# 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	
Letter symbols	
Quality conformance and reliability	
General explanatory notes	
Heatsinks	
Device specifications	
Rectifier diodes	37
Rectifier bridges	
Fast rectifier diodes	
Schottky rectifier diodes	
Breakover diodes	
Regulator diodes	
High-voltage rectifier stacks	/31
Accessories	767
Mounting instructions	777
ype number index (alpha-numerical)	799
ndex 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.

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# 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
Т3	Klystrons
T4	Magnetrons for microwave heating
T5	Cathode-ray tubes Instrument tubes, monitor and display tubes, C.R. tubes for special applications
Т6	Geiger-Müller tubes
Т8	Colour display systems Colour TV picture tubes, colour data graphic display tube assemblies, deflection units
Т9	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 unit

# SEMICONDUCTORS (RED SERIES)

The red series of data handbooks comprises:

S1	$\label{eq:continuous} \textbf{Diodes} \\ \textbf{Small-signal silicon diodes, voltage regulator diodes ($<$1,5$ W), voltage reference diodes, tuner diodes, rectifier diodes} \\$
S2a	Power diodes
S2b	Thyristors and triacs
<b>S3</b>	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
<b>S7</b>	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
<b>S9</b>	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

<sup>\*</sup>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 <sup>2</sup> 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

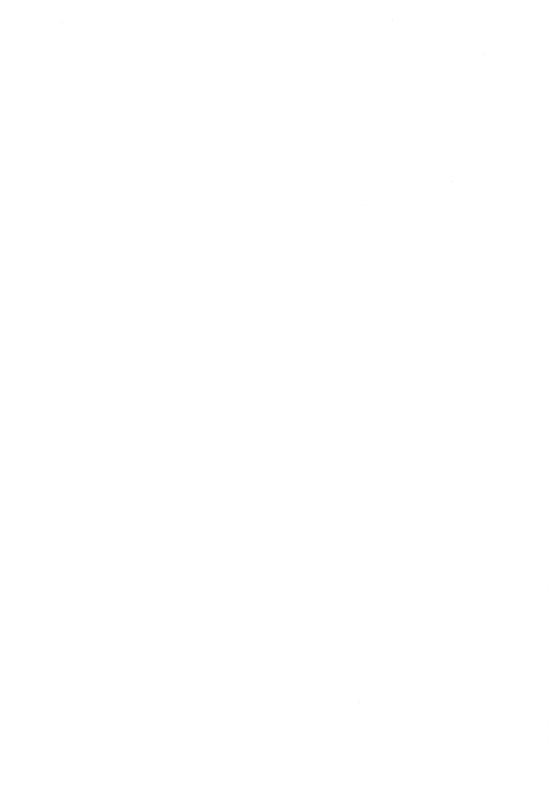
# COMPONENTS AND MATERIALS (GREEN SERIES)

# The green series of data handbooks comprises:

C22

Film capacitors

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
<b>C7</b>	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



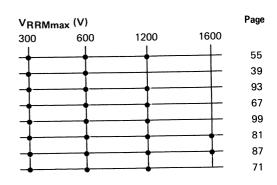
# **SELECTION GUIDE**

# SELECTION GUIDE

#### **RECTIFIER DIODES**

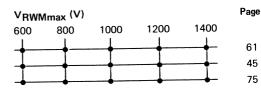
#### General purpose

deliciai parpot		
F(AV)max (A)		Outline
6	BYX38	DO-4
6.5	BY249	TO-220AC
10	BYX98	DO-4
12	BYX42	DO-4
15	BYX99	DO-4
30	BYX96	DO-4
47	BYX97	DO-5
48	BYX52	DO-5



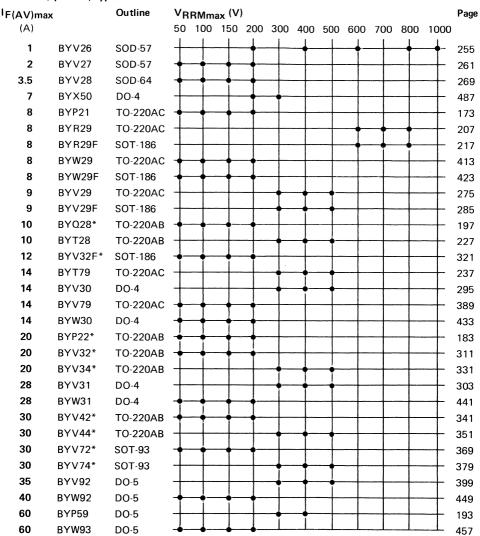
#### Avalanche

I <sub>F(AV)max</sub> (A)		
9.5	BYX39	DO-4
20	BYX25	DO-4
48	BYX56	DO-5



#### **FAST RECTIFIER DIODES**

#### Ultra fast (epitaxial) types



<sup>\*</sup>Monolithic dual rectifier diodes.

# SELECTION GUIDE

### **FAST RECTIFIER DIODES (Cont.)**

IF(AV)max		Outline	V <sub>RRMmax</sub> (V)
(A)			50 100 200 300 400 500 600
Very-fast typ	oes		
6	1N3879	DO-4	<del> </del>
6	1N3880	DO-4	
6	1N3881	DO-4	<del>                                     </del>
6	1N3882	DO-4	<del>                                      </del>
6	1N3883	DO-4	<del>                                      </del>
12	1N3889	DO-4	•
12	1N3890	DO-4	<del>                                     </del>
12	1N3891	DO-4	+-+-+
12	1N3892	DO-4	+
12	1N3893	DO-4	<del>                                     </del>
14	BYX30**	DO-4	+
22	BYX46**	DO-4	+ + + + + + + + + + + + + + + + + + + +
30	1N3909	DO-5	<del>                                     </del>
30	1N3910	DO-5	++
30	1N3911	DO-5	<del> </del>
30	1N3912	DO-5	<del>                                      </del>
30	1N3913	DO-5	
Fast types		Outline	V <sub>RRMmax</sub> (V)
			200 400 600 800 1000 1200 1300 1500
6.5	BY359	TO-220AC	
7	BY229	TO-220AC	
, 7	BY229F	SOT-186	
8	BY329	TO-220AC	
12	BYV24	DO-4	
15	BYV60	TO-238	
40	BYW25	DO-5	(85Ų V)

<sup>\*\*</sup>With avalanche characteristics

#### SCHOTTKY RECTIFIER DIODES

IF(AV)max (A)		Outline	V <sub>RRMmax</sub> (V) 30 35 40 40A <sup>▲</sup> 45	Page
10	BYV18*	TO-220AB		517
10	BYV19	TO-220AC	<del>                                      </del>	527
15	BYV20	DO-4	<b>-</b>	535
16	BYV39	TO-220AC	<del>                                     </del>	587
20	BYV33*	TO-220AB	· +	567
20	BYV33F*	SOT-186	<u> </u>	577
26	BYV43F*	SOT-186	<u> </u>	603
30	BYV21	DO-4	<del>                                      </del>	543
30	BYV43*	TO-220AB	<b></b>	595
30	BYV73*	SOT-93		611
60	BYV22	DO-5	· • • • • • • • • • • • • • • • • • • •	551
60	PHSD51	DO-5	<del>                                     </del>	619
80	BYV23	DO-5	<del>                                     </del>	559

<sup>\*</sup>Monolithic dual rectifier diodes

### **BREAKOVER DIODES**

ITRM max		Outline	V <sub>(E</sub>	O)noi	n (V)									Page
(A)			65	100	120	140	160	180	200	220	240	260	280	
40	BR210	TO-220AC	+	-	+	-	+	-		-	-	+	<b>-</b>	627
40	BR216*†	TO-220AB	+			+	-	-				-	+	639
40	BR220*	TO-220AB				_				_	<b>—</b>	_	_	643

<sup>\*</sup>Monolithic dual break over diodes.

<sup>▲</sup>With guaranteed reverse surge capability

<sup>\*†</sup>Asymmetrical break over diode.

# SELECTION GUIDE

#### **REGULATOR DIODES**

Regulated	Suppression	REGUL 20 W	ATOR SERVICE P.	tot max —		
voltage	stand-off	SUPPRESSOR SERVICE PRSM max				
- 2.603-	voltage	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					
8.2 V	6.2 V	1				
9.1 V	6.8 V	1				
10 V	7.5 V					
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	713)	993)	629		
22 V	16 V	Type No. BZY93 (page 713)	<b>Type No. BZY91</b> (page 693)	Type No. BZW86 (page 659)		
24 V	18 V	] @ 8	1 (p	d) <b>9</b>		
27 V	20 V	] % 6	6 6 7 2	2W8		
30 V	22 V	] 8	. Bž	. B.		
33 V	24 V	S S	Z S	Š		
36 V	27 V	Ţ	Typ	Typ		
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			,		
Oı	ıtline	DO-4	DO-5 /	DO-30		
Po	larity	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 <sub>F(AV)</sub> max.	V <sub>RWM</sub> max.	Page	Configuration
OSS9115-3 to -36	3.5 A (6 A in oil)	4.5 kV to 54 kV	733	= (1) t
OSS9215 3 to 36	5 A (20 A in oil)		743	anode
OSS9415-3 to -36	10 A (30 A in oil)		753	<b> </b>
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	centre - tap
OSB94154 to 36	20 A (60 A in oil)		753	7259125
OSM9115-4 to -36	3.5 A (6 A in oil)	3 kV to - 27 kV	733	ā (N) (N) †
OSM9215— 4 to -36	5 A (20 A in oil)		743	anode cathode
OSM94154 to36	10 A (30 A in oil)		753	7Z59126
OSM9510-12	1.5 A	6 kV	761	anode cathode v <sub>RWM</sub> centre-tap 7259126



# **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 ( $R_{th j-mb} \le 15 \text{ K/W}$ )
- 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 ( $R_{th i-mb} \le 15 \text{ K/W}$ )
- 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 (Rth i-mb > 15 K/W)
- S. TRANSISTOR; low power, switching (R $_{\rm th\ j\mb}$  > 15 K/W)
- T. CONTROL AND SWITCHING DEVICE; e.g. thyristor, power ( $R_{th j-mb} \le 15 \text{ K/W}$ )
- U. TRANSISTOR; power, switching ( $R_{th j-mb} \le 15 \text{ K/W}$ )
- 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)

# TYPE DESIGNATION

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.

#### **BANGE 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 VZ.

- 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.

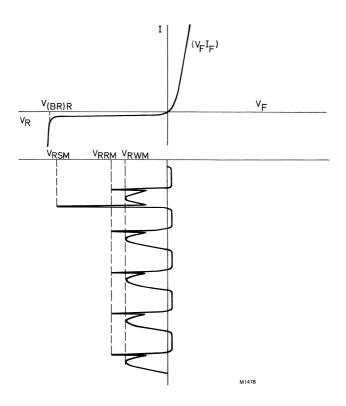
#### Subscripts

amb	Ambient
(AV), (av)	Average value
(BO)	Breakover
(BR)	Breakdown
case	Case
С	Controllable
D,d	Forward off-state 1), non-triggered (gate voltage or current)
F,f	Forward <sup>1</sup> ), fall
G,g	Gate terminal
Н	Holding
l,i	Input
J,j	Junction
L	Latching
M,m	Peak or crest value
min	Minimum
0,0	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.

<sup>1)</sup> 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 initial 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 microor 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 ( $t_{\rm rr}$ ). 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 (IF); high currents increase recovery time.
- b. Reverse bias voltage (VR); low reverse voltage increases recovery time.
- Rate of fall of anode current (dl<sub>F</sub>/dt); high rates of fall reduce recovery time, but increase stored charge.
- d. Junction temperature (Ti); high temperatures increase both recovery time and stored charge.

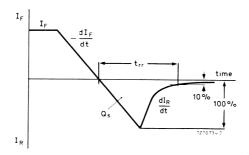


Fig. 1 Waveform showing the reverse recovery aspects.

# GENERAL EXPLANATORY NOTES

#### 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 (dl p/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<sub>R</sub> and the lower the I<sub>F</sub>. 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<sub>RWM</sub> = 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<sub>i max</sub> 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 IRRM.

The conditions which need to be specified are:

- a. Forward current (IF); high currents increase switching losses.
- b. Rate of fall of anode current (dl<sub>F</sub>/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 dl<sub>F</sub>/dt.
- c. Frequency (f); high frequency means high losses.
- d. Reverse bias voltage (VR); high reverse bias means high losses.
- e. Junction temperature  $(T_j)$ ; high temperature means high losses.

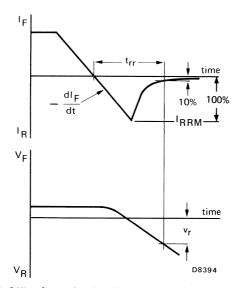


Fig.2 Waveforms showing the reverse switching losses aspects.

# GENERAL EXPLANATORY NOTES

#### SWITCHING LOSSES (continued)

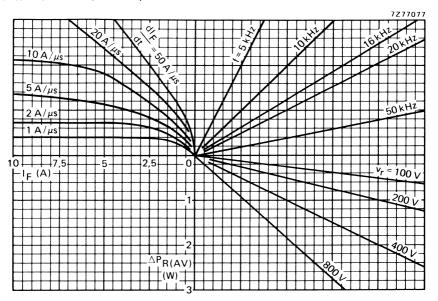


Fig. 3 Nomogram (example of reverse switching losses). Power loss  $\Delta P_{R(AV)}$  due to switching only (to be added to steady-state power losses). I<sub>F</sub> = forward current just before switching off;  $T_i$  = 150 °C.

#### 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 ( $V_{\rm fr}$ ). 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 ( $t_{\rm fr}$ ).

The conditions which need to be specified are:

- a. Forward current (I<sub>F</sub>); high currents give high recovery voltages.
- b. Current pulse rise time (t<sub>r</sub>); short rise times give high recovery voltages.
- c. Junction temperature (T<sub>i</sub>); the influence of temperature is slight.

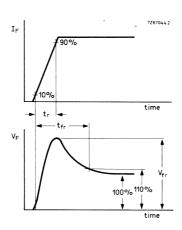


Fig. 4 Waveforms showing the forward recovery aspects.

# GENERAL EXPLANATORY NOTES

#### **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:

V <sub>RSM</sub> V <sub>RWM</sub>	RC across of trans		RC across secondary of transformer		
	C (μF)	R (Ω)	C <b>(</b> μF)	R (Ω)	
2.0	$200 \frac{I_{mag}}{V_1}$	150 C	$225 \frac{I_{mag}T^2}{V_1}$	200 C	
1.5	$400 \frac{I_{mag}}{V_1}$	225 C	$450 \frac{I_{\text{mag}} T^2}{V_1}$	275 C	
1.25	$550 \frac{I_{mag}}{V_{I}}$	260 C	$620 \frac{I_{\text{mag}} T^2}{V_1}$	310 C	
1.0	$800\frac{I_{mag}}{V_1}$	300 C	$900 \frac{I_{\text{mag}} T^2}{V_1}$	350 C	

where  $I_{mag}$  = magnetising primary r.m.s. current (A)

V<sub>1</sub> = transformer primary r.m.s. voltage (V)

V<sub>2</sub> = transformer secondary r.m.s. voltage (V)

 $T = V_1/V_2$ 

 $V_{\mbox{RSM}}$  = the transient voltage peak produced by the transformer

VRWM = 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.

<sup>1)</sup> 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

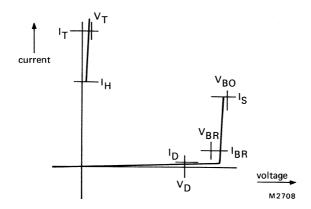


Fig.1 Breakover diode characteristics (1st quadrant).

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

VBO breakover voltage, the maximum voltage appearing across the BOD before switching to the on-state.

VD stand-off voltage, maximum normal operating voltage.

ID off-state current, normally quoted at VD.

VBR breakdown voltage, at which the BOD will commence avalanche breakdown.

IBR breakdown current, with VBR applied.

ls switching current, the avalanche current required to switch the BOD to the on-state.

IT on-state current.

V<sub>T</sub> on-state voltage, specified at a given I<sub>T</sub>.

H holding current, the minimum current at which the BOD will remain in the on-state.

# GENERAL EXPLANATORY NOTES

#### USF 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<sub>D</sub> Must not be exceeded in normal off-state operation. In the off-state the BOD will not pass more current than I<sub>D</sub>.

 ${\rm dV_D/dt}$  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.

 $V_{BR} \\ & Low \ voltage \ transients \ may \ be \ required \ not \ to \ switch \ the \ BOD \ to \ the \ on-state. \\ & To \ ensure \ the \ BOD \ remains \ in \ the \ off-state \ the \ voltage \ must \ remain \ below \ the \ minimum \ V_{BR}. \ If \ this \ is \ exceeded \ then \ clipping \ of \ the \ voltage \ or \ switching \ of \ the \ BOD \ may \ occur.$ 

Is If VBR is exceeded but the current limited to below Is minimum, the BOD is prevented from switching to the on-state.

C<sub>j</sub> 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 Is maximum.

To enable the BOD to switch to the on-state a current greater than I<sub>S</sub> maximum is required.

#### On-state conditions

V<sub>T</sub> The on-state voltage is quoted for a given I<sub>T</sub>.

IH To enable the BOD to switch to the off-state the current must fall below IH minimum.

ITRM ITRM specifies the rate of increase and duration of a transient peak on-state current. The convention used to specify ITRM is illustrated in Fig.2. This waveform is specified as a t<sub>1</sub>/t<sub>2</sub> μs impulse.

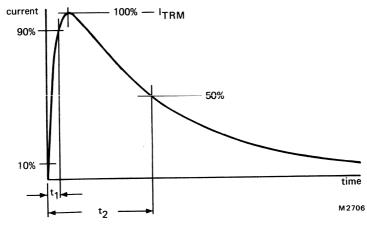


Fig.2 Definition of ITRM waveform.

#### Thermal conditions

- Rth 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<sub>th</sub> 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<sub>S</sub> maximum. When this current is reached the BOD will switch and generate heat in the on-state.

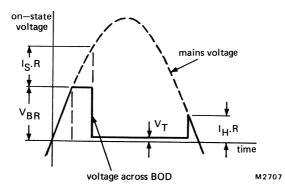


Fig.3 Voltage across BOD during mains contact fault, R = total fault impedance.

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<sub>BR</sub> 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  $500\Omega$ - $5k\Omega$  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

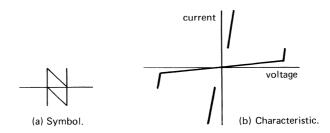


Fig.4 Symmetric BOD.

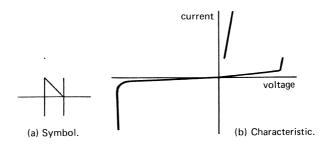


Fig.5 Reverse-blocking BOD.

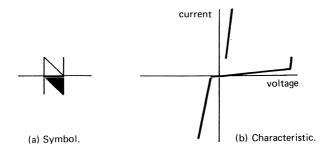


Fig.6 Reverse-conducting BOD.

# Heatsinks

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  $\Omega$ ).

Fig. 1 shows the heat path from junction to ambient as three thermal resistances in series:

R<sub>th j-mb</sub> The thermal resistance from junction to mounting base. Its value is given in the data sheets of a device.

Rth mb-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.

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

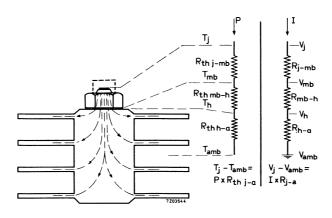


Fig. 1

# 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  $R_{th\,h}$ -a to keep the total thermal resistance below the maximum given for P and  $T_{amb}$ . A larger heatsink may be necessary.

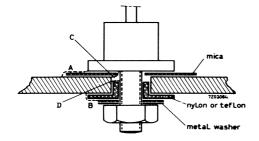


Fig. 2 Creepage distances with an insulated diode

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.

# Heatsinks

#### 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.

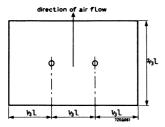


Fig. 3 Plain cooling fin with two diodes

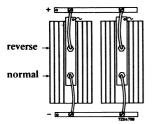


Fig. 5 Single phase full wave rectifier with diodes of different polarity on extruded aluminium heatsinks

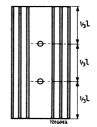


Fig. 4 Extruded aluminium heatsink with two diodes

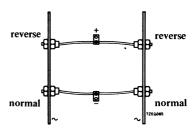


Fig. 6 Single phase full wave rectifier with diodes of different polarity on plain cooling fins (top view)

# CONSTRUCTIONS (continued)

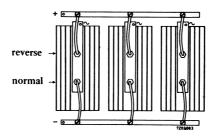


Fig. 7 Three phase full wave rectifier with diodes of different polarity on extruded aluminium heatsinks

# Heatsinks

# **EXAMPLES OF HEATSINK CALCULATION**

1. Devices without controlled avalanche properties.

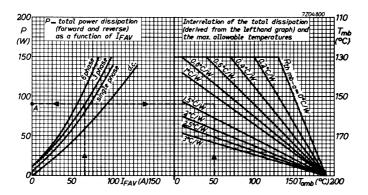
Assume that the diode of which the outlines are shown, is used in a three phase 50 Hz rectifier circuit at  $T_{amb}$  = 50 °C. Further assume: average forward current per diode  $I_{F(AV)}$  = 65 A; contact thermal resistance  $R_{th\,mb-h}$ =0,1 °C/W.



Stud: M12

Mounting base, across the flats: max. 27 mm

From the data of the diode the graph to be used is shown below.



From the lefthand graph it follows that  $P_{tot}$  = 90 W per diode (point A). From the righthand graph it follows that  $R_{th~mb-a} \approx$  1, 2  $^{\rm O}$ C/W. Thus  $R_{th~h-a}$  =  $R_{th~mb-a}$  -  $R_{th~mb-h}$  = (1, 2 - 0, 1)  $^{\rm O}$ C/W = 1, 1  $^{\rm O}$ C/W. This may be achieved by different types of heatsinks as shown below.

Туре	Free convection	Forced cooling
flat, blackened bright	-	125 cm <sup>2</sup> ; 2 m/s or 300 cm <sup>2</sup> ; 1 m/s 175 cm <sup>2</sup> ; 2 m/s
diecast 56280	applicable	
extrusion		
56230 bright blackened 56231 bright	<pre>l = 12 cm l = 8 cm l = 7 cm</pre>	$\ell = 5 \text{ cm}^{-1}$ ); $1 \text{ m/s}$ $\ell = 5 \text{ cm}^{-1}$ ); $1 \text{ m/s}$
blackened	$\ell = 5 \text{ cm}^{-1})$	

<sup>1)</sup> Practical minimum length

# EXAMPLES OF HEATSINK CALCULATION (continued)

## 2. Devices with controlled avalanche properties

Assume that the diode of which the outlines are shown, is used in a three phase 50 Hz rectifier circuit at  $T_{amb}$  = 40 °C. Further assume: average forward current per diode  $I_{F(AV)}$  = 10 A; contact thermal resistance:

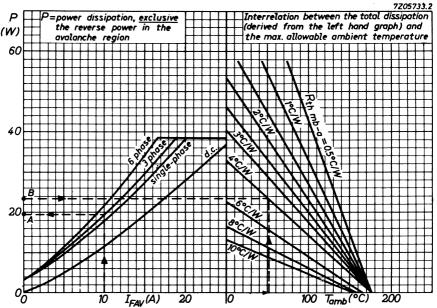
 $R_{th\ mb}$ -h = 0,5 °C/W; repetitive peak reverse power in the avalanche region (t = 40 µs)  $P_{RRM}$  = 2 kW (per diode).



Stud: M12

Mounting base, across the flats: max. 27 mm

From the data of this diode the graph to be used is shown below.



From the lefthand graph it follows that  $P_{tot}$  = 19,5 W per diode (point A). The awrage 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  $R_{th\ mb}$ -a = 4  $^{o}$ C/W. Hence the heatsink thermal resistance should be:

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

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

# Flat heatsink

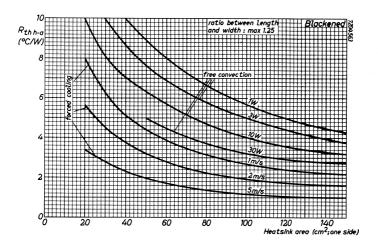
Thermal resistance of flat heatsinks of 2 mm copper or 3 mm aluminium. The graphs are valid for the combination of device and heatsink.

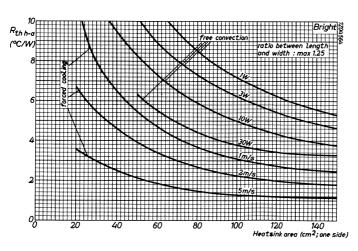




Studs: 10-32UNF

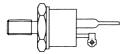
Mounting bases, across the flats: max. 11,0 mm





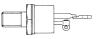
# Flat heatsink

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



Stud: 1/4" x 28 UNF

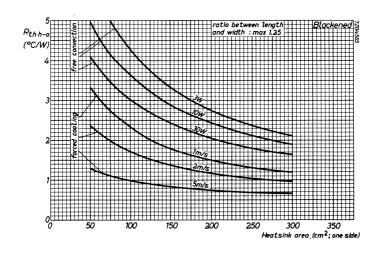
Mounting base, across the flats: max. 17 mm

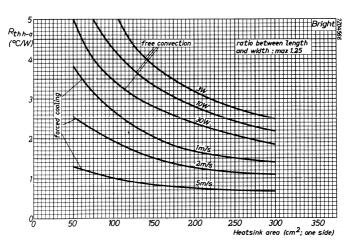


Stud: M6

Stud: ½" 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.

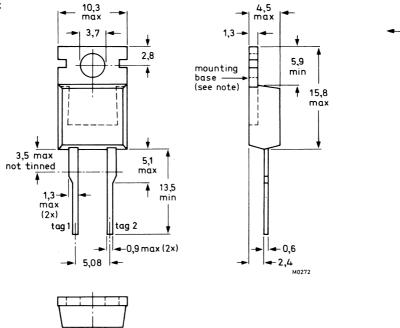
#### QUICK REFERENCE DATA

			BY249-300(R)	600(R)	-
Repetitive peak reverse voltage	V <sub>RRM</sub>	max.	300	600	٧
Average forward current	IF(AV)	max.	6	.5	Α
Non-repetitive peak forward current	<sup>I</sup> 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*		BY2	49-300(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	٧
Continuous reverse voltage	$v_R$	max.	200	400	V
Currents					
Average forward current;					
sinusoidal; up to T <sub>mb</sub> = 110 °C		<sup>I</sup> F(AV)	max.	6.5	Α
sinusoidal; at T <sub>mb</sub> = 125 <sup>o</sup> C		IF(AV)	max.	4.0	Α
R.M.S. forward current		IF(RMS)	max.	9.5	Α
Repetitive peak forward current;					
t = 10 ms; half sine-wave		<sup>I</sup> FRM	max.	60	Α
Non-repetitive peak forward current;					
t = 10 ms; half sine-wave;					
$T_j = 150$ °C prior to surge;					
with re-applied V <sub>RWMmax</sub>		<sup>I</sup> FSM	max.	60	Α
$I^2$ t for fusing; t = 10 ms		l²t	max.	18	$A^2s$
Temperatures					
Storage temperature		$T_{stg}$	-40 to	+150	оС
Junction temperature		Tj	max.	150	оС
CHARACTERISTICS					
Forward voltage					
$I_F = 20 \text{ A}; T_j = 25 ^{\circ}\text{C}$		$V_{F}$	<	1.6	V**
I <sub>F</sub> = 5 A; T <sub>j</sub> = 100 °C		٧ <sub>F</sub>	<	1.05	V**
Reverse current					
$V_R = V_{RWMmax}$ ; $T_j = 125  {}^{\circ}C$		I <sub>R</sub>	<	0.4	mΑ

<sup>\*</sup>To ensure thermal stability,  $\rm R_{th~j\text{-}a}\,{<}\,15~^{o}\text{C/W}$  for continuous reverse voltage.

<sup>\*\*</sup>Measured under pulse conditions to avoid excessive dissipation.

#### THERMAL RESISTANCE

From junction to mounting base		R <sub>th i-mb</sub>	= 4.2	oC/W
Transient thermal impedance; t = 1 ms		Z <sub>th i-mb</sub>	= 0.46	oc/w

#### Influence of mounting method

1. Heatsink mounted with clip (see mounting instructions)

Thermal resistance from mounting base to heatsink

a. with heatsink compound	$R_{th\ mb-h} = 0.3$	oC/W
b. with heatsink compound and 0.06 mm maximum mica insulator	$R_{th\ mb-h} = 1.4$	oC/W
c. with heatsink compound and 0.1 mm maximum mica insulator (56369)	$R_{th\ mb-h} = 2.2$	oC/W
d. with heatsink compound and 0.25 mm maximum alumina		

e. without heatsink compound

 $R_{th mb-h} = 0.8$  °C/W  $R_{th mb-h} = 1.4$  °C/W

7778248

## 2. Free-air operation

insulator (56367)

The quoted value of  $R_{th\ j-a}$  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.

nt in free air:
ny lead length.

R<sub>th j-a</sub> = 60 °C/W

Fig. 2 a

## MOUNTING INSTRUCTIONS

- 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.
- 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  $R_{\mbox{th}\mbox{mb-h}}$  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<sub>th mb-h</sub> given for mounting with heatsink compound refer to the use of a metallic-oxide loaded compound. Ordinary silicone grease is not recommended.
- 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.

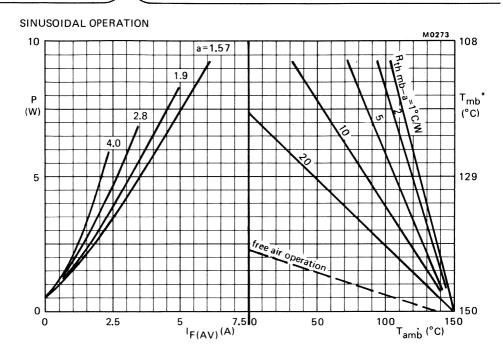


Fig. 3 The right-hand part shows the interrelationship between the power (derived from the left-hand part) and the maximum permissible temperatures. a = form factor = IF(RMS)/IF(AV).

 $<sup>^*</sup>T_{mb}$  scale is for comparison purposes and is correct only for R $_{th\ mb-a}$  < 19.3  $^{o}C/W$ .

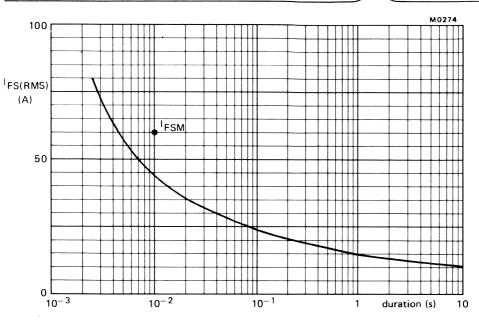
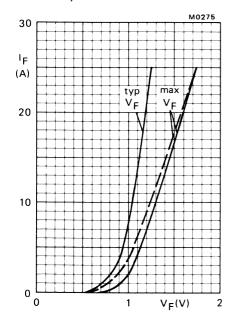


Fig. 4 Maximum permissible non-repetitive r.m.s. forward current based on sinusoidal currents (f = 50 Hz);  $T_i$  = 150  $^{\rm O}$ C prior to surge.



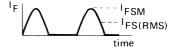


Fig. 5 —— $T_j = 25 \, {}^{\circ}\text{C}; --- T_j = 100 \, {}^{\circ}\text{C}$ 

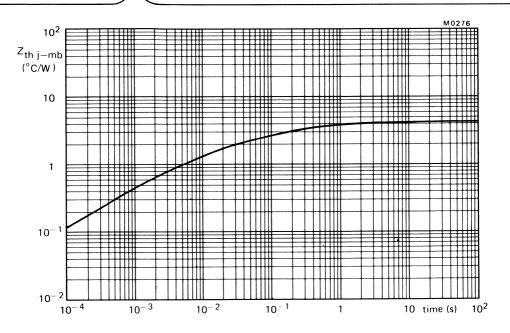


Fig. 6

# 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(F	₹)
Crest working reverse voltage Reverse avalanche breakdown	$V_{RWM}$	max.	600	800	1000	1200	1400	V
voltage	V <sub>(BR)R</sub>	>	750	1000	1250	1450	1650	٧
Average forward current	IF(AV)	max.			20			Α
Non-repetitive peak forward current	IFSM	max.			360			Α
Non-repetitive peak reverse power	PRSM	max.			18			kW

#### MECHANICAL DATA

Fig. 1 DO-4.

10-32UNF 4.83 5.2 9.3 max max max 1.98 max 23 3.9 min max 10.25 11.5 20.3 10.7 max

11.0

Net mass: 7 q.

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 Products approved to CECC 50 009-022 available on request. max. 1.7 Nm (17 kg cm).

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

The mark shown applies to to the normal polarity types.

M0184A

Dimensions in mm



**April 1984** 

45

# BYX25 SERIES

#### **RATINGS**

Voltages\*

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

Crest working reverse voltage	V <sub>RWM</sub>	max.	600	800	1000	1200	1400	٧
Continuous reverse voltage	$V_{R}$	max.	600	800	1000	1200	1400	V
Currents								
Average forward current (aver up to T <sub>mb</sub> = 125 °C	aged over	any 20 i	ms period)	l <sub>F(A</sub>	V) ma:	۲.	20	Α
Repetitive peak forward curre	nt			IFRM	η ma:	۲.	440	Α
Non-repetitive peak forward of t = 10 ms (half sine-wave);		C prior	to surge;					
with reapplied V <sub>RWMmax</sub>	,		3 ,	<sup>I</sup> FSM	ma:	κ.	360	Α
l <sup>2</sup> t for fusing				$I^2t$	ma	∢.	650	$A^2 s$
Reverse power dissipation								
Average reverse power dissipat (averaged over any 20 ms pe		= 175 <sup>O</sup> (	C	P <sub>R(A</sub>	.V) ma:	κ.	38	W
Repetitive peak reverse power $t = 10 \mu s$ (square-wave; $f = 9$ )	•		С	PRRI	VI ma:	κ.	3	kW
Non-repetitive peak reverse po $t = 10 \mu s$ (square-wave)	wer dissip	oation						
T <sub>j</sub> = 25 °C prior to surge				PRSN	л ma:	×.	18	kW
$T_j = 175$ °C prior to surge				PRSN	л ma:	х.	3	kW
Temperatures								
Storage temperature				$T_{stg}$		−55 to	+175	oC
Junction temperature				$T_{j}$	ma	x.	175	oC

BYX25-600(R) | 800(R) | 1000(R) | 1200(R) | 1400(R)

<sup>\*</sup>To ensure thermal stability:  $R_{\mbox{th}\ j\mbox{-}a} < 5\ \mbox{K/W}$  (a.c.)

# THERMAL RESISTANCE

From junction to ambient in free air	R <sub>th j-a</sub>	=	50	oC/M
From junction to mounting base	R <sub>th j-mb</sub>	**************************************	1.3	oC/W
From mounting base to heatsink	R <sub>th mb-h</sub>	=	0.5	oC/W

# CHARACTERISTICS

		BYX25-	-600(R)	800(R)	1000(R)	1200(R)	1400(R)
Forward voltage $I_F = 50 \text{ A}; T_j = 25 ^{\circ}\text{C}$	V <sub>F</sub>	<	1.8	1.8	1.8	1.8	1.8 V*
Reverse avalanche breakdown voltage I <sub>R</sub> = 5 mA; T <sub>j</sub> = 25 °C	V <sub>(BR)R</sub>	> <	750 2400	1000 2400	1250 2400	1450 2400	1650 V 2400 V
Peak reverse current $V_R = V_{RWMmax}$ ; $T_j = 125  ^{\circ}C$	I <sub>R</sub>	<	1.0	0.8	0.6	0.5	0.5 mA

<sup>\*</sup>Measured under pulse conditions to avoid excessive dissipation.

#### **OPERATING NOTES**

- 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

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 = 50 Hz $I_{FAV} = 10 A \text{ (per diode)}$ average forward current  $T_{amb} = 40 \, {}^{\circ}C$ ambient temperature repetitive peak reverse power dissipation  $P_{RRM} = 2 \text{ kW (per diode)}$ t = 40 \(\mu\s in the avalanche region duration of PRRM

From the left hand part of the upper graph on page 5 it follows that at IFAV = 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:

$$P_{RAV} = \delta \times P_{RRM}$$
, where the duty cycle  $\delta = \frac{40 \ \mu s}{20 \ ms} = 0.002$ 

Thus:  $P_{RAV} = 0.002 \times 2 \text{ kW} = 4 \text{ W}$ 

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 \mus; 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.

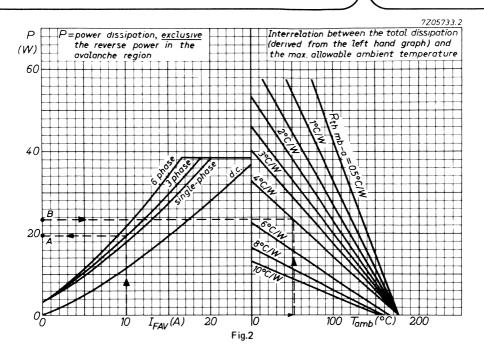
Using this in the curve leads to a thermal resistance

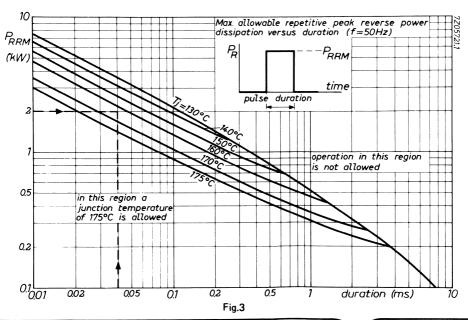
$$R_{th mb-a} \approx 4 \, {}^{\circ}C/W$$

 $$\rm R_{th~mb\text{-}a} \approx -4~^{o}C/W$$  The contact thermal resistance  $\rm R_{th~mb\text{-}h} = 0.5~^{o}C/W$ 

Hence the heatsink thermal resistance should be:

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





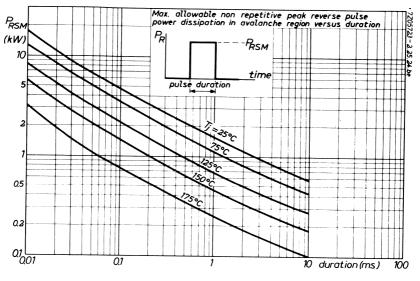


Fig.4

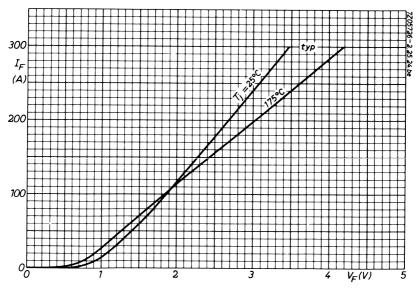


Fig.5

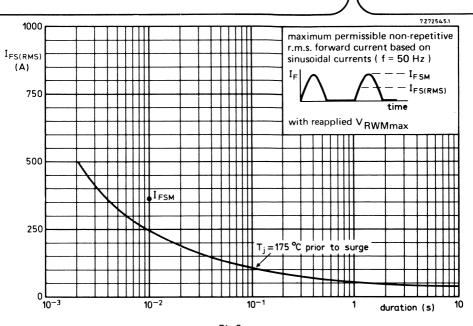


Fig.6



# SILICON RECTIFIER DIODES

Diffused silicon diodes in metal envelopes with ceramic insulation, intended for power rectifier application. The series consists of the following types:

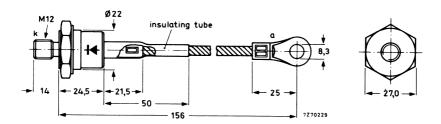
Normal polarity (cathode to stud): BYX32-600 to BYX32-1600 Reverse polarity (anode to stud): BYX32-600R to BYX32-1600R

#### QUICK REFERENCE DATA

		BYX3	2- 600 R	800 800R	1000 1000R	1200 1200R	1600 1600R	
Crest working reverse voltage	V <sub>RWM</sub>	max.	600	800	1000	1200	1200	V
Repetitive peak reverse voltage	V <sub>RRM</sub>	max.	600	800	1000	1200	1600	٧
Average forward current			<sup>J</sup> F(AV	)	max.	15	50	Α
Non-repetitive peak forward o	urrent		<sup>I</sup> FSM		max.	160	00	Α

#### **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) BYX32-

Voltages 1)		В	YX32-	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 ≤ 10 ms)	v <sub>RSM</sub>	max.		650	900	1100	1300	1600 V
Currents						~		
Average forward current (averaged over any 20 ms period) up to $T_{mb} = 100$ °C $I_{F(AV)}$ max. 150 A $I_{T(AV)}$ max. 115 A								
Forward current (d. c	e.)				IF	, ,	max. 2	240 A
R. M. S. forward current						(RMS)	max. 2	240 A
Repetitive peak forward current					IF	RM	max. 7	750 A
Non-repetitive peak forward current (t = 10 ms; half sine wave) $T_j = 190$ °C prior to surge						DIVI	max. 16	600 A
I squared t for fusing (t = 10 ms)					I2	$I^{2}t$ max. 12800 $A^{2}s$		

# Temperatures

Storage temperature	$T_{\mathbf{stg}}$	-55 to	+200 °C
Operating junction temperature	$T_{j}$	max.	190 °C

#### THERMAL RESISTANCE

1 1000 Janetton to 1111 2 1111 1	- th j-mb	<b>-,</b>
From mounting base to heatsink without heatsink compound	$R_{th\ mb-h} =$	0.1 °C/W
From mounting base to heatsink		

with heatsink compound (Dow Corning 340)

From junction to mounting base

 $R_{\text{th mb-h}} = 0.04 \, {}^{\circ}\text{C/W}$  $Z_{th j-mb} = 0.025$  °C/W Transient thermal impedance; t = 1 ms

For continuous reverse voltage:  $R_{th}$   $j_{-a}$  =1  $^{o}$ C/W, then  $T_{jmax}$  = 184  $^{o}$ C  $R_{th}$   $j_{-a}$  =1.2 C/W, then  $T_{jmax}$  = 180  $^{o}$ C  $R_{th}$   $j_{-a}$  =1.5 C/W, then  $T_{jmax}$  = 175  $^{o}$ C

 $0.4^{\circ}C/W$ 

Rth i-mb =

 $<sup>^{1}</sup>$ ) To ensure thermal stability:  $R_{th j-a} < 0.75$   $^{o}$ C/W (continuous reverse voltage) or < 1.5 OC/W (a.c.) For smaller heatsinks T<sub>i</sub> should be derated.

# 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.

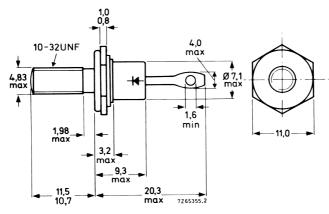
#### QUICK REFERENCE DATA

		BYX38	-300(R)	600(R)	1200(R)	
Repetitive peak reverse voltage	$v_{RRM}$	max.	300	600	1200 V	
Average forward current	<sup>I</sup> F(AV)	max.	6		A	
Non-repetitive peak forward current	<sup> </sup> FSM	max.		50	Α	

#### 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.

<b>RATINGS</b> Limiting values	in accordance with the Absolute	Maximum System (IEC 134)
--------------------------------	---------------------------------	--------------------------

Voltages		BYX38	3-300(R)	600(R)	1200(R	)
Non-repetitive peak reverse voltage (t ≤ 10 ms)	$v_{RSM}$	max.	300	600	1200	v
Repetitive peak reverse voltage ( $\delta \le 0.01$ )	$v_{RRM}$	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 $^{o}C$ at $T_{mb}$ = 125 $^{o}C$			(AV) (AV)	max.	6 4	A A
R.M.S. forward current		$I_{\mathbf{F}}$	I <sub>F(RMS)</sub>		10	Α
Repetitive peak forward current	Repetitive peak forward current			max.	50	Α
Non-repetitive peak forward current (t = 10 ms; half sine-wave) T <sub>j</sub> = 150 °C; with reapplied V <sub>RWMmax</sub> I <sup>2</sup> t for fusing (t = 10 ms)	prior to su		SM	max.	50 13	$A$ $A^2$ s
Temperatures						
Storage temperature		$T_{s}$	tg	-55 to	o +150	oС
Junction temperature		$T_{\mathbf{j}}$	Тj		150	$^{\mathrm{o}}\mathrm{C}$
THERMAL RESISTANCE						
From junction to ambient in free air		Rt	h j-a	=	50	°C/W
From junction to mounting base		Rt	h j-mb	=	4	°C/W
From mounting base to heatsink with heatsink compound		R <sub>t</sub>	h mb-h	=	0,5	°C/W
without heatsink compound		$R_{t}$	h mb-h	=	0,6	°C/W
Transient thermal impedance; t = 1 ms		$z_{t}$	hj-mab	-	0,3	°C/W

#### **CHARACTERISTICS**

# Forward voltage

$$I_F = 20 \text{ A}; T_i = 25 \text{ }^{\circ}\text{C}$$

VF

 $1, 7 V^{1}$ 

# Reverse current

$$V_R = V_{RWMmax}$$
;  $T_j = 125$  oc

IR

20

200 μΑ

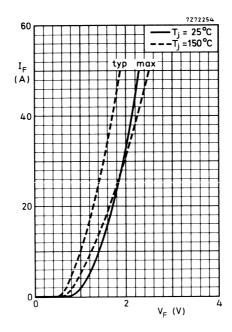
## **OPERATING NOTES**

- 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.
- 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.

November 1975

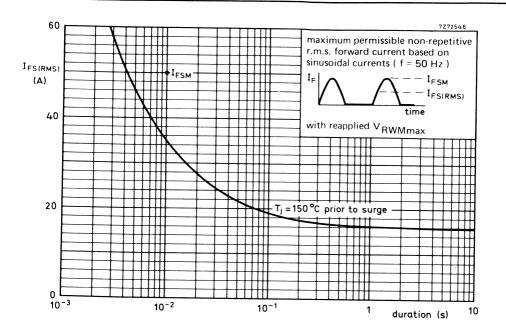
<sup>1)</sup> Measured under pulse conductions to avoid excessive dissipation.

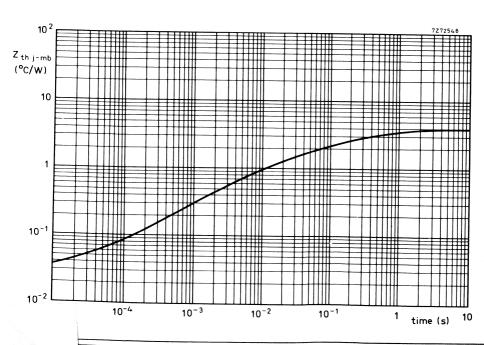
7272547 single phase: a = 1,6 interrelation between the power (derived IF(RMS) from the left-hand graph) and the maxi-: a = 1,75 a = 3-phase IF(AV) mum permissible temperatures : a = 2,46-phase 90 15 Ρ  $\mathsf{T}_{\mathsf{mb}}$ (°C) (W) R<sub>th mb-a</sub>= 110 10 0,5 °C/W 1,75 1,6 10 a = 2.420 130 5 150 2,5 7,5 0 50 100 150 5 T<sub>amb</sub> (°C) I<sub>F(AV)</sub> (A)



November 1975

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# CONTROLLED AVALANCHE RECTIFIER DIODES

#### Also available to BS9333-F005

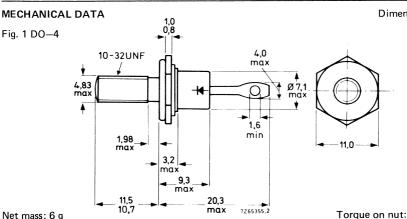
Silicon diodes in a DO-4 metal envelope, capable of absorbing transients and intended for use in power rectifier application.

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(F	?)
Crest working reverse voltage V <sub>RWM</sub>	max.	600	800	1000	1200	1400	٧
Reverse avalanche breakdown voltage $V(BR)R$	>	750	1000	1250	1450	1650	V
Average forward current		l <sub>F</sub> ∙(A∨	)	max.	9.5		Α
Non-repetitive peak forward current		I <sub>FSM</sub>		max.	125		Α
Non-repetitive peak reverse power dissipation		PRSM		max.	4		kW



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.

Dimensions in mm

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	٧
Crest working reverse voltage	V <sub>RWM</sub>	max.	600	800	1000	1200	1400	V
Currents								
Average forward current (aver 20 ms period) up to T <sub>mb</sub> = at T <sub>mb</sub> =	85 °C	any		lF(AV			9.5 6.0	A A
R.M.S. forward current				l <sub>F(RN</sub>	1S) max	<b>c.</b>	15	Α
Repetitive peak forward curre	ent			IFRM	max	ζ.	100	Α
Non-repetitive peak forward of t = 10 ms (half sine-wave); with reapplied V <sub>RWMmax</sub>		°C prior to	o surge;	I <sub>FSM</sub>	max	ς.	125	A
$I^2$ t for fusing (t = 10 ms)				l²t m		ι.	78	$A^2 s$
Reverse power dissipation								
Average reverse power dissipation (averaged over any 20 ms p		= 125 °C		PR(A)	/) max	۲.	10	w
Repetitive peak reverse power $t = 10 \mu s$ (square-wave; $f = 9$			:	PRRM	max	<b></b> .	2	kW
Non-repetitive peak reverse po $t = 10 \mu s$ (square-wave) $T_j = 25  ^{\circ}\text{C}$ prior to surge $T_j = 175  ^{\circ}\text{C}$ prior to surge	wer dissip	ation		PRSM PRSM	max max		4 0.8	kW kW
Temperatures								
Storage temperature				$T_{stg}$		-55 to +	175	οС
Junction temperature				$T_{j}$	max	: <b>.</b>	175	οС

<sup>\*</sup>To ensure thermal stability: R  $_{th~j\cdot a}$   $\leq$  5 °C/W (continuouse reverse voltage) or  $\leq$  20 °C/W (a.c.)

#### THERMAL RESISTANCE

From junction to ambient in free air	R <sub>th i-a</sub>	=	50	oC/M
From junction to mounting base	R <sub>th j-mb</sub>	= ,	4.5	oC/W
From mounting base to heatsink without heatsink compound with heatsink compound with mica washer	R <sub>th</sub> mb-h R <sub>th</sub> mb-h R <sub>th</sub> mb-h	=.	1.0 0.5 2.0	°C/W °C/W °C/W
Transient thermal impedance; t = 1 ms	Z <sub>th j-mb</sub>	=	0.35	oC/W

#### **CHARACTERISTICS**

		BYX39-	-600(R)	800(R)	1000(R)	1200(R)	1400(F	?)
Forward voltage $I_F = 20 \text{ A}; T_j = 25 ^{\circ}\text{C}$	V <sub>F</sub>	<	1.7	1.7	1.7	1.7	1.7	V*
Reverse avalanche breakdown voltage $I_R = 5 \text{ mA}; T_j = 25 ^{\circ}\text{C}$	V <sub>(BR)R</sub>	> <	750 2400	1000 2400	1250 2400	1450 2400	1650 2400	v v
Reverse current  VR = VRWMmax;  T <sub>j</sub> = 125 °C	I <sub>R</sub>	<	200	200	200	200	200	μΑ

## **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.

<sup>\*</sup>Measured under pulse conditions to avoid excessive dissipation.

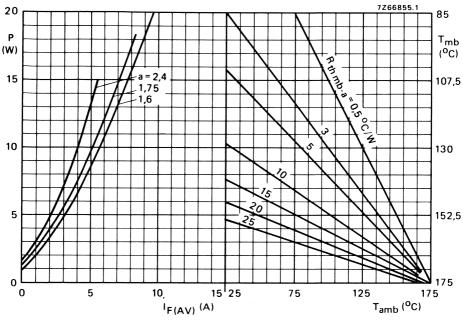
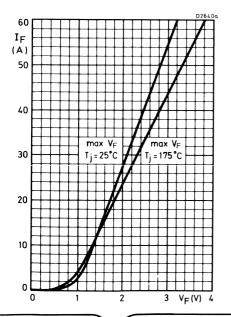


Fig.2



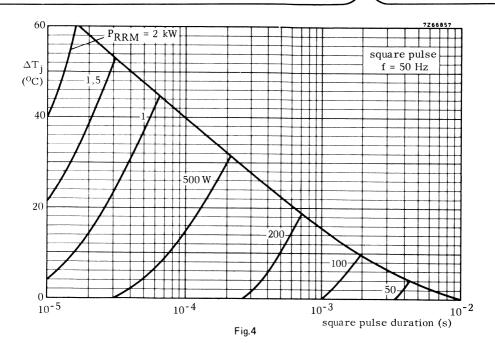
The right-hand part shows the interrelationship between the power (derived from the left-hand part) and the maximum permissible temperatures.

P = dissipation excluding power in the avalanche region.

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

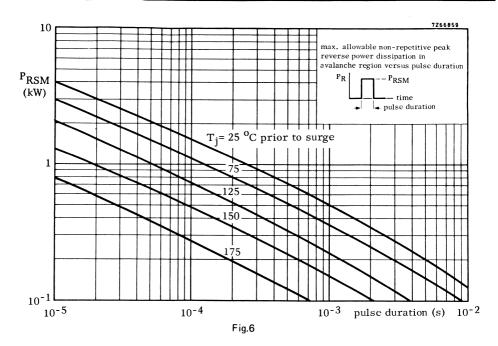
$$a = I_F(RMS)/I_F(AV)$$

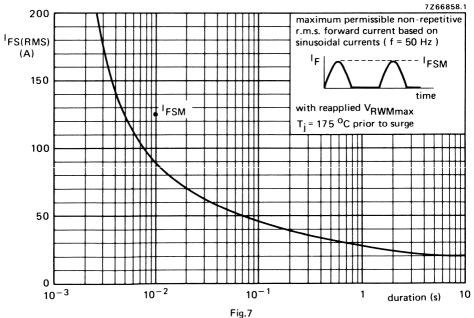
Fig.3



30 square pulse  $\Delta T_{i}$ f = 400 Hz(OC)  $P_{RRM} = 1.5 \text{ kW}$ 20 10 750 W 200 10-5 10-3 10-4 10-2 square pulse duration (s)

Fig.5





# 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.

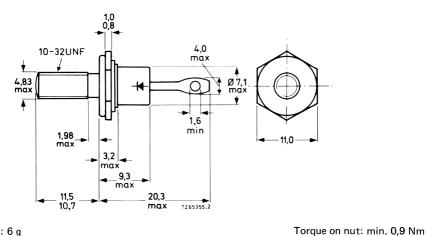
#### QUICK REFERENCE DATA

		BYX42-300(R)		600(R)	1200(R)
Repetitive peak reverse voltage	$V_{RRM}$	max.	300	600	1200 V
Average forward current	<sup>I</sup> F(AV)	max.		12	A
Non-repetitive peak forward current	<sup>1</sup> FSM	max.		125	Α

#### **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

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.

(9 kg cm)

(17 kg cm)

max. 1,7 Nm

RATINGS Limiting values	in accordance with the Absolute	Maximum System (IEC 134)
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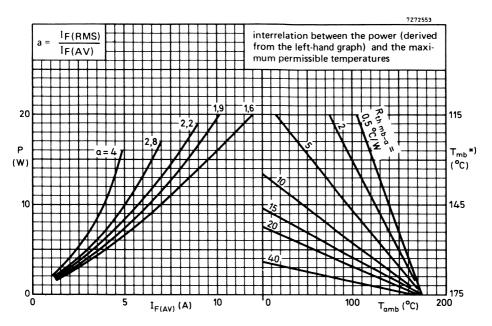
Voltages		BYX4	2-300(R)	600(R)	1200(R	.)
Non-repetitive peak reverse voltage (t ≤ 10 ms)	$v_{RSM}$	max.	300	600	1200	v
Repetitive peak reverse voltage $(\delta \le 0,01)$	$v_{RRM}$	max.	300	600	1200	v
Crest working reverse voltage	$v_{RWM}$	max.	200	400	800	v
Continuous reverse voltage	$v_R$	max.	200	400	800	V
Currents						
Average forward current (averaged over any 20 ms period) up to $T_{\mbox{mb}}$ at $T_{\mbox{mb}}$	I <sub>F</sub> (AV)	max. max.	12 10	A A		
R.M.S. forward current	I <sub>F(RMS)</sub>	max.	20	Α		
Repetitive peak forward current	$I_{FRM}$	max.	60	Α		
		Non-repetitive peak forward current (t = 10 ms; half sine-wave) $T_j$ = 175 °C prior to surge; with reapplied $V_{RWMmax}$				
(t = 10 ms; half sine-wave) $T_i = 17$		surge;	I <sub>FSM</sub>	max.	125	A
(t = 10 ms; half sine-wave) $T_i = 17$		surge;	$I_{FSM}$	max.	125	A
(t = 10 ms; half sine-wave) $T_j = 17$ with reapplied $V_{RWMmax}$		surge;			125 to +175	A °C
(t = 10 ms; half sine-wave) T <sub>j</sub> = 17 with reapplied V <sub>RWMmax</sub> Temperatures		surge;	$T_{\text{FSM}}$ $T_{\text{stg}}$ $T_{\text{j}}$			
(t = 10 ms; half sine-wave) T <sub>j</sub> = 17 with reapplied V <sub>RWMmax</sub> Temperatures  Storage temperature		surge;	$T_{stg}$	-55 t	o +175	°C
(t = 10 ms; half sine-wave) T <sub>j</sub> = 17 with reapplied V <sub>RWMmax</sub> <u>Temperatures</u> Storage temperature  Junction temperature	75°C prior to	surge;	т <sub>stg</sub> т <sub>ј</sub>	-55 t	o +175	°C
(t = 10 ms; half sine-wave) T <sub>j</sub> = 17 with reapplied V <sub>RWMmax</sub> Temperatures Storage temperature Junction temperature  THERMAL RESISTANCE	75°C prior to	surge;	T <sub>stg</sub> T <sub>j</sub>	-55 t max.	ro +175 175	°C °C/
(t = 10 ms; half sine-wave) T <sub>j</sub> = 17 with reapplied V <sub>RWMmax</sub> Temperatures  Storage temperature  Junction temperature  THERMAL RESISTANCE  From junction to ambient in free air	75°C prior to	surge;	т <sub>stg</sub> т <sub>ј</sub>	-55 t max. = =	50 +175 175	°C °C
(t = 10 ms; half sine-wave) T <sub>j</sub> = 17 with reapplied V <sub>RWMmax</sub> Temperatures  Storage temperature  Junction temperature  THERMAL RESISTANCE  From junction to ambient in free air From junction to mounting base	75°C prior to	surge;	$T_{stg}$ $T_{j}$ $R_{th \ j-a}$ $R_{th \ j-mb}$	-55 t max. = =	50 3	°C/
(t = 10 ms; half sine-wave) T <sub>j</sub> = 17 with reapplied V <sub>RWMmax</sub> Temperatures  Storage temperature  Junction temperature  THERMAL RESISTANCE  From junction to ambient in free air From junction to mounting base From mounting base to heatsink	75°C prior to	surge;	$T_{stg}$ $T_{j}$ $R_{th \ j-a}$ $R_{th \ j-mb}$	-55 t max. = =	50 3	°C/

#### MOUNTING INSTRUCTIONS

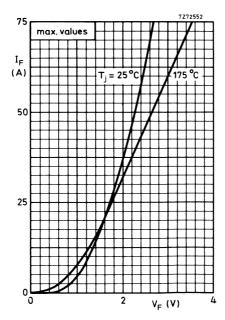
The top connector should neither be bent nor twisted; it should be soldered into the circuit so that there is no strain on it.

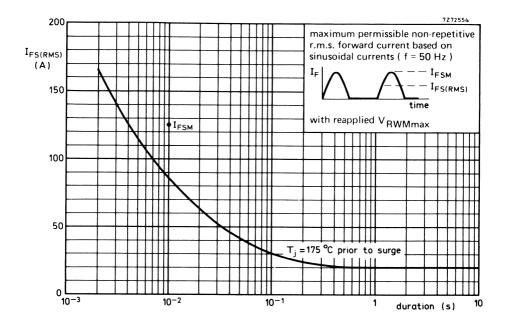
During soldering the heat conduction to the junction should be kept to a minimum.

 $<sup>^{1}</sup>$ ) Measured under pulse conditions to avoid excessive dissipation.



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







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.

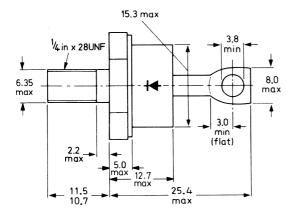
#### QUICK REFERENCE DATA

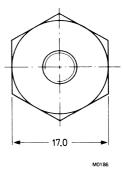
		BYX52	–300(R)	600(R)	1200(R)	
Repetitive peak reverse voltage	$v_{RRM}$	max.	300	600	1200	٧
Average forward current		IF(AV)		max.	48	Α
Non-repetitive peak forward current		<sup>I</sup> FSM		max.	800	Α

## **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 q

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.

# **BYX52 SERIES**

#### **RATINGS**

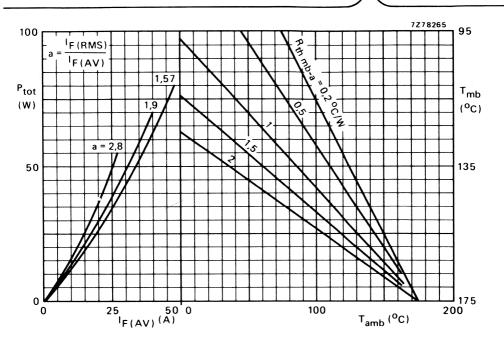
Limiting values in accordance with the Absolute Maximum System (IEC134).

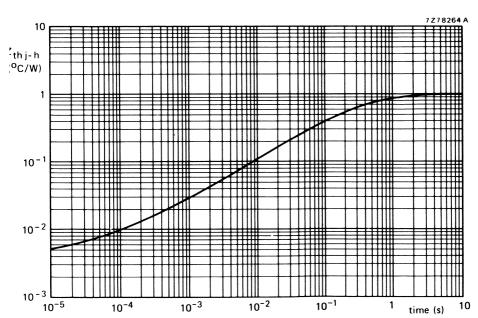
Voltages		BYX52	2-300(R)	600(R)	1200(R)	_
Non-repetitive peak reverse voltage ( $t \le 10 \text{ ms}$ )	$v_{RSM}$	max.	300	600	1200	V
Repetitive peak reverse voltage $(\delta = 0.01)$	$v_{RRM}$	max.	300	600	1200	V
Crest working reverse voltage	$v_{RWM}$	max.	200	400	800	V
Currents						
Average forward current (averaged						
over any 20 ms period) up to T <sub>m</sub> at T <sub>ml</sub>	lF(AV) lF(AV)	max. max.	48 40	A A		
R.M.S. forward current			F(RMS)	max.	75	Α
Repetitive peak forward current					450	Α
Non-repetitive peak forward current (t = 10 ms; half-sinewave) $T_j = 17$	IFSM	max. 800		Α		
$I^2$ t for fusing (t = 10 ms)			I² t	max. 3	200	$A^2 s$
Temperatures						
Storage temperature			$T_{stg}$	-55 to +	175	оС
Junction temperature			$T_{j}$	max.	175	оС
THERMAL RESISTANCE						
From junction to mounting base			R <sub>th j-mb</sub>	=	0.8	oC/M
From mounting base to heatsink			R <sub>th mb-h</sub>	=	0.2	oC/M
CHARACTERISTICS						
Forward voltage I <sub>F</sub> = 150 A; T <sub>j</sub> = 25 °C			V <sub>F</sub>	<	1.8	V*
Reverse current $V_R = V_{RWM max}$ ; $T_j = 125  {}^{O}C$			I <sub>R</sub>	<	1.6	mA

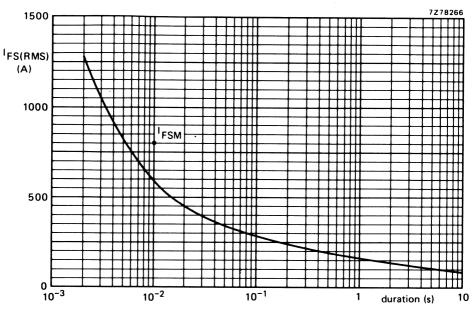
## **OPERATING NOTE**

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

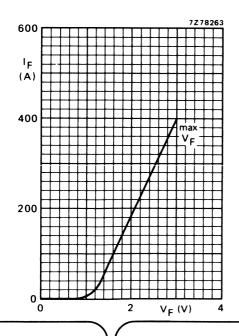
<sup>\*</sup>Measured under pulse conditions to avoid excessive dissipation.

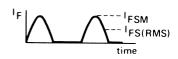






Maximum permissible non-repetitive r.m.s. forward current based on sinusoidal currents (f = 50 Hz);  $T_i = 175 \text{ }^{\circ}\text{C}$  prior to surge; with reapplied  $V_{RWMmax}$ .





# 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:

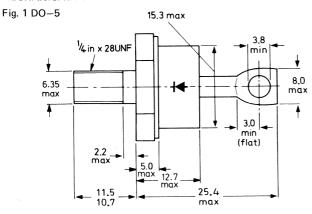
Normal polarity (cathode to stud): BYX56–600 to BYX56–1400. Reverse polarity (anode to stud): BYX56–600R to BYX56–1400R.

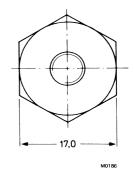
#### QUICK REFERENCE DATA

		BYX56	-600(R)	800(R)	1000(R)	1200(R)	1400(F	<u>(</u>
Crest working reverse voltage	$V_{RWM}$	max.	600	800	1000	1200	1400	٧
Reverse avalanche breakdown voltage	V <sub>(BR)R</sub>	>	750	1000	1250	1450	1650	٧
Average forward current	I <sub>F</sub> (AV)	max.			48			A
Non-repetitive peak forward current	I <sub>FSM</sub>	max.			800			Α
Non-repetitive peak reverse power dissipation	PRSM	max.			40			kW

## **MECHANICAL DATA**

Dimensions in mm





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.

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

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.

# BYX56 SERIES

## **RATINGS**

Voltages\*

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

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 p up to $T_{mb} = 112$ °C at $T_{mb} = 125$ °C	eriod)			lf(AV)			48 40	A A
R.M.S. forward current				IF(RM	S) max	: <b>.</b>	75	Α
Repetitive peak forward curre	ent			IFRM	max	·.	450	Α
Non-repetitive peak forward of $t = 10$ ms (half sine-wave); $T_j = 175$ °C prior to surge;	urrent							
with reapplied VRWMmax				<sup>I</sup> FSM	max	i.	800	Α
$I^2$ t for fusing (t $\leq$ 10 ms)				l²t	max	:. 3	200	$A^2 s$
Reverse power dissipation								
Repetitive peak reverse power $t = 10 \mu s$ (square-wave; $f = 10 \mu s$		on		_				
$T_{j} = 175 {}^{\circ}\text{C}$				PRRM	max		6.5	kW
Non-repetitive peak reverse po t = 10 \(\mu s\) (square-wave)	ower dissip	ation						
$T_j = 25 ^{\circ}\text{C}$ prior to surge $T_j = 175 ^{\circ}\text{C}$ prior to surge				P <sub>RSM</sub> P <sub>RSM</sub>	max max		40 6.5	kW kW
Temperatures								
Storage temperature				$T_{stg}$		-55 to +	175	οС
Junction temperature				$T_{j}$	max		175	oC
THERMAL RESISTANCE								
From junction to mounting ba	ase			R <sub>th j-m</sub>	nb =		8.0	oC/W
From mounting base to heatsi	nk			R <sub>th mb</sub>	o-h =		0.2	oC/M
Transient thermal impedance;	t = 1 ms			Z <sub>th j-h</sub>	=	(	0.03	oC/W

BYX56-600(R) 800(R) 1000(R) 1200(R) 1400(R)

<sup>\*</sup>To ensure thermal stability:  $\rm R_{th~j-a}$   $\leq$  2.2  $^{\rm o}\rm C/W$  (a.c.)

CHARACTERISTICS								
		BYX56	YX56-600(R) 800(R)		1000(R)	1200(R)	1400(F	۲)
Forward voltage I <sub>F</sub> = 150 A; T <sub>j</sub> = 25 °C	VF	< '	1.8	1.8	1.8	1.8	1.8	V*
Reverse avalanche breakdown voltage $I_R = 5 \text{ mA}; T_j = 25 ^{\circ}\text{C} ^{\circ}\text{V(BR)R}$		>	750	1000	1250	1450	1650	<b>V</b>
	v(BR)R	< '	2400	2400	2400	2400	2400	٧
Reverse current					-			
V <sub>R</sub> = V <sub>RWMmax</sub> ; T <sub>i</sub> = 125 <sup>o</sup> C	I <sub>R</sub>	<	1.6	1.6	1.6	1.6	1.6	mΑ

## **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.

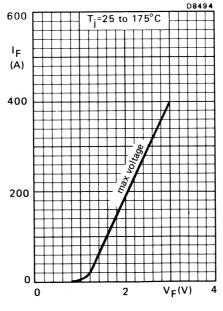
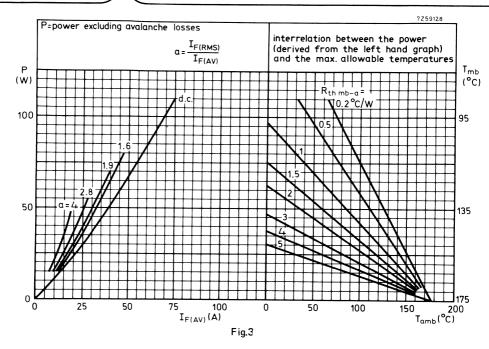
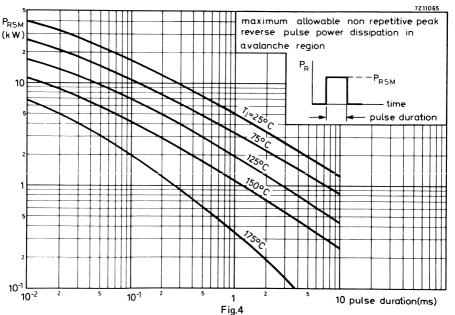


Fig.2

<sup>\*</sup>Measured under pulsed conditions to avoid excessive dissipation.





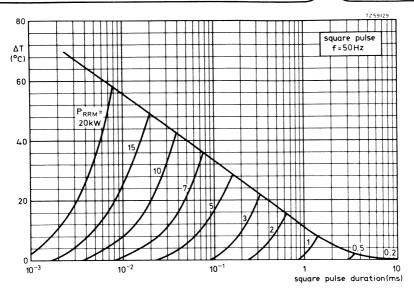


Fig.5

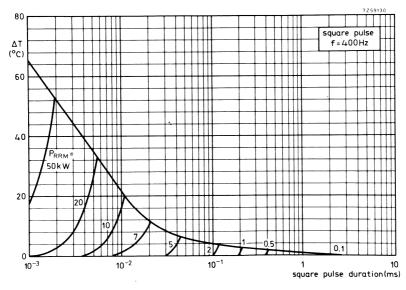
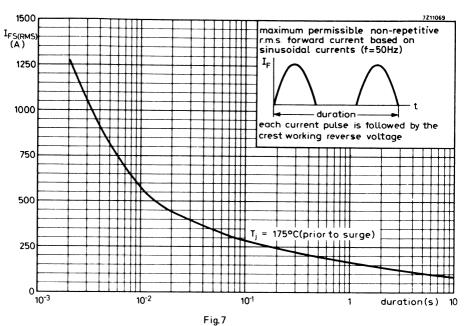
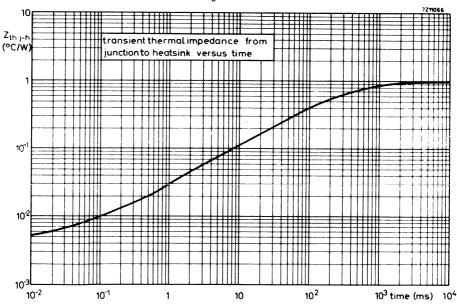


Fig.6

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





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

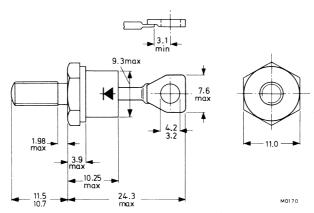
		BYX96-300(R)		600(R) 1200(F		1600(R)	
Repetitive peak reverse voltage	$v_{RRM}$	max.	300	600	1200	1600	٧
Average forward current		IF(AV)		max.		30	Α
Non-repetitive peak forward current		<sup>I</sup> FSM		max.		400	Α

#### MECHANICAL DATA

Dimensions in mm

Fig.1 DO-4: with metric M5 stud ( $\phi$  5 mm); e.g. BYX96-300(R).

Types with 10-32 UNF stud ( $\phi$  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 a

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	5-300(R)	600(R)	1200(R)	160	0(R)
Non-repetitive peak reverse voltage (t ≤ 10 ms)	v <sub>rsm</sub>	max.	300	600	1200	160	00 V
Repetitive peak reverse voltage ( $\delta \le 0,01$ )	V <sub>RRM</sub>	max.	300	600	1200	160	00 V
Crest working reverse voltage	$v_{RWM}$	max.	200	400	800	80	0 V
Continuous reverse voltage	$v_R$	max.	200	400	800	80	00 V
Currents							
Average forward current (average over any 20 ms period) up to 7	$I_{\mathrm{F}}$	(AV)	max.	30	A		
R.M.S. forward current			$I_{\mathrm{F}}$	(RMS)	max.	48	Α
Repetitive peak forward current	$I_{\mathrm{F}}$	I <sub>FRM</sub> ma		<b>4</b> 00	A		
Non-repetitive peak forward cur (t = 10 ms; half sine-wave) T <sub>j</sub> =	_			<b>4</b> 00	Α		
with reapplied V <sub>RWMmax</sub>				SM	-		
$I^2$ t for fusing (t = 10 ms)			$I^2t$		max.	800	$A^2s$
Temperatures							
Storage temperature			$T_s$	tg	-55 to +	175	oC
Junction temperature			$T_{\mathbf{j}}$		max.	175	$^{\mathrm{o}}\mathrm{C}$
THERMAL RESISTANCE							
From junction to mounting base			Rt	n j- <b>m</b> b	=	1,0	°C/W
From mounting base to heatsink without heatsink compound				n mb-h	=	0,5	°C/W
with heatsink compound				n mb-h	=	0,3	°C/W
Transient thermal impedance; t	= 1 ms			n j- <b>m</b> b	=	0, 2	°C/W

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  $^{o}$ C/W, then  $T_{j\,max}$  = 138  $^{o}$ C, if  $R_{th}$   $_{j-a}$  = 6  $^{o}$ C/W, then  $T_{j\,max}$  = 125  $^{o}$ C.

 $<sup>^{</sup>l})$  To ensure thermal stability: R  $_{th~j\text{-a}}$   $\leq$  2  $^{o}\text{C/W}$  (continuous reverse voltage) or  $\leq 8 \text{ }^{\circ}\text{C/W} \text{ (a.c.)}$ 

## **CHARACTERISTICS**

## Forward voltage

$$I_F = 100 \text{ A}; T_1 = 25 \text{ }^{\circ}\text{C}$$

$$V_{F} < 1, 7 V^{-1}$$

## Reverse current

$$V_R = V_{RWMmax}$$
;  $T_j = 125$  °C

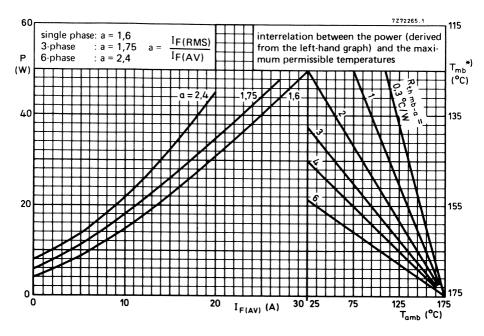
 $I_R$  < 1 mA

## **OPERATING NOTES**

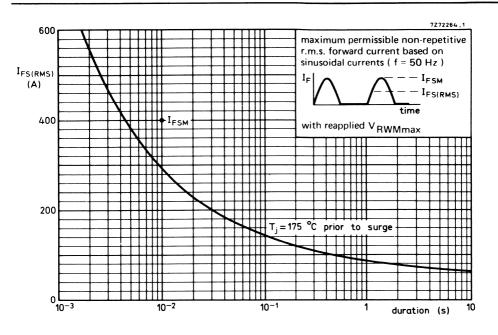
- The top connector should neither be bent nor twisted; it should be soldered into the circuit so that there is no strain on it.
   During soldering the heat conduction to the junction should be kept to a minimum.
- 2. Where there is a possibility that transients, due to the energy stored in the transformer,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

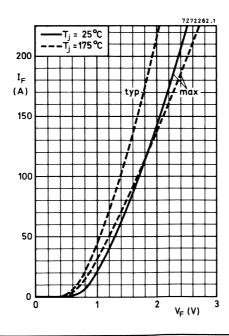
0.0

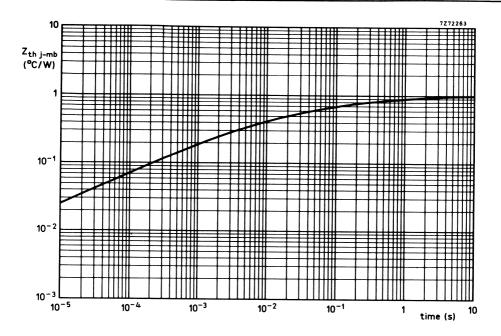
<sup>1)</sup> Measured under pulse conditions to avoid excessive dissipation.



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







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

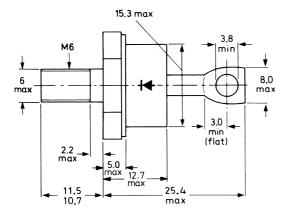
		BYX97-300(R)		600(R) 1200(R)		1600(R)	
Repetitive peak reverse voltage	$V_{RRM}$	max.	300	600	1200	1600	V
Average forward current		l <sub>F(AV</sub>	)	max.		47	Α
Non-repetitive peak forward current		<sup>I</sup> FSM		max.		800	Α

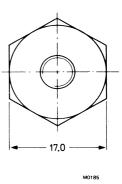
#### **MECHANICAL DATA**

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)

 ${f RATINGS}$  Limiting values in accordance with the Absolute Maximum System (IEC 134)

Voltages 1)		BYX97-300(R)		600(R)	1200(R) 1600(R		00(R)	
Non-repetitive peak reverse voltage (t ≤ 10 ms)	$v_{RSM}$	max.	300	600	1200	160	00 V	V
Repetitive peak reverse voltage ( $\delta \leq 0,01$ )	V <sub>RRM</sub>	max.	300	600	1200	160	00 V	V
Crest working reverse voltage	$v_{RWM}$	max.	200	400	800	80	00 V	I
Continuous reverse voltage	$v_R$	max.	200	400	800	80	00 V	I
Currents								
Average forward current (average any 20 ms period) up to $T_{mb}$ = at $T_{mb}$ =	120 °C			(AV) (AV)	max.	47 40	A A	
R.M.S. forward current			$I_{\mathbf{F}}$	(RMS)	max.	75	A	
Repetitive peak forward current			$I_{\mathbf{F}}$	RM	max.	550	A	
Non-repetitive peak forward cur (t = 10 ms; half sine-wave) T <sub>j</sub> = with reapplied V <sub>RWMmax</sub>		ior to su	ırge; I <sub>F</sub> ;	SM	max.	800	A	
$I^{2}t$ for fusing (t = 10 ms)			I2t		max.	3200	$A^2s$	
Temperatures								
Storage temperature			$T_{\mathbf{S}}$	tg	-55 to	+150	$^{\mathrm{o}\mathrm{C}}$	
Junction temperature			$T_{\mathbf{j}}$		max.	150	$^{\rm o}$ C	
THERMAL RESISTANCE								
From junction to mounting base			Rtl	ı j-mb	=	0,6	oC/W	,
From mounting base to heatsink without heatsink compound			R <sub>tl</sub>	ı mb-h	=	0,3	oC/W	,
with heatsink compound			R <sub>ti</sub>	n mb-h	=	0,2	o <sub>C/W</sub>	,
Transient thermal impedance; t	= 1 ms			ı j-mb	=	0,1	<sup>o</sup> C/W	,

 $<sup>^{</sup>l})$  To ensure thermal stability:  $R_{th~j-a} \leq$  1  $^{o}\text{C/W}$  (continuous reverse voltage) or  $\leq$  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  $R_{th\,\,j^-a}$  = 2  $^o$ C/W, then  $T_{j\,max}$  = 138  $^o$ C, if  $R_{th\,\,j^-a}$  = 3  $^o$ C/W, then  $T_{j\,max}$  = 125  $^o$ C.

#### **CHARACTERISTICS**

### Forward voltage

$$I_F = 150 \text{ A}; T_1 = 25 \text{ }^{\circ}\text{C}$$

$$V_{\rm F}$$
 < 1, 45  $V^{-1}$ )

## Reverse current

$$V_R = V_R W_{max}$$
;  $T_i = 125 \text{ }^{\circ}C$ 

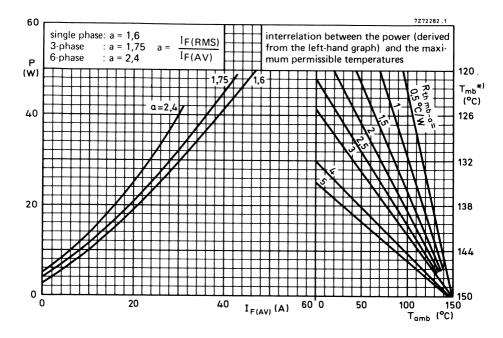
 $I_R$  < 4 mA

## **OPERATING NOTES**

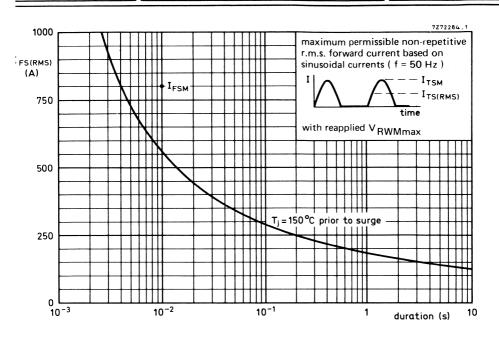
- The top connector should neither be bent nor twisted; it should be soldered into the circuit so that there is no strain on it.
   During soldering the heat conduction to the junction should be kept to a minimum.
- 2. Where there is a possibility that transients, due to the energy stored in the transformer,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

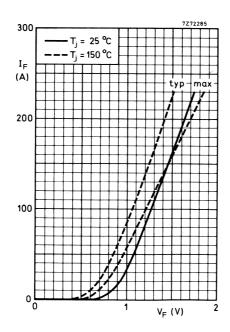
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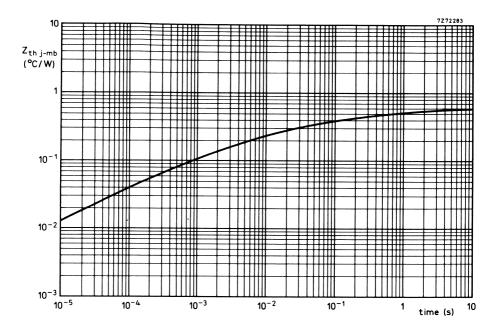
<sup>1)</sup> Measured under pulse conditions to avoid excessive dissipation.



\*)  $T_{mb}\text{-scale}$  is for comparison purposes only and is correct only for  $R_{th\ mb\text{-}a} \leq 3.4\,^{o}\text{C/W}$ 









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.

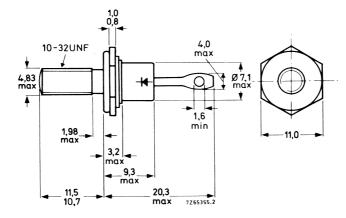
#### QUICK REFERENCE DATA

		BYX98-300(R)	600(R)	1200(R)	
Repetitive peak reverse voltage	$v_{RRM}$	max. 300	600	1200	V
Average forward current		IF(AV)	max.	10	Α
Non-repetitive peak forward current		<sup>I</sup> FSM	max.	75	Α

#### 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

Transient thermal impedance; t = 1 ms

RATINGS Limiting values in accordance	with the A	bsolute	Maximun	n System	(IEC 13	4)
Voltages		BYX9	8-300(R)	600(R)	1200(R	.)
Non-repetitive peak reverse voltage (t ≤ 10 ms)	$v_{RSM}$	max.	300	600	1200	v
Repetitive peak reverse voltage $(\delta \le 0.01)$	$v_{RRM}$	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	$\mathbf{v}$
Currents						
Average forward current (averaged over any 20 ms period) up to $T_{mb}$ = 97 °C at $T_{mb}$ = 125 °C			I <sub>F(AV)</sub> I <sub>F(AV)</sub>	max. max.	10 6	A A
R.M.S. forward current			I <sub>F</sub> (RMS)	max.	16	Α
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 s	surge;				
with reapplied V <sub>RWMmax</sub>			$I_{FSM}$	max.	75	Α
I <sup>2</sup> t for fusing (t = 10 ms)			$I^2t$	max.	28	$A2_{S}$
Temperatures						
Storage temperature			${ m T_{stg}}$	-55 to +150		°С
Junction temperature			Тj	max.	150	$^{\mathrm{o}}\mathrm{C}$
THERMAL RESISTANCE						
From junction to ambient in free air			R <sub>th j-a</sub>	=	50	°C/W
From junction to mounting base			R <sub>th j-mb</sub>	=	3	oC/W
From mounting base to heatsink with heatsink compound			R <sub>th mb-l</sub>		0,5	°C/W
without heatsink compound			R <sub>th mb-1</sub>		0,6	°C/W

0,3 °C/W

 $Z_{th j-mb} =$ 

#### **CHARACTERISTICS**

## Forward voltage

$$I_F = 20 \text{ A}; T_i = 25 \text{ }^{\circ}\text{C}$$
  $V_F$ 

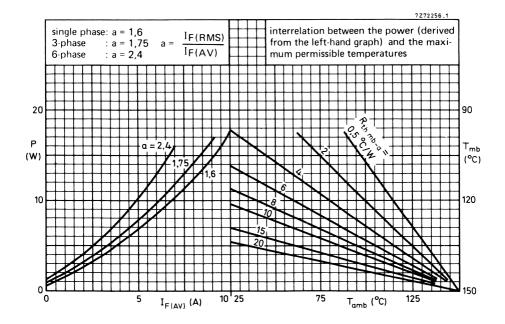
 $V_{\mathbf{F}}$  < 1,7 V 1)

## Reverse current

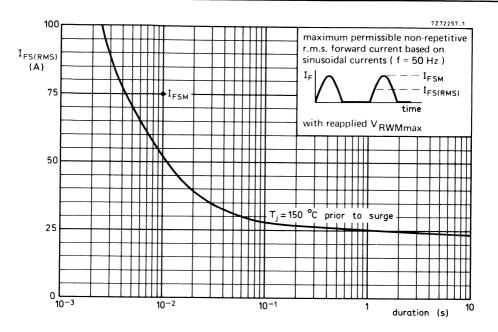
$$V_R = V_{RWMmax}$$
;  $T_j = 125$  °C  $I_R < 200 \mu A$ 

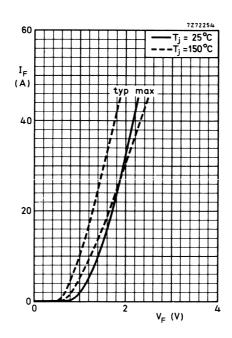
#### **OPERATING NOTES**

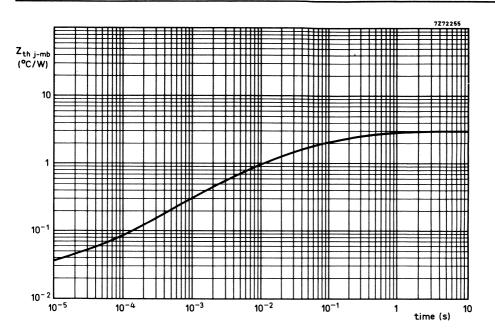
- The top connector should neither be bent nor twisted; it should be soldered into the circuit so that there is no strain on it.
   During soldering the heat conduction to the junction should be kept to a minimum.
- 2. Where there is a possibility that transients, due to the energy stored in the transformer,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



 $<sup>^{1}</sup>$ ) Measured under pulse conditions to avoid excessive dissipation.







## 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.

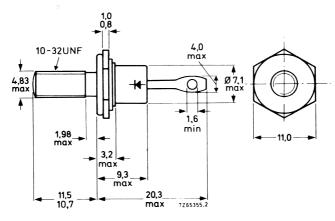
#### **QUICK REFERENCE DATA**

		BYX99-300(R)	600(R)	1200(R)	
Repetitive peak reverse voltage	$V_{RRM}$	max. 300	600	1200	V
Average forward current		lF(AV)	max.	15	A
Non-repetitive peak forward current		<sup>I</sup> FSM	max.	180	Α

#### 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 v	vith the Absolute	Maximum Syst	tem (IEC 134)
---------	-----------------	-----------------	-------------------	--------------	---------------

Voltages		BYX99	9-300(R)	600(R)	1200(R)	)
Non-repetitive peak reverse voltage (t ≤ 10 ms)	v <sub>rsm</sub>	max.	300	600	1200	v
Repetitive peak reverse voltage ( $\delta \leq 0,01$ )	v <sub>RRM</sub>	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 of any 20 ms period) up to $T_{mb}$ = 129	_	Ι <sub>Ε</sub>	F(AV)	max.	15	A
R.M.S. forward current		IF	(RMS)	max.	24	Α
Repetitive peak forward current		IF	RM	max.	180	A
Non-repetitive peak forward current (t = 10 ms; half sine-wave) $T_i = 175$ °C	Cprior to s	urge;				
with reapplied V <sub>RWMmax</sub>		$I_{\mathbf{F}}$	'SM	max.	180	Α
$I^2t$ for fusing (t = 10 ms)		$I^2$	t	max.	162	$A^2s$
Temperatures						
Storage temperature		T	stg	-55 t	o + 175	°C
Junction temperature		$T_{j}$	i	max.	175	$^{\mathrm{o}}\mathrm{C}$
THERMAL RESISTANCE				•		
From junction to ambient in free air		Rt	h j-a	=	50	°C/W
From junction to mounting base		Rt	h j-mb	=	2,3	°C/W
From mounting base to heatsink with heatsink compound		R <sub>t</sub>	h mb-h	=	0,5	°C/W
without heatsink compound			h mb-h	=	0,6	°C/W
Transient thermal impedance; t = 1 m	ıs		h j-mb	=	0,13	°C/W

#### **CHARACTERISTICS**

#### Forward voltage

$$I_F = 50 \text{ A}; T_j = 25 \text{ }^{0}\text{C}$$
  $V_F < 1,55 \text{ }^{0}\text{C}$ 

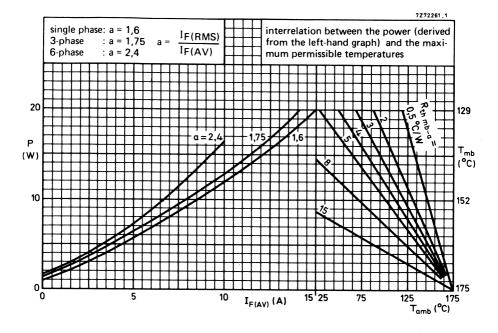
#### Reverse current

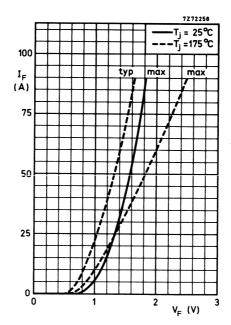
$$V_R = V_{RWMmax}; T_j = 125 \, {}^{O}C$$
  $I_R < 200 \, \mu A$ 

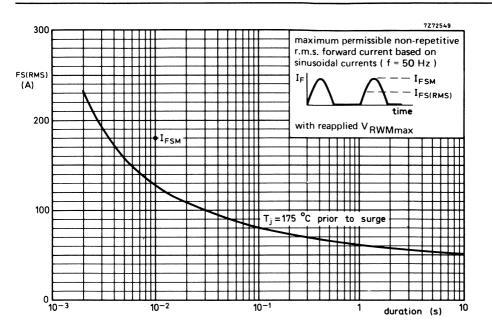
#### **OPERATING NOTES**

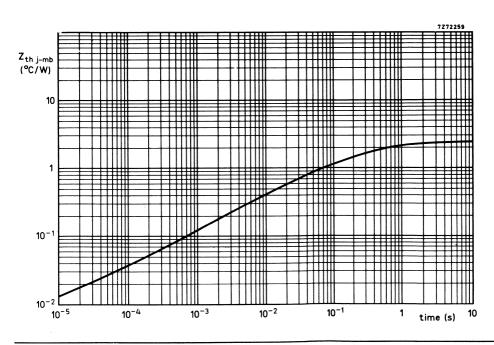
- The top connector should neither be bent nor twisted; it should be soldered into the circuit so that there is no strain on it.
   During soldering the heat conduction to the junction should be kept to a minimum.
- 2. Where there is a possibility that transients, due to the energy stored in the transformer,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

 $<sup>{</sup>f 1}$ ) Measured under pulse conductions to avoid excessive dissipation.











# **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.

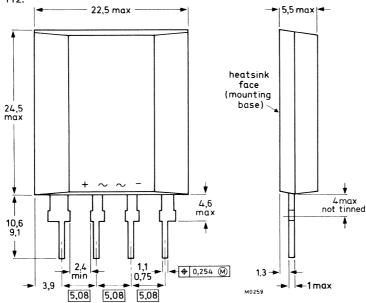
#### QUICK REFERENCE DATA

-	BY224	-400	600 V
VI(RMS)	max.	220	280 V
$v_{IRM}$	max.	400	600 V
ISM	max.		100 A
IIIM	max.		200 A
lO(AV)	max.		4,8 A
	V <sub>IRM</sub> IISM IIIM	VIRM max. IISM max. IIIM max.	VIRM max. 400 IISM max. IIIM max.

## MECHANICAL DATA (see also Fig. 1a)

Dimensions in mm



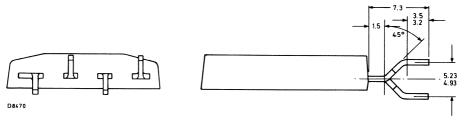


Net mass: 6,8 g

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	1–400	600	
Non-repetitive peak voltage ( $t \le 10 \text{ ms}$ )	$v_{ISM}$	max.	400	600	٧
Repetitive peak voltage	$v_{IRM}$	max.	400	600	٧
Crest working voltage	$\vee_{IWM}$	max.	350	400	٧
R.M.S. voltage (sine-wave)	VI(RMS)	max.	220	280	٧
Non-repetitive peak current half sine-wave; t = 20 ms; with reapplied V <sub>IWMmax</sub> $T_j = 25$ °C prior to surge $T_j = 150$ °C prior to surge	ISM ISM	max. max.		100 85	
Peak inrush current (see Fig. 6)	IIIM	max.		200	Α
Output					
Average current (averaged over any 20 ms period; see Figs 2 and 3) heatsink operation up to T <sub>mb</sub> = 90 °C free-air operation at T <sub>amb</sub> = 45 °C;	I <sub>O(AV)</sub>	max.		4,8	Α
(mounting method 1a)	lo(AV)	max.		2,5	Α
Repetitive peak current	IORM	max.		50	Α
Temperatures					
Storage temperature	$T_{stg}$		-40 to	+150	οС
Junction temperature	$T_{j}^{T}$	max.		150	οС

#### THERMAL RESISTANCE

From junction to mounting base

$$R_{th j-mb} = 4.0 \text{ }^{\circ}\text{C/W}$$

#### Influence of mounting method

1. Free-air operation

The quoted values of R<sub>th j-a</sub> 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<sup>2</sup> of copper laminate to + and - leads

 $R_{th i-a} = 19,5 \, {}^{\circ}C/W$ 

b. Mounted on a printed-circuit board with minimal copper laminate

 $R_{th i-a} = 25 \text{ }^{\circ}\text{C/W}$ 

2. Heatsink mounted with clip (see mounting instructions)

Thermal resistance from mounting base to heatsink

a. With zinc-oxide heatsink compound

 $R_{th mb-h} = 1.0 \text{ }^{\circ}\text{C/W}$ 

b. Without heatsink compound

 $R_{th mb-h} = 2.0 \text{ oC/W}$ 

#### 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.
- 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).
- 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)

 $I_F = 10 \text{ A}; T_j = 25 \text{ }^{\circ}\text{C}$ 

V<sub>F</sub> < 2,3 V\*

Reverse current (2 diodes in parallel) V<sub>R</sub> = V<sub>IWMmax</sub>; T<sub>i</sub> = 25 °C

1<sub>R</sub>

200 μA

<sup>\*</sup> Measured under pulse conditions to avoid excessive dissipation.

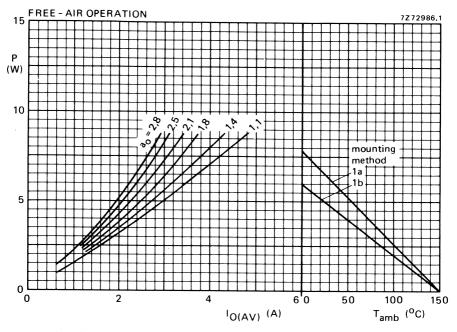


Fig. 2 The right-hand part shows the interrelationship between the power (derived from the left-hand graph) and the maximum permissible ambient temperature.

Output form factor  $a_0 = I_{O(RMS)}/I_{O(AV)} = 0.707 \times I_{F(RMS)}/I_{F(AV)}$  per diode.

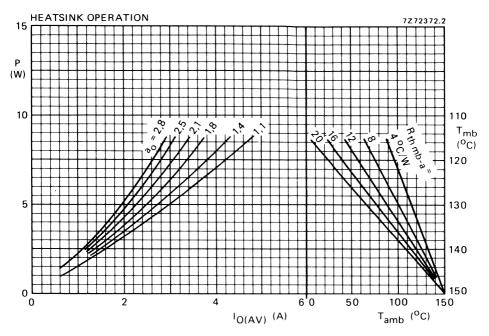


Fig. 3 The right-hand part shows the interrelationship between the power (derived from the left-hand graph) and the maximum permissible temperatures.

Output form factor  $a_0 = I_{O(RMS)}/I_{O(AV)} = 0.707 \times I_{F(RMS)}/I_{F(AV)}$  per diode.

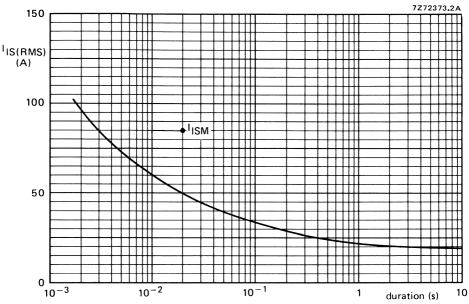


Fig.4 Maximum permissible non-repetitive r.m.s. input current based on sinusoidal currents (f = 50 Hz); T<sub>i</sub> = 150 °C prior to surge; with reapplied V<sub>IWMmax</sub>. <sup>1</sup>IS

- IS(RMS)

time

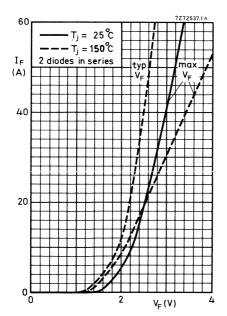
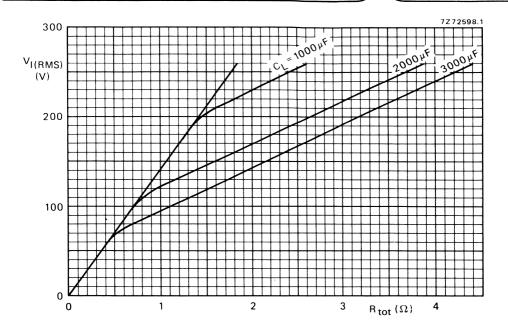
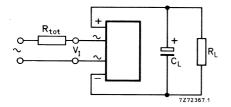


Fig.5



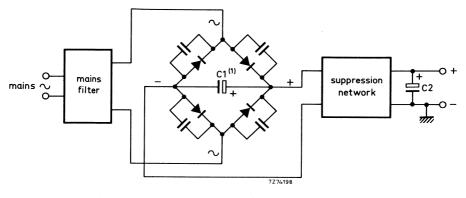


The graph takes the possibility of the following spreads into account:

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

Fig. 6 Minimum value of the total series resistance  $R_{\mbox{tot}}$  (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  $\mu$ F, 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.

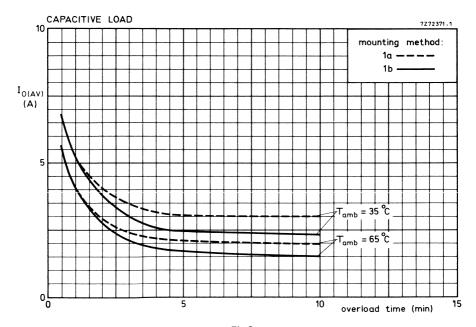


Fig.8

## SILICON BRIDGE RECTIFIERS

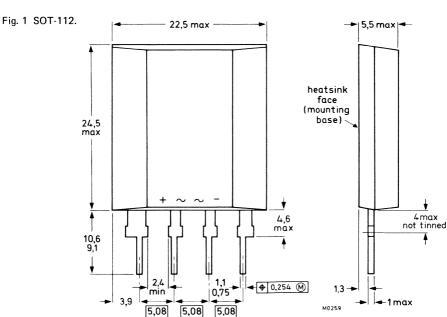
Ready-for-use full-wave bridge rectifiers in a plastic encapsulation. The bridges are intended for use in equipment supplied from a.c. with r.m.s. voltages up to 80 V and are capable of delivering output currents up to 4,8 A. They are also suitable for use in hi-fi audio equipments and low-voltage industrial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

#### QUICK REFERENCE DATA

Input		BY225	-100	200
R.M.S. voltage	VI(RMS)	max.	50	80 V
Repetitive peak voltage	VIRM	max.	100	V
Non-repetitive peak current	ISM	max.		100 A
Peak inrush current	IIIM	max.		200 A
Output				
Average current	IO(AV)	max.		4,8 A

#### **MECHANICAL DATA**

Dimensions in mm



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).

## BY225 SERIES

## **RATINGS**

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

Input		BY225	5–100	200	
Non-repetitive peak voltage (t ≤ 10 ms)	V <sub>ISM</sub>	max.	100	200	V
Repetitive peak voltage	VIRM	max.	100	200	٧
Crest working voltage	$v_{IWM}$	max.	70	112	٧
R.M.S. voltage (sine-wave)	V <sub>I</sub> (RMS)	max.	50	80	٧
Non-repetitive peak current; half sine-wave; $t = 20$ ms; with reapplied $V_{IWMmax}$ $T_j = 25$ °C prior to surge $T_j = 150$ °C prior to surge	IISM IISM	max. max.		100 85	
Peak inrush current (see Fig. 6)	IIIM	max.		200	Α
Output					
Average current (averaged over any 20 ms period; see Figs 2 and 3)					
heatsink operation up to T <sub>mb</sub> = 115 °C	lO(AV)	max.		4,8	Α
heatsink operation at T <sub>mb</sub> = 125 °C	lo(AV)	max.		3,6	Α
free-air operation at $T_{amb} = 45  {}^{\circ}\text{C}$ ; (mounting method 1a)	l <sub>O(AV)</sub>	max.		3,2	Α
Repetitive peak current	IORM	max.		50	Α
Temperatures					
Storage temperature	$T_{stg}$		-40 to	+150	$^{\rm oC}$
Junction temperature	Tj	max.		150	oC

#### THERMAL RESISTANCE

From junction to mounting base

R<sub>th j-mb</sub>

4.0 °C/W

#### Influence of mounting method

1. Free-air operation

The quoted values of  $R_{th\ j-a}$  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<sup>2</sup> of copper laminate to + and - leads

 $R_{th j-a} = 19.5 \text{ }^{\circ}\text{C/W}$ 

b. Mounted on a printed-circuit board with minimal copper laminate

- $R_{th i-a} = 25 \text{ }^{\circ}\text{C/W}$
- 2. Heatsink mounted with clip (see mounting instructions)

Thermal resistance from mounting base to heatsink

a. With zinc-oxide heatsink compound

 $R_{th mb-h} = 1.0 \text{ °C/W}$ 

b. Without heatsink compound

 $R_{th mb-h} = 2.0 \text{ }^{\circ}\text{C/W}$ 

#### MOUNTING INSTRUCTIONS

- 1. Soldered joints must be at least 4 mm from the seal.
- The maximum permissible temperature of the soldering iron or bath is 270 °C; contact with the joint must not exceed 3 seconds.
- 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).
- 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)

$$I_F = 10 \text{ A}; T_i = 25 \text{ }^{\circ}\text{C}$$

Reverse current (2 diodes in parallel)

$$V_R = V_{IWMmax}$$
;  $T_j = 25 \text{ }^{\circ}\text{C}$ 

<sup>\*</sup> Measured under pulse conditions to avoid excessive dissipation.

