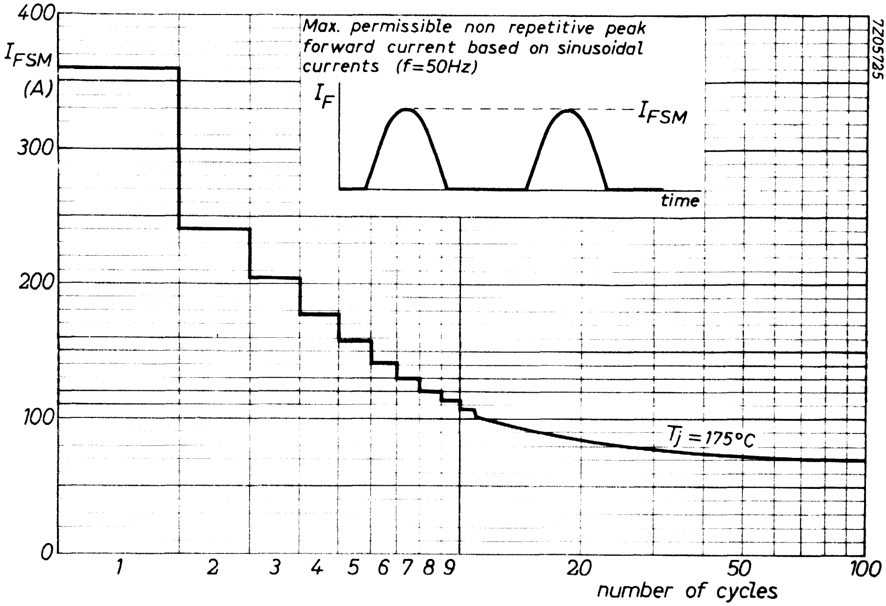
The applicable heatsink(s) may then be found in the Section HEATSINKS.


7Z05733.2
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 ambient temperature
60
40
20
0
6 phase
3 phase
single-phase
d.c.
B
A
$R_{th\ mb-a}$ = 0.5°C/W
1°C/W
2°C/W
3°C/W
4°C/W
6°C/W
8°C/W
10°C/W
0
10
I_{FAV}(A)
20
0
100
T_{amb}(°C)
200


7Z05721.1
P_{RRM} (kW)
10
2
1
0.5
0.2
0.1
Max. allowable repetitive peak reverse power dissipation versus duration (f=50Hz)
P_R
P_{RRM}
time
pulse duration
T_j=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
0.01
0.02
0.05
0.1
0.2
0.5
1
duration (ms)
10


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)
0.01
0.1
1
10
100
10
5
2
1
0.5
0.2
0.1
7205723 - 2.25.24.be


I_F (A)
300
200
100
0
typ
$T_j = 25°C$
175°C
V_F (V)
0
1
2
3
4
5
7205726 - 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
$T_j = 175°C$
1
2
3
4
5
6
7
8
9
20
50
100
number of cycles
7Z05725


800
$I_{FS(RMS)}$
(A)
600
400
200
0
Max. allowable non repetitive r.m.s. forward current (sub cycle surge curve)
$T_j = 175°C$
0
2
4
6
8
10
12
duration (ms)
7Z05724.1

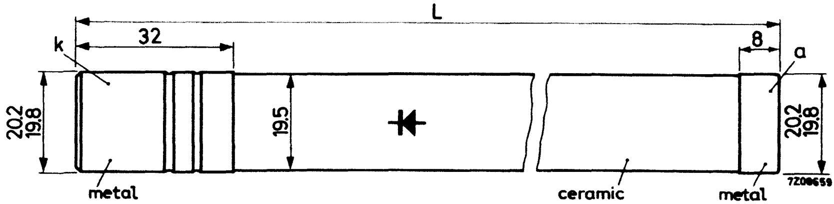
CONTROLLED AVALANCHE HIGH VOLTAGE DIODES

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	^oC
Thermal resistance from junction to cooling oil	$R_{th\ j-o}$	=	3.2	2.7	1.6	1.6	$^oC/W$

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

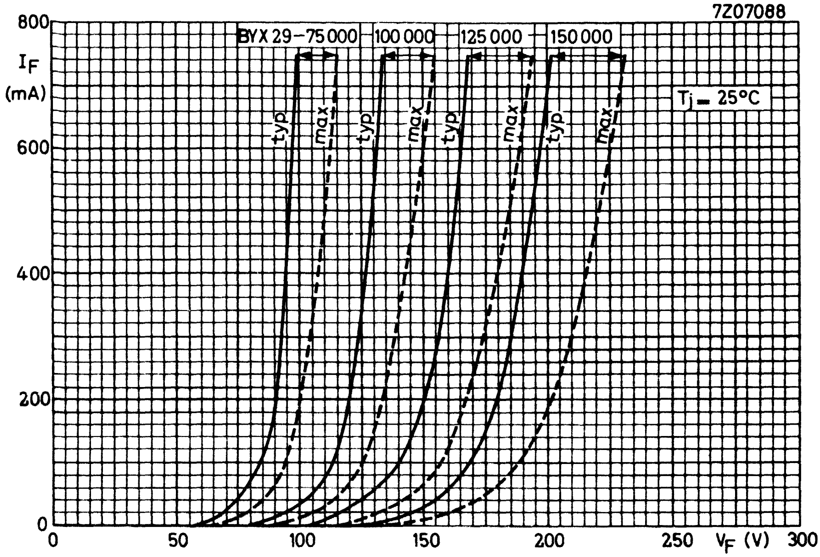
$t < 10$ µs; T_j = 25 °C	I_{RSM}	max.	500	mA
T_j = 125 °C	I_{RSM}	max.	400	mA

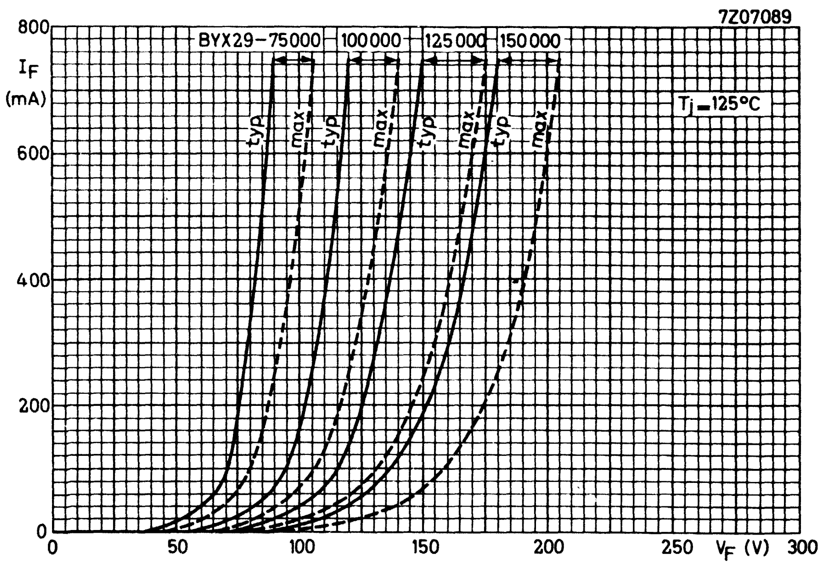
Temperatures

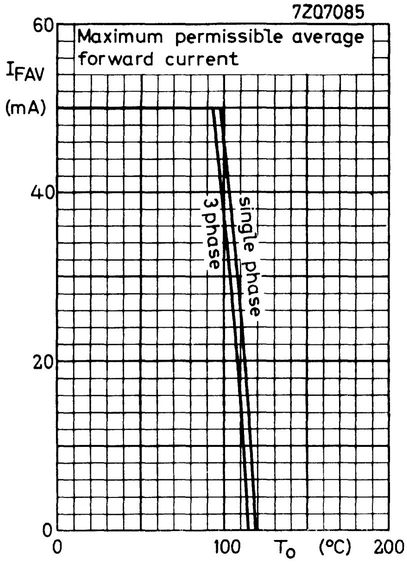
Storage temperature	T_{stg}		−30 to +125	°C
Junction temperature	T_j	max.	125	°C

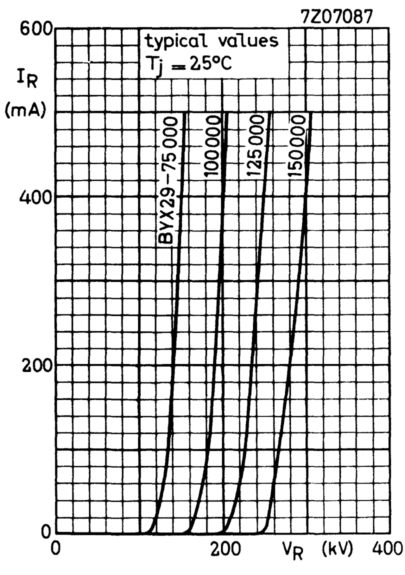
THERMAL RESISTANCE		BYX29-75000	100000	125000	150000	
From junction to cooling oil	$R_{th\ j\text{-}o}$ =	3.2	2.7	1.6	1.6	°C/W
CHARACTERISTICS						
Voltages at T_j = 25 °C						
Forward voltage at I_F = 50 mA	V_F	< 88	116	145	175	V
Reverse breakdown voltage						
I_R = 1 mA	$V_{(BR)R}$	> 100	135	165	200	kV
Currents at T_j = 125 °C						
Reverse current at $V_R = V_{RWMmax}$	I_R	< 33	33	33	33	µA

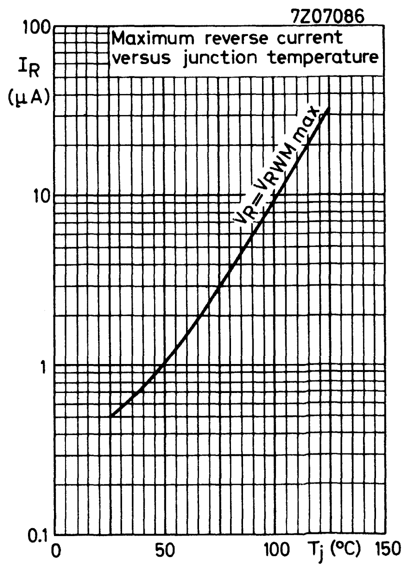
[1]) Limiting values according to the Absolute Maximum System as defined in IEC publication 134.


7Z07088
800
I_F
(mA)
600
400
200
0
0
50
100
150
200
250
V_F (V)
300
BYX 29−75 000
100 000
125 000
150 000
typ
max
T_j = 25°C


7Z07089
800
I_F
(mA)
600
400
200
0
0
50
100
150
200
250
V_F (V)
300
BYX29−75000
100000
125000
150000
typ
max
T_j = 125°C


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

FAST RECOVERY RECTIFIER DIODES WITH CONTROLLED AVALANCHE

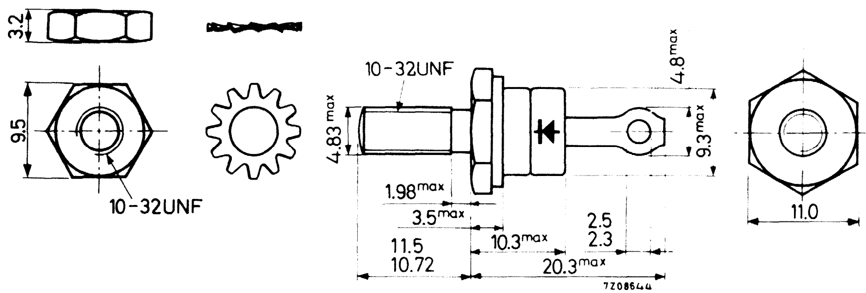
Diffused silicon diodes in a DO-4 metal envelope, capable of absorbing transients. They are primarily intended for use in high frequency power supplies, thyristor inverters and multi-phase power rectifier applications.
The series consists of the following types:
Normal polarity (cathode to stud): BYX30-200 to BYX30-600.
Reverse polarity (anode to stud) : 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
Reverse avalanche breakdown voltage	$V_{(BR)R}$ >	250	375	500	625	750	V

Average forward current at T_{mb} = 100 °C	$I_{F(AV)}$	max.	14	A
T_{mb} = 125 °C	$I_{F(AV)}$	max.	7.5	A
Non-repetitive peak forward current t = 10 ms; T_j = 150 °C prior to surge	I_{FSM}	max.	250	A
Junction temperature	T_j	max.	150	°C
Reverse recovery time when switched from I_F = 2 A to V_R = 30 V −dI/dt = 100 A/μs	t_{rr}	<	0.35	μs

MECHANICAL DATA Dimensions in mm



The mark shown applies to normal polarity types
Net weight: 7.6 g
Diameter of clearance hole: max. 5.2 mm
Accessories supplied on request: 56295, (56262A)

Torque on nut: min. 8 kg cm (0.8 Newton-metres)
max. 17 kg cm (1.7 Newton-metres)

All information applies to frequencies up to 50 kHz

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

Voltages [1]		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) up to T_{mb} = 100 °C	$I_{F(AV)}$	max.	14	A
at T_{mb} = 125 °C	$I_{F(AV)}$	max.	7.5	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; half sine wave) T_j = 150 °C prior to surge	I_{FSM}	max.	250	A
Repetitive peak reverse current (during turn-off)	I_{RRM}	max.	20	A

Reverse power dissipation

Repetitive peak reverse power dissipation t = 10 µs (square wave; f = 50 Hz) T_j = 150 °C	P_{RRM}	max.	5.5	kW
Non-repetitive peak reverse power dissipation t = 10 µs (square wave) T_j = 25 °C prior to surge	P_{RSM}	max.	18	kW
T_j = 150 °C prior to surge	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	$R_{th\ j\text{-}a}$	=	50	°C/W
From junction to mounting base	$R_{th\ j\text{-}mb}$	=	1.3	°C/W
From mounting base to heatsink	$R_{th\ mb\text{-}h}$	=	0.5	°C/W

[1]) To ensure thermal stability: $R_{th\ j\text{-}a}$ < 2.5 °C/W (continuous reverse voltage) or < 5 °C/W (a.c.).
For smaller heatsinks $T_{j\ max}$ should be derated. For a.c. see page 5.
For continuous reverse voltage: 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.

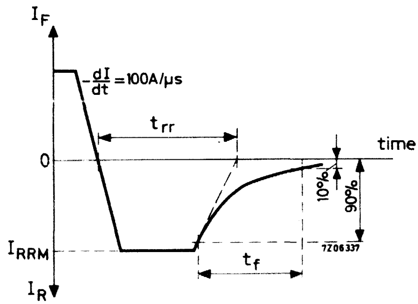
CHARACTERISTICS

			BYX30-200(R)	300(R)	400(R)	500(R)	600(R)	
Forward voltage I_F = 50 A; T_j = 25 °C	V_F	<	3.2	3.2	3.2	3.2	3.2	V [1]
Reverse breakdown voltage I_R = 5 mA; T_j = 25 °C	$V_{(BR)R}$	>	250	375	500	625	750	V
		<	1050	1050	1050	1050	1050	V
Peak reverse current $V_{RM}=V_{RWMmax}$; T_j=125 °C	I_{RM}	<	4.0	4.0	4.0	4.0	4.0	mA

Reverse recovery charge when switched from
I_F = 2 A to V_R = 30 V;
with $-dI/dt$ = 100 A/µs; T_j = 25 °C — Q_s < 0.70 µC

Reverse recovery time when switched from
I_F = 2 A to V_R = 30 V;
$-\frac{dI}{dt}$ = 100 A/µs; T_j = 150 °C — t_{rr} < 0.35 µs

Fall time under all conditions — t_f < 0.30 µs



OPERATING NOTES (See also general pages at the beginning of this section.)

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 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}	=	45	°C
switched from	I_F	=	12	A
to	V_R	=	400	V
at a rate	$-\frac{dI}{dt}$	=	20	A/µs

At a duty cycle $\delta = 0.5$ the average forward current $I_{FAV} = 6$ A.
From the upper graph on page 5 it follows, that at $I_{FAV} = 6$ A the average forward power + average leakage power = 15 W (point A).
The additional power losses due to switching-off can be read from the nomogram on page 10 (the example being based on optimum use, i.e. $T_j = 150$ °C). Starting from $I_F = 12$ A on the horizontal scale trace upwards until the appropriate line $-\frac{dI}{dt} = 20$ 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 $P_{RAV} = 4$ W.
Therefore the total power dissipation $P_{tot} = 15\ W + 4\ W = 19$ W (point B of the upper graph on page 5). From the right hand part follows the thermal resistance, required at $T_{amb} = 45$ °C.

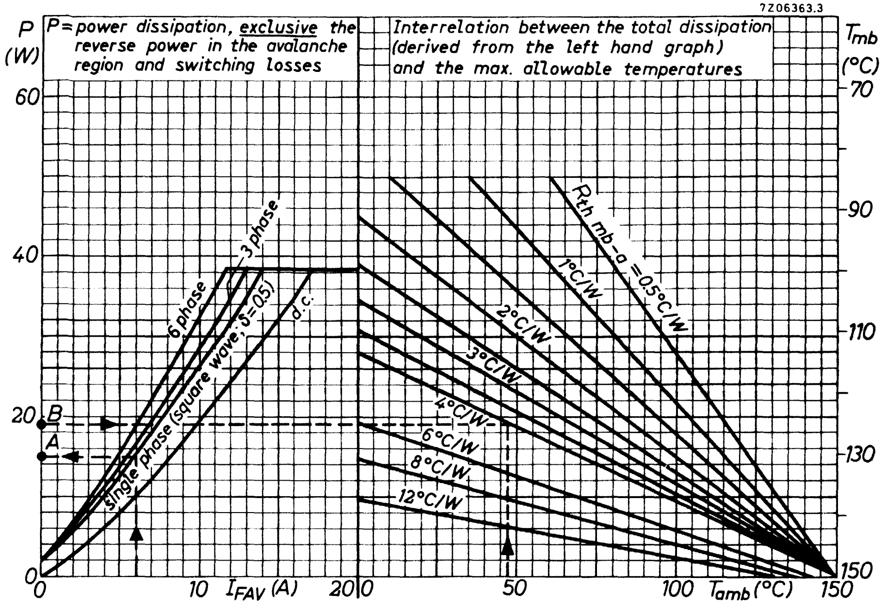
$$R_{th\ mb\text{-}a} \approx 4\ ^{o}C/W$$

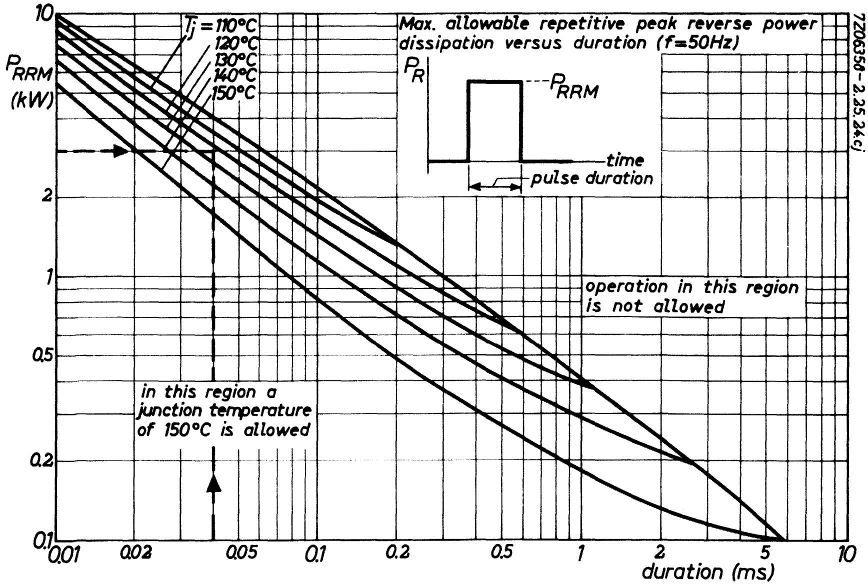
The contact thermal resistance $R_{th\ mb\text{-}h} = 0.5$ °C/W.

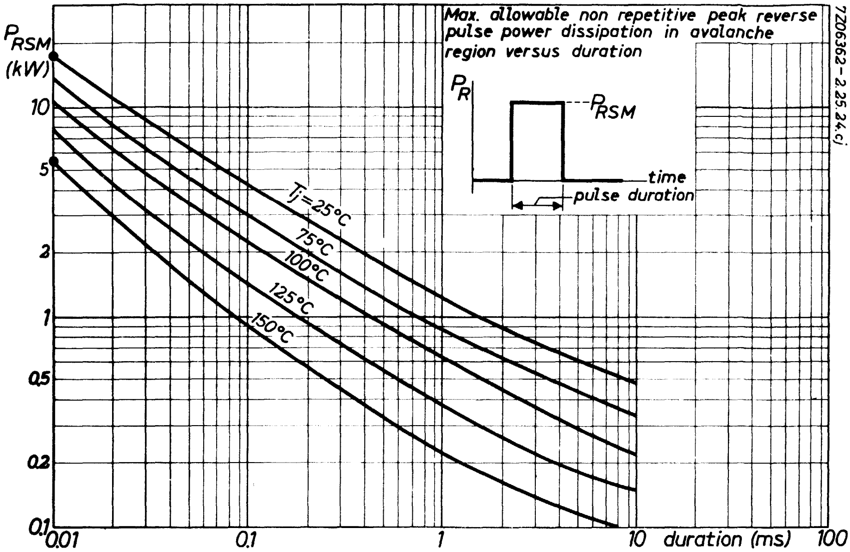
Hence the heatsink thermal resistance should be:

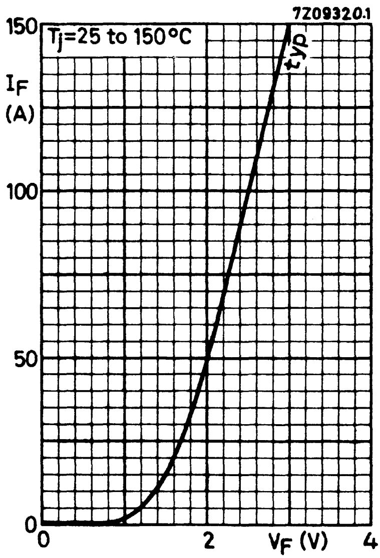
$$R_{th\ h\text{-}a} = R_{th\ mb\text{-}a} - R_{th\ mb\text{-}h} = (4 - 0.5)\ ^{o}C/W = 3.5\ ^{o}C/W.$$

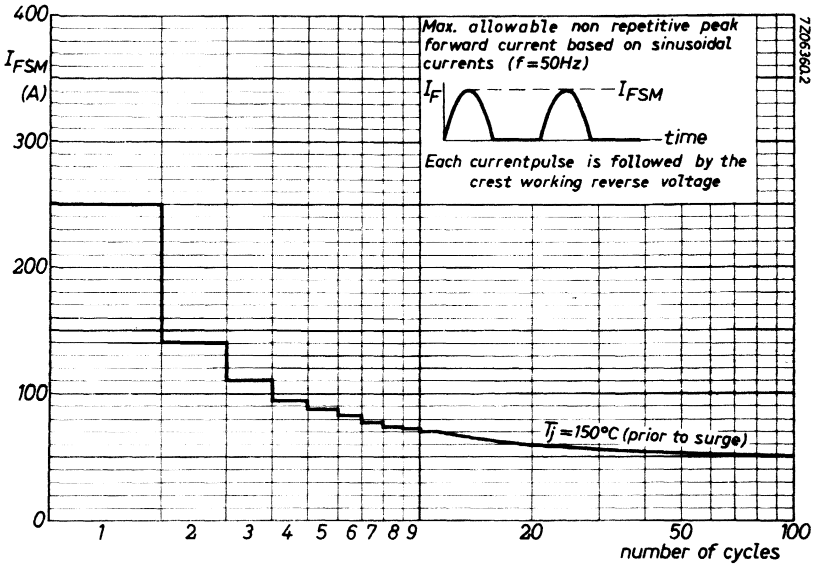
The applicable heatsink(s) may then be found in the Section HEATSINKS.

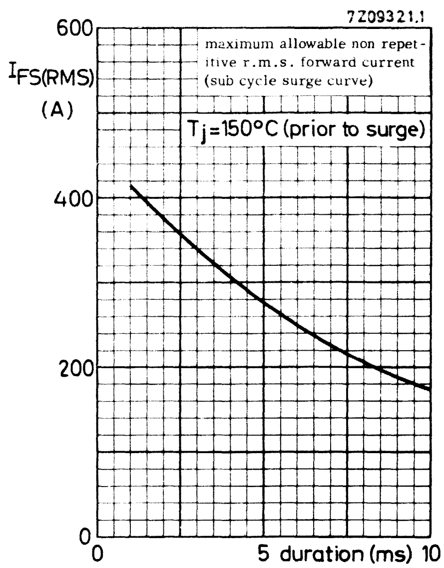

7Z06363.3
P (W)
P = power dissipation, exclusive the reverse power in the avalanche region and switching losses
Interrelation between the total dissipation (derived from the left hand graph) and the max. allowable temperatures
Tmb (°C)
6 phase
3 phase
single phase (square wave; δ = 0.5)
d.c.
B
A
Rth mb-a = 0.5°C/W
1°C/W
2°C/W
3°C/W
4°C/W
6°C/W
8°C/W
12°C/W
IFAV (A)
Tamb (°C)

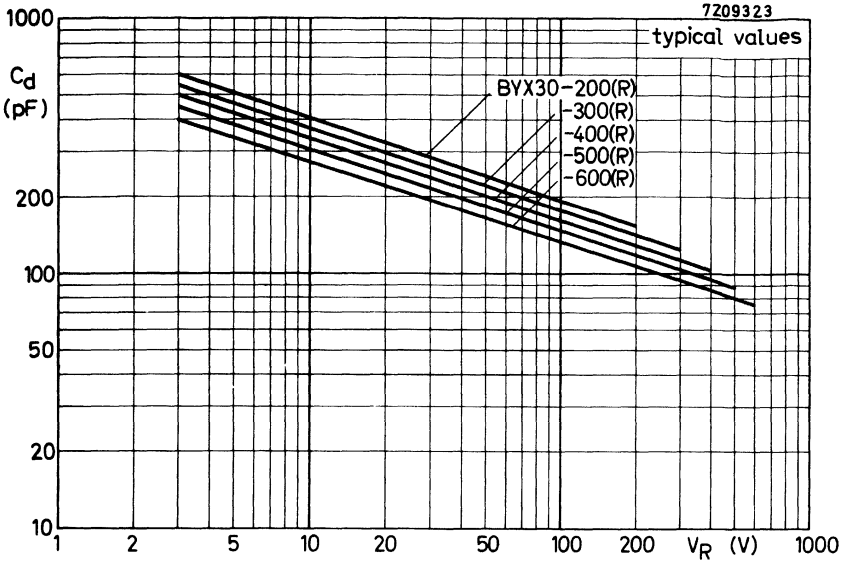

7Z06358-2.25.24.c)
PRRM (kW)
Tj = 110°C
120°C
130°C
140°C
150°C
Max. allowable repetitive peak reverse power dissipation versus duration (f = 50Hz)
PR
PRRM
time
pulse duration
operation in this region is not allowed
in this region a junction temperature of 150°C is allowed
duration (ms)

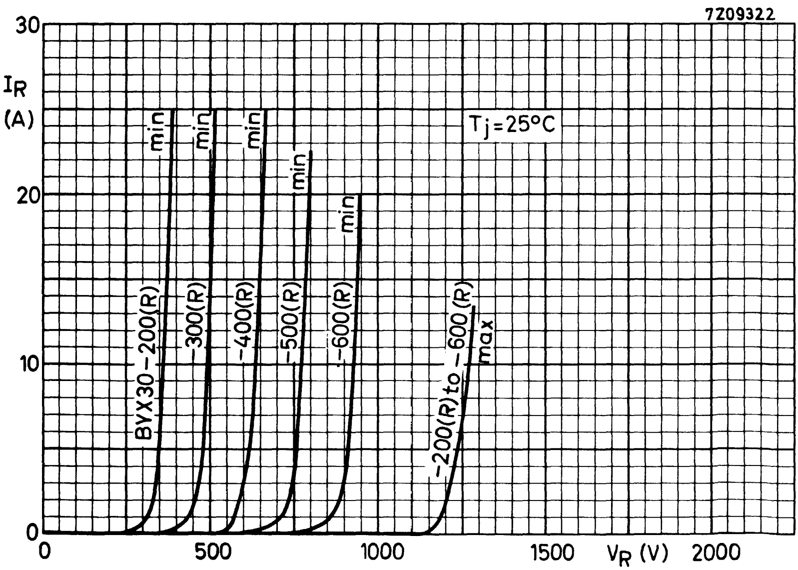

Max. allowable non repetitive peak reverse pulse power dissipation in avalanche region versus duration
7Z06362-2.25.24.c)
P_{RSM} (kW)
10
5
2
1
0.5
0.2
0.1
0.01
0.1
1
10
duration (ms)
100
T_j=25°C
75°C
100°C
125°C
150°C
P_R
P_{RSM}
time
pulse duration

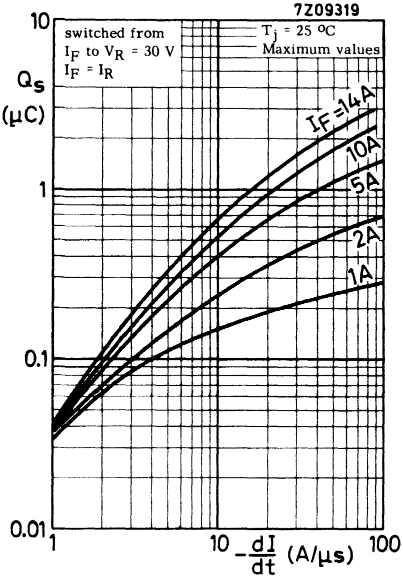

7Z09320.1
T_j=25 to 150°C
typ
I_F (A)
150
100
50
0
0
2
V_F (V)
4

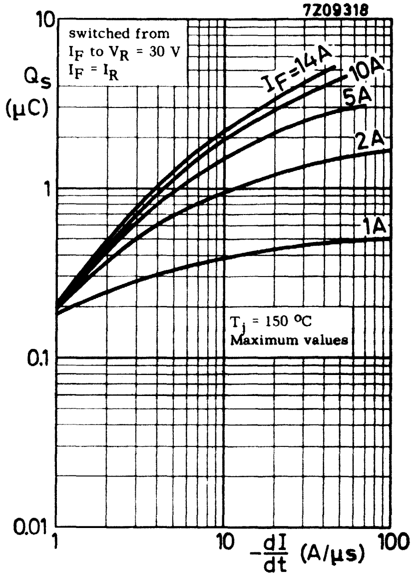

Max. allowable non repetitive peak forward current based on sinusoidal currents (f=50Hz)
I_F
I_{FSM}
time
Each currentpulse is followed by the crest working reverse voltage
I_{FSM} (A)
400
300
200
100
0
1 2 3 4 5 6 7 8 9 20 50 100
number of cycles
T_j =150°C (prior to surge)
7Z06360.2

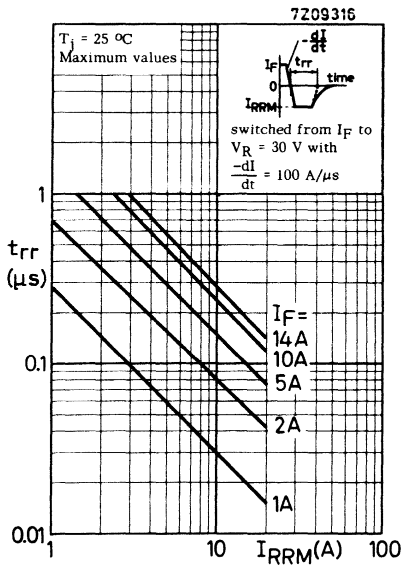

7Z09321.1
maximum allowable non repetitive r.m.s. forward current (sub cycle surge curve)
T_j=150°C (prior to surge)
$I_{FS(RMS)}$ (A)
600
400
200
0
0
5 duration (ms) 10

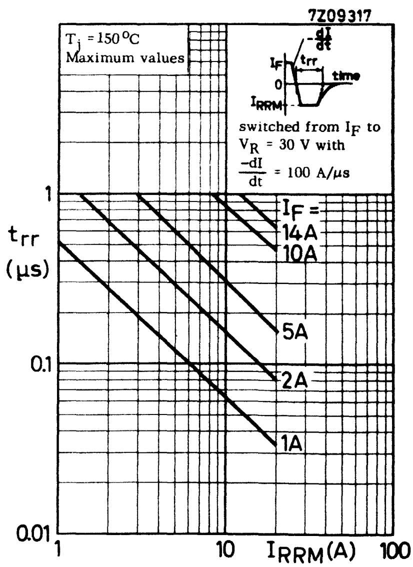

7Z09323
typical values
Cd
(pF)
BYX30-200(R)
-300(R)
-400(R)
-500(R)
-600(R)
1000
200
100
50
20
10
1
2
5
10
20
50
100
200
VR (V)
1000

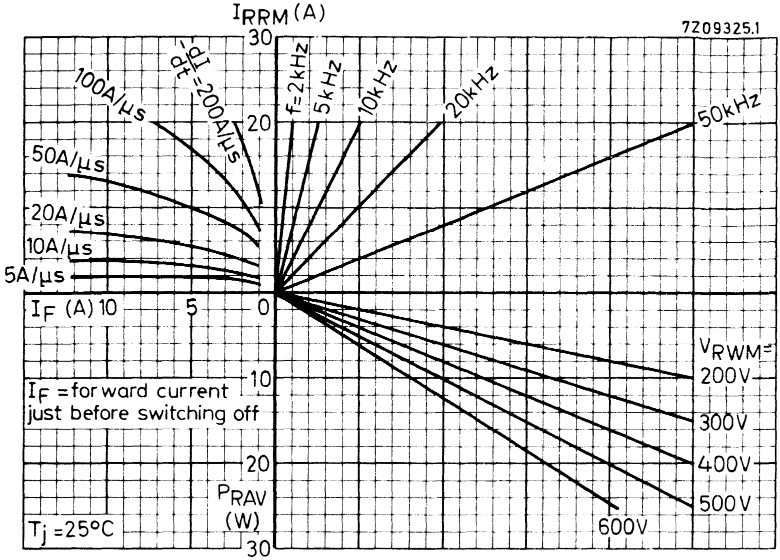

7Z09322
IR
(A)
Tj=25°C
min
BYX30-200(R)
-300(R)
-400(R)
-500(R)
-600(R)
-200(R) to -600(R)
max
30
20
10
0
0
500
1000
1500
VR (V)
2000

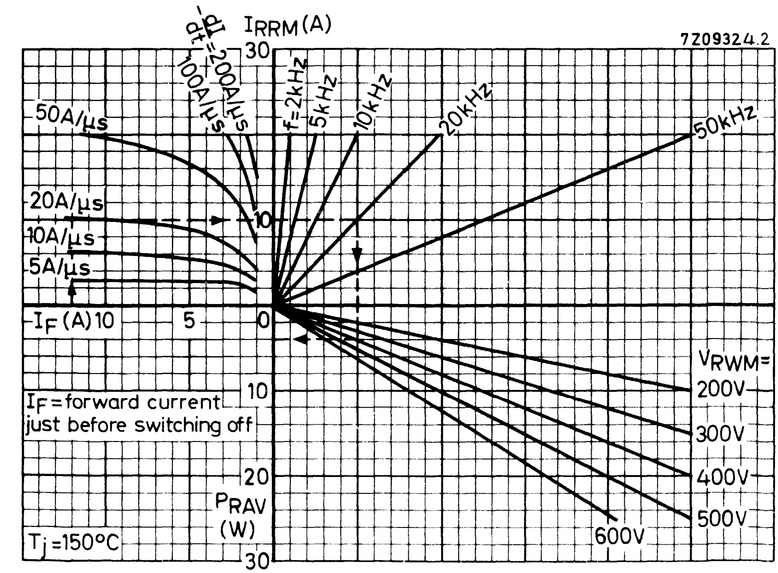

7Z09319
switched from
I_F to V_R = 30 V
I_F = I_R
T_j = 25 °C
Maximum values
Q_s
(μC)
I_F=14A
10A
5A
2A
1A
10
1
0.1
0.01
1
10
100
$-\frac{dI}{dt}$ (A/μs)


7Z09318
switched from
I_F to V_R = 30 V
I_F = I_R
T_j = 150 °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)


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 (cathode to stud): BYX32-400 to BYX32-1600
Reverse polarity (anode to stud): BYX32-400R to BYX32-1600R

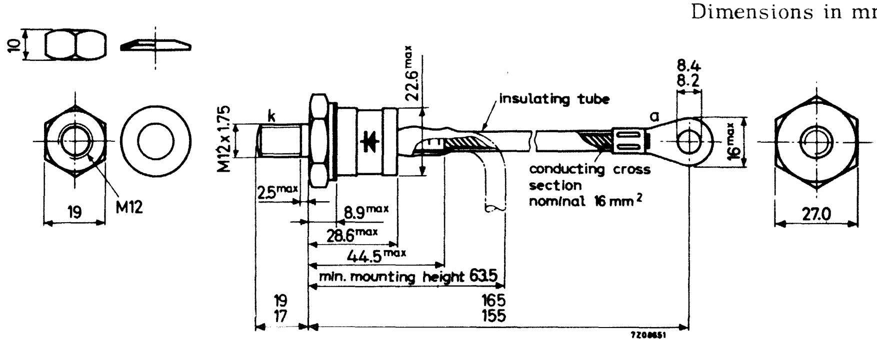
QUICK REFERENCE DATA

			BYX32-	400 400R	600 600R	800 800R	1000 1000R	1200 1200R	1600 1600R	
Crest working reverse voltage	V_{RWM}	max.		400	600	800	1000	1200	1200	V
Repetitive peak reverse voltage	V_{RRM}	max.		400	600	800	1000	1200	1600	V

Average forward current up to T_{mb} = 100 °C	$I_{F(AV)}$	max.	150	A
at T_{mb} = 125 °C	$I_{F(AV)}$	max.	115	A
Non-repetitive peak forward current t = 10 ms; T_j = 190 °C prior to surge	I_{FSM}	max.	1600	A
Operating junction temperature	T_j	max.	190	°C

MECHANICAL DATA

Dimensions in mm



Normal polarity (⊣◄⊢): blue cable. Reverse polarity (⊣►⊢): red cable.

Net weight : 115 g

Diameter of clearance hole: max. 13.0 mm

Torque on nut: min. 100 kg cm (10 Newton-metres)
max. 250 kg cm (25 Newton-metres)

All information applies to frequencies up to 400 Hz.

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

Voltages [1]		BYX32–	400 400R	600 600R	800 800R	1000 1000R	1200 1200R	1600 1600R	
Continuous reverse voltage	V_R	max.	400	600	800	1000	1200	1200	V
Crest working reverse voltage	V_{RWM}	max.	400	600	800	1000	1200	1200	V
Repetitive peak reverse voltage	V_{RRM}	max.	400	600	800	1000	1200	1600	V
Non-repetitive peak reverse voltage ($t \leq 10$ ms)	V_{RSM}	max.	450	650	900	1100	1300	1600	V

Currents

Average forward current (averaged over any 20 ms period) up to T_{mb} = 100 °C	$I_{F(AV)}$	max.	150 A
at T_{mb} = 125 °C	$I_{F(AV)}$	max.	115 A
Forward current (d.c.)	I_F	max.	240 A
R.M.S. forward current	$I_{F(RMS)}$	max.	240 A
Repetitive peak forward current	I_{FRM}	max.	750 A
Non-repetitive peak forward current (t = 10 ms; half sine wave) T_j = 190 °C prior to surge	I_{FSM}	max.	1600 A
I squared t for fusing (t = 10 ms)	I^2t	max.	12800 A^2s

Temperatures

Storage temperature	T_{stg}		-55 to +200 °C
Operating junction temperature	T_j	max.	190 °C

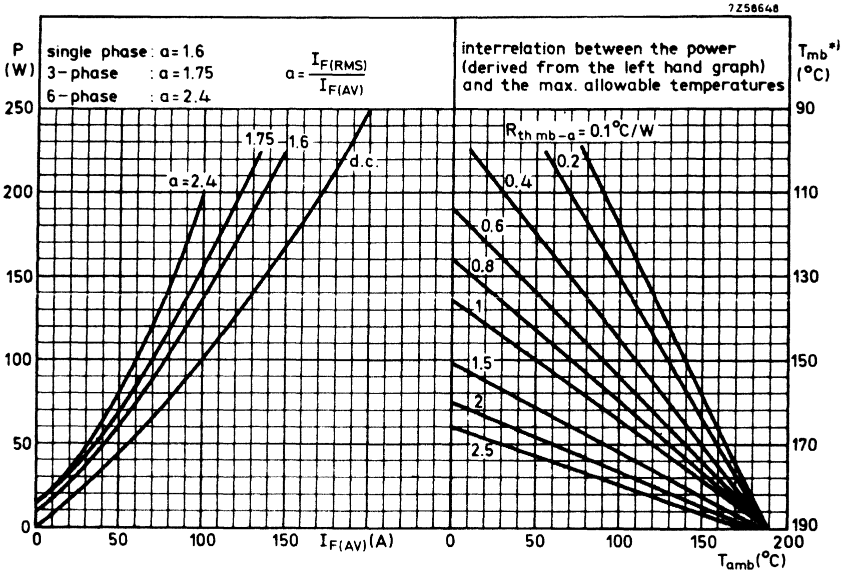
THERMAL RESISTANCE

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
Transient thermal impedance; t = 1 ms	$Z_{th\ j\text{-}mb}$	=	0.025 °C/W

[1]) To ensure thermal stability: $R_{th\ j\text{-}a} < 0.75$ °C/W (continuous reverse voltage) or < 1.5 °C/W (a.c.)
For smaller heatsinks T_j should be derated. For a.c. see graph on page 3.
For continuous reverse voltage: $R_{th\ j\text{-}a}$ = 1 °C/W, then T_{jmax} = 184 °C
$R_{th\ j\text{-}a}$ = 1.2 °C/W, then T_{jmax} = 180 °C
$R_{th\ j\text{-}a}$ = 1.5 °C/W, then T_{jmax} = 175 °C

CHARACTERISTICS

	BYX32 – 400(R)	600(R)	800(R)	1000(R)	1200(R)	1600(R)	
Forward voltage $I_F = 500\,A$; $T_j = 25\,^oC$ V_F <	1.6	1.6	1.6	1.6	1.6	1.6	V [1]
Peak reverse current $V_{RM} = V_{RWM\,max}$ $T_j = 175\,^oC$ I_{RM} <	30	24	18	15	12	12	mA

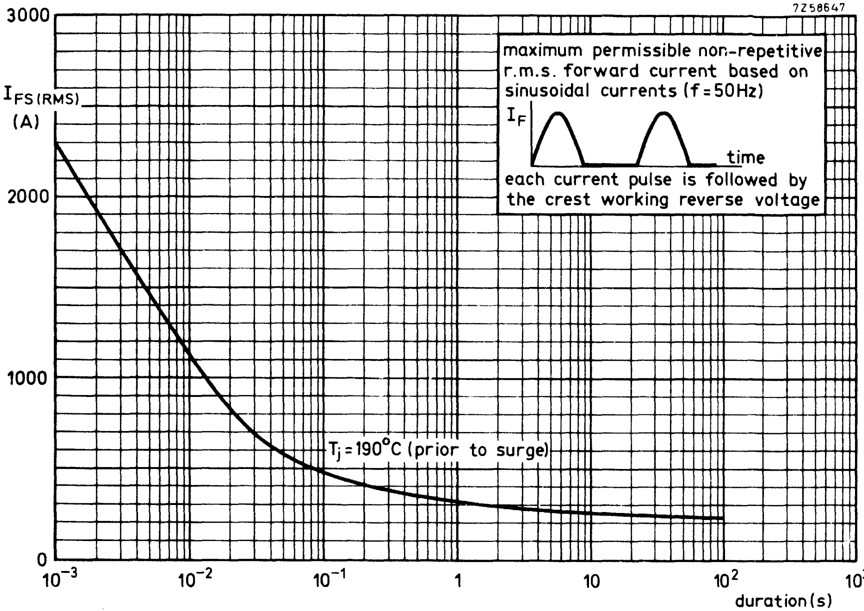


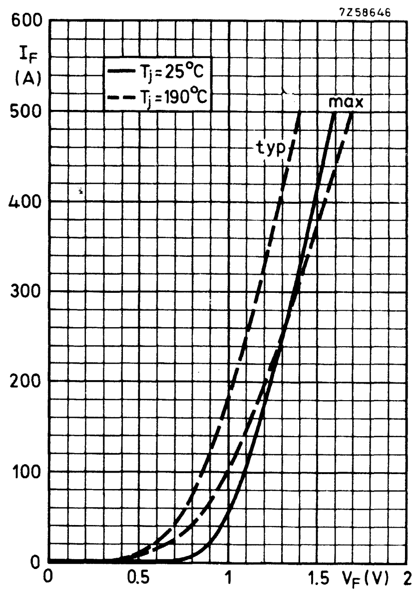
*) T_{mb}-scale is for comparison purposes only and is correct only for $R_{th\,mb-a} \leq 1.1\,^oC/W$

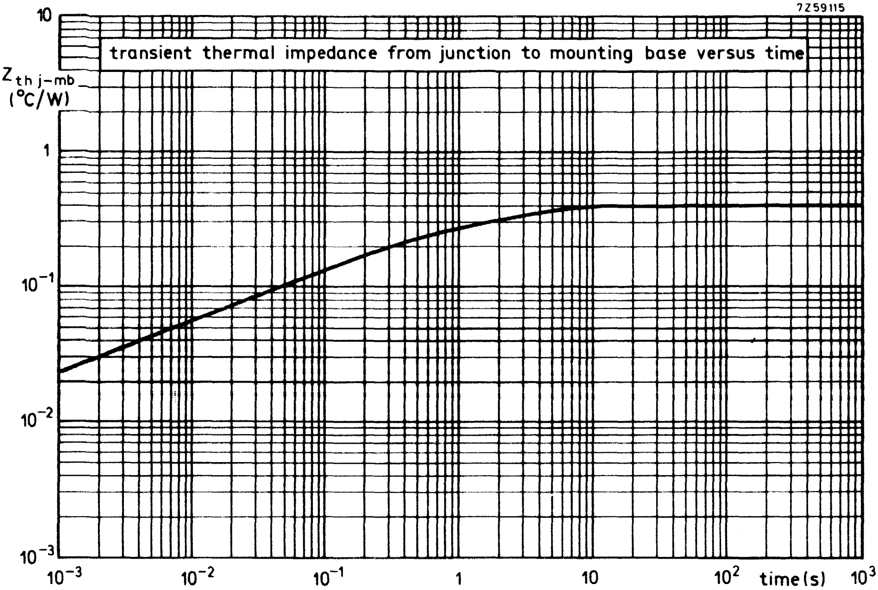
APPLICATION INFORMATION AND OPERATING NOTES

See general pages at the beginning of this section.

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


7Z58647
maximum permissible non-repetitive r.m.s. forward current based on sinusoidal currents (f = 50Hz)
I_F
time
each current pulse is followed by the crest working reverse voltage
$I_{FS(RMS)}$ (A)
3000
2000
1000
0
T_j = 190°C (prior to surge)
10^{-3}
10^{-2}
10^{-1}
1
10
10^2
10^3
duration (s)


7Z58646
I_F (A)
600
500
400
300
200
100
0
T_j = 25°C
T_j = 190°C
typ
max
0
0.5
1
1.5
V_F (V)
2

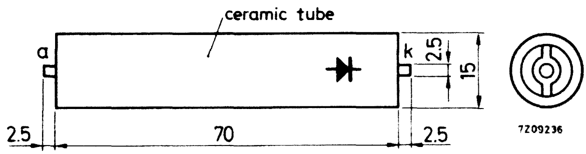

7Z59115
transient thermal impedance from junction to mounting base versus time
Z th j-mb (°C/W)
10
1
10^-1
10^-2
10^-3
10^-3
10^-2
10^-1
1
10
10^2
time (s)
10^3

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	$^{o}C/W$

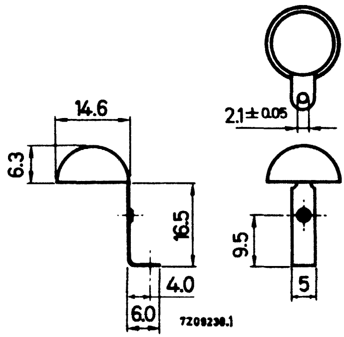
CHARACTERISTICS

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.



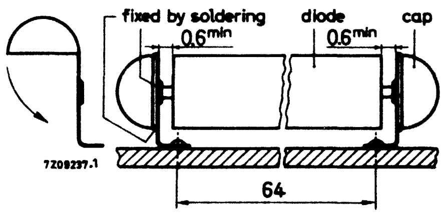
1. Mount clip on board.
2. Solder diode into fixing hole. Solder temperature: max. 300 °C; duration: max. 5 s.
3. Bend anti-corona cap down in direction of arrow and solder into position.

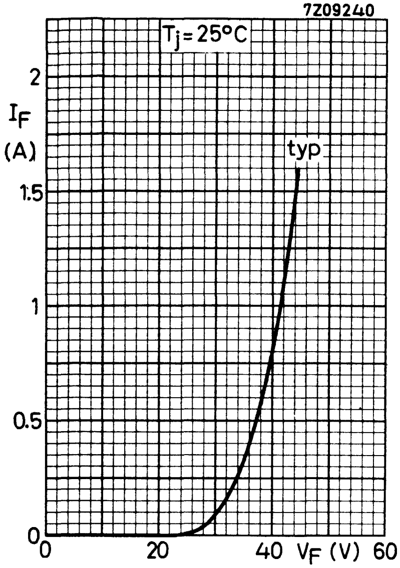
Notes:

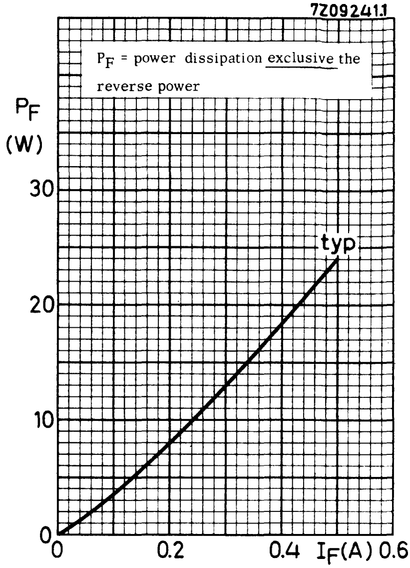
a. For good heat transfer and insulation, the devices must be immersed in oil.

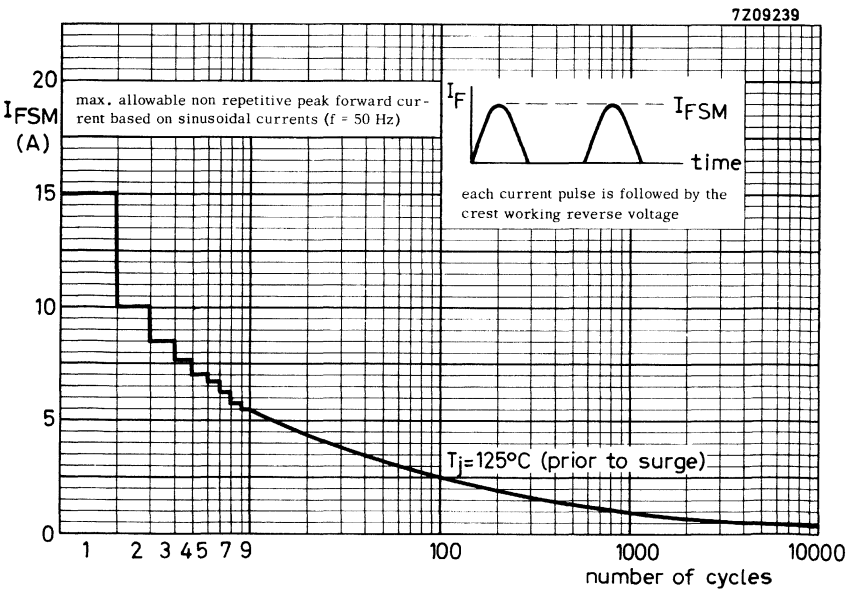
b. Any mounting position can be used.

c. Use acid free soldering flux.




7Z09240
$T_j = 25^oC$
I_F
(A)
typ
2
1.5
1
0.5
0
0
20
40
V_F (V)
60


7Z09241.1
P_F = power dissipation exclusive the reverse power
P_F
(W)
typ
30
20
10
0
0
0.2
0.4
I_F(A)
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)
20
15
10
5
0
1
2 3 4 5 7 9
100
1000
10000
number of cycles

SILICON RECTIFIER DIODES

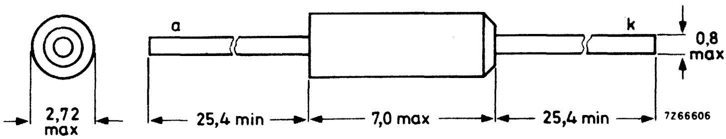
Diffused silicon rectifier diodes in a DO-15 plastic envelope for general purposes. The series consists of the following types: BYX36-150, BYX36-300, BYX36-600.

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	$I_{F(AV)}$	max.		0.8		A
Non-repetitive peak forward current t = 10 ms; T_j = 125 °C prior to surge	I_{FSM}	max.		30		A
Junction temperature	T_j	max.		125		°C

MECHANICAL DATA

Dimensions in mm

DO-15



The coned end indicates the cathode

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

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 ($\delta \leq 0.01$)	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 $T_{amb} = 40\ ^oC$	$I_{F(AV)}$	max.	0.8	A
Forward current (d.c.) up to $T_{amb} = 40\ ^oC$	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 $T_j = 125\ ^oC$ prior to surge	I_{FSM}	max.	30	A

Temperatures				
Storage temperature	T_{stg}		-55 to +125	^oC
Junction temperature	T_j	max.	125	^oC

CHARACTERISTICS

Forward voltage				
$I_F = 1$ A; $T_j = 25\ ^oC$	V_F	typ.	0.9	V[1]
		<	1.2	V[1]
$I_F = 5$ A; $T_j = 25\ ^oC$	V_F	typ.	1.1	V[1]

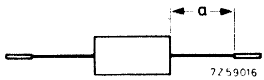
Peak reverse current				
$V_{RM} = V_{RWMmax}$; $T_j = 125\ ^oC$	I_{RM}	<	120	μA

[1]) Measured under pulsed conditions to avoid excessive dissipation

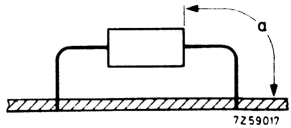
MOUNTING METHODS

The upper graph on page 4 applies when no other leads run to the tie-points. If leads of other dissipating components share the same tie-points, refer to the lower graph.

1. Mounted to solder tags at a lead-length a = 10 mm.
2. Mounted to solder tags at a = maximum lead-length.

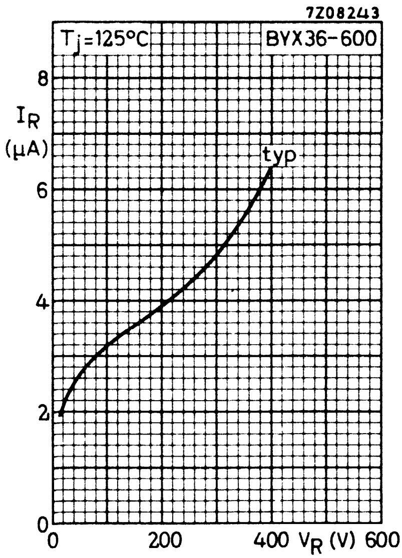


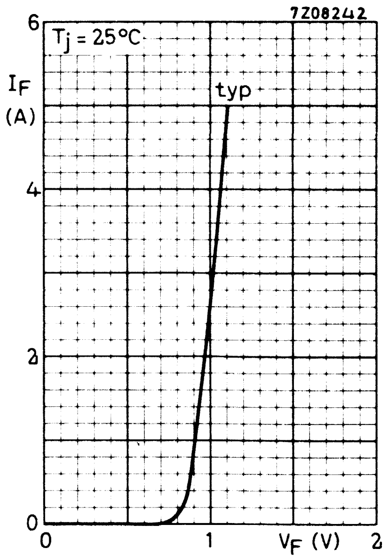
3. Mounted on printed-wiring board at a = maximum lead-length.
4. Mounted on printed-wiring board at a lead-length a = 10 mm.

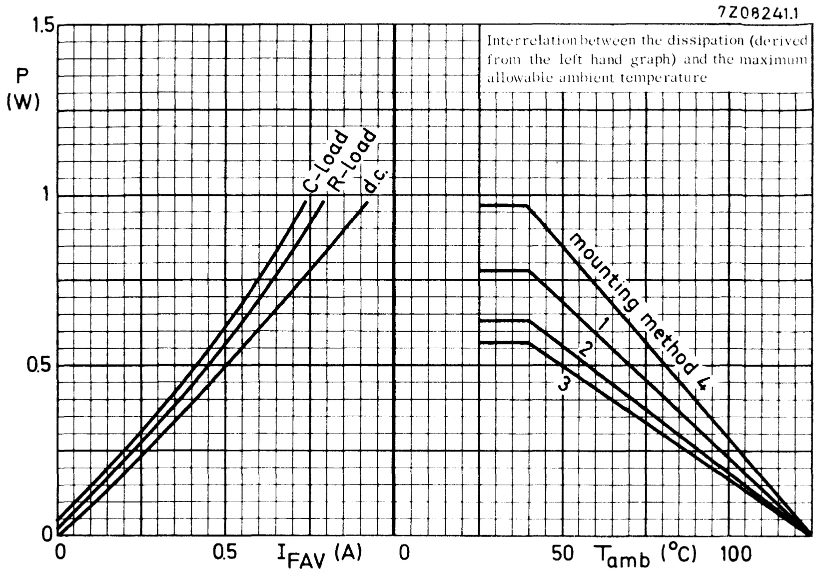


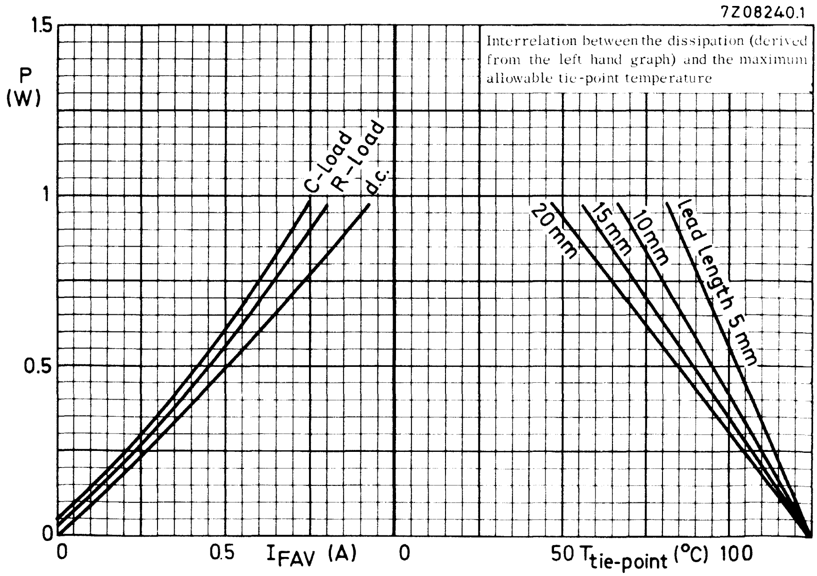
SOLDERING AND MOUNTING NOTES

1. Soldered joints must be at least 5 mm from the seal.
2. The maximum permissible temperature of the soldering iron or bath is 300 °C; it must be in contact with the joint for no more than 3 seconds.
3. Avoid hot spots due to handling or mounting; the body of the device must not come into contact with or be exposed to a temperature higher than 150 °C.






7Z08241.1
1.5
P
(W)
1
0.5
0
0
0.5
I_{FAV} (A)
0
50
T_{amb} (°C)
100
C-Load
R-Load
d.c.
Interrelation between the dissipation (derived from the left hand graph) and the maximum allowable ambient temperature
mounting method 4
1
2
3


7Z08240.1
1.5
P
(W)
1
0.5
0
0
0.5
I_{FAV} (A)
0
50
$T_{tie-point}$ (°C)
100
C-Load
R-Load
d.c.
Interrelation between the dissipation (derived from the left hand graph) and the maximum allowable tie-point temperature
20 mm
15 mm
10 mm
lead length 5 mm

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 (cathode to stud): BYX38-300 to 1200
Reverse polarity (anode to stud): BYX38-300R to 1200R

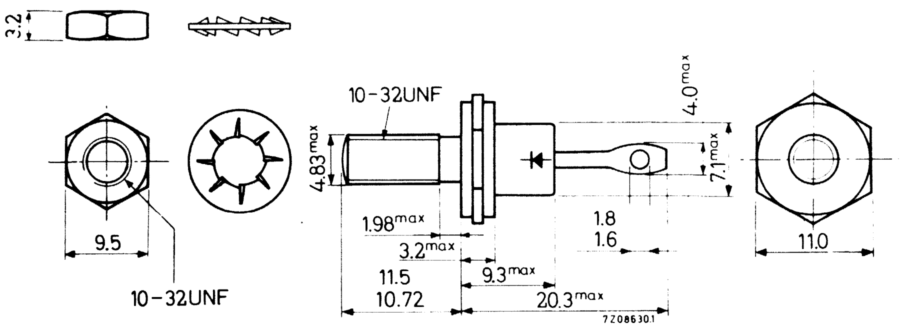
QUICK REFERENCE DATA

			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	$I_{F(AV)}$	max.	6	A
at T_{mb} = 125 °C	$I_{F(AV)}$	max.	2.5	A
Non-repetitive peak forward current				
t = 10 ms; T_j = 150 °C prior to surge	I_{FSM}	max.	38	A
Junction temperature	T_j	max.	150	°C

MECHANICAL DATA Dimensions in mm

DO-4



Net weight: 6.5 g
Diameter of clearance hole: max. 5.2 mm
Accessories supplied on request:
56295 (56262A)

Torque on nut: min. 8 kg cm
(0.8 Newton-metres)
max. 17 kg cm
(1.7 Newton-metres)
The mark shown applies to normal polarity types

All information applies to frequencies up to 400 Hz

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

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 ($\delta \leq 0.01$)	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) up to T_{mb} = 75 °C	$I_{F(AV)}$	max.	6.0	A
at T_{mb} = 125 °C	$I_{F(AV)}$	max.	2.5	A
Forward current (d.c.) up to T_{mb} = 90 °C	I_F	max.	6.0	A
at 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; half sine wave) T_j=150 °C prior to surge	I_{FSM}	max.	38	A
I^2t 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	$R_{th\ mb\text{-}h}$	=	0.5	°C/W

CHARACTERISTICS

Forward voltage

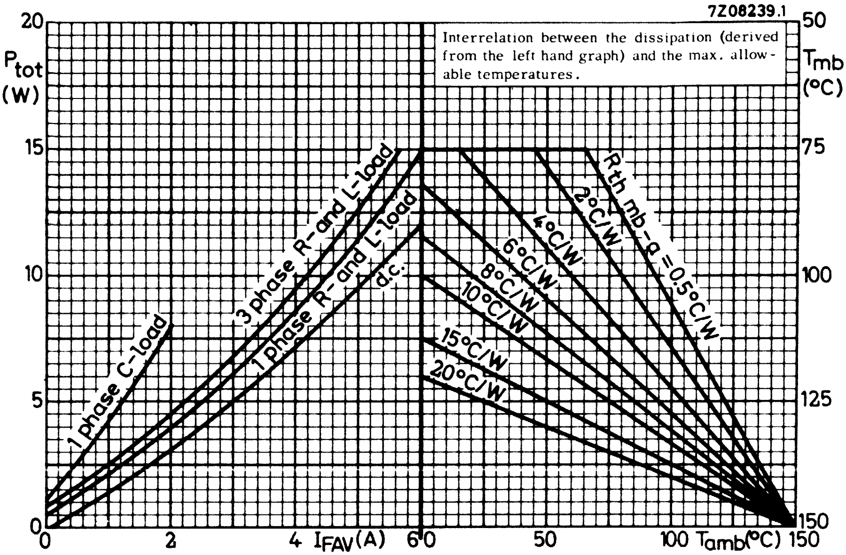
I_F = 5 A; T_j = 25 °C	V_F	<	1.7	V [1]
I_F = 15 A; T_j = 25 °C	V_F	<	2.1	V [1]

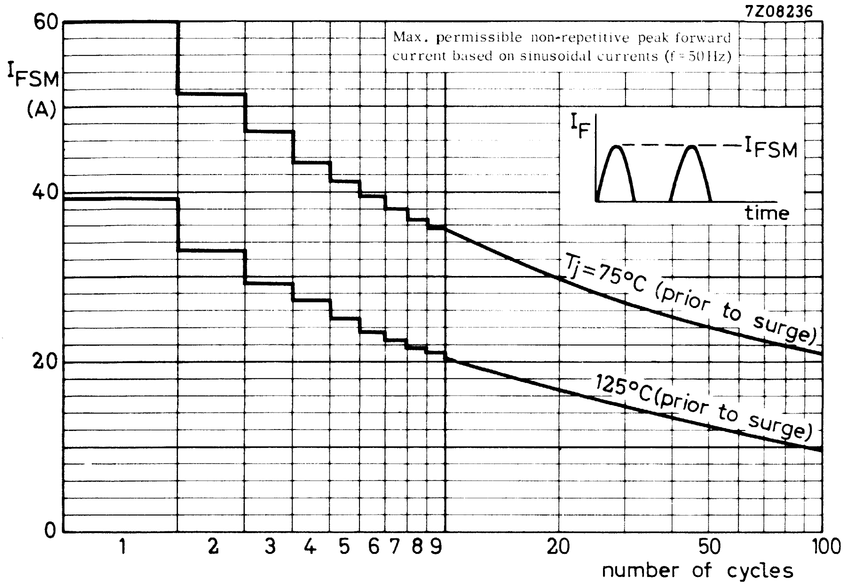
Peak reverse current	$V_R = V_{RWMmax}$; T_j = 25 °C	I_R	<	10	µA
	$V_R = V_{RWMmax}$; T_j = 125 °C	I_R	<	200	µA

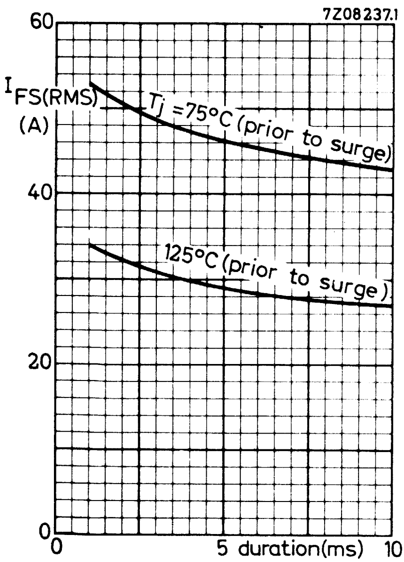
[1]) Measured under pulsed conditions to avoid excessive dissipation.

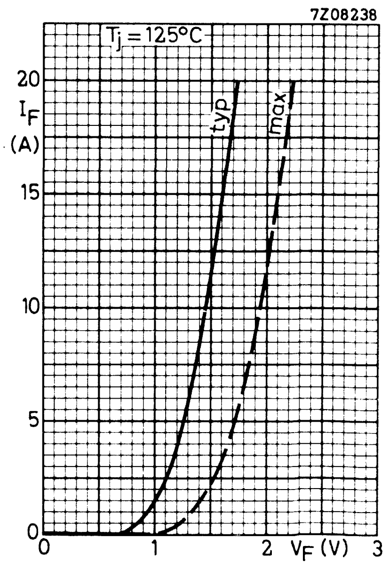
OPERATING NOTE (See also general pages at the beginning of this section)

The top connector should neither be bent nor twisted; it should be soldered into the circuit so that 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.



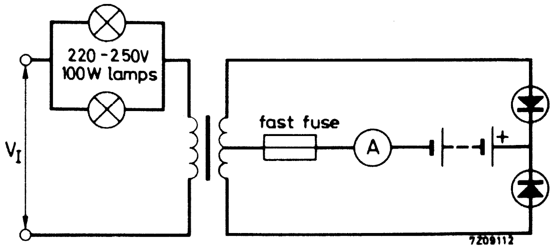

7Z08236
Max. permissible non-repetitive peak forward current based on sinusoidal currents (f = 50 Hz)
I_{FSM} (A)
60
40
20
0
I_F
I_{FSM}
time
T_j = 75°C (prior to surge)
125°C (prior to surge)
1
2
3
4
5
6
7
8
9
20
50
100
number of cycles


7Z08237.1
$I_{FS(RMS)}$ (A)
60
40
20
0
T_j = 75°C (prior to surge)
125°C (prior to surge)
0
5 duration (ms)
10


7Z08238
T_j = 125°C
I_F (A)
20
15
10
5
0
typ
max
0
1
2
V_F (V)
3

APPLICATION INFORMATION

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:

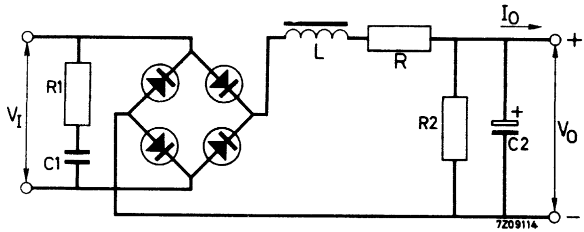
n (primary to half secondary)	0.094	
$V_{T(RMS)}$	150	V
$I_{primary(rms)}$	0.75	A
$I_{secondary(rms)}$	4.5	A
$I_{primary}$ (off-load saturation current with two 100 W lamps in parallel, connected in series with primary)	0.6	A

APPLICATION INFORMATION (continued)

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

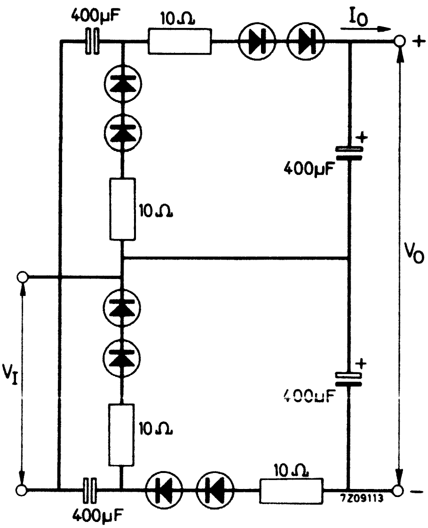
	BYX38-600(R)	900(R)	1200(R)	
R1	220	220	390	Ω [1]
C1	1.0	1.0	0.5	μF [1]
L	0.5 (R = 3)	1.0 (R = 5)	1.0 (R = 5)	H Ω
R2	200 (50)	300 (75)	400 (100)	Ω W
C2	500	250	250	μF

[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 aluminium cooling fin. Thickness 1.6 mm.

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 (cathode to stud): BYX39-600; BYX39-800; BYX39-1000
Reverse polarity (anode to stud): BYX39-600R; BYX39-800R; BYX39-1000R

QUICK REFERENCE DATA

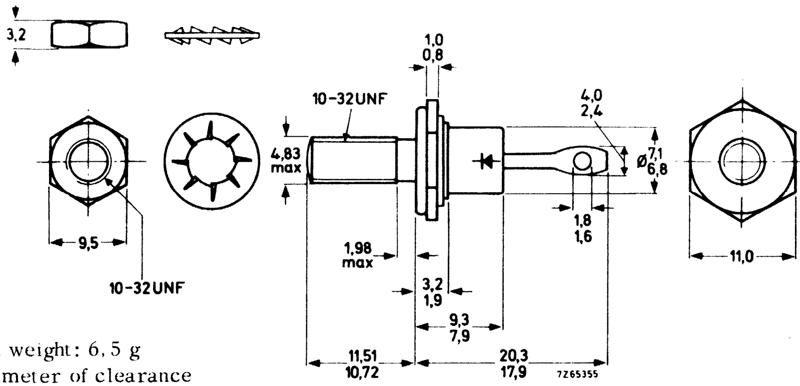
			BXY39-600(R)	800(R)	1000(R)	
Crest working reverse voltage	V_{RWM}	max.	600	800	1000	V
Reverse avalanche breakdown voltage	$V_{(BR)R}$	>	750	1000	1250	V

Average forward current up to T_{mb} = 85 °C	$I_{F(AV)}$	max.	9,5	A
at T_{mb} = 125 °C	$I_{F(AV)}$	max.	6,0	A
Non-repetitive peak forward current t = 10 ms; T_j = 150 °C prior to surge	I_{FSM}	max.	100	A
Non-repetitive peak reverse power dissipation (t = 10 μs; T_j = 25 °C)	P_{RSM}	max.	4	kW
Junction temperature	T_j	max.	175	°C

MECHANICAL DATA

Dimensions in mm

DO-4



Net weight: 6,5 g
Diameter of clearance hole: max. 5,2 mm
Accessories available: 56295; (56262A)
The mark shown applies to normal polarity types.

Torque on nut: min. 0,8 Nm (8 kgcm)
max. 1,7 Nm (17 kgcm)

All information applies to frequencies up to 400 Hz

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

Voltages[1]			BYX39-600(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) up to T_{mb} = 85 °C	$I_{F(AV)}$	max.	9,5	A
at T_{mb} = 125 °C	$I_{F(AV)}$	max.	6,0	A
Forward current (d.c.)	I_F	max.	6,8	A
→ R.M.S. forward current	$I_{F(RMS)}$	max.	15	A
→ Repetitive peak forward current	I_{FRM}	max.	100	A
Non-repetitive peak forward current (t = 10 ms; half sine wave) T_j = 150 °C prior to surge	I_{FSM}	max.	100	A
T_j = 175 °C prior to surge	I_{FSM}	max.	85	A
I^2t for fusing (t = 10 ms)	I^2t	max.	50	A^2s

Reverse power dissipation

Average reverse power dissipation (averaged over any 20 ms period) T_j = 125 °C	$P_{R(AV)}$	max.	10	W
Repetitive peak reverse power dissipation t = 10 μs (square wave; f = 50 Hz) T_j = 125 °C	P_{RRM}	max.	2	kW
Non-repetitive peak reverse power dissipation t = 10 μs (square wave) T_j = 25 °C prior to surge	P_{RSM}	max.	4	kW
T_j = 175 °C prior to surge	P_{RSM}	max.	0,8	kW

Temperatures

Storage temperature	T_{stg}		-55 to +175	°C
Junction temperature	T_j	max.	175	°C

→ 1) To ensure thermal stability: $R_{th\ j\text{-}a} \leq 10$ °C/W (continuous reverse voltage) or ≤ 20 °C/W (a.c.).
For smaller heatsinks $T_{j\,max}$ should be derated.
For continuous reverse voltage: if $R_{th\ j\text{-}a}$ = 15 °C/W, then $T_{j\,max}$ = 140 °C
if $R_{th\ j\text{-}a}$ = 20 °C/W, then $T_{j\,max}$ = 135 °C

THERMAL RESISTANCE

From junction to ambient in free air	$R_{th\ j\text{-}a}$	=	50	°C/W
From junction to mounting base	$R_{th\ j\text{-}mb}$	=	4,5	°C/W
From mounting base to heatsink				
without heatsink compound	$R_{th\ mb\text{-}h}$	=	1,0	°C/W
with heatsink compound	$R_{th\ mb\text{-}h}$	=	0,5	°C/W
with mica washer	$R_{th\ mb\text{-}h}$	=	2,0	°C/W
Transient thermal impedance; t = 1 ms	$Z_{th\ j\text{-}mb}$	=	0,35	°C/W

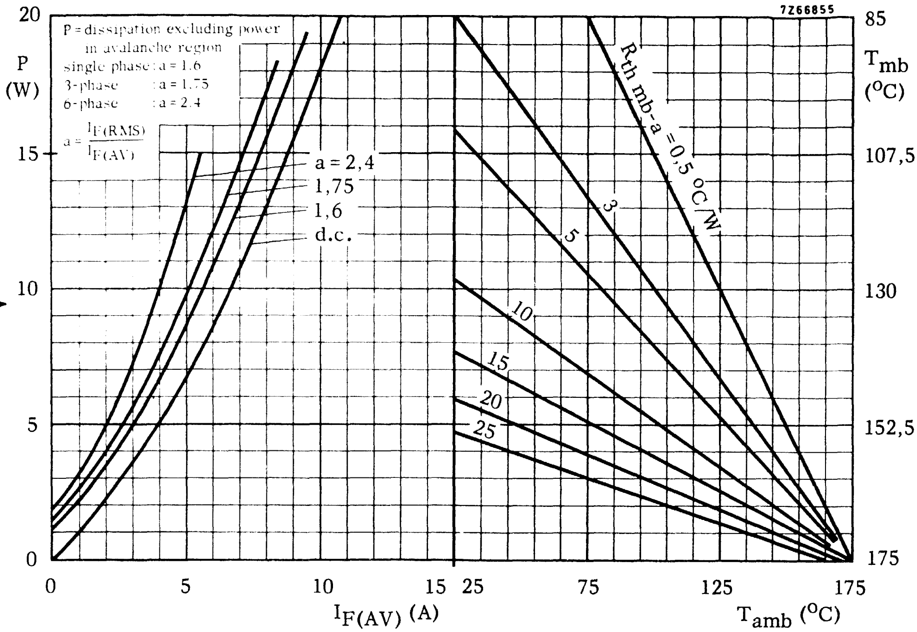
CHARACTERISTICS

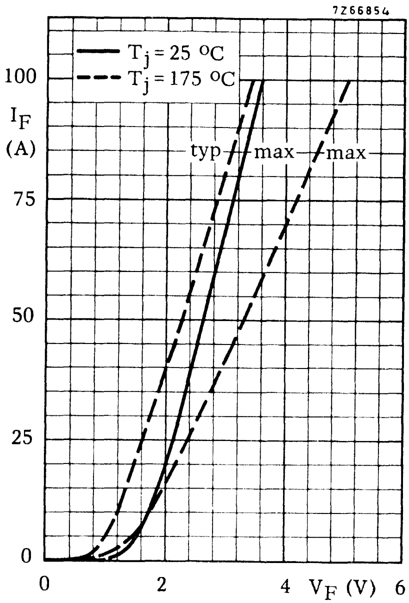
			BYX39-600(R)	800(R)	1000(R)	
Forward voltage						
I_F = 20 A; T_j = 25 °C	V_F	<	2,0	2,0	2,0	V [1]
Reverse avalanche breakdown voltage						
I_R = 5 mA; T_j = 25 °C	$V_{(BR)R}$	>	750	1000	1250	V
		<	2000	2000	2000	V
Peak reverse current						
$V_{RM} = V_{RWMmax}$; T_j = 125 °C	I_{RM}	<	150	150	150	µA

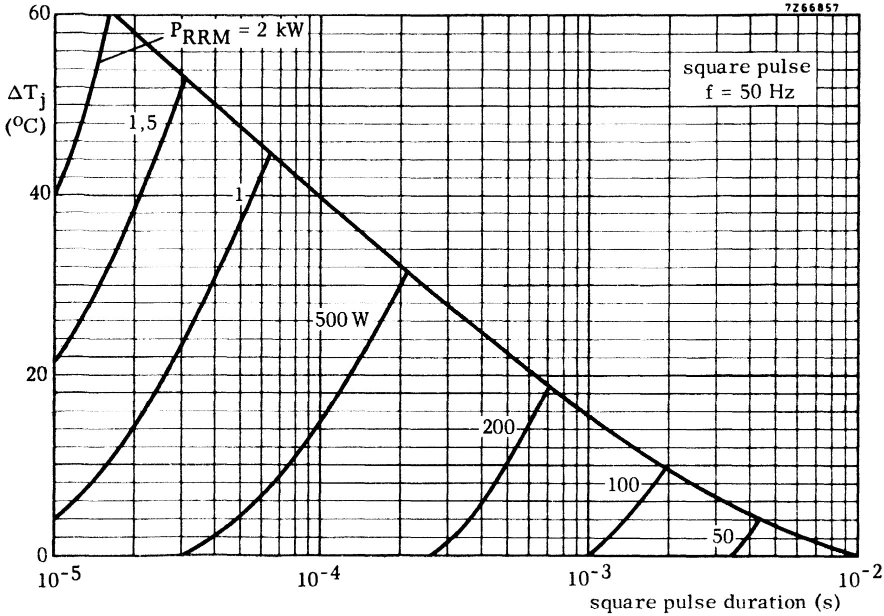
OPERATING NOTES (See also general pages at the beginning of this section)

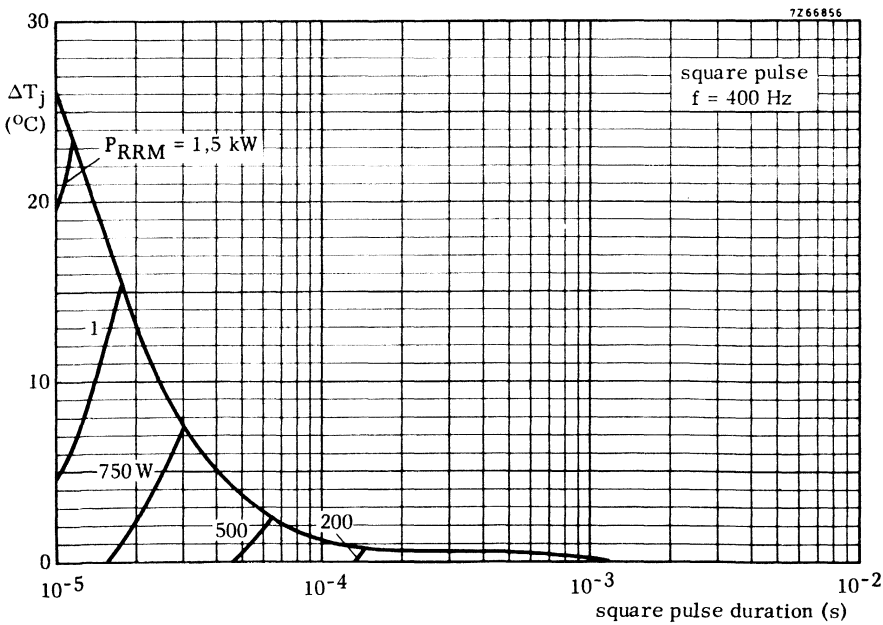
The top connector should neither be bent nor twisted; it should be soldered into the circuit so that there is no strain on it.
During soldering the heat conduction to the junction should be kept to a minimum.

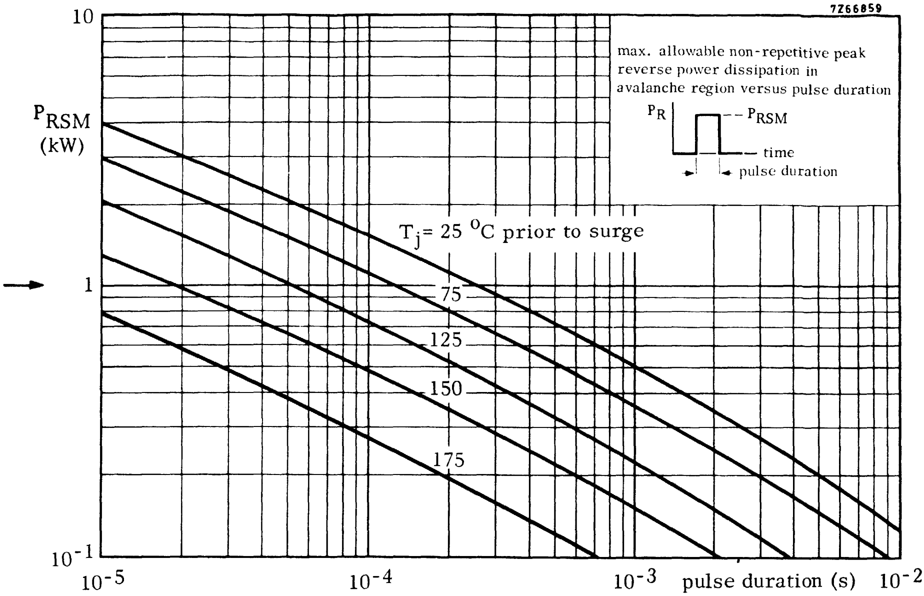
1) Measured under pulse conditions to avoid excessive dissipation.

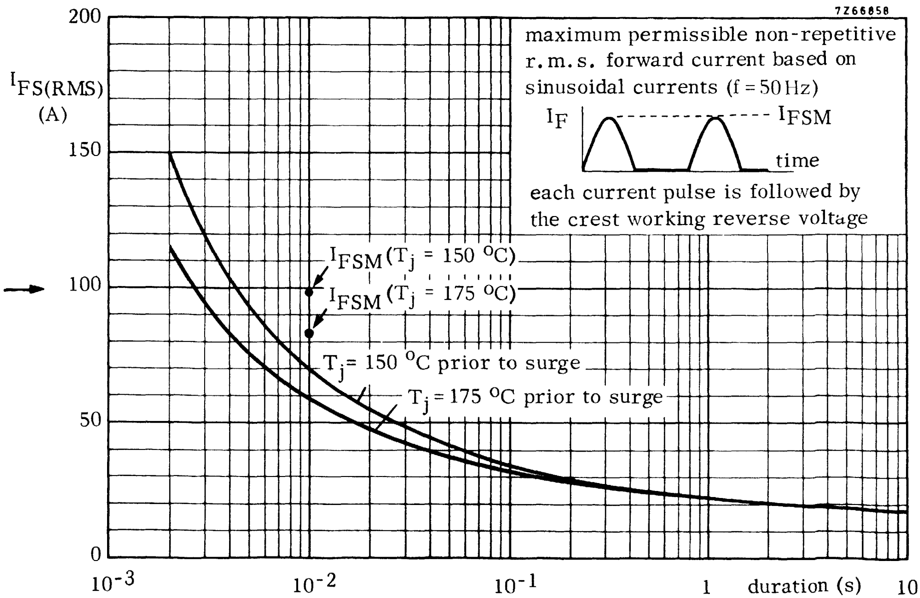

7Z66855
P = dissipation excluding power in avalanche region
single phase : a = 1.6
3-phase : a = 1.75
6-phase : a = 2.4
a = I F(RMS) / I F(AV)
a = 2,4
1,75
1,6
d.c.
P (W)
20
15
10
5
0
0
5
10
15
I F(AV) (A)
25
75
125
175
T amb (°C)
R th mb-a = 0,5 °C/W
3
5
10
15
20
25
T mb (°C)
85
107,5
130
152,5
175


7Z66854
T j = 25 °C
T j = 175 °C
I F (A)
100
75
50
25
0
typ
max
max
0
2
4
V F (V)
6


7Z66857
60
40
20
0
ΔTj
(°C)
PRRM = 2 kW
1,5
1
500 W
200
100
50
square pulse
f = 50 Hz
10-5
10-4
10-3
10-2
square pulse duration (s)


7Z66856
30
20
10
0
ΔTj
(°C)
PRRM = 1,5 kW
1
750 W
500
200
square pulse
f = 400 Hz
10-5
10-4
10-3
10-2
square pulse duration (s)


7Z66859
max. allowable non-repetitive peak reverse power dissipation in avalanche region versus pulse duration
P_R
P_RSM
time
pulse duration
P_RSM (kW)
10
1
10^-1
T_j = 25 °C prior to surge
75
125
150
175
10^-5
10^-4
10^-3
pulse duration (s)
10^-2


7Z66858
maximum permissible non-repetitive r.m.s. 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
I_FS(RMS) (A)
200
150
100
50
0
I_FSM (T_j = 150 °C)
I_FSM (T_j = 175 °C)
T_j = 150 °C prior to surge
T_j = 175 °C prior to surge
10^-3
10^-2
10^-1
1
duration (s)
10

CONTROLLED AVALANCHE RECTIFIER DIODES

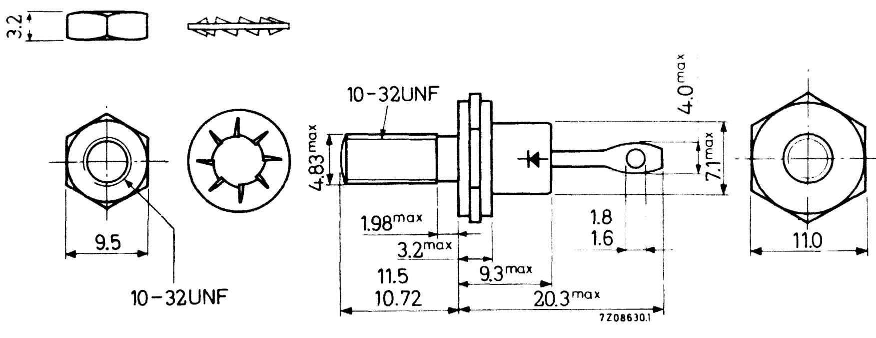
Diffused silicon diodes in a DO-4 metal envelope, capable of absorbing transients and intended for power rectifier applications.
The series consists of the following types:
Normal polarity (cathode to stud): BYX40-600, BYX40-800, BYX40-1000.
Reverse polarity (anode to stud): BYX40-600R, BYX40-800R, BYX40-1000R.

QUICK REFERENCE DATA

			BYX40-600(R)	800(R)	1000(R)	
Crest working reverse voltage	V_{RWM}	max.	600	800	1000	V
Reverse avalanche breakdown voltage	$V_{(BR)R}$	>	750	1000	1250	V
Average forward current up to T_{mb} = 125 °C	$I_{F(AV)}$	max.		12		A
Non-repetitive peak forward current; t = 10 ms; T_j = 175 °C prior to surge	I_{FSM}	max.		180		A
Non-repetitive peak reverse power t = 10 μs; T_j = 25 °C	P_{RSM}	max.		8		kW
Junction temperature	T_j	max.		175		°C

MECHANICAL DATA Dimensions in mm

DO-4
The mark shown applies to normal polarity types.



Net weight : 6.5 g

Torque on nut: min. 8 kg cm (0.8 Newton-metres)
max. 17 kg cm (1.7 Newton-metres)

Diameter of clearance hole: max. 5.2 mm
Accessories supplied on request: 56295 (56262A)

All information applies to frequencies up to 400 Hz

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

			BYX40-600(R)	800(R)	1000(R)	
Voltages						
Crest working reverse voltage	V_{RWM}	max.	600	800	1000	V

Currents

Average forward current up to T_{mb} = 125 °C (averaged over any 20 ms period)	$I_{F(AV)}$	max.	12	A
Forward current (d.c.) at T_{mb} = 125 °C	I_F	max.	19	A
R.M.S. forward current	$I_{F(RMS)}$	max.	19	A
Repetitive peak forward current	I_{FRM}	max.	250	A
Non-repetitive peak forward current t = 10 ms; half sine wave T_j = 175 °C prior to surge	I_{FSM}	max.	180	A
I^2t for fusing (t = 10 ms)	I^2t	max.	162	A^2s

RATINGS (continued)

Reverse power dissipation

Repetitive peak reverse power dissipation				
$t = 10\ \mu s$ (square wave: f = 50 Hz) $T_j = 175\ ^oC$	P_{RRM}	max.	1.2	kW
Non-repetitive peak reverse power dissipation; $t = 10\ \mu s$				
$T_j = 25\ ^oC$ prior to surge	P_{RSM}	max.	8	kW
$T_j = 175\ ^oC$ prior to surge	P_{RSM}	max.	1.2	kW

Temperatures

Storage temperature	T_{stg}	-55 to +175		^oC
Junction temperature	T_j	max.	175	^oC

THERMAL RESISTANCE

From junction to ambient in free air	$R_{th\ j-a}$	=	50	$^oC/W$
From junction to mounting base	$R_{th\ j-mb}$	=	2.2	$^oC/W$
From mounting base to heatsink	$R_{th\ mb-h}$	=	0.5	$^oC/W$

CHARACTERISTICS

Voltages

			BYX40-600(R)	800(R)	1000(R)	
Forward voltage at $I_F = 50$ A; $T_j = 25\ ^oC$	V_F	<	2.5	2.5	2.5	V [1]
Reverse avalanche breakdown voltage $I_R = 5$ mA; $T_j = 25\ ^oC$	$V_{(BR)R}$	>	750	1000	1250	V [2]
		<	2000	2000	2000	V

Current

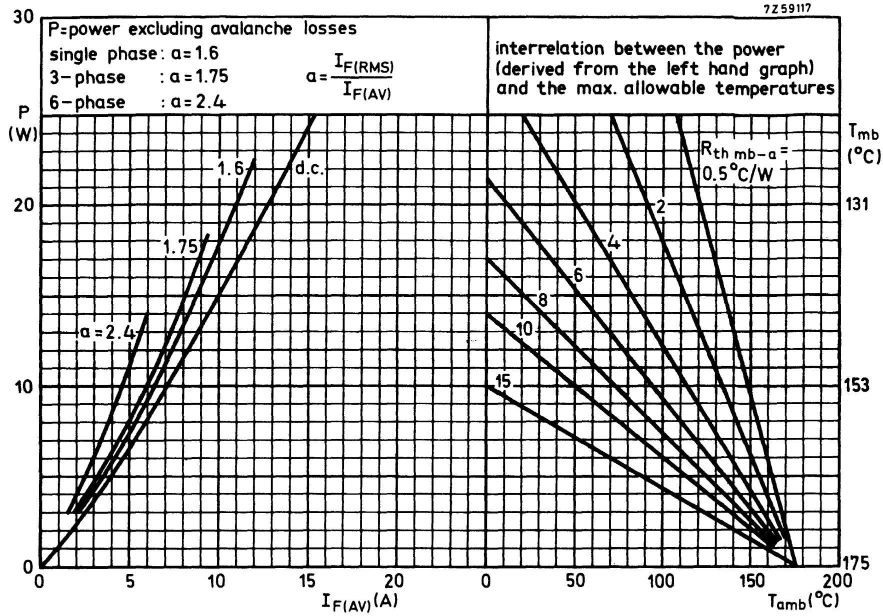
Peak reverse current at $T_j = 125\ ^oC$ $V_{RM} = V_{RWMmax}$	I_{RM}	<	300	μA

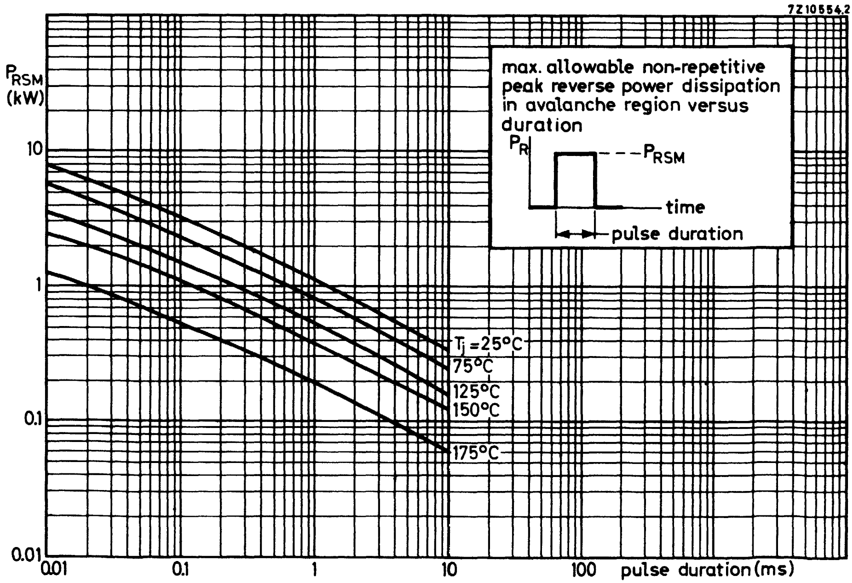
OPERATING NOTES (See also general pages at the beginning of this section)

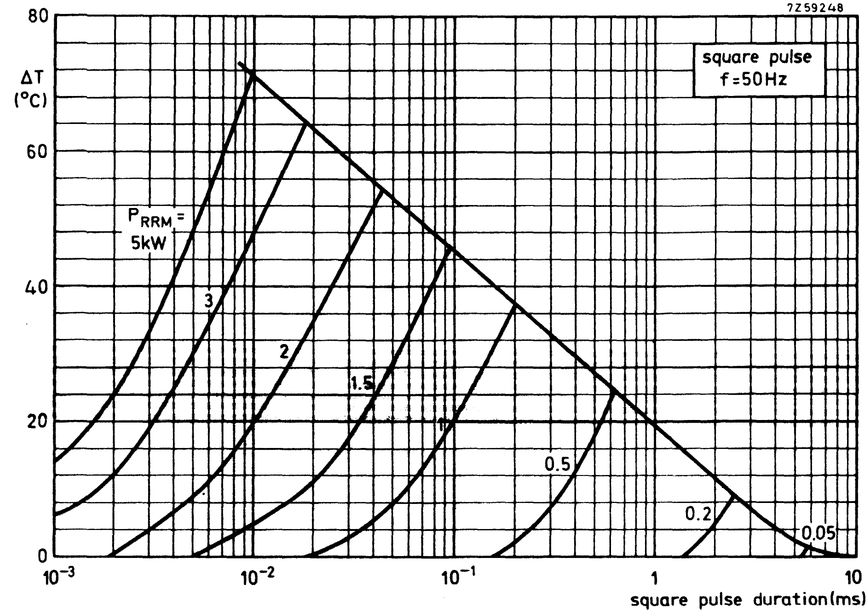
1. Voltage sharing of series connected controlled avalanche diodes.
   If diodes with avalanche characteristics are connected in series, the usual R and C elements for voltage sharing can be omitted.
2. The top connector should neither be bent not twisted; it should be soldered into the circuit so that 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.

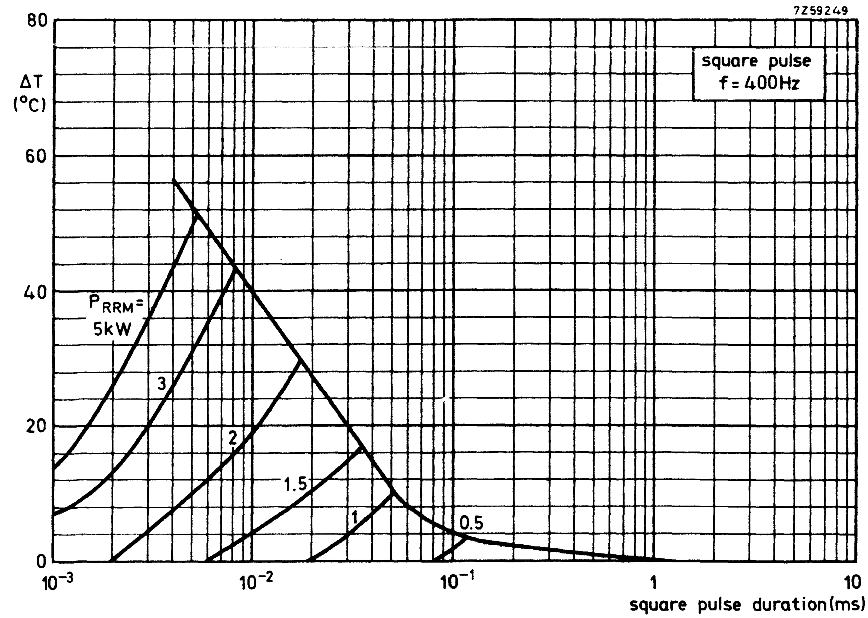
APPLICATION INFORMATION See general pages at the beginning of this section.

[1]) Measured under pulsed conditions to avoid excessive dissipation.
[2]) The avalanche breakdown voltage increases by about 0.1%/^oC with increasing junction temperature.

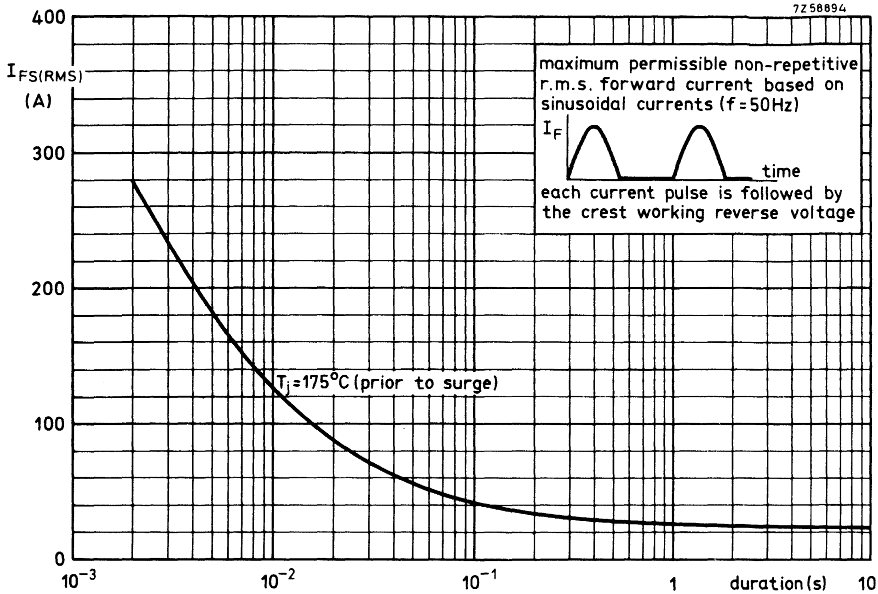

7Z59117
P=power excluding avalanche losses
single phase: a=1.6
3-phase : a=1.75
6-phase : a=2.4
a = I F(RMS) / I F(AV)
interrelation between the power (derived from the left hand graph) and the max. allowable temperatures
P (W)
1.6
d.c.
1.75
a=2.4
R th mb-a = 0.5°C/W
2
4
6
8
10
15
Tmb (°C)
131
153
175
I F(AV) (A)
Tamb (°C)

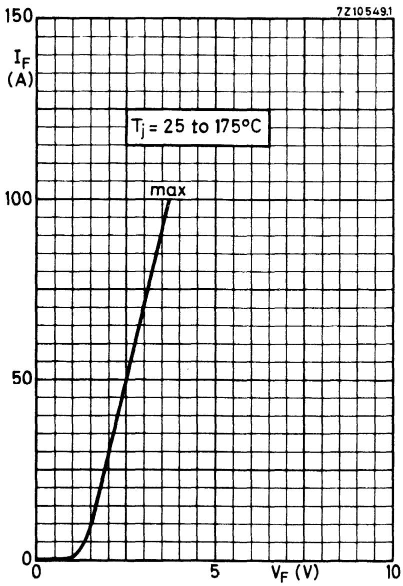

7Z10554.2
P RSM (kW)
max. allowable non-repetitive peak reverse power dissipation in avalanche region versus duration
P R
P RSM
time
pulse duration
Tj =25°C
75°C
125°C
150°C
175°C
pulse duration (ms)





ΔT = neccessary derating of $T_{j\,max}$ to accommodate repetitive transients in the reverse direction. Allowance can be made for this by assuming the ambient temperature ΔT higher.


7Z58894
400
300
200
100
0
$I_{FS(RMS)}$
(A)
maximum permissible non-repetitive r.m.s. forward current based on sinusoidal currents (f = 50Hz)
I_F
time
each current pulse is followed by the crest working reverse voltage
T_j = 175°C (prior to surge)
10^{-3}
10^{-2}
10^{-1}
1
duration (s)
10


7Z10549.1
150
I_F
(A)
T_j = 25 to 175°C
max
100
50
0
0
5
V_F (V)
10

SILICON RECTIFIER DIODES

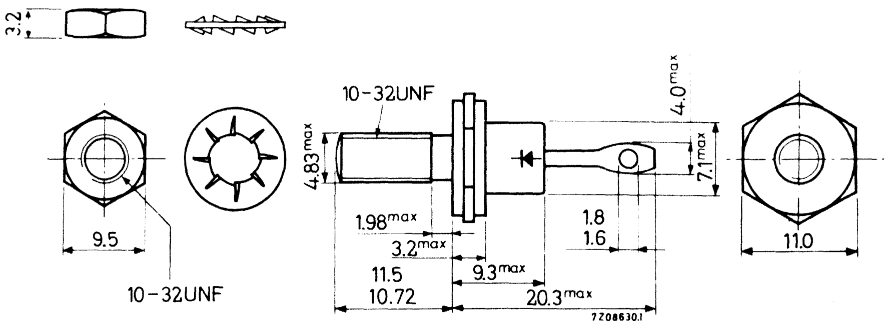
Diffused silicon rectifier diodes in a DO-4 metal envelope intended for power rectifier applications. The series consists of the following types.
Normal polarity (cathode to stud): BYX42-300 to 1200.
Reverse polarity (anode to stud): BYX42-300R to 1200R.

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	$I_{F(AV)}$	max.	10				A
Non-repetitive peak forward current t = 10 ms; T_j = 175 °C prior to surge	I_{FSM}	max.	125				A
Junction temperature	T_j	max.	175				°C

MECHANICAL DATA Dimensions in mm

DO-4



Net weight: 6.5 g
Diameter of clearance hole: max. 5.2 mm
Accessories supplied on request:
56295 (56262A)

Torque on nut: min. 8 kg cm (0.8 Newton-metres)
max. 17 kg cm (1.7 Newton-metres)

The mark shown applies to normal polarity types

AH information applies to frequencies up to 400 Hz

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

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 ($\delta \leq 0.01$)	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) up to T_{mb} = 130 °C	$I_{F(AV)}$	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; half sine wave) T_j=125°C prior to surge	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	V_F	<	1.4	V [1]
Peak reverse current at $V_{RM} = V_{RWMmax}$; T_j = 125 °C	I_{RM}	<	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]) Measured under pulsed conditions to avoid 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

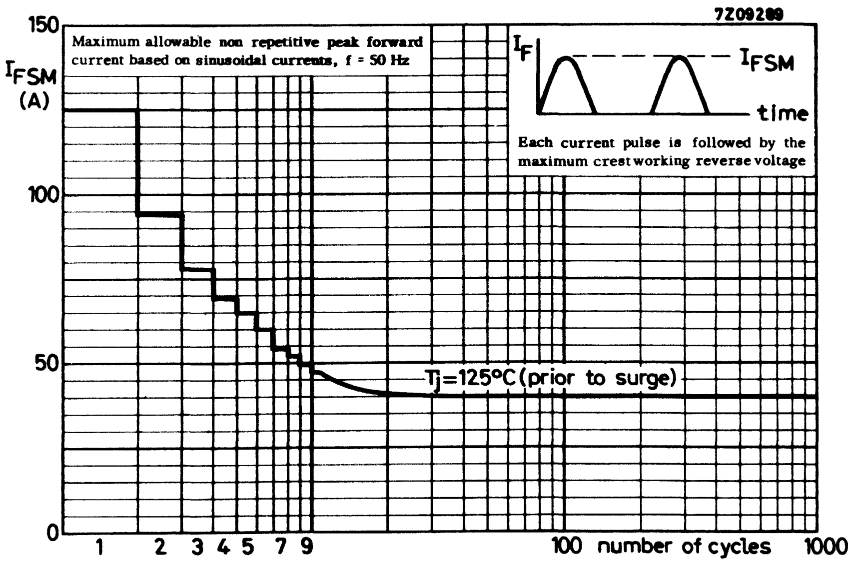
V_2 = transformer secondary r.m.s. voltage (V)

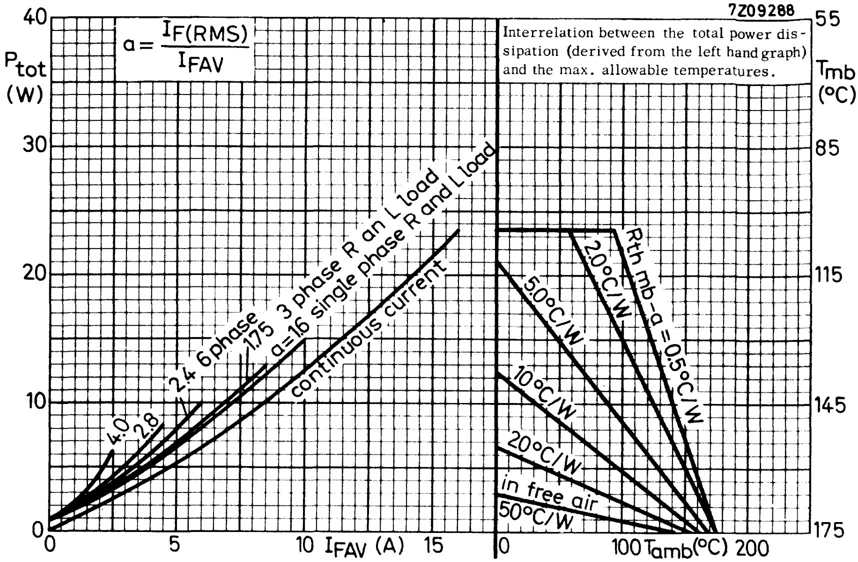
T = V_1/V_2

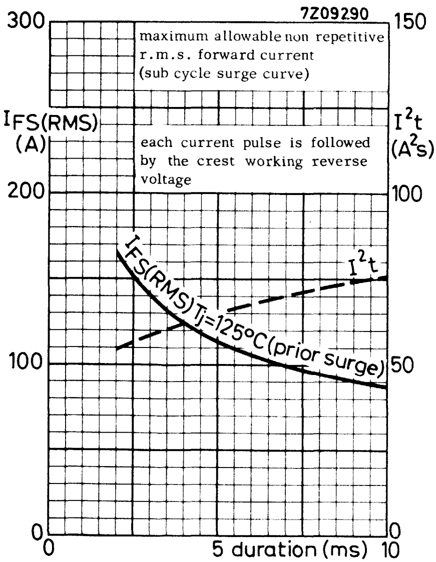
V_{RWM} stands for the actually applied crest working reverse voltage

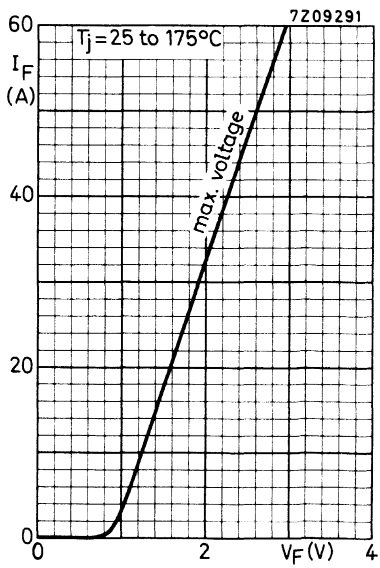
2. In order to prevent the diodes from being damaged by surge currents higher than those mentioned in the curve on page 4 a fast fuse is recommended.

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.
Ptot (W)
Tmb (°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
Rth 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
IFAV (A)
Tamb(°C)
0
5
10
15
100
200
10
20
30
40
55
85
115
145
175


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
IFS(RMS) (A)
I²t (A²s)
IFS(RMS) Tj=125°C (prior surge)
I²t
duration (ms)
0
5
10
100
200
300
50
150


7Z09291
Tj = 25 to 175°C
IF (A)
max. voltage
VF (V)
0
2
4
20
40
60

CONTROLLED AVALANCHE RECTIFIER DIODES

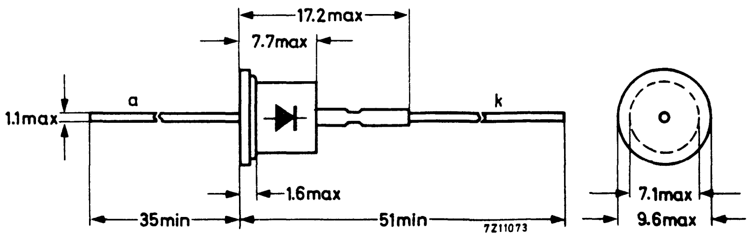
Diffused silicon diodes in a DO-1 metal envelope, capable of absorbing transients. They are intended for rectifier applications and particularly suited for series operation.
The series consists of the following reverse polarity types (anode to case): BYX45-600R, BYX45-800R, BYX45-1000R.

QUICK REFERENCE DATA						
			BYX45-600R	800R	1000R	
Crest working reverse voltage	V_{RWM}	max.	600	800	1000	V
Reverse breakdown voltage	$V_{(BR)R}$	>	750	1000	1250	V
Average forward current	I_{FAV}	max.		1.5		A
Non repetitive peak forward current t = 10 ms; T_j = 150 °C (prior to surge)	I_{FSM}	max.		40		A
Non repetitive peak reverse power t = 10 µs; T_j = 25 °C	P_{RSM}	max.		2.5		kW
Junction temperature	T_j	max.		150		°C

MECHANICAL DATA

Dimensions in mm

DO-1



All information applies to frequencies up to 400 Hz

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

Voltages

			BYX45-600R	800R	1000R	
Crest working reverse voltage	V_{RWM}	max.	600	800	1000	V

Currents

Average forward current (averaged over any 20 ms period) (see also page 5)	I_{FAV}	max.	1.5	A
Forward current (d.c.)	I_F	max.	2.0	A
R.M.S. forward current	$I_{F(RMS)}$	max.	2.4	A
Repetitive peak forward current	I_{FRM}	max.	15	A
Non repetitive peak forward current t = 10 ms; T_j = 150 °C (prior to surge)	I_{FSM}	max.	40	A
I squared t for fusing (t = 10 ms)	I^2t	max.	8	A^2s

Reverse power dissipation

Repetitive peak reverse power dissipation (square wave) f = 50 Hz; t = 10 μs; T_j = 125 °C	P_{RRM}	max.	800	W
Non repetitive peak reverse power dissipation (square wave) t = 10 μs; T_j = 25 °C (prior to surge)	P_{RSM}	max.	2.5	kW
t = 10 μs; T_j = 150 °C (prior to surge)	P_{RSM}	max.	800	W

Temperatures

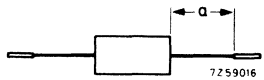
Storage temperature	T_{stg}		−55 to +150	°C
Junction temperature	T_j	max.	150	°C

THERMAL RESISTANCE

Effect of mounting on thermal resistance $R_{th\ j-a}$

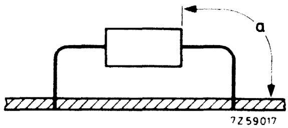
The quoted values apply when no other leads run to the tie-points. If leads of other dissipating components share the same tie-points, the thermal resistance will be higher than that quoted.

1. Mounted to solder tags at a lead-length a = 10 mm. $R_{th\ j-a}$ = 60 °C/W



2. Mounted to solder tags at a = maximum lead-length. $R_{th\ j-a}$ = 70 °C/W

3. Mounted on printed-wiring board at a = maximum lead-length. $R_{th\ j-a}$ = 80 °C/W



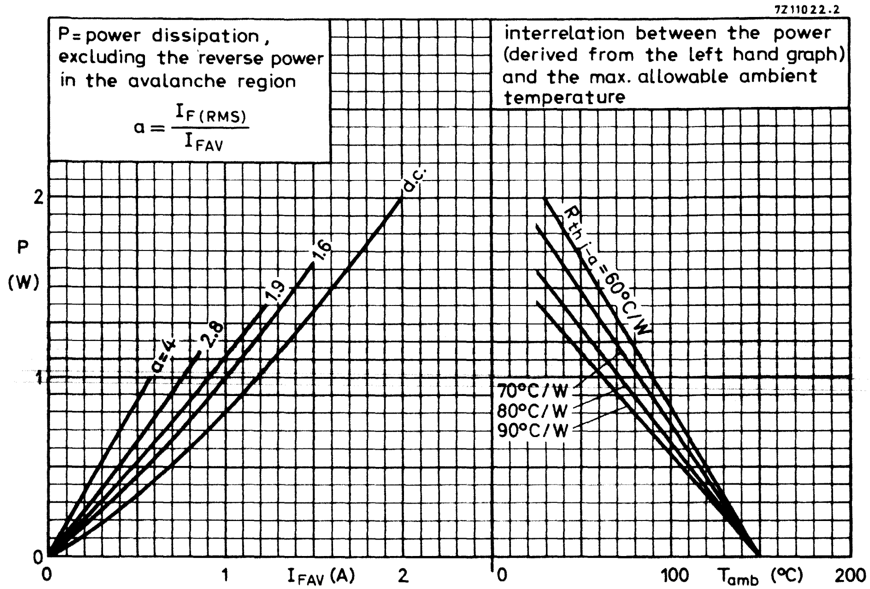
4. Mounted on printed-wiring board at a lead-length a = 10 mm. $R_{th\ j-a}$ = 90 °C/W

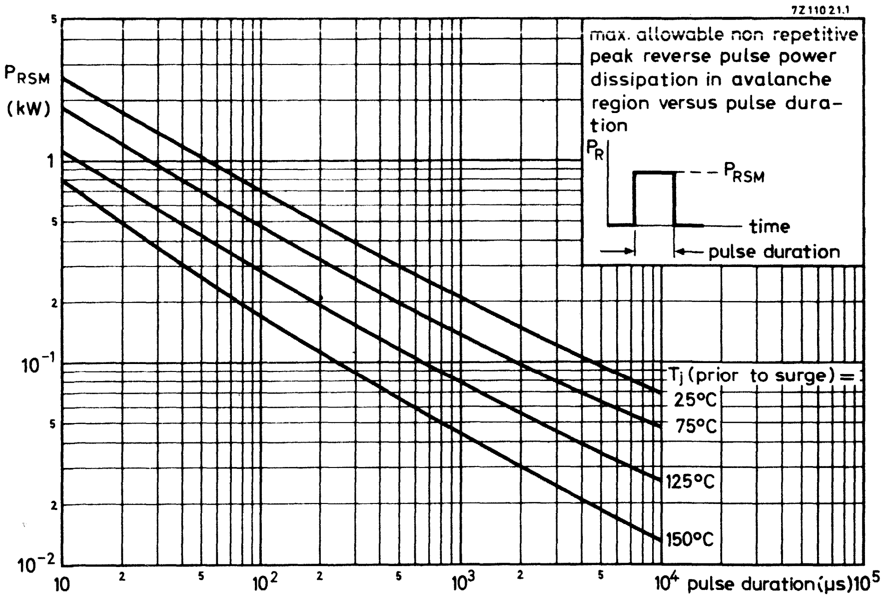
SOLDERING AND MOUNTING NOTES

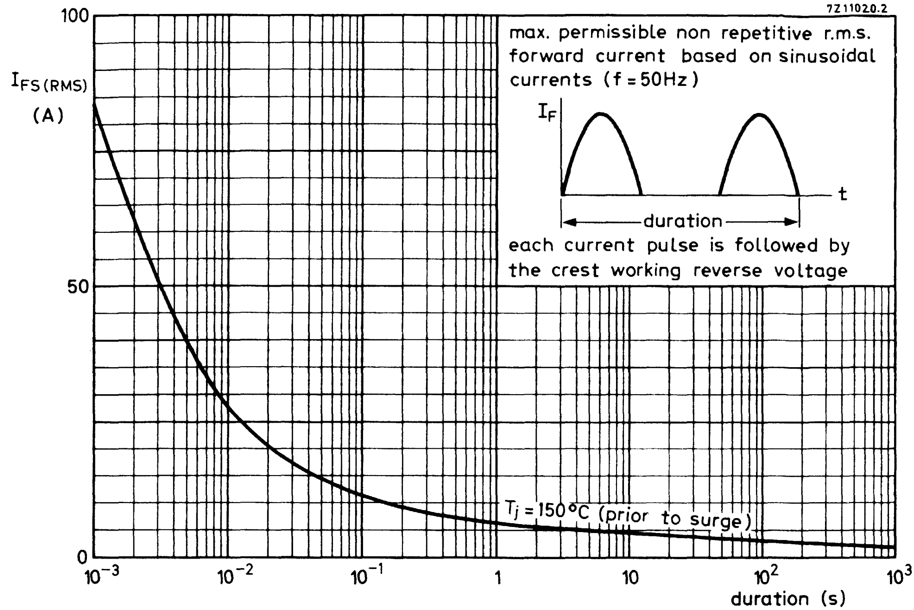
1. At a soldering iron or bath temperature of up to 245 °C, the maximum permissible soldering time is 10 s if the joint is 5 mm from the seal, 3 s if it is 1.5 mm from the seal.
2. At a temperature between 245 °C and 400 °C (max.), the joint must be more than 5 mm from the seal and soldering time must not exceed 5 s.
3. Leads should not be bent less than 1.5 mm from the seal; excert no axial pull when bending.

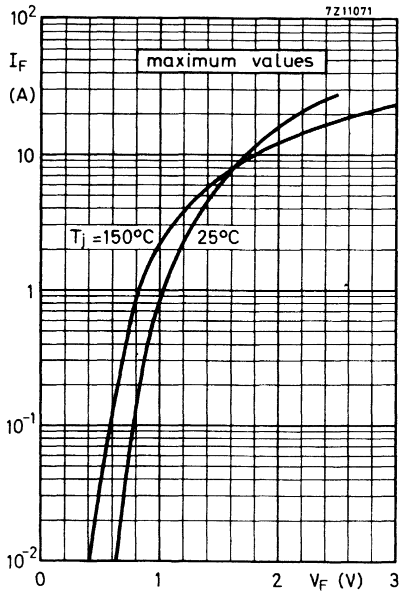
CHARACTERISTICS

			BYX45-600R	800R	1000R	
Voltages						
Forward voltage at I_F = 5 A; T_j = 25 °C	V_F	<	1.45	1.45	1.45	V
Reverse avalanche breakdown voltage I_R = 1 mA; T_j = 25 °C	$V_{(BR)R}$	>	750	1000	1250	V
		<	2000	2000	2000	V
Current						
Peak reverse current at T_j = 125 °C $V_R = V_{RWMmax}$	I_{RM}	<	100	100	100	μA


7Z11022.2
P = power dissipation, excluding the reverse power in the avalanche region
a = I F(RMS) / I FAV
interrelation between the power (derived from the left hand graph) and the max. allowable ambient temperature
P (W)
2
1
0
0
1
2
I FAV (A)
d.c.
1.6
1.9
2.8
a=4
R th j-a = 60°C/W
70°C/W
80°C/W
90°C/W
0
100
T amb (°C)
200


7Z11021.1
max. allowable non repetitive peak reverse pulse power dissipation in avalanche region versus pulse duration
P RSM (kW)
1
10^-1
10^-2
P R
P RSM
time
pulse duration
T j (prior to surge) =
25°C
75°C
125°C
150°C
10
10^2
10^3
10^4
pulse duration (μs)
10^5


7Z11020.2
100
$I_{FS(RMS)}$
(A)
50
0
10^{-3}
10^{-2}
10^{-1}
1
10
10^2
10^3
duration (s)
max. permissible non repetitive r.m.s. forward current based on sinusoidal currents (f = 50Hz)
I_F
t
duration
each current pulse is followed by the crest working reverse voltage
T_j = 150°C (prior to surge)


7Z11071
10^2
I_F
(A)
10
1
10^{-1}
10^{-2}
0
1
2
V_F (V)
3
maximum values
T_j =150°C
25°C

FAST RECOVERY 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 (cathode to stud): BYX46-200 to BYX46 -600
Reverse polarity (anode to stud): BYX46-200R to BYX46-600(R)

QUICK REFERENCE DATA

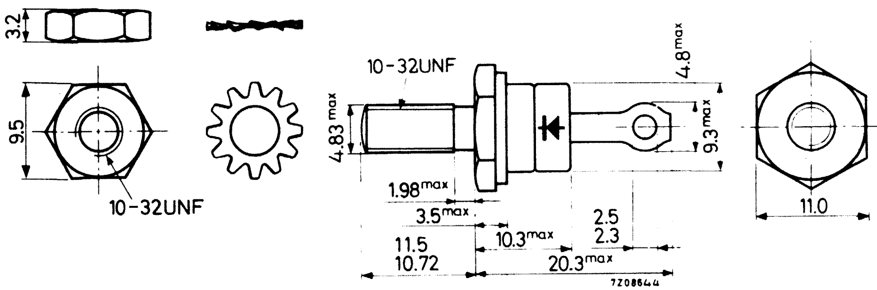
			BYX46-200(R)	300(R)	400(R)	500(R)	600(R)	
Crest working reverse voltage	V_{RWM}	max.	200	300	400	500	600	V
Reverse avalanche breakdown voltage	$V_{(BR)R}$	>	250	375	500	625	750	V

Average forward current up to $T_{mb} = 100^{o}C$	$I_{F(AV)}$	max.	22	A
at $T_{mb} = 125^{o}C$	$I_{F(AV)}$	max.	15	A
Non-repetitive peak forward current; t = 10 ms $T_j = 165\,^{o}C$ prior to surge	I_{FSM}	max.	300	A
Junction temperature	T_j	max.	165	^{o}C
Reverse recovery time when switched from $I_F = 2$ A to $V_R = 30$ V I_R limited to $I_{RRM} = 2$ A; $-dI/dt = 100$ A/µs	t_{rr}	<	0.35	µs

MECHANICAL DATA

Dimensions in mm

DO-4



Net weight: 7.8 g
Diameter of clearance hole: max. 5.2 mm
Accessories supplied on request:
56295, (56262A)

Torque on nut: min. 9 kg cm
(0.9 Newton-metres)
max. 17 kg cm
(1.7 Newton-metres)
The mark shown applies to normal polarity types.

All information applies to frequencies up to 50 kHz

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

Voltage			BYX46-200(R)	300(R)	400(R)	500(R)	600(R)	
Crest working reverse voltage	V_{RWM}	max.	200	300	400	500	600	V

Currents

Average forward current (averaged over any 20 ms period) up to T_{mb} = 100 °C	$I_{F(AV)}$	max.	22	A
at T_{mb} = 125 °C	$I_{F(AV)}$	max.	15	A
Forward current (d.c.)	I_F	max.	30	A
Repetitive peak forward current	I_{FRM}	max.	400	A
Non-repetitive peak forward current (t = 10 ms; half sine wave) T_j = 165 °C prior to surge	I_{FSM}	max.	300	A
Repetitive peak reverse current (during turn-off)	I_{RRM}	max.	25	A

Reverse power dissipation

Repetitive peak reverse power dissipation t = 10 µs (square wave; f = 50 Hz) T_j = 100 °C	P_{RRM}	max.	9.5	kW
Non-repetitive peak reverse power dissipation t = 10 µs (square wave) T_j = 25 °C prior to surge	P_{RSM}	max.	18	kW
T_j = 165 °C prior to surge	P_{RSM}	max.	4	kW

Temperatures

Storage temperature	T_{stg}		-55 to +165	°C
Junction temperature	T_j	max.	165	°C

THERMAL RESISTANCE

From junction to ambient in free air	$R_{th\ j\text{-}a}$	=	50	°C/W
From junction to mounting base	$R_{th\ j\text{-}mb}$	=	1.3	°C/W
From mounting base to heatsink	$R_{th\ mb\text{-}h}$	=	0.5	°C/W

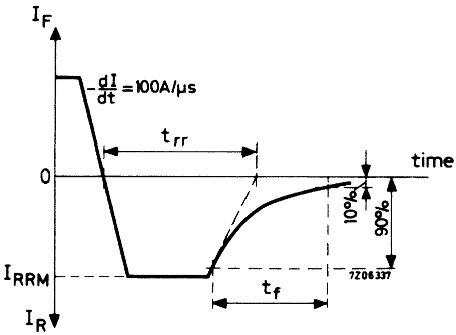
CHARACTERISTICS

			BYX46-200(R)	300(R)	400(R)	500(R)	600(R)	
Forward voltage								
I_F = 50 A; T_j = 25 °C	V_F	<	2.0	2.0	2.0	2.0	2.0	V
Reverse avalanche breakdown voltage								
I_R = 5 mA; T_j = 25 °C	$V_{(BR)R}$	>	250	375	500	625	750	V
		<	1050	1050	1050	1050	1050	V
Peak reverse current								
$V_{RM} = V_{RWMmax}$; T_j = 125 °C	I_{RM}	<	4.0	4.0	4.0	4.0	4.0	mA

Reverse recovery charge when switched from
I_F = 2 A to V_R = 30 V;
with $-\frac{dI}{dt}$ = 100 A/μs; T_j = 25 °C — 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_j = 25 °C — t_{rr} < 0.35 μs

Fall time under all conditions — t_f < 0.30 μs



OPERATING NOTES FOR (See also general pages at the beginning of this section.)

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 11)

p.t.o.

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 50 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	=	12	A
to	V_R	=	300	V
at a rate	$-\frac{dI}{dt}$	=	50	A/μs

At a duty cycle $\delta = 0.5$ the average forward current $I_{FAV} = 6$ A.
From the upper graph on page 5 it follows, that at $I_{FAV} = 6$ A the average forward power + average leakage power = 13 W (point A).
The additional power losses due to switching-off can be read from the nomogram on page 10 (the example being based on optimum use, i.e. $T_j = 165$ °C). Starting from $I_F = 12$ 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 $V_R = 300$ V and ultimately trace horizontally to the left and on the vertical axis read the additional average power dissipation $P_{RAV} = 6$ W.
Therefore the total power dissipation $P_{tot} = 13\ W + 6\ W = 19\ W$ (point B of the upper graph on page 5).

From the right hand part of the upper graph on page 5 follows the thermal resistance, required at $T_{amb} = 40$ °C.

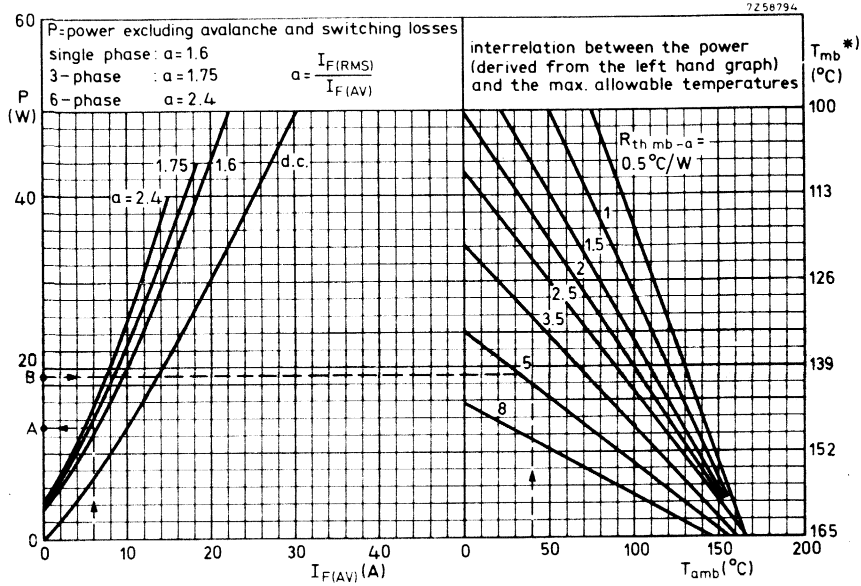
$$R_{th\ mb\text{-}a} \approx 5\ °C/W$$

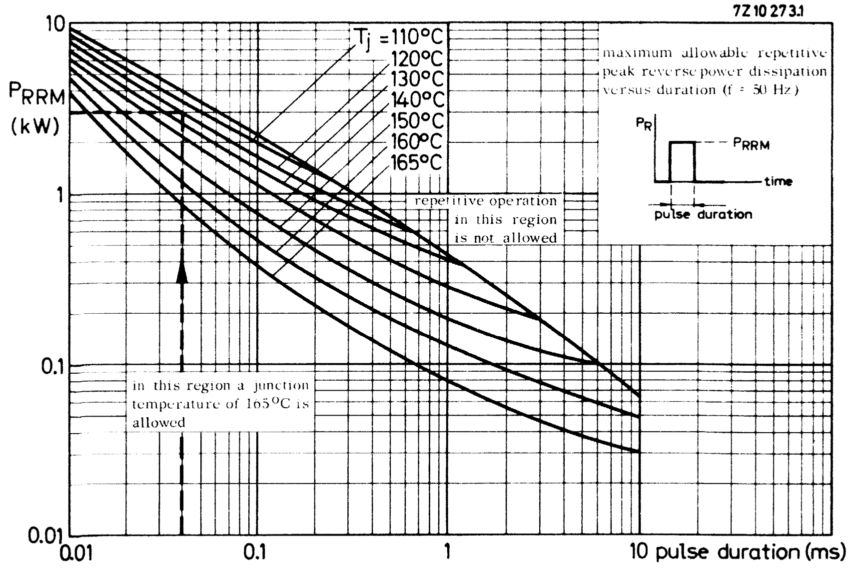
The contact thermal resistance $R_{th\ mb\text{-}h} = 0.5$ °C/W.

