PHILIPS

Power diodes

S2a 1987

PHILIPS

Data handbook

PHILIPS

Electronic
components
and materials

Semiconductors

Book S2a 1987

Rectifier diodes

Regulator diodes

Breakover diodes

High - voltage rectifier stacks

Accessories

POWER DIODES

page

Selection guide 1

General
  Type designation 11
  Rating systems 13
  Letter symbols 15
  Quality conformance and reliability 17
  General explanatory notes 19
  Heatsinks 29

Device specifications
  Rectifier diodes 37
  Rectifier bridges 105
  Fast rectifier diodes 127
  Schottky rectifier diodes 515
  Breakover diodes 625
  Regulator diodes 657
  High-voltage rectifier stacks 731

Accessories 767

Mounting instructions 777

Type number index (alpha-numerical) 799

Index of all devices in semiconductor Data Handbooks 801

DATA HANDBOOK SYSTEM

Our Data Handbook System comprises more than 60 books with specifications on electronic components, subassemblies and materials. It is made up of four series of handbooks:

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

The contents of each series are listed on pages iv to vii.

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

When ratings or specifications differ from those published in the preceding edition they are indicated with arrows in the page margin. Where application information is given it is advisory and does not form part of the product specification.

Condensed data on the preferred products of Philips Electronic Components and Materials Division is given in our Preferred Type Range catalogue (issued annually).

Information on current Data Handbooks and on how to obtain a subscription for future issues is available from any of the Organizations listed on the back cover.
Product specialists are at your service and enquiries will be answered promptly.

ELECTRON TUBES (BLUE SERIES)

The blue series of data handbooks comprises:

T1	**Tubes for r.f. heating**
T2a	**Transmitting tubes for communications, glass types**
T2b	**Transmitting tubes for communications, ceramic types**
T3	**Klystrons**
T4	**Magnetrons for microwave heating**
T5	**Cathode-ray tubes** Instrument tubes, monitor and display tubes, C.R. tubes for special applications
T6	**Geiger-Müller tubes**
T8	**Colour display systems** Colour TV picture tubes, colour data graphic display tube assemblies, deflection units
T9	**Photo and electron multipliers**
T10	**Plumbicon camera tubes and accessories**
T11	**Microwave semiconductors and components**
T12	**Vidicon and Newvicon camera tubes**
T13	**Image intensifiers and infrared detectors**
T15	**Dry reed switches**
T16	**Monochrome tubes and deflection units** Black and white TV picture tubes, monochrome data graphic display tubes, deflection units

SEMICONDUCTORS (RED SERIES)

The red series of data handbooks comprises:

S1	**Diodes** Small-signal silicon diodes, voltage regulator diodes (< 1,5 W), voltage reference diodes, tuner diodes, rectifier diodes
S2a	**Power diodes**
S2b	**Thyristors and triacs**
S3	**Small-signal transistors**
S4a	**Low-frequency power transistors and hybrid modules**
S4b	**High-voltage and switching power transistors**
S5	**Field-effect transistors**
S6	**R.F. power transistors and modules**
S7	**Surface mounted semiconductors**
S8a	**Light-emitting diodes**
S8b	**Devices for optoelectronics** Optocouplers, photosensitive diodes and transistors, infrared light-emitting diodes and infrared sensitive devices, laser and fibre-optic components
S9	**Power MOS transistors**
S10	**Wideband transistors and wideband hybrid IC modules**
S11	**Microwave transistors**
S12	**Surface acoustic wave devices**
S13	**Semiconductor sensors**
*S14	**Liquid Crystal Displays**

*To be issued shortly.

INTEGRATED CIRCUITS (PURPLE SERIES)

The NEW SERIES of handbooks is now completed. With effect from the publication date of this handbook the "N" in the handbook code number will be deleted.
Handbooks to be replaced during 1986 are shown below.

The purple series of handbooks comprises:

IC01	**Radio, audio and associated systems** Bipolar, MOS	new issue 1986 IC01N 1985
IC02a/b	**Video and associated systems** Bipolar, MOS	new issue 1986 IC02Na/b 1985
IC03	**Integrated circuits for telephony** Bipolar, MOS	new issue 1987 IC03N 1985
IC04	**HE4000B logic family** CMOS	new issue 1986 IC4 1983
IC05N	**HE4000B logic family – uncased ICs** CMOS	published 1984
IC06N	**High-speed CMOS; PC74HC/HCT/HCU** Logic family	published 1986
IC08	**ECL 10K and 100K logic families**	New issue 1986 IC08N 1984
IC09N	**TTL logic series**	published 1986
IC10	**Memories** MOS, TTL, ECL	new issue 1986 IC7 1982
IC11N	**Linear LSI**	published 1985
Supplement to IC11N	**Linear LSI**	published 1986
IC12	**I^{2}C-bus compatible ICs**	not yet issued
IC13	**Semi-custom** Programmable Logic Devices (PLD)	new issue 1986 IC13N 1985
IC14	**Microcontrollers and peripherals** Bipolar, MOS	published 1986
IC15	**FAST TTL logic series**	new issue 1986 IC15N 1985
IC16	**CMOS integrated circuits for clocks and watches**	first issue 1986
IC17	**Integrated Services Digital Networks (ISDN)**	not yet issued
IC18	**Microprocessors and peripherals**	new issue 1986

COMPONENTS AND MATERIALS (GREEN SERIES)

The green series of data handbooks comprises:

C2	**Television tuners, coaxial aerial input assemblies, surface acoustic wave filters**
C3	**Loudspeakers**
C4	**Ferroxcube potcores, square cores and cross cores**
C5	**Ferroxcube for power, audio/video and accelerators**
C6	**Synchronous motors and gearboxes**
C7	**Variable capacitors**
C8	**Variable mains transformers**
C9	**Piezoelectric quartz devices**
C11	**Varistors, thermistors and sensors**
C12	**Potentiometers, encoders and switches**
C13	**Fixed resistors**
C14	**Electrolytic and solid capacitors**
C15	**Ceramic capacitors**
C16	**Permanent magnet materials**
C17	**Stepping motors and associated electronics**
C18	**Direct current motors**
C19	**Piezoelectric ceramics**
C20	**Wire-wound components for TVs and monitors**
C22	**Film capacitors**

SELECTION GUIDE

RECTIFIER DIODES

General purpose

$I_{F(AV)max}$ (A)		Outline	V_{RRMmax} (V)				Page
			300	600	1200	1600	
6	BYX38	DO-4	●	●	●		55
6.5	BY249	TO-220AC	●	●			39
10	BYX98	DO-4	●	●	●		93
12	BYX42	DO-4	●	●	●		67
15	BYX99	DO-4	●	●	●		99
30	BYX96	DO-4	●	●	●	●	81
47	BYX97	DO-5	●	●	●	●	87
48	BYX52	DO-5	●	●	●		71

Avalanche

$I_{F(AV)max}$ (A)			V_{RWMmax} (V)					Page
			600	800	1000	1200	1400	
9.5	BYX39	DO-4	●	●	●	●	●	61
20	BYX25	DO-4	●	●	●	●	●	45
48	BYX56	DO-5	●	●	●	●	●	75

FAST RECTIFIER DIODES

Ultra fast (epitaxial) types

$I_{F(AV)max}$ (A)		Outline	V_{RRMmax} (V)											Page
			50	100	150	200	300	400	500	600	700	800	1000	
1	BYV26	SOD-57				●		●		●		●	●	255
2	BYV27	SOD-57	●	●	●	●								261
3.5	BYV28	SOD-64	●	●	●	●								269
7	BYX50	DO-4				●	●							487
8	BYP21	TO-220AC	●	●	●	●								173
8	BYR29	TO-220AC								●	●	●		207
8	BYR29F	SOT-186								●	●	●		217
8	BYW29	TO-220AC	●	●	●	●								413
8	BYW29F	SOT-186	●	●	●	●								423
9	BYV29	TO-220AC					●	●	●					275
9	BYV29F	SOT-186					●	●	●					285
10	BYQ28*	TO-220AB	●	●	●	●								197
10	BYT28	TO-220AB					●	●	●					227
12	BYV32F*	SOT-186	●	●	●	●								321
14	BYT79	TO-220AC					●	●	●					237
14	BYV30	DO-4					●	●	●					295
14	BYV79	TO-220AC	●	●	●	●								389
14	BYW30	DO-4	●	●	●	●								433
20	BYP22*	TO-220AB	●	●	●	●								183
20	BYV32*	TO-220AB	●	●	●	●								311
20	BYV34*	TO-220AB					●	●	●					331
28	BYV31	DO-4					●	●	●					303
28	BYW31	DO-4	●	●	●	●								441
30	BYV42*	TO-220AB	●	●	●	●								341
30	BYV44*	TO-220AB					●	●	●					351
30	BYV72*	SOT-93	●	●	●	●								369
30	BYV74*	SOT-93					●	●	●					379
35	BYV92	DO-5					●	●	●					399
40	BYW92	DO-5	●	●	●	●								449
60	BYP59	DO-5					●	●						193
60	BYW93	DO-5	●	●	●	●								457

*Monolithic dual rectifier diodes.

FAST RECTIFIER DIODES (Cont.)

Very-fast types

$I_{F(AV)max}$ (A)		Outline	V_{RRMmax} (V) 50	100	200	300	400	500	600	Page
6	1N3879	DO-4	●							495
6	1N3880	DO-4		●						495
6	1N3881	DO-4			●					495
6	1N3882	DO-4				●				495
6	1N3883	DO-4					●			495
12	1N3889	DO-4	●							501
12	1N3890	DO-4		●						501
12	1N3891	DO-4			●					501
12	1N3892	DO-4				●				501
12	1N3893	DO-4					●			501
14	BYX30**	DO-4			●	●	●	●	●	465
22	BYX46**	DO-4			●	●	●	●	●	475
30	1N3909	DO-5	●							507
30	1N3910	DO-5		●						507
30	1N3911	DO-5			●					507
30	1N3912	DO-5				●				507
30	1N3913	DO-5					●			507

Fast types

		Outline	V_{RRMmax} (V) 200	400	600	800	1000	1200	1300	1500	Page
6.5	BY359	TO-220AC					●		●	●	165
7	BY229	TO-220AC	●	●	●	●					129
7	BY229F	SOT-186	●	●	●	●					141
8	BY329	TO-220AC				●	●	●			153
12	BYV24	DO-4				●	●				247
15	BYV60	TO-238				●	●	●			361
40	BYW25	DO-5				(850 V) ●	●				407

**With avalanche characteristics

SCHOTTKY RECTIFIER DIODES

$I_{F(AV)max}$ (A)		Outline	V_{RRMmax} (V)					Page
			30	35	40	40A▲	45	
10	BYV18*	TO-220AB	●	●	●	●	●	517
10	BYV19	TO-220AC	●	●	●	●	●	527
15	BYV20	DO-4	●	●	●	●	●	535
16	BYV39	TO-220AC	●	●	●	●	●	587
20	BYV33*	TO-220AB	●	●	●	●	●	567
20	BYV33F*	SOT-186	●	●	●	●	●	577
26	BYV43F*	SOT-186	●	●	●	●	●	603
30	BYV21	DO-4	●	●	●	●	●	543
30	BYV43*	TO-220AB	●	●	●	●	●	595
30	BYV73*	SOT-93	●	●	●	●	●	611
60	BYV22	DO-5	●	●	●	●	●	551
60	PHSD51	DO-5					●	619
80	BYV23	DO-5	●	●	●	●	●	559

*Monolithic dual rectifier diodes
▲With guaranteed reverse surge capability

BREAKOVER DIODES

$I_{TRM\ max}$ (A)		Outline	$V_{(BO)nom}$ (V)											Page
			65	100	120	140	160	180	200	220	240	260	280	
40	BR210	TO-220AC		●	●	●	●	●	●	●	●	●	●	627
40	BR216*†	TO-220AB	●											639
40	BR220*	TO-220AB		●	●	●	●	●	●	●	●	●	●	643

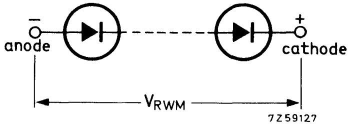
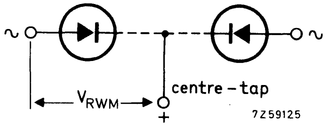
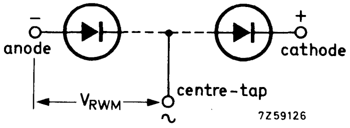
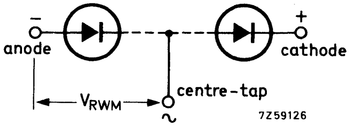
*Monolithic dual breakover diodes.
*†Asymmetrical breakover diode.

REGULATOR DIODES

Regulated voltage	Suppression stand-off voltage	REGULATOR SERVICE $P_{tot\,max}$		
		20 W	100 W	–
		SUPPRESSOR SERVICE $P_{RSM\,max}$		
		700 W	9.5 kW	25 kW
4.7 V	3.6 V			
5.1 V	3.9 V			
5.6 V	4.3 V			
6.2 V	4.7 V			
6.8 V	5.1 V			
7.5 V	5.6 V	Type No. **BZY93** (page 713)	Type No. **BZY91** (page 693)	
8.2 V	6.2 V			
9.1 V	6.8 V			
10 V	7.5 V			Type No. **BZW86** (page 659)
11 V	8.2 V			
12 V	9.1 V			
13 V	10 V			
15 V	11 V			
16 V	12 V			
18 V	13 V			
20 V	15 V			
22 V	16 V			
24 V	18 V			
27 V	20 V			
30 V	22 V			
33 V	24 V			
36 V	27 V			
39 V	30 V			
43 V	33 V			
47 V	36 V			
51 V	39 V			
56 V	43 V			
62 V	47 V			
68 V	51 V			
75 V	56 V			
82 V	62 V			
Outline		DO-4	DO-5	DO-30
Polarity		both	both	both

Normal polarity (cathode to stud)	no end-letter
Reverse polarity (anode to stud)	R
Both polarities available	(R)

HIGH-VOLTAGE RECTIFIER STACKS

Type No.	$I_{F(AV)}$ max.	V_{RWM} max.	Page	Configuration
OSS9115–3 to –36	3.5 A (6 A in oil)	4.5 kV to 54 kV	733	
OSS9215–3 to –36	5 A (20 A in oil)		743	
OSS9415–3 to –36	10 A (30 A in oil)		753	
OSB9115–4 to –36	7 A (12 A in oil)	3 kV to 27 kV	733	
OSB9215–4 to –36	10 A (40 A in oil)		743	
OSB9415–4 to –36	20 A (60 A in oil)		753	
OSM9115–4 to –36	3.5 A (6 A in oil)	3 kV to 27 kV	733	
OSM9215–4 to –36	5 A (20 A in oil)		743	
OSM9415–4 to –36	10 A (30 A in oil)		753	
OSM9510–12	1.5 A	6 kV	761	

GENERAL SECTION

Type Designation
Rating Systems
Letter Symbols
Quality Conformance and Reliability
General Explanatory Notes
Heatsinks

PRO ELECTRON TYPE DESIGNATION CODE FOR SEMICONDUCTOR DEVICES

This type designation code applies to discrete semiconductor devices – as opposed to integrated circuits –, multiples of such devices and semiconductor chips.

"Although not all type numbers accord with the Pro Electron system, the following explanation is given for the ones that do."

A basic type number consists of:

TWO LETTERS FOLLOWED BY A SERIAL NUMBER

FIRST LETTER

The first letter gives information about the material used for the active part of the devices.

A. GERMANIUM or other material with band gap of 0,6 to 1,0 eV.
B. SILICON or other material with band gap of 1,0 to 1,3 eV.
C. GALLIUM-ARSENIDE or other material with band gap of 1,3 eV or more.
R. COMPOUND MATERIALS (e.g. Cadmium-Sulphide).

SECOND LETTER

The second letter indicates the function for which the device is primarily designed.

A. DIODE; signal, low power
B. DIODE; variable capacitance
C. TRANSISTOR; low power, audio frequency ($R_{th\ j\text{-}mb} > 15$ K/W)
D. TRANSISTOR; power, audio frequency ($R_{th\ j\text{-}mb} \leqslant 15$ K/W)
E. DIODE; tunnel
F. TRANSISTOR; low power, high frequency ($R_{th\ j\text{-}mb} > 15$ K/W)
G. MULTIPLE OF DISSIMILAR DEVICES – MISCELLANEOUS; e.g. oscillator
H. DIODE; magnetic sensitive
L. TRANSISTOR; power, high frequency ($R_{th\ j\text{-}mb} \leqslant 15$ K/W)
N. PHOTO-COUPLER
P. RADIATION DETECTOR; e.g. high sensitivity phototransistor
Q. RADIATION GENERATOR; e.g. light-emitting diode (LED)
R. CONTROL AND SWITCHING DEVICE; e.g. thyristor, low power ($R_{th\ j\text{-}mb} > 15$ K/W)
S. TRANSISTOR; low power, switching ($R_{th\ j\text{-}mb} > 15$ K/W)
T. CONTROL AND SWITCHING DEVICE; e.g. thyristor, power ($R_{th\ j\text{-}mb} \leqslant 15$ K/W)
U. TRANSISTOR; power, switching ($R_{th\ j\text{-}mb} \leqslant 15$ K/W)
X. DIODE: multiplier, e.g. varactor, step recovery
Y. DIODE; rectifying, booster
Z. DIODE; voltage reference or regulator (transient suppressor diode, with third letter W)

The remainder of the type number is a **serial number** indicating a particular design or development and is in one of the following two groups:

(a) **A serial number** consisting of three figures from 100 to 999.

(b) **A serial number** consisting of one letter (Z, Y, X, W, etc.) followed by two figures.

RANGE NUMBERS

Where there is a range of variants of a basic type of rectifier diode, thyristor or voltage regulator diode the type number as defined above is often used to identify the range; further letters and figures are added after a hyphen to identify associated types within the range. These additions are as follows:

RECTIFIER DIODES, THYRISTORS AND TRIACS

A group of figures indicating the rated repetitive peak reverse voltage, V_{RRM}, or the rated repetitive peak off-state voltage, V_{DRM}, whichever value is lower, in volts for each type.

The final letter R is used to denote a reverse polarity version (stud-anode) where applicable. The normal polarity version (stud cathode) has no special final letter.

REGULATOR DIODES

A first letter indicating the nominal percentage tolerance in the operating voltage V_Z.

A. 1% (according to IEC 63: series E96)
B. 2% (according to IEC 63: series E48)
C. 5% (according to IEC 63: series E24)
D. 10% (according to IEC 63: series E12)
E. 20% (according to IEC 63: series E6)

A group of figures indicating the typical operating voltage V_Z for each type at the nominal operating current I_Z rating of the range.

The letter V is used to denote a decimal sign.

The final letter R is used to denote a reverse polarity version (stud anode) where applicable. The normal polarity version (stud cathode) has no special final letter.

Examples:

BYX38-600	Silicon rectifier in the BYX38 range with 600 V maximum repetitive peak voltage, normal polarity, stud connected to cathode.
BZY91-C7V5	Silicon voltage regulator diode in the BZY91 range with 7.5 V operating ± 5% tolerance, normal polarity, stud connected to cathode.

RATING SYSTEMS

The rating systems described are those recommended by the International Electrotechnical Commission (IEC) in its Publication 134.

DEFINITIONS OF TERMS USED

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

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

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.

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.

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.

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.

ABSOLUTE MAXIMUM RATING SYSTEM **(As used throughout this book)**

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.

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.

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.

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.

LETTER SYMBOLS FOR RECTIFIER DIODES, THYRISTORS, TRIACS AND BREAKOVER DIODES

LETTER SYMBOLS FOR CURRENTS, VOLTAGES AND POWERS

Basic letters: – The basic letters to be used are:

I, i = current V, v = voltage P, p = power

Lower-case basic letters shall be used for the representation of instantaneous values which vary with time. In all other instances upper-case letters shall be used.

Subscripts

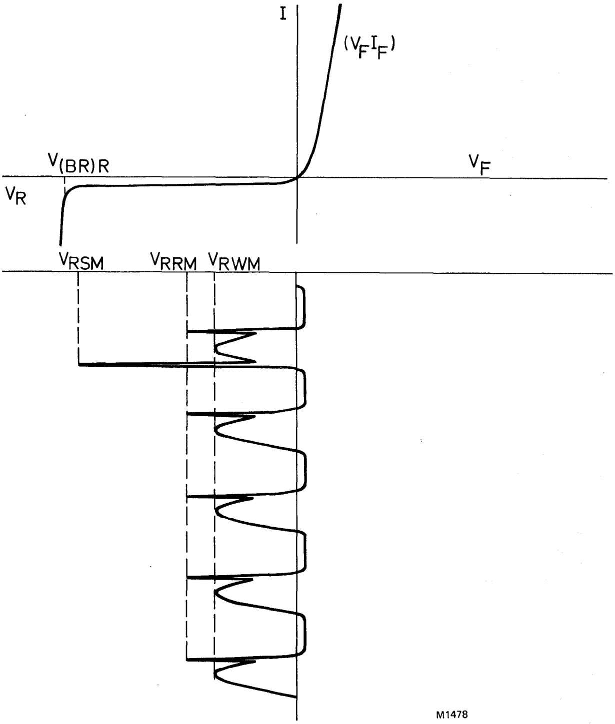
amb	Ambient
(AV), (av)	Average value
(BO)	Breakover
(BR)	Breakdown
case	Case
C	Controllable
D,d	Forward off-state 1), non-triggered (gate voltage or current)
F,f	Forward 1), fall
G,g	Gate terminal
H	Holding
I,i	Input
J,j	Junction
L	Latching
M,m	Peak or crest value
min	Minimum
O,o	Output, open circuit
(OV)	Overload
P,p	Pulse
Q,q	Turn-off
R,r	As first subscript: reverse, rise As second subscript: repetitive, recovery
(RMS), (rms)	R.M.S. value
S,s	As first subscript: storage, stray, series, source, switching As second subscript: non-repetitive
stg	Storage
T,t	Forward on-state 1), triggered (gate voltage or current)
th	Thermal
(TO)	Threshold
tot	Total
W	Working
Z	Reference or regulator (i.e. zener)

For power rectifier diodes, thyristors and triacs, the terminals are **not** indicated in the subscript, except for the gate-terminal of thyristors and triacs.

---

1) For the anode-cathode voltage of thyristors and triacs, F is replaced either by D or T, to distinguish between 'off-state' (non-triggered) and 'on-state' (triggered).

Example of the use of letter symbols



Simplified rectifier characteristic together with an anode-cathode voltage as a function of time.

QUALITY CONFORMANCE AND RELIABILITY

In addition to 100% testing of all major device parameters in the production department, independently controlled statistical sampling for conformance and reliability takes place using BS6001 'Sampling Procedures and Tables'. BS6001 is consistent with MIL–STD–105D. DEF131A, IS02859, CA–C–115.

The market demand for a continuously improving product quality is being met by the annual updating of formal quality improvement plans.

The 'Defect free' and 'Right first time' concepts are applied regularly as part of an overall quality programme covering all aspects of device quality from initital design to final production. These concepts, together with the quality assurance requirements, embrace all the principles outlined in DEF STAN 05–21, AQAP–1, and BS5750 Pt1.

CONFORMANCE

The Company actively promote a policy of customer cooperation to determine their quality problems and future requirements. This cooperation is often in the form of a 'ppm' activity. The 'ppm' is a measure of conformance of the outgoing product, and is expressed as the number of reject devices found per million of products delivered (e.g. a process average of 0.01% = 100 ppm). Mutually agreed ppm targets are set, and a programme of quality improvement work initiated.

In addition to the above, special inspection and/or test procedures are available, following consultation with the customer and the agreement of a special specification.

RELIABILITY

'Screening', or 'Burn-in' procedures are also available, based on the requirements of CECC 50 000.

CECC 50 000 offers a choice of four screening sequences: 'A', 'B', 'C', 'D'. The Company's standard 'Hi-rel' procedure offers a combination of 'C' and 'D' sequences.

Sequence 'C'

1. High temperature storage – 24 hours minimum.
2. Rapid change of temperature – as detailed in agreed specification.
3. Sealing – fine leak test.
   – gross leak test.
4. Functional electrical characteristics – within group 'A' limits.

Sequence 'D'

1. 'Burn-in' – high-voltage reverse bias, 48 hours duration. Conditions as specified in CECC 50 000.
2. Post 'Burn-in' measurements – functional electrical characteristics, within group 'A' limits.

Other 'Hi-rel', 'Burn-in', or 'Screening' procedures may be available on request.

RECTIFIER DIODES

REVERSE RECOVERY

When a semiconductor rectifier diode has been conducting in the forward direction sufficiently long to establish the steady state, 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 transient reverse current and this, together with the reverse bias voltage results in additional power dissipation which reduces the rectification efficiency. At sine-wave frequencies up to about 400 Hz these effects can often be ignored, but at higher frequencies and for square waves the switching losses must be considered.

Stored charge

The area under the I_R- time curve is known as the stored charge (Q_s) and is normally quoted in micro- or nanocoulombs. Low stored charge devices are preferred for fast switching applications.

Reverse recovery time

Another parameter which can be used to determine the speed of the rectifier is the reverse recovery time (t_{rr}). This is measured from the instant the current passes through zero (from forward to reverse) to the instant the current recovers to 10% of its peak reverse value. Low reverse recovery times are associated with low stored charge devices.

The conditions which need to be specified are:

a. Steady-state forward current (I_F); high currents increase recovery time.
b. Reverse bias voltage (V_R); low reverse voltage increases recovery time.
c. Rate of fall of anode current (dI_F/dt); high rates of fall reduce recovery time, but increase stored charge.
d. Junction temperature (T_j); high temperatures increase both recovery time and stored charge.

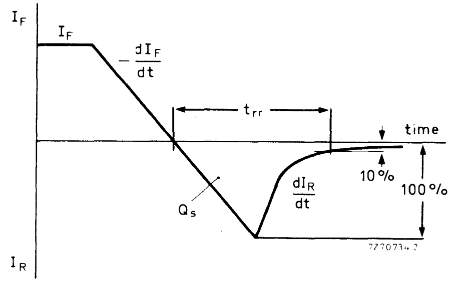


Fig. 1 Waveform showing the reverse recovery aspects.

REVERSE RECOVERY (continued)

Softness of recovery

In many switching circuits it is not just the magnitude but the shape of the reverse recovery characteristic that is important. If the positive-going edge of the characteristic has a fast rise time (as in a so-called 'snap-off' device) this edge may cause conducted or radiated r.f.i., or it may generate high voltages across inductors which may be in series with the rectifier. The maximum slope of the reverse recovery current (dI_R/dt) is quoted as a measure of the 'softness' of the characteristic. Low values are less liable to give r.f.i. problems. The measurement conditions which need to be specified are as above. When stored charges are very low, e.g. for epitaxial and Schottky-barrier rectifier diodes,this softness characteristic can be ignored.

DOUBLE-DIFFUSED RECTIFIER DIODES

A single-diffused diode with a two layer p-n structure cannot combine a high forward current density with a high reverse blocking voltage.

A way out of this dilemma is provided by the three layer double-diffused structure. A lightly doped silicon layer, called the base, is sandwiched between highly doped diffused p^+ and n^+ outer layers giving a $p^+ -pn^+$ or $p^+ -nn^+$ layer. Generally, the base gives the diode its high reverse voltage, and the two diffused regions give the high forward current rating.

Although double-diffused diodes are highly efficient, a slight compromise is still necessary. Generally, for a given silicon chip area, the thicker the base layer the higher the V_R and the lower the I_F. Reverse switching characteristics also determine the base design. Fast recovery diodes usually have n-type base regions to give 'soft' recovery. Other diodes have the base type, n or p, chosen to meet their specific requirements.

ULTRA FAST RECTIFIER DIODES

Ultra fast rectifier diodes, made by epitaxial technology, are intended for use in applications where low conduction and switching losses are of paramount importance and relatively low reverse blocking voltage (V_{RWM} = 150 V) is required: e.g., switched-mode power supplies operating at frequencies of about 50 kHz.

The use of epitaxial technology means that there is very close control over the almost ideal diffusion profile and base width giving very high carrier injection efficiencies leading to lower conduction losses than conventional technology permits. The well defined diffusion profile also allows a tight control of stored minority carriers in the base region, so that very fast turn-off times (35 ns) can be achieved. The range of devices also has a soft reverse recovery and a low forward recovery voltage.

SCHOTTKY-BARRIER RECTIFIER DIODES

Schottky-barrier rectifiers find application in low-voltage switched-mode power supplies (e.g. 5 V output) where they give an increase in efficiency due to the very low forward drop, and low switching losses. Power Schottky diodes are made by a metal-semiconductor barrier process to minimise forward voltage losses, and being majority carrier devices have no stored charge. They are therefore capable of operating at extremely high speeds. Electrical performance in forward and reverse conduction is uniquely defined by the device's metal-semiconductor 'barrier height'. We have a process to minimise forward voltage, whilst maintaining reverse leakage current at full rated working voltage and $T_{j\ max}$ at an acceptable level.

To obtain the maximum benefit from the use of Schottky devices it is recommended that particular attention be paid to the adequate suppression of voltage transients in practical circuit designs.

SWITCHING LOSSES (see also Fig.3)

The product of transient reverse current and reverse bias voltage is a power dissipation, most of which occurs during the fall time. In repetitive operation an average power can be calculated. This is then added to the forward dissipation to give the total power. The peak value of transient reverse current is known as I_{RRM}.

The conditions which need to be specified are:

a. Forward current (I_F); high currents increase switching losses.
b. Rate of fall of anode current (dI_F/dt); high rates of fall increase switching losses. This is particularly important in square-wave operation. Power losses in sine-wave operation for a given frequency are considerably less due to the much lower dI_F/dt.
c. Frequency (f); high frequency means high losses.
d. Reverse bias voltage (V_R); high reverse bias means high losses.
e. Junction temperature (T_j); high temperature means high losses.

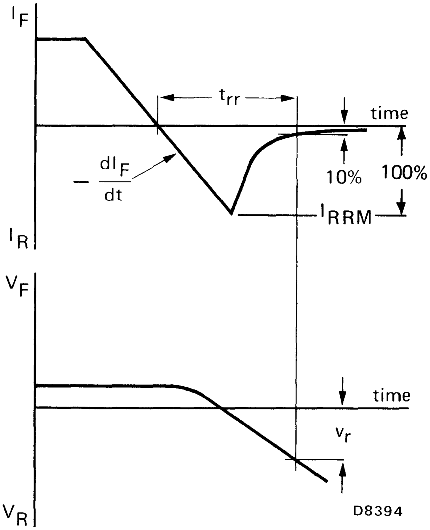


Fig.2 Waveforms showing the reverse switching losses aspects.

SWITCHING LOSSES (continued)

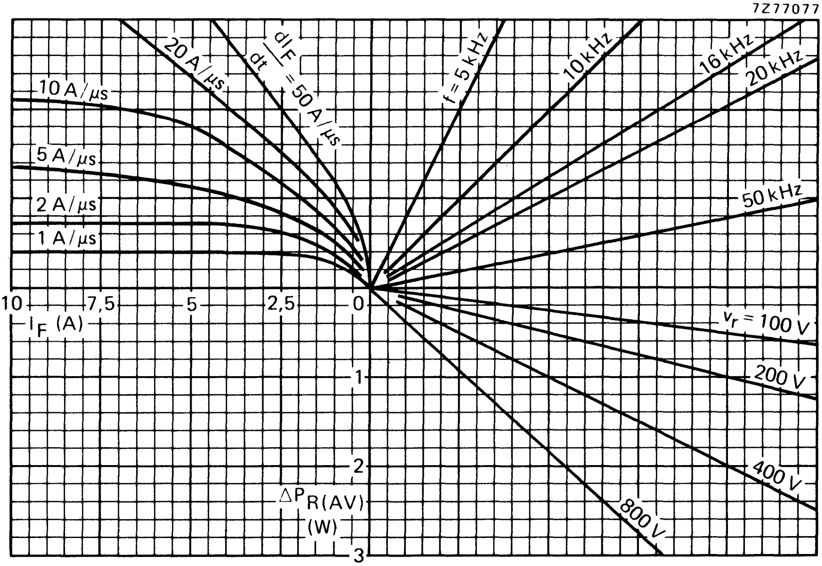


Fig. 3 **Nomogram** (example of reverse switching losses). Power loss $\Delta P_{R(AV)}$ due to switching only (to be added to steady-state power losses). I_F = forward current just before switching off; T_j = 150 °C.

FORWARD RECOVERY

At the instant a semiconductor rectifier diode is switched into forward conduction there are no carriers present at the junction, hence the forward voltage drop may be instantaneously of a high value. As the stored charge builds-up, conductivity modulation takes place and the forward voltage drop rapidly falls to the steady-state value. The peak value of forward voltage drop is known as the forward recovery voltage (V_{fr}). The time from the instant the current reaches 10% of its steady-state value to the time the forward voltage drop falls to within 10% of its final steady-state value is known as the forward recovery time (t_{fr}).

The conditions which need to be specified are:
a. Forward current (I_F); high currents give high recovery voltages.
b. Current pulse rise time (t_r); short rise times give high recovery voltages.
c. Junction temperature (T_j); the influence of temperature is slight.

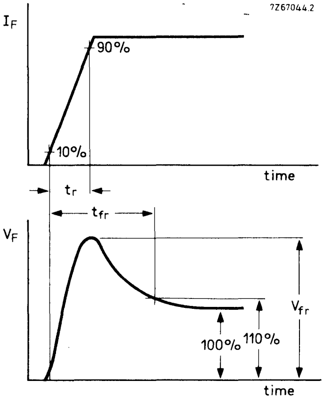


Fig. 4 Waveforms showing the forward recovery aspects.

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.

BREAKOVER DIODES

GENERAL

Breakover diodes (BODs) are two-terminal devices that operate in either an off (non-conducting) state or an on (conducting) state. A BOD will remain in the off-state until the maximum breakover voltage is applied across its terminals. A BOD will then conduct with a low on-state voltage until the current is reduced below the minimum holding current.

BODs are available as single or dual symmetric (operation in 1st and 3rd quadrants)types in a TO-220 outline. BODs are graded according to breakover voltage.

BREAKOVER DIODE CHARACTERISTICS

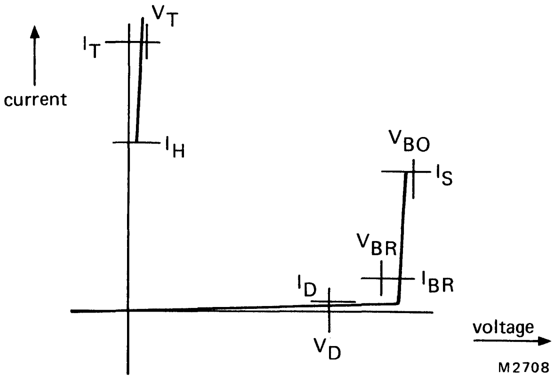


Fig.1 Breakover diode characteristics (1st quadrant).

The main characteristics are illustrated in Fig.1. These characteristics are:-

V_{BO}	breakover voltage, the maximum voltage appearing across the BOD before switching to the on-state.
V_D	stand-off voltage, maximum normal operating voltage.
I_D	off-state current, normally quoted at V_D.
V_{BR}	breakdown voltage, at which the BOD will commence avalanche breakdown.
I_{BR}	breakdown current, with V_{BR} applied.
I_S	switching current, the avalanche current required to switch the BOD to the on-state.
I_T	on-state current.
V_T	on-state voltage, specified at a given I_T.
I_H	holding current, the minimum current at which the BOD will remain in the on-state.

USE OF BREAKOVER DIODES

BODs are primarily designed to protect electronic equipment connected to transmission lines against transient overvoltages. However, there are many uses for BODs as breakover switches.

In designing BOD circuits the following must be considered:-

Off-state conditions

V_D	Must not be exceeded in normal off-state operation. In the off-state the BOD will not pass more current than I_D.
dV_D/dt	The rate of rise of voltage must not exceed that quoted for the device. If this is exceeded, the BOD may switch to on-state.
V_{BR}	Low voltage transients may be required not to switch the BOD to the on-state. To ensure the BOD remains in the off-state the voltage must remain below the minimum V_{BR}. If this is exceeded then clipping of the voltage or switching of the BOD may occur.
I_S	If V_{BR} is exceeded but the current limited to below I_S minimum, the BOD is prevented from switching to the on-state.
C_j	The off-state capacitance across the BOD. In transmission line protection applications this will be across the termination of the line.

Switching conditions

V_{BO}	A transient voltage greater than V_{BO} maximum is required to switch the BOD. V_{BO} may be greater than the voltage across the BOD passing current I_S maximum.
I_S	To enable the BOD to switch to the on-state a current greater than I_S maximum is required.

On-state conditions

V_T	The on-state voltage is quoted for a given I_T.
I_H	To enable the BOD to switch to the off-state the current must fall below I_H minimum.
I_{TRM}	I_{TRM} specifies the rate of increase and duration of a transient peak on-state current. The convention used to specify I_{TRM} is illustrated in Fig.2. This waveform is specified as a t_1/t_2 μs impulse.

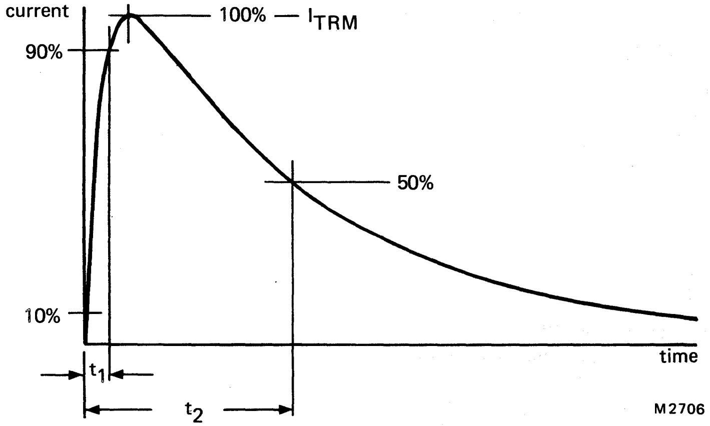


Fig.2 Definition of I_{TRM} waveform.

Thermal conditions

R_{th} For extended on-state operation ($>$ 0.1ms) the steady-state thermal resistance should be considered. The total thermal resistance to ambient sould be sufficiently low to dissipate the heat generated by the device. For this type of application it is recommended that the BOD is mounted on a heatsink.

Z_{th} If the BOD is used only during transient overvoltages then the transient thermal impedance to ambient should be considered. It may be sufficient to mount the BOD in free-air.

Mains contact

Fig.3 illustrates the operation of a BOD during one cycle of a mains contact fault. The BOD will generate heat in avalache breakdown until the instantaneous current is greater than I_S maximum. When this current is reached the BOD will switch and generate heat in the on-state.

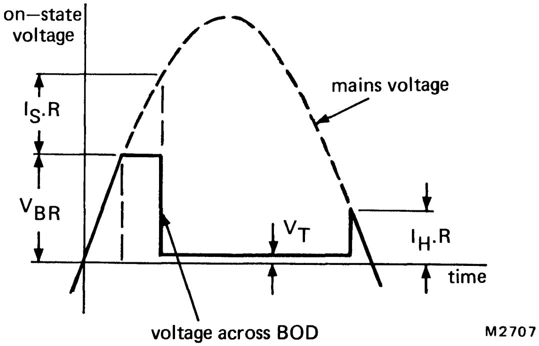


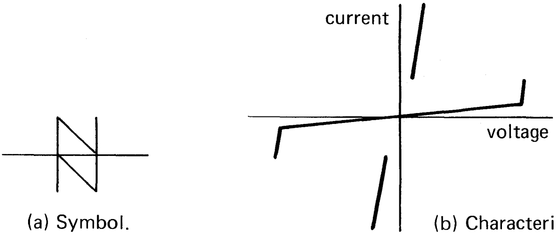
Fig.3 Voltage across BOD during mains contact fault,
R = total fault impedance.

During avalanche a large amount of heat is generated. If the mains fault impedance is sufficiently high the BOD will remain in avalanche breakdown until the mains voltage falls below V_{BR} minimum. Under this condition the junction temperature may be raised considerably.

Power dissipation curves are not published for BODs during avalanche breakdown. This is because individual cases will vary greatly. However, in general if the fault impedance is about 500Ω-5kΩ then there will be excessive dissipation due to the avalanche breakdown.

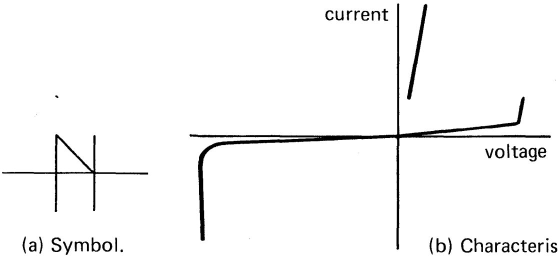
If mains contact faults are likely with impedances in the range quoted, the dissipation of the BOD should be considered carefully.

BREAKOVER DIODE SYMBOLS AND CHARACTERISTICS



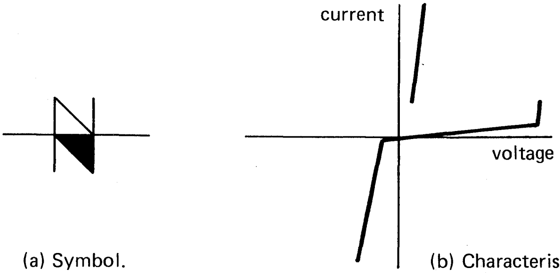
(a) Symbol. (b) Characteristic.

Fig.4 Symmetric BOD.



(a) Symbol. (b) Characteristic.

Fig.5 Reverse-blocking BOD.



(a) Symbol. (b) Characteristic.

Fig.6 Reverse-conducting BOD.

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: $T_j - T_{amb} = P \times (R_{th\ j\text{-}mb} + R_{th\ mb\text{-}h} + R_{th\ h\text{-}a})$

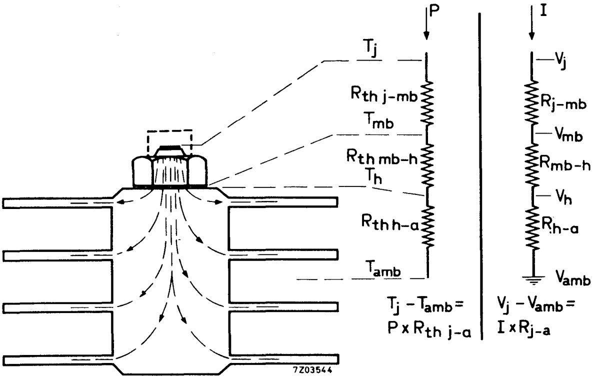


Fig. 1

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 metal oxide-loaded compound to fill air pockets.

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 intake 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.

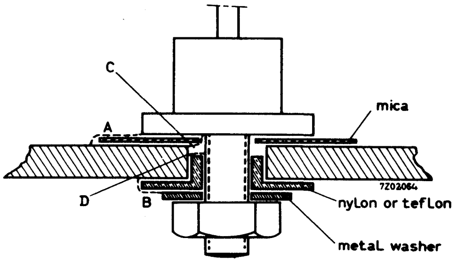


Fig. 2 Creepage distances with an insulated diode

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.

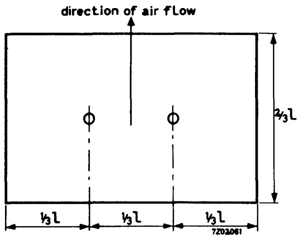


Fig. 3 Plain cooling fin with two diodes

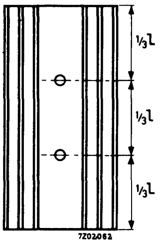


Fig. 4 Extruded aluminium heatsink with two diodes

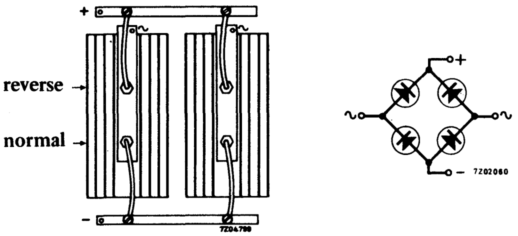


Fig. 5 Single phase full wave rectifier with diodes of different polarity on extruded aluminium heatsinks

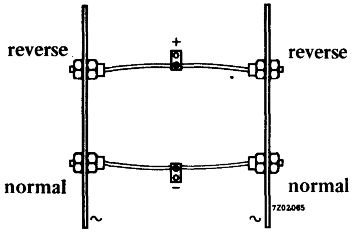


Fig. 6 Single phase full wave rectifier with diodes of different polarity on plain cooling fins (top view)

CONSTRUCTIONS (continued)

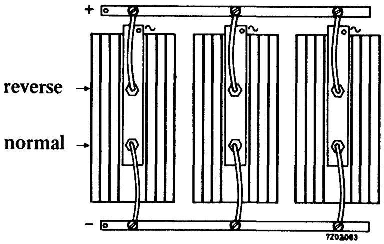
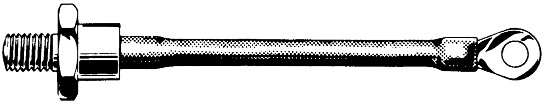


Fig. 7 Three phase full wave rectifier with diodes of different polarity on extruded aluminium heatsinks

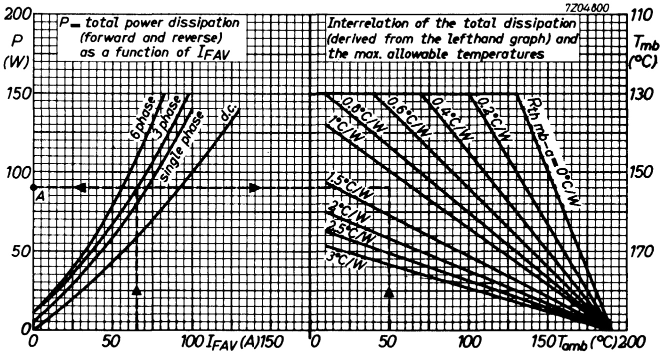
EXAMPLES OF HEATSINK CALCULATION

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 $T_{amb} = 50\ ^{o}C$. Further assume: average forward current per diode $I_{F(AV)} = 65$ A; contact thermal resistance $R_{th\ mb\text{-}h} = 0,1\ ^{o}C/W$.



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 $R_{th\ mb\text{-}a} \approx 1,2\ ^{o}C/W$.
Thus $R_{th\ h\text{-}a} = R_{th\ mb\text{-}a} - R_{th\ mb\text{-}h} = (1,2 - 0,1)\ ^{o}C/W = 1,1\ ^{o}C/W$.
This may be achieved by different types of heatsinks as shown below.

Type	Free convection	Forced cooling
flat, blackened bright	– –	125 cm^2; 2 m/s or 300 cm^2; 1 m/s 175 cm^2; 2 m/s
diecast 56280	applicable	
extrusion		
56230 bright	ℓ = 12 cm	ℓ = 5 cm 1); 1 m/s
blackened	ℓ = 8 cm	ℓ = 5 cm 1); 1 m/s
56231 bright	ℓ = 7 cm	
blackened	ℓ = 5 cm 1)	

---

1) Practical minimum length

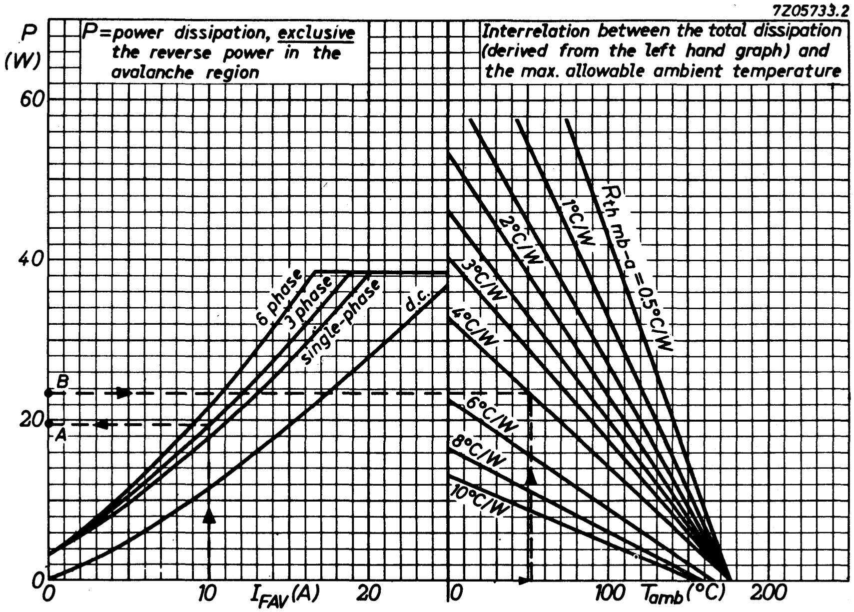
EXAMPLES OF HEATSINK CALCULATION (continued)

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 $T_{amb} = 40\ ^{o}C$. Further assume: average forward current per diode $I_{F(AV)} = 10$ A; contact thermal resistance: $R_{th\ mb\text{-}h} = 0,5\ ^{o}C/W$; repetitive peak reverse power in the avalanche region ($t = 40\,\mu s$) $P_{RRM} = 2$ 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 $\delta = \frac{40\ \mu s}{20\,ms} = 0,002$.

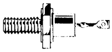
Thus $P_{R(AV)} = 0,002 \times 2\ kW = 4$ W.

Therefore the total device power dissipation $P_{tot} = 19,5 + 4 = 23,5$ W (point B). From the righthand graph it follows that $R_{th\ mb\text{-}a} = 4\ ^{o}C/W$. Hence the heatsink thermal resistance should be:

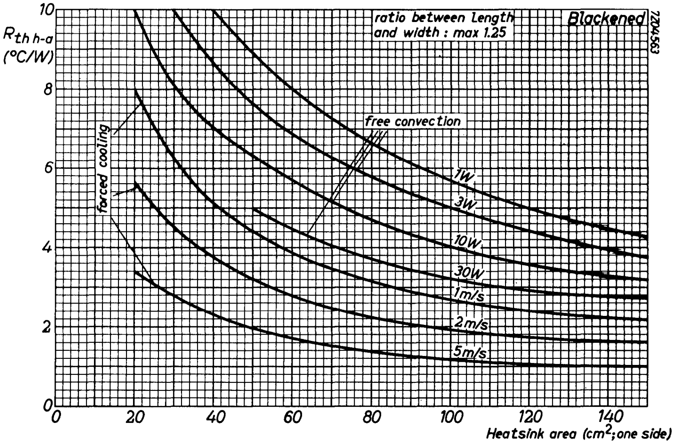
$$R_{th\ h\text{-}a} = R_{th\ mb\text{-}a} - R_{th\ mb\text{-}h} = (4 - 0,5)\ ^{o}C/W = 3,5\ ^{o}C/W.$$

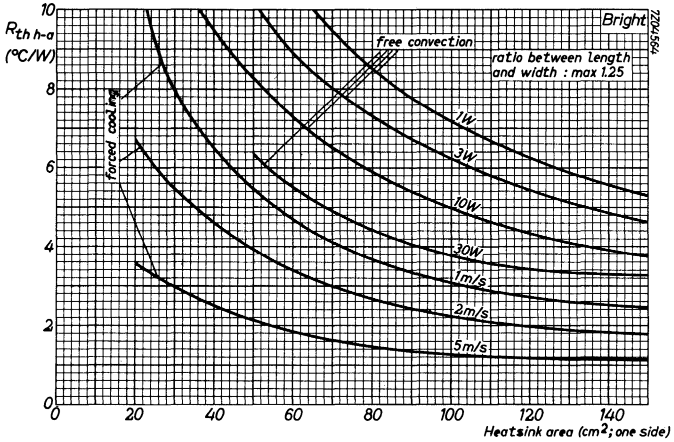
A table of applicable heatsinks, similar to that on the foregoing page, can de derived for this case.

Thermal resistance of flat heatsinks of 2 mm copper or 3 mm aluminium.
The graphs are valid for the combination of device and heatsink.



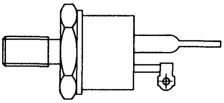
Studs: 10-32UNF
Mounting bases, across the flats: max. 11,0 mm



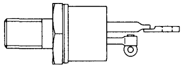


Flat heatsink

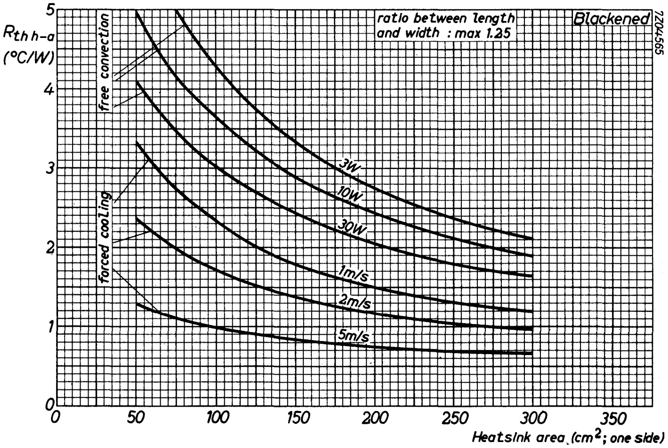
Thermal resistance of flat heatsinks of 2 mm copper or 3 mm aluminium.
The graphs are valid for the combination of device and heatsink.

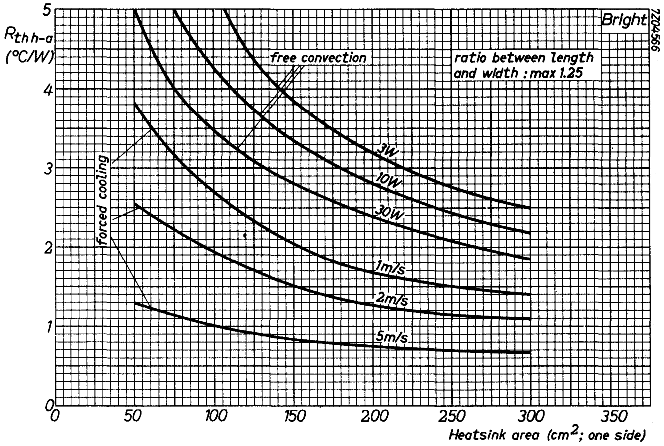


Stud: ¼" x 28 UNF
Mounting base, across the flats: max. 17 mm



Stud: M6
Stud: $\frac{1}{4}$" x 28 UNF
Mounting base, across the flats: max. 14,0 mm





RECTIFIER DIODES

SILICON RECTIFIER DIODES

Glass-passivated double-diffused rectifier diodes in TO-220 plastic envelopes, intended for power rectifier applications.
The series consists of the following types:
Normal polarity (cathode to base plate): BY249–300 and BY249–600.
Reverse polarity (anode to base plate): BY249–300R and BY249–600R.

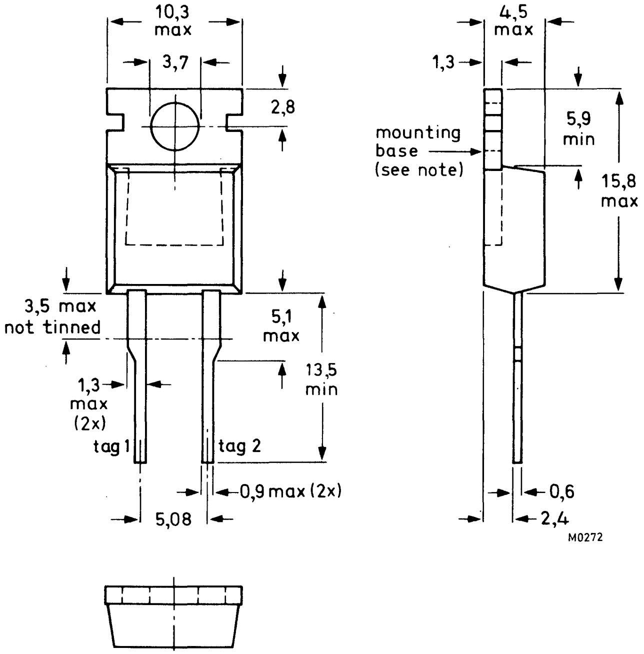
QUICK REFERENCE DATA

			BY249–300(R)	600(R)	
Repetitive peak reverse voltage	V_{RRM}	max.	300	600	V
Average forward current	$I_{F(AV)}$	max.	6.5		A
Non-repetitive peak forward current	I_{FSM}	max.	60		A

MECHANICAL DATA (see next page for polarity of connections)

Dimensions in mm

Fig. 1 TO-220AC



Note: The exposed metal mounting base is directly connected to tag 1.

Accessories supplied on request: see data sheets Mounting instructions and accessories for TO-220 envelopes.

MECHANICAL DATA (continued)

Polarity of connections:

	BY249–300 BY249–600	BY249–300R BY249–600R
base plate	cathode	anode
tag 1	cathode	anode
tag 2	anode	cathode

RATINGS

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

Voltages*			BY249–300(R)	600(R)	
Non-repetitive peak reverse voltage	V_{RSM}	max.	300	600	V
Repetitive peak reverse voltage	V_{RRM}	max.	300	600	V
Crest working reverse voltage	V_{RWM}	max.	200	400	V
Continuous reverse voltage	V_R	max.	200	400	V

Currents				
Average forward current;				
sinusoidal; up to T_{mb} = 110 °C	$I_{F(AV)}$	max.	6.5	A
sinusoidal; at T_{mb} = 125 °C	$I_{F(AV)}$	max.	4.0	A
R.M.S. forward current	$I_{F(RMS)}$	max.	9.5	A
Repetitive peak forward current; t = 10 ms; half sine-wave	I_{FRM}	max.	60	A
Non-repetitive peak forward current; t = 10 ms; half sine-wave; T_j = 150 °C prior to surge; with re-applied V_{RWMmax}	I_{FSM}	max.	60	A
I^2t for fusing; t = 10 ms	I^2t	max.	18	A^2s
Temperatures				
Storage temperature	T_{stg}		−40 to +150	°C
Junction temperature	T_j	max.	150	°C

CHARACTERISTICS

Forward voltage				
I_F = 20 A; T_j = 25 °C	V_F	$<$	1.6	V**
I_F = 5 A; T_j = 100 °C	V_F	$<$	1.05	V**
Reverse current				
$V_R = V_{RWMmax}$; T_j = 125 °C	I_R	$<$	0.4	mA

*To ensure thermal stability, $R_{th\ j\text{-}a} < 15$ °C/W for continuous reverse voltage.

**Measured under pulse conditions to avoid excessive dissipation.

THERMAL RESISTANCE

From junction to mounting base $R_{th\ j\text{-}mb} = 4.2$ °C/W

Transient thermal impedance; t = 1 ms $Z_{th\ j\text{-}mb} = 0.46$ °C/W

Influence of mounting method

1. Heatsink mounted with clip (see mounting instructions)

Thermal resistance from mounting base to heatsink

a. with heatsink compound $R_{th\ mb\text{-}h} = 0.3$ °C/W

b. with heatsink compound and 0.06 mm maximum mica insulator $R_{th\ mb\text{-}h} = 1.4$ °C/W

c. with heatsink compound and 0.1 mm maximum mica insulator (56369) $R_{th\ mb\text{-}h} = 2.2$ °C/W

d. with heatsink compound and 0.25 mm maximum alumina insulator (56367) $R_{th\ mb\text{-}h} = 0.8$ °C/W

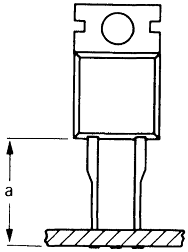
e. without heatsink compound $R_{th\ mb\text{-}h} = 1.4$ °C/W

2. Free-air operation

The quoted value of $R_{th\ j\text{-}a}$ should be used only when no leads of other dissipating components run to the same tie-point. Thermal resistance from junction to ambient in free air: mounted on a printed-circuit board at a = any lead length.

$R_{th\ j\text{-}a} = 60$ °C/W

Fig. 2



D8397 7Z78248

MOUNTING INSTRUCTIONS

1. The device may be soldered directly into the circuit, but the maximum permissible temperature of the soldering iron or bath is 275 °C; it must not be in contact with the joint for more than 5 seconds. Soldered joints must be at least 4.7 mm from the seal.
2. The leads should not be bent less than 2.4 mm from the seal, and should be supported during bending. The bend radius must be no less than 1.0 mm. ←
3. It is recommended that the circuit connection be made to tag 1, rather than direct to the heatsink.
4. Mounting by means of a spring clip is the best mounting method because it offers:
   a. a good thermal contact under the crystal area and slightly lower $R_{th\ mb\text{-}h}$ values than screw mounting.
   b. safe isolation for mains operation.

   However, if a screw is used, it should be M3 cross-recess pan-head. Care should be taken to avoid damage to the plastic body.
5. For good thermal contact heatsink compound should be used between mounting base and heatsink. Values of $R_{th\ mb\text{-}h}$ given for mounting with heatsink compound refer to the use of a metallic-oxide loaded compound. Ordinary silicone grease is not recommended.
6. Rivet mounting (only possible for non-insulated mounting)
   Devices may be rivetted to flat heatsinks; such a process **must neither** deform the mounting tab, **nor** enlarge the mounting hole.

SINUSOIDAL OPERATION

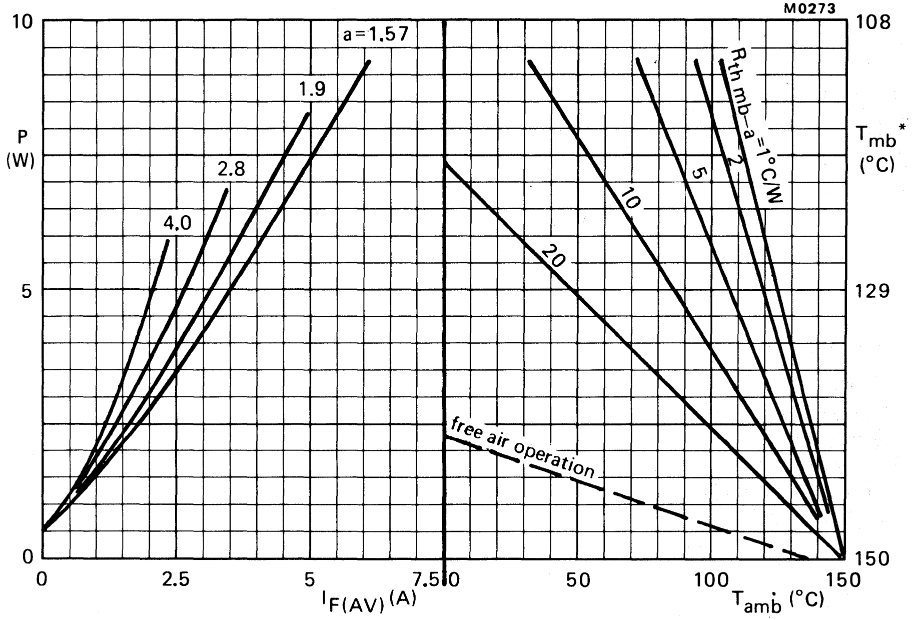


Fig. 3 The right-hand part shows the interrelationship between the power (derived from the left-hand part) and the maximum permissible temperatures.
a = form factor = $I_{F(RMS)}/I_{F(AV)}$.

---

*T_{mb} scale is for comparison purposes and is correct only for $R_{th\ mb\text{-}a} < 19.3$ °C/W.

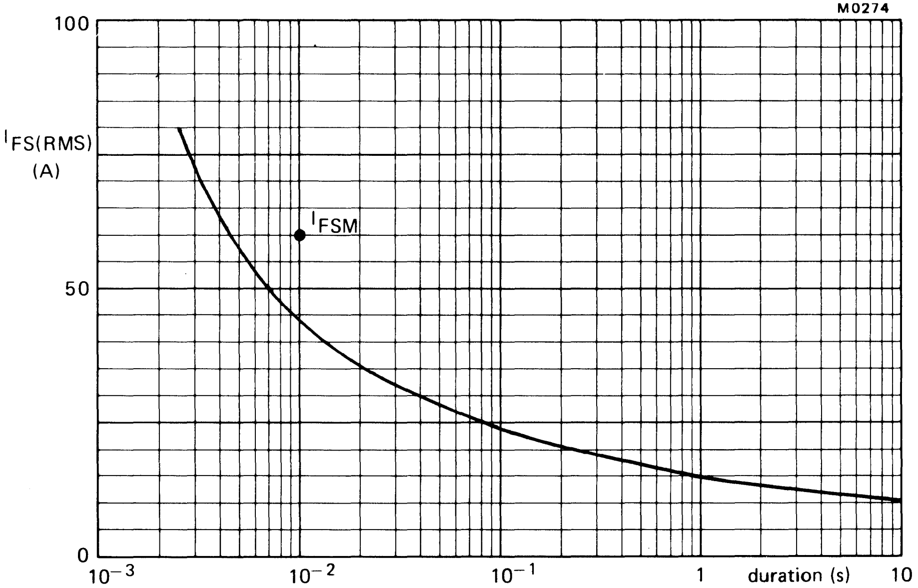


Fig. 4 Maximum permissible non-repetitive r.m.s. forward current based on sinusoidal currents (f = 50 Hz); T_j = 150 °C prior to surge.

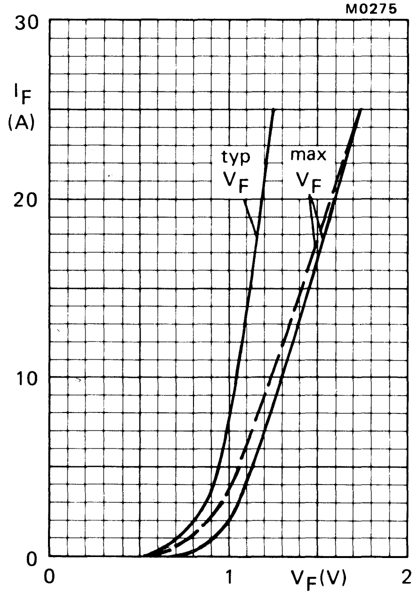


Fig. 5 —— T_j = 25 °C; — — — T_j = 100 °C

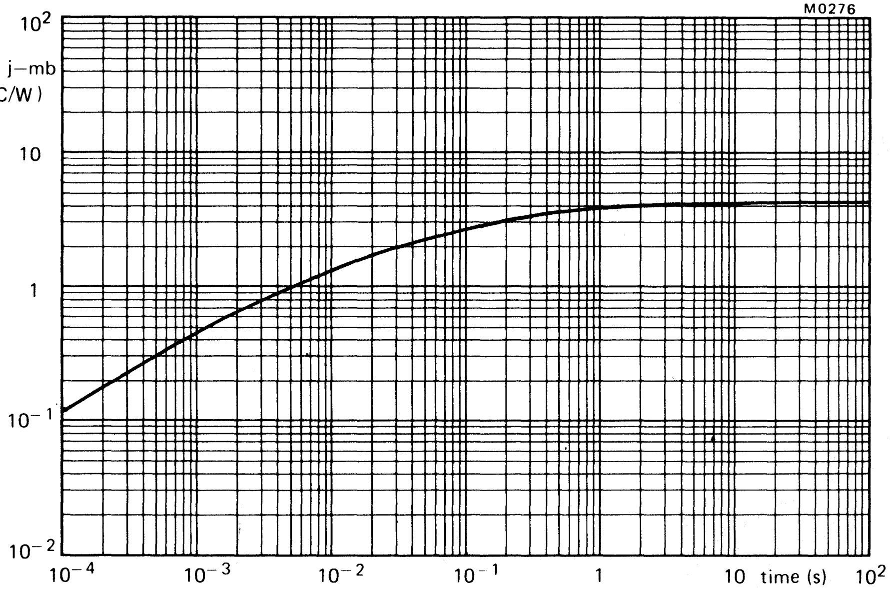


Fig. 6

CONTROLLED AVALANCHE RECTIFIER DIODES

Diffused silicon diodes in DO–4 metal envelopes, 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 BYX25–1400.
Reverse polarity (anode to stud): BYX25–600R to BYX25–1400R.

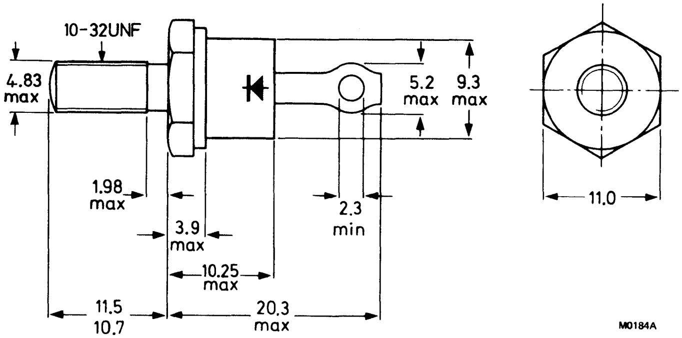
QUICK REFERENCE DATA

			BYX25–600(R)	800(R)	1000(R)	1200(R)	1400(R)	
Crest working reverse voltage	V_{RWM}	max.	600	800	1000	1200	1400	V
Reverse avalanche breakdown voltage	$V_{(BR)R}$	>	750	1000	1250	1450	1650	V
Average forward current	$I_{F(AV)}$	max.	20					A
Non-repetitive peak forward current	I_{FSM}	max.	360					A
Non-repetitive peak reverse power	P_{RSM}	max.	18					kW

MECHANICAL DATA

Dimensions in mm

Fig. 1 DO–4.



Net mass: 7 g.

Diameter of clearance hole: max. 5.2 mm.

Accessories supplied on request:
see ACCESSORIES section

Supplied with device: 1 nut, 1 lock washer.

Nut dimensions across the flats: 9.5 mm

Torque on nut:
min. 0.9 Nm (9 kg cm),
max. 1.7 Nm (17 kg cm).

The mark shown applies to to the normal polarity types.

Products approved to CECC 50 009–022 available on request.

RATINGS

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

Voltages*			BYX25–600(R)	800(R)	1000(R)	1200(R)	1400(R)	
Crest working reverse voltage	V_{RWM}	max.	600	800	1000	1200	1400	V
Continuous reverse voltage	V_R	max.	600	800	1000	1200	1400	V

Currents				
Average forward current (averaged over any 20 ms period) → up to T_{mb} = 125 °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; with reapplied V_{RWMmax}	I_{FSM}	max.	360	A
I^2t for fusing	I^2t	max.	650	A^2s
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	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	kW
Temperatures				
Storage temperature	T_{stg}		−55 to +175	°C
Junction temperature	T_j	max.	175	°C

---

*To ensure thermal stability: $R_{th\ j\text{-}a} < 5$ K/W (a.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)	1200(R)	1400(R)	
Forward voltage $I_F = 50$ A; $T_j = 25$ °C	V_F	<	1.8	1.8	1.8	1.8	1.8	V*
Reverse avalanche breakdown voltage $I_R = 5$ mA; $T_j = 25$ °C	$V_{(BR)R}$	>	750	1000	1250	1450	1650	V
		<	2400	2400	2400	2400	2400	V
Peak reverse current $V_R = V_{RWMmax}$; $T_j = 125$ °C	I_R	<	1.0	0.8	0.6	0.5	0.5	mA

---

*Measured under pulse conditions to avoid excessive dissipation.

OPERATING NOTES

1. **Voltage sharing of series connected controlled avalanche diodes.**

   If diodes with avalanche characteristics are connected in series, the usual R and C elements for voltage sharing can be omitted.

2. The top connector should not be bent; it should be soldered into the circuit so 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 49).

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

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

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

Hence the heatsink thermal resistance should be:

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

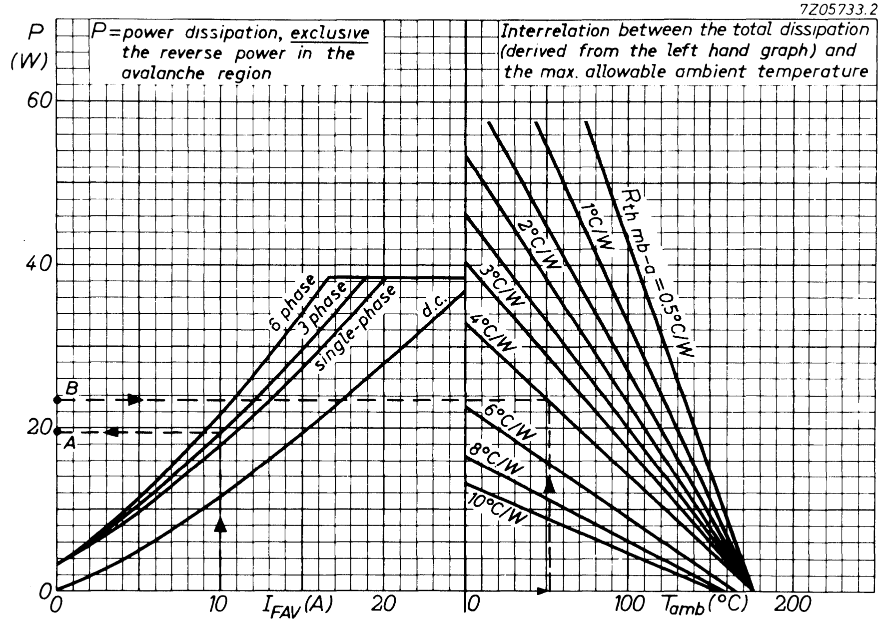

7Z05733.2
P (W)
P = power dissipation, exclusive the reverse power in the avalanche region
Interrelation between the total dissipation (derived from the left hand graph) and the max. allowable ambient temperature
60
40
20
0
0
10
I_{FAV} (A)
20
0
100
T_{amb} (°C)
200
6 phase
3 phase
single-phase
d.c.
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

Fig.2

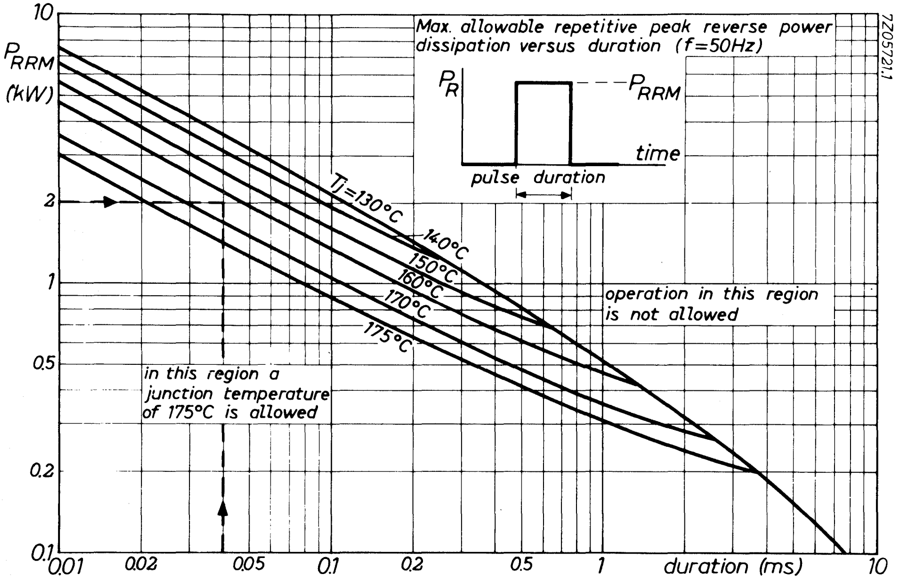

7Z05721.1
P_{RRM} (kW)
10
2
1
0.5
0.2
0.1
0.01
0.02
0.05
0.1
0.2
0.5
1
duration (ms)
10
Max. allowable repetitive peak reverse power dissipation versus duration (f=50Hz)
P_R
P_{RRM}
time
pulse duration
T_j=130°C
140°C
150°C
160°C
170°C
175°C
operation in this region is not allowed
in this region a junction temperature of 175°C is allowed

Fig.3

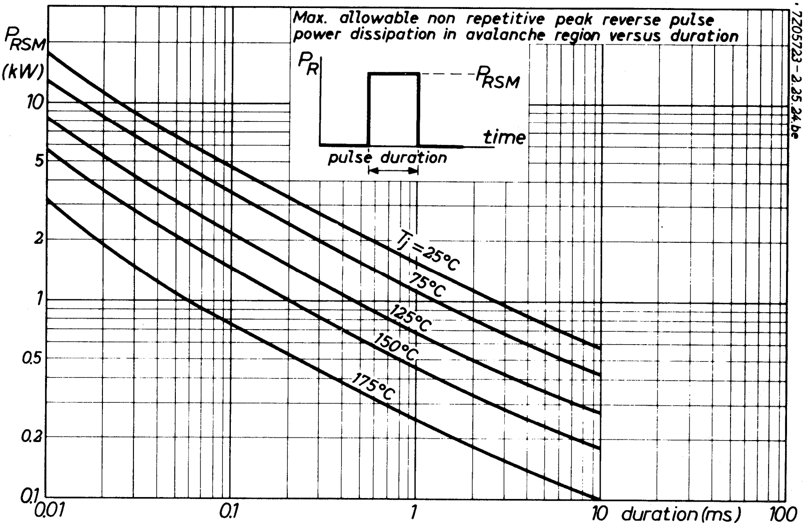

Max. allowable non repetitive peak reverse pulse power dissipation in avalanche region versus duration
P_R
P_{RSM}
time
pulse duration
P_{RSM} (kW)
10
5
2
1
0.5
0.2
0.1
0.01
0.1
1
10
duration (ms)
100
T_j = 25°C
75°C
125°C
150°C
175°C
7Z05723-2.25.24.be

Fig.4

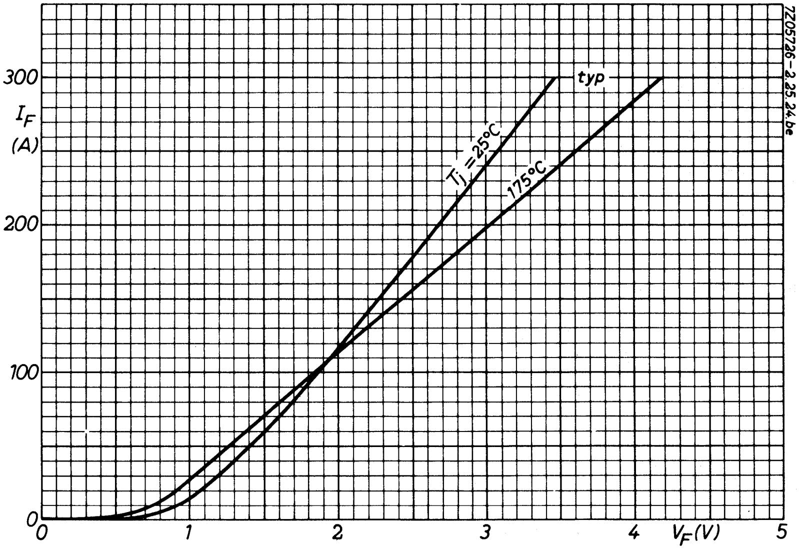

300
I_F (A)
200
100
0
0
1
2
3
4
V_F (V)
5
typ
T_j = 25°C
175°C
7Z05726-2.25.24.be

Fig.5

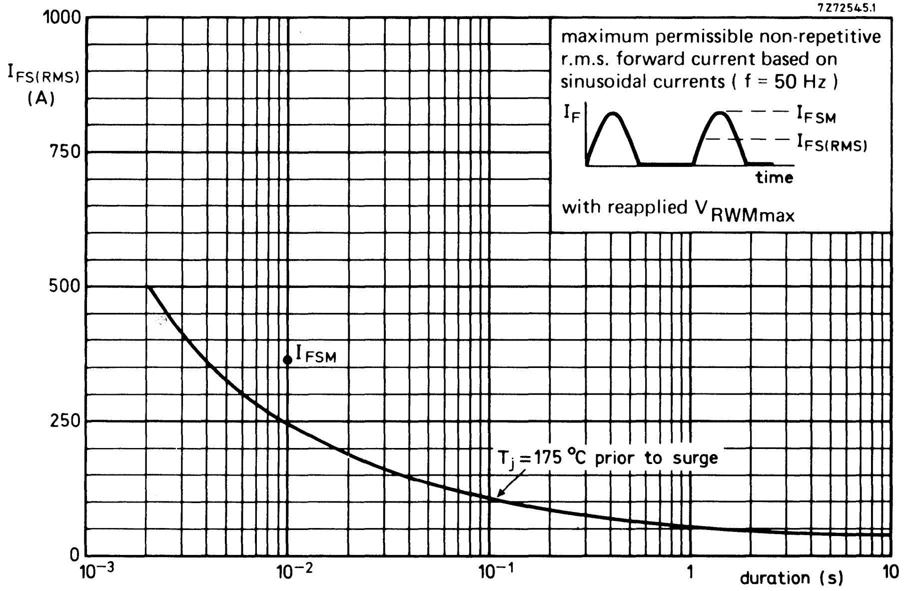

7Z72545.1
1000
$I_{FS(RMS)}$
(A)
750
500
250
0
10^{-3}
10^{-2}
10^{-1}
1
duration (s)
10
maximum permissible non-repetitive r.m.s. forward current based on sinusoidal currents (f = 50 Hz)
I_F
I_{FSM}
$I_{FS(RMS)}$
time
with reapplied V_{RWMmax}
I_{FSM}
T_j = 175 °C prior to surge

Fig.6

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): BYX32–600 to BYX32–1600
Reverse polarity (anode to stud): BYX32–600R to BYX32–1600R

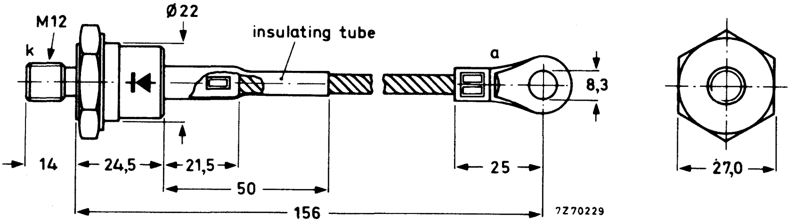
QUICK REFERENCE DATA

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

Average forward current	$I_{F(AV)}$	max.	150	A
Non-repetitive peak forward current	I_{FSM}	max.	1600	A

MECHANICAL DATA

Dimensions in mm



Normal polarity (–|◀–): blue cable. Reverse polarity (–▶|–): red cable.

Net mass: 115 g

Diameter of clearance hole: max. 13.0 mm

Torque on nut: min. 10 Nm
(100 kg cm)
max. 25 Nm
(250 kg cm)

All information applies to frequencies up to 400 Hz.

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

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

Currents

Average forward current (averaged over any 20 ms period) up to $T_{mb} = 100\ ^oC$	$I_{F(AV)}$	max.	150 A
at $T_{mb} = 125\ ^oC$	$I_{F(AV)}$	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) $T_j = 190\ ^oC$ 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 ^oC
Operating junction temperature	T_j	max.	190 ^oC

THERMAL RESISTANCE

From junction to mounting base	$R_{th\ j-mb}$	=	0.4 $^oC/W$
From mounting base to heatsink without heatsink compound	$R_{th\ mb-h}$	=	0.1 $^oC/W$
From mounting base to heatsink with heatsink compound (Dow Corning 340)	$R_{th\ mb-h}$	=	0.04 $^oC/W$
Transient thermal impedance; t = 1 ms	$Z_{th\ j-mb}$	=	0.025 $^oC/W$

---

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

SILICON RECTIFIER DIODES

Silicon rectifier diodes in DO-4 metal envelopes, intended for use in 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.

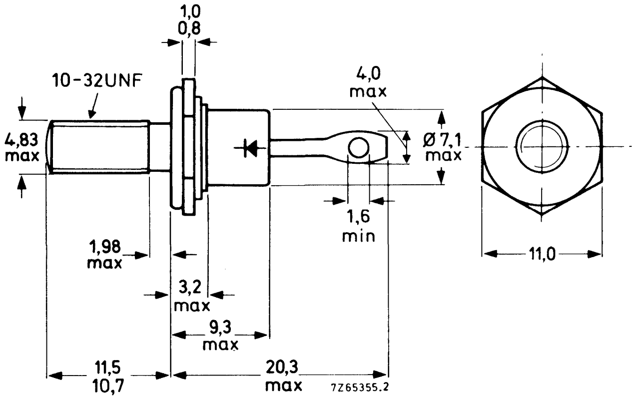
QUICK REFERENCE DATA

			BYX38-300(R)	600(R)	1200(R)	
Repetitive peak reverse voltage	V_{RRM}	max.	300	600	1200	V
Average forward current	$I_{F(AV)}$	max.		6		A
Non-repetitive peak forward current	I_{FSM}	max.		50		A

MECHANICAL DATA

Dimensions in mm

DO-4



Net mass: 6 g

Diameter of clearance hole: max. 5,2 mm

Accessories supplied on request:
see ACCESSORIES section

Torque on nut: min. 0,9 Nm
(9 kg cm)
max. 1,7 Nm
(17 kg cm)

Supplied with device: 1 nut, 1 lock washer
Nut dimensions across the flats: 9,5 mm

The mark shown applies to normal polarity types.

Products approved to CECC 50 009-019 available on request.

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

Voltages			BYX38-300(R)	600(R)	1200(R)	
Non-repetitive peak reverse voltage ($t \leq 10$ ms)	V_{RSM}	max.	300	600	1200	V
Repetitive peak reverse voltage ($\delta \leq 0,01$)	V_{RRM}	max.	300	600	1200	V
Crest working reverse voltage	V_{RWM}	max.	200	400	800	V
Continuous reverse voltage	V_R	max.	200	400	800	V

Currents

Average forward current (averaged over any 20 ms period) up to $T_{mb} = 110\ ^{o}C$	$I_{F(AV)}$	max.	6	A
at $T_{mb} = 125\ ^{o}C$	$I_{F(AV)}$	max.	4	A
R.M.S. forward current	$I_{F(RMS)}$	max.	10	A
Repetitive peak forward current	I_{FRM}	max.	50	A
Non-repetitive peak forward current ($t = 10$ ms; half sine-wave) $T_j = 150\ ^{o}C$ prior to surge; with reapplied V_{RWMmax}	I_{FSM}	max.	50	A
I^2t for fusing ($t = 10$ ms)	I^2t	max.	13	A^2s

Temperatures

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

THERMAL RESISTANCE

From junction to ambient in free air	$R_{th\ j\text{-}a}$	=	50	$^{o}C/W$
From junction to mounting base	$R_{th\ j\text{-}mb}$	=	4	$^{o}C/W$
From mounting base to heatsink with heatsink compound	$R_{th\ mb\text{-}h}$	=	0,5	$^{o}C/W$
without heatsink compound	$R_{th\ mb\text{-}h}$	=	0,6	$^{o}C/W$
Transient thermal impedance; $t = 1$ ms	$Z_{th\ j\text{-}mb}$	=	0,3	$^{o}C/W$

CHARACTERISTICS

Forward voltage

$I_F = 20\,A$; $T_j = 25\ ^oC$	V_F	$<$	1,7	V [1]

Reverse current

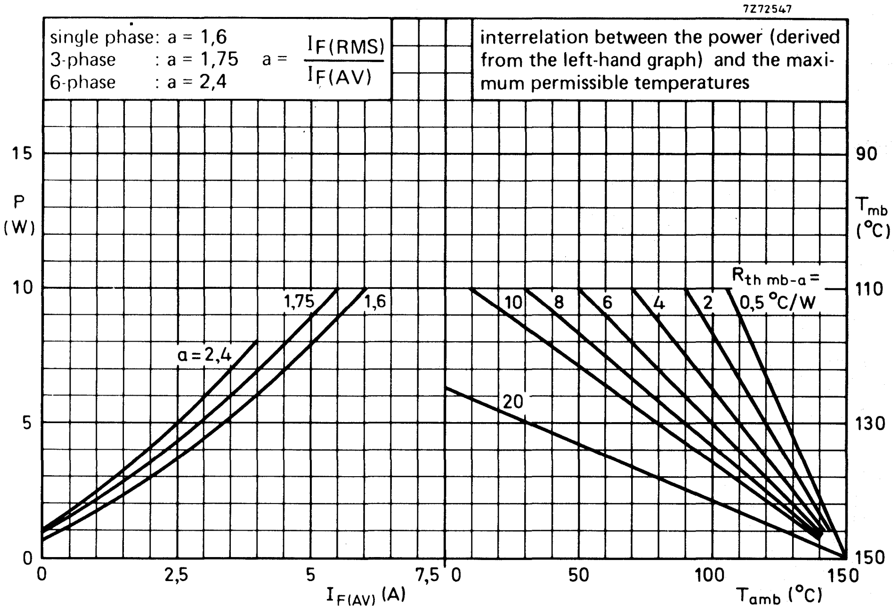
$V_R = V_{RWMmax}$; $T_j = 125\ ^oC$	I_R	$<$	200	μA

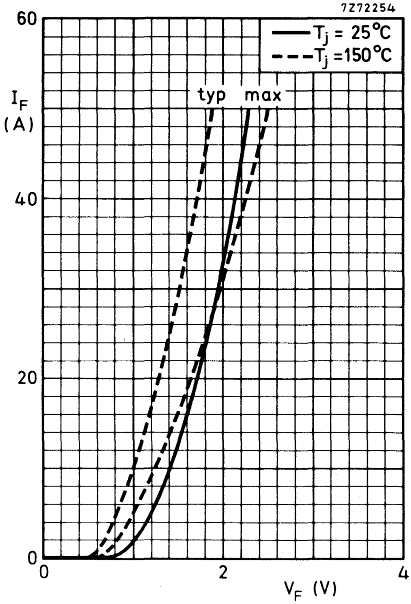
OPERATING NOTES

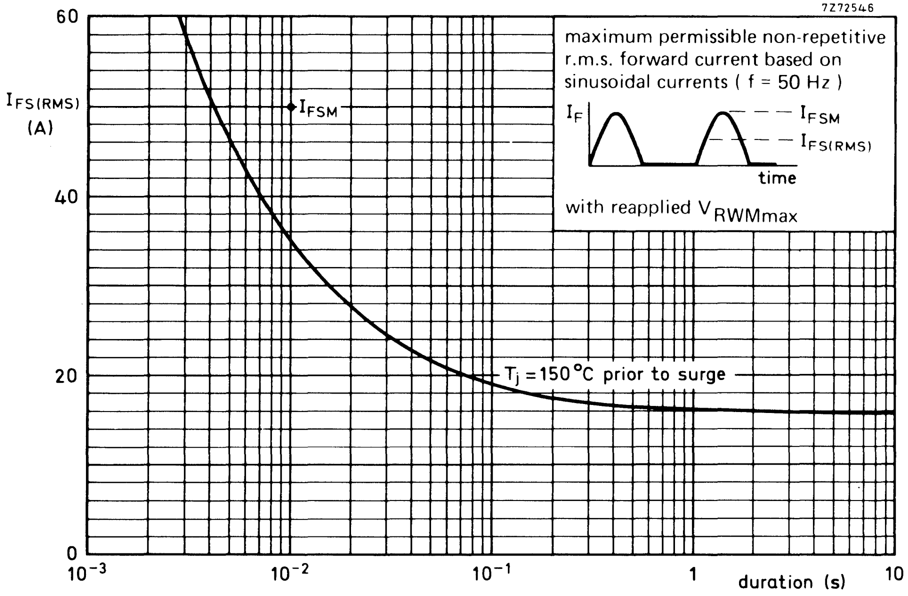
1. The top connector should neither be bent nor twisted; it should be soldered into the circuit so that there is no strain on it.
   During soldering the heat conduction to the junction should be kept to a minimum.
2. Where there is a possibility that transients, due to the energy stored in the transformer, will exceed the maximum permissible non-repetitive peak reverse voltage, see General Section for information on damping circuits.

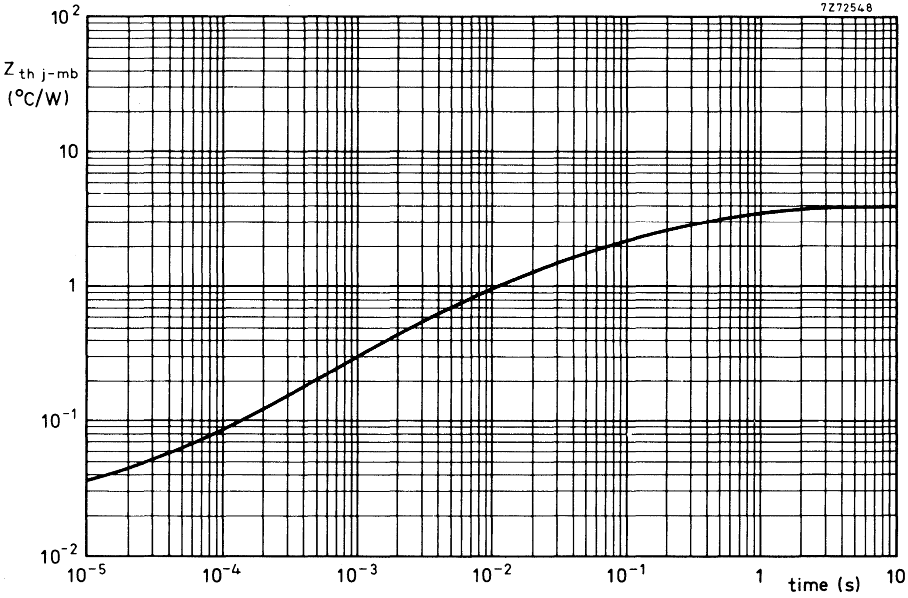
---

1) Measured under pulse conductions to avoid excessive dissipation.


7Z72547
single phase: a = 1,6
3-phase : a = 1,75
6-phase : a = 2,4
a = $\frac{I_{F(RMS)}}{I_{F(AV)}}$
interrelation between the power (derived from the left-hand graph) and the maximum permissible temperatures
P (W)
15
10
5
0
a = 2,4
1,75
1,6
0
2,5
5
7,5
$I_{F(AV)}$ (A)
0
50
100
150
T_{amb} (°C)
$R_{th\ mb-a}$ =
10
8
6
4
2
0,5 °C/W
20
T_{mb} (°C)
90
110
130
150


7Z72254
T_j = 25°C
T_j = 150°C
typ
max
I_F (A)
60
40
20
0
0
2
4
V_F (V)


7Z72546
60
40
20
0
$I_{FS(RMS)}$
(A)
I_{FSM}
maximum permissible non-repetitive r.m.s. forward current based on sinusoidal currents (f = 50 Hz)
I_F
I_{FSM}
$I_{FS(RMS)}$
time
with reapplied V_{RWMmax}
$T_j = 150\,°C$ prior to surge
10^{-3}
10^{-2}
10^{-1}
1
10
duration (s)


7Z72548
10^2
10
1
10^{-1}
10^{-2}
$Z_{th\ j\text{-}mb}$
(°C/W)
10^{-5}
10^{-4}
10^{-3}
10^{-2}
10^{-1}
1
10
time (s)

CONTROLLED AVALANCHE RECTIFIER DIODES

Also available to BS9333–F005

Silicon diodes in a DO–4 metal envelope, capable of absorbing transients and intended for use in power rectifier application.
The series consists of the following types:
Normal polarity (cathode to stud): BYX39–600 to BYX39–1400.
Reverse polarity (anode to stud): BYX39–600R to BYX39–1400R.

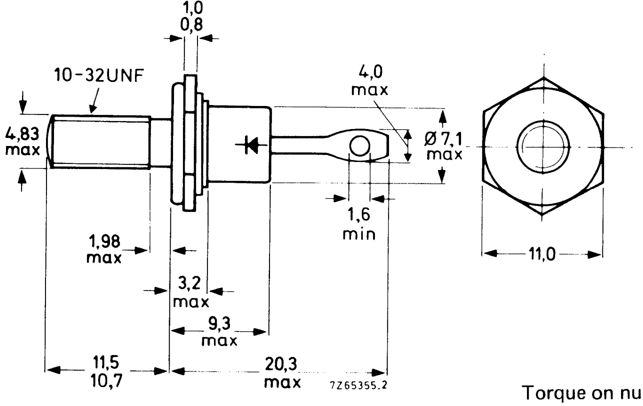
QUICK REFERENCE DATA

			BYX39–600(R)	800(R)	1000(R)	1200(R)	1400(R)	
Crest working reverse voltage	V_{RWM}	max.	600	800	1000	1200	1400	V
Reverse avalanche breakdown voltage	$V_{(BR)R}$	>	750	1000	1250	1450	1650	V
Average forward current	$I_{F(AV)}$	max.	9.5					A
Non-repetitive peak forward current	I_{FSM}	max.	125					A
Non-repetitive peak reverse power dissipation	P_{RSM}	max.	4					kW

MECHANICAL DATA

Dimensions in mm

Fig. 1 DO–4



Net mass: 6 g
Diameter of clearance hole: max. 5.2 mm
Accessories supplied on request:
see ACCESSORIES section

Supplied with device: 1 nut, 1 lock-washer.

Nut dimensions across the flats: 9.5 mm.

The mark shown applies to normal polarity types.

Torque on nut:
min. 0.9 Nm (9 kg cm),
max. 1.7 Nm (17 kg cm).

RATINGS

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

Voltages*			BYX39–600(R)	800(R)	1000(R)	1200(R)	1400(R)	
Continuous reverse voltage	V_R	max.	600	800	1000	1200	1400	V
Crest working reverse voltage	V_{RWM}	max.	600	800	1000	1200	1400	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
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 = 175 °C prior to surge; with reapplied V_{RWMmax}	I_{FSM}	max.	125	A
I^2t for fusing (t = 10 ms)	I^2t	max.	78	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

---

*To ensure thermal stability: $R_{th\ j\text{-}a} \leqslant 5$ °C/W (continuouse reverse voltage) or $\leqslant 20$ °C/W (a.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)	1200(R)	1400(R)	
Forward voltage I_F = 20 A; T_j = 25 °C	V_F	<	1.7	1.7	1.7	1.7	1.7	V*
Reverse avalanche breakdown voltage I_R = 5 mA; T_j = 25 °C	$V_{(BR)R}$	>	750	1000	1250	1450	1650	V
		<	2400	2400	2400	2400	2400	V
Reverse current $V_R = V_{RWMmax}$; T_j = 125 °C	I_R	<	200	200	200	200	200	μA

OPERATING NOTES

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.

---

*Measured under pulse conditions to avoid excessive dissipation.

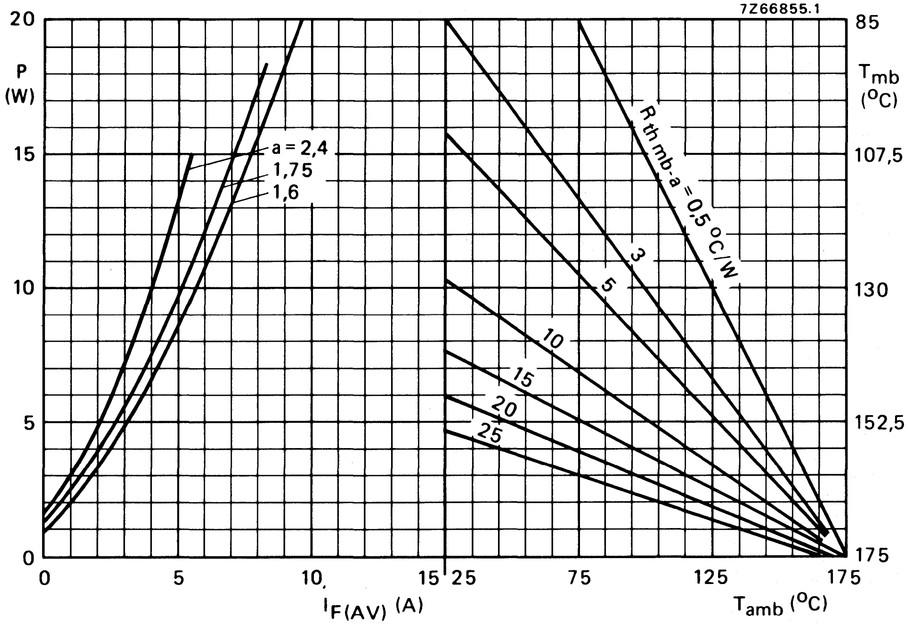


Fig.2

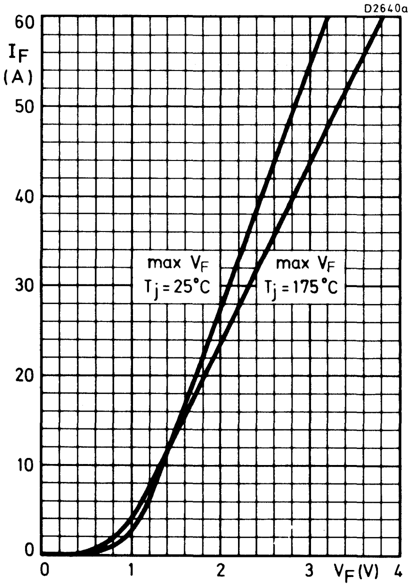


Fig.3

The right-hand part shows the interrelationship between the power (derived from the left-hand part) and the maximum permissible temperatures.

P = dissipation excluding power in the avalanche region.

single phase: a = 1.6
3-phase : a = 1.75
6-phase : a = 2.4

$a = I_{F(RMS)}/I_{F(AV)}$

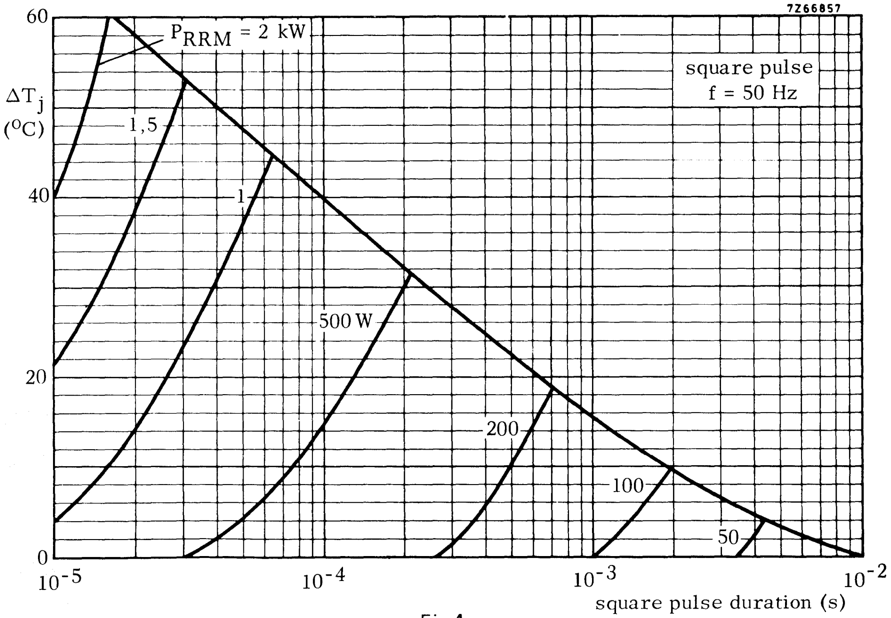

7Z66857
60
40
20
0
ΔT_j
(°C)
P_RRM = 2 kW
1,5
1
500 W
200
100
50
square pulse
f = 50 Hz
10^-5
10^-4
10^-3
10^-2
square pulse duration (s)

Fig.4

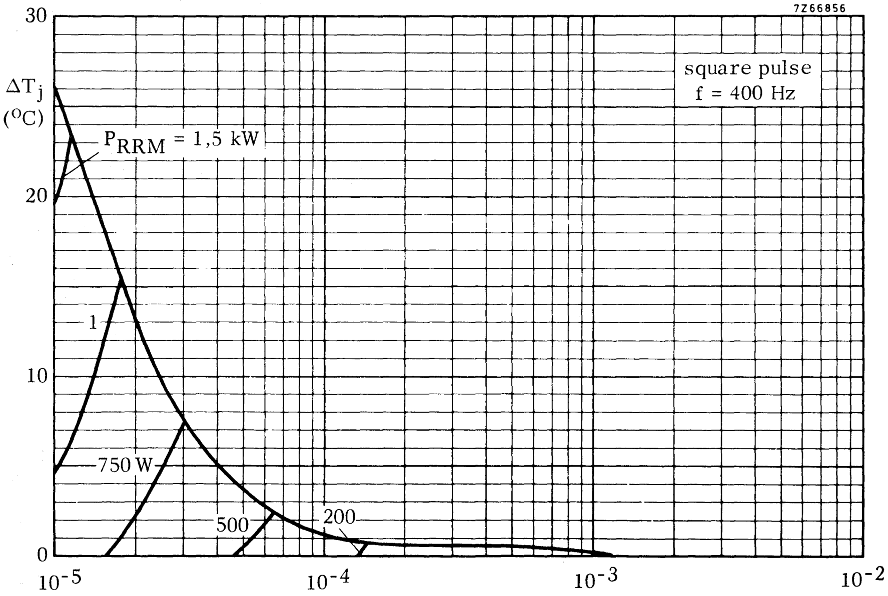

7Z66856
30
20
10
0
ΔT_j
(°C)
P_RRM = 1,5 kW
1
750 W
500
200
square pulse
f = 400 Hz
10^-5
10^-4
10^-3
10^-2
square pulse duration (s)

Fig.5

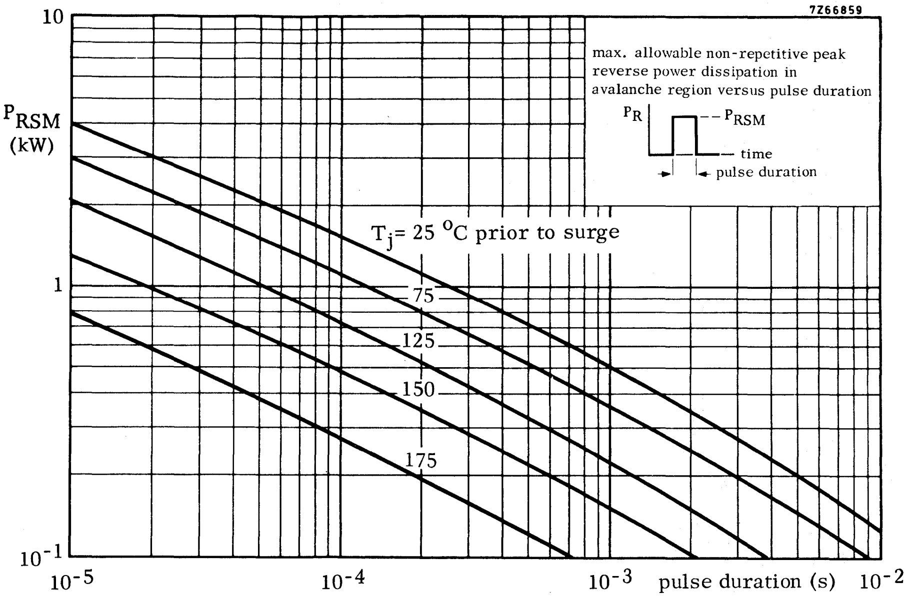

7Z66859
10
P_{RSM}
(kW)
1
10^{-1}
10^{-5}
10^{-4}
10^{-3}
pulse duration (s)
10^{-2}
max. allowable non-repetitive peak reverse power dissipation in avalanche region versus pulse duration
P_R
P_{RSM}
time
pulse duration
T_j = 25 °C prior to surge
75
125
150
175

Fig.6

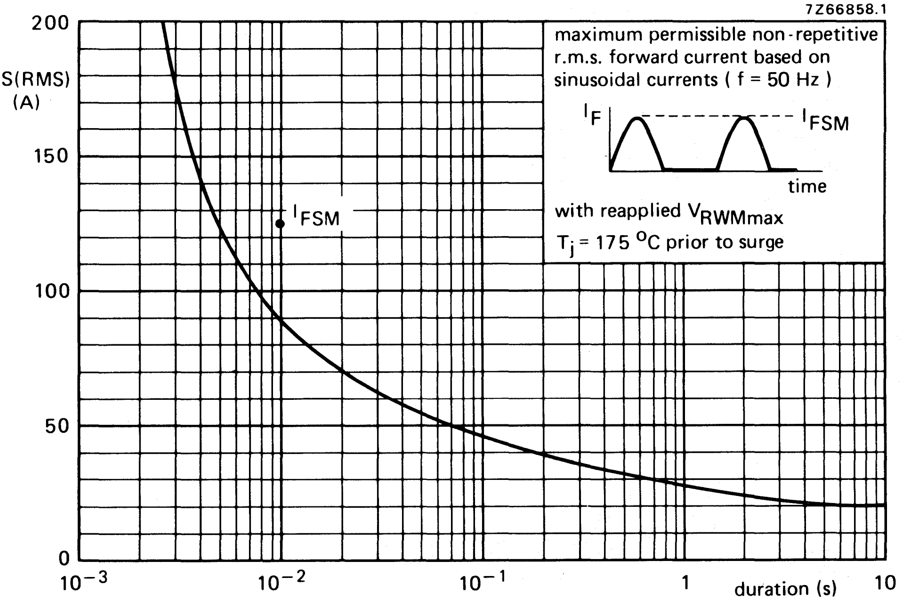

7Z66858.1
200
$I_{FS(RMS)}$
(A)
150
100
50
0
10^{-3}
10^{-2}
10^{-1}
1
duration (s)
10
I_{FSM}
maximum permissible non-repetitive r.m.s. forward current based on sinusoidal currents (f = 50 Hz)
I_F
I_{FSM}
time
with reapplied V_{RWMmax}
T_j = 175 °C prior to surge

Fig.7

SILICON RECTIFIER DIODES

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

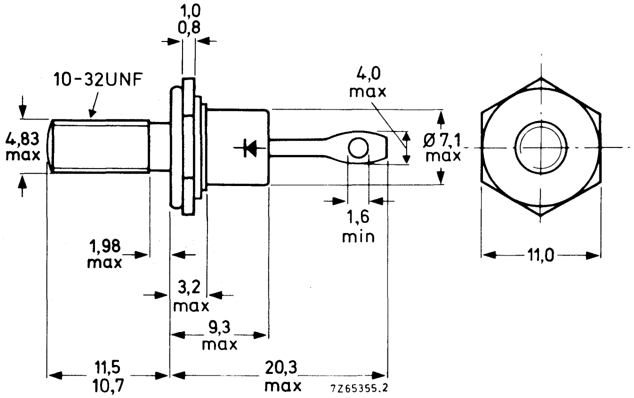
QUICK REFERENCE DATA

			BYX42-300(R)	600(R)	1200(R)	
Repetitive peak reverse voltage	V_{RRM}	max.	300	600	1200	V
Average forward current	$I_{F(AV)}$	max.	12			A
Non-repetitive peak forward current	I_{FSM}	max.	125			A

MECHANICAL DATA

Dimensions in mm

DO-4



Net mass: 6 g

Diameter of clearance hole: 5,2 mm

Accessories supplied on request:
see ACCESSORIES section

Torque on nut: min. 0,9 Nm
(9 kg cm)
max. 1,7 Nm
(17 kg cm)

Supplied with device: 1 nut, 1 lock washer
Nut dimensions accross the flats: 9,5 mm

The mark shown applies to normal polarity types.

Products approved to CECC 50 009-020 available on request.

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

Voltages			BYX42-300(R)	600(R)	1200(R)	
Non-repetitive peak reverse voltage ($t \leq 10$ ms)	V_{RSM}	max.	300	600	1200	V
Repetitive peak reverse voltage ($\delta \leq 0,01$)	V_{RRM}	max.	300	600	1200	V
Crest working reverse voltage	V_{RWM}	max.	200	400	800	V
Continuous reverse voltage	V_R	max.	200	400	800	V

Currents				
Average forward current (averaged over any 20 ms period) up to T_{mb} = 115 °C	$I_{F(AV)}$	max.	12	A
at T_{mb} = 125 °C	$I_{F(AV)}$	max.	10	A
R.M.S. forward current	$I_{F(RMS)}$	max.	20	A
Repetitive peak forward current	I_{FRM}	max.	60	A
Non-repetitive peak forward current (t = 10 ms; half sine-wave) T_j = 175 °C prior to surge; with reapplied V_{RWMmax}	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	°C/W
From mounting base to heatsink	$R_{th\ mb\text{-}h}$	=	0,5	°C/W

CHARACTERISTICS

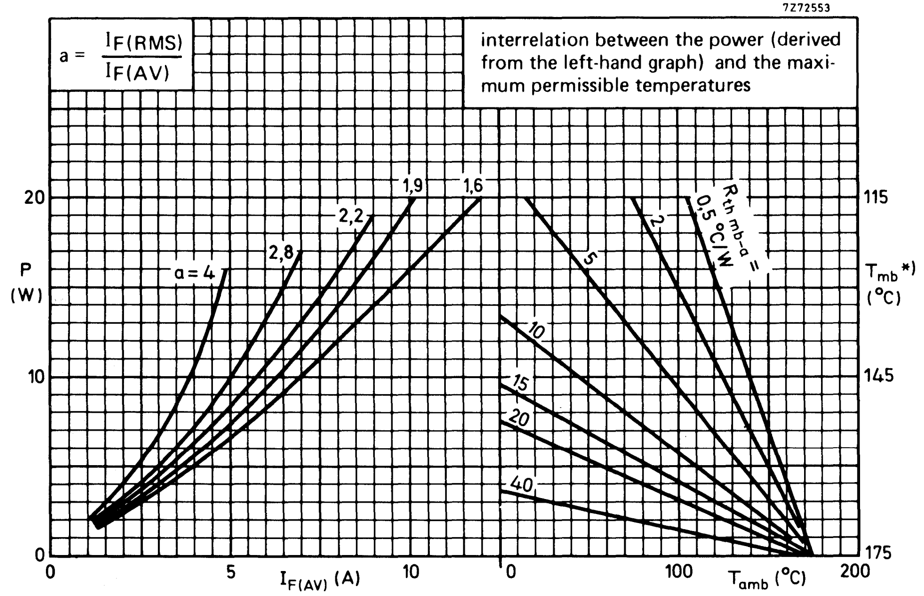
Forward voltage at I_F = 15 A; T_j = 25 °C	V_F	<	1,4	V [1]
Reverse current at $V_R = V_{RWMmax}$; T_j = 125 °C	I_R	<	200	µA

MOUNTING INSTRUCTIONS

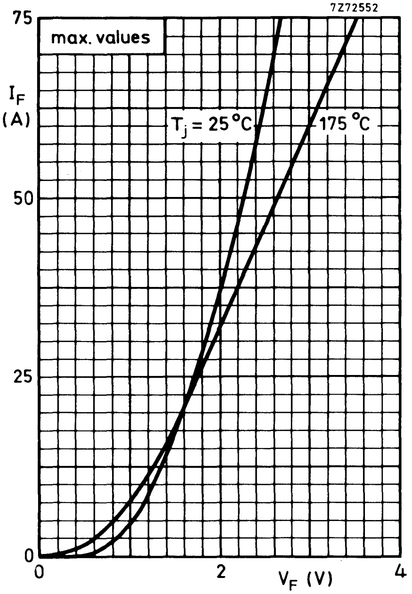
The top connector should neither be bent nor twisted; it should be soldered into the circuit so that there is no strain on it.
During soldering the heat conduction to the junction should be kept to a minimum.

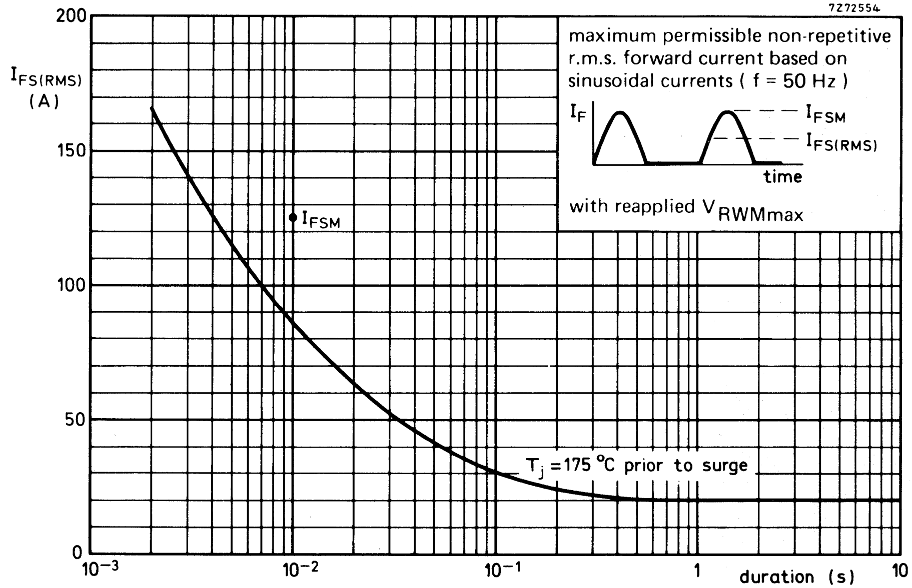
---

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



*) T_{mb}-scale is for comparison purposes only and is correct only for $R_{th\ mb-a} \leq 22$ °C/W




7Z72554
200
150
100
50
0
$I_{FS(RMS)}$
(A)
maximum permissible non-repetitive r.m.s. forward current based on sinusoidal currents (f = 50 Hz)
I_F
I_{FSM}
$I_{FS(RMS)}$
time
with reapplied V_{RWMmax}
I_{FSM}
T_j = 175 °C prior to surge
10^{-3}
10^{-2}
10^{-1}
1
duration (s)
10

RECTIFIER DIODES

Silicon rectifier diodes in DO-5 metal envelopes, intended for use in power rectifier applications.
The series consists of the following types:
Normal polarity (cathode to stud): BYX52–300, BYX52–600, BYX52–1200.
Reverse polarity (anode to stud): BYX52–300R, BYX52–600R, BYX52–1200R.

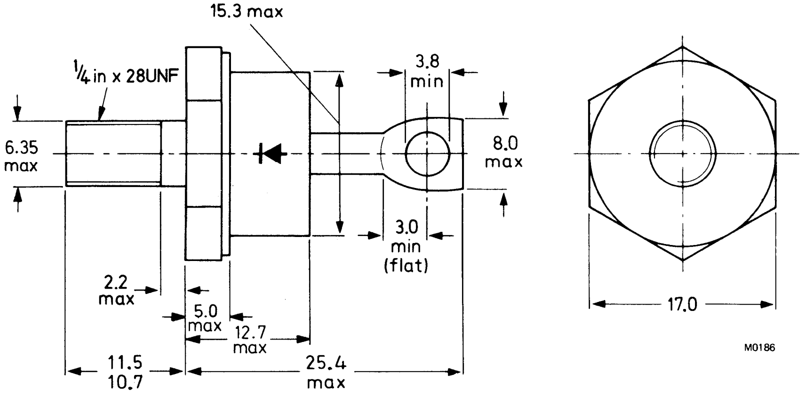
QUICK REFERENCE DATA

			BYX52–300(R)	600(R)	1200(R)	
Repetitive peak reverse voltage	V_{RRM}	max.	300	600	1200	V
Average forward current	$I_{F(AV)}$	max.	48			A
Non-repetitive peak forward current	I_{FSM}	max.	800			A

MECHANICAL DATA

Dimensions in mm

Fig.1 DO-5 Supplied with device: 1 nut, 1 lock-washer
Nut dimensions across the flats: 11.1 mm



Net mass: 22 g
Diameter of clearance hole: max. 6.5 mm
Accessories supplied on request:
see ACCESSORIES section

The mark shown applies to the normal polarity types

Torque on nut: min. 1.7 Nm
(17 kg cm)
max. 3.5 Nm
(35 kg cm)

Products approved to CECC 50 009-024 available on request.

RATINGS

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

Voltages			BYX52–300(R)	600(R)	1200(R)	
Non-repetitive peak reverse voltage ($t \leqslant 10$ ms)	V_{RSM}	max.	300	600	1200	V
Repetitive peak reverse voltage ($\delta = 0.01$)	V_{RRM}	max.	300	600	1200	V
Crest working reverse voltage	V_{RWM}	max.	200	400	800	V

Currents				
Average forward current (averaged over any 20 ms period) up to $T_{mb} = 112\ ^{o}C$	$I_{F(AV)}$	max.	48	A
at $T_{mb} = 125\ ^{o}C$	$I_{F(AV)}$	max.	40	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-sinewave) $T_j = 175\ ^{o}C$ 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	^{o}C
Junction temperature	T_j	max.	175	^{o}C

THERMAL RESISTANCE

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

CHARACTERISTICS

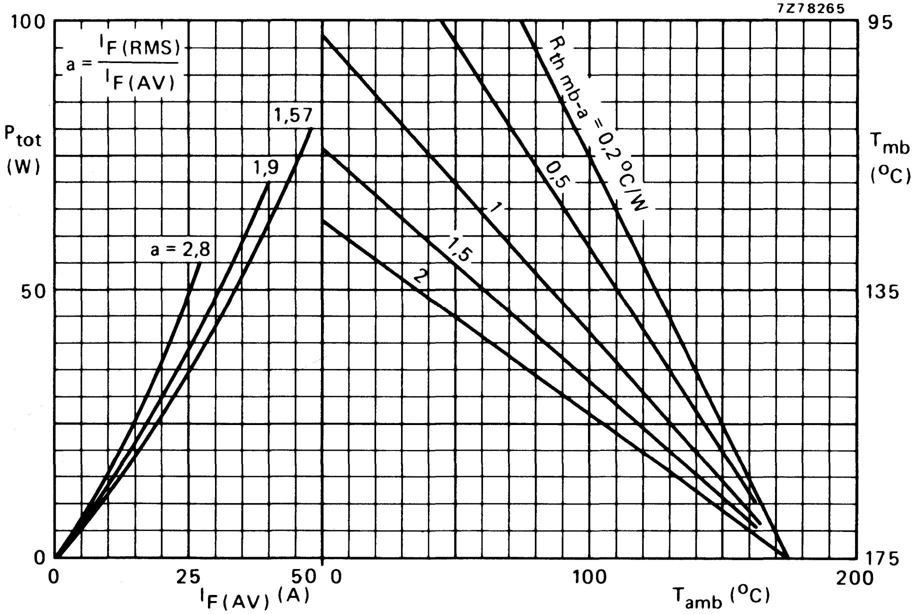
Forward voltage $I_F = 150$ A; $T_j = 25\ ^{o}C$	V_F	$<$	1.8	V*
Reverse current $V_R = V_{RWM\ max}$; $T_j = 125\ ^{o}C$	I_R	$<$	1.6	mA

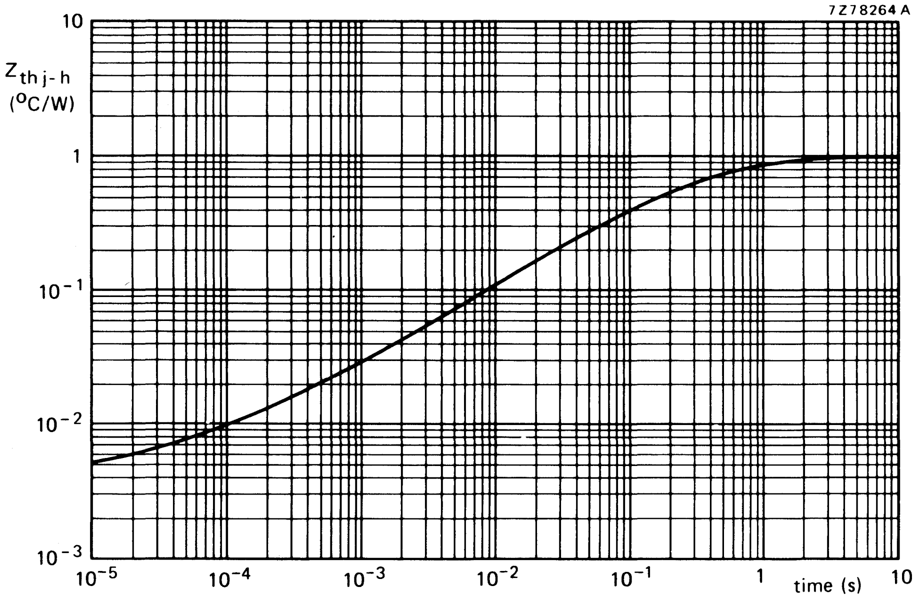
OPERATING NOTE

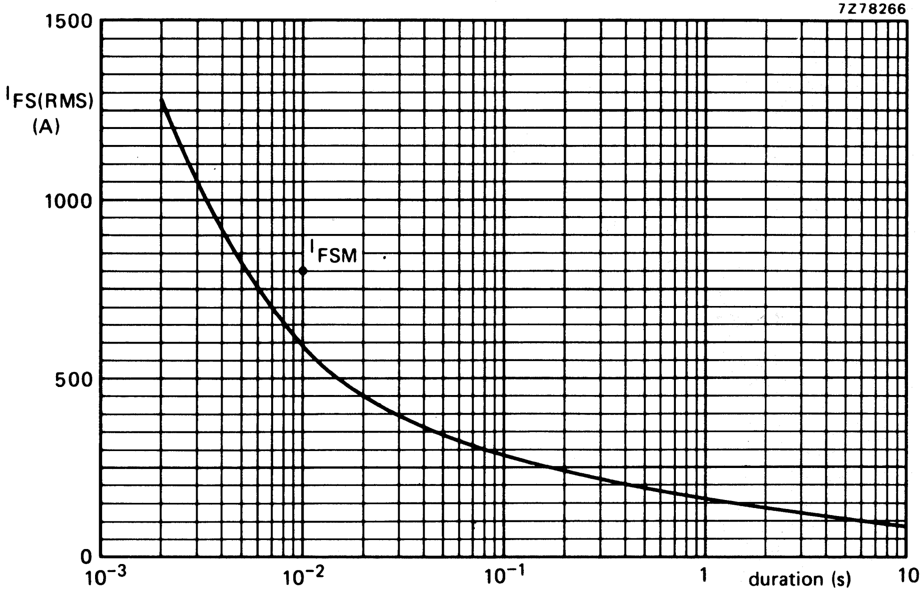
The top connector should be neither bent nor twisted; it should be soldered into the circuit so that there is no strain on it.

---

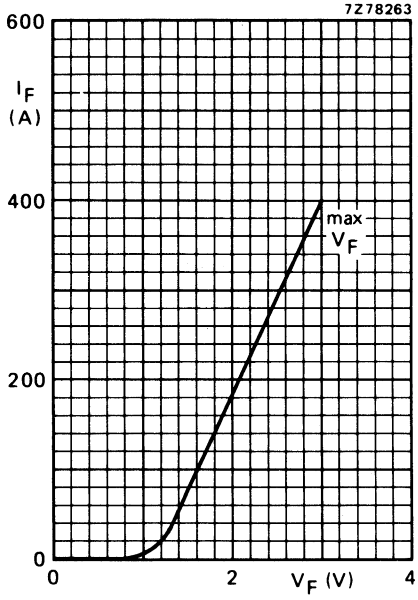
*Measured under pulse conditions to avoid excessive dissipation.

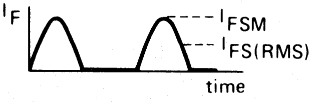

7Z78265
100
50
0
P_{tot} (W)
$a = \frac{I_{F(RMS)}}{I_{F(AV)}}$
a = 2,8
1,9
1,57
0
25
50
$I_{F(AV)}$ (A)
0
100
200
T_{amb} (°C)
$R_{th\ mb\text{-}a}$ = 0,2 °C/W
0,5
1
1,5
2
95
135
175
T_{mb} (°C)


7Z78264 A
10
1
10^{-1}
10^{-2}
10^{-3}
$Z_{th\ j\text{-}h}$ (°C/W)
10^{-5}
10^{-4}
10^{-3}
10^{-2}
10^{-1}
1
10
time (s)



Maximum permissible non-repetitive r.m.s. forward current based on sinusoidal currents (f = 50 Hz); T_j = 175 °C prior to surge; with reapplied V_{RWMmax}.





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 to BYX56—1400.
Reverse polarity (anode to stud): BYX56—600R to BYX56—1400R.

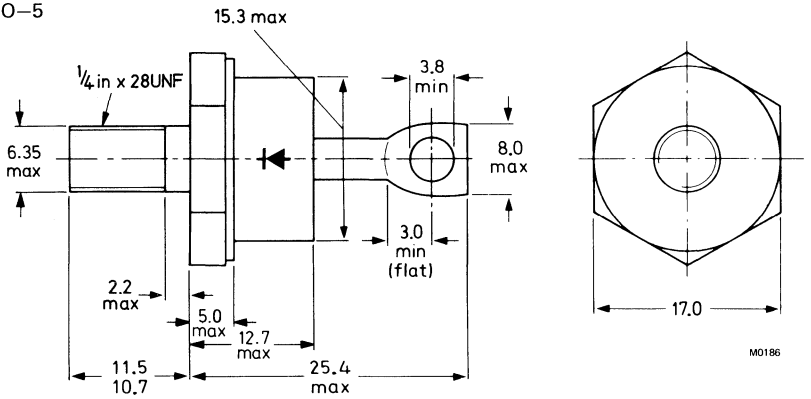
QUICK REFERENCE DATA

			BYX56—600(R)	800(R)	1000(R)	1200(R)	1400(R)	
Crest working reverse voltage	V_{RWM}	max.	600	800	1000	1200	1400	V
Reverse avalanche breakdown voltage	$V_{(BR)R}$	>	750	1000	1250	1450	1650	V
Average forward current	$I_{F(AV)}$	max.			48			A
Non-repetitive peak forward current	I_{FSM}	max.			800			A
Non-repetitive peak reverse power dissipation	P_{RSM}	max.			40			kW

MECHANICAL DATA

Dimensions in mm

Fig. 1 DO—5



Net mass: 22 g
Diameter of clearance hole: max. 6.5 mm
Accessories supplied on request:
see ACCESSORIES section

Supplied with device: 1 nut, 1 lock washer.

Nut dimensions across the flats: 11.1 mm.

Torque on nut:
min. 1.7 Nm (17 kg cm),
max. 2.5 Nm (25 kg cm).

The mark shown applies to normal polarity types.

Products approved to CECC 50 009-023 available on request.

RATINGS

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

Voltages*			BYX56–600(R)	800(R)	1000(R)	1200(R)	1400(R)	
Crest working reverse voltage	V_{RWM}	max.	600	800	1000	1200	1400	V
Continuous reverse voltage	V_R	max.	600	800	1000	1200	1400	V

Currents				
Average forward current (averaged over any 20 ms period)				
up to T_{mb} = 112 °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
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; with reapplied V_{RWMmax}	I_{FSM}	max.	800	A
I^2t for fusing ($t \leqslant 10$ 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	$R_{th\ j\text{-}mb}$	=	0.8	°C/W
From mounting base to heatsink	$R_{th\ mb\text{-}h}$	=	0.2	°C/W
Transient thermal impedance; t = 1 ms	$Z_{th\ j\text{-}h}$	=	0.03	°C/W

---

*To ensure thermal stability: $R_{th\ j\text{-}a} < 2.2$ °C/W (a.c.)

CHARACTERISTICS

			BYX56–600(R)	800(R)	1000(R)	1200(R)	1400(R)	
Forward voltage I_F = 150 A; T_j = 25 °C	V_F	<	1.8	1.8	1.8	1.8	1.8	V*
Reverse avalanche breakdown voltage I_R = 5 mA; T_j = 25 °C	$V_{(BR)R}$	>	750	1000	1250	1450	1650	V
		<	2400	2400	2400	2400	2400	V
Reverse current $V_R = V_{RWMmax}$; T_j = 125 °C	I_R	<	1.6	1.6	1.6	1.6	1.6	mA

OPERATING NOTES

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.

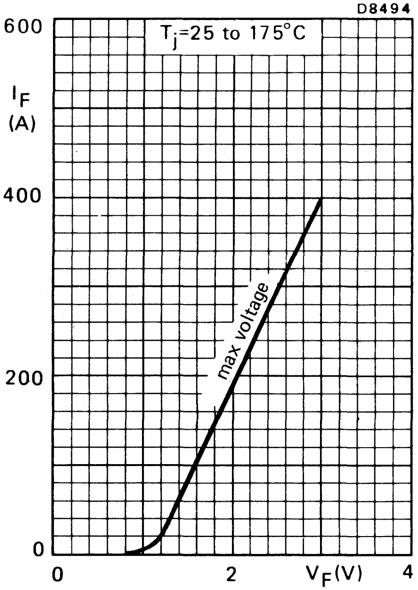


Fig.2

---

*Measured under pulsed conditions to avoid excessive dissipation.

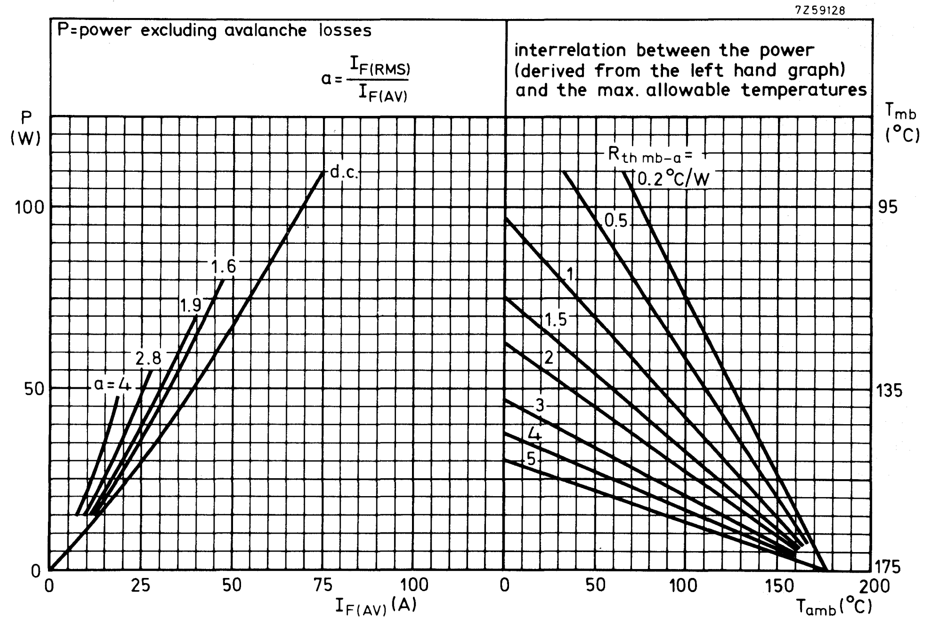

7Z59128
P=power excluding avalanche losses
$a = \frac{I_{F(RMS)}}{I_{F(AV)}}$
interrelation between the power (derived from the left hand graph) and the max. allowable temperatures
P (W)
100
50
0
0
25
50
75
100
$I_{F(AV)}$ (A)
d.c.
1.6
1.9
2.8
a=4
T_{mb} (°C)
95
135
175
$R_{th\,mb-a}$ =
0.2 °C/W
0.5
1
1.5
2
3
4
5
0
50
100
150
200
T_{amb} (°C)

Fig.3

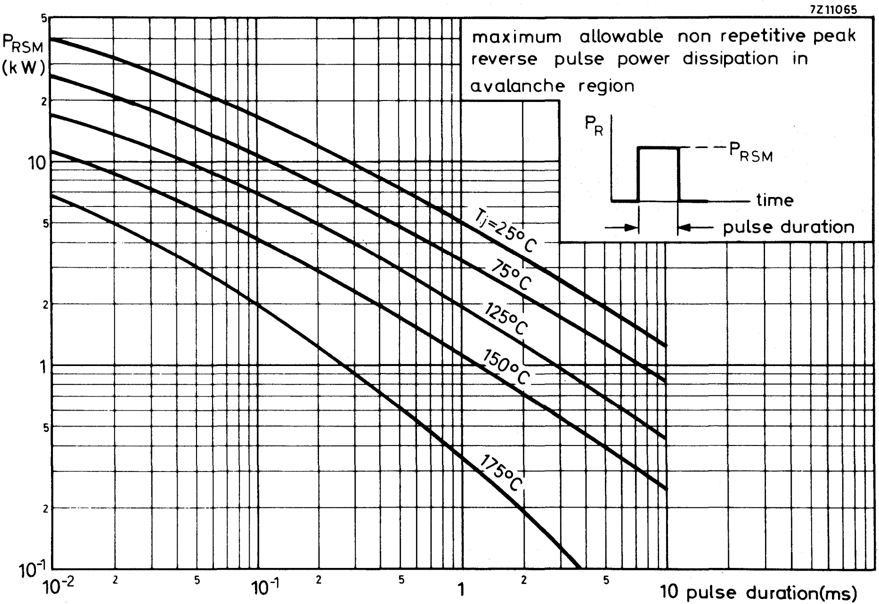

7Z11065
maximum allowable non repetitive peak reverse pulse power dissipation in avalanche region
P_{RSM} (kW)
5
2
10
5
2
1
5
2
10^{-1}
10^{-2}
2
5
10^{-1}
2
5
1
2
5
10 pulse duration(ms)
T_j=25°C
75°C
125°C
150°C
175°C
P_R
P_{RSM}
time
pulse duration

Fig.4

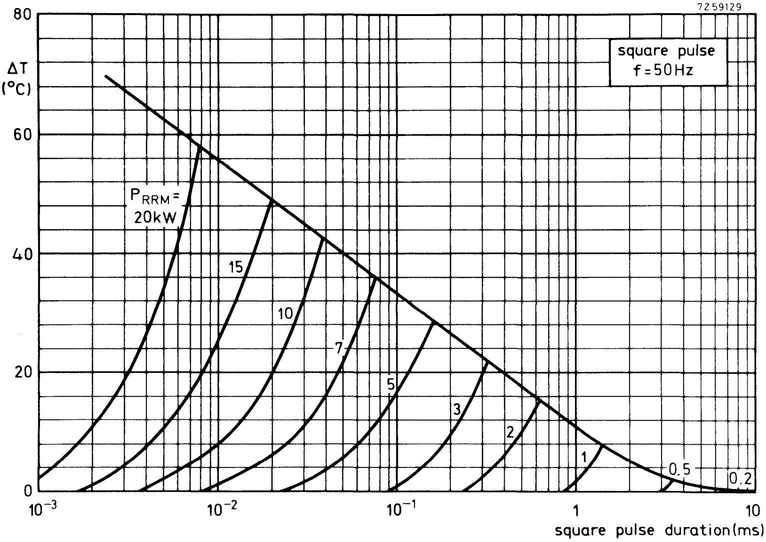


Fig.5

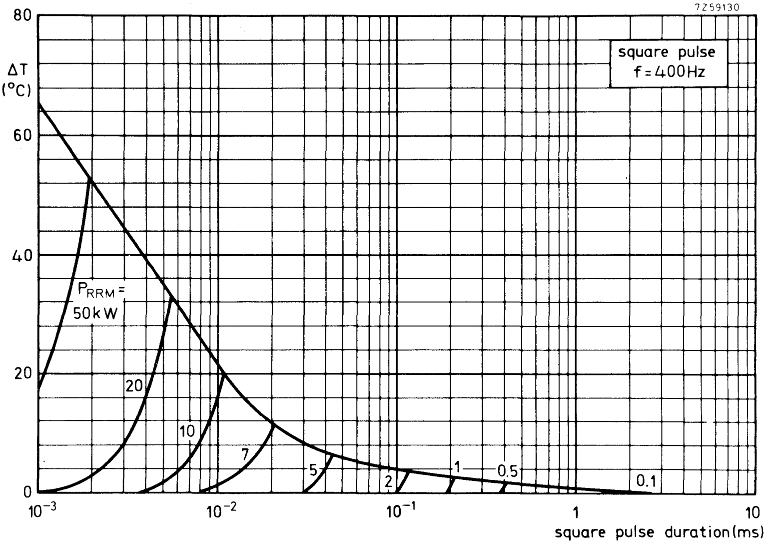


Fig.6

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

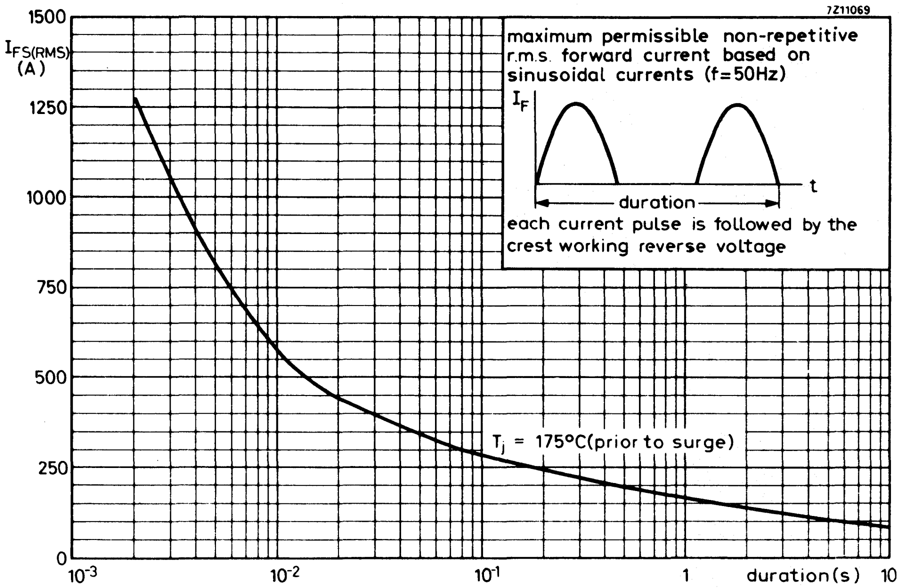

7Z11069
1500
1250
1000
750
500
250
0
$I_{FS(RMS)}$ (A)
10^{-3}
10^{-2}
10^{-1}
1
duration(s)
10
maximum permissible non-repetitive r.m.s. forward current based on sinusoidal currents (f=50Hz)
I_F
t
duration
each current pulse is followed by the crest working reverse voltage
T_j = 175°C(prior to surge)

Fig.7

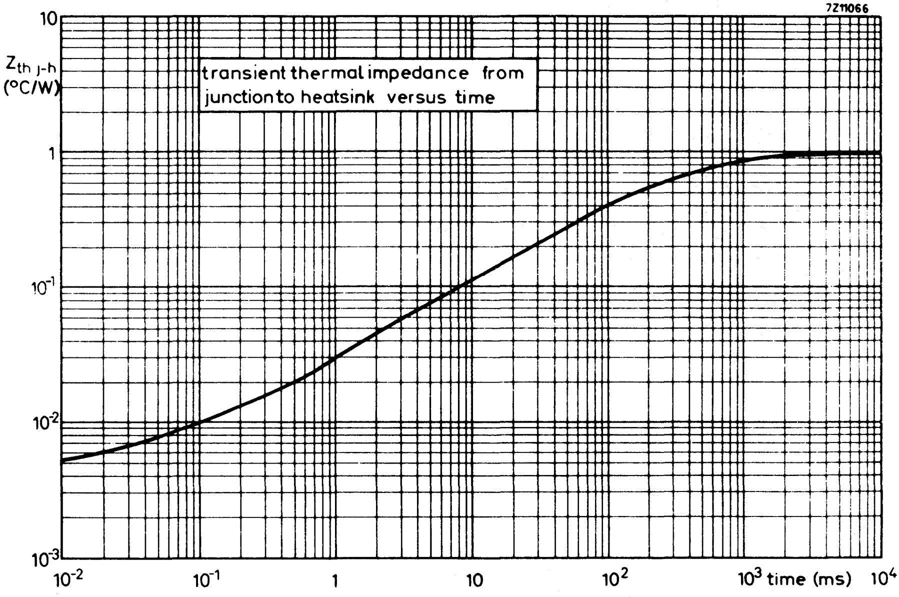

7Z11066
10
1
10^{-1}
10^{-2}
10^{-3}
$Z_{th\ j-h}$ (°C/W)
transient thermal impedance from junction to heatsink versus time
10^{-2}
10^{-1}
1
10
10^2
10^3
time (ms)
10^4

Fig.8

RECTIFIER DIODES

Also available to BS9331-F129

Silicon rectifier diodes in metal envelopes similar to DO-4, intended for use in power rectifier applications.
The series consists of the following types:
Normal polarity (cathode to stud): BYX96-300 to 1600.
Reverse polarity (anode to stud): BYX96-300R to 1600R.

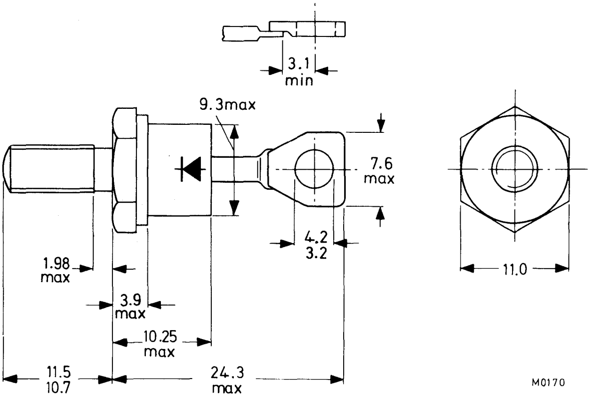
QUICK REFERENCE DATA

			BYX96-300(R)	600(R)	1200(R)	1600(R)	
Repetitive peak reverse voltage	V_{RRM}	max.	300	600	1200	1600	V
Average forward current	$I_{F(AV)}$	max.				30	A
Non-repetitive peak forward current	I_{FSM}	max.				400	A

MECHANICAL DATA

Dimensions in mm

Fig.1 DO-4: with metric M5 stud (ϕ 5 mm); e.g. BYX96-300(R).
Types with 10-32 UNF stud (ϕ 4,83 mm) are available on request. These are indicated by the suffix U; e.g. BYX96-300U(RU).



Supplied with device: 1 nut, 1 lock-washer
Nut dimensions across the flats, M5 thread: 8 mm, 10-32 UNF thread: 9.5 mm

Net mass: 7 g
Diameter of clearance hole: max. 5.2 mm
Supplied on request: see ACCESSORIES section
a version with insulated flying leads
The mark shown applies to normal polarity types.

Torque on nut: min. 0.9 Nm
(9 kg cm)
max. 1.7 Nm
(17 kg cm)

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

Voltages [1]			BYX96-300(R)	600(R)	1200(R)	1600(R)	
Non-repetitive peak reverse voltage ($t \leq 10$ ms)	V_{RSM}	max.	300	600	1200	1600	V
Repetitive peak reverse voltage ($\delta \leq 0,01$)	V_{RRM}	max.	300	600	1200	1600	V
Crest working reverse voltage	V_{RWM}	max.	200	400	800	800	V
Continuous reverse voltage	V_R	max.	200	400	800	800	V

Currents				
Average forward current (averaged over any 20 ms period) up to $T_{mb} = 125$ °C	$I_{F(AV)}$	max.	30	A
R.M.S. forward current	$I_{F(RMS)}$	max.	48	A
Repetitive peak forward current	I_{FRM}	max.	400	A
Non-repetitive peak forward current ($t = 10$ ms; half sine-wave) $T_j = 175$ °C prior to surge; with reapplied V_{RWMmax}	I_{FSM}	max.	400	A
I^2t for fusing ($t = 10$ ms)	I^2t	max.	800	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	$R_{th\ j-mb}$	=	1,0	°C/W
From mounting base to heatsink without heatsink compound	$R_{th\ mb-h}$	=	0,5	°C/W
with heatsink compound	$R_{th\ mb-h}$	=	0,3	°C/W
Transient thermal impedance; $t = 1$ ms	$Z_{th\ j-mb}$	=	0,2	°C/W

---

[1] To ensure thermal stability: $R_{th\ j-a} \leq 2$ °C/W (continuous reverse voltage) or ≤ 8 °C/W (a.c.)
For smaller heatsinks $T_{j\ max}$ should be derated. For a.c. see page 4.
For continuous reverse voltage: if $R_{th\ j-a} = 4$ °C/W, then $T_{j\ max} = 138$ °C,
if $R_{th\ j-a} = 6$ °C/W, then $T_{j\ max} = 125$ °C.

CHARACTERISTICS

Forward voltage

I_F = 100 A; T_j = 25 °C	V_F	<	1,7	V [1]

Reverse current

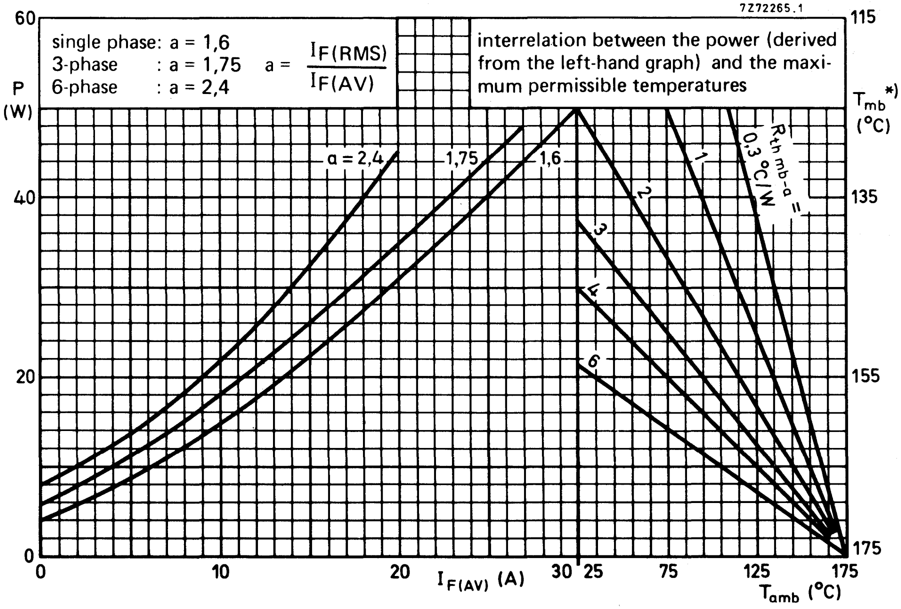
$V_R = V_{RWMmax}$; T_j = 125 °C	I_R	<	1	mA

OPERATING NOTES

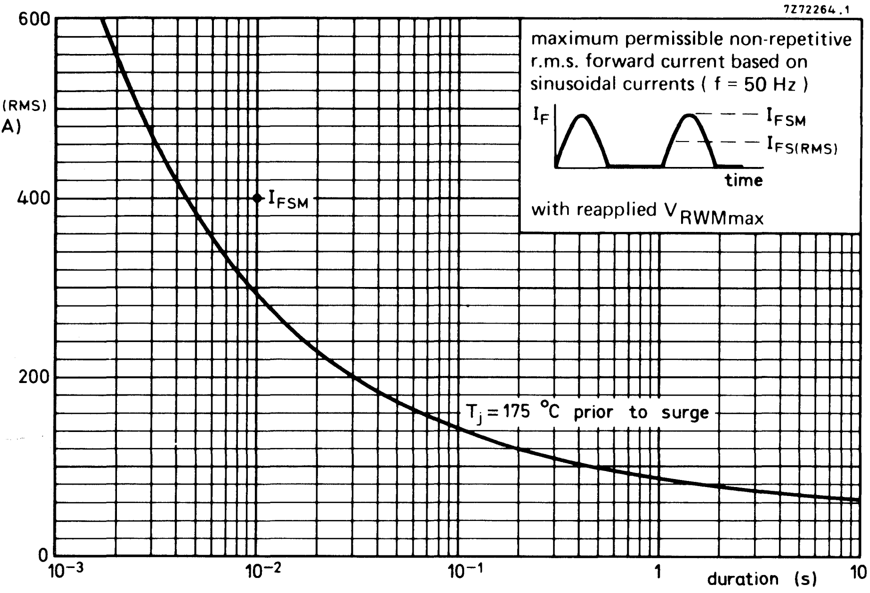
1. The top connector should neither be bent nor twisted; it should be soldered into the circuit so that there is no strain on it.
   During soldering the heat conduction to the junction should be kept to a minimum.
2. Where there is a possibility that transients, due to the energy stored in the transformer, will exceed the maximum permissible non-repetitive peak reverse voltage, see General Section for information on damping circuits.

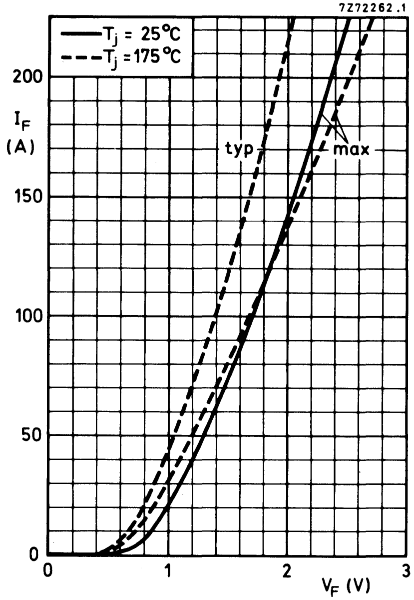
---

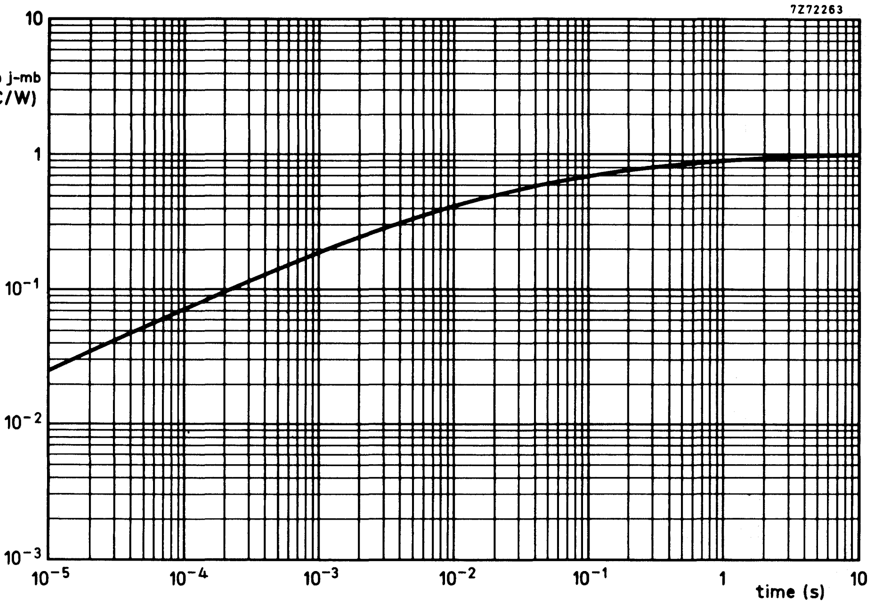
1) Measured under pulse conditions to avoid excessive dissipation.



*) T_{mb}-scale is for comparison purposes only and is correct only for $R_{th\ mb\text{-}a} \leq 6,5$ °C/W


7Z72264.1
600
400
200
0
$I_{FS(RMS)}$
(A)
maximum permissible non-repetitive r.m.s. forward current based on sinusoidal currents (f = 50 Hz)
I_F
I_{FSM}
$I_{FS(RMS)}$
time
with reapplied V_{RWMmax}
I_{FSM}
T_j = 175 °C prior to surge
10^{-3}
10^{-2}
10^{-1}
1
duration (s)
10


7Z72262.1
T_j = 25°C
T_j = 175 °C
200
150
100
50
0
I_F
(A)
typ
max
0
1
2
3
V_F (V)


7Z72263
$Z_{th\ j-mb}$
(°C/W)
10
1
10^{-1}
10^{-2}
10^{-3}
10^{-5}
10^{-4}
10^{-3}
10^{-2}
10^{-1}
1
10
time (s)

RECTIFIER DIODES

Also available to BS9331-F130

Silicon rectifier diodes in metal envelopes similar to DO-5, intended for use in power rectifier applications.
The series consists of the following types:
Normal polarity (cathode to stud): BYX97-300 to 1600.
Reverse polarity (anode to stud): BYX97-300R to 1600R.

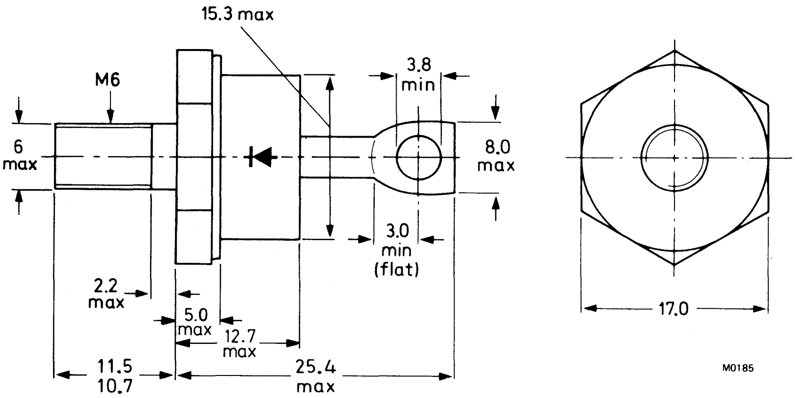
QUICK REFERENCE DATA

		BYX97-300(R)	600(R)	1200(R)	1600(R)	
Repetitive peak reverse voltage	V_{RRM}	max. 300	600	1200	1600	V
Average forward current	$I_{F(AV)}$		max.		47	A
Non-repetitive peak forward current	I_{FSM}		max.		800	A

MECHANICAL DATA

Dimensions in mm

DO-5 (except for M6 stud); Supplied with device: 1 nut, 1 lock-washer
Nut dimensions across the flats: 10 mm



Net mass: 22 g
Diameter of clearance hole: max. 6.5 mm
Supplied on request: see ACCESSORIES section
a version with insulated flying leads
The mark shown applies to normal polarity types.

Torque on nut: min. 1.7 Nm
(17 kg cm)
max. 3.5 Nm
(35 kg cm)

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

Voltages [1]			BYX97-300(R)	600(R)	1200(R)	1600(R)	
Non-repetitive peak reverse voltage ($t \leq 10$ ms)	V_{RSM}	max.	300	600	1200	1600	V
Repetitive peak reverse voltage ($\delta \leq 0,01$)	V_{RRM}	max.	300	600	1200	1600	V
Crest working reverse voltage	V_{RWM}	max.	200	400	800	800	V
Continuous reverse voltage	V_R	max.	200	400	800	800	V

Currents

Average forward current (averaged over any 20 ms period) up to T_{mb} = 120 °C	$I_{F(AV)}$	max.	47	A
at T_{mb} = 125 °C	$I_{F(AV)}$	max.	40	A
R.M.S. forward current	$I_{F(RMS)}$	max.	75	A
Repetitive peak forward current	I_{FRM}	max.	550	A
Non-repetitive peak forward current (t = 10 ms; half sine-wave) T_j = 150 °C prior to surge; with reapplied V_{RWMmax}	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 +150	°C
Junction temperature	T_j	max.	150	°C

THERMAL RESISTANCE

From junction to mounting base	$R_{th\ j\text{-}mb}$	=	0,6	°C/W
From mounting base to heatsink without heatsink compound	$R_{th\ mb\text{-}h}$	=	0,3	°C/W
with heatsink compound	$R_{th\ mb\text{-}h}$	=	0,2	°C/W
Transient thermal impedance; t = 1 ms	$Z_{th\ j\text{-}mb}$	=	0,1	°C/W

---

[1] To ensure thermal stability: $R_{th\ j\text{-}a} \leq 1$ °C/W (continuous reverse voltage) or ≤ 4 °C/W (a.c.)
For smaller heatsinks $T_{j\ max}$ should be derated. For a.c. see page 90.
For continuous reverse voltage: if $R_{th\ j\text{-}a}$ = 2 °C/W, then $T_{j\ max}$ = 138 °C,
if $R_{th\ j\text{-}a}$ = 3 °C/W, then $T_{j\ max}$ = 125 °C.

CHARACTERISTICS

Forward voltage

I_F = 150 A; T_j = 25 °C	V_F	<	1,45	V [1]

Reverse current

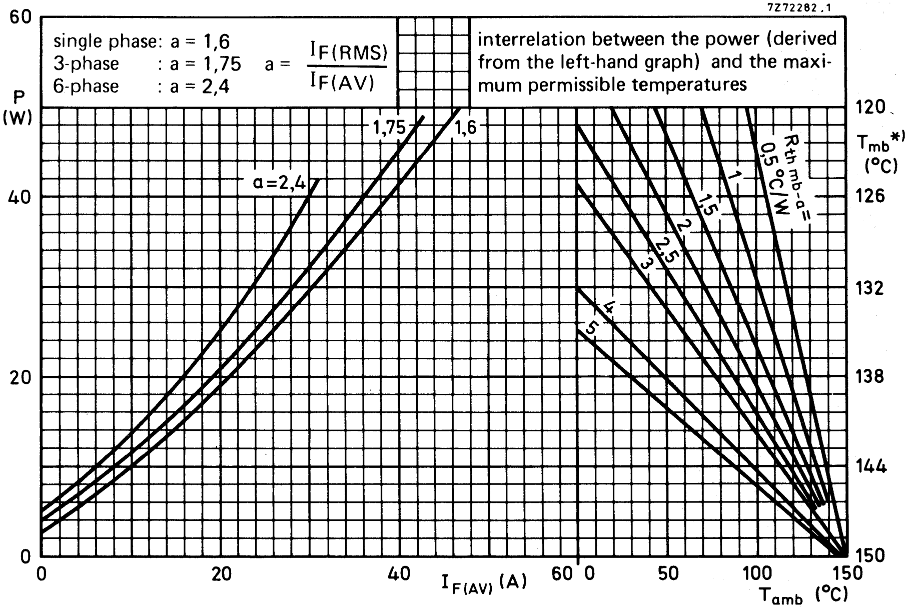
$V_R = V_{RWMmax}$; T_j = 125 °C	I_R	<	4	mA

OPERATING NOTES

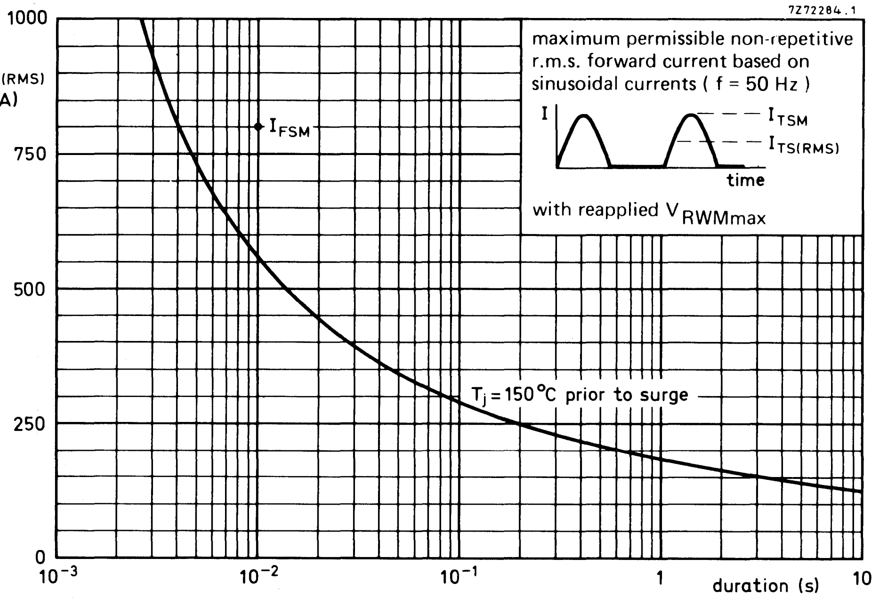
1. The top connector should neither be bent nor twisted; it should be soldered into the circuit so that there is no strain on it.
   During soldering the heat conduction to the junction should be kept to a minimum.
2. Where there is a possibility that transients, due to the energy stored in the transformer, will exceed the maximum permissible non-repetitive peak reverse voltage, see General Section for information on damping circuits.

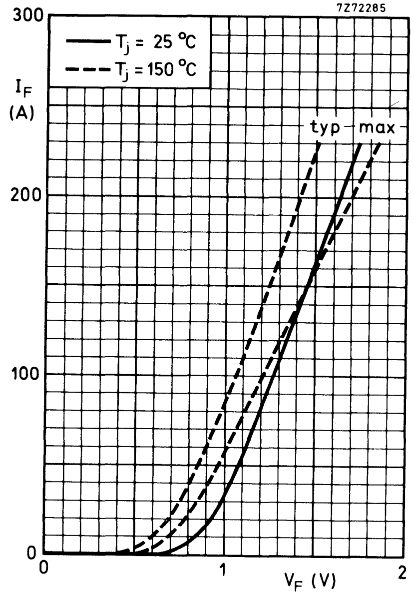
---

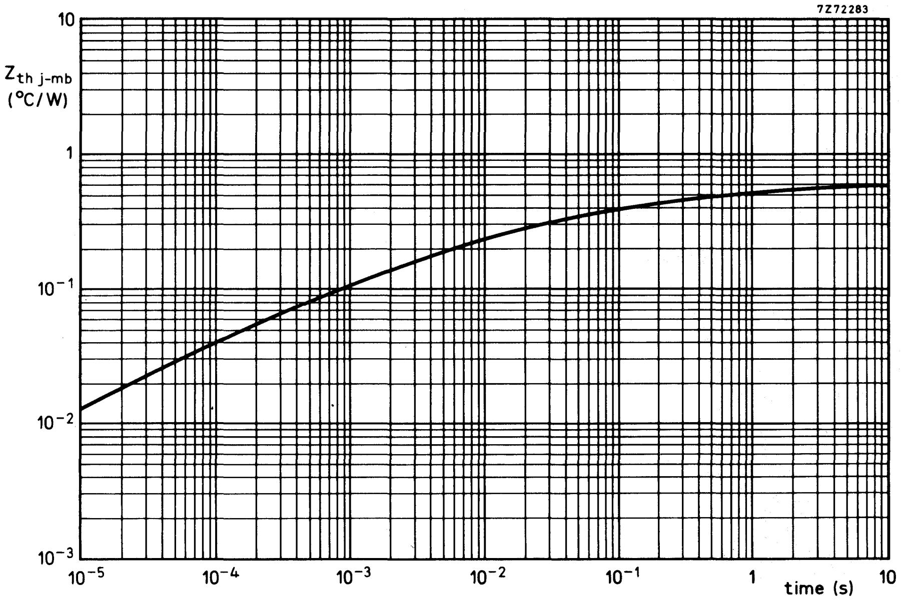
[1] Measured under pulse conditions to avoid excessive dissipation.



*) T_{mb}-scale is for comparison purposes only and is correct only for $R_{th\ mb-a} \leq 3,4\,^{\circ}C/W$


7Z72284.1
1000
$I_{FS(RMS)}$
(A)
750
500
250
0
10^{-3}
10^{-2}
10^{-1}
1
10
duration (s)
I_{FSM}
maximum permissible non-repetitive r.m.s. forward current based on sinusoidal currents (f = 50 Hz)
I
I_{TSM}
$I_{TS(RMS)}$
time
with reapplied V_{RWMmax}
$T_j = 150\,°C$ prior to surge


7Z72285
300
200
100
0
I_F
(A)
$T_j = 25\,°C$
$T_j = 150\,°C$
typ
max
0
1
2
V_F (V)


7Z72283
$Z_{th\ j\text{-}mb}$ (°C/W)
10
1
10^{-1}
10^{-2}
10^{-3}
10^{-5}
10^{-4}
10^{-3}
10^{-2}
10^{-1}
1
10
time (s)

RECTIFIER DIODES

Silicon rectifier diodes in DO-4 metal envelopes, intended for use in power rectifier applications.
The series consists of the following types:
Normal polarity (cathode to stud): BYX98-300 to 1200.
Reverse polarity (anode to stud): BYX98-300R to 1200R.

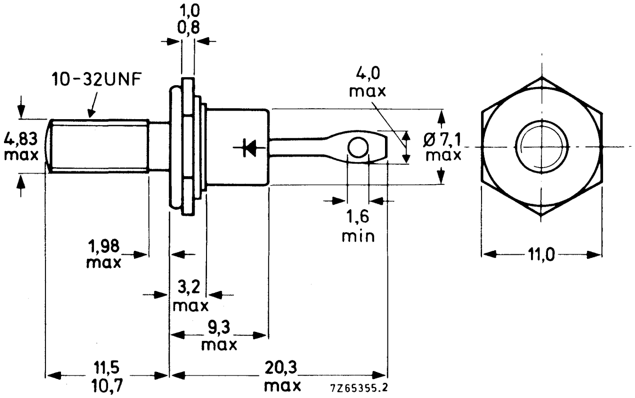
QUICK REFERENCE DATA

			BYX98-300(R)	600(R)	1200(R)	
Repetitive peak reverse voltage	V_{RRM}	max.	300	600	1200	V
Average forward current	$I_{F(AV)}$			max.	10	A
Non-repetitive peak forward current	I_{FSM}			max.	75	A

MECHANICAL DATA

Dimensions in mm

DO-4: Supplied with device: 1 nut, 1 lock-washer
Nut dimensions across the flats: 9.5 mm



Net mass: 6 g
Diameter of clearance hole: max. 5.2 mm
Accessories supplied on request:
see ACCESSORIES section
The mark shown applies to normal polarity types.

Torque on nut: min. 0.9 Nm
(9 kg cm)
max. 1.7 Nm
(17 kg cm)

Products approved to CECC 50 009-004, available on request

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

Voltages

			BYX98-300(R)	600(R)	1200(R)	
Non-repetitive peak reverse voltage ($t \leq 10$ ms)	V_{RSM}	max.	300	600	1200	V
Repetitive peak reverse voltage ($\delta \leq 0,01$)	V_{RRM}	max.	300	600	1200	V
Crest working reverse voltage	V_{RWM}	max.	200	400	800	V
Continuous reverse voltage	V_R	max.	200	400	800	V

Currents

Average forward current (averaged over any 20 ms period) up to T_{mb} = 97 °C	$I_{F(AV)}$	max.	10	A
at T_{mb} = 125 °C	$I_{F(AV)}$	max.	6	A
R.M.S. forward current	$I_{F(RMS)}$	max.	16	A
Repetitive peak forward current	I_{FRM}	max.	75	A
Non-repetitive peak forward current ($t = 10$ ms; half sine-wave) T_j = 150 °C prior to surge; with reapplied V_{RWMmax}	I_{FSM}	max.	75	A
I^2t for fusing ($t = 10$ ms)	I^2t	max.	28	A^2s

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	$R_{th\ j\text{-}mb}$	=	3	°C/W
From mounting base to heatsink with heatsink compound	$R_{th\ mb\text{-}h}$	=	0,5	°C/W
without heatsink compound	$R_{th\ mb\text{-}h}$	=	0,6	°C/W
Transient thermal impedance; $t = 1$ ms	$Z_{th\ j\text{-}mb}$	=	0,3	°C/W

CHARACTERISTICS

Forward voltage

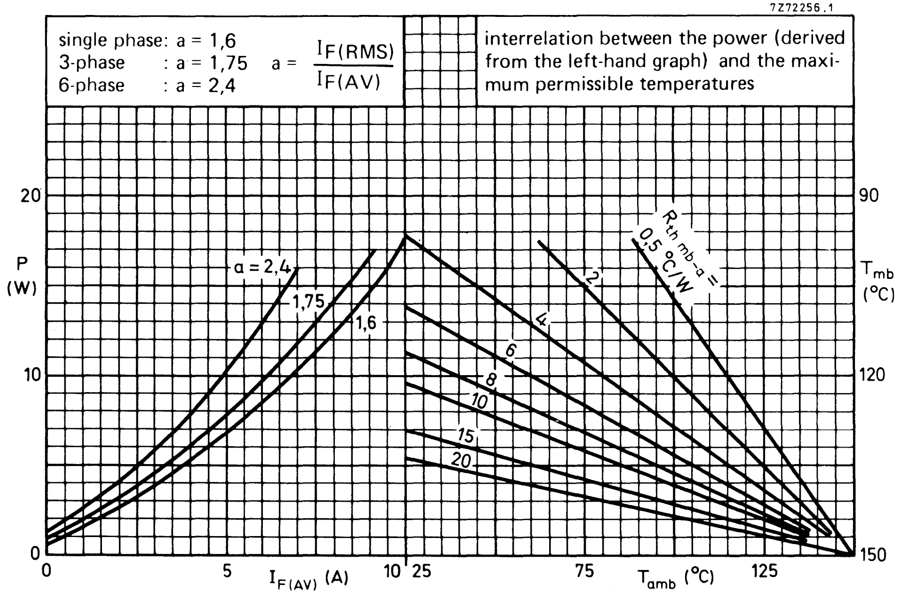
$I_F = 20$ A; $T_j = 25$ °C	V_F	$<$	1,7	V [1]

Reverse current

$V_R = V_{RWMmax}$; $T_j = 125$ °C	I_R	$<$	200	μA

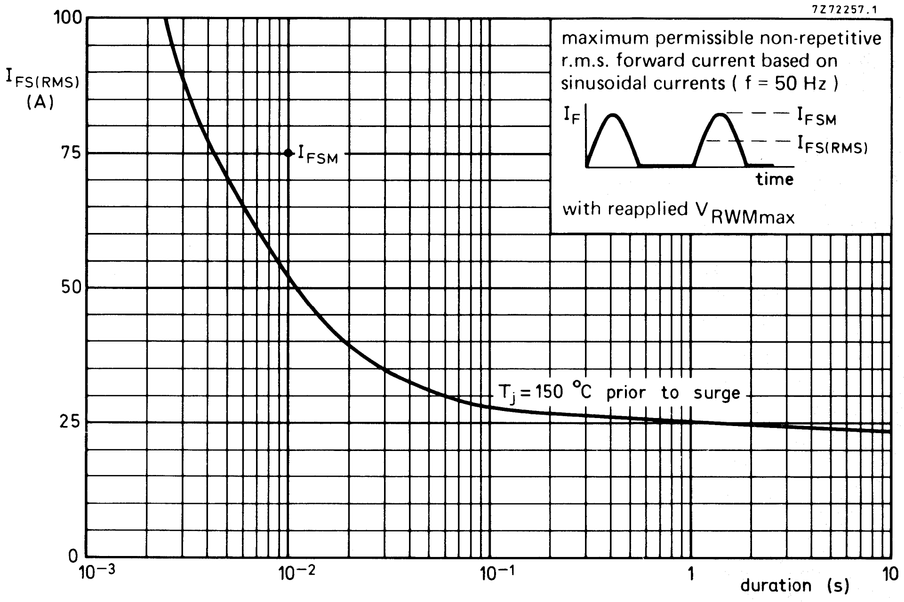
OPERATING NOTES

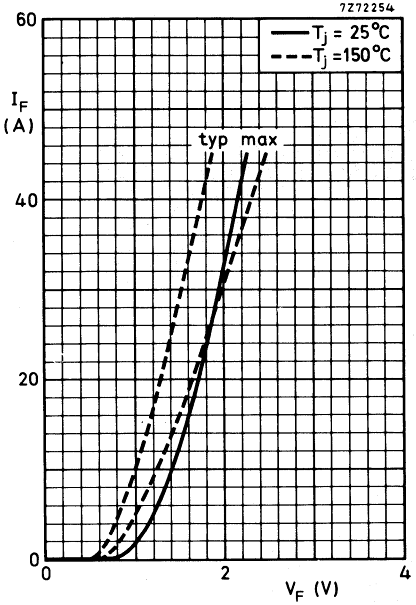
1. The top connector should neither be bent nor twisted; it should be soldered into the circuit so that there is no strain on it.
   During soldering the heat conduction to the junction should be kept to a minimum.
2. Where there is a possibility that transients, due to the energy stored in the transformer, will exceed the maximum permissible non-repetitive peak reverse voltage, see General Section for information on damping circuits.

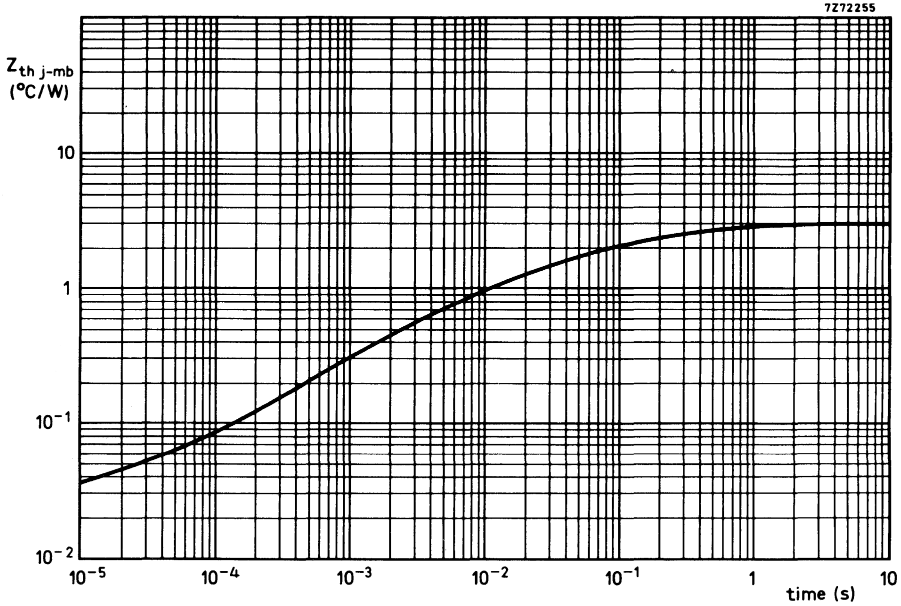


---

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


7Z72257.1
100
75
50
25
0
$I_{FS(RMS)}$ (A)
I_{FSM}
maximum permissible non-repetitive r.m.s. forward current based on sinusoidal currents (f = 50 Hz)
I_F
I_{FSM}
$I_{FS(RMS)}$
time
with reapplied V_{RWMmax}
$T_j = 150$ °C prior to surge
10^{-3}
10^{-2}
10^{-1}
1
10
duration (s)


7Z72254
60
40
20
0
I_F (A)
T_j = 25°C
T_j =150°C
typ
max
0
2
4
V_F (V)


7Z72255
$Z_{th\ j\text{-}mb}$
(°C/W)
10
1
10^{-1}
10^{-2}
10^{-5}
10^{-4}
10^{-3}
10^{-2}
10^{-1}
1
10
time (s)

RECTIFIER DIODES

Silicon rectifier diodes in DO-4 metal envelopes, intended for use in power rectifier applications.
The series consists of the following types:
Normal polarity (cathode to stud): BYX99-300 to 1200.
Reverse polarity (anode to stud): BYX99-300R to 1200R.

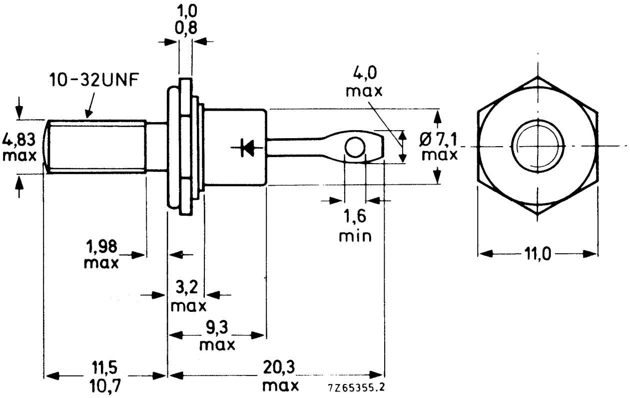
QUICK REFERENCE DATA

			BYX99-300(R)	600(R)	1200(R)	
Repetitive peak reverse voltage	V_{RRM}	max.	300	600	1200	V
Average forward current	$I_{F(AV)}$	max.			15	A
Non-repetitive peak forward current	I_{FSM}	max.			180	A

MECHANICAL DATA

Dimensions in mm

DO-4: Supplied with device: 1 nut, 1 lock-washer
Nut dimensions across the flats: 9.5 mm



Net mass: 6 g
Diameter of clearance hole: 5.2 mm
Accessories supplied on request:
see ACCESSORIES section
The mark shown applies to normal polarity types.

Torque on nut: min. 0.9 Nm
(9 kg cm)
max. 1.7 Nm
(17 kg cm)

Products approved to CECC 50 009-005, available on request

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

Voltages			BYX99-300(R)	600(R)	1200(R)	
Non-repetitive peak reverse voltage ($t \leq 10$ ms)	V_{RSM}	max.	300	600	1200	V
Repetitive peak reverse voltage ($\delta \leq 0,01$)	V_{RRM}	max.	300	600	1200	V
Crest working reverse voltage	V_{RWM}	max.	200	400	800	V
Continuous reverse voltage	V_R	max.	200	400	800	V

Currents				
Average forward current (averaged over any 20 ms period) up to $T_{mb} = 129$ °C	$I_{F(AV)}$	max.	15	A
R.M.S. forward current	$I_{F(RMS)}$	max.	24	A
Repetitive peak forward current	I_{FRM}	max.	180	A
Non-repetitive peak forward current ($t = 10$ ms; half sine-wave) $T_j = 175$ °C prior to surge; with reapplied V_{RWMmax}	I_{FSM}	max.	180	A
I^2t for fusing ($t = 10$ ms)	I^2t	max.	162	A^2s

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	$R_{th\ j\text{-}mb}$	=	2,3	°C/W
From mounting base to heatsink with heatsink compound	$R_{th\ mb\text{-}h}$	=	0,5	°C/W
without heatsink compound	$R_{th\ mb\text{-}h}$	=	0,6	°C/W
Transient thermal impedance; $t = 1$ ms	$Z_{th\ j\text{-}mb}$	=	0,13	°C/W

CHARACTERISTICS

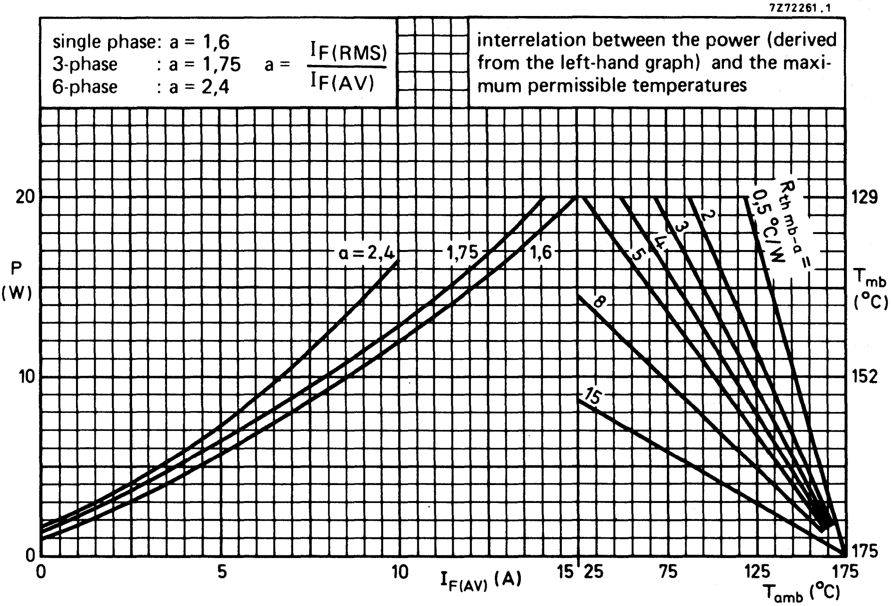
Forward voltage				
$I_F = 50$ A; $T_j = 25$ °C	V_F	<	1,55	V [1]
Reverse current				
$V_R = V_{RWMmax}$; $T_j = 125$ °C	I_R	<	200	μA

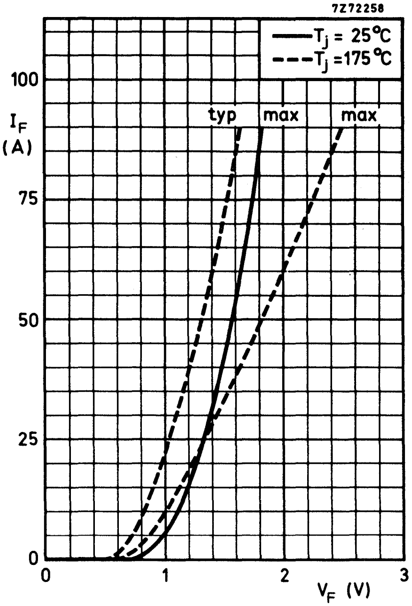
OPERATING NOTES

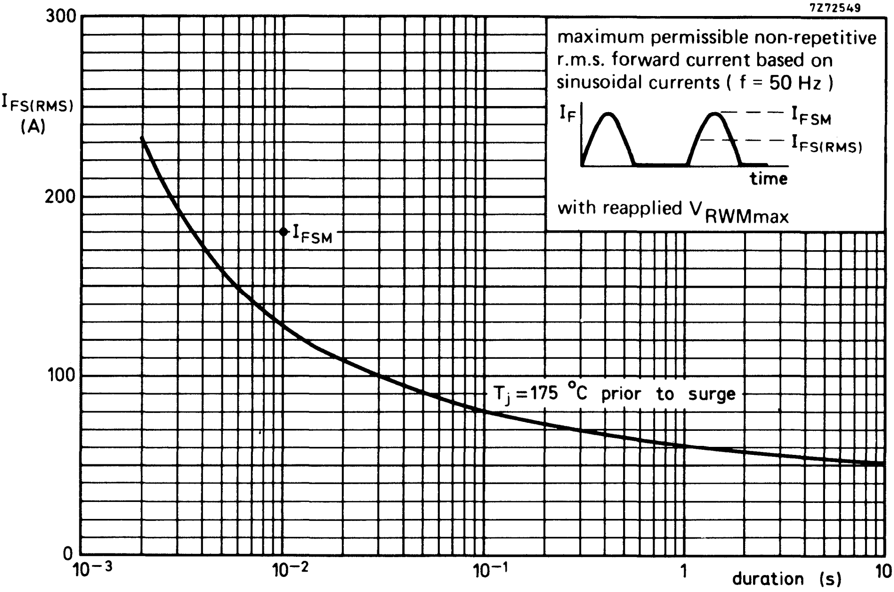
1. The top connector should neither be bent nor twisted; it should be soldered into the circuit so that there is no strain on it.
   During soldering the heat conduction to the junction should be kept to a minimum.
2. Where there is a possibility that transients; due to the energy stored in the transformer, will exceed the maximum permissible non-repetitive peak reverse voltage, see General Section for information on damping circuits.

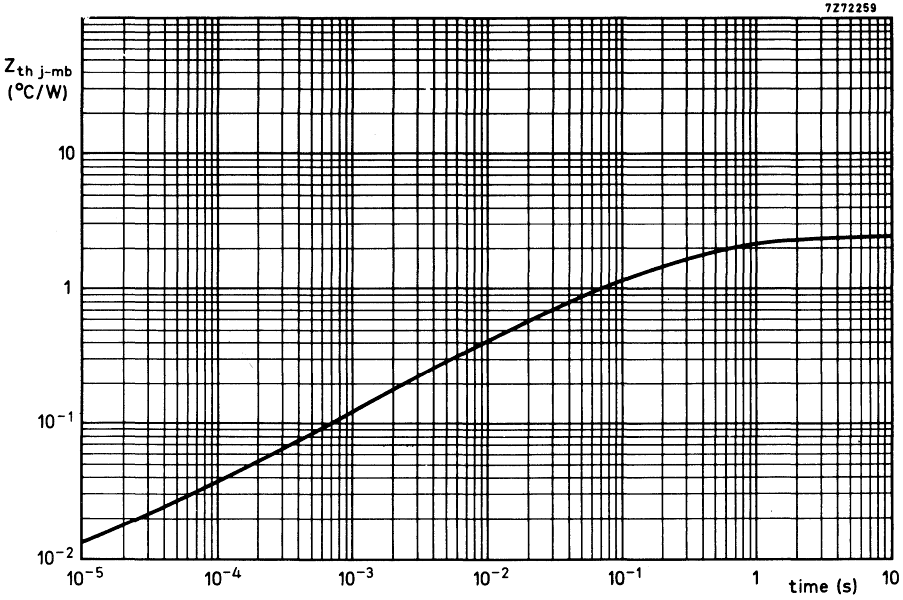
---

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


7Z72261.1
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 maximum permissible temperatures
P (W)
20
10
0
a = 2,4
1,75
1,6
0
5
10
15
IF(AV) (A)
25
75
125
175
Tamb (°C)
Rth mb-a = 0,5 °C/W
2
3
4
5
8
15
129
152
175
Tmb (°C)


7Z72258
Tj = 25°C
Tj = 175 °C
IF (A)
100
75
50
25
0
typ
max
max
0
1
2
3
VF (V)


7Z72549
300
200
100
0
$I_{FS(RMS)}$
(A)
10^{-3}
10^{-2}
10^{-1}
1
10
duration (s)
maximum permissible non-repetitive r.m.s. forward current based on sinusoidal currents (f = 50 Hz)
I_F
I_{FSM}
$I_{FS(RMS)}$
time
with reapplied V_{RWMmax}
I_{FSM}
T_j = 175 °C prior to surge


7Z72259
$Z_{th\ j\text{-}mb}$
(°C/W)
10
1
10^{-1}
10^{-2}
10^{-5}
10^{-4}
10^{-3}
10^{-2}
10^{-1}
1
10
time (s)

RECTIFIER BRIDGES

SILICON BRIDGE RECTIFIERS

Ready-for-use mains full-wave bridges, each consisting of four double-diffused silicon diodes, in a plastic encapsulation. The bridges are intended for use in equipment supplied from mains with r.m.s. voltages up to 280 V and are capable of delivering up to 1000 W into capacitive loads. They may be used in free air or clipped to a heatsink.

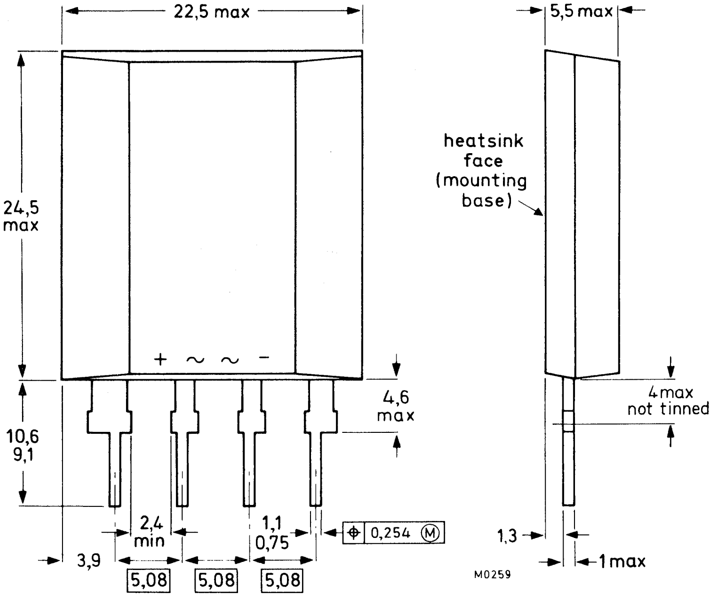
QUICK REFERENCE DATA

Input			BY224–400	600	V
R.M.S. voltage	$V_{I(RMS)}$	max.	220	280	V
Repetitive peak voltage	V_{IRM}	max.	400	600	V
Non-repetitive peak current	I_{ISM}	max.	100		A
Peak inrush current	I_{IIM}	max.	200		A
Output					
Average current	$I_{O(AV)}$	max.	4,8		A

MECHANICAL DATA (see also Fig. 1a)

Dimensions in mm

Fig. 1 SOT-112.



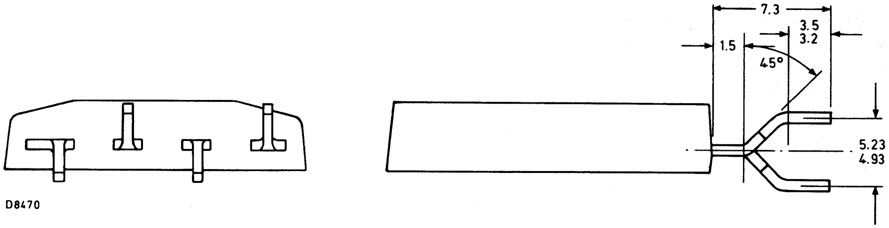
Net mass: 6,8 g

Accessories supplied on request: 56379 (clip); see Accessories and Mounting Instructions.

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

MECHANICAL DATA (continued)

Fig. 1a



A 600V version with cranked pins (as shown in figure 1a) is available as type OF432.

RATINGS

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

Input			BY224–400	600	
Non-repetitive peak voltage ($t \leqslant 10$ ms)	V_{ISM}	max.	400	600	V
Repetitive peak voltage	V_{IRM}	max.	400	600	V
Crest working voltage	V_{IWM}	max.	350	400	V
R.M.S. voltage (sine-wave)	$V_{I(RMS)}$	max.	220	280	V
Non-repetitive peak current half sine-wave; t = 20 ms; with reapplied V_{IWMmax}					
T_j = 25 °C prior to surge	I_{ISM}	max.		100	A
T_j = 150 °C prior to surge	I_{ISM}	max.		85	A
Peak inrush current (see Fig. 6)	I_{IIM}	max.		200	A
Output					
Average current (averaged over any 20 ms period; see Figs 2 and 3) heatsink operation up to T_{mb} = 90 °C	$I_{O(AV)}$	max.		4,8	A
free-air operation at T_{amb} = 45 °C; (mounting method 1a)	$I_{O(AV)}$	max.		2,5	A
Repetitive peak current	I_{ORM}	max.		50	A
Temperatures					
Storage temperature	T_{stg}			−40 to +150	°C
Junction temperature	T_j	max.		150	°C

THERMAL RESISTANCE

From junction to mounting base	$R_{th\ j\text{-}mb}$	=	4,0 °C/W

Influence of mounting method

1. Free-air operation

The quoted values of $R_{th\ j\text{-}a}$ should be used only when no loads of other dissipating components run to the same tie-point (see Fig. 3).

Thermal resistance from junction to ambient in free air

a. Mounted on a printed-circuit board with 4 cm^2 of copper laminate to + and – leads	$R_{th\ j\text{-}a}$	=	19,5 °C/W
b. Mounted on a printed-circuit board with minimal copper laminate	$R_{th\ j\text{-}a}$	=	25 °C/W

2. Heatsink mounted with clip (see mounting instructions)

Thermal resistance from mounting base to heatsink

a. With zinc-oxide heatsink compound	$R_{th\ mb\text{-}h}$	=	1,0 °C/W
b. Without heatsink compound	$R_{th\ mb\text{-}h}$	=	2,0 °C/W

MOUNTING INSTRUCTIONS

1. Soldered joints must be at least 4 mm from the seal.
2. The maximum permissible temperature of the soldering iron or bath is 270 °C; contact with the joint must not exceed 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.
4. Leads should not be bent less than 4 mm from the seal. Exert no axial pull when bending.
5. Recommended force of clip on device is 120 N (12 kgf).
6. The heatsink should be in contact with the entire mounting base of the device and heatsink compound should be used.

CHARACTERISTICS

Forward voltage (2 diodes in series) $I_F = 10$ A; $T_j = 25$ °C	V_F	<	2,3 V*
Reverse current (2 diodes in parallel) $V_R = V_{IWMmax}$; $T_j = 25$ °C	I_R	<	200 μA

---

* Measured under pulse conditions to avoid excessive dissipation.

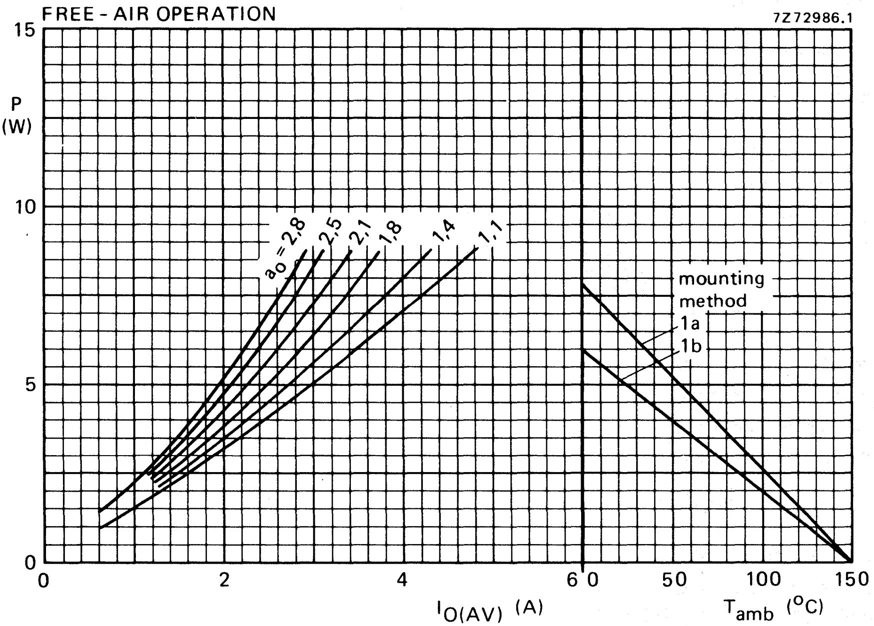


Fig. 2 The right-hand part shows the interrelationship between the power (derived from the left-hand graph) and the maximum permissible ambient temperature.

Output form factor $a_o = I_{O(RMS)}/I_{O(AV)} = 0,707 \times I_{F(RMS)}/I_{F(AV)}$ per diode.

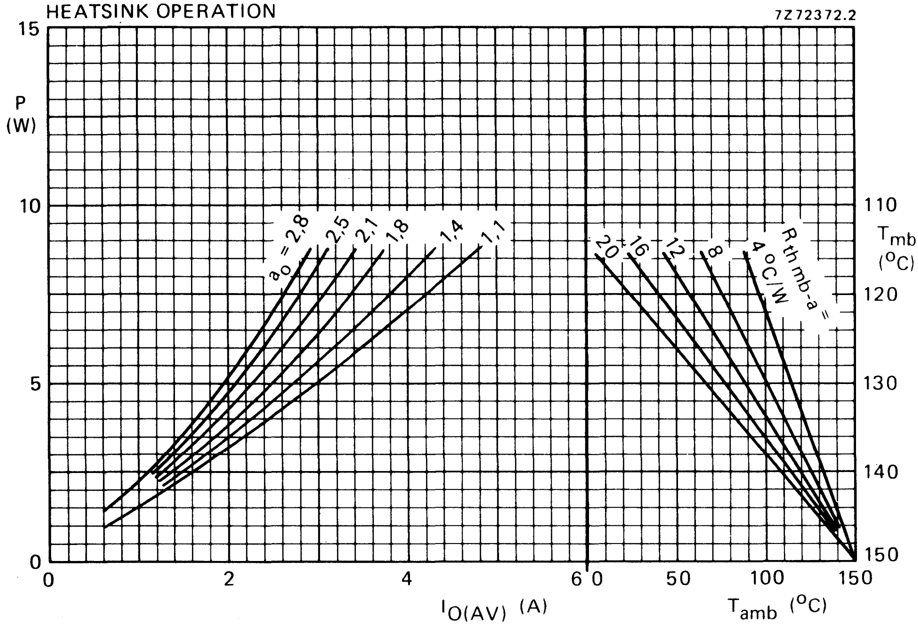


Fig. 3 The right-hand part shows the interrelationship between the power (derived from the left-hand graph) and the maximum permissible temperatures.

Output form factor $a_o = I_{O(RMS)}/I_{O(AV)} = 0{,}707 \times I_{F(RMS)}/I_{F(AV)}$ per diode.

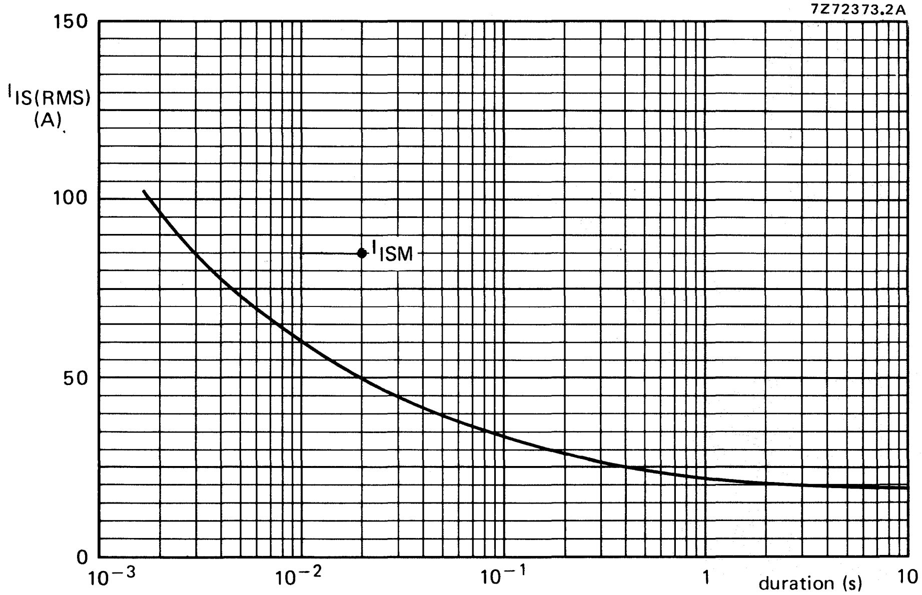
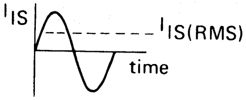


Fig.4 Maximum permissible non-repetitive r.m.s. input current based on sinusoidal currents (f = 50 Hz); T_j = 150 °C prior to surge; with reapplied V_{IWMmax}.



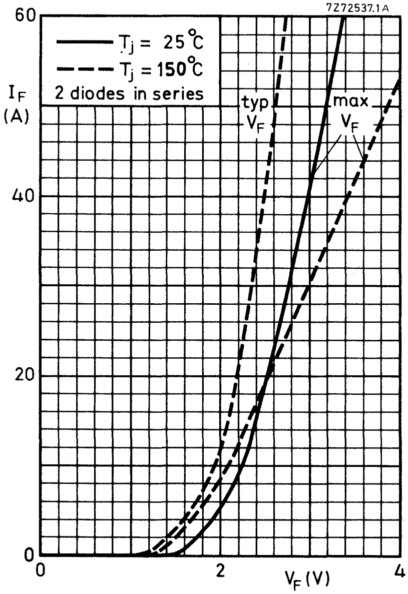
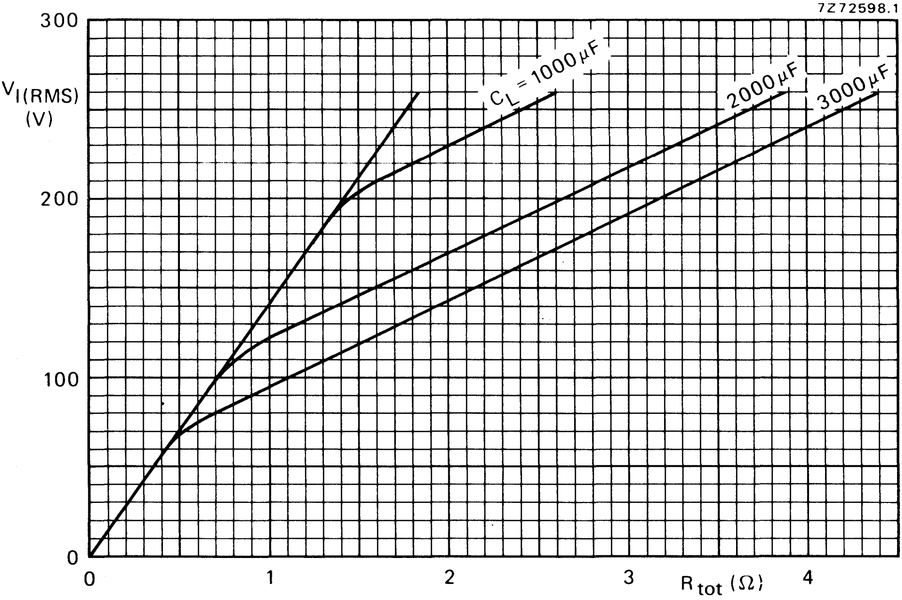
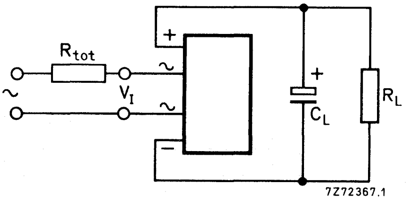


Fig.5



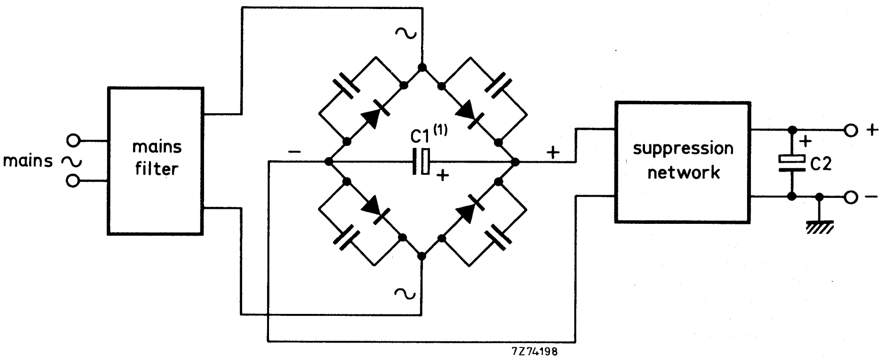


The graph takes the possibility of the following spreads into account:

mains voltage	+10%
capacitance	+50%
resistance	−10%

Fig. 6 Minimum value of the total series resistance R_{tot} (including the transformer resistance) required to limit the peak inrush current.

APPLICATION INFORMATION



(1) External capacitor.

Fig. 7 Because smoothing capacitor C2 is not always connected directly across the bridge (a suppression network may be sited between capacitor and bridge as shown), it is necessary to connect a capacitor of about 1 μF, C1, between the + and – terminals of the bridge. This capacitor should be as close to the bridge as possible, to give optimum suppression of mains transients.

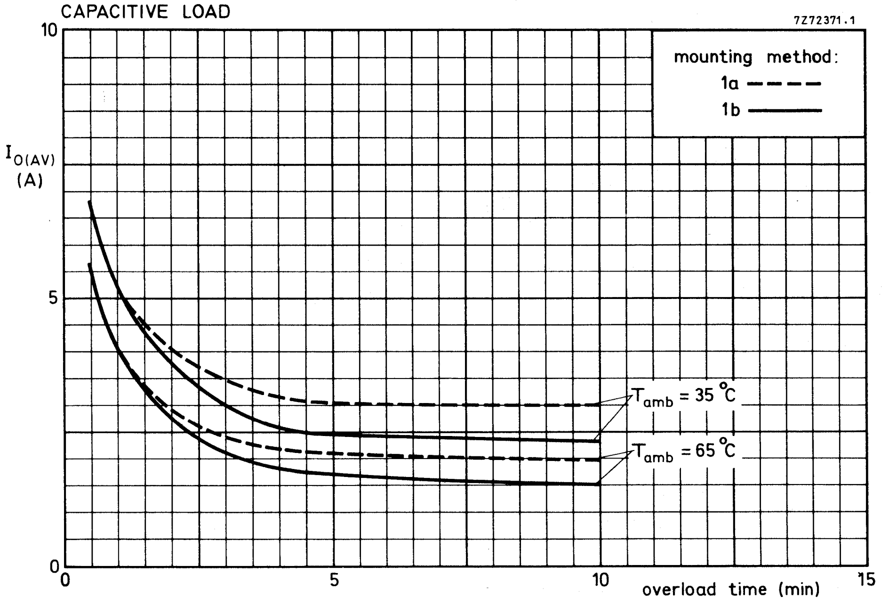


Fig.8

SILICON BRIDGE RECTIFIERS

Ready-for-use full-wave bridge rectifiers in a plastic encapsulation. The bridges are intended for use in equipment supplied from a.c. with r.m.s. voltages up to 80 V and are capable of delivering output currents up to 4,8 A. They are also suitable for use in hi-fi audio equipments and low-voltage industrial power supplies. They may be used in free air or clipped to a heatsink.

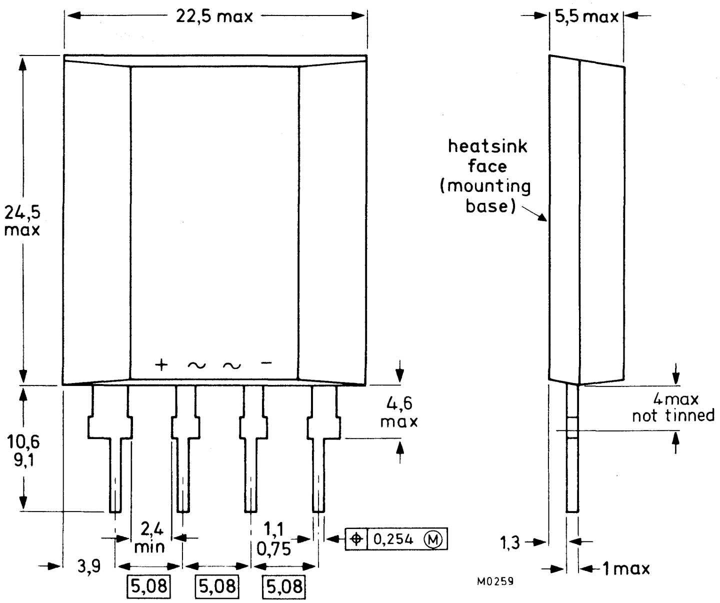
QUICK REFERENCE DATA

			BY225–100	200	
Input					
R.M.S. voltage	$V_{I(RMS)}$	max.	50	80	V
Repetitive peak voltage	V_{IRM}	max.	100	200	V
Non-repetitive peak current	I_{ISM}	max.	100		A
Peak inrush current	I_{IIM}	max.	200		A
Output					
Average current	$I_{O(AV)}$	max.	4,8		A

MECHANICAL DATA

Dimensions in mm

Fig. 1 SOT-112.



Net mass: 6,8 g

Accessories supplied on request: 56379 (clip); see Accessories and Mounting Instructions.

The sealing of the plastic 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)

Input			BY225–100	200	
Non-repetitive peak voltage ($t \leqslant 10$ ms)	V_{ISM}	max.	100	200	V
Repetitive peak voltage	V_{IRM}	max.	100	200	V
Crest working voltage	V_{IWM}	max.	70	112	V
R.M.S. voltage (sine-wave)	$V_{I(RMS)}$	max.	50	80	V
Non-repetitive peak current; half sine-wave; t = 20 ms; with reapplied V_{IWMmax}					
T_j = 25 °C prior to surge	I_{ISM}	max.		100	A
T_j = 150 °C prior to surge	I_{ISM}	max.		85	A
Peak inrush current (see Fig. 6)	I_{IIM}	max.		200	A
Output					
Average current (averaged over any 20 ms period; see Figs 2 and 3)					
heatsink operation up to T_{mb} = 115 °C	$I_{O(AV)}$	max.		4,8	A
heatsink operation at T_{mb} = 125 °C	$I_{O(AV)}$	max.		3,6	A
free-air operation at T_{amb} = 45 °C; (mounting method 1a)	$I_{O(AV)}$	max.		3,2	A
Repetitive peak current	I_{ORM}	max.		50	A
Temperatures					
Storage temperature	T_{stg}			−40 to +150	°C
Junction temperature	T_j	max.		150	°C

THERMAL RESISTANCE

From junction to mounting base	$R_{th\ j\text{-}mb}$	=	4,0 °C/W

Influence of mounting method

1. Free-air operation

The quoted values of $R_{th\ j\text{-}a}$ should be used only when no leads of other dissipating components run to the same tie-point (see Fig. 2).

Thermal resistance from junction to ambient in free air

a. Mounted on a printed-circuit board with 4 cm^2 of copper laminate to + and – leads	$R_{th\ j\text{-}a}$	=	19,5 °C/W
b. Mounted on a printed-circuit board with minimal copper laminate	$R_{th\ j\text{-}a}$	=	25 °C/W

2. Heatsink mounted with clip (see mounting instructions)

Thermal resistance from mounting base to heatsink

a. With zinc-oxide heatsink compound	$R_{th\ mb\text{-}h}$	=	1,0 °C/W
b. Without heatsink compound	$R_{th\ mb\text{-}h}$	=	2,0 °C/W

MOUNTING INSTRUCTIONS

1. Soldered joints must be at least 4 mm from the seal.
2. The maximum permissible temperature of the soldering iron or bath is 270 °C; contact with the joint must not exceed 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.
4. Leads should not be bent less than 4 mm from the seal. Exert no axial pull when bending.
5. Recommended force of clip on device is 120 N (12 kgf).
6. The heatsink should be in contact with the entire mounting base of the device and heatsink compound should be used.

CHARACTERISTICS

Forward voltage (2 diodes in series) $I_F = 10$ A; $T_j = 25$ °C	V_F	<	2,3 V*
Reverse current (2 diodes in parallel) $V_R = V_{IWMmax}$; $T_j = 25$ °C	I_R	<	200 μA

---

* Measured under pulse conditions to avoid excessive dissipation.

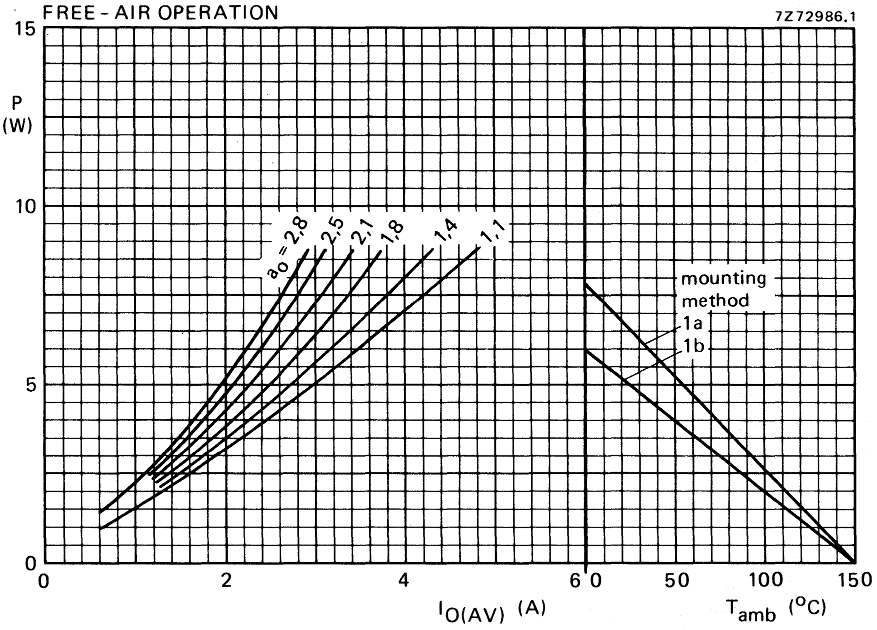


Fig. 2 The right-hand part shows the interrelationship between the power (derived from the left-hand graph) and the maximum permissible ambient temperature.

Output form factor $a_o = I_{O(RMS)}/I_{O(AV)} = 0,707 \times I_{F(RMS)}/I_{F(AV)}$ per diode.

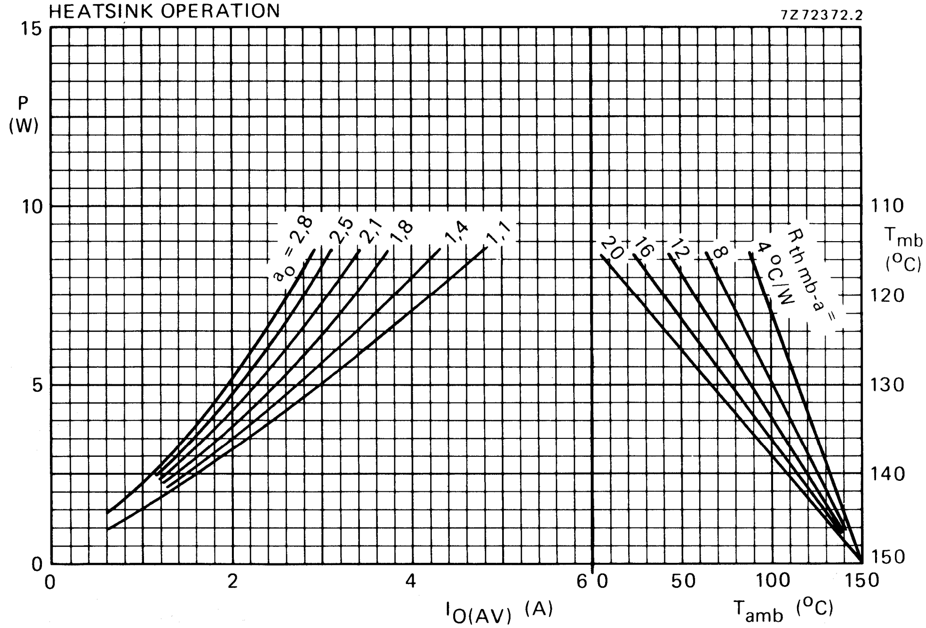


Fig. 3 The right-hand part shows the interrelationship between the power (derived from the left-hand graph) and the maximum permissible temperatures.

Output form factor $a_o = I_{O(RMS)}/I_{O(AV)} = 0{,}707 \times I_{F(RMS)}/I_{F(AV)}$ per diode.

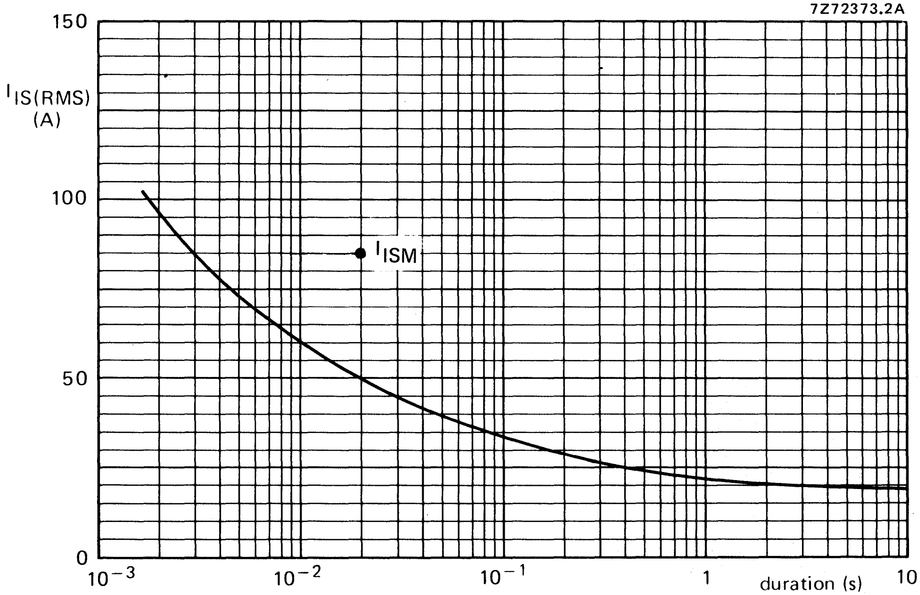
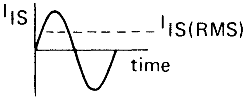


Fig. 4 Maximum permissible non-repetitive r.m.s. input current based on sinusoidal currents (f = 50 Hz); T_j = 150 °C prior to surge; with reapplied V_{IWMmax}.



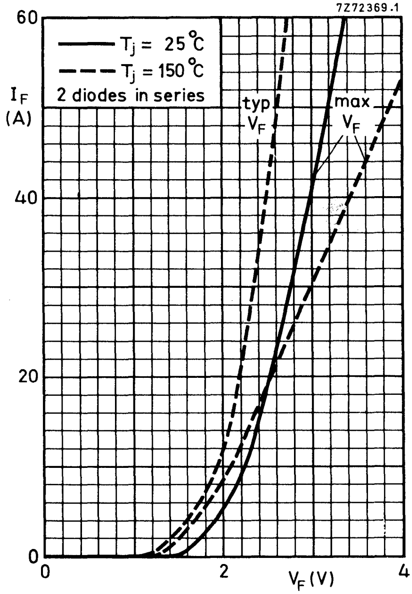
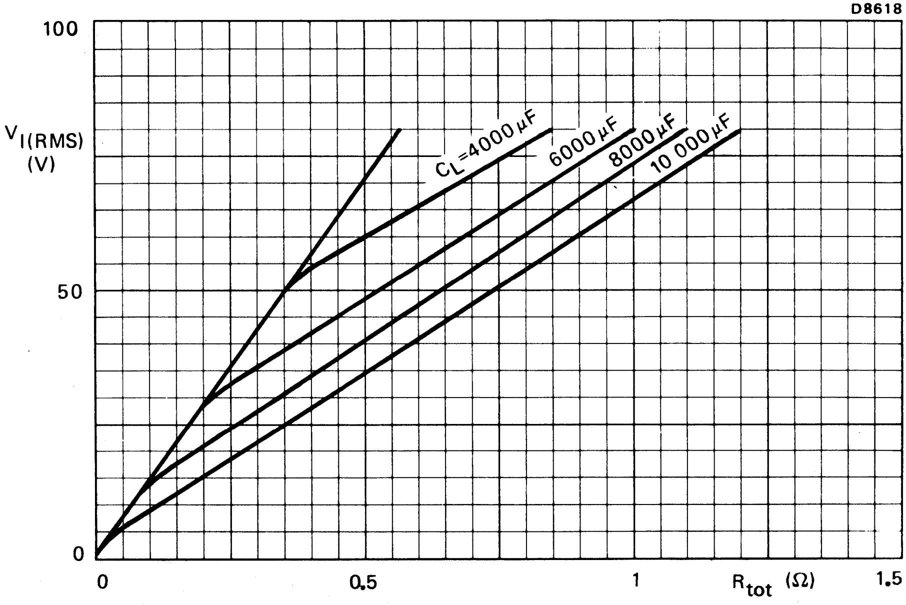
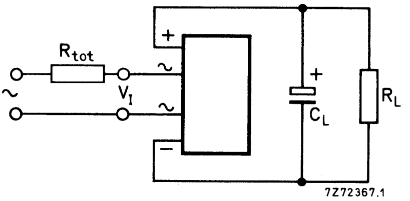


Fig. 5.





The graph takes the possibility of the following spreads into account:

input voltage	+10%
capacitance	+50%
resistance	−10%

Fig. 6 Minimum value of the total series resistance R_{tot} (including the transformer resistance) required to limit the peak inrush current.