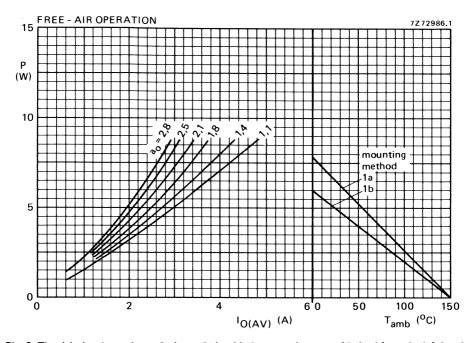


Fig. 2 The right-hand part shows the interrelationship between the power (derived from the left-hand graph) and the maximum permissible ambient temperature.

Output form factor  $a_0 = I_{O(RMS)}/I_{O(AV)} = 0.707 \times I_{F(RMS)}/I_{F(AV)}$  per diode.

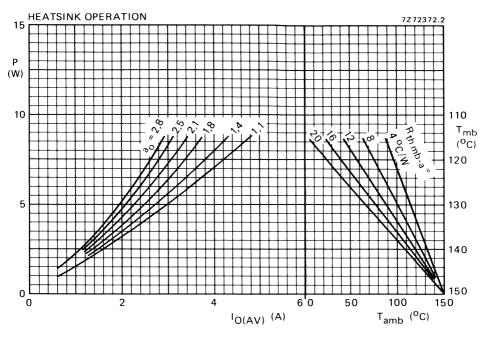


Fig. 3 The right-hand part shows the interrelationship between the power (derived from the left-hand graph) and the maximum permissible temperatures.

Output form factor  $a_0 = I_{O(RMS)}/I_{O(AV)} = 0.707 \times I_{F(RMS)}/I_{F(AV)}$  per diode.

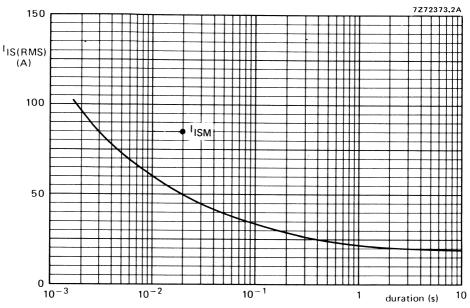
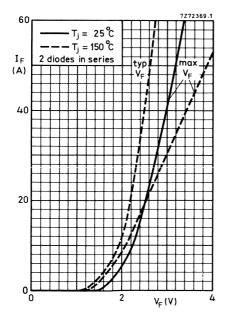


Fig. 4 Maximum permissible non-repetitive r.m.s. input current based on sinusoidal currents (f = 50 Hz);  $T_j = 150$  °C prior to surge; with reapplied  $V_{IWMmax}$ .



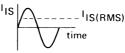


Fig. 5.

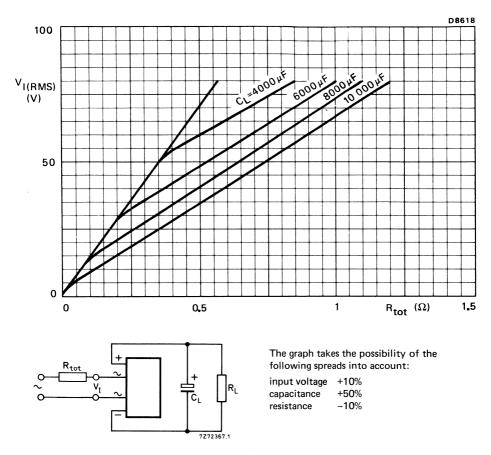
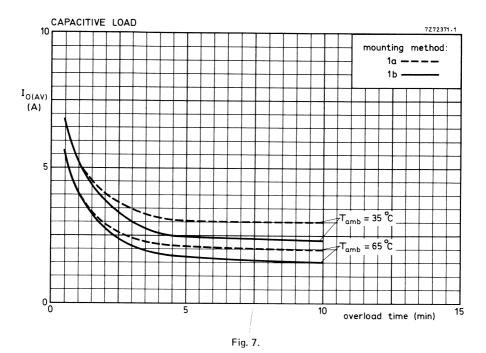


Fig. 6 Minimum value of the total series resistance  $R_{\mbox{tot}}$  (including the transformer resistance) required to limit the peak inrush current.



## 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.

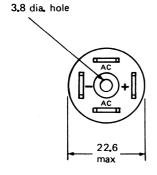
#### QUICK REFERENCE DATA

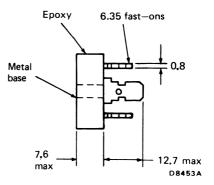
Input		BY260-200	400   600	
R.M.S. voltage	V <sub>I(RMS)</sub>	max. 140	280 420	V
Repetitive peak voltage	V <sub>IRM</sub>	max. 200	400 600	V
Non-repetitive peak current	ISM	max.	125	A
Peak inrush current	IIIM		250	A
Output Average current	lO(AV)	max.	12	A

#### **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 $\leq$ 10 ms)	V <sub>ISM</sub>	max.	200	400	600	V
Repetitive peak voltage	$v_{IRM}$	max.	200	400	600	V
Crest working voltage	VIWM	max.	200	400	600	٧
R.M.S. voltage (sine-wave)	V <sub>I(RMS)</sub>	max.	140	280	420	V
Non-repetitive peak current half-sinewave; t = 20 ms; with reapplied V <sub>IW</sub>	Mmax			·		
T <sub>i</sub> = 25 <sup>o</sup> C prior to surge		ISM	max.	12	25	Α
T <sub>j</sub> = 150 <sup>o</sup> C prior to surge		ISM	max.	10	00	Α
Peak inrush current (see Fig. 5)		IIM	max.	2	50	Α
Output						
Average current (averaged over any 20 ms perion heatsink operation up to T <sub>mb</sub> = 60 °C (R-loa heatsink operation up to T <sub>mb</sub> = 60 °C (C-loa	ad)	<sup>I</sup> O(AV) <sup>I</sup> O(AV)	max. max.		12 .5	A A
Repetitive peak current		IORM	max.	2	20	Α
Temperatures						
Storage temperature		T <sub>stq</sub>	-5	5 to +15	0	°C
Junction temperature		Tj	max.	15	50	οС
THERMAL RESISTANCE						
From junction to mounting base		R <sub>th j-mb</sub>	=	4	.5	°C/W
CHARACTERISTICS						
Forward voltage (2 diodes in series) I <sub>F</sub> = 7 A; T <sub>j</sub> = 25 °C		٧ <sub>F</sub>	<	2	.0	V*
Reverse current (2 diodes in parallel) $V_R = V_{IWMmax}; T_j = 100 ^{\circ}\text{C}$		I <sub>R</sub>	<	15	50	μΑ

<sup>\*</sup>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.

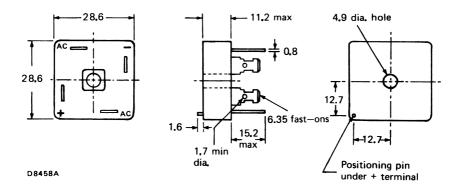
## **QUICK REFERENCE DATA**

Input		BY261-	-200	400	600	
R.M.S. voltage Repetitive peak voltage	V <sub>I(RMS)</sub> V <sub>IRM</sub>	max.	140 200	280 400	420 600	V V
Non-repetitive peak current Peak inrush current	I <sub>ISM</sub>	max. max.		320 640		A A
Output Average current	I <sub>O</sub> (AV)	max.		25		Α

#### **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 ≤ 10 ms)	V <sub>ISM</sub>	max.	200	400	600	٧
Repetitive peak voltage	VIRM	max.	200	400	600	V
Crest working voltage	VIWM	max.	200	400	600	V
R.M.S. voltage (sine-wave)	V <sub>I(RMS)</sub>	max.	140	280	420	<b>V</b>
Non-repetitive peak current half sinewave; t = 20 ms; with reapplied V	'IWMmax					
T <sub>j</sub> = 25 <sup>o</sup> C prior to surge		ISM	max.		20	Α
$T_j' = 150$ °C prior to surge		<sup>l</sup> ISM	max.	2	50	Α
Peak inrush current (see Fig. 5)		IIIM	max.	6	40	Α
Output						
Average current (averaged over any 20 ms pe						
heatsink operation; up to T <sub>mb</sub> = 55 °C (F	R-load)	O(AV)	max.		25 18	A A
heatsink operation; up to $T_{mb} = 55$ °C (C	J-10ad)	lO(AV)	max.		10	A
Repetitive peak current		IORM	max.		75	Α
Temperatures						
Storage temperature		$T_{stg}$	-5	55 to +1	75	°C
Junction temperature		Tj	max.	1	75	oC
THERMAL RESISTANCE						
From junction to mounting base		$R_{th\ j\text{-}mb}$	=	2	2.5	oC/M
CHARACTERISTICS						
Forward voltage (2 diodes in series) $I_F = 12 \text{ A}; T_j = 25 ^{\circ}\text{C}$		VF	<	2	2.3	V*
Reverse current (2 diodes in parallel)				_		
$V_R = V_{IWMmax}$ ; $T_j = 100  {}^{\circ}C$		<sup>I</sup> R	<	2	00	μΑ

<sup>\*</sup>Measured under pulse conditions to avoid excessive dissipation.

# **FAST RECTIFIER DIODES**



## FAST SOFT-RECOVERY RECTIFIER DIODES

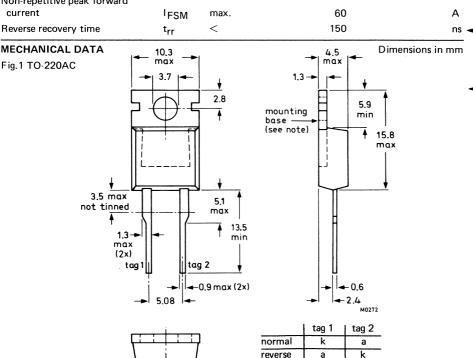


Glass-passivated double-diffused rectifier diodes in plastic envelopes, featuring fast reverse recovery times and non-snap-off characteristics. They are intended for use in chopper applications as well as in switched-mode power supplies, as efficiency diodes and scan rectifiers in television receivers,

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 Non-repetitive peak forward	I <sub>F(AV)</sub>	max.			7		Α
current	I <sub>FSM</sub>	max.			60		Α
Reverse recovery time	t <sub>rr</sub>	<			150		ns 🚤



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.

## **BY229 SERIES**

#### **RATINGS**

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

	Voltages*		BY229	9-200(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	٧
	Currents							
	Average forward current assuming zero switching losses							
	square-wave; $\delta = 0.5$ ; up to $T_{mb} = 100$ °C	F(AV)	max.		7			Α
	square-wave; $\delta$ = 0.5; at T <sub>mb</sub> = 125 °C	F(AV)	max.		4.1 6.5			A A
	sinusoidal; up to T <sub>mb</sub> = 100 <sup>o</sup> C sinusoidal; at T <sub>mb</sub> = 125 <sup>o</sup> C	lF(AV) lF(AV)	max. max.		4			A
	R.M.S. forward current	F(RMS)	max.		10			Α
-	Repetitive peak forward current $t_p = 20 \mu s$ ; $\delta \le 0.02$	FRM	max.		135			Α
	Non-repetitive peak forward current t = 10 ms;half sine-wave; T <sub>i</sub> = 150 °C prior to surge;							
	with reapplied V RWM max	<sup>I</sup> FSM	max.		60			Α
-	$I^2$ t for fusing (t = 10 ms)	l²t	max.		18			$A^2s$
	Temperatues							
	Storage temperature	$T_{stg}$		-40	to +150			oC
	Junction temperature	Tj	max.		150			oC

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

THERMAL RESISTANCE				
From junction to mounting base	R <sub>th j-mb</sub>	-	4.5	K/W
Influence of mounting method				
1. Heatsink-mounted with clip (see mour	iting instructions)			
Thermal resistance from mounting base to	heatsink			
a. with heatsink compound	R <sub>th mb-h</sub>	=	0.3	K/W
<ul> <li>with heatsink compound and 0.06 mm insulator</li> </ul>	ı maximum mica R <sub>th mb-h</sub>	=	1.4	K/W
c. with heatsink compound and 0.1 mm insulator (56369)	maximum mica R <sub>th</sub> mb-h	. =	2.2	K/W
<li>d. with heatsink compound and 0.25 mm alumina insulator (56367)</li>	n maximum R <sub>th mb-h</sub>	=	0.8	K/W
e. without heatsink compound	R <sub>th mb-h</sub>	=	1.4	K/W
2. Free air operation				
The quoted value of R <sub>th j-a</sub> should be use to the same tie point.  Thermal resistance from junction to amble mounted on a printed circuit board at any	ent in free air:	ing coi	mponent	ts run
length and with copper laminate on the bo	pard R <sub>th j-a</sub>	=	60	K/W

#### MOUNTING INSTRUCTIONS

- 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.
- 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<sub>th mb-h</sub> 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<sub>th mb-h</sub> 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 <sub>j</sub> = 25 °C unless otherwise specified					
Forward voltage		VF	<	1.85	V*
Reverse current					
$V_R = V_{RWMmax}$ ; $T_i = 125  {}^{\circ}C$	normal polarity	<sup>I</sup> R	<	0.4	mA
,	reverse polarity	I <sub>R</sub>	<	0.6	mΑ
Reverse recovery when switched from $I_F = 1 \text{ A to V}_R \geqslant 30 \text{ V with } -dI_F/\text{recovery time}$		t <sub>rr</sub>	<	150	ns 🖛
$I_F = 2 \text{ A to } V_R \geqslant 30 \text{ V with } -dI_F/$	dt = 20 A/us	••			
recovered charge	ατ 20 Α/μ3	$Q_s$	<	0.7	$\muC$
Maximum slope of the reverse recover	y current				
$I_F = 2 A$ , $-dI_F/dt = 20 A/\mu s$	normal polarity	dl <sub>R</sub> /dt	<	60	A/μs
	reverse polarity	dl <sub>R</sub> /dt	<	75	A/μs

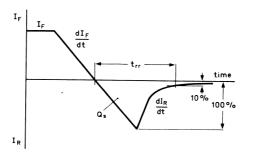


Fig.3 Definition of  $t_{\mbox{\scriptsize rr}}$  and  $Q_{\mbox{\scriptsize S}}.$ 

D8403

<sup>\*</sup>Measured under pulse conditions to avoid excessive dissipation.

#### **SQUARE-WAVE OPERATION**

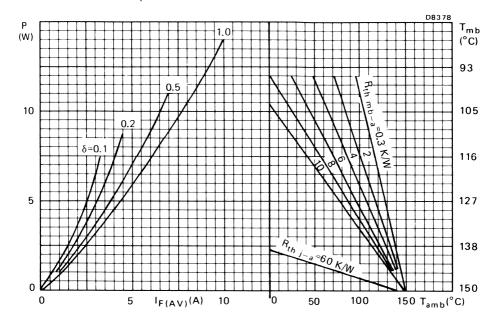


Fig. 4 The right-hand part shows the interrelationship between the power (derived from the left-hand part) and the maximum permissible temperatures.

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

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

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

#### SINUSOIDAL OPERATION

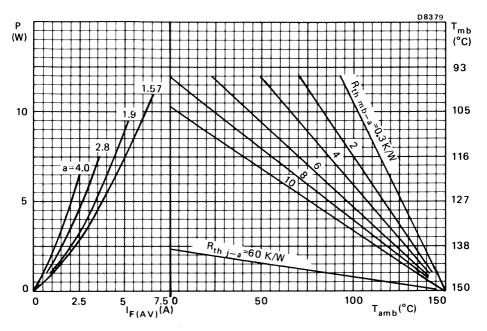
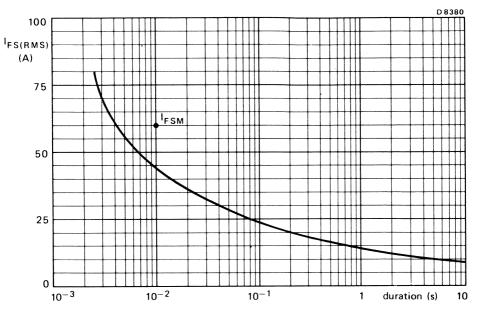


Fig. 5 The right-hand part shows the interrelationship between the power (derived from the left-hand part) and the maximum permissible temperatures.

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

a = form factor = IF(RMS)/IF(AV).



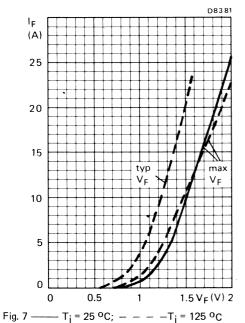
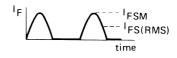


Fig. 6 Maximum permissible non-repetitive r.m.s. forward current based on sinusoidal currents (f = 50 Hz);  $T_j$  = 150 °C prior to surge; with reapplied  $V_{RWMmax}$ .



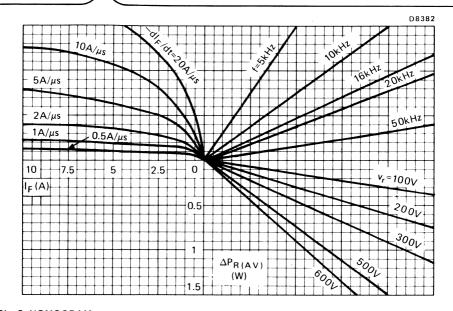
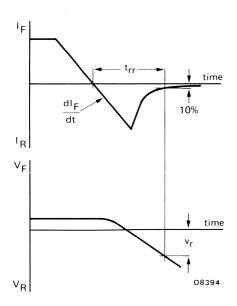
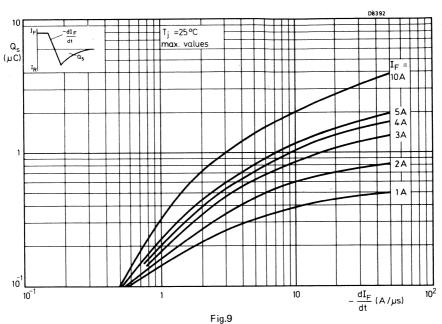
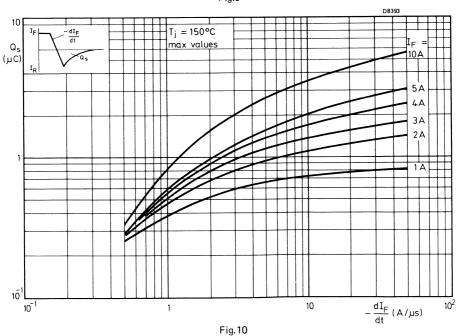
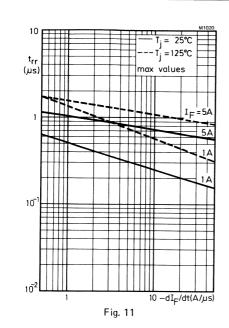


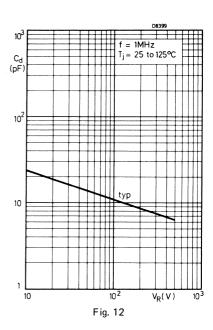
Fig. 8 NOMOGRAM Power loss  $\triangle P_{R(AV)}$  due to switching only (to be added to steady state power losses). I<sub>F</sub> = forward current just before switching off; T<sub>j</sub> = 150 °C

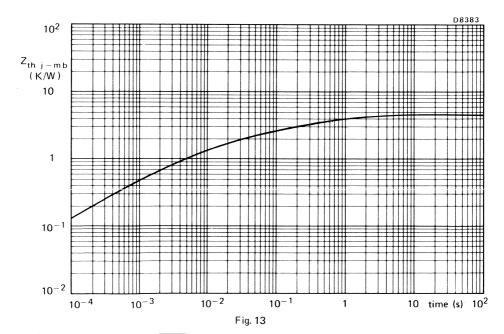












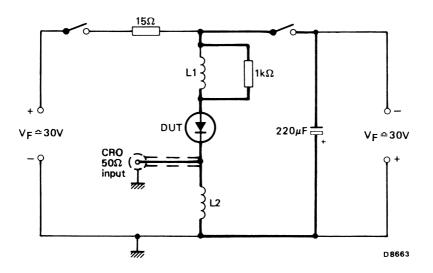


Fig.14 Simplified circuit diagram of practical apparatus to test softness of recovery.

#### **NOTES**

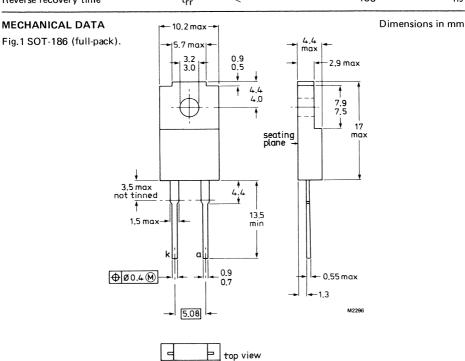
- 1. Duty factor of forward current should be low, <2%.
- 2. dI<sub>F</sub>/dt is set by L1, 1.5  $\mu$ H gives 20 A/ $\mu$ s
- 3. dI<sub>B</sub>/dt is measured across L2, 200 nH gives  $5A/\mu$ s/V.
- 4. Wiring shown in heavy should be kept as short as possible.

# 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

		BY229	9F-200	400	600	800	
Repetitive peak reverse voltage	$V_{RRM}$	max.	200	400	600	800	<b>V</b>
Average forward current	I <sub>F(AV)</sub>	max.			7		Α
Non-repetitive peak forward current	<sup>I</sup> FSM	<		6	0		Α
Reverse recovery time	t <sub>rr</sub>	<		15	0		ns 🚤



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).

# BY229F SERIES

#### **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 °C sinusoidal; up to $T_{hs}$ = 93 °C		IF(AV) IF(AV)		max. max.	7 6.25		A A
R.M.S. forward current		IF(RMS)		max.	10		Α
Repetitive peak forward current $t_p = 20 \mu s$ ; $\delta = 0.02$		I <sub>FRM</sub>		max.	135		Α
Non-repetitive peak forward current half sine-wave; T <sub>j</sub> = 150 <sup>o</sup> C prior to surge; with reapplied V <sub>RWM max</sub>							
t = 10 ms		<sup>I</sup> FSM		max.	60		Α
t = 8.3 ms		<sup>i</sup> FSM		max.	65		Α
$I^2$ t for fusing (t = 10 ms)		l²t		max.	18		A <sup>2</sup> s
Temperatures							
Storage temperature		$T_{stg}$		<b>40</b>	to +150		oC
Junction temperature		$T_{j}$		max.	150		oC
ISOLATION							
Peak isolation voltage from all terminals to external heatsink		V <sub>isol</sub>		max.	1000		V
Isolation capacitance from cathode to external heatsink (Note 3)		Cp		typ.	12		рF

#### Notes

- 1. To ensure thermal stability:  $R_{\mbox{th}\mbox{ }j\mbox{-}a}$  < 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 ambient

#### THERMAL RESISTANCE

#### Free-air operation

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

in free air, mounted on a printed circuit board	R <sub>th j-a</sub>	=	55	K/W
CHARACTERISTICS				
T <sub>j</sub> = 25 °C unless otherwise specified				
Forward voltage I <sub>F</sub> = 20 A	VF	<	1.85	V*
Reverse current $V_R = V_{RWM max}$ ; $T_j = 125 ^{\circ}\text{C}$	I <sub>R</sub>	<	0.4	mA
Reverse recovery when switched from $I_F = 1 \text{ A to V}_R \geqslant 30 \text{ V with } -dI_F/dt = 50 \text{ A}/\mu\text{s}$ , recovery time	t <sub>rr</sub>	<	150	ns 🖜
$I_F = 2 \text{ A to } V_R \geqslant 30 \text{ V with } -dI_F/dt = 20 \text{ A}/\mu\text{s}$ recovered charge	$Q_{s}$	<	0.7	μC
Maximum slope of the reverse recovery current $I_F = 2 A$ , $-dI_F/dt = 20 A/\mu s$	dl <sub>R</sub> /dt	<	60	A/μs

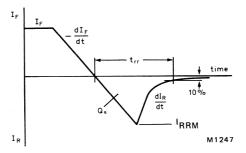


Fig.2 Definition of  $t_{rr}$  and  $\Omega_s$ .

<sup>\*</sup>Measured under pulse conditions to avoid excessive dissipation.

#### MOUNTING INSTRUCTIONS

Maximum torque to avoid damage to the device:

- 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<sub>th j-h</sub> 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
- 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)
- 5. For good thermal contact, heatsink compound should be used between baseplate and heatsink. Values of R<sub>th j-h</sub> given for mounting with heatsink compound refer to the use of a metallic-oxide loaded compound. Ordinary silicone grease is not recommended.

8.0 kgf (0.80 Nm)

- 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.

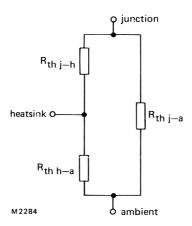


Fig.3.

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

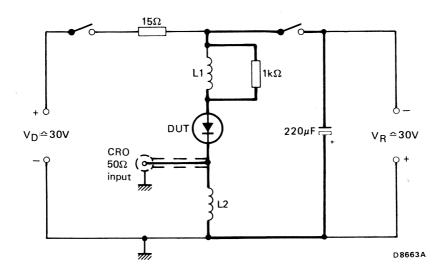


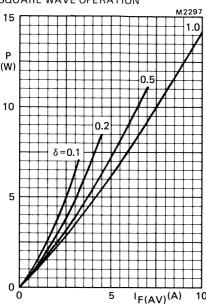
Fig.4 Simplified circuit diagram of practical apparatus to test softness of recovery.

#### NOTES

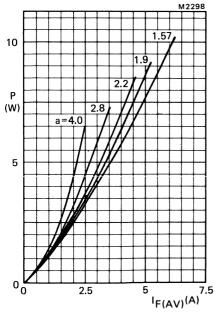
- 1. Duty factor of forward current should be low, < 2%.
- 2. dI<sub>F</sub>/dt is set by L1, 1.5  $\mu$ H gives 20 A/ $\mu$ s.
- 3. dI<sub>R</sub>/dt is measured across L2, 200 nH gives 5 A/ $\mu$ s/V.
- 4. Wiring shown in heavy should be kept as short as possible.

# **BY229F SERIES**

#### SQUARE-WAVE OPERATION



#### SINUSOIDAL OPERATION



#### Fig.5 Power rating.

The power loss in the diode should first be determined from the required forward current on the I<sub>F(AV)</sub> 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.

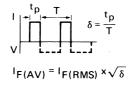


Fig.6 Power rating.

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.

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

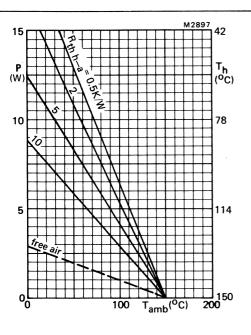


Fig.7 Heatsink rating; without heatsink compound.

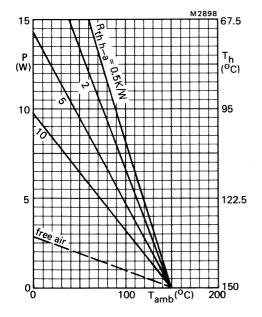


Fig.8 Heatsink rating; with heatsink compound.

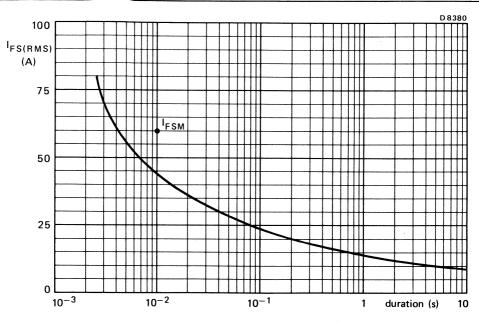


Fig.9 Maximum permissible non-repetitive r.m.s. forward current based on sinusoidal currents (f = 50 Hz);  $T_j$  = 150  $^{\rm OC}$  prior to surge; with reapplied  $V_{RWMmax}$ .

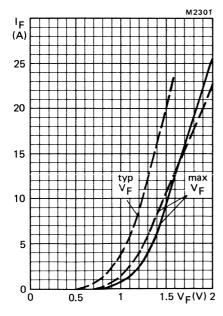




Fig.10 ——— 
$$T_j$$
 = 25 °C;  $--- T_j$  = 125 °C.

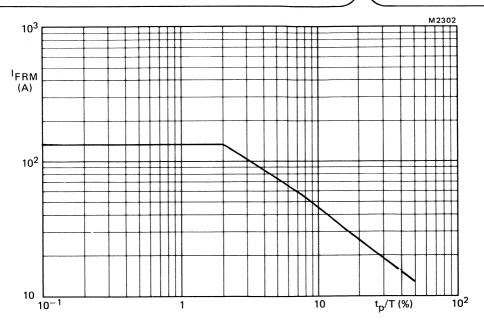
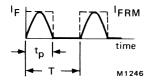


Fig.11 Maximum permissible repetitive peak forward current for square or sinusoidal currents; 1  $\mu$ s < t $_p$  < 1 ms.



Definition of IFRM and  $t_{\mbox{\footnotesize p}}/T$ .

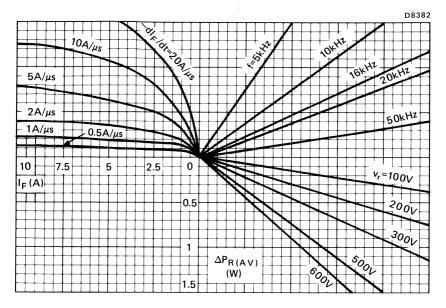
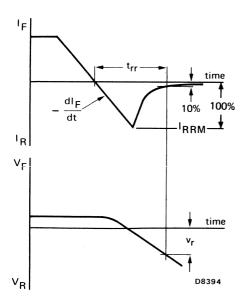
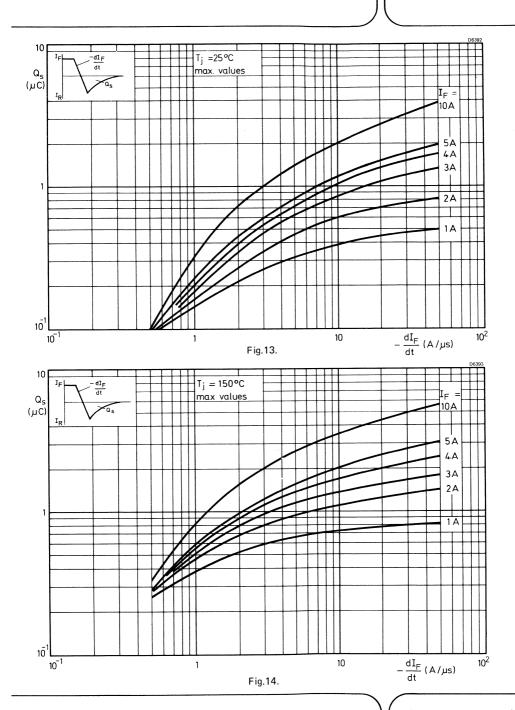
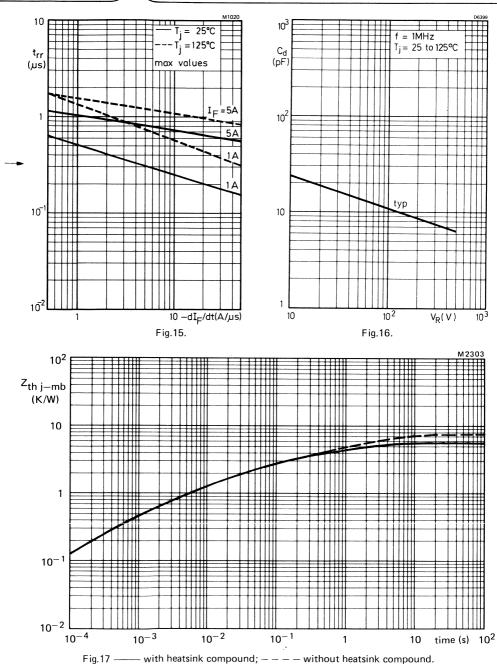


Fig.12 NOMOGRAM

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







# 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).

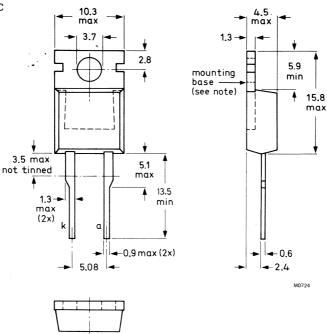
#### QUICK REFERENCE DATA

		BY329	-800	1000	1200	
Repetitive peak reverse voltage	$V_{RRM}$	max.	800	1000	1200	V
Average forward current	lF(AV)	max.		8		Α
Non-repetitive peak forward current	<sup>I</sup> FSM	max.		80		Α
Reverse recovery time	t <sub>rr</sub>	<		150		ns

#### MECHANICAL DATA

Dimensions in mm





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.

# BY329 SERIES

### **RATINGS**

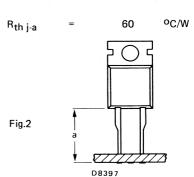
Limiting values in accordance with the Absolute Maximum System (IEC 134)

	Voltages		BY32	9-800	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 $T_{mb} = 108$ °C	F(AV)	max.		8		A
	square-wave; $\delta$ = 0.5; at T <sub>mb</sub> = 125 °C sinusoidal; up to T <sub>mb</sub> = 113 °C	F(AV)	max. max.		5.3 7		A A
	sinusoidal; at T <sub>mb</sub> = 125 °C	<sup>I</sup> F(AV) <sup>I</sup> F(AV)	max.		5.2		A
	R.M.S. forward current	F(RMS)	max.		11		Α
	Repetitive peak forward current	FRM	max.	*	80		Α
	Non-repetitive peak forward current: $t = 10 \text{ ms}$ half sine-wave; $T_j = 150 ^{\circ}\text{C}$ prior to surge;						
	with reapplied V <sub>RWM max</sub>	<sup>I</sup> FSM	max.		80		Α
-	$I^2$ t for fusing (t = 10 ms)	l²t	max.		32		$A^2 s$
	Temperatues						
	Storage temperature	$T_{stg}$		-40 t	o +150		oC
	Junction temperature	$T_{j}$	max.		150		oC
	THERMAL RESISTANCE						
	From junction to mounting base	R <sub>th j-mb</sub>	=		3.0		K/W
	Influence of mounting method						
	1. Heatsink mounted with clip (see mounting instruc-	tions)					
	Thermal resistance from mounting base to heatsink						
	a. with heatsink compound	R <sub>th mb-h</sub>	=		0.3		K/W
	b. with heatsink compound and 0.06 mm maximum mica insulator	R <sub>th mb-h</sub>	=		1.4		K/W
	c. with heatsink compound and 0.1 mm maximum mica insulator (56369)	R <sub>th mb-h</sub>	=		2.2		K/W
	d. with heatsink compound and 0.25 mm maximum						
	alumina insulator (56367)	R <sub>th mb-h</sub>	=		8.0		K/W
	e. without heatsink compound	R <sub>th mb-h</sub>	=		1.4		K/W

#### THERMAL RESISTANCE (continued)

#### 2. Free-air operation

The quoted value of  $R_{th\ j-a}$  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.



#### **CHARACTERISTICS**

Forward voltage $I_F = 20 \text{ A; } T_j = 25 ^{\circ}\text{C}$	VF	<	1.85	V*
Reverse current $V_R = V_{RWMmax}$ ; $T_j = 125$ °C	IR	<	1.0	mA
Reverse recovery when switched from $I_F = 2 \text{ A to V}_R \ge 30 \text{ V with } -dI_F/dt = 20 \text{ A/}\mu\text{s}; T_j = 25 \text{ °C}$ Recovered charge	$\Omega_{S}$	<	0.7	μC
I <sub>F</sub> = 1 A to $V_R \ge 30 V$ with $-dI_F/dt = 50 A/\mu s$ ; $T_j = 25 °C$ Recovery time	t <sub>rr</sub>	<	150	ns
Maximum slope of the reverse recovery current $I_F = 2 A; -dI_F/dt = 20 A/\mu s; T_i = 25  ^{O}C$	dl <sub>R</sub> /dt	<	60	A/μs

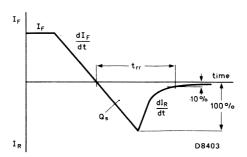


Fig.3 Definition of  $t_{\mbox{\scriptsize rr}}$  and  $Q_{\mbox{\scriptsize S}}$ 

<sup>\*</sup>Measured under pulse conditions to avoid excessive dissipation

#### MOUNTING INSTRUCTIONS

- 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<sub>th mb-h</sub> 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<sub>th mb-h</sub> 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

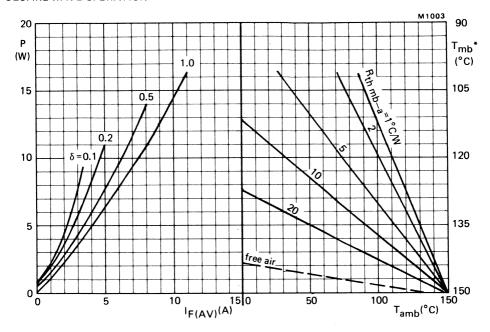


Fig.4 The right-hand part shows the interrelationship between the power (derived from the left-hand part) and the maximum permissible temperatures.

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

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

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

 $<sup>^*</sup>T_{mb}$  scale is for comparison purposes and is correct only for R  $_{th\ mb\text{-}a}\!<\!10^o\text{C/W}.$ 

#### SINUSOIDAL OPERATION

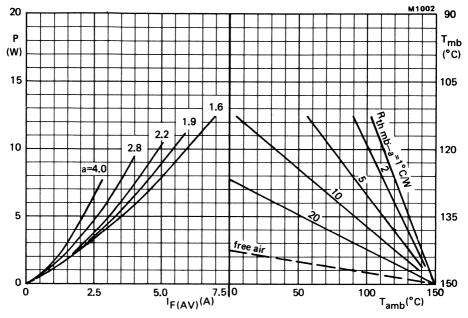


Fig.5 The right-hand part shows the interrelationship between the power (derived from the left-hand part) and the maximum permissible temperatures.

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

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

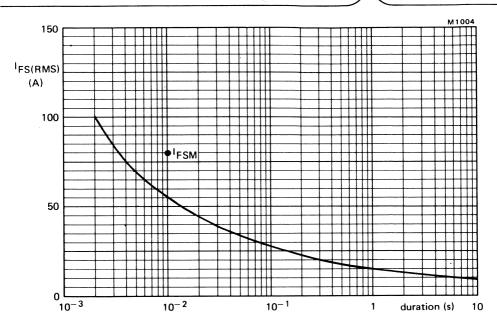
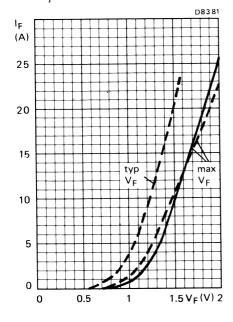


Fig.6 Maximum permissible non-repetitive r.m.s. forward current based on sinusoidal currents (f = 50 Hz);  $T_i$  = 150 °C prior to surge; with reapplied  $V_{RWMmax}$ .



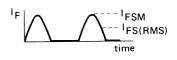


Fig.7 -----T<sub>j</sub> = 25 °C; 
$$---$$
T<sub>j</sub> = 125 °C

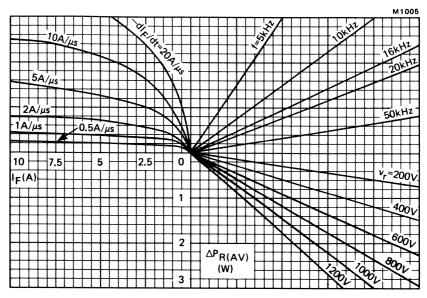
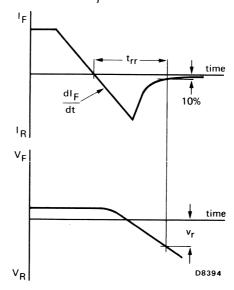
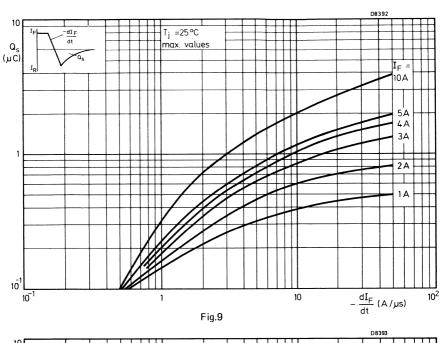
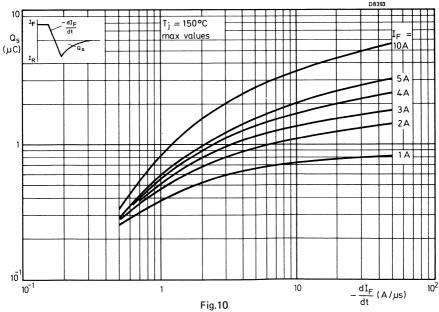


Fig.8 NOMOGRAM

Power loss  $\triangle P_{R(AV)}$  due to switching only (to be added to steady state power losses). I<sub>F</sub> = forward current just before switching off;  $T_i$  = 150 °C







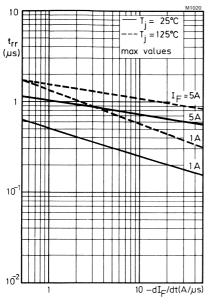
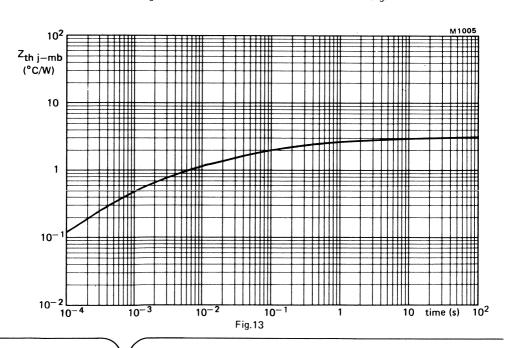


Fig.11

Fig.12



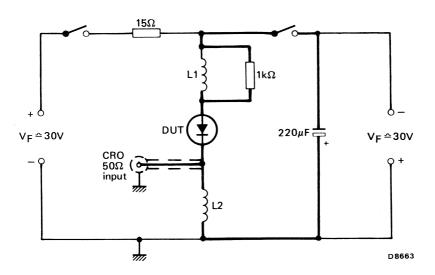


Fig.14 Simplified circuit diagram of practical apparatus to test softness of recovery.

#### **NOTES**

- 1. Duty factor of forward current should be low, <2%.
- 2. dI<sub>F</sub>/dt is set by L1, 1.5  $\mu$ H gives 20 A/ $\mu$ s.
- 3.  $dI_R/dt$  is measured across L2, 200 nH gives  $5A/\mu s/V$ .
- 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).

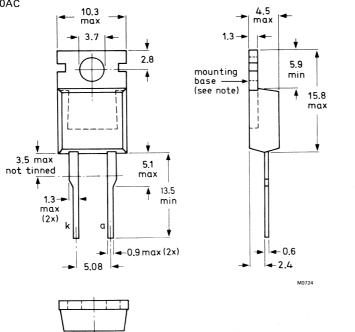
#### QUICK REFERENCE DATA

		BY359	-1000	1300	1500	
Repetitive peak reverse voltage	$v_{RRM}$	max.	1000	1300	1500	V
Average forward current	IF(AV)	max.		6.5		Α
Non-repetitive peak forward current	<sup>I</sup> FSM	max.		60		Α
Reverse recovery time	t <sub>rr</sub>	<		0.6		μs

#### **MECHANICAL DATA**

Dimensions in mm





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)

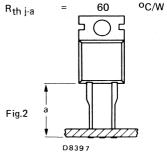
Voltages*						
Voitages		BY359-	-1000	1300	1500	
Non-repetitive peak reverse voltage	$V_{RSM}$	max.	1100	1500	1650	
Repetitive peak reverse voltage	V <sub>RRM</sub>	max.	1000	1300	1500	٧
Crest working reverse voltage	$v_{RWM}$	max.	800	1200	1300	٧
Continuous reverse voltage	$V_{R}$	max.	600	750	800	V
Currents				,		
Average forward current assuming zero switching losses sinusoidal;						
up to T <sub>mb</sub> = 94 °C		IF(AV)	m	ax.	6.5	Α
R.M.S. forward current		IF(RMS	) ma	ax.	10	Α
Repetitive peak froward current		IFRM	m:	ax.	60	Α
Non-repetitive peak forward current: t = 10 ms half sine-wave; T <sub>j</sub> = 125 °C prior to surge;						
with reapplied V <sub>RWM max</sub>		IFSM	m	ax.	60	Α
Temperatures						
Storage temperature		$T_{stg}$		-40 to +	150	oC
Junction temperature		Tj	ma	ax.	125	oC
THERMAL RESISTANCE						
From junction to mounting base		R <sub>th j-mb</sub>	=		3.0	oC/W
Influence of mounting method						
1. Heatsink mounted with clip (see mounting ins	structions)					
Thermal resistance from mounting base to heats	ink					
a. with heatsink compound		R <sub>th mb-l</sub>	h =		0.3	oC/W
b. with heatsink compound and 0.06 mm maxim mica insulator	num	Rth mb-l			1.4	oC/W
c. with heatsink compound and 0.1 mm maximu mica insulator (56369)	ım	R <sub>th mb-l</sub>	h =		2.2	oC/W
d. with heatsink compound and 0.25 mm maxim alumina insulator (56367)	num	R <sub>th mb-l</sub>	h =		0.8	oC/W
e. without heatsink compound		R <sub>th mb-l</sub>			1.4	oC/W

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

#### THERMAL RESISTANCE (continued)

#### 2. Free-air operation

The quoted value of  $R_{\mbox{\scriptsize th}}$   $_{\mbox{\scriptsize $j$-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



#### CHARACTERISTICS

Forward voitage					
$I_F = 20 \text{ A; } T_j = 25 ^{\circ}\text{C}$					
Reverse current					

Reverse recovery when switched from

I<sub>F</sub> = 2 A to 
$$V_R \ge 30$$
 V with  $-dI_F/dt = 20$  A/ $\mu$ s;  $T_j = 25$  °C recovered charge recovery time

Forward recovery when switched to

$$I_F = 5$$
 A with  $t_r = 0.1 \mu s$ ;  $T_j = 25$  °C recovery time

Fig.2	a	8397	
VF	<	2.3	V*
IR	<	0.6	mA

tfr	<	1.0	μs

2.0

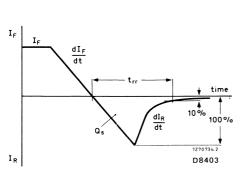
0.6

μC

μs

 $Q_s$ 

trr





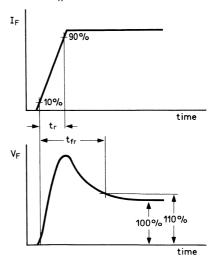


Fig.4 Definition of tfr.

<sup>\*</sup>Measured under pulse conditions to avoid excessive dissipation

## **BY359 SERIES**

#### MOUNTING INSTRUCTIONS

- 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.
- 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<sub>th mb-h</sub> 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<sub>th mb-h</sub> 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

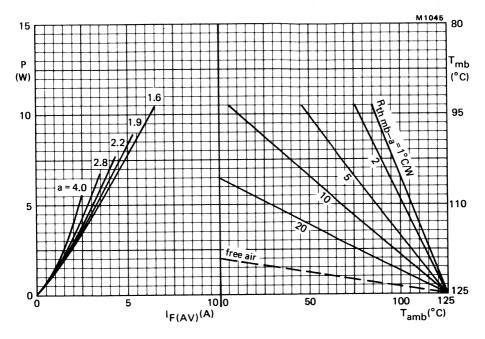


Fig.5 The right-hand part shows the interrelationship between the power (derived from the left-hand part) and the maximum permissible temperatures.

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

a = form factor = IF(RMS)/IF(AV).

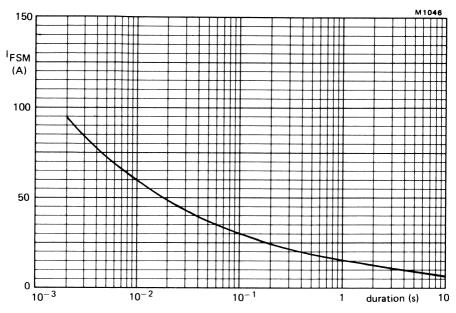


Fig.6 Maximum permissible non-repetitive peak forward current based on sinusoidal currents (f = 50 Hz);  $T_j$  = 125 °C prior to surge; with reapplied  $V_{RWMmax}$ .

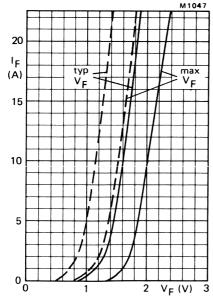




Fig.7 ——
$$T_j = 25 \text{ °C}; ----T_j = 100 \text{ °C}.$$

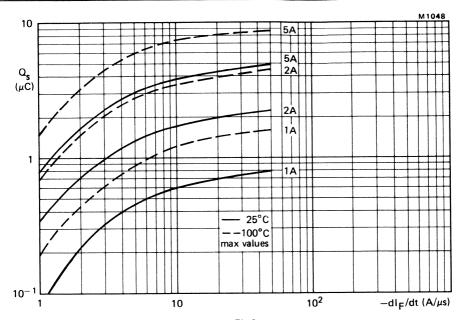


Fig.8

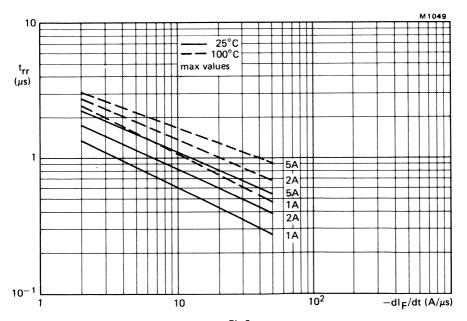


Fig.9

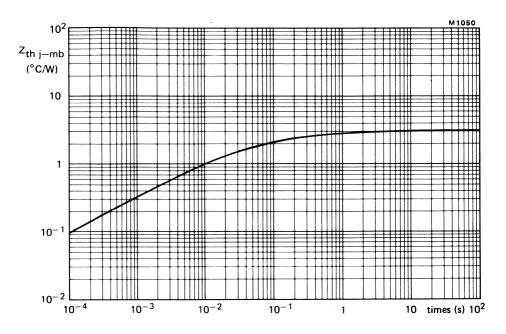


Fig.10

# 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

			BYP:	21-50	100	150	200	
Repetitive peak reverse voltage	$V_{RRM}$	max.		50	100	150	200	V
Average forward current	I <sub>F(AV)</sub>	max.	•			8		Α
Forward voltage	٧F	<			0.89	95		V
Reverse recovery time	t <sub>rr</sub>	<			2	25		ns
Reverse leakage current	IR	<				5		μΑ

### **MECHANICAL DATA** Dimensions in mm 10.3 4.5 Fig.1 TO-220AC max max 3.7 1.3 -5.9 mounting min base (see note) 15.8 max 3.5 max 5.1 not tinned max 13.5 1.3 min max (2x) 4-0.9 max (2x) -0.6 5.08 M0724

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.

# **BYP21 SERIES**

## **RATINGS**

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

Voltages			BYP21-50	1 100	l 150	1 200	
Repetitive peak reverse voltage	$V_{RRM}$	max.	50	100	150	200	V
Crest working reverse voltage	V <sub>RWM</sub>	max.	50	100	150	200	v
Continuous reverse voltage	VR	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 <sub>mb</sub> = 150 °C	<sup>I</sup> F(AV)	max.			8		Α
sinusoidal; up to T <sub>mb</sub> = 150 °C	IF(AV)	max.		9.	.4		A
R.M.S. forward current	IF(RMS)	max.		11.	.5		Α
Repetitive peak forward current $t_p = 20 \mu s$ ; $\delta = 0.02$	I <sub>FRM</sub>	max.		17	5		Α
Non-repetitive peak forward current half sine-wave; $T_j = 175$ °C prior to surge; with reapplied V <sub>RWMmax</sub>							
t = 10 ms	<sup>I</sup> FSM	max.		8	0		Α
t = 8.3 ms	<sup>I</sup> FSM	max.		10	0		Α
$I^2$ t for fusing (t = 10 ms)	l² t	max.		3	2		$A^2s$
Temperatures							
Storage temperature	$T_{stg}$		-65	5 to +17	5		οс
Junction temperature	тj	max.		17	5		οС

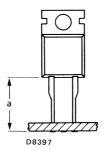
mounted on a printed circuit board at

a = any lead length

K/W

60

THERMAL RESISTANCE				
From junction to mounting base	R <sub>th j-mb</sub>	=	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 <sub>th mb-h</sub>	=	0.3	K/W
<ul> <li>with heatsink compound and 0.06 mm maximum mica insulator</li> </ul>	R <sub>th mb-h</sub>	=	1.4	K/W
c. with heatsink compound and 0.1 mm maximum mica washer (56369)	R <sub>th mb-h</sub>	=	2.2	K/W
<ul> <li>d. with heatsink compound and 0.25 mm maximum alumina insulator (56367)</li> </ul>	R <sub>th mb-h</sub>	=	0.8	K/W
e. without heatsink compound	R <sub>th mb-h</sub>	=	1.4	K/W
2. Free air operation				
The quoted values of $R_{th\ j\cdot a}$ should be used only when no lead to the same tie point.  Thermal resistance from junction to ambient in free air:	ds of other dissip	oating co	mponen	ts run

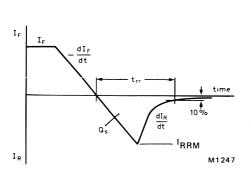


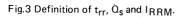
R<sub>th j-a</sub>

Fig.2

## **CHARACTERISTICS**

CHARACTERISTICS				
Forward voltage I <sub>F</sub> = 8 A; T <sub>i</sub> = 100 °C	V <sub>F</sub>	<	0.895	V*
I <sub>F</sub> = 8 A; T <sub>i</sub> = 25 °C	•	<	1.045	v V*
I <sub>F</sub> = 20 A; T <sub>i</sub> = 25 °C	V <sub>F</sub>			•
1F - 20 A, 1j - 25 °C	VF	<	1.15	V*
Reverse current				
$V_R = V_{RWMmax}$ ; $T_j = 175  {}^{\circ}C$	۱ <sub>R</sub>	<	500	μΑ
T <sub>j</sub> = 125 °C	I <sub>R</sub>	<	250	μΑ
T <sub>j</sub> = 100 °C	<sup>I</sup> R	< -	50	μΑ
$T_j = 25$ °C	IR	<	5	μΑ
Reverse recovery when switched from IF = 1 A to $V_R \ge 30$ V with $-dI_F/dt = 100$ A/ $\mu$ s; $T_j = 25$ °C; recovery time	t <sub>rr</sub>	<	25	ns
Step reverse recovery when switched from $I_F = 0.5 \text{ A to } I_R = 1 \text{ A}$ , measured at $I_{RR} = 0.25 \text{ A}$ ; recovery time	t <sub>rr</sub>	<	25	ns
$I_F$ = 2 A to $V_R$ $\geqslant$ 30 Vwith – $dI_F/dt$ = 20 A/ $\mu$ s; $T_j$ = 25 $^{o}$ C; recovered charge	$\Omega_{s}$	<	15	nC
I <sub>F</sub> = 10 A to $V_R \ge 30 V$ with $-dI_F/dt = 50 A/\mu s$ ; $T_j = 100  ^{\circ}C$ ; peak recovery current	<sup>I</sup> RRM	<	2	А
Forward recovery when switched to $I_F = 1$ A with $dI_F/dt = 10$ A/ $\mu$ s; $T_j = 25$ °C	$V_{fr}$	typ.	0.9	٧





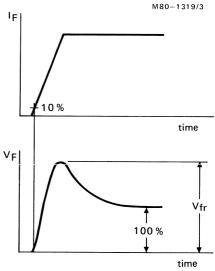


Fig.4 Definition of V<sub>fr</sub>.

<sup>\*</sup>Measured under pulse conditions to avoid excessive dissipation.

#### MOUNTING INSTRUCTIONS

- 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.
- 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<sub>th mb-h</sub> 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<sub>th mb-h</sub> given for mounting with heatsink compound refer to the use of a metallic oxide-loaded compound. Ordinary silicone grease is not recommended.
- 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:

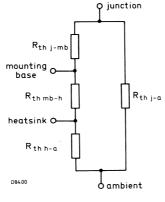


Fig.5

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  $I_{amb}$  scale. The intersection determines the  $R_{th\ mb-a}$ . The heatsink thermal resistance value  $(R_{th\ h-a})$  can now be calculated from:

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

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

## **BYP21 SERIES**

#### SQUARE-WAVE OPERATION

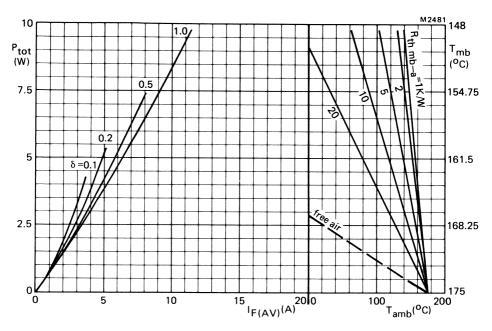


Fig.6 The right-hand part shows the relationship between the power (derived from the left-hand part) and the maximum permissible temperatures. Power includes reverse current losses and switching losses up to f = 500 kHz.

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

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

#### SINUSOIDAL OPERATION

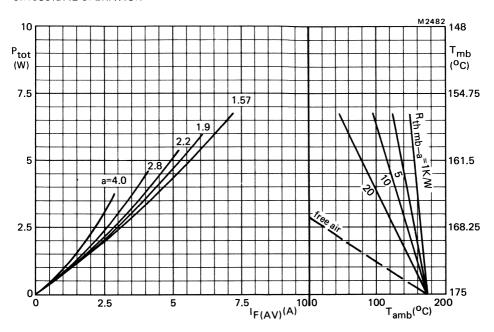


Fig.7 The right-hand part shows the interrelationship between the power (derived from the left-hand part) and the maximum permissible temperatures. a = form factor =  $I_{F(RMS)}/I_{F(AV)}$ .

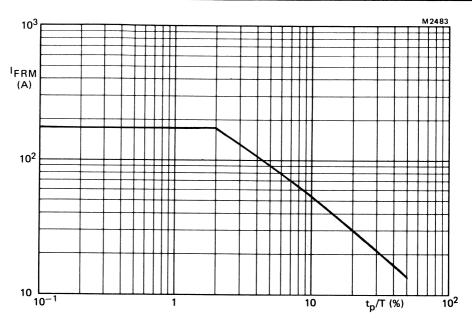
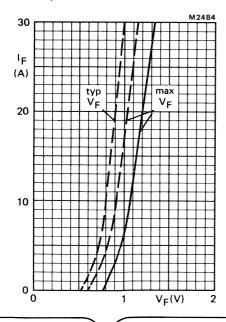
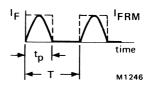


Fig.8 Maximum permissible repetitive peak forward current for square or sinusoidal currents; 1  $\mu s < t_p < 1$  ms.





Definition of IFRM and  $t_p/T$ .

Fig.9 — 
$$T_j = 25$$
 °C; —  $-T_j = 100$  °C.

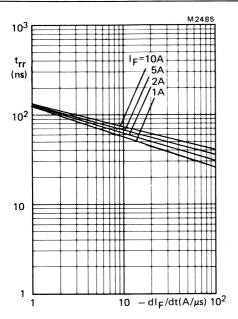


Fig. 10 Maximum  $t_{rr}$  at  $T_i = 25$  °C.

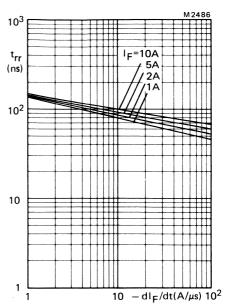


Fig.11 Maximum  $t_{rr}$  at  $T_j = 100$  °C.

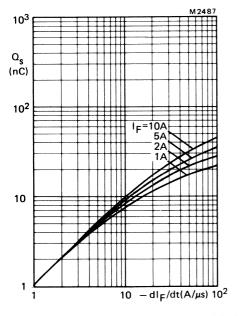


Fig. 12 Maximum  $Q_s$  at  $T_j$  = 25  $^{o}$ C.

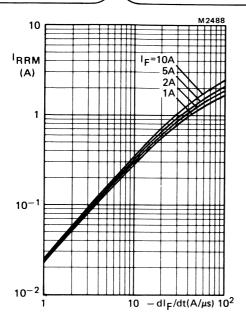


Fig.13 Maximum  $I_{RRM}$  at  $T_j$  = 25 °C.

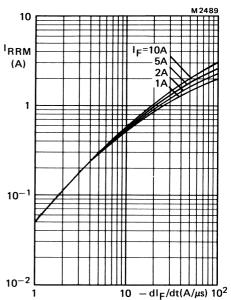


Fig.14 Maximum  $I_{RRM}$  at  $T_j = 100$  °C.

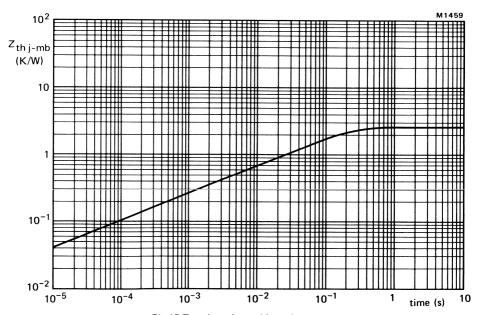


Fig.15 Transient thermal impedance.

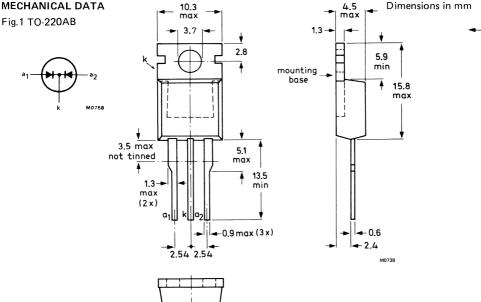
## ULTRA FAST-RECOVERY DOUBLE RECTIFIER DIODES FEATURING LOW REVERSE LEAKAGE

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.

#### OHICK REFERENCE DATA

GOIOR HEI EHENOL 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)	IO	max.			20		_ А
Forward voltage	٧F	<		0.89	95		V
Reverse recovery time	t <sub>rr</sub>	<		:	25		ns
Reverse leakage current	I <sub>R</sub>	<			5		μΑ

#### **MECHANICAL DATA**



Net mass: 2 g Accessories supplied on request: see data sheets Mounting instructions and accessories for TO-220 envelopes.

## **BYP22 SERIES**

#### **RATINGS**

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

Voltages			BYP22-50	1 100	150	200	
Repetitive peak reverse voltage	$V_{RRM}$	max.	50	100	150	200	V
Crest working reverse voltage	V <sub>RWM</sub>	max.	50	100	150	200	V
Continuous reverse voltage	VR	max.	50	100	150	200	V
Currents (both diodes conducting; no	te 1)		<u> </u>				_
Output current; switching losses negligible up to 500 kHz; square wave; $\delta = 0.5$ ;							
up to T <sub>mb</sub> = 150 °C	10	max.		1	16		Α
square wave; $\delta$ = 0.5; up to T <sub>mb</sub> = 143 °C	10	max.		2	20		Α
sinusoidal; up to T <sub>mb</sub> = 150 °C	10	max.		1	6		Α
R.M.S. forward current	IF(RMS)	max.		2	20		Α
Repetitive peak forward current $t_p = 20 \mu s$ ; $\delta = 0.02$ (note 2)	<sup> </sup> FRM	max.		23	80		Α
Non-repetitive peak forward current half sine-wave; T <sub>j</sub> = 175 <sup>o</sup> C prior to surge; with reapplied V <sub>RWM</sub> max. (r	note 2)						
t = 10 ms	<sup>I</sup> FSM	max.		14	0		Α
t = 8.3 ms	<sup>I</sup> FSM	max.		15	0		Α
$I^2$ t for fusing (t = 10 ms; note 2)	l²t	max.		9	8		A²s
Temperatures							
Storage temperature	T <sub>stg</sub>		6	5 to +17	5		οс
Junction temperature	T <sub>j</sub>	max.	· ·	17	_		°C

#### Notes

- 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 <sub>th j-mb</sub>	_	1.6	K/W
per diode	R <sub>th j-mb</sub>	=	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 <sub>th mb-h</sub>	=	0.3	K/W
b. with heatsink compound and 0.06 mm maximum mica insulator	R <sub>th mb-h</sub>	=	1.4	K/W
<ul> <li>with heatsink compound and 0.1 mm maximum mica washer (56369)</li> </ul>	R <sub>th mb-h</sub>	=	2.2	K/W
<li>d. with heatsink compound and 0.25 mm maximum alumina insulator (56367)</li>	R <sub>th mb-h</sub>	=	0.8	K/W
e. without heatsink compound	R <sub>th mb-h</sub>	=	1.4	K/W
2. Free air operation				
The quoted values of $R_{\mbox{th}\ j\mbox{-}a}$ should be used only when no lead to the same tie point.	ls of other dissi	pating co	omponen:	ts run
Thermal resistance from junction to ambient in free air: mounted on a printed circuit board at any lead length	R <sub>th j-a</sub>		60	K/W

CHARACTERISTICS					
Forward voltage					
$I_F = 8 \text{ A}; T_j = 100 ^{\circ}\text{C}$		٧ <sub>F</sub>	<	0.895	V*
I <sub>F</sub> = 8 A; T <sub>j</sub> = 25 °C		$V_{F}$	<	0.975	V*
$I_F = 20 \text{ A}; T_j = 25 ^{\circ}\text{C}$		VF	<	1.15	V*
Reverse current					
$V_R = V_{RWMmax}$ ; $T_j = 175  {}^{\circ}\text{C}$		I <sub>R</sub>	<	500	μΑ
T <sub>j</sub> = 125 °C		I <sub>R</sub>	<	250	μΑ
T <sub>j</sub> = 100 °C		I <sub>R</sub>	<	50	μΑ
$T_j = 25$ °C		I <sub>R</sub>	<	5	μA
Reverse recovery when switched from IF = 1 A to $V_R \ge 30$ V with $-dI_F/dt = 100$ A/ $\mu$ s, $T_j = 25$ °C; recovery time	;	t <sub>rr</sub>	<	25	ns
Step reverse recovery when switched from IF = 0.5 A to IR = 1 A, measured at IRR = 0.25 A; recovery time IF = 2 A to VR $\geqslant$ 30 V with $-dI_F/dt = 20$ A/ $\mu$ s; $T_j = 25$ °C; recovered charge		t <sub>rr</sub>	<	25	ns
IF = 10 A to $V_R \ge 30 V$ with $-dI_F/dt = 50 A/\mu s$ $T_j = 100  ^{\circ}C$ ; peak recovery current	;	O <sub>s</sub>	<	15 2	nC A
Forward recovery when switched to $I_F = 1$ A with $dI_F/dt = 10$ A/ $\mu$ s; $T_j = 25$ °C		V <sub>fr</sub>	typ.	0.9 <sub>M80-13</sub>	V 19/3
	IF 1	0 %			
I <sub>F</sub>				tir	ne

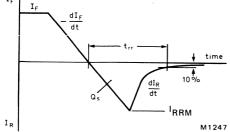


Fig.2 Definition of  $t_{rr},$   $\Omega_{\text{S}}$  and  $I_{\mbox{\scriptsize RRM}}.$ 

100%

time

Fig.3 Definition of  $V_{fr}$ .

<sup>\*</sup>Measured under pulse conditions to avoid excessive dissipation.

#### MOUNTING INSTRUCTIONS

- 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.
- 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<sub>th mb-h</sub> 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<sub>th mb-h</sub> given for mounting with heatsink compound refer to the use of a metallic-oxide loaded compound. Ordinary silicone grease is not recommended.
- 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:

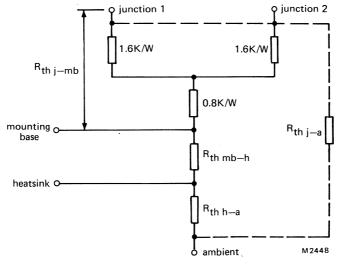


Fig.4

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

## SQUARE-WAVE OPERATION (PER DIODE)

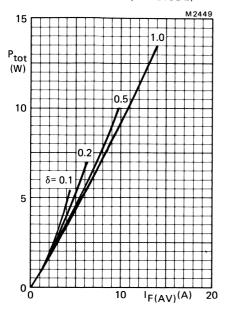
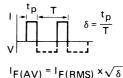


Fig.5 Power rating per diode.
The individual power loss in each diode should first be determined then both added together. The resulting total power loss is then used in conjunction with Fig.6 to determine the heatsink size and corresponding maximum ambient and mounting base temperatures.



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

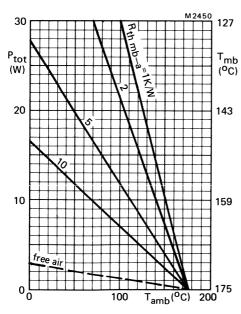


Fig.6

#### SINUSOIDAL OPERATION (PER DIODE)

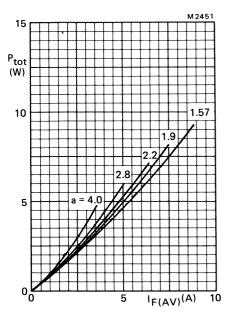


Fig.7 Power rating per diode.
The individual power loss in each diode should first be determined then both added together. The resulting total power loss is then used in conjunction with Fig.6 to determine the heatsink size and corresponding maximum ambient and mounting base temepratures.

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

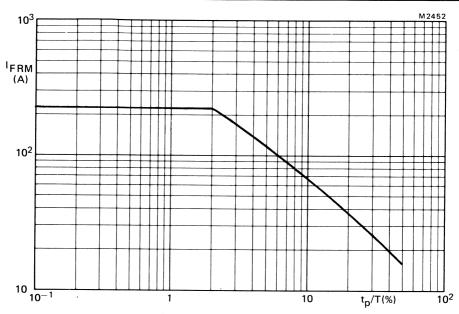
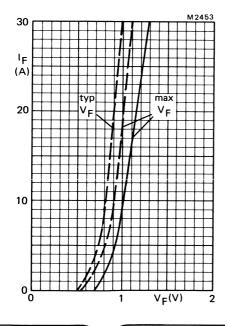
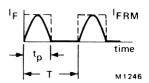


Fig.8 Maximum permissible repetitive peak forward current for either square or sinusoidal currents for 1  $\mu s < t_D < 1$  ms.





Definition of IFRM and  $t_p/T$ .

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

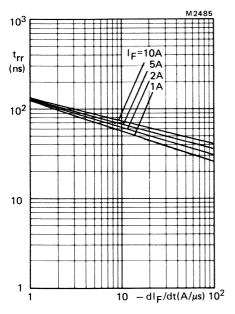
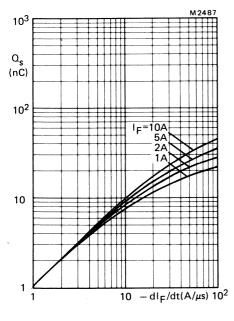


Fig. 10 Maximum  $t_{rr}$  at  $T_j = 25$  °C.



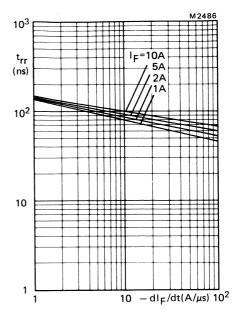


Fig.11 Maximum  $t_{rr}$  at  $T_j = 100$  °C.

Fig.12 Maximum  $Q_s$  at  $T_j$  = 25  $^{o}$ C.

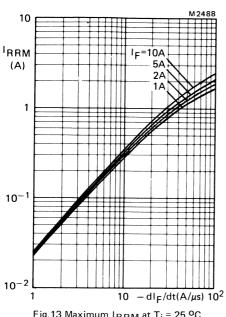


Fig.13 Maximum  $I_{RRM}$  at  $T_j$  = 25 °C.

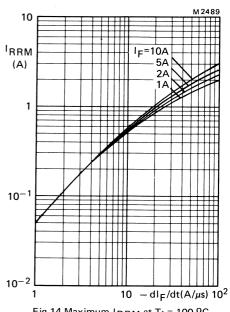


Fig.14 Maximum IRRM at  $T_i$  = 100 °C.

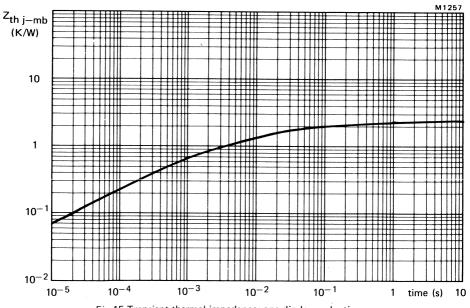


Fig. 15 Transient thermal impedance; one diode conducting.

## **DEVELOPMENT DATA**

This data sheet contains advance information and specifications are subject to change without notice.

# 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.

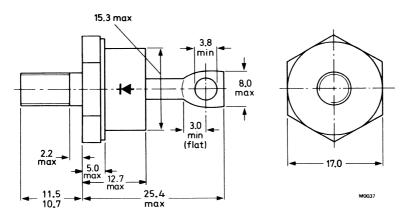
#### QUICK REFERENCE DATA

		BYP59-300		400	
Repetitive peak reverse voltage	$v_{RRM}$	max.	300	400	V
Average forward current	IF(AV)	max.	60	)	Α
Forward voltage	VF	<	1.05	5	V
Reverse recovery time	t <sub>rr</sub>	<	60	)	V
Reverse leakage current	1 <sub>R</sub>	<	25	5	$\mu A$

#### **MECHANICAL DATA**

Dimensions in mm

Fig.1 DO-5: with % in x 28 UNF stud ( $\phi$ 6.35 mm); e.g. BYP59-300U, with metric M6 stud ( $\phi$ 6 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.

# **BYP59 SERIES**

#### **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 <sub>RWM</sub>	max.	200	300	V
Continuous reverse voltage	VR	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 °C	IF(AV)	max.		60	Α
R.M.S. foward current	<sup>I</sup> F(RMS)	max.		85	Α
Repetitive peak forward current $t_p = 20 \mu s$ , $\delta = 0.02$	<sup>I</sup> FRM	max.	1:	200	Α
Non-repetitive peak forward current half sine-wave; T <sub>j</sub> = 150 <sup>o</sup> C prior to surge; with reapplied V RWM max					
t = 10 ms	IFSM	max.	-	650	Α
t = 8.3 ms	<sup>I</sup> FSM	max.	-	700	Α
$l^2 t$ for fusing (t = 10 ms)	l² t	max.	2	100	A <sup>2</sup> s
Temperatures					
Storage temperature	$T_{stg}$		55 to +1	150	oC
Junction temperature	Тj	max.		150	oC
THERMAL RESISTANCE					
From junction to mounting base From mounting base to heatsink:	R <sub>th j-mb</sub>	=		0.7	K/W
a. with heatsink compound	R <sub>th mb-h</sub>	=		0.2	K/W
b. without heatsink compound	R <sub>th mb-h</sub>	=		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.

CHAR	AC	TER	IST	ICS
------	----	-----	-----	-----

Forward voltage $I_F = 60 \text{ A}; T_i = 150 ^{\circ}\text{C}$	VF	<	1.05	V*
$I_F = 150 \text{ A}; T_j = 25 ^{\circ}\text{C}$	٧̈́F	<	1.4	V*
Reverse current				
$V_R = V_{RWM max}$ ; $T_j = 100  ^{\circ}C$	1 <sub>R</sub>	<	0.5	mΑ
$V_R = V_{RWM \text{ max}}; T_j = 25 ^{\circ}\text{C}$	1F	<	25	$\mu A$
Reverse recovery when switched from $I_F = 1 \text{ A to V}_B \ge 30 \text{ V with } -dI_F/dt = 100 \text{ A/}\mu\text{s};$				
$T_j = 25$ °C; recovery time	t <sub>rr</sub>	<	60	ns
$I_F = 2 \text{ A to V}_R \geqslant 30 \text{ V with } -dI_F/dt = 20 \text{ A}/\mu\text{s};$ $T_j = 25 ^{\text{O}}\text{C}$ ; recovered charge	$\Omega_{s}$	<	100	nC
$I_F$ = 10 A to $V_R \ge 30$ V with $-dI_F/dt$ = 50 A/ $\mu$ s; $T_j$ = 100 $^{o}$ C; peak recovery current	<sup>I</sup> RRM	<	5	Α
Forward recovery when switched to $I_F = 10 \text{ A}$ with $dI_F/dt = 10 \text{ A}/\mu\text{s}$ ; $T_j = 25 ^{\circ}\text{C}$	$v_fr$	typ.	2.5	٧

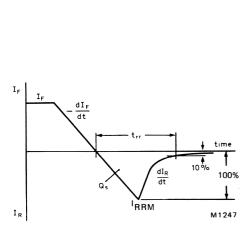


Fig.2 Definition of  $t_{\mbox{\scriptsize rr}},\, \mbox{\scriptsize Q}_{\mbox{\scriptsize S}}$  and  $\mbox{\scriptsize I}_{\mbox{\scriptsize RRM}}.$ 

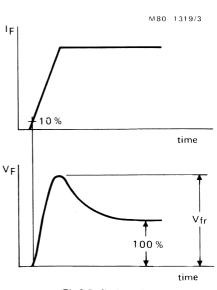


Fig.3 Defintion of V<sub>fr</sub>.

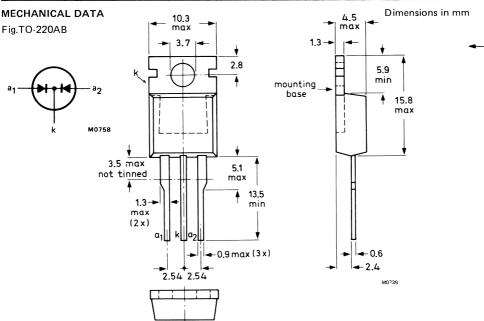
<sup>\*</sup>Measured under pulse conditions to avoid excessive dissipation

## 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)	10	max.			10	1	Å
Forward voltage	٧ <sub>F</sub>	<		0.85			, V
Reverse recovery time	t <sub>rr</sub>	<	20			ns	



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.

# **BYQ28 SERIES**

#### **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 <sub>RWM</sub>	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	10	max.			10		A
sinusoidal; up to T <sub>mb</sub> = 130 °C	10	max.	10				Α
R.M.S. forward current	IF(RMS)	max.	14			Α	
Repetitive peak forward current $t_p = 20 \mu s$ , $\delta = 0.02$ (per diode)	<sup>I</sup> FRM	max.		8	30		Α
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	<sup>I</sup> FSM	max.		Ę	50		Α
t = 8.3  ms	<sup>I</sup> FSM	max.		6	60		Α
$I^2$ t for fusing (t = 10 ms, per diode)	l² t	max.		12	.5		$A^2s$
Temperatures							
Storage temeprature	$T_{stg}$		40	0 to +15	50		oC
Junction temperature	тj	max.		15	60		οС

#### Notes:

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

### **CHARACTERISTICS** (per diode)

F	or	10/5	ard	MO	tage

$I_F = 5 \text{ A}; T_j = 150 ^{\circ}\text{C}$	٧F	<	0.85	V*
$I_F = 15 \text{ A}$ : $T_i = 25  ^{\circ}\text{C}$	VE	<	1.3	V*

Reverse current

$$V_R = V_{RWM max}; T_j = 100 \, ^{o}C$$
  $I_R < 0.2 \, ^{mA}$   $V_R = V_{RWM max}; T_j = 25 \, ^{o}C$   $I_R < 10 \, ^{\mu}A$ 

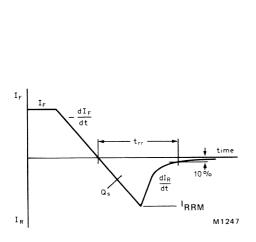
Reverse recovery when switched from

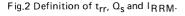
I<sub>F</sub> = 1 A to 
$$V_R \ge 30$$
 V with  $-dI_F/dt = 100$  A/ $\mu$ s;  $T_j = 25$  °C recovery time
I<sub>F</sub> = 2 A to  $V_R \ge 30$  V with  $-dI_F/dt = 20$  A/ $\mu$ s;  $T_i = 25$  °C

recovered charge 
$$I_F = 5 \text{ A to V}_R \geqslant 30 \text{ V with } -dI_F/dt = 50 \text{ A/$\mu$s; $T_j$} = 100 \text{ }^{\circ}\text{C}$$
 peak recovery current

Forward recovery when switched to I<sub>F</sub> = 1 A with dI<sub>F</sub>/dt = 10 A/
$$\mu$$
s; T<sub>j</sub> = 25 °C recovery voltage







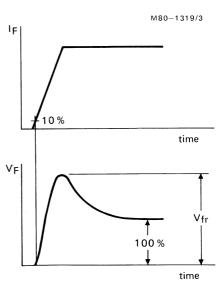


Fig.3 Definition of Vfr.

<sup>\*</sup>Measured under pulse conditions to avoid excessive dissipation.

	THERMAL RESISTANCE				
	From junction to mounting base (both diodes conducting)	R <sub>th i-mb</sub>	=	2.2	K/W
	From junction to mounting base (per diode)	R <sub>th j-mb</sub>	=	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 <sub>th mb-h</sub>	=	0.3	K/W
	b. with heatsink compound and 0.06 mm maximum mica insulator	R <sub>th mb-h</sub>	=	1.4	K/W
	c. with heatsink compound and 0.1 mm maximum mica insulator (56369)	R <sub>th mb-h</sub>	=	2.2	K/W
	<ul> <li>d. with heatsink compound and 0.25 mm maximum alumina insulator (56367)</li> </ul>	R <sub>th mb-h</sub>	=	0.8	K/W
	e. without heatsink compound	R <sub>th mb-h</sub>	=	1.4	K/W
	2. Free air operation				
	The quoted values of $R_{th\ j-a}$ should be used only when no leads o to the same tie point. Thermal resistance from junction to ambient in free air: mounted on a printed circuit board at any device lead	f other dissipa	ating comp	oonents	run
	length and with copper laminate on the board	R <sub>th j-a</sub>	=	60	K/W

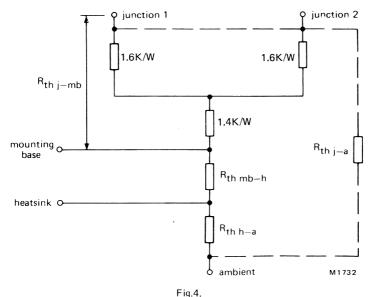
#### MOUNTING INSTRUCTIONS

- 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  $R_{th\ mb-h}$  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<sub>th mb-h</sub> given for mounting with heatsink compound refer to the use of a metallic-oxide loaded compound. Ordinary silicone grease is not recommended.
- 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.



, ,9. ..

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

## SQUARE-WAVE OPERATION (PER DIODE)

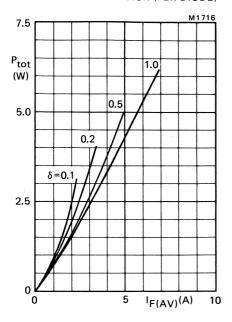
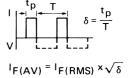


Fig.5 Power rating per diode.
The individual power loss in each diode should first be determined then both added together. The resulting total power loss is then used in conjunction with Fig.6 to determine the heatsink size and corresponding maximum ambient and mounting base temperatures.



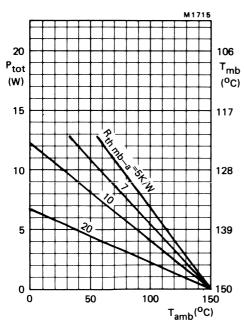


Fig.6

#### SINUSOIDAL OPERATION (PER DIODE)

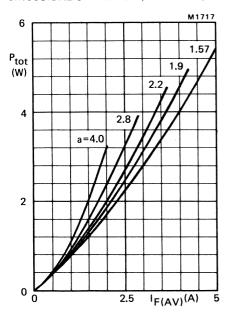


Fig.7 Power rating per diode.
The individual power loss in each diode should first be determined then both added together. The resulting total power loss is then used in conjunction with Fig.6 to determine the heatsink size and corresponding maximum ambient and mounting base temperatures.

 $a = form factor = I_F(RMS)/I_F(AV)$ 

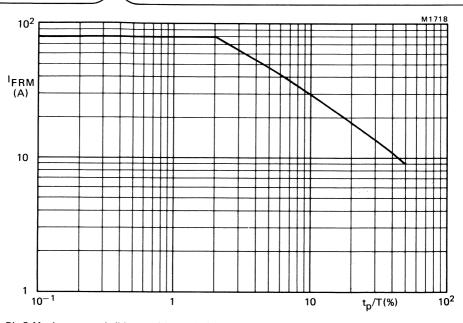
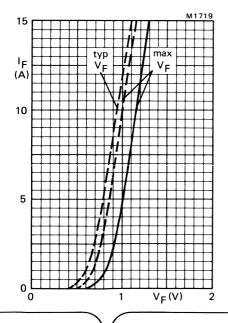
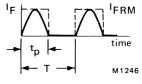


Fig.8 Maximum permissible repetitive peak forward current for either square or sinusoidal currents for 1  $\mu s < t_p < 1$  ms.





Definition of I  $_{\mbox{FRM}}$  and  $t_{\mbox{\scriptsize p}}/\mbox{\scriptsize T}$ 

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

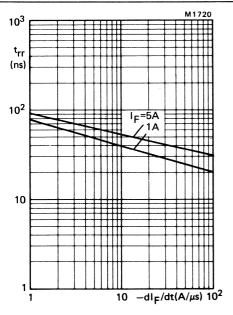


Fig. 10 Maximum  $t_{rr}$  at  $T_i = 25$  °C.

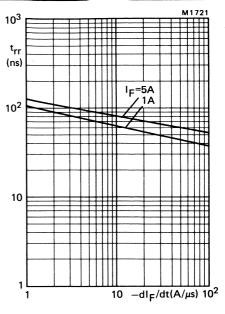


Fig.11 Maximum  $t_{rr}$  at  $T_j = 100$  °C.

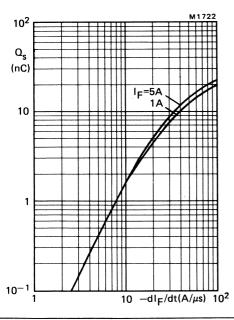


Fig. 12 Maximum  $Q_s$  at  $T_i = 25$  °C.

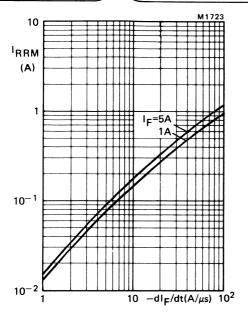


Fig. 13 Maximum  $I_{RRM}$  at  $T_j = 25$  °C

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

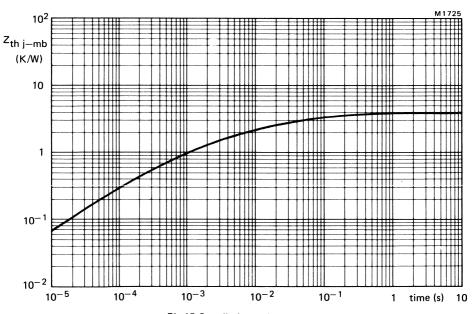


Fig. 15 One diode conducting.

### **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.

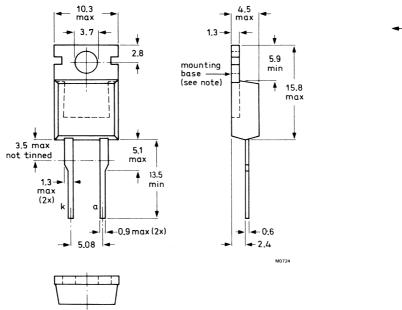
### QUICK REFERENCE DATA

			BYR29-600	700	800		<b>-</b>
Repetitive peak reverse voltage	$V_{RRM}$	max.	600	700	800	V	
Average forward current	I <sub>F(AV)</sub>	max.		8		Α	
Forward voltage	VF	<		1.3		V	
Reverse recovery time	t <sub>rr</sub>	<		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.

### **BYR 29 SERIES**

### **RATINGS**

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

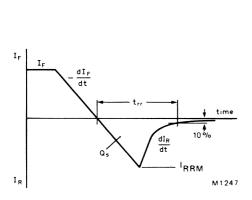
-	Voltages		E	3YR29-600	700	800		
	Repetitive peak reverse voltage	$V_{RRM}$	max.	600	700	800	V	
	Crest working reverse voltage	V <sub>RWM</sub>	max.	500	500	600	V	
	Continuous reverse voltage*	VR	max.	500	500	600	٧	
	Currents							
	Average forward current; switching losses negligible up to 100 kHz square wave; $\delta$ = 0.5; up to $T_{mb}$ = up to $T_{mb}$ =	= 117 °C = 125 °C	IF(AV) IF(AV)	max. max.	8 6.5		A A	
	sinusoidal; up to $T_{mb}$ = 120 ${}^{o}C$ up to $T_{mb}$ = 125 ${}^{o}C$		IF(AV) IF(AV)	max. max.	7.8 7.2		A A	
	R.M.S. forward current		IF(RMS)	max.	11.5		Α	
	Repetitive peak forward current $t_p = 20 \mu s$ ; $\delta = 0.02$		IFRM	max.	130		Α	
	Non-repetitive peak forward current half sine-wave; T <sub>j</sub> = 150 °C prior with reapplied V <sub>RWMmax</sub> ; t = 10 ms t = 8.3 ms		IFSM IFSM	max. max.	60 72		A A	
	I <sup>2</sup> t for fusing (t = 10 ms)		l²t	max.	18		$A^2s$	
	Temperatures							
	Storage temperature		T <sub>stg</sub>	-40 to	+150		οС	
	Junction temperature		т <sub>ј</sub>	max.	150		oC	

<sup>\*</sup>To ensure thermal stability:  $\rm R_{th~j-a} \, \leqslant 5.7~K/W.$ 

### **CHARACTERISTICS**

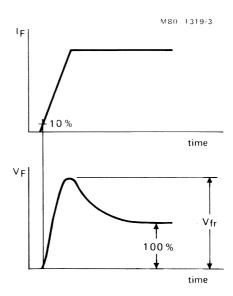
Forward voltage $I_F = 10 \text{ A; } T_j = 150  ^{\circ}\text{C}$ $I_F = 25 \text{ A; } T_j = 25  ^{\circ}\text{C}$	V <sub>F</sub> V <sub>F</sub>	< < < < < < < < < < < < < < < < < < <	1.30 1.75	V* V*
Reverse current $V_R = V_{RWM \ max}$ ; $T_j = 100 \ ^{\circ}C$ $T_j = 25 \ ^{\circ}C$	I <sub>R</sub> I <sub>R</sub>	< <	0.2 10	mΑ μΑ
Reverse recovery when switched from IF = 1 A to $V_R \ge 30$ V with – $dI_F/dt = 100$ A/ $\mu$ s; $T_j = 25$ °C; recovery time	t <sub>rr</sub>	<	75	ns
I <sub>F</sub> = 2 A to V <sub>R</sub> $\geqslant$ 30 V with $-dI_F/dt$ = 20 A/ $\mu$ s; T <sub>j</sub> = 25 °C; recovered charge	$O_{S}$	<	200	nC
I <sub>F</sub> = 10 A to V <sub>R</sub> $\geqslant$ 30 V with $-dI_F/dt$ = 50 A/ $\mu$ s; T <sub>j</sub> = 100 $^{o}$ C; peak recovery current	IRRM	<	6	Α

 $V_{\mathsf{fr}}$ 



Forward recovery when switched to I  $_F$  = 10 A with dI  $_F/dt$  = 10 A/ $\mu s;$  T  $_j$  = 25  $^{o}C$ 

Fig.2 Definition of  $t_{rr},\, {\rm Q}_{\rm S}$  and  ${\rm I}_{\rm RRM}.$ 



typ.

5

Fig.3 Definition of V<sub>fr</sub>.

<sup>\*</sup>Measured under pulse conditions to avoid excessive dissipation.

# BYR 29 SERIES

THERMAL RESISTANCE				
From junction to mounting base	R <sub>th j-mb</sub>	=	2.5	K/W
Influence of mounting method				
<ol> <li>Heatsink-mounted with clip (see mounting instructions)</li> </ol>				
Thermal resistance from mounting base to heatsink				
a. with heatsink compound	R <sub>th mb-h</sub>	=	0.3	K/W
b. with heatsink compound and 0.06 mm maximum mica				
insulator	R <sub>th mb-h</sub>	=	1.4	K/W
c. with heatsink compound and 0.1 mm maximum mica	_			
insulator (56369)	R <sub>th</sub> mb-h	=	2.2	K/W
d. with heatsink compound and 0.25 mm maximum	_			
alumina insulator (56367)	R <sub>th mb-h</sub>	=	8.0	K/W
e. without heatsink compound	R <sub>th mb-h</sub>	=	1.4	K/W
2. Free air operation				
The quoted value of R <sub>th j-a</sub> should be used only when no leads of	other dissipati	ing con	nponent	s 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 <sub>th j-a</sub>	=	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 1.0 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 Rth mb-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<sub>th mb-h</sub> given for mounting with heatsink compound refer to the use of a metallic oxideloaded 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.

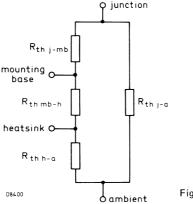


Fig. 4.

- 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<sub>amb</sub> scale. The intersection determines the R<sub>th mb-a</sub>. The heatsink thermal resistance value (Rth h-a) can be calculated from:

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

### SQUARE-WAVE OPERATION

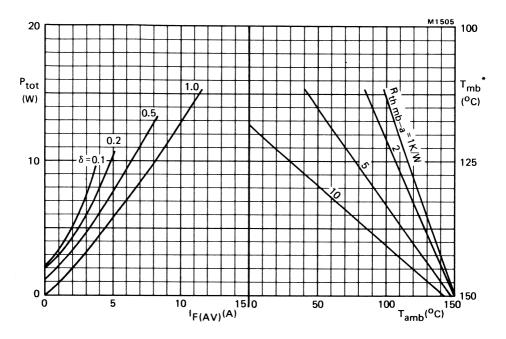


Fig.5 The right-hand part shows the relationship between the power (derived from the left-hand part) and the maximum permissible temperatures. Power includes reverse current losses and switching losses up to f = 100 kHz.

$$\delta = \frac{\mathsf{tp}}{\mathsf{T}}$$

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

 $<sup>^*</sup>T_{mb}$  scale is for comparison purposes and is correct only for R<sub>th mb-a</sub> < 3.2 K/W.

### SINUSOIDAL OPERATION

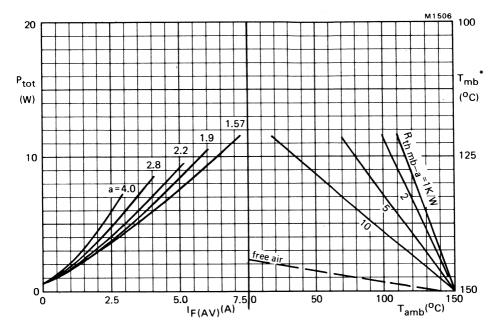


Fig.6 The right-hand part shows the interrelationship between the power (derived from the left-hand part) and the maximum permissible temperatures.

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

 $<sup>^{*}\</sup>mathrm{T}_{\mathrm{mb}}$  scale is for comparison purposes and is correct only for  $\mathrm{R}_{\mathrm{th}\;\mathrm{mb}\text{-}\mathrm{a}}\!<\!16\;\mathrm{K/W}.$ 

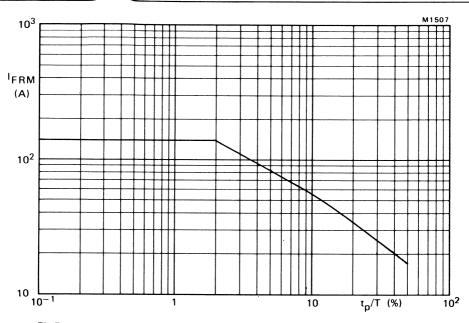
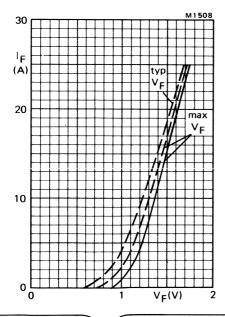
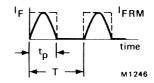


Fig.7 Maximum permissible repetitive peak forward current for square or sinusoidal currents; 1  $\mu s < t_p < 1$  ms.





Definition of IFRM and  $t_p/T$ .

Fig.8 ---- 
$$T_j = 25 \text{ °C}; --- T_j = 150 \text{ °C}.$$

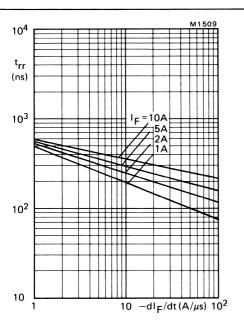


Fig.9 Maximum  $t_{rr}$  at  $T_i = 25$  °C.

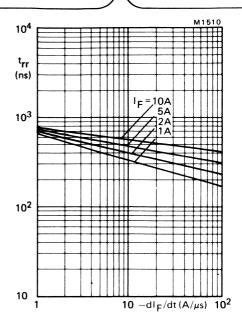


Fig.10 Maximum  $t_{rr}$  at  $T_j = 100$  °C.

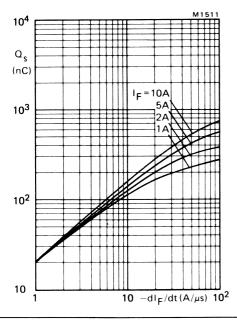


Fig.11 Maximum  $Q_s$  at  $T_j = 25$  °C

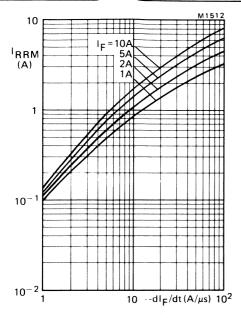


Fig.12 Maximum  $I_{RRM}$  at  $T_j = 25$  °C.

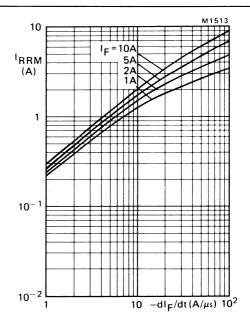


Fig.13 Maximum  $I_{RRM}$  at  $T_i = 100$  °C.

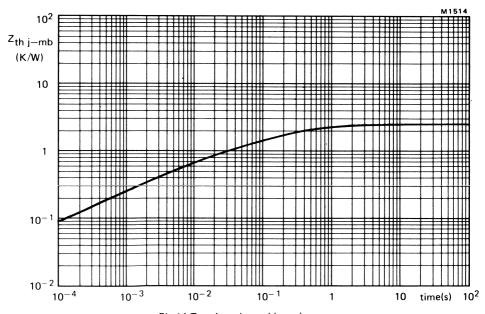


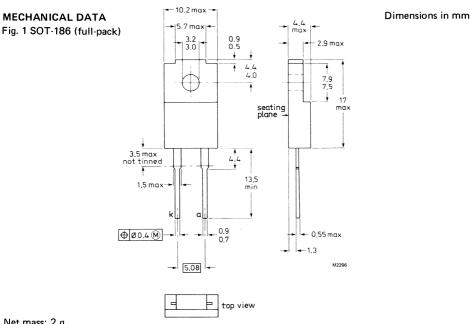
Fig.14 Transient thermal impedance.

### 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 softrecovery 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	VRRM	max.	600	700	800	٧
Average forward current	IF(AV)	max.	8			Α
Forward voltage	٧F	<	1.3			٧
Reverse recovery time	t <sub>rr</sub>	<		75		ns



Net mass: 2 q.

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).

## **BYR29F SERIES**

### **RATINGS**

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

Voltages			BYR2	9F-600	700	800	
Repetitive peak reverse voltage	VRRM	max.		600	700	800	V
Crest working reverse voltage	VRWM	max.		500	500	600	V
Continuous reverse voltage (note 1)	$V_{R}$	max.		500	500	600	٧
Currents							
Average forward current; switching losses negligible up to 100 kHz (note square wave; $\delta$ = 0.5; up to T <sub>mb</sub> = 75 sinusoidal; up to T <sub>mb</sub> = 87°C		I <sub>F(AV)</sub> I <sub>F(AV)</sub>	max. max.		8 7.2		A A
R.M.S. forward current		IF(RMS)	max.		11.5		Α
Repetitive peak forward current $t_p = 20 \ \mu s$ ; $\delta = 0.02$		IFRM	max.		130		Α
Non-repetitive peak forward current half sine-wave; $T_j = 150^{\circ}$ C prior to surge; with reapplied V RWM max t = 10 ms		<sup>I</sup> FSM	max.		60		
t = 8.3 ms		IFSM	max.		72		A A
I <sup>2</sup> t for fusing (t = 10 ms)		l <sup>2</sup> t	max.		18		$A^2s$
Temperatures							
Storage temperature		$T_{stg}$		-40 to -	+150		°C
Junction temperature		Tj	max.		150		°C
ISOLATION							
Peak isolation voltage from all terminals to external heatsink		V <sub>isol</sub>	max.	1	1000		V
Isolation capacitance from cathode to external heatsink (note 3)		Cp	typ.		12		pF

### Notes:

- 1. To ensure thermal stability:  $R_{th\ j-a} < 5.7\ K/W$ .
- 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
without heatsink compound

R <sub>th j-a</sub>	=
Rth i-a	=

### Free air operation

The quoted value of Rth j-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

75

200

6

### **CHARACTERISTICS**

Ti = 25°C unless otherwise stated

Forward voltage

Reverse current

$$V_R = V_{RWM max}$$
;  $T_j = 100^{\circ}C$   
 $V_R = V_{RWM max}$ 

$$\begin{array}{ccc} I_{\hbox{\scriptsize R}} & < & 0.2 \\ I_{\hbox{\scriptsize R}} & < & 10 \end{array}$$

Reverse recovery when switched from

IF = 1 A to VR 
$$\geqslant$$
 30 V with  $-dI_F/dt$  = 100 A/ $\mu$ s; recovery time

IF = 2 A to VR  $\geqslant$  30 V with  $-dIF/dt = 20 A/\mu s$ ; recovered charge

IF = 10 A to VR  $\geqslant$  30 V with  $-dIF/dt = 50 A/\mu s$ ; T<sub>i</sub> = 100°C; peak recovery current

Forward recovery when switched to IF = 10 A with  $dI_F/dt = 10 A/\mu s$ 

 $V_{fr}$ typ.



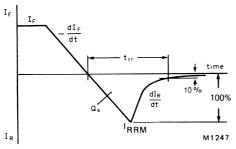


Fig. 2 Definition of trr, Qs and IRRM.

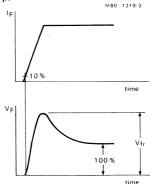


Fig. 3 Definition of Vfr.

<sup>\*</sup>Measured under pulse conditions to avoid excessive dissipation.