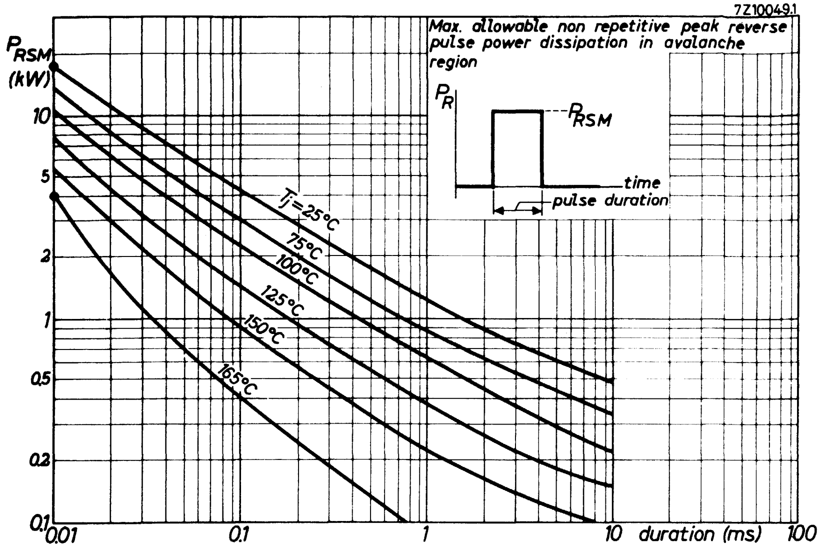
Hence the heatsink thermal resistance should be:

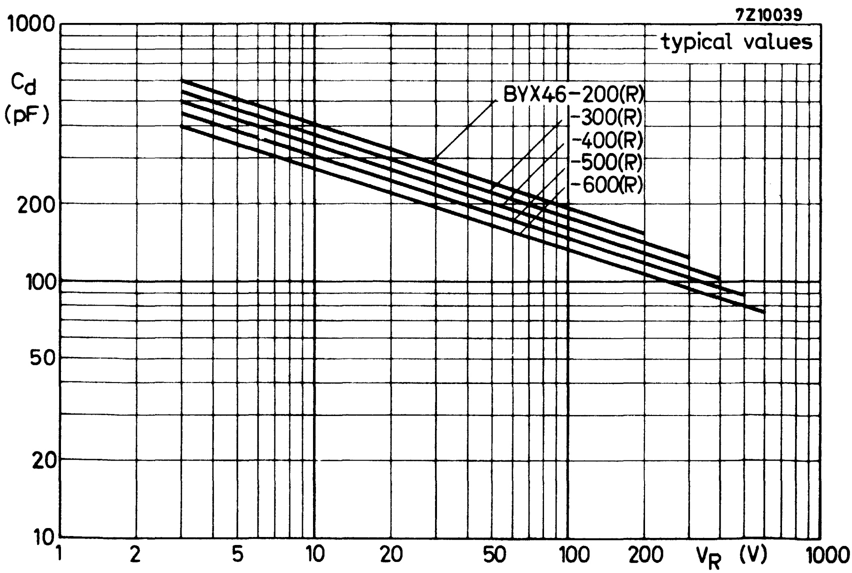
$$R_{th\ h\text{-}a} = R_{th\ mb\text{-}a} - R_{th\ mb\text{-}h} = (5 - 0.5)\ °C/W = 4.5\ °C/W.$$

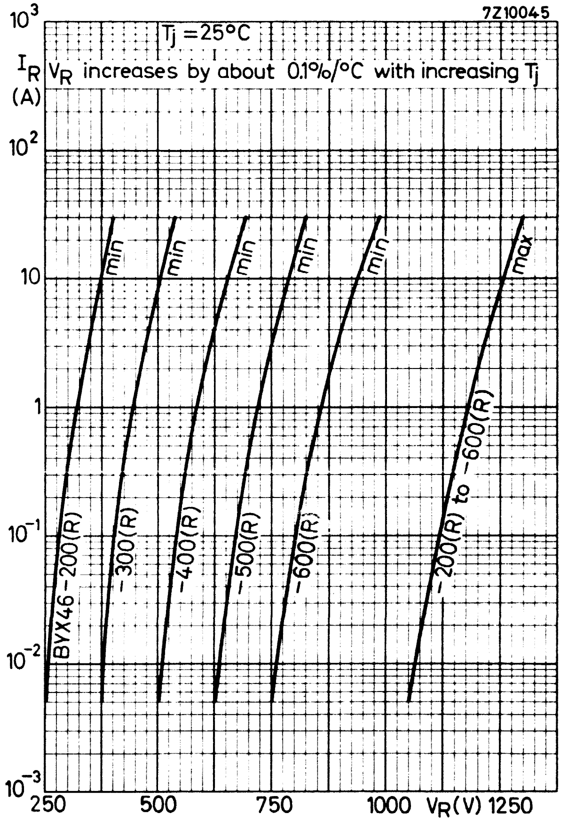
The applicable heatsink(s) may then be found in the Section HEATSINKS.

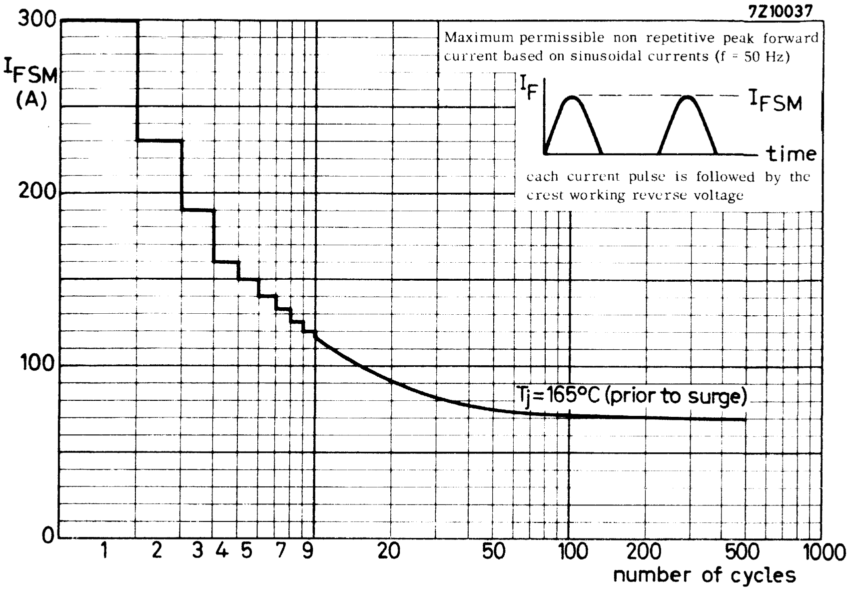

7Z58794
P=power excluding avalanche and switching losses
single phase: a=1.6
3-phase : a=1.75
6-phase a=2.4
a = IF(RMS) / IF(AV)
interrelation between the power
(derived from the left hand graph)
and the max. allowable temperatures
P
(W)
a=2.4
1.75
1.6
d.c.
Rth mb-a =
0.5°C/W
1
1.5
2
2.5
3.5
5
8
B
A
Tmb *)
(°C)
100
113
126
139
152
165
IF(AV) (A)
Tamb (°C)

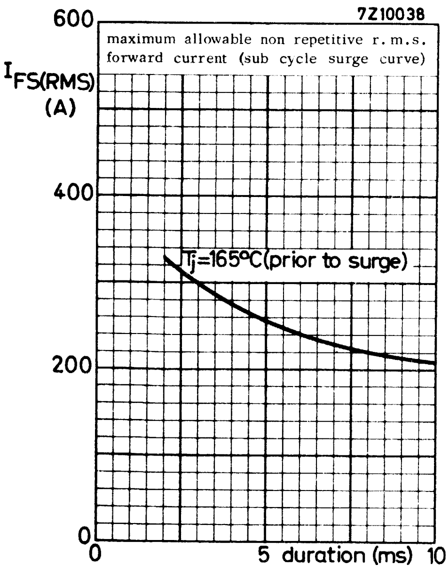

7Z10273.1
PRRM
(kW)
Tj =110°C
120°C
130°C
140°C
150°C
160°C
165°C
maximum allowable repetitive peak reverse power dissipation versus duration (f = 50 Hz)
PR
PRRM
time
pulse duration
repetitive operation in this region is not allowed
in this region a junction temperature of 165°C is allowed
pulse duration (ms)

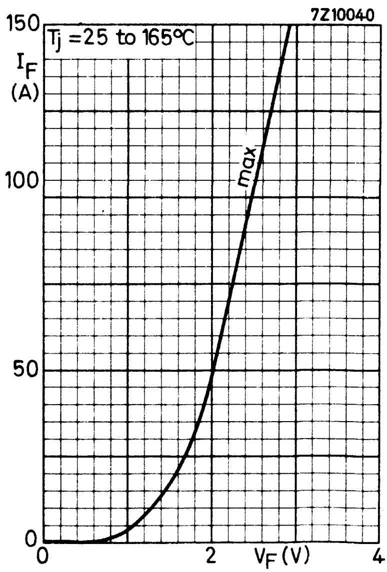

7Z10049.1
Max. allowable non repetitive peak reverse pulse power dissipation in avalanche region
P_RSM (kW)
10
5
2
1
0.5
0.2
0.1
0.01
0.1
1
10
duration (ms)
100
Tj=25°C
75°C
100°C
125°C
150°C
165°C
P_R
P_RSM
time
pulse duration

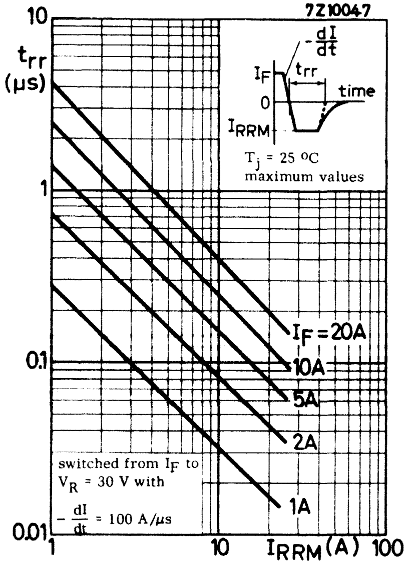

7Z10039
typical values
1000
Cd (pF)
200
100
50
20
10
1
2
5
10
20
50
100
200
V_R (V)
1000
BYX46-200(R)
-300(R)
-400(R)
-500(R)
-600(R)

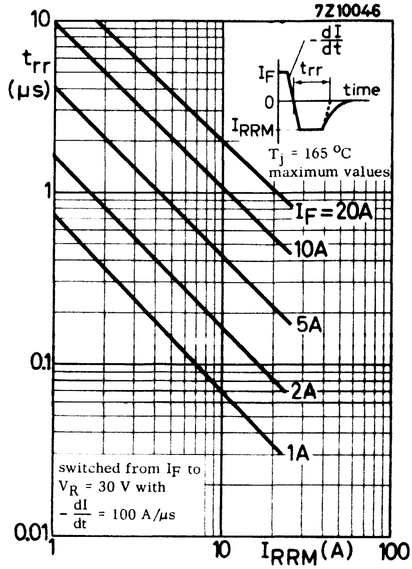

7Z10045
T_j = 25°C
V_R increases by about 0.1%/°C with increasing T_j
I_R (A)
10^3
10^2
10
1
10^{-1}
10^{-2}
10^{-3}
250
500
750
1000
V_R(V)
1250
min
min
min
min
min
max
BYX46−200(R)
−300(R)
−400(R)
−500(R)
−600(R)
−200(R) to −600(R)

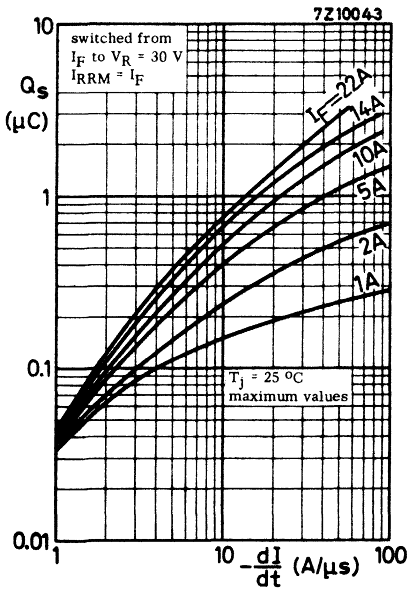

7Z10037
Maximum permissible non repetitive peak forward current based on sinusoidal currents (f = 50 Hz)
each current pulse is followed by the crest working reverse voltage
IFSM
(A)
IF
IFSM
time
Tj=165°C (prior to surge)
300
200
100
0
1
2
3
4
5
7
9
20
50
100
200
500
1000
number of cycles

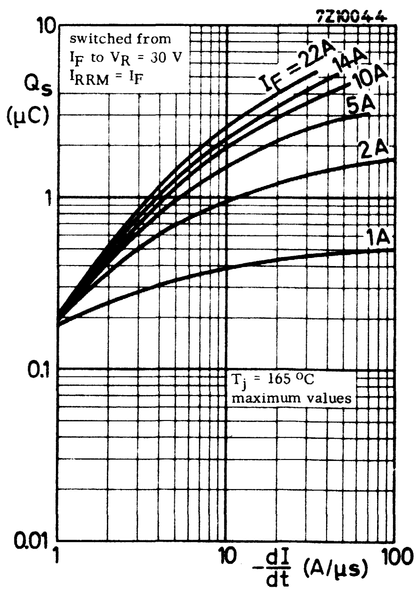

7Z10038
maximum allowable non repetitive r.m.s. forward current (sub cycle surge curve)
IFS(RMS)
(A)
Tj=165°C(prior to surge)
600
400
200
0
0
5
duration (ms)
10

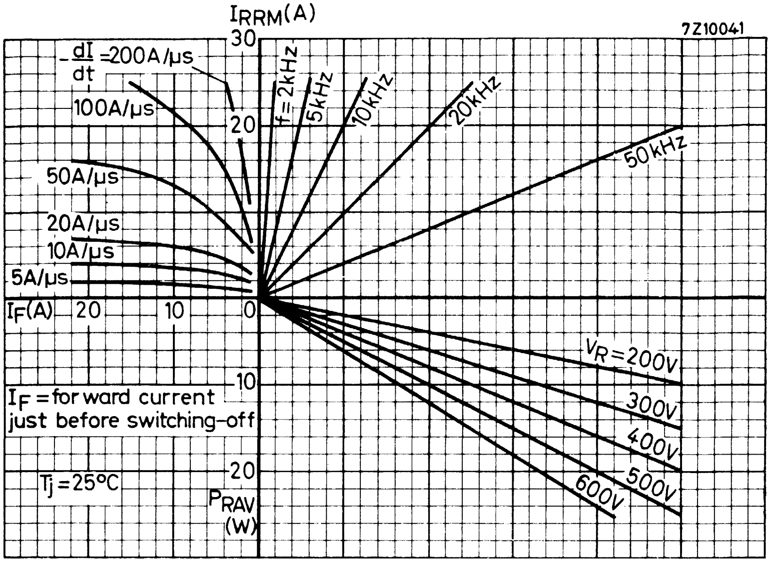

7Z10040
Tj =25 to 165°C
IF
(A)
max
150
100
50
0
0
2
VF (V)
4

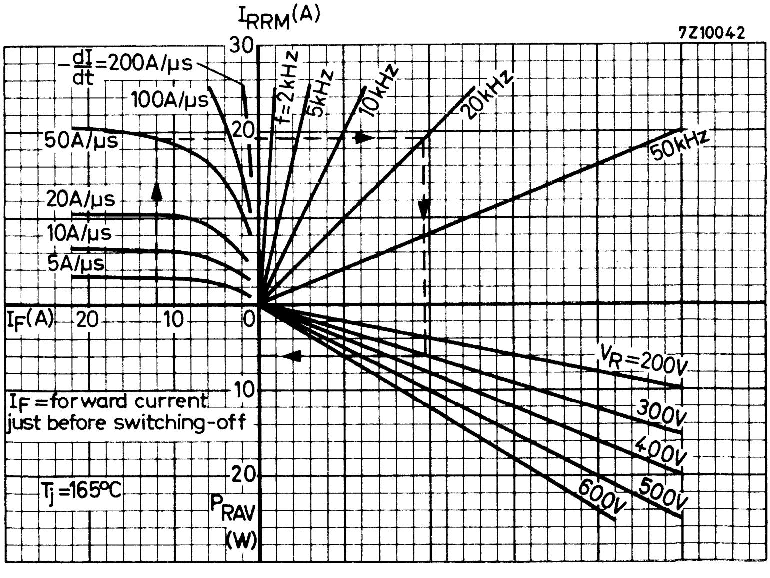

7Z10047
10
t_{rr}
(µs)
1
0.1
0.01
1
10
I_{RRM}(A)
100
$-\frac{dI}{dt}$
I_F
t_{rr}
time
0
I_{RRM}
T_j = 25 °C
maximum values
I_F=20A
10A
5A
2A
1A
switched from I_F to
V_R = 30 V with
$-\frac{dI}{dt}$ = 100 A/µs


7Z10046
10
t_{rr}
(µs)
1
0.1
0.01
1
10
I_{RRM}(A)
100
$-\frac{dI}{dt}$
I_F
t_{rr}
time
0
I_{RRM}
T_j = 165 °C
maximum values
I_F=20A
10A
5A
2A
1A
switched from I_F to
V_R = 30 V with
$-\frac{dI}{dt}$ = 100 A/µs


7Z10043
10
Q_s
(µC)
1
0.1
0.01
1
10
$-\frac{dI}{dt}$ (A/µs)
100
switched from
I_F to V_R = 30 V
I_{RRM} = I_F
I_F=22A
14A
10A
5A
2A
1A
T_j = 25 °C
maximum values


7Z10044
10
Q_s
(µC)
1
0.1
0.01
1
10
$-\frac{dI}{dt}$ (A/µs)
100
switched from
I_F to V_R = 30 V
I_{RRM} = I_F
I_F=22A
14A
10A
5A
2A
1A
T_j = 165 °C
maximum values





Nomogram: Power loss P_{RAV} due to switching only (square wave operation)

SILICON RECTIFIER DIODES

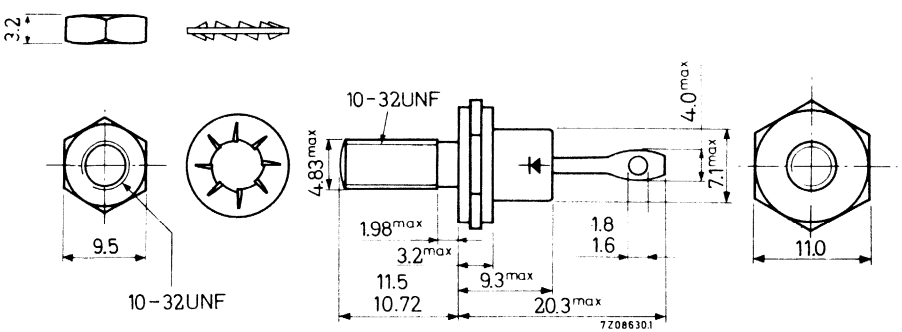
Diffused silicon rectifier diodes in a DO-4 metal envelope intended for power rectifier applications. The series consists of the following types.
Normal polarity (cathode to stud): BYX48-300 to BYX48-1200
Reverse polarity (anode to stud): BYX48-300R to BYX48-1200R

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	$I_{F(AV)}$	max.	6.0				A
Non-repetitive peak forward current t = 10 ms; T_j = 175 °C prior to surge	I_{FSM}	max.	90				A
Junction temperature	T_j	max.	175				°C

MECHANICAL DATA Dimensions in mm

DO-4



Net weight: 6.5 g
Diameter of clearance hole: max. 5.2 mm
Accessories supplied on request:
56295 (56262A)

Torque on nut: min. 8 kg cm
(0.8 Newton-metres)
max. 17 kg cm
(1.7 Newton-metres)
The mark shown applies to normal polarity types

All information applies to frequencies up to 400 Hz

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

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 ($\delta \leq 0.01$)	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) up to T_{mb} = 130 °C	$I_{F(AV)}$	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; half sine wave) T_j = 175 °C prior to surge	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	$R_{th\ j\text{-}a}$	=	50	°C/W
From junction to mounting base	$R_{th\ j\text{-}mb}$	=	4.5	°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	V_F	<	1.8	V [1]
Peak reverse current at V_{RM} = V_{RWMmax}; T_j = 125 °C	I_{RM}	<	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]) Measured under pulsed conditions to avoid 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)

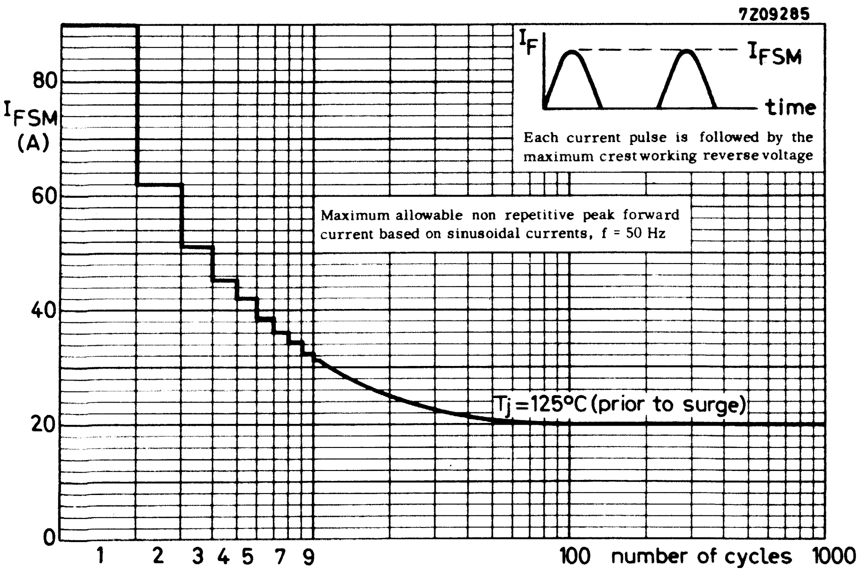
V_2 = transformer secondary r.m.s. voltage (V)

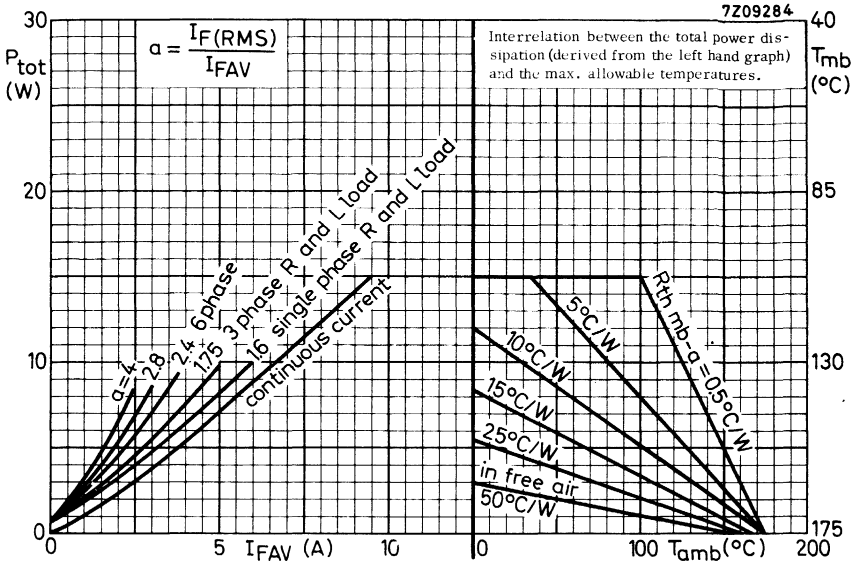
T = V_1/V_2

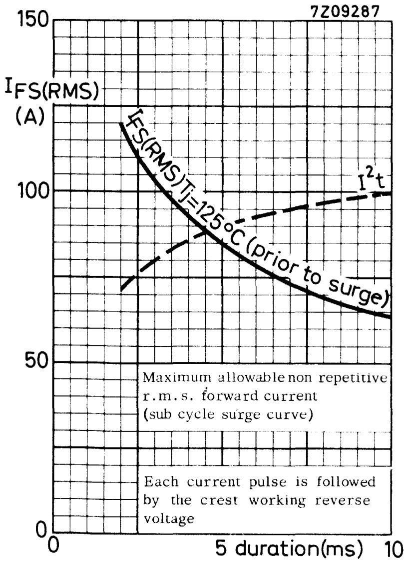
V_{RWM} stands for the actually applied crest working reverse voltage

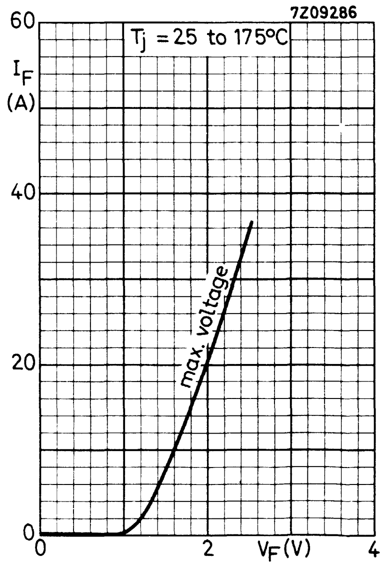
2. In order to prevent the diodes from being damaged by surge currents higher than those mentioned in the curves on page 4 a fast fuse is recommended.

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
P_{tot} (W)
$a = \frac{I_{F(RMS)}}{I_{FAV}}$
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
I_{FAV} (A)
Interrelation between the total power dissipation (derived from the left hand graph) and the max. allowable temperatures.
T_{mb} (°C)
Rth mb-a =0.5°C/W
5°C/W
10°C/W
15°C/W
25°C/W
in free air
50°C/W
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

Plastic-encapsulated rectifier diodes intended for power rectifier applications.
Normal and reverse polarity types are available.

QUICK REFERENCE DATA

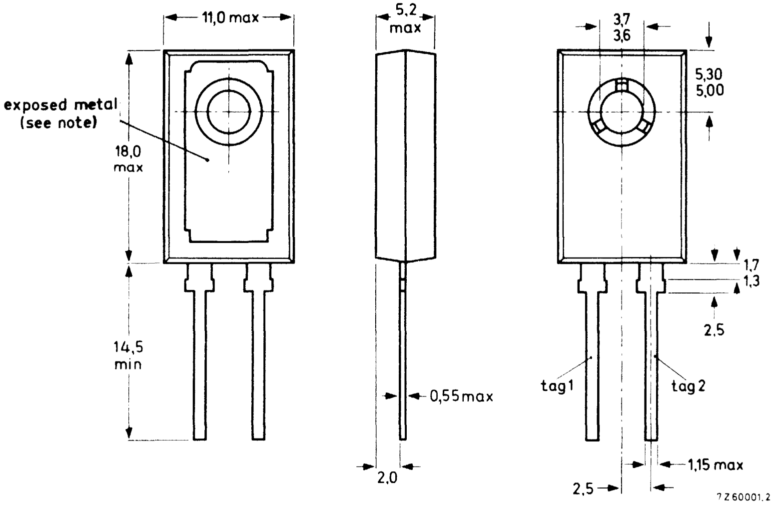
			BYX49-300(R)	600(R)	900(R)	1200(R)	
Crest working reverse voltage	V_{RWM}	max.	200	400	600	800	V
Repetitive peak reverse voltage	V_{RRM}	max.	300	600	900	1200	V

Average forward current up to T_{mb} = 85 °C	$I_{F(AV)}$	max.	6,0	A
at T_{mb} = 120 °C	$I_{F(AV)}$	max.	3,0	A
Non-repetitive peak forward current t = 10 ms; T_j = 150 °C prior to surge	I_{FSM}	max.	40	A
Junction temperature	T_j	max.	150	°C

MECHANICAL DATA See page 2

MECHANICAL DATA

Dimensions in mm



Net weight: 2,5 g

Torque on screw: min. 0,95 Nm (9,5 kgcm)
max. 1,5 Nm (15 kgcm)

Accessories:
- supplied with the device: spread washer
- available on request : 56316 mica insulating washer

POLARITY OF CONNECTIONS

	BYX49-300 to BYX49-1200	BYX49-300R to BYX49-1200R
Base-plate:	cathode	anode
Tag 1 :	cathode	anode
Tag 2 :	anode	cathode

Note: the exposed metal base-plate is directly connected to tag 1.

All information applies to frequencies up to 400 Hz.

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

Voltages			BYX49-300(R)	600(R)	900(R)	1200(R)	
Continuous reverse voltage	V_R	max.	200	400	600	800	V
Crest working reverse voltage	V_{RWM}	max.	200	400	600	800	V
Repetitive peak reverse voltage (δ = 0,01)	V_{RRM}	max.	300	600	900	1200	V
Non-repetitive peak reverse voltage (t ≤ 10 ms)	V_{RSM}	max.	300	600	900	1200	V

Currents

Average forward current (averaged over any 20 ms period) up to T_{mb} = 85 °C	$I_{F(AV)}$	max.	6,0	A
at T_{mb} = 120 °C	$I_{F(AV)}$	max.	3,0	A
without heatsink; at T_{amb} = 50 °C	$I_{F(AV)}$	max.	1,1	A
Forward current (d.c.)	I_F	max.	9,5	A
R.M.S. forward current	$I_{F(RMS)}$	max.	9,5	A
Repetitive peak forward current	I_{FRM}	max.	20	A
Non-repetitive peak forward current (t = 10 ms; half sine wave) T_j = 150 °C prior to surge	I_{FSM}	max.	40	A
I^2t for fusing (t = 10 ms)	I^2t	max.	8,0	A^2s

Temperatures

Storage temperature	T_{stg}		−55 to +125	°C
Junction temperature	T_j	max.	150	°C

THERMAL RESISTANCE

From junction to mounting base	$R_{th\ j\text{-}mb}$	=	4,5	$^oC/W$
Transient thermal impedance; t = 1 ms	$Z_{th\ j\text{-}mb}$	=	0,3	$^oC/W$

Influence of mounting method

1. Heatsink mounted

From mounting base to heatsink

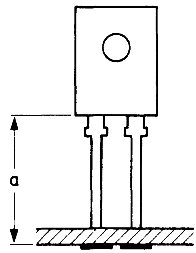
a. with heatsink compound	$R_{th\ mb\text{-}h}$	=	1,5	$^oC/W$
b. with heatsink compound and 56316 mica washer	$R_{th\ mb\text{-}h}$	=	2,7	$^oC/W$
c. without heatsink compound	$R_{th\ mb\text{-}h}$	=	2,7	$^oC/W$
d. without heatsink compound; with 56316 mica washer	$R_{th\ mb\text{-}h}$	=	5	$^oC/W$

2. Free air operation

The quoted values of $R_{th\ j\text{-}a}$ should be used only when no other leads run to the tie-points.

From junction to ambient in free air mounted on a printed circuit board
at a = maximum lead length
and with a copper laminate

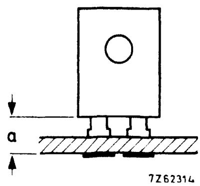
a. > 1 cm^2 $R_{th\ j\text{-}a}$ = 50 $^oC/W$
b. < 1 cm^2 $R_{th\ j\text{-}a}$ = 55 $^oC/W$



7Z62315.1

at a lead-length a = 3 mm
and with a copper laminate

c. > 1 cm^2 $R_{th\ j\text{-}a}$ = 55 $^oC/W$
d. < 1 cm^2 $R_{th\ j\text{-}a}$ = 60 $^oC/W$



7Z62314

CHARACTERISTICS

Forward voltage

I_F = 20 A; T_j = 25 °C	V_F	<	2,3	V [1]

Peak reverse current

V_{RM} = V_{RWMmax}; T_j = 125 °C	I_{RM}	<	200	µA

SOLDERING AND MOUNTING NOTES

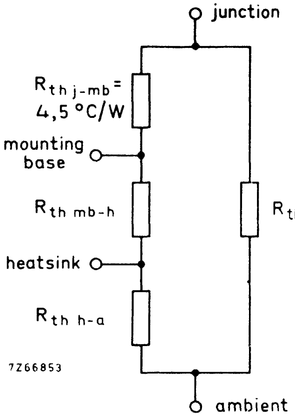
1. Soldered joints must be at least 2,5 mm from the seal.
2. A soldering iron must not be in contact with the joint for more than 3 seconds.
3. The maximum permissible temperature of the soldering iron or bath is 270 °C; it must not be in contact with the joint for more than 3 seconds.
4. The devices should not be immersed in oil, and few potting resins are suitable for re-encapsulation. Advice on these materials is available on request.
5. Leads should not be bent less than 2,5 mm from the seal; exert no axial pull when bending.
6. For good thermal contact heatsink component should be used between base-plate and heatsink.

[1]) Measured under pulse conditions to avoid excessive dissipation.

OPERATING NOTES

Dissipation and heatsink considerations:

a. The various components of junction temperature rise above ambient are illustrated below:

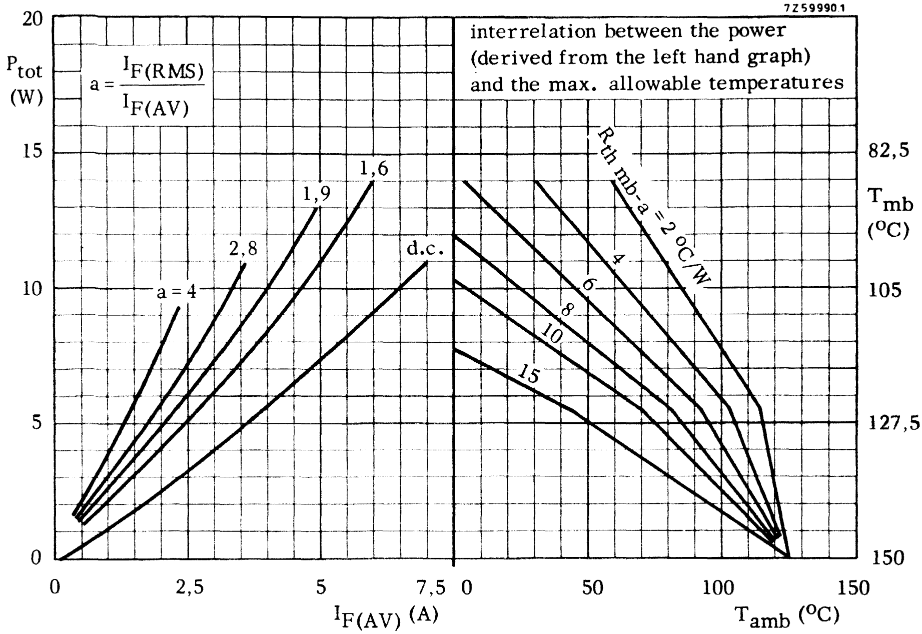


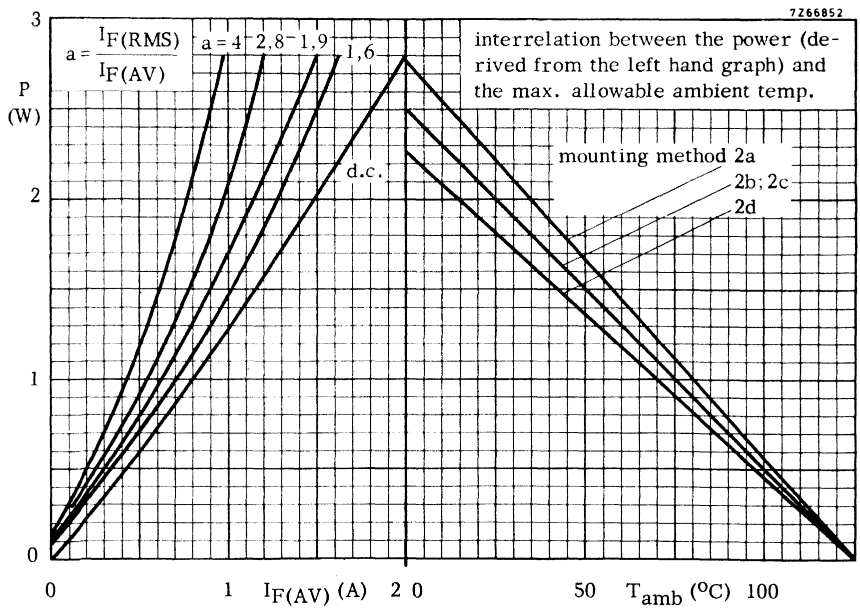
b. The method of using the graph on page 7 is as follows:
Starting with the curve of maximum dissipation as a function of $I_{F(AV)}$, for a particular current value trace upwards to meet the appropriate form factor curve. Trace horizontally until the $R_{th\ mb\text{-}a}$ curve is reached.
Finally trace upwards from the T_{amb} scale. The intersection determines the $R_{th\ mb\text{-}a}$ required.
The heatsink thermal resistance value ($R_{th\ h\text{-}a}$) can now be calculated from:

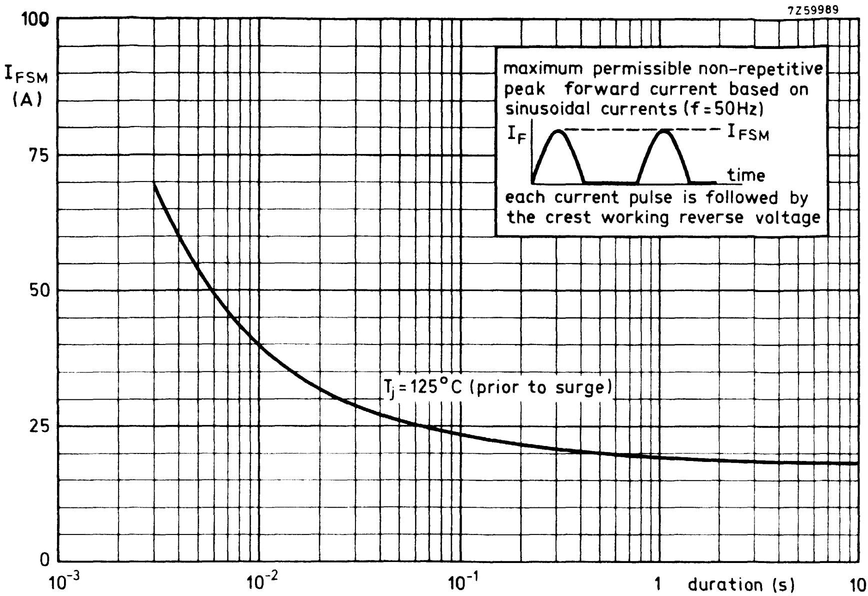
$$R_{th\ h\text{-}a} = R_{th\ mb\text{-}a} - R_{th\ mb\text{-}h}$$

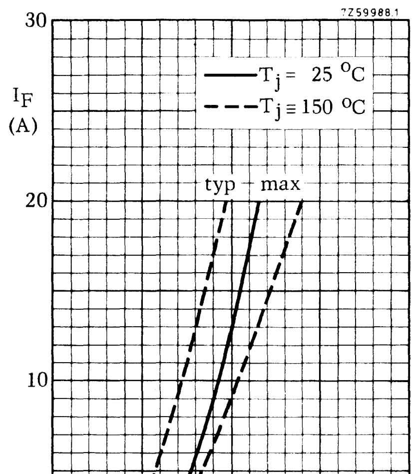
Any measurement of heatsink temperature should be made immediately adjacent to the device.

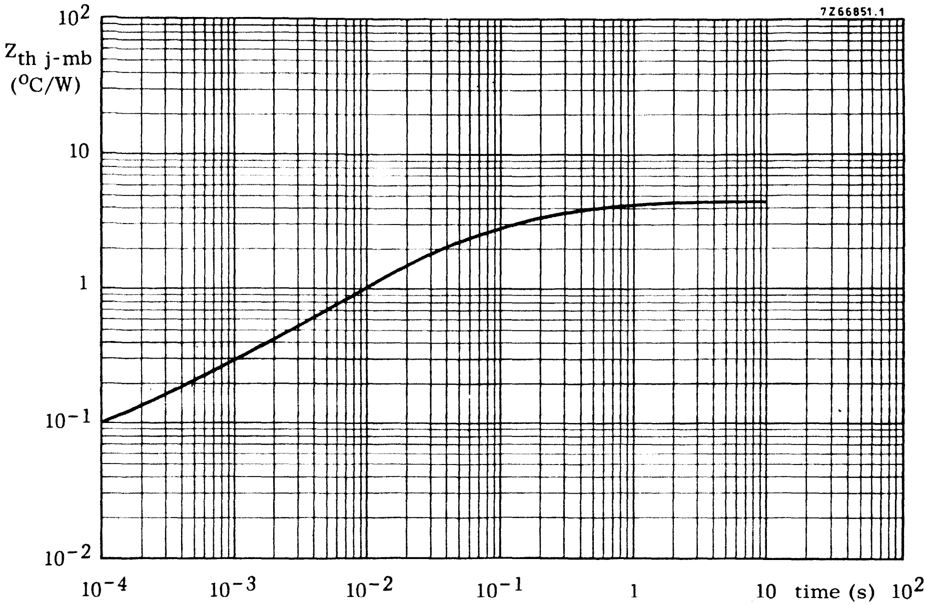
c. The heatsink curves are optimised to allow the junction temperature to run up to 150 °C ($T_{j\,max}$) whilst limiting T_{mb} to 125 °C (or less).


7Z59990.1
20
15
10
5
0
P_{tot} (W)
$a = \frac{I_{F(RMS)}}{I_{F(AV)}}$
a = 4
2,8
1,9
1,6
d.c.
0
2,5
5
7,5
$I_{F(AV)}$ (A)
interrelation between the power (derived from the left hand graph) and the max. allowable temperatures
$R_{th\ mb-a}$ = 2 °C/W
4
6
8
10
15
0
50
100
150
T_{amb} (°C)
82,5
105
127,5
150
T_{mb} (°C)


7Z66852
3
2
1
0
P (W)
$a = \frac{I_{F(RMS)}}{I_{F(AV)}}$
a = 4
2,8
1,9
1,6
d.c.
0
1
2
$I_{F(AV)}$ (A)
interrelation between the power (derived from the left hand graph) and the max. allowable ambient temp.
mounting method 2a
2b; 2c
2d
0
50
100
T_{amb} (°C)


7Z59989
100
I_{FSM}
(A)
75
50
25
0
maximum permissible non-repetitive peak forward current based on sinusoidal currents (f = 50Hz)
I_F
I_{FSM}
time
each current pulse is followed by the crest working reverse voltage
T_j = 125°C (prior to surge)
10^{-3}
10^{-2}
10^{-1}
1
duration (s)
10


7Z59988.1
30
I_F
(A)
T_j = 25 °C
T_j = 150 °C
typ
max
20
10
0
0
2
V_F(V)
4


7Z66851.1
10^2
$Z_{th\ j\text{-}mb}$
(°C/W)
10
1
10^{-1}
10^{-2}
10^{-4}
10^{-3}
10^{-2}
10^{-1}
1
10
time (s)
10^2

FAST RECOVERY RECTIFIER DIODES

Diffused silicon diodes in a DO-4 metal envelope, 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 (cathode to stud): BYX50-200 to BYX50-600
Reverse polarity (anode to stud): BYX50-200R to BYX50-600R.

QUICK REFERENCE DATA

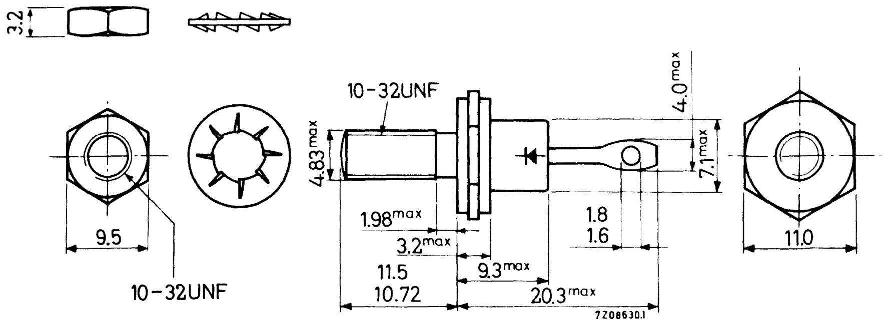
			BYX50-200(R)	300(R)	400(R)	500(R)	600(R)
Crest working reverse voltage	V_{RWM}	max.	200	300	400	500	600
Repetitive peak reverse voltage	V_{RRM}	max.	200	300	400	500	600

Average forward current up to T_{mb} = 110 °C	$I_{F(AV)}$	max.	6	A
at T_{mb} = 125 °C	$I_{F(AV)}$	max.	4	A
Non-repetitive peak forward current t = 10 ms; T_j = 150 °C (prior to surge)	I_{FSM}	max.	80	A
Junction temperature	T_j	max.	150	°C
Reverse recovery time when switched form I_F = 4 A to V_R = 30 V −dI/dt = 4 A/µs	t_{rr}	<	500	ns

MECHANICAL DATA see page 2

MECHANICAL DATA Dimensions in mm

DO-4



Net weight: 6.5 g

Torque on nut: min. 8 kg cm (0.8 Newton metres) max. 17 kg cm (1.7 Newton metres)

Diameter of clearance hole: max. 5.2 mm

Accessories supplied on request: 56295

The mark shown applies to the normal polarity type

All information applies to frequencies up to 50 kHz

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

Voltages [1]			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
Repetitive peak reverse voltage	V_{RRM}	max.	200	300	400	500	600	V
Non-repetitive peak reverse voltage ($t \leq 10$ ms)	V_{RSM}	max.	250	350	450	550	650	V

[1]) To ensure thermal stability: $R_{th\ j\text{-}a} \leq 6.5\,^{o}C/W$ (d.c.) or $\leq 13\,^{o}C/W$ (a.c.).
For smaller heatsinks $T_{j\ max}$ should be derated (see page 4 upper graph)

RATINGS (continued)

Currents

Average forward current (averaged over any 20 ms period) up to T_{mb} = 110 °C	$I_{F(AV)}$	max.	6	A
at T_{mb} = 125 °C	$I_{F(AV)}$	max.	4	A
Forward current (d.c.)	I_F	max.	10	A
R.M.S. forward current	$I_{F(RMS)}$	max.	10	A
Repetitive peak forward current	I_{FRM}	max.	40	A
Non-repetitive peak forward current t = 10 ms; T_j = 150 °C prior to surge	I_{FSM}	max.	80	A
I^2t for fusing (t = 10 ms)	I^2t	max.	32	A^2s
Repetitive peak reverse current (during turn-off)	I_{RRM}	max.	10	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
From junction to mounting base	$R_{th\ j-mb}$	=	3.5	°C/W
From mounting base to heatsink	$R_{th\ mb-h}$	=	0.5	°C/W
Transient thermal impedance; t = 1 ms	$Z_{th\ j-mb}$	=	1	°C/W

CHARACTERISTICS

Forward voltage at I_F = 20 A; T_j = 25 °C — V_F < 1.95 V

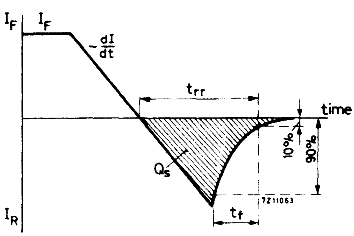
Peak reverse current at T_j = 125 °C
$V_{RM} = V_{RWMmax}$ — I_{RM} < 1.4 mA

Reverse recovery when switched from

I_F = 1 A to V_R = 30 V with $-\frac{dI}{dt}$ = 100 A/µs; T_j = 150 °C — t_{rr} < 200 ns

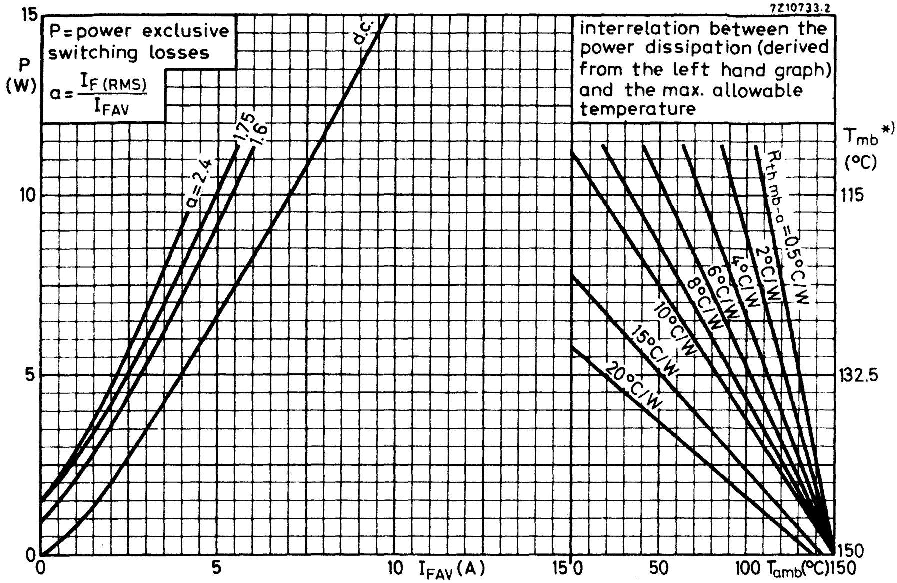
I_F = 4 A to V_R = 30 V with $-\frac{dI}{dt}$ = 4 A/µs; T_j = 25 °C

Recovery charge	Q_s	<	250	nC
Recovery time	t_{rr}	<	500	ns
Fall time	t_f	<	250	ns

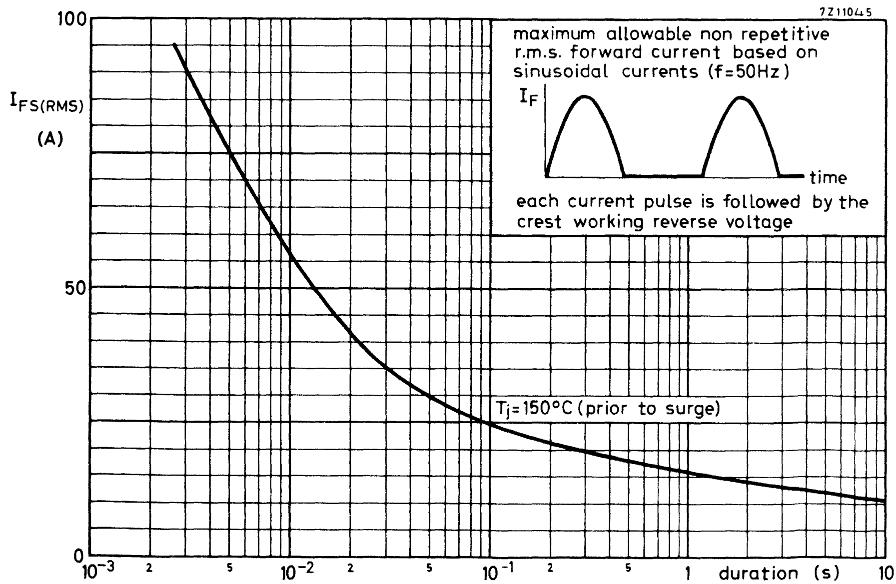


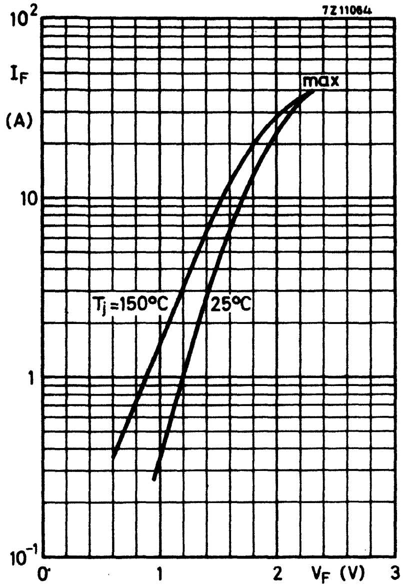
APPLICATION INFORMATION AND OPERATING NOTES

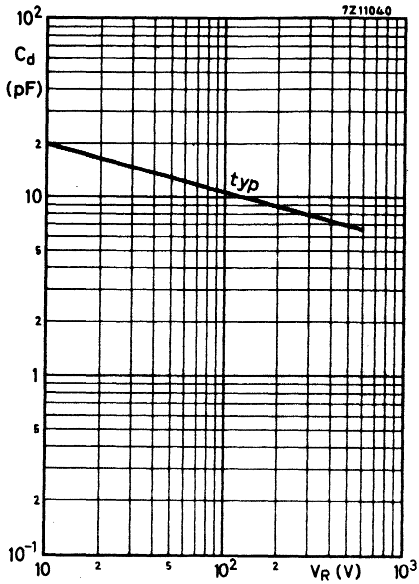
See general pages at the beginning of this section

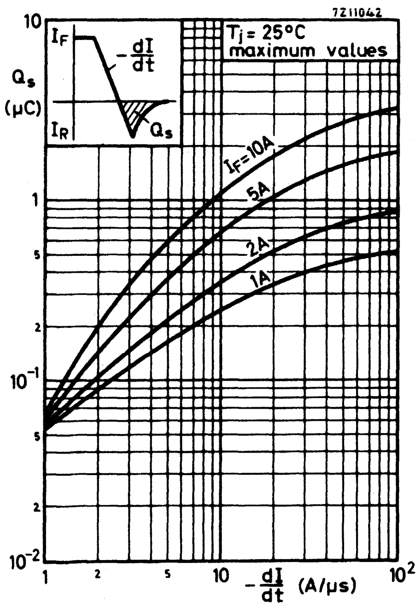


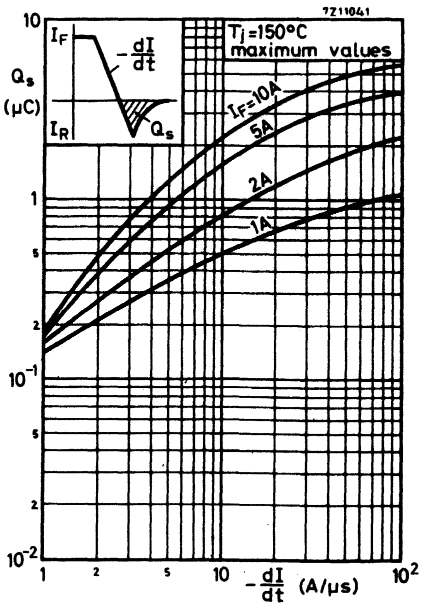
*) T_{mb}-scale is for comparison purposes only and is correct only for $R_{th\ mb-a} \leq 9.5\ °C/W$

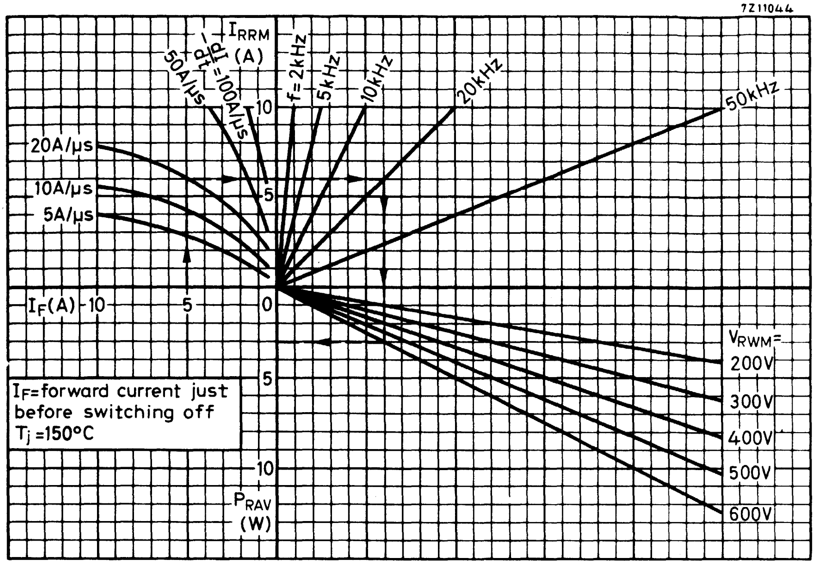



7Z11064
10^2
I_F
(A)
max
10
T_j=150°C
25°C
1
10^{-1}
0
1
2
V_F (V)
3

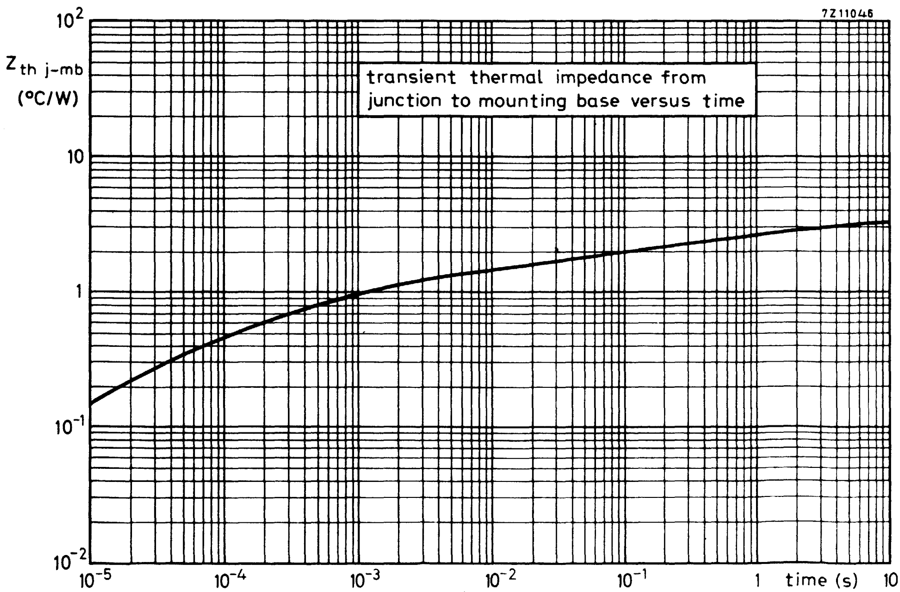

7Z11040
10^2
C_d
(pF)
2
typ
10
5
2
1
5
2
10^{-1}
10
2
5
10^2
2
V_R (V)
10^3

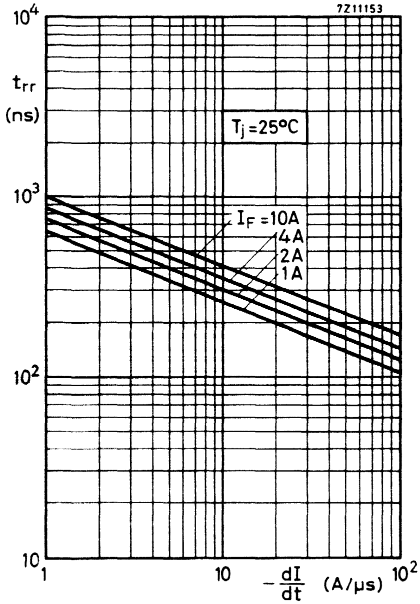

7Z11042
10
I_F
$-\frac{dI}{dt}$
Q_s
(μC)
I_R
Q_s
T_j = 25°C
maximum values
I_F=10A
5A
2A
1A
1
5
2
10^{-1}
5
2
10^{-2}
1
2
5
10
$-\frac{dI}{dt}$ (A/μs)
10^2

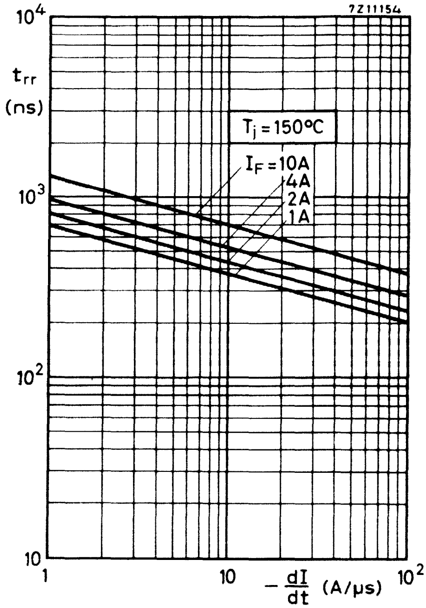

7Z11041
10
I_F
$-\frac{dI}{dt}$
Q_s
(μC)
I_R
Q_s
T_j=150°C
maximum values
I_F=10A
5A
2A
1A
1
5
2
10^{-1}
5
2
10^{-2}
1
2
5
10
$-\frac{dI}{dt}$ (A/μs)
10^2



Nomogram: Power loss P_{RAV} due to switching only (square wave operation)




7Z11153
10^4
t_{rr}
(ns)
$T_j = 25°C$
10^3
$I_F = 10A$
4A
2A
1A
10^2
10
1
10
$-\frac{dI}{dt}$ (A/μs)
10^2


7Z11154
10^4
t_{rr}
(ns)
$T_j = 150°C$
$I_F = 10A$
4A
2A
1A
10^3
10^2
10
1
10
$-\frac{dI}{dt}$ (A/μs)
10^2

SILICON RECTIFIER DIODES

Silicon rectifier diodes in a DO-5 metal envelope intended for power rectifier applications. The series consists of the following types.
Normal polarity (cathode to stud): BYX52-300 to BYX52-1200
Reverse polarity (anode to stud) : BYX52-300R to BYX52-1200R.

QUICK REFERENCE DATA

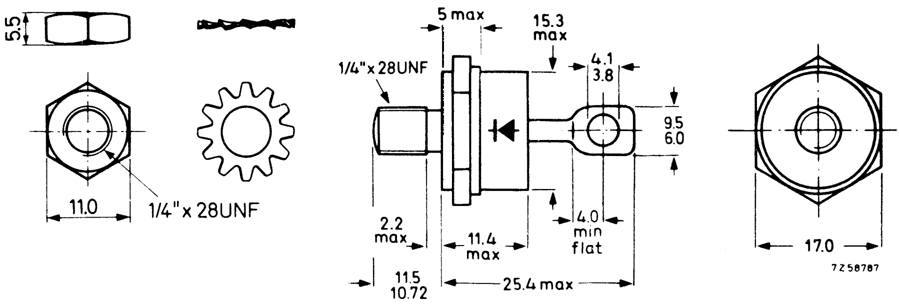
			BYX52-300(R)	600(R)	900(R)	1200(R)	
Crest working reverse voltage	V_{RWM}	max.	200	400	600	800	V
Repetitive peak reverse voltage	V_{RRM}	max.	300	600	900	1200	V

Average forward current up to T_{mb} = 110 °C	$I_{F(AV)}$	max.	48	A
at T_{mb} = 125 °C	$I_{F(AV)}$	max.	40	A
Non-repetitive peak forward current (t = 10 ms) T_j = 175 °C prior to surge	I_{FSM}	max.	800	A
Junction temperature	T_j	max.	175	°C/W

MECHANICAL DATA

Dimensions in mm

DO-5



Net weight: 20.5 g
Diameter of clearance hole: max. 6.5 mm
Accessories supplied on request:
56264A; 56309B; 56309R
The mark shown applies to the normal polarity types

Torque on nut: min. 17.5 kg cm
(1.75 Newton-metres)
max. 35 kg cm
(3.5 Newton-metres)

All information applies to frequencies up to 400 Hz

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

Voltages			BYX52-300(R)	600(R)	900(R)	1200(R)	
Crest working reverse voltage	V_{RWM}	max.	200	400	600	800	V
Repetitive peak reverse voltage (δ = 0.01)	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) up to T_{mb} = 110 °C	$I_{F(AV)}$	max.	48	A
at T_{mb} = 125 °C	$I_{F(AV)}$	max.	40	A
R.M.S. forward current	$I_{F(RMS)}$	max.	75	A
Forward current (d.c.)	I_F	max.	75	A
Repetitive peak forward current	I_{FRM}	max.	450	A
Non-repetitive peak forward current (t = 10 ms; half sine wave) T_j = 175 °C prior to surge	I_{FSM}	max.	800	A
I^2t for fusing (t = 10 ms)	I^2t	max.	3200	A^2s

Temperatures

Storage temperature	T_{stg}		−55 to +175	°C
Junction temperature	T_j	max.	175	°C

THERMAL RESISTANCE

From junction to mounting base	$R_{th\ j\text{-}mb}$	=	0.8	°C/W
From mounting base to heatsink	$R_{th\ mb\text{-}h}$	=	0.2	°C/W

CHARACTERISTICS

Forward voltage

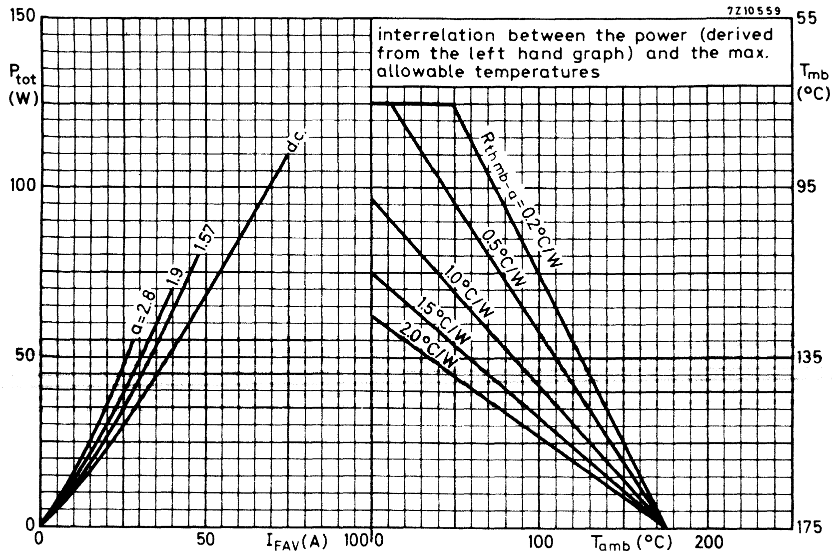
I_F = 150 A; T_j = 25 °C	V_F	<	1.8	V

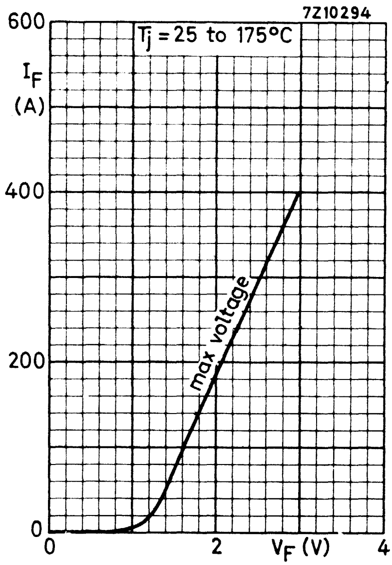
Peak reverse current

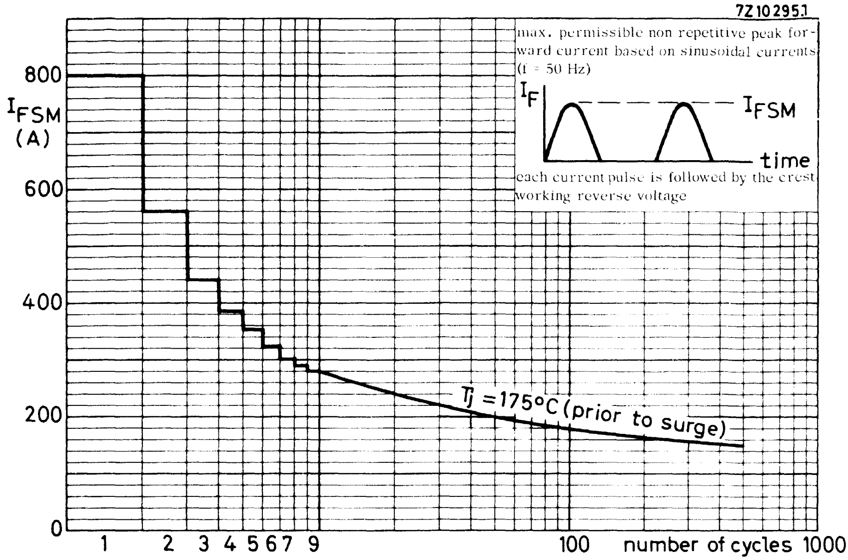
$V_{RM} = V_{RWMmax}$; T_j = 125 °C	I_{RM}	<	1.6	mA

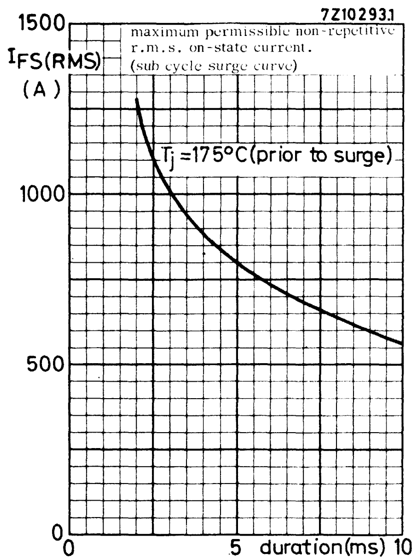
OPERATING NOTES (See also general pages at the beginning of this section)

The top connector should neither be bent nor twisted; it should be soldered into the circuit so that there is no strain on it.


7Z10559
interrelation between the power (derived from the left hand graph) and the max. allowable temperatures
150
100
50
0
Ptot (W)
0
50
IFAV(A)
100
a=2.8
1.9
1.57
d.c.
0
100
Tamb (°C)
200
55
95
135
175
Tmb (°C)
Rth mb-a = 0.2°C/W
0.5°C/W
1.0°C/W
1.5°C/W
2.0°C/W


7Z10294
Tj = 25 to 175°C
600
400
200
0
IF (A)
0
2
VF (V)
4
max voltage


7Z10295.1
max. permissible 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
800
I_FSM
(A)
600
400
200
0
1
2
3
4
5
6
7
9
100
number of cycles
1000
Tj = 175°C (prior to surge)


7Z10293.1
1500
I_FS(RMS)
(A)
maximum permissible non-repetitive r.m.s. on-state current.
(sub cycle surge curve)
Tj = 175°C (prior to surge)
1000
500
0
0
5
duration (ms)
10

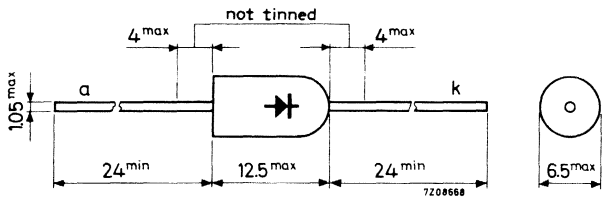
FAST SOFT-RECOVERY RECTIFIER DIODES

Silicon double diffused rectifier diodes in a plastic envelope. They are intended for use in inverter and converter applications as well as in switched-mode power supplies, scan rectifiers in television receivers and other h.f. power supplies. The devices feature non snap-off characteristics.

QUICK REFERENCE DATA					
			BYX55-350	-600	
Working reverse voltage	V_{RW}	max.	300	500	V
Repetitive peak reverse voltage	V_{RRM}	max.	350	600	V
Average forward current	$I_{F(AV)}$	max.	1.2		A
Non-repetitive peak forward current t = 10 ms; T_j = 125 °C prior to surge	I_{FSM}	max.	40		A
Junction temperature	T_j	max.	125		°C
Reverse recovery charge when switched from I_F = 1 A to $V_R \geq$ 50 V with $-dI/dt$ = 1 A/µs; T_j = 25 °C	Q_s	<	120		nC

MECHANICAL DATA

Dimensions in mm



The rounded end indicates the cathode side.

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 in accordance with the Absolute Maximum System (IEC134)

Voltages			BYX55 -350	-600	
Continuous reverse voltage	V_R	max.	300	500	V
Working reverse voltage	V_{RW}	max.	300	500	V
Repetitive peak reverse voltage ($t \leq 10\ \mu s$)	V_{RRM}	max.	350	600	V
Non-repetitive peak reverse voltage ($t \leq 10$ ms)	V_{RSM}	max.	350	600	V

Currents				
Average forward current (averaged over any 20 ms period), see also pages 4 and 5	$I_{F(AV)}$	max.	1.2	A
Repetitive peak forward current	I_{FRM}	max.	8	A
Non-repetitive peak forward current ($t = 10$ ms; half sine wave) $T_j = 125\ ^oC$ prior to surge	I_{FSM}	max.	40	A
Rate of change of commutation current See also nomogram on page 6	$-\frac{dI}{dt}$	max.	20	A/μs

Temperatures				
Storage temperature	T_{stg}		-40 to +125	^oC
Junction temperature	T_j	max.	125	^oC

THERMAL RESISTANCE See page 3

CHARACTERISTICS

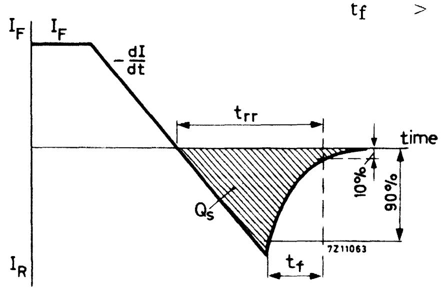
Forward voltage $I_F = 5$ A; $T_j = 25\ ^oC$	V_F	<	1.25	V[1]
Reverse current				
$V_R = V_{RWmax}$; $T_j = 125\ ^oC$	I_R	<	0.75	mA
$V_R = V_{RWmax}$; $T_j = 25\ ^oC$	I_R	<	10	μA
Capacitance at f = 1 MHz $V_R = 250$ V; $T_j = 25$ to $125\ ^oC$	C_d	typ.	8	pF

[1]) Measured under pulse conditions to avoid excessive dissipation.

CHARACTERISTICS (continued)

Reverse recovery when switched from
I_F = 1 A to V_R ≥ 50 V with −dI/dt =
T_j = 25 °C

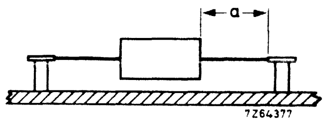
			1	20	A/µs
Recovery charge	Q_s	<	120	400	nC
Recovery time	t_{rr}	<	750	350	ns
Fall time	t_f	>	120	100	ns



THERMAL RESISTANCE (influence of mounting method)

The quoted values of $R_{th\ j\text{-}a}$ should be used only when no other leads run to the tie-points. If the leads of other dissipating components share the same tie-points, the thermal resistance will be higher than that quoted.

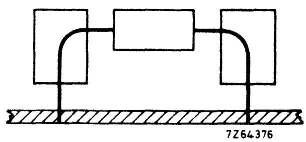
1. Mounted on solder tags at a lead-length: a = 10 mm — $R_{th\ j\text{-}a}$ = 60 °C/W
   a = max. lead length — $R_{th\ j\text{-}a}$ = 70 °C/W



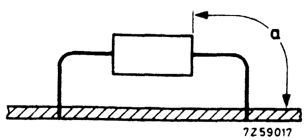
2. Mounted on printed-wiring board at a = maximum lead-length and heatsinks (0, 3 mm Cu) on leads.

   Heatsink size 2 cm² (per side) — $R_{th\ j\text{-}a}$ = 60 °C/W

   Heatsink size 1 cm² (per side) — $R_{th\ j\text{-}a}$ = 70 °C/W

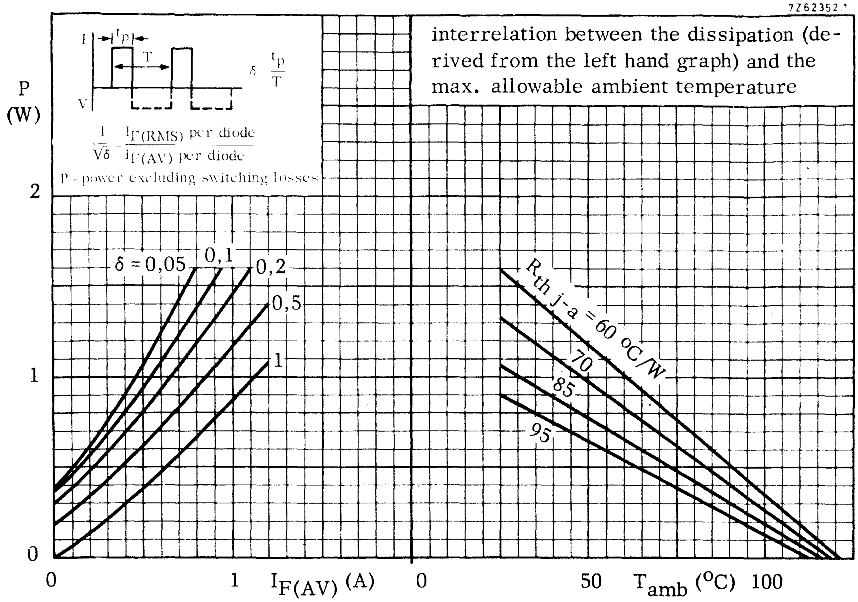


3. Mounted on printed-wiring board at a = maximum lead-length. — $R_{th\ j\text{-}a}$ = 85 °C/W
4. Mounted on printed-wiring board at a lead-length a = 10 mm. — $R_{th\ j\text{-}a}$ = 95 °C/W

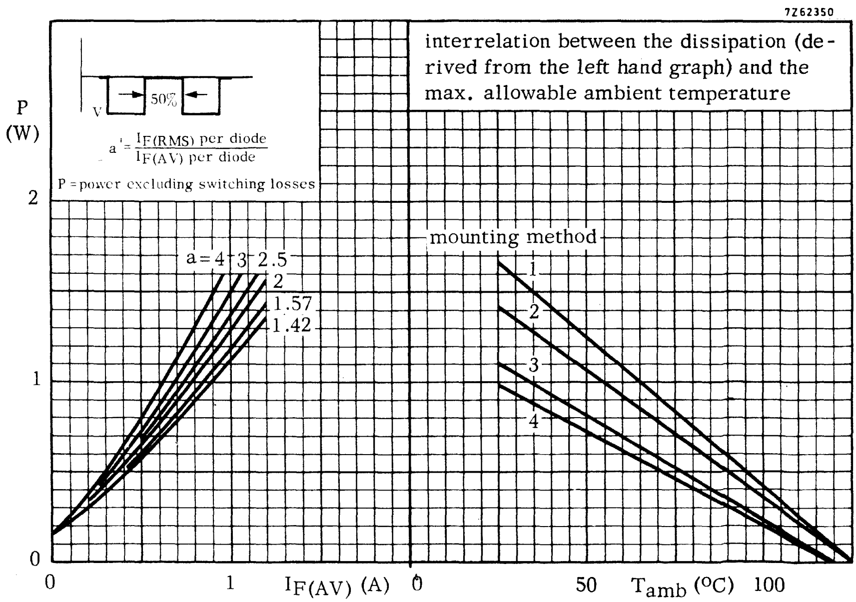


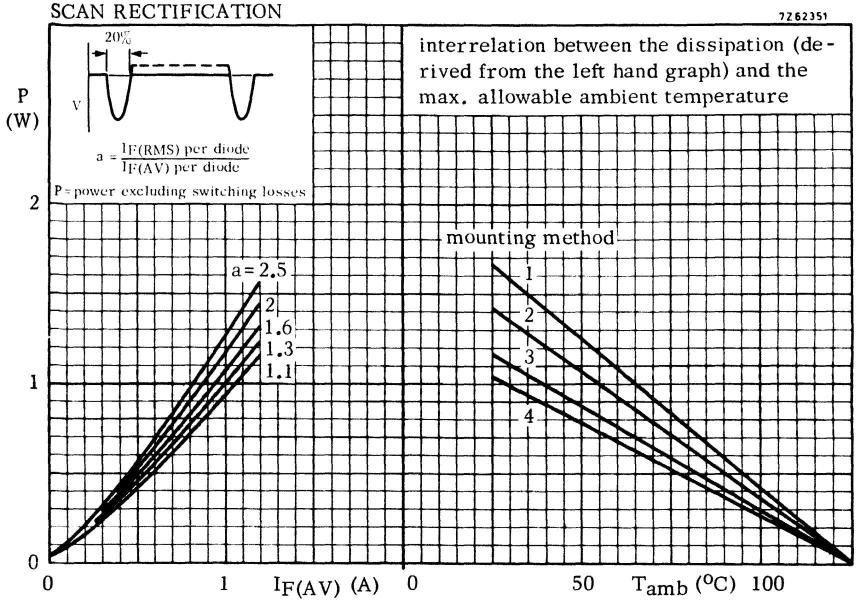
SOLDERING AND MOUNTING NOTES

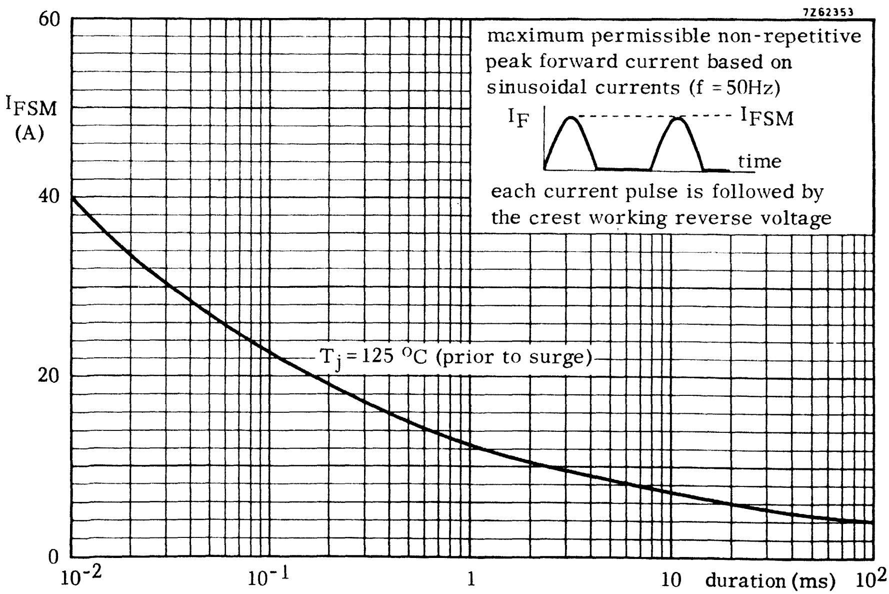
1. Soldered joints must be at least 5 mm from the seal.
2. The maximum permissible temperature of the soldering iron or bath is 300 °C; it must be in contact with the joint for no more than 3 seconds.
3. Avoid hot spots due to handling or mounting; the body of the device must not come into contact with or be exposed to a temperature higher than 150 °C.

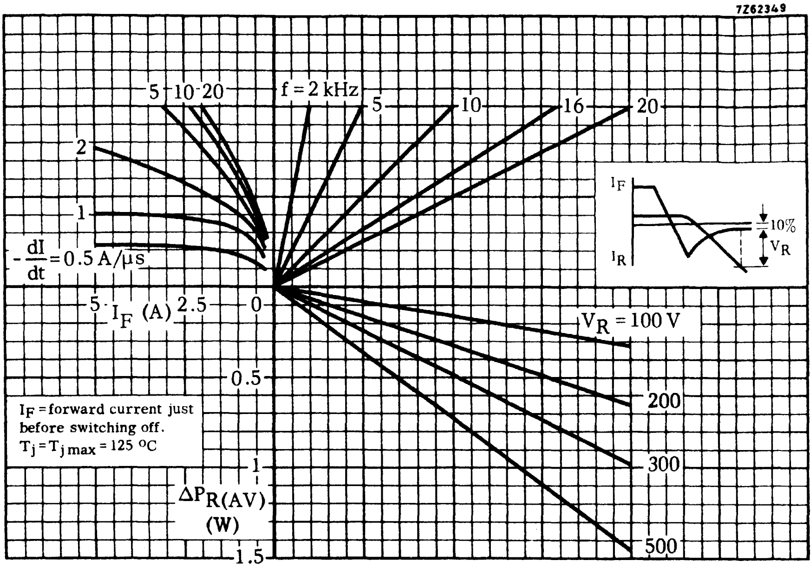


SWITCHED-MODE APPLICATION

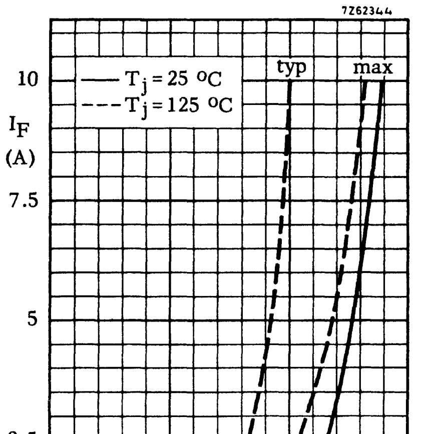


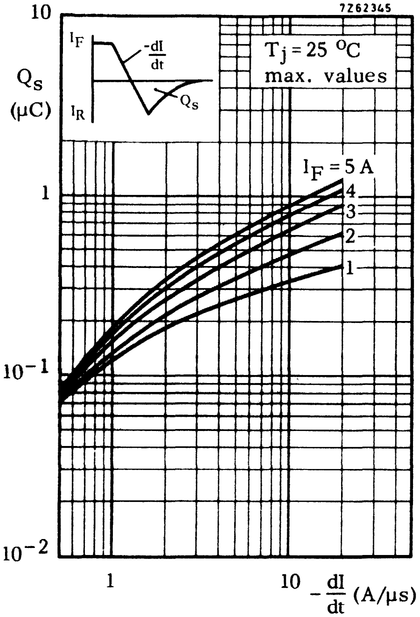

SCAN RECTIFICATION
7Z62351
20%
V
a = IF(RMS) per diode / IF(AV) per diode
P = power excluding switching losses
P (W)
interrelation between the dissipation (derived from the left hand graph) and the max. allowable ambient temperature
mounting method
a = 2.5
2
1.6
1.3
1.1
1
2
3
4
0
1
2
0
1
IF(AV) (A)
0
50
Tamb (°C)
100

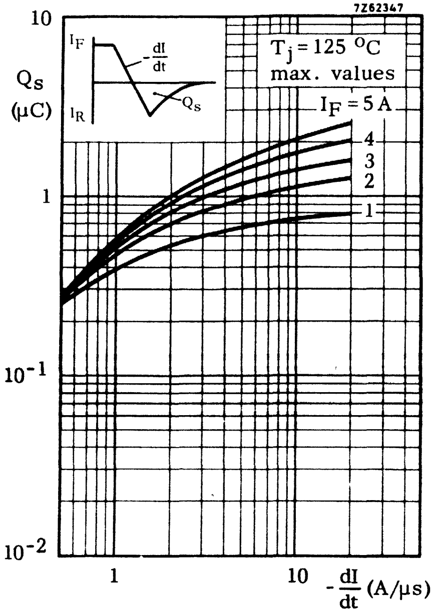

7Z62353
IFSM (A)
maximum permissible non-repetitive peak forward current based on sinusoidal currents (f = 50Hz)
IF
IFSM
time
each current pulse is followed by the crest working reverse voltage
Tj = 125 °C (prior to surge)
0
20
40
60
10^-2
10^-1
1
10
duration (ms)
10^2

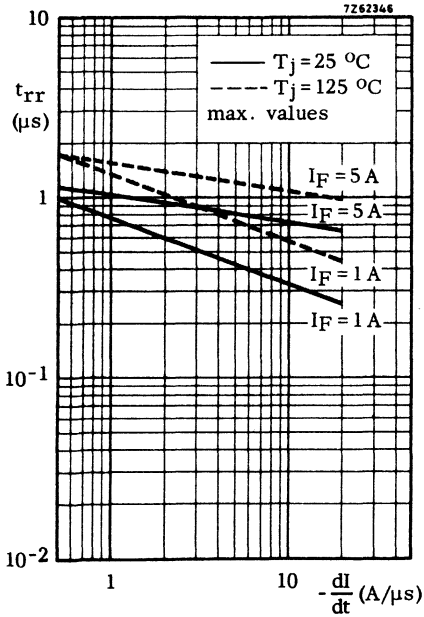


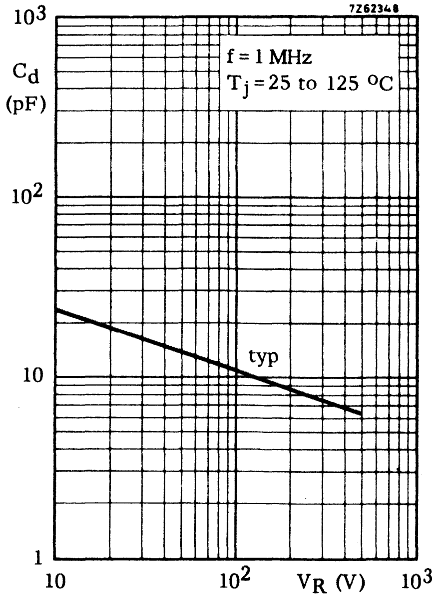
nomogram: power loss $\Delta P_{R(AV)}$ due to switching only (to be added to forward and reverse power losses)




7Z62345
Q_s (μC)
$T_j = 25$ °C
max. values
$I_F = 5$ A
4
3
2
1
$-\frac{dI}{dt}$ (A/μs)


7Z62347
Q_s (μC)
$T_j = 125$ °C
max. values
$I_F = 5$ A
4
3
2
1
$-\frac{dI}{dt}$ (A/μs)


7Z62346
t_{rr} (μs)
$T_j = 25$ °C
$T_j = 125$ °C
max. values
$I_F = 5$ A
$I_F = 5$ A
$I_F = 1$ A
$I_F = 1$ A
$-\frac{dI}{dt}$ (A/μs)


7Z62348
C_d (pF)
f = 1 MHz
$T_j = 25$ to 125 °C
typ
V_R (V)

CONTROLLED AVALANCHE RECTIFIER DIODES

Silicon diodes in a DO-5 metal envelope, capable of absorbing transients and intended for power rectifier applications.
The series consists of the following types:
Normal polarity (cathode to stud): BYX56-600; BYX56-800; BYX56-1000.
Reverse polarity (anode to stud): BYX56-600R; BYX56-800R; BYX56-1000R.

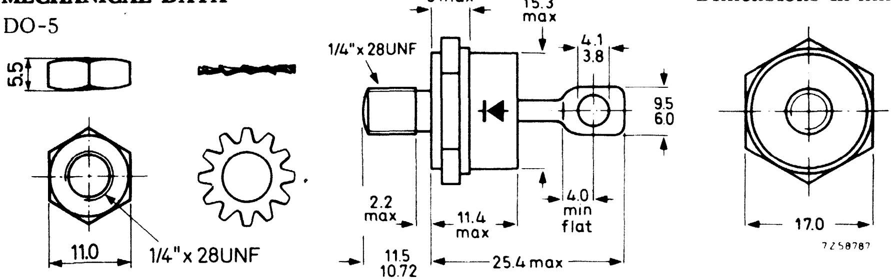
QUICK REFERENCE DATA

			BYX56-600(R)	800(R)	1000(R)	
Crest working reverse voltage	V_{RWM}	max.	600	800	1000	V
Reverse avalanche breakdown voltage	$V_{(BR)R}$	>	750	1000	1250	V
Average forward current						
up to T_{mb} = 110 °C	$I_{F(AV)}$	max.	47	A		
at T_{mb} = 125 °C	$I_{F(AV)}$	max.	40	A		
Non-repetitive peak forward current t = 10 ms; T_j = 175 °C prior to surge	I_{FSM}	max.	800	A		
Non-repetitive peak reverse power dissipation (t = 10 μs; T_j = 25 °C)	P_{RSM}	max.	40	kW		
Junction temperature	T_j	max.	175	°C		

MECHANICAL DATA

Dimensions in mm

DO-5



Net weight: 20.5 g
Diameter of clearance hole: max. 6.5 mm
Accesories supplied on request:
56264A; 56309B; 56309R

Torque on nut: min. 17.5 kg cm
(1.75 Newton-metres)
max. 35 kg cm
(3.5 Newton-metres)
The mark shown applies to normal polarity types

All information applies to frequencies up to 400 Hz

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

Voltages			BYX56-600(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) up to T_{mb} = 110 °C	$I_{F(AV)}$	max.	47	A
at T_{mb} = 125 °C	$I_{F(AV)}$	max.	40	A
Forward current (d.c.)	I_F	max.	75	A
R.M.S. forward current	$I_{F(RMS)}$	max.	75	A
Repetitive peak forward current	I_{FRM}	max.	450	A
Non-repetitive peak forward current t = 10 ms; half sine-wave; T_j = 175 °C prior to surge	I_{FSM}	max.	800	A
I squared t for fusing (t $\leq$ 10 ms)	I^2t	max.	3200	A^2s

Reverse power dissipation

Repetitive peak reverse power dissipation t = 10 μs (square wave; f = 50 Hz) T_j = 175 °C	P_{RRM}	max.	6.5	kW
Non-repetitive peak reverse power dissipation t = 10 μs (square wave) T_j = 25 °C prior to surge	P_{RSM}	max.	40	kW
T_j = 175 °C prior to surge	P_{RSM}	max.	6.5	kW

Temperatures

Storage temperature	T_{stg}		−55 to +175	°C
Junction temperature	T_j	max.	175	°C

THERMAL RESISTANCE

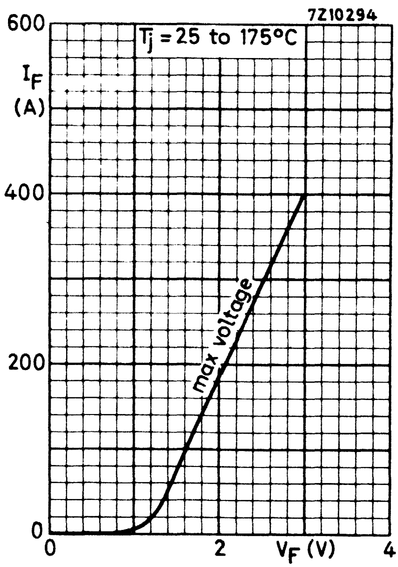
From junction to mounting base	$R_{th\ j-mb}$	=	0.8	°C/W
From mounting base to heatsink	$R_{th\ mb-h}$	=	0.2	°C/W
Transient thermal impedance (t = 1 ms)	$Z_{th\ j-h}$	=	0.03	°C/W

CHARACTERISTICS

		BYX56-600(R)	800(R)	1000(R)	
Forward voltage at I_F = 150 A; T_j = 25 °C	V_F	< 1.8	1.8	1.8	V [1]
Reverse avalanche breakdown voltage					
I_R = 5 mA; T_j = 25 °C	$V_{(BR)R}$	> 750	1000	1250	V
		< 2000	2000	2000	V
Peak reverse current					
$V_{RM} = V_{RWMmax}$; T_j = 125 °C	I_{RM}	< 1.6	1.6	1.6	mA

OPERATING NOTES (see general pages at the beginning of this section)

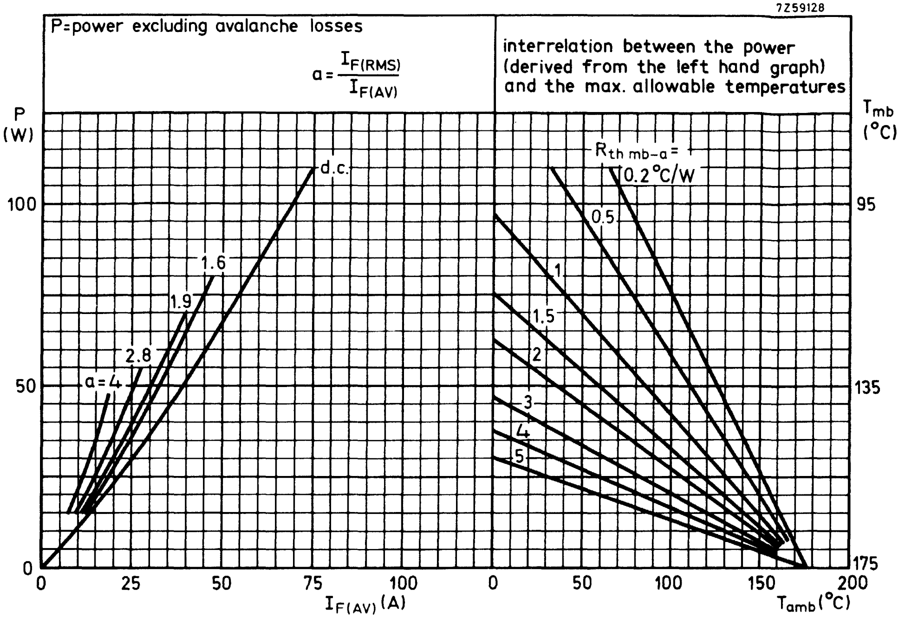
The top connector should neither be bent nor twisted; it should be soldered into the circuit so that there is no strain on it.
During soldering the heat conduction to the junction should be kept to a minimum by using a thermal shunt.

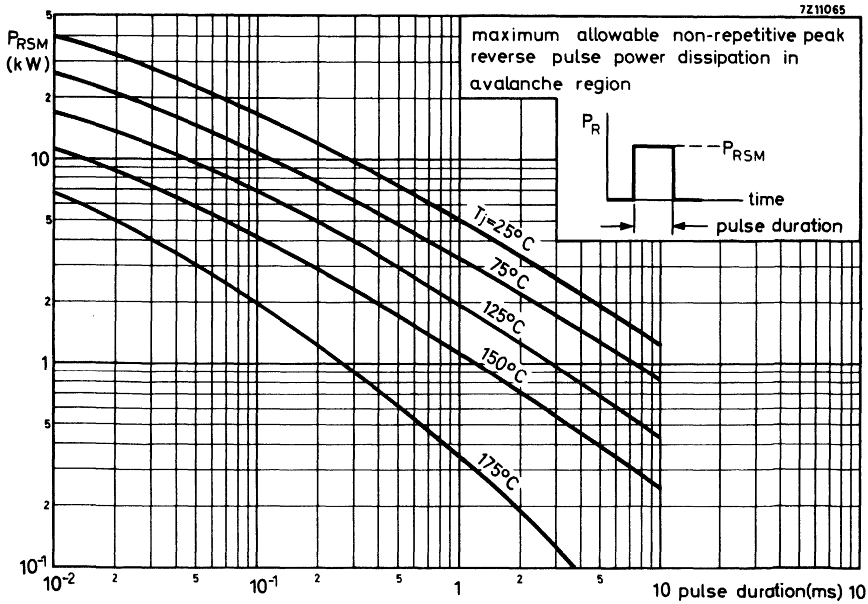


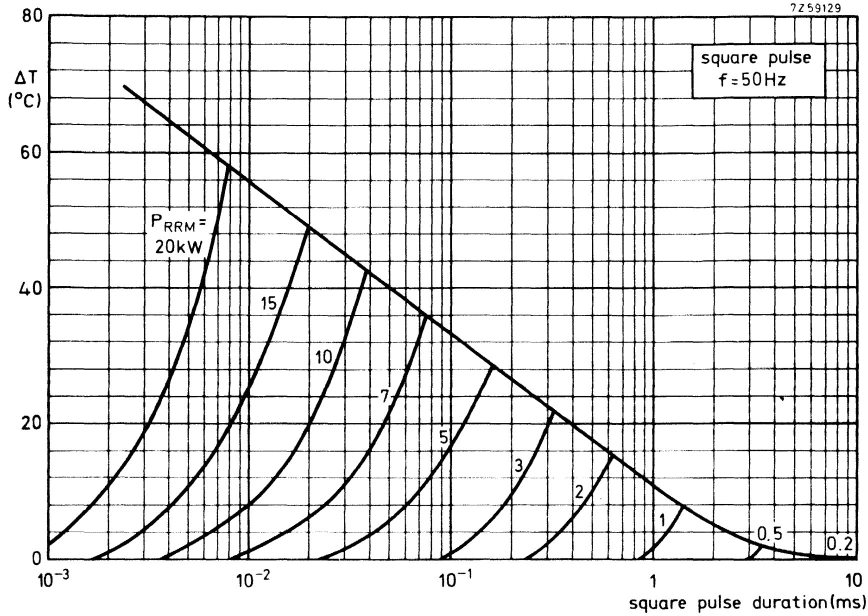
APPLICATION INFORMATION

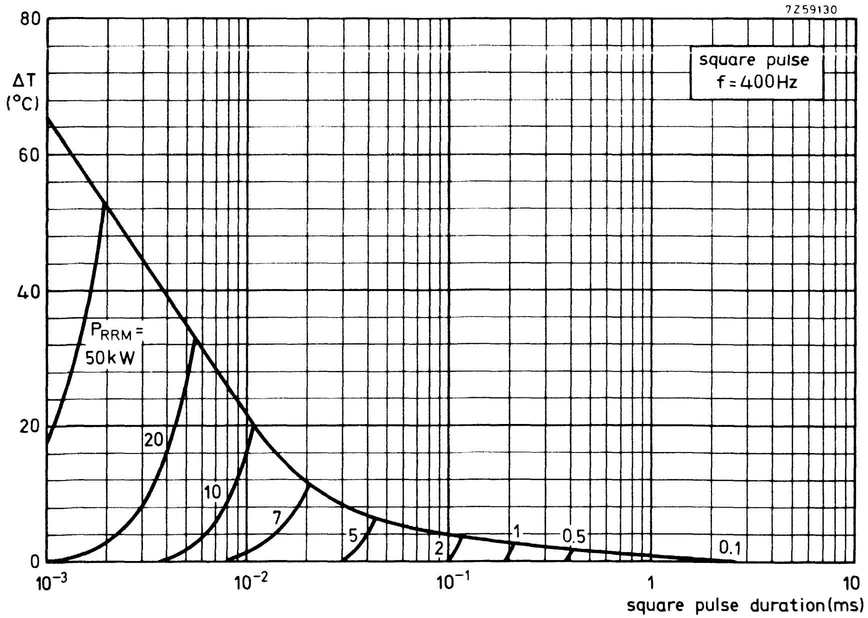
See general pages at the beginning of this section

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

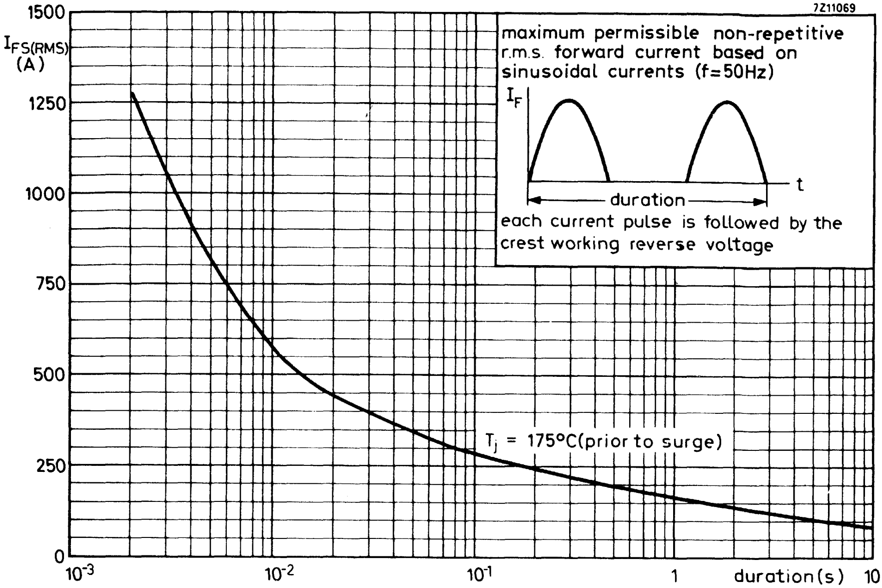

7Z59128
P=power excluding avalanche losses
a = I_F(RMS) / I_F(AV)
interrelation between the power (derived from the left hand graph) and the max. allowable temperatures
P (W)
T_mb (°C)
d.c.
1.6
1.9
2.8
a=4
R_th mb-a =
0.2 °C/W
0.5
1
1.5
2
3
4
5
I_F(AV) (A)
T_amb (°C)

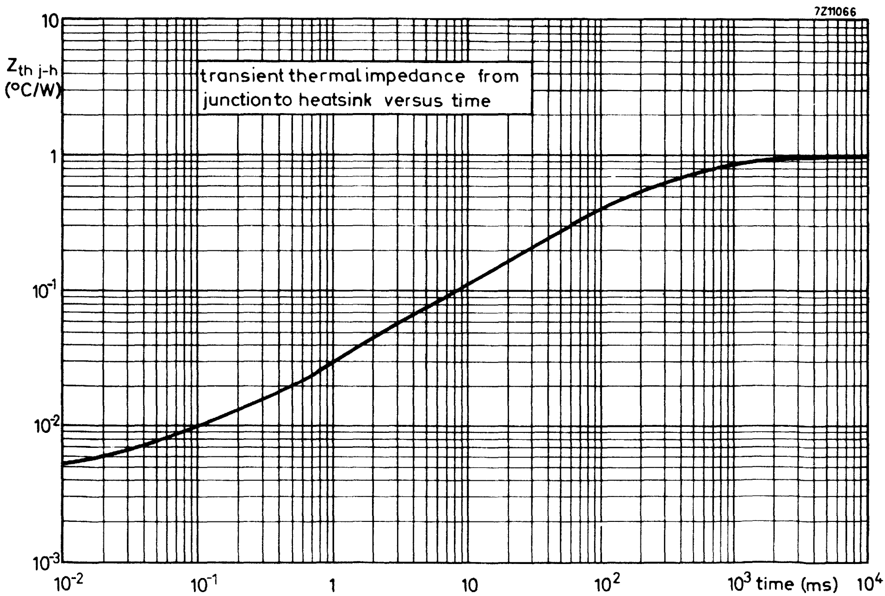

7Z11065
maximum allowable non-repetitive peak reverse pulse power dissipation in avalanche region
P_RSM (kW)
P_R
P_RSM
time
pulse duration
Tj=25°C
75°C
125°C
150°C
175°C
pulse duration(ms)





ΔT = neccessary derating of $T_{j\,max}$ to accommodate repetitive transients in the reverse direction. Allowance can be made for this by assuming the ambient temperature ΔT higher.


7Z11069
maximum permissible non-repetitive r.m.s. forward current based on sinusoidal currents (f=50Hz)
I_F
t
duration
each current pulse is followed by the crest working reverse voltage
$I_{FS(RMS)}$ (A)
1500
1250
1000
750
500
250
0
T_j = 175°C(prior to surge)
10^{-3}
10^{-2}
10^{-1}
1
duration(s)
10


7Z11066
transient thermal impedance from junction to heatsink versus time
$Z_{th\ j\text{-}h}$ (°C/W)
10
1
10^{-1}
10^{-2}
10^{-3}
10^{-2}
10^{-1}
1
10
10^2
10^3
time (ms)
10^4

FAST RECOVERY RECTIFIER DIODES

Diffused silicon diodes in a metal envelope, primarily intended for use in high frequency power supplies, inverters, choppers, sonar power supplies and ultra-sonic systems.
The series consists of the normal polarity types (cathode to stud) BYX59-200 to -500.

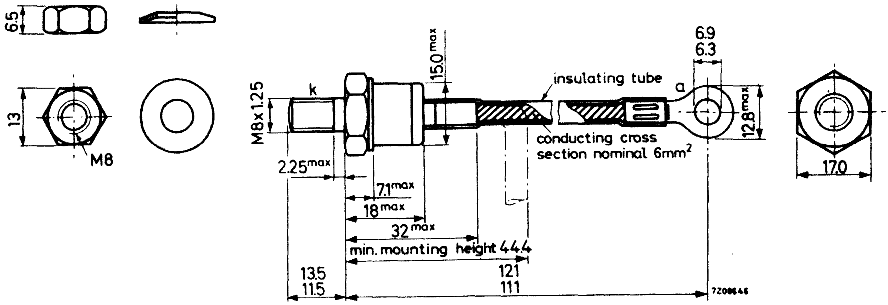
QUICK REFERENCE DATA

			BYX59 – 200	300	400	500	
Crest working reverse voltage	V_{RWM}	max.	200	300	400	500	V
Repetitive peak reverse voltage	V_{RRM}	max.	200	300	400	500	V

Average forward current up to T_{mb} = 105 °C	$I_{F(AV)}$	max.	70	A
at T_{mb} = 125 °C	$I_{F(AV)}$	max.	40	A
Non-repetitive peak forward current t = 10 ms; T_j = 150 °C prior to surge	I_{FSM}	max.	1200	A
Junction temperature	T_j	max.	150	°C
Reverse recovery time when switched from I_F = 50 A to $V_R \geq 30$ V with $-\frac{dI}{dt}$ = 50 A/µs; T_j = 25 °C	trr	<	0.7	µs

MECHANICAL DATA

Dimensions in mm



Net weight: 42 g
Diameter of clearance hole: max. 8.5 mm

Torque on nut: min 40 kg cm
(4 Newton-metres)
max. 60 kg cm
(6 Newton-metres)

All information applies to frequencies up to 50 kHz

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

Voltages [1]

			BYX59 – 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
Repetitive peak reverse voltage	V_{RRM}	max.	200	300	400	500	V
Non-repetitive peak reverse voltage ($t \leq 10$ ms)	V_{RSM}	max.	220	330	440	550	V

Currents

Average forward current (averaged over any 20 ms period) up to T_{mb} = 105 °C	$I_{F(AV)}$	max.	70	A
at T_{mb} = 125 °C	$I_{F(AV)}$	max.	40	A
Forward current (d.c.)	I_F	max.	120	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; half sine wave) T_j = 150 °C prior to surge	I_{FSM}	max.	1200	A
I squared t for fusing (t = 10 ms)	I^2t	max.	7200	A^2s
Rate of change of commutation current	$-\frac{dI}{dt}$	max.	100	A/µs

Temperatures

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

THERMAL

From junction to mounting base	$R_{th\ j\text{-}mb}$	=	0.4	°C/W
From mounting base to heatsink without heatsink compound	$R_{th\ mb\text{-}h}$	=	0.4	°C/W
with heatsink compound (e.g. Dow Corning 340)	$R_{th\ mb\text{-}h}$	=	0.2	°C/W
Transient thermal impedance; t = 1 ms	$Z_{th\ j\text{-}mb}$	=	0.045	°C/W

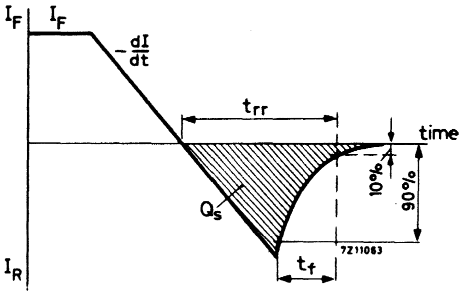
[1]) To ensure thermal stability $R_{th\ j\text{-}a} \leq 0.75$ °C/W (continuous reverse voltage) or ≤ 1.5 °C/W (a.c.)
For smaller heatsinks $T_{j\ max}$ should be derated. For a.c. see page 4.
For continuous reverse voltage: $R_{th\ j\text{-}a} = 1$ °C/W, then $T_{j\ max} = 145$ °C
$R_{th\ j\text{-}a} = 1.2$ °C/W, then $T_{j\ max} = 140$ °C

CHARACTERISTICS

			BYX59 – 200	300	400	500	
Forward voltage I_F = 250 A; T_j = 25 °C	V_F	<	1.8	1.8	1.8	1.8	V[1]
Peak reverse current V_{RM} = $V_{RWM max}$; T_j = 125 °C	I_{RM}	<	25	25	18	15	mA

Reverse recovery when switched from
I_F = 50 A to $V_R \geq$ 30 V
with $-\frac{dI}{dt}$ = 50 A/µs; T_j = 25 °C

reverse recovery charge	Q_s	<	7.5	µC
reverse recovery time	t_{rr}	<	0.7	µs
fall time	t_f	<	0.3	µs



APPLICATION INFORMATION AND OPERATING NOTES

See general pages at the beginning of this section.

[1]) Measured under pulse conditions to avoid excessive dissipation.

FAST SOFT-RECOVERY RECTIFIER DIODES

Silicon double diffused rectifier diodes in a plastic encapsulation. They are intended for use in chopper applications as well as in switched-mode power supplies, as efficiency diodes and scan rectifiers in television receivers. The device feature non snap-off characteristcs. Normal and reverse polarity types are available.

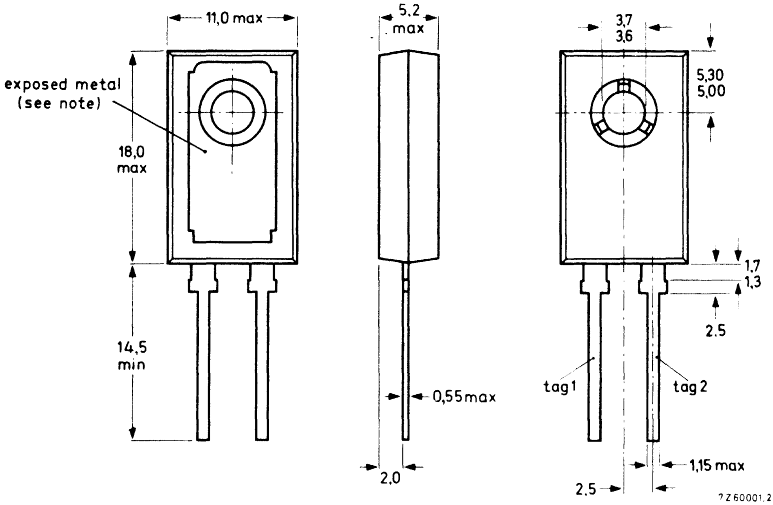
QUICK REFERENCE DATA

			BYX71-350(R)	600(R)	
Working reverse voltage	V_{RW}	max.	300	500	V
Repetitive peak reverse voltage	V_{RRM}	max.	350	600	V
Average forward current up to T_{mb} = 85 °C	$I_{F(AV)}$	max.		7	A
Non-repetitive peak forward current t = 10 ms; T_j = 150 °C prior to surge	I_{FSM}	max.		60	A
Junction temperature	T_j	max.		150	°C
Reverse recovery charge when switched from I_F = 2 A to V_R = 30 V with −dI/dt = 20 A/μs; T_j = 25 °C	Q_s	<		700	nC

MECHANICAL DATA See page 2

MECHANICAL DATA

Dimensions in mm



Net weight: 2,5 g

Accessories:
supplied with device: spread washer
available on request: 56316 mica insulating washer

Torque on screw: min. 0 95 Nm (9,5 kg cm)
max. 1,5 Nm (15 kg cm)

POLARITY OF CONNECTIONS

	BYX71-350 and BYX71-600	BYX71-350R and BYX71-600R
Base-plate:	cathode	anode
Tag 1 :	cathode	anode
Tag 2 :	anode	cathode

Note: the exposed metal base-plate is directly connected to tag 1.

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

Voltages

			BYX71-350(R)	600(R)	
Continuous reverse voltage	V_R	max.	300	500	V
Working reverse voltage	V_{RW}	max.	300	500	V
Repetitive peak reverse voltage ($\delta \leq 0,01$)	V_{RRM}	max.	350	600	V
Non-repetitive peak reverse voltage ($t \leq 10$ ms)	V_{RSM}	max.	350	600	V

Currents

Average on-state current assuming zero switching losses (averaged over any 20 ms period)				
square wave: $\delta = 0,5$; up to $T_{mb} = 85\ ^{o}C$	$I_{F(AV)}$	max.	7	A
without heatsink at $T_{amb} = 50\ ^{o}C$	$I_{F(AV)}$	max.	1,4	A
sinusoidal: at $T_{mb} = 85\ ^{o}C$	$I_{F(AV)}$	max.	6,5	A
R.M.S. forward current	$I_{F(RMS)}$	max.	10	A
Repetitive peak forward current	I_{FRM}	max.	25	A
Non-repetitive peak forward current				
half sine wave; $t = 10$ ms; $T_j = 150\ ^{o}C$ prior to surge	I_{FSM}	max.	60	A
square pulse; $t = 5$ ms; $T_j = 150\ ^{o}C$ prior to surge	I_{FSM}	max.	60	A
Rate of change of commutation current	$-\frac{dI}{dt}$	max.	50	A/µs

Temperatures

Storage temperature	T_{stg}		−55 to +125	^{o}C
Junction temperature	T_j	max.	150	^{o}C

THERMAL RESISTANCE

From junction to mounting base	$R_{th\ j\text{-}mb}$	=	6,5	°C/W
Transient thermal impedance; t = 1 ms	$Z_{th\ j\text{-}mb}$	=	0,3	°C/W

Influence of mounting method

1. Heatsink mounted

From mounting base to heatsink

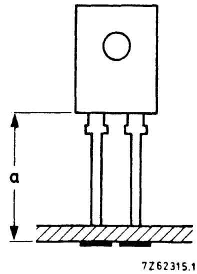
a. with heatsink compound	$R_{th\ mb\text{-}h}$	=	1,5	°C/W
b. with heatsink compound and 56316 mica washer	$R_{th\ mb\text{-}h}$	=	2,7	°C/W
c. without heatsink compound	$R_{th\ mb\text{-}h}$	=	2,7	°C/W
d. without heatsink compound; with 56316 mica washer	$R_{th\ mb\text{-}h}$	=	5	°C/W

2. Free air operation

The quoted values of $R_{th\ j\text{-}a}$ should be used only when no other leads run to the tie-points.

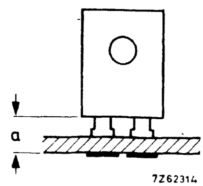
From junction to ambient in free air mounted on a printed circuit board
at a = maximum lead length
and with a copper laminate

a. > 1 cm² $R_{th\ j\text{-}a}$ = 50 °C/W
b. < 1 cm² $R_{th\ j\text{-}a}$ = 55 °C/W



at a lead-length a = 3 mm
and with a copper laminate

c. > 1 cm² $R_{th\ j\text{-}a}$ = 55 °C/W
d. < 1 cm² $R_{th\ j\text{-}a}$ = 60 °C/W



SOLDERING AND MOUNTING NOTES

1. Soldered joints must be at least 2,5 mm from the seal.
2. A soldering iron must not be in contact with the joint for more than 3 seconds.
3. The maximum permissible temperature of the soldering iron or bath is 270 °C; it must not be in contact with the joint for more than 3 seconds.
4. The devices should not be immersed in oil, and few potting resins are suitable for re-encapsulation. Advice on these materials is available on request.
5. Leads should not be bent less than 2,5 mm from the seal; exert no axial pull when bending.
6. For good thermal contact heatsink compound should be used between base-plate and heatsink.

CHARACTERISTICS

Forward voltage

I_F = 5 A; T_j = 25 °C	V_F	<	1,25	V [1]

Peak reverse current

V_{RM} = V_{RWmax}; T_j = 125 °C	I_{RM}	<	0,4	mA

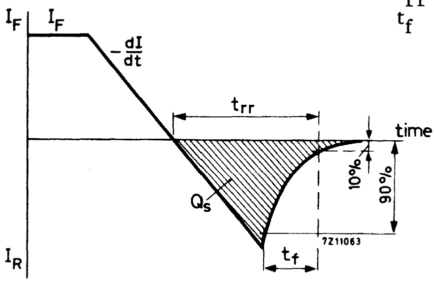
Capacitance at f = 1 MHz

V_R = 250 V; T_j = 25 to 150 °C	C_d	typ.	8	pF

Reverse recovery when switched from

I_F = 2 A to V_R = 30 V with
−dI/dt = 20 A/µs; T_j = 25 °C

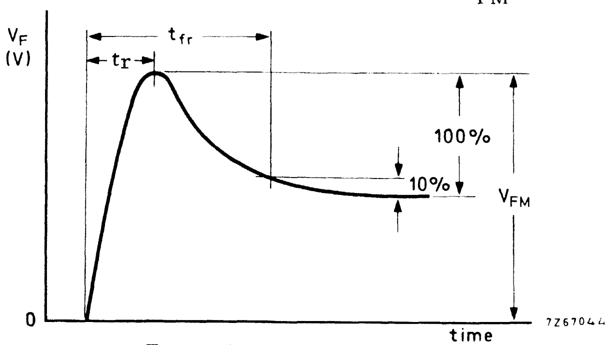
Recovery charge	Q_s	<	700	nC
Recovery time	t_{rr}	<	300	ns
Fall time	t_f	>	150	ns



Forward recovery when switched

to I_{FRM} = 25 A with t_r = 0,5 µs at T_j = 25 °C

recovery time	t_{fr}	<	0,8	µs
recovery voltage	V_{FM}	<	3,5	V



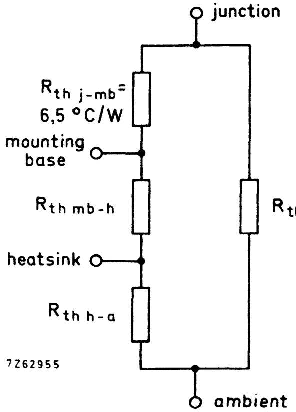
Forward output wave form

[1]) Measured under pulse conditions to avoid excessive dissipation.

OPERATING NOTES

Dissipation and heatsink **considerations:**

a. The various components of junction temperature rise above ambient are illustrated below:



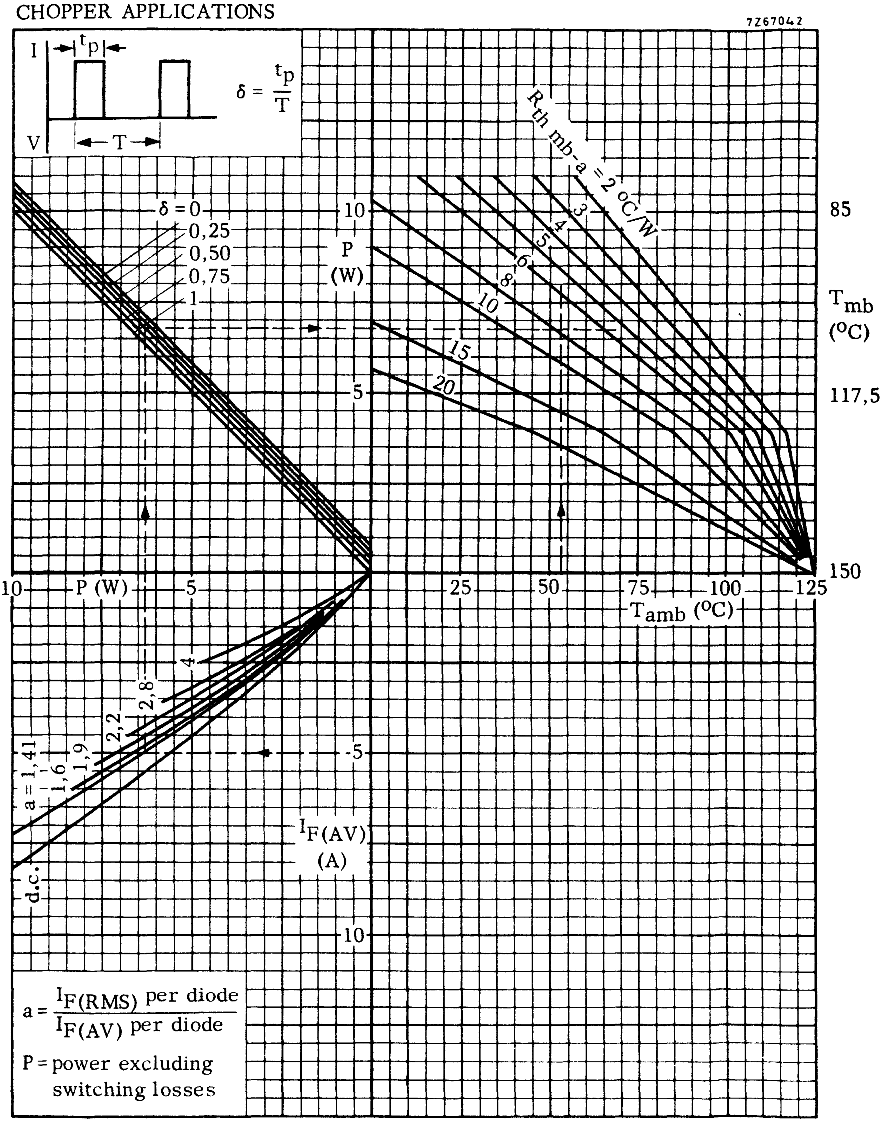
b. The method of using the graph on page 8 is as follows:
Starting with the curve of maximum dissipation as a function of $I_{F(AV)}$, for a particular current trace horizontally to meet the appropriate form factor; upwards to the operating duty cycle (δ) line; horizontally until the $R_{th\ mb\text{-}a}$ curve is reached. Finally trace upwards from the T_{amb} scale. The intersection determines the $R_{th\ mb\text{-}a}$ required.
The heatsink thermal resistance value ($R_{th\ h\text{-}a}$) can now be calculated from:

$$R_{th\ h\text{-}a} = R_{th\ mb\text{-}a} - R_{th\ mb\text{-}h}$$

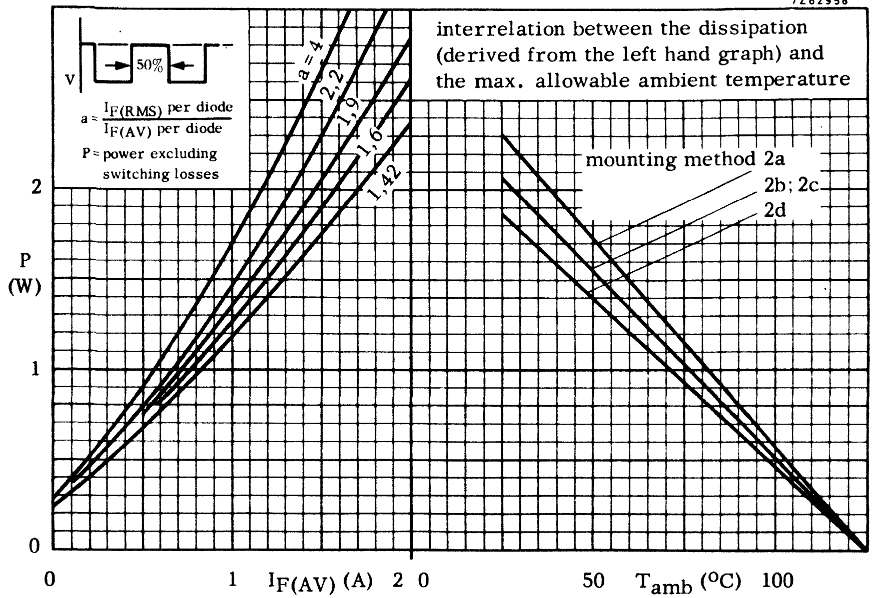
Any measurement of heatsink temperature should be made immediately adjacent to the device.

c. The heatsink curves are optimised to allow the junction temperature to run up to 150 °C ($T_{j\ max}$) whilst limiting T_{mb} to 125 °C (or less).