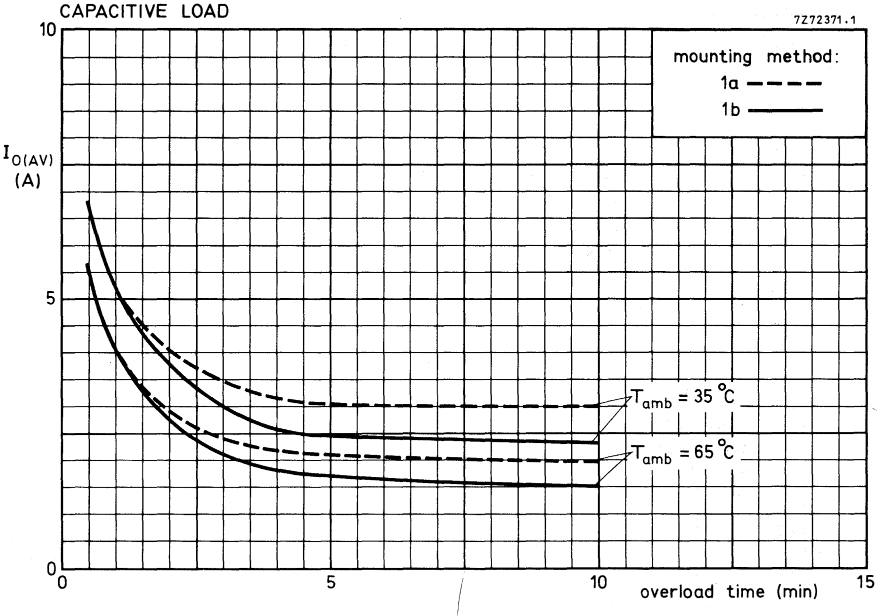

CAPACITIVE LOAD
7Z72371.1
mounting method:
1a - - - -
1b ——
$I_{O(AV)}$
(A)
10
5
0
0
5
10
15
overload time (min)
T_{amb} = 35 °C
T_{amb} = 65 °C

Fig. 7.

SILICON BRIDGE RECTIFIERS

Ready for use full-wave bridge rectifiers in a plastic encapsulation.
The bridges are intended for use in equipment supplied from a.c. with r.m.s. voltages up to 420 V and are capable of delivering output currents up to 12A. They are also suitable for use in hi-fi audio equipments and low-voltage industrial power supplies. They may be used in free air or on a heatsink.

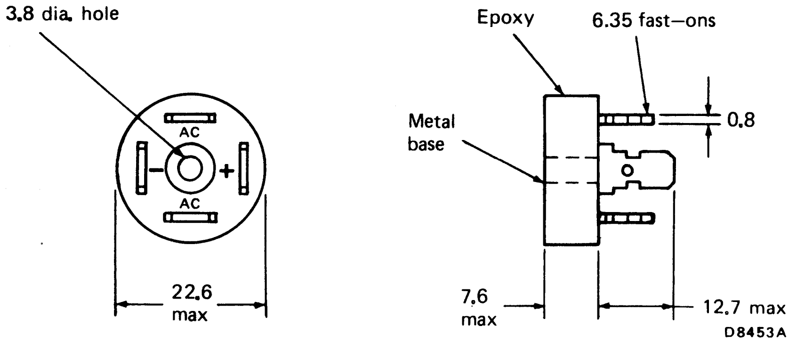
QUICK REFERENCE DATA

Input			BY260–200	400	600	
R.M.S. voltage	$V_{I(RMS)}$	max.	140	280	420	V
Repetitive peak voltage	V_{IRM}	max.	200	400	600	V
Non-repetitive peak current	I_{ISM}	max.	125			A
Peak inrush current	I_{IIM}	max.	250			A
Output						
Average current	$I_{O(AV)}$	max.	12			A

MECHANICAL DATA

Dimensions in mm

Fig. 1.



RATINGS

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

Input			BY260–200	400	600	
Non-repetitive peak voltage ($t \leqslant 10$ ms)	V_{ISM}	max.	200	400	600	V
Repetitive peak voltage	V_{IRM}	max.	200	400	600	V
Crest working voltage	V_{IWM}	max.	200	400	600	V
R.M.S. voltage (sine-wave)	$V_{I(RMS)}$	max.	140	280	420	V

Non-repetitive peak current half-sinewave; t = 20 ms; with reapplied V_{IWMmax}				
T_j = 25 °C prior to surge	I_{ISM}	max.	125	A
T_j = 150 °C prior to surge	I_{ISM}	max.	100	A
Peak inrush current (see Fig. 5)	I_{IIM}	max.	250	A

Output

Average current (averaged over any 20 ms period)				
heatsink operation up to T_{mb} = 60 °C (R-load)	$I_{O(AV)}$	max.	12	A
heatsink operation up to T_{mb} = 60 °C (C-load)	$I_{O(AV)}$	max.	7.5	A
Repetitive peak current	I_{ORM}	max.	20	A

Temperatures

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

THERMAL RESISTANCE

From junction to mounting base	$R_{th\ j\text{-}mb}$	=	4.5	°C/W

CHARACTERISTICS

Forward voltage (2 diodes in series) I_F = 7 A; T_j = 25 °C	V_F	<	2.0	V*
Reverse current (2 diodes in parallel) $V_R = V_{IWMmax}$; T_j = 100 °C	I_R	<	150	µA

---

*Measured under pulse conditions to avoid excessive dissipation.

SILICON BRIDGE RECTIFIERS

Ready for use full-wave bridge rectifiers in a plastic encapsulation.
The bridges are intended for use in equipment supplied from a.c. with r.m.s. voltages up to 420 V and are capable of delivering output currents up to 25A. They may be used in free air or on a heatsink.

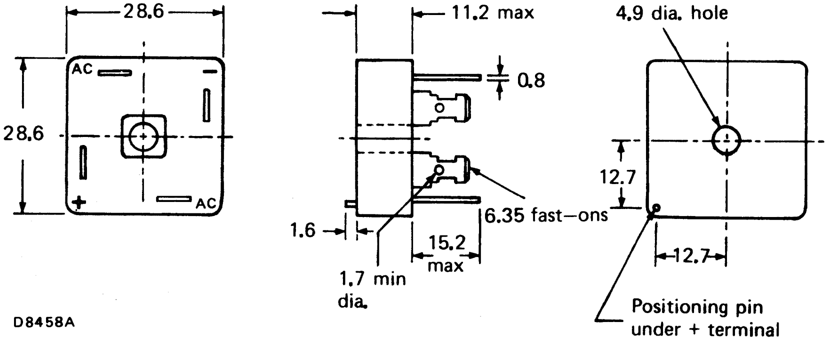
QUICK REFERENCE DATA

Input			BY261–200	400	600	
R.M.S. voltage	$V_{I(RMS)}$	max.	140	280	420	V
Repetitive peak voltage	V_{IRM}	max.	200	400	600	V
Non-repetitive peak current	I_{ISM}	max.		320		A
Peak inrush current	I_{IIM}	max.		640		A
Output						
Average current	$I_{O(AV)}$	max.		25		A

MECHANICAL DATA

Dimensions in mm

Fig. 1



RATINGS

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

Input			BY261–200	400	600	
Non-repetitive peak voltage ($t \leq 10$ ms)	V_{ISM}	max.	200	400	600	V
Repetitive peak voltage	V_{IRM}	max.	200	400	600	V
Crest working voltage	V_{IWM}	max.	200	400	600	V
R.M.S. voltage (sine-wave)	$V_{I(RMS)}$	max.	140	280	420	V

Non-repetitive peak current half sinewave; t = 20 ms; with reapplied V_{IWMmax}				
T_j = 25 °C prior to surge	I_{ISM}	max.	320	A
T_j = 150 °C prior to surge	I_{ISM}	max.	250	A
Peak inrush current (see Fig. 5)	I_{IIM}	max.	640	A
Output				
Average current (averaged over any 20 ms period)				
heatsink operation; up to T_{mb} = 55 °C (R-load)	$I_{O(AV)}$	max.	25	A
heatsink operation; up to T_{mb} = 55 °C (C-load)	$I_{O(AV)}$	max.	18	A
Repetitive peak current	I_{ORM}	max.	75	A
Temperatures				
Storage temperature	T_{stg}		−55 to +175	°C
Junction temperature	T_j	max.	175	°C

THERMAL RESISTANCE

From junction to mounting base	$R_{th\ j\text{-}mb}$	=	2.5	°C/W

CHARACTERISTICS

Forward voltage (2 diodes in series) I_F = 12 A; T_j = 25 °C	V_F	<	2.3	V*
Reverse current (2 diodes in parallel) $V_R = V_{IWMmax}$; T_j = 100 °C	I_R	<	200	µA

*Measured under pulse conditions to avoid excessive dissipation.

FAST RECTIFIER DIODES

FAST SOFT-RECOVERY RECTIFIER DIODES

Glass-passivated double-diffused rectifier diodes in plastic envelopes, featuring fast reverse recovery times and non-snap-off characteristics. 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 series consists of the following types:
Normal polarity: BY229–200 to 800.
Reverse polarity: BY229–200R to 800R.

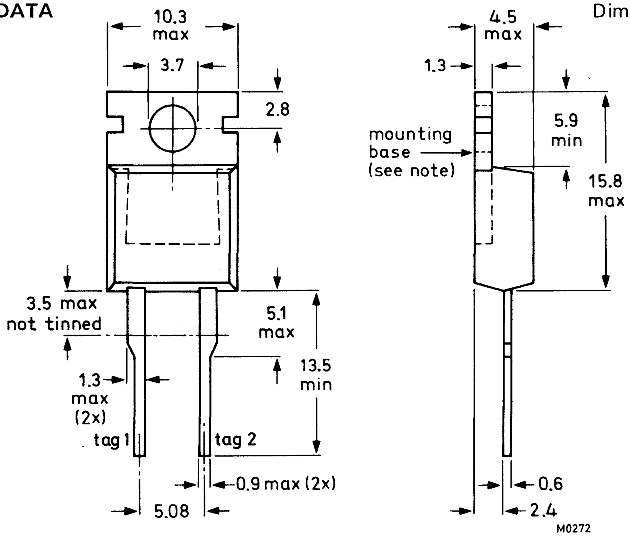
QUICK REFERENCE DATA

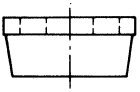
			BY229–200(R)	400(R)	600(R)	800(R)	
Repetitive peak reverse voltage	V_{RRM}	max.	200	400	600	800	V
Average forward current	$I_{F(AV)}$	max.	7				A
Non-repetitive peak forward current	I_{FSM}	max.	60				A
Reverse recovery time	t_{rr}	<	150				ns

MECHANICAL DATA

Dimensions in mm

Fig.1 TO-220AC





	tag 1	tag 2
normal	k	a
reverse	a	k

Note: The exposed metal mounting base is directly connected to tag 1. Accessories supplied on request: see data sheets Mounting instructions and accessories for TO–220 envelopes.

Products approved to CECC 50 009-021 available on request.

RATINGS

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

Voltages*			BY229-200(R)	400(R)	600(R)	800(R)	
Non-repetitive peak reverse voltage	V_{RSM}	max.	200	400	600	800	V
Repetitive peak reverse voltage	V_{RRM}	max.	200	400	600	800	V
Crest working reverse voltage	V_{RWM}	max.	150	300	500	600	V
Continuous reverse voltage	V_R	max.	150	300	500	600	V

Currents				
Average forward current assuming zero switching losses				
square-wave; $\delta = 0.5$; up to $T_{mb} = 100\ ^{o}C$	$I_{F(AV)}$	max.	7	A
square-wave; $\delta = 0.5$; at $T_{mb} = 125\ ^{o}C$	$I_{F(AV)}$	max.	4.1	A
sinusoidal; up to $T_{mb} = 100\ ^{o}C$	$I_{F(AV)}$	max.	6.5	A
sinusoidal; at $T_{mb} = 125\ ^{o}C$	$I_{F(AV)}$	max.	4	A
R.M.S. forward current	$I_{F(RMS)}$	max.	10	A
→ Repetitive peak forward current $t_p = 20\ \mu s$; $\delta \leqslant 0.02$	I_{FRM}	max.	135	A
Non-repetitive peak forward current t = 10 ms;half sine-wave; $T_j = 150\ ^{o}C$ prior to surge; with reapplied V_{RWM} max	I_{FSM}	max.	60	A
→ I^2t for fusing (t = 10 ms)	I^2t	max.	18	A^2s

Temperatues				
Storage temperature	T_{stg}		−40 to +150	^{o}C
Junction temperature	T_j	max.	150	^{o}C

---

*To ensure thermal stability: $R_{th\ j\text{-}a} \leqslant 15$ K/W for continuous reverse voltage.

THERMAL RESISTANCE

From junction to mounting base $R_{th\ j\text{-}mb}$ = 4.5 K/W

Influence of mounting method

1. Heatsink-mounted with clip (see mounting instructions)

Thermal resistance from mounting base to heatsink

a. with heatsink compound $R_{th\ mb\text{-}h}$ = 0.3 K/W

b. with heatsink compound and 0.06 mm maximum mica insulator $R_{th\ mb\text{-}h}$ = 1.4 K/W

c. with heatsink compound and 0.1 mm maximum mica insulator (56369) $R_{th\ mb\text{-}h}$ = 2.2 K/W

d. with heatsink compound and 0.25 mm maximum alumina insulator (56367) $R_{th\ mb\text{-}h}$ = 0.8 K/W

e. without heatsink compound $R_{th\ mb\text{-}h}$ = 1.4 K/W

2. Free air operation

The quoted value of $R_{th\ j\text{-}a}$ should be used only when no leads of other dissipating components run to the same tie point.
Thermal resistance from junction to ambient in free air: mounted on a printed circuit board at any device lead length and with copper laminate on the board $R_{th\ j\text{-}a}$ = 60 K/W

MOUNTING INSTRUCTIONS

1. The device may be soldered directly into the circuit, but the maximum permissible temperature of the soldering iron or bath is 275 °C; it must not be in contact with the joint for more than 5 seconds. Soldered joints must be at least 4.7 mm from the seal.
2. The leads should not be bent less than 2.4 mm from the seal, and should be supported during bending. The bend radius must be no less than 1.0 mm. ←
3. It is recommended that the circuit connection be made to tag 1, rather than direct to the heatsink.
4. Mounting by means of a spring clip is the best mounting methode because it offers:
   a. a good thermal contact under the crystal area and slightly lower $R_{th\ mb\text{-}h}$ values than screw mounting;
   b. safe isolation for mains operation.
   However, if a screw is used, it should be M3 cross-recess pan head. Care should be taken to avoid damage to the plastic body.
5. For good thermal contact heatsink compound should be used between base-plate and heatsink. Values of $R_{th\ mb\text{-}h}$ given for mounting with heatsink compound refer to the use of a metallic-oxide loaded compound. Ordinary silicone grease is not recommended.
6. Rivet mounting (only possible for non-insulated mounting)

   Devices may be rivetted to flat heatsinks; such a process **must neither** deform the mounting tab, **nor** enlarge the mounting hole.

CHARACTERISTICS

T_j = 25 °C unless otherwise specified

Forward voltage						
I_F = 20 A		V_F	<	1.85	V*	
Reverse current						
$V_R = V_{RWMmax}$; T_j = 125 °C	normal polarity	I_R	<	0.4	mA	
	reverse polarity	I_R	<	0.6	mA	
Reverse recovery when switched from						
I_F = 1 A to $V_R \geqslant$ 30 V with $-dI_F/dt$ = 50 A/μs						
recovery time		t_{rr}	<	150	ns	◄
I_F = 2 A to $V_R \geqslant$ 30 V with $-dI_F/dt$ = 20 A/μs						
recovered charge		Q_s	<	0.7	μC	
Maximum slope of the reverse recovery current						
I_F = 2 A, $-dI_F/dt$ = 20 A/μs	normal polarity	$\lvert dI_R/dt \rvert$	<	60	A/μs	
	reverse polarity	$\lvert dI_R/dt \rvert$	<	75	A/μs	

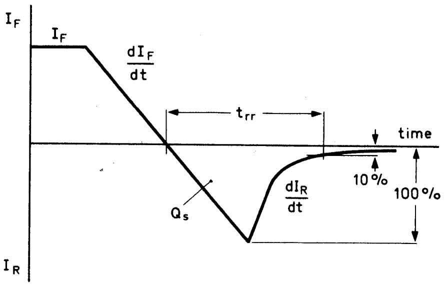


Fig.3 Definition of t_{rr} and Q_s.

---

*Measured under pulse conditions to avoid excessive dissipation.

SQUARE-WAVE OPERATION

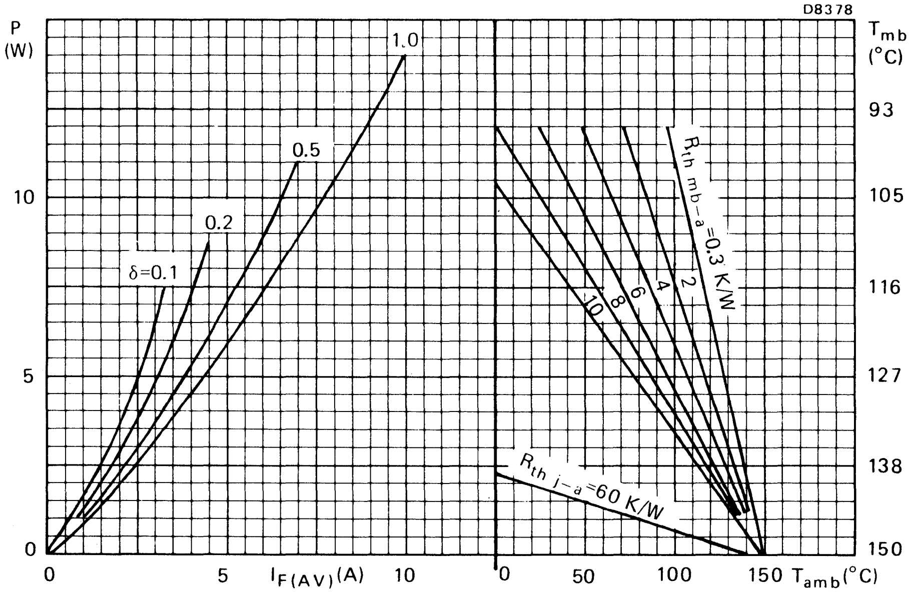
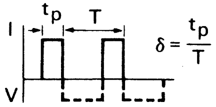


Fig. 4 The right-hand part shows the interrelationship between the power (derived from the left-hand part) and the maximum permissible temperatures.
P = power including reverse current losses but excluding switching losses.



$I_{F(AV)} = I_{F(RMS)} \times \sqrt{\delta}$

SINUSOIDAL OPERATION

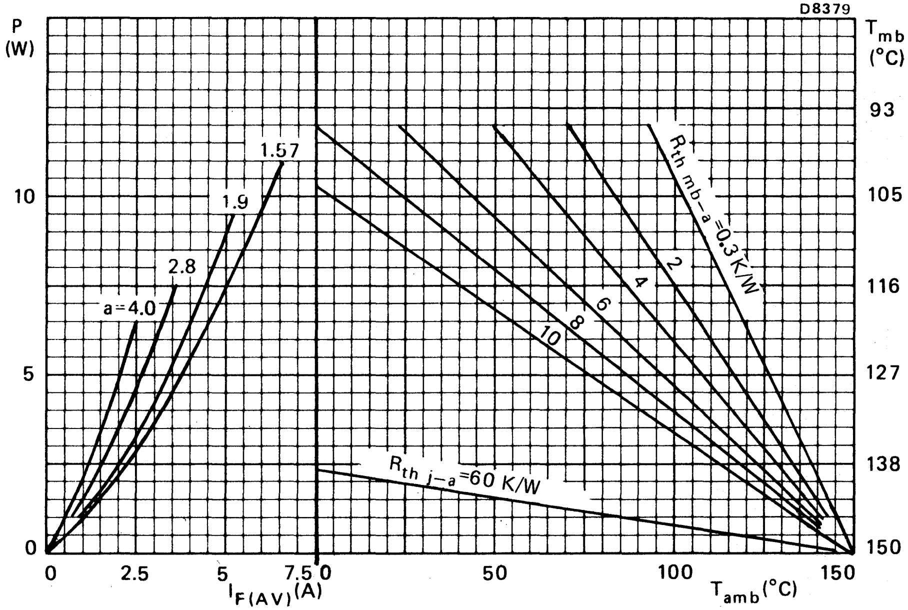


Fig. 5 The right-hand part shows the interrelationship between the power (derived from the left-hand part) and the maximum permissible temperatures.
P = power including reverse current losses but excluding switching losses.
a = form factor = $I_{F(RMS)}/I_{F(AV)}$.

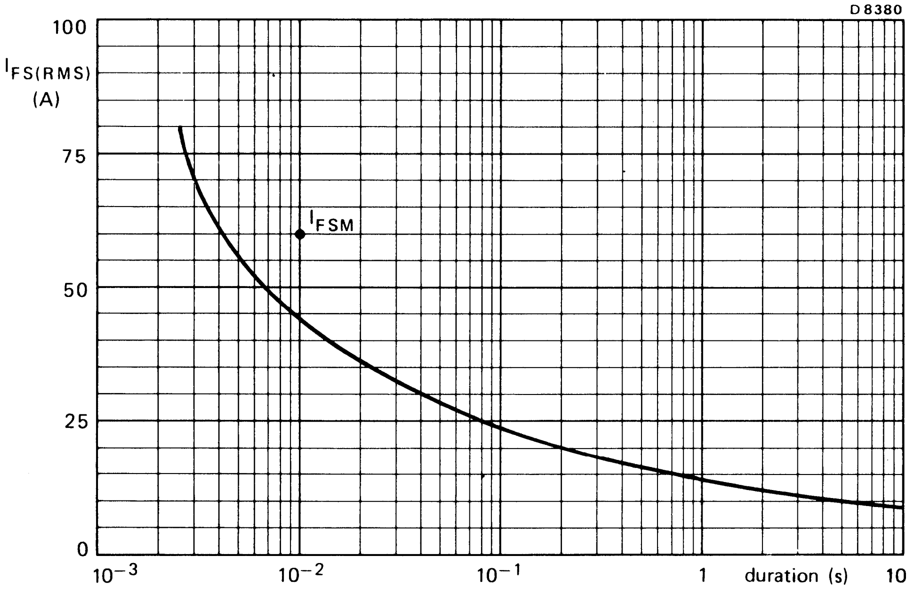
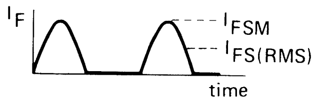


Fig. 6 Maximum permissible non-repetitive r.m.s. forward current based on sinusoidal currents (f = 50 Hz); T_j = 150 °C prior to surge; with reapplied V_{RWMmax}.



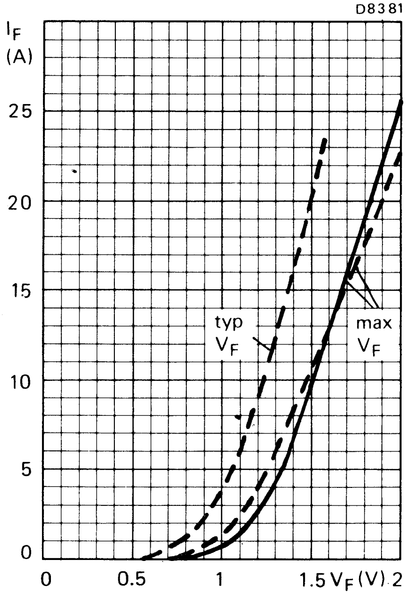


Fig. 7 —— T_j = 25 °C; – – – –T_j = 125 °C

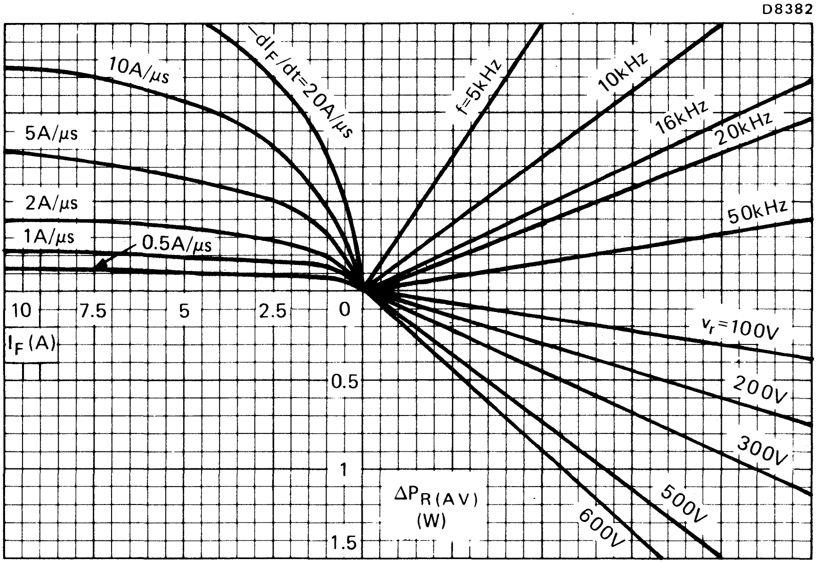
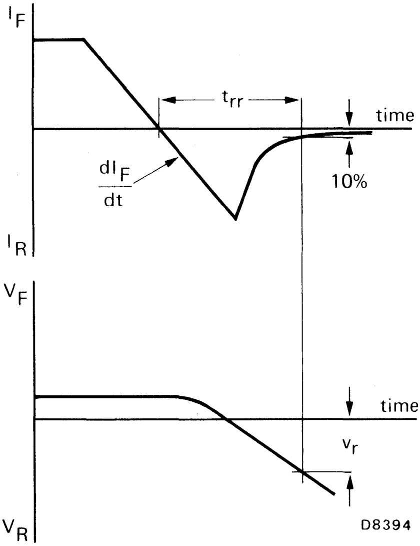


Fig. 8 NOMOGRAM

Power loss $\Delta P_{R(AV)}$ due to switching only (to be added to steady state power losses).
I_F = forward current just before switching off; T_j = 150 °C



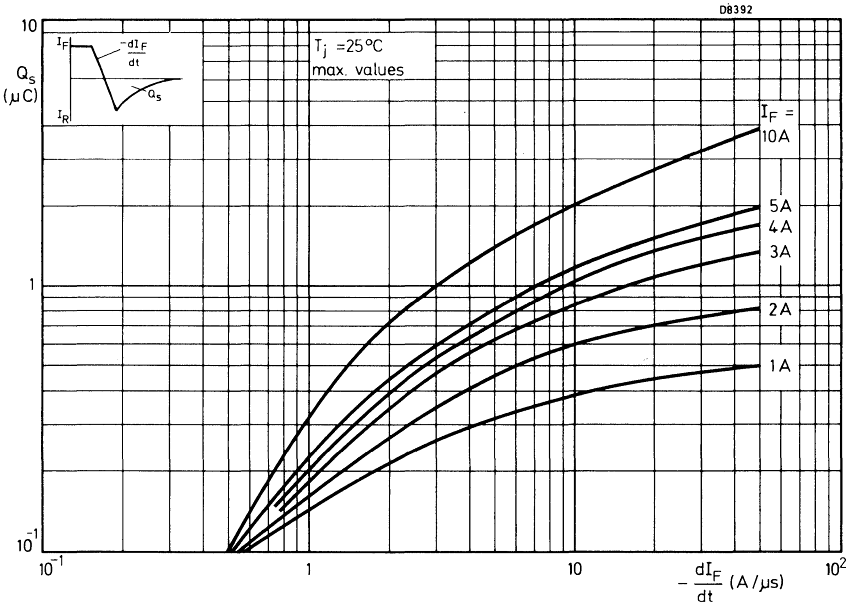

D8392
10
1
10^{-1}
Q_s (μC)
I_F
$-\frac{dI_F}{dt}$
Q_s
I_R
T_j =25°C
max. values
I_F = 10A
5A
4A
3A
2A
1A
10^{-1}
1
10
10^2
$-\frac{dI_F}{dt}$ (A/μs)

Fig.9

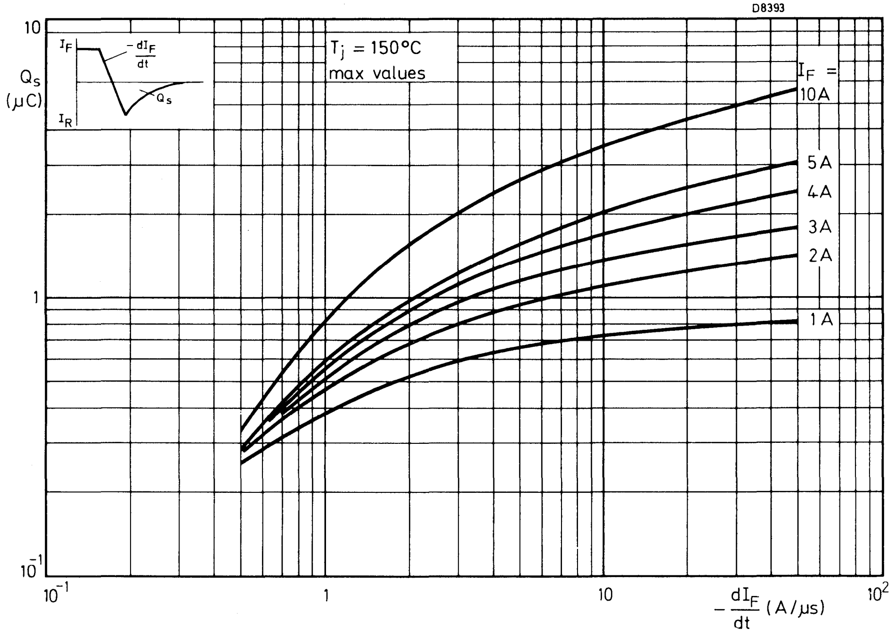

D8393
10
1
10^{-1}
Q_s (μC)
I_F
$-\frac{dI_F}{dt}$
Q_s
I_R
T_j = 150°C
max values
I_F = 10A
5A
4A
3A
2A
1A
10^{-1}
1
10
10^2
$-\frac{dI_F}{dt}$ (A/μs)

Fig.10

→

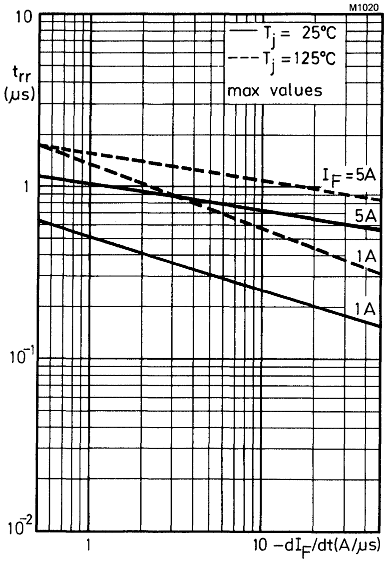


Fig. 11

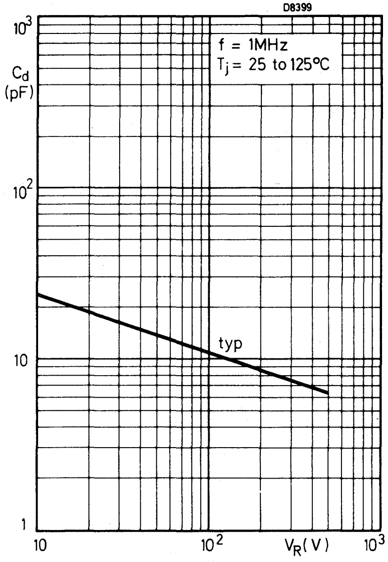


Fig. 12

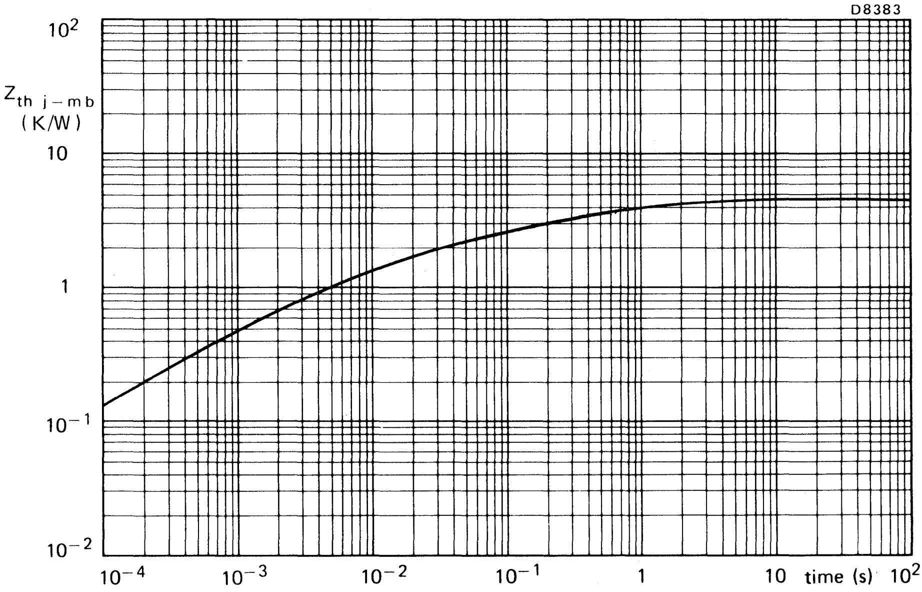


Fig. 13

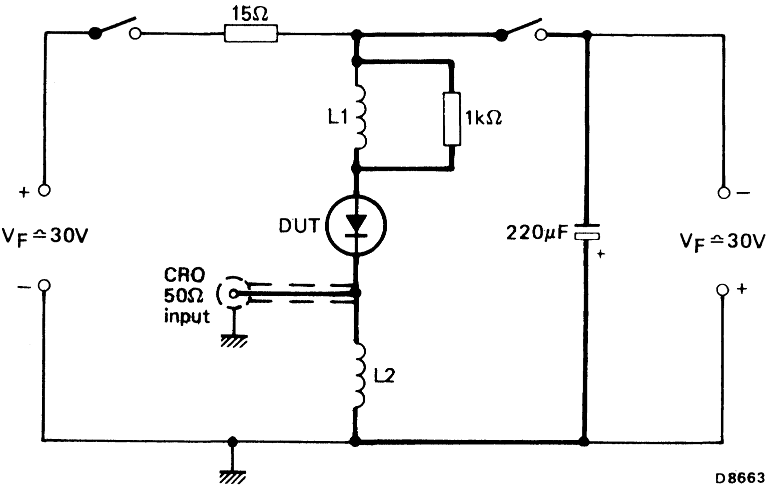


Fig.14 Simplified circuit diagram of practical apparatus to test softness of recovery.

NOTES

1. Duty factor of forward current should be low, <2%.
2. dI_F/dt is set by L1, 1.5 µH gives 20 A/µs
3. dI_R/dt is measured across L2, 200 nH gives 5A/µs/V.
4. Wiring shown in heavy should be kept as short as possible.

FAST SOFT-RECOVERY ELECTRICALLY ISOLATED RECTIFIER DIODES

Glass-passivated, double-diffused rectifier diodes in full-pack plastic envelopes, featuring fast reverse recovery times and non-snap-off characteristics. Their electrical isolation makes them ideal for mounting on a common heatsink alongside other components without the need for additional insulators. They are intended for use in chopper applications as well as in switched-mode power supplies and as efficiency diodes and scan rectifiers in television receivers.

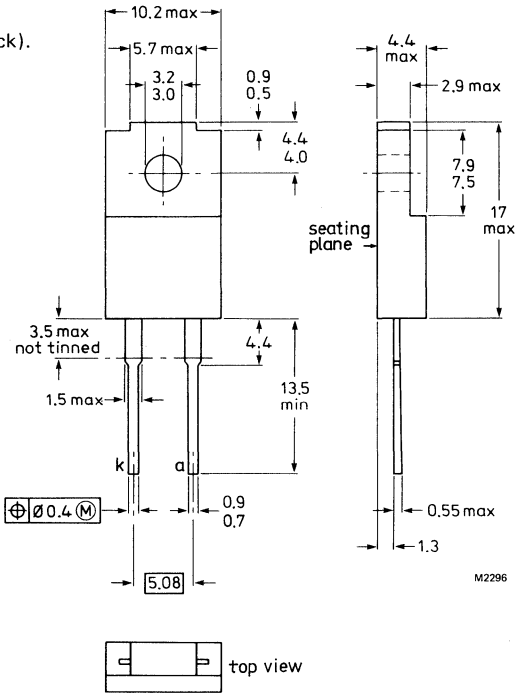
QUICK REFERENCE DATA

			BY229F–200	400	600	800	
Repetitive peak reverse voltage	V_{RRM}	max.	200	400	600	800	V
Average forward current	$I_{F(AV)}$	max.	7				A
Non-repetitive peak forward current	I_{FSM}	<	60				A
Reverse recovery time	t_{rr}	<	150				ns ←

MECHANICAL DATA

Dimensions in mm

Fig.1 SOT-186 (full-pack).



Net mass: 2 g.

The seating plane is electrically isolated from all terminals.

Accessories supplied on request (see data sheets Mounting instructions for F-pack devices and Accessories for SOT-186 envelopes).

RATINGS

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

Voltages (Note 1)			BY229F–200	400	600	800	
Non-repetitive peak reverse voltage	V_{RSM}	max.	200	400	600	800	V
Repetitive peak reverse voltage	V_{RRM}	max.	200	400	600	800	V
Crest working reverse voltage	V_{RWM}	max.	150	300	500	600	V
Continuous reverse voltage	V_R	max.	150	300	500	600	V

Currents				
Average forward current assuming zero switching losses (Note 2)				
square wave; $\delta = 0.5$; up to $T_{hs} = 90\ ^oC$	$I_{F(AV)}$	max.	7	A
sinusoidal; up to $T_{hs} = 93\ ^oC$	$I_{F(AV)}$	max.	6.25	A
R.M.S. forward current	$I_{F(RMS)}$	max.	10	A
Repetitive peak forward current $t_p = 20\ \mu s$; $\delta = 0.02$	I_{FRM}	max.	135	A
Non-repetitive peak forward current half sine-wave; $T_j = 150\ ^oC$ prior to surge; with reapplied $V_{RWM\,max}$				
t = 10 ms	I_{FSM}	max.	60	A
t = 8.3 ms	i_{FSM}	max.	65	A
I^2t for fusing (t = 10 ms)	I^2t	max.	18	A^2s
Temperatures				
Storage temperature	T_{stg}		−40 to +150	^oC
Junction temperature	T_j	max.	150	^oC
ISOLATION				
Peak isolation voltage from all terminals to external heatsink	V_{isol}	max.	1000	V
Isolation capacitance from cathode to external heatsink (Note 3)	C_p	typ.	12	pF

Notes

1. To ensure thermal stability: $R_{th\ j\text{-}a} < 15$ K/W for continuous reverse voltage.
2. The quoted temperatures assume heatsink compound is used.
3. Mounted without heatsink compound and 20 Newtons pressure on the centre of the envelope.

THERMAL RESISTANCE

From junction to external heatsink with minimum of 2 kgf (20 Newtons) pressure on the centre of the envelope,

without heatsink compound	$R_{th\ j\text{-}h}$	=	7.2	K/W
with heatsink compound	$R_{th\ j\text{-}h}$	=	5.5	K/W

Free-air operation

The quoted value of $R_{th\ j\text{-}a}$ should be used only when no leads of other dissipating components run to the same point.

Thermal resistance from junction to ambient in free air, mounted on a printed circuit board	$R_{th\ j\text{-}a}$	=	55	K/W

CHARACTERISTICS

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

Forward voltage $I_F = 20$ A	V_F	<	1.85	V*	
Reverse current $V_R = V_{RWM\ max}$; $T_j = 125\ ^{o}C$	I_R	<	0.4	mA	
Reverse recovery when switched from $I_F = 1$ A to $V_R \geqslant 30$ V with $-dI_F/dt = 50$ A/μs, recovery time	t_{rr}	<	150	ns	←
$I_F = 2$ A to $V_R \geqslant 30$ V with $-dI_F/dt = 20$ A/μs recovered charge	Q_s	<	0.7	μC	
Maximum slope of the reverse recovery current $I_F = 2$ A, $-dI_F/dt = 20$ A/μs	$\lvert dI_R/dt \rvert$	<	60	A/μs	

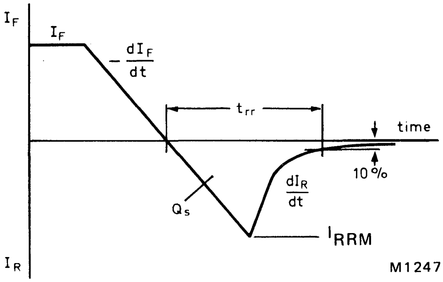


Fig.2 Definition of t_{rr} and Q_s.

---

*Measured under pulse conditions to avoid excessive dissipation.

MOUNTING INSTRUCTIONS

1. The device may be soldered directly into the circuit, but the maximum permissible temperature of the soldering iron or bath is 275 ^{o}C; the heat source must not be in contact with the joint for more than 5 seconds. Soldered joints must be at least 4.7 mm from the seal.
2. The leads should not be bent less than 2.4 mm from the seal, and should be supported during bending. The bend radius must be no less than 1 mm.
3. Mounting by means of a spring clip is the best mounting method because it offers a good thermal contact under the crystal area and slightly lower $R_{th\ j\text{-}h}$ values than screw mounting. The force exerted on the top of the device by the clip should be at least 2 kgf (20 Newtons) to ensure good thermal contact and must not exceed 3.5 kgf (35 Newtons) to avoid damage to the device.
4. If screw mounting is used, it should be M3 cross-recess pan head.
   Minimum torque to ensure good thermal contact: 5.5 kgf (0.55 Nm)
   Maximum torque to avoid damage to the device: 8.0 kgf (0.80 Nm)
5. For good thermal contact, heatsink compound should be used between baseplate and heatsink. Values of $R_{th\ j\text{-}h}$ given for mounting with heatsink compound refer to the use of a metallic-oxide loaded compound. Ordinary silicone grease is not recommended.
6. Rivet mounting.
   It is not recommended to use rivets, since extensive damage could result to the plastic, which could destroy the insulating properties of the device.
7. The heatsink must have a flatness in the mounting area of 0.02 mm maximum per 10 mm. Mounting holes must be deburred.

OPERATING NOTES

The various components of junction temperature rise above ambient are illustrated in Fig.3.

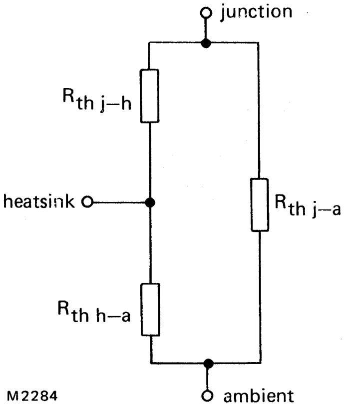


Fig.3.

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

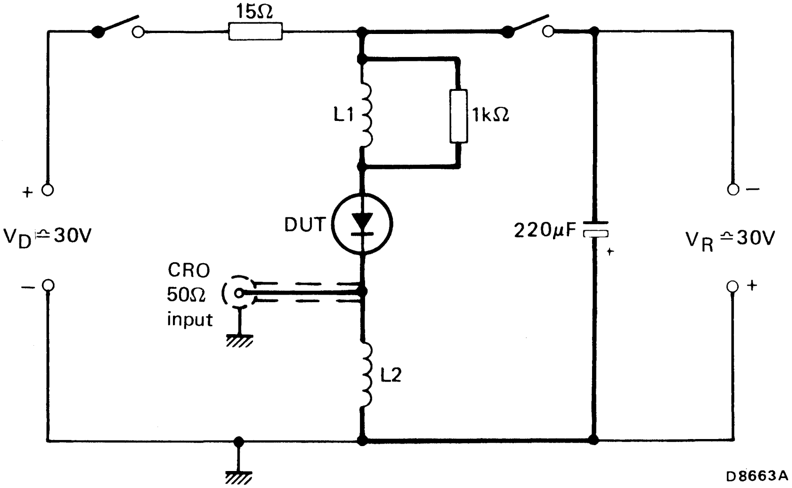


Fig.4 Simplified circuit diagram of practical apparatus to test softness of recovery.

NOTES

1. Duty factor of forward current should be low, $< 2\%$.
2. dI_F/dt is set by L1, 1.5 μH gives 20 A/μs.
3. dI_R/dt is measured across L2, 200 nH gives 5 A/μs/V.
4. Wiring shown in heavy should be kept as short as possible.

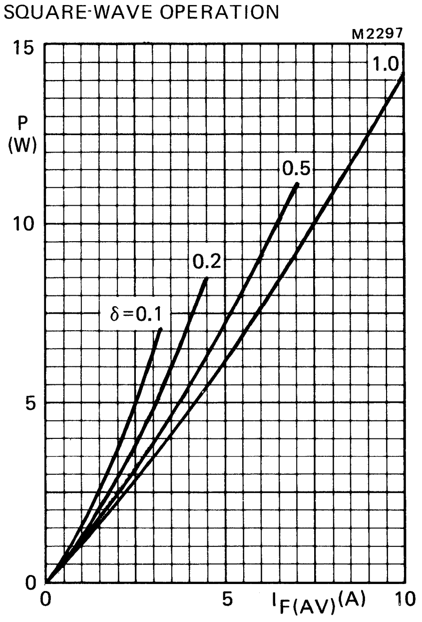
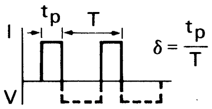


Fig.5 Power rating.

The power loss in the diode should first be determined from the required forward current on the $I_{F(AV)}$ axis and the appropriate duty cycle.
Having determined the power (P), use Fig.7 (if heatsink compound is not being used) or Fig.8 (if heatsink compound is being used) to determine the heatsink size and corresponding maximum ambient and heatsink temperatures.

Note: P = power including reverse current losses but excluding switching losses.



$$I_{F(AV)} = I_{F(RMS)} \times \sqrt{\delta}$$

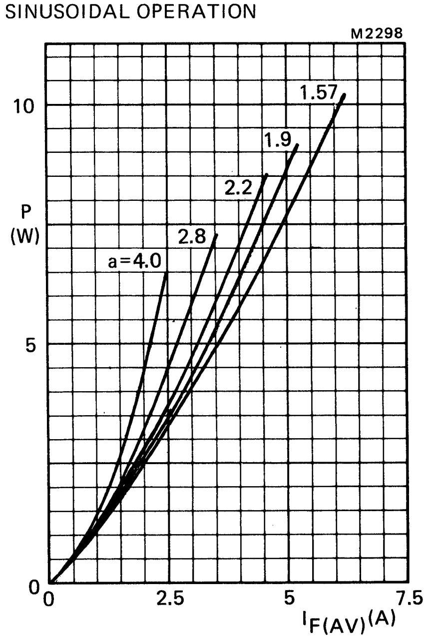


Fig.6 Power rating.

The power loss in the diode should first be determined from the required forward current on the $I_{F(AV)}$ axis and the appropriate form factor.
Having determined the power (P), use Fig.7 (if heatsink compound is not being used) or Fig.8 (if heatsink compound is being used) to determine the heatsink size and corresponding maximum ambient and heatsink temperatures.

Note: P = power including reverse current losses but excluding switching losses.

a = form factor = $I_{F(RMS)}/I_{F(AV)}$

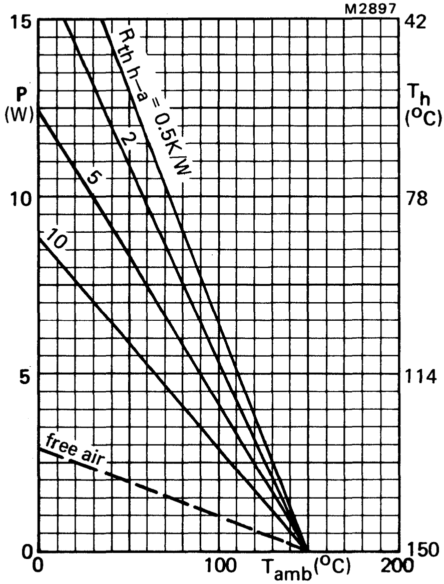


Fig.7 Heatsink rating;
without heatsink compound.

←

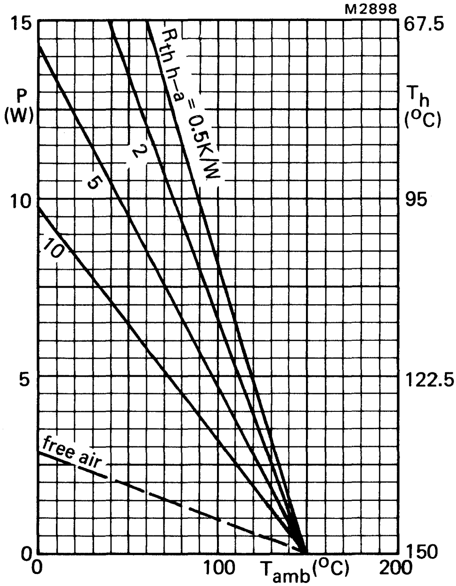


Fig.8 Heatsink rating;
with heatsink compound.

←

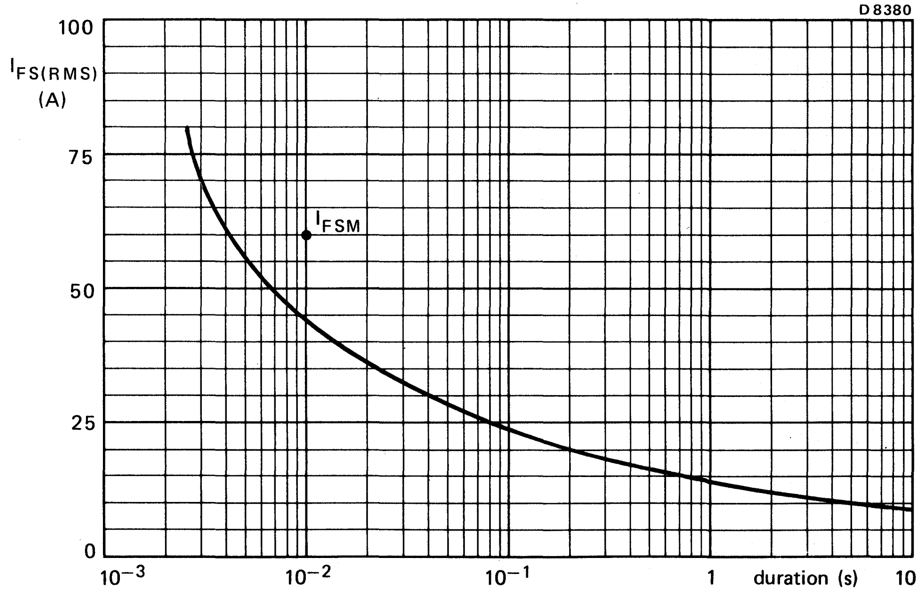
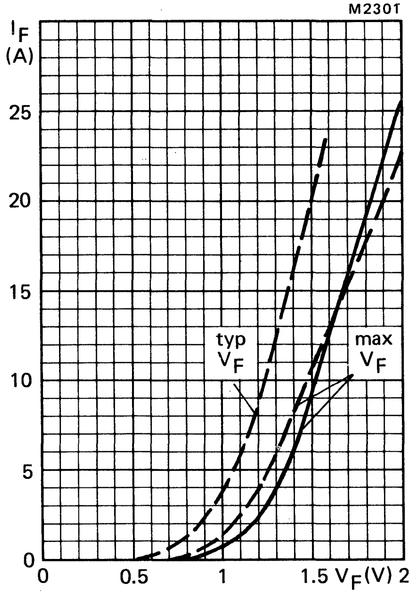


Fig.9 Maximum permissible non-repetitive r.m.s. forward current based on sinusoidal currents (f = 50 Hz); T_j = 150 °C prior to surge; with reapplied V_{RWMmax}.



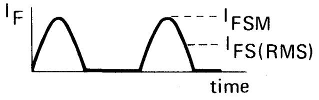


Fig.10 —— T_j = 25 °C; – – – – T_j = 125 °C.

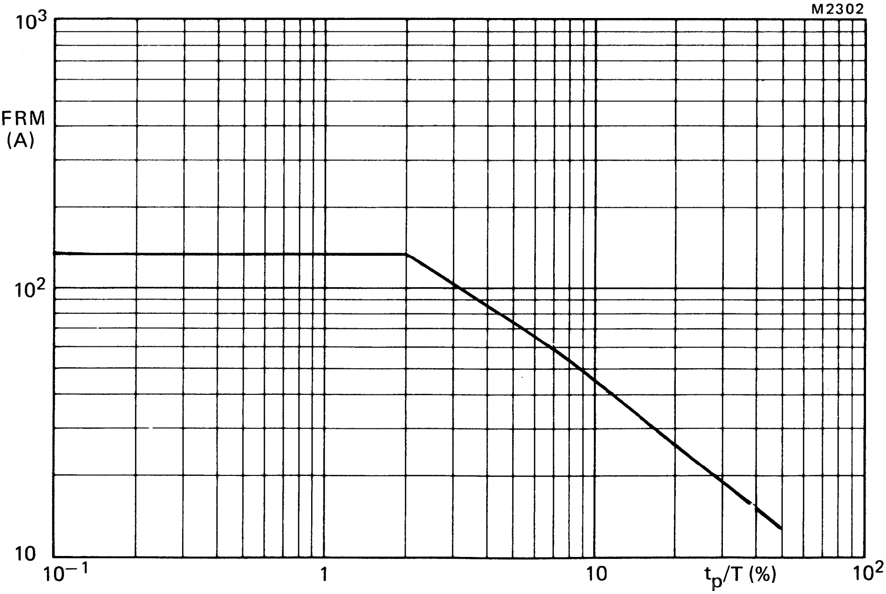
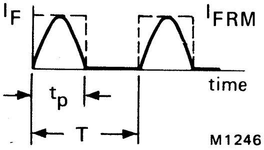


Fig.11 Maximum permissible repetitive peak forward current for square or sinusoidal currents; 1 µs $< t_p <$ 1 ms.



Definition of I_{FRM} and t_p/T.

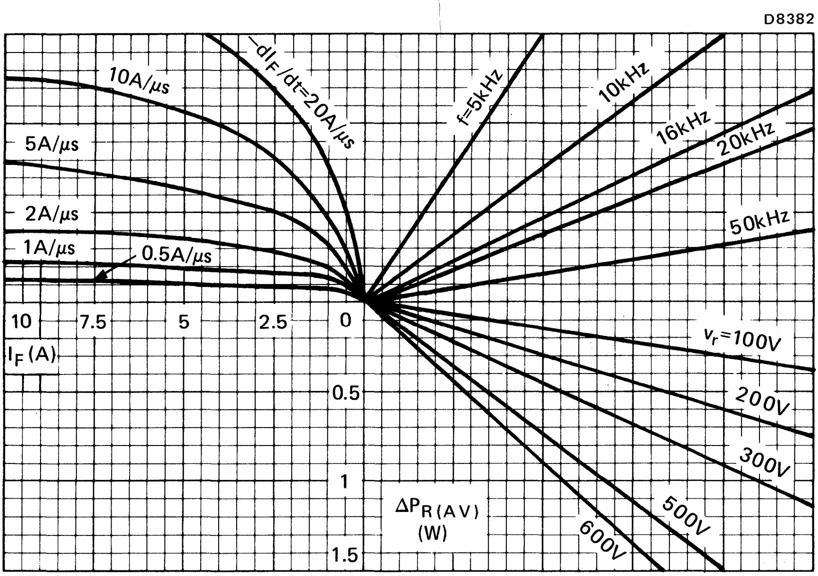
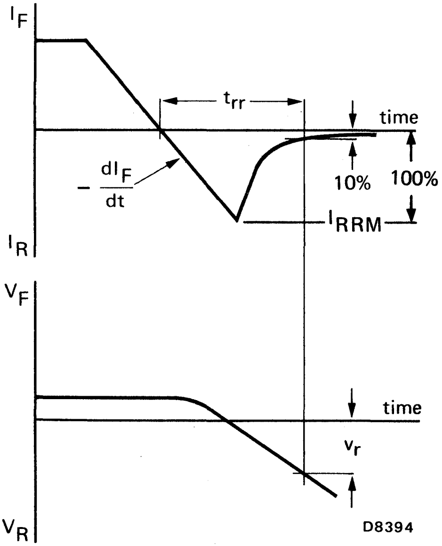


Fig.12 NOMOGRAM

Power loss $\Delta P_{R(AV)}$ due to switching only (to be added to steady state power losses).
I_F = forward current just before switching off; T_j = 150 °C.



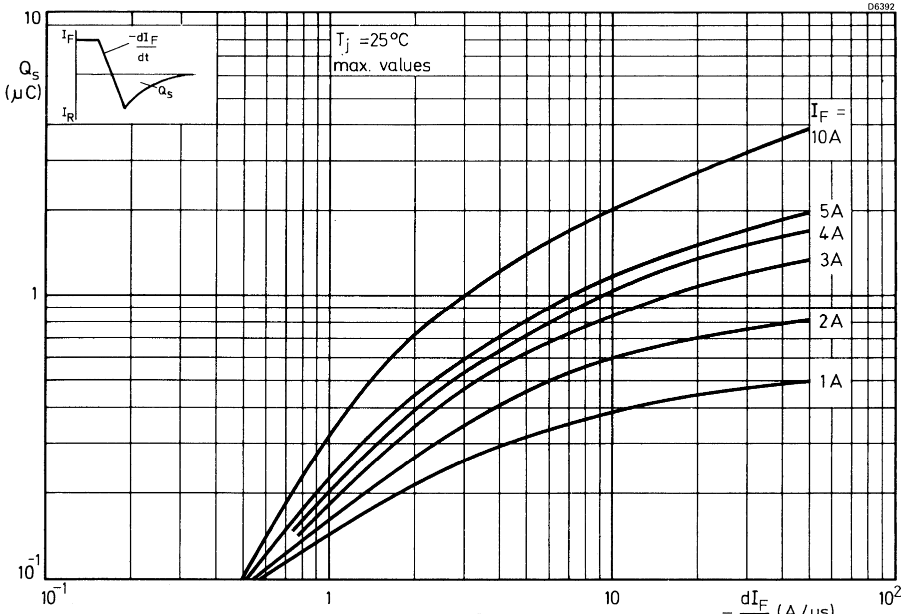

D6392
10
1
10⁻¹
Qs (μC)
IF
IR
−dIF/dt
Qs
Tj =25°C
max. values
IF =
10A
5A
4A
3A
2A
1A
10⁻¹
1
10
10²
−dIF/dt (A/μs)

Fig.13.

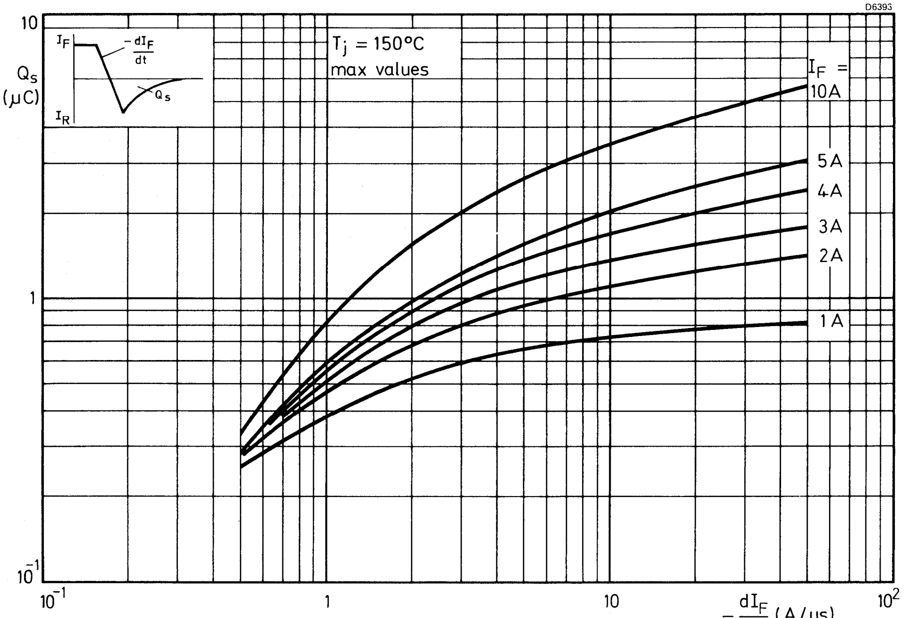

D6393
10
1
10⁻¹
Qs (μC)
IF
IR
−dIF/dt
Qs
Tj = 150°C
max values
IF =
10A
5A
4A
3A
2A
1A
10⁻¹
1
10
10²
−dIF/dt (A/μs)

Fig.14.

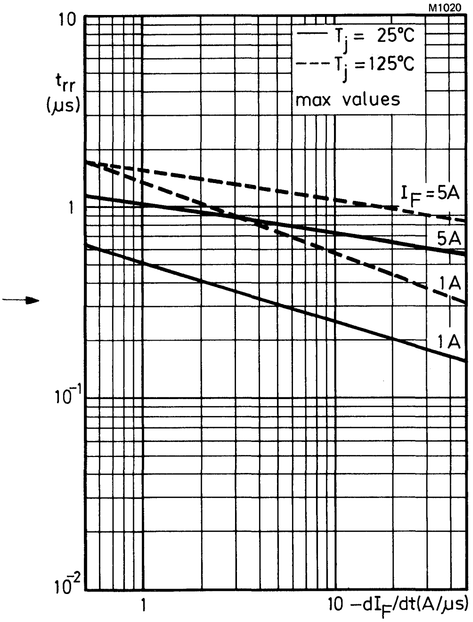


Fig.15.

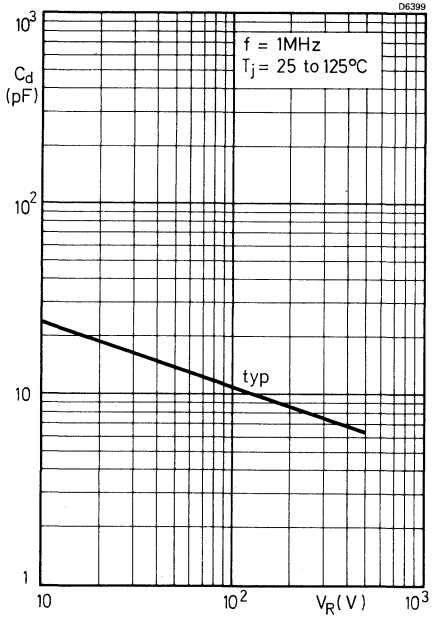


Fig.16.

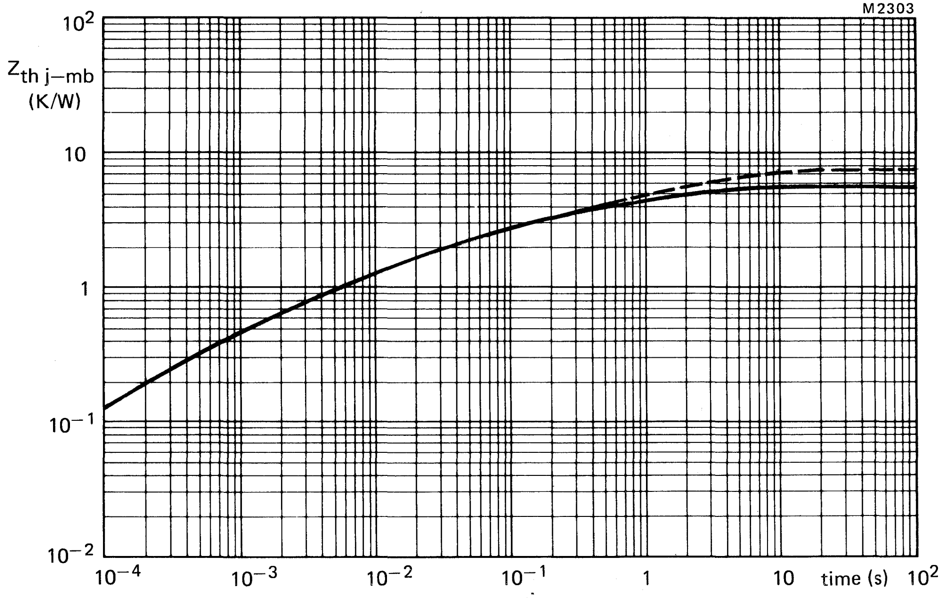


Fig.17 ——— with heatsink compound; – – – – without heatsink compound.

FAST SOFT-RECOVERY RECTIFIER DIODES

Glass-passivated double-diffused rectifier diodes in plastic envelopes, featuring fast reverse recovery times and non-snap-off characteristics. 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 series consists of normal polarity types (cathode to mounting base).

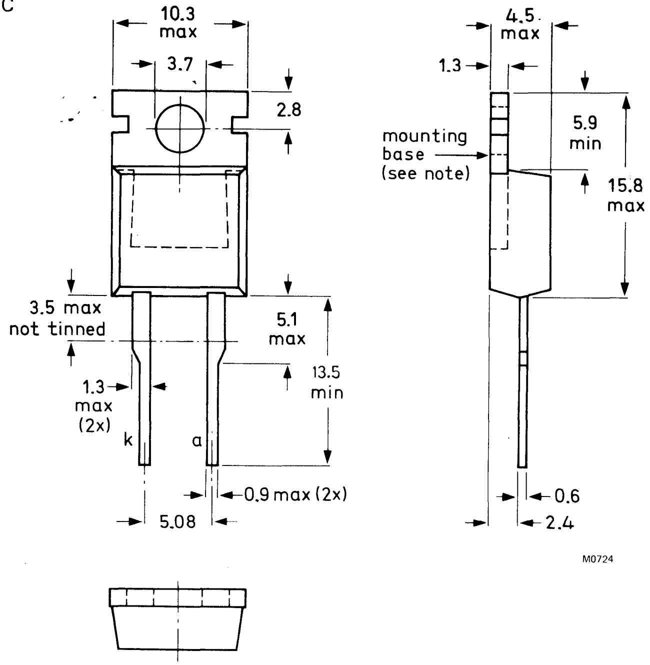
QUICK REFERENCE DATA

			BY329–800	1000	1200	
Repetitive peak reverse voltage	V_{RRM}	max.	800	1000	1200	V
Average forward current	$I_{F(AV)}$	max.		8		A
Non-repetitive peak forward current	I_{FSM}	max.		80		A
Reverse recovery time	t_{rr}	<		150		ns

MECHANICAL DATA

Dimensions in mm

Fig.1 TO-220AC



Note: The exposed metal mounting base is directly connected to the cathode. Accessories supplied on request: see data sheets Mounting instructions and accessories for TO–220 envelopes.

RATINGS

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

Voltages			BY329-800	1000	1200	
Non-repetitive peak reverse voltage	V_{RSM}	max.	800	1000	1200	V
Repetitive peak reverse voltage	V_{RRM}	max.	800	1000	1200	V
Crest working reverse voltage	V_{RWM}	max.	600	800	1000	V

Currents				
Average forward current assuming zero switching losses				
square-wave; $\delta = 0.5$; up to $T_{mb} = 108\ ^{o}C$	$I_{F(AV)}$	max.	8	A
square-wave; $\delta = 0.5$; at $T_{mb} = 125\ ^{o}C$	$I_{F(AV)}$	max.	5.3	A
sinusoidal; up to $T_{mb} = 113\ ^{o}C$	$I_{F(AV)}$	max.	7	A
sinusoidal; at $T_{mb} = 125\ ^{o}C$	$I_{F(AV)}$	max.	5.2	A
R.M.S. forward current	$I_{F(RMS)}$	max.	11	A
Repetitive peak forward current	I_{FRM}	max.	80	A
Non-repetitive peak forward current: $t = 10$ ms half sine-wave; $T_j = 150\ ^{o}C$ prior to surge; with reapplied $V_{RWM\,max}$	I_{FSM}	max.	80	A
→ I^2t for fusing ($t = 10$ ms)	I^2t	max.	32	A^2s

Temperatues				
Storage temperature	T_{stg}		−40 to +150	^{o}C
Junction temperature	T_j	max.	150	^{o}C

THERMAL RESISTANCE

From junction to mounting base	$R_{th\ j\text{-}mb}$	=	3.0	K/W

Influence of mounting method

1. Heatsink mounted with clip (see mounting instructions)

Thermal resistance from mounting base to heatsink

a. with heatsink compound	$R_{th\ mb\text{-}h}$	=	0.3	K/W
b. with heatsink compound and 0.06 mm maximum mica insulator	$R_{th\ mb\text{-}h}$	=	1.4	K/W
c. with heatsink compound and 0.1 mm maximum mica insulator (56369)	$R_{th\ mb\text{-}h}$	=	2.2	K/W
d. with heatsink compound and 0.25 mm maximum alumina insulator (56367)	$R_{th\ mb\text{-}h}$	=	0.8	K/W
e. without heatsink compound	$R_{th\ mb\text{-}h}$	=	1.4	K/W

THERMAL RESISTANCE (continued)

2. Free-air operation $R_{th\ j\text{-}a}$ = 60 °C/W

The quoted value of $R_{th\ j\text{-}a}$ should be used only when no leads of other dissipating components run to the same tie-point. Thermal resistance from junction to ambient in free air: mounted on a printed-circuit board at a = any lead length.

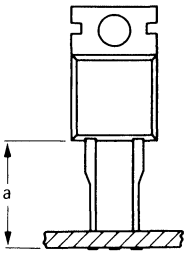


Fig.2

D8397

CHARACTERISTICS

Forward voltage $I_F = 20$ A; $T_j = 25$ °C	V_F	<	1.85	V*
Reverse current $V_R = V_{RWMmax}$; $T_j = 125$ °C	I_R	<	1.0	mA
Reverse recovery when switched from $I_F = 2$ A to $V_R \geqslant 30$ V with $-dI_F/dt = 20$ A/µs; $T_j = 25$ °C Recovered charge	Q_s	<	0.7	µC
$I_F = 1$ A to $V_R \geqslant 30$ V with $-dI_F/dt = 50$ A/µs; $T_j = 25$ °C Recovery time	t_{rr}	<	150	ns
Maximum slope of the reverse recovery current $I_F = 2$ A; $-dI_F/dt = 20$ A/µs; $T_j = 25$ °C	$\lvert dI_R/dt \rvert$	<	60	A/µs

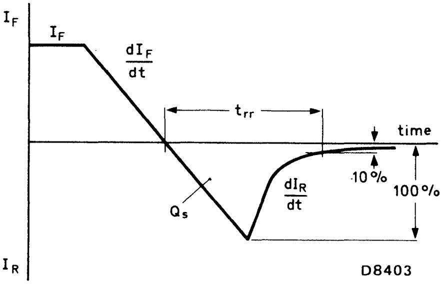


Fig.3 Definition of t_{rr} and Q_s

---

*Measured under pulse conditions to avoid excessive dissipation

MOUNTING INSTRUCTIONS

1. The device may be soldered directly into the circuit, but the maximum permissible temperature of the soldering iron or bath is 275 °C; it must not be in contact with the joint for more than 5 seconds. Soldered joints must be at least 4.7 mm from the seal.
2. The leads should not be bent less than 2.4 mm from the seal, and should be supported during bending. The bend radius must be no less than 1.0 mm.
3. It is recommended that the circuit connection be made to the cathode tag, rather than direct to the heatsink.
4. Mounting by means of a spring clip is the best mounting method because it offers:
   a. a good thermal contact under the crystal area and slightly lower $R_{th\ mb\text{-}h}$ values than screw mounting;
   b. safe isolation for mains operation.
   However, if a screw is used, it should be M3 cross-recess pan head. Care should be taken to avoid damage to the plastic body.
5. For good thermal contact heatsink compound should be used between base-plate and heatsink. Values of $R_{th\ mb\text{-}h}$ given for mounting with heatsink compound refer to the use of a metallic-oxide loaded compound. Ordinary silicone grease is not recommended.
6. Rivet mounting (only possible for non-insulated mounting).

   Devices may be rivetted to flat heatsinks; such a process **must neither** deform the mounting tab, **nor** enlarge the mounting hole.

SQUARE-WAVE OPERATION

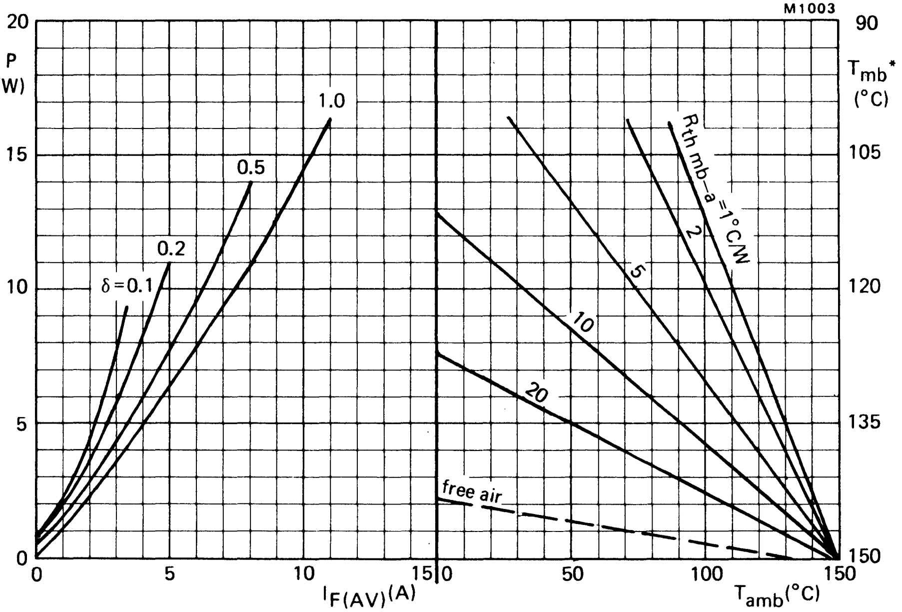
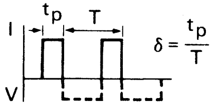


Fig.4 The right-hand part shows the interrelationship between the power (derived from the left-hand part) and the maximum permissible temperatures.
P = power including reverse current losses but excluding switching losses.



$$\delta = \frac{t_p}{T}$$

$I_{F(AV)} = I_{F(RMS)} \times \sqrt{\delta}$

---

*T_{mb} scale is for comparison purposes and is correct only for $R_{th\ mb-a} < 10^{o}C/W$.

SINUSOIDAL OPERATION

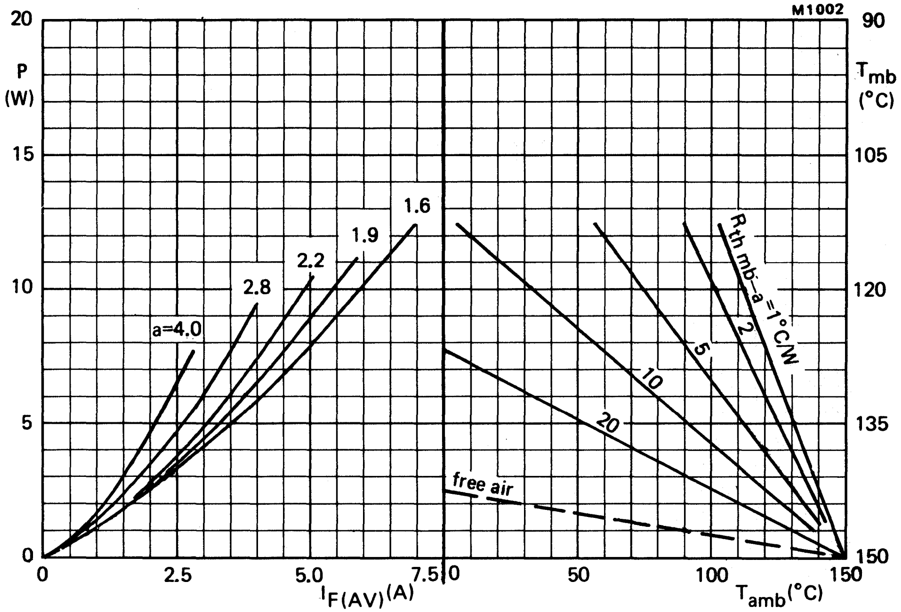


Fig.5 The right-hand part shows the interrelationship between the power (derived from the left-hand part) and the maximum permissible temperatures.

P = power including reverse current losses but excluding switching losses.

a = form factor = $I_{F(RMS)}/I_{F(AV)}$.

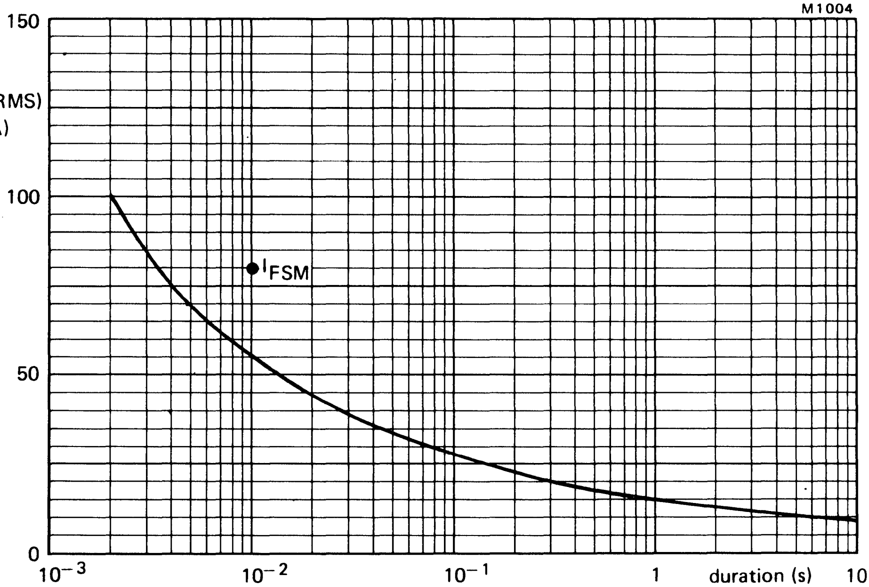
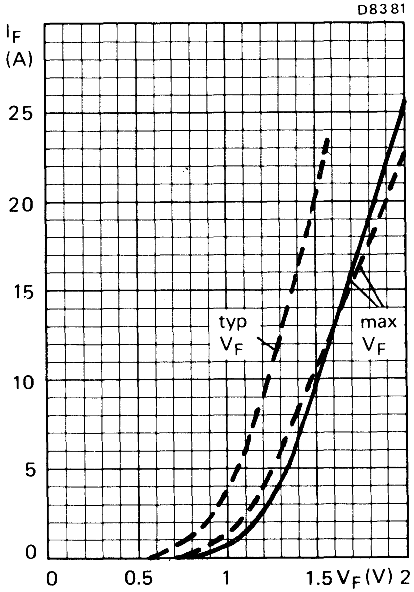


Fig.6 Maximum permissible non-repetitive r.m.s. forward current based on sinusoidal currents (f = 50 Hz); T_j = 150 °C prior to surge; with reapplied V_{RWMmax}.



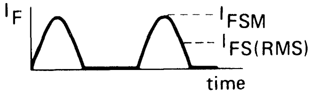


Fig.7 ———— T_j = 25 °C; – – – – T_j = 125 °C

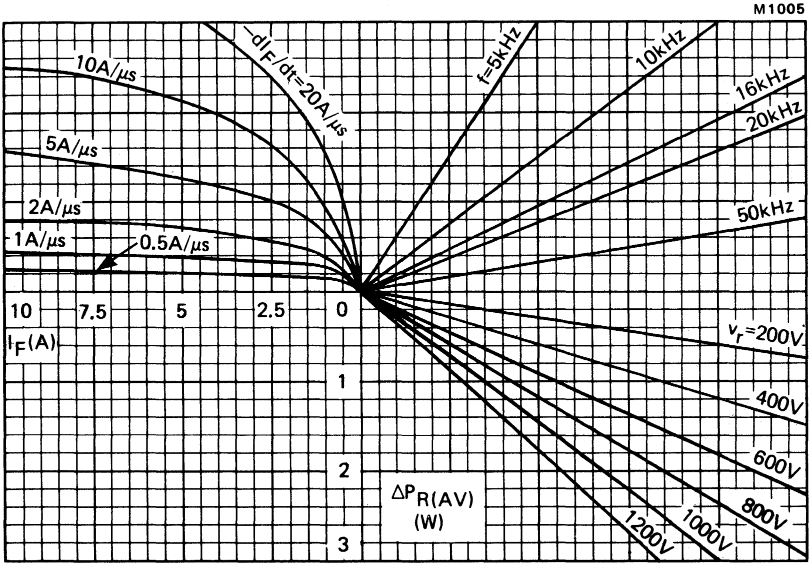
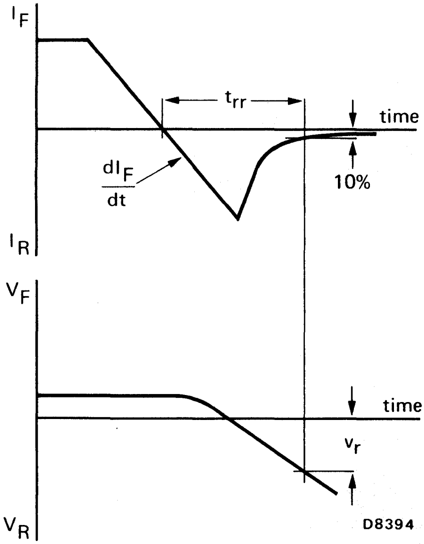


Fig.8 NOMOGRAM

Power loss $\Delta P_{R(AV)}$ due to switching only (to be added to steady state power losses).
I_F = forward current just before switching off; T_j = 150 °C



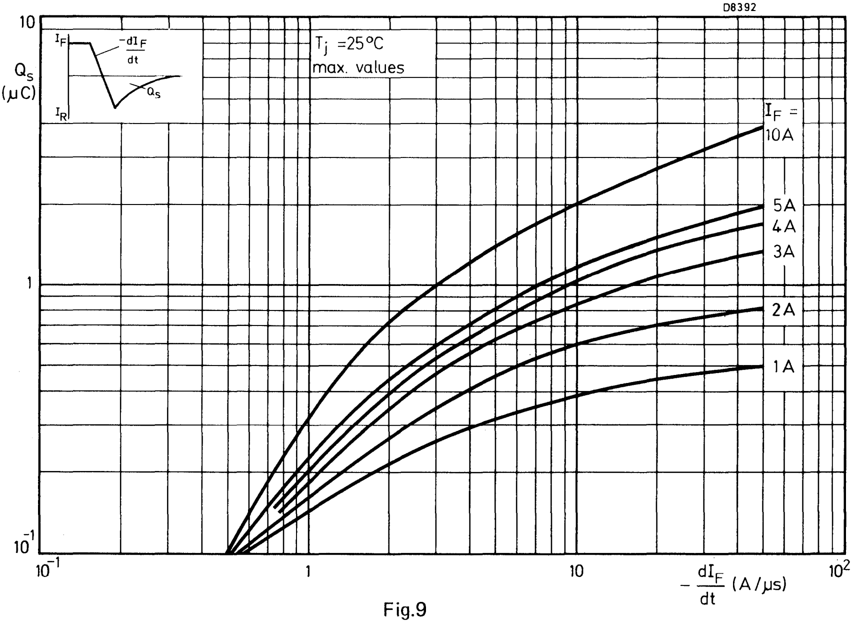

D8392
10
1
10^{-1}
Q_s (μC)
I_F
$-\frac{dI_F}{dt}$
Q_s
I_R
T_j =25°C
max. values
I_F =
10A
5A
4A
3A
2A
1A
10^{-1}
1
10
10^2
$-\frac{dI_F}{dt}$ (A/µs)

Fig.9

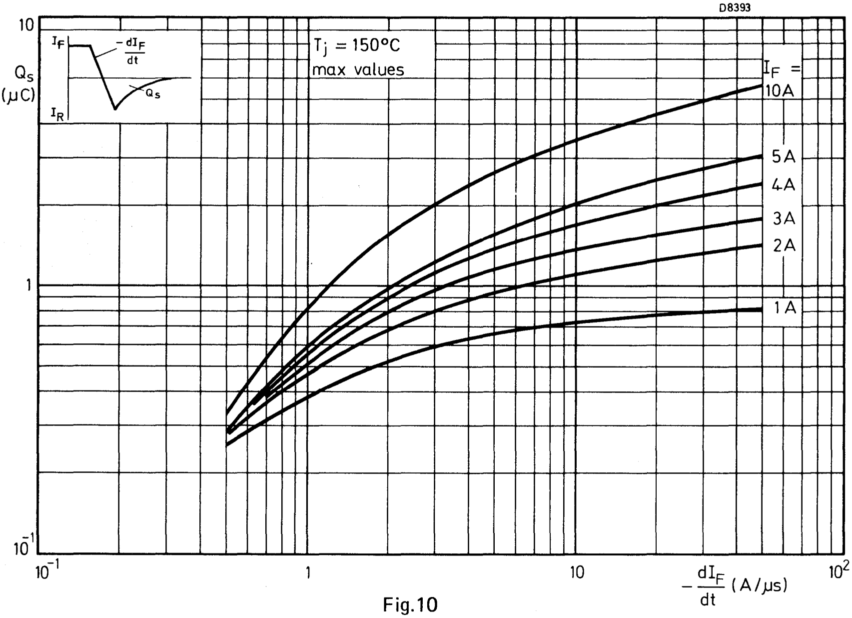

D8393
10
1
10^{-1}
Q_s (μC)
I_F
$-\frac{dI_F}{dt}$
Q_s
I_R
T_j = 150°C
max values
I_F =
10A
5A
4A
3A
2A
1A
10^{-1}
1
10
10^2
$-\frac{dI_F}{dt}$ (A/µs)

Fig.10

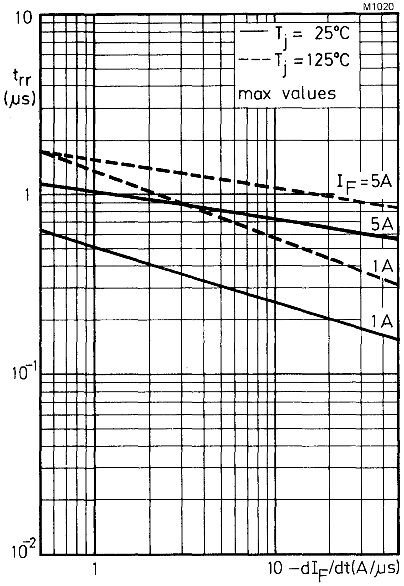


Fig.11

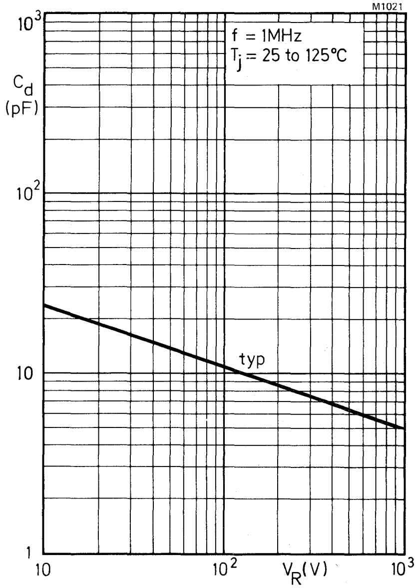


Fig.12

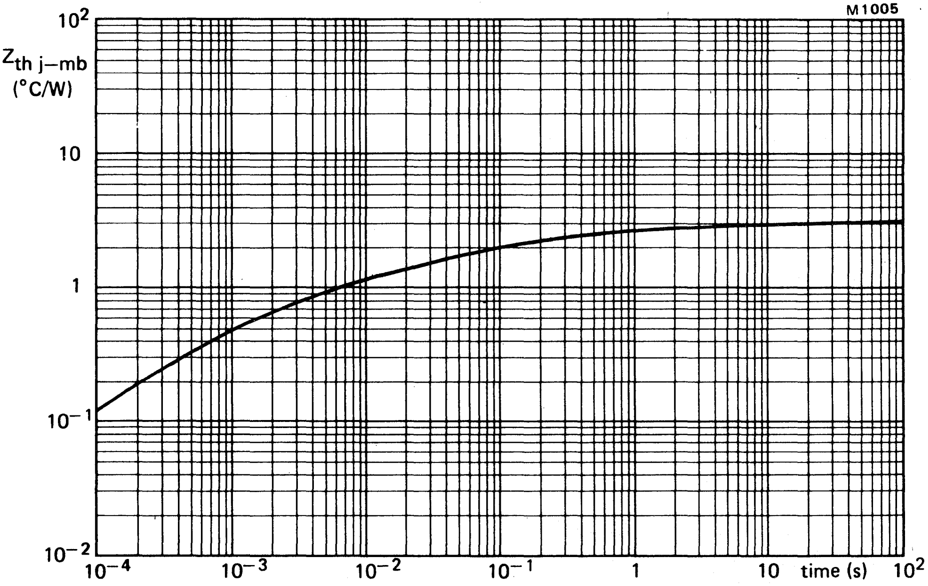


Fig.13

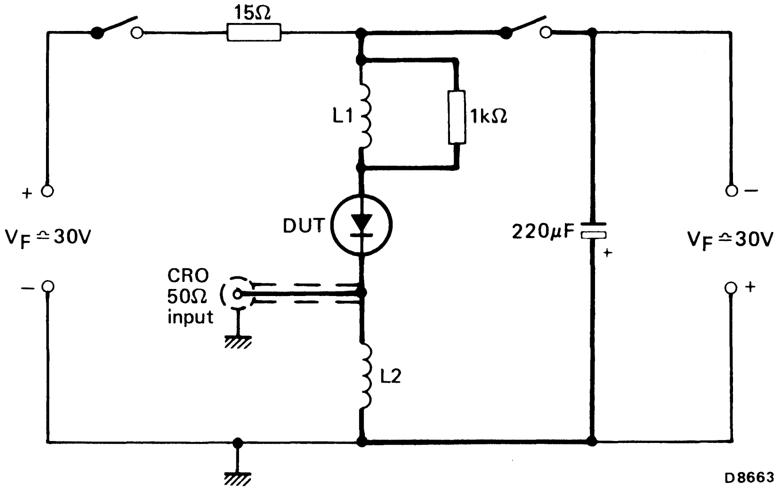


Fig.14 Simplified circuit diagram of practical apparatus to test softness of recovery.

NOTES

1. Duty factor of forward current should be low, <2%.
2. dI_F/dt is set by L1, 1.5 μH gives 20 A/μs.
3. dI_R/dt is measured across L2, 200 nH gives 5A/μs/V.
4. Wiring shown in heavy should be kept as short as possible.

FAST HIGH-VOLTAGE RECTIFIER DIODES

Glass-passivated double-diffused rectifier diodes in TO-220 plastic envelopes, featuring fast recovery times. They are intended for use as an anti-parallel diode to GTOs and similar high-voltage switches, in chopper applications such as Series Resonant Power Supplies (SRPS) and other high-voltage circuits. The series consists of normal polarity types (cathode to mounting base).

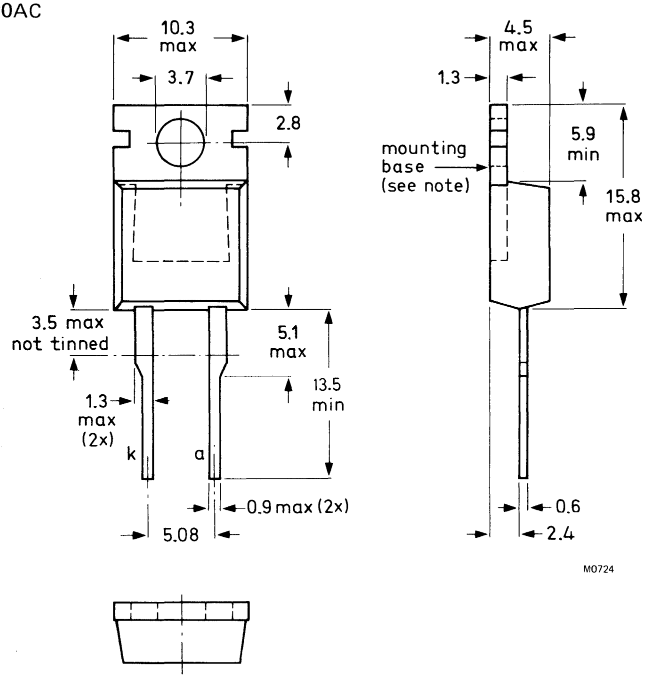
QUICK REFERENCE DATA

			BY359–1000	1300	1500	
Repetitive peak reverse voltage	V_{RRM}	max.	1000	1300	1500	V
Average forward current	$I_{F(AV)}$	max.		6.5		A
Non-repetitive peak forward current	I_{FSM}	max.		60		A
Reverse recovery time	t_{rr}	<		0.6		μs

MECHANICAL DATA

Dimensions in mm

Fig.1 TO-220AC



Note: The exposed metal mounting base is directly connected to the cathode.Accessories supplied on request: see data sheets Mounting instructions and accessories for TO–220 envelopes.

RATINGS

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

Voltages*

			BY359–1000	1300	1500	
Non-repetitive peak reverse voltage	V_{RSM}	max.	1100	1500	1650	
Repetitive peak reverse voltage	V_{RRM}	max.	1000	1300	1500	V
Crest working reverse voltage	V_{RWM}	max.	800	1200	1300	V
Continuous reverse voltage	V_R	max.	600	750	800	V

Currents

Average forward current assuming zero switching losses sinusoidal; up to T_{mb} = 94 °C	$I_{F(AV)}$	max.	6.5	A
R.M.S. forward current	$I_{F(RMS)}$	max.	10	A
Repetitive peak froward current	I_{FRM}	max.	60	A
Non-repetitive peak forward current: t = 10 ms half sine-wave; T_j = 125 °C prior to surge; with reapplied $V_{RWM\,max}$	I_{FSM}	max.	60	A

Temperatures

Storage temperature	T_{stg}		−40 to +150	°C
Junction temperature	T_j	max.	125	°C

THERMAL RESISTANCE

From junction to mounting base	$R_{th\,j\text{-}mb}$	=	3.0	°C/W

Influence of mounting method

1. Heatsink mounted with clip (see mounting instructions)

Thermal resistance from mounting base to heatsink

a. with heatsink compound	$R_{th\,mb\text{-}h}$	=	0.3	°C/W
b. with heatsink compound and 0.06 mm maximum mica insulator	$R_{th\,mb\text{-}h}$	=	1.4	°C/W
c. with heatsink compound and 0.1 mm maximum mica insulator (56369)	$R_{th\,mb\text{-}h}$	=	2.2	°C/W
d. with heatsink compound and 0.25 mm maximum alumina insulator (56367)	$R_{th\,mb\text{-}h}$	=	0.8	°C/W
e. without heatsink compound	$R_{th\,mb\text{-}h}$	=	1.4	°C/W

---

*To ensure thermal stability: $R_{th\,j\text{-}a} \leqslant 10.4$ °C/W for continuous reverse voltage.

THERMAL RESISTANCE (continued)

2. Free-air operation	$R_{th\ j\text{-}a}$	=	60	°C/W

The quoted value of $R_{th\ j\text{-}a}$ should be used only when no leads of other dissipating components run to the same tie-point. Thermal resistance from junction to ambient in free air: mounted on a printed-circuit board at a = any lead length

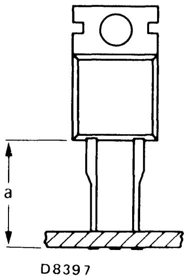


Fig.2

CHARACTERISTICS

Forward voltage $I_F = 20$ A; $T_j = 25$ °C	V_F	<	2.3	V*
Reverse current $V_R = V_{RWMmax}$; $T_j = 100$ °C	I_R	<	0.6	mA
Reverse recovery when switched from $I_F = 2$ A to $V_R \geqslant 30$ V with $-dI_F/dt = 20$ A/μs; $T_j = 25$ °C				
recovered charge	Q_s	<	2.0	μC
recovery time	t_{rr}	<	0.6	μs
Forward recovery when switched to $I_F = 5$ A with $t_r = 0.1$ μs; $T_j = 25$ °C				
recovery time	t_{fr}	<	1.0	μs

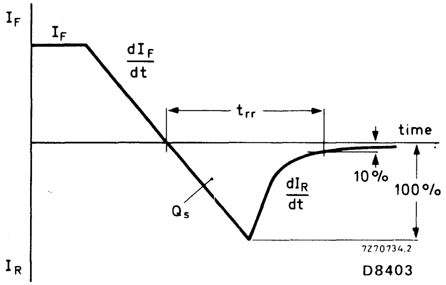


Fig.3 Definition of t_{rr} and Q_s.

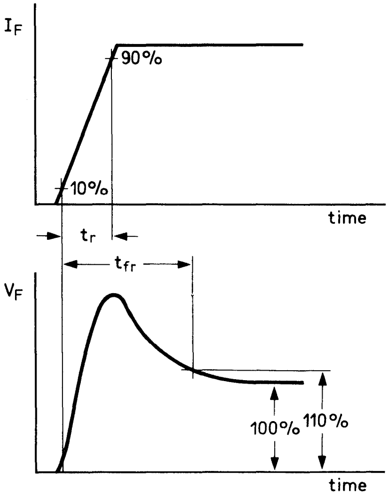


Fig.4 Definition of t_{fr}.

*Measured under pulse conditions to avoid excessive dissipation

MOUNTING INSTRUCTIONS

1. The device may be soldered directly into the circuit, but the maximum permissible temperature of the soldering iron or bath is 275 °C; it must not be in contact with the joint for more than 5 seconds. Soldered joints must be at least 4.7 mm from the seal.
2. The leads should not be bent less than 2.4 mm from the seal, and should be supported during bending. The bend radius must be no less than 1.0 mm.
3. It is recommended that the circuit connection be made to the cathode tag, rather than direct to the heatsink.
4. Mounting by means of a spring clip is the best mounting method because it offers:
   a. a good thermal contact under the crystal area and slightly lower $R_{th\ mb\text{-}h}$ values than screw mounting;
   b. safe isolation for mains operation.
   However, if a screw is used, it should be M3 cross-recess pan head. Care should be taken to avoid damage to the plastic body.
5. For good thermal contact heatsink compound should be used between base-plate and heatsink. Values of $R_{th\ mb\text{-}h}$ given for mounting with heatsink compound refer to the use of a metallic-oxide loaded compound. Ordinary silicone grease is not recommended.
6. Rivet mounting (only possible for non-insulated mounting).

   Devices may be rivetted to flat heatsinks; such a process **must neither** deform the mounting tab, **nor** enlarge the mounting hole.

SINUSOIDAL OPERATION

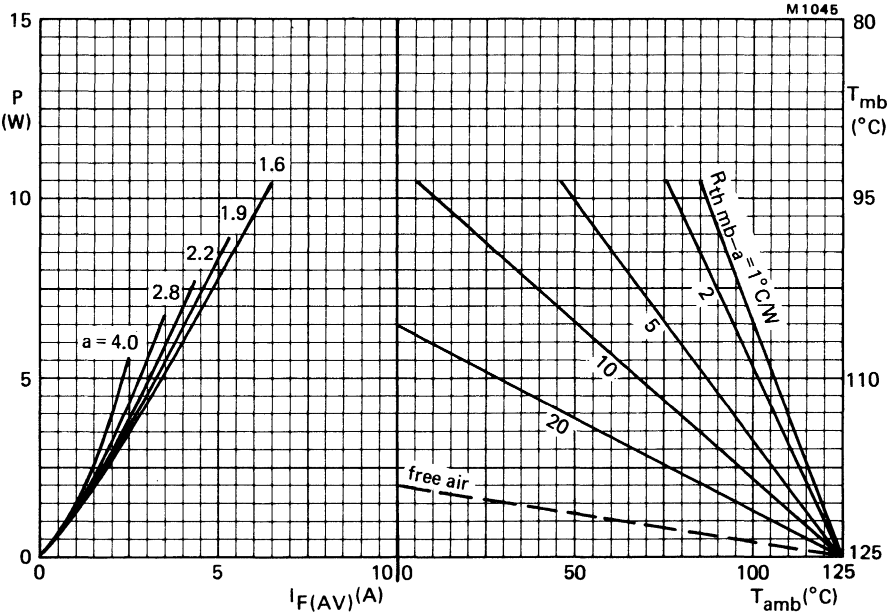


Fig.5 The right-hand part shows the interrelationship between the power (derived from the left-hand part) and the maximum permissible temperatures.
P = power including reverse current losses but excluding switching losses.
a = form factor = $I_{F(RMS)}/I_{F(AV)}$.

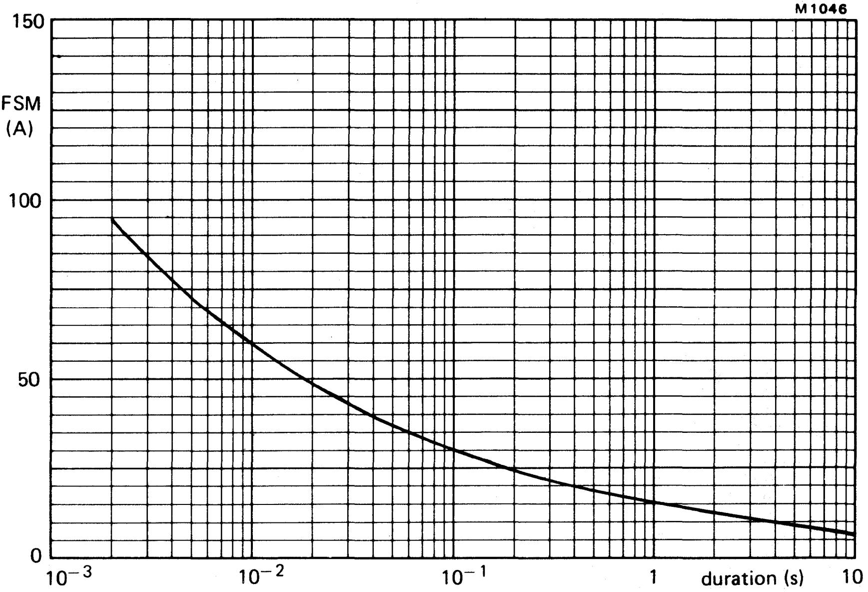
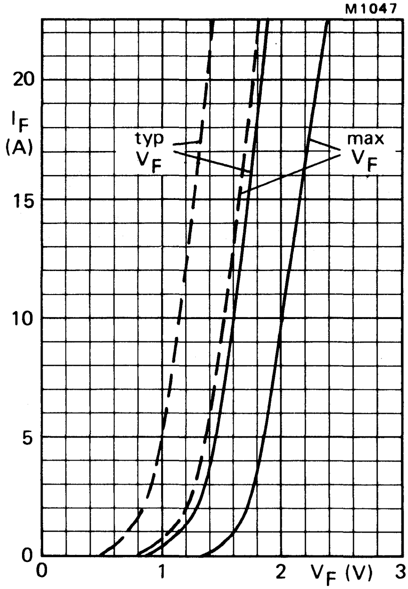


Fig.6 Maximum permissible non-repetitive peak forward current based on sinusoidal currents (f = 50 Hz); T_j = 125 °C prior to surge; with reapplied V_{RWMmax}.



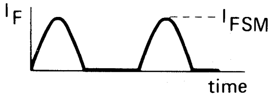


Fig.7 ——— T_j = 25 °C; – – – – T_j = 100 °C.

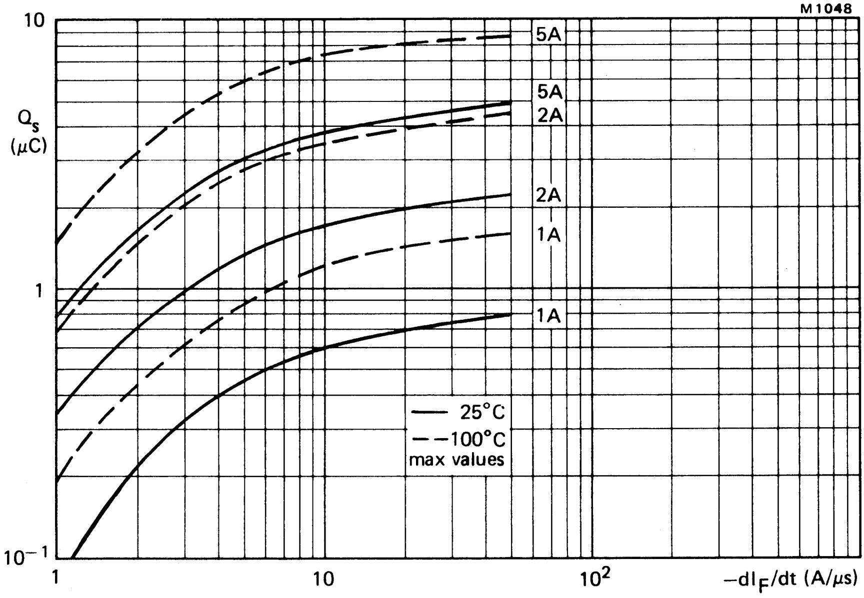

M1048
10
Q_s
(μC)
1
10^{-1}
1
10
10^2
$-dI_F/dt$ (A/μs)
5A
5A
2A
2A
1A
1A
25°C
100°C
max values

Fig.8

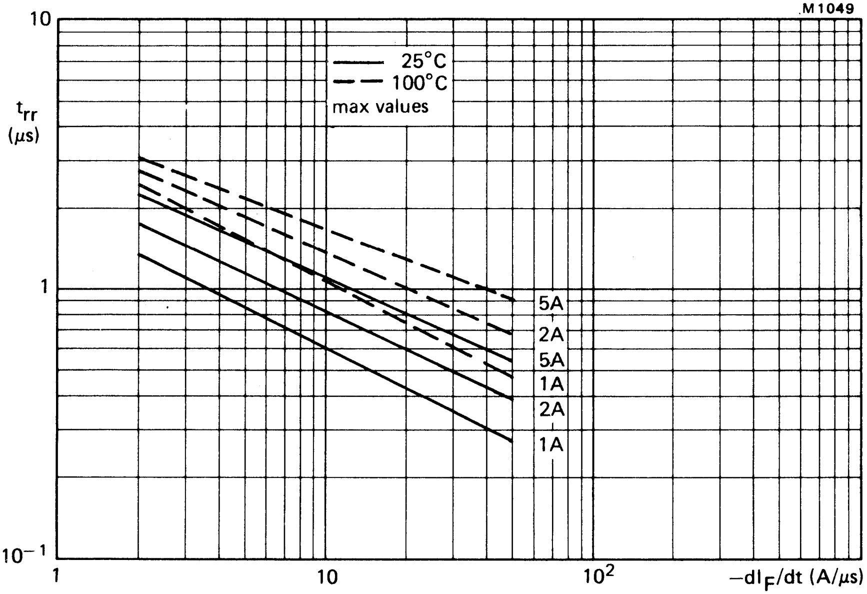

M1049
10
t_{rr}
(μs)
1
10^{-1}
1
10
10^2
$-dI_F/dt$ (A/μs)
25°C
100°C
max values
5A
2A
5A
1A
2A
1A

Fig.9

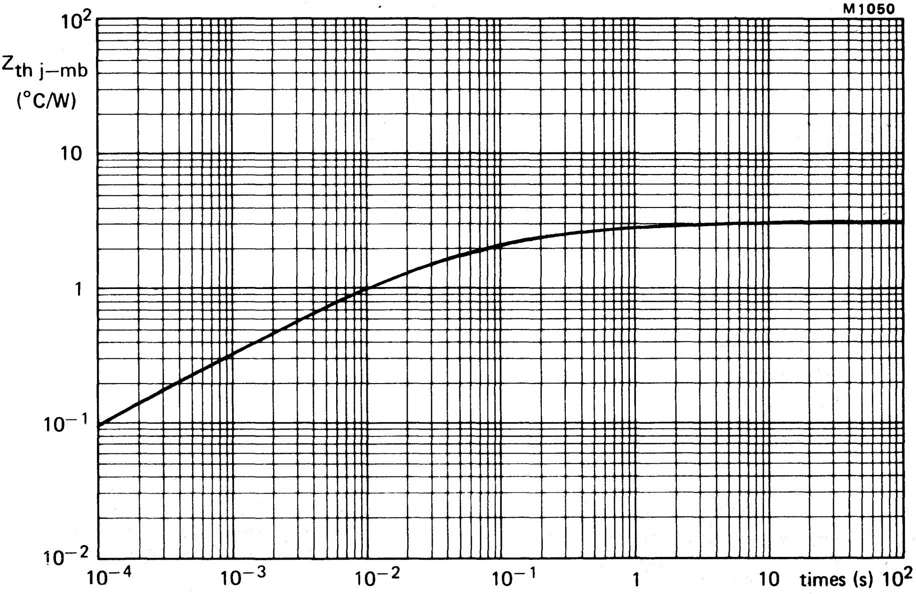


Fig.10

ULTRA FAST-RECOVERY RECTIFIER DIODES FEATURING LOW REVERSE LEAKAGE

Glass-passivated, high-efficiency epitaxial rectifier diodes in plastic envelopes, featuring low reverse leakage current, low forward voltage drop, ultra fast reverse recovery times, very low stored charge and soft recovery characteristics. They are intended for use in switched-mode power supplies and high-frequency circuits in general, where both low conduction and low switching losses are essential. The series consists of normal polarity (cathode to mounting base) types.

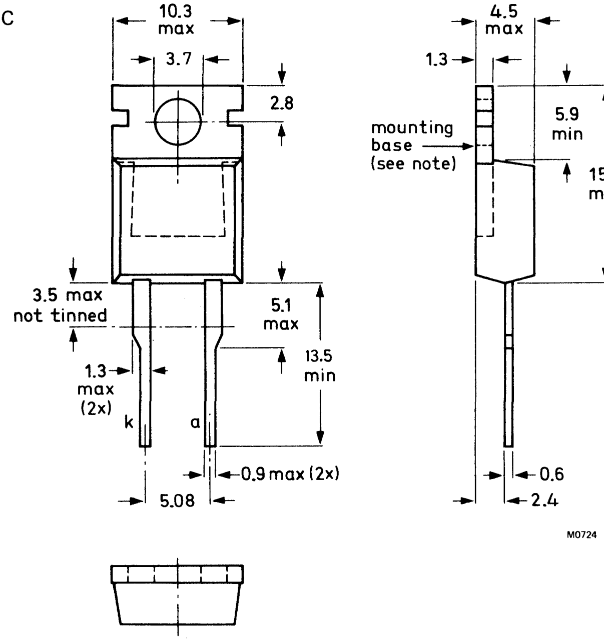
QUICK REFERENCE DATA

			BYP21-50	100	150	200	
Repetitive peak reverse voltage	V_{RRM}	max.	50	100	150	200	V
Average forward current	$I_{F(AV)}$	max.	8				A
Forward voltage	V_F	$<$	0.895				V
Reverse recovery time	t_{rr}	$<$	25				ns
Reverse leakage current	I_R	$<$	5				μA

MECHANICAL DATA

Dimensions in mm

Fig.1 TO-220AC



Net mass: 2 g

Note: The exposed metal mounting base is directly connected to the cathode.

Accessories supplied on request: see data sheets Mounting instructions and accessories for TO-220 envelopes.

RATINGS

Limiting values in accordance with the Absulute Maximum System (IEC 134).

			BYP21-50	100	150	200	
Voltages							
Repetitive peak reverse voltage	V_{RRM}	max.	50	100	150	200	V
Crest working reverse voltage	V_{RWM}	max.	50	100	150	200	V
Continuous reverse voltage	V_R	max.	50	100	150	200	V
Currents							
Average forward current; switching losses negligible up to 500 kHz square wave; $\delta = 0.5$; up to $T_{mb} = 150\ ^{o}C$	$I_{F(AV)}$	max.	8				A
sinusoidal; up to $T_{mb} = 150\ ^{o}C$	$I_{F(AV)}$	max.	9.4				A
R.M.S. forward current	$I_{F(RMS)}$	max.	11.5				A
Repetitive peak forward current $t_p = 20\ \mu s$; $\delta = 0.02$	I_{FRM}	max.	175				A
Non-repetitive peak forward current half sine-wave; $T_j = 175\ ^{o}C$ prior to surge; with reapplied V_{RWMmax}							
$t = 10$ ms	I_{FSM}	max.	80				A
$t = 8.3$ ms	I_{FSM}	max.	100				A
I^2t for fusing ($t = 10$ ms)	I^2t	max.	32				A^2s
Temperatures							
Storage temperature	T_{stg}		–65 to +175				^{o}C
Junction temperature	T_j	max.	175				^{o}C

THERMAL RESISTANCE

From junction to mounting base	$R_{th\ j\text{-}mb}$	=	2.7	K/W

Influence of mounting method

1. Heatsink mounted with clip (see mounting instructions)

Thermal resistance from mounting base to heatsink

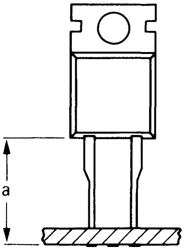
a. with heatsink compound	$R_{th\ mb\text{-}h}$	=	0.3	K/W
b. with heatsink compound and 0.06 mm maximum mica insulator	$R_{th\ mb\text{-}h}$	=	1.4	K/W
c. with heatsink compound and 0.1 mm maximum mica washer (56369)	$R_{th\ mb\text{-}h}$	=	2.2	K/W
d. with heatsink compound and 0.25 mm maximum alumina insulator (56367)	$R_{th\ mb\text{-}h}$	=	0.8	K/W
e. without heatsink compound	$R_{th\ mb\text{-}h}$	=	1.4	K/W

2. Free air operation

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

Thermal resistance from junction to ambient in free air:
mounted on a printed circuit board at

a = any lead length	$R_{th\ j\text{-}a}$	60	K/W



D8397

Fig.2

CHARACTERISTICS

Forward voltage				
$I_F = 8$ A; $T_j = 100$ °C	V_F	<	0.895	V*
$I_F = 8$ A; $T_j = 25$ °C	V_F	<	1.045	V*
$I_F = 20$ A; $T_j = 25$ °C	V_F	<	1.15	V*
Reverse current				
$V_R = V_{RWMmax}$; $T_j = 175$ °C	I_R	<	500	μA
$T_j = 125$ °C	I_R	<	250	μA
$T_j = 100$ °C	I_R	<	50	μA
$T_j = 25$ °C	I_R	<	5	μA
Reverse recovery when switched from $I_F = 1$ A to $V_R \geqslant 30$ V with $-dI_F/dt = 100$ A/μs; $T_j = 25$ °C; recovery time	t_{rr}	<	25	ns
Step reverse recovery when switched from $I_F = 0.5$ A to $I_R = 1$ A, measured at $I_{RR} = 0.25$ A; recovery time	t_{rr}	<	25	ns
$I_F = 2$ A to $V_R \geqslant 30$ Vwith $-dI_F/dt = 20$ A/μs; $T_j = 25$ °C; recovered charge	Q_s	<	15	nC
$I_F = 10$ A to $V_R \geqslant 30$ V with $-dI_F/dt = 50$ A/μs; $T_j = 100$ °C; peak recovery current	I_{RRM}	<	2	A
Forward recovery when switched to $I_F = 1$ A with $dI_F/dt = 10$ A/μs; $T_j = 25$ °C	V_{fr}	typ.	0.9	V

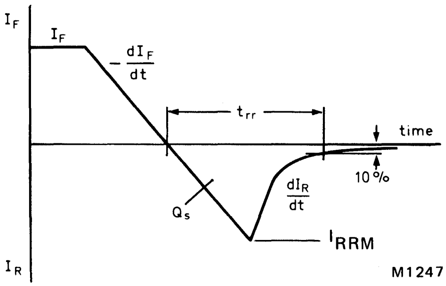


Fig.3 Definition of t_{rr}, Q_s and I_{RRM}.

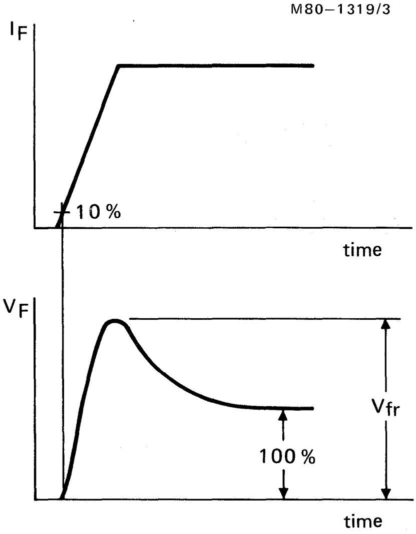


Fig.4 Definition of V_{fr}.

*Measured under pulse conditions to avoid excessive dissipation.

MOUNTING INSTRUCTIONS

1. The device may be soldered directly into the circuit, but the maximum permissible temperature of the soldering iron or bath is 275 ^{o}C; the heat source must not be in contact with the joint for more than 5 seconds. Soldered joints must be at least 4.7 mm from the seal.
2. The leads should not be bent less than 2.4 mm from the seal, and should be supported during bending. The bend radius must be no less than 1.0 mm.
3. Mounting by means of a spring clip is the best mounting method because it offers:
   a. a good thermal contact under the crystal area and slightly lower $R_{th\ mb\text{-}h}$ values than does screw mounting.
   b. safe isolation for mains operation.
   However, if a screw is used, it should be M3 cross-recess pan head. Care should be taken to avoid damage to the plastic body.
4. For good thermal contact, heatsink compound should be used between mounting base and heatsink. Values of $R_{th\ mb\text{-}h}$ given for mounting with heatsink compound refer to the use of a metallic oxide-loaded compound. Ordinary silicone grease is not recommended.
5. Rivet mounting (only possible for non-insulated mounting).
   Devices may be rivetted to flat heatsinks; such a process must **neither** deform the mounting tab, **nor** enlarge the mounting hole.

OPERATING NOTES

Dissipation and heatsink considerations:

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

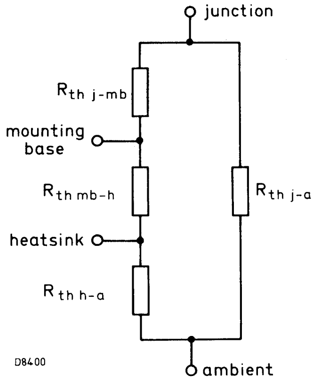


Fig.5

b. The method of using Figs.6 and 7 is as follows:
Starting with the required current on the $I_{F(AV)}$ axis, trace upwards to meet the appropriate duty factor or form factor curve. Trace right horizontally and upwards from the appropriate value on the T_{amb} scale. The intersection determines the $R_{th\ mb\text{-}a}$. The heatsink thermal resistance value ($R_{th\ h\text{-}a}$) can now be calculated from:

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

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

SQUARE-WAVE OPERATION

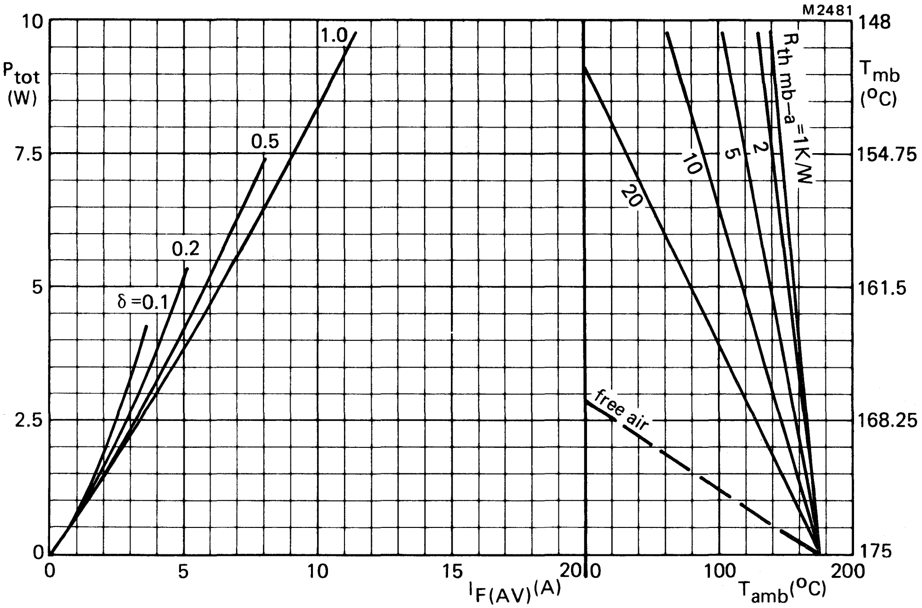
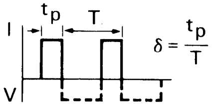


Fig.6 The right-hand part shows the relationship between the power (derived from the left-hand part) and the maximum permissible temperatures. Power includes reverse current losses and switching losses up to f = 500 kHz.



$I_{F(AV)} = I_{F(RMS)} \times \sqrt{\delta}$

SINUSOIDAL OPERATION

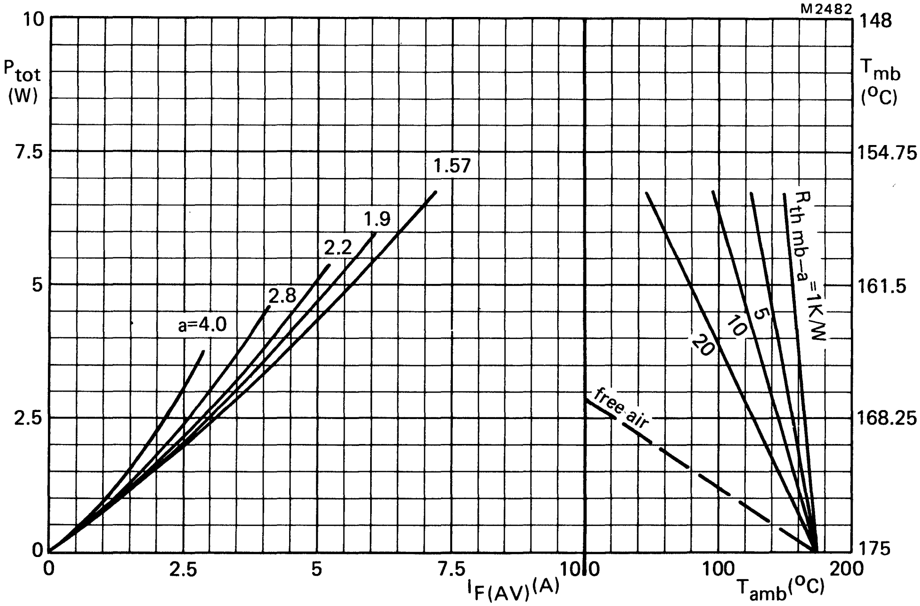


Fig.7 The right-hand part shows the interrelationship between the power (derived from the left-hand part) and the maximum permissible temperatures.
a = form factor = $I_{F(RMS)}/I_{F(AV)}$.

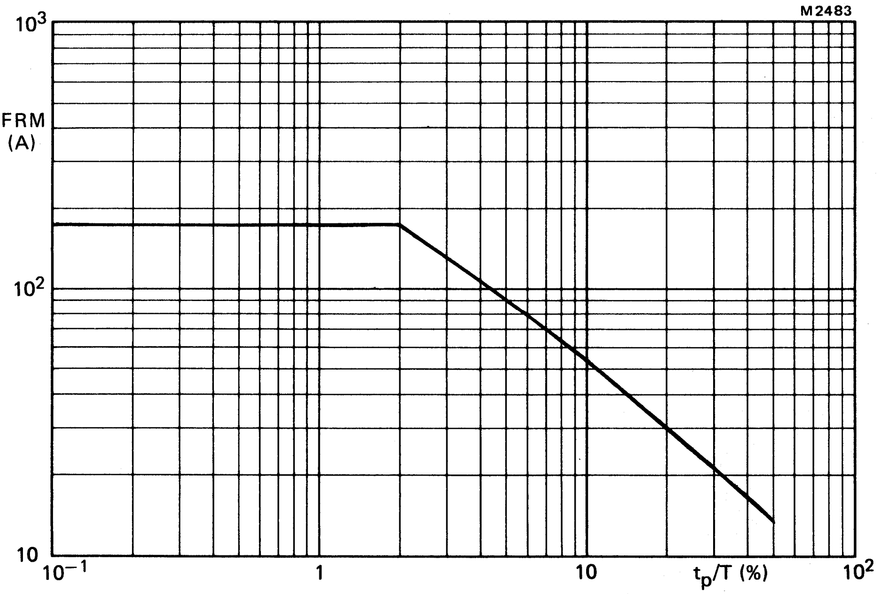
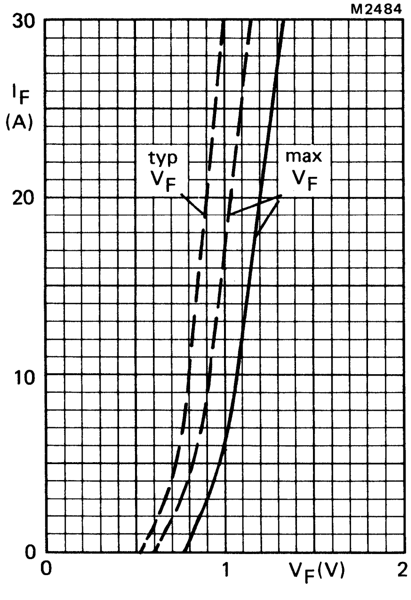
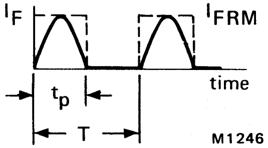


Fig.8 Maximum permissible repetitive peak forward current for square or sinusoidal currents; 1 µs $< t_p <$ 1 ms.





Definition of I_{FRM} and t_p/T.

Fig.9 —— T_j = 25 °C; – – – T_j = 100 °C.

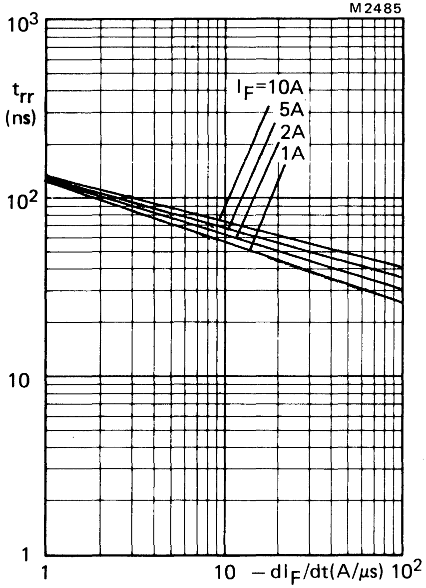


Fig.10 Maximum t_{rr} at T_j = 25 °C.

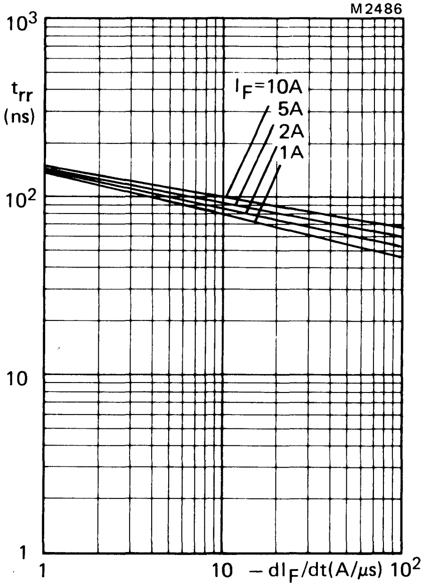


Fig.11 Maximum t_{rr} at T_j = 100 °C.

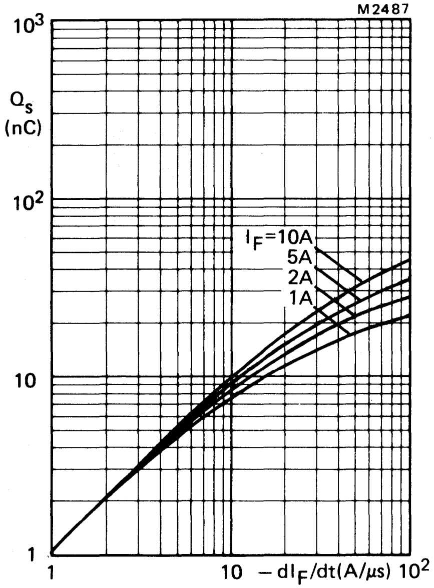


Fig.12 Maximum Q_s at T_j = 25 °C.

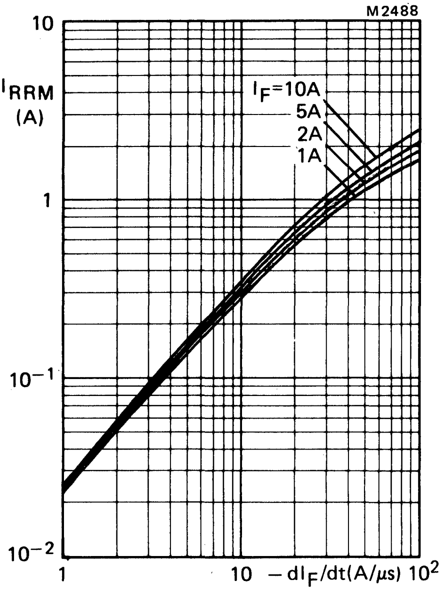


Fig.13 Maximum I_{RRM} at T_j = 25 °C.

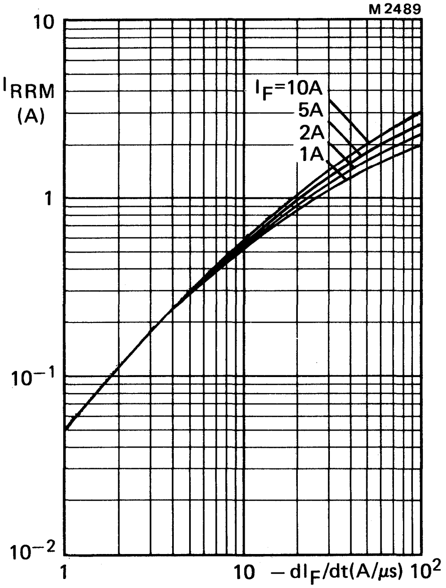


Fig.14 Maximum I_{RRM} at T_j = 100 °C.

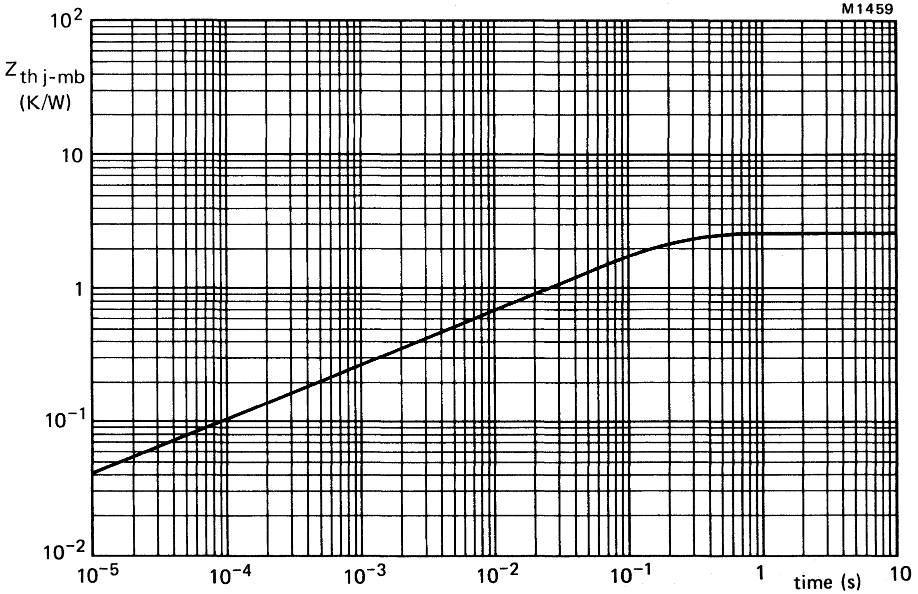


Fig.15 Transient thermal impedance.

ULTRA FAST-RECOVERY DOUBLE RECTIFIER DIODES FEATURING LOW REVERSE LEAKAGE

Glass-passivated, high-efficiency epitaxial rectifier diodes in plastic envelopes, featuring low reverse leakage current, low forward voltage drop, ultra fast reverse recovery times with very low stored charge and soft recovery characteristics. They are intended for use in switched-mode power supplies and high frequency circuits in general, where both low conduction and low switching losses are essential. Their single chip construction ensures excellent matching of the forward and switching characteristics of the two halves, allowing parallel operation without the need for derating. The series consists of common-cathode types.

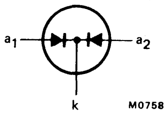
QUICK REFERENCE DATA

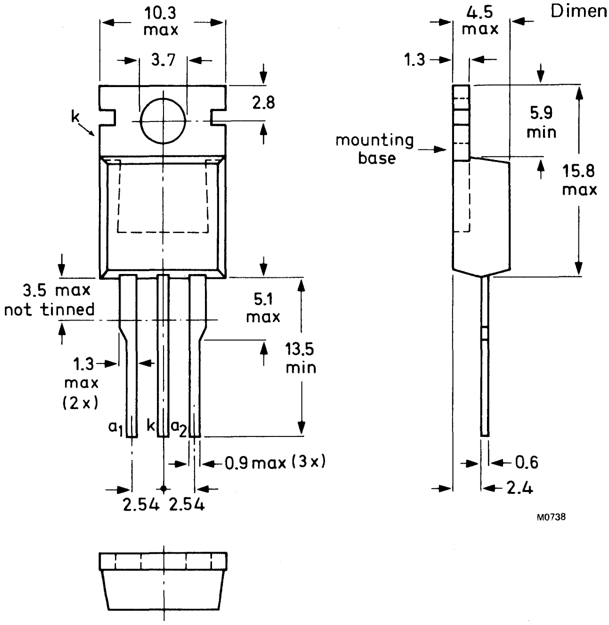
Per diode, unless otherwise stated			BYP22-50	100	150	200	
Repetitive peak reverse voltage	V_{RRM}	max.	50	100	150	200	V
Output current (both diodes conducting)	I_O	max.	20				A
Forward voltage	V_F	$<$	0.895				V
Reverse recovery time	t_{rr}	$<$	25				ns
Reverse leakage current	I_R	$<$	5				μA

MECHANICAL DATA

Fig.1 TO-220AB

Dimensions in mm





Net mass: 2 g

Accessories supplied on request: see data sheets Mounting instructions and accessories for TO-220 envelopes.

RATINGS

Limiting values in accordance with the Absulute Maximum System (IEC 134).

Voltages			BYP22-50	100	150	200	
Repetitive peak reverse voltage	V_{RRM}	max.	50	100	150	200	V
Crest working reverse voltage	V_{RWM}	max.	50	100	150	200	V
Continuous reverse voltage	V_R	max.	50	100	150	200	V

Currents (both diodes conducting; note 1)				
Output current; switching losses negligible up to 500 kHz; square wave; $\delta = 0.5$; up to $T_{mb} = 150\ ^{o}C$	I_O	max.	16	A
square wave; $\delta = 0.5$; up to $T_{mb} = 143\ ^{o}C$	I_O	max.	20	A
sinusoidal; up to $T_{mb} = 150\ ^{o}C$	I_O	max.	16	A
R.M.S. forward current	$I_{F(RMS)}$	max.	20	A
Repetitive peak forward current $t_p = 20\ \mu s$; $\delta = 0.02$ (note 2)	I_{FRM}	max.	230	A
Non-repetitive peak forward current half sine-wave; $T_j = 175\ ^{o}C$ prior to surge; with reapplied V_{RWM}max. (note 2)				
$t = 10$ ms	I_{FSM}	max.	140	A
$t = 8.3$ ms	I_{FSM}	max.	150	A
I^2t for fusing ($t = 10$ ms; note 2)	I^2t	max.	98	A^2s
Temperatures				
Storage temperature	T_{stg}		−65 to +175	^{o}C
Junction temperature	T_j	max.	175	^{o}C

Notes

1. The limits for both diodes apply whether both diodes conduct simultaneously or on alternate half cycles.
2. Figures apply to each diode.

THERMAL RESISTANCE

From junction to mounting base; total package	$R_{th\ j\text{-}mb}$	=	1.6	K/W
per diode	$R_{th\ j\text{-}mb}$	=	2.4	K/W

Influence of mounting method

1. Heatsink mounted with clip (see mounting instructions)

Thermal resistance from mounting base to heatsink

a. with heatsink compound	$R_{th\ mb\text{-}h}$	=	0.3	K/W
b. with heatsink compound and 0.06 mm maximum mica insulator	$R_{th\ mb\text{-}h}$	=	1.4	K/W
c. with heatsink compound and 0.1 mm maximum mica washer (56369)	$R_{th\ mb\text{-}h}$	=	2.2	K/W
d. with heatsink compound and 0.25 mm maximum alumina insulator (56367)	$R_{th\ mb\text{-}h}$	=	0.8	K/W
e. without heatsink compound	$R_{th\ mb\text{-}h}$	=	1.4	K/W

2. Free air operation

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

Thermal resistance from junction to ambient in free air:
mounted on a printed circuit board at any lead length $R_{th\ j\text{-}a}$ 60 K/W

CHARACTERISTICS

Forward voltage				
$I_F = 8$ A; $T_j = 100$ °C	V_F	<	0.895	V*
$I_F = 8$ A; $T_j = 25$ °C	V_F	<	0.975	V*
$I_F = 20$ A; $T_j = 25$ °C	V_F	<	1.15	V*
Reverse current				
$V_R = V_{RWMmax}$; $T_j = 175$ °C	I_R	<	500	µA
$T_j = 125$ °C	I_R	<	250	µA
$T_j = 100$ °C	I_R	<	50	µA
$T_j = 25$ °C	I_R	<	5	µA
Reverse recovery when switched from $I_F = 1$ A to $V_R \geqslant 30$ V with $-dI_F/dt = 100$ A/µs; $T_j = 25$ °C; recovery time	t_{rr}	<	25	ns
Step reverse recovery when switched from $I_F = 0.5$ A to $I_R = 1$ A, measured at $I_{RR} = 0.25$ A; recovery time	t_{rr}	<	25	ns
$I_F = 2$ A to $V_R \geqslant 30$ V with $-dI_F/dt = 20$ A/µs; $T_j = 25$ °C; recovered charge	Q_s	<	15	nC
$I_F = 10$ A to $V_R \geqslant 30$ V with $-dI_F/dt = 50$ A/µs; $T_j = 100$ °C; peak recovery current	I_{RRM}	<	2	A
Forward recovery when switched to $I_F = 1$ A with $dI_F/dt = 10$ A/µs; $T_j = 25$ °C	V_{fr}	typ.	0.9	V

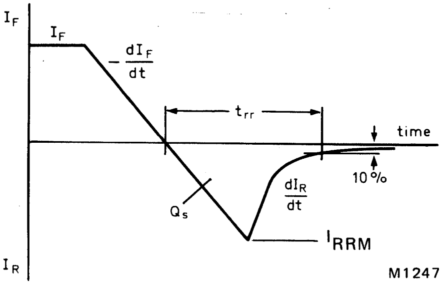


Fig.2 Definition of t_{rr}, Q_s and I_{RRM}.

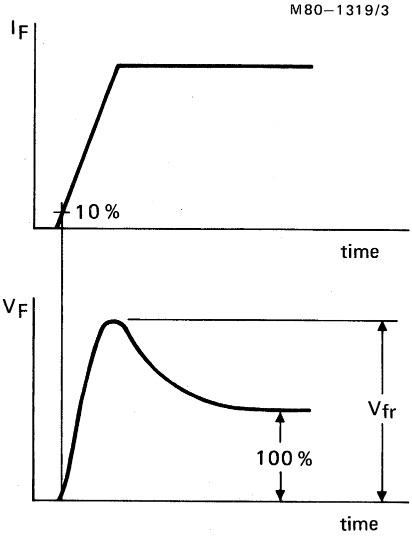


Fig.3 Definition of V_{fr}.

*Measured under pulse conditions to avoid excessive dissipation.

MOUNTING INSTRUCTIONS

1. The device may be soldered directly into the circuit, but the maximum permissible temperature of the soldering iron or bath is 275 °C; the heat source must not be in contact with the joint for more than 5 seconds. Soldered joints must be at least 4.7 mm from the seal.
2. The leads should not be bent less than 2.4 mm from the seal, and should be supported during bending. The bend radius must be no less than 1.0 mm.
3. Mounting by means of a spring clip is the best mounting method because it offers:
   a. a good thermal contact under the crystal area and slightly lower $R_{th\ mb\text{-}h}$ values than does screw mounting.
   b. safe isolation for mains operation.
   However, if a screw is used, it should be M3 cross-recess pan head. Care should be taken to avoid damage to the plastic body.
4. For good thermal contact heatsink compound should be used between mounting base and heatsink. Values of $R_{th\ mb\text{-}h}$ given for mounting with heatsink compound refer to the use of a metallic-oxide loaded compound. Ordinary silicone grease is not recommended.
5. Rivet mounting (only possible for non-insulated mounting).
   Devices may be rivetted to flat heatsinks; such a process **must neither** deform the mounting tab, **nor** enlarge the mounting hole.

OPERATING NOTES

Dissipation and heatsink considerations:

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

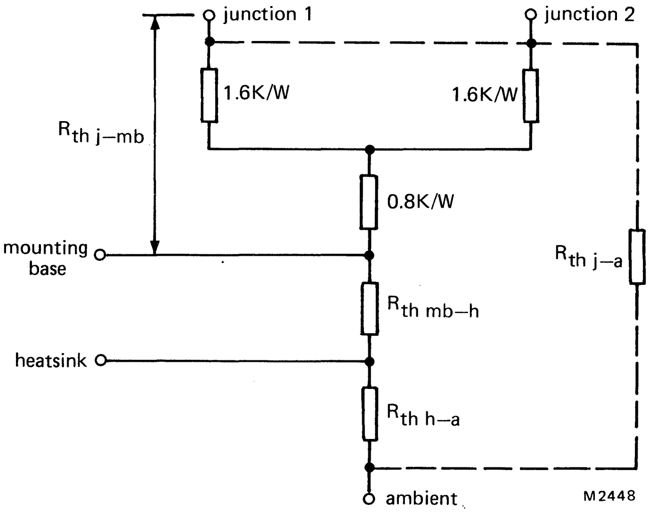


Fig.4

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

SQUARE-WAVE OPERATION (PER DIODE)

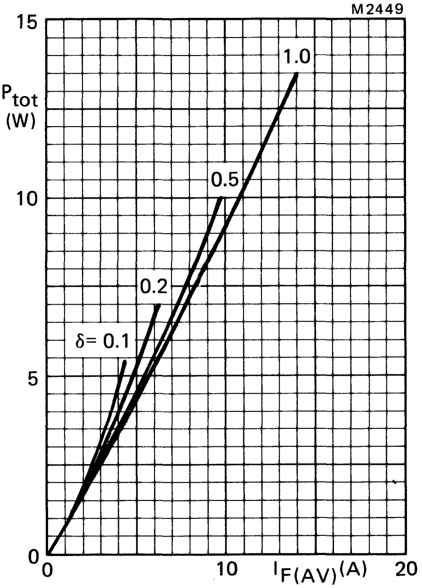
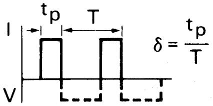


Fig.5 Power rating per diode.
The individual power loss in each diode should first be determined then both added together. The resulting total power loss is then used in conjunction with Fig.6 to determine the heatsink size and corresponding maximum ambient and mounting base temperatures.



$$\delta = \frac{t_p}{T}$$

$$I_{F(AV)} = I_{F(RMS)} \times \sqrt{\delta}$$

Power includes reverse current losses and switching losses up to f = 500 kHz

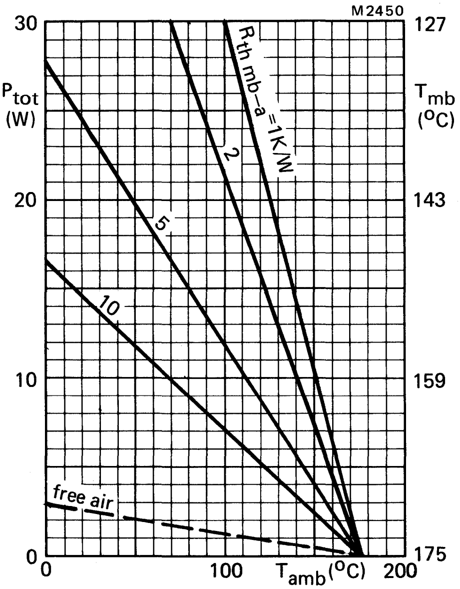


Fig.6

SINUSOIDAL OPERATION (PER DIODE)

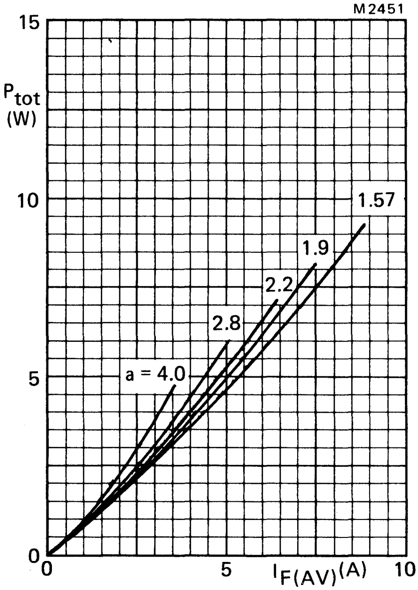


Fig.7 Power rating per diode.
The individual power loss in each diode should first be determined then both added together. The resulting total power loss is then used in conjunction with Fig.6 to determine the heatsink size and corresponding maximum ambient and mounting base temepratures.

a = form factor = $I_{F(RMS)}/I_{F(AV)}$

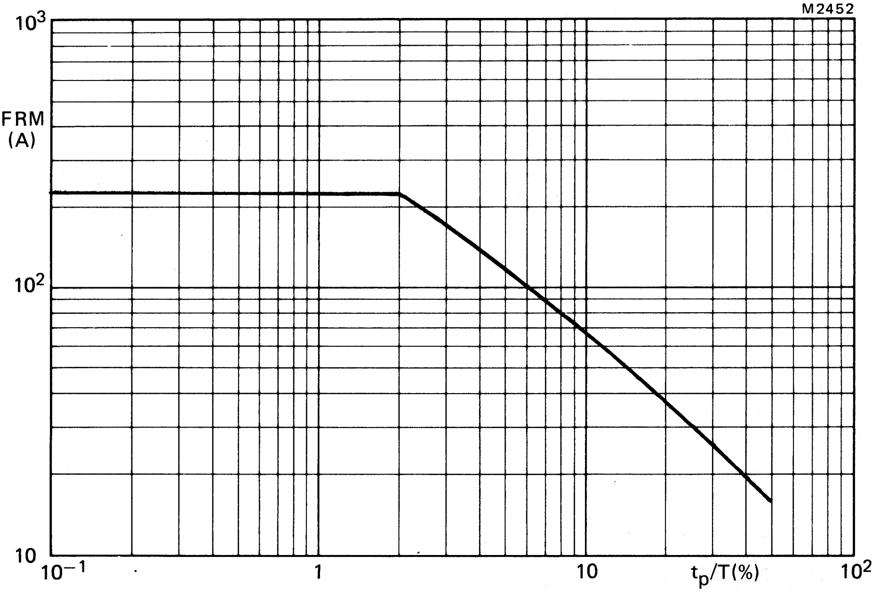
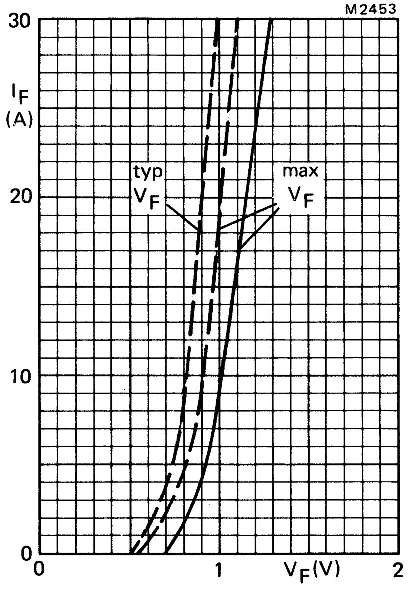
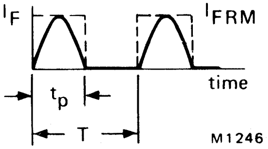


Fig.8 Maximum permissible repetitive peak forward current for either square or sinusoidal currents for 1 $\mu s < t_p < 1$ ms.





Definition of I_{FRM} and t_p/T.

Fig.9 —— $T_j = 25$ °C; – – – $T_j = 100$ °C.
per diode.

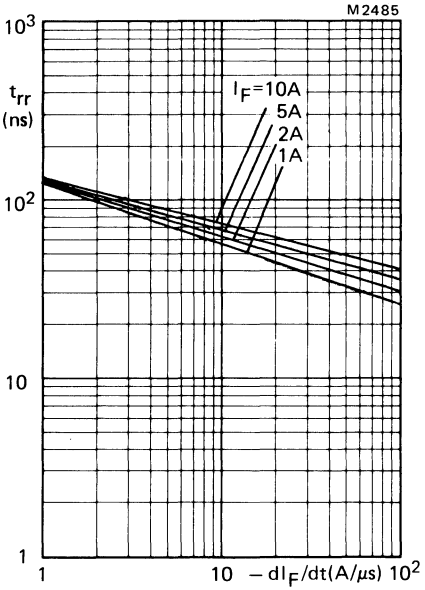


Fig.10 Maximum t_{rr} at T_j = 25 °C.

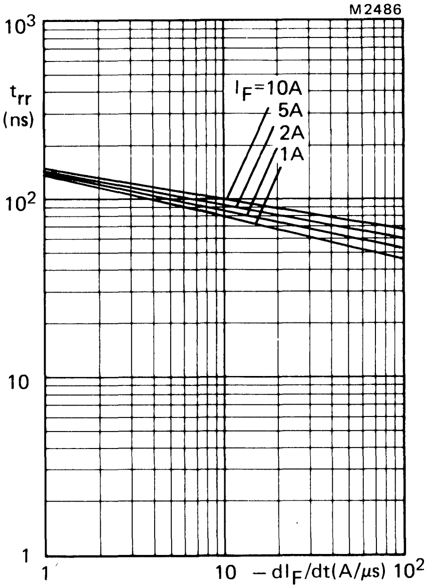


Fig.11 Maximum t_{rr} at T_j = 100 °C.

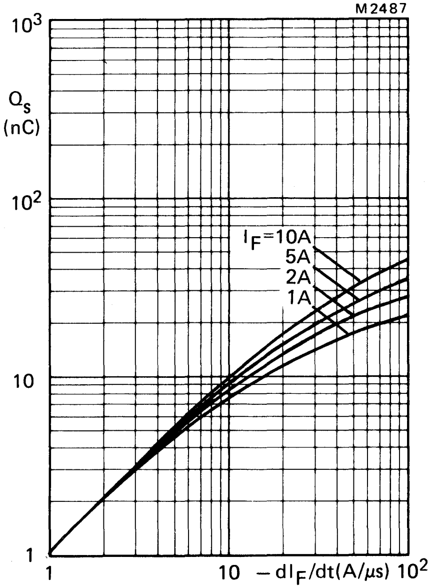


Fig.12 Maximum Q_s at T_j = 25 °C.

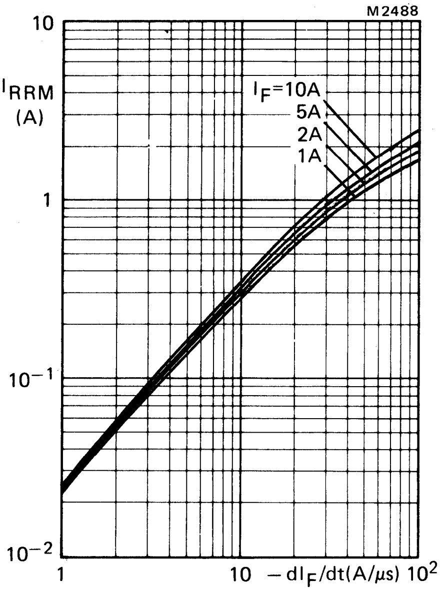


Fig.13 Maximum I_{RRM} at T_j = 25 °C.

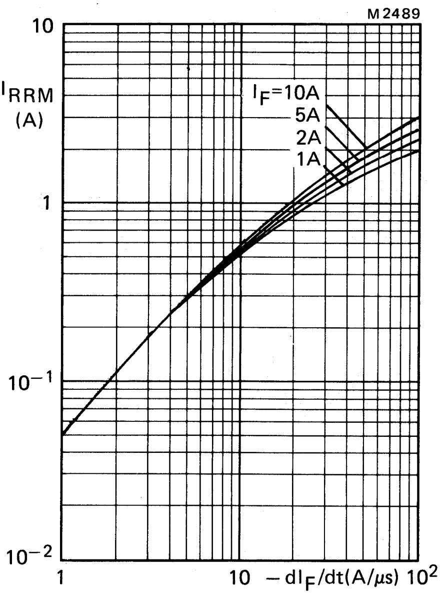


Fig.14 Maximum I_{RRM} at T_j = 100 °C.

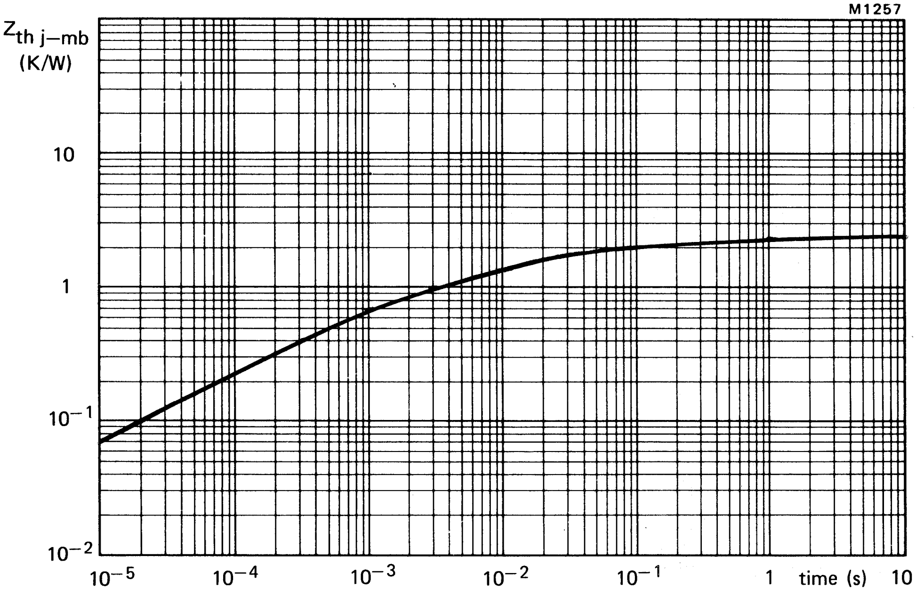


Fig.15 Transient thermal impedance; one diode conducting.

ULTRA FAST RECOVERY RECTIFIER DIODES FEATURING LOW REVERSE LEAKAGE

Glass-passivated, high-efficiency epitaxial rectifier diodes in DO–5 metal envelopes, featuring low reverse leakage current, low forward voltage drop, ultra fast reverse recovery times with very low stored charge and soft-recovery characteristic. They are intended for use in switched-mode power supplies and high-frequency circuits in general, where both low conduction losses and low switching losses are essential.
The series consists of normal polarity (cathode to stud) types.

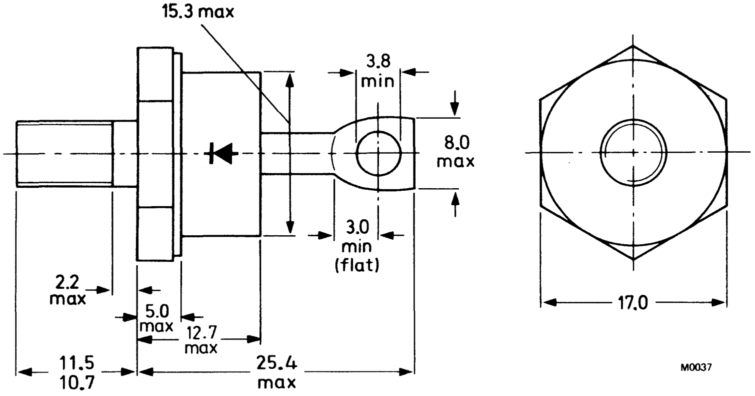
QUICK REFERENCE DATA

			BYP59–300	400	
Repetitive peak reverse voltage	V_{RRM}	max.	300	400	V
Average forward current	$I_{F(AV)}$	max.	60		A
Forward voltage	V_F	<	1.05		V
Reverse recovery time	t_{rr}	<	60		V
Reverse leakage current	I_R	<	25		μA

MECHANICAL DATA

Dimensions in mm

Fig.1 DO–5: with ¼ in x 28 UNF stud (ϕ6.35 mm); e.g. BYP59-300U,
with metric M6 stud (ϕ6 mm); e.g. BYP59-300M.



Net mass: 22 g

Diameter of clearance hole: max. 6.5 mm

Accessories supplied on request:
56264a (mica washer)
56264b (insulating bush).

Supplied with device: 1 nut, 1 lock washer

Torque on nut: min. 1.7 Nm (17 kg cm),
max. 3.5 Nm (35 kg cm).

Nut dimensions across the flats:
¼ in x 28 UNF: 11.1 mm. M6: 10.0 mm.

RATINGS

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

Voltages			BYP59–300	400	
Repetitive peak reverse voltage	V_{RRM}	max.	300	400	V
Crest working reverse voltage	V_{RWM}	max.	200	300	V
Continuous reverse voltage	V_R	max.	200	300	V

Currents				
Average forward current; switching losses negligible up to 200 kHz; square wave; $\delta = 0.5$; up to $T_{mb} = 100\ ^oC$	$I_{F(AV)}$	max.	60	A
R.M.S. foward current	$I_{F(RMS)}$	max.	85	A
Repetitive peak forward current $t_p = 20\ \mu s$, $\delta = 0.02$	I_{FRM}	max.	1200	A
Non-repetitive peak forward current half sine-wave; $T_j = 150\ ^oC$ prior to surge; with reapplied $V_{RWM\ max}$				
t = 10 ms	I_{FSM}	max.	650	A
t = 8.3 ms	I_{FSM}	max.	700	A
I^2t for fusing (t = 10 ms)	I^2t	max.	2100	A^2s
Temperatures				
Storage temperature	T_{stg}		−55 to +150	^oC
Junction temperature	T_j	max.	150	^oC

THERMAL RESISTANCE

From junction to mounting base	$R_{th\ j\text{-}mb}$	=	0.7	K/W
From mounting base to heatsink:				
a. with heatsink compound	$R_{th\ mb\text{-}h}$	=	0.2	K/W
b. without heatsink compound	$R_{th\ mb\text{-}h}$	=	0.3	K/W

MOUNTING INSTRUCTIONS

The top connector should be neither 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.

CHARACTERISTICS

Forward voltage				
I_F = 60 A; T_j = 150 °C	V_F	<	1.05	V*
I_F = 150 A; T_j = 25 °C	V_F	<	1.4	V*
Reverse current				
$V_R = V_{RWM\,max}$; T_j = 100 °C	I_R	<	0.5	mA
$V_R = V_{RWM\,max}$; T_j = 25 °C	I_F	<	25	µA
Reverse recovery when switched from				
I_F = 1 A to $V_R \geqslant 30$ V with $-dI_F/dt$ = 100 A/µs; T_j = 25 °C; recovery time	t_{rr}	<	60	ns
I_F = 2 A to $V_R \geqslant 30$ V with $-dI_F/dt$ = 20 A/µs; T_j = 25 °C; recovered charge	Q_s	<	100	nC
I_F = 10 A to $V_R \geqslant 30$ V with $-dI_F/dt$ = 50 A/µs; T_j = 100 °C; peak recovery current	I_{RRM}	<	5	A
Forward recovery when switched to I_F = 10 A with dI_F/dt = 10 A/µs; T_j = 25 °C	V_{fr}	typ.	2.5	V

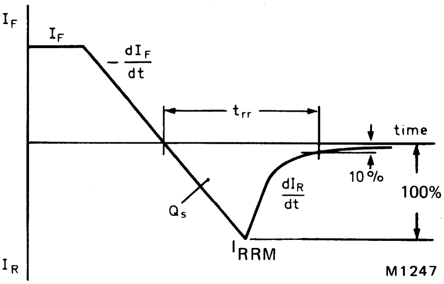


Fig.2 Definition of t_{rr}, Q_s and I_{RRM}.

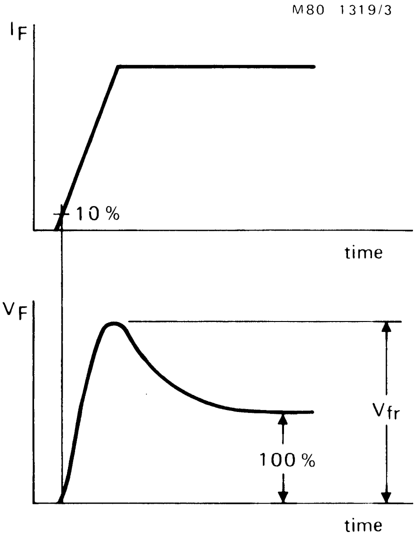


Fig.3 Defintion of V_{fr}.

---

*Measured under pulse conditions to avoid excessive dissipation

ULTRA FAST RECOVERY DOUBLE RECTIFIER DIODES

Glass-passivated, high-efficiency double rectifier diodes in plastic envelopes, featuring low forward voltage drop, ultra fast reverse recovery times and soft recovery characteristic. They are intended for use in switched-mode power supplies and high-frequency circuits in general, where both low conduction losses and low switching losses are essential. Their single chip (monolithic) construction ensures excellent matching of the forward and switching characteristics of the two halves, allowing parallel operation without the need for derating. The series consists of common cathode types.

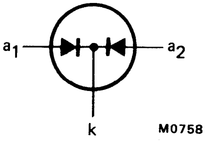
QUICK REFERENCE DATA

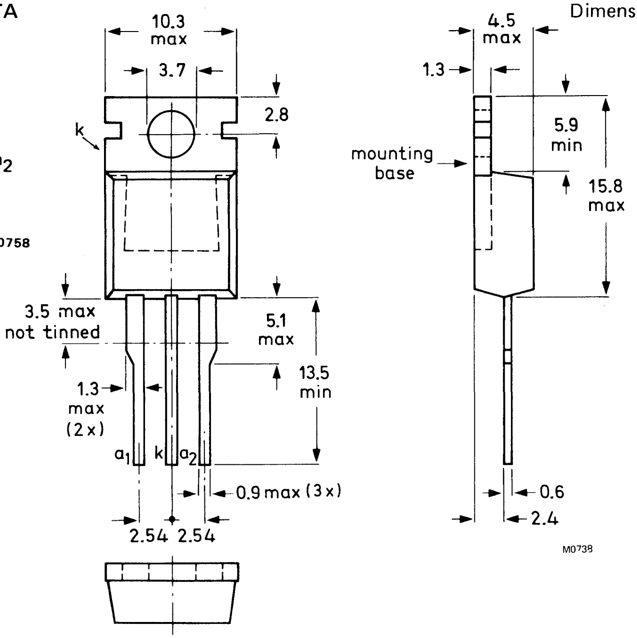
Per diode, unless otherwise stated			BYQ28–50	100	150	200	
Repetitive peak reverse voltage	V_{RRM}	max.	50	100	150	200	V
Output current (both diodes conducting)	I_O	max.	10				A
Forward voltage	V_F	<	0.85				V
Reverse recovery time	t_{rr}	<	20				ns

MECHANICAL DATA

Fig.TO-220AB

Dimensions in mm





Net mass: 2 g

Note: the exposed metal mounting base is directly connected to the common cathode.

Accessories supplied on request: see data sheets Mounting Instructions and accessories for TO-220 envelopes.

RATINGS

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

Voltages (per diode)			BYQ28–50	100	150	200	
Repetitive peak reverse voltage	V_{RRM}	max.	50	100	150	200	V
Crest working reverse voltage	V_{RWM}	max.	50	100	150	200	V
Continuous reverse voltage	V_R	max.	50	100	150	200	V

Currents (both diodes conducting; note 1)				
Output current; switching losses negligible up to 500 kHz;				
square wave; $\delta = 0.5$; up to T_{mb} = 128 °C	I_O	max.	10	A
sinusoidal; up to T_{mb} = 130 °C	I_O	max.	10	A
R.M.S. forward current	$I_{F(RMS)}$	max.	14	A
Repetitive peak forward current t_p = 20 µs, δ = 0.02 (per diode)	I_{FRM}	max.	80	A
Non-repetitive peak forward current (per diode) half sine-wave; T_j = 150 °C prior to surge; with reapplied $V_{RWM\,max}$				
t = 10 ms	I_{FSM}	max.	50	A
t = 8.3 ms	I_{FSM}	max.	60	A
I^2t for fusing (t = 10 ms, per diode)	I^2t	max.	12.5	A^2s
Temperatures				
Storage temeprature	T_{stg}		−40 to +150	°C
Junction temperature	T_j	max.	150	°C

Notes:

1. The limits for both diodes apply whether both diodes conduct simultaneously or on alternate half cycles.

CHARACTERISTICS (per diode)

Forward voltage				
I_F = 5 A; T_j = 150 °C	V_F	$<$	0.85	V*
I_F = 15 A; T_j = 25 °C	V_F	$<$	1.3	V*
Reverse current				
$V_R = V_{RWM\,max}$; T_j = 100 °C	I_R	$<$	0.2	mA
$V_R = V_{RWM\,max}$; T_j = 25 °C	I_R	$<$	10	μA
Reverse recovery when switched from				
I_F = 1 A to $V_R \geqslant$ 30 V with $-dI_F/dt$ = 100 A/μs; T_j = 25 °C recovery time	t_{rr}	$<$	20	ns
I_F = 2 A to $V_R \geqslant$ 30 V with $-dI_F/dt$ = 20 A/μs; T_j = 25 °C recovered charge	Q_s	$<$	5.5	nC
I_F = 5 A to $V_R \geqslant$ 30 V with $-dI_F/dt$ = 50 A/μs; T_j = 100 °C peak recovery current	I_{RRM}	$<$	1.2	A
Forward recovery when switched to I_F = 1 A with dI_F/dt = 10 A/μs; T_j = 25 °C recovery voltage	V_{fr}	typ.	1.0	V

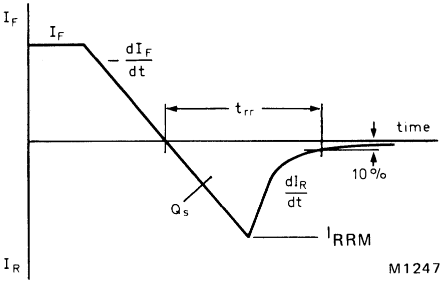


Fig.2 Definition of t_{rr}, Q_s and I_{RRM}.

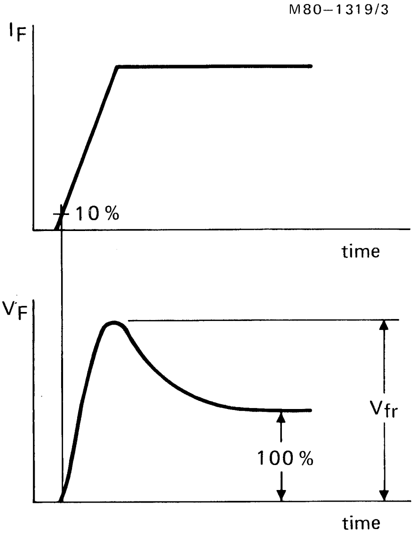


Fig.3 Definition of V_{fr}.

---

*Measured under pulse conditions to avoid excessive dissipation.

THERMAL RESISTANCE

From junction to mounting base (both diodes conducting) $R_{th\ j\text{-}mb}$ = 2.2 K/W

From junction to mounting base (per diode) $R_{th\ j\text{-}mb}$ = 3.0 K/W

→ **Influence of mounting method**

1. Heatsink-mounted with clip (see mounting instructions)

Thermal resistance from mounting base to heatsink

a. with heatsink compound $R_{th\ mb\text{-}h}$ = 0.3 K/W

b. with heatsink compound and 0.06 mm maximum mica insulator $R_{th\ mb\text{-}h}$ = 1.4 K/W

c. with heatsink compound and 0.1 mm maximum mica insulator (56369) $R_{th\ mb\text{-}h}$ = 2.2 K/W

d. with heatsink compound and 0.25 mm maximum alumina insulator (56367) $R_{th\ mb\text{-}h}$ = 0.8 K/W

e. without heatsink compound $R_{th\ mb\text{-}h}$ = 1.4 K/W

2. Free air operation

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

Thermal resistance from junction to ambient in free air: mounted on a printed circuit board at any device lead length and with copper laminate on the board $R_{th\ j\text{-}a}$ = 60 K/W

MOUNTING INSTRUCTIONS

1. The device may be soldered directly into the circuit, but the maximum permissible temperature of the soldering iron or bath is 275 °C; the heat source must not be in contact with the joint for more than 5 seconds. Soldered joints must be at least 4.7 mm from the seal.
2. The leads should not be bent less than 2.4 mm from the seal, and should be supported during bending. The bend radius must be no less than 1.0 mm. ←
3. Mounting by means of a spring clip is the best mounting method because it offers:
   a. a good thermal contact under the crystal area and slightly lower $R_{th\ mb\text{-}h}$ values than does screw mounting.
   b. safe isolation for mains operation.
   However, if a screw is used, it should be M3 cross-recess pan head. Care should be taken to avoid damage to the plastic body.
4. For good thermal contact heatsink compound should be used between mounting base and heatsink. Values of $R_{th\ mb\text{-}h}$ given for mounting with heatsink compound refer to the use of a metallic-oxide loaded compound. Ordinary silicone grease is not recommended.
5. Rivet mounting (only possible for non-insulated mounting).
   Devices may be rivetted to flat heatsinks; such a process **must neither** deform the mounting tab, **nor** enlarge the mounting hole.

OPERATING NOTES

Dissipation and heatsink calculations

The various components of junction temperature rise above ambient are illustrated in Fig.4.

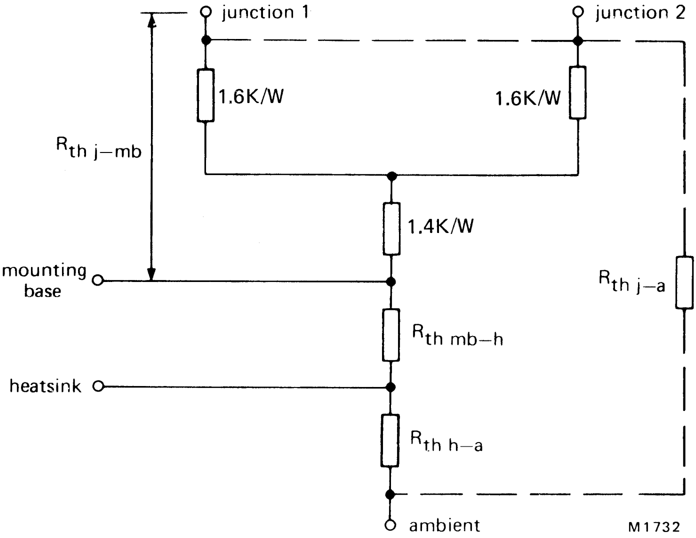


Fig.4.

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

SQUARE-WAVE OPERATION (PER DIODE)

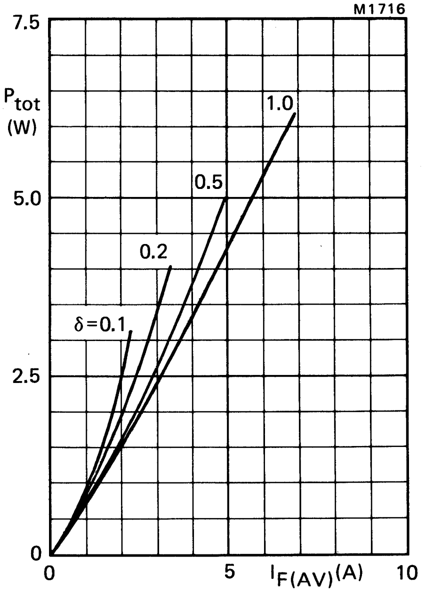
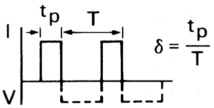


Fig.5 Power rating per diode.
The individual power loss in each diode should first be determined then both added together. The resulting total power loss is then used in conjunction with Fig.6 to determine the heatsink size and corresponding maximum ambient and mounting base temperatures.



$\delta = \frac{t_p}{T}$

$I_{F(AV)} = I_{F(RMS)} \times \sqrt{\delta}$

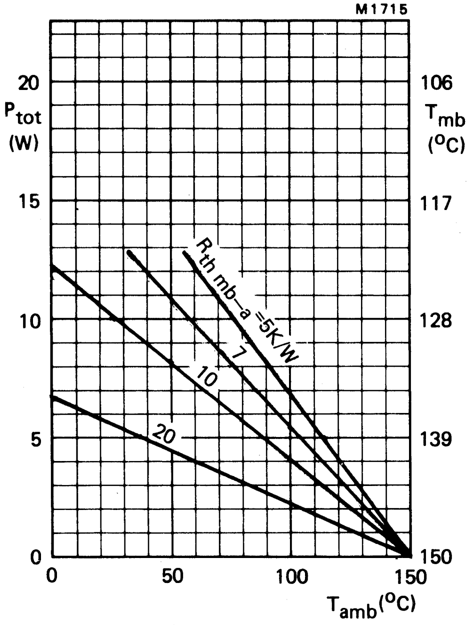


Fig.6

SINUSOIDAL OPERATION (PER DIODE)

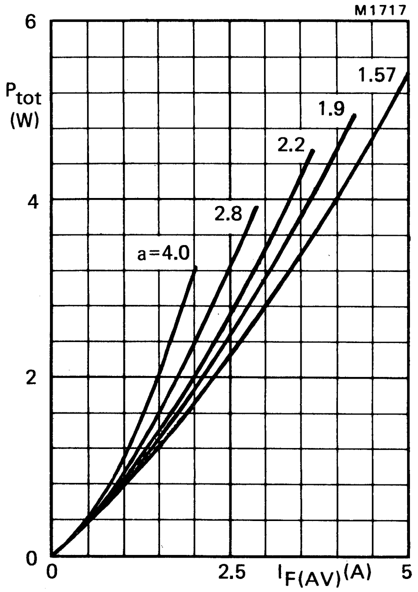


Fig.7 Power rating per diode.
The individual power loss in each diode should first be determined then both added together. The resulting total power loss is then used in conjunction with Fig.6 to determine the heatsink size and corresponding maximum ambient and mounting base temperatures.

a = form factor = $I_{F(RMS)}/I_{F(AV)}$

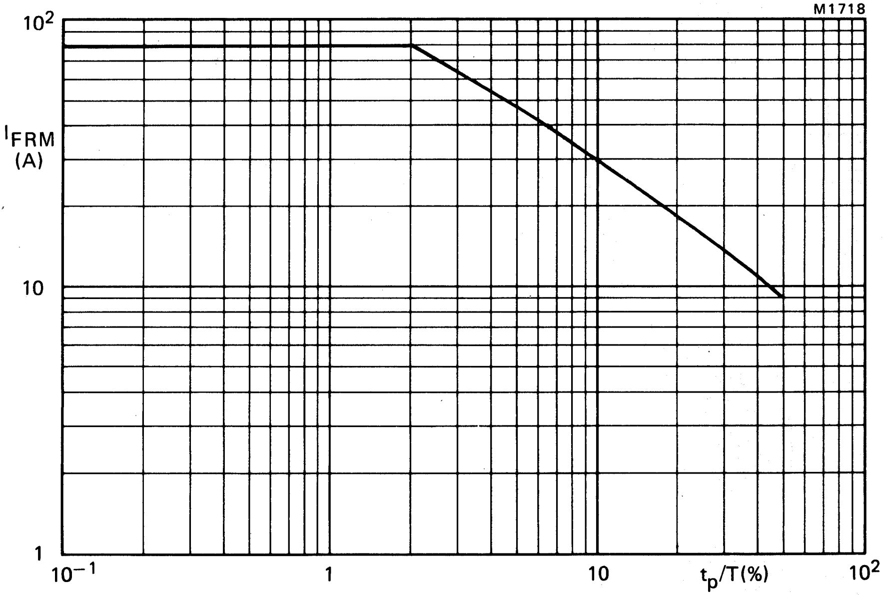
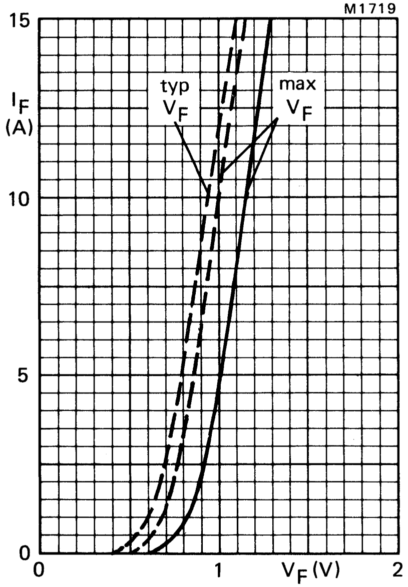
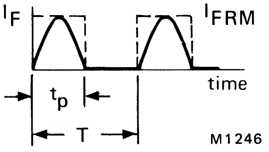


Fig.8 Maximum permissible repetitive peak forward current for either square or sinusoidal currents for 1 μs $< t_p <$ 1 ms.





Definition of I_{FRM} and t_p/T

Fig.9 —— T_j = 25 °C; – – – T_j = 150 °C per diode.

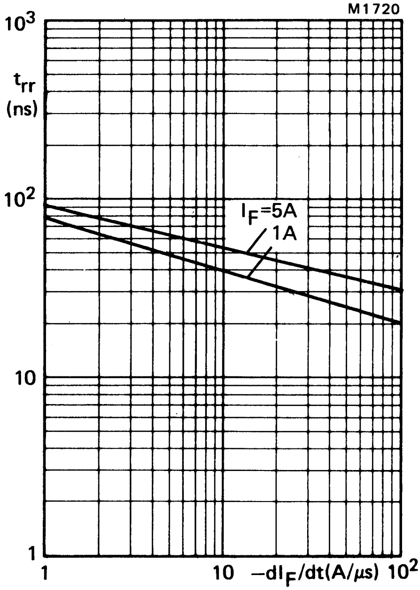


Fig.10 Maximum t_{rr} at T_j = 25 °C.

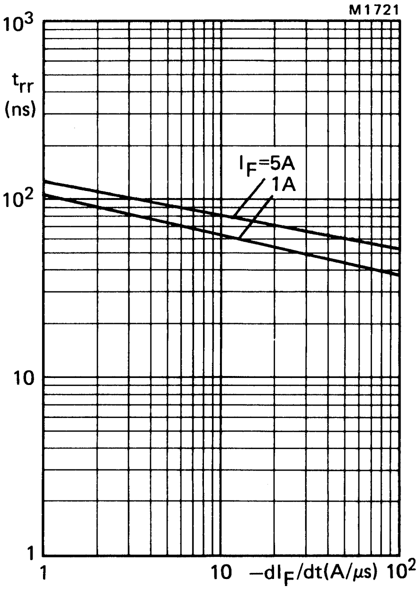


Fig.11 Maximum t_{rr} at T_j = 100 °C.

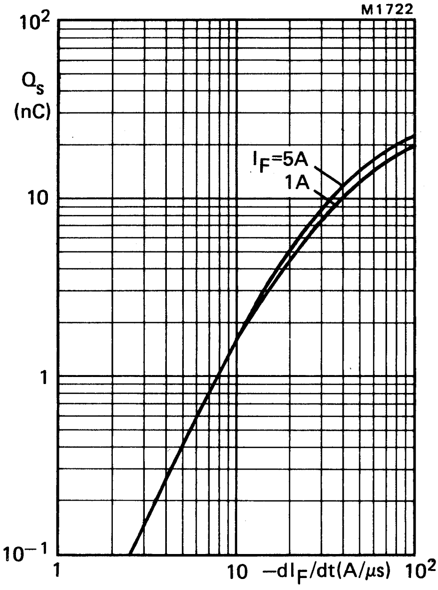


Fig.12 Maximum Q_s at T_j = 25 °C.

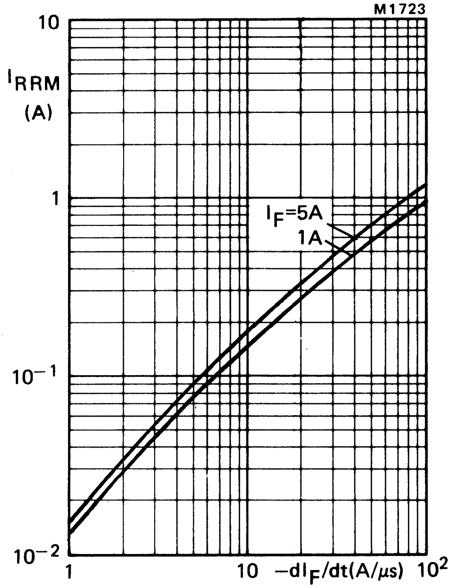


Fig.13 Maximum I_{RRM} at T_j = 25 °C

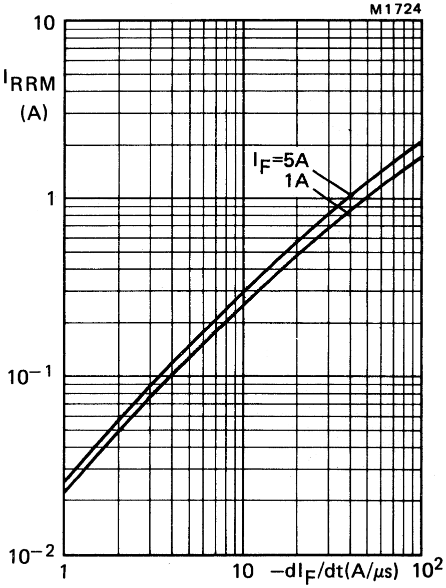


Fig.14 Maximum I_{RRM} at T_j = 100 °C;

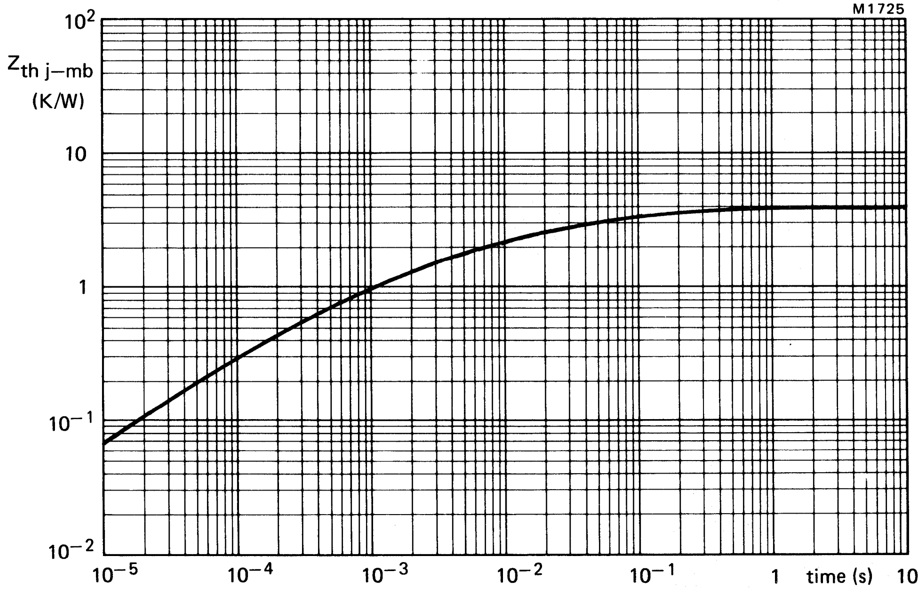


Fig.15 One diode conducting.

ULTRA FAST RECOVERY RECTIFIER DIODES

Glass-passivated, high-efficiency epitaxial rectifier diodes in plastic envelopes, featuring low forward voltage drop, ultra fast reverse recovery times with very low stored charge and soft-recovery characteristic. They are intended for use in switched-mode power supplies and high-frequency circuits in general, where both low conduction losses and low switching losses are essential.
The series consists of normal polarity (cathode to mounting base) types.

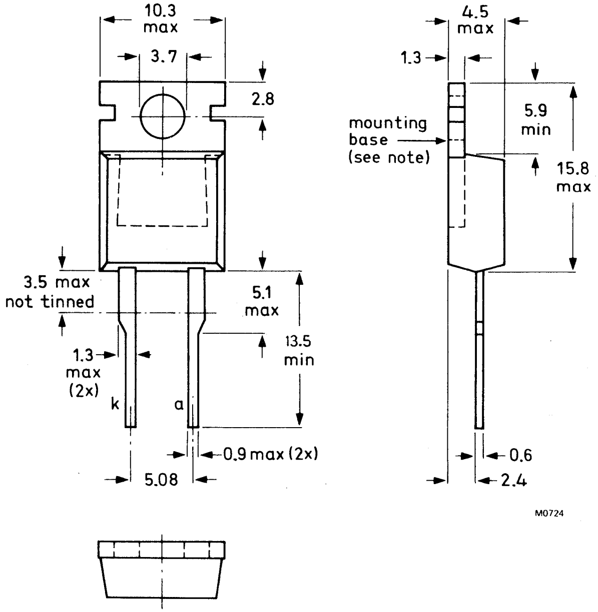
QUICK REFERENCE DATA

			BYR29–600	700	800	
Repetitive peak reverse voltage	V_{RRM}	max.	600	700	800	V
Average forward current	$I_{F(AV)}$	max.	8			A
Forward voltage	V_F	$<$	1.3			V
Reverse recovery time	t_{rr}	$<$	75			ns

MECHANICAL DATA

Dimensions in mm

Fig.1 TO-220AC



Net mass: 2 g

Note: The exposed metal mounting base is directly connected to the cathode.

Accessories supplied on request: see data sheets Mounting instructions and accessories for TO-220 envelopes.

RATINGS

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

→ Voltages

			BYR29–600	700	800	
Repetitive peak reverse voltage	V_{RRM}	max.	600	700	800	V
Crest working reverse voltage	V_{RWM}	max.	500	500	600	V
Continuous reverse voltage*	V_R	max.	500	500	600	V

Currents

Average forward current; switching losses negligible up to 100 kHz				
square wave; $\delta = 0.5$; up to $T_{mb} = 117$ °C	$I_{F(AV)}$	max.	8	A
up to $T_{mb} = 125$ °C	$I_{F(AV)}$	max.	6.5	A
sinusoidal; up to $T_{mb} = 120$ °C	$I_{F(AV)}$	max.	7.8	A
up to $T_{mb} = 125$ °C	$I_{F(AV)}$	max.	7.2	A
R.M.S. forward current	$I_{F(RMS)}$	max.	11.5	A
Repetitive peak forward current $t_p = 20\ \mu s$; $\delta = 0.02$	I_{FRM}	max.	130	A
Non-repetitive peak forward current half sine-wave; $T_j = 150$ °C prior to surge; with reapplied V_{RWMmax};				
$t = 10$ ms	I_{FSM}	max.	60	A
$t = 8.3$ ms	I_{FSM}	max.	72	A
I^2t for fusing ($t = 10$ ms)	I^2t	max.	18	A^2s

Temperatures

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

---

*To ensure thermal stability: $R_{th\ j\text{-}a} \leqslant 5.7$ K/W.

CHARACTERISTICS

Forward voltage				
$I_F = 10$ A; $T_j = 150$ °C	V_F	<	1.30	V*
$I_F = 25$ A; $T_j = 25$ °C	V_F	<	1.75	V*
Reverse current				
$V_R = V_{RWM\,max}$; $T_j = 100$ °C	I_R	<	0.2	mA
$T_j = 25$ °C	I_R	<	10	μA
Reverse recovery when switched from				
$I_F = 1$ A to $V_R \geqslant 30$ V with $-dI_F/dt = 100$ A/μs; $T_j = 25$ °C; recovery time	t_{rr}	<	75	ns
$I_F = 2$ A to $V_R \geqslant 30$ V with $-dI_F/dt = 20$ A/μs; $T_j = 25$ °C; recovered charge	Q_s	<	200	nC
$I_F = 10$ A to $V_R \geqslant 30$ V with $-dI_F/dt = 50$ A/μs; $T_j = 100$ °C; peak recovery current	I_{RRM}	<	6	A
Forward recovery when switched to $I_F = 10$ A with $dI_F/dt = 10$ A/μs; $T_j = 25$ °C	V_{fr}	typ.	5	V

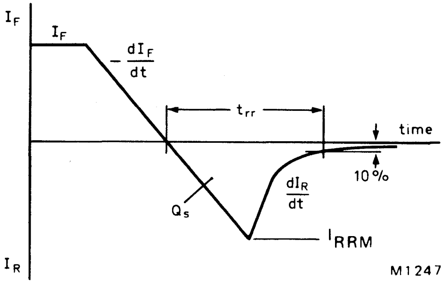


Fig.2 Definition of t_{rr}, Q_s and I_{RRM}.

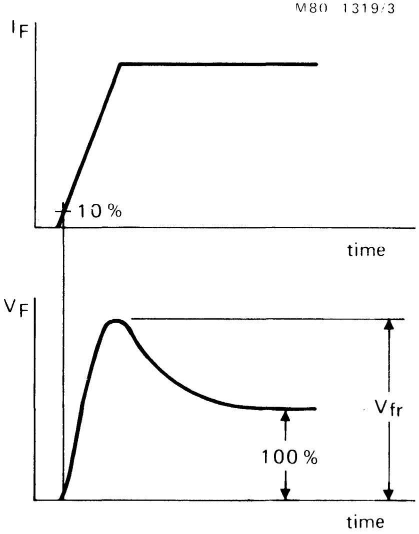


Fig.3 Definition of V_{fr}.

---

*Measured under pulse conditions to avoid excessive dissipation.

THERMAL RESISTANCE

From junction to mounting base $R_{th\ j\text{-}mb}$ = 2.5 K/W

Influence of mounting method

1. Heatsink-mounted with clip (see mounting instructions)

Thermal resistance from mounting base to heatsink

a. with heatsink compound $R_{th\ mb\text{-}h}$ = 0.3 K/W

b. with heatsink compound and 0.06 mm maximum mica insulator $R_{th\ mb\text{-}h}$ = 1.4 K/W

c. with heatsink compound and 0.1 mm maximum mica insulator (56369) $R_{th\ mb\text{-}h}$ = 2.2 K/W

d. with heatsink compound and 0.25 mm maximum alumina insulator (56367) $R_{th\ mb\text{-}h}$ = 0.8 K/W

e. without heatsink compound $R_{th\ mb\text{-}h}$ = 1.4 K/W

2. Free air operation

The quoted value of $R_{th\ j\text{-}a}$ should be used only when no leads of other dissipating components run to the same tie point.
Thermal resistance from junction to ambient in free air:
mounted on a printed circuit board at any device lead length and with copper laminate on the board $R_{th\ j\text{-}a}$ = 60 K/W

MOUNTING INSTRUCTIONS

1. The device may be soldered directly into the circuit, but the maximum permissible temperature of the soldering iron or bath is 275°C; the heat source must not be in contact with the joint for more than 5 seconds. Soldered joints must be at least 4.7 mm from the seal.

2. The leads should not be bent less than 2.4 mm from the seal, and should be supported during bending. The bend radius must be no less than 1.0 mm. ←

3. Mounting by means of a spring clip is the best mounting method because it offers:
   a. a good thermal contact under the crystal area and slightly lower $R_{th\ mb\text{-}h}$ values than does screw mounting.
   b. safe isolation for mains operation.
   However, if a screw is used, it should be M3 cross-recess pan head. Care should be taken to avoid damage to the plastic body.

4. For good thermal contact, heatsink compound should be used between mounting base and heatsink. Values of $R_{th\ mb\text{-}h}$ given for mounting with heatsink compound refer to the use of a metallic oxide-loaded compound. Ordinary silicone grease is not recommended.

5. Rivet mounting (only possible for non-insulated mounting).
   Devices may be rivetted to flat heatsinks; such a process must **neither** deform the mounting tab, **nor** enlarge the mounting hole.

OPERATING NOTES

Dissipation and heatsink calculations

a. The various components of junction temperature rise above ambient are illustrated in Fig.4.

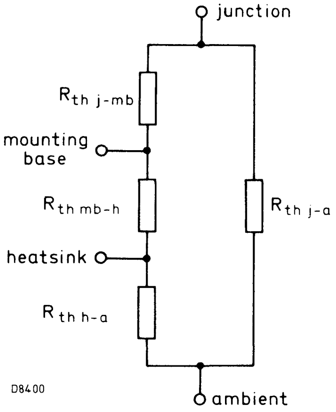


Fig. 4.

b. Any measurement of heatsink temperature should be made immediately adjacent to the device.
c. The method of using Figs. 5 and 6 is as follows:
Starting with the required current on the $I_{F(AV)}$ axis, trace upwards to meet the appropriate duty cycle or form factor curve. Trace right horizontally and upwards from the required value on the T_{amb} scale. The intersection determines the $R_{th\ mb\text{-}a}$. The heatsink thermal resistance value ($R_{th\ h\text{-}a}$) can be calculated from:

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

SQUARE-WAVE OPERATION

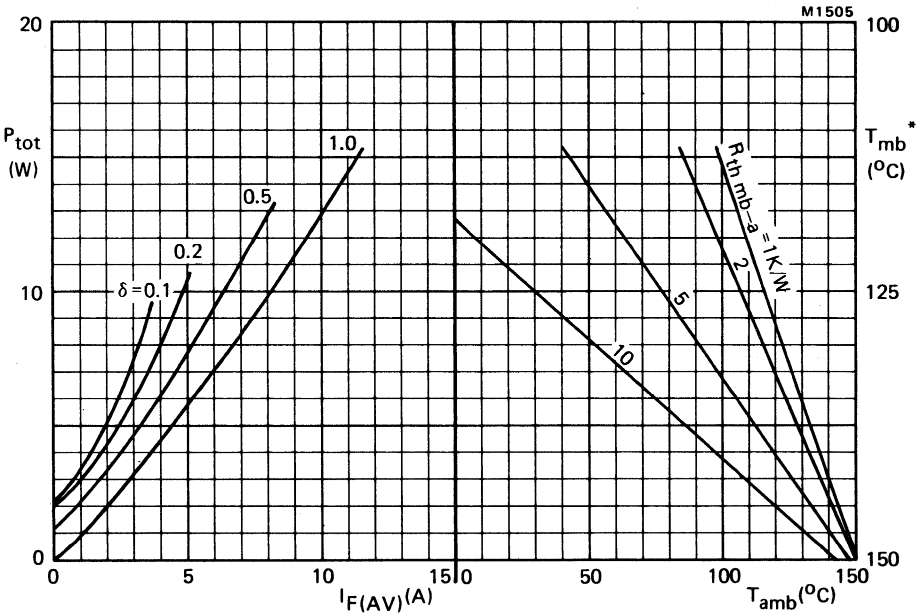
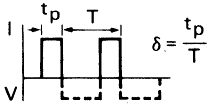


Fig.5 The right-hand part shows the relationship between the power (derived from the left-hand part) and the maximum permissible temperatures. Power includes reverse current losses and switching losses up to f = 100 kHz.



$I_{F(AV)} = I_{F(RMS)} \times \sqrt{\delta}$

*T_{mb} scale is for comparison purposes and is correct only for $R_{th\ mb\text{-}a} < 3.2$ K/W.

SINUSOIDAL OPERATION

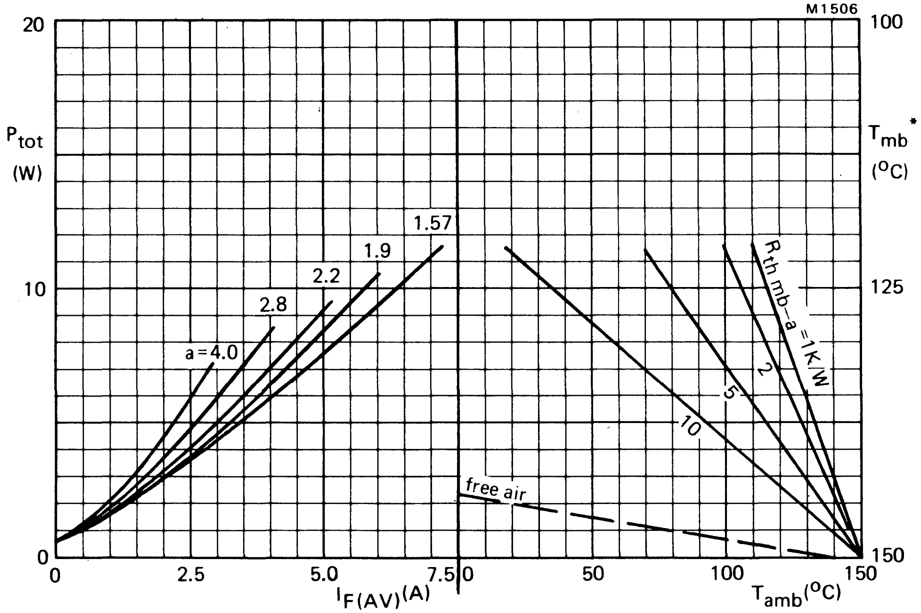


Fig.6 The right-hand part shows the interrelationship between the power (derived from the left-hand part) and the maximum permissible temperatures.
a = form factor = $I_{F(RMS)}/I_{F(AV)}$.

---

*T_{mb} scale is for comparison purposes and is correct only for $R_{th\ mb\text{-}a} < 16$ K/W.

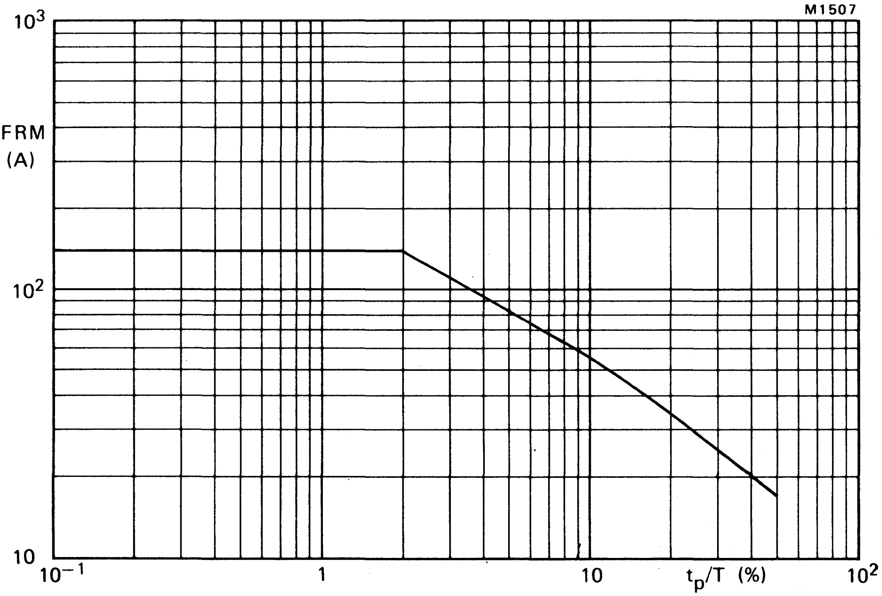
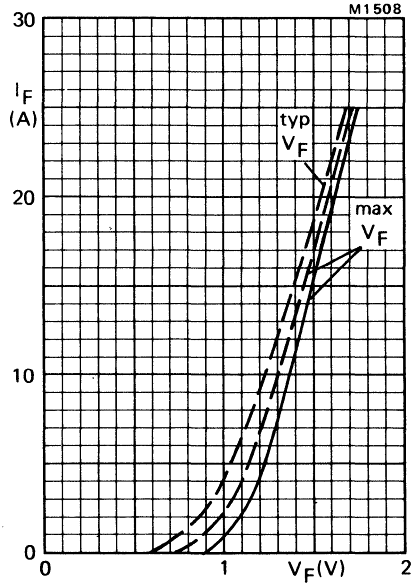
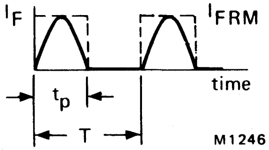


Fig.7 Maximum permissible repetitive peak forward current for square or sinusoidal currents; 1 μs $< t_p <$ 1 ms.





Definition of I_{FRM} and t_p/T.

Fig.8 —— T_j = 25 °C; – – – T_j = 150 °C.

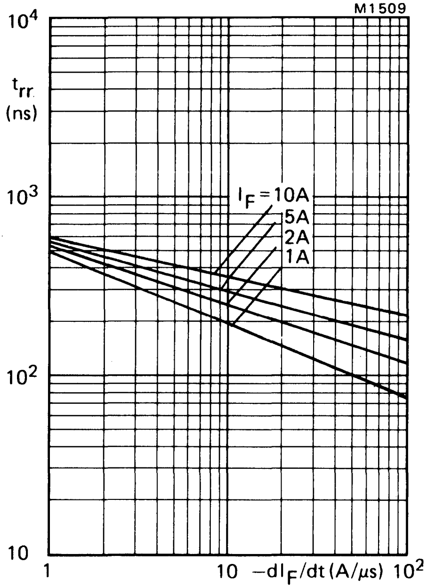


Fig.9 Maximum t_{rr} at T_j = 25 °C.

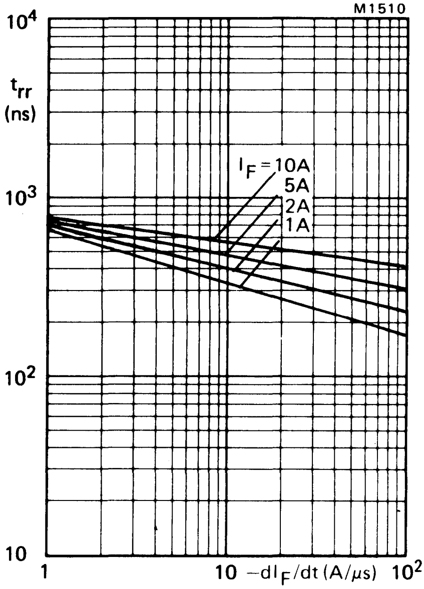


Fig.10 Maximum t_{rr} at T_j = 100 °C.

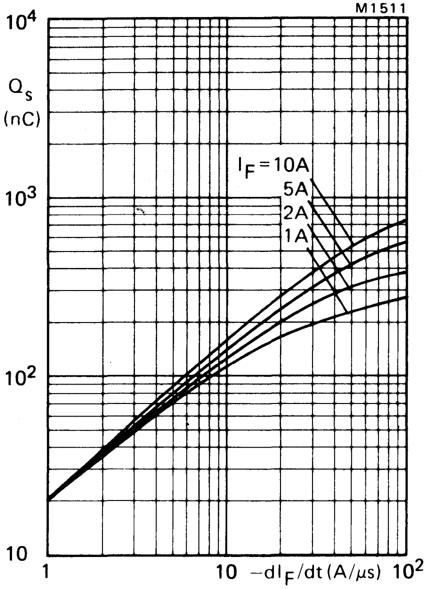


Fig.11 Maximum Q_s at T_j = 25 °C

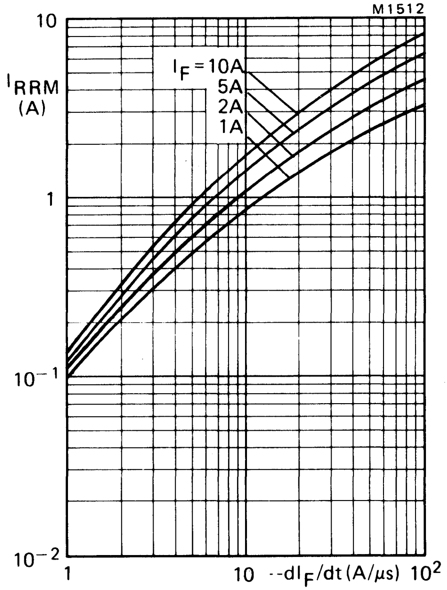


Fig.12 Maximum I_{RRM} at T_j = 25 °C.

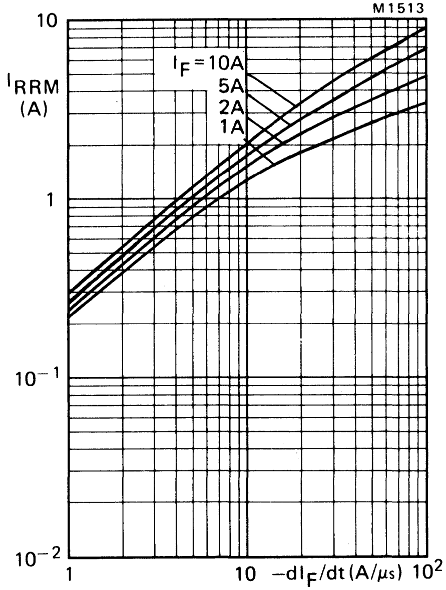


Fig.13 Maximum I_{RRM} at T_j = 100 °C.

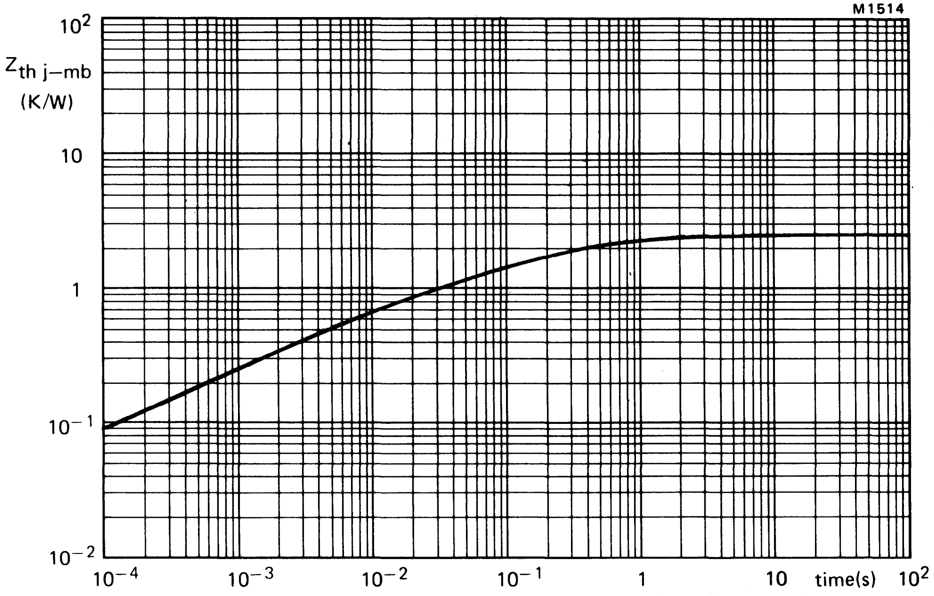


Fig.14 Transient thermal impedance.

ULTRA FAST RECOVERY ELECTRICALLY-ISOLATED RECTIFIER DIODES

Glass-passivated, high-efficiency epitaxial rectifier diodes in SOT-186 (full-pack) envelopes, featuring low forward voltage drop, ultra fast reverse recovery times with very low stored charge and soft-recovery characteristic. Their electrical isolation makes them ideal for mounting on a common heatsink alongside other components without the need for additional insulators. They are intended for use in switched-mode power supplies and high-frequency circuits in general, where both low conduction losses and low switching losses are essential.

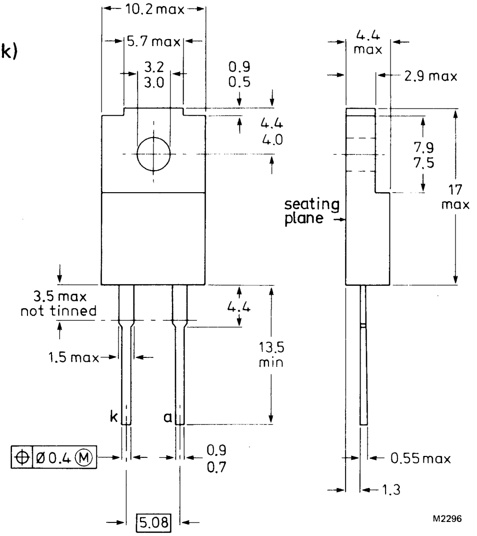
QUICK REFERENCE DATA

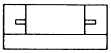
			BYR29F-600	700	800	
Repetitive peak reverse voltage	V_{RRM}	max.	600	700	800	V
Average forward current	$I_{F(AV)}$	max.	8			A
Forward voltage	V_F	<	1.3			V
Reverse recovery time	t_{rr}	<	75			ns

MECHANICAL DATA

Dimensions in mm

Fig. 1 SOT-186 (full-pack)





Net mass: 2 g.

The seating plane is electrically isolated from all terminals.

Accessories supplied on request (see data sheets Mounting instructions for F-pack devices and Accessories for SOT-186 envelopes).

RATINGS

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

Voltages			BYR29F-600	700	800	
Repetitive peak reverse voltage	V_{RRM}	max.	600	700	800	V
Crest working reverse voltage	V_{RWM}	max.	500	500	600	V
Continuous reverse voltage (note 1)	V_R	max.	500	500	600	V

Currents

Average forward current; switching losses negligible up to 100 kHz (note 2); square wave; $\delta = 0.5$; up to $T_{mb} = 79°C$	$I_{F(AV)}$	max.	8	A
sinusoidal; up to $T_{mb} = 87°C$	$I_{F(AV)}$	max.	7.2	A
R.M.S. forward current	$I_{F(RMS)}$	max.	11.5	A
Repetitive peak forward current $t_p = 20\ \mu s$; $\delta = 0.02$	I_{FRM}	max.	130	A
Non-repetitive peak forward current half sine-wave; $T_j = 150°C$ prior to surge; with reapplied $V_{RWM\,max}$ $t = 10$ ms	I_{FSM}	max.	60	A
$t = 8.3$ ms	I_{FSM}	max.	72	A
I^2t for fusing ($t = 10$ ms)	I^2t	max.	18	A^2s

Temperatures

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

ISOLATION

Peak isolation voltage from all terminals to external heatsink	V_{isol}	max.	1000	V
Isolation capacitance from cathode to external heatsink (note 3)	C_p	typ.	12	pF

Notes:

1. To ensure thermal stability: $R_{th\ j\text{-}a} < 5.7$ K/W.
2. The quoted temperatures assume heatsink compound is used.
3. Mounted without heatsink compound and 20 Newtons pressure on the centre of the evelope.

THERMAL RESISTANCE

From junction to external heatsink with minimum of 2 kgf (20 Newtons) pressure on the centre of the envelope,				
with heatsink compound	$R_{th\ j\text{-}a}$	=	5.5	K/W
without heatsink compound	$R_{th\ j\text{-}a}$	=	7.2	K/W

Free air operation

The quoted value of $R_{th\ j\text{-}a}$ should be used only when no leads of other dissipating components run to the same point.

Thermal resistance from junction to ambient in free air, mounted on a printed circuit board	$R_{th\ j\text{-}a}$	=	55	K/W

CHARACTERISTICS

$T_j = 25°C$ unless otherwise stated

Forward voltage				
$I_F = 10$ A; $T = 150°C$	V_F	$<$	1.3	V*
$I_F = 25$ A	V_F	$<$	1.75	V*
Reverse current				
$V_R = V_{RWM\ max}$; $T_j = 100°C$	I_R	$<$	0.2	mA
$V_R = V_{RWM\ max}$	I_R	$<$	10	μA
Reverse recovery when switched from				
$I_F = 1$ A to $V_R \geqslant 30$ V with $-dI_F/dt = 100$ A/μs; recovery time	t_{rr}	$<$	75	ns
$I_F = 2$ A to $V_R \geqslant 30$ V with $-dI_F/dt = 20$ A/μs; recovered charge	Q_s	$<$	200	nC
$I_F = 10$ A to $V_R \geqslant 30$ V with $-dI_F/dt = 50$ A/μs; $T_j = 100°C$; peak recovery current	I_{RRM}	$<$	6	A
Forward recovery when switched to $I_F = 10$ A with $dI_F/dt = 10$ A/μs	V_{fr}	typ.	5	V

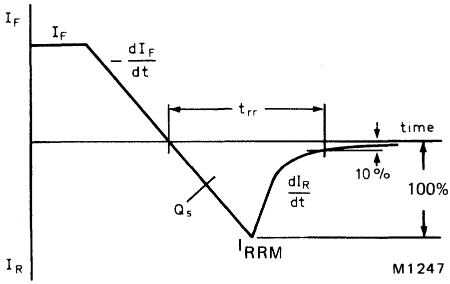


Fig. 2 Definition of t_{rr}, Q_s and I_{RRM}.

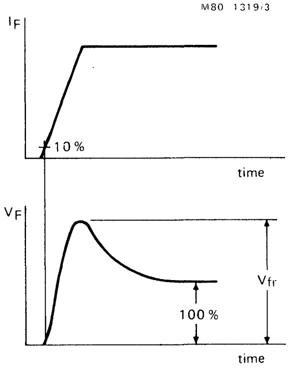


Fig. 3 Definition of V_{fr}.

*Measured under pulse conditions to avoid excessive dissipation.

MOUNTING INSTRUCTIONS

1. The device may be soldered directly into the circuit, but the maximum permissible temperature of the soldering iron or bath is 275 °C; the heat source must not be in contact with the joint for more than 5 seconds. Soldered joints must be at least 4.7 mm from the seal.
2. The leads should not be bent less than 2.4 mm from the seal, and should be supported during bending. The bend radius must be no less than 1 mm.
3. Mounting by means of a spring clip is the best mounting method because it offers a good thermal contact under the crystal area and slightly lower $R_{th\ j\text{-}h}$ values than screw mounting. The force exerted on the top of the device by the clip should be at least 2 kgf (20 Newtons) to ensure good thermal contact and must not exceed 3.5 kgf (35 Newtons) to avoid damage to the device.
4. If screw mounting is used, it should be M3 cross-recess pan head.
   Minimum torque to ensure good thermal contact: 5.5 kgf (0.55 Nm)
   Maximum torque to avoid damage to the device: 8.0 kgf (0.80 Nm)
5. For good thermal contact, heatsink compound should be used between baseplate and heatsink. Values of $R_{th\ j\text{-}h}$ given for mounting with heatsink compound refer to the use of a metallic-oxide loaded compound. Ordinary silicone grease is not recommended.
6. Rivet mounting.
   It is not recommended to use rivets, since extensive damage could result to the plastic, which could destroy the insulating properties of the device.
7. The heatsink must have a flatness in the mounting area of 0.02 mm maximum per 10 mm. Mounting holes must be deburred.

OPERATING NOTES

The various components of junction temperature rise above ambient are illustrated in Fig.4.

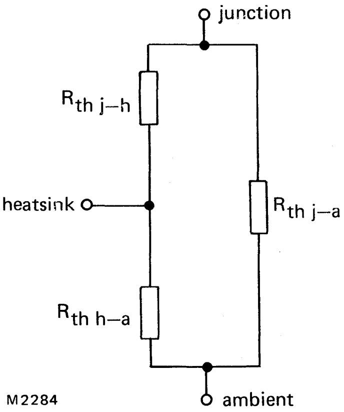


Fig.4.

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

SQUARE-WAVE OPERATION

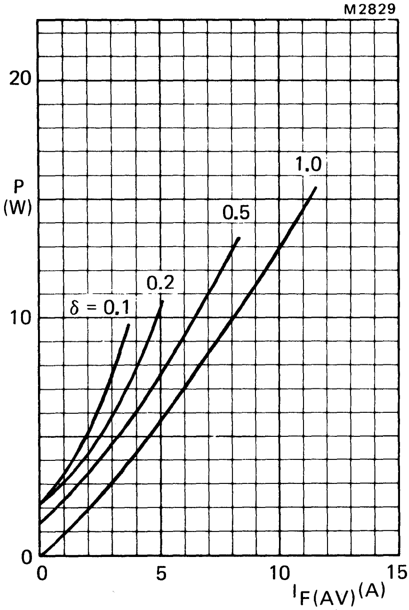
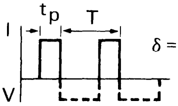


Fig. 5 Power rating.

The power loss in the diode should first be determined from the required forward current on the $I_{F(AV)}$ axis and the appropriate duty cycle.
Having determined the power (P), use Fig. 7 (if heatsink compound is not being used) or Fig. 8 (if heatsink compound is being used) to determine the heatsink size and corresponding maximum ambient and heatsink temperatures.

Note: P = power including reverse current losses but excluding switching losses.



$$\delta = \frac{t_p}{T}$$

$$I_{F(AV)} = I_{F(RMS)} \times \sqrt{\delta}$$

SINUSOIDAL OPERATION

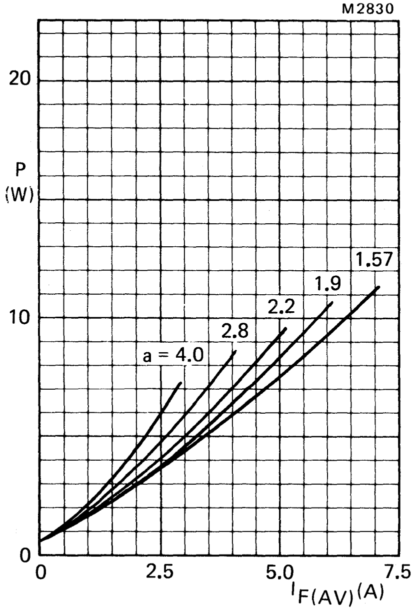


Fig. 6 Power rating.

The power loss in the diode should first be determined from the required forward current on the $I_{F(AV)}$ axis and the appropriate form factor.
Having determined the power (P), use Fig. 7 (if heatsink compound is not being used) or Fig. 8 (if heatsink compound is being used) to determine the heatsink size and corresponding maximum ambient and heatsink temperatures.

Note: P = power including reverse current losses but excluding switching losses.

a = form factor = $I_{F(RMS)}/I_{F(AV)}$

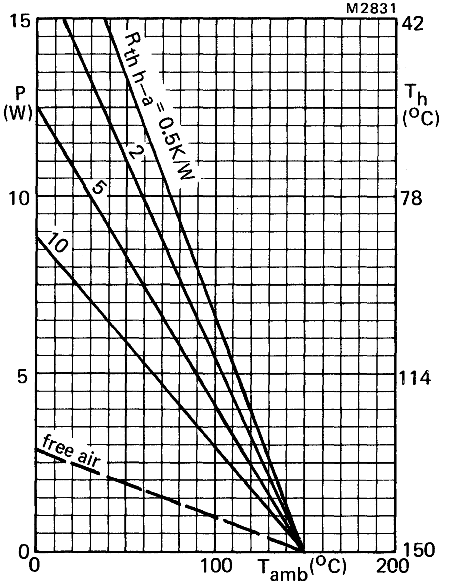


Fig. 7 Heatsink rating; without heatsink compound.

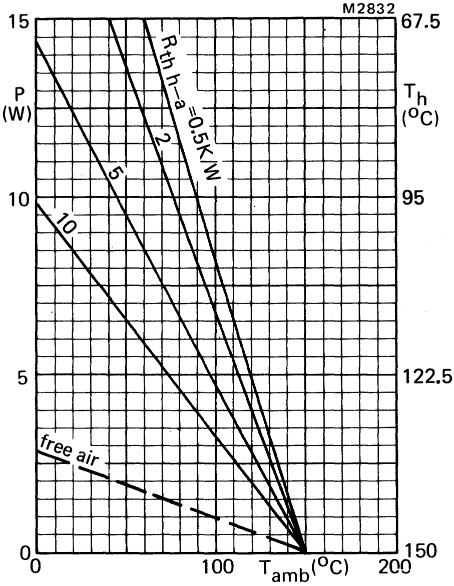


Fig. 8 Heatsink rating; with heatsink compound.

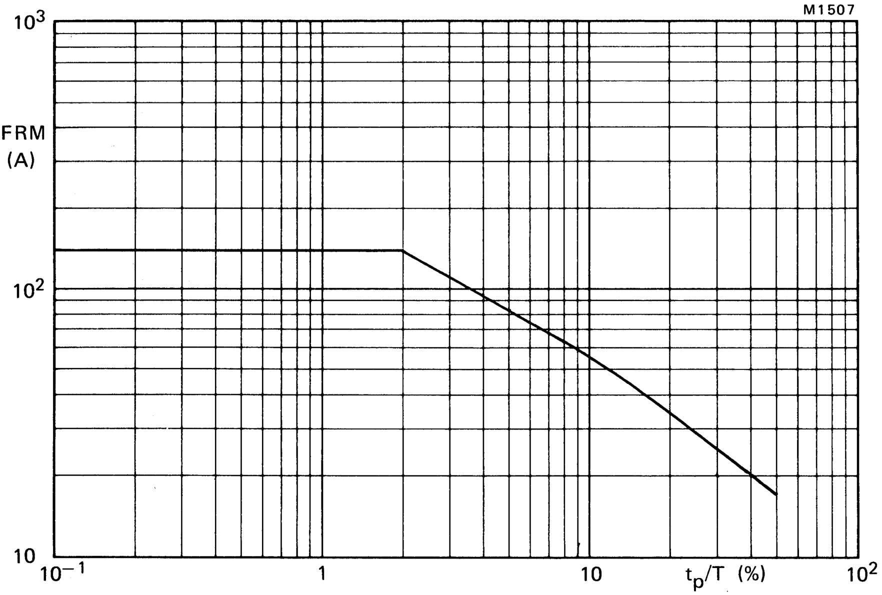
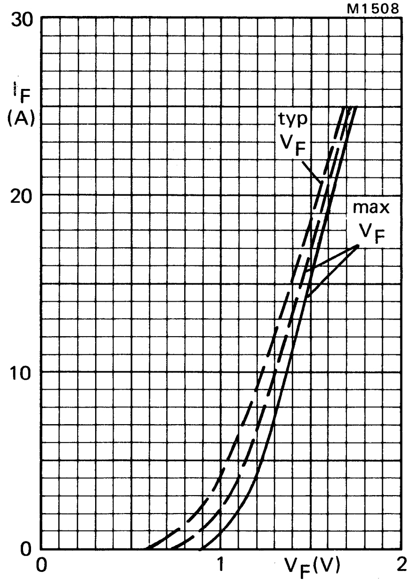
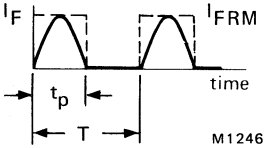


Fig. 9 Maximum permissible repetitive peak forward current for square or sinusoidal currents; 1 μs < t_p < 1 ms.





Definition of I_{FRM} and t_p/T.

Fig. 10 —— T_j = 25°C; – – – T_j = 150°C

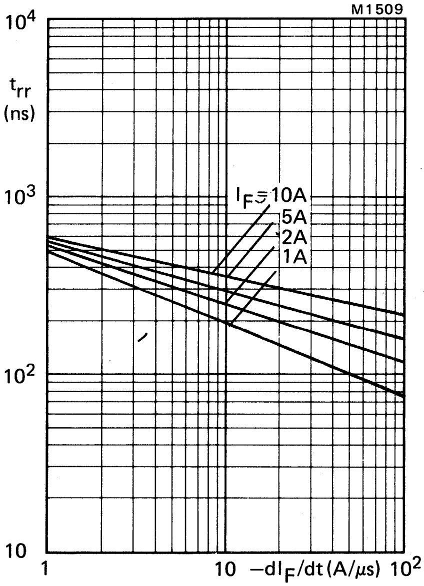


Fig. 11 Maximum t_{rr} at $T_j = 25°C$

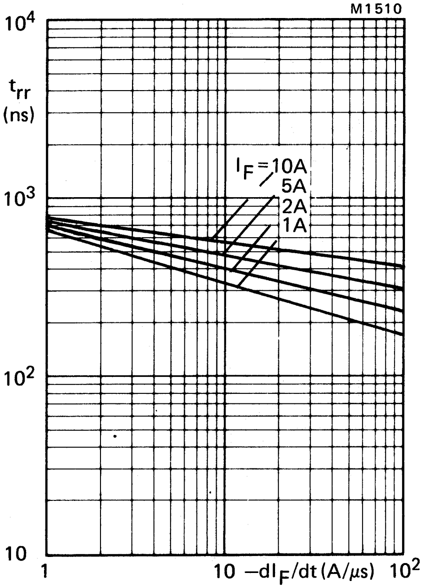


Fig. 12 Maximum t_{rr} at $T_j = 100°C$.