### MOUNTING INSTRUCTIONS

- 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<sub>th j-h</sub> 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: Maximum torque to avoid damage to the device:

5.5 kgf (0.55 Nm) 8.0 kgf (0.80 Nm)

- 5. For good thermal contact, heatsink compound should be used between baseplate and heatsink. Values of R<sub>th j-h</sub> given for mounting with heatsink compound refer to the use of a metallic-oxide loaded compound. Ordinary silicone grease is not recommended.
- 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.

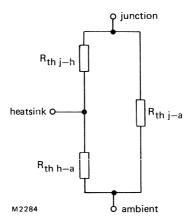
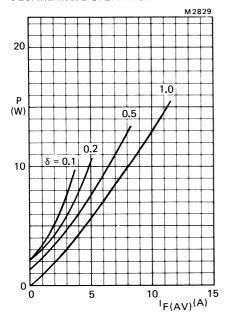


Fig.4.

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

### SQUARE-WAVE OPERATION



SINUSOIDAL OPERATION

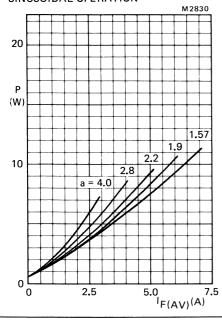


Fig. 5 Power rating.

The power loss in the diode should first be determined from the required forward current on the IF(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.

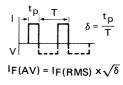


Fig. 6 Power rating.

The power loss in the diode should first be determined from the required forward current on the IF(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 = IF(RMS)/IF(AV)

## **BYR29F SERIES**

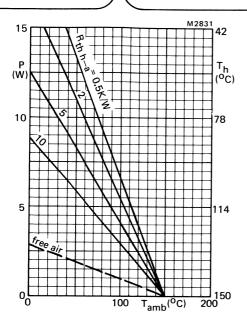


Fig. 7 Heatsink rating; without heatsink compound.

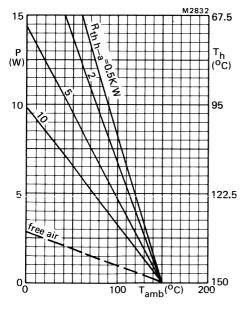


Fig. 8 Heatsink rating; with heatsink compound.

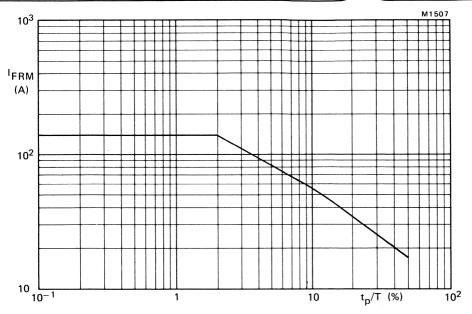
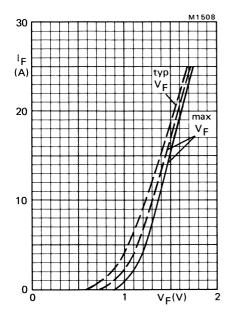


Fig. 9 Maximum permissible repetitive peak forward current for square or sinusoidal currents; 1  $\mu s < t_D < 1$  ms.



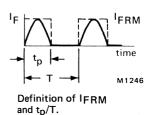


Fig. 10 ——  $T_j = 25^{\circ}C$ ; ——  $T_j = 150^{\circ}C$ 

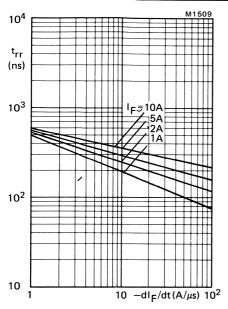
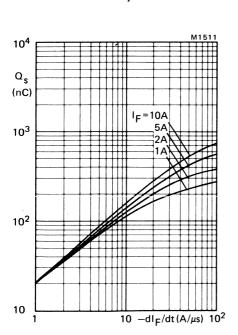


Fig. 11 Maximum  $t_{rr}$  at  $T_j = 25^{\circ}$ C



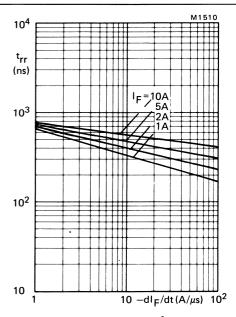


Fig. 12 Maximum  $t_{rr}$  at  $T_j = 100$ °C.

Fig. 13 Maximum  $Q_S$  at  $T_j$  = 25°C.

10<sup>-1</sup>

 $10^{-2}$ 

 $10^{-4}$ 

 $10^{-3}$ 

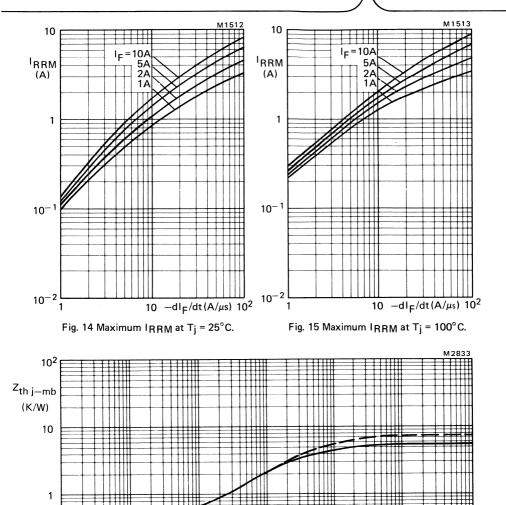


Fig. 16 Transient thermal impedance; —— with heatsink compound; — — without heatsink compound.

 $10^{-2}$ 

10<sup>-1</sup>

1

10

time (s)

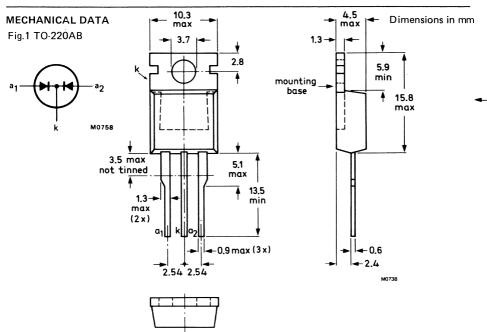
10<sup>2</sup>

### 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	VRRM	max.	300 400	500 V
Output current (both diodes conducting)	l <sub>O</sub>	max.	10	A
Forward voltage	VF	<	1.05	V
Reverse recovery time	t <sub>rr</sub>	<	50	ns



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.

### **BYT28 SERIES**

### **RATINGS**

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

Voltages (per diode)			BYT28	-300	400	500	
Repetitive peak reverse voltage Crest working reverse voltage	V <sub>RRM</sub> V <sub>RWM</sub>	max. max.		300 200	400 300	500 400	V
Continuous reverse voltage	v <sub>R</sub>	max.		200	300	400	V
Currents (both diodes conducting: n	ote 1)						
Output current; switching losses negligible up to 200 kHz;							
square wave; $\delta$ = 0.5; up to $T_{mb}$ =	: 117 °C		I <sub>O</sub>	ma	x.	10	Α
sinusoidal; up to $T_{mb} = 120  {}^{\circ}C$			10	ma	x.	10	Α
R.M.S. forward current			IF(RMS)	ma	×.	14	Α
Repetitive peak forward current $t_p = 20 \mu s$ ; $\delta = 0.02$ (per diode)			I <sub>FRM</sub>	ma	×.	80	Α
Non-repetitive peak forward current half sine-wave; $T_j = 150 ^{\circ}$ C prior twith re-applied $V_{RWM\ max}$							
t = 10 ms			<sup>I</sup> FSM	ma	×.	50	Α
t = 8.3 ms			FSM	ma	x.	60	Α
I <sup>2</sup> t for fusing (t = 10 ms; per diode)			l² t	ma	x.	12.5	$A^2s$
Temperatures							
Storage temperature			T <sub>stg</sub>		-40 to	+150	oC
Junction temperature			Тј	ma	x.	150	oC

### Notes

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

### CHARACTERISTICS (per diode)

_			
Forw	ard \	oltac/	16

I <sub>F</sub> = 5 A; T <sub>j</sub> = 150 °C	VF	<	1.05	V*
I <sub>F</sub> = 15 A; T <sub>i</sub> = 25 °C	VF	<	1.4	V*

### Reverse current

$$V_R = V_{RWM max}; T_j = 100 \, ^{o}C$$
  $I_R < 0.2 mA$   $V_R = V_{RWM max}; T_j = 25 \, ^{o}C$   $I_R < 10 \mu A$ 

### 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 
$$t_{rr} ~<~50~{\rm ns}$$

$$I_F$$
 = 2 A to V  $_R$   $\geqslant$  30 V with  $-dI_F/dt$  = 20 A/µs; T  $_j$  = 25  $^o\text{C}$  recovered charge

$$I_F = 5 \text{ A to V}_R \geqslant 30 \text{ V with } -dI_F/dt = 50 \text{ A}/\mu\text{s; T}_j = 100 \text{ }^{\text{O}}\text{C}$$
 peak recovery current

Forward recovery when switched to  $I_F = 1$  A with  $dI_F/dt = 10$  A/ $\mu s$ ;  $T_j = 25$  °C recovery voltage

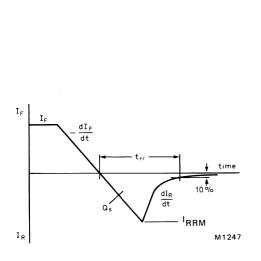
 $V_{\mathsf{fr}}$ 

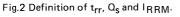
 $Q_{s}$ 

typ. 2.5

50

nC





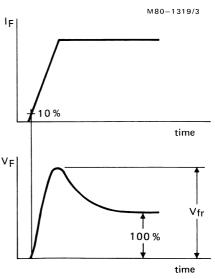


Fig.3 Definition of V<sub>fr</sub>.

<sup>\*</sup>Measured under pulse conditions to avoid excessive dissipation.

	TH	IERMAL RESISTANCE				
	Fre	om junction to mounting base (both diodes conducting)	R <sub>th i-mb</sub>	=	2.5	K/W
	Fre	om junction to mounting base (per diode)	R <sub>th j-mb</sub>	=	3.5	K/W
-	Inf	luence of mounting method				
	1.	Heatsink-mounted with clip (see mounting instructions)				
	Th	ermal resistance from mounting base to heatsink				
	a.	with heatsink compound	R <sub>th mb-h</sub>	=	0.3	K/W
	b.	with heatsink compound and 0.06 mm maximum mica				
		insulator	R <sub>th mb-h</sub>	=	1.4	K/W
	c.	with heatsink compound and 0.1 mm maximum mica				
		insulator (56369)	R <sub>th mb-h</sub>	=	2.2	K/W
	d.	with heatsink compound and 0.25 mm maximum	_			
		alumina insulator (56367)	R <sub>th mb-h</sub>	=	8.0	K/W
	e.	without heatsink compound	R <sub>th mb-h</sub>	=	1.4	K/W
	2.	Free air operation				
	to The	e quoted value of $R_{th\ j-a}$ should be used only when no leads of othe same tie point. ermal resistance from junction to ambient in free air:	ther dissipatio	ng com	ponents	run
		unted on a printed circuit board at any device lead gth and with copper laminate on the board	Rus : -	=	60	K/W
		O I-le	R <sub>th j-a</sub>		50	

### MOUNTING INSTRUCTIONS

- 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  $R_{th\ mb-h}$  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<sub>th mb-h</sub> given for mounting with heatsink compound refer to the use of a metallic oxide-loaded compound. Ordinary silicone grease is not recommended.
- 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

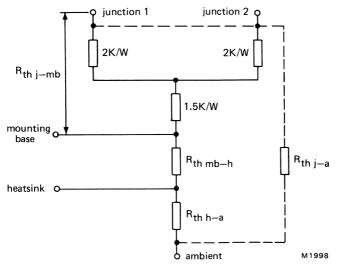


Fig.4

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

### SQUARE-WAVE OPERATION (PER DIODE)

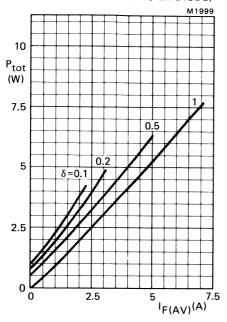
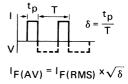


Fig.5 Power rating per diode.
The individual power loss in each diode should first be determined then both added together. The resulting total power loss is then used in conjunction with Fig.6 to determine the heatsink size and corresponding maximum ambient and mounting base temperatures.



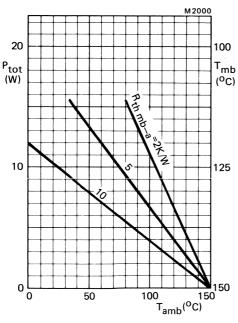


Fig.6

### SINUSOIDAL OPERATION (PER DIODE)

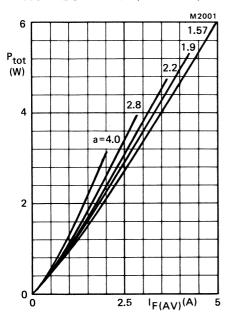


Fig.7 Power rating per diode.
The individual power loss in each diode should first be determined then both added together.
The resulting total power loss is then used in conjunction with Fig.6 to determine the heatsink size and corresponding maximum ambient and mounting base temperatures.

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

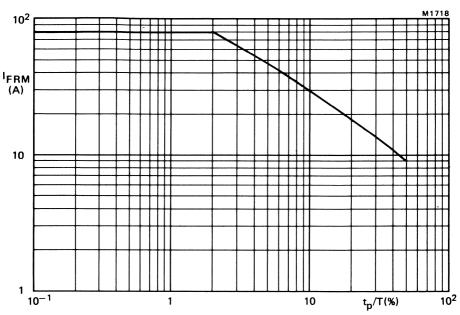
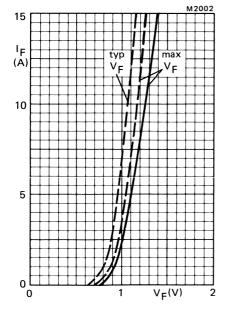
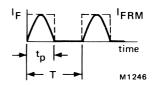


Fig.8 Maximum permissible repetitive peak forward current for either square or sinusoidal currents for 1  $\mu$ s < t $_p$  < 1 ms per diode.





Definition of I  $_{\mbox{FRM}}$  and  $t_p/T$ 

Fig.9 
$$\longrightarrow$$
 T<sub>j</sub> = 25 °C;  $--$  T<sub>j</sub> = 150 °C per diode.

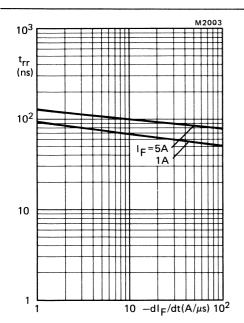
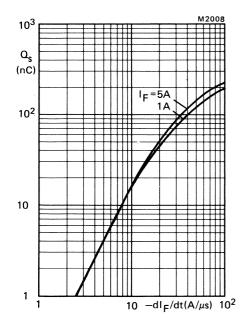


Fig.10 Maximum  $t_{rr}$  at  $T_j = 25$  °C; per diode.



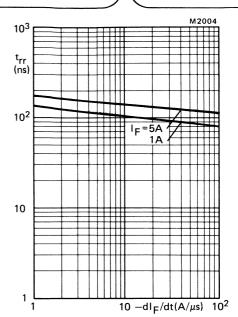
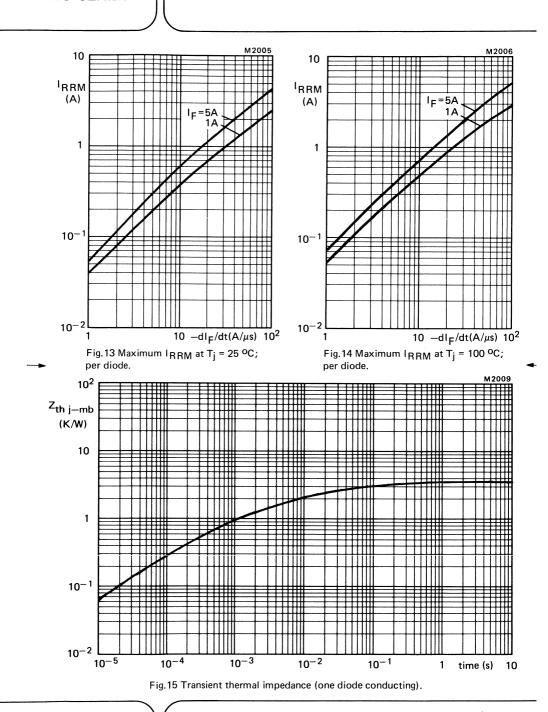


Fig.11 Maximum  $t_{rr}$  at  $T_j$  = 100  ${}^{o}$ C; per diode.

Fig.12 Maximum  $O_s$  at  $T_j$  = 25  $^o$ 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.

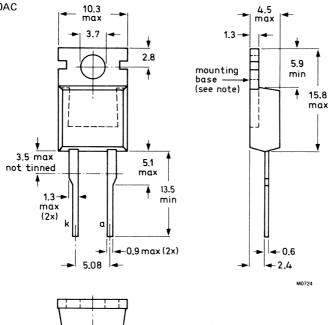
### QUICK REFERENCE DATA

			BYT79-300	400	500	
Repetitive peak reverse voltage	$V_{RRM}$	max.	300	400	500	٧
Average forward current	lF(AV)	max.		14		Α
Forward voltage	VF	<		1.05		V
Reverse recovery time	t <sub>rr</sub>	<		50		ns

### MECHANICAL DATA

Fig.1 TO-220AC

Dimensions in mm



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**

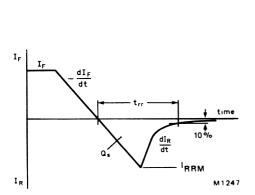
Limiting values in accordance with the Absolute Maximum System (IEC 134).

Voltages			BYT79-30	400	500	
Repetitive peak reverse voltage	$V_{RRM}$	max.	30	400	500	V
Crest working reverse voltage	$v_{RWM}$	max.	20	300	400	V
Continuous reverse voltage*	$V_{R}$	max.	20	300	400	V
Currents			_			
 Average forward current; switching losses negligible up to 200 kHz; square wave; $\delta$ = 0.5; up to T <sub>mb</sub> = 113 °C		lerano	max.	.14		Α
up to T <sub>mb</sub> = 125 °C		lF(AV) lF(AV)	max.	10		A
sinusoidal; up to T <sub>mb</sub> = 118 °C up to T <sub>mb</sub> = 125 °C		IF(AV)	max. max.	12.5 10		A A
R.M.S. forward current		IF(RMS)	max.	20		Α
Repetitive peak forward current $t_p = 20 \mu s$ ; $\delta = 0.02$		IFRM	max.	320		Α
Non-repetitive peak forward current half sine-wave; $T_j = 150$ °C prior to surge; with reapplied $V_{RWMmax}$ ;						
t = 10 ms		<sup>I</sup> FSM	max.	150		Α
t = 8.3 ms		IFSM	max.	180		Α
$I^2$ t for fusing (t = 10 ms)		l² t	max.	112		$A^2s$
Temperatures						
Storage temperature		T <sub>stg</sub>	<b>-40</b> t	o +150		οС
Junction temperature		т <sub>ј</sub>	max.	150		oC

<sup>\*</sup>To ensure thermal stability: R  $_{\mbox{th j-a}} \, \! \leqslant \! 4.6 \mbox{ K/W}.$ 

CH			

Forward voltage				
I <sub>F</sub> = 15 A; T <sub>i</sub> = 150 °C	٧ <sub>F</sub>	<	1.05	V*
$I_F = 50 \text{ A}; T_j' = 25 ^{\circ}\text{C}$	٧F	<	1.40	V*
Reverse current				
$V_R = V_{RWM max}; T_j = 100  {}^{\circ}C$	I <sub>R</sub>	<	8.0	mΑ
$T_j' = 25$ °C	<sup>I</sup> R	<	50	μΑ
Reverse recovery when switched from $I_F = 1 \text{ A to V}_R \geqslant 30 \text{ V with } -dI_F/dt = 100 \text{ A}/\mu\text{s};$				
$T_j = 25$ °C; recovery time	t <sub>rr</sub>	<	50	ns
$I_F = 2 A$ to $V_R \ge 30 V$ withd $I_F$ /dt = 20 A/μs; $T_j = 25$ °C; recovered charge	$Q_{\mathbf{s}}$	<	50	nC
I <sub>F</sub> = 10 A to $V_R \ge 30 V$ with $-dI_F/dt = 50 A/\mu s$ ; $T_j = 100  ^{\circ}C$ ; peak recovery current	IRRM	<	5.2	A
Forward recovery when switched to $I_F = 10 \text{ A}$ with $dI_F/dt = 10 \text{ A}/\mu\text{s}$ ; $T_j = 25 \text{ °C}$	$V_{fr}$	typ.	2.5	V



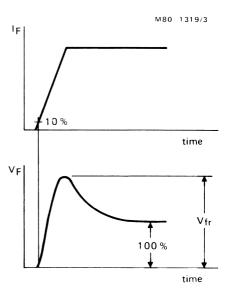


Fig.2 Definition of  $t_{\mbox{\scriptsize rr}},\, \mbox{\scriptsize Q}_{\mbox{\scriptsize S}}$  and  $\mbox{\scriptsize I}_{\mbox{\scriptsize RRM}}.$ 

Fig.3 Definition of V<sub>fr</sub>.

<sup>\*</sup>Measured under pulse conditions to avoid excessive dissipation.

# BYT79 SERIES

THERMAL RESISTANCE				
From junction to mounting base	R <sub>th j-mb</sub>	=	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 <sub>th mb-h</sub>	=	0.3	K/W
<li>b. with heatsink compound and 0.06 mm maximum mica insulator</li>	R <sub>th mb-h</sub>	=	1.4	K/W
<ul> <li>with heatsink compound and 0.1 mm maximum mica insulator (56369)</li> </ul>	R <sub>th mb-h</sub>	=	2.2	K/W
<li>d. with heatsink compound and 0.25 mm maximum alumina insulator (56367)</li>	R <sub>th mb-h</sub>	=	0.8	K/W
e. without heatsink compound	R <sub>th mb-h</sub>	=	1.4	K/W
2. Free air operation				
The quoted value of $R_{th\ j-a}$ should be used only when no leads of to the same tie point.  Thermal resistance from junction to ambient in free air: mounted on a printed circuit board at any device lead	other dissipati	ing con	nponent	s run
length and with copper laminate on the board	R <sub>th j-a</sub>	=	60	K/W

### MOUNTING INSTRUCTIONS

- 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.
- 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<sub>th mb-h</sub> values than does screw mounting.
  - b. safe isolation for mains operation.

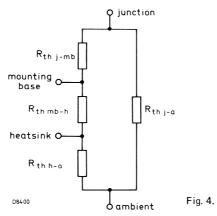
However, if a screw is used, it should be M3 cross-recess pan head. Care should be taken to avoid damage to the plastic body.

- 4. For good thermal contact, heatsink compound should be used between mounting base and heatsink. Values of R<sub>th mb-h</sub> given for mounting with heatsink compound refer to the use of a metallic oxide-loaded compound. Ordinary silicone grease is not recommended.
- 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.



- 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  $R_{th\ mb-a}$ . The heatsink thermal resistance value ( $R_{th\ h-a}$ ) can be calculated from:

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

### SQUARE-WAVE OPERATION

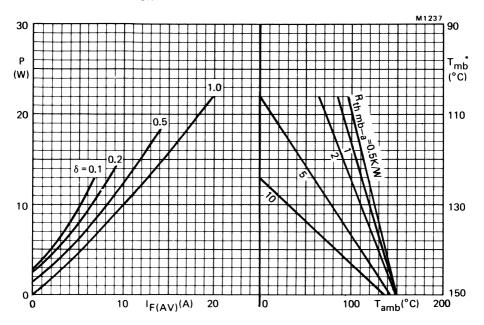


Fig.5 The right-hand part shows the relationship between the power (derived from the left-hand part) and the maximum permissible temperatures. Power includes reverse current losses and switching

losses up to f = 200 kHz.

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

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

 $<sup>^*</sup>T_{mb}$  scale is for comparison purposes and is correct only for R<sub>th mb-a</sub> < 4.1 K/W.

### SINUSOIDAL OPERATION

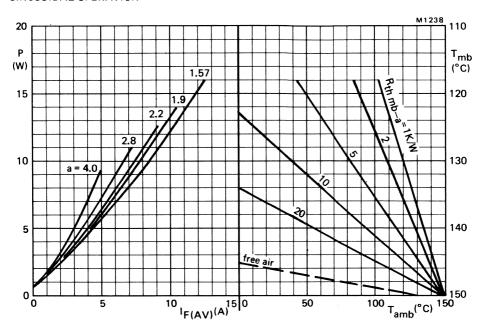


Fig.6 The right-hand part shows the interrelationship between the power (derived from the left-hand part) and the maximum permissible temperatures.  $a = form\ factor = I_{F(RMS)}/I_{F(AV)}$ .

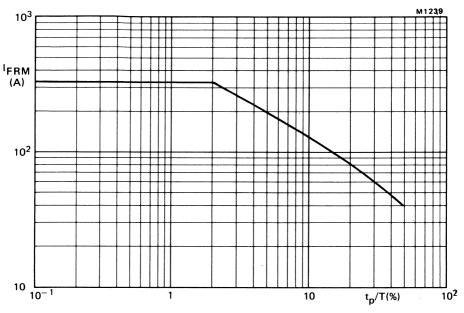
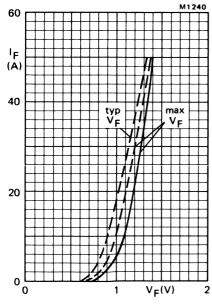
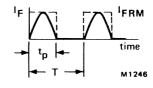


Fig.7 Maximum permissible repetitive peak forward current for square or sinusoidal currents; 1  $\mu s < t_p < 1$  ms.





Definition of IFRM and  $t_p/T$ .

Fig.8 —  $T_j = 25$  °C;  $---T_j = 150$  °C.

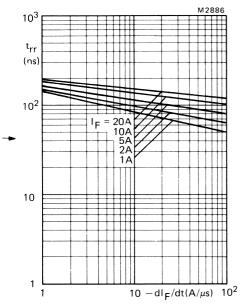
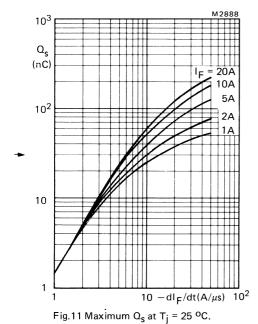


Fig.9 Maximum  $t_{rr}$  at  $T_i = 25$  °C.



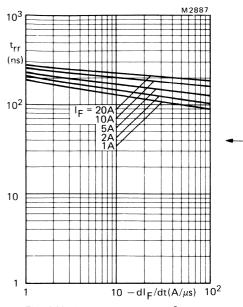
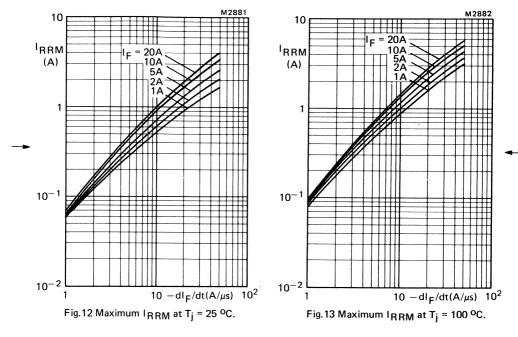


Fig.10 Maximum  $t_{rr}$  at  $T_j = 100$  °C.



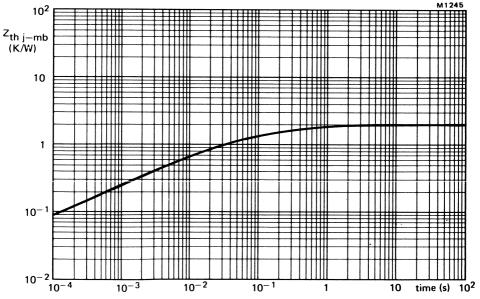


Fig.14 Transient thermal impedance.

### 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.

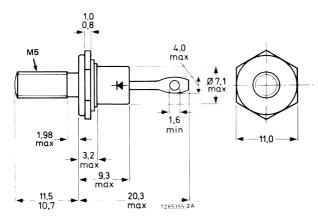
### QUICK REFERENCE DATA

		BYV2	4-800(R)	1000(R)	
Repetitive peak reverse voltage	$v_{RRM}$	max.	800	1000	V
Average forward current	l <sub>F(AV)</sub>	max.	1	2	Α
Non-repetitive peak forward current	<sup>I</sup> FSM	max.	15	0	Α
Reverse recovery time	<sup>t</sup> rr	<	45	0	ns

### MECHANICAL DATA

Dimensions in mm

Fig. 1 DO-4: with metric M5 stud ( $\phi$ 5 mm)



Net mass: 6 q

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\*

			BYV2	4-800(R	(R) 1000(R)	
Non-repetitive peak reverse voltage	$v_{RSM}$	max.		1000	1200	V
Repetitive peak reverse voltage	VRRM	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 $T_{mb} = 103$ $^{\rm o}{\rm C}$ sinusoidal; at $T_{mb} = 125$ $^{\rm o}{\rm C}$			l <sub>F</sub> (AV) l <sub>F</sub> (AV)	max. max.	12 7	A A
square-wave; $\delta$ = 0.5; up to T <sub>mb</sub> = square-wave; $\delta$ = 0.5; at T <sub>mb</sub> = 125			IF(AV) IF(AV)	max. max.	14 8	A A
R.M.S. forward current			IF(RMS)	max.	20	Α
Repetitive peak forward current			IFRM	max.	120	Α
Non-repetitive peak forward current t = 10 ms; half sine-wave; T <sub>j</sub> = 150 °C prior to surge; without re-applied voltage with re-applied V <sub>RWMmax</sub>			I <sub>FSM</sub> I <sub>FSM</sub>	max. max.	150 120	A A
$I^2$ t for fusing (t = 10 ms)			l²t	max.	72	$A^2s$
Temperatures						
Storage temperature			T <sub>stg</sub>	-55 to	+150	оС
Junction temperature			Тј	max.	150	οС
THERMAL RESISTANCE						
From junction to mounting base			R <sub>th j-mb</sub>	=	2.0	oC/W
From mounting base to heatsink with heatsink compound without heatsink compound	_		R <sub>th</sub> mb-h	=	0.3 0.5	oC/W
Transient thermal impedance; t = 1 m	S		Z <sub>th j-mb</sub>	=	0.85	oC/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.

<sup>\*</sup>To ensure thermal stability: R  $_{th\ j\text{-}a}$   $\leqslant$  8 °C/W (continuous reverse voltage).

		IST	

Forward voltage				
$I_F = 20 \text{ A}; T_j = 25 ^{\circ}\text{C}$	V <sub>F</sub>	< 1	1.7	V*
Reverse current				
$V_R = V_{RWMmax}$ ; $T_j = 125  {}^{\circ}C$	I <sub>R</sub>	<	1.5	mA
Reverse recovery when switched from I $_F$ = 10 A to V $_R$ $\geqslant$ 30 V with $-dI_F/dt$ = 10 A/ $\mu s$ ; T $_j$ = 25 $^o$ C Recovery time	t <sub>rr</sub>	<	450	ns
I <sub>F</sub> = 2 A to V <sub>R</sub> $\geqslant$ 30 V with $-dI_F/dt$ = 20 A/ $\mu s$ ; T <sub>j</sub> = 25 °C Recovered charge	$Q_{S}$	<	800	nC
Maximum slope of the reverse recovery current when switched from $I_F = 2 \text{ A to V}_R \ge 30 \text{ V}$ ; with $-dI_F/dt = 2 \text{ A/us} \cdot \text{T} := 25 \text{ °C}$	l dl p/dt l	_	7	Δ/με

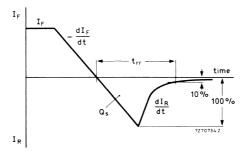


Fig.2 Definition of  $t_{rr}$  and  $Q_s$ .

<sup>\*</sup>Measured under pulse conditions to avoid excessive dissipation.

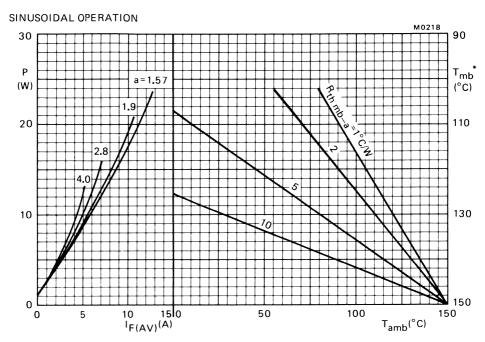


Fig.3 The right-hand part shows the interrelationship between the power (derived from the left-hand part) and the maximum permissible temperatures.

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

 $a = form factor = I_F(RMS)/I_F(AV)$ .

 $<sup>^*</sup>T_{mb}$  scale is for comparison purposes and is correct only for R $_{th\ mb\text{-}a}$  < 8  $^{o}C/W$ .

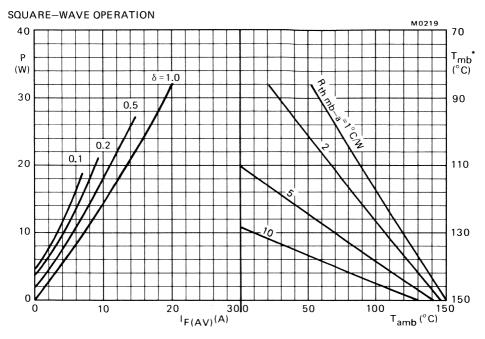


Fig.4 The right-hand part shows the interrelationship between the power (derived from the left-hand part) and the maximum permissible temperatures.

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

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

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

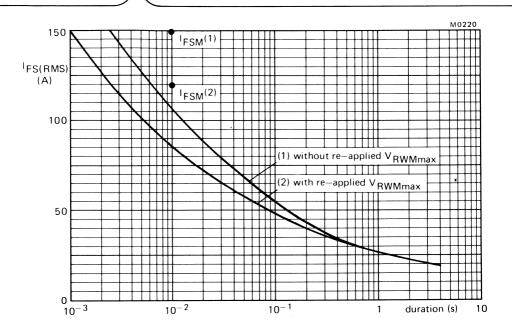


Fig.5 Maximum permissible non-repetitive r.m.s. forward current based on sinusoidal currents (f = 50 Hz);  $T_i = 150$   $^{\circ}$ C prior to surge.

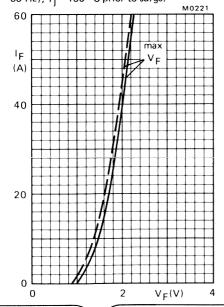




Fig.6. — 
$$T_j = 25$$
 °C; —  $T_j = 100$  °C.

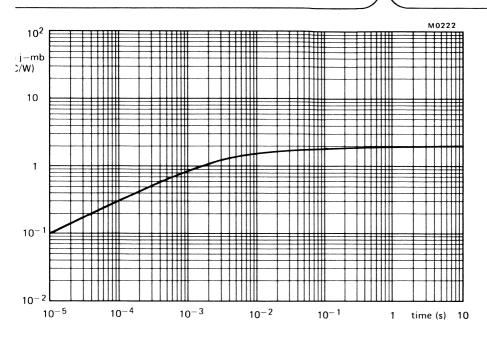


Fig.7



# 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.

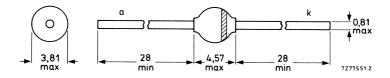
### QUICK REFERENCE DATA

		В	YV26A	26B	26C	26D	26E
Repetitive peak reverse voltage	$v_{RRM}$	max.	200	400	600	800	1000 V
Continuous reverse voltage	VR	max.	200	400	600	800	1000 V
Average forward current	l <sub>F(AV)</sub>	max.	1	1	1	1	1 A
Non-repetitive peak forward current	<sup>I</sup> FSM	max.	30	30	30	30	30 A <b>→</b>
Non-repetitive peak reverse energy	ERSM	max.	10	10	10	10	10 mJ
Reverse recovery time	t <sub>rr</sub>	<	30	30	30	75	75 ns

### **MECHANICAL DATA**

Fig. 1 SOD-57.

Dimensions in mm



The marking band indicates the cathode.

### **RATINGS**

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

			SYV26A	26B	26C	26D	26E	_
Repetitive peak reverse voltage	$v_{RRM}$	max.	200	400	600	800	1000	٧
Continuous reverse voltage	$V_{R}$	max.	200	400	600	800	1000	٧
Average forward current averaged over any 20 ms period $T_{tp} = 85  {}^{\circ}\text{C}$ ; lead length 10 mm $T_{amb} = 60  {}^{\circ}\text{C}$ ; see Fig. 2	IF(AV)	max.	-		1 0,65	1	1	A A
Repetitive peak forward current; see Figs 11 and 12	I <sub>FRM</sub>	max.			10			Α
Non-repetitive peak forward current $t = 10 \text{ ms}$ ; half-sinewave; $T_j = T_j \max$ prior to surge; $V_R = V_{RRMmax}$	<sup>I</sup> FSM	max.			30			Α
Non-repetitive peak reverse avalanche energ I <sub>R</sub> = 400 mA; T <sub>j</sub> = T <sub>j max</sub> prior to surge; with inductive load switched off	_	may			10			
	ERSM	max.		_				m
Storage temperature	$T_{stg}$			6	55 to + 1	75		0(
Junction temperature	т <sub>ј</sub>	max.			175			0(
THERMAL RESISTANCE								
Influence of mounting method								
1. Thermal resistance from junction to tie-point at a lead length of 10 mm 2. Thermal resistance from junction to ambient; device mounted on an 1,5 mm	R <sub>th j-tp</sub>	=			46			K
thick epoxy-glass printed-circuit board; Cu-thickness > 40 µm; Fig. 2	R <sub>th j-a</sub>	=			100			K

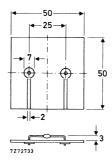


Fig. 2 Mounted on a printed-circuit board.

### **CHARACTERISTICS**

T<sub>i</sub> = 25 °C unless otherwise specified

1								
			BYV26A	26B	26C	26D	26E	
Forward voltage*						2.7		
IF = 1 A; T <sub>j</sub> = 175 °C	$V_{F}$	<	1,3	1,3	1,3	1,3	1,3 V*	
I <sub>F</sub> = 1 A	٧F	<	2,5	2,5	2,5	2,5	2,5 V	
Reverse avalanche breakdown voltage								
I <sub>R</sub> = 0,1 mA	$V_{(BR)R}$	>	300	500	700	900	1100 V	
Reverse current								
$V_R = V_{RRMmax}$	I <sub>R</sub>	<	5	5	5	5	5 μΑ	◄
$V_R = V_{RRMmax}$ ; $T_j = 165  {}^{\circ}\text{C}$	I <sub>R</sub>	<	150	150	150	150	150 μΑ	
Reverse recovery time when switched from								
$I_F = 0.5 A \text{ to } I_R = 1 A;$				,				
measured at $I_R = 0.25 A$				-				
for definition see Figs 3 and 4	t <sub>rr</sub>	<	30	30	30	75	75 ns	
				•	•	•		

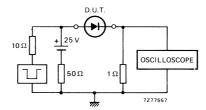


Fig. 3 Test circuit. Input impedance oscilloscope: 1 M $\Omega$ ; 22 pF; rise time < 7 ns. Source impedance: 50  $\Omega$ ; rise time < 15 ns.

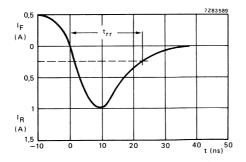


Fig. 4 Reverse recovery time characteristic.

<sup>\*</sup> Measured under pulse conditions to avoid excessive dissipation.

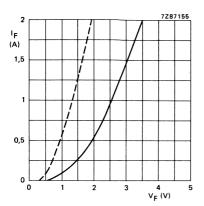
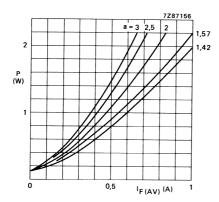


Fig. 5 Maximum forward voltage at  $T_j = 25$  °C ---  $T_j = 175$  °C.



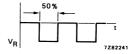


Fig. 6 Maximum steady state power dissipation (forward plus leakage current) excluding switching losses as a function of the average forward current.

The graph is for switched-mode application.

$$a = I_F(RMS)/I_F(AV);$$
  
 $V_R = V_{RRMmax}, \delta = 0,5.$ 

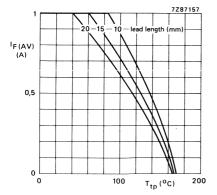
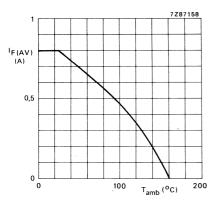
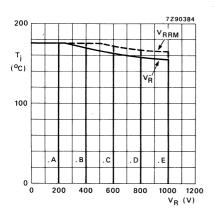


Fig. 7 Maximum average forward current as a function of the tie-point temperature; the curves include losses due to reverse leakage.

The graph is for switched-mode application.  $V_R = V_{RRMmax}$ ,  $\delta = 0.5$ ; a = 1.42.





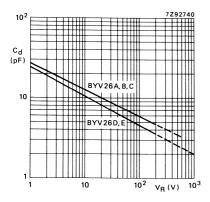


Fig. 8 Maximum average forward current as a function of the ambient temperature; the curve includes losses due to reverse leakage. Mounting method see Fig. 2. The graph is for switched-mode application.  $V_R = V_{RRMmax}$ ,  $\delta = 0.5$ ; a = 1.42.

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

Fig. 10 Capacitance versus voltage; typical values.

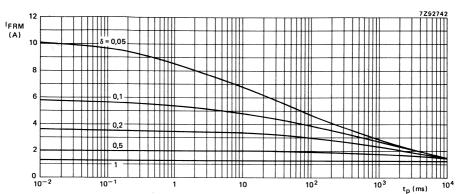


Fig. 11 Maximum repetitive peak forward current versus pulse time (square pulse) and duty factor  $\delta$  at  $T_{tp}$  = 85 °C;  $R_{th\ j-tp}$  = 46 K/W;  $V_{RRM}$  during 1 -  $\delta$ ; the curves include derating for  $T_{j\ max}$  at  $V_{RRM}$  = 1000 V.

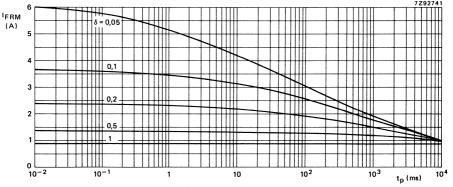


Fig. 12 Maximum repetitive peak forward current versus pulse time (square pulse) and duty factor  $\delta$  at  $T_{amb}$  = 60 °C;  $R_{th\ j-a}$  = 100 K/W;  $V_{RRM}$  during 1 -  $\delta$ ; the curves include derating for  $T_{j\ max}$  at  $V_{RRM}$  = 1000 V.

# 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.

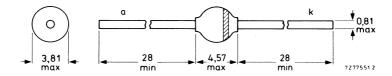
### QUICK REFERENCE DATA

		BYV2	7-50	100	150	200	
Repetitive peak reverse voltage	$v_{RRM}$	max.	50	100	150	200	V
Continuous reverse voltage	VR	max.	50	100	150	200	٧
Average forward current	l <sub>F(AV)</sub>	max.	2				Α
Non-repetitive peak reverse energy	E <sub>RSM</sub>	max.		4	0		mJ
Reverse recovery time	t <sub>rr</sub>	<		2	5		ns

### **MECHANICAL DATA**

Fig. 1 SOD-57.

Dimensions in mm



The marking band indicates the cathode.

The diodes are type-branded.

### **RATINGS**

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

		BYV2	7-50   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 °C; lead length = 10 mm $T_{amb}$ = 60 °C; Fig. 2	lF(AV) lF(AV)	max. max.	1,	2 3	A A
Repetitive peak forward current	<sup>I</sup> FRM	max.	1	5	Α
Non-repetitive peak forward current (t = 10 ms; half sine-wave) T <sub>j</sub> = T <sub>j</sub> max prior to surge; with reapplied V <sub>RRM</sub>	I <sub>FSM</sub>	max.	5	0	Α
Non-repetitive peak reverse avalanche energy; I <sub>R</sub> = 600 mA; prior to surge; with inductive load switched off:					
$T_j = 25$ °C, prior to surge	ERSM	max.	4	0	mJ
$T_j^i = T_{j \text{ max}}$ , prior to surge	ERSM	max.	2	0	mJ
Storage temperature	T <sub>stg</sub>		-65 to +17	5	oC
Junction temperature	Tj	max.	17	5	oC
THERMAL RESISTANCE					
Influence of mounting method					
Thermal resistance from junction to tie-point at a lead length of 10 mm	R <sub>th j-tp</sub>	=	4	6	K/W
<ol> <li>Thermal resistance from junction to ambient when mounted on a 1,5 mm thick epoxy-glass printed-circuit board;</li> </ol>	, ,				
Cu-thickness $\geq$ 40 $\mu$ m; Fig. 2	R <sub>th j-a</sub>	=	10	0	K/V

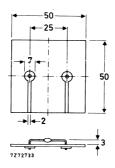


Fig. 2 Mounted on a printed-circuit board.

### **CHARACTERISTICS**

$T_i$	= 25	oC	unless	otherwise	specified
-------	------	----	--------	-----------	-----------

,		BYV	27-50	100	150	200	
Reverse avalanche breakdown voltage							
$I_R = 0.1 \text{ mA}$	$V_{(BR)R}$	>	55	110	165	220	V
Forward voltage*			***************************************				
I <sub>F</sub> = 3 A; T <sub>i</sub> = T <sub>i max</sub>	٧F	<		0	,88		V
I <sub>F</sub> = 3 A	$V_{F}$	<		1	,07		V
Reverse current							
$V_R = V_{RRMmax}$	<sup>I</sup> R	<			1		μΑ
$V_R = V_{RRMmax}$ ; $T_j = 165  {}^{\circ}\text{C}$	<sup>I</sup> R	<		•	150		μΑ
Reverse recovery time when switched from							
$I_F = 0.5 A$ to $I_R = 1 A$ ; measured at $I_R = 0.25 A$	t <sub>rr</sub>	<			25		ns
for definition see Figs 3 and 4							

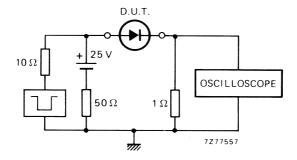


Fig. 3 Test circuit. Input impedance oscilloscope 1 M $\Omega$ ; 22 pF. Rise time  $\leq$  7 ns. Source impedance 50  $\Omega$ . Rise time  $\leq$  15 ns.

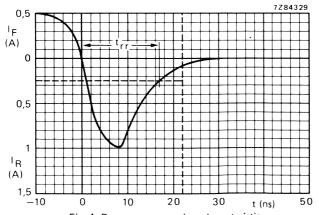


Fig. 4 Reverse recovery time characteristic.

<sup>\*</sup> 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/ $\mu$ s (see Fig. 5) recovered charge recovery time

 $\begin{array}{cccc} \mathrm{O_S} & & < & & 15 \text{ nC} \\ \mathrm{t_{rr}} & & < & & 50 \text{ ns} \end{array}$ 

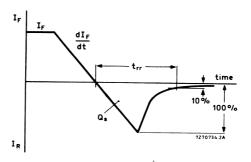


Fig. 5 Definitions of  $t_{rr}$  and  $Q_s$ .

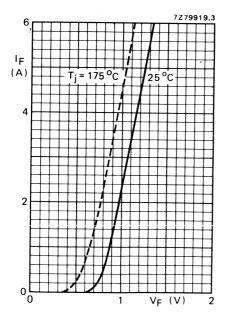


Fig.6 Maximum forward voltage.

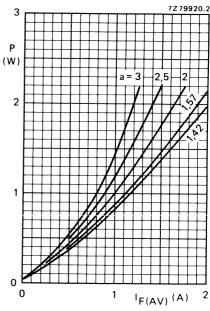


Fig. 7 a = IF(RMS)/IF(AV); VR = VRRMmax. Pulsed reverse voltage;  $\delta = 0.5$ . (Including reverse current losses and switching losses up to f = 200 kHz).

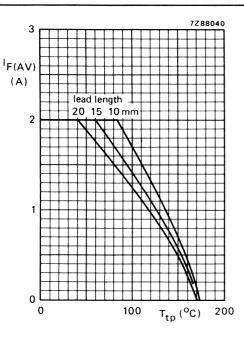


Fig. 8 Maximum average forward current. The curves include losses due to reverse current and switching up to f = 200 kHz. Pulsed reverse voltage,  $\delta$  = 0,5. V R = V R R Mmax. Square wave current, a = 1,42.

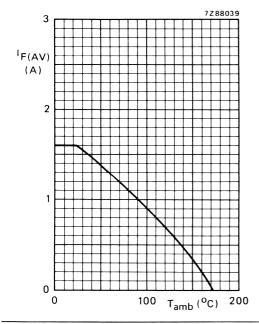


Fig. 9 Maximum average forward current. The curve includes losses due to reverse current and switching up to f = 200 kHz. Mounting method see Fig. 2. Pulsed reverse voltage,  $\delta$  = 0,5 V  $_{\rm R}$  = V  $_{\rm RRMmax}$  . Square wave current, a = 1,42.

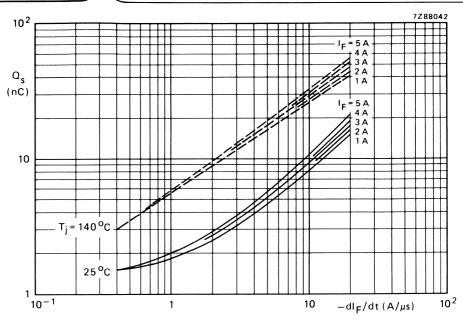


Fig. 10 Maximum values reverse recovery charge. For definition see Fig. 5.

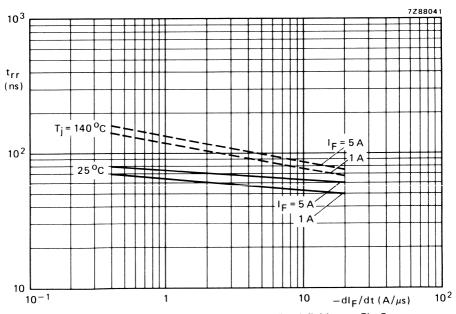


Fig. 11 Maximum values reverse recovery time. For definition see Fig. 5.

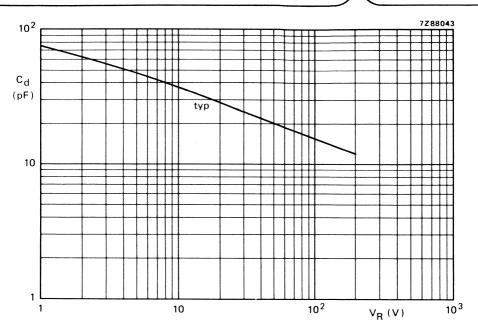


Fig. 12 Typical values diode capacitance at f = 1 MHz;  $T_i$  = 25 °C.

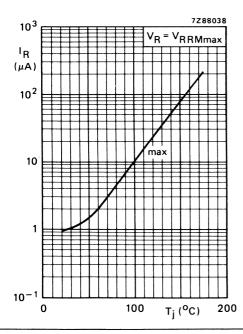


Fig. 13 Maximum values reverse current.



# **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.

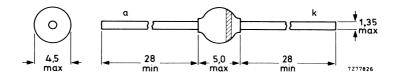
### QUICK REFERENCE DATA

		BYV2	8-50	100   150		200	
Repetitive peak reverse voltage	$v_{RRM}$	max.	50	100	150	200	V
Continuous reverse voltage	VR	max.	50	100	150	200	V
Average forward current	I <sub>F</sub> (AV)	max.		3,	5		Α
Non-repetitive peak reverse energy	E <sub>RSM</sub>	max.		40			mJ
Reverse recovery time	t <sub>rr</sub>	< 30				ns	

### **MECHANICAL DATA**

Fig. 1 SOD-64.

Dimensions in mm



The marking band indicates the cathode.

The diodes are type-branded.

### **RATINGS**

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

		BYV2	8-50	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)							
$T_{tp} = 85  {}^{\circ}\text{C}$ ; lead length = 10 mm	F(AV)	max.			3,5		Α
$T_{amb} = 60$ °C; p.c.b. mounting (see Fig. 2)	<sup>I</sup> F(AV)	max.			1,9		Α
Repetitive peak forward current	<sup> </sup> FRM	max.			25		Α
Non-repetitive peak forward current (t = 10 ms; half sine-wave) $T_j = T_{j \text{ max}}$ prior to surge; with reapplied $V_{RRM}$	<sup>I</sup> FSM	max.			90		Α
Non-repetitive peak reverse avalanche energy; I <sub>R</sub> = 600 mA; with inductive load switched off							
$T_j = 25$ °C, prior to surge	ERSM	max.			40		mJ
$T_j = T_{j \text{ max}}$ , prior to surge	ERSM	max.			20		mJ
Storage temperature	$T_{stg}$		6	5 to +1	75		oC .
Junction temperature	Тj	max.		1	75		οС
THERMAL RESISTANCE							
Influence of mounting method							
Thermal resistance from junction to tie-point at a lead length of 10 mm	R <sub>th j-tp</sub>	=			25		K/W
<ol> <li>Thermal resistance from junction to ambient when mounted on a 1,5 mm thick epoxy-glass printed-circuit board;</li> </ol>							
Cu-thickness $\geq$ 40 $\mu$ m; Fig. 2	R <sub>th j-a</sub>	=			75		K/W

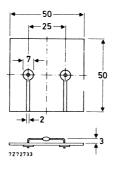


Fig. 2 Mounted on a printed-circuit board.

### **CHARACTERISTICS**

T<sub>i</sub> = 25 °C, unless otherwise specified

Reverse avalanche breakdown voltage		BYV28-50		100	150	200	
I <sub>R</sub> = 0,1 mA	V <sub>(BR)R</sub>	>	55	110	165	220	٧
Forward voltage*			-		,——		
I <sub>F</sub> = 5 A;	٧ <sub>F</sub>	<		1,	10		V
$I_F = 5 A; T_j = T_{j max}$	٧F	<		0,	89		٧
Reverse current							
$V_R = V_{RRMmax}$	1 <sub>R</sub>	<			1		μΑ
V <sub>R</sub> = V <sub>RRMmax</sub> ; T <sub>j</sub> = 165 °C	IR	<		1	50		μΑ
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 <sub>rr</sub>	<			30		ns

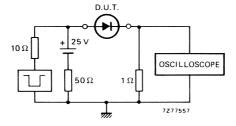


Fig. 3 Test circuit. Input impedance oscilloscope 1 M $\Omega$ ; 22 pF; Rise time  $\leq$  7 ns. Source impedance 50  $\Omega$ . Rise time  $\leq$  15 ns.

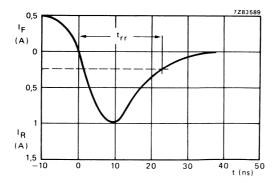


Fig. 4 Reverse recovery time characteristic.

<sup>\*</sup> Measured under pulse conditions to avoid excessive dissipation.

## **BYV28 SERIES**

Reverse recovery when switched from  $I_F = 1 \text{ A to V}_R \geqslant 30 \text{ V with}$   $-dI_F/dt = 20 \text{ A}/\mu\text{s}$  (see Fig. 5) recovered charge recovery time

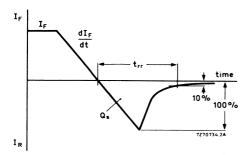


Fig. 5 Definitions of  $t_{rr}$  and  $Q_s$ .

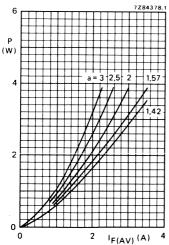


Fig. 7 Power dissipation (forward plus leakage current) as a function of the average forward current. Pulsed reverse voltage;  $\delta = 50\%$ .  $a = I_F(RMS)/I_F(AV)$ ;  $V_R = V_RRMmax$ .



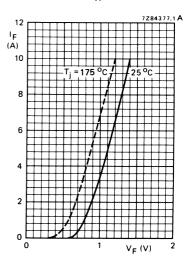


Fig.6 Maximum forward voltage.

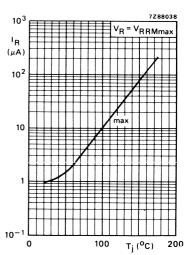


Fig. 8 Reverse current as a function of the junction temperature

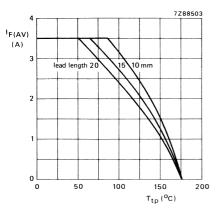


Fig. 9 Maximum average forward current. The curves include losses due to reverse current and switching up to f = 200 kHz. Pulsed reverse voltage;  $\delta$  = 0,5 V  $_{R}$  = V  $_{RRM\ max}$  Square-wave current; a = 1,42.

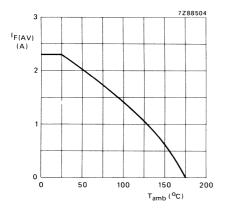


Fig. 10 Maximum average forward current. The curve includes losses due to reverse current and switching up to f = 200 kHz; mounting method see Fig. 2.

Pulsed reverse voltage;  $\delta$  = 0,5 V<sub>R</sub> = V<sub>RRM</sub> max-Square-wave current; a = 1,42.

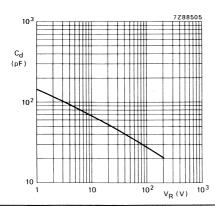


Fig. 11 Typical values diode capacitance at f=1 MHz.  $T_j=25$  °C.

# 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.

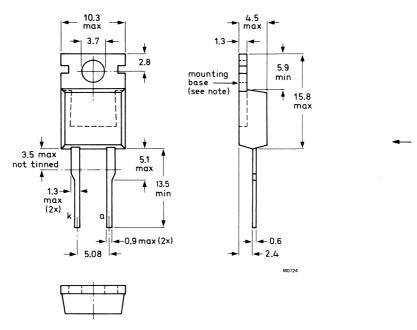
### QUICK REFERENCE DATA

			BYV29-300	400	500	
Repetitive peak reverse voltage	$v_{RRM}$	max.	300	400	500	٧
Average forward current	<sup>I</sup> F(AV)	max.		9		Α
Forward voltage	٧F	<		1.05		V
Reverse recovery time	t <sub>rr</sub>	· <		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.

# **BYV29 SERIES**

### **RATINGS**

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

500	
500	V
400	V
400	V
<u> </u>	
	Α
	Α
	Α
	Α
	Α
	Α
	$A^2s$
	οС
	oC
_	500 400

### Notes:

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

mΑ

1.05

0.35

1.4

### **CHARACTERISTICS**

T<sub>i</sub> = 25 °C unless otherwise stated

Forward voltage

$$I_F = 5 \text{ A}; T_j = 100 \text{ }^{\circ}\text{C}$$
  
 $I_F = 20 \text{ A}$ 

Reverse current

$$V_R = V_{RWM max}$$
;  $T_j = 100 \, {}^{o}C$   
 $V_R = V_{RWM max}$ 

Reverse recovery when switched from

I F = 1 A to V 
$$_{R} \geqslant$$
 30 V with  $-dI_{F}/dt$  = 100 A/ $\mu$ s; recovery time

IF = 2 A to VR 
$$\geqslant$$
 30 V with  $-dI_F/dt$  = 20 A/ $\mu$ s; recovered charge

$$I_F = 10 \text{ A to V}_R \geqslant 30 \text{ V with } -dI_F/dt = 50 \text{ A}/\mu\text{s};$$
  
 $T_i = 100 \,^{\circ}\text{C}$ ; peak recovery current

Forward recovery when switched to  $I_F = 10 \text{ A}$ with  $dI_F/dt = 10 \text{ A}/\mu\text{s}$ 

<sup>I</sup> R	<	10	μA <b>-</b>
t <sub>rr</sub>	<	50	ns
$o_s$	<	55	nC
IRRM	<	5.5	• A • <b>←</b>
$V_{fr}$	typ.	2.5	V

<

٧F

1<sub>R</sub>

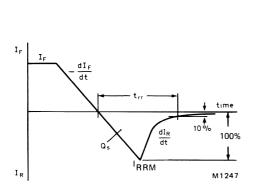


Fig.2 Definition of  $t_{rr},\, Q_{s}$  and  $I_{RRM}.$ 

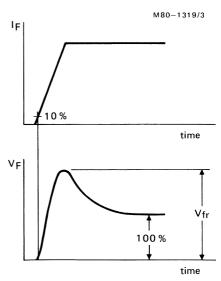


Fig.3 Definition of Vfr.

<sup>\*</sup>Measured under pulse conditions to avoid excessive dissipation.

# **BYV29 SERIES**

THERMAL RESISTANCE From junction to mounting base			0.5	14 044
•	R <sub>th j-mb</sub>	=	2.5	K/W
Influence of mounting method				
<ol> <li>Heatsink-mounted with clip (see mounting instructions)</li> </ol>				
Thermal resistance from mounting base to heatsink				
a. with heatsink compound	R <sub>th mb-h</sub>	=	0.3	K/W
<ul> <li>with heatsink compound and 0.06 mm maximum mica insulator</li> </ul>	R <sub>th mb-h</sub>	=	1.4	K/W
<ul> <li>with heatsink compound and 0.1 mm maximum mica insulator (56369)</li> </ul>	R <sub>th mb-h</sub>	=	2.2	K/W
<ul> <li>with heatsink compound and 0.25 mm maximum alumina insulator (56367)</li> </ul>	R <sub>th mb-h</sub>	=	0.8	K/W
e. without heatsink compound	R <sub>th mb-h</sub>	=	1.4	K/W
2. Free air operation				
The quoted value of $R_{th\ j-a}$ should be used only when no leads of to the same tie point.  Thermal resistance from junction to ambient in free air: mounted on a printed circuit board at any device lead	other dissipati	ing con	nponent	s run
length and with copper laminate on the board	R <sub>th j-a</sub>	=	60	K/W

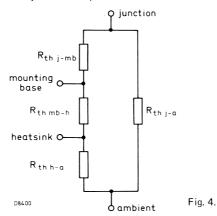
#### MOUNTING INSTRUCTIONS

- 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<sub>th mb-h</sub> 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<sub>th mb-h</sub> given for mounting with heatsink compound refer to the use of a metallic oxide-loaded compound. Ordinary silicone grease is not recommended.
- 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.



- 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  $R_{th\ mb-a}$ . The heatsink thermal resistance value ( $R_{th\ h-a}$ ) can be calculated from:

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

## **BYV29 SERIES**

#### SQUARE-WAVE OPERATION

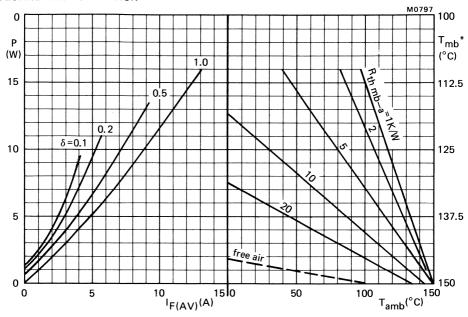


Fig.5 The right-hand part shows the relationship between the power (derived from the left-hand part) and the maximum permissible temperatures.

$$\begin{array}{c|c}
 & tp & T \\
 & \delta = \frac{tp}{T}
\end{array}$$

$$\begin{array}{c|c}
 & \delta = \frac{tp}{T}
\end{array}$$

$$\begin{array}{c|c}
 & \delta = \frac{tp}{T}
\end{array}$$

$$\begin{array}{c|c}
 & \delta = \frac{tp}{T}
\end{array}$$

 $<sup>^*</sup>T_{mb}$  scale is for comparison purposes and is correct only for R  $_{th\ mb\text{-}a}$  < 4.1  $^o$  K/W.

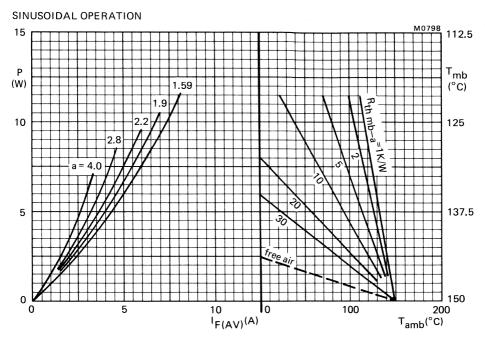


Fig.6 The right-hand part shows the interrelationship between the power (derived from the left-hand part) and the maximum permissible temperatures.  $a = form\ factor = I_F(RMS)/I_F(AV)$ .

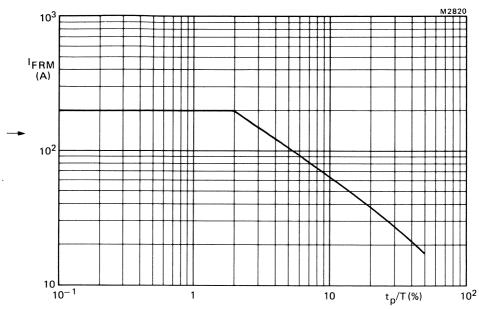
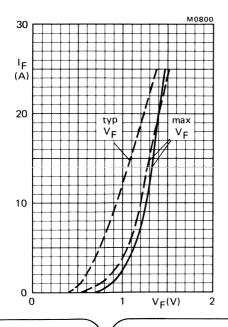


Fig.7 Maximum permissible repetitive peak forward current for square or sinusoidal currents; 1  $\mu s < t_p < 1$  ms.



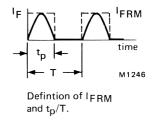


Fig.8 ——  $T_j = 25$  °C;  $---T_j = 100$  °C.

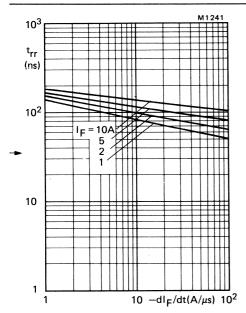


Fig.9 Maximum  $t_{rr}$  at  $T_i = 25$  °C.

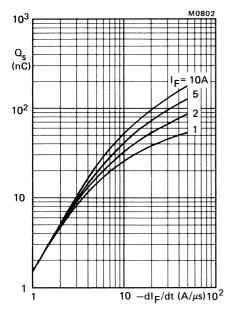


Fig.11 Maximum  $Q_s$  at  $T_j$  = 25  $^{o}$ C.

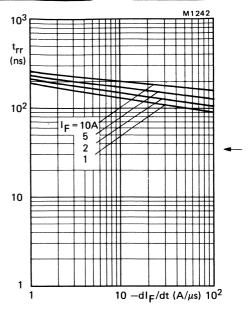


Fig.10 Maximum  $t_{rr}$  at  $T_j = 100$  °C.

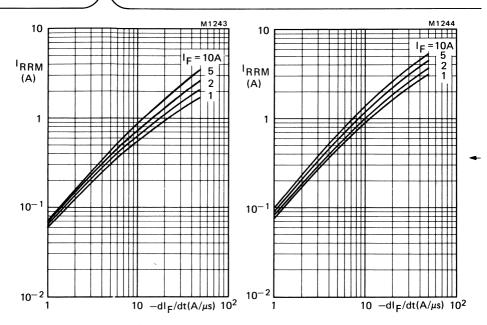


Fig.12 Maximum  $I_{RRM}$  at  $T_j = 25$  °C.

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

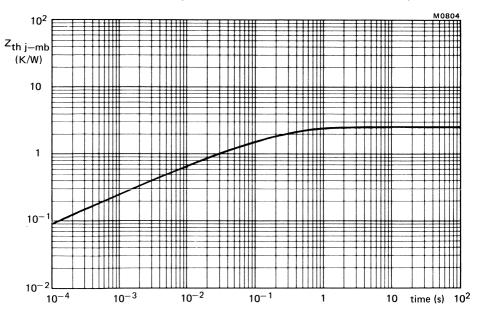


Fig.14 Transient thermal impedance.

# ULTRA FAST RECOVERY ELECTRICALLY ISOLATED RECTIFIER DIODES

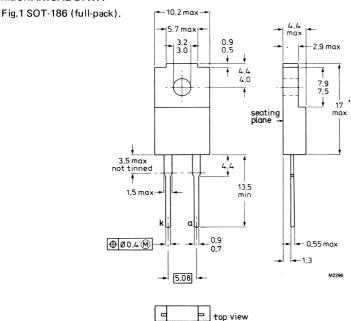
Glass-passivated, high-efficiency epitaxial rectifier diodes in full-pack envelopes, featuring low forward voltage drop, ultra fast reverse recovery times with very low stored charge and soft-recovery characteristic. Their electrical isolation makes them ideal for mounting on a common heatsink alongside 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**

		BYV29	F-300	400	500	
Repetitive peak reverse voltage	$v_{RRM}$	max.	300	400	500	V
Average foward current	lF(AV)	max.		9		Α
Forward voltage	٧ <sub>F</sub>	<		1.05		, V
Reverse recovery time	t <sub>rr</sub>	<		50		ns

#### MECHANICAL DATA

Dimensions in mm



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).

## BYV29F SERIES

#### **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 <sub>RWM</sub>	max.	200	300	400	V
Continuous reverse voltage (note 1)	VR	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 <sub>mb</sub> = 76 °C sinusoidal; up to T <sub>mb</sub> = 87 °C	lF(AV) lF(AV)	max. max.		9		A A
R.M.S. forward current		max.		13		Ā
Repetitive peak forward current	<sup>I</sup> F(RMS)	max.		13		
$t_p = 20 \mu s$ ; $\delta = 0.02$	IFRM	max.		200		Α
Non-repetitive peak forward current half sine-wave; T <sub>j</sub> = 150 <sup>O</sup> C prior to surge; with reapplied V <sub>RWM max</sub>						
t = 10 ms	<sup> </sup> FSM	max.		100		Α
t = 8.3 ms	<sup>I</sup> FSM	max.		110		Α
$I^2$ t for fusing (t = 10 ms)	l²t	max.		50		$A^2s$
Temperatures						
Storage temperature	$T_{stg}$		-40 to	+150		oC
Junction temperature	Tj	max.		150		oC
ISOLATION						
Peak isolation voltage from all terminals to external heatsink	V <sub>isol</sub>	max.		1000		V
Isolation capacitance from cathode to external heatsink (note 3)	Cp	typ.		12		pF

#### Notes:

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

without heatsink compound

R <sub>th i-h</sub>	=	5.5	K/W
R <sub>th i-h</sub>	=	7.2	K/W

#### Free-air operation

The quoted value of  $R_{th\ j-a}$  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

$$R_{th i-a} = 55 K/W$$

#### **CHARACTERISTICS**

Forward voltage

$$I_F = 5 A$$
;  $T_j = 100 °C$   
 $I_F = 20 A$ ;  $T_i = 25 °C$ 

Reverse current

$$V_R = V_{RWM max}$$
;  $T_j = 100 \, {}^{o}C$   
 $V_R = V_{RWM max}$ ;  $T_j = 25 \, {}^{o}C$ 

Reverse recovery when switched from

I<sub>F</sub> = 1 A to 
$$V_R \ge 30$$
 V with  $-dI_F/dt = 100$  A/ $\mu$ s;  $T_i = 25$  °C; recovery time

$$I_F = 2 \text{ A to V}_R \geqslant 30 \text{ V with } -dI_F/dt = 20 \text{ A}/\mu\text{s};$$
  
 $T_i = 25 \,^{\circ}\text{C}$ ; recovered charge

IF = 10 A to V<sub>R</sub> 
$$\geqslant$$
 30 V with  $-dI_F/dt$  = 50 A/ $\mu$ s;  
T<sub>j</sub> = 100 °C; peak recovery current

Forward recovery when switched to I<sub>F</sub> = 10 A with dI<sub>F</sub>/dt = 10 A/µs; T<sub>I</sub> = 25 °C

٧F	<	1.05	V*
٧F	<	1.4	V*

$$l_R$$
 < 0.35 mA  $l_R$  < 10  $\mu$ A

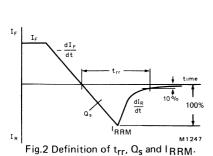
$$t_{rr}$$
 < 50 ns

55

nC

<

Qç



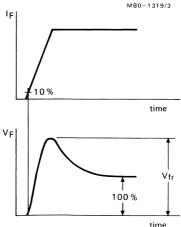


Fig.3 Definition of Vfr.

<sup>\*</sup>Measured under pulse conditions to avoid excessive dissipation

#### MOUNTING INSTRUCTIONS

- 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<sub>th j-h</sub> 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:

  Maximum torque to avoid damage to the device:

  5.5 kgf (0.55 Nm)
  8.0 kgf (0.80 Nm)
- 5. For good thermal contact, heatsink compound should be used between baseplate and heatsink. Values of R<sub>th j-h</sub> given for mounting with heatsink compound refer to the use of a metallic-oxide loaded compound. Ordinary silicone grease is not recommended.
- 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.
- 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.

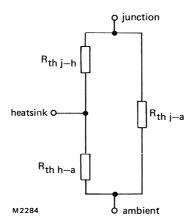
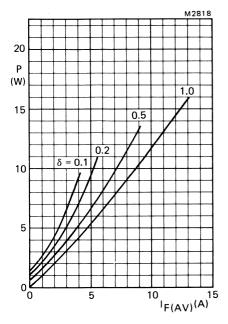


Fig.4.

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

#### SOUARE-WAVE OPERATION

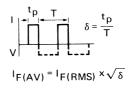


#### Fig.5 Power rating.

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.



#### SINUSOIDAL OPERATION

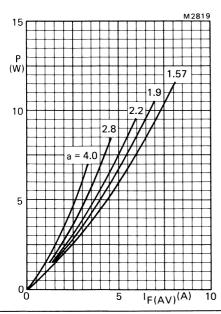


Fig.6 Power rating.

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.

$$a = form factor = IF(RMS)/IF(AV)$$

## **BYV29F SERIES**

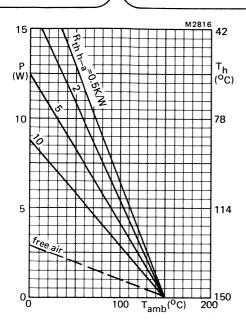


Fig.7 Heatsink rating; without heatsink compound.

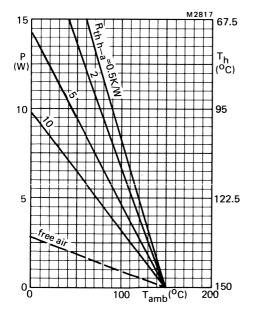


Fig.8 Heatsink rating; with heatsink compound.

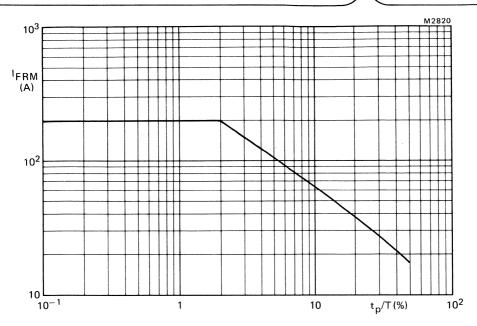
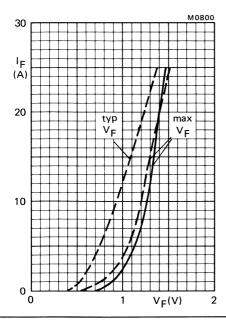


Fig.9 Maximum permissible repetitive peak forward current for square or sinusoidal currents; 1  $\mu s < t_{\rm p} < 1$  ms.



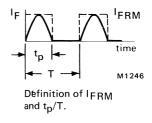


Fig.10 —— 
$$T_j = 25$$
 °C;  $---T_j = 100$  °C.

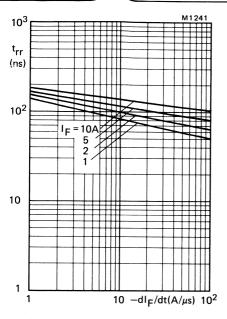


Fig.11 Maximum  $t_{rr}$  at  $T_j = 25$  °C.

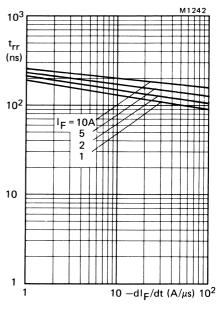


Fig. 12 Maximum  $t_{rr}$  at  $T_i = 100$  °C.

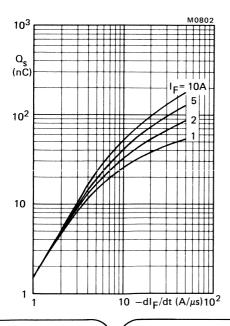


Fig.13 Maximum  $Q_s$  at  $T_j = 25$  °C.

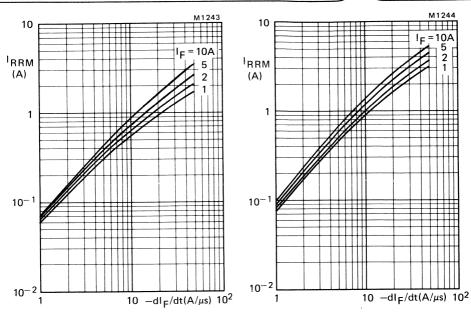


Fig.14 Maximum  $I_{RRM}$  at  $T_j = 25$  °C.



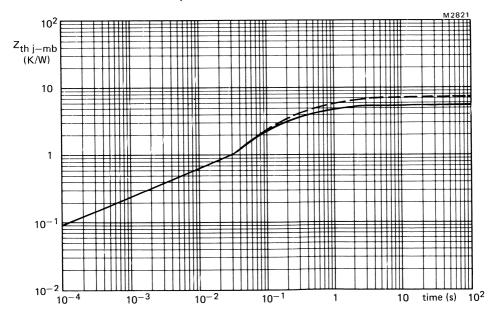


Fig. 16 Transient thermal impedance; —— with heatsink compound; — — — without heatsink compound.

#### **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

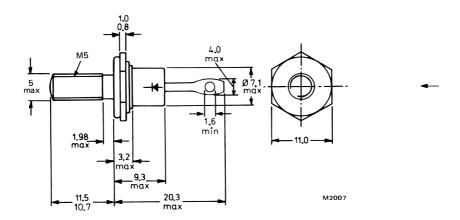
			BYV30-300	400	500	
Repetitive peak reverse voltage	$V_{RRM}$	max.	300	400	500	<b>V</b>
Average forward current	I <sub>F(AV)</sub>	max.		14		Α
Forward voltage	VF	<		1.05		V
Reverse recovery time	t <sub>rr</sub>	<		50		ns

#### **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)

## **BYV30 SERIES**

#### --- 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 <sub>mb</sub> up to T <sub>mb</sub>	= 113 <sup>o</sup> C	IF(AV) IF(AV)	max. max.	14 10	A A
sinusoidal; up to T <sub>mb</sub> = 118 °C		l <sub>F(AV)</sub>	max.	12.5	Α
up to T <sub>mb</sub> = 125 °C		IF(AV)	max.	10	Â
R.M.S. forward current		IF(RMS)	max.	20	Α
Repetitive peak forward current $t_p = 20 \mu s$ ; $\delta = 0.02$		IFRM	max.	320	A
Non-repetitive peak forward currer half sine-wave; T <sub>j</sub> = 150 °C prior with reapplied V <sub>RWMmax</sub> ; t = 10 ms t = 8.3 ms		I <sub>FSM</sub> I <sub>FSM</sub>	max. max.	150 180	A A
I <sup>2</sup> t for fusing (t = 10 ms)		l²t	max.	112	$A^2s$
Temperatures					
Storage temperature		$T_{stg}$	-6	65 to +175	oC
Junction temperature		Tj	max.	150	oC
 THERMAL RESISTANCE					
From junction to mounting base		R <sub>th j-mb</sub>	=	2.0	K/W
From mounting base to heatsink with heatsink compound		R <sub>th mb-h</sub>	=	0.3	K/W
From junction to ambient in free air		R <sub>th j-a</sub>	=	50	K/W

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

	RIST	

Forward voitage	е
$I_F = 15 A; T$	<sub>i</sub> = 150 <sup>o</sup> C
IF = 50 A; T	= 25 °C

$$V_{F}$$
 < 1.05  $V_{T}$  < 1.40  $V_{T}$ 

Reverse current

$$V_R = V_{RWM max}$$
;  $T_j = 100 \, {}^{o}C$   
 $T_j = 25 \, {}^{o}C$ 

Reverse recovery when switched from

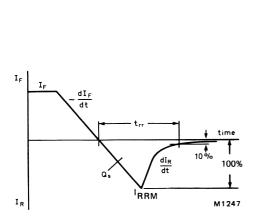
$$I_F$$
 = 1 A to  $V_R \geqslant$  30 V with  $-dI_F/dt$  = 100 A/ $\mu$ s;  $T_i$  = 25 °C; recovery time

$$t_{rr}$$
  $<$  50 ns

I<sub>F</sub> = 2 A to 
$$V_R \ge 30 V$$
 with  $-dI_F/dt = 20 A/\mu s$ ;  $T_i = 25 \, ^{O}C$ ; recovered charge

$$I_F$$
 = 10 A to  $V_R \geqslant$  30 V with  $-dI_F/dt$  = 50 A/ $\mu$ s;  $T_i$  = 100 °C; peak recovery current

Forward recovery when switched to 
$$I_F = 10 \text{ A}$$
  
with  $dI_F/dt = 10 \text{ A}/\mu\text{s}$ ;  $T_i = 25 \text{ }^{\circ}\text{C}$ 



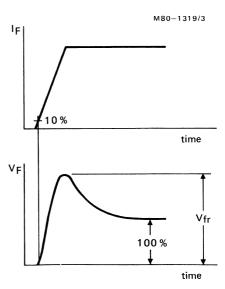


Fig.2 Definition of  $t_{rr}$ ,  $Q_s$  and  $I_{RRM}$ .

Fig.3 Definition of Vfr.

<sup>\*</sup>Measured under pulse conditions to avoid excessive dissipation.

#### SQUARE-WAVE OPERATION

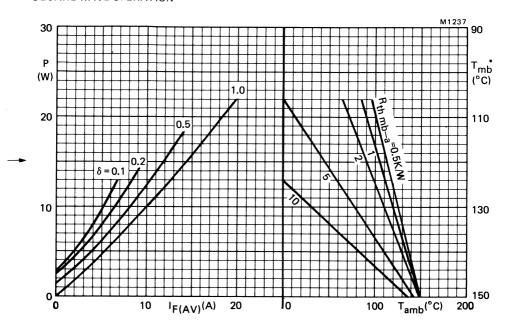


Fig.4 The right-hand part shows the relationship between the power (derived from the left-hand part) and the maximum permissible temperatures. Power includes reverse current losses and switching losses up to f = 100 kHz.

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

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

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

#### SINUSOIDAL OPERATION

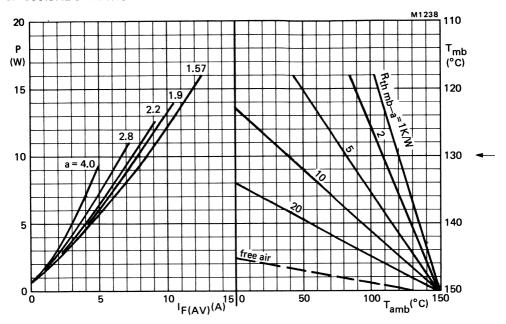


Fig.5 The right-hand part shows the interrelationship between the power (derived from the left-hand part) and the maximum permissible temperatures.

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

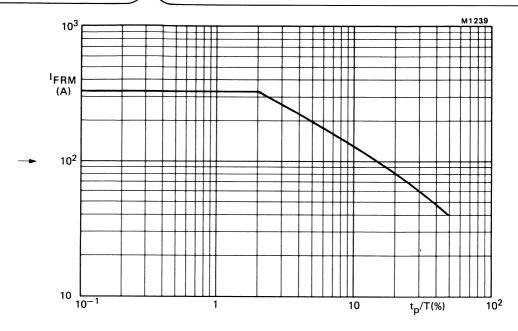
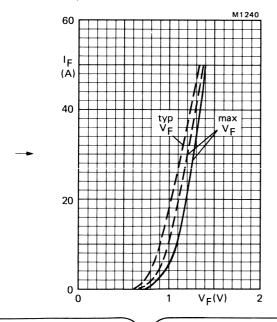
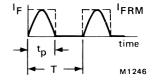


Fig.6 Maximum permissible repetitive peak forward current for square or sinusoidal currents; 1  $\mu s < t_p < 1$  ms.





Definition of  $I_{FRM}$  and  $t_p/T$ .

Fig.7 — 
$$T_j = 25$$
 °C;  $---T_j = 150$  °C.

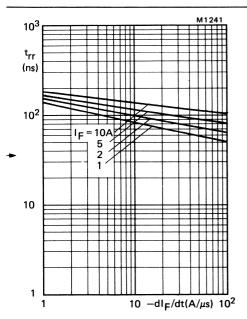
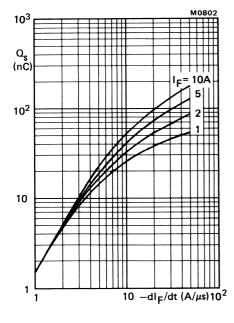


Fig.8 Maximum  $t_{rr}$  at  $T_j = 25$  °C



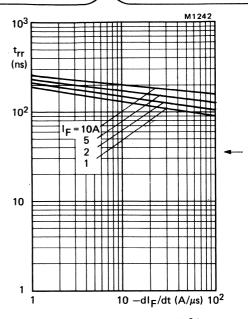
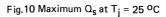


Fig.9 Maximum  $t_{rr}$  at  $T_j$  = 100 °C.



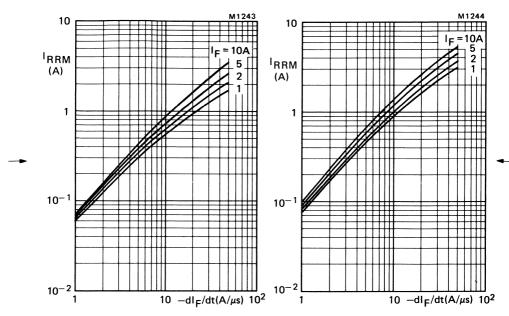


Fig.11 Maximum  $I_{RRM}$  at  $T_j = 25$  °C

Fig.12 Maximum  $I_{RRM}$  at  $T_j = 100$  °C.

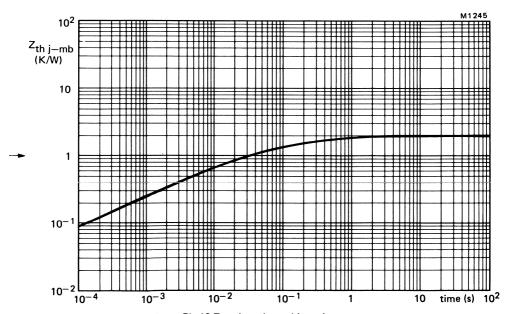


Fig.13 Transient thermal impedance.

### 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 both low conduction and switching losses are essential. The series consists of normal polarity (cathode to stud) types.

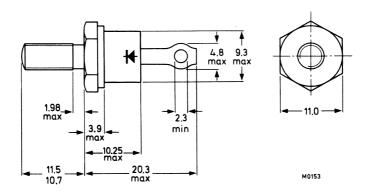
#### QUICK REFERENCE DATA

			BYV31-300	400	500	
Repetitive peak reverse voltage	$V_{RRM}$	max	300	400	500	V
Average forward current	I <sub>F(AV)</sub>	max.		28		Α
Forward voltage	VF	<		1.05		V
Reverse recovery time	t <sub>rr</sub>	<		50		ns

#### MECHANICAL DATA

Dimensions in mm

Fig.1 DO-4; with metric M5 stud ( $\phi$ 5 mm); e.g. BYV31-500 with 10-32 UNF stud ( $\phi$ 4.83 mm); e.g. BYV31-500U



Net mass: 7 q

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*	VR	max.	200	300	400	V
Currents						
Average forward current, switching losses negligible up to 100 kHz						
square wave; $\delta = 0.5$ ; up to $T_{mb}$			F(AV)	max.	28	Α
up to T <sub>mb</sub>	= 125 °C		<sup>I</sup> F(AV)	max.	20	Α
sinusoidal; up to $T_{mb} = 119  {}^{\circ}C$			IF(AV)	max.	25	A
up to $T_{mb} = 125  {}^{\circ}C$			IF(AV)	max.	21	A
R.M.S. forward current			<sup>I</sup> F(RMS)	max.	40	Α
Repetitive peak forward current $t_p = 20 \mu s$ ; $\delta = 0.02$			I <sub>FRM</sub>	max.	550	Α
Non-repetitive peak forward curren half sine-wave; T <sub>j</sub> = 150 °C prior with reapplied V <sub>RWMmax</sub> ;						
t = 10 ms			<sup>I</sup> FSM	max.	300	Α
t = 8.3 ms			IFSM	max.	360	Α
$I^2$ t for fusing (t = 10 ms)			l² t	max.	450	$A^2s$
Temperatures						
Storage temperature			$T_{stg}$	-55 to	+150	oC
Junction temperature			$T_{j}$	max.	150	oC
THERMAL RESISTANCE						
From junction to mounting base			R <sub>th j-mb</sub>	=	1.0	K/W
From mounting base to heatsink						
a. with heatsink compound			Rth mb-h	=	0.3	K/W
b. without heatsink compound			R <sub>th mb-h</sub>	=	0.5	K/W

#### MOUNTING INSTRUCTIONS

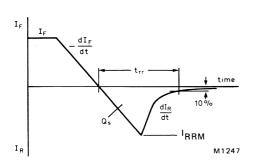
The top connector should be neither bent nor twisted; it should be soldered into the circuit so that there is no strain on it.

During soldering the heat conduction to the junction should be kept to a minimum.

<sup>\*</sup>To ensure thermal stability:  $R_{th\ j-a} \leq 3.4\ K/W$ .

#### **CHARACTERISTICS**

Forward voltage $I_F = 30 \text{ A}; T_j = 150 ^{\circ}\text{C}$ $I_F = 100 \text{ A}; T_j = 25 ^{\circ}\text{C}$	V <sub>F</sub>	< <	1.05 1.4	V* V*
Reverse current $V_R = V_{RWM\ max}$ ; $T_j = 100\ ^{o}\text{C}$ $T_j = 25\ ^{o}\text{C}$	I <sub>R</sub>	< <	2.0 50	mΑ μΑ
Reverse recovery when switched from $I_F = 1 \text{ A to V}_R \geqslant 30 \text{ V with } -dI_F/dt = 100 \text{ A}/\mu\text{s};$ $T_j = 25 ^{\circ}\text{C};$ recovery time	t <sub>rr</sub>	<	50	ns
$I_F = 2 \text{ A to } V_R \geqslant 30 \text{ V with } -dI_F/dt = 20 \text{ A}/\mu\text{s};$ $T_j = 25 ^{\circ}\text{C}$ ; recovered charge	$O_s$	< ,	75	nC
I <sub>F</sub> = 10 A to $V_R \ge 30 \text{ V}$ with $-\text{dI}_F/\text{dt} = 50 \text{ A}/\mu\text{s}$ ; $T_j = 100 ^{\circ}\text{C}$ ; peak recovery current	<sup>I</sup> RRM	< 1	4	Α
Forward recovery when switched to $I_F = 10 \text{ A}$ with $dI_F/dt = 10 \text{ A}/\mu s$ ; $T_j = 25  ^{O}C$	$V_{fr}$	typ.	2.5	٧



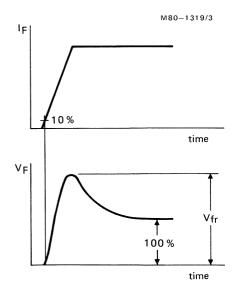


Fig.2 Definition of  $t_{rr},\, Q_{s}$  and  $I_{R\,RM}.$ 

Fig.3 Definition of  $V_{fr}$ .

<sup>\*</sup>Measured under pulse conditions to avoid excessive dissipation.

## **BYV31 SERIES**

#### SQUARE-WAVE OPERATION

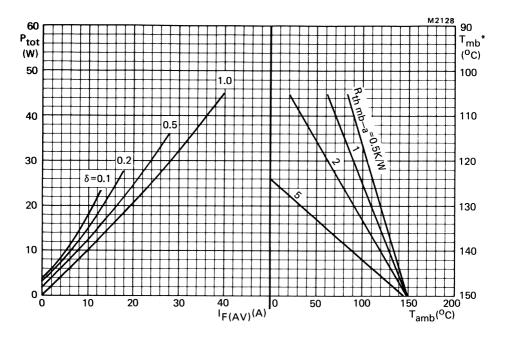


Fig.4 The right-hand part shows the relationship between the power (derived from the left-hand part) and the maximum permissible temperatures. Power includes reverse current losses and switching losses up to f = 100 kHz.

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

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

 $<sup>^*</sup>T_{mb}$  scale is for comparison purposes and is correct only for R<sub>th mb-a</sub> < 2.4 K/W.

#### SINUSOIDAL OPERATION

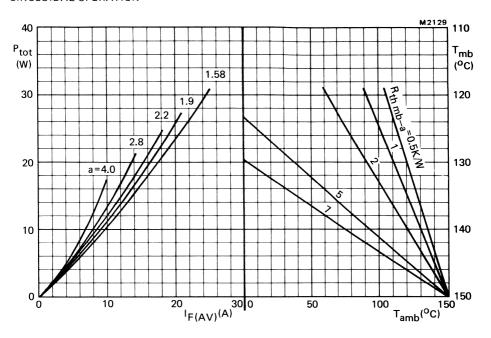


Fig.5 The right-hand part shows the interrelationship between the power (derived from the left-hand part) and the maximum permissible temperatures.  $a = form\ factor = I_F(RMS)/I_F(AV)$ .

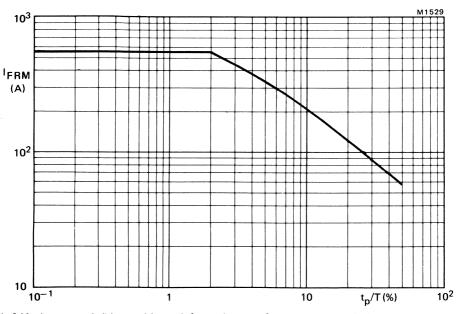
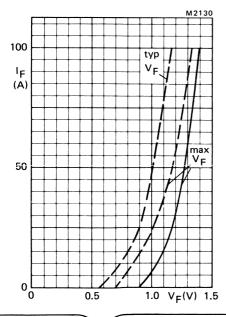
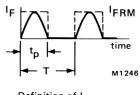


Fig.6 Maximum permissible repetitive peak forward current for square or sinusoidal currents; 1  $\mu s <$   $t_p <$  1 ms.





Definition of IFRM and  $t_p/T$ .

Fig.7 — 
$$T_j = 25$$
 °C;  $---T_j = 150$  °C.

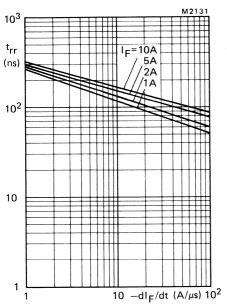
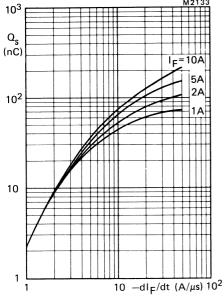


Fig.8 Maximum  $t_{rr}$  at  $T_j = 25$  °C .



F=10A 5A //2A //1A (ns) 10<sup>2</sup> 10  $10 - dI_F/dt (A/\mu s) 10^2$ Fig.9 Maximum  $t_{rr}$  at  $T_i = 100$  °C.

10<sup>3</sup>

 $t_{rr}$ 

Fig.10 Maximum  $Q_s$  at  $T_j = 25$  °C

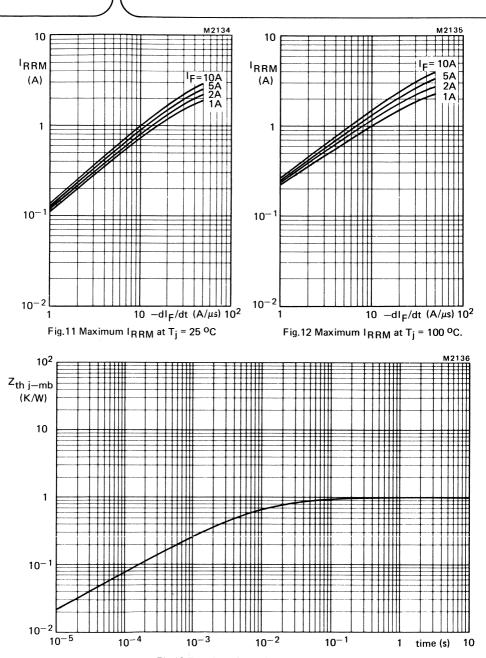


Fig.13 Transient thermal impedance

### ULTRA FAST RECOVERY DOUBLE RECTIFIER DIODES



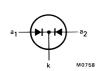
Glass-passivated, high-efficiency double rectifier diodes in plastic envelopes, featuring low forward voltage drop, ultra fast reverse recovery times and soft-recovery characteristic. They are intended for use in switched mode power supplies and high-frequency circuits in general, where both low conduction 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

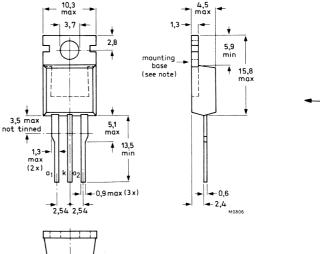
Per diode, unless otherwise stated		BYV32	-50	100	150	200	
Repetitive peak reverse voltage	$V_{RRM}$	max.	50	100	150	200	٧
Output current (both diodes conducting)	l <sub>O</sub>	max.		2	0		Α
Forward Voltage	٧ <sub>F</sub>	<	0.85				V
Reverse recovery time	t <sub>rr</sub>	<		2	5		ns

#### MECHANICAL DATA

Fig.1 TO-220AB.



## Dimensions in mm



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.

# BYV32 SERIES

#### **RATINGS**

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

	Voltages (per diode)		BYV32	2 50	100	150	200		
	Repetitive peak reverse voltage	$V_{RRM}$	max.	50	100	150	200	V	
	Crest working reverse voltage	V <sub>RWM</sub>	max.	50	100	150	200	٧	
	Continuous reverse voltage (note 1)	v <sub>R</sub>	max.	50	100	150	200	٧	
-	Currents (both diodes conducting; note 2)								
	Output current; switching								
	losses negligible up to 500 kHz;								
	square wave; $\delta = 0.5$ ; up to $T_{mb} = 118  {}^{\circ}C$	l <sub>O</sub>	max.		20	)		Α	
	square wave; $\delta = 0.5$ ; up to $T_{mb} = 125$ °C	lo	max.		16.5	<b>,</b>		Α	
	sinusoidal; up to $T_{mb} = 120$ $^{\circ}C$	lo	max.		18	3		Α	
	sinusoidal; up to T <sub>mb</sub> = 125 <sup>o</sup> C	lo	max.		16	5		Α	
	R.M.S. forward current	I <sub>F(RMS)</sub>	max.		28	3		A	
	Repetitive peak forward current								
	$t_p = 20 \mu s$ , $\delta = 0.02$ (per diode)	<sup>I</sup> FRM	max.		230	)		Α	
	Non-repetitive peak forward current (per diode)								
	half sine-wave; T <sub>i</sub> = 150 <sup>O</sup> C prior to								
	surge; with reapplied V <sub>RWM</sub> max								
	t = 10 ms	<sup>I</sup> FSM	max.		150	)		Α	
	t = 8.3 ms	<sup>I</sup> FSM	max.		160	)		Α	
	I <sup>2</sup> t for fusing (t = 10ms; per diode)	l² t	max.		112	!		A²s	
	Temperatures								
	Storage temperature	T <sub>stg</sub>		40	to +150	1		°С	
	Junction temperature	т <sub>і</sub>	max.		150	1		οС	
		J							

#### Notes:

- 1. To ensure thermal stability,  $R_{th\;j-a} <$  14 K/W.
- 2. The limits for both diodes apply whether both diodes conduct simultaneously or on alternate half cycles.

#### CHARACTERISTICS (per diode)

Forwar	ď	vol	tage

$$I_F = 5 \text{ A}; T_j = 100 \text{ }^{0}\text{C}$$
  
 $I_F = 20 \text{ A}; T_i = 25 \text{ }^{0}\text{C}$ 

٧F 0.85 1.15

Reverse current

Reverse recovery when switched from

$$I_F$$
 = 2 A to  $V_R$   $\geqslant$  30 V with  $-dI_F/dt$  = 20 A/ $\mu$ s;  $T_j$  = 25  $^{0}C$ ; recovered charge

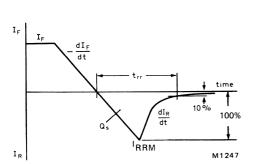
$$I_F = 10 \text{ A to V}_F \ge 30 \text{ V with } -dI_F/dt = 50 \text{ A}/\mu\text{s};$$
  
 $T_i = 100 \,^{0}\text{C};$  peak recovery current

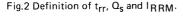
Forward recovery when switched to  $I_F = 1A$ with  $dI_F/dt = 10 A/\mu s$ ;  $T_i = 25 \, {}^{O}C$ 

$$t_{rr}$$
 < 25 ns  $Q_s$  < 12.5 nC

Α

M80-1319/3





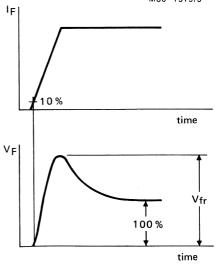


Fig.3 Definition of Vfr.

<sup>\*</sup>Measured under pulse conditions to avoid excessive dissipation

## **BYV32 SERIES**

#### **→ THERMAL RESISTANCE**

From junction to mounting base (both diodes conducting)	R <sub>th j-mb</sub>	=	1.6	K/W
From junction to mounting base (per diode)	R <sub>th j-mb</sub>	=	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 <sub>th mb-h</sub>	=	0.3	K/W
<ul> <li>with heatsink compound and 0.06 mm maximum mica insulator</li> </ul>	R <sub>th mb-h</sub>	= ,	1.4	K/W
c. with heatsink compound and 0.1 mm maximum mica insulator (56369)	R <sub>th mb-h</sub>	=	2.2	K/W
<ul> <li>with heatsink compound and 0.25 mm maximum alumina insulator (56367)</li> </ul>	R <sub>th mb-h</sub>	=	0.8	K/W
e. without heatsink compound	R <sub>th mb-h</sub>	=	1.4	K/W
2. Free air operation				
The quoted values of $R_{th\;j-a}$ should be used only when no leat to the same tie point.  Thermal resistance from junction to ambient in free air: mounted on a printed circuit board at any device lead	ds of other dissi	pating co	omponent	s run
length and with copper laminate on the board	R <sub>th j-a</sub>	=	60	K/W

#### MOUNTING INSTRUCTIONS

- 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<sub>th mb-h</sub> 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<sub>th mb-h</sub> given for mounting with heatsink compound refer to the use of a metallic oxide-loaded compound. Ordinary silicone grease is not recommended.
- 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:

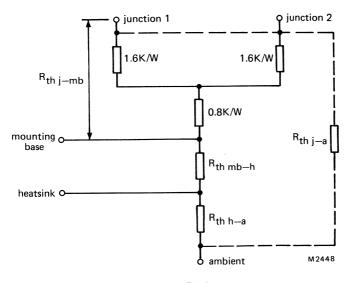


Fig.4

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

# SQUARE-WAVE OPERATION (PER DIODE)

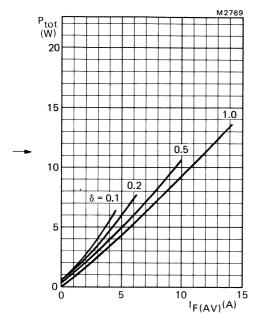
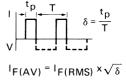


Fig. 5 Power rating per diode.
The individual power loss in each diode should first be determined then both added together. The resulting total power loss is then used in conjunction with Fig.6 to determine the heatsink size and corresponding maximum ambient and mounting base temperatures.