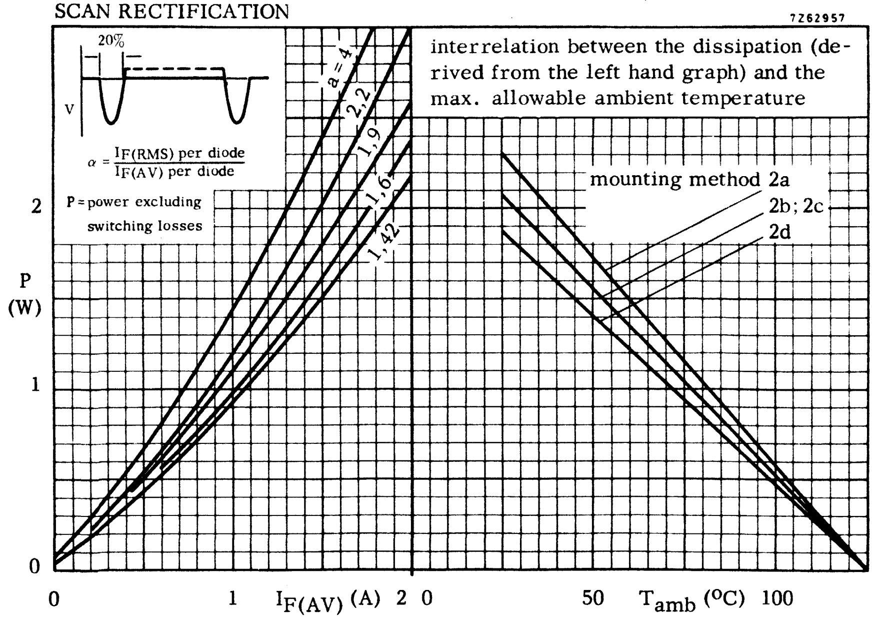
CHOPPER APPLICATIONS

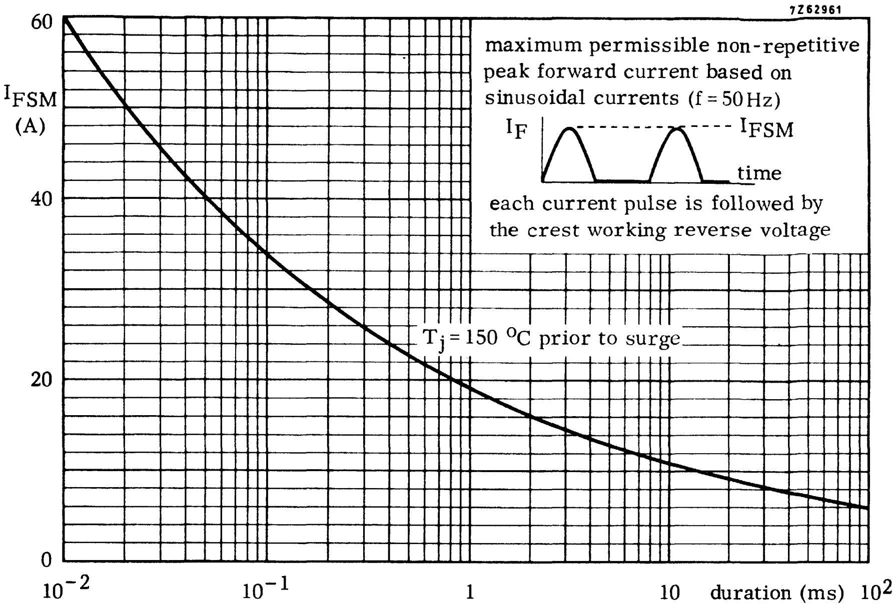


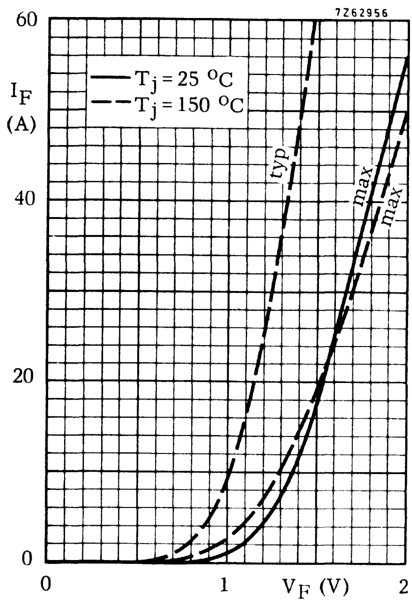
SWITCHED-MODE APPLICATION

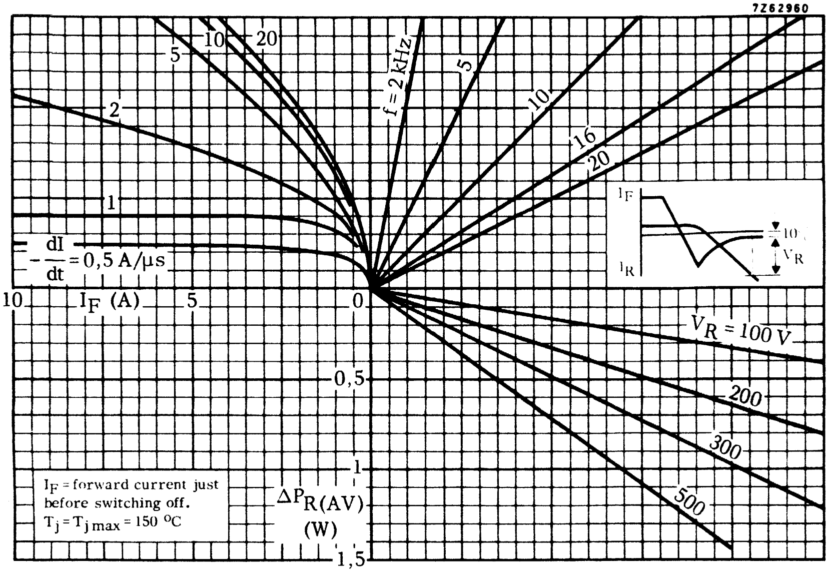


SCAN RECTIFICATION

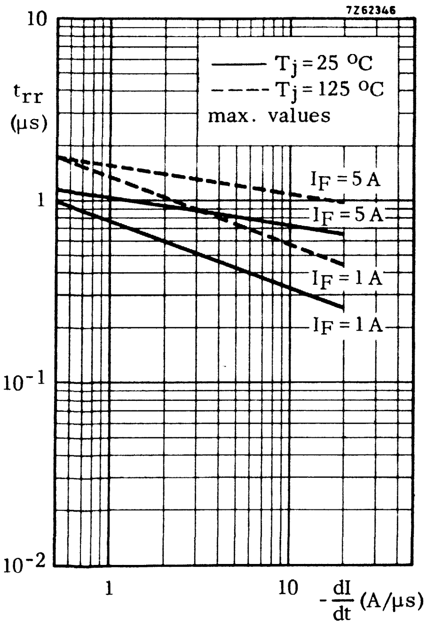


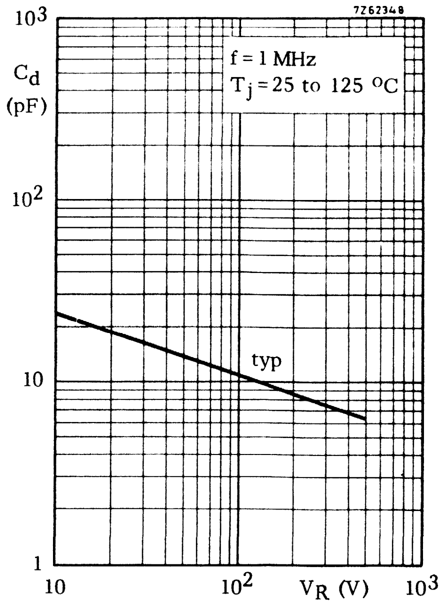

7Z62961
60
40
20
0
I_{FSM}
(A)
maximum permissible non-repetitive peak forward current based on sinusoidal currents (f = 50 Hz)
I_F
I_{FSM}
time
each current pulse is followed by the crest working reverse voltage
T_j = 150 °C prior to surge
10^{-2}
10^{-1}
1
10
duration (ms)
10^2

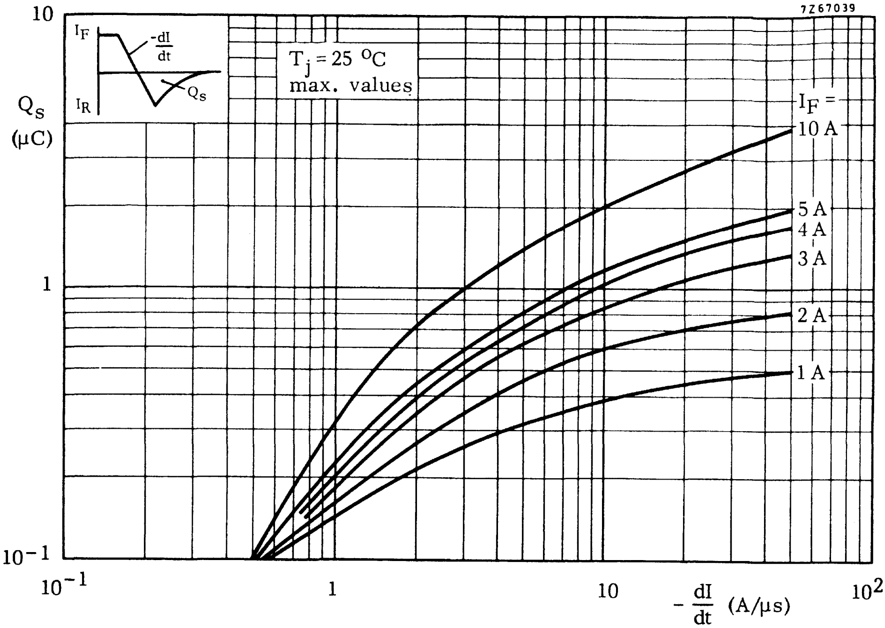

7Z62956
60
40
20
0
I_F
(A)
T_j = 25 °C
T_j = 150 °C
typ
max
max
0
1
V_F (V)
2

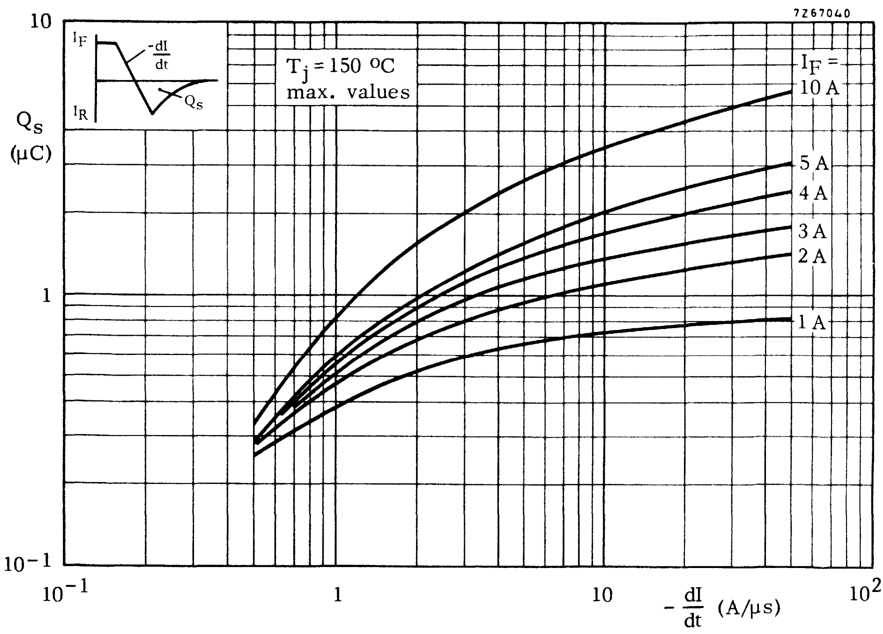


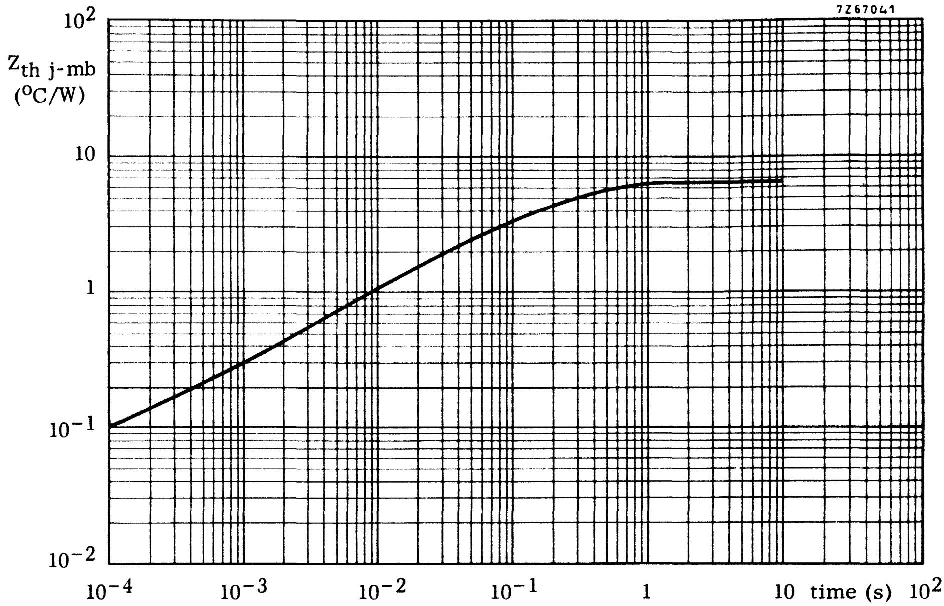
Nomogram: power loss $\Delta P_{R(AV)}$ due to switching only (to be added to forward and reverse power losses).






7Z67039
10
1
10−1
Qs
(μC)
IF
IR
-dI/dt
Qs
Tj = 25 °C
max. values
IF =
10 A
5 A
4 A
3 A
2 A
1 A
10−1
1
10
10²
- dI/dt (A/μs)


7Z67040
10
1
10−1
Qs
(μC)
IF
IR
-dI/dt
Qs
Tj = 150 °C
max. values
IF =
10 A
5 A
4 A
3 A
2 A
1 A
10−1
1
10
10²
- dI/dt (A/μs)


7Z67041
$Z_{th\ j\text{-}mb}$ (°C/W)
10^2
10
1
10^{-1}
10^{-2}
10^{-4}
10^{-3}
10^{-2}
10^{-1}
1
10
time (s)
10^2

Voltage regulator diodes

Medium to high power

TYPE SELECTION

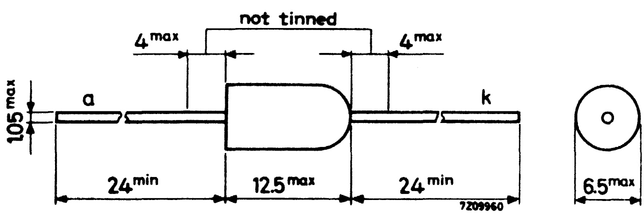
Reference voltage ± 5% V_Z (V)	1,5 W DO-1 metal	2,5 W plastic	10 W DO-4 metal	20 W DO-4 metal	75 W DO-5 metal
				Reverse polarity available	
4,7	-C4V7				
5,1					
5,6			BZZ14		
6,2			BZZ15		
6,8	BZY96series		BZZ16		
7,5			BZZ17	-C7V5(R)	
8,2			BZZ18		
9,1	-C9V1		BZZ19		
10	-C10	-C10	BZZ20		-C10(R)
11			BZZ21		
12			BZZ22		
13			BZZ23		
15			BZZ24		
16			BZZ25		
18			BZZ26		
20			BZZ27		
22			BZZ28		
24			BZZ29	BZY93series	
27		BZX70series			
30	BZY95series				BZY91series
33					
36					
39					
43					
47					
51					
56					
62					
68					
75	-C75	-C75		-C75(R)	-C75(R)

VOLTAGE REGULATOR DIODES

Silicon diodes in a plastic envelope for general purpose use as medium power voltage stabilizers or voltage references.
The series consist of 22 types with nominal zener voltages ranging from 10 V 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.	5	A
Total power dissipation up to T_{amb} = 25 °C	P_{tot}	max.	2.5	W
Non repetitive peak reverse power	P_{ZSM}	max.	100	W
Junction temperature	T_j	max.	150	°C
Thermal resistance from junction to ambient with 10 mm tie points on an infinite heatsink	$R_{th\ j\text{-}a}$	=	50	°C/W

MECHANICAL DATA Dimensions in mm



The rounded end 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).

MOUNTING METHODS see page 6.

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

Currents

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 $T_{amb} = 25\ ^oC$ with max. lead length; mounting method 2 (see pages 6 and 11)	P_{tot}	max.	1.75	W
with 10 mm tie points on infinite heatsink (see page 11)	P_{tot}	max.	2.5	W
Non repetitive peak reverse power	P_{ZSM}	max.	100	W

Temperatures

Storage temperature	T_{stg}		-65 to +150	^oC
Junction temperature	T_j	max.	150	^oC

THERMAL RESISTANCE (see pages 6 and 11)

From junction to ambient

with max. lead length: mounting method 2	$R_{th\ j-a}$	=	70	$^oC/W$
with 10 mm tie points: mounting method 1	$R_{th\ j-a}$	=	60	$^oC/W$
with 10 mm tie points mounted on infinite heatsink	$R_{th\ j-a}$	=	50	$^oC/W$

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

BZX70-...	Zener voltage V_Z at I_Z = 50 mA			Temperature coefficient S_Z at I_Z = 50 mA	Differential resistance r_z 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

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

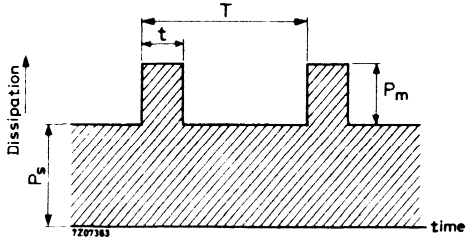
$$P_{m\ max} = \frac{(T_{j\ max} - T_{amb}) - (P_S \cdot R_{th\ j\text{-}a})}{Z_{th\ j\text{-}a}}$$

   where P_S is the steady-state dissipation, excluding that in the pulses,
   $Z_{th\ j\text{-}a}$ is the effective thermal impedance of the device from junction to ambient. It is a function of the pulse duration t and duty cycle δ (see page 10)

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

The steady-state power P_S when biased in the zener direction at a given zener current can be found from page 11, lower 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 11, lower 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 BZX70series is 100 s (see page 10).

OPERATING NOTES (continued)



Example

The following example illustrates how to calculate the maximum permissible repetitive peak zener current of a BZX70-C30 zener diode mounted on a printed circuit board with max. lead length at a maximum ambient temperature of 60 °C. The steady-state zener current is 25 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 25 mA (from page 11, lower figure) = 0.9 W.
The thermal resistance from junction to ambient $R_{th\ j\text{-}a} = 85$ °C/W (mounting method 3 on page 6).
The thermal impedance $Z_{th\ j\text{-}a}$ with a duty cycle $\delta = 0.1$ and a pulse duration $t = 1$ ms (from page 10, lower figure).

$$Z_{th\ j\text{-}a} = 9.2\ ^{\circ}\mathrm{C/W}$$

The maximum additional pulse power dissipation

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

If $P_S = 0.9$ W, $Z_{th\ j\text{-}a} = 9.2$ °C/W

$$P_{m\ max} = \frac{(150-60) - (0.9 \times 85)}{9.2} = 1.47\ \mathrm{W}$$

therefore, the total repetitive peak power dissipation,

$$P_{ZRM} = 0.9 + 1.47 = 2.37\ \mathrm{W}$$

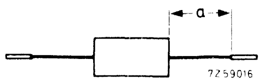
From page 11, lower figure, the corresponding repetitive peak zener current is 65 mA. This is within the rating of the BZX70-C30 and is therefore permissible.

THERMAL RESISTANCE

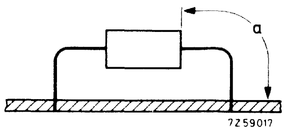
Effect of mounting on thermal resistance $R_{th\ j-a}$

The quoted values apply when no other leads run to the tie-points. If leads of other dissipating components share the same tie-points, the thermal resistance will be higher than that quoted.

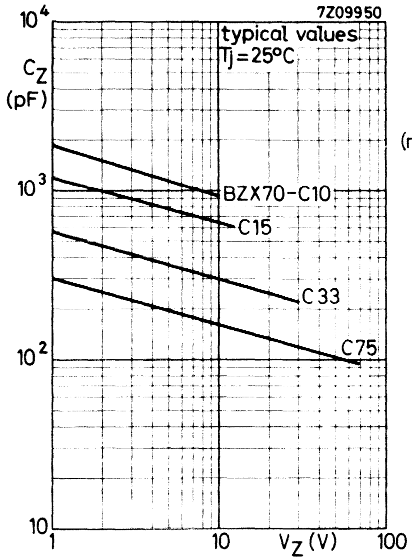
1. Mounted to solder tags at a lead-length a = 10 mm. $R_{th\ j-a}$ = 60 °C/W
2. Mounted to solder tags at a = maximum lead-length. $R_{th\ j-a}$ = 70 °C/W

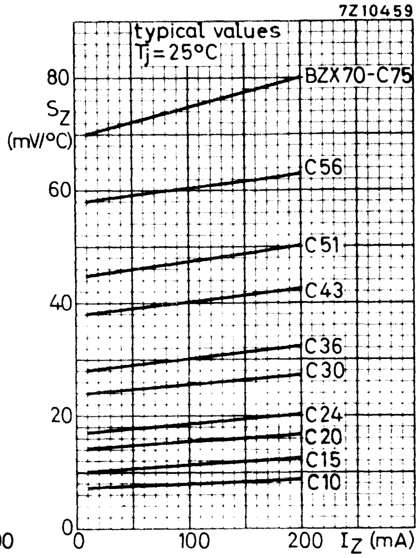


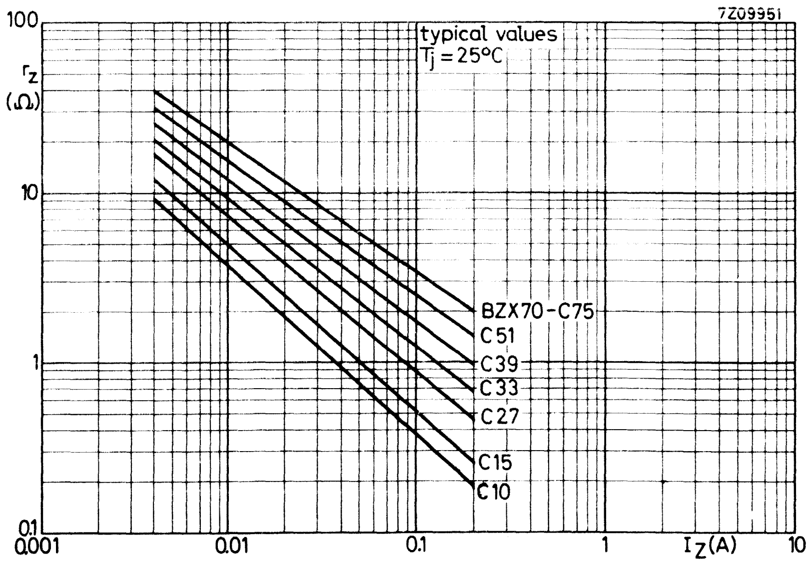
3. Mounted on printed-wiring board at a = maximum lead-length. $R_{th\ j-a}$ = 85 °C/W
4. Mounted on printed-wiring board at a lead-length a = 10 mm. $R_{th\ j-a}$ = 95 °C/W

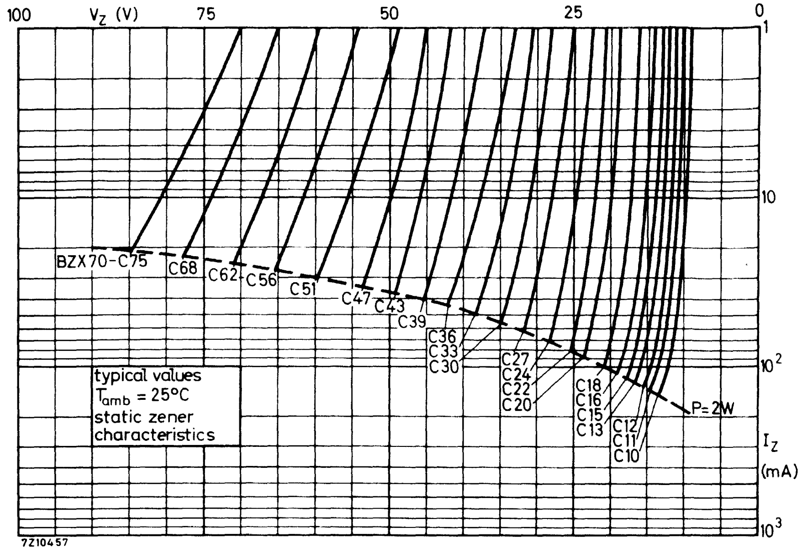


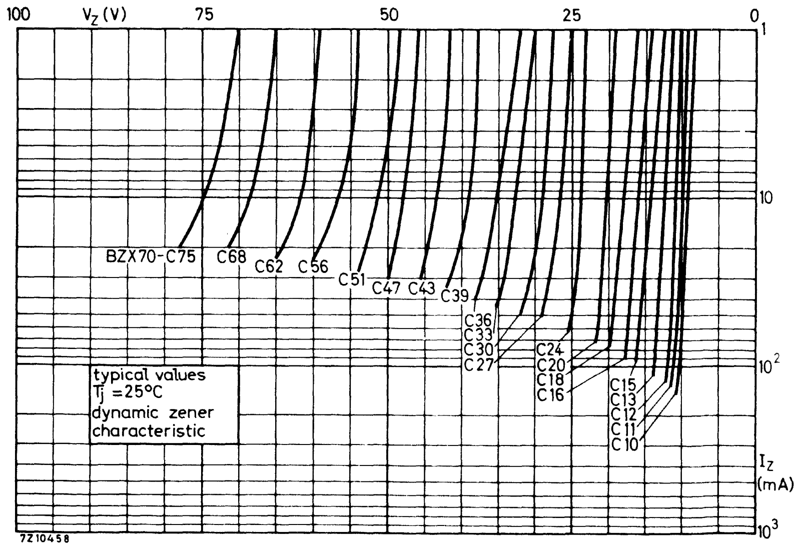
1. Soldered joints must be at least 5 mm from the seal.
2. The maximum permissible temperature of the soldering iron or bath is 300 °C; it must be in contact with the joint for no more than 3 seconds.
3. Avoid hot spots due to handling or mounting; the body of the device must not come into contact with or be exposed to a temperature higher than 150 °C.

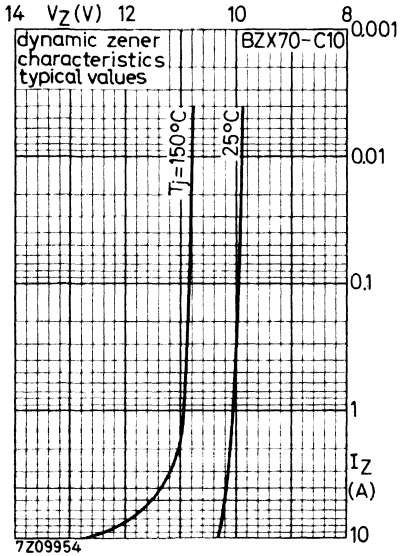

7Z09950
typical values
Tj = 25°C
CZ (pF)
BZX70-C10
C15
C33
C75
VZ (V)

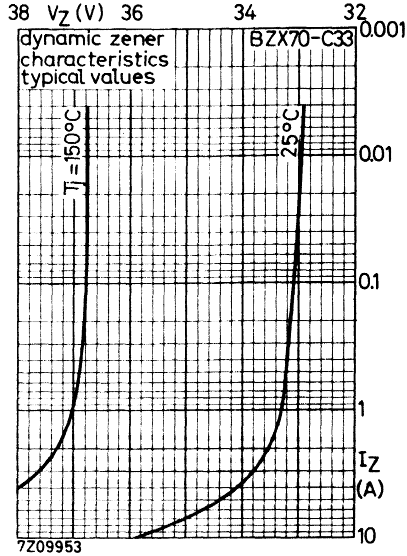

7Z10459
typical values
Tj = 25°C
SZ (mV/°C)
BZX70-C75
C56
C51
C43
C36
C30
C24
C20
C15
C10
IZ (mA)

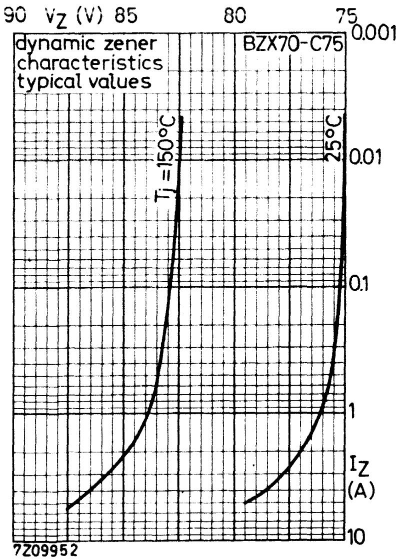

7Z09951
typical values
Tj = 25°C
rZ (Ω)
BZX70-C75
C51
C39
C33
C27
C15
C10
IZ(A)

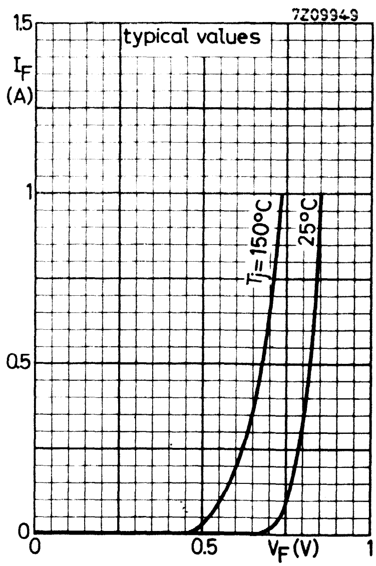

100
V_Z (V)
75
50
25
0
1
10
10^2
10^3
I_Z
(mA)
BZX70-C75
C68
C62
C56
C51
C47
C43
C39
C36
C33
C30
C27
C24
C22
C20
C18
C16
C15
C13
C12
C11
C10
P=2W
typical values
T_{amb} = 25°C
static zener characteristics
7Z10457

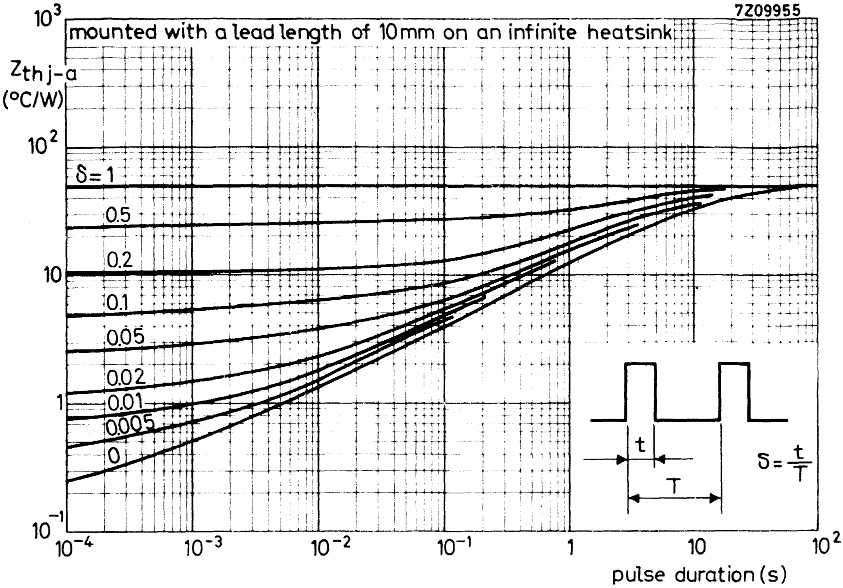

100
V_Z (V)
75
50
25
0
1
10
10^2
10^3
I_Z
(mA)
BZX70-C75
C68
C62
C56
C51
C47
C43
C39
C36
C33
C30
C27
C24
C20
C18
C16
C15
C13
C12
C11
C10
typical values
T_j =25°C
dynamic zener characteristic
7Z10458

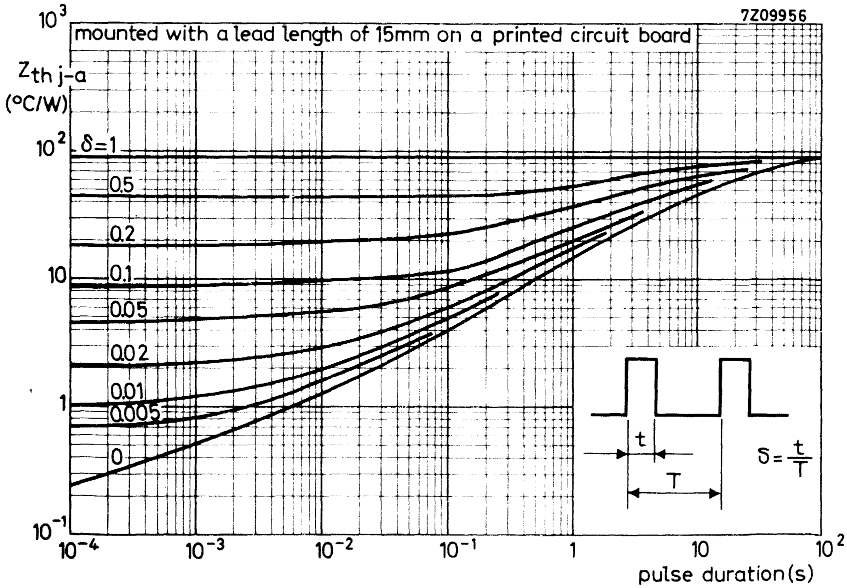

14 V_Z(V) 12 10 8
dynamic zener characteristics typical values
BZX70-C10
T_j=150°C
25°C
0.001
0.01
0.1
1
I_Z (A)
10
7Z09954

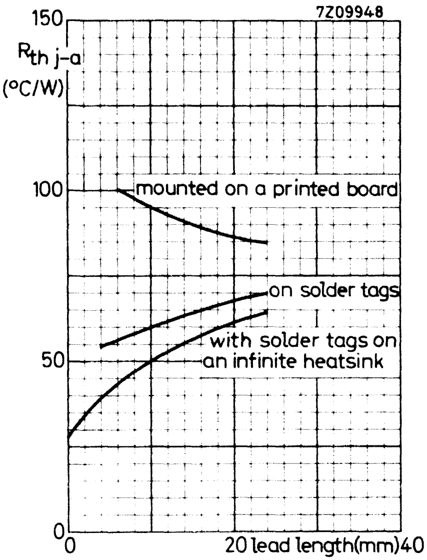

38 V_Z(V) 36 34 32
dynamic zener characteristics typical values
BZX70-C33
T_j=150°C
25°C
0.001
0.01
0.1
1
I_Z (A)
10
7Z09953

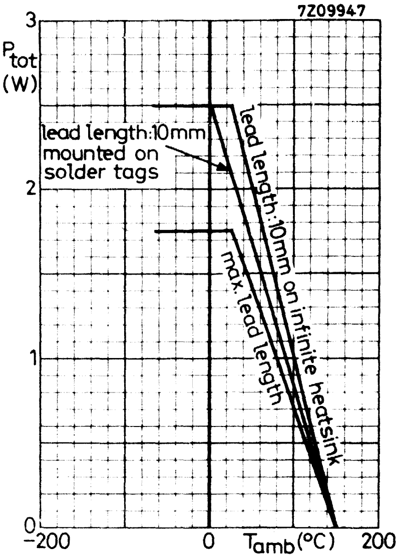

90 V_Z(V) 85 80 75
dynamic zener characteristics typical values
BZX70-C75
T_j=150°C
25°C
0.001
0.01
0.1
1
I_Z (A)
10
7Z09952

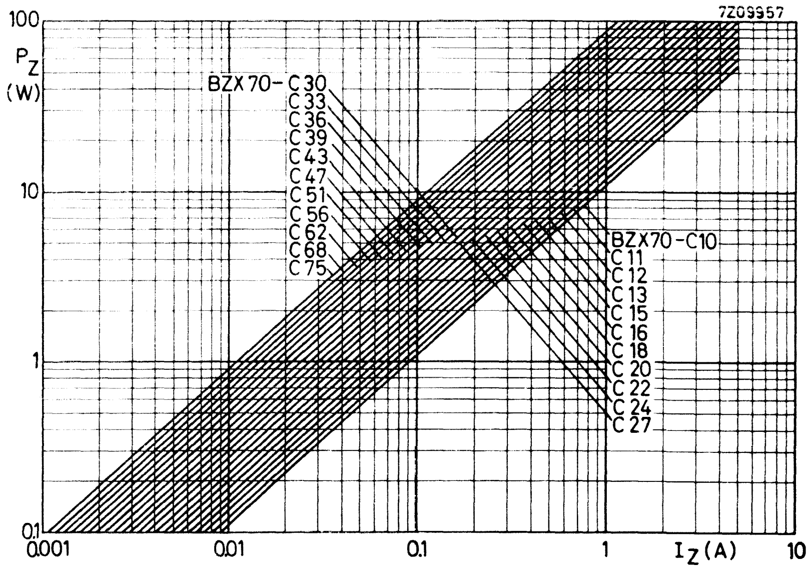

7Z09949
typical values
1.5
I_F (A)
1
0.5
0
T_j=150°C
25°C
0 0.5 V_F(V) 1


7Z09955
mounted with a lead length of 10mm on an infinite heatsink
$Z_{th\,j-a}$ (°C/W)
δ = 1
0.5
0.2
0.1
0.05
0.02
0.01
0.005
0
t
T
δ = t/T
pulse duration (s)


7Z09956
mounted with a lead length of 15mm on a printed circuit board
$Z_{th\,j-a}$ (°C/W)
δ = 1
0.5
0.2
0.1
0.05
0.02
0.01
0.005
0
t
T
δ = t/T
pulse duration (s)


7Z09948
150
$R_{th\ j-a}$
(°C/W)
100
mounted on a printed board
on solder tags
with solder tags on
an infinite heatsink
50
0
0
20 lead length(mm) 40


7Z09947
3
P_{tot}
(W)
lead length:10mm
mounted on
solder tags
lead length:10mm on infinite heatsink
max. lead length
2
1
0
−200
0
T_{amb} (°C)
200


7Z09957
100
P_Z
(W)
10
1
0.1
BZX70-C30
C33
C36
C39
C43
C47
C51
C56
C62
C68
C75
BZX70-C10
C11
C12
C13
C15
C16
C18
C20
C22
C24
C27
0.001
0.01
0.1
1
I_Z (A)
10

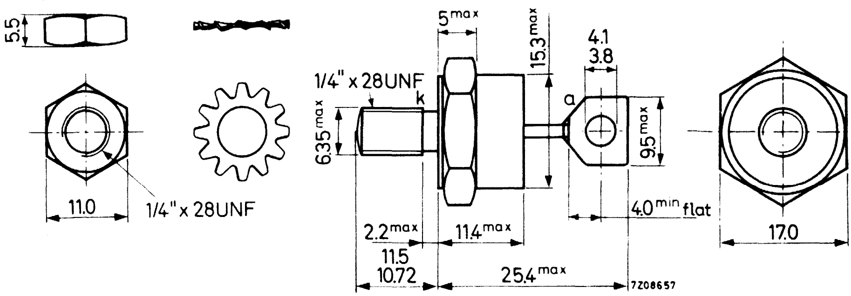
VOLTAGE REGULATOR DIODES

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 $T_{mb} = 65\ ^oC$	P_{tot}	max.	75	W
Non repetitive peak reverse power at $T_{mb} = 65\ ^oC$; $\delta = 0$				
$t = 100\ \mu s$	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	^oC
Junction temperature	T_j	max.	175	^oC

THERMAL RESISTANCE

From junction to mounting base	$R_{th\ j-mb}$	=	1.47	$^oC/W$
From mounting base to heatsink	$R_{th\ mb-h}$	=	0.2	$^oC/W$

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 at I_Z = 2 A [1] min.	nom.	max.	Differential resistance r_Z at I_Z = 2 A max.
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] min.	nom.	max.	at I_Z = 1 A 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] min.	nom.	max.	at I_Z = 0.5 A 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 $t_p \leqq 100\ \mu s$, duty cycle $\delta \leqq 0.001$ 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 $^{o}C/W$,

$R_{th\ h-a}$ 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,

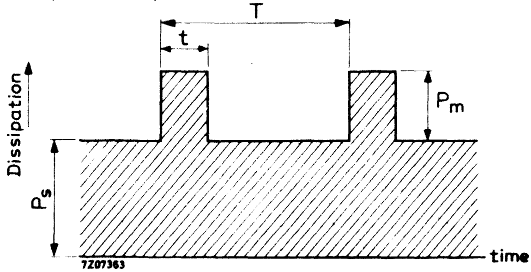
$R_{th\ t}$ is the effective transient thermal resistance of the device from junction to mounting base. It is a function of the pulse duration t and duty cycle δ (see page 8),

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

$$P_{m\ max.} = \frac{(T_{j\ max} - T_{amb}) - P_S \cdot R_{th\ j\text{-}a}}{R_{th\ t} + \delta \cdot R_{th\ mb\text{-}a}}$$

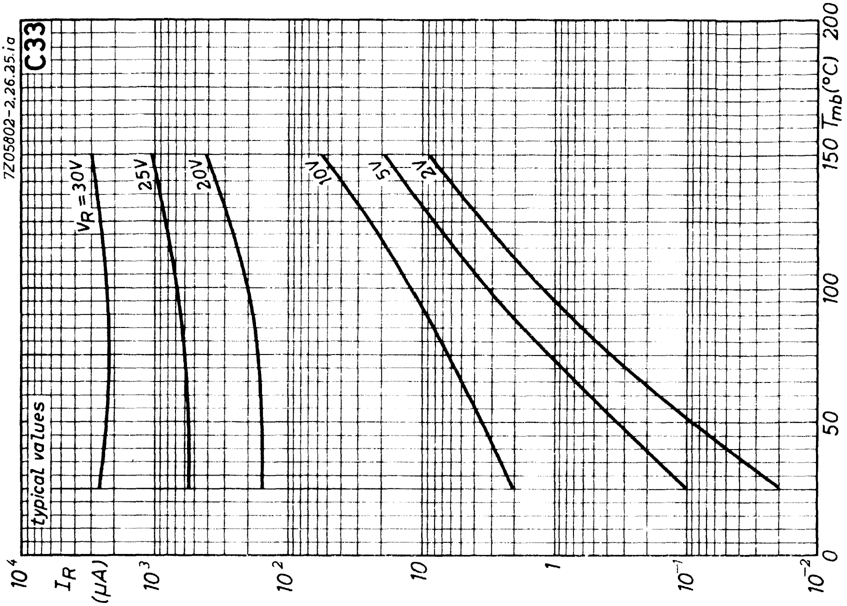
If $P_S = 28$ W, $R_{th\ t} = 0.23\ ^oC/W$,

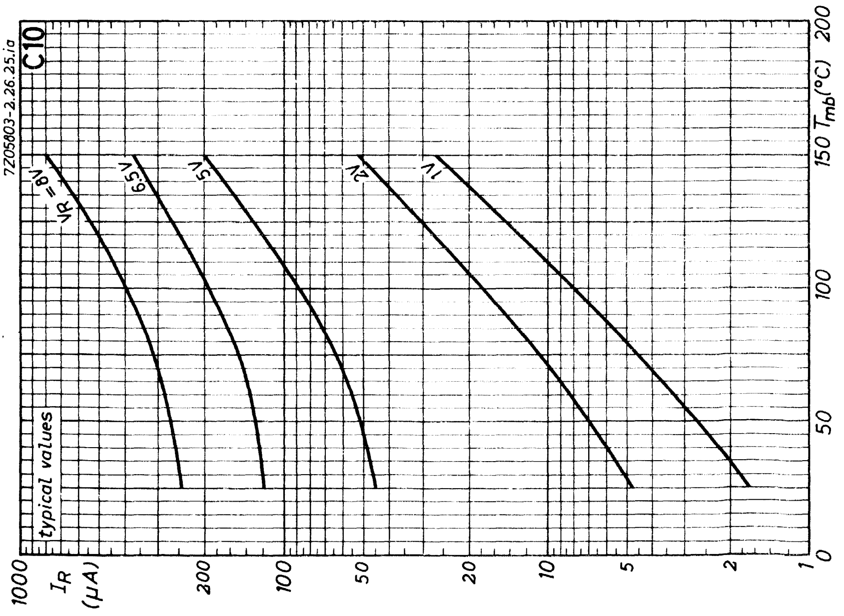
then $$P_{m\ max} = \frac{(175 - 50) - (28 \times 3.67)}{0.23 + 0.1 \times 2.2} = 49\ W$$

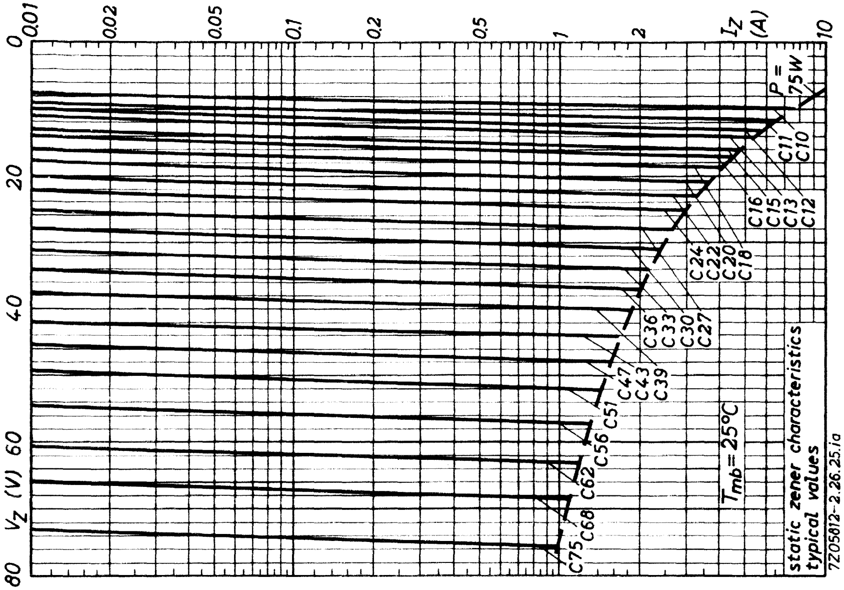
therefore, the total repetitive peak power dissipation,

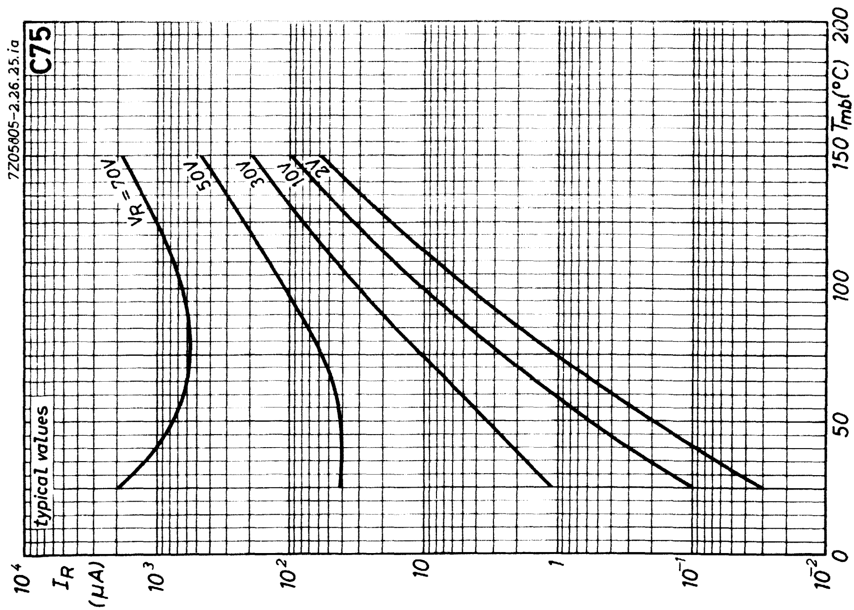
$$P_{ZRM} = (28\ W + 49\ W) = 77\ W$$

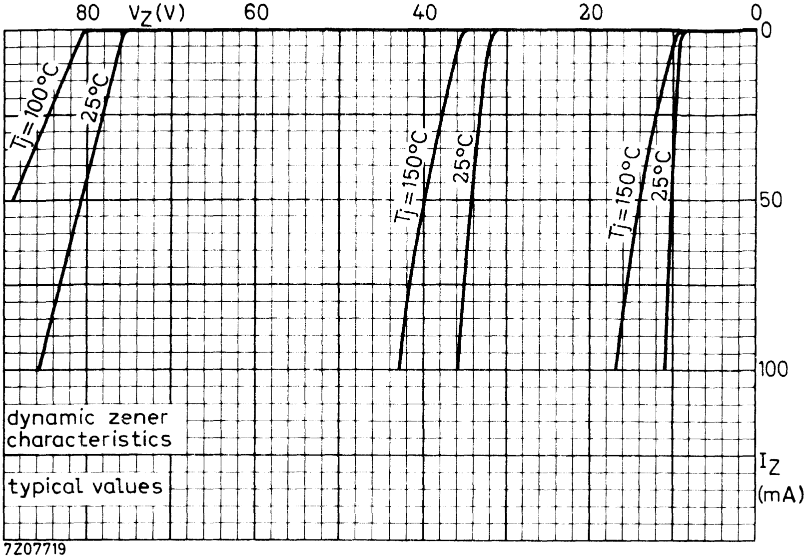
From page 9, upper figure, the corresponding repetitive peak zener current is 1.3 A. This is within the rating of the BZY91-C56 and is therefore permissible.

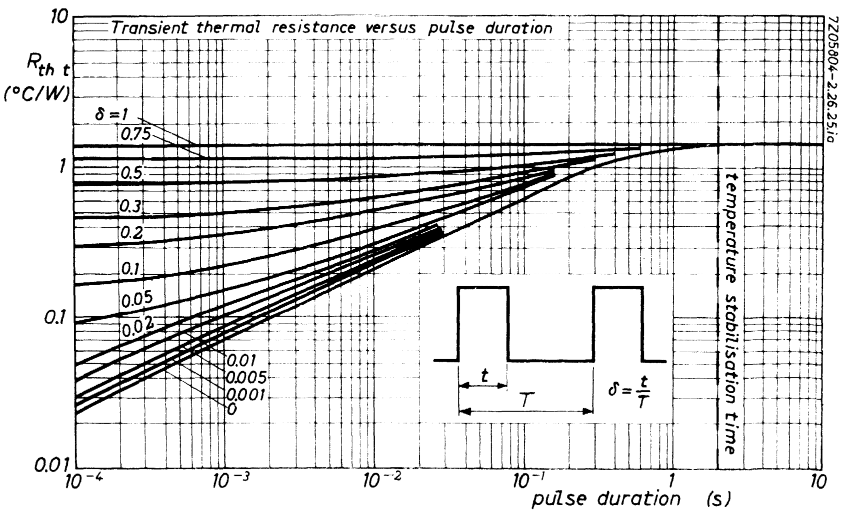

7Z05802-2.26.25.ia
C33
typical values
V_R = 30V
25V
20V
10V
5V
2V
I_R (μA)
10^4
10^3
10^2
10
1
10^{-1}
10^{-2}
0
50
100
150
200
T_{mb} (°C)

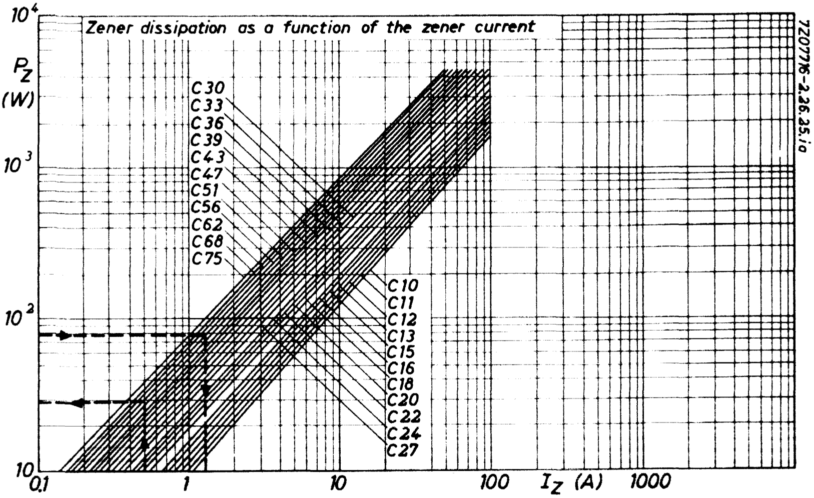

7Z05803-2.26.25.ia
C10
typical values
V_R = 8V
6.5V
5V
2V
1V
I_R (μA)
1000
200
100
50
20
10
5
2
1
0
50
100
150
200
T_{mb} (°C)

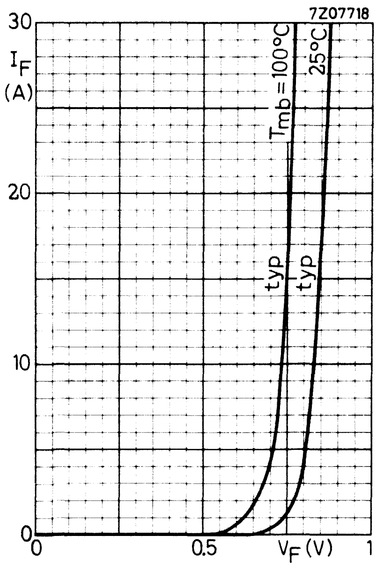

V_Z (V)
I_Z (A)
P = 75W
T_{mb}= 25°C
static zener characteristics
typical values
7Z05812-2.26.25.ia
C10
C11
C12
C13
C15
C16
C18
C20
C22
C24
C27
C30
C33
C36
C39
C43
C47
C51
C56
C62
C68
C75

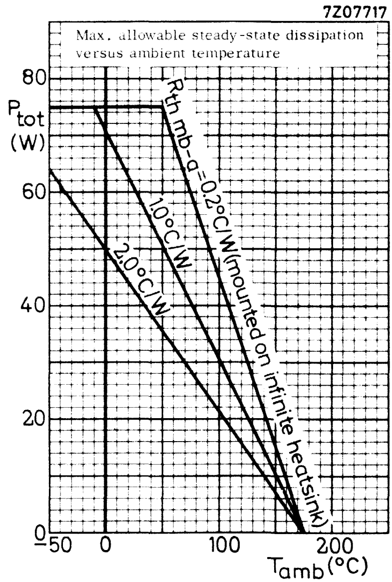

C75
7Z05805-2.26.25.ia
typical values
I_R (μA)
T_{mb}(°C)
V_R = 70V
50V
30V
10V
2V

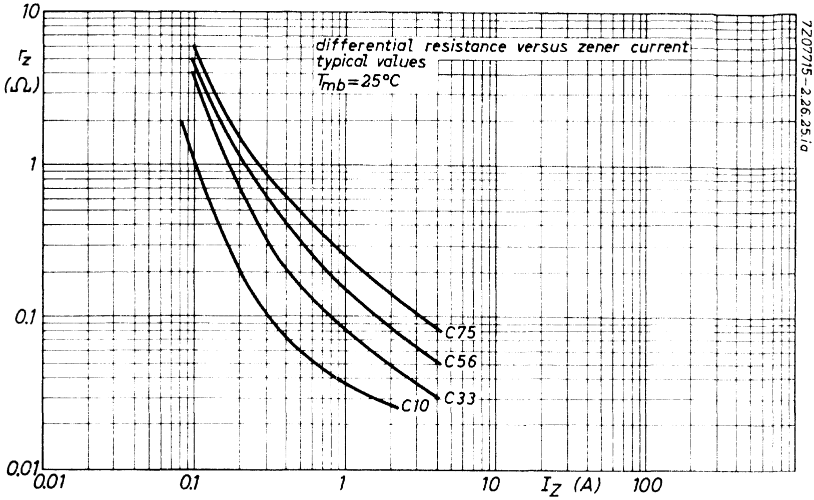

80
V_Z(V)
60
40
20
0
0
50
100
I_Z
(mA)
T_j=100°C
25°C
T_j=150°C
25°C
T_j=150°C
25°C
dynamic zener characteristics
typical values
7Z07719

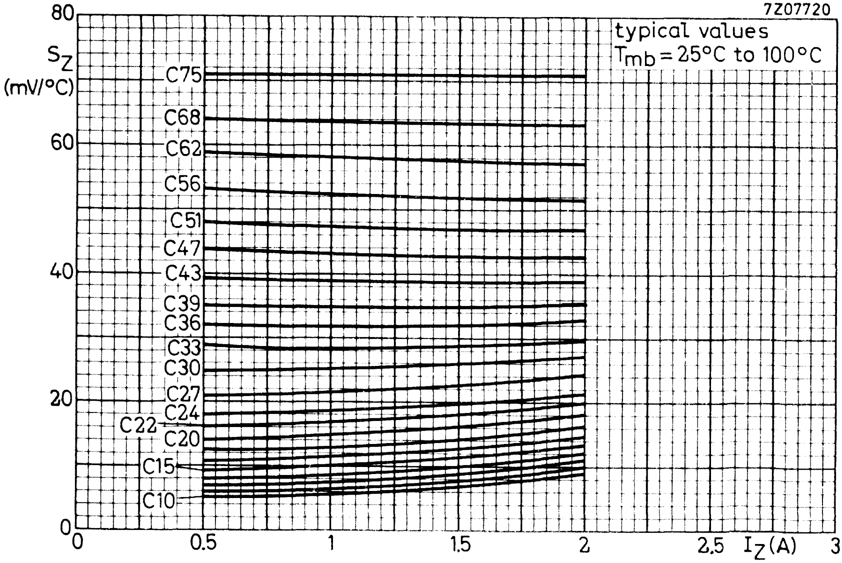

Transient thermal resistance versus pulse duration
7Z05804-2.26.25.ia
10
1
0.1
0.01
$R_{th\ t}$ (°C/W)
δ =1
0.75
0.5
0.3
0.2
0.1
0.05
0.02
0.01
0.005
0.001
0
t
T
$\delta = \frac{t}{T}$
temperature stabilisation time
10^{-4}
10^{-3}
10^{-2}
10^{-1}
1
10
pulse duration (s)


Zener dissipation as a function of the zener current
7Z07716-2.26.35.io
P_Z (W)
I_Z (A)
C30
C33
C36
C39
C43
C47
C51
C56
C62
C68
C75
C10
C11
C12
C13
C15
C16
C18
C20
C22
C24
C27
10
10^2
10^3
10^4
0.1
1
10
100
1000


7Z07718
I_F (A)
V_F (V)
T_{mb} = 100°C
25°C
typ
typ
0
10
20
30
0
0.5
1


7Z07717
Max. allowable steady-state dissipation versus ambient temperature
P_{tot} (W)
T_{amb} (°C)
$R_{th\ mb-a}$ = 0.2°C/W (mounted on infinite heatsink)
1.0°C/W
2.0°C/W
0
20
40
60
80
−50
0
100
200


differential resistance versus zener current
typical values
T_{mb} = 25°C
7Z07715-2.26.25.ia
r_Z
(Ω)
10
1
0.1
0.01
0.01
0.1
1
10
100
I_Z (A)
C75
C56
C33
C10


7Z07720
typical values
T_{mb} = 25°C to 100°C
S_Z
(mV/°C)
80
60
40
20
0
0
0.5
1
1.5
2
2.5
3
I_Z (A)
C75
C68
C62
C56
C51
C47
C43
C39
C36
C33
C30
C27
C24
C22
C20
C15
C10

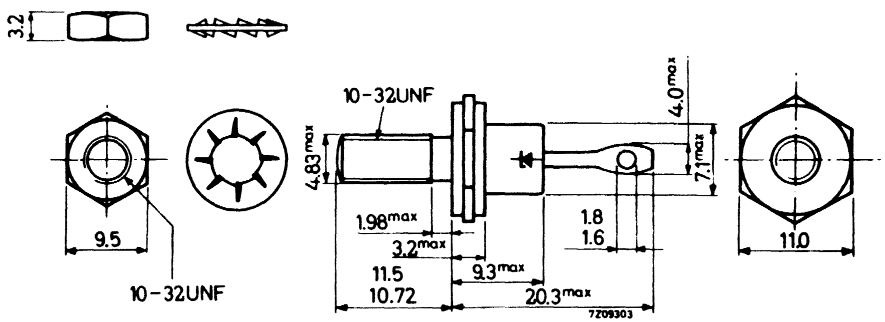
SILICON POWER VOLTAGE REGULATORS

Diffused silicon diodes in a DO-4 metal envelope intended for general purpose applications.
The series consists of 25 normal polarity types (stud cathode) and 25 reverse polarity types (stud anode) with nominal zener voltages ranging from 7.5 V to 75 V with a tolerance of ±5%.

QUICK REFERENCE DATA				
Zener voltage range		nom.	7.5 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 in accordance with the Absolute Maximum System (IEC 134)

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- C7V5(R)	C8V2(R)	C9V1(R) to C75(R)	
V_R = 2 V	I_R	<	100			μA
V_R = 5.6 V	I_R	<		100		μA
$V_R = \frac{2}{3} \cdot V_{Znom}$	I_R	<			50	μA

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

BZY93-...	Zener voltage V_Z at I_Z = 2 A			Temperature coefficient at I_Z = 2 A	Differential resistance at I_Z = 2 A	
	min.	nom.	max.	typ.	typ.	max.
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			at I_Z = 1 A	at I_Z = 1 A	
	min.	nom.	max.	typ.	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			at I_Z = 0.5 A	at I_Z = 0.5 A	
	min.	nom.	max.	typ.	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			at I_Z = 0.2 A	at I_Z = 0.2 A	
	min.	nom.	max.	typ.	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

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

   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
   $R_{th\,j\text{-}a} = R_{th\,j\text{-}mb} + R_{th\,mb\text{-}h} + R_{th\,h\text{-}a}$,

   $R_{th\,mb\text{-}h}$ is the thermal resistance from mounting base to heatsink, that is 0.6 $^oC/W$,

   $R_{th\,h\text{-}a}$ 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

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

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

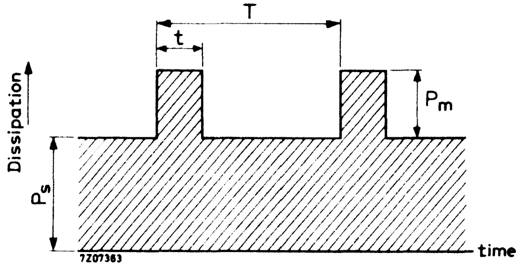
   $R_{th\,t}$ is the effective transient thermal resistance of the device from junction to mounting base. It is a function of the pulse duration t and duty cycle δ (see page 6, upper figure).

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

   $R_{th\,mb\text{-}a}$ is the total thermal resistance from mounting base to ambient. $R_{th\,mb\text{-}a} = R_{th\,mb\text{-}h} + R_{th\,h\text{-}a}$.

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

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

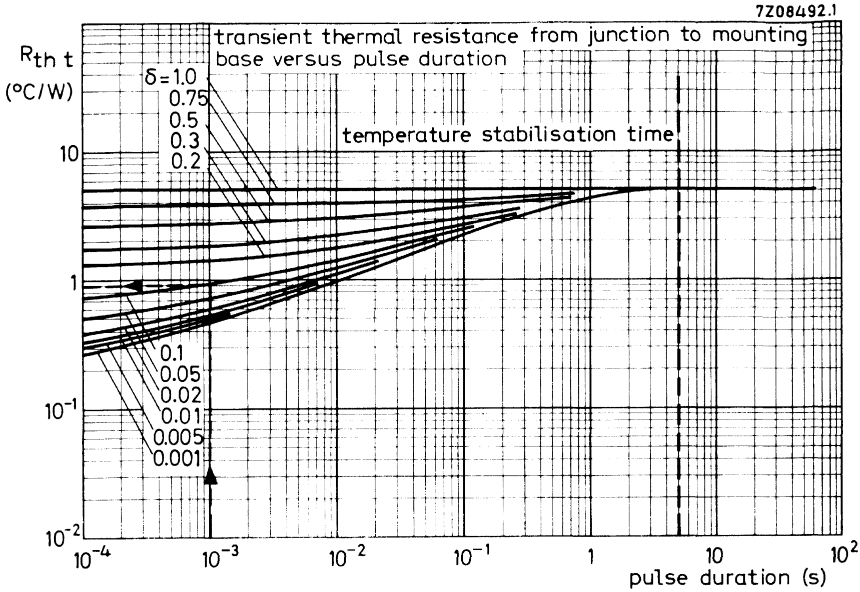
If $P_s = 7$ W, $R_{th\ t} = 0.92\ ^oC/W$,

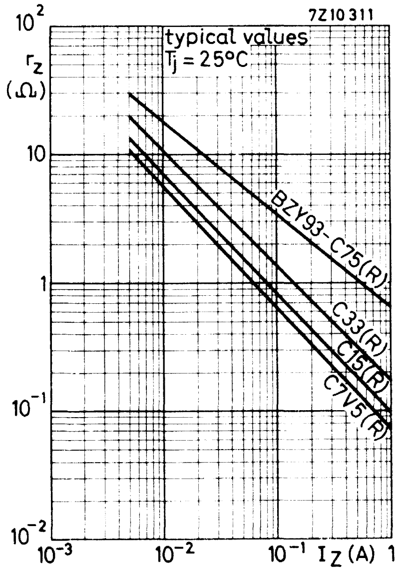
$$P_{m\ max} = \frac{(175 - 50) - (7 \times 7.6)}{0.92 + 0.1 \times 2.6} = 61\ W$$

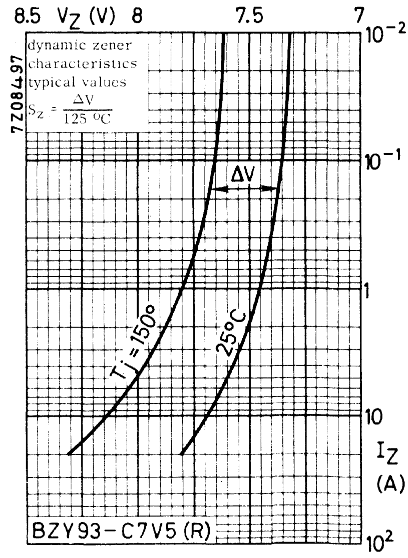
therefore, the total repetitive peak power dissipation,

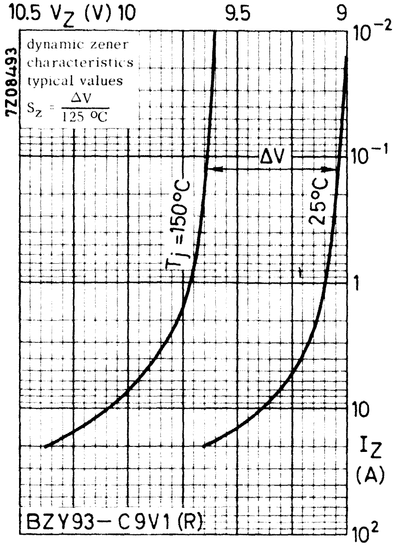
$$P_{ZRM} = (7 + 61) = 68\ W$$

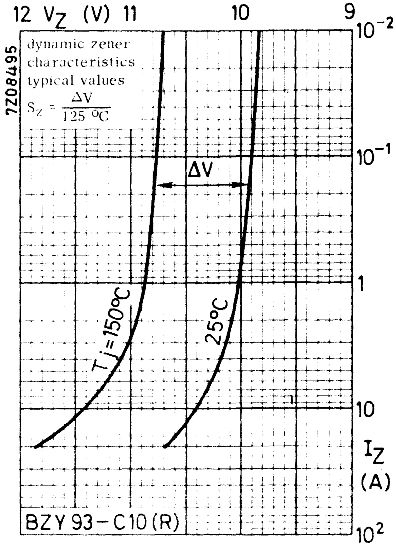
From page 8, upper figure, the corresponding repetitive peak zener current is 5 A. This is within the rating of the BZY93-C12 and is therefore permissible.

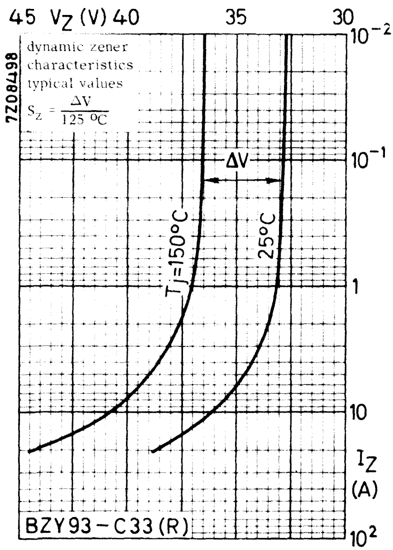

7Z08492.1
transient thermal resistance from junction to mounting base versus pulse duration
$R_{th\ t}$ (°C/W)
δ = 1.0
0.75
0.5
0.3
0.2
temperature stabilisation time
0.1
0.05
0.02
0.01
0.005
0.001
10
1
10^{-1}
10^{-2}
10^{-4}
10^{-3}
10^{-2}
10^{-1}
1
10
10^{2}
pulse duration (s)

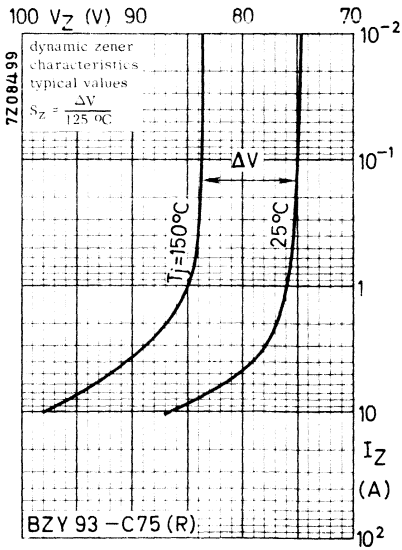

7Z10311
typical values
$T_j = 25°C$
r_Z (Ω)
10^{2}
10
1
10^{-1}
10^{-2}
BZY93-C75(R)
C33(R)
C15(R)
C7V5(R)
10^{-3}
10^{-2}
10^{-1}
I_Z (A)
1

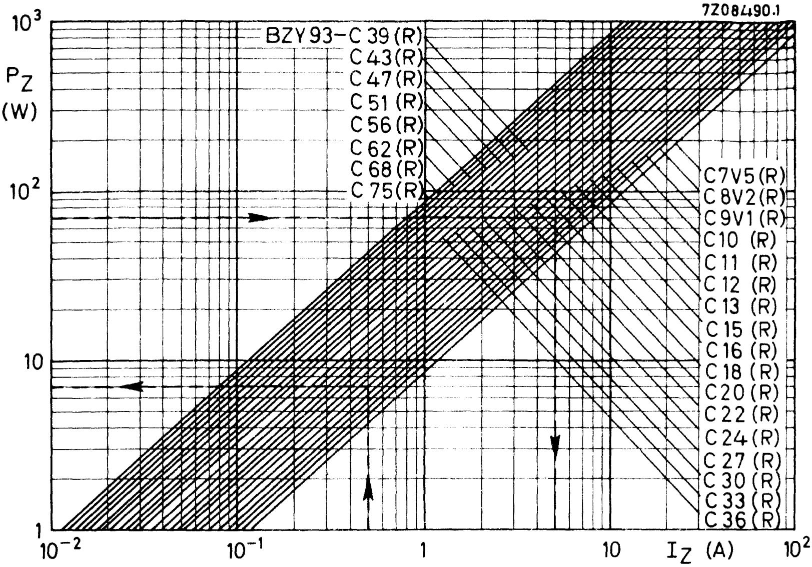

7Z08497
8.5
V_Z (V)
8
7.5
7
dynamic zener characteristics typical values
$S_Z = \frac{\Delta V}{125\ °C}$
ΔV
$T_j = 150°$
25°C
10^{-2}
10^{-1}
1
10
10^{2}
I_Z (A)
BZY93-C7V5 (R)

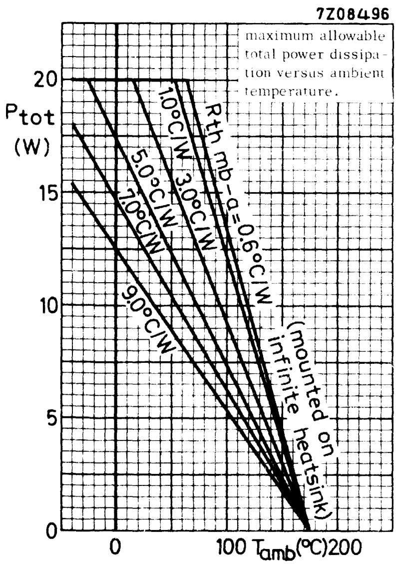

10.5 VZ (V) 10 9.5 9
7Z08493
dynamic zener characteristics typical values
Sz = ΔV / 125 °C
ΔV
Tj =150°C
25°C
10−2
10−1
1
10
IZ (A)
102
BZY93−C9V1 (R)

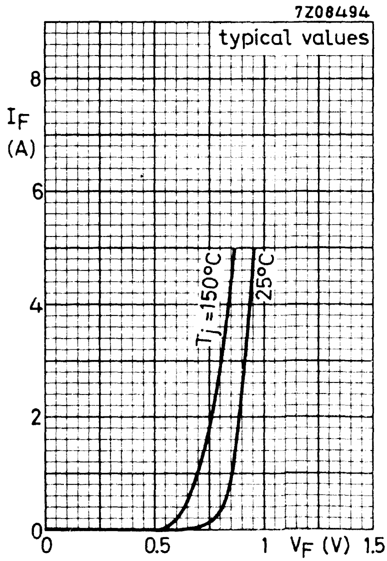

12 VZ (V) 11 10 9
7Z08495
dynamic zener characteristics typical values
Sz = ΔV / 125 °C
ΔV
Tj =150°C
25°C
10−2
10−1
1
10
IZ (A)
102
BZY 93−C10 (R)


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)
102
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)
102
BZY 93 −C75 (R)


7Z08490.1
P_Z
(W)
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)
C7V5 (R)
C 8V2 (R)
C 9V1 (R)
C 10 (R)
C 11 (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)
I_Z (A)


7Z08496
maximum allowable total power dissipation versus ambient temperature.
P_{tot}
(W)
$R_{th\ mb-a}$ = 0.6 °C/W
1.0 °C/W
3.0 °C/W
5.0 °C/W
7.0 °C/W
9.0 °C/W
(mounted on infinite heatsink)
T_{amb} (°C)


7Z08494
typical values
I_F
(A)
T_j = 150 °C
25 °C
V_F (V)

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

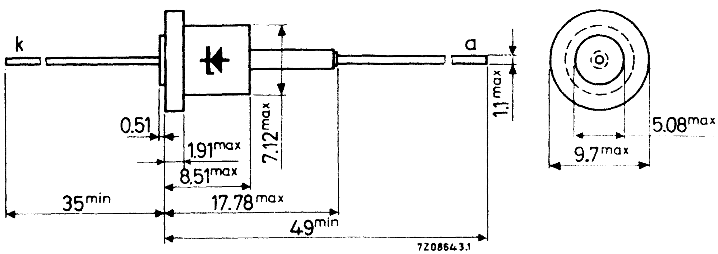
Storage temperature	T_{stg}		-65 to +175	°C
Junction temperature	T_j	max.	175	°C

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

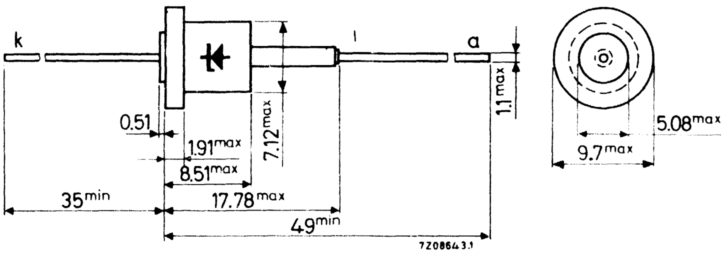
Storage temperature	T_{stg}		-65 to +175	°C
Junction temperature	T_j	max.	175	°C

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

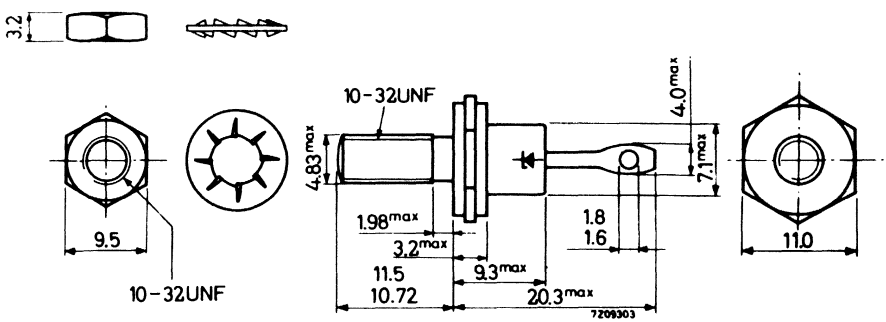
MEDIUM POWER VOLTAGE REGULATORS

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	$R_{th\ j-a}$	=	70	°C/W
From junction to mounting base	$R_{th\ j-mb}$	=	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

Transient suppressor diodes

TRANSIENT SUPPRESSOR DIODES

A range of diffused silicon diodes in a DO-30 metal envelope intended for use in the protection of the electrical and electronic equipment against voltage transients.
The series consists of the following types:
Normal polarity (cathode to stud): BZW86-7V5 to 62
Reverse polarity (anode to stud) : BZW86-7V5R to 62R

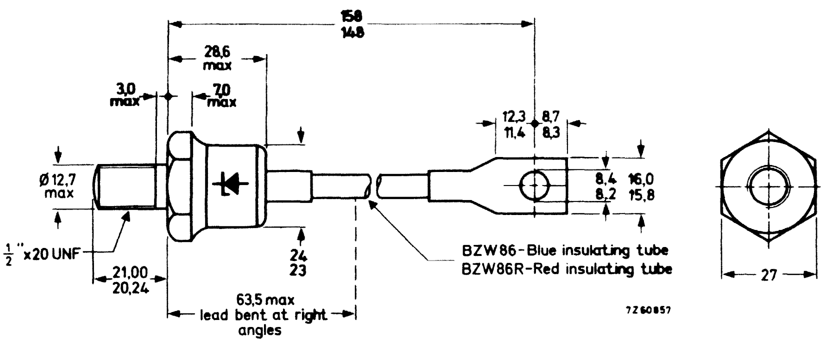
QUICK REFERENCE DATA

Stand-off voltage *)	V_R		7,5 to 62	V
Reverse breakdown voltage	$V_{(BR)R}$		9,4 to 70	V
Non-repetitive peak reverse power dissipation; T_j = 25 °C prior to surge; t_p = 100 μs (exponential pulse)	P_{RSM}	max.	60	kW

*) The stand-off voltage is the maximum reverse voltage recommended for continuous operation; at this value non-conduction is ensured.

MECHANICAL DATA Dimensions in mm

DO-30



Diameter of clearance hole: max. 13 mm
Net weight: 123 g
The mark shown applies to the normal polarity types.

Torque on nut: min. 9 Nm (90 kgcm)
max. 17,5 Nm (175 kgcm)

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

Stand-off voltage [1]	V_R	equal to type number suffix		
Currents				
Non-repetitive peak reverse current				
T_j = 25 °C prior to surge				
t_p = 10 μs; square pulse				
BZW86-9V1(R)	I_{RSM}	max.	3700	A
BZW86-27(R)	I_{RSM}	max.	1200	A
BZW86-56(R)	I_{RSM}	max.	700	A
BZW86-62(R)	I_{RSM}	max.	700	A
t_p = 1 ms; exponential pulse				
BZW86-9V1(R)	I_{RSM}	max.	1200	A
BZW86-27(R)	I_{RSM}	max.	400	A
BZW86-56(R)	I_{RSM}	max.	250	A
BZW86-62(R)	I_{RSM}	max.	250	A
Power dissipation				
Repetitive peak reverse power dissipation T_{mb} = 65 °C; f = 50 Hz; t_p = 10 μs (square pulse; see also graphs on page 6)	P_{RRM}	max.	50	kW
Non-repetitive peak reverse power dissipation T_j = 25 °C prior to surge; t_p = 100 μs (exponential pulse; see also graph on page 5)	P_{RSM}	max.	60	kW
Temperatures				
Storage temperature	T_{stg}		−55 to +175	°C
Junction temperature	T_j	max.	175	°C

THERMAL RESISTANCE

From junction to mounting base	$R_{th\ j\text{-}mb}$	=	0,3	°C/W
From mounting base to heatsink	$R_{th\ mb\text{-}h}$	=	0,1	°C/W

CHARACTERISTICS

Forward voltage

I_F = 500 A at T_j = 25 °C	V_F	<	1,5	V [2]

1) The stand-off voltage is the maximum reverse voltage recommended for continuous operation; at this value non-conduction is ensured.
2) Measured under pulse condition.

CHARACTERISTICS (continued)

	Clamping voltages (exp. pulse) at T_j = 25 ^oC prior to surge: t_p = 500 μs $V_{(CL)R}$ (V) typ.	max.		Reverse breakdown voltage at T_j = 25 ^oC $V_{(BR)R}$ (V) min.	
BZW86 -7V5(R)	12	14		8,5	
-8V2(R)	13	15,5		9,4	
-9V1(R)	14	17		10,4	
-10(R)	15,5	18,5		11,4	
-11(R)	17	20	I_R = 1000 A	12,4	I_R = 10 A
-12(R)	18,5	22		13,8	
-13(R)	20	24		15,3	
-15(R)	23	27		16,8	
-16(R)	27	32		18,8	
-18(R)	31	36		20,8	
-20(R)	34	40		22,8	
-22(R)	37	43	I_R = 500 A	25,1	I_R = 5 A
-24(R)	40	47		28	
-27(R)	44	52		31	
-30(R)	47	55		34	
-33(R)	51	60		37	
-36(R)	55	65		40	
-39(R)	60	70		44	
-43(R)	66	77	I_R = 250 A	48	I_R = 2 A
-47(R)	72	84		52	
-51(R)	78	92		58	
-56(R)	85	102		64	
-62(R)	92	102		70	

The maximum clamping voltage is the maximum reverse voltage which appear across the diode at the specified pulse duration and junction temperature.
See curves on pages 8 and 9 for square pulses and pages 10 and 11 for exponential pulses.

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

Peak reverse current

V_{RM} = recommended stand-off voltage	I_{RM}	<	2	mA
Temperature coefficient of clamping voltage	S	typ.	+0,1	%/°C

OPERATING NOTES

Heatsink considerations

(a) For non-repetitive transients, the device may be used without a heatsink for pulses up to 10 ms in duration.

(b) For repetitive transients which fall within the permitted operating range shown in the curves on page 6 the required heatsink is found as follows:

$$R_{th\ j\text{-}mb} + R_{th\ mb\text{-}h} + R_{th\ h\text{-}a} = \frac{T_{j\ max} - T_{amb}}{P_S + \delta .\ P_{RRM}}$$

where $T_{j\ max}$ = 175 °C

T_{amb} = ambient temperature

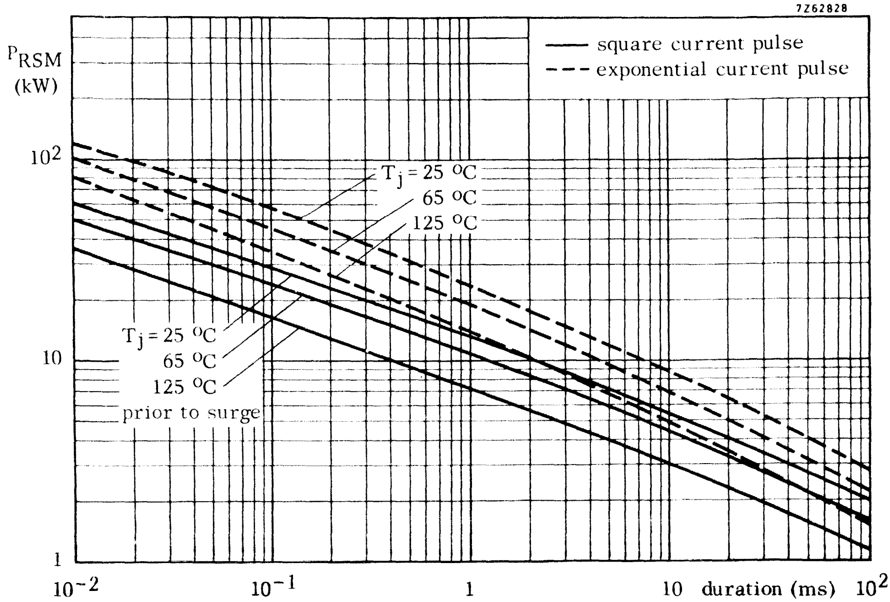
P_S = any steady state dissipation excluding that in pulses

δ = duty factor (t_p/T)

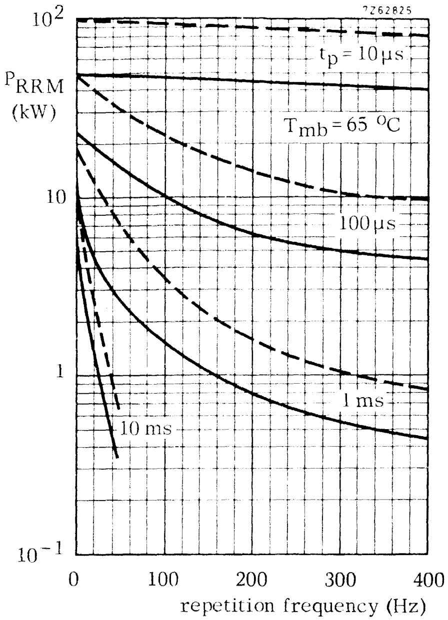
$R_{th\ j\text{-}mb}$ = 0,3 °C/W

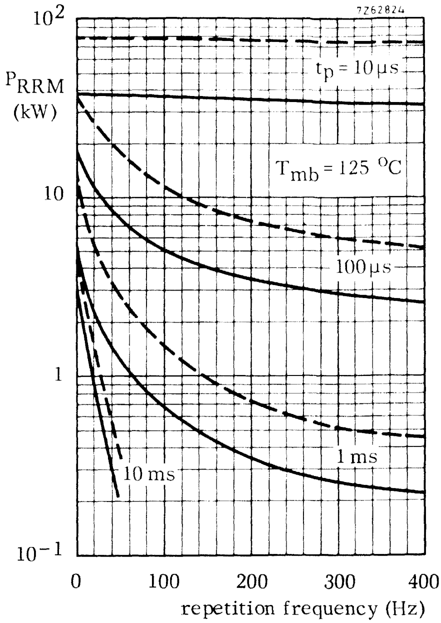
$R_{th\ mb\text{-}h}$ = 0,1 °C/W

thus $R_{th\ h\text{-}a}$ can be found.



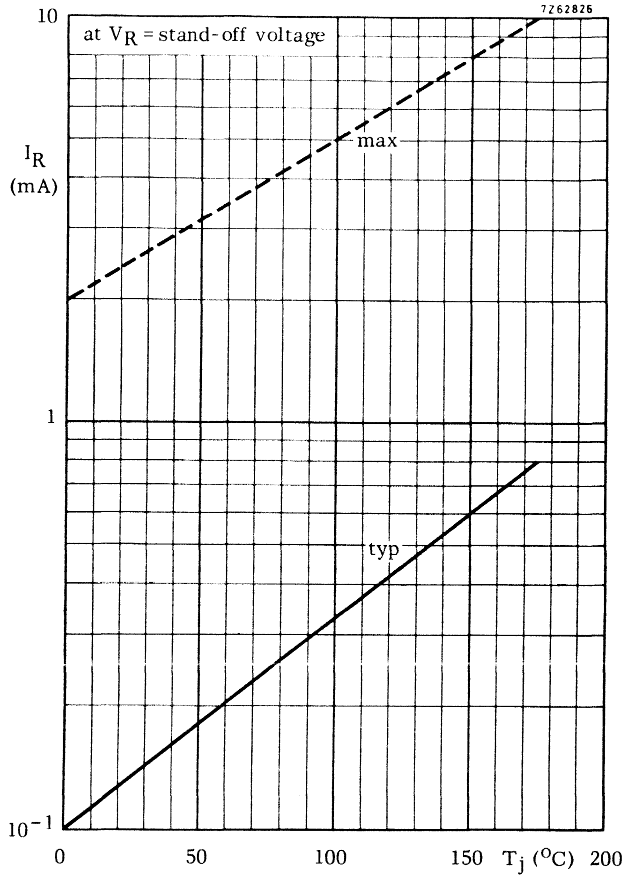
Duration of an exponential pulse is defined as the time taken for the pulse to fall to 37% of its initial value. It is assumed that the energy content does not continue beyond twice this time.

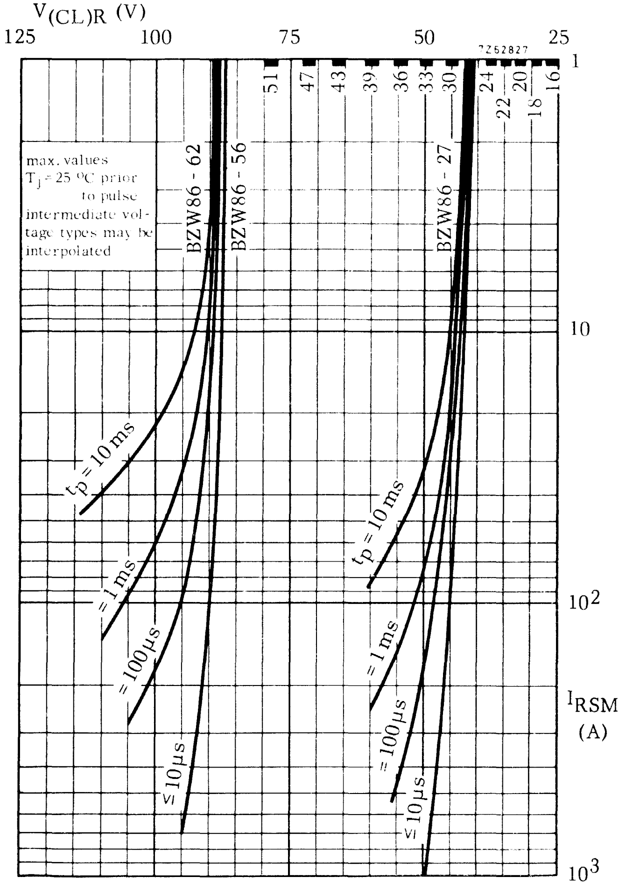




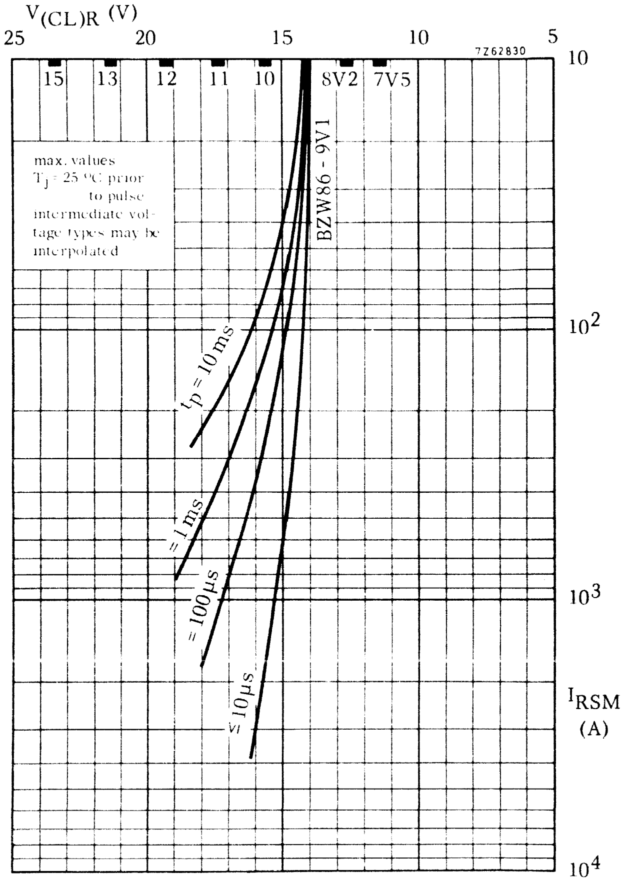
—— square current pulses

- - - exponential current pulses

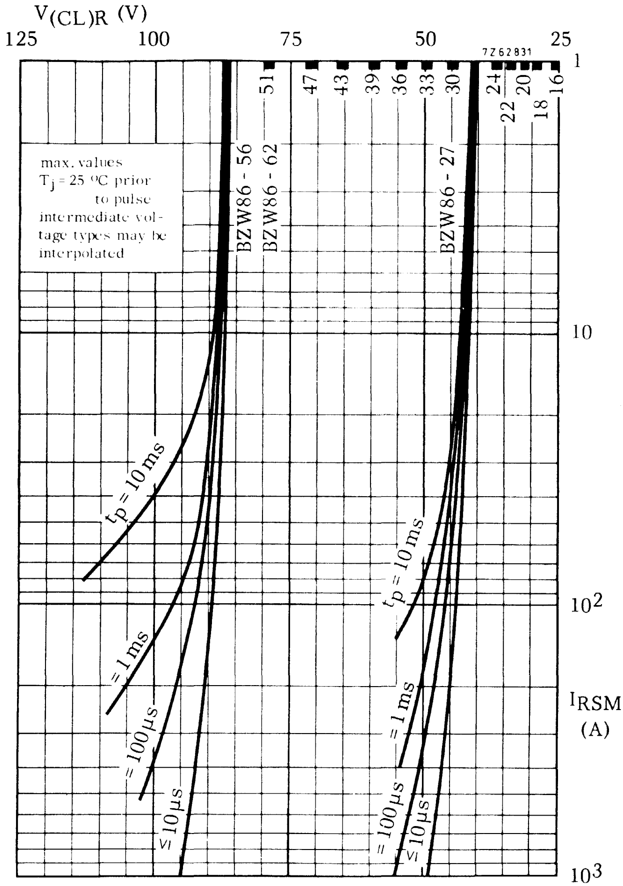

7Z62826
at V_R = stand-off voltage
I_R (mA)
10
1
10^{-1}
max
typ
0
50
100
150
200
T_j (°C)



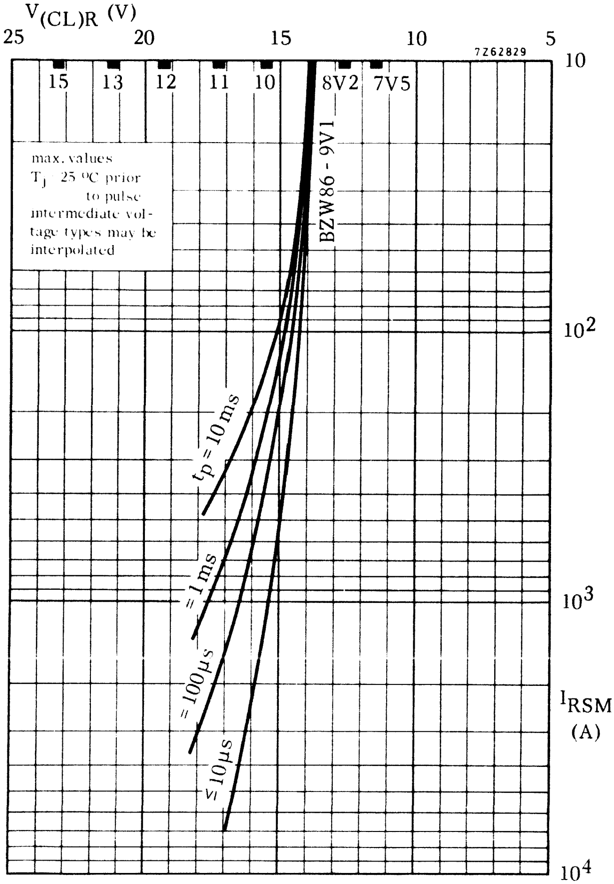
square pulses



square pulses



exponential pulses



exponential pulses

TRANSIENT SUPPRESSOR DIODES

A range of diffused silicon diodes in a DO-5 metal envelope intended for use in the protection of the electrical and electronic equipment against voltage transients.
The series consists of the following types:
Normal polarity (cathode to stuf): BZW91-5V6 to 62
Reverse polarity (anode to stud) : BZW91-5V6R to 62R

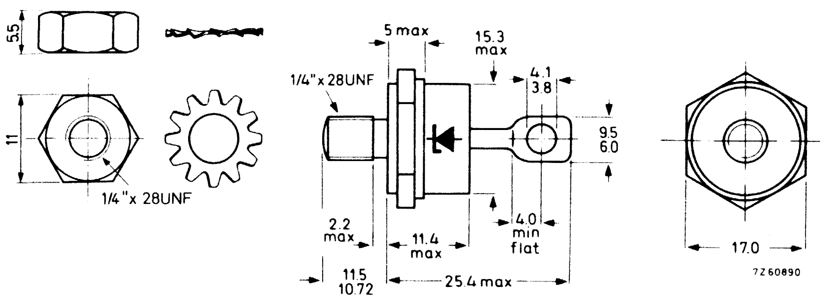
QUICK REFERENCE DATA

Stand-off voltage *)	V_R		5, 6 to 62	V
Reverse breakdown voltage	$V_{(BR)R}$		6, 4 to 70	V
Non-repetitive peak reverse power dissipation; T_j = 25 °C prior to surge; t_p = 100 µs (exponential pulse)	P_{RSM}	max.	27	kW

*) The stand-off voltage is the maximum reverse voltage recommended for continuous operation; at this value non-conduction is ensured.

MECHANICAL DATA Dimensions in mm

DO-5



Diameter of clearance hole: max. 6, 5 mm
Net weight: 16, 5 kg
Accessories available: 56264A; 56309B; 56309R
The mark shown applies to the normal polarity types.

Torque on nut: min. 1, 7 Nm (17 kgcm)
max. 3, 5 Nm (35 kgcm)

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

Stand-off voltage [1]	V_R	equal to type number suffix		
Currents				
Non-repetitive peak reverse current				
T_j = 25 °C prior to surge				
t_p = 10 μs; square pulse				
BZW91-6V8(R)	I_{RSM}	max.	2800	A
BZW91-11(R)	I_{RSM}	max.	1700	A
BZW91-18(R)	I_{RSM}	max.	1000	A
BZW91-39(R)	I_{RSM}	max.	480	A
BZW91-62(R)	I_{RSM}	max.	350	A
t_p = 1 ms; exponential pulse				
BZW91-6V8(R)	I_{RSM}	max.	660	A
BZW91-11(R)	I_{RSM}	max.	430	A
BZW91-18(R)	I_{RSM}	max.	240	A
BZW91-39(R)	I_{RSM}	max.	120	A
BZW91-62(R)	I_{RSM}	max.	85	A
Power dissipation				
Repetitive peak reverse power dissipation T_{mb} = 65 °C; f = 50 Hz; t_p = 10 μs (square pulse; see also graphs on page 6)	P_{RRM}	max.	25	kW
Non-repetitive peak reverse power dissipation T_j = 25 °C prior to surge; t_p = 100 μs (exponetial pulse; see also graph on page 5)	P_{RSM}	max.	27	kW
Temperatures				
Storage temperature	T_{stg}		−55 to +175	°C
Junction temperature	T_j	max.	175	°C

THERMAL RESISTANCE

From junction to ambient	$R_{th\ j\text{-}a}$	=	25	°C/W
From junction to mounting base	$R_{th\ j\text{-}mb}$	=	1,5	°C/W
From mounting base to heatsink	$R_{th\ mb\text{-}h}$	=	0,2	°C/W

CHARACTERISTICS

Forward voltage

I_F = 10 A at T_j = 25 °C	V_F	<	1,5	V [2]

1) The stand-off voltage is the maximum reverse voltage recommended for continuous operation; at this value non-conduction is ensured.
2) Measured under pulse conditions.

CHARACTERISTICS (continued)

	Clamping voltages (exp. pulse) at T_j = 25 °C prior to pulse; t_p = 500 μs $V_{(CL)R}$ (V) typ.	max.		Reverse breakdown voltage at T_j = 25 °C $V_{(BR)R}$ (V) min.	
BZW91 -5V6 (R)	8,5	9,5	I_R = 150 A	6,4	I_R = 5 A
-6V2 (R)	9,5	10,5		7,0	
-6V8 (R)	10	11,5		7,7	
-7V5 (R)	11	12,5		8,5	I_R = 2 A
-8V2 (R)	12	13,5		9,4	
-9V1 (R)	13	15	I_R = 100 A	10,4	
-10(R)	14,5	17		11,4	
-11(R)	16	19		12,4	
-12(R)	17,5	22		13,8	
-13(R)	19	26		15,3	
-15(R)	22	28		16,8	
-16(R)	24	31		18,8	I_R = 1 A
-18(R)	26	34		20,8	
-20(R)	28	37		22,8	
-22(R)	31	40		25,1	
-24(R)	34	44		28	
-27(R)	38	48		31	
-30(R)	40	52	I_R = 50 A	34	
-33(R)	44	56		37	I_R = 0,5 A
-36(R)	49	61		40	
-39(R)	54	66		44	
-43(R)	60	72		48	
-47(R)	66	79		52	
-51(R)	72	87		58	
-56(R)	79	97		64	
-62(R)	86	97		70	

The maximum clamping voltage is the maximum reverse voltage which appear across the diode at the specified pulse duration and junction temperature.
See curves on pages 8 and 9 for square pulses and pages 10 and 11 for exponential pulses.

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

Peak reverse current

V_{RM} = recommended stand-off voltage				
BZW91-5V6 to BZW91-6V8	I_{RM}	<	60	mA
BZW91-7V5 to BZW91-30	I_{RM}	<	5	mA
BZW91-33 to BZW91-62	I_{RM}	<	10	mA
Temperature coefficient of clamping voltage	S	typ.	+0,1	%/°C

OPERATING NOTES

Heatsink considerations

(a) For non-repetitive transients, the device may be used without a heatsink for pulses up to 10 ms in duration.

(b) For repetitive transients which fall within the permitted operating range shown in the curves on page 6 the required heatsink is found as follows:

$$R_{th\ j\text{-}mb} + R_{th\ mb\text{-}h} + R_{th\ h\text{-}a} = \frac{T_{j\ max} - T_{amb}}{P_s + \delta .\ P_{RRM}}$$

where $T_{j\ max}$ = 175 °C

T_{amb} = ambient temperature

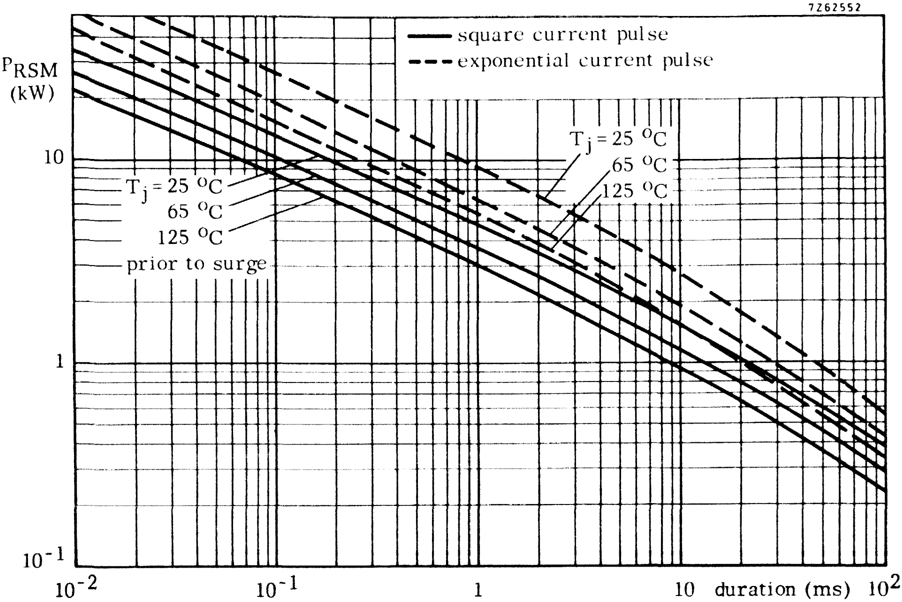
P_s = any steady state dissipation exluding that in pulses

δ = duty factor (t_p/T)

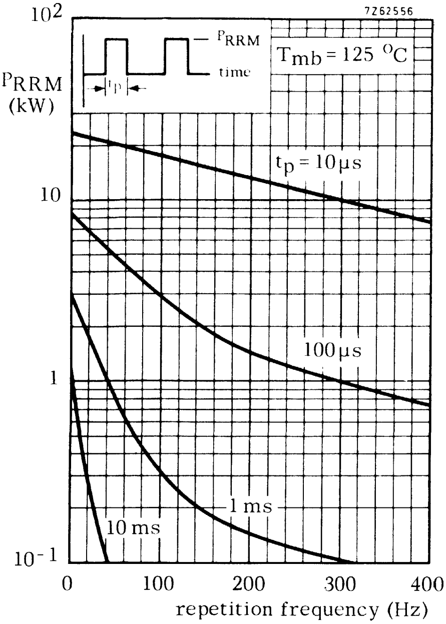
$R_{th\ j\text{-}mb}$ = 1,5 °C/W

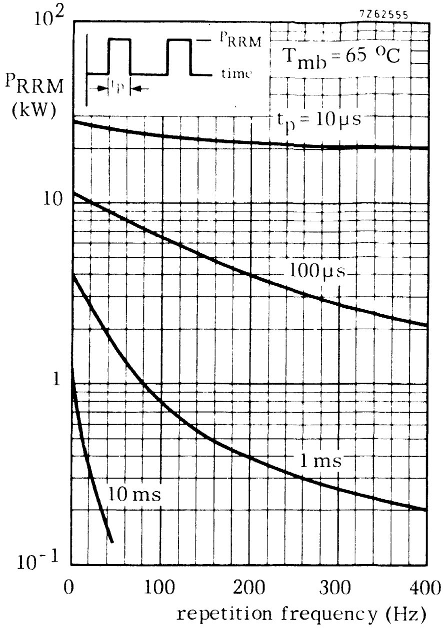
$R_{th\ mb\text{-}h}$ = 0 2 °C/W

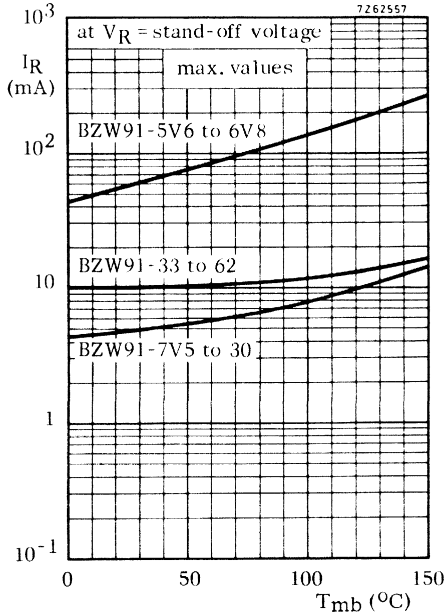
thus $R_{th\ h\text{-}a}$ can be found.

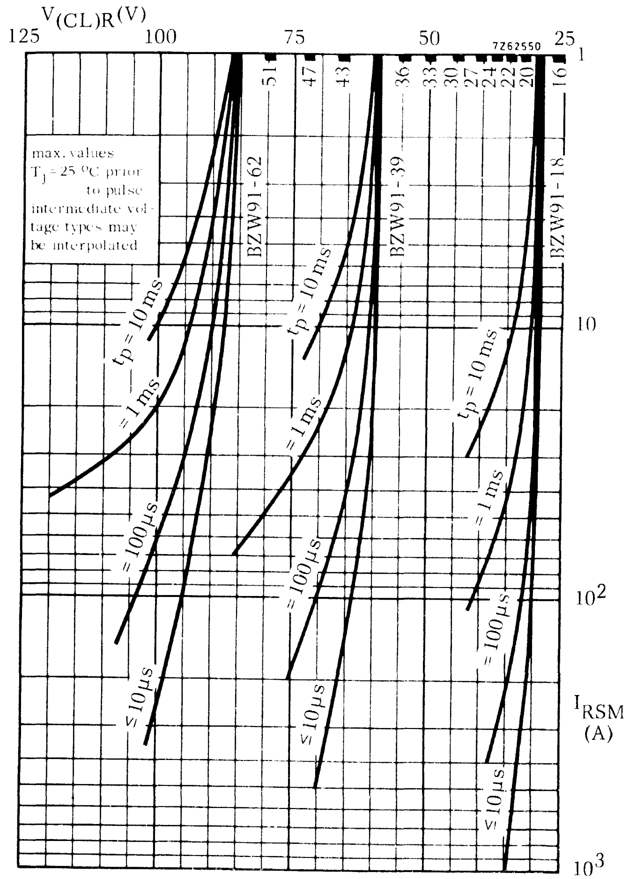


Duration of an exponential pulse is defined as the time taken for the pulse to fall to 37% of its initial value. It is assumed that the energy content does not continue beyond twice this time.

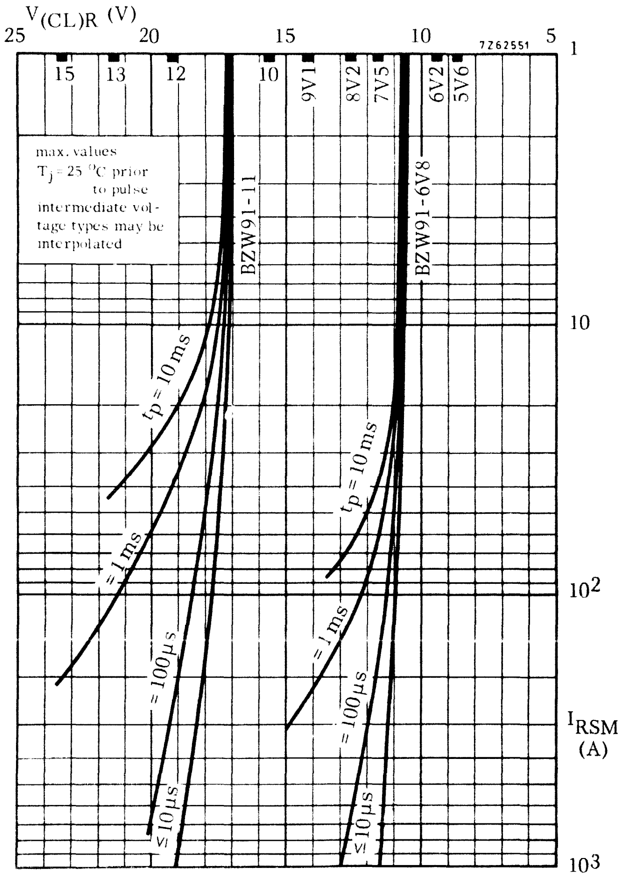

7Z62556
10^2
P_{RRM}
(kW)
10
1
10^{-1}
P_{RRM}
time
t_p
T_{mb} = 125 °C
t_p = 10 μs
100 μs
1 ms
10 ms
0
100
200
300
400
repetition frequency (Hz)


7Z62555
10^2
P_{RRM}
(kW)
10
1
10^{-1}
P_{RRM}
time
t_p
T_{mb} = 65 °C
t_p = 10 μs
100 μs
1 ms
10 ms
0
100
200
300
400
repetition frequency (Hz)

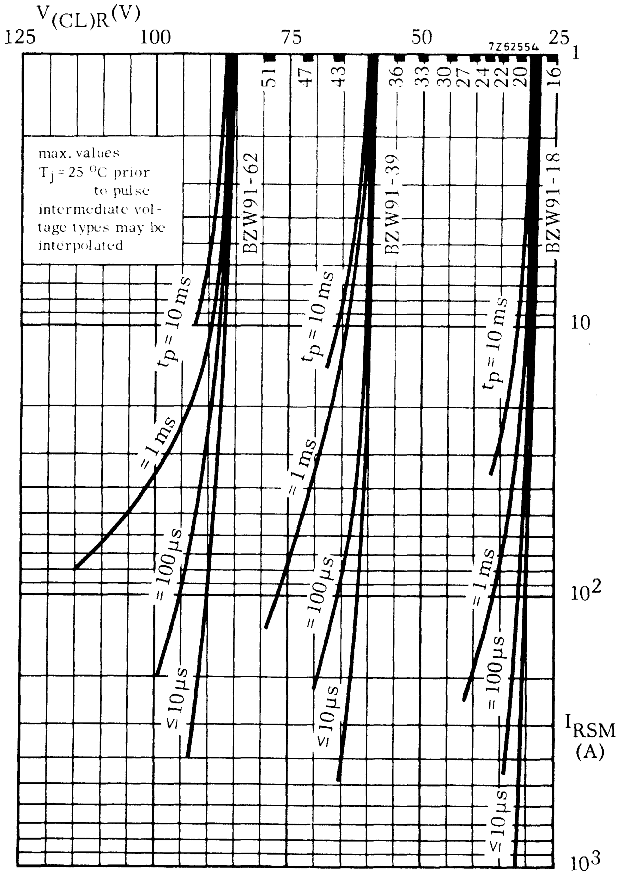

7Z62557
at V_R = stand-off voltage
max. values
I_R
(mA)
10^3
10^2
10
1
10^{-1}
BZW91-5V6 to 6V8
BZW91-33 to 62
BZW91-7V5 to 30
0
50
100
150
T_{mb} (°C)



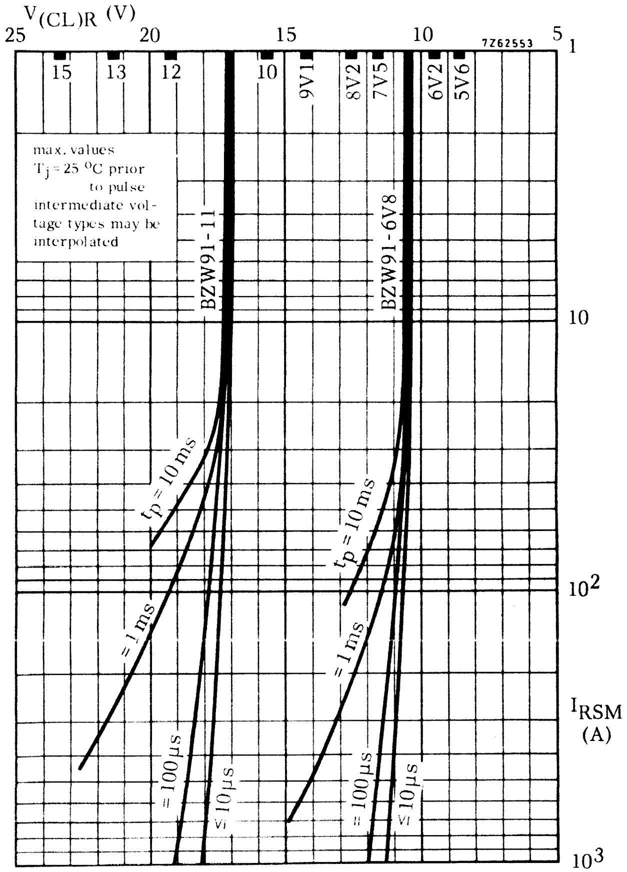
square pulses



square pulses



exponential pulses



exponential pulses

TRANSIENT SUPPRESSOR DIODES

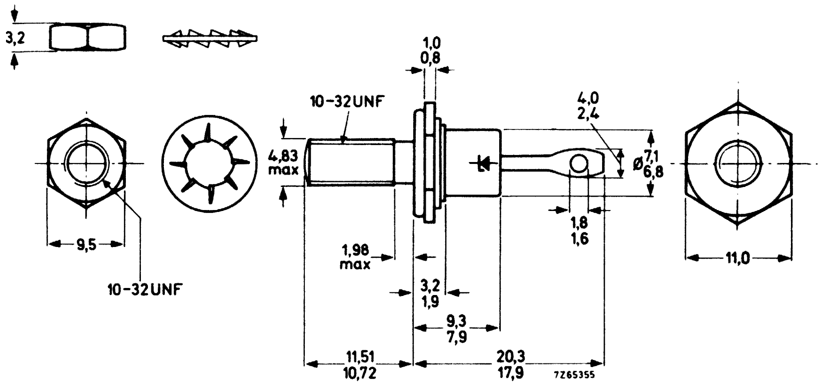
A range of diffused silicon diodes in a DO-4 metal envelope intended for use in the protection of the electrical and electronic equipment against voltage transients.
The series consists of the following types:
Normal polarity (cathode to stud): BZW93-5V6 to 62
Reverse polarity (anode to stud) : BZW93-5V6R to 62R

QUICK REFERENCE DATA				
Stand-off voltage *)	V_R		5,6 to 62	V
Reverse breakdown voltage	$V_{(BR)R}$		6,4 to 70	V
Non-repetitive peak reverse power dissipation; T_j = 25 °C prior to surge; t_p = 100 μs (exponential pulse)	P_{RSM}	max.	3	kW

*) The stand-off voltage is the maximum reverse voltage recommended for continuous operation; at this value non-conduction is ensured.

MECHANICAL DATA Dimensions in mm

DO-4



Diameter of clearance hole: max. 5,2 mm
Net weight: 6,5 g
The mark shown applies to the normal polarity types.

Torque on nut: min. 0,8 Nm (8 kgcm)
max. 1,7 Nm (17 kgcm)

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

Stand-off voltage [1]	V_R	equal to type number suffix		
Currents				
Non-repetitive peak reverse current				
T_j = 25 °C prior to surge				
t_p = 10 µs; square pulse				
BZW93-6V8(R)	I_{RSM}	max.	300	A
BZW93-11(R)	I_{RSM}	max.	180	A
BZW93-18(R)	I_{RSM}	max.	100	A
BZW93-39(R)	I_{RSM}	max.	50	A
BZW93-62(R)	I_{RSM}	max.	33	A
t_p = 1 ms; exponential pulse				
BZW93-6V8(R)	I_{RSM}	max.	58	A
BZW93-11(R)	I_{RSM}	max.	33	A
BZW93-18(R)	I_{RSM}	max.	20	A
BZW93-39(R)	I_{RSM}	max.	10	A
BZW93-62(R)	I_{RSM}	max.	6,5	A
Power dissipation				
Repetitive peak reverse power dissipation T_{mb} = 65 °C; f = 50 Hz; t_p = 10 µs (square pulse; see also graphs on page 6)	P_{RRM}	max.	3	kW
Non-repetitive peak reverse power dissipation T_j = 25 °C prior to surge; t_p = 100 µs (exponential pulse; see also graph on page 5)	P_{RSM}	max.	3	kW
Temperatures				
Storage temperature	T_{stg}		−55 to +175	°C
Junction temperature	T_j	max.	175	°C

THERMAL RESISTANCE

From junction to ambient	$R_{th\ j\text{-}a}$	=	50	°C/W
From junction to mounting base	$R_{th\ j\text{-}mb}$	=	5,0	°C/W
From mounting base to heatsink	$R_{th\ mb\text{-}h}$	=	0,6	°C/W

CHARACTERISTICS

Forward voltage

I_F = 10 A at T_j = 25 °C	V_F	<	1	1,5	V [2]

1) The stand-off voltage is the maximum reverse voltage recommended for continuous operation; at this value non-conduction is ensured.

2) Measured under pulse conditions.

CHARACTERISTICS (continued)

	Clamping voltages (exp. pulse) at T_j = 25 °C prior to pulse; t_p = 500 μs $V_{(CL)R}$ (V) typ.	max.		Reverse breakdown voltage at T_j = 25 °C $V_{(BR)R}$ (V) min.	
BZW93 -5V6(R)	9	10	I_R = 20 A	6,4	I_R = 2 A
-6V2(R)	10	11,2		7,0	
-6V8(R)	11	12,5		7,7	
-7V5(R)	12	14		8,5	I_R = 1 A
-8V2(R)	13,5	15,5		9,4	
-9V1(R)	15	17,5		10,4	
-10(R)	17	19		11,4	
-11(R)	19	21		12,4	
-12(R)	21	23		13,8	
-13(R)	23	26		15,3	I_R = 0,5 A
-15(R)	22	26		16,8	
-16(R)	25	29	I_R = 10 A	18,8	
-18(R)	28	33		20,8	
-20(R)	32	38		22,8	
-22(R)	36	43		25,1	
-24(R)	41	48		28	
-27(R)	47	54		31	
-30(R)	44	52	I_R = 5 A	34	I_R = 0,2 A
-33(R)	49	58		37	
-36(R)	56	65		40	
-39(R)	63	72		44	
-43(R)	71	82		48	
-47(R)	80	93		52	
-51(R)	89	104		58	
-56(R)	98	116		64	
-62(R)	104	116		70	

The maximum clamping voltage is the maximum reverse voltage which appear across the diode at the specified pulse duration and junction temperature.
See curves on pages 8 and 9 for square pulses and pages 10 and 11 for exponential pulses.

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

Peak reverse current

V_{RM} = recommended stand-off voltage

BZW93-5V6 to BZW93-6V8	I_{RM}	<	0,5	mA
BZW93-7V5 to BZW93-62	I_{RM}	<	0,1	mA

Temperature coefficient of clamping voltage	S	typ.	+0,1	%/°C

OPERATING NOTES

Heatsink considerations

(a) For non-repetitive transients, the device may be used without a heatsink for pulses up to 10 ms in duration.

(b) For repetitive transients which fall within the permitted operating range shown in the curves on page 6 the required heatsink is found as follows:

$$R_{th\ j\text{-}mb} + R_{th\ mb\text{-}h} + R_{th\ h\text{-}a} = \frac{T_{j\ max} - T_{amb}}{P_S + \delta .\ P_{RRM}}$$

where $T_{j\ max}$ = 175 °C

T_{amb} = ambient temperature

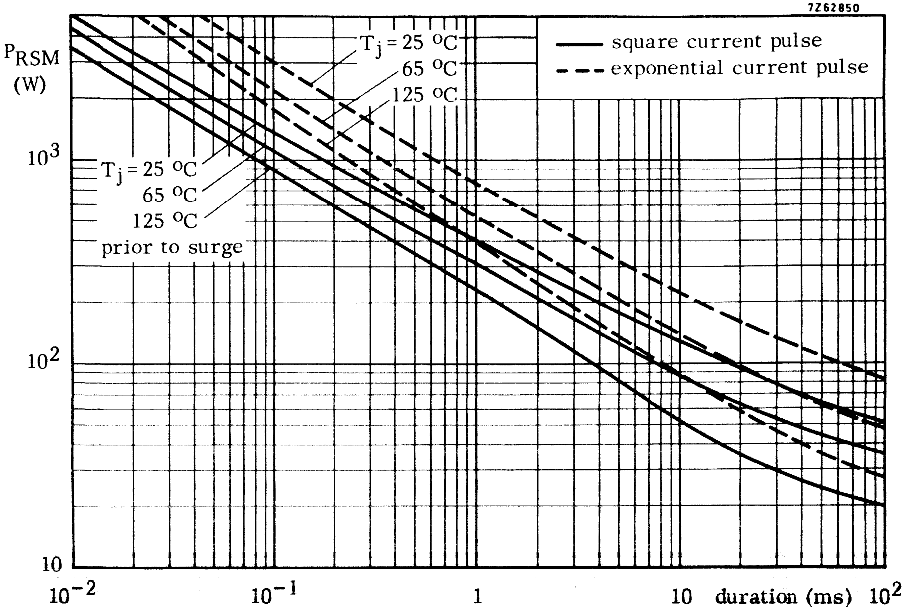
P_S = any steady state dissipation excluding that in pulses

δ = duty factor (t_p/T)

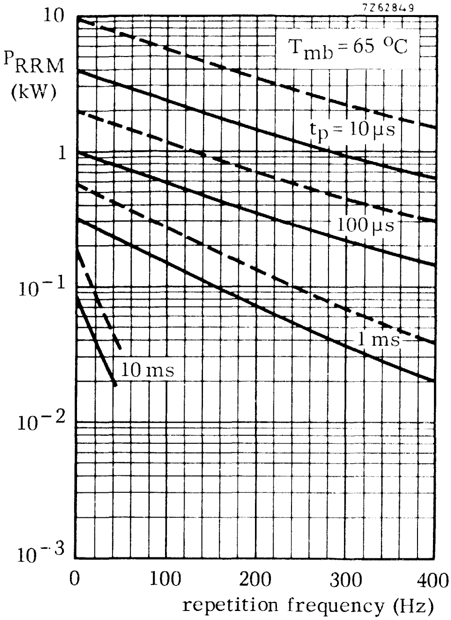
$R_{th\ j\text{-}mb}$ = 5,0 °C/W

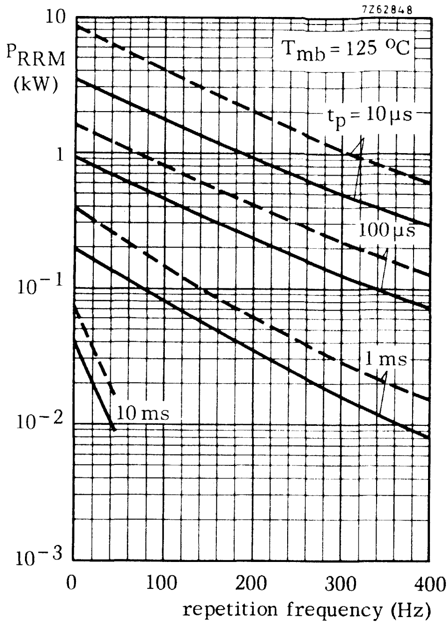
$R_{th\ mb\text{-}h}$ = 0,6 °C/W

thus $R_{th\ h\text{-}a}$ can be found.



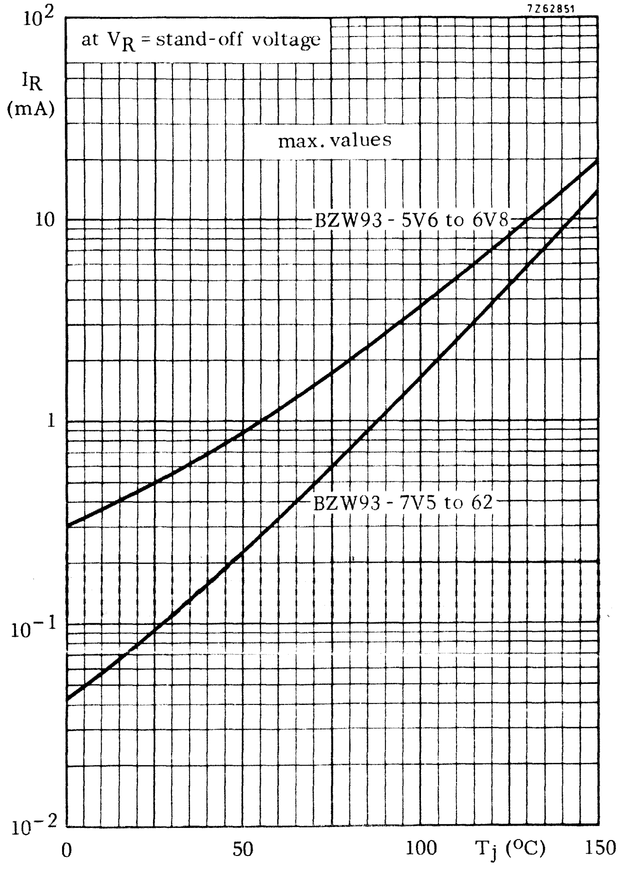
Duration of an exponential pulse is defined as the time taken for the pulse to fall to 37% of its initial value. It is assumed that the energy content does not continue beyond twice this time.

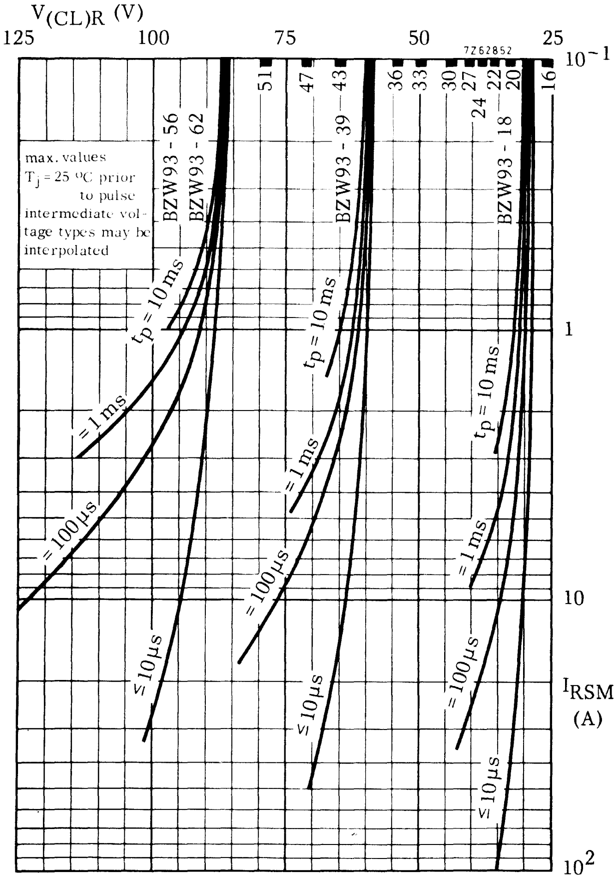




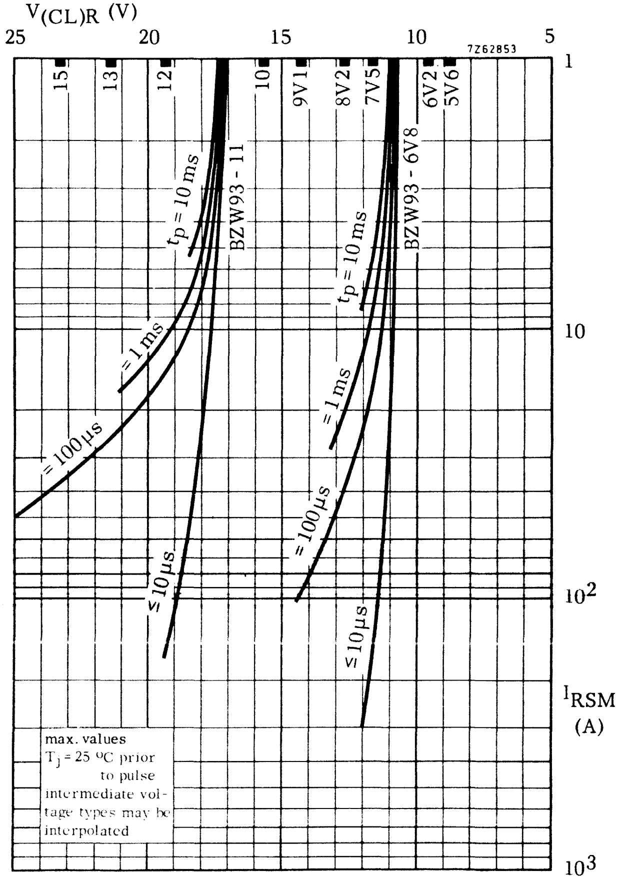
——— square current pulses

– – – exponential current pulses

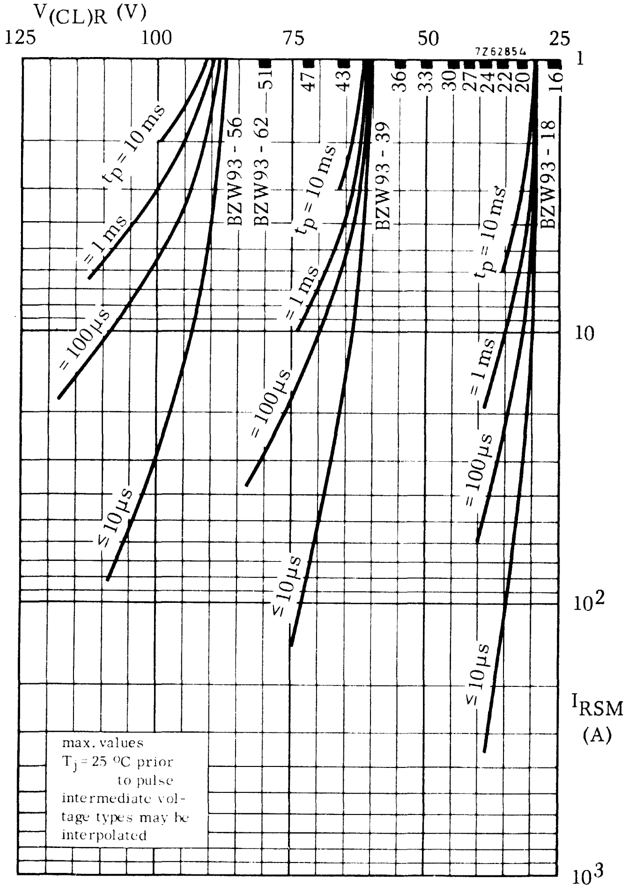

7Z62851
at V_R = stand-off voltage
I_R (mA)
max. values
BZW93 - 5V6 to 6V8
BZW93 - 7V5 to 62
10^2
10
1
10^{-1}
10^{-2}
0
50
100
T_j (°C)
150



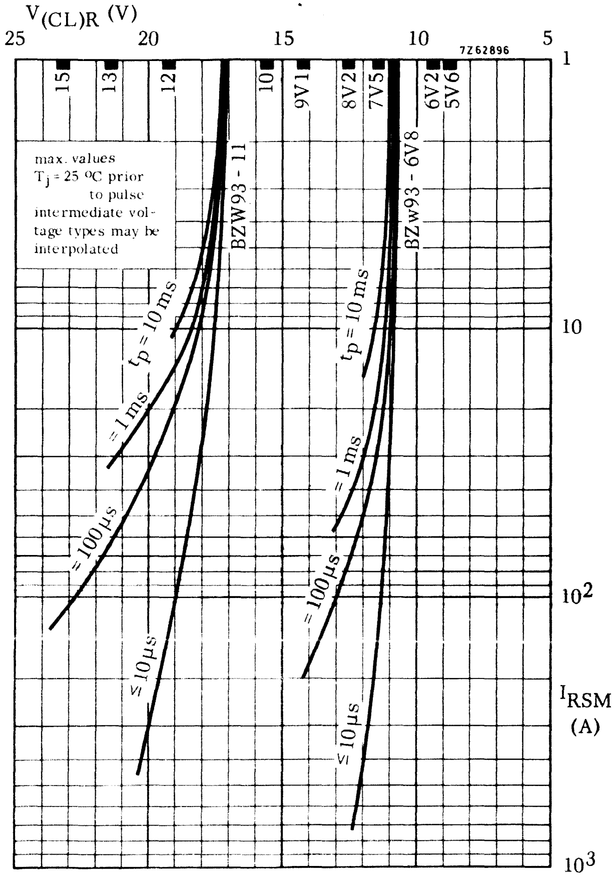
square pulses



square pulses



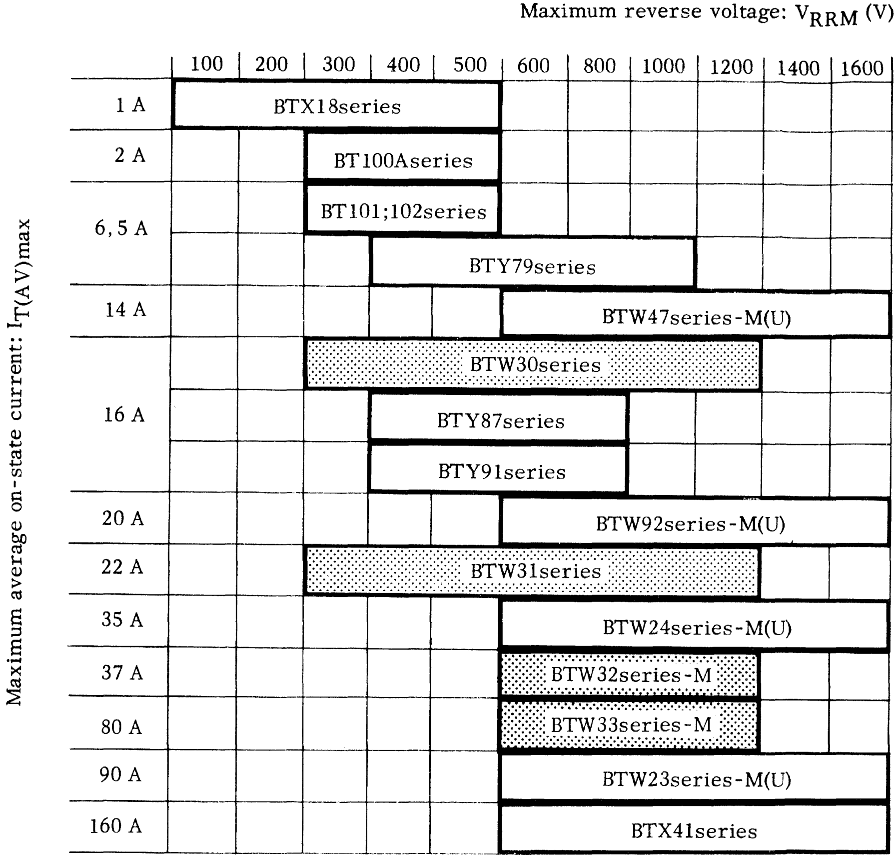
exponential pulses



exponential pulses

Thyristors, diacs, triacs

TYPE SELECTION CHART



general purpose types

fast turn-off types

Diac BR100 : $V_{(BO)}$ = 28 to 36 V; I_{FRM} = 2 A

Triac BTX94-400 to 1200 : $I_{T(RMS)}$ = 25 A; BTW34-600M to 1600M: $I_{T(RMS)}$ = 55 A

Thyristor tetrode BRY39 : 70 V; 250 mA

Pulse modulator thyristor BTX95-500R to 800R : $I_{T(RMS)}$ = 15 A

OPERATING NOTES

When there is a possibility that transients, due to the energy stored in the transformer, will exceed the maximum permissible non-repetitive peak reverse voltage [1]), a damping circuit should be connected across the transformer.
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_{RSM} = the transient voltage peak produced by the transformer
V_{RWM} = the actually applied crest working reverse voltage

The capacitance values calculated from the above table are minimum values; to allow for circuit variations and component tolerances, larger values should be used.

[1]) For controlled avalanche types read: non-repetitive peak reverse power.