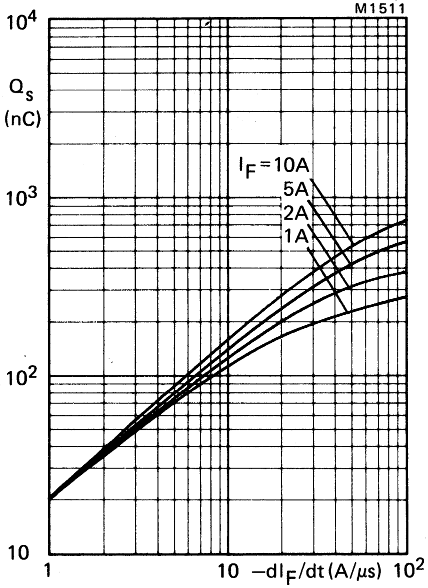


Fig. 13 Maximum Q_s at $T_j = 25°C$.

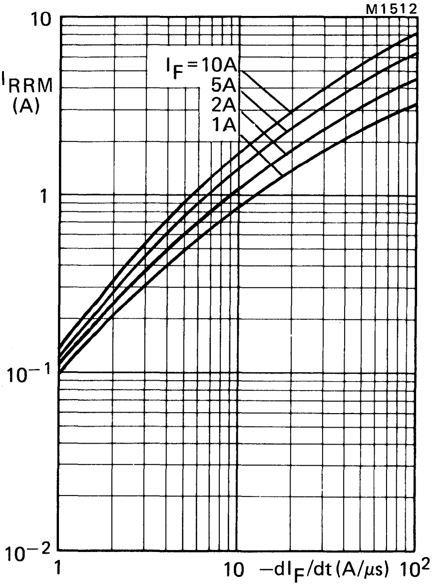


Fig. 14 Maximum I_{RRM} at $T_j = 25°C$.

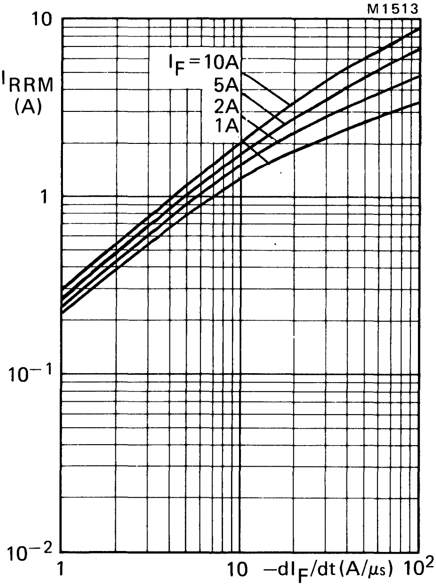


Fig. 15 Maximum I_{RRM} at $T_j = 100°C$.

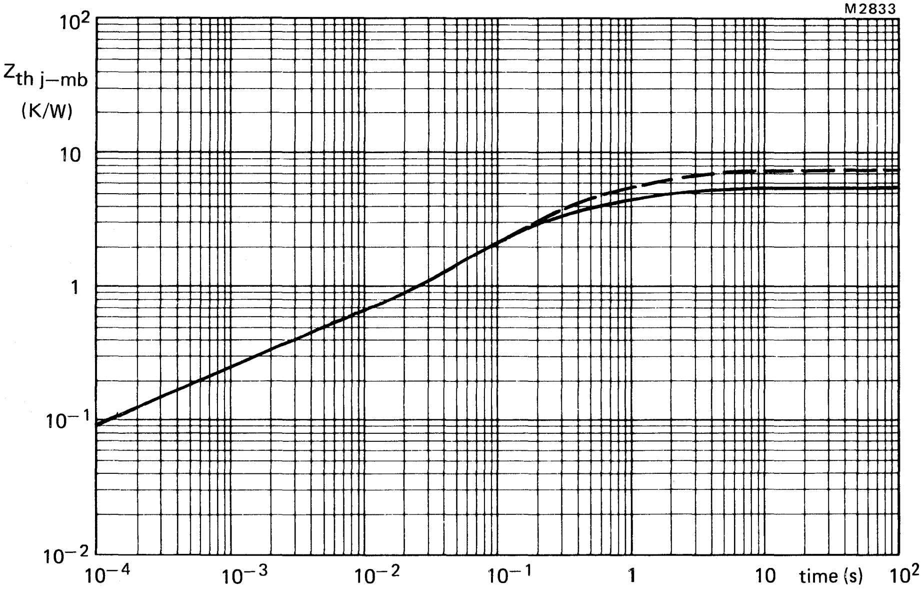


Fig. 16 Transient thermal impedance; —— with heatsink compound; – – – without heatsink compound.

ULTRA FAST RECOVERY DOUBLE RECTIFIER DIODES

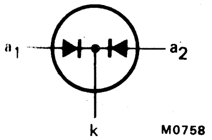
Glass-passivated, high-efficiency double rectifier diodes in plastic envelopes, featuring low forward voltage drop, ultra fast reverse recovery times and soft-recovery characteristic. They are intended for use in switched-mode power supplies and high-frequency circuits in general, where both low conduction losses and low switching losses are essential. Their single chip (monolithic) contruction ensures excellent matching of the forward and switching characteristics of the two halves, allowing parallel operation without the need for derating. The series consists of common-cathode types.

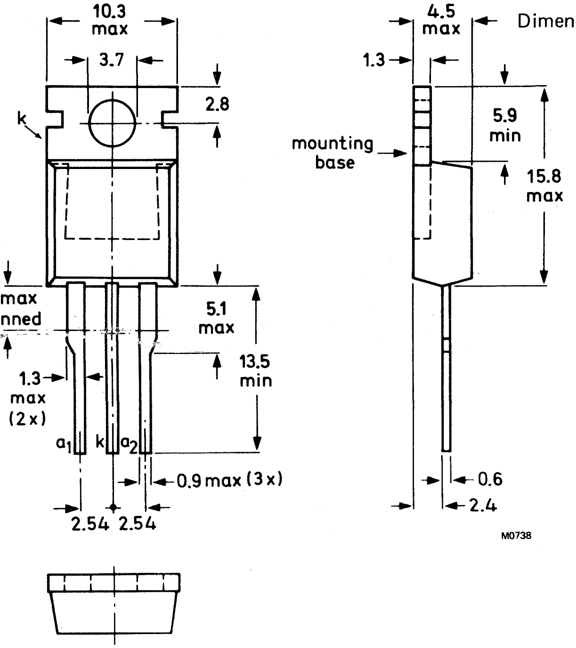
QUICK REFERENCE DATA

Per diode, unless otherwise stated			BYT28–300	400	500	
Repetitive peak reverse voltage	V_{RRM}	max.	300	400	500	V
Output current (both diodes conducting)	I_O	max.	10			A
Forward voltage	V_F	<	1.05			V
Reverse recovery time	t_{rr}	<	50			ns

MECHANICAL DATA

Fig.1 TO-220AB





Dimensions in mm

Net mass: 2 g

Note: the exposed metal mounting base is directly connected to the common cathode.

Accessories supplied on request: see data sheet Mounting Instructions and accessories for TO-220 envelopes.

RATINGS

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

Voltages (per diode)			BYT28–300	400	500	
Repetitive peak reverse voltage	V_{RRM}	max.	300	400	500	V
Crest working reverse voltage	V_{RWM}	max.	200	300	400	V
Continuous reverse voltage	V_R	max.	200	300	400	V

→ **Currents** (both diodes conducting: note 1)

Output current; switching losses negligible up to 200 kHz;				
square wave; $\delta = 0.5$; up to $T_{mb} = 117\ ^oC$	I_O	max.	10	A
sinusoidal; up to $T_{mb} = 120\ ^oC$	I_O	max.	10	A
R.M.S. forward current	$I_{F(RMS)}$	max.	14	A
Repetitive peak forward current $t_p = 20\ \mu s$; $\delta = 0.02$ (per diode)	I_{FRM}	max.	80	A
Non-repetitive peak forward current (per diode) half sine-wave; $T_j = 150\ ^oC$ prior to surge with re-applied $V_{RWM\,max}$				
t = 10 ms	I_{FSM}	max.	50	A
t = 8.3 ms	I_{FSM}	max.	60	A
I^2t for fusing (t = 10 ms; per diode)	I^2t	max.	12.5	A^2s

Temperatures

Storage temperature	T_{stg}		−40 to +150	^oC
Junction temperature	T_j	max.	150	^oC

Notes

1. The limits for both diodes apply whether both diodes conduct simultaneously or on alternate half cycles.

CHARACTERISTICS (per diode)

Forward voltage				
$I_F = 5$ A; $T_j = 150$ °C	V_F	$<$	1.05	V*
$I_F = 15$ A; $T_j = 25$ °C	V_F	$<$	1.4	V*
Reverse current				
$V_R = V_{RWM\ max}$; $T_j = 100$ °C	I_R	$<$	0.2	mA
$V_R = V_{RWM\ max}$; $T_j = 25$ °C	I_R	$<$	10	μA
Reverse recovery when switched from				
$I_F = 1$ A to $V_R \geqslant 30$ V with $-dI_F/dt = 100$ A/μs; $T_j = 25$ °C recovery time	t_{rr}	$<$	50	ns
$I_F = 2$ A to $V_R \geqslant 30$ V with $-dI_F/dt = 20$ A/μs; $T_j = 25$ °C recovered charge	Q_s	$<$	50	nC
$I_F = 5$ A to $V_R \geqslant 30$ V with $-dI_F/dt = 50$ A/μs; $T_j = 100$ °C peak recovery current	I_{RRM}	$<$	3.0	A
Forward recovery when switched to $I_F = 1$ A with $dI_F/dt = 10$ A/μs; $T_j = 25$ °C recovery voltage	V_{fr}	typ.	2.5	V

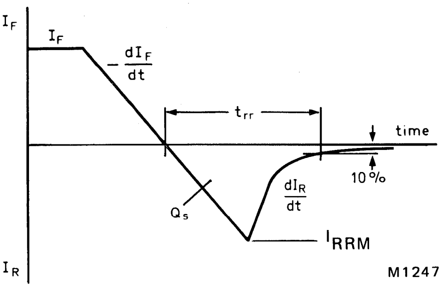


Fig.2 Definition of t_{rr}, Q_s and I_{RRM}.

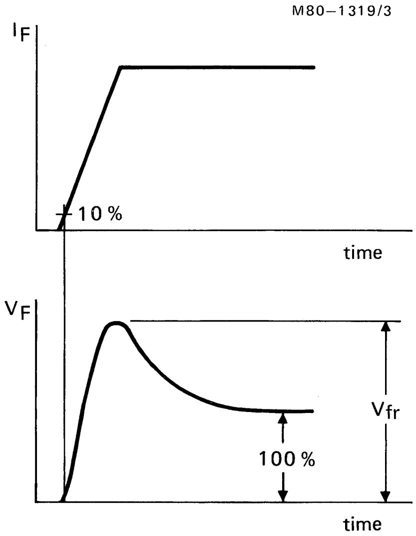


Fig.3 Definition of V_{fr}.

*Measured under pulse conditions to avoid excessive dissipation.

THERMAL RESISTANCE

From junction to mounting base (both diodes conducting)	$R_{th\ j\text{-}mb}$	=	2.5	K/W
From junction to mounting base (per diode)	$R_{th\ j\text{-}mb}$	=	3.5	K/W

→ **Influence of mounting method**

1. Heatsink-mounted with clip (see mounting instructions)

Thermal resistance from mounting base to heatsink

a. with heatsink compound	$R_{th\ mb\text{-}h}$	=	0.3	K/W
b. with heatsink compound and 0.06 mm maximum mica insulator	$R_{th\ mb\text{-}h}$	=	1.4	K/W
c. with heatsink compound and 0.1 mm maximum mica insulator (56369)	$R_{th\ mb\text{-}h}$	=	2.2	K/W
d. with heatsink compound and 0.25 mm maximum alumina insulator (56367)	$R_{th\ mb\text{-}h}$	=	0.8	K/W
e. without heatsink compound	$R_{th\ mb\text{-}h}$	=	1.4	K/W

2. Free air operation

The quoted value of $R_{th\ j\text{-}a}$ should be used only when no leads of other dissipating components run to the same tie point.

Thermal resistance from junction to ambient in free air: mounted on a printed circuit board at any device lead length and with copper laminate on the board	$R_{th\ j\text{-}a}$	=	60	K/W

MOUNTING INSTRUCTIONS

1. The device may be soldered directly into the circuit, but the maximum permissible temperature of the soldering iron or bath is 275 °C; the heat source must not be in contact with the joint for more than 5 seconds. Soldered joints must be at least 4.7 mm from the seal.
2. The leads should not be bent less than 2.4 mm from the seal, and should be supported during bending. The bend radius must be no less than 1.0 mm. ←
3. Mounting by means of a spring clip is the best mounting method because it offers:
   a. a good thermal contact under the crystal area and slightly lower $R_{th\ mb\text{-}h}$ values than does screw mounting.
   b. safe isolation for mains operation.
   However, if a screw is used, it should be M3 cross-recess pan head. Care should be taken to avoid damage to the plastic body.
4. For good thermal contact heatsink compound should be used between mounting base and heatsink. Values of $R_{th\ mb\text{-}h}$ given for mounting with heatsink compound refer to the use of a metallic oxide-loaded compound. Ordinary silicone grease is not recommended.
5. Rivet mounting (only possible for non-insulated mounting).
   Devices may be rivetted to flat heatsinks; such a process must **neither** deform the mounting tab, **nor** enlarge the mounting hole.

OPERATING NOTES

Dissipation and heatsink calculations

The various components of junction temperature rise above ambient are illustrated in Fig.4

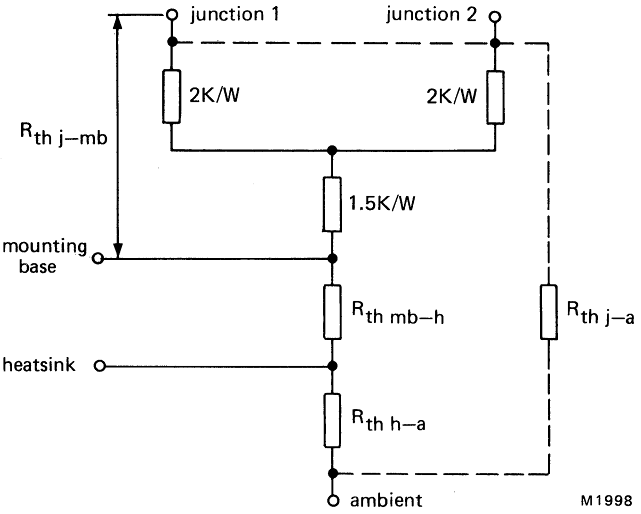


Fig.4

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

SQUARE-WAVE OPERATION (PER DIODE)

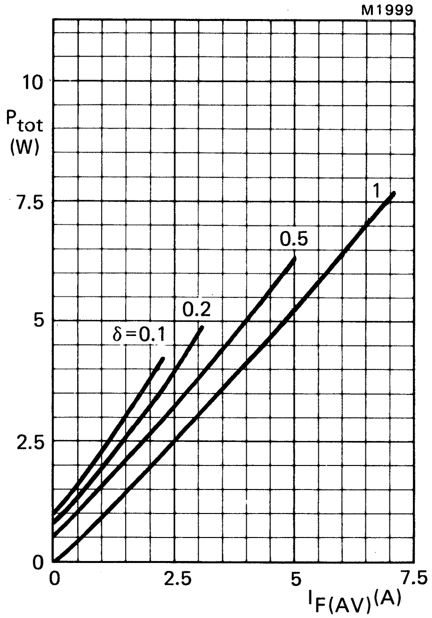
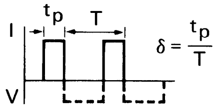


Fig.5 Power rating per diode.
The individual power loss in each diode should first be determined then both added together. The resulting total power loss is then used in conjunction with Fig.6 to determine the heatsink size and corresponding maximum ambient and mounting base temperatures.



$I_{F(AV)} = I_{F(RMS)} \times \sqrt{\delta}$

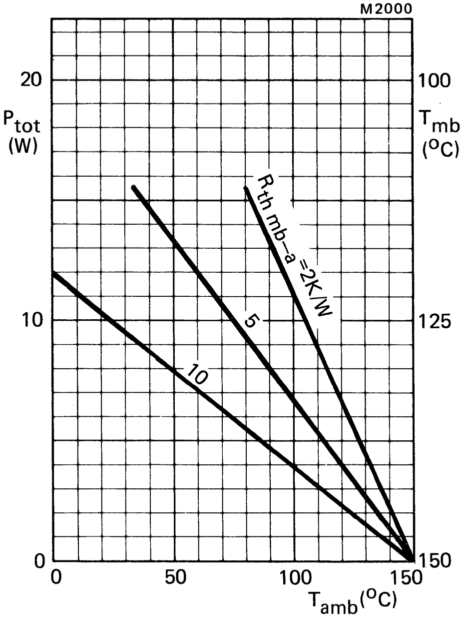


Fig.6

SINUSOIDAL OPERATION (PER DIODE)

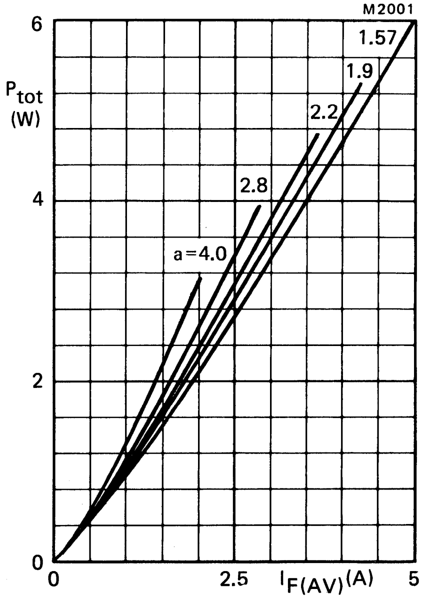


Fig.7 Power rating per diode.
The individual power loss in each diode should first be determined then both added together. The resulting total power loss is then used in conjunction with Fig.6 to determine the heatsink size and corresponding maximum ambient and mounting base temperatures.

a = form factor = $I_{F(RMS)}/I_{F(AV)}$

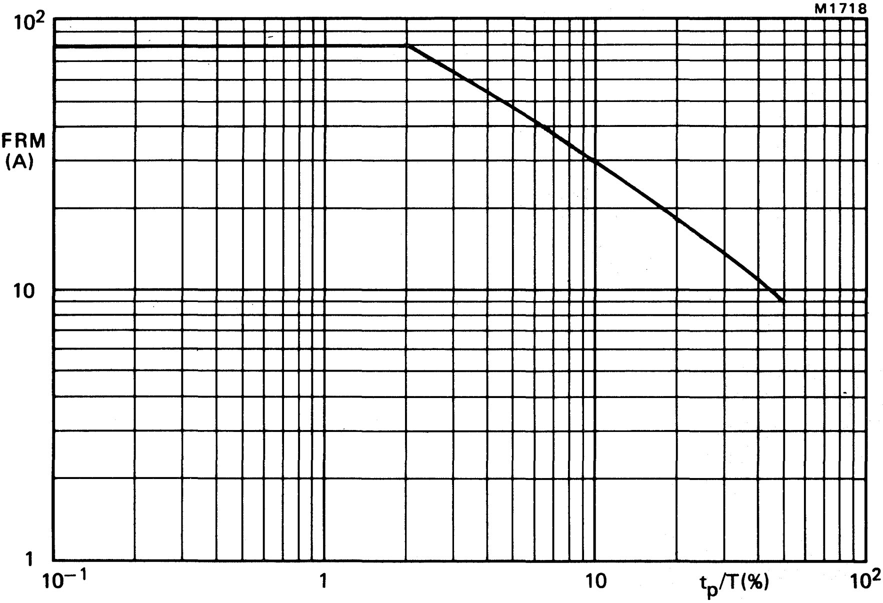
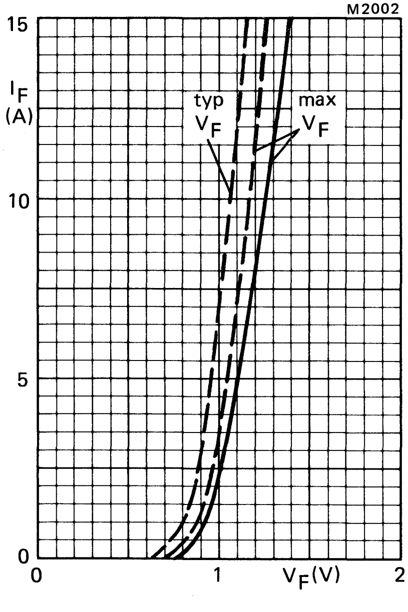
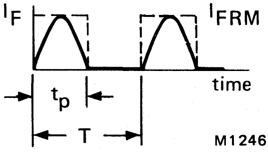


Fig.8 Maximum permissible repetitive peak forward current for either square or sinusoidal currents for 1 $\mu s < t_p < 1$ ms per diode.





Definition of I_{FRM} and t_p/T

Fig.9 —— $T_j = 25$ °C; – – – $T_j = 150$ °C per diode.

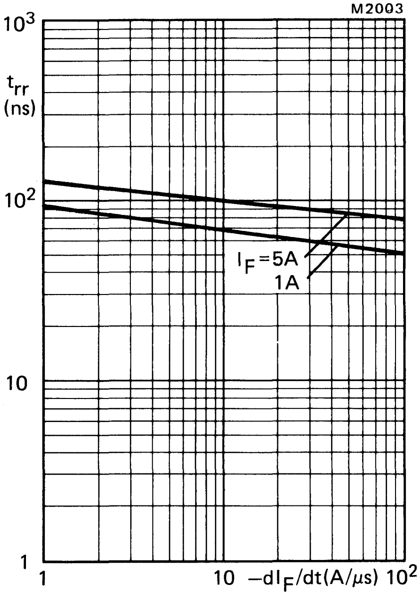


Fig.10 Maximum t_{rr} at T_j = 25 °C; per diode.

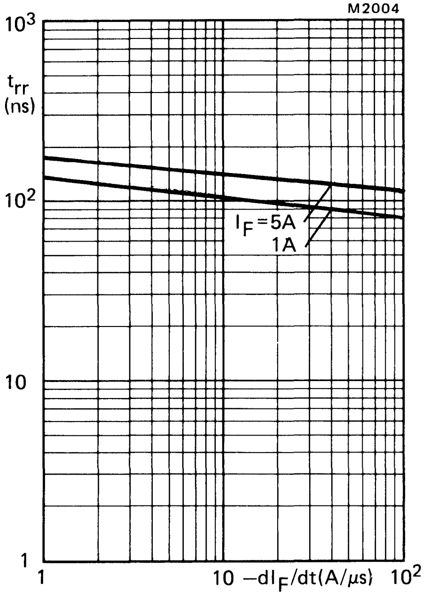


Fig.11 Maximum t_{rr} at T_j = 100 °C; per diode.

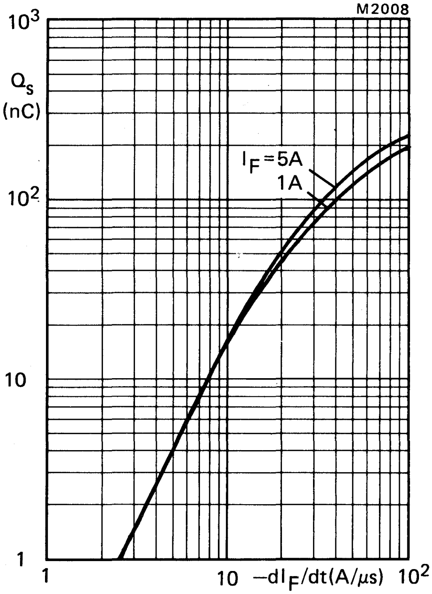


Fig.12 Maximum Q_s at T_j = 25 °C; per diode.

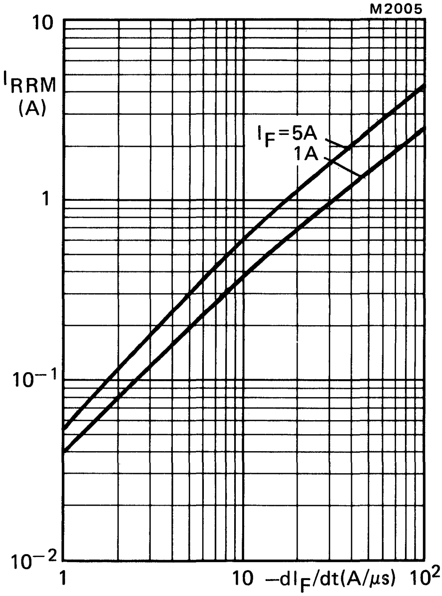


Fig.13 Maximum I_{RRM} at T_j = 25 °C; per diode.

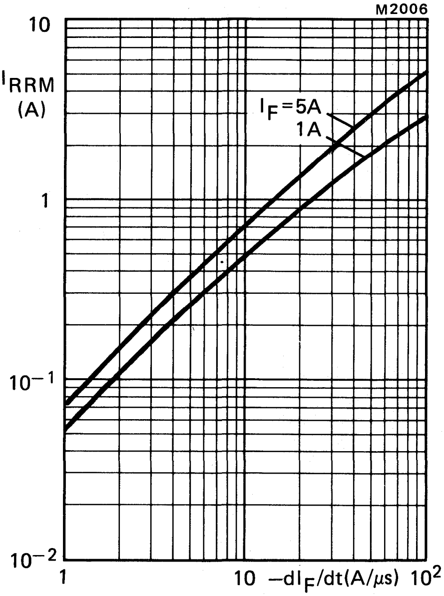


Fig.14 Maximum I_{RRM} at T_j = 100 °C; per diode.

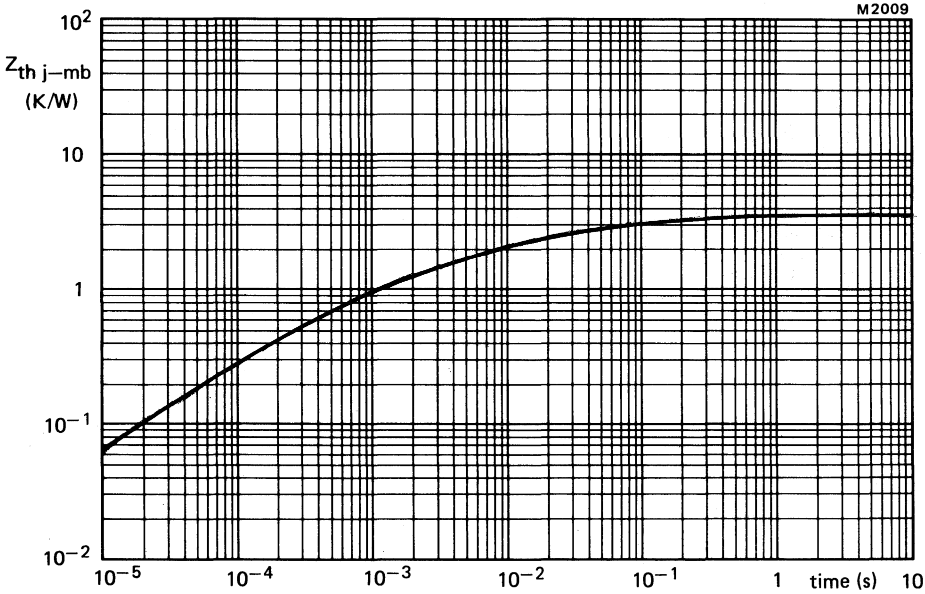


Fig.15 Transient thermal impedance (one diode conducting).

ULTRA FAST RECOVERY RECTIFIER DIODES

Glass-passivated, high-efficiency epitaxial rectifier diodes in plastic envelopes, featuring low forward voltage drop, ultra fast reverse recovery times with very low stored charge and soft-recovery characteristic. They are intended for use in switched-mode power supplies and high-frequency circuits in general, where both low conduction losses and low switching losses are essential.
The series consists of normal polarity (cathode to mounting base) types.

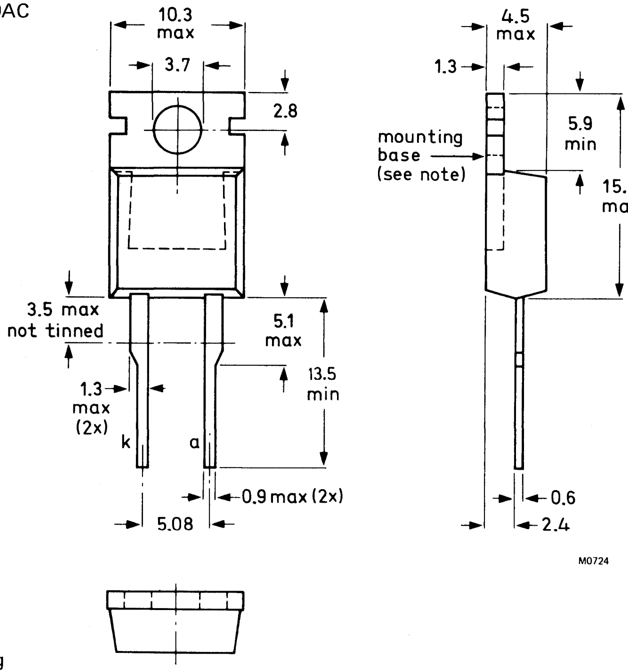
QUICK REFERENCE DATA

			BYT79–300	400	500	
Repetitive peak reverse voltage	V_{RRM}	max.	300	400	500	V
Average forward current	$I_{F(AV)}$	max.		14		A
Forward voltage	V_F	<		1.05		V
Reverse recovery time	t_{rr}	<		50		ns

MECHANICAL DATA

Dimensions in mm

Fig.1 TO-220AC



Net mass: 2 g

Note: The exposed metal mounting base is directly connected to the cathode.

Accessories supplied on request: see data sheets Mounting instructions and accessories for TO-220 envelopes.

RATINGS

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

Voltages

			BYT79–300	400	500	
Repetitive peak reverse voltage	V_{RRM}	max.	300	400	500	V
Crest working reverse voltage	V_{RWM}	max.	200	300	400	V
Continuous reverse voltage*	V_R	max.	200	300	400	V

Currents

Average forward current; switching → losses negligible up to 200 kHz; square wave; $\delta = 0.5$; up to $T_{mb} = 113\ ^{o}C$	$I_{F(AV)}$	max.	14	A
up to $T_{mb} = 125\ ^{o}C$	$I_{F(AV)}$	max.	10	A
sinusoidal; up to $T_{mb} = 118\ ^{o}C$	$I_{F(AV)}$	max.	12.5	A
up to $T_{mb} = 125\ ^{o}C$	$I_{F(AV)}$	max.	10	A
R.M.S. forward current	$I_{F(RMS)}$	max.	20	A
Repetitive peak forward current $t_p = 20\ \mu s$; $\delta = 0.02$	I_{FRM}	max.	320	A
Non-repetitive peak forward current half sine-wave; $T_j = 150\ ^{o}C$ prior to surge; with reapplied V_{RWMmax}; t = 10 ms	I_{FSM}	max.	150	A
t = 8.3 ms	I_{FSM}	max.	180	A
I^2t for fusing (t = 10 ms)	I^2t	max.	112	A^2s

Temperatures

Storage temperature	T_{stg}		−40 to +150	^{o}C
Junction temperature	T_j	max.	150	^{o}C

---

*To ensure thermal stability: $R_{th\ j\text{-}a} \leqslant 4.6$ K/W.

CHARACTERISTICS

Forward voltage				
I_F = 15 A; T_j = 150 °C	V_F	<	1.05	V*
I_F = 50 A; T_j = 25 °C	V_F	<	1.40	V*
Reverse current				
$V_R = V_{RWM\ max}$; T_j = 100 °C	I_R	<	0.8	mA
T_j = 25 °C	I_R	<	50	µA
Reverse recovery when switched from				
I_F = 1 A to $V_R \geqslant$ 30 V with $-dI_F/dt$ = 100 A/µs; T_j = 25 °C; recovery time	t_{rr}	<	50	ns
I_F = 2 A to $V_R \geqslant$ 30 V with $-dI_F/dt$ = 20 A/µs; T_j = 25 °C; recovered charge	Q_s	<	50	nC
I_F = 10 A to $V_R \geqslant$ 30 V with $-dI_F/dt$ = 50 A/µs; T_j = 100 °C; peak recovery current	I_{RRM}	<	5.2	A
Forward recovery when switched to I_F = 10 A with dI_F/dt = 10 A/µs; T_j = 25 °C	V_{fr}	typ.	2.5	V

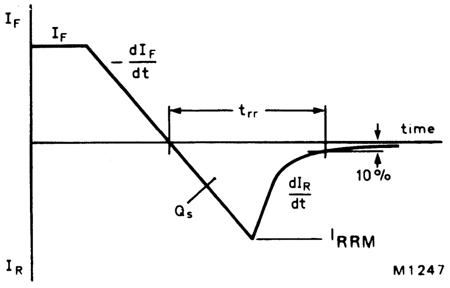


Fig.2 Definition of t_{rr}, Q_s and I_{RRM}.

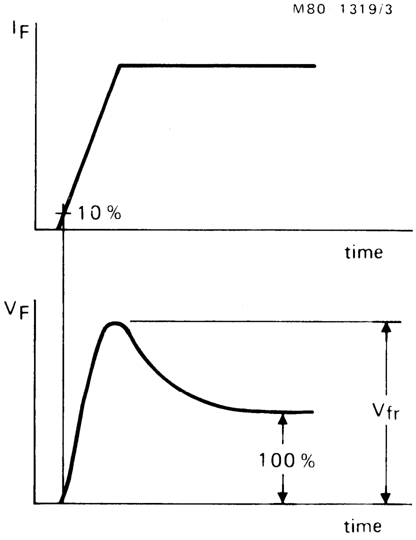


Fig.3 Definition of V_{fr}.

*Measured under pulse conditions to avoid excessive dissipation.

THERMAL RESISTANCE

From junction to mounting base	$R_{th\ j\text{-}mb}$	=	2	K/W

Influence of mounting method

1. Heatsink-mounted with clip (see mounting instructions)

Thermal resistance from mounting base to heatsink

a. with heatsink compound	$R_{th\ mb\text{-}h}$	=	0.3	K/W
b. with heatsink compound and 0.06 mm maximum mica insulator	$R_{th\ mb\text{-}h}$	=	1.4	K/W
c. with heatsink compound and 0.1 mm maximum mica insulator (56369)	$R_{th\ mb\text{-}h}$	=	2.2	K/W
d. with heatsink compound and 0.25 mm maximum alumina insulator (56367)	$R_{th\ mb\text{-}h}$	=	0.8	K/W
e. without heatsink compound	$R_{th\ mb\text{-}h}$	=	1.4	K/W

2. Free air operation

The quoted value of $R_{th\ j\text{-}a}$ should be used only when no leads of other dissipating components run to the same tie point.

Thermal resistance from junction to ambient in free air: mounted on a printed circuit board at any device lead length and with copper laminate on the board	$R_{th\ j\text{-}a}$	=	60	K/W

MOUNTING INSTRUCTIONS

1. The device may be soldered directly into the circuit, but the maximum permissible temperature of the soldering iron or bath is 275°C; the heat source must not be in contact with the joint for more than 5 seconds. Soldered joints must be at least 4.7 mm from the seal.
2. The leads should not be bent less than 2.4 mm from the seal, and should be supported during bending. The bend radius must be no less than 1.0 mm. ←
3. Mounting by means of a spring clip is the best mounting method because it offers:
   a. a good thermal contact under the crystal area and slightly lower $R_{th\ mb\text{-}h}$ values than does screw mounting.
   b. safe isolation for mains operation.

   However, if a screw is used, it should be M3 cross-recess pan head. Care should be taken to avoid damage to the plastic body.
4. For good thermal contact, heatsink compound should be used between mounting base and heatsink. Values of $R_{th\ mb\text{-}h}$ given for mounting with heatsink compound refer to the use of a metallic oxide-loaded compound. Ordinary silicone grease is not recommended.
5. Rivet mounting (only possible for non-insulated mounting).
   Devices may be rivetted to flat heatsinks; such a process must **neither** deform the mounting tab, **nor** enlarge the mounting hole.

OPERATING NOTES

Dissipation and heatsink calculations

a. The various components of junction temperature rise above ambient are illustrated in Fig.4.

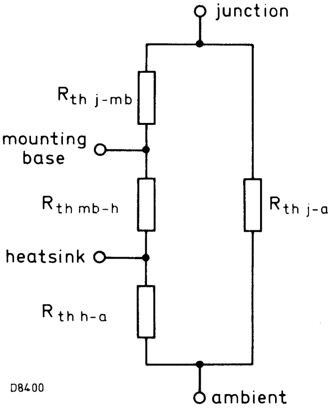


Fig. 4.

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

c. The method of using Figs. 5 and 6 is as follows:

Starting with the required current on the $I_{F(AV)}$ axis, trace upwards to meet the appropriate duty cycle or form factor curve. Trace right horizontally and upwards from the required value on the T_{amb} scale. The intersection determines the $R_{th\ mb\text{-}a}$. The heatsink thermal resistance value ($R_{th\ h\text{-}a}$) can be calculated from:

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

SQUARE-WAVE OPERATION

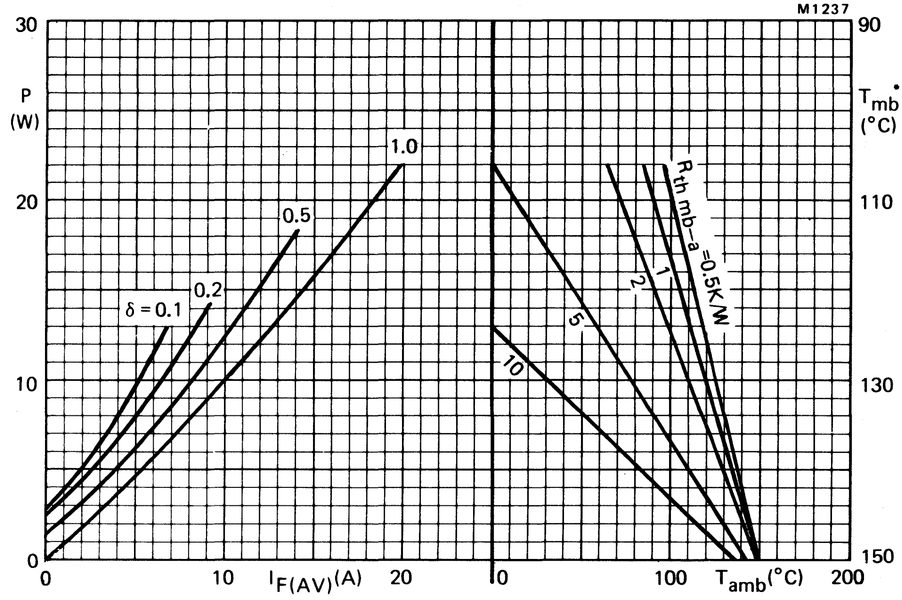
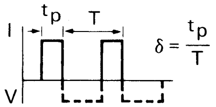


Fig.5 The right-hand part shows the relationship between the power (derived from the left-hand part) and the maximum permissible temperatures. Power includes reverse current losses and switching losses up to f = 200 kHz.



$$I_{F(AV)} = I_{F(RMS)} \times \sqrt{\delta}$$

*T_{mb} scale is for comparison purposes and is correct only for $R_{th\ mb-a} < 4.1$ K/W.

SINUSOIDAL OPERATION

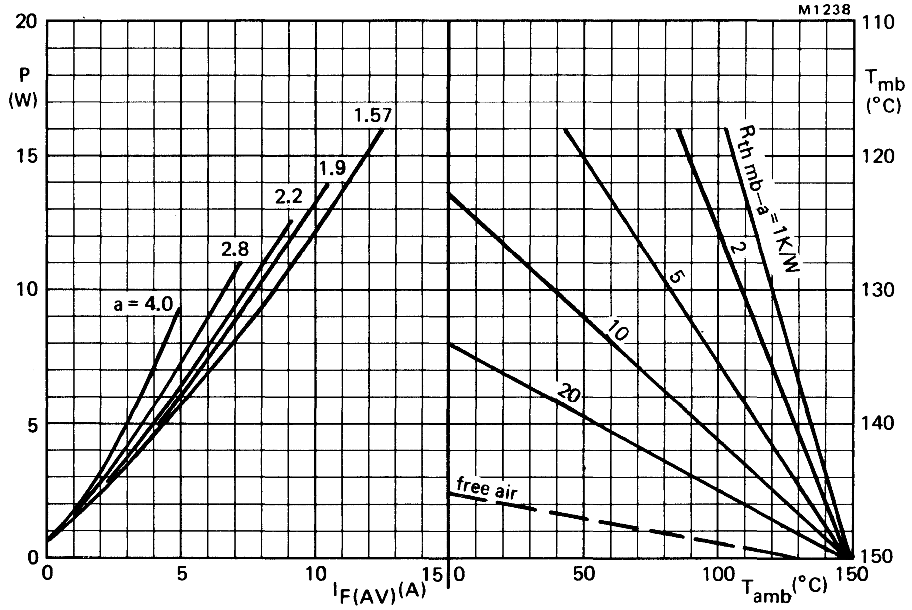


Fig.6 The right-hand part shows the interrelationship between the power (derived from the left-hand part) and the maximum permissible temperatures.
a = form factor = $I_{F(RMS)}/I_{F(AV)}$.

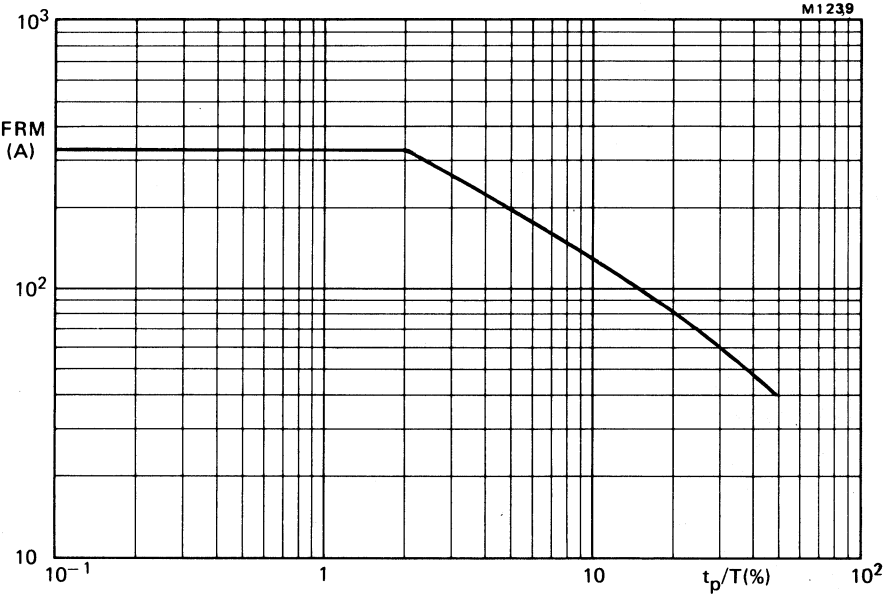
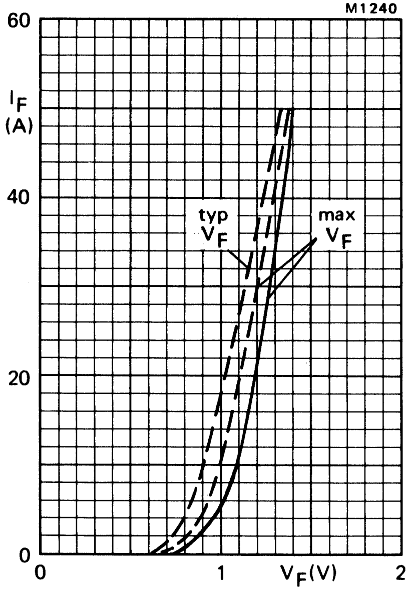
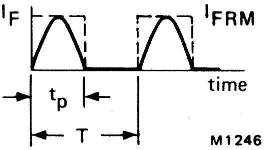


Fig.7 Maximum permissible repetitive peak forward current for square or sinusoidal currents; 1 μs $< t_p <$ 1 ms.





Definition of I_{FRM} and t_p/T.

Fig.8 —— T_j = 25 °C; – – – T_j = 150 °C.

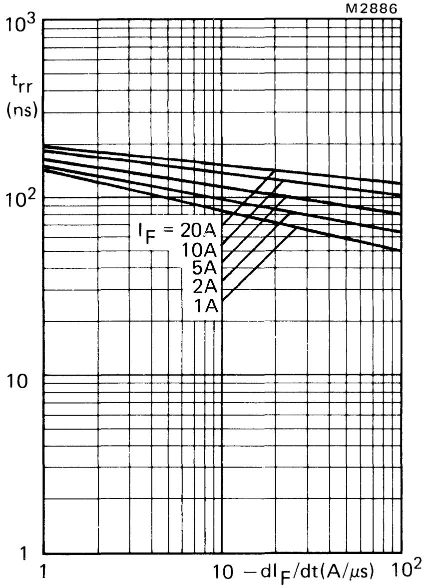


Fig.9 Maximum t_{rr} at T_j = 25 °C.

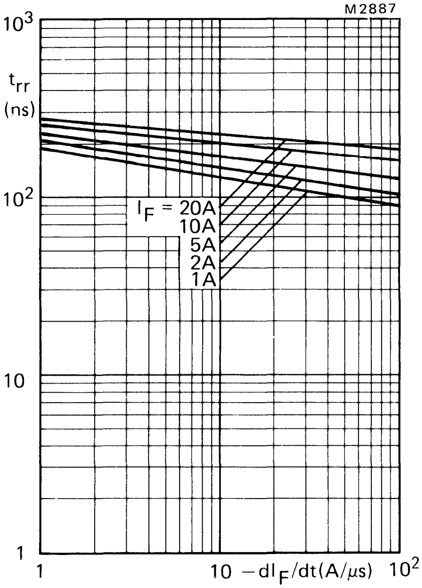


Fig.10 Maximum t_{rr} at T_j = 100 °C.

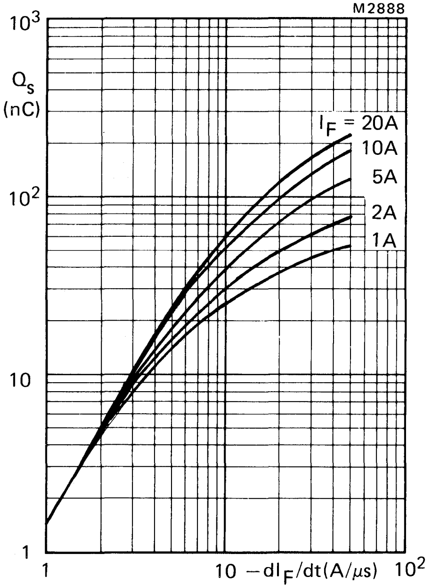


Fig.11 Maximum Q_s at T_j = 25 °C.

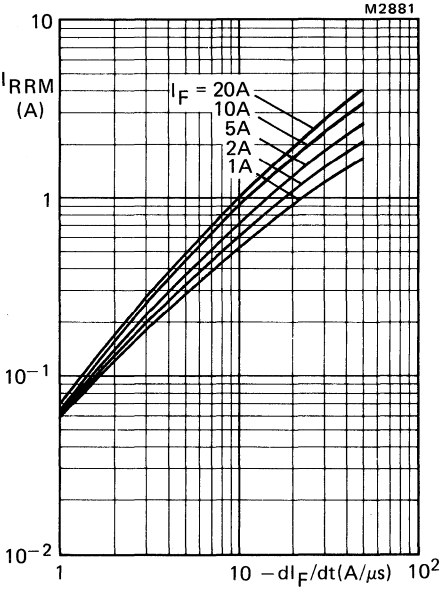


Fig.12 Maximum I_{RRM} at T_j = 25 °C.

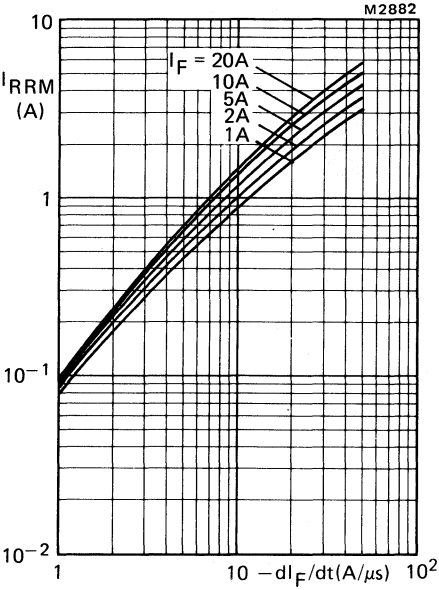


Fig.13 Maximum I_{RRM} at T_j = 100 °C.

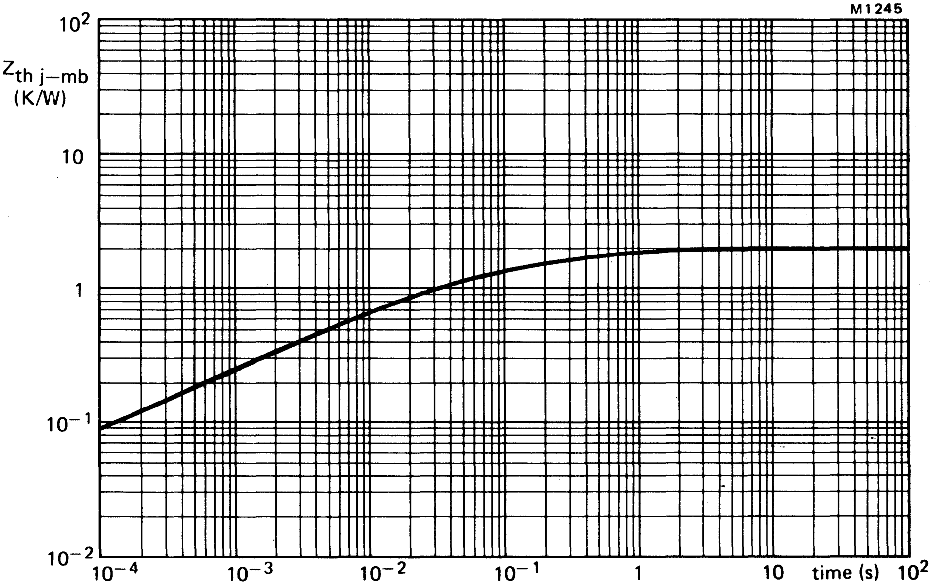


Fig.14 Transient thermal impedance.

FAST SOFT-RECOVERY RECTIFIER DIODES

Fast soft-recovery diodes in DO-4 metal envelopes especially suitable for operation as main and commutating diodes in 3-phase a.c. motor speed control inverters and in high frequency power supplies in general.
The series consists of the following types:
Normal polarity (cathode to stud): BYV24-800 and BYV24-1000.
Reverse polarity (anode to stud): BYV24-800R and BYV24-1000R.

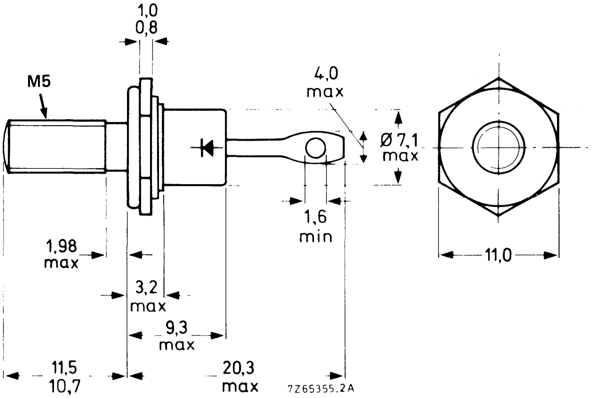
QUICK REFERENCE DATA

			BYV24-800(R)	1000(R)	
Repetitive peak reverse voltage	V_{RRM}	max.	800	1000	V
Average forward current	$I_{F(AV)}$	max.	12		A
Non-repetitive peak forward current	I_{FSM}	max.	150		A
Reverse recovery time	t_{rr}	<	450		ns

MECHANICAL DATA

Dimensions in mm

Fig. 1 DO—4: with metric M5 stud (ϕ5 mm)



Net mass: 6 g
Diameter of clearance hole: max 5.2 mm
Accessories supplied on request:
see ACCESSORIES section

Supplied with device: 1 nut, 1 lock washer.
Torque on nut: min. 0.9 Nm (9 kg cm)
max. 1.7 Nm (17 kg cm)
Nut dimensions across the flats: 8.0 mm.

The mark shown applies to the normal polarity types.

RATINGS

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

Voltages*

			BYV24–800(R)	1000(R)	
Non-repetitive peak reverse voltage	V_{RSM}	max.	1000	1200	V
Repetitive peak reverse voltage	V_{RRM}	max.	800	1000	V
Crest working reverse voltage	V_{RWM}	max.	650	850	V
Continuous reverse voltage	V_R	max.	650	850	V

Currents

Average forward current				
sinusoidal; up to T_{mb} = 103 °C	$I_{F(AV)}$	max.	12	A
sinusoidal; at T_{mb} = 125 °C	$I_{F(AV)}$	max.	7	A
square-wave; $\delta = 0.5$; up to T_{mb} = 103 °C	$I_{F(AV)}$	max.	14	A
square-wave; $\delta = 0.5$; at T_{mb} = 125 °C	$I_{F(AV)}$	max.	8	A
R.M.S. forward current	$I_{F(RMS)}$	max.	20	A
Repetitive peak forward current	I_{FRM}	max.	120	A
Non-repetitive peak forward current t = 10 ms; half sine-wave; T_j = 150 °C prior to surge;				
without re-applied voltage	I_{FSM}	max.	150	A
with re-applied V_{RWMmax}	I_{FSM}	max.	120	A
I^2t for fusing (t = 10 ms)	I^2t	max.	72	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	$R_{th\ j\text{-}mb}$	=	2.0	°C/W
From mounting base to heatsink				
with heatsink compound	$R_{th\ mb\text{-}h}$	=	0.3	°C/W
without heatsink compound	$R_{th\ mb\text{-}h}$	=	0.5	°C/W
Transient thermal impedance; t = 1 ms	$Z_{th\ j\text{-}mb}$	=	0.85	°C/W

MOUNTING INSTRUCTIONS

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.

---

*To ensure thermal stability: $R_{th\ j\text{-}a} \leq 8$ °C/W (continuous reverse voltage).

CHARACTERISTICS

Forward voltage				
$I_F = 20$ A; $T_j = 25$ °C	V_F	$<$	1.7	V*
Reverse current				
$V_R = V_{RWMmax}$; $T_j = 125$ °C	I_R	$<$	1.5	mA
Reverse recovery when switched from				
$I_F = 10$ A to $V_R \geqslant 30$ V with $-dI_F/dt = 10$ A/µs; $T_j = 25$ °C Recovery time	t_{rr}	$<$	450	ns
$I_F = 2$ A to $V_R \geqslant 30$ V with $-dI_F/dt = 20$ A/µs; $T_j = 25$ °C Recovered charge	Q_s	$<$	800	nC
Maximum slope of the reverse recovery current when switched from $I_F = 2$ A to $V_R \geqslant 30$ V; with $-dI_F/dt = 2$ A/µs; $T_j = 25$ °C	$\lvert dI_R/dt \rvert$	$<$	7	A/µs

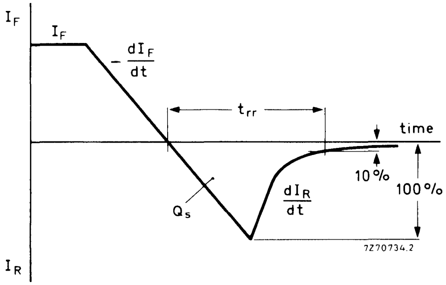


Fig.2 Definition of t_{rr} and Q_s.

---

*Measured under pulse conditions to avoid excessive dissipation.

SINUSOIDAL OPERATION

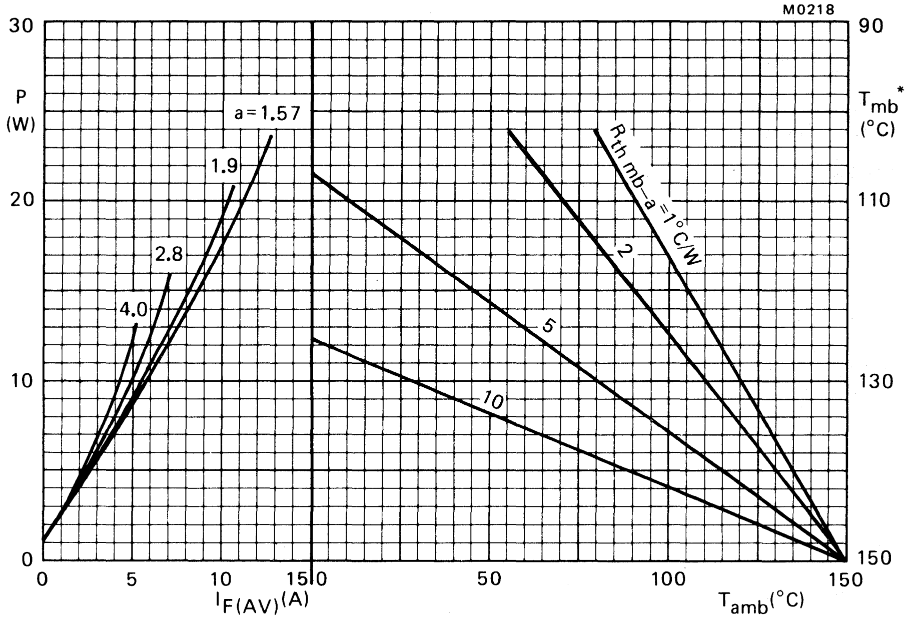


Fig.3 The right-hand part shows the interrelationship between the power (derived from the left-hand part) and the maximum permissible temperatures.
P = power including reverse current losses but excluding switching losses.
a = form factor = $I_{F(RMS)}/I_{F(AV)}$.

---

*T_{mb} scale is for comparison purposes and is correct only for $R_{th\ mb\text{-}a} < 8$ °C/W.

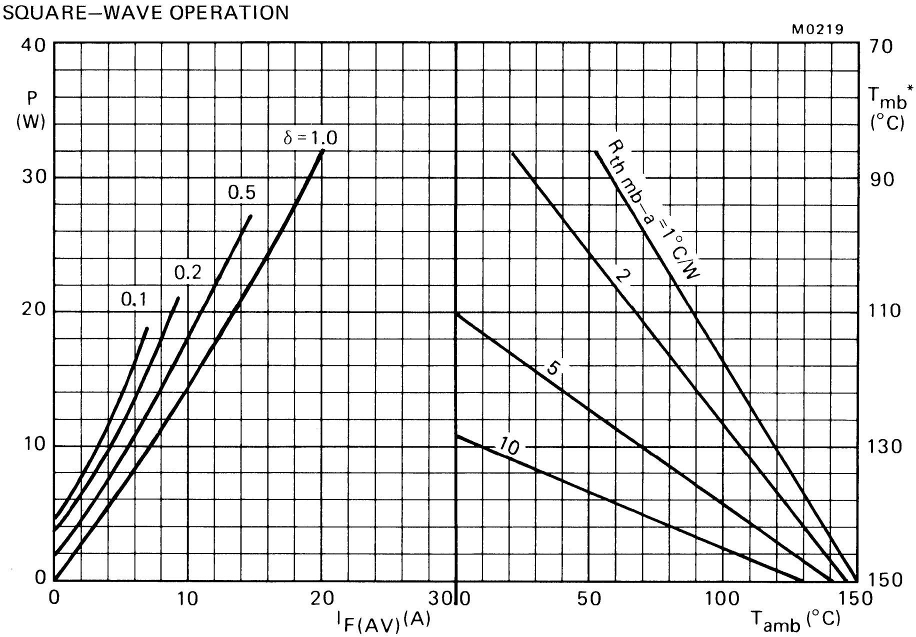
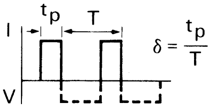


Fig.4 The right-hand part shows the interrelationship between the power (derived from the left-hand part) and the maximum permissible temperatures.
P = power including reverse current losses but excluding switching losses.



$$\delta = \frac{t_p}{T}$$

$$I_{F(AV)} = I_{F(RMS)} \times \sqrt{\delta}$$

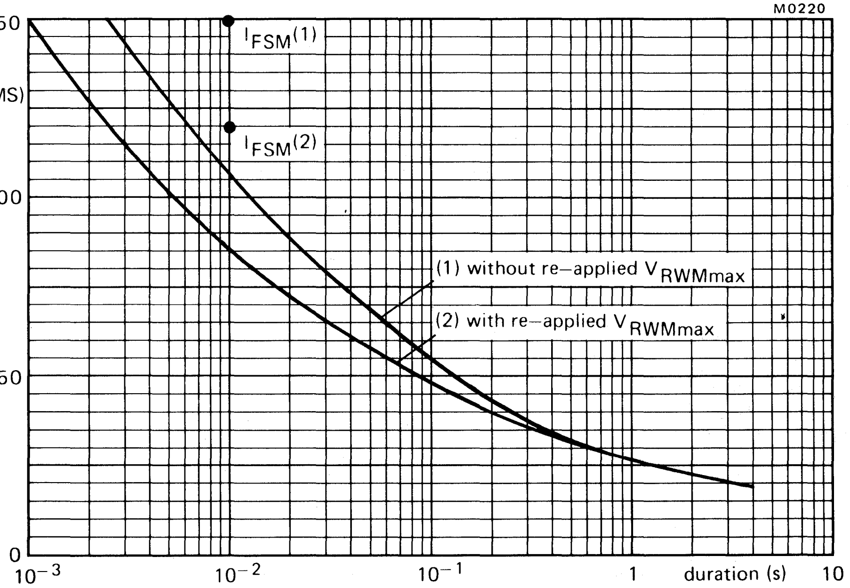
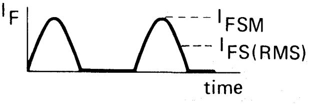


Fig.5 Maximum permissible non-repetitive r.m.s. forward current based on sinusoidal currents (f = 50 Hz); T_j = 150 °C prior to surge.



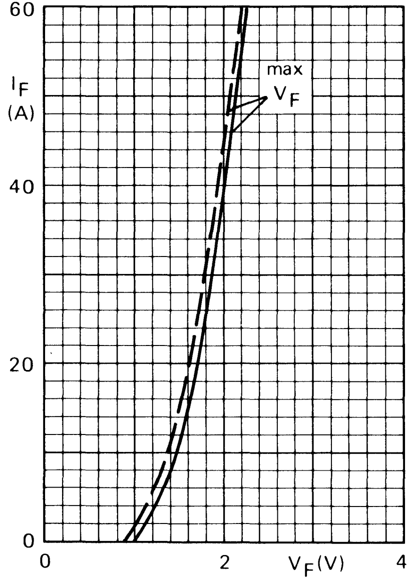


Fig.6. —— T_j = 25 °C; – – – T_j = 100 °C.

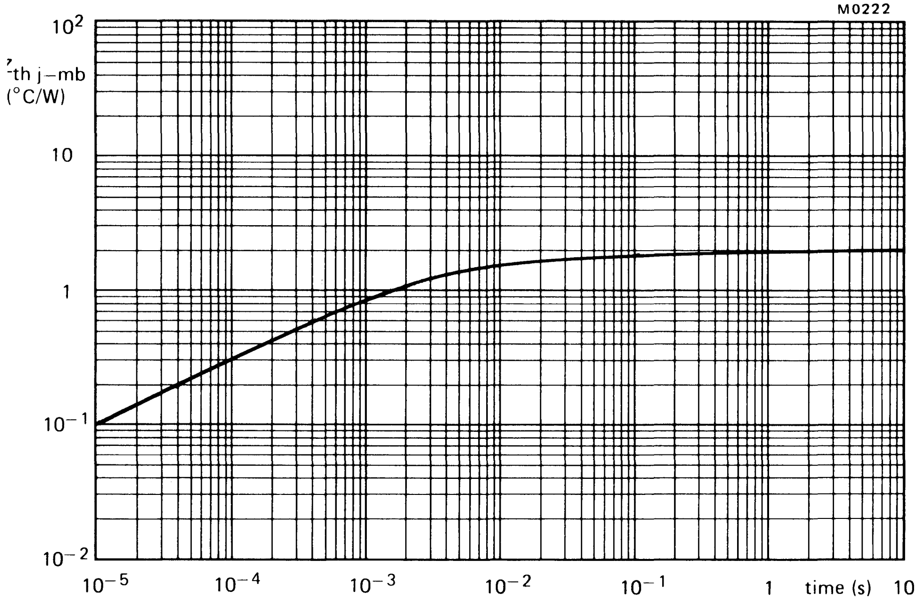


Fig.7

VERY FAST SOFT-RECOVERY AVALANCHE RECTIFIER DIODES

Glass passivated rectifier diodes in hermetically sealed axial-leaded glass envelopes. They are intended for use in switched-mode power supplies and high-frequency inverter circuits. In general, they are used where high output voltages and low switching losses are essential. The devices feature non-snap-off (soft-recovery) switching characteristics and are capable of absorbing reverse transient energy.

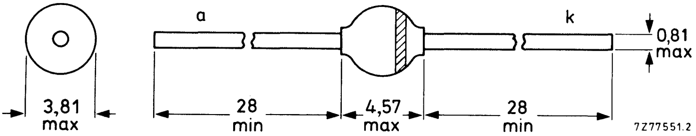
QUICK REFERENCE DATA

			BYV26A	26B	26C	26D	26E	
Repetitive peak reverse voltage	V_{RRM}	max.	200	400	600	800	1000	V
Continuous reverse voltage	V_R	max.	200	400	600	800	1000	V
Average forward current	$I_{F(AV)}$	max.	1	1	1	1	1	A
Non-repetitive peak forward current	I_{FSM}	max.	30	30	30	30	30	A ←
Non-repetitive peak reverse energy	E_{RSM}	max.	10	10	10	10	10	mJ
Reverse recovery time	t_{rr}	<	30	30	30	75	75	ns

MECHANICAL DATA

Dimensions in mm

Fig. 1 SOD-57.



The marking band indicates the cathode.

RATINGS

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

			BYV26A	26B	26C	26D	26E	
Repetitive peak reverse voltage	V_{RRM}	max.	200	400	600	800	1000	V
Continuous reverse voltage	V_R	max.	200	400	600	800	1000	V
Average forward current averaged over any 20 ms period								
T_{tp} = 85 °C; lead length 10 mm	$I_{F(AV)}$	max.			1			A
T_{amb} = 60 °C; see Fig. 2	$I_{F(AV)}$	max.			0,65			A
Repetitive peak forward current; see Figs 11 and 12	I_{FRM}	max.			10			A
Non-repetitive peak forward current t = 10 ms; half-sinewave; $T_j = T_{j\,max}$ → prior to surge; $V_R = V_{RRMmax}$	I_{FSM}	max.			30			A
Non-repetitive peak reverse avalanche energy I_R = 400 mA; $T_j = T_{j\,max}$ prior to surge; with inductive load switched off	E_{RSM}	max.			10			mJ
Storage temperature	T_{stg}				−65 to + 175			°C
Junction temperature	T_j	max.			175			°C

THERMAL RESISTANCE

Influence of mounting method

1. Thermal resistance from junction to tie-point at a lead length of 10 mm	$R_{th\ j\text{-}tp}$	=	46	K/W
2. Thermal resistance from junction to ambient; device mounted on an 1,5 mm thick epoxy-glass printed-circuit board; Cu-thickness > 40 μm; Fig. 2	$R_{th\ j\text{-}a}$	=	100	K/W

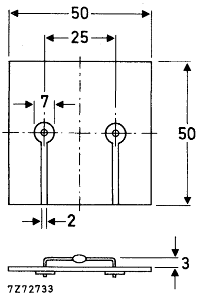


Fig. 2 Mounted on a printed-circuit board.

CHARACTERISTICS

T_j = 25 °C unless otherwise specified

			BYV26A	26B	26C	26D	26E	
Forward voltage*								
I_F = 1 A; T_j = 175 °C	V_F	$<$	1,3	1,3	1,3	1,3	1,3	V*
I_F = 1 A	V_F	$<$	2,5	2,5	2,5	2,5	2,5	V
Reverse avalanche breakdown voltage								
I_R = 0,1 mA	$V_{(BR)R}$	$>$	300	500	700	900	1100	V
Reverse current								
$V_R = V_{RRMmax}$	I_R	$<$	5	5	5	5	5	µA ←
$V_R = V_{RRMmax}$; T_j = 165 °C	I_R	$<$	150	150	150	150	150	µA
Reverse recovery time when switched from I_F = 0,5 A to I_R = 1 A; measured at I_R = 0,25 A for definition see Figs 3 and 4	t_{rr}	$<$	30	30	30	75	75	ns

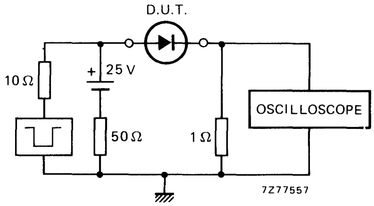


Fig. 3 Test circuit. Input impedance oscilloscope: 1 MΩ; 22 pF; rise time < 7 ns. Source impedance: 50 Ω; rise time < 15 ns.

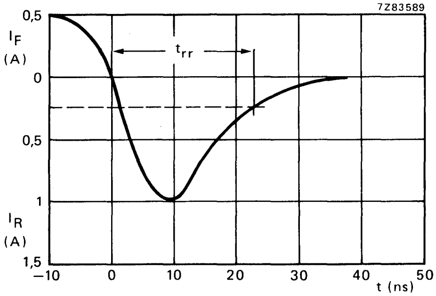


Fig. 4 Reverse recovery time characteristic.

---

* Measured under pulse conditions to avoid excessive dissipation. ←

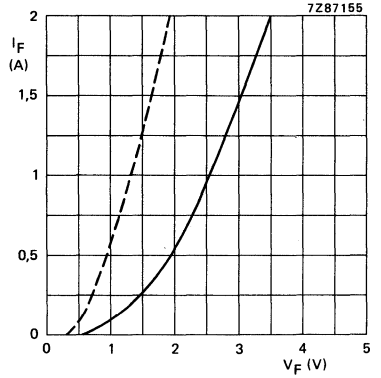
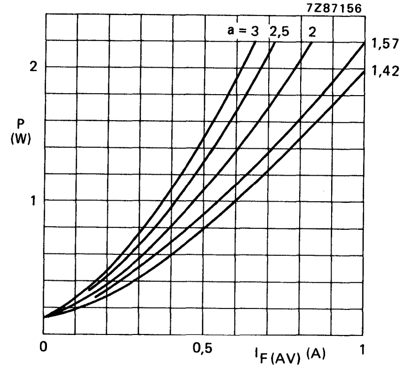


Fig. 5 Maximum forward voltage at
—— $T_j = 25$ °C
– – – $T_j = 175$ °C.



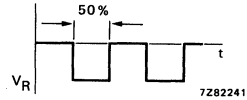


Fig. 6 Maximum steady state power dissipation (forward plus leakage current) excluding switching losses as a function of the average forward current.

The graph is for switched-mode application.

$a = I_{F(RMS)}/I_{F(AV)}$;

$V_R = V_{RRMmax}$, $\delta = 0{,}5$.

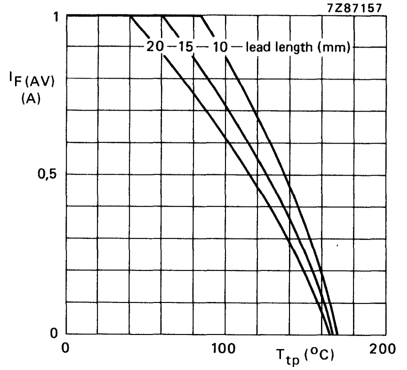


Fig. 7 Maximum average forward current as a function of the tie-point temperature; the curves include losses due to reverse leakage.

The graph is for switched-mode application. $V_R = V_{RRMmax}$, $\delta = 0{,}5$; a = 1,42.

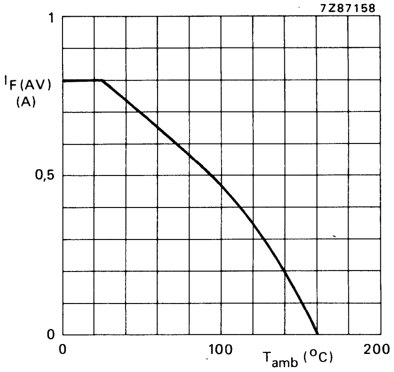


Fig. 8 Maximum average forward current as a function of the ambient temperature; the curve includes losses due to reverse leakage. Mounting method see Fig. 2. The graph is for switched-mode application. $V_R = V_{RRMmax}$, $\delta = 0{,}5$; a = 1,42.

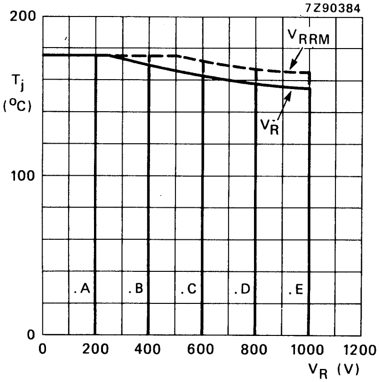


Fig. 9 Maximum permissible junction temperature as a function of the applied reverse voltage.

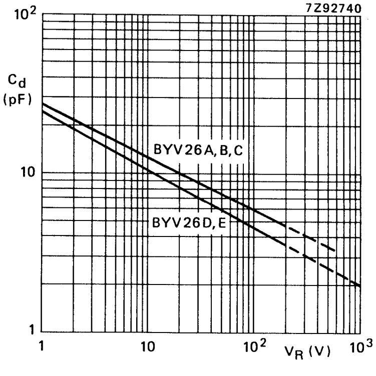


Fig. 10 Capacitance versus voltage; typical values.

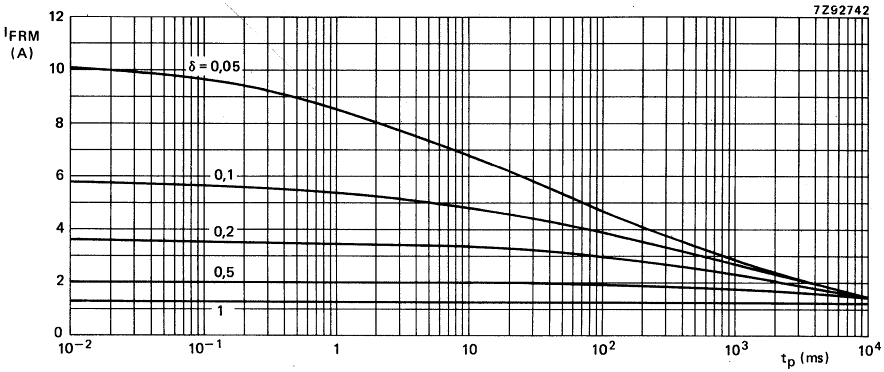


Fig. 11 Maximum repetitive peak forward current versus pulse time (square pulse) and duty factor δ at T_{tp} = 85 °C; $R_{th\ j\text{-}tp}$ = 46 K/W; V_{RRM} during 1 - δ; the curves include derating for $T_{j\ max}$ at V_{RRM} = 1000 V.

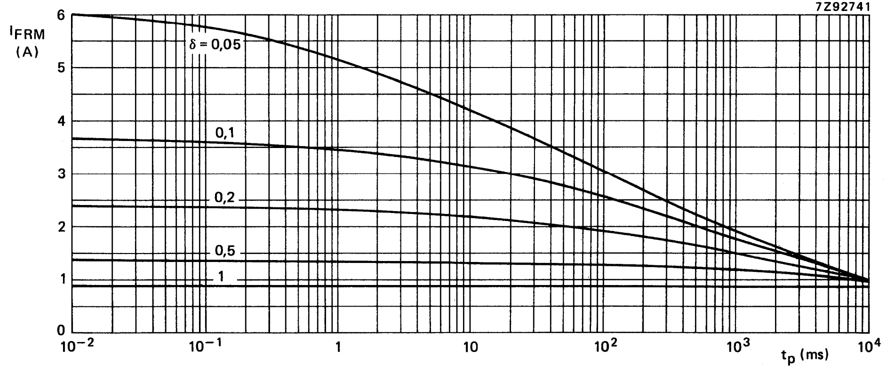


Fig. 12 Maximum repetitive peak forward current versus pulse time (square pulse) and duty factor δ at T_{amb} = 60 °C; $R_{th\ j\text{-}a}$ = 100 K/W; V_{RRM} during 1 - δ; the curves include derating for $T_{j\ max}$ at V_{RRM} = 1000 V.

EPITAXIAL AVALANCHE DIODES

Glass passivated epitaxial rectifier diodes in hermetically sealed axial-leaded glass envelopes. They feature low forward voltage drop, very fast recovery, very low stored charge, non-snap-off switching characteristics and are capable of absorbing reverse transient energy (e.g. during flashover in a picture tube). These properties make the diodes very suitable for use in switched-mode power supplies and in general high-frequency circuits, where low conduction and switching losses are essential.

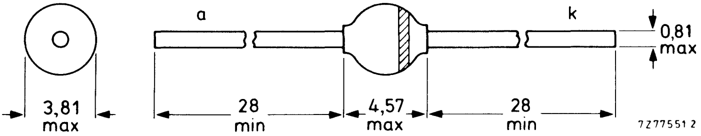
QUICK REFERENCE DATA

			BYV27-50	100	150	200	
Repetitive peak reverse voltage	V_{RRM}	max.	50	100	150	200	V
Continuous reverse voltage	V_R	max.	50	100	150	200	V
Average forward current	$I_{F(AV)}$	max.	2				A
Non-repetitive peak reverse energy	E_{RSM}	max.	40				mJ
Reverse recovery time	t_{rr}	<	25				ns

MECHANICAL DATA

Dimensions in mm

Fig. 1 SOD-57.



The marking band indicates the cathode.

The diodes are type-branded.

RATINGS

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

			BYV27-50	100	150	200	
Repetitive peak reverse voltage	V_{RRM}	max.	50	100	150	200	V
Continuous reverse voltage	V_R	max.	50	100	150	200	V

Average forward current				
(switching losses negligible up to 200 kHz)				
square wave; $\delta = 0,5$				
$T_{tp} = 85\ ^oC$; lead length = 10 mm	$I_{F(AV)}$	max.	2	A
$T_{amb} = 60\ ^oC$; Fig. 2	$I_{F(AV)}$	max.	1,3	A
Repetitive peak forward current	I_{FRM}	max.	15	A
Non-repetitive peak forward current				
(t = 10 ms; half sine-wave) $T_j = T_{j\,max}$				
prior to surge; with reapplied V_{RRM}	I_{FSM}	max.	50	A
Non-repetitive peak reverse avalanche				
energy; $I_R = 600$ mA; prior to surge;				
with inductive load switched off:				
$T_j = 25\ ^oC$, prior to surge	E_{RSM}	max.	40	mJ
$T_j = T_{j\,max}$, prior to surge	E_{RSM}	max.	20	mJ
Storage temperature	T_{stg}		−65 to + 175	^oC
Junction temperature	T_j	max.	175	^oC

THERMAL RESISTANCE

Influence of mounting method

1. Thermal resistance from junction to tie-point at a lead length of 10 mm	$R_{th\,j\text{-}tp}$	=	46	K/W
2. Thermal resistance from junction to ambient when mounted on a 1,5 mm thick epoxy-glass printed-circuit board; Cu-thickness $\geqslant 40\ \mu m$; Fig. 2	$R_{th\,j\text{-}a}$	=	100	K/W

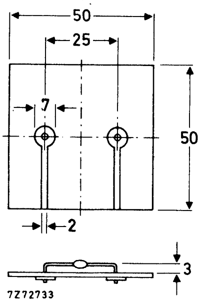


Fig. 2 Mounted on a printed-circuit board.

CHARACTERISTICS

T_j = 25 °C unless otherwise specified

			BYV27-50	100	150	200	
Reverse avalanche breakdown voltage I_R = 0,1 mA	$V_{(BR)R}$	>	55	110	165	220	V
Forward voltage* I_F = 3 A; $T_j = T_{j\,max}$	V_F	<	0,88				V
I_F = 3 A	V_F	<	1,07				V
Reverse current $V_R = V_{RRMmax}$	I_R	<	1				μA
$V_R = V_{RRMmax}$; T_j = 165 °C	I_R	<	150				μA
Reverse recovery time when switched from I_F = 0,5 A to I_R = 1 A; measured at I_R = 0,25 A for definition see Figs 3 and 4	t_{rr}	<	25				ns

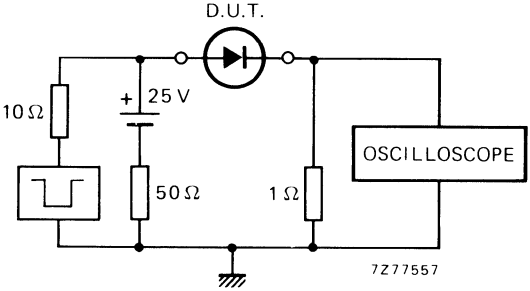


Fig. 3 Test circuit.
Input impedance oscilloscope 1 MΩ; 22 pF. Rise time ≤ 7 ns.
Source impedance 50 Ω. Rise time ≤ 15 ns.

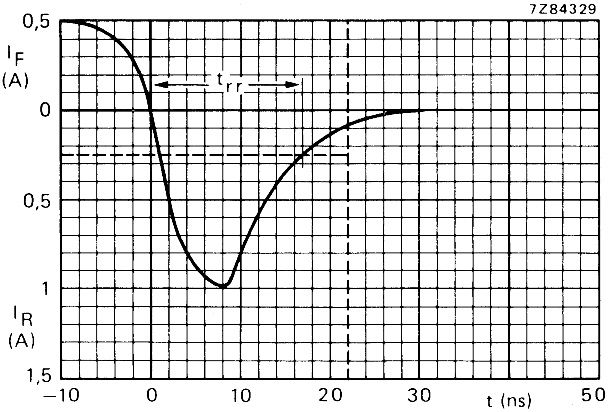


Fig. 4 Reverse recovery time characteristic.

---

* Measured under pulse conditions to avoid excessive dissipation.

Reverse recovery when switched from
$I_F = 1$ A to $V_R \geqslant 30$ V with
$-dI_F/dt = 20$ A/µs (see Fig. 5)

recovered charge	Q_s	<	15 nC
recovery time	t_{rr}	<	50 ns

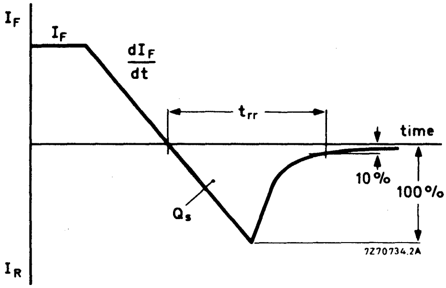


Fig. 5 Definitions of t_{rr} and Q_s.

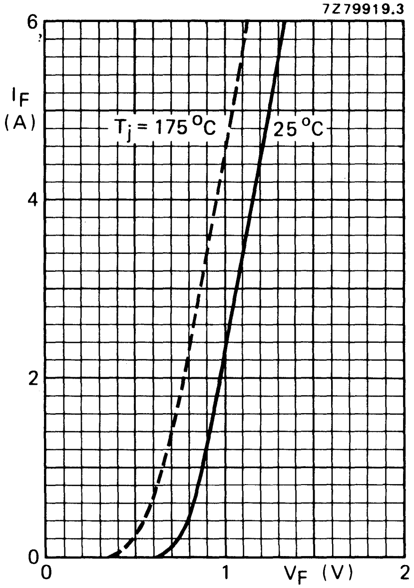


Fig.6 Maximum forward voltage.

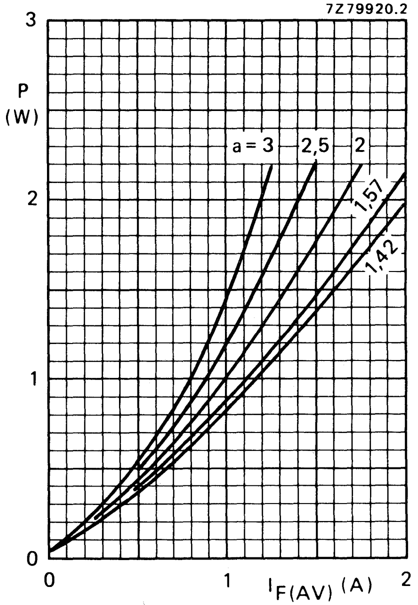


Fig. 7 $a = I_{F(RMS)}/I_{F(AV)}$; $V_R = V_{RRMmax}$.
Pulsed reverse voltage; $\delta = 0,5$.
(Including reverse current losses and switching losses up to f = 200 kHz).

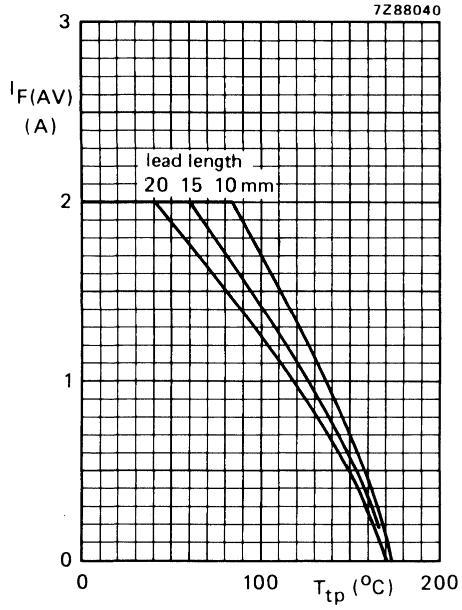


Fig. 8 Maximum average forward current.
The curves include losses due to reverse current and switching up to f = 200 kHz.
Pulsed reverse voltage, δ = 0,5.
$V_R = V_{RRMmax}$.
Square wave current, a = 1,42.

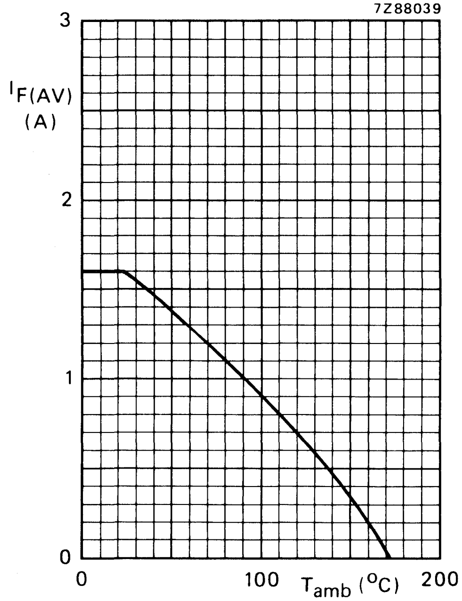


Fig. 9 Maximum average forward current.
The curve includes losses due to reverse current and switching up to f = 200 kHz.
Mounting method see Fig. 2.
Pulsed reverse voltage, δ = 0,5
$V_R = V_{RRMmax}$.
Square wave current, a = 1,42.

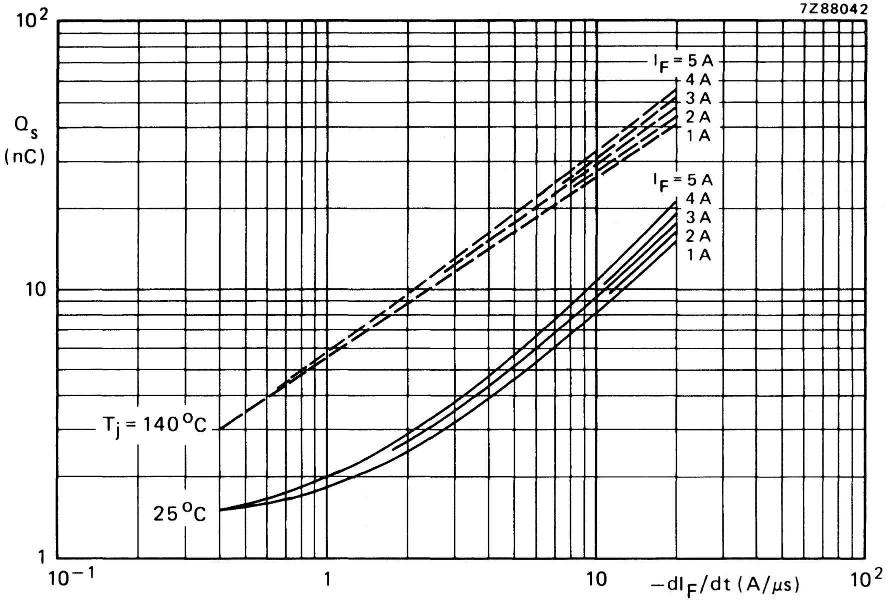


Fig. 10 Maximum values reverse recovery charge. For definition see Fig. 5.

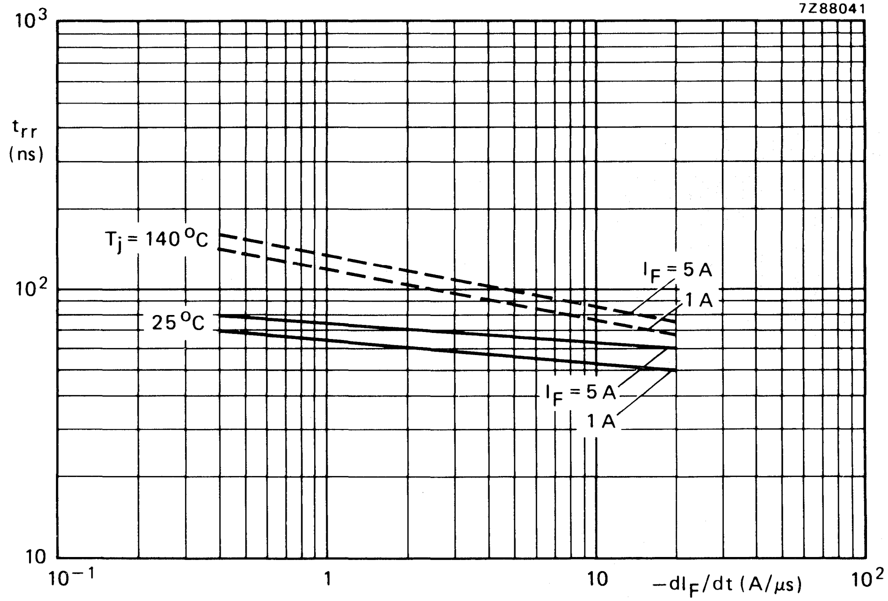


Fig. 11 Maximum values reverse recovery time. For definition see Fig. 5.

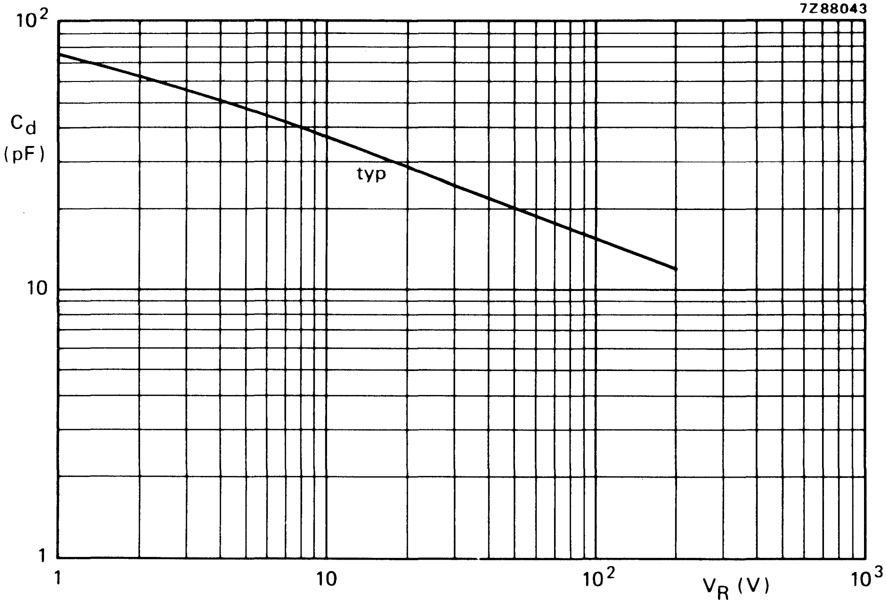


Fig. 12 Typical values diode capacitance at f = 1 MHz; T_j = 25 °C.

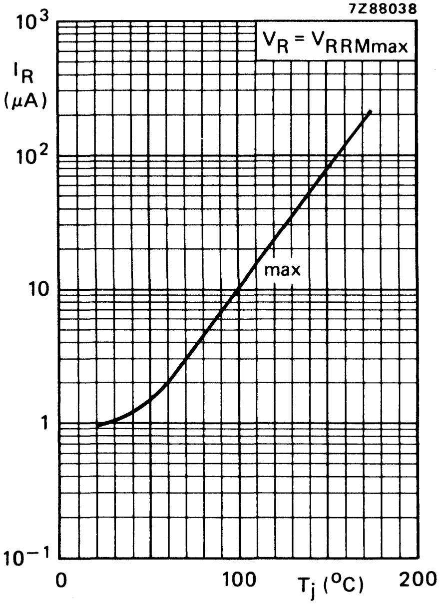


Fig. 13 Maximum values reverse current.

EPITAXIAL AVALANCHE DIODES

Glass passivated epitaxial rectifier diodes in hermetically sealed axial-leaded glass envelopes. They feature low forward voltage drop, very fast recovery, very low stored charge, non-snap-off switching characteristics and are capable of absorbing reverse transient energy (e.g. during flashover in a picture tube). These properties make the diodes very suitable for use in switched-mode power supplies and in general in high-frequency circuits, where low conduction and switching losses are essential.

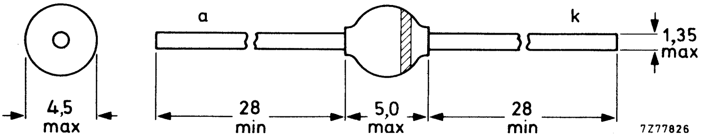
QUICK REFERENCE DATA

			BYV28-50	100	150	200	
Repetitive peak reverse voltage	V_{RRM}	max.	50	100	150	200	V
Continuous reverse voltage	V_R	max.	50	100	150	200	V
Average forward current	$I_{F(AV)}$	max.	3,5				A
Non-repetitive peak reverse energy	E_{RSM}	max.	40				mJ
Reverse recovery time	t_{rr}	<	30				ns

MECHANICAL DATA

Dimensions in mm

Fig. 1 SOD-64.



The marking band indicates the cathode.

The diodes are type-branded.

RATINGS

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

			BYV28-50	100	150	200	
Repetitive peak reverse voltage	V_{RRM}	max.	50	100	150	200	V
Continuous reverse voltage	V_R	max.	50	100	150	200	V
Average forward current (averaged over any 20 ms period)							
T_{tp} = 85 °C; lead length = 10 mm	$I_{F(AV)}$	max.	3,5				A
T_{amb} = 60 °C; p.c.b. mounting (see Fig. 2)	$I_{F(AV)}$	max.	1,9				A
Repetitive peak forward current	I_{FRM}	max.	25				A
Non-repetitive peak forward current (t = 10 ms; half sine-wave) $T_j = T_{j\,max}$ prior to surge; with reapplied V_{RRM}	I_{FSM}	max.	90				A
Non-repetitive peak reverse avalanche energy; I_R = 600 mA; with inductive load switched off							
T_j = 25 °C, prior to surge	E_{RSM}	max.	40				mJ
$T_j = T_{j\,max}$, prior to surge	E_{RSM}	max.	20				mJ
Storage temperature	T_{stg}		−65 to +175				°C
Junction temperature	T_j	max.	175				°C

THERMAL RESISTANCE

Influence of mounting method

1. Thermal resistance from junction to tie-point at a lead length of 10 mm	$R_{th\,j\text{-}tp}$	=	25	K/W
2. Thermal resistance from junction to ambient when mounted on a 1,5 mm thick epoxy-glass printed-circuit board; Cu-thickness $\geqslant$ 40 μm; Fig. 2	$R_{th\,j\text{-}a}$	=	75	K/W

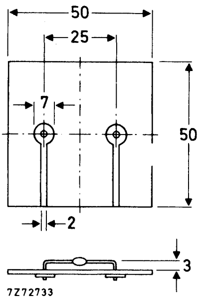


Fig. 2 Mounted on a printed-circuit board.

CHARACTERISTICS

T_j = 25 °C, unless otherwise specified

			BYV28-50	100	150	200	
Reverse avalanche breakdown voltage I_R = 0,1 mA	$V_{(BR)R}$	>	55	110	165	220	V
Forward voltage* I_F = 5 A;	V_F	<	1,10				V
I_F = 5 A; $T_j = T_{j\,max}$	V_F	<	0,89				V
Reverse current $V_R = V_{RRMmax}$	I_R	<	1				μA
$V_R = V_{RRMmax}$; T_j = 165 °C	I_R	<	150				μA
Reverse recovery time when switched from I_F = 0,5 A to I_R = 1 A; measured at I_R = 0,25 A for definition see Figs 3 and 4	t_{rr}	<	30				ns

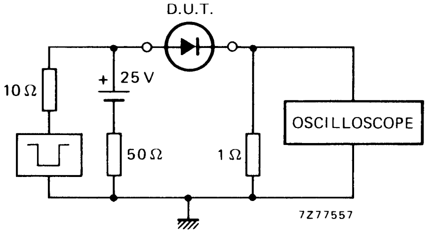


Fig. 3 Test circuit.
Input impedance oscilloscope 1 MΩ; 22 pF; Rise time ≤ 7 ns.
Source impedance 50 Ω. Rise time ≤ 15 ns.

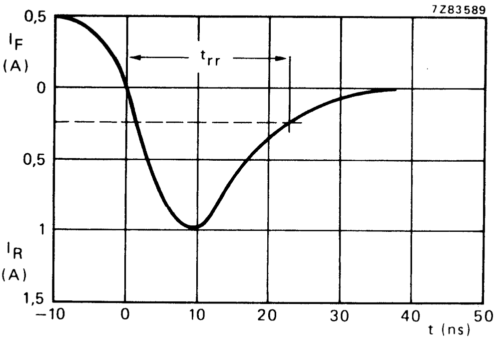


Fig. 4 Reverse recovery time characteristic.

---

* Measured under pulse conditions to avoid excessive dissipation.

Reverse recovery when switched from $I_F = 1$ A to $V_R \geqslant 30$ V with $-dI_F/dt = 20$ A/μs (see Fig. 5)				
recovered charge	Q_s	<	20	nC
recovery time	t_{rr}	<	50	ns

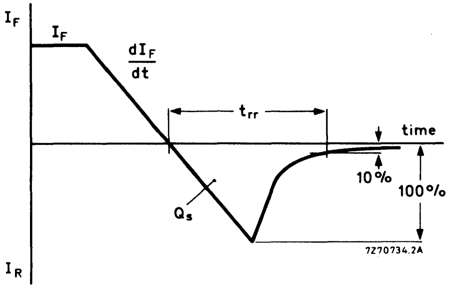


Fig. 5 Definitions of t_{rr} and Q_s.

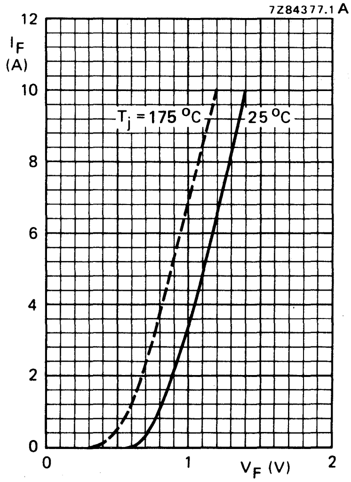


Fig.6 Maximum forward voltage.

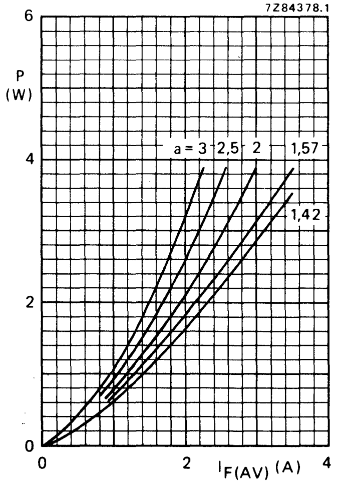


Fig. 7 Power dissipation (forward plus leakage current) as a function of the average forward current. Pulsed reverse voltage; $\delta = 50\%$. $a = I_{F(RMS)}/I_{F(AV)}$; $V_R = V_{RRMmax}$.

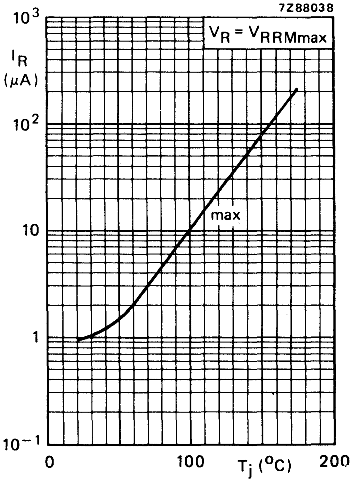


Fig. 8 Reverse current as a function of the junction temperature

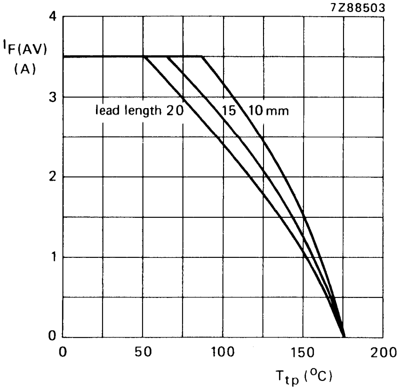


Fig. 9 Maximum average forward current. The curves include losses due to reverse current and switching up to f = 200 kHz.
Pulsed reverse voltage; $\delta = 0{,}5$ $V_R = V_{RRM\,max}$.
Square-wave current; a = 1,42.

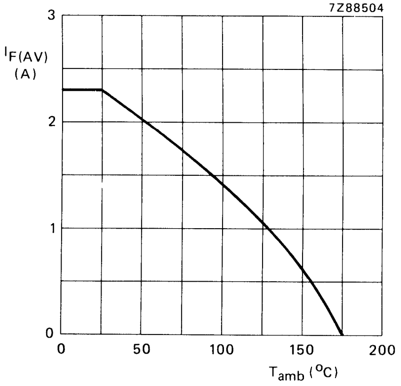


Fig. 10 Maximum average forward current. The curve includes losses due to reverse current and switching up to f = 200 kHz; mounting method see Fig. 2.
Pulsed reverse voltage; $\delta = 0{,}5$ $V_R = V_{RRM\,max}$.
Square-wave current; a = 1,42.

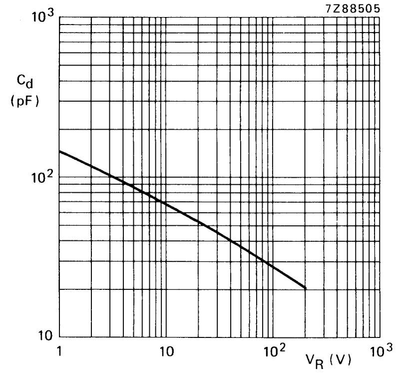


Fig. 11 Typical values diode capacitance at f = 1 MHz. T_j = 25 °C.

ULTRA FAST RECOVERY RECTIFIER DIODES

Glass-passivated, high-efficiency epitaxial rectifier diodes in plastic envelopes, featuring low forward voltage drop, ultra fast reverse recovery times with very low stored charge and soft-recovery characteristic. They are intended for use in switched-mode power supplies and high-frequency circuits in general, where both low conduction losses and switching losses are essential.
The series consists of normal polarity (cathode to mounting base) types.

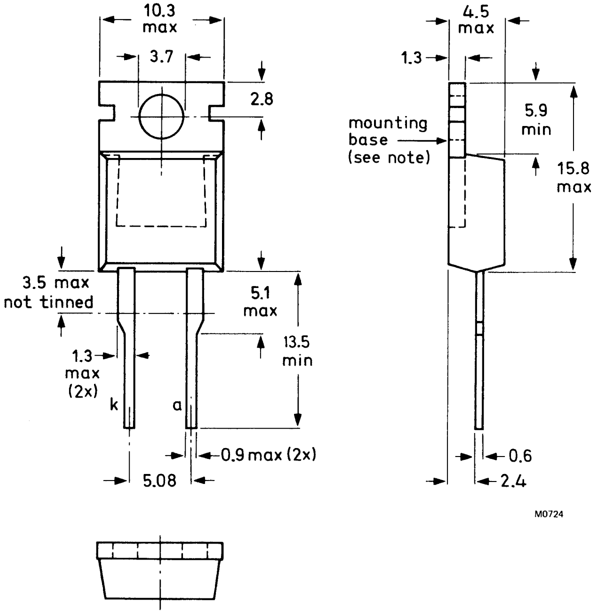
QUICK REFERENCE DATA

			BYV29–300	400	500	
Repetitive peak reverse voltage	V_{RRM}	max.	300	400	500	V
Average forward current	$I_{F(AV)}$	max.	9			A
Forward voltage	V_F	$<$	1.05			V
Reverse recovery time	t_{rr}	$<$	50			ns

MECHANICAL DATA

Dimensions in mm

Fig.1 TO-220AC



Net mass: 2 g

Note: The exposed metal mounting base is directly connected to the cathode.

Accessories supplied on request: see data sheets Mounting instructions and accessories for TO-220 envelopes.

RATINGS

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

Voltages

			BYV29–300	400	500	
Repetitive peak reverse voltage	V_{RRM}	max.	300	400	500	V
Crest working reverse voltage	V_{RWM}	max.	200	300	400	V
Continuous reverse voltage (note 1)	V_R	max.	200	300	400	V

→ **Currents**

Average forward current; switching losses negligible up to 200 kHz;				
square wave; $\delta = 0.5$; up to $T_{mb} = 116$ °C	$I_{F(AV)}$	max.	9	A
sinusoidal; up to $T_{mb} = 125$ °C	$I_{F(AV)}$	max.	7.4	A
R.M.S. forward current	$I_{F(RMS)}$	max.	13	A
Repetitive peak forward current $t_p = 20\ \mu s$; $\delta = 0.02$	I_{FRM}	max.	200	A
Non-repetitive peak forward current half sine-wave; $T_j = 150$ °C prior to surge; with reapplied $V_{RWM\ max}$				
t = 10 ms	I_{FSM}	max.	100	A
t = 8.3 ms	I_{FSM}	max.	110	A
I^2t for fusing (t = 10 ms)	I^2t	max.	50	A^2s

Temperatures

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

Notes:

1. To ensure thermal stability: $R_{th\ j\text{-}a} < 6.8$ K/W.

CHARACTERISTICS

T_j = 25 °C unless otherwise stated

Forward voltage					
$I_F = 5$ A; $T_j = 100$ °C	V_F	<	1.05	V*	
$I_F = 20$ A	V_F	<	1.4	V*	
Reverse current					
$V_R = V_{RWM\,max}$; $T_j = 100$ °C	I_R	<	0.35	mA	
$V_R = V_{RWM\,max}$	I_R	<	10	µA	←
Reverse recovery when switched from					
$I_F = 1$ A to $V_R \geqslant 30$ V with $-dI_F/dt = 100$ A/µs; recovery time	t_{rr}	<	50	ns	
$I_F = 2$ A to $V_R \geqslant 30$ V with $-dI_F/dt = 20$ A/µs; recovered charge	Q_s	<	55	nC	
$I_F = 10$ A to $V_R \geqslant 30$ V with $-dI_F/dt = 50$ A/µs; $T_j = 100$ °C; peak recovery current	I_{RRM}	<	5.5	A	←
Forward recovery when switched to $I_F = 10$ A with $dI_F/dt = 10$ A/µs	V_{fr}	typ.	2.5	V	

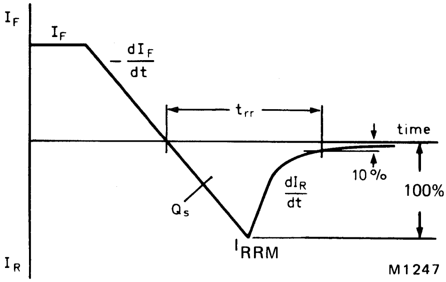


Fig.2 Definition of t_{rr}, Q_s and I_{RRM}.

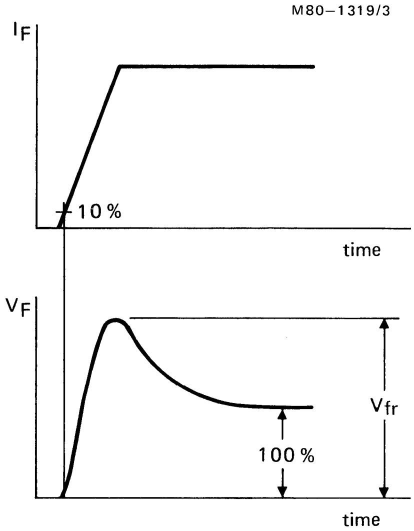


Fig.3 Definition of V_{fr}.

---

*Measured under pulse conditions to avoid excessive dissipation.

THERMAL RESISTANCE

From junction to mounting base	$R_{th\ j\text{-}mb}$ =	2.5	K/W

Influence of mounting method

1. Heatsink-mounted with clip (see mounting instructions)

Thermal resistance from mounting base to heatsink

a. with heatsink compound	$R_{th\ mb\text{-}h}$ =	0.3	K/W
b. with heatsink compound and 0.06 mm maximum mica insulator	$R_{th\ mb\text{-}h}$ =	1.4	K/W
c. with heatsink compound and 0.1 mm maximum mica insulator (56369)	$R_{th\ mb\text{-}h}$ =	2.2	K/W
d. with heatsink compound and 0.25 mm maximum alumina insulator (56367)	$R_{th\ mb\text{-}h}$ =	0.8	K/W
e. without heatsink compound	$R_{th\ mb\text{-}h}$ =	1.4	K/W

2. Free air operation

The quoted value of $R_{th\ j\text{-}a}$ should be used only when no leads of other dissipating components run to the same tie point.

Thermal resistance from junction to ambient in free air: mounted on a printed circuit board at any device lead length and with copper laminate on the board	$R_{th\ j\text{-}a}$ =	60	K/W

MOUNTING INSTRUCTIONS

1. The device may be soldered directly into the circuit, but the maximum permissible temperature of the soldering iron or bath is 275°C; the heat source must not be in contact with the joint for more than 5 seconds. Soldered joints must be at least 4.7 mm from the seal.
2. The leads should not be bent less than 2.4 mm from the seal, and should be supported during bending. The bend radius must be no less than 1.0 mm. ←
3. Mounting by means of a spring clip is the best mounting method because it offers:
   a. a good thermal contact under the crystal area and slightly lower $R_{th\ mb\text{-}h}$ values than does screw mounting.
   b. safe isolation for mains operation.
   However, if a screw is used, it should be M3 cross-recess pan head. Care should be taken to avoid damage to the plastic body.
4. For good thermal contact, heatsink compound should be used between mounting base and heatsink. Values of $R_{th\ mb\text{-}h}$ given for mounting with heatsink compound refer to the use of a metallic oxide-loaded compound. Ordinary silicone grease is not recommended.
5. Rivet mounting (only possible for non-insulated mounting).
   Devices may be rivetted to flat heatsinks; such a process must **neither** deform the mounting tab, **nor** enlarge the mounting hole.

OPERATING NOTES

Dissipation and heatsink calculations

a. The various components of junction temperature rise above ambient are illustrated in Fig.4.

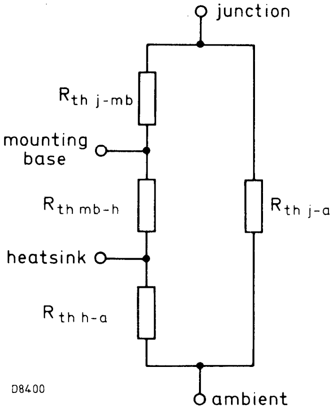


Fig. 4.

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

c. The method of using Figs. 5 and 6 is as follows:

Starting with the required current on the $I_{F(AV)}$ axis, trace upwards to meet the appropriate duty cycle or form factor curve. Trace right horizontally and upwards from the required value on the T_{amb} scale. The intersection determines the $R_{th\ mb\text{-}a}$. The heatsink thermal resistance value ($R_{th\ h\text{-}a}$) can be calculated from:

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

SQUARE-WAVE OPERATION

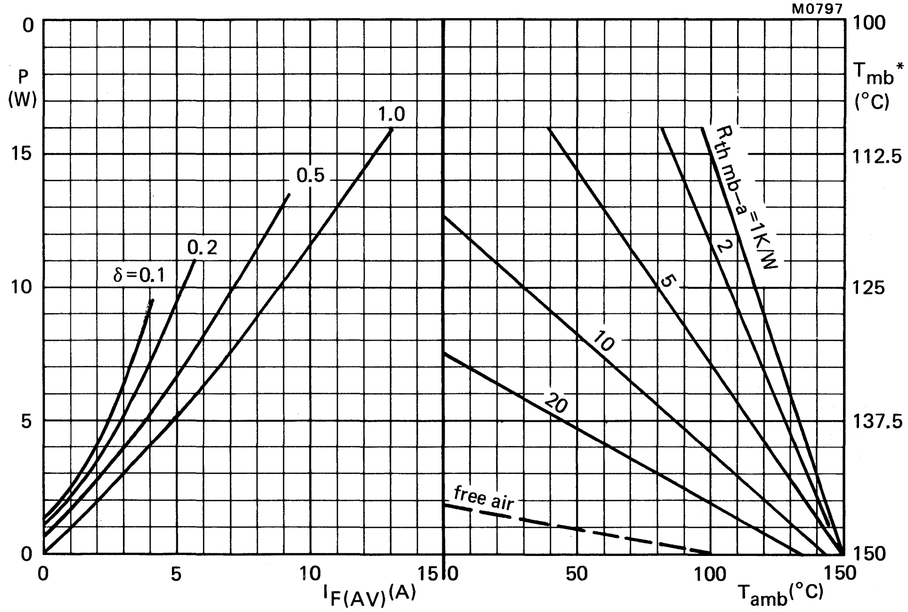
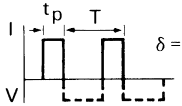


Fig.5 The right-hand part shows the relationship between the power (derived from the left-hand part) and the maximum permissible temperatures.



$$\delta = \frac{t_p}{T}$$

$$I_{F(AV)} = I_{F(RMS)} \times \sqrt{\delta}$$

---

*T_{mb} scale is for comparison purposes and is correct only for $R_{th\ mb\text{-}a} < 4.1$ °K/W.

SINUSOIDAL OPERATION

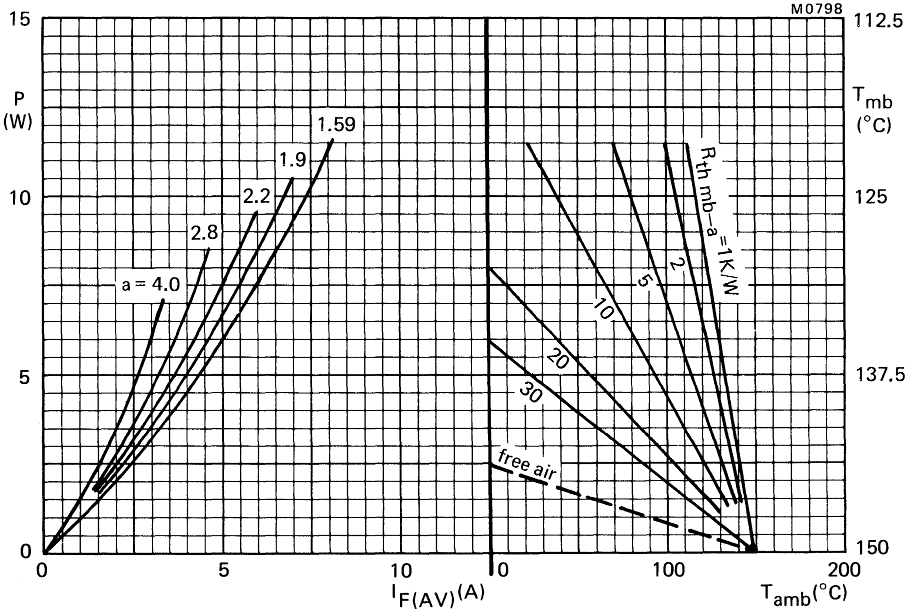


Fig.6 The right-hand part shows the interrelationship between the power (derived from the left-hand part) and the maximum permissible temperatures.
a = form factor = $I_{F(RMS)}/I_{F(AV)}$.

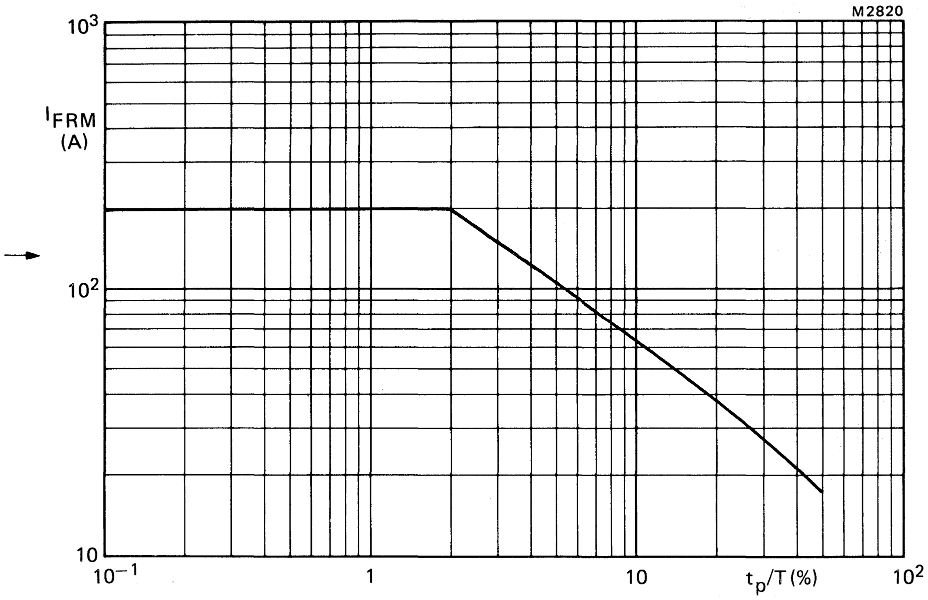
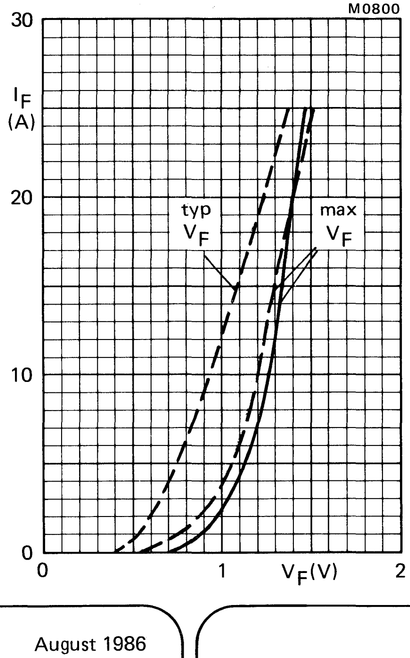
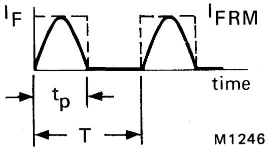


Fig.7 Maximum permissible repetitive peak forward current for square or sinusoidal currents; 1 μs $< t_p <$ 1 ms.





Defintion of I_{FRM} and t_p/T.

Fig.8 —— T_j = 25 °C; – – – T_j = 100 °C.

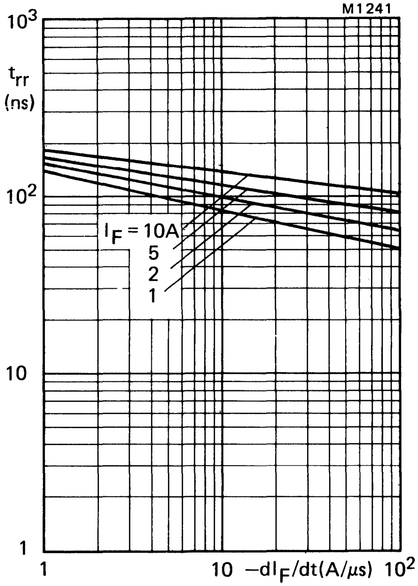


Fig.9 Maximum t_{rr} at T_j = 25 °C.

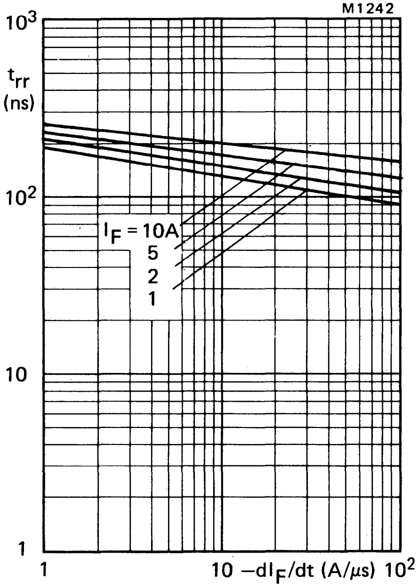


Fig.10 Maximum t_{rr} at T_j = 100 °C.

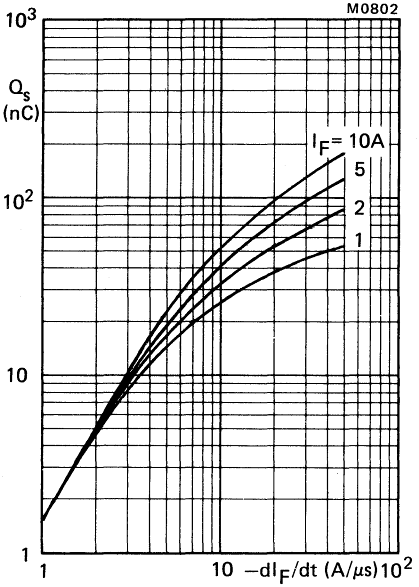


Fig.11 Maximum Q_s at T_j = 25 °C.

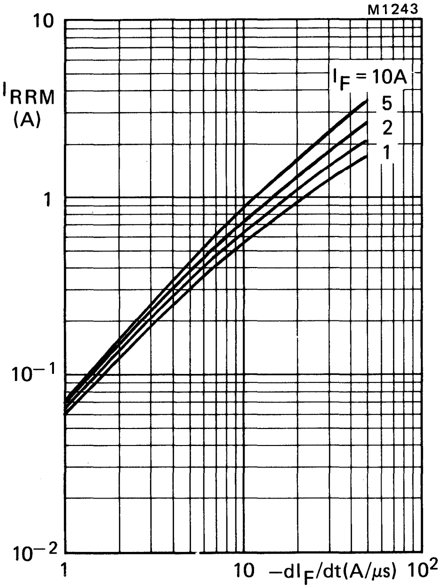


Fig.12 Maximum I_{RRM} at T_j = 25 °C.

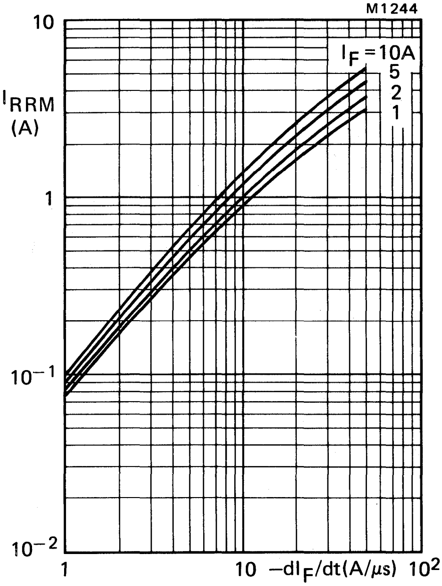


Fig.13 Maximum I_{RRM} at T_j = 100 °C.

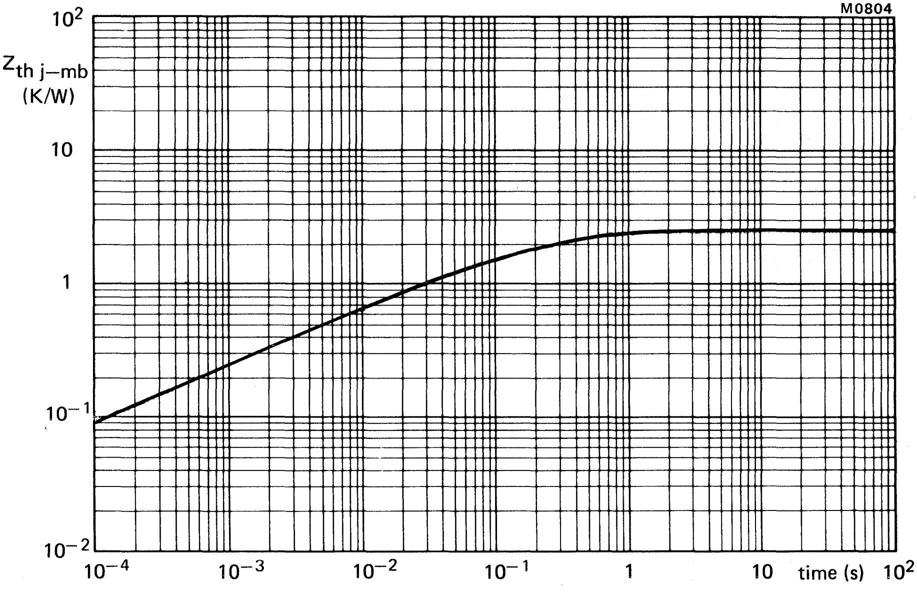


Fig.14 Transient thermal impedance.

ULTRA FAST RECOVERY ELECTRICALLY ISOLATED RECTIFIER DIODES

Glass-passivated, high-efficiency epitaxial rectifier diodes in full-pack envelopes, featuring low forward voltage drop, ultra fast reverse recovery times with very low stored charge and soft-recovery characteristic. Their electrical isolation makes them ideal for mounting on a common heatsink alongside other components without the need for additional insulators. They are intended for use in switched-mode power supplies and high-frequency circuits in general, where both low conduction losses and low switching losses are essential.

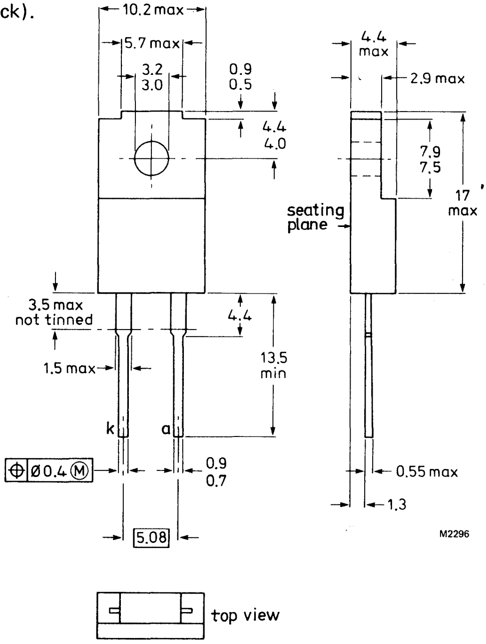
QUICK REFERENCE DATA

			BYV29F–300	400	500	
Repetitive peak reverse voltage	V_{RRM}	max.	300	400	500	V
Average foward current	$I_{F(AV)}$	max.	9			A
Forward voltage	V_F	$<$	1.05			V
Reverse recovery time	t_{rr}	$<$	50			ns

MECHANICAL DATA

Dimensions in mm

Fig.1 SOT-186 (full-pack).



Net mass: 2 g.

The seating plane is electrically isolated from all terminals.

Accessories supplied on request (see data sheets Mounting instructions for F-pack devices and Accessories for SOT-186 envelopes).

RATINGS

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

Voltages			BYV29F– 300	400	500	
Repetitive peak reverse voltage	V_{RRM}	max.	300	400	500	V
Crest working reverse voltage	V_{RWM}	max.	200	300	400	V
Continuous reverse voltage (note 1)	V_R	max.	200	300	400	V

Currents				
Average forward current; switching losses negligible up to 200 kHz (note 2);				
square wave; $\delta = 0.5$; up to $T_{mb} = 76\ ^oC$	$I_{F(AV)}$	max.	9	A
sinusoidal; up to $T_{mb} = 87\ ^oC$	$I_{F(AV)}$	max.	8	A
R.M.S. forward current	$I_{F(RMS)}$	max.	13	A
Repetitive peak forward current $t_p = 20\ \mu s$; $\delta = 0.02$	I_{FRM}	max.	200	A
Non-repetitive peak forward current half sine-wave; $T_j = 150\ ^oC$ prior to surge; with reapplied $V_{RWM\ max}$				
$t = 10$ ms	I_{FSM}	max.	100	A
$t = 8.3$ ms	I_{FSM}	max.	110	A
I^2t for fusing ($t = 10$ ms)	I^2t	max.	50	A^2s
Temperatures				
Storage temperature	T_{stg}		−40 to +150	^oC
Junction temperature	T_j	max.	150	^oC

ISOLATION

Peak isolation voltage from all terminals to external heatsink	V_{isol}	max.	1000	V
Isolation capacitance from cathode to external heatsink (note 3)	C_p	typ.	12	pF

Notes:

1. To ensure thermal stability: $R_{th\ j\text{-}a} < 6.8$ K/W.
2. The quoted temperatures assume heatsink compound is used.
3. Mounted without heatsink compound and 20 Newtons pressure on the centre of the envelope.

THERMAL RESISTANCE

From junction to external heatsink with minimum of 2 kgf (20 Newtons) pressure on the centre of the envelope,				
with heatsink compound	$R_{th\ j\text{-}h}$	=	5.5	K/W
without heatsink compound	$R_{th\ j\text{-}h}$	=	7.2	K/W

Free-air operation

The quoted value of $R_{th\ j\text{-}a}$ should be used only when no leads of other dissipating components run to the same point.

Thermal resistance from junction to ambient in free air, mounted on a printed circuit board	$R_{th\ j\text{-}a}$	=	55	K/W

CHARACTERISTICS

Forward voltage				
$I_F = 5$ A; $T_j = 100$ °C	V_F	$<$	1.05	V*
$I_F = 20$ A; $T_j = 25$ °C	V_F	$<$	1.4	V*
Reverse current				
$V_R = V_{RWM\ max}$; $T_j = 100$ °C	I_R	$<$	0.35	mA
$V_R = V_{RWM\ max}$; $T_j = 25$ °C	I_R	$<$	10	μA
Reverse recovery when switched from				
$I_F = 1$ A to $V_R \geqslant 30$ V with $-dI_F/dt = 100$ A/μs; $T_j = 25$ °C; recovery time	t_{rr}	$<$	50	ns
$I_F = 2$ A to $V_R \geqslant 30$ V with $-dI_F/dt = 20$ A/μs; $T_j = 25$ °C; recovered charge	Q_s	$<$	55	nC
$I_F = 10$ A to $V_R \geqslant 30$ V with $-dI_F/dt = 50$ A/μs; $T_j = 100$ °C; peak recovery current	I_{RRM}	$<$	5.5	A
Forward recovery when switched to $I_F = 10$ A with $dI_F/dt = 10$ A/μs; $T_j = 25$ °C	V_{fr}	typ.	2.5	V

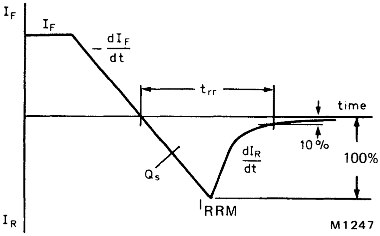


Fig.2 Definition of t_{rr}, Q_s and I_{RRM}.

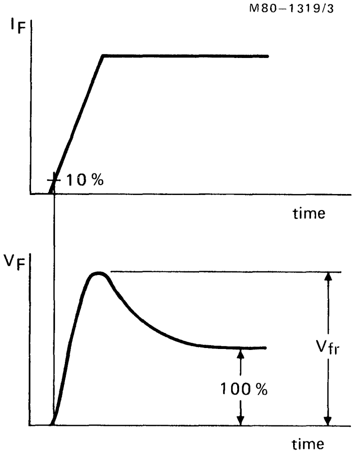


Fig.3 Definition of V_{fr}.

*Measured under pulse conditions to avoid excessive dissipation

MOUNTING INSTRUCTIONS

1. The device may be soldered directly into the circuit, but the maximum permissible temperature of the soldering iron or bath is 275 °C; the heat source must not be in contact with the joint for more than 5 seconds. Soldered joints must be at least 4.7 mm from the seal.
2. The leads should not be bent less than 2.4 mm from the seal, and should be supported during bending. The bend radius must be no less than 1 mm.
3. Mounting by means of a spring clip is the best mounting method because it offers a good thermal contact under the crystal area and slightly lower $R_{th\ j\text{-}h}$ values than screw mounting. The force exerted on the top of the device by the clip should be at least 2 kgf (20 Newtons) to ensure good thermal contact and must not exceed 3.5 kgf (35 Newtons) to avoid damage to the device.
4. If screw mounting is used, it should be M3 cross-recess pan head.

Minimum torque to ensure good thermal contact:	5.5 kgf (0.55 Nm)
Maximum torque to avoid damage to the device:	8.0 kgf (0.80 Nm)

5. For good thermal contact, heatsink compound should be used between baseplate and heatsink. Values of $R_{th\ j\text{-}h}$ given for mounting with heatsink compound refer to the use of a metallic-oxide loaded compound. Ordinary silicone grease is not recommended.
6. Rivet mounting.
   It is not recommended to use rivets, since extensive damage could result to the plastic, which could destroy the insulating properties of the device.
7. The heatsink must have a flatness in the mounting area of 0.02 mm maximum per 10 mm. Mounting holes must be deburred.

OPERATING NOTES

The various components of junction temperature rise above ambient are illustrated in Fig.4.

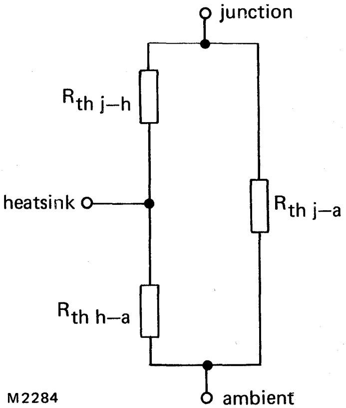


Fig.4.

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

SQUARE-WAVE OPERATION

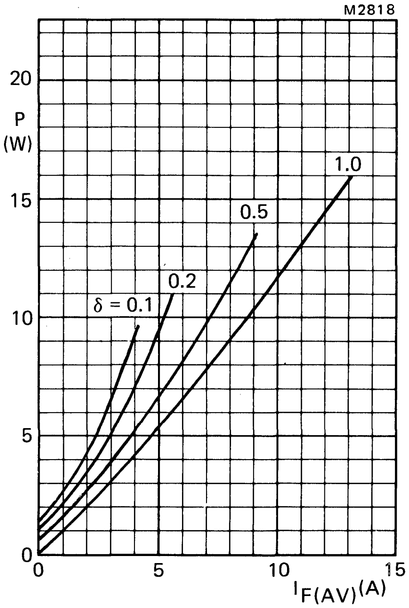
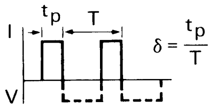


Fig.5 Power rating.

The power loss in the diode should first be determined from the required forward current on the $I_{F(AV)}$ axis and the appropriate duty cycle.
Having determined the power (P), use Fig.7 (if heatsink compound is not being used) or Fig.8 (if heatsink compound is being used) to determine the heatsink size and corresponding maximum ambient and heatsink temperatures.

Note: P = power including reverse current losses but excluding switching losses.



$I_{F(AV)} = I_{F(RMS)} \times \sqrt{\delta}$

SINUSOIDAL OPERATION

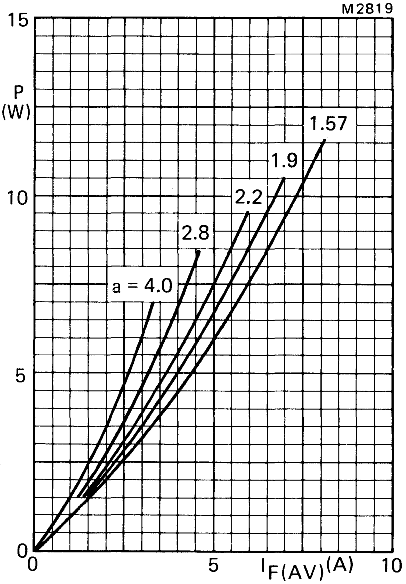


Fig.6 Power rating.

The power loss in the diode should first be determined from the required forward current on the $I_{F(AV)}$ axis and the appropriate form factor.
Having determined the power (P), use Fig.7 (if heatsink compound is not being used) or Fig.8 (if heatsink compound is being used) to determine the heatsink size and corresponding maximum ambient and heatsink temperatures.

Note: P = power including reverse current losses but excluding switching losses.

a = form factor = $I_{F(RMS)}/I_{F(AV)}$

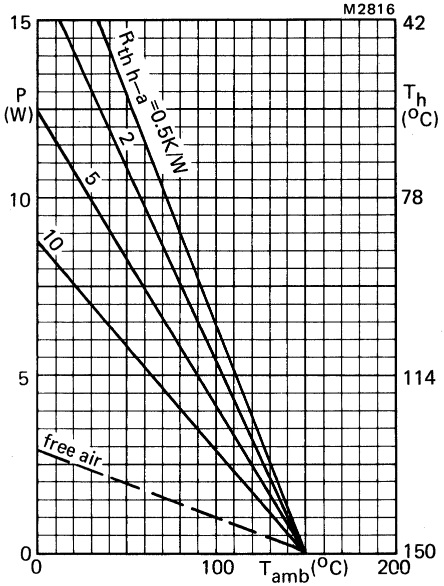


Fig.7 Heatsink rating; without heatsink compound.

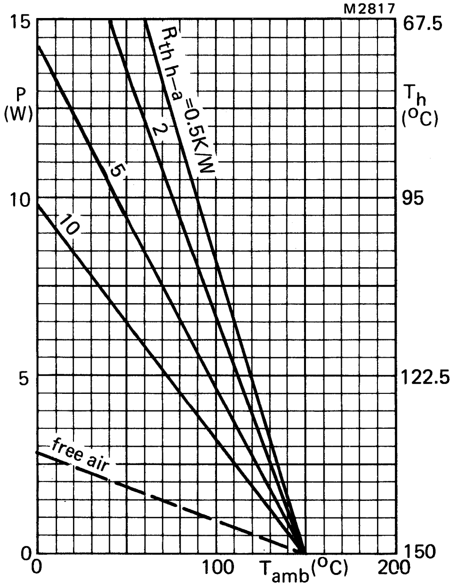


Fig.8 Heatsink rating; with heatsink compound.

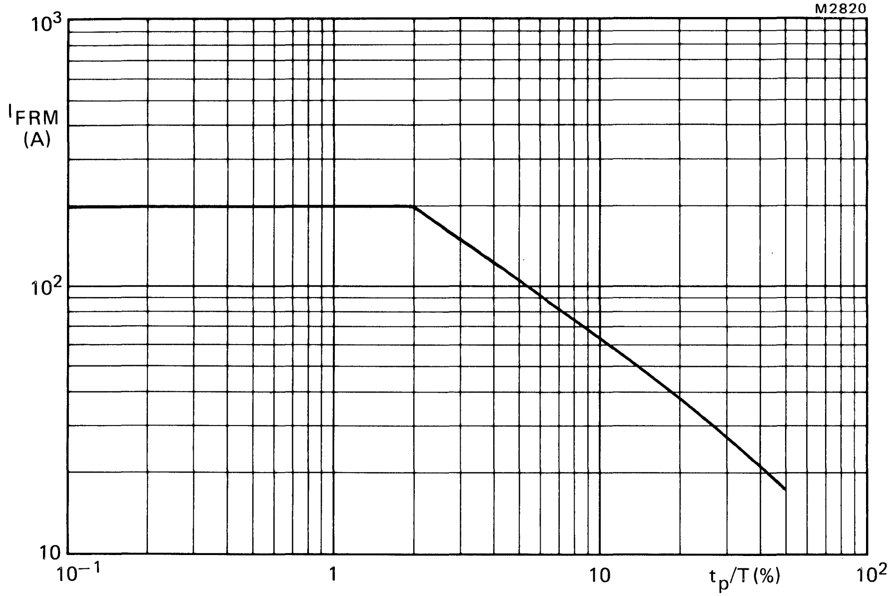
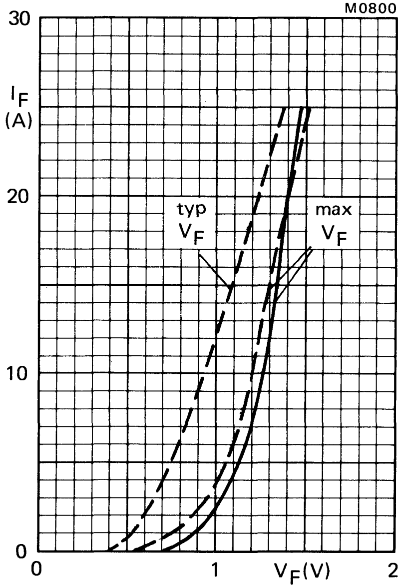
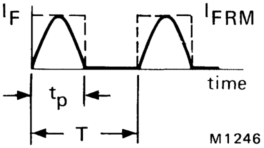


Fig.9 Maximum permissible repetitive peak forward current for square or sinusoidal currents; 1 $\mu s < t_p < 1$ ms.





Definition of I_{FRM} and t_p/T.

Fig.10 —— $T_j = 25\ ^oC$; – – – $T_j = 100\ ^oC$.

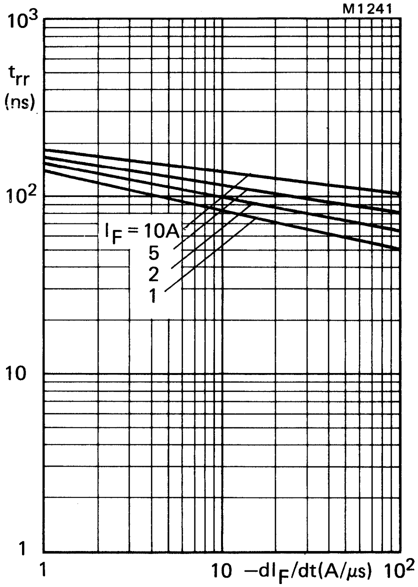


Fig.11 Maximum t_{rr} at T_j = 25 °C.

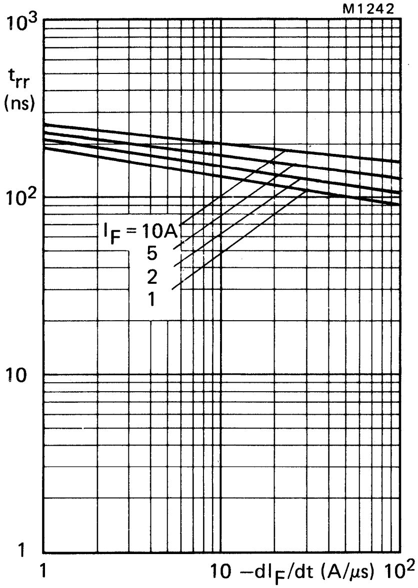


Fig.12 Maximum t_{rr} at T_j = 100 °C.

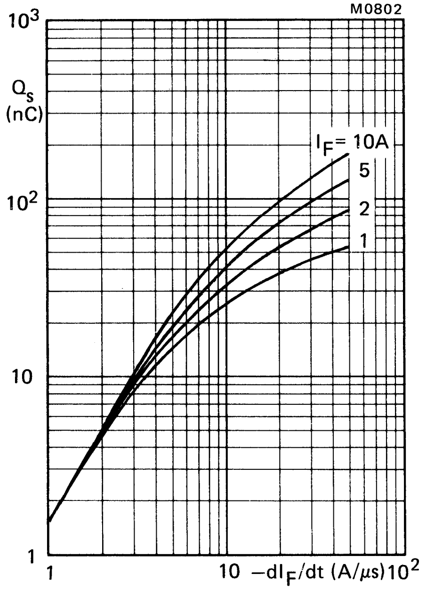


Fig.13 Maximum Q_s at T_j = 25 °C.

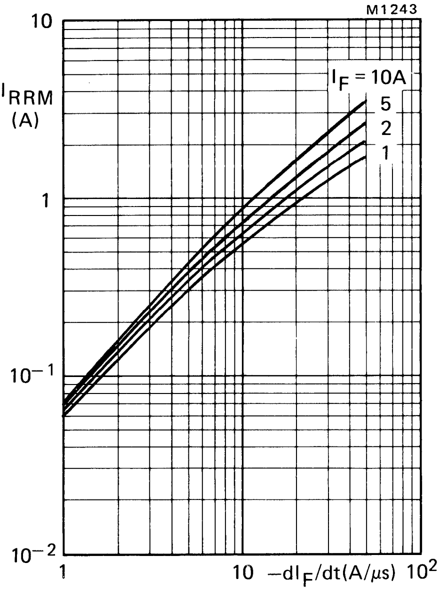


Fig.14 Maximum I_{RRM} at $T_j = 25\ ^oC$.

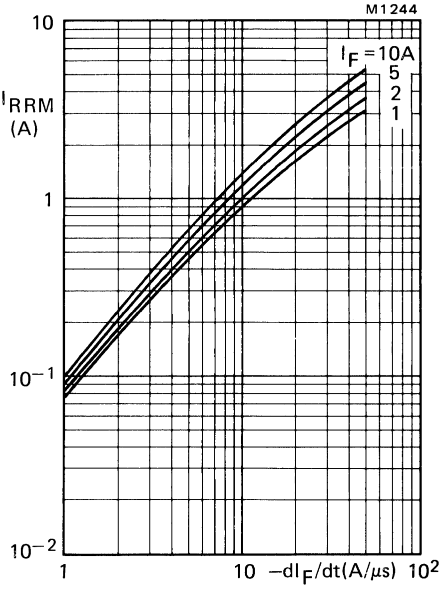


Fig.15 Maximum I_{RRM} at $T_j = 100\ ^oC$.

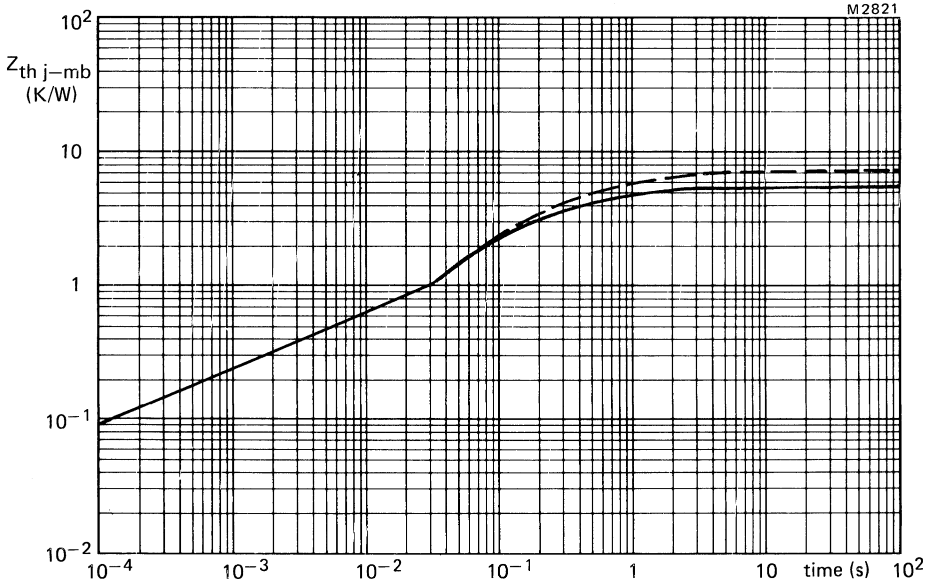


Fig.16 Transient thermal impedance; —— with heatsink compound; – – – without heatsink compound.

ULTRA FAST RECOVERY RECTIFIER DIODES

Glass-passivated, high-efficiency epitaxial rectifier diodes in DO–4 metal envelopes, featuring low forward voltage drop, ultra fast reverse recovery times, very low stored charge and soft recovery characteristic. They are intended for use in switched-mode power supplies and high-frequency circuits in general, where low conduction and switching losses are essential. The series consists of normal polarity (cathode to stud) types. ←

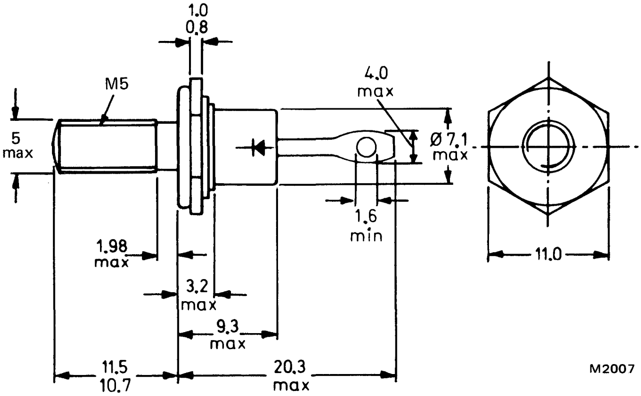
QUICK REFERENCE DATA ←

			BYV30–300	400	500	
Repetitive peak reverse voltage	V_{RRM}	max.	300	400	500	V
Average forward current	$I_{F(AV)}$	max.	14			A
Forward voltage	V_F	<	1.05			V
Reverse recovery time	t_{rr}	<	50			ns

MECHANICAL DATA

Dimensions in mm

Fig.1 DO-4 with metric (M5) stud as standard.
10-32 UNF is available upon request with suffix U (e.g. BYV30-400U).



←

Net mass: 6 g

Diameter of clearance hole: max. 5.2 mm

Accessories supplied on request: see data sheets Mounting instructions and Accessories for DO-4 envelopes.

Supplied with device: 1 nut, 1 lock washer.

Nut dimensions across the flats: 9.5 mm

Torque on nut:
min. 0.9 Nm (9 kg cm)
max. 1.7 Nm (17 kg cm)

→ RATINGS

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

Voltages			BYV30–300	400	500	V
Repetitive peak reverse voltage	V_{RRM}	max.	300	400	500	V
Crest working reverse voltage	V_{RWM}	max.	200	300	400	V
Continuous reverse voltage*	V_R	max.	200	300	400	V

Currents				
Average forward current; switching losses negligible up to 100 kHz				
square wave; $\delta = 0.5$; up to $T_{mb} = 113\ ^{o}C$	$I_{F(AV)}$	max.	14	A
up to $T_{mb} = 125\ ^{o}C$	$I_{F(AV)}$	max.	10	A
sinusoidal; up to $T_{mb} = 118\ ^{o}C$	$I_{F(AV)}$	max.	12.5	A
up to $T_{mb} = 125\ ^{o}C$	$I_{F(AV)}$	max.	10	A
R.M.S. forward current	$I_{F(RMS)}$	max.	20	A
Repetitive peak forward current $t_p = 20\ \mu s$; $\delta = 0.02$	I_{FRM}	max.	320	A
Non-repetitive peak forward current half sine-wave; $T_j = 150\ ^{o}C$ prior to surge; with reapplied V_{RWMmax};				
$t = 10$ ms	I_{FSM}	max.	150	A
$t = 8.3$ ms	I_{FSM}	max.	180	A
I^2t for fusing ($t = 10$ ms)	I^2t	max.	112	A^2s
Temperatures				
Storage temperature	T_{stg}		−65 to +175	^{o}C
Junction temperature	T_j	max.	150	^{o}C

→ THERMAL RESISTANCE

From junction to mounting base	$R_{th\ j\text{-}mb}$	=	2.0	K/W
From mounting base to heatsink with heatsink compound	$R_{th\ mb\text{-}h}$	=	0.3	K/W
From junction to ambient in free air	$R_{th\ j\text{-}a}$	=	50	K/W

---

*To ensure thermal stability: $R_{th\ j\text{-}a} \leqslant 4.6$ K/W.

CHARACTERISTICS

←

Forward voltage				
$I_F = 15$ A; $T_j = 150$ °C	V_F	<	1.05	V*
$I_F = 50$ A; $T_j = 25$ °C	V_F	<	1.40	V*
Reverse current				
$V_R = V_{RWM\,max}$; $T_j = 100$ °C	I_R	<	0.8	mA
$T_j = 25$ °C	I_R	<	50	μA
Reverse recovery when switched from				
$I_F = 1$ A to $V_R \geqslant 30$ V with $-dI_F/dt = 100$ A/μs; $T_j = 25$ °C; recovery time	t_{rr}	<	50	ns
$I_F = 2$ A to $V_R \geqslant 30$ V with $-dI_F/dt = 20$ A/μs; $T_j = 25$ °C; recovered charge	Q_s	<	50	nC
$I_F = 10$ A to $V_R \geqslant 30$ V with $-dI_F/dt = 50$ A/μs; $T_j = 100$ °C; peak recovery current	I_{RRM}	<	5.2	A
Forward recovery when switched to $I_F = 10$ A with $dI_F/dt = 10$ A/μs; $T_j = 25$ °C	V_{fr}	typ.	2.5	V

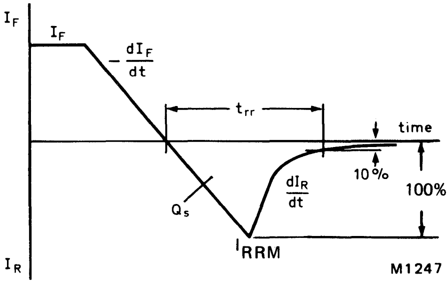


Fig.2 Definition of t_{rr}, Q_s and I_{RRM}.

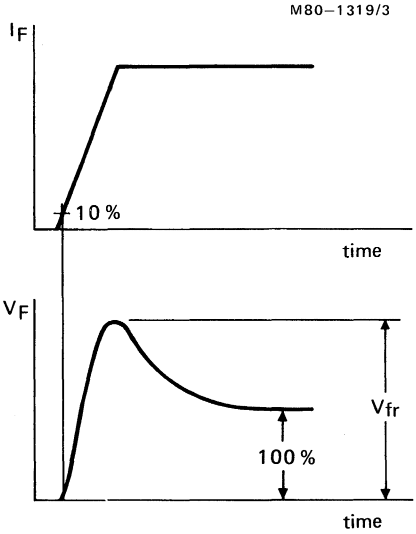


Fig.3 Definition of V_{fr}.

---

*Measured under pulse conditions to avoid excessive dissipation.

SQUARE-WAVE OPERATION

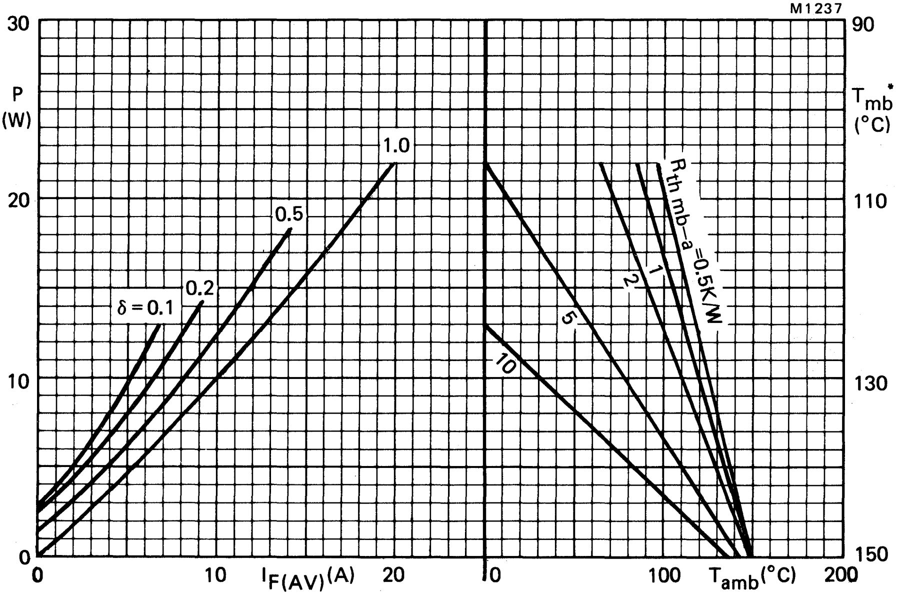
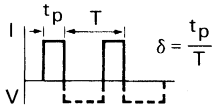


Fig.4 The right-hand part shows the relationship between the power (derived from the left-hand part) and the maximum permissible temperatures. Power includes reverse current losses and switching losses up to f = 100 kHz.



$I_{F(AV)} = I_{F(RMS)} \times \sqrt{\delta}$

---

*T_{mb} scale is for comparison purposes and is correct only for $R_{th\ mb\text{-}a} < 4.1$ K/W.

SINUSOIDAL OPERATION

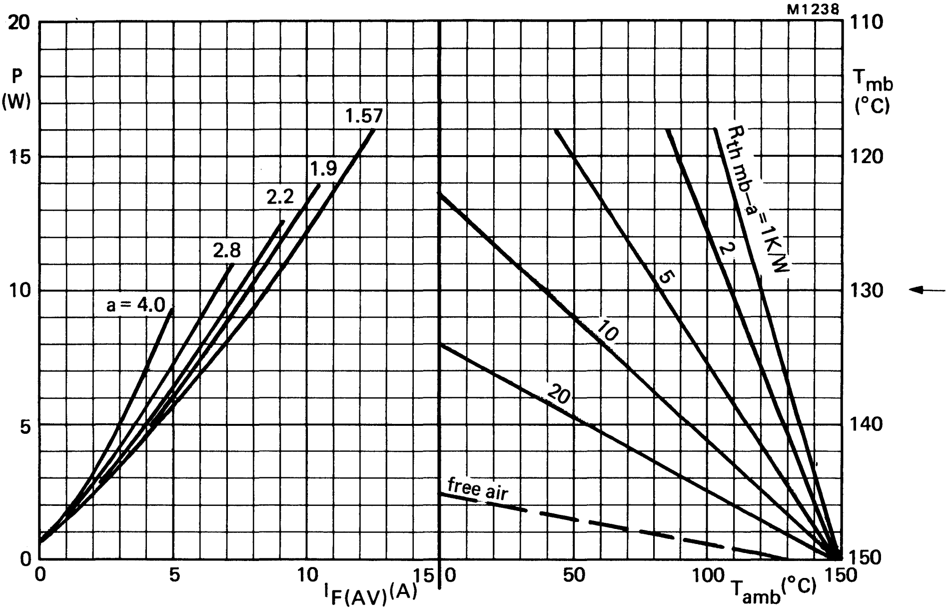


Fig.5 The right-hand part shows the interrelationship between the power (derived from the left-hand part) and the maximum permissible temperatures.
a = form factor = $I_{F(RMS)}/I_{F(AV)}$.

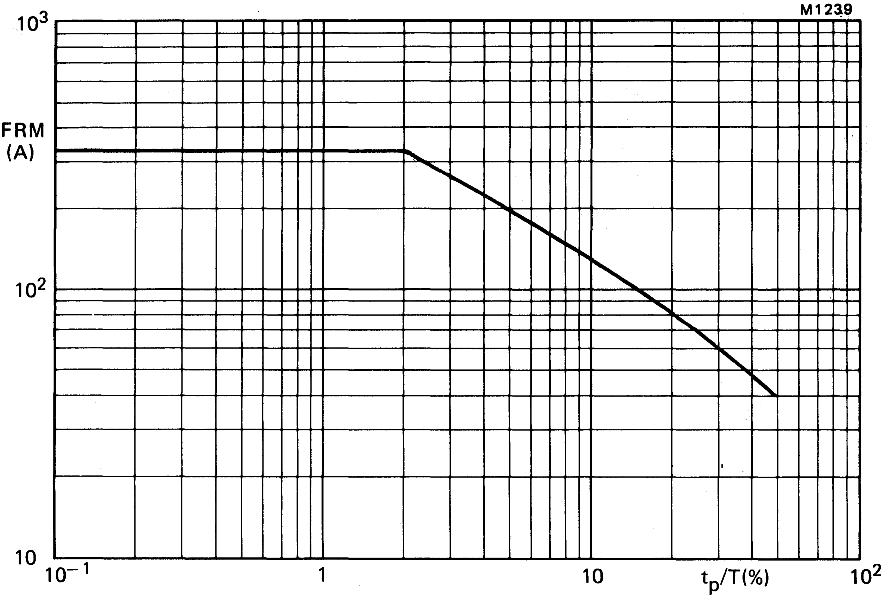
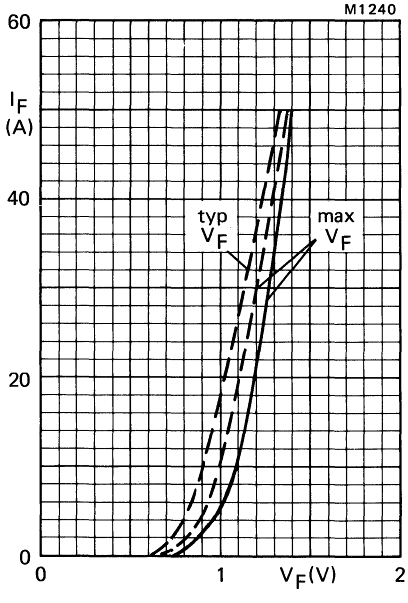
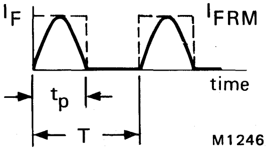


Fig.6 Maximum permissible repetitive peak forward current for square or sinusoidal currents; 1 $\mu s < t_p < 1$ ms.





Definition of I_{FRM} and t_p/T.

Fig.7 —— T_j = 25 °C; – – – T_j = 150 °C.

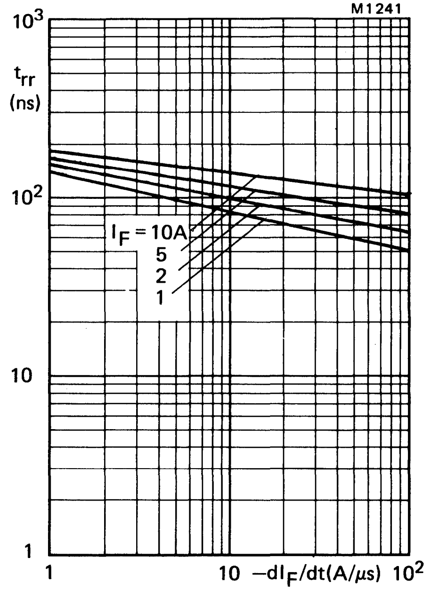


Fig.8 Maximum t_{rr} at $T_j = 25\ ^oC$

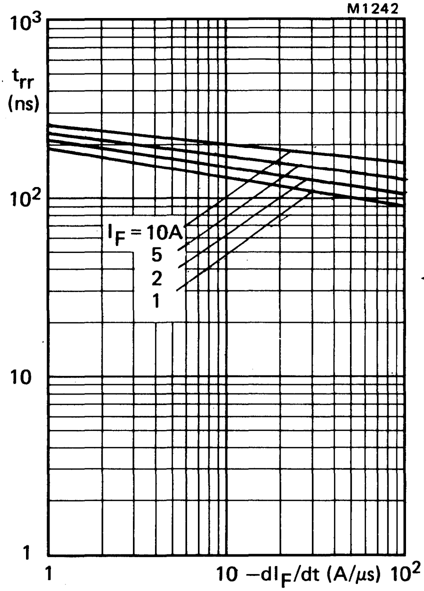


Fig.9 Maximum t_{rr} at $T_j = 100\ ^oC$.

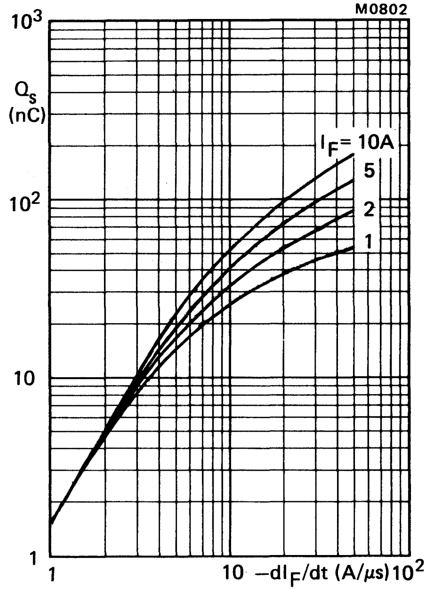


Fig.10 Maximum Q_s at $T_j = 25\ ^oC$

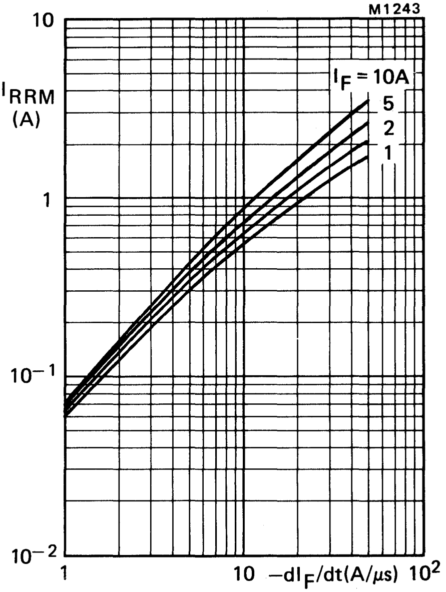


Fig.11 Maximum I_{RRM} at T_j = 25 °C

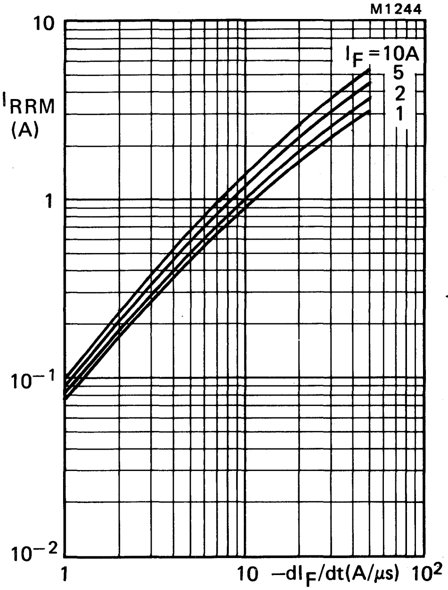


Fig.12 Maximum I_{RRM} at T_j = 100 °C.

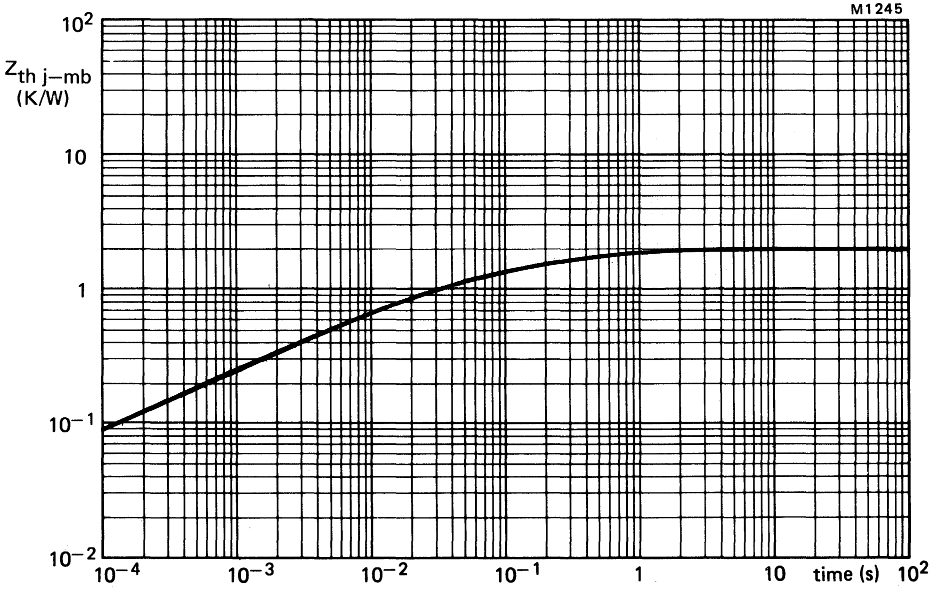


Fig.13 Transient thermal impedance.

ULTRA FAST RECOVERY RECTIFIER DIODES

Glass-passivated, high-efficiency epitaxial rectifier diodes in DO–4 metal envelopes, featuring low forward voltage drop, ultra fast reverse recovery times, very low stored charge and soft recovery characteristic. They are intended for use in switched-mode power supplies and high-frequency circuits in general, where both low conduction and switching losses are essential. The series consists of normal polarity (cathode to stud) types.

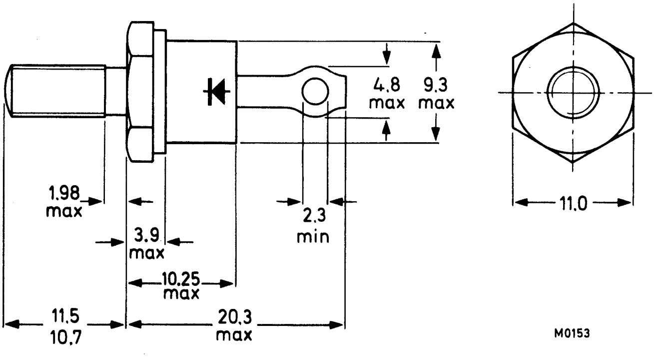
QUICK REFERENCE DATA

			BYV31–300	400	500	
Repetitive peak reverse voltage	V_{RRM}	max	300	400	500	V
Average forward current	$I_{F(AV)}$	max.	28			A
Forward voltage	V_F	$<$	1.05			V
Reverse recovery time	t_{rr}	$<$	50			ns

MECHANICAL DATA

Dimensions in mm

Fig.1 DO–4; with metric M5 stud (ϕ5 mm); e.g. BYV31–500
with 10-32 UNF stud (ϕ4.83 mm); e.g. BYV31–500U



Net mass: 7 g

Diameter of clearance hole: max. 5.2 mm

Accessories supplied on request:
mica washer (56295a);
PTFE ring (56295b); insulating bush (56295c).

Supplied with device: 1 nut, 1 lock washer

Torque on nut: min. 0.9 Nm (9 kg cm)
max. 1.7 Nm (17 kg cm)

Nut dimensions across the flats;
M5: 8.0 mm, 10-32 UNF: 9.5 mm

RATINGS

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

Voltages			BYV31–300	400	500	
Repetitive peak reverse voltage	V_{RRM}	max.	300	400	500	V
Crest working reverse voltage	V_{RWM}	max.	200	300	400	V
Continuous reverse voltage*	V_R	max.	200	300	400	V

Currents

Average forward current, switching losses negligible up to 100 kHz				
square wave; $\delta = 0.5$; up to $T_{mb} = 114\ ^{o}C$	$I_{F(AV)}$	max.	28	A
up to $T_{mb} = 125\ ^{o}C$	$I_{F(AV)}$	max.	20	A
sinusoidal; up to $T_{mb} = 119\ ^{o}C$	$I_{F(AV)}$	max.	25	A
up to $T_{mb} = 125\ ^{o}C$	$I_{F(AV)}$	max.	21	A
R.M.S. forward current	$I_{F(RMS)}$	max.	40	A
Repetitive peak forward current $t_p = 20\ \mu s$; $\delta = 0.02$	I_{FRM}	max.	550	A
Non-repetitive peak forward current half sine-wave; $T_j = 150\ ^{o}C$ prior to surge; with reapplied V_{RWMmax};				
$t = 10$ ms	I_{FSM}	max.	300	A
$t = 8.3$ ms	I_{FSM}	max.	360	A
I^2t for fusing ($t = 10$ ms)	I^2t	max.	450	A^2s

Temperatures

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

THERMAL RESISTANCE

From junction to mounting base	$R_{th\ j\text{-}mb}$	=	1.0	K/W
From mounting base to heatsink				
a. with heatsink compound	$R_{th\ mb\text{-}h}$	=	0.3	K/W
b. without heatsink compound	$R_{th\ mb\text{-}h}$	=	0.5	K/W

MOUNTING INSTRUCTIONS

The top connector should be neither 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.

---

*To ensure thermal stability: $R_{th\ j\text{-}a} \leqslant 3.4$ K/W.

CHARACTERISTICS

Forward voltage				
$I_F = 30$ A; $T_j = 150$ °C	V_F	<	1.05	V*
$I_F = 100$ A; $T_j = 25$ °C	V_F	<	1.4	V*
Reverse current				
$V_R = V_{RWM\,max}$; $T_j = 100$ °C	I_R	<	2.0	mA
$T_j = 25$ °C	I_R	<	50	µA
Reverse recovery when switched from				
$I_F = 1$ A to $V_R \geqslant 30$ V with $-dI_F/dt = 100$ A/µs; $T_j = 25$ °C; recovery time	t_{rr}	<	50	ns
$I_F = 2$ A to $V_R \geqslant 30$ V with $-dI_F/dt = 20$ A/µs; $T_j = 25$ °C; recovered charge	Q_s	<	75	nC
$I_F = 10$ A to $V_R \geqslant 30$ V with $-dI_F/dt = 50$ A/µs; $T_j = 100$ °C; peak recovery current	I_{RRM}	<	4	A
Forward recovery when switched to $I_F = 10$ A with $dI_F/dt = 10$ A/µs; $T_j = 25$ °C	V_{fr}	typ.	2.5	V

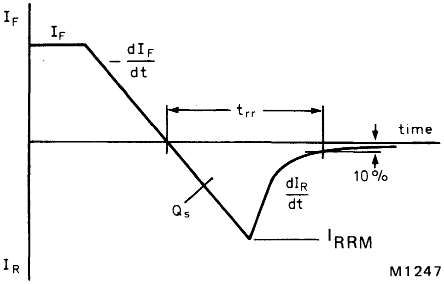


Fig.2 Definition of t_{rr}, Q_s and I_{RRM}.

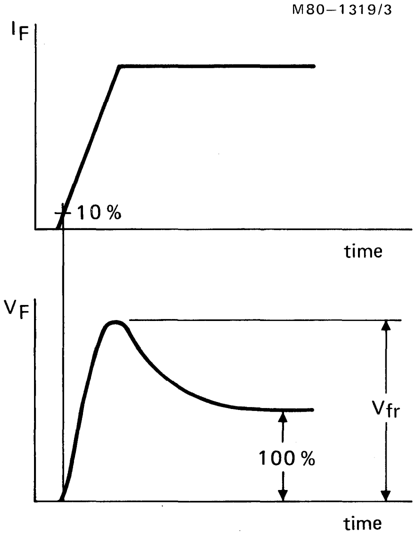


Fig.3 Definition of V_{fr}.

*Measured under pulse conditions to avoid excessive dissipation.

SQUARE-WAVE OPERATION

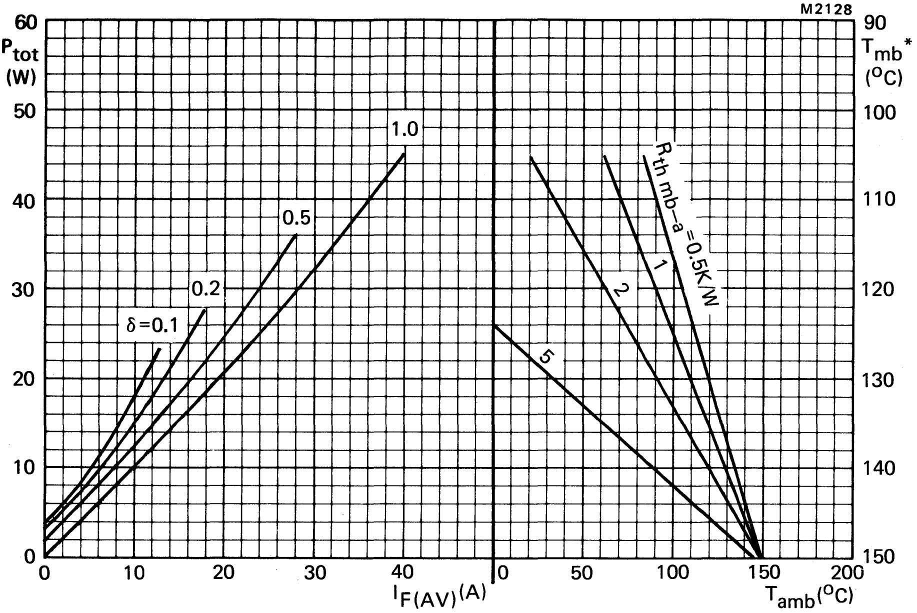
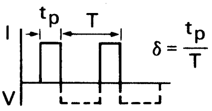


Fig.4 The right-hand part shows the relationship between the power (derived from the left-hand part) and the maximum permissible temperatures. Power includes reverse current losses and switching losses up to f = 100 kHz.



$I_{F(AV)} = I_{F(RMS)} \times \sqrt{\delta}$

---

*T_{mb} scale is for comparison purposes and is correct only for $R_{th\ mb-a} < 2.4$ K/W.

SINUSOIDAL OPERATION

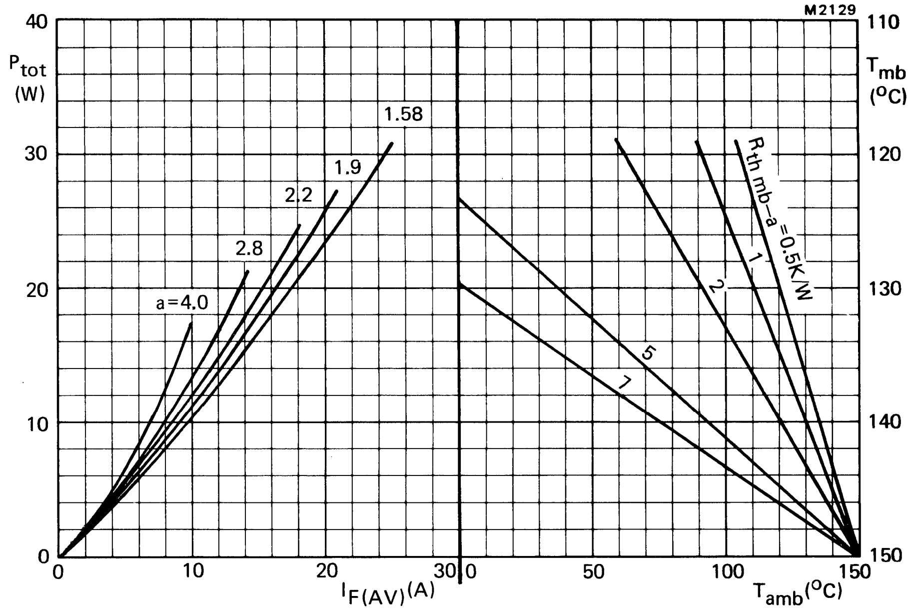


Fig.5 The right-hand part shows the interrelationship between the power (derived from the left-hand part) and the maximum permissible temperatures.
a = form factor = $I_{F(RMS)}/I_{F(AV)}$.

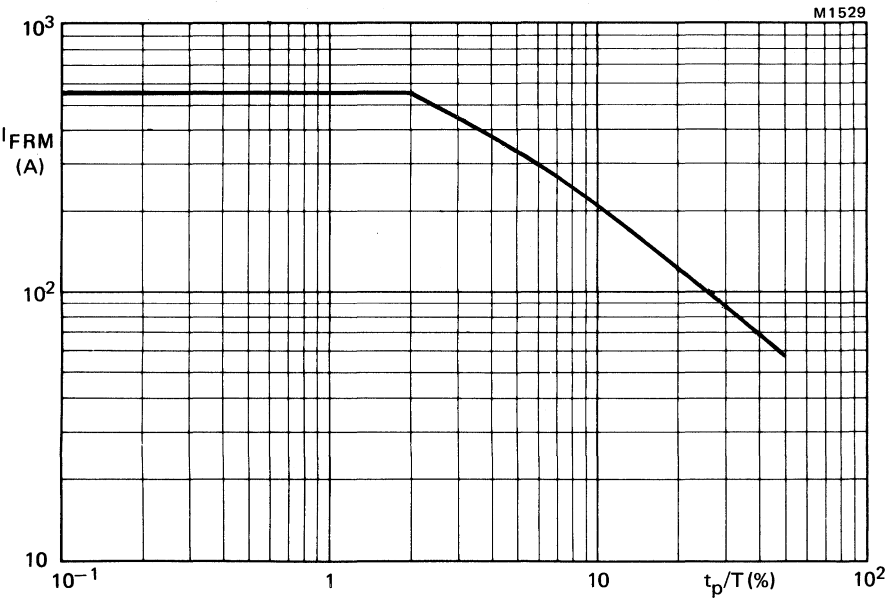
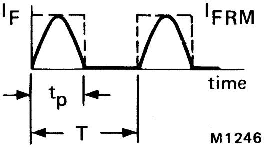


Fig.6 Maximum permissible repetitive peak forward current for square or sinusoidal currents; 1 $\mu s < t_p <$ 1 ms.



Definition of I_{FRM} and t_p/T.

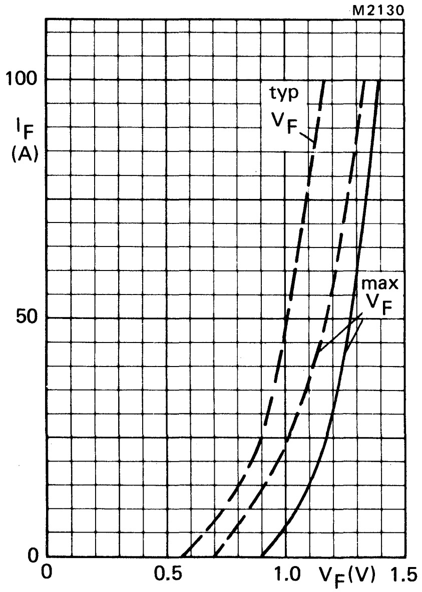


Fig.7 —— T_j = 25 °C; – – – T_j = 150 °C.

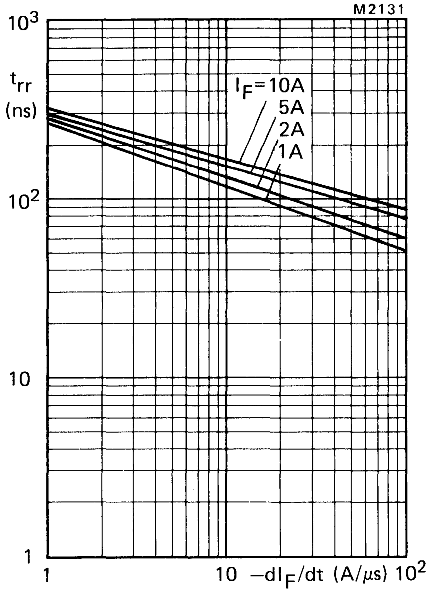


Fig.8 Maximum t_{rr} at T_j = 25 °C.

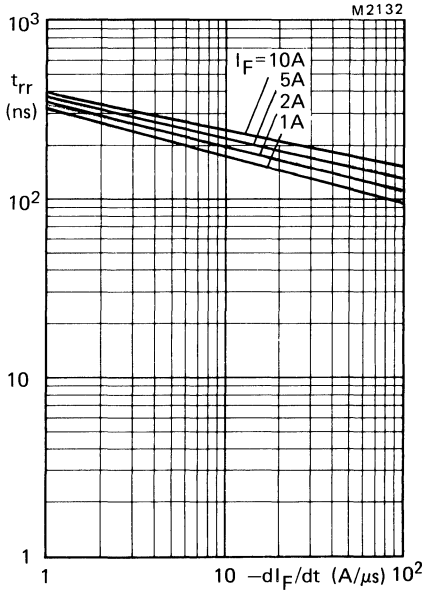


Fig.9 Maximum t_{rr} at T_j = 100 °C.

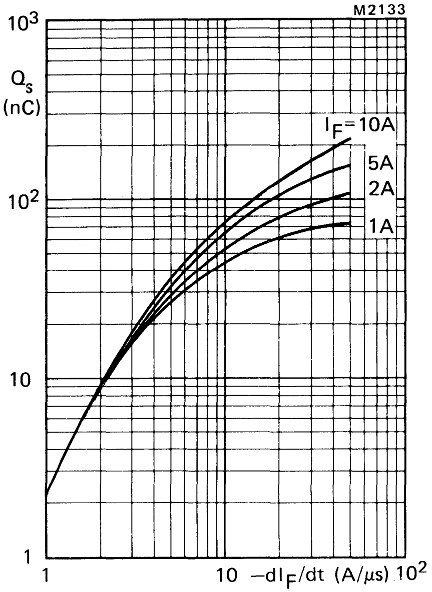


Fig.10 Maximum Q_s at T_j = 25 °C

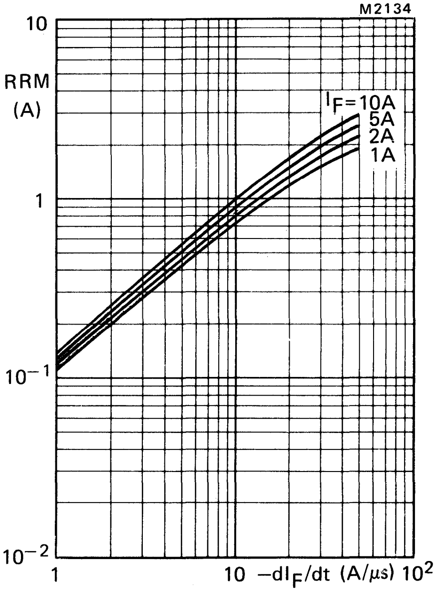


Fig.11 Maximum I_{RRM} at T_j = 25 °C

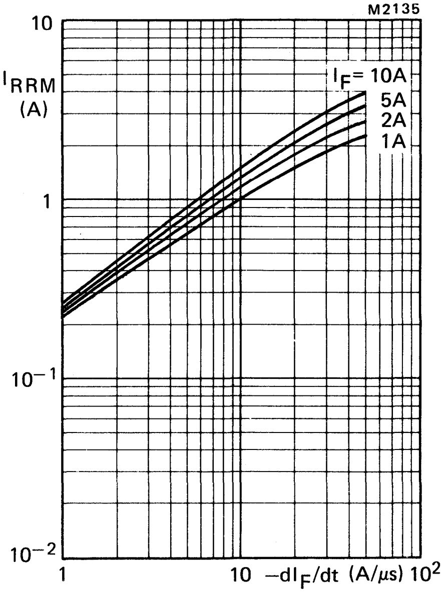


Fig.12 Maximum I_{RRM} at T_j = 100 °C.

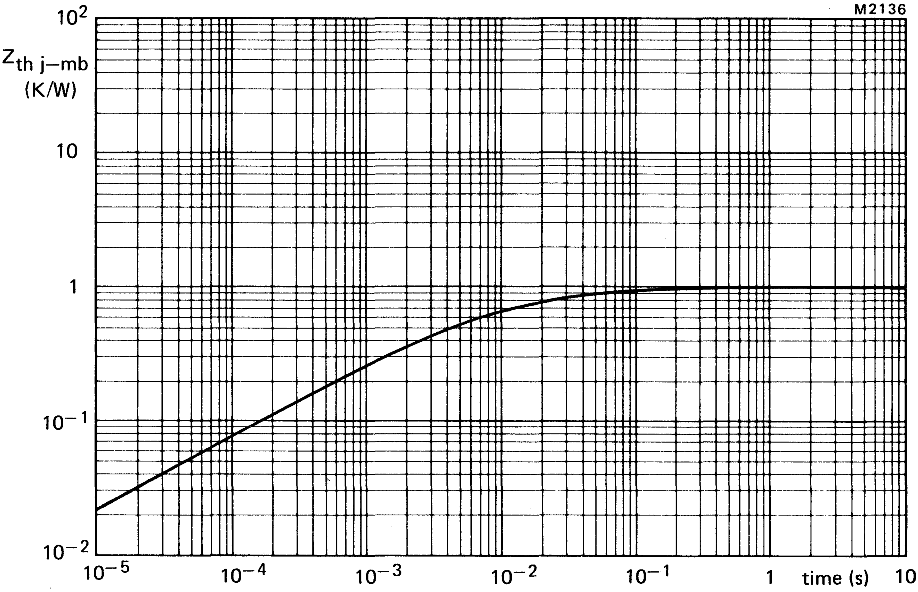


Fig.13 Transient thermal impedance

ULTRA FAST RECOVERY DOUBLE RECTIFIER DIODES

Glass-passivated, high-efficiency double rectifier diodes in plastic envelopes, featuring low forward voltage drop, ultra fast reverse recovery times and soft-recovery characteristic. They are intended for use in switched mode power supplies and high-frequency circuits in general, where both low conduction losses and low switching losses are essential. Their single chip (monolithic) construction ensures excellent matching of the forward and switching characteristics of the two halves, allowing parallel operation without the need for derating. The series consists of common-cathode types.

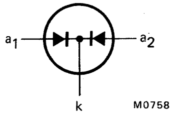
QUICK REFERENCE DATA

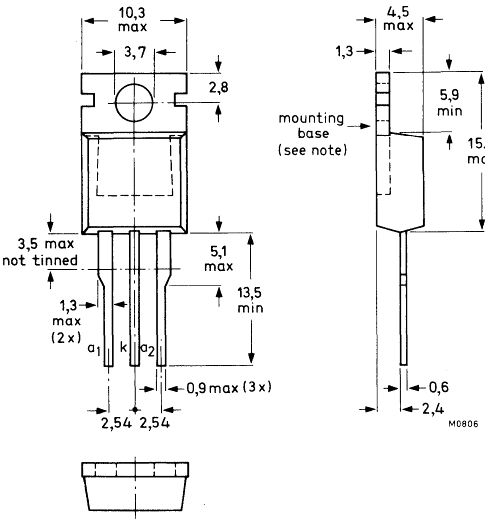
Per diode, unless otherwise stated			BYV32–50	100	150	200	
Repetitive peak reverse voltage	V_{RRM}	max.	50	100	150	200	V
Output current (both diodes conducting)	I_O	max.	20				A
Forward Voltage	V_F	<	0.85				V
Reverse recovery time	t_{rr}	<	25				ns

MECHANICAL DATA

Dimensions in mm

Fig.1 TO-220AB.





Net mass: 2g

Note: the exposed metal mounting base is directly connected to the common cathode.

Accessories supplied on request: see data sheets Mounting Instructions and accessories for TO-220 envelopes.

Products approved to CECC 50 009-026 available on request.

RATINGS

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

Voltages (per diode)			BYV32–50	100	150	200	
Repetitive peak reverse voltage	V_{RRM}	max.	50	100	150	200	V
Crest working reverse voltage	V_{RWM}	max.	50	100	150	200	V
Continuous reverse voltage (note 1)	V_R	max.	50	100	150	200	V

→ **Currents** (both diodes conducting; note 2)

Output current; switching losses negligible up to 500 kHz;				
square wave; $\delta = 0.5$; up to $T_{mb} = 118\ ^{o}C$	I_O	max.	20	A
square wave; $\delta = 0.5$; up to $T_{mb} = 125\ ^{o}C$	I_O	max.	16.5	A
sinusoidal; up to $T_{mb} = 120\ ^{o}C$	I_O	max.	18	A
sinusoidal; up to $T_{mb} = 125\ ^{o}C$	I_O	max.	16	A
R.M.S. forward current	$I_{F(RMS)}$	max.	28	A
Repetitive peak forward current $t_p = 20\ \mu s$, $\delta = 0.02$ (per diode)	I_{FRM}	max.	230	A
Non-repetitive peak forward current (per diode) half sine-wave; $T_j = 150\ ^{o}C$ prior to surge; with reapplied V_{RWM} max				
$t = 10$ ms	I_{FSM}	max.	150	A
$t = 8.3$ ms	I_{FSM}	max.	160	A
I^2t for fusing ($t = 10$ms; per diode)	I^2t	max.	112	A^2s

Temperatures

Storage temperature	T_{stg}		−40 to +150	^{o}C
Junction temperature	T_j	max.	150	^{o}C

Notes:

1. To ensure thermal stability, $R_{th\ j\text{-}a} < 14$ K/W.
2. The limits for both diodes apply whether both diodes conduct simultaneously or on alternate half cycles.

CHARACTERISTICS (per diode) ←

Forward voltage				
$I_F = 5$ A; $T_j = 100\ ^oC$	V_F	<	0.85	V*
$I_F = 20$ A; $T_j = 25\ ^oC$	V_F	<	1.15	V*
Reverse current				
$V_R = V_{RWM\ max}$; $T_j = 100\ ^oC$	I_R	<	0.6	mA
$V_R = V_{RWM\ max}$; $T_j = 25\ ^oC$	I_R	<	30	μA
Reverse recovery when switched from				
$I_F = 1$ A to $V_R \geqslant 30$ V with $-dI_F/dt = 100$ A/μs; $T_j = 25\ ^oC$; recovery time	t_{rr}	<	25	ns
$I_F = 2$ A to $V_R \geqslant 30$ V with $-dI_F/dt = 20$ A/μs; $T_j = 25\ ^oC$; recovered charge	Q_s	<	12.5	nC
$I_F = 10$ A to $V_F \geqslant 30$ V with $-dI_F/dt = 50$ A/μs; $T_j = 100\ ^oC$; peak recovery current	I_{RRM}	<	2	A
Forward recovery when switched to $I_F = 1$A with $dI_F/dt = 10$ A/μs; $T_j = 25\ ^oC$	V_{fr}	typ.	0.9	V

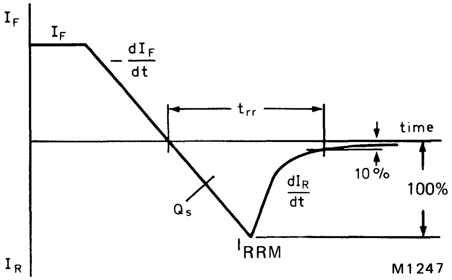


Fig.2 Definition of t_{rr}, Q_s and I_{RRM}.

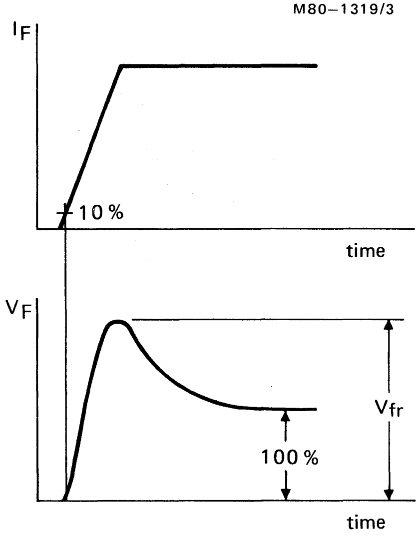


Fig.3 Definition of V_{fr}.

*Measured under pulse conditions to avoid excessive dissipation

→ THERMAL RESISTANCE

From junction to mounting base (both diodes conducting)	$R_{th\ j\text{-}mb}$	=	1.6	K/W
From junction to mounting base (per diode)	$R_{th\ j\text{-}mb}$	=	2.4	K/W

Influence of mounting method

1. Heatsink mounted with clip (see mounting instructions)

Thermal resistance from mounting base to heatsink

a. with heatsink compound	$R_{th\ mb\text{-}h}$	=	0.3	K/W
b. with heatsink compound and 0.06 mm maximum mica insulator	$R_{th\ mb\text{-}h}$	=	1.4	K/W
c. with heatsink compound and 0.1 mm maximum mica insulator (56369)	$R_{th\ mb\text{-}h}$	=	2.2	K/W
d. with heatsink compound and 0.25 mm maximum alumina insulator (56367)	$R_{th\ mb\text{-}h}$	=	0.8	K/W
e. without heatsink compound	$R_{th\ mb\text{-}h}$	=	1.4	K/W

2. Free air operation

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

Thermal resistance from junction to ambient in free air: mounted on a printed circuit board at any device lead length and with copper laminate on the board	$R_{th\ j\text{-}a}$	=	60	K/W

MOUNTING INSTRUCTIONS

1. The device may be soldered directly into the circuit, but the maximum permissible temperature of the soldering iron or bath is 275 °C; the heat source must not be in contact with the joint for more than 5 seconds. Soldered joints must be at least 4.7 mm from the seal.
2. The leads should not be bent less than 2.4 mm from the seal, and should be supported during bending. The bend radius must be no less than 1.0 mm.
3. Mounting by means of a spring clip is the best mounting method because it offers:
   a. a good thermal contact under the crystal area and slightly lower $R_{th\ mb\text{-}h}$ values than does screw mounting.
   b. safe isolation for mains operation.
   However, if a screw is used, it should be M3 cross-recess pan head. Care should be taken to avoid damage to the plastic body.
4. For good thermal contact heatsink compound should be used between mounting base and heatsink. Values of $R_{th\ mb\text{-}h}$ given for mounting with heatsink compound refer to the use of a metallic oxide-loaded compound. Ordinary silicone grease is not recommended.
5. Rivet mounting (only possible for non-insulated mounting).
   Devices may be rivetted to flat heatsinks; such a process must **neither** deform the mounting tab, **nor** enlarge the mounting hole.

OPERATING NOTES

Dissipation and heatsink calculations

The various components of junction temperature rise above ambient are illustrated in Fig.4:

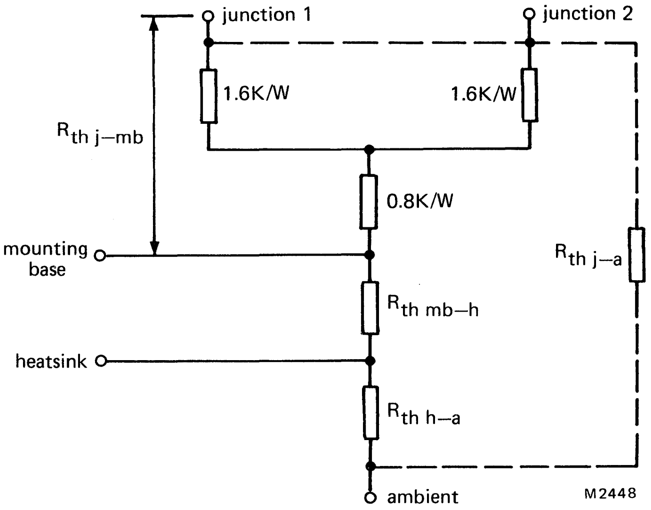


Fig.4

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

SQUARE-WAVE OPERATION (PER DIODE)

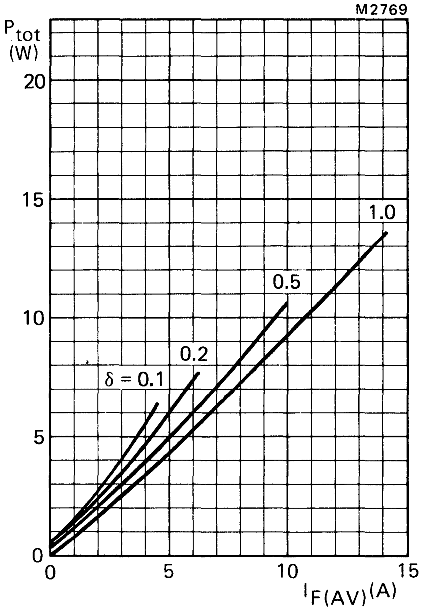
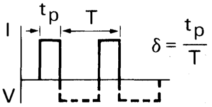


Fig. 5 Power rating per diode.
The individual power loss in each diode should first be determined then both added together. The resulting total power loss is then used in conjunction with Fig.6 to determine the heatsink size and corresponding maximum ambient and mounting base temperatures.



$\delta = \frac{t_p}{T}$

$I_{F(AV)} = I_{F(RMS)} \times \sqrt{\delta}$

Power includes reverse current losses and switching losses up to f = 500 kHz

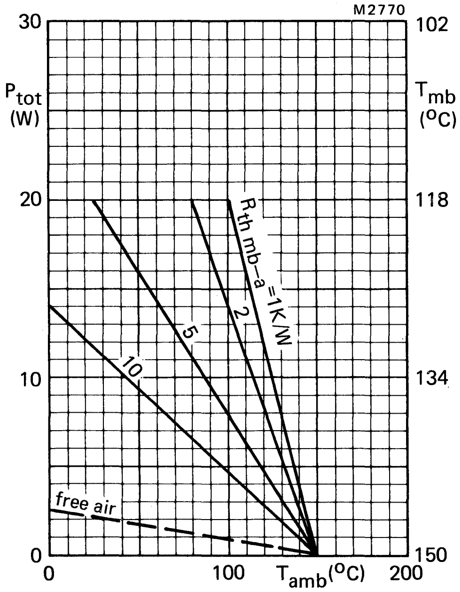


Fig.6

SINUSOIDAL OPERATION (PER DIODE)

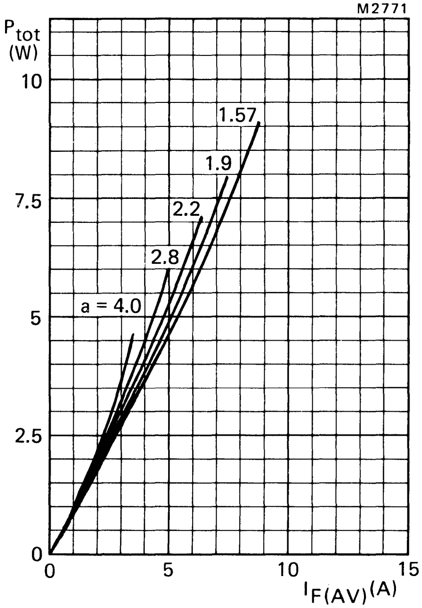


Fig.7 Power rating per diode.
The individual power loss in each diode should first be determined then both added together. The resulting total power loss is then used in conjunction with Fig.6 to determine the heatsink size and corresponding maximum ambient and mounting base temperatures.

a = form factor = $I_{F(RMS)}/I_{F(AV)}$

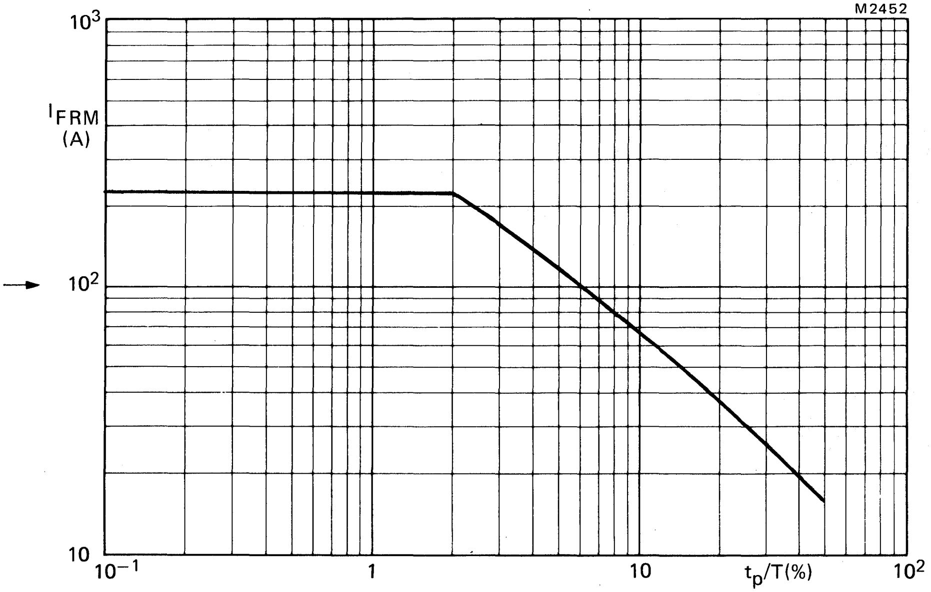
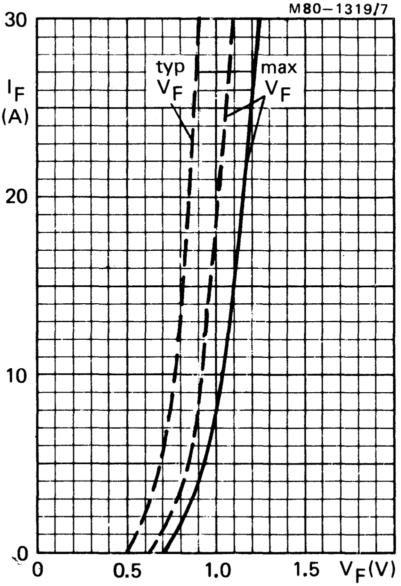
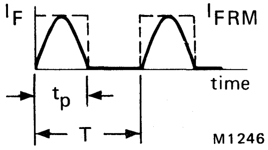


Fig.8 Maximum permissible repetitive peak forward current for either square or sinusoidal currents for 1 μs $< t_p <$ 1 ms; per diode.





Definition of I_{FRM} and t_p/T.

Fig.9 —— T_j = 25 °C; – – – T_j = 100 °C; per diode.

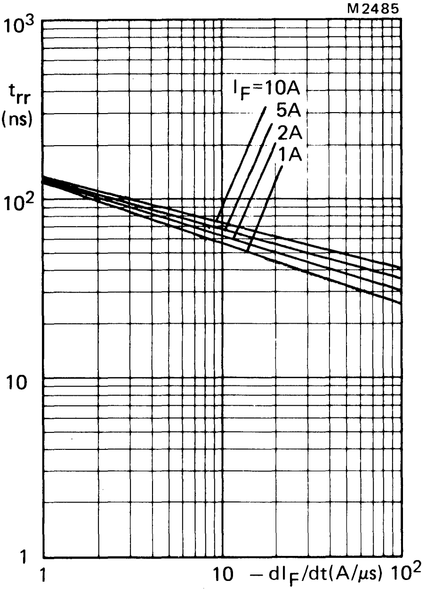


Fig.10 Maximum t_{rr} at T_j = 25 °C; per diode.

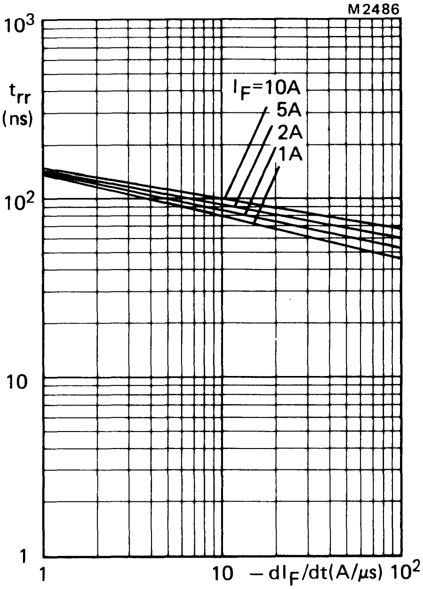


Fig.11 Maximum t_{rr} at T_j = 100 °C; per diode.

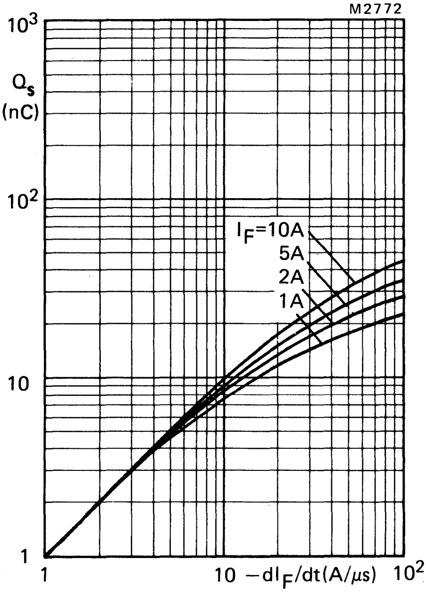


Fig.12 Maximum Q_s at T_j = 25 °C; per diode.

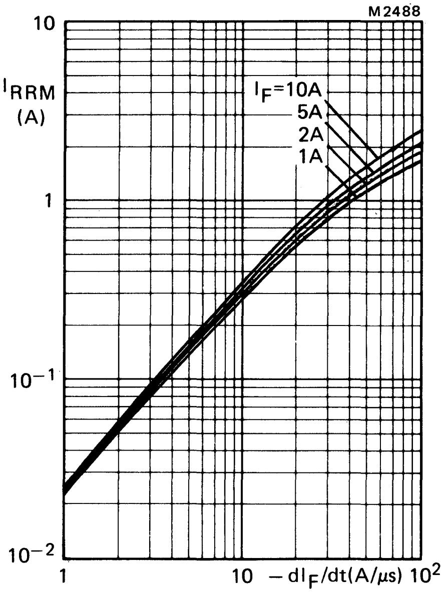


Fig.13 Maximum I_{RRM} at T_j = 25 °C; per diode.

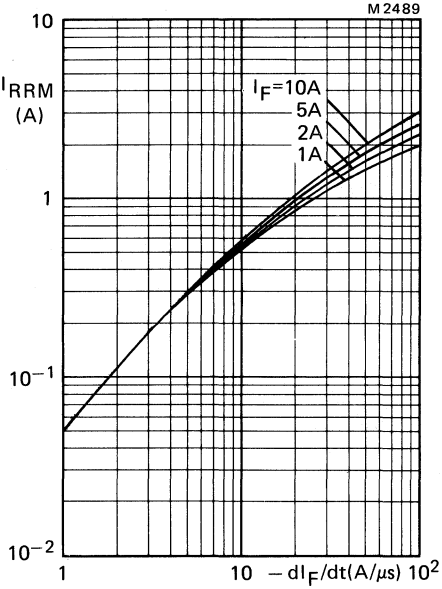


Fig.14 Maximum I_{RRM} at T_j = 100 °C; per diode.

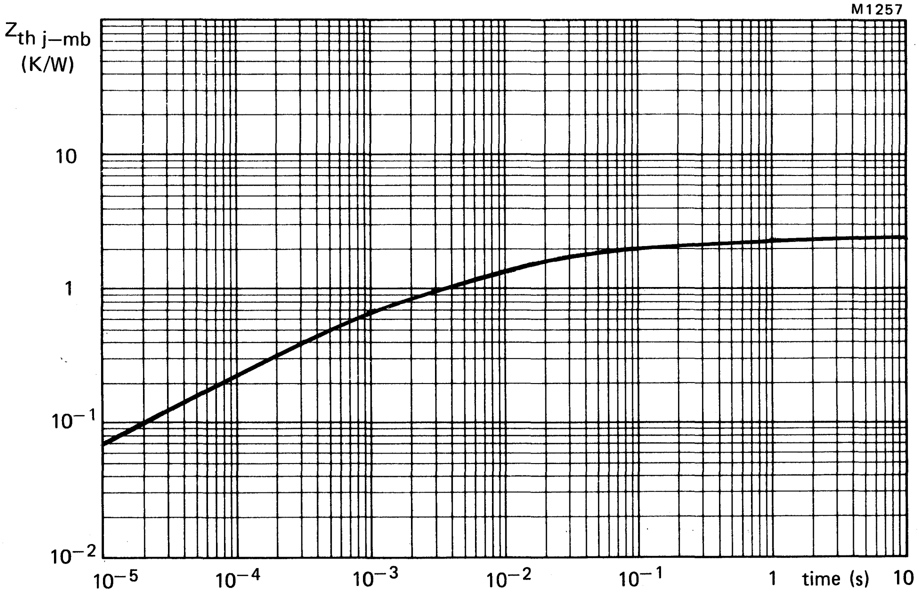


Fig.15 Transient thermal impedance; one diode conducting.

ULTRA FAST-RECOVERY ELECTRICALLY-ISOLATED DOUBLE RECTIFIER DIODES

Glass-passivated, high-efficiency epitaxial double rectifier diodes in SOT-186 (full-pack) plastic envelopes, featuring low forward voltage drop, very fast reverse recovery times and soft-recovery characteristic. Their electrical isolation makes them ideal for mounting on a common heatsink alongside other components without the need for additional insulators. They are intended for use in switched-mode power supplies and high-frequency circuits in general, where both low conduction and switching losses are essential. Their single chip construction ensures excellent matching of the forward and switching characteristics of the two halves, allowing parallel operation without the need for derating. The series consists of common cathode types.

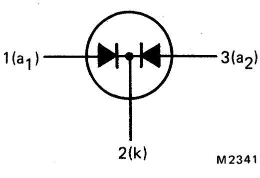
QUICK REFERENCE DATA

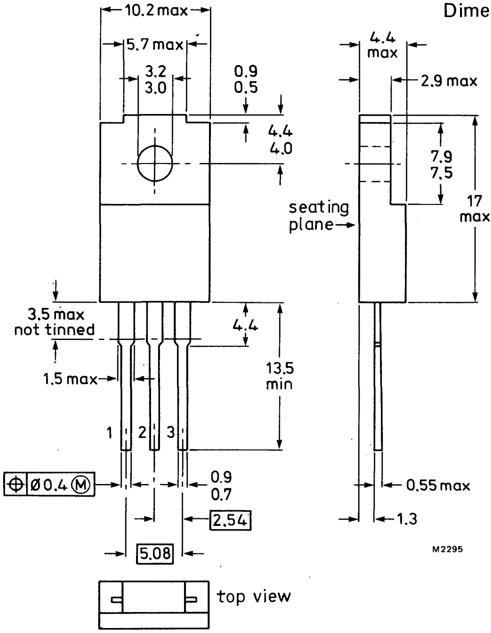
Per diode, unless otherwise stated			BYV32F-50	100	150	200	
Repetitive peak reverse voltage	V_{RRM}	max.	50	100	150	200	V
Output current (both diodes conducting)	I_O	max.		12			A
Forward voltage	V_F	$<$		0.85			V
Reverse recovery time	t_{rr}	$<$		25			ns

MECHANICAL DATA

Dimensions in mm

Fig.1 SOT-186 (full-pack)





Net mass: 2 g.

The seating plane is electrically isolated from all terminals.

Accessories supplied on request (see data sheets Mounting instructions for F-pack devices and Accessories for SOT-186 envelopes).

RATINGS

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

Voltages (per diode; see note 1)			BYV32F-50	100	150	200	
Repetitive peak reverse voltage	V_{RRM}	max.	50	100	150	200	V
Crest working reverse voltage	V_{RWM}	max.	50	100	150	200	V
Continuous reverse voltage	V_R	max.	50	100	150	200	V
Currents (see notes 2 and 3)							
Output current, switching losses negligible up to 500 kHz							
square wave; $\delta = 0.5$; up to $T_h = 92$ °C	I_O	max.	12				A
sinusoidal; up to $T_h = 100$ °C	I_O	max.	10.6				A
R.M.S. forward current	$I_{F(RMS)}$	max.	12				A
Repetitive peak forward current $t_p = 20$ µs, $\delta = 0.02$ (per diode)	I_{FRM}	max.	155				A
Non-repetitive peak forward current half sine-wave; $T_j = 150$ °C prior to surge; with reapplied $V_{RWM\ max}$;							
t = 10 ms (per diode)	I_{FSM}	max.	150				A
t = 8.3 ms (per diode)	I_{FSM}	max.	160				A
I^2t for fusing (t = 10 ms; per diode)	I^2t	max.	112				A^2s
Temperatures							
Storage temperature	T_{stg}		−40 to +150				°C
Junction temperature	T_j	max.	150				°C

ISOLATION

Peak isolation voltage from all terminals to external heatsink	V_{isol}	max.	1000	V
Isolation capacitance from cathode to external heatsink (see note 4)	C_p	typ.	12	pF

Notes

1. To ensure thermal stability: $R_{th\ j\text{-}a} < 6.3$ K/W for continuous reverse voltage.
2. The limits for both diodes apply whether both diodes conduct simultaneously or on alternate half cycles.
3. The quoted temperatures assume heatsink compound is used.
4. Mounted without heatsink compound and with 20 Newtons pressure on the centre of the envelope.

THERMAL RESISTANCE

From junction to external heatsink with minimum of 2 kgf (20 Newtons) pressure on the centre of the envelope, total package:				
without heatsink compound	$R_{th\ j\text{-}h}$	=	7.0	K/W
with heatsink compound	$R_{th\ j\text{-}h}$	=	5.0	K/W

Free-air operation

The quoted value of $R_{th\ j\text{-}a}$ should be used only when no leads of other dissipating components run to the same point.

Thermal resistance from junction to ambient in free air, device mounted on a printed circuit board	$R_{th\ j\text{-}a}$	=	55	K/W

CHARACTERISTICS

Forward voltage					
$I_F = 5$ A; $T_j = 100$ °C	V_F	$<$	0.85	V*	
$I_F = 20$ A; $T_j = 25$ °C	V_F	$<$	1.15	V*	
Reverse current					
$V_R = V_{RWM\ max}$; $T_j = 100$ °C	I_R	$<$	0.6	mA	
$V_R = V_{RWM\ max}$; $T_j = 25$ °C	I_R	$<$	10	μA	
Reverse recovery when switched from					
$I_F = 1$ A to $V_R \geqslant 30$ V with $-dI_F/dt = 100$ A/μs; $T_j = 25$ °C; recovery time	t_{rr}	$<$	25	ns	
$I_F = 2$ A to $V_R \geqslant 30$ V with $-dI_F/dt = 20$ A/μs; $T_j = 25$ °C; recovered charge	Q_s	$<$	12.5	nC	←
$I_F = 10$ A to $V_R \geqslant 30$ V with $-dI_F/dt = 50$ A/μs; $T_j = 100$ °C; peak recovery current	I_{RRM}	$<$	2	A	←
Forward recovery when switched to $I_F = 1$ A with $dI_F/dt = 10$ A/μs; $T_j = 25$ °C	V_{fr}	typ.	1	V	

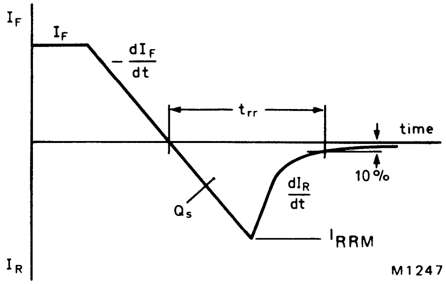


Fig.2 Definition of t_{rr}, Q_s and I_{RRM}.

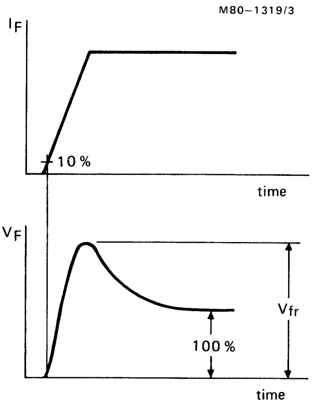


Fig.3 Definition of V_{fr}.

*Measured under pulse conditions to avoid excessive dissipation.

MOUNTING INSTRUCTIONS

1. The device may be soldered directly into the circuit, but the maximum permissible temperature of the soldering iron or bath is 275 °C; the heat source must not be in contact with the joint for more than 5 seconds. Soldered joints must be at least 4.7 mm from the seal.
2. The leads should not be bent less than 2.4 mm from the seal, and should be supported during → bending. The bend radius must be no less than 1 mm.
3. Mounting by means of a spring clip is the best mounting method because it offers a good thermal contact under the crystal area and slightly lower $R_{th\ j\text{-}h}$ values than screw mounting. The force exerted on the top of the device by the clip should be at least 2 kgf (20 Newtons) to ensure good thermal contact and must not exceed 3.5 kgf (35 Newtons) to avoid damage to the device.
4. If screw mounting is used, it should be M3 cross-recess pan head.

. Minimum torque to ensure good thermal contact:	5.5 kgf (0.55 Nm)
Maximum torque to avoid damage to the device:	8.0 kgf (0.80 Nm)

5. For good thermal contact, heatsink compound should be used between baseplate and heatsink. Values of $R_{th\ j\text{-}h}$ given for mounting with heatsink compound refer to the use of a metallic-oxide loaded compound. Ordinary silicone grease is not recommended.
6. Rivet mounting.
   It is not recommended to use rivets, since extensive damage could result to the plastic, which could destroy the insulating properties of the device.
7. → The heatsink must have a flatness in the mounting area of 0.02 mm maximum per 10 mm. Mounting holes must be deburred.

OPERATING NOTES

Dissipation and heatsink considerations:

a. The various components of junction temperature rise above ambient are illustrated in Fig.4:

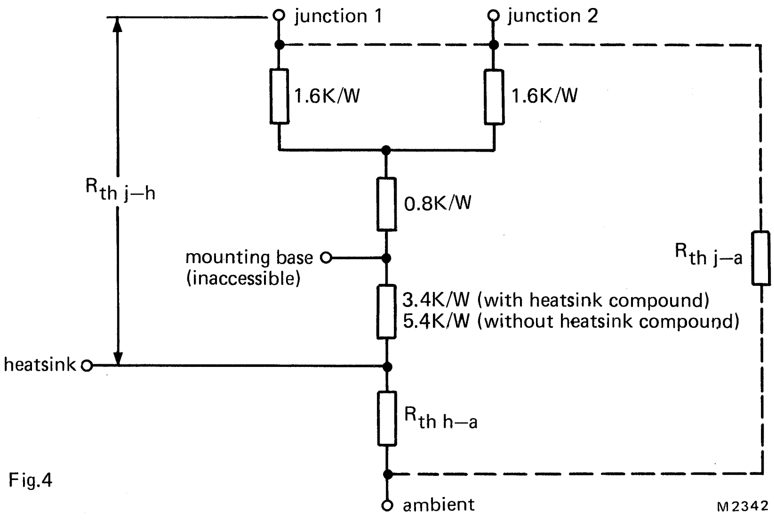


Fig.4

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

SQUARE-WAVE OPERATION

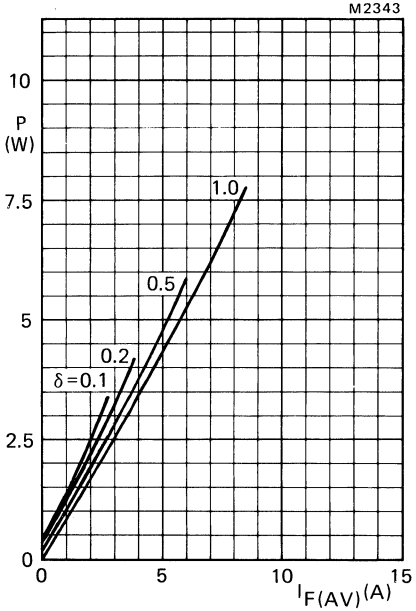
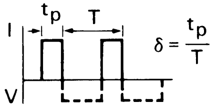


Fig.5 Power rating.