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

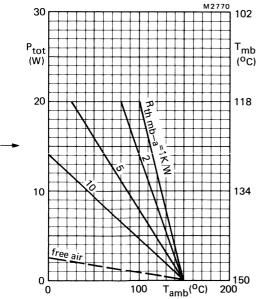


Fig.6

# SINUSOIDAL OPERATION (PER DIODE)

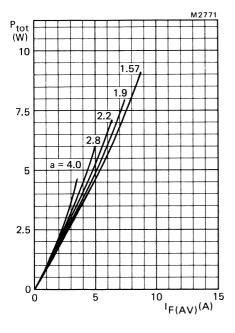


Fig.7 Power rating per diode.

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.

$$a = form factor = I_F(RMS)/I_F(AV)$$

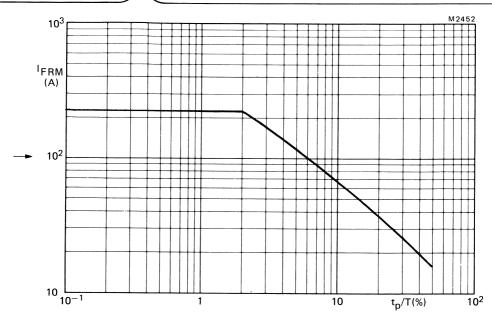
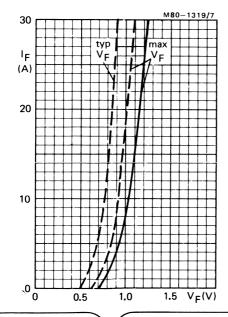


Fig.8 Maximum permissible repetitive peak forward current for either square or sinusoidal currents for 1  $\mu$ s < t $_D$  < 1 ms; per diode.



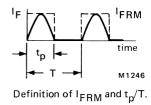


Fig.9 —  $T_j = 25 \, {}^{\circ}\text{C}; --- T_j = 100 \, {}^{\circ}\text{C}; \text{ per diode.}$ 

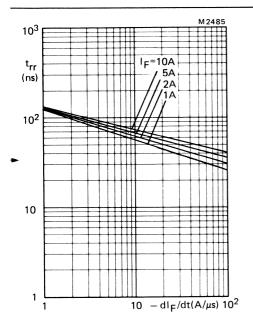
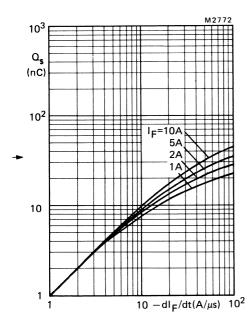


Fig.10 Maximum  $t_{rr}$  at  $T_i = 25$  °C; per diode.



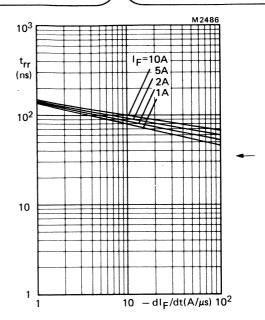
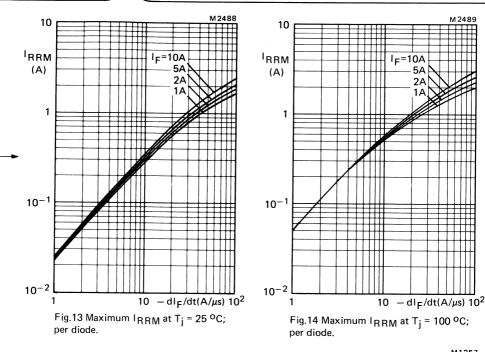


Fig.11 Maximum  $t_{rr}$  at  $T_j = 100$  °C; per diode.

Fig.12 Maximum  $Q_s$  at  $T_j$  = 25  $^{\rm O}$ C; per diode.



2th j-mb (K/W)

10

1

10<sup>-2</sup>

10<sup>-5</sup>

10<sup>-4</sup>

10<sup>-3</sup>

10<sup>-2</sup>

10<sup>-1</sup>

1 time (s) 10

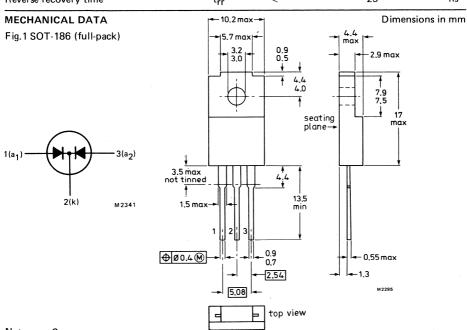
Fig.15 Transient thermal impedance; one diode conducting.

# 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 along-side 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.

#### OUICK REFERENCE DATA

QUICK REFERENCE DATA							
Per diode, unless otherwise stated		BYV32	2F-50	100	150	200	
Repetitive peak reverse voltage	$v_{RRM}$	max.	50	100	150	200	٧
Output current (both diodes conducting)	10	max.			12		A
Forward voltage	٧F	<		0.8	35		V
Reverse recovery time	t <sub>rr</sub>	<		:	25		ns



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).

# **BYV32F SERIES**

# **RATINGS**

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

Voltages (per diode; see note 1)		BYV32	F-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	VR	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 <sub>h</sub> = 92 °C sinusoidal; up to T <sub>h</sub> = 100 °C	1 <sub>0</sub> 1 <sub>0</sub>	max. max.	12 10.6	A A
R.M.S. forward current	IF(RMS)	max.	12	Α
Repetitive peak forward current $t_p = 20 \mu s$ , $\delta = 0.02$ (per diode)	I <sub>FRM</sub>	max.	155	Α
Non-repetitive peak forward current half sine-wave; T <sub>j</sub> = 150 °C prior to surge; with reapplied V <sub>RWM max</sub> ;				
t = 10 ms (per diode)	FSM	max.	150	Α
t = 8.3 ms (per diode)	<sup>I</sup> FSM	max.	160	A
I <sup>2</sup> t for fusing (t = 10 ms; per diode)	l²t	max.	112	A <sup>2</sup> s
Temperatures				
Storage temperature	$T_{stg}$		-40 to +150	oC
Junction temperature	$T_{j}$	max.	150	οС
ISOLATION				
Peak isolation voltage from all terminals to external heatsink	V <sub>isol</sub>	max.	1000	V
Isolation capacitance from cathode to external heatsink (see note 4)	Сp	typ.	12	pF

#### Notes

- 1. To ensure thermal stability:  $R_{th\ j\text{-}a}\!<\!6.3$  K/W for continuous reverse voltage.
- 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
- with heatsink compound

R <sub>th i-h</sub>	=	7.0	K/W
R <sub>th j-h</sub>	=	5.0	K/W

# Free-air operation

The quoted value of R<sub>th j-a</sub> 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

 $R_{th i-a} = 55 K/W$ 

0.85

1.15

٧r

۷F

#### **CHARACTERISTICS**

Forward voltage

$$I_F = 5 \text{ A}; T_j = 100 \text{ }^{\circ}\text{C}$$
  
 $I_F = 20 \text{ A}; T_j = 25 \text{ }^{\circ}\text{C}$ 

Reverse current

$$V_R = V_{RWM max}$$
;  $T_j = 100 \, {}^{o}\text{C}$   
 $V_R = V_{RWM max}$ ;  $T_j = 25 \, {}^{o}\text{C}$ 

Reverse recovery when switched from

 $I_F = 1 \text{ A to V}_R \geqslant 30 \text{ V with } -dI_F/dt = 100 \text{ A}/\mu\text{s};$ 

 $T_i = 25$  °C; recovery time

IF = 2 A to  $V_R \ge 30 V$  with  $-dI_F/dt = 20 A/\mu s$ ;

T<sub>i</sub> = 25 °C; recovered charge

 $I_F = 10 \text{ A} \text{ to V}_R \geqslant 30 \text{ V with } -dI_F/dt = 50 \text{ A/}\mu\text{s};$ 

T<sub>i</sub> = 100 <sup>o</sup>C; peak recovery current

Forward recovery when switched to  $I_F = 1 \text{ A}$ with  $dI_F/dt = 10 \text{ A}/\mu\text{s}$ ;  $T_i = 25 \text{ }^{0}\text{C}$ 

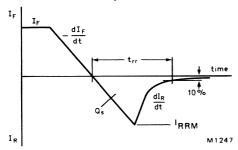
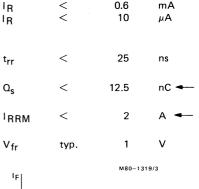
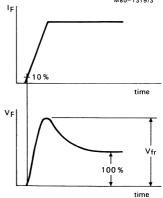


Fig.2 Definition of  $t_{rr}$ ,  $Q_s$  and  $I_{RRM}$ .





<sup>\*</sup>Measured under pulse conditions to avoid excessive dissipation.

Fig.3 Definition of Vfr.

# MOUNTING INSTRUCTIONS

- 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<sub>th j-h</sub> 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:

    Maximum torque to avoid damage to the device:

5.5 kgf (0.55 Nm) 8.0 kgf (0.80 Nm)

- 5. For good thermal contact, heatsink compound should be used between baseplate and heatsink. Values of R<sub>th j-h</sub> 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.

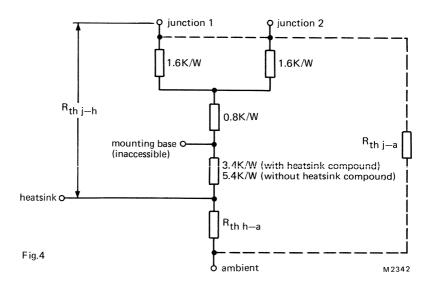
It is not recommended to use rivets, since extensive damage could result to the plastic, which could destroy the insulating properties of the device.

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**

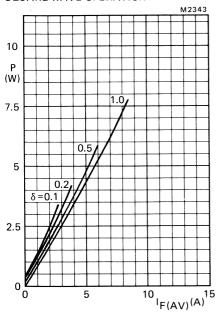
Dissipation and heatsink considerations:

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



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

#### SQUARE-WAVE OPERATION



# SINUSOIDAL OPERATION 6 P (W) 1.57 4 2.8 2.8 1 F(AV)(A) 10

1

### Fig.5 Power rating.

The individual power loss in each diode should first be determined from the required forward current on the IF(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.

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

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

Fig.6 Power rating.

The individual power loss in each diode should first be determined from the required forward current on the IF(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.

$$a = form factor = I_F(RMS)/I_F(AV)$$

# **BYV32F SERIES**

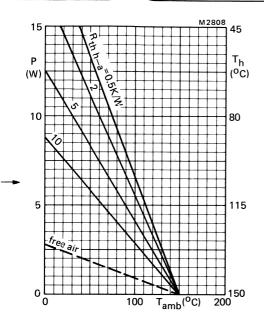


Fig.7 Heatsink rating. Without heatsink compound.

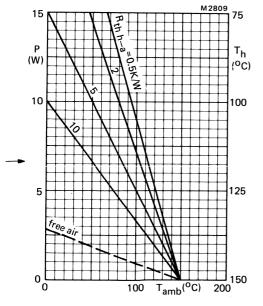


Fig.8 Heatsink rating.
With heatsink compound.

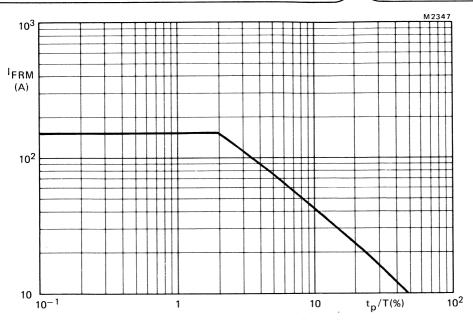
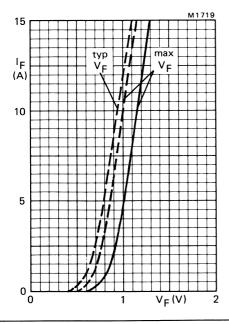
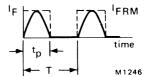


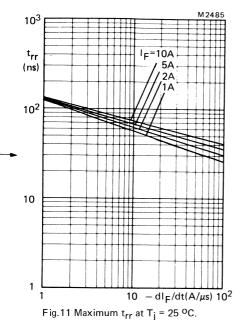
Fig.9 Maximum permissible repetitive peak forward current for either square or sinusoidal currents for 1  $\mu$ s <  $t_D$  < 1 ms.

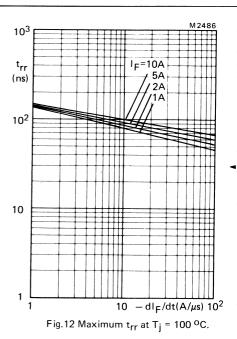


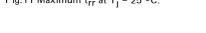


Definition of I  $_{\mbox{\scriptsize FRM}}$  and  $t_{\mbox{\scriptsize p}}/T$ 

Fig.10 —— 
$$T_j = 25$$
 °C;  $---T_j = 150$  °C per diode.







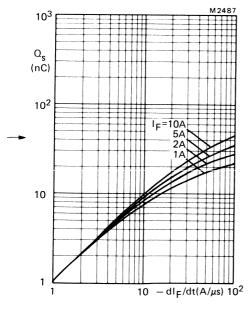


Fig. 13 Maximum  $Q_s$  at  $T_j = 25$  °C.

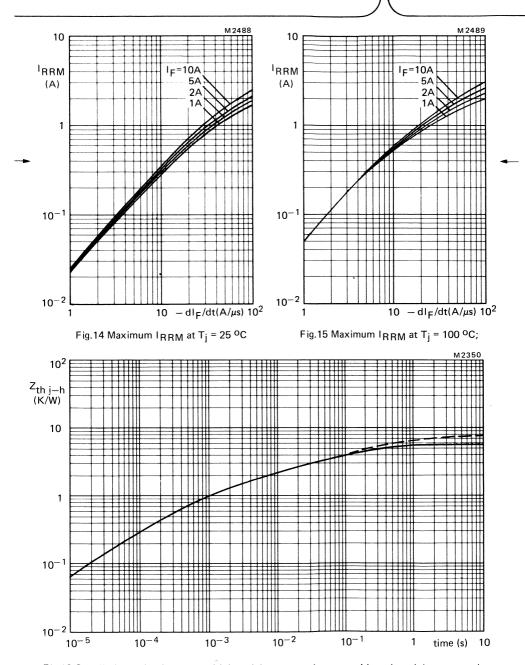


Fig. 16 One diode conducting; —— with heatsink compound; -- without heatsink compound.

329

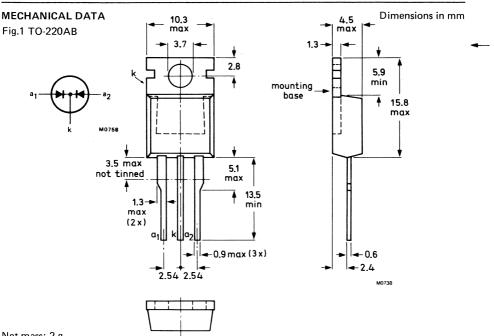


# ULTRA FAST RECOVERY DOUBLE RECTIFIER DIODES

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		BYV3	4-300	400	500	
Repetitive peak reverse voltage	$V_{RRM}$	max.	300	400	500	V
Output current (both diodes conducting)	10	max.		20		А
Forward voltage	V <sub>F</sub>	<		0.93		· V
Reverse recovery time	t <sub>rr</sub>	<		50		ns



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.

# **BYV34 SERIES**

# **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 <sub>RWM</sub>	max.	200	300	400	V
	Continuous reverse voltage (note 1)	VR	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 °C up to $T_{mb}$ = 125 °C	1 <sub>0</sub>	max. max.		20 14		A A
	sinusoidal; up to $T_{mb}$ = 120 ${}^{o}$ C up to $T_{mb}$ = 125 ${}^{o}$ C	10 10	max. max.		17.5 14		A A
-	R.M.S. forward current	IF(RMS)	max.		28		Α
	Repetitive peak forward current $t_p = 20 \mu s$ ; $\delta = 0.02$ (note 3)	I <sub>FRM</sub>	max.		240		A
	Non-repetitive peak forward current (per diode) half sine-wave; T <sub>j</sub> = 150 °C prior to surge with re-applied V <sub>RWM max</sub>						
	t = 10 ms t = 8.3 ms	FSM	max.		120		Α
		IFSM	max.		150		Α
	I <sup>2</sup> t for fusing (t = 10 ms; per diode)	l² t	max.		72		A <sup>2</sup> s
	Temperatures						
	Storage temperature	T <sub>stg</sub>		-40 to	+150		oC
	Junction temperature	тј	max.		150		оС

# Notes

- 1. To ensure thermal stability:  $\rm R_{th~j-a} \! < \! 4.5~K/W.$
- 2. The limits for both diodes apply whether both diodes conduct simultaneously or on alternate half cycles.

CHAR	ACTER	ISTICS	(per diode)

Forward	voltage
	J

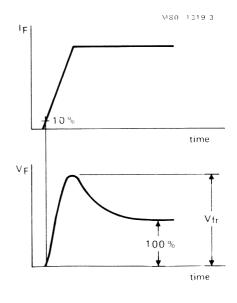
$I_F = 10 \text{ A}; T_j = 150  {}^{\circ}\text{C}$	VF	<	0.93	V*
$I_F = 30 \text{ A}; T_j = 25 ^{\circ}\text{C}$	VF	<	1.4	V*

Reverse current

$$V_R = V_{RWM max}$$
;  $T_j = 100 \, ^{\circ} C$   $I_R < 0.6 \, ^{mA}$   $V_R = V_{RWM max}$ ;  $T_j = 25 \, ^{\circ} C$   $I_R < 50 \, ^{\mu} A$ 

Reverse recovery when switched from 
$$\begin{aligned} &\text{I}_F = 1 \text{ A to V}_R \geqslant 30 \text{ V with } -\text{dI}_F/\text{dt} = 100 \text{ A}/\mu\text{s}; \text{T}_j = 25 \text{ }^{\text{OC}} \\ &\text{recovery time} & \text{t}_{rr} & < & 50 & \text{ns} \end{aligned}$$
 
$$\begin{aligned} &\text{I}_F = 2 \text{ A to V}_R \geqslant 30 \text{ V with } -\text{dI}_F/\text{dt} = 20 \text{ A}/\mu\text{s}; \text{T}_j = 25 \text{ }^{\text{OC}} \\ &\text{recovered charge} & \text{Q}_s & < & 45 & \text{nC} \end{aligned}$$
 
$$\begin{aligned} &\text{I}_F = 10 \text{ A to V}_R \geqslant 30 \text{ V with } -\text{dI}_F/\text{dt} = 50 \text{ A}/\mu\text{s}; \text{T}_j = 100 \text{ }^{\text{OC}} \\ &\text{peak recovery current} & \text{I}_{RRM} & < & 5.0 & \text{A} \end{aligned}$$

Forward recovery when switched to IF = 10 A with  $dI_F/dt = 10 A/\mu s$ ;  $T_i = 25 \, {}^{O}C$ recovery voltage



 $V_{fr}$ 

2.5

typ.

V

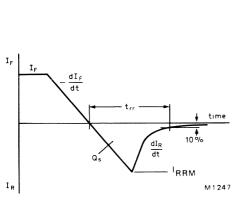


Fig.2 Definition of  $t_{rr}$ ,  $Q_s$  and  $I_{RRM}$ .

Fig.3 Definition of Vfr.

<sup>\*</sup>Measured under pulse conditions to avoid excessive dissipation.

# BYV34 SERIES

	ТН	ERMAL RESISTANCE				
	Fro	om junction to mounting base (both diodes conducting)	R <sub>th i-mb</sub>	=	1.6	K/W
	Fro	om junction to mounting base (per diode)	R <sub>th j-mb</sub>	=	2.3	K/W
-	Inf	luence of mounting method				
	1.	Heatsink-mounted with clip (see mounting instructions)				
	The	ermal resistance from mounting base to heatsink				
	a.	with heatsink compound	R <sub>th mb-h</sub>	=	0.3	K/W
	b.	with heatsink compound and 0.06 mm maximum mica insulator	R <sub>th mb-h</sub>	=	1.4	K/W
	c.	with heatsink compound and 0.1 mm maximum mica insulator (56369)	R <sub>th mb-h</sub>	=	2.2	K/W
	d.	with heatsink compound and 0.25 mm maximum alumina insulator (56367)	R <sub>th mb-h</sub>	=	0.8	K/W
	e.	without heatsink compound	R <sub>th mb-h</sub>	=	1.4	K/W
	2.	Free air operation				
	to t	e quoted value of $R_{th\ j-a}$ should be used only when no leads of othe same tie point.	ther dissipatii	ng com	ponents	run
		ermal resistance from junction to ambient in free air: unted on a printed circuit board at any device lead				
		gth and with copper laminate on the board	R <sub>th j-a</sub>	=	60	K/W

R<sub>th j-a</sub>

#### MOUNTING INSTRUCTIONS

- 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.
- 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<sub>th mb-h</sub> 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<sub>th mb-h</sub> given for mounting with heatsink compound refer to the use of a metallic-oxide loaded compound. Ordinary silicone grease is not recommended.
- 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

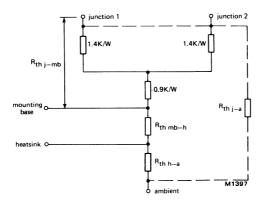


Fig.4

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

# SQUARE-WAVE OPERATION (PER DIODE)

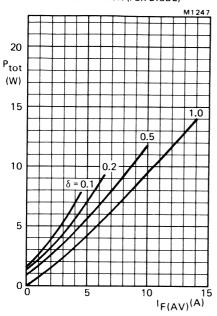
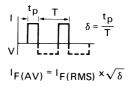


Fig.5 Power rating per diode.
The individual power loss in each diode should first be determined then both added together. The resulting total power loss is then used in conjunction with Fig.6 to determine the heatsink size and corresponding maximum ambient and mounting base temperatures.



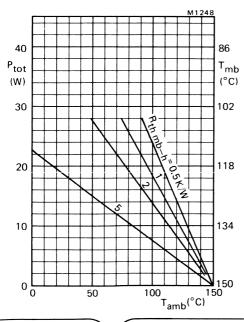


Fig.6

#### SINUSOIDAL OPERATION (PER DIODE)

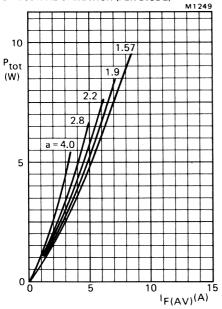


Fig.7 Power rating per diode.
The individual power loss in each diode should first be determined then both added together. The resulting total power loss is then used in conjunction with Fig.6 to determine the heatsink size and corresponding maximum ambient and mounting base temperatures.

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

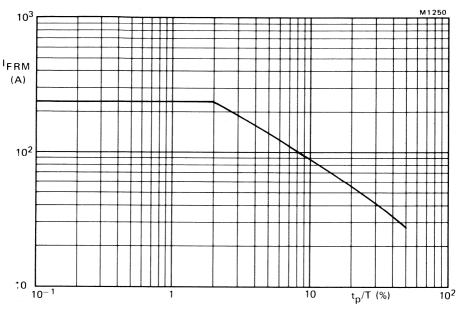
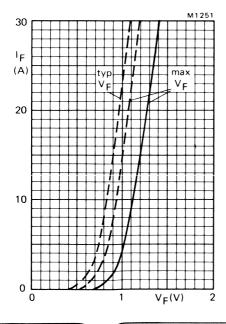


Fig.8 Maximum permissible repetitive peak forward current for either square or sinusoidal currents for 1  $\mu$ s < t $_p$  < 1 ms.(per diode).



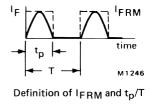


Fig. 9 ——  $T_j = 25$  °C;  $---T_j = 150$  °C (per diode).

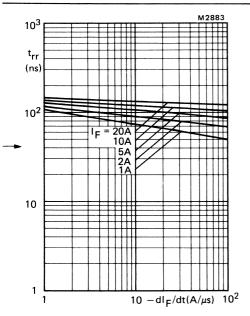
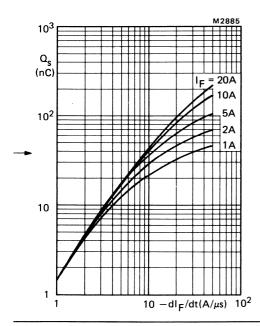


Fig.10 Maximum  $t_{rr}$  at  $T_j = 25$  °C. (per diode).



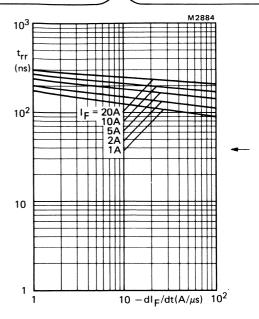
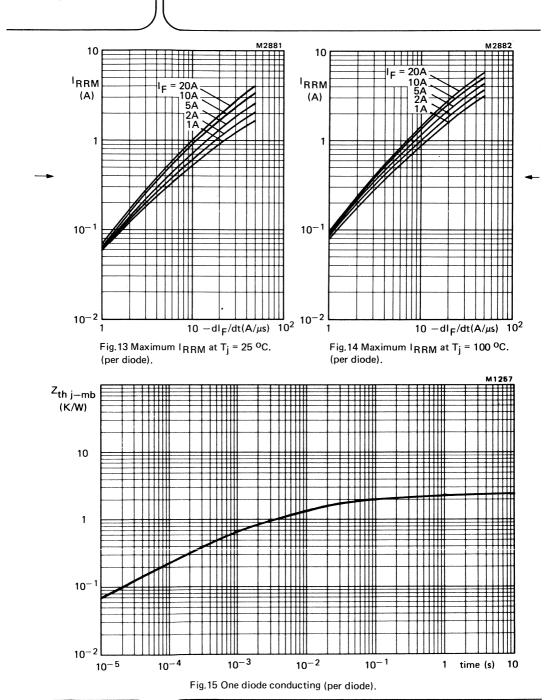


Fig.11 Maximum  $t_{rr}$  at  $T_j = 100$  °C. (per diode).

Fig.12 Maximum  $Q_s$  at  $T_j$  = 25 °C. (per diode).



# ULTRA FAST RECOVERY DOUBLE RECTIFIER DIODES

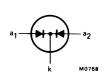
Glass-passivated, high-efficiency double rectifier diodes in plastic envelopes, featuring low forward voltage drop, ultra fast reverse recovery times and soft-recovery characteristic. They are intended for use in switched-mode power supplies and high-frequency circuits in general, where both low conduction 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.

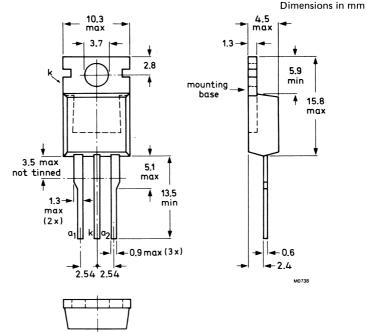
#### QUICK REFERENCE DATA

Per diode, unless otherwise stated		BYV42	2–50	100	150	200	
Repetitive peak reverse voltage	$v_{RRM}$	max.	50	100	150	200	٧
Output current (both diodes conducting)	10	max.		;	30		Α
Forward voltage	٧ <sub>F</sub>	<		0.8	35		V
Reverse recovery time	t <sub>rr</sub>	<			28		ns

#### **MECHANICAL DATA**

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.

# **BYV42 SERIES**

# **RATINGS**

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

	Voltages (per diode)		BYV42	-50 <b> </b>	100	150	200		
	Repetitive peak reverse voltage	$v_{RRM}$	max.	50	100	150	200	V	
	Crest working reverse voltage	V <sub>RWM</sub>	max.	50	100	150	200	٧	
	Continuous reverse voltage	VR	max.	50	100	150	200	٧	
-	Currents (both diodes conducting: note 1)			***************************************					
	Output current; switching losses negligible up to 500 kHz; square wave; $\delta$ = 0.5; up to T <sub>mb</sub> = 104 °C (note 2)	Io	max.		3	80		Α	
	R.M.S. forward current (note 2)	IF(RMS)	max.		4	13		Α	
	Repetitive peak forward current $t_p = 20 \mu s$ ; $\delta = 0.02$ (per diode)	<sup>I</sup> FRM	max.		32	20		Α	
	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 $t = 8.3$ ms	<sup> </sup> FSM <sup> </sup> FSM	max. max.		20 22			A A	
	I <sup>2</sup> t for fusing (t = 10 ms; per diode)	l <sup>2</sup> t	max.		20			A <sup>2</sup> s	;
	Temperatures								
	Storage temperature	T <sub>stg</sub>		-40	) to +15	60		οС	
	Junction temperature	Tj	max.		15	60		оС	

# 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

$T_i$	=	25	oC	unless	otherwise	stated
-------	---	----	----	--------	-----------	--------

Forv	var	ď	٧	ol	ta	age	;
1-	. =	1	Λ	٨		т.	

$$I_F = 10 \text{ A}; T_j = 100 \text{ }^{\circ}\text{C}$$
  
 $I_F = 30 \text{ A}$ 

Reverse current

$$V_R = V_{RWM max}$$
;  $T_j = 100 \, {}^{\circ}\text{C}$   
 $V_R = V_{RWM max}$ 

Reverse recovery when switched from

$$I_F = 1 \text{ A to V}_R \geqslant 30 \text{ V with } -dI_F/dt = 100 \text{ A}/\mu\text{s};$$
 recovery time

I<sub>F</sub> = 2 A to 
$$V_R \ge 30 V$$
 with  $-dI_F/dt = 20 A/\mu s$ ; recovered charge

$$I_F$$
 = 10 A to  $V_R \geqslant$  30 V with  $-dI_F/dt$  = 50 A/ $\mu$ s;  $T_i$  = 100 °C; peak recovery current

Forward recovery when switched to 
$$I_F = 1$$
 A with  $dI_F/dt = 10$  A/ $\mu$ s

< <	1.0 100	mΑ μΑ
<	28	ns 🕶
<	15	nC
<	2.4	A -
	< <	< 100 < 28 < 15

٧F

 $V_{\mathsf{fr}}$ 

0.85

1.15

1.0

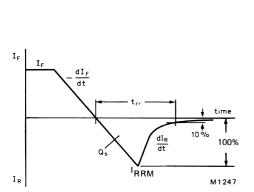
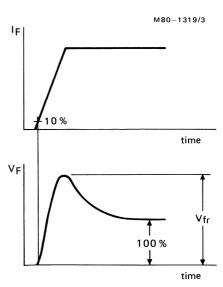


Fig.2 Definition of  $t_{rr},\,\Omega_{s}$  and  $I_{\mbox{\footnotesize{RRM}}}.$ 



typ.

Fig.3 Definition of Vfr.

<sup>\*</sup>Measured under pulse conditions to avoid excessive dissipation.

# **BYV42 SERIES**

 THE	RMAI	RESIST	ANCE

	om junction to mounting base (both diodes conducting)	R <sub>th j-mb</sub>	=	1.4	K/W
Fr	om junction to mounting base (per diode)	R <sub>th j-mb</sub>	=	2.4	K/W
Int	fluence of mounting method				
1.	Heatsink-mounted with clip (see mounting instructions)				
Th	ermal resistance from mounting base to heatsink				
a.	with heatsink compound	R <sub>th mb-h</sub>	=	0.3	K/W
b.	with heatsink compound and 0.06 mm maximum mica insulator	R <sub>th mb-h</sub>	=	1.4	K/W
c.	with heatsink compound and 0.1 mm maximum mica insulator (56369)	R <sub>th mb-h</sub>	=	2.2	K/W
d.	with heatsink compound and 0.25 mm maximum alumina insulator (56367)	R <sub>th mb-h</sub>	=	0.8	K/W
e.	without heatsink compound	R <sub>th mb-h</sub>	=	1.4	K/W
2.	Free air operation				

The quoted value of  $R_{th\;j-a}$  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

#### MOUNTING INSTRUCTIONS

- 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.
- 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<sub>th mb-h</sub> 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<sub>th mb-h</sub> given for mounting with heatsink compound refer to the use of a metallic oxide loaded compound. Ordinary silicone grease is not recommended.
- 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

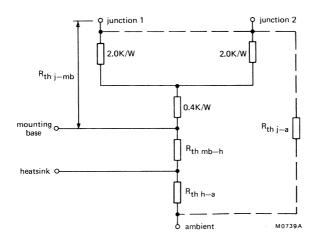


Fig. 4

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

# SQUARE-WAVE OPERATION (PER DIODE)

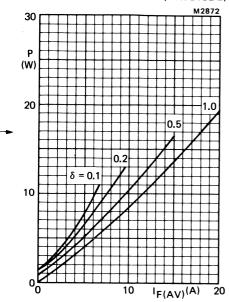
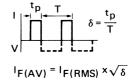


Fig.5 Power rating per diode.
The individual power loss in each diode should first be determined then both added together. The resulting total power loss is then used in conjunction with Fig.6 to determine the heatsink size and corresponding maximum ambient and mounting base temperatures.



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

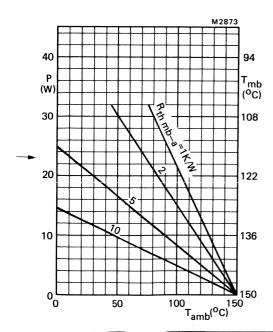


Fig.6.

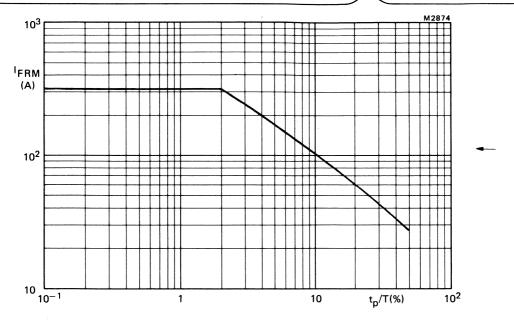
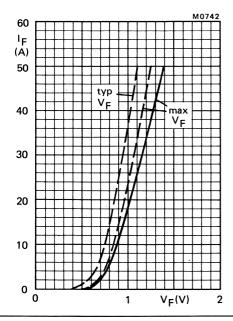
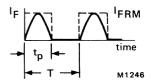


Fig.7 Maximum permissible repetitive peak forward current for square or sinusoidal currents for 1  $\mu$ s <  $t_D$  < 1 ms; per diode.





Defintion of IFRM and  $t_p/T$ .

Fig.8 — 
$$T_j = 25$$
 °C;  $---T_j = 100$  °C; per diode.

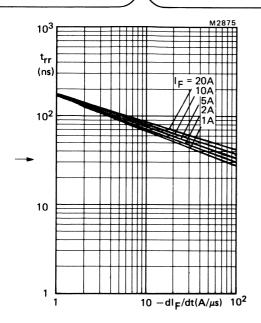
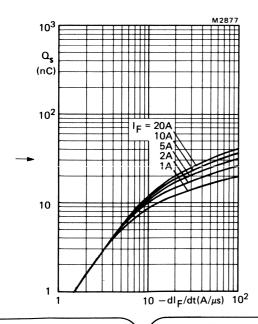


Fig.9 Maximum  $t_{rr}$  at  $T_j = 25$  °C; per diode.



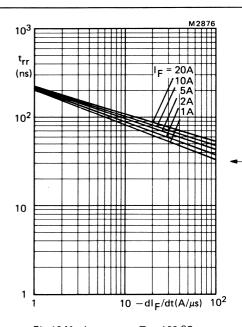


Fig. 10 Maximum  $t_{rr}$  at  $T_j = 100$  °C; per diode.

Fig.11 Maximum  $Q_s$  at  $T_j = 25$  °C; per diode.

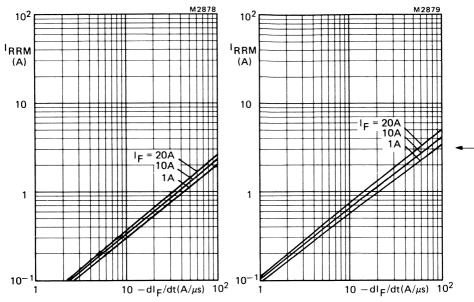


Fig.12 Maximum  $I_{RRM}$  at  $T_j = 25$  °C; per diode.

Fig.13 Maximum  $I_{RRM}$  at  $T_j = 100$  °C; per diode.

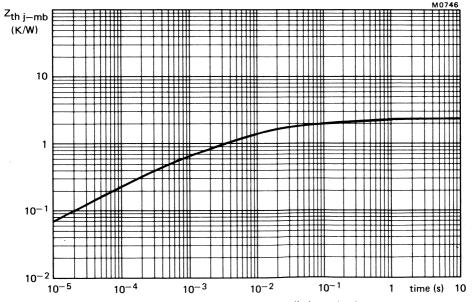


Fig. 14 Transient thermal impedance; one diode conducting.

		•	

### 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.

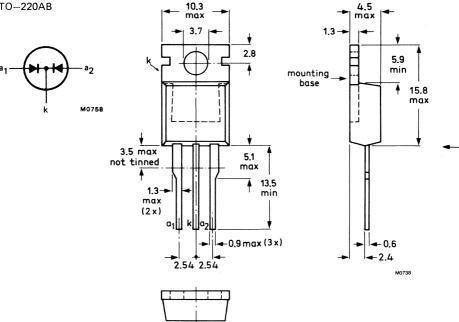
#### OUICK REFERENCE DATA

	GOICK HEI EHENCE DATA						
Output current (both diodes conducting)  Forward voltage  V <sub>F</sub> 10  max. 30  Forward voltage  V <sub>F</sub> 1.05	Per diode, unless otherwise stated		BYV4	4-300	400	500	٧
(both diodes conducting) $I_{O}$ max. 30 Forward voltage $V_{F}$ < 1.05	Repetitive peak reverse voltage	$v_{RRM}$	max.	300	400	500	٧
	•	I <sub>O</sub>	max.		30		Α
Reverse recovery time t <sub>rr</sub> < 50	Forward voltage	$v_{F}$	<		1.05		V
	Reverse recovery time	t <sub>rr</sub>	<		50		ns

#### **MECHANICAL DATA**

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.

# **BYV44 SERIES**

#### **RATINGS**

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

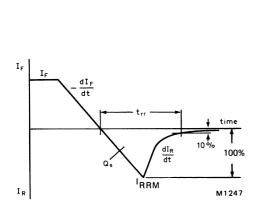
	Voltages (per diode)		BYV4	4–300	400	500	
	Repetitive peak reverse voltage	$V_{RRM}$	max.	300	400	500	V
	Crest working reverse voltage	$V_{RWM}$	max.	200	300	400	V
	Continuous reverse voltage (note 1)	$v_R$	max.	200	300	400	V
-	Currents (both diodes conducting; note 2)						
	Output current; switching losses negligible up to 200 kHz;						
	square wave; $\delta$ = 0.5; up to $T_{mb}$ = 92 °C (note 3)	10	max.		30		Α
	sinusoidal; up to T <sub>mb</sub> = 103 °C (note 3)	lo	max.		26		Α
	R.M.S. forward current (note 3)	IF(RMS)	max.		43		Α
	Repetitive peak forward current $t_p = 20 \mu s$ ; $\delta = 0.02$ (per diode)	IFRM	max.		320		Α
	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	<sup>I</sup> FSM	max.		150		Α
	t = 8.3 ms	IFSM	max.		180		Α
	I <sup>2</sup> t for fusing (t = 10 ms; per diode)	l²t	max.		112		$A^2s$
	Temperatures						
	Storage temperature	$T_{stq}$		-40 to	+150		oC
	Junction temperature	Tj	max.		150		oC

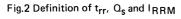
#### Notes:

- 1. To ensure thermal stability:  $R_{\mbox{th j-a}}\!<\!9.3$  K/W.
- 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	Iner diode: T	· = 25 00 unless	otherwise stated)
CHARACIERISTICS	mer anone: i	i = 70 °C umess	Otherwise statem

, ,				
Forward voltage	V-		1.05	V*
$I_F = 15 \text{ A}; T_j = 150 ^{\circ}\text{C}$	V <sub>F</sub>			
I <sub>F</sub> = 50 A	VF	<	1.4	V*
Reverse current				
$V_R = V_{RWM max}; T_j = 100  {}^{\circ}C$	<sup>I</sup> R	< <	8.0	mA
$V_R = V_{RWM max}$	<sup>I</sup> R	<	50	μΑ
Reverse recovery when switched from				
$I_F$ = 1 A to $V_R \geqslant$ 30 V with $-dI_F/dt$ = 100 A/ $\mu$ s; recovery time	t <sub>rr</sub>	< 1	50	ns
$I_F = 2 \text{ A to } V_R \geqslant 30 \text{ V with } -dI_F/dt = 20 \text{ A}/\mu\text{s};$ recovered charge	$Q_{s}$	<	50	nC
$I_F$ = 10 A to $V_R \ge 30$ V with $-dI_F/dt$ = 50 A/ $\mu$ s; $T_j$ = 100 °C; peak recovery current	IRRM	<	5.2	Α
Forward recovery when switched to I <sub>F</sub> = 10 A with dI <sub>F</sub> /dt = 10 A/ $\mu$ s;				
recovery voltage	$v_{fr}$	typ.	2.5	V





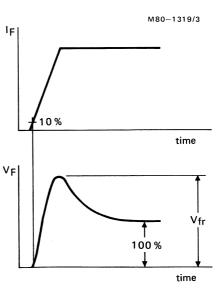


Fig.3 Definition of V<sub>fr</sub>.

<sup>\*</sup>Measured under pulse conditions to avoid excessive dissipation.

# **BYV44 SERIES**

	TH	IERMAL RESISTANCE				
	Fre	om junction to mounting base (both diodes conducting)	R <sub>th j-mb</sub>	=	1.4	K/W
	Fre	om junction to mounting base (per diode)	R <sub>th j-mb</sub>	=	2.0	K/W
-	Inf	fluence of mounting method				
	1.	Heatsink-mounted with clip (see mounting instructions)				
	Th	ermal resistance from mounting base to heatsink				
	a.	with heatsink compound	R <sub>th mb-h</sub>	=	0.3	K/W
	b.	with heatsink compound and 0.06 mm maximum mica	_			
		insulator	R <sub>th mb-h</sub>	=	1.4	K/W
	c.	with heatsink compound and 0.1 mm maximum mica insulator (56369)	R <sub>th mb-h</sub>	=	2.2	K/W
	d.	with heatsink compound and 0.25 mm maximum				
		alumina insulator (56367)	R <sub>th mb-h</sub>	=	8.0	K/W
	e.	without heatsink compound	R <sub>th mb-h</sub>	=	1.4	K/W
	2.	Free-air operation				
	to Th	e quoted value of R <sub>th j-a</sub> should be used only when no leads of o the same tie point. ermal resistance from junction to ambient in free air: ounted on a printed circuit board at any device lead	ther dissipation	ng com	ponents	run
	len	gth and with copper laminate on the board.	R <sub>th j-a</sub>	=	60	K/W

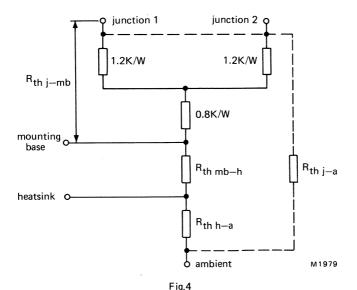
#### MOUNTING INSTRUCTIONS

- 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<sub>th mb-h</sub> 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<sub>th mb-h</sub> given for mounting with heatsink compound refer to the use of a metallic oxide-loaded compound. Ordinary silicone grease is not recommended.
- 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:



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

#### SQUARE-WAVE OPERATION

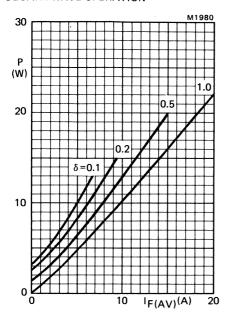
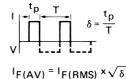


Fig.5 Power rating per diode.

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.



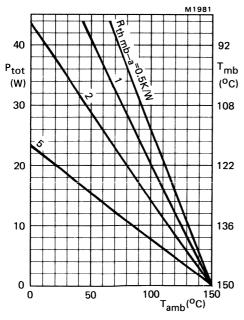


Fig.6

#### SINUSOIDAL OPERATION

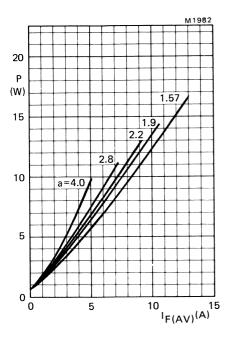


Fig.7 Power rating per diode. The individual power loss in each diode

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.

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

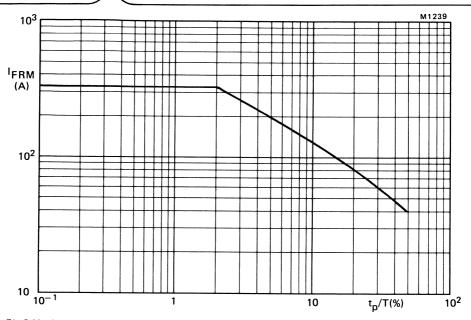
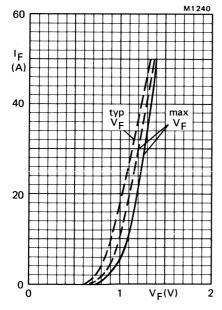
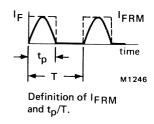
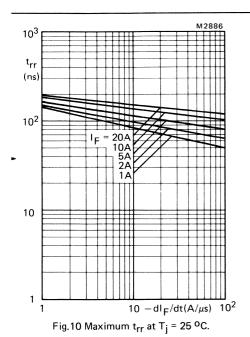


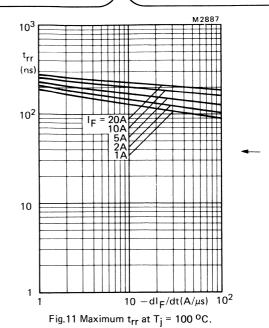
Fig.8 Maximum permissible repetitive peak forward current for square or sinusoidal currents; 1  $\mu s < t_p < 1$  ms.

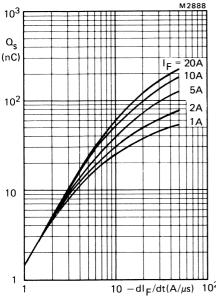




2 Fig.9 —  $T_j = 25$  °C;  $- - T_j = 150$  °C.







July 1986

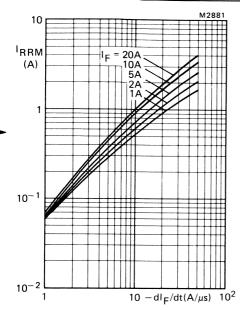


Fig. 13 Maximum  $I_{RRM}$  at  $T_i = 25$  °C.

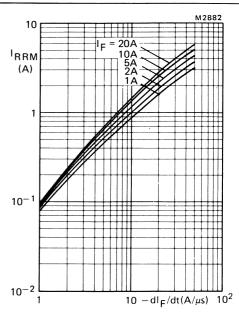


Fig.14 Maximum I<sub>RRM</sub> at T<sub>i</sub> = 100 °C.

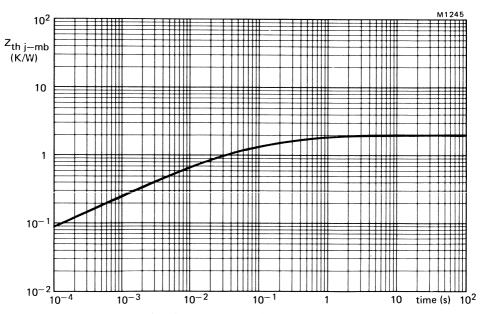


Fig.15 Transient thermal impedance (one diode conducting).

### 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.

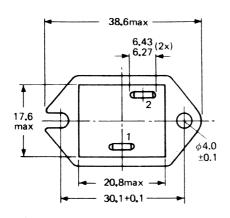
#### QUICK REFERENCE DATA

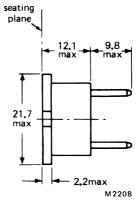
		BYV60-850		1000	1200	
Repetitive peak reverse voltage	$v_{RRM}$	max.	850	1000	1200	
Average forward current	IF(AV)	max.		15		Α
Non-repetitive peak forward current	<sup>I</sup> FSM	max.		150		Α
Reverse recovery time	t <sub>rr</sub>	<		0.6		μs

#### **MECHANICAL DATA**

Fig.1 TO-238 (2-pin)

Dimensions in mm





Pin 1 = cathode (AMO 250 series)

2 = anode (AMP 250 series)

Baseplate is electrically isolated.

Net mass = 16.5 g

# **BYV60 SERIES**

### **RATINGS**

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

Voltages		BYV60	-850	100	0	1200		
Non-repetitive peak reverse voltage	VRSM	max.	1000	110	0	1300	V	
Repetitive peak reverse voltage	$v_{RRM}$	max.	850	100	0	1200	V	
Crest working reverse voltage	$v_{RWM}$	max.	600	80	0	1000	V	
Continuous reverse voltage	$v_R$	max.	500	65	o	750	_	
Currents								
Average forward current assuming zero switching losses								
square-wave; $\delta = 0.5$ ; up to $T_{mb} = 76$ °C		lF(AV)		max.	15	5	Α	
sinusoidal; up to T <sub>mb</sub> = 81 °C		IF(AV)		max.	13.	5	Α	
R.M.S. forward current		IF(RMS	;)	max.	2	1	Α	
Repetitive peak forward current; 1 $\mu s < t_p < 1 \text{ ms}; \delta \le 0.02$		IFRM		max.	300	)	Α	
Non-repetitive peak forward current; t = 1 half sine-wave; $T_j$ = 125 °C prior to surg with reapplied $V_{RWM\ max}$		IFSM		max.	150	0	Α	
Temperatures								
Storage temperature		T <sub>stg</sub>		−40 t	o +12!	5	οС	
Junction temperature		тј		max.	12	5	оС	
THERMAL RESISTANCE								
From mounting base to heatsink; with heatsink compound		R <sub>th mb</sub>	-h	=	0.3	3	K/W	
From junction to mounting base		R <sub>th j-ml</sub>	b	=	:	2	K/W	
ISOLATION*								
R.M.S. isolation voltage		$V_{isol}$		min.	2500	)	V	

<sup>\*</sup>From baseplate to terminals strapped together.

μs

#### **CHARACTERISTICS**

Forward voltage I <sub>F</sub> = 50 A; T <sub>j</sub> = 25 °C	VF	<	2.45	V*
Reverse current $V_R = V_{RWMmax}$ ; $T_j = 100  {}^{\circ}\text{C}$	I <sub>R</sub>	<	1.2	mA
Reverse recovery when switched from IF = 2 A to VR $\geqslant$ 30 V with $-dI_F/dt$ = 20 A/ $\mu$ s; T $_j$ = 25 °C recovered charge	$\Omega_{s}$	<	2.0	μC

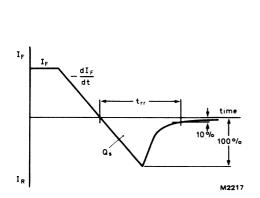
recovery time

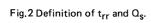
Forward recovery when switched to

 $I_F = 5$  A with  $t_r = 0.1 \ \mu s$ ;  $T_j = 25 \ ^{O}C$  recovery time

t<sub>fr</sub> < 1.0 μs

0.6





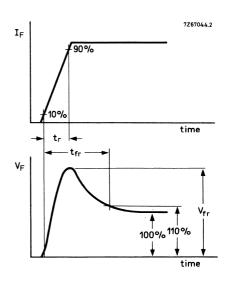
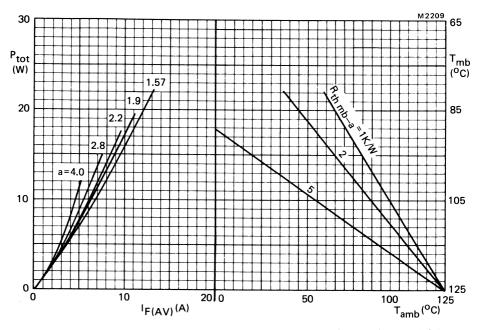


Fig. 3 Definition of  $t_{fr}$ .

<sup>\*</sup>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

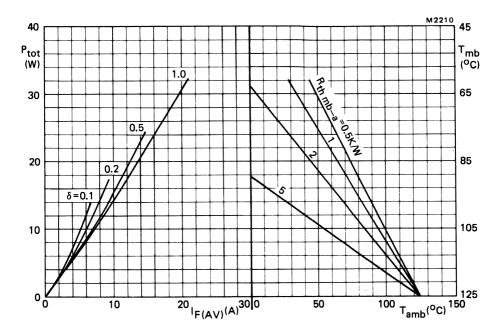


Fig. 5 The right-hand part shows the interrelationship between the power (derived from the left-hand part) and the maximum permissible temperatures.

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

$$\delta = \frac{\mathsf{t}_{p}}{\mathsf{T}}$$

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

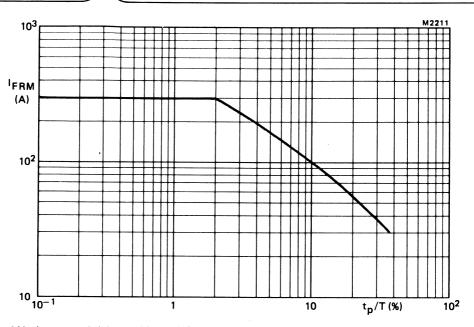


Fig. 6 Maximum permissible repetitive peak forward current based on sinusoidal currents; 1  $\mu s < t_p < 1$  ms.

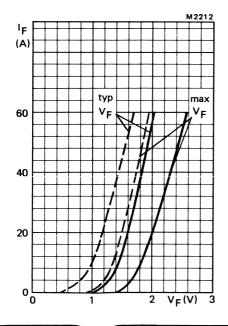


Fig.7 ——— $T_j = 25 \text{ °C}; ----T_j = 100 \text{ °C}.$ 

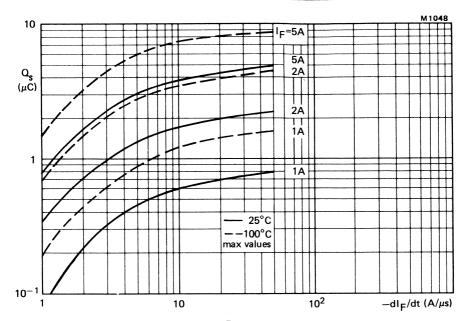


Fig.8

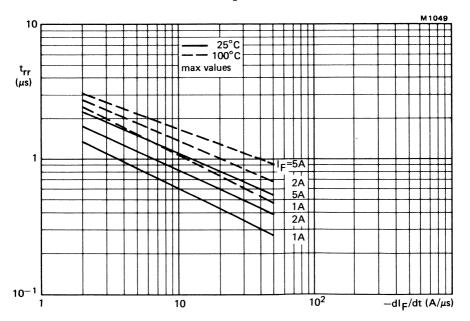


Fig.9

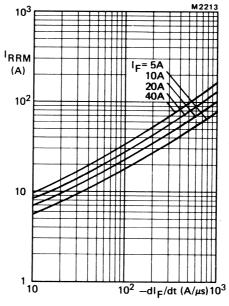
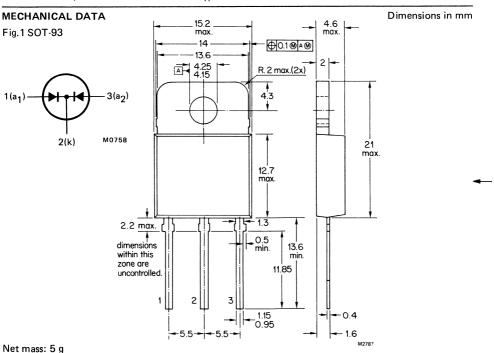


Fig. 10

### 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 BYV72-50 100 150 200 Per diode, unless otherwise stated 200 50 100 150 V Repetitive peak reverse voltage $V_{RRM}$ max. Output current 30 (both diodes conducting) 10 max. Α 0.85 < Forward voltage ٧F 28 < Reverse recovery time ns $t_{rr}$



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.

## **BYV72 SERIES**

#### **RATINGS**

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

Voltages (per diode)		BYV7	2-50	100	150	200		
Repetitive peak reverse voltage	VRRM	max.	50	100	150	200	V	
Crest working reverse voltage	VRWM	max.	50	100	150	200	V	
Continuous reverse voltage	VR	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 <sub>O</sub>	max.		3	0		A	
R.M.S. forward current (note 2)	F(RMS)	max.		4:	3		Α	
Repetitive peak forward current $t_p = 20 \mu s$ ; $\delta = 0.02$ (per diode)	I <sub>FRM</sub>	max.		320	0		Α	
Non-repetitive peak forward current (per diode) half sine-wave; $T_j = 150  ^{\circ}\text{C}$ prior to surge; with reapplied $V_{RWM\ max}$ t = 10 ms t = 8.3 ms	<sup>I</sup> FSM <sup>I</sup> FSM	max. max.		150 160	-		A A	
$I^2$ t for fusing (t = 10 ms; per diode)	l <sup>2</sup> t	max.		112	2		A <sup>2</sup> s	
Temperatures								
Storage temperature	T <sub>stq</sub>		-40	to +15(	)		оС	
Junction temperature	Tj	max.		150	)		оС	

#### 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

#### CHARACTERISTICS

 $T_i$  = 25  $^{o}$ C unless otherwise stated

Forward voltage

$$I_F = 10 \text{ A}; T_j = 100 \text{ }^{\circ}\text{C}$$
  
 $I_F = 30 \text{ A}$ 

Reverse current

$$V_R = V_{RWM max}$$
;  $T_j = 100 \, {}^{\circ}C$   
 $V_R = V_{RWM max}$ 

Reverse recovery when switched from

$$I_R$$
 = 1 A to  $V_R$   $\geqslant$  30 V with  $-dI_F/dt$  = 100 A/ $\mu s$ ; recovery time

I<sub>F</sub> = 2 A to  $V_R \ge 30 V$  with  $-dI_F/dt = 20 A/\mu s$ ; recovered charge

$$I_F = 10 \text{ A to V}_R \geqslant 30 \text{ V with } -dI_F/dt = 50 \text{ A}/\mu\text{s};$$

T<sub>j</sub> = 100 °C; peak recovery current

Forward recovery when switched to  $I_F = 1 A$ with  $dI_F/dt = 10 A/\mu s$ 

V <sub>F</sub>	< <	0.85 1.15	V* V*
I <sub>R</sub> I <sub>R</sub>	< <	1.0 25	mΑ μΑ
t <sub>rr</sub>	<	28	ns 🚤
$Q_{S}$	<	15	nC
IRRM	<	2.4	A ,
$V_{fr}$	typ.	1.0	V

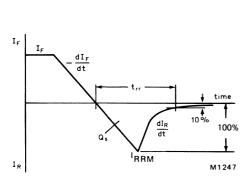


Fig.2 Definition of  $t_{rr}$ ,  $Q_s$  and  $I_{RRM}$ .

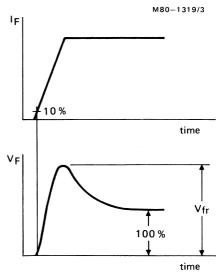


Fig.3 Definition of V<sub>fr</sub>.

<sup>\*</sup>Measured under pulse conditions to avoid excessive dissipation.

# **BYV72 SERIES**

### **→ THERMAL RESISTANCE**

Fr	om junction to mounting base (both diodes conducting)	R <sub>th j-mb</sub>	=	1.4	K/W
	om junction to mounting base (per diode)	R <sub>th j-mb</sub>	=	2.4	K/W
In	fluence of mounting method	•			
1.	Heatsink-mounted with clip (see mounting instructions)				
Th	ermal resistance from mounting base to heatsink				
a.	with heatsink compound	R <sub>th mb-h</sub>	=	0.2	K/W
b.	with heatsink compound and 0.06 mm maximum mica insulator (56378)	R <sub>th mb-h</sub>	=	1.4	K/W
c.	with heatsink compound and 0.1 mm maximum mica insulator	R <sub>th mb-h</sub>	=	2.2	K/W
d.	with heatsink compound and 0.25 mm maximum				
	alumina insulator	R <sub>th mb-h</sub>	=	8.0	K/W
e.	without heatsink compound	R <sub>th mb-h</sub>	=	1.4	K/W
2.	Free air operation				
Th to	e quoted value $$ of $$ R $_{thj\cdot a}$ should be used only when no leads of the same tie point.	other dissipat	ng cor	nponent	s run

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

#### MOUNTING INSTRUCTIONS

- 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.
- 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<sub>th mb-h</sub> 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<sub>th mb-h</sub> given for mounting with heatsink compound refer to the use of a metallic-oxide loaded compound. Ordinary silicone grease is not recommended.
- 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

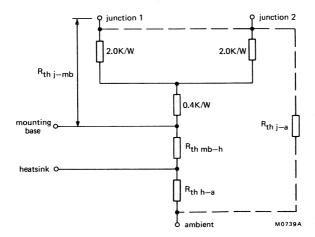


Fig.4

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

### SQUARE-WAVE OPERATION (BOTH DIODES)

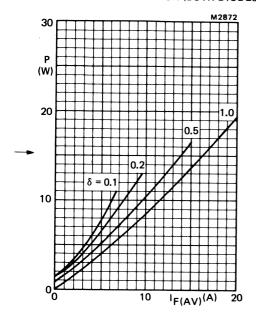
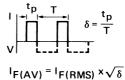


Fig.5 Power rating per diode.
The individual power loss in each diode should first be determined then both added together. The resulting total power loss is then used in conjunction with Fig.6 to determine the heatsink size and corresponding maximum ambient and mounting base temperatures.



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

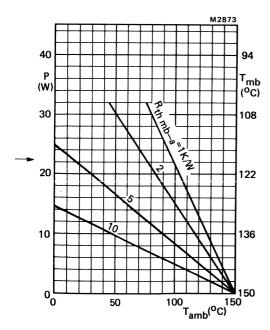


Fig.6

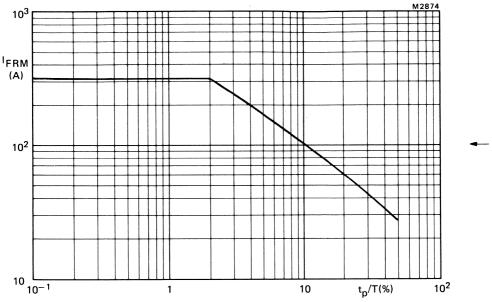
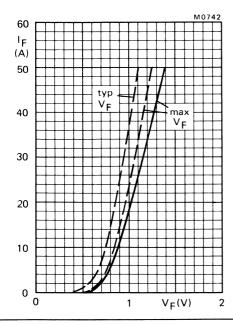
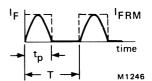


Fig.7 Maximum permissible repetitive peak forward current for either square or sinusoidal currents for 1  $\mu$ s < t $_p$  < 1 ms; per diode.





Defintion of I FRM and  $t_p/T$ .

Fig.8 —  $T_j$  = 25 °C; — —  $T_j$  = 100 °C. per diode.

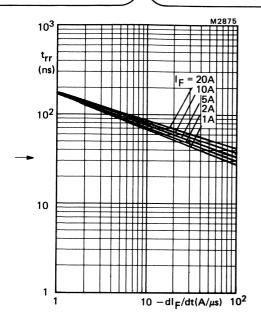
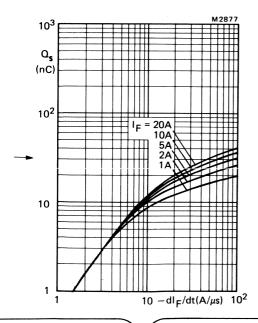


Fig.9 Maximum  $t_{rr}$  at  $T_j = 25$  °C; per diode.



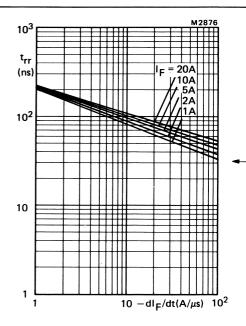


Fig.10 Maximum  $t_{rr}$  at  $T_j$  = 100 °C; per diode.

Fig.11 Maximum  $Q_s$  at  $T_j$  = 25  $^{o}$ C; per diode.

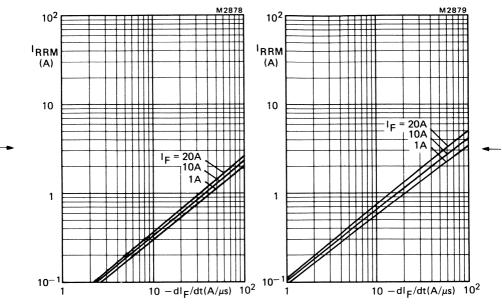


Fig. 12 Maximum  $I_{RRM}$  at  $T_j = 25$  °C; per diode.

Fig.13 Maximum  $I_{RRM}$  at  $T_j = 100$  °C; per diode.

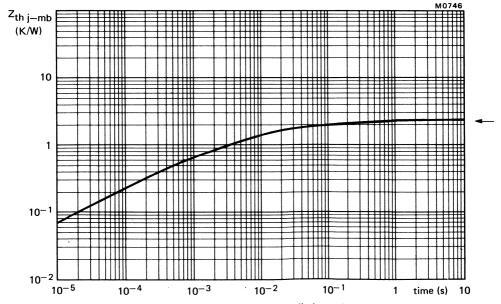


Fig. 14 Transient thermal impedance; one diode conducting.



### ULTRA FAST RECOVERY DOUBLE RECTIFIER DIODES

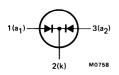
Glass-passivated, high-efficiency epitaxial double rectifier diodes in plastic envelopes which feature low forward voltage drop, very fast reverse recovery times and soft-recovery characteristic. They are intended for use in switched-mode power supplies and high-frequency circuits in general, where low 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.

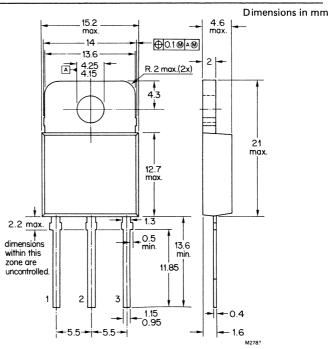
#### QUICK REFERENCE DATA

	BYV74	4-300	400	500	V
$v_{RRM}$	max.	300	400	500	V
10	max.		30		Α
٧ <sub>F</sub>	<		1.05		V
t <sub>rr</sub>	<		50		ns
	I <sub>O</sub> V <sub>F</sub>	V <sub>RRM</sub> max.  I <sub>O</sub> max.  V <sub>F</sub> <	IO max. VF <	V <sub>RRM</sub> max. 300 400  I <sub>O</sub> max. 30 V <sub>F</sub> < 1.05	V <sub>RRM</sub> max. 300 400 500  I <sub>O</sub> max. 30 V <sub>F</sub> < 1.05

#### MECHANICAL DATA

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.

# **BYV74 SERIES**

#### **RATINGS**

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

Voltages (per diode)		BYV7	4-300	400	500	
Repetitive peak reverse voltage	$V_{RRM}$	max.	300	400	500	V
Crest working reverse voltage	VRWM	max.	200	300	400	V
Continuous reverse voltage (note 1)	V <sub>R</sub>	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 $^{o}C$	10	max.		30		Α
sinusoidal; up to T <sub>mb</sub> = 103 °C	10	max.	. 26			Α
R.M.S. forward current	<sup> </sup> F(RMS)	max.	. 30			Α
Repetitive peak forward current	, , , , , , , , , , , , , , , , , , , ,					
$t_p = 20 \ \mu s; \ \delta = 0.02 \ (note 4)$	<sup>I</sup> FRM	max.		320		Α
Non-repetitive peak forward current half sine-wave; T <sub>i</sub> = 150 °C prior to						
surge; with reapplied V <sub>RWM max</sub> (note 4)						
t = 10 ms	<sup>I</sup> FSM	max.		130		Α
t = 8.3 ms	<sup>I</sup> FSM	max.		140		Α
I <sup>2</sup> t for fusing (t = 10 ms; note 4)	l² t	max.		84		$A^2s$
Temperatures						
Storage temperature	T <sub>stg</sub>		-40 to	+150		οС
Junction temperature	Тj	max.		150		oC

#### Notes:

- 1. To ensure thermal stability:  $R_{\mbox{th j-a}}\!<\!9.3$  K/W.
- The limits for both diodes apply whether both diodes conduct simultaneously or on alternate half cycles.
- 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<sub>i</sub> = 25 °C unless otherwise stated

Forward	volta	ige
---------	-------	-----

I <sub>F</sub> = 15 A; T <sub>j</sub> = 150 °C	V <sub>F</sub>	< <	1.05	V*
I <sub>F</sub> = 50 A	V <sub>F</sub>		1.6	V*
Reverse current	·			

neverse current

$V_R = V_{RWM max}$ ; $T_i = 100  {}^{\circ}C$	۱ <sub>R</sub>	<	8.0	mA
$V_R = V_{RWM max}$	1 <sub>R</sub>	<	50	μΑ

Reverse recovery when switched from

I<sub>F</sub> = 1 A to  $V_R \ge 30 \text{ V}$  with  $-dI_F/dt = 100 \text{ A}/\mu\text{s}$ ; recovery time

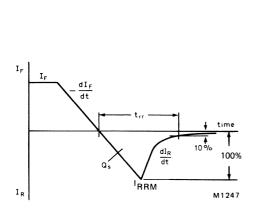
I F = 2 A to V  $_{\rm R}$   $\geqslant$  30 V with -dI  $_{\rm F}$ /dt = 20 A/ $_{\rm \mu}$ s; recovered charge

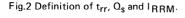
I<sub>F</sub> = 10 A to V<sub>R</sub>  $\geqslant$  30 V with  $-dI_F/dt$  = 50 A/ $\mu$ s; T<sub>i</sub> = 100  $^{9}$ C; peak recovery current

Forward recovery when switched to I<sub>F</sub> = 10 A

with  $dI_F/dt = 10 A/\mu s$  recovery voltage

I <sub>R</sub> I <sub>R</sub>	< <	0.8 50	mΑ μΑ
t <sub>rr</sub>	<	50	ns
$O_s$	<	50	nC
<sup>I</sup> RRM	<	5.2	Α
$V_{fr}$	typ.	2.5	V





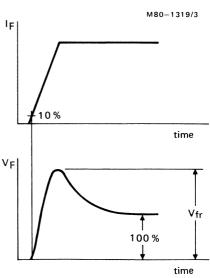


Fig.3 Definition of Vfr.

<sup>\*</sup>Measured under pulse conditions to avoid excessive dissipation.

THERMAL RESISTANCE					
From junction to mounting base	e; total package	R <sub>th j-mb</sub>	=	1.4	K/W
	per diode	R <sub>th j-mb</sub>	=	2.0	K/W
Influence of mounting method					
1. Heatsink-mounted with clip (	see mounting instructions)				
Thermal resistance from mounti	ng base to heatsink				
a. with heatsink compound		R <sub>th mb-h</sub>	=	0.2	K/W
b. with heatsink compound and	0.06 mm maximum mica				
insulator (56378)		R <sub>th mb-h</sub>	=	1.4	K/W
c. without heatsink compound		R <sub>th mb-h</sub>	=	1.4	K/W

### 2. Free air operation

The quoted value of  $R_{th\ j\cdot a}$  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  $R_{th\ j-a} = 60\ K/W$ 

#### MOUNTING INSTRUCTIONS

- 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<sub>th mb-h</sub> 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<sub>th mb-h</sub> given for mounting with heatsink compound refer to the use of a metallic oxide-loaded compound. Ordinary silicone grease is not recommended.
- 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.

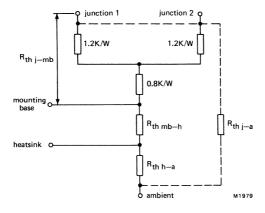


Fig. 4.

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  $R_{th\ mb-a}$ . The heatsink thermal resistance value ( $R_{th\ h-a}$ ) can be calculated from:

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

# **BYV74 SERIES**

#### SQUARE-WAVE OPERATION

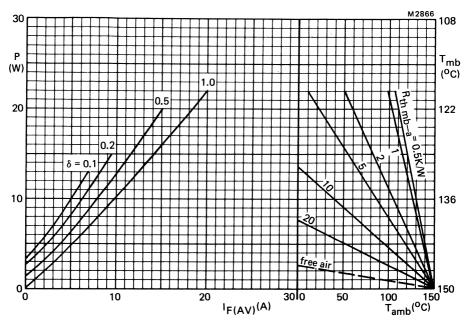


Fig.5 The right-hand part shows the relationship between the power (derived from the left-hand part) and the maximum permissible temperatures (per diode).

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

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

#### SINUSOIDAL OPERATION

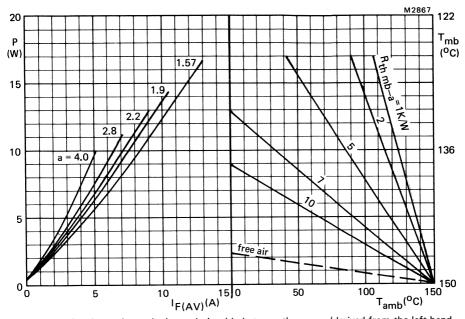


Fig.6 The right-hand part shows the interrelationship between the power (derived from the left-hand part) and the maximum permissible temperatures (per diode).

a = form factor = IF(RMS)/IF(AV).

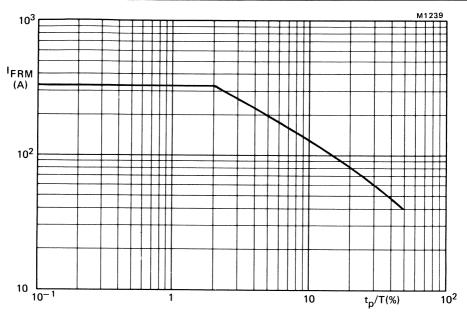
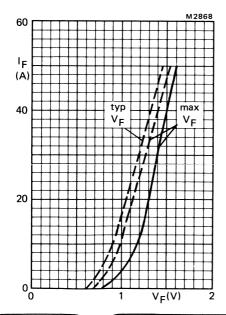


Fig.7 Maximum permissible repetitive peak forward current for square or sinusoidal currents; 1  $\mu$ s < t $_p$  < 1 ms (per diode).



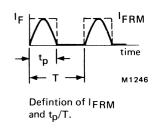


Fig.8 —  $T_j$  = 25 °C; ---  $T_j$  = 150 °C (per diode).

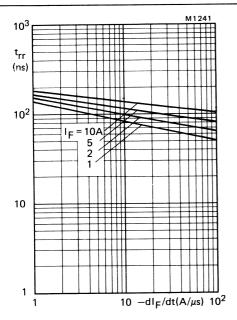
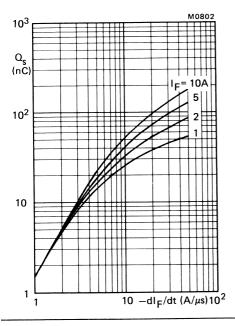


Fig.9 Maximum  $t_{rr}$  at  $T_j = 25$  °C. (per diode).



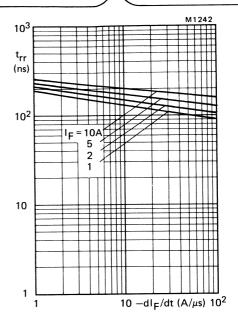


Fig.10 Maximum  $t_{rr}$  at  $T_j = 100$  °C. (per diode).

Fig.11 Maximum  $Q_s$  at  $T_j$  = 25  $^{o}C$ . (per diode).

## ULTRA FAST RECOVERY RECTIFIER DIODES

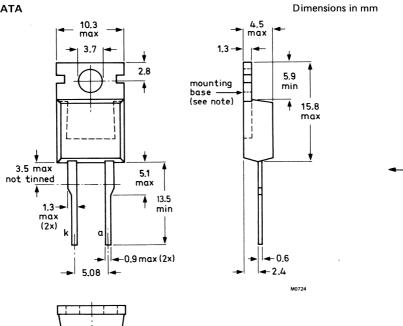
Glass-passivated, high-efficiency epitaxial rectifier diodes in plastic envelopes, featuring low forward voltage drop, ultra fast reverse recovery times with very low stored charge and soft-recovery characteristic. They are intended for use in switched-mode power supplies and high-frequency circuits 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	٧	
Average forward current	I <sub>F</sub> (AV)	max.			14		Α	
Forward voltage	VF	<		0.	85		٧	
Reverse recovery time	t <sub>rr</sub>	<			30		ns	4

#### **MECHANICAL DATA**

Fig.1 TO-220AC



Net mass: 2 a

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.

## **BYV79 SERIES**

THERMAL RESISTANCE				
From junction to mounting base	R <sub>th j-mb</sub>	=	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 <sub>th mb-h</sub>	=	0.3	K/W
b. with heatsink compound and 0.06 mm maximum mica insulator	R <sub>th mb-h</sub>	=	1.4	K/W
<ul> <li>with heatsink compound and 0.1 mm maximum mica insulator (56369)</li> </ul>	R <sub>th mb-h</sub>	=	2.2	K/W
<ul> <li>with heatsink compound and 0.25 mm maximum alumina insulator (56367)</li> </ul>	R <sub>th mb-h</sub>	=	0.8	K/W
e. without heatsink compound	R <sub>th mb-h</sub>	=	1.4	K/W
2. Free air operation				
The quoted value of $R_{th\ j-a}$ should be used only when no leads of to the same tie point.  Thermal resistance from junction to ambient in free air: mounted on a printed circuit board at any device lead	other dissipat	ing cor	nponent	s run
length and with copper laminate on the board	R <sub>th j-a</sub>	=	60	K/W

#### MOUNTING INSTRUCTIONS

- 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<sub>th mb-h</sub> values than does screw mounting.

b. safe isolation for mains operation.

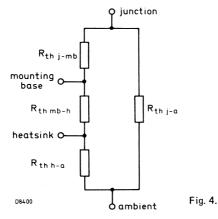
However, if a screw is used, it should be M3 cross-recess pan head. Care should be taken to avoid damage to the plastic body.

- 4. For good thermal contact, heatsink compound should be used between mounting base and heatsink. Values of R<sub>th mb-h</sub> 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.



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  $R_{th\ mb-a}$ . The heatsink thermal resistance value ( $R_{th\ h-a}$ ) can be calculated from:

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

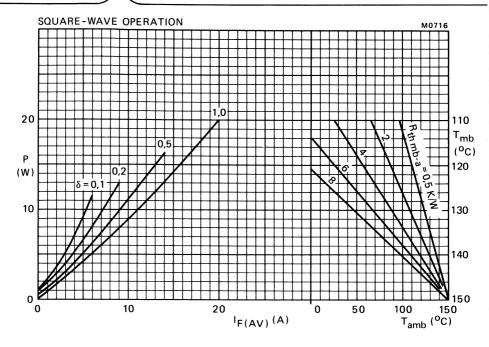


Fig.5 The right-hand part shows the interrelationship between the power (derived from the left-hand part) and the maximum permissible temperatures.

P = power including reverse current losses and switching losses up to f = 500 kHz.

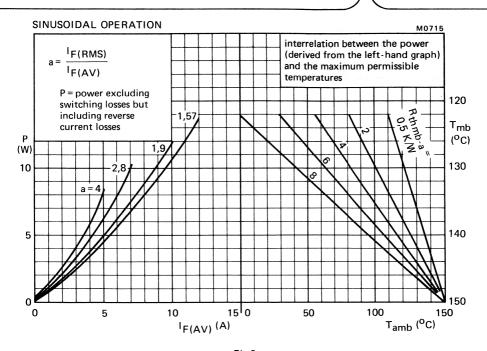


Fig.6

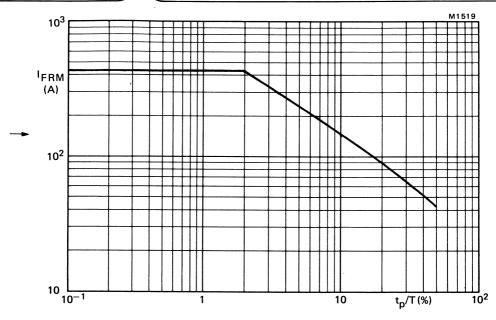
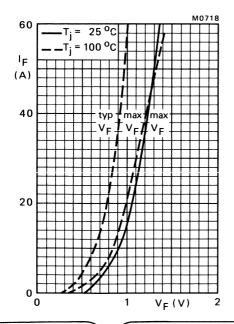


Fig.7 Maximum permissible repetitive peak forward current for square or sinusoidal currents; 1  $\mu s < t_p < 1$  ms.



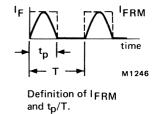


Fig.8.

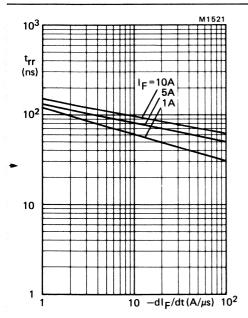


Fig.9 Maximum  $t_{rr}$  at  $T_j = 25$  °C.

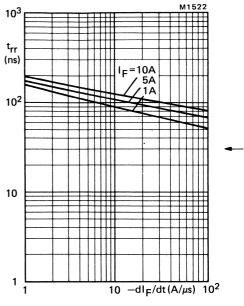


Fig.10 Maximum  $t_{rr}$  at  $T_i = 100$  °C.

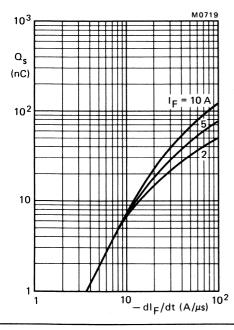


Fig.11 Maximum  $Q_s$  at  $T_i = 25$  °C.

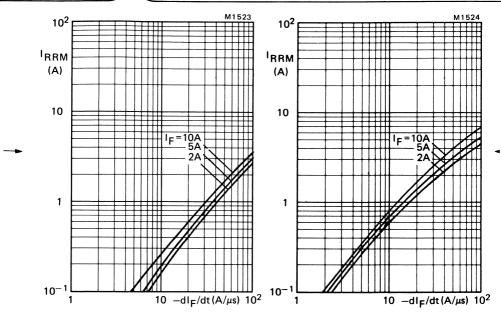


Fig.12 Maximum  $I_{RRM}$  at  $T_i = 25$  °C.

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

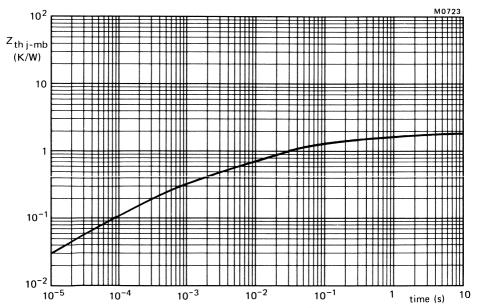


Fig.14 Transient thermal impedance.

## 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.

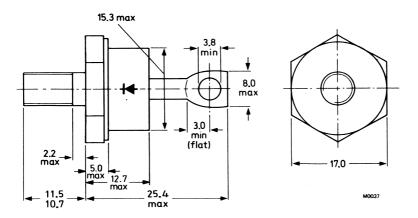
## QUICK REFERENCE DATA

		BYV92-30	0   400	500	
Repetitive peak reverse voltage	V <sub>RRM</sub>	max. 30	0 400	500	V
Average forward current	IF(AV)	max.	35		A
Forward voltage	VF	<	1.05		V
Reverse recovery time	t <sub>rr</sub>	<	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		BYV9	2-300	400	500	
	Repetitive peak reverse voltage	$v_{RRM}$	max.	300	400	500	V
	Crest working reverse voltage	V <sub>RWM</sub>	max.	200	300	400	٧
	Continuous reverse voltage*	VR	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 up to $T_{mb}$ = 125 °C	lF(AV) lF(AV)	max. max.		38 21		A A
	sinusoidal, up to $T_{mb}$ = 106 $^{o}$ C up to $T_{mb}$ = 125 $^{o}$ C	l <sub>F(AV)</sub> l <sub>F(AV)</sub>	max. max.		34 21		A A
	R.M.S. forward current	IF(RMS)	max.		55		Α
	Repetitive peak forward current $t_p = 20 \mu s$ , $\delta = 0.02$	<sup>I</sup> FRM	max.		800		Α
	Non-repetitive peak forward current half sine-wave, T <sub>j</sub> = 150 °C prior to surge t = 10 ms	l <sub>FSM</sub>	max.		500		A
	t = 8.3  ms	<sup>I</sup> FSM	max.		600		Α
	with reapplied V <sub>RWM</sub> max t = 10 ms t = 8.3 ms	<sup> </sup> FSM <sup> </sup> FSM	max. max.		350 440		A A
	$I^2$ t for fusing (t = 10 ms)	l <sup>2</sup> t	max.		610		A <sup>2</sup> s
	Temperatures						
	Storage temperature	$T_{stg}$		-55 to	+150		οС
	Junction temperature	Тj			150		oC
	THERMAL RESISTANCE						
	From junction to mounting base	R <sub>th j-mb</sub>	=		1.0		K/W
	From mounting base to heatsink with heatsink compound without heatsink compound	Rth mb-h	= =		0.3 0.5		K/W 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.

<sup>\*</sup>To ensure thermal stability: R<sub>th j-a</sub>  $\leq$  3.4 K/W.

CHARACTERISTICS				* a.a 🔻
Forward voltage $I_F = 35 \text{ A}$ ; $T_j = 150 ^{\circ}\text{C}$ $I_F = 100 \text{ A}$ ; $T_j = 25 ^{\circ}\text{C}$	V <sub>F</sub> V <sub>F</sub>	< <	1.05 1.4	V* V*
Reverse current $V_R = V_{RWM \ max}$ ; $T_j = 100 \ ^{\circ}C$ $T_j = 25 \ ^{\circ}C$	I <sub>R</sub>	< <	2.0 50	mΑ μΑ
Reverse recovery when switched from IF = 1 A to $V_R \ge 30 V$ with $-dI_F/dt = 100 A/\mu s$ ; $T_j = 25  ^{\circ}C$ ; recovery time	t <sub>rr</sub>	<	50	ns
$I_F$ = 2 A to $V_R \geqslant 30$ V with $-dI_F/dt$ = 20 A/ $\mu$ s; $T_j$ = 25 $^{o}$ C; recovered charge	$O_s$	<	75	nC
I <sub>F</sub> = 10 A to $V_R \ge 30 V$ with $-dI_F/dt = 50 A/\mu s$ ; $T_j = 100  ^{o}C$ ; peak recovery current	IRRM	<	4	Α
Forward recovery when switched to I <sub>F</sub> = 10 A with dI <sub>F</sub> /dt = 10 A/ $\mu$ s; T $_j$ = 25 °C	V <sub>fr</sub>	typ.	2.5	V

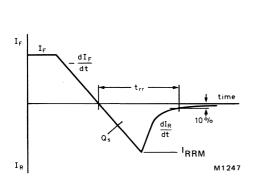


Fig.2 Definition of  $t_{\mbox{\scriptsize rr}},$   $\mbox{\scriptsize Q}_{\mbox{\scriptsize S}}$  and  $\mbox{\scriptsize I}_{\mbox{\scriptsize RRM}}.$ 

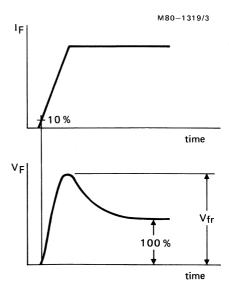


Fig.3 Definition of V<sub>fr</sub>.

<sup>\*</sup>Measured under pulse conditions to avoid excessive dissipation.

## SQUARE-WAVE OPERATION

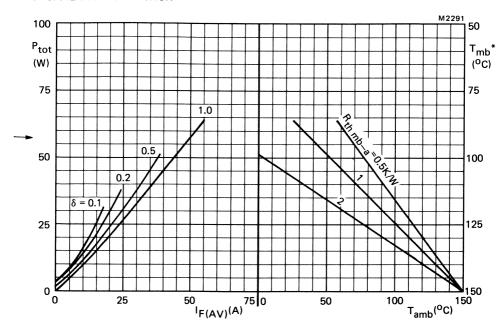


Fig.4 The right-hand part shows the relationship between the power (derived from the left-hand part) and the maximum permissible temperatures. Power includes reverse current losses and switching losses up to f = 100 kHz.

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

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

 $<sup>^*</sup>T_{mb}$  scale is for comparison purposes and is correct only for R<sub>th mb-a</sub> < 2.4 K/W.

## SINUSOIDAL OPERATION

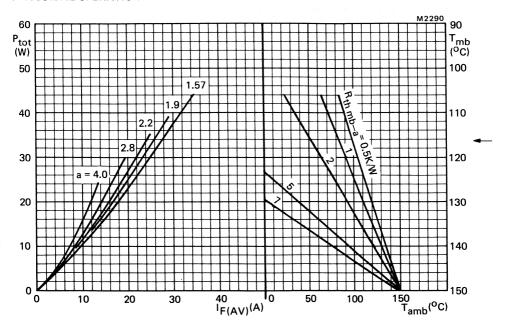


Fig.5 The right-hand part shows the interrelationship between the power (derived from the left-hand part) and the maximum permissible temperatures.  $a = form\ factor = I_{F(RMS)}/I_{F(AV)}$ .

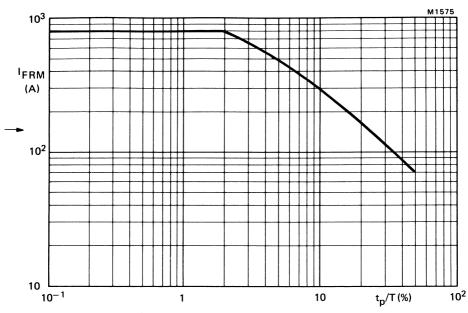
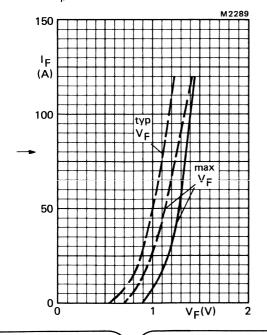
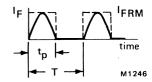


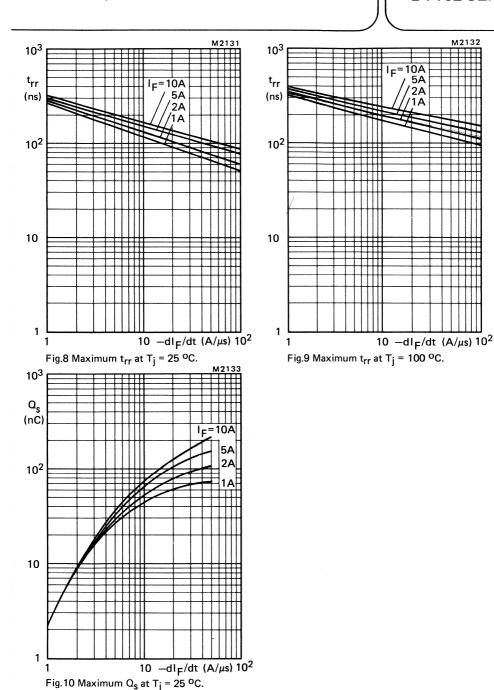
Fig.6 Maximum permissible repetitive peak forward current for square or sinusoidal currents; 1  $\mu s < t_p < 1$  ms.

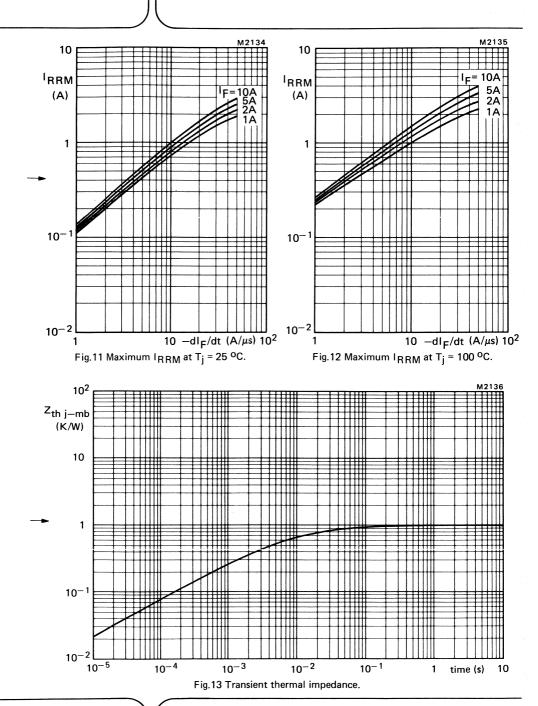




Definition of IFRM and  $t_p/T$ .

Fig.7 —— 
$$T_j = 25$$
 °C;  $---T_j = 150$  °C.





## 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.

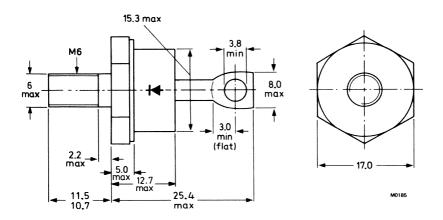
## **QUICK REFERENCE DATA**

			BYW25-800(R)	1000(R)	
Repetitive peak reverse voltage	$v_{RRM}$	max.	800	1000	V
Average forward current	I <sub>F(AV)</sub>	max.	4	0	A
Repetitive peak forward current	IFRM	max.	60	0	<b>A</b>
Reverse recovery time	t <sub>rr</sub>	<	450	0	ns

#### **MECHANICAL DATA**

Dimensions in mm

Fig.1 DO-5: with metric M6 stud ( $\phi$ 6 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

## **BYW25 SERIES**

**RATINGS** 

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

Voltages*		BYW25-8	00(R)	1000(R	<u>)</u>
Non-repetitive peak reverse voltage	V <sub>RSM</sub>	max. 100	00	1200	٧
Repetitive peak reverse voltage	$v_{RRM}$	max. 80	00	1000	٧
Crest working reverse voltage	$v_{\sf RWM}$	max. 65	50	850	٧
Continuous reverse voltage	VR	max. 65	50	850	٧
Currents					
Average forward current; switching losses negligible up to 20 kHz sinusoidal; up to T <sub>mb</sub> = 100 °C sinusoidal; at T <sub>mb</sub> = 125 °C		IF(AV) IF(AV)	max. max.	40 23	A A
R.M.S. forward current		IF(RMS)	max.	60	Α
Repetitive peak forward current		IFRM	max.	600	Α
Non-repetitive peak forward current; t = 10 ms; half sine-wave; T <sub>j</sub> = 150 °C prior to surge		IFSM	max.	550	A
I <sup>2</sup> t for fusing (t = 10 ms)		l²t	max.	1500	A <sup>2</sup> s
Temperatures					
Storage temperature		$T_{stg}$	-55	to +150	оC
Junction temperature		т <sub>ј</sub>	max.	150	οС
THERMAL RESISTANCE					
From junction to mounting base		R <sub>th j-mb</sub>	=	0.6	°C/
From mounting base to heatsink with heatsink compound without heatsink compound		R <sub>th mb-h</sub> R <sub>th mb-h</sub>	=	0.3 0.5	°C/

<sup>\*</sup>To ensure thermal stability:  $R_{\mbox{th}\mbox{ j-a}} \leqslant 1$  °C/W (continuous reverse voltage).

450 ns

 $1 \mu s$ 

## **CHARACTERISTICS**

Forward	voltage

Reverse current

$$V_R = 650 \text{ V; } T_i = 125 \text{ }^{\circ}\text{C}$$
  $I_R < 7 \text{ mA}$ 

Reverse recovery when switched from

$$I_F = 10 \text{ A to V}_R = 30 \text{ V with } -dI_F/dt = 50 \text{ A}/\mu\text{s}; T_j = 25 \text{ °C}$$
  
Recovery time

 $I_F = 600 \text{ A to V}_R \ge 30 \text{ V with } -dI_F/dt = 70 \text{ A/$\mu$s; } T_{mb} = 85 \text{ }^{\circ}\text{C}$ 

From the Recovery time R = 30 V with  $-\text{dif/dt} = 70 \text{ A/}\mu\text{s}$ ;  $R_{mb} = 8 \text{ Recovery time}$ 

Maximum slope of the reverse recovery current when switched from I<sub>F</sub> = 600 A to  $V_R \ge 30 V$ ;

with  $-dI_F/dt = 35 \text{ A/}\mu\text{s}$ ;  $T_j = 25 \text{ °C}$   $\left| dI_R/dt \right| < 100 \text{ A/}\mu\text{s}$ 

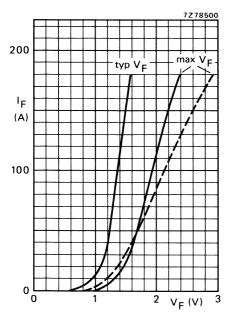
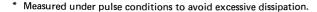
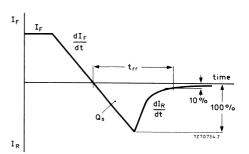


Fig. 3 —  $T_j = 25 \text{ °C}; --- T_j = 150 \text{ °C}.$ 





trr

trr

Fig. 2 Definitions of  $Q_s$ ,  $t_{rr}$  and  $dI_R/dt$ .

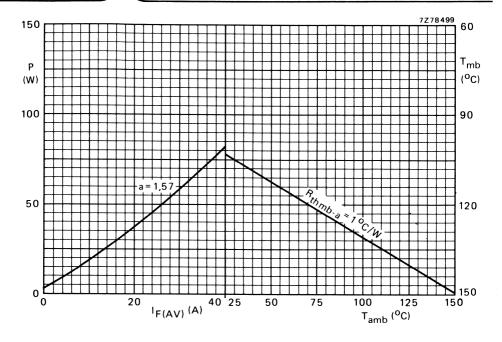


Fig. 4 The right-hand part shows the interrelationship between the power (derived from the left-hand part) and the maximum permissible temperatures.

P = power including reverse current losses and switching losses up to f = 20 kHz.

 $a = I_F(RMS)/I_F(AV)$ 

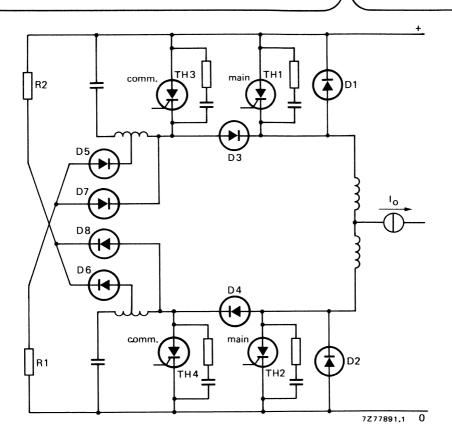


Fig. 5 One phase of a three-phase inverter for a.c. motor speed control. D1 to D4 are BYW25 types.



## ULTRA FAST RECOVERY RECTIFIER DIODES



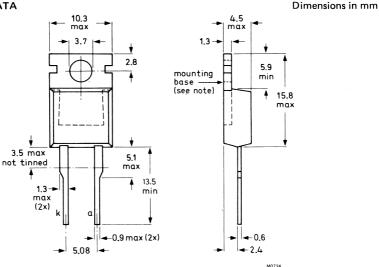
Glass-passivated, high-efficiency epitaxial rectifier diodes in plastic envelopes, featuring low forward voltage drop, ultra fast reverse recovery times with very low stored charge and soft-recovery characteristic. They are intended for use in switched-mode power supplies and high-frequency circuits 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 <sub>RRM</sub>	max.	50	100	150	200	V
Average forward current	<sup>I</sup> F(AV)	max.			8		A
Forward voltage	VF	< 0.8		0.8		٧	
Reverse recovery time	t <sub>rr</sub>	<			25		ns

## **MECHANICAL DATA**

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.



Products approved to CECC 50 009-014 available on request.

# BYW29 SERIES

## **RATINGS**

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

Voltages		BYW29	950	100	150	200	
Repetitive peak reverse voltage	VRRM	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	ς. <b>V</b>
Currents							
Average forward current; switching losses negligible up to 500 kHz square wave; $\delta = 0.5$ ; up to T <sub>mb</sub> =	= 125 °C	lF(AV)		max.	8	ı	A
sinusoidal; up to T <sub>mb</sub> = 125 °C		IF(AV)		max.	7.3		Α
R.M.S. forward current		IF(RMS		max.	11.5		Α
Repetitive peak forward current $t_p = 20 \mu s$ ; $\delta = 0.02$		IFRM	,	max.	240	ı	Α
Non-repetitive peak forward current half sine-wave; T <sub>j</sub> = 150 °C prior with reapplied V <sub>RWMmax</sub> ;	to surge;						
t = 10 ms		IFSM		max.	80		Α
t = 8.3 ms		IFSM		max.	100		Α
$I^2$ t for fusing (t = 10 ms)		l²t		max.	32		$A^2s$
Temperatures							
Storage temperature		T <sub>stg</sub>		4	10 to +150		oC
Junction temperature		Tj		max.	150		oC.

## Notes:

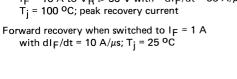
1. To ensure thermal stability:  $R_{th\ j-a} < 11.6\ K/W$ 

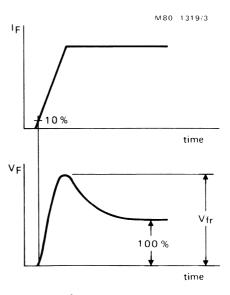
0.9

## **CHARACTERISTICS**

Forward voltage				
I <sub>F</sub> = 8 A; T <sub>i</sub> = 150 °C	VF	<	0.8	V*
$I_F = 20 \text{ A}, T_j = 25 \text{ °C}$	V <sub>F</sub>	*	1.3	V*
Reverse current				
$V_R = V_{RWM max}$ ; $T_i = 100  {}^{\circ}C$	I <sub>R</sub>	<	0.6	mA
$V_R = V_{RWM max}; T_j = 100  {}^{\circ}\text{C}$ $T_j = 25  {}^{\circ}\text{C}$	1 <sub>R</sub>	<	10	μΑ
Reverse recovery when switched from $I_F = 1 \text{ A to V}_R \geqslant 30 \text{ V}$ with $-dI_F/dt = 100 \text{ A}/\mu s$ ;				
$T_j = 25$ °C; recovery time	t <sub>rr</sub>	<	25	ns
$I_F$ = 2 A to $V_R$ $\geqslant$ 30 V with $-dI_F/dt$ = 20 A/ $\mu$ s; $T_j$ = 25 °C; recovered charge	$Q_{s}$	<	11	nC 🕶
$I_F$ = 10 A to $V_R \ge 30$ V with $-dI_F/dt$ = 50 A/ $\mu$ s; $T_i$ = 100 °C; peak recovery current	I <sub>RRM</sub>	<	2	A -

 $V_{\mathsf{fr}}$ 





typ.

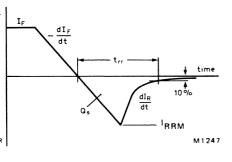


Fig.2 Definition of  $t_{\mbox{\scriptsize rr}},$   $\Omega_{\mbox{\scriptsize g}}$  and  $I_{\mbox{\scriptsize RRM}}.$ 

Fig.3 Definition of V<sub>fr</sub>.

<sup>\*</sup>Measured under pulse conditions to avoid excessive dissipation.

THERMAL RESISTANCE					
From junction to mounting base	R <sub>th j-mb</sub>	=	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 <sub>th mb-h</sub>	=	0.3	K/W	
<ul> <li>with heatsink compound and 0.06 mm maximum mica insulator</li> </ul>	R <sub>th mb-h</sub>	=	1.4	K/W	
<ul> <li>with heatsink compound and 0.1 mm maximum mica insulator (56369)</li> </ul>	R <sub>th mb-h</sub>	=	2.2	K/W	
<li>d. with heatsink compound and 0.25 mm maximum alumina insulator (56367)</li>	R <sub>th mb-h</sub>	=	0.8	K/W	
e. without heatsink compound	R <sub>th mb-h</sub>	=	1.4	K/W	
2. Free-air operation					
The quoted value of $R_{th\ j-a}$ 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	R <sub>th j-a</sub>	=	60	K/W	

length and with copper laminate on the board

#### 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 1.0 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<sub>th mb-h</sub> values than does screw mounting.
  - b. safe isolation for mains operation.

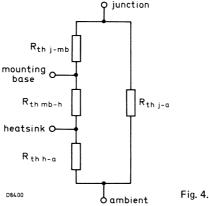
However, if a screw is used, it should be M3 cross-recess pan head. Care should be taken to avoid damage to the plastic body.