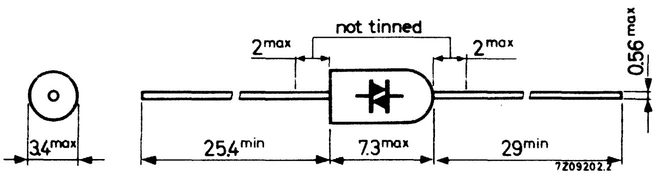
SILICON BI-DIRECTIONAL TRIGGER DEVICE

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 ($t \leq 20\ \mu s$)	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 up to T_{amb} = 70 °C	P_{tot}	max.	150	mW
Repetitive peak current ($t \leq 20\ \mu s$)	I_{FRM}	max.	2	A
Storage temperature	T_{stg}		−65 to +100	°C
Junction temperature	T_j	max.	100	°C

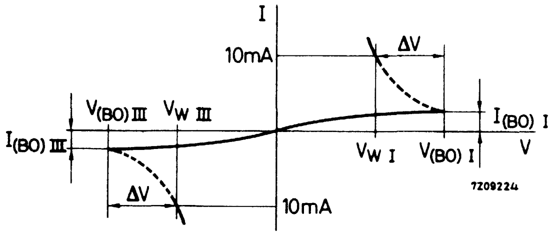
THERMAL RESISTANCE

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

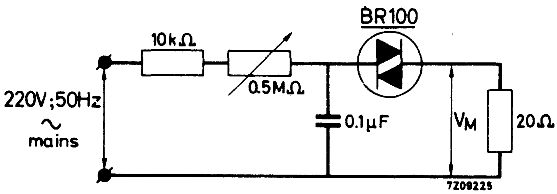
1) Limiting values according to the Absolute Maximum System as defined in IEC publication 134.

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 at V = 0,98 $V_{(BO)}$	$I_{(BO)}$	< 20	µA



Test circuit for peak output voltage



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

THYRISTOR TETRODE

The BRY39 is a planar p-n-p-n trigger device in a TO-72 metal envelope, intended for use in switching applications such as relay and lamp drivers, sensing network for temperature, etc.
For the applications of the BRY39 as SCS see Handbook Part 3, section SWITCHING TRANSISTORS and as PROGRAMMABLE UNIJUNCTION TRANSISTOR see Handbook Part 3, section SWITCHING TRANSISTORS.

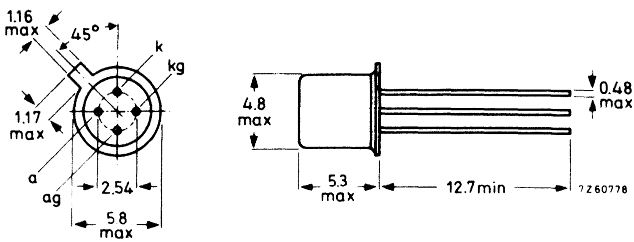
QUICK REFERENCE DATA

Continuous voltages	$V_D = V_R$	max.	70	V
Repetitive peak voltages	$V_{DRM} = V_{RRM}$	max.	70	V
On-state current up to T_{case} = 85 °C	I_T	max.	250	mA
Non-repetitive peak on-state current t = 10 μs; T_j = 150 °C prior to surge	I_{TSM}	max.	3	A
Junction temperature	T_j	max.	150	°C
Rate of rise of on-state current	$\frac{dI_T}{dt}$	max.	20	A/μs

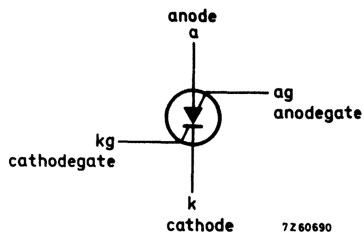
MECHANICAL DATA Dimensions in mm

Anodegate connected to case

TO-72



Accessories supplied on request: 56246; 56263



MEANING OF SYMBOLS

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

ANODE TO CATHODE

Voltages [1]

Continuous voltages	$V_D = V_R$	max.	70	V
Repetitive peak voltages	$V_{DRM} = V_{RRM}$	max.	70	V
Non-repetitive peak voltages	$V_{DSM} = V_{RSM}$	max.	70	V

Currents

On-state current (d.c.) up to T_{case} = 85 °C	I_T	max.	250	mA
up to T_{amb} = 25 °C	I_T	max.	175	mA
Repetitive peak on-state current t = 10 µs; δ = 0.01	I_{TRM}	max.	2.5	A
Non-repetitive peak on-state current t = 10 µs; T_j = 150 °C prior to surge	I_{TSM}	max.	3	A
Rate of rise of on-state current after triggering to I_T = 2.5 A	$\frac{dI_T}{dt}$	max.	20	A/µs

CATHODEGATE TO CATHODE

Voltage

Reverse peak voltage	V_{RGKM}	max.	5	V

Current

Forward peak current	I_{FGKM}	max.	100	mA

ANODEGATE TO ANODE

Voltage

Reverse peak voltage	V_{RGAM}	max.	70	V

Current

Forward peak current	I_{FGAM}	max.	100	mA

TEMPERATURES

Storage temperature	T_{stg}		−65 to +200	°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
From junction to case	$R_{th\ j\text{-}c}$	=	0.15	°C/mW

[1] These ratings apply for zero or negative bias on the cathodegate with respect to the cathode, and when a resistor R ≤ 10 kΩ is connected between cathodegate and cathode.

CHARACTERISTICS

ANODE TO CATHODE

Voltages

On-state voltage I_T = 100 mA; T_j = 25 °C	V_T	<	1.4	V
Rate of rise of off-state voltage that will not trigger any device [1]	$\frac{dV_D}{dt}$ [1]			

Currents

Peak reverse current V_{RM} = 70 V; T_j = 25 °C	I_{RM}	typ.	1	nA
		<	100	nA
T_j = 150 °C	I_{RM}	<	2	μA
Peak off-state current V_{DM} = 70 V; T_j = 25 °C	I_{DM}	typ.	1	nA
		<	100	nA
T_j = 150 °C	I_{DM}	<	2	μA
Holding current; R_{GK} = 10 kΩ; R_{GA} = 220 kΩ; T_j = 25 °C	I_H	<	250	μA

CATHODEGATE TO CATHODE

Voltages

Voltage that will trigger all devices V_D = 6 V; T_j = 25 °C	V_{GKT}	>	0.5	V

Current

Current that will trigger all devices V_D = 6 V; T_j = 25 °C	I_{GKT}	>	1	μA

ANODEGATE TO ANODE

Voltages

Voltage that will trigger all devices V_D = 6 V; T_j = 25 °C	V_{GAT}	>	1	V

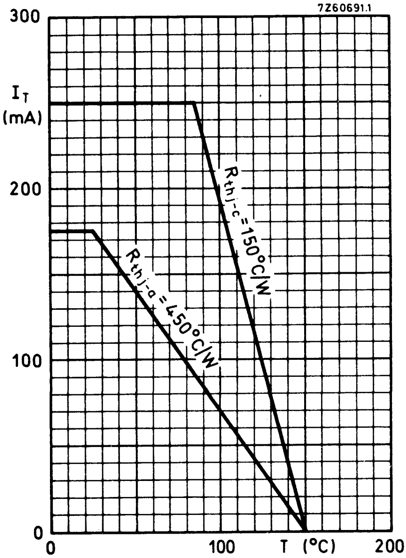
Current

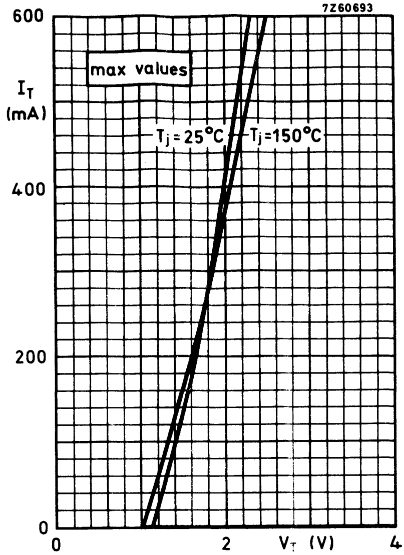
Current that will trigger all devices V_D = 6 V; R_{GK} = 10 kΩ; T_j = 25 °C	I_{GAT}	>	100	μA

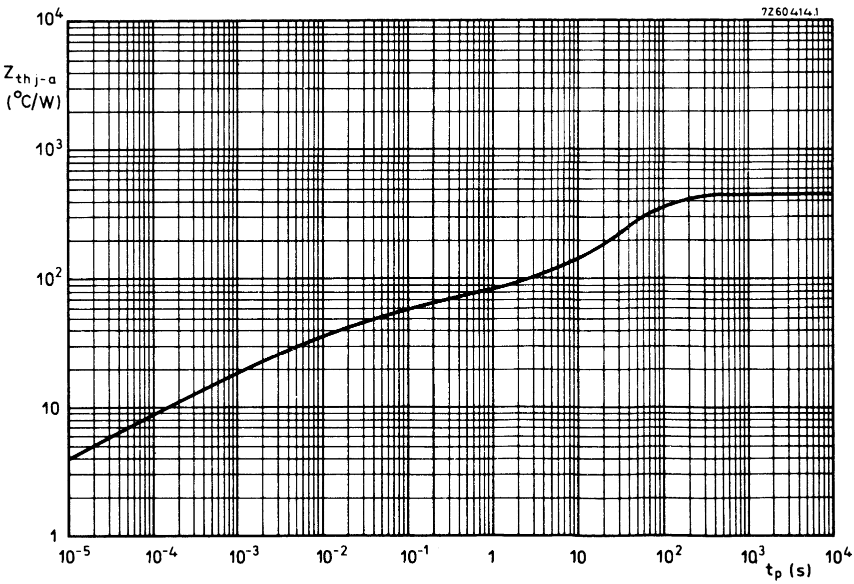
[1]) The dV_D/dt is unlimited when the anodegate lead is returned to the anode supply voltage through a current limiting resistor.

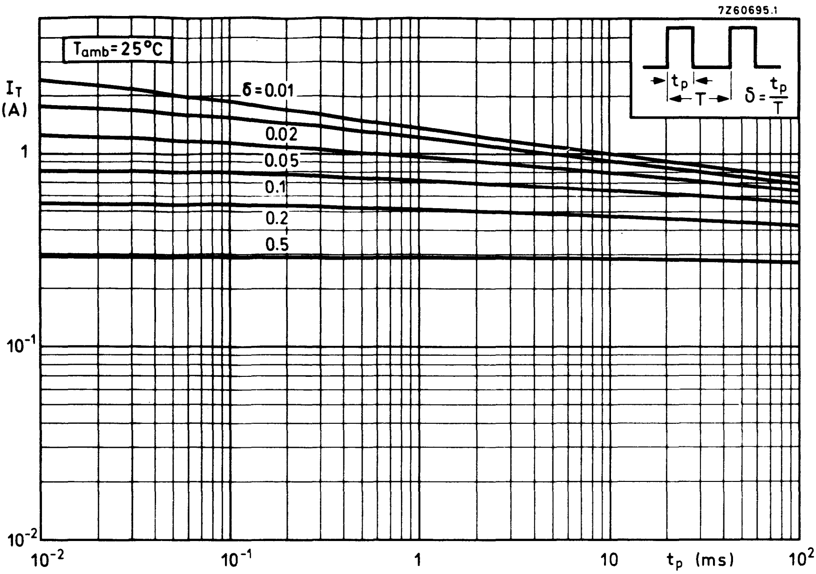
SWITCHING CHARACTERISTICS

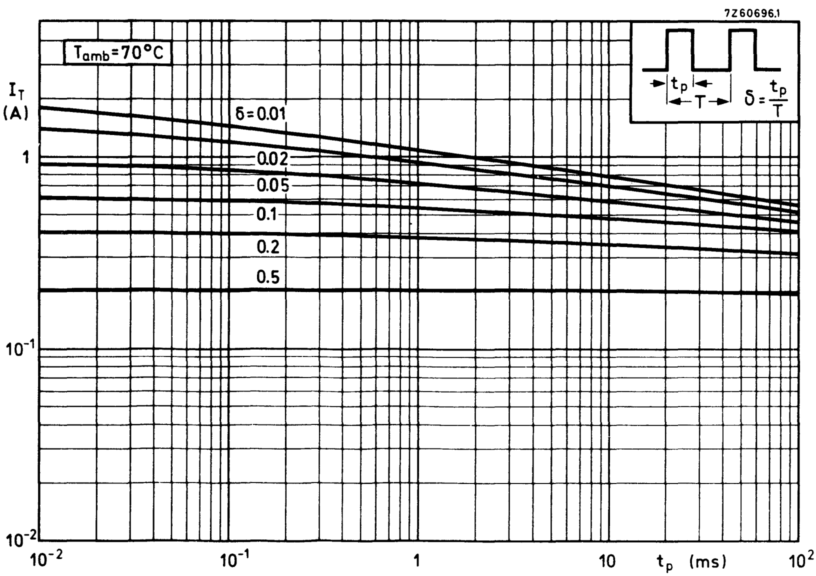
Turn-on time ($t_{on} = t_d + t_r$)				
V_D = 15 V; I_T = 150 mA				
R_{GK} = 10 kΩ; T_j = 25 °C	t_{on}	<	300	ns
Circuit-commutated turn-off time				
$V_D = V_R$ = 15 V; I_T = 150 mA				
R_{GK} = 10 kΩ; T_j = 25 °C	t_{off}	<	3	μs

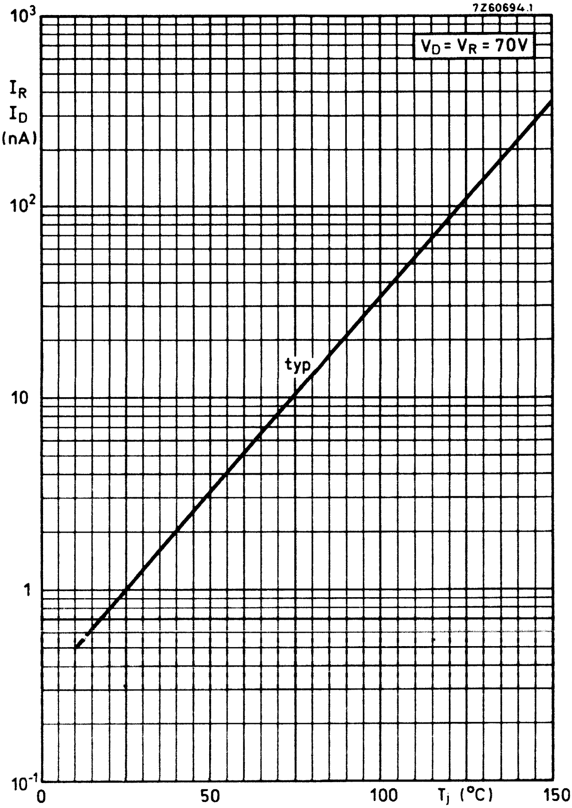

7Z60691.1
300
200
100
0
I_T
(mA)
$R_{th\,j-c}$ = 150°C/W
$R_{th\,j-a}$ = 450°C/W
0
100
T (°C)
200


7Z60693
600
400
200
0
I_T
(mA)
max values
T_j = 25°C
T_j = 150°C
0
2
V_T (V)
4


7Z60414.1
10^4
10^3
10^2
10
1
$Z_{th\,j-a}$
(°C/W)
10^{-5}
10^{-4}
10^{-3}
10^{-2}
10^{-1}
1
10
10^2
10^3
10^4
t_p (s)

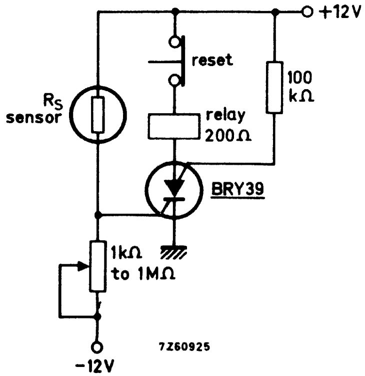

7Z60695.1
T_{amb} = 25 °C
I_T (A)
δ = 0.01
0.02
0.05
0.1
0.2
0.5
1
10^{-1}
10^{-2}
10^{-2}
10^{-1}
1
10
t_p (ms)
10^2
t_p
T
$\delta = \frac{t_p}{T}$


7Z60696.1
T_{amb} = 70 °C
I_T (A)
δ = 0.01
0.02
0.05
0.1
0.2
0.5
1
10^{-1}
10^{-2}
10^{-2}
10^{-1}
1
10
t_p (ms)
10^2
t_p
T
$\delta = \frac{t_p}{T}$


7Z60694.1
$V_D = V_R = 70V$
I_R
I_D
(nA)
10^3
10^2
10
1
10^{-1}
typ
0
50
100
T_j (°C)
150

APPLICATION INFORMATION

Sensing network



R_S must be chosen in accordance with the light, temperature, or radiation intensity to be sensed; its resistance should be of the same order as that of the potentiometer.

In the arrangement shown, a decline in resistance of R_S triggers the thyristor, closing the relay that activates the warning system. If the positions of R_S and the potentiometer are interchanged, an increase in the resistance of R_S triggers the thyristor.

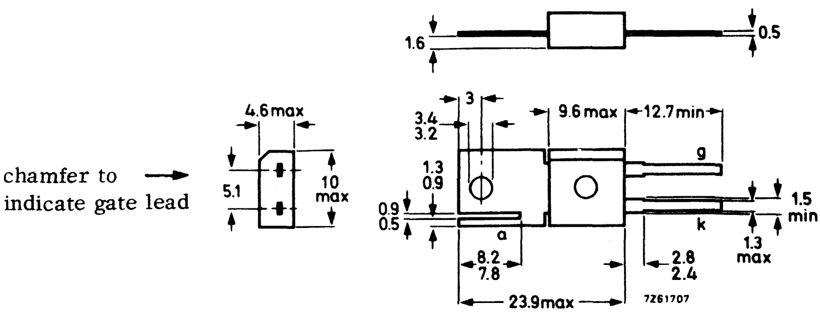
SILICON THYRISTORS

Plastic encapsulated p-gate silicon thyristors, intended for motor control in food mixers, sewing machines and hand drills, and for use in switching, ignition and starting systems. The series consists of the reverse polarity types: BT100A-300R; BT100A-500R.

QUICK REFERENCE DATA					
			BT100A-300R	500R	
Crest working voltages	$V_{DWM} = V_{RWM}$	max.	200	400	V
Repetitive peak voltages	$V_{DRM} = V_{RRM}$	max.	200	400	V
Average on-state current up to T_{tab}=75 °C	$I_{T(AV)}$	max.	2		A
R.M.S. on-state current	$I_{T(RMS)}$	max.	4.5		A
Non-repetitive peak on-state current t = 10 ms; T_j = 100 °C prior to surge	I_{TSM}	max.	40		A
Junction temperature	T_j	max.	100		°C

MECHANICAL DATA

Dimensions in mm



All information applies to frequencies up to 400 Hz.

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

ANODE TO CATHODE			BT100A - 300R	500R	
Voltages [1]					
Continuous reverse voltage	V_R	max.	200	400	V
Crest working voltages	$V_{DWM} = V_{RWM}$	max.	200	400	V
Repetitive peak voltages ($\delta \leq 0.01$)	$V_{DRM} = V_{RRM}$	max.	300	500	V
Non-repetitive peak reverse voltage ($t \leq 10$ ms)	V_{RSM}	max.	300	500	V
Continuous off-state voltage	V_D	max.	200	400	V
Non-repetitive peak off-state voltage ($t \leq 10$ ms)	V_{DSM}	max.	300	500	V

Currents (for overload conditions see curve on page 6)

Average on-state current (averaged over any 20 ms period) up to $T_{tab} = 75\ ^{o}C$	$I_{T(AV)}$	max.	2	A
On-state current (d.c.)	I_T	max.	4.5	A
R.M.S. on-state current	$I_{T(RMS)}$	max.	4.5	A
Repetitive peak on-state current	I_{TRM}	max.	20	A
Non-repetitive peak on-state current (t = 10 ms; half sine wave) $T_j = 100\ ^{o}C$ prior to surge	I_{TSM}	max.	40	A
I squared t for fusing (t = 10 ms)	I^2t	max.	8	A^2s
Rate of rise of on-state current after triggering with $I_G = I_{GT}$ to $I_T = 20$ A	$\frac{dI_T}{dt}$	max.	100	A/µs
Starting current		see page 5		

[1] To ensure thermal stability: $R_{th\ j-a} < 37.5\ ^{o}C/W$ (d.c. blocking) or $< 60\ ^{o}C/W$ (a.c.)

RATINGS (continued)

GATE TO CATHODE

Voltages

Forward peak voltage				
Reverse peak voltage	V_{RGM}	max.	5	V

Current

Forward peak current	I_{FGM}	max.	250	mA

Power dissipation

Average power dissipation (averaged over any 20 ms period)	$P_{G(AV)}$	max.	100	mW
Peak power dissipation	P_{GM}	max.	1	W

TEMPERATURES

Storage temperature	T_{stg}	−40 to +100		^oC
Junction temperature	T_j	max.	100	^oC

THERMAL RESISTANCE

From junction to ambient in free air	$R_{th\ j-a}$	75	$^oC/W$
From junction to tab	$R_{th\ j-tab}$	8	$^oC/W$
From tab to heatsink			
without heatsink compound	$R_{th\ tab-h}$	3	$^oC/W$
with heatsink compound, (e.g. Dow Corning 340)	$R_{th\ tab-h}$	1	$^oC/W$
Transient thermal impedance; t = 1 ms	$Z_{th\ j-tab}$	0.9	$^oC/W$

CHARACTERISTICS

ANODE TO CATHODE

Voltages			BT100A - 300R	500R	
On-state voltage I_T = 5 A; T_j = 25 ^oC	V_T	<	1.4	1.4	V[1]
Rate of rise of off-state voltage that will not trigger any device; T_j = 100 ^oC	$\frac{dV_D}{dt}$	<	10	10	V/µs
Currents					
Peak reverse current at T_j = 100 ^oC $V_{RM} = V_{RWMmax}$	I_{RM}	<	2	1	mA
Peak off-state current at T_j = 100 ^oC $V_{DM} = V_{DWMmax}$	I_{DM}	<	2	1	mA
Latching current; T_j = 25 ^oC	I_L	typ.	10	10	mA
		<	40	40	mA
Holding current; T_j = 25 ^oC	I_H	typ.	4	4	mA
		<	15	15	mA

1) Measured under pulsed conditions to avoid excessive dissipation.

CHARACTERISTIC (continued)

GATE TO CATHODE

Voltages

Voltage that will trigger all devices

V_D = 6 V; T_j = 25 °C	V_{GT}	>	2	V
V_D = 6 V; T_j = −40 °C	V_{GT}	>	2.5	V

Voltage that will not trigger any device

V_D = V_{DRMmax}; T_j = 100 °C	V_{GD}	<	0.20	V

Current

Current that will trigger all devices

V_D = 6 V; T_j = 25 °C	I_{GT}	>	10	mA
V_D = 6 V; T_j = −40 °C	I_{GT}	>	15	mA

SWITCHING CHARACTERISTICS

Turn-on time when switched from

V_D = V_{DWMmax} to I_T = 3 A Gate source 5 V; 100 Ω; T_j = 25 °C	t_{on}	typ.	1.3	μs

Turn-off time when switched from

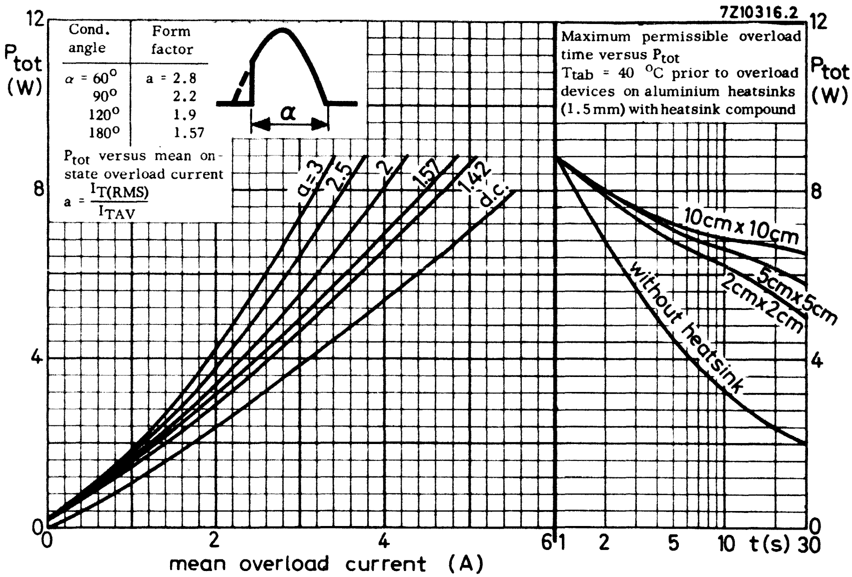
I_T = 1 A; $\frac{dV_D}{dt}$ = 10 V/μs; T_j = 25 °C	t_q	typ.	10	μs

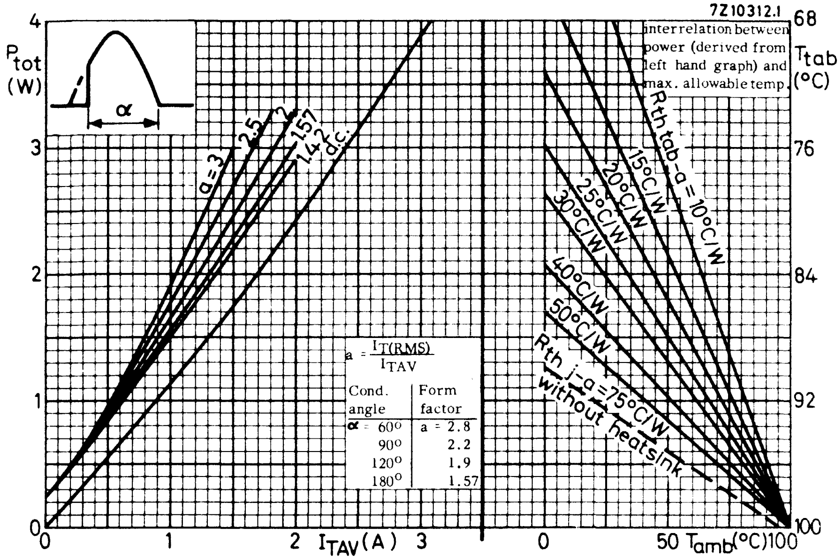
OPERATING NOTES

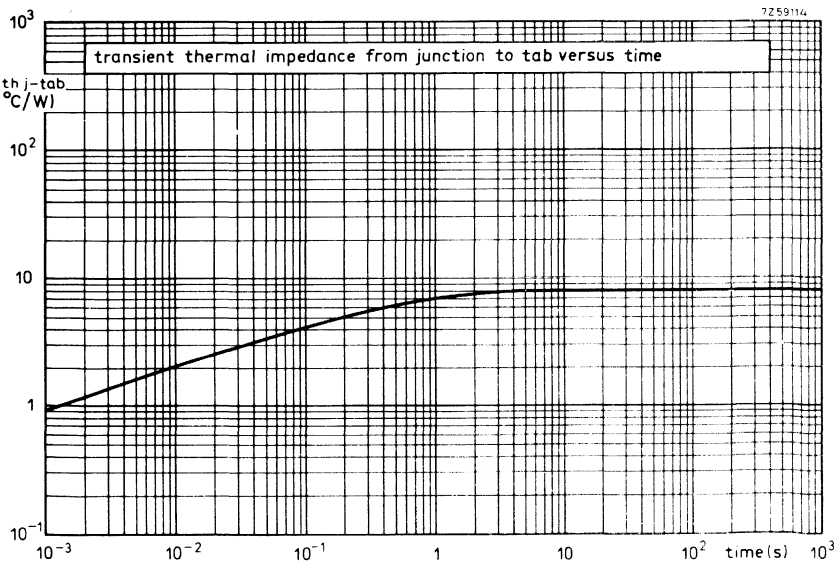
1. The thyristors may be soldered directly into the circuit but a thermal shunt should be used to keep heat conduction to the junction to a minimum.

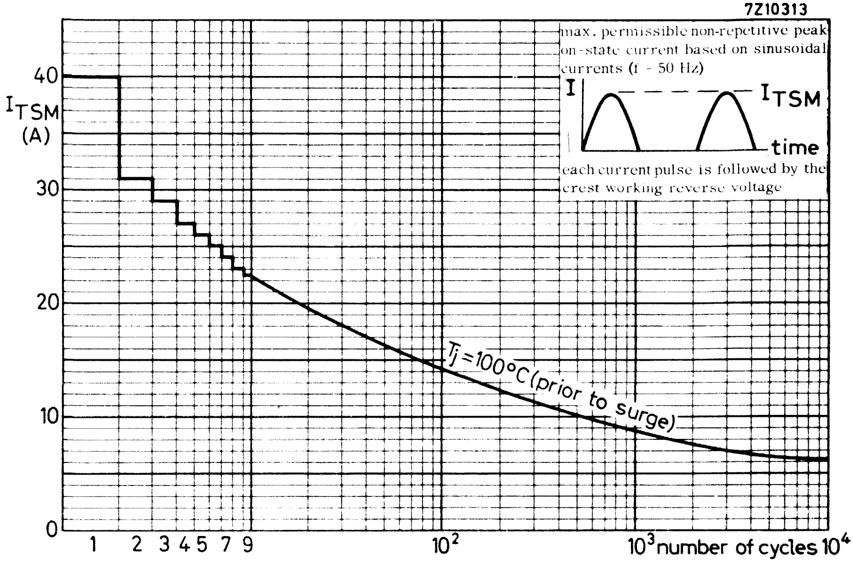
2. Overload conditions

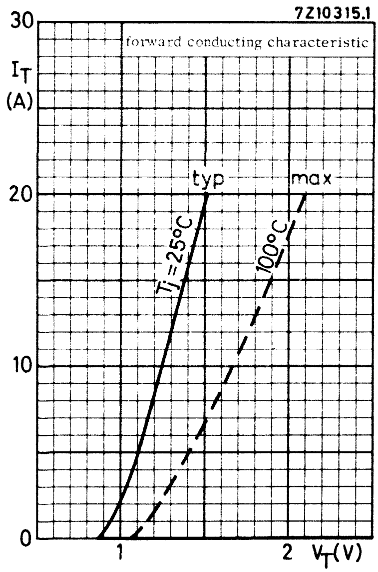
   The method of using the graph below is as follows:
   Starting with the curves of dissipation versus mean on-state overload current, for a particular current value trace upwards to meet the appropriate form factor curve. Then trace horizontally until the appropriate heatsink curve is reached. Finally trace downwards to determine the permitted overload time. After the permitted overload time the device must revert to normal operations as derived from the graph on page 6.

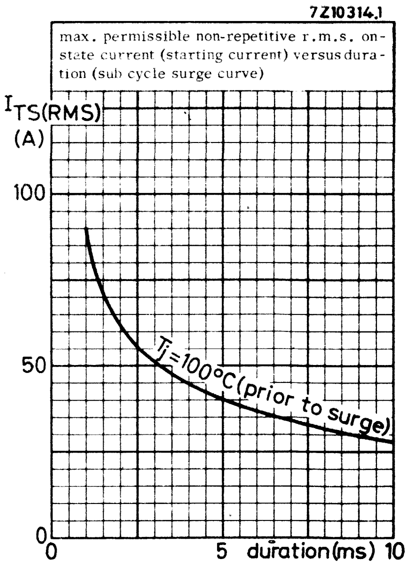



7Z10312.1
P_{tot} (W)
α
a=3
2.5
2
1.57
1.42
d.c.
$a = \frac{I_{T(RMS)}}{I_{TAV}}$
Cond. angle | Form factor
α = 60° | a = 2.8
90° | 2.2
120° | 1.9
180° | 1.57
I_{TAV} (A)
interrelation between power (derived from left hand graph) and max. allowable temp.
$R_{th\ tab-a}$ = 10°C/W
15°C/W
20°C/W
25°C/W
30°C/W
40°C/W
50°C/W
$R_{th\ j-a}$ = 75°C/W without heatsink
T_{tab} (°C)
T_{amb} (°C)


7Z59114
transient thermal impedance from junction to tab versus time
$Z_{th\ j-tab}$ (°C/W)
time (s)


7Z10313
max. permissible non-repetitive peak on-state current based on sinusoidal currents (f = 50 Hz)
I
ITSM
time
each current pulse is followed by the crest working reverse voltage
40
ITSM
(A)
30
20
10
0
1
2 3 4 5 7 9
10²
10³ number of cycles 10⁴
Tj=100°C(prior to surge)


7Z10315.1
forward conducting characteristic
30
IT
(A)
20
10
0
typ
max
Tj=25°C
100°C
1
2 VT(V)


7Z10314.1
max. permissible non-repetitive r.m.s. on-state current (starting current) versus duration (sub cycle surge curve)
ITS(RMS)
(A)
100
50
0
0
5 duration(ms) 10
Tj=100°C(prior to surge)

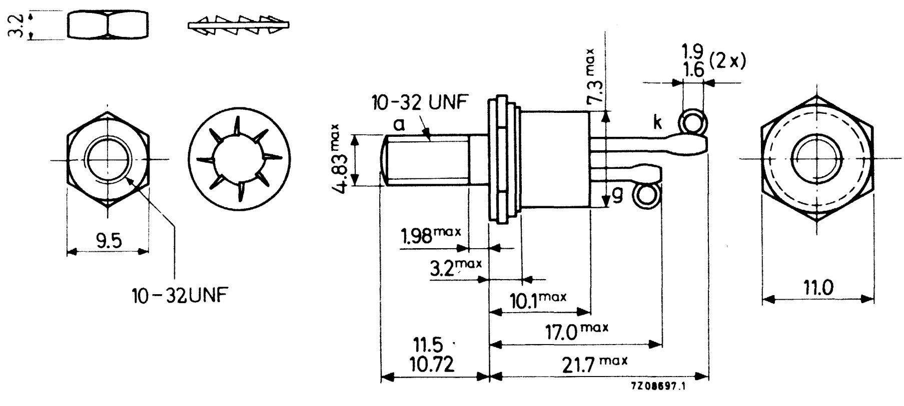
SILICON THYRISTORS

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 on-state current (T_{mb} = 85 °C)	I_{TAV}	max.	6.5		A
R.M.S. on-state current	$I_{T(RMS)}$	max.	15		A
Non repetitive peak on-state 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. 9 cmkg
max. 17 cmkg

All information applies to frequencies up to 400 Hz.

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

ANODE TO CATHODE

Voltages [1]			BT101; BT102-300R	500R	
Crest working reverse voltage	V_{RWM}	max.	200	400	V
Repetitive peak reverse voltage ($\delta \leq 0.01$; f = 50 Hz)	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 ($\delta \leq 0.01$; f = 50 Hz)	V_{DRM}	max.	300	500	V
Non repetitive peak off-state voltage ($t \leq 10$ ms)	V_{DSM}	max.	300	500	V

Currents (for overload conditions see curve on page 8)

Average on-state current (averaged over any 20 ms period) T_{mb} = 85 °C	I_{TAV}	max.	6.5	A
R.M.S. on-state current	$I_{T(RMS)}$	max.	15	A
Repetitive peak on-state current	I_{TRM}	max.	50	A
Non repetitive peak on-state current (t = 10 ms) (see also page 7)	I_{TSM}	max.	55	A
I squared t for fusing ($t \leq 10$ ms)	I^2t	max.	15	A^2s
Rate of rise of on-state current	$\frac{dI_T}{dt}$	max.	50	A/μs
Starting current		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 (averaged over any 20 ms period)	P_{GAV}	max.	0.5	W
Peak power dissipation	P_{GM}	max.	5	W

[1]) These ratings apply to a gate voltage range of −5 to +0.25 V.
To ensure thermal stability: $R_{th\ j-a} \leq 20$ °C/W (d.c.) or ≤ 40 °C/W (a.c.).

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	$R_{th\ j-mb}$	=	3	°C/W
From junction to ambient in free air with nut and washer	$R_{th\ j-a}$	=	40	°C/W
From mounting base to heatsink for a torque of 9 kg cm on the nut	$R_{th\ mb-h}$	=	0.5	°C/W

CHARACTERISTICS T_j = 125 °C unless otherwise specified

ANODE TO CATHODE

Voltage

On-state voltage I_T = 20 A; T_j = 25 °C	V_T	<	2.3	V [1]

Currents

Reverse current $V_R = V_{RWMmax}$	I_R	<	1.5	mA
Off-state current $V_D = V_{DWMmax}$	I_D	<	1.5	mA

GATE TO CATHODE

Voltages

			BT101	BT102	
Voltage to trigger all devices					
V_D = 6 V; T_j = +25 °C	V_{GT}	>	2	2.5	V
V_D = 6 V; T_j = −10 °C	V_{GT}	>	2.1	2.8	V
Voltage not to trigger any device	V_{GD}	<	0.25		V

Current

			BT101	BT102	
Current to trigger all devices					
V_D = 6 V; T_j = +25 °C	I_{GT}	>	10	50	mA
V_D = 6 V; T_j = −10 °C	I_{GT}	>	13	65	mA

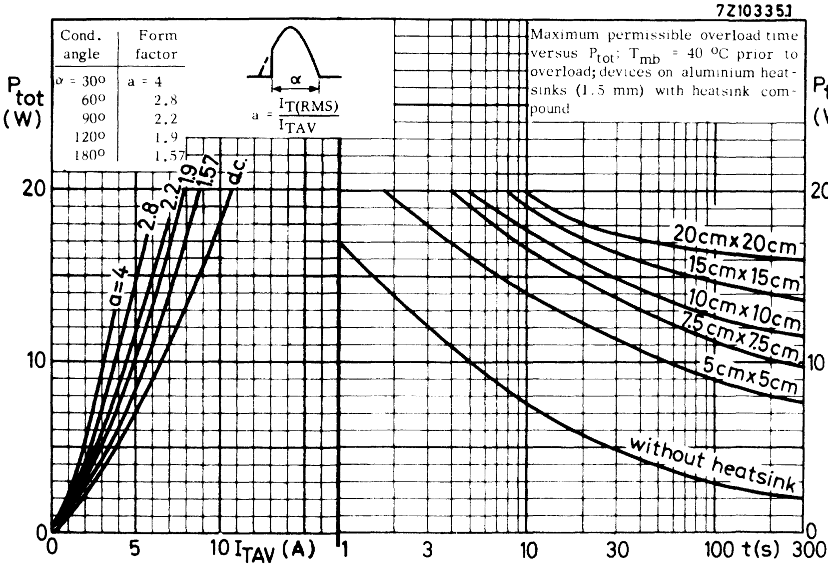
[1]) Measured under pulsed conditions to prevent excessive dissipation.

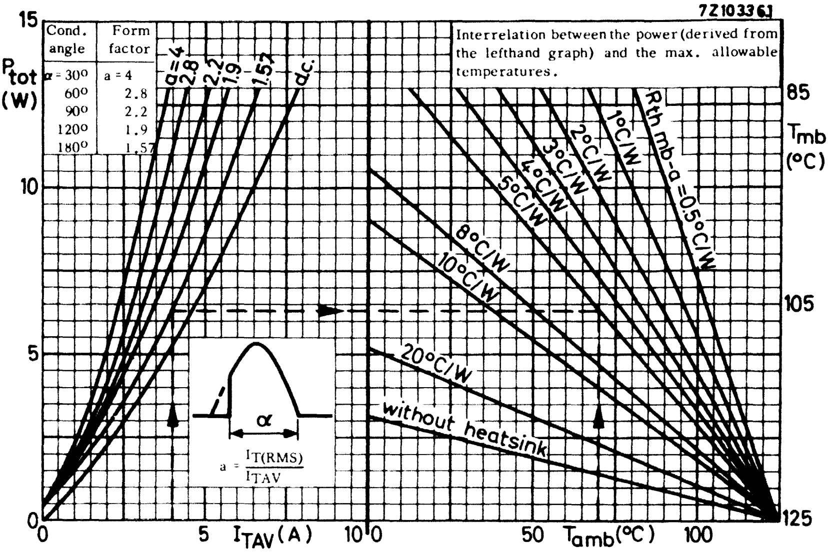
OPERATING NOTES (See also general pages at the beginning of this section)

1. The gate and cathode connectors should not be bent or twisted; they should be soldered into the circuit so that 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.

2. Overload conditions

   The method of using the graph below is as follows:
   Starting with the curves of dissipation versus mean on-state overload current, for a particular current value trace upwards to meet the appropriate form factor curve. Then trace horizontally until the appropriate heatsink curve is reached. Finally trace downwards to determine the permitted overload time. After the permitted overload time the device must revert to normal operation as derived from the graph on page 5.





Determination of the heatsink thermal resistance.

Example:

Assume a thyristor, used in a single phase rectifier circuit.

conduction angle	α	= 180°
average forward current	I_{TAV}	= 4 A
ambient temperature	T_{amb}	= 70 °C

From the left hand part of the graph above it follows that at $I_{TAV} = 4$ A and $\alpha = 180^{\circ}$ in a single phase rectifier circuit the average forward power + average leakage power = 6.4 W.

From the right hand part of the graph above follows the thermal resistance, required for $P_{tot} = 6.4$ W at $T_{amb} = 70$ °C

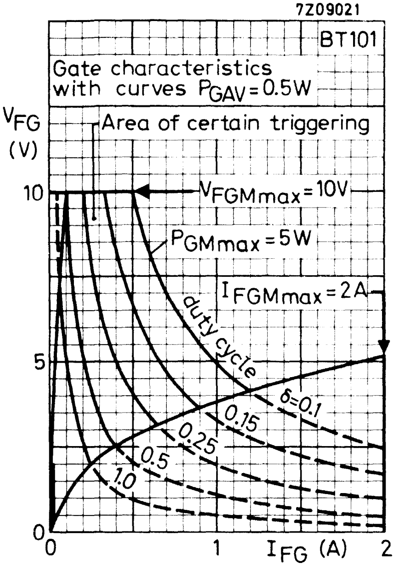
$$R_{th\ mb\text{-}a} \approx 5 \ {}^{\circ}\mathrm{C/W}$$

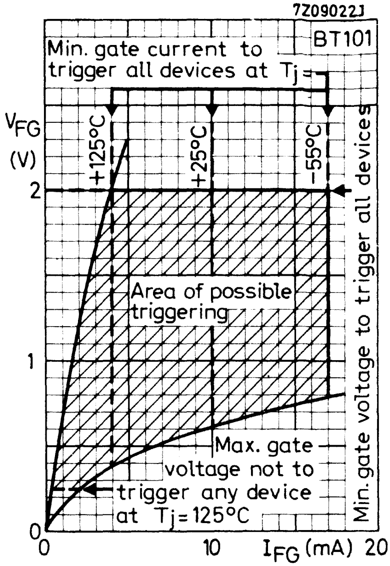
The contact thermal resistance $R_{th\ mb\text{-}h} = 0.5$ °C/W

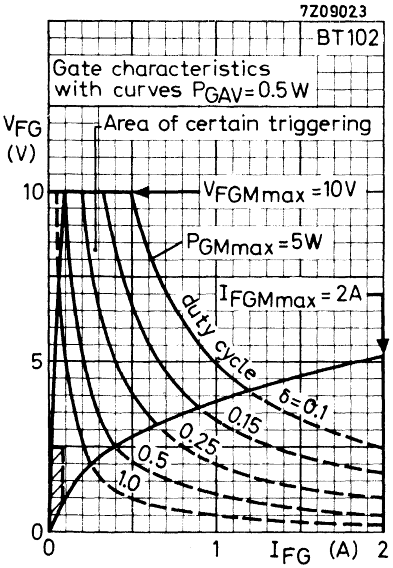
Hence the heatsink thermal resistance should be:

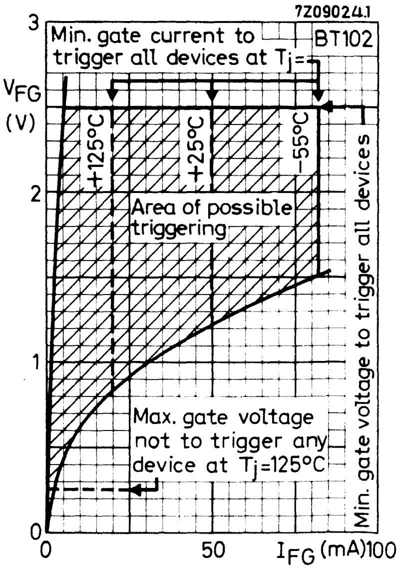
$$R_{th\ h\text{-}a} = R_{th\ mb\text{-}a} - R_{th\ mb\text{-}h} = (5 - 0.5)\ {}^{\circ}\mathrm{C/W} = 4.5\ {}^{\circ}\mathrm{C/W}$$

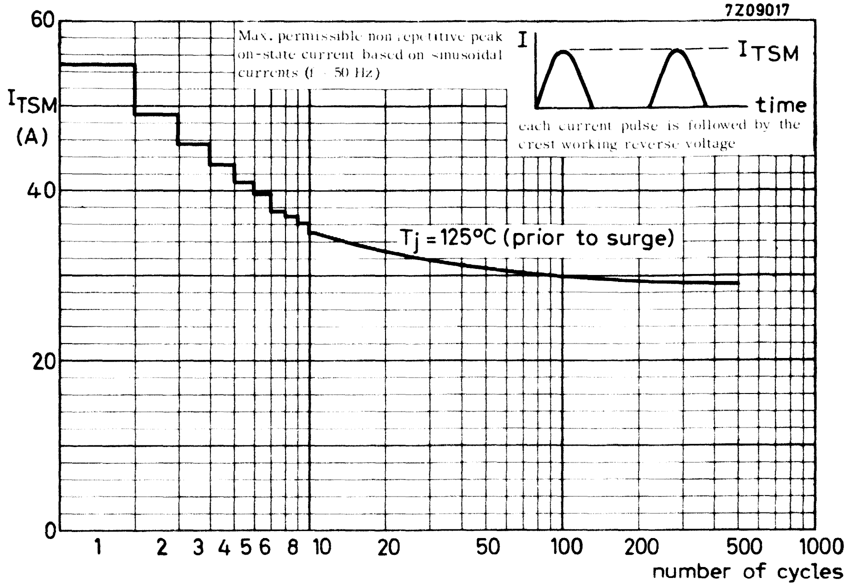
The applicable heatsink(s) may then be found in the section HEATSINKS.

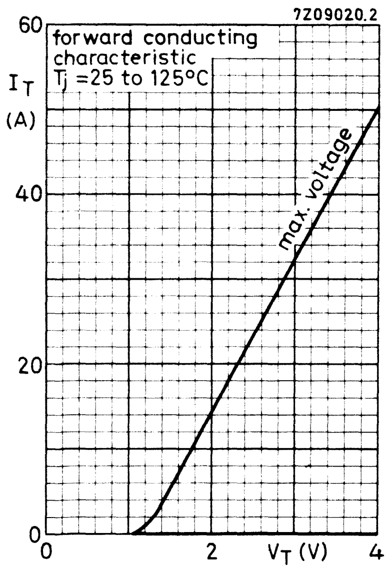

7Z09021
BT101
Gate characteristics
with curves P_{GAV}=0.5W
V_{FG}
(V)
Area of certain triggering
V_{FGMmax}=10V
P_{GMmax}=5W
I_{FGMmax}=2A
duty cycle
δ=0.1
0.15
0.25
0.5
1.0
10
5
0
0
1
I_{FG} (A)
2

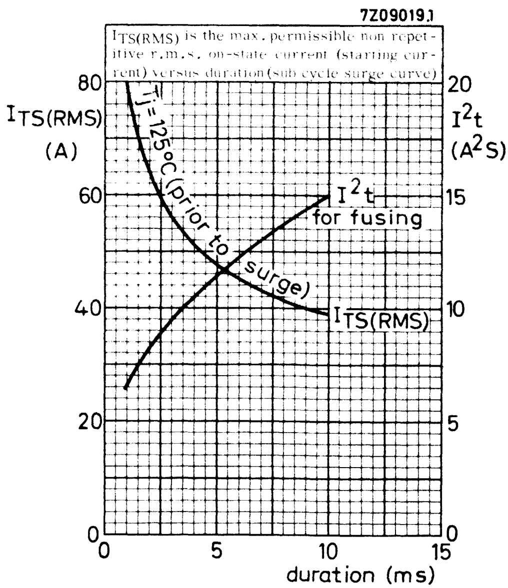

7Z09022J
BT101
Min. gate current to
trigger all devices at T_j=
+125°C
+25°C
−55°C
V_{FG}
(V)
Area of possible
triggering
Max. gate
voltage not to
trigger any device
at T_j=125°C
Min. gate voltage to trigger all devices
2
1
0
0
10
I_{FG} (mA)
20


7Z09023
BT102
Gate characteristics
with curves P_{GAV}=0.5W
V_{FG}
(V)
Area of certain triggering
V_{FGMmax}=10V
P_{GMmax}=5W
I_{FGMmax}=2A
duty cycle
δ=0.1
0.15
0.25
0.5
1.0
10
5
0
0
1
I_{FG} (A)
2


7Z09024.1
BT102
Min. gate current to
trigger all devices at T_j=
+125°C
+25°C
−55°C
V_{FG}
(V)
Area of possible
triggering
Max. gate voltage
not to trigger any
device at T_j=125°C
Min. gate voltage to trigger all devices
3
2
1
0
0
50
I_{FG} (mA)100


7Z09017
Max. permissible non repetitive peak on-state current based on sinusoidal currents (f = 50 Hz)
I
I_{TSM}
time
each current pulse is followed by the crest working reverse voltage
I_{TSM} (A)
T_j = 125°C (prior to surge)
number of cycles
60
40
20
0
1
2
3
4
5
6
8
10
20
50
100
200
500
1000


7Z09020.2
forward conducting characteristic
T_j = 25 to 125°C
I_T (A)
max. voltage
V_T (V)
60
40
20
0
0
2
4


7Z09019.1
$I_{TS(RMS)}$ is the max. permissible non repetitive r.m.s. on-state current (starting current) versus duration (sub cycle surge curve)
$I_{TS(RMS)}$ (A)
I^2t (A^2s)
T_j = 125°C (prior to surge)
I^2t for fusing
$I_{TS(RMS)}$
duration (ms)
80
60
40
20
0
0
5
10
15
20
15
10
5
0

90A AVALANCHE THYRISTORS

Silicon thyristors in metal envelopes, with avalanche properties.
A version with guaranteed values of avalanche voltage and avalanche power can be supplied on request.
BTW23 series-M has metric thread, BTW23series-U UNF thread. Both series consist of reverse polarity types (anode to stud) identified by a suffix R:
BTW23-600RM to 1600RM and BTW23-600RU to 1600RU.

QUICK REFERENCE DATA

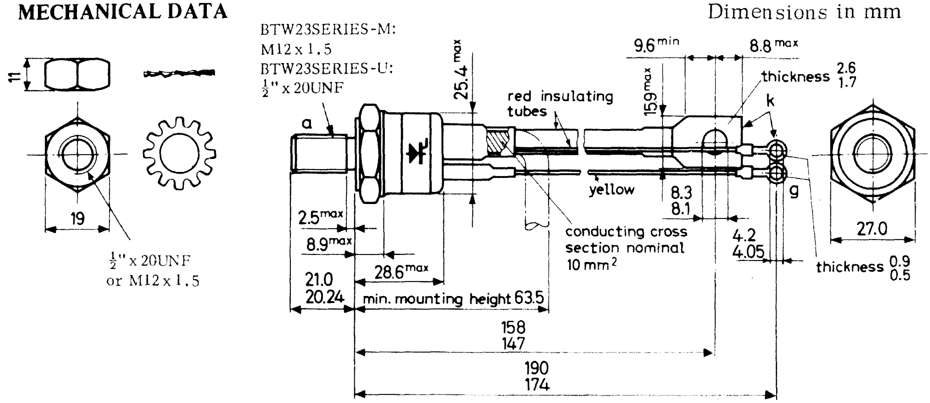
		BTW23-600RM BTW23-600RU	800RM 800RU	1000RM 1000RU	1200RM 1200RU	1400RM 1400RU	1600RM 1600RU	
Repetitive peak voltages $V_{DRM} = V_{RRM}$	max.	600	800	1000	1200	1400	1600	V
Crest working voltages $V_{DWM} = V_{RWM}$	max.	600	800	1000	1200	1200	1200	V
Forward breakover voltage $V_{(BO)}$	>	700	900	1100	1300	1400	1600	V

Average on-state current up to $T_{mb} = 85\ ^{o}C$	$I_{T(AV)}$	max.	90	A
R.M.S. on-state current	$I_{T(RMS)}$	max.	140	A
Non-repetitive peak on-state current $t = 10\,ms$; $T_j = 125\ ^{o}C$ prior to surge	I_{TSM}	max.	2000	A
Junction temperature	T_j	max.	125	^{o}C
Rate of rise of on-state current after triggering	$\frac{dI_T}{dt}$	max.	300	A/µs
Rate of rise of off-state voltage that will not trigger any device	$\frac{dV_D}{dt}$	<	200	V/µs
On request	$\frac{dV_D}{dt}$	up to	1000	V/µs

MECHANICAL DATA see page 2

MECHANICAL DATA

Dimensions in mm



Torque on nut: min. 9 Nm
(90 kg cm)
max. 17,5 Nm
(175 kg cm)

→ Net weight: 134 g
Diameter of clearance hole: max. 13.0 mm

All information applies to frequencies up to 400 Hz.

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

Anode to cathode		BTW23-600RM BTW23-600RU	800RM 800RU	1000RM 1000RU	1200RM 1200RU	1400RM 1400RU	1600RM 1600RU	
Voltages [1]								
Non-repetitive peak voltages ($t \leq 10$ ms) V_{DSM} [2] $= V_{RSM}$	max.	700	900	1100	1300	1400	1600	V
Repetitive peak voltages ($\delta \leq 0.01$) $V_{DRM} = V_{RRM}$	max.	600	800	1000	1200	1400	1600	V
Crest working voltages $V_{DWM} = V_{RWM}$	max.	600	800	1000	1200	1200	1200	V
Continuous voltages $V_D = V_R$	max.	600	800	1000	1200	1200	1200	V

[1]) To ensure thermal stability: $R_{th\ j-a} < 0.75\ ^{\circ}C/W$ (d.c. blocking) or $< 1.5\ ^{\circ}C/W$ (a.c.). For smaller heatsinks $T_j$max should be derated. For a.c. see page 6.
[2]) Higher off-state voltages may be applied without damage, but at voltages higher than the minimum forward breakover voltage (p.4) the thyristor may switch into the on-state. The rate of rise of on-state current should not exceed 100 A/µs.

RATINGS (continued)

Currents

Average on-state current (averaged over any 20 ms period) up to T_{mb} = 85 °C	$I_{T(AV)}$	max.	90	A	←
On-state current (d.c.)	I_T	max.	140	A	←
R.M.S. on-state current	$I_{T(RMS)}$	max.	140	A	←
Repetitive peak on-state current	I_{TRM}	max.	1250	A	←
Non-repetitive peak on-state current (t = 10 ms; half sine wave) T_j = 125 °C prior to surge	I_{TSM}	max.	2000	A	←
I^2t for fusing (t = 10 ms)	I^2t	max.	20000	A^2s	←
Rate of rise of on-state current after triggering with $I_G = I_{GT}$ to I_T = 300 A dI_G/dt = 1 A/µs (see upper nomogram on page 11)	$\frac{dI_T}{dt}$	max.	300	A/µs	←
Rate of rise of on-state current after breakover	$\frac{dI_T}{dt}$	max.	100	A/µs	
Rate of change of commutation current	see lower nomogram on page 11				

Gate to cathode

Voltage

Reverse peak voltage	V_{RGM}	max.	10	V

Power dissipation

Average power dissipation (averaged over any 20 ms period)	$P_{G(AV)}$	max.	2	W
Peak power dissipation	P_{GM}	max.	10	W

Temperatures

Storage temperature	T_{stg}		-55 to +125	°C
Junction temperature	T_j	max.	125	°C

THERMAL RESISTANCE

From junction to mounting base	$R_{th\,j\text{-}mb}$	=	0.3	°C/W
From mounting base to heatsink	$R_{th\,mb\text{-}h}$	=	0.1	°C/W
Transient thermal impedance; t = 1 ms	$Z_{th\,j\text{-}mb}$	=	0.015	°C/W

CHARACTERISTICS

Anode to cathode

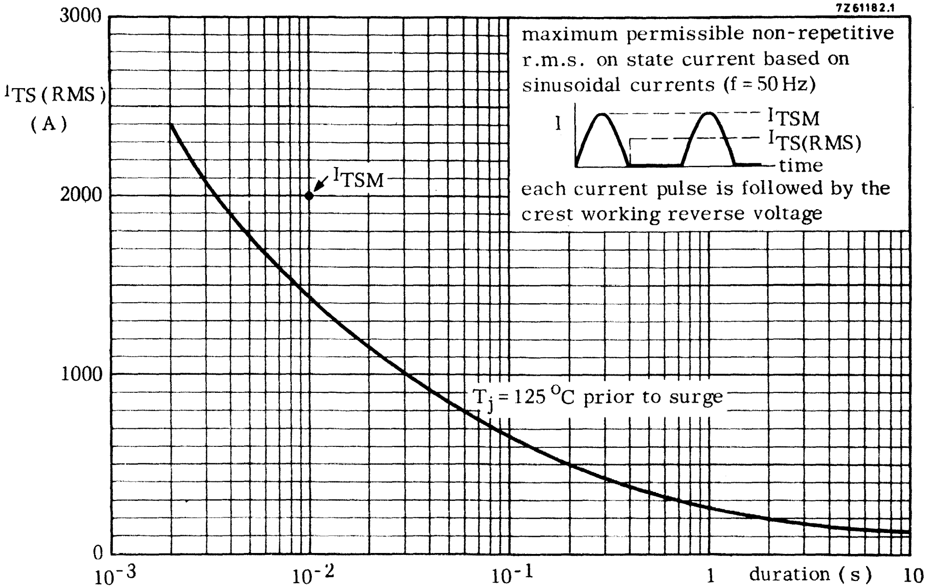
Voltages			BTW23-600RM BTW23-600RU	800RM 800RU	1000RM 1000RU	1200RM 1200RU	1400RM 1400RU	1600RM 1600RU	
→ On-state voltage I_T = 500 A; T_j = 25 °C	V_T	<	2.2	2.2	2.2	2.2	2.2	2.2	V [1])
Forward breakover voltage up to T_j = 125 °C	$V_{(BO)}$	>	700	900	1100	1300	1400	1600	V
Rate of rise of off-state voltage that will not trigger any device; T_j=125°C	$\frac{dV_D}{dt}$	<	200	200	200	200	200	200	V/μs
Currents									
Peak reverse current $V_{RM}=V_{RWMmax}$; T_j=125°C	I_{RM}	<	20	18	15	13	13	13	mA
Peak off-state current $V_{DM}=V_{DWMmax}$; T_j=125°C	I_{DM}	<	20	18	15	13	13	13	mA

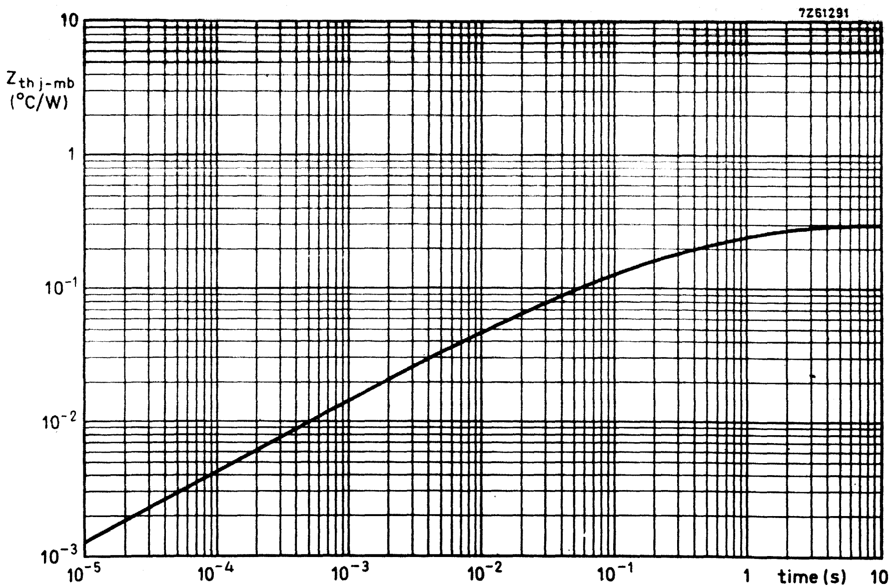
Holding current; T_j=25 °C	I_H	<	200	mA

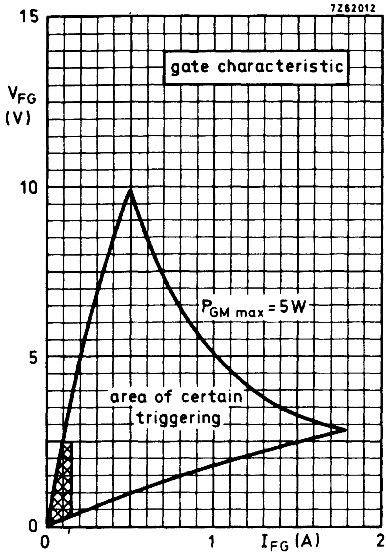
Gate to cathode

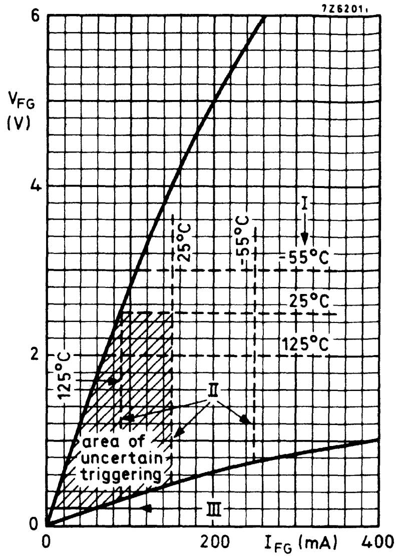
Voltages				
Voltage that will trigger all devices V_D = 6 V; T_j = 25 °C	V_{GT}	>	2.5	V
Voltage that will not trigger any device $V_D = V_{DRMmax}$; T_j = 125 °C	V_{GD}	<	250	mV
Current				
→ Current that will trigger all devices V_D = 6 V; T_j = 25 °C	I_{GT}	>	150	mA

[1]) Measured under pulse conditions to avoid excessive dissipation.


7Z61182.1
3000
2000
1000
0
$I_{TS(RMS)}$ (A)
maximum permissible non-repetitive r.m.s. on state current based on sinusoidal currents (f = 50 Hz)
I
I_{TSM}
$I_{TS(RMS)}$
time
each current pulse is followed by the crest working reverse voltage
I_{TSM}
T_j = 125 °C prior to surge
10^{-3}
10^{-2}
10^{-1}
1
duration (s)
10


7Z61291
$Z_{th\,j\text{-}mb}$ (°C/W)
10
1
10^{-1}
10^{-2}
10^{-3}
10^{-5}
10^{-4}
10^{-3}
10^{-2}
10^{-1}
1
time (s)
10





I = minimum gate voltage that will trigger all devices at T_j = →

II = minimum gate current that will trigger all devices at T_j = →

III = maximum gate voltage that will not trigger any device at T_j = 125 °C

CHARACTERISTICS (continued)

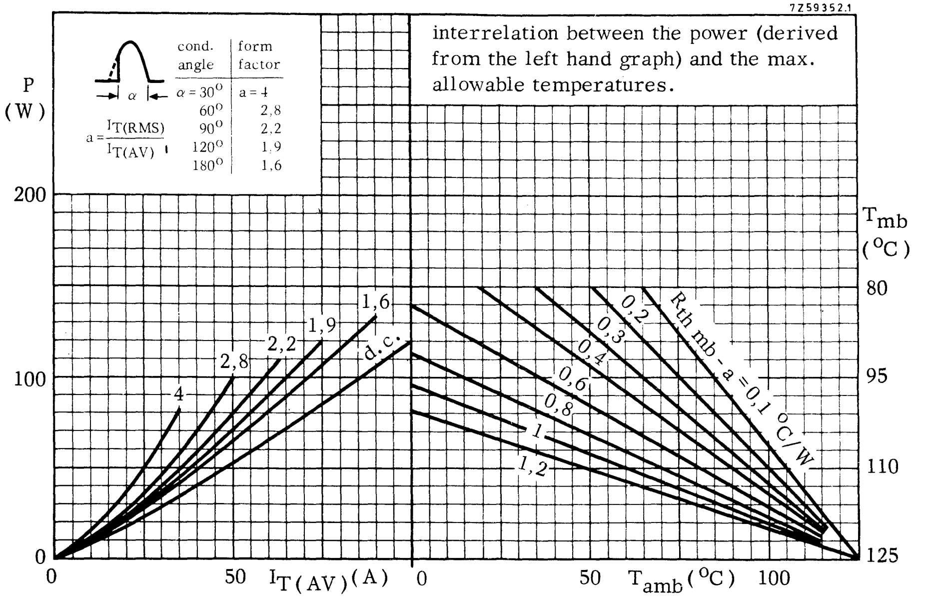
Switching characteristics

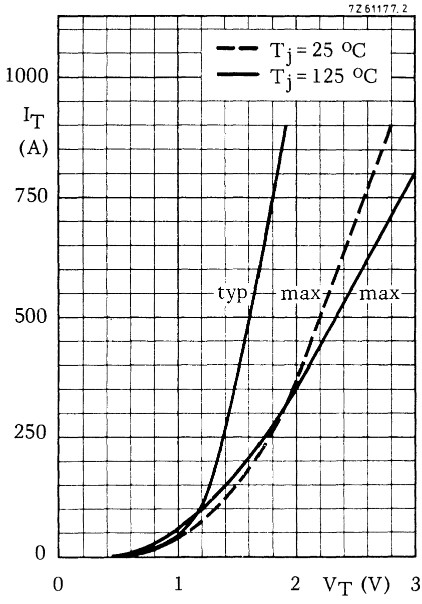
Turn-on time ($t_{on} = t_d + t_r$) when switched from $V_D = V_{DWMmax}$ to I_T = 100 A; I_{GT} = 200 mA; dI_G/dt = 1 A/µs; T_j = 25 °C	t_{on}	<	2.5	µs
	t_r	typ.	1	µs
Circuit-commutated turn-off time when switched from I_T = 50 A to $V_R \geq$ 50 V with $-dI_T/dt$ = 50 A/µs; dV_D/dt = 200 V/µs; T_j = 125 °C	t_q	typ.	100	µs
	t_q	<	200	µs
T_j = 25 °C	t_q	typ.	60	µs
	t_q	<	120	µs
Spread of reverse recovery charge ($Q_{s\,max} - Q_{s\,min}$) when switched from I_T = 70 A to V_R = 50 V with $-dI_T/dt$ = 10 A/µs; T_j = 125 °C	ΔQ_s	<	50	µC

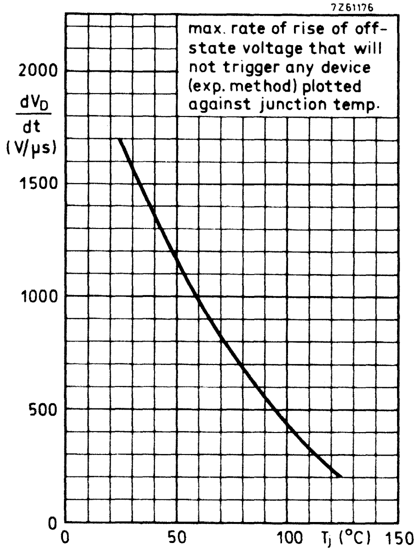
OPERATING NOTES

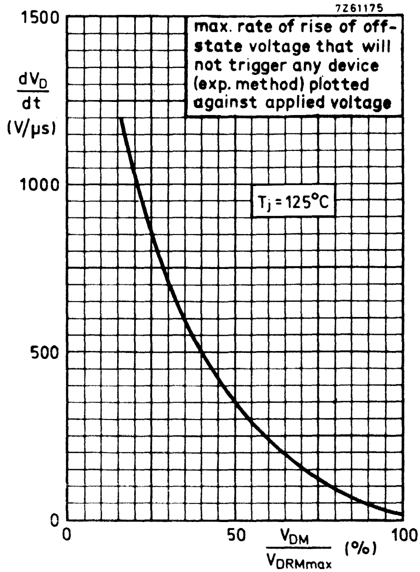
1. Switching losses in commutation

   For applications in which the thyristor is forced to switch from an on-state current I_{TRM} to a high reverse voltage at a high commutation rate ($-dI/dt$), consult the nomogram on page 11 to find the increase in total average power. This increase must be added to the loss from the curves on page 6.

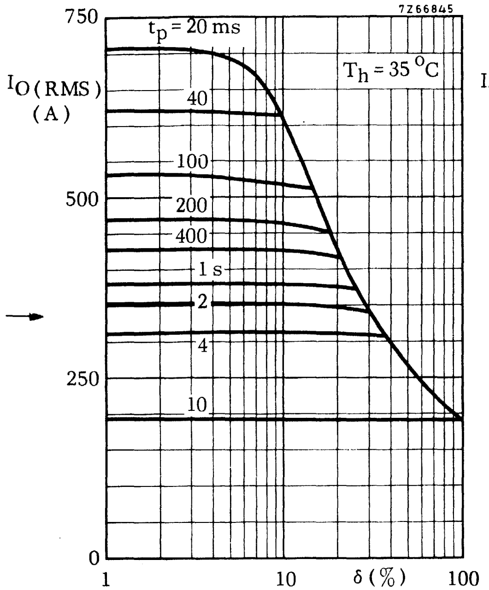

7Z59352.1
cond. angle
form factor
α = 30° a = 4
60° 2,8
90° 2,2
120° 1,9
180° 1,6
a = I_T(RMS) / I_T(AV)
P (W)
200
100
0
0
50
I_T(AV) (A)
4
2,8
2,2
1,9
1,6
d.c.
interrelation between the power (derived from the left hand graph) and the max. allowable temperatures.
T_mb (°C)
80
95
110
125
0
50
T_amb (°C)
100
R_th mb-a = 0,1 °C/W
0,2
0,3
0,4
0,6
0,8
1
1,2

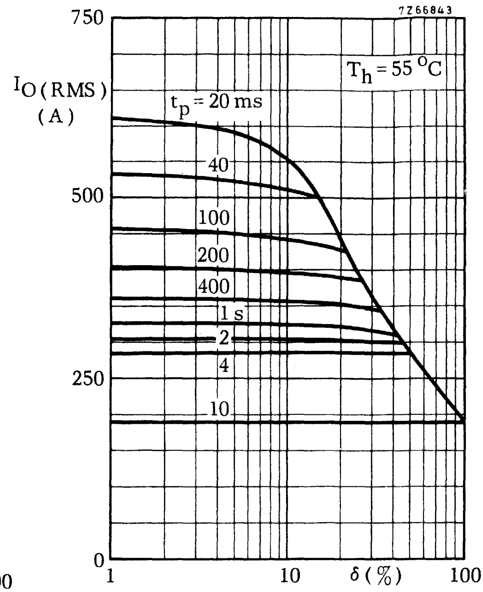

7Z61177.2
T_j = 25 °C
T_j = 125 °C
1000
I_T (A)
750
500
250
0
typ
max
max
0
1
2
V_T (V)
3

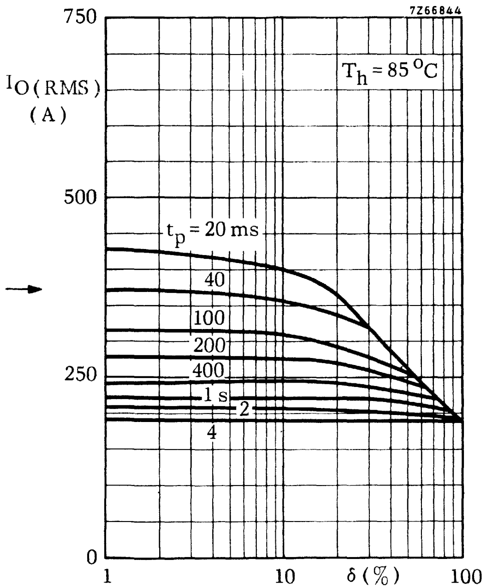

7Z61176
max. rate of rise of off-state voltage that will not trigger any device (exp. method) plotted against junction temp.
dVD/dt (V/μs)
2000
1500
1000
500
0
0
50
100
Tj (°C)
150

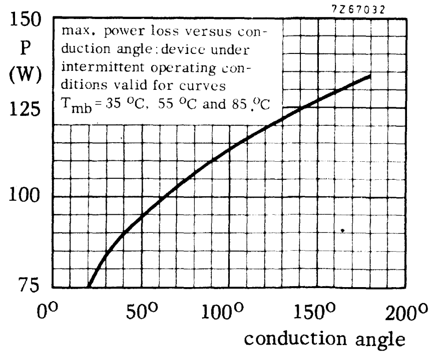

7Z61175
max. rate of rise of off-state voltage that will not trigger any device (exp. method) plotted against applied voltage
dVD/dt (V/μs)
1500
1000
500
0
Tj = 125°C
0
50
VDM/VDRMmax (%)
100

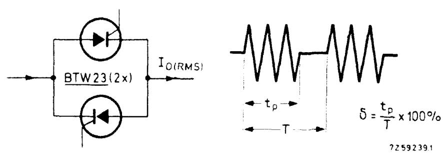
Intermittent overload capability of two BTW23 thyristors in antiparallel connection in a single phase a.c. control circuit (e.g. welding); conduction angle 360°

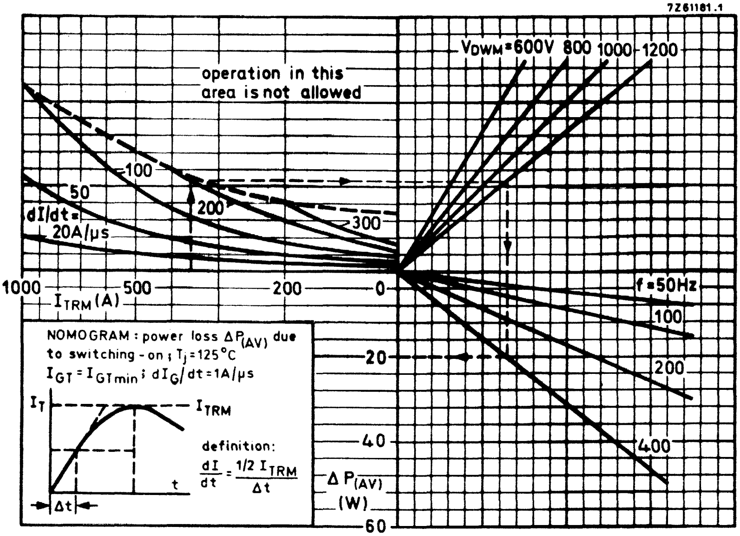


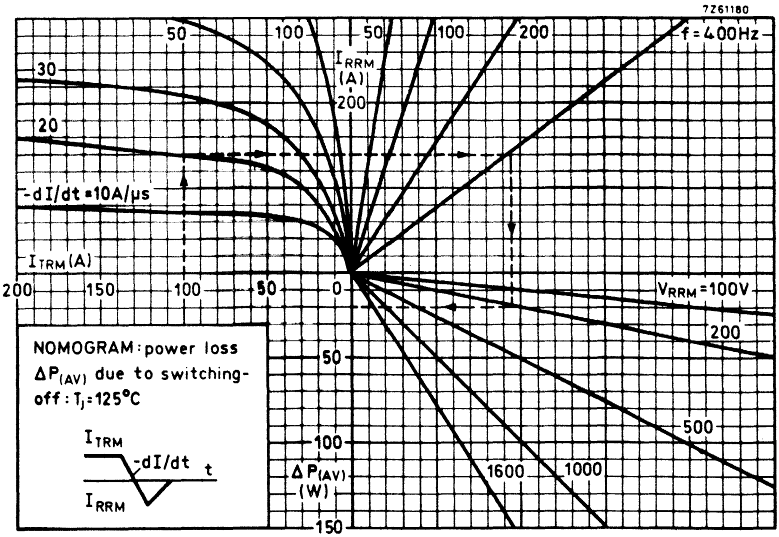




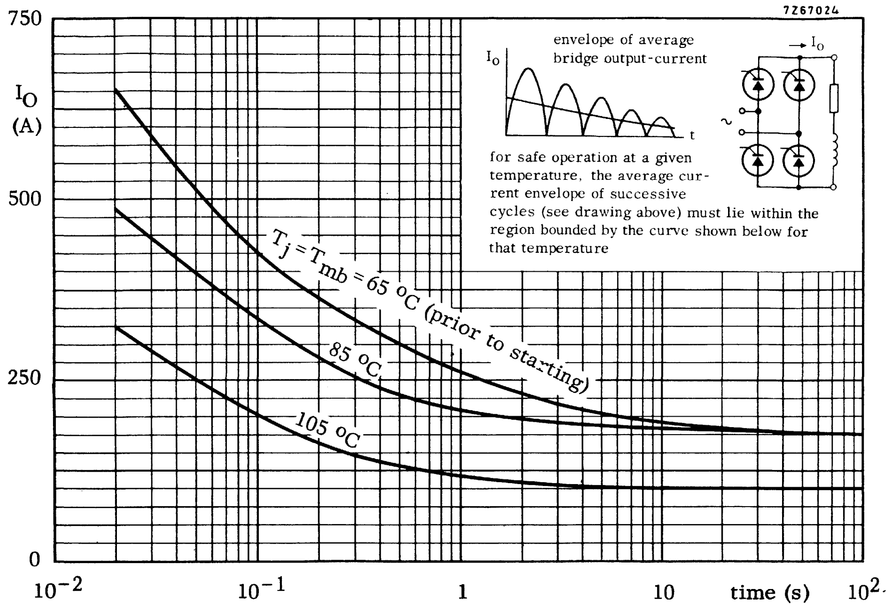


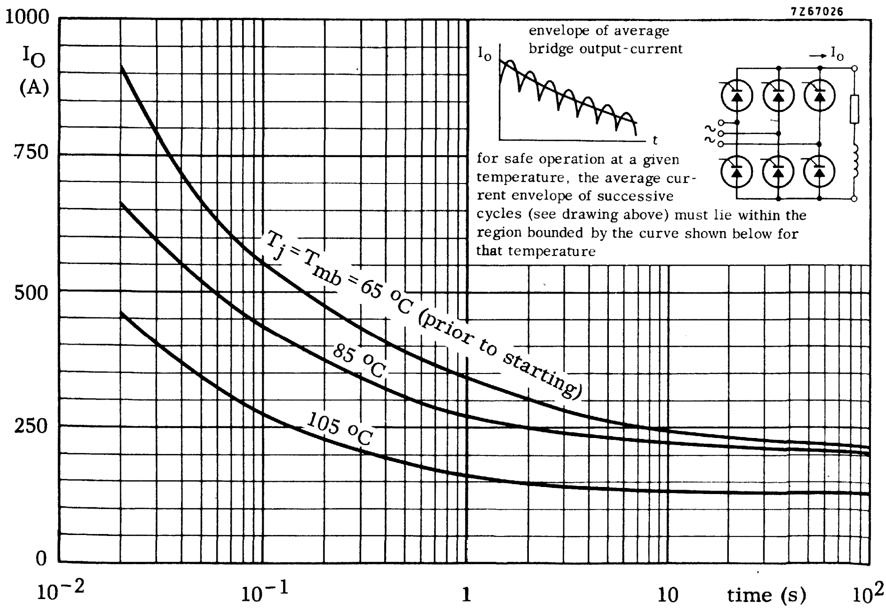



7Z61181.1
operation in this area is not allowed
VDWM=600V 800 1000 1200
dI/dt= 20A/µs
50
100
200
300
1000
500
200
0
ITRM (A)
f=50Hz
100
200
400
20
40
60
ΔP(AV) (W)
NOMOGRAM : power loss ΔP(AV) due to switching - on ; Tj=125°C
IGT = IGTmin ; dIG/dt=1A/µs
IT
ITRM
definition:
dI/dt = 1/2 ITRM / Δt
t
Δt


7Z61180
50
100
50
100
200
f=400Hz
IRRM (A)
200
30
20
-dI/dt=10A/µs
ITRM (A)
200
150
100
50
0
VRRM=100V
200
500
1000
1600
50
100
150
ΔP(AV) (W)
NOMOGRAM: power loss ΔP(AV) due to switching-off : Tj=125°C
ITRM
-dI/dt
t
IRRM

Limits for starting or inrush-currents





35A AVALANCHE THYRISTORS

Silicon thyristors in metal envelopes, with avalanche properties.
A version with guaranteed values of avalanche voltage and avalanche power can be supplied on request.
BTW24 series-M has metric thread, BTW24 series-U UNF thread. Both series consist of reverse polarity types (anode to stud) identified by a suffix R:
BTW24-600RM to 1600RM and BTW24-600RU to 1600RU.

QUICK REFERENCE DATA

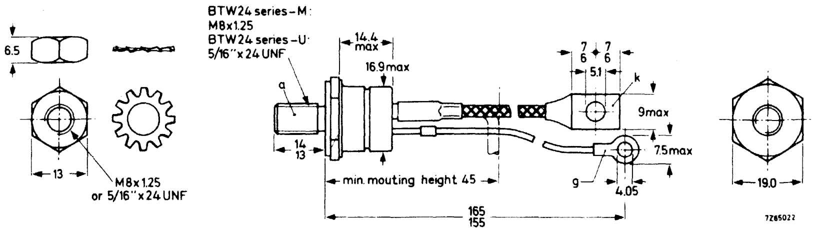
		BTW24-600RM	800RM	1000RM	1200RM	1400RM	1600RM	
		BTW24-600RU	800RU	1000RU	1200RU	1400RU	1600RU	
Repetitive peak voltages $V_{DRM} = V_{RRM}$	max.	600	800	1000	1200	1400	1600	V
Crest working voltages $V_{DWM} = V_{RWM}$	max.	600	800	1000	1200	1200	1200	V
Forward breakover voltage $V_{(BO)}$	>	700	900	1100	1300	1400	1600	V

Average on-state current up to T_{mb} = 85 °C	$I_{T(AV)}$	max.	35	A
R.M.S. on-state current	$I_{T(RMS)}$	max.	55	A
Non-repetitive peak on-state current t = 10 ms; T_j = 125 °C prior to surge	I_{TSM}	max.	800	A
Junction temperature	T_j	max.	125	°C
Rate of rise of on-state current after triggering	$\frac{dI_T}{dt}$	max.	300	A/µs
Rate of rise of off-state voltage that will not trigger any device	$\frac{dV_D}{dt}$	<	200	V/µs
On request	$\frac{dV_D}{dt}$	up to	1000	V/µs

MECHANICAL DATA see page 2

MECHANICAL DATA

Dimensions in mm



Torque on nut: min. 4 Nm (40 kg cm)
max. 6 Nm (60 kg cm)

Net weight: 46 g

→ Diameter of clearance hole: 8,5 mm

All information applies to frequencies up to 400 Hz.

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

Anode to cathode		BTW24-600RM BTW24-600RU	800RM 800RU	1000RM 1000RU	1200RM 1200RU	1400RM 1400RU	1600RM 1600RU	
Voltages [1]								
Non-repetitive peak voltages ($t \leq 10$ ms) V_{DSM} [2] $= V_{RSM}$	max.	700	900	1100	1300	1400	1600	V
Repetitive peak voltages ($\delta \leq 0.01$) $V_{DRM} = V_{RRM}$	max.	600	800	1000	1200	1400	1600	V
Crest working voltages $V_{DWM} = V_{RWM}$	max.	600	800	1000	1200	1200	1200	V
Continuous voltages $V_D = V_R$	max.	600	800	1000	1200	1200	1200	V

1) To ensure thermal stability: $R_{th\ j-a} < 1$ °C/W (d.c. blocking) or < 2 °C/W (a.c.). For smaller heatsinks T_{jmax} should be derated. For a.c. see page 6.

2) Higher off-state voltages may be applied without damage, but at voltages higher than the minimum forward breakover voltage (p. 4) the thyristor may switch into the on-state. The rate of rise of on-state current should not exceed 100 A/µs.

RATINGS (continued)

Currents

Average on-state current (averaged over any 20 ms period) up to T_{mb} = 85 °C	$I_{T(AV)}$	max.	35	A	←
On-state current (d.c.)	I_T	max.	55	A	←
R.M.S. on-state current	$I_{T(RMS)}$	max.	55	A	←
Repetitive peak on-state current	I_{TRM}	max.	450	A	←
Non-repetitive peak on-state current (t = 10 ms; half sine wave) T_j = 125 °C prior to surge	I_{TSM}	max.	800	A	←
I^2t for fusing (t = 10 ms)	I^2t	max.	3200	A^2s	←
Rate of rise of on-state current after triggering with $I_G = I_{GT}$ to I_T = 300 A dI_G/dt = 1 A/µs (see nomogram on page 9)	$\frac{dI_T}{dt}$	max.	300	A/µs	←
Rate of rise of on-state current after breakover	$\frac{dI_T}{dt}$	max.	100	A/µs	

Gate to cathode

Voltage

Reverse peak voltage	V_{RGM}	max.	10	V

Power dissipation

Average power dissipation (averaged over any 20 ms period)	$P_{G(AV)}$	max.	1	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	$R_{th\ mb\text{-}h}$	=	0.2	°C/W
Transient thermal impedance; t = 1 ms	$Z_{th\ j\text{-}mb}$	=	0.04	°C/W

CHARACTERISTICS

Anode to cathode

Voltages		BTW24-600RM BTW24-600RU	800RM 800RU	1000RM 1000RU	1200RM 1200RU	1400RM 1400RU	1600RM 1600RU
→ On-state voltage $I_T = 100$ A; $T_j = 25\ ^oC$	V_T	< 1.9	1.9	1.9	1.9	1.9	1.9 V [1]
Forward breakover voltage up to $T_j = 125\ ^oC$	$V_{(BO)}$	> 700	900	1100	1300	1400	1600 V
Rate of rise of off-state voltage that will not trigger any device; $T_j = 125\ ^oC$	$\frac{dV_D}{dt}$	< 200	200	200	200	200	200 V/µs
Currents							
Peak reverse current $V_{RM} = V_{RWMmax}$; $T_j = 125\ ^oC$	I_{RM}	< 18	15	12	10	10	10 mA
Peak off-state current $V_{DM} = V_{DWMmax}$; $T_j = 125\ ^oC$	I_{DM}	< 18	15	12	10	10	10 mA

Holding current; $T_j = 25\ ^oC$	I_H	<	200 mA
Latching current; $T_j = 25\ ^oC$	I_L	<	300 mA

Gate to cathode

Voltages

Voltage that will trigger all devices $V_D = 6$ V; $T_j = 25\ ^oC$	V_{GT}	>	2.5 V
Voltage that will not trigger any device $V_D = V_{DRMmax}$; $T_j = 125\ ^oC$	V_{GD}	<	200 mV

Current

Current that will trigger all devices $V_D = 6$ V; $T_j = 25\ ^oC$	I_{GT}	>	150 mA

[1]) Measured under pulse conditions to avoid excessive dissipation.

CHARACTERISTICS (continued)

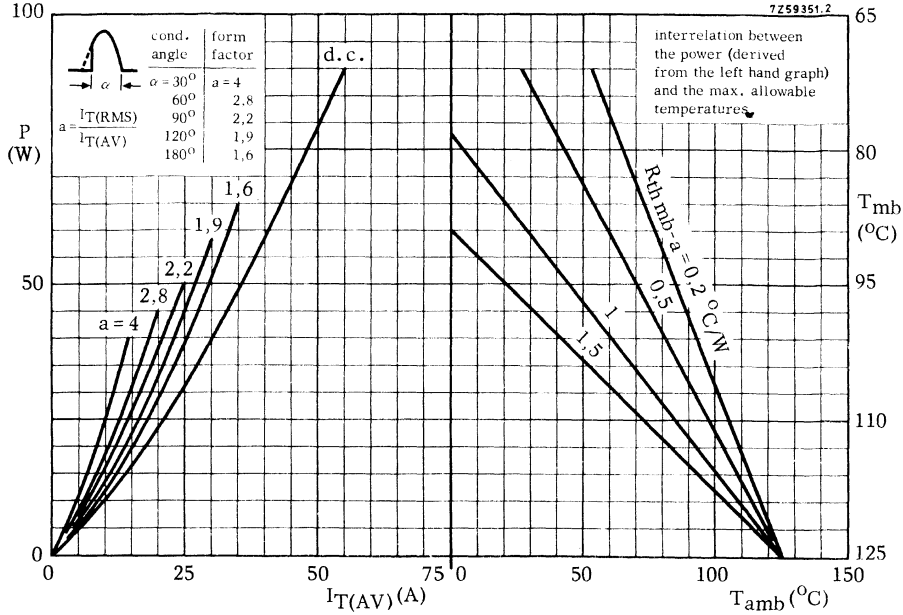
Switching characteristics

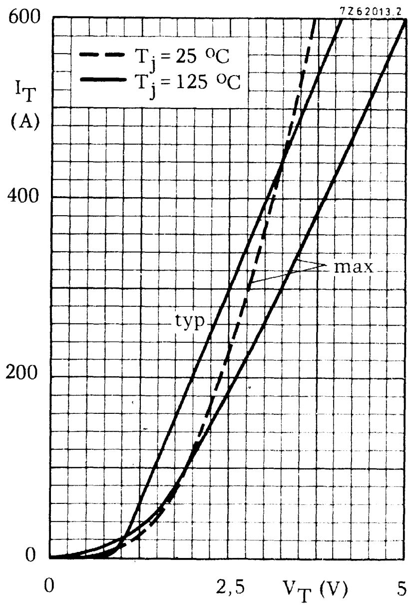
Turn-on time ($t_{on} = t_d + t_r$) when switched from				
$V_D = V_{DWMmax}$ to $I_T = 100$ A	t_{on}	typ.	2	μs
$I_{GT} = 150$ mA; $dI_G/dt = 1$ A/μs; $T_j = 25$ °C	t_r	typ.	1	μs
Circuit-commutated turn-off time when switched				
from $I_T = 30$ A to $V_R \geq 50$ V		typ.	140	μs
with $-dI_T/dt = 30$ A/μs; $dV_D/dt = 100$ V/μs; $T_j = 125$ °C	t_q	<	200	μs
$T_j = 25$ °C	t_q	<	100	μs

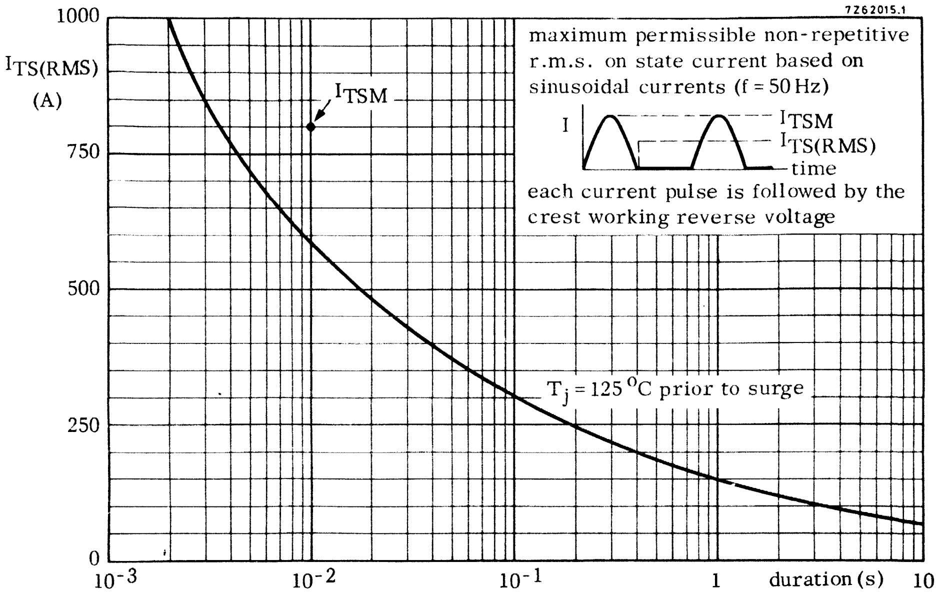
OPERATING NOTES

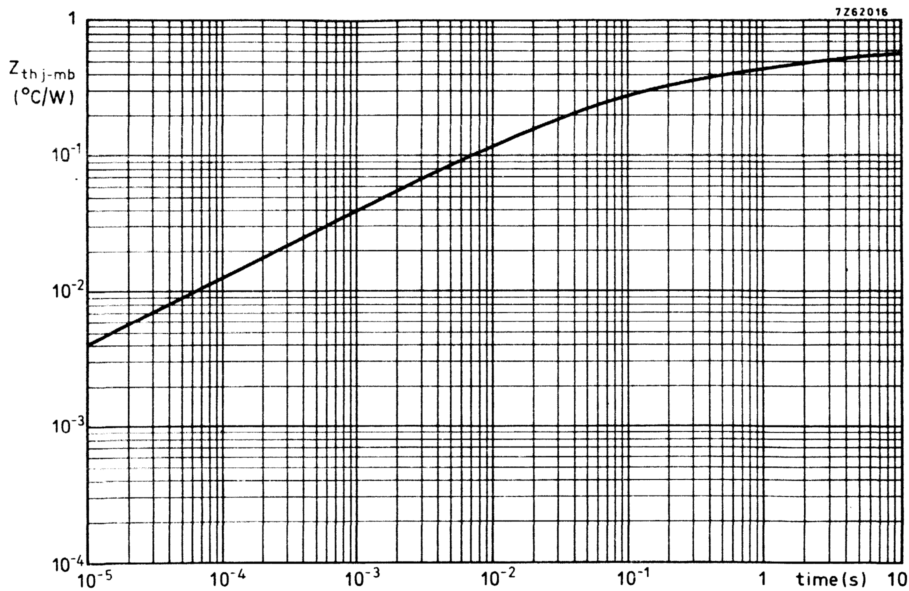
1. Switching losses in commutation

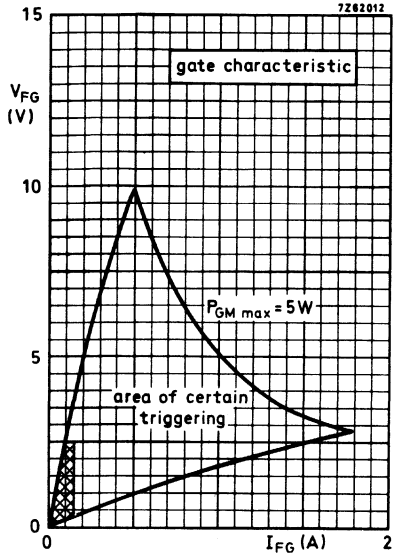
For applications in which the thyristor is forced to switch from an on-state current I_{TRM} to a high reverse voltage at a high commutation rate ($-dI/dt$), consult the nomogram on page 8 to find the increase in total average power. This increase must be added to the loss from the curves on page 6.

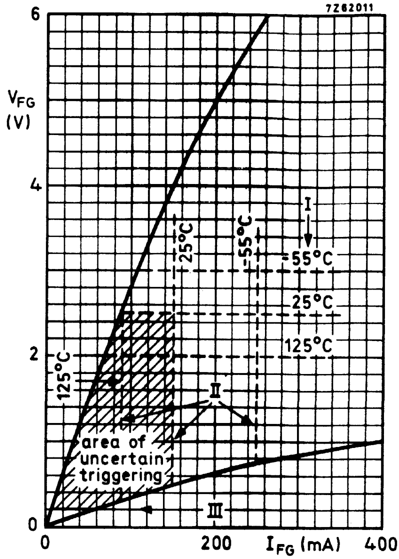

7Z59351.2
P
(W)
cond. angle
form factor
α = 30°
60°
90°
120°
180°
a = 4
2,8
2,2
1,9
1,6
$a = \frac{I_{T(RMS)}}{I_{T(AV)}}$
d.c.
interrelation between the power (derived from the left hand graph) and the max. allowable temperatures
Rth mb-a = 0,2 °C/W
0,5
1
1,5
$I_{T(AV)}$ (A)
T_{amb} (°C)
T_{mb} (°C)


7Z62013.2
T_j = 25 °C
T_j = 125 °C
I_T
(A)
max
typ
V_T (V)


7Z62015.1
1000
750
500
250
0
$I_{TS(RMS)}$
(A)
I_{TSM}
maximum permissible non-repetitive r.m.s. on state current based on sinusoidal currents (f = 50 Hz)
I
I_{TSM}
$I_{TS(RMS)}$
time
each current pulse is followed by the crest working reverse voltage
T_j = 125 °C prior to surge
10^{-3}
10^{-2}
10^{-1}
1
duration (s)
10


7Z62016
1
$Z_{th\ j\text{-}mb}$
(°C/W)
10^{-1}
10^{-2}
10^{-3}
10^{-4}
10^{-5}
10^{-4}
10^{-3}
10^{-2}
10^{-1}
1
time (s)
10

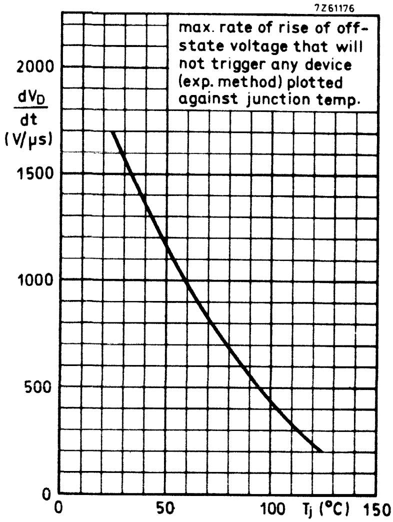


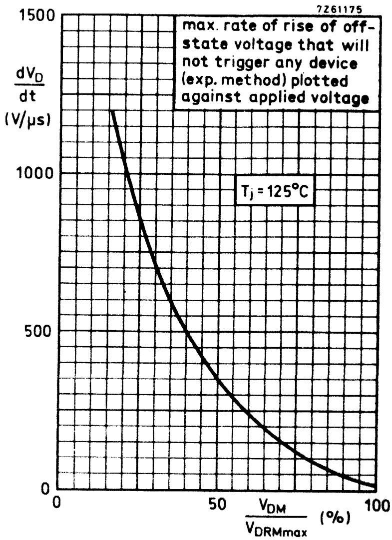


I = minimum gate voltage that will trigger all devices at T_j = →

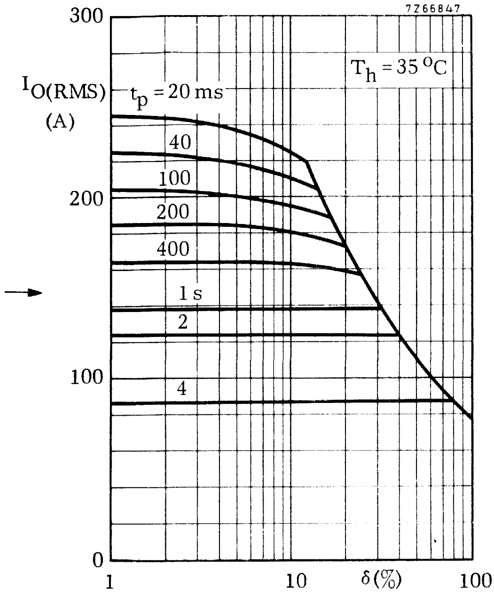
II = minimum gate current that will trigger all devices at T_j = →

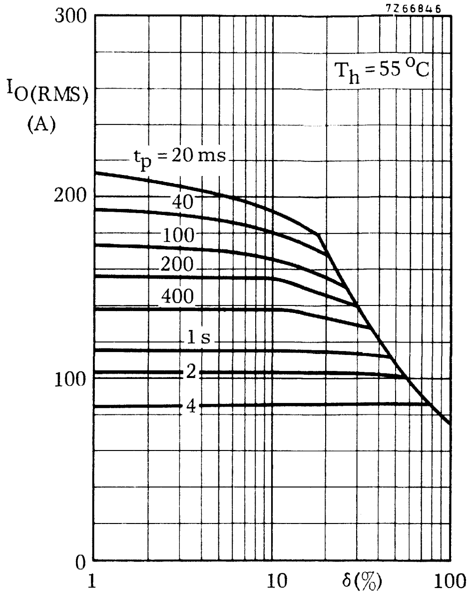
III = maximum gate voltage that will not trigger any devices at T_j = 125 ^oC

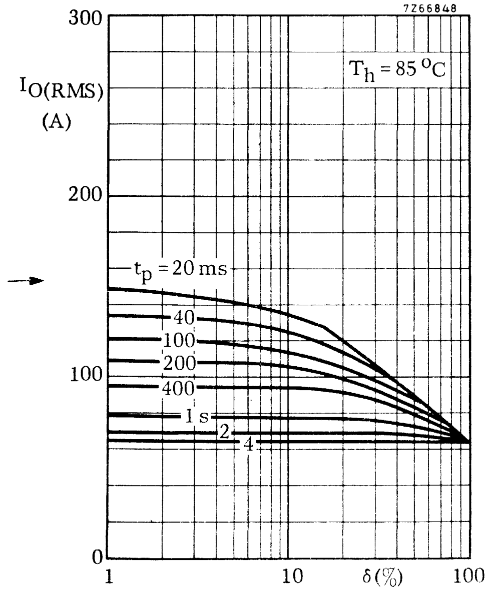

7Z61176
max. rate of rise of off-state voltage that will not trigger any device (exp. method) plotted against junction temp.
2000
1500
1000
500
0
dV_D/dt (V/µs)
0
50
100
150
T_j (°C)

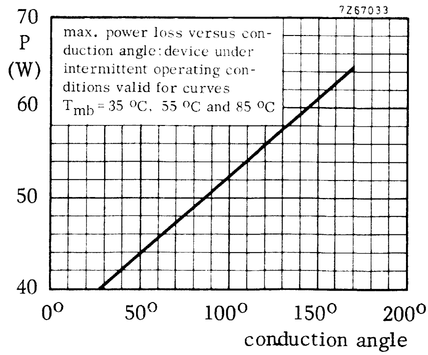

7Z61175
max. rate of rise of off-state voltage that will not trigger any device (exp. method) plotted against applied voltage
T_j = 125°C
1500
1000
500
0
dV_D/dt (V/µs)
0
50
100
V_DM/V_DRMmax (%)

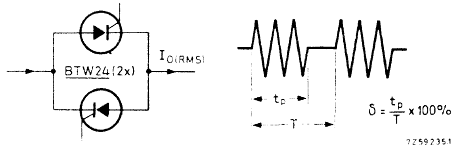
Intermittent overload capability of two BTW24 thyristors in antiparallel connection in a single phase a.c. control circuit (e.g. welding); conduction angle: 360°.



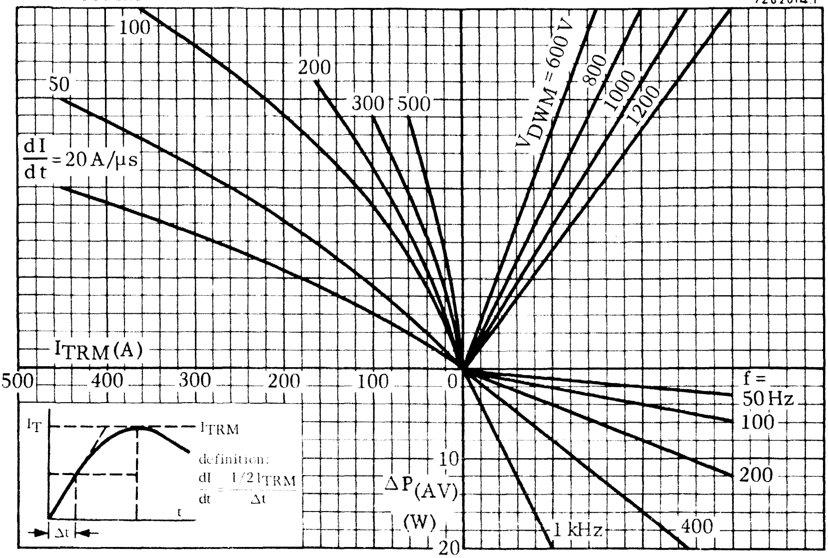




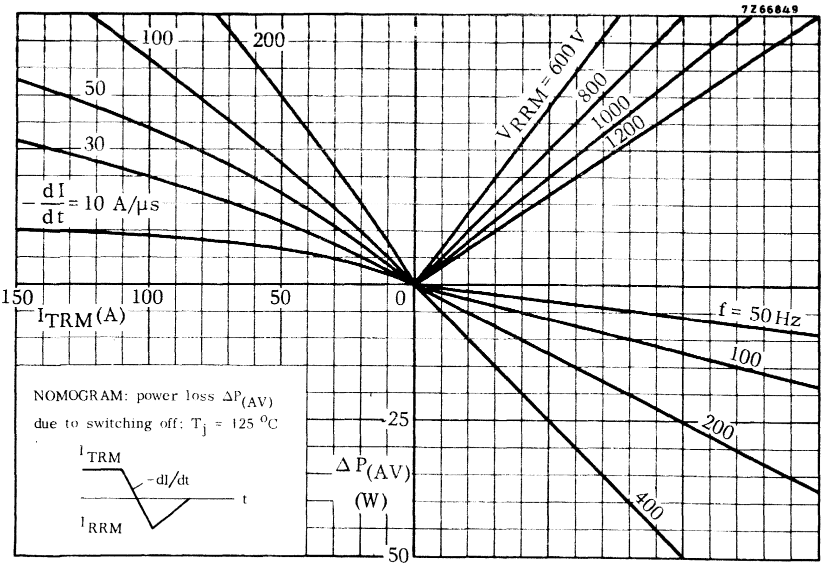




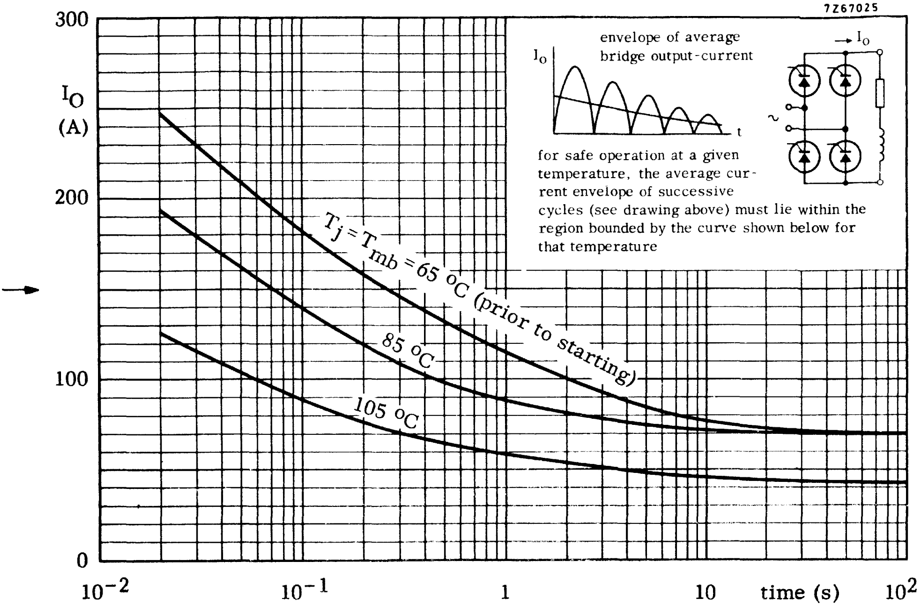
NOMOGRAM

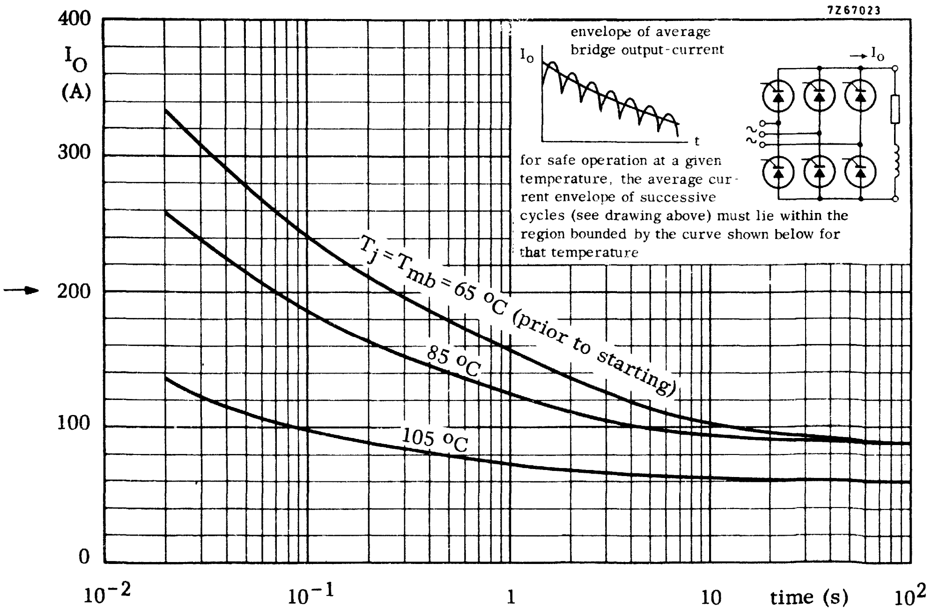


Power loss $\Delta P_{(AV)}$ due to switching-on; T_j = 125 °C; $I_{GT} = I_{GTmin}$; dI_G/dt = 1 A/µs



Limits for starting or inrush-currents





12A FAST TURN-OFF THYRISTORS

The BTW30 series is a range of medium current fast turn-off thyristors in a metal envelope similar to TO-48 with M6 thread. They are intended for use in inverter applications up to frequencies of 25 kHz at crest working voltages up to 800 V.
The BTW30 series consists of reverse polarity types (anode to stud) BTW30-300RM to 1200RM.

QUICK REFERENCE DATA

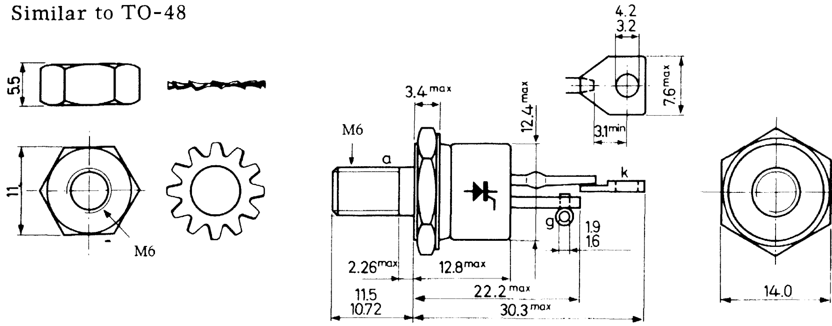
		BTW30-300..	400..	500..	600..	800..	1000..	1200RM	
Repetitive peak voltages $V_{DRM} = V_{RRM}$	max.	300	400	500	600	800	1000	1200	V
Crest working off-state voltage V_{DWM}	max.	300	400	500	600	600	700	800	V
Forward breakover voltage $V_{(BO)}$	>	300	400	500	600	800	1000	1200	V

Average on-state current (square wave; $\delta = 0.5$)				
up to $T_{mb} = 65\ ^oC$	$I_{T(AV)}$	max.	16	A
at $T_{mb} = 85\ ^oC$	$I_{T(AV)}$	max.	12	A
R.M.S. on-state current	$I_{T(RMS)}$	max.	24	A
Non-repetitive peak on-state current single square pulse; t = 5 ms $T_j = 125\ ^oC$ prior to surge	I_{TSM}	max.	150	A
Junction temperature	T_j	max.	125	^oC
Rate of rise of on-state current after triggering	$\frac{dI_T}{dt}$	max.	100	A/μs
Rate of rise of off-state voltage that will not trigger any device	$\frac{dV_D}{dt}$	<	200	V/μs
Circuit-commutated turn-off time at $T_j = 125\ ^oC$ BTW30-300RM to 600RM :	t_q	<	6	μs
BTW30-800RM to 1200RM :	t_q	<	12	μs

MECHANICAL DATA see page 2

MECHANICAL DATA Dimensions in mm

Similar to TO-48



Net weight: 15 g
Diameter of clearance hole: max. 6.5 mm

Torque on nut: min. 17 kg cm (1.7 Newton-metres) max. 35 kg cm (3.5 Newton-metres)

Accessories supplied on request: 56264A

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

ANODE TO CATHODE

Voltages 1)

		BTW30-300..	400..	500..	600..	800..	1000..	1200RM	
Non-repetitive peak voltages ($t \leq 10$ ms) V_{DSM} 2) = V_{RSM}	max.	300	400	500	600	800	1000	1200	V
Repetitive peak voltages ($\delta \leq 0.01$) $V_{DRM} = V_{RRM}$ 3)	max.	300	400	500	600	800	1000	1200	V
Crest working off-state voltage V_{DWM}	max.	300	400	500	600	600	700	800	V
Continuous off-state voltage V_D	max.	300	400	500	600	600	700	800	V

1) To ensure thermal stability: $R_{th\ j-a} \leq 3^{o}C/W$ (d.c. blocking) or $\leq 6\ ^{o}C/W$ (square wave; $\delta = 0.5$)
For smaller heatsinks T_{jmax} should be derated. For square wave see page 6 .

2) Higher off-state voltages may be applied without damage, but at voltages higher than the minimum forward breakover voltage ($V_{(BO)}$) the thyristor may switch into the on-state. The rate of rise of on-state current should not exceed 30 A/µs.

3) Thermal stability at higher voltage ratings is dependent on duty factor. See graphs on page 11.

RATINGS (continued)

Currents

Average on-state current assuming zero switching losses (averaged over any 20 ms period)				
square wave; δ = 0.5 up to $T_{mb} \leq 65\ ^{o}C$	$I_{T(AV)}$	max.	16	A
at T_{mb} = 85 ^{o}C	$I_{T(AV)}$	max.	12	A
sinusoidal at T_{mb} = 85 ^{o}C	$I_{T(AV)}$	max.	10	A
On-state current (d.c.)	I_T	max.	24	A
R.M.S. on-state current	$I_{T(RMS)}$	max.	24	A
Repetitive peak on-state current	I_{TRM}	max.	150	A
Non-repetitive peak on-state current				
half sine wave; t = 10 ms; T_j = 125 ^{o}C prior to surge	I_{TSM}	max.	150	A
square pulse ; t = 5 ms; T_j = 125 ^{o}C prior to surge	I_{TSM}	max.	150	A
I^2t for fusing (t = 10 ms)	I^2t	max.	115	A^2s
Rate of rise of on-state current after triggering with I_G = 1 A to I_T = 50 A; dI_G/dt = 1A/µs	$\frac{dI_T}{dt}$	max.	100	A/µs
after breakover	$\frac{dI_T}{dt}$	max.	30	A/µs

GATE TO CATHODE

Voltage

Reverse peak voltage	V_{RGM}	max.	10	V

Power dissipation

Average power dissipation (averaged over any 20 ms period)	$P_{G(AV)}$	max.	1.0	W
Peak power dissipation	P_{GM}	max.	5.0	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	$R_{th\ j-mb}$	=	1.0	$^{o}C/W$
From mounting base to heatsink	$R_{th\ mb-h}$	=	0.2	$^{o}C/W$
Transient thermal impedance; t = 1 ms	$Z_{th\ j-mb}$	=	0.06	$^{o}C/W$

CHARACTERISTICS

ANODE TO CATHODE

Voltages

On-state voltage
I_T = 50 A; T_j = 25 °C — V_T < 5.0 V

		BTW30-300..	400..	500..	600..	800..	1000..	1200RM	
Forward breakover voltage up to T_j = 125 °C	$V_{(BO)}$ >	300	400	500	600	800	1000	1200	V
Rate of rise of off-state voltage that will not trigger any device; T_j = 125 °C	$\frac{dV_D}{dt}$ <	200	200	200	200	200	200	200	V/μs
Currents									
Peak off-state current $V_{DM} = V_{DWMmax}$; T_j = 125 °C	I_{DM} <	13	11	9	7	7	6	5	mA

Holding current; T_j = 25 °C — I_H < 200 mA

GATE TO CATHODE

Voltages

Voltage that will trigger all devices
V_D = 6 V; T_j = 25 °C — V_{GT} > 2.5 V

Voltage that will not trigger any device
$V_D = V_{DRMmax}$; T_j = 125 °C — V_{GD} < 0.2 V

Current

Current that will trigger all devices
V_D = 6 V; T_j = 25 °C — I_{GT} > 200 mA

SWITCHING CHARACTERISTICS

			BTW30-300RM to 600RM	800RM to 1200RM	
Turn-on time ($t_{on} = t_d + t_r$) when switched from $V_D = V_{DWM}$ to I_T = 50 A; I_{GT} = 200 mA; dI_G/dt = 1 A/μs; T_j = 25 °C	t_d	<	2.0	1.0	μs
	t_r	<	1.2	1.0	μs
Circuit-commutated turn-off time when switched from I_T = 10 A to $V_R \geq$ 50 V with $-dI_T/dt$ = 10 A/μs; $\frac{dV_D}{dt}$ = 50 V/μs; T_j = 125 °C	t_q	<	6	12	μs

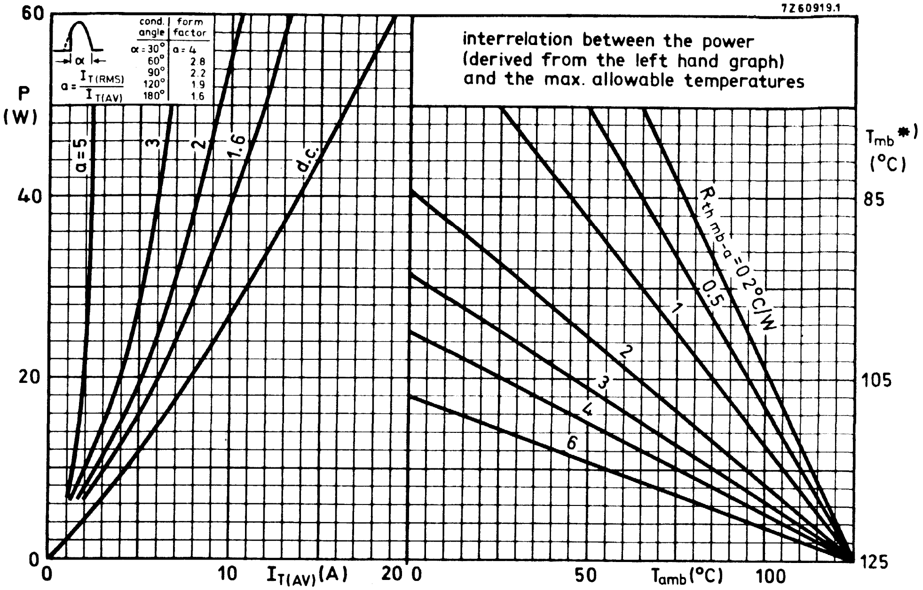
OPERATING NOTES

1.The gate and cathode connectors should not be bent; they should be soldered into the circuit so that there is no strain on them.
During soldering the heat conduction to the junction should be kept to a minimum.

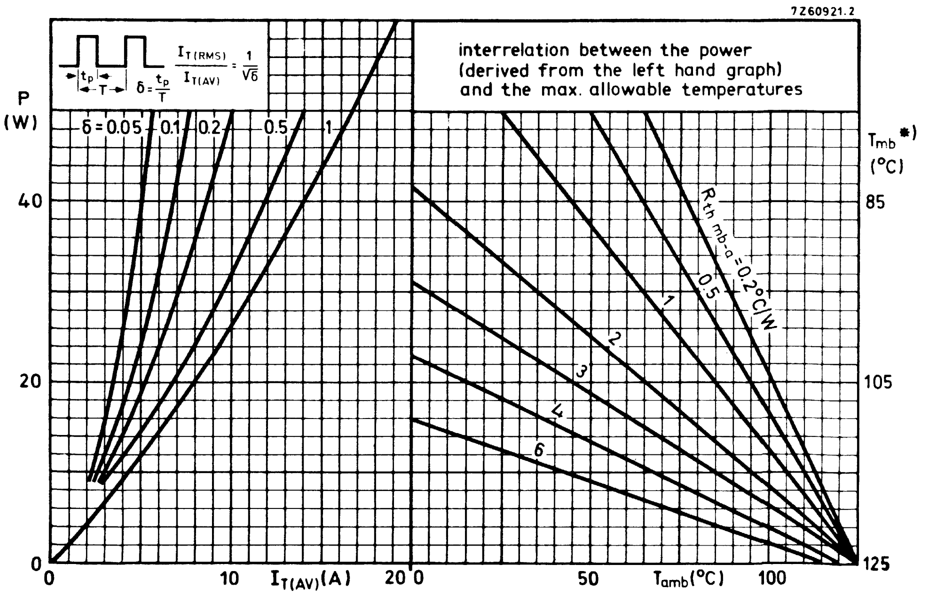
2.High frequency operation.

a. The curves on pages 8 and 9 show the additional average power losses due to turning-on and turning-off the thyristor in square pulse operation. This power should be added to that derived from the curves on page 6.

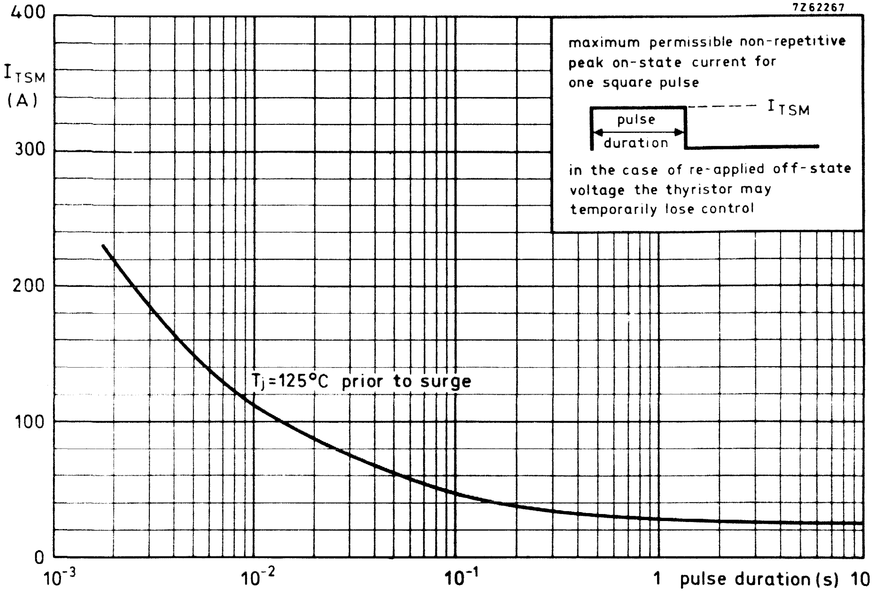
b. Power loss due to turn-off may be discounted if an inverse parallel diode (such as BYX30 series) is connected across the thyristor to clip any reverse voltage which may occur following commutation. Note should be taken of the consequent increase in turn-off time (see page 10).

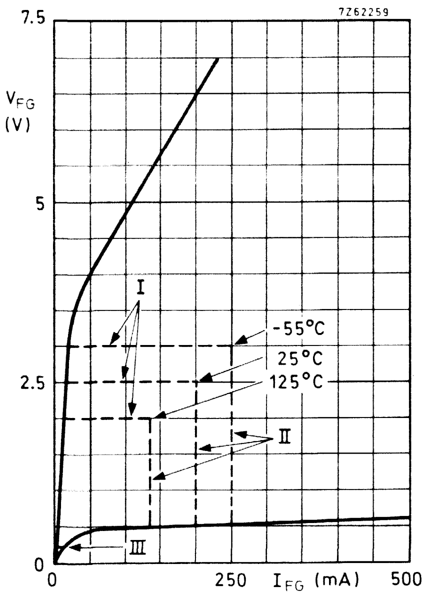


*) T_{mb}-scale is for comparison purposes only and is correct only for $R_{th\ mb-a} \leq 6$°C/W



*) T_{mb}-scale is for comparison purposes only and is correct only for $R_{th\ mb-a} \leq 2$°C/W

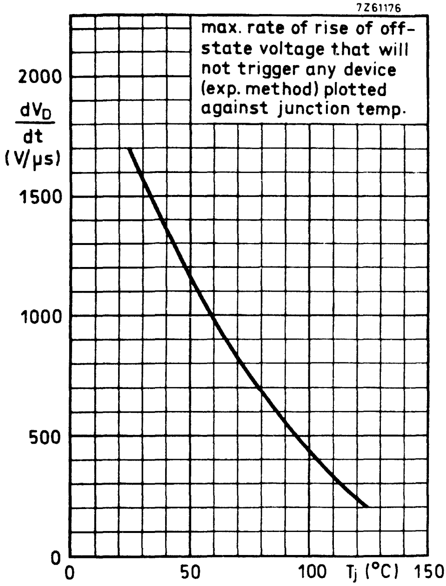


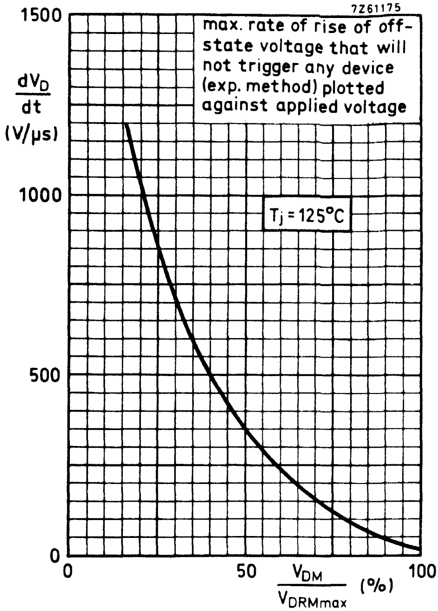


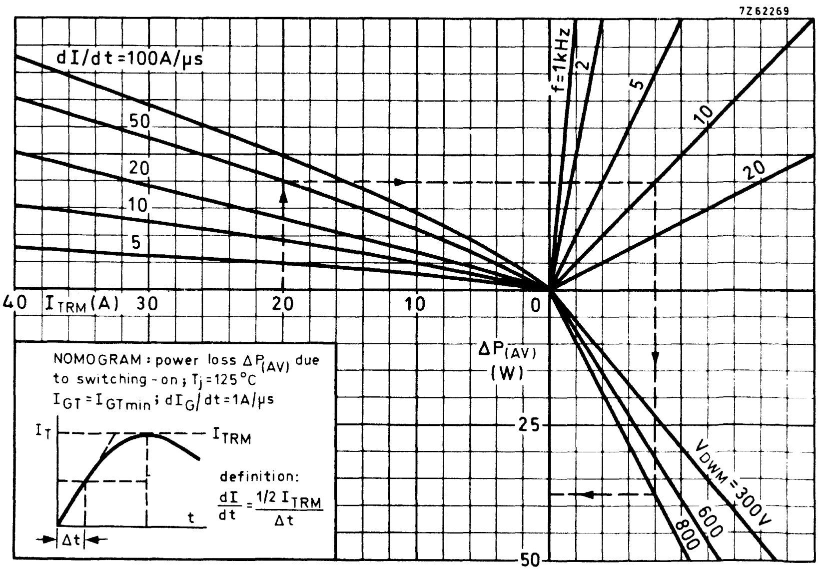
I = minimum gate voltage that will trigger all devices at T_j =→

II = minimum gate current that will trigger all devices at T_j =→

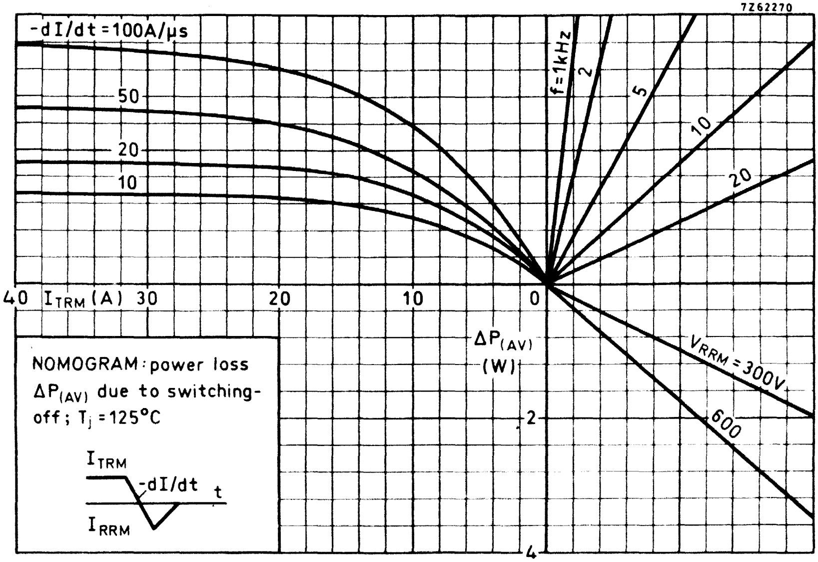
III = maximum gate voltage that will not trigger any device at T_j = 125 °C


7Z61176
max. rate of rise of off-state voltage that will not trigger any device (exp. method) plotted against junction temp.
$\frac{dV_D}{dt}$ (V/μs)
2000
1500
1000
500
0
0
50
100
T_j (°C)
150

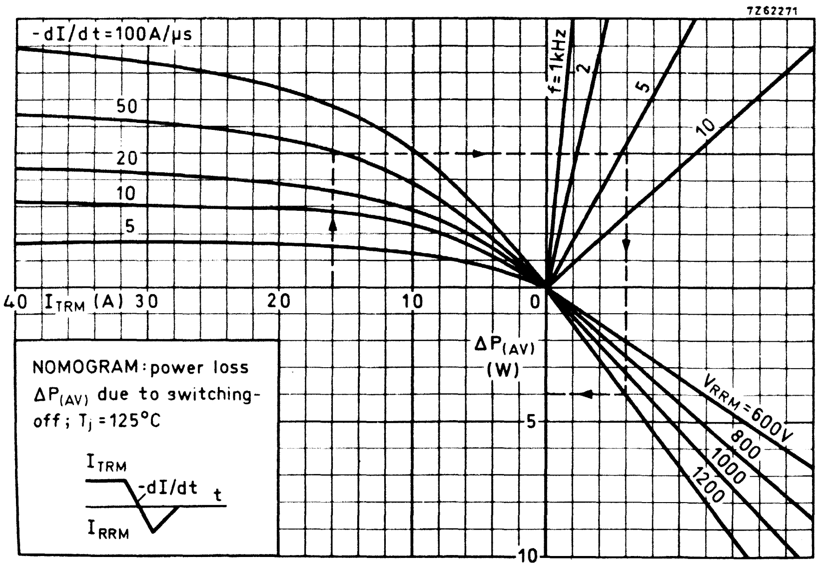

7Z61175
max. rate of rise of off-state voltage that will not trigger any device (exp. method) plotted against applied voltage
$\frac{dV_D}{dt}$ (V/μs)
1500
1000
500
0
T_j = 125°C
0
50
$\frac{V_{DM}}{V_{DRMmax}}$ (%)
100


7Z62269
dI/dt = 100A/μs
50
20
10
5
f = 1kHz
2
5
10
20
40
I_{TRM} (A)
30
20
10
0
$\Delta P_{(AV)}$ (W)
25
50
V_{DWM} = 300V
600
800
NOMOGRAM : power loss $\Delta P_{(AV)}$ due to switching-on ; T_j = 125°C
$I_{GT} = I_{GTmin}$; dI_G/dt = 1A/μs
I_T
I_{TRM}
t
Δt
definition:
$\frac{dI}{dt} = \frac{1/2\ I_{TRM}}{\Delta t}$

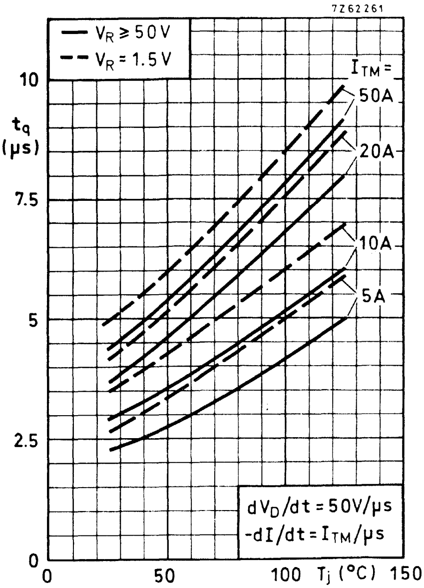
BTW30-300RM to 600RM



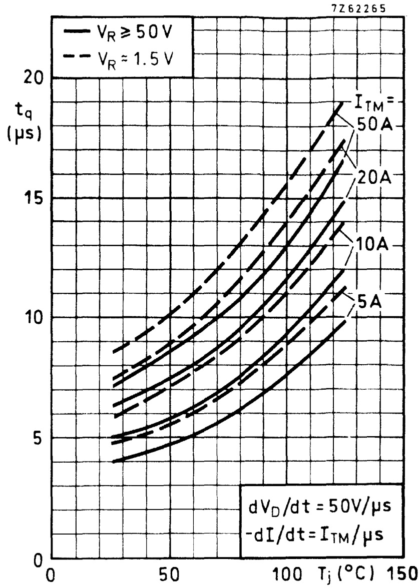
BTW30-800RM to 1200RM



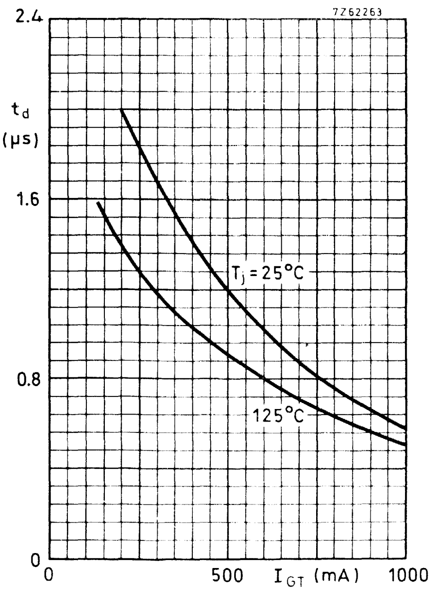
BTW30-300RM to 600RM



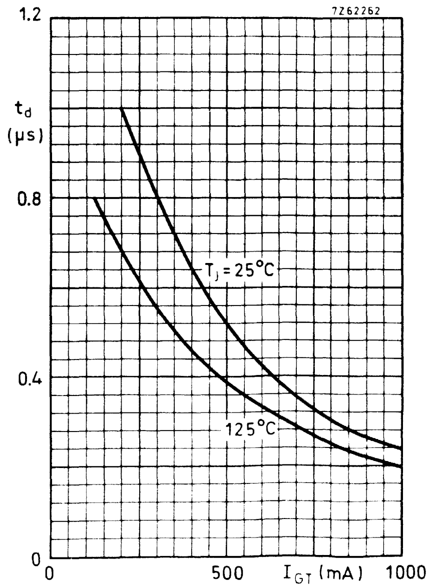
BTW30-800RM to 1200RM

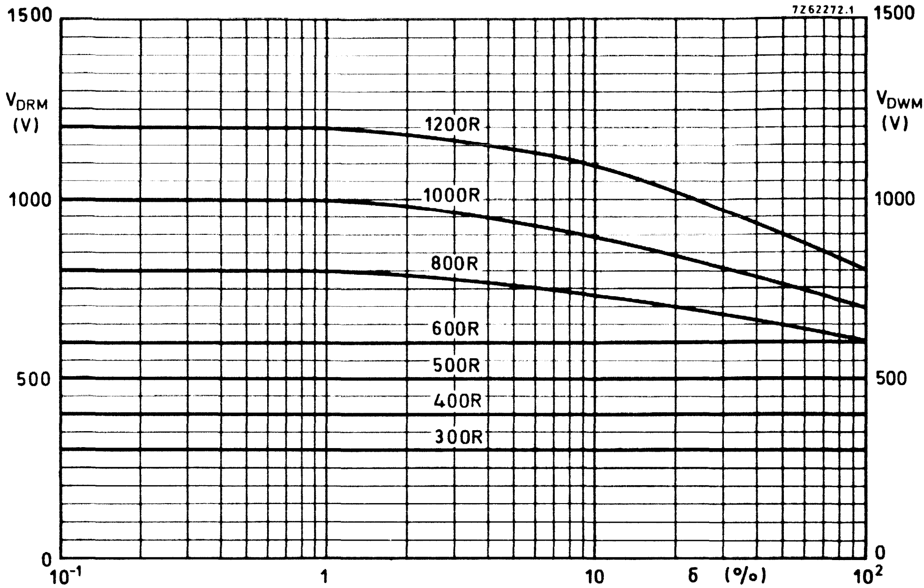


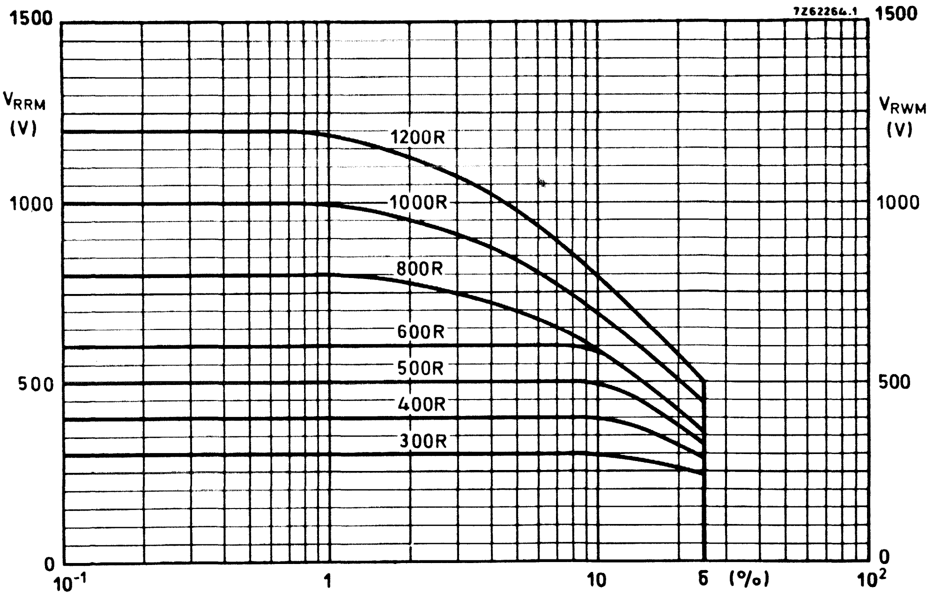
BTW30-300RM to 600RM

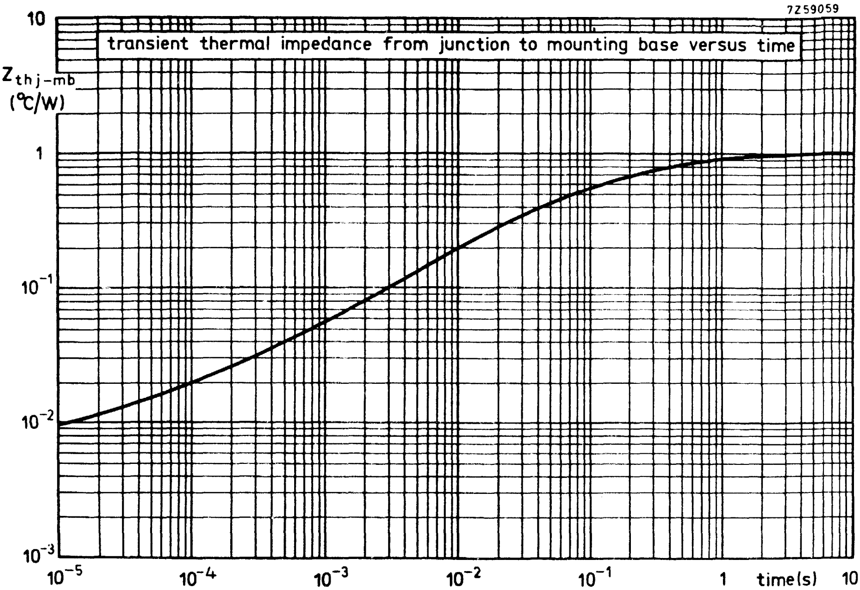


BTW30-800RM to 1200RM




7Z62272.1
1500
1000
500
0
V_{DRM} (V)
V_{DWM} (V)
1200R
1000R
800R
600R
500R
400R
300R
10^{-1}
1
10
δ (%)
10^2


7Z62264.1
1500
1000
500
0
V_{RRM} (V)
V_{RWM} (V)
1200R
1000R
800R
600R
500R
400R
300R
10^{-1}
1
10
δ (%)
10^2


7Z59059
transient thermal impedance from junction to mounting base versus time
$Z_{th\,j-mb}$ (°C/W)
10
1
10^{-1}
10^{-2}
10^{-3}
10^{-5}
10^{-4}
10^{-3}
10^{-2}
10^{-1}
1
time(s)
10

16A FAST TURN-OFF THYRISTORS

The BTW31 series is a range of medium current fast turn-off thyristors in a metal envelope similar to TO-48 with M6 thread. They are intended for use in inverter applications up to frequencies of 20 kHz at crest working voltages up to 800 V.
The BTW31 series consists of reverse polarity types (anode to stud) BTW31-300RM to 1200RM.