The individual power loss in each diode should first be determined from the required forward current on the $I_{F(AV)}$ axis and the appropriate duty cycle, then both added together to give a total power loss for the whole device.
Having determined this power (P), use Fig.7 (if heatsink compound is not being used) or Fig.8 (if heatsink compound is being used) to determine the heatsink size and corresponding maximum ambient and heatsink temperatures.

Note: P = power including reverse current losses but excluding switching losses.



$I_{F(AV)} = I_{F(RMS)} \times \sqrt{\delta}$

SINUSOIDAL OPERATION

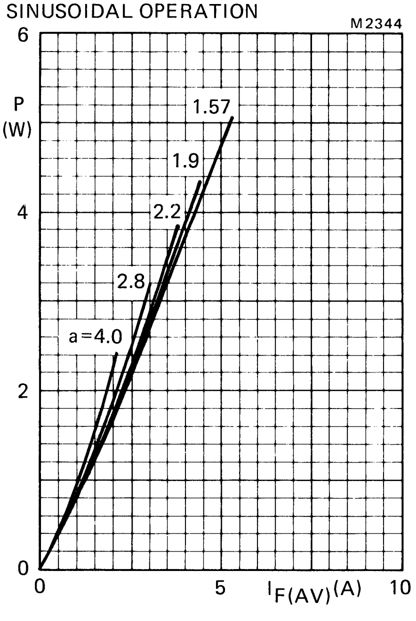


Fig.6 Power rating.

The individual power loss in each diode should first be determined from the required forward current on the $I_{F(AV)}$ axis and the appropriate form factor, then both added together to give a total power loss for the whole device.
Having determined this power (P), use Fig.7 (if heatsink compound is not being used) or Fig.8 (if heatsink compound is being used) to determine the heatsink size and corresponding maximum ambient and heatsink temperatures.

Note: P = power including reverse current losses but excluding switching losses.

a = form factor = $I_{F(RMS)}/I_{F(AV)}$

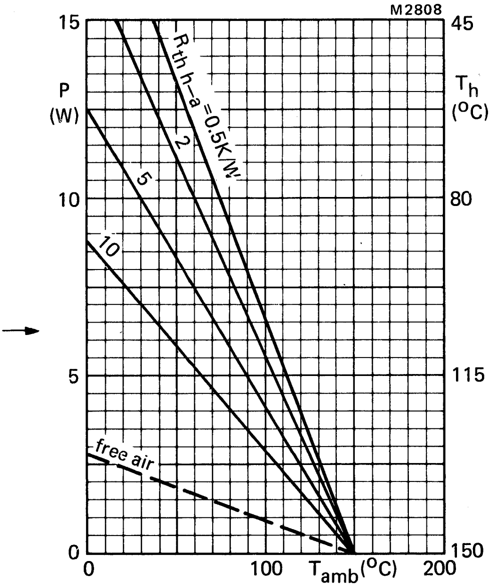


Fig.7 Heatsink rating.
Without heatsink compound.

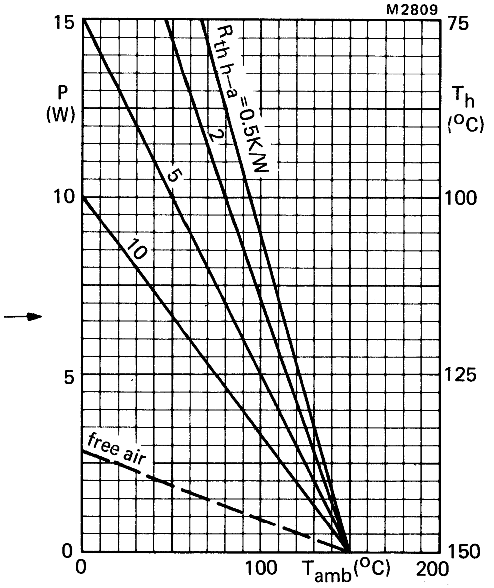


Fig.8 Heatsink rating.
With heatsink compound.

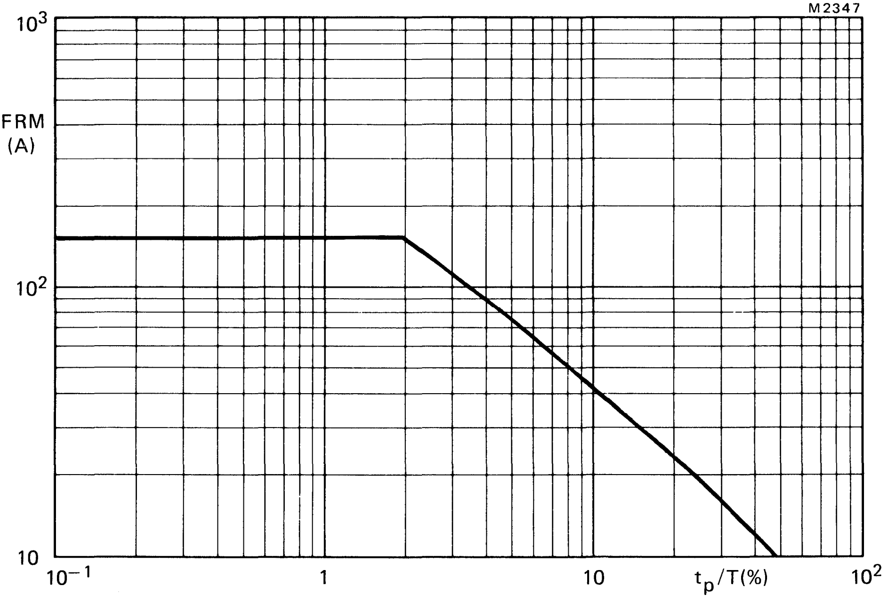
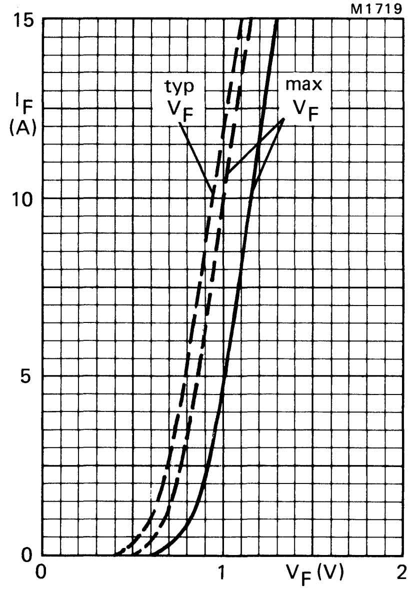
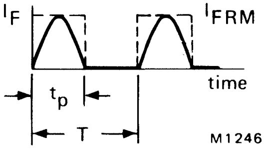


Fig.9 Maximum permissible repetitive peak forward current for either square or sinusoidal currents for 1 $\mu s < t_p < 1$ ms.





Definition of I_{FRM} and t_p/T

Fig.10 —— $T_j = 25\ ^oC$; – – – $T_j = 150\ ^oC$ per diode.

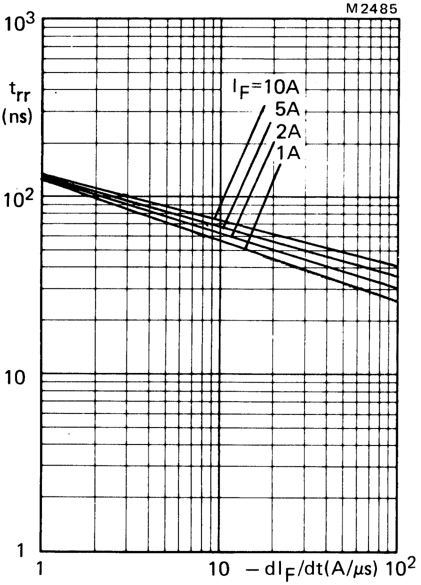


Fig.11 Maximum t_{rr} at T_j = 25 °C.

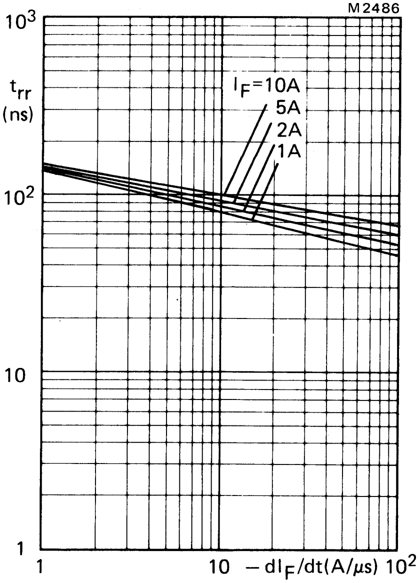


Fig.12 Maximum t_{rr} at T_j = 100 °C.

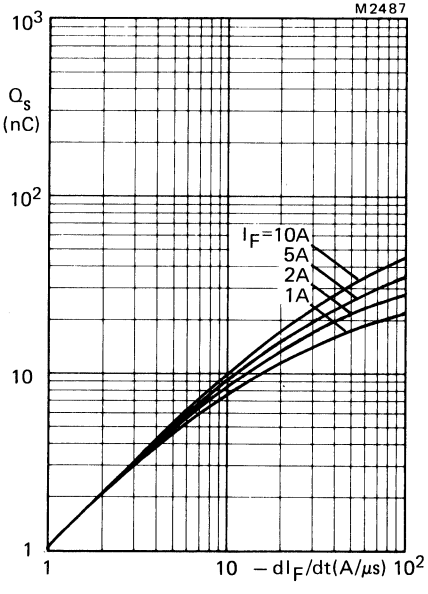


Fig.13 Maximum Q_s at T_j = 25 °C.

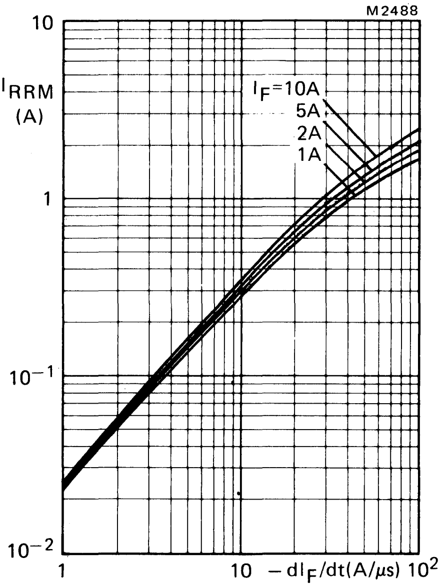


Fig.14 Maximum I_{RRM} at T_j = 25 °C

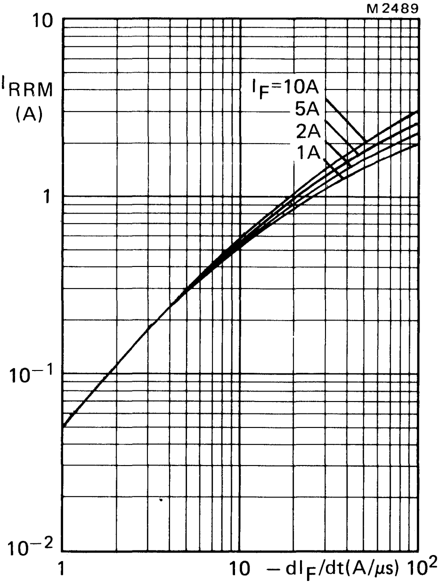


Fig.15 Maximum I_{RRM} at T_j = 100 °C;

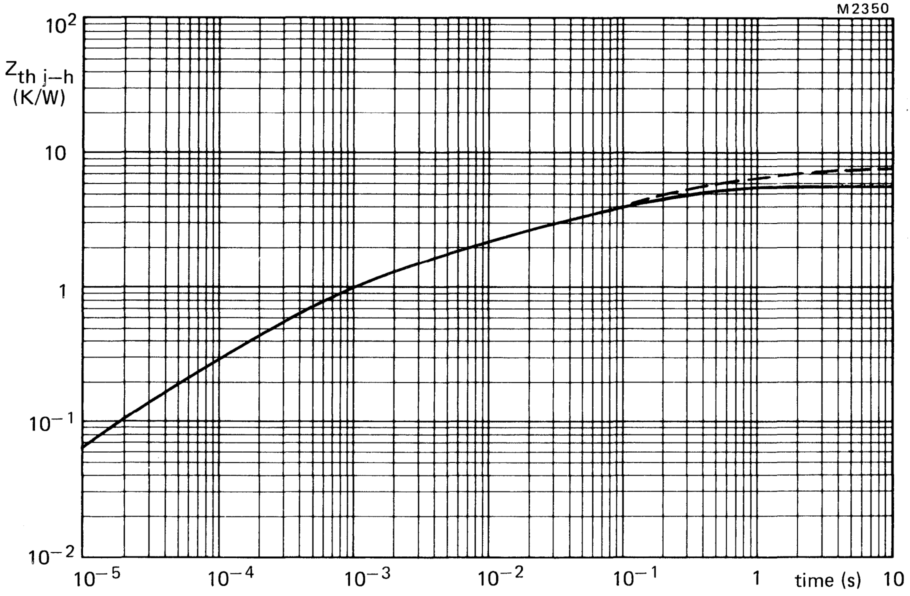


Fig.16 One diode conducting; —— with heatsink compound; — — — without heatsink compound.

ULTRA FAST RECOVERY DOUBLE RECTIFIER DIODES

Glass-passivated, high-efficiency double rectifier diodes in plastic envelopes, featuring low forward voltage drop, ultra fast reverse recovery times and soft-recovery characteristic. They are intended for use in switched-mode power supplies and high-frequency circuits in general, where both low conduction losses and low switching losses are essential. Their single chip (monolithic) construction ensures excellent matching of the forward and switching characteristics of the two halves, allowing parallel operation without the need for derating. The series consists of common-cathode types.

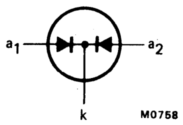
QUICK REFERENCE DATA

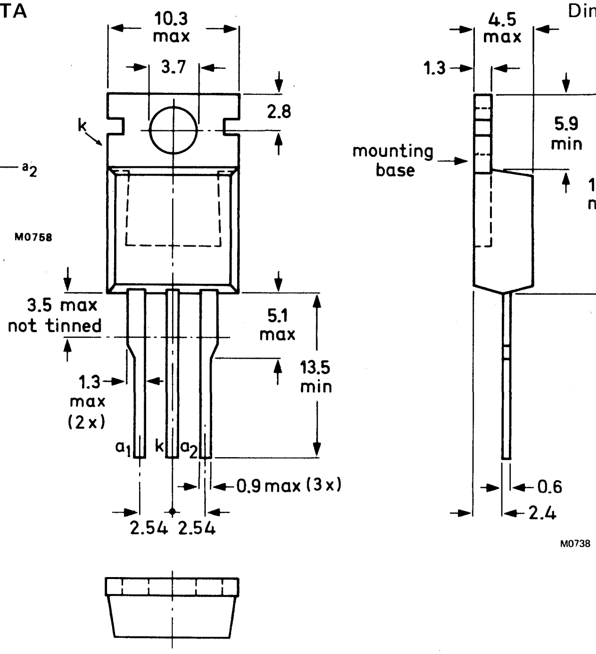
Per diode, unless otherwise stated			BYV34–300	400	500	
Repetitive peak reverse voltage	V_{RRM}	max.	300	400	500	V
Output current (both diodes conducting)	I_O	max.		20		A
Forward voltage	V_F	<		0.93		V
Reverse recovery time	t_{rr}	<		50		ns

MECHANICAL DATA

Fig.1 TO-220AB

Dimensions in mm





Net mass: 2 g

Note: the exposed metal mounting base is directly connected to the common cathode.

Accessories supplied on request: see data sheets Mounting Instructions and accessories for TO-220 envelopes.

RATINGS

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

Voltages (per diode)			BYV34–300	400	500	
Repetitive peak reverse voltage	V_{RRM}	max.	300	400	500	V
Crest working reverse voltage	V_{RWM}	max.	200	300	400	V
Continuous reverse voltage (note 1)	V_R	max.	200	300	400	V

Currents (both diodes conducting; note 2)				
Output current; switching				
→ losses negligible up to 200 kHz;				
square wave; $\delta = 0.5$; up to $T_{mb} = 113\ ^{o}C$	I_O	max.	20	A
up to $T_{mb} = 125\ ^{o}C$	I_O	max.	14	A
sinusoidal; up to $T_{mb} = 120\ ^{o}C$	I_O	max.	17.5	A
up to $T_{mb} = 125\ ^{o}C$	I_O	max.	14	A
→ R.M.S. forward current	$I_{F(RMS)}$	max.	28	A
Repetitive peak forward current				
$t_p = 20\ \mu s$; $\delta = 0.02$ (note 3)	I_{FRM}	max.	240	A
Non-repetitive peak forward current (per diode)				
half sine-wave; $T_j = 150\ ^{o}C$ prior to surge				
with re-applied $V_{RWM\,max}$				
t = 10 ms	I_{FSM}	max.	120	A
t = 8.3 ms	I_{FSM}	max.	150	A
I^2t for fusing (t = 10 ms; per diode)	I^2t	max.	72	A^2s
Temperatures				
Storage temperature	T_{stg}		−40 to +150	^{o}C
Junction temperature	T_j	max.	150	^{o}C

Notes

1. To ensure thermal stability: $R_{th\ j\text{-}a} < 4.5$ K/W.
2. The limits for both diodes apply whether both diodes conduct simultaneously or on alternate half cycles.

CHARACTERISTICS (per diode)

Forward voltage				
I_F = 10 A; T_j = 150 °C	V_F	<	0.93	V*
I_F = 30 A; T_j = 25 °C	V_F	<	1.4	V*
Reverse current				
$V_R = V_{RWM\ max}$; T_j = 100 °C	I_R	<	0.6	mA
$V_R = V_{RWM\ max}$; T_j = 25 °C	I_R	<	50	µA
Reverse recovery when switched from				
I_F = 1 A to $V_R \geqslant$ 30 V with $-dI_F/dt$ = 100 A/µs; T_j = 25 °C recovery time	t_{rr}	<	50	ns
I_F = 2 A to $V_R \geqslant$ 30 V with $-dI_F/dt$ = 20 A/µs; T_j = 25 °C recovered charge	Q_s	<	45	nC
I_F = 10 A to $V_R \geqslant$ 30 V with $-dI_F/dt$ = 50 A/µs; T_j = 100 °C peak recovery current	I_{RRM}	<	5.0	A
Forward recovery when switched to I_F = 10 A with dI_F/dt = 10 A/µs; T_j = 25 °C recovery voltage	V_{fr}	typ.	2.5	V

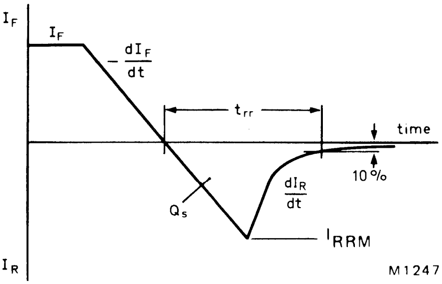


Fig.2 Definition of t_{rr}, Q_s and I_{RRM}.

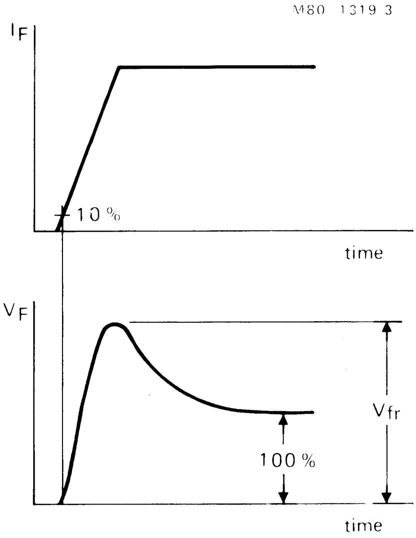


Fig.3 Definition of V_{fr}.

*Measured under pulse conditions to avoid excessive dissipation.

THERMAL RESISTANCE

From junction to mounting base (both diodes conducting) $R_{th\ j\text{-}mb}$ = 1.6 K/W

From junction to mounting base (per diode) $R_{th\ j\text{-}mb}$ = 2.3 K/W

→ **Influence of mounting method**

1. Heatsink-mounted with clip (see mounting instructions)

Thermal resistance from mounting base to heatsink

a. with heatsink compound $R_{th\ mb\text{-}h}$ = 0.3 K/W

b. with heatsink compound and 0.06 mm maximum mica insulator $R_{th\ mb\text{-}h}$ = 1.4 K/W

c. with heatsink compound and 0.1 mm maximum mica insulator (56369) $R_{th\ mb\text{-}h}$ = 2.2 K/W

d. with heatsink compound and 0.25 mm maximum alumina insulator (56367) $R_{th\ mb\text{-}h}$ = 0.8 K/W

e. without heatsink compound $R_{th\ mb\text{-}h}$ = 1.4 K/W

2. Free air operation

The quoted value of $R_{th\ j\text{-}a}$ should be used only when no leads of other dissipating components run to the same tie point.
Thermal resistance from junction to ambient in free air:
mounted on a printed circuit board at any device lead length and with copper laminate on the board $R_{th\ j\text{-}a}$ = 60 K/W

MOUNTING INSTRUCTIONS

1. The device may be soldered directly into the circuit, but the maximum permissible temperature of the soldering iron or bath is 275 °C; the heat source must not be in contact with the joint for more than 5 seconds. Soldered joints must be at least 4.7 mm from the seal.
2. The leads should not be bent less than 2.4 mm from the seal, and should be supported during bending. The bend radius must be no less than 1.0 mm. ←
3. Mounting by means of a spring clip is the best mounting method because it offers:
   a. a good thermal contact under the crystal area and slightly lower $R_{th\ mb\text{-}h}$ values than does screw mounting.
   b. safe isolation for mains operation.
   However, if a screw is used, it should be M3 cross-recess pan head. Care should be taken to avoid damage to the plastic body.
4. For good thermal contact heatsink compound should be used between mounting base and heatsink. Values of $R_{th\ mb\text{-}h}$ given for mounting with heatsink compound refer to the use of a metallic-oxide loaded compound. Ordinary silicone grease is not recommended.
5. Rivet mounting (only possible for non-insulated mounting).
   Devices may be rivetted to flat heatsinks; such a process must **neither** deform the mounting tab, **nor** enlarge the mounting hole.

OPERATING NOTES

Dissipation and heatsink calculations

a. The various components of junction temperature rise above ambient are illustrated in Fig.4

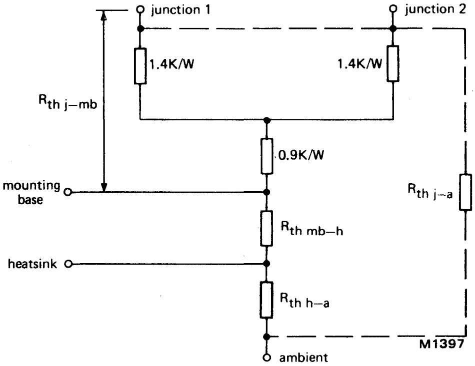


Fig.4

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

SQUARE-WAVE OPERATION (PER DIODE)

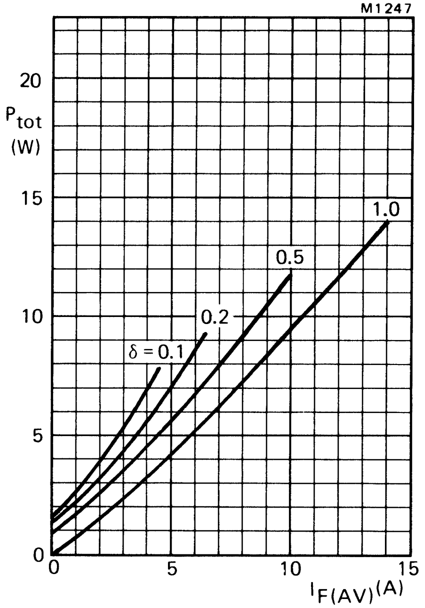
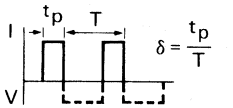


Fig.5 Power rating per diode.
The individual power loss in each diode should first be determined then both added together. The resulting total power loss is then used in conjunction with Fig.6 to determine the heatsink size and corresponding maximum ambient and mounting base temperatures.



$$\delta = \frac{t_p}{T}$$

$$I_{F(AV)} = I_{F(RMS)} \times \sqrt{\delta}$$

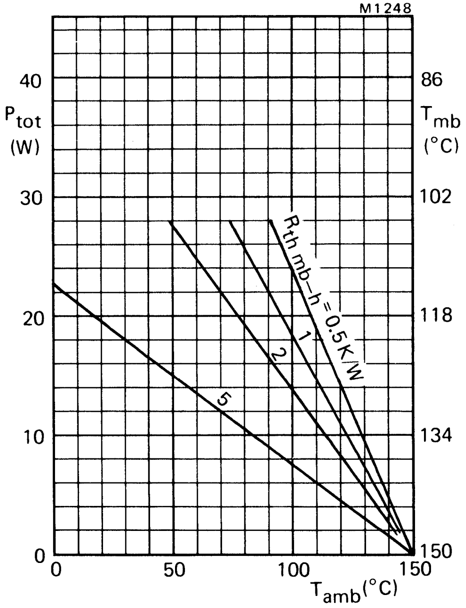


Fig.6

SINUSOIDAL OPERATION (PER DIODE)

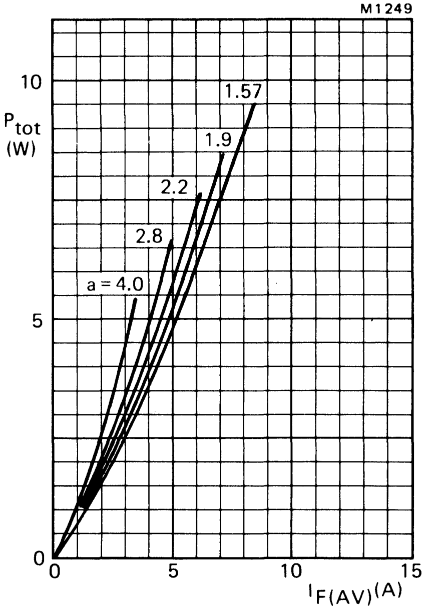


Fig.7 Power rating per diode.
The individual power loss in each diode should first be determined then both added together. The resulting total power loss is then used in conjunction with Fig.6 to determine the heatsink size and corresponding maximum ambient and mounting base temperatures.

a = form factor = $I_{F(RMS)}/I_{F(AV)}$

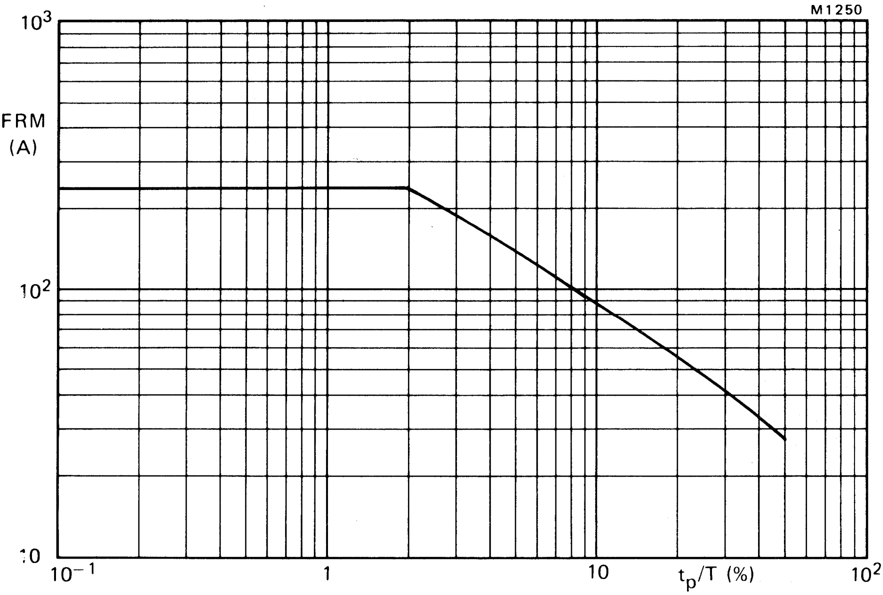
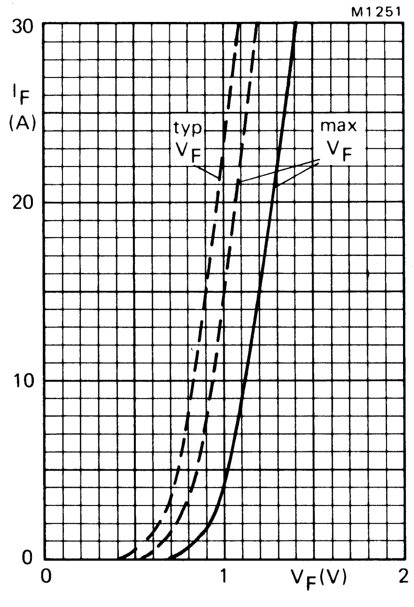
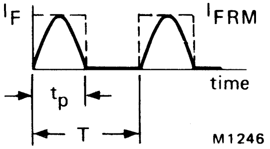


Fig.8 Maximum permissible repetitive peak forward current for either square or sinusoidal currents for $1\ \mu s < t_p < 1$ ms.(per diode).





Definition of I_{FRM} and t_p/T

Fig. 9 —— T_j = 25 °C; – – – T_j = 150 °C (per diode).

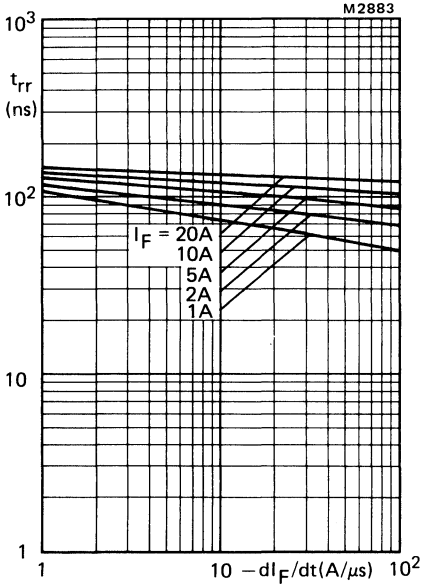


Fig.10 Maximum t_{rr} at T_j = 25 °C.
(per diode).

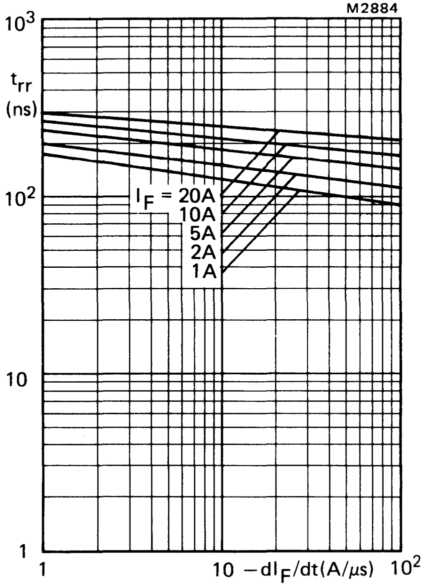


Fig.11 Maximum t_{rr} at T_j = 100 °C.
(per diode).

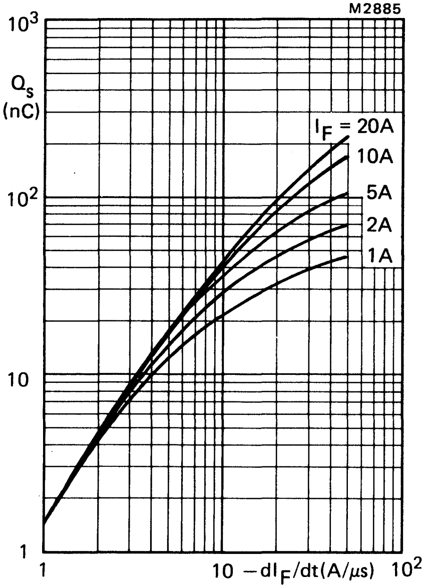


Fig.12 Maximum Q_s at T_j = 25 °C.
(per diode).

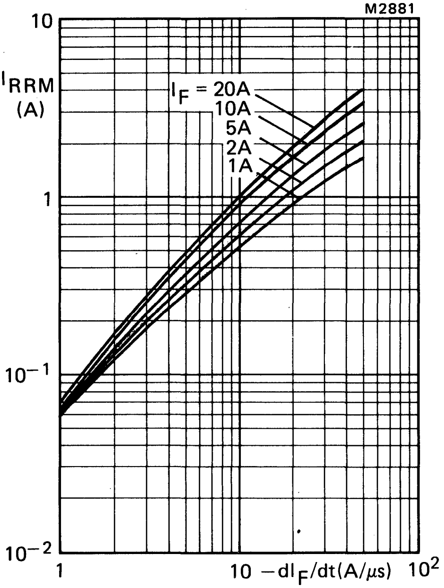


Fig.13 Maximum I_{RRM} at T_j = 25 °C. (per diode).

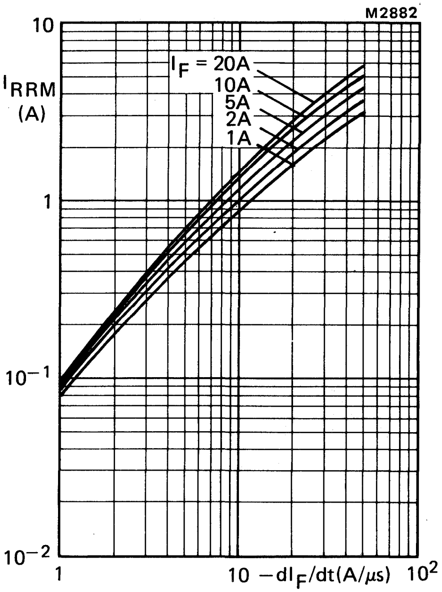


Fig.14 Maximum I_{RRM} at T_j = 100 °C. (per diode).

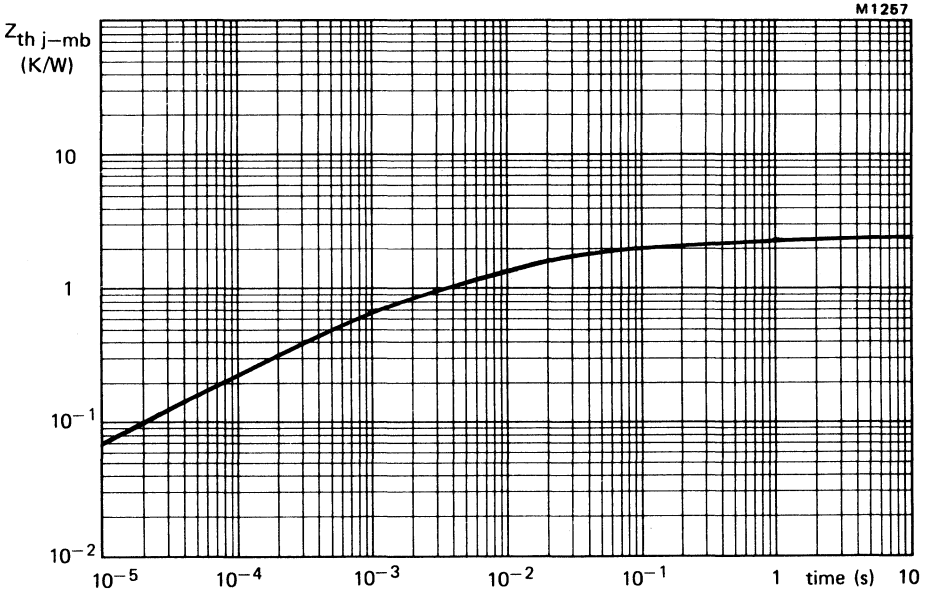


Fig.15 One diode conducting (per diode).

ULTRA FAST RECOVERY DOUBLE RECTIFIER DIODES

Glass-passivated, high-efficiency double rectifier diodes in plastic envelopes, featuring low forward voltage drop, ultra fast reverse recovery times and soft-recovery characteristic. They are intended for use in switched-mode power supplies and high-frequency circuits in general, where both low conduction losses and low switching losses are essential. Their single chip (monolithic) construction ensures excellent matching of the forward and switching characteristics of the two halves, allowing parallel operation without the need for derating. The series consists of common-cathode types.

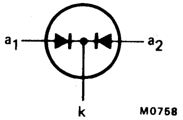
QUICK REFERENCE DATA

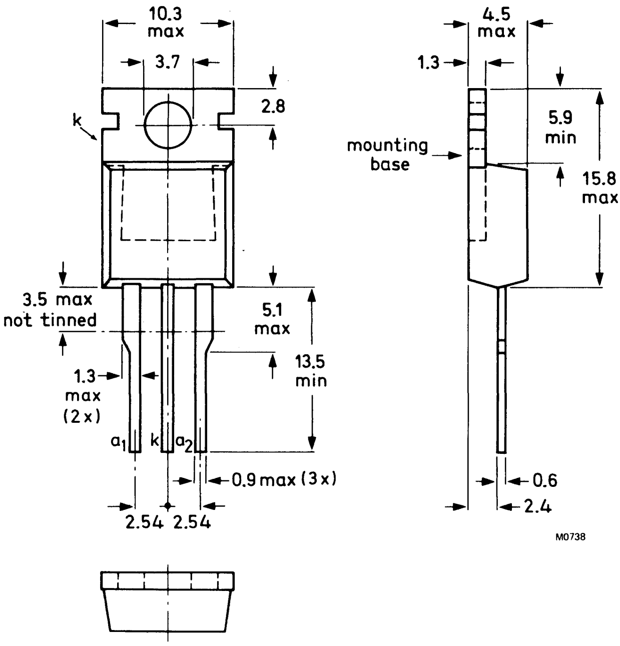
Per diode, unless otherwise stated			BYV42–50	100	150	200	
Repetitive peak reverse voltage	V_{RRM}	max.	50	100	150	200	V
Output current (both diodes conducting)	I_O	max.	30				A
Forward voltage	V_F	<	0.85				V
Reverse recovery time	t_{rr}	<	28				ns

MECHANICAL DATA

Dimensions in mm

Fig.1 TO-220AB





Net mass: 2 g

Note: the exposed metal mounting base is directly connected to the common-cathode.

Accessories supplied on request: see data sheets Mounting instructions and accessories for TO-220 envelopes.

RATINGS

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

Voltages (per diode)			BYV42–50	100	150	200	
Repetitive peak reverse voltage	V_{RRM}	max.	50	100	150	200	V
Crest working reverse voltage	V_{RWM}	max.	50	100	150	200	V
Continuous reverse voltage	V_R	max.	50	100	150	200	V

→ **Currents** (both diodes conducting: note 1)

Output current; switching losses negligible up to 500 kHz; square wave; $\delta = 0.5$; up to $T_{mb} = 104$ °C (note 2)	I_O	max.	30	A
R.M.S. forward current (note 2)	$I_{F(RMS)}$	max.	43	A
Repetitive peak forward current $t_p = 20\ \mu s$; $\delta = 0.02$ (per diode)	I_{FRM}	max.	320	A
Non-repetitive peak forward current (per diode) half sine-wave; $T_j = 150$ °C prior to surge; with reapplied $V_{RWM\,max}$				
t = 10 ms	I_{FSM}	max.	200	A
t = 8.3 ms	I_{FSM}	max.	220	A
I^2t for fusing (t = 10 ms; per diode)	I^2t	max.	200	A^2s

Temperatures

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

Notes:

1. The limits for both diodes apply whether both diodes conduct simultaneously or on alternate half cycles.
2. For output currents in excess of 20 A, connection should be made to the exposed metal mounting base.

CHARACTERISTICS

T_j = 25 °C unless otherwise stated

Forward voltage					
I_F = 10 A; T_j = 100 °C	V_F	$<$	0.85	V*	
I_F = 30 A	V_F	$<$	1.15	V*	
Reverse current					
$V_R = V_{RWM}$ max; T_j = 100 °C	I_R	$<$	1.0	mA	
$V_R = V_{RWM}$ max	I_R	$<$	100	μA	
Reverse recovery when switched from					
I_F = 1 A to $V_R \geqslant$ 30 V with $-dI_F/dt$ = 100 A/μs; recovery time	t_{rr}	$<$	28	ns	←
I_F = 2 A to $V_R \geqslant$ 30 V with $-dI_F/dt$ = 20 A/μs; recovered charge	Q_s	$<$	15	nC	
I_F = 10 A to $V_R \geqslant$ 30 V with $-dI_F/dt$ = 50 A/μs; T_j = 100 °C; peak recovery current	I_{RRM}	$<$	2.4	A	←
Forward recovery when switched to I_F = 1 A with dI_F/dt = 10 A/μs	V_{fr}	typ.	1.0	V	

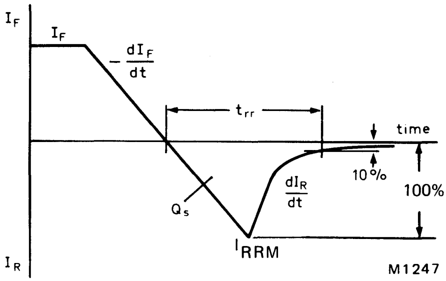


Fig.2 Definition of t_{rr}, Q_s and I_{RRM}.

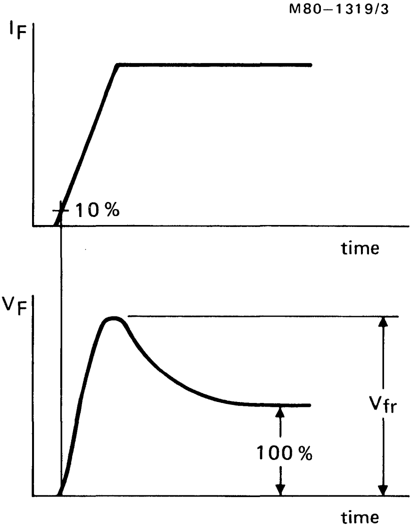


Fig.3 Definition of V_{fr}.

---

*Measured under pulse conditions to avoid excessive dissipation.

→ THERMAL RESISTANCE

From junction to mounting base (both diodes conducting)	$R_{th\ j\text{-}mb}$	=	1.4	K/W
From junction to mounting base (per diode)	$R_{th\ j\text{-}mb}$	=	2.4	K/W

Influence of mounting method

1. Heatsink-mounted with clip (see mounting instructions)

Thermal resistance from mounting base to heatsink

a. with heatsink compound	$R_{th\ mb\text{-}h}$	=	0.3	K/W
b. with heatsink compound and 0.06 mm maximum mica insulator	$R_{th\ mb\text{-}h}$	=	1.4	K/W
c. with heatsink compound and 0.1 mm maximum mica insulator (56369)	$R_{th\ mb\text{-}h}$	=	2.2	K/W
d. with heatsink compound and 0.25 mm maximum alumina insulator (56367)	$R_{th\ mb\text{-}h}$	=	0.8	K/W
e. without heatsink compound	$R_{th\ mb\text{-}h}$	=	1.4	K/W

2. Free air operation

The quoted value of $R_{th\ j\text{-}a}$ should be used only when no leads of other dissipating components run to the same tie point.

Thermal resistance from junction to ambient in free air: mounted on a printed circuit board at any device lead length and with copper laminate on the board $R_{th\ j\text{-}a}$ = 60 K/W

MOUNTING INSTRUCTIONS

1. The device may be soldered directly into the circuit, but the maximum permissible temperature of the soldering iron or bath is 275 °C; the heat source must not be in contact with the joint for more than 5 seconds. Soldered joints must be at least 4.7 mm from the seal.
2. The leads should not be bent less than 2.4 mm from the seal, and should be supported during bending. The bend radius must be no less than 1.0 mm.
3. Mounting by means of a spring clip is the best mounting method because it offers:
   a. a good thermal contact under the crystal area and slightly lower $R_{th\ mb\text{-}h}$ values than does screw mounting.
   b. safe isolation for mains operation.
   However, if a screw is used, it should be M3 cross-recess pan head. Care should be taken to avoid damage to the plastic body.
4. For good thermal contact heatsink compound should be used between mounting base and heatsink. Values of $R_{th\ mb\text{-}h}$ given for mounting with heatsink compound refer to the use of a metallic oxide loaded compound. Ordinary silicone grease is not recommended.
5. Rivet mounting (only possible for non-insulated mounting).
   Devices may be rivetted to flat heatsinks; such a process must **neither** deform the mounting tab, **nor** enlarge the mounting hole.

OPERATING NOTES

Dissipation and heatsink calculations

The various components of junction temperature rise above ambient are illustrated in Fig.4

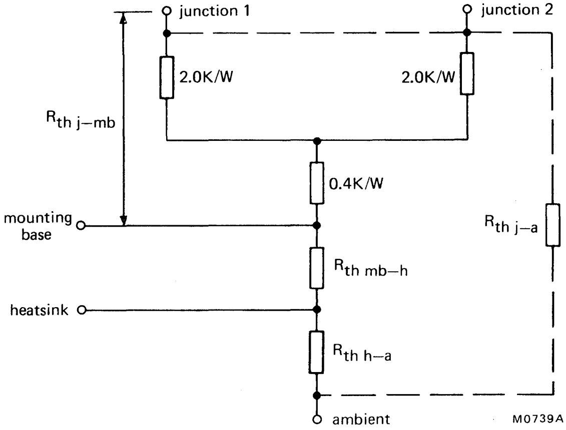


Fig. 4

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

SQUARE-WAVE OPERATION (PER DIODE)

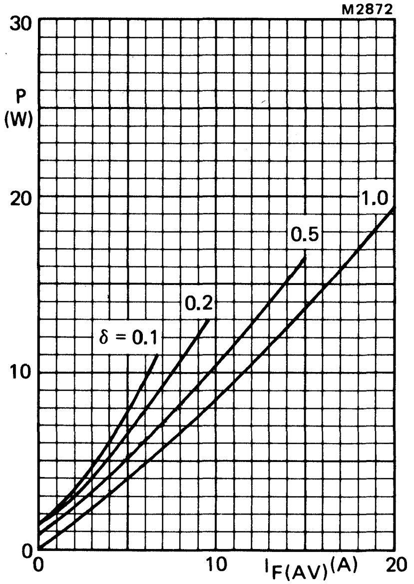
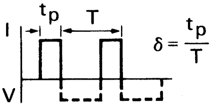


Fig.5 Power rating per diode.
The individual power loss in each diode should first be determined then both added together. The resulting total power loss is then used in conjunction with Fig.6 to determine the heatsink size and corresponding maximum ambient and mounting base temperatures.



$$\delta = \frac{t_p}{T}$$

$$I_{F(AV)} = I_{F(RMS)} \times \sqrt{\delta}$$

Power includes reverse current losses and switching losses up to f = 500 kHz.

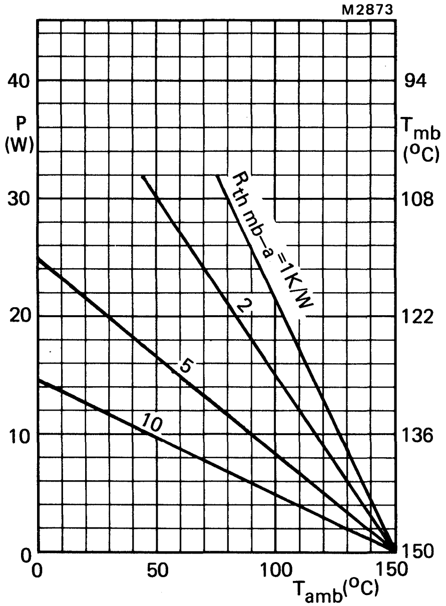


Fig.6.

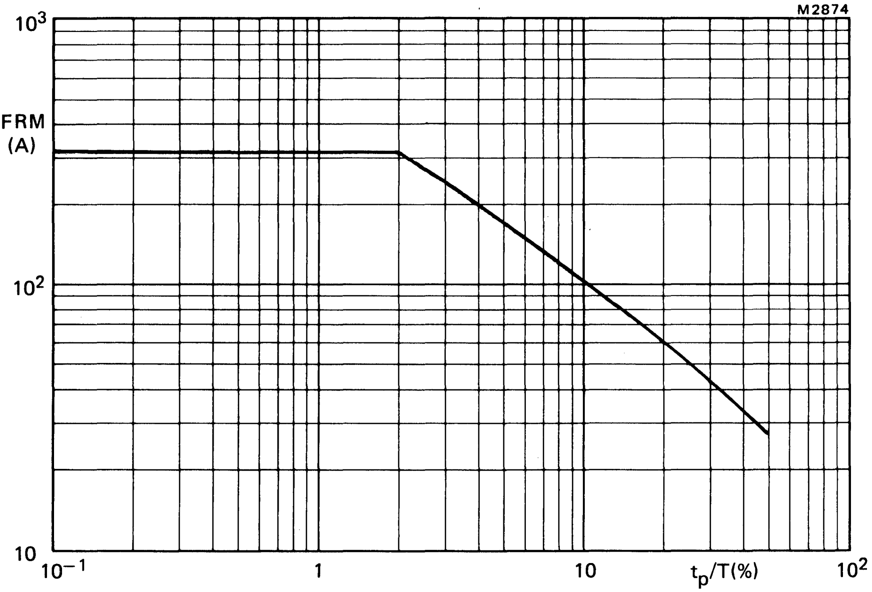
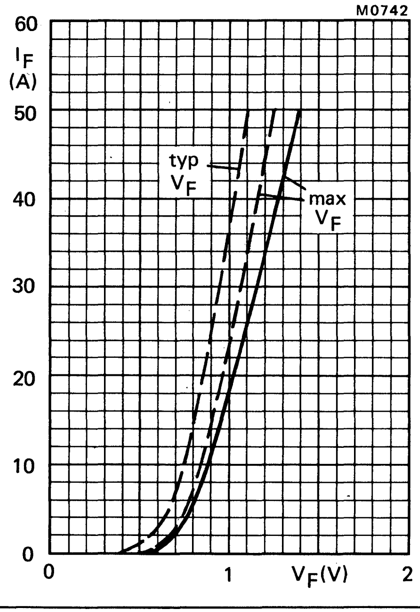
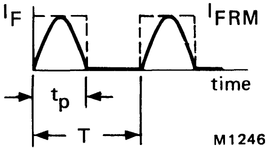


Fig.7 Maximum permissible repetitive peak forward current for square or sinusoidal currents for 1 $\mu s < t_p < 1$ ms; per diode.





Defintion of I_{FRM} and t_p/T.

Fig.8 —— $T_j = 25$ °C; – – – $T_j = 100$ °C; per diode.

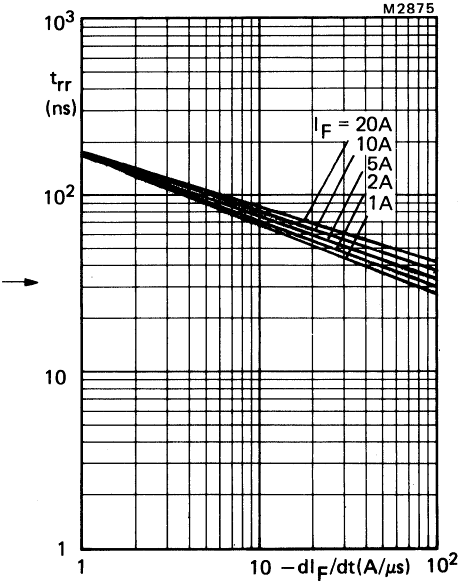


Fig.9 Maximum t_{rr} at T_j = 25 °C; per diode.

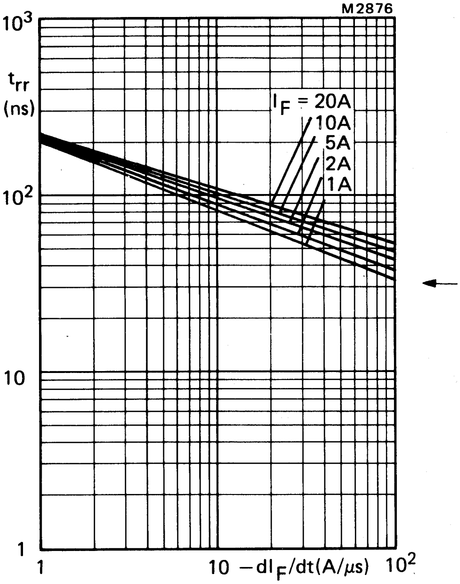


Fig.10 Maximum t_{rr} at T_j = 100 °C; per diode.

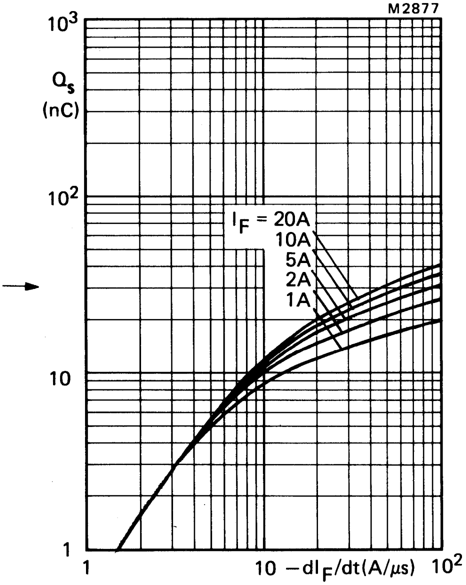


Fig.11 Maximum Q_s at T_j = 25 °C; per diode.

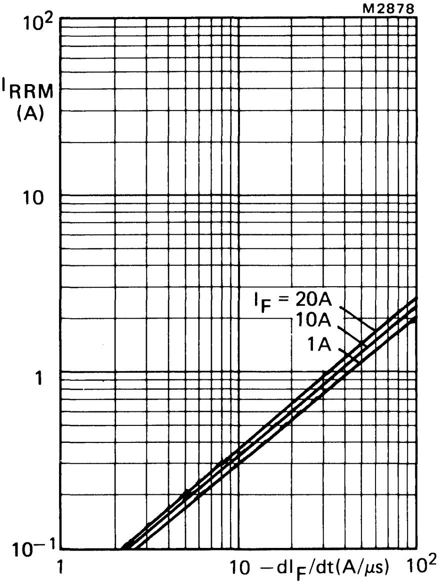


Fig. 12 Maximum I_{RRM} at T_j = 25 °C; per diode.

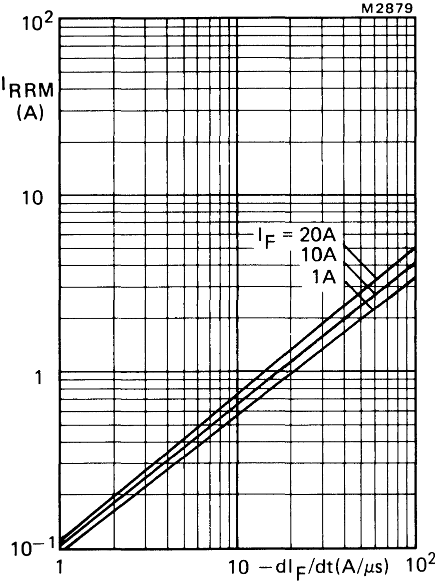


Fig. 13 Maximum I_{RRM} at T_j = 100 °C; per diode.

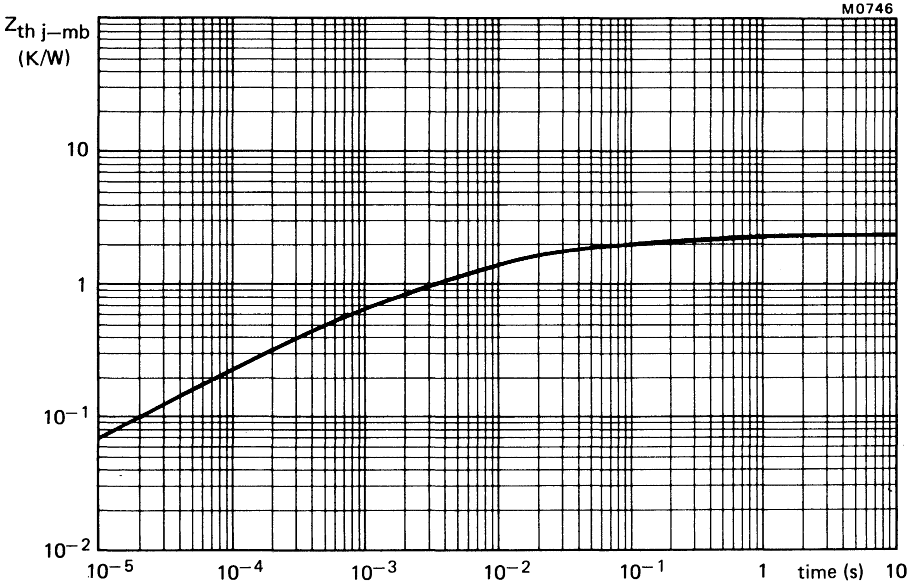


Fig. 14 Transient thermal impedance; one diode conducting.

ULTRA FAST RECOVERY DOUBLE RECTIFIER DIODES

Glass-passivated, high-efficiency double rectifier diodes in plastic envelopes, featuring low forward voltage drop, ultra fast reverse recovery times and soft-recovery characteristic. They are intended for use in switched-mode power supplies and high-frequency circuits in general, where both low conduction losses and low switching losses are essential. Their single chip (monolithic) construction ensures excellent matching of the forward and switching characteristics of the two halves, allowing parallel operation without the need for derating. The series consists of common-cathode types.

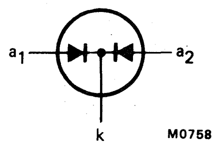
QUICK REFERENCE DATA

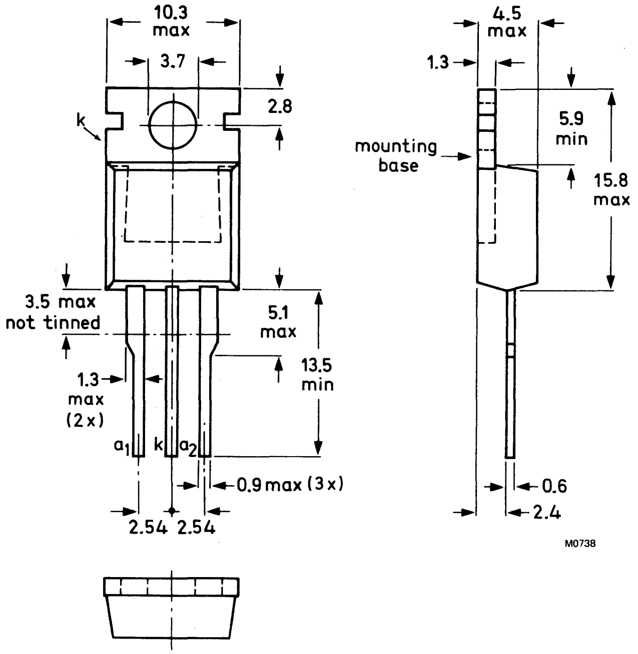
Per diode, unless otherwise stated			BYV44–300	400	500	V
Repetitive peak reverse voltage	V_{RRM}	max.	300	400	500	V
Output current (both diodes conducting)	I_O	max.	30			A
Forward voltage	V_F	<	1.05			V
Reverse recovery time	t_{rr}	<	50			ns

MECHANICAL DATA

Dimensions in mm

Fig. TO–220AB





Net mass: 2 g

Note: the exposed metal mounting base is directly connected to the common cathode.

Accessories supplied on request: see data sheets Mounting instructions and accessories for TO-220 envelopes.

RATINGS

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

Voltages (per diode)			BYV44–300	400	500	
Repetitive peak reverse voltage	V_{RRM}	max.	300	400	500	V
Crest working reverse voltage	V_{RWM}	max.	200	300	400	V
Continuous reverse voltage (note 1)	V_R	max.	200	300	400	V

→ **Currents** (both diodes conducting; note 2)

Output current; switching losses negligible up to 200 kHz;				
square wave; $\delta = 0.5$; up to $T_{mb} = 92$ °C (note 3)	I_O	max.	30	A
sinusoidal; up to $T_{mb} = 103$ °C (note 3)	I_O	max.	26	A
R.M.S. forward current (note 3)	$I_{F(RMS)}$	max.	43	A
Repetitive peak forward current $t_p = 20\ \mu s$; $\delta = 0.02$ (per diode)	I_{FRM}	max.	320	A
Non-repetitive peak forward current (per diode) half sine-wave; $T_j = 150$ °C prior to surge; with reapplied $V_{RWM\,max}$				
t = 10 ms	I_{FSM}	max.	150	A
t = 8.3 ms	I_{FSM}	max.	180	A
I^2t for fusing (t = 10 ms; per diode)	I^2t	max.	112	A^2s

Temperatures

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

Notes:

1. To ensure thermal stability: $R_{th\ j\text{-}a} < 9.3$ K/W.
2. The limits for both diodes apply whether both diodes conduct simultaneously or on alternate half cycles.
3. For output currents in excess of 20 A, connection should be made to the exposed metal mounting base.

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

Forward voltage				
I_F = 15 A; T_j = 150 °C	V_F	<	1.05	V*
I_F = 50 A	V_F	<	1.4	V*
Reverse current				
$V_R = V_{RWM\,max}$; T_j = 100 °C	I_R	<	0.8	mA
$V_R = V_{RWM\,max}$	I_R	<	50	μA
Reverse recovery when switched from				
I_F = 1 A to $V_R \geqslant$ 30 V with $-dI_F/dt$ = 100 A/μs; recovery time	t_{rr}	<	50	ns
I_F = 2 A to $V_R \geqslant$ 30 V with $-dI_F/dt$ = 20 A/μs; recovered charge	Q_s	<	50	nC
I_F = 10 A to $V_R \geqslant$ 30 V with $-dI_F/dt$ = 50 A/μs; T_j = 100 °C; peak recovery current	I_{RRM}	<	5.2	A
Forward recovery when switched to I_F = 10 A with dI_F/dt = 10 A/μs; recovery voltage	V_{fr}	typ.	2.5	V

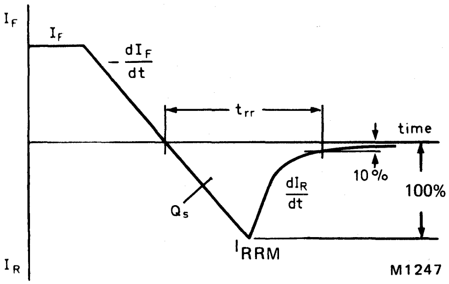


Fig.2 Definition of t_{rr}, Q_s and I_{RRM}

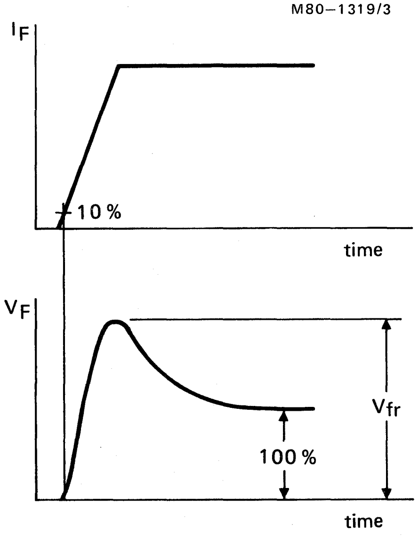


Fig.3 Definition of V_{fr}.

---

*Measured under pulse conditions to avoid excessive dissipation.

THERMAL RESISTANCE

From junction to mounting base (both diodes conducting)	$R_{th\ j\text{-}mb}$	=	1.4	K/W
From junction to mounting base (per diode)	$R_{th\ j\text{-}mb}$	=	2.0	K/W

→ **Influence of mounting method**

1. Heatsink-mounted with clip (see mounting instructions)

Thermal resistance from mounting base to heatsink

a. with heatsink compound	$R_{th\ mb\text{-}h}$	=	0.3	K/W
b. with heatsink compound and 0.06 mm maximum mica insulator	$R_{th\ mb\text{-}h}$	=	1.4	K/W
c. with heatsink compound and 0.1 mm maximum mica insulator (56369)	$R_{th\ mb\text{-}h}$	=	2.2	K/W
d. with heatsink compound and 0.25 mm maximum alumina insulator (56367)	$R_{th\ mb\text{-}h}$	=	0.8	K/W
e. without heatsink compound	$R_{th\ mb\text{-}h}$	=	1.4	K/W

2. Free-air operation

The quoted value of $R_{th\ j\text{-}a}$ should be used only when no leads of other dissipating components run to the same tie point.

Thermal resistance from junction to ambient in free air: mounted on a printed circuit board at any device lead length and with copper laminate on the board.	$R_{th\ j\text{-}a}$	=	60	K/W

MOUNTING INSTRUCTIONS

1. The device may be soldered directly into the circuit, but the maximum permissible temperature of the soldering iron or bath is 275 °C; the heat source must not be in contact with the joint for more than 5 seconds. Soldered joints must be at least 4.7 mm from the seal.
2. The leads should not be bent less than 2.4 mm from the seal, and should be supported during bending. The bend radius must be no less than 1.0 mm.
3. Mounting by means of a spring clip is the best mounting method because it offers:
   a. a good thermal contact under the crystal area and slightly lower $R_{th\ mb\text{-}h}$ values than does screw mounting.
   b. safe isolation for mains operation.
   However, if a screw is used, it should be M3 cross-recess pan head. Care should be taken to avoid damage to the plastic body.
4. For good thermal contact heatsink compound should be used between mounting base and heatsink. Values of $R_{th\ mb\text{-}h}$ given for mounting with heatsink compound refer to the use of a metallic oxide-loaded compound. Ordinary silicone grease is not recommended.
5. Rivet mounting (only possible for non-insulated mounting).
   Devices may be rivetted to flat heatsinks; such a process must **neither** deform the mounting tab, **nor** enlarge the mounting hole.

OPERATING NOTES

Dissipation and heatsink calculations

The various components of junction temperature rise above ambient are illustrated in Fig.4:

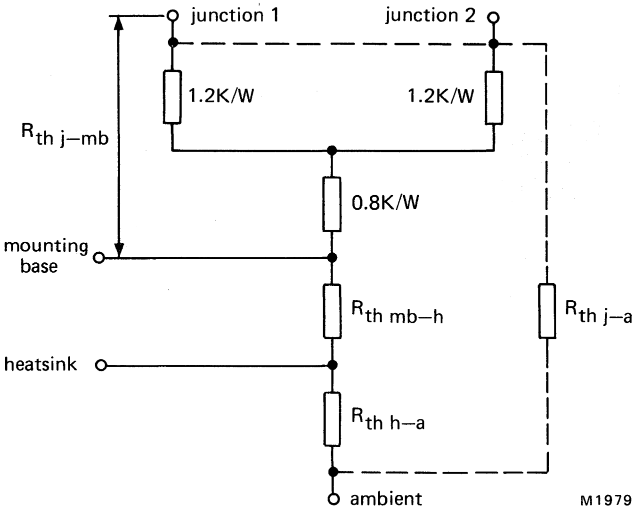


Fig.4

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

SQUARE-WAVE OPERATION

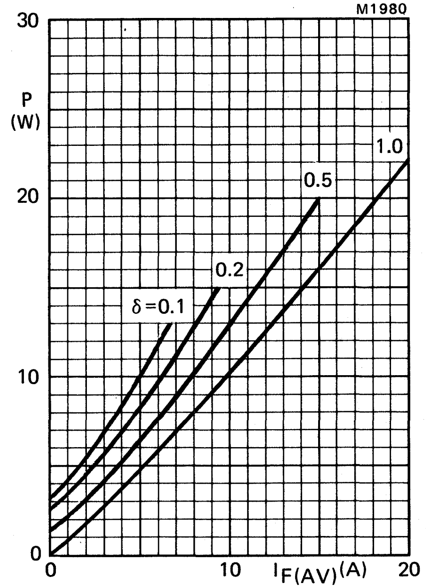
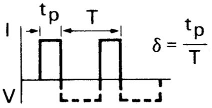


Fig.5 Power rating per diode.
The individual power loss in each diode should first be determined then both added together. The resulting total power loss is then used in conjunction with Fig.6 to determine the heatsink size and corresponding maximum ambient and mounting base temperatures.

Power includes reverse current losses and switching losses up to f = 100 kHz.



$I_{F(AV)} = I_{F(RMS)} \times \sqrt{\delta}$

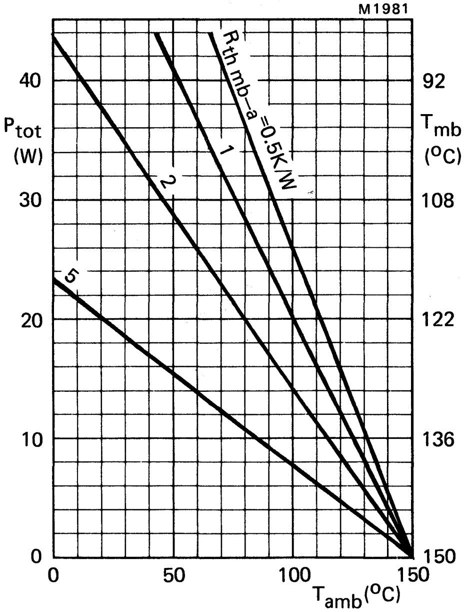


Fig.6

SINUSOIDAL OPERATION

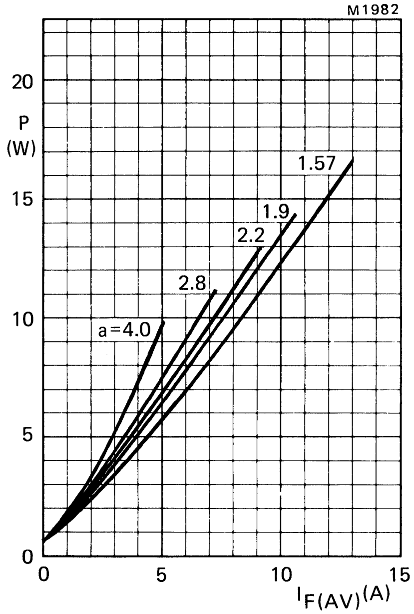


Fig.7 Power rating per diode.
The individual power loss in each diode should first be determined then both added together. The resulting total power loss is then used in conjunction with Fig.6 to determine the heatsink size and corresponding maximum ambient and mounting base temperatures.

a = form factor = $I_{F(RMS)}/I_{F(AV)}$.

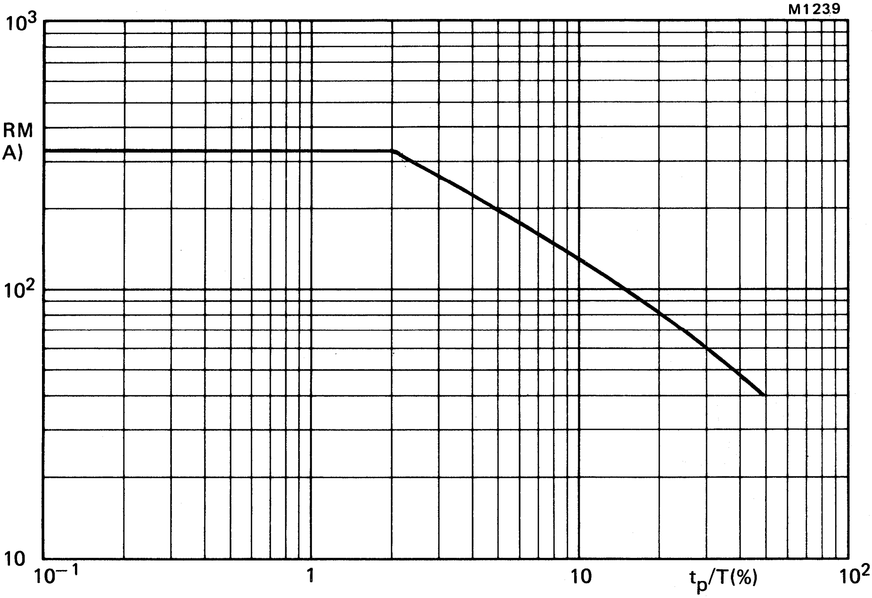
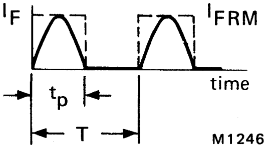


Fig.8 Maximum permissible repetitive peak forward current for square or sinusoidal currents; 1 μs $< t_p <$ 1 ms.



Definition of I_{FRM} and t_p/T.

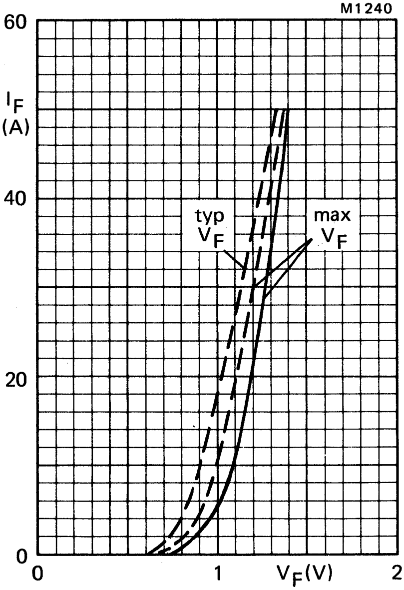


Fig.9 —— T_j = 25 °C; – – – T_j = 150 °C.

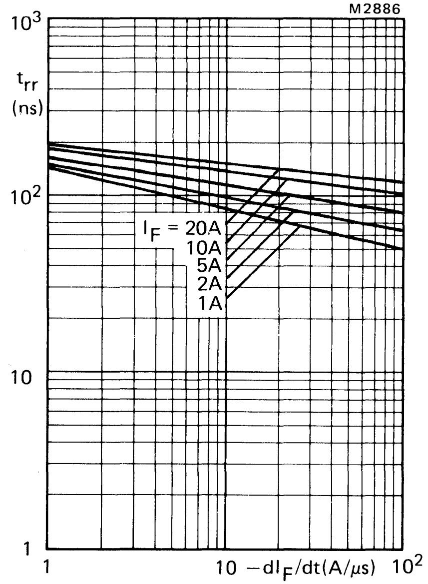


Fig.10 Maximum t_{rr} at T_j = 25 °C.

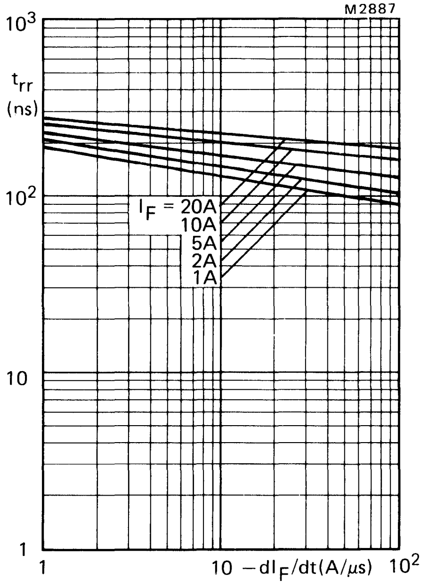


Fig.11 Maximum t_{rr} at T_j = 100 °C.

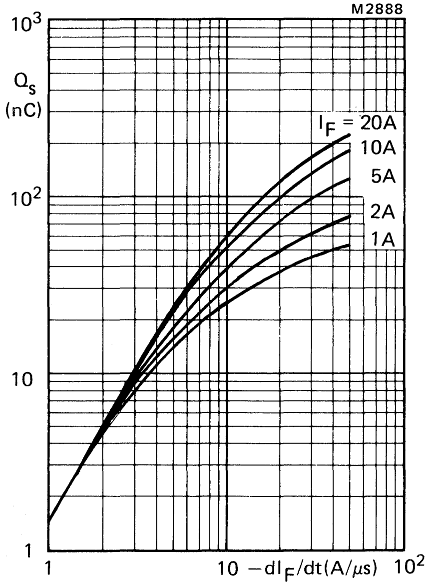


Fig.12 Maximum Q_s at T_j = 25 °C.

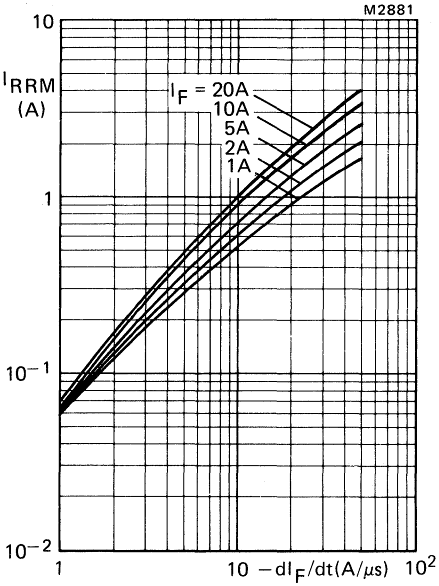


Fig. 13 Maximum I_{RRM} at T_j = 25 °C.

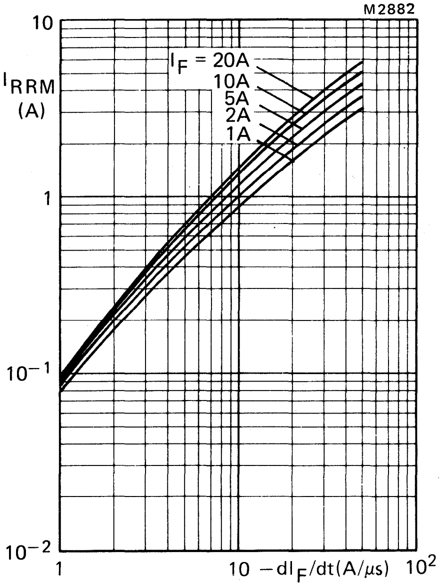


Fig. 14 Maximum I_{RRM} at T_j = 100 °C.

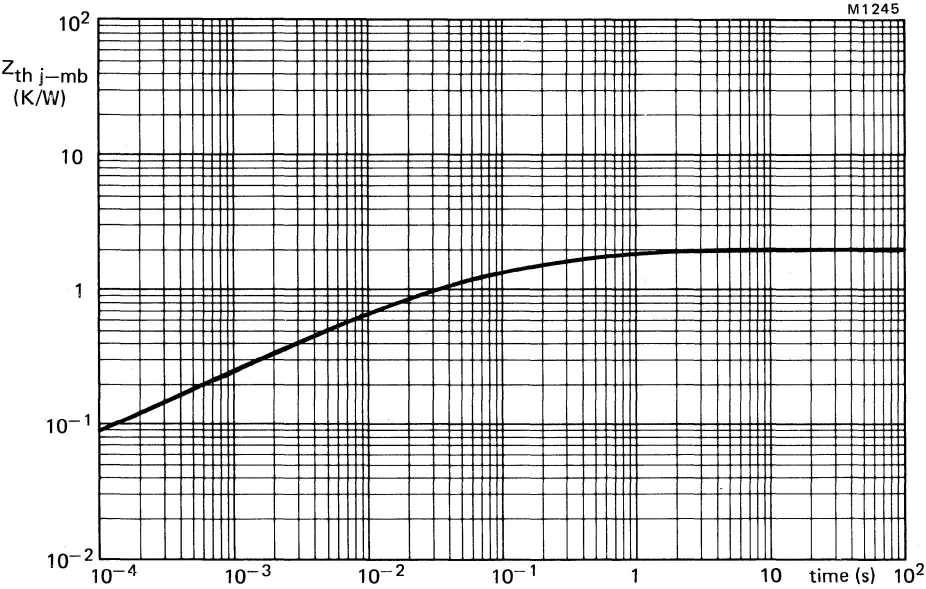


Fig. 15 Transient thermal impedance (one diode conducting).

FAST SOFT-RECOVERY RECTIFIER DIODES

Glass-passivated double-diffused rectifier diodes in TO-238 envelope, featuring fast reverse recovery times with soft recovery characteristics.
They are primarily intended for use in a.c. motor control systems as an anti-parallel diode to switching devices such as GTO, ASCR, etc. They are also suitable for use in high-frequency inverters.
The envelope baseplate is electrically isolated.

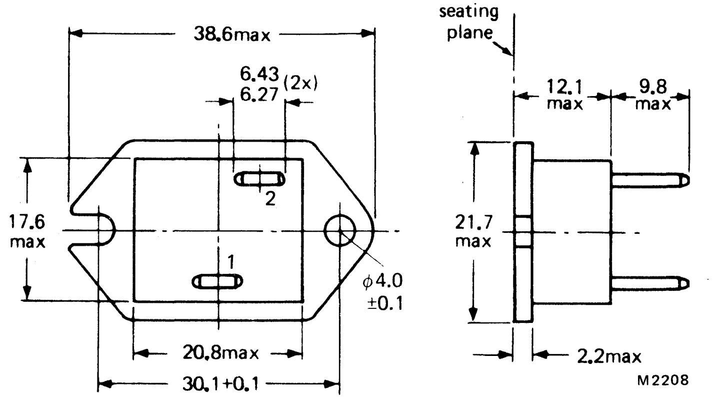
QUICK REFERENCE DATA

			BYV60–850	1000	1200	
Repetitive peak reverse voltage	V_{RRM}	max.	850	1000	1200	
Average forward current	$I_{F(AV)}$	max.		15		A
Non-repetitive peak forward current	I_{FSM}	max.		150		A
Reverse recovery time	t_{rr}	<		0.6		μs

MECHANICAL DATA

Dimensions in mm

Fig.1 TO-238 (2-pin)



Pin 1 = cathode (AMO 250 series)
2 = anode (AMP 250 series)
Baseplate is electrically isolated.

Net mass = 16.5 g

RATINGS

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

Voltages

			BYV60–850	1000	1200	
Non-repetitive peak reverse voltage	V_{RSM}	max.	1000	1100	1300	V
Repetitive peak reverse voltage	V_{RRM}	max.	850	1000	1200	V
Crest working reverse voltage	V_{RWM}	max.	600	800	1000	V
Continuous reverse voltage	V_R	max.	500	650	750	V

Currents

Average forward current assuming zero switching losses square-wave; $\delta = 0.5$; up to $T_{mb} = 76$ °C	$I_{F(AV)}$	max.	15	A
sinusoidal; up to $T_{mb} = 81$ °C	$I_{F(AV)}$	max.	13.5	A
R.M.S. forward current	$I_{F(RMS)}$	max.	21	A
Repetitive peak forward current; $1\ \mu s < t_p < 1$ ms; $\delta \leqslant 0.02$	I_{FRM}	max.	300	A
Non-repetitive peak forward current; t = 10 ms half sine-wave; $T_j = 125$ °C prior to surge; with reapplied $V_{RWM\ max}$	I_{FSM}	max.	150	A

Temperatures

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

THERMAL RESISTANCE

From mounting base to heatsink; with heatsink compound	$R_{th\ mb-h}$	=	0.3	K/W
From junction to mounting base	$R_{th\ j-mb}$	=	2	K/W

ISOLATION*

R.M.S. isolation voltage	V_{isol}	min.	2500	V

---

*From baseplate to terminals strapped together.

CHARACTERISTICS

Forward voltage				
$I_F = 50$ A; $T_j = 25$ °C	V_F	$<$	2.45	V*
Reverse current				
$V_R = V_{RWMmax}$; $T_j = 100$ °C	I_R	$<$	1.2	mA
Reverse recovery when switched from				
$I_F = 2$ A to $V_R \geqslant 30$ V with $-dI_F/dt = 20$ A/μs; $T_j = 25$ °C				
recovered charge	Q_s	$<$	2.0	μC
recovery time	t_{rr}	$<$	0.6	μs
Forward recovery when switched to				
$I_F = 5$ A with $t_r = 0.1$ μs; $T_j = 25$ °C				
recovery time	t_{fr}	$<$	1.0	μs

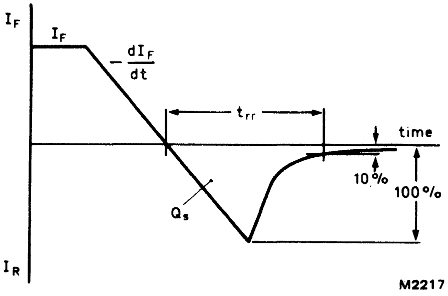


Fig.2 Definition of t_{rr} and Q_s.

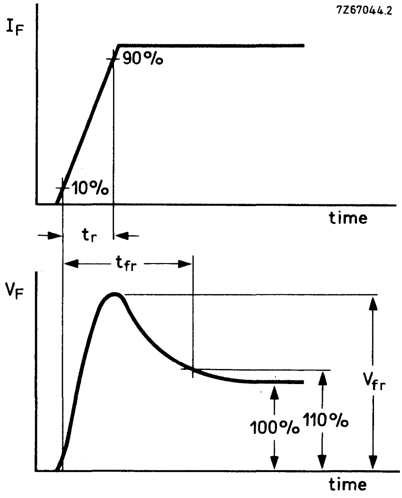


Fig.3 Definition of t_{fr}.

---

*Measured under pulse conditions to avoid excessive dissipation.

SINUSOIDAL OPERATION

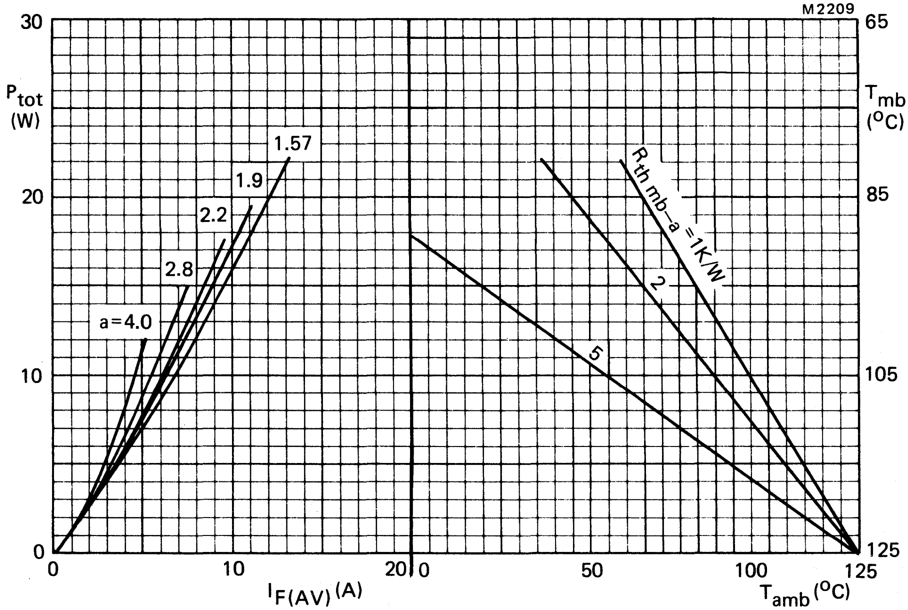


Fig. 4 The right-hand part shows the interrelationship between the power (derived from the left-hand part) and the maximum permissible temperatures.
P = power including reverse current losses but excluding switching losses.
a = form factor = $I_{F(RMS)}/I_{F(AV)}$.

SQUARE-WAVE OPERATION

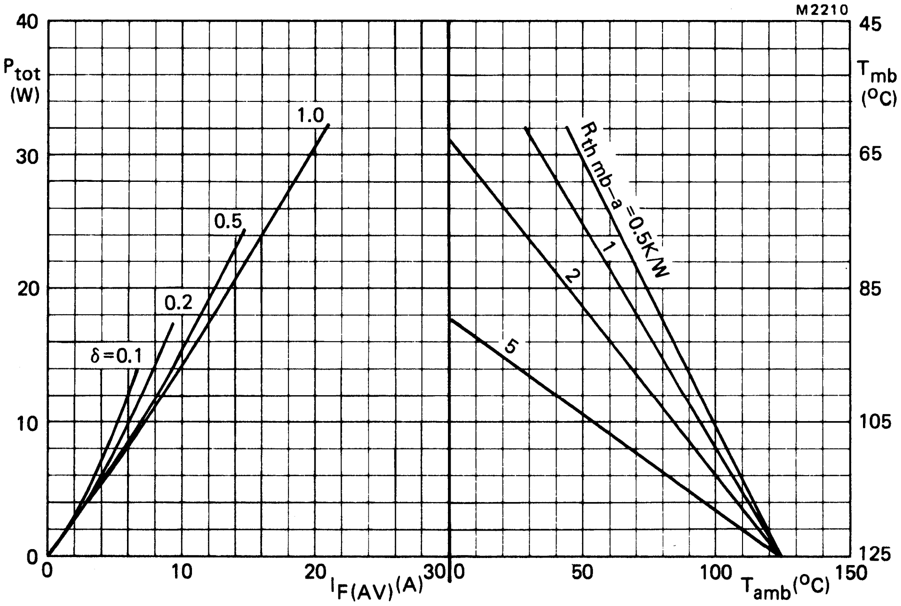
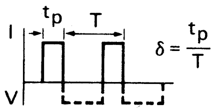


Fig.5 The right-hand part shows the interrelationship between the power (derived from the left-hand part) and the maximum permissible temperatures.
P = power including reverse current losses but excluding switching losses.



$I_{F(AV)} = I_{F(RMS)} \times \sqrt{\delta}$

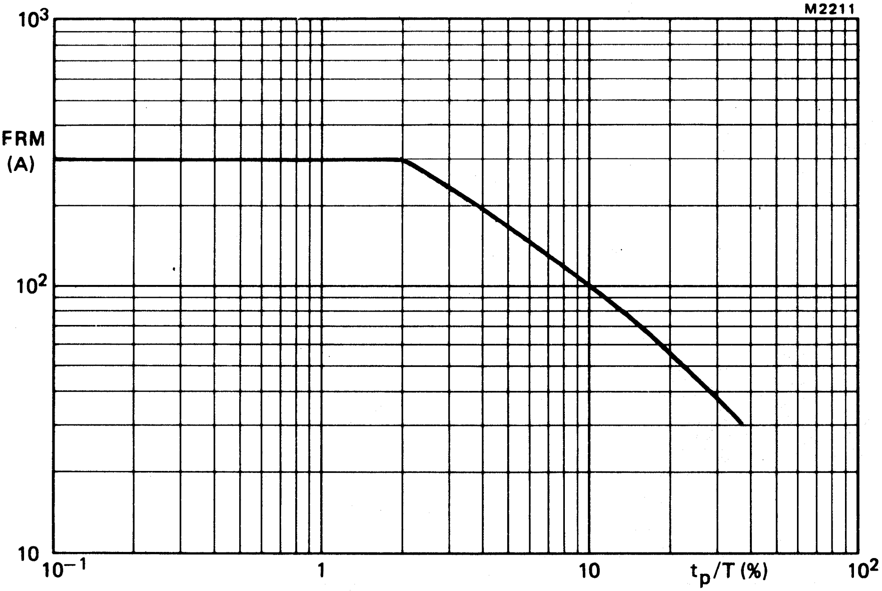


Fig. 6 Maximum permissible repetitive peak forward current based on sinusoidal currents; 1 μs $< t_p <$ 1 ms.

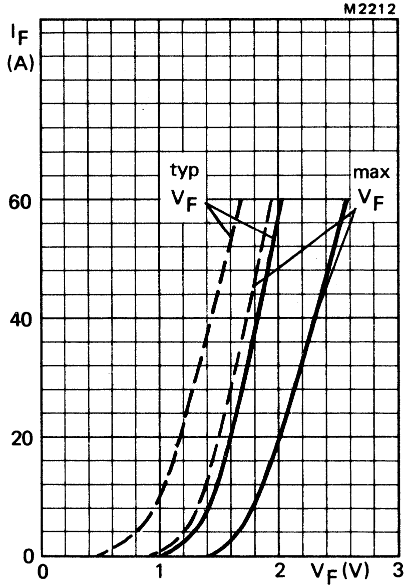


Fig.7 ——— T_j = 25 °C; – – – – T_j = 100 °C.

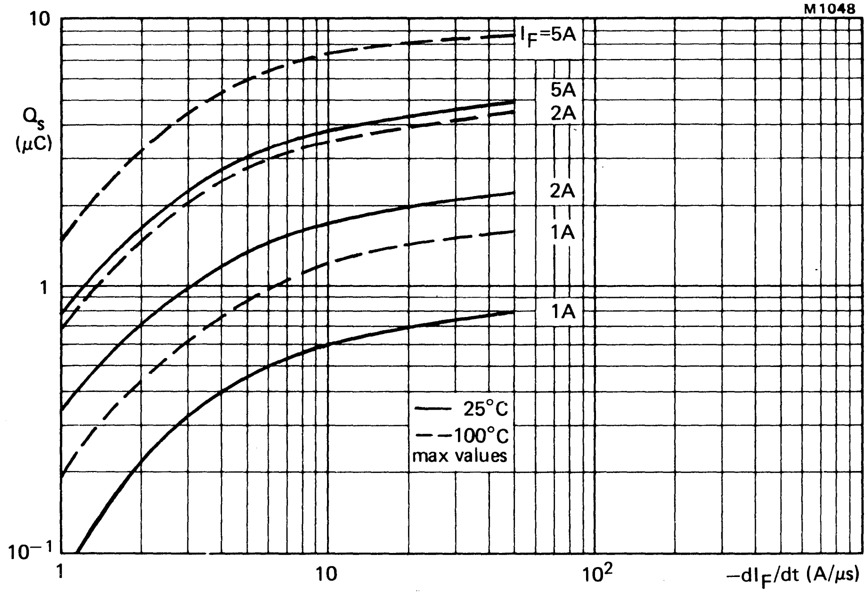

M1048
10
Q_s
(μC)
1
10^{-1}
1
10
10^2
$-dI_F/dt$ (A/μs)
I_F=5A
5A
2A
2A
1A
1A
— 25°C
– –100°C
max values

Fig.8

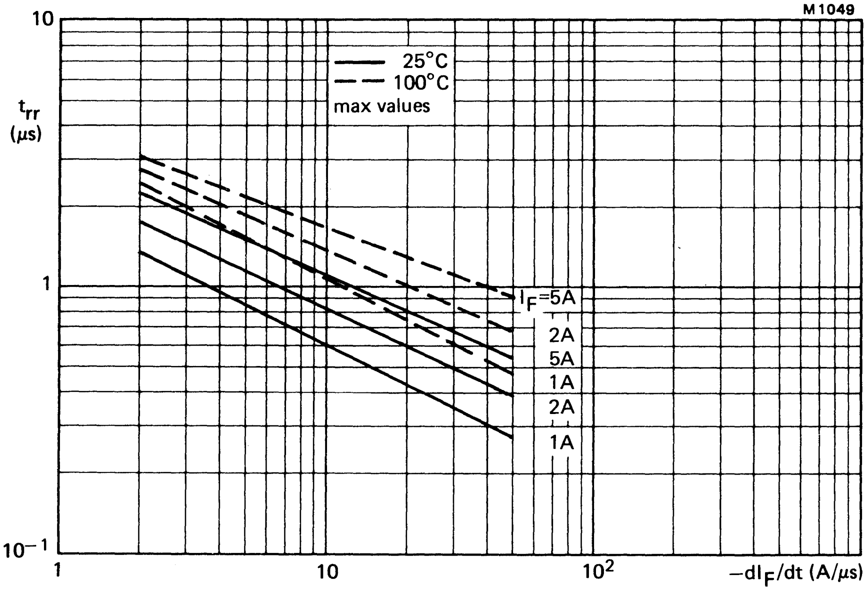

M1049
10
t_{rr}
(μs)
1
10^{-1}
1
10
10^2
$-dI_F/dt$ (A/μs)
— 25°C
– – 100°C
max values
I_F=5A
2A
5A
1A
2A
1A

Fig.9

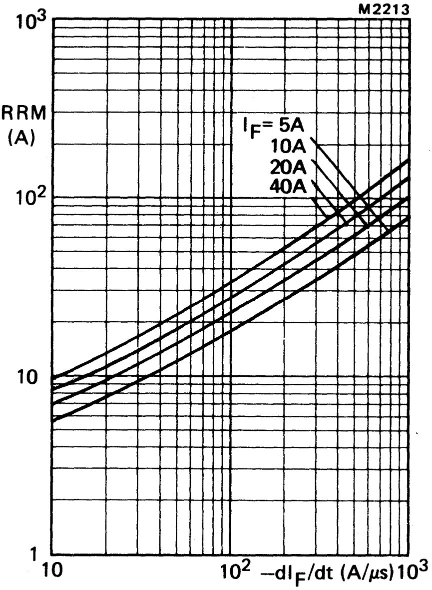


Fig.10

ULTRA FAST RECOVERY DOUBLE RECTIFIER DIODES

Glass-passivated, high-efficiency double rectifier diodes in plastic envelopes, featuring low forward voltage drop, ultra fast reverse-recovery times and soft-recovery characteristic. They are intended for use in switched-mode power supplies and high-frequency circuits in general, where both low conduction losses and low switching losses are essential. Their single chip (monolithic) construction ensures excellent matching of the forward and switching characteristics of the two halves, allowing parallel operation without the need for derating. The series consists of common-cathode types.

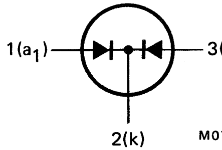
QUICK REFERENCE DATA

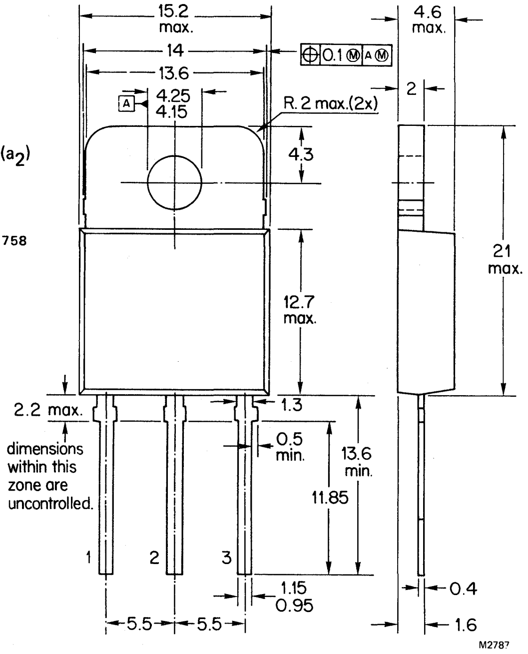
Per diode, unless otherwise stated			BYV72–50	100	150	200	
Repetitive peak reverse voltage	V_{RRM}	max.	50	100	150	200	V
Output current (both diodes conducting)	I_O	max.		30			A
Forward voltage	V_F	<		0.85			V
Reverse recovery time	t_{rr}	<		28			ns

MECHANICAL DATA

Dimensions in mm

Fig.1 SOT-93





Net mass: 5 g

Note: the exposed metal mounting base is directly connected to the common cathode.

Accessories supplied on request: see data sheets Mounting instructions and accessories for SOT-93 envelopes.

RATINGS

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

Voltages (per diode)			BYV72–50	100	150	200	
Repetitive peak reverse voltage	V_{RRM}	max.	50	100	150	200	V
Crest working reverse voltage	V_{RWM}	max.	50	100	150	200	V
Continuous reverse voltage	V_R	max.	50	100	150	200	V

→ **Currents** (both diodes conducting; note 1)

Output current; switching losses negligible up to 500 kHz; square wave; $\delta = 0.5$; up to $T_{mb} = 104\ ^{\circ}C$ (note 2)	I_O	max.	30	A
R.M.S. forward current (note 2)	$I_{F(RMS)}$	max.	43	A
Repetitive peak forward current $t_p = 20\ \mu s$; $\delta = 0.02$ (per diode)	I_{FRM}	max.	320	A
Non-repetitive peak forward current (per diode) half sine-wave; $T_j = 150\ ^{\circ}C$ prior to surge; with reapplied $V_{RWM\,max}$				
t = 10 ms	I_{FSM}	max.	150	A
t = 8.3 ms	I_{FSM}	max.	160	A
I^2t for fusing (t = 10 ms; per diode)	I^2t	max.	112	A^2s

Temperatures

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

Notes:

1. The limits for both diodes apply whether both diodes conduct simultaneously or on alternate half cycles.
2. For output currents in excess of 20 A, connection should be made to the exposed metal mounting base.

CHARACTERISTICS

T_j = 25 °C unless otherwise stated

Forward voltage					
I_F = 10 A; T_j = 100 °C	V_F	<	0.85	V*	
I_F = 30 A	V_F	<	1.15	V*	
Reverse current					
$V_R = V_{RWM\,max}$; T_j = 100 °C	I_R	<	1.0	mA	
$V_R = V_{RWM\,max}$	I_R	<	25	µA	
Reverse recovery when switched from					
I_R = 1 A to $V_R \geq 30$ V with $-dI_F/dt$ = 100 A/µs; recovery time	t_{rr}	<	28	ns	←
I_F = 2 A to $V_R \geq 30$ V with $-dI_F/dt$ = 20 A/µs; recovered charge	Q_s	<	15	nC	
I_F = 10 A to $V_R \geq 30$ V with $-dI_F/dt$ = 50 A/µs; T_j = 100 °C; peak recovery current	I_{RRM}	<	2.4	A	←
Forward recovery when switched to I_F = 1 A with dI_F/dt = 10 A/µs	V_{fr}	typ.	1.0	V	

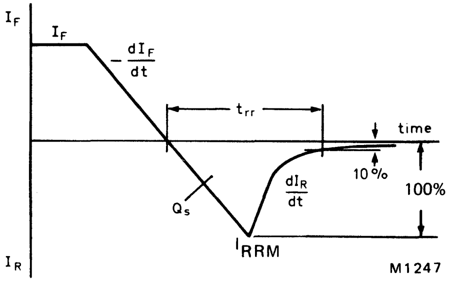


Fig.2 Definition of t_{rr}, Q_s and I_{RRM}.

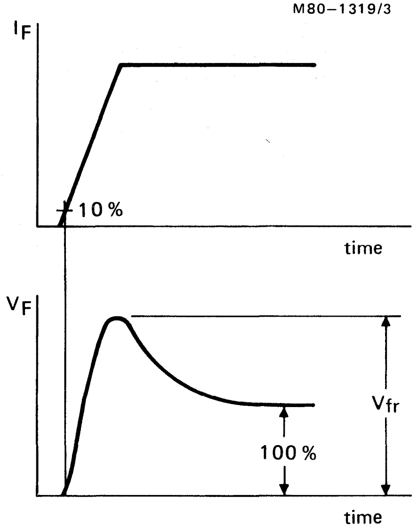


Fig.3 Definition of V_{fr}.

---

*Measured under pulse conditions to avoid excessive dissipation.

→ THERMAL RESISTANCE

From junction to mounting base (both diodes conducting)	$R_{th\ j\text{-}mb}$	=	1.4	K/W
From junction to mounting base (per diode)	$R_{th\ j\text{-}mb}$	=	2.4	K/W

Influence of mounting method

1. Heatsink-mounted with clip (see mounting instructions)

Thermal resistance from mounting base to heatsink

a. with heatsink compound	$R_{th\ mb\text{-}h}$	=	0.2	K/W
b. with heatsink compound and 0.06 mm maximum mica insulator (56378)	$R_{th\ mb\text{-}h}$	=	1.4	K/W
c. with heatsink compound and 0.1 mm maximum mica insulator	$R_{th\ mb\text{-}h}$	=	2.2	K/W
d. with heatsink compound and 0.25 mm maximum alumina insulator	$R_{th\ mb\text{-}h}$	=	0.8	K/W
e. without heatsink compound	$R_{th\ mb\text{-}h}$	=	1.4	K/W

2. Free air operation

The quoted value of $R_{th\ j\text{-}a}$ should be used only when no leads of other dissipating components run to the same tie point.

Thermal resistance from junction to ambient in free air: mounted on a printed circuit board at any device lead length and with copper laminate on the board $R_{th\ j\text{-}a}$ = 60 K/W

MOUNTING INSTRUCTIONS

1. The device may be soldered directly into the circuit, but the maximum permissible temperature of the soldering iron or bath is 275 °C; the heat source must not be in contact with the joint for more than 5 seconds. Soldered joints must be at least 4.7 mm from the seal.
2. The leads should not be bent less than 2.4 mm from the seal, and should be supported during bending. The bend radius must be no less than 1.0 mm.
3. Mounting by means of a spring clip is the best mounting method because it offers:
   a. a good thermal contact under the crystal area and slightly lower $R_{th\ mb\text{-}h}$ values than does screw mounting.
   b. safe isolation for mains operation.
   However, if a screw is used, it should be M4 cross-recess pan head. Care should be taken to avoid damage to the plastic body.
4. For good thermal contact heatsink compound should be used between mounting base and heatsink. Values of $R_{th\ mb\text{-}h}$ given for mounting with heatsink compound refer to the use of a metallic-oxide loaded compound. Ordinary silicone grease is not recommended.
5. Rivet mounting (only possible for non-insulated mounting).
   Devices may be rivetted to flat heatsinks; such a process must **neither** deform the mounting tab, **nor** enlarge the mounting hole.

OPERATING NOTES

Dissipation and heatsink calculations

The various components of junction temperature rise above ambient are illustrated in Fig.4

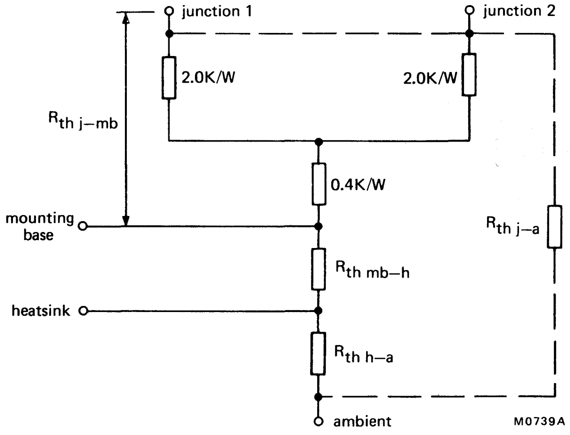


Fig.4

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

SQUARE-WAVE OPERATION (BOTH DIODES)

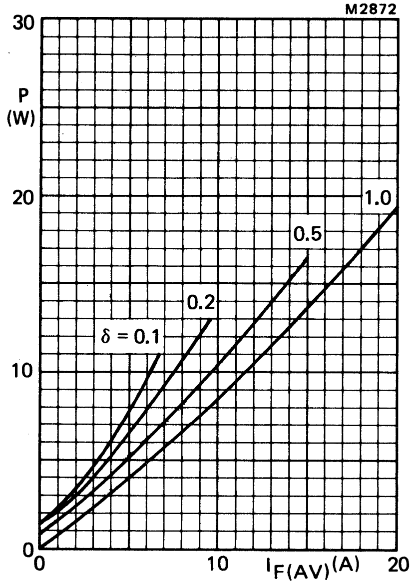
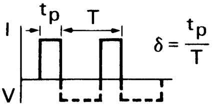


Fig.5 Power rating per diode.
The individual power loss in each diode should first be determined then both added together. The resulting total power loss is then used in conjunction with Fig.6 to determine the heatsink size and corresponding maximum ambient and mounting base temperatures.



$I_{F(AV)} = I_{F(RMS)} \times \sqrt{\delta}$

Power includes reverse current losses and switching losses up to f = 500 kHz

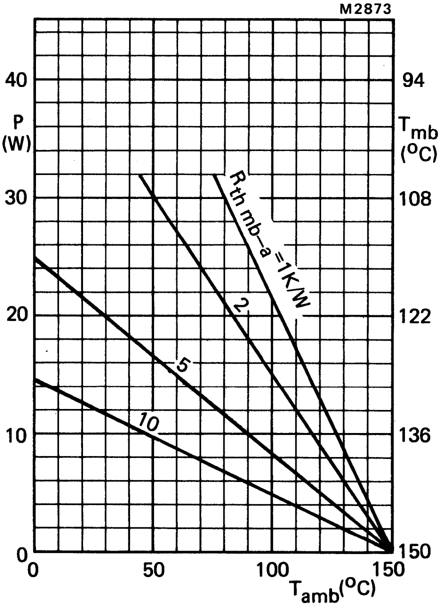


Fig.6

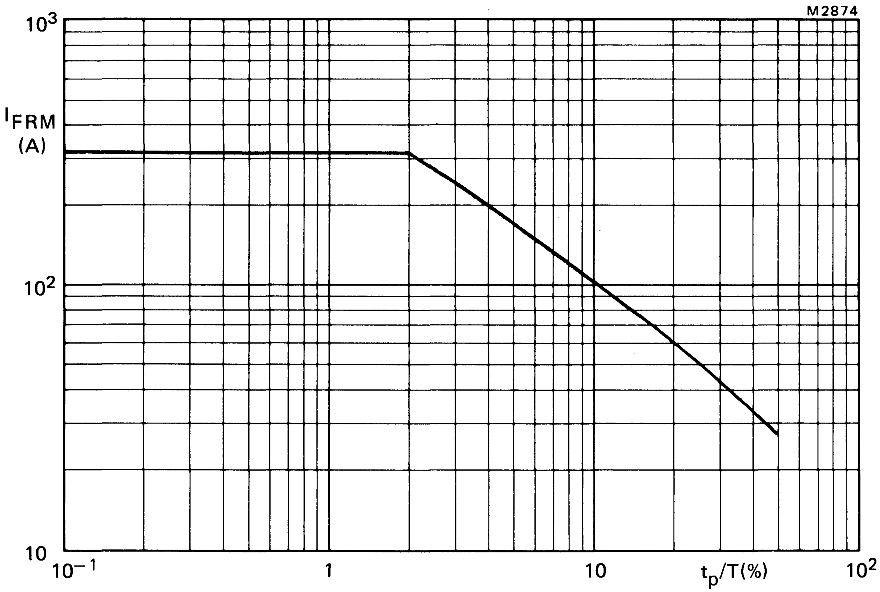
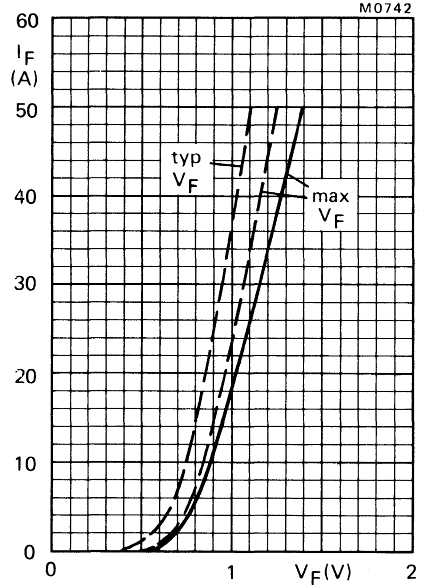
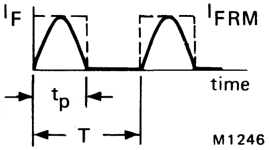


Fig.7 Maximum permissible repetitive peak forward current for either square or sinusoidal currents for 1 $\mu s < t_p <$ 1 ms; per diode.





Defintion of I_{FRM} and t_p/T.

Fig.8 —— T_j = 25 °C; – – – T_j = 100 °C. per diode.

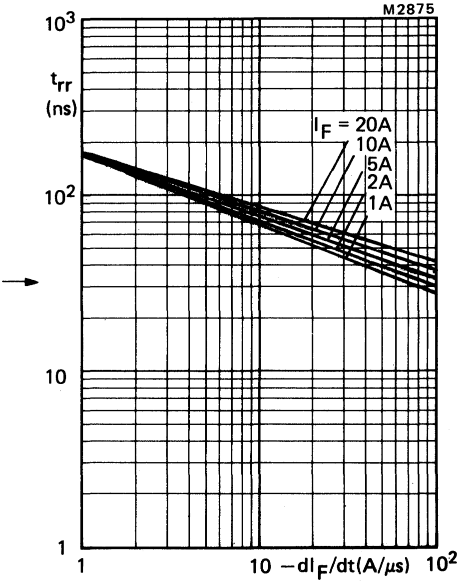


Fig.9 Maximum t_{rr} at T_j = 25 °C; per diode.

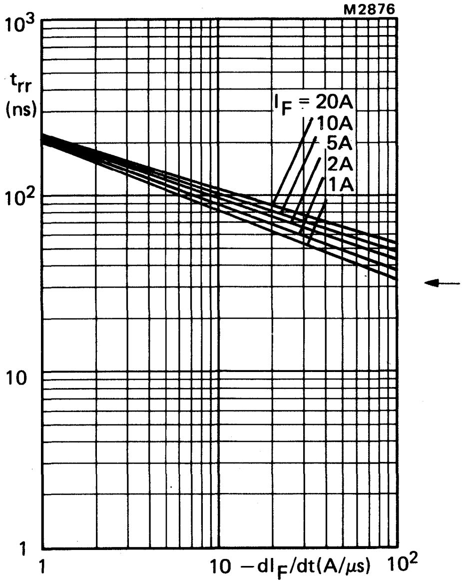


Fig.10 Maximum t_{rr} at T_j = 100 °C; per diode.

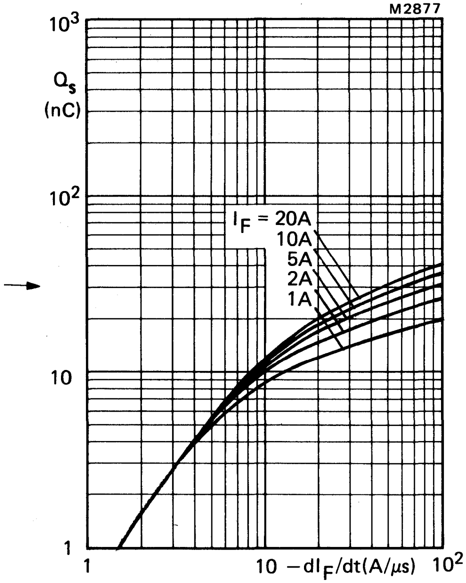


Fig.11 Maximum Q_s at T_j = 25 °C; per diode.

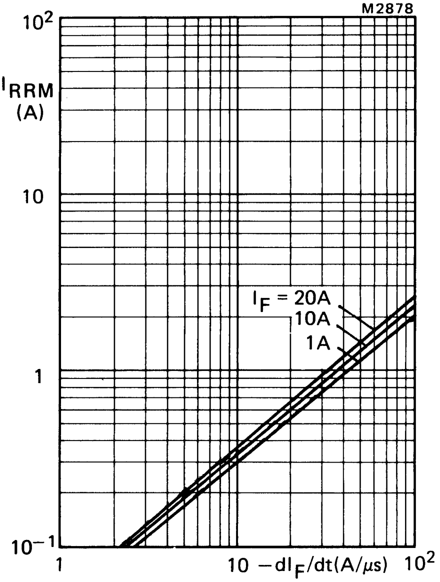


Fig.12 Maximum I_{RRM} at T_j = 25 °C; per diode.

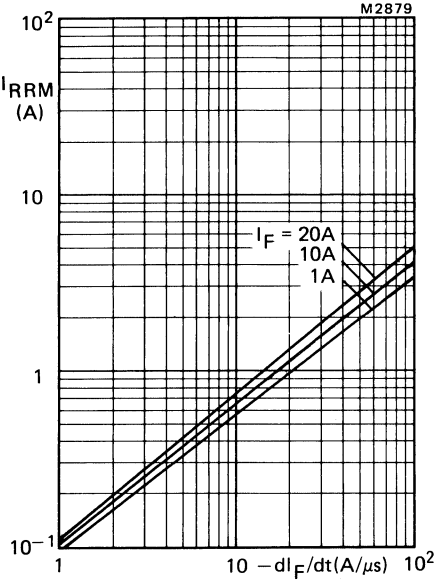


Fig.13 Maximum I_{RRM} at T_j = 100 °C; per diode.

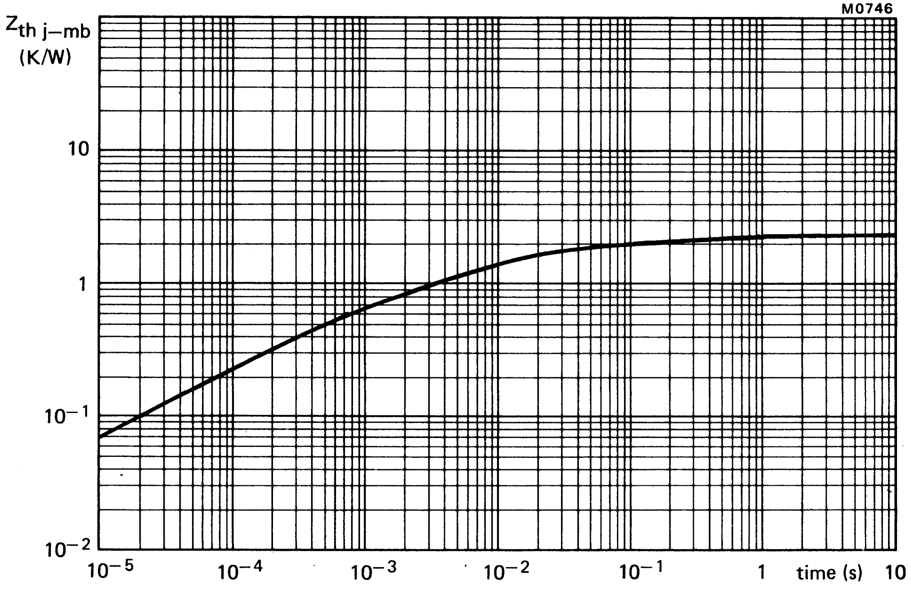


Fig.14 Transient thermal impedance; one diode conducting.

ULTRA FAST RECOVERY DOUBLE RECTIFIER DIODES

Glass-passivated, high-efficiency epitaxial double rectifier diodes in plastic envelopes which feature low forward voltage drop, very fast reverse recovery times and soft-recovery characteristic. They are intended for use in switched-mode power supplies and high-frequency circuits in general, where low conduction losses and switching losses are essential. Their single chip construction ensures excellent matching of the forward and switching characteristics of the two halves, allowing parallel operation without derating. The series consists of common-cathode types.

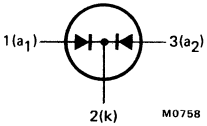
QUICK REFERENCE DATA

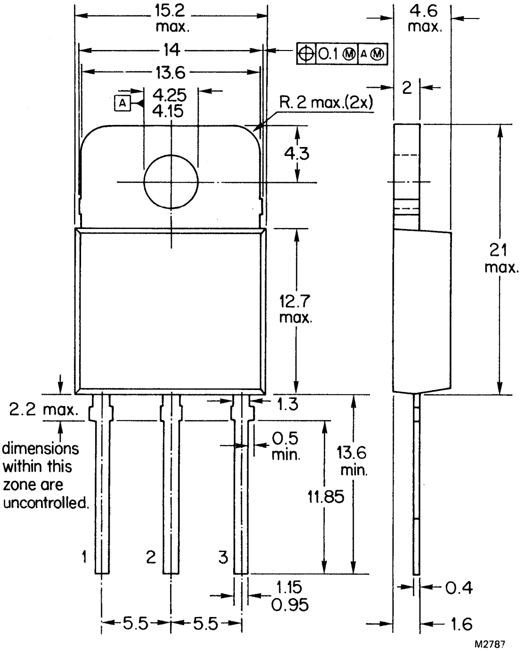
Per diode, unless otherwise stated			BYV74–300	400	500	V
Repetitive peak reverse voltage	V_{RRM}	max.	300	400	500	V
Output current (both diodes conducting)	I_O	max.		30		A
Forward voltage	V_F	<		1.05		V
Reverse recovery time	t_{rr}	<		50		ns

MECHANICAL DATA

Dimensions in mm

Fig.1 SOT-93





Net mass: 5 g

Note: the exposed metal mounting base is directly connected to the common-cathode.

Accessories supplied on request: see data sheets Mounting instructions and accessories for SOT-93 envelopes.

RATINGS

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

			BYV74–300	400	500	
Voltages (per diode)						
Repetitive peak reverse voltage	V_{RRM}	max.	300	400	500	V
Crest working reverse voltage	V_{RWM}	max.	200	300	400	V
Continuous reverse voltage (note 1)	V_R	max.	200	300	400	V
Currents (both diodes conducting; note 2)						
Output current (note 3)						
square wave; $\delta = 0.5$; up to $T_{mb} = 92\ ^{\circ}C$	I_O	max.	30			A
sinusoidal; up to $T_{mb} = 103\ ^{\circ}C$	I_O	max.	26			A
R.M.S. forward current	$I_{F(RMS)}$	max.	30			A
Repetitive peak forward current $t_p = 20\ \mu s$; $\delta = 0.02$ (note 4)	I_{FRM}	max.	320			A
Non-repetitive peak forward current half sine-wave; $T_j = 150\ ^{\circ}C$ prior to surge; with reapplied $V_{RWM\ max}$ (note 4)						
t = 10 ms	I_{FSM}	max.	130			A
t = 8.3 ms	I_{FSM}	max.	140			A
I^2t for fusing (t = 10 ms; note 4)	I^2t	max.	84			A^2s
Temperatures						
Storage temperature	T_{stg}		−40 to +150			°C
Junction temperature	T_j	max.	150			°C

Notes:

1. To ensure thermal stability: $R_{th\ j\text{-}a} < 9.3$ K/W.
2. The limits for both diodes apply whether both diodes conduct simultaneously or on alternate half cycles.
3. For output currents in excess of 20 A, connection should be made to the exposed metal mounting base.
4. Figures apply to each diode.

CHARACTERISTICS (per diode)

T_j = 25 °C unless otherwise stated

Forward voltage				
I_F = 15 A; T_j = 150 °C	V_F	<	1.05	V*
I_F = 50 A	V_F	<	1.6	V*
Reverse current				
$V_R = V_{RWM\,max}$; T_j = 100 °C	I_R	<	0.8	mA
$V_R = V_{RWM\,max}$	I_R	<	50	μA
Reverse recovery when switched from				
I_F = 1 A to $V_R \geqslant 30$ V with $-dI_F/dt$ = 100 A/μs; recovery time	t_{rr}	<	50	ns
I_F = 2 A to $V_R \geqslant 30$ V with $-dI_F/dt$ = 20 A/μs; recovered charge	Q_s	<	50	nC
I_F = 10 A to $V_R \geqslant 30$ V with $-dI_F/dt$ = 50 A/μs; T_j = 100 °C; peak recovery current	I_{RRM}	<	5.2	A
Forward recovery when switched to I_F = 10 A with dI_F/dt = 10 A/μs recovery voltage	V_{fr}	typ.	2.5	V

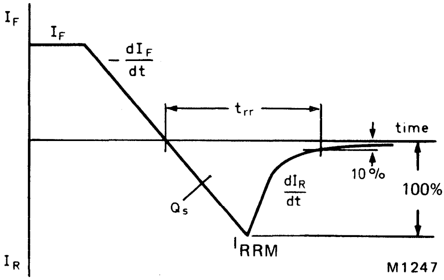


Fig.2 Definition of t_{rr}, Q_s and I_{RRM}.

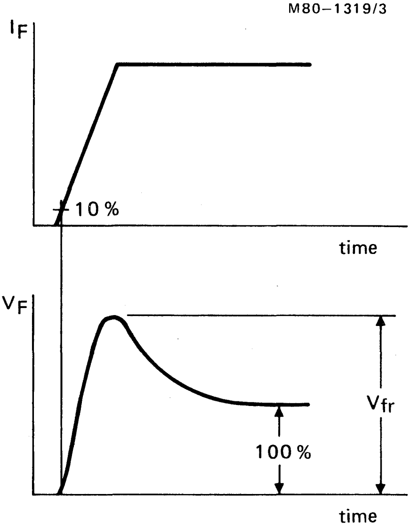


Fig.3 Definition of V_{fr}.

---

*Measured under pulse conditions to avoid excessive dissipation.

THERMAL RESISTANCE

From junction to mounting base; total package	$R_{th\ j\text{-}mb}$	=	1.4	K/W
per diode	$R_{th\ j\text{-}mb}$	=	2.0	K/W

Influence of mounting method

1. Heatsink-mounted with clip (see mounting instructions)

Thermal resistance from mounting base to heatsink

a. with heatsink compound	$R_{th\ mb\text{-}h}$	=	0.2	K/W
b. with heatsink compound and 0.06 mm maximum mica insulator (56378)	$R_{th\ mb\text{-}h}$	=	1.4	K/W
c. without heatsink compound	$R_{th\ mb\text{-}h}$	=	1.4	K/W

2. Free air operation

The quoted value of $R_{th\ j\text{-}a}$ should be used only when no leads of other dissipating components run to the same tie point.

Thermal resistance from junction to ambient in free air: mounted on a printed circuit board at any device lead length and with copper laminate on the board	$R_{th\ j\text{-}a}$	=	60	K/W

MOUNTING INSTRUCTIONS

1. The device may be soldered directly into the circuit, but the maximum permissible temperature of the soldering iron or bath is 275°C; the heat source must not be in contact with the joint for more than 5 seconds. Soldered joints must be at least 4.7 mm from the seal.
2. The leads should not be bent less than 2.4 mm from the seal, and should be supported during bending. The bend radius must be no less than 1.0 mm.
3. Mounting by means of a spring clip is the best mounting method because it offers:
   a. a good thermal contact under the crystal area and slightly lower $R_{th\ mb\text{-}h}$ values than does screw mounting.
   b. safe isolation for mains operation.
   However, if a screw is used, it should be M4 cross-recess pan head. Care should be taken to avoid damage to the plastic body.
4. For good thermal contact, heatsink compound should be used between mounting base and heatsink. Values of $R_{th\ mb\text{-}h}$ given for mounting with heatsink compound refer to the use of a metallic oxide-loaded compound. Ordinary silicone grease is not recommended.
5. Rivet mounting (only possible for non-insulated mounting).
   Devices may be rivetted to flat heatsinks; such a process must **neither** deform the mounting tab, **nor** enlarge the mounting hole.

OPERATING NOTES

Dissipation and heatsink calculations

a. The various components of junction temperature rise above ambient are illustrated in Fig.4.

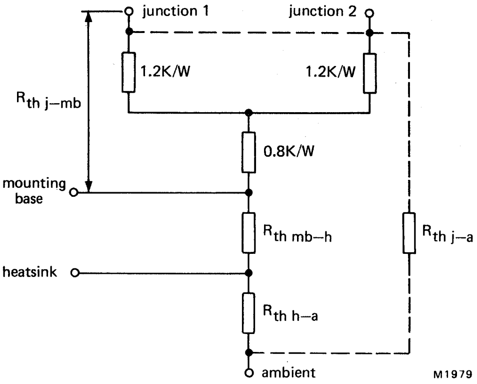


Fig. 4.

b. Any measurement of heatsink temperature should be made immediately adjacent to the device.
c. The method of using Figs. 5 and 6 is as follows:
Starting with the required current on the $I_{F(AV)}$ axis, trace upwards to meet the appropriate duty cycle or form factor curve. Trace right horizontally and upwards from the required value on the T_{amb} scale. The intersection determines the $R_{th\ mb\text{-}a}$. The heatsink thermal resistance value ($R_{th\ h\text{-}a}$) can be calculated from:

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

SQUARE-WAVE OPERATION

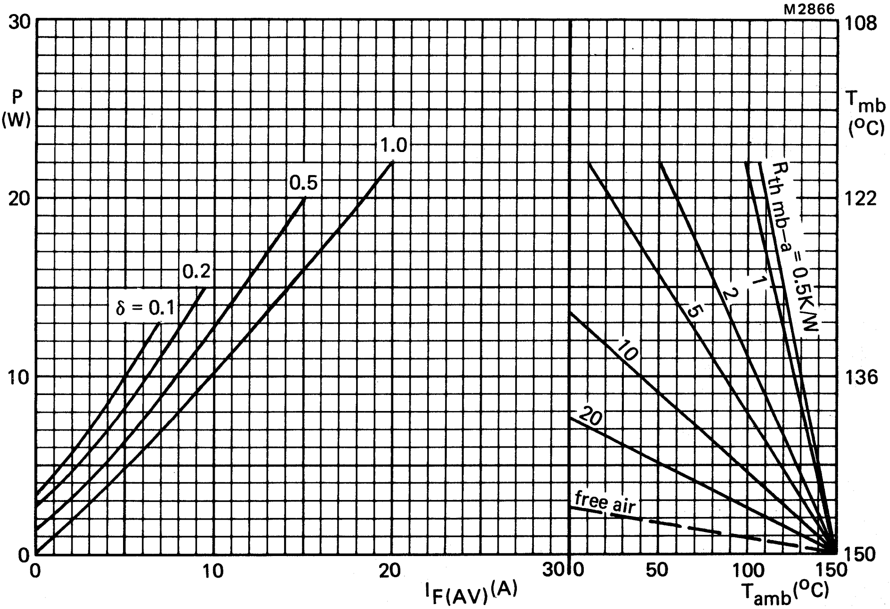
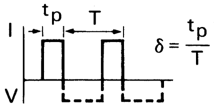


Fig.5 The right-hand part shows the relationship between the power (derived from the left-hand part) and the maximum permissible temperatures (per diode).



$\delta = \frac{t_p}{T}$

$I_{F(AV)} = I_{F(RMS)} \times \sqrt{\delta}$

SINUSOIDAL OPERATION

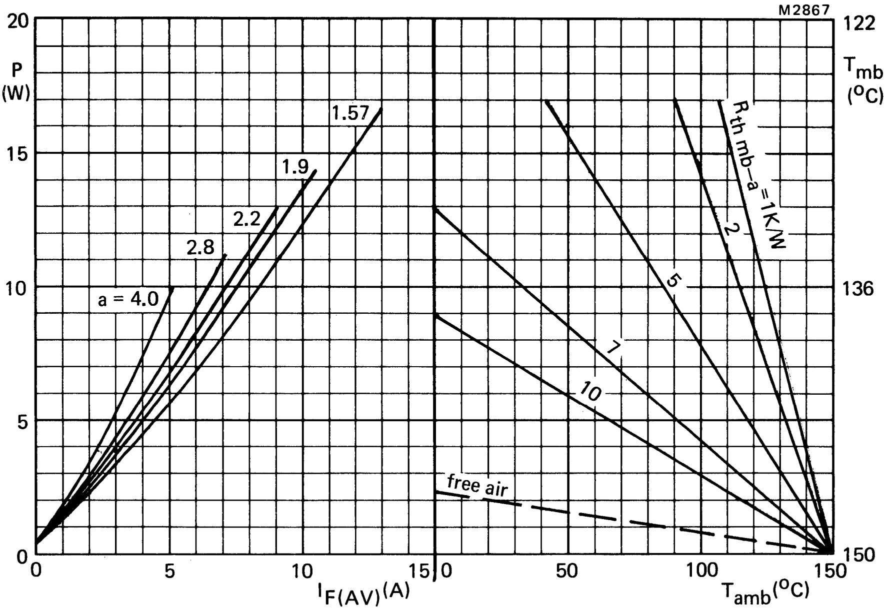


Fig.6 The right-hand part shows the interrelationship between the power (derived from the left-hand part) and the maximum permissible temperatures (per diode).

a = form factor = $I_{F(RMS)}/I_{F(AV)}$.

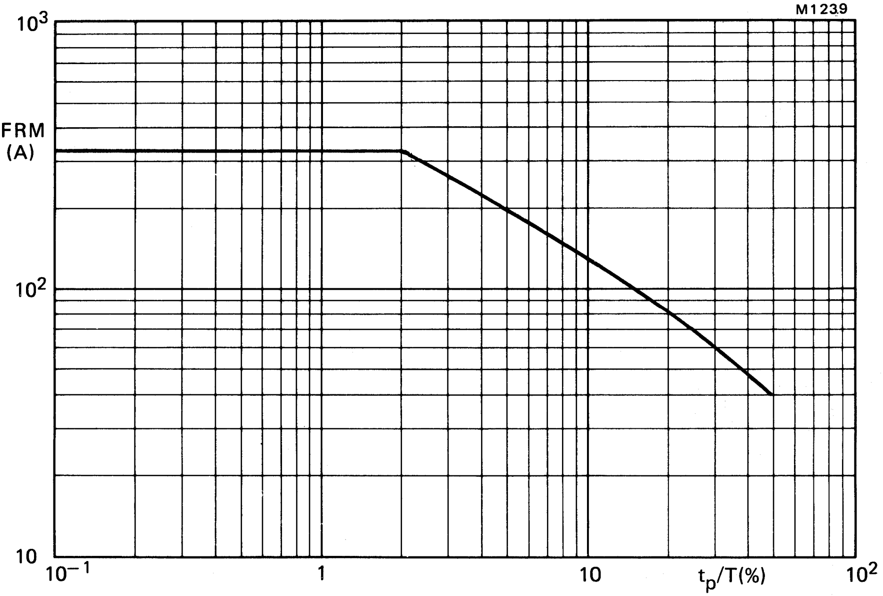
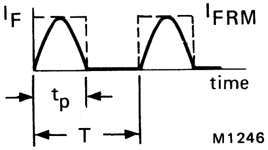


Fig.7 Maximum permissible repetitive peak forward current for square or sinusoidal currents; 1 μs $< t_p <$ 1 ms (per diode).



Defintion of I_{FRM} and t_p/T.

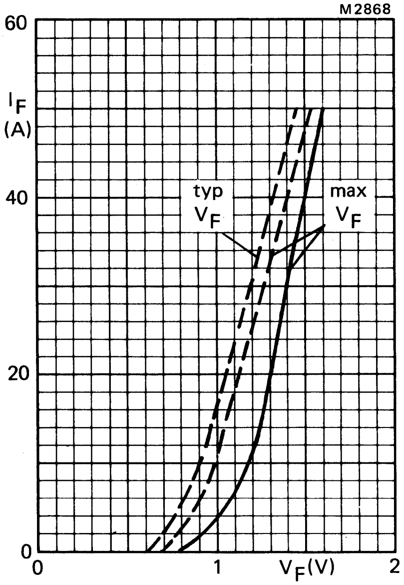


Fig.8 —— T_j = 25 °C; – – – T_j = 150 °C (per diode).

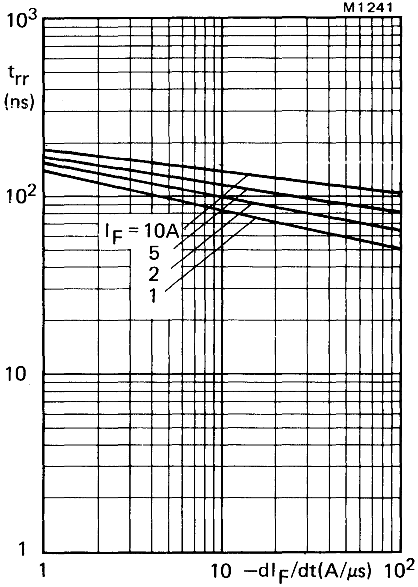


Fig.9 Maximum t_{rr} at $T_j = 25$ °C.
(per diode).

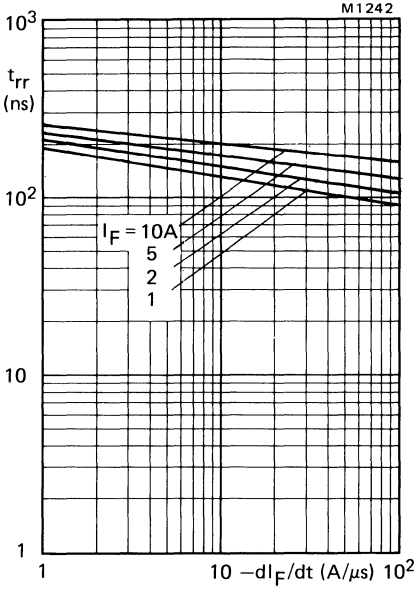


Fig.10 Maximum t_{rr} at $T_j = 100$ °C.
(per diode).

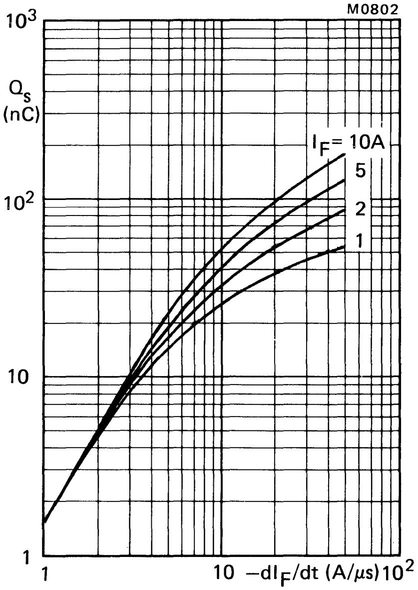


Fig.11 Maximum Q_s at $T_j = 25$ °C.
(per diode).

ULTRA FAST RECOVERY RECTIFIER DIODES

Glass-passivated, high-efficiency epitaxial rectifier diodes in plastic envelopes, featuring low forward voltage drop, ultra fast reverse recovery times with very low stored charge and soft-recovery characteristic. They are intended for use in switched-mode power supplies and high-frequency circuits in general, where both low conduction losses and low switching losses are essential.
The series consists of normal polarity (cathode to mounting base) types.

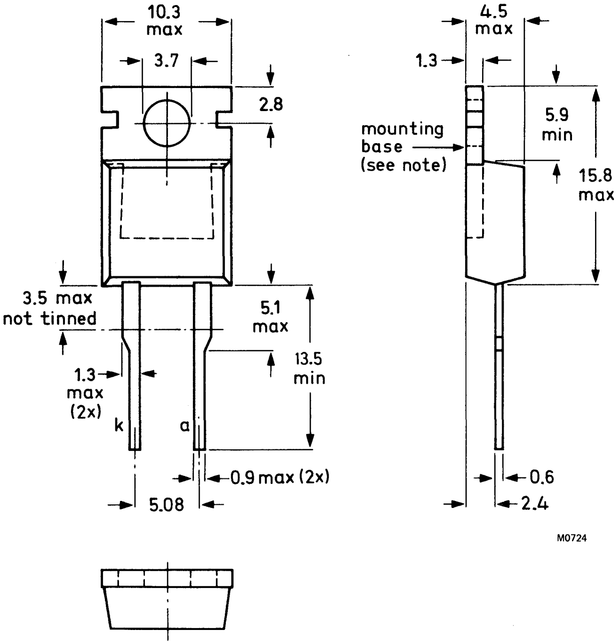
QUICK REFERENCE DATA

			BYV79–50	100	150	200	
Repetitive peak reverse voltage	V_{RRM}	max.	50	100	150	200	V
Average forward current	$I_{F(AV)}$	max.	14				A
Forward voltage	V_F	<	0.85				V
Reverse recovery time	t_{rr}	<	30				ns

MECHANICAL DATA

Dimensions in mm

Fig.1 TO-220AC



Net mass: 2 g

Note: The exposed metal mounting base is directly connected to the cathode.

Accessories supplied on request: see data sheets Mounting instructions and accessories for TO-220 envelopes.

RATINGS

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

			BYV79–50	100	150	200	
Voltages							
Repetitive peak reverse voltage	V_{RRM}	max.	50	100	150	200	V
Crest working reverse voltage	V_{RWM}	max.	50	100	150	200	V
Continuous reverse voltage (note 1)	V_R	max.	50	100	150	200	V
Currents							
Average forward current; switching losses negligible up to 500 kHz;							
square wave; $\delta = 0.5$; up to $T_{mb} = 115\ ^oC$	$I_{F(AV)}$	max.	14				A
sinusoidal; up to $T_{mb} = 122\ ^oC$	$I_{F(AV)}$	max.	12				A
R.M.S. forward current	$I_{F(RMS)}$	max.	20				A
→ Repetitive peak forward current $t_p = 20\ \mu s$; $\delta = 0.02$	I_{FRM}	max.	420				A
→ Non-repetitive peak forward current half sine-wave; $T_j = 150\ ^oC$ prior to surge; with reapplied $V_{RWM\ max}$							
t = 10 ms	I_{FSM}	max.	180				A
t = 8.3 ms	I_{FSM}	max.	200				A
→ I^2t for fusing (t = 10 ms)	I^2t	max.	160				A^2s
Temperatures							
Storage temperature	T_{stg}		−40 to +150				^oC
Junction temperature	T_j	max.	150				^oC

Notes:

1. To ensure thermal stability: $R_{th\ j\text{-}a} \leq 8$ K/W.

CHARACTERISTICS

T_j = 25 °C unless otherwise stated

Forward voltage					
I_F = 10 A; T_j = 100 °C	V_F	<	0.85	V*	
I_F = 50 A	V_F	<	1.3	V*	
Reverse current					
$V_R = V_{RWM\,max}$; T_j = 100 °C	I_R	<	1.3	mA	
$V_R = V_{RWM\,max}$	I_R	<	50	µA	←
Reverse recovery when switched from					
I_F = 1 A to $V_R \geqslant$ 30 V with $-dI_F/dt$ = 100 A/µs; recovery time	t_{rr}	<	30	ns	←
I_F = 2 A to $V_R \geqslant$ 30 V with $-dI_F/dt$ = 20 A/µs; recovered charge	Q_s	<	15	nC	
I_F = 10 A to $V_R \geqslant$ 30 V with $-dI_F/dt$ = 50 A/µs; T_j = 100 °C; peak recovery current	I_{RRM}	<	4	A	←
Forward recovery when switched to I_F = 10 A with dI_F/dt = 10 A/µs	V_{fr}	typ.	1.0	V	

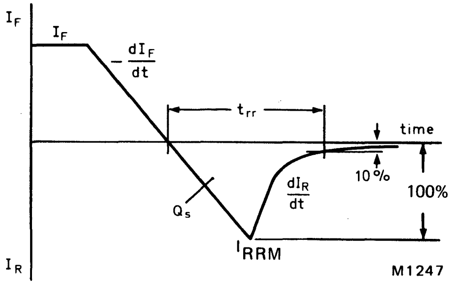


Fig.2 Definition of t_{rr}, Q_s and I_{RRM}.

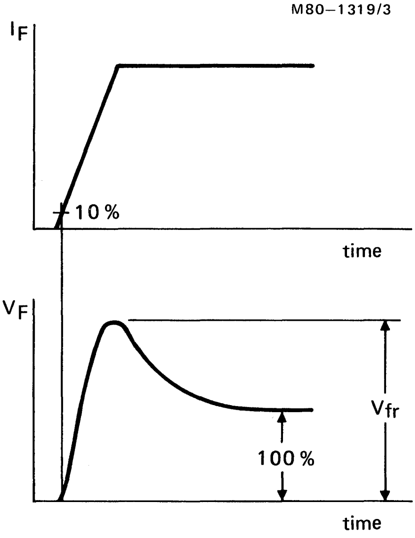


Fig.3 Definition of V_{fr}.

*Measured under pulse conditions to avoid excessive dissipation.

THERMAL RESISTANCE

From junction to mounting base $R_{th\,j\text{-}mb}$ = 2 K/W

Influence of mounting method

1. Heatsink-mounted with clip (see mounting instructions)

Thermal resistance from mounting base to heatsink

a. with heatsink compound $R_{th\,mb\text{-}h}$ = 0.3 K/W

b. with heatsink compound and 0.06 mm maximum mica insulator $R_{th\,mb\text{-}h}$ = 1.4 K/W

c. with heatsink compound and 0.1 mm maximum mica insulator (56369) $R_{th\,mb\text{-}h}$ = 2.2 K/W

d. with heatsink compound and 0.25 mm maximum alumina insulator (56367) $R_{th\,mb\text{-}h}$ = 0.8 K/W

e. without heatsink compound $R_{th\,mb\text{-}h}$ = 1.4 K/W

2. Free air operation

The quoted value of $R_{th\,j\text{-}a}$ should be used only when no leads of other dissipating components run to the same tie point.
Thermal resistance from junction to ambient in free air:
mounted on a printed circuit board at any device lead length and with copper laminate on the board $R_{th\,j\text{-}a}$ = 60 K/W

MOUNTING INSTRUCTIONS

1. The device may be soldered directly into the circuit, but the maximum permissible temperature of the soldering iron or bath is 275°C; the heat source must not be in contact with the joint for more than 5 seconds. Soldered joints must be at least 4.7 mm from the seal.
2. The leads should not be bent less than 2.4mm from the seal, and should be supported during bending. The bend radius must be no less than 1.0mm. ←
3. Mounting by means of a spring clip is the best mounting method because it offers:
   a. a good thermal contact under the crystal area and slightly lower $R_{th\ mb\text{-}h}$ values than does screw mounting.
   b. safe isolation for mains operation.
   However, if a screw is used, it should be M3 cross-recess pan head. Care should be taken to avoid damage to the plastic body.
4. For good thermal contact, heatsink compound should be used between mounting base and heatsink. Values of $R_{th\ mb\text{-}h}$ given for mounting with heatsink compound refer to the use of a metallic oxide-loaded compound. Ordinary silicone grease is not recommended.
5. Rivet mounting (only possible for non-insulated mounting).
   Devices may be rivetted to flat heatsinks; such a process must **neither** deform the mounting tab, **nor** enlarge the mounting hole.

OPERATING NOTES

Dissipation and heatsink calculations

a. The various components of junction temperature rise above ambient are illustrated in Fig.4.

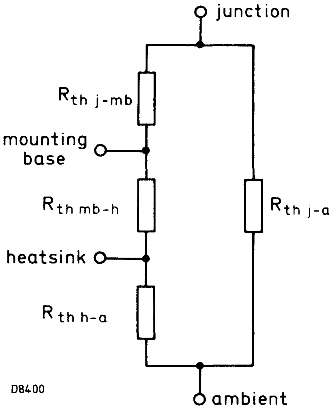


Fig. 4.

b. Any measurement of heatsink temperature should be made immediately adjacent to the device.
c. The method of using Figs. 5 and 6 is as follows:
Starting with the required current on the $I_{F(AV)}$ axis, trace upwards to meet the appropriate duty cycle or form factor curve. Trace right horizontally and upwards from the required value on the T_{amb} scale. The intersection determines the $R_{th\ mb\text{-}a}$. The heatsink thermal resistance value ($R_{th\ h\text{-}a}$) can be calculated from:

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

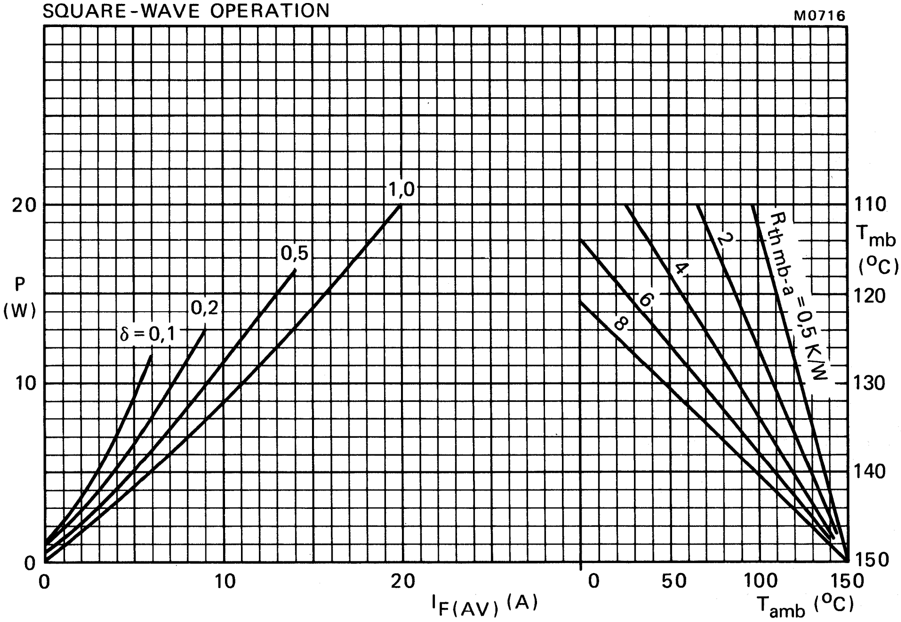
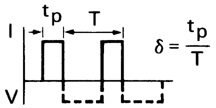


Fig.5 The right-hand part shows the interrelationship between the power (derived from the left-hand part) and the maximum permissible temperatures.
P = power including reverse current losses and switching losses up to f = 500 kHz.



$I_{F(AV)} = I_{F(RMS)} \times \sqrt{\delta}$

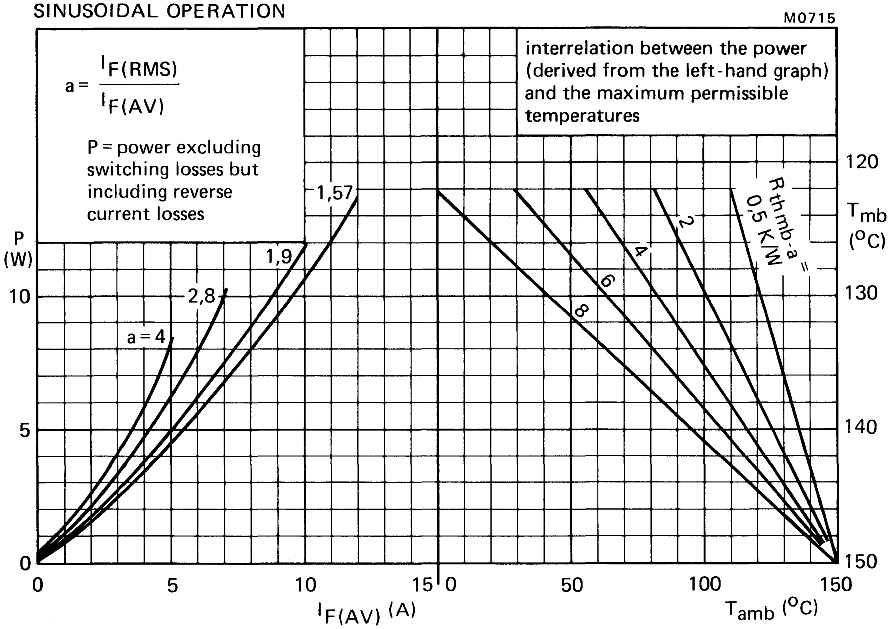

SINUSOIDAL OPERATION
M0715
$a = \frac{I_{F(RMS)}}{I_{F(AV)}}$
P = power excluding switching losses but including reverse current losses
interrelation between the power (derived from the left-hand graph) and the maximum permissible temperatures
P (W)
10
5
0
0
5
10
15
$I_{F(AV)}$ (A)
a = 4
2,8
1,9
1,57
0
50
100
150
T_{amb} (^{o}C)
$R_{th\,mb\text{-}a}$ = 0,5 K/W
2
4
6
8
120
130
140
150
T_{mb} (^{o}C)

Fig.6

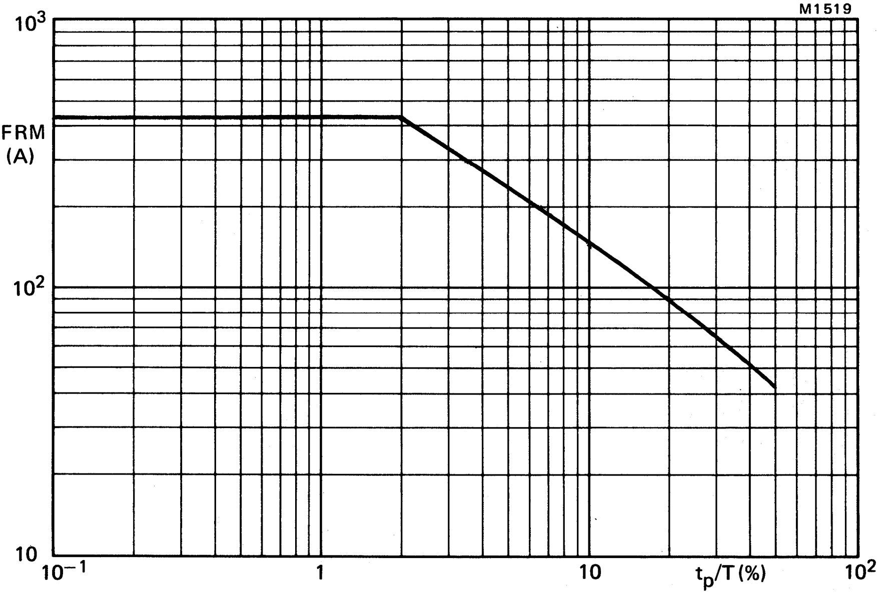
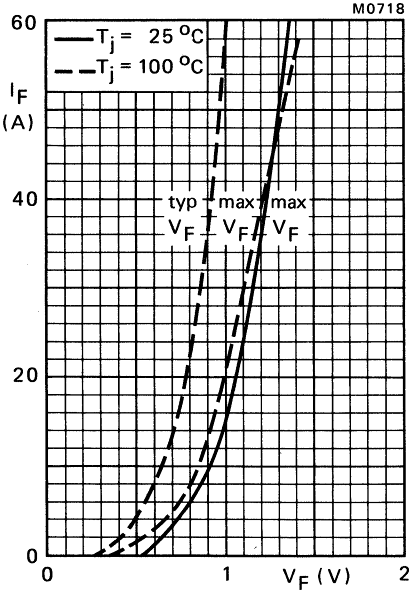
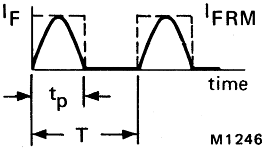


Fig.7 Maximum permissible repetitive peak forward current for square or sinusoidal currents; 1 μs $< t_p <$ 1 ms.





Definition of I_{FRM} and t_p/T.

Fig.8.

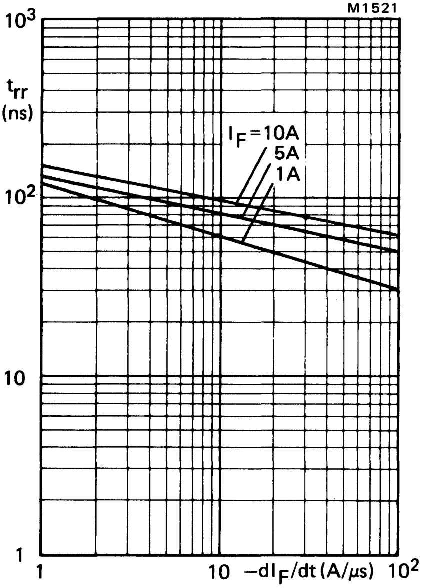


Fig.9 Maximum t_{rr} at T_j = 25 °C.

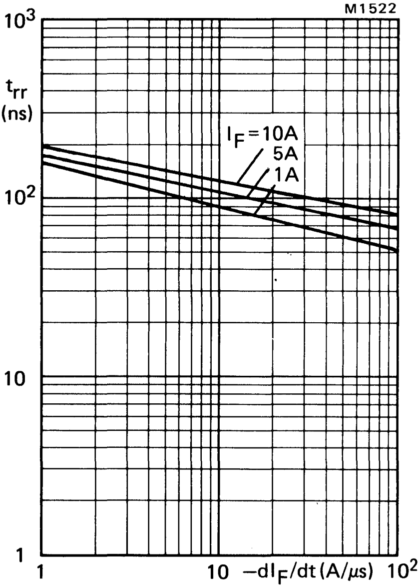


Fig.10 Maximum t_{rr} at T_j = 100 °C.

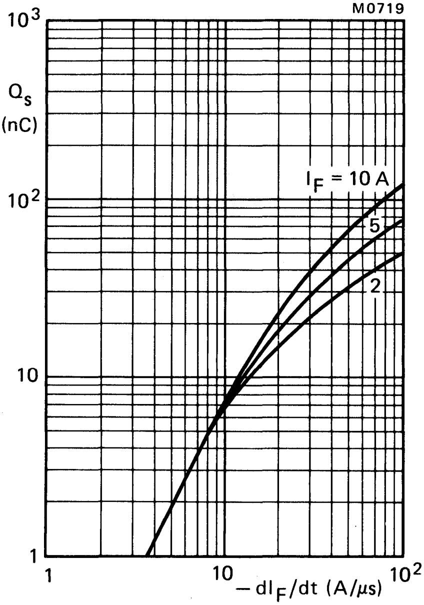


Fig.11 Maximum Q_s at T_j = 25 °C.

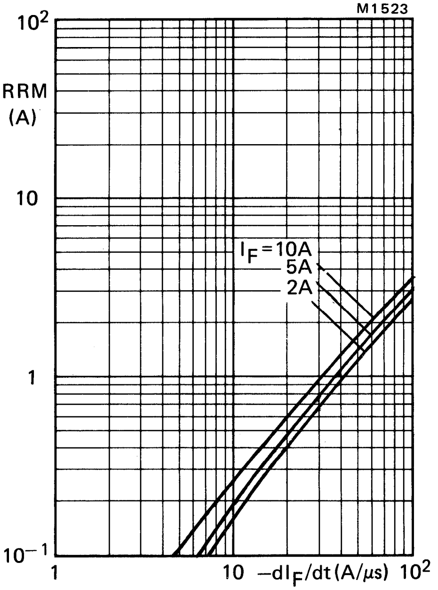


Fig.12 Maximum I_{RRM} at T_j = 25 °C.

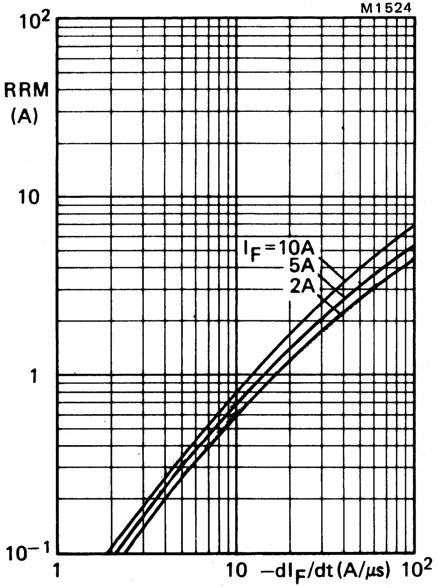


Fig.13 Maximum I_{RRM} at T_j = 100 °C.

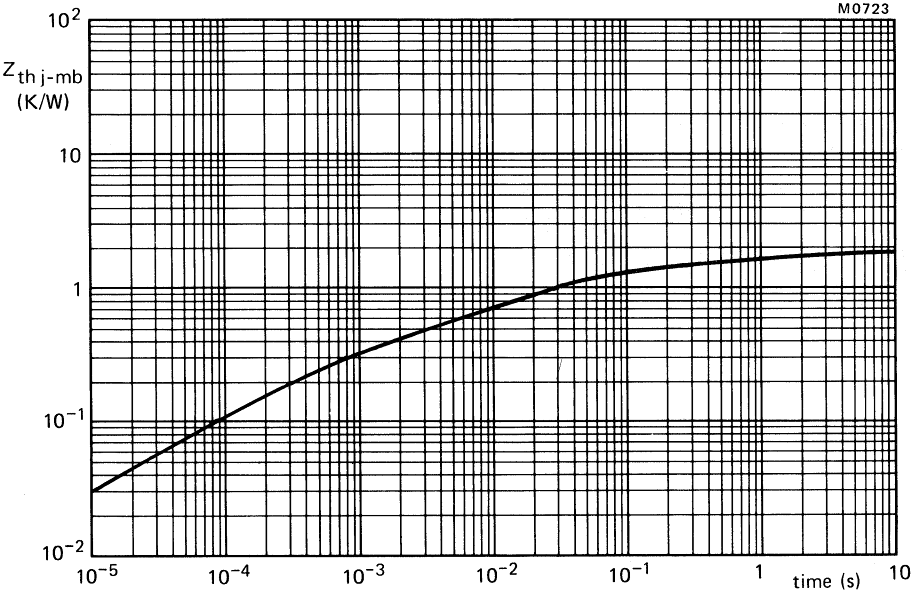


Fig.14 Transient thermal impedance.

ULTRA FAST RECOVERY RECTIFIER DIODES

Glass-passivated, high-efficiency epitaxial rectifier diodes in DO-5 metal envelopes, featuring low forward voltage drop,ultra fast reverse recovery times, very low stored charge and soft recovery characteristic. They are intended for use in switched-mode power supplies and high-frequency circuits in general, where both low conduction and low switching losses are essential.
The series consists of normal polarity (cathode to stud) types.

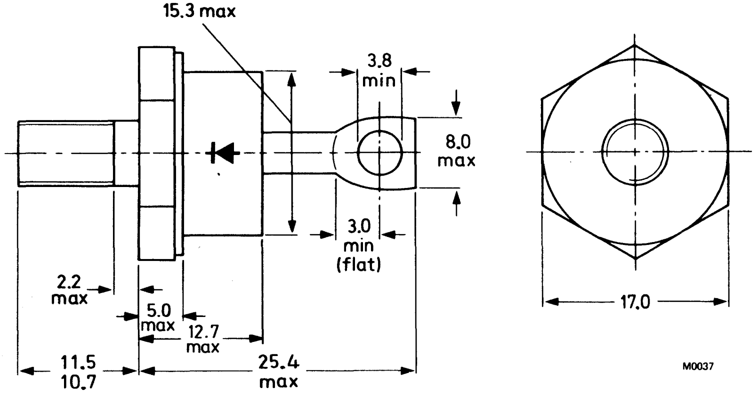
QUICK REFERENCE DATA

			BYV92-300	400	500	
Repetitive peak reverse voltage	V_{RRM}	max.	300	400	500	V
Average forward current	$I_{F(AV)}$	max.		35		A
Forward voltage	V_F	$<$		1.05		V
Reverse recovery time	t_{rr}	$<$		50		ns

MECHANICAL DATA

Dimensions in mm

Fig.1 DO-5: with metric M6 stud (ϕ 6 mm); e.g. BYV92-500M;
with ¼ in x 28UNF stud (ϕ 6.35 mm), e.g. BYV92-500U.



Net mass: 22 g
Diameter of clearance hole:
max. 6.5 mm
Accessories supplied on request:
56264a (mica washer),
56264b (insulating bush).

Supplied with device:
1 nut, 1 lock washer.
Torque on nut:
min. 1.7 Nm (17 kg cm);
max. 3.5 Nm (35 kg cm).
Nut dimensions across flats:
M6: 10 mm; ¼ in x 28UNF: 11.1 mm.

RATINGS

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

→ **Voltages**			BYV92-300	400	500	
Repetitive peak reverse voltage	V_{RRM}	max.	300	400	500	V
Crest working reverse voltage	V_{RWM}	max.	200	300	400	V
Continuous reverse voltage*	V_R	max.	200	300	400	V

→ **Currents**				
Average forward current; switching losses negligible up to 100 kHz				
square wave, $\delta = 0.5$, up to $T_{mb} = 100$ °C	$I_{F(AV)}$	max.	38	A
up to $T_{mb} = 125$ °C	$I_{F(AV)}$	max.	21	A
sinusoidal, up to $T_{mb} = 106$ °C	$I_{F(AV)}$	max.	34	A
up to $T_{mb} = 125$ °C	$I_{F(AV)}$	max.	21	A
R.M.S. forward current	$I_{F(RMS)}$	max.	55	A
Repetitive peak forward current $t_p = 20\ \mu s$, $\delta = 0.02$	I_{FRM}	max.	800	A
Non-repetitive peak forward current half sine-wave, $T_j = 150$ °C prior to surge				
t = 10 ms	I_{FSM}	max.	500	A
t = 8.3 ms	I_{FSM}	max.	600	A
with reapplied V_{RWM} max				
t = 10 ms	I_{FSM}	max.	350	A
t = 8.3 ms	I_{FSM}	max.	440	A
I^2t for fusing (t = 10 ms)	I^2t	max.	610	A^2s

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

THERMAL RESISTANCE

From junction to mounting base	$R_{th\ j\text{-}mb}$	=	1.0	K/W
From mounting base to heatsink				
with heatsink compound	$R_{th\ mb\text{-}h}$	=	0.3	K/W
without heatsink compound	$R_{th\ mb\text{-}h}$	=	0.5	K/W

MOUNTING INSTRUCTIONS

The top connector should be neither 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.

---

*To ensure thermal stability: $R_{th\ j\text{-}a} \leqslant 3.4$ K/W.

CHARACTERISTICS

←

Forward voltage				
$I_F = 35$ A; $T_j = 150$ °C	V_F	<	1.05	V*
$I_F = 100$ A; $T_j = 25$ °C	V_F	<	1.4	V*
Reverse current				
$V_R = V_{RWM\,max}$; $T_j = 100$ °C	I_R	<	2.0	mA
$T_j = 25$ °C	I_R	<	50	µA
Reverse recovery when switched from				
$I_F = 1$ A to $V_R \geqslant 30$ V with $-dI_F/dt = 100$ A/µs; $T_j = 25$ °C; recovery time	t_{rr}	<	50	ns
$I_F = 2$ A to $V_R \geqslant 30$ V with $-dI_F/dt = 20$ A/µs; $T_j = 25$ °C; recovered charge	Q_s	<	75	nC
$I_F = 10$ A to $V_R \geqslant 30$ V with $-dI_F/dt = 50$ A/µs; $T_j = 100$ °C; peak recovery current	I_{RRM}	<	4	A
Forward recovery when switched to $I_F = 10$ A with $dI_F/dt = 10$ A/µs; $T_j = 25$ °C	V_{fr}	typ.	2.5	V

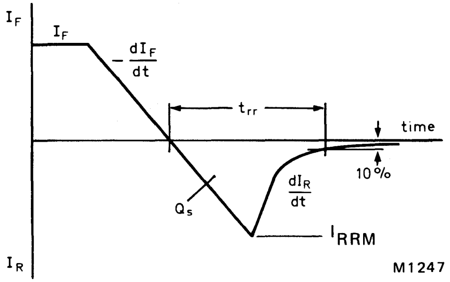


Fig.2 Definition of t_{rr}, Q_s and I_{RRM}.

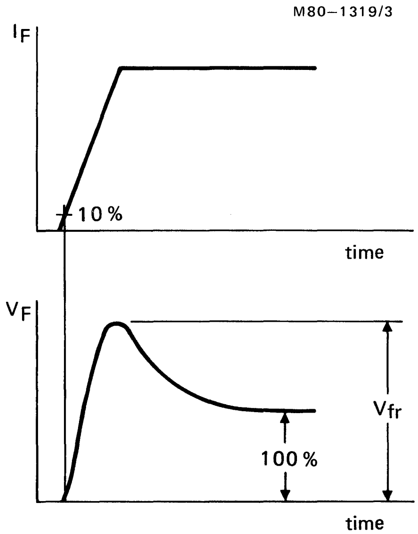


Fig.3 Definition of V_{fr}.

*Measured under pulse conditions to avoid excessive dissipation.

SQUARE-WAVE OPERATION

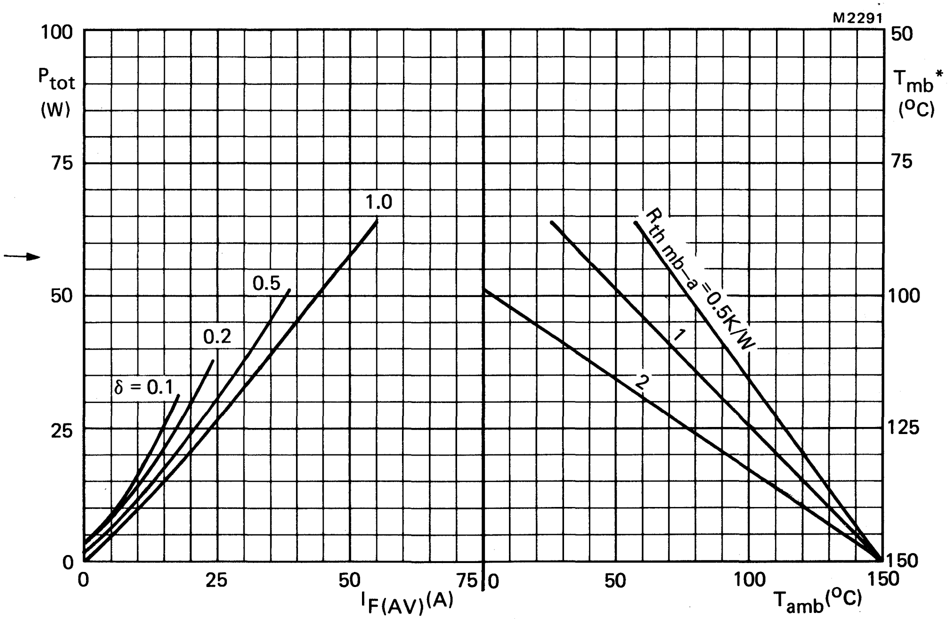
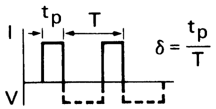


Fig.4 The right-hand part shows the relationship between the power (derived from the left-hand part) and the maximum permissible temperatures. Power includes reverse current losses and switching losses up to f = 100 kHz.



$I_{F(AV)} = I_{F(RMS)} \times \sqrt{\delta}$

---

*T_{mb} scale is for comparison purposes and is correct only for $R_{th\ mb\text{-}a} < 2.4$ K/W.

SINUSOIDAL OPERATION

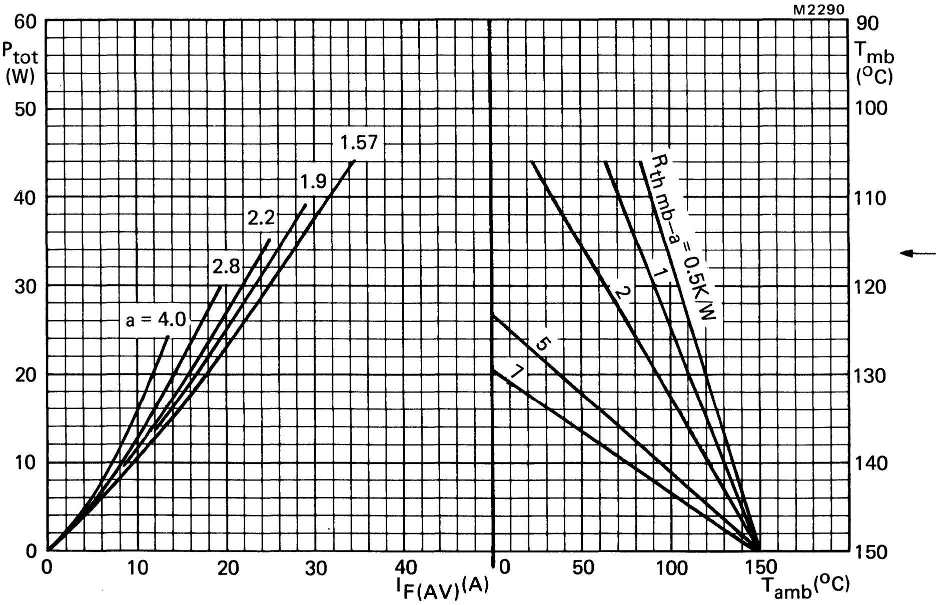


Fig.5 The right-hand part shows the interrelationship between the power (derived from the left-hand part) and the maximum permissible temperatures.
a = form factor = $I_{F(RMS)}/I_{F(AV)}$.

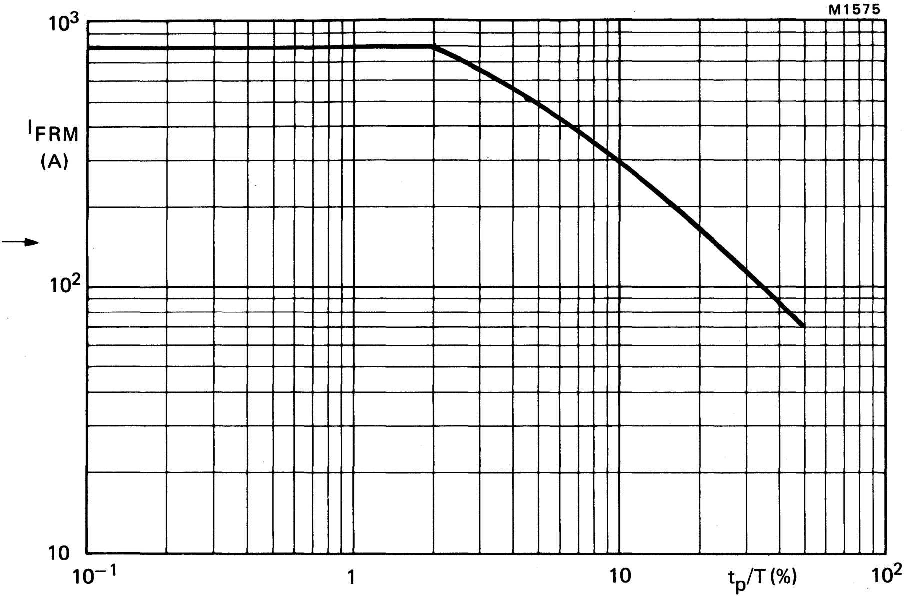
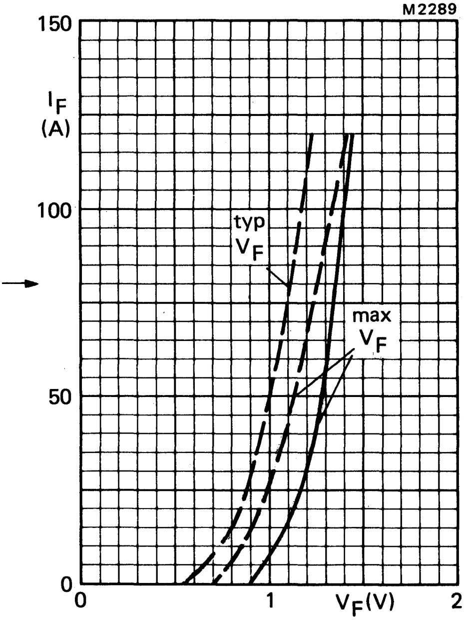
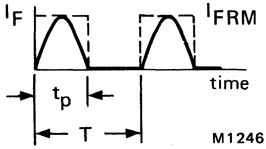


Fig.6 Maximum permissible repetitive peak forward current for square or sinusoidal currents; 1 μs $< t_p <$ 1 ms.





Definition of I_{FRM} and t_p/T.

Fig.7 —— T_j = 25 °C; – – – T_j = 150 °C.

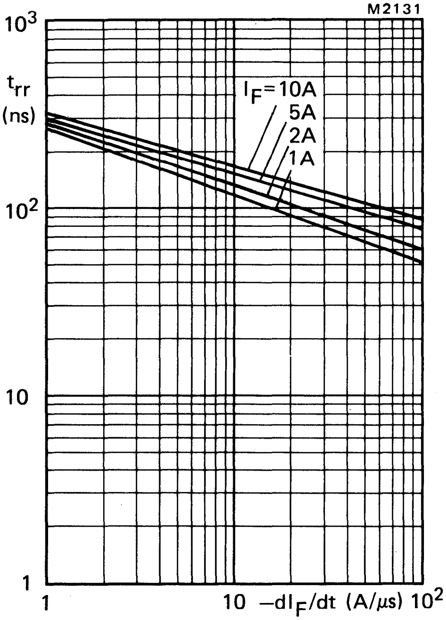


Fig.8 Maximum t_{rr} at T_j = 25 °C.

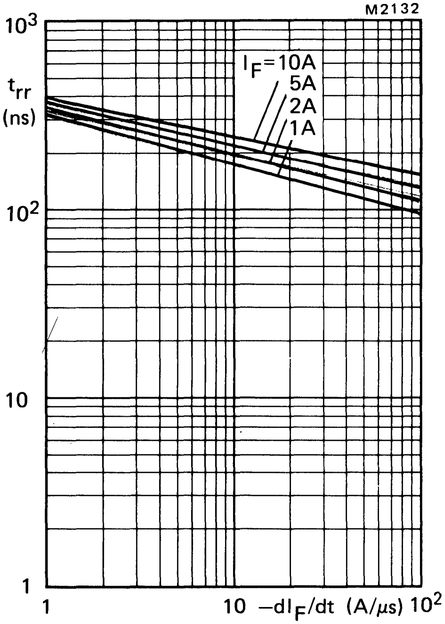


Fig.9 Maximum t_{rr} at T_j = 100 °C.

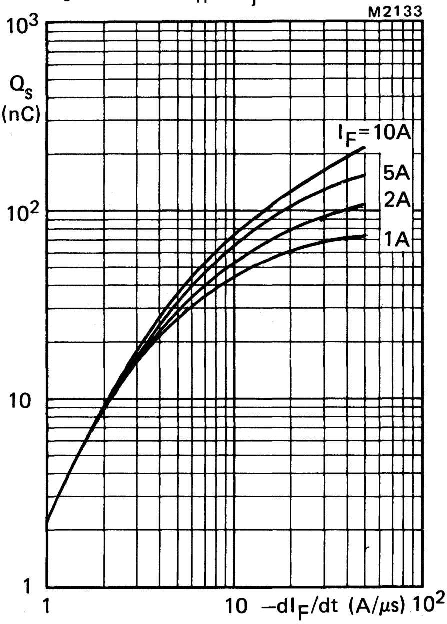


Fig.10 Maximum Q_s at T_j = 25 °C.

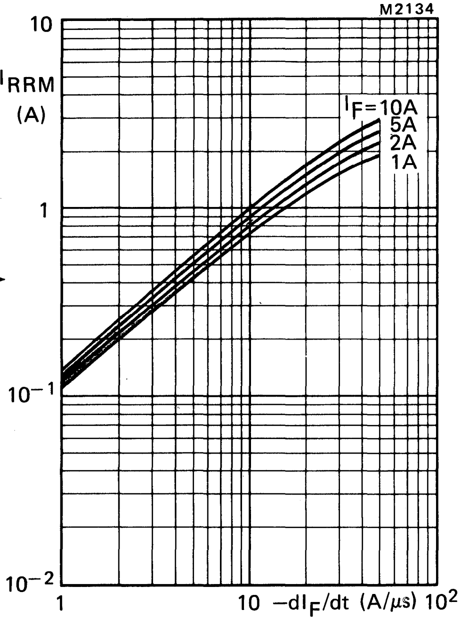


Fig.11 Maximum I_{RRM} at T_j = 25 °C.

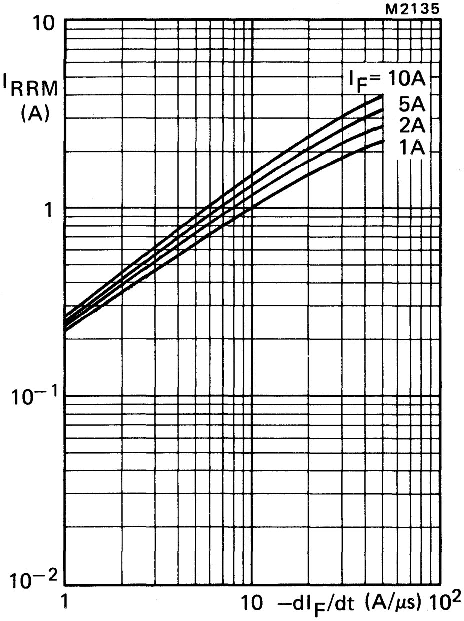


Fig.12 Maximum I_{RRM} at T_j = 100 °C.

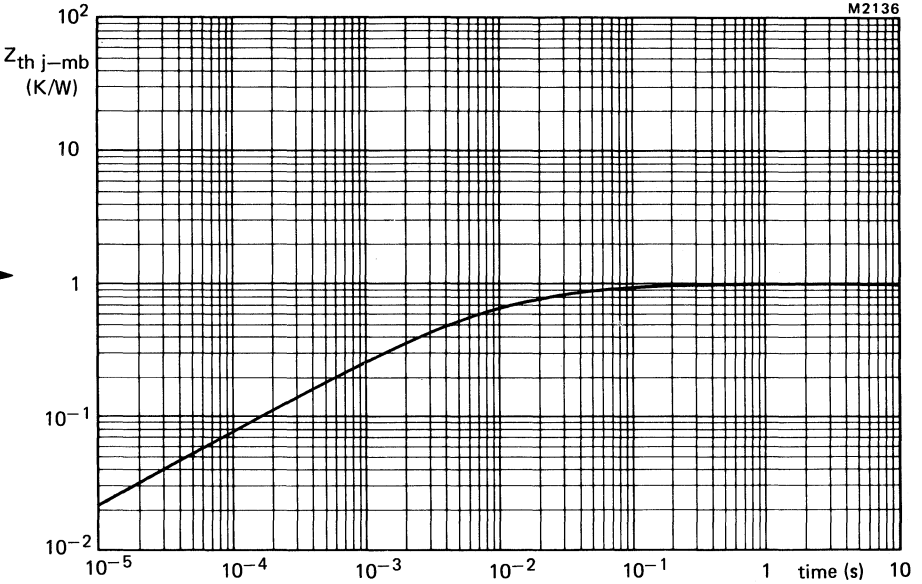


Fig.13 Transient thermal impedance.

FAST SOFT-RECOVERY RECTIFIER DIODES

Fast soft-recovery diodes in DO-5 metal envelopes especially suitable for operation as main and commutating diodes in 3-phase a.c. motor speed control inverters and in high frequency power supplies in general.
The series consists of the following types:
Normal polarity (cathode to stud): BYW25–800 and BYW25–1000.
Reverse polarity (anode to stud): BYW25–800R and BYW25–1000R.

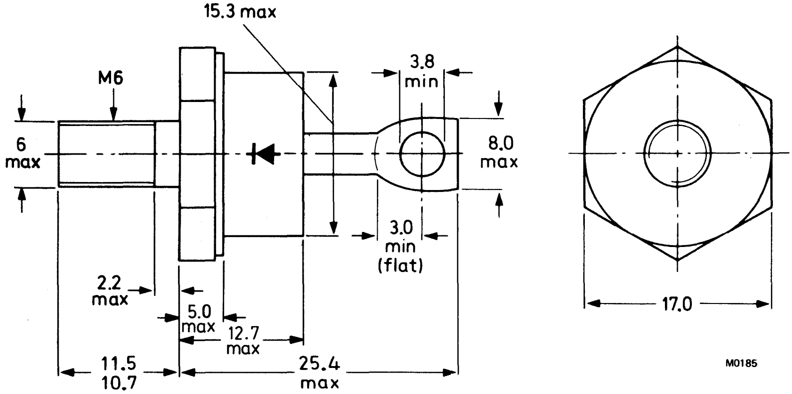
QUICK REFERENCE DATA

			BYW25–800(R)	1000(R)	
Repetitive peak reverse voltage	V_{RRM}	max.	800	1000	V
Average forward current	$I_{F(AV)}$	max.	40		A
Repetitive peak forward current	I_{FRM}	max.	600		A
Reverse recovery time	t_{rr}	<	450		ns

MECHANICAL DATA

Dimensions in mm

Fig.1 DO-5: with metric M6 stud (ϕ6 mm)



Net mass: 22 g
Diameter of clearance hole: max. 6.5 mm
Accessories supplied on request:
see ACCESSORIES section
The mark shown applies to normal polarity types.

Supplied with device: 1 nut, 1 lock washer
Torque on nut: min. 1.7 Nm (17 kg cm)
max. 3.5 Nm (35 kg cm)
Nut dimensions across the flats: 10 mm

RATINGS

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

Voltages*			BYW25–800(R)	1000(R)	
Non-repetitive peak reverse voltage	V_{RSM}	max.	1000	1200	V
Repetitive peak reverse voltage	V_{RRM}	max.	800	1000	V
Crest working reverse voltage	V_{RWM}	max.	650	850	V
Continuous reverse voltage	V_R	max.	650	850	V

Currents

Average forward current; switching losses negligible up to 20 kHz sinusoidal; up to T_{mb} = 100 °C	$I_{F(AV)}$	max.	40	A
sinusoidal; at T_{mb} = 125 °C	$I_{F(AV)}$	max.	23	A
R.M.S. forward current	$I_{F(RMS)}$	max.	60	A
Repetitive peak forward current	I_{FRM}	max.	600	A
Non-repetitive peak forward current; t = 10 ms; half sine-wave; T_j = 150 °C prior to surge	I_{FSM}	max.	550	A
I^2t for fusing (t = 10 ms)	I^2t	max.	1500	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	$R_{th\ j\text{-}mb}$	=	0.6	°C/W
From mounting base to heatsink with heatsink compound	$R_{th\ mb\text{-}h}$	=	0.3	°C/W
without heatsink compound	$R_{th\ mb\text{-}h}$	=	0.5	°C/W

---

*To ensure thermal stability: $R_{th\ j\text{-}a} \leqslant 1$ °C/W (continuous reverse voltage).

CHARACTERISTICS

Forward voltage			
I_F = 35 A; T_j = 25 °C	V_F	<	1,55 V *
I_F = 150 A; T_j = 25 °C	V_F	<	2,25 V *
Reverse current			
V_R = 650 V; T_j = 125 °C	I_R	<	7 mA
Reverse recovery when switched from			
I_F = 10 A to V_R = 30 V with $-dI_F/dt$ = 50 A/μs; T_j = 25 °C			
Recovery time	t_{rr}	<	450 ns
I_F = 600 A to $V_R \geqslant$ 30 V with $-dI_F/dt$ = 70 A/μs; T_{mb} = 85 °C			
Recovery time	t_{rr}	<	1 μs
Maximum slope of the reverse recovery current when switched from I_F = 600 A to $V_R \geqslant$ 30 V; with $-dI_F/dt$ = 35 A/μs; T_j = 25 °C	$\|dI_R/dt\|$	<	100 A/μs

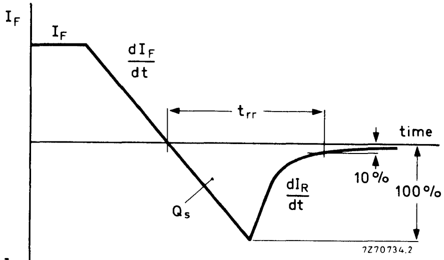


Fig. 2 Definitions of Q_s, t_{rr} and dI_R/dt.

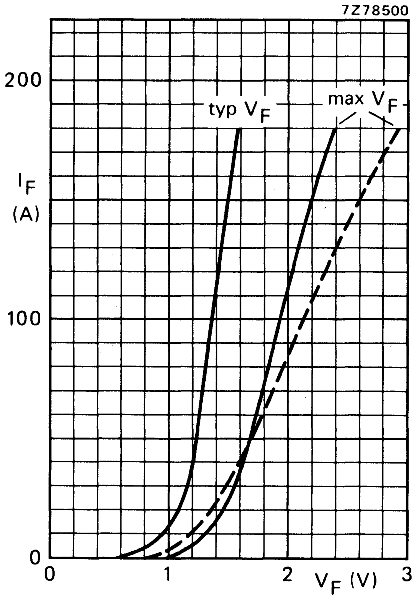


Fig. 3 —— T_j = 25 °C; – – – T_j = 150 °C.

* Measured under pulse conditions to avoid excessive dissipation.

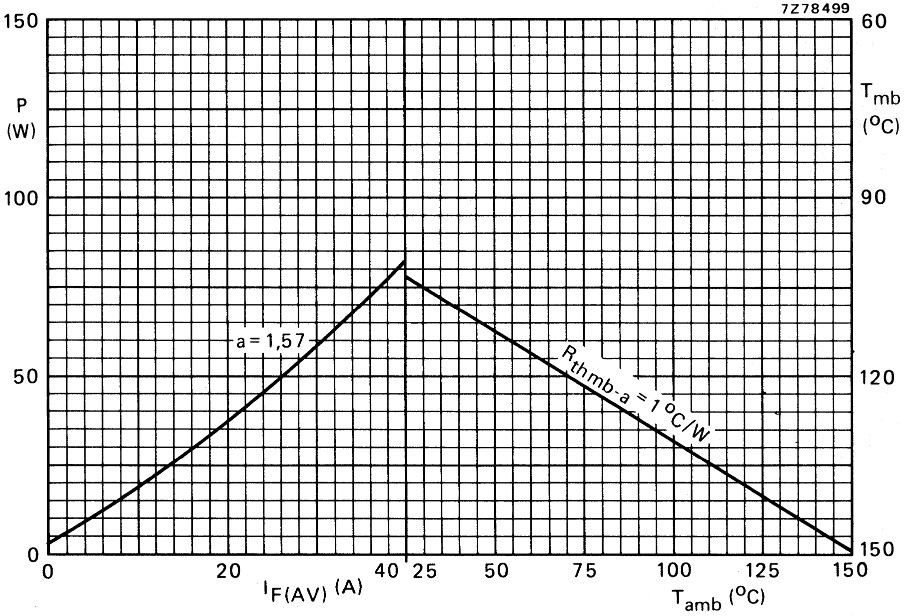


Fig. 4 The right-hand part shows the interrelationship between the power (derived from the left-hand part) and the maximum permissible temperatures.
P = power including reverse current losses and switching losses up to f = 20 kHz.
a = $I_{F(RMS)}/I_{F(AV)}$.

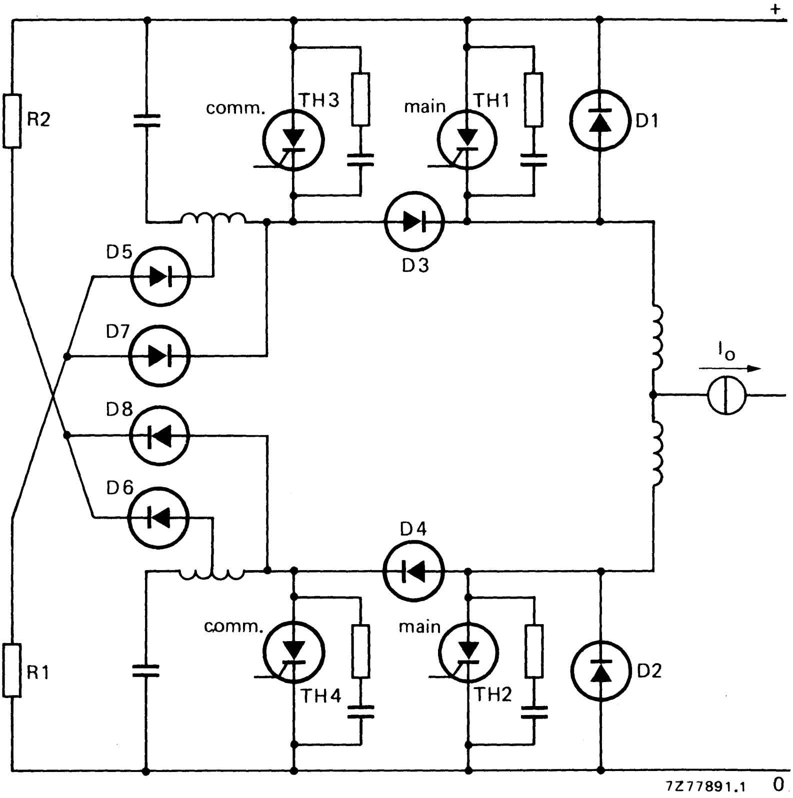


Fig. 5 One phase of a three-phase inverter for a.c. motor speed control.
D1 to D4 are BYW25 types.

ULTRA FAST RECOVERY RECTIFIER DIODES

Glass-passivated, high-efficiency epitaxial rectifier diodes in plastic envelopes, featuring low forward voltage drop, ultra fast reverse recovery times with very low stored charge and soft-recovery characteristic. They are intended for use in switched-mode power supplies and high-frequency circuits in general, where both low conduction losses and low switching losses are essential.
The series consists of normal polarity (cathode to mounting base) types.

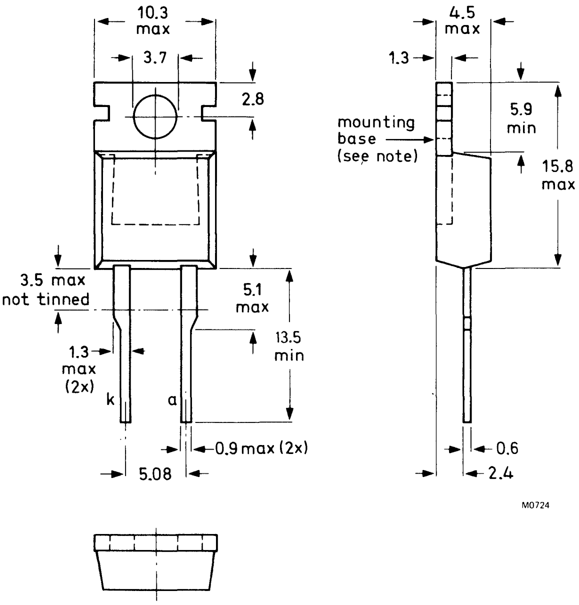
QUICK REFERENCE DATA

			BYW29–50	100	150	200	
Repetitive peak reverse voltage	V_{RRM}	max.	50	100	150	200	V
Average forward current	$I_{F(AV)}$	max.	8				A
Forward voltage	V_F	<	0.8				V
Reverse recovery time	t_{rr}	<	25				ns

MECHANICAL DATA

Dimensions in mm

Fig.1 TO-220AC



Net mass: 2 g
Note: The exposed metal mounting base is directly connected to the cathode.
Accessories supplied on request: see data sheets Mounting instructions and accessories for TO-220 envelopes.

Products approved to CECC 50 009-014 available on request.

RATINGS

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

Voltages			BYW29–50	100	150	200	
Repetitive peak reverse voltage	V_{RRM}	max.	50	100	150	200	V
Crest working reverse voltage	V_{RWM}	max.	50	100	150	200	V
Continuous reverse voltage (note 1)	V_R	max.	50	100	150	200	V

Currents

Average forward current; switching losses negligible up to 500 kHz				
square wave; $\delta = 0.5$; up to $T_{mb} = 125\ ^{o}C$	$I_{F(AV)}$	max.	8	A
→ sinusoidal; up to $T_{mb} = 125\ ^{o}C$	$I_{F(AV)}$	max.	7.3	A
R.M.S. forward current	$I_{F(RMS)}$	max.	11.5	A
Repetitive peak forward current $t_p = 20\ \mu s$; $\delta = 0.02$	I_{FRM}	max.	240	A
Non-repetitive peak forward current half sine-wave; $T_j = 150\ ^{o}C$ prior to surge; with reapplied V_{RWMmax};				
$t = 10$ ms	I_{FSM}	max.	80	A
$t = 8.3$ ms	I_{FSM}	max.	100	A
I^2t for fusing ($t = 10$ ms)	I^2t	max.	32	A^2s

Temperatures

Storage temperature	T_{stg}		−40 to +150	^{o}C
Junction temperature	T_j	max.	150	^{o}C

Notes:

1. To ensure thermal stability: $R_{th\ j\text{-}a} < 11.6$ K/W

CHARACTERISTICS

Forward voltage					
I_F = 8 A; T_j = 150 °C	V_F	$<$	0.8	V*	
I_F = 20 A; T_j = 25 °C	V_F	$<$	1.3	V*	
Reverse current					
$V_R = V_{RWM\,max}$; T_j = 100 °C	I_R	$<$	0.6	mA	
T_j = 25 °C	I_R	$<$	10	μA	
Reverse recovery when switched from					
I_F = 1 A to $V_R \geqslant$ 30 V with $-dI_F/dt$ = 100 A/μs; T_j = 25 °C; recovery time	t_{rr}	$<$	25	ns	
I_F = 2 A to $V_R \geqslant$ 30 V with $-dI_F/dt$ = 20 A/μs; T_j = 25 °C; recovered charge	Q_s	$<$	11	nC	←
I_F = 10 A to $V_R \geqslant$ 30 V with $-dI_F/dt$ = 50 A/μs; T_j = 100 °C; peak recovery current	I_{RRM}	$<$	2	A	←
Forward recovery when switched to I_F = 1 A with dI_F/dt = 10 A/μs; T_j = 25 °C	V_{fr}	typ.	0.9	V	←

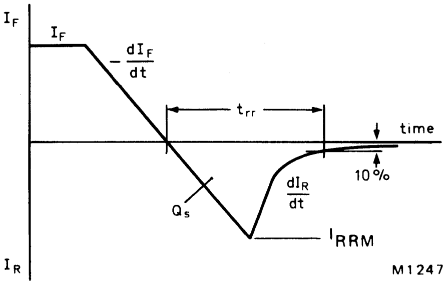


Fig.2 Definition of t_{rr}, Q_s and I_{RRM}.

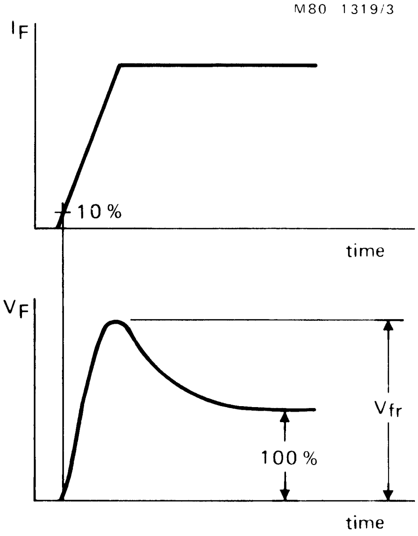


Fig.3 Definition of V_{fr}.

---

*Measured under pulse conditions to avoid excessive dissipation.

THERMAL RESISTANCE

From junction to mounting base	$R_{th\ j\text{-}mb}$	=	2.7	K/W

Influence of mounting method

1. Heatsink mounted with clip (see mounting instructions)

Thermal resistance from mounting base to heatsink

a. with heatsink compound	$R_{th\ mb\text{-}h}$	=	0.3	K/W
b. with heatsink compound and 0.06 mm maximum mica insulator	$R_{th\ mb\text{-}h}$	=	1.4	K/W
c. with heatsink compound and 0.1 mm maximum mica insulator (56369)	$R_{th\ mb\text{-}h}$	=	2.2	K/W
d. with heatsink compound and 0.25 mm maximum alumina insulator (56367)	$R_{th\ mb\text{-}h}$	=	0.8	K/W
e. without heatsink compound	$R_{th\ mb\text{-}h}$	=	1.4	K/W

2. Free-air operation

The quoted value of $R_{th\ j\text{-}a}$ should be used only when no leads of other dissipating components run to the same tie-point.
Thermal resistance from junction to ambient in free air:

mounted on a printed circuit board at any device lead length and with copper laminate on the board	$R_{th\ j\text{-}a}$	=	60	K/W

MOUNTING INSTRUCTIONS

1. The device may be soldered directly into the circuit, but the maximum permissible temperature of the soldering iron or bath is 275°C; the heat source must not be in contact with the joint for more than 5 seconds. Soldered joints must be at least 4.7 mm from the seal.
2. The leads should not be bent less than 2.4 mm from the seal, and should be supported during bending. The bend radius must be no less than 1.0 mm. ←
3. Mounting by means of a spring clip is the best mounting method because it offers:
   a. a good thermal contact under the crystal area and slightly lower $R_{th\ mb\text{-}h}$ values than does screw mounting.
   b. safe isolation for mains operation.
   However, if a screw is used, it should be M3 cross-recess pan head. Care should be taken to avoid damage to the plastic body.
4. For good thermal contact, heatsink compound should be used between mounting base and heatsink. Values of $R_{th\ mb\text{-}h}$ given for mounting with heatsink compound refer to the use of a metallic oxide-loaded compound. Ordinary silicone grease is not recommended.
5. Rivet mounting (only possible for non-insulated mounting).
   Devices may be rivetted to flat heatsinks; such a process must **neither** deform the mounting tab, **nor** enlarge the mounting hole.

OPERATING NOTES

Dissipation and heatsink calculations

a. The various components of junction temperature rise above ambient are illustrated in Fig.4.

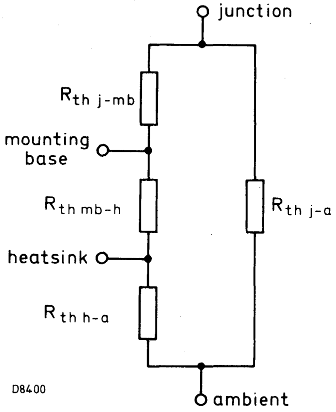


Fig. 4.

b. Any measurement of heatsink temperature should be made immediately adjacent to the device.
c. The method of using Figs. 5 and 6 is as follows:
Starting with the required current on the $I_{F(AV)}$ axis, trace upwards to meet the appropriate duty cycle or form factor curve. Trace right horizontally and upwards from the required value on the T_{amb} scale. The intersection determines the $R_{th\ mb\text{-}a}$. The heatsink thermal resistance value ($R_{th\ h\text{-}a}$) can be calculated from:

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

SQUARE-WAVE OPERATION

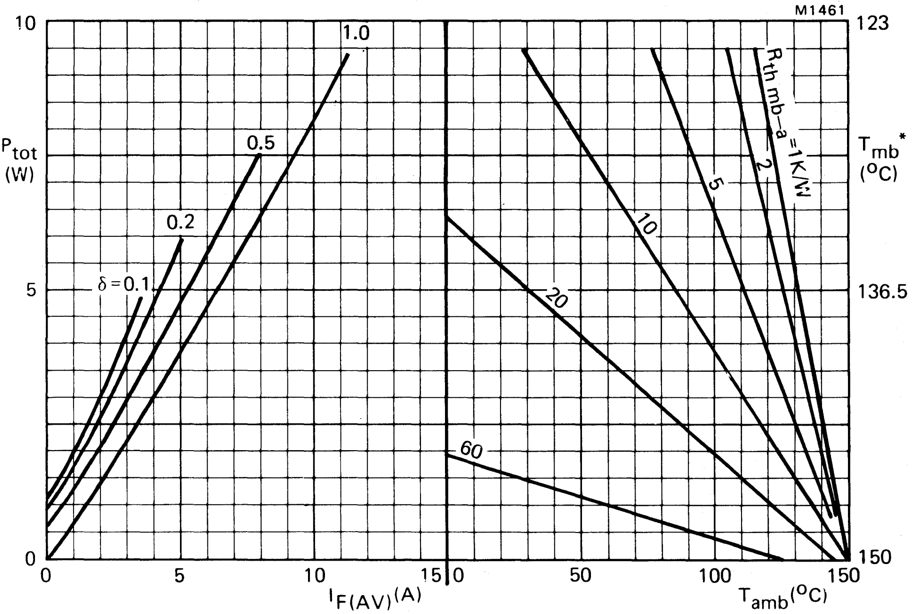
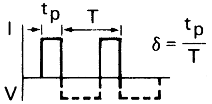


Fig.5 The right-hand part shows the interrelationship between the power (derived from the left-hand part) and the maximum permissible temperatures.
Power includes reverse current losses and switching losses up to f = 500 kHz.



$I_{F(AV)} = I_{F(RMS)} \times \sqrt{\delta}$

---

*T_{mb} scale is for comparison purposes and is correct only for $R_{th\ mb\text{-}a} < 8.9$ K/W.

SINUSOIDAL OPERATION

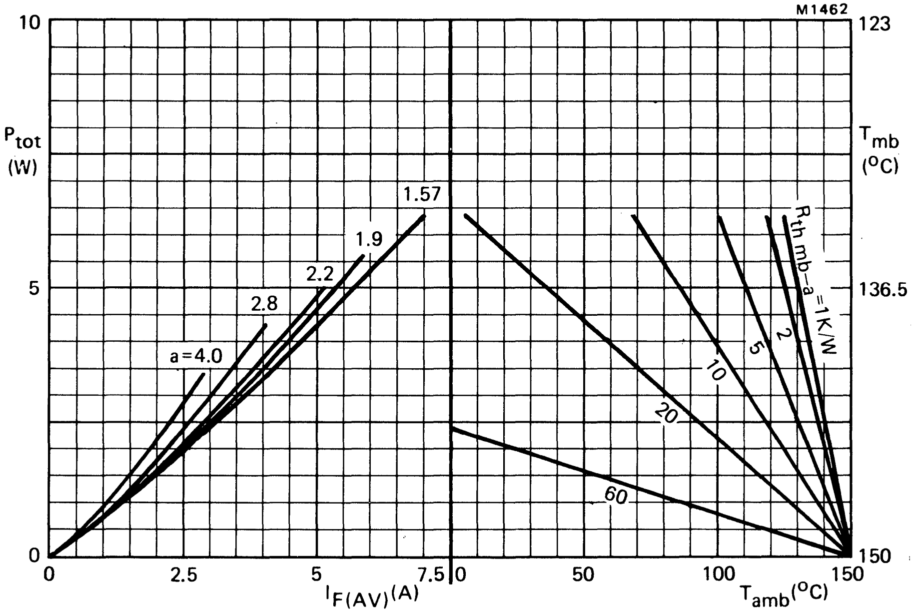


Fig.6 The right-hand part shows the interrelationship between the power (derived from the left-hand part) and the maximum permissible temperatures.
Power includes reverse current losses and switching losses up to f = 500 kHz.
a = form factor = $I_{F(RMS)}/I_{F(AV)}$.

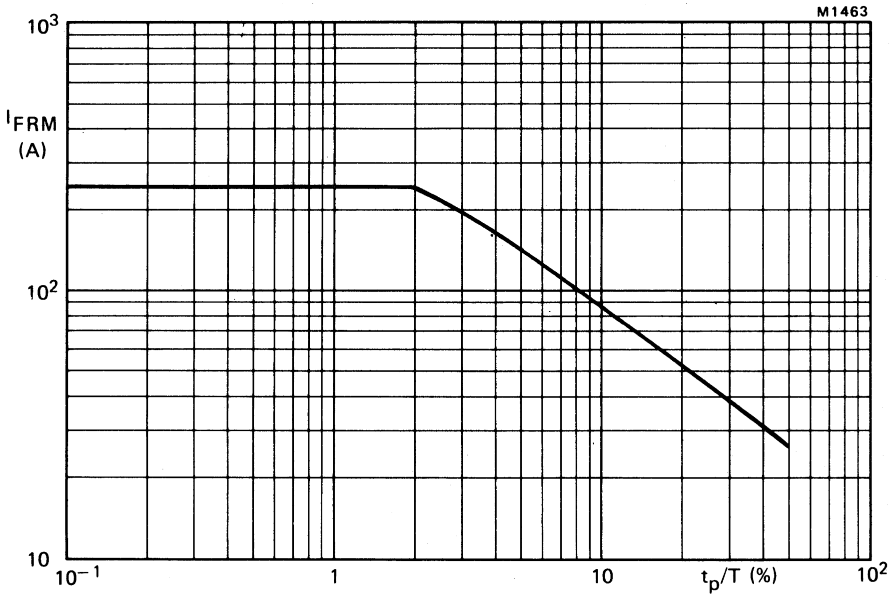
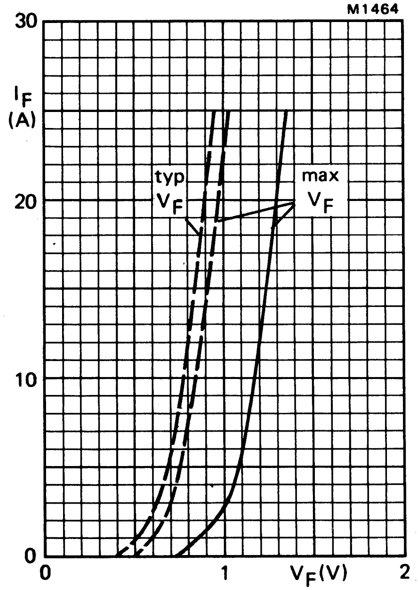
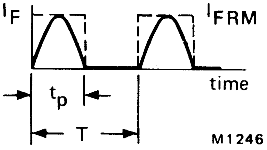


Fig.7 Maximum permissible repetitive peak forward current for square or sinusoidal currents; 1 $\mu s < t_p < 1 ms$.





Definition of I_{FRM} and t_p/T.

Fig.8 —— T_j = 25 °C; – – – T_j = 150 °C.

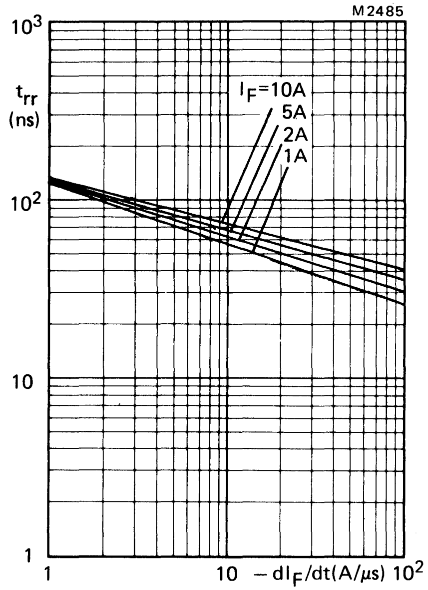


Fig.9 Maximum t_{rr} at T_j = 25 °C.

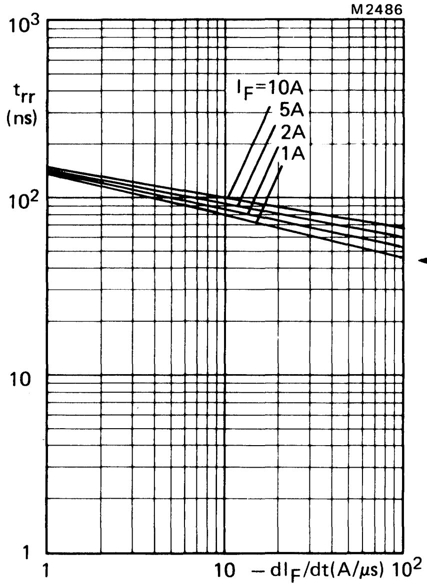


Fig.10 Maximum t_{rr} at T_j = 100 °C.

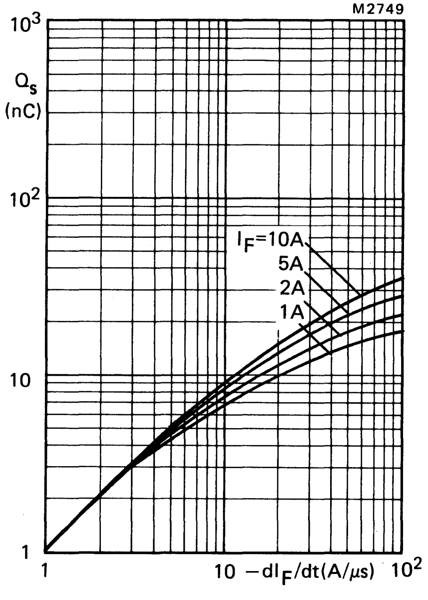


Fig.11 Maximum Q_s at T_j = 25 °C.

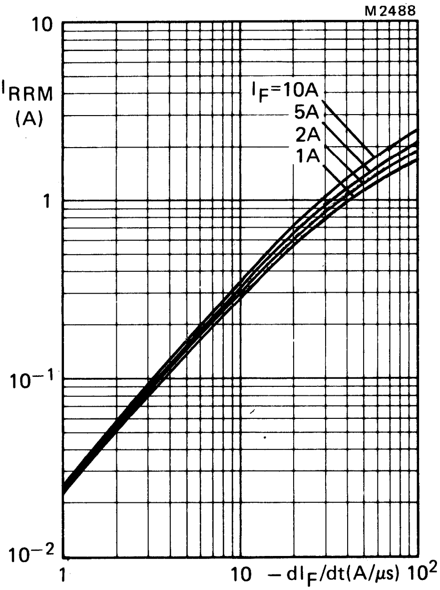


Fig.12 Maximum I_{RRM} at T_j = 25 °C.

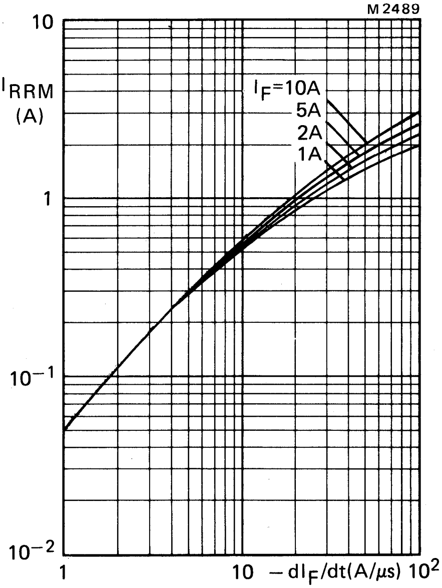


Fig.13 Maximum I_{RRM} at T_j = 100 °C.

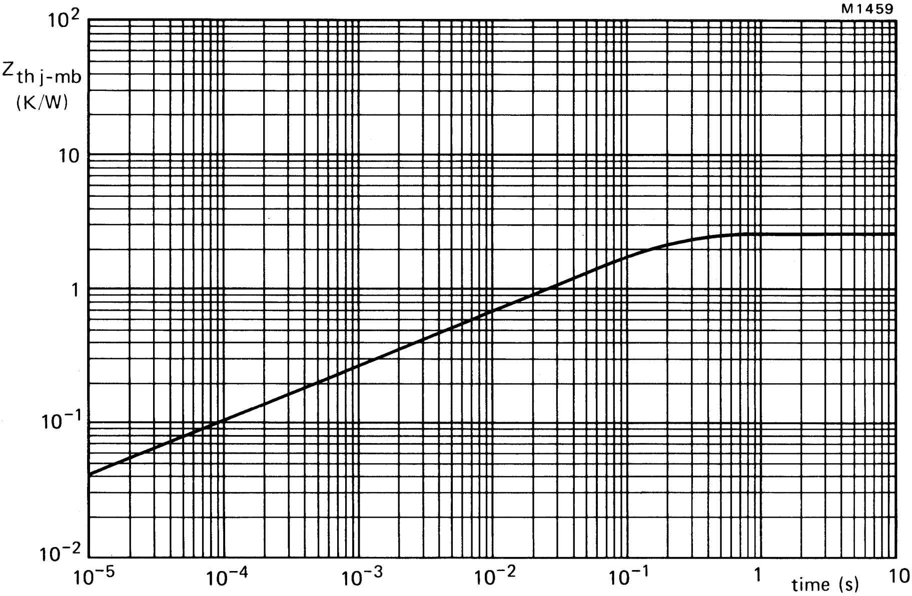


Fig.14 Transient thermal impedance.

ULTRA FAST RECOVERY, ELECTRICALLY-ISOLATED RECTIFIER DIODES

Glass-passivated, high-efficiency epitaxial rectifier diodes in SOT-186 (full-pack) envelopes, featuring low forward voltage drop, ultra fast reverse recovery times with very low stored charge and soft-recovery characteristic. Their electrical isolation makes them ideal for mounting on a common heatsink alongside other components without the need for additional insulators. They are intended for use in switched-mode power supplies and high-frequency circuits in general, where both low conduction losses and low switching losses are essential.

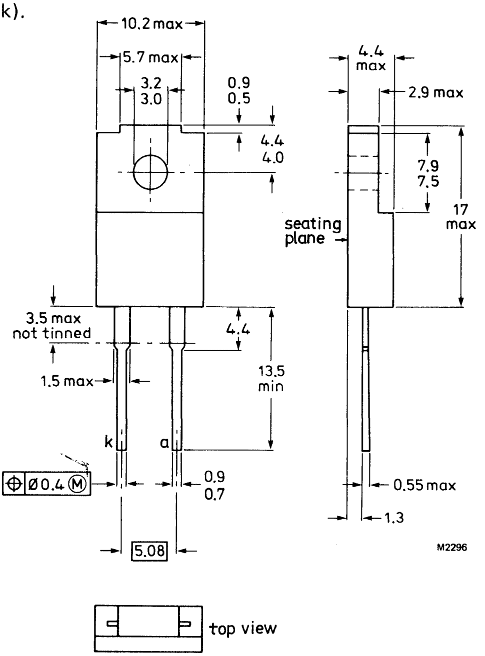
QUICK REFERENCE DATA

		BYW29F–	50	100	150	200	
Repetitive peak reverse voltage	V_{RRM}	max.	50	100	150	200	V
Average forward current	$I_{F(AV)}$	max.	8				A
Forward voltage	V_F	<	0.8				V
Reverse recovery time	t_{rr}	<	25				ns

MECHANICAL DATA

Dimensions in mm

Fig.1 SOT-186 (full-pack).



Net mass: 2 g.

The seating plane is electrically isolated from all terminals.

Accessories supplied on request (see data sheets Mounting instructions for F-pack devices and Accessories for SOT-186 envelopes).

RATINGS

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

Voltages			BYW29F–50	100	150	200	
Repetitive peak reverse voltage	V_{RRM}	max.	50	100	150	200	V
Crest working reverse voltage	V_{RWM}	max.	50	100	150	200	V
Continuous reverse voltage (note 1)	V_R	max.	50	100	150	200	V

Currents				
Average forward current; switching losses negligible up to 500 kHz (note 2);				
square wave; $\delta = 0.5$; up to $T_{mb} = 108\ ^{o}C$	$I_{F(AV)}$	max.	8	A
sinusoidal; up to $T_{mb} = 114\ ^{o}C$	$I_{F(AV)}$	max.	7.3	A
R.M.S. forward current	$I_{F(RMS)}$	max.	11.5	A
Repetitive peak forward current $t_p = 20\ \mu s$, $\delta = 0.02$	I_{FRM}	max.	240	A
Non-repetitive peak forward current half sine-wave; $T_j = 150\ ^{o}C$ prior to surge; with reapplied $V_{RWM\ max}$				
t = 10 ms	I_{FSM}	max.	80	A
t = 8.3 ms	I_{FSM}	max.	100	A
I^2t for fusing (t = 10 ms)	I^2t	max.	32	A^2s

Temperatures				
Storage temperature	T_{stg}		−40 to +150	^{o}C
Junction temperature	T_j	max.	150	^{o}C

ISOLATION

Peak isolation voltage from all terminals to external heatsink	V_{isol}	max.	1000	V
Isolation capacitance from cathode to external heatsink (note 3)	C_p	typ.	12	pF

Notes:

1. To ensure thermal stability: $R_{th\ j\text{-}a} < 11.6$ K/W.
2. The quoted temperatures assume heatsink compound is used.
3. Mounted without heatsink compound and 20 Newtons pressure on the centre of the envelope.

THERMAL RESISTANCE

From junction to external heatsink with minimum of 2 kgf (20 Newtons) pressure on the centre of the envelope,

with heatsink compound	$R_{th\ j\text{-}h}$	=	5.5	K/W
without heatsink compound	$R_{th\ j\text{-}h}$	=	7.2	K/W

Free air operation

The quoted value of $R_{th\ j\text{-}a}$ should be used only when no leads of other dissipating components run to the same tie point.

Thermal resistance from junction to ambient in free air, mounted on a printed circuit board	$R_{th\ j\text{-}a}$	=	55	K/W

CHARACTERISTICS

T_j = 25 °C unless otherwise stated

Forward voltage				
I_F = 8 A; T_j = 150 °C	V_F	<	0.8	V*
I_F = 20 A	V_F	<	1.3	V*
Reverse current				
$V_R = V_{RWM\ max}$; T_j = 100 °C	I_R	<	0.6	mA
$V_R = V_{RWM\ max}$	I_R	<	10	µA
Reverse recovery when switched from				
I_F = 1 A to $V_R \geqslant$ 30 V with $-dI_F/dt$ = 100 A/µs; recovery time	t_{rr}	<	25	ns
I_F = 2 A to $V_R \geqslant$ 30 V with $-dI_F/dt$ = 20 A/µs; recovered charge	Q_s	<	11	nC
I_F = 10 A to $V_R \geqslant$ 30 V with $-dI_F/dt$ = 50 A/µs; T_j = 100 °C; peak recovery current	I_{RRM}	<	2	A
Forward recovery when switched to I_F = 1 A with dI_F/dt = 10 A/µs	V_{fr}	typ.	0.9	V

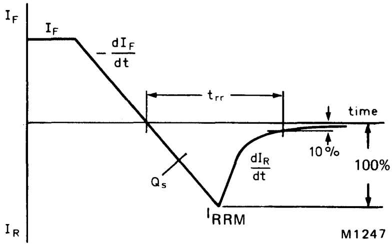


Fig.2 Definition of t_{rr}, Q_s and I_{RRM}.

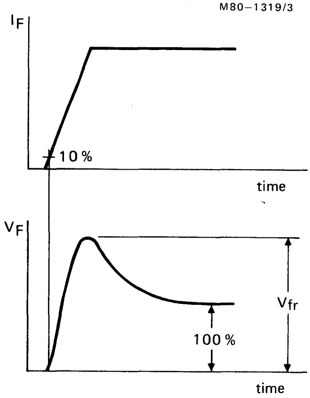


Fig.3 Definition of V_{fr}.

*Measured under pulse conditions to avoid excessive dissipation.

MOUNTING INSTRUCTIONS

1. The device may be soldered directly into the circuit, but the maximum permissible temperature of the soldering iron or bath is 275 °C; the heat source must not be in contact with the joint for more than 5 seconds. Soldered joints must be at least 4.7 mm from the seal.
2. The leads should not be bent less than 2.4 mm from the seal, and should be supported during bending. The bend radius must be no less than 1 mm.
3. Mounting by means of a spring clip is the best mounting method because it offers a good thermal contact under the crystal area and slightly lower $R_{th\ j\text{-}h}$ values than screw mounting. The force exerted on the top of the device by the clip should be at least 2 kgf (20 Newtons) to ensure good thermal contact and must not exceed 3.5 kgf (35 Newtons) to avoid damage to the device.
4. If screw mounting is used, it should be M3 cross-recess pan head.

Minimum torque to ensure good thermal contact:	5.5 kgf (0.55 Nm)
Maximum torque to avoid damage to the device:	8.0 kgf (0.80 Nm)

5. For good thermal contact, heatsink compound should be used between baseplate and heatsink. Values of $R_{th\ j\text{-}h}$ given for mounting with heatsink compound refer to the use of a metallic oxide-loaded compound. Ordinary silicone grease is not recommended.
6. Rivet mounting.
   It is not recommended to use rivets, since extensive damage could result to the plastic, which could destroy the insulating properties of the device.
7. The heatsink must have a flatness in the mounting area of 0.02 mm maximum per 10 mm. Mounting holes must be deburred.

OPERATING NOTES

The various components of junction temperature rise above ambient are illustrated in Fig.4.

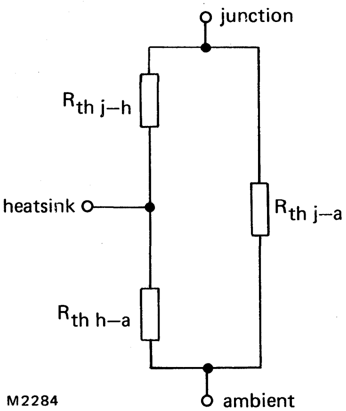


Fig.4.

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

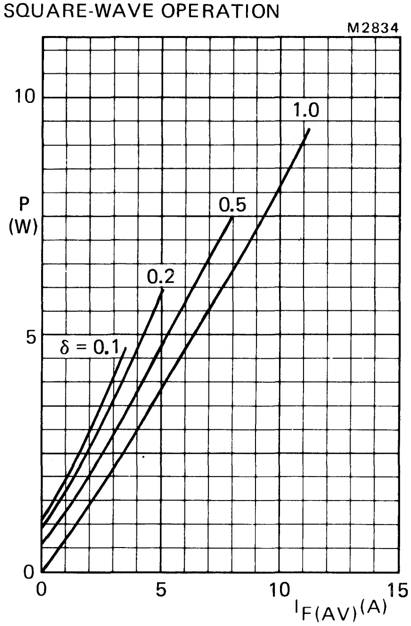
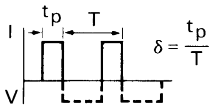


Fig.5 Power rating.