- 4. For good thermal contact, heatsink compound should be used between mounting base and heatsink. Values of R<sub>th mb-h</sub> given for mounting with heatsink compound refer to the use of a metallic oxideloaded 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.



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 IF(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<sub>amb</sub> scale. The intersection determines the R<sub>th mb-a</sub>. The heatsink thermal resistance value (Rth h-a) can be calculated from:

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

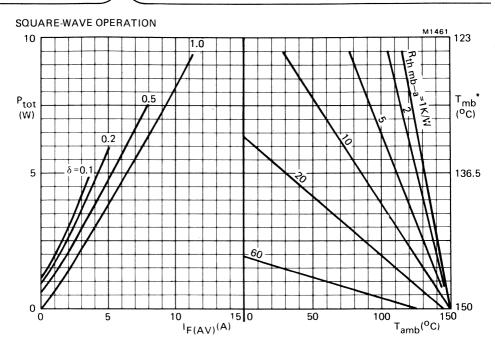


Fig.5 The right-hand part shows the interrelationship between the power (derived from the left-hand part) and the maximum permissible temperatures.

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

$$\begin{array}{c|c}
 & t_p & T \\
\hline
 & \delta = \frac{t_p}{T} \\
\hline
 & F(AV) = F(RMS) \times \sqrt{\delta}
\end{array}$$

 $<sup>^*</sup>T_{mb}$  scale is for comparison purposes and is correct only for R  $_{th\ mb\text{-}a}$  < 8.9 K/W.

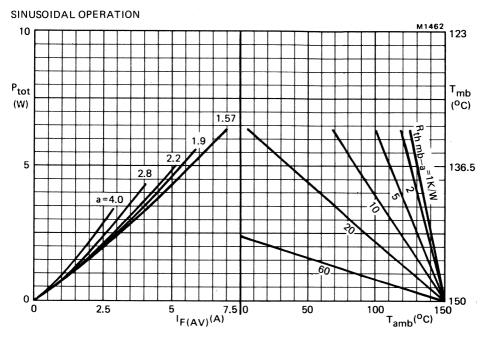


Fig.6 The right-hand part shows the interrelationship between the power (derived from the left-hand part) and the maximum permissible temperatures.

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

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

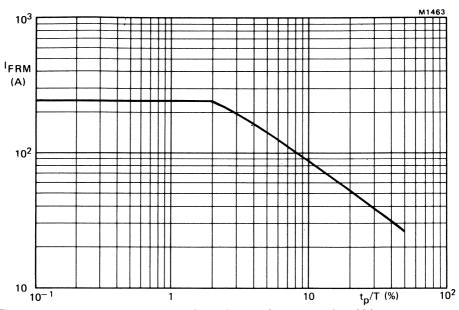
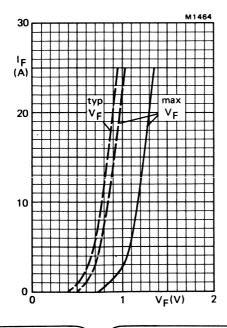


Fig.7 Maximum permissible repetitive peak forward current for square or sinusoidal currents; 1  $\mu s <$   $t_p <$  1ms.



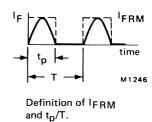
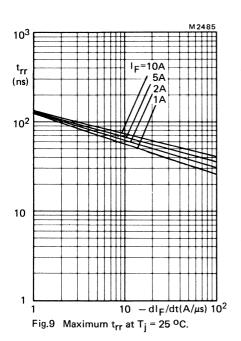
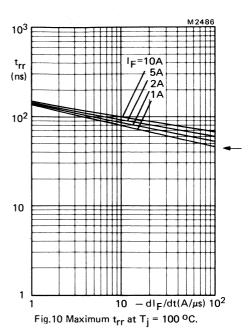


Fig.8 —— 
$$T_j = 25$$
 °C;  $---T_j = 150$  °C.





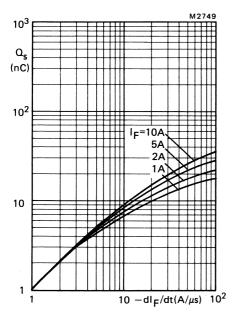


Fig.11 Maximum  $Q_s$  at  $T_i = 25$  °C.

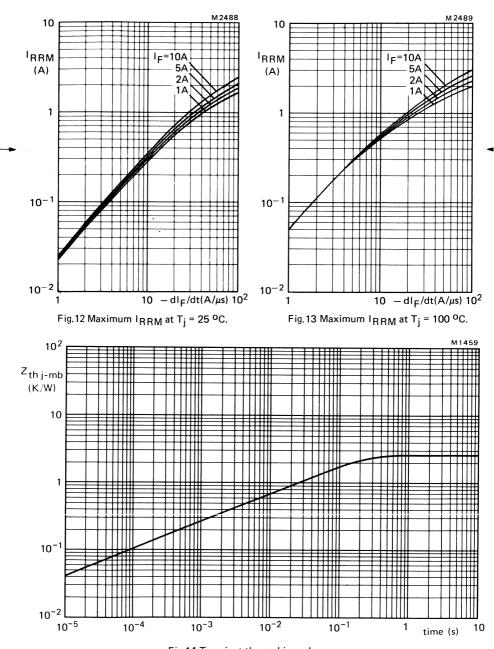


Fig.14 Transient thermal impedance.

# 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.

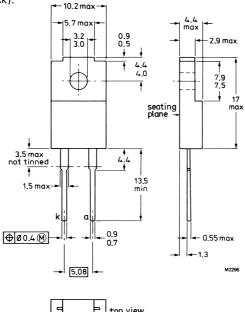
### QUICK REFERENCE DATA

		BYW29F-50		100	150	200		
Repetitive peak reverse voltage	$v_{RRM}$	max.	50	100	150	200	V	
Average forward current	IF(AV)	max.	8				Α	
Forward voltage	٧ <sub>F</sub>	<		· , (	0.8		V	
Reverse recovery time	t <sub>rr</sub>	<			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).

## BYW29F SERIES

## **RATINGS**

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

Voltages		BYW29	BYW29F-50   1		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			<u> </u>				
Average forward current; switching losses negligible up to 500 kHz (note 2);							
square wave; $\delta = 0.5$ ; up to $T_{mb} = 108$ °C	F(AV)	max.	8				A
sinusoidal; up to T <sub>mb</sub> = 114 °C	F(AV)	max.		7.3			Α
R.M.S. forward current	<sup>I</sup> F(RMS)	max.	11.5				Α
Repetitive peak forward current $t_p = 20 \mu s$ , $\delta = 0.02$	<sup>I</sup> FRM	max.	240				Α
Non-repetitive peak forward current half sine-wave; $T_j = 150$ °C prior to surge; with reapplied V <sub>RWM max</sub>							
t = 10 ms	<sup>I</sup> FSM	max.	80				Α
t = 8.3  ms	<sup>I</sup> FSM	max.	100				Α
$I^2$ t for fusing (t = 10 ms)	I²t	max.	32			A <sup>2</sup> s	
Temperatures							
Storage temperature	T <sub>stg</sub>		-40 to +150				oC
Junction temperature	Тj	max.	150			oC	
ISOLATION							
Peak isolation voltage from all terminals to external heatsink	V <sub>isol</sub>	max.		10	00		V
Isolation capacitance from cathode to external heatsink (note 3)	Cp	typ.			12		pF

## Notes:

- 1. To ensure thermal stability:  $R_{th\ j-a} < 11.6\ K/W$ .
- 2. The quoted temperatures assume heatsink compound is used.
- 3. Mounted without heatsink compound and 20 Newtons pressure on the centre of the envelope.

K/W

K/W

mA

μΑ

ns

nC

Α

### THERMAL RESISTANCE

From junction to external heatsink with minimum

of 2 kgf (20 Newtons) pressure on the centre

of the envelope,

with heatsink compound

without heatsink compound

5.5 Rth j-h 7.2 Rth j-h

## Free air operation

The quoted value of Rth i-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

Rth j-a 55 K/W

# CHARACTERISTICS

T<sub>i</sub> = 25 °C unless otherwise stated

Forward voltage

 $I_F = 8 A; T_i = 150 \, {}^{\circ}\text{C}$ 

IF = 20 A

Reverse current

 $V_R = V_{RWM max}$ ;  $T_i = 100 \, {}^{\circ}C$ 

 $V_R = V_{RWM max}$ 

Reverse recovery when switched from

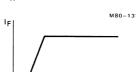
 $I_F = 1 \text{ A to } V_R \geqslant 30 \text{ V with } -dI_F/dt = 100 \text{ A}/\mu\text{s};$ recovery time

IF = 2 A to  $V_R \ge 30 V$  with  $-dI_F/dt = 20 A/\mu s$ ; recovered charge

IF = 10 A to  $V_R \ge 30 \text{ V}$  with  $-dI_F/dt = 50 \text{ A}/\mu\text{s}$ ; T<sub>i</sub> = 100 °C; peak recovery current

Forward recovery when switched to IF = 1 A with  $dI_F/dt = 10 A/\mu s$ 

V <sub>F</sub> V <sub>F</sub>	<	0.8 1.3
IR IR	< <	0.6 10
t <sub>rr</sub>	<	25
$Q_{s}$	<	11
IRRM	<	2
$V_{fr}$	typ.	0.9



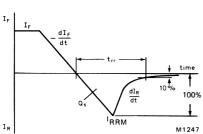


Fig.2 Definition of trr, Qs and IRRM.

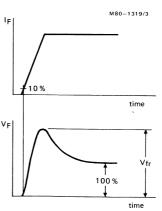


Fig.3 Definition of Vfr.

<sup>\*</sup>Measured under pulse conditions to avoid excessive dissipation.

### MOUNTING INSTRUCTIONS

- 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.
- 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<sub>th j-h</sub> 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: Maximum torque to avoid damage to the device:

5.5 kgf (0.55 Nm) 8.0 kgf (0.80 Nm)

- 5. For good thermal contact, heatsink compound should be used between baseplate and heatsink. Values of R<sub>th j-h</sub> given for mounting with heatsink compound refer to the use of a metallic oxide-loaded compound. Ordinary silicone grease is not recommended.
- 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.
- 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.

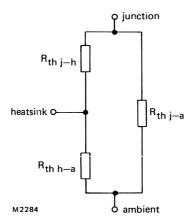
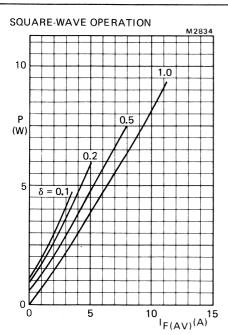
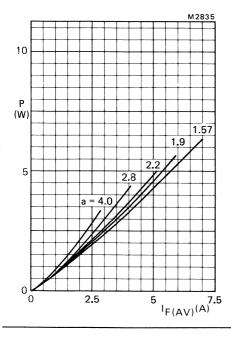


Fig.4.

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



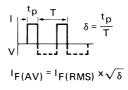


# Fig.5 Power rating.

The power loss in the diode should first be determined from the required forward current on the I<sub>F(AV)</sub> 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.



# Fig.6 Power rating.

The power loss in the diode should first be determined from the required forward current on the IF(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.

$$a = form factor = I_F(RMS)/I_F(AV)$$

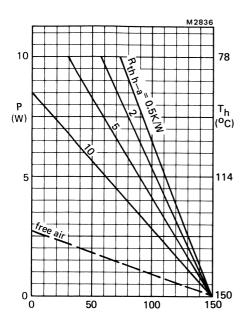


Fig.7 Heatsink rating; without heatsink compound.

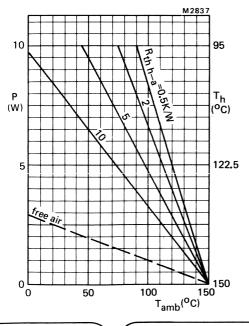


Fig.8 Heatsink rating; with heatsink compound.

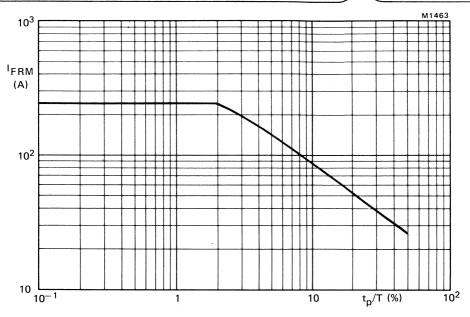
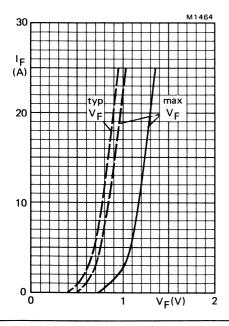
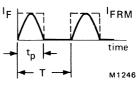


Fig.9 Maximum permissible repetitive peak forward current for square or sinusoidal currents; 1  $\mu s < t_p < 1$  ms.





Definition of I  $_{\mbox{\scriptsize FRM}}$  and  $t_p/T.$ 

Fig. 10 — 
$$T_j = 25$$
 °C;  $-- T_j = 150$  °C.

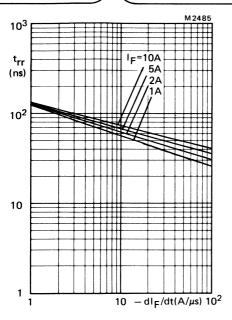


Fig.11 Maximum  $t_{rr}$  at  $T_i = 25$  °C.

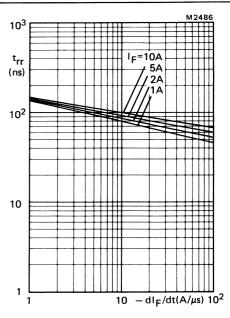


Fig. 12 Maximum  $t_{rr}$  at  $T_j = 100$  °C.

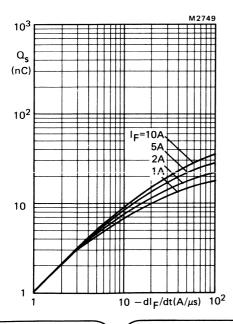


Fig.13 Maximum  $Q_s$  at  $T_j$  = 25  $^{o}$ C.

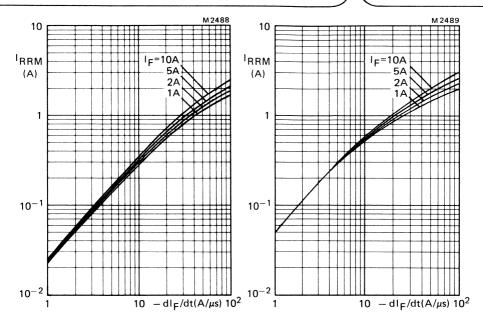


Fig.14 Maximum  $I_{RRM}$  at  $T_j = 25$  °C.

Fig.15 Maximum  $I_{RRM}$  at  $T_j = 100 \, ^{\circ}$ C.

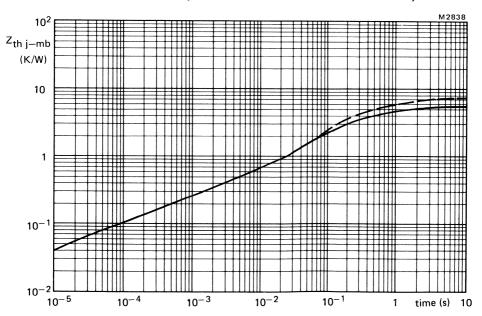


Fig. 16 Transient thermal impedance: —— with heatsink compound; — — without heatsink compound.





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.

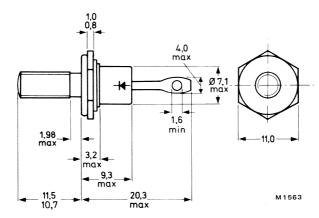
### QUICK REFERENCE DATA

		BYW30-50		100	150	200	
Repetitive peak reverse voltage	$V_{RRM}$	max.	50	100	150	200	V
Average forward current	IF(AV)	max.			14		Α
Forward voltage	VF	<		. 0	.8		V
Reverse recovery time	t <sub>rr</sub>	<		;	30		ns

### MECHANICAL DATA

Dimensions in mm

Fig.1 DO-4: with metric M5 stud ( $\phi$ 5 mm); e.g. BYW30–50. with 10-32 UNF stud ( $\phi$ 4.83 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 $T_{mb}$ = 1 up to $T_{mb}$ = 1		F(AV)	max. max.		14 12	A A
	25 - 0	IF(AV)	max.		2.5	A
sinusoidal; up to $T_{mb} = 125  {}^{\circ}C$		l <sub>F(AV)</sub>	IIIax.			
R.M.S. forward current		IF(RMS)	max.		20	Α
Repetitive peak forward current $t_p = 20 \mu s$ ; $\delta = 0.02$		IFRM	max.	4	20	Α
Non-repetitive peak forward current half sine-wave; T <sub>j</sub> = 150 °C prior to with reapplied V <sub>RWMmax</sub> ;	surge;					
t = 10 ms		<sup>I</sup> FSM	max.	2	00	Α
t = 8.3 ms		IFSM	max.	2	40	Α
$I^2$ t for fusing (t = 10 ms)		l²t	max.	2	00	$A^2s$
Temperatures						
Storage temperature		$T_{stg}$	-	55 to +1	50	oC
Junction temperature		Tj	max.	1	50	oC
THERMAL RESISTANCE						
From junction to mounting base		R <sub>th j-mb</sub>	=	2	2.2	K/W
From mounting base to heatsink		•				
a. with heatsink compound		R <sub>th</sub> mb-h	=	(	0.5	K/W
b. without heatsink compound		R <sub>th mb-h</sub>	=	(	0.6	K/W
Transient thermal impedance; t = 1 ms		Z <sub>th j-mb</sub>	=	(	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.

<sup>\*</sup>To ensure thermal stability: R  $_{th\ j\text{-}a}$   $\leqslant$  5.6 K/W (continuous reverse voltage).

# **CHARACTERISTICS**

Forward voltage $I_F = 15 \text{ A}; T_j = 150 ^{\circ}\text{C}$ $I_F = 50 \text{ A}; T_j = 25 ^{\circ}\text{C}$	V <sub>F</sub> V <sub>F</sub>	< < <	0.8 1.3	V* V*
Reverse current $V_R = V_{RWM \ max}$ ; $T_j = 100  ^{\circ}C$ $T_i = 25  ^{\circ}C$	I <sub>R</sub>	<	1.3	mA
,	<sup>I</sup> R	<	50	μΑ
Reverse recovery when switched from $I_F = 1 \text{ A to V}_R \ge 30 \text{ V with } -dI_F/dt = 100 \text{ A/}\mu\text{s};$ $T_i = 25 ^{\circ}\text{C};$ recovery time	t <sub>rr</sub>	<	30	ns
$I_F = 2 \text{ A to } V_R \geqslant 30 \text{ V with } -dI_F/dt = 20 \text{ A}/\mu s;$ $T_j = 25 ^{\circ}\text{C}$ ; recovered charge	$O_{S}$	<	15	nC
I <sub>F</sub> = 10 A to V <sub>R</sub> $\geqslant$ 30 V with –dI <sub>F</sub> /dt = 50 A/ $\mu$ s; T <sub>j</sub> = 100 °C; peak recovery current	IRRM	<	4	Α
Forward recovery when switched to $I_F = 10 \text{ A}$ with $dI_F/dt = 10 \text{ A}/\mu s$ ; $T_j = 25  ^{\circ}\text{C}$	$V_{fr}$	typ.	1.0	V

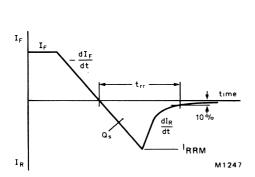


Fig.2 Definition of  $t_{\mbox{\scriptsize rr}},$   $\mbox{\scriptsize Q}_{\mbox{\scriptsize S}}$  and  $\mbox{\scriptsize I}_{\mbox{\scriptsize RRM}}.$ 

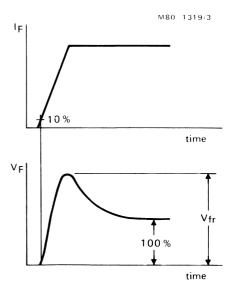


Fig.3 Definition of Vfr.

<sup>\*</sup>Measured under pulse conditions to avoid excessive dissipation.

# SQUARE-WAVE OPERATION

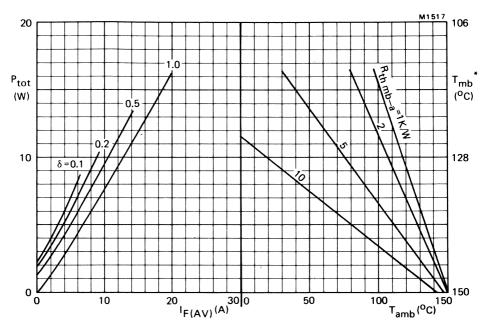


Fig.4 The right-hand part shows the interrelationship between the power (derived from the left-hand part) and the maximum permissible temperatures. Power includes reverse current losses and switching losses up to f = 500 kHz.

$$\begin{array}{c|c}
 & \tau_{p} & T \\
\hline
 & \delta = \frac{\tau_{p}}{T} \\
\hline
 & I_{F}(AV) = I_{F}(RMS) \times \sqrt{\delta}
\end{array}$$

 $<sup>^*</sup>T_{mb}$  scale is for comparison purposes and is correct only for R<sub>th mb-a</sub> < 3.1 K/W.

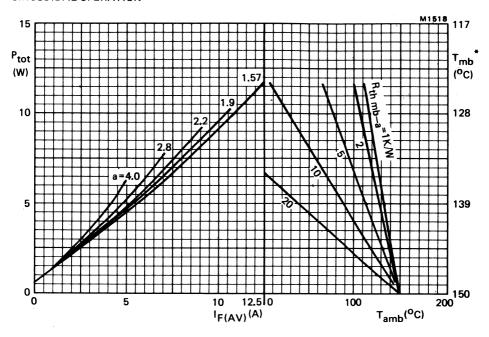


Fig.5 The right-hand part shows the interrelationship between the power (derived from the left-hand part) and the maximum permissible temperatures. a = form factor =  $I_{F(RMS)}/I_{F(AV)}$ .

 $<sup>^{*}</sup>T_{mb}$  scale is for comparison purposes and is correct only for R<sub>th mb-a</sub> < 17 K/W.

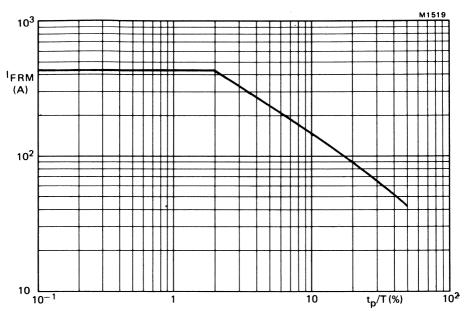
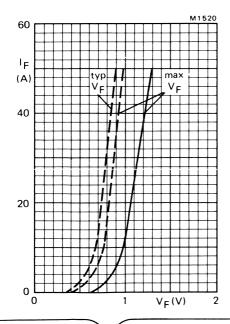
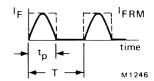


Fig.6 Maximum permissible repetitive peak forward current for square or sinusoidal currents; 1  $\mu s < t_p < 1$  ms.





Definition of  $I_{FRM}$  and  $t_p/T$ .

Fig.7 ——— 
$$T_j = 25 \, {}^{\circ}\text{C}; --- T_j = 150 \, {}^{\circ}\text{C}.$$

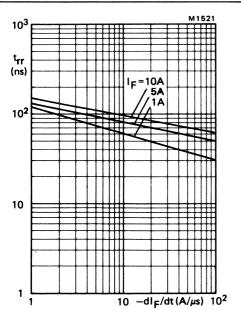
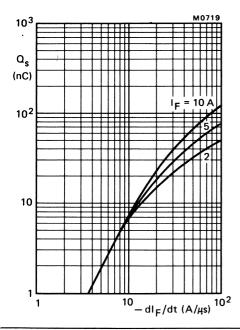


Fig.8 Maximum  $t_{rr}$  at  $T_j$  = 25 °C.



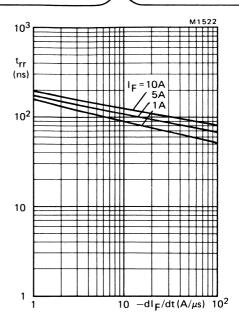
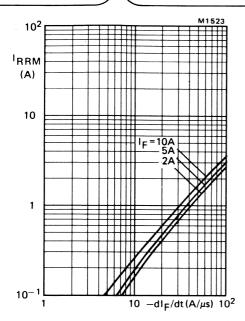


Fig.9 Maximum  $t_{rr}$  at  $T_j = 100$  °C.

Fig. 10 Maximum  $\Omega_s$  at  $T_j$  = 25 °C.



10<sup>2</sup>
IRRM
(A)
10
I<sub>F</sub>=10A
5A
2A
10-1
10 -dI<sub>F</sub>/dt (A/µs) 10<sup>2</sup>

Fig.11 Maximum  $I_{RRM}$  at  $T_i = 25$  °C.

Fig.12 Maximum  $I_{RRM}$  at  $T_i = 100$  °C.

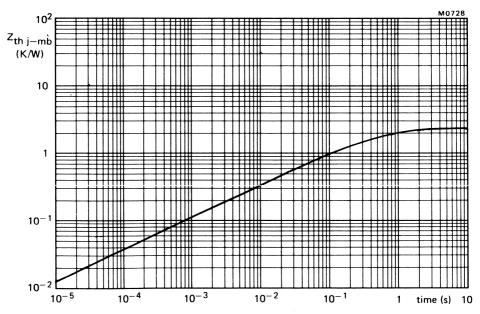


Fig.13 Transient thermal impedance.



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.

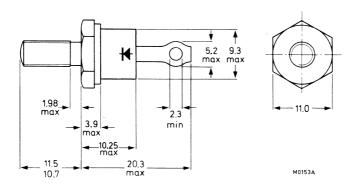
## QUICK REFERENCE DATA

		BYW3	1–50	100	150	200	
Repetitive peak reverse voltage	V <sub>RRM</sub>	max.	50	100	150	200	$V_{i}$
Average forward current	IF(AV)	max.		2	28		Α
Forward voltage	VF	<	0.8				V
Reverse recovery time	t <sub>rr</sub>	<			10		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 q

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.

# **BYW31 SERIES**

**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	٧
Crest working reverse voltage	$v_{RWM}$	max.	50	100	150	200	٧
Continuous reverse voltage*	$v_R$	max.	50	100	150	200	٧
Currents			-				
Average forward current; switching losses negligible up to 500 kHz							
square wave; $\delta$ = 0.5; up to $T_{mb}$ up to $T_{mb}$		lF(AV) lF(AV)		max. max.	28 26		A A
sinsusoidal; up to $T_{mb} = 127  {}^{\circ}C$		IF(AV)		max.	25	i	Α
R.M. S. forward current		I <sub>F(RMS</sub>	S)	max.	40	)	Α
Repetitive peak forward current $t_p = 20 \mu s$ ; $\delta = 0.02$		IFRM		max.	550	)	Α
Non-repetitive peak forward curren half sine-wave; T <sub>j</sub> = 150 °C prior with reapplied V <sub>RWMmax</sub> ;							
t = 10 ms		IFSM		max.	320	)	Α
t = 8.3 ms		IFSM		max.	380	)	Α
$I^2$ t for fusing (t = 10 ms)		l² t		max.	500	)	$A^2s$
Temperatures							
Storage temperature		$T_{stg}$		_	55 to +150		οС
Junction temperature		Тј		max.	150	1	οС
THERMAL RESISTANCE							
From junction to mounting base		R <sub>th j-m</sub>	b	=	1.0	)	K/W
From mounting base to heatsink							
a. with heatsink compound		R <sub>th mb</sub>	-h	=	0.3	;	K/W
b. without heatsink compound		R <sub>th mb</sub>	-h	=	0.5	i	K/W
Transient thermal impedance: t = 1	ms	Z <sub>th j-m</sub>	b	=	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.

<sup>\*</sup>To ensure thermal stability: R  $_{th\ j\text{-a}}$   $\leqslant$  4.9 K/W (continuous reverse voltage).

## **CHARACTERISTICS**

Forward voltage				
I <sub>F</sub> = 30 A; T <sub>i</sub> = 150 °C	VF	<	0.8	V*
$I_F = 100 \text{ A}; T_j' = 25 ^{\circ}\text{C}$	V <sub>F</sub>	<	1.3	V*
Reverse current				
$V_R = V_{RWM max}; T_j = 100 {}^{\circ}\text{C}$ $T_j = 25 {}^{\circ}\text{C}$	I <sub>R</sub>	<	1.5	mA
Tj = 25 °C	<sup>I</sup> R	< 1	100	μΑ
Reverse recovery when switched from $I_F = 1 \text{ A to V}_B \ge 30 \text{ V with } -dI_F/dt = 100 \text{ A/}\mu\text{s};$				
T <sub>j</sub> = 25 °C; recovery time	t <sub>rr</sub>	<	40	ns
I <sub>F</sub> = 2 A to V <sub>R</sub> $\geqslant$ 30 V withdI <sub>F</sub> /dt = 20 A/ $\mu$ s; T <sub>j</sub> = 25 °C; recovered charge	$Q_{\mathbf{s}}$	<	20	nC
I <sub>F</sub> = 10 A to $V_R \ge 30$ V with $-dI_F/dt = 50$ A/ $\mu$ s; $T_j = 100$ °C; peak recovery current	IRRM	<	4	Α
Forward recovery when switched to I <sub>F</sub> = 10 A with dI <sub>F</sub> /dt = 10 A/µs; T <sub>i</sub> = 25 °C	$V_{fr}$	typ.	1	V

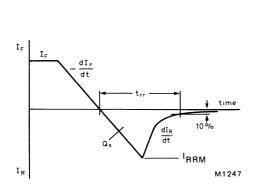


Fig.2 Definition of  $t_{rr},\,\Omega_{s}$  and  $I_{RRM}.$ 

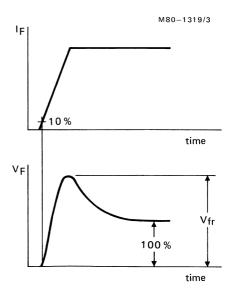


Fig.3 Definition of V<sub>fr</sub>.

<sup>\*</sup>Measured under pulse conditions to avoid excessive dissipation.



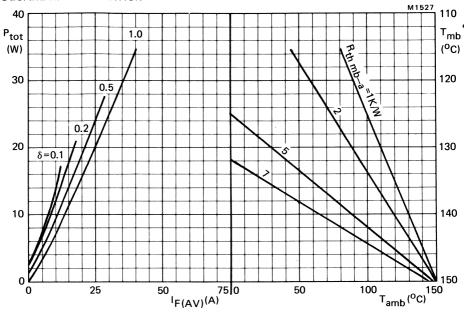


Fig.4 The right-hand part shows the interrelationship between the power (derived from the left-hand part) and the maximum permissible temperatures. Power includes reverse current losses and switching losses up to f = 500 kHz.

$$\begin{vmatrix}
t & T & T \\
V & T & \delta & = \frac{tp}{T}
\end{vmatrix}$$

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

 $<sup>^*</sup> T_{mb}$  scale is for comparison purposes and is correct only for R  $_{th\ mb\text{-}a} \,{<}\, 3.6$  K/W.

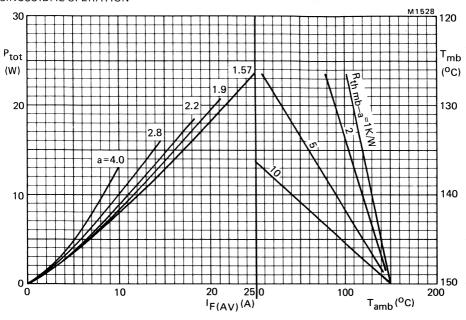


Fig.5 The right-hand part shows the interrelationship between the power (derived from the left-hand part) and the maximum permissible temperatures. Power includes reverse current losses and switching losses up to  $f = 500 \ \text{kHz}$ .

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

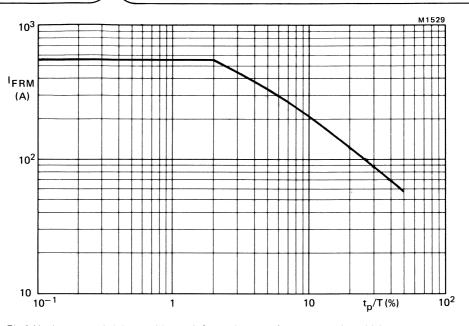
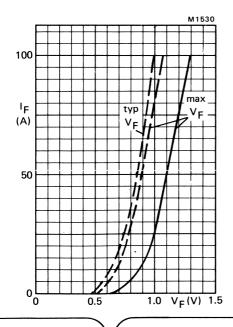
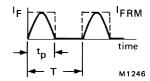


Fig.6 Maximum permissible repetitive peak forward current for square or sinusoidal currents; 1  $\mu s < t_p < 1$  ms.





Definition of IFRM and  $t_p/T$ .

Fig.7 ———
$$T_j = 25 \, {}^{\circ}\text{C}; --- T_j = 150 \, {}^{\circ}\text{C}.$$

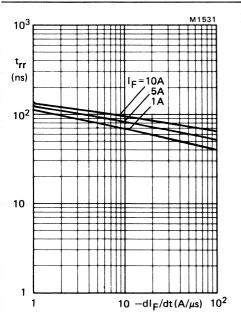
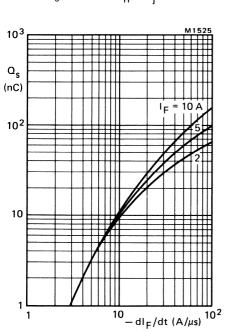


Fig.8 Maximum  $t_{rr}$  at  $T_j = 25$  °C.



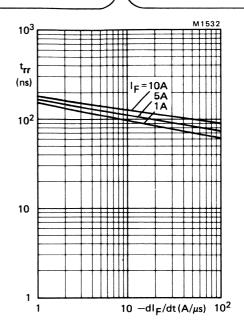


Fig.9 Maximum  $t_{rr}$  at  $T_j = 100 \, {}^{\circ}\text{C}$ .

Fig.10 Maximum  $Q_s$  at  $T_j$  = 25  $^{o}$ C.

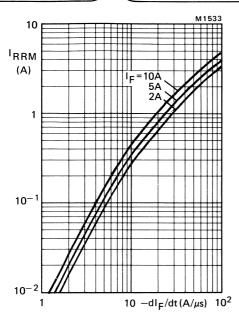


Fig.11 Maximum  $I_{RRM}$  at  $T_j = 25$  °C.

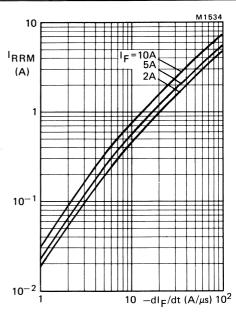


Fig.12 Maximum  $I_{RRM}$  at  $T_j = 100$  °C.

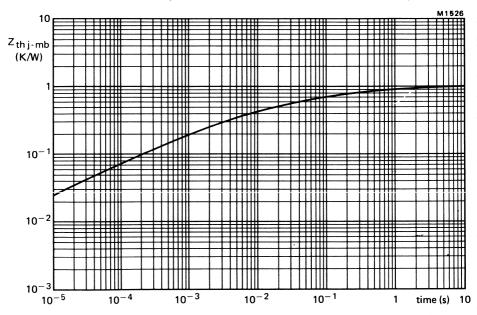


Fig.13 Transient thermal impedance.



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.

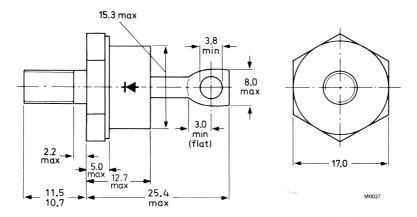
### QUICK REFERENCE DATA

		BYW92-50		100	150	200	
Repetitive peak reverse voltage	$v_{RRM}$	max.	50	100	150	200	٧
Average forward current	l <sub>F(AV)</sub>	max.	-	- 2	10		Α
Forward voltage	VF	<		0	.8		V
Reverse recovery time	t <sub>rr</sub>	<		4	10		ns

## MECHANICAL DATA

Dimensions in mm

Fig.1 DO-5: with metric M6 stud ( $\phi$  6 mm); e.g. BYW92-50. with % in x 28 UNF stud ( $\phi$  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	2–50	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; switchin losses negligible up to 500 kHz	-						
	square wave; $\delta$ = 0.5; up to $T_{ml}$ up to $T_{ml}$	o = 110 °C o = 125 °C	lF(AV) lF(AV)		max. max.	40 27		A A
	sinusoidal; up to T <sub>mb</sub> = 115 °C		lF(AV)	)	max.	35		Α
	up to T <sub>mb</sub> = 125 °C	<b>;</b>	<sup>I</sup> F(AV)	)	max.	26	3	Α
	R.M.S. forward current		IF(RM	S)	max.	55	5	Α
	Repetitive peak forward current $t_p$ = 20 $\mu$ s; $\delta$ = 0.02		IFRM		max.	800	)	Α
	Non-repetitive peak forward curre half sine-wave; T <sub>j</sub> = 150 °C price with reapplied V <sub>RWMmax</sub> ;							
	t = 10 ms		<sup>I</sup> FSM		max.	500	כ	Α
	t = 8.3 ms		<sup>I</sup> FSM		max.	600	)	Α
	$I^2$ t for fusing (t = 10 ms)		l²t		max.	1250	כ	$A^2s$
	Temperatures							
-	Storage temperature		$T_{stg}$		_	55 to +150	)	oC
	Junction temperature		Tj		max.	150	)	oC
	THERMAL RESISTANCE							
	From junction to mounting base		R <sub>th j-m</sub>	nb	=	1.0	כ	K/W
	From mounting base to heatsink							
	a. with heatsink compound		R <sub>th mb</sub>	o-h	= "	0.3	3	K/W
	b. without heatsink compound		R <sub>th mb</sub>	o-h	=	0.9	5	K/W
	Transient thermal impedance; t =	1 ms	Z <sub>th j-m</sub>	nb	=	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.

<sup>\*</sup>To ensure thermal stability: R  $_{th\ j\text{-a}}$   $\leqslant$  4.9 K/W

011	IAR		-			
(.H	IAK	AI.		- K	151	11:5

Forward voltage				
I <sub>F</sub> = 35 A; T <sub>i</sub> = 150 °C	VF	< 1	0.8	V*
$I_F = 100 \text{ A; } T_j' = 25  {}^{\circ}\text{C}$	VF	<	1.3	V*
Reverse current				
$V_R = V_{RRMmax}; T_j = 100  {}^{\circ}\text{C}$ $T_j = 25  {}^{\circ}\text{C}$	IR	<	2.5	mA
$T_j = 25$ °C	I <sub>R</sub>	<	100	μΑ
Reverse recovery when switched from $I_F = 1 \text{ A to V}_R \geqslant 30 \text{ V with } -dI_F/dt = 100 \text{ A}/\mu s;$				
T <sub>j</sub> = 25 °C; recovery time	t <sub>rr</sub>	<	40	ns
$I_F$ = 2 A to $V_R \ge 30$ V with $-dI_F/dt$ = 20 A/ $\mu$ s; $T_j$ = 25 $^{\circ}$ C; recovered charge	$O_s$	<	20	nC
I <sub>F</sub> = 10 A to $V_R \ge 30 V$ with $-dI_F/dt = 50 A/\mu s$ ; $T_j = 100  ^{\circ}C$ ; peak recovery current	IRRM	<	4.5	Α
Forward recovery when switched to I <sub>F</sub> = 10 A with dI <sub>F</sub> /dt = 10 A/ $\mu$ s; T <sub>j</sub> = 25 °C	$V_{fr}$	typ.	1.0	· <b>V</b>

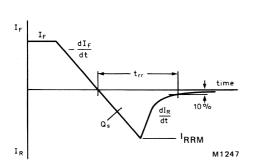


Fig.2 Definition of  $t_{\mbox{\scriptsize rr}},\, \mbox{\scriptsize Q}_{\mbox{\scriptsize S}}$  and  $\mbox{\scriptsize I}_{\mbox{\scriptsize RRM}}.$ 

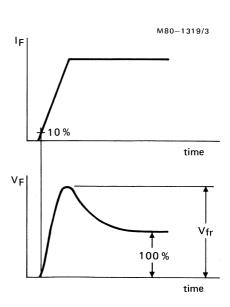


Fig.3 Definition of V<sub>fr</sub>.

<sup>\*</sup>Measured under pulse conditions to avoid axcessive dissipation.

# SQUARE-WAVE OPERATION

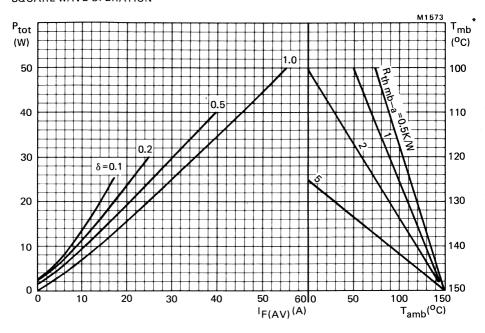


Fig.4 The right-hand part shows the interrelationship between the power (derived from the left-hand part) and the maximum permissible temperatures. Power includes reverse current losses and switching losses up to f = 500 kHz.

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

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

 $<sup>^*\</sup>text{T}_{mb}$  scale is for comparison purposes and is correct only for R  $_{th\ mb\text{-a}}$  < 3.6 K/W.

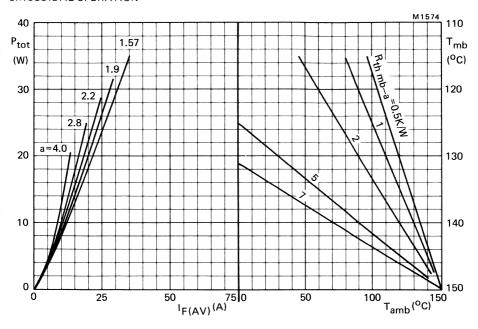


Fig.5 The right-hand part shows the interrelationship between the power (derived from the left-hand part) and the maximum permissible temperatures. Power includes reverse current losses and switching losses up to f = 500 kHz.

a = form factor = I<sub>F(RMS)</sub>/I<sub>F(AV)</sub>.

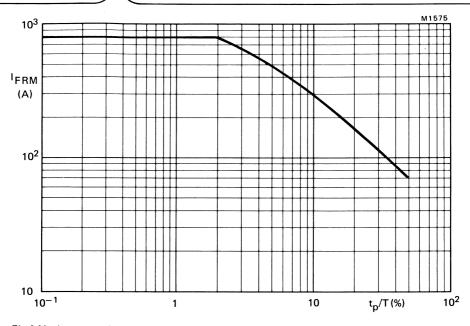
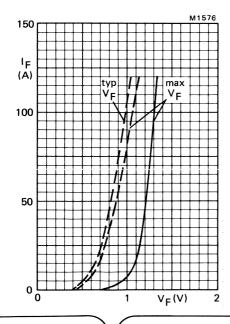
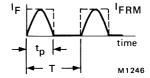


Fig.6 Maximum permissible repetitive peak forward current for square or sinusoidal currents; 1  $\mu s <$   $t_p <$  1 ms.





Definition of IFRM and  $t_p/T$ .

Fig.7 —— 
$$T_j = 25$$
 °C;  $---T_j = 150$  °C.

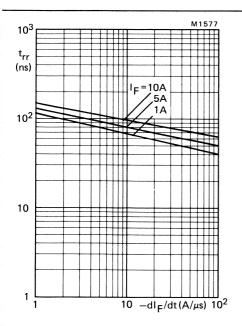
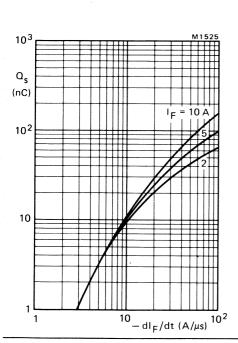


Fig.8 Maximum  $t_{rr}$  at  $T_j = 25$  °C.



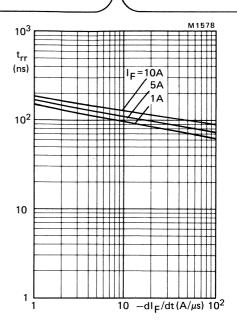


Fig.9 Maximum  $t_{rr}$  at  $T_j = 100$   $^{o}$ C.

Fig. 10 Maximum  $Q_s$  at  $T_i = 25$  °C.

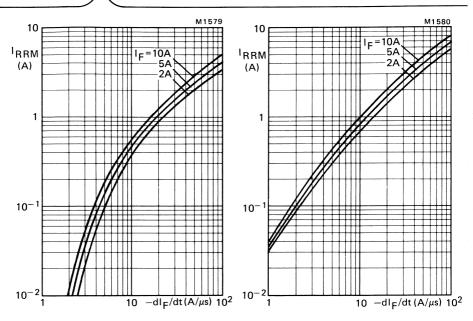


Fig.11 Maximum  $I_{RRM}$  at  $T_i = 25$  °C.

Fig.12 Maximum  $I_{RRM}$  at  $T_j = 100$  °C.

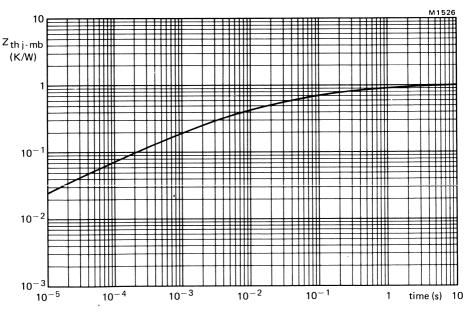


Fig.13 Transient thermal impedance.



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.

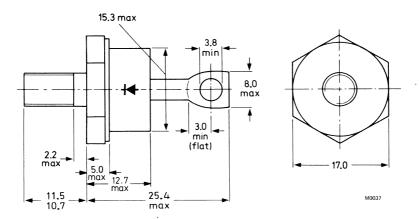
### QUICK REFERENCE DATA

		BYW93-50		100	150	200	
Repetitive peak reverse voltage	$v_{RRM}$	max.	50	100	150	200	V
Average forward current	<sup>I</sup> F(AV)	max.			60		Α
Forward voltage	VF	<		0.8			V
Reverse recovery time	t <sub>rr</sub>	<		4	45		ns

#### MECHANICAL DATA

Dimensions in mm

Fig.1 DO-5; with metric M6 stud ( $\phi$  6 mm): e.g. BYW93–50 with % in x 28 UNF stud ( $\phi$  6.35 mm); e.g. BYW93–50U



Net mass: 22 q

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,

1/4 in x 28 UNF: 11.1 mm



Products approved to CECC 50 009-028, available on request.

# **BYW93 SERIES**

**RATINGS** 

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

Voltages		BYW93	-50	100   150   200		200	
Repetitive peak reverse voltage	V <sub>RRM</sub>	max.	50	100	150	200	٧
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; switchin losses negligible up to 500 kHz							
square wave; $\delta$ = 0.5; up to $T_{ml}$ up to $T_{ml}$	<sub>o</sub> = 110 °C <sub>o</sub> = 125 °C	<sup>l</sup> F(AV) <sup>l</sup> F(AV)		max. max.	60 40		A A
sinusoidal; up to $T_{mb} = 115  {}^{\circ}C$	•	IF(AV)		max.			A
up to $T_{mb} = 125  {}^{\circ}C$	;	lF(AV)		max.			Α
R.M.S. forward current	I.M.S. forward current		IF(RMS)		85		Α
Repetitive peak forward current $t_p = 20 \mu s$ ; $\delta = 0.02$		<sup>I</sup> FRM		max.	1500	)	Α
Non-repetitive peak forward curre half sine-wave; T <sub>j</sub> = 150 °C pric with reapplied V <sub>RWMmax</sub> ;							
t = 10 ms		<sup>I</sup> FSM		max.	800	)	Α
t = 8.3 ms		IFSM		max.	1000	)	Α
$I^2$ t for fusing (t = 10 ms)		l²t		max.	3200		$A^2s$
Temperatures							
Storage temperature		$T_{stg}$		-55 to +150		)	oC
Junction temperature		т <sub>j</sub>	•		150	)	oC
THERMAL RESISTANCE							
From junction to mounting base		R <sub>th j-ml</sub>	b	=	0.7	•	K/W
From mounting base to heatsink							
a. with heatsink compound		R <sub>th mb</sub>	-h	=	0.2	?	K/W
b. without heatsink compound		R <sub>th mb</sub>		= 0.3		3	K/W
Transient thermal impedance; t =	1 ms	$Z_{th j-mb} = 0.32$		?	K/W		

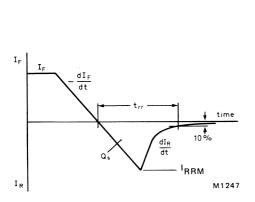
# MOUNTING INSTRUCTIONS

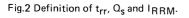
The top connector should be neither bent nor twisted; it should be soldered into the circuit so that there is no strain on it.

<sup>\*</sup>To ensure thermal stability:  $\rm R_{th~j\text{-}a} \leqslant 3.0~K/W.$ 

### **CHARACTERISTICS**

Forward voltage				
I <sub>F</sub> = 50 A; T <sub>i</sub> = 150 °C	VF	<	8.0	V*
I <sub>F</sub> = 50 A; T <sub>j</sub> = 150 °C I <sub>F</sub> = 150 A; T <sub>j</sub> = 25 °C	VF	< 1	1.3	V*
Reverse current				
$V_R = V_{RWM max}$ ; $T_j = 100  {}^{\circ}\text{C}$ $T_i = 25  {}^{\circ}\text{C}$	l <sub>R</sub>	<	5	mA
$T_j' = 25  {}^{\circ}\text{C}$	<sup>I</sup> R	<	250	μΑ
Reverse recovery when switched from				
$I_F = 1 \text{ A to } V_R \geqslant 30 \text{ V with } -dI_F/dt = 100 \text{ A}/\mu\text{s};$				
T <sub>j</sub> = 25 °C; recovery time	<sup>t</sup> rr	<	45	ns
$I_F = 2 \text{ A to } V_R \geqslant 30 \text{ V with } -dI_F/dt = 20 \text{ A}/\mu\text{s}$				
$T_j = 25$ °C; recovered charge	$oldsymbol{o}_s$	<	35	nC
I <sub>F</sub> = 10 A to $V_B \ge 30 \text{ V}$ with $-dI_F/dt = 50 \text{ A}/\mu s$ ;				
T <sub>j</sub> = 100 °C; peak recovery current	IRRM	<	6	Α
Forward recovery when switched to I <sub>F</sub> = 10 A				
with $dI_F/dt = 10 A/\mu s$ ; $T_i = 25  {}^{\circ}C$	$V_{fr}$	typ.	1.0	V





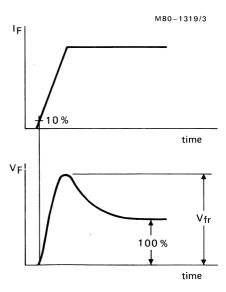


Fig.3 Definition of V<sub>fr</sub>.

<sup>\*</sup>Measured under pulse conditions to avoid excessive dissipation.

# SQUARE-WAVE OPERATION

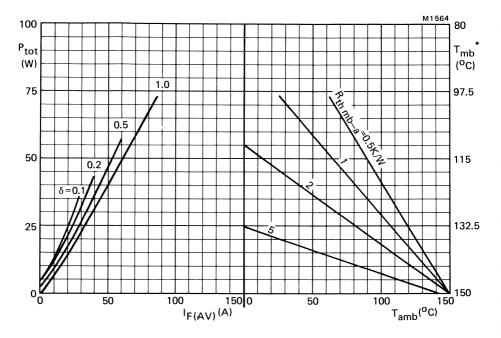


Fig.4 The right-hand part shows the interrelationship between the power (derived from the left-hand part) and the maximum permissible temperatures.

Power includes reverse current losses.

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

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

 $<sup>^*</sup>T_{mb}$  scale is for comparison purposes and is correct only for R<sub>th mb-a</sub> < 2.1 K/W

#### SINUSOIDAL OPERATION

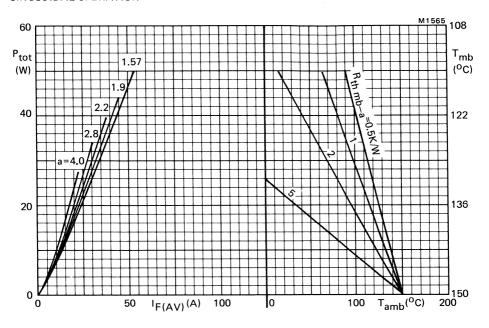


Fig.5 The right-hand part shows the interrelationship between the power (derived from the left-hand part) and the maximum permissible temperatures.

Power includes reverse current losses.

a = form factor = IF(RMS)/IF(AV).

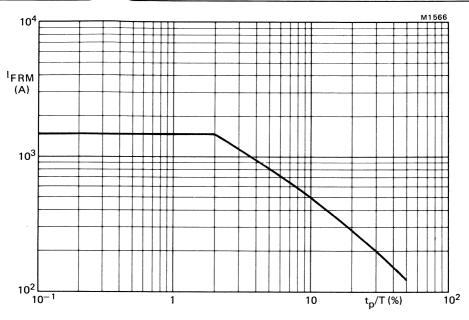
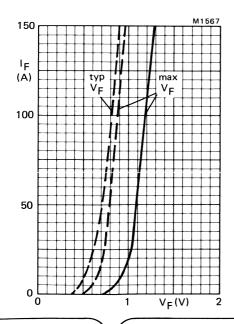
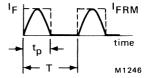


Fig.6 Maximum permissible repetitive peak forward current for square or sinusoidal currents; 1  $\mu s < t_p < 1$  ms.





Definition of IFRM and  $t_p/T$ .

Fig.7 —— 
$$T_j = 25 \, {}^{\circ}\text{C}; --- T_j = 150 \, {}^{\circ}\text{C}.$$

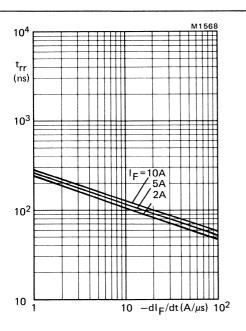


Fig.8 Maximum  $t_{rr}$  at  $T_j = 25$  °C.

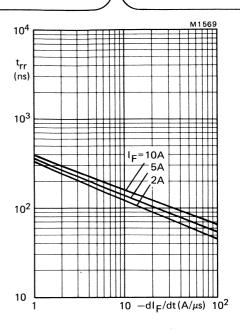


Fig.9 Maximum  $t_{rr}$  at  $T_i = 100$  °C.

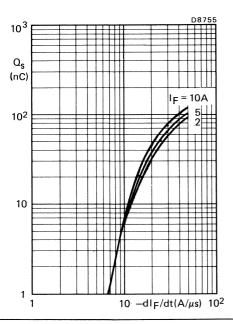


Fig. 10 Maximum  $Q_s$  at  $T_i = 25$  °C.

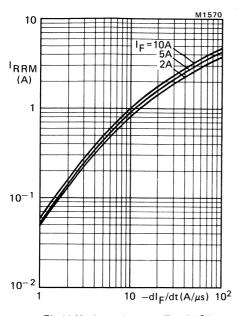


Fig.11 Maximum  $I_{RRM}$  at  $T_j$  = 25 °C.

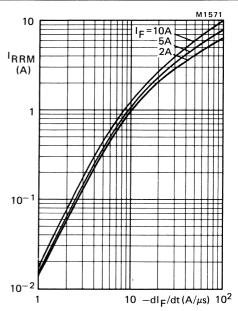


Fig.12 Maximum  $I_{RRM}$  at  $T_j = 100$  °C.

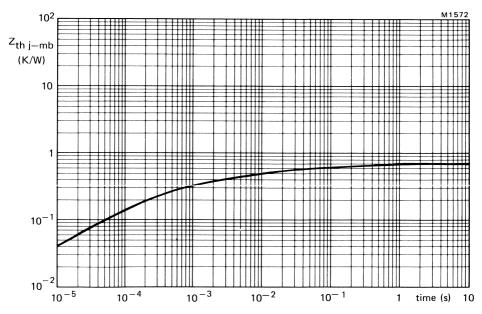


Fig.13 Transient thermal impedance.

#### 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:

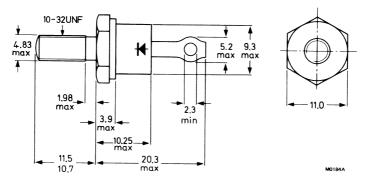
Normal polarity (cathode to stud): BYX30-200 to BYX30-600 Reverse polarity (anode to stud): BYX30-200R to BYX30-600R.

QUICK REFERENCE DATA								
		BYX 30	-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 <sub>(BR)R</sub>	>	250	375	500	625	750	V
Average forward current			I <sub>F(A</sub> V	7) n	nax.	14		$\mathbf{A}_{\mathbf{x}}$
Non-repetitive peak forward cu	rrent		$I_{FSM}$	n	nax.	250		A
Non-repetitive peak reverse po	wer		P <sub>RSM</sub>	ı n	nax.	18		kW
Reverse recovery time			trr	<	<	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: 7g

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.

# **BYX30 SERIES**

RATINGS Limiting values in accordance with the Absolut	te Maximum	System	(IEC	134)
Voltages 1) BYX 30-200(R)   300	0(R) 400(R)	500(R)	600(R	3)
Crest working reverse voltage VRWM max. 200 300	0 400	500	600	V
Continuous reverse voltage V <sub>R</sub> max. 200 300	0 400	500	600	v
Currents				
Average forward current (averaged over any 20 ms period) up to $T_{mb}$ = 100 ${}^{o}C$ at $T_{mb}$ = 125 ${}^{o}C$	I <sub>F(AV)</sub> I <sub>F(AV)</sub>	max.	14 7.5	A A
R.M.S. forward current	$I_{F(RMS)}$	max.	22	A
Repetitive peak forward current	$I_{FRM}$	max.	310	Α
Non-repetitive peak forward current (t = 10 ms; half-sinewave) $T_j = 150$ °C prior to surge; with reapplied $V_{RWM}$ max. $I^2$ t for fusing (t = 10 ms)	I <sub>FSM</sub> I2 <sub>t</sub>	max.	250 312	$\begin{array}{c} \text{A} \\ \text{A}^2 \text{s} \end{array}$
Reverse power dissipation				
Repetitive peak reverse power dissipation $t = 10 \mu s$ (square wave; $f = 50 \text{ Hz}$ ) $T_j = 150 ^{\circ}\text{C}$	P <sub>RRM</sub>	max.	5.5	kW
Non-repetitive peak reverse power dissipation t = 10 $\mu s$ (square wave) $T_j$ = 25 $^{o}C$ prior to surge $T_j$ = 150 $^{o}C$ prior to surge	PRSM PRSM	max. max.	18 5.5	kW kW
Temperatures				
Storage temperature	${ m T_{stg}}$	-55 to	+150	°C
Junction temperature	$T_{j}$	max.	150	°C
THERMAL RESISTANCE				
From junction to ambient in free air	R <sub>th j-a</sub>	=	50	°C/W
From junction to mounting base	R <sub>th j-mb</sub>	=	1.3	°C/W
From mounting base to heatsink	R <sub>th mb-h</sub>	=	0.5	°C/W

 $<sup>^{</sup>l})$  To ensure thermal stability:  $R_{th\ j\text{-a}}$  < 2.5  $^{o}\text{C/W}$  (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  $R_{th\ j-a}=5\,^{o}\text{C/W}$ , then  $T_j$  max = 135 °C. if  $R_{th\ j-a}=10\,^{o}\text{C/W}$ , then  $T_j$  max = 120 °C.

#### CHARACTERISTICS

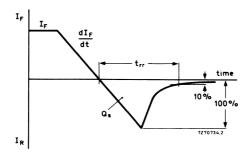
	BYX3	0-2	00(R)	300(R)	400(R)	500(R)	600(R)	
Forward voltage								
$I_F = 50 \text{ A}; T_j = 25 ^{\circ}\text{C}$	$v_{\mathbf{F}}$	<	3. 2	3. 2	3. 2	3. 2	3. 2	V 1)
Reverse breakdown voltage								
$I_R = 5 \text{ mA}; T_i = 25 ^{\circ}\text{C}$	V	>	250	375	500	625	750	$\mathbf{v}$
IR 3 MM, 1 <sub>j</sub> - 23 C	V <sub>(BR)R</sub>	<	1050	1050	1050	1050	1050	V
Reverse current								
$V_R = V_{RWMmax}$ ; $T_j = 125  {}^{\circ}C$	<sup>I</sup> R	<	4.0	4.0	4.0	4.0	4.0	mA

# Reverse recovery charge when switched from

$$I_F$$
 = 2 A to  $V_R \ge 30$  V; with  $-dI_F/dt$  = 100 A/ $\mu s$ ;  $T_j$  = 25  $^{o}$  C  $~Q_s~<~0.70~\mu C$ 

## Reverse recovery time when switched from

$$I_F$$
 = 1 A to  $V_R$   $\geq$  30 V; 
$$-dI_F/dt = 50~A/\mu s;~T_j = 25~^{o}C~t_{rr}~<~200~ns$$



#### **OPERATING NOTES**

#### 1. Square-wave operation

When I<sub>F</sub> 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.

<sup>1)</sup> 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  $20~\mathrm{kHz}$ .

#### 3. Determination of the heatsink thermal resistance

### Example:

Assume a diode, used in an inverter.

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.  $T_j=150\,^{\circ}\text{C}$ ). Starting from  $I_F=12$  A on the horizontal scale trace upwards until the appropriate line

 $-\frac{dI}{dt}$  = 20 A/ $\mu$ s. 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.

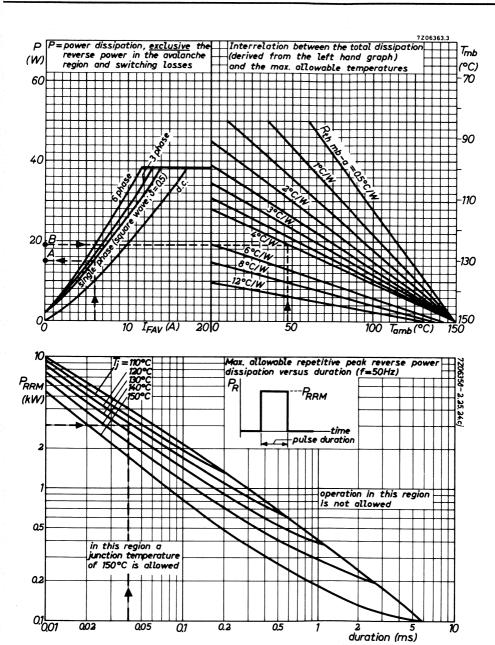
Therefore the total power dissipation  $P_{tot}=15~W+4~W=19~W$  (point B of the upper graph on page 469). From the right hand part follows the thermal resistance required at  $T_{amb}=45~^{\circ}C$ .

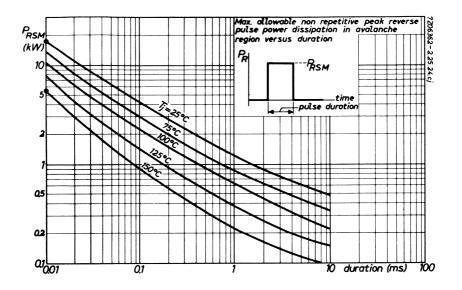
$$R_{th mb-a} \approx 4 \, {}^{\circ}C/W$$

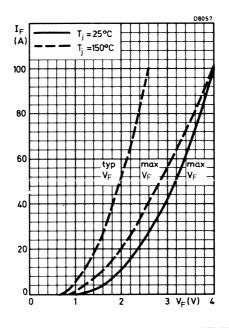
The contact thermal resistance  $R_{th\ mb-h}$  = 0.5  $^{o}C/W$ .

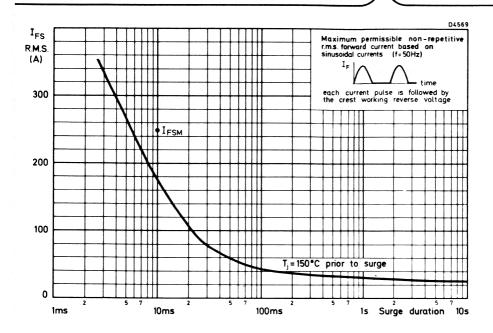
Hence the heatsink thermal resistance should be:

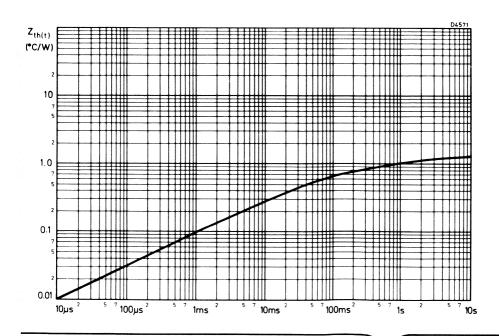
$$R_{th h-a} = R_{th mb-a} - R_{th mb-h} = (4 - 0.5) \circ C/W = 3.5 \circ C/W$$
.

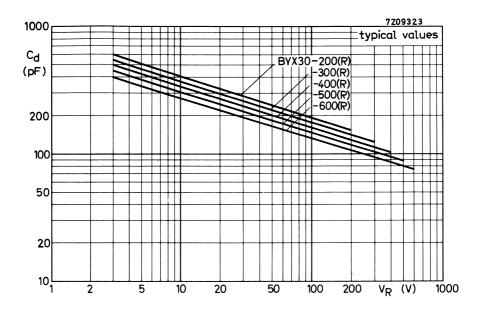


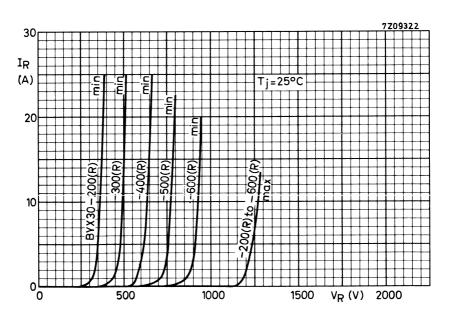




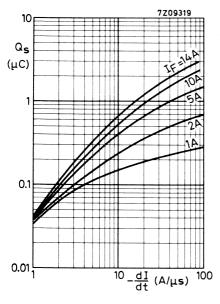




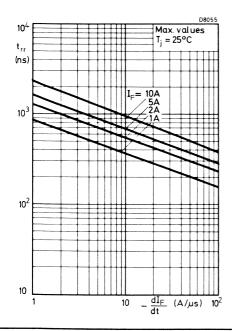


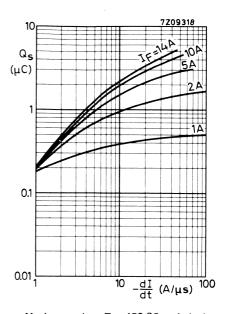


472 | March 1968

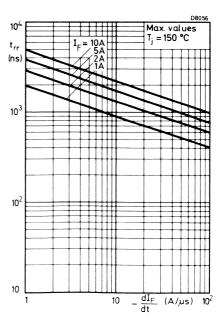


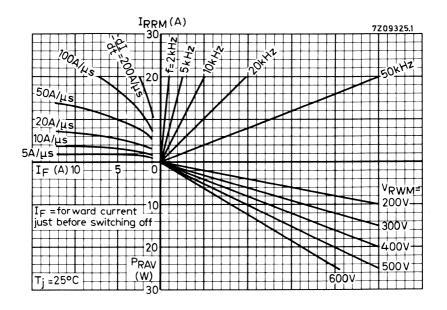
Maximum values; T  $_{j}$  = 25 °C; switched from I  $_{F}$  to V  $_{R}$   $\geqslant$  30 V.

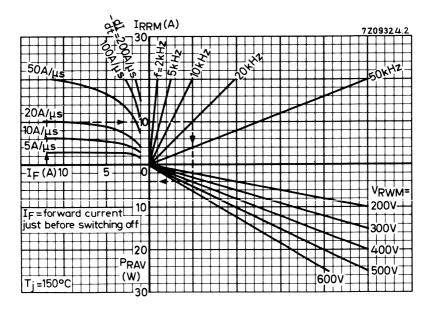




Maximum values; T  $_{j}$  = 150  $^{o}\text{C};$  switched from I  $_{F}$  to V  $_{R} \geqslant$  30 V.







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

#### 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

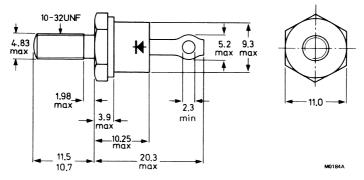
#### QUICK REFERENCE DATA

		BYX46-2	00(R)3	00(R)	400(R)	500(R)	600(R)	
Crest working reverse voltage	$v_{RWM}$	max.	200	300	400	500	600	٧
Reverse avalanche breakdown voltage	V <sub>(BR)R</sub>	>	250	375	500	625	750	٧
Average forward current	I <sub>F</sub> (AV)	max.			22			Α
Non-repetitive peak forward current	<sup>1</sup> FSM	max.			300			Α
Non-repetitive peak reverse power	PRSM	max.			18			kW
Reverse recovery time	t <sub>rr</sub>	<			200	1		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 a

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.

# BYX46 SERIES

#### **RATINGS**

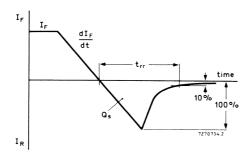
Limiting values in accordance with the Absolute Maximum System (IEC 134)

Voltages *		BYX46-2	200(R)	00(R)4	00(R)5	00(R)	00(R)	
Crest working reverse voltage	V <sub>RWM</sub>	max.	200	300	400	500	600	٧
Continuous reverse voltage	$v_R$	max.	200	300	400	500	600	٧
Currents					-			
Average forward current (averaged over any 20 ms period)	•							
up to T <sub>mb</sub> = 100 °C	<sup>I</sup> F(AV)	max.			22			Α
at T <sub>mb</sub> = 125 °C	<sup>I</sup> F(AV)	max.			15			Α
R.M.S. forward current	IF(RMS)	max.			35			Α
Repetitive peak forward current	IFRM	max.			400			Α
Non-repetitive peak forward current (t = 10 ms; half-sinewave) $T_j$ = 165 $^{\circ}$ prior to surge; with reapplied	С							
$V_{RWMmax}$	<sup>I</sup> FSM	max.			300			Α
$I^2$ t for fusing (t = 10 ms)	l² t	max.			450			A <sup>2</sup>
Reverse power dissipation								
Repetitive peak reverse power dissipation $t = 10 \mu s$ (square wave; $f = 50 Hz$ ) $T_i = 100  ^{\circ}C$	on PRRM	max.			9,5			kW
Non-repetitive peak reverse power dissipation t = 10 μs (square wave)	' KKW	max.			5,5			NVV
$T_i = 25$ °C prior to surge	PRSM	max.			18			kW
T <sub>j</sub> = 165 <sup>O</sup> C prior to surge	PRSM	max.			4			kW
Temperatures								
Storage temperature	T <sub>stg</sub>			-55 to	+165			οС
Junction temperature	Tj	max.			165			οС
THERMAL RESISTANCE								
From junction to ambient in free air	R <sub>th i-a</sub>	=			50			oC,
From junction to mounting base	R <sub>th j-mb</sub>	=			1,3			ōC,
From mounting base to heatsink	R <sub>th mb-h</sub>				0,5			oc.

<sup>\*</sup> To ensure thermal stability:  $R_{th\ j-a} < 2.5\ ^{\circ}\text{C/W}$  (continuous reverse voltage) or  $< 5\ ^{\circ}\text{C/W}$  (a.c.). For smaller heatsinks  $T_{j\ max}$  should be derated. For a.c. see page 479. For continuous reverse voltage: if  $R_{th\ j-a} = 5\ ^{\circ}\text{C/W}$ , then  $T_{j\ max} = 135\ ^{\circ}\text{C}$ ; if  $R_{th\ j-a} = 10\ ^{\circ}\text{C/W}$ , then  $T_{j\ max} = 125\ ^{\circ}\text{C}$ .

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		BYX4	6-200(R)	300(R)	400(R)	500(R)	600(R)	
Forward voltage							<u> </u>	
$I_F = 50 \text{ A}; T_j = 25 ^{\circ}\text{C}$	VF	<	2,0	2,0	2,0	2,0	2,0	V *
Reverse breakdown voltage					4			
I <sub>R</sub> = 5 mA; T <sub>i</sub> = 25 °C	V <sub>(BR)R</sub>	>	250	375	500	625	750	V
,	(BR)R	<	1050	1050	1050	1050	1050	V
Reverse current								•
$V_R = V_{RWMmax}$ ; $T_j = 125  {}^{\circ}C$	I <sub>R</sub>	<	4,0	4,0	4,0	4,0	4,0	mΑ
Reverse recovery charge when switched	ed from					<u> </u>	<u> </u>	
$I_F = 2 \text{ A to } V_R \geqslant 30 \text{ V};$								
$-dI_F/dt = 100 \text{ A}/\mu\text{s}; T_j = 25 \text{ °C}$	$Q_{s}$	<			0,70			μC
Reverse recovery time when switched	from							
$I_F = 1 \text{ A to } V_R \ge 30 \text{ V};$								
$-dI_F/dt = 50 A/\mu s; T_j = 25 °C$	t <sub>rr</sub>	<			200			ns



#### **OPERATING NOTES**

#### 1. Square-wave operation

When IF 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	$^{\rm o}{ m C}$
switched from	$_{ m IF}$	=	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/ $\mu$ s. 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).

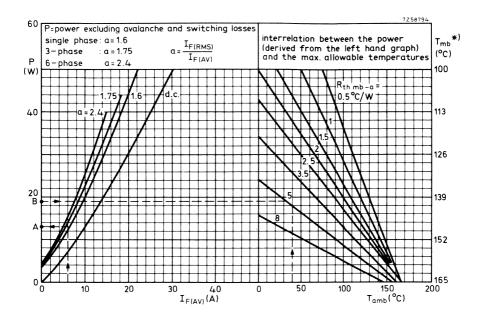
From the right hand part of the upper graph on page 479 follows the thermal resistance, required at  $T_{amb}$  = 40 °C.

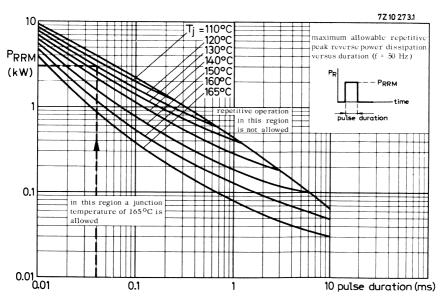
$$R_{th mb-a} \approx 5 \, {}^{\circ}C/W$$

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

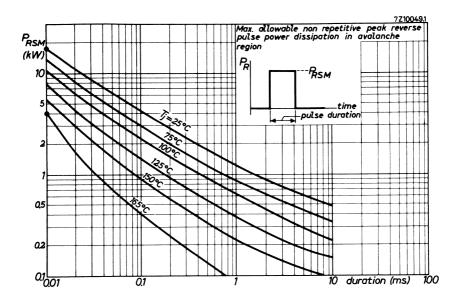
Hence the heatsink thermal resistance should be:

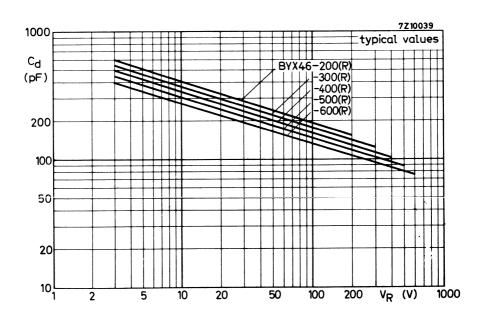
$$R_{th\ h-a} = R_{th\ mb-a} - R_{th\ mb-h} = (5 - 0.5) \circ C/W = 4.5 \circ C/W$$
.



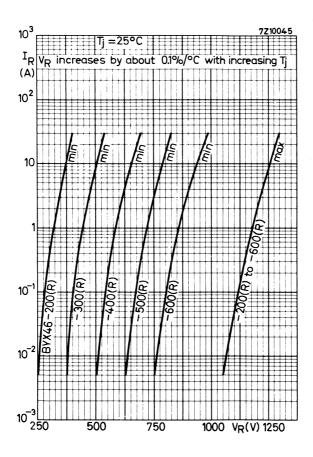


May 1970 | 479

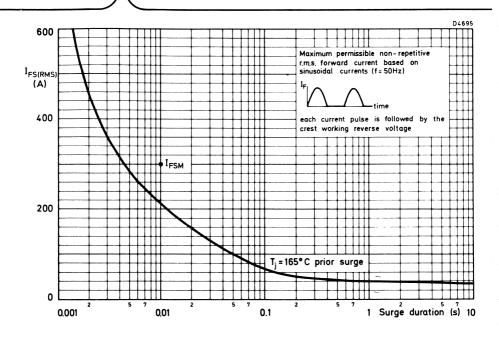


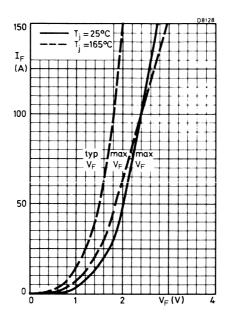


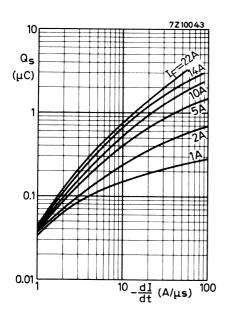
481

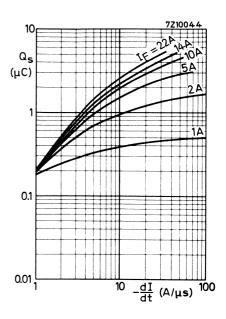


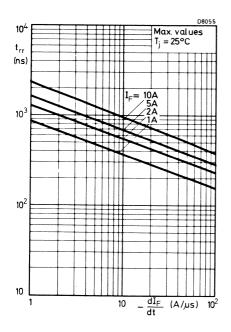
May 1969

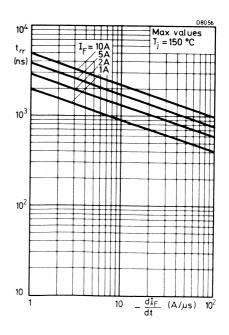


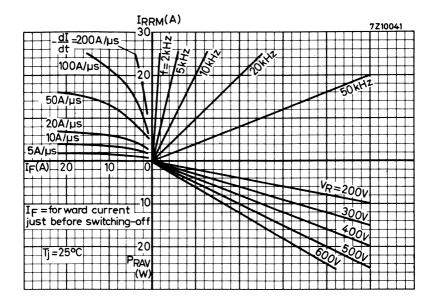


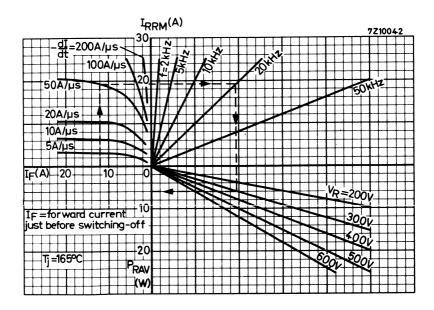






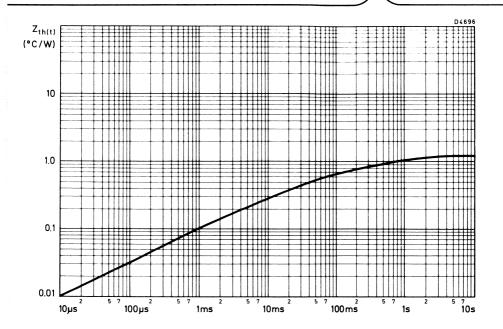






Nomogram: Power loss P<sub>RAV</sub> due to switching only (square wave operation)

484 | May 1969





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.

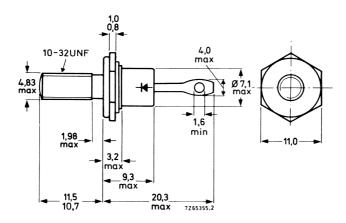
#### **QUICK REFERENCE DATA**

		BYX50-200		300		-
Repetitive peak reverse voltage	$V_{RRM}$	max.	200	300	٧	
Average forward current	I <sub>F(AV)</sub>	max.	7	7	Α	
Non-repetitive peak forward current	<sup>I</sup> FSM	max.	80		Α	
Reverse recovery time	t <sub>rr</sub>	< ,	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 q

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)

# **BYX50 SERIES**

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

→ Voltages		BYX5	0–200	300	
Non-repetitive peak reverse voltage;					
t ≤ 10 ms	V <sub>RSM</sub>	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 $T_{mb} = 103  {}^{\circ}\text{C}$	l <sub>F</sub> (A		max.	7	Α
at T <sub>mb</sub> = 125 <sup>o</sup> C	lF(A	(V)	max.	4	Α
R.M.S. forward current	lF(R	MS)	max.	11	Α
Repetitive peak forward current	<sup>I</sup> FRI	M	max.	80	Α
Non-repetitive peak forward current t = 10 ms; T <sub>j</sub> = 150 °C prior to surge					
with reapplied V <sub>RWMmax</sub>	<sup>1</sup> FSN	Λ	max.	80	Α
$1^2$ t for fusing (t = 10 ms)	I²t		max.	32	$A^2 s$
Rate of change of commutation current	See r	nomogram	(Fig.6)		
Temperatures					
Storage temperature	$T_{stg}$		−55 to	+150	oC
Junction temperature	$T_{j}$		max.	150	οС
THERMAL RESISTANCE					
From junction to ambient in free air	R <sub>th</sub>	j-a	=	50	K/W
From junction to mounting base	R <sub>th</sub>	j-mb	=	3,5	K/W
From mounting base to heatsink	$R_{th}$	mb-h	=	0,5	K/W
Transient thermal impedance; t = 1 ms	Z <sub>th j</sub>	-mb	=	1	K/W

	RIST	

Forward voltage				
$I_F = 20 \text{ A}; T_j = 25 ^{\circ}\text{C}$	VF	<	1,95	V*
Reverse current				
$V_R = V_{RWMmax}$ ; $T_j = 125  {}^{\circ}C$	IR	<	3	mA
Reverse recovery when switched from				
$I_F$ = 1 A to $V_R$ = 30 V; $-dI_F/dt$ = 100 A/ $\mu$ s; $T_j$ = 25 °C Recovery time	t <sub>rr</sub>	<	100	ns
$I_F$ = 1 A to $V_R$ = 30 V; $-dI_F/dt$ = 35 A/ $\mu$ s; $T_j$ = 25 °C Recovery time	t <sub>rr</sub>	<	150	ns
$I_F$ = 2 A to $V_R$ = 30 V; $-dI_F/dt$ = 20 A/ $\mu$ s; $T_j$ = 25 °C Recovered charge	$Q_{s}$	<	250	nC
$I_F = 2 A$ to $V_R = 50 V$ ; $-dI_F/dt = 2 A/\mu s$ ; $T_j = 25  ^{O}C$ Max. slope of the reverse recovery current	dl <sub>R</sub> /dt	<	5	A/μs

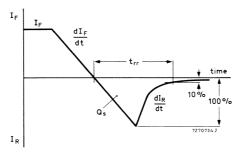


Fig.2 Definition of  $t_{rr}$  and  $Q_s$ .

<sup>\*</sup> Measured under pulse conditions to avoid excessive dissipation.

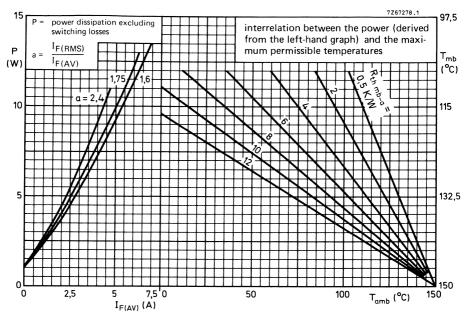


Fig.3

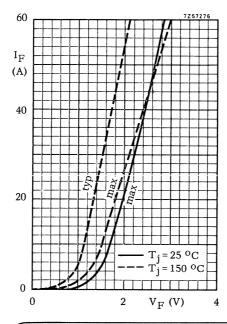
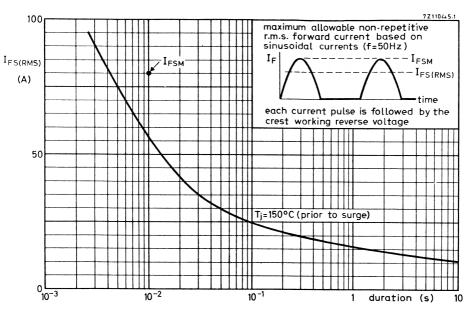


Fig.4





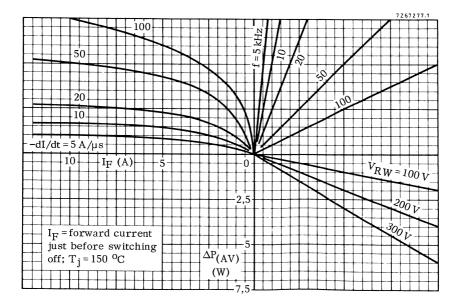
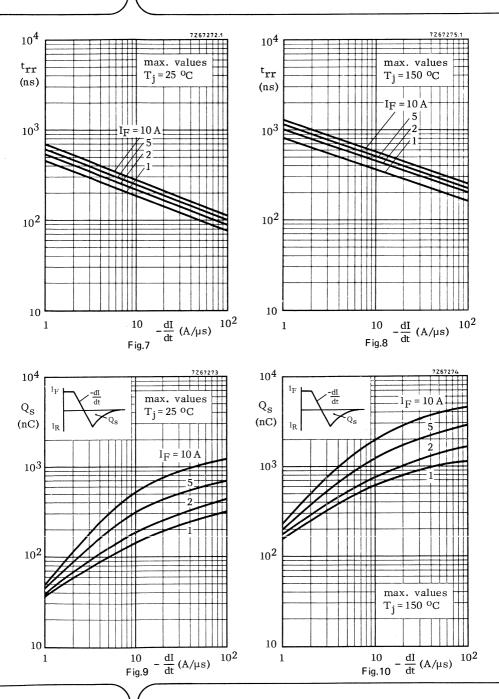


Fig.6



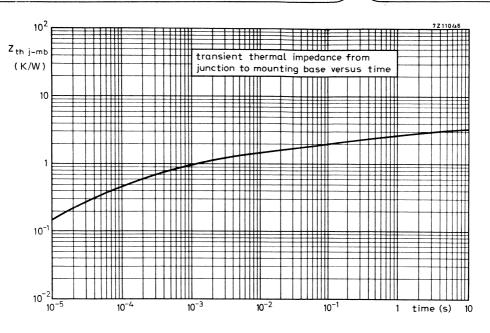
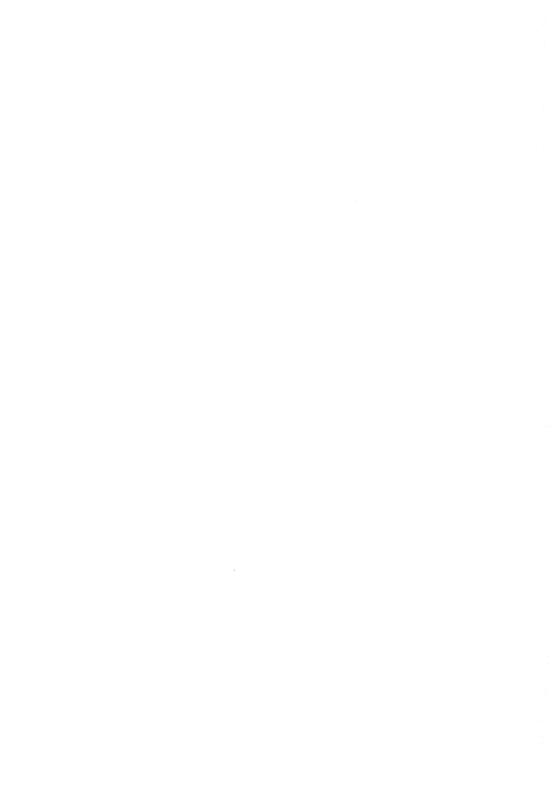


Fig.11



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.

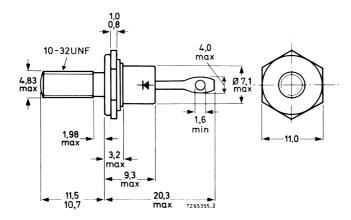
#### QUICK REFERENCE DATA

		1N3879	1N3880	1N3881	1N3882	1N3883	-
Repetitive peak reverse voltage VRRM	max.	50	100	200	300	400 V	
Average forward current			I <sub>F(AV)</sub>	max	. 6	6 A	
Non-repetitive peak forward current			<sup>I</sup> FSM	max	. 80	) A	
Reverse recovery time			t <sub>rr</sub>	<	200	D ns	3

#### **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 $\leq$ 10 ms)	V <sub>RSM</sub> max	100	150	250	350	450	٧
Repetitive peak reverse voltage ( $\delta \le 0.01$ )	V <sub>RRM</sub> max.	50	100	200	300	400	V
Crest working reverse voltage	V <sub>RWM max</sub> .	50	100	200	300	400	V

Currents				
Average on-state current assuming zero switching losses (averaged over any 20 ms period) up to T <sub>mb</sub> = 100 °C	<sup> </sup> F(AV)	max.	6	А
at T <sub>mb</sub> = 125 °C	IF(AV)	max.	3,5	Α
R.M.S. forward current	<sup>I</sup> F(RMS)	max.	10	Α
Repetitive peak forward current	<sup>I</sup> FRM	max.	75	Α
Non-repetitive peak forward current T <sub>j</sub> = 150 °C prior to surge; half sine-wave with reapplied V <sub>RWMmax</sub> ;				
t = 10 ms	FSM	max.	75 80	A
t = 8,3 ms	<sup>1</sup> FSM	max.	80	Α
$I^2$ t for fusing (t = 10 ms)	l²t	max.	28	$A^2s$
Temperatures				
Storage temperature	$T_{stg}$	-65 to +175		oC
Operating junction temperature	т <sub>ј</sub>	max.	150	oC
THERMAL RESISTANCE				
From junction to ambient in free air	R <sub>th j-a</sub>	=	50	K/W
From junction to mounting base	R <sub>th j-mb</sub>	=	4,4	K/W
From mounting base to heatsink	R <sub>th mb-h</sub>	=	0,5	K/W
Transient thermal impedance; $t = 1 \text{ ms}$ ; $\delta = 0$	Z <sub>th j-mb</sub>	=	1	K/W

CLI	A 1	n 1	CTE	- D	CT	201
1.0	м	пΑ				

Forward	i voitage
---------	-----------

I <sub>F</sub> = 6 A; T <sub>j</sub> = 25 °C	V <sub>F</sub>	< , "	1,4	V*

Reverse current

$$V_R = V_{RWMmax}$$
;  $T_j = 125 \, {}^{O}C$   $I_R$   $<$  3 mA

# Reverse recovery when switched from

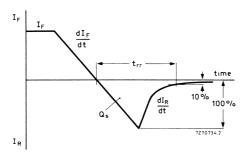
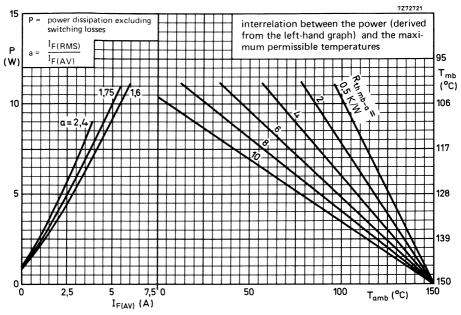


Fig.2 Definition of  $t_{rr}$  and  $Q_s$ .

<sup>\*</sup>Measured under pulse conditions to avoid excessive dissipation





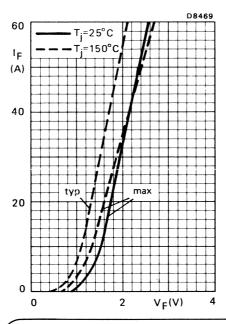


Fig.4

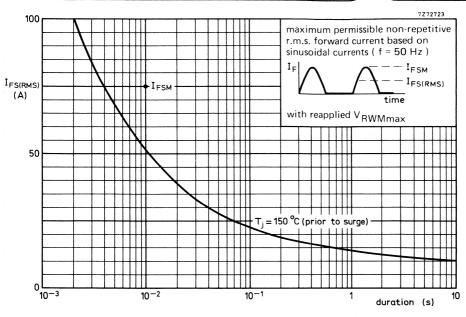


Fig.5

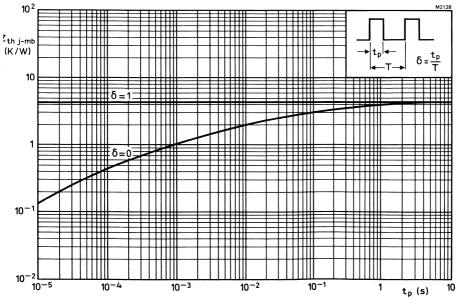


Fig.6

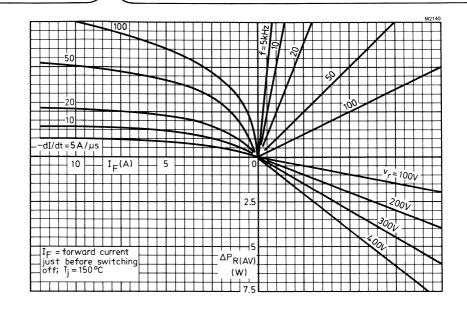
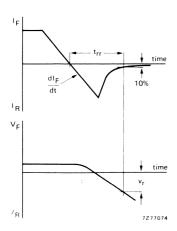


Fig.7

# **NOMOGRAM**

Power loss  $\triangle P_{R(AV)}$  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.

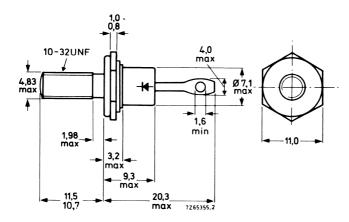
# QUICK REFERENCE DATA

			1N3889	1N3890	1N3891	1N3892	1N3893	_	•
Repetitive peak reverse voltage	$v_{RRM}$	max.	50	100	200	300	400	V	
Average forward current				I <sub>F(A\</sub>	/)	max.	12	Α	
Non-repetitive peak forward current				IFSM		max.	150	Α	
Reverse recovery time				t <sub>rr</sub>		<	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 ≤ 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 switching losses (averaged over a		period)					
up to T <sub>mb</sub> = 100 °C				I <sub>F</sub> (AV)	max.	12	Α
at $T_{mb}$ = 125 °C				IF(AV)	max.	7	Α
R.M.S. forward current				IF(RMS)	max.	20	· A
Repetitive peak forward current				IFRM	max.	140	Α
Non-repetitive peak forward currer $T_j = 150$ $^{ m OC}$ prior to surge; half sine-wave with reapplied $V_{ m R}$							
t = 10 ms	www.max,			I <sub>FSM</sub>	max.	140	Α
t = 8,3  ms				FSM	max.	150	Α
<sup>2</sup> t for fusing (t = 10 ms)				I²t	max.	100	$A^2$ s
Temperatures							
Storage temperature				$T_{stg}$	-6	65 to +175	оС
Operating junction temperature				Tj	max.	150	oC
THERMAL RESISTANCE							
From junction to ambient in free a	ir			R <sub>th j-a</sub>	=	50	K/V
From junction to mounting base				R <sub>th j-mb</sub>	=	2,2	K/V
From mounting base to heatsink				R <sub>th mb-h</sub>	=	0,5	K/V
Transient thermal impedance; t = 1	ms; δ = 0	j		Z <sub>th j-mb</sub>	=	0,8	K/V

5

A/µs

### **CHARACTERISTICS**

Forward	l vo	itage
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$I_F = 12 A; T_i$	<sub>i</sub> = 25 °C	VF	<	1,4	V*

Reverse current

$$V_R = V_{RWMmax}$$
;  $T_i = 125 \, {}^{\circ}\text{C}$   $I_R$   $<$  3 mA

Reverse recovery when switched from

 $-dI_F/dt = 2 A/\mu s; T_i = 25 °C$ 

Max. slope of the reverse recovery current

| dl <sub>R</sub>/dt|

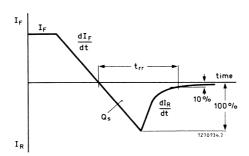


Fig.2 Definition of  $t_{rr}$  and  $Q_s$ .

<sup>\*</sup> Measured under pulse conditions to avoid excessive dissipation.

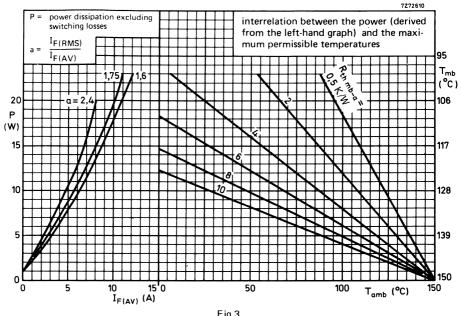


Fig.3

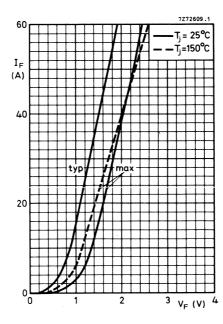


Fig.4

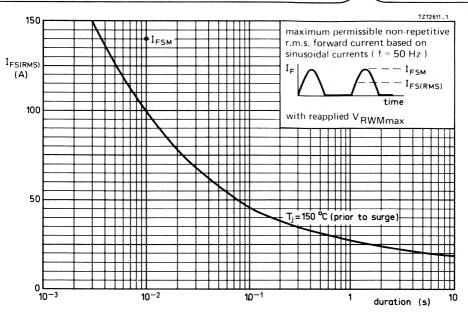


Fig.5

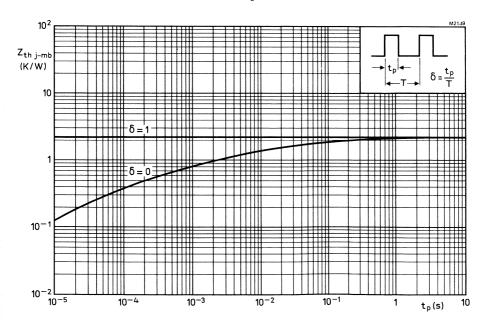


Fig.6

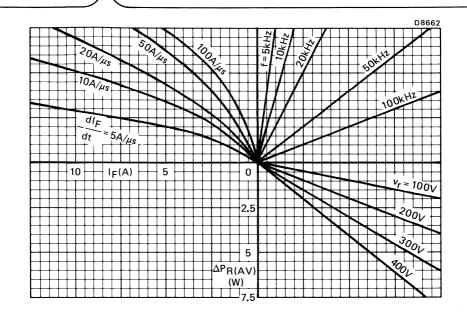
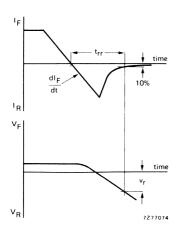


Fig.7

# **NOMOGRAM**

Power loss  $\triangle P_{R(AV)}$  due to switching only (to be added to steady state power losses). I<sub>F</sub> = forward current just before switching off;  $T_i$  = 150  $^{o}$ 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,

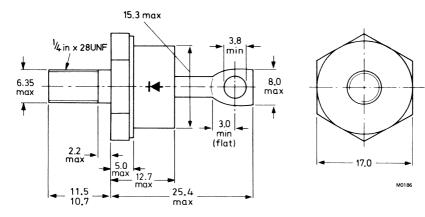
#### QUICK REFERENCE DATA

			1N3909	3910	3911	3912	3913	◄
Repetitive peak reverse voltage	V <sub>RRM</sub>	max.	50	100	200	300	400 V	
Average forward current	lF(AV)	max.			30		Α	
Non-repetitive peak forward current	I <sub>FSM</sub>	max.			300		А	
Reverse recovery time	t <sub>rr</sub>	<			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	6
----------	---

-	Vortages			1N3909	3910	3911	3912	3913	
	Non-repetitive peak reverse voltage (t = 10 ms)	V <sub>RSM</sub>	max.	75	200	300	400	500	V
	Repetitive peak reverse voltage ( $\delta \le 0.01$ )	V <sub>RRM</sub>	max.	50	100	200	300	400	V
	Crest working voltage	$v_{\text{RWM}}$	max.	50	100	200	300	400	V
	Currents								
	Average on-state current as switching losses (average up to $T_{mb}$ = 100 $^{\rm o}$ C at $T_{mb}$ = 125 $^{\rm o}$ C	-		period)	<sup>I</sup> F (AV <sup>I</sup> F (AV		max. max.	30 15	A A
	R.M.S. forward current				I <sub>F</sub> (RM	IS)	max.	45	Α
	Repetitive peak forward cu	rrent			IFRM	.0,	max.	125	Α
	Non-repetitive peak forwar T <sub>j</sub> = 150 °C prior to sure half sine-wave with reap; t = 10 ms t = 8.3 ms	je;	/Mmax;		<sup>I</sup> FSM <sup>I</sup> FSM		max. max.	275 300	A A
	$I^2$ t for fusing (t = 10 ms)				I²t		max.	375	$A^2s$
	Temperatures								
	Storage temperature				$T_{stg}$		-65 t	o 175	οС
	Operating junction temperation	ature			Тj		max.	150	οС
	THERMAL RESISTANCE								
	From junction to mounting	g ba <b>s</b> e			R <sub>th j-1</sub>	mb	=	1.0	K/W
	From mounting base to hea with heatsink compound				R <sub>th m</sub>	b-h	=	0.3	K/W
	Transient thermal impedan	ce; t = 1 r	ns		Z <sub>th j-r</sub>	mb	= '	0.2	K/W

# CHARACTERISTICS

Forward voltage				
$I_F = 30 \text{ A}; T_j = 25 ^{\circ}\text{C}$	VF	<	1.4	٧*
Reverse current				
$V_R = V_{RWMmax}; T_j = 100  {}^{\circ}C$	IR	<	10	mA
Reverse recovery when switched from $I_F = 1 \text{ A to V}_R \ge 30 \text{ V}; -dI_F/dt = 35 \text{ A}/\mu\text{s}; T_i = 25 ^{O}\text{C}$				
Recovery time $I_F = 2 \text{ A to } V_R \ge 30 \text{ V}; -dI_F/dt = 20 \text{ A}/\mu\text{s}; T_j = 25 ^{\circ}\text{C}$	t <sub>rr</sub>	<	200	ns
Recovered charge	$O_s$	< -	250	nC
Maximum slope of the reverse recovery current				
when switched from I <sub>F</sub> = 1 A to $V_R \ge 30 V$ ; $-dI_F/dt = 2 A/\mu s$ ; $T_i = 25 °C$	dlp/dt	<	5	A/μs

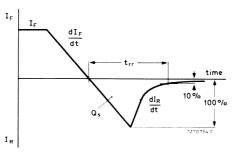


Fig. 2 Definitions of  $t_{\mbox{\scriptsize rr}}$  and  $\Omega_{\mbox{\scriptsize S}}.$ 

D8403

<sup>\*</sup>Measured under pulse conditions to avoid excessive dissipation.

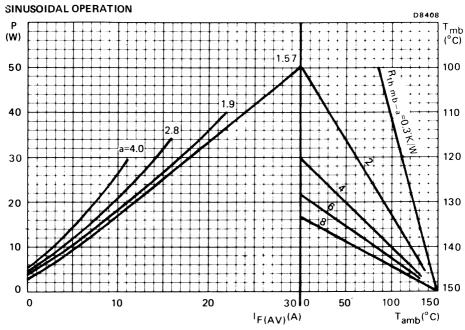


Fig. 3 The right-hand part shows the interrelationship between the power (derived from the left-hand part) and the maximum permissible temperatures.

P = power dissipation excluding switching losses.

 $a = form factor = I_F(RMS)/I_F(AV)$ 

#### SQUARE-WAVE OPERATION

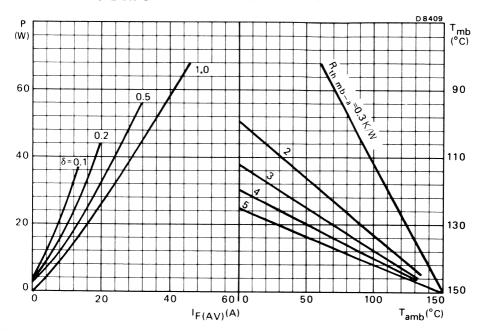


Fig. 4 The right-hand part shows the interrelationship between the power (derived from the left-hand part) and the maximum permissible temperatures.