QUICK REFERENCE DATA

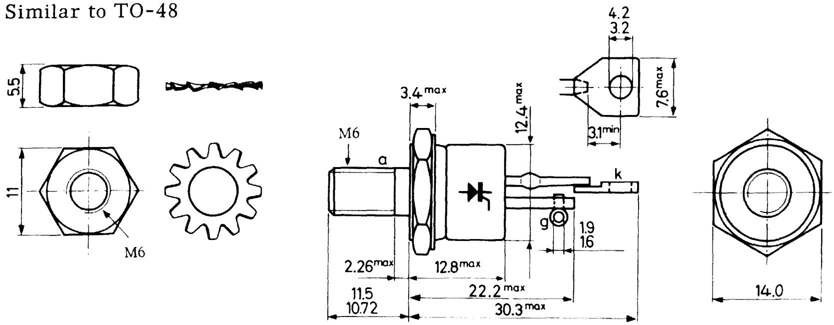
		BTW31-300..	400..	500..	600..	800..	1000..	1200RM	
Repetitive peak voltages $V_{DRM} = V_{RRM}$	max.	300	400	500	600	800	1000	1200	V
Crest working off-state voltage V_{DWM}	max.	300	400	500	600	600	700	800	V
Forward breakover voltage $V_{(BO)}$	>	300	400	500	600	800	1000	1200	V

Average on-state current (square wave; $\delta = 0.5$) up to $T_{mb} = 65\ ^{o}C$		$I_{T(AV)}$	max.	22	A
at $T_{mb} = 85\ ^{o}C$		$I_{T(AV)}$	max.	16	A
R.M.S. on-state current		$I_{T(RMS)}$	max.	31	A
Non-repetitive peak on-state current single square pulse; t = 5 ms $T_j = 125\ ^{o}C$ prior to surge		I_{TSM}	max.	225	A
Junction temperature		T_j	max.	125	^{o}C
Rate of rise of on-state current after triggering		$\frac{dI_T}{dt}$	max.	100	A/µs
Rate of rise of off-state voltage that will not trigger any device		$\frac{dV_D}{dt}$	<	200	V/µs
Circuit-commutated turn-off time at $T_j = 125\ ^{o}C$	BTW31-300RM to 600RM:	t_q	<	12	µs
	BTW31-800RM to 1200RM:	t_q	<	20	µs

MECHANICAL DATA see page 2

MECHANICAL DATA — Dimensions in mm

Similar to TO-48



Net weight: 15 g

Diameter of clearance hole: max. 6.5 mm

Torque on nut: min. 17 kg cm (1.7 Newton-metres)
max. 35 kg cm (3.5 Newton-metres)

Accessories supplied on request: 56264A

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

ANODE TO CATHODE

Voltages 1)

	BTW31-300..	400..	500..	600..	800..	1000..	1200RM	
Non-repetitive peak voltages ($t \leq 10$ ms) V_{DSM} 2) = V_{RSM}	max. 300	400	500	600	800	1000	1200	V
Repetitive peak voltages ($\delta \leq 0.01$) $V_{DRM} = V_{RRM}$ 3)	max. 300	400	500	600	800	1000	1200	V
Crest working off-state voltage V_{DWM}	max. 300	400	500	600	600	700	800	V
Continuous off-state voltage V_D	max. 300	400	500	600	600	700	800	V

1) To ensure thermal stability: $R_{th\ j-a} \leq 3$ °C/W (d.c. blocking) or ≤ 6 °C/W (square wave; $\delta = 0.5$)
For smaller heatsinks $T_{j\ max}$ should be derated. For square wave see page 6.

2) Higher off-state voltages may be applied without damage, but at voltages higher than the minimum forward breakover voltage ($V_{(BO)}$) the thyristor may switch into the on-state. The rate of rise of on-state current should not exceed 30 A/μs.

3) Thermal stability at higher voltage ratings is dependent on duty factor. See graphs on page 11.

RATINGS (continued)

Currents

Average on-state current assuming zero switching losses (averaged over any 20 ms period)				
square wave; δ = 0.5 up to $T_{mb} \leq 65\ ^oC$	$I_{T(AV)}$	max.	22	A
at $T_{mb} = 85\ ^oC$	$I_{T(AV)}$	max.	16	A
sinusoidal at $T_{mb} = 85\ ^oC$	$I_{T(AV)}$	max.	15	A
On-state current (d.c.)	I_T	max.	31	A
R.M.S. on-state current	$I_{T(RMS)}$	max.	31	A
Repetitive peak on-state current	I_{TRM}	max.	150	A
Non-repetitive peak on-state current				
half sine wave; t = 10 ms; $T_j = 125\ ^oC$ prior to surge	I_{TSM}	max.	225	A
square pulse; t = 5 ms; $T_j = 125\ ^oC$ prior to surge	I_{TSM}	max.	225	A
I^2t for fusing (t = 10 ms)	I^2t	max.	250	A^2s
Rate of rise of on-state current after triggering with I_G = 1 A to I_T = 50 A; dI_G/dt = 1 A/µs	$\frac{dI_T}{dt}$	max.	100	A/µs
after breakover	$\frac{dI_T}{dt}$	max.	30	A/µs

GATE TO CATHODE

Voltages

Reverse peak voltage	V_{RGM}	max.	10	V

Power dissipation

Average power dissipation (averaged over any 20 ms period)	$P_{G(AV)}$	max.	1.0	W
Peak power dissipation	P_{GM}	max.	5.0	W

TEMPERATURES

Storage temperature	T_{stg}	-55 to +125		^oC
Junction temperature	T_j	max.	125	^oC

THERMAL RESISTANCE

From junction to mounting base	$R_{th\ j-mb}$	=	1.0	$^oC/W$
From mounting base to heatsink	$R_{th\ j-mb}$	=	0.2	$^oC/W$
Transient thermal impedance; t = 1 ms	$Z_{th\ j-mb}$	=	0.06	$^oC/W$

CHARACTERISTICS

ANODE TO CATHODE

Voltages

On-state voltage
I_T = 50 A; T_j = 25 °C — V_T < 2.9 V

			BTW31-300..	400..	500..	600..	800..	1000..	1200RM	
Forward breakover voltage up to T_j = 125 °C	$V_{(BO)}$	>	300	400	500	600	800	1000	1200	V
Rate of rise of off-state voltage that will not trigger any device; T_j = 125 °C	$\frac{dV_D}{dt}$	<	200	200	200	200	200	200	200	V/µs
Currents										
Peak off-state current $V_{DM} = V_{DWMmax}$; T_j = 125 °C	I_{DM}	<	13	11	9	7	7	6	5	mA

Holding current; T_j = 25 °C — I_H < 200 mA

GATE TO CATHODE

Voltages

Voltage that will trigger all devices
V_D = 6 V; T_j = 25 °C — V_{GT} > 2.5 V

Voltage that will not trigger any device
$V_D = V_{DRMmax}$; T_j = 125 °C — V_{GD} < 0.2 V

Current

Current that will trigger all devices
V_D = 6 V; T_j = 25 °C — I_{GT} > 200 mA

SWITCHING CHARACTERISTICS

			BTW31-300RM to 600RM	800RM to 1200RM	
Turn-on time ($t_{on} = t_d + t_r$) when switched from $V_D \doteq V_{DWM}$ to I_T = 50 A; I_{GT} = 200 mA; dI_G/dt = 1 A/µs; T_j = 25 °C	t_d	<	2.0	1.0	µs
	t_r	<	1.2	0.7	µs
Circuit-commutated turn-off time when switched from I_T = 10 A to $V_R \geq$ 50 V with $-dI_T/dt$ = 10 A/µs; $\frac{dV_D}{dt}$ = 50 V/µs; T_j = 125 °C	t_q	<	12	20	µs

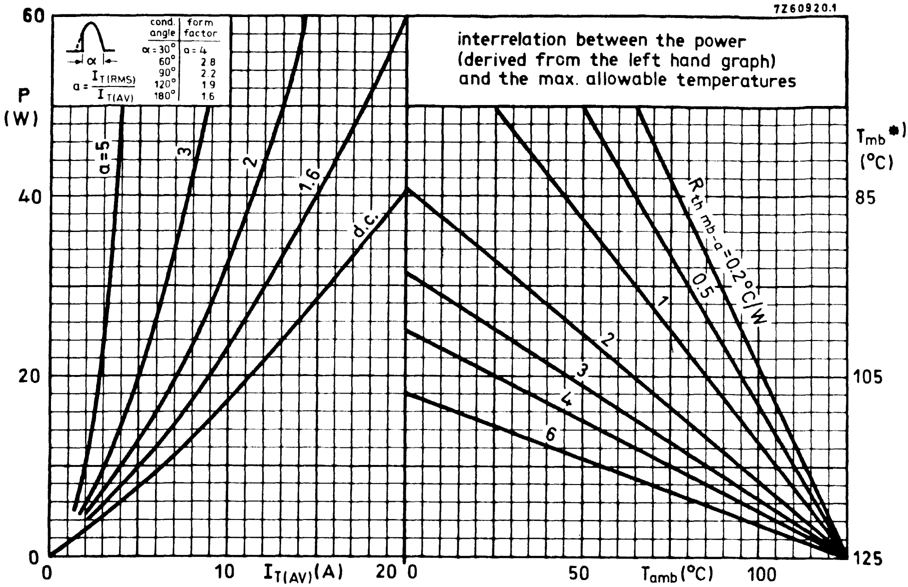
OPERATING NOTES

1 The gate and cathode connectors should not be bent; they should be soldered into the circuit so that there is no strain on them.
During soldering the heat conduction to the junction should be kept to a minimum.

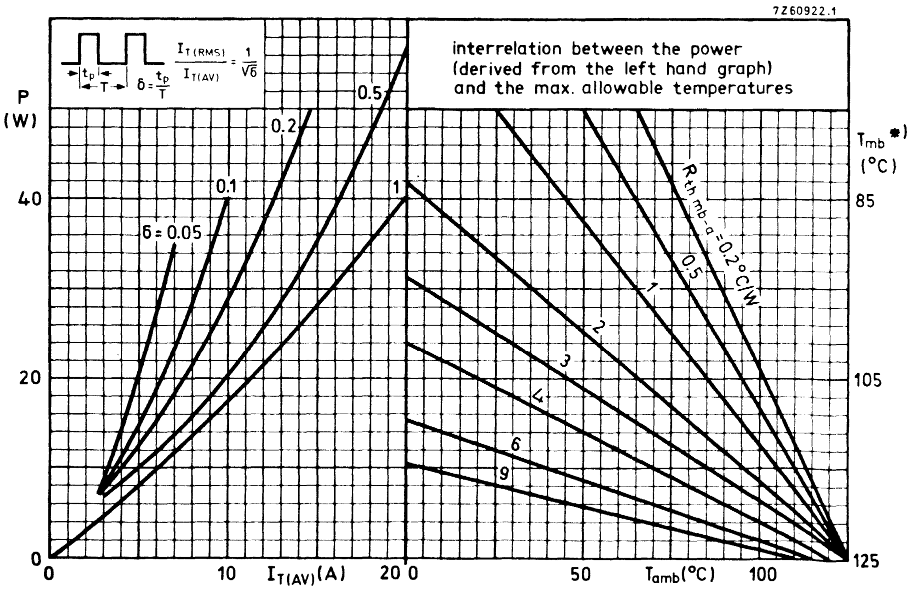
2 High frequency operation

a. The curves on pages 8 and 9 show the additional average power losses due to turning-on and turning-off the thyristor in square pulse operation. This power should be added to that derived from the curves on page 6.

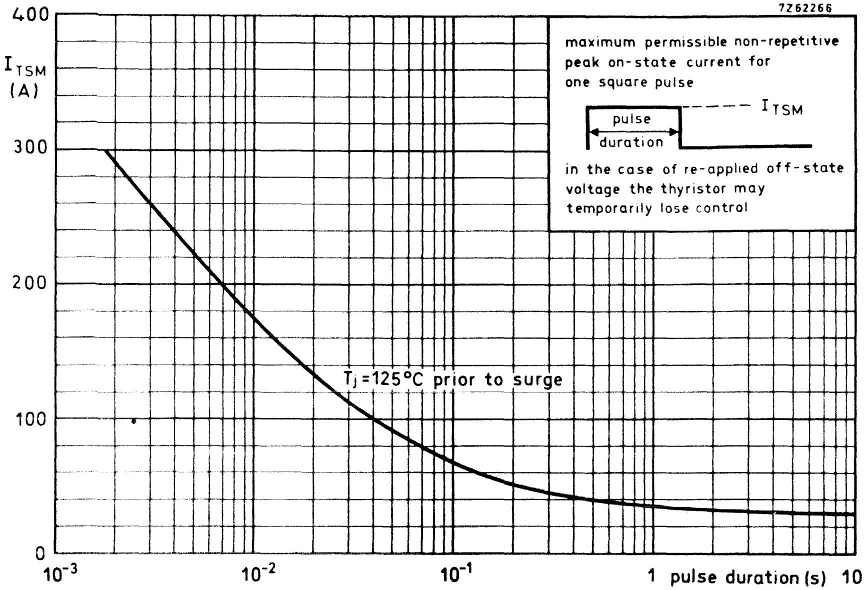
b. Power loss due to turn-off may be discounted if an inverse parallel diode (such as BYX30 series) is connected across the thyristor to clip any reverse voltage which may occur following commutation. Note should be taken of the consequent increase in turn-off time (see page 10).

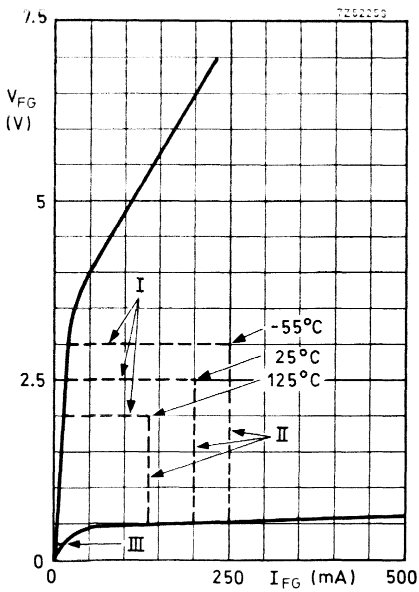


*) T_{mb}–scale is for comparison purposes only and is correct only for $R_{th\ mb-a} \leq 6$ °C/W



*) T_{mb} -scale is for comparison purposes only and is correct only for $R_{th\ mb-a} \leq 2$ °C/W

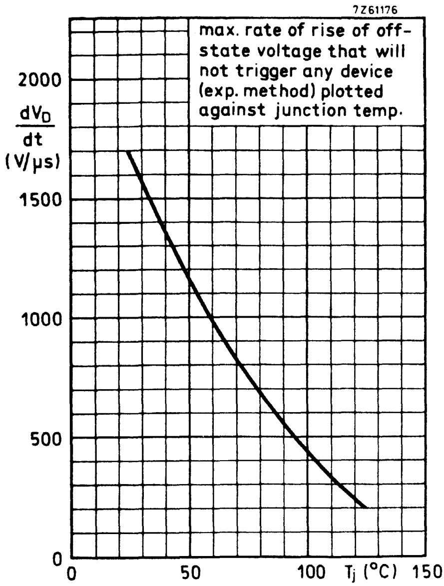


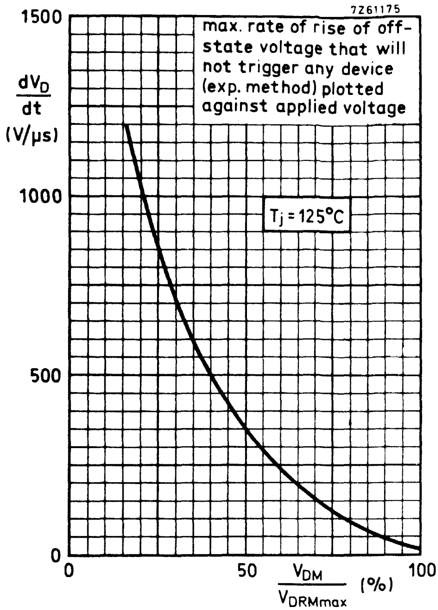


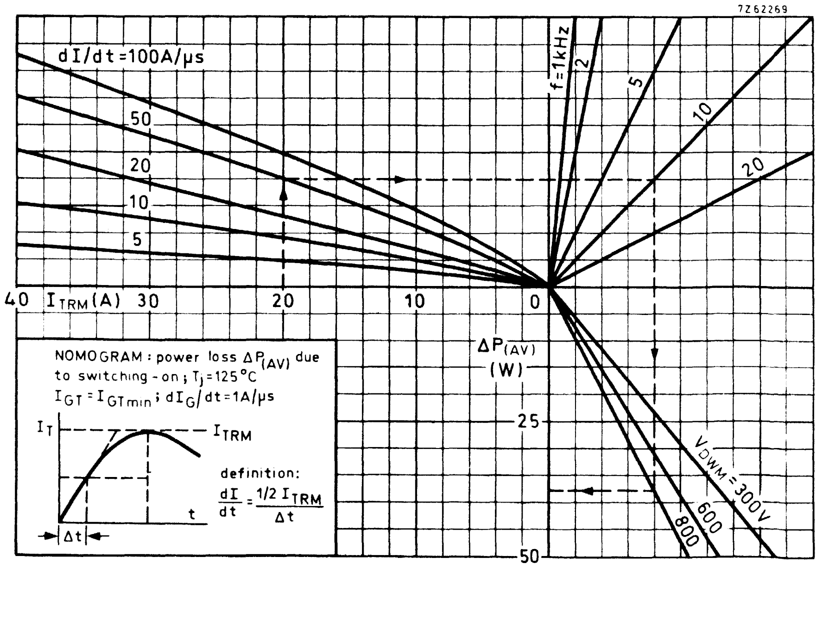
I = minimum gate voltage that will trigger all devices at T_j = →

II = minimum gate current that will trigger all devices at T_j = →

III = maximum gate voltage that will not trigger any device at T_j = 125 °C

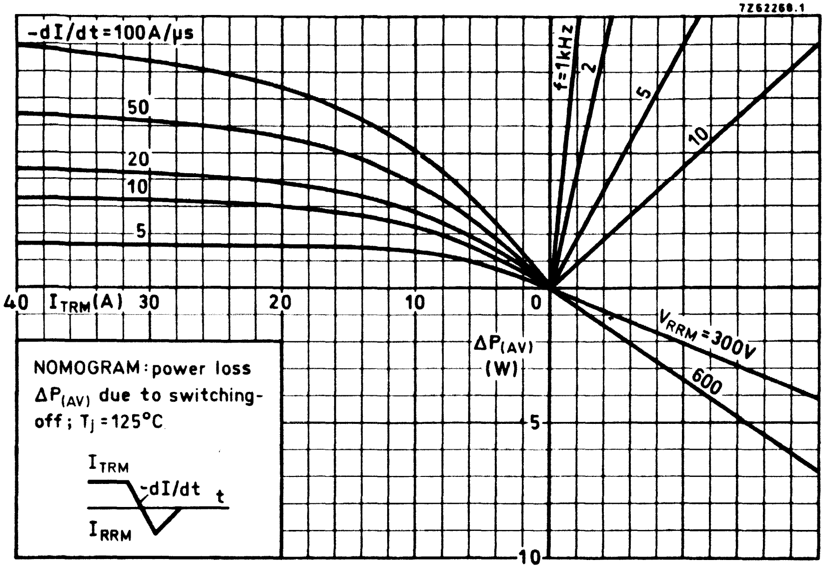

7Z61176
max. rate of rise of off-state voltage that will not trigger any device (exp. method) plotted against junction temp.
2000
1500
1000
500
0
$\frac{dV_D}{dt}$ (V/μs)
0
50
100
150
T_j (°C)


7Z61175
max. rate of rise of off-state voltage that will not trigger any device (exp. method) plotted against applied voltage
T_j = 125°C
1500
1000
500
0
$\frac{dV_D}{dt}$ (V/μs)
0
50
100
$\frac{V_{DM}}{V_{DRMmax}}$ (%)


7Z62269
dI/dt = 100A/μs
50
20
10
5
f = 1kHz
2
5
10
20
40
I_{TRM} (A)
30
20
10
0
$\Delta P_{(AV)}$ (W)
25
50
V_{DWM} = 300V
600
800
NOMOGRAM : power loss $\Delta P_{(AV)}$ due to switching-on ; T_j = 125 °C
$I_{GT} = I_{GTmin}$; dI_G/dt = 1A/μs
I_T
I_{TRM}
t
Δt
definition:
$\frac{dI}{dt} = \frac{1/2\, I_{TRM}}{\Delta t}$

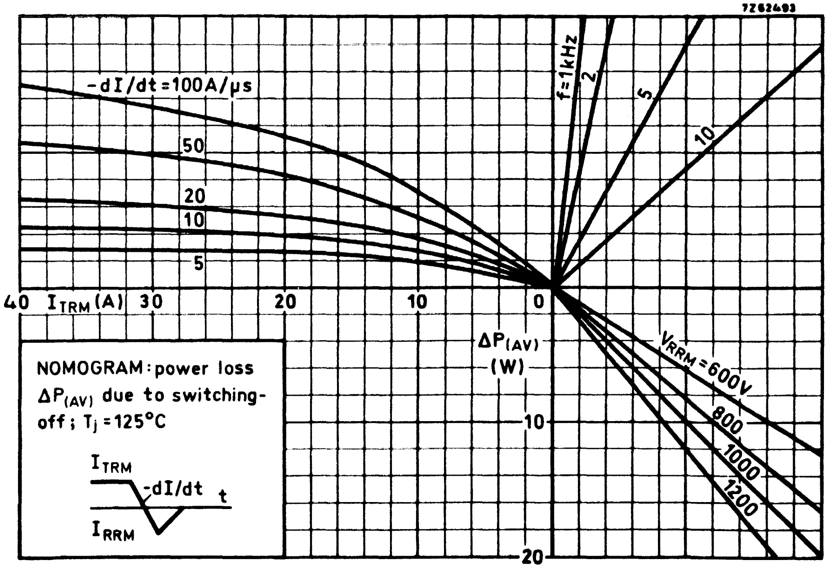
BTW31-300RM to 600RM

7Z62268.1

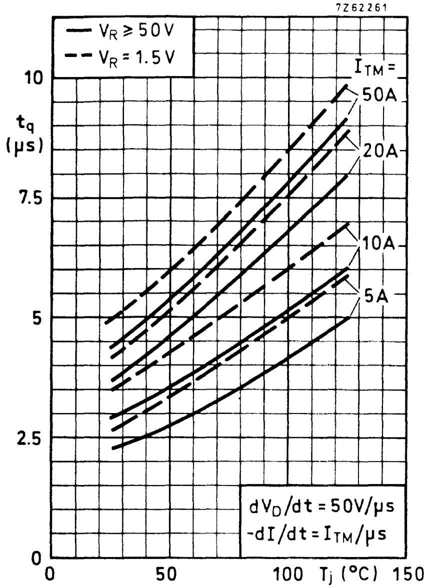


BTW31-800RM to 1200RM

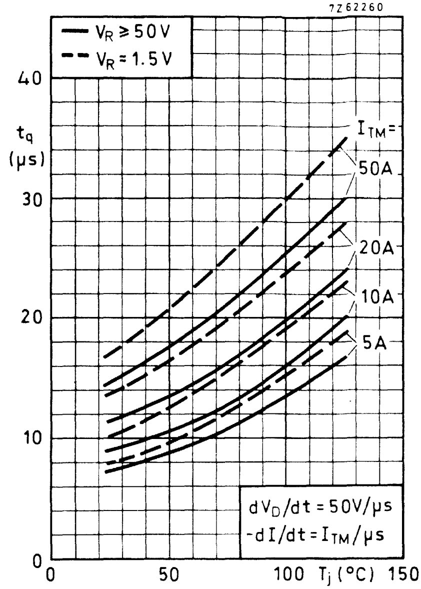
7Z62493



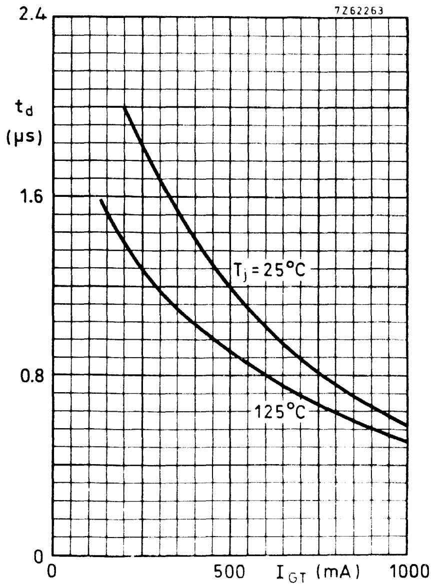
BTW31-300RM to 600RM



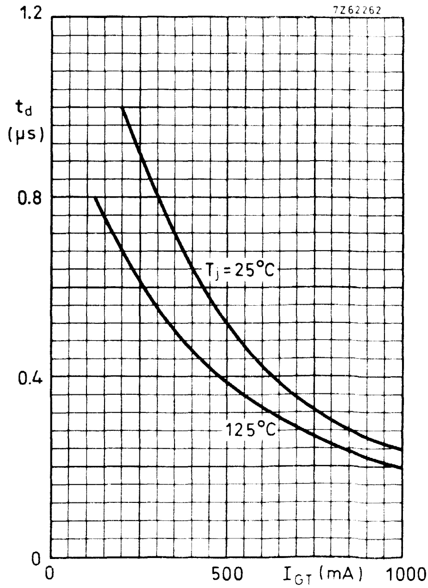
BTW31-800RM to 1200RM

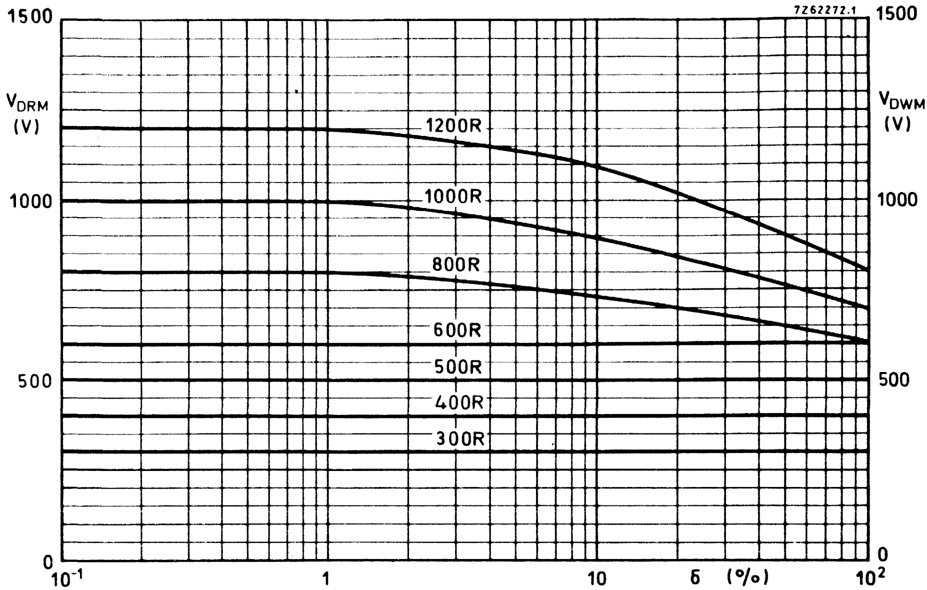


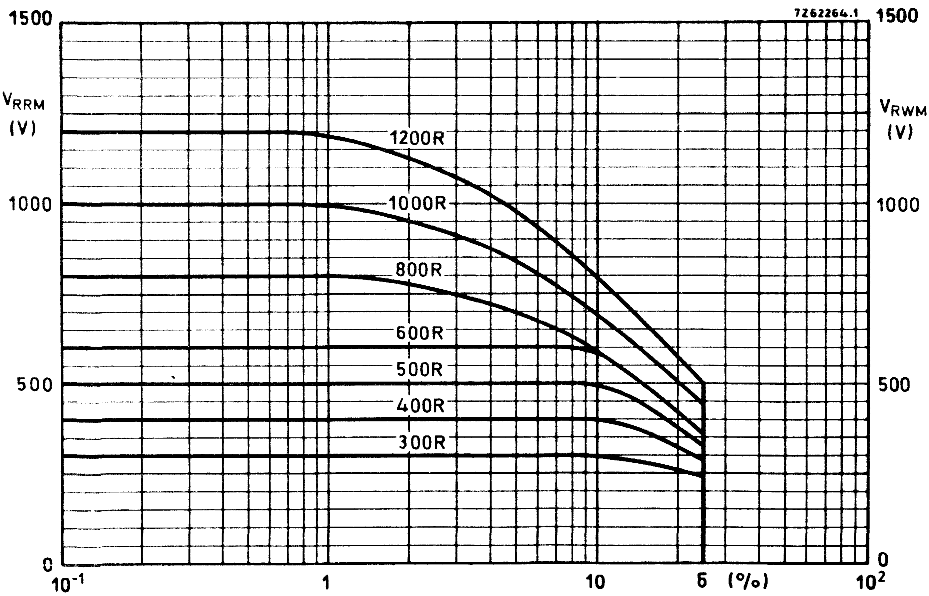
BTW31-300RM to 600RM

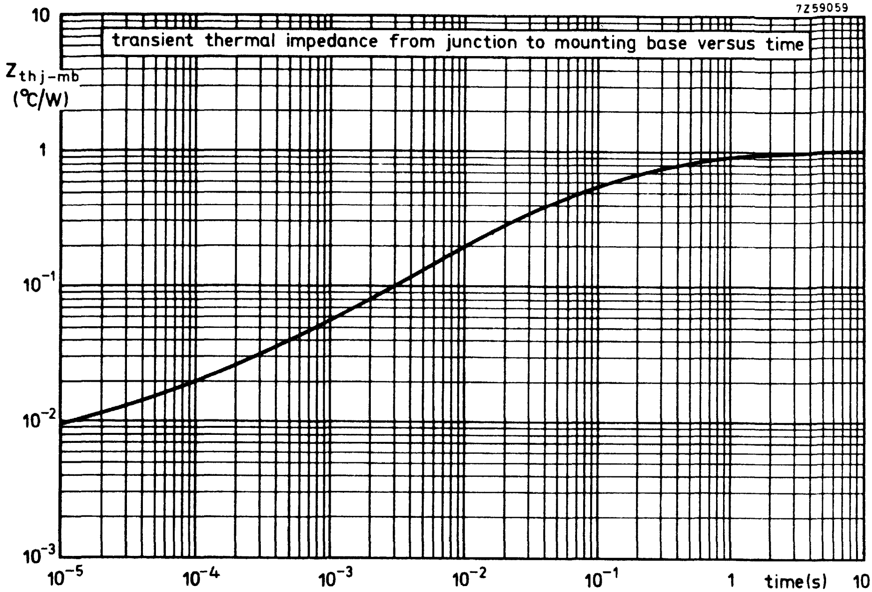


BTW31-800RM to 1200RM




7Z62272.1
1500
1000
500
0
V_{DRM}
(V)
V_{DWM}
(V)
1200R
1000R
800R
600R
500R
400R
300R
10^{-1}
1
10
δ (%)
10^2


7Z62264.1
1500
1000
500
0
V_{RRM}
(V)
V_{RWM}
(V)
1200R
1000R
800R
600R
500R
400R
300R
10^{-1}
1
10
δ (%)
10^2


7Z59059
transient thermal impedance from junction to mounting base versus time
$Z_{th\,j-mb}$ (°C/W)
10
1
10^{-1}
10^{-2}
10^{-3}
10^{-5}
10^{-4}
10^{-3}
10^{-2}
10^{-1}
1
time(s)
10

26A FAST TURN-OFF THYRISTORS

The BTW32series-RM is a range of fast turn-off thyristors intended for use in inverter applications up to frequencies of 15 kHz at crest working voltages up to 1000 V.
The series consists of reverse polarity types (anode to stud) identified by a suffix R: BTW32-600RM to 1200RM.

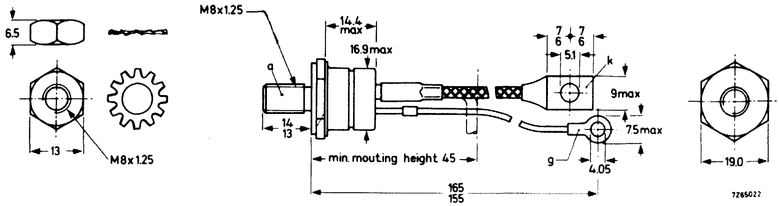
QUICK REFERENCE DATA

		BTW32-600RM	800RM	1000RM	1200RM	
Repetitive peak voltages: $V_{DRM} = V_{RRM}$	max.	600	800	1000	1200	V
Crest working off-state voltage V_{DWM}	max.	500	600	800	1000	V
Forward breakover voltage $V_{(BO)}$	>	600	800	1000	1200	V

Average on-state current (square wave; δ = 0.5)	up to T_{mb} = 65 °C	$I_{T(AV)}$	max.	37	A
	at T_{mb} = 85 °C	$I_{T(AV)}$	max.	25	A
R.M.S. on-state current		$I_{T(RMS)}$	max.	55	A
Non-repetitive peak on-state current; single square pulse;t = 5 ms; T_j = 125 °C prior to surge		I_{TSM}	max.	600	A
Junction temperature		T_j	max.	125	°C
Rate of rise of on-state current after triggering		$\frac{dI_T}{dt}$	max.	100	A/µs
Rate of rise of off-state voltage that will not trigger any device		$\frac{dV_D}{dt}$	<	200	V/µs
On request		$\frac{dV_D}{dt}$	up to	1000	V/µs
Circuit-commutated turn-off time at T_j = 125 °C		t_q	<	25	µs

MECHANICAL DATA See page 2

MECHANICAL DATA Dimensions in mm



Net weight : 46 g
Diameter of clearance hole : max. 8.5 mm

Torque on nut : min. 40 kgcm (4 Nm)
max . 60 kgcm (6 Nm)

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

Anode to cathode		BTW32-600RM	800RM	1500RM	1200RM	
Voltages 1)						
Non-repetitive peak voltages ($t \leq 10$ms) V_{DSM} 2) = V_{RSM}	max.	600	800	1000	1200	V
Repetitive peak voltages ($\delta \leq 0.1$) $V_{DRM} = V_{RRM}$	max.	600	800	1000	1200	V
Crest working off-state voltage (square wave; $\delta = 0.5$) V_{DWM}	max.	500	600	800	1000	V
Continuous off-state voltage V_D	max.	500	600	700	800	V

Currents

Average on-state current assuming zero switching losses (averaged over any 20 ms period)

square wave: $\delta = 0.5$	up to $T_{mb} = 65\ ^{o}C$	$I_{T(AV)}$	max.	37	A
	at $T_{mb} = 85\ ^{o}C$	$I_{T(AV)}$	max.	25	A
sinusoidal	at $T_{mb} = 85\ ^{o}C$	$I_{T(AV)}$	max.	26	A
On-state current (d.c.)		I_T	max.	55	A
R.M.S. on-state current		$I_{T(RMS)}$	max.	55	A

1) To ensure thermal stability: $R_{th\ j-a} < 1.5\ ^{o}C/W$ (d.c. blocking) or $< 2\ ^{o}C/W$ (square wave; $\delta = 0.5$); $< 4\ ^{o}C/W$ (a.c.).
For smaller heatsinks $T_{j\ max}$ should be derated. For a.c. see page 5.

2) Higher off-state voltages may be applied without damage, but at voltages higher than the minimum forward breakover voltage (p.4) the thyristor may switch into the on-state. The rate of rise of on-state current should not exceed 20 A/μs.

RATINGS (continued)

Repetitive peak on-state current	I_{TRM}	max.	300	A
Non-repetitive peak on-state current				
(t = 10 ms; half sine-wave) T_j = 125 °C prior to surge	I_{TSM}	max.	600	A
(t = 5 ms; square wave) T_j = 125 °C prior to surge	I_{TSM}	max.	600	A
I^2t for fusing (t = 10 ms)	I^2t	max.	1800	A^2s
Rate of rise of on-state current after triggering with $I_G = I_{GTmin}$ to I_T = 100 A, dI_G/dt = 1 A/µs	$\frac{dI_T}{dt}$	max.	100	A/µs
Rate of rise of on-state current after breakover	$\frac{dI_T}{dt}$	max.	20	A/µs

Gate to cathode

Voltage

Reverse peak voltage	V_{RGM}	max.	10	V

Power dissipation

Average power dissipation (averaged over any 20 ms period)	$P_{G(AV)}$	max.	1	W
Peak power dissipation	P_{GM}	max.	5	W

Temperatures

Storage temperatures	T_{stg}		−55 to +125	°C
Junction temperatures	T_j	max.	125	°C

THERMAL RESISTANCE

From junction to mounting base	$R_{th\ j-mb}$	=	0.6	°C/W
From mounting base to heatsink	$R_{th\ mb-h}$	=	0.2	°C/W
Transient thermal impedance; t = 1 ms	$Z_{th\ j-mb}$	=	0.04	°C/W

CHARACTERISTICS

Anode to cathode

			BTW32-600RM	800RM	1000RM	1200RM	
<u>Voltages</u>							
On-state voltage I_T = 100 A; T_j = 25 °C	V_T	<	3.5	3.5	3.5	3.5	V
Forward breakover voltage up to T_j = 125 °C	$V_{(BO)}$	>	600	800	1000	1200	V
Rate of rise of off-state voltage that will not trigger any device; T_j = 125 °C	$\frac{dV_D}{dt}$	<	200	200	200	200	V/μs
On request	$\frac{dV_D}{dt}$	up to	1000	1000	1000	1000	V/μs
<u>Currents</u>							
Peak off-state current $V_{DM} = V_{DWMmax}$; T_j = 125 °C	I_{DM}	<	24	18	15	12	mA

Holding current; T_j = 25 °C	I_H	<	200	mA
Latching current; T_j = 25 °C	I_L	<	300	mA

Gate to cathode

<u>Voltages</u>

Voltage that will trigger all devices V_D = 6 V; T_j = 25 °C	V_{GT}	>	2.5	V
Voltage that will not trigger any device $V_D = V_{DRM\,max}$; T_j = 125 °C	V_{GD}	<	0.2	V

<u>Current</u>

Current that will trigger all devices V_D = 6 V; T_j = 25 °C	I_{GT}	>	150	mA

Switching characteristics

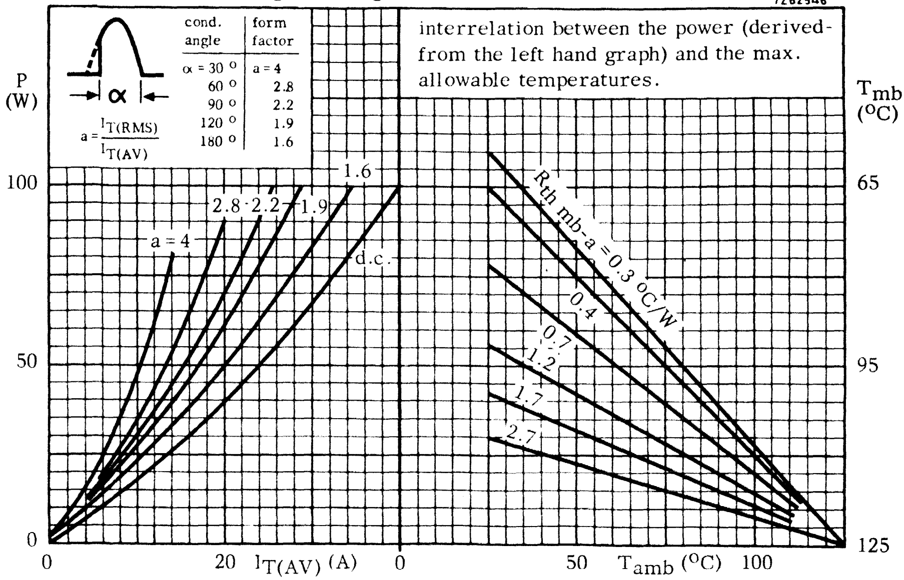
<u>Turn-on time</u> ($t_{on} = t_d + t_r$) when switched from $V_D = V_{DWM\,max}$ to I_T = 100 A; I_{GT} = 150 mA; dI_G/dt = 1 A/μs; T_j = 25 °C

t_d	<	1	μs
t_r	<	1	μs

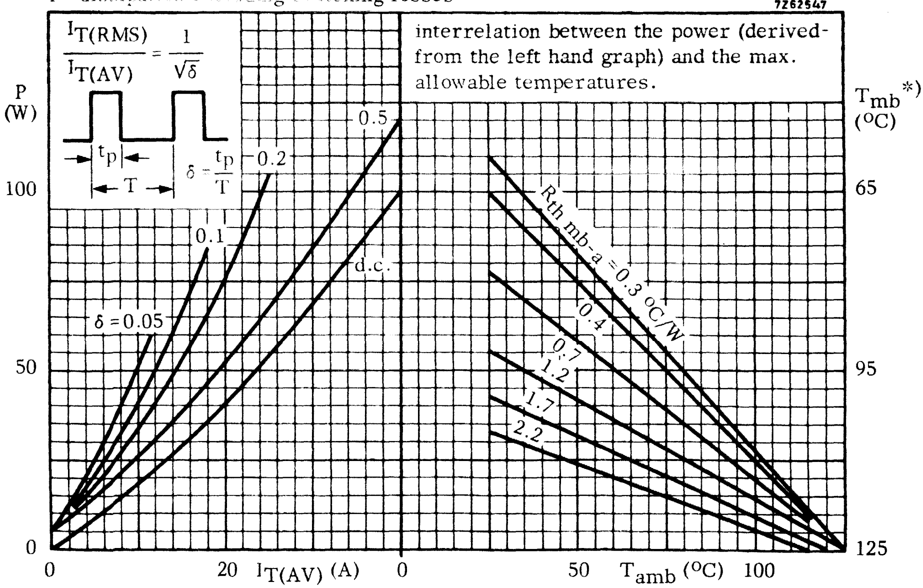
<u>Circuit-commutated turn-off time</u> when switched from I_T = 20 A to V_R ≥ 50 V with $-dI_T/dt$ = 20 A/μs; dV_D/dt = 25 V/μs;

T_j = 125 °C	t_q	<	25	μs
T_j = 25 °C	t_q	<	11	μs

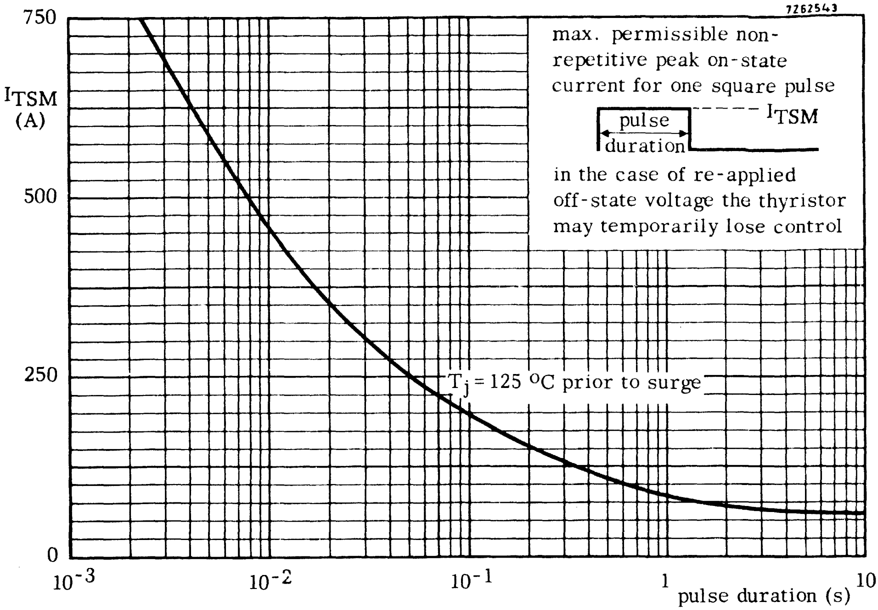
P = dissipation excluding switching losses

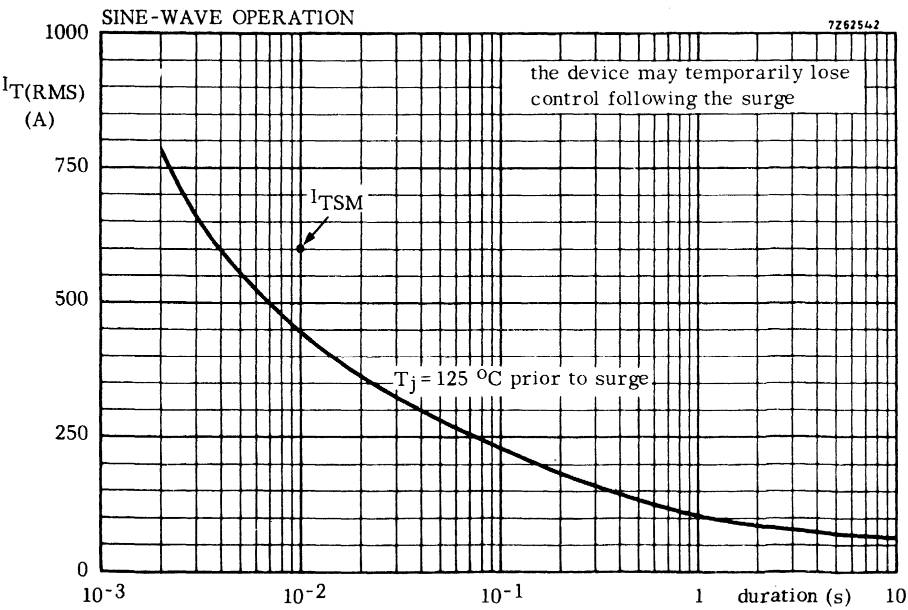


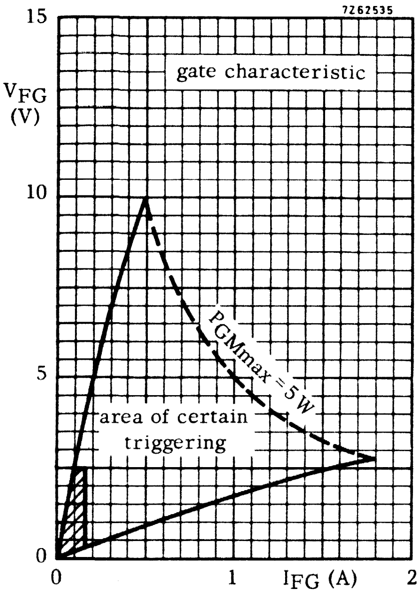
P = dissipation excluding switching losses

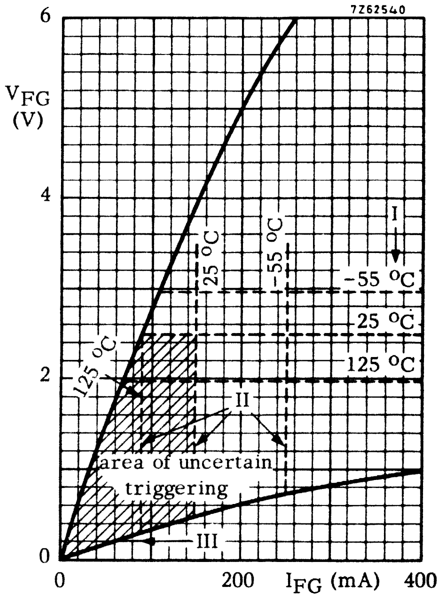


*) T_{mb} - scale is for comparison purposes only and is correct only for $R_{th\ mb\text{-}a} \leq 1.2\ ^{o}C/W$


7Z62543
750
500
250
0
I_{TSM} (A)
max. permissible non-repetitive peak on-state current for one square pulse
pulse duration
I_{TSM}
in the case of re-applied off-state voltage the thyristor may temporarily lose control
T_j = 125 °C prior to surge
10^{-3}
10^{-2}
10^{-1}
1
10
pulse duration (s)


SINE-WAVE OPERATION
7Z62542
1000
750
500
250
0
$I_{T(RMS)}$ (A)
the device may temporarily lose control following the surge
I_{TSM}
T_j = 125 °C prior to surge
10^{-3}
10^{-2}
10^{-1}
1
duration (s)
10



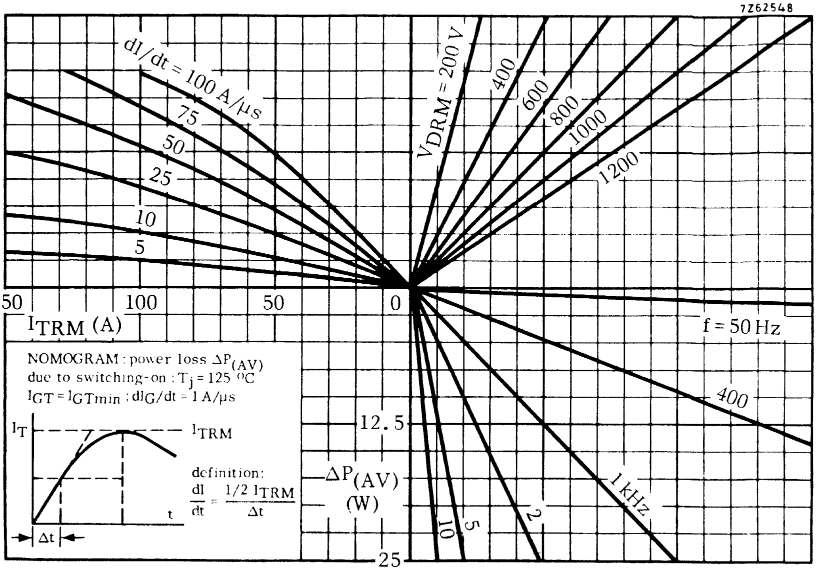


I = minimum gate voltage that will trigger all devices at T_j = ⟶

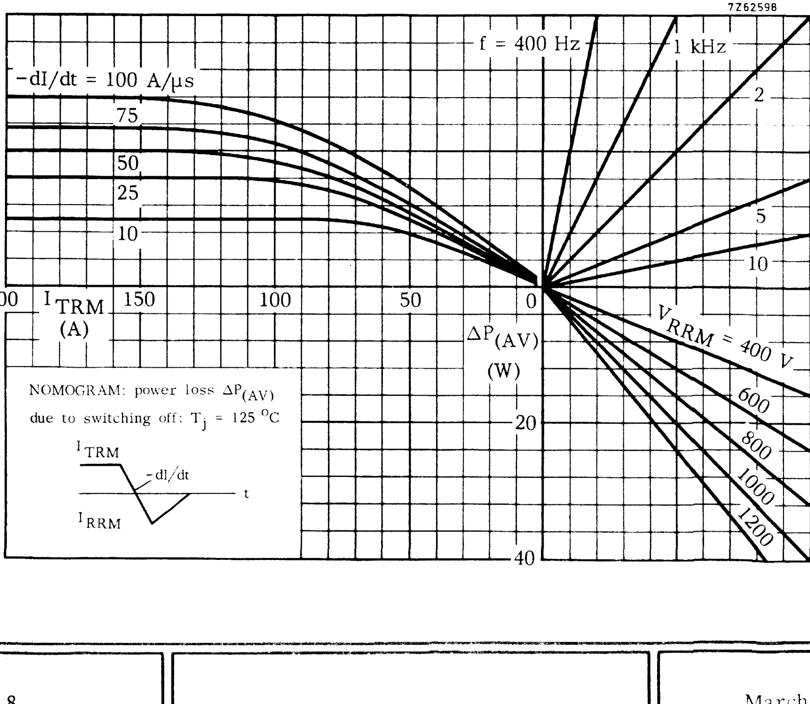
II = minimum gate current that will trigger all devices at T_j = ⟶

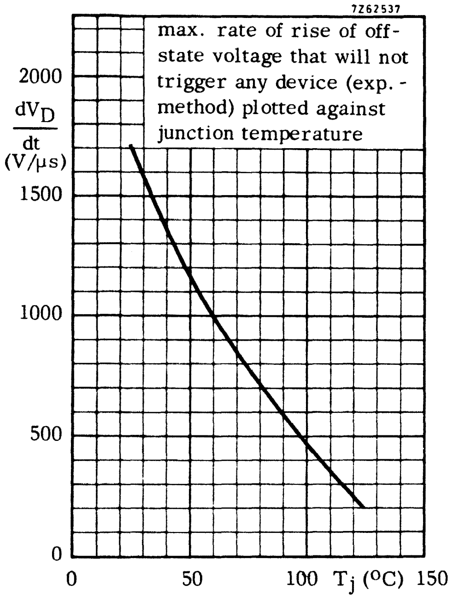
III = maximum gate voltage that will not trigger any device at T_j = 125 °C

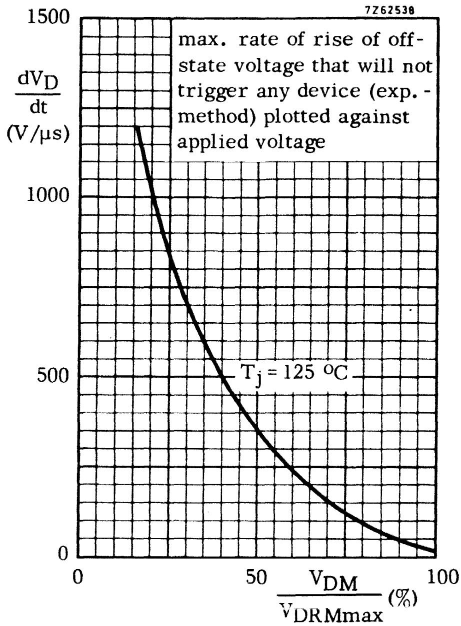
7Z62548

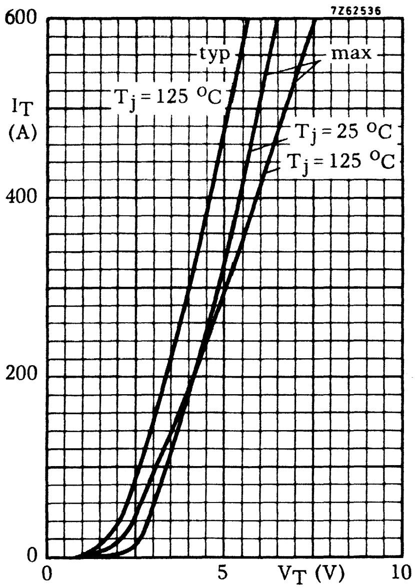


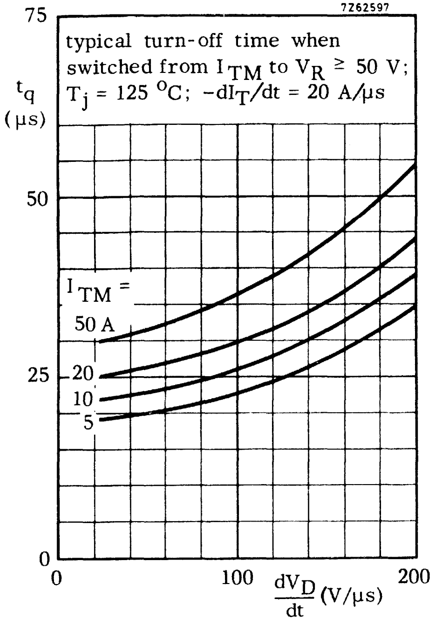
7Z62598

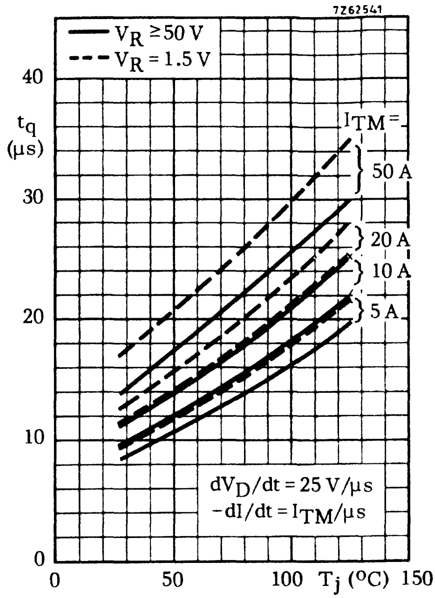


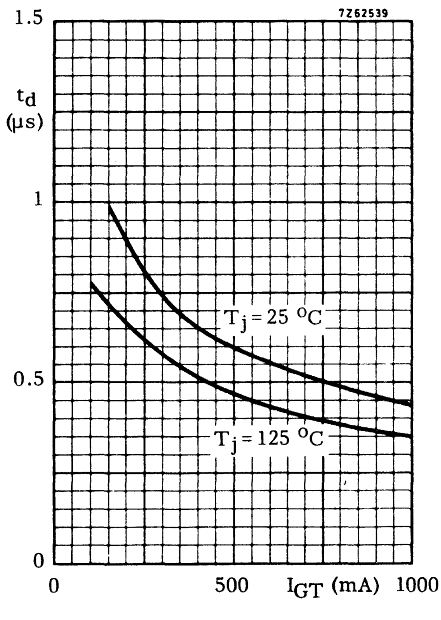

7Z62537
max. rate of rise of off-state voltage that will not trigger any device (exp.-method) plotted against junction temperature
2000
dVD/dt (V/μs)
1500
1000
500
0
0
50
100
Tj (°C)
150

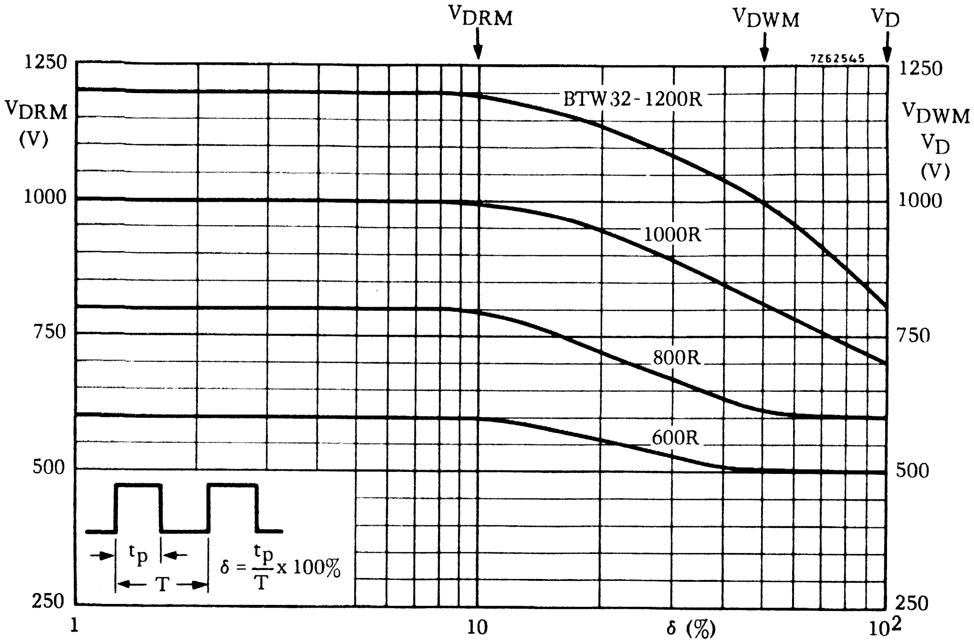

7Z62538
1500
dVD/dt (V/μs)
1000
500
0
max. rate of rise of off-state voltage that will not trigger any device (exp.-method) plotted against applied voltage
Tj = 125 °C
0
50
100
VDM/VDRMmax (%)

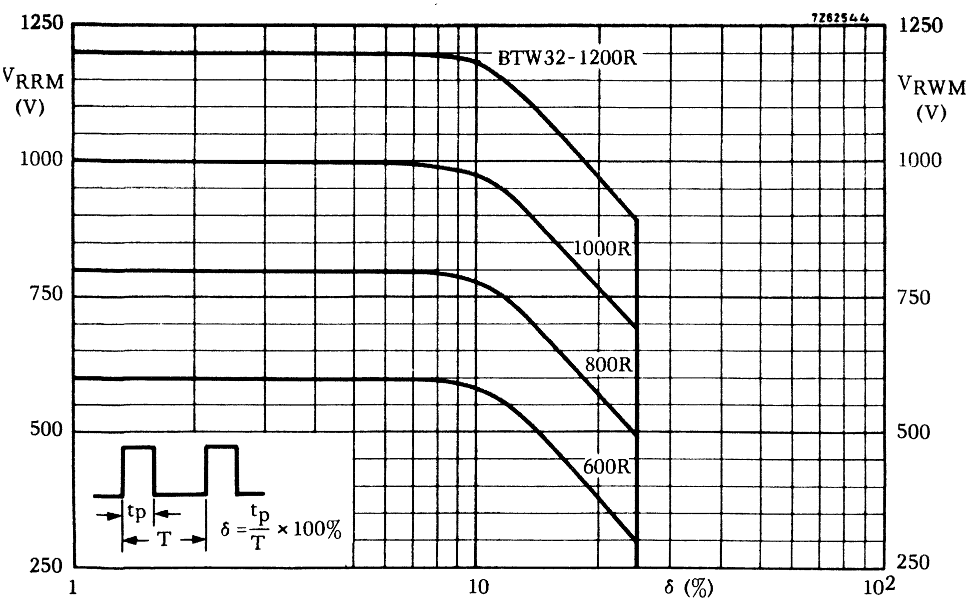

7Z62536
600
IT (A)
400
200
0
typ
max
Tj = 125 °C
Tj = 25 °C
Tj = 125 °C
0
5
VT (V)
10

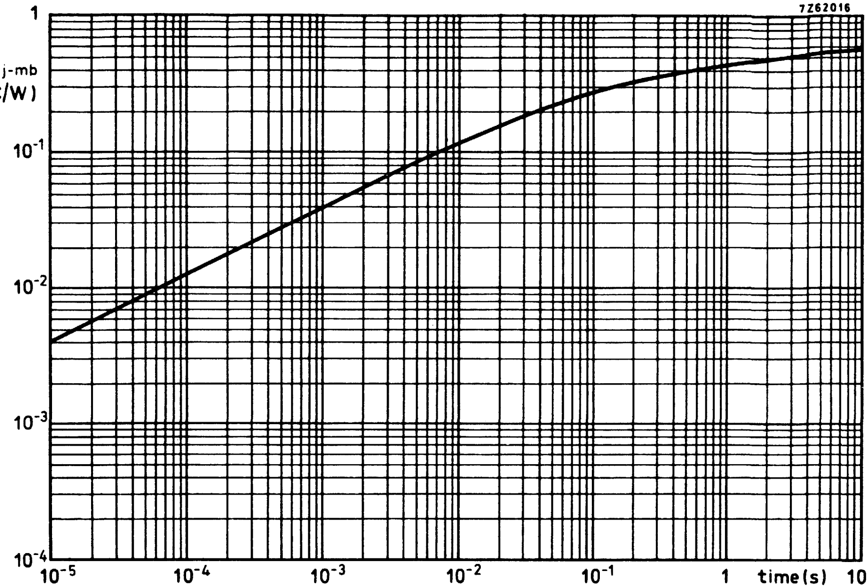

7Z62597
typical turn-off time when switched from I_{TM} to $V_R \geq 50$ V; $T_j = 125$ °C; $-dI_T/dt = 20$ A/μs
t_q (μs)
I_{TM} =
50 A
20
10
5
75
50
25
0
0
100
200
$\frac{dV_D}{dt}$ (V/μs)


7Z62541
$V_R \geq 50$ V
$V_R = 1.5$ V
t_q (μs)
I_{TM} =
50 A
20 A
10 A
5 A
$dV_D/dt = 25$ V/μs
$-dI/dt = I_{TM}$/μs
40
30
20
10
0
0
50
100
T_j (°C)
150


7Z62539
t_d (μs)
$T_j = 25$ °C
$T_j = 125$ °C
1.5
1
0.5
0
0
500
I_{GT} (mA)
1000


VDRM
VDWM
VD
7Z62545
1250
VDRM
(V)
1000
750
500
250
1250
VDWM
VD
(V)
1000
750
500
250
BTW32-1200R
1000R
800R
600R
tp
T
δ = tp/T x 100%
1
10
δ (%)
10^2


7Z62544
1250
VRRM
(V)
1000
750
500
250
1250
VRWM
(V)
1000
750
500
250
BTW32-1200R
1000R
800R
600R
tp
T
δ = tp/T × 100%
1
10
δ (%)
10^2


7Z62016
1
$Z_{th\ j\text{-}mb}$
(°C/W)
10^{-1}
10^{-2}
10^{-3}
10^{-4}
10^{-5}
10^{-4}
10^{-3}
10^{-2}
10^{-1}
1
time(s)
10

65A FAST TURN-OFF THYRISTORS

The BTW33series-RM is a range of fast turn-off thyristors intended for use in inverter applications up to frequencies of 15 kHz at crest working voltages up to 1000 V.
The series consists of reverse polarity types (anode to stud) identified by a suffix R: BTW33-600RM to 1200RM.

QUICK REFERENCE DATA

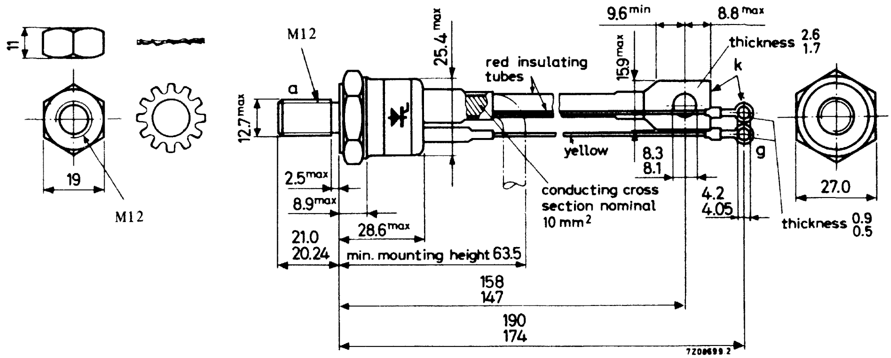
		BTW33-600RM	800RM	1000RM	1200RM	
Repetitive peak voltages: $V_{DRM} = V_{RRM}$	max.	600	800	1000	1200	V
Crest working off-state voltage V_{DWM}	max.	500	600	800	1000	V
Forward breakover voltage $V_{(BO)}$	>	600	800	1000	1200	V

Average on-state current (square wave; δ = 0.5) up to T_{mb} = 70 °C	$I_{T(AV)}$	max.	80	A
Average on-state current (square wave; δ = 0.5) at T_{mb} = 85 °C	$I_{T(AV)}$	max.	65	A
R.M.S. on-state current	$I_{T(RMS)}$	max.	110	A
Non-repetitive peak on-state current; single square pulse; t = 5 ms; T_j = 125 °C prior to surge	I_{TSM}	max.	1500	A
Junction temperature	T_j	max.	125	°C
Rate of rise of on-state current after triggering	$\frac{dI_T}{dt}$	max.	100	A/µs
Rate of rise of off-state voltage that will not trigger any device	$\frac{dV_D}{dt}$	<	200	V/µs
On request	$\frac{dV_D}{dt}$	up to	1000	V/µs
Circuit commutated turn-off time at T_j = 125 °C	t_q	<	25	µs

MECHANICAL DATA See page 2

MECHANICAL DATA

Dimensions in mm



Net weight : 108 g

Diameter of clearance hole : max. 13,0 mm

Torque on nut : min. 90 kg cm (9 Nm)
max. 175 kg cm (17,5 Nm)

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

Anode to cathode		BTW33-600RM	800RM	1000RM	1200RM	
Voltages [1]						
Non-repetitive peak voltages (t = 10 ms) V_{DSM} [2] = V_{RSM}	max.	600	800	1000	1200	V
Repetitive peak voltages ($\delta \leq 0.1$) $V_{DRM} = V_{RRM}$	max.	600	800	1000	1200	V
Crest working off-state voltage (square wave; $\delta = 0.5$) V_{DWM}	max.	500	600	800	1000	V
Continuous off-state voltage V_D	max.	500	600	700	800	V

1) To ensure thermal stability: $R_{th\ j-a} < 1.5\ ^{o}C/W$ (d.c. blocking) or $< 3\ ^{o}C/W$ (square wave; $\delta = 0.5$).
For smaller heatsinks $T_{j\ max}$ should be derated. For a.c. see page 5.

2) Higher off-state voltages may be applied without damage, but at voltages higher than the minimum forward breakover voltage (p. 4) the thyristor may switch into the on-state.
The rate of rise of on-state current should not exceed 20 A/µs.

RATINGS (continued)

Currents

Average on-state current, assuming zero switching losses (averaged over any 20 ms period)				
square wave; $\delta = 0.5$ up to $T_{mb} = 70\ ^oC$	$I_{T(AV)}$	max.	80	A
square wave; $\delta = 0.5$ at $T_{mb} = 85\ ^oC$	$I_{T(AV)}$	max.	65	A
sinusoidal at $T_{mb} = 85\ ^oC$	$I_{T(AV)}$	max.	60	A
On-state current (d.c.)	I_T	max.	110	A
R.M.S. on-state current	$I_{T(RMS)}$	max.	110	A
Repetitive peak on-state current	I_{TRM}	max.	750	A
Non-repetitive peak on-state current				
(t = 10 ms; half sine-wave) $T_j = 125\ ^oC$ prior to surge	I_{TSM}	max.	1500	A
(t = 5 ms; square wave) $T_j = 25\ ^oC$ prior to surge	I_{TSM}	max.	1500	A
I^2t for fusing (t = 10 ms)	I^2t	max.	11250	A^2s
Rate of rise of on-state current after triggering with $I_G = I_{GTmin}$ to $I_T = 200$ A $dI_G/dt = 1$ A/µs	$\frac{dI_T}{dt}$	max.	100	A/µs
Rate of rise of on-state current after breakover	$\frac{dI_T}{dt}$	max.	20	A/µs

Gate to cathode

Voltage

Reverse peak voltage	V_{RGM}	max.	10	V

Power dissipation

Average power dissipation (averaged over any 20 ms period)	$P_{G(AV)}$	max.	2	W
Peak power dissipation	P_{GM}	max.	10	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 impedance; t = 1 ms	$Z_{th\ j\text{-}mb}$	=	0.015	$^oC/W$

CHARACTERISTICS

Anode to cathode

			BTW33-600RM	800RM	1000RM	1200RM	
Voltages							
On-state voltage $I_T = 200$ A; $T_j = 25$ °C	V_T	<	3	3	3	3	V
Forward breakover voltage up to $T_j = 125$ °C	$V_{(BO)}$	>	600	800	1000	1200	V
Rate of rise of off-state voltage that will not trigger any device; $T_j = 125$ °C	$\frac{dV_D}{dt}$	<	200	200	200	200	V/μs
On request	$\frac{dV_D}{dt}$	up to	1000	1000	1000	1000	V/μs
Currents							
Peak off-state current $V_{DM} = V_{DWM\,max}$; $T_j = 125$ °C	I_{DM}	<	30	22	18	15	mA
Holding current; $T_j = 25$ °C	I_H	<				200	mA
Latching current; $T_j = 25$ °C	I_L	<				400	mA

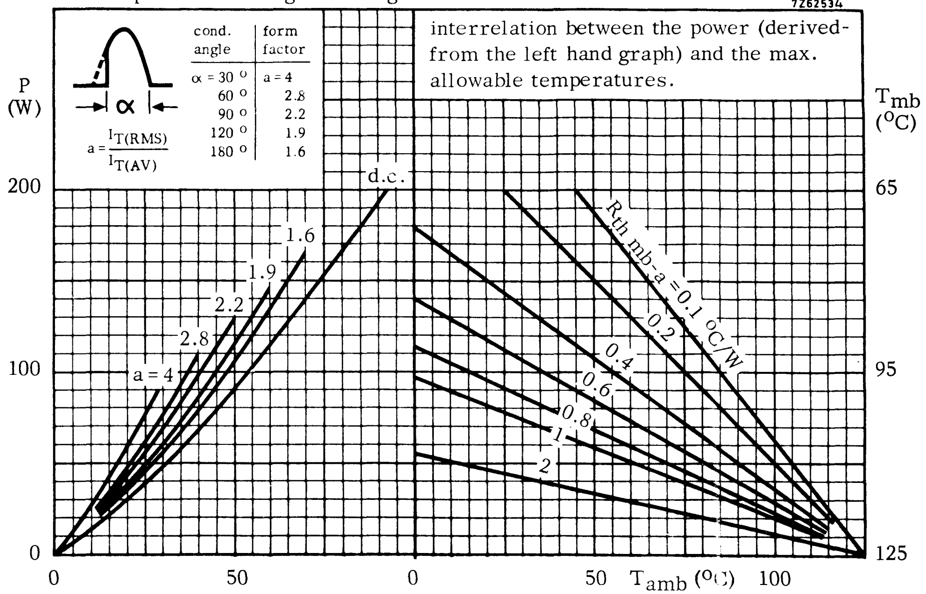
Gate to cathode

Voltages				
Voltage that will trigger all devices $V_D = 6$ V; $T_j = 25$ °C	V_{GT}	>	2.5	V
Voltage that will not trigger any device $V_D = V_{DRM\,max}$; $T_j = 125$ °C	V_{GD}	<	0.2	V
Current				
Current that will trigger all devices $V_D = 6$ V; $T_j = 25$ °C	I_{GT}	>	150	mA

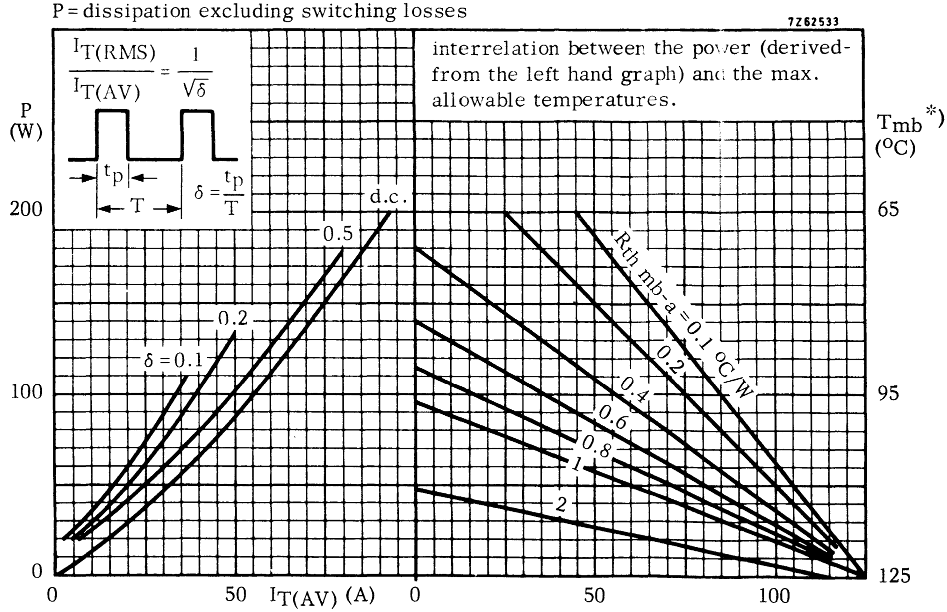
Switching characteristics

Turn-on time ($t_{on} = t_d + t_r$) when switched from $V_D = V_{DWM\,max}$ to $I_T = 200$ A	t_d	<	2	μs
$I_{GT} = 200$ mA; $dI_G/dt = 1$ A/μs; $T_j = 25$ °C	t_r	<	2	μs
Circuit-commutated turn-off time when switched from $I_T = 50$ A to $V_R \geq 50$ V with $-dI_T/dt = 50$ A/μs; $dV_D/dt = 25$ V/μs; $T_j = 125$ °C	t_q	<	25	μs
$T_j = 25$ °C	t_q	<	11	μs

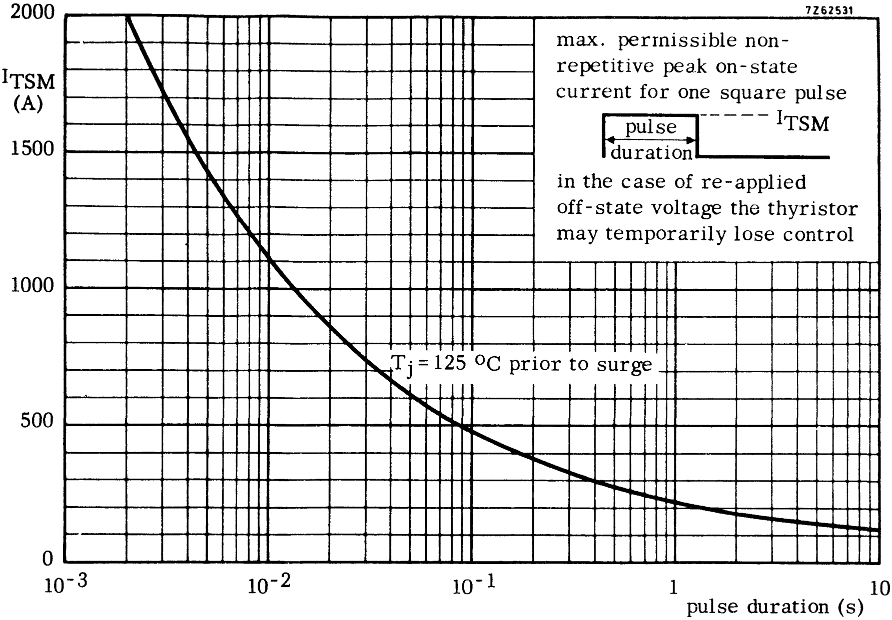
P = dissipation excluding switching losses

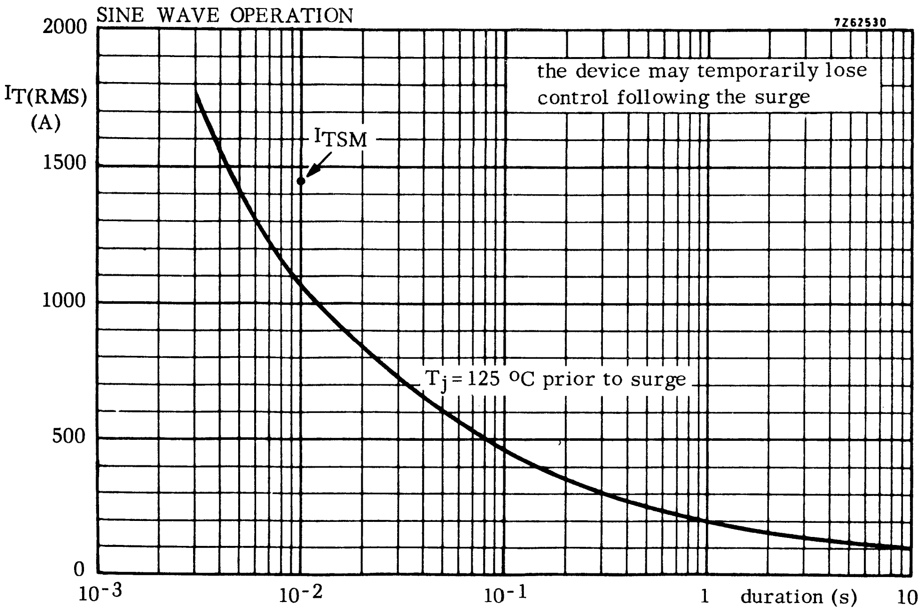


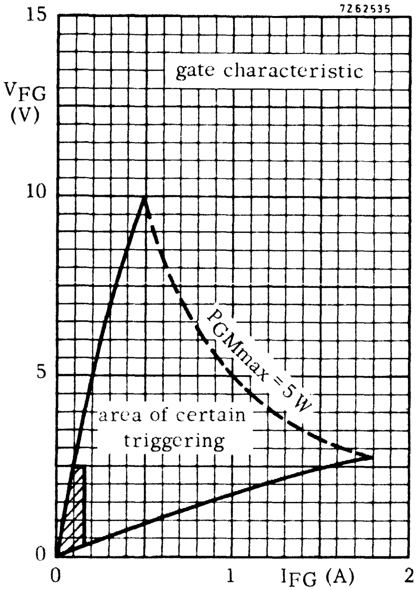
P = dissipation excluding switching losses

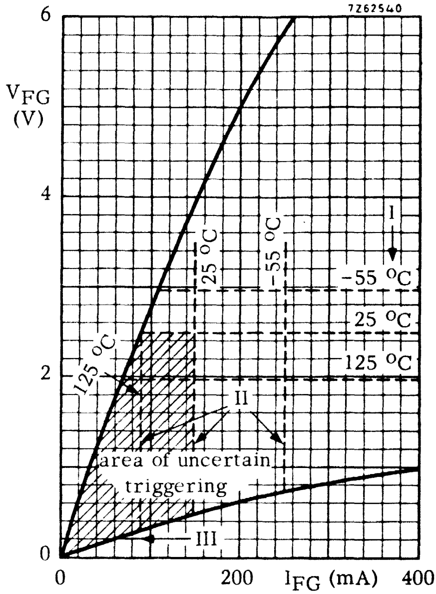


*) T_{mb}-scale is for comparison purposes only and is correct only for $R_{th\ mb-a} \leq 1.0$ °C/W


7Z62531
2000
ITSM (A)
1500
1000
500
0
10-3
10-2
10-1
1
10
pulse duration (s)
max. permissible non-repetitive peak on-state current for one square pulse
pulse duration
ITSM
in the case of re-applied off-state voltage the thyristor may temporarily lose control
Tj = 125 °C prior to surge


SINE WAVE OPERATION
7Z62530
2000
IT(RMS) (A)
1500
1000
500
0
10-3
10-2
10-1
1
duration (s)
10
the device may temporarily lose control following the surge
ITSM
Tj = 125 °C prior to surge

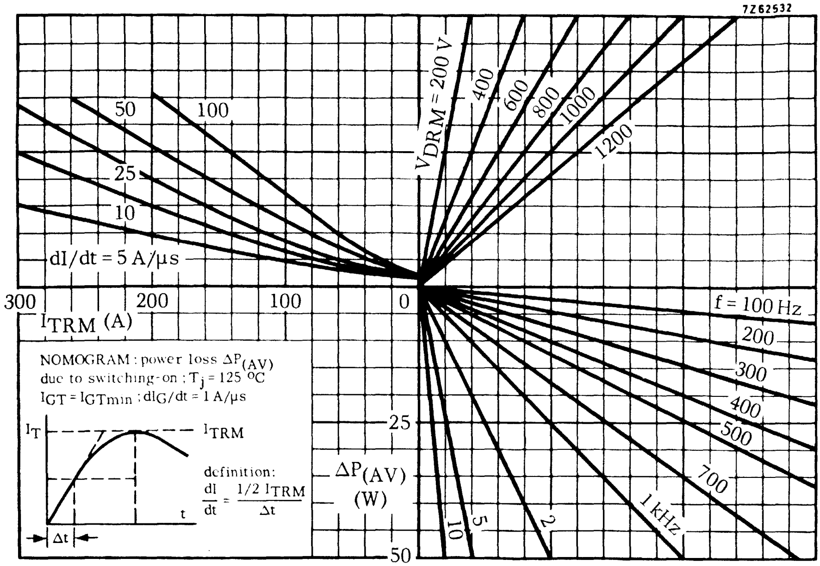


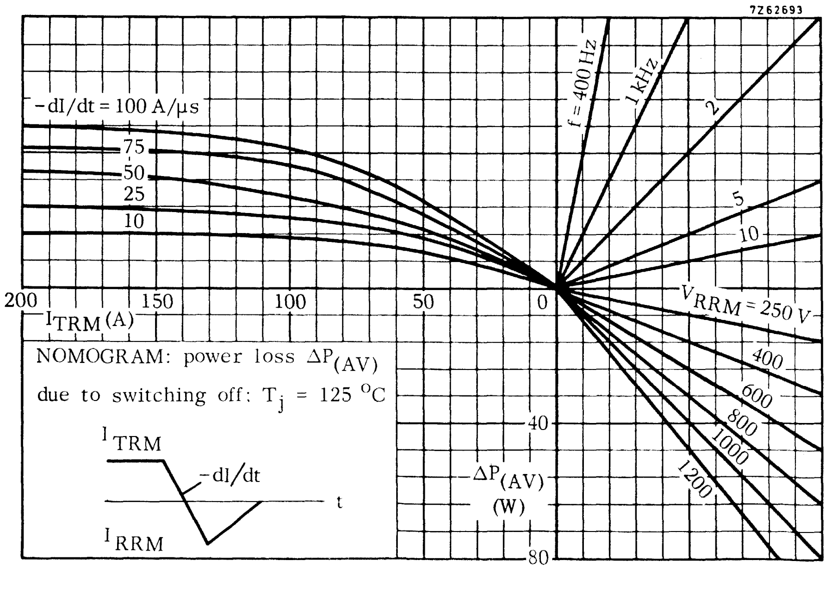


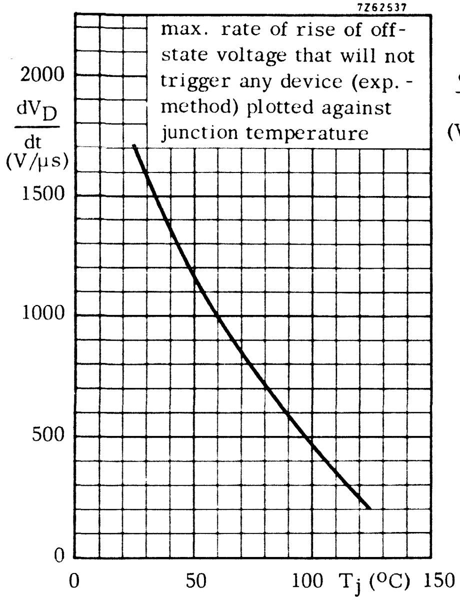
I = minimum gate voltage that will trigger all devices at T_j = ⟶

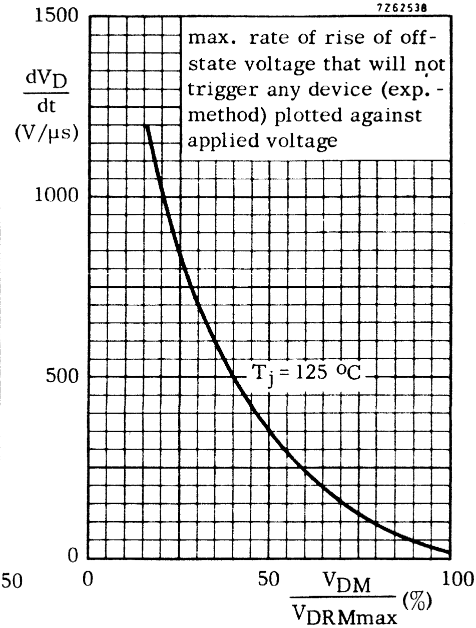
II = minimum gate current that will trigger all devices at T_j = ⟶

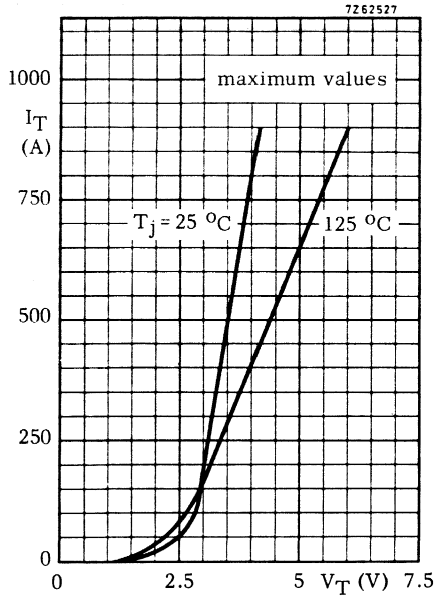
III = maximum gate voltage that will not trigger any device at T_j = 125 °C

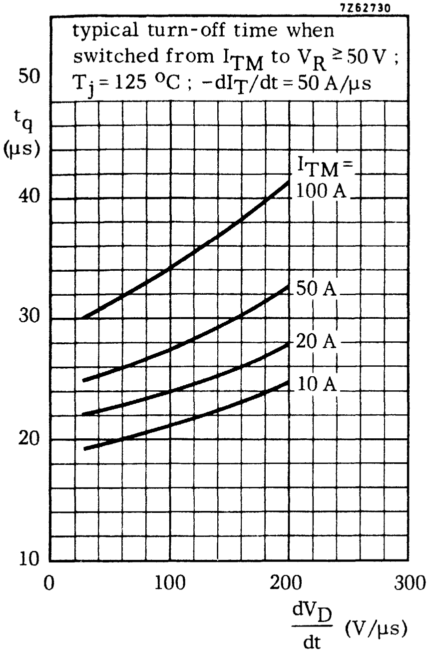

7Z62532
V_{DRM} = 200 V
400
600
800
1000
1200
50
100
25
10
dI/dt = 5 A/µs
300
200
100
0
I_{TRM} (A)
f = 100 Hz
200
300
400
500
700
1 kHz
2
5
10
25
50
$\Delta P_{(AV)}$
(W)
NOMOGRAM : power loss $\Delta P_{(AV)}$
due to switching-on ; T_j = 125 °C
$I_{GT} = I_{GTmin}$; dI_G/dt = 1 A/µs
I_T
I_{TRM}
definition:
$\frac{dI}{dt} = \frac{1/2\ I_{TRM}}{\Delta t}$
t
Δt

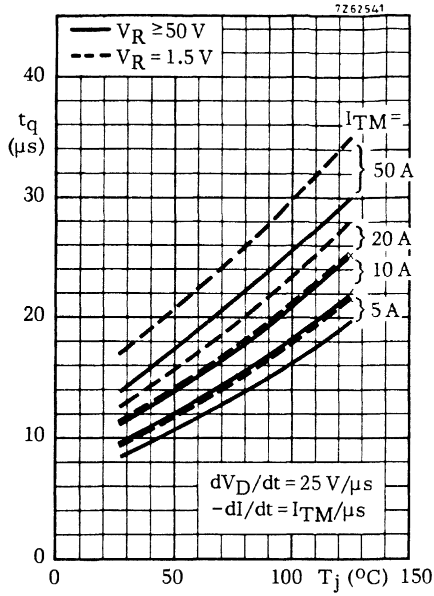

7Z62693
f = 400 Hz
1 kHz
2
5
10
−dI/dt = 100 A/µs
75
50
25
10
200
150
100
50
0
I_{TRM} (A)
V_{RRM} = 250 V
400
600
800
1000
1200
40
80
$\Delta P_{(AV)}$
(W)
NOMOGRAM: power loss $\Delta P_{(AV)}$
due to switching off: T_j = 125 °C
I_{TRM}
−dI/dt
t
I_{RRM}

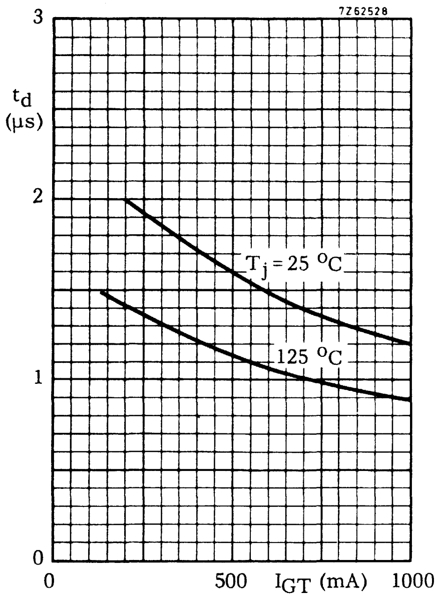

7Z62537
max. rate of rise of off-state voltage that will not trigger any device (exp.-method) plotted against junction temperature
2000
dVD/dt (V/μs)
1500
1000
500
0
0
50
100
Tj (°C)
150

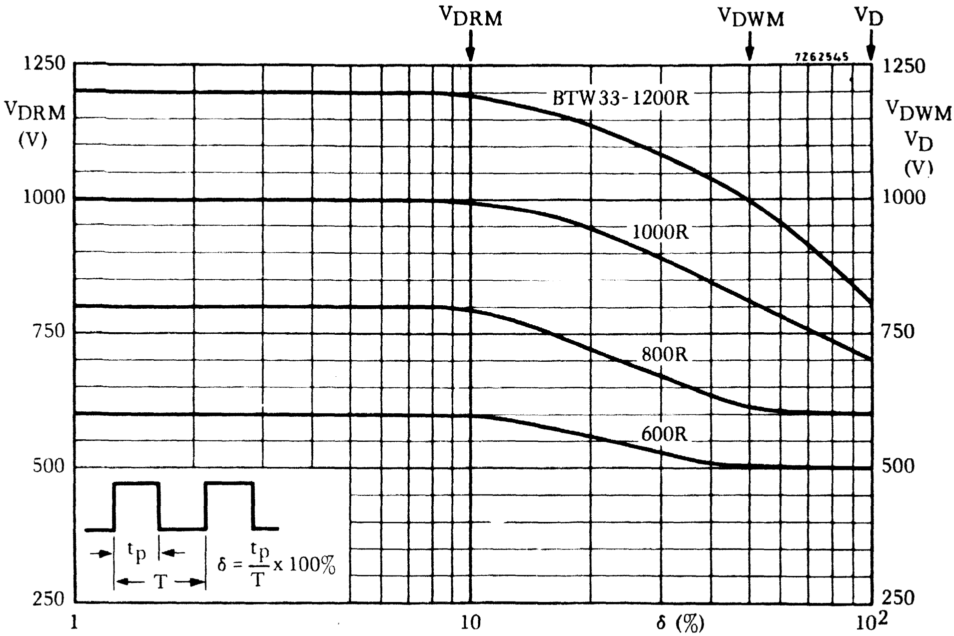

7Z62538
max. rate of rise of off-state voltage that will not trigger any device (exp.-method) plotted against applied voltage
1500
dVD/dt (V/μs)
1000
500
Tj = 125 °C
0
0
50
VDM/VDRMmax (%)
100

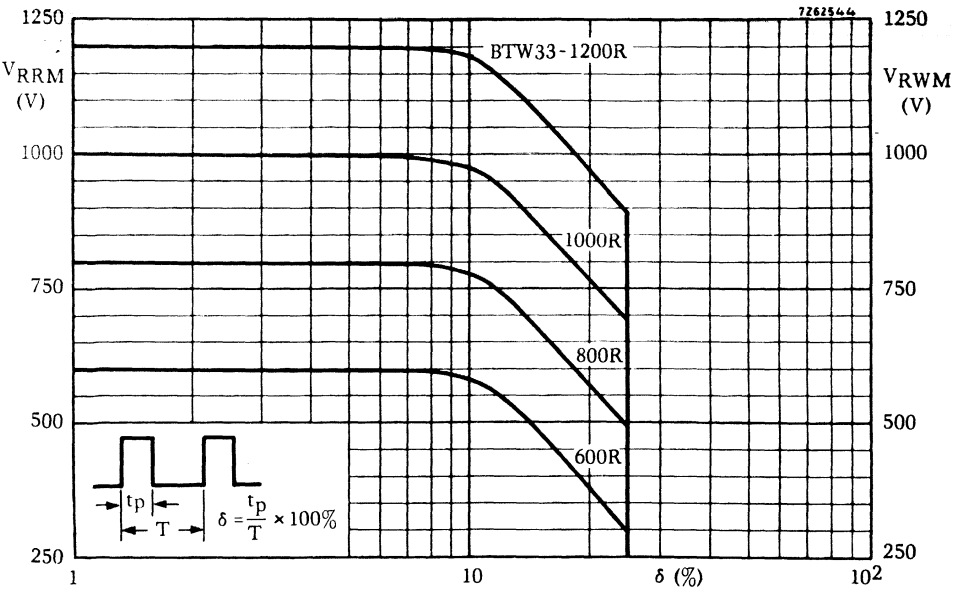

7Z62527
maximum values
1000
IT (A)
750
Tj = 25 °C
125 °C
500
250
0
0
2.5
5
VT (V)
7.5

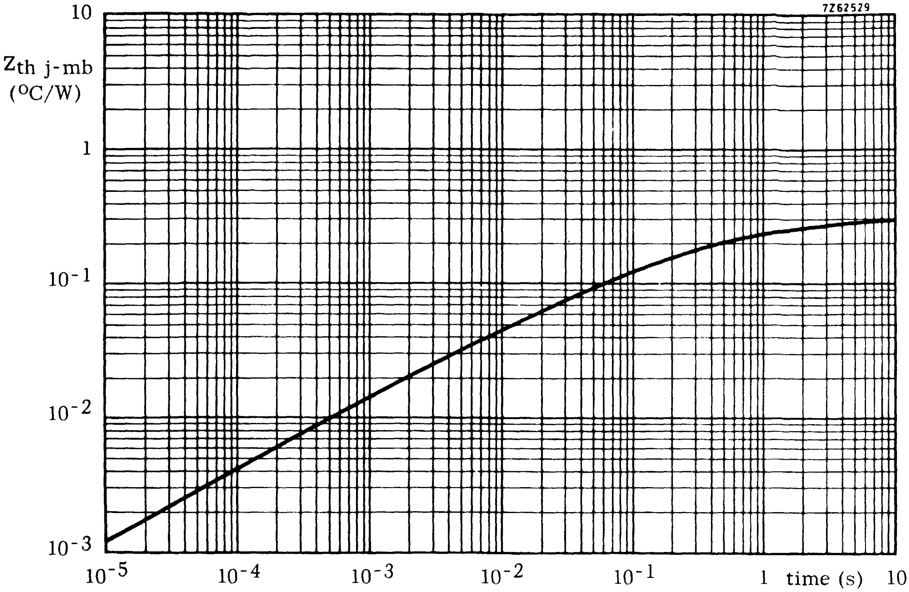

7Z62730
typical turn-off time when switched from I_{TM} to $V_R \geq 50$ V ; $T_j = 125$ °C ; $-dI_T/dt = 50$ A/µs
t_q (µs)
I_{TM} = 100 A
50 A
20 A
10 A
50
40
30
20
10
0
100
200
300
$\frac{dV_D}{dt}$ (V/µs)


7Z62541
$V_R \geq 50$ V
$V_R = 1.5$ V
t_q (µs)
I_{TM} =
50 A
20 A
10 A
5 A
$dV_D/dt = 25$ V/µs
$-dI/dt = I_{TM}$/µs
40
30
20
10
0
50
100
150
T_j (°C)


7Z62528
t_d (µs)
$T_j = 25$ °C
125 °C
3
2
1
0
500
1000
I_{GT} (mA)


V_DRM
V_DWM
V_D
7Z62545
1250
1000
750
500
250
V_DRM (V)
V_DWM V_D (V)
BTW33-1200R
1000R
800R
600R
tp
T
δ = tp/T x 100%
1
10
δ (%)
10^2


7Z62544
1250
1000
750
500
250
V_RRM (V)
V_RWM (V)
BTW33-1200R
1000R
800R
600R
tp
T
δ = tp/T × 100%
1
10
δ (%)
10^2


7Z62529
10
Zth j-mb
(°C/W)
1
10⁻¹
10⁻²
10⁻³
10⁻⁵
10⁻⁴
10⁻³
10⁻²
10⁻¹
1
time (s)
10

TRIACS

The BTW34series-M is a range of triacs intended for industrial a.c. power control applications such as furnace control, static switching, and regenerative motor control systems at currents up to 55 A, particularly on 3-phase mains.

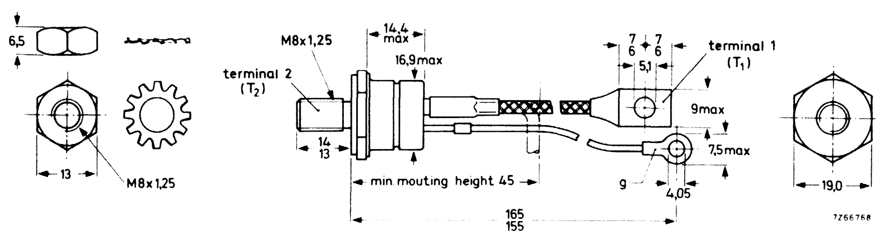
QUICK REFERENCE DATA

		BTW34-600M	800M	1000M	1200M	1400M	1600M	
Crest working off-state voltage V_{DWM}	max.	600	800	1000	1200	1200	1200	V
Repetitive peak off-state voltage V_{DRM}	max.	600	800	1000	1200	1400	1600	V
Breakover voltage $V_{(BO)}$	>	700	900	1100	1300	1400	1600	V

R.M.S. on-state current up to T_{mb} = 75 °C	$I_{T(RMS)}$	max.	55	A
at T_{mb} = 85 °C	$I_{T(RMS)}$	max.	45	A
Non-repetitive peak on-state current t = 10 ms; T_j = 125 °C prior to surge	I_{TSM}	max.	400	A
Junction temperature	T_j	max.	125	°C
Rate of rise of on-state current after triggering	$\frac{dI_T}{dt}$	max.	50	A/µs
Rate of rise of off-state voltage that will not trigger any device	$\frac{dV_D}{dt}$	<	200	V/µs
Rate of rise of commutating voltage that will not trigger any device	$\frac{dV_D}{dt}$	<	30	V/µs

MECHANICAL DATA

Dimensions in mm



Torque on nut: min. 4 Nm
(40 kg cm)
max. 6 Nm
(60 kg cm)

Net weight: 46 g
Diameter of clearance hole: 8, 5 mm

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

Voltages (in either direction) [1]		BTW34-600M	800M	1000M	1200M	1400M	1600M	
Crest working off-state voltage	V_{DWM}	max. 600	800	1000	1200	1200	1200	V
Repetitive peak off-state voltage ($\delta \leq 0,01$)	V_{DRM}	max. 600	800	1000	1200	1400	1600	V
Non-repetitive peak off-state voltage ($t \leq 10$ ms)	V_{DSM}	max. 700	900	1100	1300	1400	1600	V

Currents (in either direction)

Average on-state current for half-cycle operation (averaged over any 20 ms period) at $T_{mb} = 85\ ^oC$	$I_{T(AV)}$	max.	21	A
R.M.S. on-state current (conduction angle 360 °) up to $T_{mb} = 75\ ^oC$	$I_{T(RMS)}$	max.	55	A
at $T_{mb} = 85\ ^oC$	$I_{T(RMS)}$	max.	45	A
Repetitive peak on-state current	I_{TRM}	max.	300	A
Non-repetitive peak on-state current $T_j = 125\ ^oC$ prior to surge; t = 10 ms; half sine-wave	I_{TSM}	max.	400	A
t = 20 ms; full sine-wave	I_{TSM}	max.	400	A
I^2t for fusing (t = 10 ms)	I^2t	max.	800	A^2s
Rate of rise of on-state current after triggering with $I_G = 1$ A to $I_T = 100$ A; $dI_G/dt = 1$ A/µs	$\frac{dI_T}{dt}$	max.	50	A/µs
after breakover to $I_T = 100$ A	$\frac{dI_T}{dt}$	max.	20	A/µs

Gate to terminal 1

Power dissipation

Average power dissipation (averaged over any 20 ms period)	$P_{G(AV)}$	max.	2	W
Peak power dissipation	P_{GM}	max.	10	W

Temperatures

Storage temperature	T_{stg}		−55 to +125	°C
Junction temperature	T_j	max.	125	°C

1) To ensure thermal stability: $R_{th\ j\text{-}a} < 2\ ^oC/W$ (full cycle or half-cycle operation). For smaller heatsinks $T_{j\ max}$ should be derated. (see page 4)
2) Higher off-state voltages may be applied without damage, but at voltages higher than the minimum forward breakover voltage (see page 3) the triac may switch into the on-state. The rate of rise of on-state current should not exceed 20 A/µs.

THERMAL RESISTANCE

From junction to mounting base full cycle operation	$R_{th\ j\text{-}mb}$	=	0,6	°C/W
half cycle operation	$R_{th\ j\text{-}mb}$	=	1,2	°C/W
From mounting base to heatsink with heatsink compound	$R_{th\ mb\text{-}h}$	=	0,2	°C/W
Transient thermal impedance; t = 1 ms	$Z_{th\ j\text{-}mb}$	=	0,08	°C/W

CHARACTERISTICS (Polarities, pos. or neg., are identified with respect to T_1)

Voltages (in either direction)		BTW34-600M	800M	1000M	1200M	1400M	1600M	
Breakover voltage up to T_j = 125 °C	$V_{(BO)}$ >	700	900	1100	1300	1400	1600	V

On-state voltage I_T = 100 A; T_j = 25 °C	V_T	<	2,1	V
Rate of rise of off-state voltage that will not trigger any device; T_j = 125 °C	$\frac{dV_D}{dt}$	<	200	V/μs
Rate of rise of commutating voltage that will not trigger any device −dI/dt = 50 A/ms; T_j = 125 °C	$\frac{dV_D}{dt}$	<	30	V/μs

Currents (in either direction)		BTW34-600M	800M	1000M	1200M	1400M	1600M	
Peak off-state current $V_{DM} = V_{DWMmax}$; T_j = 125 °C	I_{DM} <	19	15	12	10	10	10	mA

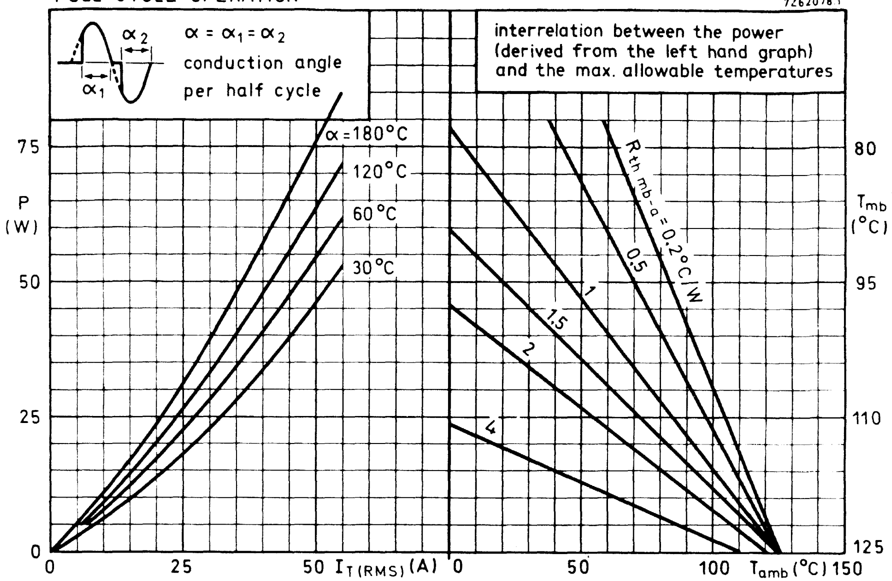
			T_2 pos	T_2 neg.	
Latching current T_j = 25 °C; G pos.	I_L	<	250	-	mA
G neg.	I_L	<	500	250	mA
Holding current T_j = 25 °C; G pos. or neg.	I_H	<	200	200	mA
Gate to terminal 1					
Voltage and Current that will trigger all devices V_D = 12 V; T_j = 25 °C					
G pos.	V_{GT}	>	2,5	-	V
	I_{GT}	>	200	-	mA
G neg.	$-V_{GT}$	>	2,5	2,5	V
	$-I_{GT}$	>	200	200	mA
Voltage that will not trigger any device $V_D = V_{DRMmax}$; T_j = 125 °C G pos. or G neg.	V_{GD}	<	0,2	0,2	V

Switching characteristics

Turn-on time ($t_{on} = t_d + t_r$) when switched from

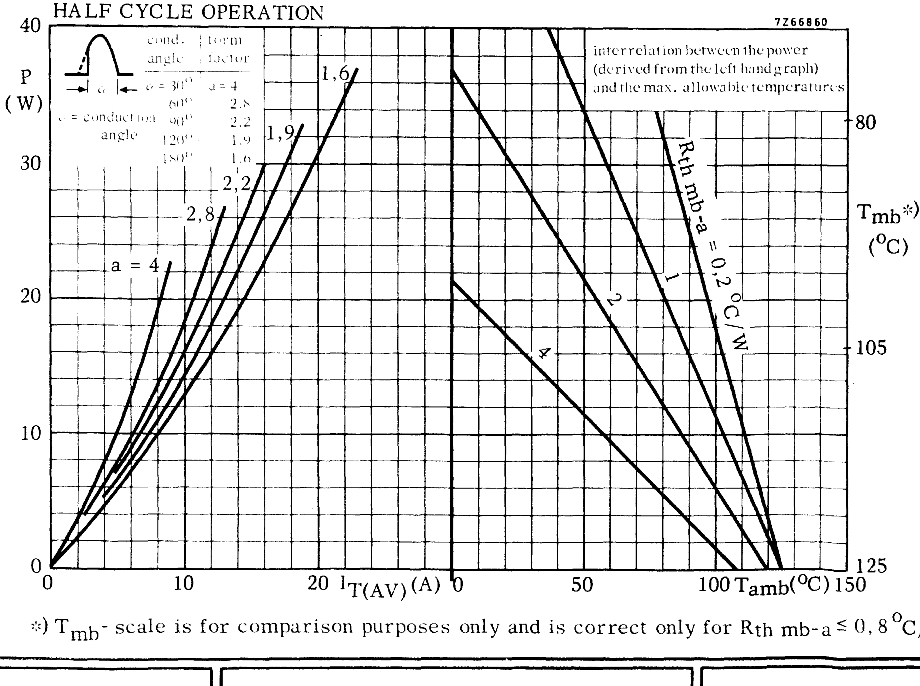
$V_D = V_{DWM}$ to I_T = 50 A	t_{on}	<	3,5	μs
I_{GT} = 1 A; dI_G/dt = 1 A/μs; T_j = 25 °C	t_r	typ.	0,5	μs

FULL CYCLE OPERATION

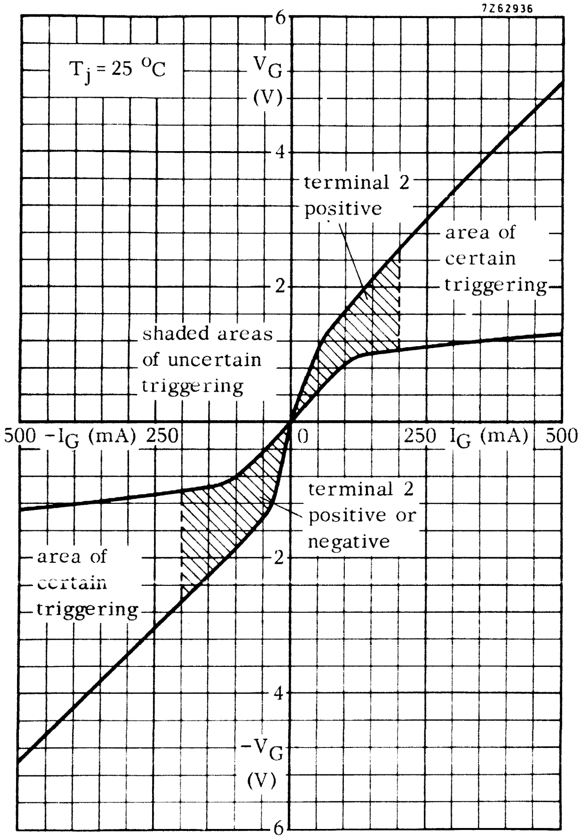


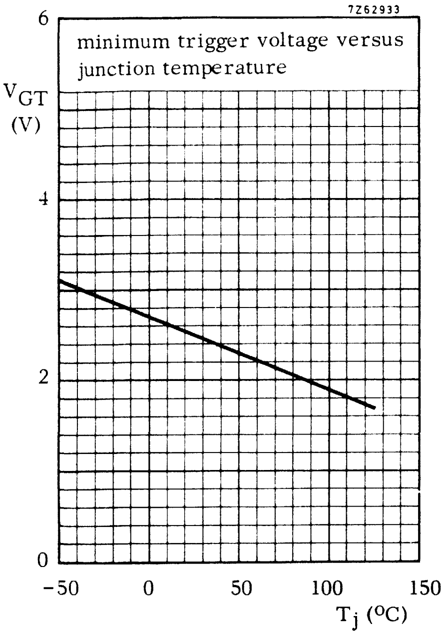
T_{mb}-scale is for comparison purposes only and is correct only for $R_{th\ mb-a} \leq 1{,}4\,°C/W$

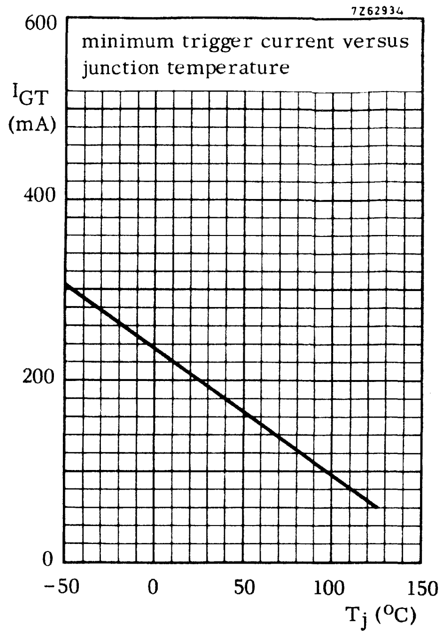
HALF CYCLE OPERATION

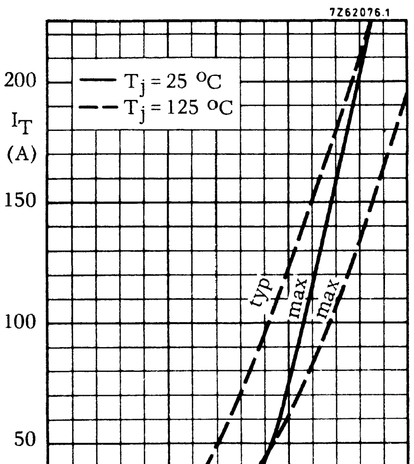


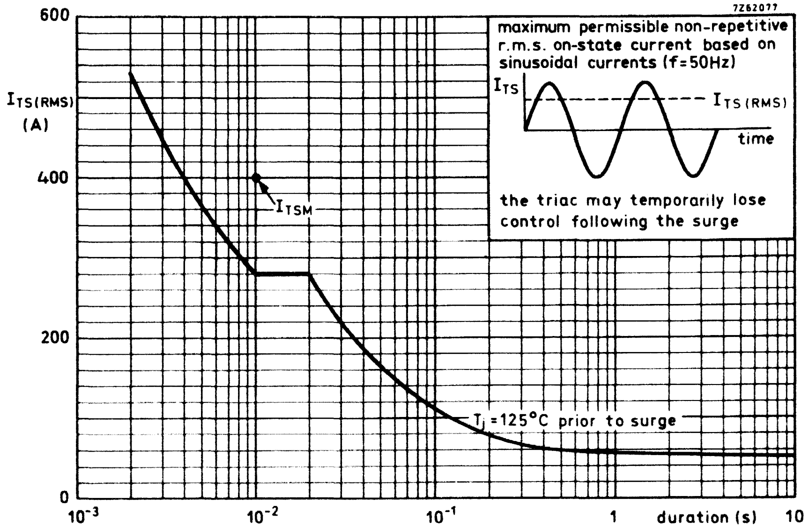
*) T_{mb}- scale is for comparison purposes only and is correct only for $R_{th\ mb-a} \leq 0{,}8\,°C/W$

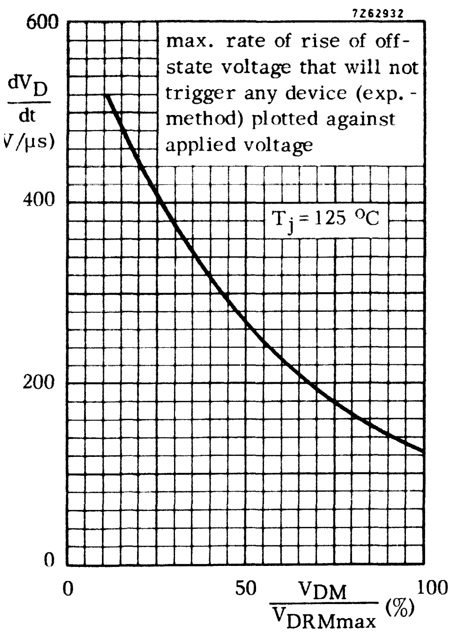

7Z62936
T_j = 25 °C
V_G
(V)
6
4
2
terminal 2
positive
area of
certain
triggering
shaded areas
of uncertain
triggering
500 $-I_G$ (mA) 250
0
250 I_G (mA) 500
terminal 2
positive or
negative
area of
certain
triggering
$-V_G$
(V)

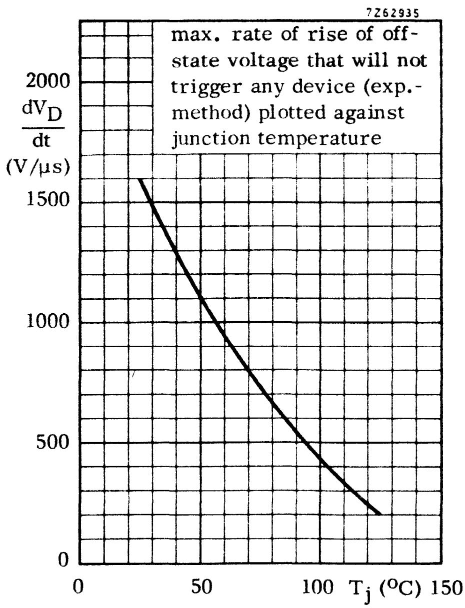

7Z62933
minimum trigger voltage versus junction temperature
V_{GT} (V)
6
4
2
0
-50
0
50
100
150
T_j (°C)

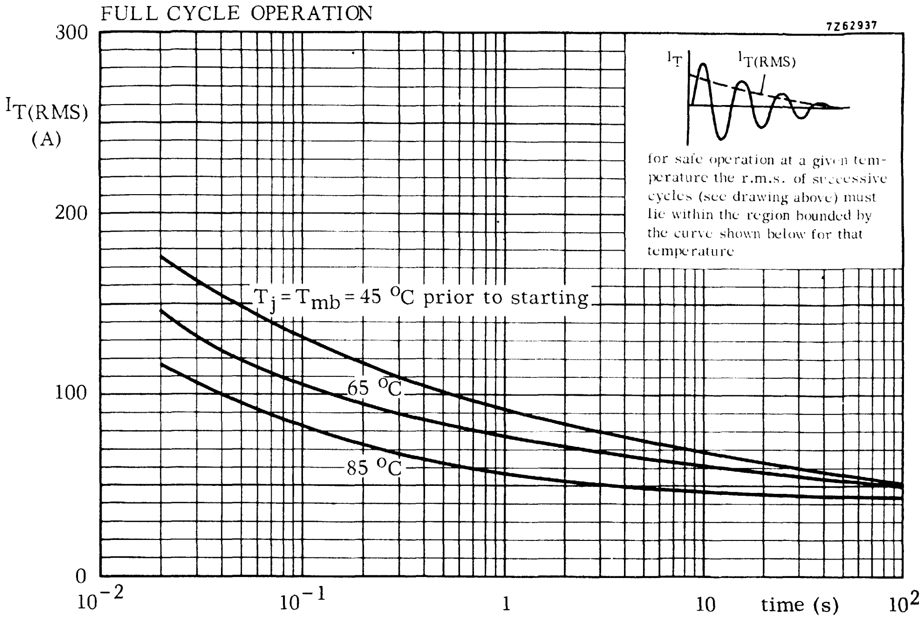

7Z62934
minimum trigger current versus junction temperature
I_{GT} (mA)
600
400
200
0
-50
0
50
100
150
T_j (°C)

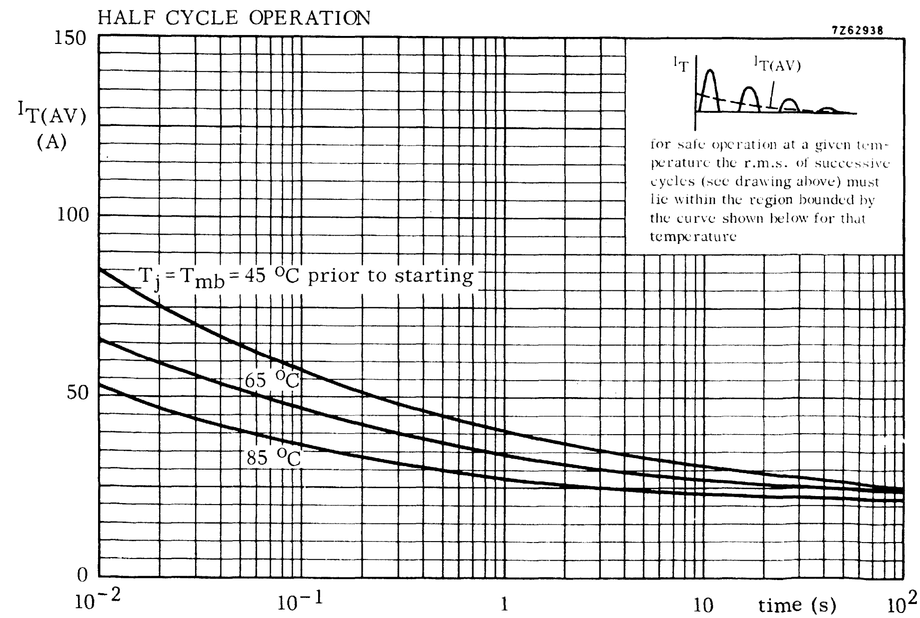

7Z62076.1
T_j = 25 °C
T_j = 125 °C
I_T (A)
200
150
100
50
0
typ
max
max
0
1
2
V_T (V)
3


7Z62077
600
400
200
0
$I_{TS(RMS)}$
(A)
maximum permissible non-repetitive r.m.s. on-state current based on sinusoidal currents (f=50Hz)
I_{TS}
$I_{TS(RMS)}$
time
the triac may temporarily lose control following the surge
I_{TSM}
T_j =125°C prior to surge
10^{-3}
10^{-2}
10^{-1}
1
duration (s)
10

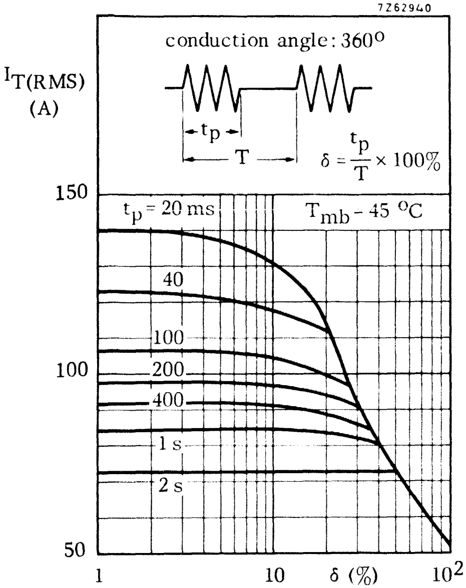

7Z62932
600
400
200
0
$\frac{dV_D}{dt}$
V/µs)
max. rate of rise of off-state voltage that will not trigger any device (exp.-method) plotted against applied voltage
T_j = 125 °C
0
50
100
$\frac{V_{DM}}{V_{DRMmax}}$ (%)

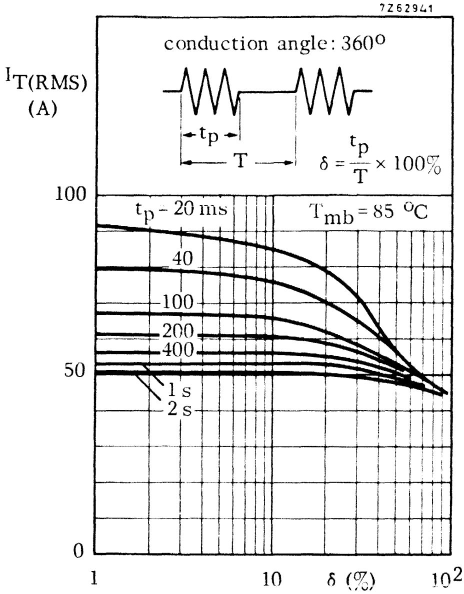

7Z62935
2000
1500
1000
500
0
$\frac{dV_D}{dt}$
(V/µs)
max. rate of rise of off-state voltage that will not trigger any device (exp.-method) plotted against junction temperature
0
50
100
T_j (°C)
150

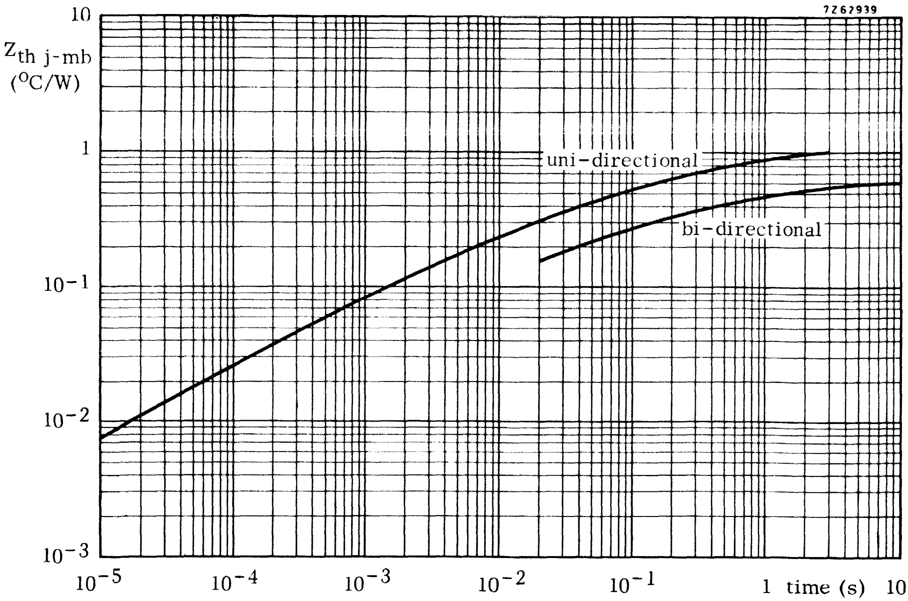

FULL CYCLE OPERATION
7Z62937
300
200
100
0
$I_{T(RMS)}$
(A)
I_T
$I_{T(RMS)}$
for safe operation at a given temperature the r.m.s. of successive cycles (see drawing above) must lie within the region bounded by the curve shown below for that temperature
$T_j = T_{mb} = 45\ ^oC$ prior to starting
65 ^oC
85 ^oC
10^{-2}
10^{-1}
1
10
time (s)
10^2


HALF CYCLE OPERATION
7Z62938
150
100
50
0
$I_{T(AV)}$
(A)
I_T
$I_{T(AV)}$
for safe operation at a given temperature the r.m.s. of successive cycles (see drawing above) must lie within the region bounded by the curve shown below for that temperature
$T_j = T_{mb} = 45\ ^oC$ prior to starting
65 ^oC
85 ^oC
10^{-2}
10^{-1}
1
10
time (s)
10^2

Intermittent overload capability of one triac in a single phase a.c. control circuit (e.g.).