The power loss in the diode should first be determined from the required forward current on the $I_{F(AV)}$ axis and the appropriate duty cycle.

Having determined the power (P), use Fig.7 (if heatsink compound is not being used) or Fig.8 (if heatsink compound is being used) to determine the heatsink size and corresponding maximum ambient and heatsink temperatures.

Note: P = power including reverse current losses but excluding switching losses.



$$I_{F(AV)} = I_{F(RMS)} \times \sqrt{\delta}$$

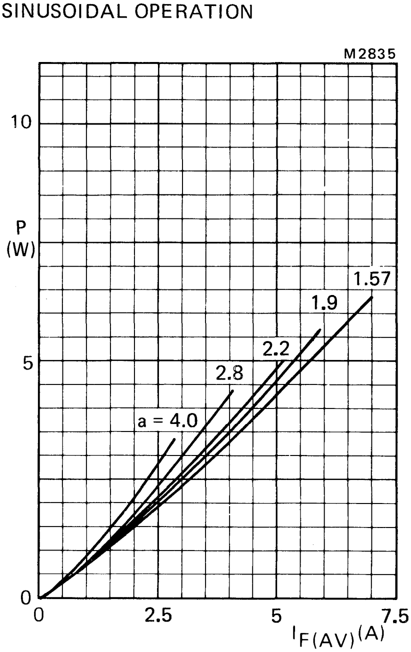


Fig.6 Power rating.

The power loss in the diode should first be determined from the required forward current on the $I_{F(AV)}$ axis and the appropriate form factor.

Having determined the power (P), use Fig.7 (if heatsink compound is not being used) or Fig.8 (if heatsink compound is being used) to determine the heatsink size and corresponding maximum ambient and heatsink temperatures.

Note: P = power including reverse current losses but excluding switching losses.

a = form factor = $I_{F(RMS)}/I_{F(AV)}$

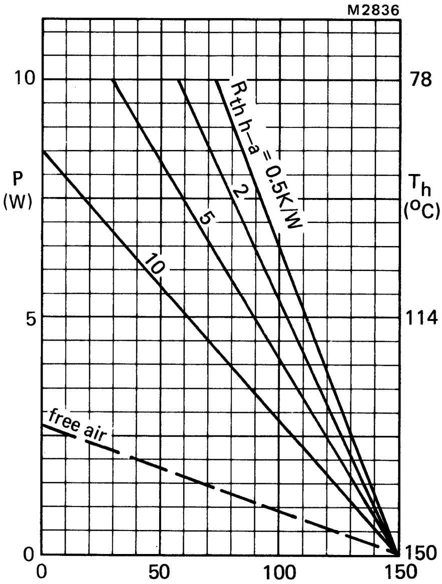


Fig.7 Heatsink rating; without heatsink compound.

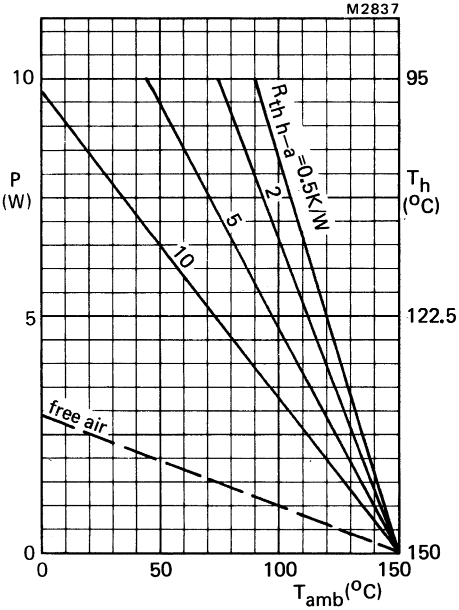


Fig.8 Heatsink rating; with heatsink compound.

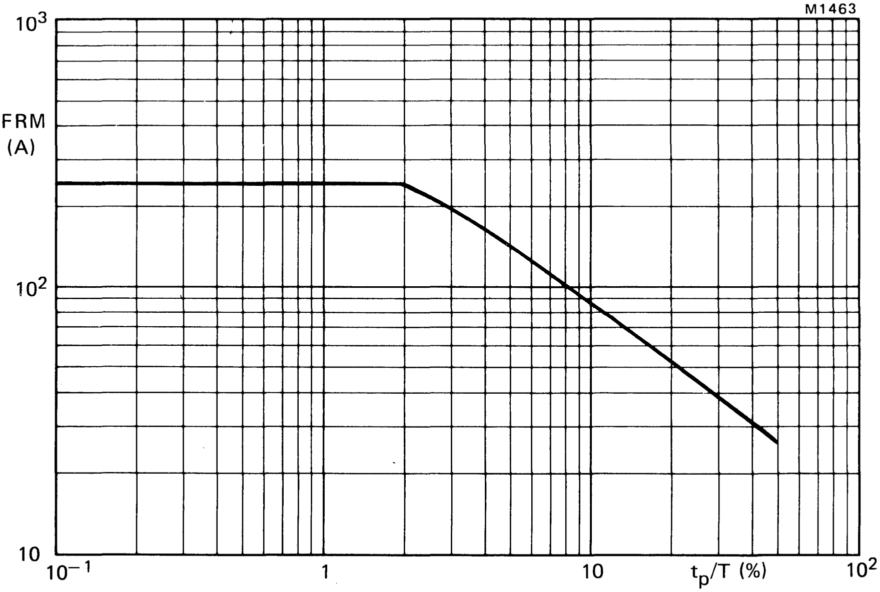
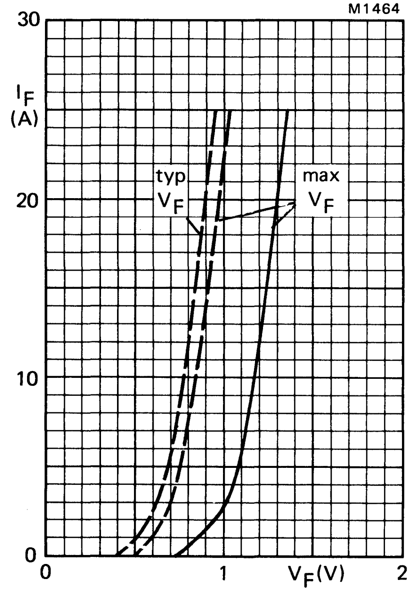
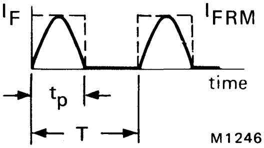


Fig.9 Maximum permissible repetitive peak forward current for square or sinusoidal currents; 1 μs $< t_p <$ 1 ms.





Definition of I_{FRM} and t_p/T.

Fig.10 —— T_j = 25 °C; – – – T_j = 150 °C.

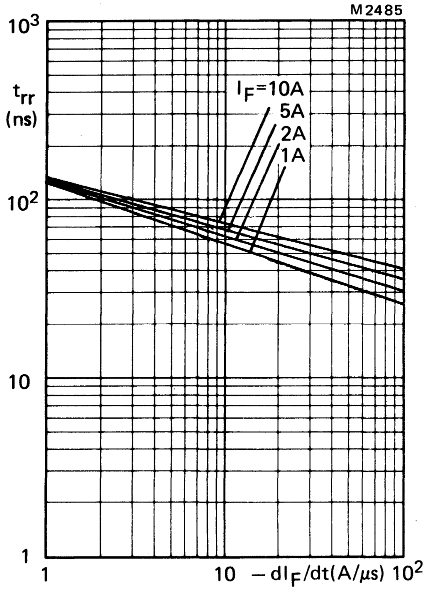


Fig.11 Maximum t_{rr} at T_j = 25 °C.

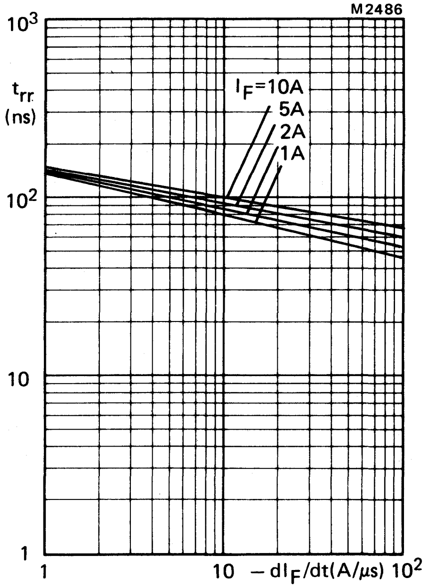


Fig.12 Maximum t_{rr} at T_j = 100 °C.

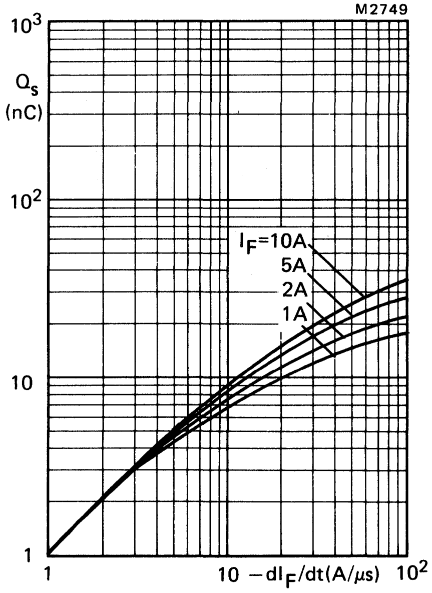


Fig.13 Maximum Q_s at T_j = 25 °C.

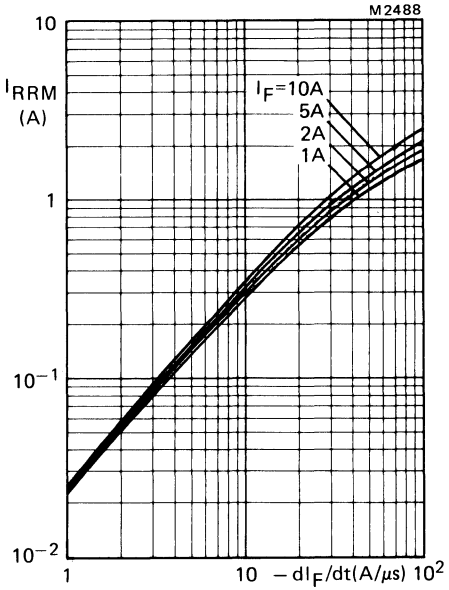


Fig.14 Maximum I_{RRM} at T_j = 25 °C.

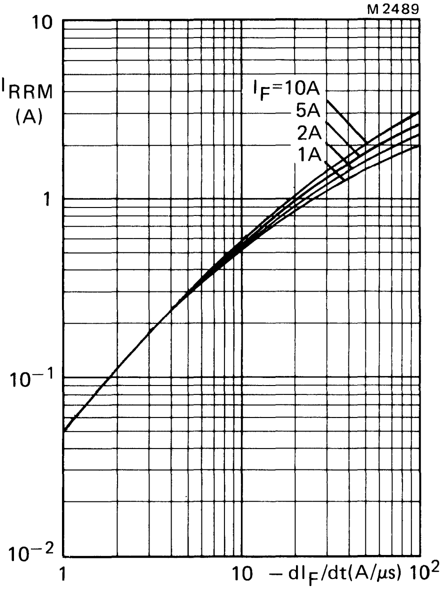


Fig.15 Maximum I_{RRM} at T_j = 100 °C.

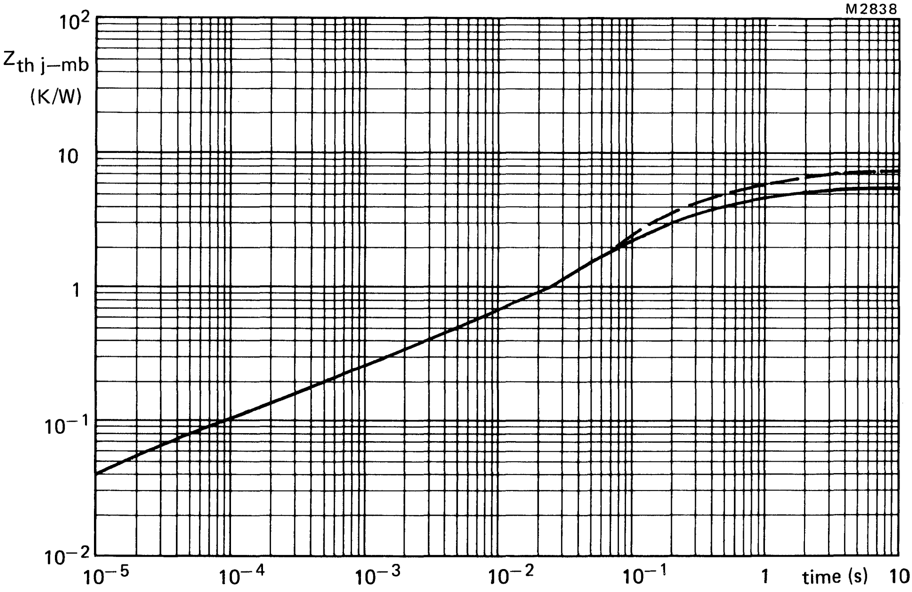


Fig.16 Transient thermal impedance: —— with heatsink compound; — — — without heatsink compound.

ULTRA FAST RECOVERY RECTIFIER DIODES

Glass-passivated, high-efficiency epitaxial rectifier diodes in DO-4 metal envelopes, featuring low forward voltage drop, ultra fast reverse recovery times, very low stored charge and soft recovery characteristic. They are intended for use in switched-mode power supplies and high-frequency circuits in general, where low conduction and switching losses are essential. The series consists of normal polarity (cathode to stud) types.

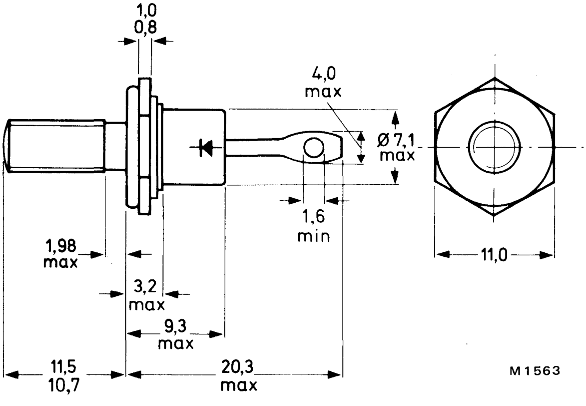
QUICK REFERENCE DATA

			BYW30–50	100	150	200	
Repetitive peak reverse voltage	V_{RRM}	max.	50	100	150	200	V
Average forward current	$I_{F(AV)}$	max.	14				A
Forward voltage	V_F	$<$	0.8				V
Reverse recovery time	t_{rr}	$<$	30				ns

MECHANICAL DATA

Dimensions in mm

Fig.1 DO-4: with metric M5 stud (ϕ5 mm); e.g. BYW30–50.
with 10-32 UNF stud (ϕ4.83 mm); e.g. BYW30-50U.



Net mass: 6 g

Diameter of clearance hole: max. 5.2 mm

Accessories supplied on request:
see ACCESSORIES section.

Supplied with device: 1 nut, 1 lock washer

Torque on nut: min. 0.9 Nm (9 kg cm)
max. 1.7 Nm (17 kg cm)

Nut dimensions across the flats:
M5: 8.0 mm; 10-32 UNF: 9.5 mm.

Products approved to CECC 50 009-001, available on request.

RATINGS

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

Voltages*			BYW30–50	100	150	200	
Repetititve peak reverse voltage	V_{RRM}	max.	50	100	150	200	V
Crest working reverse voltage	V_{RWM}	max.	50	100	150	200	V
Continuous reverse voltage	V_R	max.	50	100	150	200	V

Currents				
Average forward current; switching losses negligible up to 500 kHz				
square wave; $\delta = 0.5$; up to $T_{mb} = 120\ ^oC$	$I_{F(AV)}$	max.	14	A
up to $T_{mb} = 125\ ^oC$	$I_{F(AV)}$	max.	12	A
sinusoidal; up to $T_{mb} = 125\ ^oC$	$I_{F(AV)}$	max.	12.5	A
R.M.S. forward current	$I_{F(RMS)}$	max.	20	A
Repetitive peak forward current $t_p = 20\ \mu s$; $\delta = 0.02$	I_{FRM}	max.	420	A
Non-repetitive peak forward current half sine-wave; $T_j = 150\ ^oC$ prior to surge; with reapplied V_{RWMmax};				
$t = 10$ ms	I_{FSM}	max.	200	A
$t = 8.3$ ms	I_{FSM}	max.	240	A
I^2t for fusing ($t = 10$ ms)	I^2t	max.	200	A^2s

Temperatures				
Storage temperature	T_{stg}		−55 to +150	^oC
Junction temperature	T_j	max.	150	^oC

THERMAL RESISTANCE

From junction to mounting base	$R_{th\ j\text{-}mb}$	=	2.2	K/W
From mounting base to heatsink				
a. with heatsink compound	$R_{th\ mb\text{-}h}$	=	0.5	K/W
b. without heatsink compound	$R_{th\ mb\text{-}h}$	=	0.6	K/W
Transient thermal impedance; $t = 1$ ms	$Z_{th\ j\text{-}mb}$	=	0.3	K/W

MOUNTING INSTRUCTIONS

The top connector should be neither 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.

---

*To ensure thermal stability: $R_{th\ j\text{-}a} \leqslant 5.6$ K/W (continuous reverse voltage).

CHARACTERISTICS

Forward voltage				
I_F = 15 A; T_j = 150 °C	V_F	$<$	0.8	V*
I_F = 50 A; T_j = 25 °C	V_F	$<$	1.3	V*
Reverse current				
$V_R = V_{RWM\,max}$; T_j = 100 °C	I_R	$<$	1.3	mA
T_j = 25 °C	I_R	$<$	50	μA
Reverse recovery when switched from				
I_F = 1 A to $V_R \geqslant 30$ V with $-dI_F/dt$ = 100 A/μs; T_j = 25 °C; recovery time	t_{rr}	$<$	30	ns
I_F = 2 A to $V_R \geqslant 30$ V with $-dI_F/dt$ = 20 A/μs; T_j = 25 °C; recovered charge	Q_s	$<$	15	nC
I_F = 10 A to $V_R \geqslant 30$ V with $-dI_F/dt$ = 50 A/μs; T_j = 100 °C; peak recovery current	I_{RRM}	$<$	4	A
Forward recovery when switched to I_F = 10 A with dI_F/dt = 10 A/μs; T_j = 25 °C	V_{fr}	typ.	1.0	V

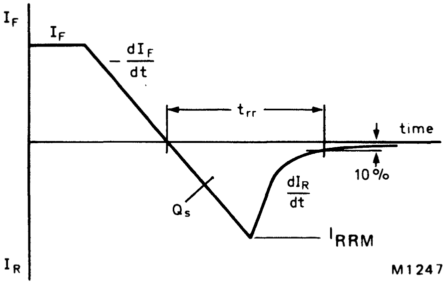


Fig.2 Definition of t_{rr}, Q_s and I_{RRM}.

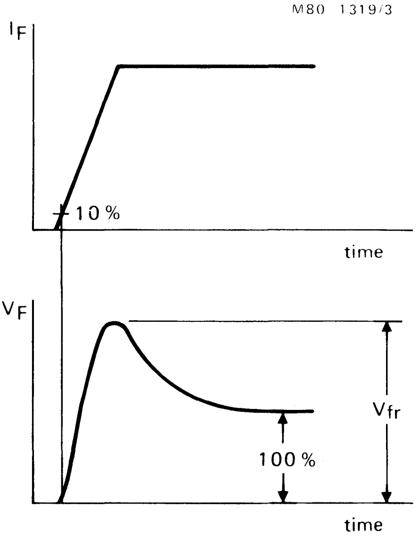


Fig.3 Definition of V_{fr}.

---

*Measured under pulse conditions to avoid excessive dissipation.

SQUARE-WAVE OPERATION

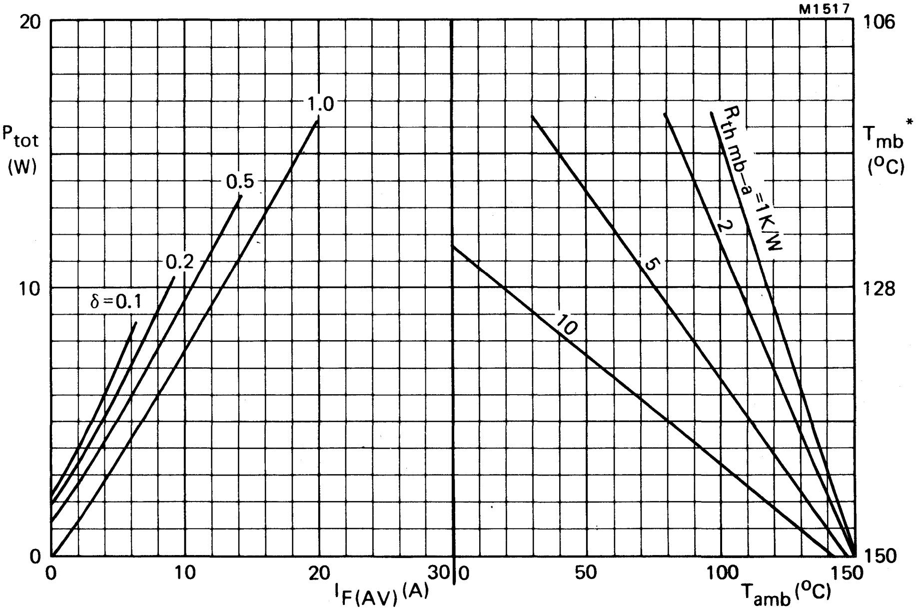
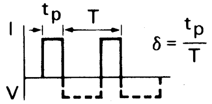


Fig.4 The right-hand part shows the interrelationship between the power (derived from the left-hand part) and the maximum permissible temperatures. Power includes reverse current losses and switching losses up to f = 500 kHz.



$I_{F(AV)} = I_{F(RMS)} \times \sqrt{\delta}$

---

*T_{mb} scale is for comparison purposes and is correct only for $R_{th\ mb\text{-}a} < 3.1$ K/W.

SINUSOIDAL OPERATION

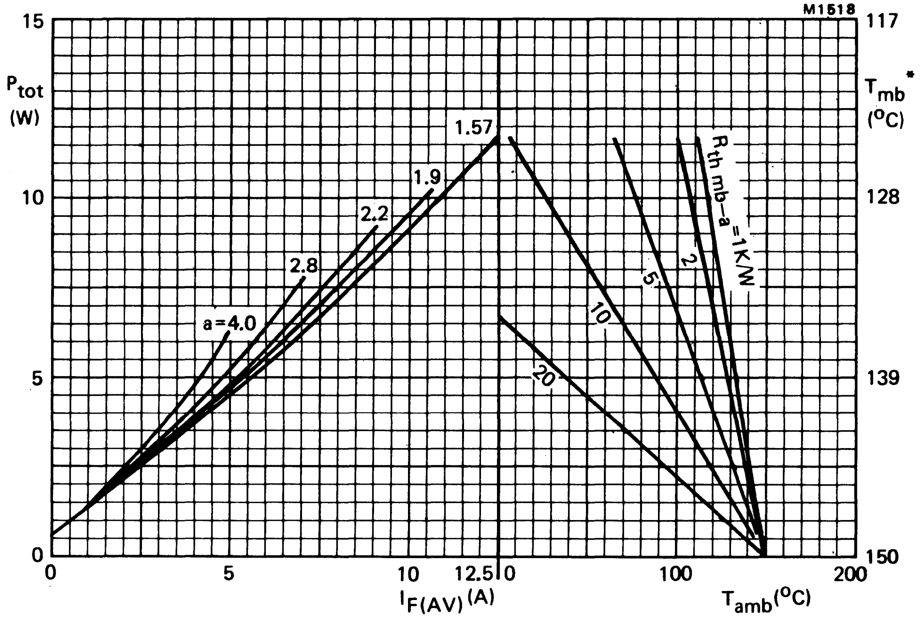


Fig.5 The right-hand part shows the interrelationship between the power (derived from the left-hand part) and the maximum permissible temperatures.
a = form factor = $I_{F(RMS)}/I_{F(AV)}$.

---

*T_{mb} scale is for comparison purposes and is correct only for $R_{th\ mb-a} < 17$ K/W.

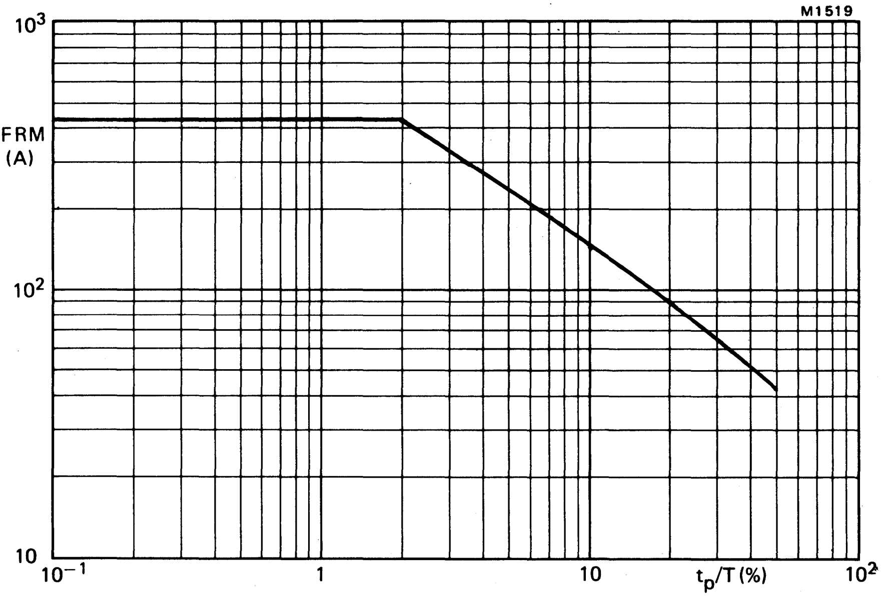
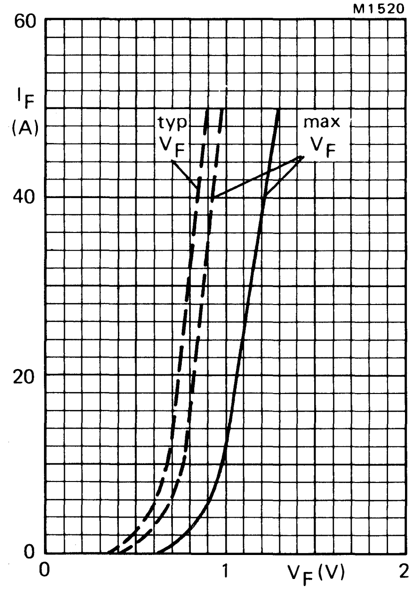
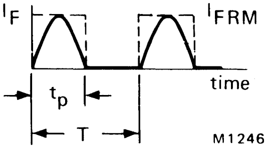


Fig.6 Maximum permissible repetitive peak forward current for square or sinusoidal currents; 1 μs $< t_p <$ 1 ms.





Definition of I_{FRM} and t_p/T.

Fig.7 —— T_j = 25 °C; – – – T_j = 150 °C.

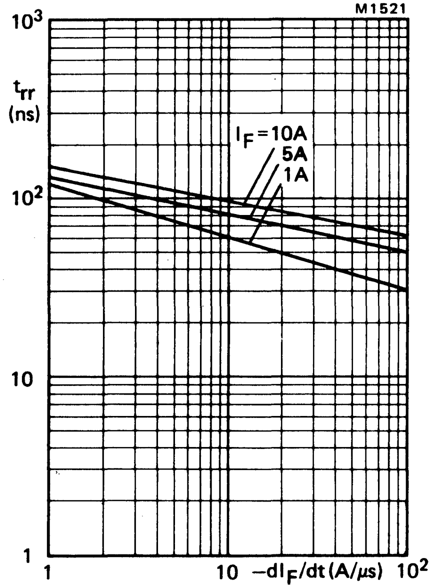


Fig.8 Maximum t_{rr} at T_j = 25 °C.

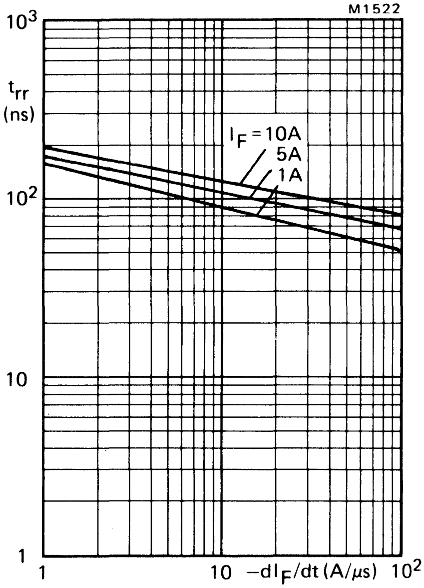


Fig.9 Maximum t_{rr} at T_j = 100 °C.

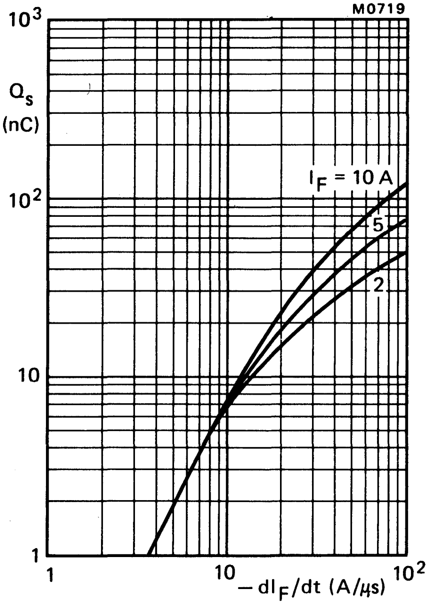


Fig.10 Maximum Q_s at T_j = 25 °C.

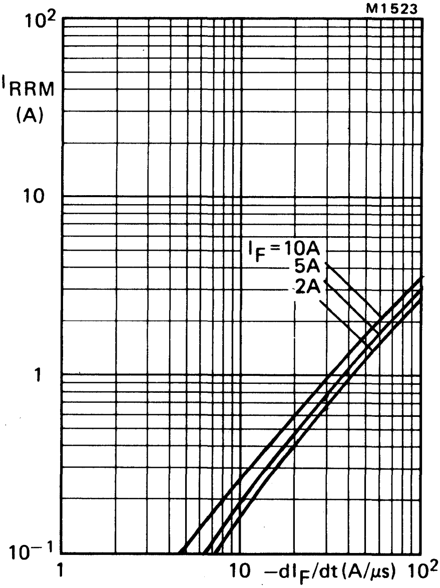


Fig.11 Maximum I_{RRM} at T_j = 25 °C.

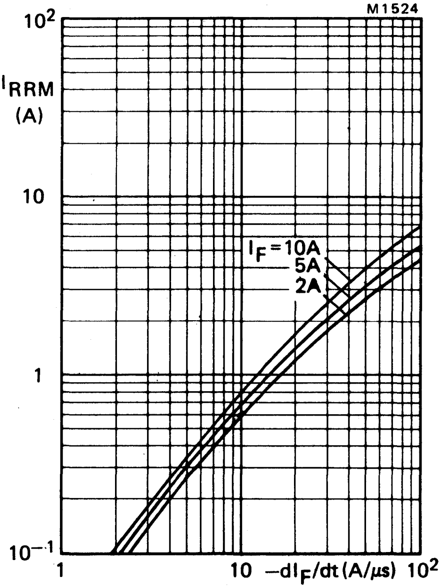


Fig.12 Maximum I_{RRM} at T_j = 100 °C.

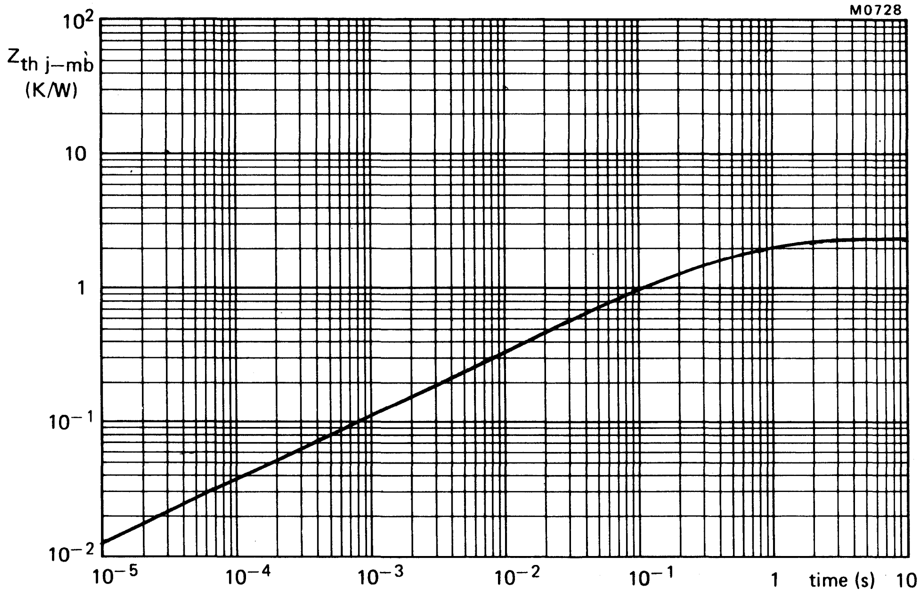


Fig. 13 Transient thermal impedance.

ULTRA FAST RECOVERY RECTIFIER DIODES

Glass-passivated, high-efficiency epitaxial rectifier diodes in DO-4 metal envelopes, featuring low forward voltage drop, ultra fast reverse recovery times, very low stored charge and soft recovery characteristic. They are intended for use in switched-mode power supplies and high-frequency circuits in general, where low conduction and switching losses are essential. The series consists of normal polarity (cathode to stud) types.

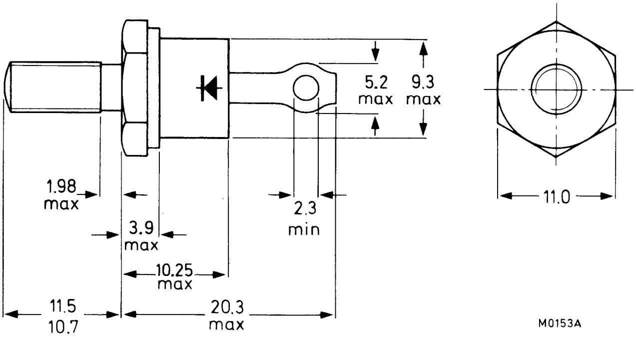
QUICK REFERENCE DATA

			BYW31–50	100	150	200	
Repetitive peak reverse voltage	V_{RRM}	max.	50	100	150	200	V
Average forward current	$I_{F(AV)}$	max.	28				A
Forward voltage	V_F	<	0.8				V
Reverse recovery time	t_{rr}	<	40				ns

MECHANICAL DATA

Dimensions in mm

Fig.1 DO-4; with metric M5 stud (ϕ5 mm); e.g. BYW31–50.
with 10-32 UNF stud (ϕ4.83 mm); e.g. BYW31–50U.



Net mass: 7 g

Diameter of clearance hole: max. 5.2 mm

Accessories supplied on request:
see ACCESSORIES section.

Supplied with device: 1 nut, 1 lock washer

Torque on nut: min. 0.9 Nm (9 kg cm)
max. 1.7 Nm (17 kg cm)

Nut dimensions across the flats;
M5: 8.0 mm; 10-32 UNF: 9.5 mm

Products approved to CECC 50 009-002, available on request.

RATINGS

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

Voltages		BYW31–50		100	150	200	
Repetitive peak reverse voltage	V_{RRM}	max.	50	100	150	200	V
Crest working reverse voltage	V_{RWM}	max.	50	100	150	200	V
Continuous reverse voltage*	V_R	max.	50	100	150	200	V

Currents				
Average forward current; switching losses negligible up to 500 kHz				
square wave; $\delta = 0.5$; up to $T_{mb} = 122\ ^{o}C$	$I_{F(AV)}$	max.	28	A
up to $T_{mb} = 125\ ^{o}C$	$I_{F(AV)}$	max.	26	A
sinsusoidal; up to $T_{mb} = 127\ ^{o}C$	$I_{F(AV)}$	max.	25	A
R.M. S. forward current	$I_{F(RMS)}$	max.	40	A
Repetitive peak forward current $t_p = 20\ \mu s$; $\delta = 0.02$	I_{FRM}	max.	550	A
Non-repetitive peak forward current half sine-wave; $T_j = 150\ ^{o}C$ prior to surge; with reapplied V_{RWMmax};				
$t = 10$ ms	I_{FSM}	max.	320	A
$t = 8.3$ ms	I_{FSM}	max.	380	A
I^2t for fusing ($t = 10$ ms)	I^2t	max.	500	A^2s

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

THERMAL RESISTANCE

From junction to mounting base	$R_{th\ j\text{-}mb}$	=	1.0	K/W
From mounting base to heatsink				
a. with heatsink compound	$R_{th\ mb\text{-}h}$	=	0.3	K/W
b. without heatsink compound	$R_{th\ mb\text{-}h}$	=	0.5	K/W
Transient thermal impedance: $t = 1$ ms	$Z_{th\ j\text{-}mb}$	=	0.2	K/W

MOUNTING INSTRUCTIONS

The top connector should be neither 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.

---

*To ensure thermal stability: $R_{th\ j\text{-}a} \leqslant 4.9$ K/W (continuous reverse voltage).

CHARACTERISTICS

Forward voltage				
$I_F = 30$ A; $T_j = 150$ °C	V_F	<	0.8	V*
$I_F = 100$ A; $T_j = 25$ °C	V_F	<	1.3	V*
Reverse current				
$V_R = V_{RWM\,max}$; $T_j = 100$ °C	I_R	<	1.5	mA
$T_j = 25$ °C	I_R	<	100	µA
Reverse recovery when switched from				
$I_F = 1$ A to $V_R \geqslant 30$ V with $-dI_F/dt = 100$ A/µs; $T_j = 25$ °C; recovery time	t_{rr}	<	40	ns
$I_F = 2$ A to $V_R \geqslant 30$ V with $-dI_F/dt = 20$ A/µs; $T_j = 25$ °C; recovered charge	Q_s	<	20	nC
$I_F = 10$ A to $V_R \geqslant 30$ V with $-dI_F/dt = 50$ A/µs; $T_j = 100$ °C; peak recovery current	I_{RRM}	<	4	A
Forward recovery when switched to $I_F = 10$ A with $dI_F/dt = 10$ A/µs; $T_j = 25$ °C	V_{fr}	typ.	1	V

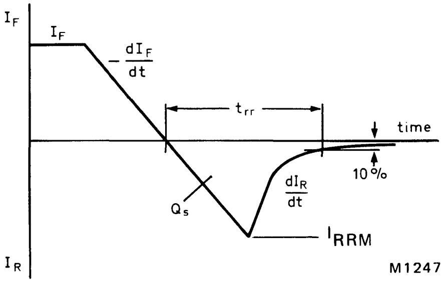


Fig.2 Definition of t_{rr}, Q_s and I_{RRM}.

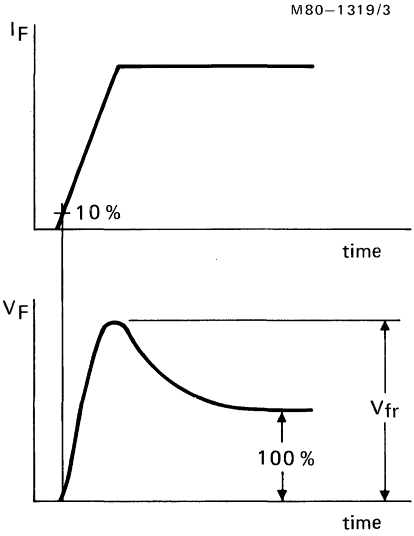


Fig.3 Definition of V_{fr}.

---

*Measured under pulse conditions to avoid excessive dissipation.

SQUARE-WAVE OPERATION

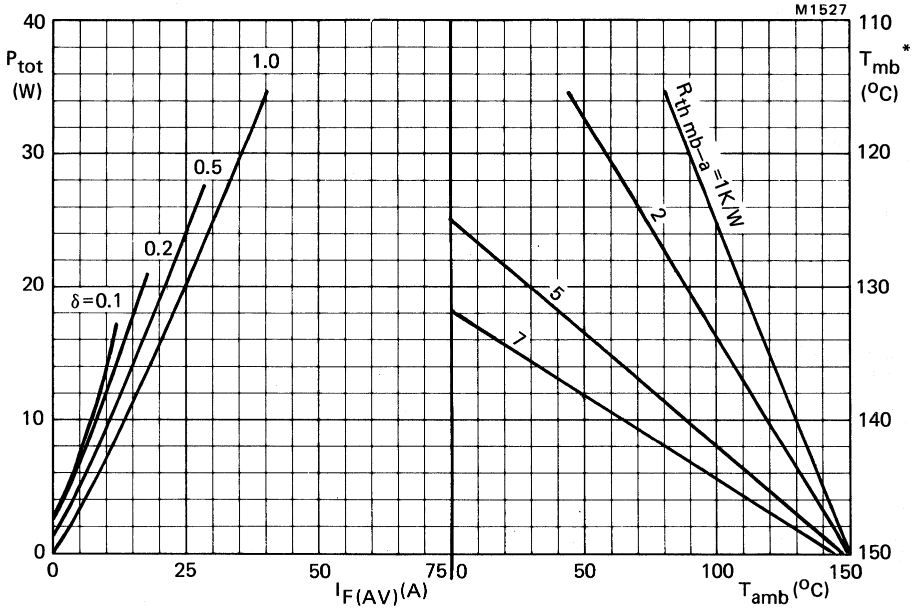
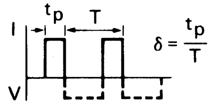


Fig.4 The right-hand part shows the interrelationship between the power (derived from the left-hand part) and the maximum permissible temperatures. Power includes reverse current losses and switching losses up to f = 500 kHz.



$I_{F(AV)} = I_{F(RMS)} \times \sqrt{\delta}$

---

*T_{mb} scale is for comparison purposes and is correct only for $R_{th\ mb-a} < 3.6$ K/W.

SINUSOIDAL OPERATION

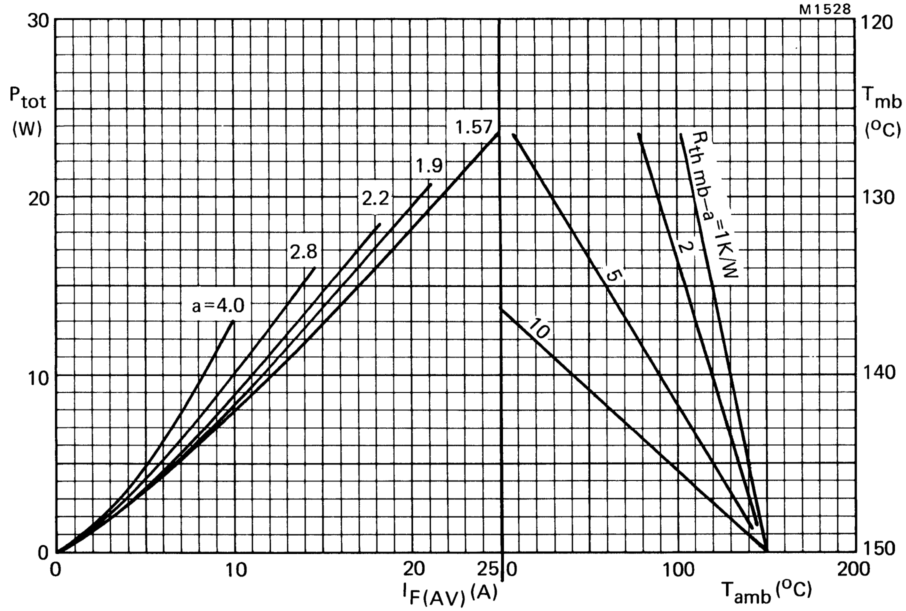


Fig.5 The right-hand part shows the interrelationship between the power (derived from the left-hand part) and the maximum permissible temperatures. Power includes reverse current losses and switching losses up to f = 500 kHz.
a = form factor = $I_{F(RMS)}/I_{F(AV)}$.

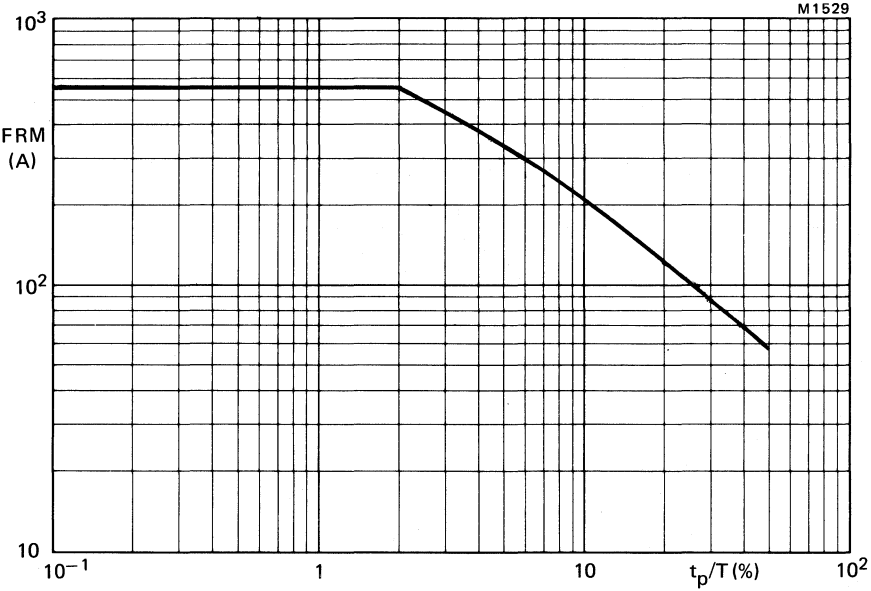
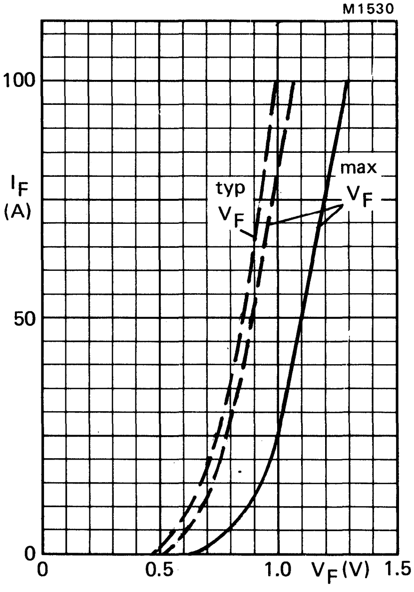
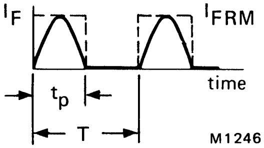


Fig.6 Maximum permissible repetitive peak forward current for square or sinusoidal currents; 1 μs $< t_p <$ 1 ms.





Definition of I_{FRM} and t_p/T.

Fig.7 ——— T_j = 25 °C; – – – T_j = 150 °C.

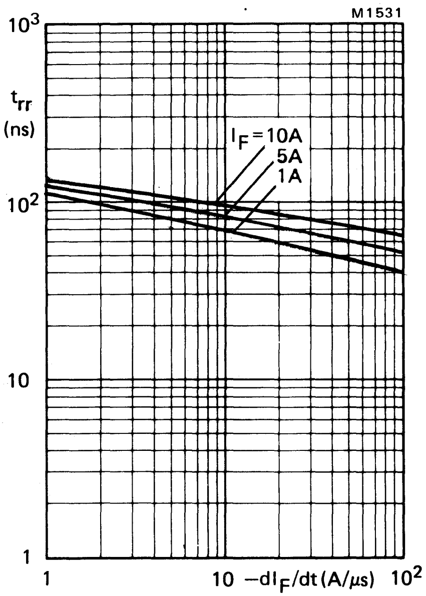


Fig.8 Maximum t_{rr} at T_j = 25 °C.

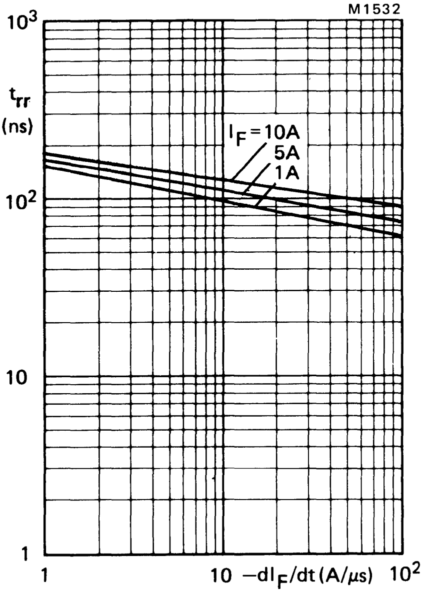


Fig.9 Maximum t_{rr} at T_j = 100 °C.

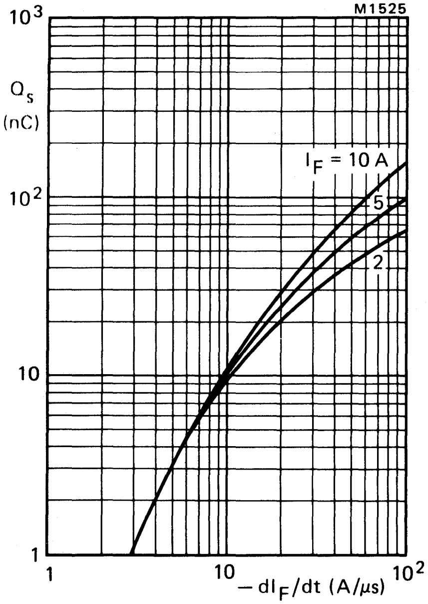


Fig.10 Maximum Q_s at T_j = 25 °C.

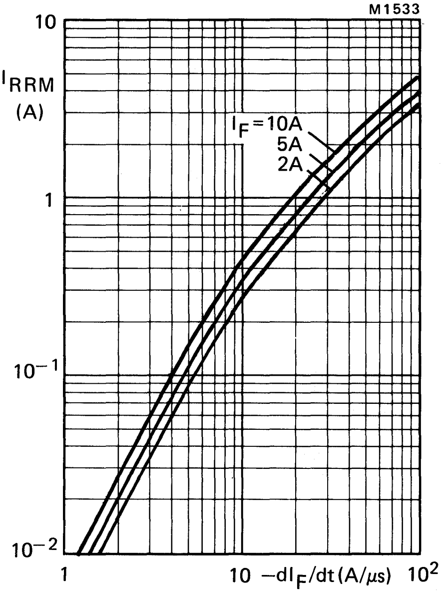


Fig.11 Maximum I_{RRM} at T_j = 25 °C.

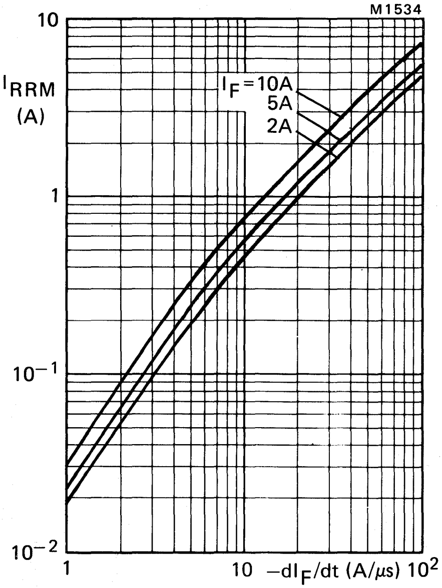


Fig.12 Maximum I_{RRM} at T_j = 100 °C.

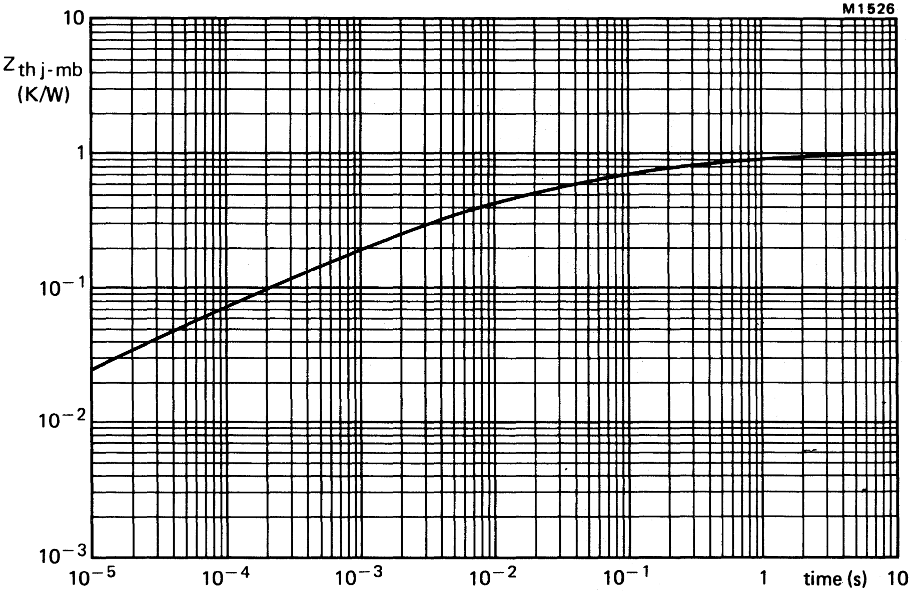


Fig.13 Transient thermal impedance.

ULTRA FAST RECOVERY RECTIFIER DIODES

Glass-passivated, high-efficiency epitaxial rectifier diodes in DO-5 metal envelopes, featuring low forward voltage drop, ultra fast reverse recovery times, very low stored charge and soft recovery characteristic. They are intended for use in switched-mode power supplies and high-frequency circuits in general, where low conduction and switching losses are essential. The series consists of normal polarity (cathode to stud) types.

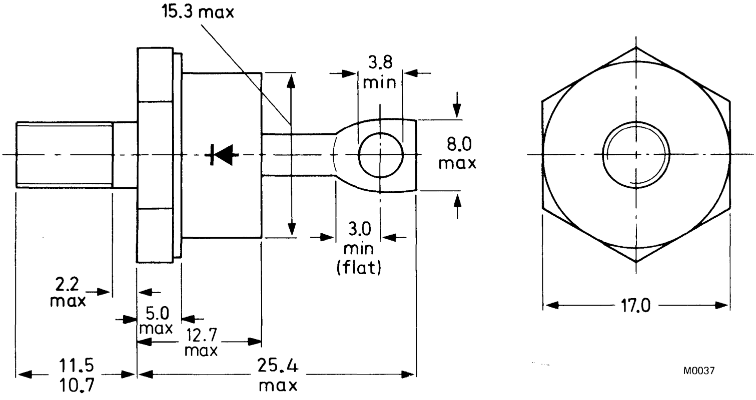
QUICK REFERENCE DATA

			BYW92–50	100	150	200	
Repetitive peak reverse voltage	V_{RRM}	max.	50	100	150	200	V
Average forward current	$I_{F(AV)}$	max.	40				A
Forward voltage	V_F	<	0.8				V
Reverse recovery time	t_{rr}	<	40				ns

MECHANICAL DATA

Dimensions in mm

Fig.1 DO-5: with metric M6 stud (ϕ 6 mm); e.g. BYW92-50.
with ¼ in x 28 UNF stud (ϕ 6.35 mm); e.g. BYW92–50U.



Net mass: 22 g
Diameter of clearance hole: max. 6.5 mm
Accessories supplied on request:
see ACCESSORIES section.

Supplied with device: 1 nut. 1 lock washer
Torque on nut: min. 1.7 Nm (17 kg cm)
max. 3.5 Nm (35 kg cm)
Nut dimensions across the flats:
M6: 10 mm; ¼ in x 28 UNF: 11.1 mm

Products approved to CECC 50 009-003, available on request.

RATINGS

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

Voltages			BYW92–50	100	150	200	
Repetitive peak reverse voltage	V_{RRM}	max.	50	100	150	200	V
Crest working reverse voltage	V_{RWM}	max.	50	100	150	200	V
Continuous reverse voltage*	V_R	max.	50	100	150	200	V

Currents

Average forward current; switching losses negligible up to 500 kHz				
square wave; $\delta = 0.5$; up to $T_{mb} = 110\ ^{o}C$	$I_{F(AV)}$	max.	40	A
up to $T_{mb} = 125\ ^{o}C$	$I_{F(AV)}$	max.	27	A
sinusoidal; up to $T_{mb} = 115\ ^{o}C$	$I_{F(AV)}$	max.	35	A
up to $T_{mb} = 125\ ^{o}C$	$I_{F(AV)}$	max.	26	A
R.M.S. forward current	$I_{F(RMS)}$	max.	55	A
Repetitive peak forward current $t_p = 20\ \mu s$; $\delta = 0.02$	I_{FRM}	max.	800	A
Non-repetitive peak forward current half sine-wave; $T_j = 150\ ^{o}C$ prior to surge; with reapplied V_{RWMmax};				
$t = 10$ ms	I_{FSM}	max.	500	A
$t = 8.3$ ms	I_{FSM}	max.	600	A
I^2t for fusing ($t = 10$ ms)	I^2t	max.	1250	A^2s

Temperatures

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

THERMAL RESISTANCE

From junction to mounting base	$R_{th\ j\text{-}mb}$	=	1.0	K/W
From mounting base to heatsink				
a. with heatsink compound	$R_{th\ mb\text{-}h}$	=	0.3	K/W
b. without heatsink compound	$R_{th\ mb\text{-}h}$	=	0.5	K/W
Transient thermal impedance; $t = 1$ ms	$Z_{th\ j\text{-}mb}$	=	0.2	K/W

MOUNTING INSTRUCTIONS

The top connector should be neither 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.

---

*To ensure thermal stability: $R_{th\ j\text{-}a} \leqslant 4.9$ K/W

CHARACTERISTICS

Forward voltage				
I_F = 35 A; T_j = 150 °C	V_F	<	0.8	V*
I_F = 100 A; T_j = 25 °C	V_F	<	1.3	V*
Reverse current				
$V_R = V_{RRMmax}$; T_j = 100 °C	I_R	<	2.5	mA
T_j = 25 °C	I_R	<	100	μA
Reverse recovery when switched from				
I_F = 1 A to $V_R \geqslant 30$ V with $-dI_F/dt$ = 100 A/μs; T_j = 25 °C; recovery time	t_{rr}	<	40	ns
I_F = 2 A to $V_R \geqslant 30$ V with $-dI_F/dt$ = 20 A/μs; T_j = 25 °C; recovered charge	Q_s	<	20	nC
I_F = 10 A to $V_R \geqslant 30$ V with $-dI_F/dt$ = 50 A/μs; T_j = 100 °C; peak recovery current	I_{RRM}	<	4.5	A
Forward recovery when switched to I_F = 10 A with dI_F/dt = 10 A/μs; T_j = 25 °C	V_{fr}	typ.	1.0	V

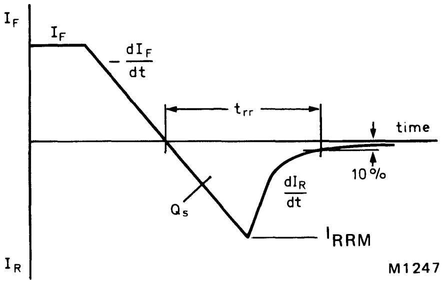


Fig.2 Definition of t_{rr}, Q_s and I_{RRM}.

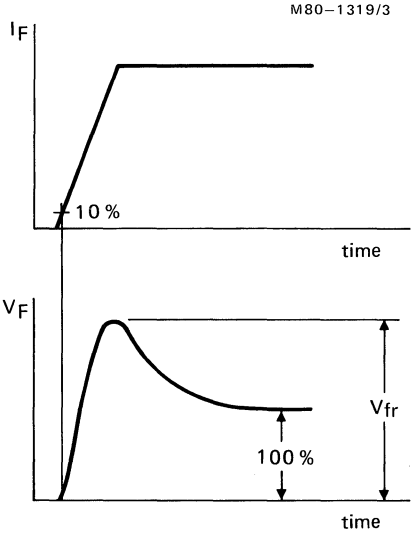


Fig.3 Definition of V_{fr}.

---

*Measured under pulse conditions to avoid axcessive dissipation.

SQUARE-WAVE OPERATION

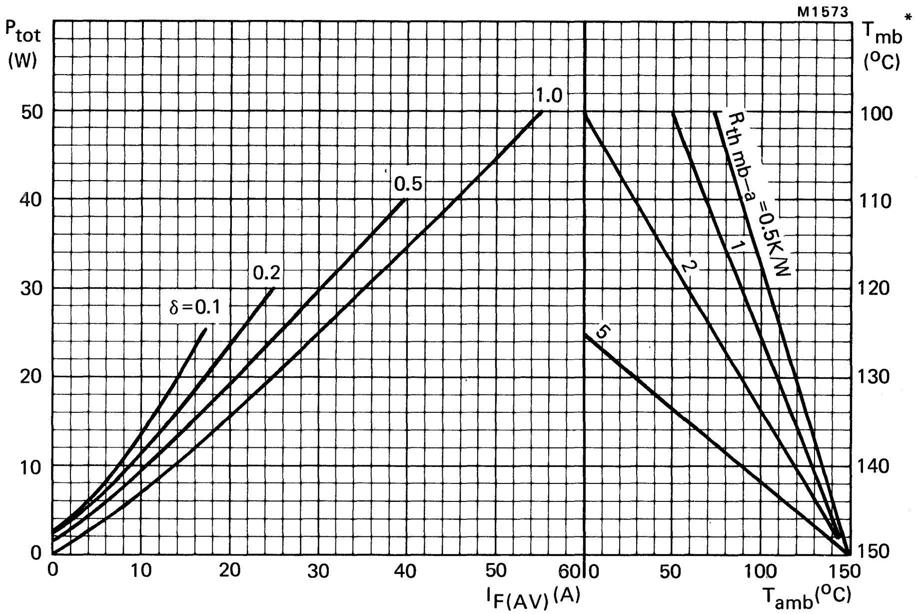
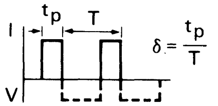


Fig.4 The right-hand part shows the interrelationship between the power (derived from the left-hand part) and the maximum permissible temperatures. Power includes reverse current losses and switching losses up to f = 500 kHz.



$\delta = \frac{t_p}{T}$

$I_{F(AV)} = I_{F(RMS)} \times \sqrt{\delta}$

---

*T_{mb} scale is for comparison purposes and is correct only for $R_{th\ mb\text{-}a} < 3.6$ K/W.

SINUSOIDAL OPERATION

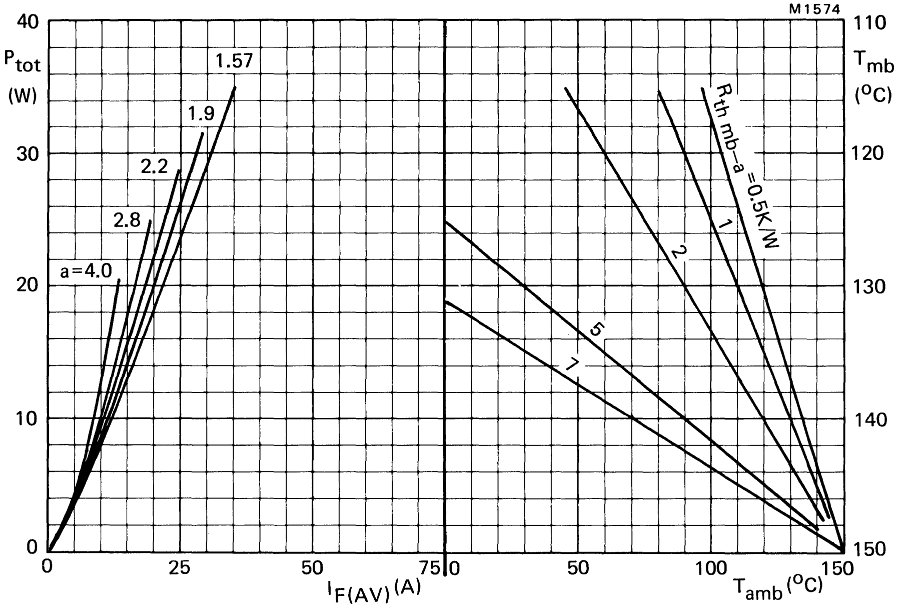


Fig.5 The right-hand part shows the interrelationship between the power (derived from the left-hand part) and the maximum permissible temperatures. Power includes reverse current losses and switching losses up to f = 500 kHz.
a = form factor = $I_{F(RMS)}/I_{F(AV)}$.

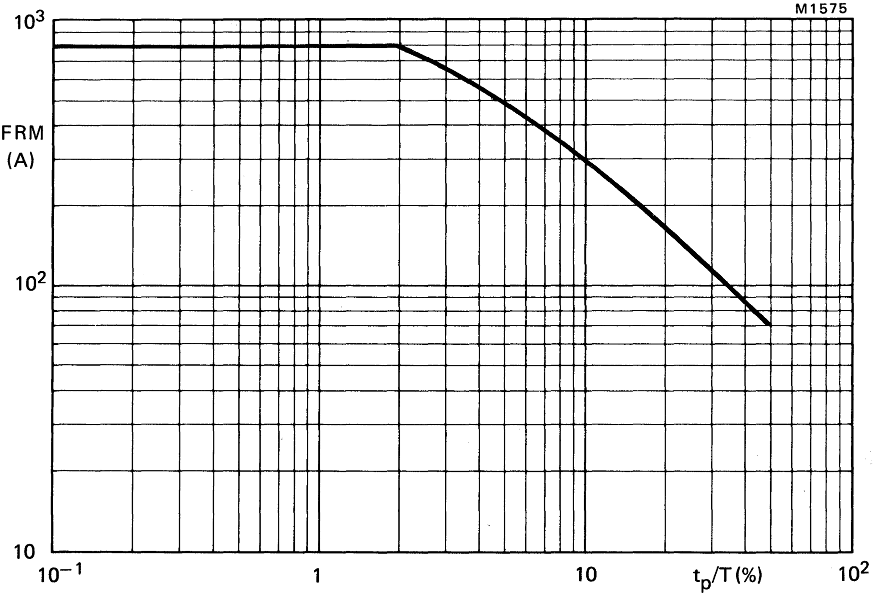
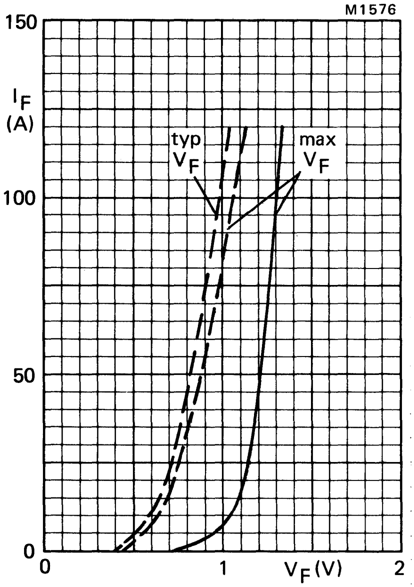
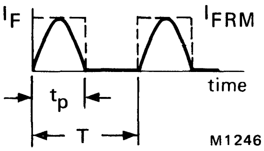


Fig.6 Maximum permissible repetitive peak forward current for square or sinusoidal currents; 1 μs < t_p < 1 ms.





Definition of I_{FRM} and t_p/T.

Fig.7 —— T_j = 25 °C; – – – T_j = 150 °C.

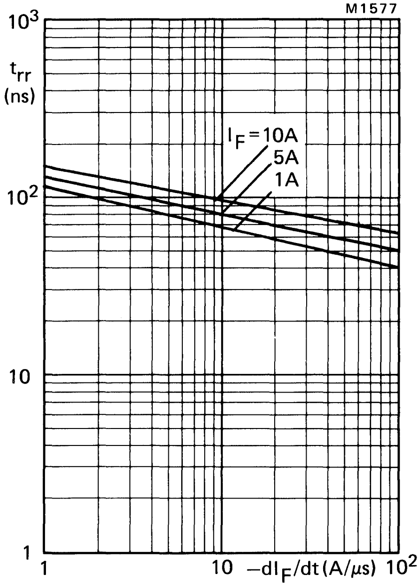


Fig.8 Maximum t_{rr} at T_j = 25 °C.

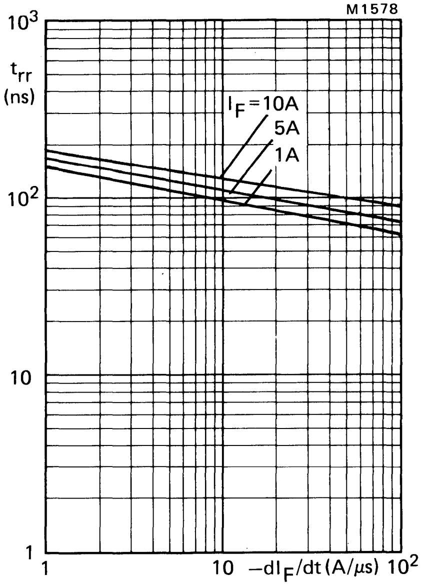


Fig.9 Maximum t_{rr} at T_j = 100 °C.

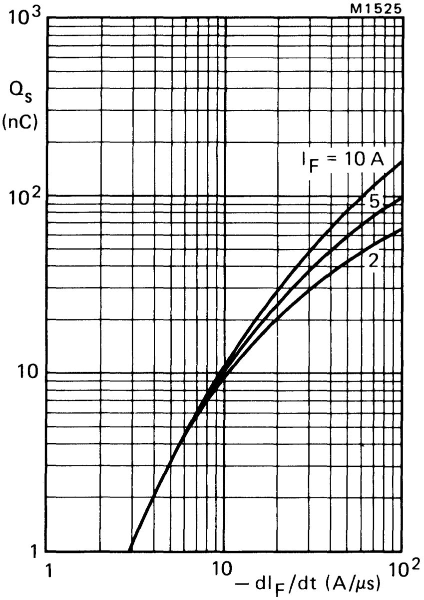


Fig.10 Maximum Q_s at T_j = 25 °C.

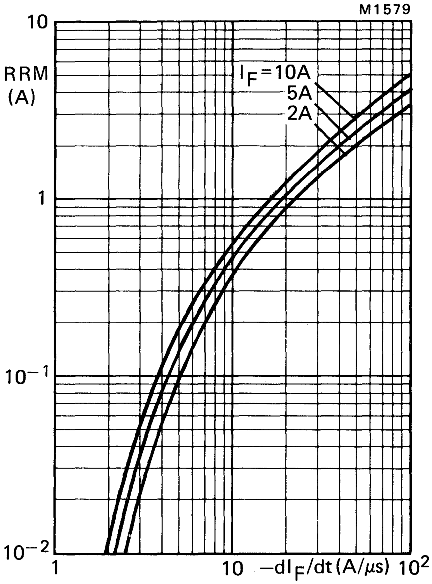


Fig.11 Maximum I_{RRM} at T_j = 25 °C.

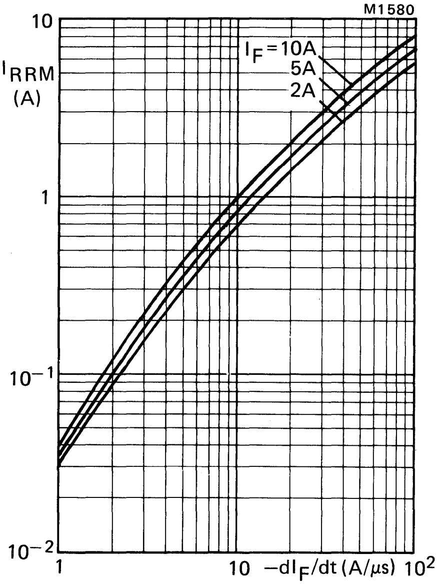


Fig.12 Maximum I_{RRM} at T_j = 100 °C.

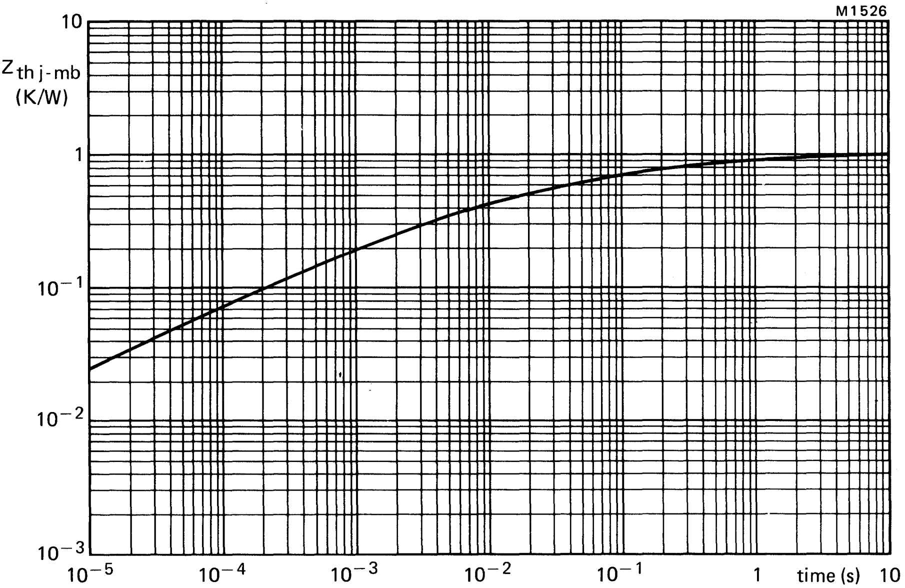


Fig.13 Transient thermal impedance.

ULTRA FAST RECOVERY RECTIFIER DIODES

Glass-passivated, high-efficiency epitaxial rectifier diodes in DO-5 metal envelopes, featuring low forward voltage drop, ultra fast reverse recovery times, very low stored charge and soft recovery characteristic. They are intended for use in switched-mode power supplies and high-frequency circuits in general, where low conduction and switching losses are essential. The series consists of normal polarity (cathode to stud) types.

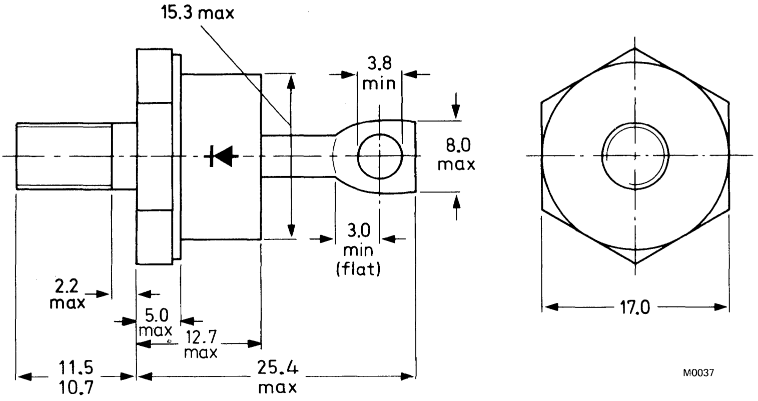
QUICK REFERENCE DATA

			BYW93–50	100	150	200	
Repetitive peak reverse voltage	V_{RRM}	max.	50	100	150	200	V
Average forward current	$I_{F(AV)}$	max.	60				A
Forward voltage	V_F	$<$	0.8				V
Reverse recovery time	t_{rr}	$<$	45				ns

MECHANICAL DATA

Dimensions in mm

Fig. 1 DO-5; with metric M6 stud (ϕ 6 mm): e.g. BYW93–50
with ¼ in x 28 UNF stud (ϕ 6.35 mm); e.g. BYW93–50U



Net mass: 22 g

Diameter of clearance hole: max. 6.5 mm

Accessories supplied on request:
see ACCESSORIES section.

Supplied with device: 1 nut, 1 lock washer

Torque on nut: min. 1.7 Nm (17 kg cm)
max. 3.5 Nm (35 kg cm)

Nut dimensions across the flats: M6: 10 mm,
¼ in x 28 UNF: 11.1 mm

Products approved to CECC 50 009-028, available on request.

RATINGS

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

Voltages			BYW93–50	100	150	200	
Repetitive peak reverse voltage	V_{RRM}	max.	50	100	150	200	V
Crest working reverse voltage	V_{RWM}	max.	50	100	150	200	V
Continuous reverse voltage*	V_R	max.	50	100	150	200	V

Currents				
Average forward current; switching losses negligible up to 500 kHz				
square wave; $\delta = 0.5$; up to $T_{mb} = 110\,^oC$	$I_{F(AV)}$	max.	60	A
up to $T_{mb} = 125\,^oC$	$I_{F(AV)}$	max.	40	A
sinusoidal; up to $T_{mb} = 115\,^oC$	$I_{F(AV)}$	max.	50	A
up to $T_{mb} = 125\,^oC$	$I_{F(AV)}$	max.	38	A
R.M.S. forward current	$I_{F(RMS)}$	max.	85	A
Repetitive peak forward current $t_p = 20\,\mu s$; $\delta = 0.02$	I_{FRM}	max.	1500	A
Non-repetitive peak forward current half sine-wave; $T_j = 150\,^oC$ prior to surge; with reapplied V_{RWMmax};				
$t = 10$ ms	I_{FSM}	max.	800	A
$t = 8.3$ ms	I_{FSM}	max.	1000	A
I^2t for fusing ($t = 10$ ms)	I^2t	max.	3200	A^2s

Temperatures				
Storage temperature	T_{stg}		−55 to +150	^oC
Junction temperature	T_j	max.	150	^oC

THERMAL RESISTANCE

From junction to mounting base	$R_{th\ j\text{-}mb}$	=	0.7	K/W
From mounting base to heatsink				
a. with heatsink compound	$R_{th\ mb\text{-}h}$	=	0.2	K/W
b. without heatsink compound	$R_{th\ mb\text{-}h}$	=	0.3	K/W
Transient thermal impedance; t = 1 ms	$Z_{th\ j\text{-}mb}$	=	0.32	K/W

MOUNTING INSTRUCTIONS

The top connector should be neither 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.

---

*To ensure thermal stability: $R_{th\ j\text{-}a} \leqslant 3.0$ K/W.

CHARACTERISTICS

Forward voltage				
I_F = 50 A; T_j = 150 °C	V_F	<	0.8	V*
I_F = 150 A; T_j = 25 °C	V_F	<	1.3	V*
Reverse current				
$V_R = V_{RWM\,max}$; T_j = 100 °C	I_R	<	5	mA
T_j = 25 °C	I_R	<	250	µA
Reverse recovery when switched from				
I_F = 1 A to $V_R \geq 30$ V with $-dI_F/dt$ = 100 A/µs; T_j = 25 °C; recovery time	t_{rr}	<	45	ns
I_F = 2 A to $V_R \geq 30$ V with $-dI_F/dt$ = 20 A/µs T_j = 25 °C; recovered charge	Q_s	<	35	nC
I_F = 10 A to $V_R \geq 30$ V with $-dI_F/dt$ = 50 A/µs; T_j = 100 °C; peak recovery current	I_{RRM}	<	6	A
Forward recovery when switched to I_F = 10 A with dI_F/dt = 10 A/µs; T_j = 25 °C	V_{fr}	typ.	1.0	V

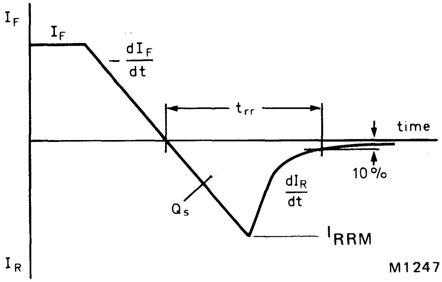


Fig.2 Definition of t_{rr}, Q_s and I_{RRM}.

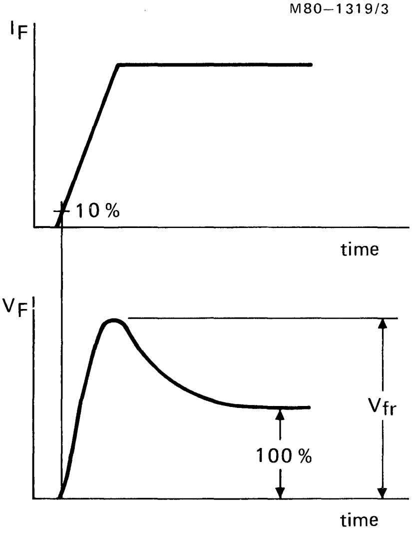


Fig.3 Definition of V_{fr}.

---

*Measured under pulse conditions to avoid excessive dissipation.

SQUARE-WAVE OPERATION

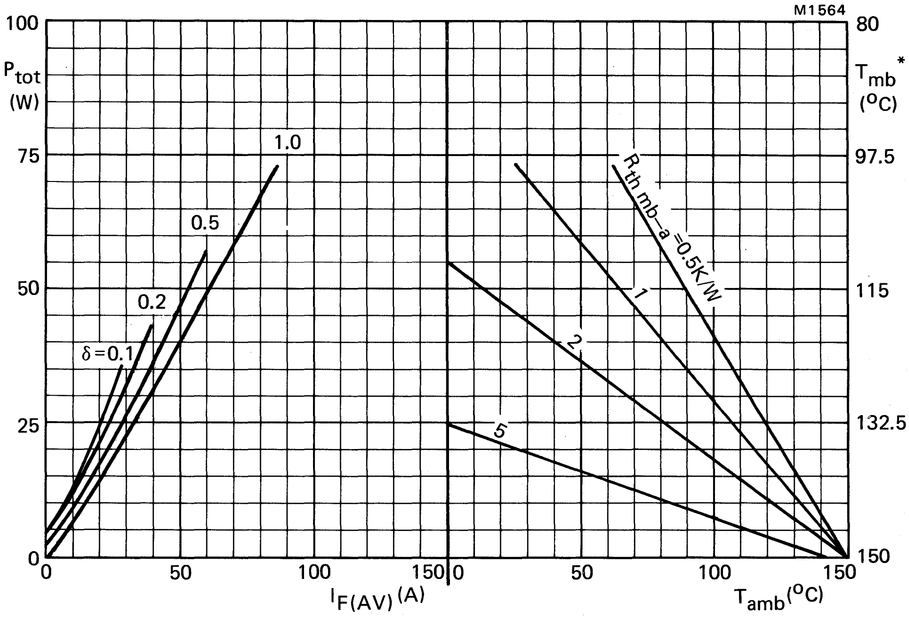
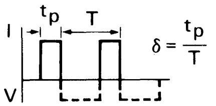


Fig.4 The right-hand part shows the interrelationship between the power (derived from the left-hand part) and the maximum permissible temperatures.
Power includes reverse current losses.



$I_{F(AV)} = I_{F(RMS)} \times \sqrt{\delta}$

---

*T_{mb} scale is for comparison purposes and is correct only for $R_{th\ mb\text{-}a} < 2.1$ K/W

SINUSOIDAL OPERATION

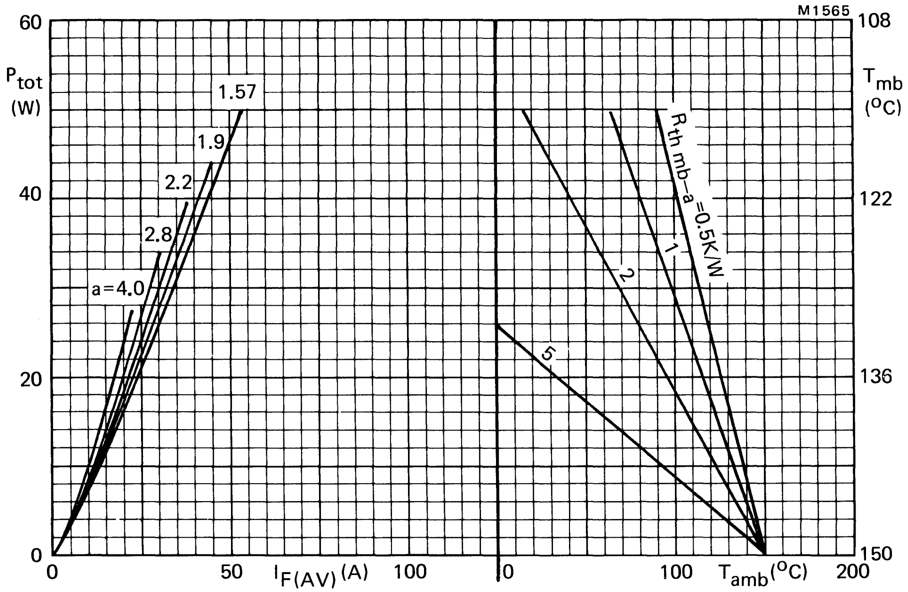


Fig.5 The right-hand part shows the interrelationship between the power (derived from the left-hand part) and the maximum permissible temperatures.
Power includes reverse current losses.
a = form factor = $I_{F(RMS)}/I_{F(AV)}$.

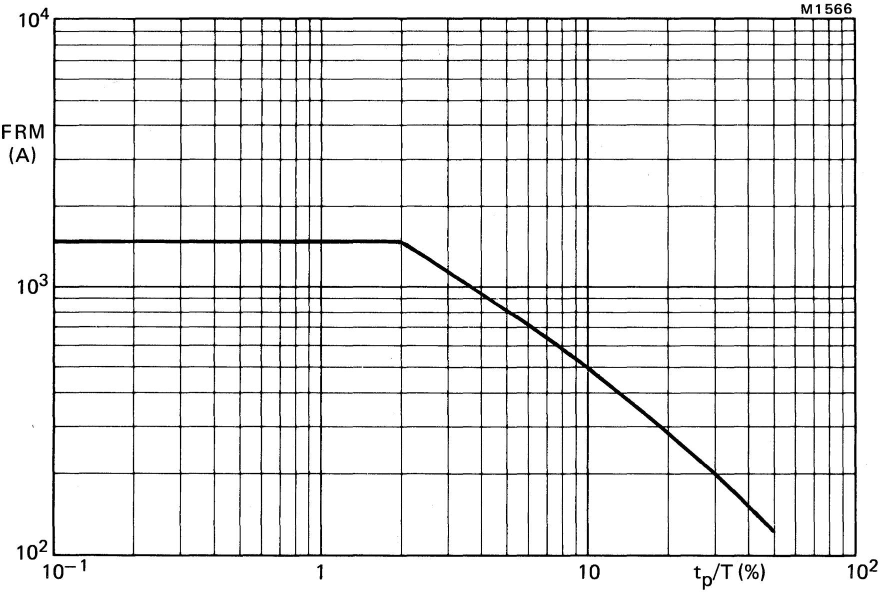
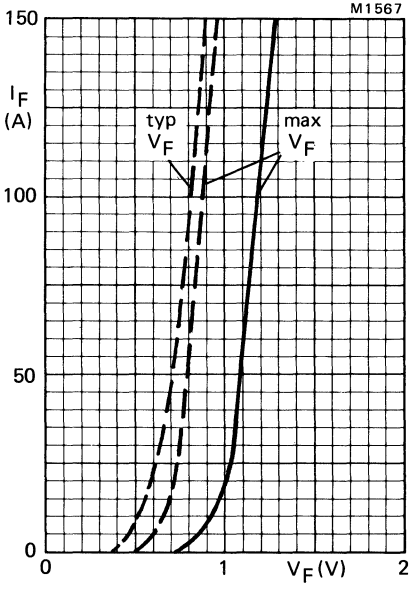
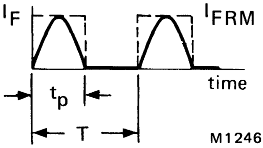


Fig.6 Maximum permissible repetitive peak forward current for square or sinusoidal currents; 1 μs $< t_p <$ 1 ms.





Definition of I_{FRM} and t_p/T.

Fig.7 —— T_j = 25 °C; – – – T_j = 150 °C.

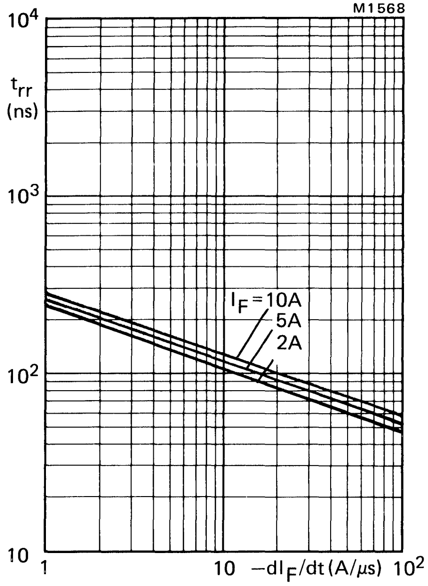


Fig.8 Maximum t_{rr} at T_j = 25 °C.

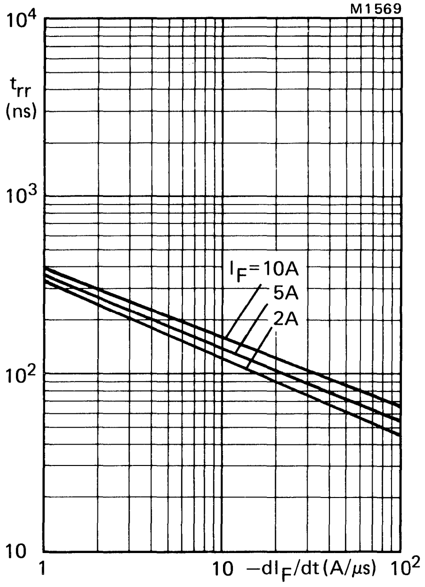


Fig.9 Maximum t_{rr} at T_j = 100 °C.

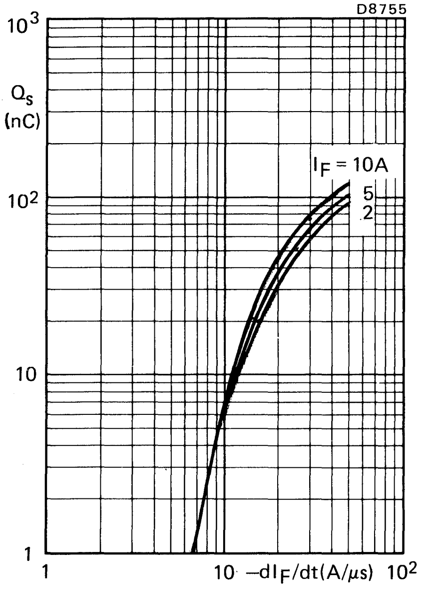


Fig.10 Maximum Q_s at T_j = 25 °C.

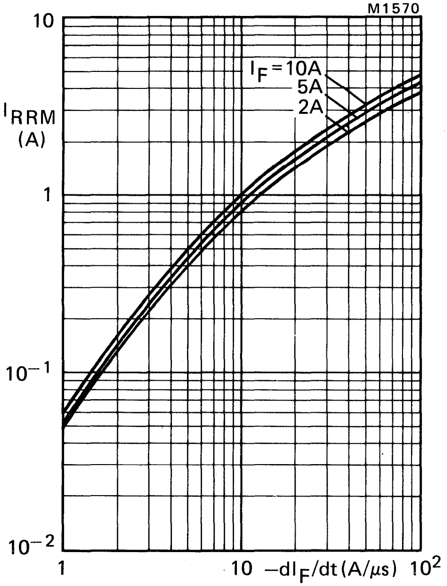


Fig.11 Maximum I_{RRM} at T_j = 25 °C.

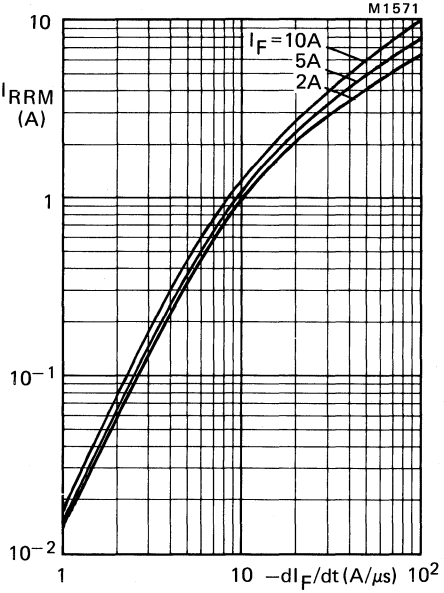


Fig.12 Maximum I_{RRM} at T_j = 100 °C.

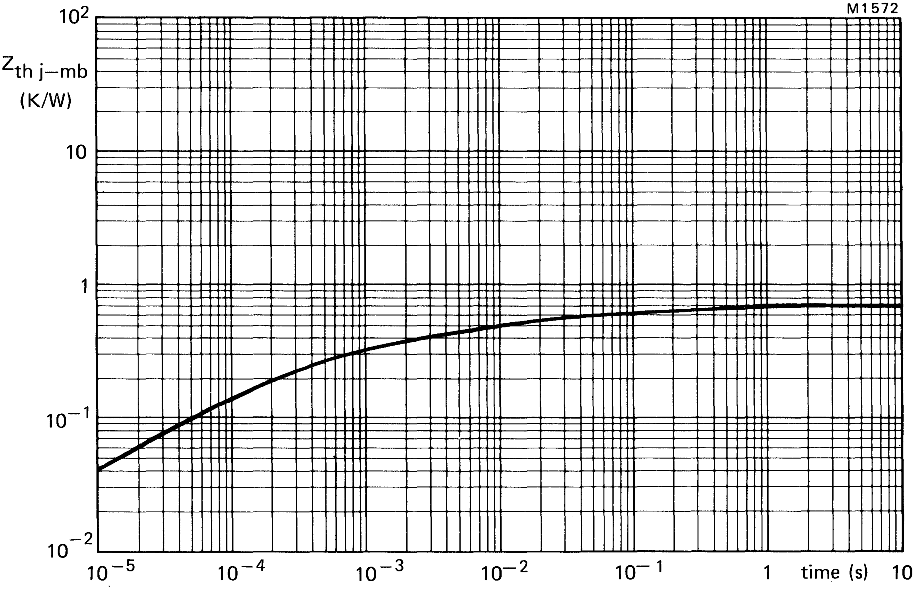


Fig.13 Transient thermal impedance.

FAST SOFT-RECOVERY RECTIFIER DIODES

- **With controlled avalanche**

Also available to BS9333-F002

Diffused silicon diodes in DO-4 metal envelopes, 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.

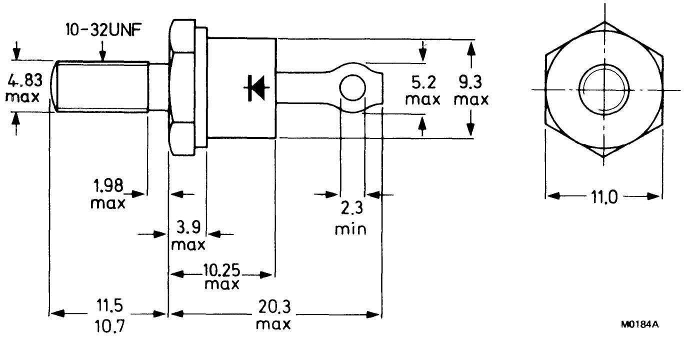
QUICK REFERENCE DATA

			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	$I_{F(AV)}$	max.	14					A
Non-repetitive peak forward current	I_{FSM}	max.	250					A
Non-repetitive peak reverse power	P_{RSM}	max.	18					kW
Reverse recovery time	t_{rr}	<	200					ns

MECHANICAL DATA

Dimensions in mm

DO-4; Supplied with device: 1 nut, 1 lock-washer
Nut dimensions across the flats: 9.5 mm



Net mass: 7 g
Diameter of clearance hole: max. 5.2 mm
Accessories supplied on request:
see ACCESSORIES section

Torque on nut: min. 0.9 Nm
(9 kg cm)
max. 1.7 Nm
(17 kg cm)

The mark shown applies to the normal polarity types.

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

Voltages [1]

			BYX30-200(R)	300(R)	400(R)	500(R)	600(R)	
Crest working reverse voltage	V_{RWM}	max.	200	300	400	500	600	V
Continuous reverse voltage	V_R	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
R.M.S. forward current	$I_{F(RMS)}$	max.	22	A
Repetitive peak forward current	I_{FRM}	max.	310	A
Non-repetitive peak forward current (t = 10 ms; half-sinewave) T_j = 150 °C prior to surge; with reapplied V_{RWM} max.	I_{FSM}	max.	250	A
I^2t for fusing (t = 10 ms)	I^2t	max.	312	A^2s

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

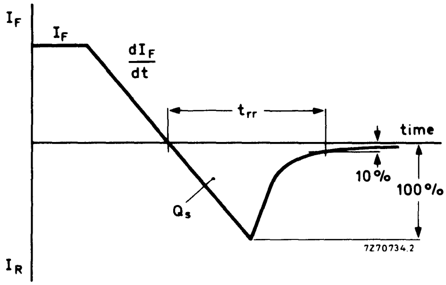
---

[1] To ensure thermal stability: $R_{th\ j-a} < 2.5$ °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 469.
For continuous reverse voltage: if $R_{th\ j-a}$ = 5 °C/W, then T_j max = 135 °C.
if $R_{th\ j-a}$ = 10 °C/W, then T_j max = 120 °C.

CHARACTERISTICS

			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
Reverse current								
$V_R = V_{RWMmax}$; T_j = 125 °C	I_R	<	4.0	4.0	4.0	4.0	4.0	mA

Reverse recovery charge when switched from I_F = 2 A to $V_R \geq$ 30 V; with $-dI_F/dt$ = 100 A/µs; T_j = 25 °C	Q_s	<	0.70	µC
Reverse recovery time when switched from I_F = 1 A to $V_R \geq$ 30 V; $-dI_F/dt$ = 50 A/µs; T_j = 25 °C	t_{rr}	<	200	ns



OPERATING NOTES

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 fall time 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 474.

---

1) Measured under pulse 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	^{o}C
switched from	I_F	=	12	A
to	V_R	=	400	V
at a rate	$-\frac{dI}{dt}$	=	20	A/μs

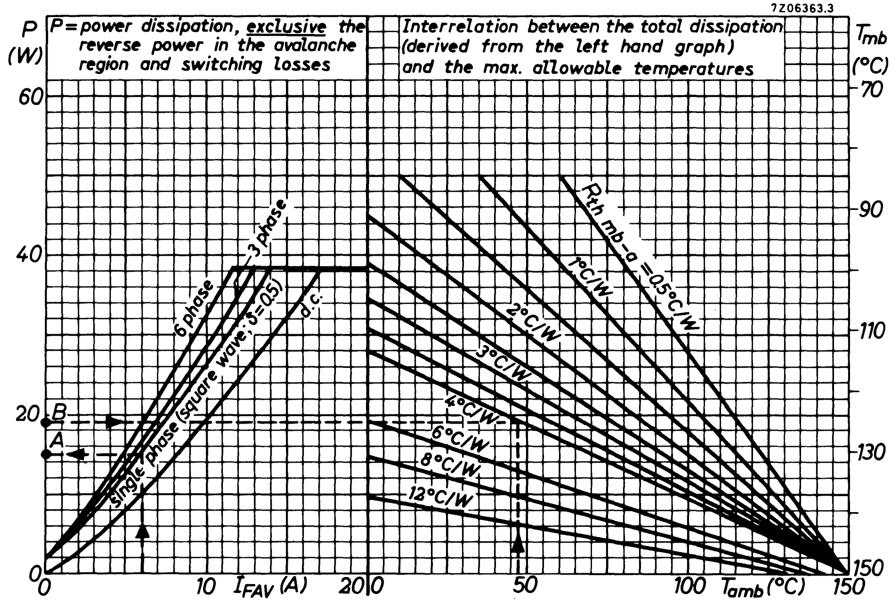
At a duty cycle $\delta = 0.5$ the average forward current $I_{FAV} = 6$ A.
From the upper graph on page 469 it follows,that at $I_{FAV} = 6$ A the average forward power + average leakage power = 15 W (point A).
The additional power losses due to switching-off can be read from the nomogram on page 474 (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 469). From the right hand part follows the thermal resistance required at $T_{amb} = 45$ °C.

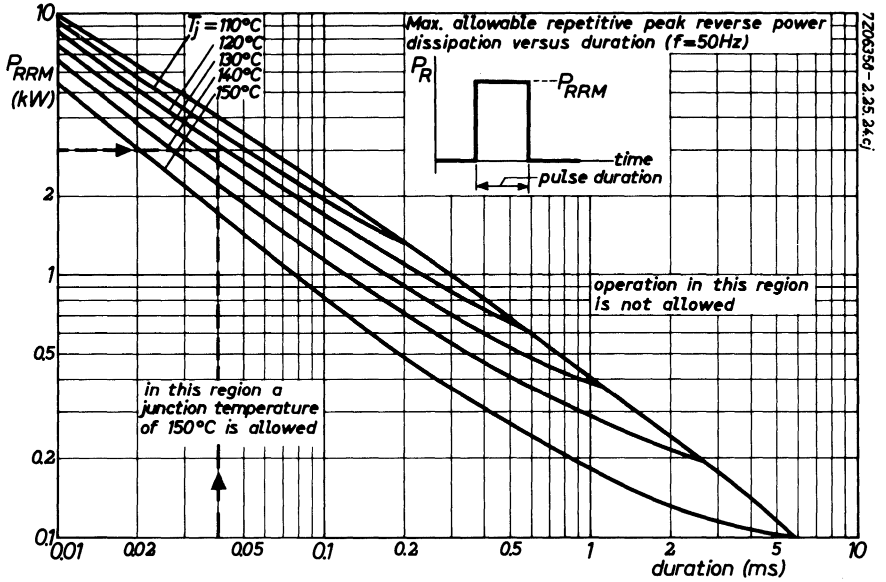
$$R_{th\ mb\text{-}a} \approx 4\ ^{o}C/W$$

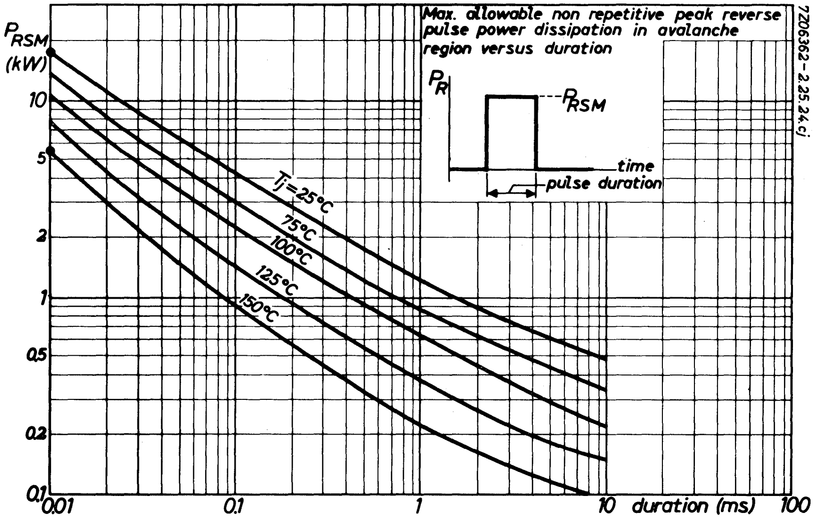
The contact thermal resistance $R_{th\ mb\text{-}h} = 0.5\ ^{o}C/W$.

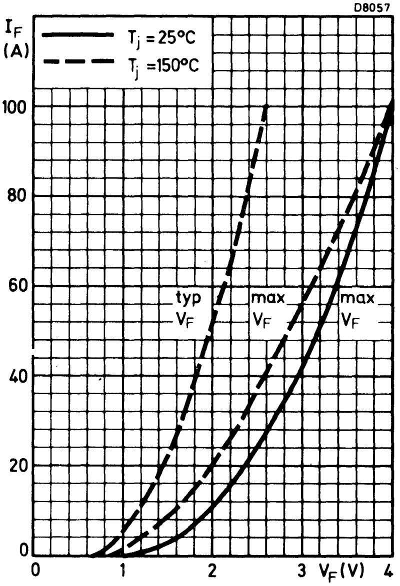
Hence the heatsink thermal resistance should be:

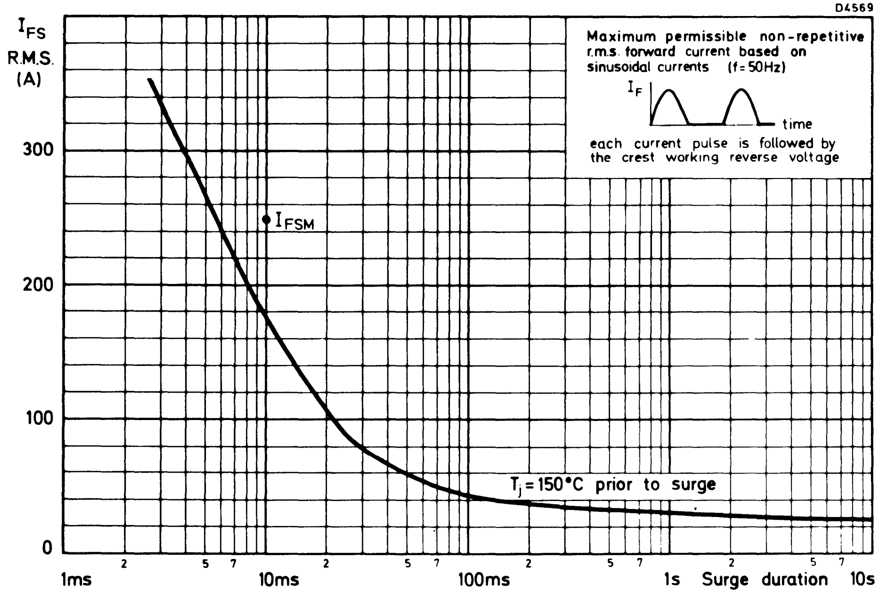
$$R_{th\ h\text{-}a} = R_{th\ mb\text{-}a} - R_{th\ mb\text{-}h} = (4 - 0.5)\ ^{o}C/W = 3.5\ ^{o}C/W.$$

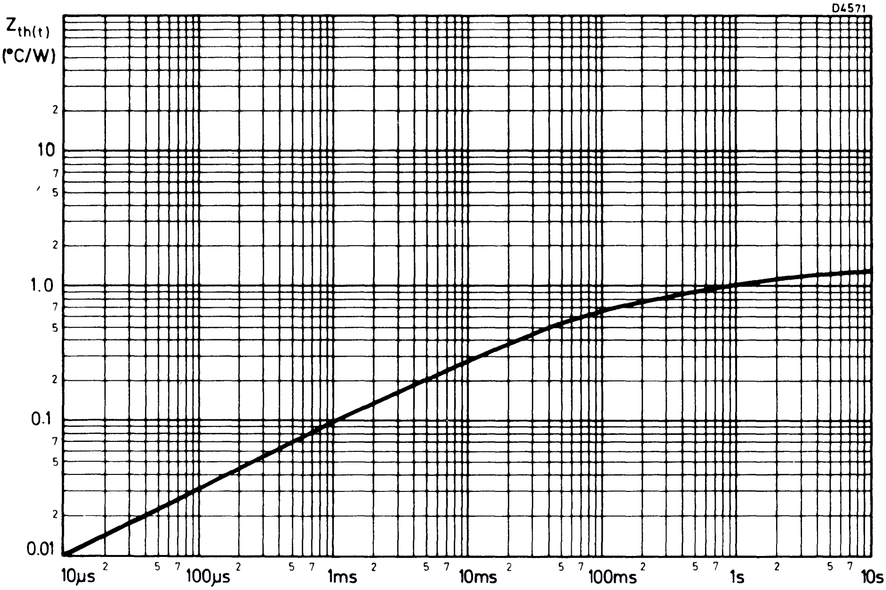

7Z06363.3
P
(W)
P = power dissipation, exclusive the reverse power in the avalanche region and switching losses
60
40
20
0
B
A
6 phase
3 phase
single phase (square wave; δ = 0.5)
d.c.
0
10
I_{FAV} (A)
20
Interrelation between the total dissipation (derived from the left hand graph) and the max. allowable temperatures
$R_{th\ mb-a}$ = 0.5°C/W
1°C/W
2°C/W
3°C/W
4°C/W
6°C/W
8°C/W
12°C/W
0
50
100
T_{amb} (°C)
150
T_{mb}
(°C)
70
90
110
130
150

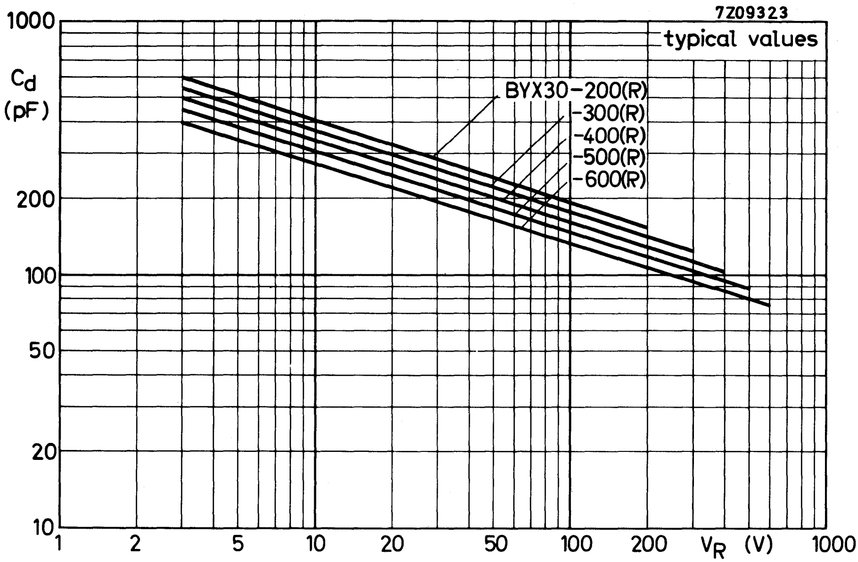

10
P_{RRM}
(kW)
2
1
0.5
0.2
0.1
T_j = 110°C
120°C
130°C
140°C
150°C
Max. allowable repetitive peak reverse power dissipation versus duration (f = 50Hz)
P_R
P_{RRM}
time
pulse duration
operation in this region is not allowed
in this region a junction temperature of 150°C is allowed
0.01
0.02
0.05
0.1
0.2
0.5
1
2
5
10
duration (ms)
7Z06358-2.25.24.c)

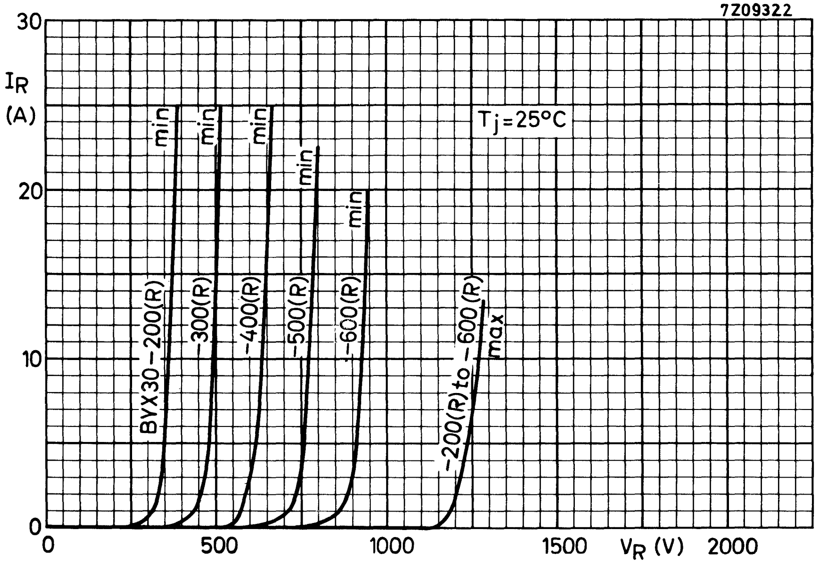

Max. allowable non repetitive peak reverse pulse power dissipation in avalanche region versus duration
P_{RSM} (kW)
10
5
2
1
0.5
0.2
0.1
0.01
0.1
1
10
duration (ms)
100
T_j=25°C
75°C
100°C
125°C
150°C
P_R
P_{RSM}
time
pulse duration
7Z06362-2.25.24.cj

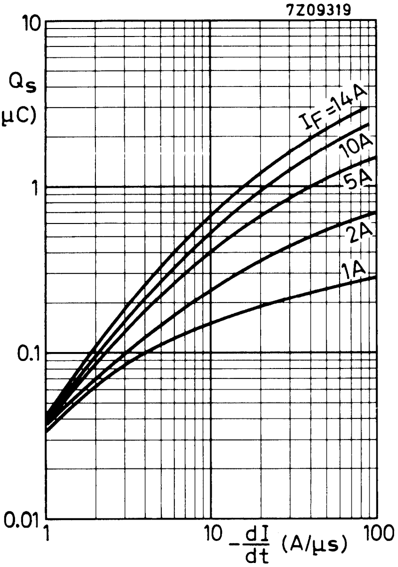

D8057
I_F (A)
T_j = 25°C
T_j =150°C
100
80
60
40
20
0
0
1
2
3
V_F (V)
4
typ V_F
max V_F
max V_F


D4569
I_{FS} R.M.S. (A)
300
200
100
0
I_{FSM}
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 = 150°C prior to surge
1ms
2
5
7
10ms
100ms
1s
Surge duration
10s

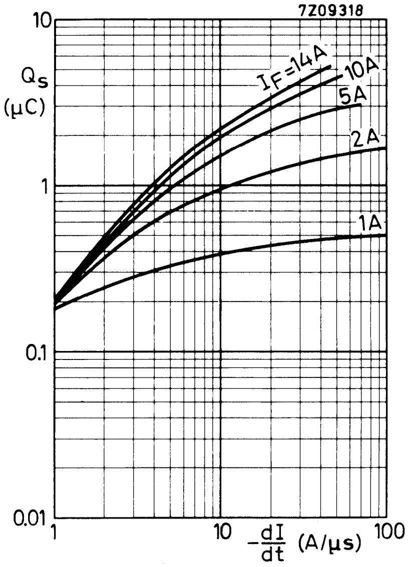

D4571
$Z_{th(t)}$ (°C/W)
2
10
7
5
1.0
0.1
0.01
10µs
100µs
1ms
10ms
100ms
1s
10s


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

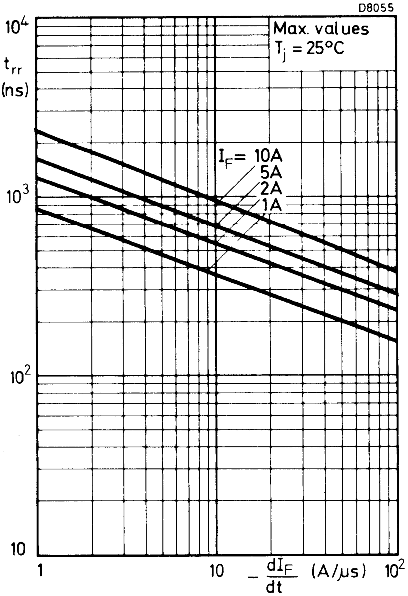

7Z09322
I_R
(A)
30
20
10
0
T_j=25°C
min
min
min
min
min
BYX30-200(R)
-300(R)
-400(R)
-500(R)
-600(R)
-200(R) to -600(R)
max
0
500
1000
1500
V_R (V)
2000

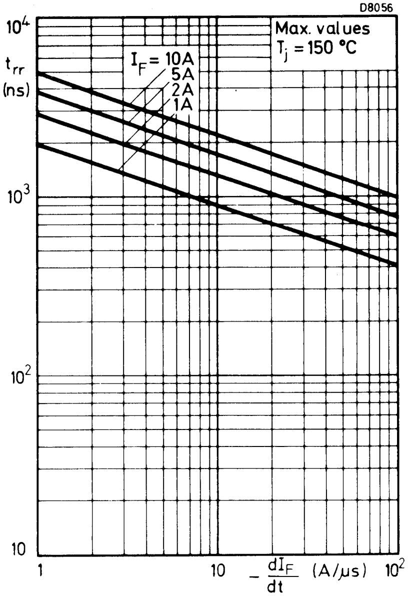


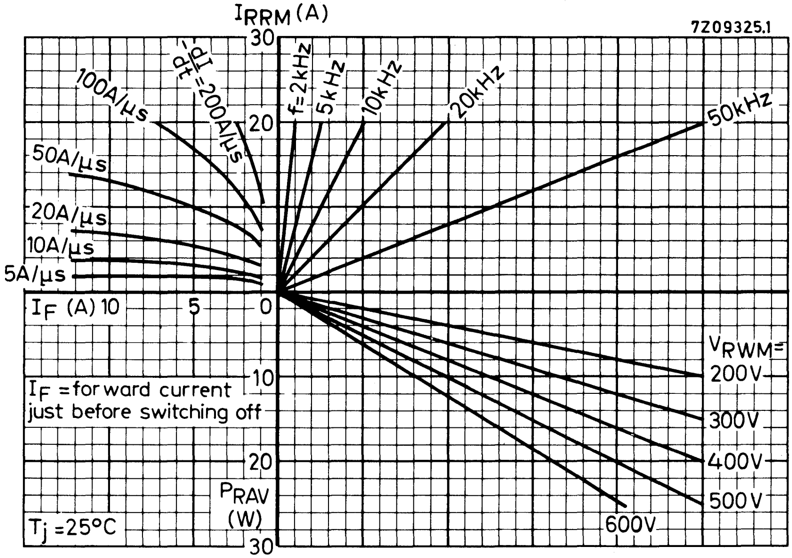
Maximum values; T_j = 25 °C; switched from I_F to $V_R \geqslant 30$ V.

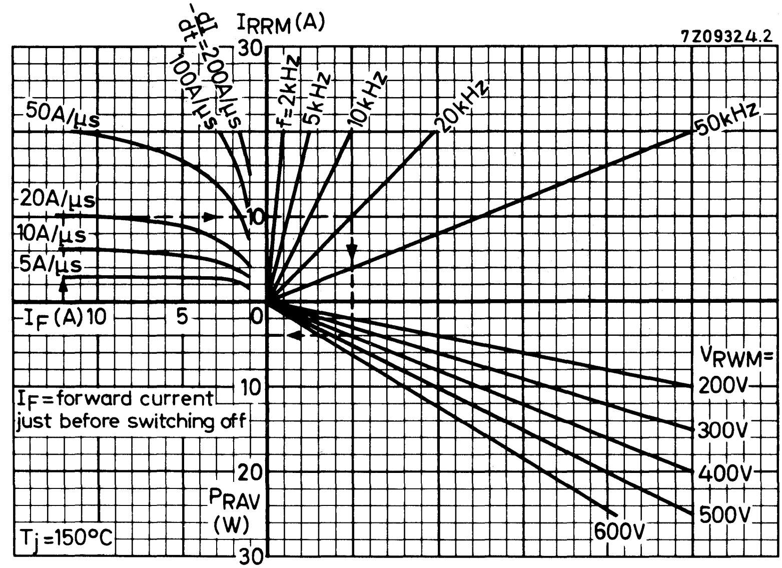


Maximum values; T_j = 150 °C; switched from I_F to $V_R \geqslant 30$ V.









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

FAST SOFT-RECOVERY RECTIFIER DIODES

- With controlled avalanche

Diffused silicon diodes in DO-4 metal envelopes, 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 BYX46-600R

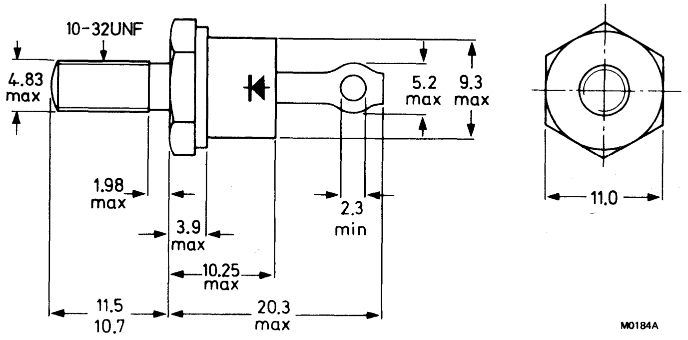
QUICK REFERENCE DATA

			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	$I_{F(AV)}$	max.			22			A
Non-repetitive peak forward current	I_{FSM}	max.			300			A
Non-repetitive peak reverse power	P_{RSM}	max.			18			kW
Reverse recovery time	t_{rr}	<			200			ns

MECHANICAL DATA

Dimensions in mm

DO-4 Supplied with device: 1 nut, 1 lock-washer
Nut dimensions across the flats: 9,5 mm



Net mass: 7 g
Diameter of clearance hole: max. 5,2 mm
Accessories supplied on request:
see ACCESSORIES section

Torque on nut: min. 0,9 Nm
(9 kg cm)
max. 1,7 Nm
(17 kg cm)

The mark shown applies to the normal polarity types.

RATINGS

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

Voltages *			BYX46-200(R)	300(R)	400(R)	500(R)	600(R)	
Crest working reverse voltage	V_{RWM}	max.	200	300	400	500	600	V
Continuous reverse voltage	V_R	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
R.M.S. forward current	$I_{F(RMS)}$	max.	35	A
Repetitive peak forward current	I_{FRM}	max.	400	A
Non-repetitive peak forward current (t = 10 ms; half-sinewave) T_j = 165 °C prior to surge; with reapplied V_{RWMmax}	I_{FSM}	max.	300	A
I^2t for fusing (t = 10 ms)	I^2t	max.	450	A^2s
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

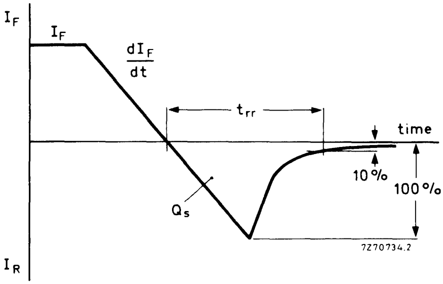
From junction to ambient in free air	$R_{th\ j\text{-}a}$	=	50	°C/W
From junction to mounting base	$R_{th\ j\text{-}mb}$	=	1,3	°C/W
From mounting base to heatsink	$R_{th\ mb\text{-}h}$	=	0,5	°C/W

---

* 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 479. 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 $T_{j\ max}$ = 125 °C.

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 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
Reverse current $V_R = V_{RWMmax}$; $T_j = 125$ °C	I_R	<	4,0	4,0	4,0	4,0	4,0	mA
Reverse recovery charge when switched from $I_F = 2$ A to $V_R \geqslant 30$ V; $-dI_F/dt = 100$ A/µs; $T_j = 25$ °C	Q_s	<	0,70					µC
Reverse recovery time when switched from $I_F = 1$ A to $V_R \geqslant 30$ V; $-dI_F/dt = 50$ A/µs; $T_j = 25$ °C	t_{rr}	<	200					ns



OPERATING NOTES

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 fall time 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 484.

---

* Measured under pulse 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 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 479 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 484 (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 $P_{tot} = 13\text{ W} + 6\text{ W} = 19\text{ W}$ (point B of the upper graph on page 479).

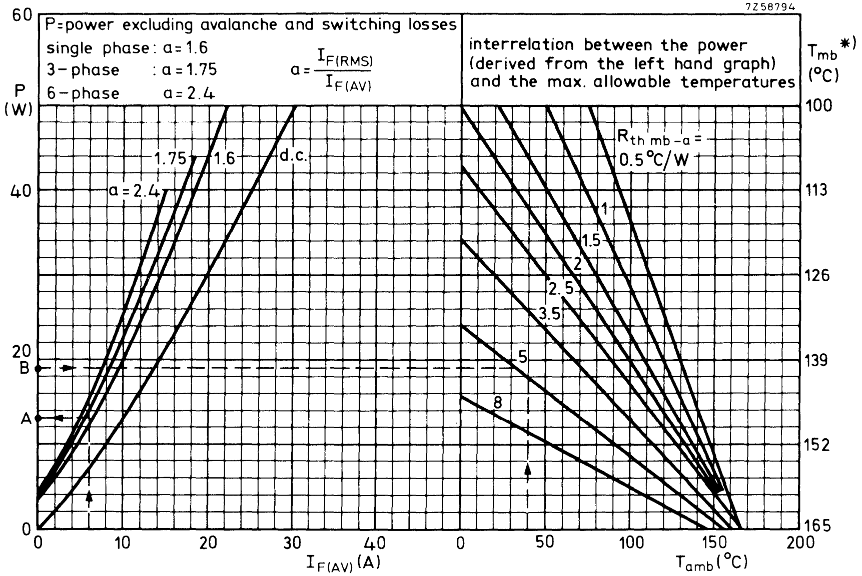
From the right hand part of the upper graph on page 479 follows the thermal resistance, required at $T_{amb} = 40$ °C.

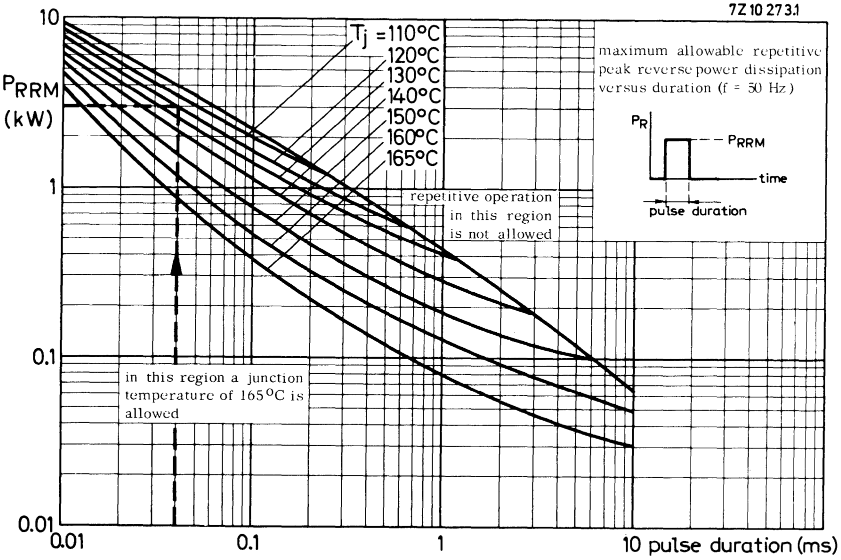
$$R_{th\ mb\text{-}a} \approx 5\ ^{\circ}\mathrm{C/W}$$

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

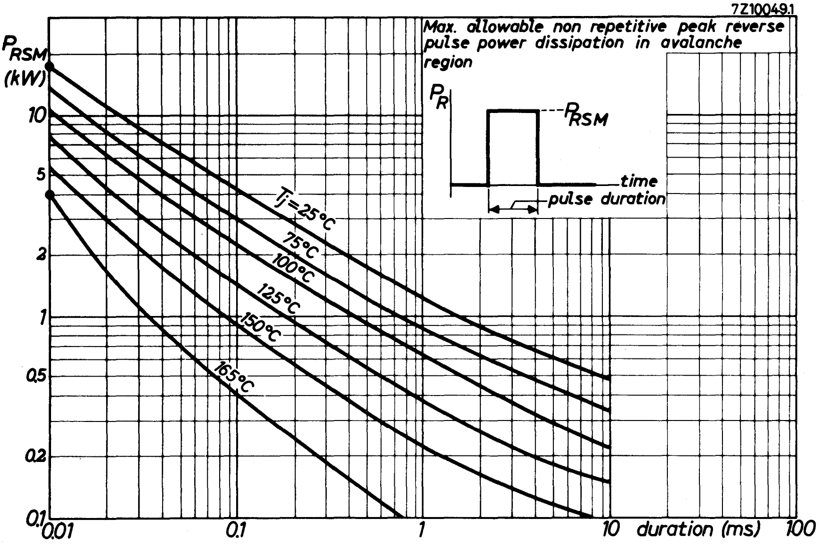
Hence the heatsink thermal resistance should be:

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

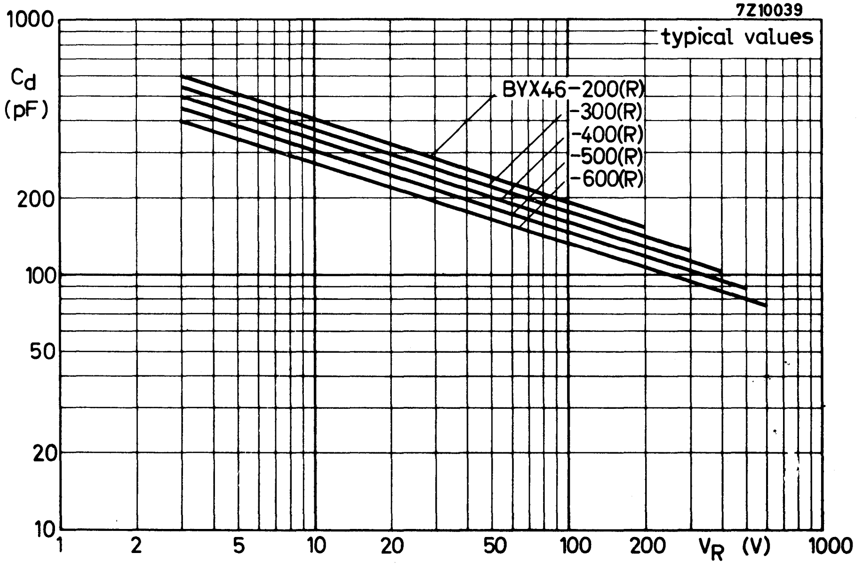

7Z58794
P=power excluding avalanche and switching losses
single phase: a = 1.6
3-phase : a = 1.75
6-phase a = 2.4
a = I_F(RMS) / I_F(AV)
interrelation between the power (derived from the left hand graph) and the max. allowable temperatures
P (W)
60
40
20
B
A
0
a = 2.4
1.75
1.6
d.c.
0
10
20
30
40
I_F(AV) (A)
R_th mb-a = 0.5 °C/W
1
1.5
2
2.5
3.5
5
8
0
50
100
150
200
T_amb (°C)
T_mb*) (°C)
100
113
126
139
152
165

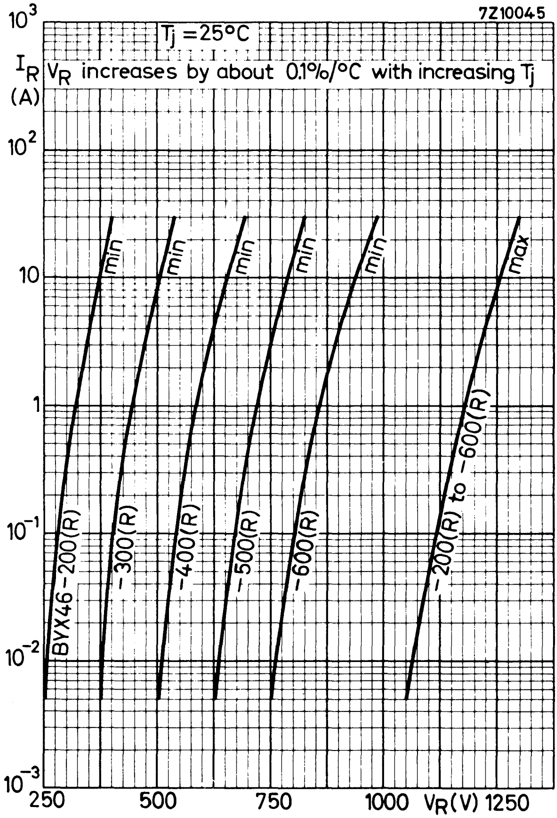

7Z10 273.1
P_RRM (kW)
10
1
0.1
0.01
T_j = 110°C
120°C
130°C
140°C
150°C
160°C
165°C
repetitive operation in this region is not allowed
in this region a junction temperature of 165 °C is allowed
maximum allowable repetitive peak reverse power dissipation versus duration (f = 50 Hz)
P_R
P_RRM
time
pulse duration
0.01
0.1
1
10 pulse duration (ms)

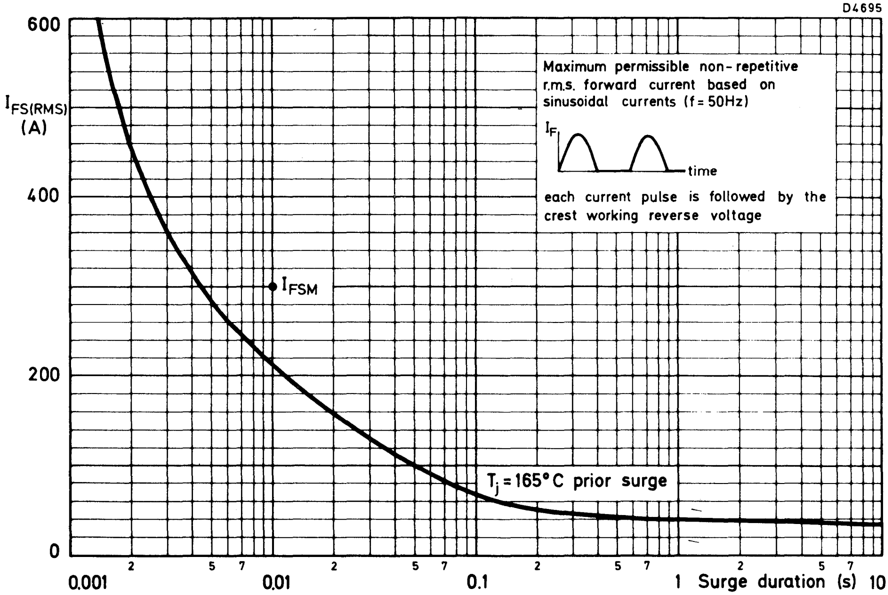
7Z10049.1

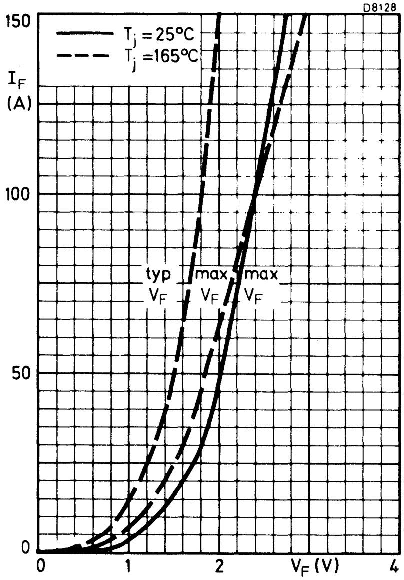


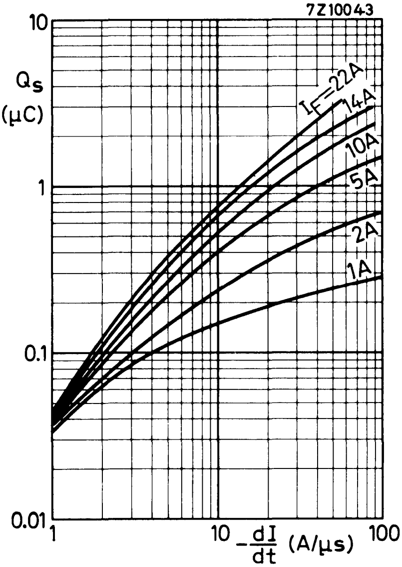
7Z10039

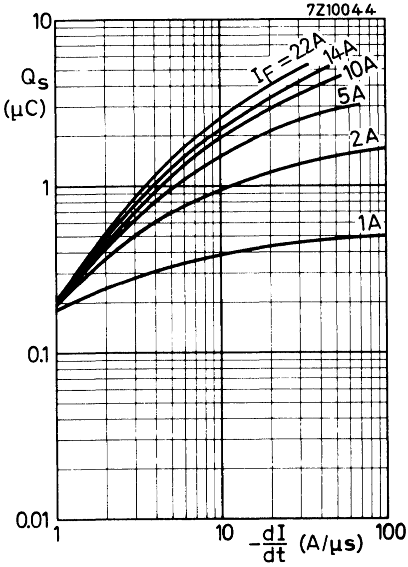


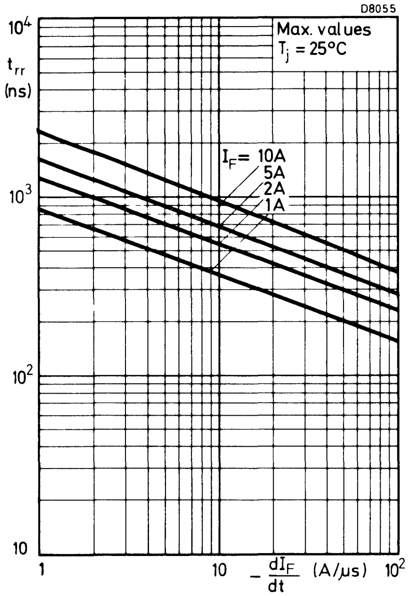

7Z10045
$T_j = 25°C$
V_R increases by about 0.1%/°C with increasing T_j
I_R (A)
10^3
10^2
10
1
10^{-1}
10^{-2}
10^{-3}
250
500
750
1000
V_R(V)
1250
min
min
min
min
min
max
BYX46-200(R)
-300(R)
-400(R)
-500(R)
-600(R)
-200(R) to -600(R)

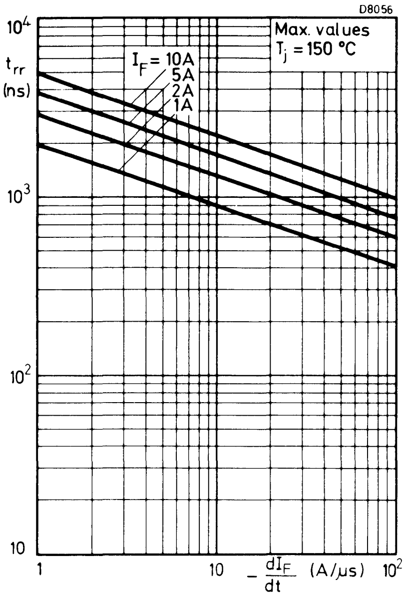

D4695
600
400
200
0
$I_{FS(RMS)}$ (A)
Maximum permissible non-repetitive r.m.s. forward current based on sinusoidal currents (f = 50Hz)
I_F
time
each current pulse is followed by the crest working reverse voltage
I_{FSM}
T_j = 165° C prior surge
0.001
2
5
7
0.01
2
5
7
0.1
2
5
7
1
2
5
7
10
Surge duration (s)

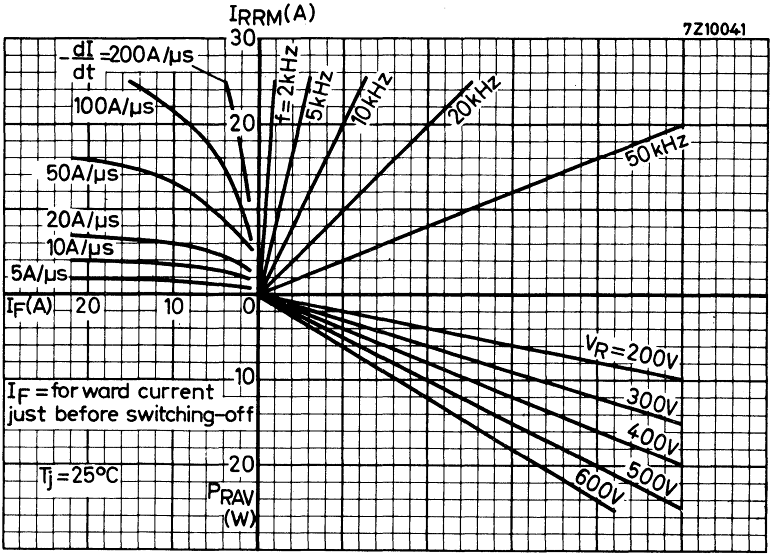

D8128
150
100
50
0
I_F (A)
T_j = 25°C
T_j = 165°C
typ V_F
max V_F
max V_F
0
1
2
4
V_F (V)

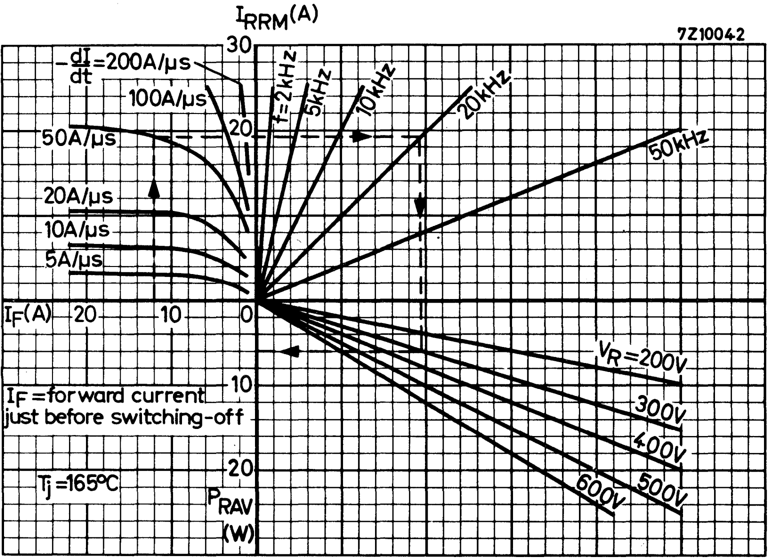

7Z10043
Q_s
(μC)
10
1
0.1
0.01
1
10
100
$-\frac{dI}{dt}$ (A/μs)
I_F=22A
14A
10A
5A
2A
1A


7Z10044
Q_s
(μC)
10
1
0.1
0.01
1
10
100
$-\frac{dI}{dt}$ (A/μs)
I_F=22A
14A
10A
5A
2A
1A

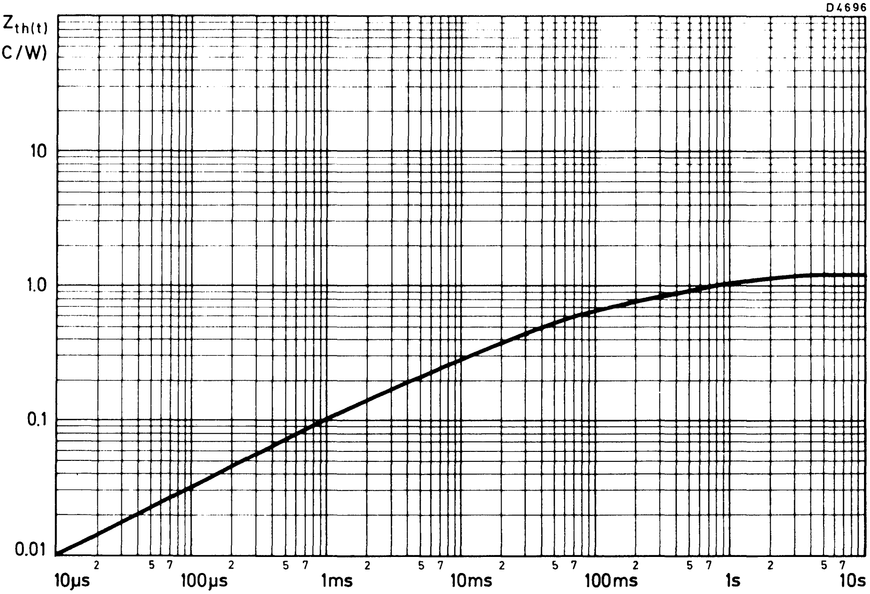

D8055
Max. values
T_j = 25°C
t_{rr}
(ns)
10^4
10^3
10^2
10
1
10
10^2
$-\frac{dI_F}{dt}$ (A/μs)
I_F= 10A
5A
2A
1A


D8056
Max. values
T_j = 150 °C
t_{rr}
(ns)
10^4
10^3
10^2
10
1
10
10^2
$-\frac{dI_F}{dt}$ (A/μs)
I_F= 10A
5A
2A
1A





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


D4696
$Z_{th(t)}$
(°C/W)
10
1.0
0.1
0.01
10µs
2
5
7
100µs
2
5
7
1ms
2
5
7
10ms
2
5
7
100ms
2
5
7
1s
2
5
7
10s

FAST SOFT-RECOVERY RECTIFIER DIODES

Silicon diodes in DO-4 metal envelopes, 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, 300.
These devices feature non-snap-off characteristics.

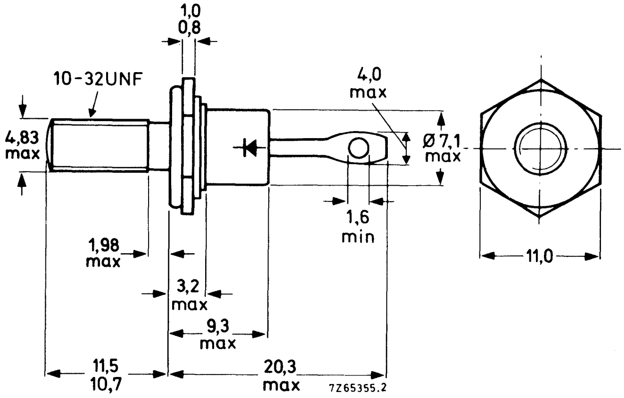
QUICK REFERENCE DATA

			BYX50–200	300	
Repetitive peak reverse voltage	V_{RRM}	max.	200	300	V
Average forward current	$I_{F(AV)}$	max.	7		A
Non-repetitive peak forward current	I_{FSM}	max.	80		A
Reverse recovery time	t_{rr}	<	100		ns

MECHANICAL DATA

Dimensions in mm

Fig.1 DO–4, Supplied with device: 1 nut, 1 lock washer
Nut dimensions across the flats: 9,5 mm



Net mass: 6 g
Diameter of clearance hole: max. 5,2 mm
Accessories supplied on request: mica washer (56295a); PTFE ring (56295b); insulating bush (56295c).

Torque on nut: min. 0,9 Nm
(9 kg cm)
max. 1,7 Nm
(17 kg cm)

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

→ **Voltages**

			BYX50–200	300	
Non-repetitive peak reverse voltage; $t \leqslant 10$ ms	V_{RSM}	max.	250	350	V
Repetitive peak reverse voltage	V_{RRM}	max.	200	300	V
Crest working reverse voltage	V_{RWM}	max.	200	300	V
Continuous reverse voltage	V_R	max.	200	300	V

Currents

Average on-state current assuming zero switching losses (averaged over any 20 ms period) up to T_{mb} = 103 °C	$I_{F(AV)}$	max.	7	A
at T_{mb} = 125 °C	$I_{F(AV)}$	max.	4	A
R.M.S. forward current	$I_{F(RMS)}$	max.	11	A
Repetitive peak forward current	I_{FRM}	max.	80	A
Non-repetitive peak forward current t = 10 ms; T_j = 150 °C prior to surge with reapplied V_{RWMmax}	I_{FSM}	max.	80	A
I^2t for fusing (t = 10 ms)	I^2t	max.	32	A^2s
Rate of change of commutation current	See nomogram (Fig.6)			

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

CHARACTERISTICS

Forward voltage				
$I_F = 20$ A; $T_j = 25$ °C	V_F	<	1,95	V*
Reverse current				
$V_R = V_{RWMmax}$; $T_j = 125$ °C	I_R	<	3	mA
Reverse recovery when switched from				
$I_F = 1$ A to $V_R = 30$ V; $-dI_F/dt = 100$ A/μs; $T_j = 25$ °C Recovery time	t_{rr}	<	100	ns
$I_F = 1$ A to $V_R = 30$ V; $-dI_F/dt = 35$ A/μs; $T_j = 25$ °C Recovery time	t_{rr}	<	150	ns
$I_F = 2$ A to $V_R = 30$ V; $-dI_F/dt = 20$ A/μs; $T_j = 25$ °C Recovered charge	Q_s	<	250	nC
$I_F = 2$ A to $V_R = 50$ V; $-dI_F/dt = 2$ A/μs; $T_j = 25$ °C Max. slope of the reverse recovery current	$\lvert dI_R/dt \rvert$	<	5	A/μs

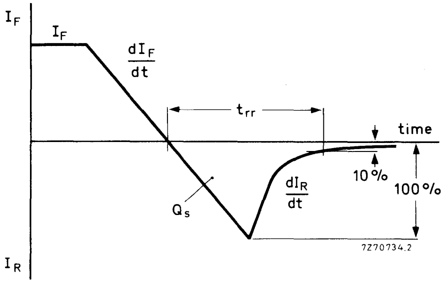


Fig.2 Definition of t_{rr} and Q_s.

---

* Measured under pulse conditions to avoid excessive dissipation.

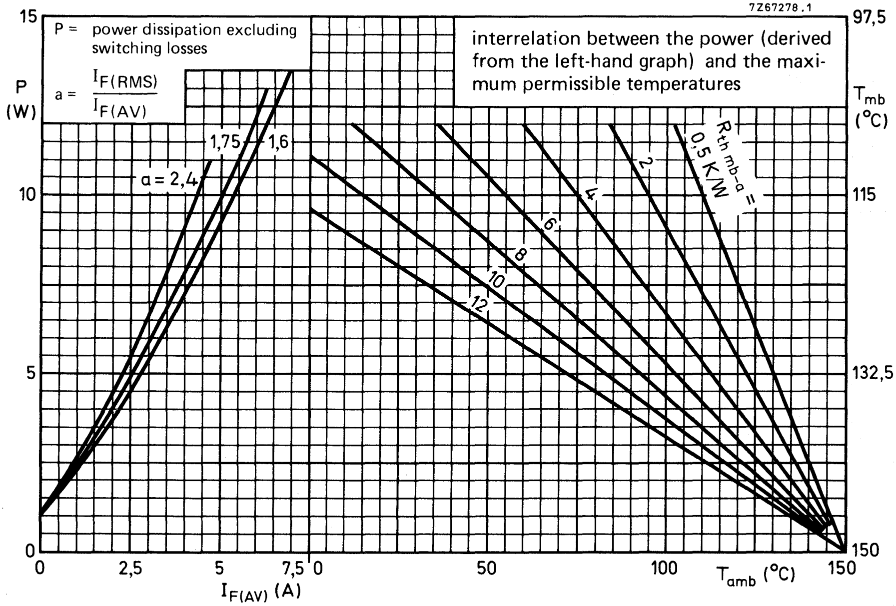

7Z67278.1
P = power dissipation excluding switching losses
$a = \frac{I_{F(RMS)}}{I_{F(AV)}}$
interrelation between the power (derived from the left-hand graph) and the maximum permissible temperatures
P (W)
15
10
5
0
0
2,5
5
7,5
$I_{F(AV)}$ (A)
a = 2,4
1,75
1,6
0
50
100
T_{amb} (°C)
150
$R_{th\ mb-a}$ = 0,5 K/W
2
4
6
8
10
12
97,5
115
132,5
150
T_{mb} (°C)

Fig.3

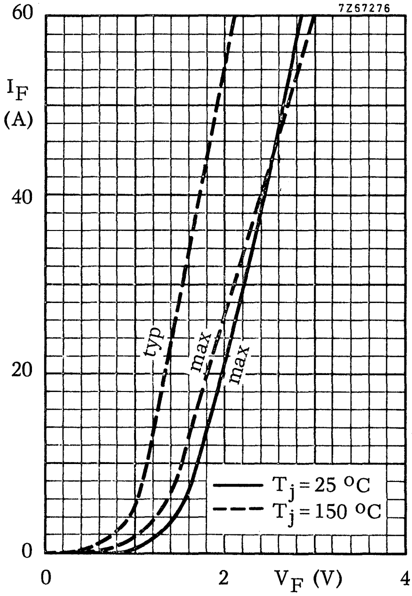

7Z67276
60
I_F (A)
40
20
0
0
2
V_F (V)
4
typ
max
max
T_j = 25 °C
T_j = 150 °C

Fig.4

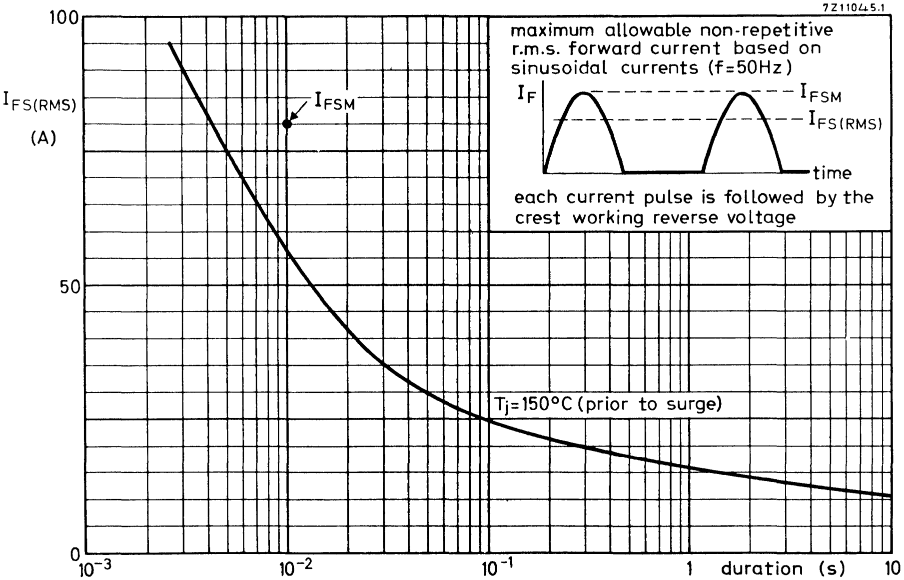

7Z11045.1
100
50
0
$I_{FS(RMS)}$
(A)
I_{FSM}
maximum allowable non-repetitive r.m.s. forward current based on sinusoidal currents (f=50Hz)
I_F
I_{FSM}
$I_{FS(RMS)}$
time
each current pulse is followed by the crest working reverse voltage
T_j=150°C (prior to surge)
10^{-3}
10^{-2}
10^{-1}
1
duration (s)
10

Fig.5

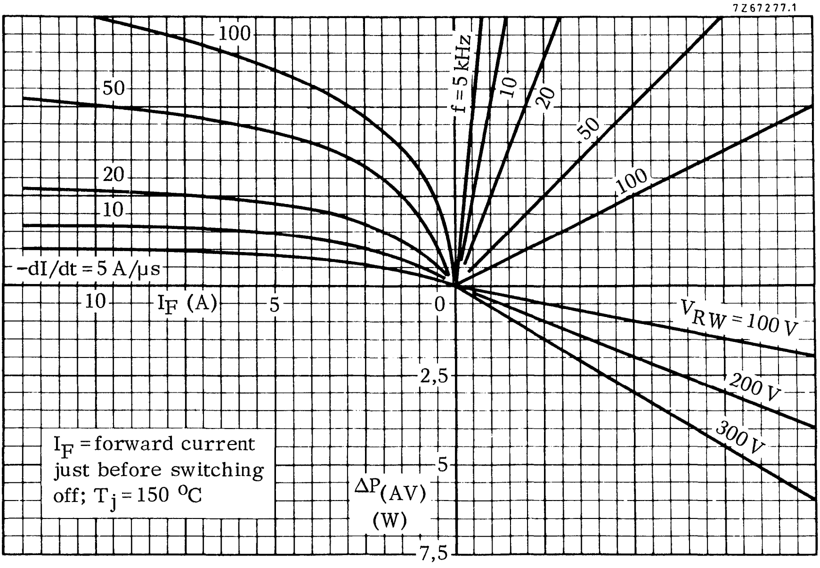

7Z67277.1
100
50
20
10
–dI/dt = 5 A/µs
f = 5 kHz
10
20
50
100
10
I_F (A)
5
0
2,5
5
7,5
V_{RW} = 100 V
200 V
300 V
I_F = forward current just before switching off; T_j = 150 °C
$\Delta P_{(AV)}$
(W)

Fig.6

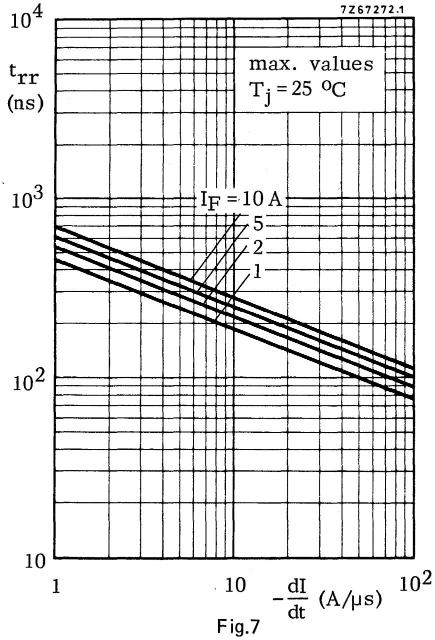


Fig.7

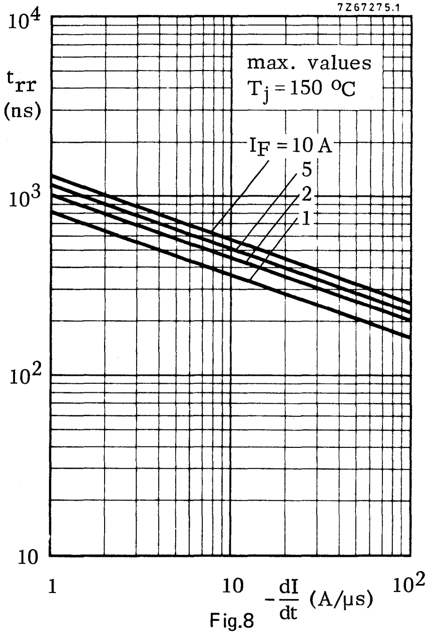


Fig.8

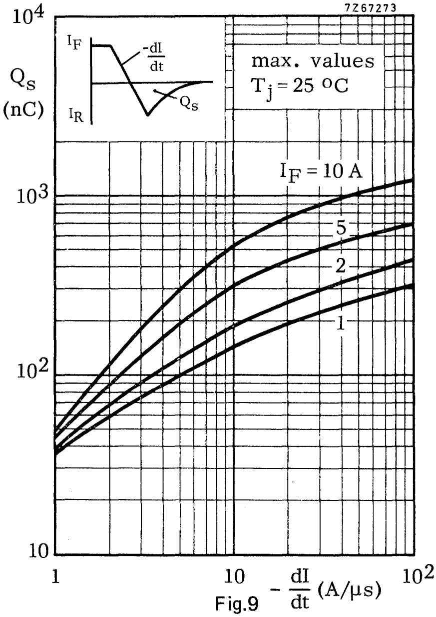


Fig.9

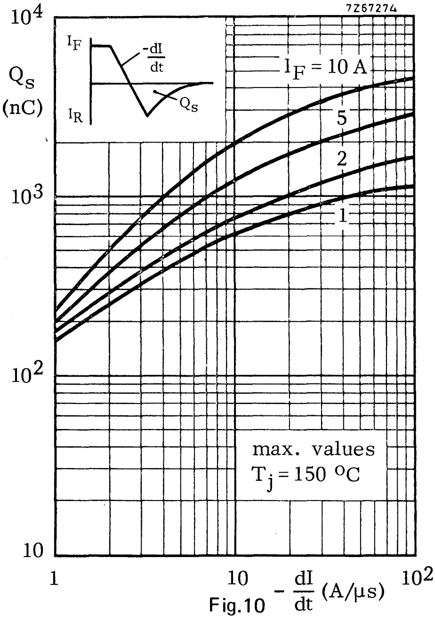


Fig.10

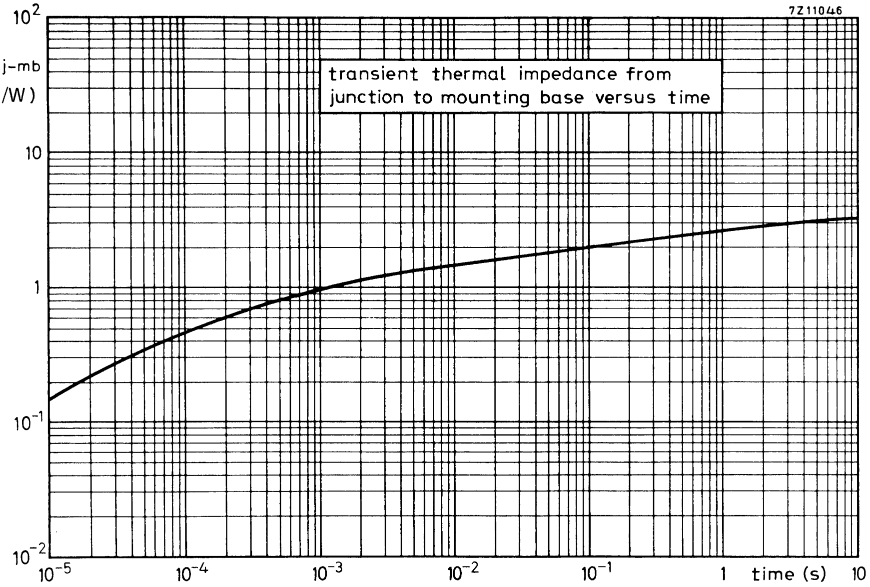

7Z11046
10^2
$Z_{th\ j\text{-}mb}$
(K/W)
10
1
10^{-1}
10^{-2}
10^{-5}
10^{-4}
10^{-3}
10^{-2}
10^{-1}
1
time (s)
10
transient thermal impedance from junction to mounting base versus time

Fig.11

FAST SOFT-RECOVERY RECTIFIER DIODES

Silicon diodes, each in a DO–4 metal envelope, featuring non-snap-off characteristics, and 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): 1N3879, 1N3880, 1N3881, 1N3882 and 1N3883. ←

QUICK REFERENCE DATA

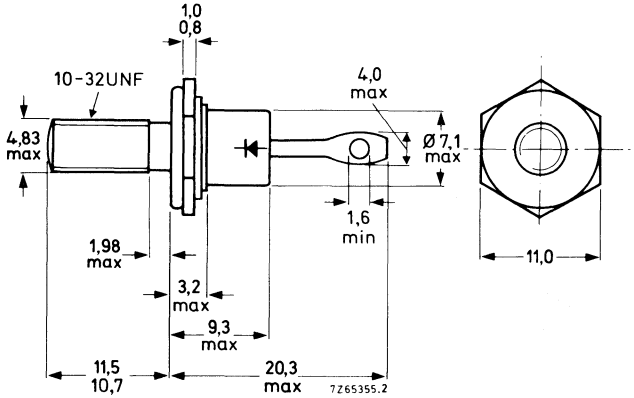
			1N3879	1N3880	1N3881	1N3882	1N3883	
Repetitive peak reverse voltage	V_{RRM}	max.	50	100	200	300	400	V

Average forward current	$I_{F(AV)}$	max.	6	A
Non-repetitive peak forward current	I_{FSM}	max.	80	A
Reverse recovery time	t_{rr}	<	200	ns

MECHANICAL DATA

Dimensions in mm

Fig.1 DO-4, Supplied with device: 1 nut, 1 lock washer
Nut dimensions across the flats: 9.5 mm.



Net mass: 6 g

Diameter of clearance hole: max. 5,2 mm

Accessories supplied on request: mica washer (56295a);
PTFE ring (56295b); insulating bush (56295c). ←

Torque on nut: min. 0,9 Nm
(9 kg cm)
max. 1,7 Nm
(17 kg cm)

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

Voltages

		1N3879	1N3880	1N3881	1N3882	1N3883	
Non-repetitive peak reverse voltage ($t \leqslant 10$ ms)	V_{RSM} max	100	150	250	350	450	V
Repetitive peak reverse voltage ($\delta \leqslant 0{,}01$)	V_{RRM} max.	50	100	200	300	400	V
Crest working reverse voltage	V_{RWM} max.	50	100	200	300	400	V

Currents

Average on-state current assuming zero switching losses (averaged over any 20 ms period)				
up to T_{mb} = 100 °C	$I_{F(AV)}$	max.	6	A
at T_{mb} = 125 °C	$I_{F(AV)}$	max.	3,5	A
R.M.S. forward current	$I_{F(RMS)}$	max.	10	A
Repetitive peak forward current	I_{FRM}	max.	75	A
Non-repetitive peak forward current T_j = 150 °C prior to surge; half sine-wave with reapplied V_{RWMmax};				
t = 10 ms	I_{FSM}	max.	75	A
t = 8,3 ms	I_{FSM}	max.	80	A
I^2t for fusing (t = 10 ms)	I^2t	max.	28	A^2s

Temperatures

Storage temperature	T_{stg}		−65 to +175	°C
Operating junction temperature	T_j	max.	150	°C

THERMAL RESISTANCE

From junction to ambient in free air	$R_{th\ j\text{-}a}$	=	50	K/W
From junction to mounting base	$R_{th\ j\text{-}mb}$	=	4,4	K/W
From mounting base to heatsink	$R_{th\ mb\text{-}h}$	=	0,5	K/W
Transient thermal impedance; t = 1 ms; δ = 0	$Z_{th\ j\text{-}mb}$	=	1	K/W

CHARACTERISTICS

Forward voltage				
$I_F = 6$ A; $T_j = 25$ °C	V_F	<	1,4	V*
Reverse current				
$V_R = V_{RWMmax}$; $T_j = 125$ °C	I_R	<	3	mA
Reverse recovery when switched from				
$I_F = 1$ A to $V_R = 30$ V; $-dI_F/dt = 35$ A/μs; $T_j = 25$ °C Recovery time	t_{rr}	<	200	ns
$I_F = 2$ A to $V_R = 30$ V; $-dI_F/dt = 20$ A/μs; $T_j = 25$ °C Recovery charge	Q_s	<	250	nC
$I_F = 1$ A to $V_R = 30$ V; $-dI_F/dt = 2$ A/μs; $T_j = 25$ °C Max. slope of the reverse recovery current	$\lvert dI_R/dt \rvert$	<	5	A/μs

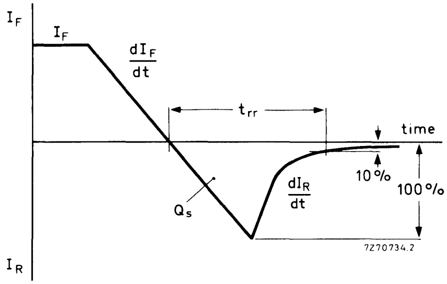


Fig.2 Definition of t_{rr} and Q_s.

---

*Measured under pulse conditions to avoid excessive dissipation

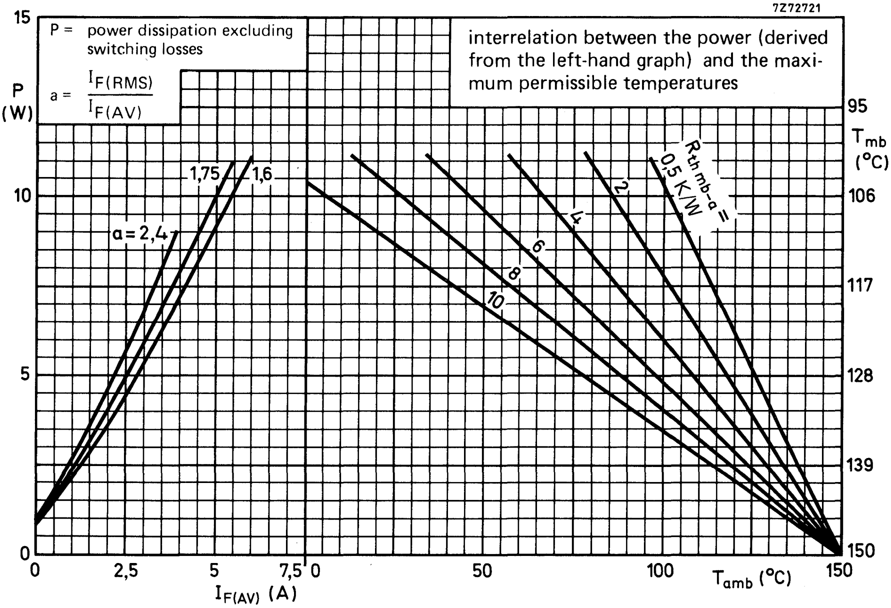

7Z72721
P = power dissipation excluding switching losses
a = $\frac{I_{F(RMS)}}{I_{F(AV)}}$
interrelation between the power (derived from the left-hand graph) and the maximum permissible temperatures
15
P (W)
10
5
0
a = 2,4
1,75
1,6
0
2,5
5
7,5
$I_{F(AV)}$ (A)
$R_{th\,mb-a}$ = 0,5 K/W
2
4
6
8
10
0
50
100
150
T_{amb} (°C)
T_{mb} (°C)
95
106
117
128
139
150

Fig.3

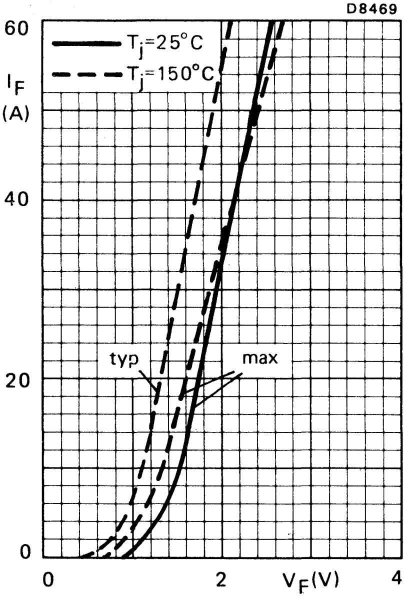

D8469
T_j=25°C
T_j=150°C
60
I_F (A)
40
20
0
typ
max
0
2
4
V_F(V)

Fig.4

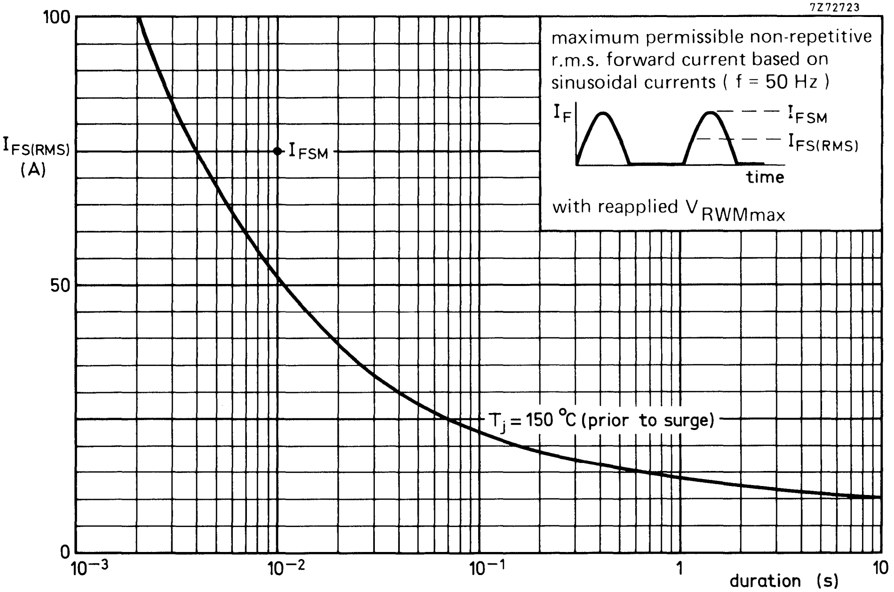

7Z72723
maximum permissible non-repetitive r.m.s. forward current based on sinusoidal currents (f = 50 Hz)
I_F
I_{FSM}
$I_{FS(RMS)}$
time
with reapplied V_{RWMmax}
$I_{FS(RMS)}$ (A)
100
50
0
I_{FSM}
T_j = 150 °C (prior to surge)
10^{-3}
10^{-2}
10^{-1}
1
10
duration (s)

Fig.5

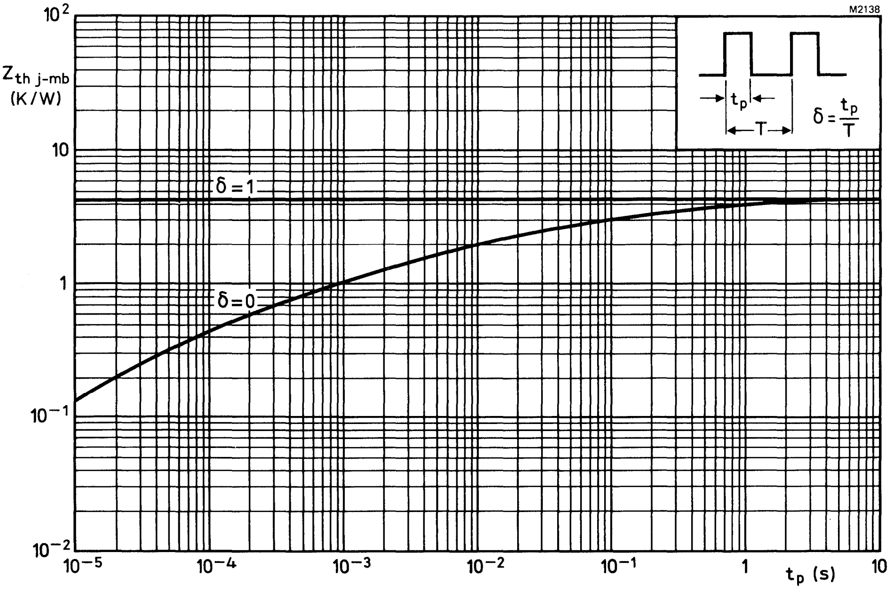

M2138
t_p
T
$\delta = \frac{t_p}{T}$
$Z_{th\ j\text{-}mb}$ (K/W)
10^2
10
1
10^{-1}
10^{-2}
δ = 1
δ = 0
10^{-5}
10^{-4}
10^{-3}
10^{-2}
10^{-1}
1
10
t_p (s)

Fig.6

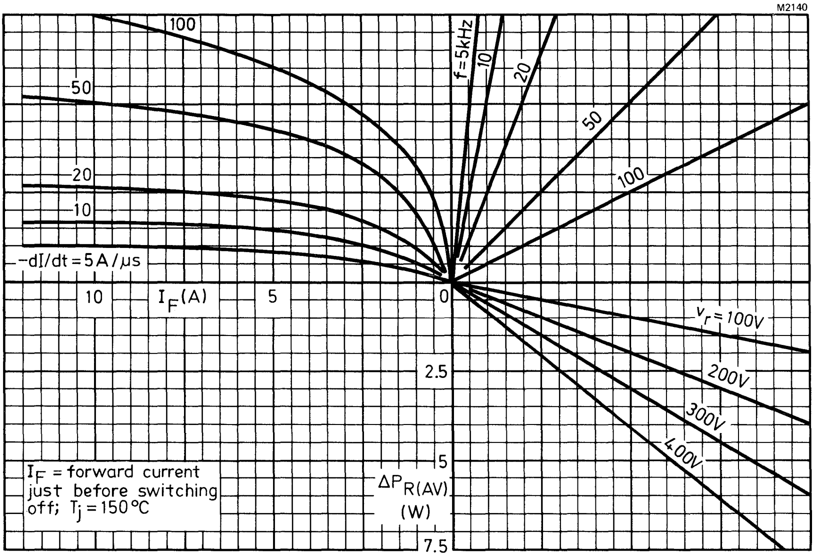
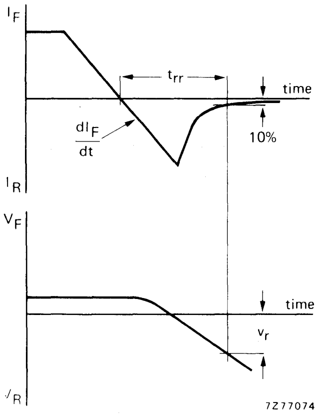


Fig.7

NOMOGRAM

Power loss $\Delta P_{R(AV)}$ due to switching only (to be added to steady state power losses).



FAST SOFT-RECOVERY RECTIFIER DIODES

Silicon diodes, each in a DO-4 metal envelope, featuring non-snap-off characteristics, and 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): 1N3889, 1N3890, 1N3891, 1N3892 and 1N3893.

QUICK REFERENCE DATA

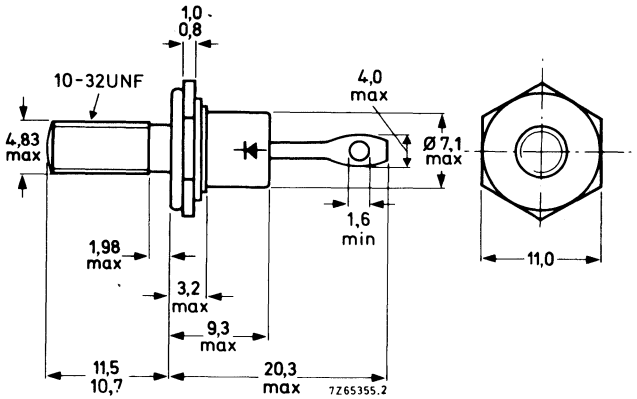
			1N3889	1N3890	1N3891	1N3892	1N3893	
Repetitive peak reverse voltage	V_{RRM}	max.	50	100	200	300	400	V

Average forward current	$I_{F(AV)}$	max.	12	A
Non-repetitive peak forward current	I_{FSM}	max.	150	A
Reverse recovery time	t_{rr}	$<$	200	ns

MECHANICAL DATA

Dimensions in mm

Fig.1 DO-4, Supplied with device: 1 nut, 1 lock washer
Nut dimensions across the flats: 9,5 mm.



Net mass: 6 g

Diameter of clearance hole: max. 5,2 mm

Accessories supplied on request: mica washer (56295a); PTFE ring (56295b); insulating bush (56295c).

Torque on nut: min. 0,9 Nm
(9 kg cm)
max. 1,7 Nm
(17 kg cm)

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

→ **Voltages**

			1N3889	1N3890	1N3891	1N3892	1N3893	
Non-repetitive peak reverse voltage ($t \leqslant 10$ ms)	V_{RSM}	max.	100	150	250	350	450	V
Repetitive peak reverse voltage ($\delta \leqslant 0{,}01$)	V_{RRM}	max.	50	100	200	300	400	V
Crest working reverse voltage	V_{RWM}	max.	50	100	200	300	400	V

Currents

Average on-state current assuming zero switching losses (averaged over any 20 ms period) up to T_{mb} = 100 °C	$I_{F(AV)}$	max.	12	A
at T_{mb} = 125 °C	$I_{F(AV)}$	max.	7	A
R.M.S. forward current	$I_{F(RMS)}$	max.	20	A
Repetitive peak forward current	I_{FRM}	max.	140	A
Non-repetitive peak forward current T_j = 150 °C prior to surge; half sine-wave with reapplied V_{RWMmax}; t = 10 ms	I_{FSM}	max.	140	A
t = 8,3 ms	I_{FSM}	max.	150	A
I^2t for fusing (t = 10 ms)	I^2t	max.	100	A^2s

Temperatures

Storage temperature	T_{stg}		−65 to +175	°C
Operating junction temperature	T_j	max.	150	°C

THERMAL RESISTANCE

From junction to ambient in free air	$R_{th\ j\text{-}a}$	=	50	K/W
From junction to mounting base	$R_{th\ j\text{-}mb}$	=	2,2	K/W
From mounting base to heatsink	$R_{th\ mb\text{-}h}$	=	0,5	K/W
Transient thermal impedance; t = 1 ms; δ = 0	$Z_{th\ j\text{-}mb}$	=	0,8	K/W

CHARACTERISTICS

Forward voltage				
$I_F = 12$ A; $T_j = 25$ °C	V_F	<	1,4	V*
Reverse current				
$V_R = V_{RWMmax}$; $T_j = 125$ °C	I_R	<	3	mA
Reverse recovery when switched from				
$I_F = 1$ A to $V_R = 30$ V; $-dI_F/dt = 35$ A/μs; $T_j = 25$ °C Recovery time	t_{rr}	<	200	ns
$I_F = 2$ A to $V_R = 30$ V; $-dI_F/dt = 20$ A/μs; $T_j = 25$ °C Recovery charge	Q_s	<	250	nC
$I_F = 1$ A to $V_R = 30$ V; $-dI_F/dt = 2$ A/μs; $T_j = 25$ °C Max. slope of the reverse recovery current	$\|dI_R/dt\|$	<	5	A/μs

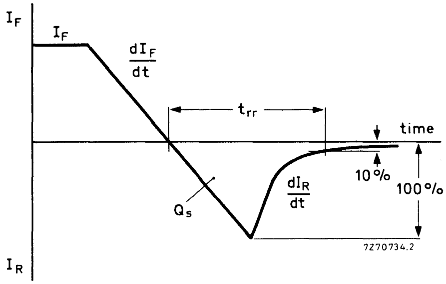


Fig.2 Definition of t_{rr} and Q_s.

---

* Measured under pulse conditions to avoid excessive dissipation.

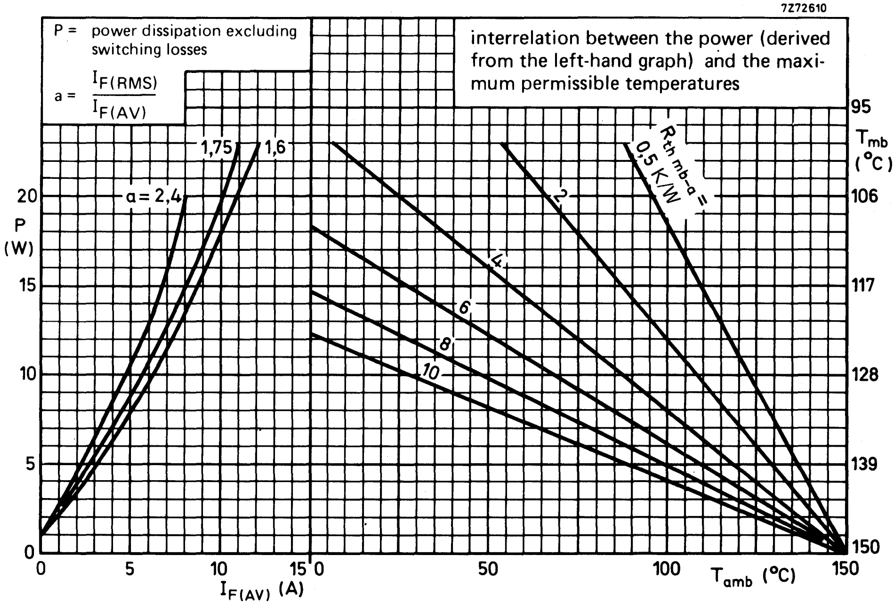

7Z72610
P = power dissipation excluding switching losses
a = $\frac{I_{F(RMS)}}{I_{F(AV)}}$
interrelation between the power (derived from the left-hand graph) and the maximum permissible temperatures
a = 2,4
1,75
1,6
P (W)
0
5
10
15
20
0
5
10
15
$I_{F(AV)}$ (A)
$R_{th\ mb-a}$ = 0,5 K/W
2
4
6
8
10
0
50
100
150
T_{amb} (°C)
T_{mb} (°C)
95
106
117
128
139
150

Fig.3

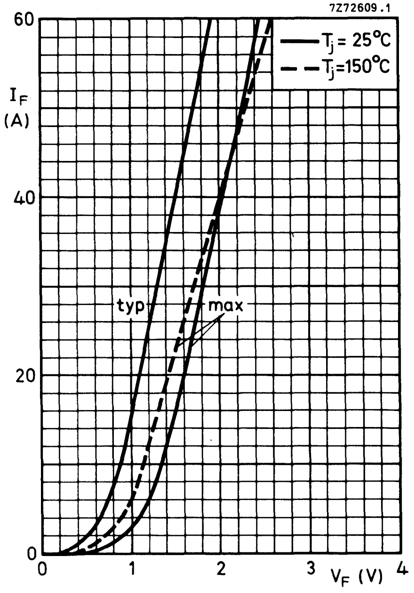

7Z72609.1
T_j = 25°C
T_j = 150°C
I_F (A)
0
20
40
60
typ
max
0
1
2
3
4
V_F (V)

Fig.4

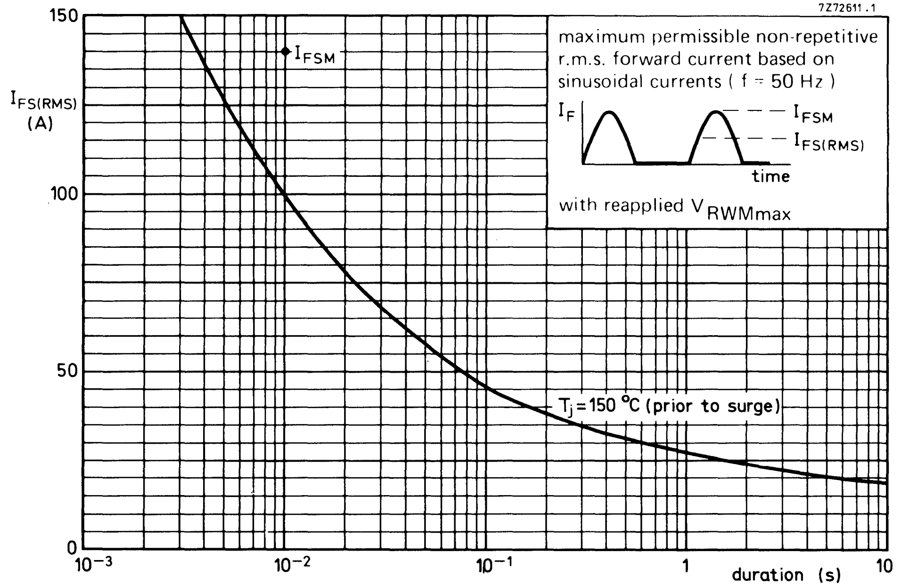

7Z72611.1
$I_{FS(RMS)}$ (A)
150
100
50
0
10^{-3}
10^{-2}
10^{-1}
1
10
duration (s)
I_{FSM}
maximum permissible non-repetitive r.m.s. forward current based on sinusoidal currents (f = 50 Hz)
I_F
I_{FSM}
$I_{FS(RMS)}$
time
with reapplied V_{RWMmax}
$T_j = 150\ ^\circ C$ (prior to surge)

Fig.5

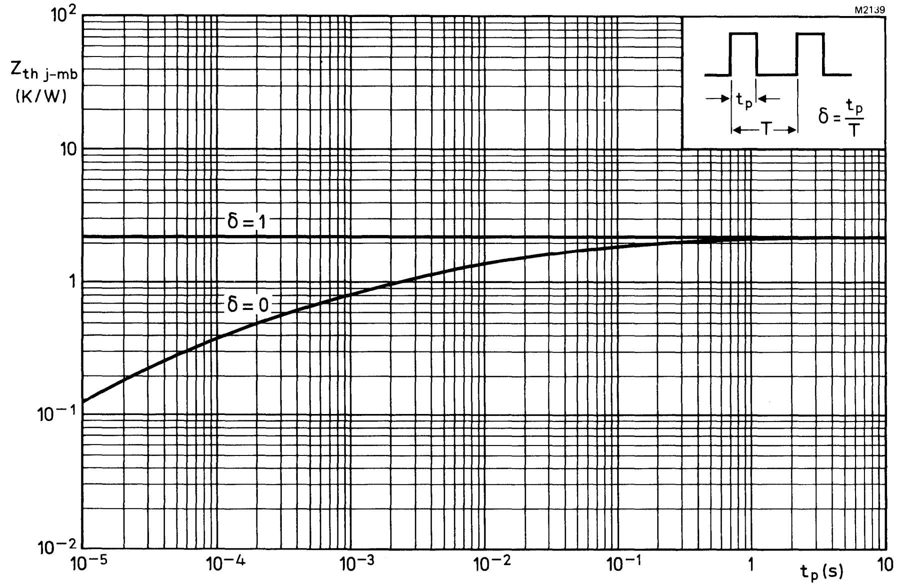

M2139
$Z_{th\ j\text{-}mb}$ (K/W)
10^2
10
1
10^{-1}
10^{-2}
10^{-5}
10^{-4}
10^{-3}
10^{-2}
10^{-1}
1
10
t_p (s)
$\delta = 1$
$\delta = 0$
t_p
T
$\delta = \frac{t_p}{T}$

Fig.6

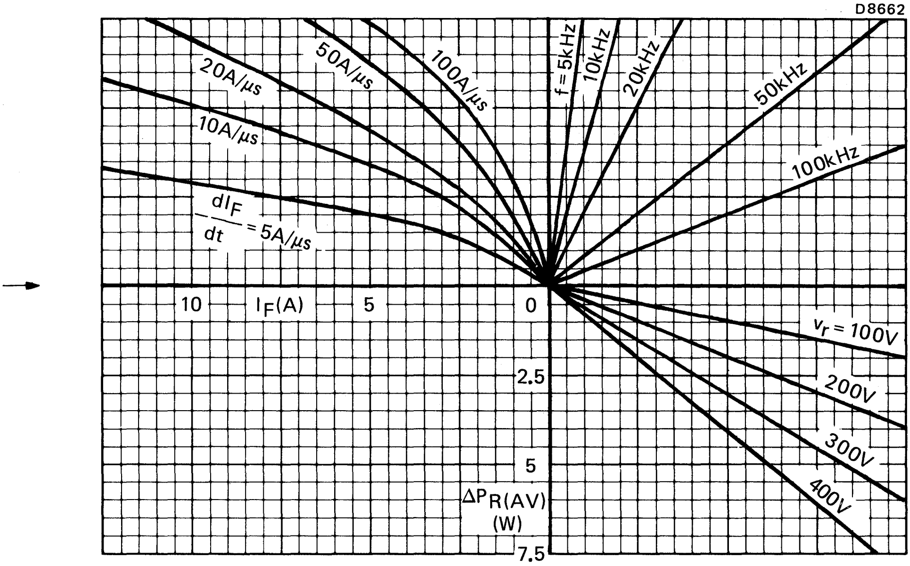
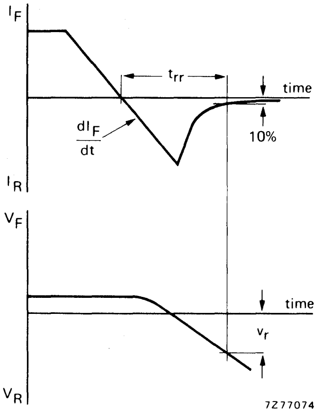


Fig.7

NOMOGRAM

Power loss $\Delta P_{R(AV)}$ due to switching only (to be added to steady state power losses).

I_F = forward current just before switching off; T_j = 150 °C



FAST SOFT-RECOVERY RECTIFIER DIODES

Silicon diodes in DO—5 metal envelopes, featuring non-snap-off characteristics. They are 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): 1N3909, 1N3910, 1N3911, 1N3912, 1N3913.

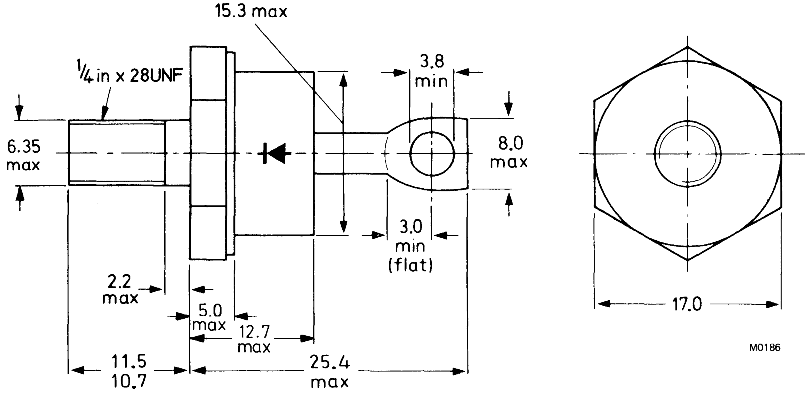
QUICK REFERENCE DATA

			1N3909	3910	3911	3912	3913	
Repetitive peak reverse voltage	V_{RRM}	max.	50	100	200	300	400	V
Average forward current	$I_{F(AV)}$	max.			30			A
Non-repetitive peak forward current	I_{FSM}	max.			300			A
Reverse recovery time	t_{rr}	<			200			ns

MECHANICAL DATA

Dimensions in mm

Fig.1 DO—5; Supplied with device: 1 nut, 1 lock-washer
Nut dimensions across the flats: 11.1 mm



Net mass: 22 g
Diameter of clearance hole: max. 6.5 mm
Accessories supplied on request:
56264a (mica washer).
56264b (insulating bush).

Torque on nut:
min. 1.7 Nm (17 kg cm)
max. 2.5 Nm (25 kg cm)

RATINGS

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

Voltages

→			1N3909	3910	3911	3912	3913	
Non-repetitive peak reverse voltage (t = 10 ms)	V_{RSM}	max.	75	200	300	400	500	V
Repetitive peak reverse voltage ($\delta \leqslant 0.01$)	V_{RRM}	max.	50	100	200	300	400	V
Crest working voltage	V_{RWM}	max.	50	100	200	300	400	V

Currents

Average on-state current assuming zero switching losses (averaged over any 20 ms period)				
up to T_{mb} = 100 °C	$I_{F(AV)}$	max.	30	A
at T_{mb} = 125 °C	$I_{F(AV)}$	max.	15	A
R.M.S. forward current	$I_{F(RMS)}$	max.	45	A
Repetitive peak forward current	I_{FRM}	max.	125	A
Non-repetitive peak forward current T_j = 150 °C prior to surge; half sine-wave with reapplied V_{RWMmax};				
t = 10 ms	I_{FSM}	max.	275	A
t = 8.3 ms	I_{FSM}	max.	300	A
I^2t for fusing (t = 10 ms)	I^2t	max.	375	A^2s

Temperatures

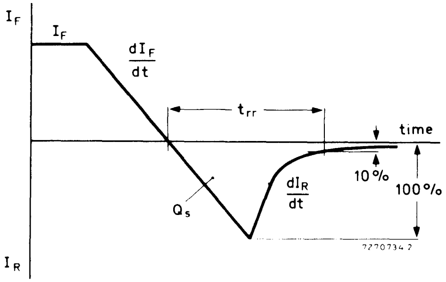
Storage temperature	T_{stg}		−65 to 175	°C
Operating junction temperature	T_j	max.	150	°C

THERMAL RESISTANCE

From junction to mounting base	$R_{th\ j\text{-}mb}$	=	1.0	K/W
From mounting base to heatsink with heatsink compound	$R_{th\ mb\text{-}h}$	=	0.3	K/W
Transient thermal impedance; t = 1 ms	$Z_{th\ j\text{-}mb}$	=	0.2	K/W

CHARACTERISTICS

Forward voltage $I_F = 30$ A; $T_j = 25$ °C	V_F	<	1.4	V*
Reverse current $V_R = V_{RWMmax}$; $T_j = 100$ °C	I_R	<	10	mA
Reverse recovery when switched from $I_F = 1$ A to $V_R \geqslant 30$ V; $-dI_F/dt = 35$ A/μs; $T_j = 25$ °C Recovery time	t_{rr}	<	200	ns
$I_F = 2$ A to $V_R \geqslant 30$ V; $-dI_F/dt = 20$ A/μs; $T_j = 25$ °C Recovered charge	Q_s	<	250	nC
Maximum slope of the reverse recovery current when switched from $I_F = 1$ A to $V_R \geqslant 30$ V; $-dI_F/dt = 2$ A/μs; $T_j = 25$ °C	$\|dI_R/dt\|$	<	5	A/μs



D8403

Fig. 2 Definitions of t_{rr} and Q_s.

---

*Measured under pulse conditions to avoid excessive dissipation.

SINUSOIDAL OPERATION

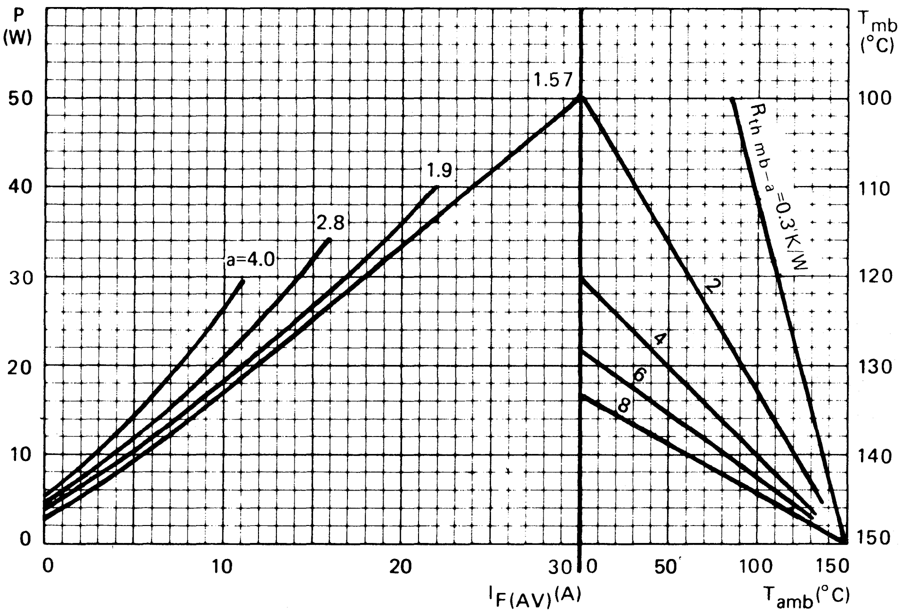


Fig. 3 The right-hand part shows the interrelationship between the power (derived from the left-hand part) and the maximum permissible temperatures.

P = power dissipation excluding switching losses.

a = form factor = $I_{F(RMS)}/I_{F(AV)}$.

SQUARE-WAVE OPERATION

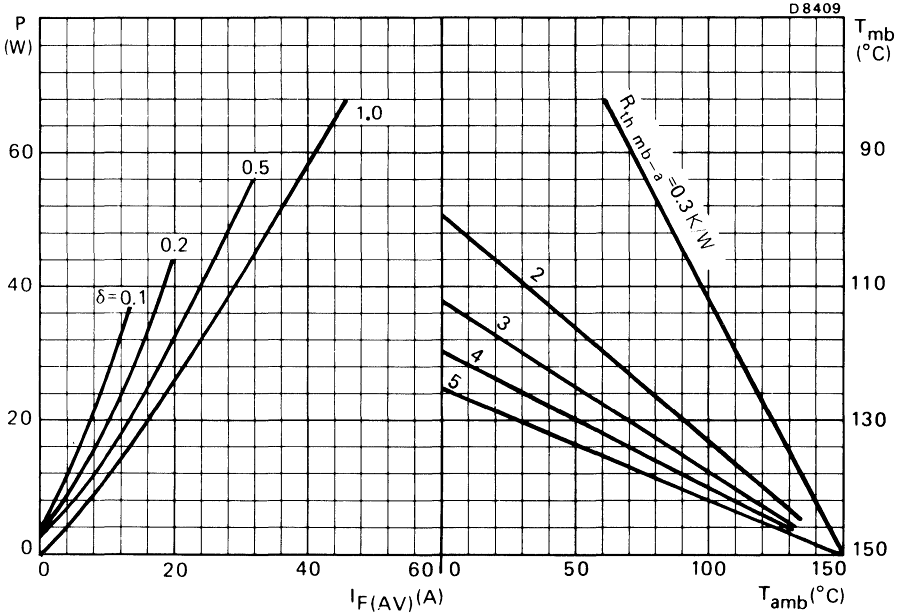
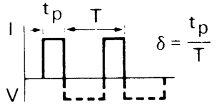


Fig. 4 The right-hand part shows the interrelationship between the power (derived from the left-hand part) and the maximum permissible temperatures.
P = power dissipation excluding switching losses.



$\delta = \frac{t_p}{T}$

$I_{F(AV)} = I_{F(RMS)} \times \sqrt{\delta}$

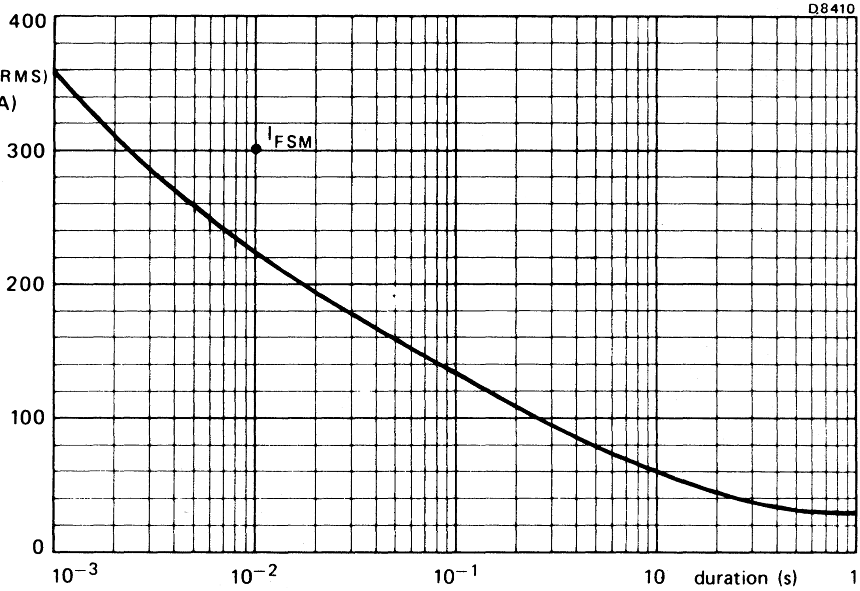
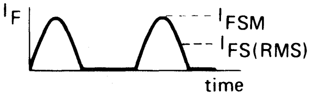


Fig.5 Maximum permissible non-repetitive r.m.s. forward current based on sinusoidal currents (f = 50 Hz); T_j = 150 °C prior to surge; with reapplied V_{RWMmax}.



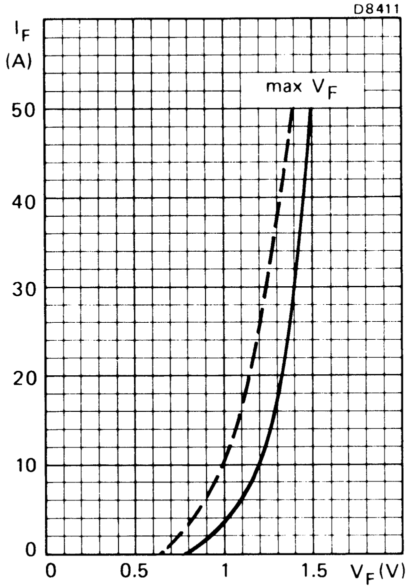


Fig. 6 —— T_j = 25 °C; – – – T_j = 150 °C

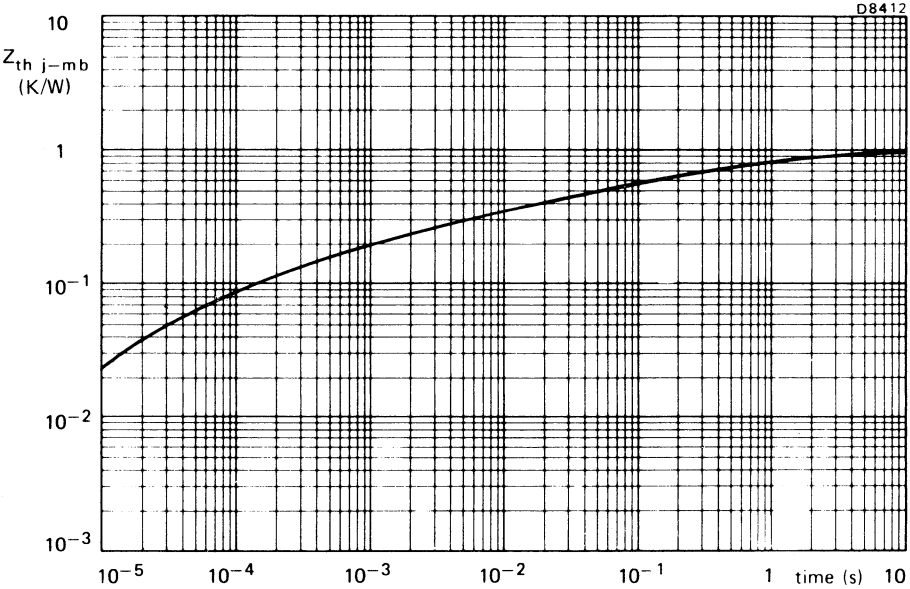


Fig. 7

SCHOTTKY RECTIFIER DIODES

SCHOTTKY-BARRIER DOUBLE RECTIFIER DIODES

High-efficiency schottky-barrier double rectifier diodes in plastic envelopes, featuring low forward voltage drop, low capacitance and absence of stored charge . They are intended for use in switched-mode power supplies and high-frequency circuits in general, where both low conduction losses and low switching losses are essential. The single chip (monolithic) construction allows both diodes to be paralleled without the need for derating. They can also withstand reverse voltage transients. The series consists of common-cathode types. A version with guaranteed reverse surge capability, BYV18—40A, is also available.

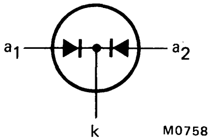
QUICK REFERENCE DATA

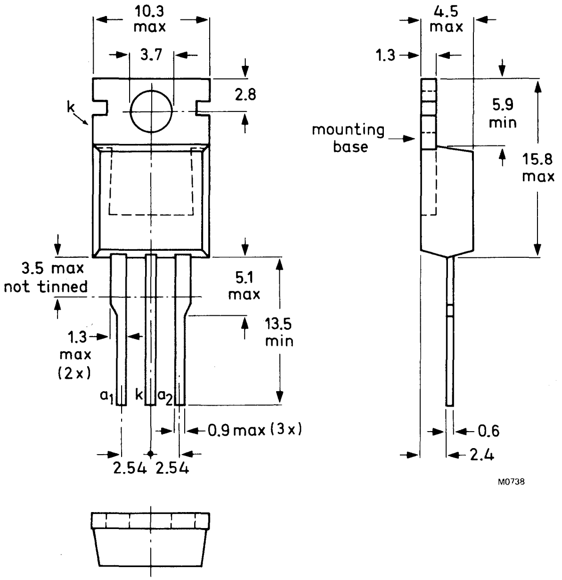
Per diode, unless otherwise stated			BYV18-30	35	40(A)	45	
Repetitive peak reverse voltage	V_{RRM}	max.	30	35	40	45	V
Output current (both diodes conducting)	I_O	max.	10				A
Forward voltage	V_F	<	0.6				V
Junction temperature	T_j	<	150				^oC

MECHANICAL DATA

Dimensions in mm

Fig.1 TO-220AB





Net mass: 2 g

Note: the exposed metal mounting base is directly connected to the common cathode.

Accessories supplied on request: see data sheets Mounting instructions and accessories for TO-220 envelopes.

RATINGS

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

Voltages (per diode)			BYV18-30	35	40(A)	45	
Repetitive peak reverse voltage	V_{RRM}	max.	30	35	40	45	V
Crest working reverse voltage (note 1)	V_{RWM}	max.	30	35	40	45	V
Continuous reverse voltage (note 1)	V_R	max.	30	35	40	45	V

Currents (both diodes conducting: note 2)				
Output current:				
square wave; δ = 0.5; up to T_{mb} = 136 °C (note 3)	I_O	max.	10	A
sinusoidal; up to T_{mb} = 137 °C (note 3)	I_O	max.	8.8	A
R.M.S. forward current	$I_{F(RMS)}$	max.	14	A
Repetitive peak forward current t_p = 20 μs; δ = 0.02 (per diode)	I_{FRM}	max.	90	A
Non-repetitive peak forward current (per diode) half sine-wave; T_j = 125 °C prior to surge; with reapplied V_{RWMmax}				
t = 10 ms	I_{FSM}	max.	100	A
t = 8.3 ms	I_{FSM}	max.	110	A
I^2t for fusing (t = 10 ms, per diode)	I^2t	max.	50	A^2s
Reverse surge current (BYV18-40A only) t_p = 100 μs	I_{RSM}	max.	0.5	A
Temperatures				
Storage temperature	T_{stg}		−40 to +150	°C
Junction temperature	T_j	max.	150	°C

Notes

1. Up to T_j = 125 °C; see derating curve for higher temperature operation.
2. The limits for both diodes apply whether both diodes conduct simultaneously or on alternate half cycles.
3. Assuming no reverse leakage current losses.

CHARACTERISTICS (per diode)

Forward voltage				
$I_F = 5$ A; $T_j = 100$ °C	V_F	<	0.6	V*
$I_F = 15$ A; $T_j = 25$ °C	V_F	<	1.05	V*
Reverse current				
$V_R = V_{RWMmax}$; $T_j = 125$ °C	I_R	<	30	mA
Junction capacitance at f = 1 MHz				
$V_R = 5$ V; $T_j = 25$ to 125 °C	C_d	typ.	200	pF

THERMAL RESISTANCE

From junction to mounting base (both diodes conducting)	$R_{th\ j\text{-}mb}$	=	1.7	K/W
From junction to mounting base (per diode)	$R_{th\ j\text{-}mb}$	=	2.7	K/W

Influence of mounting method

1. Heatsink-mounted with clip (see mounting instructions)

Thermal resistance from mounting base to heatsink

a. with heatsink compound	$R_{th\ mb\text{-}h}$	=	0.3	K/W
b. with heatsink compound and 0.06 mm maximum mica insulator	$R_{th\ mb\text{-}h}$	=	1.4	K/W
c. with heatsink compound and 0.1 mm maximum mica insulator (56369)	$R_{th\ mb\text{-}h}$	=	2.2	K/W
d. with heatsink compound and 0.25 mm maximum alumina insulator (56367)	$R_{th\ mb\text{-}h}$	=	0.8	K/W
e. without heatsink compound	$R_{th\ mb\text{-}h}$	=	1.4	K/W

2. Free air operation

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

Thermal resistance from junction to ambient in free air; mounted on a printed circuit board at any device lead length and with copper laminate on the board	$R_{th\ j\text{-}a}$	=	60	K/W

---

*Measured under pulse conditions to avoid excessive dissipation.

MOUNTING INSTRUCTIONS

1. The device may be soldered directly into the circuit, but the maximum permissible temperature of the soldering iron or bath is 275 $^{\circ}C$; the heat source must not be in contact with the joint for more than 5 seconds. Soldered joints must be at least 4.7 mm from the seal.
2. The leads should not be bent less than 2.4 mm from the seal, and should be supported during bending. The bend radius must be no less than 1.0 mm.
3. Mounting by means of a spring clip is the best mounting method because it offers:
   a. a good thermal contact under the crystal area and slightly lower $R_{th\ mb\text{-}h}$ values than does screw mounting.
   b. safe isolation for mains operation.
   However, if a screw is used, it should be M3 cross-recess pan head. Care should be taken to avoid damage to the plastic body.
4. For good thermal contact heatsink compound should be used between mounting base and heatsink. Values of $R_{th\ mb\text{-}h}$ given for mounting with heatsink compound refer to the use of a metallic-oxide loaded compound. Ordinary silicone grease is not recommended.
5. Rivet mounting (only possible for non-insulated mounting).
   Devices may be rivetted to flat heatsinks; such a process **must neither** deform the mounting tab, **nor** enlarge the mounting hole.

OPERATING NOTES

Dissipation and heatsink calculations

The various components of junction temperature rise above ambient are illustrated in Fig.2.

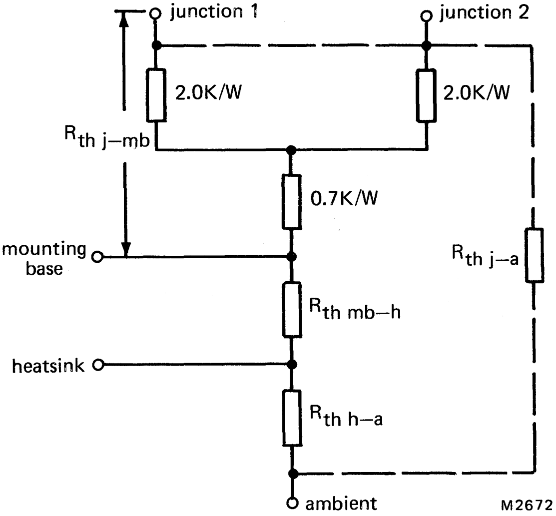


Fig.2.

OPERATING NOTES

Dissipation and heatsink calculations

Overall thermal resistance, $R_{th\ j\text{-}a} = R_{th\ j\text{-}mb} + R_{th\ mb\text{-}h} + R_{th\ h\text{-}a}$

To choose a suitable heatsink, the following information is required for each half of the dual diode:

(i) maximum operating ambient temperature
(ii) duty cycle or form factor of forward current (δ or a)
(iii) average forward current per diode
(iv) crest working reverse voltage (V_{RWM})

The total power dissipation in the diode has two components:

P_R — reverse leakage dissipation

$$P_{tot} = P_R + P_F \quad \text{.......................... 1).}$$

P_F — forward conduction dissipation

From the above it can be seen that:

$$R_{th\ h\text{-}a} = \frac{T_{jmax} - T_{amb}}{P_F + P_R} - (R_{th\ j\text{-}mb} + R_{th\ mb\text{-}h}) \quad \text{........ 2).}$$

Values for $R_{th\ j\text{-}mb}$ and $R_{th\ mb\text{-}h}$ can be found under Thermal Resistance. P_R and P_F are derived from Figs.3 and 4 for square-wave operation (and Figs.5 and 6 for sine-wave) as follows:
Look at each half of the dual diode separately; for each diode, starting at the V_{RWM} axis of Fig.3 (or Fig.5), and from a knowledge of the required V_{RWM}, trace upwards to meet the curve that matches the required T_j max. From this point trace horizontally left until the curve of the voltage grade of the device being used is met. From this point trace downwards to meet the required duty cycle (δ) or form factor (a). From this point trace right and read the actual reverse power dissipation on the P_R axis.
From this calculation, $P_R = P_R$ (diode 1) + P_R (diode 2) .... 3).
Forward conduction dissipation (P_F) for the known average current $I_{F(AV)}$ and duty cycle (or form factor) for each diode is easily derived from Fig.4 (or Fig.6).
Similarly, $P_F = P_F$ (diode 1) + P_F (diode 2) .... 4).
Substituting equations 3) and 4) into equation 2) enables the calculation of the required heatsink.

NOTE:— If both halves of the diode are being used (as is assumed above), the value of $R_{th\ j\text{-}mb}$ = 1.7 K/W. If only one half of the diode is used, follow the above procedure for one diode only, and use the value of $R_{th\ j\text{-}mb}$ of 2.7 K/W.

To ensure thermal stability, $(R_{th\ j\text{-}mb} + R_{th\ mb\text{-}h} + R_{th\ h\text{-}a}) \times P_R$ must be less than 12 °C. If the calculated value of $R_{th\ h\text{-}a}$ does not permit this, then it must be reduced (heatsink size increased or $R_{th\ mb\text{-}h}$ improved) to enable this criterion to be met.

EXAMPLE: square-wave operation, using BYV18-35 and heatsink compound;
$T_{amb} = 50$ °C; δ (diode 1) = 0.5; δ (diode 2) = 0.5;
$I_{F(AV)}$ (diode 1) = 5 A; $I_{F(AV)}$ (diode 2) = 5 A;
V_{RWM} (both diodes) = 12 V; voltage grade of device = 35 V.
From data, $R_{th\ j\text{-}mb}$ = 1.7 K/W and $R_{th\ mb\text{-}h}$ = 0.3 K/W.
For each diode from Fig.4, it is found that P_F = 3.5 W;
hence total $P_F = 2 \times 3.5 = 7$ W. (from equation 4)
If desired T_j max is chosen to be 130 °C, then, from Fig.3, P_R (per diode) = 0.1 W
Therefore total $P_R = 2 \times 0.1 = 0.2$ W. (from equation 3)
Using equation 2) we have:

$$R_{th\ h\text{-}a} = \frac{130\ ^\circ\text{C} - 50\ ^\circ\text{C}}{7\ \text{W} + 0.2\ \text{W}} - (1.7 + 0.3) = 9.1\ \text{K/W}$$

To check for thermal stability:

$$(R_{th\ j\text{-}a}) \times P_R = (1.7 + 0.3 + 9.1) \times 0.2 = 2.2\ ^\circ\text{C}.$$

This is less than 12 °C, hence thermal stability is ensured.

SQUARE WAVE OPERATION (Figs.3 and 4)

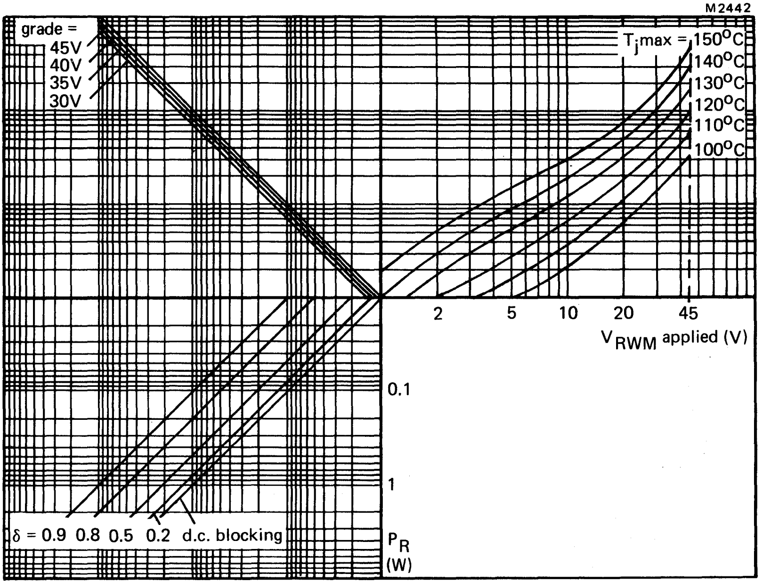
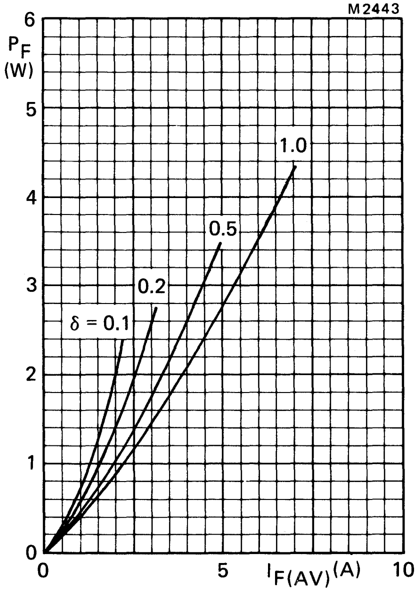
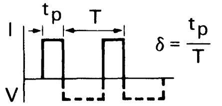


Fig.3 NOMOGRAM: for calculation of P_R (reverse leakage power dissipation) for a given T_j max., V_{RWM} applied, voltage grade and duty cycle (per diode).





$I_{F(AV)} = I_{F(RMS)} \times \sqrt{\delta}$

Fig.4 Forward current power rating (per diode).

SINUSOIDAL OPERATION (Figs.5 and 6)

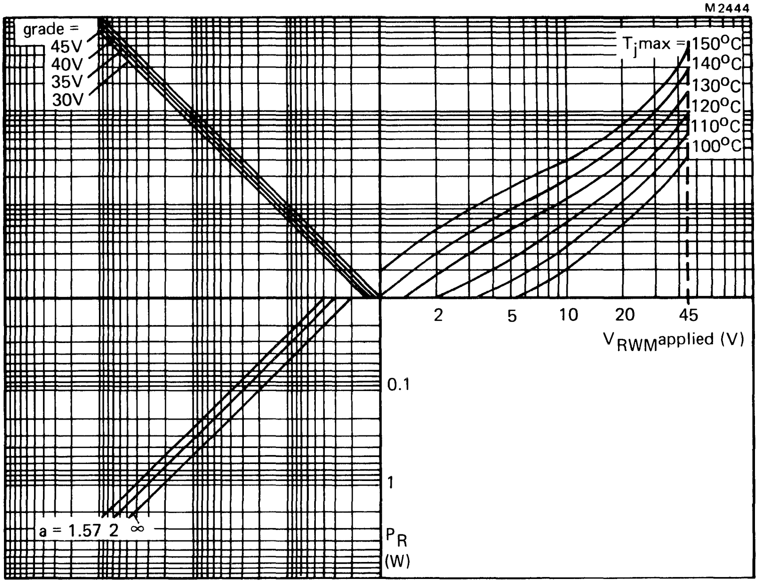


Fig.5 NOMOGRAM: for calculation of P_R (reverse leakage power dissipation) for a given T_j max., V_{RWM} applied, voltage grade and form factor (per diode).

a = form factor = $I_{F(RMS)}/I_{F(AV)}$.

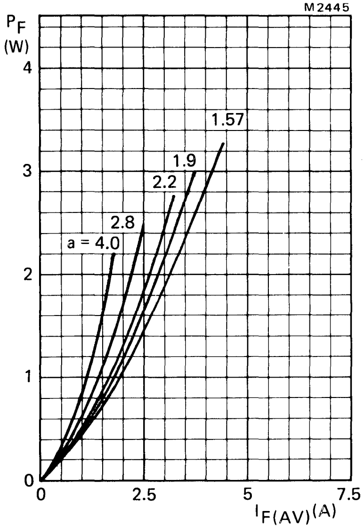


Fig.6 Forward current power rating (per diode).

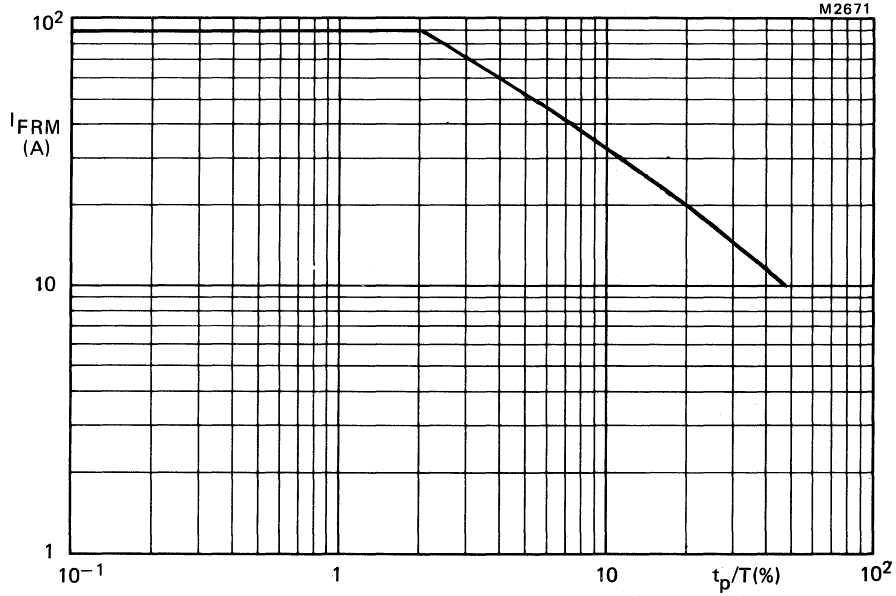
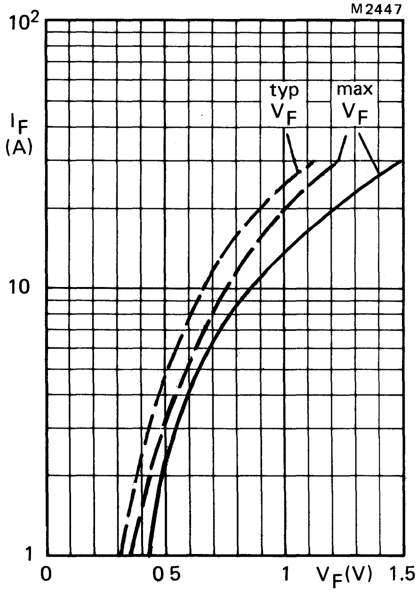
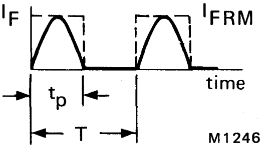


Fig.7 Maximum permissible repetitive peak forward current for either square or sinusoidal current for $1\ \mu s < t_p < 1$ ms.