P = power dissipation excluding switching losses.

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

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

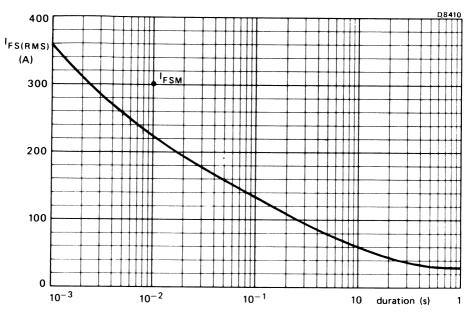


Fig.5 Maximum permissible non-repetitive r.m.s. forward current based on sinusoidal currents (f = 50 Hz);  $T_j$  = 150 °C prior to surge; with reapplied  $V_{RWMmax}$ .



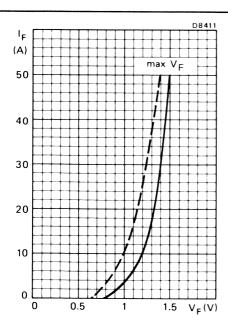
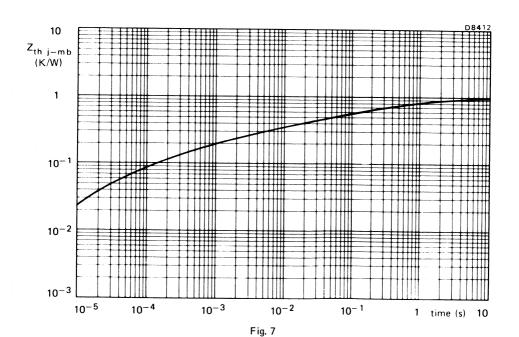


Fig. 6 —  $T_j = 25 \, {}^{\circ}\text{C}; --- T_j = 150 \, {}^{\circ}\text{C}$ 





# 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.

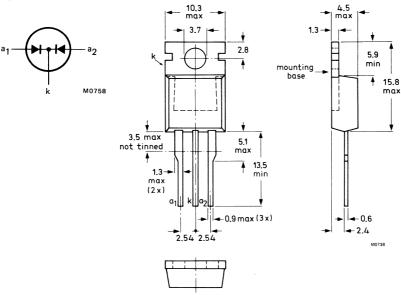
## QUICK REFERENCE DATA

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)	10	max.	-	1	0		А
Forward voltage	VF	<		0	.6		V
Junction temperature	$T_{j}$	<		15	50		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.

# **BYV18 SERIES**

# **RATINGS**

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

Voltages (per diode)		BYV1	8-30	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	٧
Continuous reverse voltage (note 1)	VR	max.	30	35	40	45	V
Currents (both diodes conducting: note 2)							
Output current:							
square wave; $\delta = 0.5$ ;					40		
up to T <sub>mb</sub> = 136 <sup>o</sup> C (note 3) sinusoidal;	Ю	max.			10		А
up to $T_{mb} = 137$ °C (note 3)	10	max.			8.8		Α
R.M.S. forward current	IF(RMS)	max.			14		Α
Repetitive peak forward current							
$t_p$ = 20 $\mu$ s; $\delta$ = 0.02 (per diode)	<sup> </sup> FRM	max.			90		Α
Non-repetitive peak forward current (per diode) half sine-wave; T <sub>j</sub> = 125 <sup>O</sup> C prior to surge; with reapplied V <sub>RWMmax</sub>							
t = 10 ms	<sup>I</sup> FSM	max.			100		Α
t = 8.3 ms	<sup>I</sup> FSM	max.			110		Α
$I^2$ t for fusing (t = 10 ms, per diode)	l²t	max.			50		$A^2 s$
Reverse surge current (BYV18-40A only)							
$t_p = 100 \mu s$	<sup>I</sup> RSM	max.			0.5		Α
Temperatures							
Storage temperature	$T_{stg}$			40 to +	-150		оС
Junction temperature	Тј	max.			150		оС

# Notes

- 1. Up to  $T_j$  = 125  $^{\rm o}$ C; see derating curve for higher temperature operation. 2. The limits for both diodes apply whether both diodes conduct simultaneously or on alternate half
- 3. Assuming no reverse leakage current losses.

CHARACTERISTICS (per diode)					
Forward voltage					
I <sub>F</sub> = 5 A; T <sub>j</sub> = 100 <sup>o</sup> C I <sub>F</sub> = 15 A; T <sub>j</sub> = 25 <sup>o</sup> C		VF	< '	0.6	V*
$I_F = 15 \text{ A}; T_j = 25 ^{\circ}\text{C}$		٧F	<	1.05	V*
Reverse current				20	
$V_R = V_{RWMmax}$ ; $T_j = 125$ °C		I <sub>R</sub>	<	30	mA
Junction capacitance at f = 1 MHz		•		000	
$V_R = 5 V; T_j = 25 \text{ to } 125 ^{\circ}\text{C}$		Cd	typ.	200	pF
THERMAL RESISTANCE					
From junction to mounting base (both	diodes conducting)	R <sub>th j-mb</sub>	=	1.7	K/W
From junction to mounting base (per d	iode)	R <sub>th j-mb</sub>	=	2.7	K/W
Influence of mounting method					
1. Heatsink-mounted with clip (see m	ounting instructions)				
Thermal resistance from mounting base	to heatsink				
a. with heatsink compound		R <sub>th mb-h</sub>	= "	0.3	K/W
b. with heatsink compound and 0.06	mm maximum mica				
insulator		R <sub>th mb-h</sub>	=	1.4	K/W
c. with heatsink compound and 0.1 m	ım maximum mica	_			
insulator (56369)		R <sub>th</sub> mb-h	=	2.2	K/W
d. with heatsink compound and 0.25	mm maximum			0.0	14 (14)
alumina insulator (56367)		R <sub>th</sub> mb-h	=	0.8	K/W
e. without heatsink compound		R <sub>th</sub> mb-h	==	1.4	K/W
2. Free air operation					
The quoted values of R <sub>th j-a</sub> should be to the same tie point.	used only when no leads	of other diss	ipating co	mponent	s run
Thermal resistance from junction to an	nbient in free air;				
mounted on a printed circuit board at					
length and with copper laminate on the	e board	R <sub>th j-a</sub>	=	60	K/W

<sup>\*</sup>Measured under pulse conditions to avoid excessive dissipation.

#### MOUNTING INSTRUCTIONS

- 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<sub>th mb-h</sub> 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<sub>th mb-h</sub> given for mounting with heatsink compound refer to the use of a metallic-oxide loaded compound. Ordinary silicone grease is not recommended.
- 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.

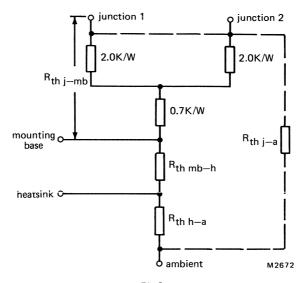


Fig.2.

#### OPERATING NOTES

Dissipation and heatsink calculations

Overall thermal resistance, Rth j-a = Rth j-mb + Rth mb-h + Rth h-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 ( $\delta$  or a)
- (iii) average forward current per diode
- (iv) crest working reverse voltage (VRWM)

The total power dissipation in the diode has two components:

P<sub>F</sub> - forward conduction dissipation

From the above it can be seen that:

$$R_{th \ h-a} = \frac{T_{jmax} - T_{amb}}{P_F + P_R} - (R_{th \ j-mb} + R_{th \ mb-h}) \ ... 2).$$

Values for Rth i-mb and Rth mb-h can be found under Thermal Resistance. PR and PF 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 VRWM axis of Fig.3 (or Fig.5), and from a knowledge of the required V<sub>RWM</sub>, trace upwards to meet the curve that matches the required T<sub>i</sub> 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 ( $\delta$ ) or form factor (a). From this point trace right and read the actual reverse power dissipation on the PR axis.

Forward conduction dissipation (PF) for the known average current IF(AV) and duty cycle (or form

factor) for each diode is easily derived from Fig.4 (or Fig.6). 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<sub>th i-mb</sub> = 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<sub>th i-mb</sub> of 2.7 K/W.

> To ensure thermal stability, (R<sub>th j-mb</sub> + R<sub>th mb-h</sub> + R<sub>th h-a</sub>) x P<sub>R</sub> must be less than 12 °C. If the calculated value of Rth h-a does not permit this, then it must be reduced (heatsink size increased or Rth mb-h improved) to enable this criterion to be met.

EXAMPLE: square-wave operation, using BYV18-35 and heatsink compound;

 $T_{amb} = 50 \, {}^{\circ}\text{C}; \, \delta \, (\text{diode 1}) = 0.5; \, \delta \, (\text{diode 2}) = 0.5;$ 

 $I_{F(AV)}$  (diode 1) = 5 A;  $I_{F(AV)}$  (diode 2) = 5 A;

V<sub>RWM</sub> (both diodes) = 12 V; voltage grade of device = 35 V.

From data,  $R_{th i-mb} = 1.7 \text{ K/W}$  and  $R_{th mb-h} = 0.3 \text{ K/W}$ .

For each diode from Fig.4, it is found that PF = 3.5 W;

hence total  $P_F = 2 \times 3.5 = 7 \text{ W}$ . (from equation 4)

If desired T<sub>i</sub> max is chosen to be 130 °C, then, from Fig.3, P<sub>R</sub> (per diode) = 0.1 W

Therefore total  $P_R = 2 \times 0.1 = 0.2 \text{ W}$ . (from equation 3)

Using equation 2) we have:

$$R_{\text{th h-a}} = \frac{130 \, ^{\circ}\text{C} - 50 \, ^{\circ}\text{C}}{7 \, \text{W} + 0.2 \, \text{W}} - (1.7 + 0.3) = 9.1 \, \text{K/W}$$

To check for thermal stability:

$$(R_{4b}: a) \times P_D = (1.7 + 0.3 + 9.1) \times 0.2 = 2.2 \, {}^{\circ}C$$

 $(R_{th~j\cdot a})\times P_R=(1.7+0.3+9.1)\times 0.2=2.2~^{O}C.$  This is less than 12  $^{O}C$ , hence thermal stability is ensured.



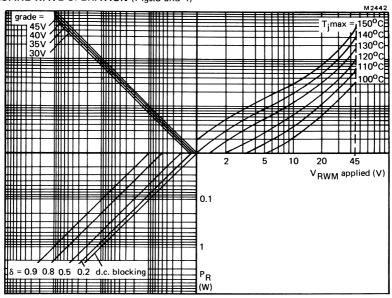
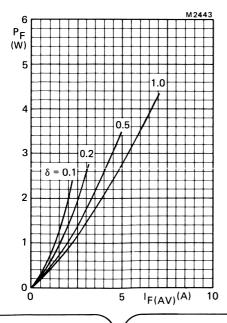


Fig.3 NOMOGRAM: for calculation of  $P_R$  (reverse leakage power dissipation) for a given  $T_i$  max.,  $V_{RWM}$  applied, voltage grade and duty cycle (per diode).



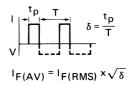


Fig.4 Forward current power rating (per diode).

#### SINUSOIDAL OPERATION (Figs.5 and 6)

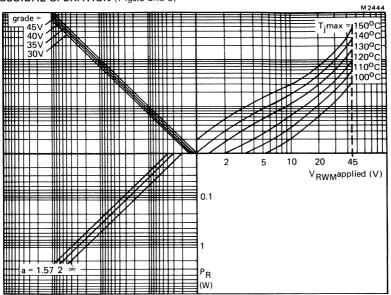


Fig.5 NOMOGRAM: for calculation of  $P_R$  (reverse leakage power dissipation) for a given  $T_i$  max.,  $V_{RWM}$  applied, voltage grade and form factor (per diode).

 $a = form factor = I_F(RMS)/I_F(AV)$ .

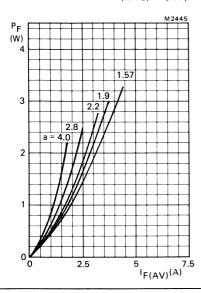


Fig.6 Forward current power rating (per diode).

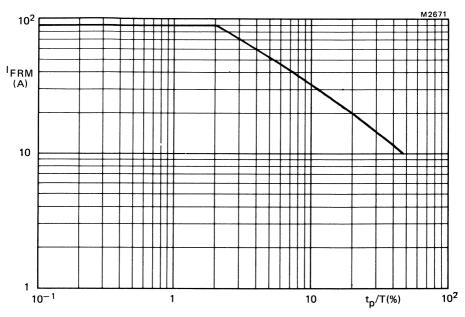
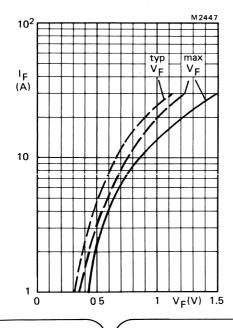
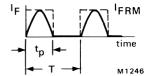


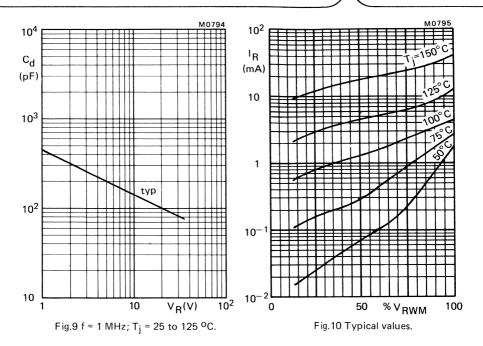
Fig.7 Maximum permissible repetitive peak forward current for either square or sinusoidal current for 1  $\mu s < t_p < 1$  ms.

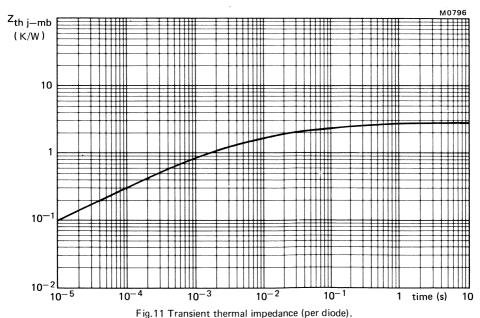




Definition of I FRM and  $t_p/T$ .

Fig.8 —— 
$$T_j = 25 \, {}^{o}\text{C}; --- T_j = 100 \, {}^{o}\text{C}.$$





# 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.

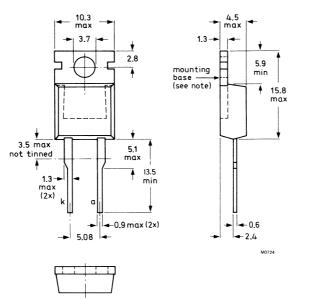
#### QUICK REFERENCE DATA

			BYV19-30	35	40(A)	45	
Repetitive peak reverse voltage	$V_{RRM}$	max.	30	35	40	45	<b>V</b>
Average forward current	IF(AV)	max.			10		Α
Forward voltage	٧ <sub>F</sub>	<			0.6		V
Junction temperature	Τj	max.		1	50		οС

#### MECHANICAL DATA

Fig.1 TO-220AC

Dimensions in mm



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.

# **BYV19 SERIES**

#### **RATINGS**

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

-	Voltages		BYV19	9–30   3	35	40(A)	45	
	Repetitive peak reverse voltage	$V_{RRM}$	max.	30 3	35	40	45	V
	Crest working reverse voltage (note 1)	$V_{RWM}$	max.	30 3	35	40	45	V
	Continuous reverse voltage (note 1)	$v_R$	max.	30 3	35	40	45	V
-	Currents			-				
	Average forward current square wave; $\delta = 0.5$ ; up to $T_{mh} = 124$ °C (note 2)	<sup>I</sup> F(AV)	max.			10		Α
	sinusoidal; up to T <sub>mb</sub> = 124 °C (note 2)	lF(AV)	max.			9		A
	R.M.S. forward current		max.			14		A
	Repetitive peak forward current $t_D = 20 \ \mu s; \ \delta = 0.02$	<sup>I</sup> F(RMS) <sup>I</sup> FRM	max.			170		A
	Non-repetitive peak forward current half sine-wave; T <sub>j</sub> = 125 °C prior to surge; with reapplied V <sub>RWM max</sub> ; t = 10 ms							
	t = 8.3 ms	FSM	max.			150		A
		<sup>I</sup> FSM	max.			165		A
	I <sup>2</sup> t for fusing (t = 10 ms)	l² t	max.	112		112	A <sup>2</sup> s	
	Reverse surge current (BYV19-40A only) $t_p = 100 \mu s$	<sup>I</sup> RSM	max.			0.5		Α
	Temperatures							
	Storage temperature	$T_{stg}$		-40	to +	150		oC
	Junction temperature	Tj	max.			150		оС
	CHARACTERISTICS							
	Forward voltage $I_F = 5 \text{ A}$ ; $T_i = 100 ^{\circ}\text{C}$ (note 3)	VF	<			0.6		V
	$I_F = 20 \text{ A}; T_i = 25 \text{ °C (note 3)}$	V <sub>F</sub>	<			1.10		V
	Reverse current	•						•
	$V_R = V_{RWMmax}$ ; $T_j = 125  {}^{\circ}C$	I <sub>R</sub>	<			30		mA
	Junction capacitance at $f = 1$ MHz V <sub>R</sub> = 5 V; T <sub>j</sub> = 25 to 125 °C	$C_d$	typ.			200		pF

# Notes:

- 1. Up to  $\rm T_{j}$  = 125  $\rm ^{o}C;$  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 <sub>th j-mb</sub>	= 2.7	K/W
--------------------------------	----------------------	-------	-----

#### Influence of mounting method

1.	Heatsink-mounted with clip (see mounting instructions)				
Th	ermal resistance from mounting base to heatsink				
a.	with heatsink compound	R <sub>th mb-h</sub>	-	0.3	K/W
b.	with heatsink compound and 0.06 mm maximum mica insulator	R <sub>th mb-h</sub>	= ,	1.4	K/W
c.	with heatsink compound and 0.1 mm maximum mica insulator (56369)	R <sub>th mb-h</sub>	=	2.2	K/W
d.	with heatsink compound and 0.25 mm maximum alumina insulator (56367)	R <sub>th mb-h</sub>	=	0.8	K/W
e.	without heatsink compound	R <sub>th mb-h</sub>	=	1.4	K/W

## 2. Free air operation

The quoted values of R<sub>th j-a</sub> 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

Rth j-a 60 K/W

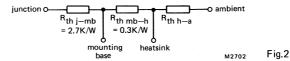
#### MOUNTING INSTRUCTIONS

- 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<sub>th mb-h</sub> 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<sub>th mb-h</sub> 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:



Overall thermal resistance, Rth j-a = Rth j-mb + Rth mb-h + Rth h-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 ( $\delta$  or a)
- (iii) average forward current
- (iv) crest working reverse voltage (VRWM)

The total power dissipation in the diode has two components:

P<sub>F</sub> - forward conduction dissipation

From the above it can be seen that:

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 ( $\delta$ ) 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<sub>F</sub>) for the known average current I<sub>F(AV)</sub> 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,  $(R_{th\ j-mb}+R_{th\ mb-h}+R_{th\ h-a})\times P_R$  must be less than 12 °C. If the calculated value of  $R_{th\ h-a}$  does not permit this, then it must be reduced (heatsink size increased or  $R_{th\ mb-h}$  improved) to enable this criterion to be met.

EXAMPLE: square-wave operation, using BYV19-35 and heatsink compound;

$$T_{amb} = 50 \text{ °C}; \delta = 0.5; I_{F(AV)} = 8 \text{ A}$$

V<sub>RWM</sub> = 12 V; voltage grade of device = 35 V

From data,  $R_{th i-mb} = 2.7 \text{ K/W}$  and  $R_{th mb-h} = 0.3 \text{ K/W}$ .

From Fig.4, it is found that  $P_F = 7 \text{ W}$ 

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:

$$R_{\text{th h-a}} = \frac{130 \text{ }^{\circ}\text{C} - 50 \text{ }^{\circ}\text{C}}{7 \text{ W} + 0.1 \text{ W}} - (2.7 + 0.3) = 8.3 \text{ K/W}$$

To check for thermal stability:

$$(R_{th j-a}) \times P_R = (2.7 + 0.3 + 8.3) \times 0.1 = 1.1 \, {}^{o}C.$$

This is less than 12 °C, hence thermal stability is ensured.

# SQUARE WAVE OPERATION (Figs.3 and 4)

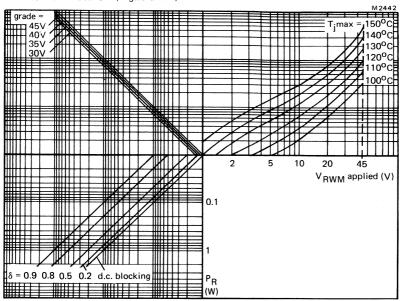
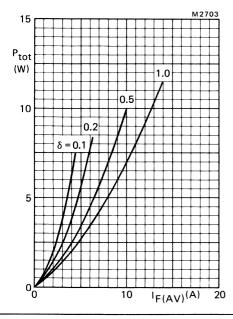


Fig.3 NOMOGRAM: for calculation of  $P_R$  (reverse leakage power dissipation) for a given  $T_i$  max.,  $V_{RWM}$  applied, voltage grade and duty cycle.



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

$$V = \frac{1}{F(AV)} = \frac{1}{F(RMS)} \times \sqrt{\delta}$$

Fig.4 Forward current power rating.

# SINUSOIDAL OPERATION (Figs.5 and 6)

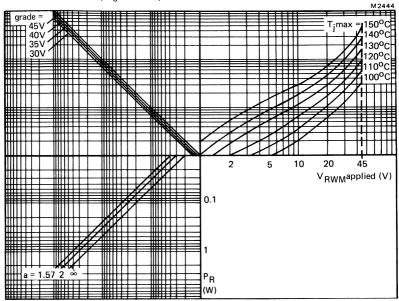


Fig.5 NOMOGRAM: for calculation of PR (reverse leakage power dissipation) for a given Tj max., VRWM applied, voltage grade and form factor. a = form factor =  $I_F(RMS)/I_F(AV)$ 

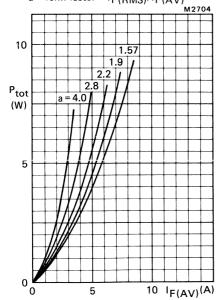


Fig.6 Forward current power rating.

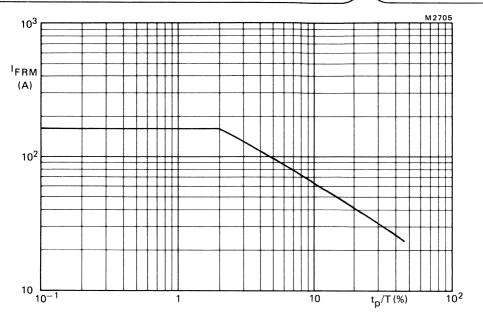
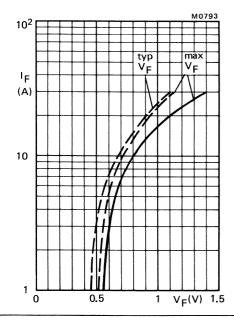
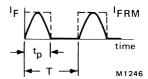


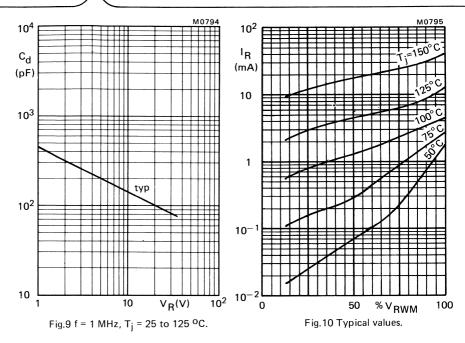
Fig.7 Maximum permissible repetitive peak forward current for either square or sinusoidal currents for 1  $\mu$ s < t $_p$  < 1 ms.





Definition of I  $_{\mbox{\scriptsize FRM}}$  and  $t_p/T.$ 

Fig.8 — 
$$T_j = 25$$
 °C;  $- - T_j = 100$  °C.



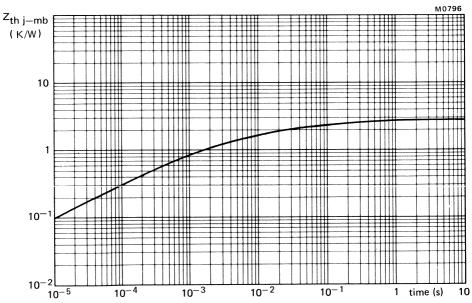


Fig.11 Transient thermal impedance.

## 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.

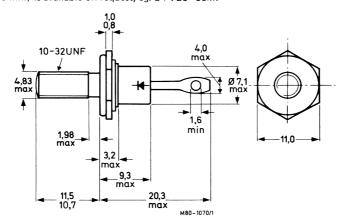
### QUICK REFERENCE DATA

		BYV2	0–30	35	40(A)	45	
Repetitive peak reverse voltage	$v_{RRM}$	max.	30	35	40	45	V
Average forward current	I <sub>F(AV)</sub>	max.			15		Α
Forward voltage	٧ <sub>F</sub>	<		C	).6		٧
Junction temperature	$T_{j}$	max.		1	50		oC

### MECHANICAL DATA

Dimensions in mm

Fig. 1 DO-4 with 10-32 UNF stud ( $\phi$ 4.83 mm) as standard. Metric M5 stud ( $\phi$ 5 mm) is available on request, eg. BYV20-30M.



Net mass: 6 q

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.

# **BYV20 SERIES**

### **RATINGS**

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

	Voltages		BYV20	0–30	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 $T_{mb} = 121$ OC (note 2)	<sup>I</sup> F(AV)	max.			15		А
	sinusoidal; up to T <sub>mb</sub> = 124 °C (note 2)	I <sub>F</sub> (AV)	max.	12.5				Α
	R.M.S. forward current	IF(RMS)	max.	21				Α
	Repetitive peak forward current $t_p = 20 \mu s$ ; $\delta = 0.02$	I <sub>FRM</sub>	max.			260		Α
	Non-repetitive peak forward current half sine-wave; T <sub>j</sub> = 125 °C prior to surge; with reapplied V <sub>RWM max</sub> ;	1				200		Α
	t = 10 ms	<sup>I</sup> FSM	max.			300		
	t = 8.3 ms	FSM	max.			330		A
	$I^2$ t for fusing (t = 10 ms)	l²t	max.			450		A <sup>2</sup> s
	Reverse surge current (BYV20-40A only) $t_p = 100 \mu s$	IRSM	max.			1.0		Α
	Temperatures							
	Storage temperature	$T_{stg}$			55 to -	⊦150		oC
	Junction temperature	тj	max.			150		oC

### 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.

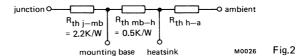
THERMAL RESISTANCE				
From junction to mounting base	R <sub>th j-mb</sub>	= "	2.2	K/W
From mounting base to heatsink with heatsink compound	R <sub>th mb-h</sub>	=	0.5	K/W
Transient thermal impedance; t = 1 ms	Z <sub>th j-mb</sub>	=	0.85	K/W ←
CHARACTERISTICS				
Forward voltage				
I <sub>F</sub> = 15 A; T <sub>j</sub> = 100 °C	V <sub>F</sub>	<	0.6	V*
I <sub>F</sub> = 40 A; T <sub>j</sub> = 25 °C	٧ <sub>F</sub>	<	1.0	V*
Rate of rise of reverse voltage				
$V_R = V_{RWMmax}$	$\frac{dV_R}{dt}$	<	1500	V/μs ◀
Reverse current				
$V_R = V_{RWMmax}$ ; $T_j = 125  {}^{\circ}C$	I <sub>R</sub>	<	70	mA
Capacitance at f = 1 MHz				
$V_R = 5 V$ ; $T_j = 25 \text{ to } 125 ^{\circ}\text{C}$	C <sub>d</sub>	typ.	520	pF

<sup>\*</sup>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,  $R_{th j-a} = R_{th j-mb} + R_{th mb-h} + R_{th h-a}$ 

To choose a suitable heatsink, the following information is required:

- (i) maximum operating ambient temperature
- (ii) duty cycle or form factor of forward current ( $\delta$  or a)
- (iii) average forward current
- (iv) crest working reverse voltage (VRWM)

The total power dissipation in the diode has two components:

P<sub>F</sub> — forward conduction dissipation

From the above it can be seen that:

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 ( $\delta$ ) 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  $P_{\mathsf{R}}$  and  $P_{\mathsf{F}}$  into equation 2) enables the calculation of the required heatsink.

To ensure thermal stability,  $(R_{th\ j-mb} + R_{th\ mb-h} + R_{th\ h-a}) \times P_R$  must be less than 12 °C. If the calculated value of  $R_{th\ h-a}$  does not permit this, then it must be reduced (heatsink size increased or  $R_{th\ mb-h}$  improved) to enable this criterion to be met.

EXAMPLE: square-wave operation, using BYV20-35 and heatsink compound;

$$T_{amb} = 50 \, {}^{\circ}\text{C}; \, \delta = 0.5; \, I_{F(AV)} = 12 \, A$$

From data,  $R_{th j-mb}$  = 2.2 K/W and  $R_{th mb-h}$  = 0.5 K/W.

From Fig.4, it is found that  $P_F = 9.2 \text{ W}$ 

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:

$$R_{\text{th h-a}} = \frac{130 \text{ }^{\circ}\text{C} - 50 \text{ }^{\circ}\text{C}}{9.2 \text{ W} + 0.3 \text{ W}} - (2.2 + 0.5) = 5.7 \text{ K/W}$$

To check for thermal stability:

$$(R_{th, i-a}) \times P_R = (2.2 + 0.5 + 5.7) \times 0.3 = 2.5 \, ^{\circ}C.$$

This is less than 12 °C, hence thermal stability is ensured.

### SQUARE-WAVE OPERATION (Figs.3 and 4)

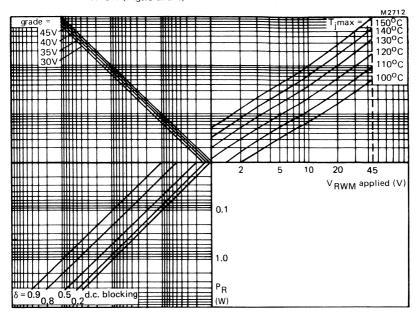
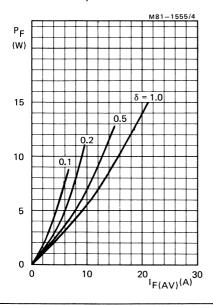


Fig.3 NOMOGRAM: for calculation of  $P_R$  (reverse leakage power dissipation) for a given  $T_i$  max.,  $V_{RWM}$  applied, voltage grade and duty cycle.



$$\delta = \frac{\mathsf{tp}}{\mathsf{T}}$$

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

### SINE-WAVE OPERATION (Figs.5 and 6)

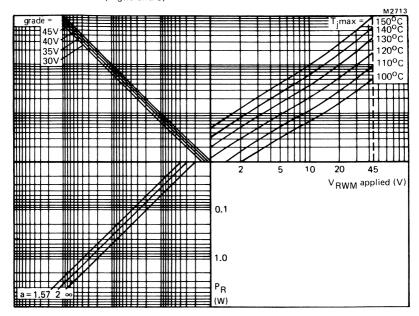


Fig.5 NOMOGRAM: for calculation of  $P_R$  (reverse leakage power dissipation) for a given  $T_j$  max.,  $V_{RWM}$  applied, voltage grade and form factor.  $a = form \ factor = I_F(RMS)/I_F(AV)$ .

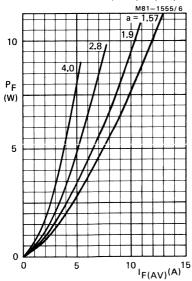


Fig.6.

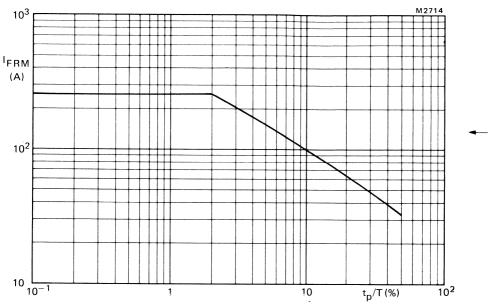
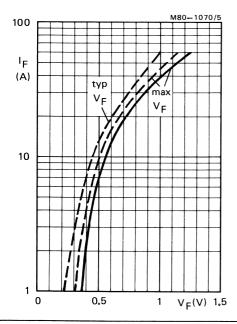
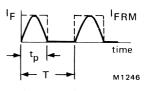


Fig.7 Maximum permissible repetitive peak forward current for either square or sinusoidal currents for 1  $\mu$ s < t $_p$  < 1 ms.





Definition of  $I_{\mbox{\scriptsize FRM}}$  and  $t_p/T.$ 

Fig.8 — 
$$T_j = 25 \, {}^{\circ}C; -- T_j = 100 \, {}^{\circ}C.$$

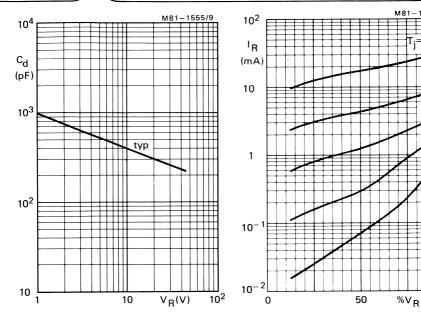


Fig.9 f = 1 MHz;  $T_j$  = 25 to 125 °C.

Fig. 10 Typical values.

100°

100

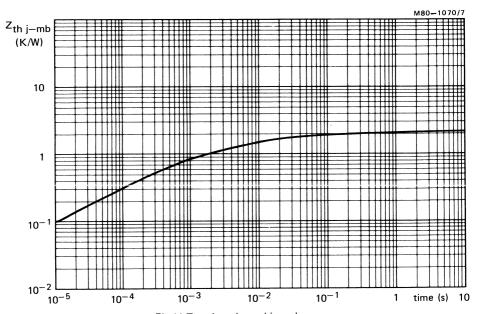


Fig.11 Transient thermal impedance.

## 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.

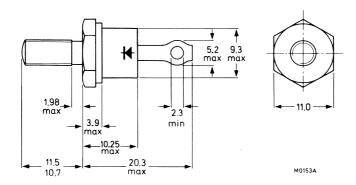
### **QUICK REFERENCE DATA**

			BYV21-30	35	40(A)	45		
Repetitive peak reverse voltage	$v_{RRM}$	max.	30	35	40	45	V	
Average forward current	IF(AV)	max.	-		30		Α	<b>-</b>
Forward voltage	٧ <sub>F</sub>	<		0.	.55		V	
Junction temperature	$T_{j}$	max.		1	50		oC	

### **MECHANICAL DATA**

Dimensions in mm

Fig.1 DO-4 with 10-32 UNF sutd ( $\phi$ 4.83 mm) as standard. Metric M5 stud ( $\phi$ 5 mm) is available on request, e.g. BYV21-30M.



Net mass: 7 q

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.

# **BYV21 SERIES**

### **RATINGS**

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

V V V
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### 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.

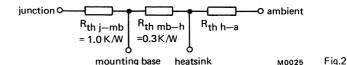
THERMAL RESISTANCE				
From junction to mounting base	R <sub>th j-mb</sub>	=	1	K/W
From mounting base to heatsink with heatsink compound without heatsink compound	R <sub>th mb-h</sub> R <sub>th mb-h</sub>		0.3 0.5	K/W K/W
Transient thermal impedance; t = 1 ms	Z <sub>th j-mb</sub>	***	0.15	K/W
CHARACTERISTICS				
Forward voltage				
I <sub>F</sub> = 30 A; T <sub>j</sub> = 100 °C	VF	<	0.55	V*
I <sub>F</sub> = 80 A; T <sub>j</sub> = 25 °C	٧ <sub>F</sub>	<	0.88	<b>V</b> *
Rate of rise of reverse voltage				
$V_R = V_{RWMmax}$	$\frac{dV_R}{dt}$	<	1500	V/μs
Reverse current				
$V_R = V_{RWMmax}$ ; $T_j = 125  {}^{\circ}C$	1 <sub>R</sub>	<	150	mA
Capacitance at f = 1 MHz $V_R = 5 V$ ; $T_j = 25 \text{ to } 125 {}^{O}C$	$c_d$	typ.	1150	pF

<sup>\*</sup>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, Rth i-a = Rth i-mb + Rth mb-h + Rth h-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 (VRWM)

The total power dissipation in the diode has two components:

From the above, it can be seen that:

 $P_{tot} = P_R + P_F \dots 1$ 

values for R<sub>th i-mb</sub> and R<sub>th mb-h</sub> 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 ( $\delta$ ) or form factor (a). From this point trace right and read the actual reverse power dissipation on the  $P_B$  axis.

Forward conduction dissipation (P<sub>F</sub>) for the known average current I<sub>F(AV)</sub> 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,  $(R_{th\ j-mb} + R_{th\ mb-h} + R_{th\ h-a}) \times P_R$  must be less than 12 °C. If the calculated value of  $R_{th\ h-a}$  does not permit this, then it must be reduced (heatsink size increased or  $R_{th\ mb-h}$  improved) to enable this criterion to be met.

EXAMPLE: square-wave operation, using BYV21-35 and heatsink compound;

 $T_{amb}$  = 30 °C;  $\delta$  = 0.5;  $I_{F(AV)}$  = 20 A;  $V_{RWM}$  = 12 V; voltage grade of device = 35 V. From data,  $R_{th\ i-mb}$  = 1.0 K/W and  $R_{th\ mb-h}$  = 0.3 K/W.

From Fig.4, it is found that PF = 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:

 $R_{\text{th h-a}} = \frac{120 \, ^{\circ}\text{C} - 30 \, ^{\circ}\text{C}}{14 \, \text{W} + 0.35 \, \text{W}} - (1.0 + 0.3) = 5 \, \text{K/W}$ 

To check for thermal stability:  $(R_{th j-a}) \times P_R = (1.0 + 0.3 + 5) \times 0.35 = 2.2$  °C. This is less than 12 °C, hence thermal stability is ensured.

### SQUARE-WAVE OPERATION (Figs.3 and 4)

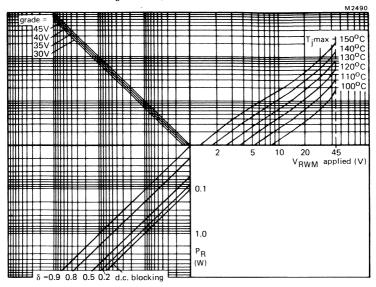
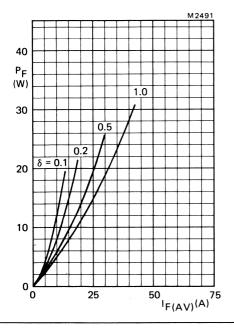


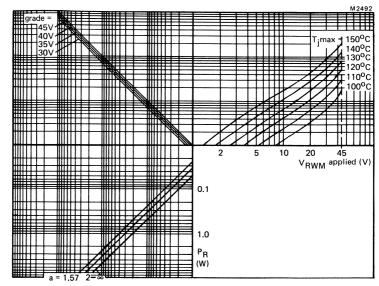
Fig.3 Maximum permissible junction temperature as a function of crest working reverse voltage and duty cycle of forward conduction.



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

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

### SINE-WAVE OPERATION (Figs.5 and 6)



 $Fig. 5 \ Maximum \ permissible junction \ temperature \ as \ a \ function \ of \ crest \ working \ reverse \ voltage \ and \ form \ factor \ of \ forward \ conduction.$ 

 $a = form factor = I_F(RMS)/I_F(AV)$ .

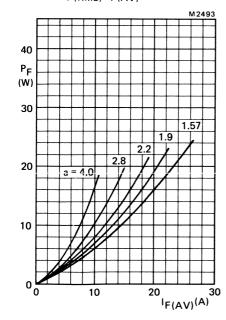


Fig.6

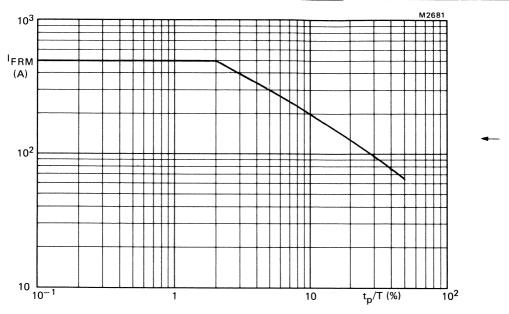
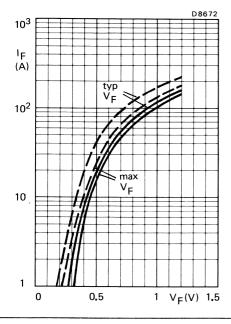
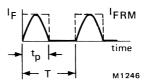


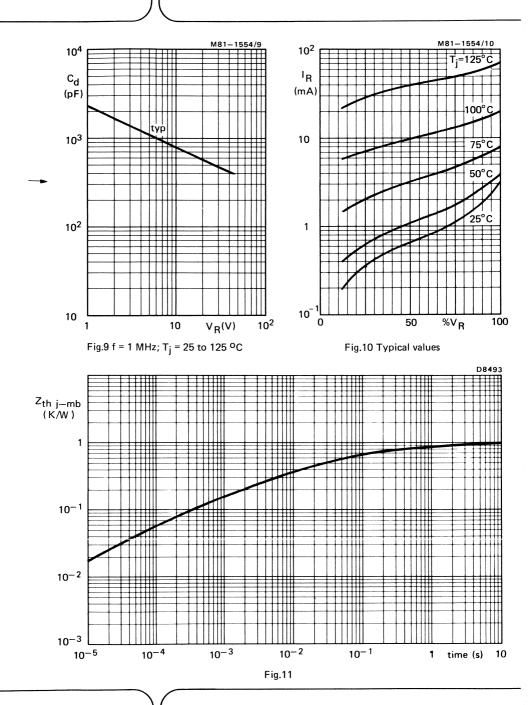
Fig.7 Maximum permissible repetitive peak forward current for either square or sinusoidal currents for 1  $\mu s < t_p < 1$  ms.





Definition of IFRM and  $t_p/T$ .

Fig.8 —— 
$$T_j = 25 \, {}^{o}C; --- T_j = 100 \, {}^{o}C.$$



# 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

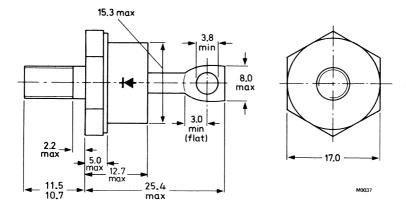
			BYV22-30	35	40(A)	45	
Repetitive peak reverse voltage	$V_{RRM}$	max.	30	35	40	45	V
Average forward current	I <sub>F(AV)</sub>	max.			60		Α
Forward voltage	VF	<		0.	55		V
Junction temperature	$T_{j}$	max.		1	50		oC

### **MECHANICAL DATA**

Dimensions in mm

Fig.1 DO—5 with ¼" x 28 UNF stud (φ6.35 mm)

Types with metric M6 stud ( $\phi$ 6 mm) are available on request; e.g. BYV22-30M.



Net mass: 22 q

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

# **BYV22 SERIES**

### **RATINGS**

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

Voltages		BYV22	2–30	35	40(A)	45	
Non-repetitive peak reverse voltage	$V_{RSM}$	max.	36	42	48	54	٧
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	٧
Currents							
Average forward current square wave; $\delta = 0.5$ ; up to							
5	<sup>I</sup> F(AV)	max.					Α
sinusoidal; up to $T_{mb}$ = 127 ${}^{o}C$ (note 2)	<sup>I</sup> F(AV)	max.			50		Α
R.M.S. forward current	IF(RMS)	max.			85		Α
Repetitive peak forward current $t_p = 20 \mu s$ ; $\delta = 0.02$	IFRM	max.			1100		Α
Non-repetitive peak forward current half sine-wave; T <sub>j</sub> = 125 <sup>O</sup> C prior to surge; with reapplied V <sub>RWM</sub> max							
							A
• • • • • • • • • • • • • • • • • • • •	<sup>I</sup> FSM	max.					Α
$I^2$ t for fusing (t = 10 ms)	l² t	max.		į	5000		A <sup>2</sup> s
Reverse surge current (BYV22-40A only) $t_p = 100 \mu s$	<sup>I</sup> RSM	max.			2.0		Α
Temperatures							
Storage temperature	T <sub>stq</sub>		_	55 to -	+150		οС
Junction temperature	Tj	max.			150		оC
	Non-repetitive peak reverse voltage Repetitive peak reverse voltage (note 1) Crest working reverse voltage Continuous reverse voltage Continuous reverse voltage Currents  Average forward current square wave; $\delta = 0.5$ ; up to $T_{mb} = 124$ °C (note 2) sinusoidal; up to $T_{mb} = 127$ °C (note 2) R.M.S. forward current Repetitive peak forward current $t_p = 20~\mu s$ ; $\delta = 0.02$ Non-repetitive peak forward current half sine-wave; $T_j = 125$ °C prior to surge; with reapplied V RWM max $t = 10~ms$ $t = 8.3~ms$ $t = 8.3~ms$ Reverse surge current (BYV22-40A only) $t_p = 100~\mu s$ Temperatures Storage temperature	Non-repetitive peak reverse voltage $V_{RSM}$ Repetitive peak reverse voltage (note 1) $V_{RRM}$ Crest working reverse voltage $V_{RSM}$ Continuous reverse voltage $V_{RSM}$ Continuous reverse voltage $V_{RSM}$ Currents  Average forward current square wave; $\delta = 0.5$ ; up to $T_{mb} = 124$ °C (note 2) $I_{F}(AV)$ sinusoidal; up to $T_{mb} = 127$ °C (note 2) $I_{F}(AV)$ R.M.S. forward current $I_{F}(RMS)$ Repetitive peak forward current $I_{F} = 20 \ \mu s$ ; $\delta = 0.02$ $I_{F}(RMS)$ Non-repetitive peak forward current half sine-wave; $T_{j} = 125$ °C prior to surge; with reapplied $V_{RWM}$ max $I_{F}(RMS)$ $I_{F}(RMS)$ Reverse surge current (BYV22-40A only) $I_{F}(RSMS)$ Reverse surge current (BYV22-40A only) $I_{F}(RSMS)$ Temperatures $I_{F}(RSMS)$ Temperatures $I_{F}(RSMS)$	Non-repetitive peak reverse voltage $V_{RSM}$ max. Repetitive peak reverse voltage (note 1) $V_{RRM}$ max. Crest working reverse voltage $V_{RWM}$ max. Continuous reverse voltage $V_{RWM}$ max. $V_{R}$ max. $V_{R$	Non-repetitive peak reverse voltage $V_{RSM}$ max. 36 Repetitive peak reverse voltage (note 1) $V_{RRM}$ max. 30 Crest working reverse voltage $V_{RWM}$ max. 30 Continuous reverse voltage $V_{RWM}$ max. 30 Continuous reverse voltage $V_{RWM}$ max. 30 $V_{RWM}$ ma	Non-repetitive peak reverse voltage Repetitive peak reverse voltage (note 1) VRRM max. 30 35 Crest working reverse voltage VRWM max. 30 35 Continuous reverse voltage value of VRWM max. 30 35 Continuous reverse voltage value of VRWM max. 30 35 Continuous reverse voltage value of RRWM max. 30 35 Continuous reverse voltage value of RRWM max. 30 35 Continuous reverse value voltage value of RRWM max. 30 35 Continuous reverse value voltage value valu	Non-repetitive peak reverse voltage Repetitive peak reverse voltage (note 1) VRRM max. 36 42 48 Repetitive peak reverse voltage (note 1) VRRM max. 30 35 40 Crest working reverse voltage VRWM max. 30 35 40 Continuous reverse voltage VR max. 30 35 40 Currents  Average forward current square wave; $\delta = 0.5$ ; up to $T_{mb} = 124$ °C (note 2) IF(AV) max. 60 sinusoidal; up to $T_{mb} = 127$ °C (note 2) IF(AV) max. 50 R.M.S. forward current $t_p = 20  \mu s$ ; $\delta = 0.02$ IFRM max. 1100 Non-repetitive peak forward current half sine-wave; $T_j = 125$ °C prior to surge; with reapplied VRWM max $t = 10  \text{ms}$ IFSM max. 1000 $t = 8.3  \text{ms}$ IFSM max. 1100 Reverse surge current (BYV22-40A only) $t_p = 100  \mu s$ IRSM max. 2.0 Temperatures  Storage temperature	Non-repetitive peak reverse voltage   Repetitive peak reverse voltage (note 1)   VRRM max. 36

### 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  $t_D$  = 200 ns a 20% increase in  $V_{RRM}$  is allowed.
- 2. Assuming no reverse leakage current losses.

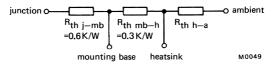
THERMAL RESISTANCE				
From junction to mounting base	R <sub>th j-mb</sub>	= "," ,"	0.6	K/W
From mounting base to heatsink with heatsink compound without heatsink compound	R <sub>th mb-h</sub> R <sub>th mb-h</sub>	=	0.3 0.5	K/W K/W
Transient thermal impedance; t = 1 ms	Z <sub>th j-mb</sub>	· =	0.072	K/W
CHARACTERISTICS				
Forward voltage				
$I_F = 50 \text{ A}; T_j = 100  {}^{\circ}\text{C}$	٧F	<	0.55	V*
I <sub>F</sub> = 150 A; T <sub>j</sub> = 25 °C	VF	<	0.9	V*
Rate of rise of reverse voltage VR = VRWMmax	dV <sub>R</sub>	<	1500	V/μs
Reverse current				
$V_R = V_{RWMmax}$ ; $T_j = 125$ °C Capacitance at $f = 1$ MHz	I <sub>R</sub>	<	250	mA
V <sub>R</sub> = 5 V; T <sub>j</sub> = 25 to 125 °C	$c_d$	typ.	2100	pF

<sup>\*</sup>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<sub>th j-a</sub> = R<sub>th j-mb</sub> + R<sub>th mb-h</sub> + R<sub>th h-a</sub>

To choose a suitable heatsink, the following information is required:

- (i) maximum operating ambient temperature
- (ii) duty cycle or form factor of forward current ( $\delta$  or a)
- (iii) average forward current
- (iv) crest working reverse voltage (VRWM)

The total power dissipation in the diode has two components:

P<sub>F</sub> — forward conduction dissipation

From the above it can be seen that:

Values for  $R_{th}$  j-mb and  $R_{th}$  mb-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 ( $\delta$ ) 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,  $(R_{th\ j-mb}+R_{th\ mb-h}+R_{th\ h-a})\times P_R$  must be less than 12 °C. If the calculated value of  $R_{th\ h-a}$  does not permit this, then it must be reduced (heatsink size increased or  $R_{th\ mb-h}$  improved) to enable this criterion to be met.

EXAMPLE: square-wave operation, using BYV22-35 and heatsink compound;

$$T_{amb} = 40 \text{ °C}; \delta = 0.5; I_{F(AV)} = 30 \text{ A}$$

V<sub>RWM</sub> = 12 V; voltage grade of device = 35 V

From data,  $R_{th j-mb} = 0.6 \text{ K/W}$  and  $R_{th mb-h} = 0.3 \text{ K/W}$ .

From Fig.4, it is found that  $P_F = 18 \text{ W}$ 

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:

$$R_{\text{th h-a}} = \frac{130 \text{ }^{\circ}\text{C} - 40 \text{ }^{\circ}\text{C}}{18 \text{ W} + 0.9 \text{ W}} - (0.6 + 0.3) = 3.9 \text{ K/W}$$

To check for thermal stability:

$$(R_{th i-a}) \times P_R = (0.6 + 0.3 + 3.9) \times 0.9 = 4.3 \text{ °C}.$$

This is less than 12 °C, hence thermal stability is ensured.



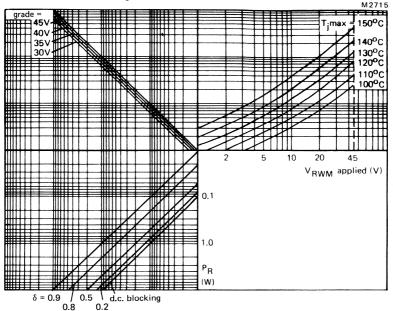
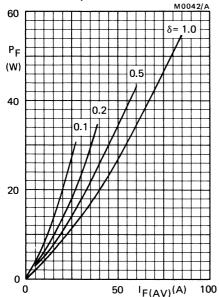


Fig.3 NOMOGRAM: for calculation of PR (reverse leakage power dissipation) for a given  $\mathsf{T}_j$  max.,  $\mathsf{V}_{RWM}$  applied, voltage grade and duty cycle.



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

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

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

$$\sqrt{\delta}$$

Fig.4.

## SINE-WAVE OPERATION (Figs.5 and 6)

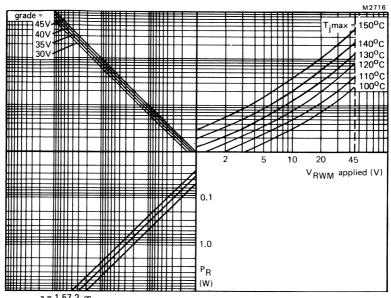


Fig.5 NOMOGRAM: for calculation of P<sub>R</sub> (reverse leakage power dissipation) for a given T<sub>j</sub> max., V<sub>RWM</sub> applied, voltage grade and form factor.

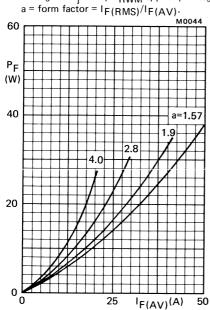


Fig.6.

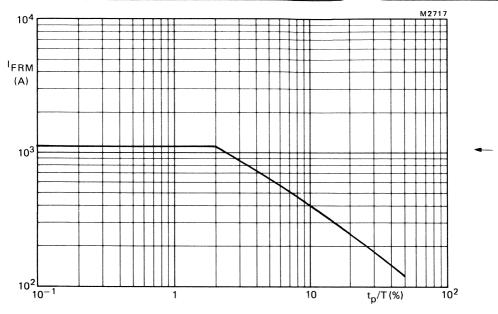
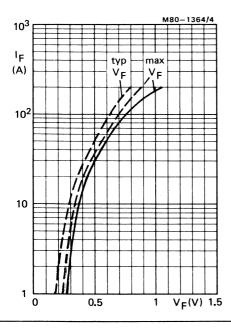
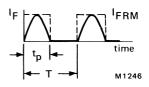


Fig.7 Maximum permissible repetitive peak forward current for either square or sinusoidal currents for 1  $\mu s < t_p < 1$  ms.

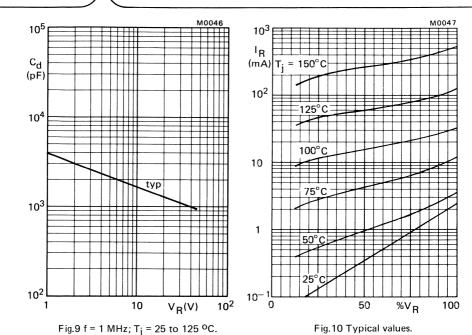




Definition of  $I_{FRM}$  and  $t_p/T$ .

Fig.8 —— 
$$T_j = 25 \, {}^{o}\text{C}; --- T_j = 100 \, {}^{o}\text{C}.$$

 $Z_{th\ j-mb}$ 



1 10<sup>-1</sup> 10<sup>-2</sup>

 $10^{-2}$ 

Fig.11 Transient thermal impedance.

 $10^{-1}$ 

M80-1364/5

time (s) 10

 $10^{-4}$ 

10<sup>-3</sup> \_\_\_

# 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

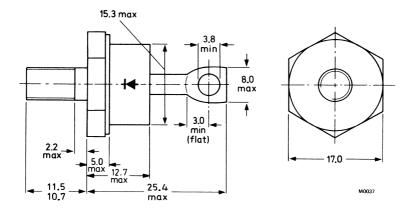
			BYV23-30	35	40(A)	45	
Repetitive peak reverse voltage	$v_{RRM}$	max.	30	35	40	45	٧
Average forward current	IF(AV)	max.			30		Α
Forward voltage	VF	<		0.5	55		V
Junction temperature	$T_{j}$	max.		15	50		οС

### MECHANICAL DATA

Dimensions in mm

Fig.1 DO-5 with  $\frac{1}{4}$ " x 28 UNF stud ( $\phi$ 6.35 mm)

Types with metric M6 stud ( $\phi$ 6 mm) are available on request; e.g. BYV23-30M.



Net mass: 22 q

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

# **BYV23 SERIES**

### **RATINGS**

Voltages

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

					(,		
Non-repetitive peak reverse voltage	V <sub>RSM</sub>	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 <sub>RWM</sub>	max.	30	35	40	45	V
Continuous reverse voltage	VR	max.	30	35	40	45	V
➤ Currents							
Average forward current square wave; $\delta = 0.5$ ;							
up to T <sub>mb</sub> = 115 °C (note 2) sinusoidal:	<sup>I</sup> F(AV)	max.			80		Α
up to $T_{mb}$ = 116 °C (note 2)	l <sub>F(AV)</sub>	max.			70		Α
R.M.S. forward current	IF(RMS)	max.			113		Α
Repetitive peak forward current $t_p = 20 \mu s$ ; $\delta = 0.02$	FRM	max.		1	1500		Α
Non-repetitive peak forward current half sine-wave; T <sub>j</sub> = 125 <sup>o</sup> C prior to surge; with reapplied V <sub>RWMmax</sub>							
t = 10 ms	<sup>I</sup> FSM	max.		1	500		Α
t = 8.3 ms	IFSM	max.		1	650		Α
$I^2$ t for fusing (t = 10 ms)	l² t	max.		11	250		$A^2s$
Reverse surge current (BYV23-40A only) $t_p = 100 \ \mu s$	IRSM	max.			2.0		Α
Temperatures							
Storage temperature	T <sub>stg</sub>		_	55 to +	150		оС
Junction temperature	Tj	max.			150		oC

BYV23-30 | 35 | 40(A) | 45

### 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.

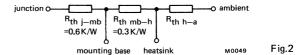
THERMAL RESISTANCE				
From junction to mounting base	R <sub>th j-mb</sub>		0.6	K/W
From mounting base to heatsink with heatsink compound without heatsink compound	R <sub>th mb-h</sub> R <sub>th mb-h</sub>	= 2, 1	0.3 0.5	K/W K/W
Transient thermal impedance; t = 1 ms	Z <sub>th j-mb</sub>	=	0.07	K/W
CHARACTERISTICS				
Forward voltage				
$I_F = 70 \text{ A}; T_j = 100 ^{\circ}\text{C}$	VF	<	0.55	V*
I <sub>F</sub> = 200 A; T <sub>j</sub> = 25 °C	VF	<	0.95	V*
Rate of rise of reverse voltage •				
$V_R = V_{RWMmax}$	$\frac{dV_R}{dt}$	<	1500	V/µs
Reverse current				
$V_R = V_{RWMmax}$ ; $T_j = 125  {}^{\circ}C$	<sup>I</sup> R	<	350	mΑ
Capacitance at $f = 1 \text{ MHz}$ $V_R = 5 \text{ V}$ ; $T_j = 25 \text{ to } 125 ^{\circ}\text{C}$	c <sub>d</sub>	typ.	2500	pF

<sup>\*</sup>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<sub>th j-a</sub> = R<sub>th j-mb</sub> + R<sub>th mb-h</sub> + R<sub>th h-a</sub>

To choose a suitable heatsink, the following information is required:

- (i) maximum operating ambient temperature
- (ii) duty cycle or form factor of forward current ( $\delta$  or a)
- (iii) average forward current
- (iv) crest working reverse voltage (VRWM)

The total power dissipation in the diode has two components:

P<sub>F</sub> — forward conduction dissipation

From the above it can be seen that:

$$R_{\text{th h-a}} = \frac{T_{\text{jmax}} - T_{\text{amb}}}{P_{\text{R}} + P_{\text{F}}} - (R_{\text{th j-mb}} + R_{\text{th mb-h}}) \dots 2).$$

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 ( $\delta$ ) 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,  $(R_{th\ j-mb}+R_{th\ mb-h}+R_{th\ h-a}) \times P_R$  must be less than 12 °C. If the calculated value of  $R_{th\ h-a}$  does not permit this, then it must be reduced (heatsink size increased or  $R_{th\ mb-h}$  improved) to enable this criterion to be met.

EXAMPLE: square-wave operation, using BYV23-35 and heatsink compound;

$$T_{amb}$$
 = 40 °C;  $\delta$  = 0.5;  $I_{F(AV)}$  = 50 A  
V<sub>RWM</sub> = 12 V; voltage grade of device = 35 V

From data,  $R_{th i-mb} = 0.6 \text{ K/W}$  and  $R_{th mb-h} = 0.3 \text{ K/W}$ .

From Fig.4, it is found that  $P_F = 35 \text{ W}$ 

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:

$$R_{\text{th h-a}} = \frac{140 \, ^{\circ}\text{C} - 40 \, ^{\circ}\text{C}}{35 \, \text{W} + 2.4 \, \text{W}} - (0.6 + 0.3) = 1.8 \, \text{K/W}$$

To check for thermal stability:

$$(R_{th j-a}) \times P_R = (0.6 + 0.3 + 1.8) \times 2.4 = 6.5 \text{ °C}.$$

This is less than 12 °C, hence thermal stability is ensured.



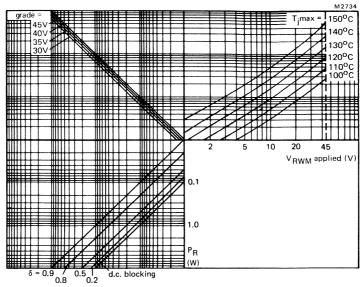
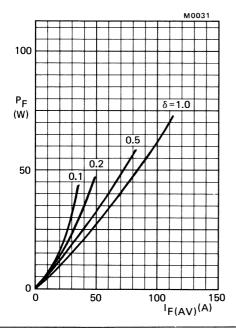
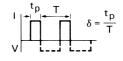


Fig.3 NOMOGRAM: for calculation of  $P_R$  (reverse leakage power dissipation) for a given  $T_{jmax}$ .  $V_{RWM}$  applied, voltage grade and duty cycle.





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

SINE-WAVE OPERATION (Figs.5 and 6)

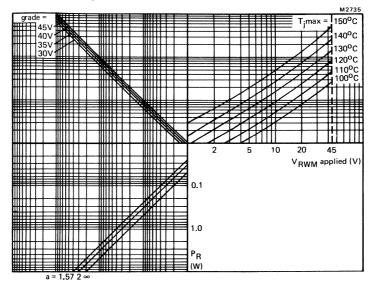


Fig.5 NOMOGRAM: for calculation of  $P_{\hbox{\scriptsize R}}$  (reverse leakage power dissipation) for a given  $T_{\hbox{\scriptsize jmax}}$  ,  $V_{\hbox{\scriptsize RWM}}$  applied, voltage grade and form factor.

 $a = form factor = I_F(RMS)/I_F(AV)$ .

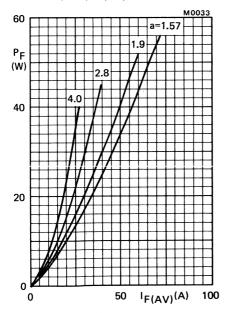


Fig.6

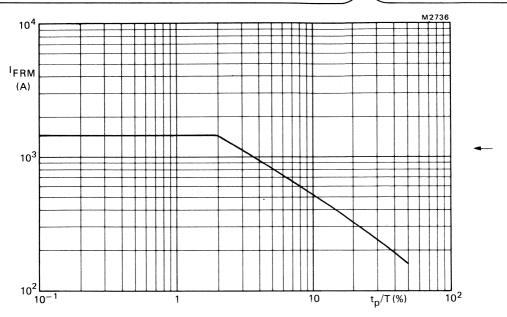
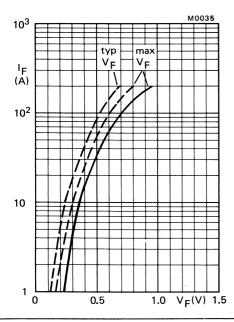
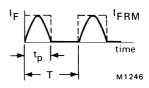


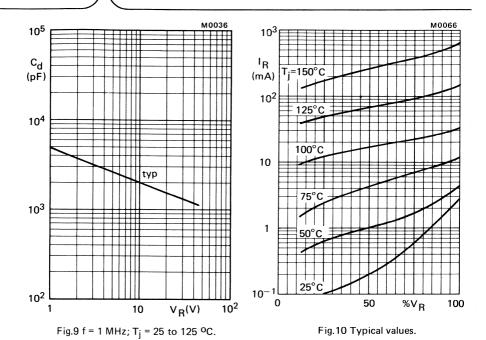
Fig.7 Maximum permissible repetitive peak forward current for either square or sinusoidal current for 1  $\mu s < t_p < 1$  ms.

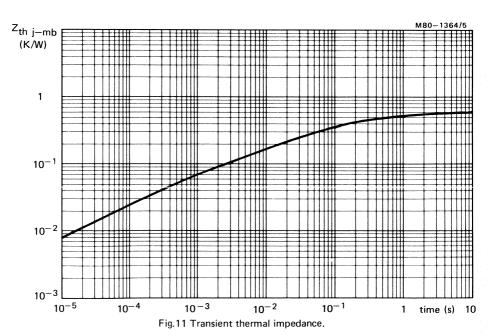




Definition of  $I_{\mbox{\scriptsize FRM}}$  and  $t_p/T.$ 

Fig.8 —-- 
$$T_j = 25$$
 °C;  $--- T_j = 100$  °C.





### 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.

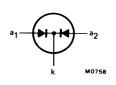
### QUICK REFERENCE DATA

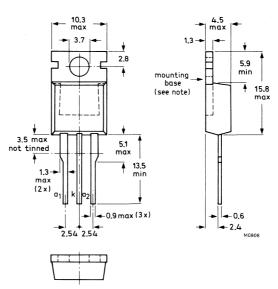
Per diode, unless otherwise stated			BYV33-30	35	40(A)	45	
Repetitive peak reverse voltage	$v_{RRM}$	max.	30	35	40	45	V
			-				
Average forward current						•	
(both diodes conducting)	lF(AV)	max.			Α		
Forward voltage	$V_{F}$	<		V			
Junction temperature	$T_{j}$	max.	150				oC

### **MECHANICAL DATA**

Dimensions in mm

Fig.1 TO-220AB





Net mass: 2 q

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.

# **BYV33 SERIES**

### **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)	VRWM	max.	30	35	40	45	V
	Continuous reverse voltage (note 1)	VR	max.	30	35	40	45	٧
-	Currents (both diodes conducting; note 2)							
	Output current: square-wave; $\delta = 0.5$ ;	1-				20		A
	up to $T_{mb}$ = 122 °C (note 3) sinusoidal; up to $T_{mb}$ = 124 °C (note 3)	10 10	max.			18		A
	R.M.S. foward current	IF(RMS)	max.			28		Α
	Repetitive peak forward current $t_p = 20 \mu s$ , $\delta = 0.02$ (per diode)	I <sub>FRM</sub>	max.			200		Α
	Non-repetitive peak forward current (per diode) half sine-wave; $T_j = 125$ °C prior to surge; with reapplied $V_{RWMmax}$							
	t = 10 ms t = 8.3 ms	FSM	max.			200		A
		IFSM	max.			220		A A <sup>2</sup> s
	$I^2$ t for fusing (t = 10 ms; per diode)	l² t	max.			200		A-s
	Reverse surge current (BYV33–40A only) $t_p = 100 \mu s$	<sup>I</sup> RSM	max.			0.5		Α
	Temperatures							
	Storage temperature	$T_{stg}$			40 to	+150		oC
	Junction temperature	Тj	max.			150		оС

### Notes:

- 1. Up to  $T_i$  = 125  $^{\rm o}$ C; see derating curve for higher temperature operation.
- 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 <sub>F</sub> = 7 A; T <sub>j</sub> = 100 <sup>o</sup> C I <sub>F</sub> = 20 A; T <sub>j</sub> = 25 <sup>o</sup> C	V <sub>F</sub>	<	0.6	V*
I <sub>F</sub> = 20 A; T <sub>j</sub> = 25 °C	٧F	<	1.0	V*
Reverse current				
$V_R = V_{RWMmax}$ ; $T_j = 125  {}^{\circ}\text{C}$	l <sub>R</sub>	<	40	mA 🔫
Junction capacitance at f = 1 MHz				
$V_R = 5 V$ ; $T_j = 25 \text{ to } 125 ^{\circ}\text{C}$	$c_d$	typ.	300	pF
THERMAL RESISTANCE				
From junction to mounting base (both diodes conducting)	R <sub>th j-mb</sub>	-	1.6	K/W
From junction to mounting base (per diode)	R <sub>th j-mb</sub>	=	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 <sub>th mb-h</sub>	=	0.2	K/W
b. with heatsink compound and 0.06 mm maximum mica				
insulator	R <sub>th mb-h</sub>	=	1.4	K/W
c. with heatsink compound and 0.1 mm maximum mica				
insulator (56369)	R <sub>th mb-h</sub>	==	2.2	K/W
d. with heatsink compound and 0.25 mm maximum				
alumina insulator (56367)	R <sub>th mb-h</sub>	=	8.0	K/W
e. without heatsink compound	R <sub>th mb-h</sub>	=	1.4	K/W
2. Free air operation				
The quoted values of $R_{th\ j-a}$ should be used only when no le	ads of other diss	sipating co	omponen	ts 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

60

R<sub>th j-a</sub>

K/W

<sup>\*</sup>Measured under pulse conditions to avoid excessive dissipation.

#### MOUNTING INSTRUCTIONS

- 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.
- The leads should not be bint less than 2.4 mm from the seal, and should be supported during bending. The bending must be no less than 1.0 mm.
  - 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<sub>th mb-h</sub> values than does
    - 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<sub>th mb-h</sub> given for mounting with heatsink compound refer to the use of a metallic oxide-loaded compound. Ordinary silicone grease is not recommended.
  - 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**

screw mounting.

Dissipation and heatsink calculations.

The various components of junction temperature rise above ambient are illustrated in Fig.2.

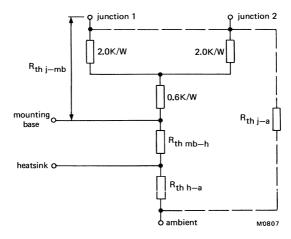


Fig.2.

#### **OPERATING NOTES**

Dissipation and heatsink calculations (continued)

Overall thermal resistance, Rth j-a = Rth j-mb + Rth mb-h + Rth h-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 ( $\delta$  or a)
- (iii) average forward current per diode
- (iv) crest working reverse voltage (VRWM)

The total power dissipation in the diode has two components:

From the above it can be seen that:

$$R_{th \ h-a} = \frac{T_{jmax} - T_{amb}}{P_F + P_R} - (R_{th \ j-mb} + R_{th \ mb-h}) \dots 2).$$

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:

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  $R_{th\ j-mb}$  = 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  $R_{th\ j-mb}$  of 2.6 K/W.

To ensure thermal stability,  $(R_{th} j_{-mb} + R_{th} m_{b-h} + R_{th} m_{b-h}) \times P_R$  must be less than 12 °C. If the calculated value of  $R_{th} m_{b-h}$  does not permit this, then it must be reduced (heatsink size increased or  $R_{th} m_{b-h}$  improved) to enable this criterion to be met.

EXAMPLE: square-wave operation, using BYV33-35 and heatsink compound;

 $T_{amb} = 50 \, {}^{\circ}\text{C}; \, \delta \, (\text{diode 1}) = 0.5; \, \delta \, (\text{diode 2}) = 0.5;$ 

 $I_{F(AV)}$  (diode 1) = 7 A;  $I_{F(AV)}$  (diode 2) = 7 A;

V<sub>RWM</sub> (both diodes) = 12 V; voltage grade of device = 35 V.

From data,  $R_{th j-mb} = 1.6 \text{ K/W}$  and  $R_{th mb-h} = 0.2 \text{ K/W}$ .

For each diode from Fig.4, it is found that  $P_F = 5.5 \text{ W}$ ;

hence total  $P_F = 2 \times 5.5 = 11 \text{ W}$ . (from equation 4)

If the desired  $T_{j \text{ max}}$  is chosen to be 130 °C, then, from Fig.3,  $P_{R}$  (per diode) = 0.17W

Therefore total  $P_R = 2 \times 0.17 = 0.34 \text{ W}$ . (from equation 3)

Using equation 2) we have:

$$R_{th h-a} = \frac{130 \text{ °C} - 50 \text{ °C}}{11 \text{ W} + 0.34 \text{ W}} - (1.6 + 0.2) = 5.3 \text{ K/W}$$

To check for thermal stability:

$$(R_{th i-a}) \times P_R = (1.6 + 0.2 + 5.3) \times 0.34 = 2.4 \text{ °C}.$$

This is less than 12 °C, hence thermal stability is ensured.

## SQUARE-WAVE OPERATION (Figs.3 and 4)

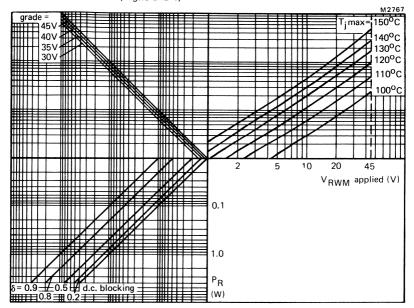
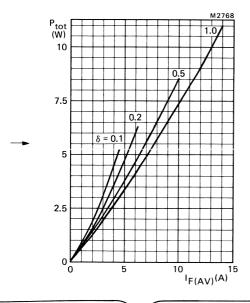


Fig.3 NOMOGRAM: for calculation of  $P_R$  (reverse leakage power dissipation) for a given  $T_j$ max.,  $V_{RWM}$  applied, voltage grade and duty cycle (per diode).



$$\begin{array}{c|c} I & T & \delta = \frac{t_p}{T} \\ V & & \delta = \frac{t_p}{T} \end{array}$$

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



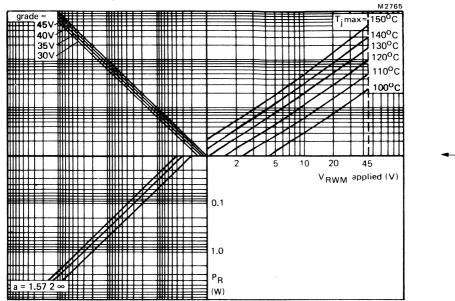


Fig.5 NOMOGRAM: for calculation of  $P_R$  (reverse leakage power dissipation) for a given  $T_j$ max.,  $V_{RWM}$  applied, voltage grade and form factor (per diode).

 $a = form factor = I_F(RMS)/I_F(AV)$ 

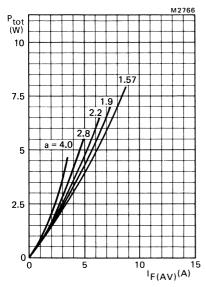


Fig.6.

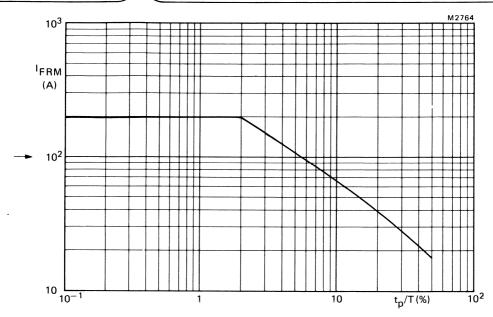
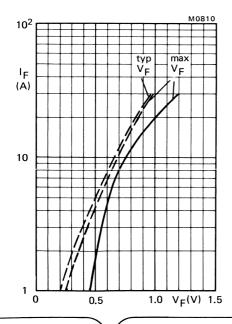
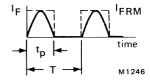


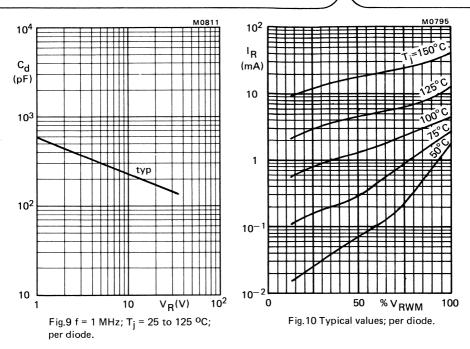
Fig.7 Maximum permissible repetitive peak forward current for either square or sinusoidal currents for 1  $\mu s < t_D < 1$  ms.





Definition of I  $_{\mbox{\scriptsize FRM}}$  and  $t_p/T.$ 

Fig.8 — 
$$T_j = 25 \, {}^{o}C; --- T_j = 100 \, {}^{o}C;$$
 per diode.



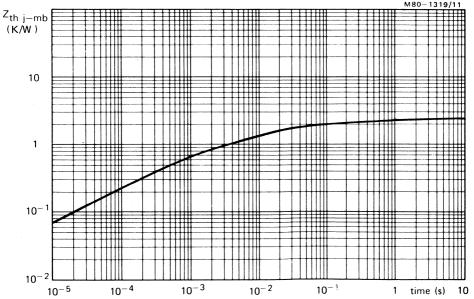


Fig.11 Transient thermal impedance; one diode conducting.



# 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.

#### OUICK REFERENCE DATA

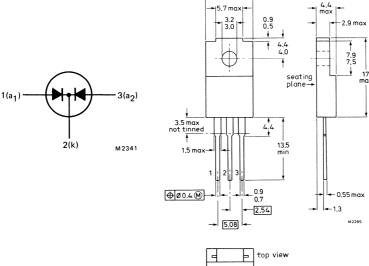
QUICK REFERENCE DATA							
Per diode, unless otherwise stated		BYV33	F-30	35	40(A) 45		
Repetitive peak reverse voltage	$v_{RRM}$	max.	30	35	40	45	V
Output current (both diodes conducting)	I <sub>O</sub>	max.			20		Α
Forward voltage	٧ <sub>F</sub>	<			0.6		V
Junction temperature	$T_{j}$	<			150		oC

10.2 max

#### **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).

## **BYV33F SERIES**

#### 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	٧
Crest working reverse voltage (note 1)	$V_{RWM}$	max.	30	35	40	45	٧
Continuous reverse voltage (note 1)	$v_R$	max.	30	35	40	45	٧
Currents (both diodes conducting; notes 2 and 4)				•	_		
Output current:							
square wave; $\delta = 0.5$ ; up to							_
$T_h = 65$ °C (note 3)	IO	max.			20		A
sinusoidal; up to $T_h = 71$ °C (note 3)	10	max.			18		Α
R.M.S. forward current	IF(RMS)	max.			28		Α
Repetitive peak forward current							
$t_p = 20 \mu s;  \delta = 0.02 (per diode)$	<sup> </sup> FRM	max.			200		Α
Non-repetitive peak forward current (per diode) half sine-wave; $T_j = 150$ °C prior to							
surge; with reapplied VRWM max							
t = 10 ms	<sup>I</sup> FSM	max.			150		A
t = 8.3 ms	<sup>I</sup> FSM	max.			165		Α
$I^2$ t for fusing (t = 10 ms, per diode)	l²t	max.			112		A²s
Reverse surge current (BYV33F-40A only)							
$t_p = 100 \mu s$	IRSM	max.			0.5		Α
Temperatures							
Storage temperature	$T_{stg}$		_	-40 to	+150		οС
Junction temperature	Тj	max.			150		oC
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		рF

#### Notes:

- 1. Up to  $T_j$  = 125 °C; see derating curve for higher temperature operation.
- 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.

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

		_		Periodo de la companya del companya della companya
CHARACTERISTICS (per diode)				
T <sub>i</sub> = 25 °C unless otherwise stated				
Forward voltage				
$I_F = 7 \text{ A}; T_j = 100 ^{\circ}\text{C}$	VF	<	0.6	V*
1 <sub>F</sub> = 20 A	VF	<	1.0	V*
Reverse current				
$V_R = V_{RWM max}$ ; $T_j = 125  {}^{\circ}C$	<sup>I</sup> R	<	40	mΑ
Junction capacitance at f = 1 MHz				
$V_R = 5 V; T_j = 25  {}^{\circ}\text{C} \text{ to } 125  {}^{\circ}\text{C}$	Cj	typ.	300	рF
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 <sub>th j-h</sub>	=	5.0	K/W
without heatsink compound	R <sub>th j-h</sub>	=	7.0	K/W
b. per diode:	_			
with heatsink compound	R <sub>th j-h</sub>	=	6.0	K/W
without heatsink compound	R <sub>th j-h</sub>	=	8.0	K/W
Free air operation				
The quoted value of $R_{\mbox{\scriptsize th}}$ $_{\mbox{\scriptsize j-h}}$ should be used only when no least the same tie point.	ds of other di	ssipating co	mponents	run to

R<sub>th j-a</sub>

55

K/W

<sup>\*</sup>Measured under pulse conditions to avoid excessive dissipation.

#### MOUNTING INSTRUCTIONS

- 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<sub>th j-h</sub> 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:

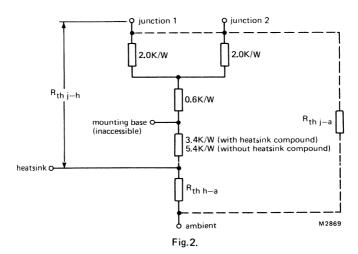
  Maximum torque to avoid damage to the device:

  5.5 kgf (0.55 Nm)

  8.0 kgf (0.80 Nm)
- 5. For good thermal contact, heatsink compound should be used between baseplate and heatsink. Values of R<sub>th j-h</sub> 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.
- 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.



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

#### **OPERATING NOTES**

Dissipation and heatsink calculations (continued)

Overall thermal resistance, Rth j-a = Rth j-h + Rth h-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 ( $\delta$  or a)
- (iii) average forward current per diode
- (iv) crest working reverse voltage (VRWM)

The total power dissipation in the diode has two components:

P<sub>B</sub> - reverse leakage dissipation

PF - forward conduction dissipation

From the above it can be seen that:

The value of  $R_{th\ j-h}$  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:

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).

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  $R_{th\ j-h} = 5\ K/W$  (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  $R_{th}$   $_{j-h}$  of 6 K/W (with heatsink compound) or 8 K/W (without heatsink compound).

To ensure thermal stability, (R<sub>th j-h</sub> + R<sub>th h-a</sub>) x P<sub>R</sub> must be less than 12  $^{o}$ C. If the calculated value of R<sub>th h-a</sub> does not permit this, then it must be reduced (heatsink size increased or R<sub>th j-a</sub> improved) to enable this cirterion to be met.

EXAMPLE: square wave operation, using BYV33F-35 and heatsink compound;

 $T_{amb} = 40 \text{ °C}; \delta \text{ (diode 1)} = 0.5; \delta \text{ (diode 2)} = 0.5;$ 

 $I_{F(AV)}$  (diode 1) = 7 A;  $I_{F(AV)}$  (diode 2) = 7 A;

V<sub>RWM</sub> (both diodes) = 12 V; voltage grade of device = 35 V.

From data,  $R_{th i-h} = 5 \text{ K/W}$ .

For each diode from Fig.4, it is found that  $P_F = 5.5 \text{ W}$ ;

hence total  $P_F = 2 \times 5.5 = 11 \text{ W}$ . (from equation 4)

If the desired  $T_{imax}$  is chosen to be 130 °C, then, from Fig.3,  $P_R$  (per diode) = 0.17 W.

Therefore total  $P_R = 2 \times 0.17 = 0.34 \text{ W}$ . (from equation 3)

Using equation 2) we have:

$$R_{\text{th h-a}} = \frac{130 \text{ }^{\circ}\text{C} - 40 \text{ }^{\circ}\text{C}}{11 \text{ W} + 0.34 \text{ W}} - (5.0) = 2.9 \text{ K/W}$$

To check for thermal stability:

$$(R_{th j-a}) \times P_R = (5.0 + 2.9) \times 0.34 = 2.69 \text{ °C}.$$

This is less than 12 °C, hence thermal stability is ensured.



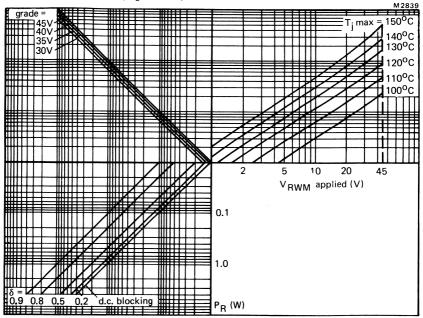
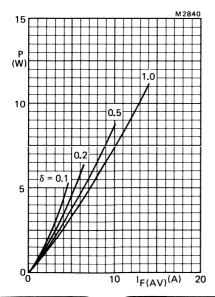


Fig.3 NOMOGRAM: for calculation of  $P_R$  (reverse leakage power dissipation) for a given  $T_j$ max.,  $V_{RWM}$  applied, voltage grade and duty cycle (per diode).



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

Fig.4.



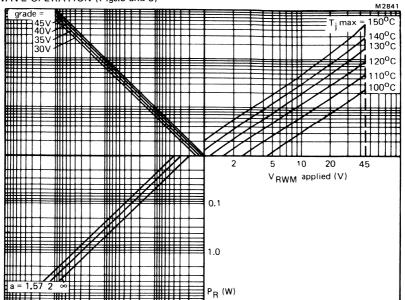


Fig.5 NOMOGRAM: for calculation of  $P_R$  (reverse leakage power dissipation) for a given  $T_j$ max.,  $V_{RWM}$  applied, voltage grade and form factor (per diode).

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

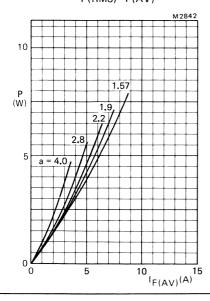


Fig.6.

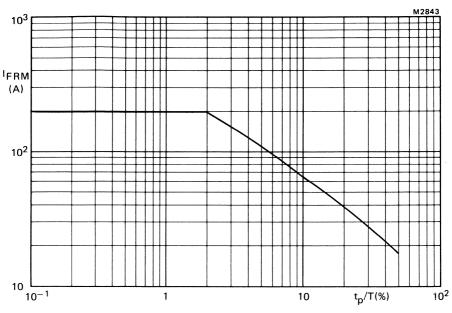
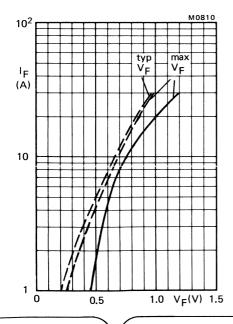
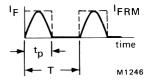


Fig.7 Maximum permissible repetitive peak forward current for either square or sinusoidal currents for 1  $\mu$ s < t $_p$  < 1 ms, per diode.





Definition of I  $_{\mbox{FRM}}$  and  $t_{\mbox{\footnotesize p}}/\mbox{T}.$ 

Fig.8 — 
$$T_j = 25$$
 °C;  $---T_j = 100$  °C; per diode.

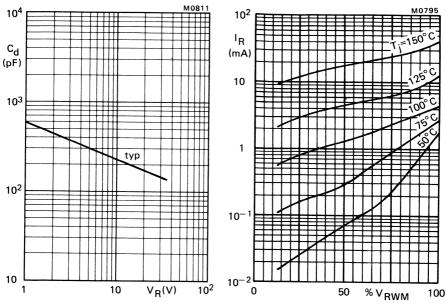


Fig.9 f = 1 MHz;  $T_j$  = 25 to 125 °C; per diode.

Fig. 10 Typical values; per diode.

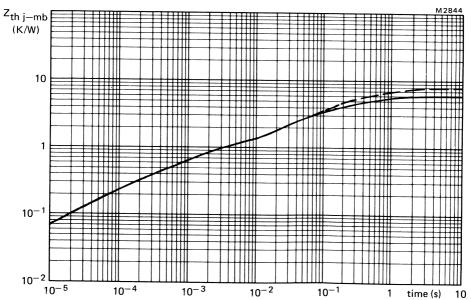


Fig.11 Transient thermal impedance; one diode conducting; —— with heatsink compound; — — without heatsink compound.

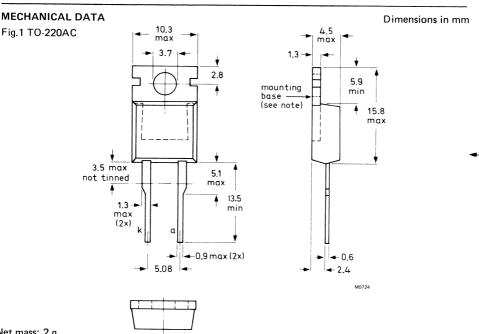


## SCHOTTKY-BARRIER RECTIFIER DIODES

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 <sub>F(AV)</sub>	max.			16		Α
Forward voltage	VF	<			0.6		V
Junction temperature	$T_{j}$	max.			150		oC



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.

## **BYV39 SERIES**

#### **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 <sub>.</sub>
	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 $^{o}$ C (note 2) sinusoidal; up to $T_{mb}$ = 124 $^{o}$ C (note 2)	I <sub>F(AV)</sub> I <sub>F(AV)</sub>	max.			16 12.5		A A
	R.M.S. forward current	<sup>I</sup> F(RMS)	max.			22		Α
	Repetitive peak forward current $t_p = 20 \mu s$ ; $\delta = 0.02$	<sup>I</sup> FRM	max.			260		Α
	Non-repetitive peak forward current half sine-wave; T <sub>j</sub> = 125 <sup>O</sup> C prior to surge; with reapplied V <sub>RWM max</sub>							
	t = 10 ms	<sup>I</sup> FSM	max.			150		Α
	t = 8.3 ms	<sup>I</sup> FSM	max.			165		Α
	$I^2$ t for fusing (t = 10 ms)	l² t	max.			112		$A^2$ s
	Reverse surge current (BYV39–40A only) $t_p = 100 \mu s$	<sup>I</sup> RSM	max.			1.0		Α
	Temperatures							
	Storage temperature	$T_{stg}$		-	-40 to	+150		оС
	Junction temperature	$T_{j}$	max.			150		оС
	CHARACTERISTICS							
	Forward voltage					0.0		.,
	$I_F = 15 \text{ A; T}_j = 100 ^{\circ}\text{C} \text{ (note 3)}$	٧ <sub>F</sub>	<			0.6		V
	$I_F = 40 \text{ A; T}_j = 25 ^{\circ}\text{C (note 3)}$	٧ <sub>F</sub>	<			1.0		V
	Reverse current							
-	$V_R = V_{RWM max}$ ; $T_j = 125  {}^{O}C$	I <sub>R</sub>	<			55		mA
	Junction capacitance at $f = 1MHz$ $V_R = 5 V; T_i = 25 \text{ to } 125 ^{O}C$	c <sub>d</sub>	typ.			520		pF

#### Notes:

- 1. Up to  $T_j$  = 125  $^{\rm O}$ C; see derating curve for higher temperature operation.
- 2. Assuming no reverse leakage current losses.
- 3. Measured under pulse conditions to avoid excessive dissipation.

THE	<b>ERM</b>	ΔII	RESI	STA	NCF

From junction to mounting base	R <sub>th j-mb</sub>	=	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 <sub>th mb-h</sub>	=	0.5	K/W
<ul> <li>with heatsink compound and 0.06 mm maximum mica insulator</li> </ul>	R <sub>th mb-h</sub>	=	1.4	K/W
c. with heatsink compound and 0.1 mm maximum mica insulator (56369)	R <sub>th mb-h</sub>	_	2.2	K/W
<li>with heatsink compound and 0.25 mm maximum alumina insulator (56367)</li>	R <sub>th mb-h</sub>	=	0.8	K/W
e. without heatsink compound	R <sub>th mb-h</sub>	=	1.4	K/W

#### 2. Free air operation

The quoted values of  $R_{th\ j-a}$  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

 $R_{th i-a} = 60 \text{ K/W}$ 

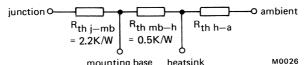
#### MOUNTING INSTRUCTIONS

- 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.
- 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  $R_{\mbox{\footnotesize{th}}\mbox{\footnotesize{mb-h}}}$  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<sub>th mb-h</sub> given for mounting with heatsink compound refer to the use of a metallic oxide-loaded compound. Ordinary silicone grease is not recommended.
- 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:



Overall thermal resistance, R<sub>th j-a</sub> = R<sub>th j-mb</sub> + R<sub>th mb-h</sub> + R<sub>th h-a</sub>

To choose a suitable heatsink, the following information is required:

- (i) maximum operating ambient temperature
- (ii) duty cycle or form factor of forward current ( $\delta$  or a)
- (iii) average forward current
- (iv) crest working reverse voltage (VRWM)

The total power dissipation in the diode has two components:

Fig.2

P<sub>F</sub> - forward conduction dissipation

From the above it can be seen that:

Values for R<sub>th j-mb</sub> and R<sub>th mb-h</sub> can be found under Thermal Resistance. P<sub>R</sub> and P<sub>F</sub> 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<sub>RWM</sub> axis of Fig.3 (or Fig.5), and from a knowledge of the required V<sub>RWM</sub>, trace upwards to meet the curve that matches the required Timax. 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 ( $\delta$ ) or form factor (a). From this point trace right and read the actual reverse power dissipation on the PR axis.

Forward conduction dissipation (PF) for the known average current IF(AV) and duty cycle (or form factor) is easily derived from Fig.4 (or Fig.6).

Substituting the values of PR and PF into equation 2) enables the calculation of the required heatsink.

To ensure thermal stability, (R<sub>th j-mb</sub> + R<sub>th mb-h</sub> + R<sub>th h-a</sub>) x P<sub>R</sub> must be less than 12 °C. If the calculated value of Rth h-a does not permit this, then it must be reduced (heatsink size increased or Rth mb-h improved) to enable this criterion to be met.

square-wave operation, using BYV39-35 and heatsink compound; **EXAMPLE:** 

$$\begin{split} T_{amb} &= 50 \text{ °C}; \ \delta = 0.5; \ I_{F(AV)} = 12 \text{ A} \\ V_{RWM} &= 12 \text{ V}; \ \text{voltage grade of device} = 35 \text{ V} \\ \text{From data, } R_{th \ j-mb} = 2.2 \text{ K/W} \ \text{and } R_{th \ mb-h} = 0.5 \text{ K/W}. \end{split}$$

From Fig.4, it is found that PF = 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:

$$R_{\text{th h-a}} = \frac{130 \text{ °C} - 50 \text{ °C}}{9.2 \text{ W} + 0.23 \text{ W}} - (2.2 + 0.5) = 5.8 \text{ K/W}$$

To check for thermal stability:

$$(R_{th j-a}) \times P_R = (2.2 + 0.5 + 5.8) \times 0.23 = 2 \, ^{O}C.$$

This is less than 12 °C, hence thermal stability is ensured.

## SQUARE-WAVE OPERATION (Figs 3 and 4)

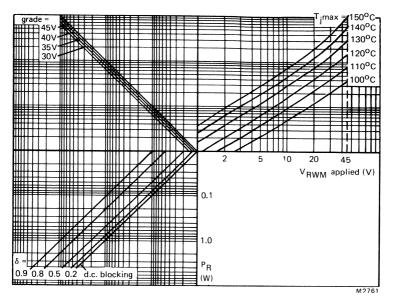
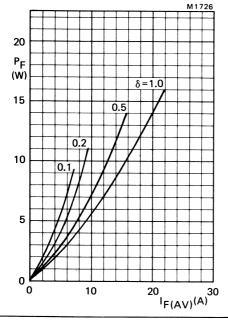


Fig.3 NOMOGRAM: for calculation of  $P_R$  (reverse leakage power dissipation) for a given  $T_j$ max.,  $V_{RWM}$  applied, voltage grade and duty cycle.



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

$$\int_{V}^{T} \int_{V}^{T} \int_{V}^{T} dt dt$$

$$\int_{V}^{T} \int_{V}^{T} \int_{V}^{T}$$

### SINUSOIDAL OPERATION (Figs.5 and 6)

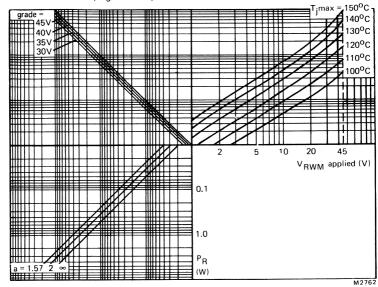


Fig.5 NOMOGRAM: for calculation of  $P_R$  (reverse leakage power dissipation) for a given  $T_j$ max.,  $V_{RWM}$  applied, voltage grade and form factor.

 $a = form factor = I_F(RMS)/I_F(AV)$ 

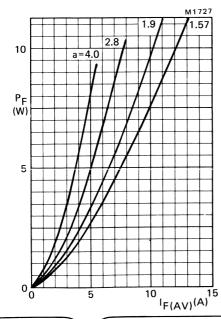


Fig.6

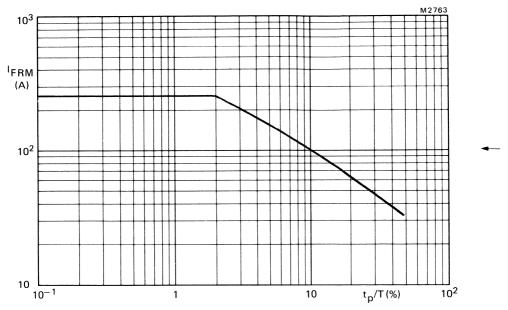
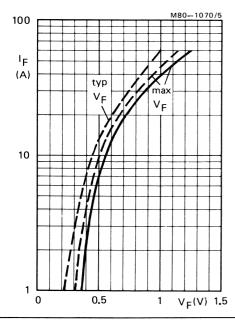


Fig.7 Maximum permissible repetitive peak forward current for either square or sinusoidal currents for 1  $\mu s < t_p < 1$  ms.



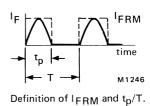


Fig.8 ——  $T_j = 25 \, {}^{\circ}\text{C}; --- T_j = 100 \, {}^{\circ}\text{C}$ 

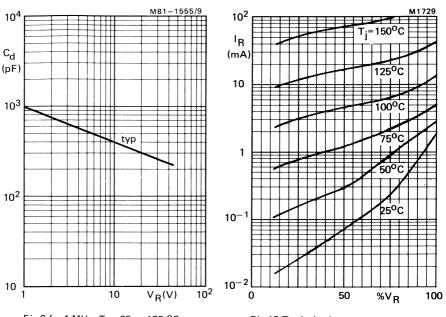


Fig.9 f = 1 MHz;  $T_i$  = 25 to 125 °C

Fig. 10 Typical values

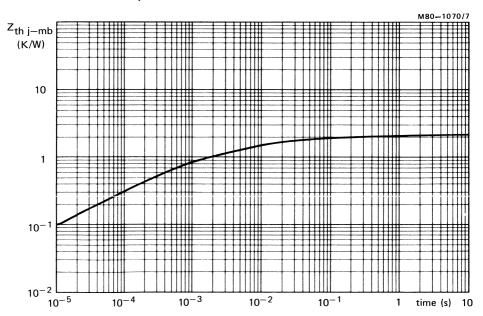


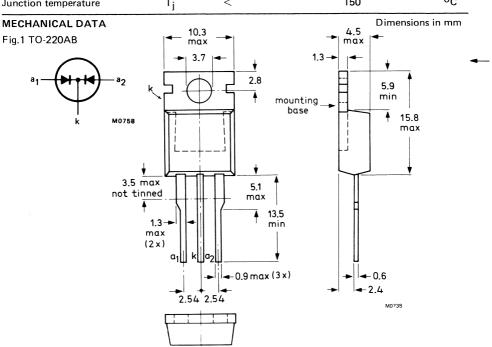
Fig.11 Transient thermal impedance

## 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			BYV43-3	0	35	40(A)	45	
Repetitive peak reverse voltage	$V_{RRM}$	max.	3	0	35	40	45	V
Output current (both diodes conducting)	Io	max.			30		_	Α
Forward voltage	٧F	<			0.6			V
Junction temperature	Τį	<			150			оС



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.

## BYV43 SERIES

#### **RATINGS**

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

-	Voltages (per diode)		BYV43-	30	35	40(A)	45	٧
	Repetitive peak reverse voltage	$v_{RRM}$	max.	30	35	40	45	٧
	Crest working reverse voltage (note 1)	V <sub>RWM</sub>	max.	30	35	40	45	V
	Continuous reverse voltage (note 1)	v <sub>R</sub>	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)	l <sub>o</sub>	max.			30		А
	R.M.S. forward current	I <sub>F(RMS)</sub>	max.			40		Α
	Repetitive peak forward current $t_p = 20 \mu\text{s}$ , $\delta = 0.02$ (per diode)	I <sub>FRM</sub>	max.			250		Α
	Non-repetitive peak forward current (per diode) half sine-wave; $T_j$ = 125 $^{\rm O}$ C prior to surge; with reapplied $V_{RWM}$ max							
	t = 10 ms	I <sub>FSM</sub>	max.			200		Α
	t = 8.3  ms	<sup>I</sup> FSM	max.			220		Α
	$I^2$ t for fusing (t = 10 ms, per diode)	l² t	max.			200		$A^2 s$
	Reverse surge current (BYV43-40A only) $t_p = 100 \mu s$	<sup>I</sup> RSM	max.			0.5		Α
	Temperatures							
	Storage temperature	$T_{stg}$		_	40 to	+150		οС
	Junction temperature	Tj	max.			150		oC

#### Notes:

- 1. Up to  $T_{\hat{i}}$  = 125  $^{\rm O}$ C; see derating curve for higher temperature operation.
- 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 <sub>F</sub>	<	0.6	V*
$I_F = 30 \text{ A}; T_j = 25 ^{\circ}\text{C}$	V <sub>F</sub>	<	0.87	V*
Reverse current $V_R = V_{RWM max}$ ; $T_j = 125  {}^{\circ}C$	IR	<	100	mA ◀
Junction capacitance at $f = 1 \text{ MHz}$ $V_R = 5 \text{ V}; T_j = 25 \text{ to } 125 ^{O}\text{C}$	C <sub>d</sub>	typ.	500	pF
THERMAL RESISTANCE				
From junction to mounting base (both diodes conducting)	R <sub>th j-mb</sub>	=	1.4	K/W
From junction to mounting base (per diode)	R <sub>th j-mb</sub>	=	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 <sub>th mb-h</sub>	=	0.2	K/W
<ul> <li>b. with heatsink compound and 0.06mm maximum mica insulator</li> </ul>	R <sub>th mb-h</sub>	=	1.4	K/W
<ul> <li>with heatsink compound and 0.1 mm maximum mica insulator (56369)</li> </ul>	R <sub>th mb-h</sub>	=	2.2	K/W
<ul> <li>d. with heatsink compound and 0.25 mm maximum alumina insulator (56367)</li> </ul>	R <sub>th mb-h</sub>	=	0.8	K/W
e. without heatsink compound	R <sub>th mb-h</sub>	=	1.4	K/W
2. Free air operation				
The quoted values of $R_{\mbox{th}\ j\mbox{-a}}$ should be used only when no lead the same tie point.	ads of other diss	ipating	components (	un to
Thermal resistance from junction to ambient in free air; mounted on a printed circuit board at any device				

R<sub>th j-a</sub>

lead length and with copper laminate on the board

60

K/W

<sup>\*</sup>Measured under pulse conditions to avoid excessive dissipation.

#### MOUNTING INSTRUCTIONS

- 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.
- 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<sub>th mb-h</sub> 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<sub>th mb-h</sub> given for mounting with heatsink compound refer to the use of a metallic oxide-loaded compound. Ordinary silicone grease is not recommended.
- 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.

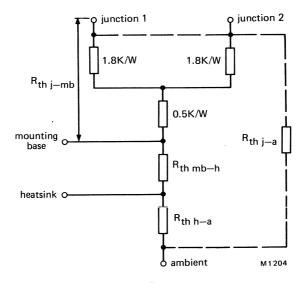


Fig.2.

#### OPERATING NOTES

Dissipation and heatsink calculations (continued)

Overall thermal resistance, Rth j-a = Rth j-mb + Rth mb-h + Rth h-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 ( $\delta$ )
- (iii) average forward current per diode
- (iv) crest working reverse voltage (VRWM)

The total power dissipation in the diode has two components:

$$P_{tot} = P_R + P_F \dots 1$$
.