14A AVALANCHE THYRISTORS

Silicon thyristors in metal envelopes, with avalanche properties. A version with guaranteed values of avalanche voltage and avalanche power can be supplied on request. BTW47series-M has metric thread, BTW47series-U UNF thread. Both series consist of reverse polarity types (anode to stud) identified by a suffix R: BTW47-600RM to 1600RM and BTW47-600RU to 1600RU.

QUICK REFERENCE DATA

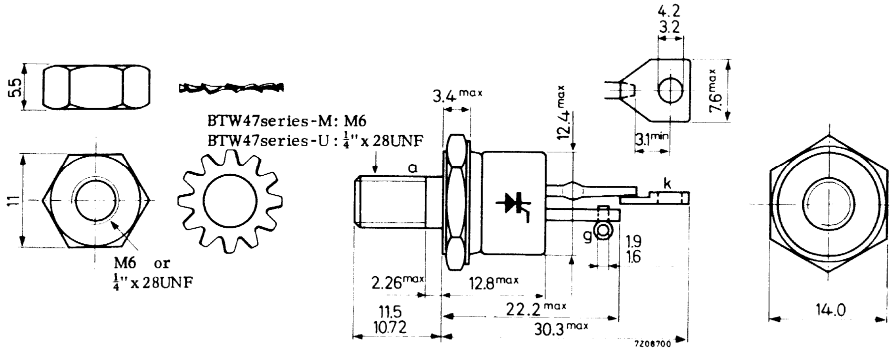
		BTW47-600RM BTW47-600RU	800RM 800RU	1000RM 1000RU	1200RM 1200RU	1400RM 1400RU	1600RM 1600RU	
Repetitive peak voltages $V_{DRM} = V_{RRM}$	max.	600	800	1000	1200	1400	1600	V
Crest working voltages $V_{DWM} = V_{RWM}$	max.	600	800	1000	1200	1200	1200	V
Forward breakover voltage $V_{(BO)}$	>	700	900	1100	1300	1400	1600	V

Average on-state current at T_{mb} = 85 °C	$I_{T(AV)}$	max.	14	A
R.M.S. on-state current	$I_{T(RMS)}$	max.	25	A
Non-repetitive peak on-state current t = 10 ms; T_j = 125 °C prior to surge	I_{TSM}	max.	220	A
Junction temperature	T_j	max.	125	°C
Rate of rise of on-state current after triggering	$\frac{dI_T}{dt}$	max.	200	A/µs
Rate of rise of off-state voltage that will not trigger any device	$\frac{dV_D}{dt}$	<	300	V/µs
On request	$\frac{dV_D}{dt}$	up to	1000	V/µs

MECHANICAL DATA see page 2

MECHANICAL DATA Dimensions in mm

Similar to TO-48



Net weight: 15 g
Diameter of clearance hole: max. 6.5 mm
Accessories supplied on request: 56264A

Torque on nut: min. 17 kg cm (1.7 Newton-metres)
max. 35 kg cm (3.5 Newton-metres)

All information applies to frequencies up to 400 Hz.

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

ANODE TO CATHODE Voltages [1]		BTW47-600RM BTW47-600RU	800RM 800RU	1000RM 1000RU	1200RM 1200RU	1400RM 1400RU	1600RM 1600RU	
Non-repetitive peak voltages ($t \leq 10$ ms) V_{DSM} [2] $= V_{RSM}$	max.	700	900	1100	1300	1400	1600	V
Repetitive peak voltages ($\delta \leq 0.01$) $V_{DRM} = V_{RRM}$	max.	600	800	1000	1200	1400	1600	V
Crest working voltages $V_{DWM} = V_{RWM}$	max.	600	800	1000	1200	1200	1200	V
Continuous voltages $V_D = V_R$	max.	600	800	1000	1200	1200	1200	V

[1] To ensure thermal stability: $R_{th\ j\text{-}a} < 1.5\,^{o}C/W$ (d.c. blocking) or $< 3\,^{o}C/W$ (a.c.) For smaller heatsinks $T_{j\ max}$ should be derated. For a.c. see page 6.

[2] Higher off-state voltages may be applied without damage, but at voltages higher than the minimum forward breakover voltage ($V_{(BO)}$) the thyristor may switch into the on-state. The rate of rise of on-state current should not exceed 100 A/μs.

RATINGS (continued)

Currents

Average on-state current (averaged over any 20 ms period) at T_{mb} = 85 °C	$I_{T(AV)}$	max.	14	A
On-state current (d.c.)	I_T	max.	25	A
R.M.S. on-state current	$I_{T(RMS)}$	max.	25	A
Repetitive peak on-state current	I_{TRM}	max.	150	A
Non-repetitive peak on-state current (t = 10 ms; half sine wave) T_j = 125 °C prior to surge	I_{TSM}	max.	220	A
I^2t for fusing (t = 10 ms)	I^2t	max.	240	A^2s
Rate of rise of on-state current after triggering with $I_G = I_{GT}$ to $I_T = 3 \times I_{T(AV)}$	$\frac{dI_T}{dt}$	max.	200	A/µs
Rate of rise of on-state current after breakover	$\frac{dI_T}{dt}$	max.	100	A/µs
Rate of change of cummutation current	see nomogram on page 10			

GATE TO CATHODE

Voltage

Reverse peak voltage	V_{RGM}	max.	10	V

Power dissipation

Average power dissipation (averaged over any 20 ms period)	$P_{G(AV)}$	max.	1	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	$^{o}C/W$
From mounting base to heatsink	$R_{th\ mb\text{-}h}$	=	0.2	$^{o}C/W$
Transient thermal impedance (t = 1 ms)	$Z_{th\ j\text{-}mb}$	=	0.06	$^{o}C/W$

CHARACTERISTICS

ANODE TO CATHODE			BTW47-600RM BTW47-600RU	800RM 800RU	1000RM 1000RU	1200RM 1200RU	1400RM 1400RU	1600RM 1600RU	
Voltages									
On-state voltage I_T = 50 A; T_j = 25 ^{o}C	V_T	<	3	3	3	3	3	3	V
Forward breakover voltage up to T_j = 125 ^{o}C	$V_{(BO)}$	>	700	900	1100	1300	1400	1600	V
Rate of rise of off-state voltage that will not trigger any device; T_j = 125 ^{o}C	$\frac{dV_D}{dt}$	<	300	300	300	300	300	300	V/μs
Currents									
Peak reverse current $V_{RM}=V_{RWMmax}$; T_j = 125^{o}C	I_{RM}	<	13	10	8	7	7	7	mA
Peak off-state current $V_{DM}=V_{DWMmax}$; T_j = 125^{o}C	I_{DM}	<	13	10	8	7	7	7	mA

Latching current; T_j = 25 ^{o}C	I_L	<	200	mA
Holding current; T_j = 25 ^{o}C	I_H	<	200	mA

GATE TO CATHODE

Voltages

Voltage that will trigger all devices V_D = 6 V; T_j = 25 ^{o}C	V_{GT}	>	3.5	V
Voltage that will not trigger any device $V_D = V_{DWMmax}$; T_j = 125 ^{o}C	V_{GD}	<	200	mV

Current

Current that will trigger all devices V_D = 6 V; T_j = 25 ^{o}C	I_{GT}	>	150	mA

CHARACTERISTICS (continued)

SWITCHING CHARACTERISITICS

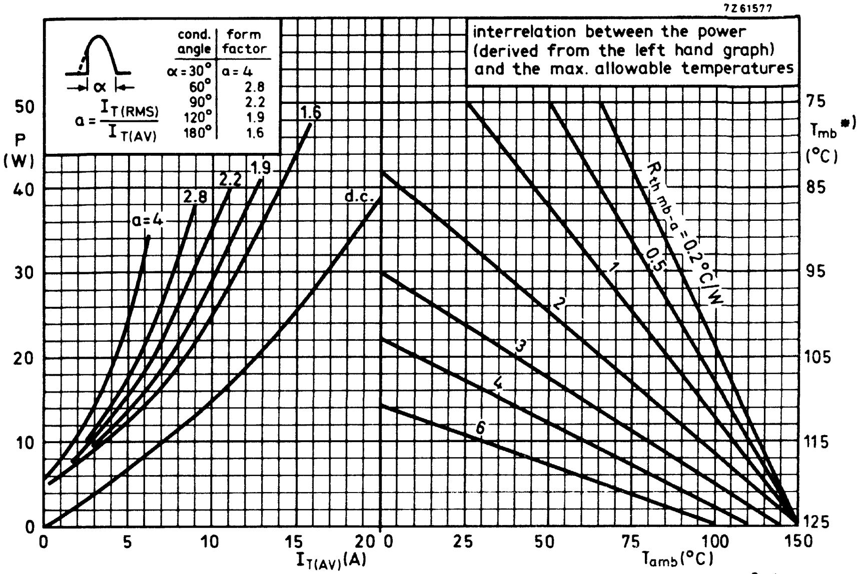
Turn-on time ($t_{on} = t_d + t_r$) when switched				
from $V_D = V_{DWMmax}$ to $I_T = 10$ A	t_{on}	typ.	2	µs
$I_{GT} = 150$ mA; $dI_G/dt = 1$ A/µs; $T_j = 25$ °C	t_r	typ.	1.2	µs
Circuit-commutated turn-off time when switched				
from $I_T = 10$ A to $V_R \geq 50$ V				
with $-dI_T/dt = 10$ A/µs; $dV_D/dt = 10$ V/µs				
$T_j = 125$ °C	t_q	typ.	75	µs
	t_q	<	250	µs
$T_j = 25$ °C	t_q	typ.	40	µs
	t_q	<	100	µs

OPERATING NOTES

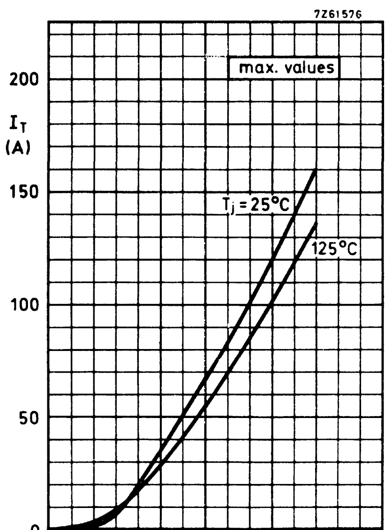
1. The gate and cathode connectors should not be bent; they should be soldered into the circuit so that there is no strain on them.

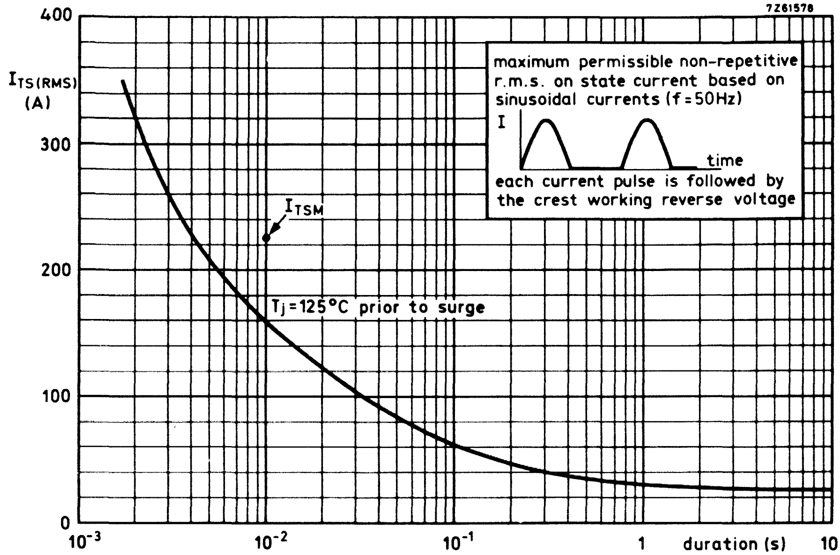
2. Switching losses in commutation

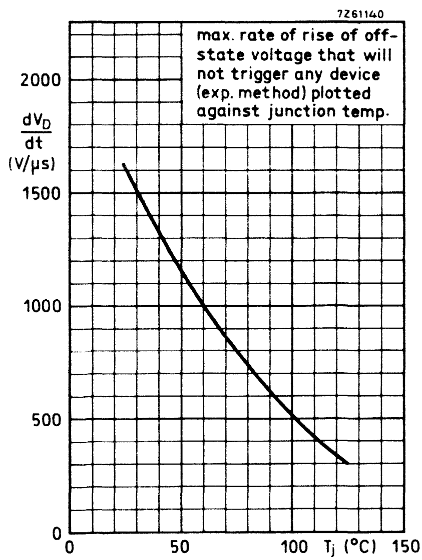
   For applications in which the thyristor is forced to switch from an on-state current I_{TRM} to a high reverse voltage at a high commutation rate ($-dI/dt$), consult the nomogram on page 10 to find the increase in total average power.
   This increase must be added to the losses derived from the curves on page 6.

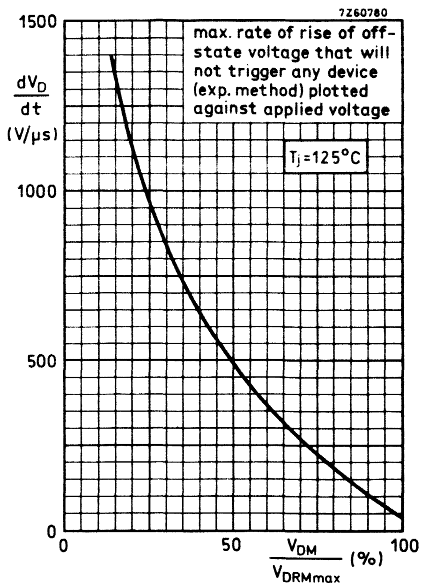


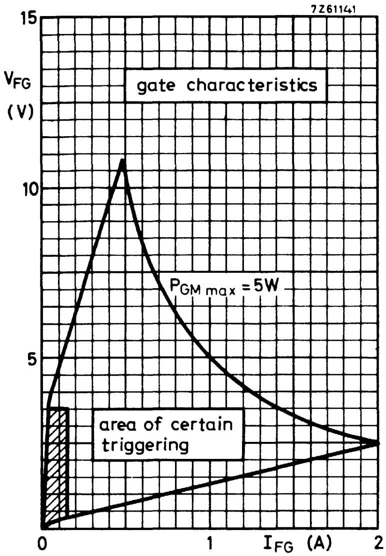
*) T_{mb} – scale is for comparison purposes only and is correct only for $R_{th\ mb-a} \leq 2$ °C/W

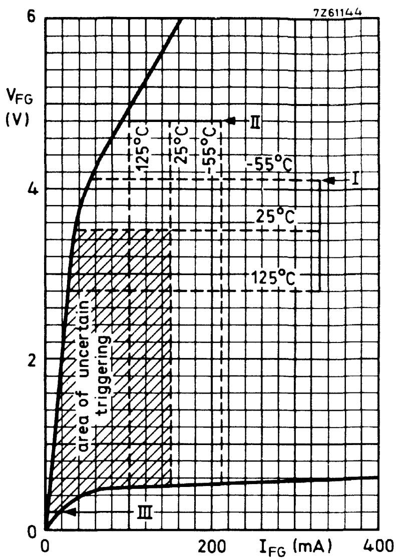



7Z61578
400
300
200
100
0
$I_{TS(RMS)}$ (A)
maximum permissible non-repetitive r.m.s. on state current based on sinusoidal currents (f = 50Hz)
I
time
each current pulse is followed by the crest working reverse voltage
I_{TSM}
T_j = 125 °C prior to surge
10^{-3}
10^{-2}
10^{-1}
1
duration (s)
10

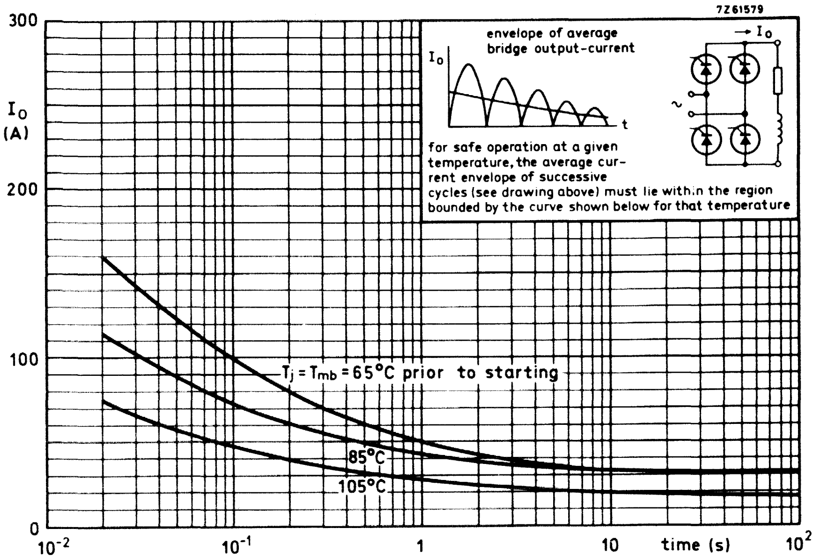

7Z61140
max. rate of rise of off-state voltage that will not trigger any device (exp. method) plotted against junction temp.
$\frac{dV_D}{dt}$ (V/μs)
2000
1500
1000
500
0
0
50
100
T_j (°C)
150

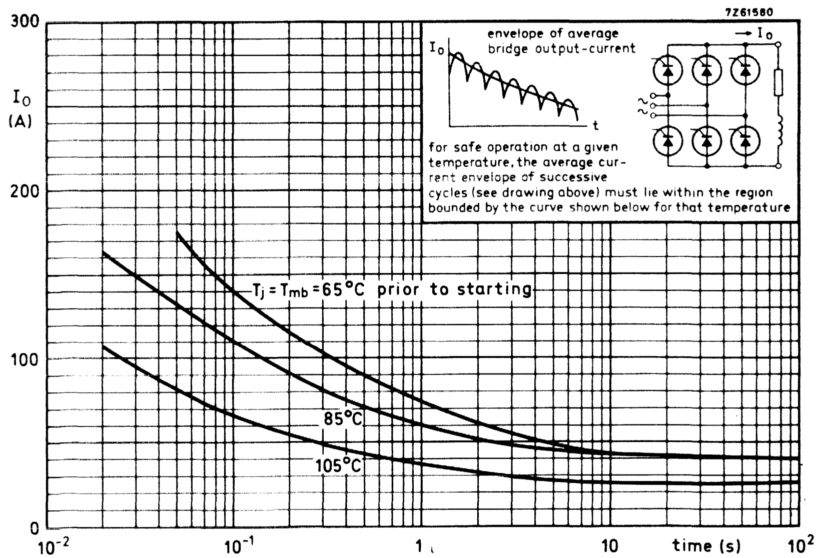

7Z60780
max. rate of rise of off-state voltage that will not trigger any device (exp. method) plotted against applied voltage
$\frac{dV_D}{dt}$ (V/μs)
T_j = 125 °C
1500
1000
500
0
0
50
$\frac{V_{DM}}{V_{DRMmax}}$ (%)
100

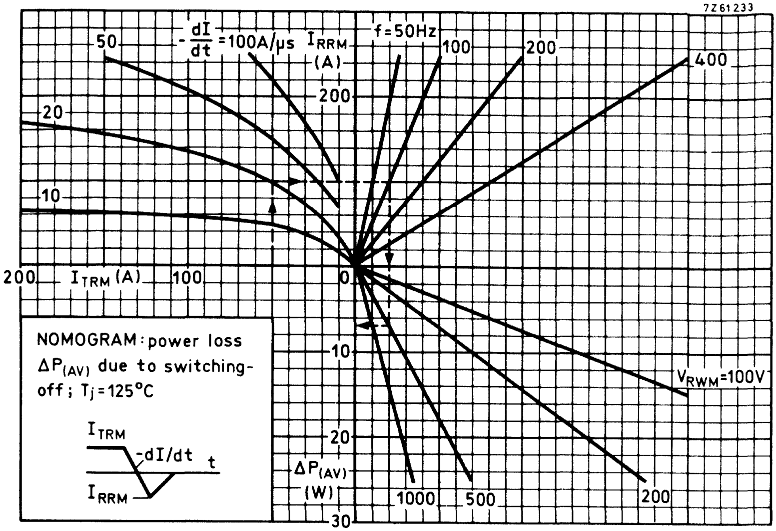


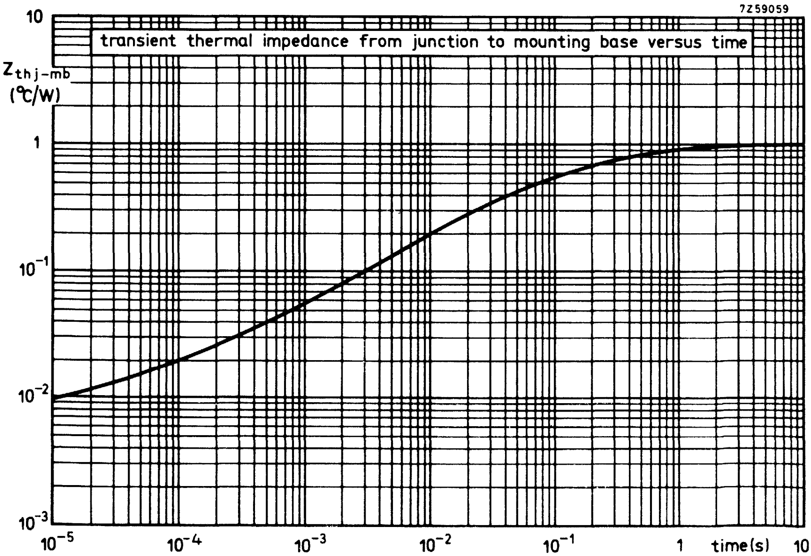


I = minimum gate voltage that will trigger all devices at T_j = ⟶
II = minimum gate current that will trigger all devices at T_j = ⟶
III = maximum gate voltage that will not trigger any device at T_j = 125 °C


7Z61579
envelope of average bridge output-current
for safe operation at a given temperature, the average current envelope of successive cycles (see drawing above) must lie within the region bounded by the curve shown below for that temperature
I_o (A)
$T_j = T_{mb} = 65°C$ prior to starting
85°C
105°C
time (s)
0
100
200
300
10^{-2}
10^{-1}
1
10
10^2


7Z61580
envelope of average bridge output-current
for safe operation at a given temperature, the average current envelope of successive cycles (see drawing above) must lie within the region bounded by the curve shown below for that temperature
I_o (A)
$T_j = T_{mb} = 65°C$ prior to starting
85°C
105°C
time (s)
0
100
200
300
10^{-2}
10^{-1}
1
10
10^2


7Z61233
$-\frac{dI}{dt}$ = 100A/μs
I_{RRM} (A)
f = 50Hz
50
20
10
200
100
200
400
200
100
0
I_{TRM} (A)
10
20
30
$\Delta P_{(AV)}$ (W)
1000
500
200
V_{RWM} = 100V
NOMOGRAM: power loss $\Delta P_{(AV)}$ due to switching-off; T_j = 125°C
I_{TRM}
-dI/dt
t
I_{RRM}


7Z59059
transient thermal impedance from junction to mounting base versus time
Z_{thj-mb} (°C/W)
10
1
10^{-1}
10^{-2}
10^{-3}
10^{-5}
10^{-4}
10^{-3}
10^{-2}
10^{-1}
1
time(s)
10

20 A AVALANCHE THYRISTORS

Silicon thyristors in metal envelopes, with avalanche properties.
A version with guaranteed values of avalanche voltage and avalanche power can be supplied on request.
BTW92series-M has metric thread, BTW92series-U UNF thread. Both series consist of reverse polarity types (anode to stud) identified by a suffix R:
BTW92-600RM to 1600RM and BTW92-600RU to 1600RU.

QUICK REFERENCE DATA

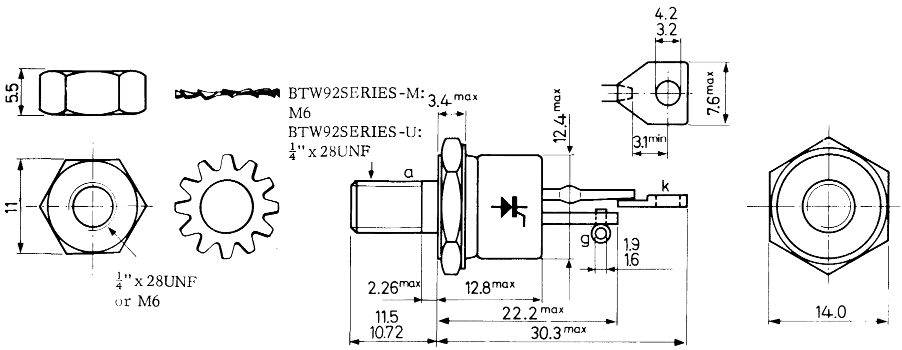
		BTW92-600RM BTW92-600RU	800RM 800RU	1000RM 1000RU	1200RM 1200RU	1400RM 1400RU	1600RM 1600RU	
Repetitive peak voltages $V_{DRM} = V_{RRM}$	max.	600	800	1000	1200	1400	1600	V
Crest working voltages $V_{DWM} = V_{RWM}$	max.	600	800	1000	1200	1200	1200	V
Forward breakover voltage $V_{(BO)}$	>	700	900	1100	1300	1400	1600	V

Average on-state current at T_{mb} = 85 °C	$I_{T(AV)}$	max.	20	A
R.M.S. on-state current	$I_{T(RMS)}$	max.	31	A
Non-repetitive peak on-state current t = 10 ms; T_j = 125 °C prior to surge	I_{TSM}	max.	320	A
Junction temperature	T_j	max.	125	°C
Rate of rise of on-state current after triggering	$\frac{dI_T}{dt}$	max.	300	A/µs
Rate of rise of off-state voltage that will not trigger any device	$\frac{dV_D}{dt}$	<	300	V/µs
On request	$\frac{dV_D}{dt}$	up to	1000	V/µs

MECHANICAL DATA see page 2

MECHANICAL DATA Dimensions in mm

Similar to TO-48



Torque on nut: min. 17 kg cm
(1.7 Newton-metres)
max. 35 kg cm
(3.5 Newton-meters)

Net weight: 15 g
Diameter of clearance hole: max. 6.5 mm
Accessories supplied on request: 56264A

All information applies to frequencies up to 400 Hz.

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

ANODE TO CATHODE		BTW92-600RM BTW92-600RU	800RM 800RU	1000RM 1000RU	1200RM 1200RU	1400RM 1400RU	1600RM 1600RU	
Voltages [1]								
Non-repetitive peak voltages ($t \leq 10$ ms) V_{DSM} [2] $= V_{RSM}$	max.	700	900	1100	1300	1400	1600	V
Repetitive peak voltages $V_{DRM} = V_{RRM}$	max.	600	800	1000	1200	1400	1600	V
Crest working voltages $V_{DWM} = V_{RWM}$	max.	600	800	1000	1200	1200	1200	V
Continuous voltages $V_D = V_R$	max.	600	800	1000	1200	1400	1600	V

[1]) To ensure thermal stability: $R_{th\ j\text{-}a} < 1.5\ ^{o}C/W$ (d.c. blocking) or $< 3\ ^{o}C/W$ (a.c.). For smaller heatsinks $T_{j\ max}$ should be derated. For a.c. see page 6.

[2]) Higher off-state voltages may be applied without damage, but at voltages higher than the minimum forward breakover voltage (see page 4) the thyristor may switch into the on-state. The rate of rise of on-state current should not exceed 100 A/μs.

RATINGS (continued)

Currents

Average on-state current (averaged over any 20 ms period) at T_{mb} = 85 °C	$I_{T(AV)}$	max.	20	A
On-state current (d.c.)	I_T	max.	31	A
R.M.S. on-state current	$I_{T(RMS)}$	max.	31	A
Repetitive peak on-state current	I_{TRM}	max.	200	A
Non-repetitive peak on-state current (t = 10 ms; half sine wave) T_j = 125 °C prior to surge	I_{TSM}	max.	320	A
I^2t for fusing (t = 10 ms)	I^2t	max.	500	A^2s
Rate of rise of on-state current after triggering with $I_G = I_{GT}$ to $I_T = 3 \times I_{T(AV)}$ (see graph on page 7)	$\frac{dI_T}{dt}$	max.	300	A/µs
Rate of rise of on-state current after breakover (see graph on page 7)	$\frac{dI_T}{dt}$	max.	100	A/µs
Rate of change of commutation current	see nomogram on page 10			

GATE TO CATHODE

Voltage

Reverse peak voltage	V_{RGM}	max.	10	V

Power dissipation

Average power dissipation (averaged over any 20 ms period)	$P_{G(AV)}$	max.	1	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	$R_{th\ j-mb}$	=	1	$^{o}C/W$
From mounting base to heatsink	$R_{th\ mb-h}$	=	0.2	$^{o}C/W$
Transient thermal impedance (t = 1 ms)	$Z_{th\ j-mb}$	=	0.06	$^{o}C/W$

CHARACTERISTICS

ANODE TO CATHODE			BTW92-600RM BTW92-600RU	800RM 800RU	1000RM 1000RU	1200RM 1200RU	1400RM 1400RU	1600RM 1600RU	
Voltages									
On-state voltage I_T = 50 A; T_j = 25 ^{o}C	V_T	<	2.3	2.3	2.3	2.3	2.3	2.3	V
Forward breakover voltage up to T_j = 125 ^{o}C	$V_{(BO)}$	>	700	900	1100	1300	1400	1600	V
Rate of rise of off-state voltage that will not trigger any device; T_j = 125 ^{o}C	$\frac{dV_D}{dt}$	<	300	300	300	300	300	300	V/µs
Currents									
Peak reverse current $V_{RM}=V_{RWMmax}$; T_j=125^{o}C	I_{RM}	<	13	10	8	7	7	7	mA
Peak off-state current $V_{DM}=V_{DWMmax}$; T_j=125^{o}C	I_{DM}	<	13	10	8	7	7	7	mA

Latching current; T_j = 25 ^{o}C	I_L	<	200	mA
Holding current; T_j = 25 ^{o}C	I_H	<	200	mA

GATE TO CATHODE

Voltages

Voltage that will trigger all devices V_D = 6 V; T_j = 25 ^{o}C	V_{GT}	>	3.5	V
Voltage that will not trigger any device V_D = V_{DWMmax}; T_j = 125 ^{o}C	V_{GD}	<	200	mV

Current

Current that will trigger all devices V_D = 6 V; T_j = 25 ^{o}C	I_{GT}	>	150	mA

CHARACTERISTICS (continued)

SWITCHING CHARACTERISTICS

Turn-on time ($t_{on} = t_d + t_r$) when switched
from $V_D = V_{DWMmax}$ to $I_T = 10$ A
$I_{GT} = 150$ mA; $dI_G/dt = 1$ A/µs; $T_j = 25$ °C

t_{on}	typ.	2	µs
t_r	typ.	1.2	µs

Circuit-commutated turn-off time when switched
from $I_T = 10$ A to $V_R \geq 50$ V
with $-dI_T/dt = 10$ A/µs; $dV_D/dt = 10$ V/µs

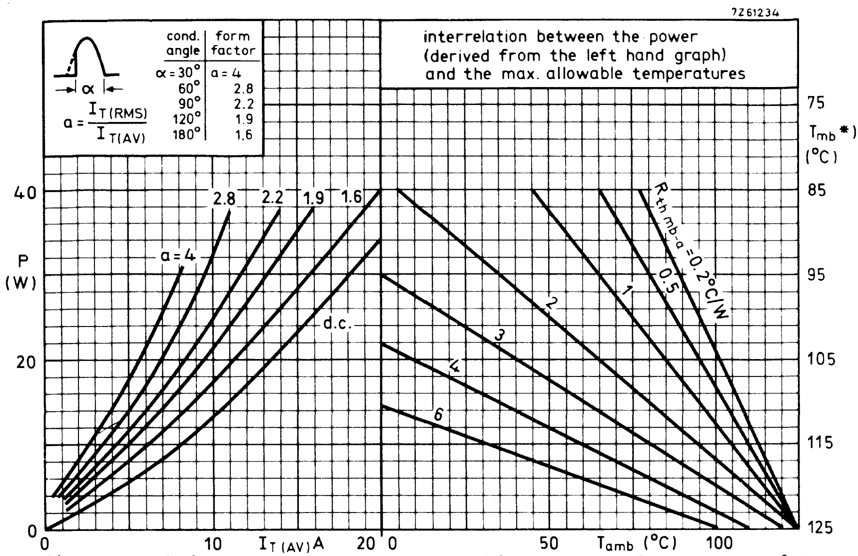
$T_j = 125$ °C	t_q	typ.	75	µs
		<	250	µs
$T_j = 25$ °C	t_q	typ.	40	µs
		<	100	µs

OPERATING NOTES

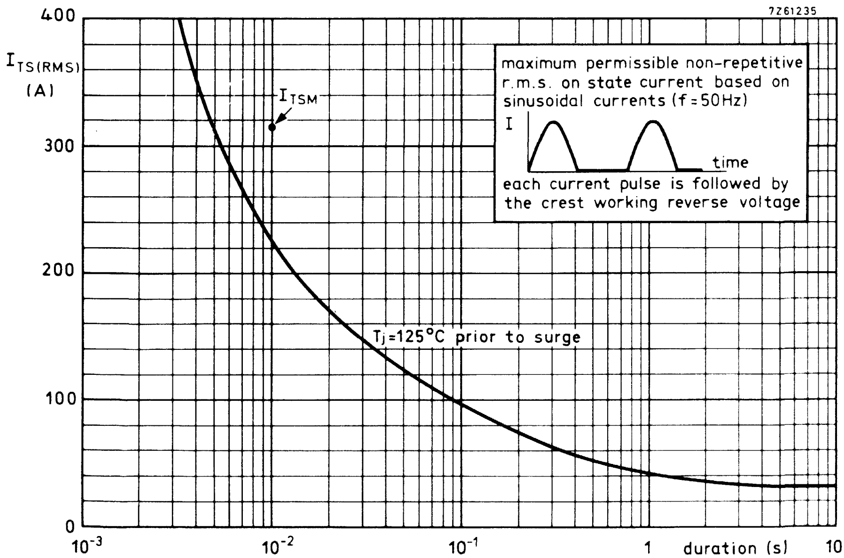
1. The gate and cathode connectors should not be bent; they should be soldered into the circuit so that there is no strain on them.

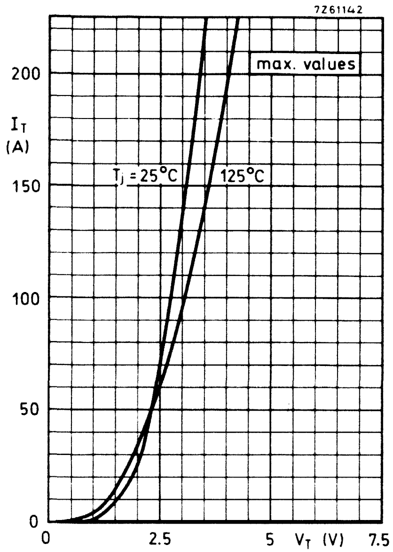
2. Switching losses in commutation

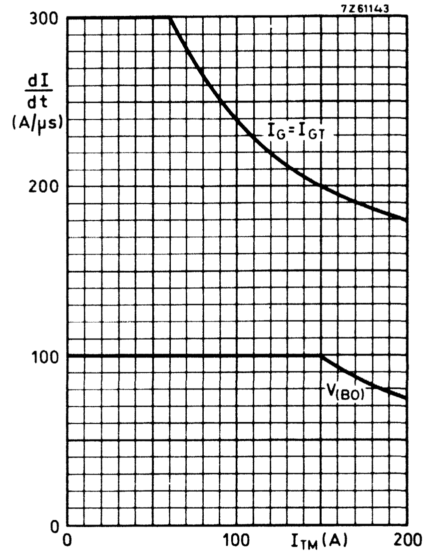
For applications in which the thyristor is forced to switch from an on-state current I_{TRM} to a high reverse voltage at a high commutation rate (-dI/dt), consult the nomogram on page 10 to find the increase in total average power.
This increase must be added to the losses derived from the curves on page 6.

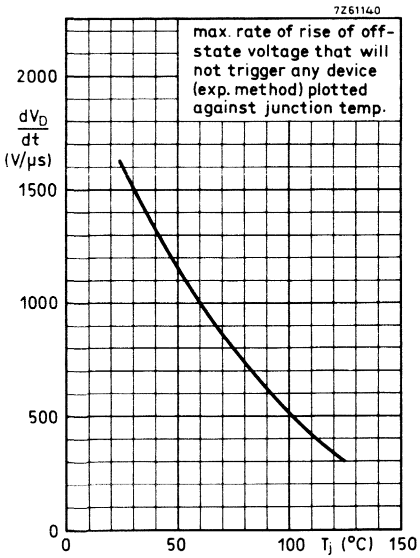


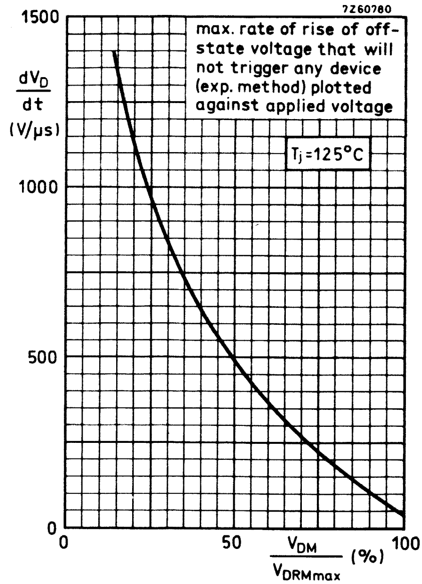
*) T_{mb}-scale is for comparison purposes only and is correct only for $R_{th\ mb-a} \leq 2°C/W$

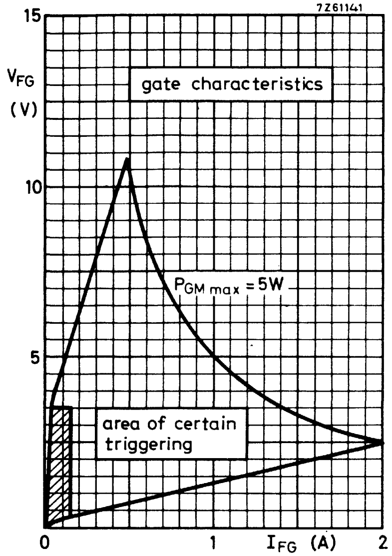


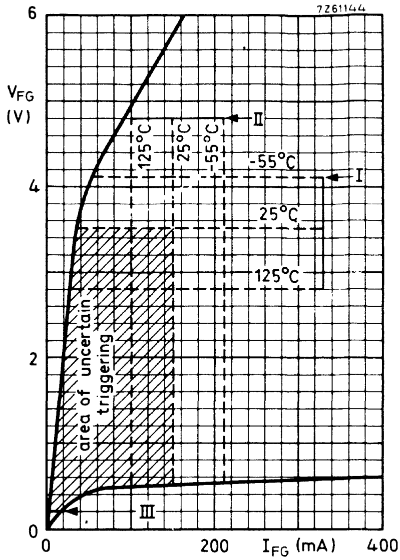

7Z61142
max. values
200
I_T
(A)
150
$T_j = 25°C$
125°C
100
50
0
0
2.5
5
V_T (V)
7.5


7Z61143
300
dI/dt
(A/μs)
$I_G = I_{GT}$
200
100
$V_{(BO)}$
0
0
100
I_{TM} (A)
200


7Z61140
max. rate of rise of off-state voltage that will not trigger any device (exp. method) plotted against junction temp.
2000
dV_D/dt
(V/μs)
1500
1000
500
0
0
50
100
T_j (°C)
150


7Z60780
1500
max. rate of rise of off-state voltage that will not trigger any device (exp. method) plotted against applied voltage
dV_D/dt
(V/μs)
$T_j = 125°C$
1000
500
0
0
50
V_{DM}/V_{DRMmax} (%)
100



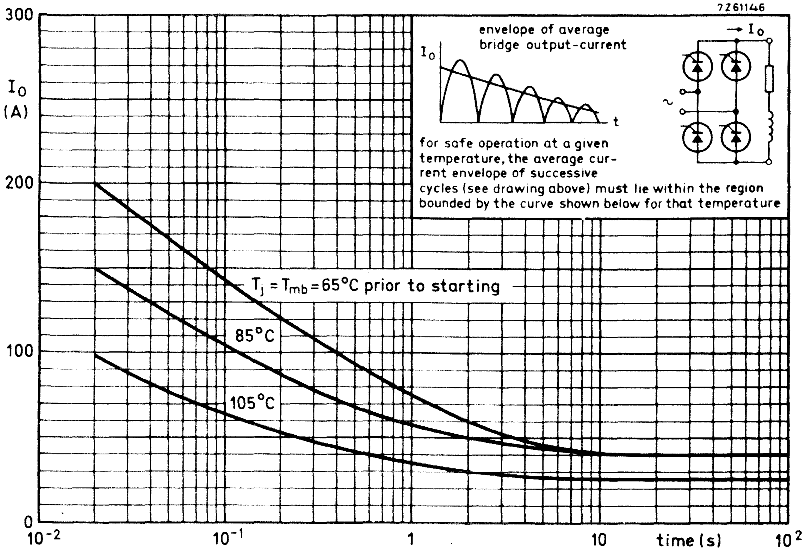


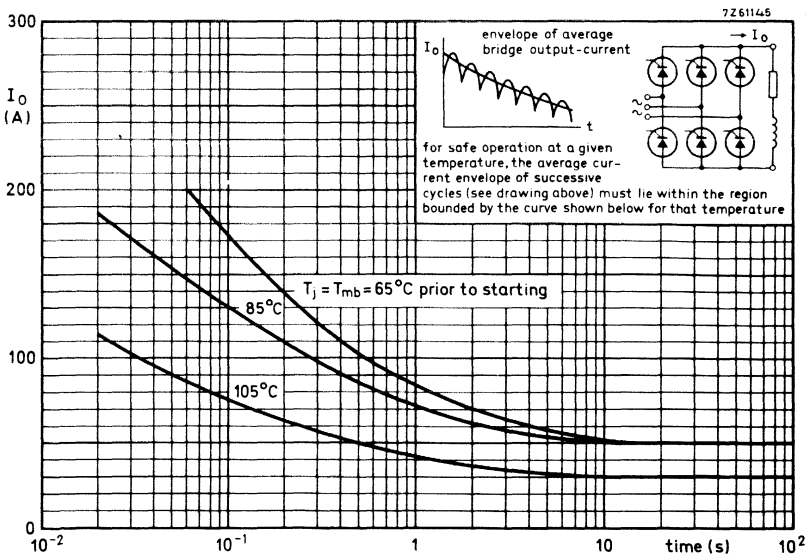
I = minimum gate voltage that will trigger all devices at T_j = ⟶

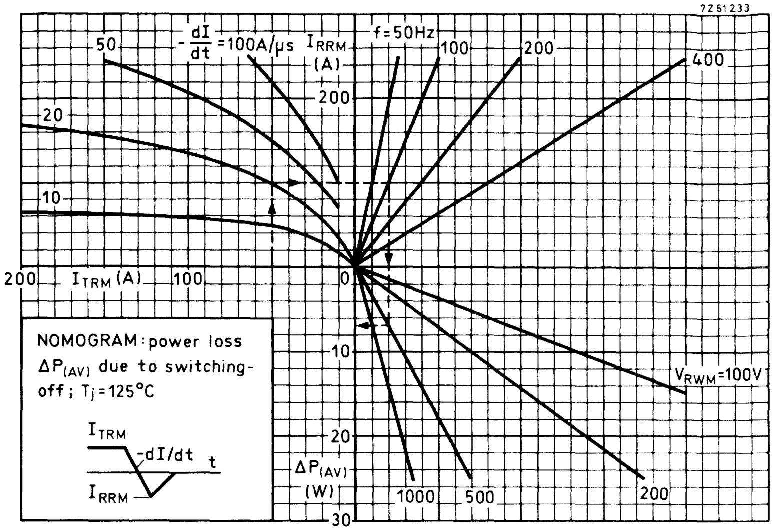
II = minimum gate current that will trigger all devices at T_j = ⟶

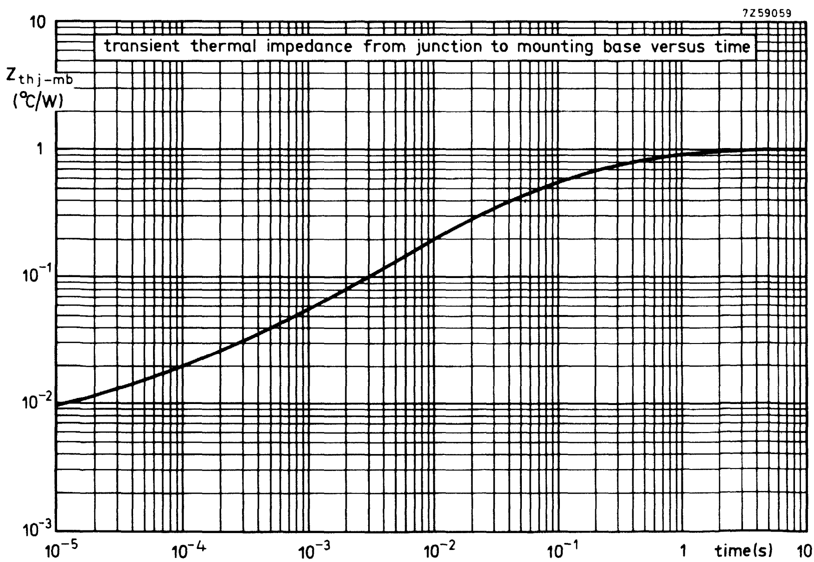
III = maximum gate voltage that will not trigger any device at T_j = 125 °C

Limits for starting or inrush-currents






7Z61233
$-\frac{dI}{dt}$ = 100A/µs
50
20
10
I_{RRM} (A)
200
f = 50Hz
100
200
400
200
I_{TRM} (A)
100
0
NOMOGRAM: power loss $\Delta P_{(AV)}$ due to switching-off; T_j = 125°C
I_{TRM}
-dI/dt
t
I_{RRM}
10
20
$\Delta P_{(AV)}$ (W)
30
1000
500
200
V_{RWM} = 100V


7Z59059
transient thermal impedance from junction to mounting base versus time
$Z_{th\,j-mb}$ (°C/W)
10
1
10^{-1}
10^{-2}
10^{-3}
10^{-5}
10^{-4}
10^{-3}
10^{-2}
10^{-1}
1
time(s)
10

SILICON THYRISTORS

The BTX18series is a range of p-gate reverse blocking thyristors, in a TO-5 metal envelope, intended for use in general low power applications up to 1 A average on-state current

QUICK REFERENCE DATA

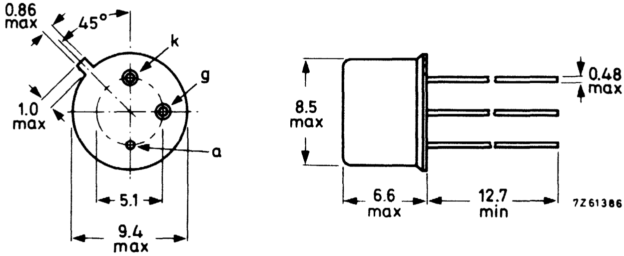
			BTX18-100	200	300	400	500	
Crest working reverse voltage	V_{RWM}	max.	100	200	300	400	500	V
Crest working off-state voltage	V_{DWM}	max.	100	200	300	400	500	V
Average on-state current up to T_{case} = 105 °C	$I_{T(AV)}$	max.	1.0					A
T_{amb} = 60 °C; in free air	$I_{T(AV)}$	max.	250					mA
Non-repetitive peak on-state current t = 10 ms; T_j = 125 °C prior to surge	I_{TSM}	max.	10					A
Junction temperature	T_j	max.	125					°C

MECHANICAL DATA

Dimensions in mm

Anode connected to the case

TO-39



Accessories supplied on request: 56218; 56245; 56265

All information applies to frequencies up to 400 Hz

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

ANODE TO CATHODE

Voltages [1]			BTX18-100	200	300	400	500	
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 (δ = 0.01; f = 50 Hz)	V_{RRM}	max.	120	240	350	500	600	V
Non-repetitive peak reverse voltage (t ≤ 10 ms)	V_{RSM}	max.	120	240	350	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 (δ = 0.01; f = 50 Hz)	V_{DRM}	max.	120	240	350	500	600	V [2]
Non-repetitive peak off-state voltage (t ≤ 10 ms)	V_{DSM}	max.	120	240	350	500	600	V [2]

Currents

Average on-state current (averaged over any 20 ms period) up to T_{case} = 105 °C	$I_{T(AV)}$	max.	1.0	A
at T_{amb} = 60 °C	$I_{T(AV)}$	max.	250	mA
On-state current (d.c.) T_{case} = 100 °C	I_T	max.	1.6	A
R.M.S. on-state current	$I_{T(RMS)}$	max.	1.6	A
Repetitive peak on-state current	I_{TRM}	max.	10	A
Non-repetitive peak on-state current (t = 10 ms, half sinewave)	I_{TSM}	max.	10	A

[1]) These ratings apply for zero or negative bias on the gate with respect to the cathode, and when a resistor R ≤ 1 kΩ is connected between gate and cathode.

[2]) The device is not suitable for operation in the forward breakover mode.

RATINGS

GATE TO CATHODE (with 1 kΩ resistor between gate and 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.	0.2	A

Power dissipation

Average power dissipation (averaged over any 20 ms period)	$P_{G(AV)}$	max.	0.05	W
Peak power dissipation	P_{GM}	max.	0.5	W

TEMPERATURES

Storage temperature	T_{stg}		-55 to +125	^oC
Junction temperature	T_j	max.	125	^oC

THERMAL RESISTANCE

From junction to case	$R_{th\ j-c}$	=	10	$^oC/W$
From junction to ambient	$R_{th\ j-a}$	=	200	$^oC/W$
Transient thermal resistance (t = 10 ms)	$Z_{th\ j-c}$	=	2.5	$^oC/W$

CHARACTERISTICS

ANODE TO CATHODE

			BTX18-100	200	300	400	500	
Voltages								
On-state voltage I_T = 1.0 A; T_j = 25 ^oC	V_T	<	1.5	1.5	1.5	1.5	1.5	V [1]
Rate of rise of off-state voltage that will not trigger any device RGK = 1 kΩ; T_j = 125 ^oC	$\frac{dV_D}{dt}$		See page 6					
Currents								
Peak reverse current $V_{RM} = V_{RWMmax}$; T_j = 125 ^oC	I_{RM}	<	800	400	275	200	160	μA
Peak off-state current $V_{DM} = V_{DWMmax}$; T_j = 125 ^oC	I_{DM}	<	800	400	275	200	160	μA

1) V_T is measured along the leads at 1 cm from the case.

CHARACTERISTICS (continued)

Latching current; T_j = 125 °C	I_L	typ.	10	mA
Holding current; T_j = 25 °C	I_H	<	5.0	mA [1)]

GATE TO CATHODE

Voltages

Voltage that will trigger all devices; T_j = 25 °C	V_{GT}	>	2.0	V
Voltage that will not trigger any device; T_j = 125 °C	V_{GD}	<	200	mV

Current

Current that will trigger all devices; T_j = 25 °C	I_{GT}	>	5.0	mA

SWITCHING CHARACTERISTICS

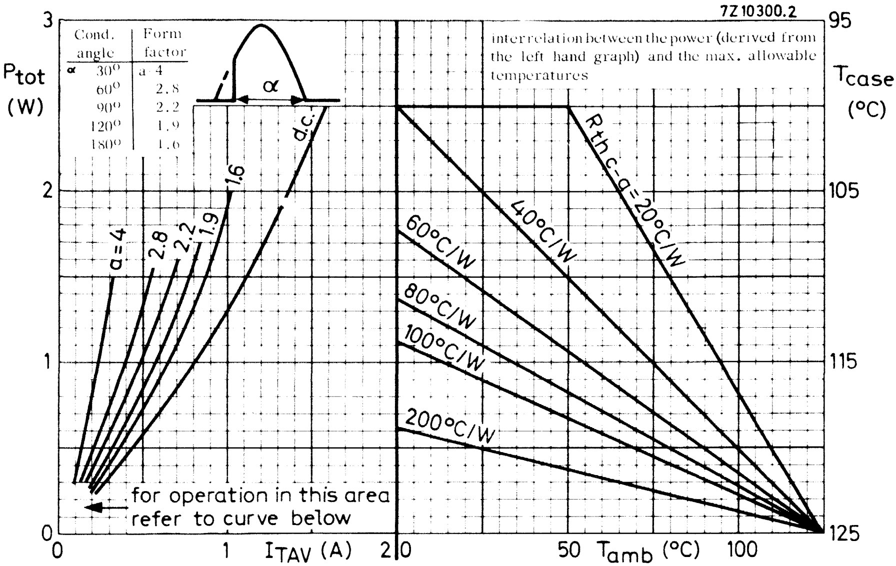
Turn off time when switched from

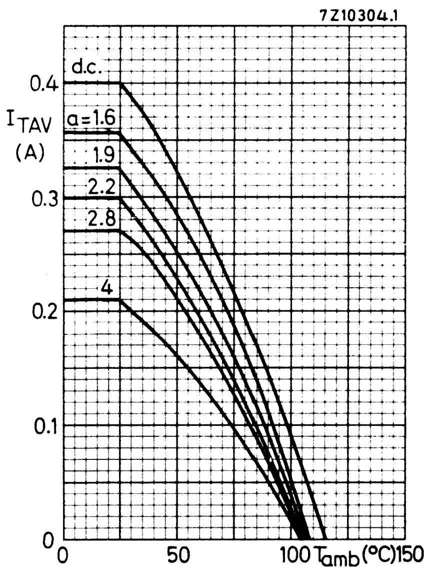
I_T = 300 mA to I_R = 175 mA; T_j = 25 °C	t_q	typ.	20	µs
T_j = 125 °C	t_q	typ.	35	µs

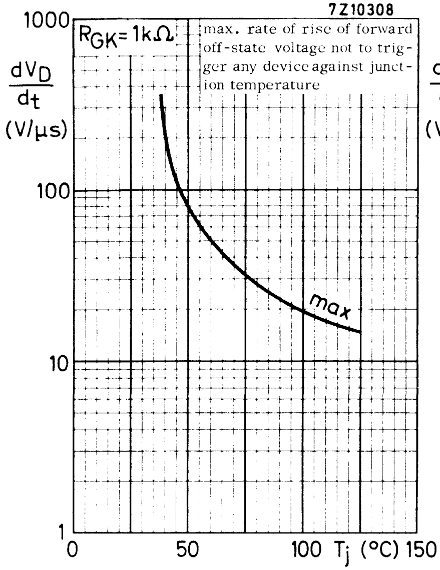
NOTES

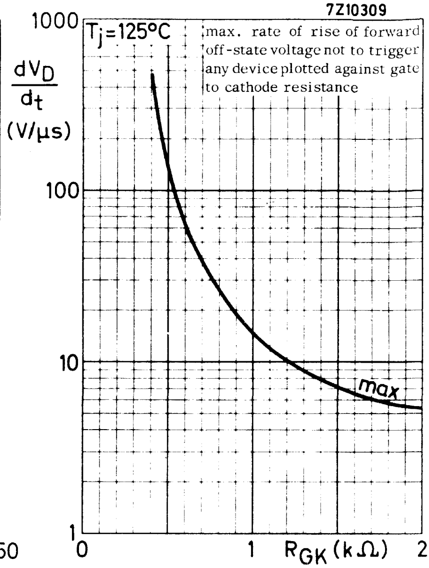
1. When using a soldering iron the thyristor may be soldered directly into the circuit, but the heat conduction to the junction should be kept to a minimum by using a thermal shunt.
2. Thyristors may be dip soldered at a solder temperature of 245 °C, for a maximum soldering time of 5 seconds. The case temperature during dip soldering must not at any time exceed the maximum storage temperature. These recommendations apply to a thyristor mounted flush on a board with punched-through holes, or spaced 1.5 mm above a board having plated-through holes.
3. Care should be taken not to bend the leads nearer than 1.5 mm from the seal.

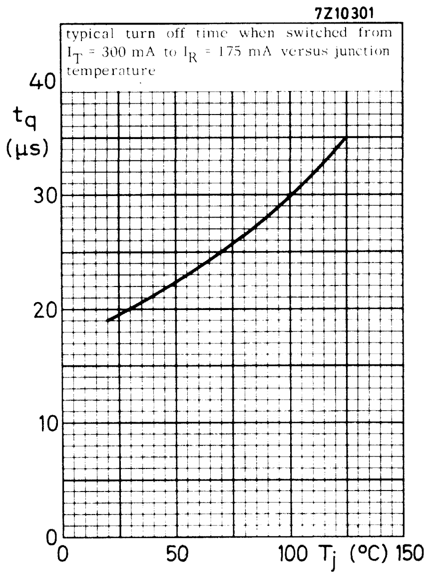
[1)] Measured under the following conditions: Anode supply voltage = +6.0 V.
Initial on-state current after gate triggering = 50 mA.
The current is reduced until the device turns of.

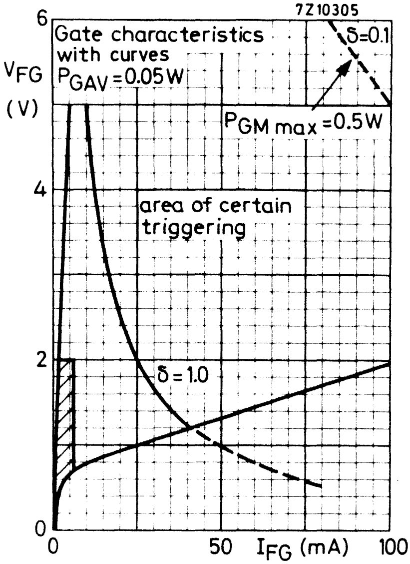

7Z10300.2
Cond. angle
Form factor
α
30°
a=4
60°
2.8
90°
2.2
120°
1.9
180°
1.6
α
d.c.
1.6
a=4
2.8
2.2
1.9
for operation in this area refer to curve below
interrelation between the power (derived from the left hand graph) and the max. allowable temperatures
Rth c-a=20°C/W
40°C/W
60°C/W
80°C/W
100°C/W
200°C/W
Ptot (W)
Tcase (°C)
ITAV (A)
Tamb (°C)
0
1
2
3
0
1
2
0
50
100
95
105
115
125

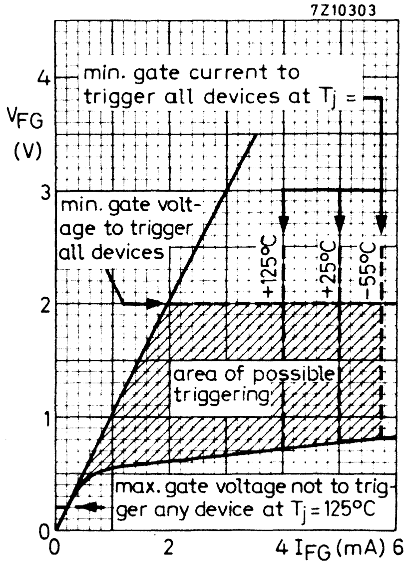

7Z10304.1
d.c.
a=1.6
1.9
2.2
2.8
4
ITAV (A)
0
0.1
0.2
0.3
0.4
0
50
100
Tamb (°C)
150

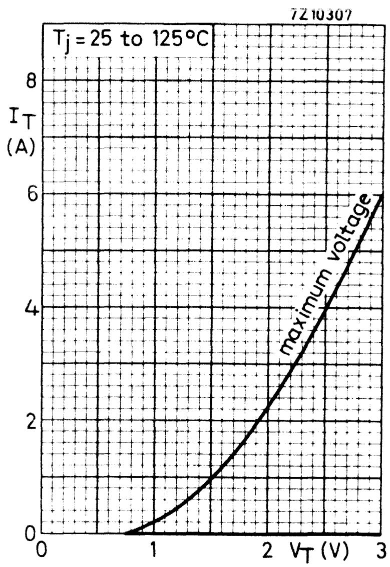

7Z10308
1000
100
10
1
R_{GK} = 1kΩ
max. rate of rise of forward off-state voltage not to trigger any device against junction temperature
dV_D/dt (V/μs)
max
0
50
100
150
T_j (°C)

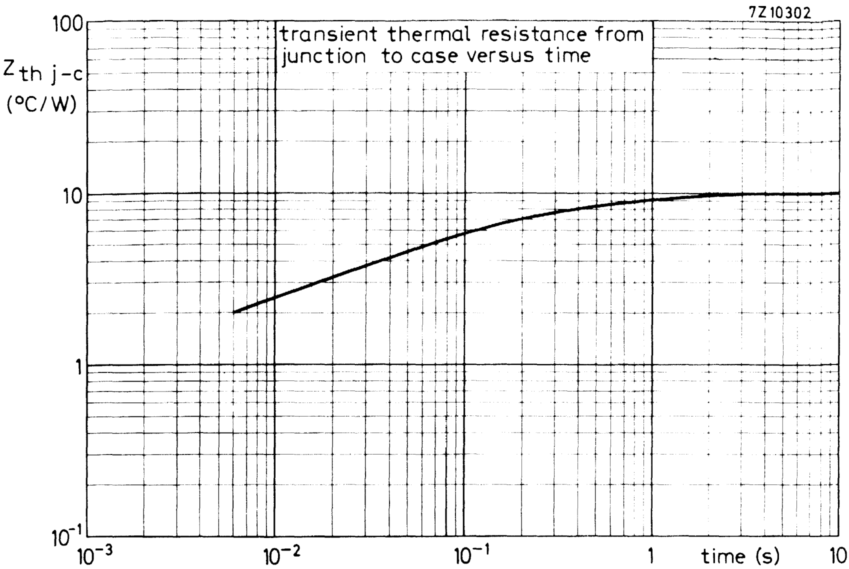

7Z10309
1000
100
10
1
T_j = 125°C
max. rate of rise of forward off-state voltage not to trigger any device plotted against gate to cathode resistance
dV_D/dt (V/μs)
max
0
1
2
R_GK (kΩ)

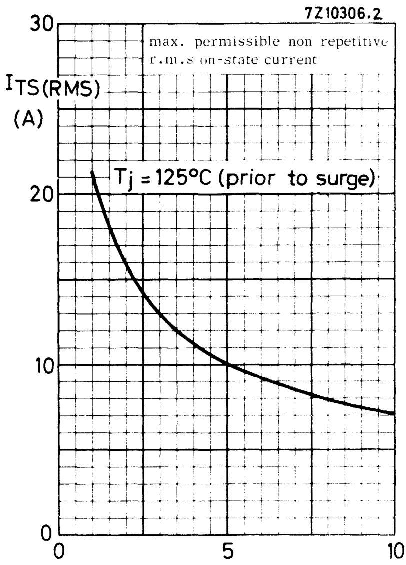

7Z10301
typical turn off time when switched from I_T = 300 mA to I_R = 175 mA versus junction temperature
40
30
20
10
0
t_q (μs)
0
50
100
150
T_j (°C)


7Z10305
Gate characteristics
with curves
$P_{GAV} = 0.05$ W
$\delta = 0.1$
$P_{GM\,max} = 0.5$ W
V_{FG}
(V)
area of certain
triggering
$\delta = 1.0$
I_{FG} (mA)
0
2
4
6
50
100


7Z10303
min. gate current to
trigger all devices at T_j =
V_{FG}
(V)
min. gate voltage to trigger all devices
+125°C
+25°C
−55°C
area of possible
triggering
max. gate voltage not to trigger any device at $T_j = 125$°C
I_{FG} (mA)
0
1
2
3
4
6


7Z10307
$T_j = 25$ to 125°C
I_T
(A)
maximum voltage
V_T (V)
0
2
4
6
8
1
3


7Z10302
transient thermal resistance from junction to case versus time
Zth j-c
(°C/W)
100
10
1
10⁻¹
10⁻³
10⁻²
10⁻¹
1
time (s)
10


7Z10306.2
max. permissible non repetitive r.m.s on-state current
ITS(RMS)
(A)
Tj = 125°C (prior to surge)
30
20
10
0
0
5
10
duration of surge (ms)

SILICON THYRISTORS

P-gate silicon thyristors in a metal envelope with ceramic insulation. They are intended for power control and power switching applications. The series consists of 5 reverse polarity types (anode to stud) BTX41-800R to BTX41-1600R. Together with the watercooled heatsink 56311 they are specially suited for welding.

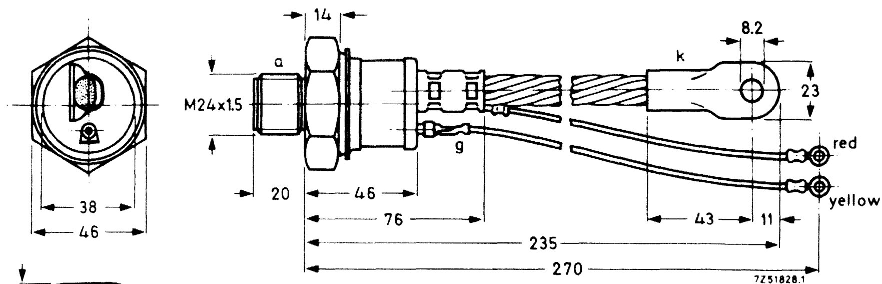
QUICK REFERENCE DATA

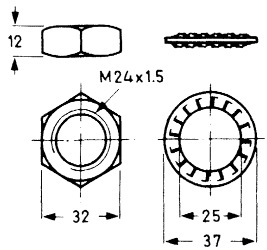
		BTX41 - 800R	1000R	1200R	1400R	1600R	
$V_{DWM} = V_{RWM}$	max.	800	1000	1200	1200	1200	V
$V_{DRM} = V_{RRM}$	max.	800	1000	1200	1400	1600	V

Average on-state current up to T_{mb} = 65 °C	I_{TAV}	max.	250	A
at T_{mb} = 85 °C	I_{TAV}	max.	160	A
R.M.S. on-state current	$I_{T(RMS)}$	max.	400	A
Non-repetitive peak on-state current; t = 10 ms	I_{TSM}	max.	5500	A
Rate of rise of on-state current	$\frac{dI_T}{dt}$	max.	30	A/µs
Rate of rise of off-state voltage that will not trigger any device exponential up to $\frac{2}{3} V_{DRMmax}$	$\frac{dV_D}{dt}$	<	20	V/µs
On request	$\frac{dV_D}{dt}$	up to	200	V/µs

MECHANICAL DATA

Dimensions in mm





Net weight: 530 g

Torque on nut: min. 300 kg cm
(30 Newton metres)
max. 400 kg cm
(40 Newton metres)

Diameter of clearance hole: max. 25 mm

Heatsinks available: 56284
56311 (for welding)

All information applies to frequencies up to 400 Hz.

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

ANODE TO CATHODE

Voltages 1)		BTX41-800R	1000R	1200R	1400R	1600R	
Continuous voltages $V_D = V_R$	max.	800	1000	1200	1400	1600	V
→ Crest working voltages $V_{DWM} = V_{RWM}$	max.	800	1000	1200	1200	1200	V
Repetitive peak voltages $V_{DRM} = V_{RRM}$	max.	800	1000	1200	1400	1600	V
Non-repetitive peak voltages $(t \le 10\,ms)\,V_{DSM} = V_{RSM}$	max.	900	1200	1400	1600	1800	V

Currents 2)

Average on-state current (averaged over any 20 ms period) up to $T_{mb} = 65\,^oC$	I_{TAV}	max.	250	A
at $T_{mb} = 85\,^oC$	I_{TAV}	max.	160	A
On-state current (d.c.)	I_T	max.	400	A
R.M.S. on-state current	$I_{T(RMS)}$	max.	400	A
Repetitive peak on-state current	I_{TRM}	max.	2500	A
Non-repetitive peak on-state current (t = 10 ms; half sine wave) $T_j = 110\,^oC$ prior to surge	I_{TSM}	max.	5500	A
I squared t for fusing (t = 10 ms)	I^2t	max.	150000	A^2s
Rate of rise of on-state current	$\frac{dI_T}{dt}$	max.	30	A/μs

GATE TO CATHODE

Forward peak voltage	V_{FGM}	max.	6	V
Reverse peak voltage	V_{RGM}	max.	5	V

Current

Forward peak current	I_{FGM}	max.	3	A

Power dissipation

Average power dissipation	P_{GAV}	max.	2	W
Peak power dissipation	P_{GM}	max.	10	W

TEMPERATURES

Storage temperature	T_{stg}		−40 to +125	^oC
Operating junction temperature	T_j	max.	110	^oC

1) These ratings apply to a gate voltage range of V_{RGMmax} to V_{GDmax}.
2) The temperature of the cathode cable lug should be kept below 105 ^oC.

THERMAL RESISTANCE

From junction to mounting base	$R_{th\ j-mb}$	=	0.12	°C/W
From mounting base to heatsink with heatsink compound, e.g. Dow Corning 340	$R_{th\ mb-h}$	=	0.03	°C/W
Transient thermal impedance from junction to mounting base (t = 10 ms)	$Z_{th\ j-mb}$	=	0.015	°C/W

CHARACTERISTICS

T_j = 110 °C unless otherwise specified

ANODE TO CATHODE

Voltages

		BTX41 - 800R	1000R	1200R	1400R	1600R	
On-state voltage at I_T = 600 A	V_T	< 1.5	1.5	1.5	1.6	1.6	V

Rate of rise of off-state
voltage that will not trigger any device

exponential up to $\frac{2}{3}V_{DRMmax}$	$\frac{dV_D}{dt}$	<	20	V/µs
On request	$\frac{dV_D}{dt}$	up to	200	V/µs

Currents

Peak reverse current $V_R = V_{RWMmax}$	I_{RM}	<	10	mA
Peak off-state current $V_D = V_{DWMmax}$	I_{DM}	<	10	mA
Holding current at T_j = 25 °C	I_H	<	150	mA

GATE TO CATHODE

Voltages

Gate trigger voltage V_D = 6 V; T_j = 25 °C	V_{GT}	>	2.5	V
Gate non-trigger voltage $V_D = V_{DRMmax}$	V_{GD}	<	0.15	V

Currents

Gate trigger current

V_D = 6 V; T_j = 25 °C	I_{GT}	>	250	mA
V_D = 6 V; T_j = −40 °C	I_{GT}	>	300	mA

SWITCHING CHARACTERISTICS

Turn on time when switched from

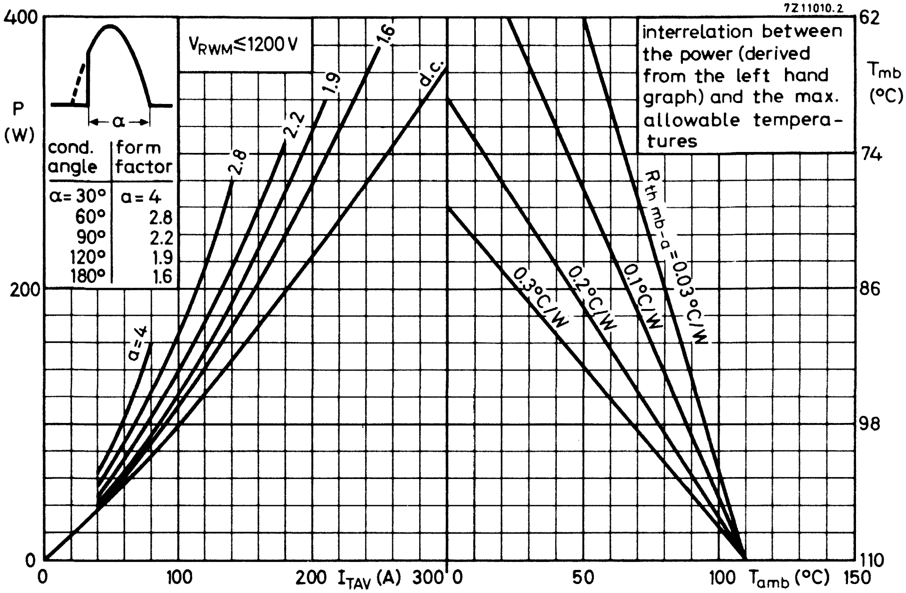
V_D = 100 V to I_T = 250 A; I_G = 1.5 A;

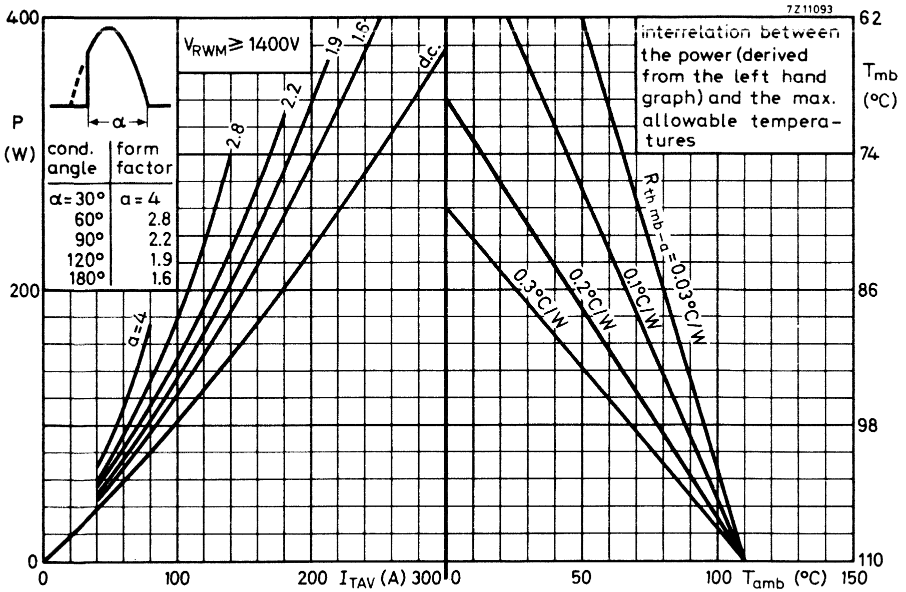
$\frac{dI_G}{dt}$ = 3 A/µs; T_j = 25 °C — t_{on} < 20 µs

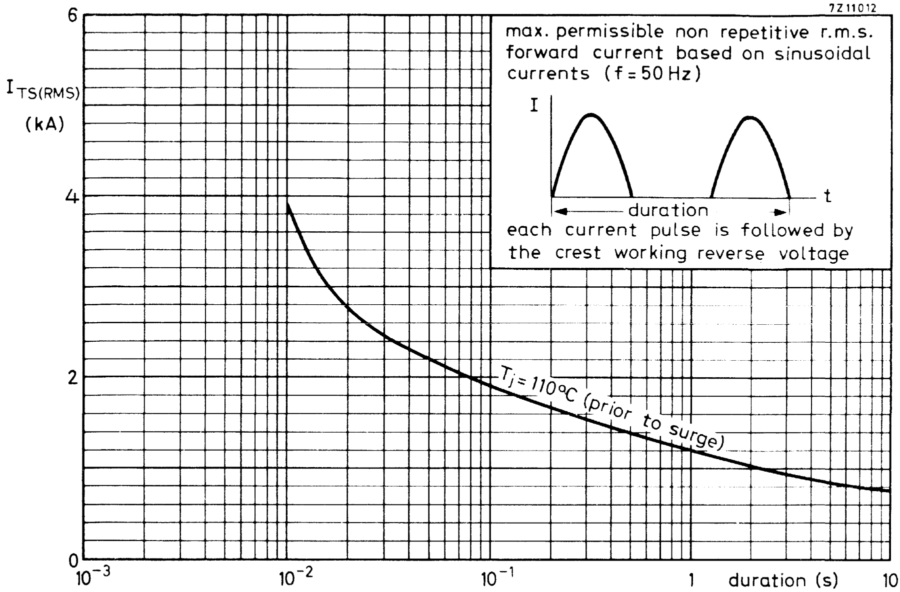
Turn off time when switched from

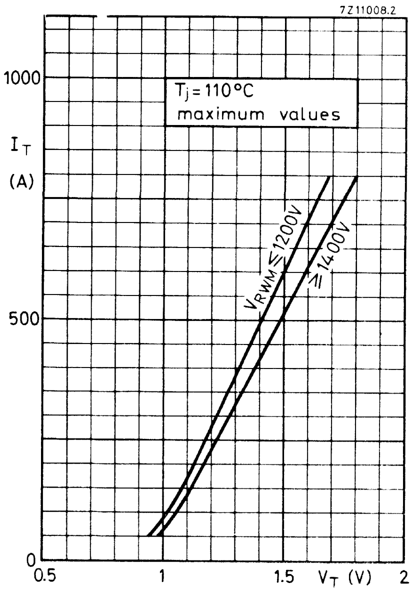
I_T = 50 A to I_R = 25 A

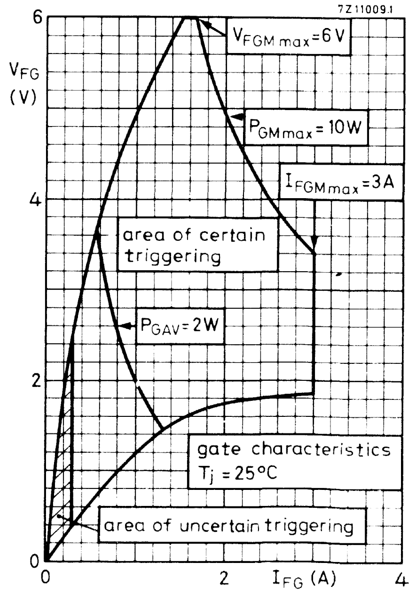
$\frac{dV_D}{dt}$ = 20 V/µs; $-\frac{dI_T}{dt}$ = 20 A/µs; T_j = 110 °C — t_{off} typ. 200 µs


7Z11010.2
400
200
0
P
(W)
VRWM≤1200 V
cond. angle
form factor
α=30° a=4
60° 2.8
90° 2.2
120° 1.9
180° 1.6
α
1.6
1.9
2.2
2.8
d.c.
a=4
0
100
200 ITAV (A) 300
0
50
100 Tamb (°C) 150
interrelation between the power (derived from the left hand graph) and the max. allowable temperatures
Rth mb-a = 0.03°C/W
0.1°C/W
0.2°C/W
0.3°C/W
62
Tmb
(°C)
74
86
98
110

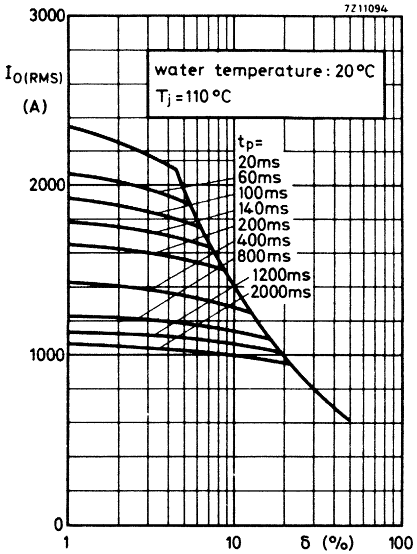

7Z11093
400
200
0
P
(W)
VRWM≥ 1400V
cond. angle
form factor
α=30° a=4
60° 2.8
90° 2.2
120° 1.9
180° 1.6
α
1.6
1.9
2.2
2.8
d.c.
a=4
0
100
200 ITAV (A) 300
0
50
100 Tamb (°C) 150
interrelation between the power (derived from the left hand graph) and the max. allowable temperatures
Rth mb-a = 0.03°C/W
0.1°C/W
0.2°C/W
0.3°C/W
62
Tmb
(°C)
74
86
98
110

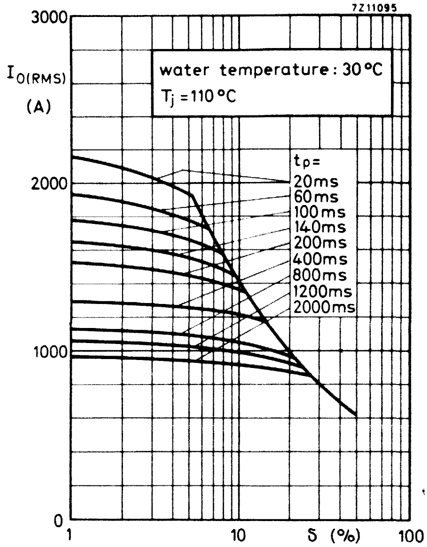

7Z11012
6
4
2
0
$I_{TS(RMS)}$
(kA)
max. permissible non repetitive r.m.s. forward current based on sinusoidal currents (f = 50 Hz)
I
t
duration
each current pulse is followed by the crest working reverse voltage
T_j = 110 °C (prior to surge)
10^{-3}
10^{-2}
10^{-1}
1
duration (s)
10

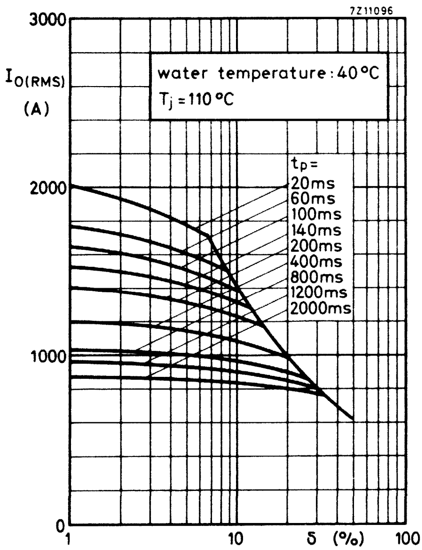

7Z11008.2
1000
500
0
I_T
(A)
T_j = 110 °C
maximum values
V_{RWM} ≤ 1200V
≥ 1400V
0.5
1
1.5
V_T (V)
2

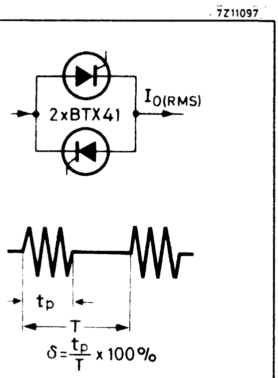

7Z11009.1
6
4
2
0
V_{FG}
(V)
$V_{FGM\,max}$ = 6 V
$P_{GM\,max}$ = 10 W
$I_{FGM\,max}$ = 3 A
area of certain triggering
P_{GAV} = 2 W
gate characteristics
T_j = 25 °C
area of uncertain triggering
0
2
I_{FG} (A)
4

Intermittent overload capability of 2 BTX41 thyristors in antiparallel connection in a single phase a.c. control circuit (e.g. welding).

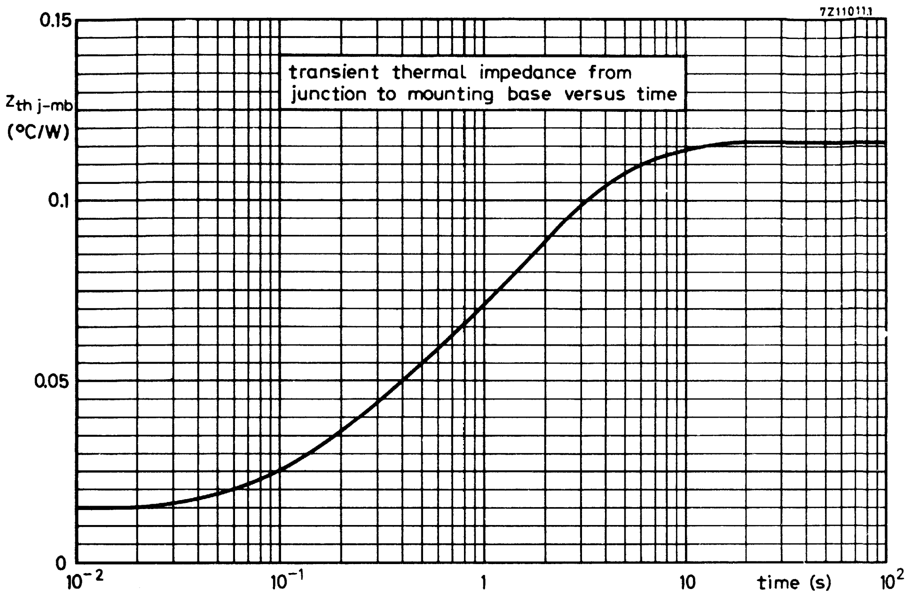








Notes:
conduction angle: 360°
heatsink : 56311
water flow : 4 ℓ/min


7Z11011.1
transient thermal impedance from junction to mounting base versus time
$Z_{th\ j-mb}$ (°C/W)
0.15
0.1
0.05
0
10^{-2}
10^{-1}
1
10
time (s)
10^{2}

TRIACS

The BTX94series is a range of bi-directional triode thyristors (triacs), in a TO-48 metal envelope, intended for industrial a.c. power control applications (a.o. furnace temperature control, static switching and motor control).
The series consists of the types BTX94-400 to BTX94-1200.

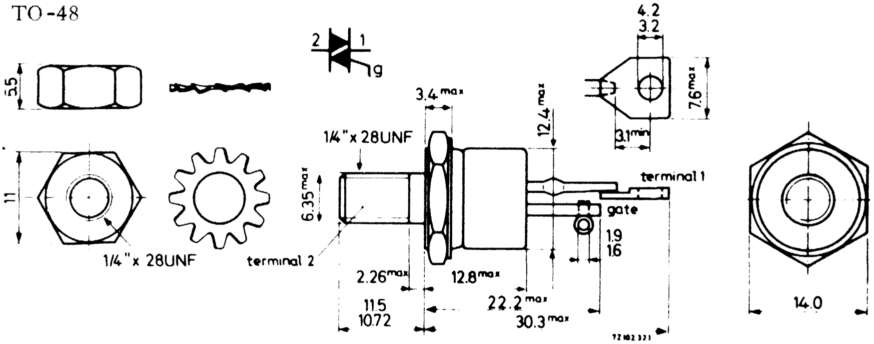
QUICK REFERENCE DATA

			BTX94-400	500	600	800	1000	1200	
Crest working off-state voltage	V_{DWM}	max.	400	500	600	800	1000	1200	V
Repetitive peak off-state voltage	V_{DRM}	max.	400	500	600	800	1000	1200	V
Breakover voltage	$V_{(BO)}$	>	500	600	700	900	1100	1300	V

R.M.S. on-state current at T_{mb} = 85 °C	$I_{T(RMS)}$	max.	25	A
Non-repetitive peak on-state current t = 10 ms; T_j = 125 °C prior to surge	I_{TSM}	max.	250	A
Junction temperature	T_j	max.	125	°C
Rate of rise of on-state current after triggering	$\frac{dI_T}{dt}$	max.	50	A/μs
Rate of rise of off-state voltage that will not trigger any device	$\frac{dV_D}{dt}$	<	100	V/μs
Rate of rise of commutating voltage that will not trigger any device	$\frac{dV_D}{dt}$	<	30	V/μs

MECHANICAL DATA Dimensions in mm

TO-48



Net weight: 15 g
Diameter of clearance hole: max. 6.5 mm
Accessories supplied on request: 56264A

Torque on nut: min. 17 kgcm
(1.7 Newton-metres)
max. 35 kgcm
(3.5 Newton-metres)

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

Voltages (in either direction) [1]		BTX94-400	500	600	800	1000	1200	
Crest working off-state voltage	V_{DWM} max.	400	500	600	800	1000	1200	[2]
Repetitive peak off-state voltage ($\delta \leq 0.01$)	V_{DRM} max.	400	500	600	800	1000	1200	[2]

Currents (in either direction)

R.M.S. on-state current (conduction angle 360°) at T_{mb} = 85 °C	$I_{T(RMS)}$	max.	25	A
Repetitive peak on-state current	I_{TRM}	max.	100	A
Non-repetitive peak on-state current T_j = 125°C prior to surge; t = 10 ms; half sine-wave	I_{TSM}	max.	250	A
t = 20 ms; full sine-wave	I_{TSM}	max.	250	A
I^2t for fusing (t = 10 ms)	I^2t	max.	312	A^2s
Rate of rise of on-state current after triggering with I_{GT} to I_T = 100 A	$\frac{dI_T}{dt}$	max.	50	A/µs

GATE TO TERMINAL 1

Power dissipation

Average power dissipation (averaged over any 20 ms period)	$P_{G(AV)}$	max.	1	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

[1]) To ensure thermal stability: $R_{th\ j-a} < 3.5$ °C/W (a.c.)

[2]) Higher off-state voltages may be applied without damage, but at voltages higher than the minimum forward breakover voltage (see page 3) the triac may switch into the on-state. The rate of rise of on-state current should not exceed 50 A/µs

THERMAL RESISTANCE

From junction to mounting base full cycle operation	$R_{th\ j\text{-}mb}$	=	1.0	°C/W
half cycle operation	$R_{th\ j\text{-}mb}$	=	2.0	°C/W
From mounting base to heatsink with heatsink compound	$R_{th\ mb\text{-}h}$	=	0.2	°C/W
Transient thermal impedance; t = 1 ms	$Z_{th\ j\text{-}mb}$	=	0.12	°C/W

CHARACTERISTICS (Polarities, pos. or neg., are indentified with respect to T_1)

Voltages (in either direction)

			BTX94-400	500	600	800	1000	1200	
Breakover voltage up to $T_j = 125°C$	$V_{(BO)}$	>	500	600	700	900	1100	1300	V

On-state voltage $I_T = 50$ A; $T_j = 25$ °C	V_T	<	2.3	V
Rate of rise of off-state voltage that will not trigger any device; $T_j = 125°C$	$\frac{dV_D}{dt}$	<	100	V/µs
Rate of rise of commutating voltage that will not trigger any device $-dI/dt = 50$ A/ms; $T_j = 125$ °C	$\frac{dV_D}{dt}$	<	30	V/µs

Currents (in either direction)

			BTX94-400	500	600	800	1000	1200	
Peak off-state current $V_{DM} = V_{DWMmax}$; $T_j = 125$ °C	I_{DM}	<	9	9	9	9	8	7	mA

SWITCHING CHARACTERISTICS

Turn-on time ($t_{on} = t_d + t_r$) when switched from

$V_D = V_{DWMmax}$ to $I_T = 10$ A; $I_G = I_{GT}$; $T_j = 25$ °C	t_{on}	typ.	1.5	µs

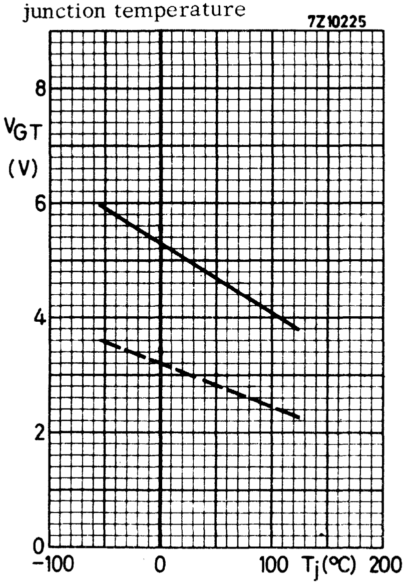
GATE TO TERMINAL 1

Voltage and Current

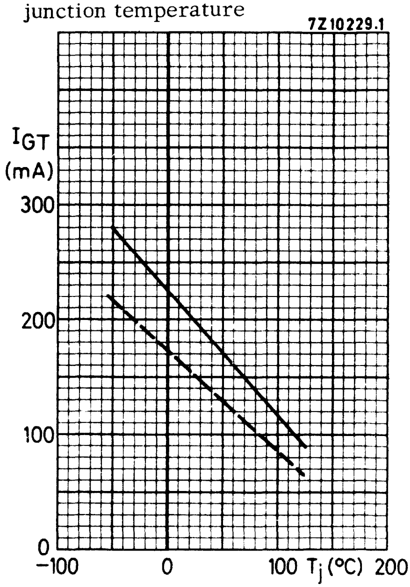
that will trigger all devices
$T_j = 25\,^oC$

			T2 pos.	T2 neg.	
G pos.	V_{GT}	>	3.0	5.0	V
	I_{GT}	>	150	200	mA
G neg.	$-V_{GT}$	>	3.0	3.0	V
	$-I_{GT}$	>	150	150	mA

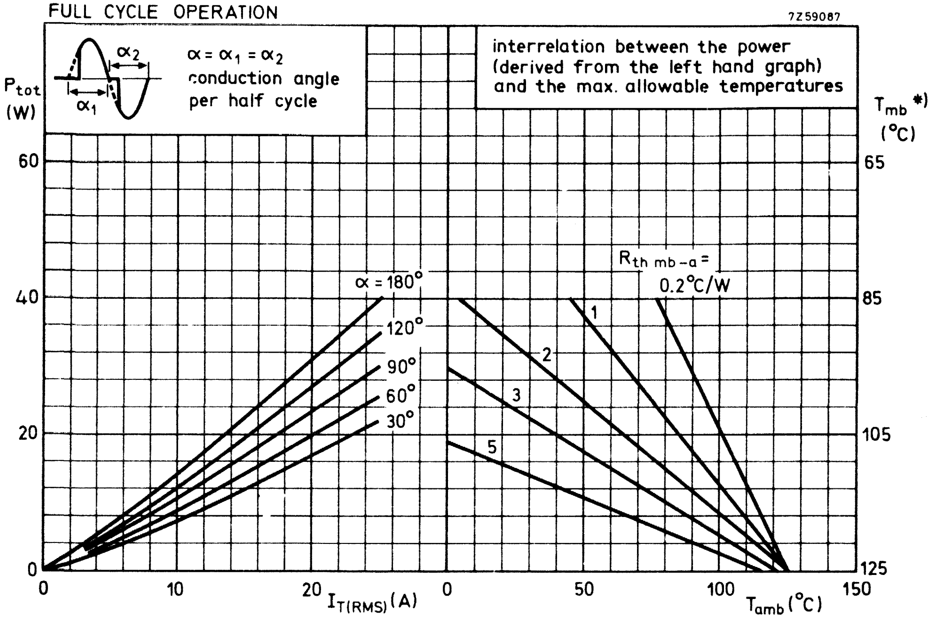
minimum trigger voltage versus junction temperature



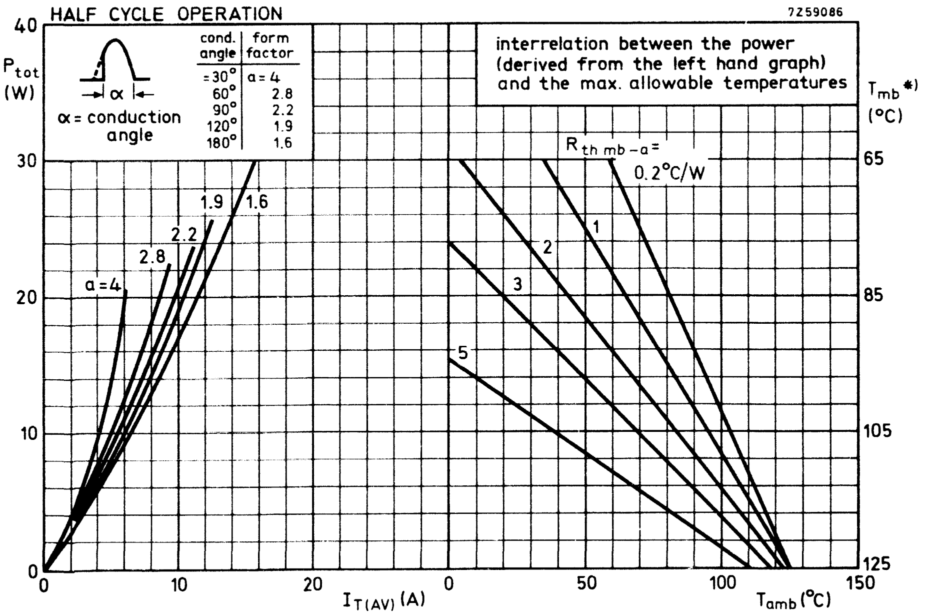
minimum trigger current versus junction temperature



—— terminal 2 negative with respect to 1; gate positive with respect to terminal 1.
---- all other conditions.

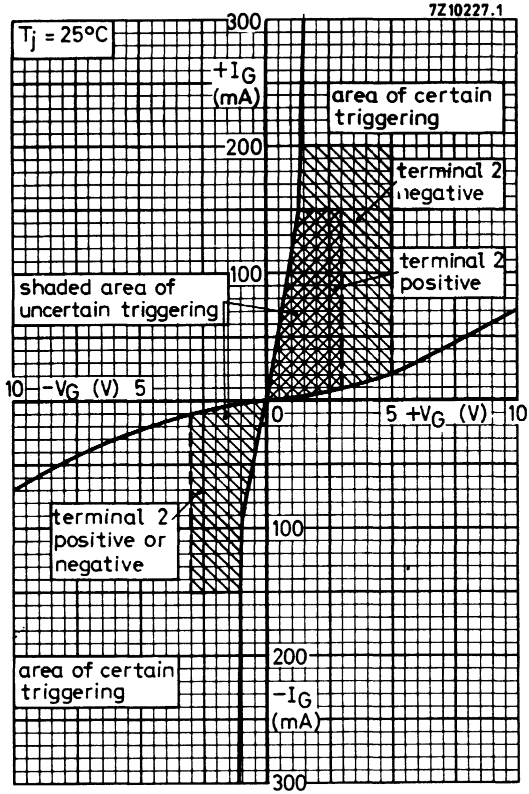


*) T_{mb}-scale is for comparison purposes only and is correct only for $R_{th\ mb-a} \leq 2.5\ ^\circ C/W$

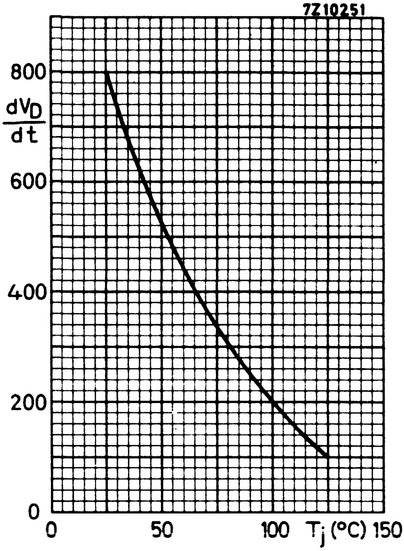


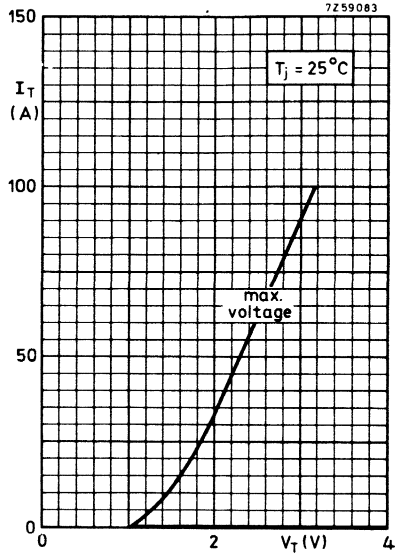
*) T_{mb}-scale is for comparison purposes only and is correct only for $R_{th\ mb-a} \leq 1.5\ ^\circ C/W$

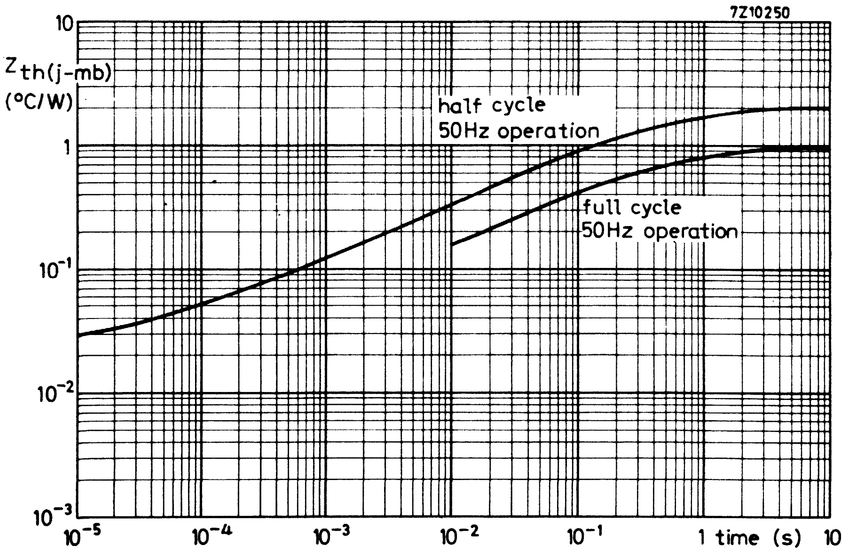
7Z10227.1

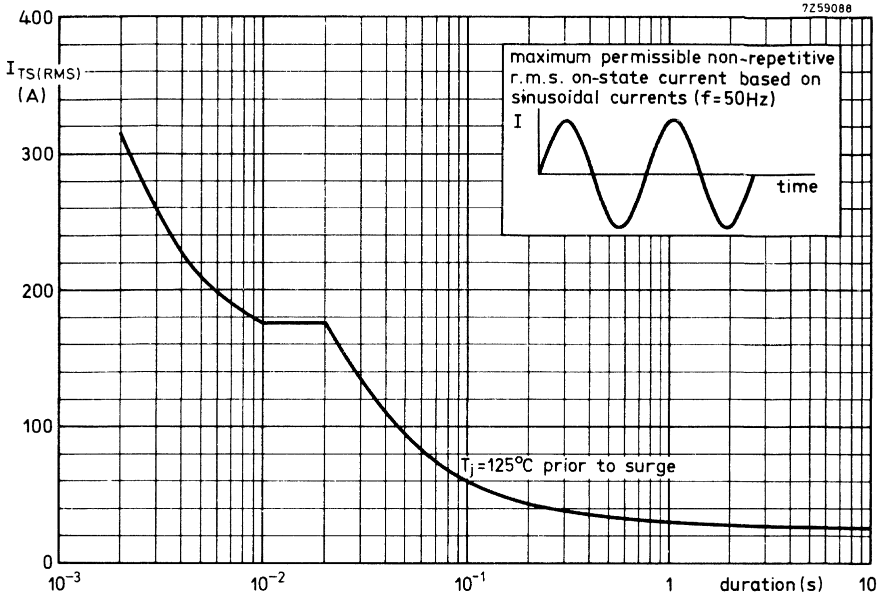

T_j = 25°C
300
+I_G
(mA)
area of certain triggering
200
terminal 2 negative
terminal 2 positive
100
shaded area of uncertain triggering
10
−V_G (V) 5
0
5 +V_G (V)
10
terminal 2 positive or negative
100
200
area of certain triggering
−I_G
(mA)
300

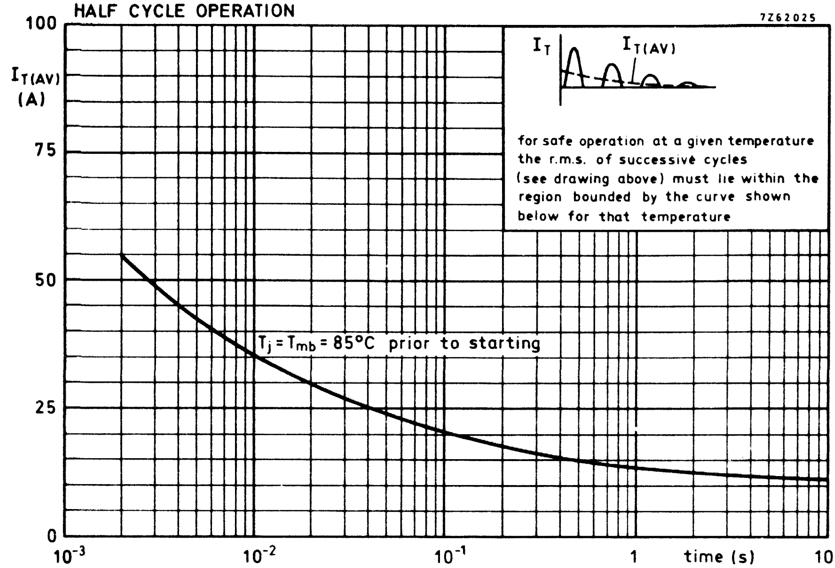
max. rate of rise of off-state voltage
that will not trigger any device.
(non-commutated condition)

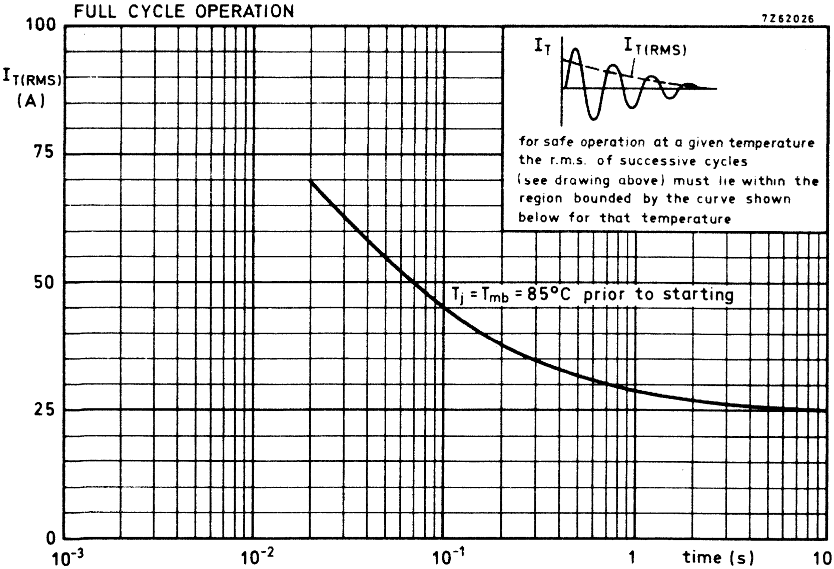







7Z59088
400
300
200
100
0
$I_{TS(RMS)}$
(A)
maximum permissible non-repetitive r.m.s. on-state current based on sinusoidal currents (f=50Hz)
I
time
T_j=125°C prior to surge
10^{-3}
10^{-2}
10^{-1}
1
duration (s)
10


HALF CYCLE OPERATION
7Z62025
$I_{T(AV)}$ (A)
100
75
50
25
0
10^{-3}
10^{-2}
10^{-1}
1
time (s)
10
I_T
$I_{T(AV)}$
for safe operation at a given temperature the r.m.s. of successive cycles (see drawing above) must lie within the region bounded by the curve shown below for that temperature
$T_j = T_{mb} = 85°C$ prior to starting


FULL CYCLE OPERATION
7Z62026
$I_{T(RMS)}$ (A)
100
75
50
25
0
10^{-3}
10^{-2}
10^{-1}
1
time (s)
10
I_T
$I_{T(RMS)}$
for safe operation at a given temperature the r.m.s. of successive cycles (see drawing above) must lie within the region bounded by the curve shown below for that temperature
$T_j = T_{mb} = 85°C$ prior to starting

PULSE MODULATOR THYRISTORS

The BTX95series is a range of fast-switching, high voltage thyristors particularly designed for radar and other similar pulse modulator applications. They are capable of switching peak powers of up to 150 kW at frequencies up to 5 kHz. The series consists of reverse polarity types (anode to stud) BTX95-500R to BTX95-800R.

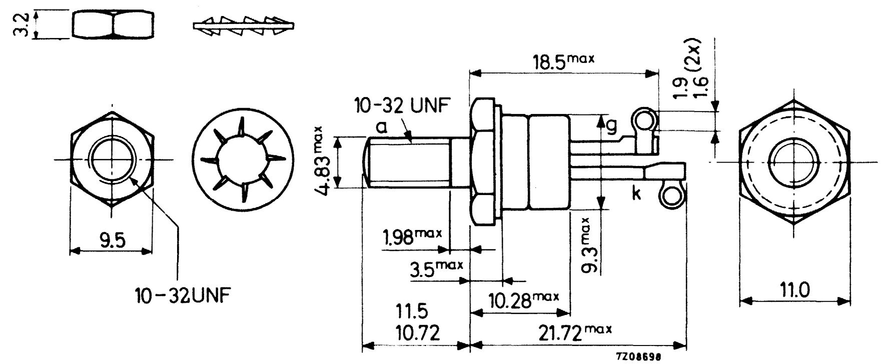
QUICK REFERENCE DATA

			BTX95-500R	600R	700R	800R	
Crest working reverse voltage	V_{RWM}	max.	250	300	350	400	V
Crest working off-state voltage	V_{DWM}	max.	500	600	700	800	V
Rise time I_{TM} = 40 A; T_j = 25 °C	t_r	<	375	300	250	220	ns

Repetitive peak forward current	I_{TRM}	max.	300	A
Junction temperature	T_j	max.	105	°C
Rate of rise of on-state current	$\frac{dI_T}{dt}$	max.	1000	A/μs

MECHANICAL DATA Dimensions in mm

TO-64



Net weight: 7.5 g
Diameter of clearance hole: max. 5.2 mm
Accessories available: 56295, (56262A)

Torque on nut: min. 8 cm kg (0.8 Newton-metres)
max. 17 cm kg (1.7 Newton-metres)

All information applies to frequencies up to 5 kHz.

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

ANODE TO CATHODE

Voltages [1]			BTX95-500R	600R	700R	800R	
Continuous reverse voltage	V_R	max.	250	300	350	400	V
Maximum crest working reverse voltage	V_{RWM}	max.	250	300	350	400	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

[1]) To ensure thermal stability $R_{th\ j-a} \leq 7.5\,^{o}C/W$.

RATINGS (continued)

Currents

R.M.S. on-state current	$I_{T(RMS)}$	max.	15	A
Repetitive peak on-state current				
square wave; $t \leq 2 \mu s$	I_{TRM}	max.	100	A
half sine wave: $t \leq 2 \mu s$	I_{TRM}	max.	200	A
half sine wave with saturable reactor priming and delay (10 A for 2 μs) $t \leq 12 \mu s$ (see also page 7)	I_{TRM}	max.	300	A
Rate of rise of on-state current after triggering with I_G = 100 mA	$\frac{dI_T}{dt}$	max.	1000	A/μs
after breakover	$\frac{dI_T}{dt}$	max.	50	A/μs

Power dissipation

Average on-state power dissipation	$P_{T(AV)}$	max.	15	W
Repetitive peak on-state power dissipation without saturable reactor; square wave operation	P_{TRM}	max.	15	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.	5	A

Power dissipation

Average power dissipation	$P_{G(AV)}$	max.	1	W
Peak power dissipation	P_{GM}	max.	20	W

OPERATING FREQUENCY

Operating frequency (see also page 5)	f	max.	5	kHz

TEMPERATURES

Storage temperature	T_{stg}		−55 to +125	^oC
Operating junction temperature	T_j	max.	105	^oC

THERMAL RESISTANCE

From junction to ambient in free air	$R_{th\ j-a}$	=	40	°C/W
From junction to mounting base	$R_{th\ j-mb}$	=	3.0	°C/W
From mounting base to heatsink	$R_{th\ mb-h}$	=	0.5	°C/W

CHARACTERISTICS

ANODE TO CATHODE

On-state voltage

1. I_T = 10 A; T_j = 25 °C	V_T	<	3	V [1]
2. at 50 ns after 10% decay point of pulse forming network discharge to 40 A peak value I_G = 100 mA; T_j = 25 °C	V_T	<	200	V
3. at 250 ns after 10% decay as above T_j = 25 °C	V_T	<	70	V

Currents

		BTX95-500R	600R	700R	800R	
Peak reverse current $V_{RM} = V_{RWMmax}$; T_j = 105 °C	I_{RM}	< 3.0	2.5	2.0	2.0	mA
Peak off-state current $V_{DM} = V_{DWMmax}$; T_j = 105 °C	I_{DM}	< 6.0	5.0	4.0	3.5	mA

GATE TO CATHODE

Voltages

Voltage that will trigger all devices V_D = 6 V; T_j = 25 °C	V_{GT}	>	1.5	V
Voltage that will not trigger any device $V_D = V_{DRMmax}$; T_j = 105 °C	V_{GD}	<	150	mV

Current

Current that will trigger all devices V_D = 6 V; T_j = 25 °C	I_{GT}	>	50	mA

SWITCHING CHARACTERISTICS

Rise time

		BTX95-500R	600R	700R	800R	
I_{TM} = 40 A; T_j = 25 °C	t_r	< 375	300	250	220	ns

Turn off time when switched from

I_T = 40 A to I_R = 2 A; T_j = 105 °C; $\frac{dV_D}{dt}$ = 20 V/μs linear ramp	t_q	<	50	μs

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

OPERATING NOTES

Enhanced performance of the devices

The power loss curves on pages 6 and 7 are given on the basis of the device operating at its maximum permitted junction temperature of 105 °C, but significant improvement in performance can be obtained by a choice of heatsink to ensure that the junction is operating at a lower temperature. This is due to the following factors:

1. On-state forward voltage is lower at lower temperatures giving lower power losses in switching.
2. Turn-off time is lower at lower temperatures (curves on page 9), hence the maximum operating frequency can be increased above 5 kHz, assuming that the maximum power rating of the device is not exceeded.

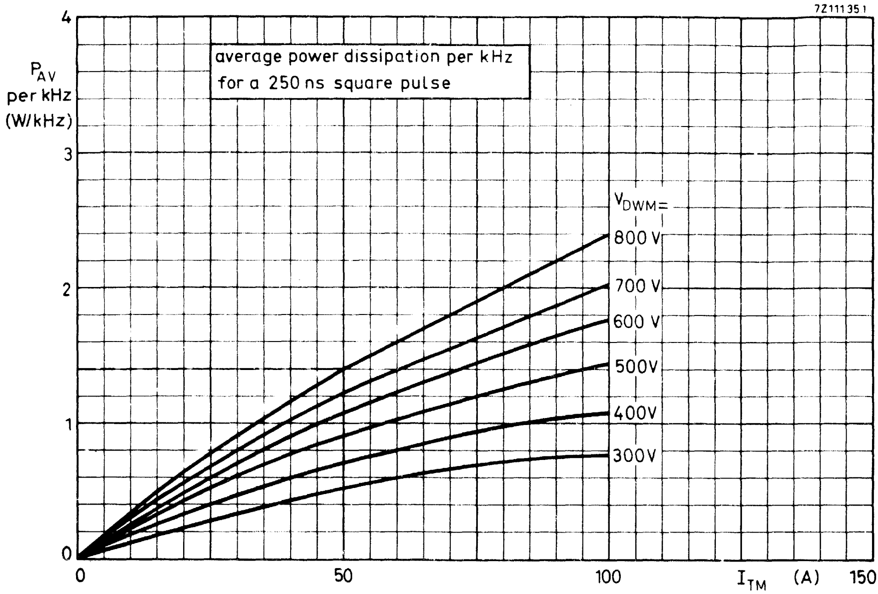
   therefore $f_{max} = \frac{1}{4\, t_q}$ in sinewave charging operation

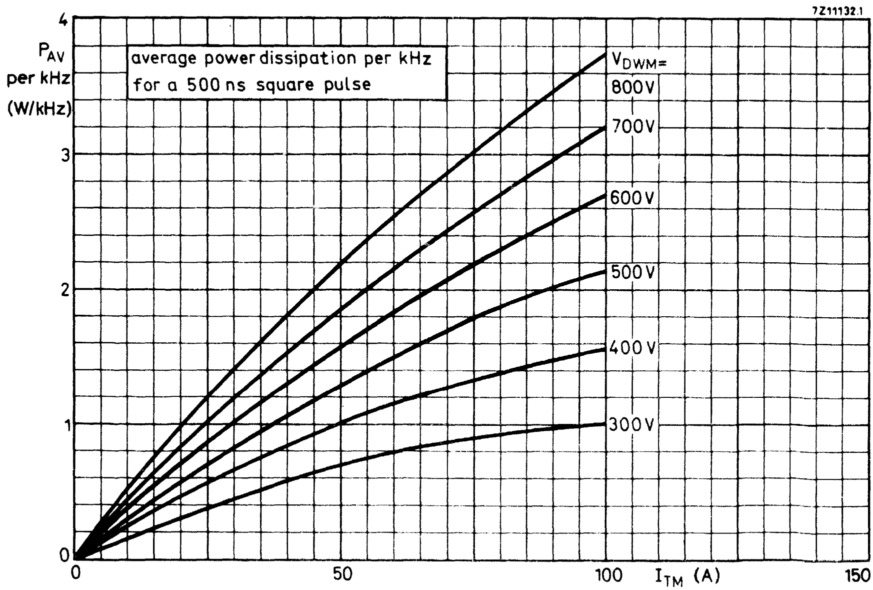
   This assumes that the requirements of dV/dt are met (see below)
3. The maximum operating frequency is also governed by the dV/dt capability of the thyristor, due to the enforced limitation on pulse forming network charging rate. Page 7 shows how dV/dt improves at lower temperatures.

   f_{max} is then given as $= \frac{dV/dt\,(V/\mu s) \times 10^6}{5.7 \times V_{Dmax}}$

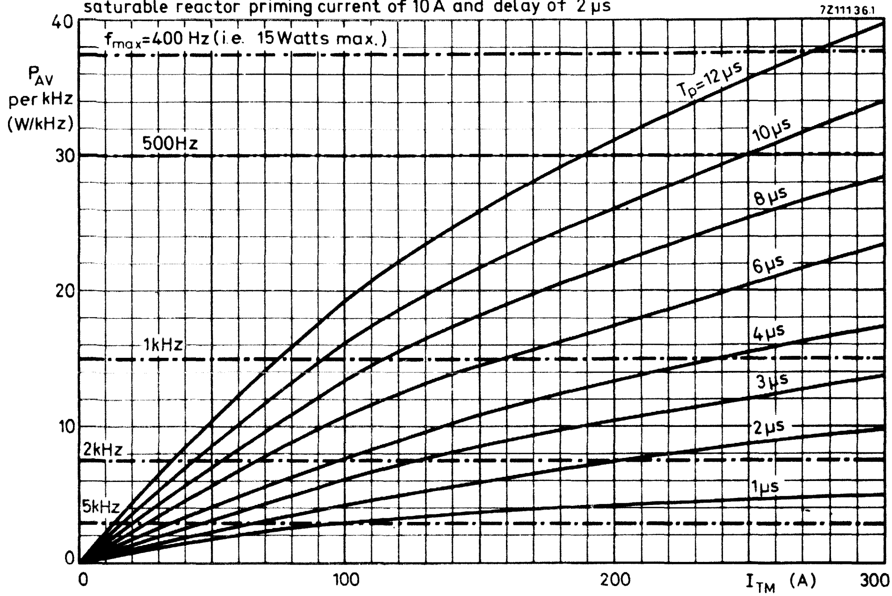
   where V_{Dmax} is the peak value of the off-state voltage to be switched.

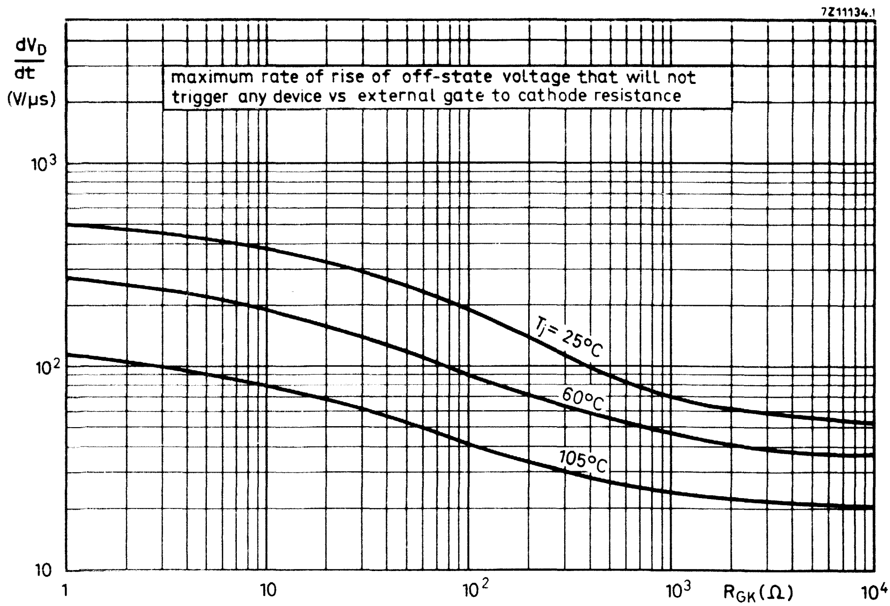
Both conditions 2 and 3 must apply simultaneously and the lower value found for f_{max} is the correct one to use.

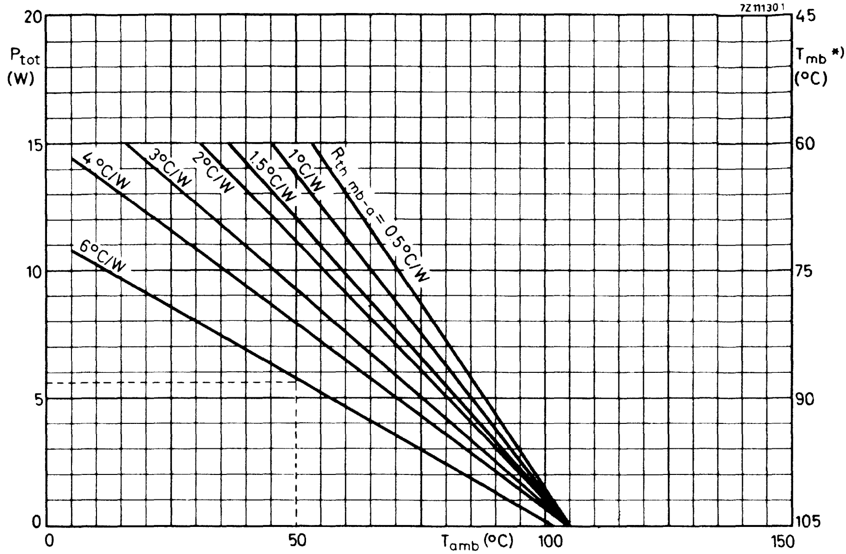

7Z11135.1
4
P_{AV}
per kHz
(W/kHz)
3
2
1
0
average power dissipation per kHz
for a 250 ns square pulse
V_{DWM} =
800 V
700 V
600 V
500V
400V
300V
0
50
100
I_{TM} (A)
150


7Z11132.1
4
P_{AV}
per kHz
(W/kHz)
3
2
1
0
average power dissipation per kHz
for a 500 ns square pulse
V_{DWM} =
800V
700V
600V
500V
400V
300V
0
50
100
I_{TM} (A)
150

Average power dissipation per kHz for sinusoidal pulses when used with saturable reactor priming current of 10 A and delay of 2 μs







*) T_{mb}-scale is for comparison purposes only and is correct only for $R_{th\ mb-a} \leq$ 4.5 °C/W

Determination of the heatsink thermal resistance.

Example:

Assume a thyristor, operating without a delay reactor, switching square pulses.

Repetitive peak on-state current	I_{TRM}	=	50	A
Pulse duration	t_p	=	250	ns
Crest working voltage	V_{DWM}	=	800	V
Pulse frequency	f	=	4	kHz
Ambient temperature	T_{amb}	=	50	°C

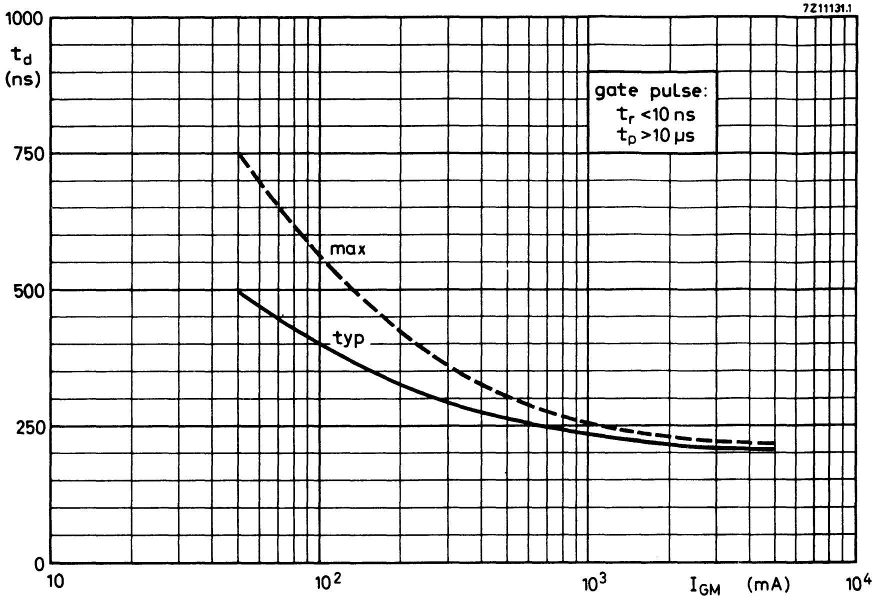
From the upper graph on page 5 it follows, that at I_{TRM} = 50 A and V_{DWM} = 800 V, the power loss per kHz = 1.4 W/kHz
The total power loss at f = 4 kHz: (4 x 1.4) W = 5.6 W

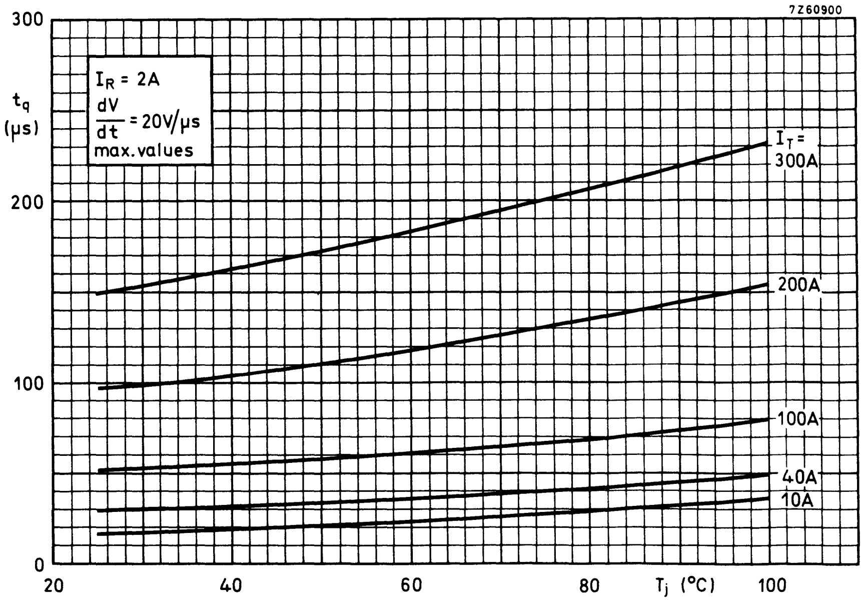
From the curve on this page, the required value of $R_{th\ mb-a}$ can be found.
At P_{tot} = 5.6 W and T_{amb} = 50 °C : $R_{th\ mb-a} \approx 6$ °C/W.

The contact thermal resistance $R_{th\ mb-h}$ = 0.5 °C/W.

Hence the heatsink thermal resistance should be:

$$R_{th\ h-a} = R_{th\ mb-a} - R_{th\ mb-h} = (6-0.5)\ ^{o}C/W = 5.5\ ^{o}C/W.$$


7Z11131.1
1000
t_d
(ns)
750
500
250
0
10
10^2
10^3
I_{GM} (mA)
10^4
gate pulse:
t_r <10 ns
t_p >10 μs
max
typ


7Z60900
300
t_q
(μs)
200
100
0
20
40
60
80
T_j (°C)
100
I_R = 2A
$\frac{dV}{dt}$ = 20V/μs
max. values
I_T =
300A
200A
100A
40A
10A

APPLICATION INFORMATION

Introduction

The behaviour of a magnetron in terms of stability, r.f. spectrum, frequency pulsing, etc. may be influenced considerably by the characteristics of the pulse modulator. Modulator and magnetron must be considered to be very closely interdependent.
For this reason, it is recommended that proposed designs for any particular magnetron-modulator combination should be discussed with the appropriate magnetron engineer.

Typical operating conditions of the magnetron YJ1200

	a	b	
Pulse duration	0.25	4	μs [1]
Pulse frequency	4000	400	Hz
Pulse voltage (V_p)	12		kV
Pulse current (I_p)	12		A
Duty factor (maximum value)	0.0025		
Rate of rise of voltage	80		kV/μs [2]
Output power (r.f. pulse)	50		kW

1. The current rating I_{TRM} (see page 3) of the BTX95series permits these operating conditions to be achieved using a pulse compression type modulator (see circuit on page 10). The thyristor current pulse is a half sine-wave having approximately a peak value

$$I_{TRM} = \pi \cdot I_p \cdot \frac{N_e}{N_t}$$

where I_p = magnetron pulse current

$$N_e = \frac{\text{magnetron pulse voltage } (V_p)}{\text{storage capacitor voltage } (V_{C1})}$$

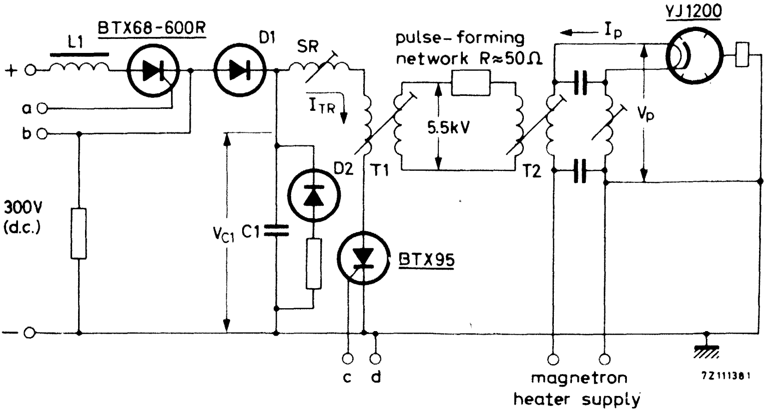
$$N_t = \frac{\text{thyristor pulse duration}}{\text{magnetron pulse duration}}$$

Assume for the 4μs application N_t = 3 and N_e = 20, giving V_{C1} = 600 V (i.e. thyristor off-state voltage). The resulting thyristor peak pulse current I_{TRM} = 250 A has a duration of 12 μs.
In practice, the current may be up to 20% higher due to magnetising current and core loss in transformer T1.

The values N_t = 3 and $\frac{dI_T}{dt}$ = 1000 A/μs permit operation of the magnetron at pulse duration down to 0.3 μs; with higher values of N_t, shorter pulse durations are achieved.

[1] Duration measured at 50% of current pulse amplitude.
[2] Voltage rate of rise is the slope of the steepest tangent to the leading edge above 80% of the voltage pulse amplitude.