Definition of I_{FRM} and t_p/T.

Fig.8 —— T_j = 25 °C; – – – T_j = 100 °C.

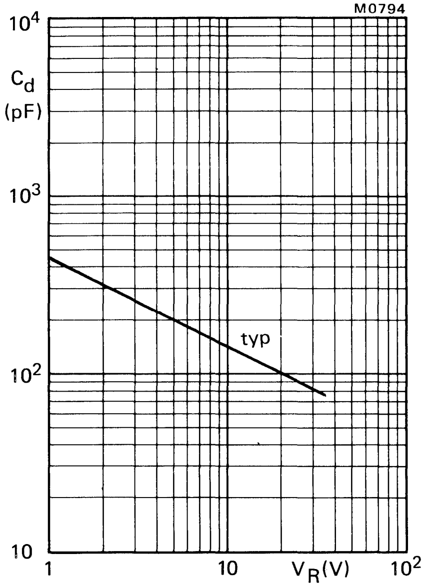


Fig.9 f = 1 MHz; T_j = 25 to 125 °C.

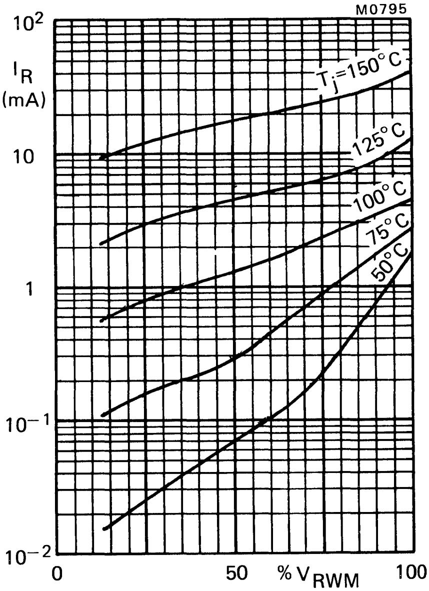


Fig.10 Typical values.

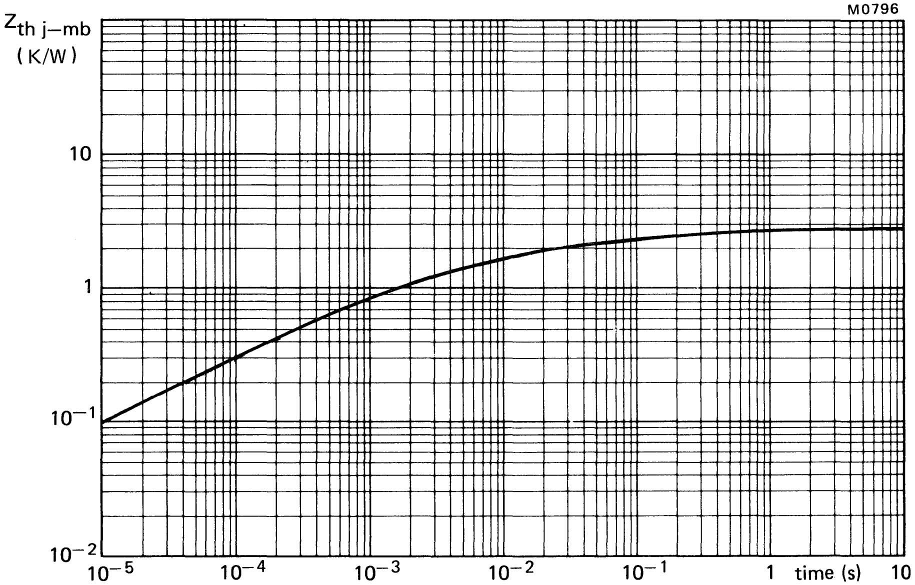


Fig.11 Transient thermal impedance (per diode).

SCHOTTKY–BARRIER RECTIFIER DIODES

High-efficiency schottky-barrier rectifier diodes in TO-220AC plastic envelopes, featuring low forward voltage drop, low capacitance, absence of stored charge, and high temperature stability. They are intended for use in low output voltage switched-mode power supplies and high-frequency circuits in general, where low conduction losses and switching losses are important. They can also withstand reverse voltage transients. The series consists of normal polarity (cathode to mounting base) types. A version with guaranteed reverse surge capability, BYV19–40A, is also available.

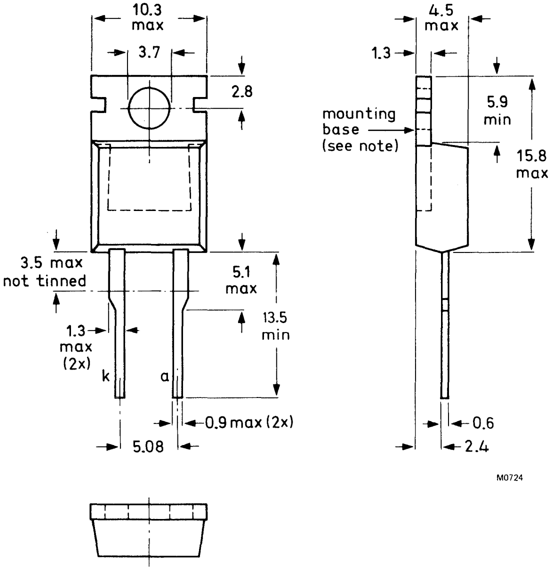
QUICK REFERENCE DATA

			BYV19–30	35	40(A)	45	
Repetitive peak reverse voltage	V_{RRM}	max.	30	35	40	45	V
Average forward current	$I_{F(AV)}$	max.	10				A
Forward voltage	V_F	$<$	0.6				V
Junction temperature	T_j	max.	150				°C

MECHANICAL DATA

Dimensions in mm

Fig.1 TO-220AC



Note: The exposed metal mounting base is directly connected to cathode.
Accessories supplied on request: see data sheets Mounting instructions and accessories for TO-220 envelopes.

RATINGS

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

→ **Voltages**

			BYV19–30	35	40(A)	45	
Repetitive peak reverse voltage	V_{RRM}	max.	30	35	40	45	V
Crest working reverse voltage (note 1)	V_{RWM}	max.	30	35	40	45	V
Continuous reverse voltage (note 1)	V_R	max.	30	35	40	45	V

→ **Currents**

Average forward current square wave; $\delta = 0.5$; up to $T_{mb} = 124\ ^{o}C$ (note 2)	$I_{F(AV)}$	max.	10	A
sinusoidal; up to $T_{mb} = 124\ ^{o}C$ (note 2)	$I_{F(AV)}$	max.	9	A
R.M.S. forward current	$I_{F(RMS)}$	max.	14	A
Repetitive peak forward current $t_p = 20\ \mu s$; $\delta = 0.02$	I_{FRM}	max.	170	A
Non-repetitive peak forward current half sine-wave; $T_j = 125\ ^{o}C$ prior to surge; with reapplied $V_{RWM\ max}$; t = 10 ms	I_{FSM}	max.	150	A
t = 8.3 ms	I_{FSM}	max.	165	A
I^2t for fusing (t = 10 ms)	I^2t	max.	112	A^2s
Reverse surge current (BYV19-40A only) $t_p = 100\ \mu s$	I_{RSM}	max.	0.5	A

Temperatures

Storage temperature	T_{stg}		−40 to +150	^{o}C
Junction temperature	T_j	max.	150	^{o}C

CHARACTERISTICS

Forward voltage $I_F = 5$ A; $T_j = 100\ ^{o}C$ (note 3)	V_F	$<$	0.6	V
$I_F = 20$ A; $T_j = 25\ ^{o}C$ (note 3)	V_F	$<$	1.10	V
Reverse current $V_R = V_{RWMmax}$; $T_j = 125\ ^{o}C$	I_R	$<$	30	mA
Junction capacitance at f = 1 MHz $V_R = 5$ V; $T_j = 25$ to $125\ ^{o}C$	C_d	typ.	200	pF

Notes:

1. Up to $T_j = 125\ ^{o}C$; see derating curve for higher temperature operation.
2. Assuming no reverse leakage current losses.
3. Measured under pulse conditions to avoid excessive dissipation.

THERMAL RESISTANCE

From junction to mounting base	$R_{th\ j\text{-}mb}$	=	2.7	K/W

Influence of mounting method

1. Heatsink-mounted with clip (see mounting instructions)

Thermal resistance from mounting base to heatsink

a. with heatsink compound	$R_{th\ mb\text{-}h}$	=	0.3	K/W
b. with heatsink compound and 0.06 mm maximum mica insulator	$R_{th\ mb\text{-}h}$	=	1.4	K/W
c. with heatsink compound and 0.1 mm maximum mica insulator (56369)	$R_{th\ mb\text{-}h}$	=	2.2	K/W
d. with heatsink compound and 0.25 mm maximum alumina insulator (56367)	$R_{th\ mb\text{-}h}$	=	0.8	K/W
e. without heatsink compound	$R_{th\ mb\text{-}h}$	=	1.4	K/W

2. Free air operation

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

Thermal resistance from junction to ambient in free air; mounted on a printed circuit board at any device lead length and with copper laminate on the board	$R_{th\ j\text{-}a}$	=	60	K/W

MOUNTING INSTRUCTIONS

1. The device may be soldered directly into the circuit, but the maximum permissible temperature of the soldering iron or bath is 275 °C; the heat source must not be in contact with the joint for more than 5 seconds. Soldered joints must be at least 4.7 mm from the seal.
2. The leads should not be bent less than 2.4 mm from the seal, and should be supported during bending. The bend radius must be no less than 1.0 mm. ←
3. Mounting by means of a spring clip is the best mounting method because it offers:
   a. a good thermal contact under the crystal area and slightly lower $R_{th\ mb\text{-}h}$ values than does screw mounting.
   b. safe isolation for mains operation.
   However, if a screw is used, it should be M3 cross-recess pan head. Care should be taken to avoid damage to the plastic body.
4. For good thermal contact, heatsink compound should be used between mounting base and heatsink. Values of $R_{th\ mb\text{-}h}$ given for mounting with heatsink compound refer to the use of a metallic oxide-loaded compound. Ordinary silicone grease is not recommended.
5. Rivet mounting (only possible for non-insulated mounting).
   Devices may be rivetted to flat heatsinks; such a process **must neither** deform the mounting tab, **nor** enlarge the mounting hole.

→ OPERATING NOTES

Dissipation and Heatsink Calculations

The various components of junction temperature rise above ambient are shown below:

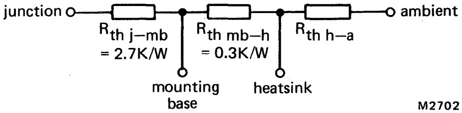


Fig.2

Overall thermal resistance, $R_{th\ j\text{-}a} = R_{th\ j\text{-}mb} + R_{th\ mb\text{-}h} + R_{th\ h\text{-}a}$

To choose a suitable heatsink, the following information is required:

(i) maximum operating ambient temperature
(ii) duty cycle or form factor of forward current (δ or a)
(iii) average forward current
(iv) crest working reverse voltage (V_{RWM})

The total power dissipation in the diode has two components:

P_R – reverse leakage dissipation

$$P_{tot} = P_R + P_F \quad \text{.......... 1).}$$

P_F – forward conduction dissipation

From the above it can be seen that:

$$R_{th\ h\text{-}a} = \frac{T_{jmax} - T_{amb}}{P_R + P_F} - (R_{th\ j\text{-}mb} + R_{th\ mb\text{-}h}) \quad \text{.......... 2).}$$

Values for $R_{th\ j\text{-}mb}$ and $R_{th\ mb\text{-}h}$ can be found under Thermal Resistance. P_R and P_F are derived from Figs.3 and 4 for square-wave operation (and Figs.5 and 6 for sine-wave) as follows:
Starting at the V_{RWM} axis of Fig.3 (or Fig.5), and from a knowledge of the required V_{RWM}, trace upwards to meet the curve that matches the required T_{jmax}. From this point trace horizontally left until the curve of the voltage grade of the device being used is met. From this point trace downwards to meet the required duty cycle (δ) or form factor (a). From this point trace right and read the actual reverse power dissipation on the P_R axis.
Forward conduction dissipation (P_F) for the known average current $I_{F(AV)}$ and duty cycle (or form factor) is easily derived from Fig.4 (or Fig.6).
Substituting the values of P_R and P_F into equation 2) enables the calculation of the required heatsink.

To ensure thermal stability, $(R_{th\ j\text{-}mb} + R_{th\ mb\text{-}h} + R_{th\ h\text{-}a}) \times P_R$ must be less than 12 °C. If the calculated value of $R_{th\ h\text{-}a}$ does not permit this, then it must be reduced (heatsink size increased or $R_{th\ mb\text{-}h}$ improved) to enable this criterion to be met.

EXAMPLE: square-wave operation, using BYV19-35 and heatsink compound;
T_{amb} = 50 °C; δ = 0.5; $I_{F(AV)}$ = 8 A
V_{RWM} = 12 V; voltage grade of device = 35 V
From data, $R_{th\ j\text{-}mb}$ = 2.7 K/W and $R_{th\ mb\text{-}h}$ = 0.3 K/W.
From Fig.4, it is found that P_F = 7 W
If the desired T_{jmax} is chosen to be 130 °C, then from Fig.3, P_R = 0.1 W
Using equation 2) we have:

$$R_{th\ h\text{-}a} = \frac{130\ ^{\circ}\mathrm{C} - 50\ ^{\circ}\mathrm{C}}{7\ \mathrm{W} + 0.1\ \mathrm{W}} - (2.7 + 0.3) = 8.3\ \mathrm{K/W}$$

To check for thermal stability:

$$(R_{th\ j\text{-}a}) \times P_R = (2.7 + 0.3 + 8.3) \times 0.1 = 1.1\ ^{\circ}\mathrm{C}.$$

This is less than 12 °C, hence thermal stability is ensured.

SQUARE WAVE OPERATION (Figs.3 and 4)

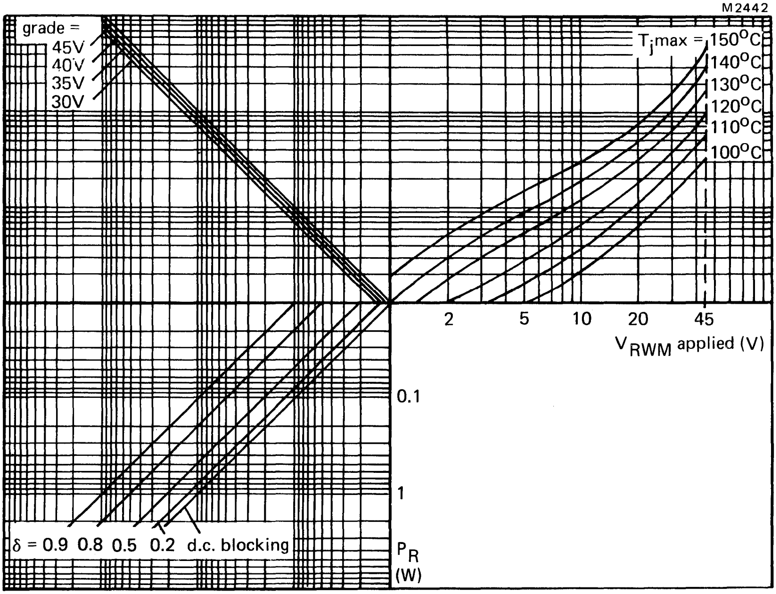
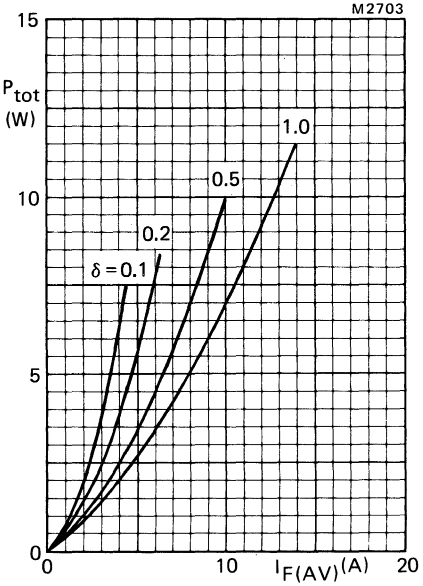
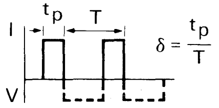


Fig.3 NOMOGRAM: for calculation of P_R (reverse leakage power dissipation) for a given T_j max., V_{RWM} applied, voltage grade and duty cycle.





$I_{F(AV)} = I_{F(RMS)} \times \sqrt{\delta}$

Fig.4 Forward current power rating.

SINUSOIDAL OPERATION (Figs.5 and 6)

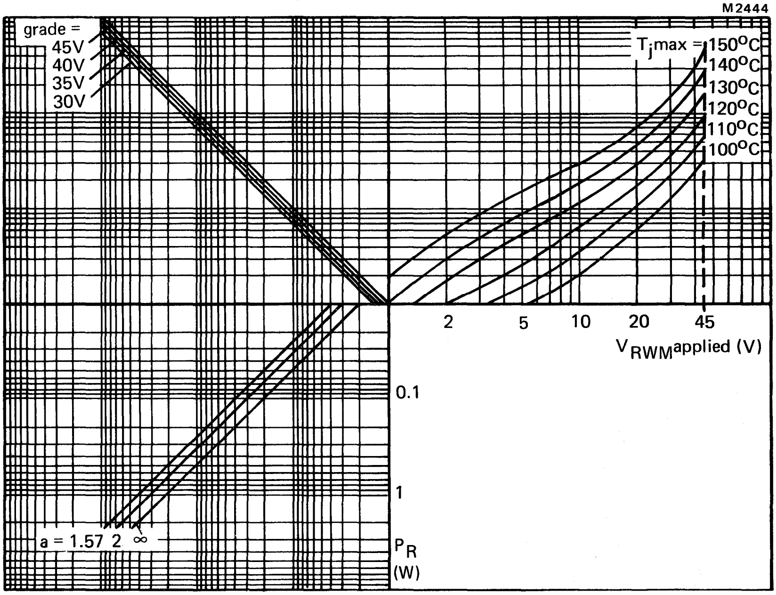


Fig.5 NOMOGRAM: for calculation of P_R (reverse leakage power dissipation) for a given T_j max., V_{RWM} applied, voltage grade and form factor.
a = form factor = $I_{F(RMS)}/I_{F(AV)}$

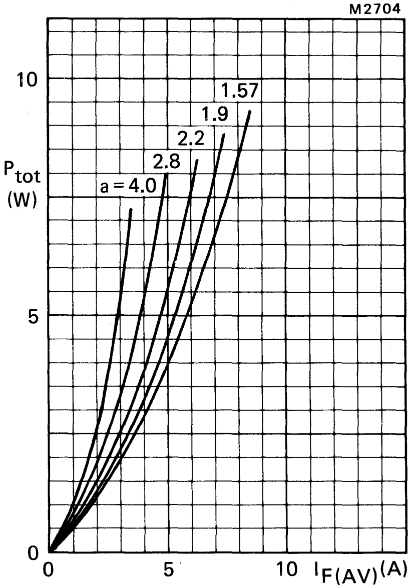


Fig.6 Forward current power rating.

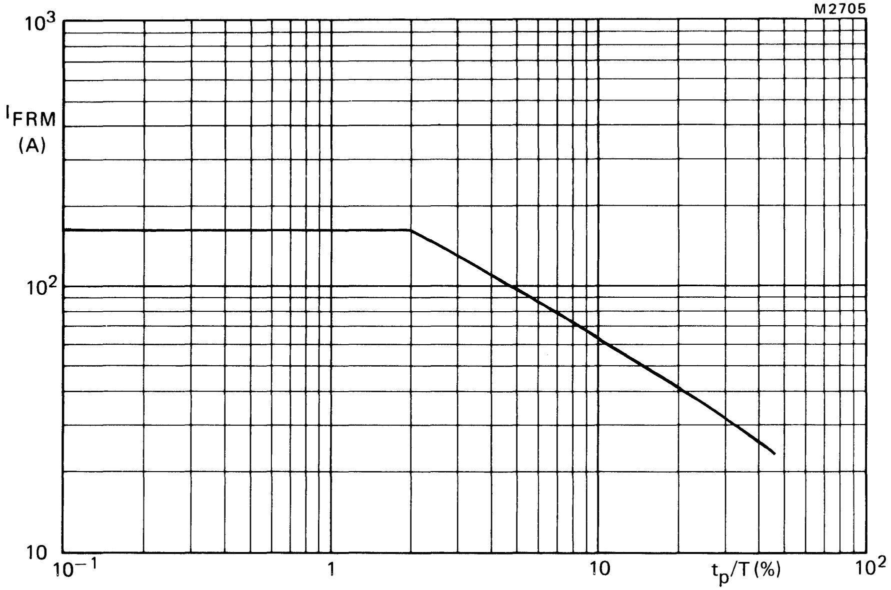
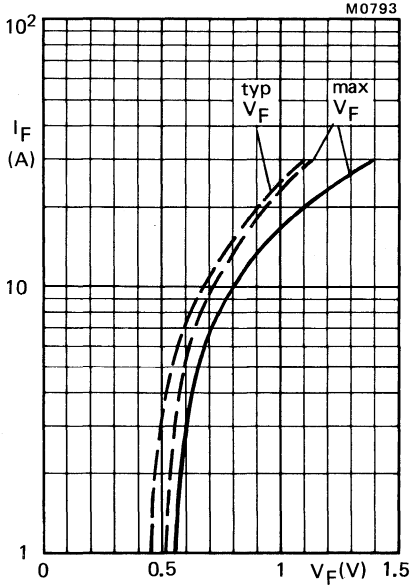
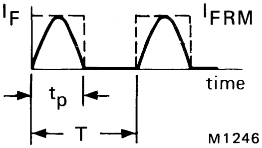


Fig.7 Maximum permissible repetitive peak forward current for either square or sinusoidal currents for 1 $\mu s < t_p < 1$ ms.





Definition of I_{FRM} and t_p/T.

Fig.8 —— T_j = 25 °C; – – – T_j = 100 °C.

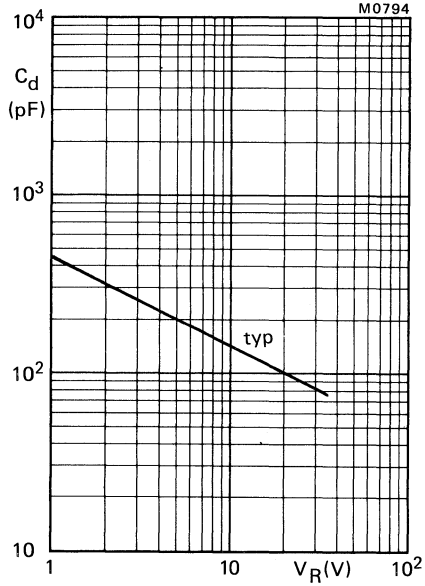


Fig.9 f = 1 MHz; T_j = 25 to 125 °C.

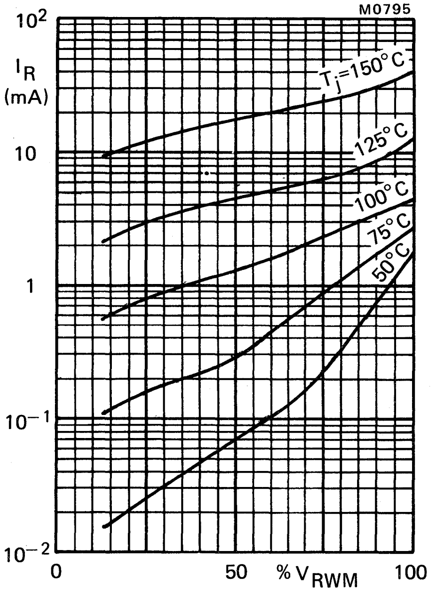


Fig.10 Typical values.

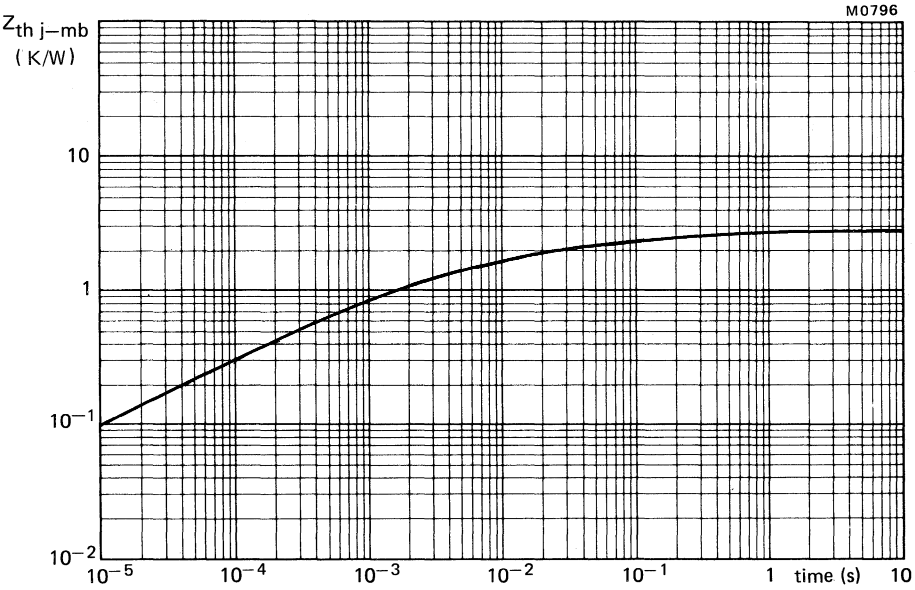


Fig.11 Transient thermal impedance.

SCHOTTKY-BARRIER RECTIFIER DIODES

High-efficiency schottky-barrier rectifier diodes in DO-4 metal envelopes, featuring low forward voltage drop, low capacitance, absence of stored charge and high temperature stability. They are intended for use in low output voltage switched-mode power supplies and high-frequency circuits in general, where both low conduction losses and zero switching losses are important. They can also withstand reverse voltage transients. The series consists of normal polarity (cathode to stud) types. A version with guaranteed reverse surge capability, BYV20—40A, is also available.

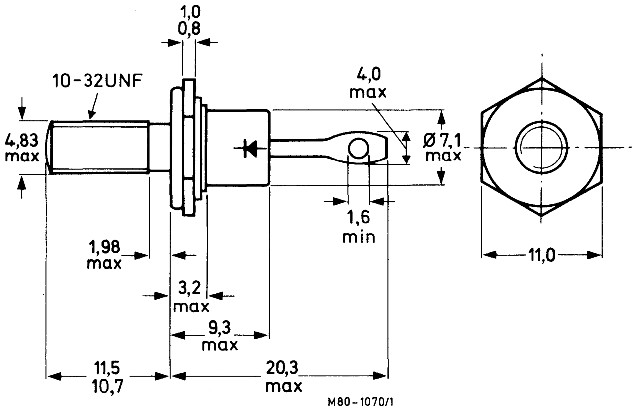
QUICK REFERENCE DATA

			BYV20—30	35	40(A)	45	
Repetitive peak reverse voltage	V_{RRM}	max.	30	35	40	45	V
Average forward current	$I_{F(AV)}$	max.	15				A
Forward voltage	V_F	$<$	0.6				V
Junction temperature	T_j	max.	150				°C

MECHANICAL DATA

Dimensions in mm

Fig.1 DO-4 with 10-32 UNF stud (ϕ4.83 mm) as standard.
Metric M5 stud (ϕ5 mm) is available on request, eg. BYV20—30M.



Net mass: 6 g

Diameter of clearance hole: 5.2 mm

Accessories supplied on request:
56295a (mica washer); 56295b (PTFE ring);
56295c (insulating bush).

Supplied with device: 1 nut, 1 lock washer.
Torque on nut:
min. 0.9 Nm (9 kg cm),
max. 1.7 Nm (17 kg cm).
Nut dimensions across the flats:
10-32 UNF, 9.5 mm; M5, 8.0 mm. ←

Products approved to CECC 50 009-033 available on request.

RATINGS

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

Voltages			BYV20–30	35	40(A)	45	
Non-repetitive peak reverse voltage	V_{RSM}	max.	36	42	48	54	V
Repetitive peak reverse voltage (note 1)	V_{RRM}	max.	30	35	40	45	V
Crest working reverse voltage	V_{RWM}	max.	30	35	40	45	V
Continuous reverse voltage	V_R	max.	30	35	40	45	V

→ **Currents**

Average forward current				
square wave; $\delta = 0.5$; up to T_{mb} = 121 °C (note 2)	$I_{F(AV)}$	max.	15	A
sinusoidal; up to T_{mb} = 124 °C (note 2)	$I_{F(AV)}$	max.	12.5	A
R.M.S. forward current	$I_{F(RMS)}$	max.	21	A
Repetitive peak forward current				
t_p = 20 μs; $\delta = 0.02$	I_{FRM}	max.	260	A
Non-repetitive peak forward current				
half sine-wave; T_j = 125 °C prior to surge; with reapplied $V_{RWM\,max}$;				
t = 10 ms	I_{FSM}	max.	300	A
t = 8.3 ms	I_{FSM}	max.	330	A
I^2t for fusing (t = 10 ms)	I^2t	max.	450	A^2s
Reverse surge current (BYV20-40A only)				
t_p = 100 μs	I_{RSM}	max.	1.0	A

Temperatures

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

MOUNTING INSTRUCTIONS

The top connector should be neither 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.

Notes:

1. For t_p = 200 ns a 20% increase in V_{RRM} is allowed.
2. Assuming no reverse leakage current losses.

THERMAL RESISTANCE

From junction to mounting base	$R_{th\ j\text{-}mb}$	=	2.2	K/W	
From mounting base to heatsink with heatsink compound	$R_{th\ mb\text{-}h}$	=	0.5	K/W	
Transient thermal impedance; t = 1 ms	$Z_{th\ j\text{-}mb}$	=	0.85	K/W	←

CHARACTERISTICS

Forward voltage					
$I_F = 15$ A; $T_j = 100$ °C	V_F	<	0.6	V*	
$I_F = 40$ A; $T_j = 25$ °C	V_F	<	1.0	V*	
Rate of rise of reverse voltage $V_R = V_{RWMmax}$	$\frac{dV_R}{dt}$	<	1500	V/μs	←
Reverse current $V_R = V_{RWMmax}$; $T_j = 125$ °C	I_R	<	70	mA	
Capacitance at f = 1 MHz $V_R = 5$ V; $T_j = 25$ to 125 °C	C_d	typ.	520	pF	

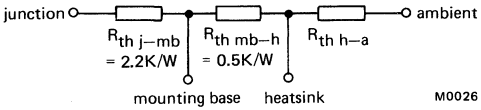
---

*Measured under pulse conditions to avoid excessive dissipation.

OPERATING NOTES

Dissipation and Heatsink Calculations

The various components of junction temperature rise above ambient are shown below:



M0026 Fig.2

Overall thermal resistance, $R_{th\ j\text{-}a} = R_{th\ j\text{-}mb} + R_{th\ mb\text{-}h} + R_{th\ h\text{-}a}$

To choose a suitable heatsink, the following information is required:

(i) maximum operating ambient temperature
(ii) duty cycle or form factor of forward current (δ or a)
(iii) average forward current
(iv) crest working reverse voltage (V_{RWM})

The total power dissipation in the diode has two components:

P_R – reverse leakage dissipation

$$P_{tot} = P_R + P_F \quad \text{.......... 1).}$$

P_F – forward conduction dissipation

From the above it can be seen that:

$$R_{th\ h\text{-}a} = \frac{T_{jmax} - T_{amb}}{P_R + P_F} - (R_{th\ j\text{-}mb} + R_{th\ mb\text{-}h}) \quad \text{.......... 2).}$$

Values for $R_{th\ j\text{-}mb}$ and $R_{th\ mb\text{-}h}$ can be found under Thermal Resistance. P_R and P_F are derived from Figs.3 and 4 for square-wave operation (and Figs.5 and 6 for sine-wave) as follows:
Starting at the V_{RWM} axis of Fig.3 (or Fig.5), and from a knowledge of the required V_{RWM}, trace upwards to meet the curve that matches the required T_{jmax}. From this point trace horizontally left until the curve of the voltage grade of the device being used is met. From this point trace downwards to meet the required duty cycle (δ) or form factor (a). From this point trace right and read the actual reverse power dissipation on the P_R axis.
Forward conduction dissipation (P_F) for the known average current $I_{F(AV)}$ and duty cycle (or form factor) is easily derived from Fig.4 (or Fig.6).
Substituting the values of P_R and P_F into equation 2) enables the calculation of the required heatsink.

To ensure thermal stability, $(R_{th\ j\text{-}mb} + R_{th\ mb\text{-}h} + R_{th\ h\text{-}a}) \times P_R$ must be less than 12 °C. If the calculated value of $R_{th\ h\text{-}a}$ does not permit this, then it must be reduced (heatsink size increased or $R_{th\ mb\text{-}h}$ improved) to enable this criterion to be met.

EXAMPLE: square-wave operation, using BYV20-35 and heatsink compound;
$T_{amb} = 50\ ^{o}C$; $\delta = 0.5$; $I_{F(AV)} = 12$ A
$V_{RWM} = 12$ V; voltage grade of device = 35 V
From data, $R_{th\ j\text{-}mb} = 2.2$ K/W and $R_{th\ mb\text{-}h} = 0.5$ K/W.
From Fig.4, it is found that $P_F = 9.2$ W
If the desired T_{jmax} is chosen to be 130 °C, then from Fig.3, $P_R = 0.3$ W
Using equation 2) we have:

$$R_{th\ h\text{-}a} = \frac{130\ ^{o}C - 50\ ^{o}C}{9.2\ W + 0.3\ W} - (2.2 + 0.5) = 5.7\ K/W$$

To check for thermal stability:

$$(R_{th\ j\text{-}a}) \times P_R = (2.2 + 0.5 + 5.7) \times 0.3 = 2.5\ ^{o}C.$$

This is less than 12 °C, hence thermal stability is ensured.

SQUARE-WAVE OPERATION (Figs.3 and 4)

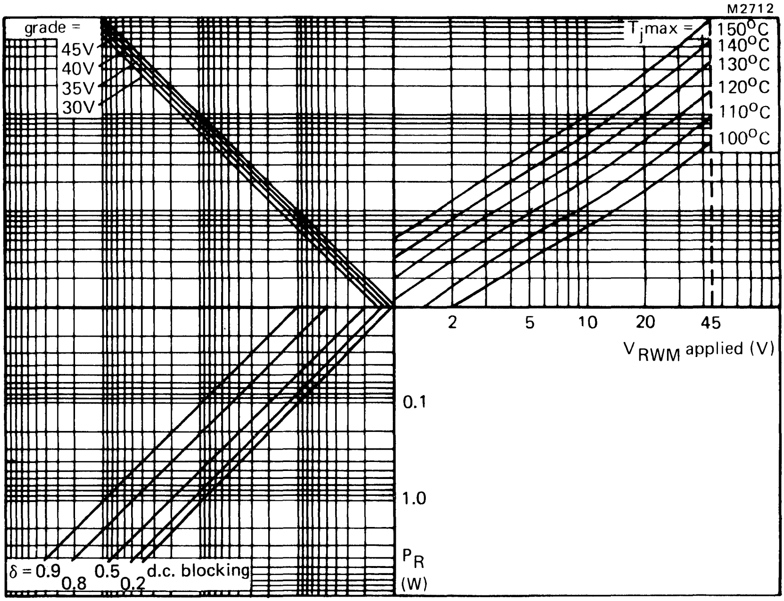


Fig.3 NOMOGRAM: for calculation of P_R (reverse leakage power dissipation) for a given T_j max., V_{RWM} applied, voltage grade and duty cycle.

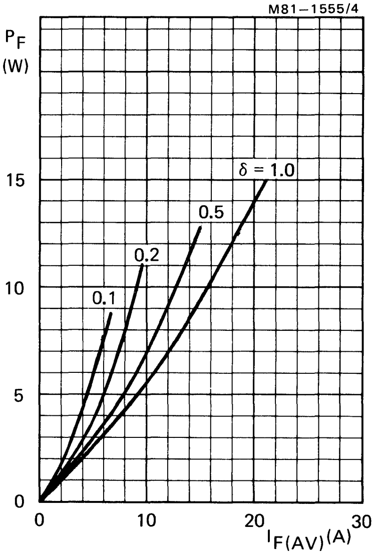
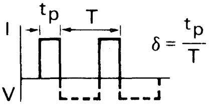


Fig.4.



$I_{F(AV)} = I_{F(RMS)} \times \sqrt{\delta}$

SINE-WAVE OPERATION (Figs.5 and 6)

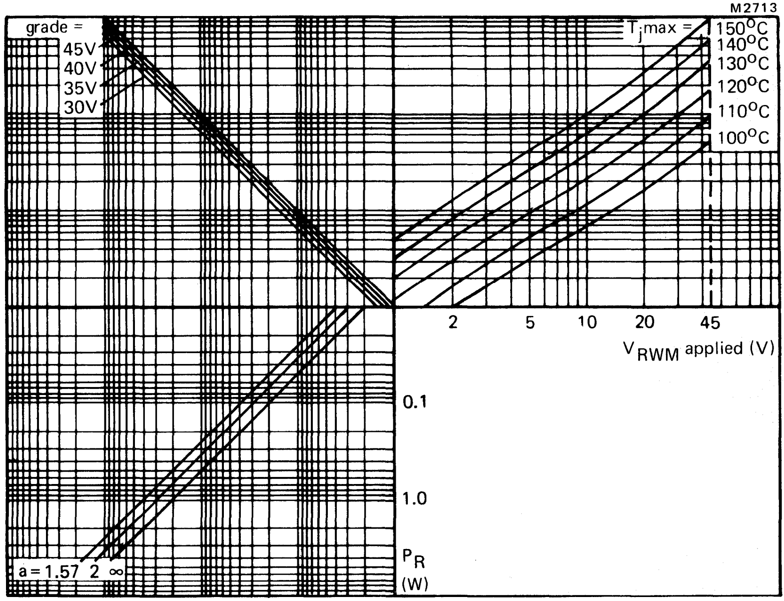


Fig.5 NOMOGRAM: for calculation of P_R (reverse leakage power dissipation) for a given T_j max., V_{RWM} applied, voltage grade and form factor.
a = form factor = $I_{F(RMS)}/I_{F(AV)}$.

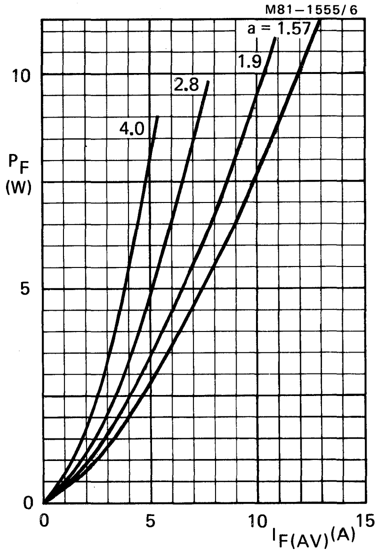


Fig.6.

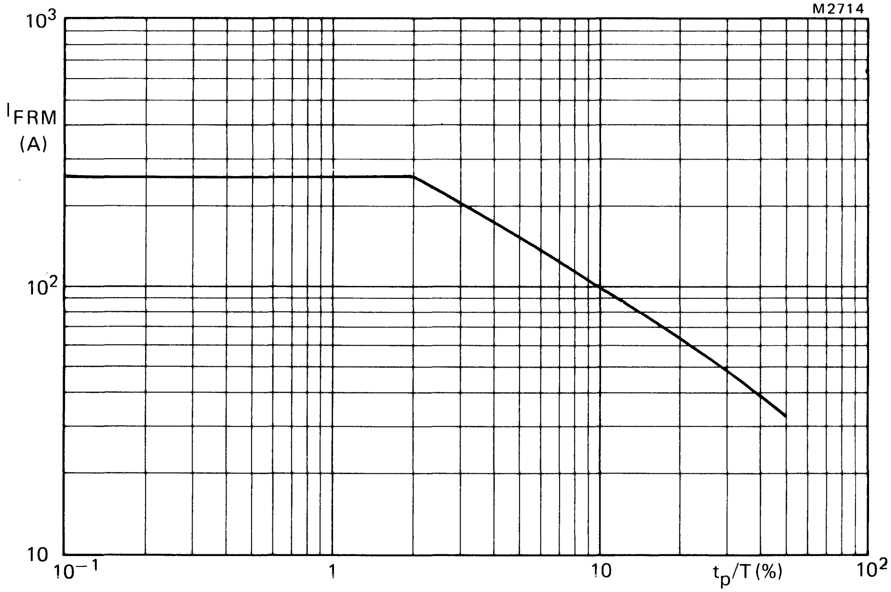
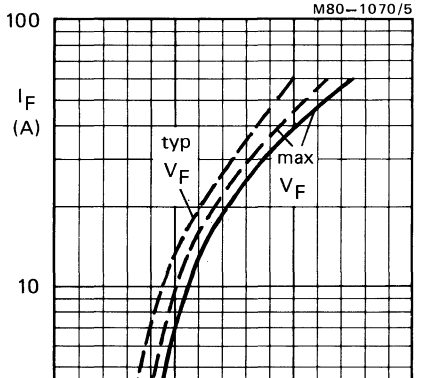
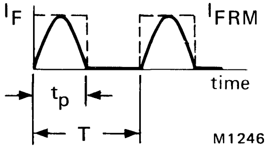


Fig.7 Maximum permissible repetitive peak forward current for either square or sinusoidal currents for 1 μs $< t_p <$ 1 ms.





Definition of I_{FRM} and t_p/T.

Fig.8 —— T_j = 25 °C; – – – T_j = 100 °C.

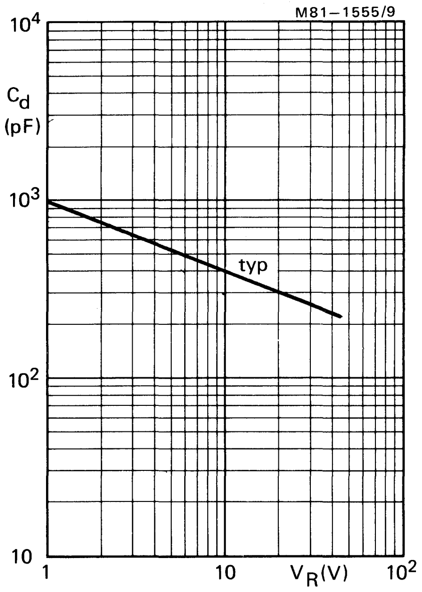


Fig.9 f = 1 MHz; T_j = 25 to 125 °C.

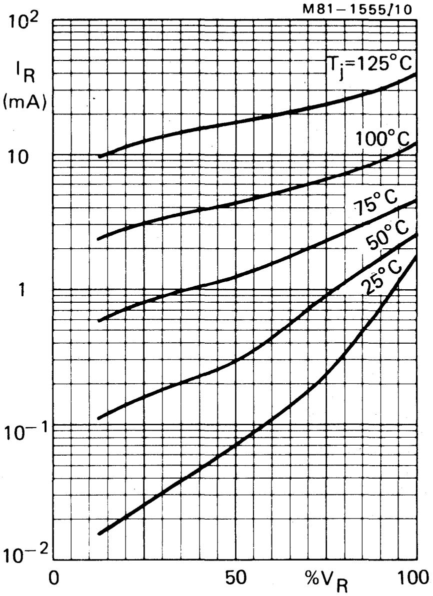


Fig.10 Typical values.

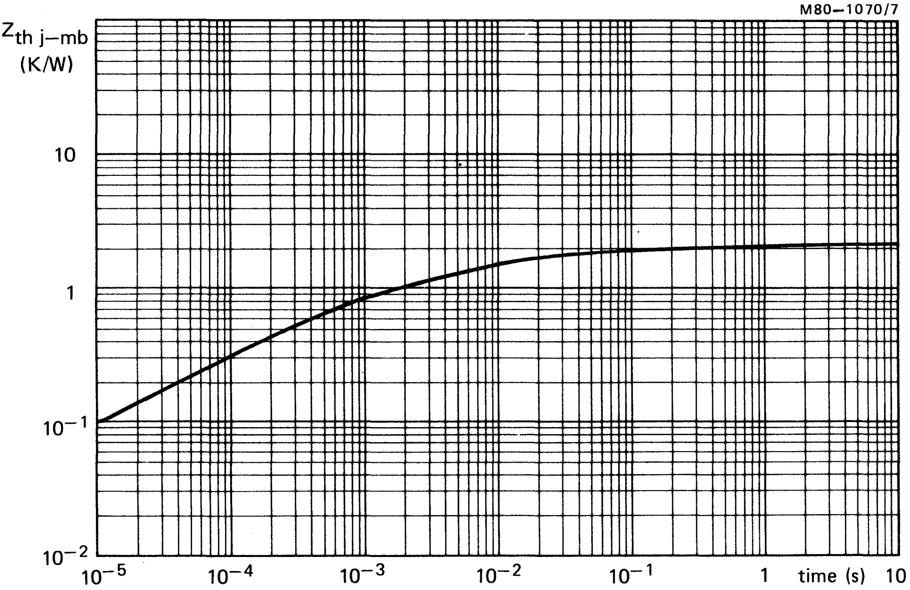


Fig.11 Transient thermal impedance.

SCHOTTKY-BARRIER RECTIFIER DIODES

High-efficiency schottky-barrier rectifier diodes in DO–4 metal envelopes, featuring low forward voltage drop, low capacitance, absence of stored charge and high temperature stability. They are intended for use in low output voltage switched-mode power supplies and high-frequency circuits in general, where both low conduction losses and zero switching losses are important. They can also withstand reverse voltage transients. The series consists of normal polarity (cathode to stud) types. A version with guaranteed reverse surge capability, BYV21-40A, is also available.

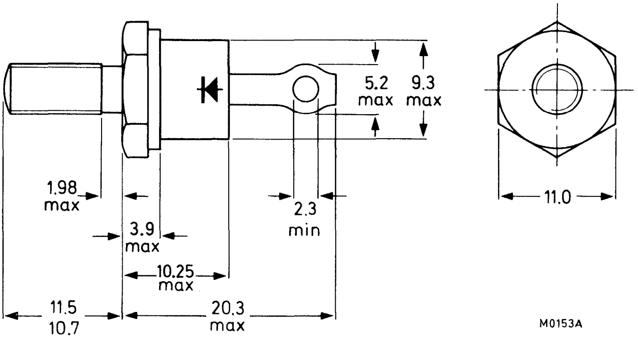
QUICK REFERENCE DATA

			BYV21–30	35	40(A)	45	
Repetitive peak reverse voltage	V_{RRM}	max.	30	35	40	45	V
Average forward current	$I_{F(AV)}$	max.	30				A
Forward voltage	V_F	<	0.55				V
Junction temperature	T_j	max.	150				°C

MECHANICAL DATA

Dimensions in mm

Fig.1 DO–4 with 10–32 UNF sutd (ϕ4.83 mm) as standard.
Metric M5 stud (ϕ5 mm) is available on request, e.g. BYV21–30M.



Net mass: 7 g

Diameter of clearance hole: 5.2 mm

Accessories supplied on request:
56295a (mica washer),
56295b (PTFE ring),
56295c (insulating bush).

Supplied with device: 1 nut, 1 lock washer.
Torque on nut:
min. 0.9 Nm (9 kg cm),
max. 1.7 Nm (17 kg cm).
Nut dimensions across the flats:
10–32 UNF, 9.5 mm; M5, 8.0 mm.

Products approved to CECC 50 009-018 available on request.

RATINGS

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

Voltages			BYV21–30	35	40(A)	45	
Non-repetitive peak reverse voltage	V_{RSM}	max.	36	42	48	54	V
Repetitive peak reverse voltage (note 1)	V_{RRM}	max.	30	35	40	45	V
Crest working reverse voltage	V_{RWM}	max.	30	35	40	45	V
Continuous reverse voltage	V_R	max.	30	35	40	45	V

→ **Currents**

Average forward current; switching losses negligible square wave; $\delta = 0.5$; up to $T_{mb} = 124\ ^{o}C$ (note 2)	$I_{F(AV)}$	max.	30	A
sinusoidal; up to $T_{mb} = 125\ ^{o}C$ (note 2)	$I_{F(AV)}$	max.	27	A
R.M.S. forward current	$I_{F(RMS)}$	max.	42.5	A
Repetitive peak forward current $t_p = 20\ \mu s$; $\delta = 0.02$	I_{FRM}	max.	500	A
Non-repetitive peak forward current half sine-wave; $T_j = 125\ ^{o}C$ prior to surge; with reapplied $V_{RWM\,max}$; $t = 10$ ms	I_{FSM}	max.	600	A
$t = 8.3$ ms	I_{FSM}	max.	650	A
I^2t for fusing ($t = 10$ ms)	I^2t	max.	1800	A^2s
Reverse surge current (BYV21-40A only) $t_p = 100\ \mu s$	I_{RSM}	max.	1.0	A

Temperatures

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

MOUNTING INSTRUCTIONS

The top connector should be neither 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.

Notes:

1. For $t_p = 200$ ns a 20% increase in V_{RRM} is allowed.
2. Assuming no reverse leakage current losses.

THERMAL RESISTANCE

From junction to mounting base	$R_{th\ j\text{-}mb}$	=	1	K/W
From mounting base to heatsink				
with heatsink compound	$R_{th\ mb\text{-}h}$	=	0.3	K/W
without heatsink compound	$R_{th\ mb\text{-}h}$	=	0.5	K/W
Transient thermal impedance; t = 1 ms	$Z_{th\ j\text{-}mb}$	=	0.15	K/W

CHARACTERISTICS

Forward voltage				
$I_F = 30$ A; $T_j = 100$ °C	V_F	<	0.55	V*
$I_F = 80$ A; $T_j = 25$ °C	V_F	<	0.88	V*
Rate of rise of reverse voltage				
$V_R = V_{RWMmax}$	$\frac{dV_R}{dt}$	<	1500	V/µs
Reverse current				
$V_R = V_{RWMmax}$; $T_j = 125$ °C	I_R	<	150	mA
Capacitance at f = 1 MHz				
$V_R = 5$ V; $T_j = 25$ to 125 °C	C_d	typ.	1150	pF

---

*Measured under pulse conditions to avoid excessive dissipation.

OPERATING NOTES

Dissipation and heatsink calculations

The various components of junction temperature rise above ambient are shown below:

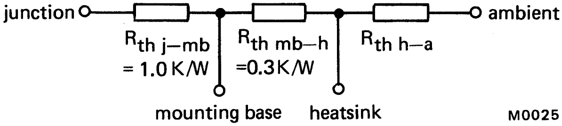


Fig.2

Overall thermal resistance, $R_{th\ j\text{-}a} = R_{th\ j\text{-}mb} + R_{th\ mb\text{-}h} + R_{th\ h\text{-}a}$

To choose a suitable heatsink, the following information is required:

(i) maximum operating ambient temperature
(ii) duty-cycle or form-factor of forward current (δ or a)
(iii) average forward current
(iv) crest working reverse voltage (V_{RWM})

The total power dissipation in the diode has two components:

P_R – reverse leakage dissipation
P_F – forward conduction dissipation

$$P_{tot} = P_R + P_F \quad \ldots\ldots\ldots\ldots \quad 1)$$

From the above, it can be seen that:

$$R_{th\ h\text{-}a} = \frac{T_{j\ max} - T_{amb}}{P_R + P_F} - (R_{th\ j\text{-}mb} + R_{th\ mb\text{-}h}) \quad \ldots\ldots\ldots\ldots \quad 2)$$

values for $R_{th\ j\text{-}mb}$ and $R_{th\ mb\text{-}h}$ can be found under Thermal resistance.

P_R and P_F are derived from Figs.3 and 4 for square-wave operation (and Figs.5 and 6 for sine-wave) as follows:

Starting at the V_{RWM} axis of Fig.3 (or Fig.5), and from a knowledge of the required V_{RWM}, trace upwards to meet the curve that matches the required T_{jmax}. From this point trace horizontally left until the curve of the voltage grade of the device being used is met. From this point trace downwards to meet the required duty cycle (δ) or form factor (a). From this point trace right and read the actual reverse power dissipation on the P_R axis.

Forward conduction dissipation (P_F) for the known average current $I_{F(AV)}$ and duty cycle (or form factor) is easily derived from Fig.4 (or Fig.6).

Substituting the values of P_R and P_F into equation 2) enables the calculation of the required heatsink. To ensure thermal stability, $(R_{th\ j\text{-}mb} + R_{th\ mb\text{-}h} + R_{th\ h\text{-}a}) \times P_R$ must be less than 12 °C. If the calculated value of $R_{th\ h\text{-}a}$ does not permit this, then it must be reduced (heatsink size increased or $R_{th\ mb\text{-}h}$ improved) to enable this criterion to be met.

EXAMPLE: square-wave operation, using BYV21-35 and heatsink compound;
$T_{amb} = 30\ ^{o}C$; $\delta = 0.5$; $I_{F(AV)} = 20$ A; $V_{RWM} = 12$ V; voltage grade of device = 35 V.
From data, $R_{th\ j\text{-}mb} = 1.0$ K/W and $R_{th\ mb\text{-}h} = 0.3$ K/W.
From Fig.4, it is found that $P_F = 14$ W
If desired T_{jmax} is chosen to be 120 °C, then, from Fig.3, $P_R = 0.35$ W
Using equation 2) we have:

$$R_{th\ h\text{-}a} = \frac{120\ ^{o}C - 30\ ^{o}C}{14\ W + 0.35\ W} - (1.0 + 0.3) = 5\ K/W$$

To check for thermal stability: $(R_{th\ j\text{-}a}) \times P_R = (1.0 + 0.3 + 5) \times 0.35 = 2.2\ ^{o}C$.
This is less than 12 °C, hence thermal stability is ensured.

SQUARE-WAVE OPERATION (Figs.3 and 4)

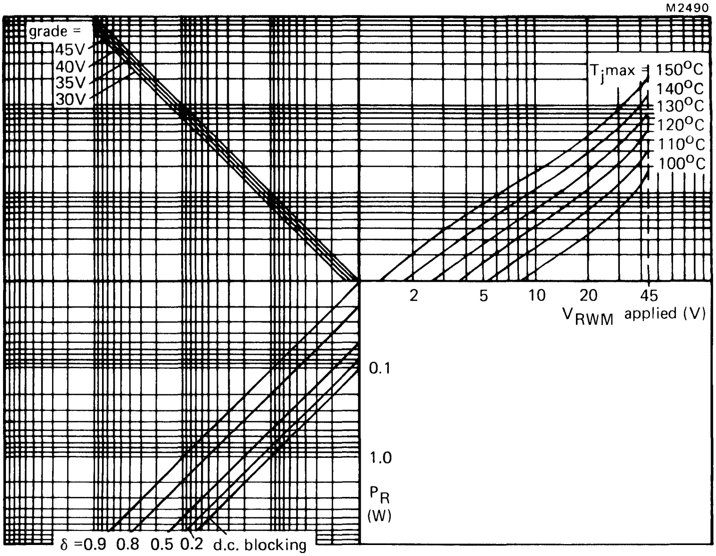
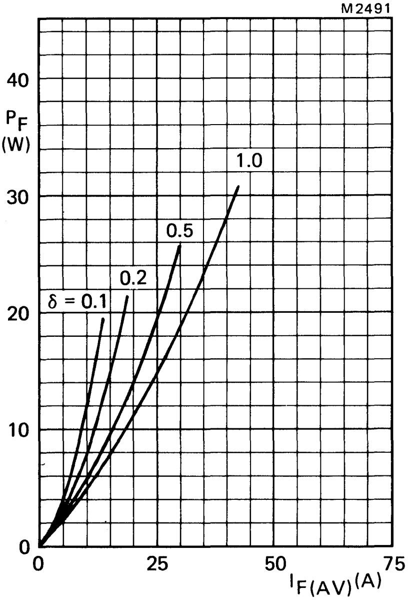
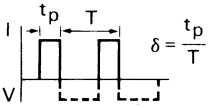


Fig.3 Maximum permissible junction temperature as a function of crest working reverse voltage and duty cycle of forward conduction.





$I_{F(AV)} = I_{F(RMS)} \times \sqrt{\delta}$

Fig.4

SINE-WAVE OPERATION (Figs.5 and 6)

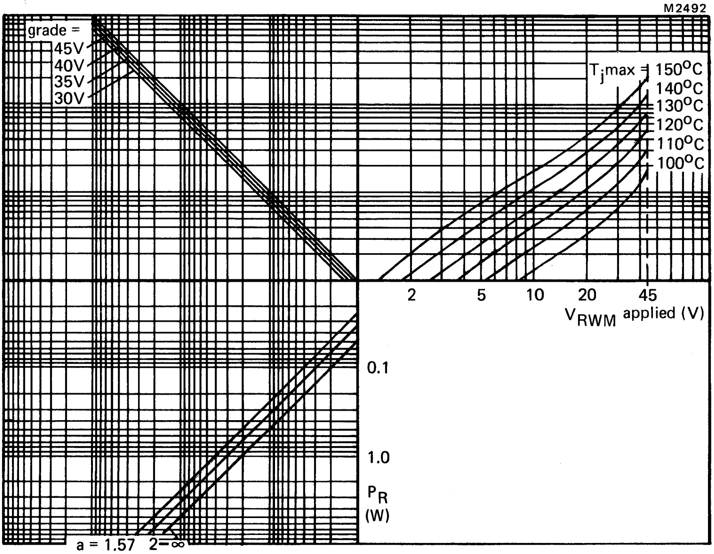


Fig.5 Maximum permissible junction temperature as a function of crest working reverse voltage and form factor of forward conduction.
a = form factor = $I_{F(RMS)}/I_{F(AV)}$.

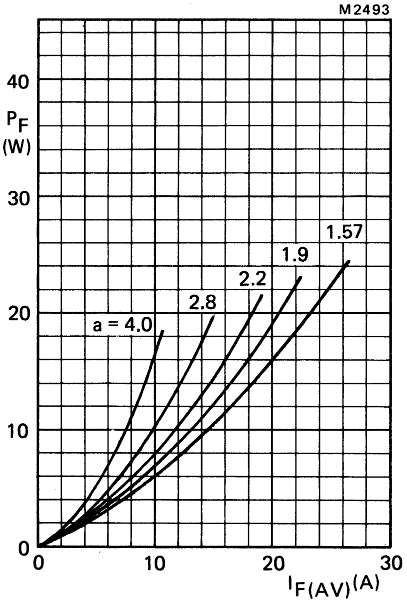


Fig.6

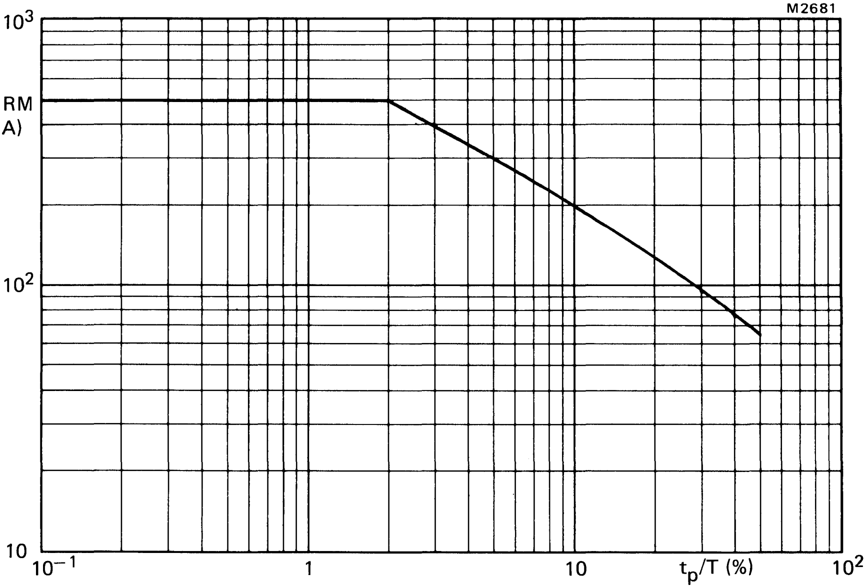
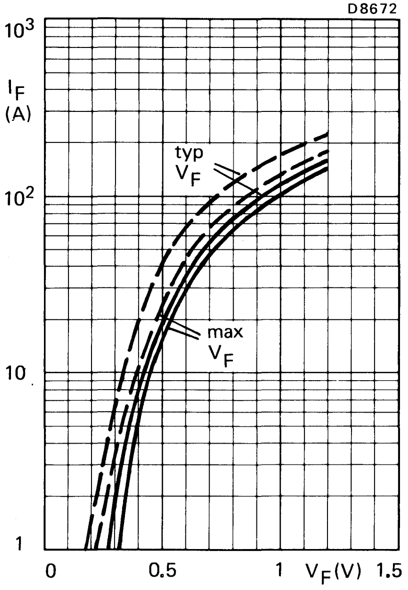
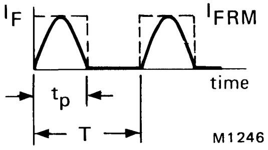


Fig.7 Maximum permissible repetitive peak forward current for either square or sinusoidal currents for 1 μs $< t_p <$ 1 ms.





Definition of I_{FRM} and t_p/T.

Fig.8 —— T_j = 25 °C; — — — T_j = 100 °C.

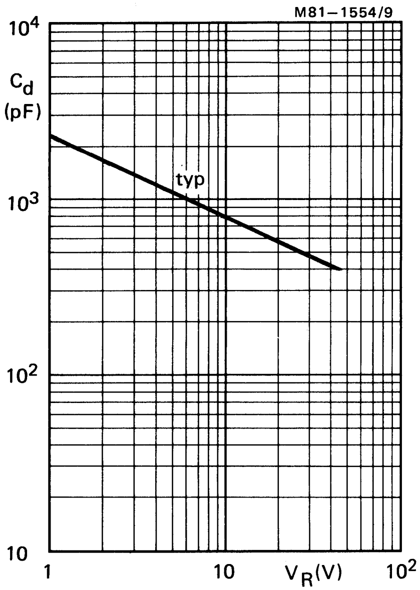


Fig.9 f = 1 MHz; T_j = 25 to 125 °C

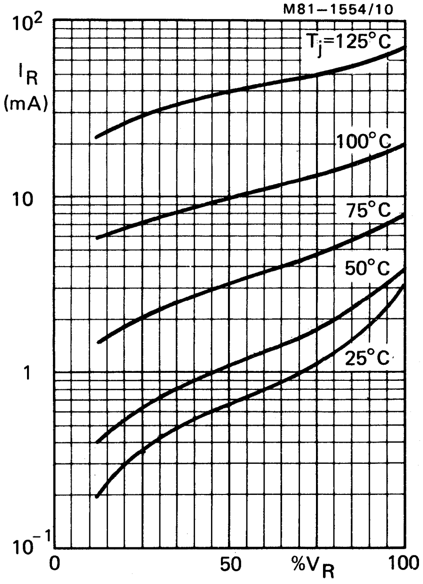


Fig.10 Typical values

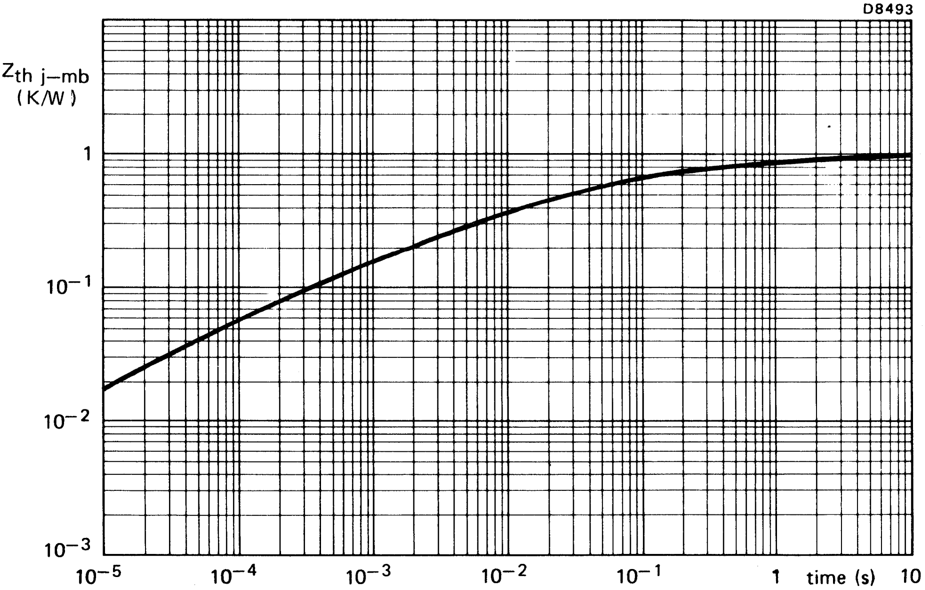


Fig.11

SCHOTTKY-BARRIER RECTIFIER DIODES

High-efficiency schottky-barrier rectifier diodes in DO-5 metal envelopes, featuring low forward voltage drop, low capacitance, absence of stored charge and high temperature stability. They are intended for use in low output voltage switched-mode power supplies and high-frequency circuits in general, where both low conduction losses and zero switching losses are important. They can also withstand reverse voltage transients. The series consists of normal polarity (cathode to stud) types. A version with guaranteed reverse surge capability, BYV22–40A, is also available.

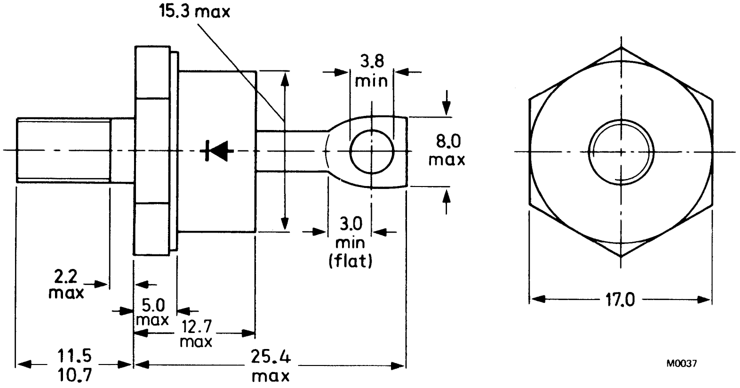
QUICK REFERENCE DATA

			BYV22–30	35	40(A)	45	
Repetitive peak reverse voltage	V_{RRM}	max.	30	35	40	45	V
Average forward current	$I_{F(AV)}$	max.	60				A
Forward voltage	V_F	<	0.55				V
Junction temperature	T_j	max.	150				°C

MECHANICAL DATA

Dimensions in mm

Fig.1 DO–5 with ¼" x 28 UNF stud (φ6.35 mm)
Types with metric M6 stud (φ6 mm) are available on request; e.g. BYV22–30M.



Net mass: 22 g

Diameter of clearance hole: 6.5 mm

Accessories supplied on request:
56264a (mica washer)
56264b (insulating bush).

Supplied with device: 1 nut, 1 lock washer
Torque on nut:
min. 1.7 Nm (17 kg cm),
max. 3.5 Nm (35 kg cm),
Nut dimensions across the flats
¼" x 28 UNF, 11.1 mm; M6, 10 mm.

Products approved to CECC 50 009-034 available on request

RATINGS

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

Voltages			BYV22–30	35	40(A)	45	
Non-repetitive peak reverse voltage	V_{RSM}	max.	36	42	48	54	V
Repetitive peak reverse voltage (note 1)	V_{RRM}	max.	30	35	40	45	V
Crest working reverse voltage	V_{RWM}	max.	30	35	40	45	V
Continuous reverse voltage	V_R	max.	30	35	40	45	V

→ **Currents**

Average forward current square wave; $\delta = 0.5$; up to $T_{mb} = 124\ ^{o}C$ (note 2)	$I_{F(AV)}$	max.	60	A
sinusoidal; up to $T_{mb} = 127\ ^{o}C$ (note 2)	$I_{F(AV)}$	max.	50	A
R.M.S. forward current	$I_{F(RMS)}$	max.	85	A
Repetitive peak forward current $t_p = 20\ \mu s$; $\delta = 0.02$	I_{FRM}	max.	1100	A
Non-repetitive peak forward current half sine-wave; $T_j = 125\ ^{o}C$ prior to surge; with reapplied $V_{RWM\ max}$ $t = 10$ ms	I_{FSM}	max.	1000	A
$t = 8.3$ ms	I_{FSM}	max.	1100	A
I^2t for fusing ($t = 10$ ms)	I^2t	max.	5000	A^2s
Reverse surge current (BYV22-40A only) $t_p = 100\ \mu s$	I_{RSM}	max.	2.0	A

Temperatures

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

MOUNTING INSTRUCTIONS

The top connector should be neither 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.

Notes:

1. For $t_p = 200$ ns a 20% increase in V_{RRM} is allowed.
2. Assuming no reverse leakage current losses.

THERMAL RESISTANCE

From junction to mounting base	$R_{th\ j\text{-}mb}$	=	0.6	K/W
From mounting base to heatsink				
with heatsink compound	$R_{th\ mb\text{-}h}$	=	0.3	K/W
without heatsink compound	$R_{th\ mb\text{-}h}$	=	0.5	K/W
Transient thermal impedance; t = 1 ms	$Z_{th\ j\text{-}mb}$	=	0.072	K/W

CHARACTERISTICS

Forward voltage				
I_F = 50 A; T_j = 100 °C	V_F	<	0.55	V*
I_F = 150 A; T_j = 25 °C	V_F	<	0.9	V*
Rate of rise of reverse voltage $V_R = V_{RWMmax}$	$\frac{dV_R}{dt}$	<	1500	V/µs
Reverse current				
$V_R = V_{RWMmax}$; T_j = 125 °C	I_R	<	250	mA
Capacitance at f = 1 MHz				
V_R = 5 V; T_j = 25 to 125 °C	C_d	typ.	2100	pF

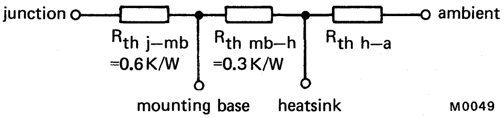
---

*Measured under pulse conditions to avoid excessive dissipation.

OPERATING NOTES

Dissipation and Heatsink Calculations

The various components of junction temperature rise above ambient are shown below:



Overall thermal resistance, $R_{th\ j\text{-}a} = R_{th\ j\text{-}mb} + R_{th\ mb\text{-}h} + R_{th\ h\text{-}a}$

To choose a suitable heatsink, the following information is required:

(i) maximum operating ambient temperature
(ii) duty cycle or form factor of forward current (δ or a)
(iii) average forward current
(iv) crest working reverse voltage (V_{RWM})

The total power dissipation in the diode has two components:

P_R – reverse leakage dissipation

$$P_{tot} = P_R + P_F \quad \text{.......... 1).}$$

P_F – forward conduction dissipation

From the above it can be seen that:

$$R_{th\ h\text{-}a} = \frac{T_{jmax} - T_{amb}}{P_R + P_F} - (R_{th\ j\text{-}mb} + R_{th\ mb\text{-}h}) \quad \text{.......... 2).}$$

Values for $R_{th\ j\text{-}mb}$ and $R_{th\ mb\text{-}h}$ can be found under Thermal Resistance. P_R and P_F are derived from Figs.3 and 4 for square-wave operation (and Figs.5 and 6 for sine-wave) as follows:
Starting at the V_{RWM} axis of Fig.3 (or Fig.5), and from a knowledge of the required V_{RWM}, trace upwards to meet the curve that matches the required T_{jmax}. From this point trace horizontally left until the curve of the voltage grade of the device being used is met. From this point trace downwards to meet the required duty cycle (δ) or form factor (a). From this point trace right and read the actual reverse power dissipation on the P_R axis.
Forward conduction dissipation (P_F) for the known average current $I_{F(AV)}$ and duty cycle (or form factor) is easily derived from Fig.4 (or Fig.6).
Substituting the values of P_R and P_F into equation 2) enables the calculation of the required heatsink.

To ensure thermal stability, $(R_{th\ j\text{-}mb} + R_{th\ mb\text{-}h} + R_{th\ h\text{-}a}) \times P_R$ must be less than 12 °C. If the calculated value of $R_{th\ h\text{-}a}$ does not permit this, then it must be reduced (heatsink size increased or $R_{th\ mb\text{-}h}$ improved) to enable this criterion to be met.

EXAMPLE: square-wave operation, using BYV22-35 and heatsink compound;
$T_{amb} = 40\ ^{o}C$; $\delta = 0.5$; $I_{F(AV)} = 30$ A
$V_{RWM} = 12$ V; voltage grade of device = 35 V
From data, $R_{th\ j\text{-}mb} = 0.6$ K/W and $R_{th\ mb\text{-}h} = 0.3$ K/W.
From Fig.4, it is found that $P_F = 18$ W
If the desired T_{jmax} is chosen to be 130 °C, then from Fig.3, $P_R = 0.9$ W
Using equation 2) we have:

$$R_{th\ h\text{-}a} = \frac{130\ ^{o}C - 40\ ^{o}C}{18\ W + 0.9\ W} - (0.6 + 0.3) = 3.9\ K/W$$

To check for thermal stability:

$$(R_{th\ j\text{-}a}) \times P_R = (0.6 + 0.3 + 3.9) \times 0.9 = 4.3\ ^{o}C.$$

This is less than 12 °C, hence thermal stability is ensured.

SQUARE-WAVE OPERATION (Figs.3 and 4)

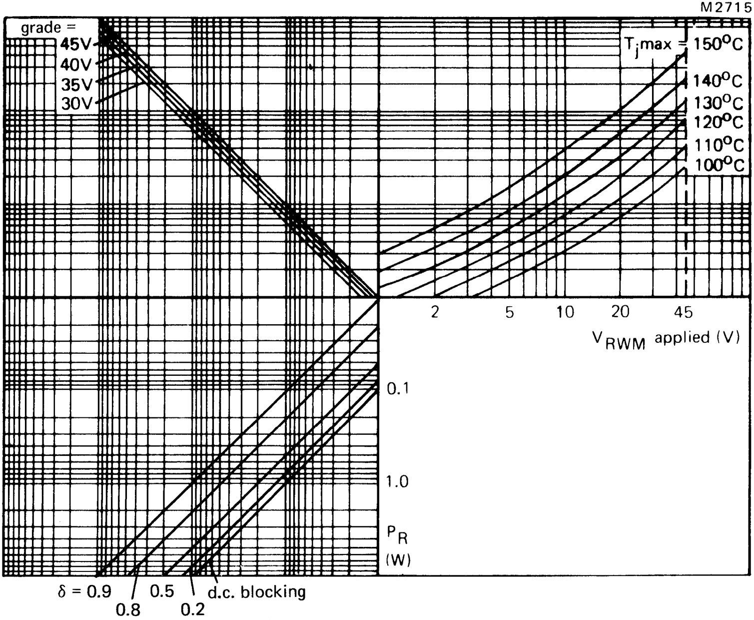
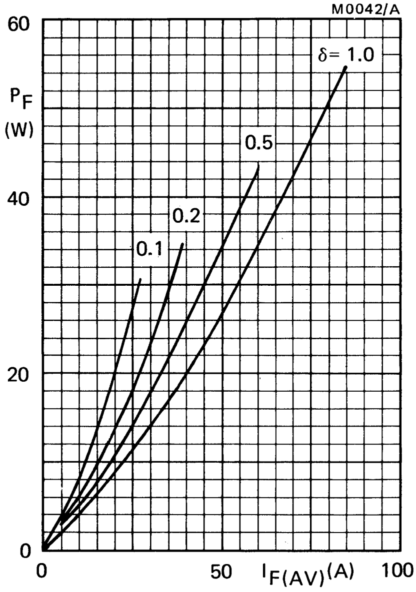
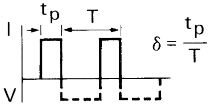


Fig.3 NOMOGRAM: for calculation of P_R (reverse leakage power dissipation) for a given T_j max., V_{RWM} applied, voltage grade and duty cycle.





$\delta = \frac{t_p}{T}$

$I_{F(AV)} = I_{F(RMS)} \times \sqrt{\delta}$

Fig.4.

SINE-WAVE OPERATION (Figs.5 and 6)

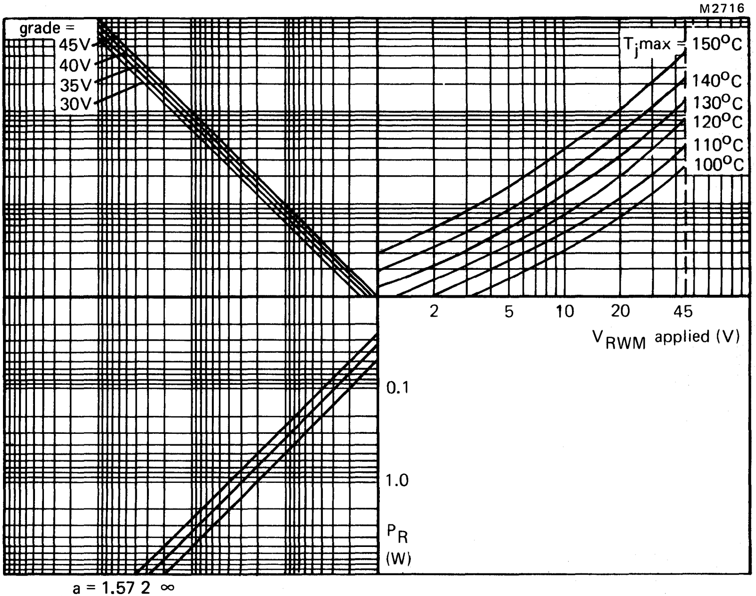


Fig.5 NOMOGRAM: for calculation of P_R (reverse leakage power dissipation) for a given T_j max., V_{RWM} applied, voltage grade and form factor.
a = form factor = $I_{F(RMS)}/I_{F(AV)}$.

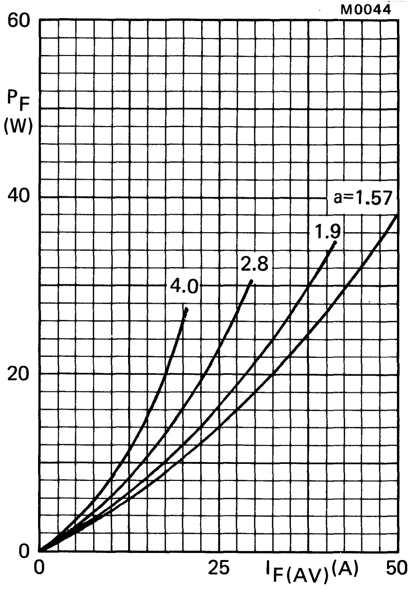


Fig.6.

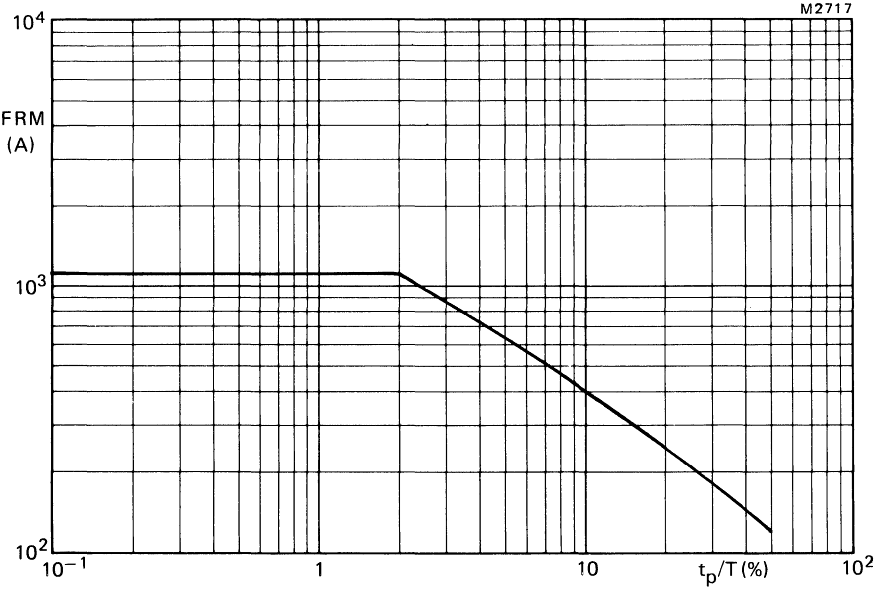
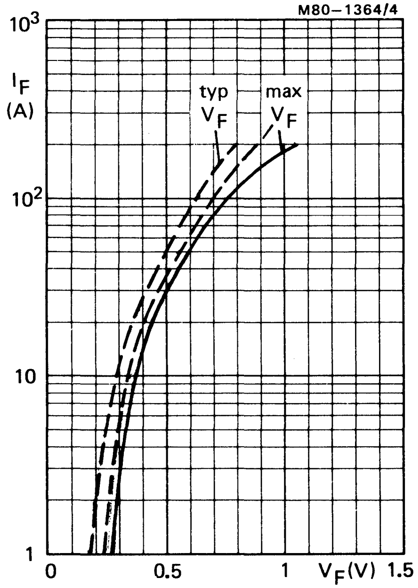
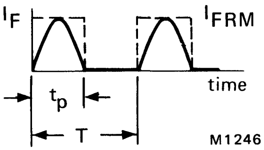


Fig.7 Maximum permissible repetitive peak forward current for either square or sinusoidal currents for 1 $\mu s < t_p < 1$ ms.





Definition of I_{FRM} and t_p/T.

Fig.8 —— T_j = 25 °C; – – – T_j = 100 °C.

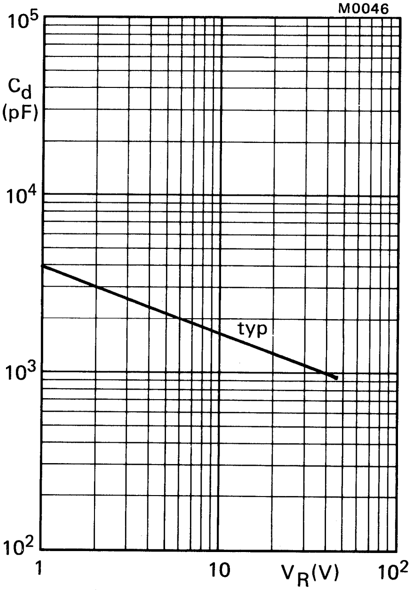


Fig.9 f = 1 MHz; T_j = 25 to 125 °C.

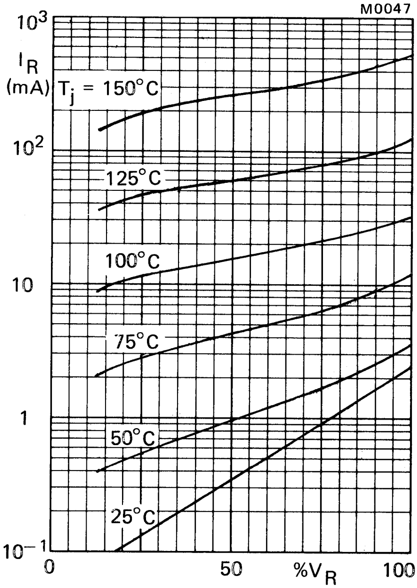


Fig.10 Typical values.

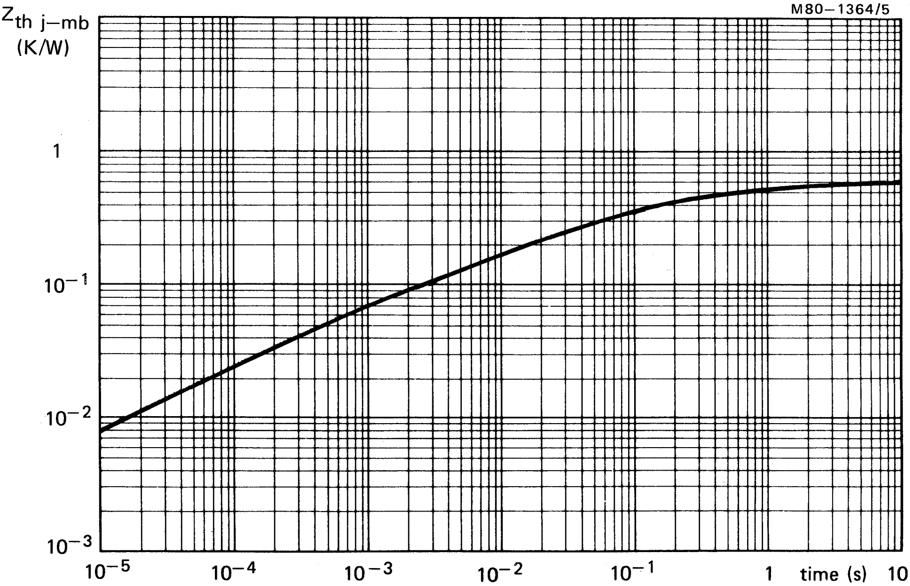


Fig.11 Transient thermal impedance.

SCHOTTKY-BARRIER RECTIFIER DIODES

High-efficiency schottky-barrier rectifier diodes in DO–5 metal envelopes, featuring low forward voltage drop, low capacitance, absence of stored charge and high temperature stability. They are intended for use in low output voltage switched-mode power supplies and high-frequency circuits in general, where low conduction losses and switching losses are important. They can also withstand reverse voltage transients. The series consists of normal polarity (cathode to stud) types.
A version with guaranteed reverse surge capability, BYV23–40A, is also available.

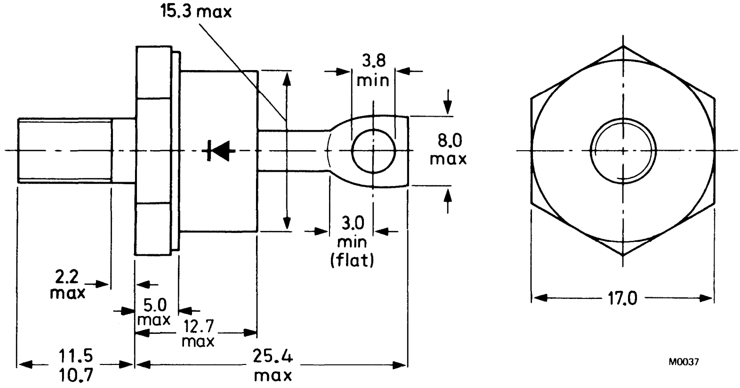
QUICK REFERENCE DATA

			BYV23–30	35	40(A)	45	
Repetitive peak reverse voltage	V_{RRM}	max.	30	35	40	45	V
Average forward current	$I_{F(AV)}$	max.	80				A
Forward voltage	V_F	<	0.55				V
Junction temperature	T_j	max.	150				°C

MECHANICAL DATA

Dimensions in mm

Fig.1 DO–5 with ¼" x 28 UNF stud (ϕ6.35 mm)
Types with metric M6 stud (ϕ6 mm) are available on request; e.g. BYV23–30M.



Net mass: 22 g

Diameter of clearance hole: 6.5 mm

Accessories supplied on request:
56264a (mica washer),
56264b (insulating bush).

Supplied with device: 1 nut, 1 lock washer
Torque on nut:
min. 1.7 Nm (17 kg cm),
max. 3.5 Nm (35 kg cm).
Nut dimensions across the flats:
¼" x 28 UNF, 11.1 mm; M6, 10 mm.

Products approved to CECC 50 009-036 available on request

RATINGS

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

Voltages			BYV23-30	35	40(A)	45	
Non-repetitive peak reverse voltage	V_{RSM}	max.	36	42	48	54	V
Repetitive peak reverse voltage (note 1)	V_{RRM}	max.	30	35	40	45	V
Crest working reverse voltage	V_{RWM}	max.	30	35	40	45	V
Continuous reverse voltage	V_R	max.	30	35	40	45	V

→ **Currents**

Average forward current square wave; $\delta = 0.5$; up to T_{mb} = 115 °C (note 2)	$I_{F(AV)}$	max.	80	A
sinusoidal; up to T_{mb} = 116 °C (note 2)	$I_{F(AV)}$	max.	70	A
R.M.S. forward current	$I_{F(RMS)}$	max.	113	A
Repetitive peak forward current $t_p = 20\ \mu s$; $\delta = 0.02$	I_{FRM}	max.	1500	A
Non-repetitive peak forward current half sine-wave; T_j = 125 °C prior to surge; with reapplied V_{RWMmax}				
$t = 10$ ms	I_{FSM}	max.	1500	A
$t = 8.3$ ms	I_{FSM}	max.	1650	A
I^2t for fusing ($t = 10$ ms)	I^2t	max.	11250	A^2s
Reverse surge current (BYV23-40A only) $t_p = 100\ \mu s$	I_{RSM}	max.	2.0	A

Temperatures

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

MOUNTING INSTRUCTIONS

The top connector should be neither 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.

Notes:

1. For t_p = 200 ns a 20% increase in V_{RRM} is allowed.
2. Assuming no reverse leakage current losses.

THERMAL RESISTANCE

From junction to mounting base	$R_{th\ j\text{-}mb}$	=	0.6	K/W
From mounting base to heatsink				
with heatsink compound	$R_{th\ mb\text{-}h}$	=	0.3	K/W
without heatsink compound	$R_{th\ mb\text{-}h}$	=	0.5	K/W
Transient thermal impedance; t = 1 ms	$Z_{th\ j\text{-}mb}$	=	0.07	K/W

CHARACTERISTICS

Forward voltage				
$I_F = 70$ A; $T_j = 100$ °C	V_F	$<$	0.55	V*
$I_F = 200$ A; $T_j = 25$ °C	V_F	$<$	0.95	V*
Rate of rise of reverse voltage				
$V_R = V_{RWMmax}$	$\frac{dV_R}{dt}$	$<$	1500	V/μs
Reverse current				
$V_R = V_{RWMmax}$; $T_j = 125$ °C	I_R	$<$	350	mA
Capacitance at f = 1 MHz				
$V_R = 5$ V; $T_j = 25$ to 125 °C	C_d	typ.	2500	pF

---

*Measured under pulse conditions to avoid excessive dissipation.

→ OPERATING NOTES

Dissipation and Heatsink Calculations

The various components of junction temperature rise above ambient are shown below:

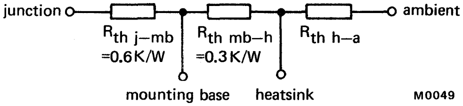


Fig.2

Overall thermal resistance, $R_{th\ j\text{-}a} = R_{th\ j\text{-}mb} + R_{th\ mb\text{-}h} + R_{th\ h\text{-}a}$

To choose a suitable heatsink, the following information is required:

(i) maximum operating ambient temperature
(ii) duty cycle or form factor of forward current (δ or a)
(iii) average forward current
(iv) crest working reverse voltage (V_{RWM})

The total power dissipation in the diode has two components:

P_R – reverse leakage dissipation

$$P_{tot} = P_R + P_F \quad \text{......} \quad 1).$$

P_F – forward conduction dissipation

From the above it can be seen that:

$$R_{th\ h\text{-}a} = \frac{T_{jmax} - T_{amb}}{P_R + P_F} - (R_{th\ j\text{-}mb} + R_{th\ mb\text{-}h}) \quad \text{......} \quad 2).$$

Values for $R_{th\ j\text{-}mb}$ and $R_{th\ mb\text{-}h}$ can be found under Thermal Resistance. P_R and P_F are derived from Figs.3 and 4 for square-wave operation (and Figs.5 and 6 for sine-wave) as follows: Starting at the V_{RWM} axis of Fig.3 (or Fig.5), and from a knowledge of the required V_{RWM}, trace upwards to meet the curve that matches the required T_{jmax}. From this point trace horizontally left until the curve of the voltage grade of the device being used is met. From this point trace downwards to meet the required duty cycle (δ) or form factor (a). From this point trace right and read the actual reverse power dissipation on the P_R axis.

Forward conduction dissipation (P_F) for the known average current $I_{F(AV)}$ and duty cycle (or form factor) is easily derived from Fig.4 (or Fig.6).

Substituting the values of P_R and P_F into equation 2) enables the calculation of the required heatsink.

To ensure thermal stability, $(R_{th\ j\text{-}mb} + R_{th\ mb\text{-}h} + R_{th\ h\text{-}a}) \times P_R$ must be less than 12 °C. If the calculated value of $R_{th\ h\text{-}a}$ does not permit this, then it must be reduced (heatsink size increased or $R_{th\ mb\text{-}h}$ improved) to enable this criterion to be met.

EXAMPLE: square-wave operation, using BYV23-35 and heatsink compound;
$T_{amb} = 40\ ^{o}C$; $\delta = 0.5$; $I_{F(AV)} = 50$ A
$V_{RWM} = 12$ V; voltage grade of device = 35 V
From data, $R_{th\ j\text{-}mb} = 0.6$ K/W and $R_{th\ mb\text{-}h} = 0.3$ K/W.
From Fig.4, it is found that $P_F = 35$ W
If the desired T_{jmax} is chosen to be 140 °C, then from Fig.3, $P_R = 2.4$ W
Using equation 2) we have:

$$R_{th\ h\text{-}a} = \frac{140\ ^{o}C - 40\ ^{o}C}{35\ W + 2.4\ W} - (0.6 + 0.3) = 1.8\ K/W$$

To check for thermal stability:

$$(R_{th\ j\text{-}a}) \times P_R = (0.6 + 0.3 + 1.8) \times 2.4 = 6.5\ ^{o}C.$$

This is less than 12 °C, hence thermal stability is ensured.

SQUARE-WAVE OPERATION (Figs.3 and 4)

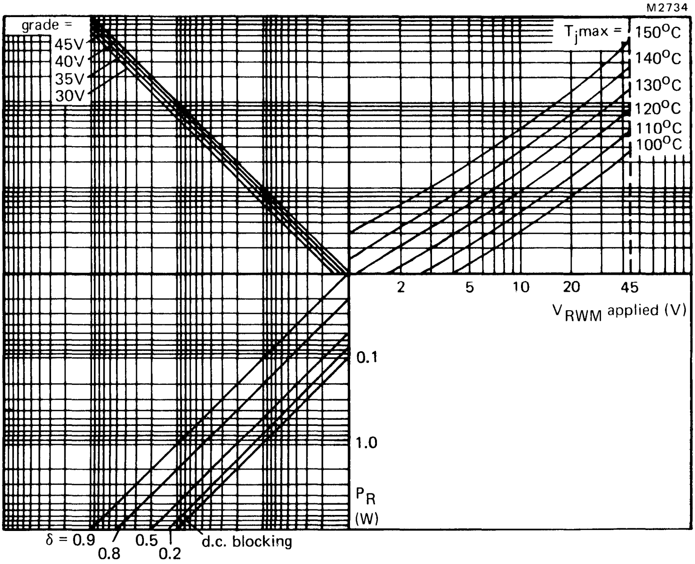
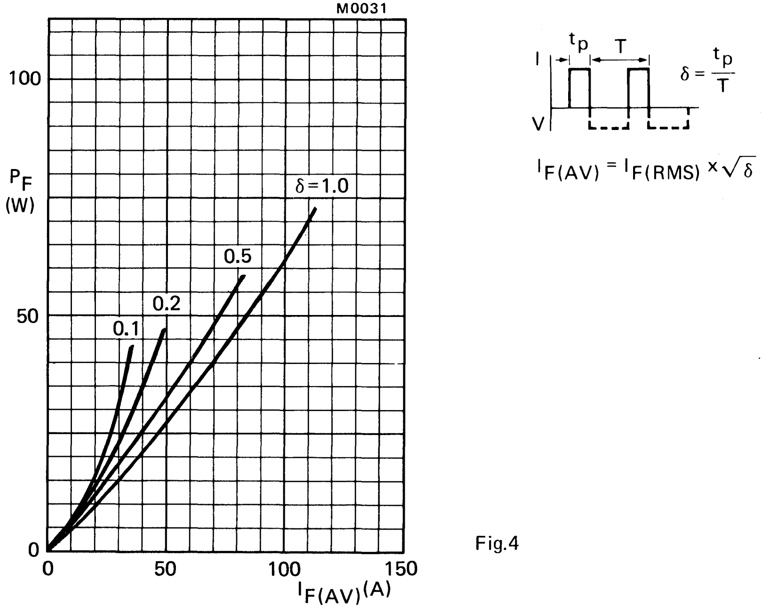


Fig.3 NOMOGRAM: for calculation of P_R (reverse leakage power dissipation) for a given T_{jmax}., V_{RWM} applied, voltage grade and duty cycle.



$I_{F(AV)} = I_{F(RMS)} \times \sqrt{\delta}$

Fig.4

SINE-WAVE OPERATION (Figs.5 and 6)

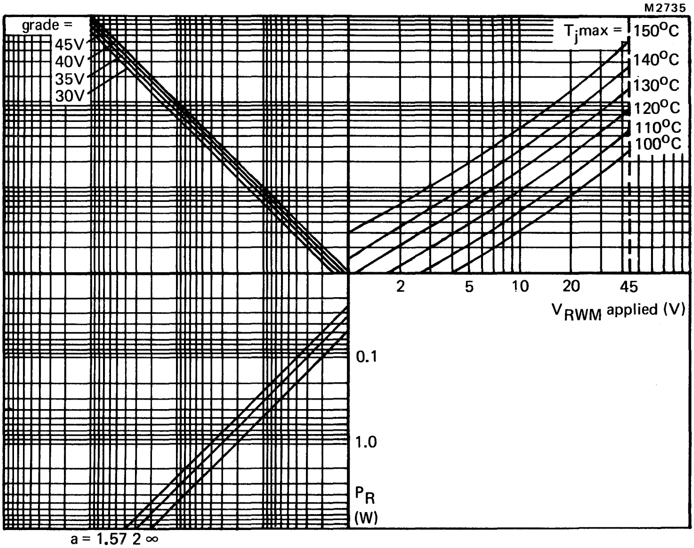


Fig.5 NOMOGRAM: for calculation of P_R (reverse leakage power dissipation) for a given T_{jmax}., V_{RWM} applied, voltage grade and form factor.

a = form factor = $I_{F(RMS)}/I_{F(AV)}$.

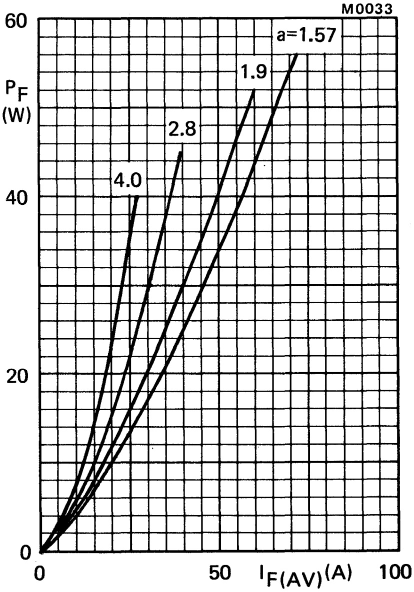


Fig.6

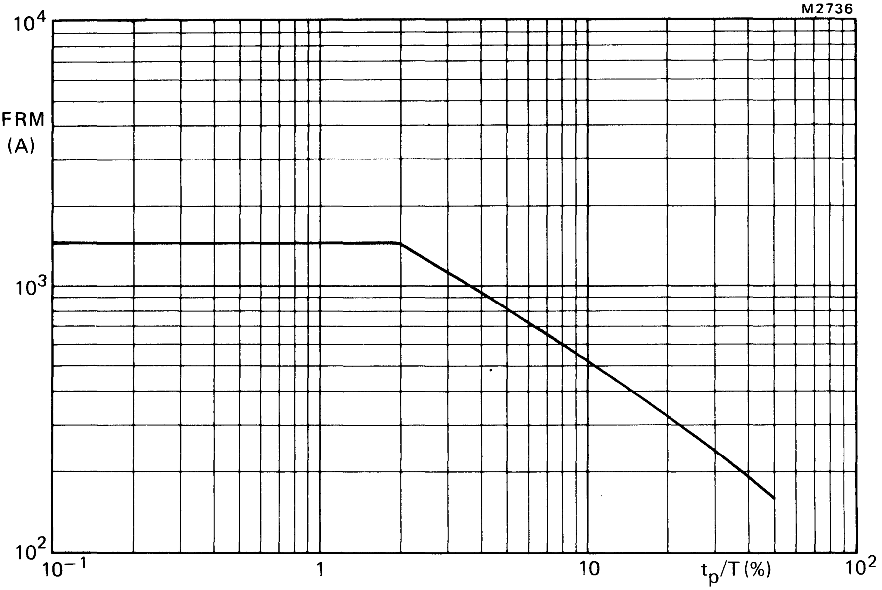
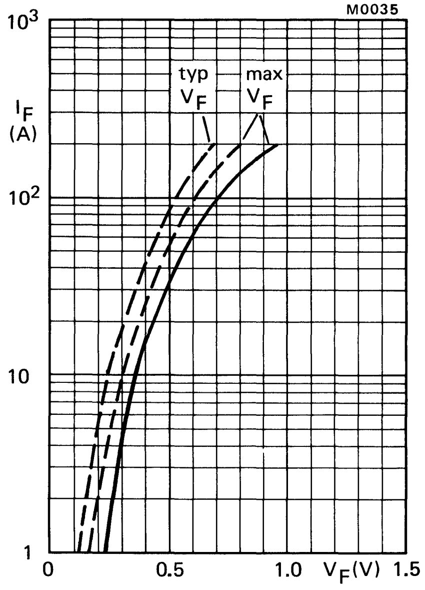
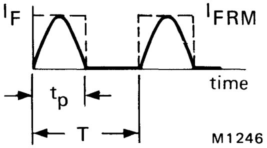


Fig.7 Maximum permissible repetitive peak forward current for either square or sinusoidal current for 1 $\mu s < t_p < 1$ ms.





Definition of I_{FRM} and t_p/T.

Fig.8 —— $T_j = 25$ °C; – – – $T_j = 100$ °C.

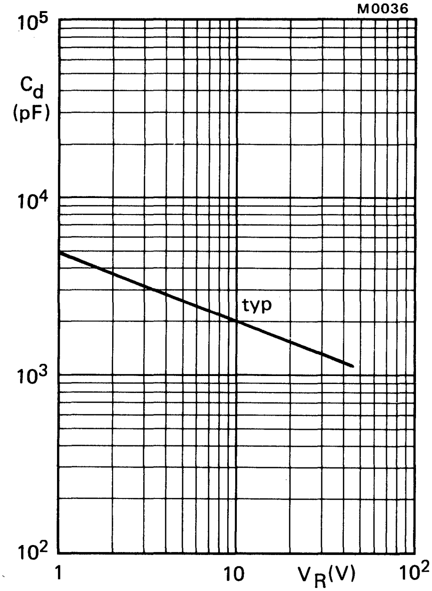


Fig.9 f = 1 MHz; T_j = 25 to 125 °C.

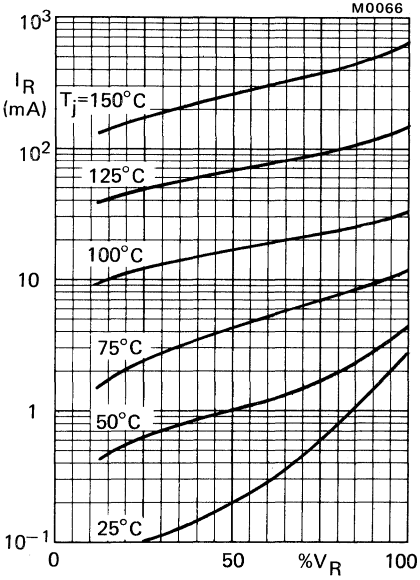


Fig.10 Typical values.

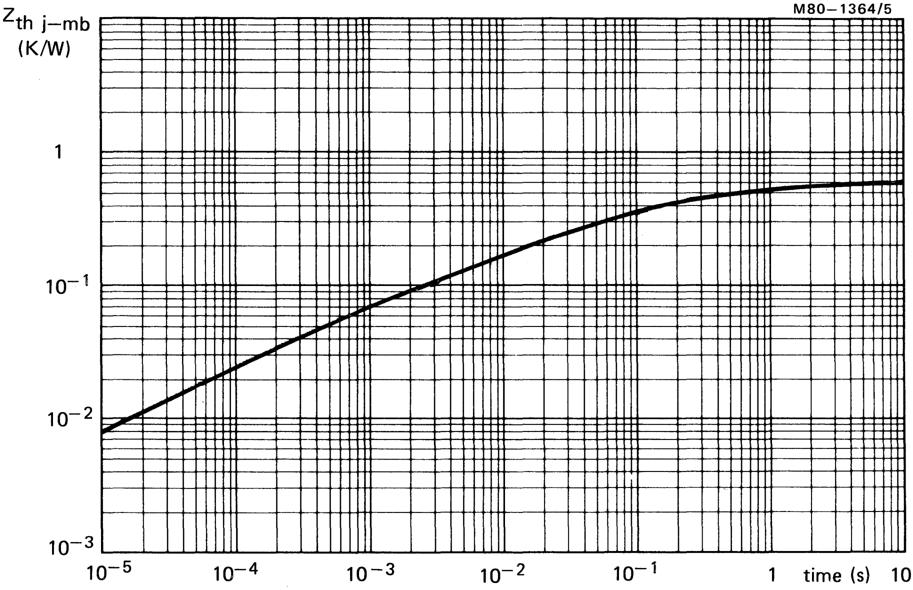


Fig.11 Transient thermal impedance.

SCHOTTKY–BARRIER DOUBLE RECTIFIER DIODES

High-efficiency schottky-barrier double rectifier diodes in plastic envelopes, featuring low forward voltage drop, low capacitance and absence of stored charge. They are intended for use in switched-mode power supplies and high-frequency circuits in general, where both low conduction losses and low switching losses are essential. The single chip (monolithic) construction allows both diodes to be paralleled without the need for derating. They can also withstand reverse voltage transients. The series consists of common-cathode types. A version with guaranteed reverse surge capability, BYV33–40A, is also available.

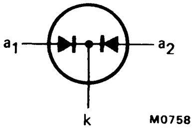
QUICK REFERENCE DATA

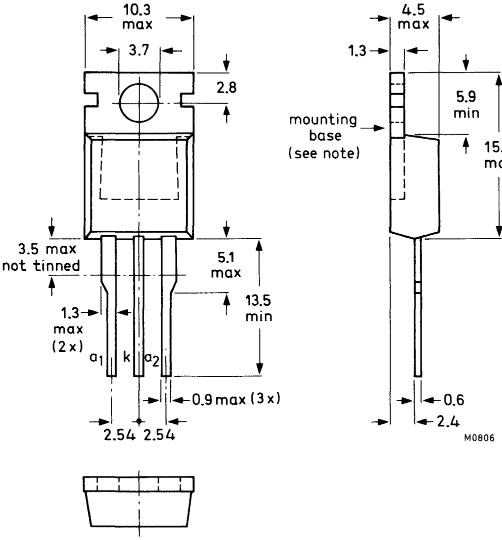
Per diode, unless otherwise stated			BYV33–30	35	40(A)	45	
Repetitive peak reverse voltage	V_{RRM}	max.	30	35	40	45	V
Average forward current (both diodes conducting)	$I_{F(AV)}$	max.	20				A
Forward voltage	V_F	<	0.6				V
Junction temperature	T_j	max.	150				°C

MECHANICAL DATA

Dimensions in mm

Fig.1 TO-220AB





Net mass: 2 g

Note: The exposed metal mounting base is directly connected to the cathode.

Accessories supplied on request: see data sheets Mounting instructions and accessories for TO-220 envelopes.

RATINGS

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

Voltages (per diode)			BYV33–30	35	40(A)	45	
Repetitive peak reverse voltage	V_{RRM}	max.	30	35	40	45	V
Crest working reverse voltage (note 1)	V_{RWM}	max.	30	35	40	45	V
Continuous reverse voltage (note 1)	V_R	max.	30	35	40	45	V

→ **Currents** (both diodes conducting; note 2)

Output current: square-wave; $\delta = 0.5$; up to $T_{mb} = 122\ ^{o}C$ (note 3)	I_O	max.	20	A
sinusoidal; up to $T_{mb} = 124\ ^{o}C$ (note 3)	I_O	max.	18	A
R.M.S. foward current	$I_{F(RMS)}$	max.	28	A
Repetitive peak forward current $t_p = 20\ \mu s$, $\delta = 0.02$ (per diode)	I_{FRM}	max.	200	A
Non-repetitive peak forward current (per diode) half sine-wave; $T_j = 125\ ^{o}C$ prior to surge; with reapplied V_{RWMmax}				
$t = 10$ ms	I_{FSM}	max.	200	A
$t = 8.3$ ms	I_{FSM}	max.	220	A
I^2t for fusing ($t = 10$ ms; per diode)	I^2t	max.	200	A^2s
Reverse surge current (BYV33—40A only) $t_p = 100\ \mu s$	I_{RSM}	max.	0.5	A

Temperatures

Storage temperature	T_{stg}		−40 to +150	^{o}C
Junction temperature	T_j	max.	150	^{o}C

Notes:

1. Up to $T_j = 125\ ^{o}C$; see derating curve for higher temperature operation.
2. The limits for both diodes apply whether both diodes conduct simultaneously or on alternate half cycles.
3. Assuming no reverse leakage current losses.

CHARACTERISTICS (per diode)

Forward voltage				
$I_F = 7$ A; $T_j = 100$ °C	V_F	<	0.6	V*
$I_F = 20$ A; $T_j = 25$ °C	V_F	<	1.0	V*
Reverse current				
$V_R = V_{RWMmax}$; $T_j = 125$ °C	I_R	<	40	mA ←
Junction capacitance at f = 1 MHz				
$V_R = 5$ V; $T_j = 25$ to 125 °C	C_d	typ.	300	pF

THERMAL RESISTANCE

From junction to mounting base (both diodes conducting)	$R_{th\ j\text{-}mb}$	=	1.6	K/W
From junction to mounting base (per diode)	$R_{th\ j\text{-}mb}$	=	2.6	K/W

Influence of mounting method

1. Heatsink mounted with clip (see mounting instructions)

Thermal resistance from mounting base to heatsink

a. with heatsink compound	$R_{th\ mb\text{-}h}$	=	0.2	K/W
b. with heatsink compound and 0.06 mm maximum mica insulator	$R_{th\ mb\text{-}h}$	=	1.4	K/W
c. with heatsink compound and 0.1 mm maximum mica insulator (56369)	$R_{th\ mb\text{-}h}$	=	2.2	K/W
d. with heatsink compound and 0.25 mm maximum alumina insulator (56367)	$R_{th\ mb\text{-}h}$	=	0.8	K/W
e. without heatsink compound	$R_{th\ mb\text{-}h}$	=	1.4	K/W

2. Free air operation

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

Thermal resistance from junction to ambient in free air; mounted on a printed circuit board at any device lead length and with copper laminate on the board	$R_{th\ j\text{-}a}$	=	60	K/W

---

*Measured under pulse conditions to avoid excessive dissipation.

MOUNTING INSTRUCTIONS

1. The device may be soldered directly into the circuit, but the maximum permissible temperature of the soldering iron or bath is 275 °C; the heat source must not be in contact with the joint for more than 5 seconds. Soldered joints must be at least 4.7 mm from the seal.
2. The leads should not be bent less than 2.4 mm from the seal, and should be supported during bending. The bend radius must be no less than 1.0 mm.
3. Mounting by means of a spring clip is the best mounting method because it offers:
   a. a good thermal contact under the crystal area and slightly lower $R_{th\ mb\text{-}h}$ values than does screw mounting.
   b. safe isolation for mains operation.
   However, if a screw is used, it should be M3 cross-recess pan head. Care should be taken to avoid damage to the plastic body.
4. For good thermal contact, heatsink compound should be used between mounting base and heatsink. Values of $R_{th\ mb\text{-}h}$ given for mounting with heatsink compound refer to the use of a metallic oxide-loaded compound. Ordinary silicone grease is not recommended.
5. Rivet mounting (only possible for non-insulated mounting).
   Devices may be rivetted to flat heatsinks; such a process **must neither** deform the mounting tab, **nor** enlarge the mounting hole.

OPERATING NOTES

Dissipation and heatsink calculations.

The various components of junction temperature rise above ambient are illustrated in Fig.2.

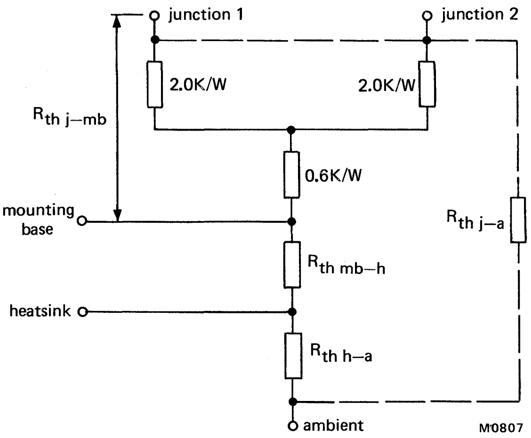


Fig.2.

OPERATING NOTES

←

Dissipation and heatsink calculations (continued)

Overall thermal resistance, $R_{th\ j\text{-}a} = R_{th\ j\text{-}mb} + R_{th\ mb\text{-}h} + R_{th\ h\text{-}a}$

To choose a suitable heatsink, the following information is required for each half of the dual diode:

(i) maximum operating ambient temperature
(ii) duty cycle or form factor of forward current (δ or a)
(iii) average forward current per diode
(iv) crest working reverse voltage (V_{RWM})

The total power dissipation in the diode has two components:

P_R – reverse leakage dissipation

P_F – forward conduction dissipation

$$P_{tot} = P_R + P_F \quad \text{........................ 1).}$$

From the above it can be seen that:

$$R_{th\ h\text{-}a} = \frac{T_{jmax} - T_{amb}}{P_F + P_R} - (R_{th\ j\text{-}mb} + R_{th\ mb\text{-}h}) \quad \text{........ 2).}$$

Values for $R_{th\ j\text{-}mb}$ and $R_{th\ mb\text{-}h}$ can be found under Thermal Resistance. P_R and P_F are derived from Figs.3 and 4 for square-wave operation (and Figs.5 and 6 for sine-wave) as follows:
Look at each half of the dual diode separately; for each diode, starting at the V_{RWM} axis of Fig.3 (or Fig.5), and from a knowledge of the required V_{RWM}, trace upwards to meet the curve that matches the required T_{jmax}. From this point trace horizontally left until the curve of the voltage grade of the device being used is met. From this point trace downwards to meet the required duty cycle (δ) or form factor (a). From this point trace right and read the actual reverse power dissipation on the P_R axis.
From this calculation, $P_R = P_R$ (diode 1) + P_R (diode 2) .... 3).
Forward conduction dissipation (P_F) for the known average current $I_{F(AV)}$ and duty cycle (or form factor) for each diode is easily derived from Fig.4 (or Fig.6).
Similarly, $P_F = P_F$ (diode 1) + P_F (diode 2) .... 4).
Substituting equations 3) and 4) into equation 2) enables the calculation of the required heatsink.

NOTE:– If both halves of the diode are being used (as is assumed above), the value of $R_{th\ j\text{-}mb}$ = 1.6 K/W. If only one half of the diode is used, follow the above procedure for one diode only, and use the value of $R_{th\ j\text{-}mb}$ of 2.6 K/W.

To ensure thermal stability, $(R_{th\ j\text{-}mb} + R_{th\ mb\text{-}h} + R_{th\ h\text{-}a}) \times P_R$ must be less than 12 °C. If the calculated value of $R_{th\ h\text{-}a}$ does not permit this, then it must be reduced (heatsink size increased or $R_{th\ mb\text{-}h}$ improved) to enable this criterion to be met.

EXAMPLE: square-wave operation, using BYV33-35 and heatsink compound;
T_{amb} = 50 °C; δ (diode 1) = 0.5; δ (diode 2) = 0.5;
$I_{F(AV)}$ (diode 1) = 7 A; $I_{F(AV)}$ (diode 2) = 7 A;
V_{RWM} (both diodes) = 12 V; voltage grade of device = 35 V.
From data, $R_{th\ j\text{-}mb}$ = 1.6 K/W and $R_{th\ mb\text{-}h}$ = 0.2 K/W.
For each diode from Fig.4, it is found that P_F = 5.5 W;
hence total P_F = 2 x 5.5 = 11 W. (from equation 4)
If the desired $T_{j\ max}$ is chosen to be 130 °C, then, from Fig.3, P_R (per diode) = 0.17W
Therefore total P_R = 2 x 0.17 = 0.34 W. (from equation 3)
Using equation 2) we have:

$$R_{th\ h\text{-}a} = \frac{130\ ^{\circ}\mathrm{C} - 50\ ^{\circ}\mathrm{C}}{11\ \mathrm{W} + 0.34\ \mathrm{W}} - (1.6 + 0.2) = 5.3\ \mathrm{K/W}$$

To check for thermal stability:

$$(R_{th\ j\text{-}a}) \times P_R = (1.6 + 0.2 + 5.3) \times 0.34 = 2.4\ ^{\circ}\mathrm{C}.$$

This is less than 12 °C, hence thermal stability is ensured.

SQUARE-WAVE OPERATION (Figs.3 and 4)

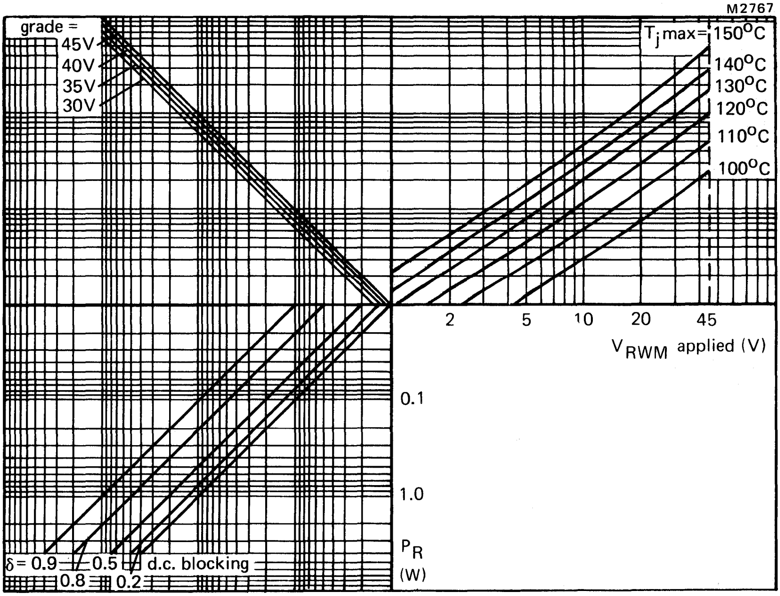
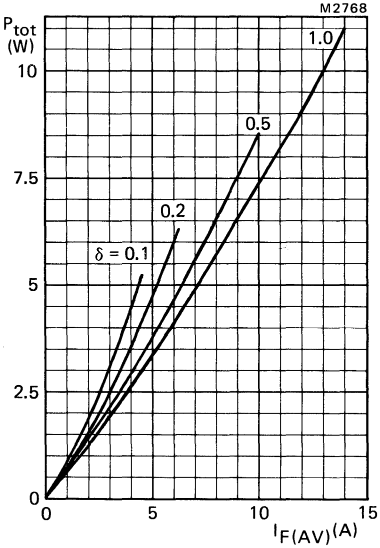
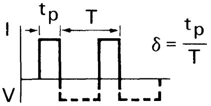


Fig.3 NOMOGRAM: for calculation of P_R (reverse leakage power dissipation) for a given $T_j$max., V_{RWM} applied, voltage grade and duty cycle (per diode).





$I_{F(AV)} = I_{F(RMS)} \times \sqrt{\delta}$

Fig.4.

SINE-WAVE OPERATION (Figs.5 and 6)

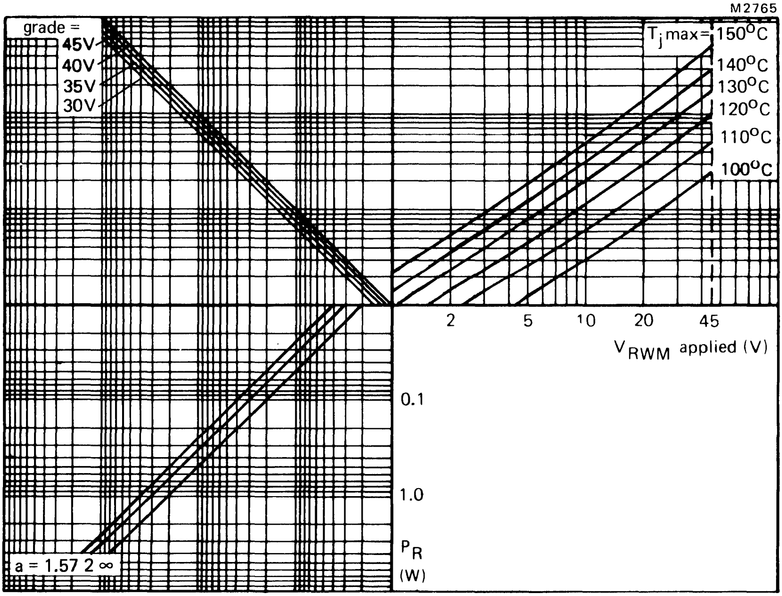


Fig.5 NOMOGRAM: for calculation of P_R (reverse leakage power dissipation) for a given $T_j$max., V_{RWM} applied, voltage grade and form factor (per diode).

a = form factor = $I_{F(RMS)}/I_{F(AV)}$

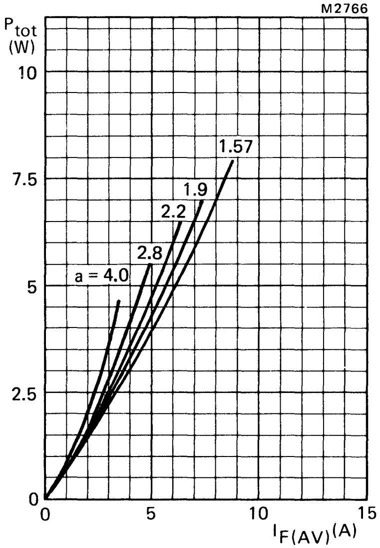


Fig.6.

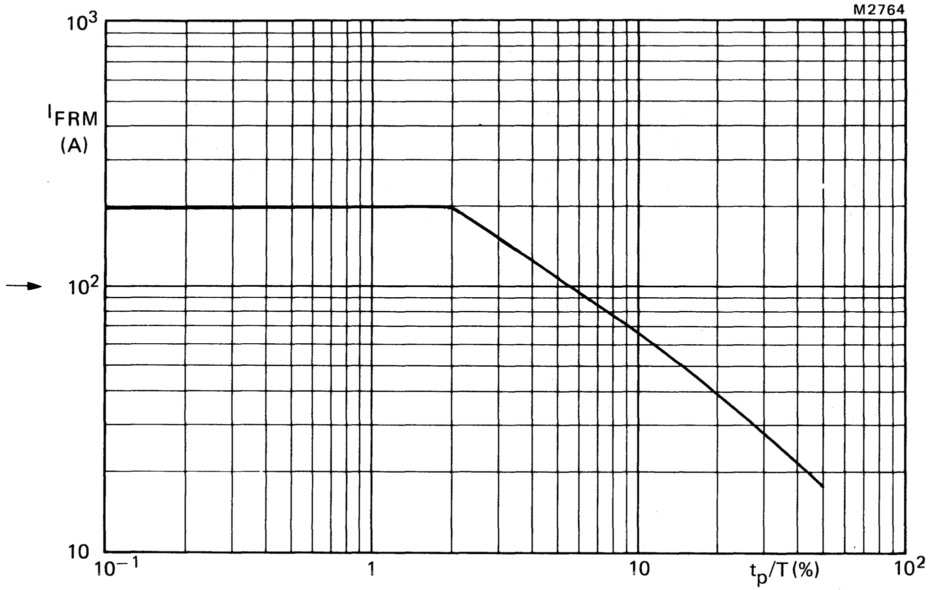
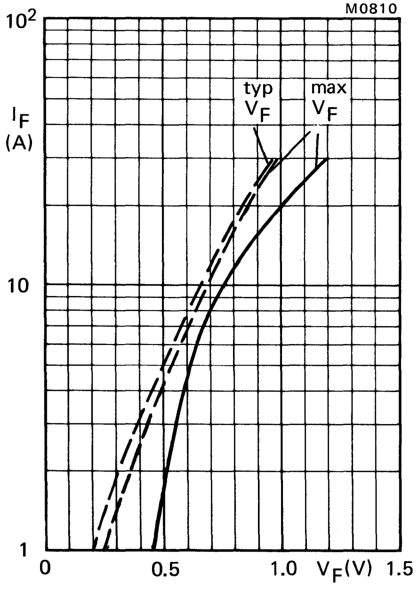
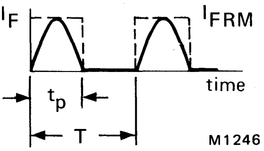


Fig.7 Maximum permissible repetitive peak forward current for either square or sinusoidal currents for 1 μs < t_p < 1 ms.





Definition of I_{FRM} and t_p/T.

Fig.8 —— T_j = 25 °C; – – – T_j = 100 °C; per diode.

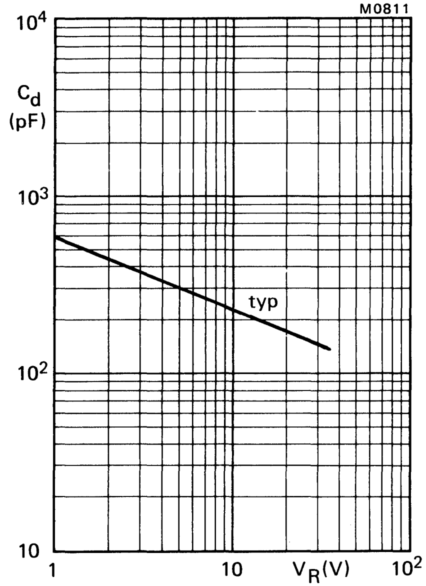


Fig.9 f = 1 MHz; T_j = 25 to 125 °C; per diode.

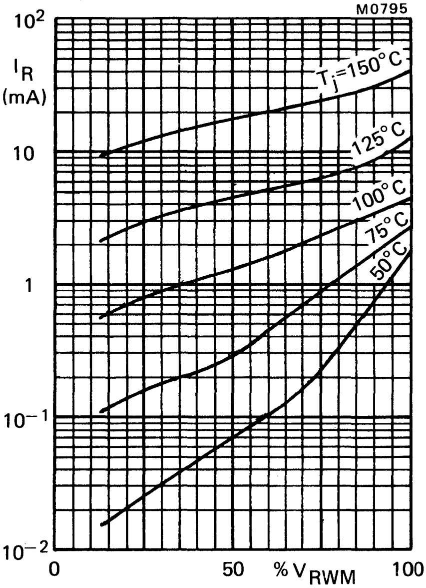


Fig.10 Typical values; per diode.

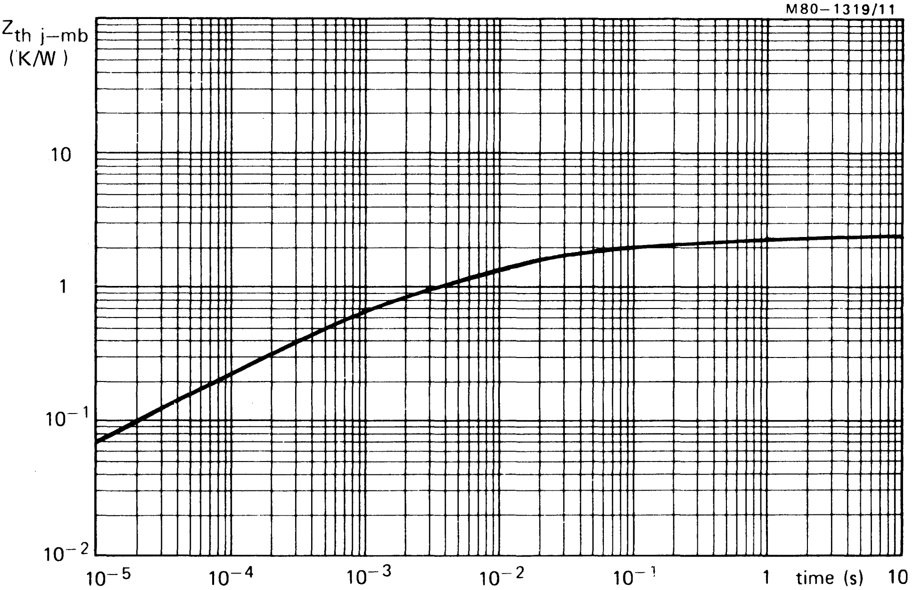


Fig.11 Transient thermal impedance; one diode conducting.

SCHOTTKY-BARRIER, ELECTRICALLY-ISOLATED DOUBLE RECTIFIER DIODES

High-efficiency schottky-barrier double rectifier diodes in SOT-186 (full-pack) plastic envelopes, featuring very low forward voltage drop, low capacitance and absence of stored charge. Their electrical isolation makes them ideal for mounting on a common heatsink alongside other components without the need for additional insulators. They are intended for use in switched-mode power supplies and high-frequency circuits in general, where low conduction losses and absence of stored charge are essential. The single chip (monolithic) construction allows both diodes to be paralleled without the need for derating. The series consists of common-cathode types.
A version with guaranteed reverse surge capability, BYV33F–40A is available.

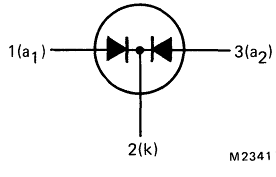
QUICK REFERENCE DATA

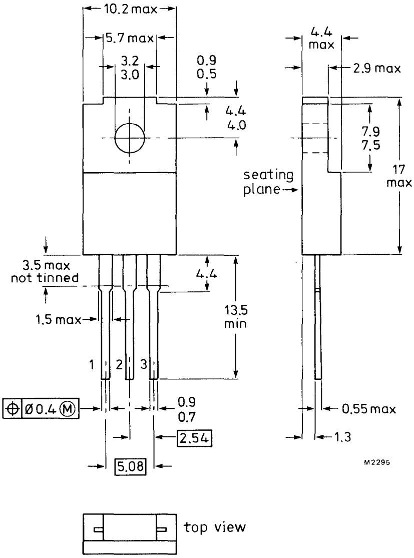
Per diode, unless otherwise stated		BYV33F–	30	35	40(A)	45	
Repetitive peak reverse voltage	V_{RRM}	max.	30	35	40	45	V
Output current (both diodes conducting)	I_O	max.			20		A
Forward voltage	V_F	<			0.6		V
Junction temperature	T_j	<			150		°C

MECHANICAL DATA

Dimensions in mm

Fig.1 SOT-186 (full-pack).





Net mass: 2 g.
The seating plane is electrically isolated from all terminals.
Accessories supplied on request (see data sheets Mounting instructions for F-pack devices and Accessories for SOT-186 envelopes).

RATINGS

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

Voltages (per diode)			BYV33F–30	35	40(A)	45	
Repetitive peak reverse voltage	V_{RRM}	max.	30	35	40	45	V
Crest working reverse voltage (note 1)	V_{RWM}	max.	30	35	40	45	V
Continuous reverse voltage (note 1)	V_R	max.	30	35	40	45	V

Currents (both diodes conducting; notes 2 and 4)				
Output current:				
square wave; $\delta = 0.5$; up to $T_h = 65$ °C (note 3)	I_O	max.	20	A
sinusoidal; up to $T_h = 71$ °C (note 3)	I_O	max.	18	A
R.M.S. forward current	$I_{F(RMS)}$	max.	28	A
Repetitive peak forward current $t_p = 20$ µs; $\delta = 0.02$ (per diode)	I_{FRM}	max.	200	A
Non-repetitive peak forward current (per diode) half sine-wave; $T_j = 150$ °C prior to surge; with reapplied $V_{RWM\,max}$				
$t = 10$ ms	I_{FSM}	max.	150	A
$t = 8.3$ ms	I_{FSM}	max.	165	A
I^2t for fusing ($t = 10$ ms, per diode)	I^2t	max.	112	A^2s
Reverse surge current (BYV33F–40A only) $t_p = 100$ µs	I_{RSM}	max.	0.5	A
Temperatures				
Storage temperature	T_{stg}		–40 to +150	°C
Junction temperature	T_j	max.	150	°C

ISOLATION

Peak isolation voltage from all terminals to external heatsink	V_{isol}	max.	1000	V
Isolation capacitance from centre lead to external heatsink (note 5)	C_p	typ.	12	pF

Notes:

1. Up to $T_j = 125$ °C; see derating curve for higher temperature operation.
2. The limits for both diodes apply whether both diodes conduct simultaneously or on alternate half cycles.
3. Assuming no reverse leakage current losses.
4. The quoted temperatures assume heatsink compound is used.
5. Mounted without heatsink compound and 20 Newtons pressure on the centre of the envelope.

CHARACTERISTICS (per diode)

T_j = 25 °C unless otherwise stated

Forward voltage				
I_F = 7 A; T_j = 100 °C	V_F	<	0.6	V*
I_F = 20 A	V_F	<	1.0	V*
Reverse current				
$V_R = V_{RWM\ max}$; T_j = 125 °C	I_R	<	40	mA
Junction capacitance at f = 1 MHz				
V_R = 5 V; T_j = 25 °C to 125 °C	C_j	typ.	300	pF

THERMAL RESISTANCE

From junction to external heatsink with minimum of 2 kgf (20 Newtons) pressure on the centre of the envelope:

a. both diodes conducting:				
with heatsink compound	$R_{th\ j\text{-}h}$	=	5.0	K/W
without heatsink compound	$R_{th\ j\text{-}h}$	=	7.0	K/W
b. per diode:				
with heatsink compound	$R_{th\ j\text{-}h}$	=	6.0	K/W
without heatsink compound	$R_{th\ j\text{-}h}$	=	8.0	K/W

Free air operation

The quoted value of $R_{th\ j\text{-}h}$ should be used only when no leads of other dissipating components run to the same tie point.

Thermal resistance from junction to ambient in free air, mounted on a printed circuit board	$R_{th\ j\text{-}a}$	=	55	K/W

---

*Measured under pulse conditions to avoid excessive dissipation.

MOUNTING INSTRUCTIONS

1. The device may be soldered directly into the circuit, but the maximum permissible temperature of the soldering iron or bath is 275 °C; the heat source must not be in contact with the joint for more than 5 seconds. Soldered joints must be at least 4.7 mm from the seal.
2. The leads should not be bent less than 2.4 mm from the seal, and should be supported during bending. The bend radius must be no less than 1 mm.
3. Mounting by means of a spring clip is the best mounting method because it offers a good thermal contact under the crystal area and slightly lower $R_{th\ j\text{-}h}$ values than screw mounting. The force exerted on the top of the device by the clip should be at least 2 kgf (20 Newtons) to ensure good thermal contact and must not exceed 3.5 kgf (35 Newtons) to avoid damage to the device.
4. If screw mounting is used, it should be M3 cross-recess pan head.

Minimum torque to ensure good thermal contact:	5.5 kgf (0.55 Nm)
Maximum torque to avoid damage to the device:	8.0 kgf (0.80 Nm)

5. For good thermal contact, heatsink compound should be used between baseplate and heatsink. Values of $R_{th\ j\text{-}h}$ given for mounting with heatsink compound refer to the use of a metallic oxide-loaded compound. Ordinary silicone grease is not recommended.
6. Rivet mounting.
   It is not recommended to use rivets, since extensive damage could result to the plastic, which could destroy the insulating properties of the device.
7. The heatsink must have a flatness in the mounting area of 0.02 mm maximum per 10 mm. Mounting holes must be deburred.

OPERATING NOTES

The various components of junction temperature rise above ambient are illustrated in Fig.2.

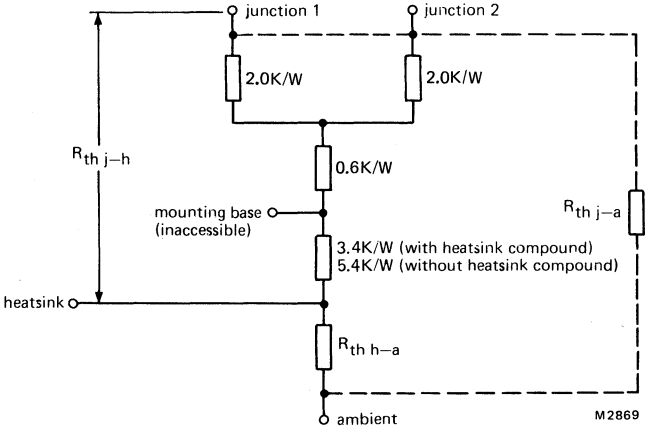


Fig.2.

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

OPERATING NOTES

Dissipation and heatsink calculations (continued)

Overall thermal resistance, $R_{th\ j\text{-}a} = R_{th\ j\text{-}h} + R_{th\ h\text{-}a}$

To choose a suitable heatsink, the following information is required for each half of the dual diode:

(i) maximum operating ambient temperature
(ii) duty cycle or form factor of forward current (δ or a)
(iii) average forward current per diode
(iv) crest working reverse voltage (V_{RWM})

The total power dissipation in the diode has two components:

P_R – reverse leakage dissipation
P_F – forward conduction dissipation

$$P_{tot} = P_R + P_F \quad \text{1).}$$

From the above it can be seen that:

$$R_{th\ h\text{-}a} = \frac{T_{jmax} - T_{amb}}{P_F + P_R} - (R_{th\ j\text{-}h}) \quad \text{2).}$$

The value of $R_{th\ j\text{-}h}$ can be found under Thermal Resistance and will depend upon whether or not heatsink compound is used. P_R and P_F are derived from Figs.3 and 4 for square-wave operation (and Figs.5 and 6 for sine-wave) as follows:

Look at each half of the dual diode separately; for each diode, starting at the V_{RWM} axis of Fig.3 (or Fig.5), and from a knowledge of the required V_{RWM}, trace upwards to meet the curve that matches the required T_{jmax}. From this point trace horizontally left until the curve of the voltage grade of the device being used is met. From this point trace downwards to meet the required duty cycle (δ) or form factor (a). From this point trace right and read the actual reverse power dissipation on the P_R axis. From this calculation, $P_R = P_R$ (diode 1) + P_R (diode 2) .... 3).

Forward conduction dissipation (P_F) for the known average current $I_{F(AV)}$ and duty cycle (or form factor) for each diode is easily derived from Fig.4 (or Fig.6).

Similarly, $P_F = P_F$ (diode 1) + P_F (diode 2) .... 4).

Substituting equations 3) and 4) into equation 2) enables the calculation of the required heatsink.

NOTE:– If both halves of the diode are being used (as is assumed above), the value of $R_{th\ j\text{-}h}$ = 5 K/W (with heatsink compound) or 7 K/W (without heatsink compound).

If only one half of the diode is used, follow the above procedure for one diode only, and use the value of $R_{th\ j\text{-}h}$ of 6 K/W (with heatsink compound) or 8 K/W (without heatsink compound).

To ensure thermal stability, $(R_{th\ j\text{-}h} + R_{th\ h\text{-}a}) \times P_R$ must be less than 12 °C. If the calculated value of $R_{th\ h\text{-}a}$ does not permit this, then it must be reduced (heatsink size increased or $R_{th\ j\text{-}a}$ improved) to enable this cirterion to be met.

EXAMPLE: square wave operation, using BYV33F–35 and heatsink compound;
T_{amb} = 40 °C; δ (diode 1) = 0.5; δ (diode 2) = 0.5;
$I_{F(AV)}$ (diode 1) = 7 A; $I_{F(AV)}$ (diode 2) = 7 A;
V_{RWM} (both diodes) = 12 V; voltage grade of device = 35 V.
From data, $R_{th\ j\text{-}h}$ = 5 K/W.
For each diode from Fig.4, it is found that P_F = 5.5 W;
hence total P_F = 2 x 5.5 = 11 W. (from equation 4)
If the desired T_{jmax} is chosen to be 130 °C, then, from Fig.3, P_R (per diode) = 0.17 W.
Therefore total P_R = 2 x 0.17 = 0.34 W. (from equation 3)
Using equation 2) we have:

$$R_{th\ h\text{-}a} = \frac{130\ ^{\circ}\mathrm{C} - 40\ ^{\circ}\mathrm{C}}{11\ \mathrm{W} + 0.34\ \mathrm{W}} - (5.0) = 2.9\ \mathrm{K/W}$$

To check for thermal stability:

$$(R_{th\ j\text{-}a}) \times P_R = (5.0 + 2.9) \times 0.34 = 2.69\ ^{\circ}\mathrm{C}.$$

This is less than 12 °C, hence thermal stability is ensured.

SQUARE-WAVE OPERATION (Figs.3 and 4)

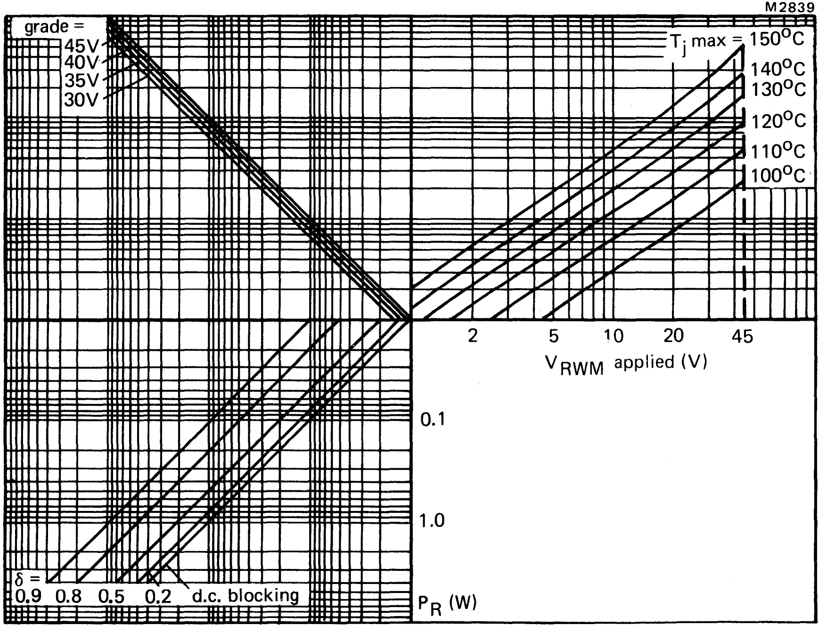
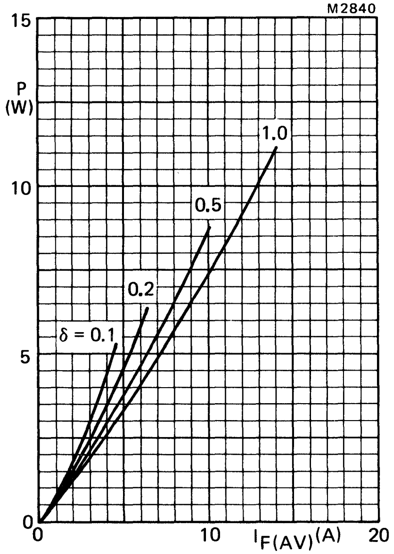
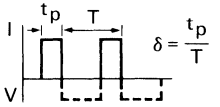


Fig.3 NOMOGRAM: for calculation of P_R (reverse leakage power dissipation) for a given $T_j$max., V_{RWM} applied, voltage grade and duty cycle (per diode).





$I_{F(AV)} = I_{F(RMS)} \times \sqrt{\delta}$

Fig.4.

SINE-WAVE OPERATION (Figs.5 and 6)

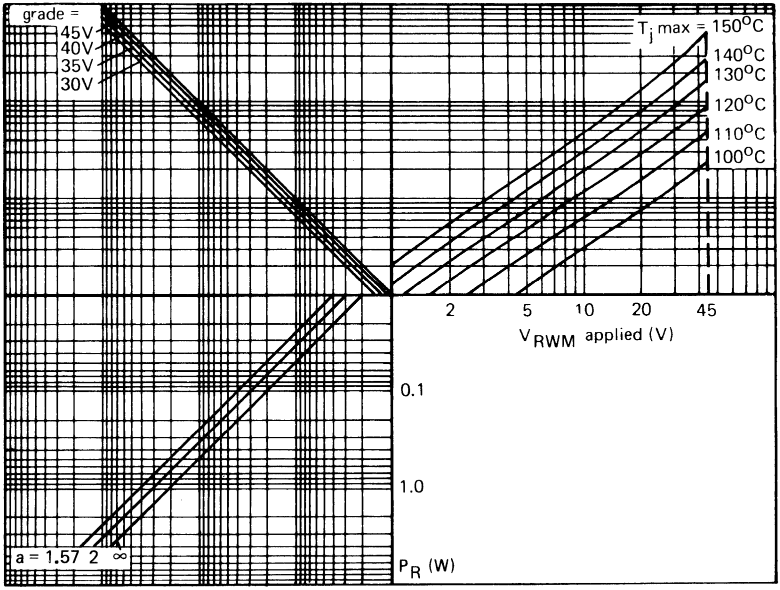


Fig.5 NOMOGRAM: for calculation of P_R (reverse leakage power dissipation) for a given $T_j$max., V_{RWM} applied, voltage grade and form factor (per diode).

a = form factor = $I_{F(RMS)}/I_{F(AV)}$.

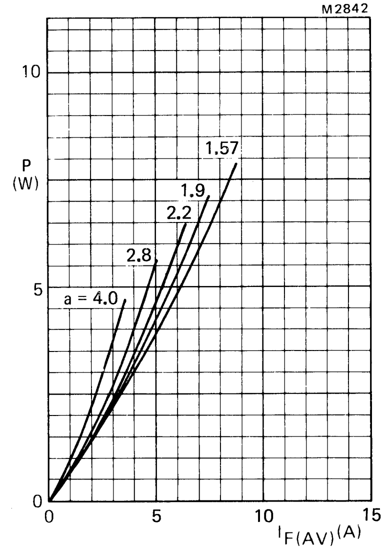


Fig.6.

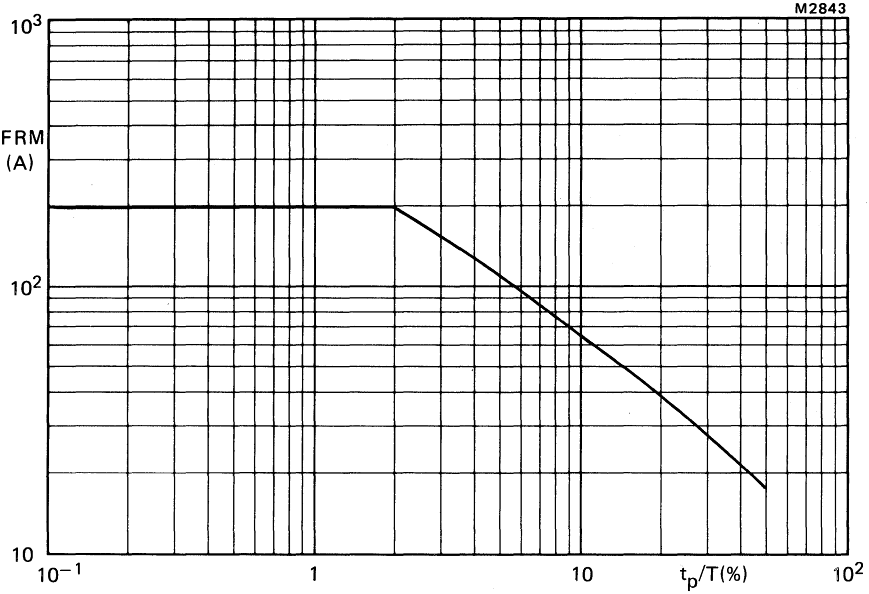
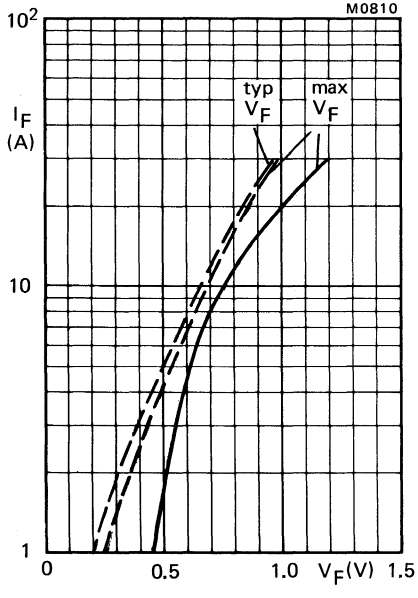
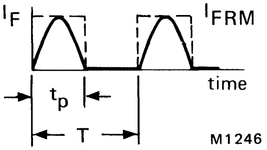


Fig.7 Maximum permissible repetitive peak forward current for either square or sinusoidal currents for 1 μs < t_p < 1 ms, per diode.





Definition of I_{FRM} and t_p/T.

Fig.8 —— T_j = 25 °C; – – – T_j = 100 °C; per diode.

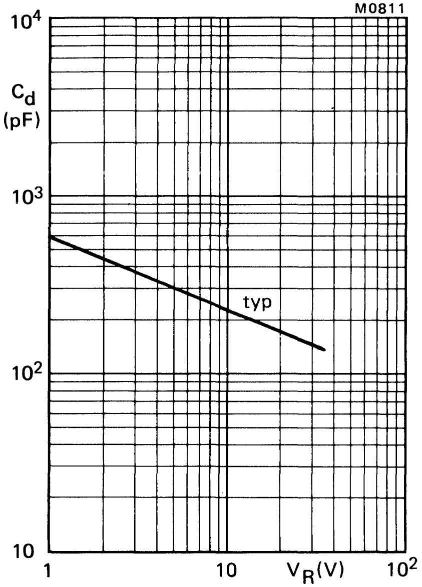


Fig.9 f = 1 MHz; T_j = 25 to 125 °C; per diode.

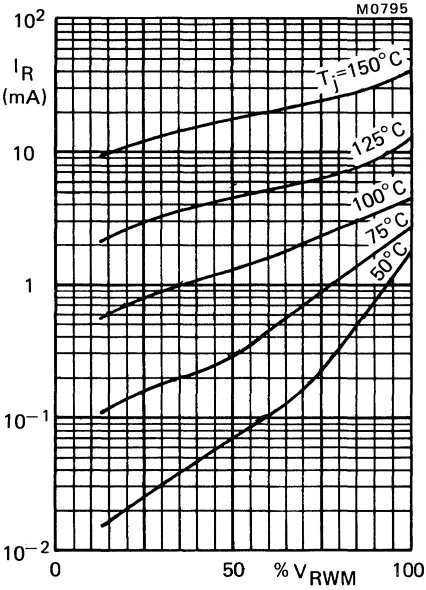


Fig.10 Typical values; per diode.

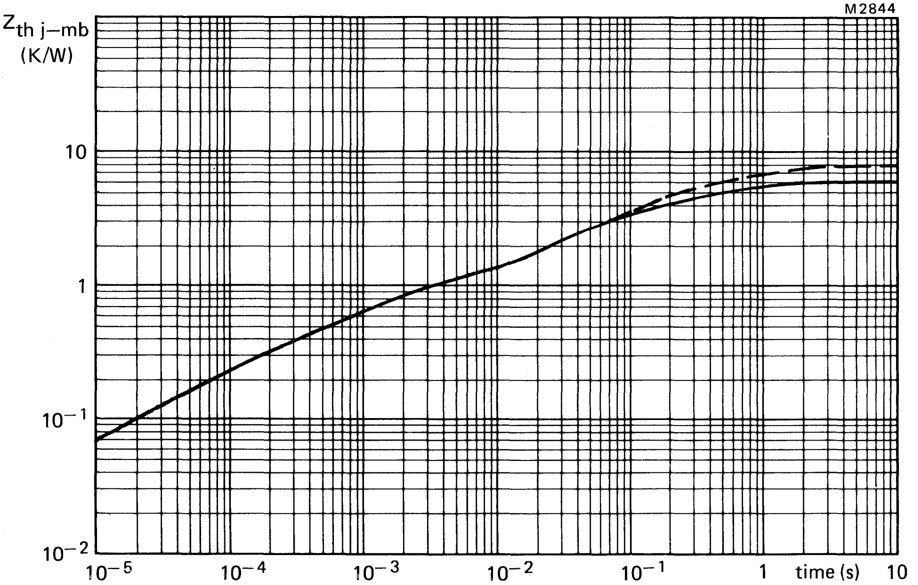


Fig.11 Transient thermal impedance; one diode conducting; —— with heatsink compound; – – – without heatsink compound.

SCHOTTKY-BARRIER RECTIFIER DIODES

High-efficiency schottky-barrier rectifier diodes in TO-220 plastic envelopes, featuring low forward voltage drop, low capacitance, absence of stored charge, and high temperature stability. They are intended for use in low output voltage switched-mode power supplies and high-frequency circuits in general, where both low conduction losses and switching losses are important. They can also withstand reverse voltage transients. The series consists of normal polarity (cathode to mounting-base) types.
A version with guaranteed reverse surge capability, BYV39-40A; is also available.

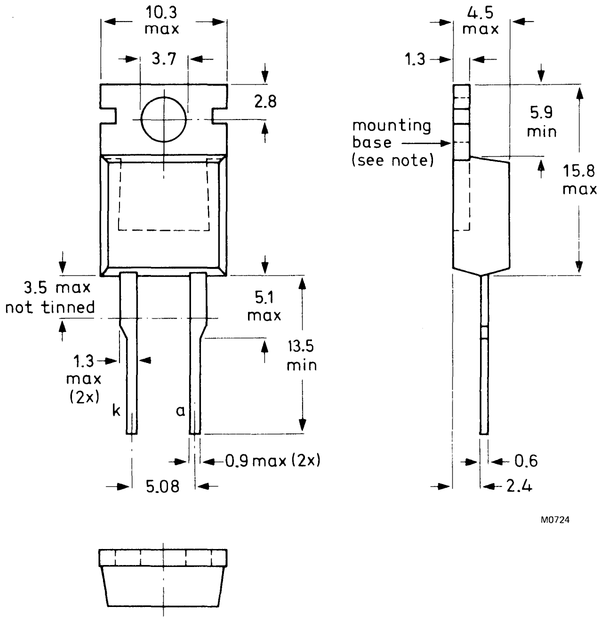
QUICK REFERENCE DATA

			BYV39–30	35	40(A)	45	
Repetitive peak reverse voltage	V_{RRM}	max.	30	35	40	45	V
Average forward current	$I_{F(AV)}$	max.			16		A
Forward voltage	V_F	$<$			0.6		V
Junction temperature	T_j	max.			150		°C

MECHANICAL DATA

Dimensions in mm

Fig.1 TO-220AC



Net mass: 2 g

Note: The exposed metal mounting base is directly connected to the cathode.

Accessories supplied on request: see data sheets Mounting instructions and accessories for TO-220 envelopes.

RATINGS

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

→ **Voltages**		BYV39–	30	35	40(A)	45	
Repetitive peak reverse voltage	V_{RRM}	max.	30	35	40	45	V
Crest working reverse voltage (note 1)	V_{RWM}	max.	30	35	40	45	V
Continuous reverse voltage (note 1)	V_R	max.	30	35	40	45	V

→ **Currents**				
Average forward current square wave; $\delta = 0.5$; up to $T_{mb} = 119\ ^{\circ}C$ (note 2)	$I_{F(AV)}$	max.	16	A
sinusoidal; up to $T_{mb} = 124\ ^{\circ}C$ (note 2)	$I_{F(AV)}$	max.	12.5	A
R.M.S. forward current	$I_{F(RMS)}$	max.	22	A
Repetitive peak forward current $t_p = 20\ \mu s$; $\delta = 0.02$	I_{FRM}	max.	260	A
Non-repetitive peak forward current half sine-wave; $T_j = 125\ ^{\circ}C$ prior to surge; with reapplied $V_{RWM\ max}$ t = 10 ms	I_{FSM}	max.	150	A
t = 8.3 ms	I_{FSM}	max.	165	A
I^2t for fusing (t = 10 ms)	I^2t	max.	112	A^2s
Reverse surge current (BYV39–40A only) $t_p = 100\ \mu s$	I_{RSM}	max.	1.0	A
Temperatures				
Storage temperature	T_{stg}		–40 to +150	°C
Junction temperature	T_j	max.	150	°C

CHARACTERISTICS

Forward voltage $I_F = 15$ A; $T_j = 100\ ^{\circ}C$ (note 3)	V_F	<	0.6	V
$I_F = 40$ A; $T_j = 25\ ^{\circ}C$ (note 3)	V_F	<	1.0	V
Reverse current → $V_R = V_{RWM\ max}$; $T_j = 125\ ^{\circ}C$	I_R	<	55	mA
Junction capacitance at f = 1MHz $V_R = 5$ V; $T_j = 25$ to $125\ ^{\circ}C$	C_d	typ.	520	pF

Notes:

1. Up to $T_j = 125\ ^{\circ}C$; see derating curve for higher temperature operation.
2. Assuming no reverse leakage current losses.
3. Measured under pulse conditions to avoid excessive dissipation.

THERMAL RESISTANCE

From junction to mounting base $R_{th\ j\text{-}mb}$ = 2.2 K/W

Influence of mounting method

1. Heatsink-mounted with clip (see mounting instructions)

Thermal resistance from mounting base to heatsink

a. with heatsink compound $R_{th\ mb\text{-}h}$ = 0.5 K/W

b. with heatsink compound and 0.06 mm maximum mica insulator $R_{th\ mb\text{-}h}$ = 1.4 K/W

c. with heatsink compound and 0.1 mm maximum mica insulator (56369) $R_{th\ mb\text{-}h}$ = 2.2 K/W

d. with heatsink compound and 0.25 mm maximum alumina insulator (56367) $R_{th\ mb\text{-}h}$ = 0.8 K/W

e. without heatsink compound $R_{th\ mb\text{-}h}$ = 1.4 K/W

2. Free air operation

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

Thermal resistance from junction to ambient in free air; mounted on a printed circuit board at any device lead length and with copper laminate on the board $R_{th\ j\text{-}a}$ = 60 K/W

MOUNTING INSTRUCTIONS

1. The device may be soldered directly into the circuit, but the maximum permissible temperature of the soldering iron or bath is 275 $^{\circ}$C; the heat source must not be in contact with the joint for more than 5 seconds. Soldered joints must be at least 4.7 mm from the seal.
2. The leads should not be bent less than 2.4 mm from the seal, and should be supported during bending. The bend radius must be no less than 1.0 mm.
3. Mounting by means of a spring clip is the best mounting method because it offers:
   a. a good thermal contact under the crystal area and slightly lower $R_{th\ mb\text{-}h}$ values than does screw mounting.
   b. safe isolation for mains operation.
   However, if a screw is used, it should be M3 cross-recess pan head. Care should be taken to avoid damage to the plastic body.
4. For good thermal contact, heatsink compound should be used between mounting base and heatsink. Values of $R_{th\ mb\text{-}h}$ given for mounting with heatsink compound refer to the use of a metallic oxide-loaded compound. Ordinary silicone grease is not recommended.
5. Rivet mounting (only possible for non-insulated mounting).
   Devices may be rivetted to flat heatsinks; such a process **must neither** deform the mounting tab, **nor** enlarge the mounting hole.

→ OPERATING NOTES

Dissipation and Heatsink Calculations

The various components of junction temperature rise above ambient are shown below:

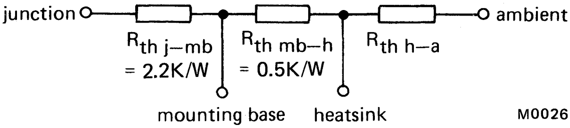


Fig.2

Overall thermal resistance, $R_{th\ j\text{-}a} = R_{th\ j\text{-}mb} + R_{th\ mb\text{-}h} + R_{th\ h\text{-}a}$

To choose a suitable heatsink, the following information is required:

(i) maximum operating ambient temperature
(ii) duty cycle or form factor of forward current (δ or a)
(iii) average forward current
(iv) crest working reverse voltage (V_{RWM})

The total power dissipation in the diode has two components:

P_R — reverse leakage dissipation

$$P_{tot} = P_R + P_F \quad \text{.......... 1).}$$

P_F — forward conduction dissipation

From the above it can be seen that:

$$R_{th\ h\text{-}a} = \frac{T_{jmax} - T_{amb}}{P_R + P_F} - (R_{th\ j\text{-}mb} + R_{th\ mb\text{-}h}) \quad \text{.......... 2).}$$

Values for $R_{th\ j\text{-}mb}$ and $R_{th\ mb\text{-}h}$ can be found under Thermal Resistance. P_R and P_F are derived from Figs.3 and 4 for square-wave operation (and Figs.5 and 6 for sine-wave) as follows:
Starting at the V_{RWM} axis of Fig.3 (or Fig.5), and from a knowledge of the required V_{RWM}, trace upwards to meet the curve that matches the required T_{jmax}. From this point trace horizontally left until the curve of the voltage grade of the device being used is met. From this point trace downwards to meet the required duty cycle (δ) or form factor (a). From this point trace right and read the actual reverse power dissipation on the P_R axis.
Forward conduction dissipation (P_F) for the known average current $I_{F(AV)}$ and duty cycle (or form factor) is easily derived from Fig.4 (or Fig.6).
Substituting the values of P_R and P_F into equation 2) enables the calculation of the required heatsink.

To ensure thermal stability, $(R_{th\ j\text{-}mb} + R_{th\ mb\text{-}h} + R_{th\ h\text{-}a}) \times P_R$ must be less than 12 °C. If the calculated value of $R_{th\ h\text{-}a}$ does not permit this, then it must be reduced (heatsink size increased or $R_{th\ mb\text{-}h}$ improved) to enable this criterion to be met.

EXAMPLE: square-wave operation, using BYV39-35 and heatsink compound;
$T_{amb} = 50$ °C; $\delta = 0.5$; $I_{F(AV)} = 12$ A
$V_{RWM} = 12$ V; voltage grade of device = 35 V
From data, $R_{th\ j\text{-}mb} = 2.2$ K/W and $R_{th\ mb\text{-}h} = 0.5$ K/W.
From Fig.4, it is found that $P_F = 9.2$ W
If the desired T_{jmax} is chosen to be 130 °C, then from Fig.3, $P_R = 0.23$ W
Using equation 2) we have:

$$R_{th\ h\text{-}a} = \frac{130\ ^{o}C - 50\ ^{o}C}{9.2\ W + 0.23\ W} - (2.2 + 0.5) = 5.8\ K/W$$

To check for thermal stability:

$$(R_{th\ j\text{-}a}) \times P_R = (2.2 + 0.5 + 5.8) \times 0.23 = 2\ ^{o}C.$$

This is less than 12 °C, hence thermal stability is ensured.

SQUARE-WAVE OPERATION (Figs 3 and 4)

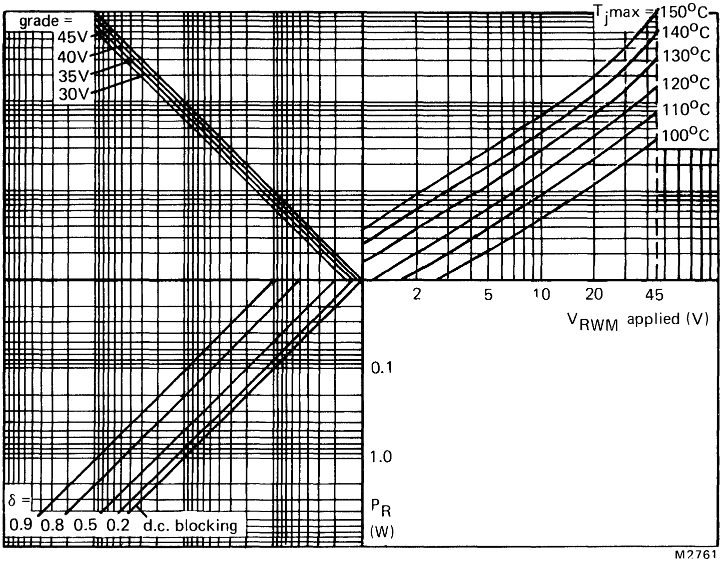
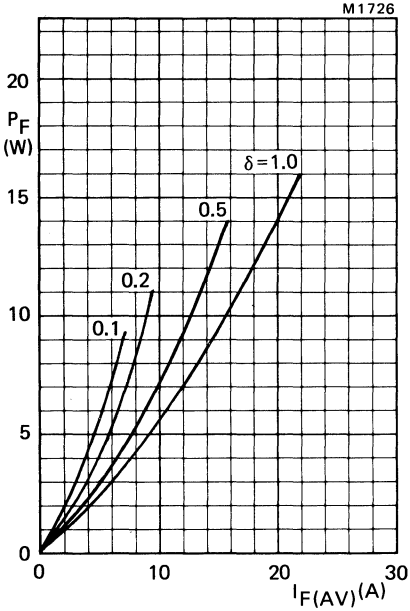
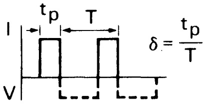


Fig.3 NOMOGRAM: for calculation of P_R (reverse leakage power dissipation) for a given $T_j$max., V_{RWM} applied, voltage grade and duty cycle.





$I_{F(AV)} = I_{F(RMS)} \times \sqrt{\delta}$

Fig.4

SINUSOIDAL OPERATION (Figs.5 and 6)

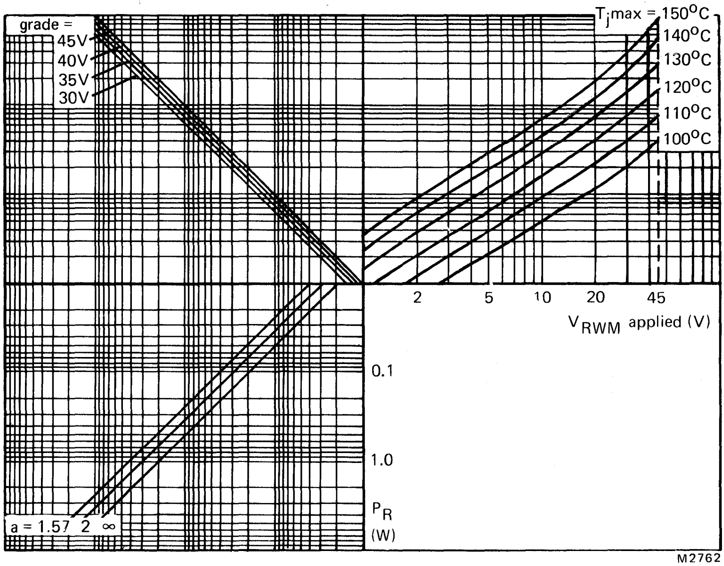


Fig.5 NOMOGRAM: for calculation of P_R (reverse leakage power dissipation) for a given $T_j$max., V_{RWM} applied, voltage grade and form factor.

a = form factor = $I_{F(RMS)}/I_{F(AV)}$

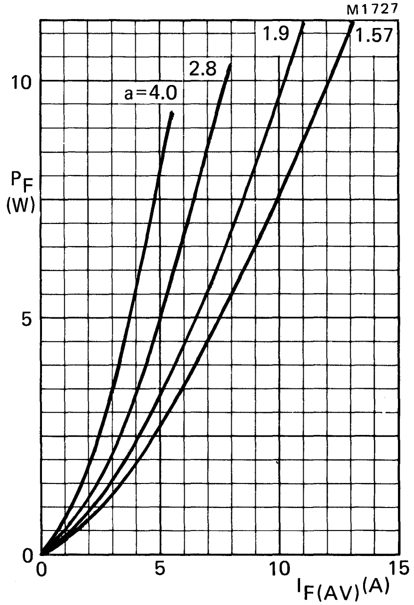


Fig.6

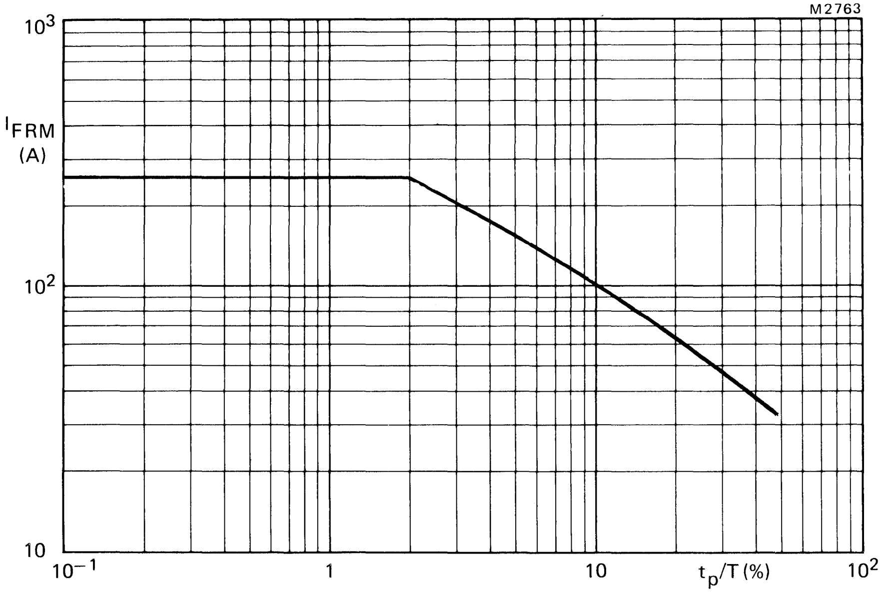
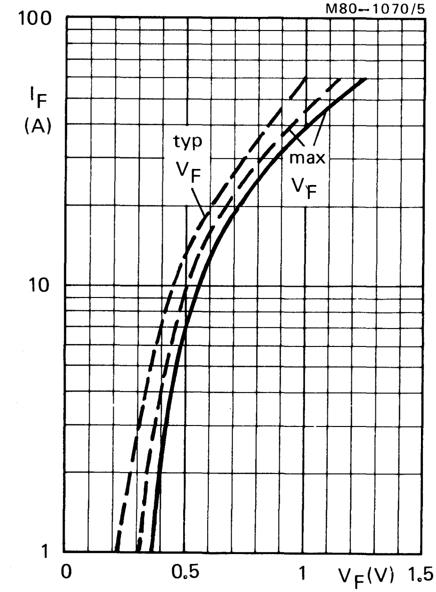
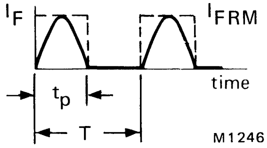


Fig.7 Maximum permissible repetitive peak forward current for either square or sinusoidal currents for 1 $\mu s < t_p <$ 1 ms.





Definition of I_{FRM} and t_p/T.

Fig.8 —— T_j = 25 °C; – – – T_j = 100 °C

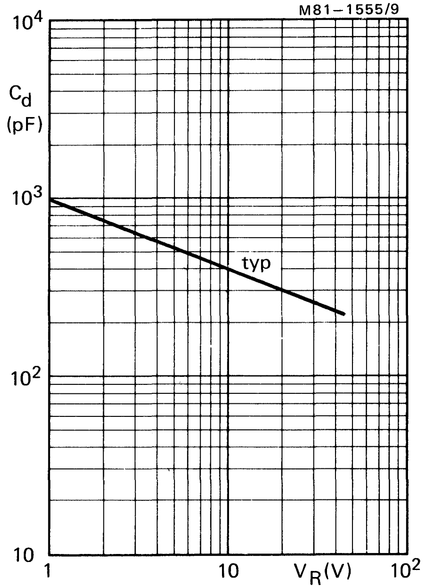


Fig.9 f = 1 MHz; T_j = 25 to 125 °C

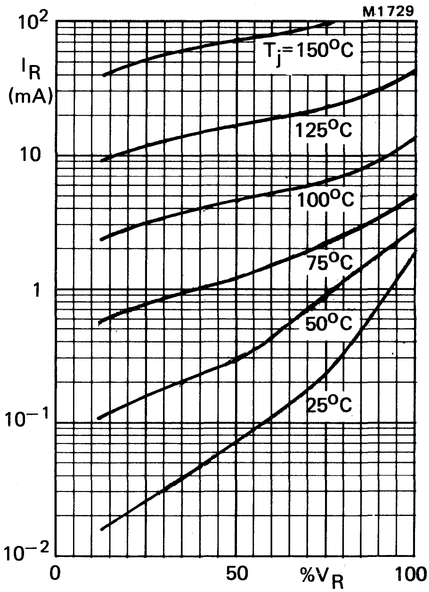


Fig.10 Typical values

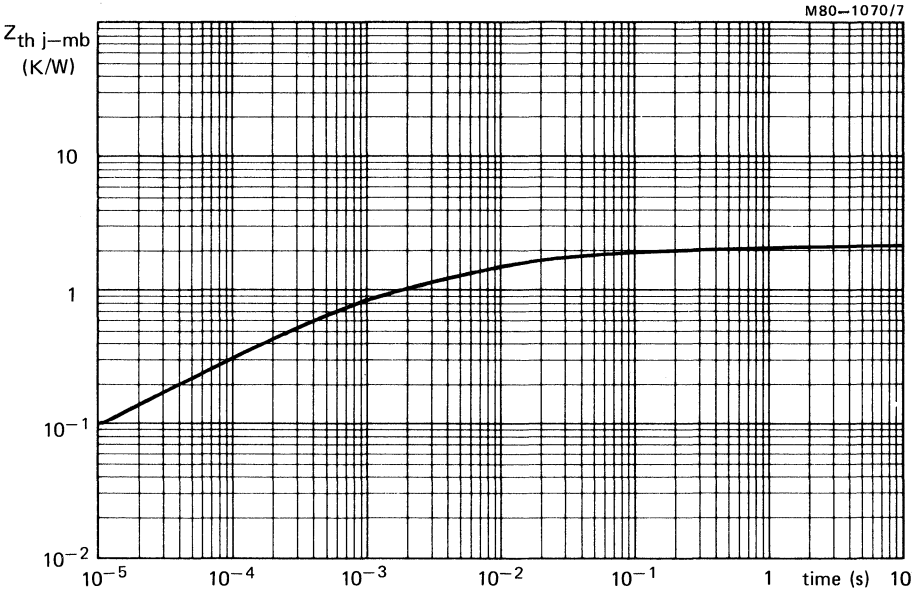


Fig.11 Transient thermal impedance

SCHOTTKY–BARRIER DOUBLE RECTIFIER DIODES

High-efficiency schottky-barrier double rectifier diodes in plastic envelopes, featuring low forward voltage drop, low capacitance and absence of stored charge. They are intended for use in switched-mode power supplies and high-frequency circuits in general, where both low conduction losses and zero switching losses are essential. Their single chip (monolithic) construction allows both diodes to be paralleled without the need for derating. They can also withstand reverse voltage transients. The series consists of common-cathode types. A version with guaranteed reverse surge capability, BYV43-40A, is also available.

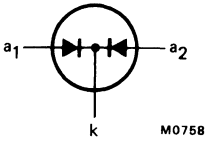
QUICK REFERENCE DATA

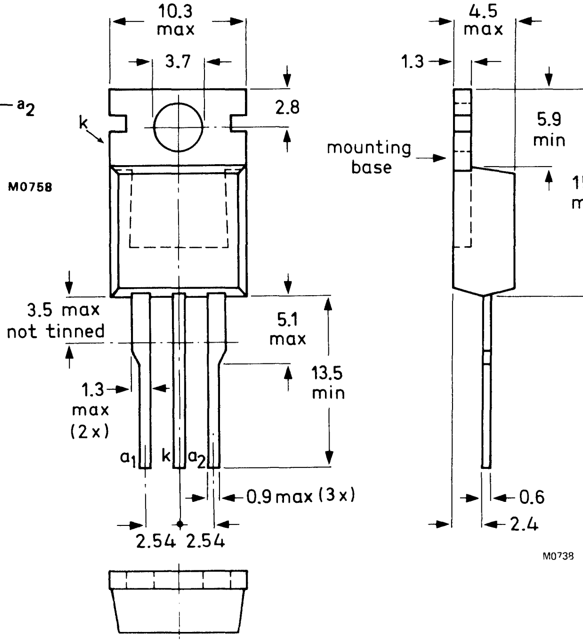
Per diode, unless otherwise stated			BYV43-30	35	40(A)	45	
Repetitive peak reverse voltage	V_{RRM}	max.	30	35	40	45	V
Output current (both diodes conducting)	I_O	max.	30				A
Forward voltage	V_F	$<$	0.6				V
Junction temperature	T_j	$<$	150				°C

MECHANICAL DATA

Dimensions in mm

Fig.1 TO-220AB





Net mass: 2g

Note: the exposed metal mounting base is directly connected to the common cathode.

Accessories supplied on request: see data sheets Mounting instructions and accessories for TO-220 envelopes.

RATINGS

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

→ **Voltages** (per diode)		BYV43–	30	35	40(A)	45	V
Repetitive peak reverse voltage	V_{RRM}	max.	30	35	40	45	V
Crest working reverse voltage (note 1)	V_{RWM}	max.	30	35	40	45	V
Continuous reverse voltage (note 1)	V_R	max.	30	35	40	45	V

→ **Currents** (both diodes conducting: note 2)				
Output current: square wave; $\delta = 0.5$; up to $T_{mb} = 112\ ^{\circ}C$ (note 3)	I_O	max.	30	A
R.M.S. forward current	$I_{F(RMS)}$	max.	40	A
Repetitive peak forward current $t_p = 20\ \mu s$, $\delta = 0.02$ (per diode)	I_{FRM}	max.	250	A
Non-repetitive peak forward current (per diode) half sine-wave; $T_j = 125\ ^{\circ}C$ prior to surge; with reapplied V_{RWM} max				
$t = 10\,ms$	I_{FSM}	max.	200	A
$t = 8.3\,ms$	I_{FSM}	max.	220	A
I^2t for fusing ($t = 10\,ms$, per diode)	I^2t	max.	200	A^2s
Reverse surge current (BYV43–40A only) $t_p = 100\ \mu s$	I_{RSM}	max.	0.5	A

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

Notes:

1. Up to $T_j = 125\ ^{\circ}C$; see derating curve for higher temperature operation.
2. The limits for both diodes apply whether both diodes conduct simultaneously or on alternate half cycles.
3. Assuming no reverse leakage current losses.

CHARACTERISTICS (per diode)

Forward voltage				
$I_F = 15$ A; $T_j = 125$ °C	V_F	<	0.6	V*
$I_F = 30$ A; $T_j = 25$ °C	V_F	<	0.87	V*
Reverse current				
$V_R = V_{RWM\ max}$; $T_j = 125$ °C	I_R	<	100	mA ←
Junction capacitance at f = 1 MHz				
$V_R = 5$ V; $T_j = 25$ to 125 °C	C_d	typ.	500	pF

THERMAL RESISTANCE

From junction to mounting base (both diodes conducting)	$R_{th\ j\text{-}mb}$	=	1.4	K/W
From junction to mounting base (per diode)	$R_{th\ j\text{-}mb}$	=	2.3	K/W

Influence of mounting method

1. Heatsink-mounted with clip (see mounting instructions)

Thermal resistance from mounting base to heatsink

a. with heatsink compound	$R_{th\ mb\text{-}h}$	=	0.2	K/W
b. with heatsink compound and 0.06 mm maximum mica insulator	$R_{th\ mb\text{-}h}$	=	1.4	K/W
c. with heatsink compound and 0.1 mm maximum mica insulator (56369)	$R_{th\ mb\text{-}h}$	=	2.2	K/W
d. with heatsink compound and 0.25 mm maximum alumina insulator (56367)	$R_{th\ mb\text{-}h}$	=	0.8	K/W
e. without heatsink compound	$R_{th\ mb\text{-}h}$	=	1.4	K/W

2. Free air operation

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

Thermal resistance from junction to ambient in free air; mounted on a printed circuit board at any device lead length and with copper laminate on the board	$R_{th\ j\text{-}a}$	=	60	K/W

---

*Measured under pulse conditions to avoid excessive dissipation.

MOUNTING INSTRUCTIONS

1. The device may be soldered directly into the circuit, but the maximum permissible temperature of the soldering iron or bath is 275 °C; the heat source must not be in contact with the joint for more than 5 seconds. Soldered joints must be at least 4.7 mm from the seal.
2. The leads should not be bent less than 2.4 mm from the seal, and should be supported during bending. The bend radius must be no less than 1.0 mm.
3. Mounting by means of a spring clip is the best mounting method because it offers:
   a. a good thermal contact under the crystal area and slightly lower $R_{th\ mb\text{-}h}$ values than does screw mounting.
   b. safe isolation for mains operation.
   However, if a screw is used, it should be M3 cross-recess pan head. Care should be taken to avoid damage to the plastic body.
4. For good thermal contact, heatsink compound should be used between mounting base and heatsink. Values of $R_{th\ mb\text{-}h}$ given for mounting with heatsink compound refer to the use of a metallic oxide-loaded compound. Ordinary silicone grease is not recommended.
5. Rivet mounting (only possible for non-insulated mounting).
   Devices may be rivetted to flat heatsinks; such a process **must neither** deform the mounting tab, **nor** enlarge the mounting hole.

OPERATING NOTES

Dissipation and heatsink calculations.

The various components of junction temperature rise above ambient are illustrated in Fig.2.

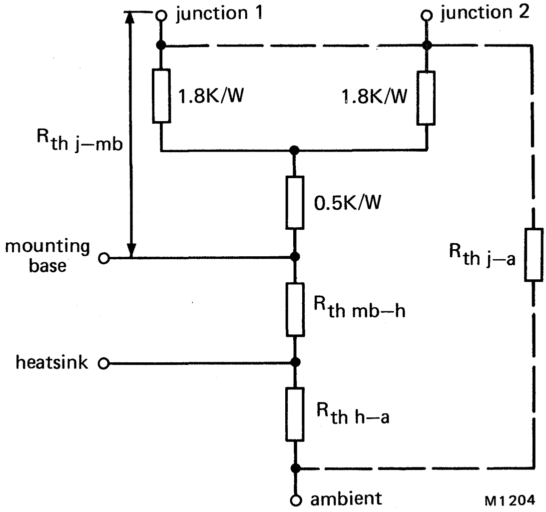


Fig.2.

OPERATING NOTES

Dissipation and heatsink calculations (continued)

Overall thermal resistance, $R_{th\ j\text{-}a} = R_{th\ j\text{-}mb} + R_{th\ mb\text{-}h} + R_{th\ h\text{-}a}$

To choose a suitable heatsink, the following information is required for each half of the dual diode:

(i) maximum operating ambient temperature
(ii) duty cycle of forward current (δ)
(iii) average forward current per diode
(iv) crest working reverse voltage (V_{RWM})

The total power dissipation in the diode has two components:

P_R – reverse leakage dissipation
P_F – forward conduction dissipation

$$P_{tot} = P_R + P_F \quad \text{.......................} \quad 1).$$

From the above it can be seen that:

$$R_{th\ h\text{-}a} = \frac{T_{jmax} - T_{amb}}{P_F + P_R} - (R_{th\ j\text{-}mb} + R_{th\ mb\text{-}h}) \quad \text{..........} \quad 2).$$

Values for $R_{th\ j\text{-}mb}$ and $R_{th\ mb\text{-}h}$ can be found under Thermal Resistance. P_R and P_F are derived from Figs.3 and 4 as follows:

Look at each half of the dual diode separately; for each diode, starting at the V_{RWM} axis of Fig.3, and from a knowledge of the required V_{RWM}, trace upwards to meet the curve that matches the required T_{jmax}. From this point trace horizontally left until the curve of the voltage grade of the device being used is met. From this point trace downwards to meet the required duty cycle (δ). From this point trace right and read the actual reverse power dissipation on the P_R axis.

From this calculation, $P_R = P_R$ (diode 1) + P_R (diode 2) .... 3).

Forward conduction dissipation (P_F) for the known average current $I_{F(AV)}$ and duty cycle for each diode is easily derived from Fig.4.

Similarly, $P_F = P_F$ (diode 1) + P_F (diode 2) .... 4).

Substituting equations 3) and 4) into equation 2) enables the calculation of the required heatsink.

NOTE:– If both halves of the diode are being used (as is assumed above), the value of $R_{th\ j\text{-}mb}$ = 1.4 K/W. If only one half of the diode is used, follow the above procedure for one diode only, and use the value of $R_{th\ j\text{-}mb}$ of 2.3 K/W.

To ensure thermal stability, $(R_{th\ j\text{-}mb} + R_{th\ mb\text{-}h} + R_{th\ h\text{-}a}) \times P_R$ must be less than 12 °C. If the calculated value of $R_{th\ h\text{-}a}$ does not permit this, then it must be reduced (heatsink size increased or $R_{th\ mb\text{-}h}$ improved) to enable this criterion to be met.

EXAMPLE: square-wave operation, using BYV43-35 and heatsink compound;
T_{amb} = 50 °C; δ (diode 1) = 0.5; δ (diode 2) = 0.5;
$I_{F(AV)}$ (diode 1) = 12 A; $I_{F(AV)}$ (diode 2) = 12 A;
V_{RWM} (both diodes) = 12 V; voltage grade of device = 35 V.
From data, $R_{th\ j\text{-}mb}$ = 1.4 K/W and $R_{th\ mb\text{-}h}$ = 0.2 K/W.
For each diode from Fig.4, it is found that P_F = 9.3 W;
hence total P_F = 2 x 9.3 = 18.6 W. (from equation 4)
If the desired $T_{j\ max}$ is chosen to be 130 °C, then, from Fig.3, P_R (per diode) = 0.44W
Therefore total P_R = 2 x 0.44 = 0.88 W. (from equation 3)
Using equation 2) we have:

$$R_{th\ h\text{-}a} = \frac{130\ ^{\circ}\mathrm{C} - 50\ ^{\circ}\mathrm{C}}{18.6\ \mathrm{W} + 0.88\ \mathrm{W}} - (1.4 + 0.2) = 2.5\ \mathrm{K/W}$$

To check for thermal stability:

$$(R_{th\ j\text{-}a}) \times P_R = (1.4 + 0.2 + 2.5) \times 0.88 = 3.6\ ^{\circ}\mathrm{C}.$$

This is less than 12 °C, hence thermal stability is ensured.

SQUARE-WAVE OPERATION (Fig.s 3 and 4)

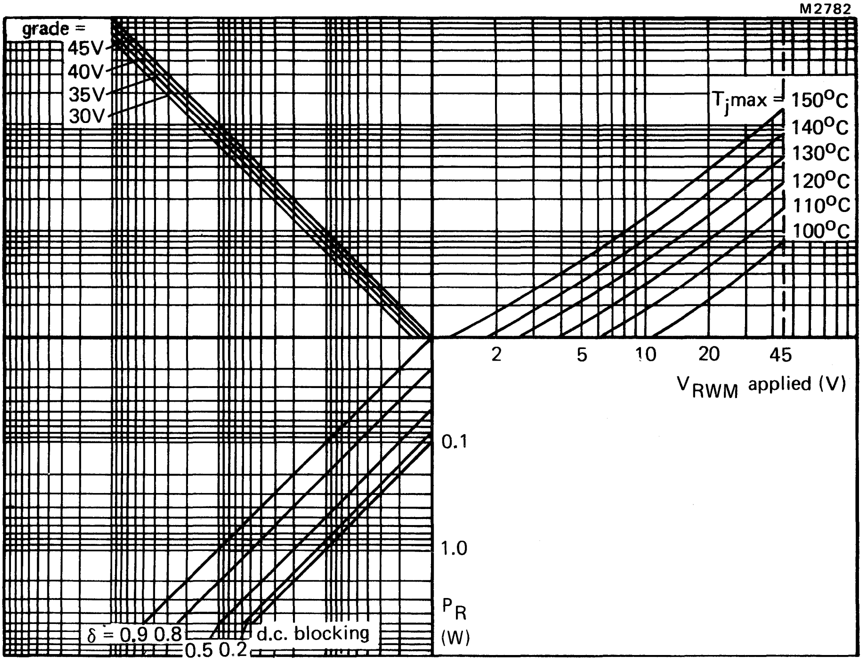
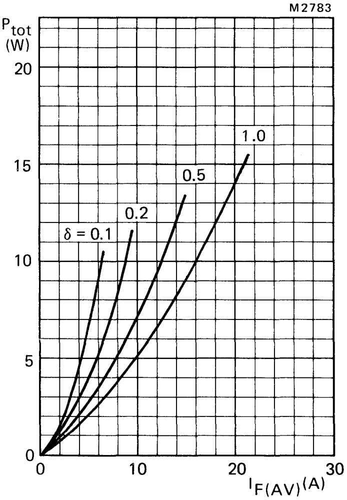
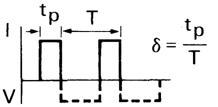


Fig.3 NOMOGRAM: for calculation of P_R (reverse leakage power dissipation) for a given $T_j$max., V_{RWM} applied, voltage grade and duty cycle (per diode).





$$I_{F(AV)} = I_{F(RMS)} \times \sqrt{\delta}$$

Fig.4.

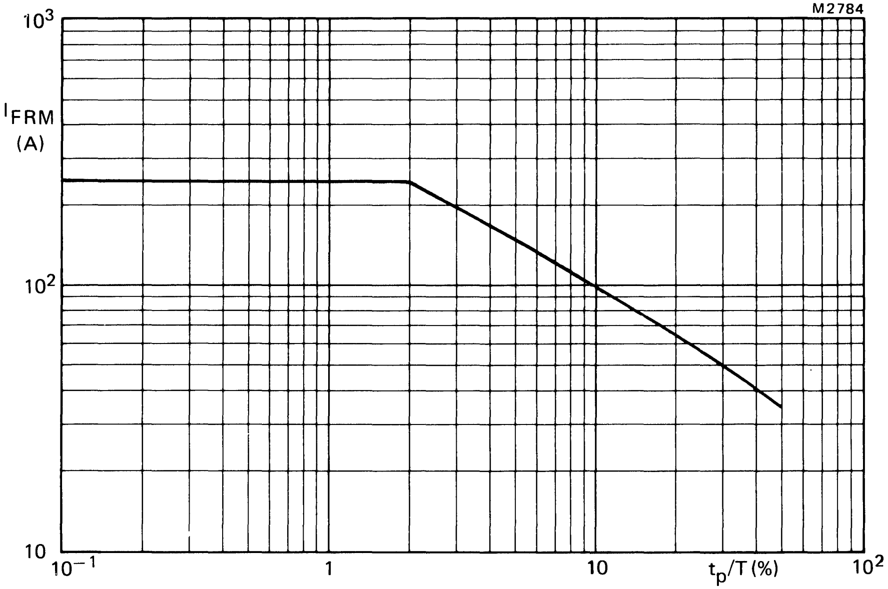
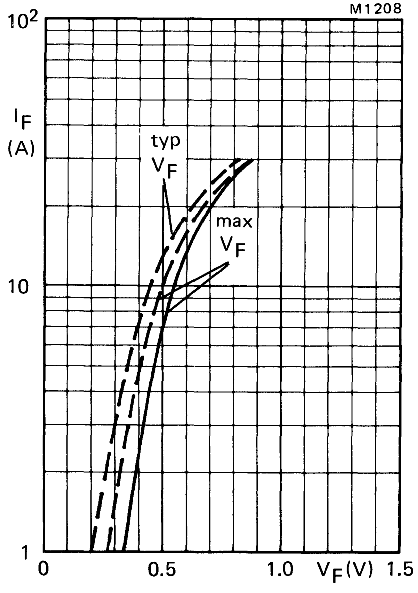
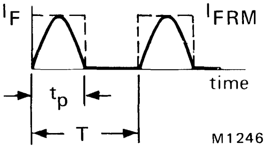


Fig.5 Maximum permissible repetitive peak forward current for either square or sinusoidal currents for 1 $\mu s < t_p < 1$ ms.





Definition of I_{FRM} and t_p/T.

Fig.6 —— T_j = 25 °C; – – – T_j = 125 °C; per diode.

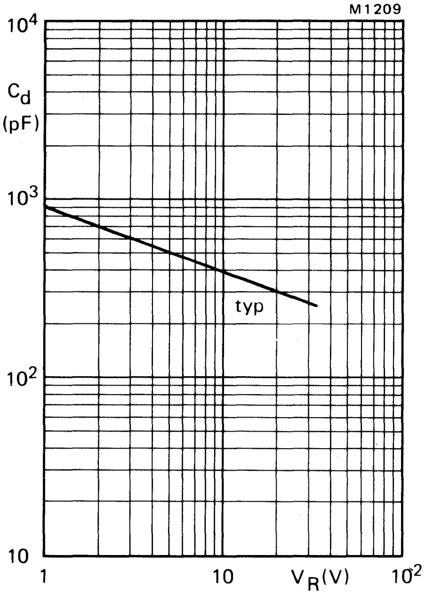


Fig.7 f = 1 MHz; T_j = 25 to 125 °C; per diode.

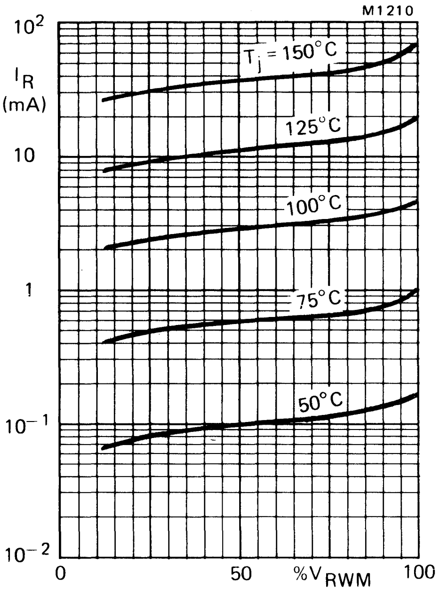


Fig.8 Typical values; per diode.

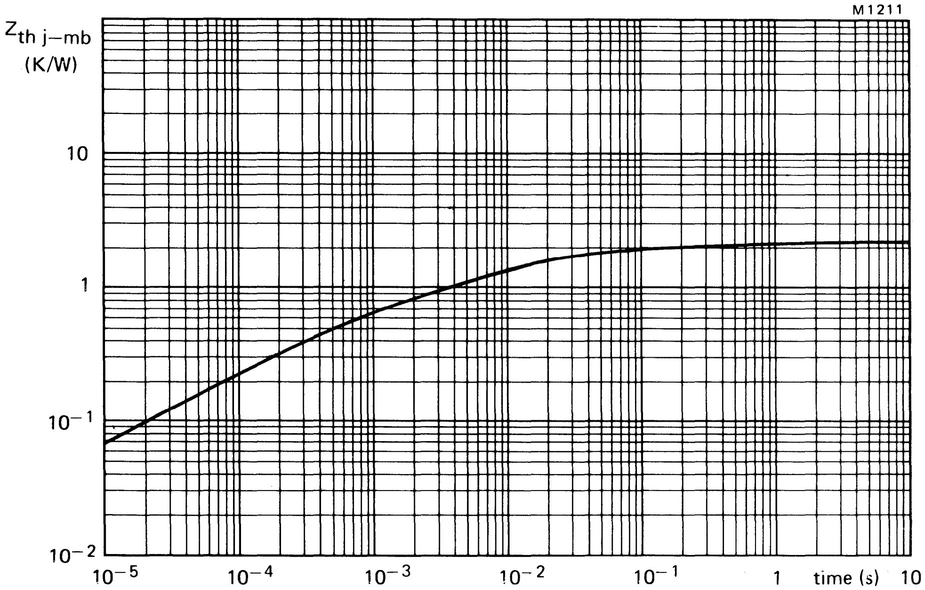


Fig.9 Transient thermal impedance; one diode conducting.

SCHOTTKY-BARRIER, ELECTRICALLY-ISOLATED DOUBLE RECTIFIER DIODES

High-efficiency schottky-barrier double rectifier diodes in SOT-186 (full-pack) plastic envelopes, featuring very low forward voltage drop, low capacitance and absence of stored charge. Their electrical isolation makes them ideal for mounting on a common heatsink alongside other components without the need for additional insulators. They are intended for use in switched-mode power supplies and high-frequency circuits in general, where low conduction losses and absence of stored charge are essential. The single chip (monolithic) construction allows both diodes to be paralleled without the need for derating. The series consists of common-cathode types.
A version with guaranteed reverse surge capability, BYV43F–40A is available.

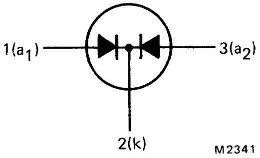
QUICK REFERENCE DATA

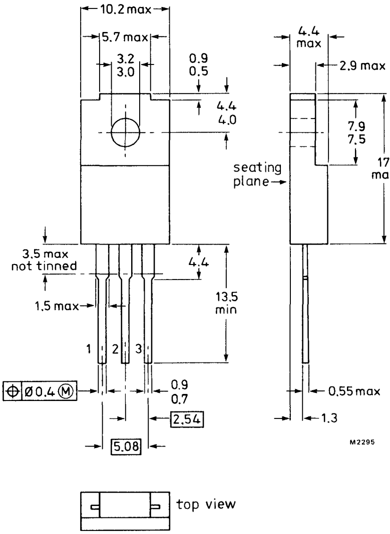
Per diode, unless otherwise stated		BYV43F–	30	35	40(A)	45	
Repetitive peak reverse voltage	V_{RRM}	max.	30	35	40	45	V
Output current (both diodes conducting)	I_O	max.			26		A
Forward voltage	V_F	<			0.6		V
Junction temperature	T_j	<			150		°C

MECHANICAL DATA

Dimensions in mm

Fig.1 SOT-186 (full-pack).





Net mass: 2 g.
The seating plane is electrically isolated from all terminals.
Accessories supplied on request (see data sheets Mounting instructions for F-pack devices and Accessories for SOT-186 envelopes).

RATINGS

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

Voltages (per diode)			BYV43F–30	35	40(A)	45	
Repetitive peak reverse voltage	V_{RRM}	max.	30	35	40	45	V
Crest working reverse voltage (note 1)	V_{RWM}	max.	30	35	40	45	V
Continuous reverse voltage (note 1)	V_R	max.	30	35	40	45	V

Currents (both diodes conducting; notes 2, 4)				
Output current: square wave; $\delta = 0.5$; up to $T_h = 49\ ^{o}C$ (note 3)	I_O	max.	26	A
R.M.S. forward current	$I_{F(RMS)}$	max.	37	A
Repetitive peak forward current $t_p = 20\ \mu s$; $\delta = 0.02$ (per diode)	I_{FRM}	max.	250	A
Non-repetitive peak forward current (per diode) half sine-wave; $T_j = 150\ ^{o}C$ prior to surge; with reapplied $V_{RWM\ max}$				
$t = 10$ ms	I_{FSM}	max.	200	A
$t = 8.3$ ms	I_{FSM}	max.	220	A
I^2t for fusing ($t = 10$ ms, per diode)	I^2t	max.	200	A^2s
Reverse surge current (BYV43F–40A only) $t_p = 100\ \mu s$	I_{RSM}	max.	0.5	A
Temperatures				
Storage temperature	T_{stg}		–40 to +150	^{o}C
Junction temperature	T_j	max.	150	^{o}C

ISOLATION

Peak isolation voltage from all terminals to external heatsink	V_{isol}	max.	1000	V
Isolation capacitance from centre lead to external heatsink (note 5)	C_p	typ.	12	pF

Notes:

1. Up to $T_j = 125\ ^{o}C$; see derating curve for higher temperature operation.
2. The limits for both diodes apply whether both diodes conduct simultaneously or on alternate half cycles.
3. Assuming no reverse leakage current losses.
4. The quoted temperatures assume heatsink compound is used.
5. Mounted without heatsink compound and 20 Newtons pressure on the centre of the envelope.

CHARACTERISTICS (per diode)

T_j = 25 °C unless otherwise stated

Forward voltage				
I_F = 15 A; T_j = 125 °C	V_F	<	0.6	V*
I_F = 30 A	V_F	<	0.87	V*
Reverse current				
$V_R = V_{RWM\,max}$; T_j = 125 °C	I_R	<	100	mA
Junction capacitance at f = 1 MHz				
V_R = 5 V; T_j = 25 °C to 125 °C	C_j	typ.	500	pF

THERMAL RESISTANCE

From junction to external heatsink with minimum of 2 kgf (20 Newtons) pressure on the centre of the envelope:

a. both diodes conducting:				
with heatsink compound	$R_{th\,j\text{-}h}$	=	4.8	K/W
without heatsink compound	$R_{th\,j\text{-}h}$	=	6.8	K/W
b. per diode:				
with heatsink compound	$R_{th\,j\text{-}h}$	=	5.7	K/W
without heatsink compound	$R_{th\,j\text{-}h}$	=	7.7	K/W

Free air operation

The quoted value of $R_{th\,j\text{-}h}$ should be used only when no leads of other dissipating components run to the same tie point.

Thermal resistance from junction to ambient in free air, mounted on a printed circuit board	$R_{th\,j\text{-}a}$	=	55	K/W

---

*Measured under pulse conditions to avoid excessive dissipation.

MOUNTING INSTRUCTIONS

1. The device may be soldered directly into the circuit, but the maximum permissible temperature of the soldering iron or bath is 275 °C; the heat source must not be in contact with the joint for more than 5 seconds. Soldered joints must be at least 4.7 mm from the seal.
2. The leads should not be bent less than 2.4 mm from the seal, and should be supported during bending. The bend radius must be no less than 1 mm.
3. Mounting by means of a spring clip is the best mounting method because it offers a good thermal contact under the crystal area and slightly lower $R_{th\ j\text{-}h}$ values than screw mounting. The force exerted on the top of the device by the clip should be at least 2 kgf (20 Newtons) to ensure good thermal contact and must not exceed 3.5 kgf (35 Newtons) to avoid damage to the device.
4. If screw mounting is used, it should be M3 cross-recess pan head.

Minimum torque to ensure good thermal contact:	5.5 kgf (0.55 Nm)
Maximum torque to avoid damage to the device:	8.0 kgf (0.80 Nm)

5. For good thermal contact, heatsink compound should be used between baseplate and heatsink. Values of $R_{th\ j\text{-}h}$ given for mounting with heatsink compound refer to the use of a metallic-oxide loaded compound. Ordinary silicone grease is not recommended.
6. Rivet mounting.
   It is not recommended to use rivets, since extensive damage could result to the plastic, which could destroy the insulating properties of the device.
7. The heatsink must have a flatness in the mounting area of 0.02 mm maximum per 10 mm. Mounting holes must be deburred.

OPERATING NOTES

The various components of junction temperature rise above ambient are illustrated in Fig.2.

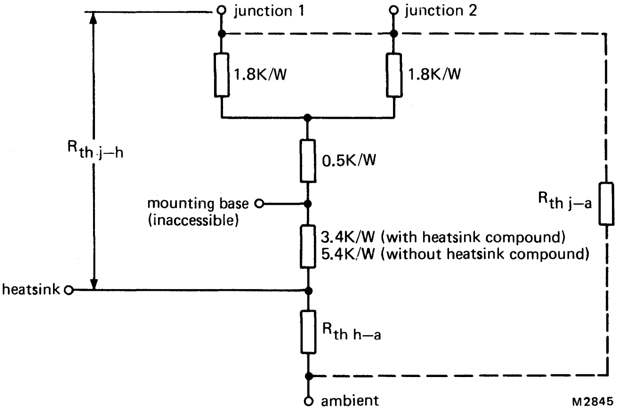


Fig.2.

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

OPERATING NOTES

Dissipation and heatsink calculations (continued)

Overall thermal resistance, $R_{th\ j\text{-}a} = R_{th\ j\text{-}h} + R_{th\ h\text{-}a}$

To choose a suitable heatsink, the following information is required for each half of the dual diode:

(i) maximum operating ambient temperature
(ii) duty cycle of forward current (δ)
(iii) average forward current per diode
(iv) crest working reverse voltage (V_{RWM})

The total power dissipation in the diode has two components:

P_R – reverse leakage dissipation
P_F – forward conduction dissipation

$$P_{tot} = P_R + P_F \quad \text{......} \quad 1).$$

From the above it can be seen that:

$$R_{th\ h\text{-}a} = \frac{T_{jmax} - T_{amb}}{P_F + P_R} - (R_{th\ j\text{-}h}) \quad \text{......} \quad 2).$$

The value of $R_{th\ j\text{-}h}$ can be found under Thermal Resistance and will depend upon whether or not heatsink compound is used. P_R and P_F are derived from Figs.3 and 4 as follows:
Look at each half of the dual diode separately; for each diode, starting at the V_{RWM} axis of Fig.3, and from a knowledge of the required V_{RWM}, trace upwards to meet the curve that matches the required T_{jmax}. From this point trace horizontally left until the curve of the voltage grade of the device being used is met. From this point trace downwards to meet the required duty cycle (δ). From this point trace right and read the actual reverse power dissipation on the P_R axis. From this calculation,

$$P_R = P_R \text{ (diode 1)} + P_R \text{ (diode 2)} \quad \text{......} \quad 3).$$

Forward conduction dissipation (P_F) for the known average current $I_{F(AV)}$ and duty cycle for each diode is easily derived from Fig.4.

$$\text{Similarly, } P_F = P_F \text{ (diode 1)} + P_F \text{ (diode 2)} \quad \text{......} \quad 4).$$

Substituting equations 3) and 4) into equation 2) enables the calculation of the required heatsink.

NOTE:– If both halves of the diode are being used (as is assumed above), the value of $R_{th\ j\text{-}h}$ = 4.8 K/W (with heatsink compound) or 6.8 K/W (without heatsink compound).
If only one half of the diode is used, follow the above procedure for one diode only, and use the value of $R_{th\ j\text{-}h}$ of 5.7 K/W (with heatsink compound) or 7.7 K/W (without heatsink compound).
To ensure thermal stability, $(R_{th\ j\text{-}h} + R_{th\ h\text{-}a}) \times P_R$ must be less than 12 °C. If the calculated value of $R_{th\ h\text{-}a}$ does not permit this, then it must be reduced (heatsink size increased or $R_{th\ j\text{-}a}$ improved) to enable this cirterion to be met.

EXAMPLE: square wave operation, using BYV43F–35 and heatsink compound;
T_{amb} = 40 °C; δ (diode 1) = 0.5; δ (diode 2) = 0.5;
$I_{F(AV)}$ (diode 1) = 9 A; $I_{F(AV)}$ (diode 2) = 9 A;
V_{RWM} (both diodes) = 12 V; voltage grade of device = 35 V.
From data, $R_{th\ j\text{-}h}$ = 4.8 K/W.
For each diode from Fig.4, it is found that P_F = 6 W;
hence total P_F = 2 x 6 = 12 W. (from equation 4)
If the desired T_{jmax} is chosen to be 130 °C, then, from Fig.3, P_R (per diode) = 0.44 W.
Therefore total P_R = 2 x 0.44 = 0.88 W. (from equation 3)
Using equation 2) we have:

$$R_{th\ h\text{-}a} = \frac{130\ ^{\circ}\text{C} - 40\ ^{\circ}\text{C}}{12\ \text{W} + 0.88\ \text{W}} - (4.8) = 2.2\ \text{K/W}$$

To check for thermal stability:

$$(R_{th\ j\text{-}a}) \times P_R = (4.8 + 2.2) \times 0.88 = 6.16\ ^{\circ}\text{C}.$$

This is less than 12 °C, hence thermal stability is ensured.

SQUARE-WAVE OPERATION (Figs.3 and 4)

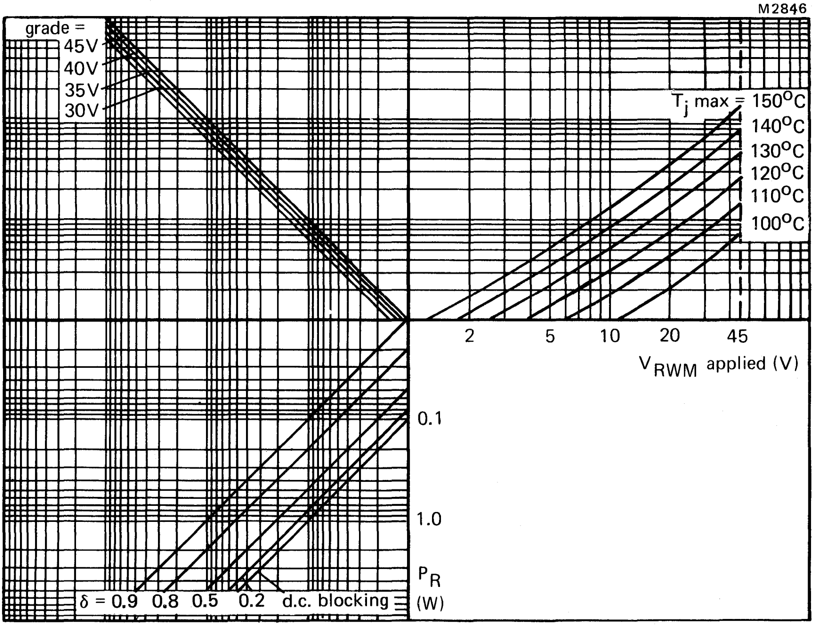
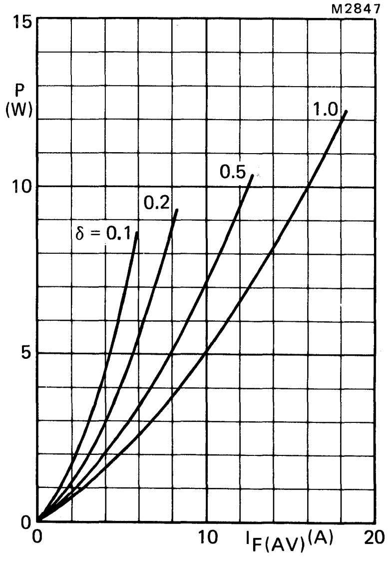
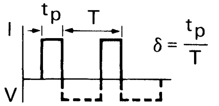


Fig.3 NOMOGRAM: for calculation of P_R (reverse leakage power dissipation) for a given $T_j$max., V_{RWM} applied, voltage grade and duty cycle (per diode).





$I_{F(AV)} = I_{F(RMS)} \times \sqrt{\delta}$

Fig.4 (per diode)

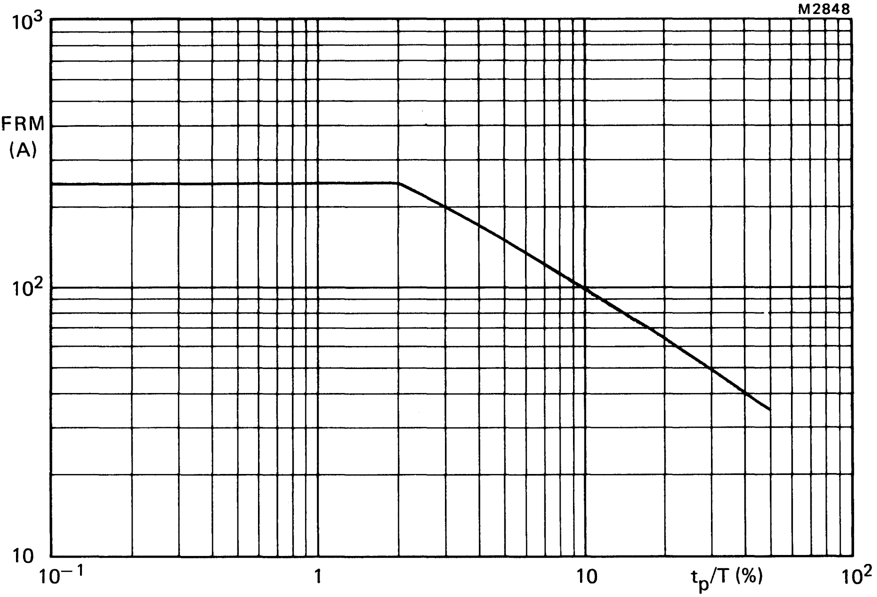
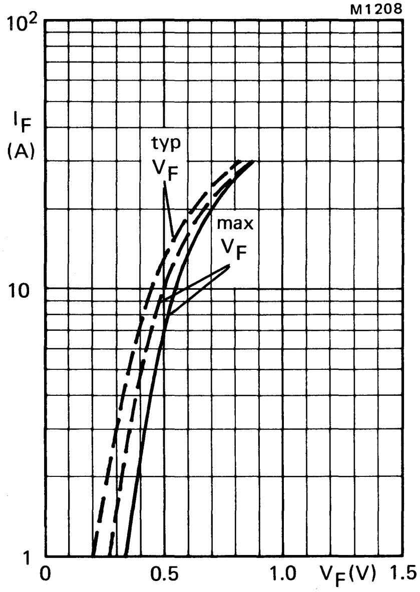
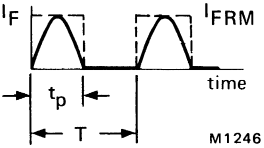


Fig.5 Maximum permissible repetitive peak forward current for either square or sinusoidal currents for 1 μs < t_p < 1 ms, per diode.





Definition of I_{FRM} and t_p/T.

Fig.6 —— T_j = 25 °C; – – – T_j = 125 °C; per diode.

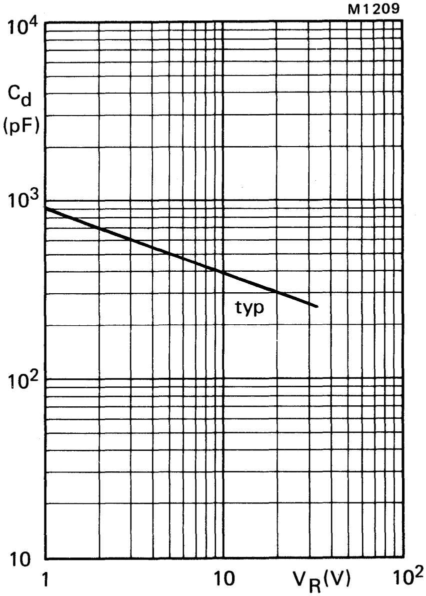


Fig.7 f = 1 MHz; T_j = 25 to 125 °C; per diode.

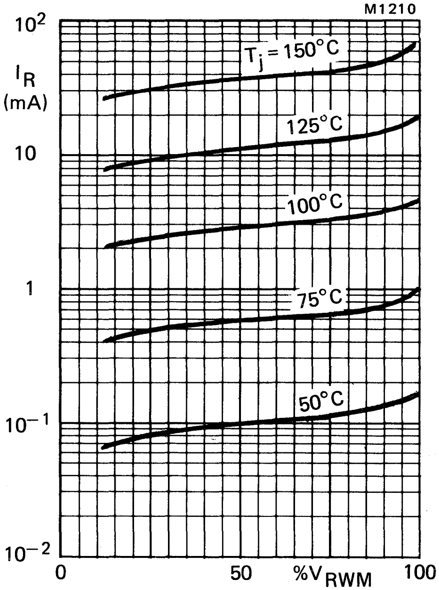


Fig.8 Typical values; per diode.

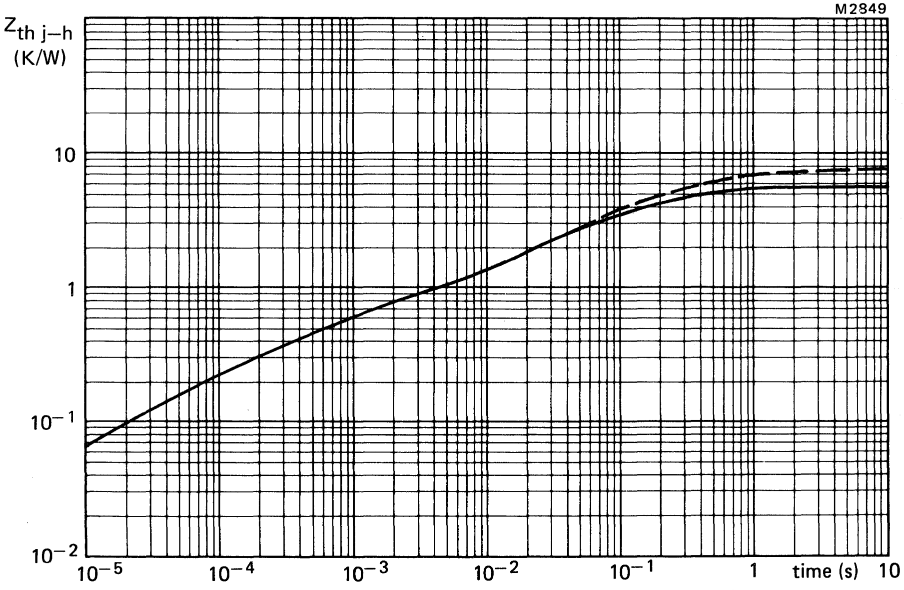


Fig.9 Transient thermal impedance; one diode conducting; —— with heatsink compound; – – – without heatsink compound.

SCHOTTKY–BARRIER DOUBLE RECTIFIER DIODES

High-efficiency schottky-barrier double rectifier diodes in plastic envelopes featuring low forward voltage drop, low capacitance and absence of stored charge. They are intended for use in switched-mode power supplies and high-frequency circuits in general, where both low conduction losses and zero switching losses are essential. Their single chip (monolithic) construction allows both diodes to be paralleled without the need for derating. They can also withstand reverse voltage transients. The series consists of common-cathode types. A version with guaranteed reverse surge capability, BYV73–40A, is also available.

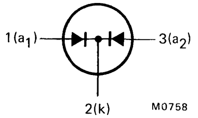
QUICK REFERENCE DATA

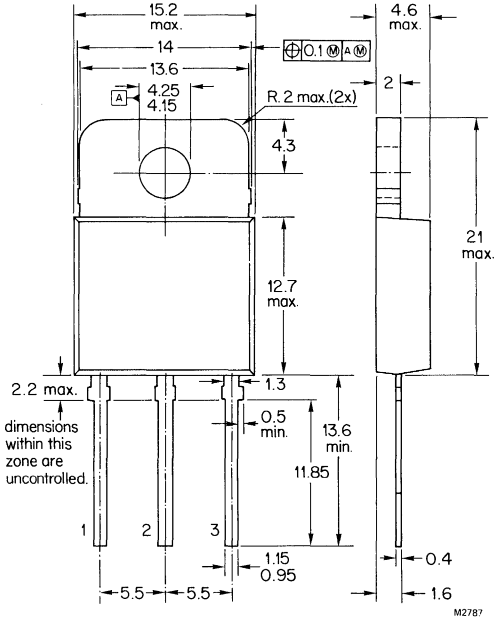
Per diode, unless otherwise stated			BYV73–30	35	40(A)	45	
Repetitive peak reverse voltage	V_{RRM}	max.	30	35	40	45	V
Output current (both diodes conducting)	I_O	max.	30				A ←
Forward voltage	V_F	<	0.6				V
Junction temperature	T_j	<	150				°C

MECHANICAL DATA

Dimensions in mm

Fig.1 SOT-93





←

Net mass: 5 g

Note: the exposed metal mounting base is directly connected to the common cathode.

Accessories supplied on request: see data sheets Mounting instructions and accessories for SOT-93 envelopes.

RATINGS

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

→ **Voltages** (per diode)

			BYV73–30	35	40(A)	45	
Repetitive peak reverse voltage	V_{RRM}	max.	30	35	40	45	V
Crest working reverse voltage (note 1)	V_{RWM}	max.	30	35	40	45	V
Continuous voltage (note 1)	V_R	max.	30	35	40	45	V

→ **Currents** (both diodes conducting; note 2)

Output current: square wave; $\delta = 0.5$; up to T_{mb} = 112 °C (note 3)	I_O	max.	30	A
R.M.S. forward current	$I_{F(RMS)}$	max.	40	A
Repetitive peak forward current t_p = 20 μs; $\delta = 0.02$ (per diode)	I_{FRM}	max.	250	A
Non-repetitive peak forward current (per diode) half sine-wave; T_j = 125 °C prior to surge; with reapplied V_{RWM} max;				
t = 10 ms	I_{FSM}	max.	150	A
t = 8.3 ms	I_{FSM}	max.	165	A
I^2t for fusing (t = 10 ms, per diode)	I^2t	max.	112	A^2s
Reverse surge current (BYV73–40A only) t_p = 100 μs	I_{RSM}	max.	0.5	A

Temperatures

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

Notes:

1. Up to T_j = 125 °C; see derating curve for higher temperature operation.
2. The limits for both diodes apply whether both diodes conduct simultaneously or on alternate half cycles.
3. Assuming no reverse leakage current losses.

CHARACTERISTICS (per diode)

Forward voltage				
$I_F = 15$ A; $T_j = 125$ °C	V_F	<	0.6	V* ←
$I_F = 30$ A; $T_j = 25$ °C	V_F	<	0.87	V* ←
Reverse current				
$V_R = V_{RWM\,max}$; $T_j = 125$ °C	I_R	<	100	mA
Junction capacitance at f = 1 MHz				
$V_R = 5$ V; $T_j = 25$ to 125 °C	C_d	typ.	500	pF

THERMAL RESISTANCE

From junction to mounting base (both diodes conducting)	$R_{th\ j\text{-}mb}$	=	1.4	K/W
From junction to mounting base (per diode)	$R_{th\ j\text{-}mb}$	=	2.4	K/W

Influence of mounting method ←

1. Heatsink-mounted with clip (see mounting instructions)

Thermal resistance from mounting base to heatsink

a. with heatsink compound	$R_{th\ mb\text{-}h}$	=	0.2	K/W
b. with heatsink compound and 0.06 mm maximum mica insulator (56378)	$R_{th\ mb\text{-}h}$	=	1.4	K/W
c. with heatsink compound and 0.1 mm maximum mica insulator	$R_{th\ mb\text{-}h}$	=	2.2	K/W
d. with heatsink compound and 0.25 mm maximum alumina insulator	$R_{th\ mb\text{-}h}$	=	0.8	K/W
e. without heatsink compound	$R_{th\ mb\text{-}h}$	=	1.4	K/W

2. Free air operation

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

Thermal resistance from junction to ambient in free air; mounted on a printed circuit board at any device lead length and with copper laminate on the board	$R_{th\ j\text{-}a}$	=	60	K/W

---

*Measured under pulse conditions to avoid excessive dissipation.

MOUNTING INSTRUCTIONS

1. The device may be soldered directly into the circuit, but the maximum permissible temperature of the soldering iron or bath is 275 ^{o}C; the heat source must not be in contact with the joint for more than 5 seconds. Soldered joints must be at least 4.7 mm from the seal.
2. The leads should not be bent less than 2.4 mm from the seal, and should be supported during bending. The bend radius must be no less than 1.0 mm.
3. Mounting by means of a spring clip is the best mounting method because it offers:
   a. a good thermal contact under the crystal area and slightly lower $R_{th\ mb\text{-}h}$ values than does screw mounting.
   b. safe isolation for mains operation.
   However, if a screw is used, it should be M4 cross-recess pan head. Care should be taken to avoid damage to the plastic body.
4. For good thermal contact, heatsink compound should be used between mounting base and heatsink. Values of $R_{th\ mb\text{-}h}$ given for mounting with heatsink compound refer to the use of a metallic oxide-loaded compound. Ordinary silicone grease is not recommended.
5. Rivet mounting (only possible for non-insulated mounting).
   Devices may be rivetted to flat heatsinks; such a process **must neither** deform the mounting tab, **nor** enlarge the mounting hole.