P<sub>F</sub> - forward conduction dissipation

From the above it can be seen that:

$$R_{th h-a} = \frac{T_{jmax} - T_{amb}}{P_F + P_R} - (R_{th j-mb} + R_{th mb-h}) \dots 2).$$

Values for R<sub>th j-mb</sub> and R<sub>th mb-h</sub> can be found under Thermal Resistance. P<sub>R</sub> and P<sub>F</sub> 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<sub>RWM</sub> axis of Fig.3, and from a knowledge of the required VRWM, trace upwards to meet the curve that matches the required T<sub>imax</sub>. 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  $(\delta)$ . From this point trace right and read the actual reverse power dissipation on the PR axis.

Forward conduction dissipation (PF) for the known average current IF(AV) and duty cycle for each diode is easily derived from Fig.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 Rth i-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<sub>th i-mb</sub> of 2.3 K/W.

> To ensure thermal stability,  $(R_{th j-mb} + R_{th mb-h} + R_{th h-a}) \times P_R$  must be less than 12 °C. If the calculated value of Rth h-a does not permit this, then it must be reduced (heatsink size increased or Rth mb-h improved) to enable this criterion to be met.

EXAMPLE: square-wave operation, using BYV43-35 and heatsink compound;

 $T_{amb} = 50 \text{ °C}; \delta \text{ (diode 1)} = 0.5; \delta \text{ (diode 2)} = 0.5;$ 

 $I_{F(AV)}$  (diode 1) = 12 A;  $I_{F(AV)}$  (diode 2) = 12 A;

V<sub>RWM</sub> (both diodes) = 12 V; voltage grade of device = 35 V.

From data,  $R_{th j-mb} = 1.4 \text{ K/W}$  and  $R_{th mb-h} = 0.2 \text{ K/W}$ .

For each diode from Fig.4, it is found that  $P_F = 9.3 W$ ;

hence total  $P_F = 2 \times 9.3 = 18.6 \text{ W}$ . (from equation 4)

If the desired  $T_{i max}$  is chosen to be 130 °C, then, from Fig.3,  $P_{R}$  (per diode) = 0.44W

Therefore total  $P_R = 2 \times 0.44 = 0.88 \text{ W}$ . (from equation 3)

Using equation 2) we have:

$$R_{\text{th h-a}} = \frac{130 \, {}^{\circ}\text{C} - 50 \, {}^{\circ}\text{C}}{18.6 \, \text{W} + 0.88 \, \text{W}} - (1.4 + 0.2) = 2.5 \, \text{K/W}$$

To check for thermal stability:

$$(R_{th\ j-a}) \times P_R = (1.4 + 0.2 + 2.5) \times 0.88 = 3.6$$
 °C. This is less than 12 °C, hence thermal stability is ensured.

### SQUARE-WAVE OPERATION (Fig.s 3 and 4)

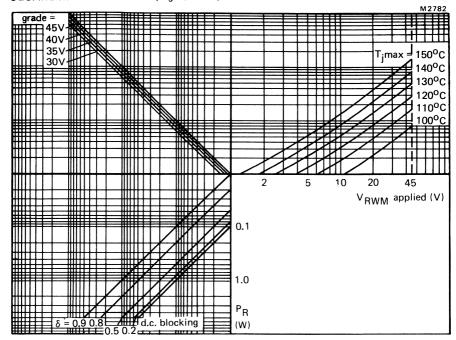


Fig.3 NOMOGRAM: for calculation of  $P_R$  (reverse leakage power dissipation) for a given  $T_j$ max.,  $V_{RWM}$  applied, voltage grade and duty cycle (per diode).

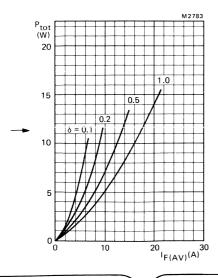


Fig.4.

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

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

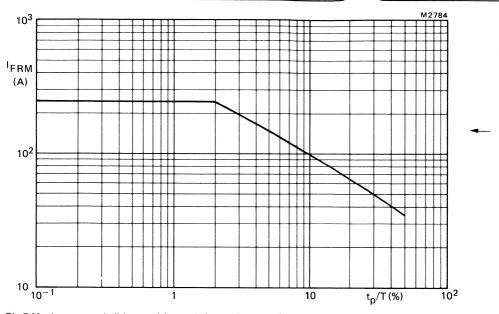
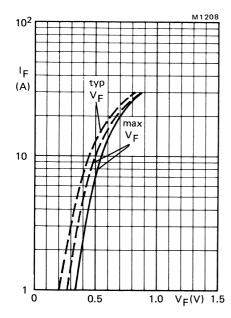
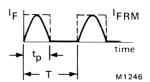


Fig.5 Maximum permissible repetitive peak forward current for either square or sinusoidal currents for 1  $\mu s < t_p < 1$  ms.





Definition of IFRM and  $t_{\mbox{\footnotesize{p}}}/\mbox{\footnotesize{T}}.$ 

Fig.6 — 
$$T_j = 25$$
 °C; —  $T_j = 125$  °C; per diode.

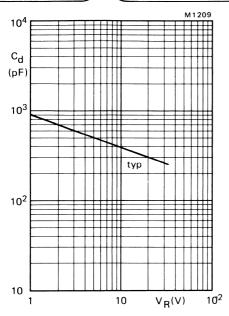


Fig.7 f = 1 MHz;  $T_j$  = 25 to 125 °C; per diode.

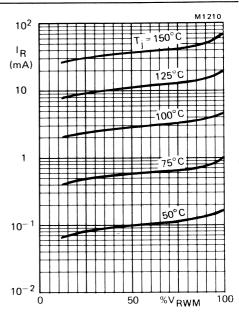


Fig.8 Typical values; per diode.

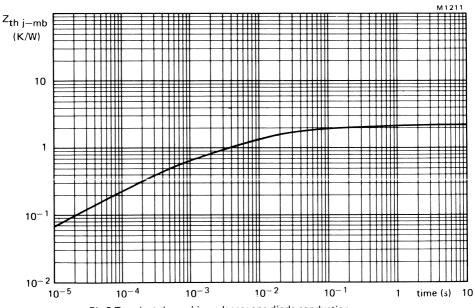


Fig.9 Transient thermal impedance; one diode conducting.

# 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.

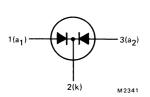
#### QUICK REFERENCE DATA

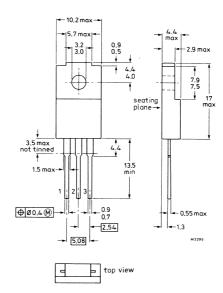
Per diode, unless otherwise stated		BYV43	F-30	35	40(A)	45	
Repetitive peak reverse voltage	$v_{RRM}$	max.	30	35	40	45	V
Output current (both diodes conducting)	I <sub>O</sub>	max.			26		A
Forward voltage	٧ <sub>F</sub>	<			0.6		V
Junction temperature	$T_{j}$	<			150		oC

#### **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).

## **BYV43F SERIES**

#### **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	٧
Continuous reverse voltage (note 1)	$v_R$	max.	30	35	40	45	٧
Currents (both diodes conducting; notes 2, 4)					· · ·		
Output current: square wave; $\delta = 0.5$ ; up to $T_h = 49$ °C (note 3)					26		Α
11	lo	max.					
R.M.S. forward current	<sup>I</sup> F(RMS)	max.			37		Α
Repetitive peak forward current $t_p = 20 \mu s$ ; $\delta = 0.02$ (per diode)	IFRM	max.			250		Α
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	FSM	max.			200		Α
t = 8.3 ms	<sup>I</sup> FSM	max.			220		Α
$I^2$ t for fusing (t = 10 ms, per diode)	l²t	max.			200		A <sup>2</sup> s
Reverse surge current (BYV43F-40A only) $t_p = 100 \mu s$	IRSM	max.			0.5		A
Temperatures							
Storage temperature	$T_{stq}$		-	-40 to	+150		οС
Junction temperature	Tj	max.			150		oC
ISOLATION							
Peak isolation voltage from all terminals to external heatsink	V <sub>isol</sub>	max.			1000		V
Isolation capacitance from centre lead to external heatsink (note 5)	Cp	typ.			12		pF

#### Notes:

- 1. Up to  $T_i$  = 125  $^{o}$ C; see derating curve for higher temperature operation.
- 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.

in free air, mounted on a printed circuit board

CHARACTERISTICS (per diode)				
T <sub>j</sub> = 25 °C unless otherwise stated				
Forward voltage				
$I_F = 15 \text{ A}; T_j = 125  {}^{\circ}\text{C}$	٧ <sub>F</sub>	< ,	0.6	V*
I <sub>F</sub> = 30 A	٧ <sub>F</sub>	<	0.87	V*
Reverse current				
$V_R = V_{RWM max}$ ; $T_j = 125  {}^{\circ}C$	1 <sub>R</sub>	<	100	mΑ
Junction capacitance at f = 1 MHz				
$V_R = 5 V; T_j = 25 {}^{\circ}\text{C}$ to 125 ${}^{\circ}\text{C}$	cj	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 <sub>th j-h</sub>	=	4.8	K/W
without heatsink compound	R <sub>th j-h</sub>	=	6.8	K/W
b. per diode:	Б			14 /14/
with heatsink compound	R <sub>th j-h</sub>	=	5.7	K/W
without heatsink compound	R <sub>th j-h</sub>	=	7.7	K/W
Free air operation				
The quoted value of $R_{\mbox{th}\ j\mbox{-}h}$ should be used only when no the same tie point.	o leads of other o	lissipating o	omponents	run to
Thermal resistance from junction to ambient				

 $R_{th\ j-a}$ 

55

K/W

<sup>\*</sup>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<sub>th j-h</sub> 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: Maximum torque to avoid damage to the device:

5.5 kgf (0.55 Nm) 8.0 kgf (0.80 Nm)

- 5. For good thermal contact, heatsink compound should be used between baseplate and heatsink. Values of R<sub>th i-h</sub> given for mounting with heatsink compound refer to the use of a metallic-oxide loaded compound. Ordinary silicone grease is not recommended.
- 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.

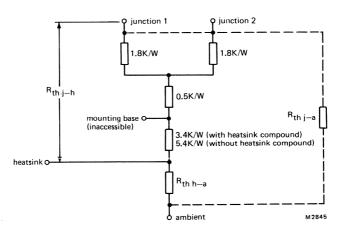


Fig.2.

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

### OPERATING NOTES

### Dissipation and heatsink calculations (continued)

Overall thermal resistance, R<sub>th i-a</sub> = R<sub>th j-h</sub> + R<sub>th h-a</sub>

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 ( $\delta$ )
- (iii) average forward current per diode
- (iv) crest working reverse voltage (VRWM)

The total power dissipation in the diode has two components:

From the above it can be seen that:

$$R_{th\ h-a} = \frac{T_{jmax} - T_{amb}}{P_F + P_R} - (R_{th\ j-h}) \dots 2).$$

The value of Rth i-h can be found under Thermal Resistance and will depend upon whether or not heatsink compound is used. PR and PF are derived from Figs.3 and 4 as follows:

Look at each half of the dual diode separately; for each diode, starting at the VRWM axis of Fig.3, and from a knowledge of the required VRWM, trace upwards to meet the curve that matches the required Timax. 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 ( $\delta$ ). From this point trace right and read the actual reverse power dissipation on the PR axis. From this calculation, 

Forward conduction dissipation (PF) for the known average current IF(AV) and duty cycle for each diode is easily derived from Fig.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<sub>th i-h</sub> = 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<sub>th i-h</sub> of 5.7 K/W (with heatsink compound) or 7.7 K/W (without heatsink compound).

> To ensure thermal stability, (R<sub>th j-h</sub> + R<sub>th h-a</sub>) x P<sub>R</sub> must be less than 12 °C. If the calculated value of Rth h-a does not permit this, then it must be reduced (heatsink size increased or Rth i-a improved) to enable this cirterion to be met.

EXAMPLE:

square wave operation, using BYV43F-35 and heatsink compound;

 $T_{amb} = 40 \, {}^{\circ}\text{C}; \, \delta \, (\text{diode 1}) = 0.5; \, \delta \, (\text{diode 2}) = 0.5;$ 

 $I_{F(AV)}$  (diode 1) = 9 A;  $I_{F(AV)}$  (diode 2) = 9 A;

V<sub>RWM</sub> (both diodes) = 12 V; voltage grade of device = 35 V.

From data,  $R_{th i-h} = 4.8 \text{ K/W}$ .

For each diode from Fig.4, it is found that  $P_F = 6 \text{ W}$ ;

hence total  $P_F = 2 \times 6 = 12 \text{ W}$ . (from equation 4)

If the desired  $T_{imax}$  is chosen to be 130 °C, then, from Fig.3,  $P_R$  (per diode) = 0.44 W.

Therefore total  $P_R = 2 \times 0.44 = 0.88 \text{ W}$ . (from equation 3)

Using equation 2) we have:

$$R_{\text{th h-a}} = \frac{130 \text{ °C} - 40 \text{ °C}}{12 \text{ W} + 0.88 \text{ W}} - (4.8) = 2.2 \text{ K/W}$$

To check for thermal stability:

$$(R_{th,i-a}) \times P_R = (4.8 + 2.2) \times 0.88 = 6.16$$
 °C.

 $(R_{th~j-a}) \times P_R = (4.8 + 2.2) \times 0.88 = 6.16$  °C. This is less than 12 °C, hence thermal stability is ensured.



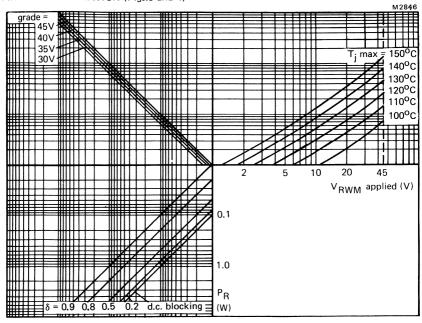
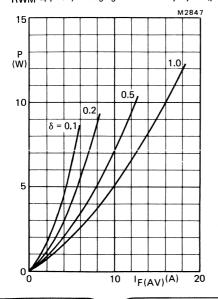


Fig.3 NOMOGRAM: for calculation of PR (reverse leakage power dissipation) for a given Timax., V<sub>RWM</sub> applied, voltage grade and duty cycle (per diode).



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

Fig.4(per diode)

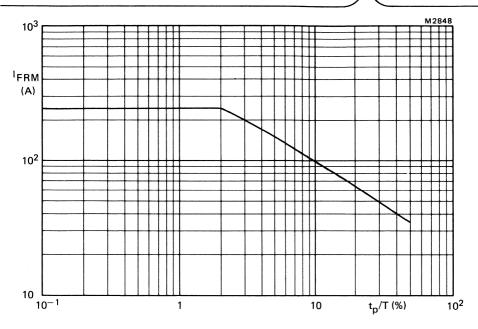
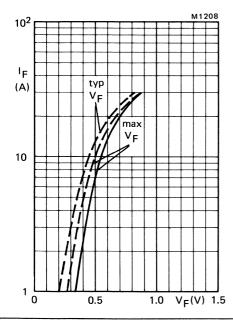
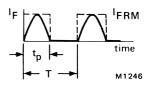


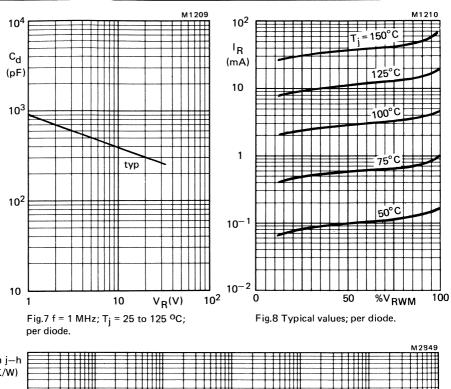
Fig.5 Maximum permissible repetitive peak forward current for either square or sinusoidal currents for 1  $\mu$ s < t $_p$  < 1 ms, per diode.





Definition of  $I_{\mbox{\scriptsize FRM}}$  and  $t_p/T.$ 

Fig.6 — 
$$T_j = 25$$
 °C;  $---T_j = 125$  °C; per diode.



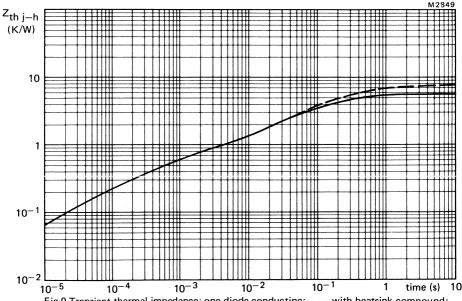


Fig.9 Transient thermal impedance; one diode conducting; —— with heatsink compound; — — without heatsink compound.

## SCHOTTKY-BARRIER DOUBLE RECTIFIER DIODES

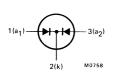
High-efficiency schottky-barrier double rectifier diodes in plastic envelopes featuring low forward voltage drop, low capacitance and absence of stored charge. They are intended for use in switched-mode power supplies and high-frequency circuits in general, where both low conduction losses and zero switching 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.

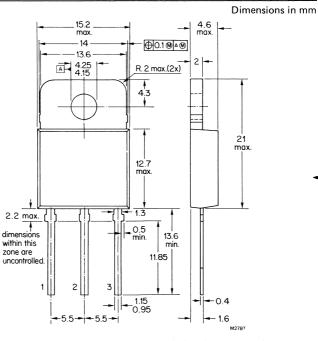
### QUICK REFERENCE DATA

Per diode, unless otherwise stated		BYV7	3–30	35	40(A)	45	
Repetitive peak reverse voltage	$V_{RRM}$	max.	30	35	40	45	V
Output current (both diodes conducting)	10	max.			30		A <b>←</b>
Forward voltage	٧ <sub>F</sub>	<			0.6		V
Junction temperature	Tį	<			150		oC

### MECHANICAL DATA

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.

## **BYV73 SERIES**

### **RATINGS**

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

-	Voltages (per diode)		BYV7	3–30	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 <sub>mb</sub> = 112 °C (note 3)	Io	max.			30		Α
	R.M.S. forward current	F(RMS)	max.			40		Α
	Repetitive peak forward current $t_p = 20 \mu s$ ; $\delta = 0.02$ (per diode)	I <sub>FRM</sub>	max.			250		Α
	Non-repetitive peak forward current (per diode) half sine-wave; T <sub>j</sub> = 125 °C prior to surge; with reapplied V <sub>RWM max</sub> ; t = 10 ms	ļFSM	max.			150		A
	t = 8.3 ms	IFSM	max.			165		A
	I <sup>2</sup> t for fusing (t = 10 ms, per diode)	l²t	max.			112		A <sup>2</sup> s
	Reverse surge current (BYV73-40A only) $t_p = 100 \mu s$	<sup>I</sup> RSM	max.			0.5		Α
	Temperatures							
	Storage temperature	T <sub>stg</sub>		-	-40 to	+150		oC
	Junction temperature	Tj	max.			150		oC

### Notes:

- 1. Up to  $T_i$  = 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 <sub>F</sub> = 15 A; T <sub>j</sub> = 125 °C	VF	<	0.6	- V* <b>←</b>
$I_F = 30 \text{ A}; T_i = 25 ^{\circ}\text{C}$	VF	<	0.87	V* -
Reverse current				
$V_R = V_{RWM max}$ ; $T_j = 125  {}^{\circ}C$	1 <sub>R</sub>	<	100	mA
Junction capacitance at f = 1 MHz				
$V_R = 5 \text{ V}; T_j = 25 \text{ to } 125 ^{\circ}\text{C}$	$c_d$	typ.	500	pF
THERMAL RESISTANCE				
From junction to mounting base (both diodes conducting)	R <sub>th j-mb</sub>	=	1.4	K/W
From junction to mounting base (per diode)	R <sub>th j-mb</sub>	=	2.4	K/W
Influence of mounting method				-
Heatsink-mounted with clip (see mounting instructions)				
Thermal resistance from mounting base to heatsink				
a. with heatsink compound	R <sub>th mb-h</sub>	=	0.2	K/W
b. with heatsink compound and 0.06 mm maximum mica	_			
insulator (56378)	R <sub>th mb-h</sub>	=	1.4	K/W
c. with heatsink compound and 0.1 mm maximum mica	_			14 (14)
insulator	R <sub>th mb-h</sub>	=	2.2	K/W
d. with heatsink compound and 0.25 mm maximum	р	_	0.0	K/W
alumina insulator	R <sub>th mb-h</sub>	=	0.8	
e. without heatsink compound	R <sub>th mb-h</sub>	=	1.4	K/W
2. Free air operation				
The quoted values of R <sub>th j-a</sub> should be used only when no lead	ds of other dissip	ating co	mponent	s 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				
mounted on a printed circuit board at any device lead			00	14 (14)

R<sub>th j-a</sub>

length and with copper laminate on the board

K/W

<sup>\*</sup>Measured under pulse conditions to avoid excessive dissipation.

### MOUNTING INSTRUCTIONS

- 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.
- 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  $R_{th\ mb-h}$  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<sub>th mb·h</sub> given for mounting with heatsink compound refer to the use of a metallic oxide-loaded compound. Ordinary silicone grease is not recommended.
  - 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.

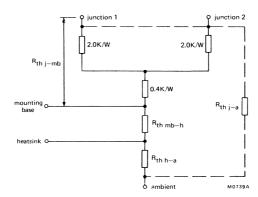


Fig.2.

### **OPERATING NOTES**

Dissipation and heatsink calculations (continued)

Overall thermal resistance,  $R_{th j-a} = R_{th j-mb} + R_{th mb-h} + R_{th h-a}$ 

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 ( $\delta$ )
- (iii) average forward current per diode
- (iv) crest working reverse voltage (V<sub>RWM</sub>)

The total power dissipation in the diode has two components:

P<sub>R</sub> - reverse leakage dissipation

From the above it can be seen that:

$$R_{th \ h-a} = \frac{T_{jmax} - T_{amb}}{P_F + P_R} - (R_{th \ j-mb} + R_{th \ mb-h}) \ ... 2).$$

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 ( $\delta$ ). From this point trace right and read the actual reverse power dissipation on the  $P_R$  axis.

diode is easily derived from Fig.4.

NOTE:— If both halves of the diode are being used (as is assumed above), the value of  $R_{th\ j-mb}$  = 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  $R_{th\ j-mb}$  of 2.4 K/W.

To ensure thermal stability,  $(R_{th\ j-mb}+R_{th\ mb-h}+R_{th\ mb-h}+R_{th\ h-a}) \times P_R$  must be less than 12 °C. If the calculated value of  $R_{th\ h-a}$  does not permit this, then it must be reduced (heatsink size increased or  $R_{th\ mb-h}$  improved) to enable this criterion to be met.

EXAMPLE: square-wave operation, using BYV73-35 and heatsink compound;

 $T_{amb} = 50 \, ^{\circ}C$ ;  $\delta$  (diode 1) = 0.5;  $\delta$  (diode 2) = 0.5;

 $I_{F(AV)}$  (diode 1) = 12 A;  $I_{F(AV)}$  (diode 2) = 12 A;

V<sub>RWM</sub> (both diodes) = 12 V; voltage grade of device = 35 V.

From data,  $R_{th i-mb} = 1.4 \text{ K/W}$  and  $R_{th mb-h} = 0.2 \text{ K/W}$ .

For each diode from Fig.4, it is found that  $P_F = 9.3 \text{ W}$ ;

hence total  $P_F = 2 \times 9.3 = 18.6 \text{ W}$ . (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:

$$R_{\text{th h-a}} = \frac{130 \text{ oC} - 50 \text{ oC}}{18.6 \text{ W} + 0.88 \text{ W}} - (1.4 + 0.2) = 2.5 \text{ K/W}$$

To check for thermal stability:

$$(R_{th i-a}) \times P_R = (1.4 + 0.2 + 2.5) \times 0.88 = 3.6 \, ^{\circ}C.$$

This is less than 12 °C, hence thermal stability is ensured.



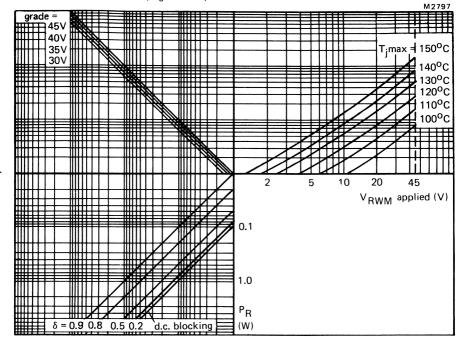
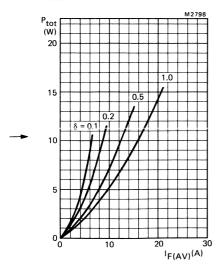


Fig.3 NOMOGRAM: for calculation of  $P_R$  (reverse leakage power dissipation) for a given  $T_j$ max.,  $V_{RWM}$  applied, voltage grade and duty cycle (per diode).



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

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

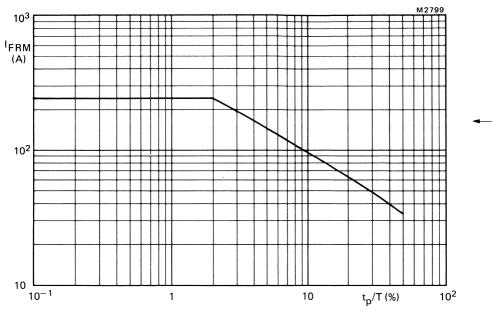
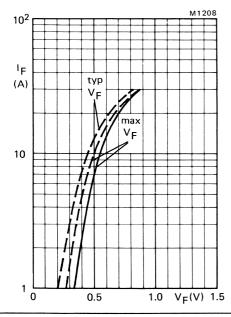
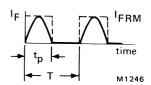


Fig.5 Maximum permissible repetitive peak forward current for either square or sinusoidal currents for 1  $\mu$ s < t $_p$  < 1 ms.





Definition of I  $_{\mbox{\scriptsize FRM}}$  and  $t_p/T.$ 

Fig.6 — 
$$T_j = 25$$
 °C;  $---T_j = 125$  °C; per diode.

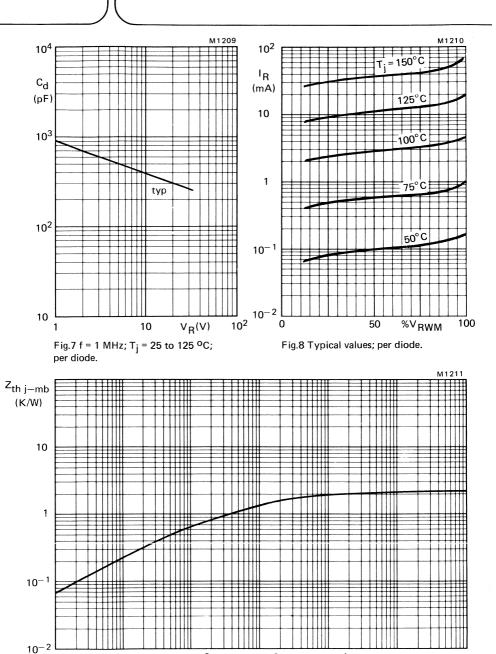


Fig.9 Transient thermal impedance; one diode conducting.

 $10^{-2}$ 

 $10^{-1}$ 

time (s)

10

 $10^{-3}$ 

10-5

## 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).

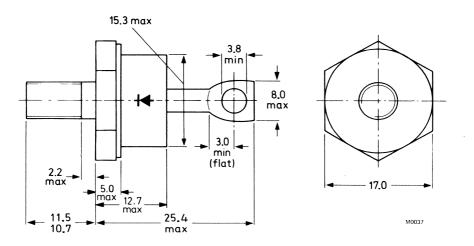
### QUICK REFERENCE DATA

Repetitive peak reverse voltage	$v_{RRM}$	max.	45	V
Average forward current	IF(AV)	max.	60	Α
Forward voltage	٧ <sub>F</sub>	<	0.6	<b>V</b>
Junction temperature	$T_{j}$	max.	150	οС

### **MECHANICAL DATA**

Dimensions in mm

Fig.1 DO-5 with  $\frac{1}{4}$ " x 28 UNF stud ( $\phi$ 6.35 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:

14" x 28 UNF, 11.1 mm

<b>RATINGS</b> Limiting	values in a	ccordance w	vith the	Absolute	Maximum S	vstem	(IEC134)
na inius Limiting	values III a	iccordance w	vitii tiie i	Ansolute	Maximum 3	y Steili	(150134)

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 <sub>F(,</sub>	AV)	max.	60	Α
R.M.S. forward current	lF(	RMS)	max.	85	Α
Non-repetitive peak forward current $t = 10$ ms; half sine-wave; $T_j = 125$ °C prior to surge; with reapplied $V_{RWMmax}$	l <sub>FS</sub>	NA	max.	700	A
I <sup>2</sup> t for fusing (t = 10 ms)	l <sup>2</sup> t	olvi		2450	A <sup>2</sup> s
					., -
Temperatures	-		-55 to	150	οс
Storage temperature	T <sub>st</sub>	g	max.		°C
Junction temperature	Тj		IIIdX.	150	-0
THERMAL RESISTANCE					0 - 4
From junction to mounting base	R <sub>th</sub>	ı j-mb	=	1	oC/W
From mounting base to heatsink with heatsink compound	р.,	n mh-h			00/14/
with heatsink compound without heatsink compound		n mb-h n mb-h	=	0.3 0.5	°C/W
Transient thermal impedance; t = 1 ms	•••	i mb-n i j-mb	=	0.15	°C/W
·	-tn	j-mb		0.10	0, 11
CHARACTERISTICS					
Forward voltage	.,		<	0.6	V*
$I_F = 60 \text{ A; } T_j = 125 ^{\circ}\text{C}$	٧ <sub>F</sub>		<	0.84	v V*
I <sub>F</sub> = 120 A; T <sub>j</sub> = 125 °C	٧ <sub>F</sub>			0.04	V
Rate of rise of reverse voltage	dV	R			
$V_R = V_{RWMmax}$	dt	<del>-</del>	<	1500	V/μs
Reverse current					
$V_R = V_{RWMmax}$ ; $T_j = 125$ °C	i <sub>R</sub>		<	200	mΑ
Capacitance at f = 1 MHz					
V <sub>R</sub> = 5 V; T <sub>i</sub> = 25 to 125 °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.

<sup>\*</sup>Measured under pulse conditions to avoid excessive dissipation.

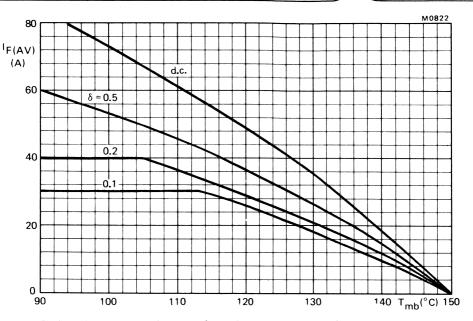
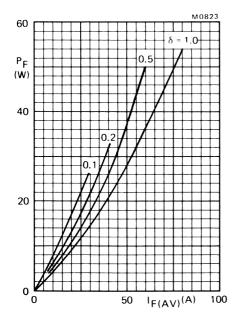


Fig.2 Maximum permissible average forward current versus mounting-base temperature at  $V_{\mbox{RWM}}$  = 35 V.



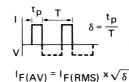


Fig.3 Forward power dissipation versus average forward current.

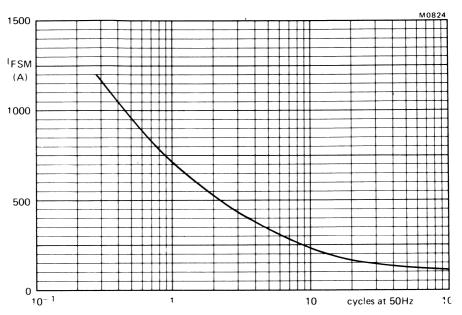


Fig.4 Maximum permissible non-repetitive peak forward current based on sinusoidal currents (f = 50 Hz);  $T_i = 125$  °C prior to surge; with reapplied  $V_{RWMmax}$ .

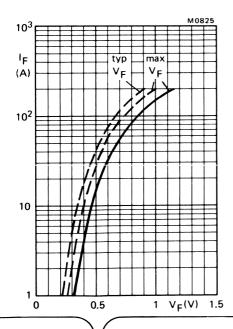
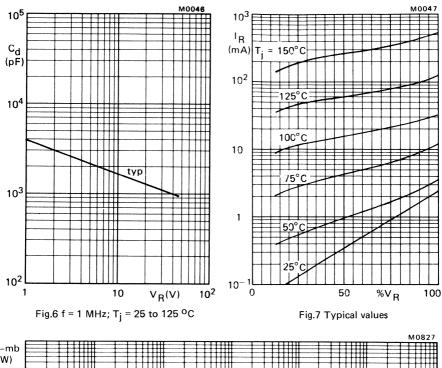
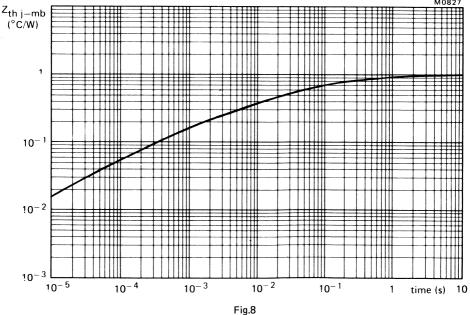


Fig.5 ———  $T_j = 25 \, {}^{o}C; --- T_j = 125 \, {}^{o}C$ 







# **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.

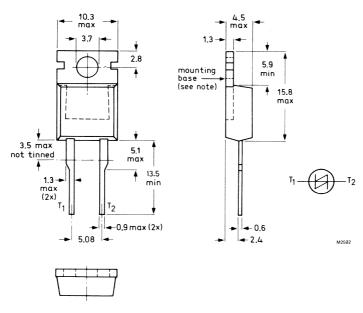
### QUICK REFERENCE DATA

			BR210-100 to 280	
Breakover voltage	$V_{BO}$	nom.	100 to 280	V
Holding current	lн	>	150	mA
Transient peak current (10/320 $\mu$ s impulse)	ITRM	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<sub>1</sub>. Accessories supplied on request: see data sheet Mounting instructions and accessories for TO-220 envelopes.

## **BR210 SERIES**

## **RATINGS**

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

Curi	rents
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(in either direc	tion)
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(iii ortifor direction)				
Transient peak current (8/20 μs impulse)	ITRM1	max.	150	Α
Transient peak current (10/320 µs impulse) equivalent to 10/700 µs 1.6 kV voltage impulse (CCITT K17); (see Fig.3)	<sup>I</sup> TRM2	max.	40	A
Average on-state current (averaged over				
any 20 ms period); up to $T_{mb} = 75  {}^{\circ}\text{C}$	IT(AV)	max.	5	Α
R.M.S. a.c. on-state current	IT(RMS)	max.	8	Α
Non-repetitive peak on-state current; $T_j = 100$ °C prior to surge;				
t = 10 ms; half sine-wave	<sup>I</sup> TSM	max.	40	Α
$I^2$ t for fusing (t = 10 ms)	l² t	max.	8	$A^2s$
Rate of rise of on-state current after				
$V_{BO}$ turn-on ( $t_p = 10 \mu s$ )	dI/dt	max.	50	A/μs
Temperatures				
		-40 to +150		
Storage temperature	$T_{stg}$	-40	to +150	oC
Storage temperature Operating temperature (off-state)	T <sub>stg</sub> T <sub>i</sub>	—40 max.	to +150 125	oC oC
• ,	T <sub>stg</sub> T <sub>j</sub> T <sub>vj</sub>			-
Operating temperature (off-state)	Тj	max.	125	oC
Operating temperature (off-state) Overload temperature (on-state)  THERMAL RESISTANCE  From junction to ambient in free air mounted on a printed circuit board	T <sub>j</sub> T <sub>vj</sub>	max.	125 150	oC 0C
Operating temperature (off-state) Overload temperature (on-state)  THERMAL RESISTANCE  From junction to ambient in free air mounted on a printed circuit board at any lead length	Тj	max.	125	oC
Operating temperature (off-state) Overload temperature (on-state) THERMAL RESISTANCE From junction to ambient in free air mounted on a printed circuit board at any lead length From junction to mounting base One line conducting	T <sub>j</sub> T <sub>vj</sub>	max.	125 150	°C °C K/W
Operating temperature (off-state) Overload temperature (on-state)  THERMAL RESISTANCE  From junction to ambient in free air mounted on a printed circuit board at any lead length  From junction to mounting base	T <sub>j</sub> T <sub>Vj</sub> R <sub>th j-amb</sub> <u>R</u> th j-mb	max.	125 150	oC 0C
Operating temperature (off-state) Overload temperature (on-state) THERMAL RESISTANCE From junction to ambient in free air mounted on a printed circuit board at any lead length From junction to mounting base One line conducting bidirectional operation	T <sub>j</sub> T <sub>vj</sub> <sup>R</sup> th j-amb	max. max.	125 150 60 2.0	°C °C K/W
Operating temperature (off-state) Overload temperature (on-state) THERMAL RESISTANCE From junction to ambient in free air mounted on a printed circuit board at any lead length From junction to mounting base One line conducting bidirectional operation unidirectional operation	T <sub>j</sub> T <sub>Vj</sub> R <sub>th j-amb</sub> R <sub>th j-mb</sub>	max. max.	125 150 60 2.0	°C °C K/W
Operating temperature (off-state) Overload temperature (on-state) THERMAL RESISTANCE From junction to ambient in free air mounted on a printed circuit board at any lead length From junction to mounting base One line conducting bidirectional operation unidirectional operation Both lines conducting	T <sub>j</sub> T <sub>Vj</sub> R <sub>th j-amb</sub> <u>R</u> th j-mb	max. max. = =	125 150 60 2.0 2.4	C C C K/W K/W

### CHARACTERISTICS

T<sub>i</sub> = 25 °C unless otherwise stated; each line to centre lead.

Voltages and currents (in either direction)

Voltages and currents (in either direction)				
On-state voltage (note 1)				
I <sub>TM</sub> = 10 A	$V_{TM}$	< 1	2.5	V
Avalanche voltage $V_{BR}$ ; ( $I_{BR}$ = 10 mA), and Breakover voltage $V_{BO}$ ; ( $I = I_S$ ):				
(100 μs pulsed)		V <sub>BR</sub> min.	V <sub>BO</sub> 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
	<b>–260</b>	228	292	V
	-280	246	314	V
Temperature coefficient of V <sub>BR</sub>	S <sub>br</sub>	typ.	+0.1	%/K
Holding current (note 2)				
T <sub>i</sub> = 25 °C	lн	>	150	mΑ
$T_{j}^{\prime} = 70 {}^{\circ}\text{C}$	l <sub>H</sub>	>	100	mΑ
Switching current (note 3)	IS	>	10	mA
(100 $\mu$ s pulsed)	IS	typ.	200	mΑ
	Is	<	500	mΑ
Off-state current; V <sub>D</sub> = 85% V <sub>BRmin</sub> (note 4	)			
$T_i = 70  {}^{\circ}\text{C}$	, ID	<	50	μΑ
T <sub>i</sub> = 125 °C	1 <sub>D</sub>	<	250	μΑ
Linear rate of rise of off-state voltage that will not trigger any device;	D	•	200	<b>,</b>
$T_j = 70  ^{\circ}\text{C}; V_{DM} = 85\% V_{BRmin}$	dV <sub>D</sub> /dt	<	2000	V/μs
Off-state capacitance V <sub>D</sub> = 0 ; f = 1 kHz to 1 MHz	Ci	<	350	pF

#### Notes:

- 1. Measured under pulsed conditions to avoid excessive dissipation.
- 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.

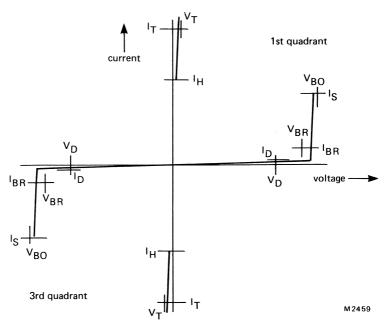


Fig.2 Breakover diode characteristics.

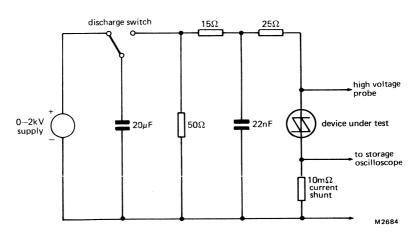


Fig.3 Test circuit for high voltage impulse (ITRM2) (according to CCITT vol IX-Rec. K17)

### Notes:

The 10/700  $\mu s$  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  $15\Omega + 25\Omega$  ouput impedance becomes effectively in parallel with the 50  $\Omega$ .

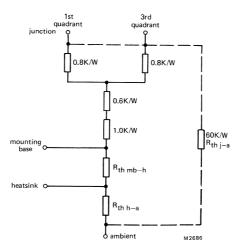
### MOUNTING INSTRUCTIONS

- 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.
- 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<sub>1</sub>, 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<sub>th mb-h</sub> 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.
- For good thermal contact heatsink compound should be used between base-plate and heatsink.
   Values of R<sub>th mb-h</sub> given for mounting with heatsink compound refer to the use of a metallic oxide-loaded compound. Ordinary silicone grease is not recommended.
- 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.
- 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.

## **BR210 SERIES**

### **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  $R_{th\ mb-a}$ . The heatsink thermal resistance value ( $R_{th\ h-a}$ ) can now be calculated from:

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

- 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  $k\Omega$ ), 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.

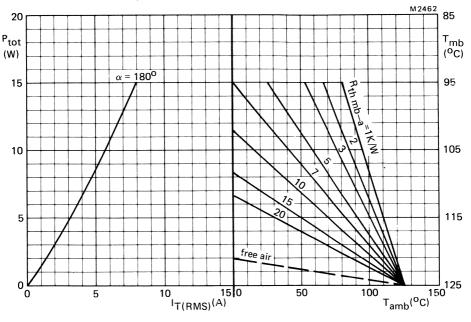
### Influence of mounting method

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

Thermal resistance from mounting base to heatsink

a.	with heatsink compound	R <sub>th mb-h</sub>	=	0.3	K/W
b.	with heatsink compound and 0.06 mm maximum mica insulator	R <sub>th mb-h</sub>	=	1.4	K/W
C.	with heatsink compound and 0.1 mm max. mica insulator (56369)	R <sub>th mb-h</sub>	=	2.2	K/W
d.	with heatsink compound and 0.25 mm max. alumina insulator (56367)	R <sub>th mb-h</sub>	=	0.8	K/W
e.	without heatsink compound	R <sub>th mb-h</sub>	=	1.4	K/W

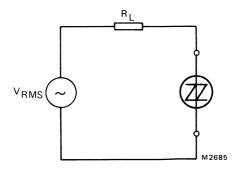




 $Fig. 5 \ The \ right-hand \ part \ shows \ the \ interrelationship \ between \ the \ power \ (derived \ from \ the \ left-hand \ part) \ and \ the \ maximum \ permissible \ temperatures.$ 

 $\alpha$  = conduction angle.

This figure applies for a low resistance load. It does not include any avalanche dissipation.



## **BR210 SERIES**

### **OVERLOAD OPERATION**

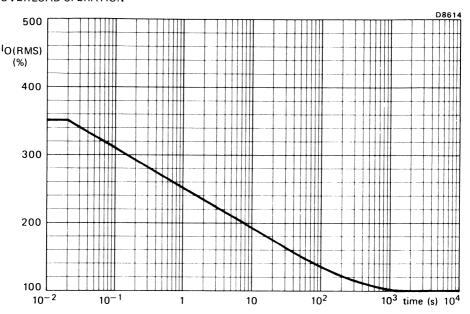


Fig.6 Maximum permissible duration of steady overload (provided that  $T_{mb}$  does not exceed 120 °C during and after overload) expressed as a percentage of the steady state r.m.s. rated current. For high r.m.s. overload currents precautions should be taken so that the temperature of the terminals 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.

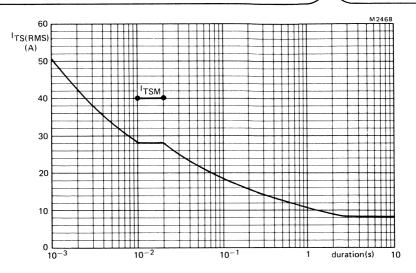
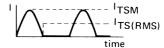


Fig.7 Maximum permissible non-repetitive r.m.s. on-state current based on sinusoidal currents (f = 50 Hz),  $T_j$  = 125  $^{\rm OC}$  prior to surge.



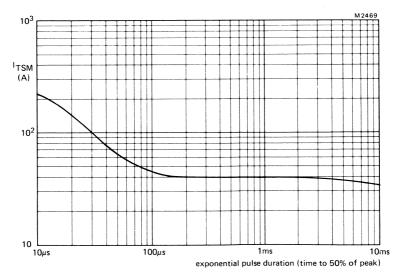


Fig.8 Maximum non-repetitive exponential waveform Impulse Current rating as a function of pulse duration.

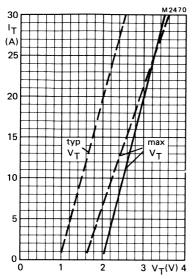


Fig.9 On-state voltage as a function of on-state current. (200  $\mu s$  pulsed condition to avoid excessive dissipation) —  $T_j = 25$ , — —  $T_j = 125$  °C.

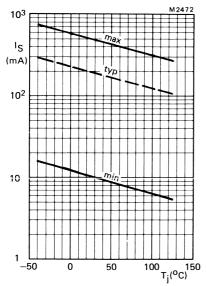


Fig. 11 Switching current as a function of temperature; ——  $T_j = 25$  °C; — —  $T_j = 125$  °C.

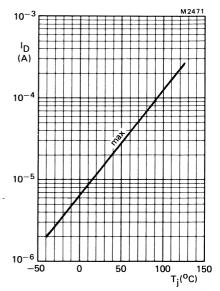


Fig. 10 Maximum off-state current as a function of temperature.

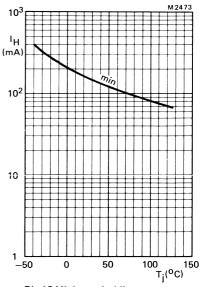


Fig. 12 Minimum holding current as a function of temperature.

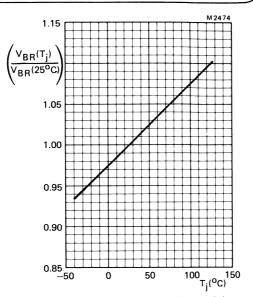


Fig. 13 Normalised avalanche breakdown voltage as a function of temperature. Note: this figure may also be used to derive normalised VBO.

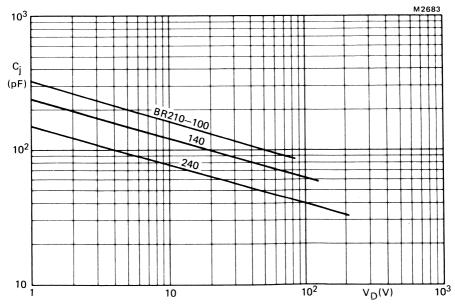


Fig.14 Typical junction capacitance as a function of off-state voltage; T<sub>i</sub> = 25 °C; f = 1 MHz.

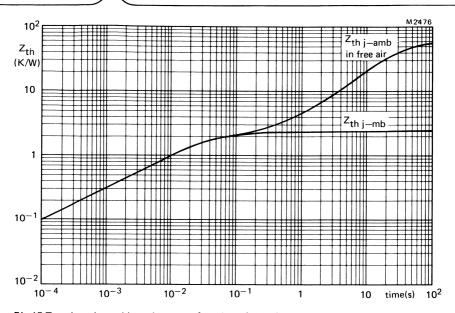


Fig.15 Transient thermal impedance as a function of time (rectangular pulse duration).

### DEVELOPMENT DATA

This data sheet contains advance information and specifications are subject to change without notice.

## 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 break over 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.

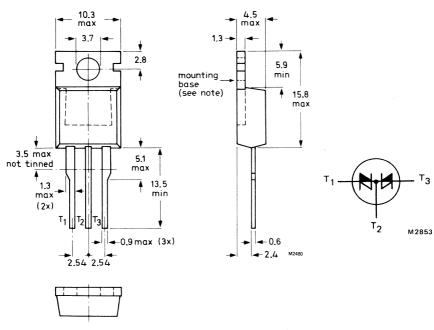
### QUICK REFERENCE DATA

Breakover voltage per line	V <sub>(BO)</sub>	<	78	V
Breakdown voltage per line	V <sub>(BR)</sub>	>	58	V
Holding current	Iн	>	150	mA
Transient peak current (10/320 μs impulse)	ITRM	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<sub>2</sub>.

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

Currents				
Transient peak current (8/20 $\mu$ s impulse)	ITRM1/IFRM1	max.	150	Α
Transient peak current (10/320 μs impulse) equivalent to 10/700 μs 1.6 kV voltage				
impulse (CCITT K17)	<sup> </sup> TRM2 <sup>/ </sup> FRM2	max.	40	Α
Average on-state current	<sup>I</sup> T(AV)	max.	5	Α
Average forward current (averaged over any 20 ms period); up to $T_{mb} = 75  {}^{\circ}\text{C}$	I <sub>F(AV)</sub>	max.	5	Α
R.M.S. a.c. on-state current	T(RMS)	max.	8	Α
Non-repetitive peak current;  T <sub>j</sub> = 100 °C prior to surge; t = 10 ms; half sine-wave	. ,		40	Α
I <sup>2</sup> t for fusing (t = 10 ms)	TSM/IFSM	max.	-	
	I <sup>2</sup> t	max.	8	A <sup>2</sup> s
Rate of rise of on-state current after $V(BO)$ turn-on $(t_p = 10 \mu s)$	dl <sub>T</sub> /dt	max.	50	A/μs
Temperatures				
Storage temperature	$T_{stg}$	-40	-40 to +150	
Operating temperature (off-state)	Тj	max.	125	оС
Overload temperature (on-state)	$T_{vj}$	max.	150	оС
THERMAL RESISTANCE				
From junction to ambient in free air mounted on a printed circuit board at any lead length	D		00	12 /141
,	R <sub>th j-amb</sub>	=	60	K/W
From junction to mounting base One line conducting				
bidirectional operation	R <sub>th j-mb</sub>	=	4.0	K/W
unidirectional operation	R <sub>th j-mb</sub>	=	5.0	K/W
Both lines conducting				
bidirectional operation	R <sub>th j-mb</sub>	=	3.0	K/W
Transient thermal impedance (t = 1 ms)	Z <sub>th j-mb</sub>	=	1.0	K/W

#### **CHARACTERISTICS**

T	= 2	50	C	unless	otherwise	stated	; each	line	to	centre	lead.	
---	-----	----	---	--------	-----------	--------	--------	------	----	--------	-------	--

On-state voltage (note 1)				
I <sub>TM</sub> = 5 A	$v_{TM}$	<	3.0	<b>V</b>
Forward voltage (note 1)				
I <sub>FM</sub> = 5 A	VFM	<	3.0	V
Avalanche voltage				
$I_{(BR)} = 10 \text{ mA}$	V(BR)	> ,	58	V
Breakover voltage				
100 $\mu$ s pulsed; I = I <sub>S</sub>	V(BO)	<	78	V
Temperature coefficient of V(BR)	S <sub>(br)</sub>	typ.	+0.1	%/K
Holding current (note 2)				
$T_j = 25$ °C	1 <sub>H</sub>	>	150	mΑ
$T_{j} = 70  {}^{\circ}\text{C}$	lн	>	100	mΑ
Switching current (note 3)	۱ <sub>S</sub>	>	10	mΑ
	۱ <sub>S</sub>	typ.	400	mΑ
	۱ <sub>S</sub>	<	830	mA
Off-state current; V <sub>D</sub> = 50 V (note 4)				
T <sub>i</sub> = 70 °C	۱ <sub>D</sub>	< <	0.5	mΑ
$T_{j} = 125  {}^{\circ}\text{C}$	I <sub>D</sub>	<	5.0	mΑ
Linear rate of rise of off-state voltage that will not trigger any device;				
$T_j = 70$ °C; $V_{DM} = 50$ V	dV <sub>D</sub> /dt	<	2000	V/μs
Off-state capacitance	5			•
$V_D = 0$ ; $f = 1$ kHz to 1 MHz	c <sub>i</sub>	<	500	рF
	J			

#### 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.

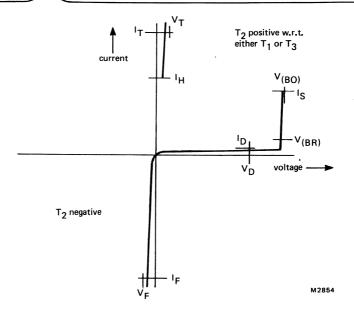


Fig.2 Breakover diode characteristics.

# **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.

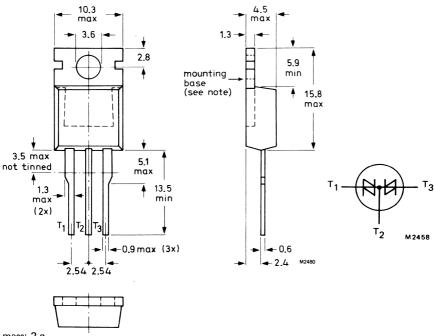
#### **QUICK REFERENCE DATA**

			BR220- 100 to 280	
Breakover voltage per line	$V_{BO}$	nom.	100 to 280	٧
Holding current	Iн	>	150	mA
Transient peak current (10/320 μs impulse)	ITRM	max.	40	Α

#### MECHANICAL DATA

Dimensions in mm

Fig.1 TO-220AB; centre lead connected to tab.



Net mass: 2 q

Note: The exposed metal mounting base is directly connected to terminal T<sub>2</sub>. Accessories supplied on request: see data sheet Mounting instructions and accessories for TO-220 envelopes.

# **BR220 SERIES**

### **RATINGS**

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

Ţ.			
ITRM1	max.	150	Α
<sup>I</sup> TRM2	max.	40	А
I <sub>T(AV)</sub>	max.	5	Α
IT(RMS)	max.	8	Α
ITSM	max.	40	A
	max	8	$A^2s$
	***************************************	· ·	
dI/dt	max.	50	A/μs
dI/dt	max.	50	A/μs
		50 to +150	A/μs o <sub>C</sub>
dI/dt T <sub>stg</sub> T <sub>i</sub>			
$T_{stg}$	-40	to +150	•С
⊤ <sub>stg</sub> ⊤ <sub>j</sub>	—40 max.	to +150 125	oC oC
T <sub>stg</sub> T <sub>j</sub> T <sub>vj</sub>	—40 max.	to +150 125	oC oC
T <sub>stg</sub> T <sub>j</sub> T <sub>vj</sub> <sup>R</sup> th j₊amb	-40 max. max.	to +150 125 150	°C °C °C
T <sub>stg</sub> T <sub>j</sub> T <sub>vj</sub> <sup>R</sup> th j-amb	-40 max. max.	to +150 125 150 60 2.0	oC oC oC K/W
T <sub>stg</sub> T <sub>j</sub> T <sub>vj</sub> <sup>R</sup> th j₊amb	-40 max. max.	to +150 125 150	°C °C °C
T <sub>stg</sub> T <sub>j</sub> T <sub>vj</sub> <sup>R</sup> th j-amb	-40 max. max.	to +150 125 150 60 2.0	oC oC oC K/W
	ITRM2	ITRM2 max. IT(AV) max. IT(RMS) max. ITSM max.	TRM2 max. 40   TRM2   TRM2   TRM2   TRM3   TRM5   TRM5

#### CHARACTERISTICS

T<sub>i</sub> = 25 °C unless otherwise stated; each line to centre lead.

Voltages and currents (in either direction)

Voltages and carrents (in cities ancetion)				
On-state voltage (note 1)				
$I_{TM} = 10 A$	$v_{TM}$	<	2.5	V
Avalanche voltage $V_{BR}$ ; ( $I_{BR} = 10 \text{ mA}$ ), and Breakover voltage $V_{BO}$ ; ( $I = I_S$ ):				
(100 μs pulsed)		V <sub>BR</sub> min.	V <sub>BO</sub> max.	
	BR220 100	88	112	V
	-120	105	135	V
	-140	123	157	V
	-160	140	180	V
	-180	158	202	V
	<b>–200</b>	176	224	V
	-220	193	247	V
	-240	211	269	V
	-260	228	292	V
	-280	246	314	V
Temperature coefficient of VBR	S <sub>br</sub>	typ.	+0.1	%/K
Holding current (note 2)				_
$T_j = 25 {}^{\circ}\text{C}$	!н	>	150	mA
$T_j' = 70  {}^{\circ}\text{C}$	lн	>	100	mA
Switching current (note 3)	IS	>	10	mΑ
(100 $\mu$ s pulsed)	IS	typ.	200	mΑ
	IS	<	500	mΑ
Off-state current; V <sub>D</sub> = 85% V <sub>BRmin</sub> (note 4	1)			
T <sub>i</sub> = 70 °C	ID	<	50	μΑ
T <sub>j</sub> = 125 °C	I <sub>D</sub>	<	250	μΑ

#### Notes:

Off-state capacitance

- 1. Measured under pulsed conditions to avoid excessive dissipation.
- Defined as the minimum current which the device can conduct before switching back to the off-state.

 $dV_D/dt$ 

 $C_i$ 

- 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.

Linear rate of rise of off-state voltage that will not trigger any device; T<sub>i</sub> = 70 °C; V<sub>DM</sub> = 85%V<sub>BRmin</sub>

 $V_D = 0$ ; f = 1 kHz to 1 MHz

2000

350

V/µs

pΕ

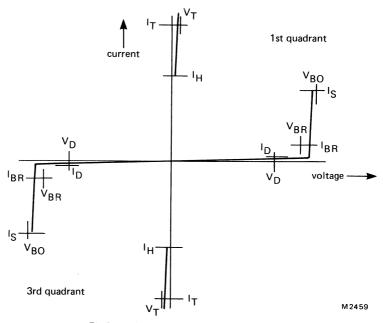


Fig.2 Breakover diode characteristics.

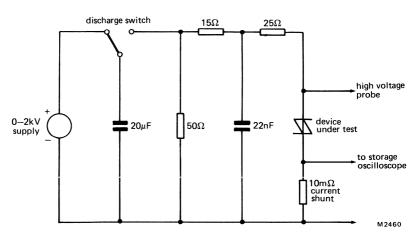


Fig.3 Test circuit for high voltage impulse (I<sub>TRM2</sub>) (according to CCITT vol IX-Rec. K17)

#### Notes:

The 10/700  $\mu s$  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  $15\Omega + 25\Omega$  ouput impedance becomes effectively in parallel with the 50  $\Omega$ .

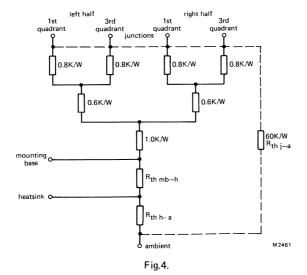
#### MOUNTING INSTRUCTIONS

- 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.
- 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<sub>th mb-h</sub> 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.
- For good thermal contact heatsink compound should be used between base-plate and heatsink.
   Values of R<sub>th mb-h</sub> given for mounting with heatsink compound refer to the use of a metallic-oxide loaded compound. Ordinary silicone grease is not recommended.
- 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:



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

# **BR220 SERIES**

#### **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  $R_{th\ mb-a}$ . The heatsink thermal resistance value ( $R_{th\ h-a}$ ) can now be calculated from:

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

- 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  $k\Omega$ ), 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 <sub>th mb-h</sub>	=	0.3	K/W
b.	with heatsink compound and 0.06 mm maximum mica insulator	R <sub>th mb-h</sub>	=	1.4	K/W
c.	with heatsink compound and 0.1 mm max. mica insulator (56369)	R <sub>th mb-h</sub>	=	2.2	K/W
d.	with heatsink compound and 0.25 mm max. alumina insulator (56367)	R <sub>th mb-h</sub>	=	0.8	K/W
e.	without heatsink compound	R <sub>th mb-h</sub>	=	1.4	K/W



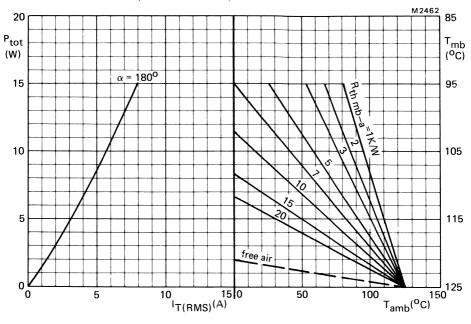
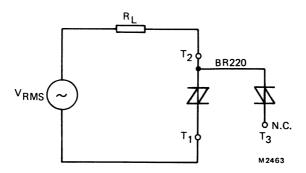


Fig.5 The right-hand part shows the interrelationship between the power (derived from the left-hand part) and the maximum permissible temperatures.

 $\alpha$  = 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.





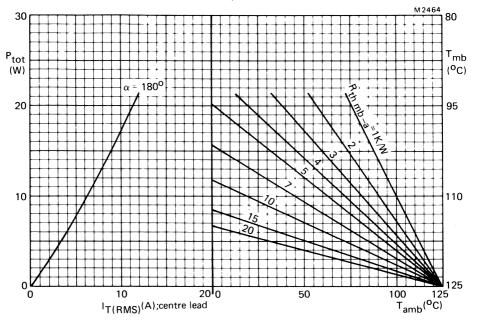
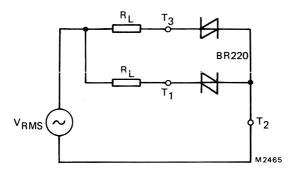


Fig.6 The right-hand part shows the interrelationship between the power (derived from the left-hand part) and the maximum permissible temperatures.

 $\alpha$  = 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)**

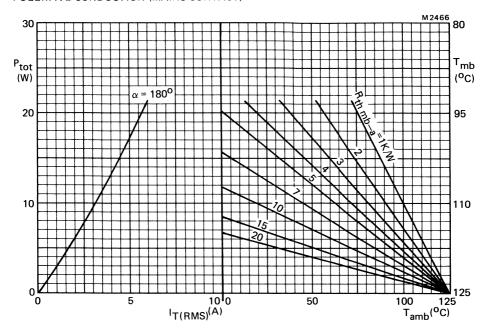
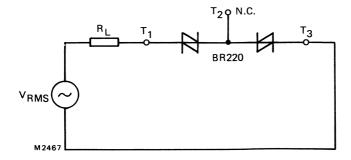


Fig.7 The right-hand part shows the interrelationship between the power (derived from the left-hand part) and the maximum permissible temperatures.

 $\alpha$  = 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**

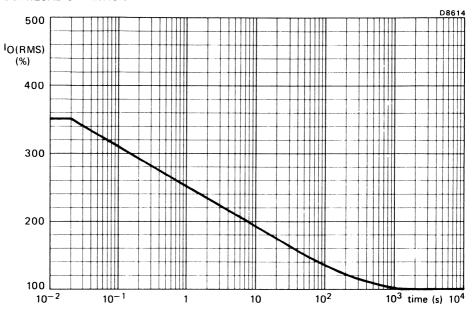


Fig.8 Maximum permissible duration of steady overload (provided that T<sub>mb</sub> does not exceed 120 °C during and after overload) expressed as a percentage of the steady state r.m.s. rated current. For high r.m.s. overload currents precautions should be taken so that the temperature of the terminals 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.

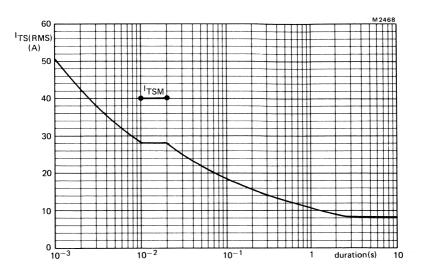
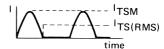


Fig.9 Maximum permissible non-repetitive r.m.s. on-state current based on sinusoidal currents (f = 50 Hz),  $T_j$  = 125  $^{\rm OC}$  prior to surge.



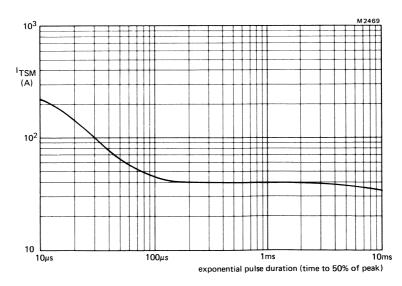


Fig. 10 Maximum non-repetitive exponential waveform Impulse Current rating as a function of pulse duration.

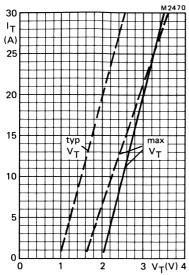


Fig. 11 On-state voltage as a function of on-state current. (200  $\mu$ s pulsed condition to avoid excessive dissipation)

T<sub>i</sub> = 25, --- T<sub>i</sub> = 125 °C.

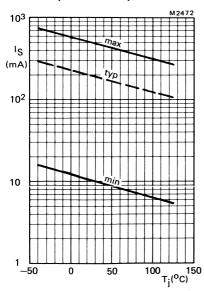


Fig. 13 Switching current as a function of temperature; ——  $T_j$  = 25 °C; — —  $T_j$  = 125 °C.

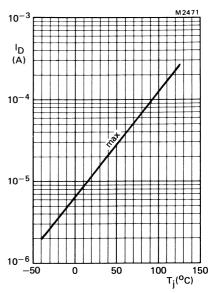


Fig.12 Maximum off-state current as a function of temperature.

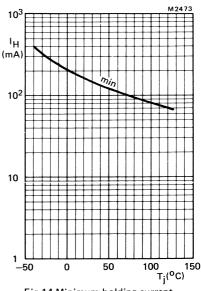


Fig.14 Minimum holding current as a function of temperature.

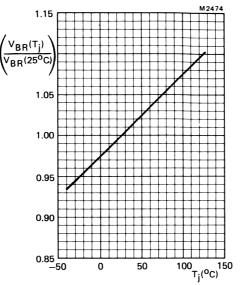


Fig.15 Normalised avalanche breakdown voltage as a function of temperature. Note: this figure may also be used to derive normalised VBO.

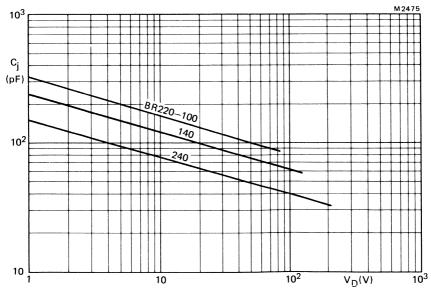


Fig.16 Typical junction capacitance as a function of off-state voltage; T<sub>i</sub> = 25 °C; f = 1 MHz.

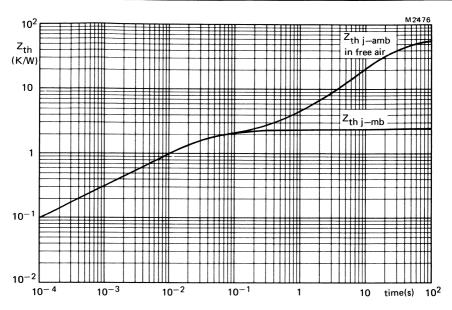


Fig.17 Transient thermal impedance as a function of time (rectangular pulse duration).

# **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:

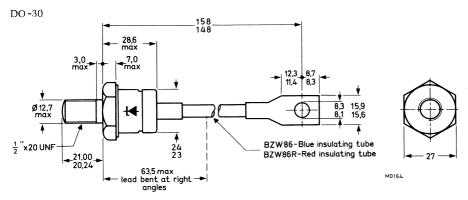
Normal polarity (cathode to stud): BZW86-7V5 to 56 Reverse polarity (anode to stud): BZW86-7V5R to 56R

QUICK REFERENCE DATA							
$v_R$	7,5 to <b>56</b>	V					
V <sub>(BR)R</sub>	9,4 to <b>64</b>	V					
P <sub>RSM</sub> ma:	x. 25	kW					
	V <sub>R</sub> V <sub>(BR)R</sub>	V <sub>R</sub> 7,5 to 56 V <sub>(BR)R</sub> 9,4 to 64					

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



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 Absolu	te Maxi	mum System (	(IEC134)
Stand-off voltage *	$v_R$		to type numbei	
Currents				
Non-repetitive peak reverse current				
$T_j = 25$ °C prior to surge				
t <sub>p</sub> = 10 μs; square pulse				
BZW86-9V1(R)	<sup>I</sup> RSM	max.	3700	Α
BZW86 -27(R)	<sup>I</sup> RSM	max.	1200	Α
BZW86-56(R)	<sup>I</sup> RSM	max.	700	Α
$t_p = 1 \text{ ms}$ ; exponential pulse				
BZW86-9V1(R)	IRSM	max.	1200	Α
BZW86-27(R)	I <sub>RSM</sub>	max.	400	A
BZW86-56(R)	IRSM	max.	250	A
Power dissipation				
Repetitive peak reverse power dissipation $T_{mb} = 65$ °C; $f = 50$ Hz; $t_p = 10 \mu s$ (square				
pulse; see also graphs on page 664)	PRRM	max.	50	kW
Non-repetitive peak reverse power dissipation $T_j = 25$ °C prior to surge; exponential pulse; see also graph on page 663				
$t_p = 100 \mu s$	PRSM	max.	60	kW
$t_p = 1 \text{ ms}$	PRSM	max.	25	kW
Temperatures				
Storage temperature	$T_{ m stg}$		<b>-</b> 55 to +175	$^{\mathrm{o}}\mathrm{C}$
Junction temperature	$T_{j}$	max.	175	$^{\mathrm{o}}\mathrm{C}$
THERMAL RESISTANCE				
From junction to mounting base	R <sub>th j-mb</sub>	= ,	0, 3	°C/W
From mounting base to heatsink	R <sub>th mb-h</sub>	=	0, 1	°C/W
CHARACTERISTICS				
Forward voltage				
$I_F = 500 \text{ A at } T_j = 25 ^{\circ}\text{C}$	$v_F$	<	1,5	v **

<sup>\*</sup> The stand-off voltage is the maximum reverse voltage recommended for continuous operation; at this value non-conduction is ensured.

<sup>\*\*</sup> Measured under pulse condition.

661

# CHARACTERISTICS (continued)

	Clamping volta at $T_j = 25$ °C $V_{ij}$		Reverse breakdown voltage at $T_j = 25$ °C $V_{(BR)R}$ (V)		
	typ.	max.		min.	2
BZW86 -7V5(R)	12	14		8,5	
-8V2(R)	13	15,5		9, 4	
-9V1(R)	14	17		10,4	
-10(R)	15,5	18,5	. T 1000 A	11,4	T - 10 A
-11(R)	17	20	$I_{R} = 1000 \text{ A}$	12,4	$I_R = 10 A$
-12(R)	18,5	22		13,8	
-13(R)	20	24		15,3	
-15(R)	23	27		16,8	
-16(R)	27	32		18,8	
-18(R)	31	36		20,8	
-20(R)	34	40	T - 500 A	22,8	$I_R = 5 A$
-22(R)	37	43	$I_R = 500 A$	25, 1	1R - 3 A
-24(R)	40	47		28	
-27(R)	44	52		31	
-30(R)	47	55	1	34	
-33(R)	51	60		37	1
-36(R)	55	65		40	
-39(R)	60	70	T = 250 A	44	I <sub>R</sub> = 2 A
-43(R)	66	77	$I_{R} = 250 \text{ A}$	48	1R -2 A
<b>-4</b> 7(R)	72	84		52	ſ
-51(R)	78	92		58	
-56(R)	85	102		64	
		I	ļ	1	ļ

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.

Max 1978

#### CHARACTERISTICS (continued)

 $T_i = 25$  OC unless otherwise specified

### Peak reverse current

#### **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:

Rth j-mb + Rth mb-h + Rth h-a = 
$$\frac{T_{j \text{ max}} - T_{amb}}{P_{s} + \delta. P_{RRM}}$$

where T<sub>i max</sub>

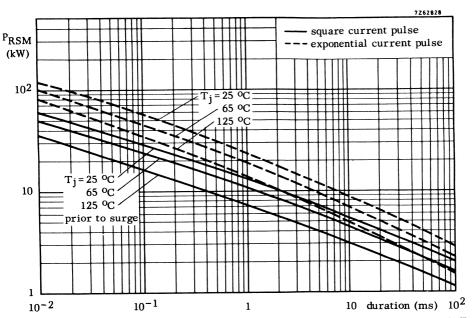
$$max = 175 ^{O}C$$

$$\delta$$
 = duty factor  $(t_p/T)$ 

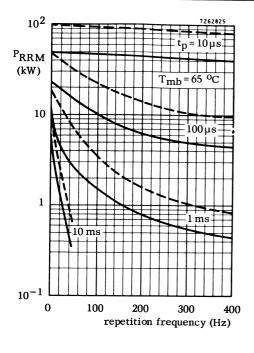
$$R_{th j-mb} = 0.3 \text{ }^{\circ}\text{C/W}$$

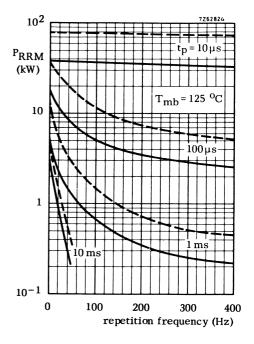
$$R_{th mb-h} = 0.1 \, {}^{\circ}C/W$$

thus Rth h-a can be found.

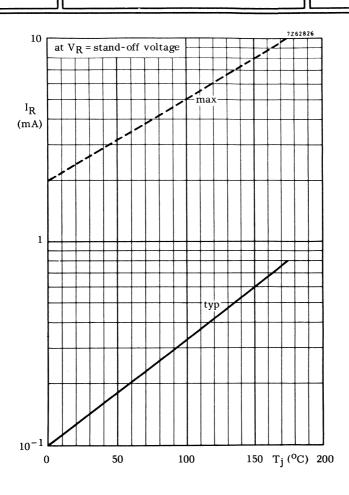


Duration of an exponential pulse is defined as the time taken for the pulse to fall to 37% of its initial value. It is assumed that the energy content does not continue beyond twice this time.

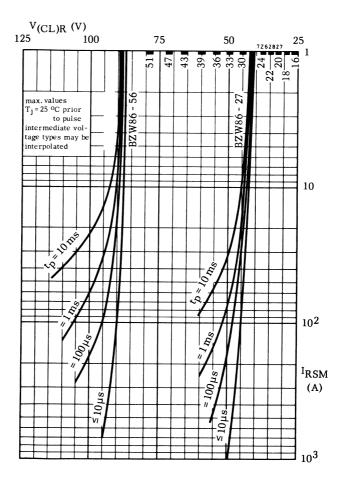




- ---- square current pulses
- --- exponential current pulses

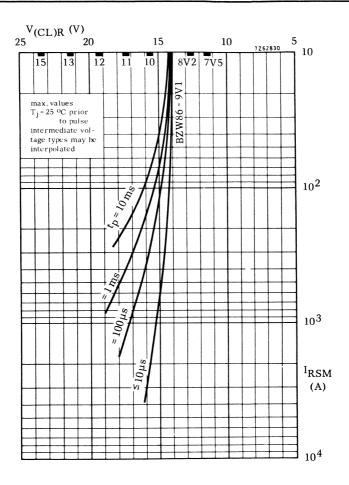


July 1972 665



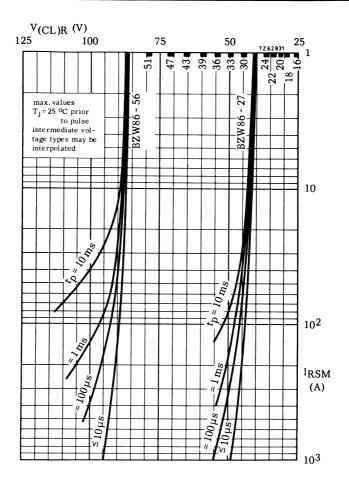
square pulses

666 || Into 1079



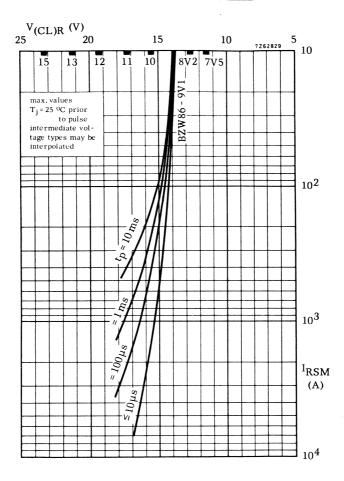
square pulses

Tuly 1972 | 667



exponential pulses

aaa II taan



exponential pulses

July 1972 669



# **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

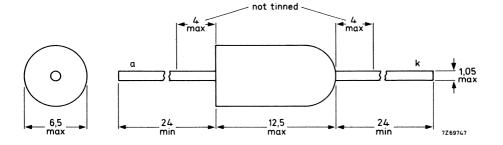
			voltage regulator	transient suppress	or
Working voltage (5% range)	$V_{Z}$	nom.	7,5 to 75		V
Stand-off voltage	$v_R$		_	5,6 to 56	V
Total power dissipation	$P_{tot}$	max.	2,5	_	W
Non-repetitive peak reverse power dissipation	PRSM	max.	_	700	W

#### **MECHANICAL DATA**

Dimensions in mm

Fig. 1 SOD-18.

The rounded end indicates the cathode.





# **BZX70 SERIES**

### **RATINGS**

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

Peak working current	IZM	max.	5	Α
Average forward current (averaged over any 20 ms period)	lF(AV)	max.	1	Α
Non-repetitive peak reverse current $T_j = 25$ °C prior to surge; $t_p = 1$ ms (exponential pulse); BZX70-C7V5 to BZX70-C75	<sup>1</sup> RSM	max. 4	4 to 6	Α
Total power dissipation at $T_{amb} = 25$ °C; with 10 mm tie-points; Fig. 5	P <sub>tot</sub>	max.	2,5	w
Non-repetitive peak reverse power dissipation $T_j = 25$ °C prior to surge; $t_p = 1$ ms (exponential pulse)	P <sub>RSM</sub>	max.	700	w
Storage temperature	T <sub>stg</sub>	-55 to	+ 150	οС
Junction temperature	Tj	max.	150	οС
THERMAL RESISTANCE				

From junction to ambient in free air see Figs 4 and 5

#### **CHARACTERISTICS**

Forward voltage  $I_F = 1 \text{ A}; T_{amb} = 25 \text{ }^{\circ}\text{C}$ < 1,5 V ٧F

#### OPERATION AS A VOLTAGE REGULATOR (see page 4)

Dissipation and heatsink considerations

a. Steady-state conditions

The maximum permissible steady-state dissipation P<sub>s max</sub> is given by the relationship

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

where: Timax is the maximum permissible operating junction temperature

Tamb is the ambient temperature

Rth i-a is the total thermal resistance from junction to ambient

b. Pulse conditions (see Fig. 2)

The maximum permissible pulse power Pp max is given by the formula

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

where: Ps is any steady-state dissipation excluding that in pulses

R<sub>th t</sub> 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  $\delta. \label{eq:delta_pulse}$ 

 $\delta$  is the duty factor (t<sub>D</sub>/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).

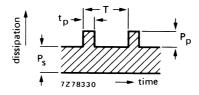


Fig. 2.

# NOTES WHEN OPERATING AS A TRANSIENT SUPPRESSOR (see page 675)

- 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.
- 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.
- 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  $^{o}$ C

BZX70	working voltage *VZ V		differential resistance *rZ Ω		temperature coefficient *SZ mV/°C	reverse reverse current at voltage  IR VR  μΑ V		$V_{R}$
	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	0.45	4.0	5.5	50	10	6.2
C10	9.4	10.6	0.75	4.0	7.0	50 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 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	<b>2</b> 5	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

<sup>\*</sup>At test I<sub>Z</sub>; measured using a pulse method with t<sub>p</sub>  $\leq$  100  $\mu s$  and  $\delta \leq$  0.001 so that the values correspond to a T<sub>j</sub> of approximately 25  $^{o}C$ .

CHARACTERISTICS - WHEN USED AS TRANSIENT SUPPRESSOR DIODES; Tamb = 25 °C

clamping at voltage t <sub>p</sub> = 500 μs exp. pulse V(CL)R		non-repetitive peak reverse current	at recor	current nmended if voltage	
		IRSM A	I <sub>R</sub> mA	V <sub>R</sub> 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**

- 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.
- Care should be taken not to bend the leads nearer than 1,5 mm from the seal; exert no axial pull when bending.

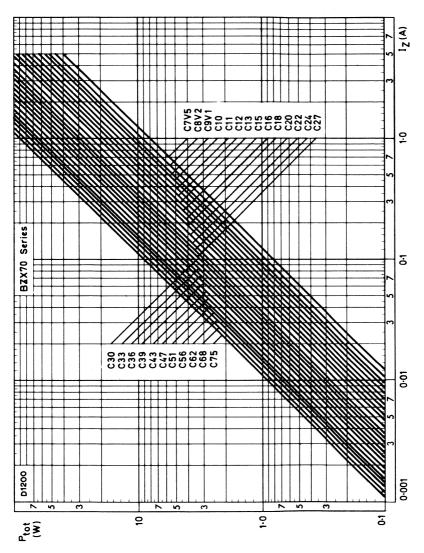


Fig. 3 Maximum permissible repetitive peak dissipation ( $P_{tot} = P_ZRM$ ).

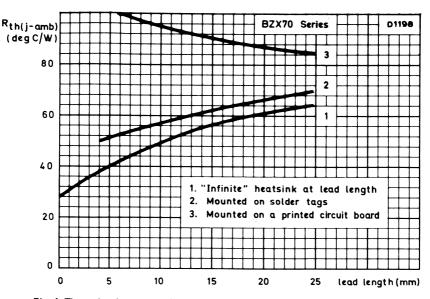


Fig. 4 Thermal resistance as a function of lead length under various mounting conditions.

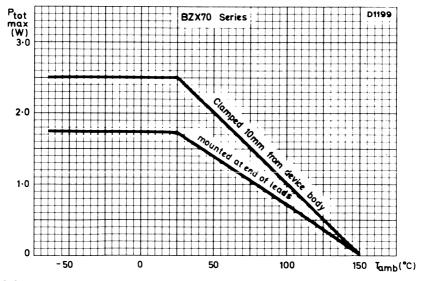


Fig. 5 Maximum permissible power dissipation; the top curve is for mounting method 1 from Fig. 4 at 10 mm lead length.

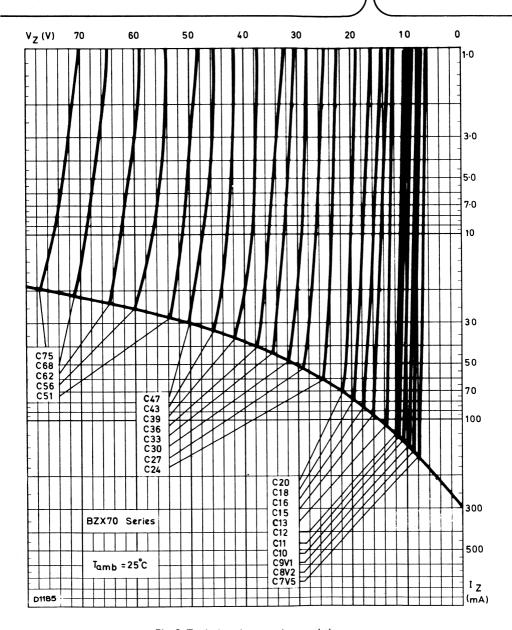


Fig. 6 Typical static zener characteristics.

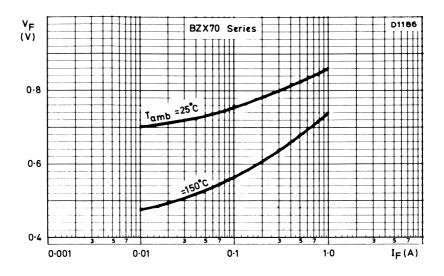


Fig. 7.

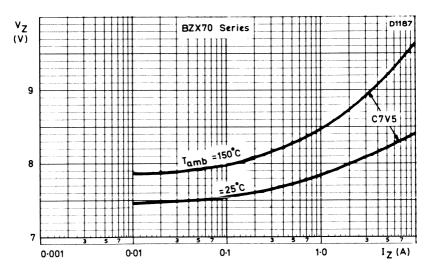


Fig. 8 Typical dynamic zener characteristics for BZX70-C7V5.

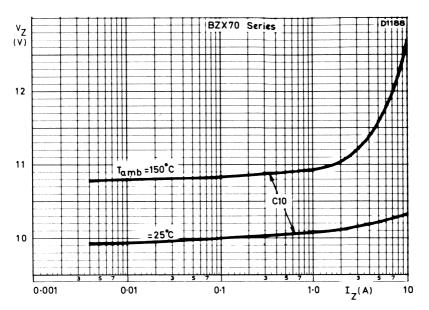


Fig. 9 Typical dynamic zener characteristics for BZX70-C10.

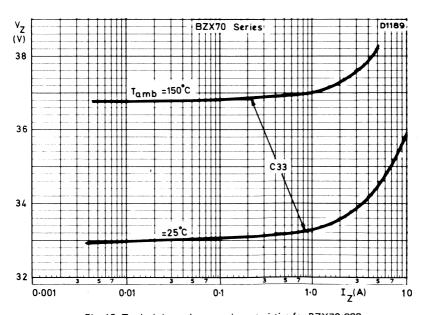


Fig. 10 Typical dynamic zener characteristics for BZX70-C33.

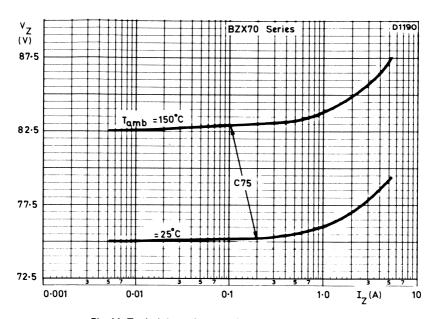
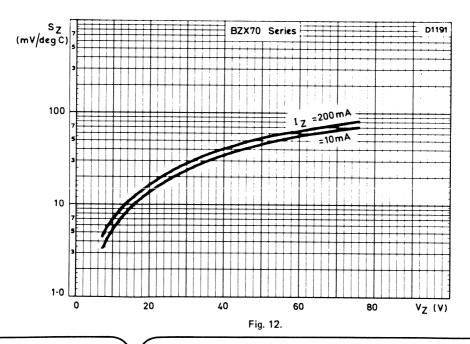
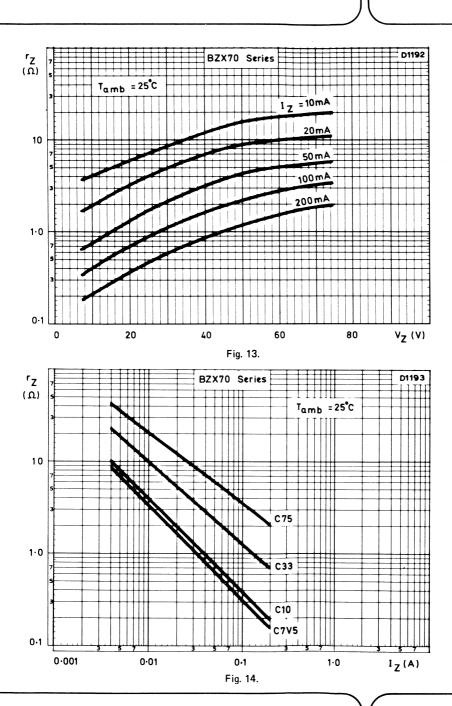


Fig. 11 Typical dynamic zener characteristics for BZX70-C75.





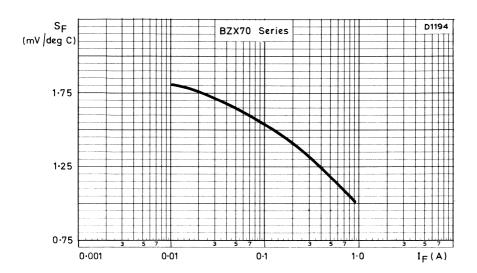


Fig. 15 Typical values.

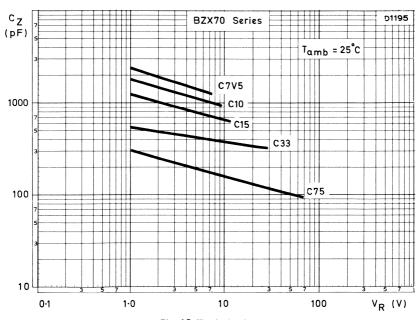


Fig. 16 Typical values.

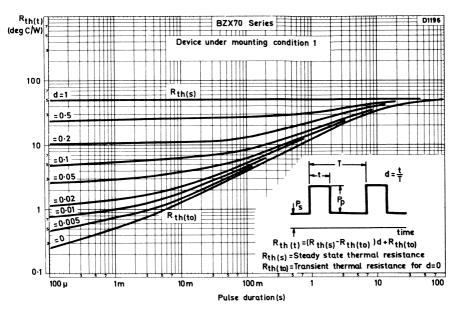


Fig. 17 Device under mounting condition 1 (infinite heatsink); see Fig. 4.

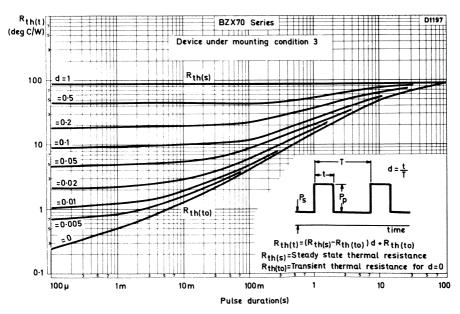


Fig. 18 Device under mounting method 3 (mounted on a printed-circuit board); see Fig. 4.

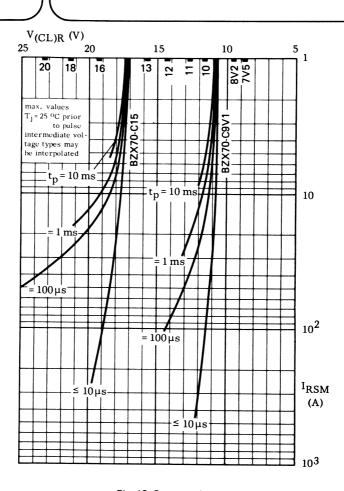


Fig. 19 Square pulses.

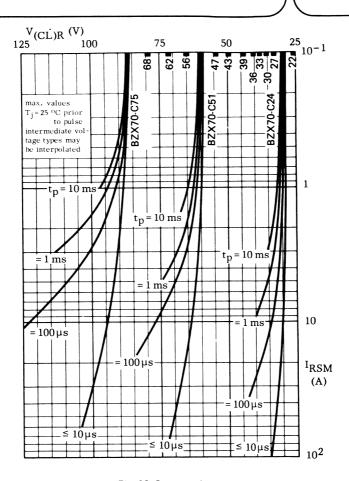


Fig. 20 Square pulses.

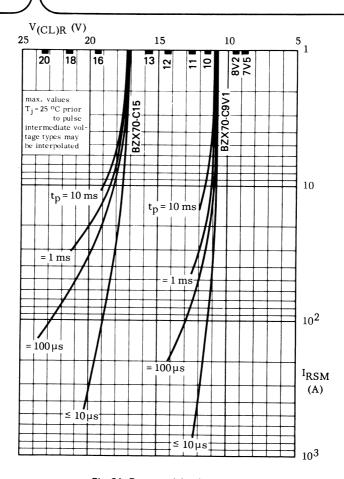


Fig. 21 Exponential pulses.

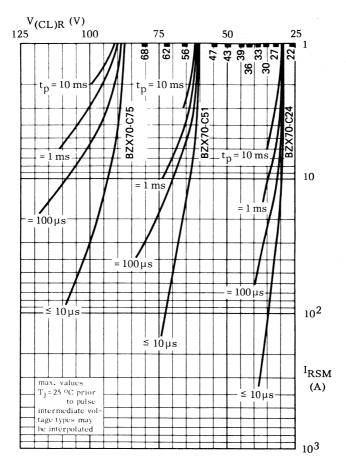
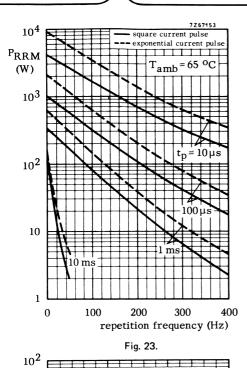
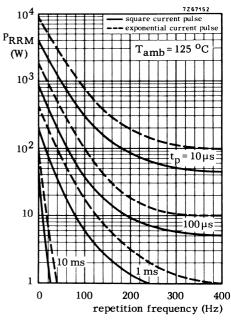
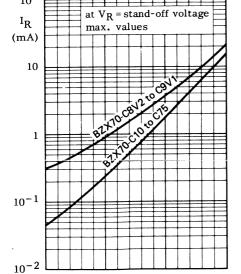


Fig. 22 Exponential pulses.







50

100

Fig. 25.

T<sub>j</sub> (<sup>o</sup>C)

150

Fig. 24.

0

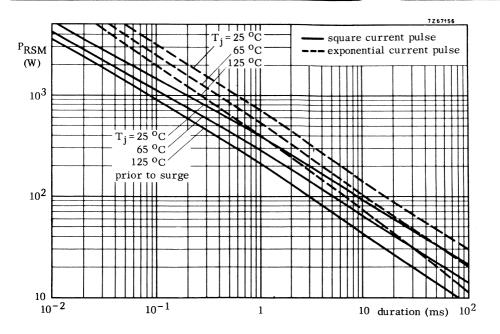


Fig. 26.

## **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.

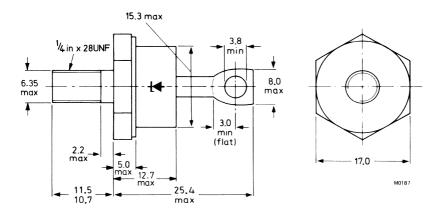
#### QUICK REFERENCE DATA

			voltage regulator	transient suppress	or
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	PRSM	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 Syste	m (IEC 134)
--	------------------------	-------------

Peak working current	Izm	max.	400	Α
Average forward current (averaged over any 20 ms period)	JF(AV)	max.	20	Α
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)	<sup>I</sup> RSM	max.	1000 to 85	A
Total power dissipation up to T <sub>mb</sub> = 25 °C at T <sub>mb</sub> = 65 °C	P <sub>tot</sub>	max.	100 75	
Non-repetitive peak reverse power dissipation $T_j = 25$ °C prior to surge; $t_p = 1$ ms (exponential pulse)	PRSM	max.	9,5	kW
Storage temperature	T <sub>stg</sub>		-55 to + 175	
Junction temperature	Тj	max.	175	٥٢
THERMAL RESISTANCE				
From junction to mounting base	R <sub>th j-mb</sub>	=	1,5	oC/W
From mounting base to heatsink	R <sub>th mb-h</sub>	=	0,2	oC/W
CHARACTERISTICS				
Forward voltage I <sub>F</sub> = 10 A; T <sub>mb</sub> = 25 °C	VF	<	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<sub>s max</sub> is given by the relationship

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

where: Timax is the maximum permissible operating junction temperature

Tamb is the ambient temperature

R<sub>th i-a</sub> is the total thermal resistance from junction to ambient

$$R_{th j-a} = R_{th j-mb} + R_{th mb-h} + R_{th h-a}$$

 $R_{th\ mb-h}$  is the thermal resistance from mounting base to heatsink, that is, 0,2 °C/W.

Rth h-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  $\Delta T$  is in addition to the mean heating effect. The value of  $\Delta T$  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:

$$R_{th j-a} = \frac{T_{j max} - T_{amb} - \Delta T}{P_s + \delta \cdot P_D}$$

where: Ti max = 175 °C

 $T_{amb}$  = ambient temperature  $\Delta T$  = from Fig. 5 or 6

P<sub>s</sub> = any steady-state dissipation excluding that in pulses

P<sub>p</sub> = peak pulse power

 $\delta$  = duty factor  $(t_D/T)$ 

 $R_{th j-a} = R_{th j-mb} + R_{th mb-h} + R_{th h-a} = 1.5 + 0.2 + R_{th h-a} \circ C/W$ .

Thus Rth h-a can be found.

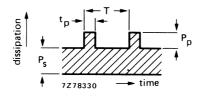


Fig. 2.

## **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:

$$R_{th j-mb} + R_{th mb-h} + R_{th h-a} = \frac{T_{j max} - T_{amb}}{P_s + \delta \cdot P_{RRM}}$$

where:  $T_{j max} = 175 \, {}^{\circ}\text{C}$ 

T<sub>amb</sub> = ambient temperature

P<sub>s</sub> = any steady-state dissipation excluding that in pulses

 $\delta$  = duty factor  $(t_p/T)$ 

 $R_{th j-mb} = 1.5 \, {}^{\circ}\text{C/W}$  $R_{th mb-h} = 0.2 \, {}^{\circ}\text{C/W}$ 

Thus R<sub>th h-a</sub> 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.
- 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.
- 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  $^{\rm o}$ C

BZY91	working voltage *Vz V		differential resistance *rz Ω	temperature coefficient *SZ %/°C	test I <sub>Z</sub>	reverse current IR mA	reverse voltage VR 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

<sup>\*</sup>At test I<sub>Z</sub>; measured using a pulse method % 100 with tp  $\leq 100~\mu s$  and  $\delta \leq 0.001$  so that the values correspond to a Tj of approximately 25 °C.

 $\label{eq:characteristics} \textbf{CHARACTERISTICS} - \textbf{WHEN USED AS TRANSIENT SUPPRESSOR DIODES; T}_{mb} = 25~^{o}\text{C}$ 

9.5 1 10 11 1 12 1 13 14.5 16 17.5 19 22 24			etitive reverse current everse at recommended ent stand-off voltage			
9.5 1 10 11 1 12 1 13 14.5 16 17.5 19 22 24	₹	IRSM A	I <sub>R</sub> V <sub>R</sub> mA V		BZY91	
9.5 1 10 11 1 12 1 13 14.5 16 17.5 19 22 24	nax.		max.			
10 11 1 12 1 13 14.5 16 17.5 19 22 24	_	_	-	_	C7V5(R)	
11 1 12 1 13 14.5 16 17.5 19 22 24	10.5	150	20	6.2	C8V2(R)	
12 1 13 14.5 16 17.5 19 22 24	11	150	20	6.8	C9V1(R)	
13 14.5 16 17.5 19 22 24	12.5	150	5	7.5	C10(R)	
14.5 16 17.5 19 22 24	13.5	150	5	8.2	C11(R)	
16 17.5 19 22 24	15	150	5	9.1	C12(R)	
17.5 19 22 24	17	150	5	10	C13(R)	
19 22 24	19	150	5	11	C15(R)	
22 24	22	150	5	12	C16(R)	
24	26	150	5	13	C18(R)	
	28	100	5	15	C20(R)	
	31	100	5	16	C22(R)	
26	34	100	5	18	C24(R)	
28	37	100	5	20	C27(R)	
31 <sup>.</sup>	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)	

# **BZY91 SERIES**

## 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.

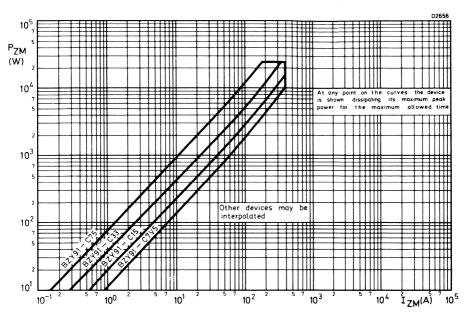


Fig. 3.

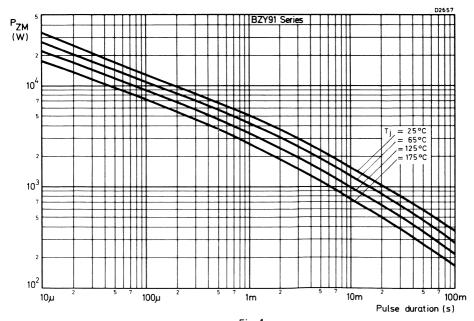


Fig. 4.

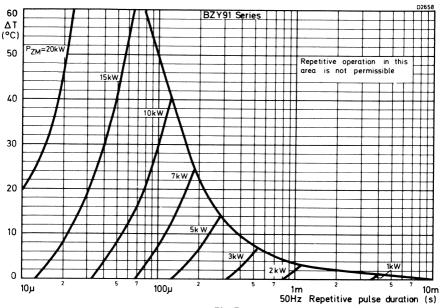


Fig. 5.

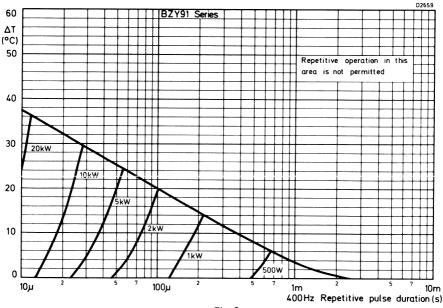
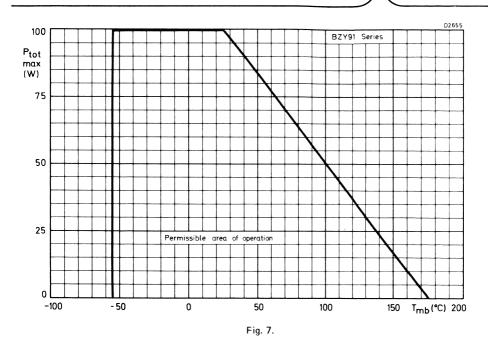


Fig. 6.



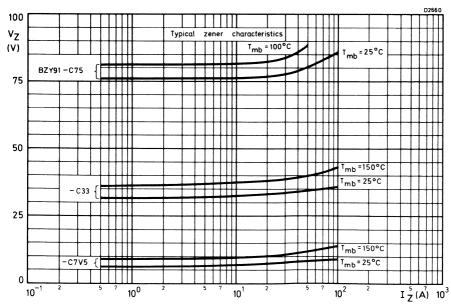


Fig. 8 Typical dynamic zener characteristics.

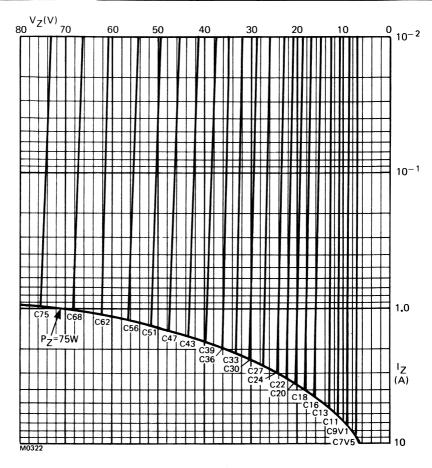
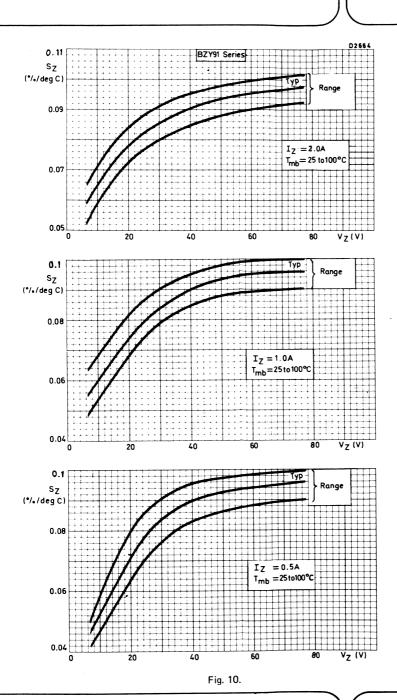
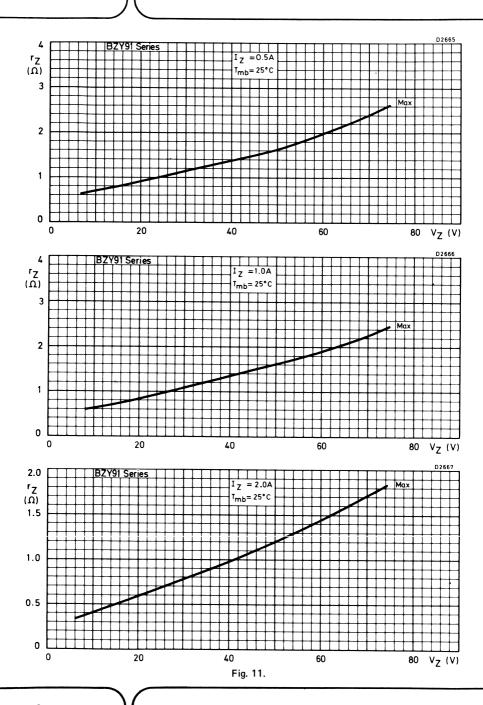


Fig.9 Typical static zener characteristics,  $T_{mb}$  = 25  $^{o}$ C





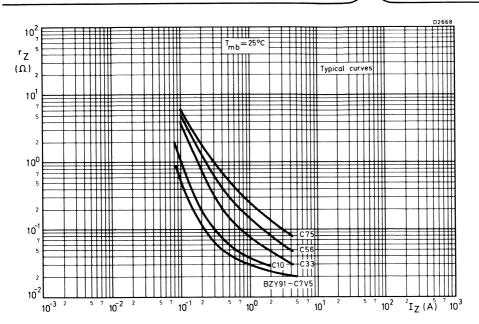


Fig. 12.