APPLICATION INFORMATION (continued)



L1 = charging inductor
D1 = hold-off diode
D2 = inverse diode
SR = 1 μs delay- and priming reactor
T1 = saturable-core charging transf. (n = 1 : 9)
T2 = saturable-core pulse transf. (n = 1 : 4.5) (bifilar secondary)
a;b = delayed-charging trigger
c;d = main trigger

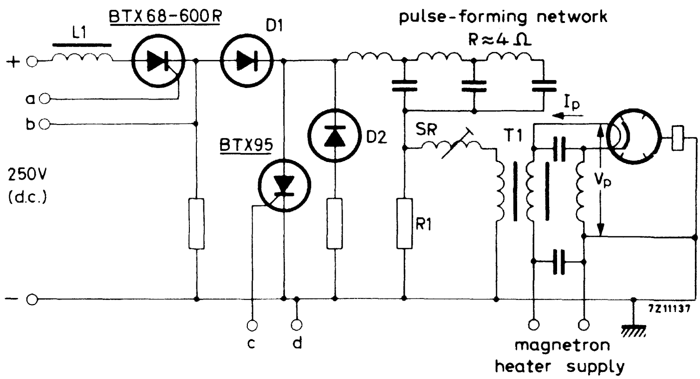
2. Magnetrons of lower power rating may be driven by more conventional line type modulators (see circuit on page 12). A marine radar magnetron of 3 kW r.f. output power has the following typical operation conditions:

	a	b	
Pulse duration	0.05	0.5	μs [1]
Pulse frequency	2	1	kHz
Pulse voltage	3.8		kV
Pulse current	3		A
Duty factor (maximum value)	0.001		
Rate of rise of voltage	60		kV/μs [2]

Those conditions are achieved in the circuit on page 12, with a pulse transformer ratio of 1 : 20 and a pulse forming network voltage of 450 V to 500 V. With correct adjustment of the pulse transformer distributed capacitance and leakage inductance, the load capacitance, the saturated inductance of reactor SR and the network parameters, the specified rate of rise of off-state voltage is achieved at the correct point on the leading edge, and the thyristor current pulse (65 A peak value) has a sinusoidal leading-edge of initial $\frac{dI_T}{dt} = 1000$ A/μs.

[1] Duration measured at 50% of current pulse amplitude.
[2] Voltage rate of rise is the slope of the steepest tangent to the leading edge above 80% of the voltage pulse amplitude.

APPLICATION INFORMATION (continued)



L1 = charging inductor
D1 = hold-off diode
D2 = inverse diode
SR = 0.25 to 0.5 μs delay reactor
R1 = priming current resistor (≈100 Ω)
T1 = linear pulse transformer
a; b = delayed-charging trigger
c; d = main trigger

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 reverse polarity types (anode to stud) BTY79-400R to BTY79-1000R.

QUICK REFERENCE DATA

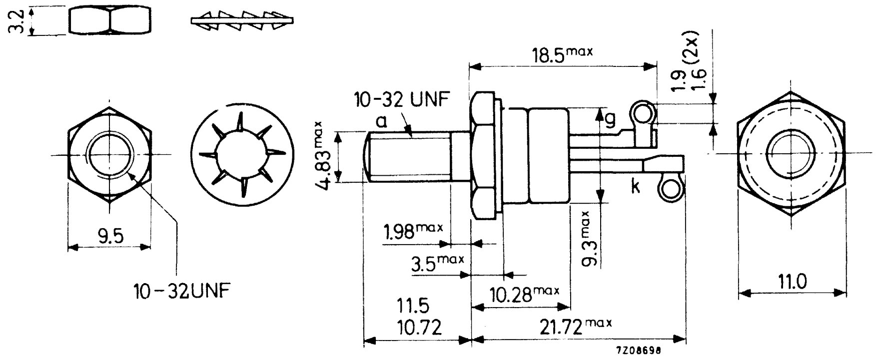
		BTY79-400R	500R	600R	800R	1000R	
Repetitive peak voltages $V_{DRM} = V_{RRM}$	max.	400	500	600	800	1000	V
Crest working voltages $V_{DWM} = V_{RWM}$	max.	400	500	600	800	1000	V
Forward breakover voltage $V_{(BO)}$	>	400	500	600	800	1000	V

Average on-state current at T_{mb} = 85 °C	$I_{T(AV)}$	max.	6.4	A
R.M.S. on-state current	$I_{T(RMS)}$	max.	10	A
Non-repetitive peak on-state current t = 10 ms; T_j = 125 °C prior to surge	I_{TSM}	max.	80	A
Junction temperature	T_j	max.	125	°C
Rate of rise of on-state current after triggering	$\frac{dI_T}{dt}$	max.	20	A/µs
Rate of rise of off-state voltage that will not trigger any device	$\frac{dV_D}{dt}$	<	20	V/µs

MECHANICAL DATA see page 2

MECHANICAL DATA — Dimensions in mm

TO-64



Net weight: 7.5 g
Diameter of clearance hole: max. 5.2 mm
Accessories supplied on request: 56295; (56262A)

Torque on nut: min. 8 kg cm (0.8 Newton-metres)
max. 17 kg cm (1.7 Newton-metres)

All information applies to frequencies up to 400 Hz.

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

ANODE TO CATHODE

Voltages [1]		BTY79-400R	500R	600R	800R	1000R	
Non-repetitive peak off-state voltage ($t \leq$ 10 ms) V_{DSM} [2]	max.	500	1100	1100	1100	1100	V
Non-repetitive peak reverse voltage ($t \leq$ 5 ms) V_{RSM}	max.	500	600	720	960	1100	V
Repetitive peak voltages $V_{DRM} = V_{RRM}$	max.	400	500	600	800	1000	V
Crest working voltages $V_{DWM} = V_{RWM}$	max.	400	500	600	800	1000	V
Continuous voltages $V_D = V_R$	max.	400	500	600	800	1000	V

1) To ensure thermal stability: $R_{th\ j\text{-}a} < 6\ ^oC/W$ (d.c. blocking) or $< 12\ ^oC/W$ (a.c.)

2) Higher off-state voltages may be applied without damage, but at voltages higher than the minimum forward breakover voltage (see page 4) the thyristor may switch into the on-state. The rate of rise of on-state current should not exceed 100 A/µs.

RATINGS (continued)

Currents

Average on-state current (averaged over any 20 ms period) at T_{mb} = 85 °C	$I_{T(AV)}$	max.	6.4	A
On-state current (d.c.)	I_T	max.	10	A
R.M.S. on-state current	$I_{T(RMS)}$	max.	10	A
Repetitive peak on-state current	I_{TRM}	max.	60	A
Non-repetitive peak on-state current (t = 10 ms; half sine wave) T_j = 125 °C prior to surge	I_{TSM}	max.	80	A
I^2t for fusing (t = 10 ms)	I^2t	max.	32	A^2s
Rate of rise of on-state current after triggering with $I_G = I_{GT}$ to $I_T = 3 \times I_{T(AV)}$	$\frac{dI_T}{dt}$	max.	20	A/µs
Repetitive peak reverse current (during turn-off)	I_{RRM}	max.	5	A

GATE TO CATHODE

Voltages

Forward peak voltage	V_{FGM}	max.	10	V
Reverse peak voltage	V_{RGM}	max.	5	V

Power dissipation

Average power dissipation (averaged over any 20 ms period)	$P_{G(AV)}$	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	$R_{th\ j\text{-}mb}$	=	3.0 °C/W
From mounting base to heatsink	$R_{th\ mb\text{-}h}$	=	0.5 °C/W
From mounting base to heatsink with mica washer	$R_{th\ mb\text{-}h}$	=	4.0 °C/W
Transient thermal impedance (t = 1 ms)	$Z_{th\ j\text{-}mb}$	=	0.16 °C/W

CHARACTERISTICS

ANODE TO CATHODE

Voltages			BTY79-400R	500R	600R	800R	1000R
On-state voltage I_T = 20 A; T_j = 25 °C	V_T	<	2.3	2.3	2.3	2.3	2.3 V
Forward breakover voltage up to T_j = 125 °C	$V_{(BO)}$	>	400	500	600	800	1000 V
Rate of rise of off-state voltage that will not trigger any device; T_j = 125 °C	$\frac{dV_D}{dt}$	<	20	20	20	20	20 V/μs
Currents							
Peak reverse current $V_{RM} = V_{RWMmax}$; T_j = 125 °C	I_{RM}	<	5	2.5	2.5	2.5	2.5 mA
Peak off-state current $V_{DM} = V_{DWMmax}$; T_j = 125 °C	I_{DM}	<	5	2.5	2.5	2.5	2.5 mA

Holding current; T_j = 25 °C	I_H	typ.	10 mA

GATE TO CATHODE

Voltages

Voltage that will trigger all devices V_D = 6 V; T_j = 25 °C	V_{GT}	>	2.5 V
Voltage that will not trigger any device $V_D = V_{DWMmax}$; T_j = 125 °C	V_{GD}	<	250 mV

Current

Current that will trigger all devices V_D = 6 V; T_j = 25 °C	I_{GT}	>	25 mA

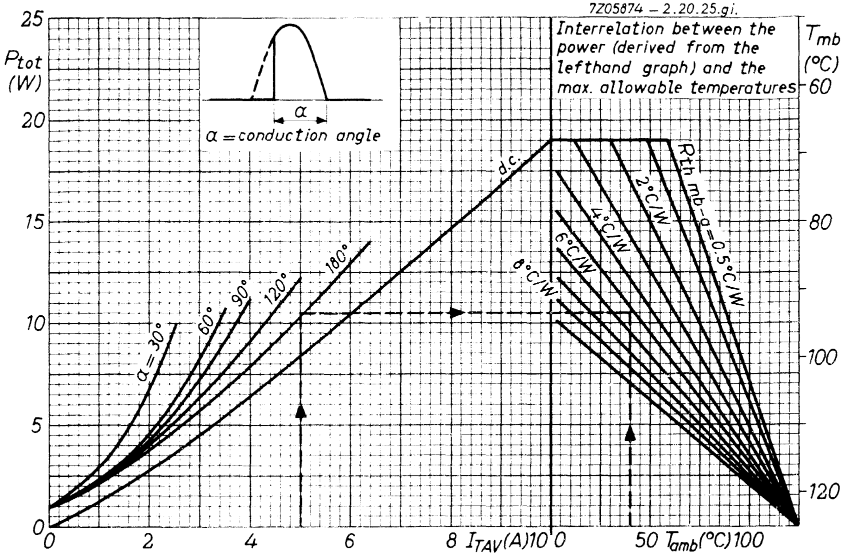
CHARACTERISTICS (continued)

SWITCHING CHARACTERISTICS

Turn-on time ($t_{on} = t_d + t_r$) when switched from V_D = 50 V to I_T = 10 A; I_{GT} = 150 mA; T_j = 25 °C	t_{on}	typ.	3	μs
Circuit-commutated turn-off time when switched from I_T = 5 A to $V_R \geq$ 50 V with $-dI_T/dt$ = 5 A/μs; dV_D/dt = 10 V/μs				
T_j = 125 °C	t_q	<	100	μs
T_j = 25 °C	t_q	<	50	μs

OPERATING NOTES

1. The gate and cathode connectors should not be bent; they should be soldered into the circuit so that there is no strain on them.



EXAMPLE (Determination of the heatsink thermal resistance)

Assume the thyristor used in a 50 Hz single phase full wave rectifier circuit (conduction angle $\alpha = 180^{0}$) at $T_{amb} = 40\ ^{0}C$.
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 $\alpha = 180^{0}$ 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 $T_{amb} = 40\ ^{0}C$.

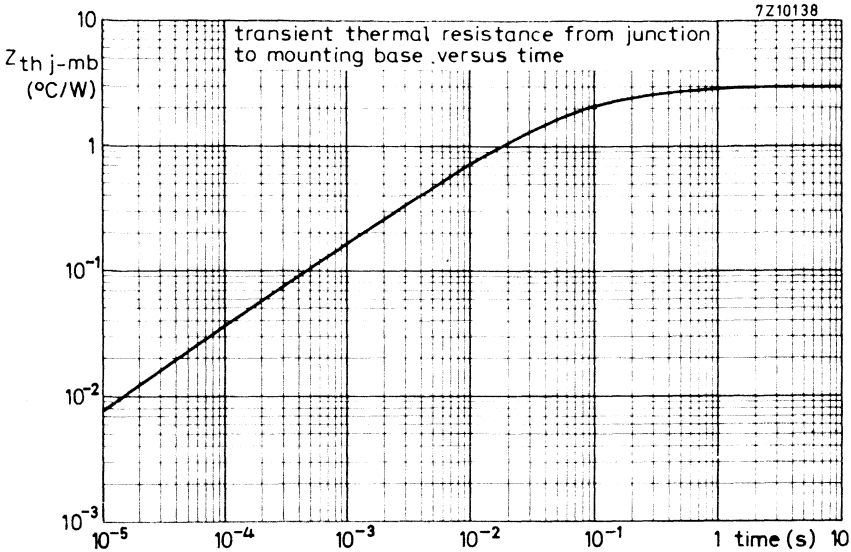
$$R_{th\ mb-a} \approx 5.2\ ^{0}C/W$$

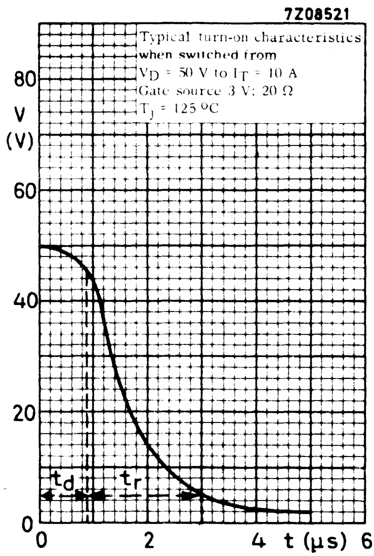
The contact thermal resistance $R_{th\ mb-h} = 0.5\ ^{0}C/W$

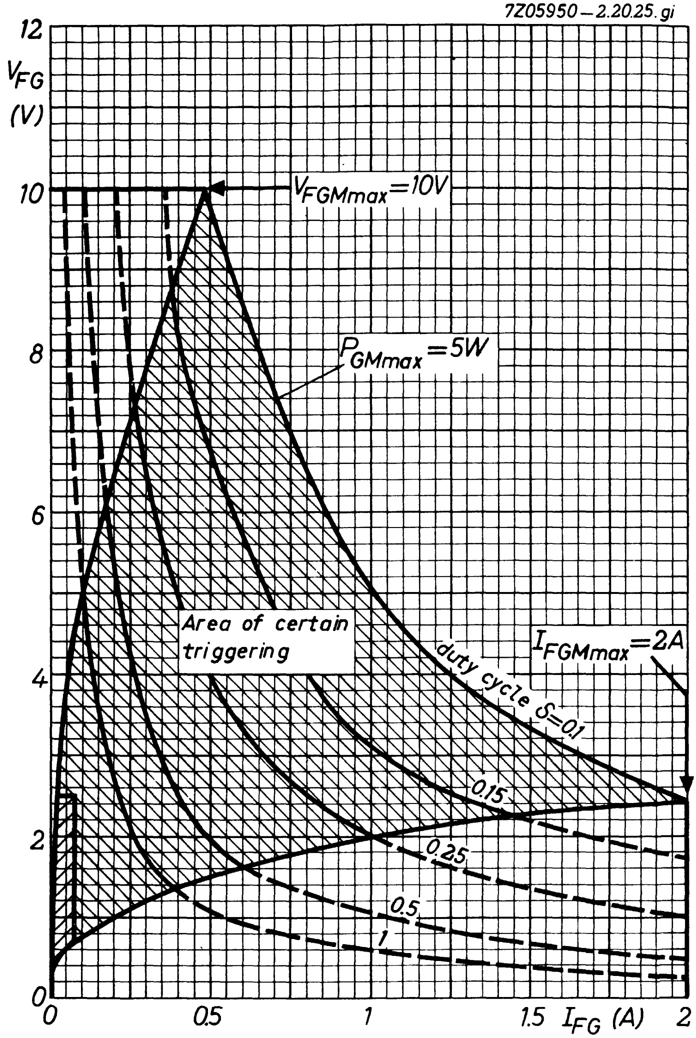
Hence the heatsink thermal resistance should be:

$$R_{th\ h-a} = R_{th\ mb-a} - R_{th\ mb-h} = (5.2 - 0.5)\ ^{0}C/W = 4.7\ ^{0}C/W$$

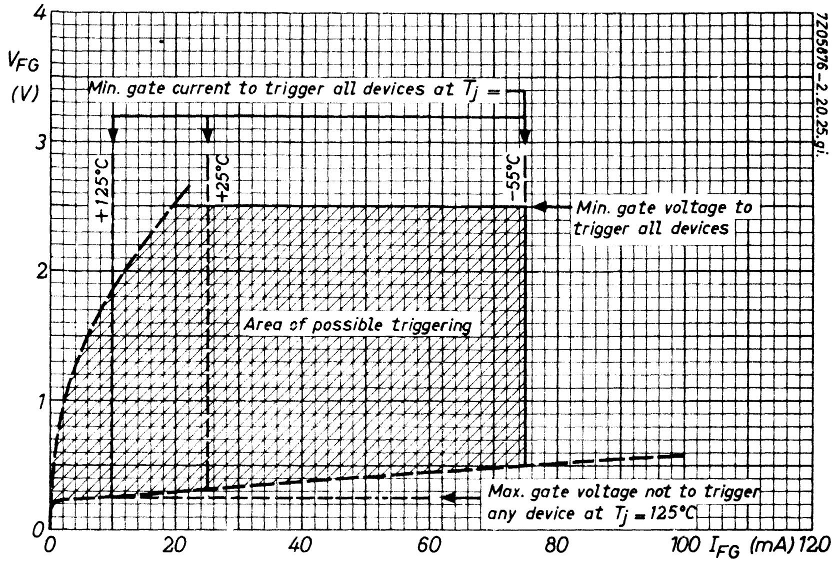
The applicable heatsink(s) may then be found in the section HEATSINKS.

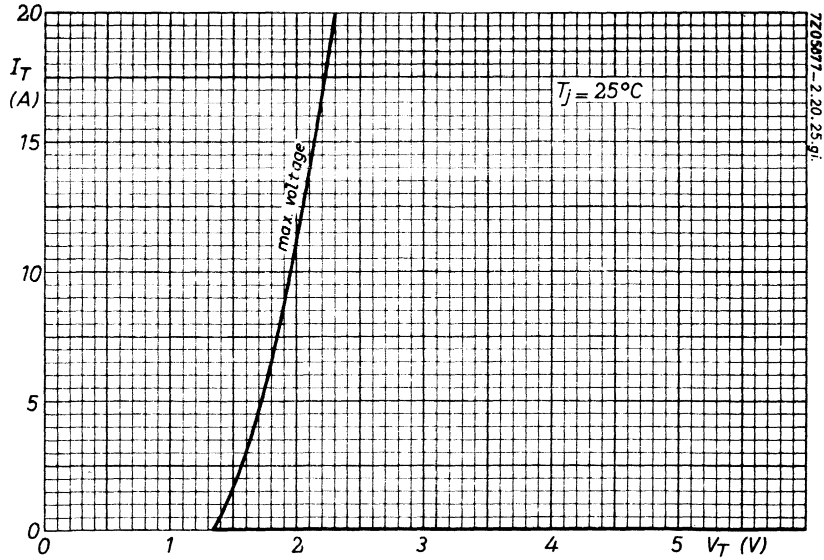

7Z10138
transient thermal resistance from junction to mounting base versus time
Z th j-mb
(°C/W)
10
1
10⁻¹
10⁻²
10⁻³
10⁻⁵
10⁻⁴
10⁻³
10⁻²
10⁻¹
1
time (s)
10

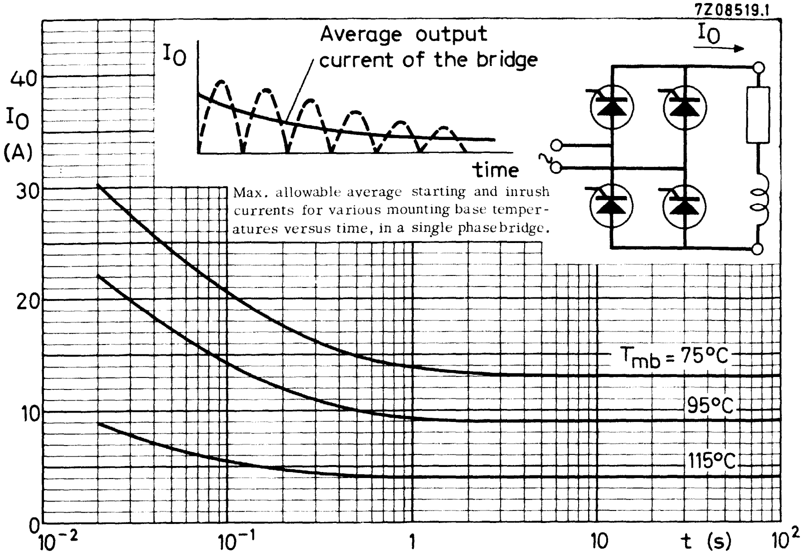

7Z08521
Typical turn-on characteristics
when switched from
VD = 50 V to IT = 10 A
Gate source 3 V; 20 Ω
Tj = 125 °C
V
(V)
80
60
40
20
0
td
tr
0
2
4
t (μs)
6



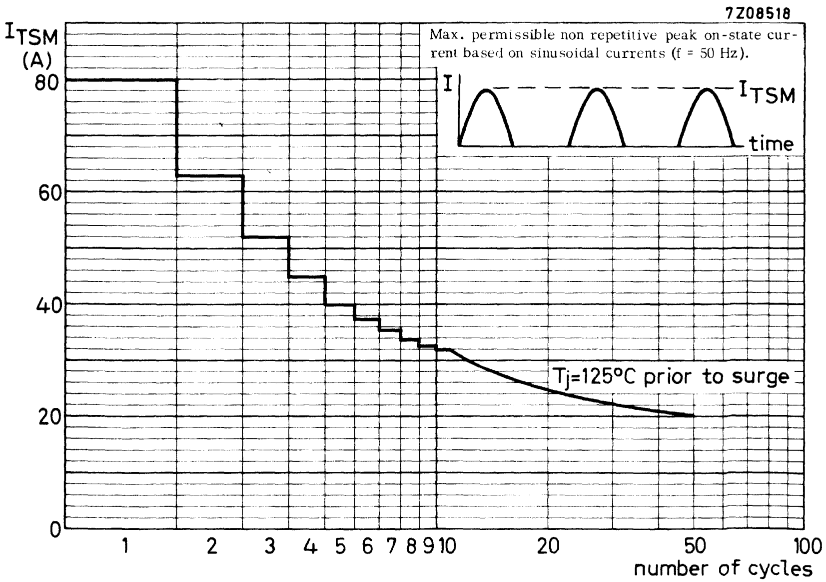
Gate characteristics with curves P_{GAV}=0.5W


4
V_{FG}
(V)
3
2
1
0
Min. gate current to trigger all devices at T_j =
+125°C
+25°C
−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
20
40
60
80
100 I_{FG} (mA) 120
7Z05876-2.20.25.gi.


20
I_T
(A)
15
10
5
0
T_j = 25°C
max. voltage
0
1
2
3
4
5 V_T (V)
7Z05877-2.20.25.gi.



Max. allowable average starting and inrush currents for various mounting base temperatures versus time, in a single phase bridge.



Max. permissible non repetitive peak on-state current based on sinusoidal currents (f = 50 Hz).

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 reverse polarity types (anode to stud) BTY87-400R to 800R.

QUICK REFERENCE DATA

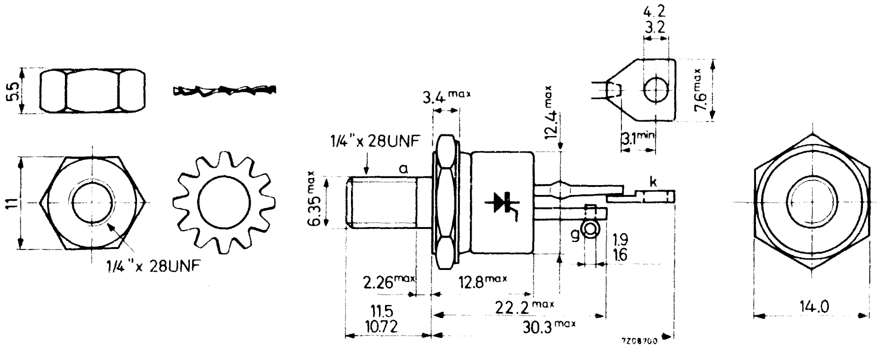
		BTY87-400R	500R	600R	800R	
Repetitive peak voltages $V_{DRM} = V_{RRM}$	max.	400	500	600	800	V
Crest working voltages $V_{DWM} = V_{RWM}$	max.	400	500	600	800	V
Forward breakover voltage $V_{(BO)}$	>	400	500	600	800	V

Average on-state current up to T_{mb} = 52 °C	$I_{T(AV)}$	max.	16	A
at T_{mb} = 85 °C	$I_{T(AV)}$	max.	10	A
R.M.S. on-state current	$I_{T(RMS)}$	max.	25	A
Non-repetitive peak on-state current t = 10 ms; T_j = 125 °C prior to surge	I_{TSM}	max.	140	A
Junction temperature	T_j	max.	125	°C
Rate of rise of on-state current after triggering	$\frac{dI_T}{dt}$	max.	20	A/µs
Rate of rise of off-state voltage that will not trigger any device	$\frac{dV_D}{dt}$	<	20	V/µs

MECHANICAL DATA see page 2

MECHANICAL DATA
TO-48

Dimensions in mm



Torque on nut: min. 17 kg cm (1.7 Newton-metres)
max. 35 kg cm (3.5 Newton-metres)

Net weight: 15 g
Diameter of clearance hole: max. 6.5 mm
Accessories supplied on request: 56264A

All information applies to frequencies up to 400 Hz.

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

ANODE TO CATHODE

		BTY87-400R	500R	600R	800R
Voltages [1]					
Non-repetitive peak off-state voltage ($t \leq 10$ ms) V_{DSM} [2]	max.	500	850	850	850 V
Non-repetitive peak reverse voltage ($t \leq 5$ ms) V_{RSM}	max.	500	600	850	960 V
Repetitive peak voltages $V_{DRM} = V_{RRM}$	max.	400	500	600	800 V
Crest working voltages $V_{DWM} = V_{RWM}$	max.	400	500	600	800 V
Continuous voltages $V_D = V_R$	max.	400	500	600	800 V

[1] To ensure thermal stability: $R_{th\ j\text{-}a} < 4.5$ °C/W (d.c. blocking) or < 9 °C/W (a.c.). For smaller heatsinks $T_{j\ max}$ should be derated.

[2] Higher off-state voltages may be applied without damage, but at voltages higher than the minimum forward breakover voltage (see page 4) the thyristor may switch into the on-state.

RATINGS (continued)

Currents

Average on-state current (averaged over any 20 ms period) up to $T_{mb} = 52\ ^oC$	$I_{T(AV)}$	max.	16	A
at $T_{mb} = 85\ ^oC$	$I_{T(AV)}$	max.	10	A
On-state current (d.c.)	I_T	max.	19	A
R.M.S. on-state current	$I_{T(RMS)}$	max.	25	A
Repetitive peak on-state current	I_{TRM}	max.	140	A
Non-repetitive peak on-state current (t = 10 ms; half sine wave) $T_j = 125\ ^oC$ prior to surge	I_{TSM}	max.	140	A
I^2t for fusing (t = 10 ms)	I^2t	max.	100	A^2s
Rate of rise of on-state current after triggering with $I_G = I_{GT}$ to $I_T = 3 \times I_{T(AV)}$	$\frac{dI_T}{dt}$	max.	20	A/µs
Repetitive peak reverse current (during turn-off)	I_{RRM}	max.	20	A

GATE TO CATHODE

Voltage

Forward peak voltage	V_{FGM}	max.	10	V
Reverse peak voltage	V_{RGM}	max.	5	V

Power dissipation

Average power dissipation (averaged over any 20 ms period)	$P_{G(AV)}$	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	$R_{th\ j\text{-}mb}$	=	1.6	°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
Transient thermal impedance (t = 1 ms)	$Z_{th\ j\text{-}mb}$	=	0.09	°C/W

CHARACTERISTICS

ANODE TO CATHODE

Voltages			BTY87-400R	500R	600R	800R	
On-state voltage I_T = 50 A; T_j = 25 °C	V_T	<	3.0	3.0	3.0	3.0	V
Forward breakover voltage up to T_j = 125 °C	$V_{(BO)}$	>	400	500	600	800	V
Rate of rise of off-state voltage that will not trigger any device; T_j = 125 °C	$\frac{dV_D}{dt}$	<	20	20	20	20	V/µs
Currents							
Peak reverse current $V_{RM} = V_{RWMmax}$; T_j = 125 °C	I_{RM}	<	8.0	6.0	5.0	4.0	mA
Peak off-state current $V_{DM} = V_{DWMmax}$; T_j = 125 °C	I_{DM}	<	8.0	6.0	5.0	4.0	mA

Latching current; T_j = 25 °C	I_L	typ.	20	mA
Holding current; T_j = 25 °C	I_H	typ.	10	mA

GATE TO CATHODE

Voltages				
Voltage that will trigger all devices V_D = 6 V; T_j = 25 °C	V_{GT}	>	3.5	V
Voltage that will not trigger any device $V_D = V_{DWMmax}$; T_j = 125 °C	V_{GD}	<	200	mV
Current				
Current that will trigger all devices V_D = 6 V; T_j = 25 °C	I_{GT}	>	65	mA

CHARACTERISTICS (continued)

SWITCHING CHARACTERISTICS

Turn-on time ($t_{on} = t_d + t_r$) when switched from V_D = 400 V to I_T = 50 A

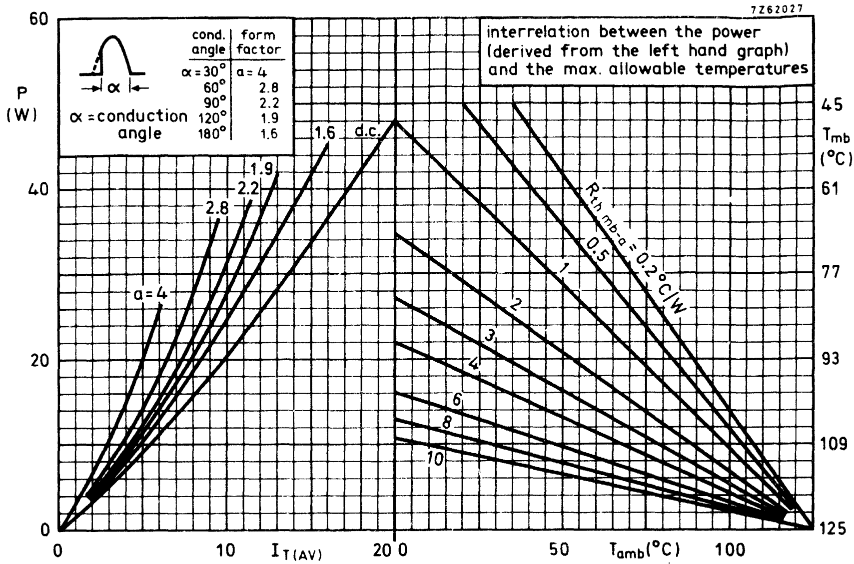
I_{GT} = 200 mA; T_j = 25 °C	t_{on}	typ.	2	µs

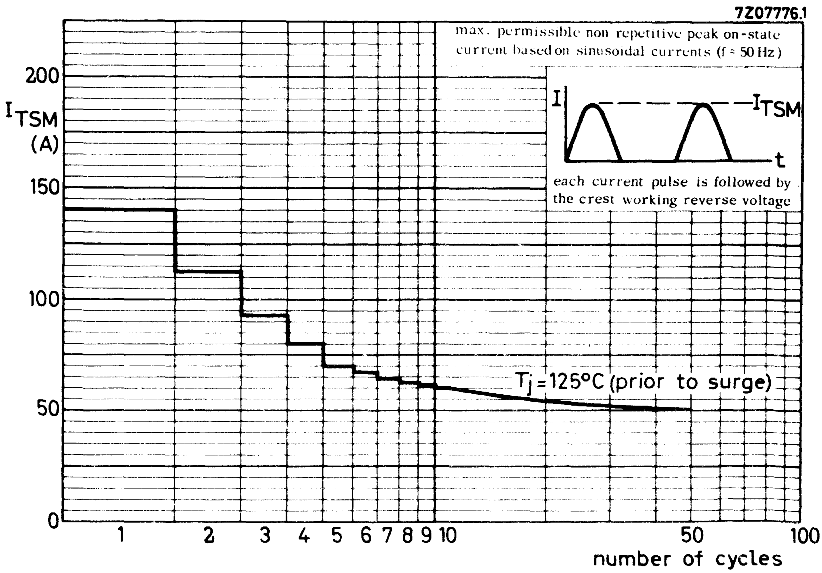
Circuit-commutated turn-off time when switched from I_T = 10 A to $V_R \geq$ 50 V with $-dI_T/dt$ = 10 A/µs; dV_D/dt = 10 V/µs

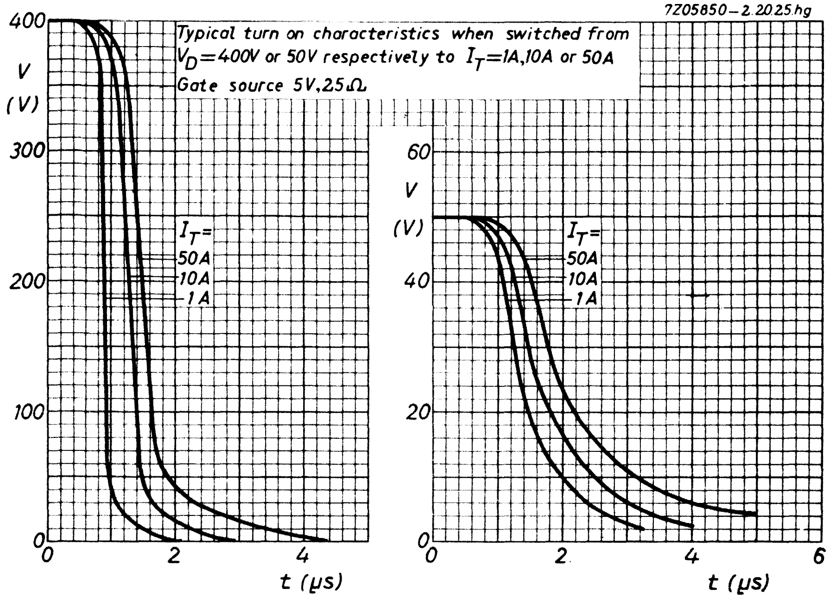
T_j = 125 °C	t_q	<	100	µs
T_j = 25 °C	t_q	<	50	µs

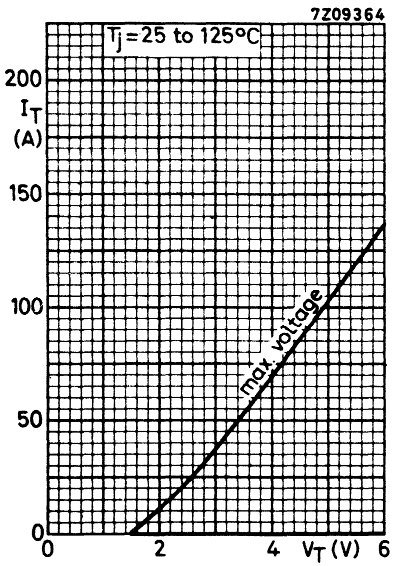
OPERATING NOTES (See also general pages at the beginning of this section)

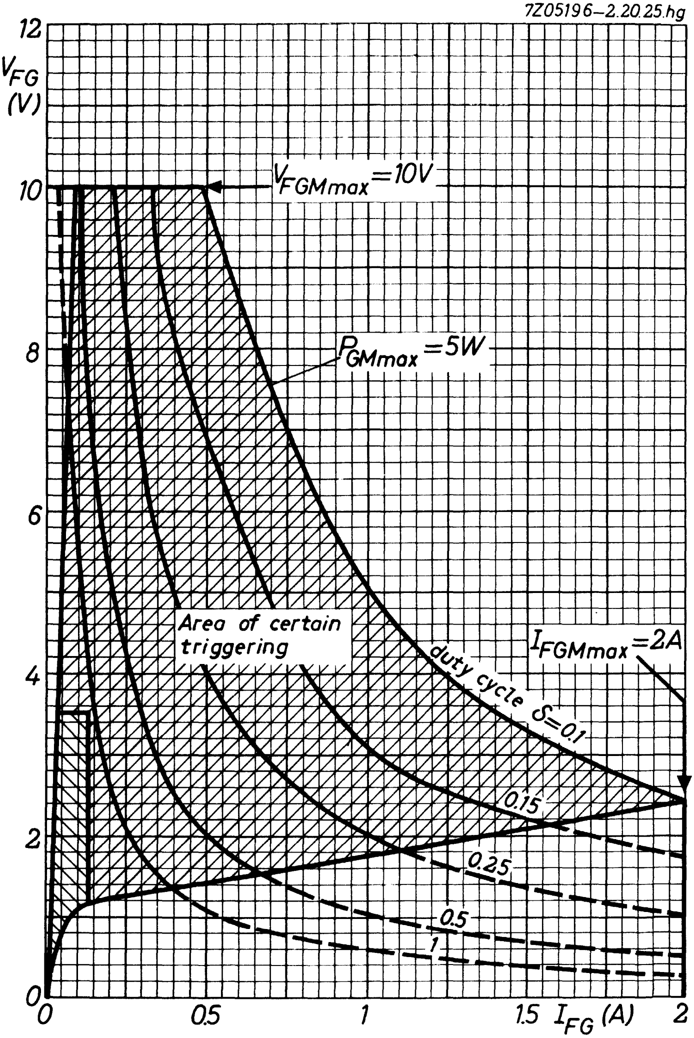
1. The gate and cathode connectors should not be bent; they should be soldered into the circuit so that there is no strain on them.


7Z62027
cond. angle
form factor
α = 30° a = 4
60° 2.8
90° 2.2
120° 1.9
180° 1.6
α = conduction angle
interrelation between the power (derived from the left hand graph) and the max. allowable temperatures
P (W)
$I_{T(AV)}$
T_{amb} (°C)
T_{mb} (°C)
$R_{th\ mb-a}$ = 0.2 °C/W
d.c.
a = 4
60
40
20
0
10
20
50
100
45
61
77
93
109
125

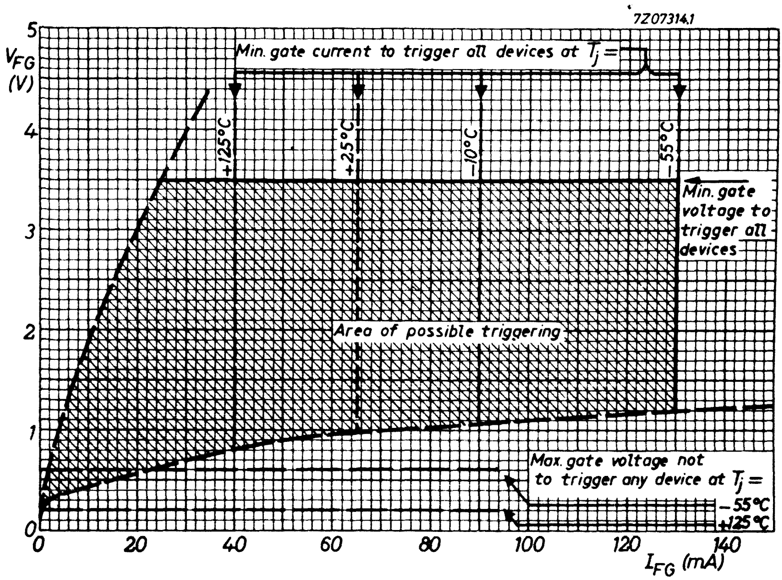

7Z07776.1
max. permissible non repetitive peak on-state current based on sinusoidal currents (f = 50 Hz)
I_{TSM} (A)
I
I_{TSM}
t
each current pulse is followed by the crest working reverse voltage
T_j = 125°C (prior to surge)
number of cycles
200
150
100
50
0
1
2
3
4
5
6
7
8
9
10
50
100

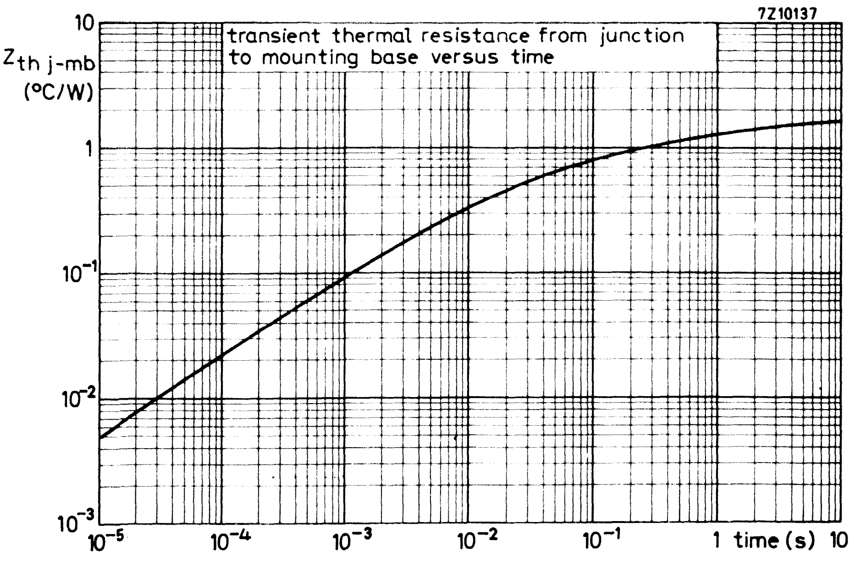

7Z05850–2.20.25.hg
Typical turn on characteristics when switched from V_D=400V or 50V respectively to I_T=1A,10A or 50A
Gate source 5V,25Ω
400
V
(V)
300
200
100
0
0
2
4
t (μs)
I_T=
50A
10A
1A
60
V
(V)
40
20
0
0
2
4
6
t (μs)
I_T=
50A
10A
1A

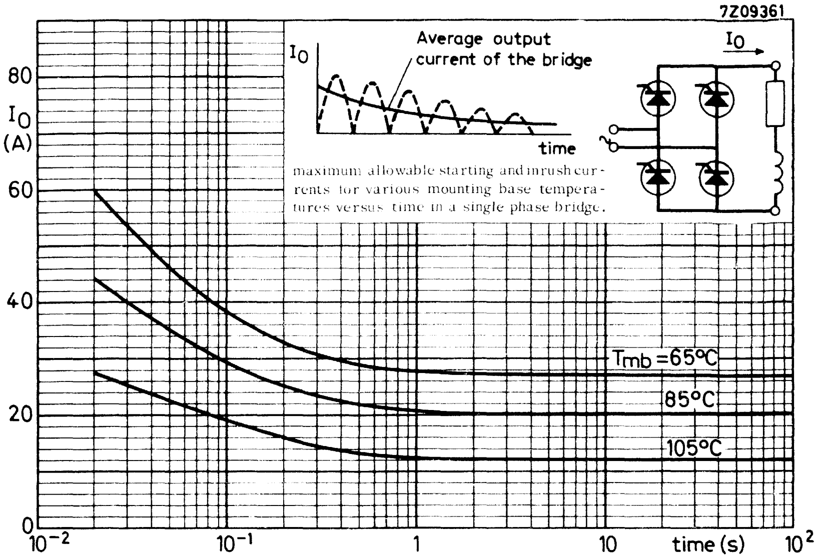

7Z09364
T_j=25 to 125°C
200
I_T
(A)
150
100
50
0
0
2
4
V_T (V)
6
max. voltage



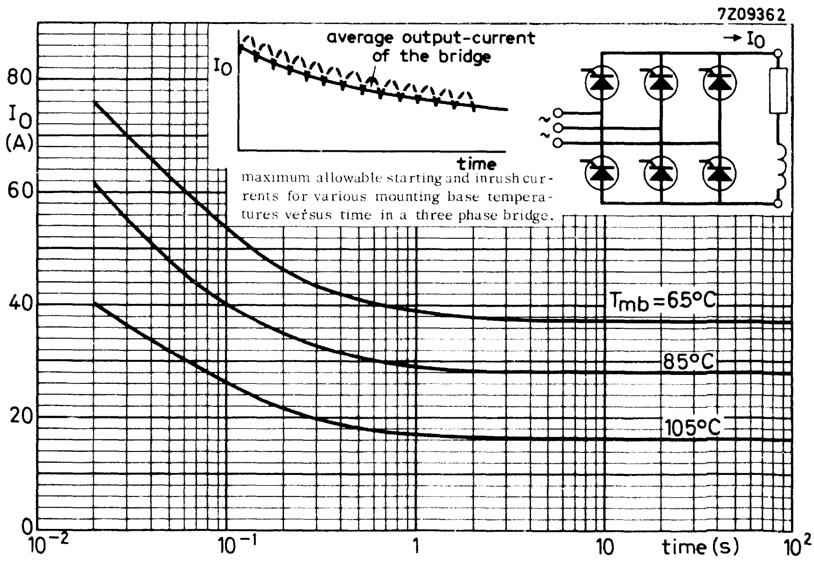
Gate characteristics with curves P_{GAV}=0.5W


7Z07314.1
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


7Z10137
transient thermal resistance from junction to mounting base versus time
$Z_{th\ j\text{-}mb}$ (°C/W)
10
1
10^{-1}
10^{-2}
10^{-3}
10^{-5}
10^{-4}
10^{-3}
10^{-2}
10^{-1}
1
time (s)
10



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 TO-48 metal envelope. They are intended for power control and power switching applications.
The series consists of the reverse polarity types (anode to stud) BTY91-400R to 800R.

QUICK REFERENCE DATA

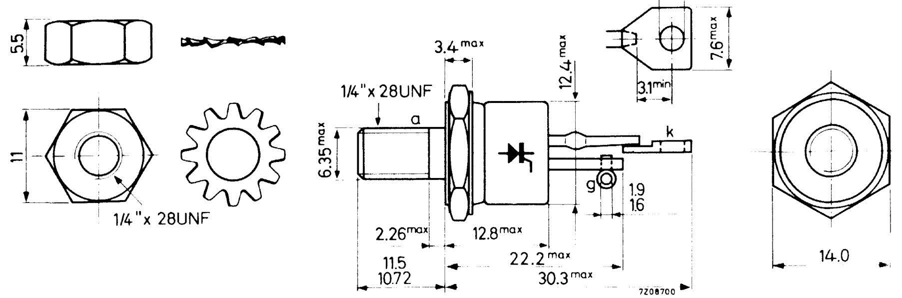
		BTY91-400R	500R	600R	800R	
Repetitive peak voltages $V_{DRM} = V_{RRM}$	max.	400	500	600	800	V
Crest working voltages $V_{DWM} = V_{RWM}$	max.	400	500	600	800	V
Forward breakover voltage $V_{(BO)}$	>	400	500	600	800	V

Average on-state current up to T_{mb} = 77 °C	$I_{T(AV)}$	max.	16	A
at T_{mb} = 85 °C	$I_{T(AV)}$	max.	14	A
R.M.S. on-state current	$I_{T(RMS)}$	max.	25	A
Non-repetitive peak on-state current t = 10 ms; T_j = 125 °C prior to surge	I_{TSM}	max.	200	A
Junction temperature	T_j	max.	125	°C
Rate of rise of on-state current after triggering	$\frac{dI_T}{dt}$	max.	20	A/µs
Rate of rise of off-state voltage that will not trigger any device	$\frac{dV_D}{dt}$	<	20	V/µs

MECHANICAL DATA see page 2

MECHANICAL DATA Dimensions in mm

TO-48



Torque on nut: min. 17 kg cm (1.7 Newton-metres)
max. 35 kg cm (3.5 Newton-metres)

Net weight: 15 g
Diameter of clearance hole: max. 6.5 mm
Accessories supplied on request: 56264A

All information applies to frequencies up to 400 Hz.

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

ANODF TO CATHODE

Voltages [1]		BTY91-400R	500R	600R	800R
Non-repetitive peak off-state voltage ($t \leq$ 10 ms) V_{DSM} [2]	max.	500	850	850	850 V
Non-repetitive peak reverse voltage ($t <$ 5 ms) V_{RSM}	max.	500	600	720	960 V
Repetitive peak voltages $V_{DRM} = V_{RRM}$	max.	400	500	600	800 V
Crest working voltages $V_{DWM} = V_{RWM}$	max.	400	500	600	800 V
Continuous voltages $V_D = V_R$	max.	400	500	600	800 V

[1] To ensure thermal stability: $R_{th\ j-a} < 4.5\ ^oC/W$ (d.c. blocking) or $< 9\ ^oC/W$ (a.c.). For smaller heatsinks $T_{j\ max}$ should be derated.

[2] Higher off-state voltages may be applied without damage, but at voltages higher than the minimum forward breakover voltage (see page 4) the thyristor may switch into the on-state.

RATINGS (continued)

Currents

Average on-state current (averaged over any 20 ms period) up to $T_{mb} = 77\ ^oC$	$I_{T(AV)}$	max.	16	A
at $T_{mb} = 85\ ^oC$	$I_{T(AV)}$	max.	14	A
On-state current (d.c.)	I_T	max.	25	A
R.M.S. on-state current	$I_{T(RMS)}$	max.	25	A
Repetitive peak on-state current	I_{TRM}	max.	200	A
Non-repetitive peak on-state current (t = 10 ms; half sine wave) $T_j = 125\ ^oC$ prior to surge	I_{TSM}	max.	200	A
I^2t for fusing (t = 10 ms)	I^2t	max.	200	A^2s
Rate of rise of on-state current after triggering with $I_G = I_{GT}$ to $I_T = 3 \times I_{T(AV)}$	$\frac{dI_T}{dt}$	max.	20	A/µs
Repetitive peak reverse current (during turn-off)	I_{RRM}	max.	20	A

GATE TO CATHODE

Voltages

Forward peak voltage	V_{FGM}	max.	10	V
Reverse peak voltage	V_{RGM}	max.	5	V

Power dissipation

Average power dissipation (averaged over any 20 ms period)	$P_{G(AV)}$	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	$R_{th\ j\text{-}mb}$	=	1.6	°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
Transient thermal impedance (t = 1 ms)	$Z_{th\ j\text{-}mb}$	=	0.09	°C/W

CHARACTERISTICS

ANODE TO CATHODE

			BTY91-400R	500R	600R	800R	
Voltages							
On-state voltage I_T = 50 A; T_j = 25 °C	V_T	<	2.0	2.0	2.0	2.0	V
Forward breakover voltage up to T_j = 125 °C	$V_{(BO)}$	>	400	500	600	800	V
Rate of rise of off-state voltage that will not trigger any device; T_j = 125 °C	$\frac{dV_D}{dt}$	<	20	20	20	20	V/µs
Currents							
Peak reverse current $V_{RM} = V_{RWMmax}$; T_j = 125 °C	I_{RM}	<	8.0	6.0	5.0	4.0	mA
Peak off-state current $V_{DM} = V_{DWMmax}$; T_j = 125 °C	I_{DM}	<	8.0	6.0	5.0	4.0	mA

Latching current; T_j = 25 °C	I_L	<	20	mA
Holding current; T_j = 25 °C	I_H	<	10	mA

GATE TO CATHODE

Voltages

Voltage that will trigger all devices V_D = 6 V; T_j = 25 °C	V_{GT}	>	3.0	V
Voltage that will not trigger any device $V_D = V_{DWMmax}$; T_j = 125 °C	V_{GD}	<	200	mV

Current

Current that will trigger all devices V_D = 6 V; T_j = 25 °C	I_{GT}	>	40	mA

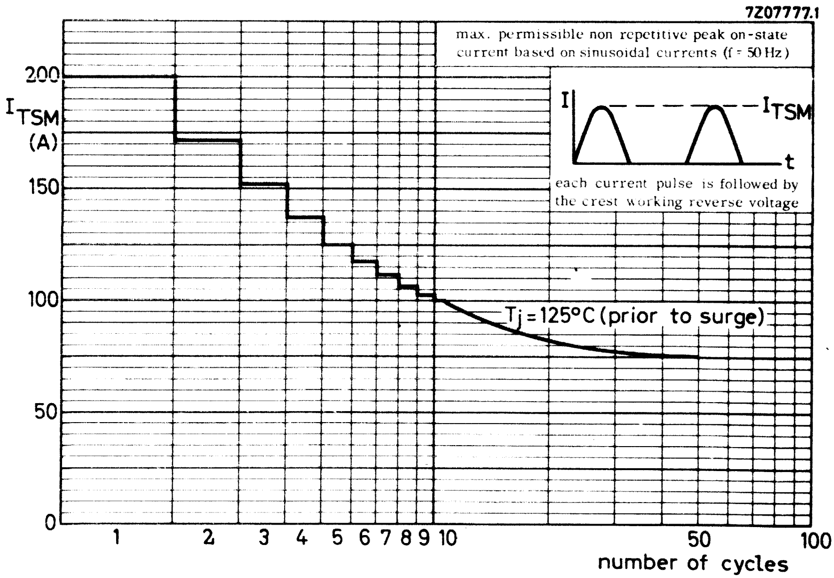
CHARACTERISTICS (continued)

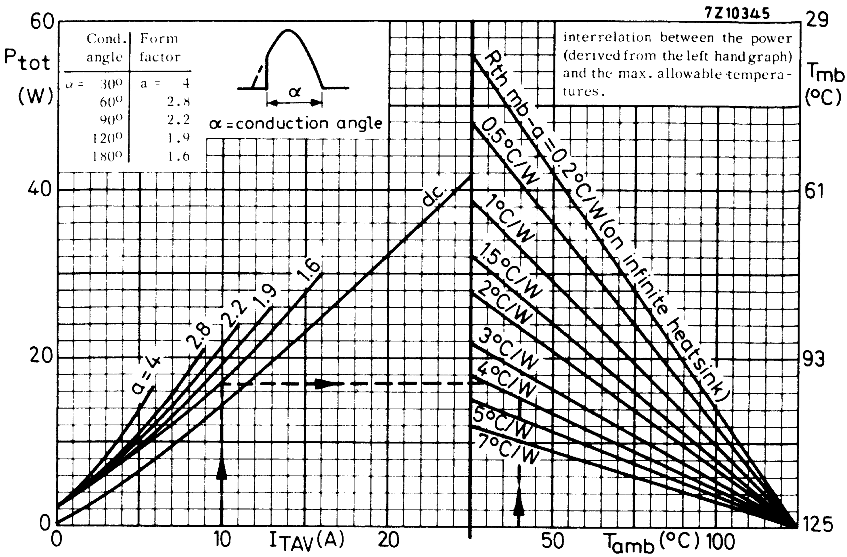
SWITCHING CHARACTERISTICS

Turn-on time ($t_{on} = t_d + t_r$) when switched from V_D = 400 V to I_T = 10 A; I_{GT} = 200 mA; T_j = 25 °C	t_{on}	typ.	2	µs
Circuit-commutated turn-off time when switched from I_T = 10 A to $V_R \geq$ 50 V with $-dI_T/dt$ = 10 A/µs; dV_D/dt = 10 V/µs				
T_j = 125 °C	$-t_q$	<	100	µs
T_j = 25 °C	$-t_q$	<	50	µs

OPERATING NOTES (See general pages at the beginning of this section)

1. The gate and cathode connectors should not be bent; they should be soldered into the circuit so that there is no strain on them





Determination of the heatsink thermal resistance

Example:
Assume a thyristor, used in a single phase full wave rectifier circuit.

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 = 17 W per thyristor.

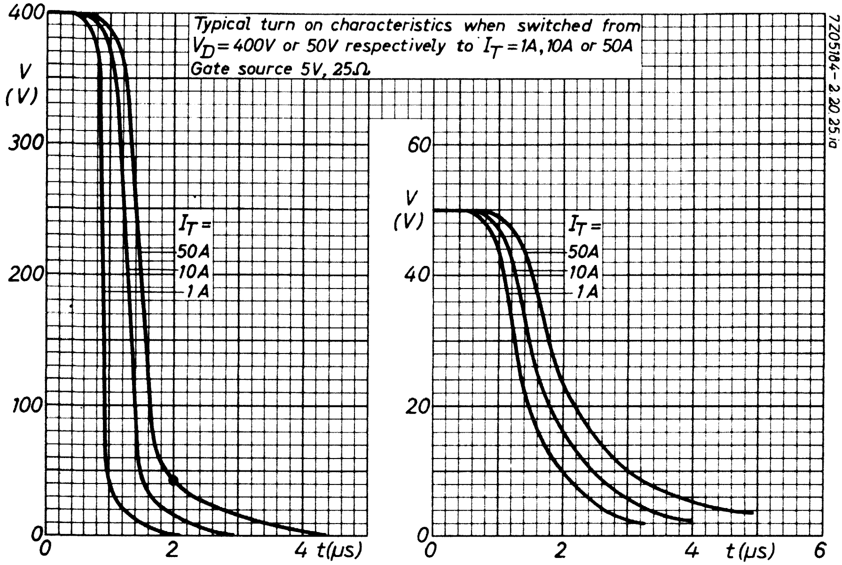
From the right hand part of the graph above follows the thermal resistance, required for P_{tot} = 17 W at T_{amb} = 40 °C

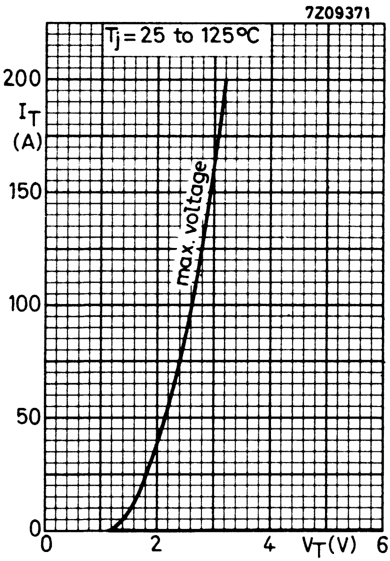
$$R_{th\ mb\text{-}a} \approx 3.5\ ^{o}C/W$$

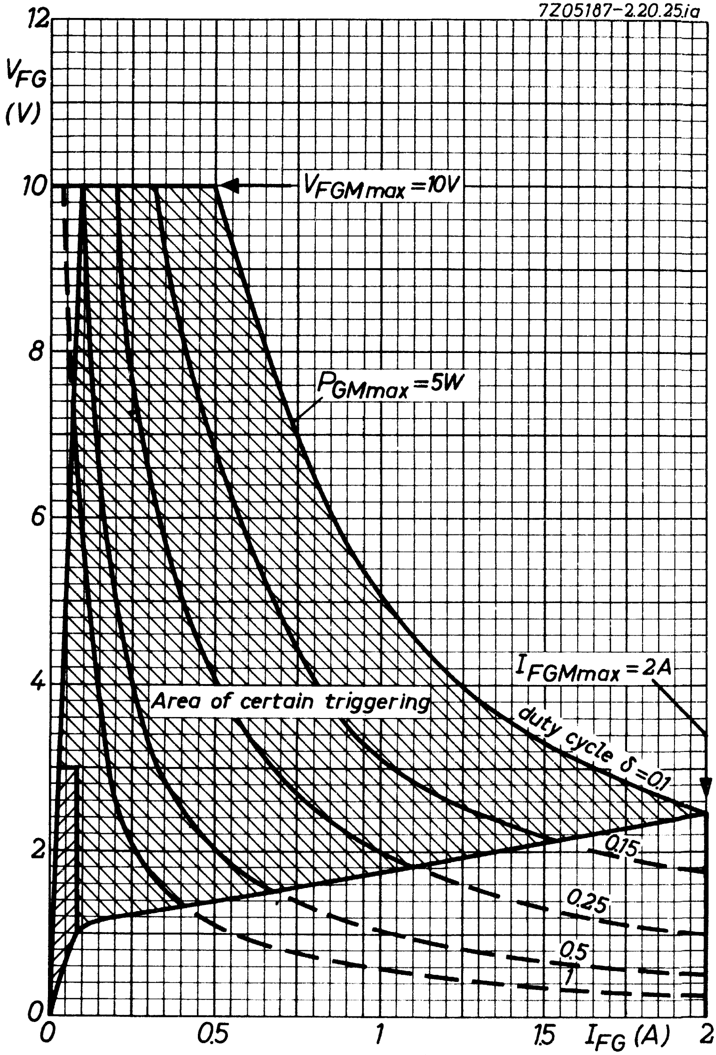
The contact thermal resistance $R_{th\ mb\text{-}h}$ = 0.2 °C/W.
Hence the heatsink thermal resistance should be:

$$R_{th\ h\text{-}a} = R_{th\ mb\text{-}a} - R_{th\ mb\text{-}h} = (3.5 - 0.2)\ ^{o}C/W = 3.3\ ^{o}C/W.$$

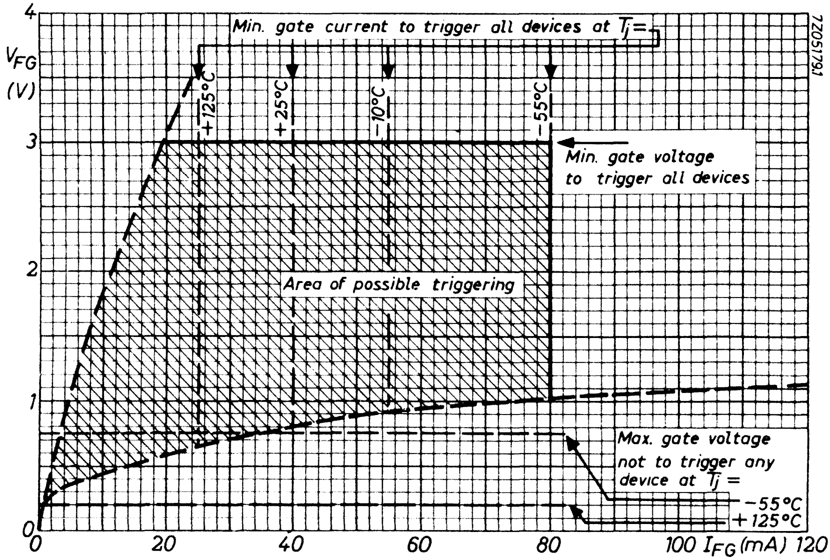
The appropriate heatsink(s) will be found in the Section HEATSINKS.

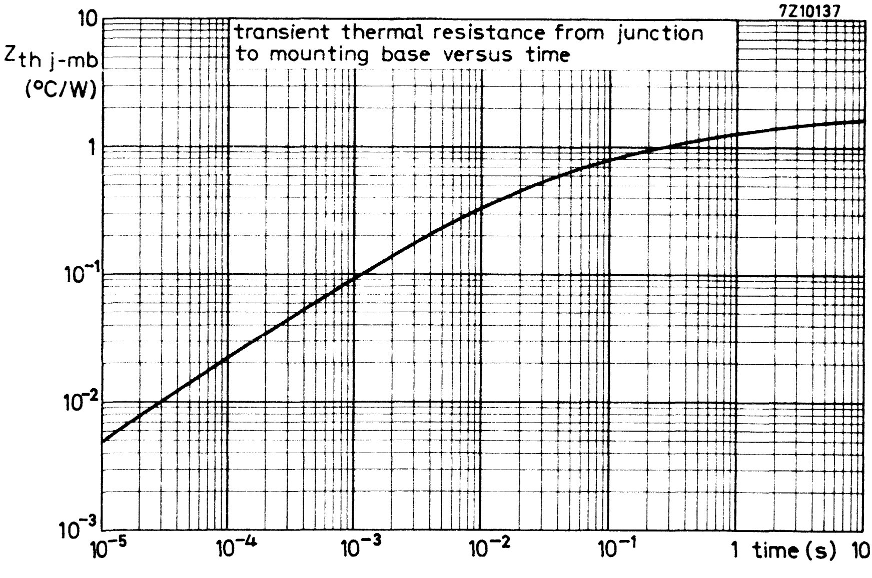

Typical turn on characteristics when switched from V_D = 400V or 50V respectively to I_T = 1A, 10A or 50A
Gate source 5V, 25Ω
7Z05184-2.20.25.ia
V (V)
I_T =
50A
10A
1A
t (μs)
400
300
200
100
0
2
4
60
40
20
6

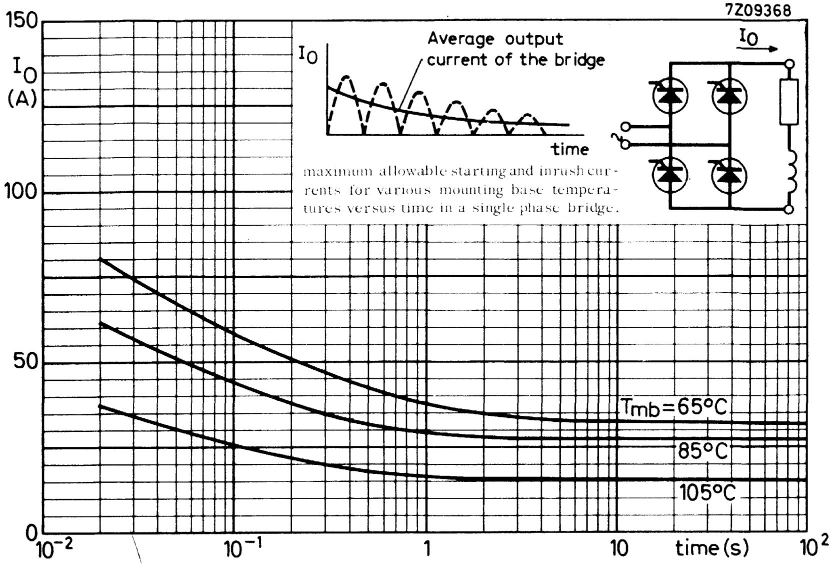

7Z09371
T_j = 25 to 125 °C
I_T (A)
max. voltage
V_T (V)
200
150
100
50
0
2
4
6



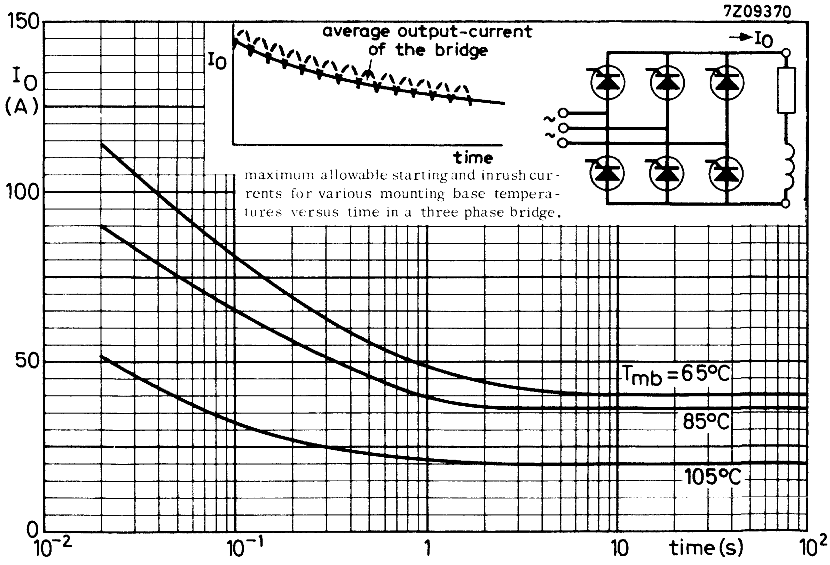
Gate characteristics with curves $P_{GAV} = 0.5W$


7Z05179.1
Min. gate current to trigger all devices at T_j =
V_{FG} (V)
+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)


7Z10137
transient thermal resistance from junction to mounting base versus time
$Z_{th\ j\text{-}mb}$ (°C/W)
time (s)



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.

Ignistors

IGNISTORS

The IGNISTOR OTH1200 is a compact unit consisting of two silicon thyristors in antiparallel connection.
The disc-type thyristors are mounted between water-cooled heat exchangers.
The cooling chambers can be connected in series in the water circuit thus avoiding problems of unequal flow that can occur in parallel water circuits.
The device is especially intended for power switching e.g. resistance welding.

QUICK REFERENCE DATA

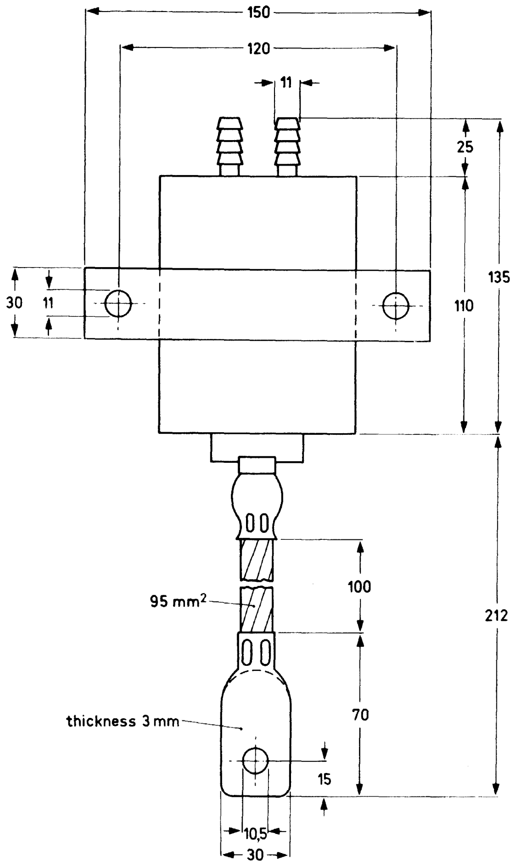
			OTH1200-800	1000	1200	1400	
Repetitive peak off-state voltage	V_{DRM}	max.	800	1000	1200	1400	V
Crest working off-state voltage	V_{DWM}	max.	600	700	800	1000	V

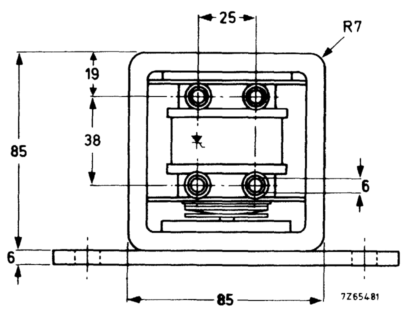
R.M.S. on-state current at T_{water} = 40 °C water flow: 4 ℓ/min	$I_{T(RMS)}$	max.	1200 A
Non-repetitive peak on-state current t = 10 ms; T_j = 125 °C prior to surge	I_{TSM}	max.	7000 A
Junction temperature	T_j	max.	125 °C
Critical rate of rise of on-state current after triggering	$\frac{dI_T}{dt}$		100 A/µs
Critical rate of rise of off-state voltage that will not trigger the device (exponential up to 2/3 V_{DRM} max)	$\frac{dV_D}{dt}$		300 V/µs

MECHANICAL DATA (See page 2)

MECHANICAL DATA

Dimensions in mm





Vibration: 10 to 150 Hz
with 5 g
Shock : 10 g

Note: Hose connectors with standard thread can be delivered on request

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

Anode to cathode

Voltages

			OTH1200 - 800	1000	1200	1400	
Non-repetitive peak off-state voltage ($t \leq 10$ ms)	V_{DSM}	max.	800	1000	1200	1400	V
Repetitive peak off-state voltage ($\delta \leq 0.01$)	V_{DRM}	max.	800	1000	1200	1400	V
Crest working off-state voltage	V_{DWM}	max.	600	700	800	1000	V

Currents

R.M.S. on-state current at $T_{water} = 40\ ^{o}C$ water flow: 4 ℓ/min	$I_{T(RMS)}$	max.	1200	A
Non-repetitive peak on-state current ($t = 10$ ms; half sine wave); $T_j = 125\ ^{o}C$ prior to surge	I_{TSM}	max.	7000	A
I^2t for fusing ($t = 10$ ms)	I^2t	max.	245.000	A^2s
Critical rate of rise of on-state current after triggering with $I_G = 1$ A; $dI_G/dt = 1$ A/μs	$\frac{dI_T}{dt}$		100	A/μs

Gate to cathode

Voltage

Reverse peak voltage	V_{RGM}	max.	5	V

Power dissipation

Average power dissipation	$P_{G(AV)}$	max.	3	W
Peak power dissipation	P_{GM}	max.	16	W

Temperature

Junction temperature	T_j	max.	125	^{o}C

THERMAL RESISTANCE

From junction to water at 4 ℓ/min per cell	$R_{th\ j\text{-}w}$	=	0.1 °C/W

CHARACTERISTICS

Anode to cathode

Voltages

On-state voltage I_T = 625 A; T_j = 25 °C	V_T	<	1.3 V
Critical rate of rise of off-state voltage that will not trigger the device (exponential up to 2/3 V_{DRMmax}) T_j = 125 °C	$\frac{dV_D}{dt}$		300 V/µs

Currents

Peak off-state current at T_j = 125 °C	I_{DM}	<	50 mA
Holding current at T_j = 25 °C	I_H	typ.	500 mA

Gate to cathode

Voltages

Minimum voltage that will trigger all devices at T_j = 125 °C	V_{GT}		4 V
Maximum voltage that will not trigger any device ; V_D = V_{DRMmax}; T_j = 125 °C	V_{GD}		0.15 V

Current

Minimum current that will trigger all devices at T_j = 25 °C	I_{GT}		400 mA

Switching characteristics

Turn-on time when switched to I_T = 100 A; I_{GT} = 1 A; dI_G/dt = 1 A/µs; T_j = 25 °C	t_{on}	typ.	5 µs
Circuit-commutated turn-off time when switched to I_T = 150 A; $-dI_T/dt$ = 50 A/µs dV_D/dt = 20 V/µs ; T_j = 125 °C	t_q	typ.	250 µs

WATER TEMPERATURE RISE

Max. rise of water temperature
at 4ℓ/min(both heatsinks in series) $\Delta T = T_{out} - T_{in} < 7.5\ ^oC$

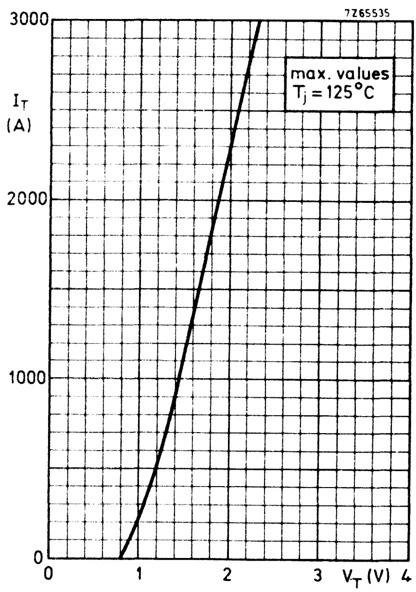
COOLING WATER

The cooling water must satisfy the following requirements as regards the content of solids and soluble chemicals:

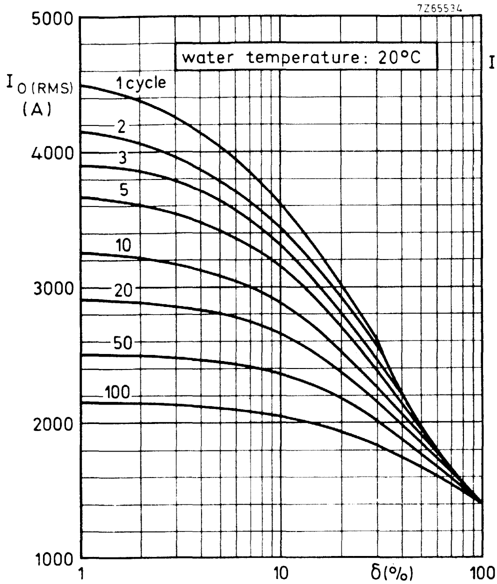
1. pH value: 7 to 9
2. Max. weight of chlorides per litre : 20 mg
   Max. weight of nitrates per litre : 10 mg
   Max. weight of sulphates per litre : 100 mg
3. Max. weight of insoluble per litre : 250 mg

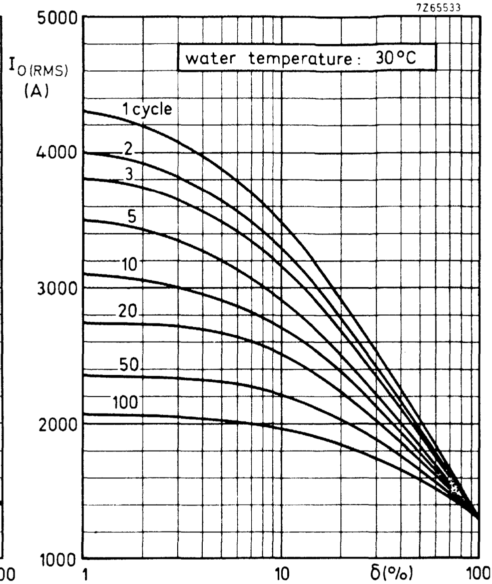
OPERATING NOTES

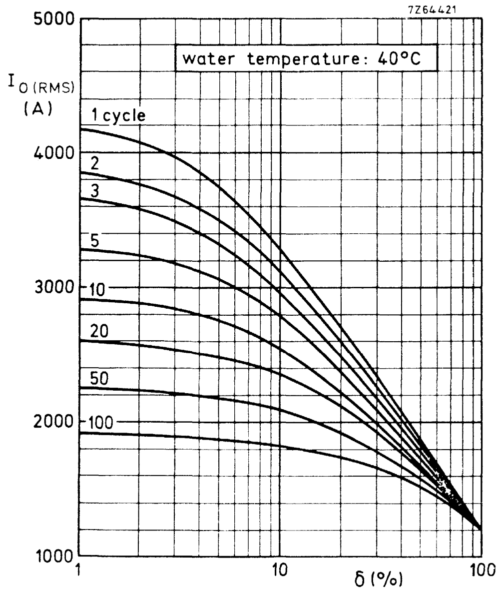
1. When using a series water-cooling circuit, the minimum hose-length between heatsink must be 550 mm.
2. Mechanical force on the cooling-bars must be avoided.
3. The construction of the ignistor meets the insulation requirements of VDE 0110, class-C.

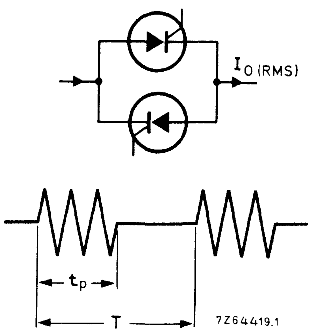


Intermittent overlaod capability of the OTH1200 in a single phase a.c. control circuit of 50 Hz (e.g. welding).



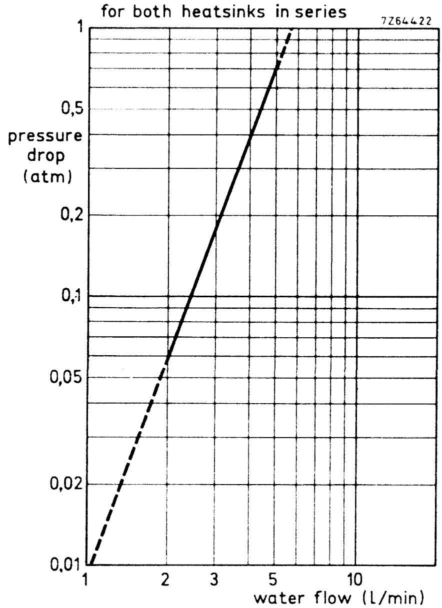


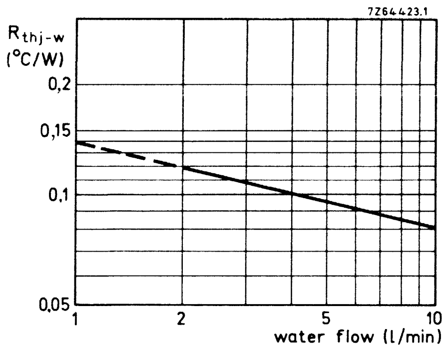




$\delta = \frac{t_p}{T} \times 100\%$

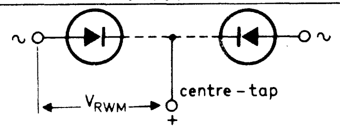
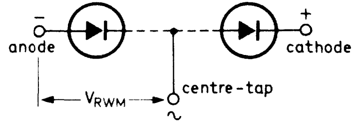
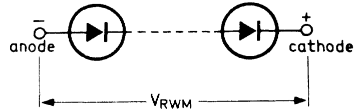
conduction angle : 360°
water flow : 4 l/min


for both heatsinks in series
7Z64422
pressure drop (atm)
1
0,5
0,2
0,1
0,05
0,02
0,01
1
2
3
5
10
water flow (l/min)


7Z64423.1
R_{thj-w} (°C/W)
0,2
0,15
0,1
0,05
1
2
5
10
water flow (l/min)

Rectifier stacks

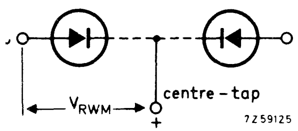
TYPE SELECTION CHART

Type number		OSB9110	OSB9210	OSB9310	OSB9410	OSM9110	OSM9210	OSM9310	OSM9410	OSS9110	OSS9210	OSS9310	OSS9410
Number of diodes		4.6...28.30				4.6...28.30				3.4....29.30			
Circuit													
Crest working reverse voltage		2.3...14.15 kV				2.3...14.15 kV				3.4....29.30 kV			
	T_{amb} = 35 °C	3.5 A	5 A	4 A	10 A	3.5 A	5 A	4 A	10 A	3.5 A	5 A	4 A	10 A
Average forward current per diode at:	T_{oil} = 30 °C		20 A				20 A				20 A		
	T_{oil} = 35 °C				30 A				30 A				30 A
	T_{oil} = 65 °C			12 A				12 A				12 A	
	T_{oil} = 100 °C	6 A				6A				6 A			
Non-repetitive peak forward current		85 A	360 A	180 A	800 A	85 A	360 A	180 A	800 A	85 A	360 A	180 A	800 A
Base		A = 1/4" UNF-studs at the ends B = 4 pin Super Jumbo (B4D) C = Goliath E = 4 pin Jumbo (B4F) F = A3-20											

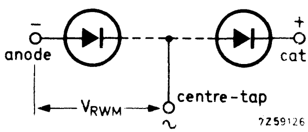
HIGH VOLTAGE RECTIFIER STACKS

The OSB9110, OSM9110 and OSS9110series are ranges of high voltage rectifier assemblies, incorporating controlled avalanche diodes mounted on fire proof triangular formers. The OSB9110series is intended for application in two phase half wave rectifier circuits. The OSM9110series is intended for application in single phase or three phase bridges or in voltage doubler circuits.
The OSS9110series is intended for all kinds of high voltage rectification. The assemblies are supplied with 1/4"UNF studs or with standard valve bases. The OSB9110-series and OSM9110series are supplied with a centre tap (8-32UNC). The maximum crest working voltages of the OSB9110 and OSM9110series cover the range from 2 kV to 15 kV, and of the OSS9110series the range from 3 kV to 30 kV, in 1 kV steps.

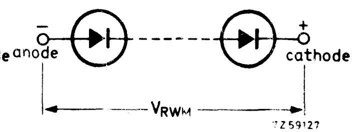
CIRCUIT OSB 9110



CIRCUIT OSM 9110



CIRCUIT OSS9110



QUICK REFERENCE DATA

		OSB9110	-4	-6	. . .	-28	-30	
		OSM9110	-4	-6	. . .	-28	-30	
Crest working reverse voltage from centre tap to end	V_{RWM}	max.	2	3	. . .	14	15	kV
		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 up to T_{amb} = 35 °C	$I_{F(AV)}$	max.					3.5	A
in oil up to T_{oil} = 100 °C	$I_{F(AV)}$	max.					6	A
Non-repetitive peak forward current t = 10 ms; half sine wave; T_j = 175 °C prior to surge	I_{FSM}	max.					85	A

MECHANICAL DATA see pages 4 and 5.

All information applies to frequencies up to 400 Hz

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

Voltages

			OSB9110 -4	-6	. .	-28	-30	
			OSM9110-4	-6	...	-28	-30	
Crest working reverse voltage	V_{RWM}	max.	2	3	...	14	15	kV

			OSS9110 -3	-4	...	-29	-30	
Crest working reverse voltage	V_{RWM}	max.	3	4	...	29	30	kV

Currents

Average forward current (averaged over any 20 ms period)				
in free air up to T_{amb} = 35 °C	$I_{F(AV)}$	max.	3.5	A
in oil up to T_{oil} = 100 °C	$I_{F(AV)}$	max.	6	A
Repetitive peak forward current	I_{FRM}	max.	120	A
Non-repetitive peak forward current t = 10 ms; half sine wave; T_j = 175 °C prior to surge	I_{FSM}	max.	85	A

Reverse power dissipation

			OSB9110 -4	-6	...	-28	-30	
			OSM9110-4	-6	...	-28	-30	
Repetitive peak reverse power t = 10 µs (square wave; f = 50 Hz) T_j = 175 °C	P_{RRM}	max.	1.2	1.8	...	8.4	9	kW
Non-repetitive peak reverse power t = 10 µs (square wave)								
T_j = 25 °C prior to surge	P_{RSM}	max.	6	9	...	42	45	kW
T_j=175 °C prior to surge	P_{RSM}	max.	1.2	1.8	...	8.4	9	kW

			OSS9110 -3	-4	...	-29	-30	
Repetitive peak reverse power dissipation t = 10 µs (square wave; f = 50 Hz) T_j = 175 °C	P_{RRM}	max.	1.8	2.4	...	17.4	18	kW
Non-repetitive peak reverse power dissipation t = 10 µs (square wave)								
T_j = 25 °C prior to surge	P_{RSM}	max.	9	12	...	87	90	kW
T_j =175 °C prior to surge	P_{RSM}	max.	1.8	2.4		17.4	18	kW

Temperatures

Storage temperature	T_{stg}		-55 to +175	°C
Junction temperature	T_j	max.	175	°C

CHARACTERISTICS (See note 1)

			OSB9110					
			OSB9110 -4	**-6**	...	**-28**	**-30**	
			OSM9110-4	**-6**	...	**-28**	**-30**	
Forward voltage								
$I_F = 20$ A; $T_j = 25$ °C	V_F	<	4	6	...	28	30	V
Reverse avalanche breakdown voltage [1]								
$I_R = 5$ mA; $T_j = 25$ °C	$V_{(BR)R}$	>	2.5	3.75	...	17.5	18.75	kV
		<	3.76	5.64	...	26.32	28.2	kV

			OSS9110 -3	-4	...	-29	-30	
Forward voltage								
$I_F = 20$ A; $T_j = 25$ °C	V_F	<	6	8	...	58	60	V
Reverse avalanche breakdown voltage [1]								
$I_R = 5$ mA; $T_j = 25$ °C	$V_{(BR)R}$	>	3.75	5.0	...	36.25	37.5	kV
		<	5.64	7.52	...	54.52	56.4	kV

Reverse current				
$V_{RM} = V_{RWM max}$; $T_j = 125$ °C	I_{RM}	<	0.6	mA

NOTES

1. The Ratings and Characteristics given apply from centre tap to end. (Not for OSS9110series)
2. Type number suffix

   The suffix consists of a figure indicating the total number of diodes, followed by a letter indicating the base.
   A = 1/4"U.N.F. studs at the ends.
   B = 4 pin Super Jumbo (B4D)
   C = Goliath
   E = 4 pin Jumbo (B4F)
   F = A3-20
3. Operating position

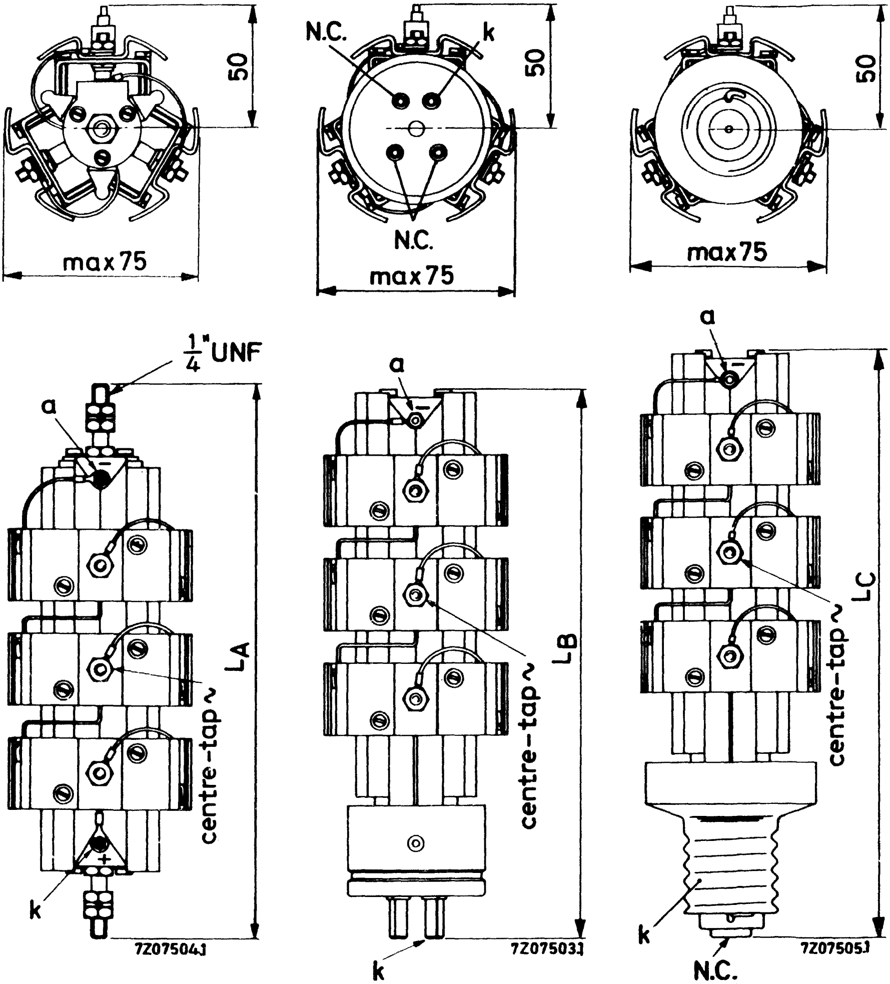
   The rectifier units can be operated at their maximum ratings when mounted in any position.

[1]) The breakdown voltage increases by approximately 0.1 % per °C with increasing junction temperature.

MECHANICAL DATA Dimensions in mm

n = total number of diodes

OSM9110-nA OSM9110-nB OSM9110-nC



The drawings show the OSM9110series; the OSB9110 and OSS9110series differ in the following respects:

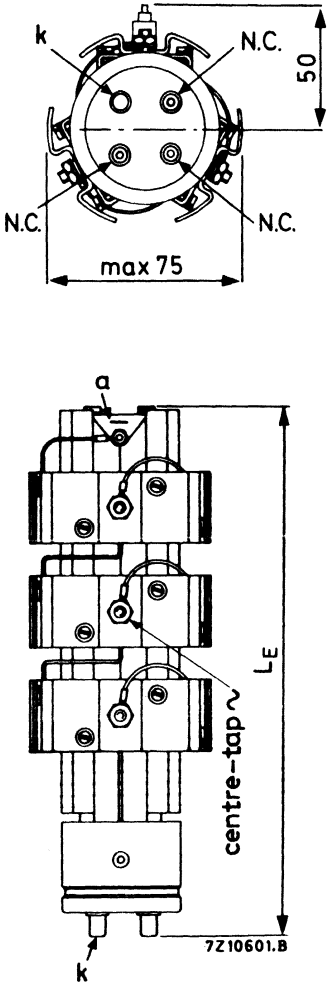
OSB9110series – terminals marked a(-) and k(+) in the drawings are both marked ∿ ; the centre-tap is marked + (instead of ∿ as in the drawings).

OSS9110series – has no centre-tap.

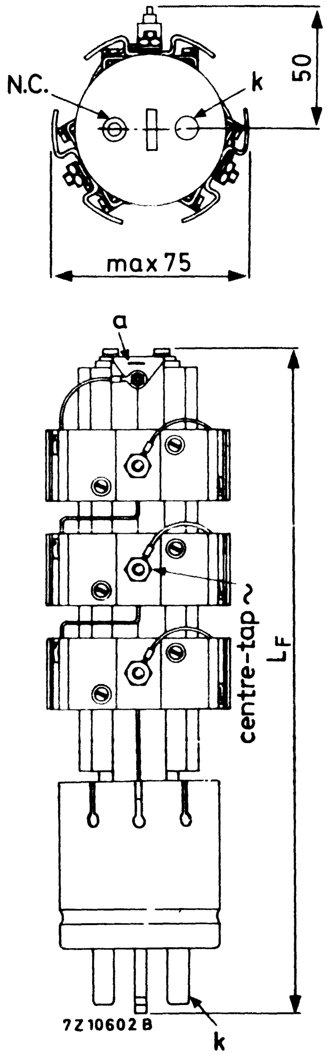
MECHANICAL DATA (continued)

n = total number of diodes.

OSM9110-nE



OSM9110-nF

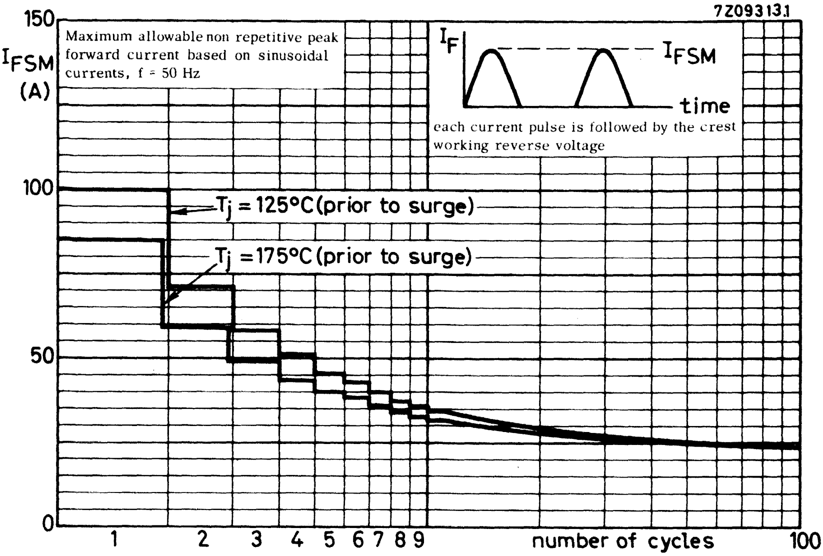


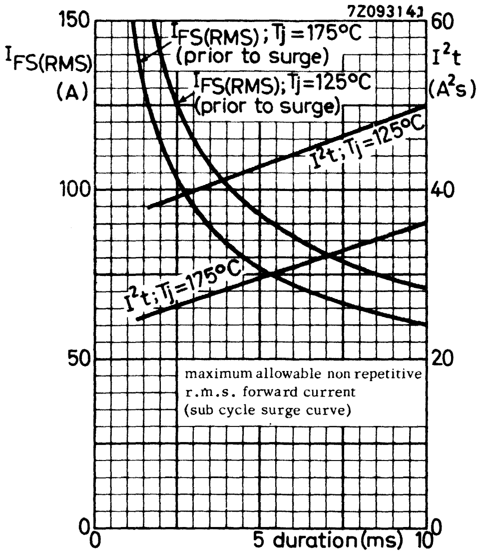
For lengths and weights see table on page 6.

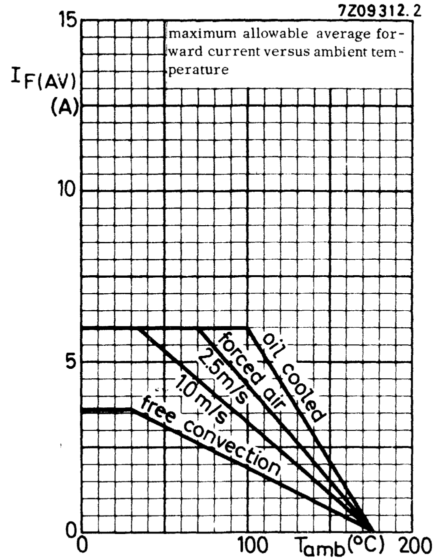
Table of lengths and weights (mm and g)

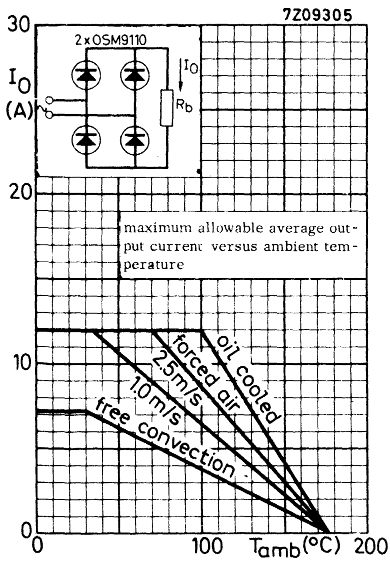
number of diodes	n	3	4 to 6	7 to 9	10 to 12	13 to 15
maximum lengths	L_A	143	184	224	264	305
	L_B	147	188	228	268	309
	L_C	159	199	239	279	320
	L_E	132	173	213	253	294
	L_F	184	225	265	305	346
weights	W_A	153	286	419	552	685
$W_B = W_C =$	W_E	218	351	484	617	750
	W_F	379	512	645	778	911

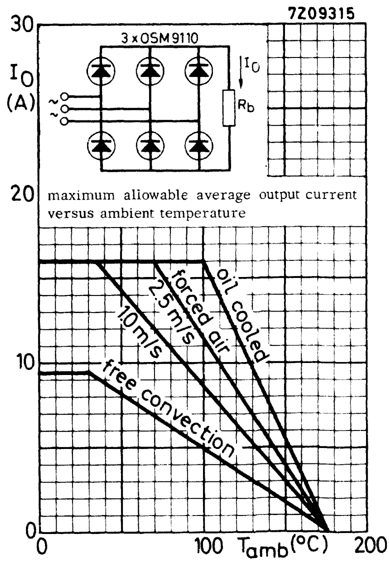
number of diodes	n	16 to 18	19 to 21	22 to 24	25 to 27	28 to 30
maximum lengths	L_A	345	385	426	466	506
	L_B	349	389	430	470	510
	L_C	360	400	441	481	521
	L_E	334	374	415	455	495
	L_F	386	426	467	507	547
weights	W_A	818	951	1048	1217	1350
$W_B = W_C =$	W_E	883	1016	1149	1282	1415
	W_F	1044	1177	1310	1443	1576


7Z09313.1
150
I_{FSM}
(A)
100
50
0
Maximum 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)
T_j = 175°C (prior to surge)
1
2
3
4
5
6
7
8
9
number of cycles
100


7Z09314.1
150
$I_{FS(RMS)}$
(A)
100
50
0
0
60
I^2t
(A^2s)
40
20
0
$I_{FS(RMS)}$; T_j = 175°C
(prior to surge)
$I_{FS(RMS)}$; T_j = 125°C
(prior to surge)
I^2t; T_j = 125°C
I^2t; T_j = 175°C
maximum allowable non repetitive
r.m.s. forward current
(sub cycle surge curve)
5 duration (ms) 10

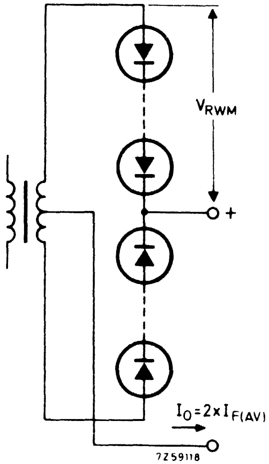

7Z09312.2
maximum allowable average forward current versus ambient temperature
$I_{F(AV)}$ (A)
15
10
5
0
0
100
200
T_{amb} (°C)
oil cooled
forced air
2.5 m/s
1.0 m/s
free convection


7Z09305
2 x OSM9110
I_O
R_b
I_O (A)
30
20
10
0
0
100
200
T_{amb} (°C)
maximum allowable average output current versus ambient temperature
oil cooled
forced air
2.5 m/s
1.0 m/s
free convection

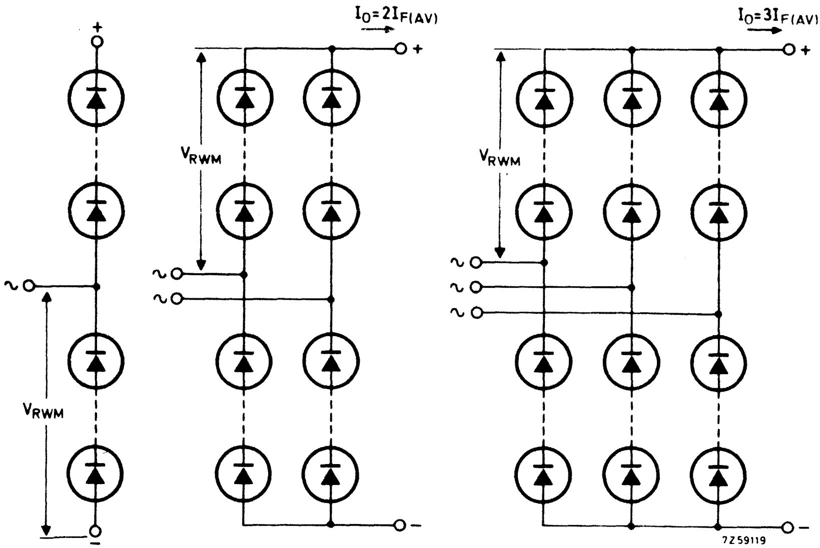

7Z09315
3 x OSM9110
I_O
R_b
I_O (A)
30
20
10
0
0
100
200
T_{amb} (°C)
maximum allowable average output current versus ambient temperature
oil cooled
forced air
2.5 m/s
1.0 m/s
free convection

APPLICATION INFORMATION

OSB9110-4



OSM9110series



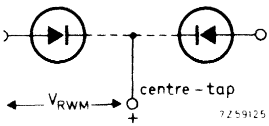
voltage doubler
1x OSM 9110

rectifier circuits with respectively
2x OSM9110 and 3x OSM9110

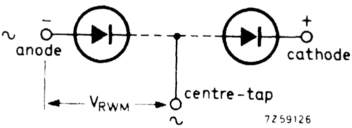
HIGH VOLTAGE RECTIFIER STACKS

The OSB9210, OSM9210 and OSS9210series are ranges of high voltage rectifier assemblies, incorporating controlled avalanche diodes mounted on fireproof triangular formers. The OSB9210series is intended for application in two phase half wave rectifier circuits. The OSM9210series is intended for application in single phase or three phase bridges or in voltage doubler circuits.
The OSS9210series is intended for all kinds of high voltage rectification. The assemblies are supplied with 1/4"UNF studs or with standard valve bases. The OSB9210-series and OSM9210series are supplied with a centre tap (8-32UNC). The maximum crest working voltages of the OSB9210 and OSM9210series cover the range from 2 kV to 15 kV, and of the OSS9210series the range from 3 kV to 30 kV, in 1 kV steps.

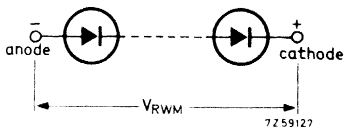
CIRCUIT OSB9210



CIRCUIT OSM9210



CIRCUIT OSS9210



QUICK REFERENCE DATA

		OSB9210	−4	−6	...	−28	−30		
		OSM9210	−4	−6	...	−28	−30		
Crest working reverse voltage from centre tap to end	V_{RWM}	max.	2	3	...	14	15	kV	
		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 up to T_{amb} = 35 ^{o}C					$I_{F(AV)}$	max.		5	A
in oil up to T_{oil} = 30 ^{o}C					$I_{F(AV)}$	max.		20	A
Non-repetitive peak forward current t = 10 ms; half sine wave; T_j = 175 ^{o}C prior to surge					I_{FSM}	max.		360	A

MECHANICAL DATA see page 4 and 5

All information applies to frequencies up to 400 Hz

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

Voltages

		OSB9210	-4	-6	...	-28	-30	
		OSM9210	-4	-6	...	-28	-30	
Crest working reverse voltage	V_{RWM}	max.	2	3	...	14	15	kV
		OSS9210	-3	-4	...	-29	-30	
Crest working reverse voltage	V_{RWM}	max.	3	4	...	29	30	kV

Currents

Average forward current (averaged over any 20 ms period)				
in free air up to T_{amb} = 35 °C	$I_{F(AV)}$	max.	5	A
in oil up to T_{oil} = 30 °C	$I_{F(AV)}$	max.	20	A
Repetitive peak forward current	I_{FRM}	max.	440	A
Non-repetitive peak forward current t = 10 ms; half sine wave; T_j = 175 °C prior to surge	I_{FSM}	max.	360	A

Reverse power dissipation

		OSB9210	-4	-6	...	-28	-30	
		OSM9210	-4	-6	...	-28	-30	
Repetitive peak reverse power t = 10 µs (square wave; f = 50 Hz) T_j = 175 °C	P_{RRM}	max.	4	6	...	28	30	kW
Non-repetitive peak reverse power t = 10 µs (square wave)								
T_j = 25 °C prior to surge	P_{RSM}	max.	26	39	...	182	195	kW
T_j = 175 °C prior to surge	P_{RSM}	max.	4	6	...	28	30	kW
		OSS9210	-3	-4	...	-29	-30	kW
Repetitive peak reverse power dissipation t = 10 µs (square wave; f = 50 Hz) T_j = 175 °C	P_{RRM}	max.	6	8	...	58	60	kW
Non-repetitive peak reverse power dissipation t = 10 µs (square wave)								
T_j = 25 °C prior to surge	P_{RSM}	max.	39	52	...	377	390	kW
T_j =175 °C prior to surge	P_{RSM}	max.	6	8		58	60	kW

Temperatures

Storage temperature	T_{stg}		-55 to +175	°C
Junction temperature	T_j	max.	175	°C

CHARACTERISTICS (See note 1)

			OSB9210 -4	-6	...	-28	-30	
			OSM9210-4	-6	...	-28	-30	
Forward voltage								
I_F = 50 A; T_j = 25 °C	V_F	<	3.6	5.4	...	25.2	27	V
Reverse breakdown voltage 1)								
I_R = 5 mA; T_j = 25 °C	$V_{(BR)R}$	>	2.5	3.75	...	17.5	18.75	kV
		<	3.76	5.64	...	26.32	28.2	kV

			OSS9210 -3	-4	...	-29	-30	
Forward voltage								
I_F = 50 A; T_j = 25 °C	V_F	<	5.4	7.2	...	52.2	54	V
Reverse breakdown voltage 1)								
I_R = 5 mA; T_j = 25 °C	$V_{(BR)R}$	>	3.75	5.0	...	36.25	37.5	kV
		<	5.64	7.52	...	54.52	56.4	kV

Reverse current

$V_{RM} = V_{RWM\,max}$; T_j = 125 °C $\quad I_{RM}$ < 0.6 mA

NOTES

1. The Ratings and Characteristics given apply from centre tap to end. (Not for OSS9210series).

2. Type number suffix

   The suffix sonsists of a figure indicating the total number of diodes, followed by a letter indicating the base.
   A = 1/4"U.N.F. studs at the ends.
   B = 4 pin Super Jumbo (B4D)
   C = Goliath
   E = 4 pin Jumbo (B4F)
   F = A3-20

3. Operating position

   The rectifier units can be operated at their maximum ratings when mounted in any position.

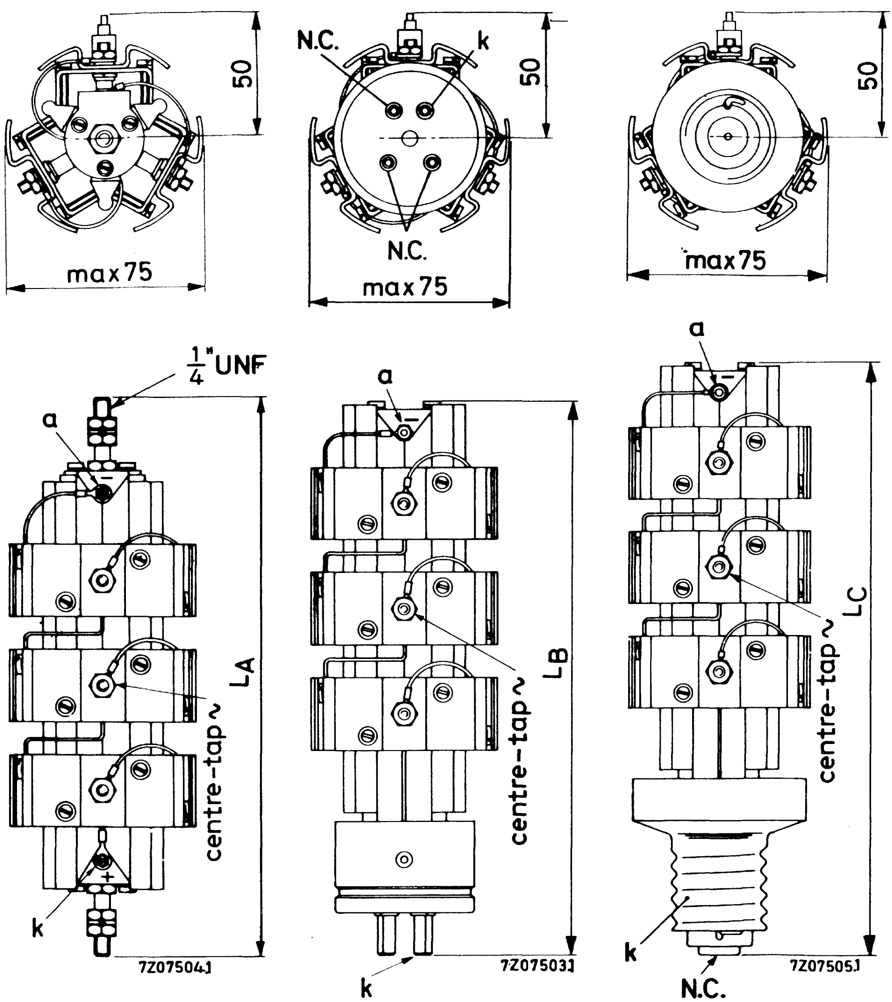
1) The breakdown voltage increases by approximately 0.1 % per °C with increasing junction temperature.

MECHANICAL DATA

Dimensions in mm

n = total number of diodes

OSM9210-nA OSM9210-nB OSM9210-nC



The drawings show the OSM9210series; the OSB9210 and OSS9210series differ in the following respects:

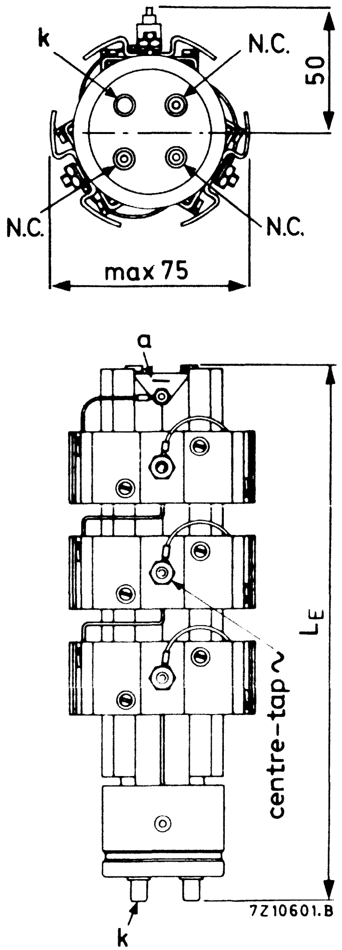
OSB9210series – terminals marked a(-) and k(+) in the drawings are both marked ∿; the centre-tap is marked + (instead of ∿ as in the drawings).

OSS9210series – has no centre-tap.

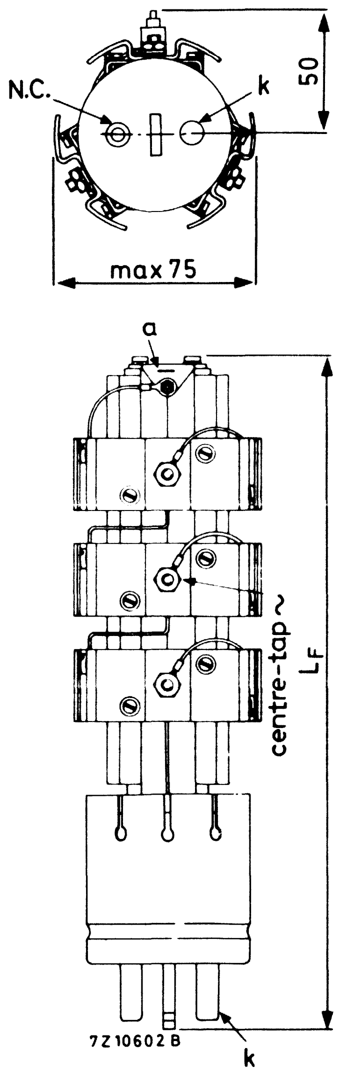
MECHANICAL DATA

n = total number of diodes.

OSM9210-nE



OSM9210-nF

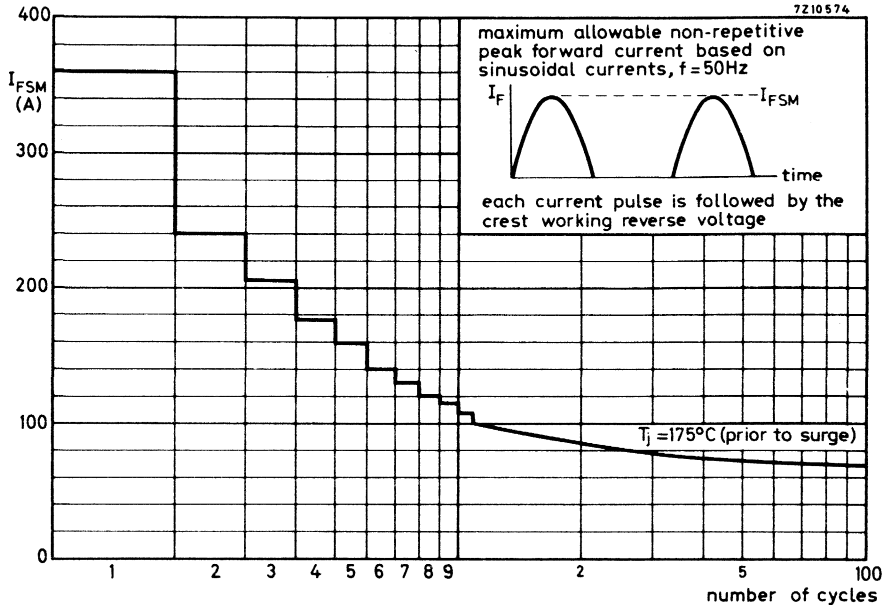


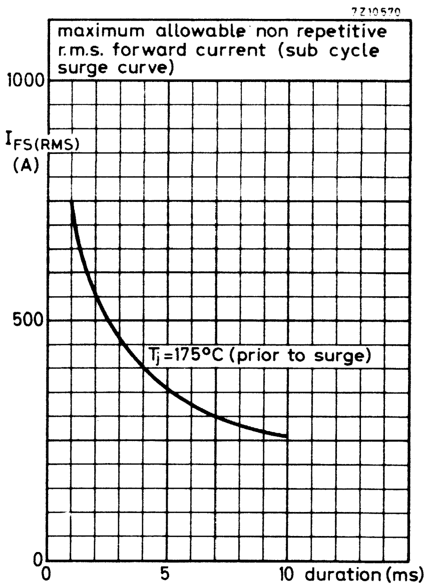
For lengths and weights see table on page 6.

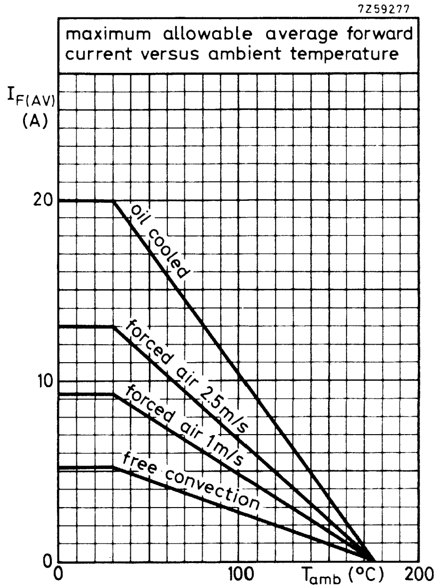
Table of lengths and weights (mm and g)

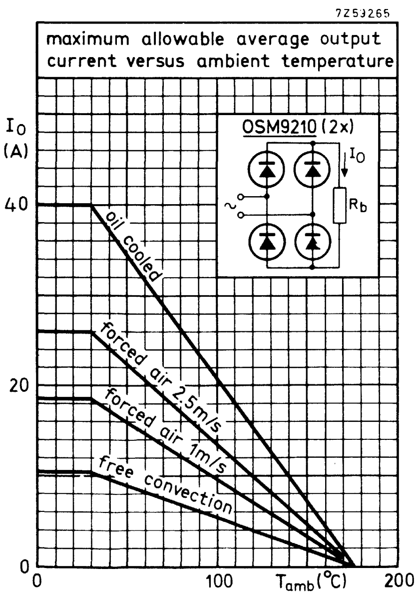
number of diodes	n	3	4 to 6	7 to 9	10 to 12	13 to 15
maximum lengths	L_A	143	184	224	264	305
	L_B	147	188	228	268	309
	L_C	159	199	239	279	320
	L_E	132	173	213	253	294
	L_F	184	225	265	305	346
weight	W_A	153	286	419	552	685
$W_B = W_C =$	W_E	218	351	484	617	750
	W_F	379	512	645	778	911

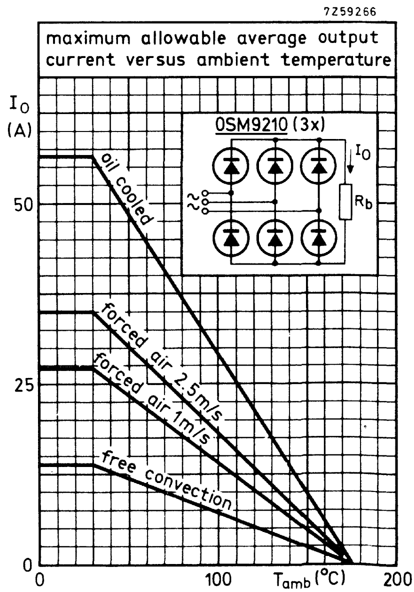
number of diodes	n	16 to 18	19 to 21	22 to 24	25 to 27	28 to 30
maximum lengths	L_A	345	385	426	466	506
	L_B	349	389	430	470	510
	L_C	360	400	441	481	521
	L_E	334	374	415	455	495
	L_F	386	426	467	507	547
weights	W_A	818	951	1084	1217	1350
$W_B = W_C =$	W_E	883	1016	1149	1282	1415
	W_F	1044	1177	1310	1443	1576


7Z10574
maximum allowable non-repetitive peak forward current based on sinusoidal currents, f = 50Hz
I_F
I_{FSM}
time
each current pulse is followed by the crest working reverse voltage
400
I_{FSM} (A)
300
200
100
0
1
2
3
4
5
6
7
8
9
2
5
100
number of cycles
T_j = 175°C (prior to surge)


7Z10570
maximum allowable non repetitive r.m.s. forward current (sub cycle surge curve)
1000
$I_{FS(RMS)}$ (A)
500
0
0
5
10
duration (ms)
T_j = 175°C (prior to surge)

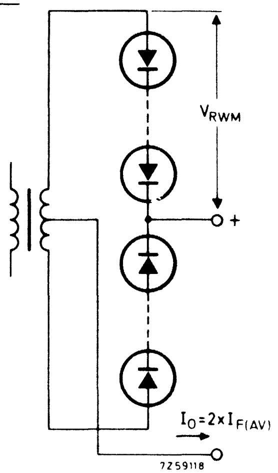

7Z59277
maximum allowable average forward current versus ambient temperature
$I_{F(AV)}$ (A)
20
10
0
0
100
T_{amb} (°C)
200
oil cooled
forced air 2.5m/s
forced air 1m/s
free convection


7Z59265
maximum allowable average output current versus ambient temperature
I_O (A)
40
20
0
0
100
T_{amb} (°C)
200
OSM9210 (2x)
I_O
R_b
oil cooled
forced air 2.5m/s
forced air 1m/s
free convection

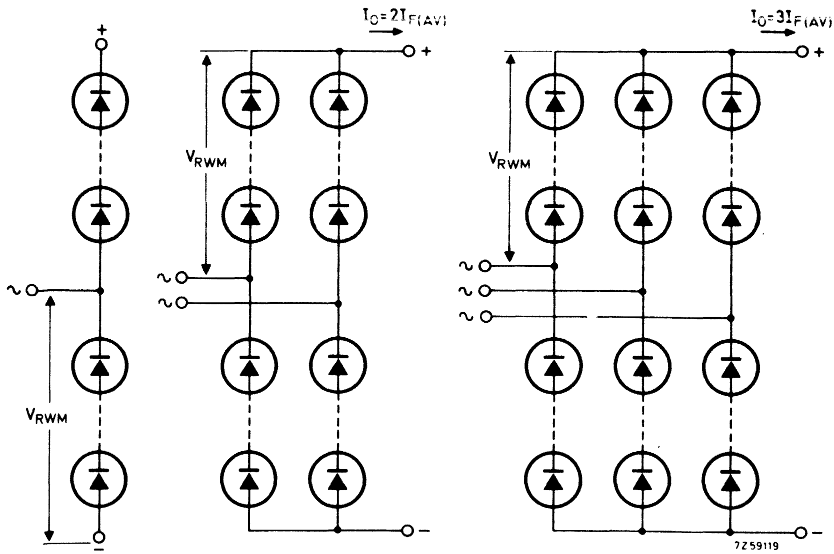

7Z59266
maximum allowable average output current versus ambient temperature
I_O (A)
50
25
0
0
100
T_{amb} (°C)
200
OSM9210 (3x)
I_O
R_b
oil cooled
forced air 2.5m/s
forced air 1m/s
free convection

APPLICATION INFORMATION

OSB9210-4



OSM9210series



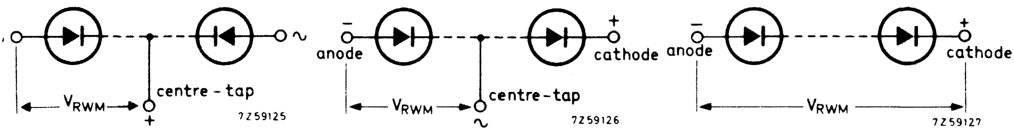
voltage doubler
1x OSM9210

rectifier circuits with respectively
2x OSM9210 and 3x OSM9210

HIGH VOLTAGE RECTIFIER STACKS

The OSB9310, OSM9310 and OSS9310 series are ranges of high voltage rectifier assemblies, incorporating controlled avalanche diodes mounted on fire proof triangular formers. The OSB9310 series is intended for application in two phase half wave rectifier circuits. The OSM9310 series is intended for application in single phase or three phase bridges or in voltage doubler circuits.
The OSS9310 series is intended for all kinds of high voltage rectification. The assemblies are supplied with 1/4"UNF studs or with standard valve bases. The OSB9310 series and OSM9310 series are supplied with a centre tap (8-32UNC). The maximum crest working voltages of the OSB9310 and OSM9310 series cover the range from 2 kV to 15 kV, and of the OSS9310 series the range from 3 kV to 30 kV, in 1 kV steps.

circuit OSB 9310 | circuit OSM 9310 | circuit OSS 9310



QUICK REFERENCE DATA

		OSB9310	-4	-6	...	-28	-30	
		OSM9310	-4	-6	...	-28	-30	
Crest working reverse voltage from centre tap to end	V_{RWM}	max.	2	3	...	14	15	kV
		OSS9310	-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 up to $T_{amb} = 35^oC$	$I_{F(AV)}$	max.	4	A
in oil up to $T_{oil} = 65^oC$	$I_{F(AV)}$	max.	12	A
Non-repetitive peak forward current $t = 10$ ms: half sinewave: $T_j = 175^oC$ prior to surge	I_{FSM}	max.	180	A

MECHANICAL DATA see page 4 and 5

All information applies to frequencies up to 400 Hz

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

Voltages

			-4	-6	...	-28	-30	
		OSB9310	-4	-6	...	-28	-30	
		OSM9310	-4	-6	...	-28	-30	
Crest working reverse voltage	V_{RWM}	max.	2	3	...	14	15	kV
		OSS9310	-3	-4	...	-29	-30	
Crest working reverse voltage	V_{RWM}	max.	3	4	...	29	30	kV

Currents

Average forward current (averaged over any 20 ms period)				
in free air up to T_{amb} = 35 °C	$I_{F(AV)}$	max.	4	A
in oil up to T_{oil} = 65 °C	$I_{F(AV)}$	max.	12	A
Repetitive peak forward current	I_{FRM}	max.	250	A
Non-repetitive peak forward current t = 10 ms; half sine wave; T_j = 175 °C prior to surge	I_{FSM}	max.	180	A

Reverse power dissipation

		OSB9310	-4	-6	...	-28	-30	
		OSM9310	-4	-6	...	-28	-30	
Repetitive peak reverse power dissipation t = 10 µs (square wave; f = 50 Hz) T_j = 175 °C	P_{RRM}	max.	2	3	...	14	15	kW
Non-repetitive peak reverse power dissipation t = 10 µs (square wave)								
T_j = 25 °C prior to surge	P_{RSM}	max.	12	18	...	84	90	kW
T_j = 175 °C prior to surge	P_{RSM}	max.	2	3	...	14	15	kW
		OSS9310	-3	-4		-29	-30	
Repetitive peak reverse power dissipation t = 10 µs (square wave; f = 50 Hz) T_j = 175 °C	P_{RRM}	max.	3	4	...	29	30	kW
Non-repetitive peak reverse power dissipation t = 10 µs (square wave)								
T_j = 25 °C prior to surge	P_{RSM}	max.	18	24	...	174	180	kW
T_j = 175 °C prior to surge	P_{RSM}	max.	3	4		29	30	kW

Temperatures

Storage temperature	T_{stg}		-55 to + 175	°C
Junction temperature	T_j	max.	175	°C

CHARACTERISTICS (See note 1)

		OSB9310	-4	-6	...	-28	-30	
Forward voltage		OSM9310	-4	-6	...	-28	-30	
I_F = 50 A; T_j = 25 °C	V_F	<	5	7.5	...	35	37.5	V
Reverse breakdown voltage [1)]								
I_R = 5 mA; T_j = 25 °C	$V_{(BR)R}$	>	2.5	3.75	...	17.5	18.75	kV
		<	4	6	...	28	30	kV
		OSS9310	-3	-4	...	-29	-30	
Forward voltage								
I_F = 50 A; T_j = 25 °C	V_F	<	7.5	10	...	72.5	75	V
Reverse breakdown voltage [1)]								
I_R = 5 mA; T_j = 25 °C	$V_{(BR)R}$	>	3.75	5	...	36.25	37.5	kV
		<	6	8	...	58	60	kV

Reverse current

$V_{RM} = V_{RWMmax}$; T_j = 125 °C $\quad I_{RM} \quad < \quad 0.3$ mA

NOTES

1. The Ratings and Characteristics given apply from centre tap to end. (Not for OSS9310series).

2. Type number suffix

   The suffix consists of a figure indicating the total number of diodes, followed by a letter indicating the base.
   A = 1/4" U.N.F. studs at the ends
   B = 4 pin Super Jumbo (B4D)
   C = Goliath
   E = 4 pin Jumbo (B4F)
   F = A3-20

3. Operating position

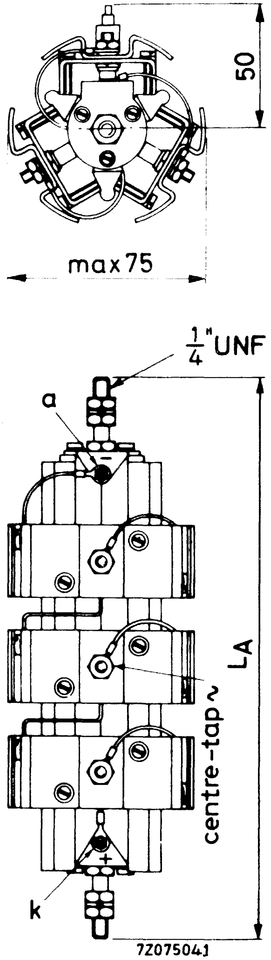
   The rectifier units can be operated at their maximum ratings when mounted in any position.

1) The breakdown voltage increases by approximately 0.1% per °C with increasing junction temperature.

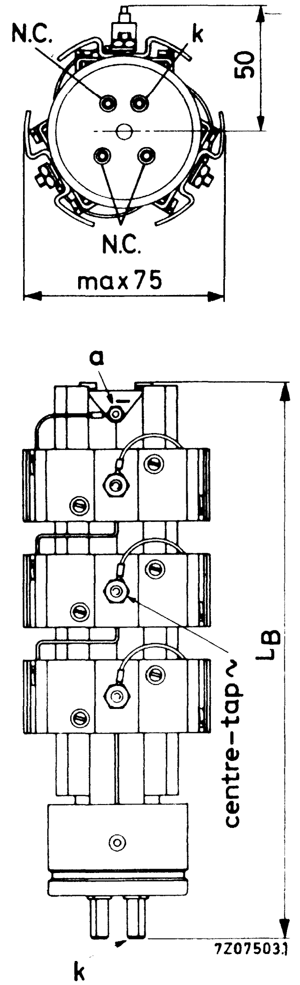
MECHANICAL DATA Dimensions in mm

n = total number of diodes

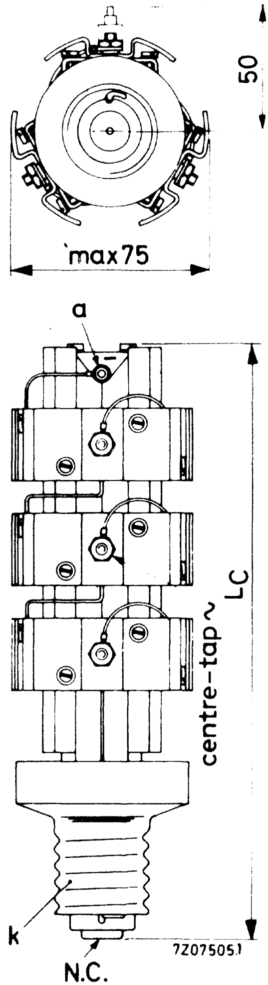
OSM9310-nA



OSM9310-nB



OSM9310-nC



The drawings show the OSM9310series; the OSB9310 and OSS9310series differ in the following respects:

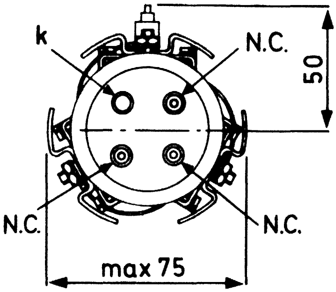
OSB9310series - terminals marked a(-) and k(+) in the drawings are both marked ~ ; the centre-tap is marked + (instead of ~ as in the drawings).

OSS9310series - has no centre-tap.