OPERATING NOTES

Dissipation and heatsink calculations.

The various components of junction temperature rise above ambient are illustrated in Fig.2.

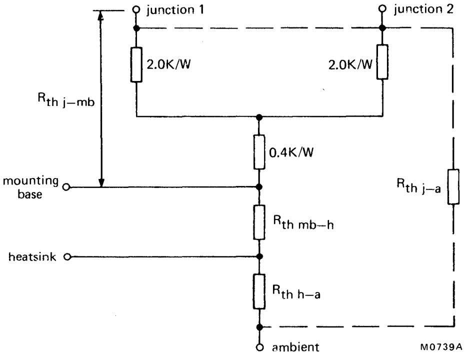


Fig.2.

OPERATING NOTES

Dissipation and heatsink calculations (continued)

Overall thermal resistance, $R_{th\ j\text{-}a} = R_{th\ j\text{-}mb} + R_{th\ mb\text{-}h} + R_{th\ h\text{-}a}$

To choose a suitable heatsink, the following information is required for each half of the dual diode:

(i) maximum operating ambient temperature
(ii) duty cycle of forward current (δ)
(iii) average forward current per diode
(iv) crest working reverse voltage (V_{RWM})

The total power dissipation in the diode has two components:

P_R — reverse leakage dissipation
P_F — forward conduction dissipation

$$P_{tot} = P_R + P_F \quad\text{........................ 1).}$$

From the above it can be seen that:

$$R_{th\ h\text{-}a} = \frac{T_{jmax} - T_{amb}}{P_F + P_R} - (R_{th\ j\text{-}mb} + R_{th\ mb\text{-}h}) \quad\text{........ 2).}$$

Values for $R_{th\ j\text{-}mb}$ and $R_{th\ mb\text{-}h}$ can be found under Thermal Resistance. P_R and P_F are derived from Figs.3 and 4 as follows:

Look at each half of the dual diode separately; for each diode, starting at the V_{RWM} axis of Fig.3, and from a knowledge of the required V_{RWM}, trace upwards to meet the curve that matches the required T_{jmax}. From this point trace horizontally left until the curve of the voltage grade of the device being used is met. From this point trace downwards to meet the required duty cycle (δ). From this point trace right and read the actual reverse power dissipation on the P_R axis.

From this calculation, $P_R = P_R$ (diode 1) + P_R (diode 2) .... 3).

Forward conduction dissipation (P_F) for the known average current $I_{F(AV)}$ and duty cycle for each diode is easily derived from Fig.4.

Similarly, $P_F = P_F$ (diode 1) + P_F (diode 2) .... 4).

Substituting equations 3) and 4) into equation 2) enables the calculation of the required heatsink.

NOTE:— If both halves of the diode are being used (as is assumed above), the value of $R_{th\ j\text{-}mb}$ = 1.4 K/W. If only one half of the diode is used, follow the above procedure for one diode only, and use the value of $R_{th\ j\text{-}mb}$ of 2.4 K/W.

To ensure thermal stability, $(R_{th\ j\text{-}mb} + R_{th\ mb\text{-}h} + R_{th\ h\text{-}a}) \times P_R$ must be less than 12 °C. If the calculated value of $R_{th\ h\text{-}a}$ does not permit this, then it must be reduced (heatsink size increased or $R_{th\ mb\text{-}h}$ improved) to enable this criterion to be met.

EXAMPLE: square-wave operation, using BYV73-35 and heatsink compound;
T_{amb} = 50 °C; δ (diode 1) = 0.5; δ (diode 2) = 0.5;
$I_{F(AV)}$ (diode 1) = 12 A; $I_{F(AV)}$ (diode 2) = 12 A;
V_{RWM} (both diodes) = 12 V; voltage grade of device = 35 V.
From data, $R_{th\ j\text{-}mb}$ = 1.4 K/W and $R_{th\ mb\text{-}h}$ = 0.2 K/W.
For each diode from Fig.4, it is found that P_F = 9.3 W;
hence total P_F = 2 x 9.3 = 18.6 W. (from equation 4)
If the desired $T_{j\ max}$ is chosen to be 130 °C, then, from Fig.3, P_R (per diode) = 0.44W
Therefore total P_R = 2 x 0.44 = 0.88 W. (from equation 3)
Using equation 2) we have:

$$R_{th\ h\text{-}a} = \frac{130\ ^{o}\text{C} - 50\ ^{o}\text{C}}{18.6\ \text{W} + 0.88\ \text{W}} - (1.4 + 0.2) = 2.5\ \text{K/W}$$

To check for thermal stability:

$$(R_{th\ j\text{-}a}) \times P_R = (1.4 + 0.2 + 2.5) \times 0.88 = 3.6\ ^{o}\text{C}.$$

This is less than 12 °C, hence thermal stability is ensured.

SQUARE-WAVE OPERATION (Figs.3 and 4)

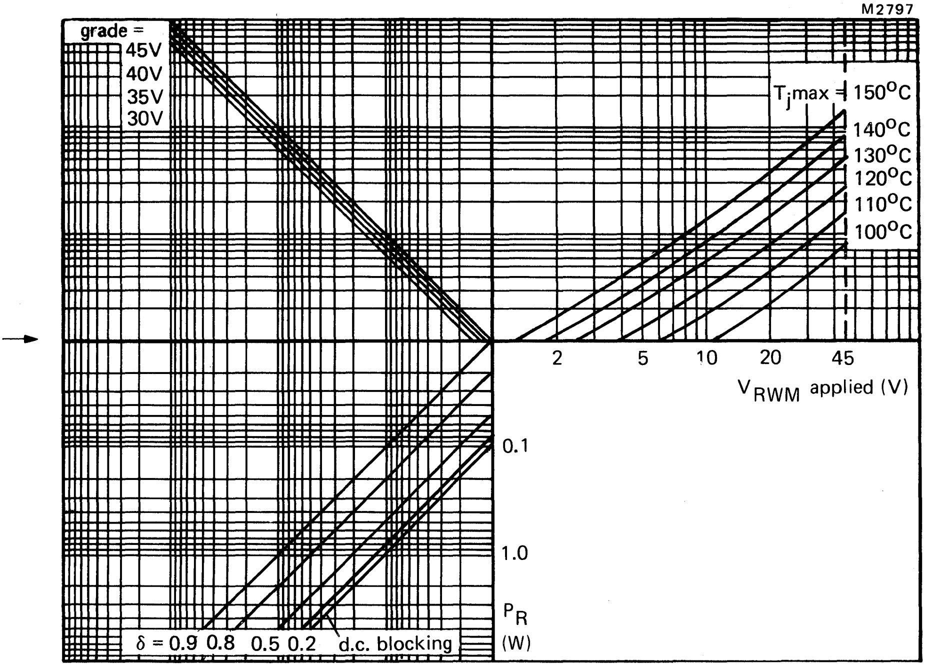


Fig.3 NOMOGRAM: for calculation of P_R (reverse leakage power dissipation) for a given $T_j$max., V_{RWM} applied, voltage grade and duty cycle (per diode).

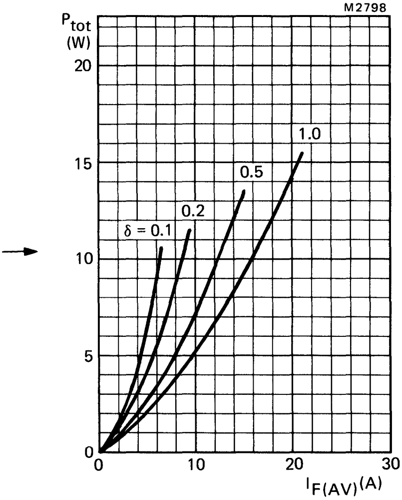
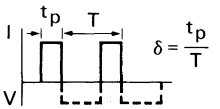


Fig.4



$I_{F(AV)} = I_{F(RMS)} \times \sqrt{\delta}$

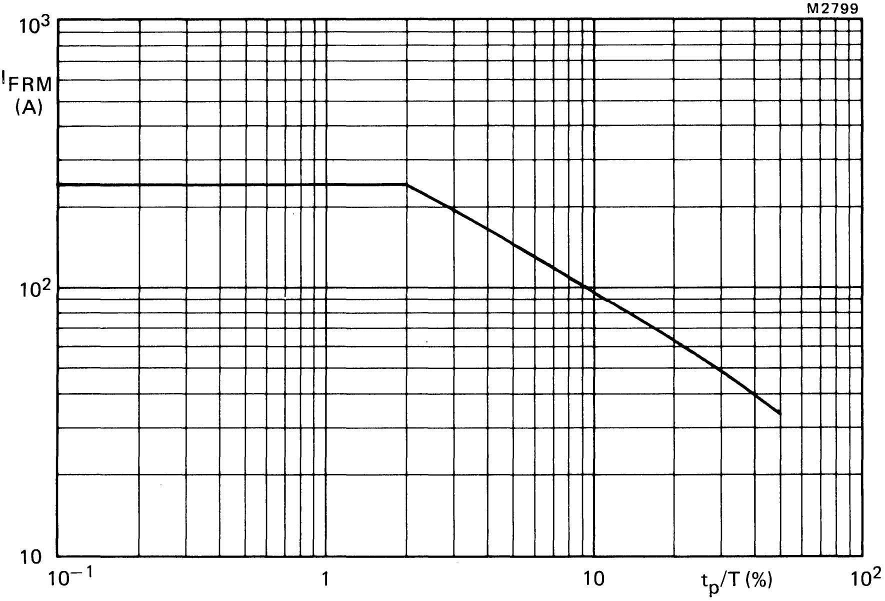
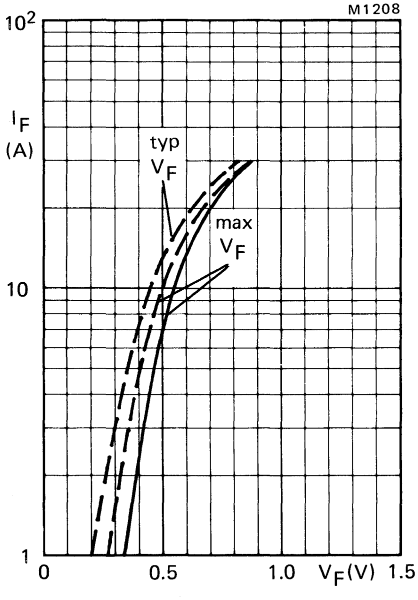
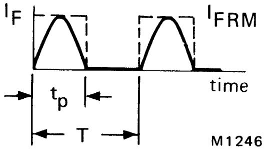


Fig.5 Maximum permissible repetitive peak forward current for either square or sinusoidal currents for 1 $\mu s < t_p < 1$ ms.





Definition of I_{FRM} and t_p/T.

Fig.6 —— T_j = 25 °C; – – – T_j = 125 °C; per diode.

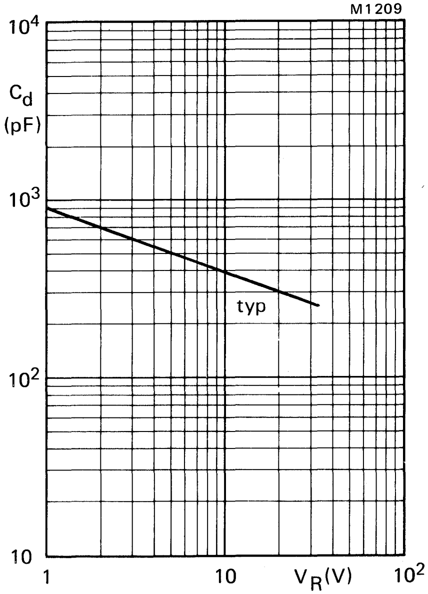


Fig.7 f = 1 MHz; T_j = 25 to 125 °C; per diode.

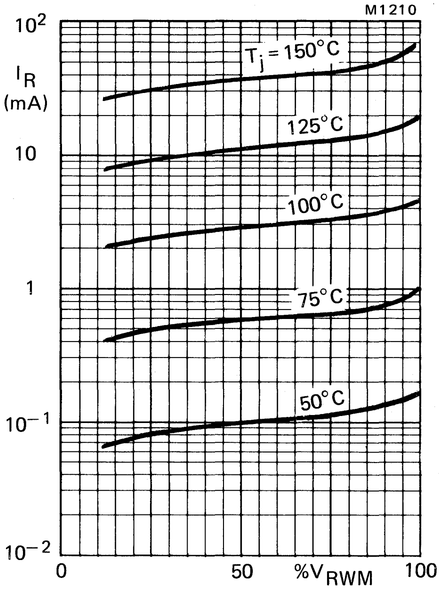


Fig.8 Typical values; per diode.

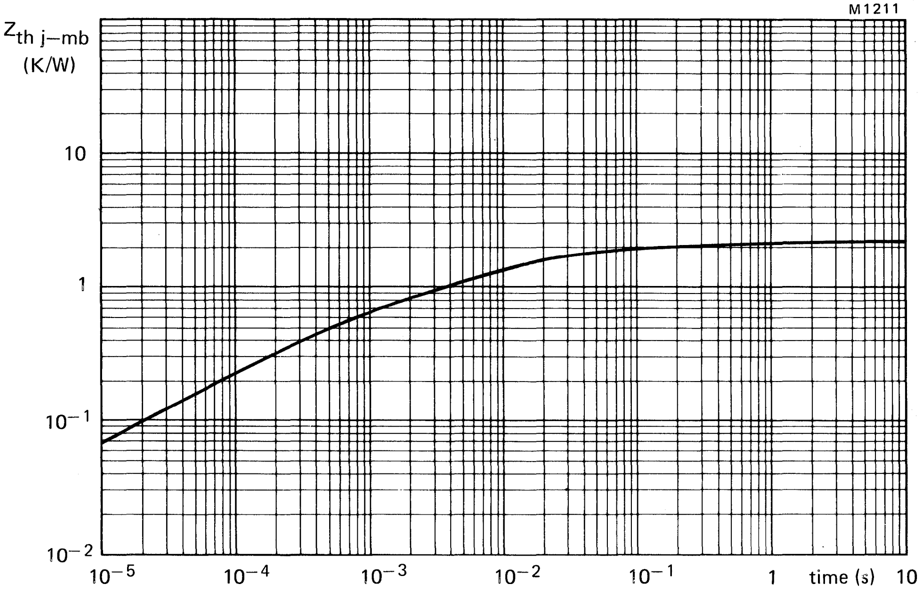


Fig.9 Transient thermal impedance; one diode conducting.

SCHOTTKY–BARRIER RECTIFIER DIODE

High-efficiency rectifier diode in a DO–5 metal envelope, featuring low forward voltage drop, low capacitance, absence of stored charge and high temperature stability. It is intended for use in low output voltage switched-mode power supplies and high-frequency circuits in general, where low conduction and switching losses are important, It can also withstand reverse voltage transients. The diode is of normal polarity (cathode to stud).

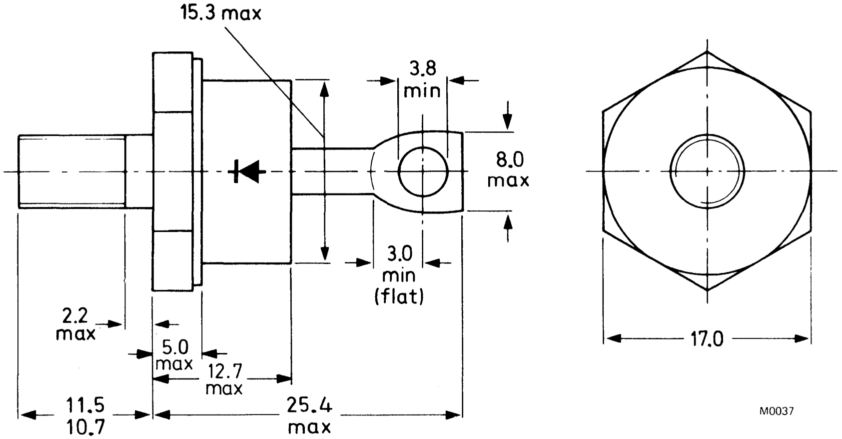
QUICK REFERENCE DATA

Repetitive peak reverse voltage	V_{RRM}	max.	45	V
Average forward current	$I_{F(AV)}$	max.	60	A
Forward voltage	V_F	<	0.6	V
Junction temperature	T_j	max.	150	°C

MECHANICAL DATA

Dimensions in mm

Fig.1 DO–5 with ¼" x 28 UNF stud (ϕ6.35 mm)



Net mass: 22 g

Diameter of clearance hole: 6.5 mm

Accessories supplied on request:
see ACCESSORIES section

Supplied with device: 1 nut, 1 lock washer.
Torque on nut:
min. 1.7 Nm (17 kg cm),
max.3.5 Nm (35 kg cm).
Nut dimensions across the flats:
¼" x 28 UNF, 11.1 mm

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

Voltages

Repetitive peak reverse voltage	V_{RRM}	max.	45	V
Crest working reverse voltage	V_{RWM}	max.	35	V
Continuous reverse voltage	V_R	max.	35	V

Currents

Average forward current; switching losses negligible square-wave; $\delta = 0.5$; up to $T_{mb} = 90\ ^{o}C$.	$I_{F(AV)}$	max.	60	A
R.M.S. forward current	$I_{F(RMS)}$	max.	85	A
Non-repetitive peak forward current $t = 10$ ms; half sine-wave; $T_j = 125\ ^{o}C$ prior to surge; with reapplied V_{RWMmax}	I_{FSM}	max.	700	A
I^2t for fusing ($t = 10$ ms)	I^2t	max.	2450	A^2s

Temperatures

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

THERMAL RESISTANCE

From junction to mounting base	$R_{th\ j\text{-}mb}$	=	1	$^{o}C/W$
From mounting base to heatsink with heatsink compound	$R_{th\ mb\text{-}h}$	=	0.3	$^{o}C/W$
without heatsink compound	$R_{th\ mb\text{-}h}$	=	0.5	$^{o}C/W$
Transient thermal impedance; $t = 1$ ms	$Z_{th\ j\text{-}mb}$	=	0.15	$^{o}C/W$

CHARACTERISTICS

Forward voltage				
$I_F = 60$ A; $T_j = 125\ ^{o}C$	V_F	$<$	0.6	V*
$I_F = 120$ A; $T_j = 125\ ^{o}C$	V_F	$<$	0.84	V*
Rate of rise of reverse voltage $V_R = V_{RWMmax}$	$\frac{dV_R}{dt}$	$<$	1500	V/μs
Reverse current $V_R = V_{RWMmax}$; $T_j = 125\ ^{o}C$	I_R	$<$	200	mA
Capacitance at f = 1 MHz $V_R = 5$ V; $T_j = 25$ to $125\ ^{o}C$	C_d	typ.	2100	pF

MOUNTING INSTRUCTIONS

The top connector should be neither 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.

*Measured under pulse conditions to avoid excessive dissipation.

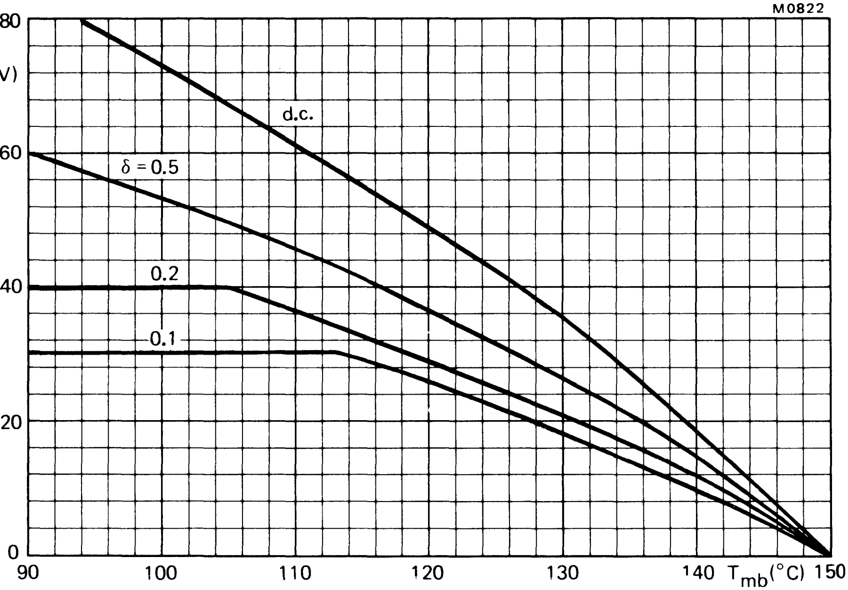
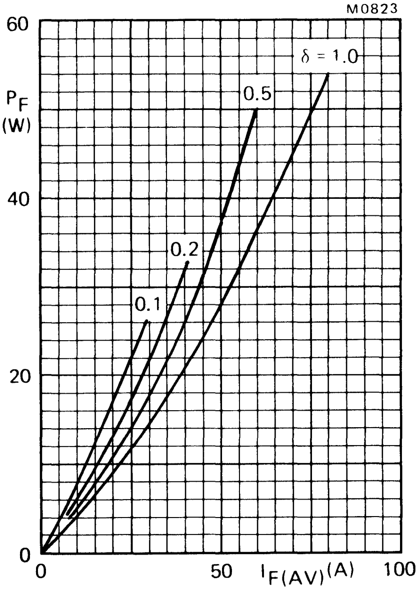
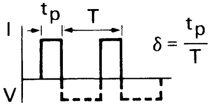


Fig.2 Maximum permissible average forward current versus mounting-base temperature at V_{RWM} = 35 V.





$I_{F(AV)} = I_{F(RMS)} \times \sqrt{\delta}$

Fig.3 Forward power dissipation versus average forward current.

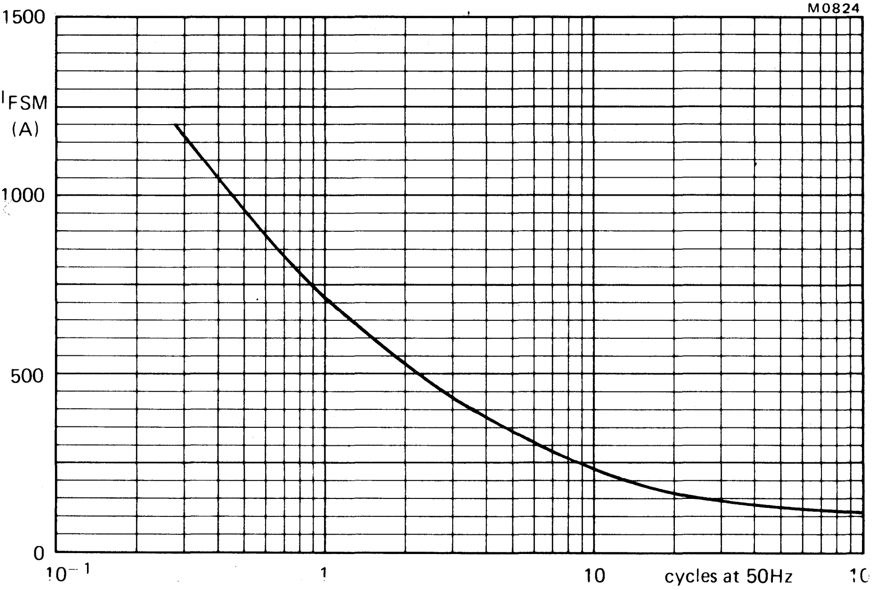


Fig.4 Maximum permissible non-repetitive peak forward current based on sinusoidal currents (f = 50 Hz); T_j = 125 °C prior to surge; with reapplied V_{RWMmax}.

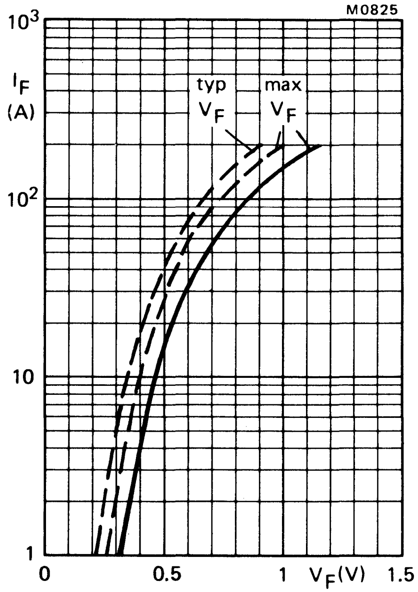


Fig.5 —— T_j = 25 °C; – – – T_j = 125 °C

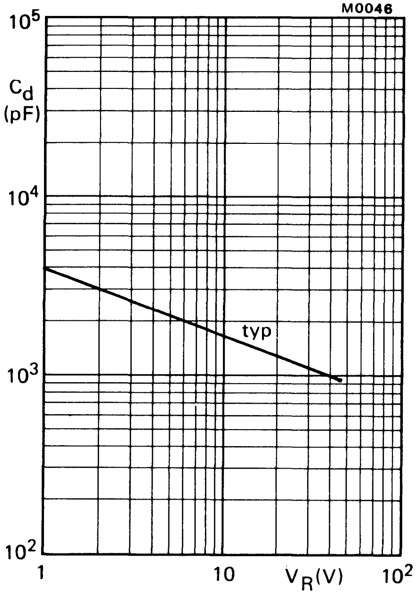


Fig.6 f = 1 MHz; T_j = 25 to 125 °C

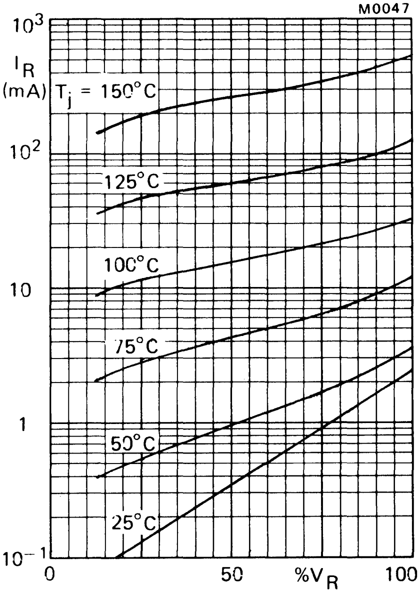


Fig.7 Typical values

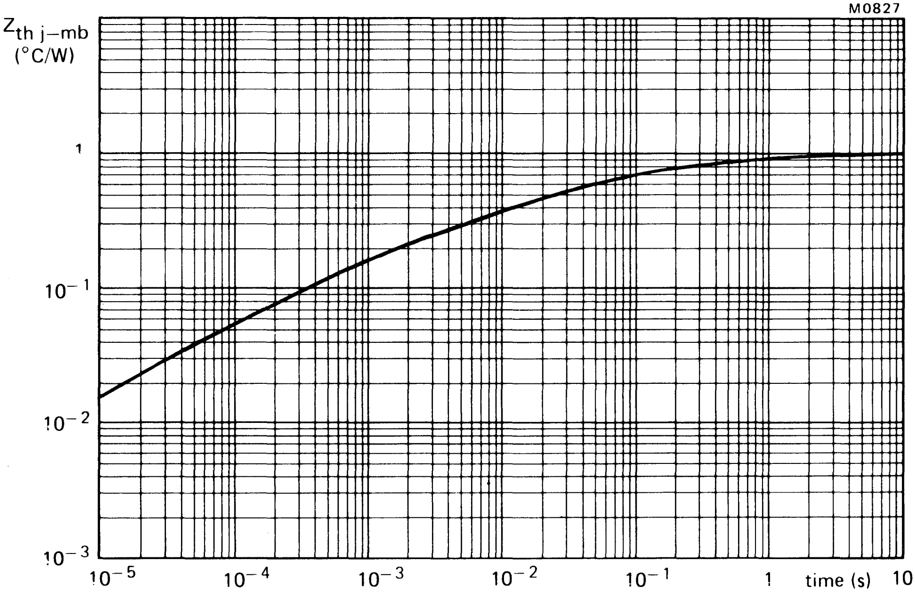


Fig.8

BREAKOVER DIODES

BREAKOVER DIODES

A range of glass-passivated bidirectional breakover diodes in the TO-220AC outline, available in a +/— 12% tolerance series of nominal breakover voltage. Their controlled breakover voltage and peak current handling capability together with the high holding current make them suitable for transient overvoltage protection in applications such as telephony equipment or other data transmission lines, and remote instrumentation lines.

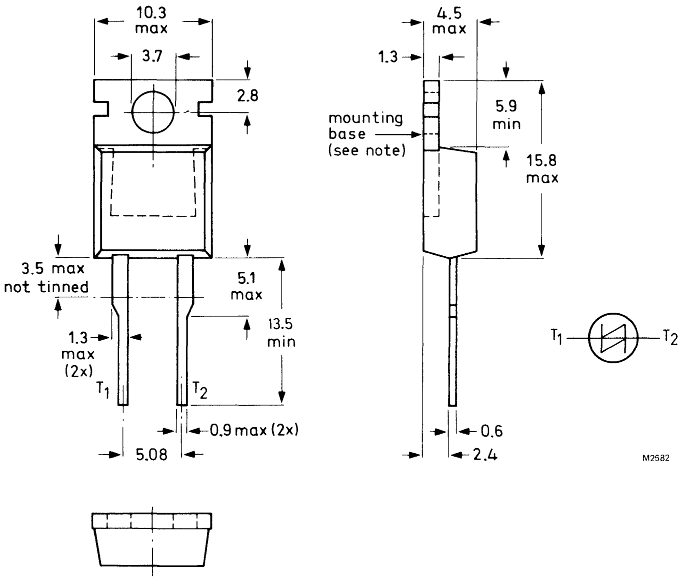
QUICK REFERENCE DATA

			BR210—100 to 280	
Breakover voltage	V_{BO}	nom.	100 to 280	V
Holding current	I_H	>	150	mA
Transient peak current (10/320 μs impulse)	I_{TRM}	max.	40	A

MECHANICAL DATA

Dimensions in mm

Fig.1 TO-220AC



Net mass: 2 g

Note: The exposed metal mounting base is directly connected to terminal T_1.
Accessories supplied on request: see data sheet Mounting instructions and accessories for TO-220 envelopes.

RATINGS

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

Currents
(in either direction)

Transient peak current (8/20 μs impulse)	I_{TRM1}	max.	150	A
Transient peak current (10/320 μs impulse) equivalent to 10/700 μs 1.6 kV voltage impulse (CCITT K17); (see Fig.3)	I_{TRM2}	max.	40	A
Average on-state current (averaged over any 20 ms period); up to T_{mb} = 75 °C	$I_{T(AV)}$	max.	5	A
R.M.S. a.c. on-state current	$I_{T(RMS)}$	max.	8	A
Non-repetitive peak on-state current; T_j = 100 °C prior to surge; t = 10 ms; half sine-wave	I_{TSM}	max.	40	A
I^2t for fusing (t = 10 ms)	I^2t	max.	8	A^2s
Rate of rise of on-state current after V_{BO} turn-on (t_p = 10 μs)	dI/dt	max.	50	A/μs

Temperatures

Storage temperature	T_{stg}		−40 to +150	°C
Operating temperature (off-state)	T_j	max.	125	°C
Overload temperature (on-state)	T_{vj}	max.	150	°C

THERMAL RESISTANCE

From junction to ambient in free air mounted on a printed circuit board at any lead length	$R_{th\ j\text{-}amb}$	=	60	K/W
From junction to mounting base				
One line conducting				
bidirectional operation	$R_{th\ j\text{-}mb}$	=	2.0	K/W
unidirectional operation	$R_{th\ j\text{-}mb}$	=	2.4	K/W
Both lines conducting				
bidirectional operation	$R_{th\ j\text{-}mb}$	=	1.5	K/W
Transient thermal impedance (t = 1 ms)	$Z_{th\ j\text{-}mb}$	=	0.3	K/W

CHARACTERISTICS

T_j = 25 °C unless otherwise stated; each line to centre lead.

Voltages and currents (in either direction)

On-state voltage (note 1)				
I_{TM} = 10 A	V_{TM}	<	2.5	V
Avalanche voltage V_{BR}; (I_{BR} = 10 mA), and Breakover voltage V_{BO}; ($I = I_S$): (100 µs pulsed)		V_{BR} min.	V_{BO} max.	
	BR210−100	88	112	V
	−120	105	135	V
	−140	123	157	V
	−160	140	180	V
	−180	158	202	V
	−200	176	224	V
	−220	193	247	V
	−240	211	269	V
	−260	228	292	V
	−280	246	314	V
Temperature coefficient of V_{BR}	S_{br}	typ.	+0.1	%/K
Holding current (note 2)				
T_j = 25 °C	I_H	>	150	mA
T_j = 70 °C	I_H	>	100	mA
Switching current (note 3)	I_S	>	10	mA
(100 µs pulsed)	I_S	typ.	200	mA
	I_S	<	500	mA
Off-state current; V_D = 85% V_{BRmin} (note 4)				
T_j = 70 °C	I_D	<	50	µA
T_j = 125 °C	I_D	<	250	µA
Linear rate of rise of off-state voltage that will not trigger any device; T_j = 70 °C; V_{DM} = 85%V_{BRmin}	dV_D/dt	<	2000	V/µs
Off-state capacitance				
V_D = 0 ; f = 1 kHz to 1 MHz	C_j	<	350	pF

Notes:

1. Measured under pulsed conditions to avoid excessive dissipation.
2. Defined as the minimum current which the device can conduct before switching back to the off-state.
3. Defined as the maximum instantaneous current that the device can sustain in the avalanche breakdown state before it switches to a low voltage.
4. I.e., at maximum recommended d.c. stand-off voltage.

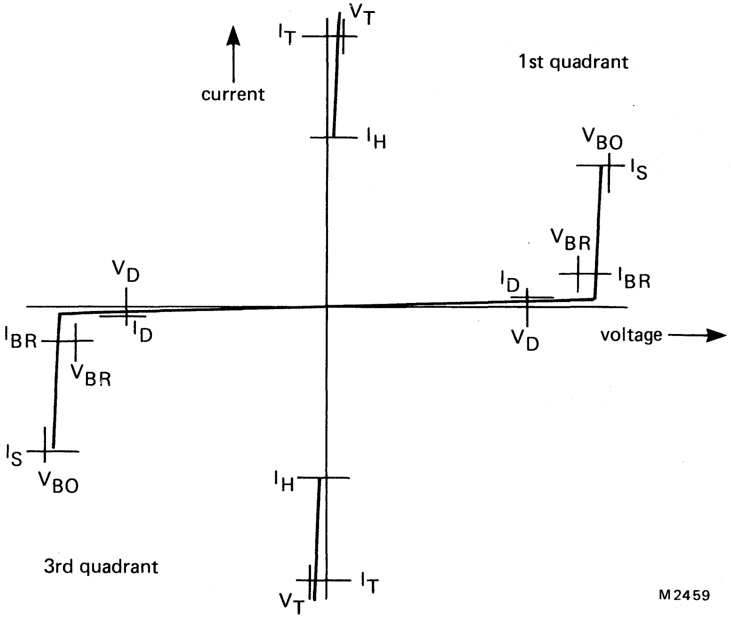


Fig.2 Breakover diode characteristics.

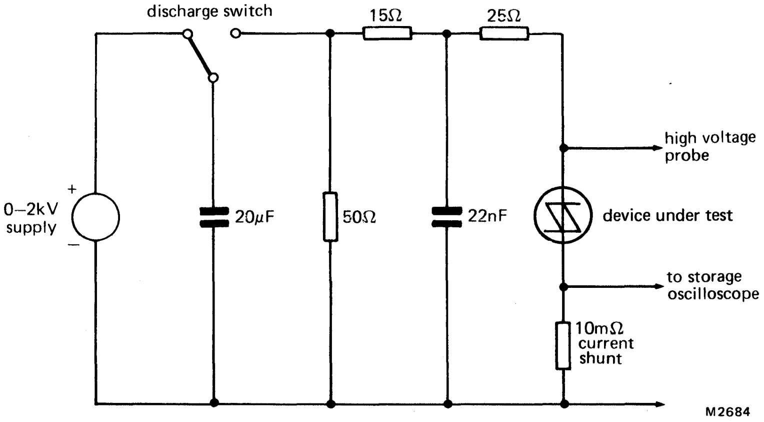


Fig.3 Test circuit for high voltage impulse (I_{TRM2})
(according to CCITT vol IX-Rec. K17)

Notes:
The 10/700 μs Impulse Waveform is defined for the voltage across the test fixture when the device under test is replaced with an open circuit. Clearly, once a breakover device has switched on to a low voltage, the current waveform will have a shorter fall-time, since the 15Ω + 25Ω ouput impedance becomes effectively in parallel with the 50 Ω.

MOUNTING INSTRUCTIONS

1. The device may be soldered directly into the circuit, but the maximum permissible temperature of the soldering iron or bath is 275 °C; it must not be in contact with the joint for more than 5 seconds. Soldered joints must be at least 4.7 mm from the seal.
2. The leads should not be bent less than 2.4 mm from the seal, and should be supported during bending. The leads can be bent, twisted or straightened by 90° maximum. The minimum bending radius is 1 mm.
3. It is recommended that the circuit connection be made to T_1, rather than direct to the heatsink.
4. Mounting by means of a spring clip is the best mounting method because it offers:
   a. a good thermal contact under the crystal area and slightly lower $R_{th\ mb\text{-}h}$ values than the screw mounting.
   b. safe isolation for mains operation.

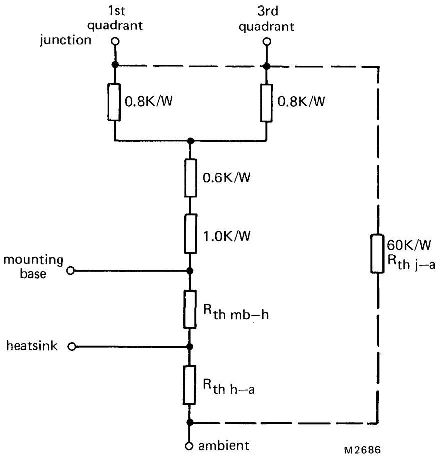
   However, if a screw is used, it should be M3 cross-recess pan head. Care should be taken to avoid damage to the plastic body.
5. For good thermal contact heatsink compound should be used between base-plate and heatsink. Values of $R_{th\ mb\text{-}h}$ given for mounting with heatsink compound refer to the use of a metallic oxide-loaded compound. Ordinary silicone grease is not recommended.
6. Rivet mounting (only possible for non-insulated mounting).

   Devices may be rivetted to flat heatsinks; such a process **must neither** deform the mounting tab, **nor** enlarge the mounting hole.
7. The heatsink must have a flatness in the mounting area of 0.02 mm maximum per 10 mm. Mounting holes must be deburred.

OPERATING NOTES

Dissipation and heatsink considerations:

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



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

OPERATING NOTES (cont.)

c. The method of using Fig.5 is:

Start with the expected r.m.s. current, trace upwards to meet the dissipation curve. Trace horizontally to the right, and upwards from the appropriate value on the T_{amb} scale. The intersection determines the required $R_{th\ mb\text{-}a}$. The heatsink thermal resistance value ($R_{th\ h\text{-}a}$) can now be calculated from:

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

d. As noted, Fig.5 applies for mains contact operation for use with low resistance loads (i.e. $R_L < 200\ \Omega$), and does not include any dissipation due to avalanche conduction prior to breakover. If mains contact conditions are expected with higher resistance loads (R_L typ. 1 kΩ), then avalanche dissipation will be significant and must be taken into account. In certain circumstances, such avalanche dissipation could be excessive. The calculations of avalanche dissipation will depend on the particular application, but the temperature dependence of switching current, and breakdown voltage should be also taken into account.

e. For many applications in which the device is intended for transient overvoltage protection only, the device will not normally be mounted on a heatsink, since the free air rating will be adequate to cope with non-repetitive transients.

Influence of mounting method

1. Heatsink-mounted with clip (see mounting instructions)

Thermal resistance from mounting base to heatsink

a. with heatsink compound	$R_{th\ mb\text{-}h}$	=	0.3	K/W
b. with heatsink compound and 0.06 mm maximum mica insulator	$R_{th\ mb\text{-}h}$	=	1.4	K/W
c. with heatsink compound and 0.1 mm max. mica insulator (56369)	$R_{th\ mb\text{-}h}$	=	2.2	K/W
d. with heatsink compound and 0.25 mm max. alumina insulator (56367)	$R_{th\ mb\text{-}h}$	=	0.8	K/W
e. without heatsink compound	$R_{th\ mb\text{-}h}$	=	1.4	K/W

FULLWAVE CONDUCTION (MAINS CONTACT)

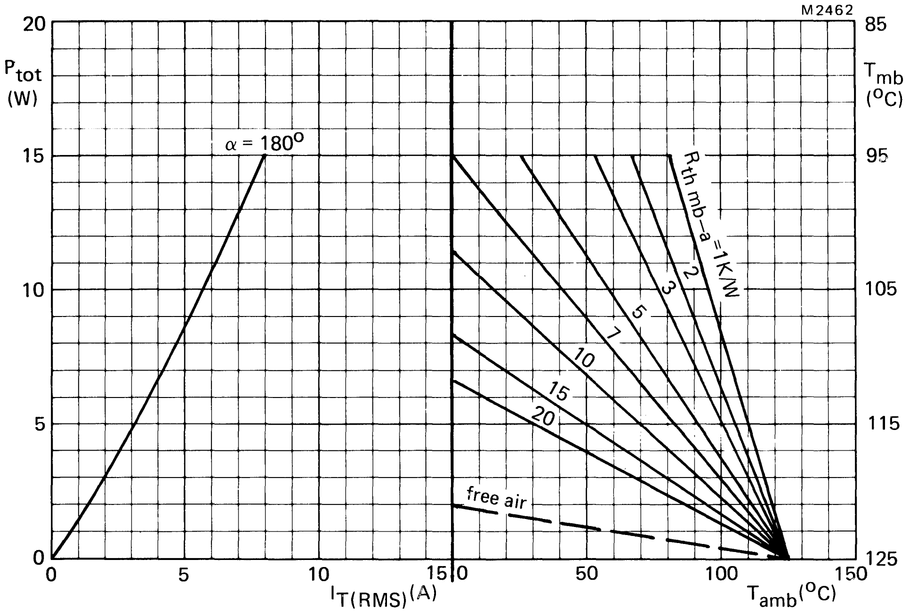
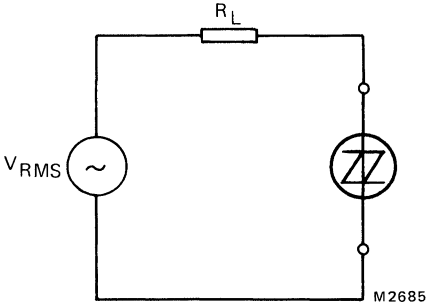


Fig.5 The right-hand part shows the interrelationship between the power (derived from the left-hand part) and the maximum permissible temperatures.

α = conduction angle.

This figure applies for a low resistance load. It does not include any avalanche dissipation.



OVERLOAD OPERATION

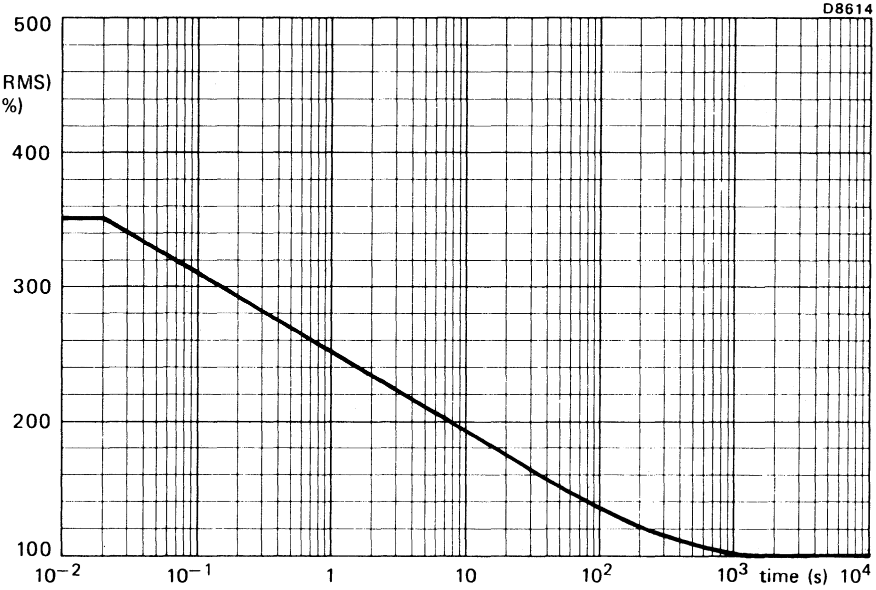


Fig.6 Maximum permissible duration of steady overload (provided that T_{mb} does not exceed 120 °C during and after overload) expressed as a percentage of the steady state r.m.s. rated current. For high r.m.s. overload currents precautions should be taken so that the temperature of the terminals does not exceed 125 °C. During these overload conditions the BOD may lose control. Therefore the overload should be terminated by a separate protection device.

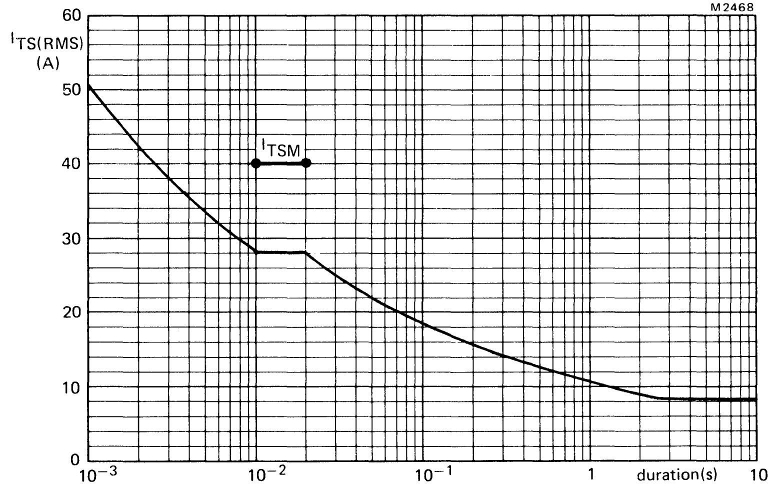
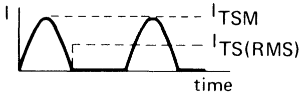


Fig.7 Maximum permissible non-repetitive r.m.s. on-state current based on sinusoidal currents (f = 50 Hz), T_j = 125 °C prior to surge.



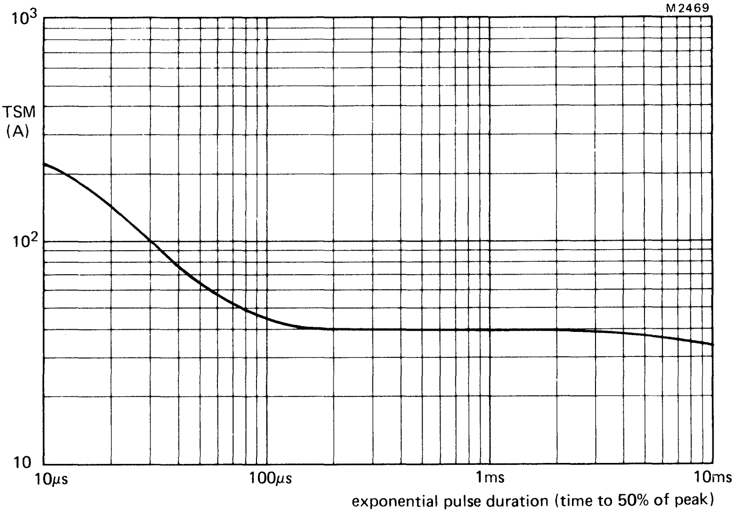


Fig.8 Maximum non-repetitive exponential waveform Impulse Current rating as a function of pulse duration.

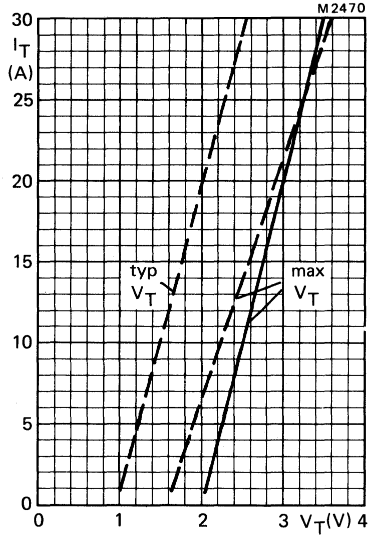


Fig.9 On-state voltage as a function of on-state current. (200 μs pulsed condition to avoid excessive dissipation) —— T_j = 25, – – – T_j = 125 °C.

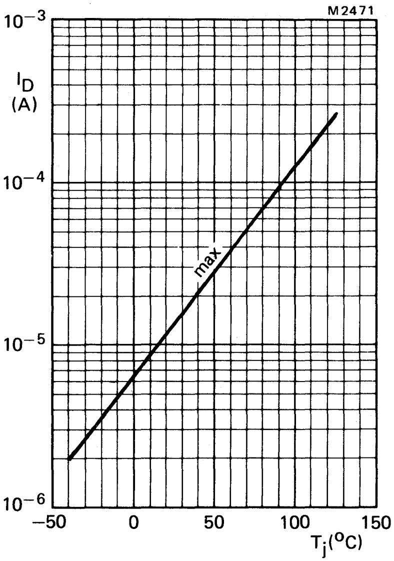


Fig.10 Maximum off-state current as a function of temperature.

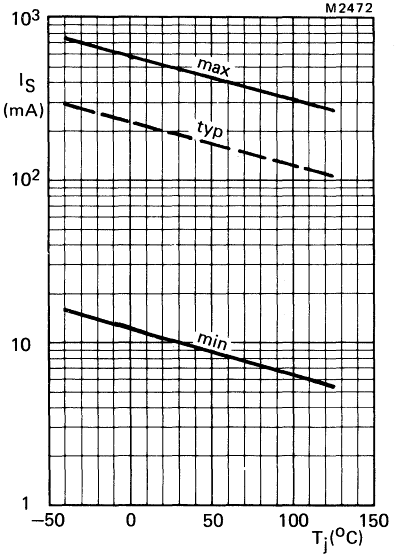


Fig.11 Switching current as a function of temperature; —— T_j = 25 °C; – – – T_j = 125 °C.

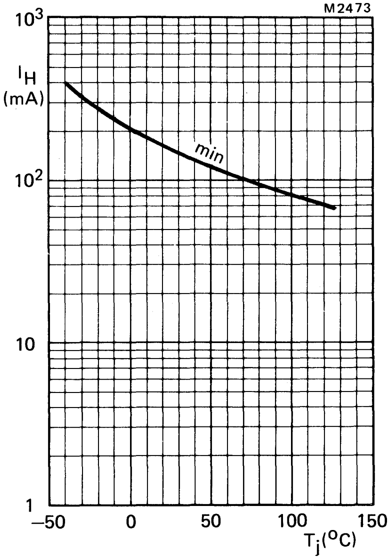


Fig.12 Minimum holding current as a function of temperature.

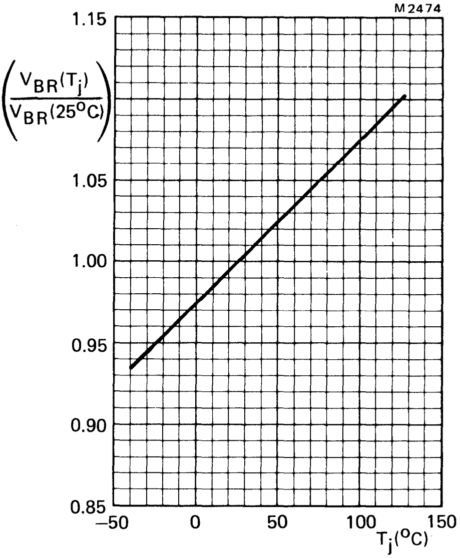


Fig.13 Normalised avalanche breakdown voltage as a function of temperature. Note: this figure may also be used to derive normalised V_{BO}.

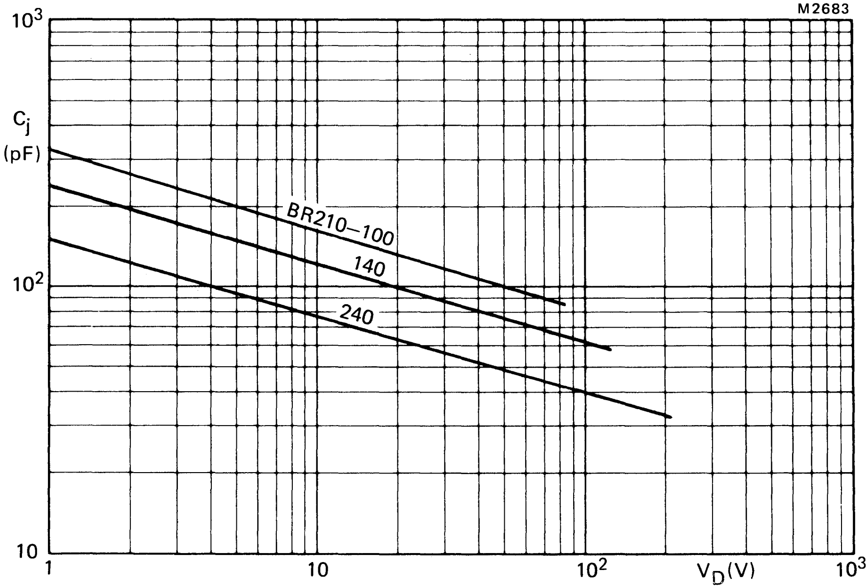


Fig.14 Typical junction capacitance as a function of off-state voltage; T_j = 25 °C; f = 1 MHz.

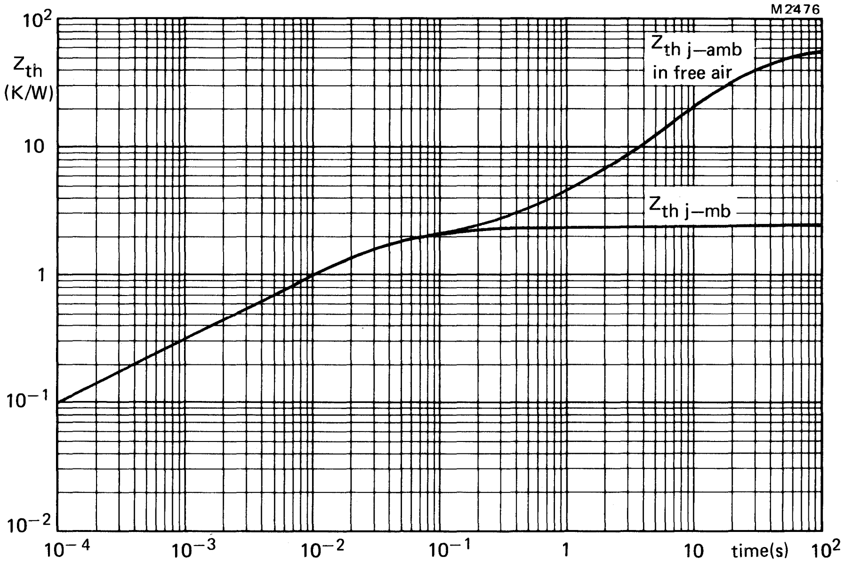


Fig.15 Transient thermal impedance as a function of time (rectangular pulse duration).

DUAL ASYMMETRICAL BREAKOVER DIODE

The BR216 is a monolithic dual asymmetrical 65 V breakover diode in the TO-220AB outline.
Each half of the device conducts normally in one direction, but in the other direction it acts as a breakover diode.
The controlled breakover voltage and peak current handling capability together with high holding current make it suitable for two-line to earth transient overvoltage protection in applications such as telephony equipment and remote instrumentation lines.

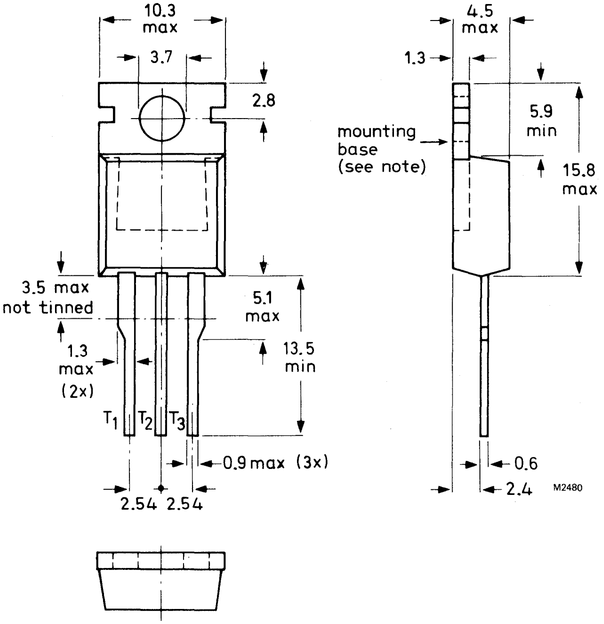
QUICK REFERENCE DATA

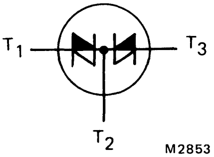
Breakover voltage per line	$V_{(BO)}$	<	78	V
Breakdown voltage per line	$V_{(BR)}$	>	58	V
Holding current	I_H	>	150	mA
Transient peak current (10/320 μs impulse)	I_{TRM}	max.	40	A

MECHANICAL DATA

Dimensions in mm

Fig.1 TO-220AB; centre lead connected to tab.





Net mass: 2 g
Note: The exposed metal mounting base is directly connected to terminal T_2.
Accessories supplied on request: see data sheet Mounting instructions and accessories for TO-220 envelopes.

RATINGS

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

Currents

Transient peak current (8/20 μs impulse)	I_{TRM1}/I_{FRM1}	max.	150	A
Transient peak current (10/320 μs impulse) equivalent to 10/700 μs 1.6 kV voltage impulse (CCITT K17)	I_{TRM2}/I_{FRM2}	max.	40	A
Average on-state current	$I_{T(AV)}$	max.	5	A
Average forward current (averaged over any 20 ms period); up to T_{mb} = 75 °C	$I_{F(AV)}$	max.	5	A
R.M.S. a.c. on-state current	$I_{T(RMS)}$	max.	8	A
Non-repetitive peak current; T_j = 100 °C prior to surge; t = 10 ms; half sine-wave	I_{TSM}/I_{FSM}	max.	40	A
I^2t for fusing (t = 10 ms)	I^2t	max.	8	A^2s
Rate of rise of on-state current after $V_{(BO)}$ turn-on (t_p = 10 μs)	dI_T/dt	max.	50	A/μs

Temperatures

Storage temperature	T_{stg}		−40 to +150	°C
Operating temperature (off-state)	T_j	max.	125	°C
Overload temperature (on-state)	T_{vj}	max.	150	°C

THERMAL RESISTANCE

From junction to ambient in free air mounted on a printed circuit board at any lead length	$R_{th\ j\text{-}amb}$	=	60	K/W
From junction to mounting base				
One line conducting				
bidirectional operation	$R_{th\ j\text{-}mb}$	=	4.0	K/W
unidirectional operation	$R_{th\ j\text{-}mb}$	=	5.0	K/W
Both lines conducting				
bidirectional operation	$R_{th\ j\text{-}mb}$	=	3.0	K/W
Transient thermal impedance (t = 1 ms)	$Z_{th\ j\text{-}mb}$	=	1.0	K/W

CHARACTERISTICS

T_j = 25 °C unless otherwise stated; each line to centre lead.

On-state voltage (note 1)				
I_{TM} = 5 A	V_{TM}	$<$	3.0	V
Forward voltage (note 1)				
I_{FM} = 5 A	V_{FM}	$<$	3.0	V
Avalanche voltage				
$I_{(BR)}$ = 10 mA	$V_{(BR)}$	$>$	58	V
Breakover voltage				
100 µs pulsed; $I = I_S$	$V_{(BO)}$	$<$	78	V
Temperature coefficient of $V_{(BR)}$	$S_{(br)}$	typ.	+0.1	%/K
Holding current (note 2)				
T_j = 25 °C	I_H	$>$	150	mA
T_j = 70 °C	I_H	$>$	100	mA
Switching current (note 3)	I_S	$>$	10	mA
	I_S	typ.	400	mA
	I_S	$<$	830	mA
Off-state current; V_D = 50 V (note 4)				
T_j = 70 °C	I_D	$<$	0.5	mA
T_j = 125 °C	I_D	$<$	5.0	mA
Linear rate of rise of off-state voltage that will not trigger any device;				
T_j = 70 °C; V_{DM} = 50 V	dV_D/dt	$<$	2000	V/µs
Off-state capacitance				
V_D = 0; f = 1 kHz to 1 MHz	C_j	$<$	500	pF

Notes:

1. Measured under pulsed conditions to avoid excessive dissipation.
2. Defined as the minimum current which the device can conduct before switching back to the off-state.
3. Defined as the maximum instantaneous current that the device can sustain in the avalanche breakdown state before it switches to a low voltage.
4. I.e., at maximum recommended d.c. stand-off voltage.

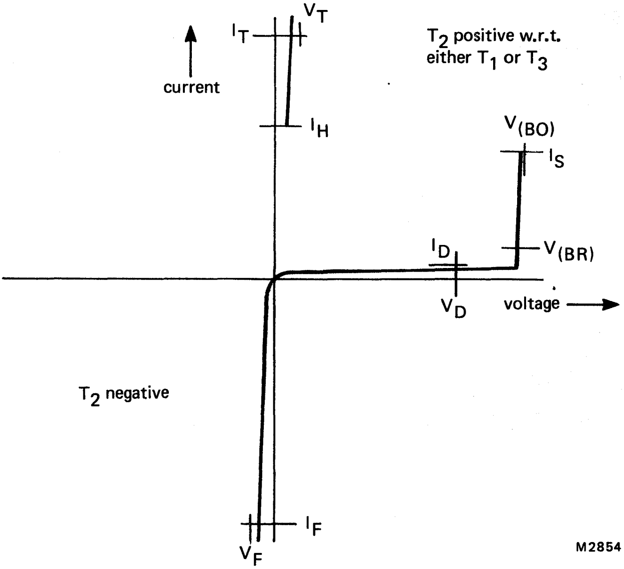


Fig.2 Breakover diode characteristics.

DUAL BREAKOVER DIODES

The BR220 is a range of monolithic diffusion-isolated glass-passivated dual bidirectional breakover diodes in the TO-220AB outline, available in a +/– 12% tolerance series of nominal breakover voltage. Their controlled breakover voltage and peak current handling capability together with high holding current make them suitable for transient two-line to earth overvoltage protection in applications such as telephony equipment or other data transmission lines, and remote instrumentation lines.

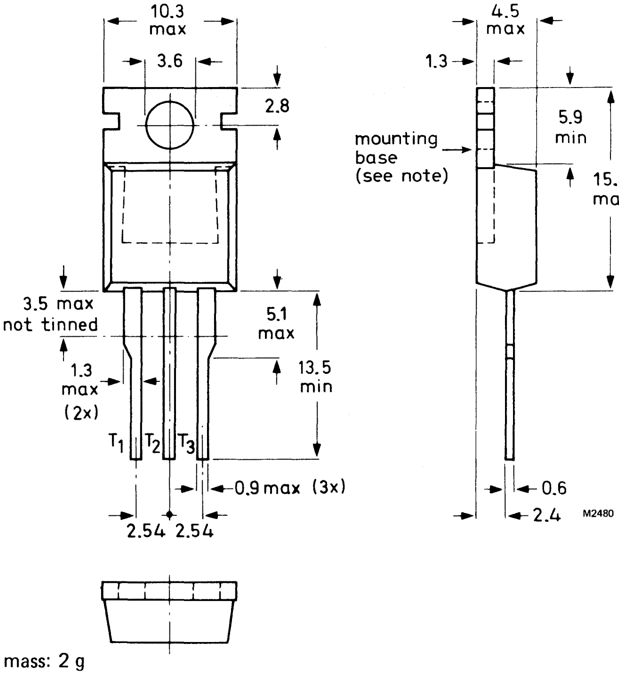
QUICK REFERENCE DATA

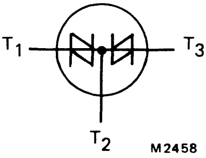
			BR220– 100 to 280	
Breakover voltage per line	V_{BO}	nom.	100 to 280	V
Holding current	I_H	>	150	mA
Transient peak current (10/320 μs impulse)	I_{TRM}	max.	40	A

MECHANICAL DATA

Dimensions in mm

Fig.1 TO-220AB; centre lead connected to tab.





Net mass: 2 g

Note: The exposed metal mounting base is directly connected to terminal T_2.

Accessories supplied on request: see data sheet Mounting instructions and accessories for TO-220 envelopes.

RATINGS

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

Currents

(Individually for each line in either direction)

Transient peak current (8/20 μs impulse)	I_{TRM1}	max.	150	A
Transient peak current (10/320 μs impulse) equivalent to 10/700 μs 1.6 kV voltage impulse (CCITT K17); (see Fig.3)	I_{TRM2}	max.	40	A
Average on-state current (averaged over any 20 ms period); up to T_{mb} = 75 °C	$I_{T(AV)}$	max.	5	A
R.M.S. a.c. on-state current	$I_{T(RMS)}$	max.	8	A
Non-repetitive peak on-state current; T_j = 100 °C prior to surge; t = 10 ms; half sine-wave	I_{TSM}	max.	40	A
I^2t for fusing (t = 10 ms)	I^2t	max.	8	A^2s
Rate of rise of on-state current after V_{BO} turn-on (t_p = 10 μs)	dI/dt	max.	50	A/μs

Temperatures

Storage temperature	T_{stg}		−40 to +150	°C
Operating temperature (off-state)	T_j	max.	125	°C
Overload temperature (on-state)	T_{vj}	max.	150	°C

THERMAL RESISTANCE

From junction to ambient in free air mounted on a printed circuit board at any lead length	$R_{th\ j\text{-}amb}$	=	60	K/W
From junction to mounting base				
One line conducting				
bidirectional operation	$R_{th\ j\text{-}mb}$	=	2.0	K/W
unidirectional operation	$R_{th\ j\text{-}mb}$	=	2.4	K/W
Both lines conducting				
bidirectional operation	$R_{th\ j\text{-}mb}$	=	1.5	K/W
Transient thermal impedance (t = 1 ms)	$Z_{th\ j\text{-}mb}$	=	0.3	K/W

CHARACTERISTICS

T_j = 25 °C unless otherwise stated; each line to centre lead.

Voltages and currents (in either direction)				
On-state voltage (note 1)				
I_{TM} = 10 A	V_{TM}	<	2.5	V
Avalanche voltage V_{BR}; (I_{BR} = 10 mA), and Breakover voltage V_{BO}; ($I = I_S$): (100 μs pulsed)		V_{BR} min.	V_{BO} max.	
	BR220 −100	88	112	V
	−120	105	135	V
	−140	123	157	V
	−160	140	180	V
	−180	158	202	V
	−200	176	224	V
	−220	193	247	V
	−240	211	269	V
	−260	228	292	V
	−280	246	314	V
Temperature coefficient of V_{BR}	S_{br}	typ.	+0.1	%/K
Holding current (note 2)				
T_j = 25 °C	I_H	>	150	mA
T_j = 70 °C	I_H	>	100	mA
Switching current (note 3)	I_S	>	10	mA
(100 μs pulsed)	I_S	typ.	200	mA
	I_S	<	500	mA
Off-state current; V_D = 85% V_{BRmin} (note 4)				
T_j = 70 °C	I_D	<	50	μA
T_j = 125 °C	I_D	<	250	μA
Linear rate of rise of off-state voltage that will not trigger any device; T_j = 70 °C; V_{DM} = 85%V_{BRmin}	dV_D/dt	<	2000	V/μs
Off-state capacitance				
V_D = 0 ; f = 1 kHz to 1 MHz	C_j	<	350	pF

Notes:

1. Measured under pulsed conditions to avoid excessive dissipation.
2. Defined as the minimum current which the device can conduct before switching back to the off-state.
3. Defined as the maximum instantaneous current that the device can sustain in the avalanche breakdown state before it switches to a low voltage.
4. I.e., at maximum recommended d.c. stand-off voltage.

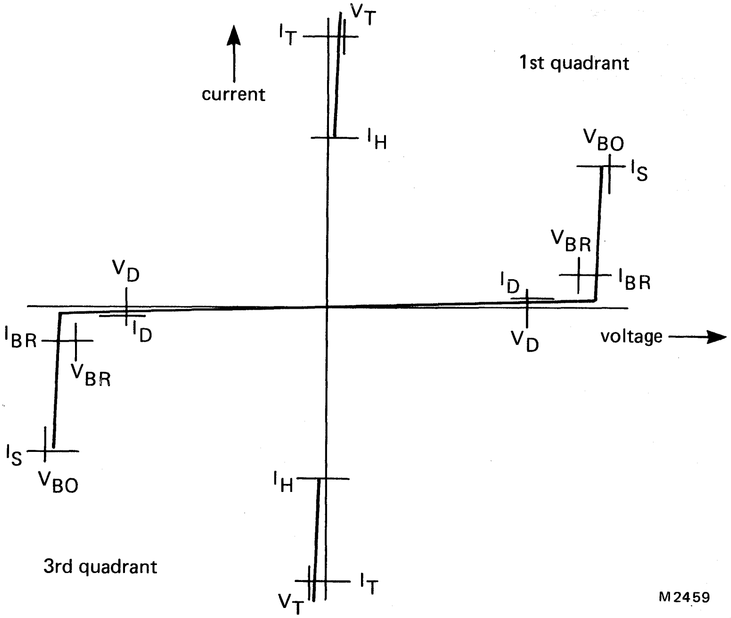


Fig.2 Breakover diode characteristics.

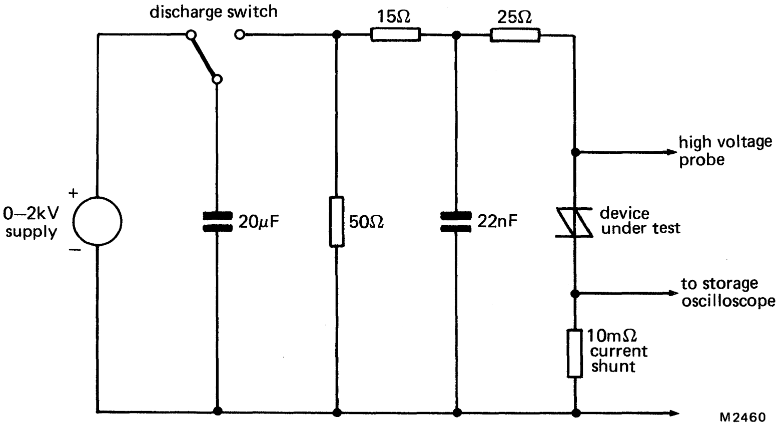


Fig.3 Test circuit for high voltage impulse (I_{TRM2})
(according to CCITT vol IX-Rec. K17)

Notes:
The 10/700 μs Impulse Waveform is defined for the voltage across the test fixture when the device under test is replaced with an open circuit. Clearly, once a breakover device has switched on to a low voltage, the current waveform will have a shorter fall-time, since the 15Ω + 25Ω ouput impedance becomes effectively in parallel with the 50 Ω.

MOUNTING INSTRUCTIONS

1. The device may be soldered directly into the circuit, but the maximum permissible temperature of the soldering iron or bath is 275 °C; it must not be in contact with the joint for more than 5 seconds. Soldered joints must be at least 4.7 mm from the seal.
2. The leads should not be bent less than 2.4 mm from the seal, and should be supported during bending.
3. It is recommended that the circuit connection be made to the centre tag, rather than direct to the heatsink.
4. Mounting by means of a spring clip is the best mounting method because if offers:
   a. a good thermal contact under the crystal area and slightly lower $R_{th\ mb\text{-}h}$ values than the screw mounting.
   b. safe isolation for mains operation.

   However, if a screw is used, it should be M3 cross-recess pan head. Care should be taken to avoid damage to the plastic body.
5. For good thermal contact heatsink compound should be used between base-plate and heatsink. Values of $R_{th\ mb\text{-}h}$ given for mounting with heatsink compound refer to the use of a metallic-oxide loaded compound. Ordinary silicone grease is not recommended.
6. Rivet mounting (only possible for non-insulated mounting).

   Devices may be rivetted to flat heatsinks; such a process **must neither** deform the mounting tab, **nor** enlarge the mounting hole.

OPERATING NOTES

Dissipation and heatsink considerations:

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

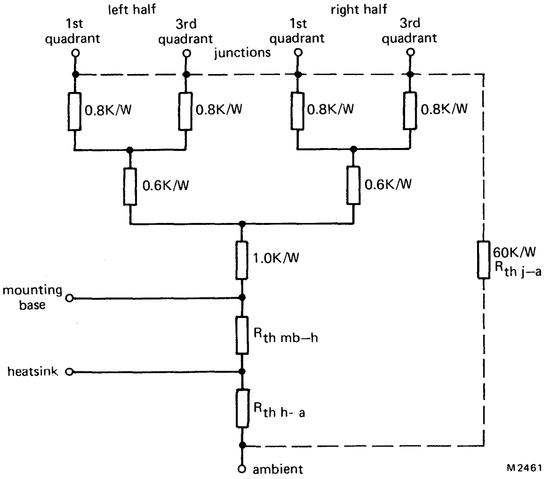


Fig.4.

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

OPERATING NOTES (cont.)

c. The method of using the following figures is:

Start with the expected r.m.s. current, trace upwards to meet the dissipation curve. Trace horizontally to the right, and upwards from the appropriate value on the T_{amb} scale. The intersection determines the required $R_{th\ mb\text{-}a}$. The heatsink thermal resistance value ($R_{th\ h\text{-}a}$) can now be calculated from:

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

d. As noted, the figures apply for mains contact operation for use with low resistance loads (i.e. $R_L < 200\ \Omega$), and do not include any dissipation due to avalanche conduction prior to breakover. If mains contact conditions are expected with higher resistance loads (R_L typ. 1 kΩ), then avalanche dissipation will be significant and must be taken into account. In certain circumstances, such avalanche dissipation could be excessive. The calculations of avalanche dissipation will depend on the particular application, but the temperature dependence of switching current, and breakdown voltage should be also taken into account.

e. For many applications in which the device is intended for transient overvoltage protection only, the device will not normally be mounted on a heatsink, since the free air rating will be adequate to cope with non-repetitive transients.

Influence of mounting method

1. Heatsink-mounted with clip (see mounting instructions)

Thermal resistance from mounting base to heatsink

a.	with heatsink compound	$R_{th\ mb\text{-}h}$	=	0.3	K/W
b.	with heatsink compound and 0.06 mm maximum mica insulator	$R_{th\ mb\text{-}h}$	=	1.4	K/W
c.	with heatsink compound and 0.1 mm max. mica insulator (56369)	$R_{th\ mb\text{-}h}$	=	2.2	K/W
d.	with heatsink compound and 0.25 mm max. alumina insulator (56367)	$R_{th\ mb\text{-}h}$	=	0.8	K/W
e.	without heatsink compound	$R_{th\ mb\text{-}h}$	=	1.4	K/W

FULLWAVE CONDUCTION (MAINS CONTACT)

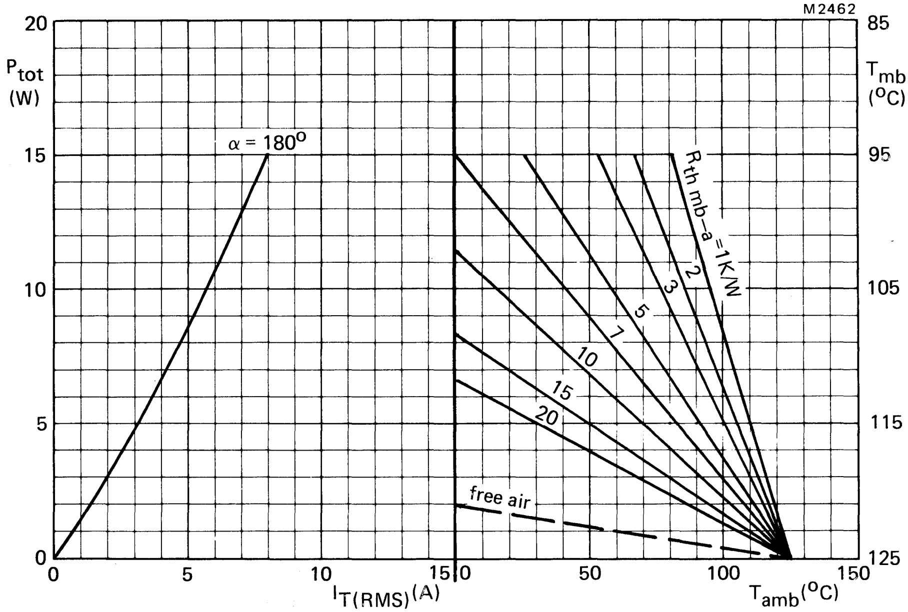
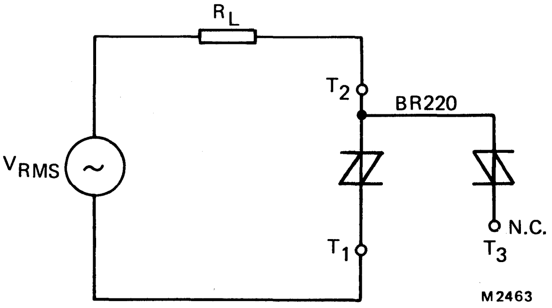


Fig.5 The right-hand part shows the interrelationship between the power (derived from the left-hand part) and the maximum permissible temperatures.

α = conduction angle.

This figure applies for one half of the device alone conducting for a low resistance load. It does not include any avalanche dissipation.



FULLWAVE CONDUCTION (MAINS CONTACT)

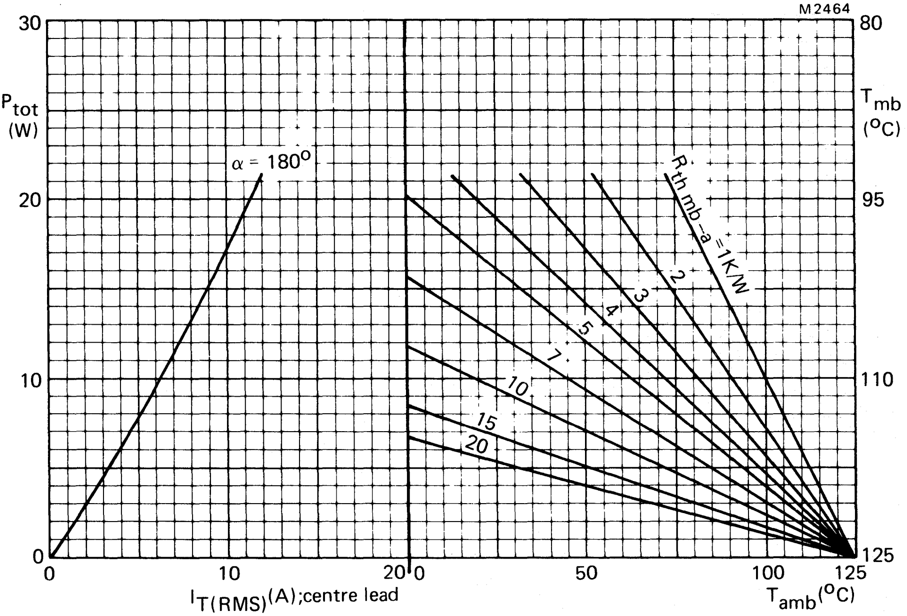
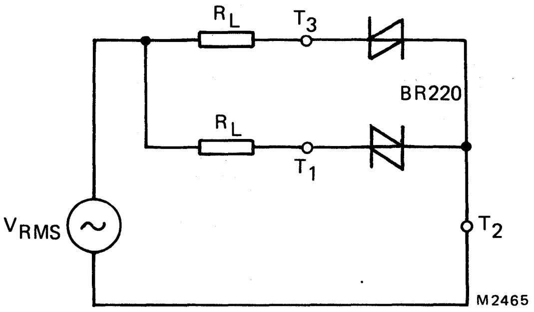


Fig.6 The right-hand part shows the interrelationship between the power (derived from the left-hand part) and the maximum permissible temperatures.

α = conduction angle.

This figure applies for both halves of the device conducting on separate loads in PARALLEL configuration. This applies for low resistive loads, and does not include avalanche dissipation.



FULLWAVE CONDUCTION (MAINS CONTACT)

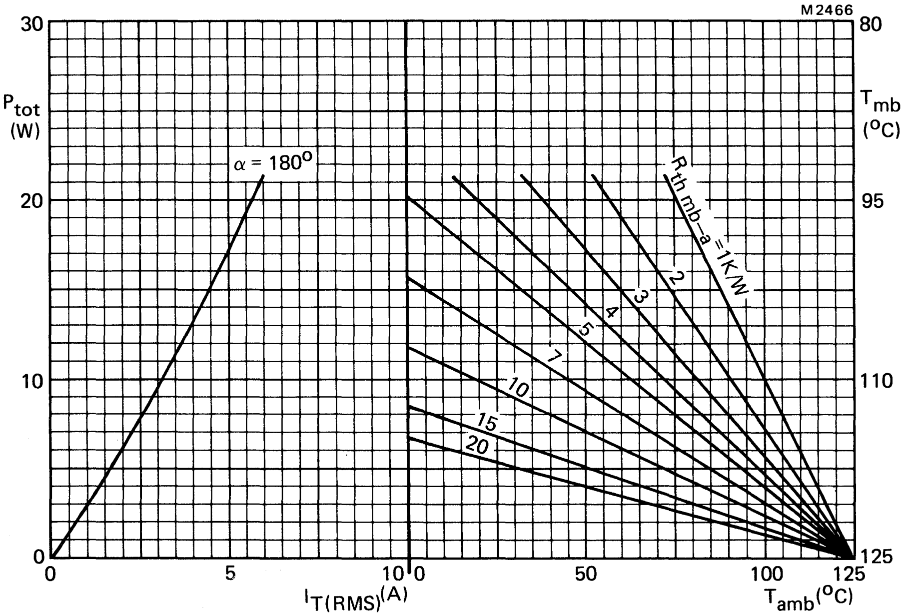
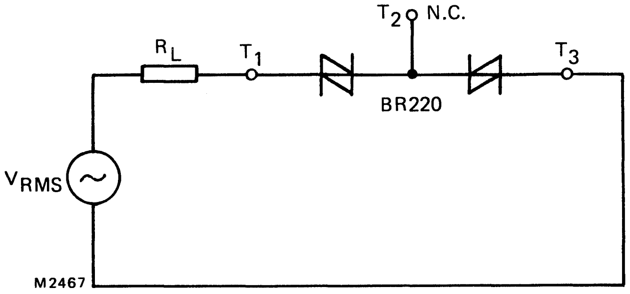


Fig.7 The right-hand part shows the interrelationship between the power (derived from the left-hand part) and the maximum permissible temperatures.

α = conduction angle.

This figure applies for both halves of the device conducting in SERIES configuration. This applies for low resistance loads, and does not include avalanche dissipation.



OVERLOAD OPERATION

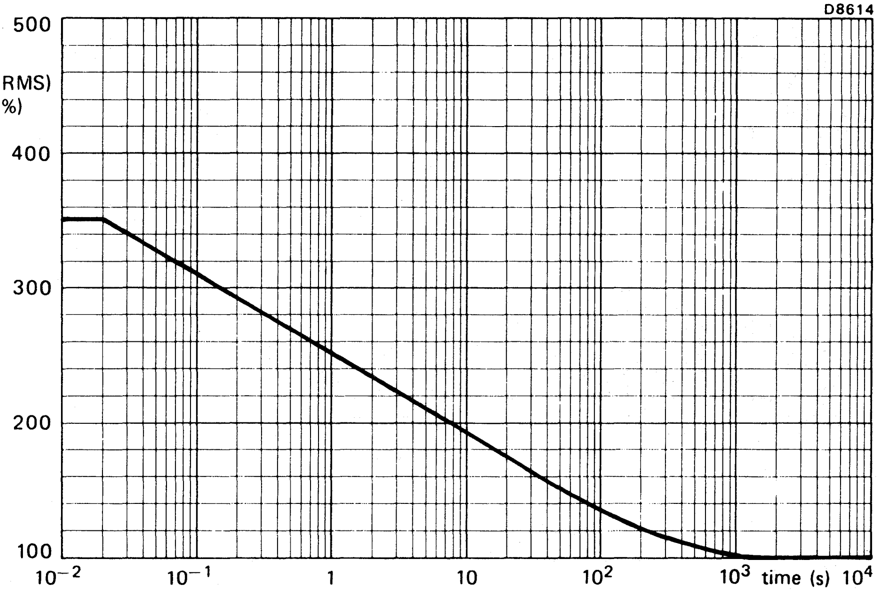


Fig.8 Maximum permissible duration of steady overload (provided that T_{mb} does not exceed 120 °C during and after overload) expressed as a percentage of the steady state r.m.s. rated current. For high r.m.s. overload currents precautions should be taken so that the temperature of the terminals does not exceed 125 °C. During these overload conditions the BOD may lose control. Therefore the overload should be terminated by a separate protection device.

This figure applies to one half of the dual device conducting.

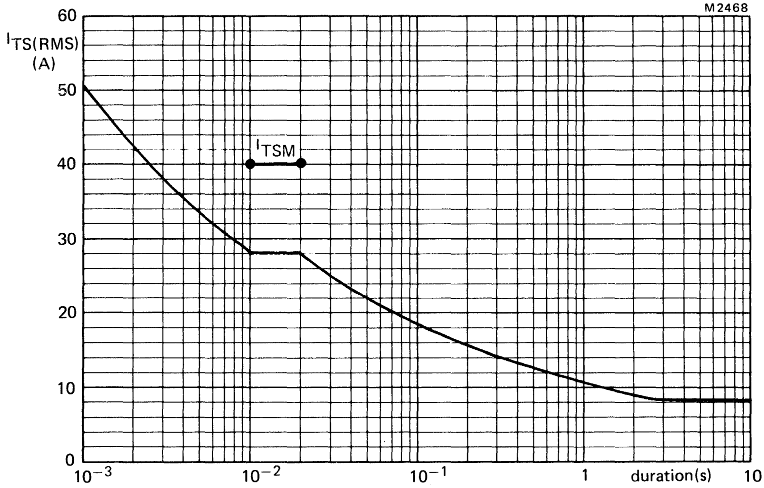
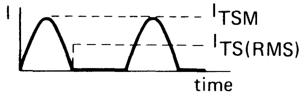


Fig.9 Maximum permissible non-repetitive r.m.s. on-state current based on sinusoidal currents (f = 50 Hz), T_j = 125 °C prior to surge.



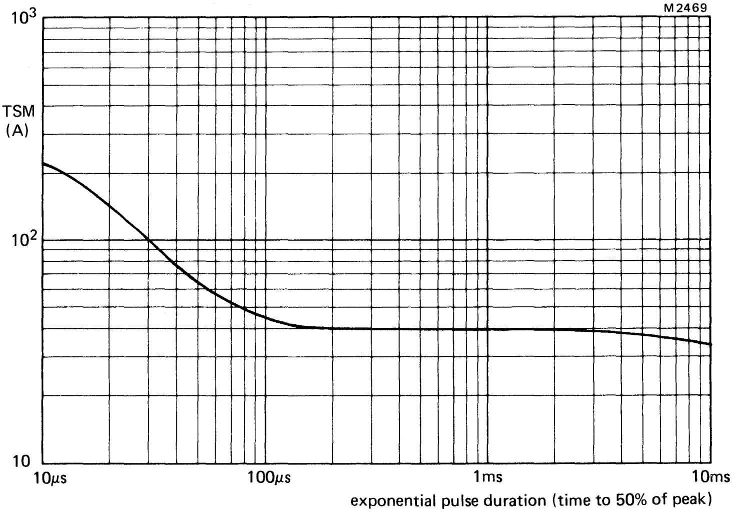


Fig.10 Maximum non-repetitive exponential waveform Impulse Current rating as a function of pulse duration.

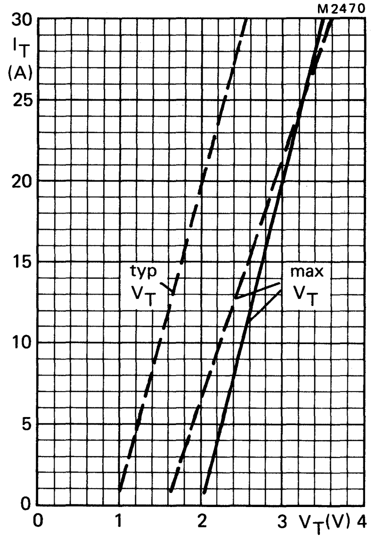


Fig. 11 On-state voltage as a function of on-state current. (200 μs pulsed condition to avoid excessive dissipation) —— T_j = 25, – – – T_j = 125 °C.

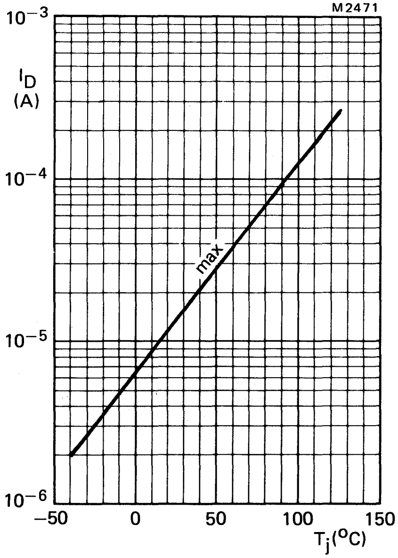


Fig. 12 Maximum off-state current as a function of temperature.

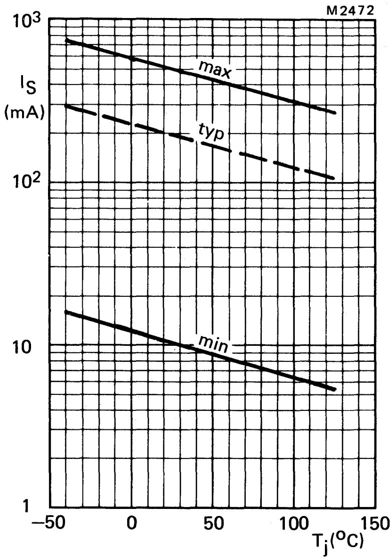


Fig. 13 Switching current as a function of temperature; —— T_j = 25 °C; – – – T_j = 125 °C.

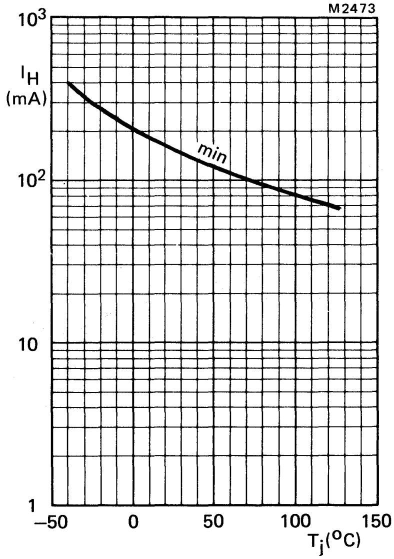


Fig. 14 Minimum holding current as a function of temperature.

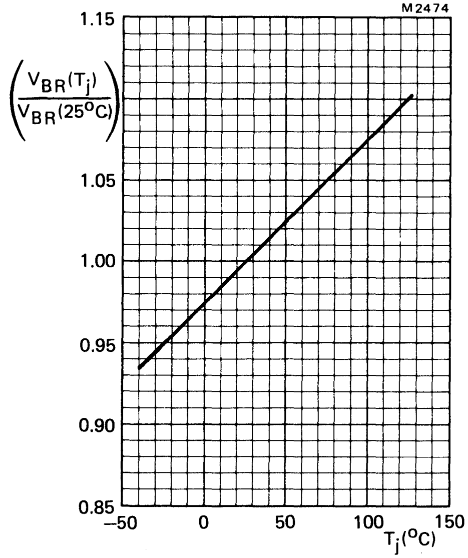


Fig.15 Normalised avalanche breakdown voltage as a function of temperature.
Note: this figure may also be used to derive normalised V_{BO}.

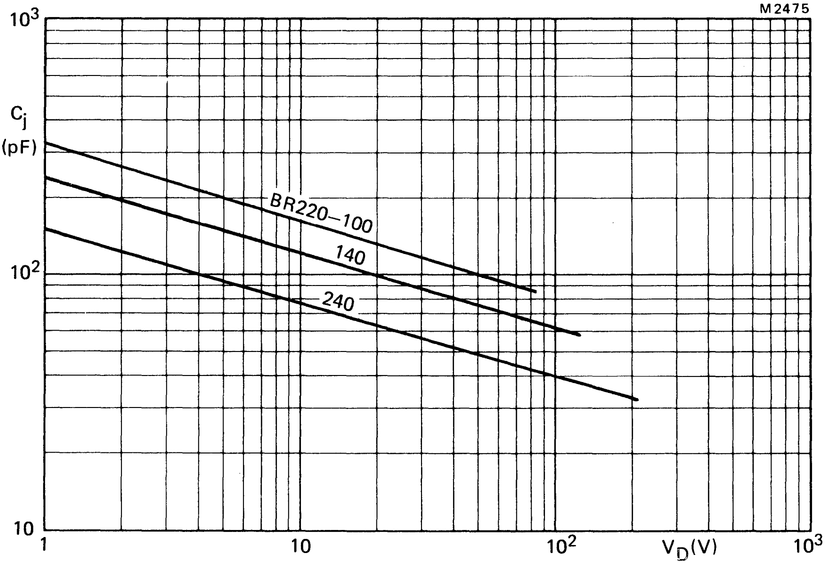


Fig.16 Typical junction capacitance as a function of off-state voltage; T_j = 25 °C; f = 1 MHz.

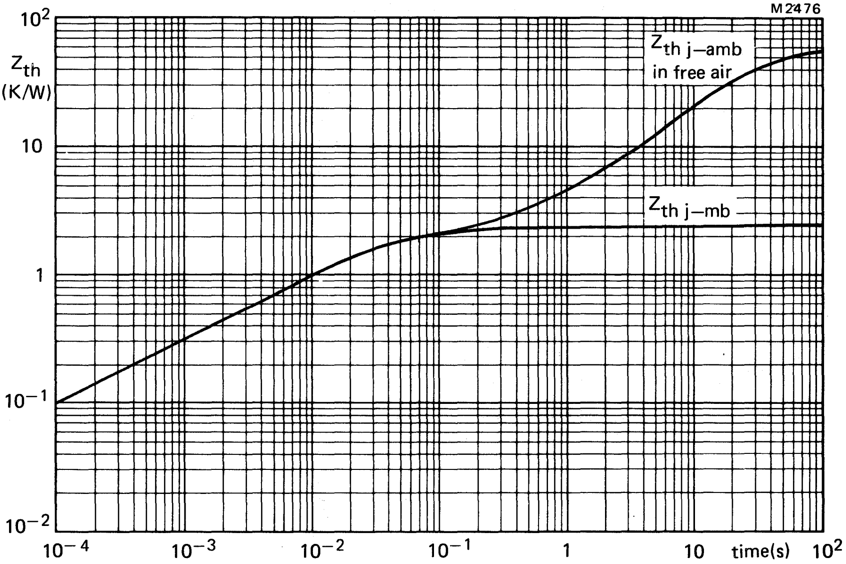


Fig.17 Transient thermal impedance as a function of time (rectangular pulse duration).

REGULATOR 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 56
Reverse polarity (anode to stud) : BZW86-7V5R to 56R

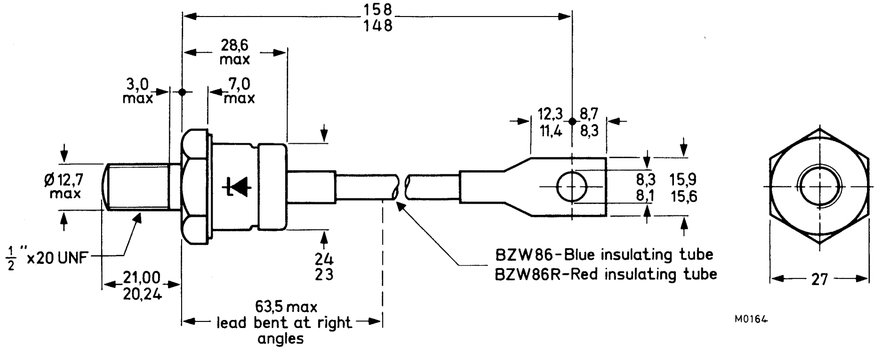
QUICK REFERENCE DATA

Stand-off voltage (15% range) *	V_R		7,5 to 56	V
Reverse breakdown voltage	$V_{(BR)R}$		9,4 to 64	V
Non-repetitive peak reverse power dissipation; exponential pulse	P_{RSM}	max.	25	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



Supplied with device: 1 nut, 1 lock washer
Nut dimensions across the flats: 19 mm

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 *	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
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

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 664)	P_{RRM}	max.	50	kW
Non-repetitive peak reverse power dissipation T_j = 25 °C prior to surge; exponential pulse; see also graph on page 663				
t_p = 100 µs	P_{RSM}	max.	60	kW
t_p = 1 ms	P_{RSM}	max.	25	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 **

---

* The stand-off voltage is the maximum reverse voltage recommended for continuous operation; at this value non-conduction is ensured.

** Measured under pulse condition.

CHARACTERISTICS (continued)

	Clamping voltages (exp. pulse) at T_j = 25 °C prior to surge; t_p = 500 µs $V_{(CL)R}$ (V)			Reverse breakdown voltage at T_j = 25 °C $V_{(BR)R}$ (V)	
	typ.	max.		min.	
BZW86 -7V5(R)	12	14	I_R = 1000 A	8,5	I_R = 10 A
-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		12,4	
-12(R)	18,5	22		13,8	
-13(R)	20	24		15,3	
-15(R)	23	27		16,8	
-16(R)	27	32	I_R = 500 A	18,8	I_R = 5 A
-18(R)	31	36		20,8	
-20(R)	34	40		22,8	
-22(R)	37	43		25,1	
-24(R)	40	47		28	
-27(R)	44	52		31	
-30(R)	47	55	I_R = 250 A	34	
-33(R)	51	60		37	I_R = 2 A
-36(R)	55	65		40	
-39(R)	60	70		44	
-43(R)	66	77		48	
-47(R)	72	84		52	
-51(R)	78	92		58	
-56(R)	85	102		64	

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 666 and 667 for square pulses and pages 668 and 669 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 664 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

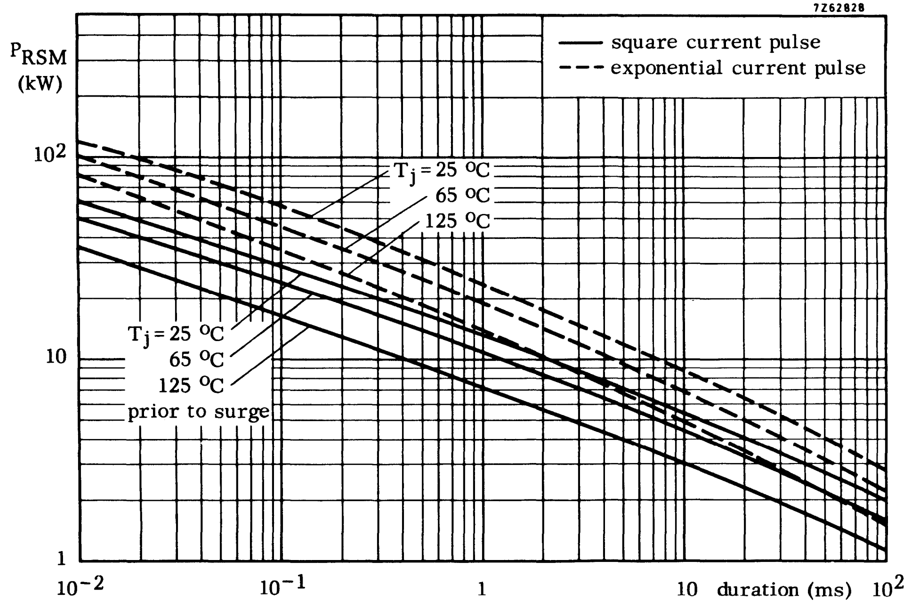
P_S = any steady state dissipation excluding that in pulses

δ = duty factor (t_p/T)

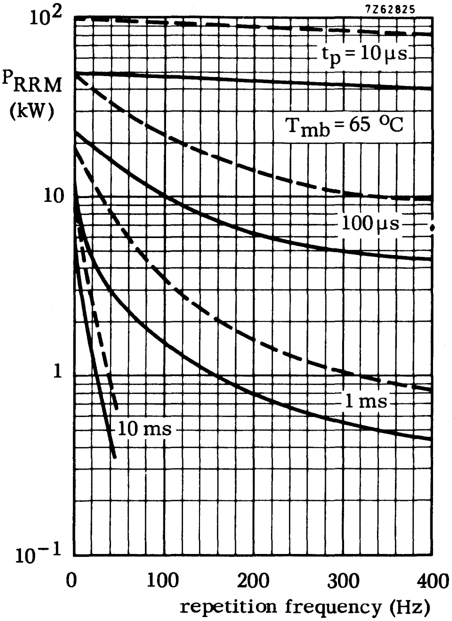
$R_{th\ j\text{-}mb}$ = 0, 3 °C/W

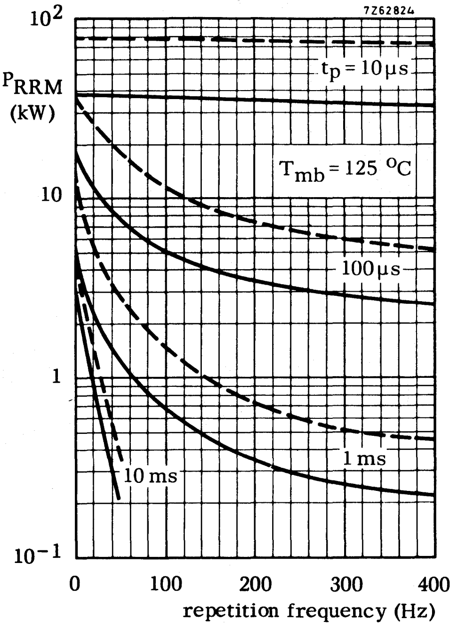
$R_{th\ mb\text{-}h}$ = 0, 1 °C/W

thus $R_{th\ h\text{-}a}$ can be found.



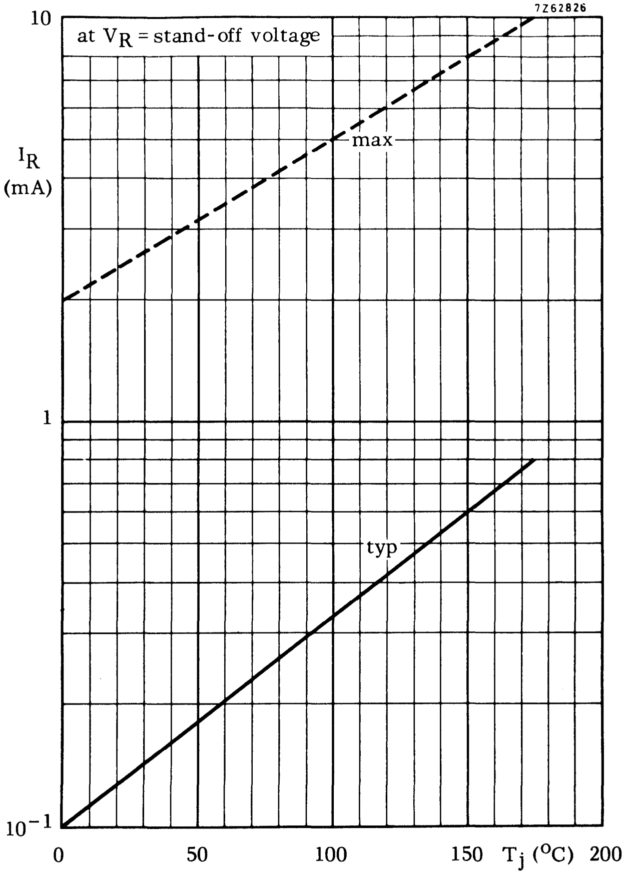
Duration of an exponential pulse is defined as the time taken for the pulse to fall to 37% of its initial value. It is assumed that the energy content does not continue beyond twice this time.

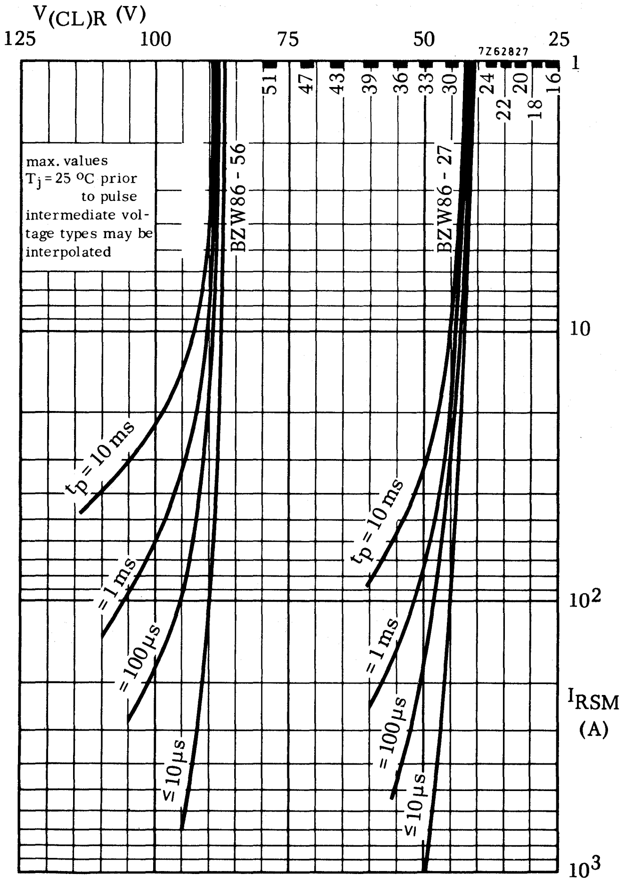




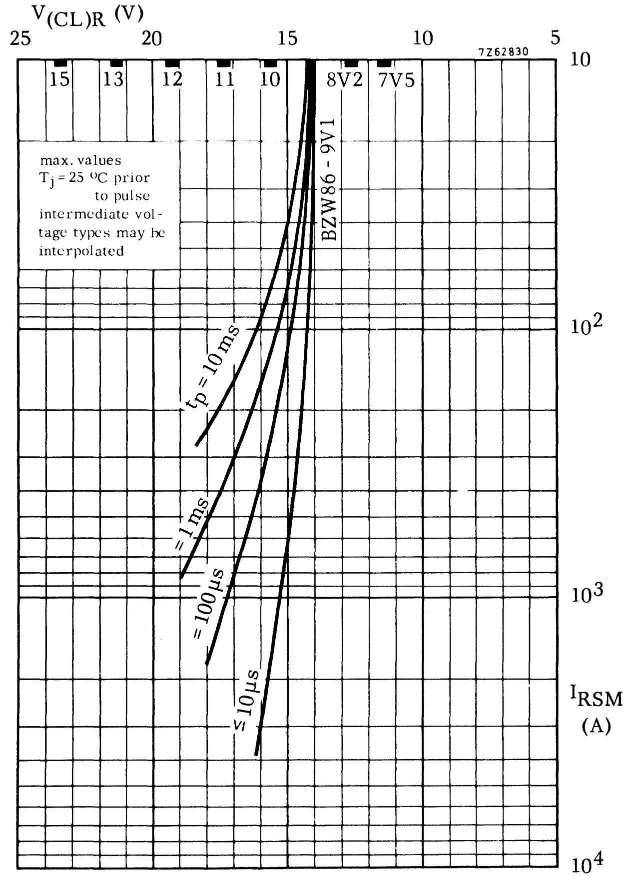
—— square current pulses

– – – exponential current pulses

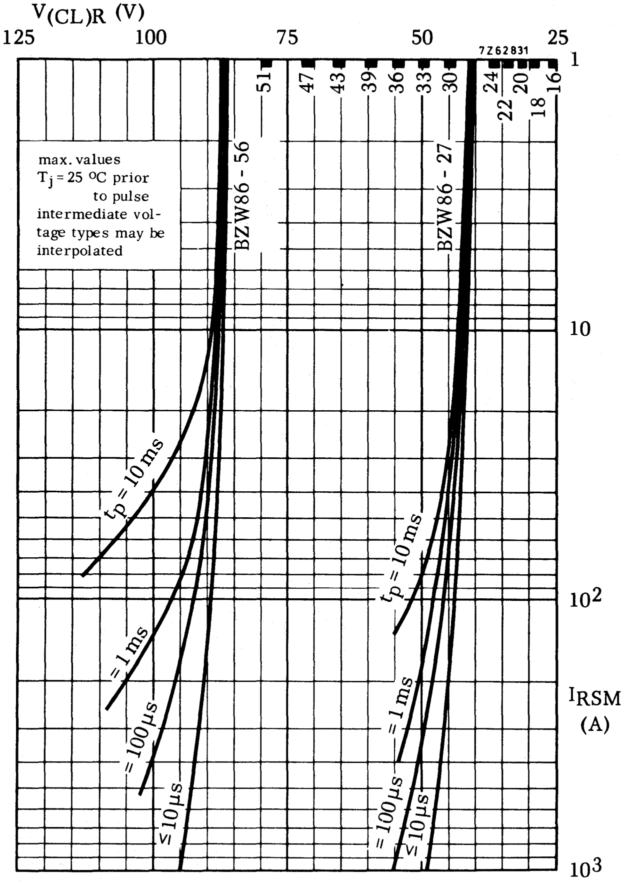

7Z62826
at V_R = stand-off voltage
I_R
(mA)
10
1
10^{-1}
max
typ
0
50
100
150
T_j (°C)
200



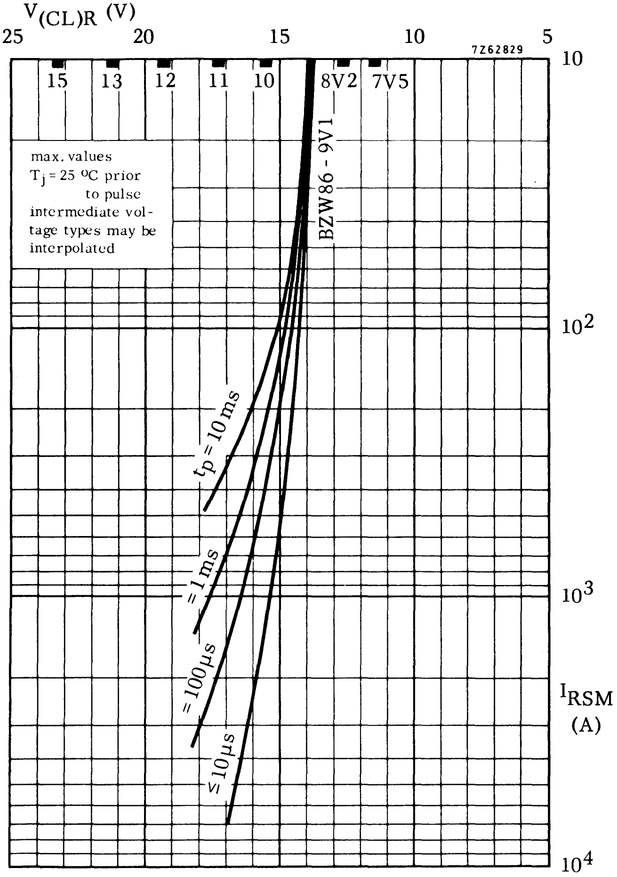
square pulses



square pulses



exponential pulses



exponential pulses

REGULATOR DIODES

A range of diffused silicon diodes in plastic envelopes, intended for use as voltage regulator and transient suppressor diodes in medium power regulators and transient suppression circuits.

The series consists of the following types: BZX70-C7V5 to BZX70-C75.

QUICK REFERENCE DATA

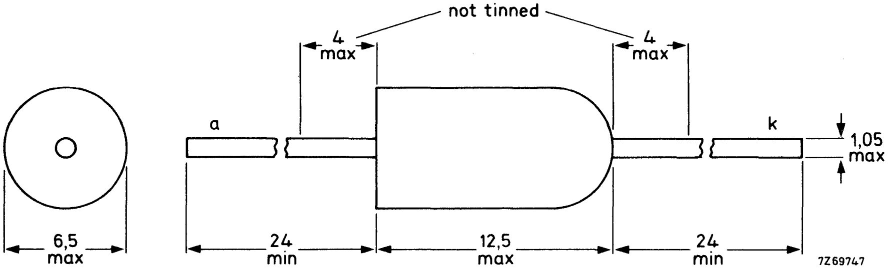
			voltage regulator	transient suppressor	
Working voltage (5% range)	V_Z	nom.	7,5 to 75	–	V
Stand-off voltage	V_R		–	5,6 to 56	V
Total power dissipation	P_{tot}	max.	2,5	–	W
Non-repetitive peak reverse power dissipation	P_{RSM}	max.	–	700	W

MECHANICAL DATA

Dimensions in mm

Fig. 1 SOD-18.

The rounded end indicates the cathode.



Products approved to CECC 50 005-015 available on request.

RATINGS

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

Peak working current	I_{ZM}	max.	5	A
Average forward current (averaged over any 20 ms period)	$I_{F(AV)}$	max.	1	A
Non-repetitive peak reverse current T_j = 25 °C prior to surge; t_p = 1 ms (exponential pulse); BZX70-C7V5 to BZX70-C75	I_{RSM}	max.	44 to 6	A
Total power dissipation at T_{amb} = 25 °C; with 10 mm tie-points; Fig. 5	P_{tot}	max.	2,5	W
Non-repetitive peak reverse power dissipation T_j = 25 °C prior to surge; t_p = 1 ms (exponential pulse)	P_{RSM}	max.	700	W
Storage temperature	T_{stg}		−55 to + 150	°C
Junction temperature	T_j	max.	150	°C

THERMAL RESISTANCE

From junction to ambient in free air	see Figs 4 and 5

CHARACTERISTICS

Forward voltage I_F = 1 A; T_{amb} = 25 °C	V_F	$<$	1,5	V

OPERATION AS A VOLTAGE REGULATOR (see page 4)

Dissipation and heatsink considerations

a. Steady-state conditions

The maximum permissible 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. 2)

The maximum permissible pulse power $P_{p\,max}$ is given by the formula

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

where: P_s is any steady-state dissipation excluding that in pulses
$R_{th\,t}$ is the effective transient thermal resistance of the device between junction and ambient. It is a function of the pulse duration t_p and duty factor δ.
δ is the duty factor (t_p/T)

The steady-state power P_s when biased in the zener direction at a given zener current can be found from Fig. 3. With the additional pulse power dissipation $P_{p\,max}$ calculated from the above expression, the total peak zener power dissipation $P_{tot} = P_{ZRM} = P_s + P_p$. From Fig. 3 the corresponding maximum repetitive peak zener current at P_{tot} 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 permissible repetitive peak dissipation P_{ZRM} is equal to the steady-state power P_s. The temperature stabilization time for the BZX70 is 100 seconds (see Figs 17 and 18).

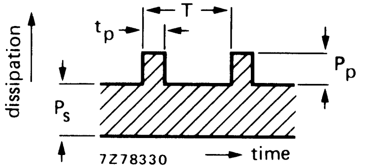


Fig. 2.

NOTES WHEN OPERATING AS A TRANSIENT SUPPRESSOR (see page 675)

1. Recommended stand-off voltage is defined as being the maximum reverse voltage to be applied without causing conduction in the avalanche mode or significant reverse dissipation.
2. Maximum clamping voltage is the maximum reverse avalanche breakdown voltage which will appear across the diode at the specified pulse duration and junction temperature. For square pulses see Figs 19 and 20, for exponential pulses see Figs 21 and 22.
3. 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 energy content does not continue beyond twice this time.

CHARACTERISTICS – WHEN USED AS VOLTAGE REGULATOR DIODES; T_{amb} = 25 °C

BZX70-. . .	working voltage $^*V_Z$ V		differential resistance $^*r_Z$ Ω		temperature coefficient $^*S_Z$ mV/°C	test I_Z mA	reverse current I_R µA	at reverse voltage V_R V
	min.	max.	typ.	max.	typ.		max.	
C7V5	7.0	7.9	0.45	3.5	3.0	50	50	2.0
C8V2	7.7	8.7	0.45	3.5	4.0	50	20	5.6
C9V1	8.5	9.6	0.55	4.0	5.5	50	10	6.2
C10	9.4	10.6	0.75	4.0	7.0	50	10	6.8
C11	10.4	11.6	0.8	4.5	7.5	50	10	7.5
C12	11.4	12.7	0.85	5.0	8.0	50	10	8.2
C13	12.4	14.1	0.9	6.0	8.5	50	10	9.1
C15	13.8	15.6	1.0	8.0	10	50	10	10
C16	15.3	17.1	2.4	9.0	11	20	10	11
C18	16.8	19.1	2.5	11	12	20	10	12
C20	18.8	21.2	2.8	12	14	20	10	13
C22	20.8	23.3	3.0	13	16	20	10	15
C24	22.7	25.9	3.4	14	18	20	10	16
C27	25.1	28.9	3.8	18	20	20	10	18
C30	28	32	4.5	22	25	20	10	20
C33	31	35	5.0	25	30	20	10	22
C36	34	38	5.5	30	32	20	10	24
C39	37	41	12	35	35	10	10	27
C43	40	46	13	40	40	10	10	30
C47	44	50	14	50	45	10	10	33
C51	48	54	15	55	50	10	10	36
C56	52	60	17	63	55	10	10	39
C62	58	66	18	75	60	10	10	43
C68	64	72	18	90	65	10	10	47
C75	70	79	20	100	70	10	10	51

*At test I_Z; measured using a pulse method with $t_p \leqslant 100\ \mu s$ and $\delta \leqslant 0.001$ so that the values correspond to a T_j of approximately 25 °C.

CHARACTERISTICS – WHEN USED AS TRANSIENT SUPPRESSOR DIODES; T_{amb} = 25 °C

clamping voltage t_p = 500 μs exp. pulse $V_{(CL)R}$ V		at non-repetitive peak reverse current I_{RSM} A	reverse current at recommended stand-off voltage I_R mA	V_R V	BZX70-. . .
typ.	max.		max.		
9	10	20	0.5	5.6	C7V5
10	11.2	20	0.5	6.2	C8V2
11	12.5	20	0.5	6.8	C9V1
12	14	20	0.1	7.5	C10
13.5	15.5	20	0.1	8.2	C11
15	17.5	20	0.1	9.1	C12
17	19	20	0.1	10	C13
19	21	20	0.1	11	C15
21	23	20	0.1	12	C16
23	26	20	0.1	13	C18
22	26	10	0.1	15	C20
25	29	10	0.1	16	C22
28	33	10	0.1	18	C24
32	38	10	0.1	20	C27
36	43	10	0.1	22	C30
41	48	10	0.1	24	C33
47	54	10	0.1	27	C36
44	52	5	0.1	30	C39
49	58	5	0.1	33	C43
56	65	5	0.1	36	C47
63	72	5	0.1	39	C51
71	82	5	0.1	43	C56
80	93	5	0.1	47	C62
89	104	5	0.1	51	C68
98	116	5	0.1	56	C75

SOLDERING AND MOUNTING INSTRUCTIONS

1. When using a soldering iron, diodes may be soldered directly into the circuit, but heat conducted to the junction should be kept to a minimum.
2. Diodes may be dip-soldered at a solder temperature of 245 °C for a maximum soldering time of 5 seconds. The case temperature during dip-soldering must not at any time exceed the maximum storage temperature. These recommendations apply to a diode with the anode end mounted flush on a printed-circuit board having punched-through holes. For mounting the anode end onto a printed-circuit board, the diode must be spaced at least 5 mm from the underside of the printed-circuit board having punched-through holes, or 5 mm from the top of the printed circuit board having plated-through holes.
3. Care should be taken not to bend the leads nearer than 1,5 mm from the seal; exert no axial pull when bending.

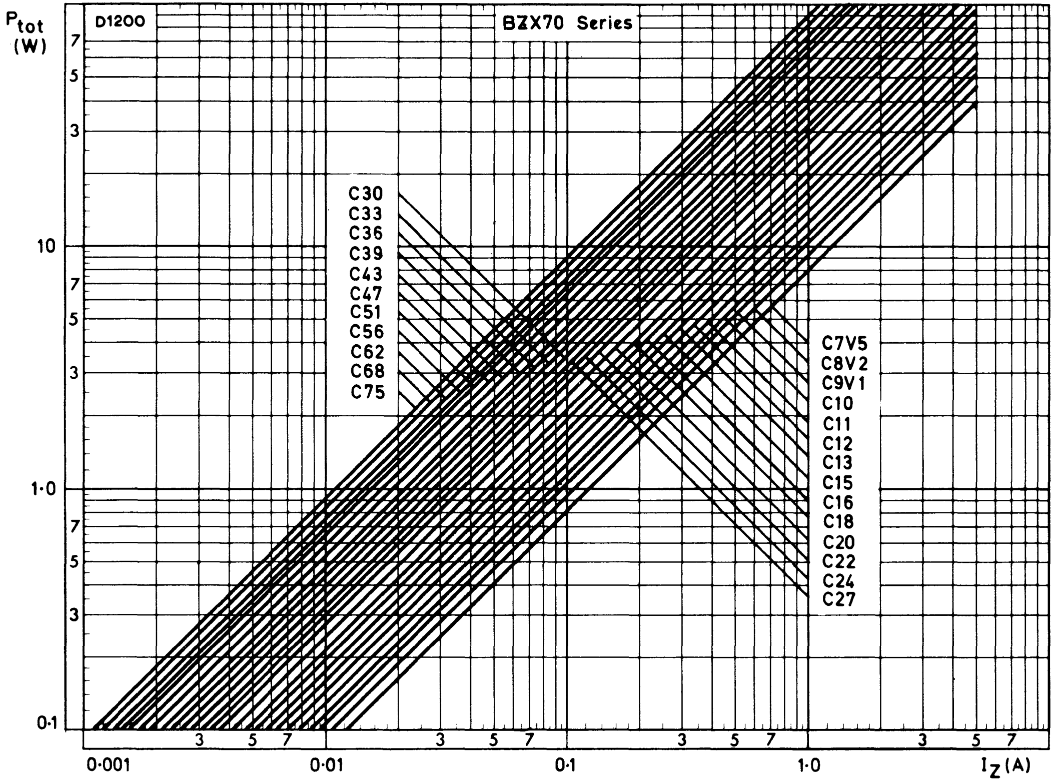


Fig. 3 Maximum permissible repetitive peak dissipation ($P_{tot} = P_{ZRM}$).

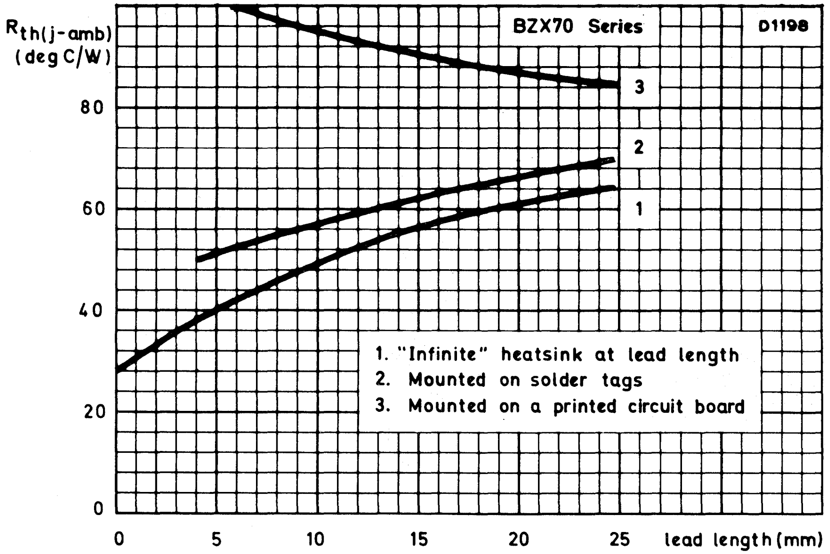


Fig. 4 Thermal resistance as a function of lead length under various mounting conditions.

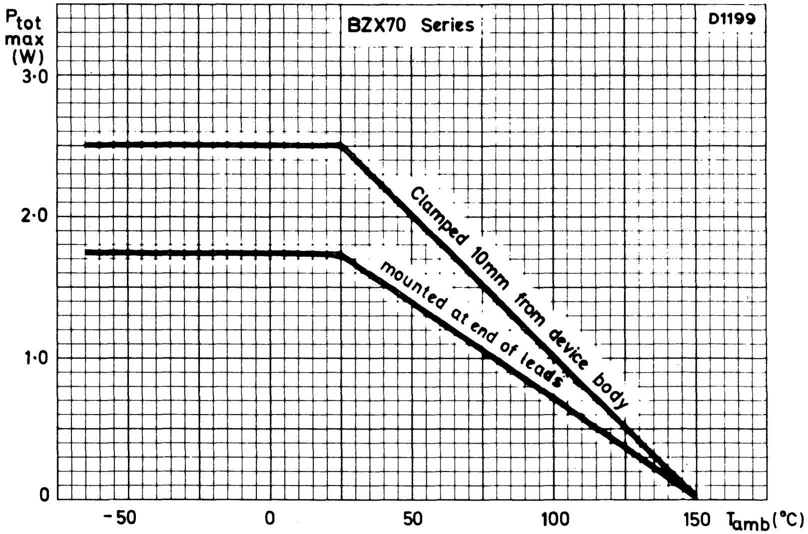


Fig. 5 Maximum permissible power dissipation; the top curve is for mounting method 1 from Fig. 4 at 10 mm lead length.

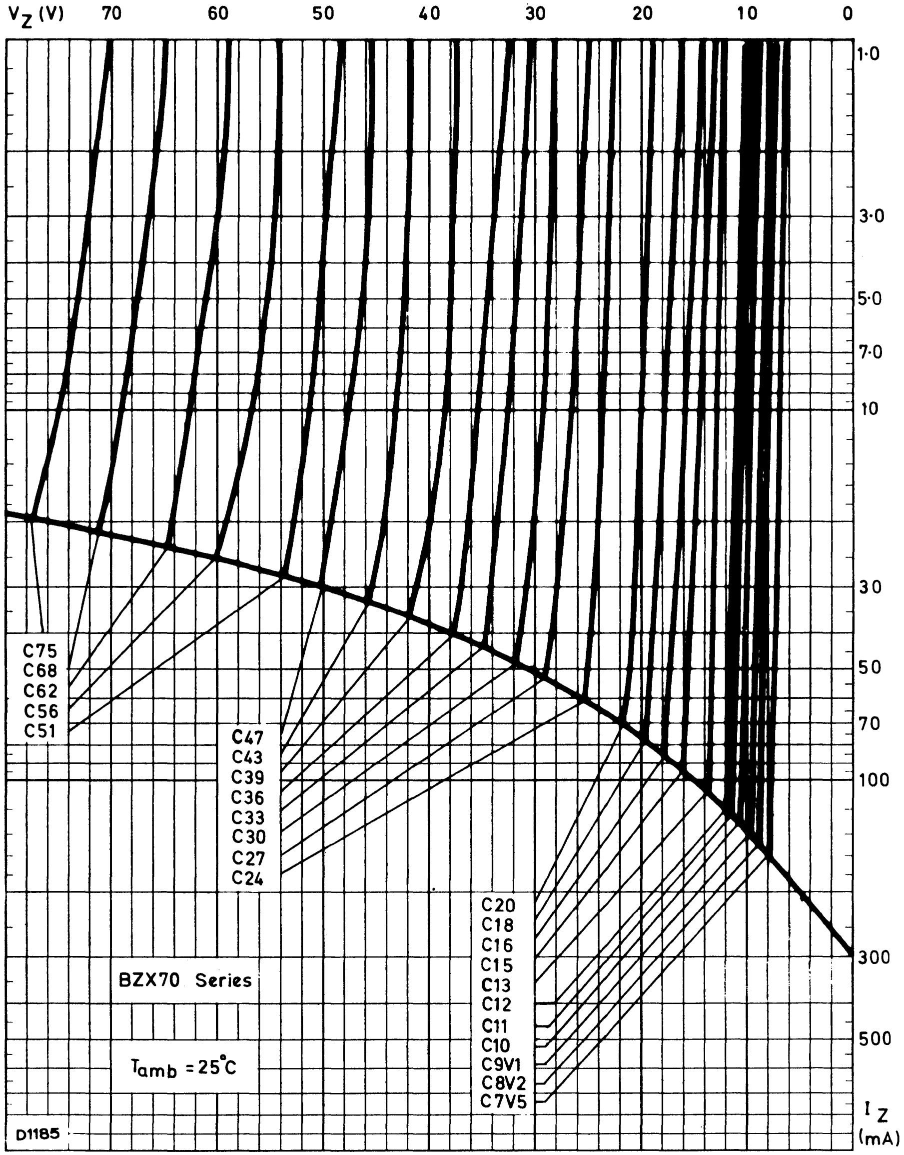


Fig. 6 Typical static zener characteristics.

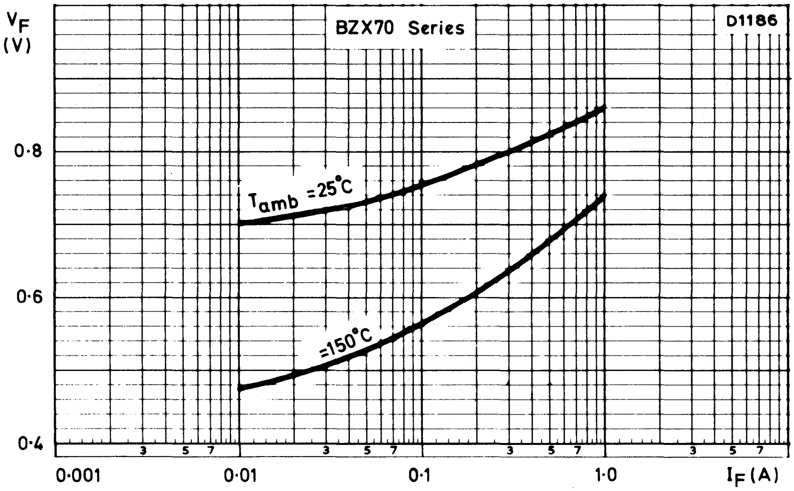


Fig. 7.

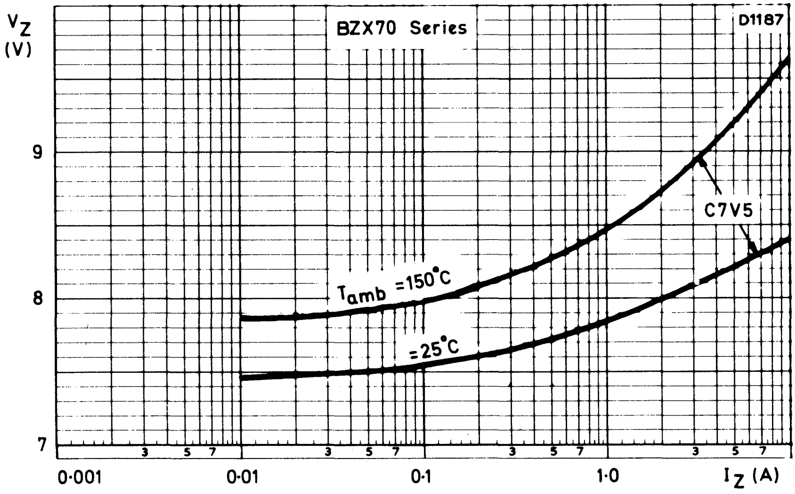


Fig. 8 Typical dynamic zener characteristics for BZX70-C7V5.

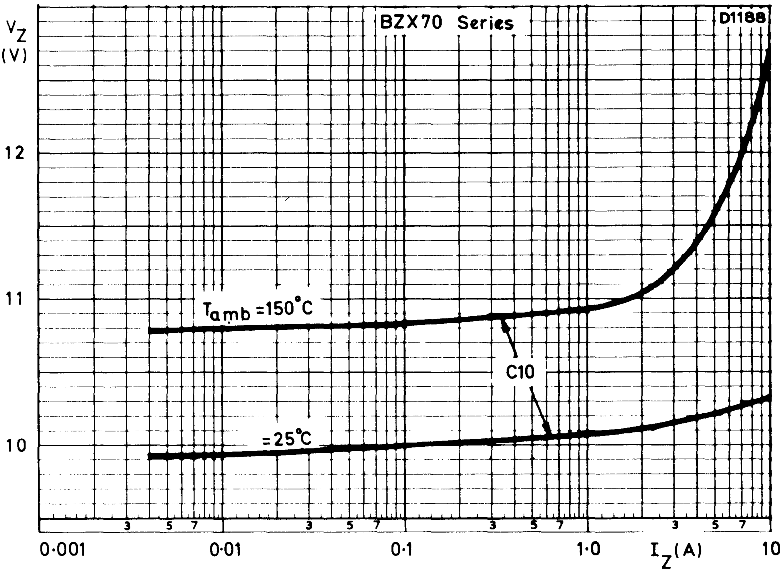


Fig. 9 Typical dynamic zener characteristics for BZX70-C10.

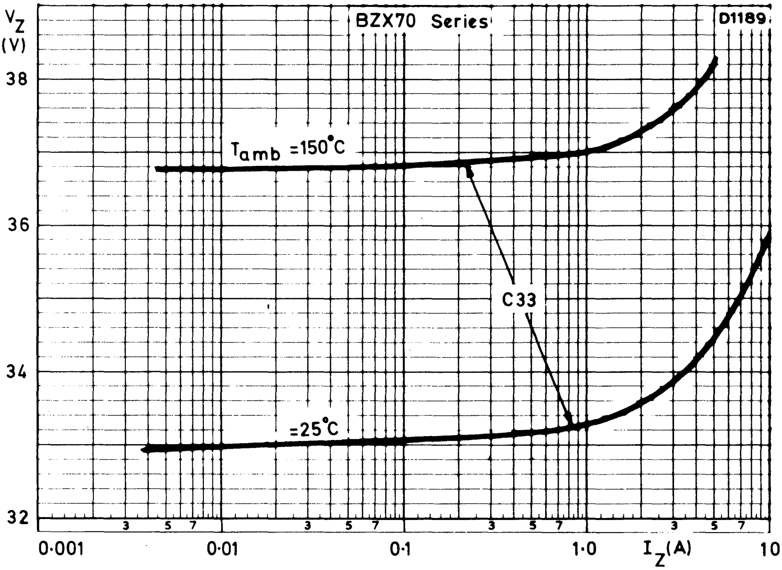


Fig. 10 Typical dynamic zener characteristics for BZX70-C33.

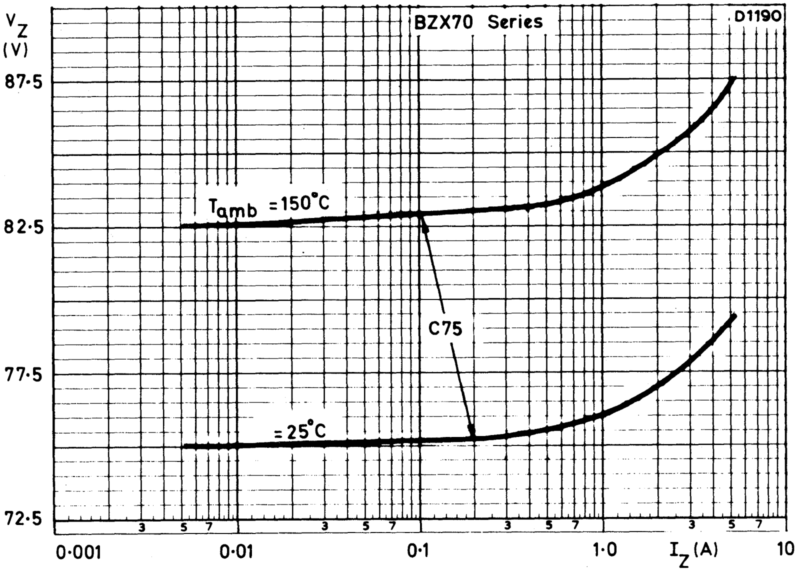


Fig. 11 Typical dynamic zener characteristics for BZX70-C75.

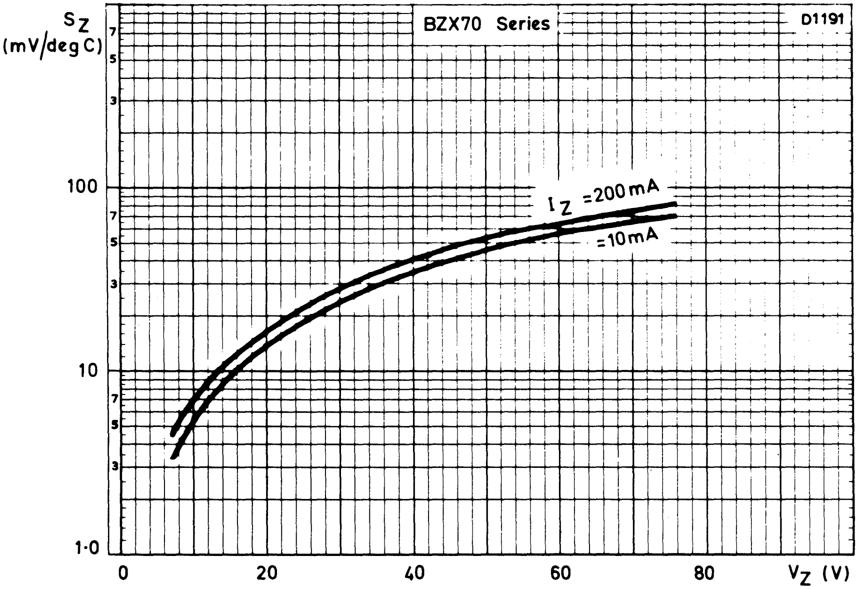


Fig. 12.

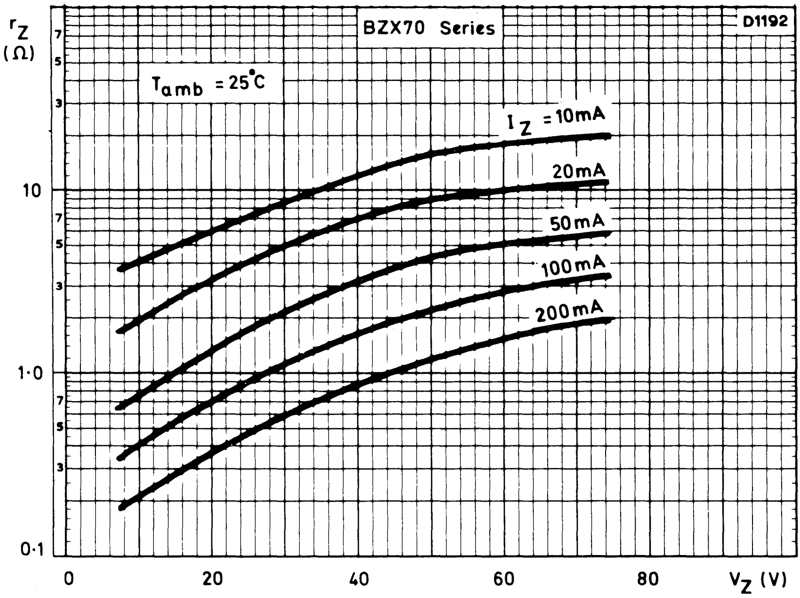

r_Z (Ω)
BZX70 Series
D1192
T_{amb} = 25°C
I_Z = 10mA
20mA
50mA
100mA
200mA
10
1·0
0·1
7
5
3
0
20
40
60
80
V_Z (V)

Fig. 13.

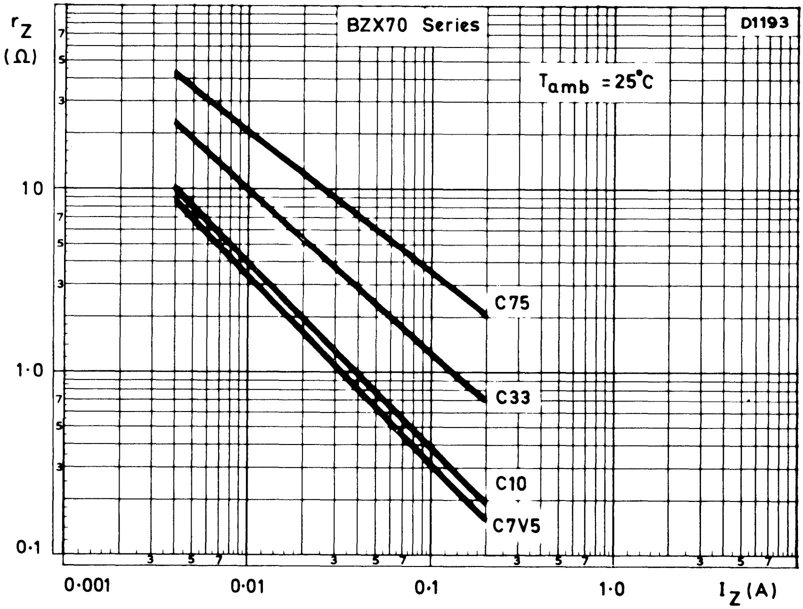

r_Z (Ω)
BZX70 Series
D1193
T_{amb} = 25°C
C75
C33
C10
C7V5
10
1·0
0·1
7
5
3
0·001
0·01
0·1
1·0
I_Z (A)

Fig. 14.

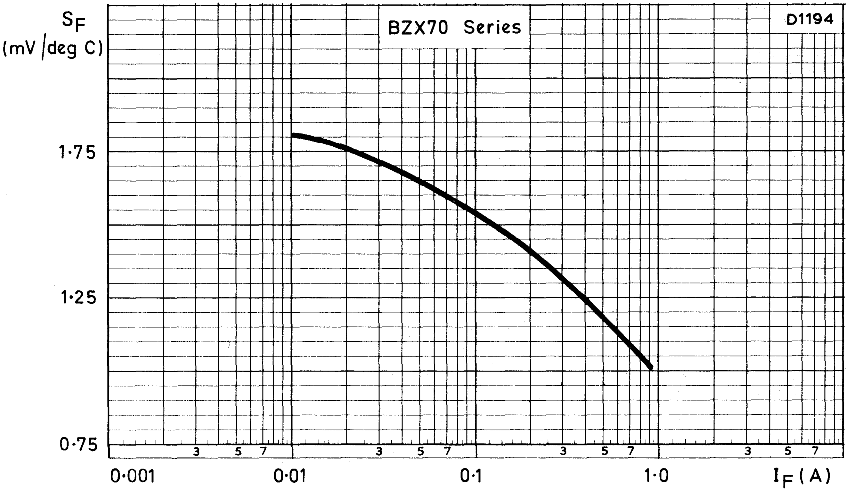


Fig. 15 Typical values.

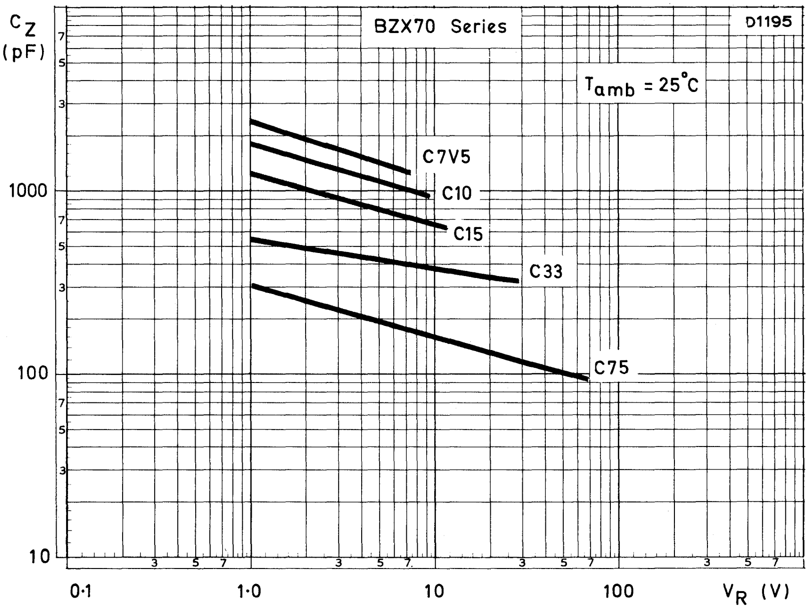


Fig. 16 Typical values.

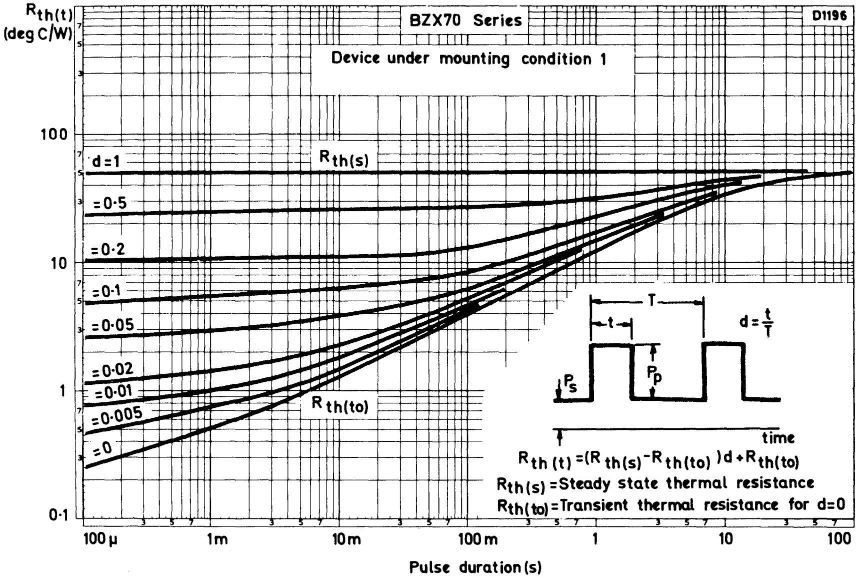


Fig. 17 Device under mounting condition 1 (infinite heatsink); see Fig. 4.

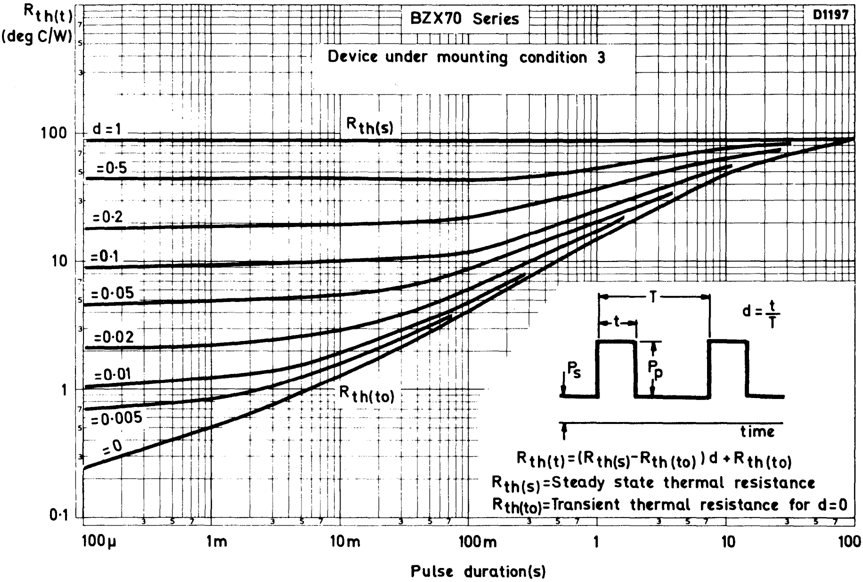


Fig. 18 Device under mounting method 3 (mounted on a printed-circuit board); see Fig. 4.

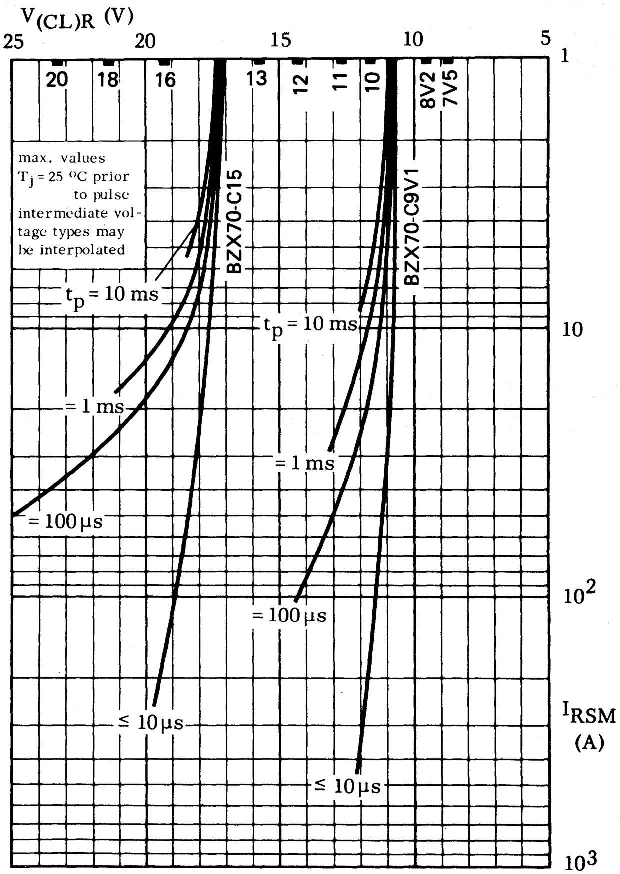


Fig. 19 Square pulses.

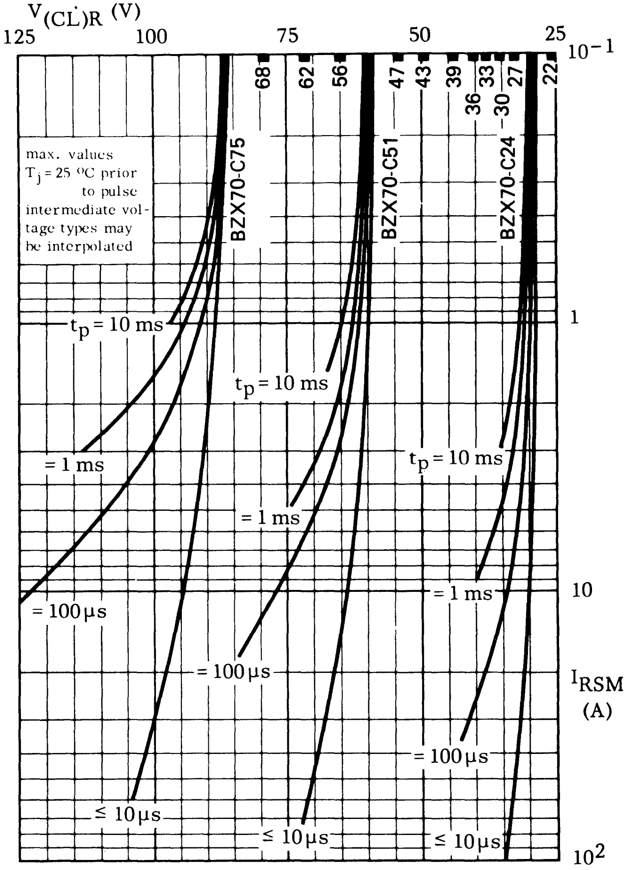


Fig. 20 Square pulses.

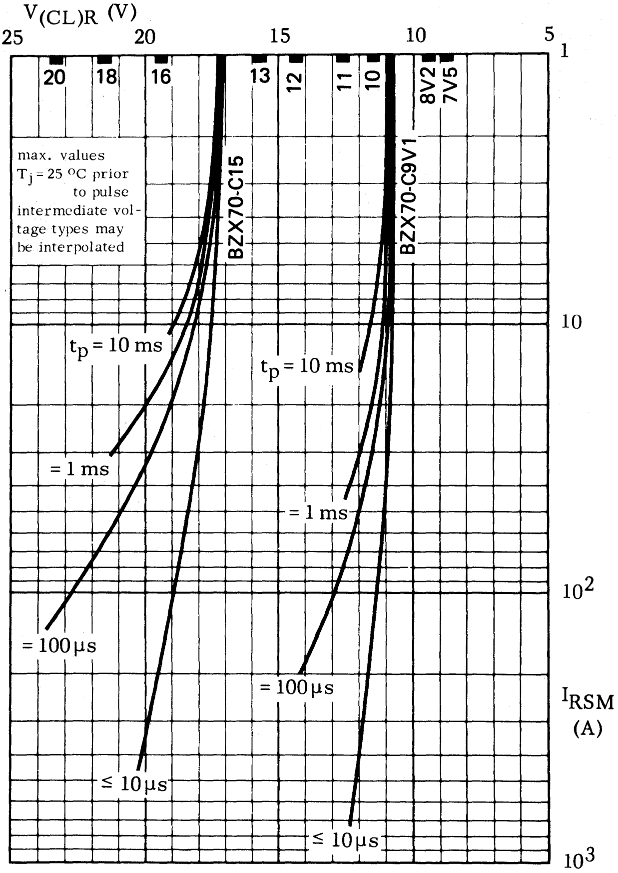


Fig. 21 Exponential pulses.

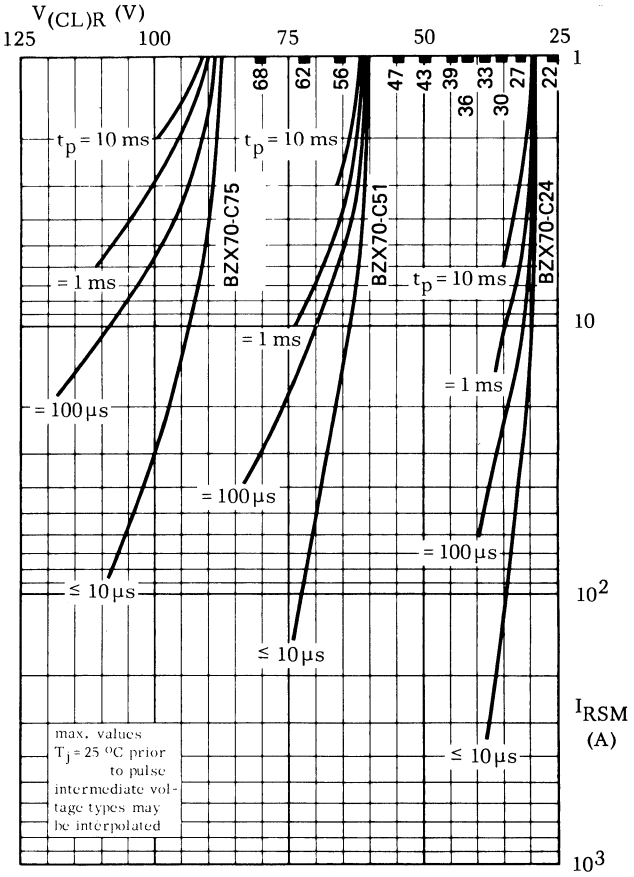


Fig. 22 Exponential pulses.

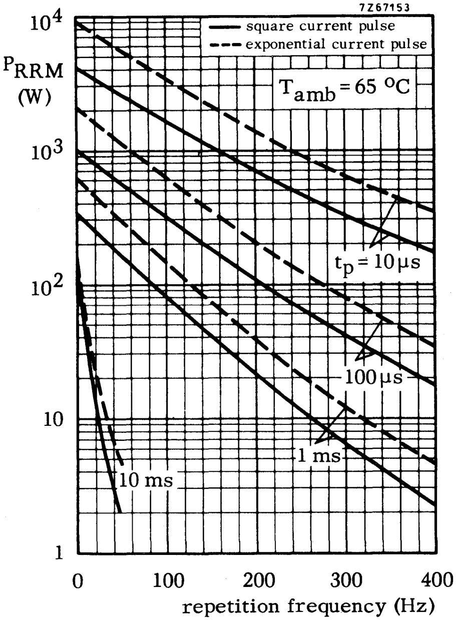


Fig. 23.

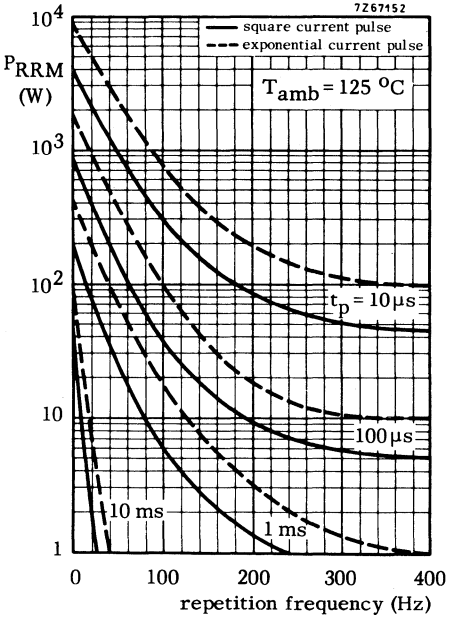


Fig. 24.

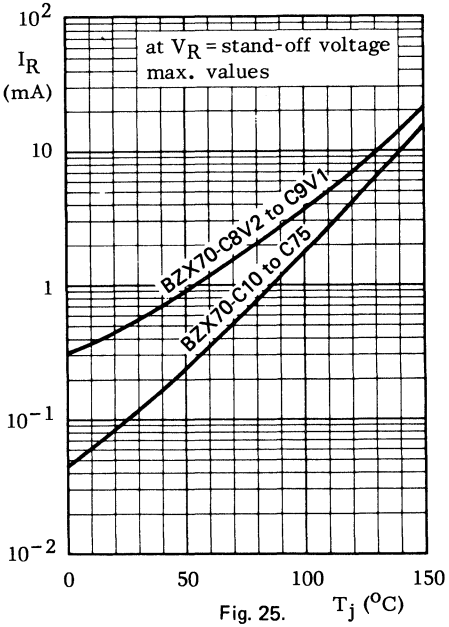


Fig. 25.

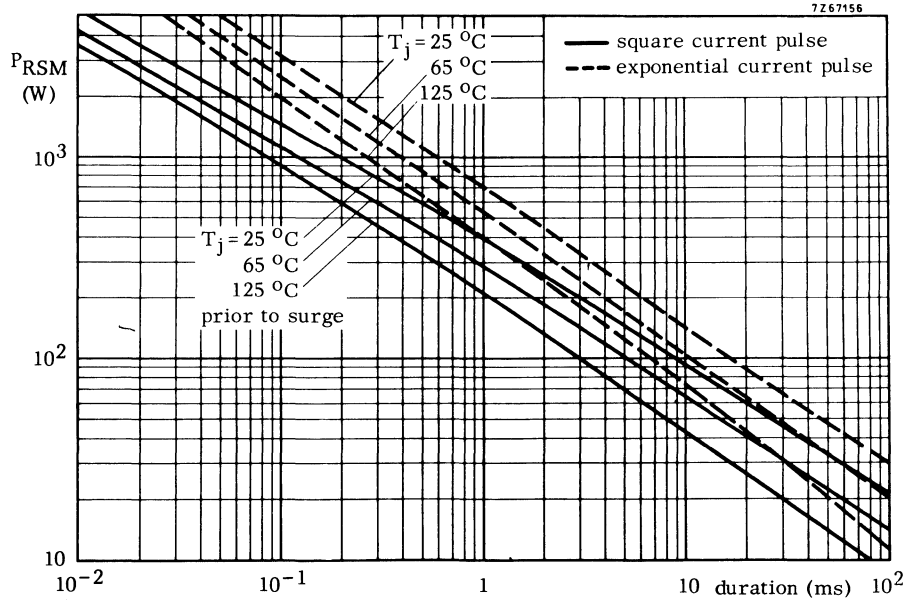

7Z67156
P_{RSM} (W)
10^3
10^2
10
10^{-2}
10^{-1}
1
10
duration (ms)
10^2
square current pulse
exponential current pulse
T_j = 25 °C
65 °C
125 °C
T_j = 25 °C
65 °C
125 °C
prior to surge

Fig. 26.

REGULATOR DIODES

Also available to BS9305–F052

A range of diffused silicon diodes in DO-5 metal envelopes, intended for use as voltage regulator and transient suppressor diodes in power stabilization and transient suppression circuits.

The series consists of the following types:
Normal polarity (cathode to stud): BZY91-C7V5 to BZY91-C75.
Reverse polarity (anode to stud): BZY91-C7V5R to BZY91-C75R.

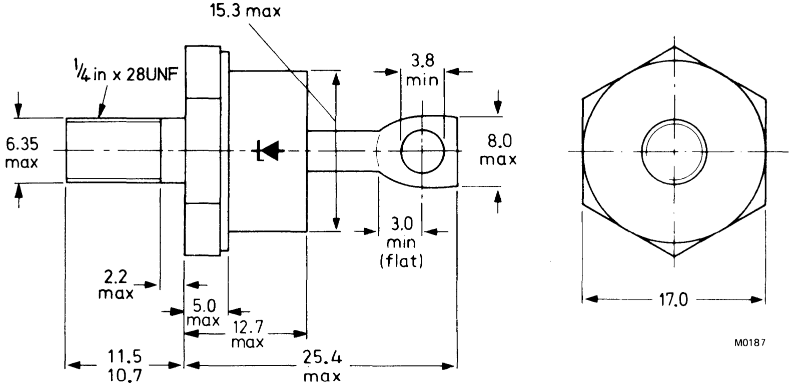
QUICK REFERENCE DATA

			voltage regulator	transient suppressor	
Working voltage (5% range)	V_Z	nom.	7,5 to 75	–	V
Stand-off voltage	V_R		–	5,6 to 56	V
Total power dissipation	P_{tot}	max.	100	–	W
Non-repetitive peak reverse power dissipation	P_{RSM}	max.	–	9,5	kW

MECHANICAL DATA

Dimensions in mm

Fig. 1 DO-5.



Net mass: 22 g

Diameter of clearance hole: max. 6,5 mm

Accessories supplied on request:
see ACCESSORIES section

Supplied with device: 1 nut, 1 lock washer
Nut dimensions across the flats: 11,1 mm

Torque on nut: min. 1,7 Nm (17 kg cm)
max. 3,5 Nm (35 kg cm)

RATINGS

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

Peak working current	I_{ZM}	max.	400	A
Average forward current (averaged over any 20 ms period)	$I_{F(AV)}$	max.	20	A
Non-repetitive peak reverse current T_j = 25 °C prior to surge; t_p = 1 ms (exponential pulse); BZY91-C7V5(R) to BZY91-C75(R)	I_{RSM}	max.	1000 to 85	A
Total power dissipation up to T_{mb} = 25 °C	P_{tot}	max.	100	W
at T_{mb} = 65 °C	P_{tot}	max.	75	W
Non-repetitive peak reverse power dissipation T_j = 25 °C prior to surge; t_p = 1 ms (exponential pulse)	P_{RSM}	max.	9,5	kW
Storage temperature	T_{stg}		−55 to + 175	°C
Junction temperature	T_j	max.	175	°C

THERMAL RESISTANCE

From junction to mounting base	$R_{th\ j\text{-}mb}$	=	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; T_{mb} = 25 °C	V_F	<	1,5	V

OPERATION AS A VOLTAGE REGULATOR (see page 696)

Dissipation and heatsink considerations

a. Steady-state conditions

The maximum permissible 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, 0,2 °C/W.
$R_{th\ h\text{-}a}$ is the thermal resistance of the heatsink.

b. Pulse conditions (see Fig. 2)

The heating effect of repetitive power pulses can be found from the curves in Figs 5 and 6 which are given for operation as a transient suppressor at 50 Hz and 400 Hz respectively. This value ΔT is in addition to the mean heating effect. The value of ΔT found from the curves for the particular operating condition should be added to the known value for ambient temperature used in calculating the required heatsink.
The value of the peak power for a given peak zener current is found from the curves in Figs 3 and 4.

The required heatsink is calculated as follows:

$$R_{th\ j\text{-}a} = \frac{T_{j\ max} - T_{amb} - \Delta T}{P_s + \delta \cdot P_p}$$

where: $T_{j\ max}$ = 175 °C
T_{amb} = ambient temperature
ΔT = from Fig. 5 or 6
P_s = any steady-state dissipation excluding that in pulses
P_p = peak pulse power
δ = duty factor (t_p/T)
$R_{th\ j\text{-}a} = R_{th\ j\text{-}mb} + R_{th\ mb\text{-}h} + R_{th\ h\text{-}a} = 1{,}5 + 0{,}2 + R_{th\ h\text{-}a}$ °C/W.

Thus $R_{th\ h\text{-}a}$ can be found.

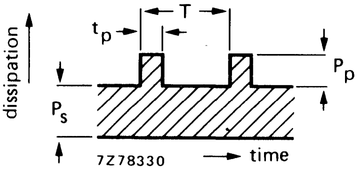


Fig. 2.

OPERATION AS A TRANSIENT SUPPRESSOR (see page 697)

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 Figs 26 and 27 the required heatsink is found as follows:

$$R_{th\ j\text{-}mb} + R_{th\ mb\text{-}h} + R_{th\ h\text{-}a} = \frac{T_{j\ max} - T_{amb}}{P_s + \delta \cdot P_{RRM}}$$

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)
$R_{th\ j\text{-}mb}$ = 1,5 °C/W
$R_{th\ mb\text{-}h}$ = 0,2 °C/W

Thus $R_{th\ h\text{-}a}$ can be found.

Notes

1. The stand-off voltage is the maximum reverse voltage recommended for continuous operation; at this value non-conduction is ensured.
2. The maximum clamping voltage is the maximum reverse voltage which appears across the diode at the specified pulse duration and junction temperature. For square pulses see Figs 22 and 23, for exponential pulses see Figs 24 and 25.
3. 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.
4. Surge suppressor diodes are extremely fast in clamping, switching on in less than 5 ns.

CHARACTERISTICS – WHEN USED AS VOLTAGE REGULATOR DIODES; $T_{mb} = 25\ ^{\circ}C$

BZY91-. . .	working voltage $^*V_Z$ V		differential resistance $^*r_Z$ Ω	temperature coefficient $^*S_Z$ %/°C	test I_Z A	reverse current I_R mA	at reverse voltage V_R V
	min.	max.	max.	typ.		max.	
C7V5(R)	7.0	7.9	0.2	0.09	5.0	5.0	2.0
C8V2(R)	7.7	8.7	0.3	0.09	5.0	5.0	5.6
C9V1(R)	8.5	9.6	0.4	0.07	2.0	5.0	6.2
C10(R)	9.4	10.6	0.4	0.07	2.0	1.0	6.8
C11(R)	10.4	11.6	0.4	0.07	2.0	1.0	7.5
C12(R)	11.4	12.7	0.5	0.07	2.0	1.0	8.2
C13(R)	12.4	14.1	0.5	0.07	2.0	1.0	9.1
C15(R)	13.8	15.6	0.6	0.075	2.0	1.0	10
C16(R)	15.3	17.1	0.6	0.075	2.0	1.0	11
C18(R)	16.8	19.1	0.7	0.075	2.0	1.0	12
C20(R)	18.8	21.2	0.8	0.075	1.0	1.0	13
C22(R)	20.8	23.3	0.8	0.075	1.0	1.0	15
C24(R)	22.7	25.9	0.9	0.08	1.0	1.0	16
C27(R)	25.1	28.9	1.0	0.082	1.0	1.0	18
C30(R)	28	32	1.1	0.085	1.0	1.0	20
C33(R)	31	35	1.2	0.088	1.0	1.0	22
C36(R)	34	38	1.3	0.09	1.0	1.0	24
C39(R)	37	41	1.4	0.09	0.5	1.0	27
C43(R)	40	46	1.5	0.092	0.5	1.0	30
C47(R)	44	50	1.7	0.093	0.5	1.0	33
C51(R)	48	54	1.8	0.093	0.5	1.0	36
C56(R)	52	60	2.0	0.094	0.5	1.0	39
C62(R)	58	66	2.2	0.094	0.5	1.0	43
C68(R)	64	72	2.4	0.094	0.5	1.0	47
C75(R)	70	79	2.6	0.095	0.5	1.0	51

*At test I_Z; measured using a pulse method with $t_p \leqslant 100\ \mu s$ and $\delta \leqslant 0.001$ so that the values correspond to a T_j of approximately 25 °C.

CHARACTERISTICS – WHEN USED AS TRANSIENT SUPPRESSOR DIODES; T_{mb} = 25 °C

clamping voltage t_p = 500 μs exp. pulse $V_{(CL)R}$ V	at	non-repetitive peak reverse current I_{RSM} A	reverse current at recommended stand-off voltage I_R mA	V_R V	BZY91-. . .
typ.	max.		max.		
–	–	–	–	–	C7V5(R)
9.5	10.5	150	20	6.2	C8V2(R)
10	11	150	20	6.8	C9V1(R)
11	12.5	150	5	7.5	C10(R)
12	13.5	150	5	8.2	C11(R)
13	15	150	5	9.1	C12(R)
14.5	17	150	5	10	C13(R)
16	19	150	5	11	C15(R)
17.5	22	150	5	12	C16(R)
19	26	150	5	13	C18(R)
22	28	100	5	15	C20(R)
24	31	100	5	16	C22(R)
26	34	100	5	18	C24(R)
28	37	100	5	20	C27(R)
31	40	100	5	22	C30(R)
34	44	100	5	24	C33(R)
38	48	100	5	27	C36(R)
40	52	50	5	30	C39(R)
44	56	50	10	33	C43(R)
49	61	50	10	36	C47(R)
54	66	50	10	39	C51(R)
60	72	50	10	43	C56(R)
66	79	50	10	47	C62(R)
72	87	50	10	51	C68(R)
79	97	50	10	56	C75(R)

MOUNTING INSTRUCTIONS

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.

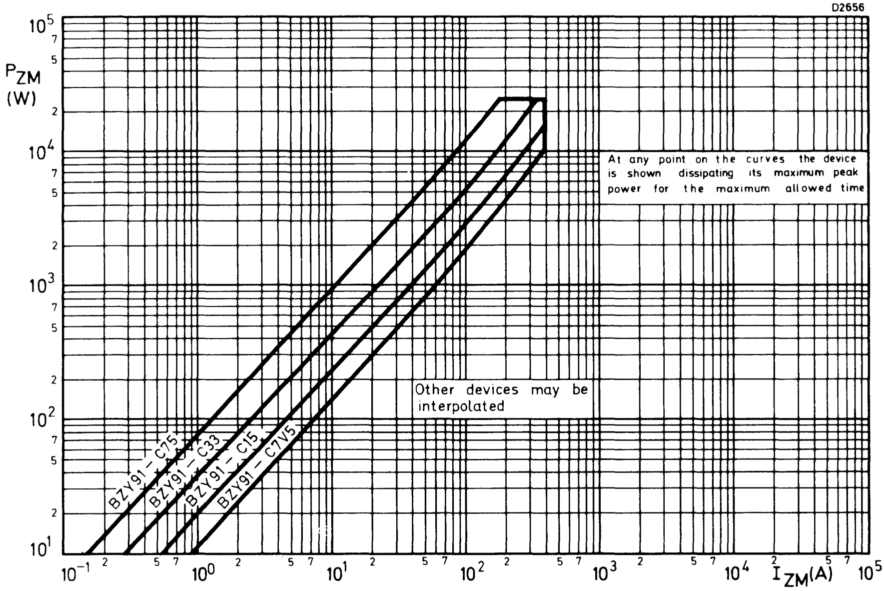

D2656
P_{ZM} (W)
10^5
10^4
10^3
10^2
10^1
10^{-1}
10^0
10^1
10^2
10^3
10^4
10^5
I_{ZM}(A)
At any point on the curves the device is shown dissipating its maximum peak power for the maximum allowed time
Other devices may be interpolated
BZY91 – C75
BZY91 – C33
BZY91 – C15
BZY91 – C7V5

Fig. 3.

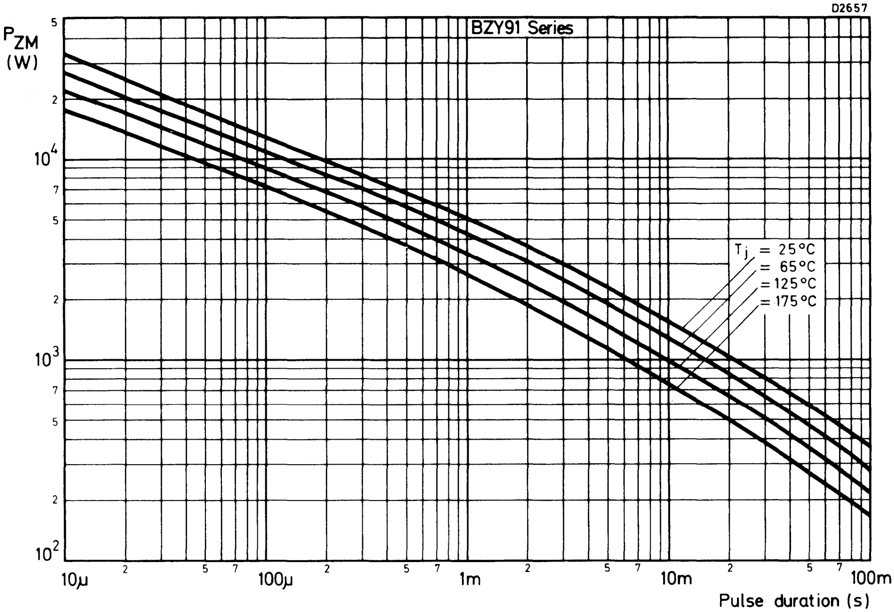

D2657
BZY91 Series
P_{ZM} (W)
10^4
10^3
10^2
10µ
100µ
1m
10m
100m
Pulse duration (s)
T_j = 25°C
= 65°C
= 125°C
= 175°C

Fig. 4.

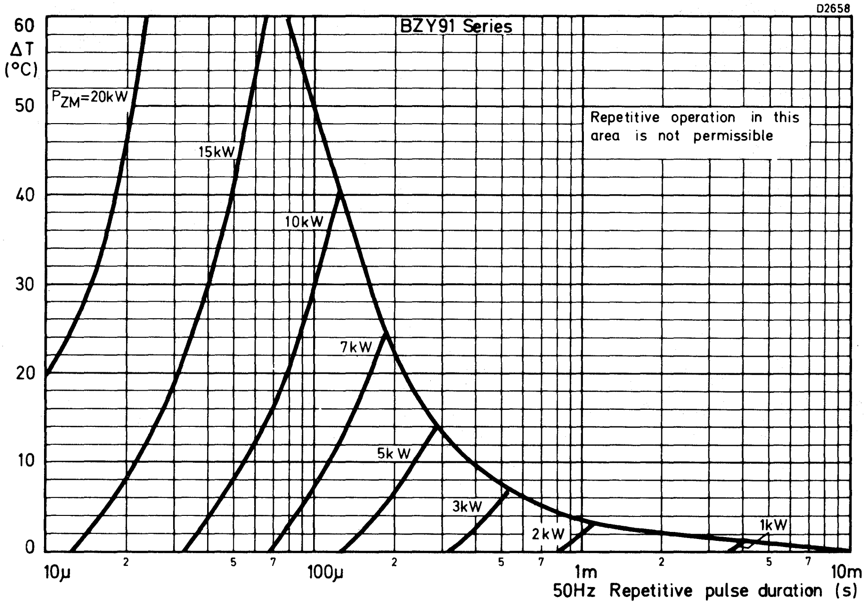

D2658
BZY91 Series
60
ΔT
(°C)
50
40
30
20
10
0
P_ZM=20kW
15kW
10kW
7kW
5k W
3kW
2kW
1kW
Repetitive operation in this area is not permissible
10μ
2
5
7
100μ
2
5
7
1m
2
5
7
10m
50Hz Repetitive pulse duration (s)

Fig. 5.

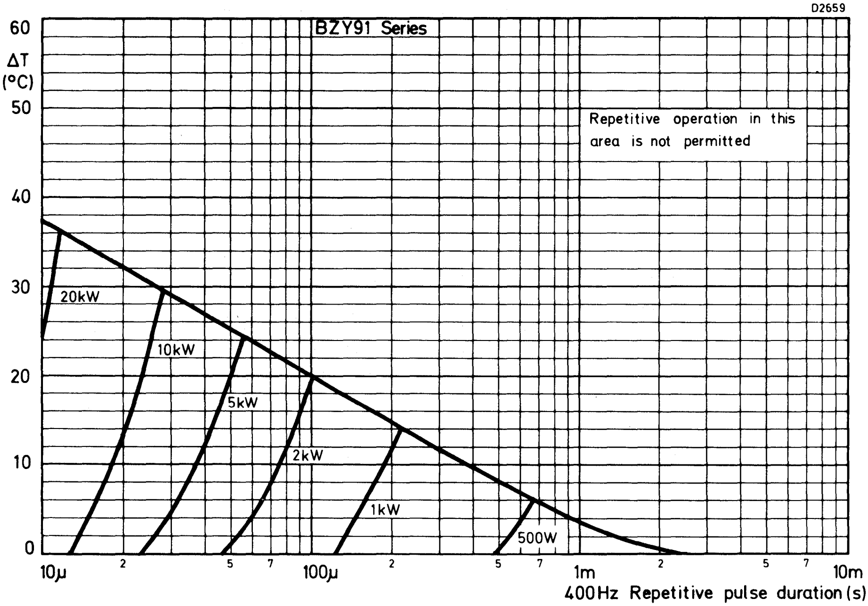

D2659
BZY91 Series
60
ΔT
(°C)
50
40
30
20
10
0
20kW
10kW
5kW
2kW
1kW
500W
Repetitive operation in this area is not permitted
10μ
2
5
7
100μ
2
5
7
1m
2
5
7
10m
400Hz Repetitive pulse duration (s)

Fig. 6.

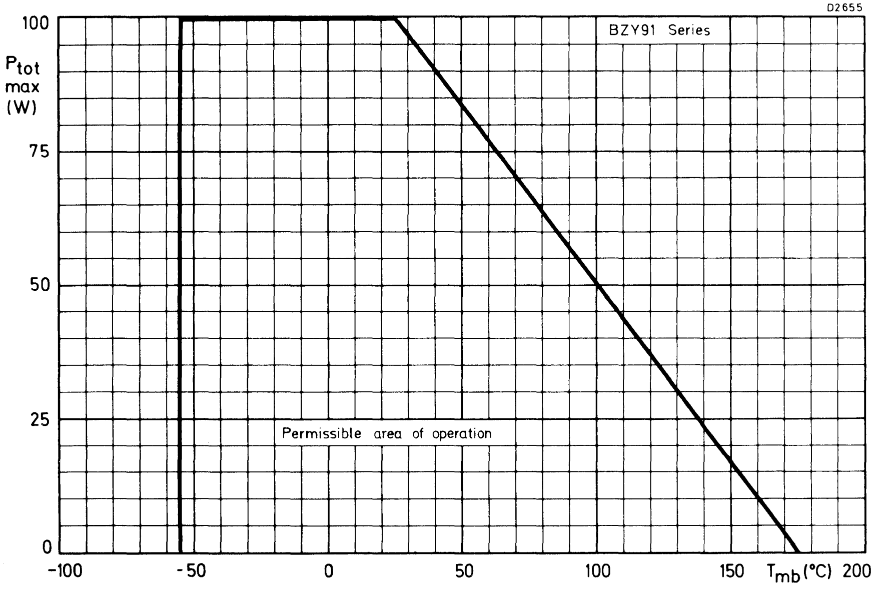


Fig. 7.

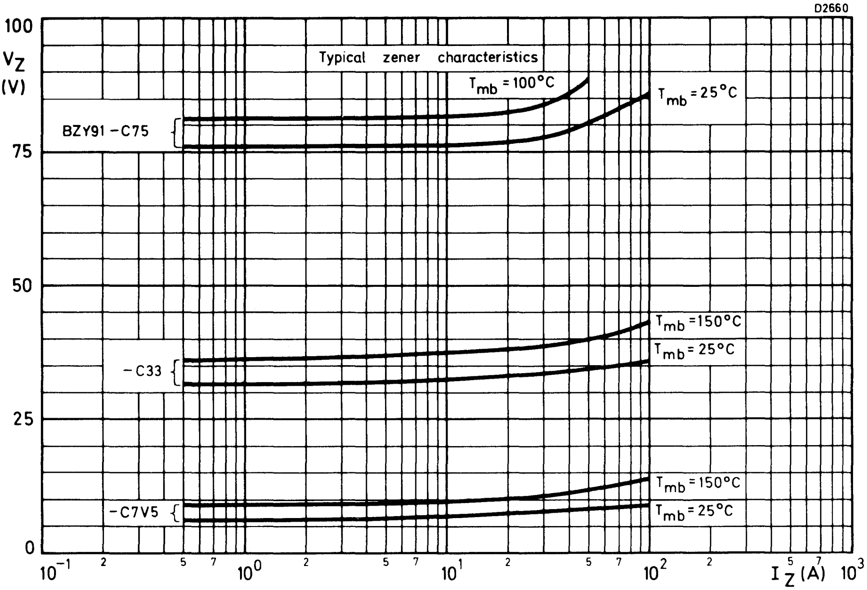


Fig. 8 Typical dynamic zener characteristics.

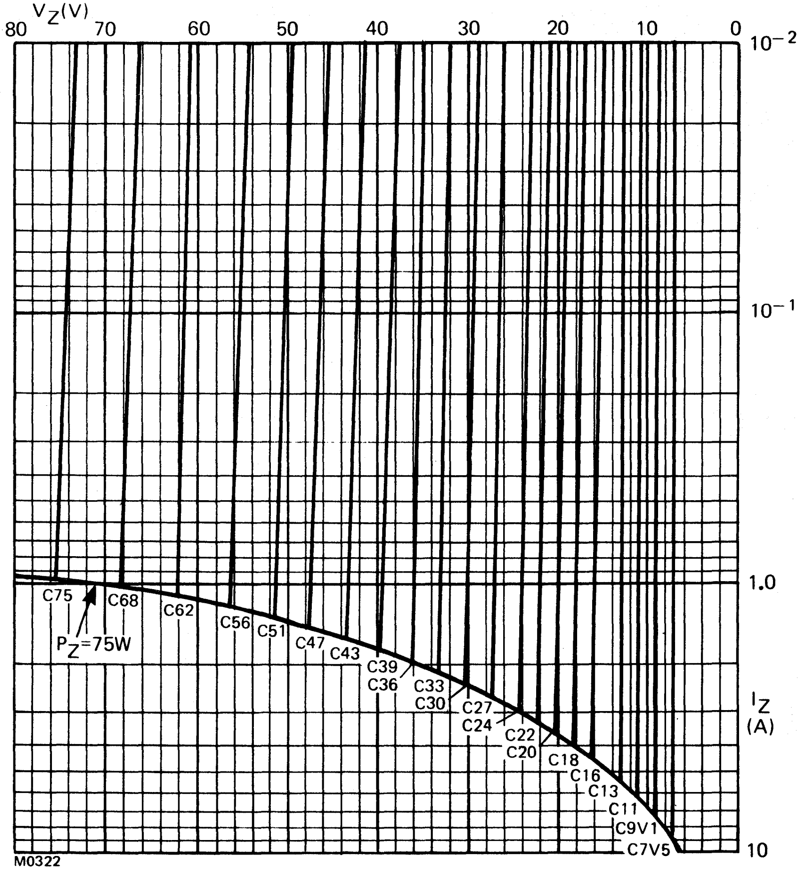
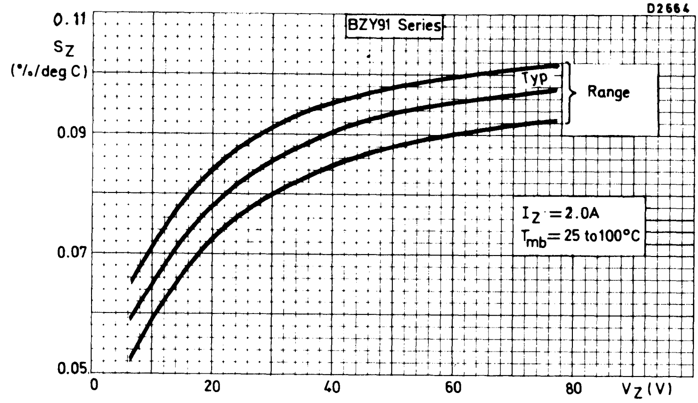
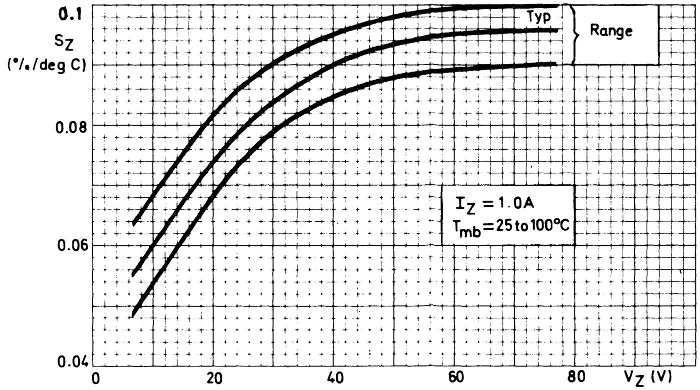


Fig.9 Typical static zener characteristics, T_{mb} = 25 °C


D2664
BZY91 Series
0.11
S_Z
(%/deg C)
0.09
0.07
0.05
0
20
40
60
80
V_Z (V)
Typ
Range
I_Z = 2.0A
T_{mb} = 25 to 100°C


0.1
S_Z
(%/deg C)
0.08
0.06
0.04
0
20
40
60
80
V_Z (V)
Typ
Range
I_Z = 1.0A
T_{mb} = 25 to 100°C

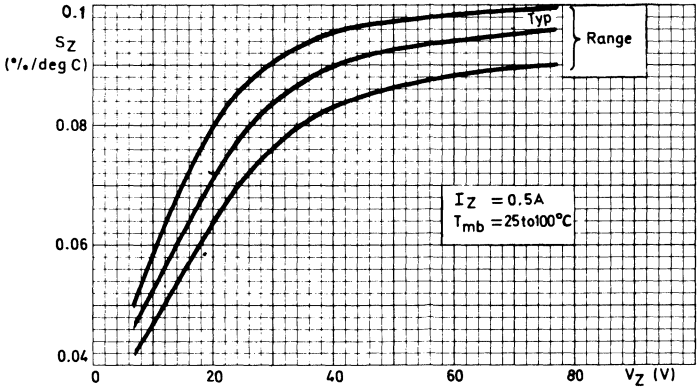
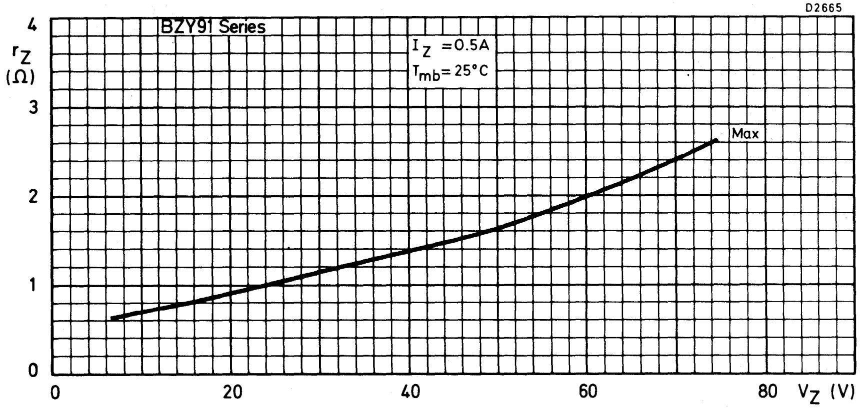
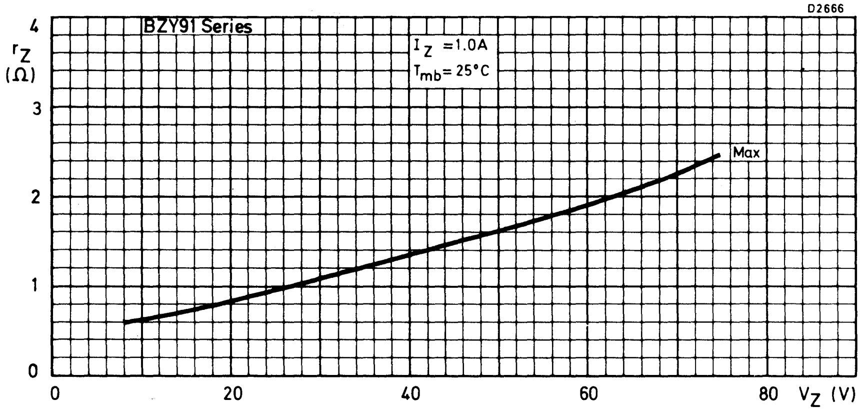

0.1
S_Z
(%/deg C)
0.08
0.06
0.04
0
20
40
60
80
V_Z (V)
Typ
Range
I_Z = 0.5A
T_{mb} = 25 to 100°C

Fig. 10.


D2665
BZY91 Series
I_Z = 0.5A
T_{mb} = 25°C
Max
r_Z (Ω)
0
1
2
3
4
0
20
40
60
80
V_Z (V)


D2666
BZY91 Series
I_Z = 1.0A
T_{mb} = 25°C
Max
r_Z (Ω)
0
1
2
3
4
0
20
40
60
80
V_Z (V)

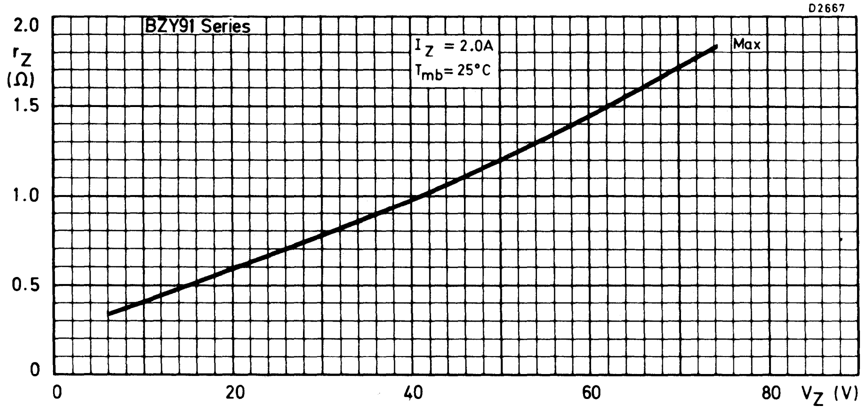

D2667
BZY91 Series
I_Z = 2.0A
T_{mb} = 25°C
Max
r_Z (Ω)
0
0.5
1.0
1.5
2.0
0
20
40
60
80
V_Z (V)

Fig. 11.

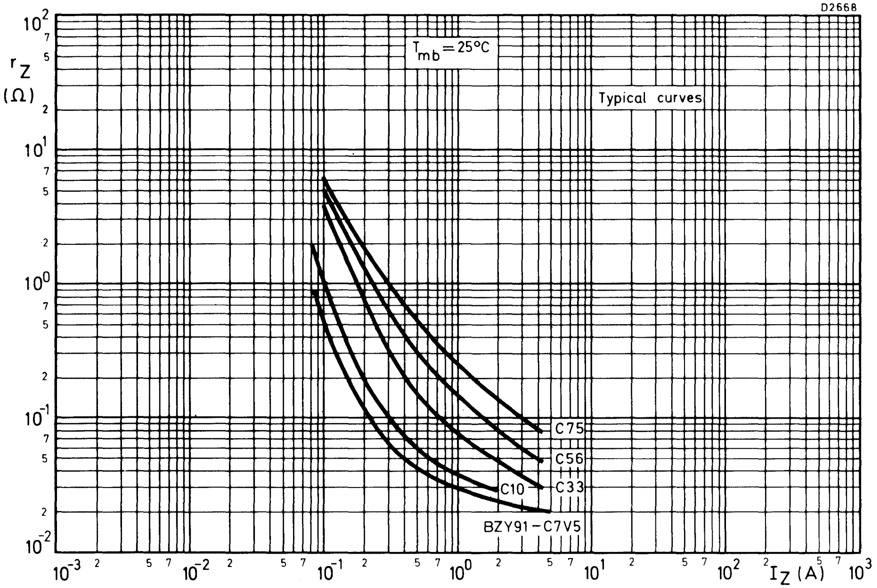

D2668
r_Z (Ω)
$T_{mb} = 25°C$
Typical curves
C75
C56
C33
C10
BZY91 – C7V5
10^2
10^1
10^0
10^{-1}
10^{-2}
10^{-3}
10^3
I_Z (A)

Fig. 12.

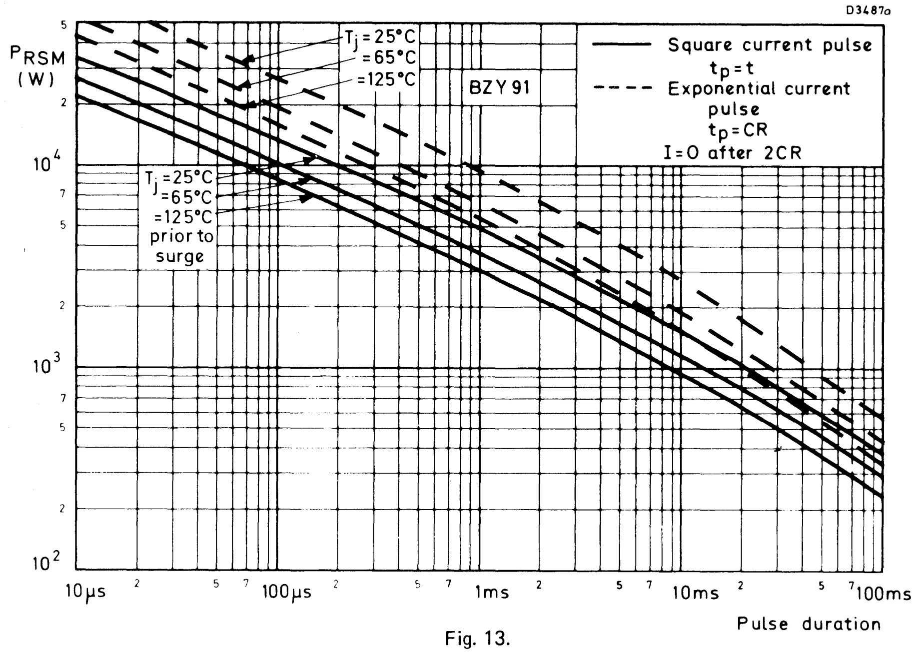

D3487a
P_{RSM} (W)
$T_j = 25°C$
= 65°C
= 125°C
BZY 91
Square current pulse $t_p = t$
Exponential current pulse $t_p = CR$
I = O after 2CR
$T_j = 25°C$
= 65°C
= 125°C
prior to surge
10^4
10^3
10^2
10μs
100μs
1ms
10ms
100ms
Pulse duration

Fig. 13.

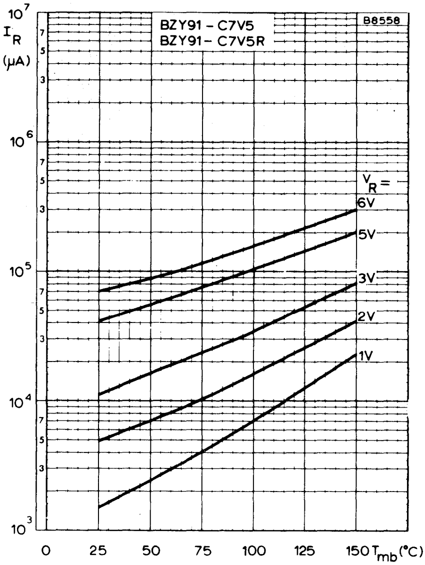


Fig. 14.

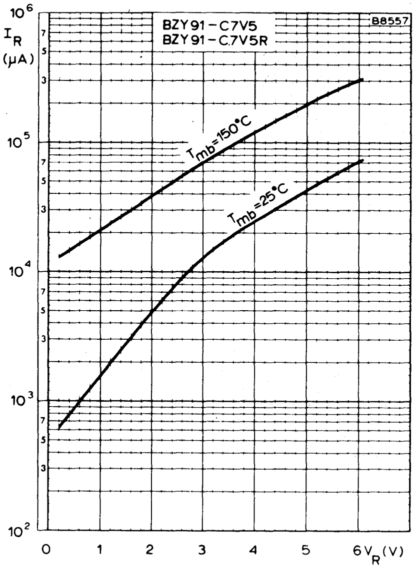


Fig. 15.

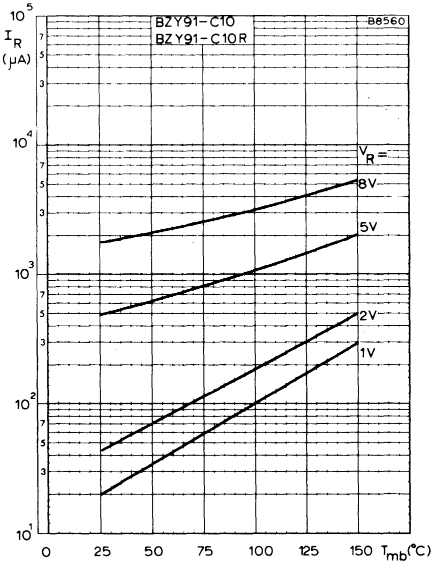


Fig. 16.

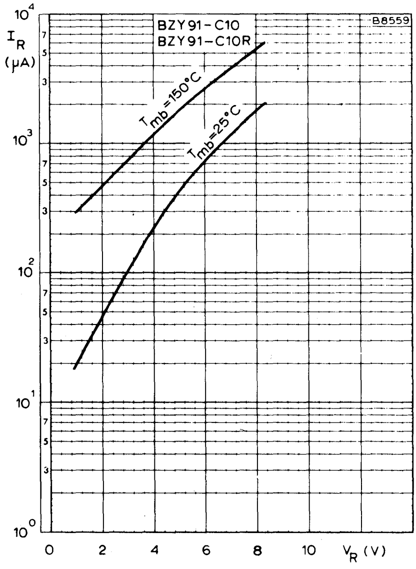


Fig. 17.

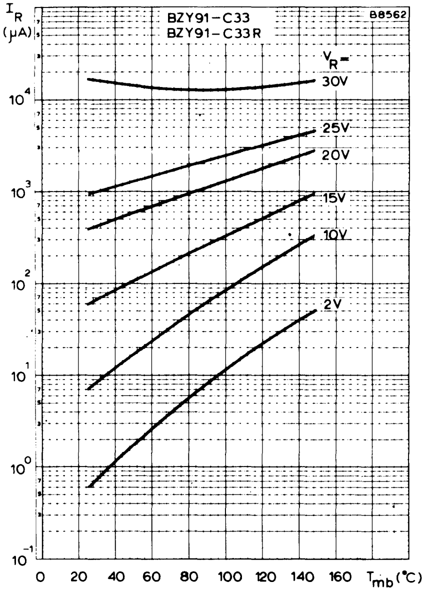


Fig. 18.

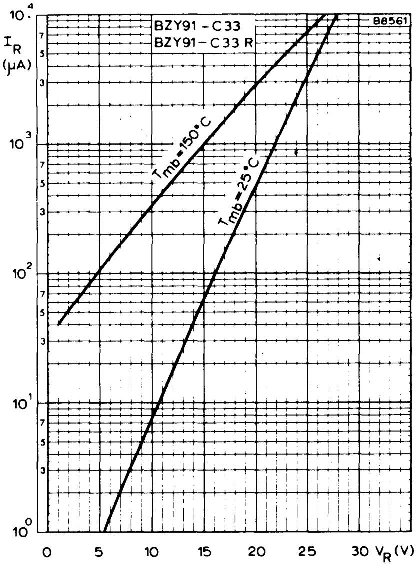


Fig. 19.

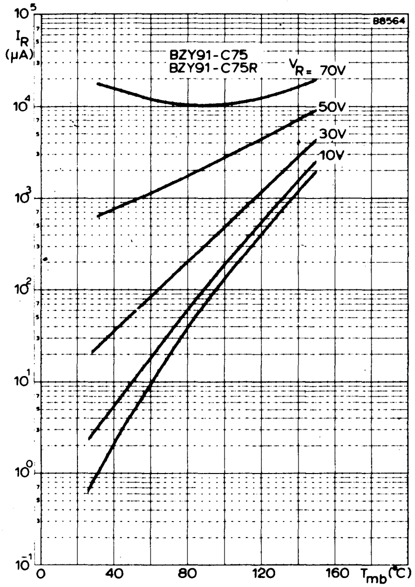


Fig. 20.

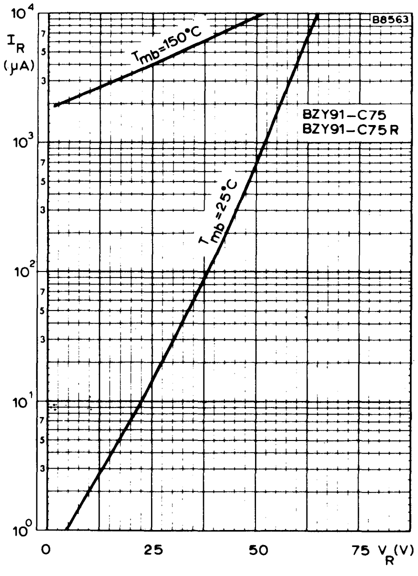


Fig. 21.

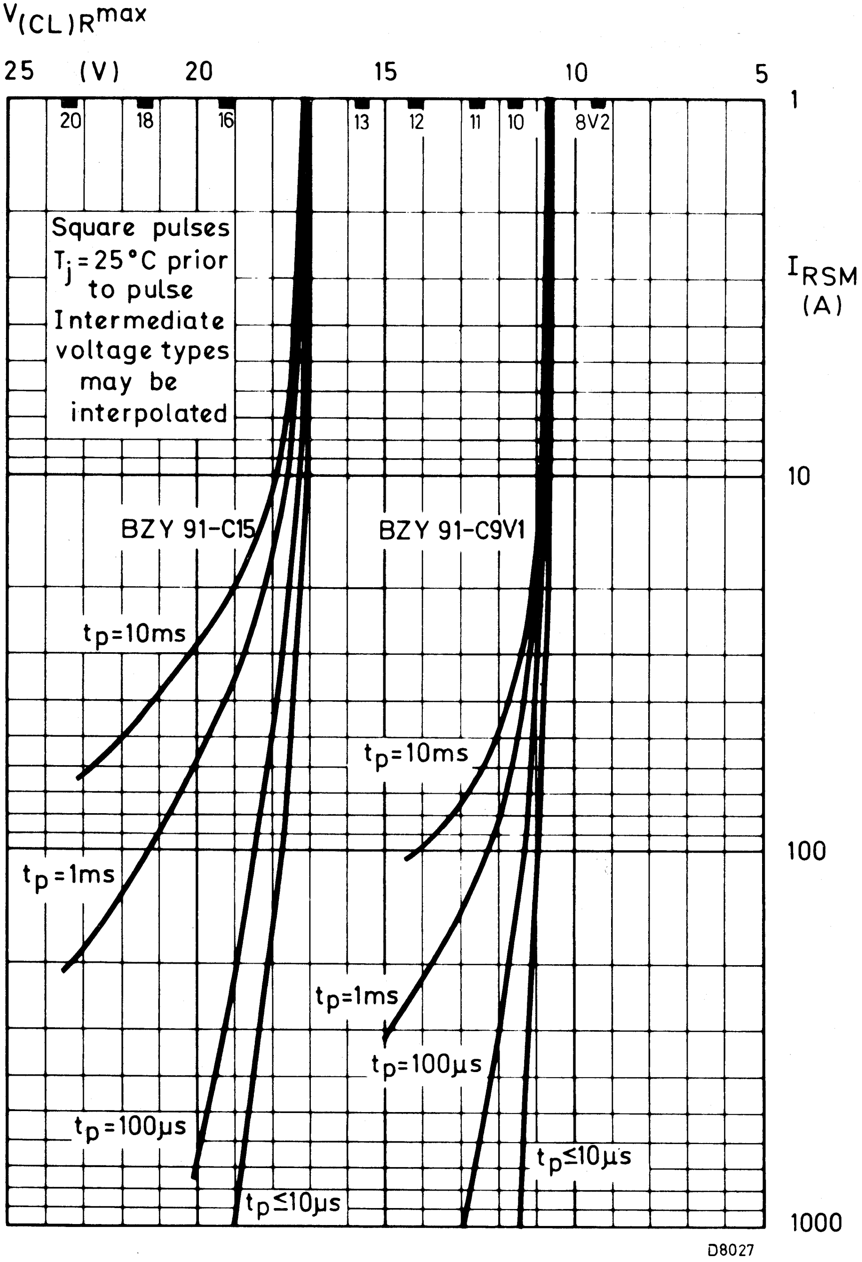

$V_{(CL)R}$max
25
(V)
20
15
10
5
20
18
16
13
12
11
10
8V2
Square pulses
T_j = 25 °C prior to pulse
Intermediate voltage types may be interpolated
I_{RSM}
(A)
1
10
100
1000
BZY 91-C15
BZY 91-C9V1
t_p = 10ms
t_p = 1ms
t_p = 100μs
t_p ≤ 10μs
t_p = 10ms
t_p = 1ms
t_p = 100μs
t_p ≤ 10μs
D8027

Fig. 22.

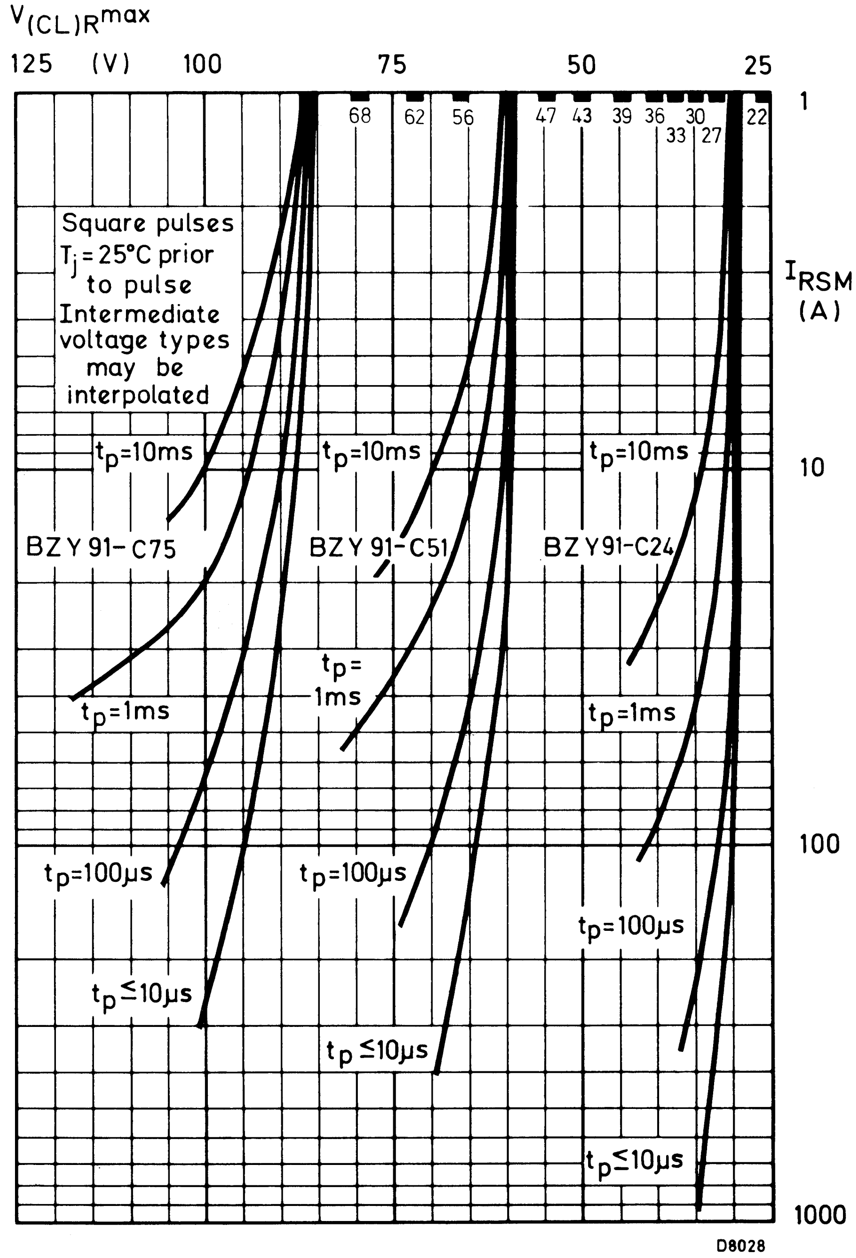

$V_{(CL)R}$max
125
(V)
100
75
50
25
68
62
56
47
43
39
36
30
33
27
22
1
10
100
1000
I_{RSM}
(A)
Square pulses
T_j = 25°C prior to pulse
Intermediate voltage types may be interpolated
t_p=10ms
t_p=10ms
t_p=10ms
BZY 91-C75
BZY 91-C51
BZY91-C24
t_p=1ms
t_p= 1ms
t_p=1ms
t_p=100µs
t_p=100µs
t_p=100µs
t_p≤10µs
t_p≤10µs
t_p≤10µs
D8028

Fig. 23.

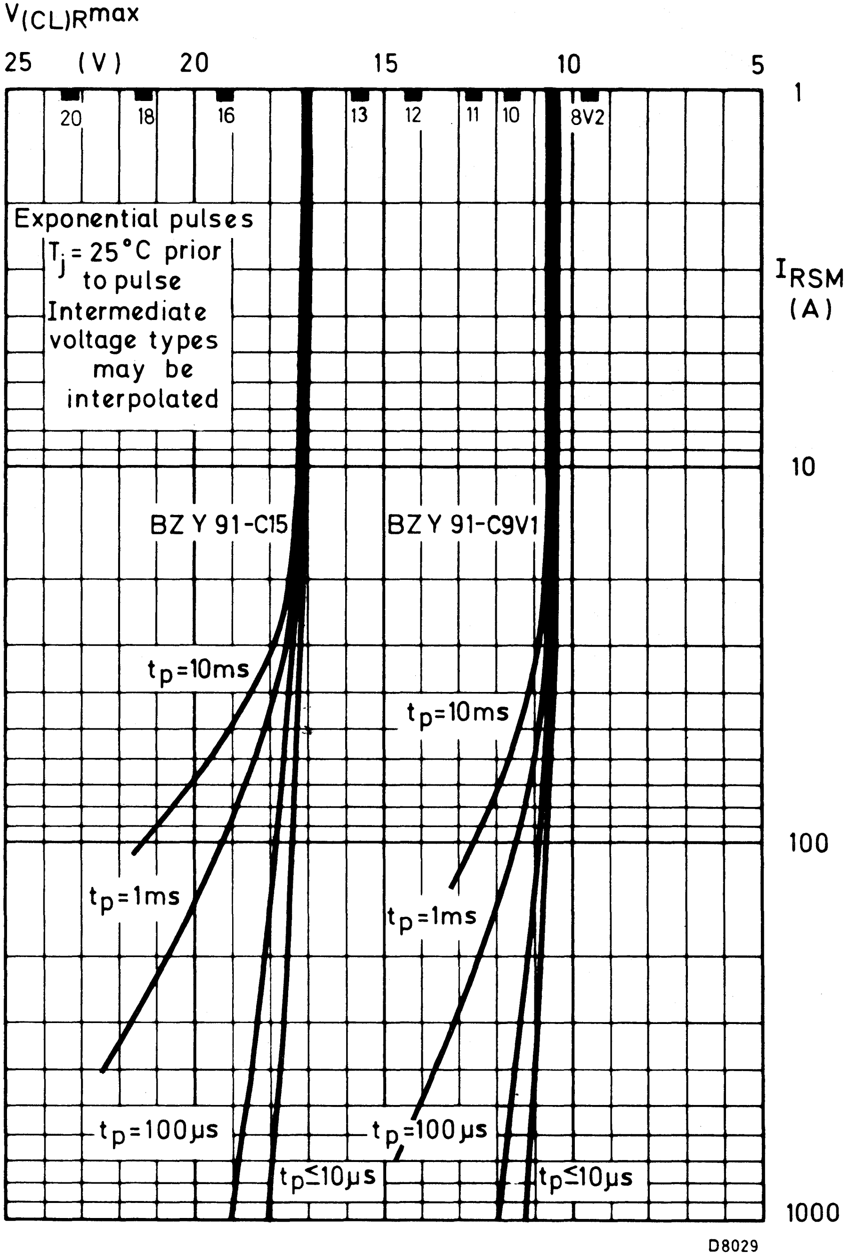

$V_{(CL)R}max$
(V)
25
20
15
10
5
20
18
16
13
12
11
10
8V2
Exponential pulses
T_j = 25°C prior to pulse
Intermediate voltage types may be interpolated
I_{RSM} (A)
1
10
100
1000
BZY 91-C15
BZY 91-C9V1
t_p=10ms
t_p=1ms
t_p=100μs
t_p≤10μs
t_p=10ms
t_p=1ms
t_p=100μs
t_p≤10μs
D8029

Fig. 24.

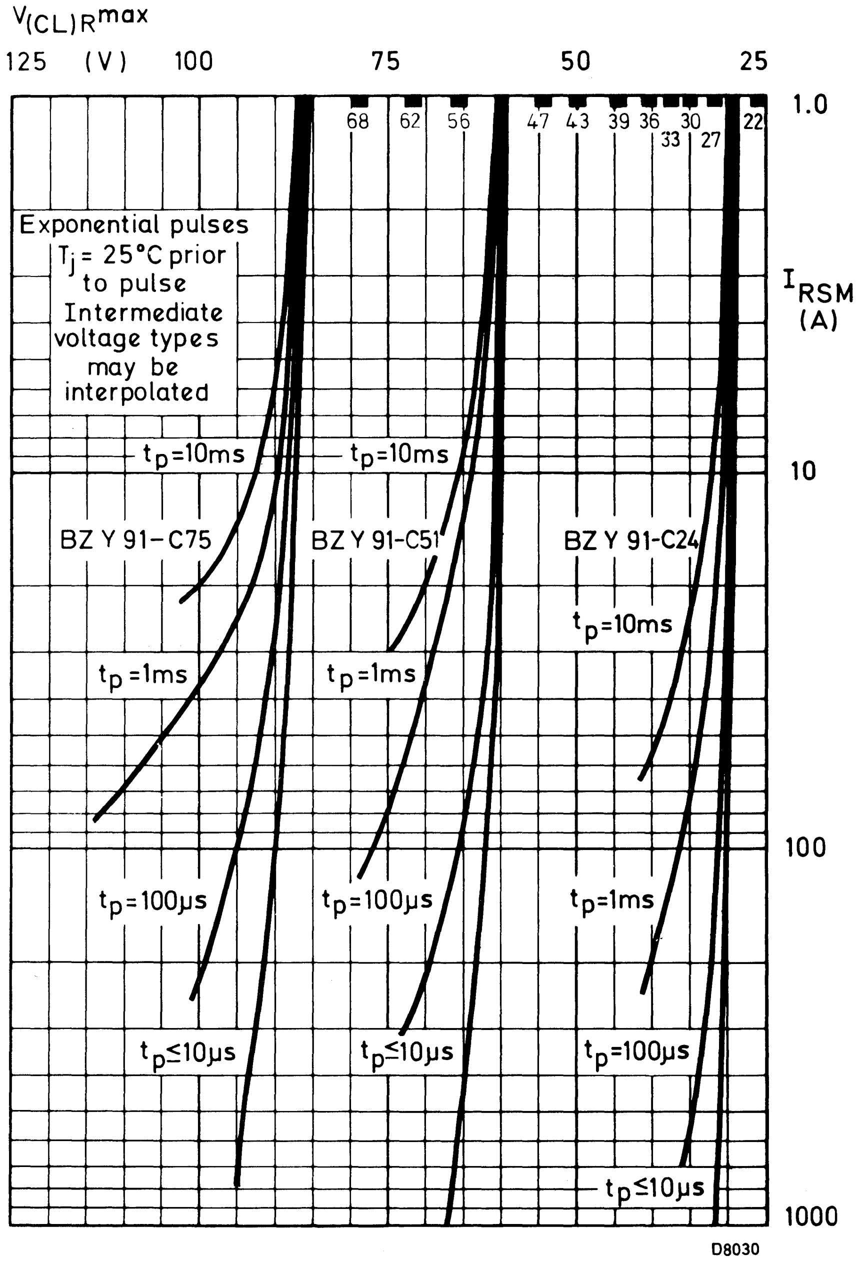

$V_{(CL)R}$max
125 (V) 100
75
50
25
68 62 56 47 43 39 36 33 30 27 22
1.0
10
100
1000
I_{RSM} (A)
Exponential pulses
T_j = 25°C prior to pulse
Intermediate voltage types may be interpolated
t_p=10ms
t_p=10ms
BZ Y 91-C75
BZ Y 91-C51
BZ Y 91-C24
t_p=10ms
t_p =1ms
t_p =1ms
t_p=100μs
t_p=100μs
t_p=1ms
t_p≤10μs
t_p≤10μs
t_p=100μs
t_p≤10μs
D8030

Fig. 25.

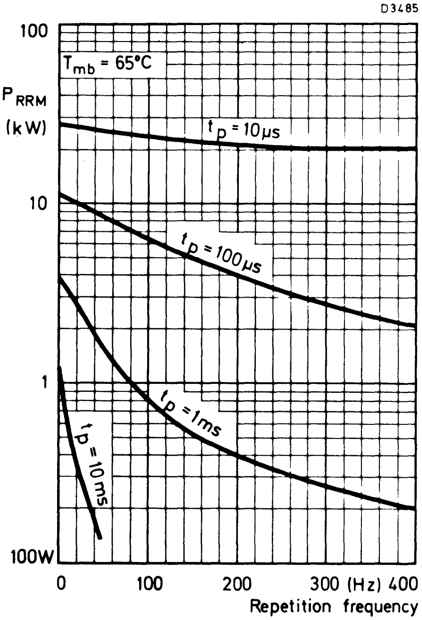


Fig. 26.

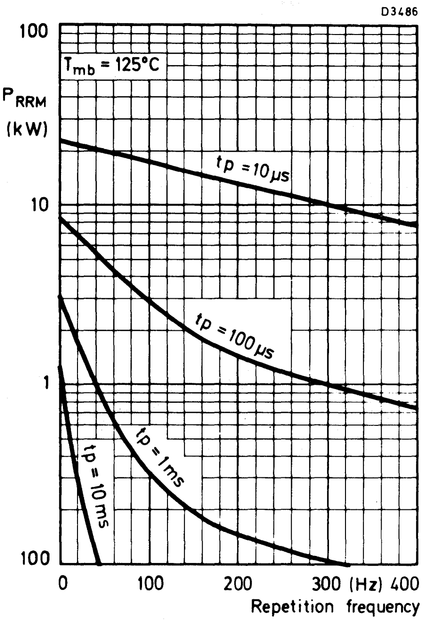


Fig. 27.

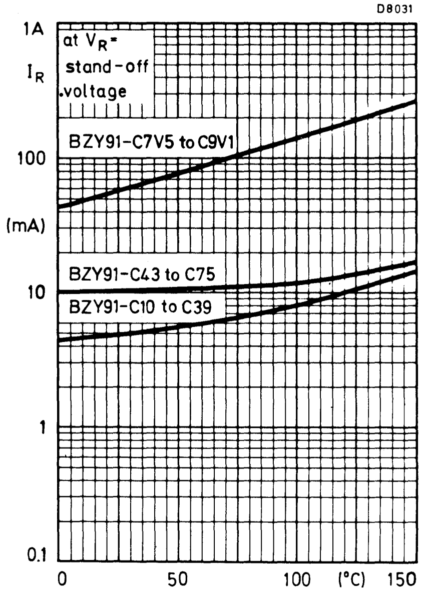


Fig. 28.

REGULATOR DIODES

Also available to BS9305—F051

A range of diffused silicon diodes in DO-4 metal envelopes, intended for use as voltage regulator and transient suppressor diodes in power stabilization and transient suppression circuits.

The series consists of the following types:
Normal polarity (cathode to stud): BZY93-C7V5 to BZY93-C75.
Reverse polarity (anode to stud): BZY93-C7V5R to BZY93-C75R.

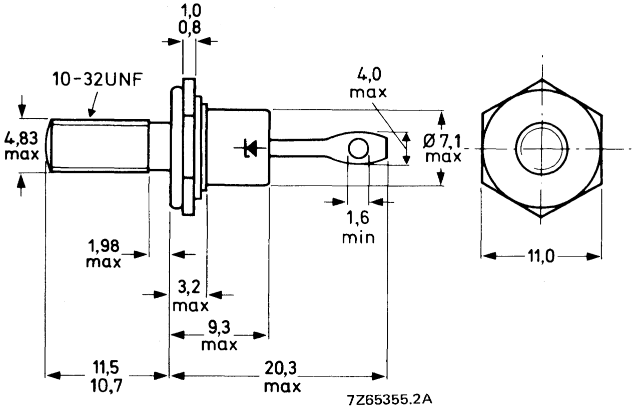
QUICK REFERENCE DATA

			voltage regulator	transient suppressor	
Working voltage (5% range)	V_Z	nom.	7,5 to 75	—	V
Stand-off voltage	V_R		—	5,6 to 56	V
Total power dissipation	P_{tot}	max.	20	—	W
Non-repetitive peak reverse power dissipation	P_{RSM}	max.	—	700	W

MECHANICAL DATA

Dimensions in mm

Fig. 1 DO-4.



Net mass: 6 g

Diameter of clearance hole: max. 5,2 mm

Accessories supplied on request:
see ACCESSORIES section

Supplied with device: 1 nut, 1 lock washer
Nut dimensions across the flats: 9,5 mm

Torque on nut: min. 0,9 Nm (9 kg cm)
max. 1,7 Nm (17 kg cm)

RATINGS

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

Peak working current	I_{ZM}	max.	20	A
Average forward current (averaged over any 20 ms period)	$I_{F(AV)}$	max.	5	A
Non-repetitive peak reverse current $T_j = 25\ ^oC$ prior to surge; $t_p = 1$ ms (exponential pulse); BZY93-C7V5(R) to BZY93-C75(R)	I_{RSM}	max.	55 to 6	A
Total power dissipation up to $T_{mb} = 75\ ^oC$	P_{tot}	max.	20	W
Non-repetitive peak reverse power dissipation $T_j = 25\ ^oC$ prior to surge; $t_p = 1$ ms (exponential pulse)	P_{RSM}	max.	700	W
Storage temperature	T_{stg}		−55 to + 175	^oC
Junction temperature	T_j	max.	175	^oC

THERMAL RESISTANCE

From junction to mounting base	$R_{th\ j\text{-}mb}$	=	5	$^oC/W$
From junction to ambient	$R_{th\ j\text{-}a}$	=	50	$^oC/W$
From mounting base to heatsink (minimum torque: 0,9 Nm)	$R_{th\ mb\text{-}h}$	=	0,6	$^oC/W$

CHARACTERISTICS

Forward voltage $I_F = 5$ A; $T_{mb} = 25\ ^oC$	V_F	<	1,5	V

OPERATION AS A VOLTAGE REGULATOR (see page 716)

Dissipation and heatsink considerations

a. Steady-state conditions

The maximum permissible 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. 2)

The maximum permissible pulse power $P_{p\ max}$ is given by the formula

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

where: P_s is any steady-state dissipation excluding that in pulses

$R_{th\ t}$ is the effective transient thermal resistance of the device between junction and mounting base. It is a function of the pulse duration t_p and duty factor δ.