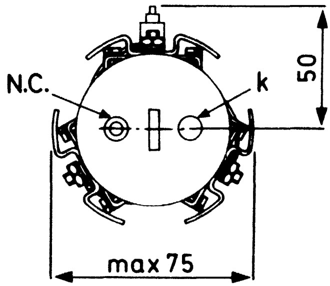
MECHANICAL DATA

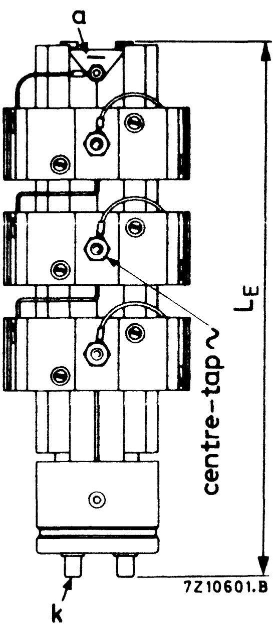
n = total number of diodes

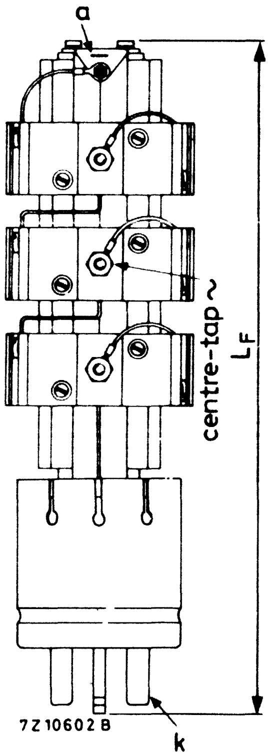
OSM9310-nE



OSM9310-nF





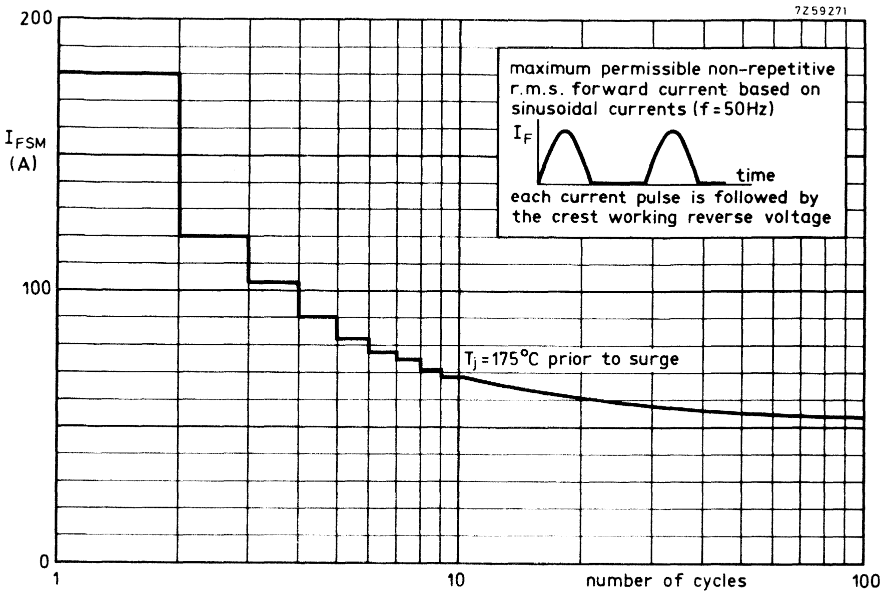


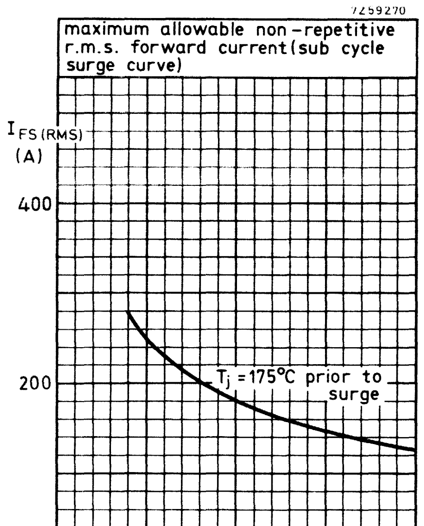
For lengths and weights see table on page 6.

Table of lengths and weights (mm and g)

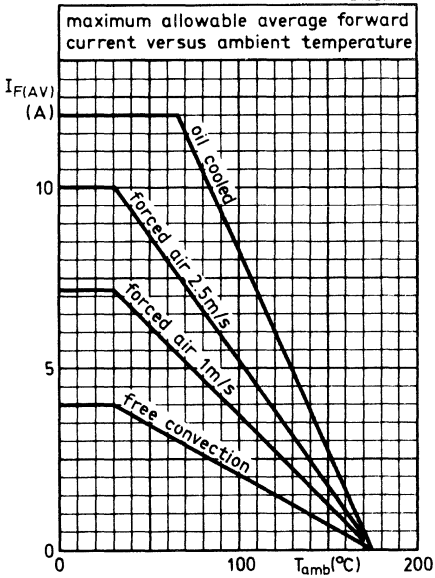
number of diodes	n	3	4 to 6	7 to 9	10 to 12	13 to 15
maximum lengths	L_A	143	184	224	264	305
	L_B	147	188	228	268	309
	L_C	159	199	239	279	320
	L_E	132	173	213	253	294
	L_F	184	225	265	305	346
weight	W_A	153	286	419	552	685
	$W_B = W_C = W_E$	218	351	484	617	750
	W_F	379	512	645	778	911

number of diodes	n	16 to 18	19 to 21	22 to 24	25 to 27	28 to 30
maximum lengths	L_A	345	385	426	466	506
	L_B	349	389	430	470	510
	L_C	360	400	441	481	521
	L_E	334	374	415	455	495
	L_F	386	426	467	507	547
weights	W_A	818	951	1084	1217	1350
	$W_B = W_C = W_E$	883	1016	1149	1282	1415
	W_F	1044	1177	1310	1443	1576

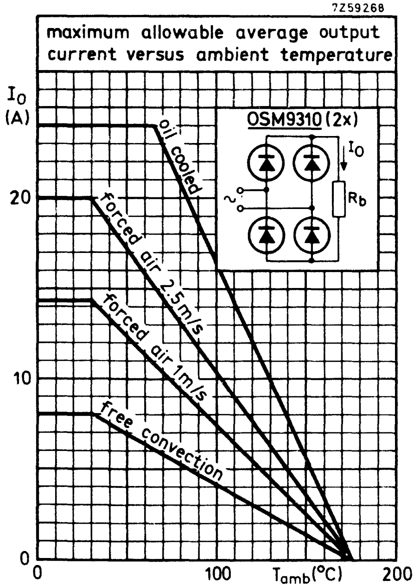

7Z59271
maximum permissible non-repetitive r.m.s. forward current based on sinusoidal currents (f = 50Hz)
I_F
time
each current pulse is followed by the crest working reverse voltage
I_{FSM} (A)
200
100
0
1
10
number of cycles
100
T_j = 175°C prior to surge


7Z59270
maximum allowable non-repetitive r.m.s. forward current (sub cycle surge curve)
$I_{FS(RMS)}$ (A)
400
200
0
0
5
duration (ms)
10
T_j = 175°C prior to surge

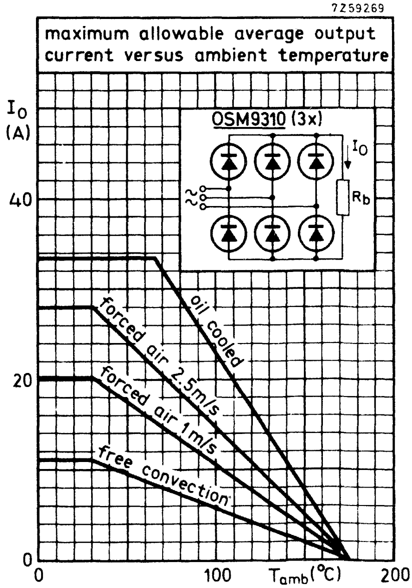
7Z59267



7Z59268

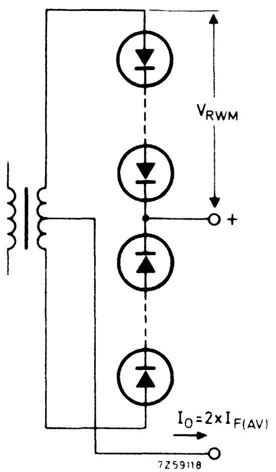


7Z59269

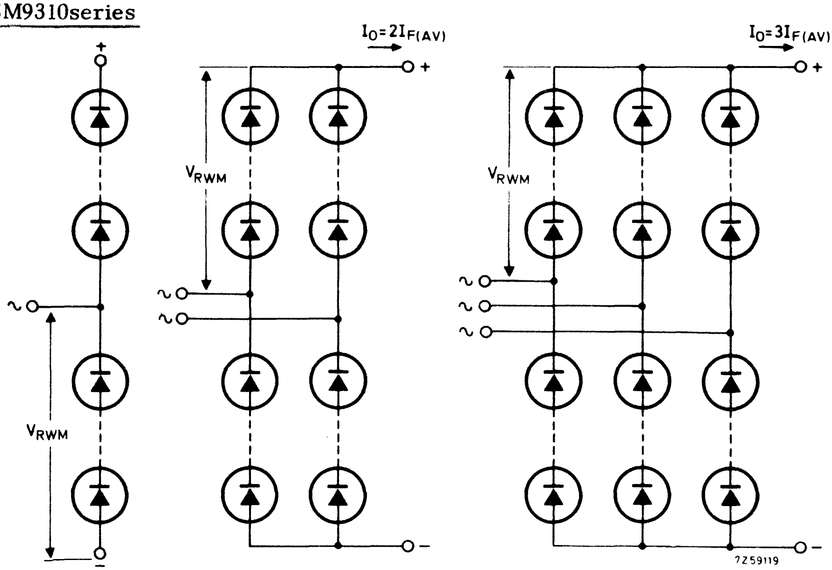


APPLICATION INFORMATION

OSB9310series



OSM9310series



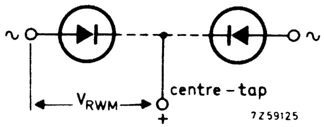
voltage doubler
1x OSM9310

rectifier circuits with respectively
2x OSM9310 and 3x OSM9310

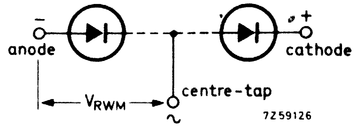
HIGH VOLTAGE RECTIFIER STACKS

Ranges of high voltage rectifier assemblies, incorporating controlled avalanche diodes mounted on fire proof triangular formers. They are supplied with 1/4 "UNF studs.
The OSB9410series is intended for application in two phase half wave rectifier circuits.
The OSM9410series is intended for application in single phase or three phase bridges or in voltage doubler circuits.
The OSS9410series is intended for all kinds of high voltage rectification.
The OSB9410series and OSM9410series are supplied with a centre tap (8-32UNC).
The maximum crest working voltages of the OSB9410 and OSM9410series cover the range from 2 kV to 15 kV, and of the OSS9410series the range from 3 kV to 30 kV, in 1 kV steps.

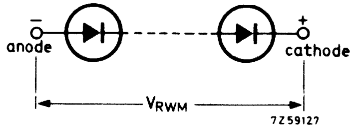
CIRCUIT OSB9410



CIRCUIT OSM9410



CIRCUIT OSS9410



QUICK REFERENCE DATA

		OSB9410	−4	−6	...	−28	−30		
		OSM9410	−4	−6	...	−28	−30		
Crest working reverse voltage from centre tap to end	V_{RWM}	max.	2	3		14	15	kV	
		OSS9410	−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 up to T_{amb} = 35 °C	$I_{F(AV)}$	max.	10	A
in oil up to T_{oil} = 35 °C	$I_{F(AV)}$	max.	30	A

Non-repetitive peak forward current

t = 10 ms; half sine wave; T_j = 175 °C prior to surge	I_{FSM}	max.	800	A

MECHANICAL DATA see page 4

All information applies to frequencies up to 400 Hz

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

Voltages

		OSB9410	-4	-6	...	-28	-30	
		OSM9410	-4	-6		-28	-30	
Crest working reverse voltage	V_{RWM}	max.	2	3	...	14	15	kV
		OSS9410	-3	-4	...	-29	-30	
Crest working reverse voltage	V_{RWM}	max.	3	4	...	29	30	kV

Currents

Average forward current (averaged over any 20 ms period)				
in free air up to T_{amb} = 35 °C	$I_{F(AV)}$	max.	10	A
in oil up to T_{oil} = 35 °C	$I_{F(AV)}$	max.	30	A
Repetitive peak forward current	I_{FRM}	max.	450	A
Non-repetitive peak forward current t = 10 ms; half sine wave; T_j = 175 °C prior to surge	I_{FSM}	max.	800	A

Reverse power dissipation

		OSB9410	-4	-6	...	-28	-30	
Repetitive peak reverse power dissipation		OSM9410	-4	-6	...	-28	-30	
t = 10 μs (square wave; f = 50 Hz) T_j = 175 °C	P_{RRM}	max.	9	13.5	...	63	67.5	kW
Non-repetitive peak reverse power dissipation t = 10 μs (square wave)								
T_j = 25 °C prior to surge	P_{RSM}	max.	55	80	...	375	400	kW
T_j = 175 °C prior to surge	P_{RSM}	max.	8.5	13	...	60.5	65	kW
Repetitive peak reverse power dissipation		OSS9410	-3	-4	...	-29	-30	
t = 10 μs (square wave; f = 50 Hz) T_j = 175 °C	P_{RRM}	max.	13.5	18	...	130.5	135	kW
Non-repetitive peak reverse power dissipation t = 10 μs (square wave)								
T_j = 25 °C prior to surge	P_{RSM}	max.	80	105	...	775	800	kW
T_j = 175 °C prior to surge	P_{RSM}	max.	13	17	...	126	130	kW

Temperatures

Storage temperature	T_{stg}	− 55 to + 175	°C
Junction temperature	T_j	max. 175	°C

CHARACTERISTICS (See note 1)

	OSB9410	−4	−6	...	−28	−30
	OSM9410	−4	−6	...	−28	−30
Forward voltage						
I_F = 150 A; T_j = 25 °C V_F	<	3.6	5.4	...	25.2	27 V
Reverse avalanche breakdown voltage [1]	>	2.5	3.75	...	17.5	18.75 kV
I_R = 5 mA; T_j = 25 °C $V_{(BR)R}$	<	4	6	...	28	30 kV

	OSS9410	−3	−4	...	−29	−30
Forward voltage						
I_F = 150 A; T_j = 25 °C V_F	<	5.4	7.2	...	52.2	54 V
Reverse avalanche breakdown voltage [1]	>	3.75	5	...	36.25	37.5 kV
I_R = 5 mA; T_j = 25 °C $V_{(BR)R}$	<	6	8	...	58	60 kV

Reverse current

$V_{RM} = V_{RWMmax}$; T_j = 125 °C I_{RM} < 1.6 mA

NOTES

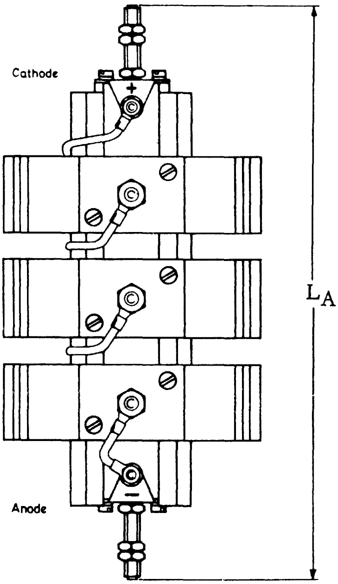
1. The Ratings and Characteristics given apply from centre tap to end. (Not for OSS9410series).
2. Type number suffix
   The suffix consists of a figure indicating the total number of diodes, followed by a letter indicating the base.
   A = 1/4 "U.N.F. studs at the ends.
3. Operating position
   The rectifier units can be operated at their maximum ratings when mounted in any position.

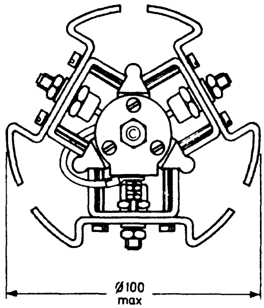
[1] The breakdown voltage increases, by approximately 0.1% per °C with increasing junction temperature.

MECHANICAL DATA Dimensions in mm

n = total number of diodes.

OSS9410-nA



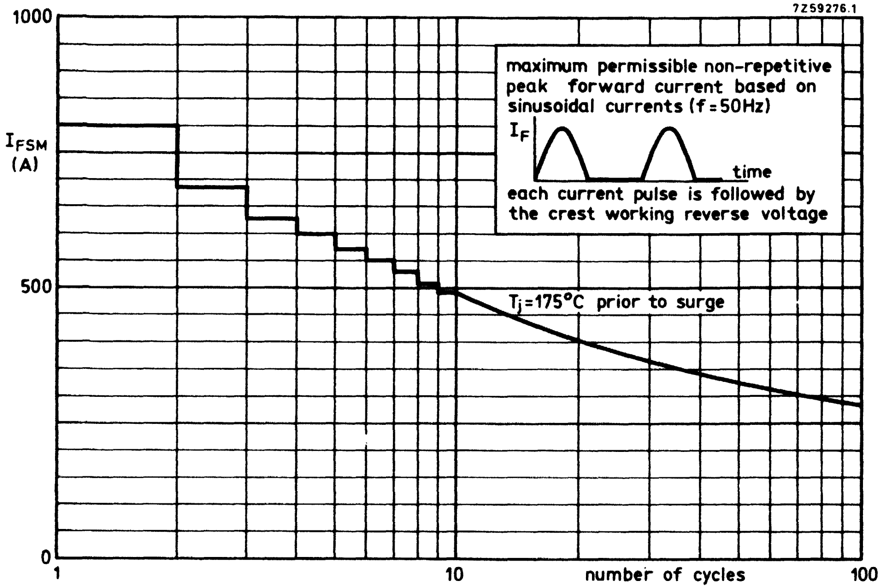


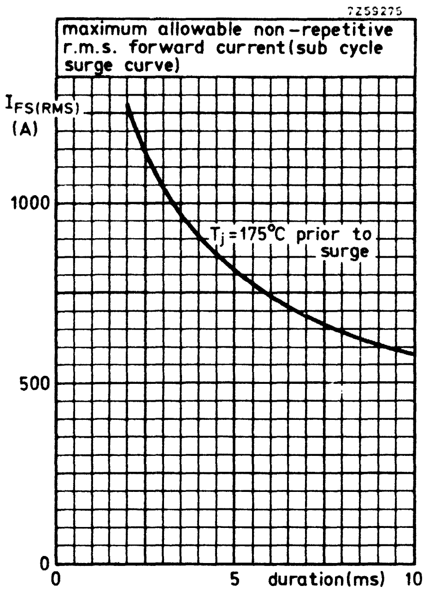
The drawing shows the OSS9410series.
The OSB9410 and OSM9410series differ in the following respects:
OSB9410 series – has a centre tap marked +; anode and cathode terminals are both marked∿.
OSM9410series – has a centre tap marked∿.

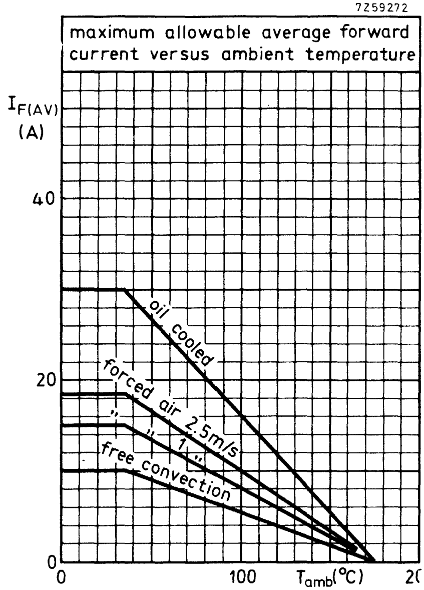
Table of lengths and weights (mm and g)

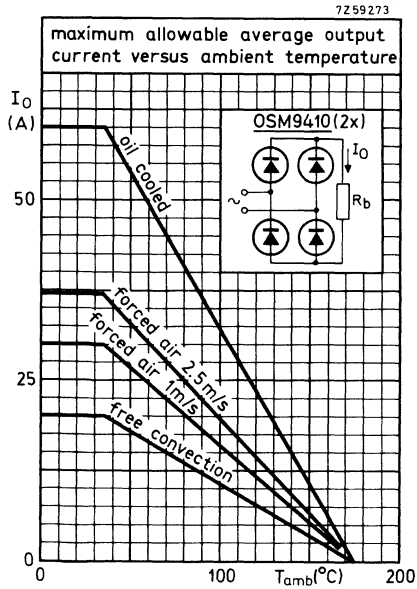
number of diodes n	3	4 to 6	7 to 9	10 to 12	13 to 15
maximum lengths L_A	143	184	224	264	305
weights W_A	215	413	611	809	1007

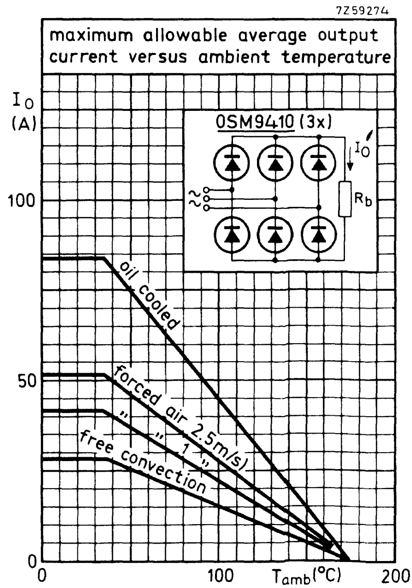
number of diodes n	16 to 18	19 to 21	22 to 24	25 to 27	28 to 30
maximum lengths L_A	345	385	426	466	506
weights W_A	1208	1406	1604	1802	2000


7Z59276.1
maximum permissible non-repetitive peak forward current based on sinusoidal currents (f = 50Hz)
IF
time
each current pulse is followed by the crest working reverse voltage
IFSM (A)
1000
500
0
1
10
number of cycles
100
Tj = 175°C prior to surge


7Z59275
maximum allowable non-repetitive r.m.s. forward current (sub cycle surge curve)
IFS(RMS) (A)
1000
500
0
0
5
duration (ms)
10
Tj = 175°C prior to surge

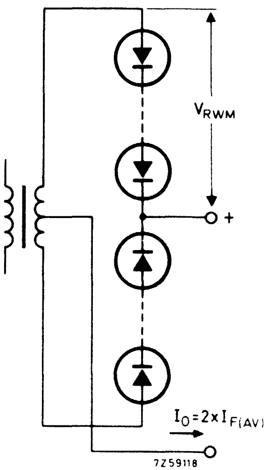

7Z59272
maximum allowable average forward current versus ambient temperature
$I_{F(AV)}$ (A)
40
20
0
0
100
T_{amb}(°C)
oil cooled
forced air 2.5m/s
" " 1 "
free convection


7Z59273
maximum allowable average output current versus ambient temperature
I_O (A)
50
25
0
0
100
T_{amb}(°C)
200
OSM9410 (2x)
I_O
R_b
oil cooled
forced air 2.5m/s
forced air 1m/s
free convection

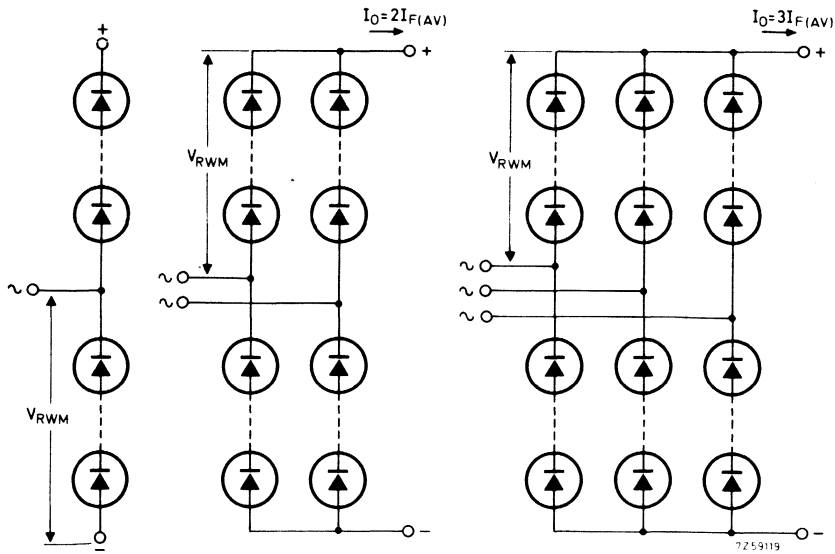

7Z59274
maximum allowable average output current versus ambient temperature
I_O (A)
100
50
0
0
100
T_{amb}(°C)
200
OSM9410 (3x)
I_O
R_b
oil cooled
forced air 2.5m/s
" " 1 "
free convection

APPLICATION INFORMATION

OSB9410series



OSM9410series



voltage doubler
1x OSM9410

rectifier circuits with respectively
2x OSM9410 and 3x OSM9410

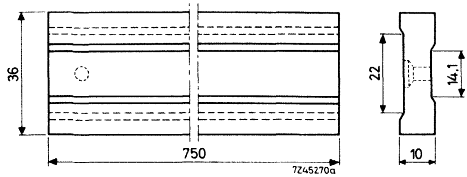
Accessories

MOUNTING STRIPS

56233

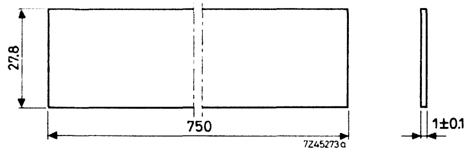
MECHANICAL DATA

Dimensions in mm



mounting strip of insulating material

Weight with cover:
330 g

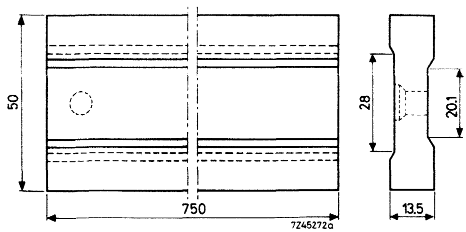


insulating plate (cover)

56234

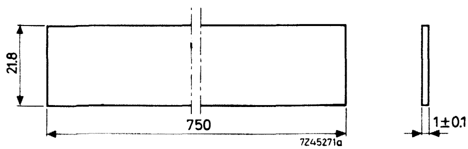
MECHANICAL DATA

Dimensions in mm



mounting strip of insulating material

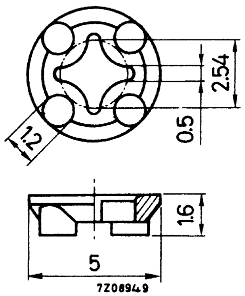
Weight with cover:
615 g



insulating plate (cover)

DISTANCE DISC

MECHANICAL DATA Dimensions in mm



Insulating material

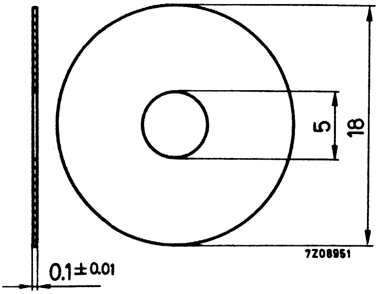
TEMPERATURE

Maximum allowable temperature $T_{max} = 100\ ^{o}C$

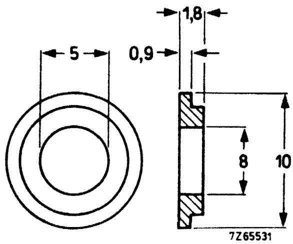
MOUNTING ACCESSORIES

MECHANICAL DATA

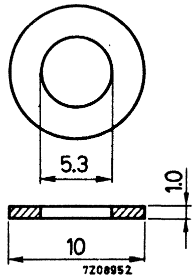
Dimensions in mm



mica washer



insulating ring



plain washer
material: brass, nickel plated

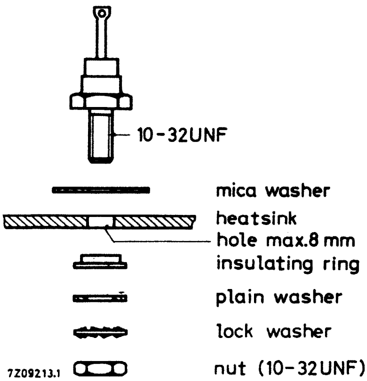
THERMAL RESISTANCE

From mounting base to heatsink (with mica washer)	$R_{th\,mb\text{-}h}$	=	5	°C/W

TEMPERATURE

Maximum allowable temperature	T_{max}	=	125	°C

MOUNTING INSTRUCTIONS

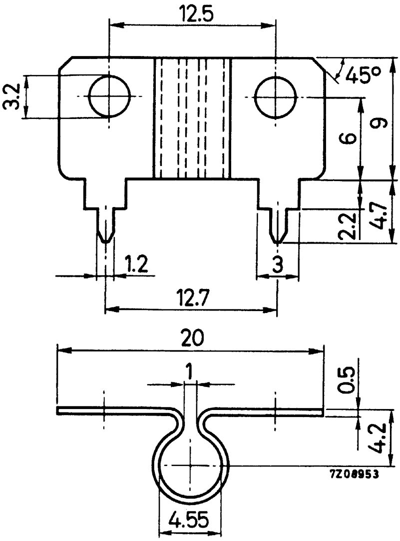


Note : When using a tag for electrical contact insert tag between nut and plain washer or replace plain washer by tag.

COOLING FIN

MECHANICAL DATA

Dimensions in mm



Fin material: copper, tin plated

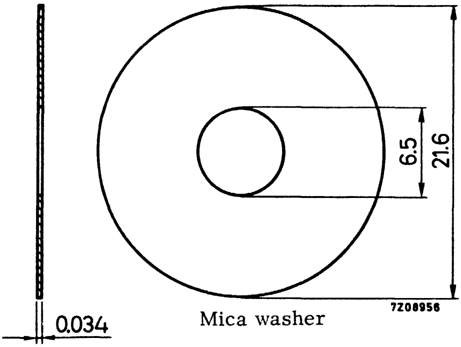
THERMAL RESISTANCE

From case to ambient $R_{th\,c\text{-}a} = 100\ ^{o}C/W$

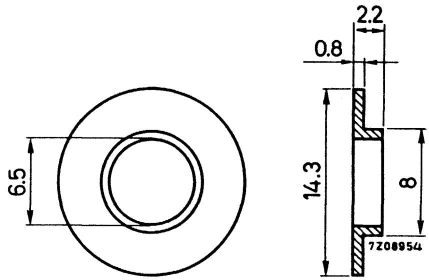
MOUNTING ACCESSORIES

MECHANICAL DATA

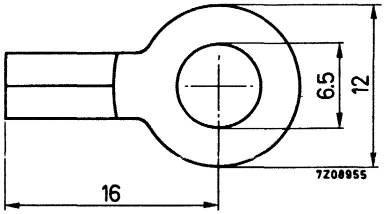
Dimensions in mm



Mica washer



Insulating ring



Soldering tag

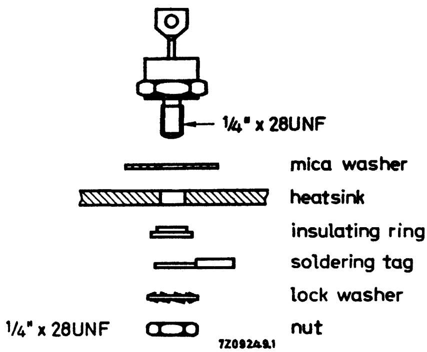
THERMAL RESISTANCE

From mounting base to heatsink with mica washer — $R_{th\,mb\text{-}h}$ = 4 °C/W

TEMPERATURE

Maximum allowable temperature — T_{max} = 175 °C

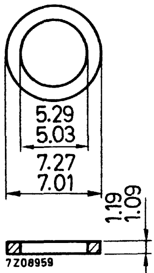
MOUNTING INSTRUCTIONS



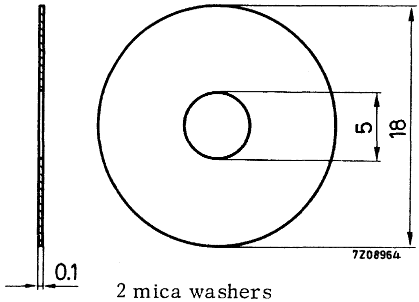
MOUNTING ACCESSORIES

MECHANICAL DATA

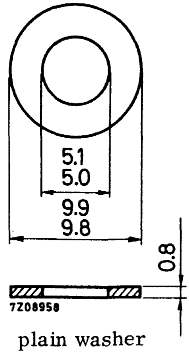
Dimensions in mm



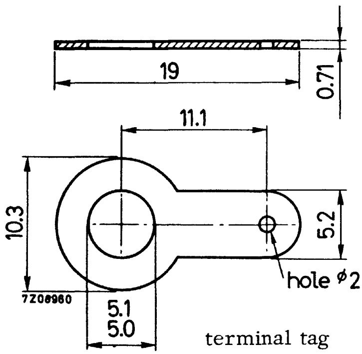
PTFE bush



2 mica washers



plain washer



terminal tag

THERMAL RESISTANCE

From mounting base to heatsink

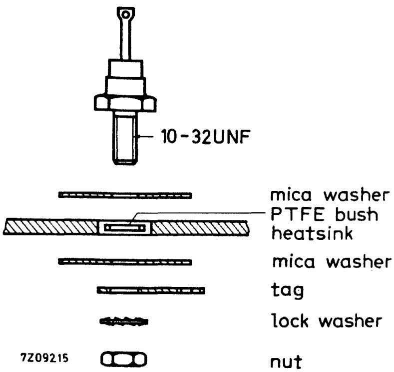
$R_{th\,mb\text{-}h} = 5\ ^{o}C/W$

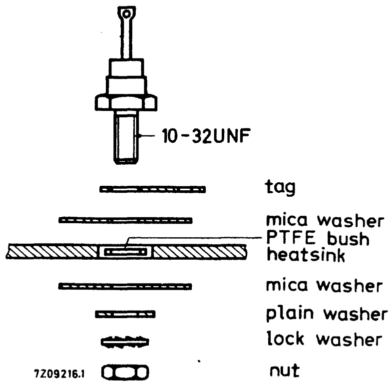
TEMPERATURE

Maximum allowable temperature

$T_{max} = 175\ ^{o}C$

MOUNTING INSTRUCTIONS

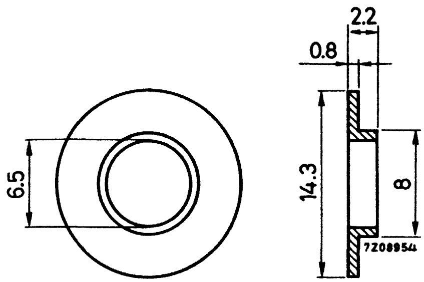




INSULATING RING

MECHANICAL DATA

Dimensions in mm



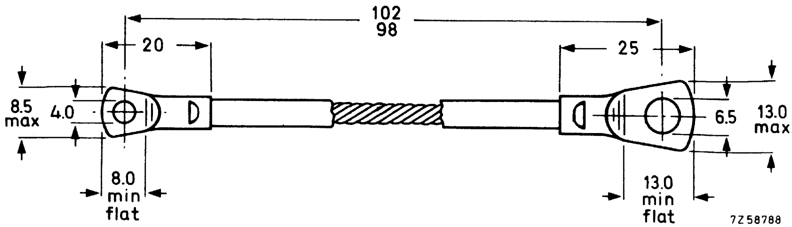
Accessories 56299 is the insulating ring of 56264A

Maximum operating temperature T_{max} = 175 ^{o}C

EXTERNAL LEAD

MECHANICAL DATA

Dimensions in mm

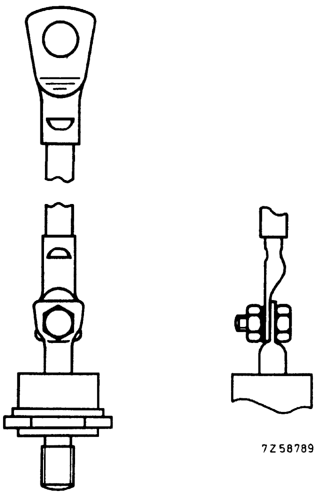


Net weight: 12 g

56309B: External anode lead (blue lead)

56309R: External cathode lead (red lead)

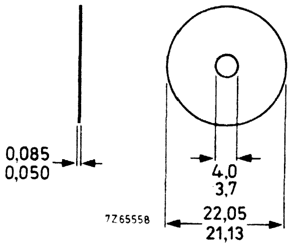
MOUNTING METHOD



MICA WASHER

MECHANICAL DATA

Dimensions in mm



THERMAL RESISTANCE

From mounting base to heatsink

with heatsink compound	$R_{th\ mb\text{-}h}$	=	1, 2 °C/W
without heatsink compound	$R_{th\ mb\text{-}h}$	=	2, 3 °C/W

Heatsinks

General

Flat heatsinks

Diecast heatsinks

Heatsink extrusions

Water cooled heatsink

Heatsinks are used where a semiconductor device is unable of itself to dissipate the heat generated by its internal power losses without the junction temperature exceeding its maximum. The simplest form of heatsink is a flat metal plate, but for economy in weight, size, and cost, more complex shapes are usually used.
Apart from information on heat transfer and the construction of assemblies, this Section shows how to take advantage of reverse polarity types, describes three types of heatsink, and gives calculation examples.

HEAT TRANSFER PATH

In, for example, a silicon rectifier the heat is generated inside the wafer and flows mainly by way of the base, through a heatsink to the ambient air.
The heat flow can be likened to the flow of electric current, with thermal resistance (R_{th} in $^{o}C/W$) analogous to the electric resistance (R in Ω).
Fig. 1 shows the heat path from junction to ambient as three thermal resistances in series:

$R_{th\ j\text{-}mb}$ The thermal resistance from junction to mounting base. Its value is given in the data sheets of a device.

$R_{th\ mb\text{-}h}$ The thermal resistance from mounting base to heatsink (contact thermal resistance). It is caused by the imperfect nature and limited size of the contact between the two. Its value is also given in the data sheets.

$R_{th\ h\text{-}a}$ The thermal resistance between the contact surface mentioned above and the ambient air.

For thermal balance air warmed by the heatsink must be replaced by cool, i.e., there must be an air flow.
From Fig. 1: $T_j - T_{amb} = P \times (R_{th\ j\text{-}mb} + R_{th\ mb\text{-}h} + R_{th\ h\text{-}a})$

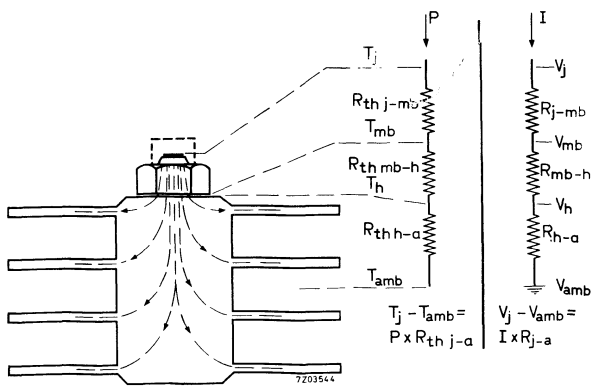


Fig. 1

IMPROVING HEAT TRANSFER

Heat transfer can be improved by reducing the thermal resistance of the contact and the thermal resistance of the heatsink.

Contact thermal resistance

- Make the contact area large
- Make the contact surfaces plane parallel by attention to drilling an punching, and make them burr-free.
- Apply sufficient pressure. Use a torque spanner adjusted to at least the rated minimum torque.
- Use silicon grease to fill air pockets. The thermal resistance of a thin film of grease (e.g. Dow Corning 340) is much less than that of a thin layer of air.

Heatsink thermal resistance

- Paint or anodise the surface to improve radiation
- Increase the flow of cooling air
- Use a larger heatsink

The simplest form of air flow is natural convection. Mount the fins vertically, make in-take and outlet apertures large, avoid obstructions, create a draught (chimney effect). A blower or fan must be used where free convection is not enough or where a smaller heatsink is wanted.

INSULATED MOUNTING

Where a semiconductor must be insulated from its heatsink (e.g., in bridge rectifiers) by a mica or teflon washer, the contact thermal resistance will be about ten times higher than without insulation. This must be compensated by a reduction in $R_{th\,h\text{-}a}$ to keep the total thermal resistance below the maximum given for P and T_{amb}. A larger heatsink may be necessary.

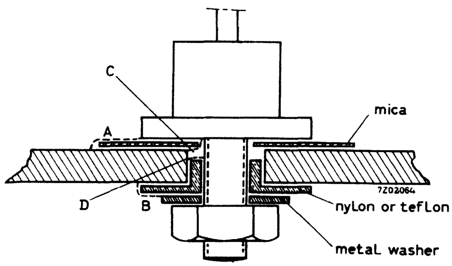


Fig. 2 Creepage distances with an insulated diode

Note: care must be taken that the creepage distances, see Fig. 2, are sufficient for the voltage involved. While A and B can be made large enough, C and D are likely to be the critical ones.

CONSTRUCTIONS

Good thermal coupling is essential to semiconductors connected in parallel to ensure good current sharing in view of the forward characteristics, and semiconductors in series in view of the reverse characteristics.
Mounting the semiconductors on the same heatsink not only saves mounting costs but also provides the needed thermal coupling.
Fig. 3 shows the construction for a plain heatsink, and Fig. 4 the construction for an extruded heatsink. The electrical connection is made with a copper strip at least 1 mm thick. For two diodes a plain heatsink should be twice the area, and an extruded heatsink twice the length needed for a single diode.
Reverse polarity devices are covenient for series connection of two diodes on a common heatsink. Figs. 5, 6 and 7 show how the use of normal polarity and reverse polarity diodes simplifies the construction of single-phase and three-phase bridge rectifiers.

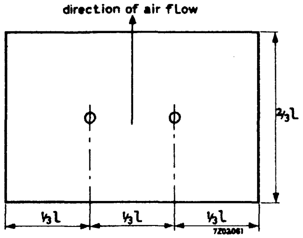


Fig. 3 Plain cooling fin with two diodes

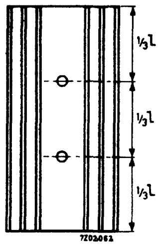


Fig. 4 Extruded aluminium heatsink with two diodes

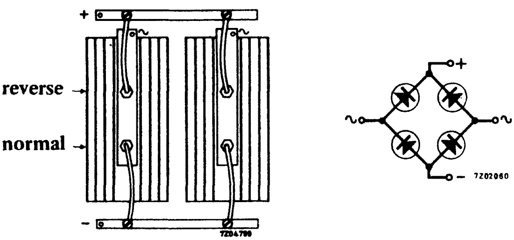


Fig. 5 Single phase full wave rectifier with diodes of different polarity on extruded aluminium heatsinks

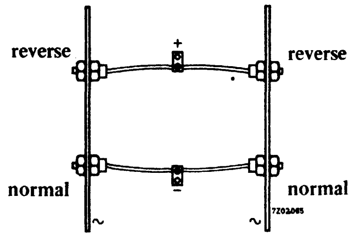


Fig. 6 Single phase full wave rectifier with diodes of different polarity on plain cooling fins (top view)

CONSTRUCTIONS (continued)

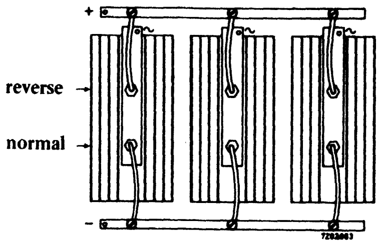
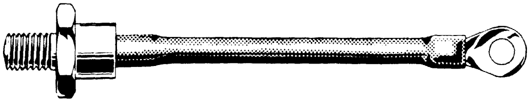


Fig. 7 Three phase full wave rectifier with diodes of different polarity on extruded aluminium heatsinks

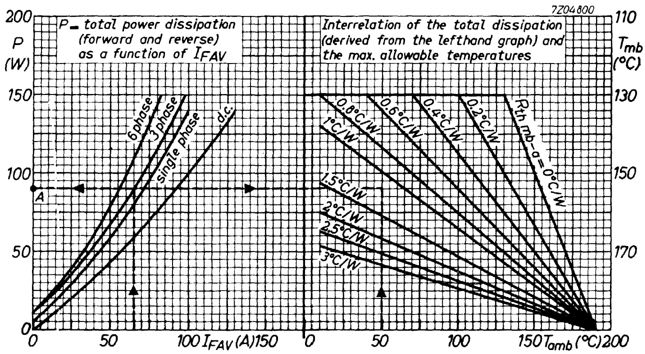
EXAMPLES OF HEATSINK CALCULATION

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 $I_{F(AV)}$ = 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.

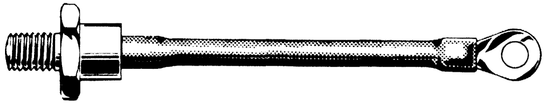
Type	Free convection	Forced cooling
flat, blackened bright	– –	125 cm²; 2 m/s or 300 cm²; 1 m/s 175 cm²; 2 m/s
diecast 56280	applicable	
extrusion 56230 bright blackened 56231 bright blackened	 ℓ = 12 cm ℓ = 8 cm ℓ = 7 cm ℓ = 5 cm [1]	 ℓ = 5 cm [1]; 1 m/s ℓ = 5 cm [1]; 1 m/s

[1]) Practical minimum length

EXAMPLES OF HEATSINK CALCULATION (continued)

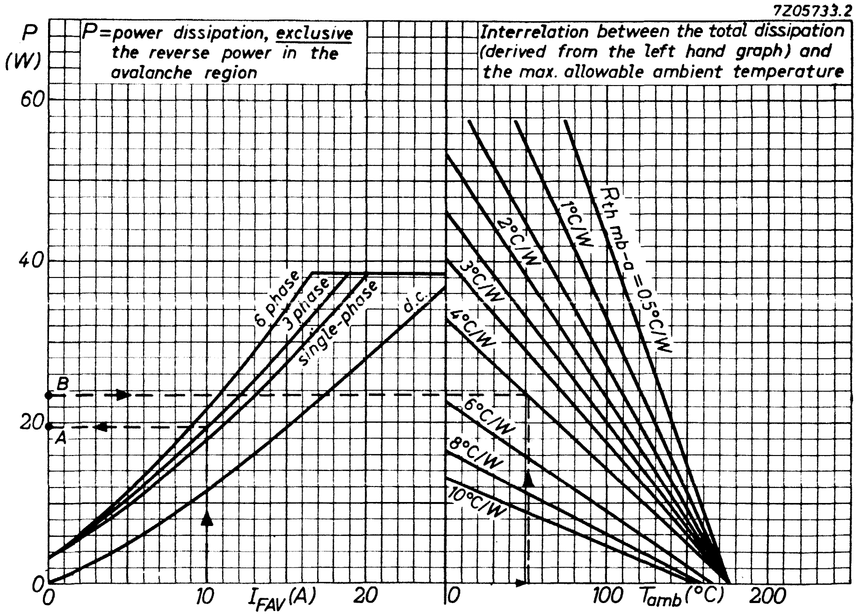
2. Devices with controlled avalanche properties

Assume that the diode of which the outlines are shown, is used in a three phase 50 Hz rectifier circuit at T_{amb} = 40 °C. Further assume: average forward current per diode $I_{F(AV)}$ = 10 A; contact thermal resistance:
$R_{th\ mb\text{-}h}$ = 0,5 °C/W; repetitive peak reverse power in the avalanche region (t = 40 μs) P_{RRM} = 2 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} = 19,5 W per diode (point A). The average reverse power in the avalanche region, averaged over any cycle, follows from

$P_{R(AV)} = \delta \times P_{RRM}$, where the duty cycle $\delta = \frac{40\ \mu s}{20\ ms} = 0,002$.

Thus $P_{R(AV)}$ = 0,002 x 2 kW = 4 W.

Therefore the total device power dissipation P_{tot} = 19,5 + 4 = 23,5 W (point B). From the righthand graph it follows that $R_{th\ mb\text{-}a}$ = 4 °C/W. Hence the heatsink thermal resistance should be:

$$R_{th\ h\text{-}a} = R_{th\ mb\text{-}a} - R_{th\ mb\text{-}h} = (4 - 0,5)\ °C/W = 3,5\ °C/W.$$

A table of applicable heatsinks, similar to that on the foregoing page, can de derived for this case.

SELECTION GUIDE FOR RECTIFIER DIODES, THYRISTORS AND TRIACS

Diecast (to DIN-41882) →	K 15	K 9	K 5	K 3			
Type number in order of current	56268	56256	56334	56319	56253	56312	56271
BYX38	●						
BYX39	●	●					
BYX50	●						
BYX48	●	●					
BYX42	●	●	●				
BYX40	●	●	●				
BYX30		●	●				
BYX13							●
BYX25			●	●			
BYX46		●	●	●			
BYX52					●		
BYX56					●		
BYX32							
BT101/102		●	●	●			
BTY79		●	●	●			
BTW47-M						●	
BTW30-M						●	
BTY87					●		
BTY91					●		
BTW92-M						●	
BTW31-M						●	
BTW32-M							
BTW24-M							
BTW33-M							
BTW23-M							
BTX41							
BTX94					●		
BTW34-M							
BTX95	●	●					

K 1,1				K 0,55			Extrusions			
56278	56313	56314	56280	56318	56315	56284	56230	56231	56290	56293
							●		●	
							●		●	
							●		●	
							●	●	●	
							●	●	●	
							●	●	●	
							●	●	●	
							●	●		
							●	●	●	
							●	●	●	
●							●	●		●
●							●	●		●
			●		●					●
									●	
									●	
	●						●	●	●	
	●						●	●	●	
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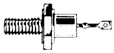
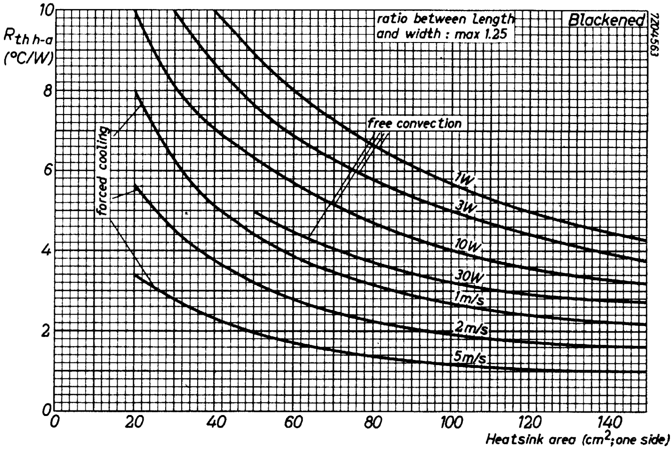
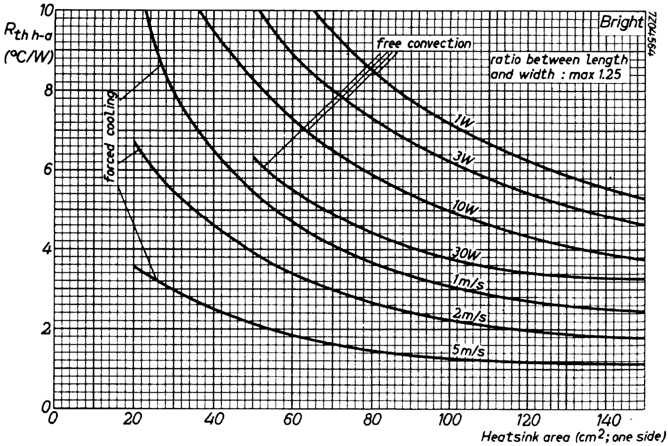
	●						●	●	●	
	●						●	●	●	
		●		●			●	●		●
		●		●			●	●		●
			●		●					●
			●		●					●
						●				●
●							●	●	●	
		●		●			●	●		●
									●	

Thermal resistance of flat heatsinks of 2 mm copper or 3 mm aluminium.
The graphs are valid for the combination of device and heatsink.

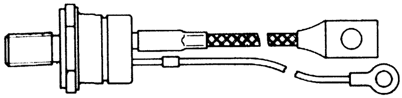


Studs: 10-32UNF
Mounting bases, across the flats: max. 11,0 mm

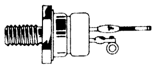




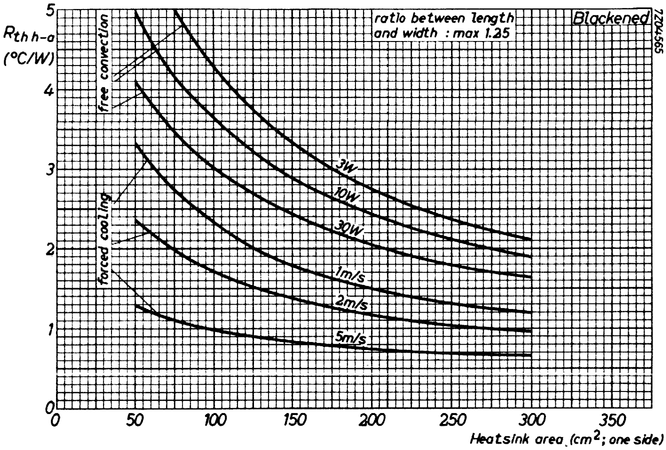
Thermal resistance of flat heatsinks of 2 mm copper or 3 mm aluminium.
The graphs are valid for the combination of device and heatsink.

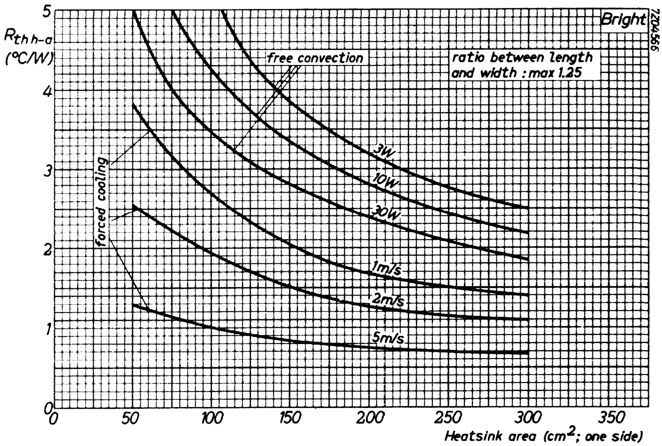


Stud: M8
Mounting base, across the flats: max. 19 mm

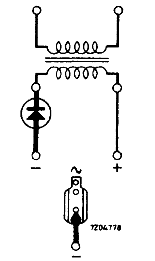
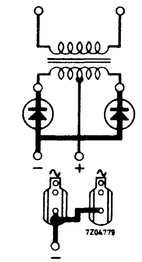
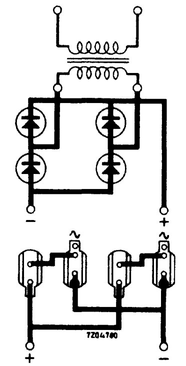
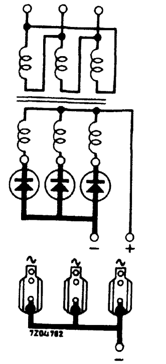


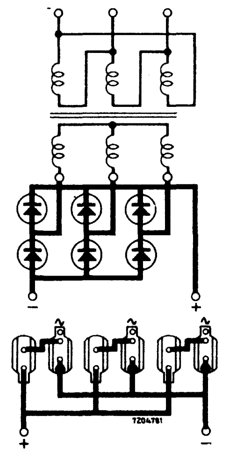
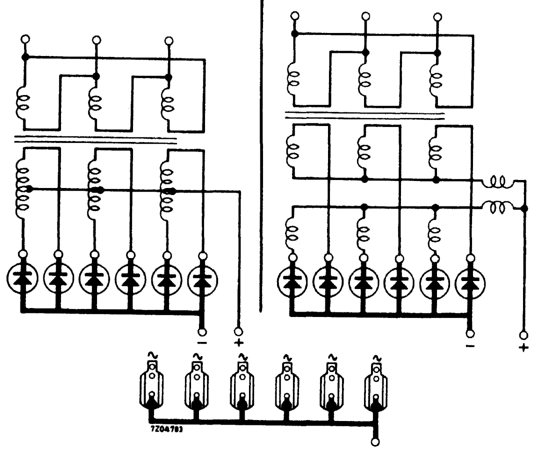
Stud: M6
Stud: $\frac{1}{4}$" x 28 UNF
Mounting base, across the flats: max. 14,0 mm





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)
			

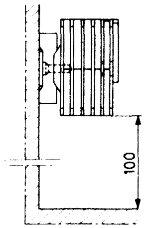
Three phase full wave (Three phase bridge)	Six phase half wave (Six phase star)	Three phase double Y with interphase transformer
		

Diecast heatsink without insulator 

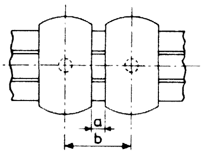
Diecast heatsink with insulator 

MOUNTING INSTRUCTION FOR DIECAST HEATSINKS

1. At free convection cooling or forced air flow < 0,5 m/s the heatsinks should be mounted with the fins vertical and with a distance to the chassis bottom > 100 mm.

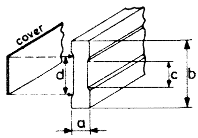


2. At forced air flow > 0,5 m/s the heatsinks may be mounted in any position.
3. Minimum distance between heatsinks in a row.



Heatsink	Distance (mm)	
	a	b
56256/268	> 5,0	> 25,0
56334	> 5,0	> 40,0
56253/334	> 10,0	> 50,0
56271	> 10,0	> 50,0

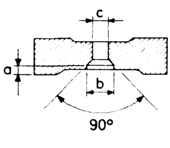
4. The rectifier devices should be fixed to their heatsinks with the torques specified in the relevant published data. Use the torque spanner.
5. For insulated mounting of heatsinks two sizes of mounting strips made of insulating material are available.



Length 750 mm

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

6. Mounting holes to be made in the strips:



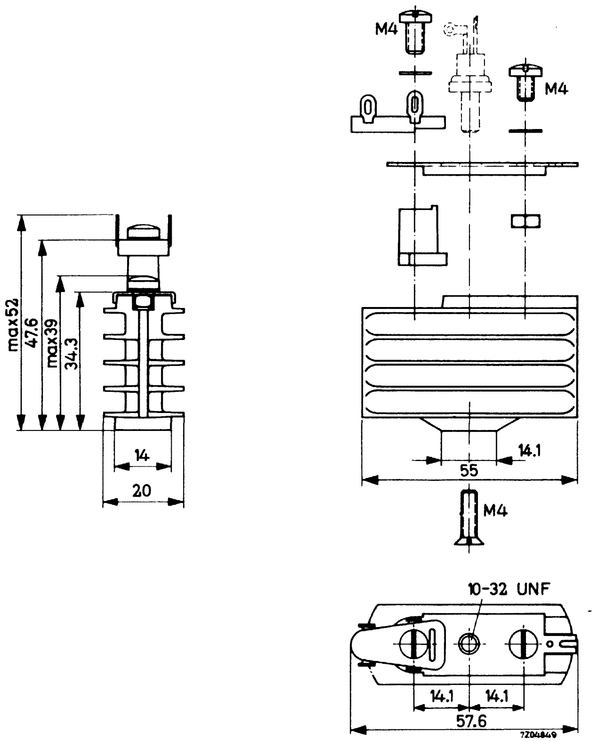
Heatsink	Strip	Dimensions in mm		
		a	b	c
56256/268	56233	< 1,5	7,5	4,3
56253/271	56234	< 1,3	10,2	6,3
56277/334	56234	< 1,3	10,2	6,3

DIECAST HEATSINK

Diecast heatsink of aluminium alloy, painted black, with 10-32 UNF tap hole for rectifier device.

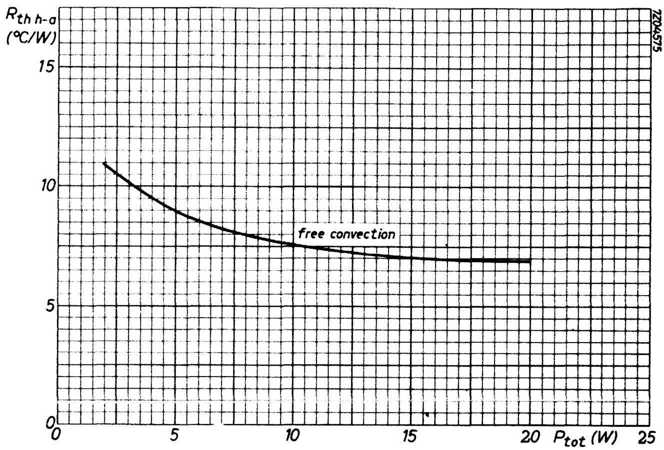
Weight: 55 g

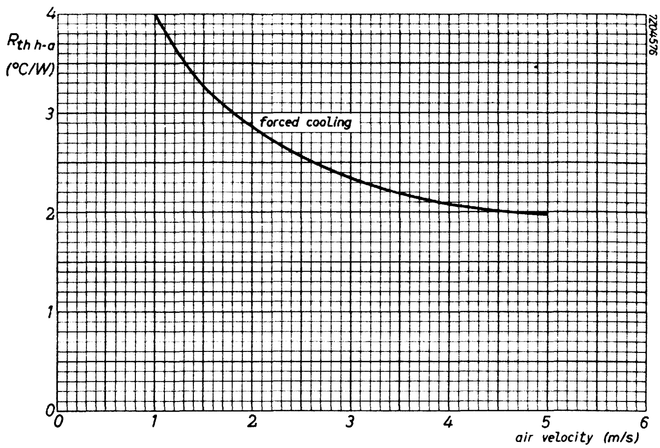
Dimensions in mm



The graphs are valid for the combination of device and heatsink.

Stud: 10 - 32 UNF
Mounting base, across the flats: 11,0 mm



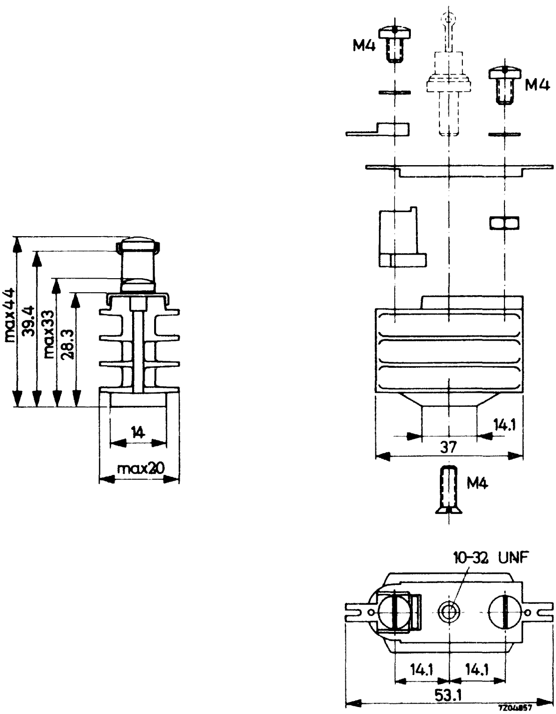


DIECAST HEATSINK

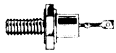
Diecast heatsink of aluminium alloy, painted black, with 10-32UNF tap hole for rectifier device.

Weight: 33 g

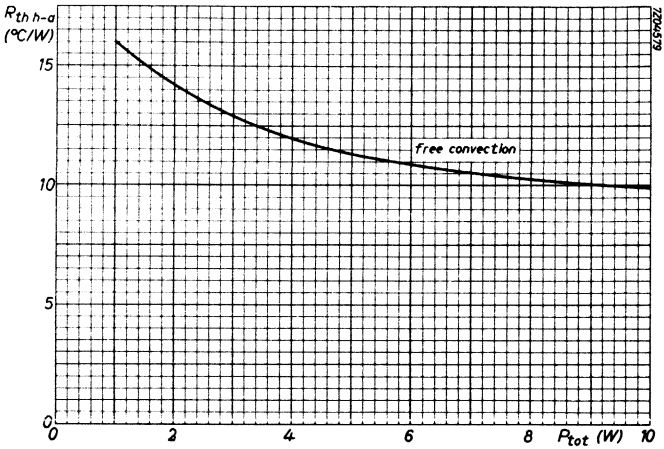
Dimensions in mm

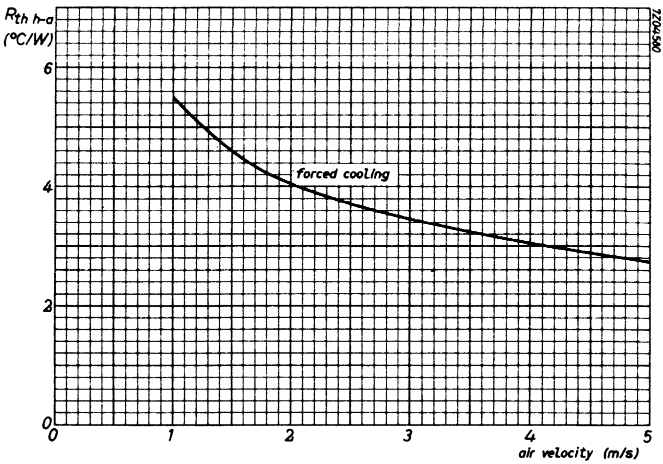


The graphs are valid for the combination of device and heatsink.



Stud: 10 - 32 UNF
Mounting base, across the flats: 11,0 mm



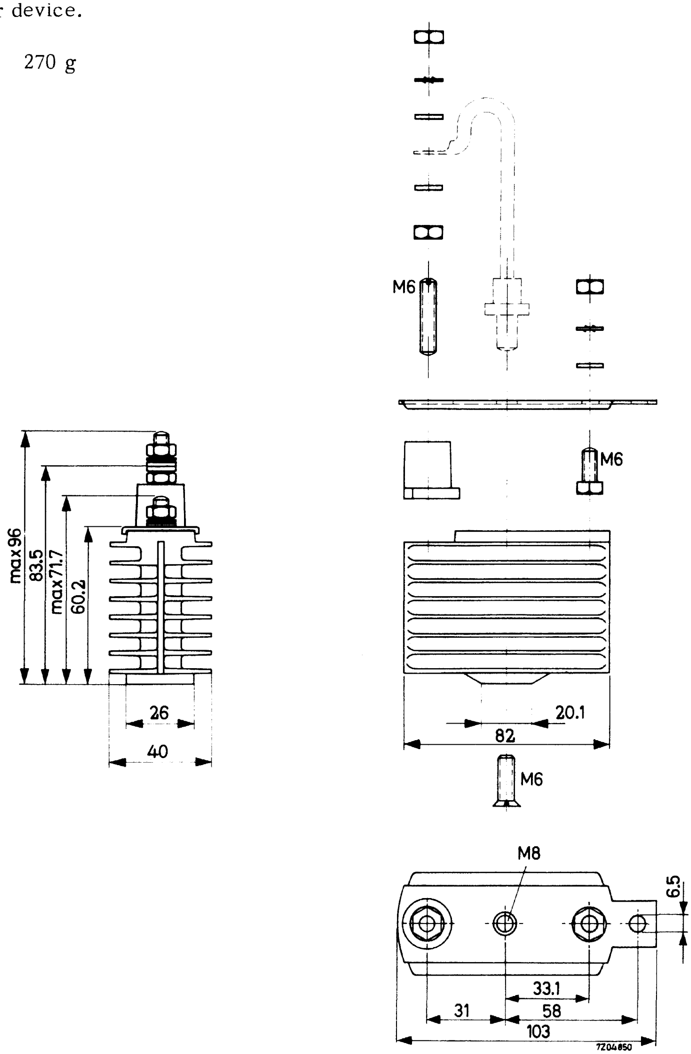


DIECAST HEATSINK

Diecast heatsink of aluminium alloy, painted black, with M8 tap hole for rectifier device.

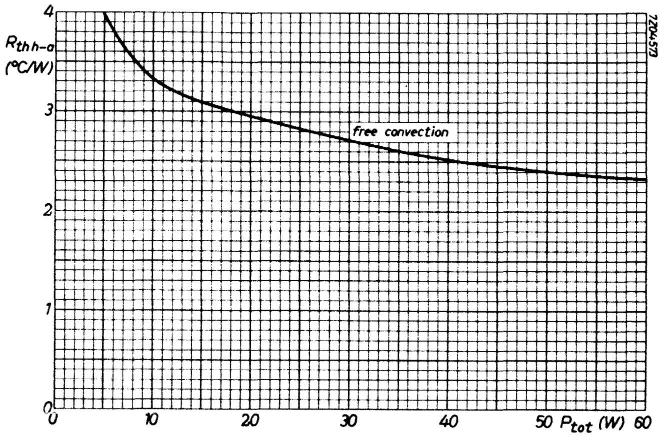
Dimensions in mm

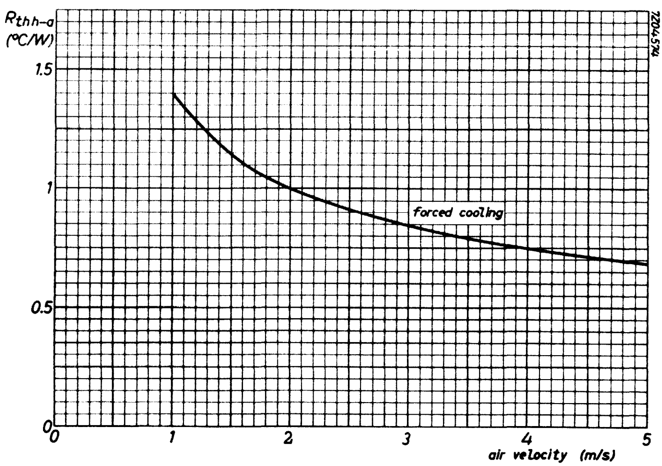
Weight: 270 g



The graphs are valid for the combination of device and heatsink.

Stud: M8
Mounting base, across the flats: 17,0 mm



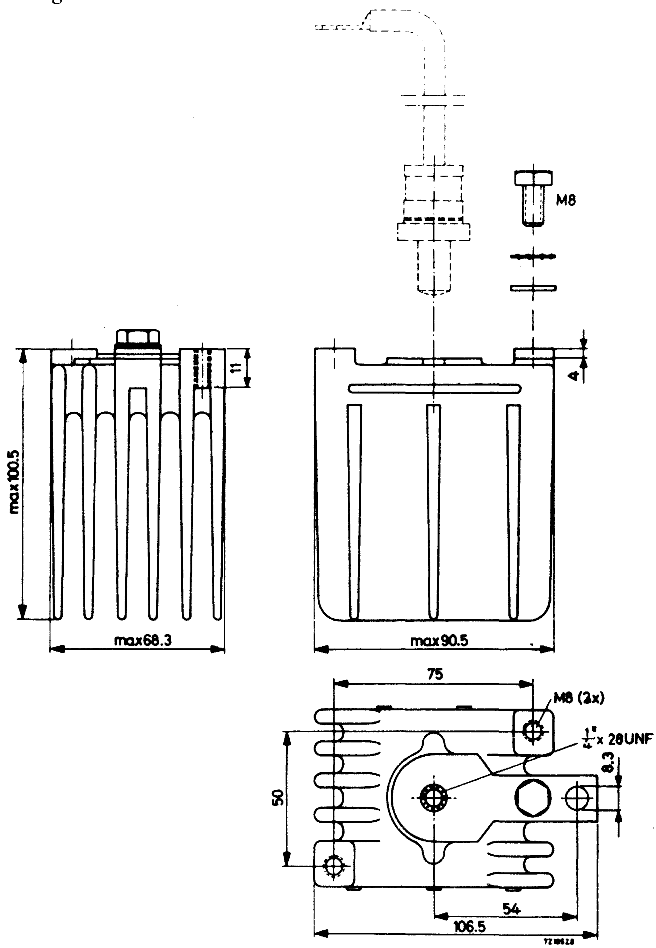


DIECAST HEATSINK

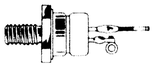
Diecast heatsink of aluminium alloy, painted black, with $\frac{1}{4}$" x 28UNF tap hole for rectifier device.

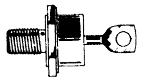
Weight: 690 g

Dimensions in mm



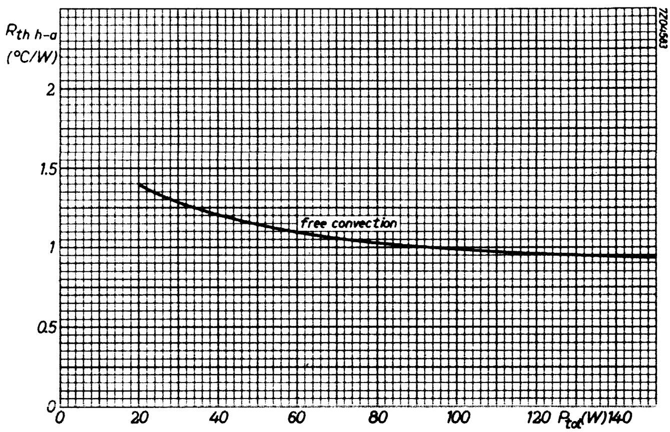
The graphs are valid for the combination of device and heatsink.

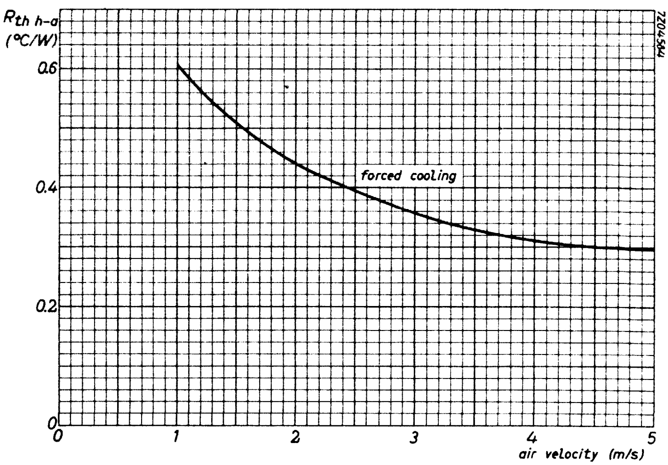




Studs: $\frac{1}{4}$" x 28 UNF

Mounting bases across the flats: 14,0 mm resp. 17,0 mm



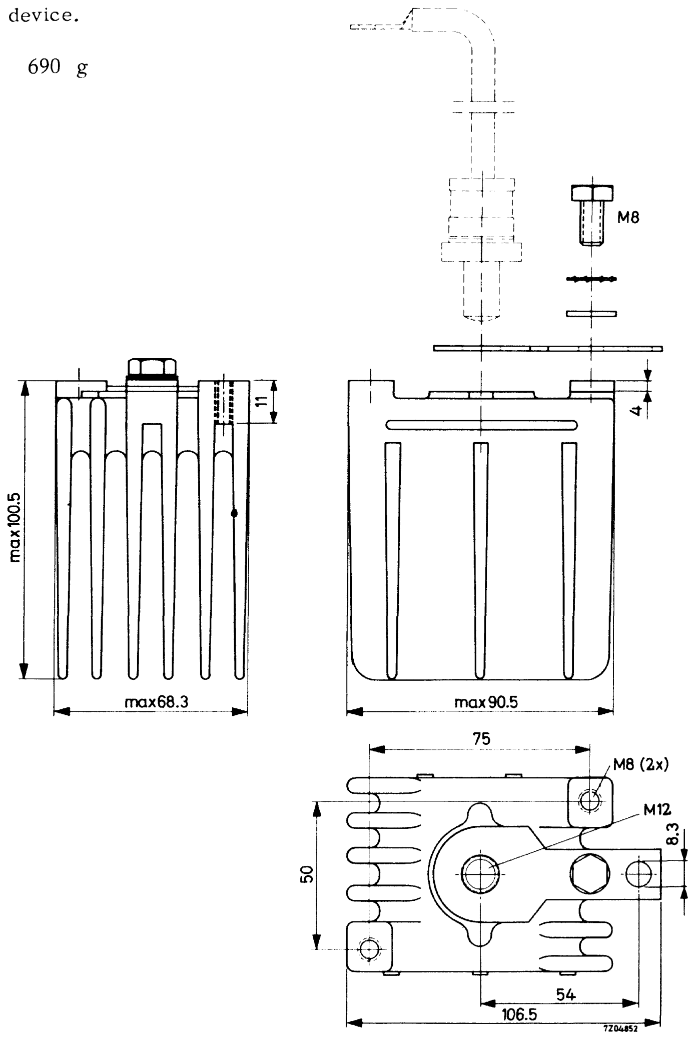


DIECAST HEATSINK

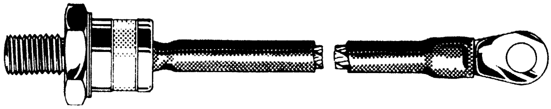
Diecast heatsink of aluminium alloy, painted black, with M12 tap hole for rectifier device.

Dimensions in mm

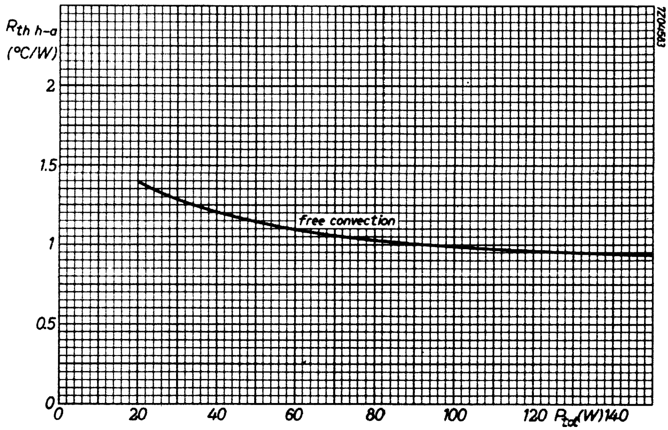
Weight: 690 g

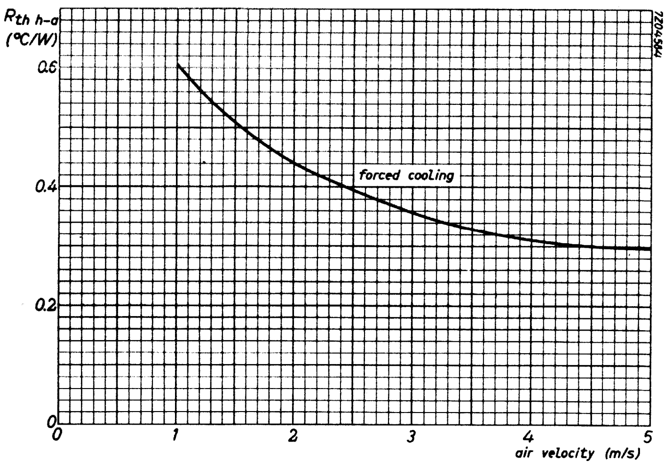


The graphs are valid for the combination of device and heatsink.



Stud: M12
Mounting base, across the flats: 27,0 mm



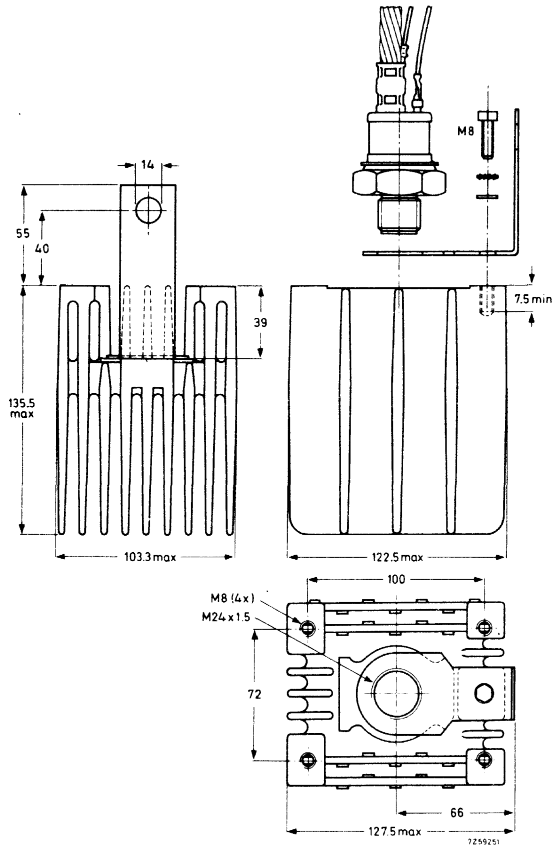


DIECAST HEATSINK

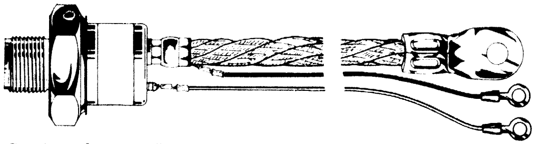
Diecast heatsink of aluminium alloy, painted black, with M24 x 1,5 tap hole, for rectifier device.

Weight: 1900 g

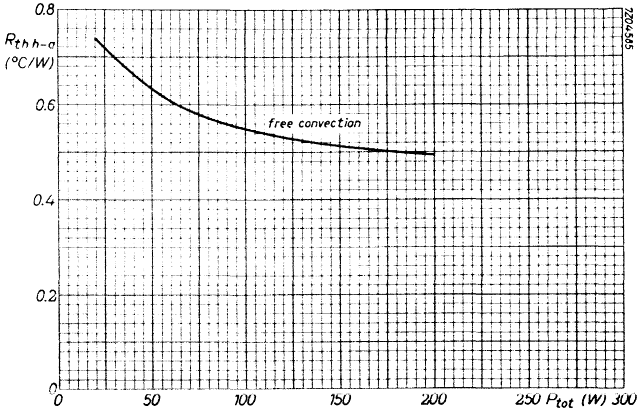
Dimensions in mm

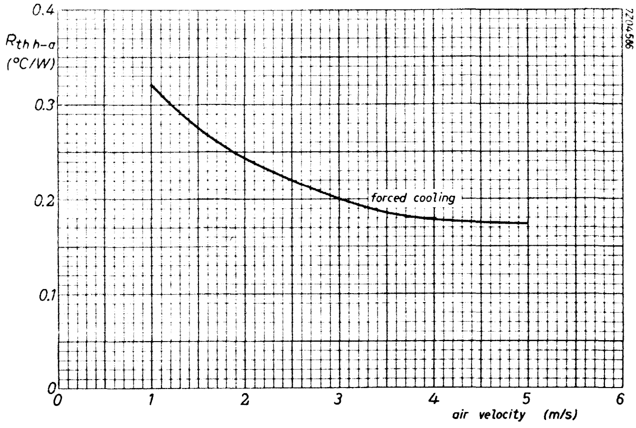


The graphs are valid for the combination of device and heatsink.



Stud: M24 x 1, 5
Mounting base, across the flats: 46 mm

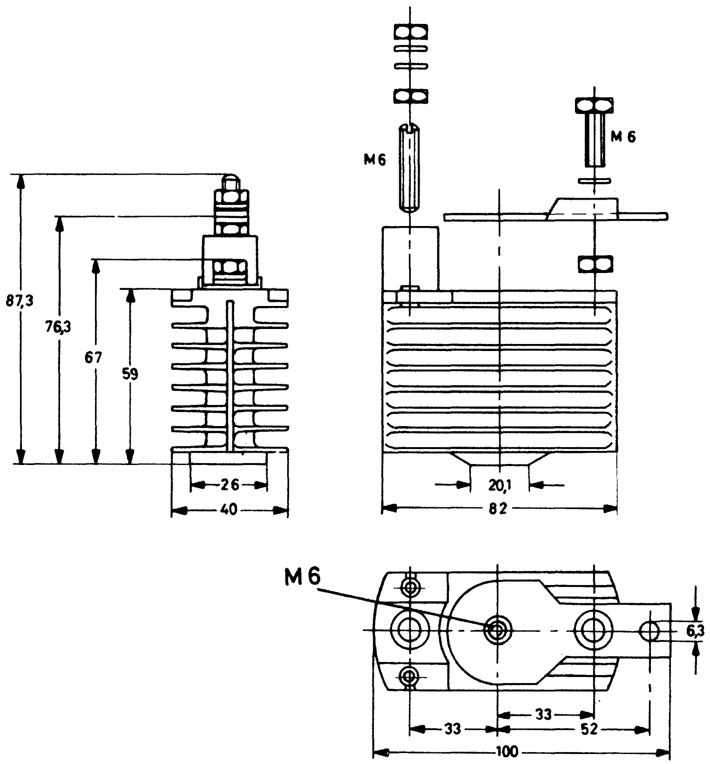




DIECAST HEATSINK

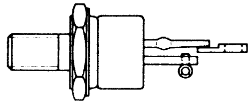
Weight: 270 g

Dimensions in mm

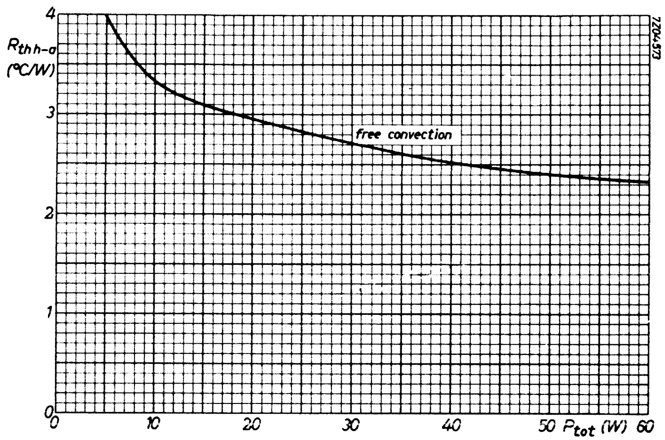


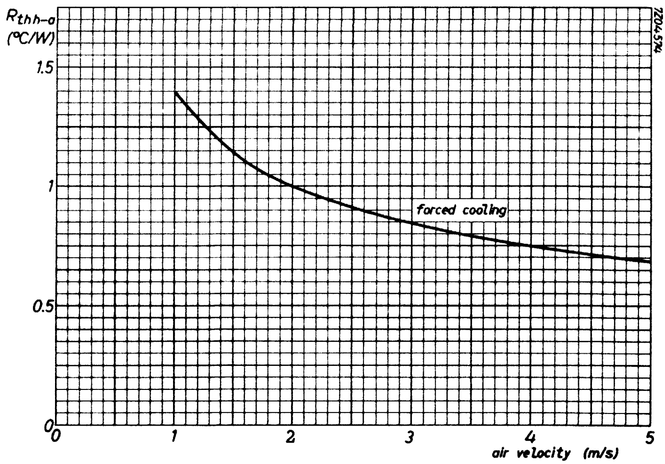
Tap hole for fixing the heatsink: M8

The graphs are valid for the combination of device and heatsink.



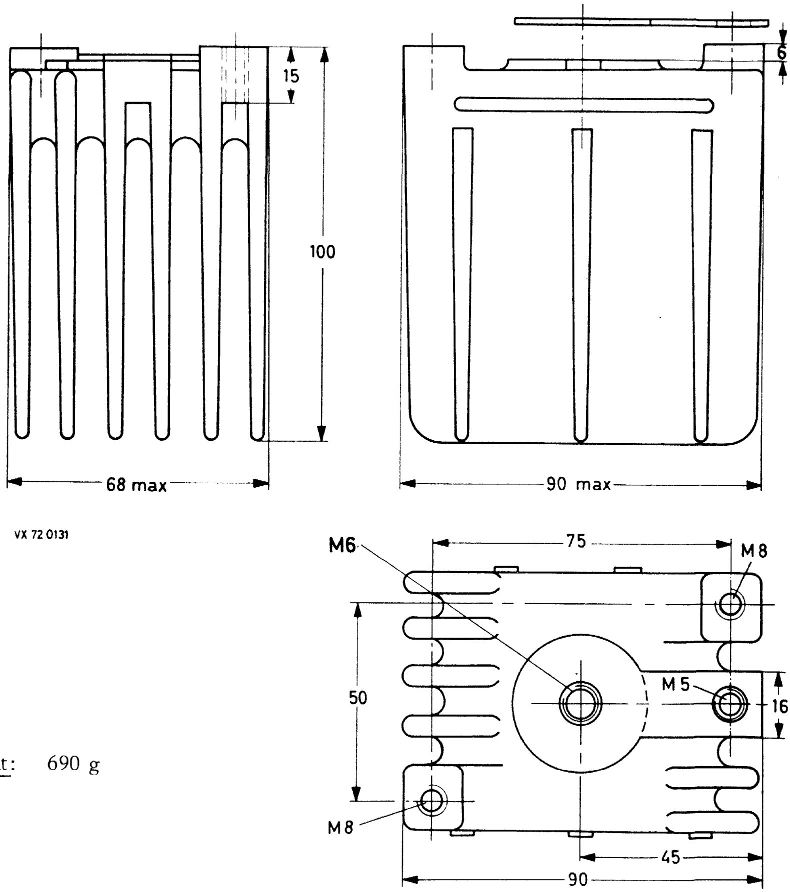
Stud: M16
Mounting base, across the flats: max. 14,0 mm





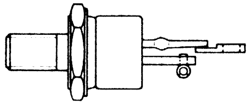
DIECAST HEATSINK

Dimensions in mm

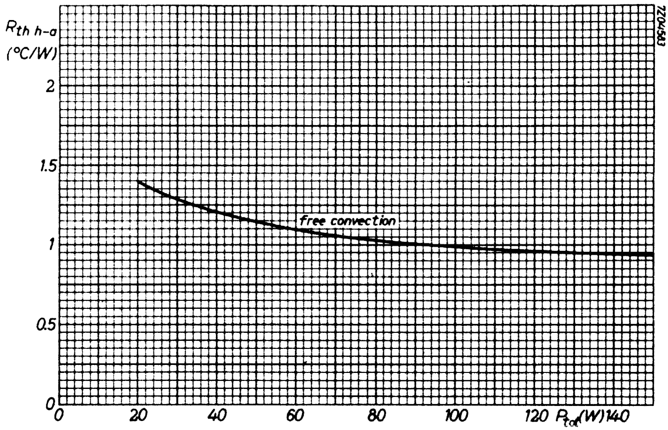


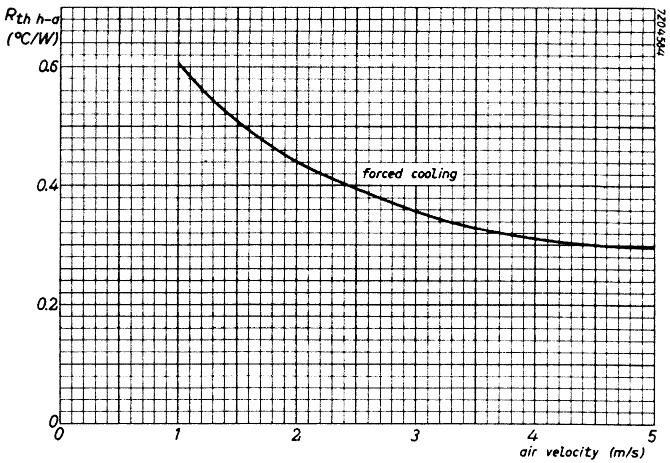
Weight: 690 g

The graphs are valid for the combination of device and heatsink.



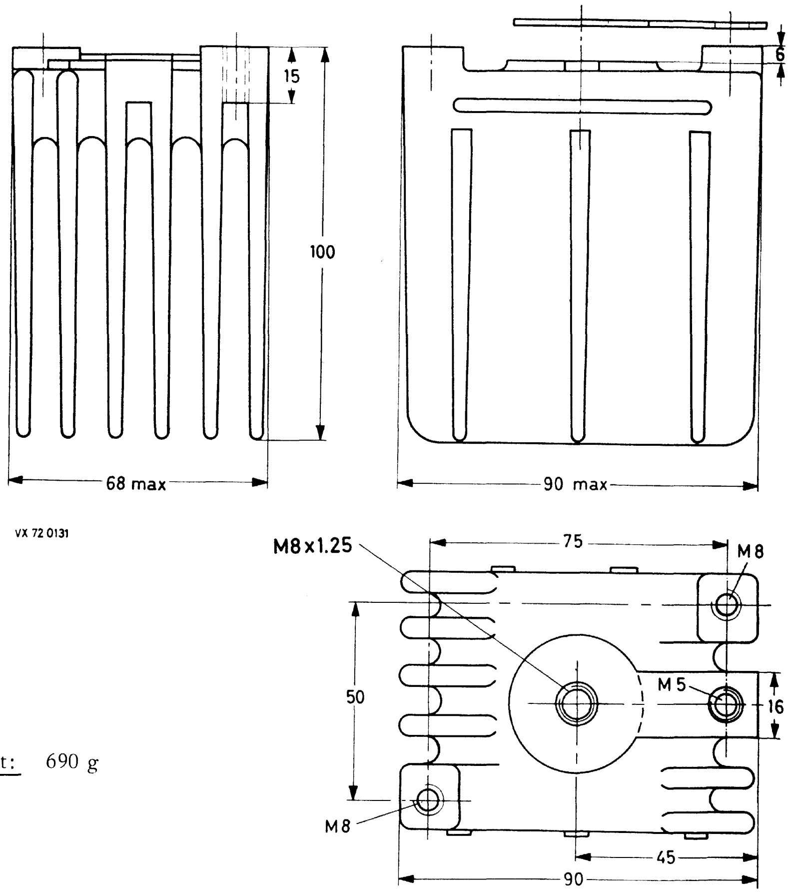
Stud: M6
Mounting base, across the flats: max. 14,0 mm





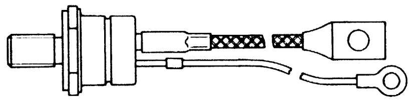
DIECAST HEATSINK

Dimensions in mm

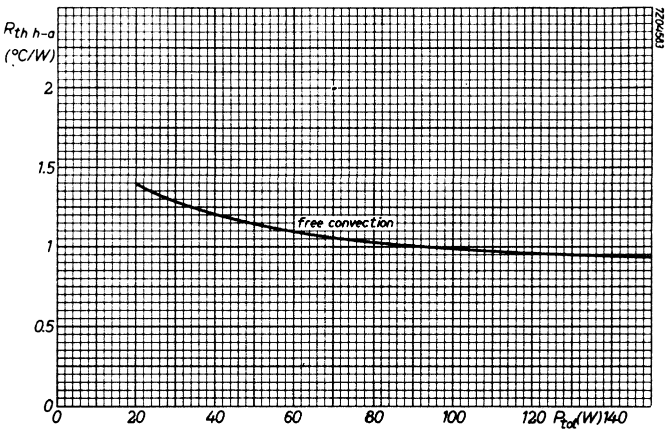


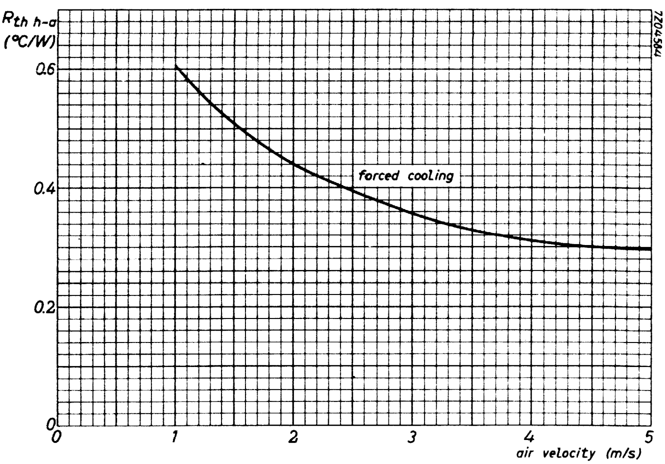
Weight: 690 g

The graphs are valid for the combination of device and heatsink.



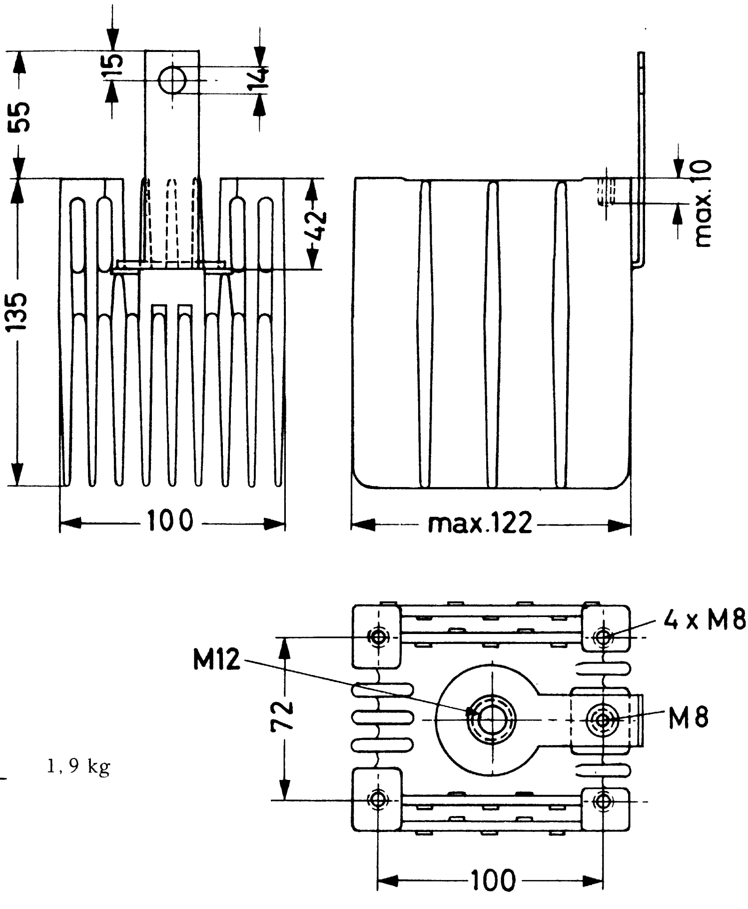
Stud: M8 x 1, 25
Mounting base, across the flats: max. 19, 0 mm





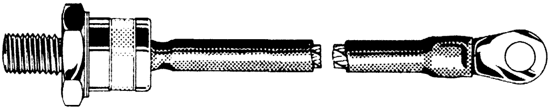
DIECAST HEATSINK

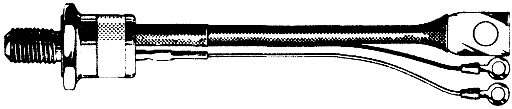
Dimensions in mm



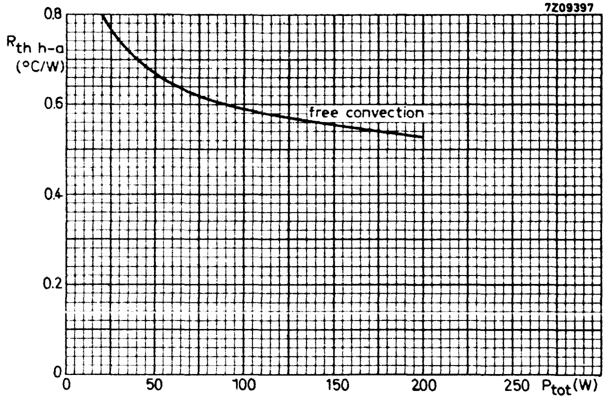
Weight: 1,9 kg

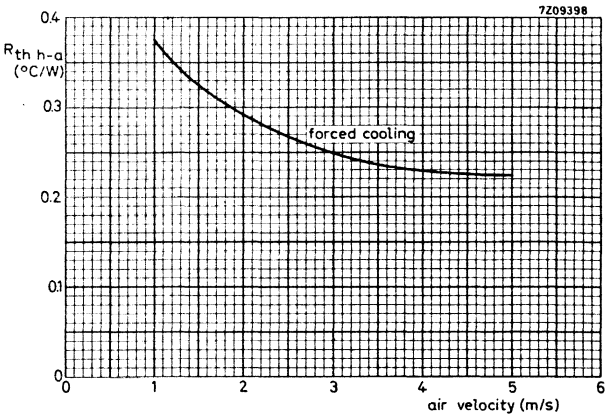
The graphs are valid for the combination of device and heatsink.





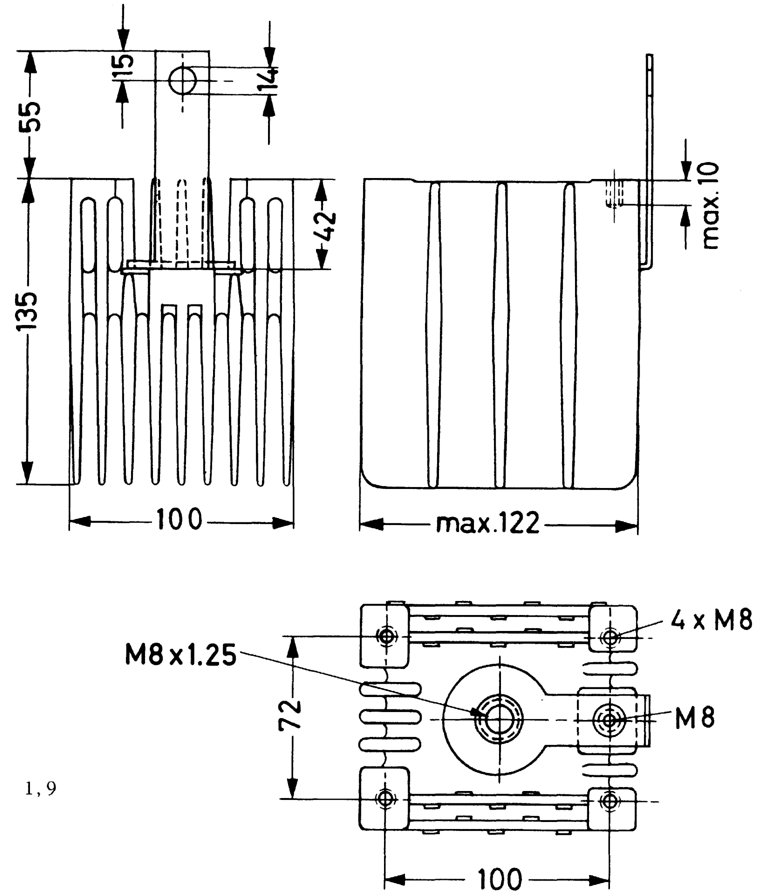
Studs: M12
Mounting base, across the flats: max. 27,0 mm





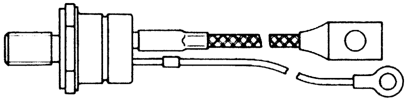
DIECAST HEATSINK

Dimensions in mm

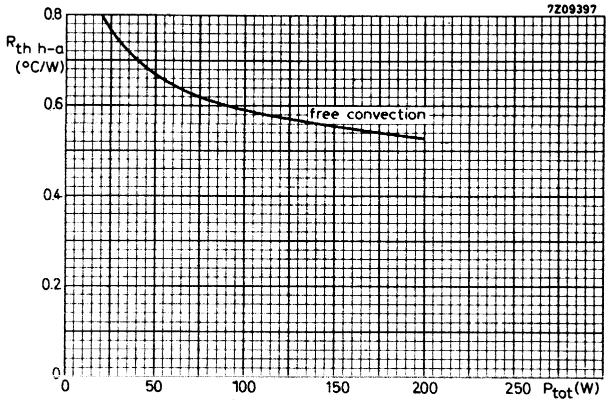


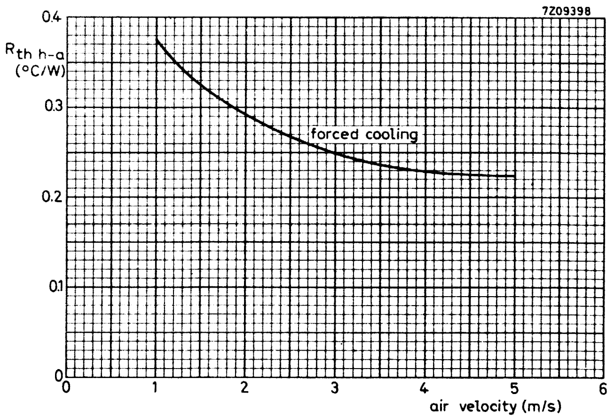
Weight: 1,9

The graphs are valid for the combintation of device and heatsink.



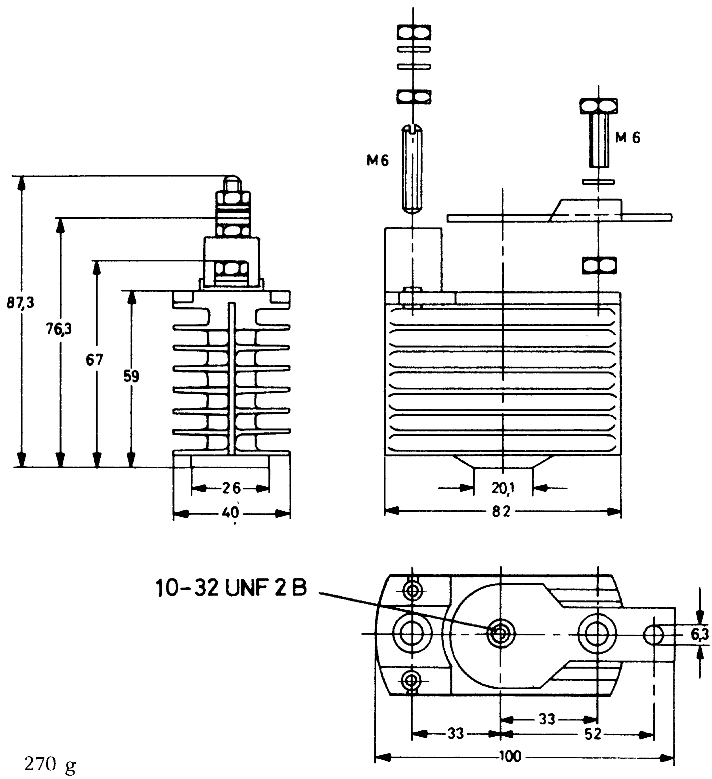
Stud: M8 x 1, 25
Mounting base, across the flats: max. 19,0 mm





DIECAST HEATSINK

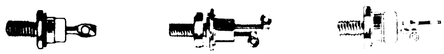
Dimensions in mm



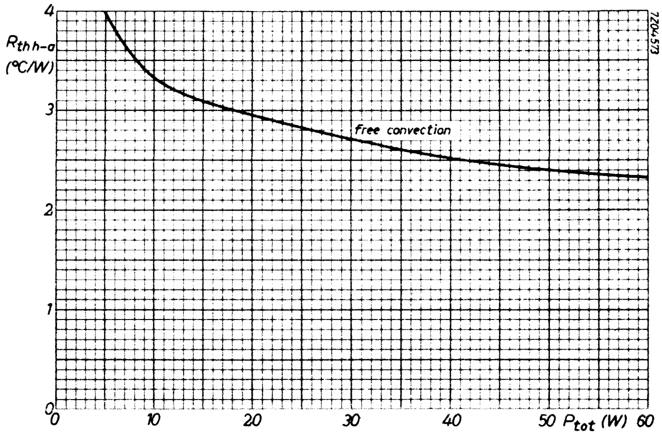
Weight: 270 g

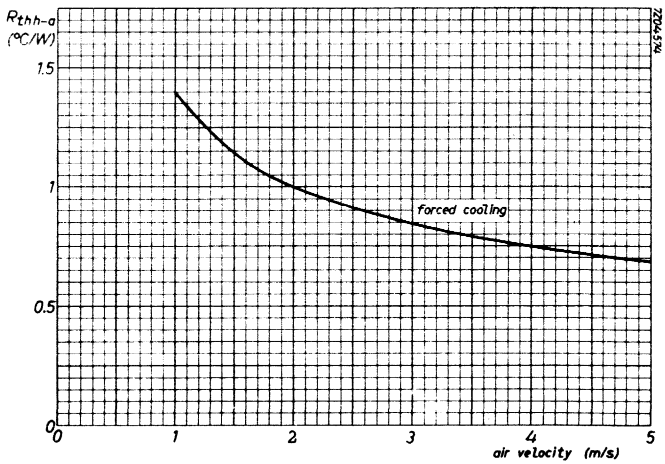
Tap hole for fixing the heatsink: M8

The graphs are valid for the combination and heatsink.



Stud: 10-32 UNF
Mounting base, across the flats:
max. 11,0 mm



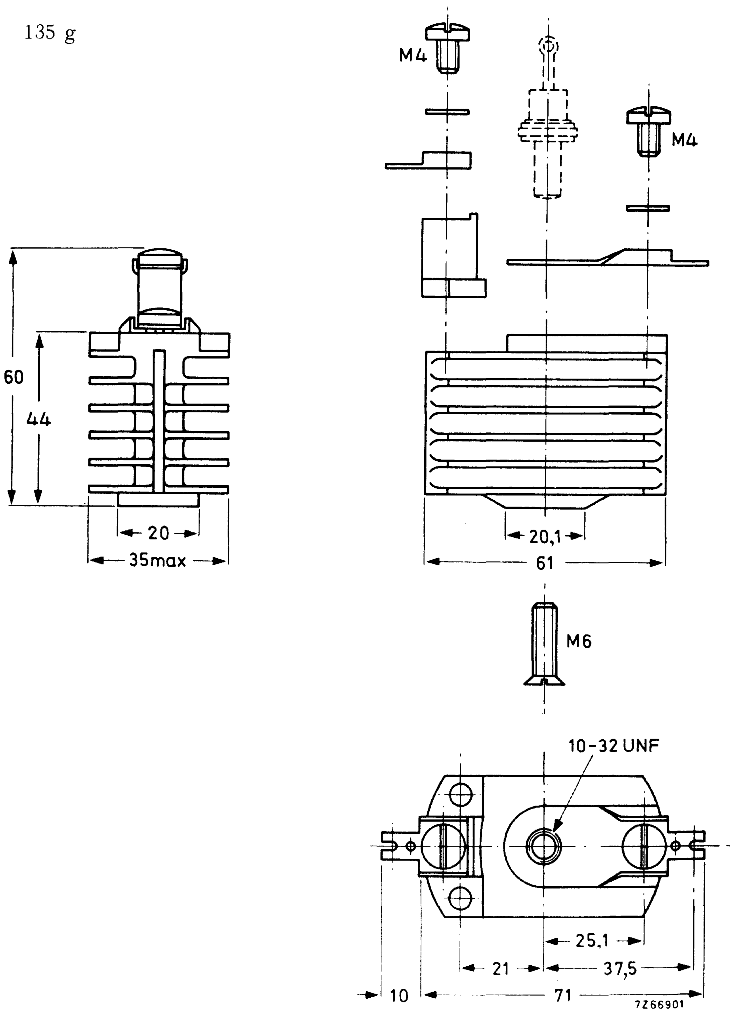


DIECAST HEATSINK

Diecast heatsink of aluminium alloy, painted black, with 10-32UNF tap hole for rectifier device.

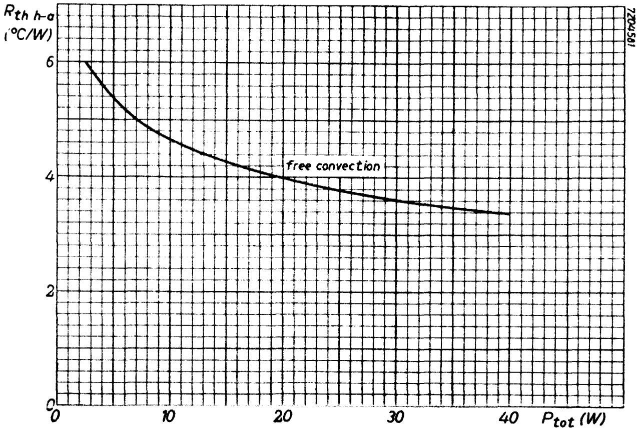
Dimensions in mm

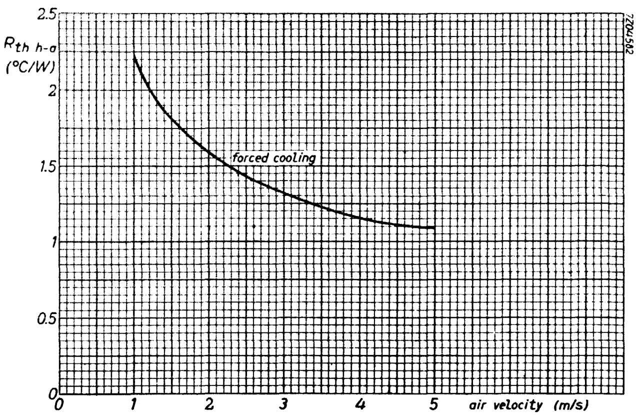
Weight: 135 g



The graphs are valid for the combination of diode and heatsink.

Stud: 10-32UNF
Mounting base, across the flats: 11,0 mm



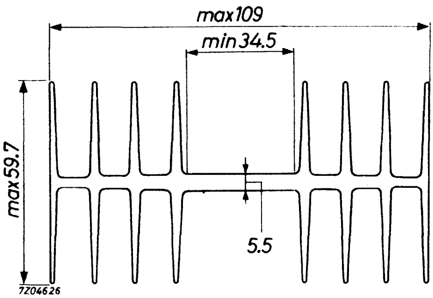


EXTRUDED ALUMINIUM HEATSINK

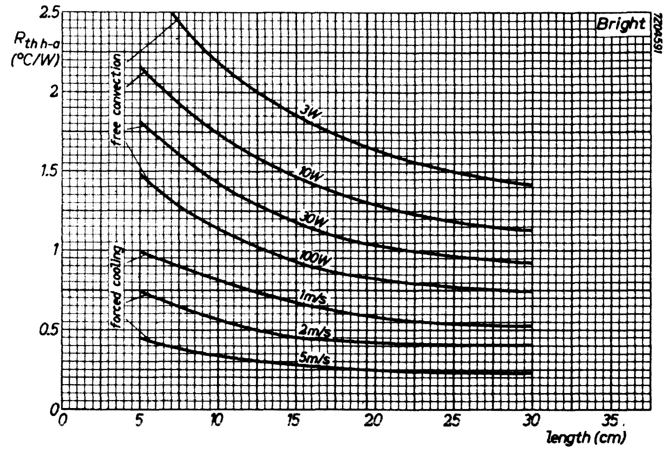
Extruded heatsink of aluminium alloy.
The extrusion is supplied unpainted, in lengths of 1,5 mm.

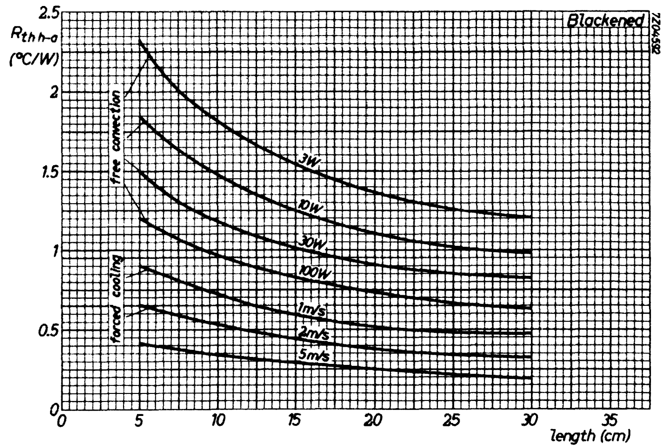
Weight: 4 kg per 1,5 m.

Dimensions in mm



The graphs are valid for the combination of device and heatsink.



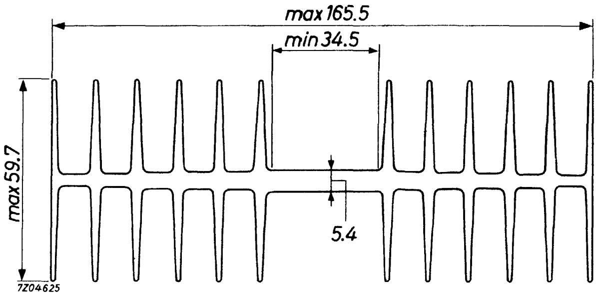


EXTRUDED ALUMINIUM HEATSINK

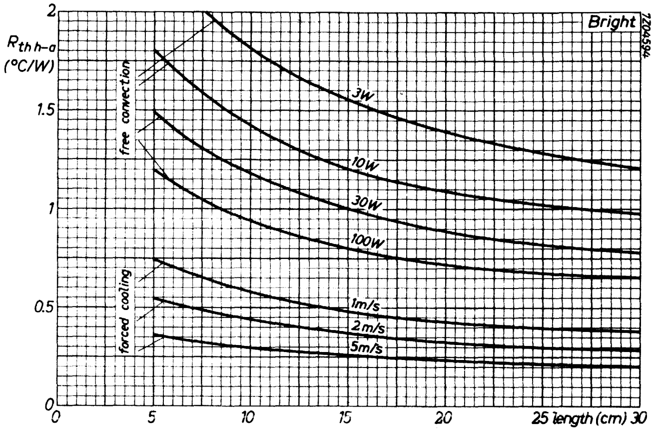
Extruded heatsink of aluminium alloy.
The extrusion is supplied unpainted, in lengths of 1,5 m.

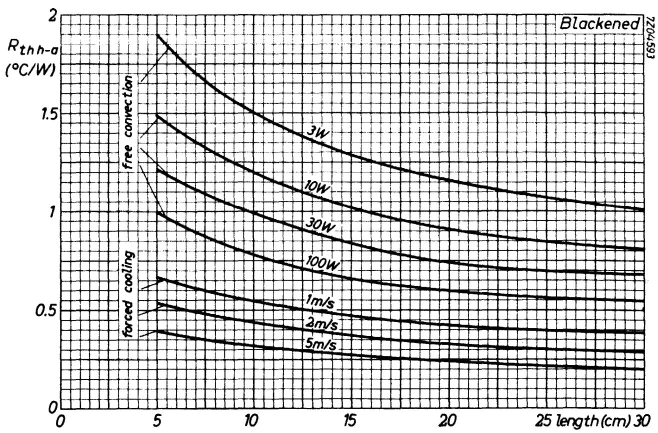
Weight: 6 kg per 1,5 m.

Dimensions in mm



The graphs are valid for the combination of device and heatsink.

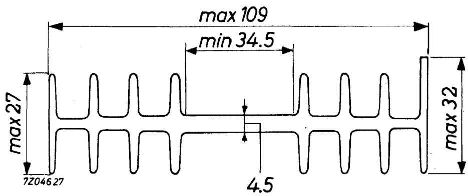




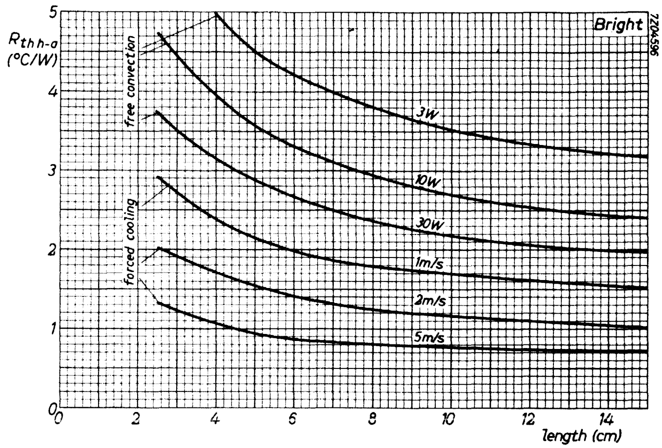
EXTRUDED ALUMINIUM HEATSINK

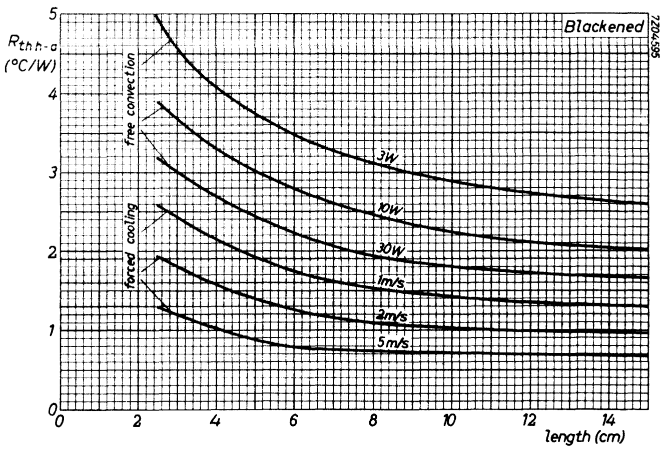
Extruded heatsink of aluminium alloy.
The extrusion is supplied unpainted, in lengths of 1, 5 m.

Weight: 2, 4 kg per 1, 5 m. Dimensions in mm



The graphs are valid for the combination of device and heatsink.



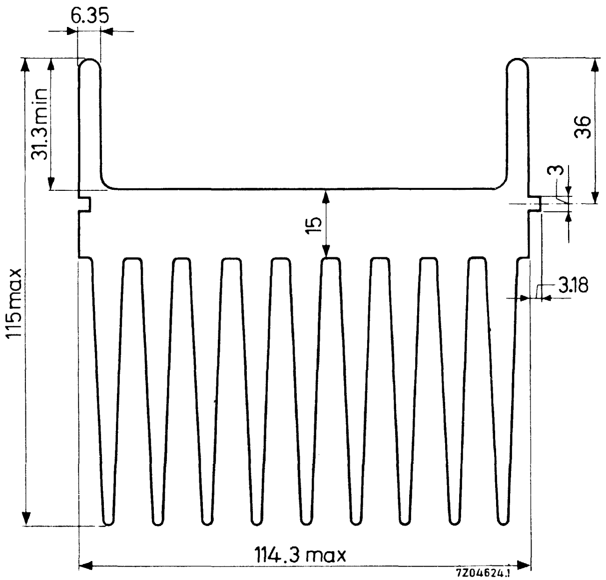


EXTRUDED ALUMINIUM HEATSINK

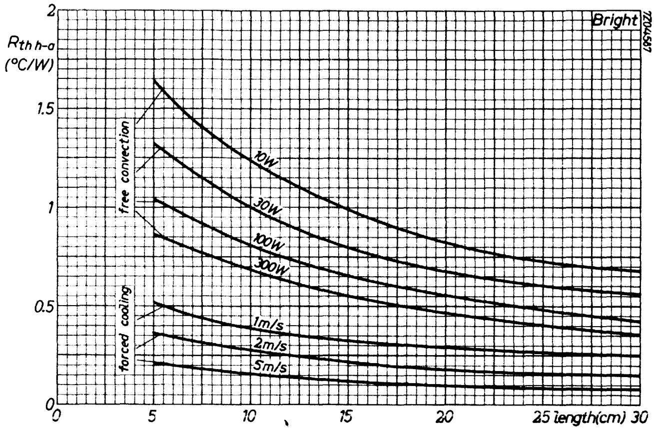
Extruded heatsink of aluminium alloy.
The extrusion is supplied unpainted, in lengths of 1,5 m.

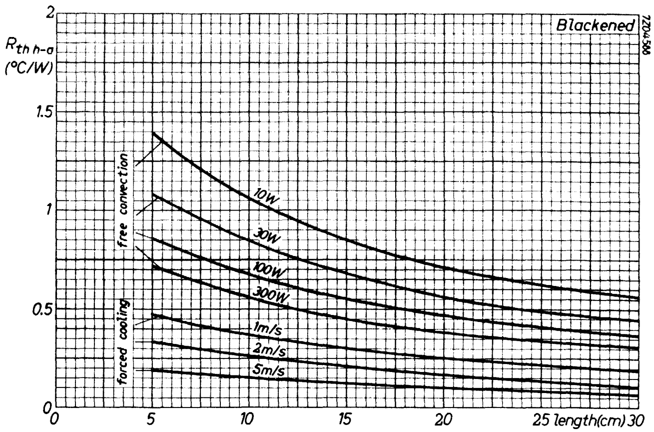
Weight: 16,2 kg per 1,5 m.

Dimensions in mm

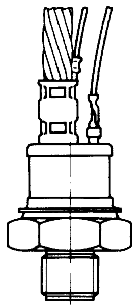


The graphs are valid for the combination of device and heatsink.



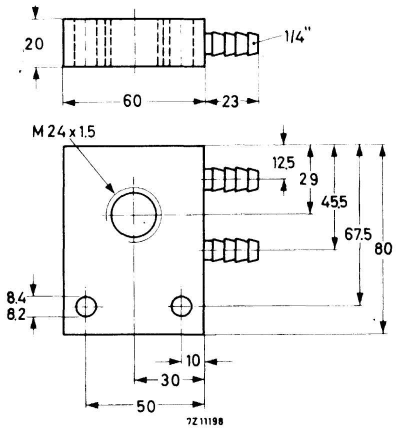


WATER COOLED HEATSINK
for BTX41series

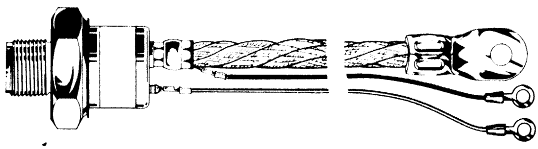


Net weight: 750 g

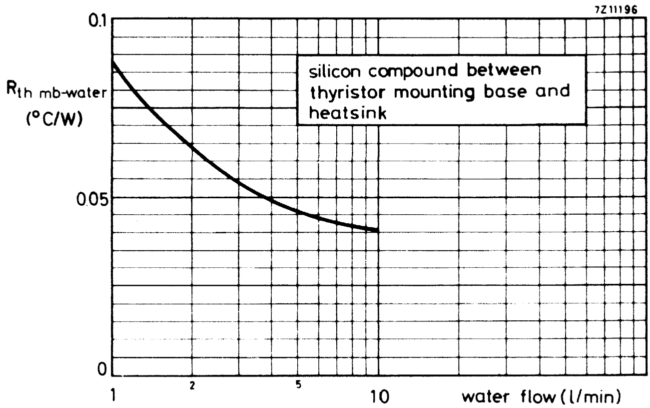
Dimensions in mm

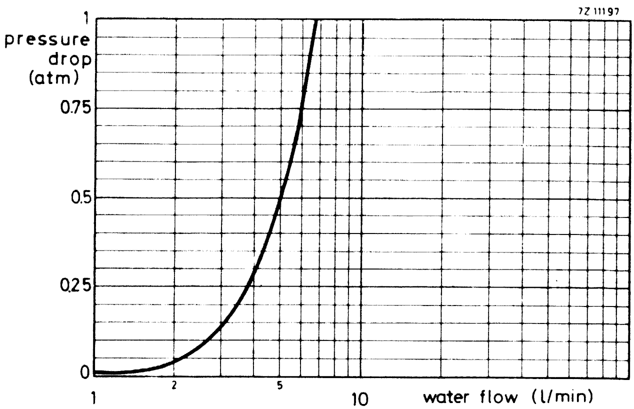


Torque on hexagon: min. 30 Nm (300 kgcm)
max. 40 Nm (400 kgcm)



Stud: M24 x 1,5
Mounting base, across flats: 46 mm





MAINTENANCE TYPE LIST

The type numbers listed below are not included in this handbook except for those marked with an asterisk.

Detailed information will be supplied on request.

BTX35series
BTX36series
BTX37series
BTX38series
BTX68series
BTX92series
*BYX13series
*BYX59series

INDEX OF TYPE NUMBERS

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

Type No.	Part	Section	Type No.	Part	Section	Type No.	Part	Section
AA119	1b	GePC	AF114	3	HF	ASZ15	2	P
AAY21	1b	GePC	AF115	3	HF	ASZ16	2	P
AAY30	1b	GeGB	AF116	3	HF	ASZ17	2	P
AAY32	1b	GeGB	AF117	3	HF	ASZ18	2	P
AAY39	4	Mw	AF118	3	HF	ASZ20	3	Sw
AAY39A	4	Mw	AF121	3	HF	ASZ21	3	Sw
AAY59	4	Mw	AF124	3	HF	BA100	1b	SiA
AAZ13	1b	GeGB	AF125	3	HF	BA102	1b	T
AAZ15	1b	GeGB	AF126	3	HF	BA114	1b	SiA
AAZ17	1b	GeGB	AF127	3	HF	BA145	1a	R
AAZ18	1b	GeGB	AF139	3	HF	BA148	1a	R
AC125	2	LF	AF178	3	HF	BA182	1b	T
AC126	2	LF	AF239	3	HF	BA216	1b	SiW
AC127	2	LF	AF239S	3	HF	BA217	1b	SiW
AC127/01	2	LF	AF240	3	HF	BA218	1b	SiW
AC128	2	LF	AF267	3	HF	BA219	1b	SiW
AC128/01	2	LF	AFY16	3	HF	BA220	1b	SiW
AC132	2	LF	AFY19	4	Tr	BA221	1b	SiW
AC132/01	2	LF	AFY40	3	HF	BA222	1b	SiW
AC172	2	LF	AFZ12	3	HF	BA314	1b	SiW
AC187	2	LF	ASY26	3	Sw	BA315	1b	SiW
AC187/01	2	LF	ASY27	3	Sw	BA316	1b	SiW
AC188	2	LF	ASY28	3	Sw	BA317	1b	SiW
AC188/01	2	LF	ASY29	3	Sw	BA318	1b	SiW
AD149	2	P	ASY73	3	Sw	BAV10	1b	SiW
AD161	2	P	ASY74	3	Sw	BAV18	1b	SiW
AD162	2	P	ASY75	3	Sw	BAV19	1b	SiW
AEY13	4	Mw	ASY76	3	Sw	BAV20	1b	SiW
AEY15	4	Mw	ASY77	3	Sw	BAV21	1b	SiW
AEY16	4	Mw	ASY80	3	Sw	BAV40	1b	Sp

GeGB = Germanium gold bonded diodes
GePC = Germanium point contact diodes
HF = High frequency transistors
LF = Low frequency transistors
Mw = Microwave devices
P = Low frequency power transistors
R = Rectifier diodes
SiA = Silicon alloyed diodes
SiW = Silicon whiskerless diodes
Sp = Special diodes
Sw = Switching transistors
T = Tuner diodes
Tr = Transmitting transistors

Dual = Dual transistors
LF = Low frequency transistors
Mm = Microminiature devices for thick-and thin-film circuits
Mw = Microwave devices
P = Low frequency power transistors
SiW = Silicon whiskerless diodes
Sp = Special diodes
T = Tuner diodes

Type No.	Part	Section	Type No.	Part	Section	Type No.	Part	Section
BD139	2	P	BF336	3	HF	BFY44	4	Tr
BD140	2	P	BF337	3	HF	BFY50	3	HF
BD181	2	P	BF338	3	HF	BFY51	3	HF
BD182	2	P	BFR29	4	FET	BFY52	3	HF
BD183	2	P	BFR30	4	Mm	BFY55	3	HF
BDY20	2	P	BFR31	4	Mm	BFY70	4	Tr
BDY38	2	P	BFR63	3	HF	BFY90	3	HF
BDY60	2	P	BFR64	3	HF	BLX13	4	Tr
BDY61	2	P	BFR65	3	HF	BLX14	4	Tr
BDY90	2	P	BFS17	4	Mm	BLX69	4	Tr
BDY91	2	P	BFS18	4	Mm	BLY14	4	Tr
BDY92	2	P	BFS19	4	Mm	BLY17	4	Tr
BF115	3	HF	BFS20	4	Mm	BLY83	4	Tr
BF167	3	HF	BFS21	4	FET	BLY84	4	Tr
BF173	3	HF	BFS21A	4	FET	BLY87A	4	Tr
BF179	3	HF	BFS22A	4	Tr	BLY88A	4	Tr
BF180	3	HF	BFS23A	4	Tr	BLY89A	4	Tr
BF181	3	HF	BFS28	4	FET	BLY90	4	Tr
BF177	3	HF	BFS92	3	HF	BLY91A	4	Tr
BF178	3	HF	BFS93	3	HF	BLY92A	4	Tr
BF182	3	HF	BFS94	3	HF	BLY93A	4	Tr
BF183	3	HF	BFS95	3	HF	BLY94	4	Tr
BF184	3	HF	BFW10	4	FET	BPX25;29	4	PhDT
BF185	3	HF	BFW11	4	FET	BPX40	4	PhDT
BF194	3	HF	BFW12	4	FET	BPX41	4	PhDT
BF195	3	HF	BFW13	4	FET	BPX42	4	PhDT
BF196	3	HF	BFW16A	3	HF	BPX66P	4	PhDT
BF197	3	HF	BFW17A	3	HF	BPX71	4	PhDT
BF198	3	HF	BFW30	3	HF	BPY10	4	PhDT
BF199	3	HF	BFW45	2	Defl	BPY68	4	PhDT
BF200	3	HF	BFW61	4	FET	BPY69	4	PhDT
BF254	3	HF	BFW92	3	HF	BPY76	4	PhDT
BF255	3	HF	BFX34	3	Sw	BPY77	4	PhDT
BF334	3	HF	BFX44	3	HF	BR100	1a	Thyr
BF335	3	HF	BFX89	3	HF	BRY39	1a	Thyr

Defl = Deflection transistors
FET = Field effect transistors
HF = High frequency transistors
Mm = Microminiature devices for thick- and thin-film circuits
P = Low frequency power transistors
PhDT = Photodiodes and phototransistors
Sw = Switching transistors
Thyr = Thyristors, diacs, triacs
Tr = Transmitting transistors

Defl = Deflection transistors
FET = Field effect transistors
Mm = Microminature devices for thick- and thin-film circuits
Mw = Microwave devices
R = Rectifier diodes
Sw = Switching transistors
Thyr = Thyristors, diacs, triacs
TS = Transient suppressor diodes
Vref = Voltage reference diodes
Vreg = Voltage regulator diodes

GeGB = Germanium gold bonded diodes
GePC = Germanium point contact diodes
I = Infrared devices
Ign = Ignistors
L = Light emitting devices
Mw = Microwave devices
PhC = Photoconductive devices
PhDT = Photodiodes and phototransistors
SiA = Silicon alloyed diodes
SiW = Silicon whiskerless diodes
St = Rectifier stacks
Sw = Switching transistors
Vref = Voltage reference diodes
Vreg = Voltage regulator diodes

FET = Field effect transistors
HF = High frequency transistors
LF = Low frequency transistors
Mw = Microwave devices
P = Low frequency power transistors
SiW = Silicon whiskerless diodes
Sw = Switching transistors
Tr = Transmitting transistors
Vreg = Voltage regulator diodes

A = Accessories
DH = Diecast heatsinks
FET = Field effect transistors
HE = Heatsink extrusions
HF = High frequency transistors
I = Infrared devices
LF = Low frequency transistors
P = Low frequency power transistors
Tr = Transmitting transistors
WH = Water cooled heatsinks

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