δ is duty factor (t_p/T)

$R_{th\ mb\text{-}a}$ is the total thermal resistance between the mounting base and 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 Fig. 14. With the additional pulse power dissipation $P_{p\ max}$ calculated from the above expression, the total peak zener power dissipation $P_{tot} = P_{ZRM} = P_s + P_p$. From Fig. 14 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 larger than the temperature stabilization time of the diode t_{stab}, the maximum permissible repetitive peak dissipation P_{ZRM} is equal to the steady-state power P_s. The temperature stabilization time for the BZY93 is 5 seconds (see Fig. **9**).

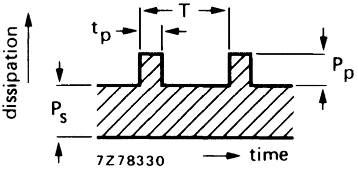


Fig. 2.

OPERATION AS A TRANSIENT SUPPRESSOR (see page 717)

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 Figs 19 and 20 the required heatsink is found as follows:

$$R_{th\ j\text{-}mb} + R_{th\ mb\text{-}h} + R_{th\ h\text{-}a} = \frac{T_{j\ max} - T_{amb}}{P_s + \delta \cdot P_{RRM}}$$

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 °C/W

$R_{th\ mb\text{-}h}$ = 0,6 °C/W

Thus $R_{th\ h\text{-}a}$ can be found.

Notes

1. The stand-off voltage is the maximum reverse voltage recommended for continuous operation; at this value non-conduction is ensured.
2. The maximum clamping voltage is the maximum reverse voltage which appears across the diode at the specified pulse duration and junction temperature. For square pulses see Figs 15 and 16, for exponential pulses see Figs 17 and 18.
3. 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.
4. Surge suppressor diodes are extremely fast in clamping, switching on in less than 5 ns.

CHARACTERISTICS – WHEN USED AS VOLTAGE REGULATOR DIODES; T_{mb} = 25 °C

BZY93-. . .	working voltage $^*V_Z$ V		differential resistance $^*r_Z$ Ω		temperature coefficient $^*S_Z$ mV/°C	test I_Z A	reverse current I_R µA	at reverse voltage V_R V
	min.	max.	typ.	max.	typ.		max.	
C7V5(R)	7.0	7.9	0.04	0.3	3.0	2.0	100	2.0
C8V2(R)	7.7	8.7	0.05	0.3	4.0	2.0	100	5.6
C9V1(R)	8.5	9.6	0.07	0.5	5.0	1.0	50	6.2
C10(R)	9.4	10.6	0.07	0.5	7.0	1.0	50	6.8
C11(R)	10.4	11.6	0.08	1.0	7.5	1.0	50	7.5
C12(R)	11.4	12.7	0.08	1.0	8.0	1.0	50	8.2
C13(R)	12.4	14.1	0.08	1.0	8.5	1.0	50	9.1
C15(R)	13.8	15.6	0.10	1.2	10	1.0	50	10
C16(R)	15.3	17.1	0.18	1.2	11	0.5	50	11
C18(R)	16.8	19.1	0.2	1.5	12	0.5	50	12
C20(R)	18.8	21.2	0.2	1.5	14	0.5	50	13
C22(R)	20.8	23.3	0.21	1.8	16	0.5	50	15
C24(R)	22.7	25.9	0.22	2.0	18	0.5	50	16
C27(R)	25.1	28.9	0.25	2.0	21	0.5	50	18
C30(R)	28	32	0.3	2.5	25	0.5	50	20
C33(R)	31	35	0.32	3.0	30	0.5	50	22
C36(R)	34	38	0.75	4.0	32	0.2	50	24
C39(R)	37	41	0.85	5.0	35	0.2	50	27
C43(R)	40	46	0.90	6.5	40	0.2	50	30
C47(R)	44	50	1.0	7.0	45	0.2	50	33
C51(R)	48	54	1.2	7.5	50	0.2	50	36
C56(R)	52	60	1.3	8.0	55	0.2	50	39
C62(R)	58	66	1.5	9.0	60	0.2	50	43
C68(R)	64	72	1.8	10	65	0.2	50	47
C75(R)	70	79	2.0	10.5	70	0.2	50	51

*At test I_Z; measured using a pulse method with $t_p \leqslant 100$ µs and $\delta \leqslant 0.001$ so that the values correspond to a T_j of approximately 25 °C.

CHARACTERISTICS – WHEN USED AS TRANSIENT SUPPRESSOR DIODES; T_{mb} = 25 °C

clamping voltage t_p = 500 μs exp. pulse $V_{(CL)R}$ V		at non-repetitive peak reverse current I_{RSM} A	reverse current at recommended stand-off voltage I_R mA	V_R V	BZY93-. . .
typ.	max.		max.		
8	9.2	20	0.5	5.6	C7V5(R)
9	10.2	20	0.5	6.2	C8V2(R)
10	11.5	20	0.5	6.8	C9V1(R)
11	12.5	20	0.1	7.5	C10(R)
12.3	14	20	0.1	8.2	C11(R)
14	16	20	0.1	9.1	C12(R)
15.3	17.5	20	0.1	10	C13(R)
17	19.5	20	0.1	11	C15(R)
19.3	22	20	0.1	12	C16(R)
21	24	20	0.1	13	C18(R)
23	27	10	0.1	15	C20(R)
26	30	10	0.1	16	C22(R)
29	34	10	0.1	18	C24(R)
33	39	10	0.1	20	C27(R)
38	44	10	0.1	22	C30(R)
42	50	10	0.1	24	C33(R)
47	56	10	0.1	27	C36(R)
40	47	5	0.1	30	C39(R)
45	52	5	0.1	33	C43(R)
51	59	5	0.1	36	C47(R)
57	66	5	0.1	39	C51(R)
64	75	5	0.1	43	C56(R)
73	85	5	0.1	47	C62(R)
81	94	5	0.1	51	C68(R)
90	105	5	0.1	56	C75(R)

MOUNTING INSTRUCTIONS

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.

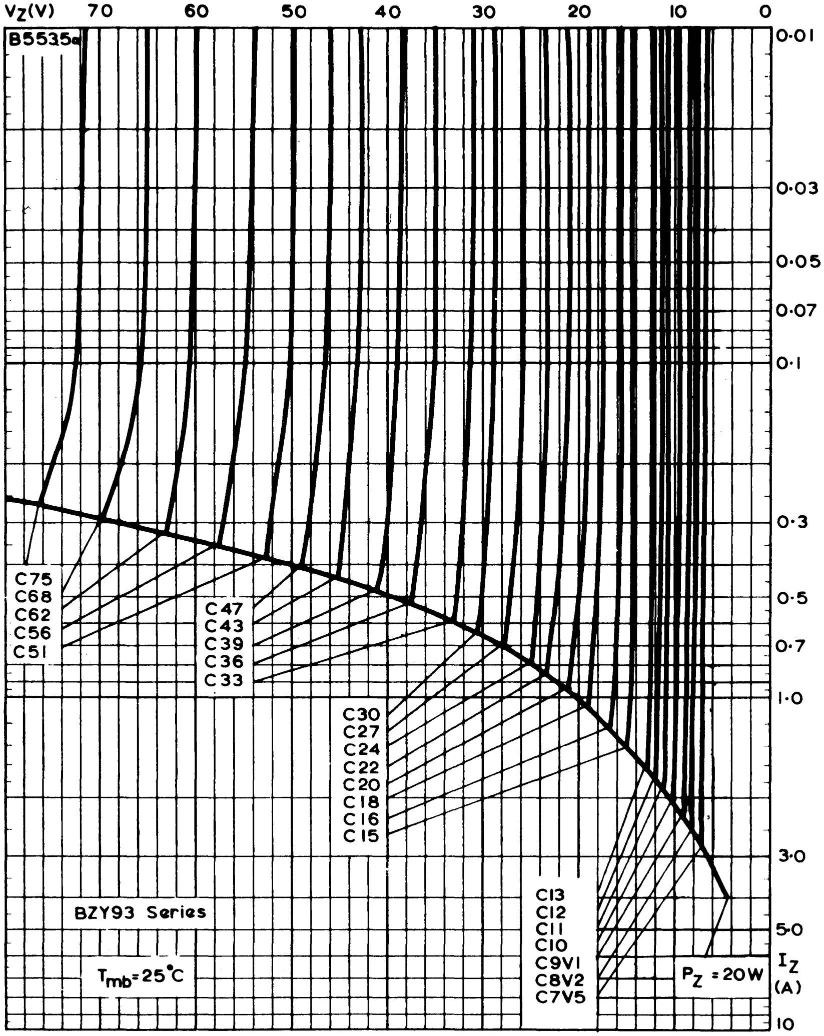


Fig. 3 Typical static zener characteristics.

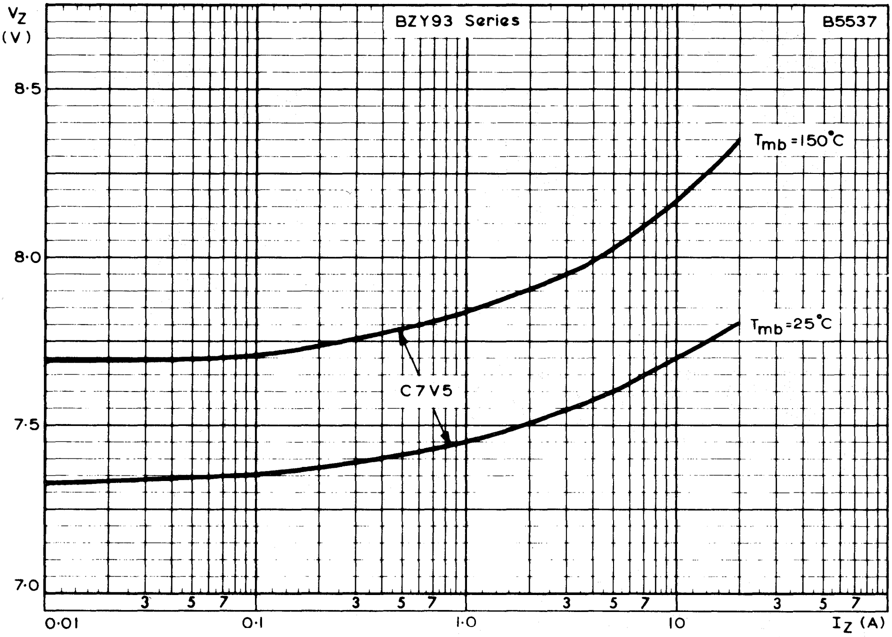


Fig. 4 Typical dynamic zener characteristics for BZY93-C7V5.

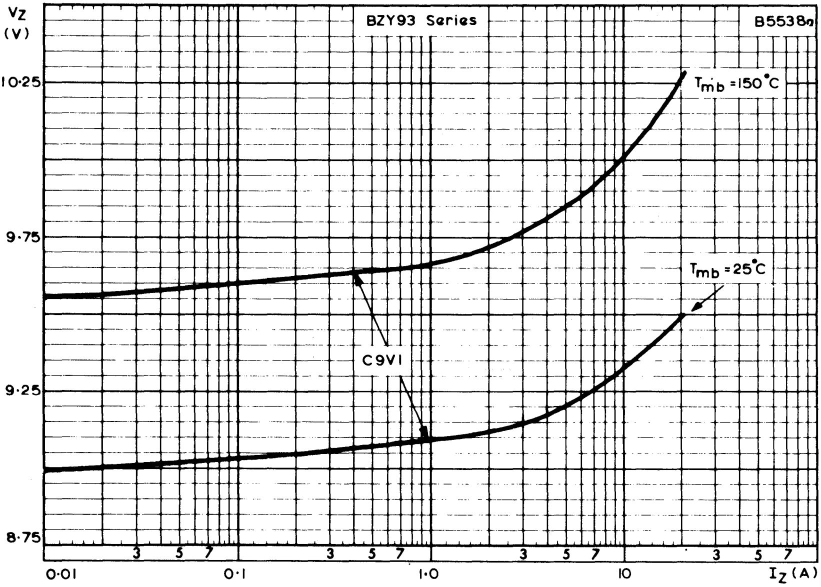


Fig. 5 Typical dynamic zener characteristics for BZY93-C9V1.

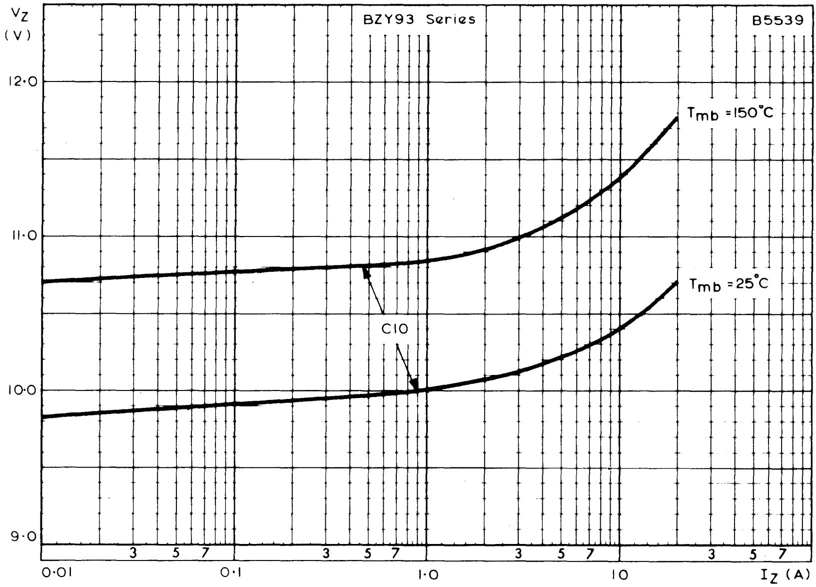


Fig. 6 Typical dynamic zener characteristics for BZY93-C10.

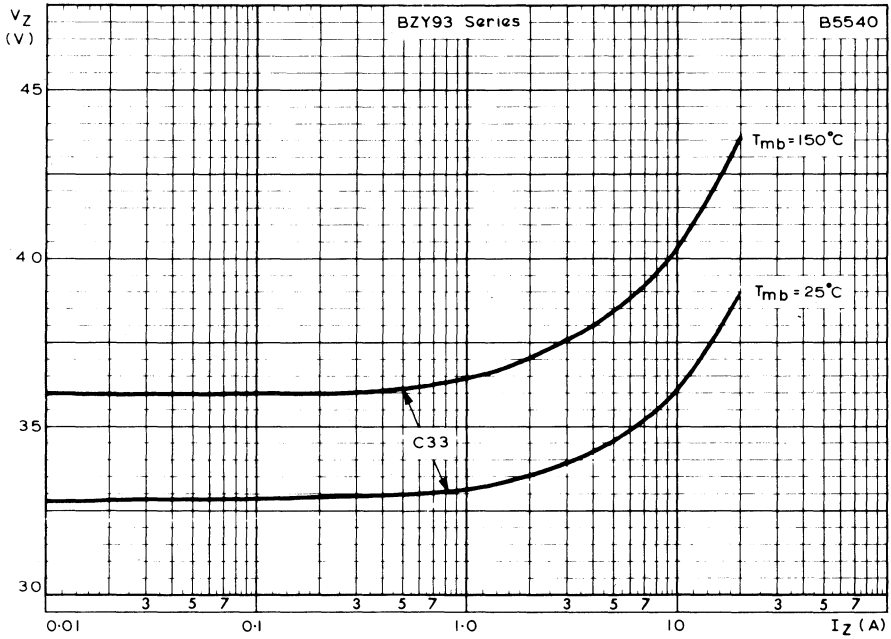


Fig. 7 Typical dynamic zener characteristics for BZY93-C33.

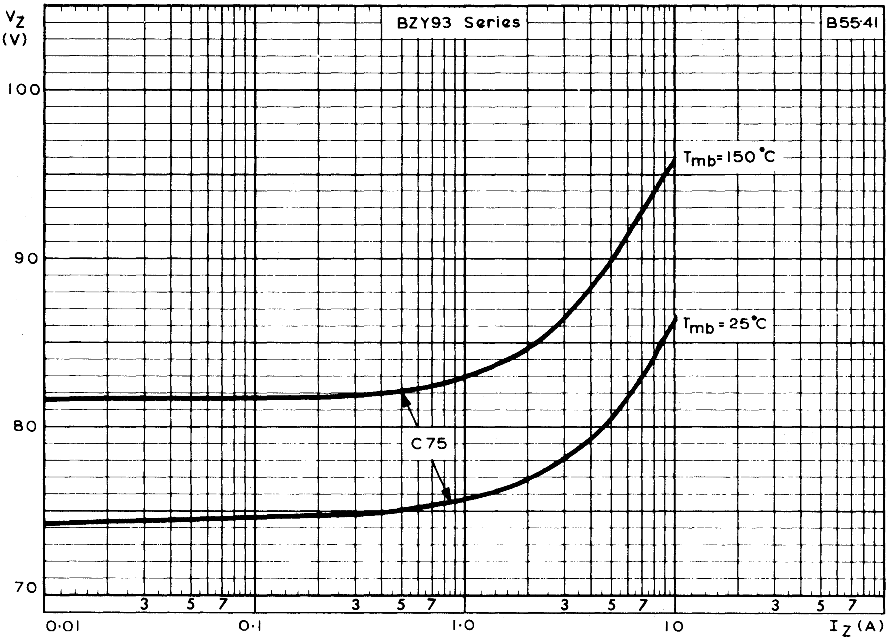


Fig. 8 Typical dynamic zener characteristics for BZY93-C75.

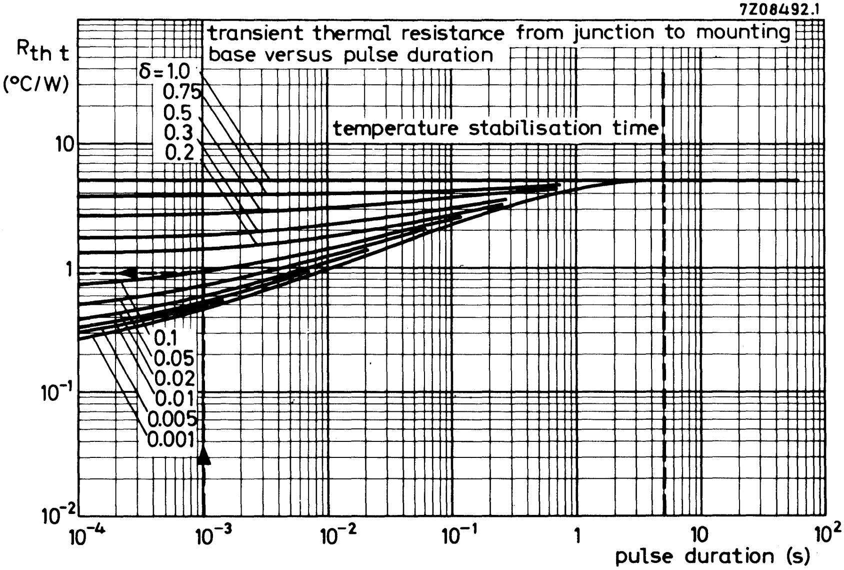


Fig. 9.

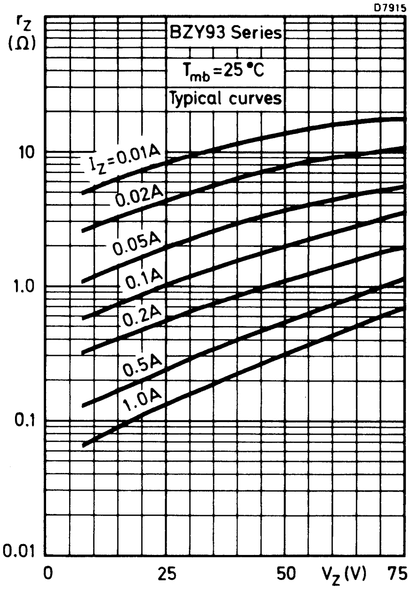


Fig. 10.

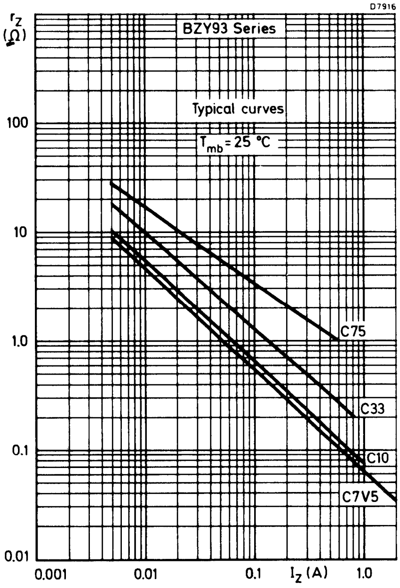


Fig. 11.

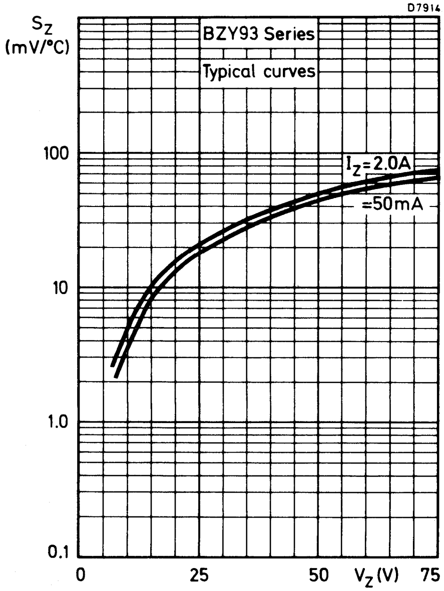


Fig. 12.

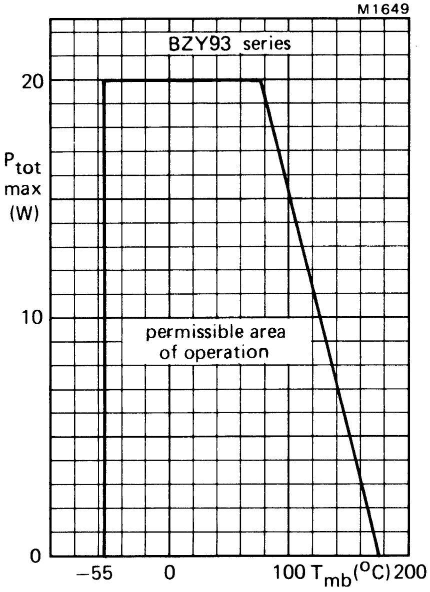


Fig. 13.

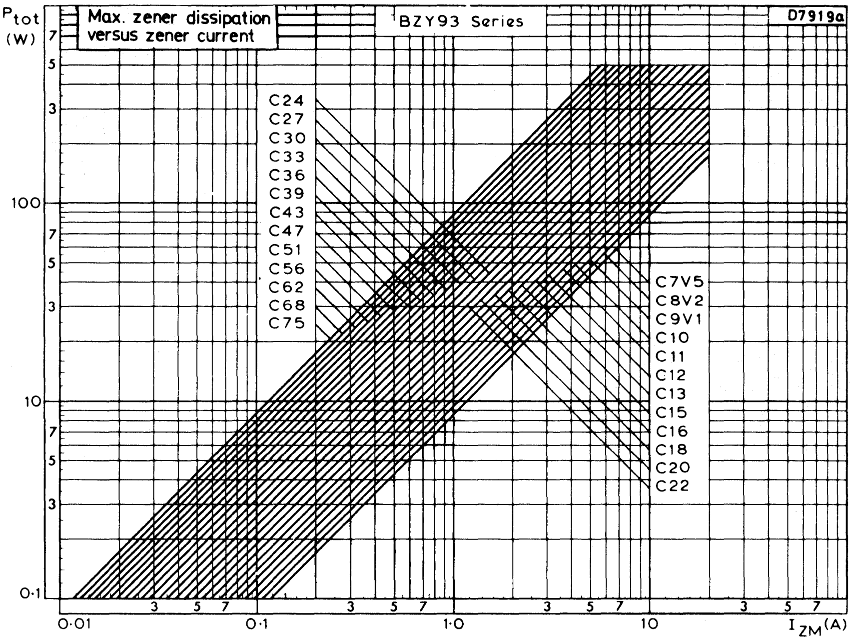


Fig. 14 Maximum permissible repetitive peak dissipation ($P_{tot} = P_{ZRM}$).

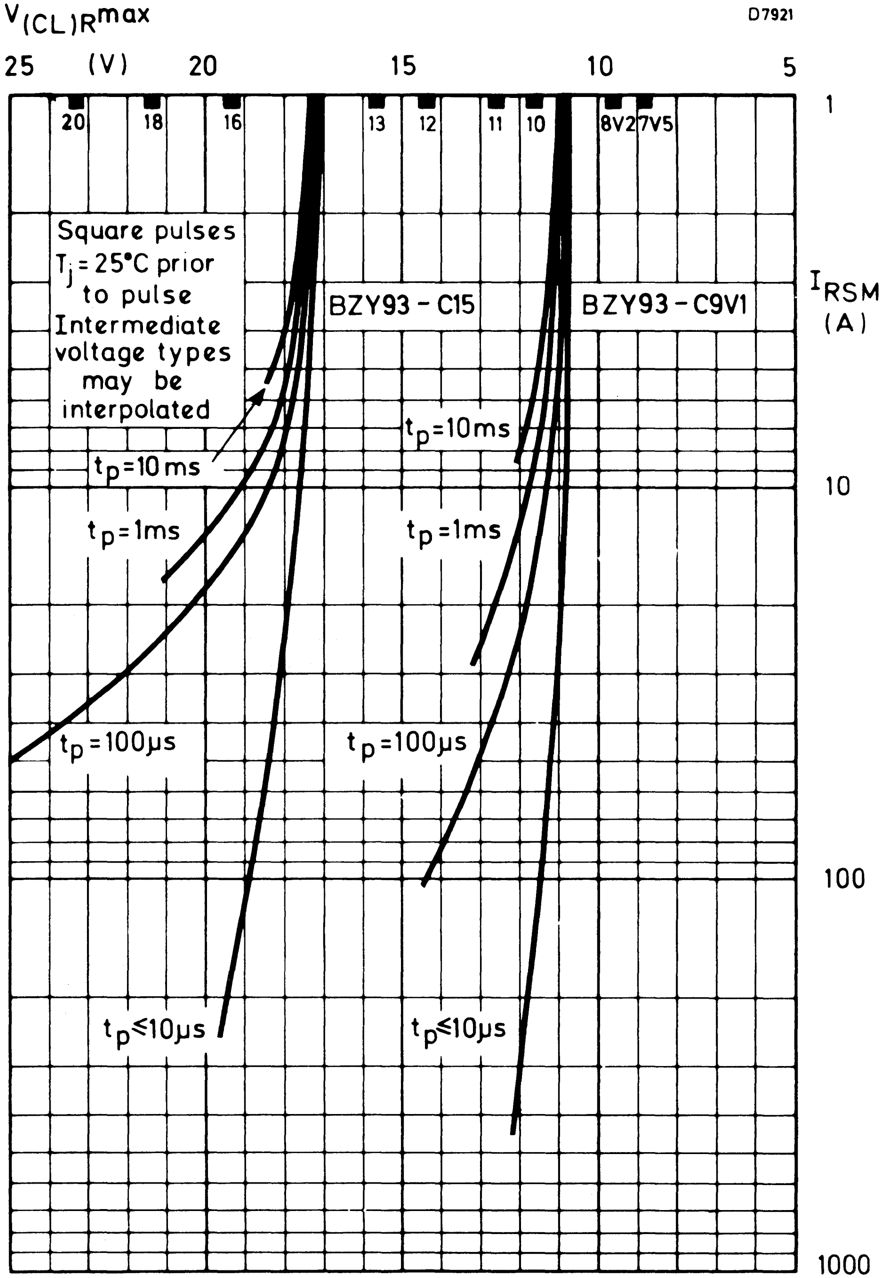

$V_{(CL)R}max$
(V)
D7921
25
20
15
10
5
20
18
16
13
12
11
10
8V2
7V5
1
10
100
1000
I_{RSM}
(A)
Square pulses
T_j = 25°C prior to pulse
Intermediate voltage types may be interpolated
BZY93 - C15
BZY93 - C9V1
t_p=10ms
t_p=1ms
t_p=100μs
t_p≤10μs
t_p=10ms
t_p=1ms
t_p=100μs
t_p≤10μs

Fig. 15.

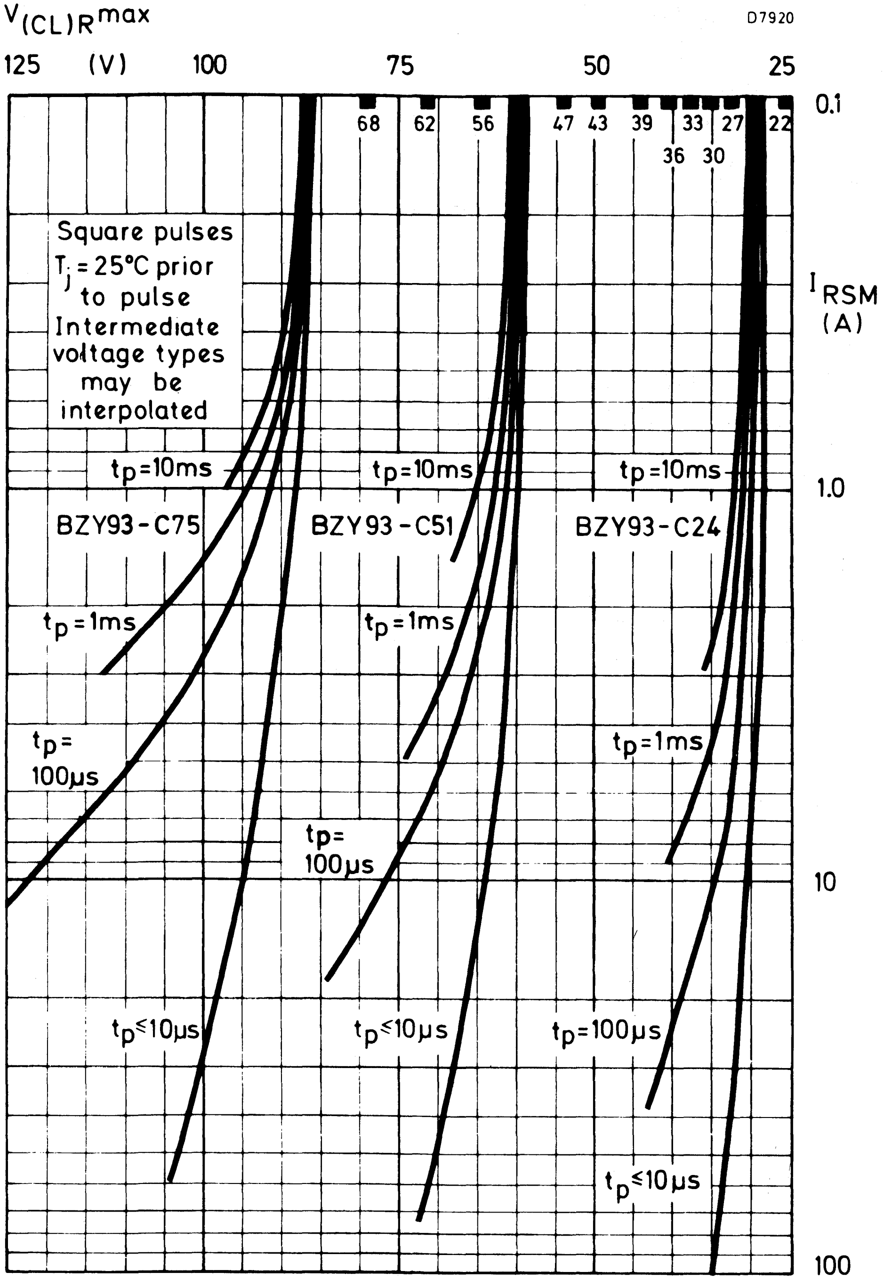

$V_{(CL)R}$max
D7920
125
(V)
100
75
50
25
68
62
56
47
43
39
36
33
30
27
22
0.1
I_{RSM}
(A)
1.0
10
100
Square pulses
T_j = 25°C prior to pulse
Intermediate voltage types may be interpolated
t_p=10ms
t_p=10ms
t_p=10ms
BZY93-C75
BZY93-C51
BZY93-C24
t_p=1ms
t_p=1ms
t_p=1ms
t_p=100µs
t_p=100µs
t_p=100µs
t_p≤10µs
t_p≤10µs
t_p≤10µs

Fig. 16.

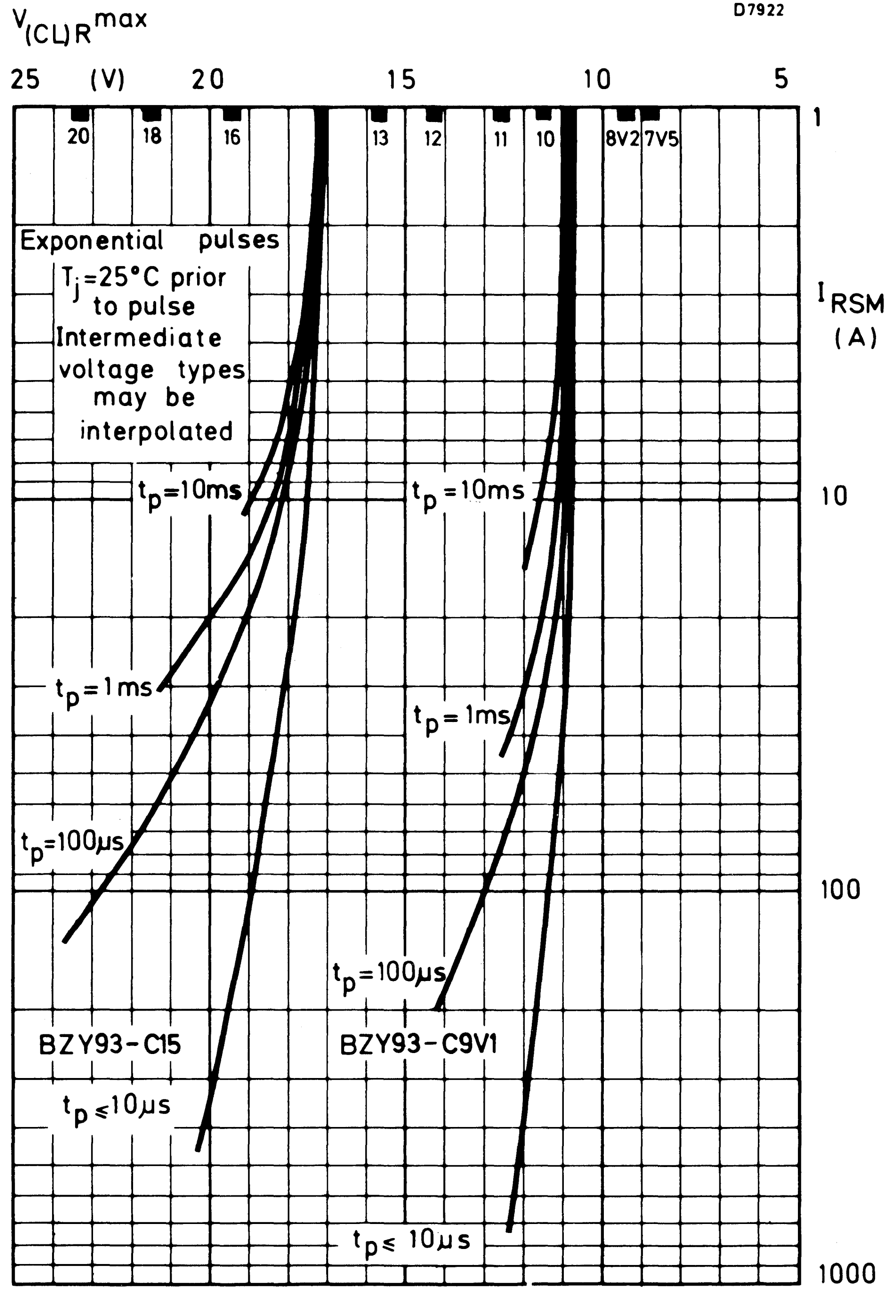

D7922
$V_{(CL)R}$ max
25
(V)
20
15
10
5
20
18
16
13
12
11
10
8V2
7V5
1
I_{RSM}
(A)
10
100
1000
Exponential pulses
T_j=25°C prior to pulse
Intermediate voltage types may be interpolated
t_p=10ms
t_p=1ms
t_p=100μs
t_p≤10μs
BZY93-C15
t_p=10ms
t_p=1ms
t_p=100μs
t_p≤10μs
BZY93-C9V1

Fig. 17.

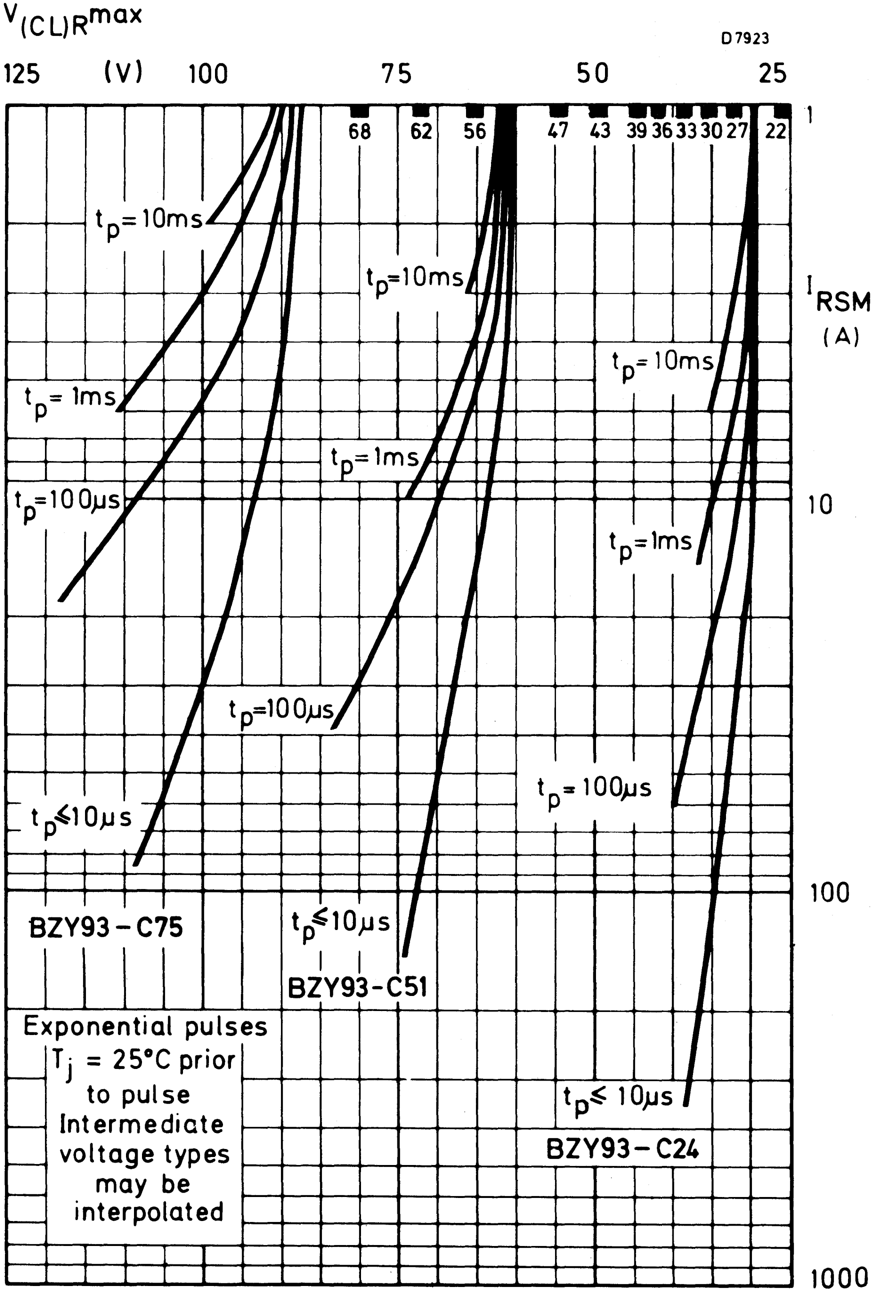

$V_{(CL)R}$max
D7923
125
(V)
100
75
50
25
68
62
56
47
43
39
36
33
30
27
22
1
10
100
1000
I_{RSM}
(A)
t_p= 10ms
t_p= 1ms
t_p=100μs
t_p≤10μs
BZY93 – C75
t_p=10ms
t_p=1ms
t_p=100μs
t_p≤10μs
BZY93-C51
t_p= 10ms
t_p=1ms
t_p= 100μs
t_p≤ 10μs
BZY93 – C24
Exponential pulses
T_j = 25°C prior
to pulse
Intermediate
voltage types
may be
interpolated

Fig. 18.

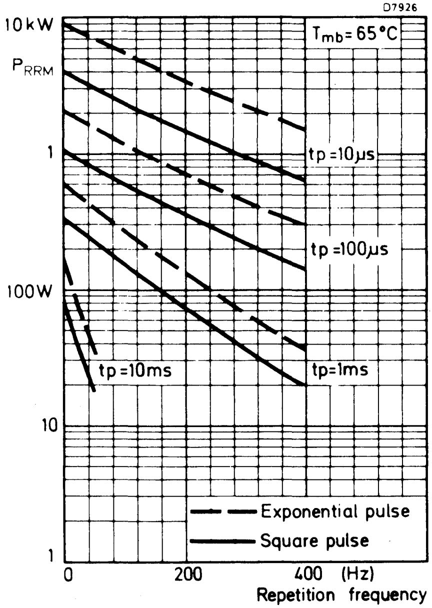


Fig. 19.

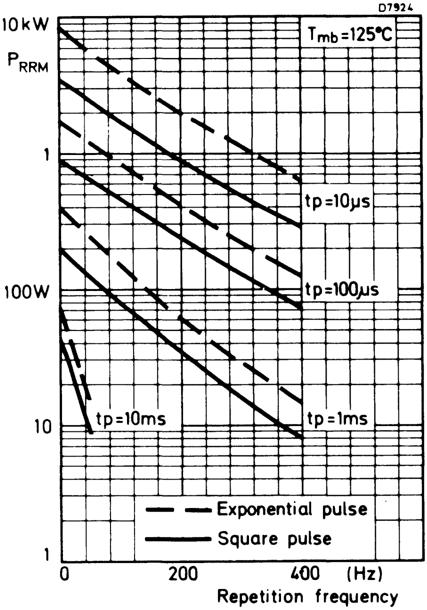


Fig. 20.

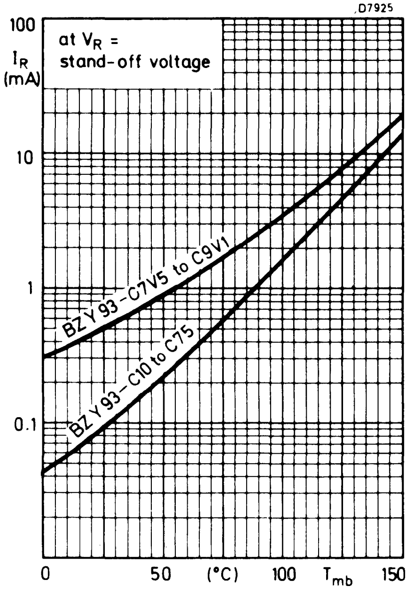


Fig. 21.

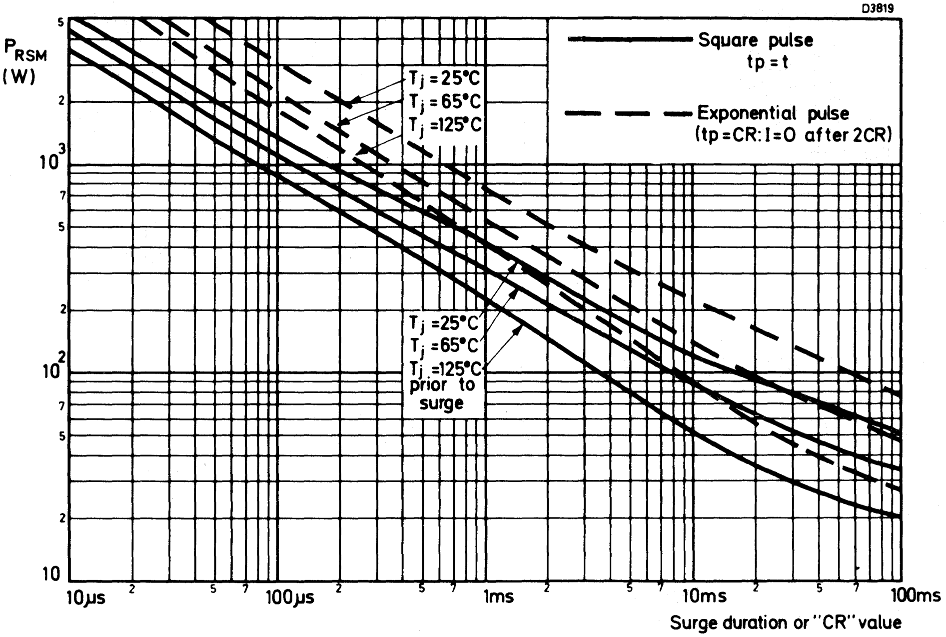

D3819
P_{RSM} (W)
5
2
10^3
7
5
2
10^2
7
5
2
10
10μs
2
5
7
100μs
2
5
7
1ms
2
5
7
10ms
2
5
7
100ms
Surge duration or "CR" value
Square pulse
tp = t
Exponential pulse
(tp = CR: I = 0 after 2CR)
T_j = 25°C
T_j = 65°C
T_j = 125°C
T_j = 25°C
T_j = 65°C
T_j = 125°C
prior to surge

Fig. 22.

HIGH VOLTAGE RECTIFIER STACKS

OSB 9115 SERIES
OSM 9115 SERIES
OSS 9115 SERIES

HIGH-VOLTAGE RECTIFIER STACKS

The OSB9115, OSM9115 and OSS9115 series are ranges of high-voltage rectifier assemblies incorporating controlled avalanche diodes mounted on fire-proof triangular formers. The OSB9115 series is intended for application in two-phase half-wave rectifier circuits. The OSM9115 series is intended for application in single-phase or three-phase bridges or in voltage doubler circuits. The OSS9115 series is intended for all kinds of high-voltage rectification. The assemblies are supplied with M6 studs or with standard valve bases. The OSB9115 series and OSM9115 series are supplied with a centre tap (8-32UNC). The maximum crest working voltages of the OSB9115 and OSM9115 series cover the range from 3 kV to 27 kV, and of the OSS9115 series the range from 4.5 kV to 54 kV in 1.5 kV steps.

Configuration:

Fig.1 OSB9115

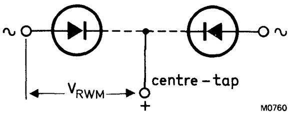


Fig.2 OSM9115

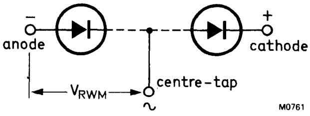
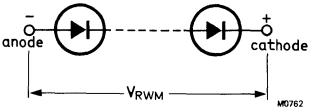


Fig.3 OSS9115



QUICK REFERENCE DATA

		OSB9115	–4	–6	. . .	–34	–36	
		OSM9115	–6	–6	. . .	–34	–36	
Crest working reverse voltage from centre tap to end	V_{RWM}	max.	3	4.5	. . .	25.5	27	kV
		OSS9115	–3	–4	. . .	–35	–36	
Crest working reverse voltage	V_{RWM}	max.	4.5	6	. . .	52.5	54	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.	125	A

MECHANICAL DATA (see pages 736 and 737)

All information applies to frequencies up to 400 Hz

RATINGS

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

Voltages

		OSB9115	–4	–6	. . .	–34	–36	
		OSM9115	–4	–6	. . .	–34	–36	
Crest working reverse voltage	V_{RWM}	max.	3	4.5	. . .	25.5	27	kV
		OSS9115	–3	–4	. . .	–35	–36	
Crest working reverse voltage	V_{RWM}	max.	4.5	6	. . .	52.5	54	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.	125	A

Reverse power dissipation

		OSB9115	–4	–6	. . .	–34	–34	
		OSM9115	–4	–6	. . .	–34	–36	
Repetitive peak reverse power t = 10 μs (square-wave; f = 50 Hz) T_j = 175 °C	P_{RRM}	max.	1.2	1.8	. . .	10.2	10.8	kW
Non-repetitive peak reverse power t = 10 μs (square -wave) T_j = 25 °C prior to surge	P_{RSM}	max.	6	9	. . .	51	54	kW
T_j = 125 °C prior to surge	P_{RSM}	max.	1.2	1.8	. . .	10.2	10.8	kW
		OSS9115	–3	–4	. . .	–35	–36	
Repetitive peak reverse power dissipation t = 10 μs (square-wave; f = 50 Hz) T_j = 175 °C	P_{RRM}	max.	1.8	2.4	. . .	21	21.6	kW
Non-repetitive peak reverse power dissipation t = 10 μs (square-wave) T_j = 25 °C prior to surge	P_{RSM}	max.	9	12	. . .	105	108	kW
T_j = 175 °C prior to surge	P_{RSM}	max.	1.8	2.4	. . .	21	21.6	kW

Temperatures

Storage temperature	T_{stg}		–55 to +150	°C
Junction temperature	T_j	max.	175	°C

CHARACTERISTICS (See note 1)

			OSB9115 –4 OSM9115 –4	–6 –6	. . . . . .	–34 –34	–36 –36	
Forward voltage I_F = 20 A; T_j = 25 °C	V_F	<	4	6	. . .	34	36	V
Reverse avalanche breakdown voltage* I_R = 5 mA; T_j = 25 °C	$V_{(BR)R}$	>	3.3	4.95	. . .	28	29.7	kV
		<	4.8	7.2	. . .	40.8	43.2	kV

			OSS9115 –3	–4	. . .	–35	–36	
Forward voltage I_F = 20 A; T_j = 25 °C	V_F	<	6	8	. . .	70	72	V
Reverse avalanche breakdown voltage* I_R = 5 mA; T_j = 25 °C	$V_{(BR)R}$	>	4.95	6.6	. . .	57.8	59.4	kV
		<	7.2	9.6	. . .	84	68.4	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 OSS9115 series).
2. **Type number suffix**

   The suffix consists of a figure indicating the total number of diodes, followed by a letter indicating the base.

   A = M6 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.

---

*The breakdown voltage increases by approximately 0.1% per °C with increasing junction temperature.

MECHANICAL DATA

Dimensions in mm

n = total number of diodes

Fig.4 OSM9115 –nA

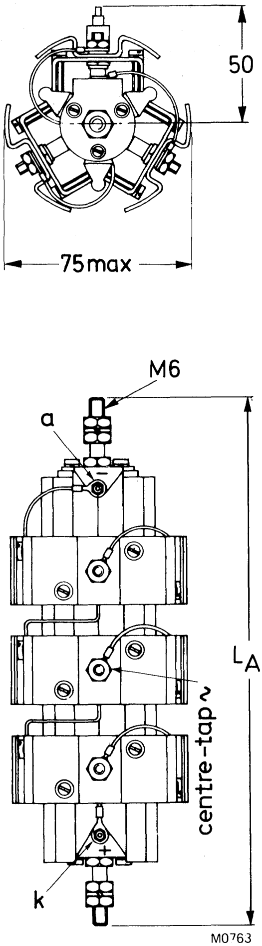


Fig.5 OSM9115 –nB

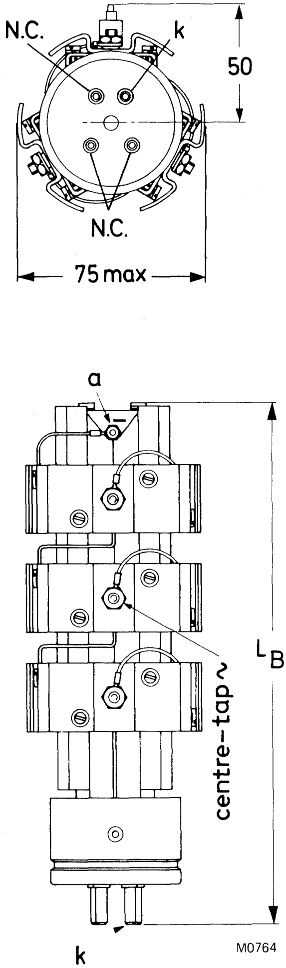
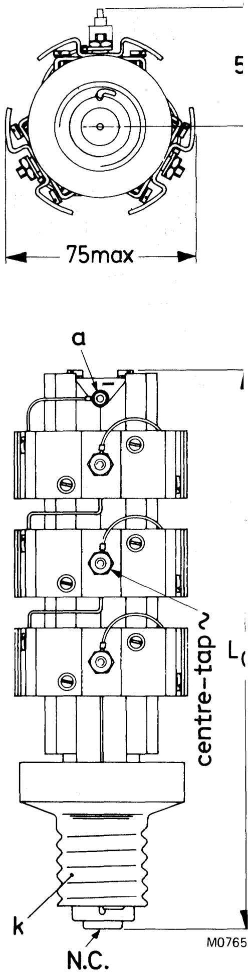


Fig.6 OSM9115 –nC



The drawings show the OSM9115 series; the OSB9115 and OSS9115 series differ in the following respects:

OSB9115 series – terminals marked a (–) and k (+) in the drawings are both marked ∿;
the centre-tap is marked + (instead of ∿ as in the drawings).

OSS9115 series – has no centre-tap.

MECHANICAL DATA (continued)

n = total number of diodes.

Fig.7 OSM9115 –nE

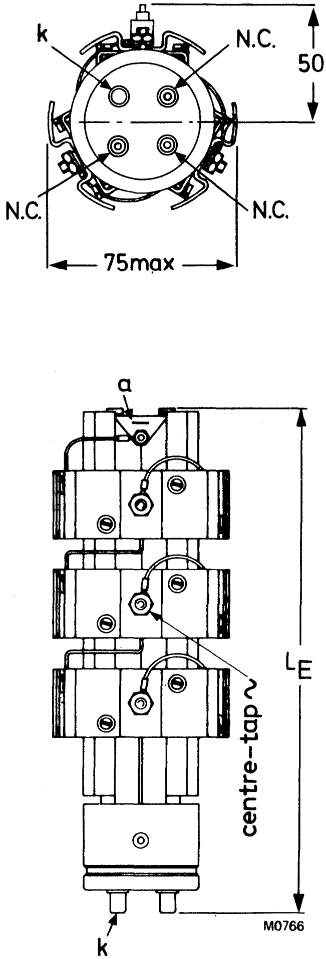
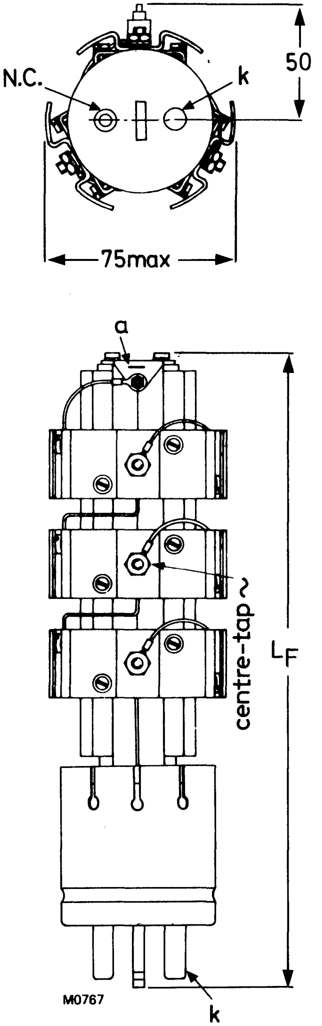


Fig.8 OSM9115 –nF



For lengths and weights see table on page 738.

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

number of diodes	n	31 to 33	34 to 36
	L_A	546	586
	L_B	550	590
	L_C	561	601
	L_E	535	575
	L_F	587	627
weights	W_A	1483	1616
	$W_B = W_C = W_E$	1548	1681
	W_F	1709	1842

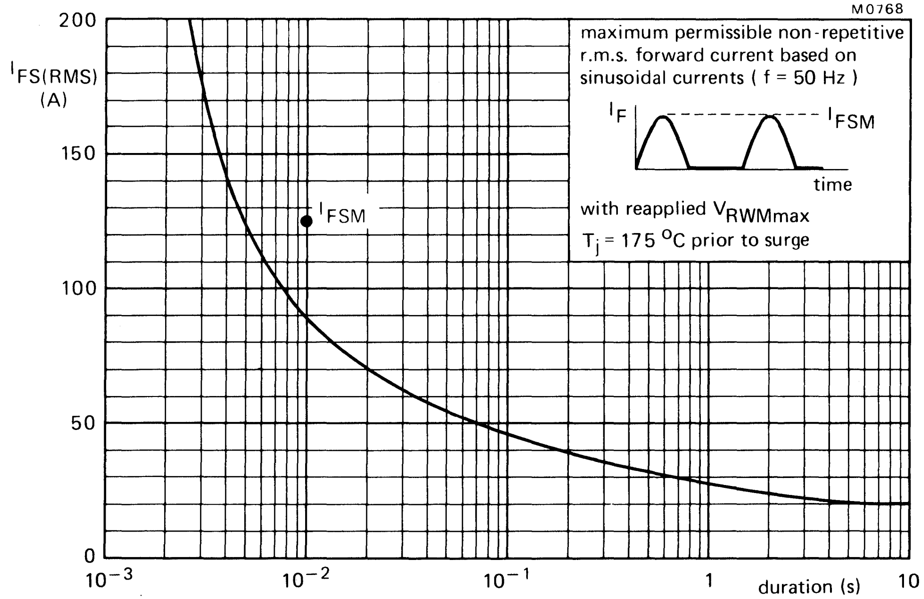

M0768
maximum permissible non-repetitive r.m.s. forward current based on sinusoidal currents (f = 50 Hz)
I_F
I_{FSM}
time
with reapplied V_{RWMmax}
T_j = 175 °C prior to surge
I_{FSM}
200
$I_{FS(RMS)}$ (A)
150
100
50
0
10^{-3}
10^{-2}
10^{-1}
1
duration (s)
10

Fig.9

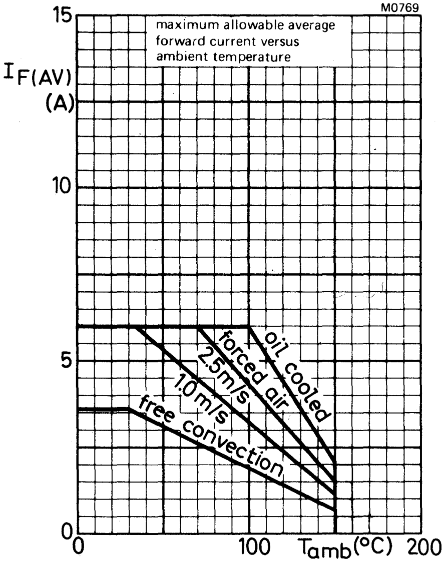


Fig.10

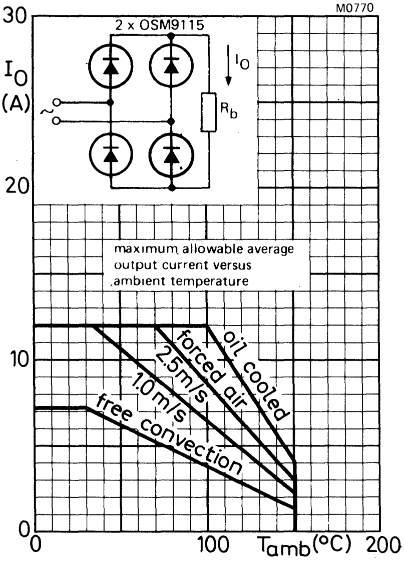


Fig.11

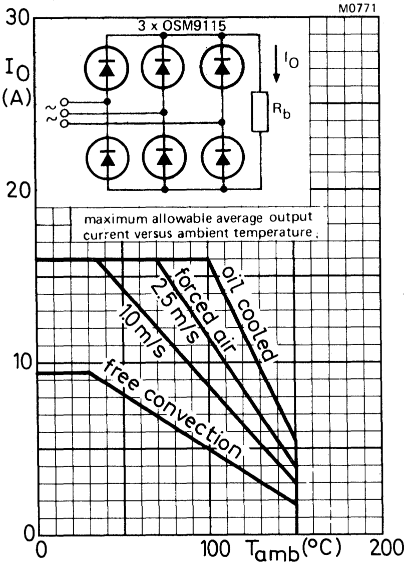


Fig.12

APPLICATION INFORMATION

Fig.13 OSB9115 –4

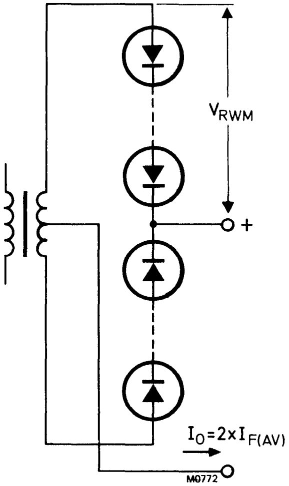
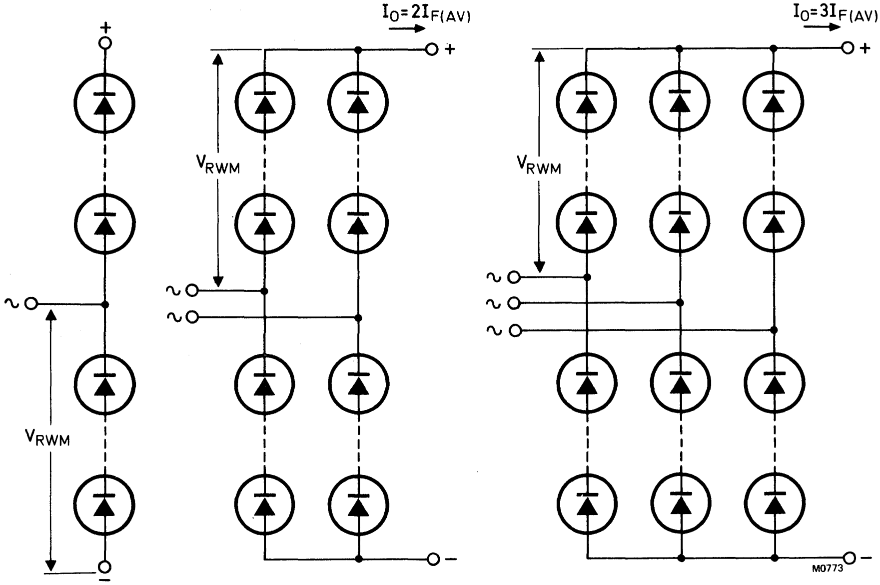


Fig.14 OSM9115 series



voltage doubler
1 x OSM9115

rectifier circuits with respectively
2 x OSM9115 and 3 x OSM9115

OSB 9215 SERIES
OSM9215 SERIES
OSS 9215 SERIES

HIGH-VOLTAGE RECTIFIER STACKS

The OSB9215, OSM9215 and OSS9215 series are ranges of high-voltage rectifier assemblies, incorporating controlled avalanche diodes mounted on fire-proof triangular formers. The OSB9215 series is intended for application in two-phase half-wave rectifier circuits. The OSM9215 series is intended for application in single-phase or three-phase bridges or in voltage doubler circuits.
The OSS9215 series is intended for all kinds of high-voltage rectification. The assemblies are supplied with M6 studs or with standard valve bases. The OSB9215 series and OSM9215 series are supplied with a centre tap (8-32UNC). The maximum crest working voltages of the OSB9215 and OSM9215 series cover the range from 3 kV to 27 kV, and of the OSS9215 series the range from 4.5 kV to 54 kV in 1.5 kV steps.

Configuration:

Fig. 1 OSB9215

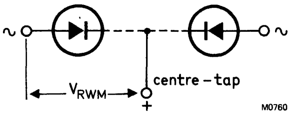


Fig. 2 OSM9215

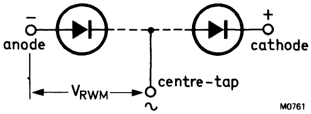
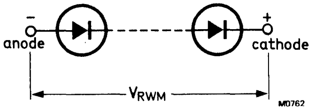


Fig. 3 OSS9215



QUICK REFERENCE DATA

		OSB9215	−4	−6	. . .	−34	−36	
		OSM9215	−4	−6	. . .	−34	−36	
Crest working reverse voltage from centre tap to end	V_{RWM}	max.	3	4.5	. . .	25.5	27	kV
		OSS9215	−3	−4	. . .	−35	−36	
Crest working reverse voltage	V_{RWM}	max.	4.5	6	. . .	52.5	54	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.	5	A
in oil up to T_{oil} = 30 °C	$I_{F(AV)}$	max.	20	A
Non-repetitive peak forward current t = 10 ms; half sine-wave; T_j = 175 °C prior to surge	I_{FSM}	max.	360	A

MECHANICAL DATA (see pages 746 and 747)

All information applies to frequencies up to 400 Hz

RATINGS

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

Voltages

		OSB9215	–4	–6	. .	4	–36	
		OSM9215	–4	–6	.	-34	–36	
Crest working reverse voltage	V_{RWM}	max.	3.0	4.5	. . .	25.5	27	kV
		OSS9215	–3	–4	. . .	–35	–36	
Crest working reverse voltage	V_{RWM}	max.	4.5	6	. . .	52.5	54	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

		OSB9215	–4	–6	. . .	–34	–36	
Repetitive peak reverse power		OSM9215	–4	–6	. . .	–34	–36	
t = 10 μs (square-wave; f = 50 Hz) T_j = 175 °C	P_{RRM}	max.	4	6	. . .	34	36	kW
Non-repetitive peak reverse power t = 10 μs (square-wave)								
T_j = 25 °C prior to surge	P_{RSM}	max.	26	39	. . .	221	234	kW
T_j = 175 °C prior to surge	P_{RSM}	max.	4	6	. . .	34	36	kW
Repetitive peak reverse power dissipation		OSS9215	–3	–4	. . .	–35	–36	kW
t = 10 μs (square-wave; f = 50 Hz) T_j = 175 °C	P_{RRM}	max.	6	8	. . .	70	72	kW
Non-repetitive peak reverse power dissipation t = 10 μs (square-wave)								
T_j = 25 °C prior to surge	P_{RSM}	max.	39	52	. . .	455	468	kW
T_j = 175 °C prior to surge	P_{RSM}	max.	6	8		70	72	kW

Temperatures

Storage temperature	T_{stg}		–55 to +150	°C
Junction temperature	T_j	max.	175	°C

CHARACTERISTICS (see note 1)

		OSB9215	–4	–6	. . .	–34	–36	
		OSM9215	–4	–6	. . .	–34	–36	
Forward voltage I_F = 50 A; T_j = 25 °C	V_F	<	3.6	5.4	. . .	30.6	32.4	V
Reverse breakdown voltage* I_R = 5 mA; T_j = 25 °C	$V_{(BR)R}$	>	3.3	4.95	. . .	28	29.7	kV
		<	4.8	7.2	. . .	40.8	43.2	kV
		OSS9215	–3	–4	. . .	–35	–36	
Forward voltage I_F = 50 A; T_j = 25 °C	V_F	<	5.4	7.2	. . .	63	64.8	V
Reverse breakdown voltage* I_R = 5 mA; T_j = 25 °C	$V_{(BR)R}$	>	4.95	6.6	. . .	57.8	59.4	kV
		<	7.2	9.6	. . .	84	86.4	kV
Reverse current $V_{RM} = V_{RWMmax}$; T_j = 125 °C	I_{RM}	<	0.6					mA

Notes

1. The Ratings and Characteristics given apply **from centre tap to end.** (Not for OSS9215 series).
2. **Type number suffix**

   The suffix consists of a figure indicating the total number of diodes, followed by a letter indicating the base.

   A = M6 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.

---

*The breakdown voltage increases by approximately 0.1% per °C with increasing junction temperature.

MECHANICAL DATA

Dimensions in mm

n = total number of diodes

Fig. 4 OSM9215-nA

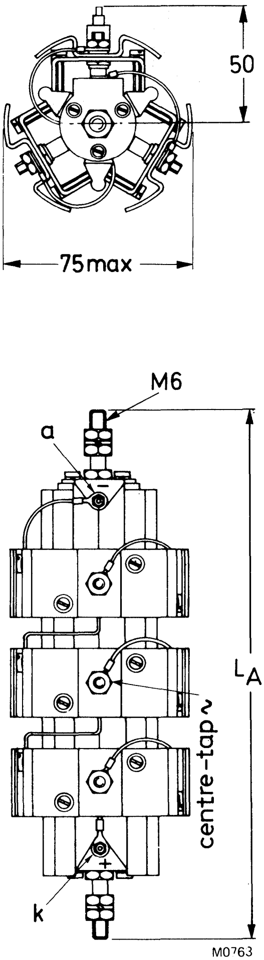


Fig. 5 OSM9215-nB

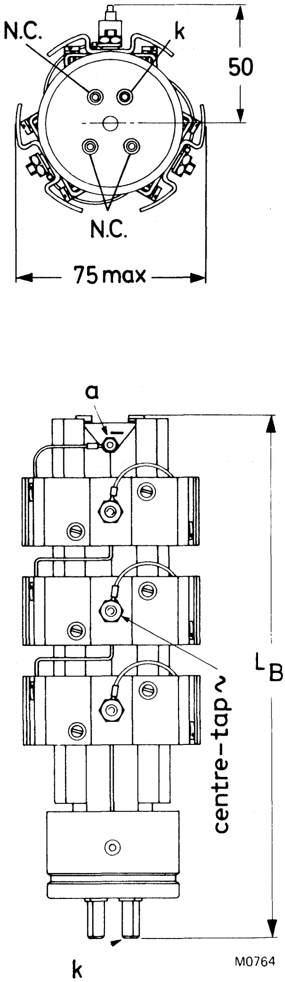
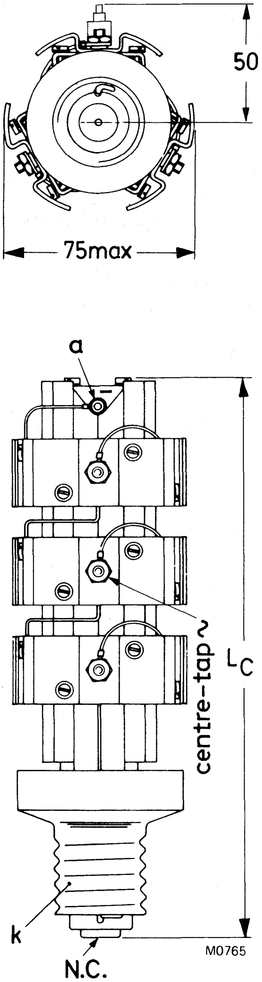


Fig. 6 OSM9215-nC



The drawings show the OSM9215 series; the OSB9215 and OSS9215 series differ in the following respects:

OSB9215 series — terminals marked a(−) and k(+) in the drawings are both marked ∿;
the centre-tap is marked + (instead of ∿ as in the drawings).

OSS9215 series — has no centre-tap.

MECHANICAL DATA (continued)

n = total number of diodes.

Fig. 7 OSM9215-nE

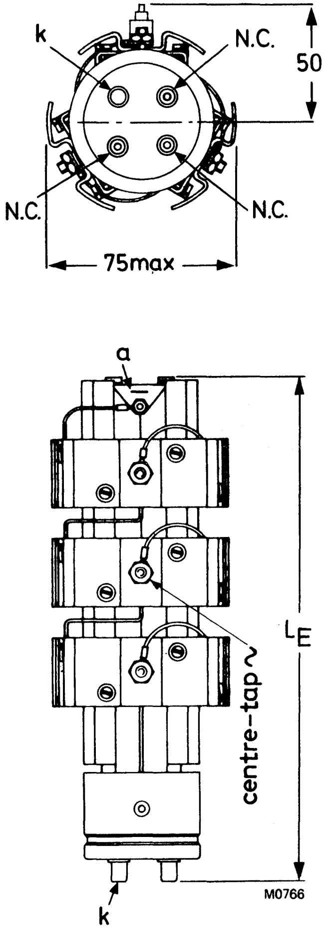
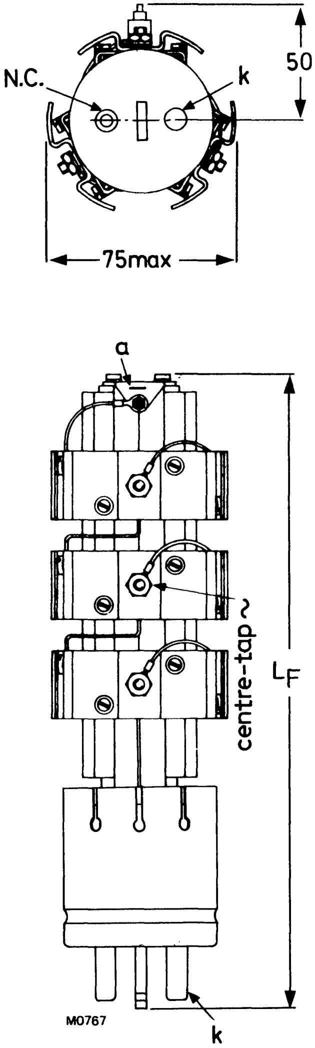


Fig. 8 OSM9215-nF



For lengths and weights see table on page 748.

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

number of diodes	n	31 to 33	34 to 36
maximum lengths	L_A	546	586
	L_B	550	590
	L_C	561	601
	L_E	535	575
	L_F	587	627
weights	W_A	1483	1616
	$W_B = W_C = W_E$	1548	1681
	W_F	1709	1842

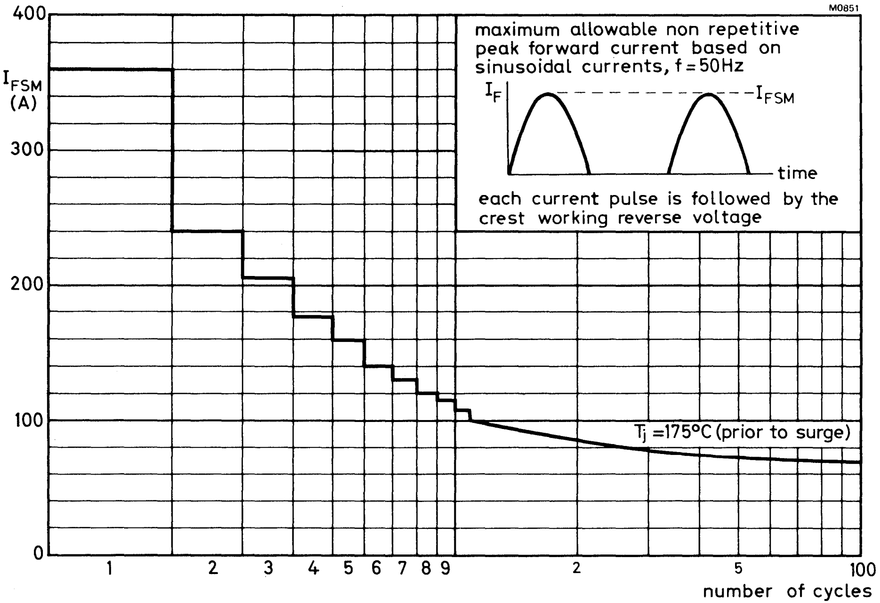

M0851
400
300
200
100
0
I_{FSM} (A)
maximum allowable non repetitive peak forward current based on sinusoidal currents, f = 50Hz
I_F
I_{FSM}
time
each current pulse is followed by the crest working reverse voltage
T_j =175°C (prior to surge)
1
2
3
4
5
6
7
8
9
2
5
100
number of cycles

Fig. 9

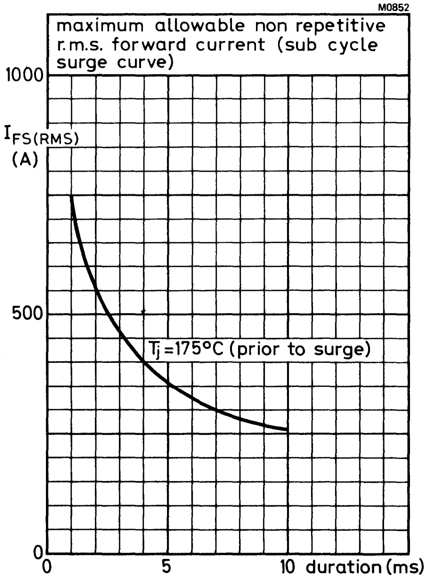

M0852
maximum allowable non repetitive r.m.s. forward current (sub cycle surge curve)
1000
$I_{FS(RMS)}$ (A)
500
0
T_j =175°C (prior to surge)
0
5
10
duration (ms)

Fig. 10

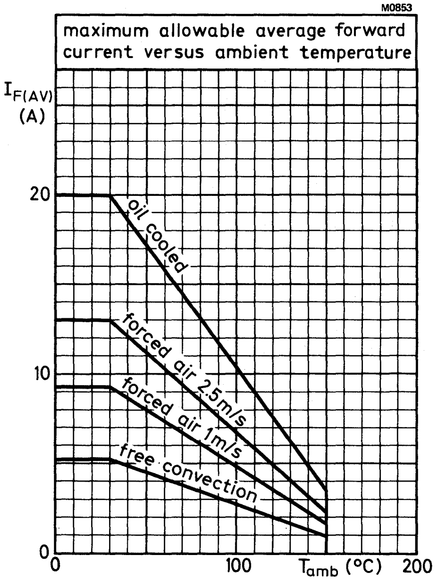


Fig. 11

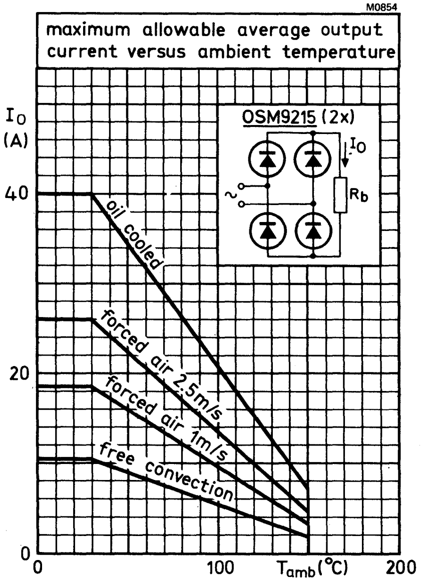


Fig. 12

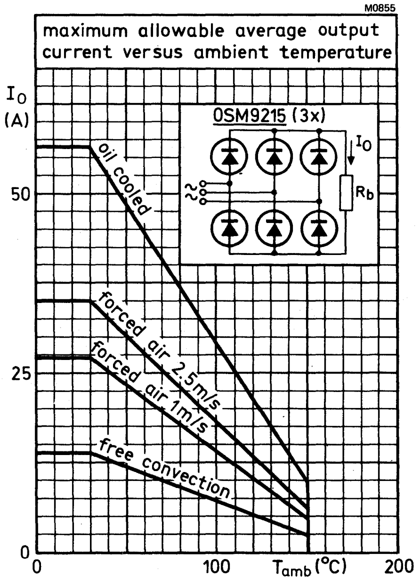


Fig. 13

APPLICATION INFORMATION

Fig. 14 OSB9215–4

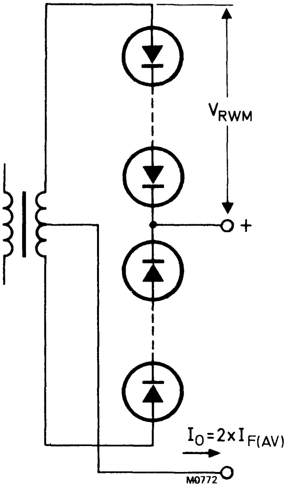
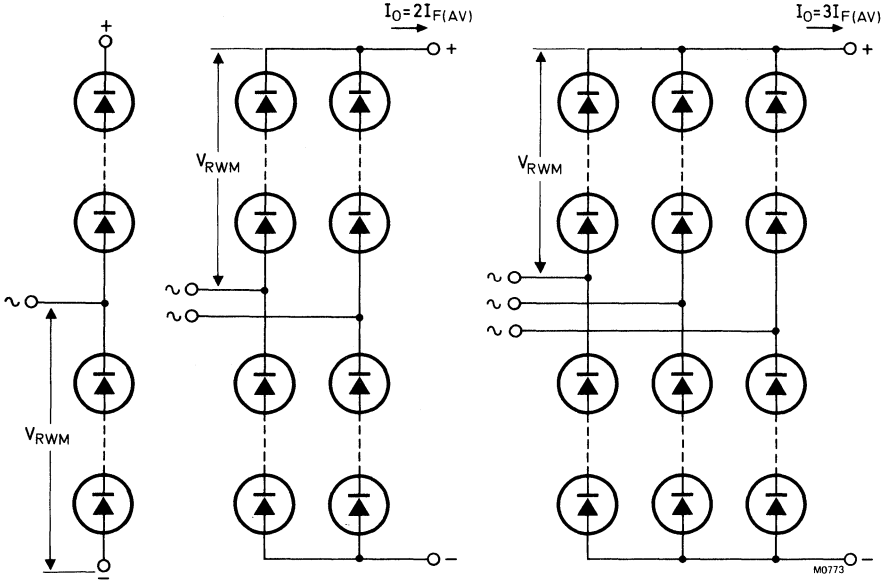


Fig. 15 OSM9215 series



voltage doubler
1x OSM9215

rectifier circuits with respectively
2x OSM9215 and 3x OSM9215

HIGH-VOLTAGE RECTIFIER STACKS

Ranges of high-voltage rectifier assemblies, incorporating controlled avalanche diodes mounted on fire-proof triangular formers. They are supplied with M6 studs.
The OSB9415 series is intended for application in two-phase half-wave rectifier circuits.
The OSM9415 series is intended for application in single-phase or three-phase bridges or in voltage doubler circuits.
The OSS9415 series is intended for all kinds of high-voltage rectification.
The OSB9415 series and OSM9415 series are supplied with a centre tap (8–32UNC).
The maximum crest working voltages of the OSB9415 and OSM9415 series cover the range from 3 kV to 27 kV, and of the OSS9415 series the range from 4.5 kV to 54 kV, in 1.5 kV steps.

Configuration:

Fig.1 OSB9415

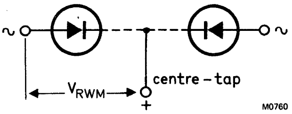


Fig.2 OSM9415

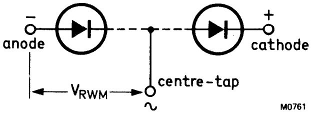
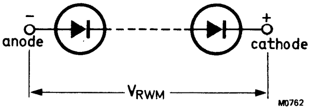


Fig.3 OSS9415



QUICK REFERENCE DATA

		OSB9415	−4	−6	. . .	−34	−36	
		OSM9415	−4	−6	. . .	−34	−36	
Crest working reverse voltage from centre tap to end	V_{RWM}	max.	3	4.5		25.5	27	kV
		OSS9415	−3	−4	. . .	−35	−36	
Crest working reverse voltage	V_{RWM}	max.	4.5	6	. . .	52.5	54	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 756)

All information applies to frequencies up to 400 Hz

RATINGS

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

Voltages

		OSB9415	–4	–6	. . .	–34	–36	
		OSM9415	–4	–6		–34	–36	
Crest working reverse voltage	V_{RWM}	max.	3	4.5	. . .	25.5	27	kV
		OSS9415	–3	–4	. . .	–35	–36	
Crest working reverse voltage	V_{RWM}	max.	4.5	6	. . .	52.5	54	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

		OSB9415	–4	–6	. . .	–34	–36	
		OSM9415	–4	–6	. . .	–34	–36	
Repetitive peak reverse power dissipation t = 10 μs (square-wave; f = 50 Hz) T_j = 175 °C	P_{RRM}	max.	9	13.5	. . .	76.5	81	kW
Non-repetitive peak reverse power dissipation t = 10 μs (square-wave) T_j = 25 °C prior to surge	P_{RSM}	max.	55	82	. . .	467	495	kW
T_j = 175 °C prior to surge	P_{RSM}	max.	8.5	13	. . .	72	77	kW
		OSS9415	–3	–4	. . .	–35	–36	
Repetitive peak reverse power dissipation t = 10 μs (square-wave; f = 50 Hz) T_j = 175 °C	P_{RRM}	max.	13.5	18	. . .	157	162	kW
Non-repetitive peak reverse power dissipation t = 10 μs (square-wave) T_j = 25 °C prior to surge	P_{RSM}	max.	80	105	. . .	919	945	kW
T_j = 175 °C prior to surge	P_{RSM}	max.	13	17	. . .	149	153	kW

Temperatures

Storage temperature	T_{stg}		–55 to +150	°C
Junction temperature	T_j	max.	175	°C

CHARACTERISTICS (See note 1)

		OSB9415	−4	−6	. . .	−34	−36	
		OSM9415	−4	−6	. . .	−34	−36	
Forward voltage								
I_F = 150 A; T_j = 25 °C	V_F	<	3.6	5.4	. . .	30.6	32.4	V
Reverse avalanche breakdown voltage*								
I_R = 5 mA; T_j = 25 °C	$V_{(BR)R}$	>	3.3	4.95	. . .	28	29.7	kV
		<	4.8	7.2	. . .	40.8	43.2	kV

		OSS9415	−3	−4	. . .	−35	−36	
Forward voltage								
I_F = 150 A; T_j = 25 °C	V_F	<	5.4	7.2	. . .	63	64.8	V
Reverse avalanche breakdown voltage*								
I_R = 5 mA; T_j = 25 °C	$V_{(BR)R}$	>	4.95	6.6	. . .	57.8	59.4	kV
		<	7.2	9.6	. . .	84	86.4	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 OSS9415 series).
2. **Type number suffix**

   The suffix consists of a figure indicating the total number of diodes, followed by a letter indicating the base.,

   A = M6 studs at the ends.
3. **Operating position**

   The rectifier units can be operated at their maximum ratings when mounted in any position.

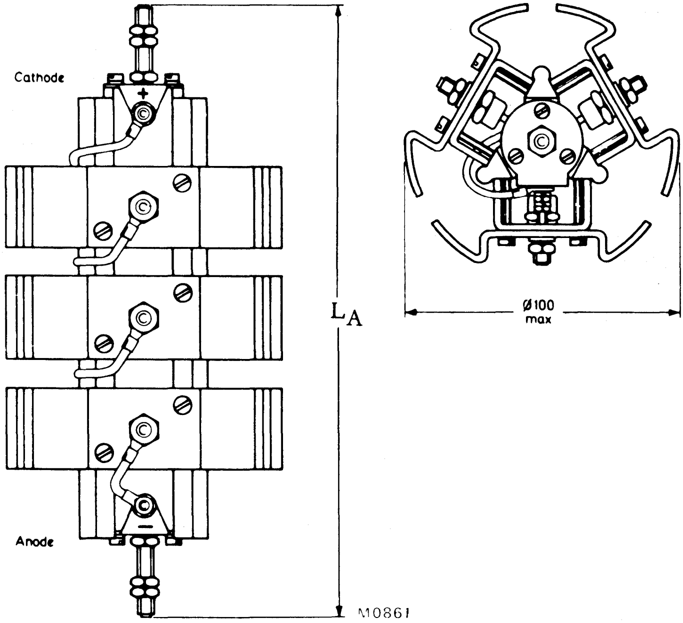
---

* The breakdown voltage increases, by approximately 0.1% per °C with increasing junction temperature.

MECHANICAL DATA Dimensions in mm

n = total number of diodes.

Fig.4 OSS9415-nA



The drawing shows the OSS9415 series.
The OSB9415 and OSM9415 series differ in the following respects:
OSB9415 series — has a centre tap marked +; anode and cathode terminals are both marked ∿.
OSM9415 series — 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	31 to 33	34 to 36
maximum lengths L_A	345	385	426	466	506	546	586
weights W_A	1208	1406	1604	1802	2000	2198	2396

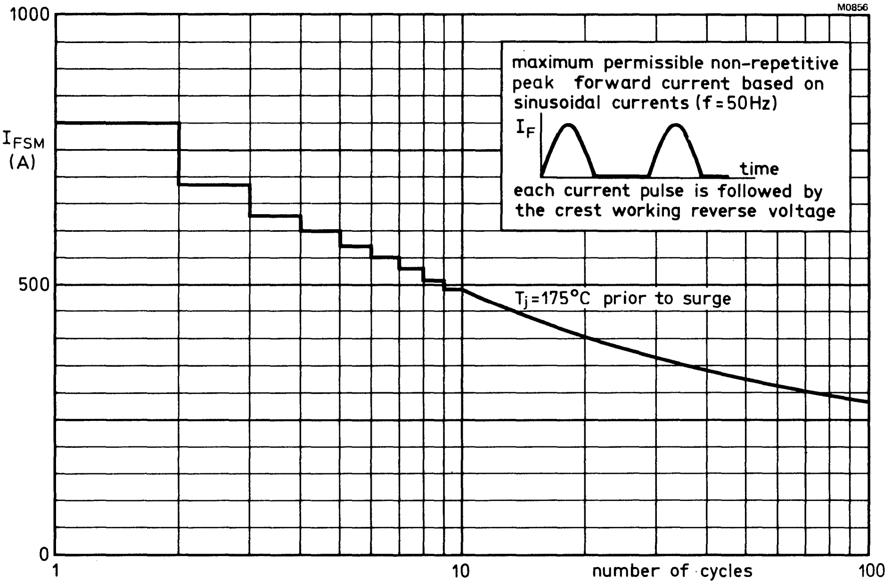

M0856
1000
500
0
I_{FSM}
(A)
1
10
number of cycles
100
maximum permissible non-repetitive peak forward current based on sinusoidal currents (f = 50Hz)
I_F
time
each current pulse is followed by the crest working reverse voltage
T_j = 175°C prior to surge

Fig.5

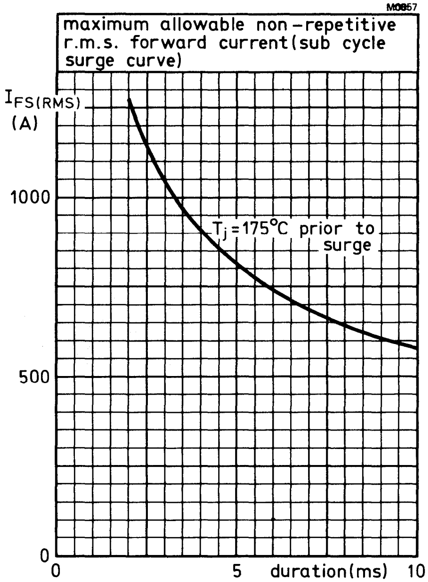

M0857
maximum allowable non-repetitive r.m.s. forward current (sub cycle surge curve)
$I_{FS(RMS)}$
(A)
1000
500
0
0
5
duration (ms)
10
T_j = 175°C prior to surge

Fig.6

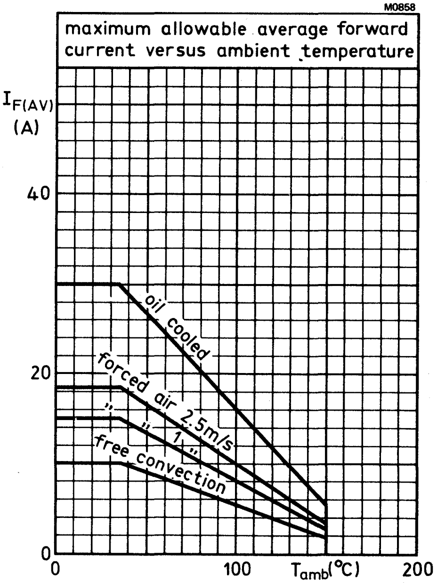


Fig.7

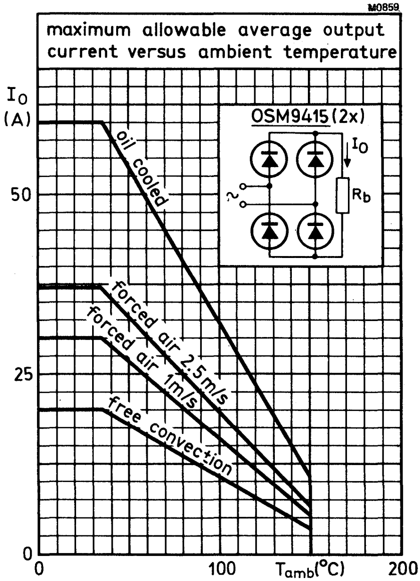


Fig.8

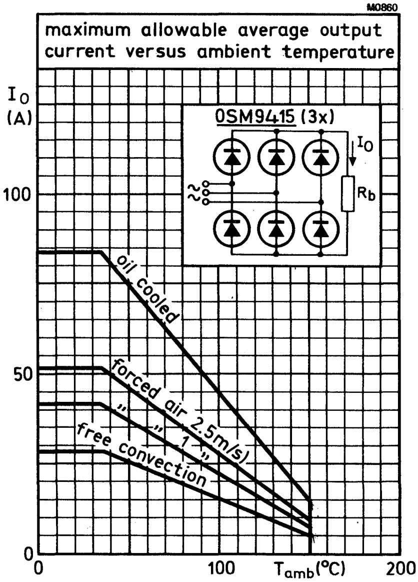


Fig.9

APPLICATION INFORMATION

Fig.10 OSB9415 series

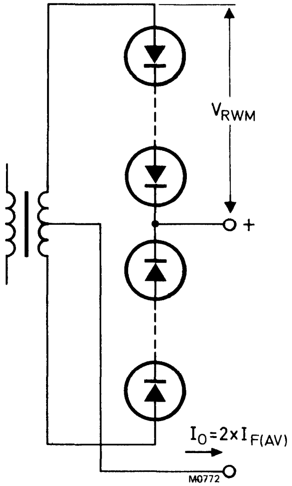
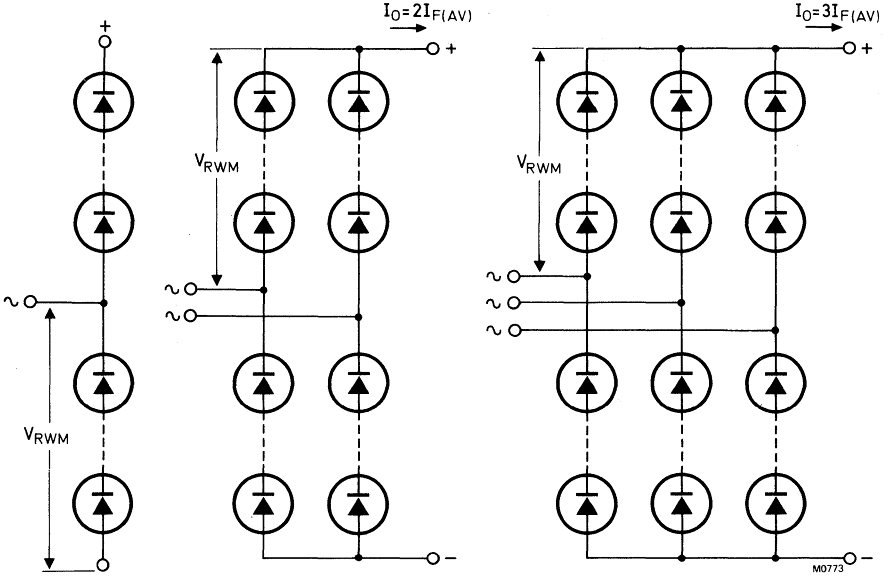


Fig.11 OSM9415 series



voltage doubler
1 x OSM9415

rectifier circuits with respectively
2 x OSM9415 and 3 x OSM9415

HIGH-VOLTAGE RECTIFIER STACK

The OSM9510-12 is a silicon rectifier stack for high voltage applications; up to 12kV in half-wave circuits, or up to 6kV as one of the arms of a bridge configuration, where the centre-tap is utilised. Because of its controlled avalanche characteristics it is capable of withstanding reverse transients generated in the circuit.

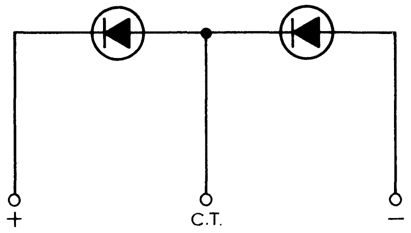
QUICK REFERENCE DATA

V_{RWM} max.	12	kV
$V_{(BR)R}$ min.	15	kV
$I_{F(AV)}$ max., in free air, $T_{amb} = 50^\circ C$	1.5	A
P_{RSM} max., $t = 10\mu s$, $T_{amb} = 25^\circ C$	20	kW

OUTLINE AND DIMENSIONS

For details see page 763

CIRCUIT DIAGRAM



RATINGS

Limiting values of operation according to the absolute maximum system.
These ratings apply for the frequency range 50 to 400Hz.
Simultaneous application of all ratings is inferred unless otherwise stated.

Electrical

V_{RWM} max.	Crest working reverse voltage	12	kV
$I_{F(AV)}$ max.	Mean forward current in free air, $T_{amb} \leq 50^{\circ}C$, 180° conduction	1.5	A
	See derating curves on page 764		
I_{FRM} max.	Repetitive peak forward current, 30° conduction	15	A
I_{FSM} max.	Surge forward current, 1 cycle (10ms peak of half sinewave)	35	A
P_{RSM} max.	Non-repetitive peak reverse power (10μs square wave, $T_j = 25^{\circ}C$)	20	kW
P_{RRM} max.	50Hz repetitive peak reverse transient power (10μs square wave, $T_j = 150^{\circ}C$)	5.0	kW

Temperature

T_{stg}	Storage temperature	-55 to 150	$^{\circ}C$
T_j	Junction temperature	-55 to 150	$^{\circ}C$

ELECTRICAL CHARACTERISTICS ($T_j = 25^{\circ}C$ unless otherwise stated)

		Min.	Max.	
*V_F	Forward voltage at $I_F = 5A$	-	17.5	V
I_R	Reverse current at V_{RWM}, $T_j = 125^{\circ}C$	-	100	μA
$V_{(BR)R}$	**Avalanche breakdown voltage, $I_{(BR)R} = 1mA$	15	25	kV

*Measured under pulsed conditions so that T_j is at, or near, the stated value.

**The avalanche voltage increases by approximately 0.1%/degC with increasing T_j.

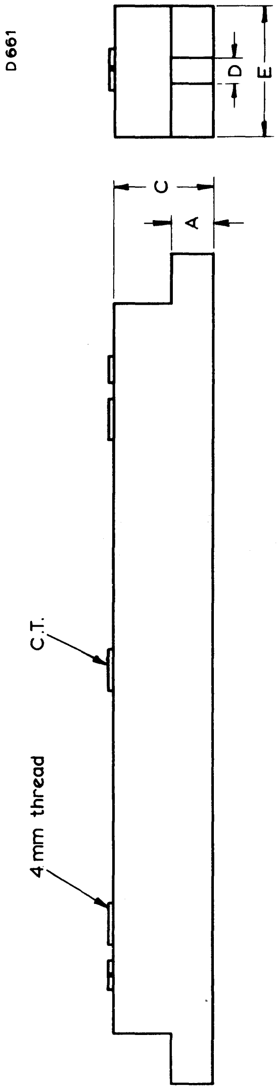
MECHANICAL DATA

Weight	130	g

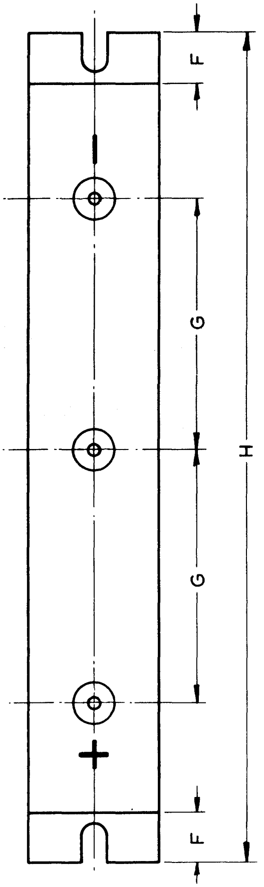
MOUNTING POSITION

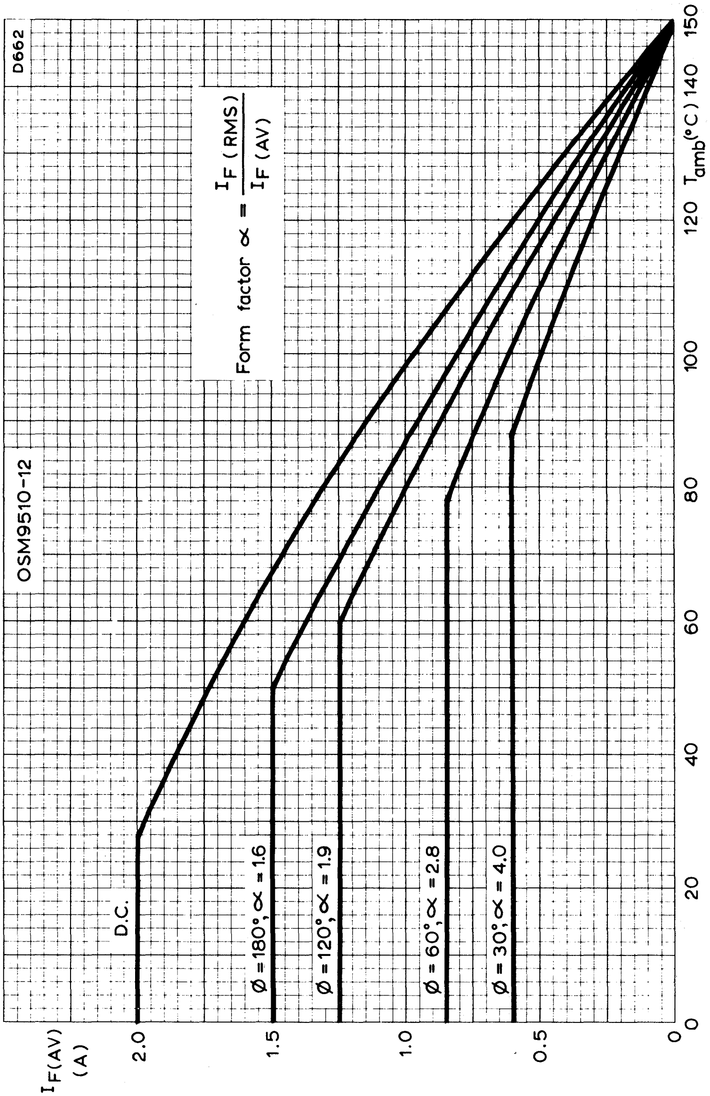
The rectifier units can be operated at their maximum ratings when mounted in any position.

OUTLINE AND DIMENSIONS

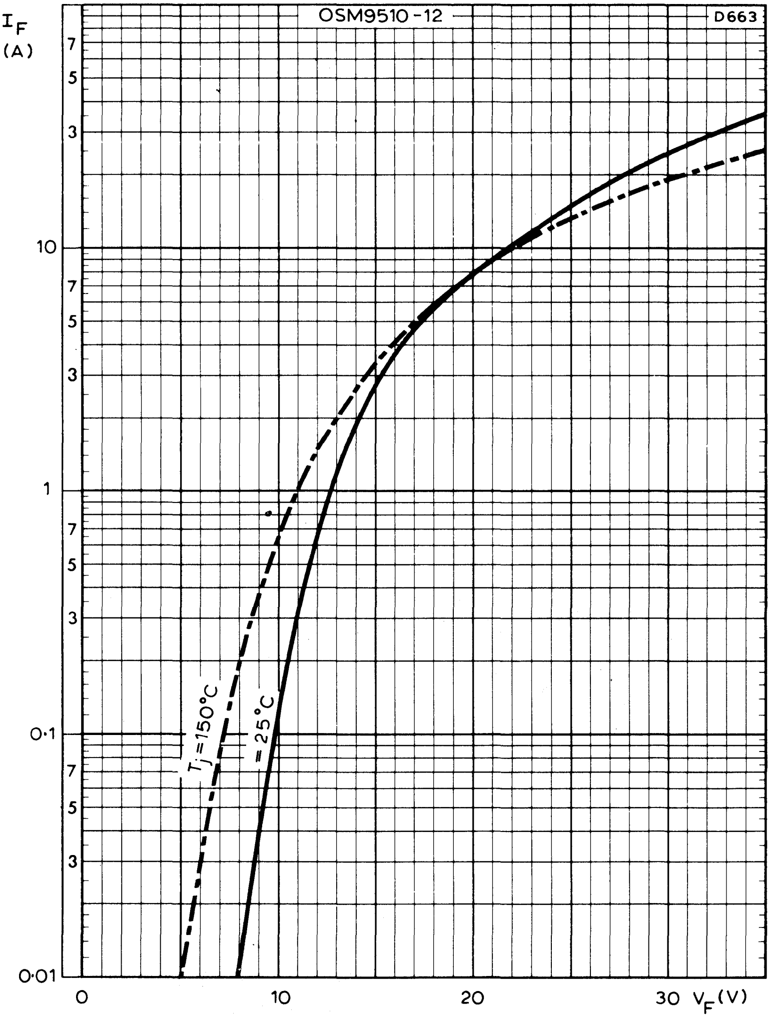


	Millimetres
A	8.0
C	18.5
D	5.3
E	26
F	10
G	50
H	165

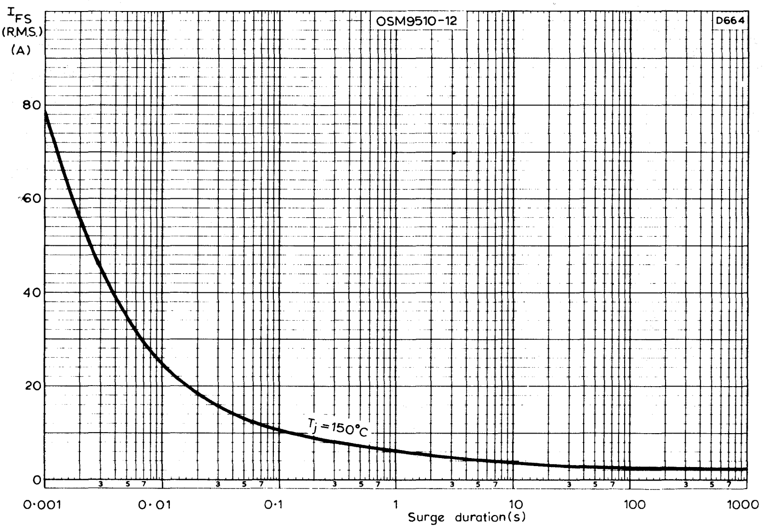




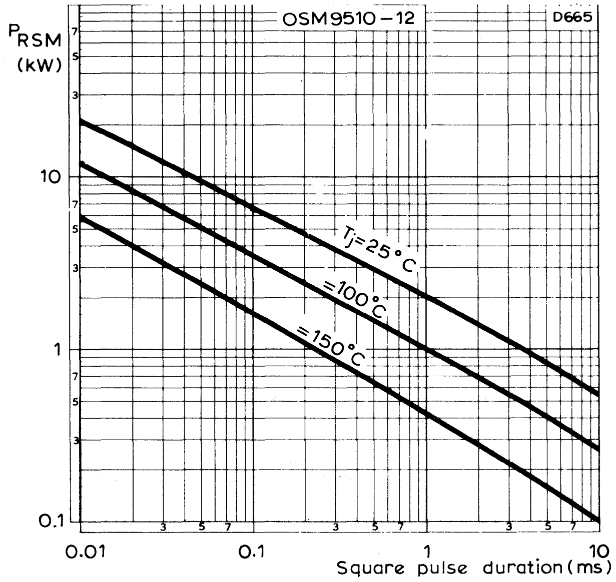
MAXIMUM MEAN FORWARD CURRENT AS A FUNCTION OF AMBIENT TEMPERATURE AND CONDUCTION ANGLE



MAXIMUM FORWARD CONDUCTION CHARACTERISTICS



MAXIMUM R.M.S. SURGE CURRENT PLOTTED AGAINST SURGE DURATION



NON-REPETITIVE PEAK REVERSE POWER PLOTTED AGAINST SQUARE PULSE DURATION

ACCESSORIES

TYPE NUMBER SUMMARY

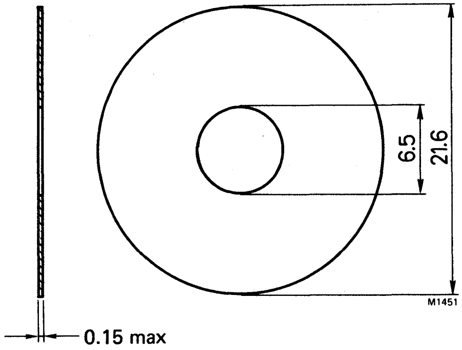
type number	description	envelope	
56264a	mica washer (up to 2000 V)	DO-5, TO-48	
56264b	insulating bush	DO-5, TO-48	
56295a	mica washer (up to 2000 V)	DO-4, TO-64	
56295b	PTFE ring	DO-4, TO-64	
56295c	insulating bush	DO-4, TO-64	
56359b	mica washer (up to 1000 V)	TO-220	
56359c	insulating bush (up to 800 V)	TO-220	
56359d	rectangular insulating bush (up to 1000 V)	TO-220	
56360a	rectangular washer	TO-220	
56363	spring clip (direct mounting)	TO-220, SOT-186	←
56364	spring clip (insulated mounting)	TO-220	
56367	alumina insulator (up to 2000 V)	TO-220	
56368b	insulating bush (up to 800 V)	SOT-93	
56368c	mica insulator (up to 800 V)	SOT-93	←
56369	mica insulator (up to 2000 V)	TO-220	
56378	mica insulator (up to 1500 V)	SOT-93	
56379	spring clip	SOT-93, SOT-112	

56264a MICA WASHER

Insulator up to 2000 V

MECHANICAL DATA

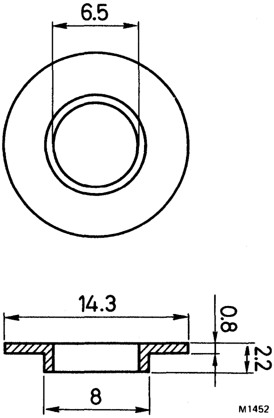
Dimensions in mm



56264b INSULATING BUSH

MECHANICAL DATA

Dimensions in mm



THERMAL RESISTANCE

From mounting base to heatsink

with mica washer, without heatsink compound $R_{th\ mb\text{-}h}$ = 5 K/W

with mica washer, with heatsink compound $R_{th\ mb\text{-}h}$ = 2.5 K/W

TEMPERATURE

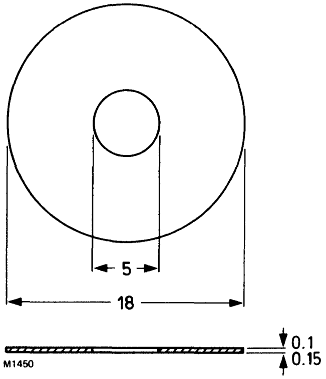
Maximum allowable temperature T_{max} = 175 °C

56295a MICA WASHER

Insulator up to 2 kV.

MECHANICAL DATA

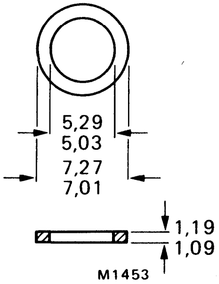
Dimensions in mm



56295b PTFE RING

MECHANICAL DATA

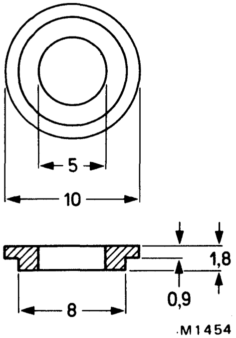
Dimensions in mm



56295c INSULATING BUSH

MECHANICAL DATA

Dimensions in mm



THERMAL RESISTANCE

From mounting base to heatsink				
without heatsink compound	$R_{th\ mb\text{-}h}$	=	5	K/W
with heatsink compound	$R_{th\ mb\text{-}h}$	=	2.5	K/W

TEMPERATURE

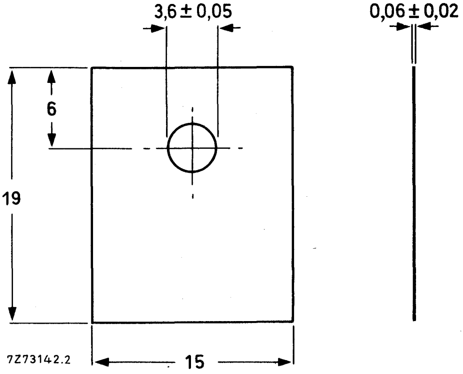
Maximum allowable temperature	T_{max}	=	175	°C

56359b MICA WASHER

Insulator up to 1000 V.

MECHANICAL DATA

Dimensions in mm



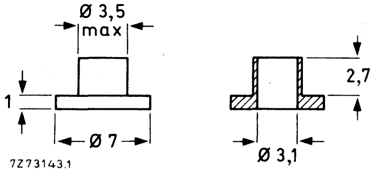
56359c INSULATING BUSH

Insulator up to 800 V.

MECHANICAL DATA

Material: polyester

Dimensions in mm



TEMPERATURE

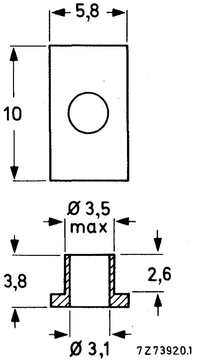
Maximum pemissible temperature T_{max} = 150 °C

56359d RECTANGULAR INSULATING BUSH

Insulator up to 1000 V.

MECHANICAL DATA

Dimensions in mm



TEMPERATURE

Maximum permissible temperature T_{max} = 150 °C

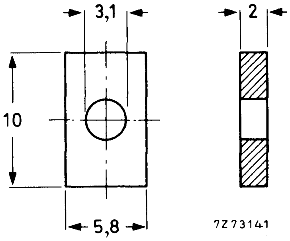
56360a RECTANGULAR WASHER (For TO-220)

For direct and insulated mounting.

MECHANICAL DATA

Dimensions in mm

Material: brass; nickel plated.



56363 SPRING CLIP (For TO-220 and SOT-186) ←

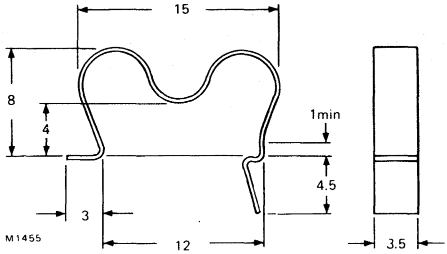
For direct mounting.

MECHANICAL DATA

Dimensions in mm

Material: stainless steel; for mounting on heatsink of 1.0 to 2.0 mm.

Recommended force
of clip on device
is 20 N (2 kgf).



56364 SPRING CLIP (For TO-220)

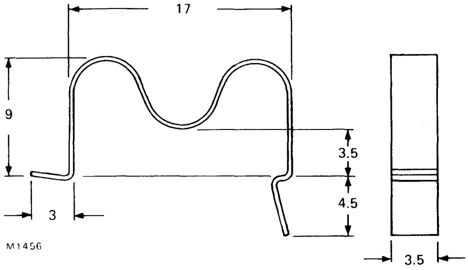
For insulated mounting.

MECHANICAL DATA

Dimensions in mm

Material: stainless steel; for mounting on heatsink of 1.0 to 1.5 mm.

Recommended force
of clip on device
is 20 N (2 kgf).



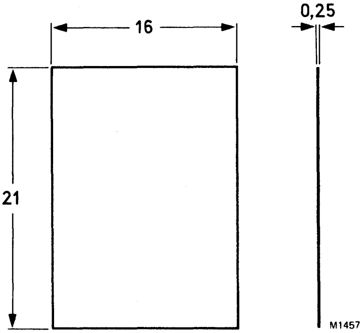
To be used in conjunction with insulators **56367** or **56369**

56367 ALUMINA INSULATOR

For insulated clip mounting up to 2 kV.

MECHANICAL DATA Dimensions in mm

Material: 96-alumina.

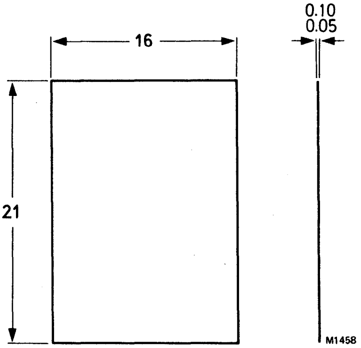


*Because alumina is brittle, extreme care must be taken when mounting devices not to crack the alumina, particularly when used without heatsink compound.

56369 MICA INSULATOR

For insulated clip mounting up to 2 kV.

MECHANICAL DATA Dimensions in mm

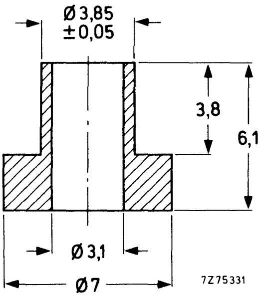


56368b INSULATING BUSH

For insulated screw mounting up to 800 V.

MECHANICAL DATA Dimensions in mm

Material: polyester



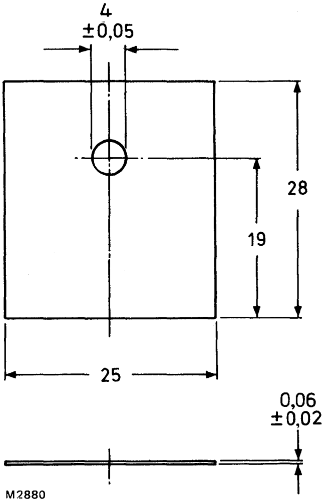
TEMPERATURE

Maximum permissible temperature T_{max} = 150 °C

56368c MICA INSULATOR

For insulated screw mounting up to 800 V.

MECHANICAL DATA Dimensions in mm



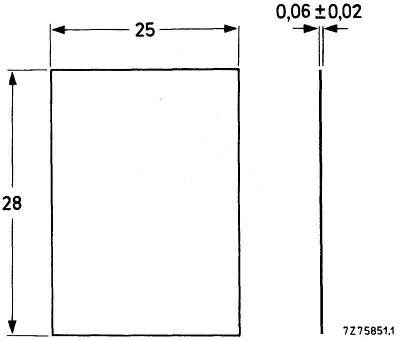
56369: see preceding page.

56378 MICA INSULATOR

For clip mounting up to 1500 V.

MECHANICAL DATA

Dimensions in mm



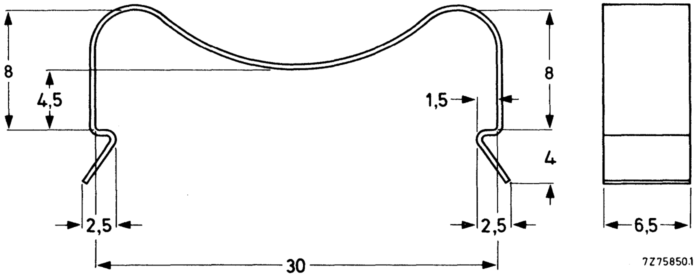
56379 SPRING CLIP

For direct and insulated mounting of SOT-93 and SOT-112 envelopes.

MECHANICAL DATA

Dimensions in mm

Material:
CrNi steel NLN-939;
thickness 0.4 ± 0.04.



MOUNTING INSTRUCTIONS

MOUNTING INSTRUCTIONS FOR TO-220 ENVELOPES

GENERAL DATA AND INSTRUCTIONS

General rules

1. First fasten the device to the heatsink before soldering the leads.
2. Avoid axial stress to the leads.
3. Keep mounting tool (e.g. screwdriver) clear of the plastic body.
4. The rectangular washer may only touch the plastic part of the body; it should not exert any force on that part (screw mounting).

Heatsink requirements

Flatness in the mounting area: 0,02 mm maximum per 10 mm.
Mounting holes must be deburred, see further mounting instructions.

Heatsink compound

Values of the thermal resistance from mounting base to heatsink ($R_{th\ mb\text{-}h}$) given for mounting with heatsink compound refer to the use of a metallic oxide-loaded compound. Ordinary silicone grease is not recommended.

For insulated mounting, the compound should be applied to the bottom of both device and insulator.

Mounting methods for power devices

1. Clip mounting

   Mounting with a spring clip gives:

   a. A good thermal contact under the crystal area, and slightly lower $R_{th\ mb\text{-}h}$ values than screw mounting.
   b. Safe insulation for mains operation.

2. M3 screw mounting

   It is recommended that the rectangular spacing washer is inserted between screw head and mounting tab.

   Mounting torque for screw mounting:

   (For thread-forming screws these are final values. Do not use self-tapping screws.)

Minimum torque (for good heat transfer)	0,55 Nm (5,5 kgcm)
Maximum torque (to avoid damaging the device)	0,80 Nm (8,0 kgcm)

N.B.: When a nut or screw is not driven direct against a curved spring washer or lock washer (not for thread-forming screw), the torques are as follows:

Minimum torque (for good heat transfer)	0,4 Nm (4 kgcm)
Maximum torque (to avoid damaging the device)	0,6 Nm (6 kgcm)

3. Rivet mounting non-insulated

The device should not be pop-rivetted to the heatsink. However, it is permissible to press-rivet providing that eyelet rivets of soft material are used, and the press forces are slowly and carefully controlled so as to avoid shock and deformation of either heatsink or mounting tab.

Thermal data

→ (Typical figures, for exact figures see data for each device type).

			clip mounting	screw mounting	
From mounting base to heatsink					
with heatsink compound, direct mounting	$R_{th\ mb\text{-}h}$	=	0,3	0,5	K/W
without heatsink compound, direct mounting	$R_{th\ mb\text{-}h}$	=	1,4	1,4	K/W
with heatsink compound and 0,1 mm maximum mica washer	$R_{th\ mb\text{-}h}$	=	2,2	–	K/W
with heatsink compound and 0,25 mm maximum alumina insulator	$R_{th\ mb\text{-}h}$	=	0,8	–	K/W
with heatsink compound and 0,05 mm mica washer					
insulated up to 500 V	$R_{th\ mb\text{-}h}$	=	–	1,4	K/W
insulated up to 800 V/1000 V	$R_{th\ mb\text{-}h}$	=	–	1,6	K/W
without heatsink compound and 0,05 mm mica washer					
insulated up to 500 V	$R_{th\ mb\text{-}h}$	=	–	3,0	K/W
insulated up to 800 V/1000 V	$R_{th\ mb\text{-}h}$	=	–	4,5	K/W

Lead bending

Maximum permissible tensile force on the body, for 5 seconds is 20 N (2 kgf).

The leads can be bent through 90° maximum, twisted or straightened. To keep forces within the above-mentioned limits, the leads are generally clamped near the body, using pliers. The leads should neither be bent nor twisted less than 2,4 mm from the body.

Soldering

Lead soldering temperature at $>$ 3 mm from the body; $t_{sld} < 5$ s:

Devices with $T_{j\ max} \leq 175$ °C, soldering temperature $T_{sld\ max} = 275$ °C.
Devices with $T_{j\ max} \leq 110$ °C, soldering temperature $T_{sld\ max} = 240$ °C.

Avoid any force on body and leads during or after soldering: do not correct the position of the device or of its leads after soldering.

It is not permitted to solder the metal tab of the device to a heatsink, otherwise its junction temperature rating will be exceeded.

Mounting base soldering

Recommended metal-alloy of solder paste (85% metal weight)
62 Sm/36 Pb/2 Ag or 60 Sn/40 Pb.
Maximum soldering temperature ≤ 200 °C (tab-temperature).
Soldering cycle duration including pre-heating ≤ 30 sec.

For good soldering and avoiding damage to the encapsulation pre-heating is recommended to a temperature ≤ 165 °C at a duration ≤ 10 s.

INSTRUCTIONS FOR CLIP MOUNTING

Direct mounting with clip 56363

1. Apply heatsink compound to the mounting base, then place the device on the heatsink.
2. Push the short end of the clip into the narrow slot in the heatsink with clip at an angle of 10° to 30° to the vertical (see Figs 1 and 2).
3. Push down the clip over the device until the long end of the clip snaps into the wide slot in the heatsink. The clip should bear on the plastic body, not on the tab (see Fig.2a).
   Do not insert more than 1 mm beyond final position.

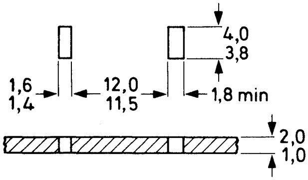


Fig. 1 Heatsink requirements.

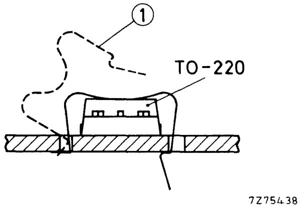


Fig. 2 Mounting.
(1) spring clip 56363.

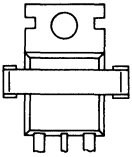


Fig. 2a Position of device (top view).

Insulated mounting with clip 56364

With the insulators 56367 or 56369 insulation up to 2 kV is obtained.

1. Apply heatsink compound to the bottom of both device and insulator, then place the device with the insulator on the heatsink.
2. Push the short end of the clip into the narrow slot in the heatsink with the clip at an angle of 10° to 30° to the vertical (see Figs 3 and 4).
3. Push down the clip over the device until the long end of the clip snaps into the wide slot in the heatsink. The clip should bear on the plastic body, not on the tab. Ensure that the device is centred on the mica insulator to prevent creepage.
   Do not insert more than 1 mm beyond final position.

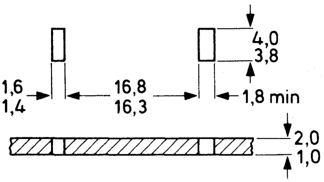


Fig. 3 Heatsink requirements.

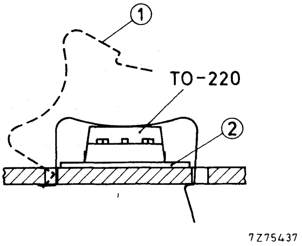


Fig. 4 Mounting.
(1) spring clip 56364.
(2) insulator 56369 or 56367.

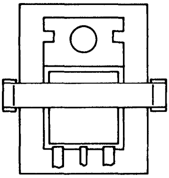


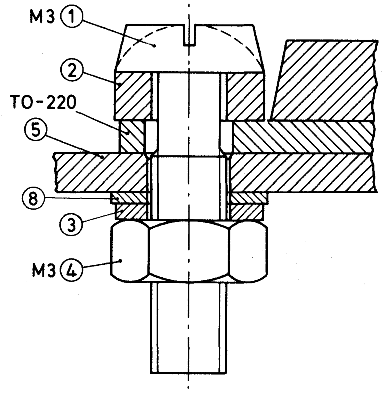
Fig.4a Position of device (top view).

INSTRUCTIONS FOR SCREW MOUNTING

Dimensions in mm

Direct mounting with screw and spacing washer

- *through heatsink with nut*



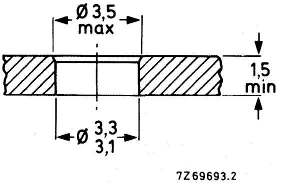
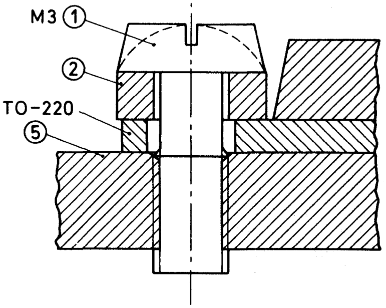


Fig. 5 Assembly.

Fig. 6 Heatsink requirements.

(1) M3 screw.
(2) rectangular washer (56360a).
(3) lock washer.
(4) M3 nut.
(5) heatsink.
(8) plain washer.

- *into tapped heatsink*



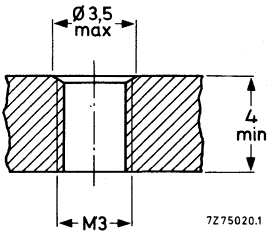


Fig. 7 Assembly.

Fig. 8 Heatsink requirements.

(1) M3 screw.
(2) rectangular washer 56360a.
(5) heatsink.

Insulated mounting with screw and spacing washer
(not recommended where mounting tab is on mains voltage)

Dimensions in mm

- *through heatsink with nut*

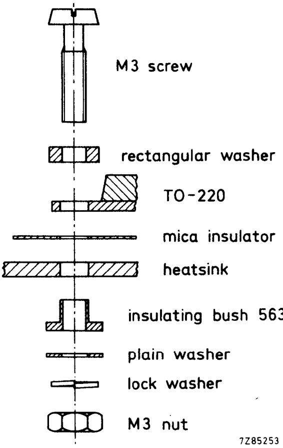


Fig. 9 Insulated screw mounting with rectangular washer. Known as a "bottom mounting".

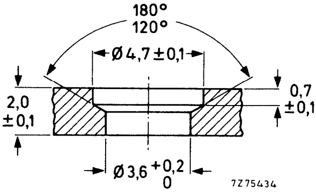


Fig. 10 Heatsink requirements for 500 V insulation.

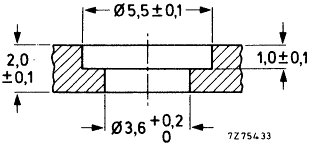


Fig. 11 Heatsink requirements for 800 V insulation.

- *into tapped heatsink*

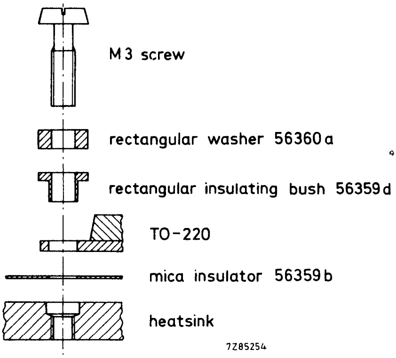


Fig. 12 Insulated screw mounting with rectangular washer into tapped heatsink. Known as a "top mounting".

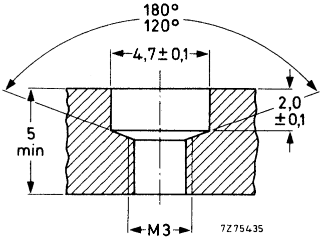


Fig. 13 Heatsink requirements for 500 V insulation.

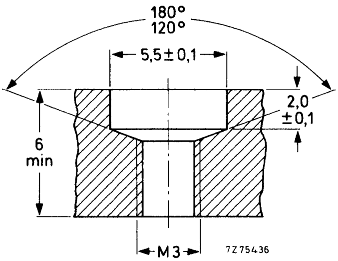


Fig. 14 Heatsink requirements for 1000 V insulation.

MOUNTING INSTRUCTIONS FOR TO-220 FULL-PACK (SOT-186) DEVICES

Use of full-pack (SOT-186 envelope) devices allows an insulated mounting with up to 1kV isolation. These devices require the assembly of less components than TO-220 devices with insulating washers.

GENERAL DATA AND INSTRUCTIONS

General rules

1. Mounting instructions for voltage isolation are given for guidance. Users should aquaint themselves with the relevant statutory and mandatory regulations if the heatsink is earthed or may be touched.
2. Fasten device to heatsink before soldering the leads.
3. Avoid axial stress to the leads.
4. Be careful to avoid damaging plastic with mounting tool (e.g. screwdriver).
5. If a rectangular washer (part no. 56360a) is used in screw mounting it may only touch the main part of the body, it should not exert any force on this part.

Heatsink requirements

Flatness in the mounting area: 0.02mm maximum per 10mm.

Mounting holes must be deburred.

Heatsink compound

Values of thermal resistance given using heatsink compound refer to the use of a metallic oxide-loaded compound. Ordinary silicone grease is not recommended.

Mounting methods for power devices

1. Clip mounting:
   This gives better thermal contact under the crystal area than screw mounting.

   For details of mounting force for spring clip mounting see data sheet "Accesories for TO-220".
2. M3 screw mounting:
   It is recommended that a rectangular spacing washer (part no. 56360a) is inserted between the screw head and plastic mounting tab.

N.B. Data on accessories are given in separate data sheet "Accesories for TO-220".

Mounting torque for screw mounting:

(For thread-forming screws these are final values. Do not use self-tapping screws.)

Minimum torque (for good heat transfer)	0.55 Nm (5.5 kgcm)
Maximum torque (to avoid damaging the device)	0.80 Nm (8.0 kgcm)

N.B. When a nut or screw is not driven against a curved spring washer or lock washer (not for thread-forming screws) the torques are as follows:

Minimum torque (for good heat transfer)	0.40 Nm (4.0 kgcm)
Maximum torque (to avoid damaging device)	0.60 Nm (6.0 kgcm)

3. Rivet mounting:
   This method is **NOT** recommended because it will damage the plastic encapsulation.

Lead bending

(Maximum permissible tensile force on the body, for 5 seconds is 20N (2kgf).

The leads should not be bent less than 2.4mm from the seal, and should be supported during bending.
The leads can be bent, twisted or straightened by 90 ° maximum. The minimum bending radius is 1mm.

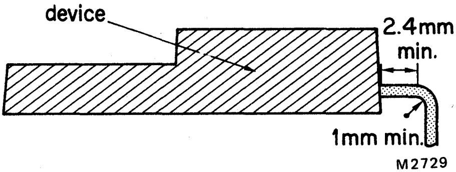


Fig.1 Lead bending of devices.

Soldering

Lead soldering temperature at >3mm from body for t_{sld} <5 seconds:

Devices with T_j max. $\leqslant 175\ ^{\circ}C$, T_{sld} max. = $275\ ^{\circ}C$.

Devices with T_j max. $\leqslant 110\ ^{\circ}C$, T_{sld} max. = $240\ ^{\circ}C$.

Avoid any force on body and leads during or after soldering. Do not correct the position of the devices or of its leads after soldering.

INSTRUCTIONS FOR CLIP MOUNTING

1.Apply heatsink compound to the mounting base, then place device on heatsink.

2.Push the short end of clip (part no. 56363) into the narrow slot in the heatsink with the clip at an angle of between 10° to 30° to the vertical (see Figs.2 & 3).

3.Push down the clip over the device until the long end of the clip snaps into the wide slot in the heatsink. The clip should bear down on the main part of the body, not on the tab (see Fig.3a).

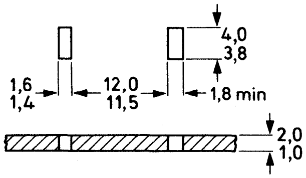


Fig.2 Heatsink requirements

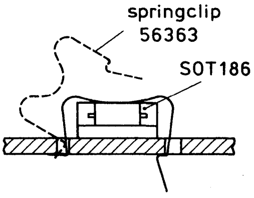


Fig.3 Mounting.

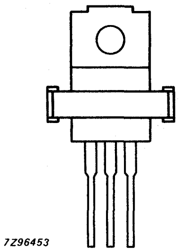


Fig.3a Position of device (top view).

INSTRUCTIONS FOR SCREW MOUNTING

Screw through heatsink with nut

Dimensions in mm

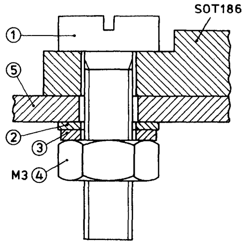


Fig.4 Assembly.

(1) M3 screw
(2) plain washer
(3) lock washer
(4) M3 nut
(5) heatsink

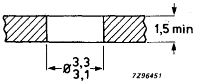


Fig.5 Heatsink requirements.

Into tapped heatsink

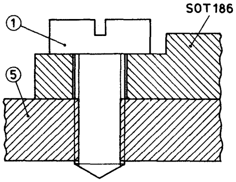


Fig.6 Assembly.

(1) M3 screw
(5) heatsink

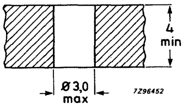


Fig.7 Heatsink requirements.

MOUNTING REQUIREMENTS FOR VOLTAGE ISOLATION

Full-pack devices may be used to maintain voltage isolation between the heatsink and the electrical circuit. However, users must ensure that there is a sufficient creepage distance between the exposed metal of the device (at both the lead and tab ends) and the heatsink. The distance required will vary according to the application and the regulations that may apply.

To increase the creepage distances the heatsink may be formed with slots or holes around the lead and tab ends of the device. The dimensions of the holes will vary according to the creepage distances required. For detail see Fig.8.

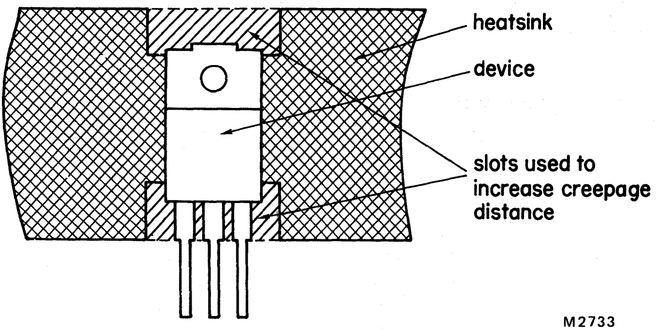


Fig.8 Slots formed in heatsink to increase creepage distance.

MOUNTING INSTRUCTIONS FOR SOT-93 ENVELOPES

GENERAL DATA AND INSTRUCTIONS

General rule

Avoid any sudden forces on leads and body; these forces, such as from falling on a hard surface, are easily underestimated. In the direct screw mounting an M4 screw must be used; an M3 screw in the insulating mounting.

Heatsink requirements

Flatness in the mounting area: 0,02 mm maximum per 10 mm.
The mounting hole must be deburred.

Heatsink compound

The thermal resistance from mounting base to heatsink ($R_{th\ mb\text{-}h}$) can be reduced by applying a metallic-oxide heatsink compound between the contact surfaces. For insulated mounting the compound should be applied to the bottom of both device and insulator.

Maximum play

The bush or the washer may only just touch the plastic part of the body, but should not exert any force on that part. Keep mounting tool (e.g. screwdriver) clear of the plastic body.

Mounting torques

For M3 screw (insulated mounting):	
Minimum torque (for good heat transfer)	0,4 Nm (4 kgcm)
Maximum torque (to avoid damaging the device)	0,6 Nm (6 kgcm)
For M4 screw (direct mounting only):	
Minimum torque (for good heat transfer)	0,4 Nm (4 kgcm)
Maximum torque (to avoid damaging the device)	1,0 Nm (10 kgcm)

Note: The M4 screw head should not touch the plastic part of the envelope.

Lead bending

Maximum permissible tensile force on the body for 5 s	20 N (2 kgf)

No torsion is permitted at the emergence of the leads.

Bending or twisting is not permitted within a lead length of 0,3 mm from the body of the device.

The leads can be bent through 90° maximum, twisted or straightened; to keep forces within the above-mentioned limits, the leads should be clamped near the body.

Soldering

Recommendations for devices with a maximum junction temperature rating ⩽ 175 °C:

a. Dip or wave soldering

Maximum permissible solder temperature is 260 °C at a distance from the body of > 5 mm and for a total contact time with soldering bath or waves of < 7 s.

b. Hand soldering

Maximum permissible temperature is 275 °C at a distance from the body of > 3 mm and for a total contact time with the soldering iron of < 5 s.

The body of the device must not touch anything with a temperature > 200 °C.

It is not permitted to solder the metal tab of the device to a heatsink, otherwise the junction temperature rating will be exceeded.

Avoid any force on body and leads during or after soldering; do not correct the position of the device or of its leads after soldering.

Thermal data

(Typical figures, for exact figures see data for each device type).

		clip mounting	screw mounting
Thermal resistance from mounting base to heatsink			
direct mounting			
with heatsink compound	$R_{th\,mb\text{-}h}$ =	0,3	0,3 K/W
without heatsink compound	$R_{th\,mb\text{-}h}$ =	1,5	0,8 K/W
with 0,05 mm mica washer			
with heatsink compound	$R_{th\,mb\text{-}h}$ =	0,8	0,8 K/W
without heatsink compound	$R_{th\,mb\text{-}h}$ =	3,0	2,2 K/W

INSTRUCTIONS FOR CLIP MOUNTING

Direct mounting with clip 56379

1. Place the device on the heatsink, applying heatsink compound to the mounting base.
2. Push the short end of the clip into the narrow slot in the heatsink with the clip at an angle of 10° to 20° to the vertical (see Fig. 1b).
3. Push down the clip over the device until the long end of the clip snaps into the wide slot in the heatsink. The clip should bear on the plastic body, not on the tab (see Fig. 1(c)).

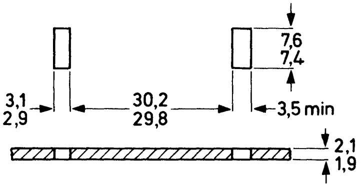


Fig. 1a Heatsink requirements.

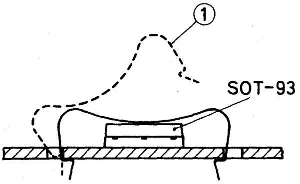


Fig. 1b Mounting.
(1) = spring clip 56379.

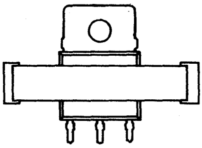


Fig. 1c Position of the device.

Insulated mounting with clip 56379

With the mica 56378 insulation up to 1500 V is obtained.

1. Place the device with the insulator on the heatsink, applying heatsink compound to the bottom of both device and insulator.
2. Push the short end of the clip into the narrow slot in the heatsink with the clip at an angle of 10° to 20° to the vertical (see Figs 2a and 2b).
3. Push down the clip over the device until the long end of the clip snaps into the wide slot in the heatsink. The clip should bear on the plastic body, not on the tab (see Fig. 2c). There should be minimum 3 mm distance between the device and the edge of the insulator for adequate creepage.

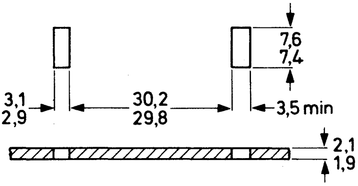


Fig. 2a Heatsink requirements.

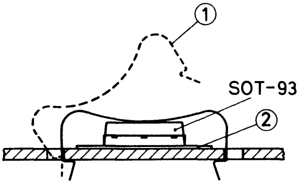


Fig. 2b Mounting.
(1) = spring clip 56379
(2) = insulator 56378

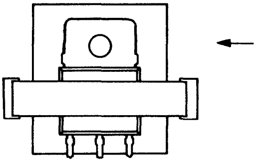


Fig. 2c Position of the device.

INSTRUCTIONS FOR SCREW MOUNTING

Direct mounting

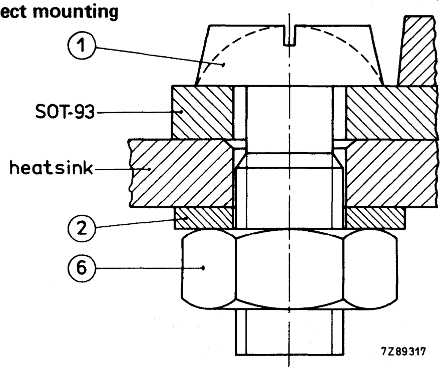


Fig. 3a Assembly through heatsink with nut.

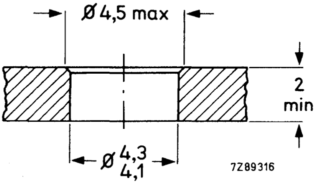
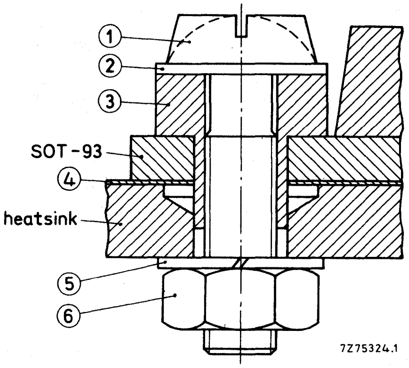


Fig. 3b Heatsink requirements.

When screw mounting the SOT-93 envelope, it is particularly important to apply a thin, even layer of heatsink compound to the mounting base, and to apply torque to the screw slowly so that the compound has time to flow and the mounting base is not deformed. Most SOT-93 envelopes contain a crystal larger than that in the other plastic envelopes, and it is more likely to crack if the mounting base is deformed.

Legend: (1) M4 screw; (2) plain washer; (6) M4 nut.
Where vibrations are to be expected the use of a lock washer or of a curved spring washer is recommended, with a plain washer between aluminium heatsink and spring washer.

Insulated screw mounting with nut; up to 800 V.



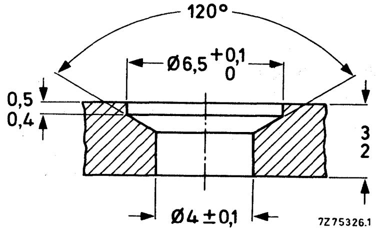
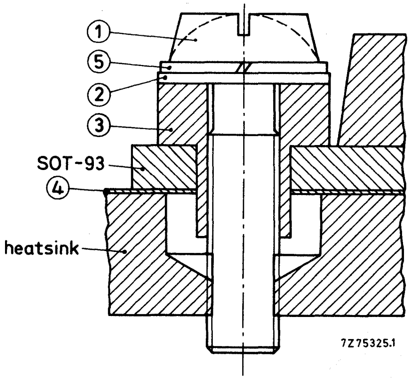


Fig. 4 Assembly.
See also Fig. 9.

Fig. 5 Heatsink requirements up to 800 V insulation.

(1) M3 screw
(2) plain washer
(3) insulating bush (56368b)
→ (4) mica insulator (56368c)
(5) lock washer
(6) M3 nut

Insulated screw mounting with tapped hole; up to 800 V.



→ Fig. 6 Assembly.
See also Fig. 9.

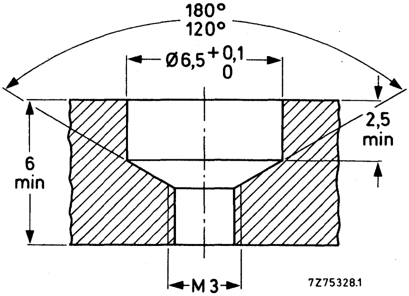


Fig. 7 Heatsink requirements up to 800 V insulation.

(1) M3 screw
(2) plain washer
(3) insulating bush (56368b)
(4) mica insulator (56368c)
(5) lock washer

Insulated screw mounting with insert nut; up to 500 V

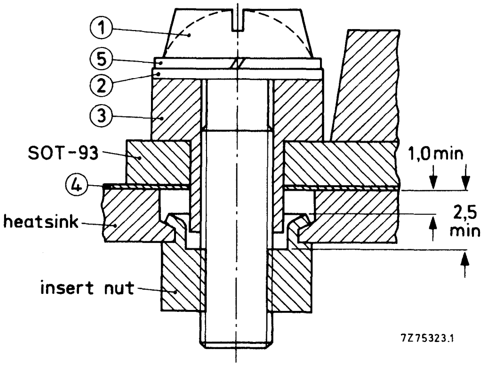


Fig. 8 Assembly and heatsink requirements for 500 V insulation. See also Fig. 3.

(1) M3 screw	
(2) plain washer	
(3) insulating bush	(56368b)
(4) mica insulator	(56368c)
(5) lock washer	

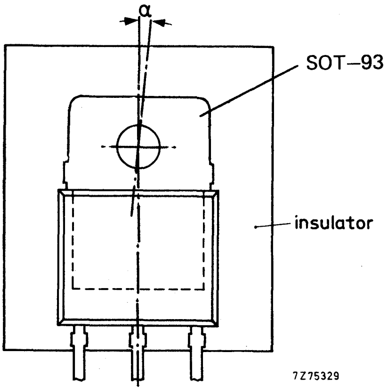
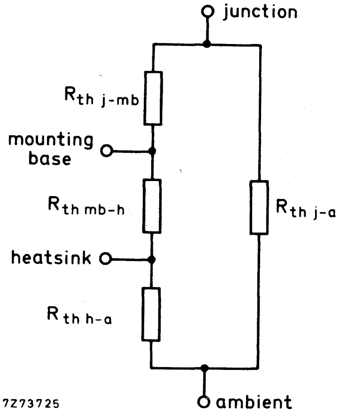


Fig. 9 Mica insulator.

The axial deviation (α) between SOT-93 and mica should not exceed 5°.

MOUNTING CONSIDERATIONS FOR STUD-MOUNTED DEVICES

Losses generated in a silicon device must flow through the case and to a lesser extent the leads.
The greatest proportion of the losses flow out through the case into a heat exchanger which can be either free convection cooled, forced convection or even liquid cooled. For the majority of devices in our range natural convection is generally adequate, however, where other considerations such as space saving must be taken into account then methods such as forced convection etc. can be considered.
The thermal path from junction to ambient may be considered as a number of resistances in series.
The first thermal resistance will be that of junction to mounting base, usually denoted by $R_{th\ j\text{-}mb}$.
The second is the contact thermal resistance $R_{th\ mb\text{-}h}$ and finally there is the thermal resistance of the heatsink $R_{th\ h\text{-}a}$.
In the rating curves, the contact thermal resistance and heatsink thermal resistances are combined as a single figure - $R_{th\ mb\text{-}a}$.
In addition to the steady state thermal conditions of the system, consideration should also be given to the possibility of any transient thermal excursions. These can be caused for example by starting conditions or overloads and in order to calculate the effect on the device, a graph of transient thermal resistance $Z_{th\ j\text{-}mb}$ as a function of time is given in each data sheet.



When mounting the device on the heatsink, care should be taken that the contact surfaces are free from burrs or projections of any kind and must be thoroughly clean.
In the case where an anodised heatsink is used, the anodising should be removed from the contact surface ensuring good electrical and thermal contact.
The contact surfaces should be smeared with a metallic oxide-loaded grease to ensure good heat transfer.
Where the device is mounted in a tapped hole, care should be taken that the hole is perpendicular to the surface of the heatsink. When mounting the device to the heatsink, it is essential that a proper torque wrench is used, applying the correct amount of torque as specified in the published data.
Excessive torque can distort the threads of the device and may even cause mechanical stress on the wafer, leading to the possible failure.
Where isolation of the device from the heatsink is required, it is common practice to use a mica washer between contact surfaces, and where a clearance hole is used, a p.t.f.e. insulating bush is inserted. A metallic oxide-loaded heatsink compound should be smeared on all contact surfaces, including the mica washer, to ensure optimum heat transfer. The use of ordinary silicone grease is not recommended.

MOUNTING INSTRUCTIONS FOR DO-4 AND TO-64 ENVELOPES

GENERAL DATA AND INSTRUCTIONS

Mounting instructions for up to 2000 V insulation using 56295c insulating bush and 56295a mica washer.

Mounting instructions for up to 2000 V insulation using 56295b insulating ring and two 56295a mica washers.

HEATSINK REQUIREMENTS

Mounting holes must be deburred.

MOUNTING TORQUES

Minimum torque (for good heat transfer)	0.9 Nm (9 kg cm)
Maximum torque (to avoid damaging device)	1.7 Nm (17 kg cm)

THERMAL DATA

The thermal resistance from mounting base to heatsink ($R_{th\ mb\text{-}h}$) can be reduced by applying a heat conducting compound between device and heatsink. For insulated mounting the compound should be applied to the bottom of both device and insulator.

Thermal resistance from mounting base to heatsink
(insulated mounting using 56295a mica washer)

without heatsink compound	$R_{th\ mb\text{-}h}$	=	5	K/W
with heatsink compound	$R_{th\ mb\text{-}h}$	=	2.5	K/W

MOUNTING INSTRUCTIONS FOR UP TO 2000 V INSULATION

Using 56295c insulating bush and 56295a mica washer.

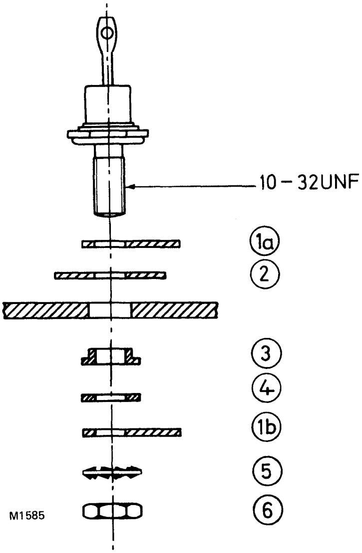


Fig.1

(1a);(1b)	tag – alternative positions
(2)	mica washer 56295a
(3)	insulating bush 56295c
(4)	plain washer (may be omitted if tag used in position 1b)
→ (5)	toothed lock washer (supplied with device)
(6)	10-32 UNF nut (supplied with device)

MOUNTING INSTRUCTIONS FOR UP TO 2000 V INSULATION

Using insulating ring 56295b and two mica washers 56295a.

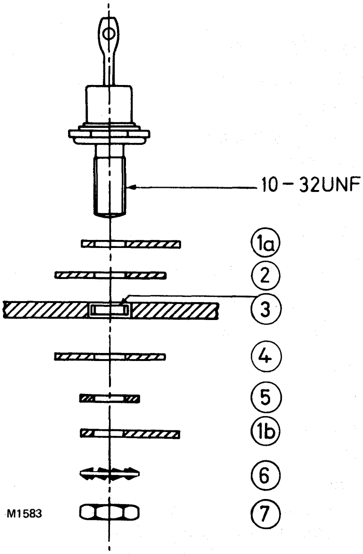


Fig. 2

(1a); (1b)	tag — alternative positions
(2)	mica washer 56295a
(3)	insulating ring 56295b
(4)	mica washer 56295a
(5)	plain washer (may be omitted if tag used in position 1b)
→ (6)	toothed lock washer (supplied with device)
(7)	10-32 nut (supplied with device)

MOUNTING INSTRUCTIONS FOR DO-5 AND TO-48 ENVELOPES

GENERAL DATA AND INSTRUCTIONS

Mounting instructions for up to 2000 V insulation using 56264b insulating bush and 56264a mica washer.

HEATSINK REQUIREMENTS

Mounting holes must be deburred.

MOUNTING TORQUES

Minimum torque (for good heat transfer)	1.7 Nm (17 kg cm)
Maximum torque (to avoid damaging device)	3.5 Nm (35 kg cm)

THERMAL DATA

The thermal resistance from mounting base to heatsink ($R_{th\ mb\text{-}h}$) can be reduced by applying a heat conducting compound between device and heatsink. For insulated mounting the compound should be applied to the bottom of both device and insulator.

Thermal resistance from mounting base
to heatsink (insulated mounting using 56264a mica washer)

without heatsink compound	$R_{th\ mb\text{-}h}$	=	5	K/W
with heatsink compound	$R_{th\ mb\text{-}h}$	=	2.5	K/W

MOUNTING INSTRUCTIONS FOR UP TO 2000 V INSULATION

Using insulating bush 56264b and mica washer 56264a.

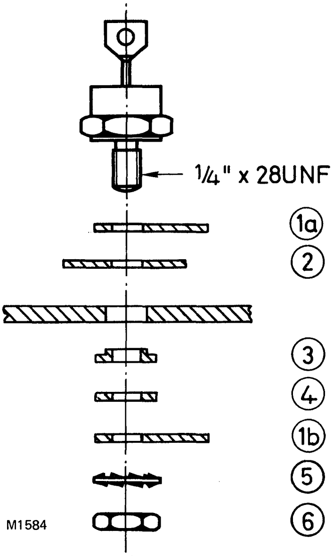


Fig.1

(1a); (1b) tag – alternative positions
(2) mica washer 56264a
(3) insulating bush 56264b
(4) plain washer (may be omitted if tag used in position 1b)
→ (5) toothed lock washer (supplied with device)
(6) ¼" x 28 UNF nut (supplied with device)

MOUNTING INSTRUCTIONS FOR SOT-112 ENVELOPE

GENERAL DATA AND INSTRUCTIONS

Mounting instructions using 56379 spring clip.

THERMAL DATA

The thermal resistance from mounting base to heatsink ($R_{th\ mb-h}$) can be reduced by applying a metallic oxide heatsink compound between the contact surfaces.

Thermal resistance from mounting base to heatsink

with a metallic oxide loaded compound	$R_{th\ mb-h}$	=	1.0	K/W
without heatsink compound	$R_{th\ mb-h}$	=	2.0	K/W

INSTRUCTIONS FOR MOUNTING

1. Place the device on the heatsink, applying a metallic oxide loaded compound to the mounting base.
2. Push the short end of the clip into the narrow slot of the heatsink with the clip at an angle of 10 ° to 30 ° to the vertical (see Fig. 1b).
3. Push down the clip over the device until the long end of the clip snaps into the wide slot. The clip should bear down on the middle of the plastic body.

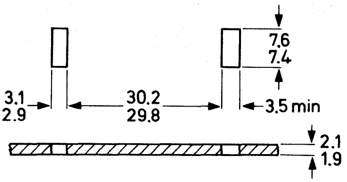


Fig. 1a Heatsink requirements.

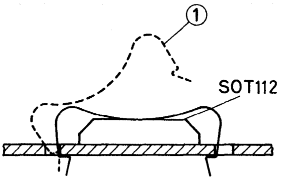


Fig. 1b Mounting.
(1) = spring clip 56379

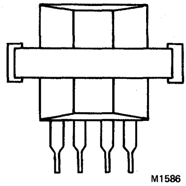


Fig. 1c Position of the device.

INDEX

INDEX

Type No.	Page
BR210 series	627
BR216 series	639
BR220 series	643
BY224 series	107
BY225 series	115
BY229 series	129
BY229F series	141
BY249 series	39
BY260 series	123
BY261 series	125
BY329 series	153
BY359 series	165
BYP21 series	173
BYP22 series	183
BYP59 series	193
BYQ28 series	197
BYR29 series	207
BYR29F series	217
BYT28 series	227
BYT79 series	237
BYV18 series	517
BYV19 series	527
BYV20 series	535
BYV21 series	543
BYV22 series	551
BYV23 series	559
BYV24 series	247
BYV26 series	255
BYV27 series	261
BYV28 series	269
BYV29 series	275
BYV29F series	285
BYV30 series	295
BYV31 series	303
BYV32 series	311
BYV32F series	321
BYV33 series	567
BYV33F series	577
BYV34 series	331
BYV39 series	587
BYV42 series	341
BYV43 series	595
BYV43F series	603
BYV44 series	351
BYV60 series	361
BYV72 series	369
BYV73 series	611

Type No.	Page
BYV74 series	379
BYV79 series	389
BYV92 series	399
BYW25 series	407
BYW29 series	413
BYW29F series	423
BYW30 series	433
BYW31 series	441
BYW92 series	449
BYW93 series	457
BYX25 series	45
BYX30 series	465
BYX32 series	53
BYX38 series	55
BYX39 series	61
BYX42 series	67
BYX46 series	475
BYX50 series	487
BYX52 series	71
BYX56 series	75
BYX96 series	81
BYX97 series	87
BYX98 series	93
BYX99 series	99
BZW86 series	659
BZX70 series	671
BZY91 series	693
BZY93 series	713
OSB/M/S9115 series	733
OSB/M/S9215 series	743
OSB/M/S9415 series	753
OSM9510-12	761
PHSD51	619
1N3879 to 3883	495
1N3889 to 3893	501
1N3909 to 3913	507
56264a,b	770
56295a,b,c	771
56359b,c,d	772
56360a	773
56363	773
56364	773
56367	774
56368b,c	775
56369	774
56378	776
56379	776

INDEX OF TYPE NUMBERS

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

type no.	book	section
BA220	S1	SD
BA221	S1	SD
BA223	S1	T
BA281	S1	SD
BA314	S1	Vrg
BA315	S1	Vrg
BA316	S1	SD
BA317	S1	SD
BA318	S1	SD
BA423	S1	T
BA480	S1	T
BA481	S1	T
BA482	S1	T
BA483	S1	T
BA484	S1	T
BA682	S1/S7	T/Mm
BA683	S1/S7	T/Mm
BAS11	S1	SD
BAS15	S1	SD
BAS16	S7/S1	Mm/SD
BAS17	S7/S1	Mm/Vrg
BAS19	S7/S1	Mm/SD
BAS20	S7/S1	Mm/SD
BAS21	S7/S1	Mm/SD
BAS28	S7/S1	Mm/SD
BAS29	S7/S1	Mm/SD
BAS31	S7/S1	Mm/SD
BAS32	S7/S1	Mm/SD
BAS35	S7/S1	Mm/SD
BAS45	S1	SD
BAS56	S1/S7	SD/Mm
BAT17	S7/S1	Mm/T
BAT18	S7/S1	Mm/T
BAT54	S1/S7	SD/Mm
BAT74	S1/S7	SD/Mm
BAT81	S1	T
BAT82	S1	T
BAT83	S1	T
BAT85	S1	T
BAT86	S1	T
BAV10	S1	SD
BAV18	S1	SD
BAV19	S1	SD
BAV20	S1	SD
BAV21	S1	SD
BAV23	S7/S1	Mm/SD
BAV45	S1	Sp
BAV45A	S1	Sp
BAV70	S7/S1	Mm/SD
BAV74	S1	SD
BAV99	S7/S1	Mm/SD
BAV100	S7/S1	Mm/SD
BAV101	S7/S1	Mm/SD
BAV102	S7/S1	Mm/SD
BAV103	S7/S1	Mm/SD
BAW56	S7/S1	Mm/SD
BAW62	S1	SD
BAX12	S1	SD
BAX14	S1	SD
BAX18	S1	SD
BAY80	S1	SD
BB112	S1	T
BB119	S1	T
BB130	S1	T
BB204B	S1	T
BB204G	S1	T
BB212	S1	T
BB215	S7/S1	Mm/SD
BB219	S7/S1	Mm/SD
BB405B	S1	T
BB417	S1	T
BB809	S1	T
BB909A	S1	T
BB909B	S1	T
BBY31	S7/S1	Mm/T

Mm = Microminiature semiconductors
for hybrid circuits
SD = Small-signal diodes

Sp = Special diodes
T = Tuner diodes
Vrg = Voltage regulator diodes

type no.	book	section
BBY39	S1	T
BBY40	S7/S1	Mm/T
BC107	S3	Sm
BC108	S3	Sm
BC109	S3	Sm
BC140	S3	Sm
BC141	S3	Sm
BC146	S3	Sm
BC160	S3	Sm
BC161	S3	Sm
BC177	S3	Sm
BC178	S3	Sm
BC179	S3	Sm
BC200	S3	Sm
BC264A	S5	FET
BC264B	S5	FET
BC264C	S5	FET
BC264D	S5	FET
BC327;A	S3	Sm
BC328	S3	Sm
BC337;A	S3	Sm
BC338	S3	Sm
BC368	S3	Sm
BC369	S3	Sm
BC375	S3	Sm
BC376	S3	Sm
BC546	S3	Sm
BC547	S3	Sm
BC548	S3	Sm
BC549	S3	Sm
BC550	S3	Sm
BC556	S3	Sm
BC557	S3	Sm
BC558	S3	Sm
BC559	S3	Sm
BC560	S3	Sm
BC635	S3	Sm
BC636	S3	Sm
BC637	S3	Sm
BC638	S3	Sm
BC639	S3	Sm
BC640	S3	Sm
BC807	S7	Mm
BC808	S7	Mm
BC817	S7	Mm
BC818	S7	Mm
BC846	S7	Mm
BC847	S7	Mm
BC848	S7	Mm
BC849	S7	Mm
BC850	S7	Mm
BC856	S7	Mm
BC857	S7	Mm
BC858	S7	Mm
BC859	S7	Mm
BC860	S7	Mm
BC868	S7	Mm
BC869	S7	Mm
BCF29;R	S7	Mm
BCF30;R	S7	Mm
BCF32;R	S7	Mm
BCF33;R	S7	Mm
BCF70;R	S7	Mm
BCF81;R	S7	Mm
BCV26	S7	Mm
BCV27	S7	Mm
BCV61	S7	Mm
BCV62	S7	Mm
BCV71;R	S7	Mm
BCV72;R	S7	Mm
BCW29;R	S7	Mm
BCW30;R	S7	Mm
BCW31;R	S7	Mm
BCW32;R	S7	Mm
BCW33;R	S7	Mm
BCW60*	S7	Mm
BCW61*	S7	Mm
BCW69;R	S7	Mm
BCW70;R	S7	Mm
BCW71;R	S7	Mm
BCW72;R	S7	Mm
BCW81;R	S7	Mm
BCW89;R	S7	Mm
BCX17;R	S7	Mm
BCX18;R	S7	Mm
BCX19;R	S7	Mm
BCX20;R	S7	Mm
BCX51	S7	Mm
BCX52	S7	Mm
BCX53	S7	Mm
BCX54	S7	Mm
BCX55	S7	Mm
BCX56	S7	Mm
BCX68	S7	Mm
BCX69	S7	mm
BCX70*	S7	Mm
BCX71*	S7	Mm
BCY56	S3	Sm
BCY57	S3	Sm
BCY58	S3	Sm
BCY59	S3	Sm
BCY70	S3	Sm
BCY71	S3	Sm
BCY72	S3	Sm
BCY78	S3	Sm
BCY79	S3	Sm
BCY87	S3	Sm
BCY88	S3	Sm
BCY89	S3	Sm
BD131	S4a	P
BD132	S4a	P
BD135	S4a	P
BD136	S4a	P
BD137	S4a	P
BD138	S4a	P
BD139	S4a	P
BD140	S4a	P
BD201	S4a	P
BD202	S4a	P
BD203	S4a	P

* = series
FET = Field-effect transistors
Mm = Microminiature semiconductors for hybrid circuits
P = Low-frequency power transistors
Sm = Small-signal transistors
T = Tuner diodes

type no.	book	section
BD204	S4a	P
BD226	S4a	P
BD227	S4a	P
BD228	S4a	P
BD229	S4a	P
BD230	S4a	P
BD231	S4a	P
BD233	S4a	P
BD234	S4a	P
BD235	S4a	P
BD236	S4a	P
BD237	S4a	P
BD238	S4a	P
BD239	S4a	P
BD239A	S4a	P
BD239B	S4a	P
BD239C	S4a	P
BD240	S4a	P
BD240A	S4a	P
BD240B	S4a	P
BD240C	S4a	P
BD241	S4a	P
BD241A	S4a	P
BD241B	S4a	P
BD241C	S4a	P
BD242	S4a	P
BD242A	S4a	P
BD242B	S4a	P
BD242C	S4a	P
BD243	S4a	P
BD243A	S4a	P
BD243B	S4a	P
BD243C	S4a	P
BD244	S4a	P
BD244A	S4a	P
BD244B	S4a	P
BD244C	S4a	P
BD329	S4a	P
BD330	S4a	P
BD331	S4a	P
BD332	S4a	P
BD333	S4a	P
BD334	S4a	P
BD335	S4a	P
BD336	S4a	P
BD337	S4a	P
BD338	S4a	P
BD433	S4a	P
BD434	S4a	P
BD435	S4a	P
BD436	S4a	P
BD437	S4a	P
BD438	S4a	P
BD645	S4a	P
BD646	S4a	P
BD647	S4a	P
BD648	S4a	P
BD649	S4a	P
BD650	S4a	P
BD651	S4a	P
BD652	S4a	P
BD675	S4a	P
BD676	S4a	P
BD677	S4a	P
BD678	S4a	P
BD679	S4a	P
BD680	S4a	P
BD681	S4a	P
BD682	S4a	P
BD683	S4a	P
BD684	S4a	P
BD813	S4a	P
BD814	S4a	P
BD815	S4a	P
BD816	S4a	P
BD817	S4a	P
BD818	S4a	P
BD825	S4a	P
BD826	S4a	P
BD827	S4a	P
BD828	S4a	P
BD829	S4a	P
BD830	S4a	P
BD839	S4a	P
BD840	S4a	P
BD841	S4a	P
BD842	S4a	P
BD843	S4a	P
BD844	S4a	P
BD845	S4a	P
BD846	S4a	P
BD847	S4a	P
BD848	S4a	P
BD849	S4a	P
BD850	S4a	P
BD933	S4a	P
BD934	S4a	P
BD935	S4a	P
BD936	S4a	P
BD937	S4a	P
BD938	S4a	P
BD939	S4a	P
BD940	S4a	P
BD941	S4a	P
BD942	S4a	P
BD943	S4a	P
BD944	S4a	P
BD945	S4a	P
BD946	S4a	P
BD947	S4a	P
BD948	S4a	P
BD949	S4a	P
BD950	S4a	P
BD951	S4a	P
BD952	S4a	P
BD953	S4a	P
BD954	S4a	P
BD955	S4a	P
BD956	S4a	P
BDT20	S4a	P

P = Low-frequency power transistors

type no.	book	section
BDT21	S4a	P
BDT29	S4a	P
BDT29A	S4a	P
BDT29B	S4a	P
BDT29C	S4a	P
BDT30	S4a	P
BDT30A	S4a	P
BDT30B	S4a	P
BDT30C	S4a	P
BDT31	S4a	P
BDT31A	S4a	P
BDT31B	S4a	P
BDT31C	S4a	P
BDT32	S4a	P
BDT32A	S4a	P
BDT32B	S4a	P
BDT32C	S4a	P
BDT41	S4a	P
BDT41A	S4a	P
BDT41B	S4a	P
BDT41C	S4a	P
BDT42	S4a	P
BDT42A	S4a	P
BDT42B	S4a	P
BDT42C	S4a	P
BDT51	S4a	P
BDT52	S4a	P
BDT53	S4a	P
BDT54	S4a	P
BDT55	S4a	P
BDT56	S4a	P
BDT57	S4a	P
BDT58	S4a	P
BDT60	S4a	P
BDT60A	S4a	P
BDT60B	S4a	P
BDT60C	S4a	P
BDT61	S4a	P
BDT61A	S4a	P
BDT61B	S4a	P
BDT61C	S4a	P
BDT62	S4a	P
BDT62A	S4a	P
BDT62B	S4a	P
BDT62C	S4a	P
BDT63	S4a	P
BDT63A	S4a	P
BDT63B	S4a	P
BDT63C	S4a	P
BDT64	S4a	P
BDT64A	S4a	P
BDT64B	S4a	P
BDT64C	S4a	P
BDT65	S4a	P
BDT65A	S4a	P
BDT65B	S4a	P
BDT65C	S4a	P
BDT81	S4a	P
BDT82	S4a	P
BDT83	S4a	P
BDT84	S4a	P
BDT85	S4a	P
BDT86	S4a	P
BDT87	S4a	P
BDT88	S4a	P
BDT91	S4a	P
BDT92	S4a	P
BDT93	S4a	P
BDT94	S4a	P
BDT95	S4a	P
BDT96	S4a	P
BDV64	S4a	P
BDV64A	S4a	P
BDV64B	S4a	P
BDV64C	S4a	P
BDV65	S4a	P
BDV65A	S4a	P
BDV65B	S4a	P
BDV65C	S4a	P
BDV66A	S4a	P
BDV66B	S4a	P
BDV66C	S4a	P
BDV66D	S4a	P
BDV67A	S4a	P
BDV67B	S4a	P
BDV67C	S4a	P
BDV67D	S4a	P
BDV91	S4a	P
BDV92	S4a	P
BDV93	S4a	P
BDV94	S4a	P
BDV95	S4a	P
BDV96	S4a	P
BDW55	S4a	P
BDW56	S4a	P
BDW57	S4a	P
BDW58	S4a	P
BDW59	S4a	P
BDW60	S4a	P
BDX35	S4a	P
BDX36	S4a	P
BDX37	S4a	P
BDX42	S4a	P
BDX43	S4a	P
BDX44	S4a	P
BDX45	S4a	P
BDX46	S4a	P
BDX47	S4a	P
BDX62	S4a	P
BDX62A	S4a	P
BDX62B	S4a	P
BDX62C	S4a	P
BDX63	S4a	P
BDX63A	S4a	P
BDX63B	S4a	P
BDX63C	S4a	P
BDX64	S4a	P
BDX64A	S4a	P
BDX64B	S4a	P
BDX64C	S4a	P

P = Low-frequency power transistors

type no.	book	section
BDX65	S4a	P
BDX65A	S4a	P
BDX65B	S4a	P
BDX65C	S4a	P
BDX66	S4a	P
BDX66A	S4a	P
BDX66B	S4a	P
BDX66C	S4a	P
BDX67	S4a	P
BDX67A	S4a	P
BDX67B	S4a	P
BDX67C	S4a	P
BDX68	S4a	P
BDX68A	S4a	P
BDX68B	S4a	P
BDX68C	S4a	P
BDX69	S4a	P
BDX69A	S4a	P
BDX69B	S4a	P
BDX69C	S4a	P
BDX77	S4a	P
BDX78	S4a	P
BDX91	S4a	P
BDX92	S4a	P
BDX93	S4a	P
BDX94	S4a	P
BDX95	S4a	P
BDX96	S4a	P
BDY90	S4a	P
BDY90A	S4a	P
BDY91	S4a	P
BDY92	S4a	P
BF198	S3	Sm
BF199	S3	Sm
BF240	S3	Sm
BF241	S3	Sm
BF245A	S5	FET
BF245B	S5	FET
BF245C	S5	FET
BF247A	S5	FET
BF247B	S5	FET
BF247C	S5	FET
BF256A	S5	FET
BF256B	S5	FET
BF256C	S5	FET
BF324	S3	Sm
BF370	S3	Sm
BF410A	S5	FET
BF410B	S5	FET
BF410C	S5	FET
BF410D	S5	FET
BF419	S4b	HVP
BF420	S3	Sm
BF421	S3	Sm
BF422	S3	Sm
BF423	S3	Sm
BF450	S3	Sm
BF451	S3	Sm
BF457	S4b	HVP
BF458	S4b	HVP
BF459	S4b	HVP
BF469	S4b	HVP
BF470	S4b	HVP
BF471	S4b	HVP
BF472	S4b	HVP
BF483	S3	Sm
BF485	S3	Sm
BF487	S3	Sm
BF494	S3	Sm
BF495	S3	Sm
BF496	S3	Sm
BF510	S7/S5	Mm/FET
BF511	S7/S5	Mm/FET
BF512	S7/S5	Mm/FET
BF513	S7/S5	Mm/FET
BF536	S7	Mm
BF550;R	S7	Mm
BF569	S7	Mm
BF579	S7	Mm
BF583	S4b	HVP
BF585	S4b	HVP
BF587	S4b	HVP
BF591	S4b	HVP
BF593	S4b	HVP
BF620	S7	Mm
BF621	S7	Mm
BF622	S7	Mm
BF623	S7	Mm
BF660;R	S7	Mm
BF689K	S10	WBT
BF763	S10	WBT
BF767	S7	Mm
BF819	S4b	HVP
BF820	S7	Mm
BF821	S7	Mm
BF822	S7	Mm
BF823	S7	Mm
BF824	S7	Mm
BF840	S7	Mm
BF841	S7	Mm
BF857	S4b	HVP
BF858	S4b	HVP
BF859	S4b	HVP
BF869	S4b	HVP
BF870	S4b	HVP
BF871	S4b	HVP
BF872	S4b	HVP
BF926	S3	Sm
BF936	S3	Sm
BF939	S3	Sm
BF960	S5	FET
BF964	S5	FET
BF966	S5	FET
BF967	S3	Sm
BF970	S3	Sm
BF979	S3	Sm
BF980	S5	FET
BF981	S5	FET
BF982	S5	FET
BF989	S7/S5	Mm/FET

FET = Field-effect transistors
HVP = High-voltage power transistors
Mm = Microminiature semiconductors for hybrid circuits
P = Low-frequency power transistors
Sm = Small-signal transistors
WBT = Wideband transistors

type no.	book	section
BF990	S7/S5	Mm/FET
BF991	S7/S5	Mm/FET
BF992	S7/S5	Mm/FET
BF994	S7/S5	Mm/FET
BF996	S7/S5	Mm/FET
BFG23	S10	WBT
BFG32	S10	WBT
BFG34	S10	WBT
BFG51	S10	WBT
BFG65	S10	WBT
BFG67	S7	Mm
BFG90A	S10	WBT
BFG91A	S10	WBT
BFG96	S10	WBT
BFP90A	S10	WBT
BFP91A	S10	WBT
BFP96	S10	WBT
BFQ10	S5	FET
BFQ11	S5	FET
BFQ12	S5	FET
BFQ13	S5	FET
BFQ14	S5	FET
BFQ15	S5	FET
BFQ16	S5	FET
BFQ17	S7	Mm
BFQ18A	S7	Mm
BFQ19	S7	Mm
BFQ22S	S10	WBT
BFQ23	S10	WBT
BFQ23C	S10	WBT
BFQ24	S10	WBT
BFQ32	S10	WBT
BFQ32C	S10	WBT
BFQ32S	S10	WBT
BFQ33	S10	WBT
BFQ34	S10	WBT
BFQ34T	S10	WBT
BFQ42	S6	RFP
BFQ43	S6	RFP
BFQ43S	S6	RFP
BFQ51	S10	WBT
BFQ51C	S10	WBT
BFQ52	S10	WBT
BFQ53	S10	WBT
BFQ63	S10	WBT
BFQ65	S10	WBT
BFQ66	S10	WBT
BFQ67	S7	Mm
BFQ68	S10	WBT
BFQ136	S10	WBT
BFR29	S5	FET
BFR30	S7/S5	Mm/FET
BFR31	S7/S5	Mm/FET
BFR49	S10	WBT
BFR53;R	S7	Mm
BFR54	S3	Sm
BFR64	S10	WBT
BFR65	S10	WBT
BFR84	S5	FET
BFR90	S10	WBT
BFR90A	S10	WBT
BFR91	S10	WBT
BFR91A	S10	WBT
BFR92;R	S7	Mm
BFR92A;R	S7	Mm
BFR93;R	S7	Mm
BFR93A;R	S7	Mm
BFR94	S10	WBT
BFR95	S10	WBT
BFR96	S10	WBT
BFR96S	S10	WBT
BFR101A;B	S7/S5	Mm/FET
BFS17;R	S7	Mm
BFS18;R	S7	Mm
BFS19;R	S7	Mm
BFS20;R	S7	Mm
BFS21	S5	FET
BFS21A	S5	FET
BFS22A	S6	RFP
BFS23A	S6	RFP
BFT24	S10	WBT
BFT25;R	S7	Mm
BFT44	S3	Sm
BFT45	S3	Sm
BFT46	S7/S5	Mm/FET
BFT92;R	S7	Mm
BFT93;R	S7	Mm
BFW10	S5	FET
BFW11	S5	FET
BFW12	S5	FET
BFW13	S5	FET
BFW16A	S10	WBT
BFW17A	S10	WBT
BFW30	S10	WBT
BFW61	S5	FET
BFW92	S10	WBT
BFW92A	S10	WBT
BFW93	S10	WBT
BFX29	S3	Sm
BFX30	S3	Sm
BFX34	S3	Sm
BFX84	S3	Sm
BFX85	S3	Sm
BFX86	S3	Sm
BFX87	S3	Sm
BFX88	S3	Sm
BFX89	S10	WBT
BFY50	S3	Sm
BFY51	S3	Sm
BFY52	S3	Sm
BFY55	S3	Sm
BFY90	S10	WBT
BG2000	S1	RT
BG2097	S1	RT
BGD102	S10	WBM
BGD102E	S10	WBM
BGD104	S10	WBM
BGD104E	S10	WBM
BGY22	S6	RFP
BGY22A	S6	RFP

FET = Field-effect transistors
Mm = Microminiature semiconductors for hybrid circuits
RFP = R.F. power transistors and modules
RT = Tripler
Sm = Small-signal transistors
WBM = Wideband hybrid IC modules
WBT = Wideband transistors

type no.	book	section
BGY23	S6	RFP
BGY23A	S6	RFP
BGY32	S6	RFP
BGY33	S6	RFP
BGY35	S6	RFP
BGY36	S6	RFP
BGY40A	S6	RFP
BGY40B	S6	RFP
BGY41A	S6	RFP
BGY41B	S6	RFP
BGY43	S6	RFP
BGY45A	S6	RFP
BGY45B	S6	RFP
BGY46A	S6	RFP
BGY46B	S6	RFP
BGY47*	S6	RFP
BGY48*	S6	RFP
BGY50	S10	WBM
BGY51	S10	WBM
BGY52	S10	WBM
BGY53	S10	WBM
BGY54	S10	WBM
BGY55	S10	WBM
BGY56	S10	WBM
BGY57	S10	WBM
BGY58	S10	WBM
BGY58A	S10	WBM
BGY59	S10	WBM
BGY60	S10	WBM
BGY61	S10	WBM
BGY65	S10	WBM
BGY67	S10	WBM
BGY67A	S10	WBM
BGY70	S10	WBM
BGY71	S10	WBM
BGY74	S10	WBM
BGY75	S10	WBM
BGY84	S10	WBM
BGY84A	S10	WBM
BGY85	S10	WBM
BGY85A	S10	WBM
BGY90A	S6	RFP
BGY90B	S6	RFP
BGY93*	S6	RFP
BGY94*	S6	RFP
BGY95A	S6	RFP
BGY95B	S6	RFP
BGY96A	S6	RFP
BGY96B	S6	RFP
BLF146	S6	RFP/FET
BLF242	S6	RFP/FET
BLF244	S6	RFP/FET
BLF245	S6	RFP/FET
BLT90/SL	S6	RFP
BLT91/SL	S6	RFP
BLT92/SL	S6	RFP
BLU20/12	S6	RFP
BLU30/12	S6	RFP
BLU45/12	S6	RFP
BLU50	S6	RFP
BLU51	S6	RFP
BLU52	S6	RFP
BLU53	S6	RFP
BLU60/12	S6	RFP
BLU97	S6	RFP
BLU98	S6	RFP
BLU99	S6	RFP
BLV10	S6	RFP
BLV11	S6	RFP
BLV20	S6	RFP
BLV21	S6	RFP
BLV25	S6	RFP
BLV30	S6	RFP
BLV30/12	S6	RFP
BLV31	S6	RFP
BLV32F	S6	RFP
BLV33	S6	RFP
BLV33F	S6	RFP
BLV36	S6	RFP
BLV45/12	S6	RFP
BLV57	S6	RFP
BLV59	S6	RFP
BLV75/12	S6	RFP
BLV80/28	S6	RFP
BLV90	S6	RFP
BLV90/SL	S6	RFP
BLV91	S6	RFP
BLV91/SL	S6	RFP
BLV92	S6	RFP
BLV93	S6	RFP
BLV94	S6	RFP
BLV95	S6	RFP
BLV97	S6	RFP
BLV98	S6	RFP
BLV99	S6	RFP
BLW29	S6	RFP
BLW31	S6	RFP
BLW32	S6	RFP
BLW33	S6	RFP
BLW34	S6	RFP
BLW50F	S6	RFP
BLW60	S6	RFP
BLW60C	S6	RFP
BLW76	S6	RFP
BLW77	S6	RFP
BLW78	S6	RFP
BLW79	S6	RFP
BLW80	S6	RFP
BLW81	S6	RFP
BLW83	S6	RFP
BLW84	S6	RFP
BLW85	S6	RFP
BLW86	S6	RFP
BLW87	S6	RFP
BLW89	S6	RFP
BLW90	S6	RFP
BLW91	S6	RFP
BLW95	S6	RFP
BLW96	S6	RFP
BLW97	S6	RFP

* = series
FET = Field-effect transistors
RFP = R.F. power transistors and modules
WMB = Wideband hybrid IC modules

type no.	book	section
BLW98	S6	RFP
BLW99	S6	RFP
BLX13	S6	RFP
BLX13C	S6	RFP
BLX14	S6	RFP
BLX15	S6	RFP
BLX39	S6	RFP
BLX65	S6	RFP
BLX65E	S6	RFP
BLX65ES	S6	RFP
BLX67	S6	RFP
BLX68	S6	RFP
BLX69A	S6	RFP
BLX91A	S6	RFP
BLX91CB	S6	RFP
BLX92A	S6	RFP
BLX93A	S6	RFP
BLX94A	S6	RFP
BLX94C	S6	RFP
BLX95	S6	RFP
BLX96	S6	RFP
BLX97	S6	RFP
BLX98	S6	RFP
BLY87A	S6	RFP
BLY87C	S6	RFP
BLY88A	S6	RFP
BLY88C	S6	RFP
BLY89A	S6	RFP
BLY89C	S6	RFP
BLY90	S6	RFP
BLY91A	S6	RFP
BLY91C	S6	RFP
BLY92A	S6	RFP
BLY92C	S6	RFP
BLY93A	S6	RFP
BLY93C	S6	RFP
BLY94	S6	RFP
BPF24	S8b	PDT
BPW22A	S8a/b	PDT
BPW50	S8a/b	PDT
BPW71	S8b	PDT
BPX25	S8b	PDT
BPX29	S8b	PDT
BPX40	S8b	PDT
BPX41	S8b	PDT
BPX42	S8b	PDT
BPX61	S8b	PDT
BPX61P	S8b	PDT
BPX71	S8b	PDT
BPX72	S8b	PDT
BR100/03	S2b	Th
BR101	S3	Sm
BR210*	S2a	Th
BR216*	S2a	Th
BR220*	S2a	Th
BRY39	S3	Sm
BRY56	S3	Sm
BRY61	S7	Mm
BRY62	S7	Mm
BS107	S5	FET
BS170	S5	FET
BSD10	S5	FET
BSD12	S5	FET
BSD20	S5/7	FET
BSD22	S5/7	FET
BSD212	S5	FET
BSD213	S5	FET
BSD214	S5	FET
BSD215	S5	FET
BSR12;R	S7	Mm
BSR13;R	S7	Mm
BSR14;R	S7	Mm
BSR15;R	S7	Mm
BSR16;R	S7	Mm
BSR17;R	S7	Mm
BSR17A;R	S7	Mm
BSR18;R	S7	Mm
BSR18A;R	S7	Mm
BSR19; A	S7	Mm
BSR20; A	S7	Mm
BSR30	S7	Mm
BSR31	S7	Mm
BSR32	S7	Mm
BSR33	S7	Mm
BSR40	S7	Mm
BSR41	S7	Mm
BSR42	S7	Mm
BSR43	S7	Mm
BSR50	S3	Sm
BSR51	S3	Sm
BSR52	S3	Sm
BSR56	S7/S5	Mm/FET
BSR57	S7/S5	Mm/FET
BSR58	S7/S5	Mm/FET
BSR60	S3	Sm
BSR61	S3	Sm
BSR62	S3	Sm
BSS38	S3	Sm
BSS50	S3	Sm
BSS51	S3	Sm
BSS52	S3	Sm
BSS60	S3	Sm
BSS61	S3	Sm
BSS62	S3	Sm
BSS63;R	S7	Mm
BSS64;R	S7	Mm
BSS68	S3	Sm
BSS83	S5/7	FET/Mm
BST15	S7	Mm
BST16	S7	Mm
BST39	S7	Mm
BST40	S7	Mm
BST50	S7	Mm
BST51	S7	Mm
BST52	S7	Mm
BST60	S7	Mm
BST61	S7	Mm
BST62	S7	Mm
BST70A	S5	FET
BST72A	S5	FET

FET = Field-effect transistors
Mm = Microminiature semiconductors for hybrid circuits
PDT = Photodiodes or transistors
RFP = R.F. power transistors and modules
Sm = Small-signal transistors
Th = Thyristors

type no.	book	section
BST74A	S5	FET
BST76A	S5	FET
BST78	S5	FET
BST80	S5/S7	FET/Mm
BST82	S5/S7	FET/Mm
BST84	S5/S7	FET/Mm
BST86	S5/S7	FET/Mm
BST90	S5	FET
BST97	S5	FET
BST100	S5	FET
BST110	S5	FET
BST120	S5/S7	FET/Mm
BST122	S5/S7	FET/Mm
BSV15	S3	Sm
BSV16	S3	Sm
BSV17	S3	Sm
BSV52;R	S7	Mm
BSV64	S3	Sm
BSV78	S5	FET
BSV79	S5	FET
BSV80	S5	FET
BSV81	S5	FET
BSW66A	S3	Sm
BSW67A	S3	Sm
BSW68A	S3	Sm
BSX19	S3	Sm
BSX20	S3	Sm
BSX45	S3	Sm
BSX46	S3	Sm
BSX47	S3	Sm
BSX59	S3	Sm
BSX60	S3	Sm
BSX61	S3	Sm
BSY95A	S3	Sm
BT136*	S2b	Tri
BT136F*	S2b	Tri
BT137*	S2b	Tri
BT137F*	S2b	Tri
BT138*	S2b	Tri
BT138F*	S2b	Tri
BT139*	S2b	Tri
BT139F*	S2b	Tri
BT145*	S2b	Tri
BT149*	S2b	Th
BT150	S2b	Th
BT151*	S2b	Th
BT151F*	S2b	Th
BT152*	S2b	Th
BT153	S2b	Th
BT157*	S2b	Th
BT169*	S2b	Th
BTA140*	S2b	Tri
BTR59*	S2b	Tri
BTS59*	S2b	Tri
BTV58*	S2b	Th
BTV59*	S2b	Th
BTV59D*	S2b	Th
BTV60*	S2b	Th
BTV60D*	S2b	Th
BTV70*	S2b	Th
BTV70D*	S2b	Th
BTW23*	S2b	Th
BTW38*	S2b	Th
BTW40*	S2b	Th
BTW42*	S2b	Th
BTW43*	S2b	Tri
BTW45*	S2b	Th
BTW58*	S2b	Th
BTW62*	S2b	Th
BTW62D*	S2b	Th
BTW63*	S2b	Th
BTY79*	S2b	Th
BTY91*	S2b	Th
BU426	S4b	SP
BU426A	S4b	SP
BU433	S4b	SP
BU505	S4b	SP
BU506	S4b	SP
BU506D	S4b	SP
BU508A	S4b	SP
BU508D	S4b	SP
BU705	S4b	SP
BU706	S4b	SP
BU706D	S4b	SP
BU806	S4b	SP
BU807	S4b	SP
BU808	S4b	SP
BU824	S4b	SP
BU826	S4b	SP
BUP22*	S4b	SP
BUP23*	S4b	SP
BUS11;A	S4b	SP
BUS12;A	S4b	SP
BUS13;A	S4b	SP
BUS14;A	S4b	SP
BUS21*	S4b	SP
BUS22*	S4b	SP
BUS23*	S4b	SP
BUT11;A	S4b	SP
BUT11A	S4b	SP
BUT11AF	S4b	SP
BUV82	S4b	SP
BUV83	S4b	SP
BUV89	S4b	SP
BUV90;A	S4b	SP
BUW11;A	S4b	SP
BUW12;A	S4b	SP
BUW13;A	S4b	SP
BUW84	S4b	SP
BUW85	S4b	SP
BUX46;A	S4b	SP
BUX47;A	S4b	SP
BUX48;A	S4b	SP
BUX80	S4b	SP
BUX81	S4b	SP
BUX82	S4b	SP
BUX83	S4b	SP
BUX84	S4b	SP
BUX84F	S4b	SP
BUX85	S4b	SP

* = series
FET = Field-effect transistors
Mm = Microminiature semiconductors for hybrid circuits
Sm = Small-signal transistors
SP = Low-frequency switching power transistors
Th = Thyristors
Tri = Triacs

type no.	book	section
BUX85F	S4b	SP
BUX86	S4b	SP
BUX87	S4b	SP
BUX88	S4b	SP
BUX90	S4b	SP
BUX98	S4b	SP
BUX98A	S4b	SP
BUX99	S4b	SP
BUY89	S4b	SP
BUZ10	S9	PM
BUZ10A	S9	PM
BUZ11	S9	PM
BUZ11A	S9	PM
BUZ14	S9	PM
BUZ15	S9	PM
BUZ20	S9	PM
BUZ21	S9	PM
BUZ23	S9	PM
BUZ24	S9	PM
BUZ25	S9	PM
BUZ30	S9	PM
BUZ31	S9	PM
BUZ32	S9	PM
BUZ33	S9	PM
BUZ34	S9	PM
BUZ35	S9	PM
BUZ36	S9	PM
BUZ40	S9	PM
BUZ41A	S9	PM
BUZ42	S9	PM
BUZ43	S9	PM
BUZ44A	S9	PM
BUZ45	S9	PM
BUZ45A	S9	PM
BUZ45B	S9	PM
BUZ45C	S9	PM
BUZ46	S9	PM
BUZ50A	S9	PM
BUZ50B	S9	PM
BUZ53A	S9	PM
BUZ54	S9	PM
BUZ54A	S9	PM
BUZ60	S9	PM
BUZ60B	S9	PM
BUZ63	S9	PM
BUZ63B	S9	PM
BUZ64	S9	PM
BUZ71	S9	PM
BUZ71A	S9	PM
BUZ72	S9	PM
BUZ72A	S9	PM
BUZ73A	S9	PM
BUZ74	S9	PM
BUZ74A	S9	PM
BUZ76	S9	PM
BUZ76A	S9	PM
BUZ80	S9	PM
BUZ80A	S9	PM
BUZ83	S9	PM
BUZ83A	S9	PM
BUZ84	S9	PM
BUZ84A	S9	PM
BY224*	S2a	R
BY225*	S2a	R
BY228	S1	R
BY229*	S2a	R
BY229F*	S2a	R
BY249*	S2a	R
BY260*	S2a	R
BY261*	S2a	R
BY329*	S2a	R
BY359*	S2a	R
BY438	S1	R
BY448	S1	R
BY458	S1	R
BY505	S1	R
BY509	S1	R
BY527	S1	R
BY584	S1	R
BY588	S1	R
BY609	S1	R
BY610	S1	R
BY614	S1	R
BY619	S1	R
BY620	S1	R
BY627	S1	R
BY707	S1	R
BY708	S1	R
BY709	S1	R
BY710	S1	R
BY711	S1	R
BY712	S1	R
BY713	S1	R
BY714	S1	R
BYD13*	S1	R
BYD14*	S1	R
BYD17*	S1	R
BYD33*	S1	R
BYD37*	S1	R
BYD73*	S1	R
BYD74*	S1	R
BYD77*	S1	R
BYM26*	S1	R
BYM36*	S1	R
BYM56*	S1	R
BYP21*	S2a	R
BYP22*	S2a	R
BYP59*	S2a	R
BYQ28*	S2a	R
BYR29*	S2a	R
BYR29F*	S2a	R
BYT28*	S2a	R
BYT79*	S2a	R
BYV10	S1	R
BYV18*	S2a	R
BYV19*	S2a	R
BYV20*	S2a	R
BYV21*	S2a	R
BYV22*	S2a	R
BYV23*	S2a	R

* = series
PM = Power MOS transistors
R = Rectifier diodes
SP = Low-frequency switching power transistors

type no.	book	section
BYV24*	S2a	R
BYV26*	S1/S2a	R
BYV27*	S1/S2a	R
BYV28*	S1/S2a	R
BYV29*	S2a	R
BYV29F*	S2a	R
BYV30*	S2a	R
BYV31*	S2a	R
BYV32*	S2a	R
BYV32F*	S2a	R
BYV33*	S2a	R
BYV33F*	S2a	R
BYV34*	S2a	R
BYV36*	S1	R
BYV39*	S2a	R
BYV42*	S2a	R
BYV43*	S2a	R
BYV43F*	S2a	R
BYV44*	S2a	R
BYV60*	S2a	R
BYV72*	S2a	R
BYV73*	S2a	R
BYV74*	S2a	R
BYV79*	S2a	R
BYV92*	S2a	R
BYV95A	S1	R
BYV95B	S1	R
BYV95C	S1	R
BYV96D	S1	R
BYV96E	S1	R
BYW25*	S2a	R
BYW29*	S2a	R
BYW29F*	S2a	R
BYW30*	S2a	R
BYW31*	S2a	R
BYW54	S1	R
BYW55	S1	R
BYW56	S1	R
BYW92*	S2a	R
BYW93*	S2a	R
BYW95A	S1	R
BYW95B	S1	R
BYW95C	S1	R
BYW96D	S1	R
BYW96E	S1	R
BYX10G	S1	R
BYX25*	S2a	R
BYX30*	S2a	R
BYX32*	S2a	R
BYX38*	S2a	R
BYX39*	S2a	R
BYX42*	S2a	R
BYX46*	S2a	R
BYX50*	S2a	R
BYX52*	S2a	R
BYX56*	S2a	R
BYX90G	S1	R
BYX96*	S2a	R
BYX97*	S2a	R
BYX98*	S2a	R
BYX99*	S2a	R
BZD23	S1	Vrg
BZD27	S1	Vrg
BZT03	S1	Vrg
BZV10	S1	Vrf
BZV11	S1	Vrf
BZV12	S1	Vrf
BZV13	S1	Vrf
BZV14	S1	Vrf
BZV37	S1	Vrf
BZV46	S1	Vrg
BZV49*	S1/S7	Vrg/Mm
BZV55*	S7	Mm
BZV80	S1	Vrf
BZV81	S1	Vrf
BZV85*	S1	Vrg
BZW03*	S1	Vrg
BZW14	S1	Vrg
BZW86*	S2a	TS
BZX55*	S1	Vrg
BZX70*	S2a	Vrg
BZX75*	S1	Vrg
BZX79*	S1	Vrg
BZX84*	S7/S1	Mm/Vrg
BZY91*	S2a	Vrg
BZY93*	S2a	Vrg
CFX13	S11	M
CFX21	S11	M
CFX30	S11	M
CFX31	S11	M
CFX32	S11	M
CFX33	S11	M
CNG35	S8b	PhC
CNG36	S8b	PhC
CNR36	S8b	PhC
CNX21	S8b	PhC
CNX35	S8b	PhC
CNX35U	S8b	PhC
CNX36	S8b	PhC
CNX36U	S8b	PhC
CNX38	S8b	PhC
CNX38U	S8b	PhC
CNX39	S8b	PhC
CNX39U	S8b	PhC
CNX44	S8b	PhC
CNX44A	S8b	PhC
CNX46	S8b	PhC
CNX48	S8b	PhC
CNX48U	S8b	PhC
CNX62	S8b	PhC
CNX72	S8b	PhC
CNX82	S8b	PhC
CNX83	S8b	PhC
CNX91	S8b	PhC
CNX92	S8b	PhC
CNY17-1	S8b	PhC
CNY17-2	S8b	PhC
CNY17-3	S8b	PhC
CNY50	S8b	PhC
CNY57	S8b	PhC

* = series
M = Microwave transistors
Mm = Microminiature semiconductors for hybrid circuits
PhC = Photocouplers

R = Rectifier diodes
TS = Transient suppressor diodes
Vrf = Voltage reference diodes
Vrg = Voltage regulator diodes

INDEX

type no.	book	section
CNY57A	S8b	PhC
CNY57AU	S8b	PhC
CNY57U	S8b	PhC
CNY62	S8b	PhC
CNY63	S8b	PhC
CQF24	S8b	Ph
CQL10A	S8b	Ph
CQL13A	S8b	Ph
CQL16	S8b	Ph
CQS51L	S8a	LED
CQS54	S8a	LED
CQS82L	S8a	LED
CQS82AL	S8a	LED
CQS84L	S8a	LED
CQS86L	S8a	LED
CQS93	S8a	LED
CQS93E	S8a	LED
CQS93L	S8a	LED
CQS95	S8a	LED
CQS95E	S8a	LED
CQS95L	S8a	LED
CQS97	S8a	LED
CQS97E	S8a	LED
CQS97L	S8a	LED
CQT10B	S8a	LED
CQT24	S8a	LED
CQT60	S8a	LED
CQT70	S8a	LED
CQT80L	S8a	LED
CQV70(L)	S8a	LED
CQV70A(L)	S8a	LED
CQV70U(L)	S8a	LED
CQV71A(L)	S8a	LED
CQV72(L)	S8a	LED
CQV80L	S8a	LED
CQV80AL	S8a	LED
CQV80UL	S8a	LED
CQV81L	S8a	LED
CQV82L	S8a	LED
CQW10A(L)	S8a	LED
CQW10B(L)	S8a	LED
CQW10U(L)	S8a	LED
CQW11B(L)	S8a	LED
CQW12B(L)	S8a	LED
CQW20A	S8a	LED
CQW21	S8a	LED
CQW22	S8a	LED
CQW24(L)	S8a	LED
CQW54	S8a	LED
CQW60(L)	S8a	LED
CQW60A(L)	S8a	LED
CQW60U(L)	S8a	LED
CQW61(L)	S8a	LED
CQW62(L)	S8a	LED
CQW89A	S8a/b	I
CQW93	S8a	LED
CQW95	S8a	LED
CQW97	S8a	LED
CQX24(L)	S8a	LED
CQX51(L)	S8a	LED
CQX54(L)	S8a	LED
CQX54D	S8a	LED
CQX64(L)	S8a	LED
CQX64D	S8a	LED
CQX74(L)	S8a	LED
CQX74D	S8a	LED
CQY11B	S8b	LED
CQY11C	S8b	LED
CQY24B(L)	S8a	LED
CQY49B	S8b	LED
CQY49C	S8b	LED
CQY50	S8b	LED
CQY52	S8b	LED
CQY53S	S8b	LED
CQY54A	S8a	LED
CQY58A	S8a/b	I
CQY89A	S8a/b	I
CQY94B(L)	S8a	LED
CQY95B	S8a	LED
CQY96(L)	S8a	LED
CQY97A	S8a	LED
Fresnel-lens	S8b	A
H11A1	S8b	PhC
H11A2	S8b	PhC
H11A3	S8b	PhC
H11A4	S8b	PhC
H11A5	S8b	PhC
H11B1	S8b	PhC
H11B2	S8b	PhC
H11B3	S8b	PhC
H11B255	S8b	PhC
KMZ10A	S13	SEN
KMZ10B	S13	SEN
KMZ10C	S13	SEN
KP100A	S13	SEN
KP101A	S13	SEN
KPZ20G	S13	SEN
KPZ21G	S13	SEN
KTY81*	S13	SEN
KTY83*	S13	SEN
KTY84*	S13	SEN
LAE2001R	S11	M
LAE4001Q	S11	M
LAE4001R	S11	M
LAE4002S	S11	M
LAE6000Q	S11	M
LBE1004R	S11	M
LBE1010R	S11	M
LBE2003S	S11	M
LBE2005Q	S11	M
LBE2008T	S11	M
LBE2009S	S11	M
LCE1010R	S11	M
LCE2003S	S11	M
LCE2005Q	S11	M
LCE2008T	S11	M
LCE2009S	S11	M
LJE42002T	S11	M
LKE1004R	S11	M

* = series
A = Accessories
I = Infrared devices
LED = Light-emitting diodes
M = Microwave transistors

Ph = Photoconductive devices
PhC = Photocouplers
SEN = Sensors

INDEX

type no.	book	section
PMLL5225B to PMLL5267B	S1	SD
P044	S8b	PhC
P044A	S8b	PhC
PPC5001T	S11	M
PQC5001T	S11	M
PTB23001X	S11	M
PTB23003X	S11	M
PTB23005X	S11	M
PTB32001X	S11	M
PTB32003X	S11	M
PTB32005X	S11	M
PTB42001X	S11	M
PTB42002X	S11	M
PTB42003X	S11	M
PV3742B4X	S11	M
PVB42004X	S11	M
PZ1418B15U	S11	M
PZ1418B30U	S11	M
PZ1721B12U	S11	M
PZ1721B25U	S11	M
PZ2024B10U	S11	M
PZ2024B20U	S11	M
PZB16035U	S11	M
PZB27020U	S11	M
RPY97	S8b	I
RPY100	S8b	I
RPY101	S8b	I
RPY102	S8b	I
RPY103	S8b	I
RPY107	S8b	I
RPY109	S8b	I
RV3135B5X	S11	M
RX1214B300Y	S11	M
RXB12350Y	S11	M
RZ1214B35Y	S11	M
RZ1214B60W	S11	M
RZ1214B65Y	S11	M
RZ1214B125W	S11	M
RZ1214B125Y	S11	M
RZ1214B150Y	S11	M
RZ2833B45W	S11	M
RZ3135B15U	S11	M
RZ3135B15W	S11	M
RZ3135B25U	S11	M
RZ3135B30W	S11	M
RZB12100Y	S11	M
RZB12350Y	S11	M
RZZ1214B300Y	S11	M
SL5500	S8b	PhC
SL5501	S8b	PhC
SL5502R	S8b	PhC
SL5504	S8b	PhC
SL5504S	S8b	PhC
SL5505S	S8b	PhC
SL5511	S8b	PhC
TIP29*	S4a	P
TIP30*	S4a	P
TIP31*	S4a	P
TIP32*	S4a	P
TIP33*	S4a	P
TIP34*	S4a	P
TIP41*	S4a	P
TIP42*	S4a	P
TIP47	S4a	P
TIP48	S4a	P
TIP49	S4a	P
TIP50	S4a	P
TIP110	S4a	P
TIP111	S4a	P
TIP112	S4a	P
TIP115	S4a	P
TIP116	S4a	P
TIP117	S4a	P
TIP120	S4a	P
TIP121	S4a	P
TIP122	S4a	P
TIP125	S4a	P
TIP126	S4a	P
TIP127	S4a	P
TIP130	S4a	P
TIP131	S4a	P
TIP132	S4a	P
TIP135	S4a	P
TIP136	S4a	P
TIP137	S4a	P
TIP140	S4a	P
TIP141	S4a	P
TIP145	S4a	P
TIP146	S4a	P
TIP147	S4a	P
TIP2955	S4a	P
TIP3055	S4a	P
1N821;A	S1	Vrf
1N823;A	S1	Vrf
1N825;A	S1	Vrf
1N827;A	S1	Vrf
1N829;A	S1	Vrf
1N914	S1	SD
1N916	S1	SD
1N3879	S2a	R
1N3880	S2a	R
1N3881	S2a	R
1N3882	S2a	R
1N3883	S2a	R
1N3889	S2a	R
1N3890	S2a	R
1N3891	S2a	R
1N3892	S2a	R
1N3893	S2a	R
1N3909	S2a	R
1N3910	S2a	R
1N3911	S2a	R
1N3912	S2a	R
1N3913	S2a	R
1N4001G	S1	R
1N4002G	S1	R
1N4003G	S1	R
1N4004G	S1	R

* = series
I = Infrared devices
M = Microwave transistors
P = Low-frequency power transistors
PhC = Photocouplers
R = Rectifier diodes
SD = Small-signal diodes
Vrf = Voltage reference diodes

type no.	book	section
LKE2002T	S11	M
LKE2004T	S11	M
LKE2015T	S11	M
LKE21004R	S11	M
LKE21015T	S11	M
LKE21050T	S11	M
LKE27010R	S11	M
LKE27025R	S11	M
LKE32002T	S11	M
LKE32004T	S11	M
LTE42005S	S11	M
LTE42008R	S11	M
LTE42012R	S11	M
LV1721E50R	S11	M
LV2024E45R	S11	M
LV2327E40R	S11	M
LV3742E16R	S11	M
LV3742E24R	S11	M
LWE2015R	S11	M
LWE2025R	S11	M
LZ1418E100R	S11	M
MCA230	S8b	PhC
MCA231	S8b	PhC
MCA255	S8b	PhC
MCT2	S8b	PhC
MCT26	S8b	PhC
MKB12040WS	S11	M
MKB12100WS	S11	M
MKB12140W	S11	M
MO6075B200Z	S11	M
MO6075B400Z	S11	M
MRB12175YR	S11	M
MRB12350YR	S11	M
MS1011B700Y	S11	M
MS6075B800Z	S11	M
MSB12900Y	S11	M
MZ0912B75Y	S11	M
MZ0912B150Y	S11	M
OM286; M	S13	SEN
OM287; M	S13	SEN
OM320	S10	WBM
OM321	S10	WBM
OM322	S10	WBM
OM323	S10	WBM
OM323A	S10	WBM
OM335	S10	WBM
OM336	S10	WBM
OM337	S10	WBM
OM337A	S10	WBM
OM339	S10	WBM
OM345	S10	WBM
OM350	S10	WBM
OM360	S10	WBM
OM361	S10	WBM
OM370	S10	WBM
OM386B	S13	SEN
OM386M	S13	SEN
OM387B	S13	SEN
OM387M	S13	SEN
OM388B	S13	SEN
OM389B	S13	SEN
OM931	S4a	P
OM961	S4a	P
OSB9115	S2a	St
OSB9215	S2a	St
OSB9415	S2a	St
OSM9115	S2a	St
OSM9215	S2a	St
OSM9415	S2a	St
OSM9510	S2a	St
OSM9511	S2a	St
OSM9512	S2a	St
OSS9115	S2a	St
OSS9215	S2a	St
OSS9415	S2a	St
P2105	S8b	I
PBMF4391	S5	FET
PBMF4392	S5	FET
PBMF4393	S5	FET
PDE1001U	S11	M
PDE1003U	S11	M
PDE1005U	S11	M
PDE1010U	S11	M
PEE1001U	S11	M
PEE1003U	S11	M
PEE1005U	S11	M
PEE1010U	S11	M
PH2222;R	S3	Sm
PH2222A;R	S3	Sm
PH2369	S3	Sm
PH2907;R	S3	Sm
PH2907A;R	S3	Sm
PH2955T	S4a	P
PH3055T	S4a	P
PH5415	S3	Sm
PH5416	S3	Sm
PH13002	S4b	SP
PH13003	S4b	SP
PHSD51	S2a	R
PKB3001U	S11	M
PKB3003U	S11	M
PKB3005U	S11	M
PKB12005U	S11	M
PKB20010U	S11	M
PKB23001U	S11	M
PKB23003U	S11	M
PKB23005U	S11	M
PKB25006T	S11	M
PKB32001U	S11	M
PKB32003U	S11	M
PKB32005U	S11	M
PMBF4391	S7	Mm
PMBF4392	S7	Mm
PMBF4392	S7	Mm
PMLL4148	S1	SD
PMLL4150	S1	SD
PMLL4151	S1	SD
PMLL4153	S1	SD
PMLL4446	S1	SD
PMLL4448	S1	SD

FET = Field-effect transistors
I = Infrared devices
M = Microwave transistors
Mm = Microminiature semiconductors for hybrid circuits
P = Low-frequency power transistors
PhC = Photocouplers
R = Rectifier diodes
SD = Small-signal diodes
SEN = Sensors
Sm = Small-signal transistors
SP = Low-frequency switching power transistors
St = Rectifier stacks
WBM = Wideband hybrid IC modules

INDEX

type no.	book	section
1N4005G	S1	R
1N4006G	S1	R
1N4007G	S1	R
1N4148	S1	SD
1N4150	S1	SD
1N4151	S1	SD
1N4153	S1	SD
1N4446	S1	SD
1N4448	S1	SD
1N4531	S1	SD
1N4532	S1	SD
1N5059	S1	R
1N5060	S1	R
1N5061	S1	R
1N5062	S1	R
1N5225B to 1N5267B	S1	SD
2N918	S10	WBT
2N929	S3	Sm
2N930	S3	Sm
2N1613	S3	Sm
2N1711	S3	Sm
2N1893	S3	Sm
2N2219	S3	Sm
2N2219A	S3	Sm
2N2222	S3	Sm
2N2222A	S3	Sm
2N2297	S3	Sm
2N2368	S3	Sm
2N2369	S3	Sm
2N2369A	S3	Sm
2N2483	S3	Sm
2N2484	S3	Sm
2N2904	S3	Sm
2N2904A	S3	Sm
2N2905	S3	Sm
2N2905A	S3	Sm
2N2906	S3	Sm
2N2906A	S3	Sm
2N2907	S3	Sm
2N2907A	S3	Sm
2N3019	S3	Sm
2N3020	S3	Sm
2N3053	S3	Sm
2N3375	S6	RFP
2N3553	S6	RFP
2N3632	S6	RFP
2N3822	S5	FET
2N3823	S5	FET
2N3866	S6	RFP
2N3903	S3	Sm
2N3904	S3	Sm
2N3905	S3	Sm
2N3906	S3	Sm
2N3924	S6	RFP
2N3926	S6	RFP
2N3927	S6	RFP
2N3966	S5	FET
2N4030	S3	Sm
2N4031	S3	Sm
2N4032	S3	Sm
2N4033	S3	Sm
2N4091	S5	FET
2N4092	S5	FET
2N4093	S5	FET
2N4123	S3	Sm
2N4124	S3	Sm
2N4125	S3	Sm
2N4126	S3	Sm
2N4391	S5	FET
2N4392	S5	FET
2N4393	S5	FET
2N4427	S6	RFP
2N4856	S5	FET
2N4857	S5	FET
2N4858	S5	FET
2N4859	S5	FET
2N4860	S5	FET
2N4861	S5	FET
2N5400	S3	Sm
2N5401	S3	Sm
2N5415	S3	Sm
2N5416	S3	Sm
2N5550	S3	Sm
2N5551	S3	Sm
2N6659	S5	FET
2N6660	S5	FET
2N6661	S5	FET
4N25	S8b	PhC
4N25A	S8b	PhC
4N26	S8b	PhC
4N27	S8b	PhC
4N28	S8b	PhC
4N35	S8b	PhC
4N36	S8b	PhC
4N37	S8b	PhC
4N38	S8b	PhC
4N38A	S8b	PhC
502CQF	S8b	Ph
503CQF	S8b	Ph
504CQL	S8b	Ph
516CQF-B	S8b	Ph
56201d	S4b	A
56201j	S4b	A
56245	S3,10	A
56246	S3,10	A
56261a	S4b	A
56264	S2a/b	A
56295	S2a/b	A
56326	S4b	A
56339	S4b	A
56352	S4b	A
56353	S4b	A
56354	S4b	A
56359b	S2,4b	A
56359c	S2,4b	A
56359d	S2,4b	A
56360a	S2,4b	A
56363	S2,4b	A

A = Accessories
FET = Field-effect transistors
Ph = Photoconductive devices
PhC = Photocouplers
R = Rectifier diodes
RFP = R.F. power transistors and modules
SD = Small-signal diodes
Sm = Small-signal transistors
WBT = Wideband transistors

type no.	book	section
56364	S2,4b	A
56367	S2a/b	A
56368b	S2,4b	A
56368c	S2,4b	A
56369	S2,4b	A
56378	S2,4b	A
56379	S2,4b	A
56387a,b	S4b	A
56397	S8b	A

A = Accessories

Electronic components and materials for professional, industrial and consumer uses from the world-wide Philips Group of Companies

Argentina: PHILIPS ARGENTINA S.A., Div. Elcoma, Vedia 3892, 1430 BUENOS AIRES, Tel. (01) 541 - 7141 to 7747.
Australia: PHILIPS INDUSTRIES LTD., Elcoma Division, 11 Waltham Street, ARTARMON, N.S.W. 2064, Tel. (02) 439 3322.
Austria: ÖSTERREICHISCHE PHILIPS INDUSTRIE G.m.b.H., UB Bauelemente, Triester Str. 64, A-1101 WIEN, Tel. (0222) 62 91 11-0.
Belgium: N.V. PHILIPS & MBLE ASSOCIATED, rue du Pavillon 9, B-1030 BRUXELLES, Tel. (02) 242 74 00.
Brazil: CONSTANTA-IBRAPE; (Active Devices): Av. Brigadeiro Faria Lima, 1735-SAO PAULO-SP, Tel. (011) 211-2600,
(Passive Devices & Materials): Av. Francisco Monteiro, 702 - RIBEIRO PIRES-SP, Tel. (011) 459-8211.
Canada: PHILIPS ELECTRONICS LTD., Elcoma Division, 601 Milner Ave., SCARBOROUGH, Ontario, M1B 1M8, Tel. (416) 292-5161.
Chile: PHILIPS CHILENA S.A., Av. Santa Maria 0760, SANTIAGO, Tel. (02) 77 38 16.
Colombia: IND. PHILIPS DE COLOMBIA S.A., c/o IPRELENSO LTD., Cra. 21, No. 56-17, BOGOTA, D.E., Tel. (01) 2 49 76 24.
Denmark: MINIWATT A/S, Strandlodsvej 2, P.O. Box 1919, DK 2300 COPENHAGEN S, Tel. (01) 54 11 33.
Finland: OY PHILIPS AB, Elcoma Division, Kaivokatu 8, SF-00100 HELSINKI 10, Tel. (90) 1 72 71.
France: RTC-COMPELEC, 130 Avenue Ledru Rollin, F-75540 PARIS 11, Tel. (01) 43 38 80 00.
Germany (Fed. Republic): VALVO, UB Bauelemente der Philips G.m.b.H., Valvo Haus, Burchardstrasse 19, D-2 HAMBURG 1, Tel. (040) 3296-0.
Greece: PHILIPS HELLENIQUE S.A., Elcoma Division, No. 15, 25th March Street, GR 17778 TAVROS, Tel. (01) 48 94 339/48 94 911.
Hong Kong: PHILIPS HONG KONG LTD., Elcoma Div., 15/F Philips Ind. Bldg., 24-28 Kung Yip St., KWAI CHUNG, Tel. (0)-24 51 21.
India: PEICO ELECTRONICS & ELECTRICALS LTD., Elcoma Dept., Band Box Building,
254-D Dr. Annie Besant Rd., BOMBAY - 400 025, Tel. (022) 4930311/4930590.
Indonesia: P.T. PHILIPS-RALIN ELECTRONICS, Elcoma Div., Setiabudi II Building, 6th Fl., Jalan H.R. Rasuna Said (P.O. Box 223/KBY) Kuningan,
JAKARTA 12910, Tel. (021) 51 79 95.
Ireland: PHILIPS ELECTRICAL (IRELAND) LTD., Elcoma Division, Newstead, Clonskeagh, DUBLIN 14, Tel. (01) 69 33 55.
Italy: PHILIPS S.p.A., Div. Componenti Elcoma, Piazza IV Novembre 3, I-20124 MILANO, Tel. (02) 6752.1.
Japan: NIHON PHILIPS CORP., Shuwa Shinagawa Bldg., 26-33 Takanawa 3-chome, Minato-ku, TOKYO (108), Tel. (03) 448-5611.
(IC Products) SIGNETICS JAPAN LTD., 8-7 Sanbancho Chiyoda-ku, TOKYO 102, Tel. (03) 230-1521.
Korea (Republic of): PHILIPS ELECTRONICS (KOREA) LTD., Elcoma Div., Philips House, 260-199 Itaewon-dong, Yongsan-ku, SEOUL,
Tel. (02) 794-5011.
Malaysia: PHILIPS MALAYSIA SDN BHD, Elcoma Div., 345 Jalan Gelugor, 11700 PULAU PINANG, Tel. (04) 87 00 44.
Mexico: ELECTRONICA, S.A de C.V., Carr. México-Toluca km. 62.5, TOLUCA, Edo. de México 50140, Tel. Toluca 91 (721) 613-00.
Netherlands: PHILIPS NEDERLAND, Marktgroep Elonco, Postbus 90050, 5600 PB EINDHOVEN, Tel. (040) 78 37 49.
New Zealand: PHILIPS NEW ZEALAND LTD., Elcoma Division, 110 Mt. Eden Road, C.P.O. Box 1041, AUCKLAND, Tel. (09) 605-914.
Norway: NORSK A/S PHILIPS, Electronica Dept., Sandstuveien 70, OSLO 6, Tel. (02) 68 02 00.
Pakistan: PHILIPS ELECTRICAL CO. OF PAKISTAN LTD., Philips Markaz, M.A. Jinnah Rd., KARACHI-3, Tel. (021) 72 57 72.
Peru: CADESA, Av. Alfonso Ugarte 1268, LIMA 5, Tel. (014) 326070.
Philippines: PHILIPS INDUSTRIAL DEV. INC., 2246 Pasong Tamo, P.O. Box 911, Makati Comm. Centre, MAKATI-RIZAL 3116, Tel. (02) 86 89 51 to 59.
Portugal: PHILIPS PORTUGUESA S.A.R.L., Av. Eng. Duarte Pacheco 6, 1009 LISBOA Codex, Tel. (019) 68 31 21.
Singapore: PHILIPS PROJECT DEV. (Singapore) PTE LTD., Elcoma Div., Lorong 1, Toa Payoh, SINGAPORE 1231, Tel. 35 02 000.
South Africa: S.A. PHILIPS (Pty) LTD., EDAC Div., 3rd Floor Rainer House, Upper Railway Rd. & Ove St., New Doornfontein, JOHANNESBURG 2001,
Tel. (011) 402-4600/07.
Spain: MINIWATT S.A., Balmes 22, BARCELONA 7, Tel. (03) 301 63 12.
Sweden: PHILIPS KOMPONENTER A.B., Lidingövägen 50, S-11584 STOCKHOLM 27, Tel. (08) 7821000.
Switzerland: PHILIPS A.G., Elcoma Dept., Allmendstrasse 140-142, CH-8027 ZÜRICH, Tel. (01) 488 22 11.
Taiwan: PHILIPS TAIWAN LTD., 150 Tun Hua North Road, P.O. Box 22978, TAIPEI, Taiwan, Tel. (02) 7120500.
Thailand: PHILIPS ELECTRICAL CO. OF THAILAND LTD., 283 Silom Road, P.O. Box 961, BANGKOK, Tel. (02) 233-6330-9.
Turkey: TÜRK PHILIPS TICARET A.S., Elcoma Department, Inönü Cad., No. 78-80, 80090 Ayazpasa ISTANBUL, Tel. (01) 143 59 10.
United Kingdom: MULLARD LTD., Mullard House, Torrington Place, LONDON WC1E 7HD, Tel. (01) 580 6633.
United States: (Active Devices & Materials) AMPEREX SALES CORP., Providence Pike, SLATERSVILLE, R.I. 02876, Tel. (401) 762-9000.
(Passive & Electromech. Dev.) MEPCO/CENTRALAB, INC., 2001 West Blue Heron Blvd, RIVIERA BEACH, Florida 33404,
Tel. (305) 881-3200.
(IC Products) SIGNETICS CORPORATION, 811 East Arques Avenue, SUNNYVALE, CA 94088-3409, Tel. (408) 991-2000.
Uruguay: LUZILECTRON S.A., Avda Uruguay 1287, P.O. Box 907, MONTEVIDEO, Tel. (02) 98 53 95.
Venezuela: IND. VENEZOLANAS PHILIPS S.A., c/o MAGNETICA S.A., Calle 6, Ed. Las Tres Jotas, App. Post. 78117, CARACAS, Tel. (02) 239 39 31.

For all other countries apply to: Philips Electronic Components and Materials Division, International Business Relations, P.O. Box 218,
5600 MD EINDHOVEN, The Netherlands, Telex 35000 phtcnl

AS53

Printed in England

9398 145 40011