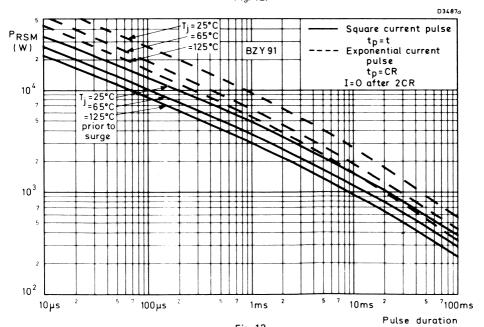
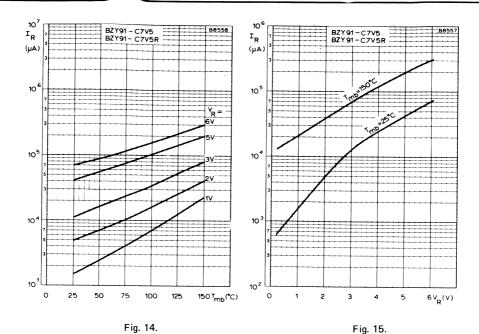
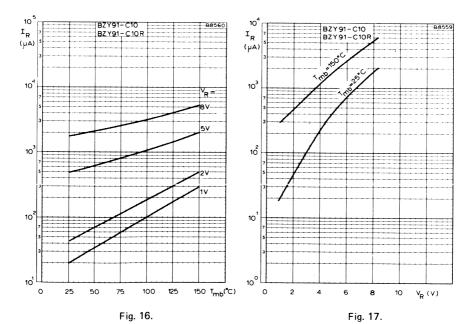
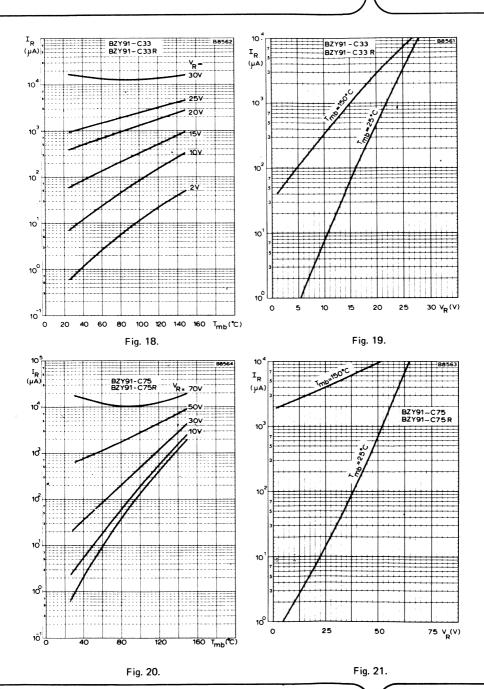


Fig. 13.







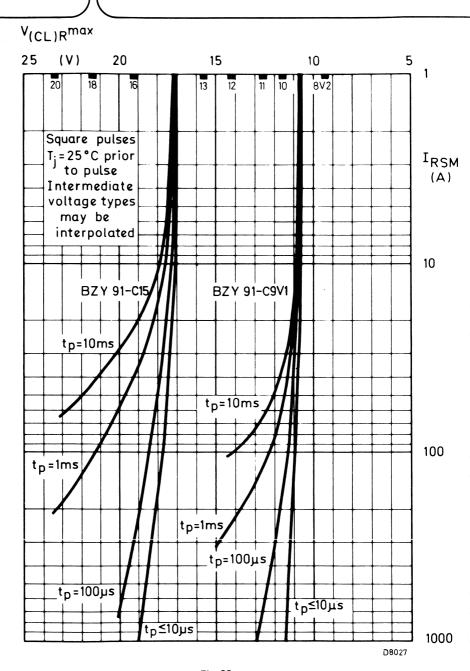


Fig. 22.

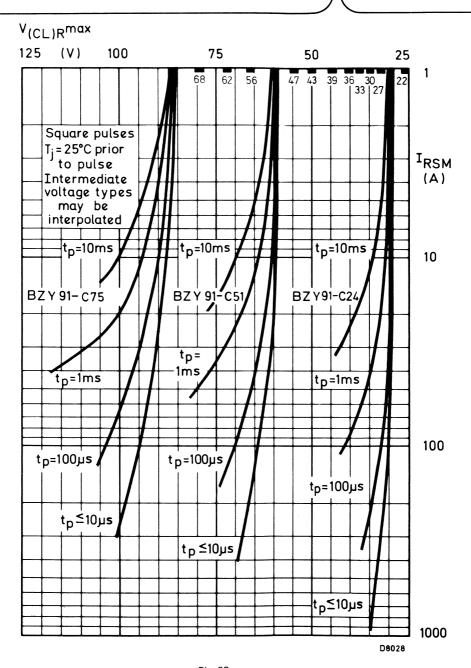


Fig. 23.

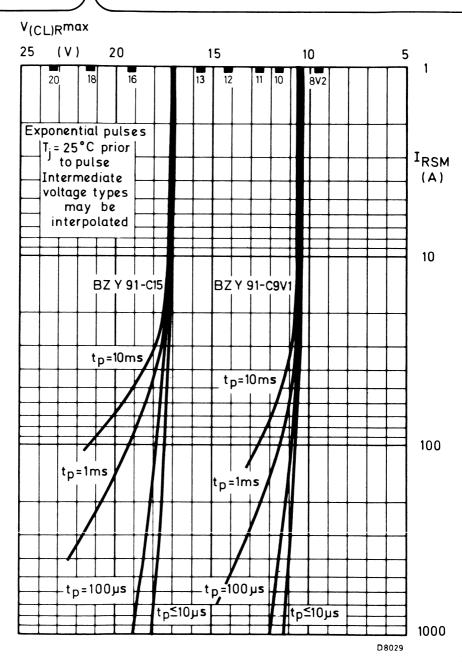


Fig. 24.

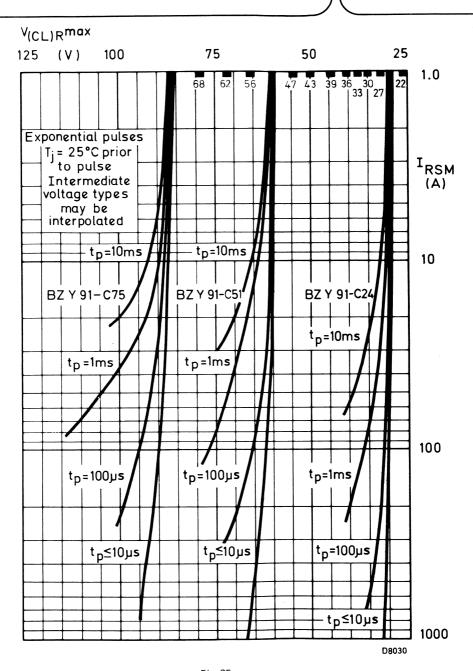
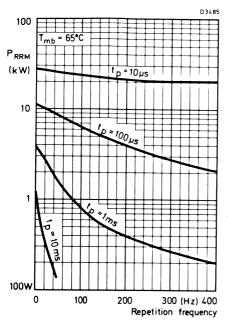
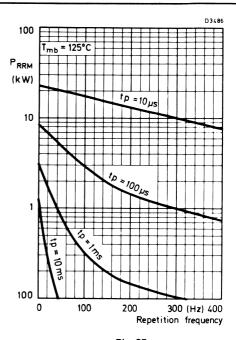


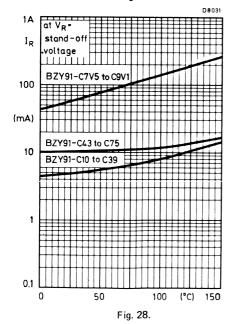
Fig. 25.











## **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.

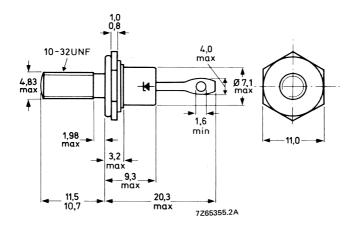
#### QUICK REFERENCE DATA

			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	ı— "	W
Non-repetitive peak reverse power dissipation	P <sub>RSM</sub>	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)

## **BZY93 SERIES**

#### RATINGS

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

	0,000 (120 10	.,		
Peak working current	<sup>I</sup> ZM	max.	20	Α
Average forward current (averaged over any 20 ms period)	<sup>I</sup> F(AV)	max.	5	Α
Non-repetitive peak reverse current $T_j = 25$ °C prior to surge; $t_p = 1$ ms (exponential pulse); BZY93-C7V5(R) to BZY93-C75(R)	I <sub>RSM</sub>	max.	55 to 6	A
Total power dissipation up to T <sub>mb</sub> = 75 °C	P <sub>tot</sub>	max.	20	w
Non-repetitive peak reverse power dissipation $T_j = 25$ °C prior to surge; $t_p = 1$ ms (exponential pulse)	PRSM	max.	700	w
Storage temperature	T <sub>stg</sub>		to + 175	
Junction temperature	rstg T <sub>j</sub>	max.	175	
THERMAL RESISTANCE				
From junction to mounting base	R <sub>th i-mb</sub>	=	5	oC/W
From junction to ambient	R <sub>th j-a</sub>	=	50	oC/W
From mounting base to heatsink (minimum torque: 0,9 Nm)	R <sub>th mb-h</sub>	=	0,6	oC/W
CHARACTERISTICS				
Forward voltage I <sub>F</sub> = 5 A; T <sub>mb</sub> = 25 °C	٧ <sub>F</sub>	<	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  ${\rm P}_{\rm S\,max}$  is given by the relationship

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

where:  $T_{i \text{ max}}$  is the maximum permissible operating junction temperature

Tamb is the ambient temperature

Rth i-a is the total thermal resistance from junction to ambient

$$R_{th j-a} = R_{th j-mb} + R_{th mb-h} + R_{th h-a}$$

R<sub>th mb-h</sub> is the thermal resistance from mounting base to heatsink, that is, 0,6 °C/W.

R<sub>th h-a</sub> is the thermal resistance of the heatsink.

b. Pulse conditions (see Fig. 2)

The maximum permissible pulse power  $P_{\mbox{\footnotesize p}\mbox{\footnotesize max}}$  is given by the formula

$$P_{p\;max} = \frac{(T_{j\;max} - T_{amb}) - (P_s \cdot R_{th\;j \cdot a})}{R_{th\;t} + \delta \cdot R_{th\;mb \cdot a}}$$

where: Ps 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  $t_{D}$  and duty factor  $\delta$ .

 $\delta$  is duty factor (t<sub>D</sub>/T)

 $R_{th\ mb-a}$  is the total thermal resistance between the mounting base and ambient ( $R_{th\ mb-a}=R_{th\ mb-h}+R_{th\ h-a}$ ).

The steady-state power  $P_s$  when biased in the zener direction at a given zener current can be found from 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).

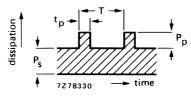


Fig. 2.

## **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:  $T_{i max} = 175 \text{ }^{\circ}\text{C}$ 

T<sub>amb</sub> = ambient temperature

P<sub>s</sub> = any steady-state dissipation excluding that in pulses

 $\delta$  = duty factor  $(t_p/T)$ 

 $R_{th j-mb} = 5 \, {}^{\circ}C/W$ 

 $R_{th\ mb-h} = 0.6\ ^{o}C/W$ Thus  $R_{th\ h-a}$  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.
- 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.
- 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  $^{o}$ C

BZY93	working voltage *Vz V		differential resistance *rZ Ω		temperature coefficient *SZ mV/°C	test I <sub>Z</sub>	reverse current I <sub>R</sub> μA	reverse at voltage VR V
	min.	max.	typ.	max.	typ.		max.	
C7V5(R)	7.0	7.9	0.04	0.3	3.0	2.0	100	20
C8V2(R)	7.7	7. <del>9</del> 8.7	0.04	0.3	4.0	2.0	100	2.0 5.6
C9V1(R)	8.5	9.6	0.05	0.5 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
C10(II)	10.4	11.6	0.07	1.0	7.0 7.5	1.0	50	7.5
C11(R)	11.4	12.7	0.08	1.0	8.0	1.0	50	8.2
C12(II)	12.4	14.1	0.08	1.0	8.5	1.0	50	9.1
C15(R)	13.8	15.6	0.08	1.2	10	1.0	50	10
C15(R)	15.3	17.1	0.10	1.2	11	0.5	50	11
C18(R)	16.8	19.1	0.18	1.5	12	0.5	50	12
C20(R)	18.8	21.2	0.2	1.5	14	0.5	50	13
C20(II)	20.8	23.3	0.21	1.8	16	0.5	50	15
C24(R)	22.7	25.9	0.21	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	0.23	2.5	25	0.5	50	20
C33(R)	31	35	0.32	3.0	30	0.5	50	20
C36(R)	34	38	0.75	4.0	32	0.3	50	24
C39(R)	37	41	0.75	5.0	35	0.2	50	27
C43(R)	40	46	0.90	6.5	40	0.2	50	30
C43(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
C51(R)	<del>5</del> 2	60	1.3	8.0	55 55	0.2	50	39
C62(R)	52 58	66	1.5	9.0	60	0.2	50	43
C62(R)	64	72	1.8	10	65	0.2	50	47
C75(R)	70	72 79	2.0	10.5	70	0.2	50	51

<sup>\*</sup>At test I<sub>Z</sub>; measured using a pulse method with t<sub>p</sub>  $\leq$  100  $\mu$ s and  $\delta$   $\leq$ 0.001 so that the values correspond to a T<sub>j</sub> of approximately 25 °C.

CHARACTERISTICS - WHEN USED AS TRANSIENT SUPPRESSOR DIODES; T<sub>mb</sub> = 25 °C

volt t <sub>p</sub> = 5	clamping non-repetitive voltage at peak reverse y= 500 \( \mu \)s current xp. pulse		reverse at recom stand-of				
V <sub>(C</sub>	L)R	IRSM A	I <sub>R</sub> mA	V <sub>R</sub> V	BZY93		
typ.	max.		max <sub>.</sub>				
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)		

## **BZY93 SERIES**

#### 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.

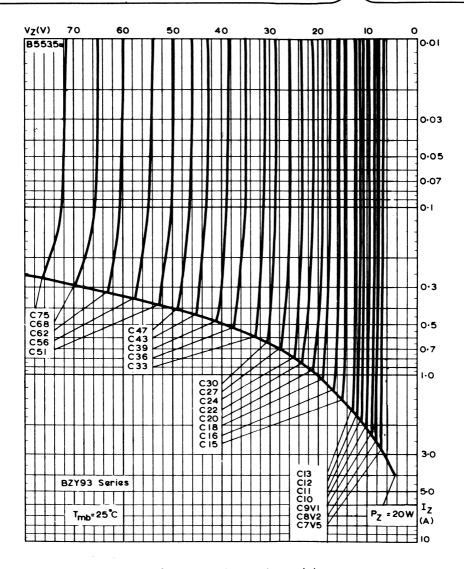


Fig. 3 Typical static zener characteristics.

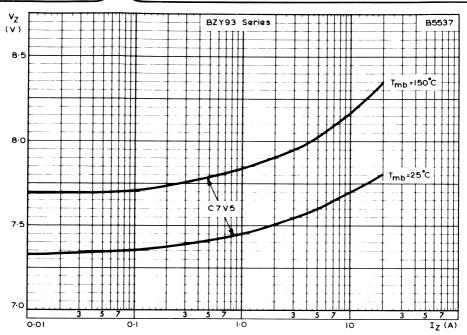


Fig. 4 Typical dynamic zener characteristics for BZY93-C7V5.

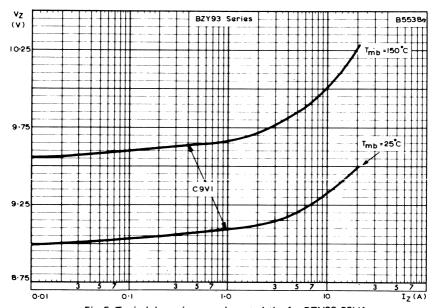


Fig. 5 Typical dynamic zener characteristics for BZY93-C9V1.

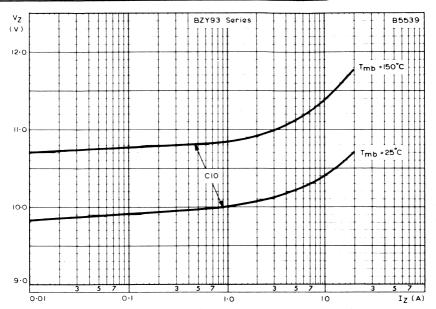


Fig. 6 Typical dynamic zener characteristics for BZY93-C10.

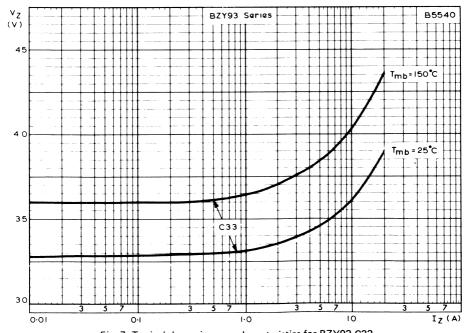


Fig. 7 Typical dynamic zener characteristics for BZY93-C33.

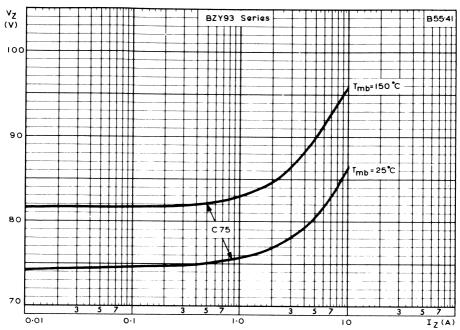
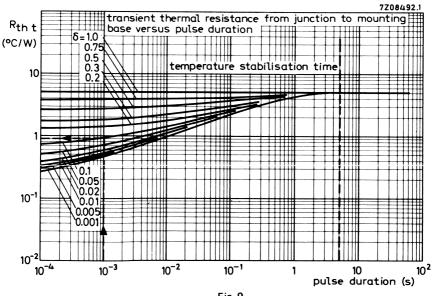
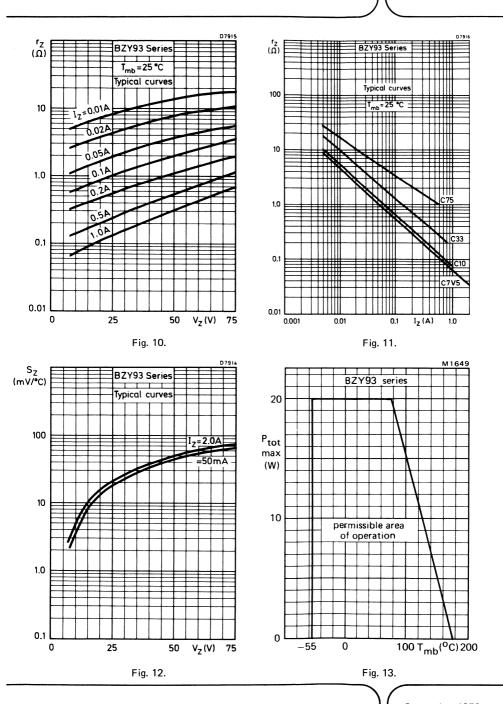


Fig. 8 Typical dynamic zener characteristics for BZY93-C75.





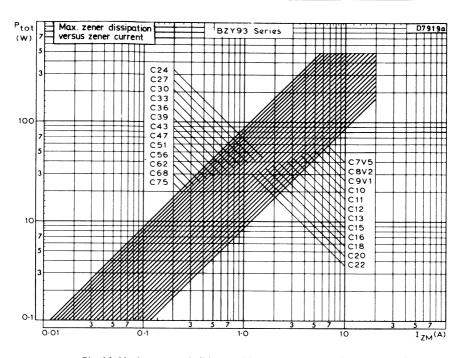


Fig. 14 Maximum permissible repetitive peak dissipation ( $P_{tot} = P_{ZRM}$ ).

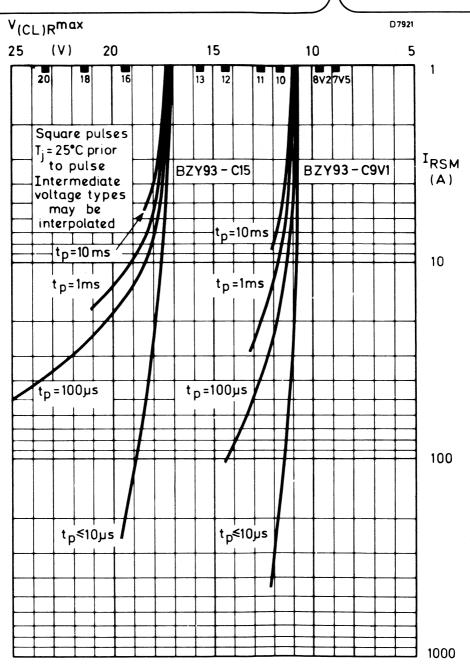
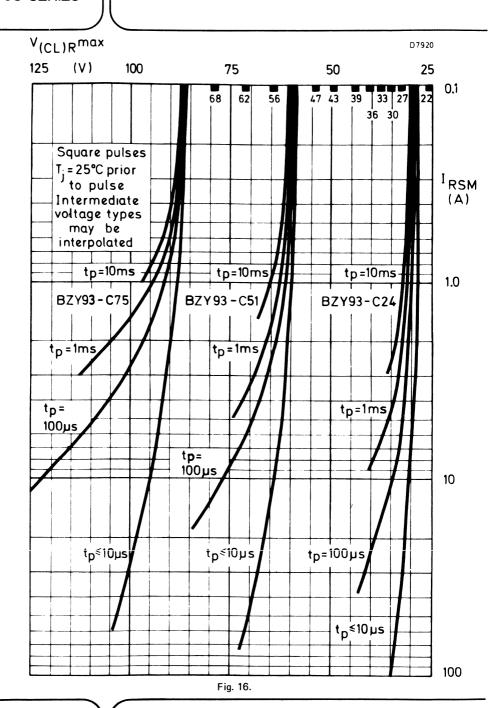


Fig. 15.



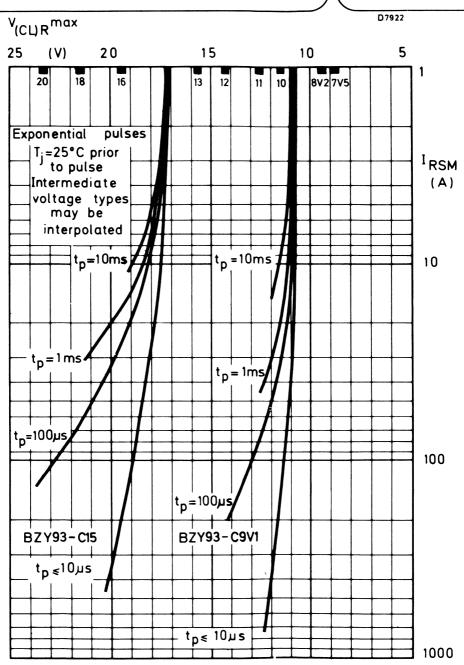
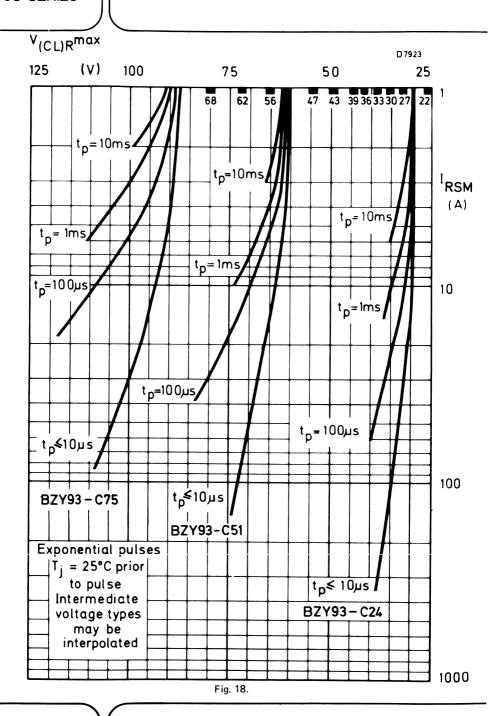
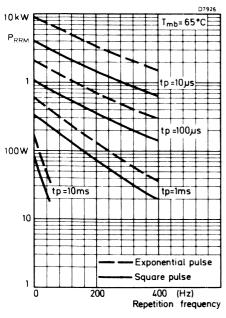
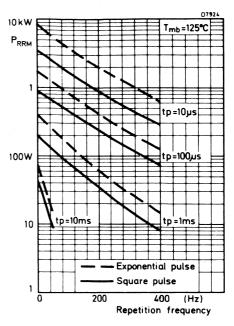


Fig. 17.









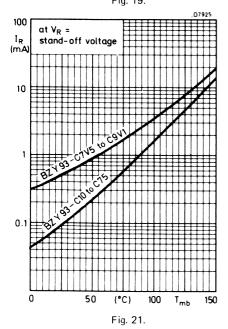


Fig. 20.

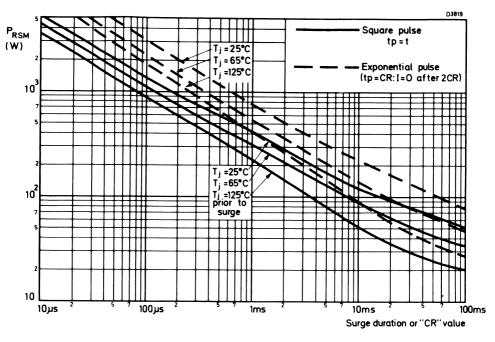


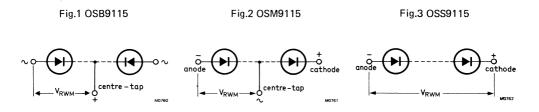
Fig. 22.

# HIGH VOLTAGE RECTIFIER STACKS

## 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:



#### QUICK REFERENCE DATA

6 6
<u> </u>
' kV
3
↓ kV
Α
Α
Α
•

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 OSM9115 -4	-6   -6	-34 -36  -34 -36	
Crest working reverse voltage	$V_{RWM}$	max. 3	4.5	25.5 27	kV
		OSS9115 -3	<u>-4  </u>	-35	
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		<sup>I</sup> F(AV)	max.	3.5	Α
in oil up to T <sub>oil</sub> = 100 °C	•	<sup>I</sup> F(AV)	max.	6	Α
Repetitive peak forward current		<sup> </sup> FRM	max.	120	Α
Non-repetitive peak forward current $t = 10 \text{ ms}$ ; half sine-wave; $T_j = 175 ^{\circ}\text{C} \text{ p}$	rior to surge	<sup> </sup> FSM	max.	125	Α
Reverse power dissipation		OSB9115 -4	-6 l	I-34 -34	
Repetitive peak reverse power		OSM9115 -4	_6   _6	-34 -36	
t = 10 $\mu$ s (square-wave; f = 50 Hz) T <sub>j</sub> = 175 °C	P <sub>RRM</sub>	max. 1.2	1.8	10.2 10.8	kW
Non-repetitive peak reverse power $t = 10 \mu s$ (square -wave)					
$T_j = 25$ °C prior to surge $T_j = 125$ °C prior to surge	P <sub>RSM</sub> P <sub>RSM</sub>	max. 6 max. 1.2	9	51 54 10.2 10.8	
Repetitive peak reverse		OSS9115 -3	-4	-35 -36	
power dissipation					
t = 10 $\mu$ s (square-wave; f = 50 Hz) T <sub>j</sub> = 175 °C	PRRM	max. 1.8	2.4	21 21.6	kW
Non-repetitive peak reverse power dissipation					
$t = 10 \mu s$ (square-wave)	PRSM	max. 9	12	105 108	kW
$T_j = 25$ °C prior to surge $T_j = 175$ °C prior to surge	PRSM	max. 1.8			
Temperatures			,		
Storage temperature		$T_{stg}$	-55 to	+150	οС
Junction temperature		Тj	max.	175	оС
		=			

CHARACTERISTICS (See note 1)								
		OSB91	15 –4 115 –4	-6		-34	-36	
		OSM9	115 –4	-6		-34	-36	
Forward voltage								
I <sub>F</sub> = 20 A; T <sub>j</sub> = 25 °C	VF	<	4	6		34	36	٧
Reverse avalanche breakdown voltage*								
I <sub>R</sub> = 5 mA; T <sub>i</sub> = 25 °C	V <sub>(BR)R</sub>	>	3.3 4.8	4.95		28	29.7	kV
(n	(DIT)IT	<	4.8	7.2	1	40.8	43.2	kV
		OSS91	15 –3	-4		-35	-36	
Forward voltage								
I <sub>F</sub> = 20 A; T <sub>j</sub> = 25 °C	٧ <sub>F</sub>	<	6	8		70	72	V
Reverse avalanche breakdown voltage*								
I <sub>R</sub> = 5 mA; T <sub>i</sub> = 25 °C	V <sub>(BR)R</sub>	>	4.95 7.2	6.6		57.8	59.4	kV
(N 0 1111 () 1 20 0 1	· (DN/N	<	7.2	9.6		84	68.4	kV
Reverse current			-					
$V_{RM} = V_{RWM \text{ max}}; T_j = 125 ^{\circ}\text{C}$		1	RM	<	<	0.6		mΑ

#### **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.

 $<sup>^*</sup>$ The breakdown voltage increases by approximately 0.1% per  $^o$ C with increasing junction temperature.

#### **MECHANICAL DATA**

Dimensions in mm

n = total number of diodes

Fig.4 OSM9115 -nA

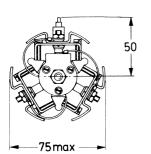


Fig.5 OSM9115 -nB

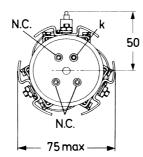
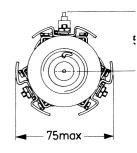
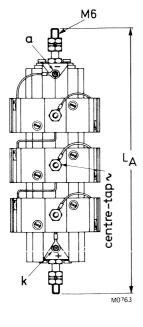
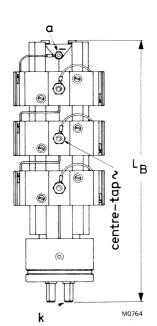
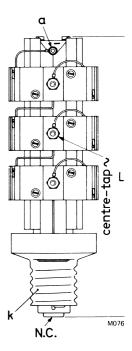


Fig.6 OSM9115 -nC









The drawings show the OSM9115 series; the OSB9115 and OSS9115 series differ in the following respects

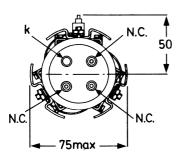
OSB9115 series — terminals marked a (–) and k (+) in the drawings are both marked  $\sim$ ; the centre-tap is marked + (instead of  $\sim$  as in the drawings).

OSS9115 series - has no centre-tap.

#### MECHANICAL DATA (continued)

n = total number of diodes.

Fig.7 OSM9115 -nE



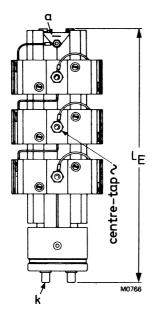
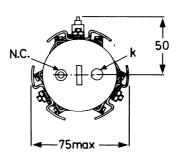
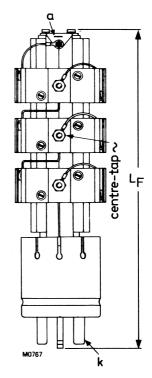


Fig.8 OSM9115 -nF





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	LA	143	184	224	264	305
	$L_B$	147	188	228	268	309
	L <sub>C</sub>	159	199	239	279	320
	LE	132	173	213	253	294
	LF	184	225	265	305	346
weights	WA	153	286	419	552	685
$W_B = V$	V <sub>C</sub> =W <sub>E</sub>	218	351	484	617	750
	WF	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	LA	345	385	426	466	506
	LB	349	389	430	470	510
	LC	360	400	441	481	521
	LE	334	374	415	455	495
	LF	386	426	467	507	547
weights	WA	818	951	1048	1217	1350
$w_B = w$	C=WE	883	1016	1149	1282	1415
	W <sub>F</sub>	1044	1177	1310	1443	1576

number of dioc	les n	31 to 33	34 to 36
	LĄ	546	586
	L <sub>B</sub>	550	590
	LC	561	601
	LE	535	575
	LF	587	627
weights	WA	1483	1616
W	$B = W_C = W_E$	1548	1681
	WF	1709	1842

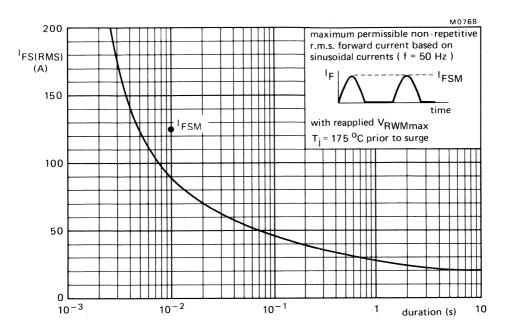


Fig.9

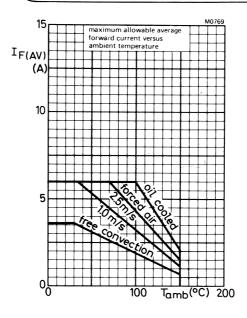


Fig.10

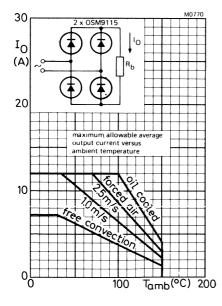


Fig.11

Fig.12

#### APPLICATION INFORMATION

Fig.13 OSB9115 -4

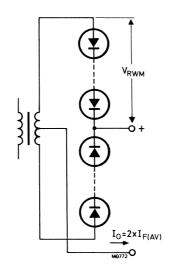
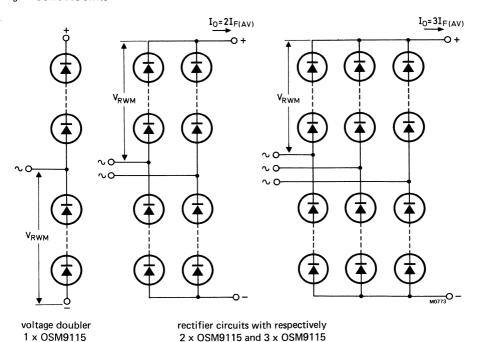


Fig.14 OSM9115 series

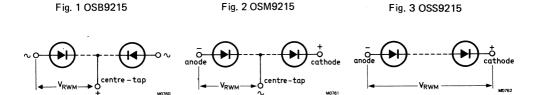




#### HIGH-VOLTAGE RECTIFIER STACKS

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:



#### **QUICK REFERENCE DATA**

		OSB9215 OSM9215		-6 -6		-34 -34	-36 -36	
Crest working reverse voltage from centre tap to end	V <sub>RWM</sub>	max.	3	4.5		25.5	27	kV
		OSS9215	-3	-4		-35	-36	
Crest working reverse voltage	$v_{\text{RWM}}$	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 <sub>amb</sub> = 35 °C			lF(	AV)	max	ζ.	5	Α
in oil up to $T_{oil} = 30$ °C			lF(	AV)	max	ζ.	20	Α
Non-repetitive peak forward current $t = 10 \text{ ms}$ ; half sine-wave; $T_j = 175 ^{\circ}\text{C}$ pri	or to surg	е	IFS	SM	max	c. 3	60	Α

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 OSM9215		6 6	· ·	-34	-36 -36	
Crest working reverse voltage	$v_{RWM}$	max.	3.0	4.5		25.5	27	kV
		OSS9215	-3	-4		<b>–35</b>	-36	
Crest working reverse voltage	V <sub>RWM</sub>	max.	4.5	6		52.5	54	kV
Currents								•
Average forward current (averaged over any 20 ms period)								
in free air up to T <sub>amb</sub> = 35 °C			I <sub>F</sub> (A	V)	max		5	Α
in oil up to T <sub>oil</sub> = 30 °C			IF(A	V)	max		20	Α
Repetitive peak forward current			IFRN	-	max	. 4	140	Α
Non-repetitive peak forward current $t = 10$ ms; half sine-wave; $T_j = 175$ °C pr	rior to surg	е	IFSN	1	max	. 3	860	Α
Reverse power dissipation								
Repetitive peak reverse power t = 10 \(\mu\)s (square-wave; f = 50 Hz)		OSB9215 OSM9215		-6 -6		-34 -34	-36 -36	
$T_i = 175 ^{\circ}\text{C}$	PRRM	max.	4	6		34	36	kW
Non-repetitive peak reverse power t = 10 \( \mu s \) (square-wave)								
$T_j = 25$ °C prior to surge	PRSM	max.	26	39		221	234	kW
Tj́ = 175 <sup>o</sup> C prior to surge	PRSM	max.	4	6	1	34	36	kW
Repetitive peak reverse power dissipation		OSS9215	-3	-4		-35	-36	kW
t = 10 $\mu$ s (square-wave; f = 50 Hz) T <sub>i</sub> = 175 °C	PRRM	max.	6	8		70	72	kW
Non-repetitive peak reverse power dissipation								
$t = 10 \mu s$ (square-wave)			00			455	400	
T <sub>j</sub> = 25 <sup>o</sup> C prior to surge T <sub>j</sub> = 175 <sup>o</sup> C prior to surge	P <sub>RSM</sub> P <sub>RSM</sub>	max. max.	39 6	52 8		455 70	468 72	kW kW
Temperatures								-
Storage temperature			T <sub>stg</sub>		-55	to +1	50	oC
Junction temperature			Tj		max	. 1	75	oC

CHARACTERISTICS (see note 1)								
		OSB921	5 –4	<b>-6</b>		-34	-36	
		OSB9219 OSM921	5 -4	-6		-34	-36	
Forward voltage								
I <sub>F</sub> = 50 A; T <sub>i</sub> = 25 °C	٧F	<	3.6	5.4		30.6	32.4	V
Reverse breakdown voltage*								
	.,	> <	3.3	4.95		28	29.7 43.2	kV
I <sub>R</sub> = 5 mA; T <sub>j</sub> = 25 °C	V(BR)R	<	4.8	7.2	١	40.8	43.2	kV
		OSS921	5 –3	4		-35	-36	
Forward voltage								
I <sub>F</sub> = 50 A; T <sub>i</sub> = 25 °C	٧F	<	5.4	7.2		63	64.8	V
Reverse breakdown voltage*								
		>	4.95	6.6		57.8 84	59.4	kV
$I_R = 5 \text{ mA}; T_j = 25 ^{\circ}\text{C}$	V(BR)R	<	7.2	9.6		84	86.4	kV
Reverse current					<u> </u>	-		
$V_{RM} = V_{RWMmax}$ ; $T_j = 125$ °C			l <sub>RI</sub>	М	<	(	0.6	mΑ

#### 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.

<sup>\*</sup>The breakdown voltage increases by approximately 0.1% per  $^{
m oC}$  with increasing junction temperature.

**MECHANICAL DATA** 

n = total number of diodes

Fig. 4 OSM9215-nA

75 max

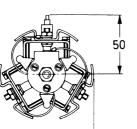
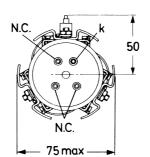
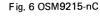
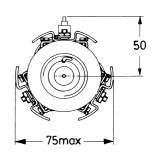


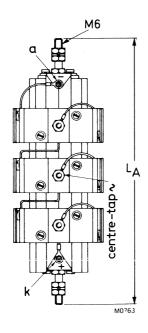
Fig. 5 OSM9215-nB

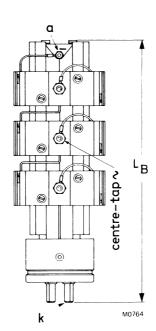


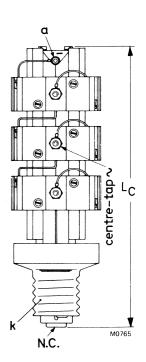
Dimensions in mm











The drawings show the OSM9215 series; the OSB9215 and OSS9215 series differ in the following respects:

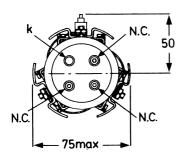
OSB9215 series - terminals marked a(-) and k(+) in the drawings are both marked  $\sim$ ;

the centre-tap is marked + (instead of  $\sim$  as in the drawings). OSS9215 series -  $\,$  has no centre-tap.

#### **MECHANICAL DATA** (continued)

n = total number of diodes.

Fig. 7 OSM9215-nE



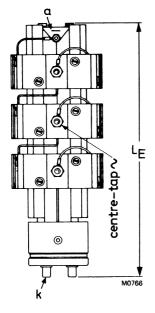
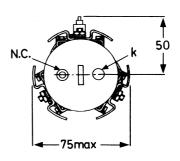
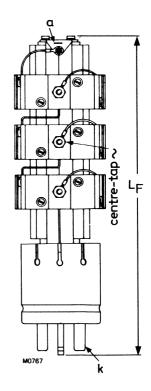


Fig. 8 OSM9215-nF





For lengths and weights see table on page 748.

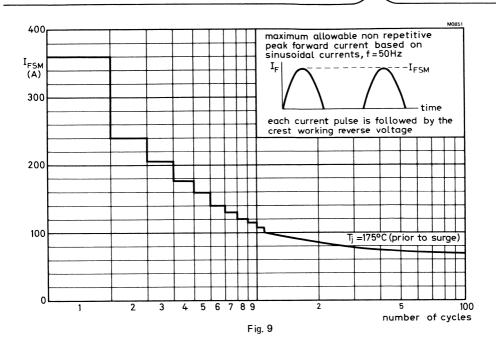
## OSB 9215 SERIES OSM 9215 SERIES OSS 9215 SERIES

## 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	LA	143	184	224	264	305
	$L_B$	147	188	228	268	309
	LC	159	199	239	279	320
	LE	132	173	213	253	294
	LF	184	225	265	305	346
weight	WA	153	286	419	552	685
$W_B = W$	c = WE	218	351	484	617	750
	WF	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	LA	345	385	426	466	506
	LB	349	389	430	470	510
	LC	360	400	441	481	521
	LE	334	374	415	455	495
	LF	386	426	467	507	547
weights	WA	818	951	1084	1217	1350
$W_B = W_0$	c = WE	883	1016	1149	1282	1415
	WF	1044	1177	1310	1443	1576

number of diodes	n	31 to 33	34 to 36	
maximum lengths	LA	546	586	
	LB	550	590	
	LC	561	601	
	LE	535	575	
	LF	587	627	
weights	WA	1483	1616	
$W_B = W_0$	c = WE	1548	1681	
	WF	1709	1842	



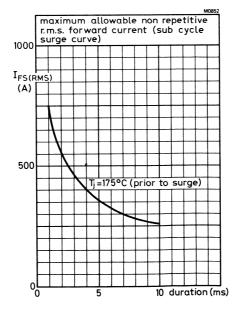


Fig. 10

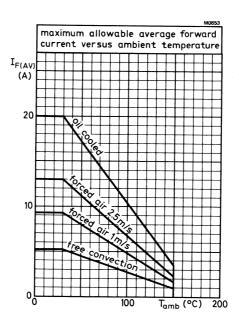
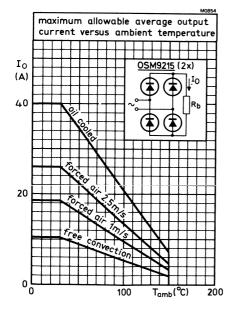


Fig. 11



maximum allowable average output current versus ambient temperature

IO
(A)

SM9215 (3x)

Rb

Rb

10

Tamb (°C) 200

Fig. 12

Fig. 13

#### **APPLICATION INFORMATION**

Fig. 14 OSB9215-4

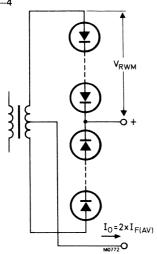
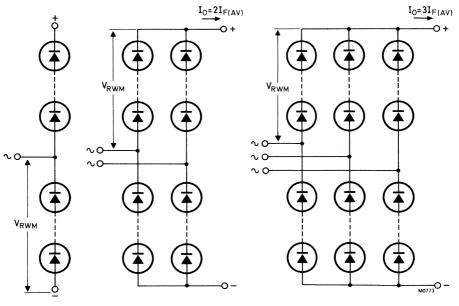


Fig. 15 OSM9215 series



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).

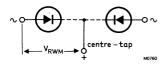
The maximum crest working voltages of the OSB9415 and OSM9415 series cover the range from 3 kV to 27 kV, and of the OSS9415 series the range from  $4.5 \, kV$  to  $54 \, kV$ , in  $1.5 \, kV$  steps.

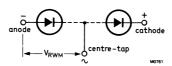
#### Configuration:

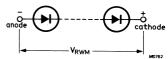
Fig.1 OSB9415

Fig.2 OSM9415

Fig.3 OSS9415







#### QUICK REFERENCE DATA

Crost working various vales as		OSB9415 OSM9415	-4 -4	-6  -6		-34 -34	-36   -36	
Crest working reverse voltage from centre tap to end	$V_{RWM}$	max. OSS9415	3 -3	4.5		25.5 -35	27	kV
Crest working reverse voltage	V <sub>RWM</sub>	max.	4.5	6		52.5	54	kV
Average forward current with R (averaged over any 20 ms perion in free air up to T <sub>amb</sub> = 35	od)		l <sub>F</sub>	(AV)	ma	x.	10	, A
in oil up to $T_{oil} = 35$ °C			1F	(AV)	ma	x.	30	Α
Non-repetitive peak forward cur t = 10 ms; half sine wave; T <sub>i</sub> =		to surge	IFSI	М	ma	x. (	300	Α

## 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)

Limiting values in accordance wi	th the Absol	ute Maximur	n Syste	em (IEC	: 134)			
Voltages		OSB9415 OSM9415	-4 4	6 6		-34 -34	-36 -36	
Crest working reverse voltage	$v_{RWM}$	max.	3	4.5		25.5	27	kV
		OSS9415	-3	-4	<u> </u>	-35	-36	
Crest working reverse voltage	V <sub>RWM</sub>	max.	4.5	6	l	52.5	54	kV
Currents								
Average forward current (average over any 20 ms period) in free air up to T <sub>amb</sub> = 35			1,	F(AV)	ma	x.	10	Α
in oil up to T <sub>oil</sub> = 35 °C			I <sub>I</sub>	F(AV)	ma	x.	30	Α
Repetitive peak forward current			11	FRM	ma	x. 4	50	Α
Non-repetitive peak forward curr t = 10 ms; half sine-wave; T <sub>j</sub> = 175 <sup>o</sup> C prior to surge	rent		I <sub>I</sub>	FSM	ma	x. 8	00	Α
Reverse power dissipation		0000445				. 04	۱ ۵۵	
Repetitive peak reverse power di	ssipation	OSB9415 OSM9415	-4 -4	6 6	: : :	-34   -34	-36 -36	
t = 10 $\mu$ s (square-wave; f = 50 T <sub>j</sub> = 175 °C	Hz) P <sub>RRM</sub>	max.	9	13.5		76.5	81	k۷
Non-repetitive peak reverse power	er dissipation							
t = 10 $\mu$ s (square-wave) $T_j = 25$ °C prior to surge $T_j = 175$ °C prior to surge	P <sub>RSM</sub> P <sub>RSM</sub>	max. max.	55 8.5	82 13		467 72	495 77	kV kV
		OSS9415	-3	_4	1	l –35	I –36	
Repetitive peak reverse power di	ssipation							
t = 10 $\mu$ s (square-wave; f = 50 T <sub>j</sub> = 175 °C	Hz) <sup>P</sup> RRM	max.	13.5	18		157	162	k۷
Non-repetitive peak reverse power dissipation t = 10 \( \mu \)s (square-wave)								
$T_j = 25$ °C prior to surge $T_j = 175$ °C prior to surge	P <sub>RSM</sub> P <sub>RSM</sub>	max. max.	80 13	105 17	   	919 149	945 153	kV kV
Temperatures								
Storage temperature				stg		5 to +1		0(
Junction temperature			Т	j	ma	x. 1	75	٥C

CHARACTERISTICS (See note 1)								
Forward voltage		OSB9415 OSM9415	-4 -4	-6 -6		-34 -34	-36 -36	
$I_F = 150 \text{ A}; T_j = 25 ^{\circ}\text{C}$	VF	<	3.6	5.4		30.6	32.4	٧
Reverse avalanche breakdown volt $I_R = 5 \text{ mA}$ ; $T_j = 25  ^{\text{O}}\text{C}$	age* V <sub>(BR)R</sub>	> <	3.3 4.8	4.95 7.2		28 40.8	29.7 43.2	kV kV
Forward voltage		OSS9415	-3	_4	<u>  </u>	-35	_36	
I <sub>F</sub> = 150 A; T <sub>j</sub> = 25 °C	VF	<	5.4	7.2		63	64.8	V
Reverse avalanche breakdown volt $I_R = 5 \text{ mA}$ ; $T_j = 25  ^{\circ}\text{C}$	age* V <sub>(BR)</sub> R	> <	4.95 7.2	6.6 9.6		57.8 84	59.4 86.4	kV kV
Reverse current			-					
$V_{RM} = V_{RWMmax}$ ; $T_j = 125 \circ 0$	С		l p	RM	<	1.6		mΑ

#### **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.

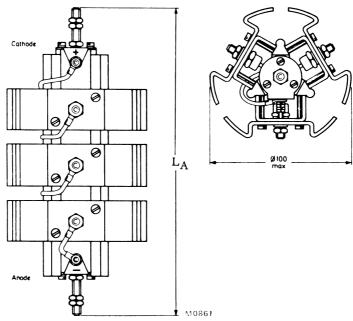
<sup>\*</sup> The breakdown voltage increases, by approximately 0.1% per °C with increasing junction temperature.

#### **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  $\sim$ .

OSM9415 series - has a centre tap marked  $\sim$ .

#### 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	LA	143	184	224	264	305
weights	WA	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 <sub>A</sub>	345	385	426	466	506	546	586
weights	WA	1208	1406	1604	1802	2000	2198	2396

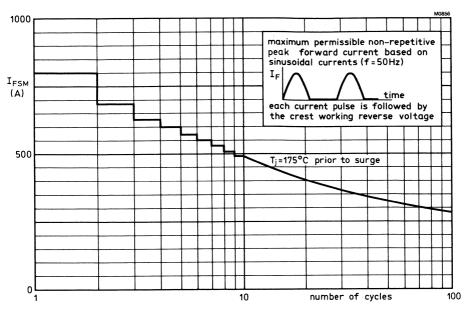


Fig.5

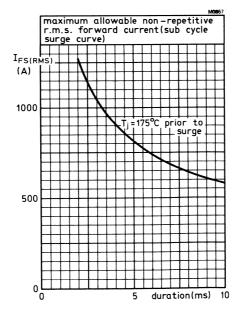


Fig.6

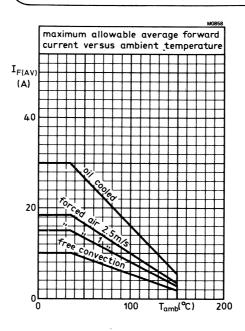
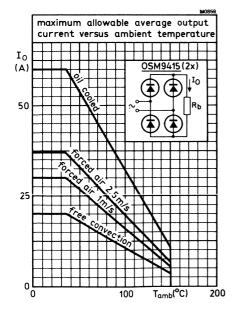


Fig.7



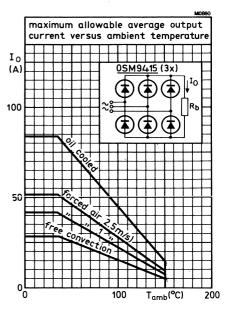


Fig.8

Fig.9

#### **APPLICATION INFORMATION**

#### Fig.10 OSB9415 series

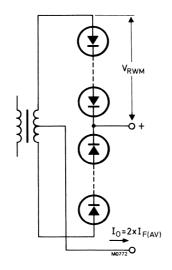
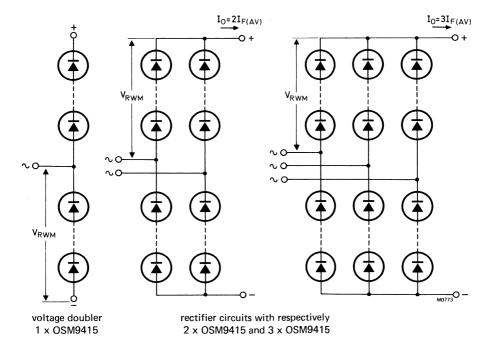


Fig.11 OSM9415 series





## HIGH-VOLTAGE RECTIFIER STACK

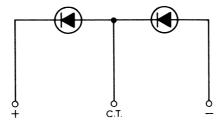
The OSM9510-12 is a silicon rectifier stack for high voltage applications; up to 12kV in half-wave circuits, or up to 6kV as one of the arms of a bridge configuration, where the centre-tap is utilised. Because of its controlled avalanche characteristics it is capable of withstanding reverse transients generated in the circuit.

QUICK REFERENCE DATA		
V <sub>RWM</sub> max.	12	kV
V <sub>(BR)R</sub> min.	15	kV
$I_{F(AV)}^{max., in free air, T_{amb} = 50^{\circ}C}$	1.5	Α
$P_{RSM} = 10\mu s, T_{amb} = 25^{\circ} C$	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 <sub>RWM</sub> max.	Crest working reverse voltage	12	kV
I <sub>F(AV)</sub> max.	amb C, 180 conduction	1.5 ng curves on pag	A e 764
IFRM max.	Repetitive peak forward		
r nw	current, 30° conduction	15	Α
I <sub>FSM</sub> max.	Surge forward current, 1 cycle (10ms peak of half sinewave)	35	A
P <sub>RSM</sub> max.	Non-repetitive peak reverse power $(10\mu s \text{ square wave, } T_i = 25^{\circ} \text{C})$	20	kW
P <sub>RRM</sub> max.	50Hz repetitive peak reverse transient power		
	(10 $\mu$ s square wave, $T_i = 150^{\circ}$ C)	5.0	kW
Temperature	,		
${ m T}_{ m stg}$	Storage temperature	-55 to 150	°c
T T	Junction temperature	-55 to 150	°c
T <sub>j</sub>	our or	55 55 200	·

ELECTRICAL CHARACTERISTICS ( $T_i = 25^{\circ}C$  unless otherwise stated)

		Min.	Max.	
$v_{F}$	Forward voltage at $I_F = 5A$	-	17.5	v
$I_{\mathbf{R}}$	Reverse current at $V_{RWM}$ , $T_j = 125^{\circ}C$	-	100	μΑ
V <sub>(BR)R</sub> *	**Avalanche breakdown voltage, I <sub>(BR)R</sub> =1mA	15	25	kV

<sup>\*</sup>Measured under pulsed conditions so that  $T_i$  is at, or near, the stated value.

#### MECHANICAL DATA

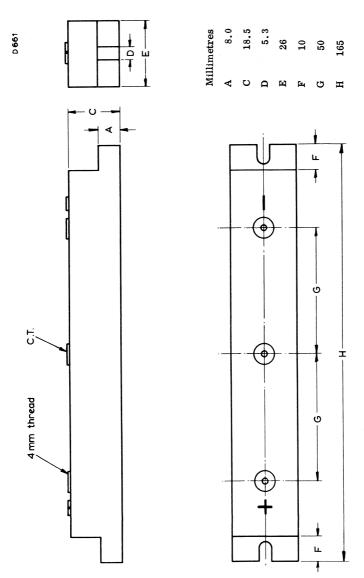
Weight	130	g

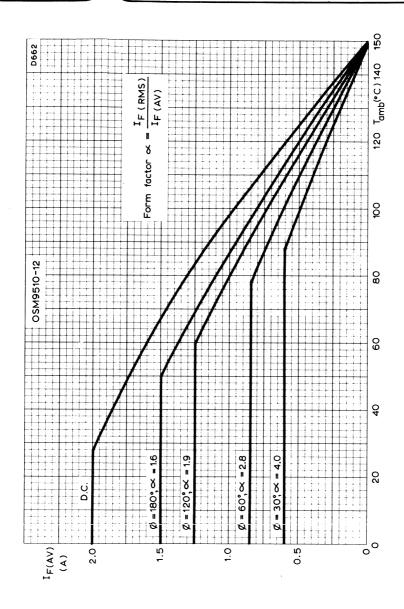
#### MOUNTING POSITION

The rectifier units can be operated at their maximum ratings when mounted in any position.

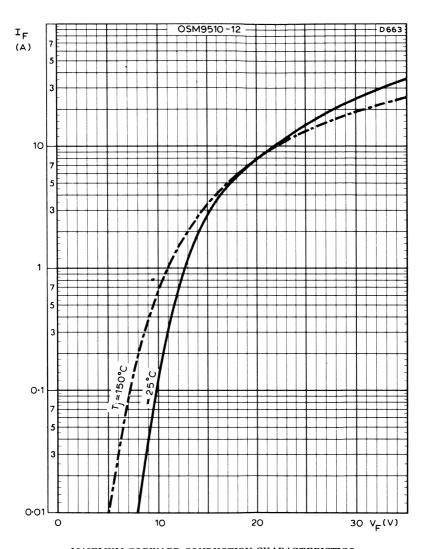
<sup>\*\*</sup>The avalanche voltage increases by approximately 0.1%/degC with increasing Ti.

## OUTLINE AND DIMENSIONS

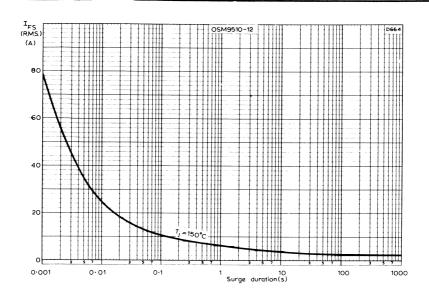




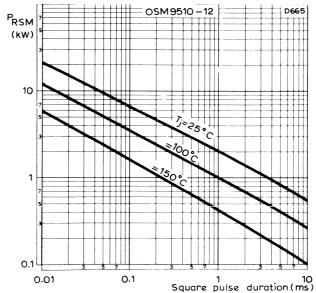
MAXIMUM MEAN FORWARD CURRENT AS A FUNCTION OF AMBIENT TEMPERATURE AND CONDUCTION ANGLE



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

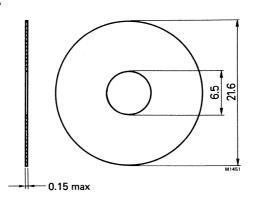
type number	description	envelope
56264a	mica washer (up to 2000 V)	DO-5, TO-48
56264b	insulating bush	DO-5, TO-48
56295a	mica washer (up to 2000 V)	DO-4, TO-64
56295b	PTFE ring	DO-4, TO-64
56295c	insulating bush	DO-4, TO-64
56359b	mica washer (up to 1000 V)	TO-220
56359c	insulating bush (up to 800 V)	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** 

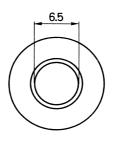


Dimensions in mm

## 56264b

## **INSULATING BUSH**

**MECHANICAL DATA** 



Dimensions in mm

## THERMAL RESISTANCE

From mounting base to heatsink

with mica washer, without heatsink compound with mica washer, with heatsink compound

-		14.3		-		0.8	
				7777	_	2.2	
	-	8	-			M1452	

5 K/W K/W

**TEMPERATURE** 

Maximum allowable temperature

Rth mb-h Rth mb-h

2.5

T<sub>max</sub>

175

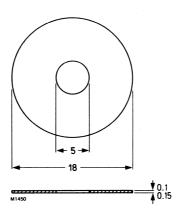
οС

## 56295a

## MICA WASHER

Insulator up to 2 kV.

#### **MECHANICAL DATA**

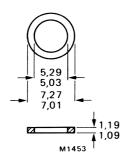


Dimensions in mm

## 56295b PTFE RING

#### **MECHANICAL DATA**

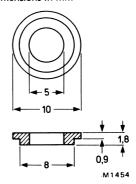
Dimensions in mm



## 56295c INSULATING BUSH

## **MECHANICAL DATA**

Dimensions in mm



#### THERMAL RESISTANCE

From mounting base to heatsink without heatsink compound with heatsink compound

#### **TEMPERATURE**

Maximum allowable temperature

R <sub>th mb-h</sub>	=	5	K/W
R <sub>th mb-h</sub>	=	2.5	K/W

$$T_{max} = 175$$
 °C

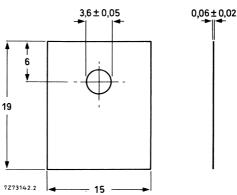
## **ACCESSORIES** for TO-220

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**

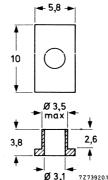
Maximum pemissible temperature

 $T_{max} = 150 \, {}^{\circ}\text{C}$ 

#### 56359d RECTANGULAR INSULATING BUSH

Insulator up to 1000 V.

**MECHANICAL DATA** 



Dimensions in mm

#### **TEMPERATURE**

Maximum permissible temperature



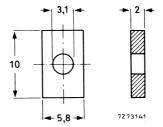
## 56360a

## RECTANGULAR WASHER (For TO-220)

For direct and insulated mounting.

#### **MECHANICAL DATA**

Material: brass; nickel plated.



Dimensions in mm

## 56363

SPRING CLIP (For TO-220 and SOT-186)

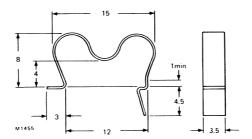
For direct mounting.

#### **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)

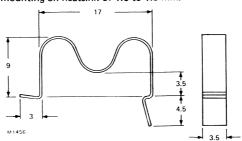
For insulated mounting.

#### **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

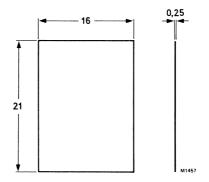
## **ALUMINA INSULATOR**

For insulated clip mounting up to 2 kV.

#### **MECHANICAL DATA**

Material: 96-alumina.

Dimensions in mm



<sup>\*</sup>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**

21 M1458

Dimensions in mm

Dimensions in mm

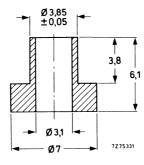
56368b

## **INSULATING BUSH**

For insulated screw mounting up to 800 V.

#### MECHANICAL DATA

Material: polyester



**TEMPERATURE** 

Maximum permissible temperature

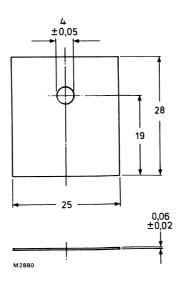
T<sub>max</sub> = 150.0C

56368c

MICA INSULATOR

For insulated screw mounting up to 800 V.

**MECHANICAL DATA** 



Dimensions in mm

56369: see preceding page.

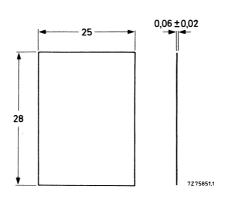
# ACCESSORIES for SOT-93

56378

## MICA INSULATOR

For clip mounting up to 1500 V.

#### **MECHANICAL DATA**



Dimensions in mm

56379

## SPRING CLIP

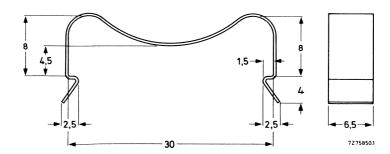
For direct and insulated mounting of SOT-93 and SOT-112 envelopes.

## **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<sub>th mb-h</sub>) 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 good thermal contact under the crystal area, and slightly lower R<sub>th mb-h</sub> 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)

## MOUNTING INSTRUCTIONS TO-220

#### 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). From mounting base to heatsink		clip mounting		screw mounting	
with heatsink compound, direct mounting	R <sub>th mb-h</sub>	=	0,3	0,5	K/W
without heatsink compound, direct mounting	R <sub>th mb-h</sub>	=	1,4	1,4	K/W
with heatsink compound and 0,1 mm maximum mica washer	R <sub>th mb-h</sub>	=	2,2	_	K/W
with heatsink compound and 0,25 mm maximum alumina insulator	R <sub>th mb-h</sub>	=	0,8	_	K/W
with heatsink compound and 0,05 mm mica washer insulated up to 500 V insulated up to 800 V/1000 V	Rth mb-h	=	_	1,4 1,6	K/W K/W
without heatsink compound and 0,05 mm mica washer insulated up to 500 V insulated up to 800 V/1000 V $$	R <sub>th mb-h</sub>	=	_	3,0 4,5	K/W 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 abovementioned 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  $_{i~max}$   $\leq$  175 °C, soldering temperature T  $_{sld~max}$  = 275 °C.

Devices with  $T_{i \text{ max}} \le 110 \text{ °C}$ , soldering temperature  $T_{sld \text{ max}} = 240 \text{ °C}$ .

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  $\leq$  165 °C at a duration  $\leq$  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.

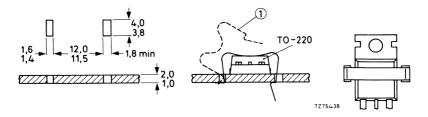


Fig. 1 Heatsink requirements.

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.
- 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.

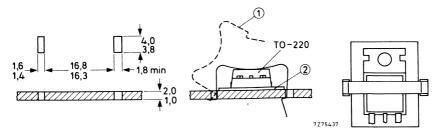


Fig. 3 Heatsink requirements.

Fig. 4 Mounting. (1) spring clip 56364.

(2) insulator 56369 or 56367.

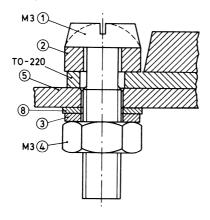
Fig.4a Position of device (top view).

## INSTRUCTIONS FOR SCREW MOUNTING

Direct mounting with screw and spacing washer

• through heatsink with nut





Ø 3,5 max 1,5 min 1,5

Fig. 5 Assembly.

,

- (1) M3 screw.
- (2) rectangular washer (56360a).
- (3) lock washer.
- (4) M3 nut.
- (5) heatsink.
- (8) plain washer.

Fig. 6 Heatsink requirements.

#### • into tapped heatsink

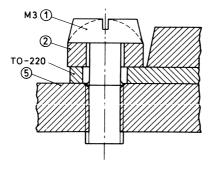


Fig. 7 Assembly.

(1) M3 screw.

- (2) rectangular washer 56360a.
- (5) heatsink.

Fig. 8 Heatsink requirements.

## Insulated mounting with screw and spacing washer (not recommended where mounting tab is on mains voltage)

#### Dimensions in mm

#### • through heatsink with nut

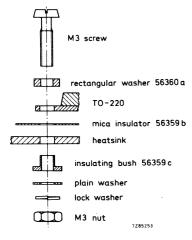


Fig. 9 Insulated screw mounting with rectangular washer. Known as a "bottom mounting".

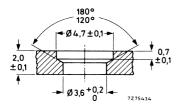


Fig. 10 Heatsink requirements for 500 V insulation.

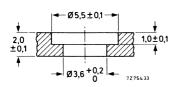


Fig. 11 Heatsink requirements for 800 V insulation.

## • into tapped heatsink

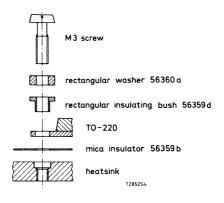


Fig. 12 Insulated screw mounting with rectangular washer into tapped heatsink. Known as a "top mounting".

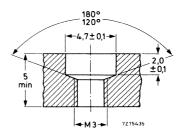


Fig. 13 Heatsink requirements for 500 V insulation.

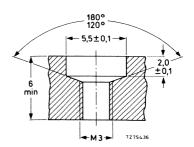


Fig. 14 Heatsink requirements for 1000 V insulation.

# 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.

## MOUNTING INSTRUCTIONS F-PACK

## 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  $^{\rm O}$  maximum. The minimum bending radius is 1mm.

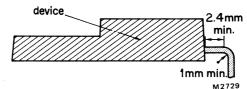


Fig.1 Lead bending of devices.

## Soldering

Lead soldering temperature at >3mm from body for t<sub>sld</sub> <5 seconds:

Devices with  $T_i$  max.  $\leq$ 175 °C,  $T_{sld}$  max. = 275 °C.

Devices with T<sub>i</sub> max. ≤110 °C, T<sub>sld</sub> max. = 240 °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  $10^{\circ}$  to  $30^{\circ}$  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).

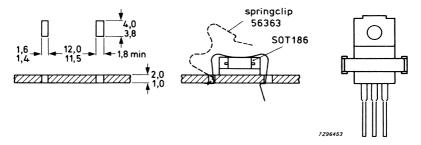


Fig.2 Heatsink requirements

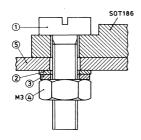
Fig.3 Mounting.

Fig.3a Position of device (top view).

## INSTRUCTIONS FOR SCREW MOUNTING

## Screw through heatsink with nut

Dimensions in mm



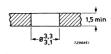
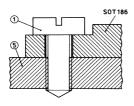


Fig.4 Assembly.

- (1) M3 screw
- (2) plain washer
- (3) lock washer
- (4) M3 nut
- (5) heatsink

Fig.5 Heatsink requirements.

## Into tapped heatsink



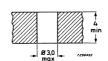


Fig.6 Assembly.

- (1) M3 screw
- (5) heatsink

Fig.7 Heatsink requirements.

## MOUNTING INSTRUCTIONS F-PACK

## 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.

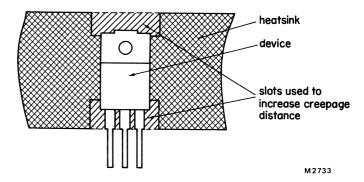


Fig.8 Slots formed in heatsink to increase creepage distance.

## 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<sub>th mb-h</sub>) 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)

Maximum torque (to avoid damaging the device)

0,4 Nm ( 4 kgcm)

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 abovementioned 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  $^{\circ}$ 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  $^{\circ}$ 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.

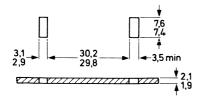
#### Thermal data

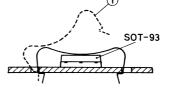
-	(Typical figures, for exact figures see data for each device type)			clip ounting	screw	
	Thermal resistance from mounting base to heatsink direct mounting with heatsink compound without heatsink compound	R <sub>th mb-h</sub> R <sub>th mb-h</sub>		0,3 1.5	0,3	K/W K/W
	with 0,05 mm mica washer with heatsink compound without heatsink compound	R <sub>th mb-h</sub>	=	0,8 3,0	0,8	K/W 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.
- 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).
- 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)).





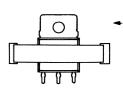


Fig. 1a Heatsink requirements.

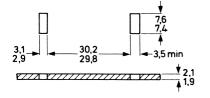
Fig. 1b Mounting. (1) = spring clip 56379.

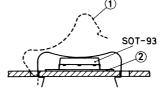
Fig. 1c Position of the device.

## Insulated mounting with clip 56379

With the mica 56378 insulation up to 1500 V is obtained.

- Place the device with the insulator on the heatsink, applying heatsink compound to the bottom of both device and insulator.
- 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.





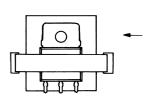
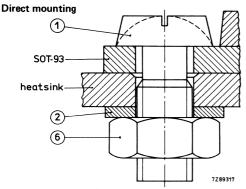


Fig. 2a Heatsink requirements.

Fig. 2b Mounting. (1) = spring clip 56379 (2) = insulator 56378

Fig. 2c Position of the device.

## INSTRUCTIONS FOR SCREW MOUNTING



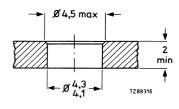


Fig. 3a Assembly through heatsink with nut.

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.

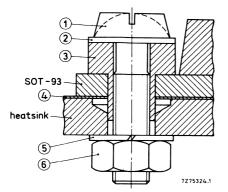


Fig. 4 Assembly. See also Fig. 9.

- (1) M3 screw
- (2) plain washer
- (3) insulating bush (56368b)
- (4) mica insulator (56368c)
- (5) lock washer
- (6) M3 nut

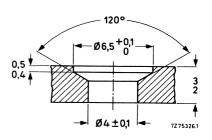


Fig. 5 Heatsink requirements up to 800 V insulation.

## Insulated screw mounting with tapped hole; up to 800 V.

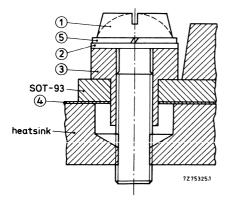


Fig. 6 Assembly. See also Fig. 9.

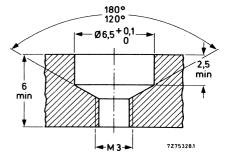


Fig. 7 Heatsink requirements up to 800 V insulation.

- (1) M3 screw
- (2) plain washer
- (3) insulating bush (56368b)
- (4) mica insulator (56
- (5) lock washer
- (56368c)

(3) TOCK Wastle

## Insulated screw mounting with insert nut; up to 500 V

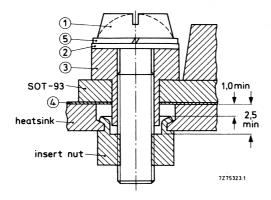


Fig. 8 Assembly and heatsink requirements for 500 V insulation. See also Fig. 3.

- (1) M3 screw
- (2) plain washer
- (3) insulating bush (56368b)
- (4) mica insulator (56368c)
- (5) lock washer

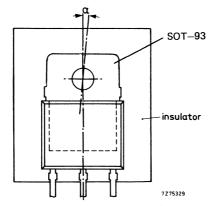


Fig. 9 Mica insulator.

The axial deviation ( $\alpha$ ) between SOT-93 and mica should not exceed 5°.

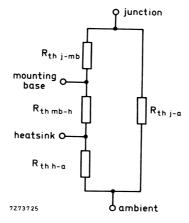
## MOUNTING CONSIDERATIONS FOR STUD-MOUNTED DEVICES

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 Reb implements.

The first thermal resistance will be that of junction to mounting base, usually denoted by  $R_{th}$  j-mb-the second is the contact thermal resistance  $R_{th}$  mb-h and finally there is the thermal resistance of the heatsink  $R_{th}$  h-a·

In the rating curves, the contact thermal resistance and heatsink thermal resistances are combined as a single figure -  $R_{th\ mb-a}$ -

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  $Z_{th\ i-mb}$  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) Maximum torque (to avoid damaging device) 0.9 Nm (9 kg cm) 1.7 Nm (17 kg cm)

#### THERMAL DATA

The thermal resistance from mounting base to heatsink (Rth mb-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

with heatsink compound

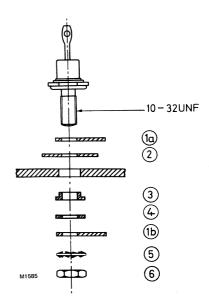
Rth mb-h Rth mb-h

5 2.5 KΛW

K/W

## MOUNTING INSTRUCTIONS FOR UP TO 2000 V INSULATION

Using 56295c insulating bush and 56295a mica washer.



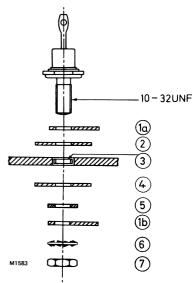
if tag used in position 1b) (5) toothed lock washer (supplied with device)

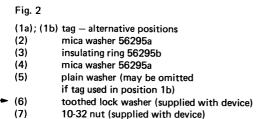
(6)10-32 UNF nut (supplied with device)

## MOUNTING INSTRUCTIONS DO-4; TO-64

## MOUNTING INSTRUCTIONS FOR UP TO 2000 V INSULATION

Using insulating ring 56295b and two mica washers 56295a.





# 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)
Maximum torque (to avoid damaging device)

1.7 Nm (17 kg cm) 3.5 Nm (35 kg cm)

#### THERMAL DATA

The thermal resistance from mounting base to heatsink (R<sub>th mb-h</sub>) 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 with heatsink compound

 $R_{th mb-h} = 5$  K/W  $R_{th mb-h} = 2.5$  K/W

## MOUNTING INSTRUCTIONS FOR UP TO 2000 V INSULATION

Using insulating bush 56264b and mica washer 56264a.

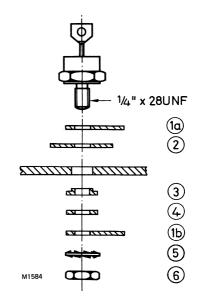


Fig.1

(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 without heatsink compound

R <sub>th</sub> mb-h	=	1.0	K/W
R <sub>th</sub> 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  $^{\rm O}$  to 30  $^{\rm O}$  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.

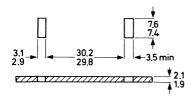


Fig. 1a Heatsink requirements.

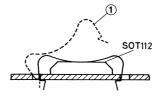


Fig. 1b Mounting. (1) = spring clip 56379

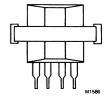


Fig. 1c Position of the device.

## **INDEX**

Type No.	Page	Type No.	Page
BR210 series	627	BYV74 series	379
BR216 series	639	BYV79 series	389
BR220 series	643	BYV92 series	399
BY224 series	107	BYW25 series	407
BY225 series	115	BYW29 series	413
BY229 series	129	BYW29F series	423
BY229F series	141	BYW30 series	433
BY249 series	39	BYW31 series	441
BY260 series	123	BYW92 series	449
BY261 series	125	BYW93 series	449 457
BY329 series	153	BYX25 series	45
BY359 series	165	BYX30 series	465
BYP21 series	173	BYX32 series	53
BYP22 series	183	BYX38 series	55
BYP59 series	193	BYX39 series	61
BYQ28 series	197	BYX42 series	67
BYR29 series	207	BYX46 series	475
BYR29F series	217	BYX50 series	487
BYT28 series	227	BYX52 series	71
BYT79 series	237	BYX56 series	75
BYV18 series	517	BYX96 series	81
BYV19 series	527	BYX97 series	87
BYV20 series	535	BYX98 series	93
BYV21 series	543	BYX99 series	99
BYV22 series	551	BZW86 series	659
BYV23 series	559	BZX70 series	671
BYV24 series	247	BZY91 series	693
BYV26 series	255	BZY93 series	713
BYV27 series	261	OSB/M/S9115 series	733
BYV28 series	269	OSB/M/S9215 series	743
BYV29 series	275	OSB/M/S9415 series	753
BYV29F series	285	OSM9510-12	761
BYV30 series	295	PHSD51	619
BYV31 series	303	1N3879 to 3883	495
BYV32 series	311	1N3889 to 3893	501
BYV32F series	321	1N3909 to 3913	507
BYV33 series	567	56264a,b	770
BYV33F series	577	56295a,b,c	770
BYV34 series	331	56359b,c,d	771 772
BYV39 series	587	56360a	773
BYV42 series	341	56363	
BYV43 series	595		773
BYV43F series		56364	773
BYV43F series BYV44 series	603	56367	774
BYV60 series	351 361	56368b,c	775
		56369	774
BYV72 series	369	56378	776
BYV73 series	611	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	type no.	book	section	type no.	book	section
<b>D1000</b>	<b>a</b> 4		D1 000	07.104	M (an	22400	07/04	M (GD
BA220	S1	SD	BAS29	S7/S1	Mm/SD	BAV99	S7/S1	Mm/SD
BA221	S1	SD	BAS31	S7/S1	Mm/SD	BAV 100	S7/S1	Mm/SD
BA223	S1	T	BAS32	S7/S1	Mm/SD	BAV101	S7/S1	Mm/SD
BA281	S1	SD	BAS35	S7/S1	Mm/SD	BAV 102	S7/S1	Mm/SD
BA314	S1	Vrg	BAS45	S1	SD	BAV 103	S7/S1	Mm/SD
BA315	<b>S</b> 1	Vrg	BAS56	S1/S7	SD/Mm	BAW56	S7/S1	Mm/SD
BA316	S1	SD	BAT17	S7/S1	Mm/T	BAW62	S1	SD
BA317	S1	SD	BAT18	S7/S1	Mm/T	BAX12	S1	SD
BA318	S1	SD	BAT54	S1/S7	SD/Mm	BAX14	S1	SD
BA423	S1	T	BAT74	S1/S7	SD/Mm	BAX18	S1	SD
BA480	S1	Т	BAT81	S1	T ·	BAY80	S1	SD
BA481	S1	Ť	BAT82	S1	Ť	BB112	S1	T
BA482	S1	Ť	BAT83	S1	Ť	BB119	S1	T
BA483	S1	Ť	BAT85	S1	Ť	BB130	S1	T
BA484	S1	T	BAT86	S1	T	BB204B	S1	T
BA682	S1/S7	T/Mm	BAV10	S1	SD	BB204G	S1	т
BA683	S1/S7	T/Mm	BAV18	S1	SD	BB212	S1	T
BAS11	S1	SD	BAV19	S1	SD	BB215	S7/S1	Mm/SD
BAS15	S1	SD	BAV20	S1	SD	BB219	S7/S1	Mm/SD
BAS16	S7/S1	Mm/SD	BAV21	S1	SD	BB405B	S1	Т
BAS17	S7/S1	Mm/Vrg	BAV23	S7/S1	Mm/SD	BB417	S1	T
BAS19	S7/S1	Mm/SD	BAV45	S1/51	Sp	BB809	S1	T
BAS20	S7/S1	Mm/SD	BAV45A	S1	Sp	BB909A	S1	Ť
BAS21	S7/S1	Mm/SD	BAV70	S7/S1	Mm/SD	BB909B	S1	Ť
BAS28	S7/S1	Mm/SD	BAV74	S1	SD	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	type no.	book	section	type no.	book	section
вву39	S1	T	BC639	S3	Sm	BCW72:R	<b>s</b> 7	Mm
BBY40	S7/S1	Mm/T	BC640	S3	Sm	BCW81;R	s7	Mm
BC 107	<b>S</b> 3	Sm	BC807	<b>S</b> 7	Mm	BCW89;R	s7	Mm
BC108	<b>S</b> 3	Sm	BC808	S7	Mm	BCX17;R	s7	Mm
BC109	<b>S</b> 3	Sm	BC817	S7	Mm	BCX18;R	s7	Mm
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BC140	S3	Sm	BC818	S7	Mm	BCX19;R	s7	Mm
BC141	S3	Sm	BC846	S7	Mm	BCX20;R	s7	Mm
BC146	S3	Sm	BC847	S7	Mm	BCX51	s7	Mm
BC160	<b>S</b> 3	Sm	BC848	<b>S</b> 7	Mm	BCX52	s7	Mm
BC161	<b>S</b> 3	Sm	BC849	s7	Mm	BCX53	<b>S</b> 7	Mm
BC177	<b>S</b> 3	Sm	BC850	s7	Mm	BCX54	S7	Mm
BC178	\$3	Sm	BC856	<b>S</b> 7	Mm	BCX55	s7	Mm
BC179	\$3	Sm	BC857	s7	Mm	BCX56	s7	Mm
BC200	S3	Sm	BC858	<b>S</b> 7	Mm	BCX68	S7	Mm
BC264A	S5	FET	BC859	<b>S</b> 7	Mm	BCX69	<b>S</b> 7	mm
BC264B	S5	FET	BC860	s7	Mm	BCX70*	<b>S</b> 7	Mm
BC264C	S5	FET	BC868	<b>S</b> 7	Mm	BCX71*	S7	Mm
BC264D	S5	FET	BC869	<b>S</b> 7	Mm	BCY56	<b>S</b> 3	Sm
BC327;A	S3	Sm	BCF29;R	S7	Mm	BCY57	S3	Sm
BC328	<b>S</b> 3	Sm	BCF30;R	S7	Mm	BCY58	s3	Sm
BC337;A	S3	Sm	BCF32;R	<b>S</b> 7	Mm	BCY59	<b>S</b> 3	Sm
BC338	53	Sm	BCF33:R	S7	Mm	BCY70	<b>S</b> 3	Sm
BC368	<b>S</b> 3	Sm	BCF70;R	S7	Mm	BCY71	<b>S</b> 3	Sm
BC369	<b>S</b> 3	Sm	BCF81:R	<b>S</b> 7	Mm	BCY72	<b>S</b> 3	Sm
BC375	S3	Sm	BCV26	s7	Mm	BCY78	<b>S</b> 3	Sm
BC376	s3	Sm	BCV27	S7	Mm	BCY79	<b>S</b> 3	Sm
BC546	<b>S</b> 3	Sm	BCV61	s7	Mm	BCY87	<b>S</b> 3	Sm
BC547	<b>S</b> 3	Sm	BCV62	S7	Mm	BCY88	<b>S</b> 3	Sm
BC548	S3	Sm	BCV71;R	s7	Mm	BCY89	<b>S</b> 3	Sm
BC549	<b>S</b> 3	Sm	BCV72;R	<b>S</b> 7	Mm	BD131	S4a	P
BC550	<b>S</b> 3	Sm	BCW29:R	<b>S</b> 7	Mm	BD132	S4a	P
BC556	<b>S</b> 3	Sm	BCW30;R	s7	Mm	BD135	S4a	P
BC557	<b>S</b> 3	Sm	BCW31;R	s7	Mm	BD136	54a	P
BC558	<b>S</b> 3	Sm	BCW32;R	<b>S</b> 7	Mm	BD137	S4a	P
BC559	s3	Sm	BCW33;R	s7	Mm	BD138	S4a	P
BC560	<b>S</b> 3	Sm	BCW60*	S7	Mm	BD139	S4a	P
BC635	<b>S</b> 3	Sm	BCW61*	<b>S</b> 7	Mm	BD140	S4a	P
BC636	<b>S</b> 3	Sm	BCW69;R	<b>S</b> 7	Mm	BD201	S4a	P
BC637	<b>S</b> 3	Sm	BCW70;R	<b>S</b> 7	Mm	BD202	S4a	P
BC638	<b>S</b> 3	Sm	BCW71;R	<b>S</b> 7	Mm	BD203	S4a	P

<sup>\* =</sup> 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	type no.	book	section	type no.	book	section
BD204	S4a	P	BD332	S4a	P	BD828	S4a	P
BD226	S4a	P	BD333	S4a	P	BD829	S4a	P
BD227	S4a	P	BD334	S4a	P	BD830	S4a	P
BD228	S4a	P	BD335	S4a	P	BD839	S4a	P
BD229	S4a	P	BD336	S4a	<b>P</b>	BD840	S4a	P
BD230	S <b>4</b> a	P	BD337	S4a	P.	BD841	S4a	P
BD231	S4a	P	BD338	S4a	P	BD842	S4a	P
BD233	S4a	P	BD433	S4a	P	BD843	S4a	P
BD234	S4a	P	BD434	S4a	P	BD844	S4a	P
BD235	S4a	P	BD435	S4a	P	BD845	S4a	P
BD236	S4a	P	BD436	S4a	P	BD846	S4a	P
BD237	S4a	P	BD437	S4a	P	BD847	S4a	P
BD238	S4a	P	BD438	S4a	P	BD848	S4a	P
BD239	S4a	P	BD645	S4a	P	BD849	S4a	P
BD239A	S4a	P	BD646	S4a	P	BD850	S4a	P
BD239B	S4a	P	BD647	S4a	P	BD933	S4a	P
BD239C	S4a	P	BD648	S4a	P	BD934	S4a	P
BD240	S4a	P	BD649	S4a	P	BD935	S4a	P
BD240A	S4a	P	BD650	S4a	P	BD936	S4a	P
BD240B	S4a	P	BD651	S4a	P	BD937	S4a	P
BD24OC	S4a	P	BD652	S4a	P	BD938	S4a	P
BD241	S4a	P	BD675	S4a	P	BD939	S4a	P
BD241A	S4a	P	BD676	S4a	P	BD940	S4a	P
BD241B	S4a	P	BD677	S4a	P	BD941	S4a	P
BD241C	S4a	P	BD678	5 <b>4</b> a	P	BD942	S4a	P
BD242	S4a	P	BD679	S4a	P	BD943	S4a	P
BD242A	S4a	P	BD680	S4a	P	BD944	S4a	P
BD242B	S4a	P	BD681	S4a	P	BD945	S4a	P
BD242C	S4a	P	BD682	S4a	P	BD946	S4a	P
BD243	S4a	P	BD683	S4a	P	BD947	S4a	P
BD243A	S4a	P	BD684	S4a	P	BD948	S4a	<b>P</b>
BD243B	S4a	P	BD813	S4a	P	BD949	S4a	P
BD243C	S4a	P	BD814	S4a	P	BD950	S4a	P
BD244	S4a	P	BD815	S4a	P	BD951	S4a	P
BD244A	S4a	P	BD816	S4a	P	BD952	S4a	P
BD244B	S4a	P	BD817	S4a	P	BD953	S4a	P
BD244C	S4a	P	BD818	S4a	P	BD954	S4a	P
BD329	S4a	P	BD825	S4a	P	BD955	S4a	P
BD330	S4a	P	BD826	S4a	P	BD956	S4a	P
BD331	S4a	P	BD827	S4a	P	BDT20	S4a	P
BD331	S4a	P	BD827	S4a	P	BDT20	S4a	P

P = Low-frequency power transistors

type no.	book	section	type no.	book	section	type no.	book	sectio
BDT21	S4a	P	BDT61C	S4a	P	BDV66B	S4a	P
BDT29	S4a	P ·	BDT62	S4a	P	BDV66C	S4a	P
BDT29A	S4a	P	BDT62A	S4a	P	BDV66D	S4a	P
BDT29B	S4a	P	BDT62B	S4a	P	BDV67A	S4a	P
BDT29C	S4a	P	BDT62C	S4a	P	BDV67B	S4a	P
BDT30	S4a		22763	~4	_			_
BDT3OA		P	BDT63	S4a	P	BDV67C	S4a	P
	S4a	P	BDT63A	S4a	P	BDV67D	S4a	P
BDT30B	S4a	P	BDT63B	S4a	P	BDV91	S4a	P
BDT30C	S4a	P	BDT63C	S4a	P	BDV92	S4a	P
BDT31	S4a	P	BDT64	S4a	P	BDV93	S4a	P
BDT31A	S4a	P	BDT64A	S4a	P	BDV94	S4a	P
BDT31B	S4a	P	BDT64B	S4a	P	BDV95	S4a	P
BDT31C	S4a	P	BDT64C	S4a	P	BDV96	S4a	P
BDT32	S4a	P	BDT65	S4a	P	BDW55	S4a	P
BDT32A	S4a	P	BDT65A	S4a	P	BDW56	S4a	P
BDT32B	S4a	P	DDWCED	C4-		DDME 7	0.4	
BDT32B	S4a	P P	BDT65B	S4a	P	BDW57	S4a	P
	S4a S4a	-	BDT65C	S4a	P	BDW58	S4a	P
BDT41		P	BDT81	S4a	P	BDW59	S4a	P
BDT41A	54a	P	BDT82	S4a	P	BDW60	S4a	P
BDT41B	S4a	P	BDT83	S4a	P	BDX35	S4a	P
BDT41C	S4a	P	BDT84	S4a	P	BDX36	S4a	P
BDT42	S4a	P	BDT85	S4a	P	BDX37	S4a	P
BDT42A	S4a	P	BDT86	S4a	P	BDX42	S4a	P
BDT42B	S4a	P	BDT87	S4a	P	BDX43	S4a	P
BDT42C	S4a	P	BDT88	S4a	P	BDX44	S4a	P
BDT51	S4a	P	BDT91	S4a	P	DDVAE	S4a	n
BDT52	S4a	P	BDT92	54a 54a	P P	BDX45		P
BDT53	S4a	P P	BDT93	S4a S4a	P P	BDX46	S4a	P
BDT54	S4a	P				BDX47	S4a	P
BDT55	S4a S4a	P P	BDT94	S4a	P	BDX62	54a	P
50133	54a	P	BDT95	S4a	P	BDX62A	S4a	P
BDT56	S4a	P	BDT96	S4a	P	BDX62B	S4a	P
BDT57	S4a	P	BDV64	S4a	P	BDX62C	S4a	P
BDT58	S4a	P	BDV64A	S4a	P	BDX63	S4a	P
BDT60	S4a	P	BDV64B	S4a	P	BDX63A	S4a	P
BDT6OA	S4a	P	BDV64C	S4a	P	BDX63B	S4a	P
BDT60B	S4a	P	BDV65	S4a	P	BDX63C	S4a	P
BDT60C	S4a	P	BDV65A	S4a	P	BDX64	S4a	P
BDT61	S4a	P	BDV65B	S4a	P P	BDX64A	S4a	P
BDT61A	S4a	P	BDV65C	S4a	P	BDX64B		
BDT61B	S4a	P	BDV65C	54a 54a	P	BDX64B	S4a	P
221010	570	r	DDVOOM	Jaa	F	DDVOAC	S4a	P

P = Low-frequency power transistors

type no.	book	section	type no.	book	section	type no.	book	section
BDX65	S4a	P	BF247B	S5	FET	BF585	S4b	HVP
BDX65A	S4a	P	BF247C	S5	FET	BF587	S4b	HVP
BDX65B	S4a	P	BF256A	S5	FET	BF591	S4b	HVP
BDX65C	S4a	P	BF256B	S5	FET	BF593	S4b	HVP
BDX66	S4a	P	BF256C	S5	FET	BF620	S7	Mm
DDMOG	5.14							
BDX66A	S4a	P	BF324	S3	Sm	BF621	S7	Mm
BDX66B	S4a	P	BF370	<b>S</b> 3	Sm	BF622	s7	Mm
BDX66C	S4a	P	BF410A	S5	FET	BF623	s7	Mm
BDX67	S4a	P	BF410B	S5	FET	BF660;R	<b>S</b> 7	Mm
BDX67A	S4a	P	BF410C	S5	FET	BF689K	S10	WBT
DDROTA	514	•						
BDX67B	S4a	P	BF410D	S5	FET	BF763	S10	WBT
BDX67C	S4a	P	BF419	S4b	HVP	BF767	<b>S</b> 7	Mm
BDX68	S4a	P	BF420	S3	Sm	BF819	S4b	HVP
BDX68A	S4a	P	BF421	53	Sm	BF820	S7	Mm
BDX68B	S4a	P	BF422	S3	Sm	BF821	S7	Mm
DDROOD	514	•						
BDX68C	S4a	P	BF423	S3	Sm	BF822	S7	Mm
BDX69	S4a	P	BF450	<b>S</b> 3	Sm	BF823	<b>S</b> 7	Mm
BDX69A	54a	P	BF451	53	Sm	BF824	<b>S</b> 7	Mm
BDX69B	S4a	P	BF457	S4b	HVP	BF840	<b>S</b> 7	Mm
BDX69C	S4a	P	BF458	S4b	HVP	BF841	<b>S</b> 7	Mm
DDAGGC	570	•	22.100					
BDX77	S4a	P	BF459	S4b	HVP	BF857	S4b	HVP
BDX78	S4a	P	BF469	S4b	HVP	BF858	S4b	HVP
BDX91	S4a	P	BF470	S4b	HVP	BF859	S4b	HVP
BDX92	S4a	P	BF471	S4b	HVP	BF869	S4b	HVP
BDX93	S4a	P	BF472	S4b	HVP	BF870	S'4b	HVP
DDMJJ	U .u	•						
BDX94	S4a	P	BF483	<b>S</b> 3	Sm	BF871	S4b	HVP
BDX95	54a	P	BF485	53	Sm	BF872	S4b	HVP
BDX96	S4a	P	BF487	<b>S</b> 3	Sm	BF926	<b>S</b> 3	Sm
BDY90	S4a	P	BF494	S3	Sm	BF936	s3	Sm
BDY90A	S4a	P	BF495	<b>S</b> 3	Sm	BF939	S3	Sm
DDIJOR	544	•						
BDY91	S4a	P	BF496	<b>S</b> 3	Sm	BF960	<b>S</b> 5	FET
BDY92	S4a	P	BF510	S7/S5	Mm/FET	BF964	S5	FET
BF198	<b>S</b> 3	Sm	BF511	S7/S5	Mm/FET	BF966	S5	FET
BF199	<b>S</b> 3	Sm	BF512	S7/S5	Mm/FET	BF967	S3	Sm
BF240	<b>S</b> 3	Sm	BF513	S7/S5	Mm/FET	BF970	<b>S</b> 3	Sm
DI 240	55	J.M.		,				
BF241	s3	Sm	BF536	S7	Mm	BF979	<b>S</b> 3	Sm
BF245A	S5	FET	BF550;R		Mm	BF980	S5	FET
BF245B	S5	FET	BF569	S7	Mm	BF981	S5	FET
BF245C	S5	FET	BF579	s7	Mm	BF982	S5	FET
BF247A	S5	FET	BF583	S4b	HVP	BF989	S7/S5	Mm/FE
ひしんていれ	J J		1			1	,	,

HVP = High-voltage power transistors

Mm = Microminiature semiconductors for hybrid circuits

= Low-frequency power transistors

Sm = Small-signal transistors

WBT = Wideband transistors

type no.	book	section	type no.	book	section	type no.	book	section
BF990	S7/S5	Mm/FET	BFQ51	S10	WBT	BFT24	S10	WBT
BF991	S7/S5	Mm/FET	BFQ51C	S10	WBT	BFT25;R	S7	Mm Mm
BF992	S7/S5	Mm/FET	BFQ52	S10	WBT	BFT44	57 53	
BF994	S7/S5	Mm/FET	BFQ53	S10				Sm
BF996	S7/S5	Mm/FET	~	S10	WBT	BFT45	S3	Sm
D1 330	51755	rim/ FEI	BFQ63	510	WBT	BFT46	S7/S5	Mm/FET
BFG23	S10	WBT	BFQ65	S10	WBT	BFT92;R	s7	Mm
BFG32	S10	WBT	BFQ66	S10	WBT	BFT93;R	S7	Mm
BFG34	S10	WBT	BFQ67	<b>S</b> 7	Mm	BFW10	<b>S</b> 5	FET
BFG51	S10	WBT	BFQ68	S10	WBT	BFW11	S5	FET
BFG65	S10	WBT	BFQ136	S10	WBT	BFW12	S5	FET
BFG67	S7	Mm	BFR29	<b>S</b> 5	FET	BFW13	<b>S</b> 5	FET
BFG90A	S10	WBT	BFR30	S7/S5	Mm/FET	BFW16A	S10	WBT
BFG91A	S10	WBT	BFR31	S7/S5	Mm/FET	BFW17A	S10	WBT
BFG96	S10	WBT	BFR49	S10	WBT	BFW30	S10	WBT
BFP90A	S10	WBT	BFR53;R	S7	Mm	BFW61	S5	FET
	2.0		DI KSS, K	57	17111	Drwo	3)	r E I
BFP91A	S10	WBT	BFR54	<b>S</b> 3	Sm	BFW92	S10	WBT
BFP96	S10	WBT	BFR64	S10	WBT	BFW92A	S10	WBT
BFQ10	<b>S</b> 5	FET	BFR65	S10	WBT	BFW93	S10	WBT
BFQ11	S5	FET	BFR84	S5	FET	BFX29	S3	Sm
BFQ12	<b>S</b> 5	FET	BFR90	S10	WBT	BFX30	<b>S</b> 3	Sm
BFQ13	S5	FET	BFR90A	S10	WBT	BFX34	<b>S</b> 3	Sm
BFQ14	S5	FET	BFR91	S10	WBT	BFX84	<b>S</b> 3	Sm
BFQ15	S5	FET	BFR91A	510	WBT	BFX85	S3	Sm
BFQ16	S5	FET	BFR92;R	S7	Mm	BFX86	S3	Sm
BFQ17	<b>S</b> 7	Mm	BFR92A;R		Mm	BFX87	S3	Sm
&	-,		DIKJZA, K	57	Lim	DIAG	33	JIII
BFQ18A	s7	Mm	BFR93;R	S7	Mm	BFX88	S3	Sm
BFQ19	s7	Mm	BFR93A;R		Mm	BFX89	S10	WBT
BFQ22S	510	WBT	BFR94	S10	WBT	BFY50	S3	Sm
BFQ23	S10	WBT	BFR95	S10	WBT	BFY51	s3	Sm
BFQ23C	S10	WBT	BFR96	S10	WBT	BFY52	<b>S</b> 3	Sm
BFQ24	S10	WBT	BFR96S	S10	WBT	BFY55	s3	Sm
BFQ32	S10	WBT	BFR101A;		Mm/FET	BFY90	S10	WBT
BFQ32C	S10	WBT	BFS17;R	s7	Mm	BG2000	S1	RT
BFQ32S	S10	WBT	BFS18;R	S7	Mm	BG2097	S1	RT
BFQ33	S10	WBT	BFS19;R	s7	Mm	BGD102	S10	WBM
BFQ34	S10	WBT	BFS20;R	S7	Mm	BGD102E	S10	WBM
BFQ34T	S10	WBT	BFS20; R	S 7	rm FET	BGD 102E	S10 S10	
BFQ42	S6	RFP	BFS21A	S5	FET	BGD 104 BGD 104E	S10 S10	WBM
BFQ43	S6	RFP	BFS27A	S6		BGY22		WBM
BFQ43S	S6	RFP	BFS23A	56 56	RFP	BGY22 BGY22A	S6 S6	RFP
21 8422	50	MFF	DESCOR	30	RFP	DGIZZA	20	RFP

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	type no.	book	section	type no.	book	section
BGY23	<b>S</b> 6	RFP	BGY85A	S10	WBM	BLV57	s6	RFP
BGY23A	S6	RFP	BGY90A	s6	RFP	BLV59	S6	RFP
BGY32	<b>S6</b>	RFP	BGY90B	S6	RFP	BLV75/12	S6	RFP
BGY33	S6	RFP	BGY93 <sup>*</sup>	S6	RFP	BLV80/28		RFP
BGY35	s6	RFP	BGY94*	s6	RFP	BLV90	S6	RFP
BGY36	s6	RFP	BGY95A	s6	RFP	BLV90/SL	s6	RFP
BGY40A	S6	RFP	BGY95B	S6	RFP	BLV91	S6	RFP
BGY40B	S6	RFP	BGY96A	S6	RFP	BLV91/SL	S6	RFP
BGY41A	S6	RFP	BGY96B	S6	RFP	BLV92	s6	RFP
BGY41B	<b>S</b> 6	RFP	BLF146	s6	RFP/FET	BLV93	S6	RFP
BGY43	s6	RFP	BLF242	S6	RFP/FET	BLV94	S6	RFP
BGY45A	S6	RFP	BLF244	S6	RFP/FET	BLV95	S6	RFP
BGY45B	S6	RFP	BLF245	S6	RFP/FET	BLV97	S6	RFP
BGY46A	56	RFP	BLT90/SI	. S6	RFP	BLV98	S6	RFP
BGY46B	s6	RFP	BLT91/SI		RFP	BLV99	S6	RFP
BGY47*	s6	RFP	BLT92/SI	. s6	RFP	BLW29	S6	RFP
BGY48*	56	RFP	BLU20/12		RFP	BLW31	S6	RFP
BGY50	S10	WBM	BLU30/12		RFP	BLW32	S6	RFP
BGY51	S10	WBM	BLU45/12		RFP	BLW33	S6	RFP
BGY52	510	WBM	BLU50	S6	RFP	BLW34	S6 .	RFP
BGY53	S10	WBM	BLU51	s6	RFP	BLW5OF	s6	RFP
BGY54	S10	WBM	BLU52	S6	RFP	BLW60	S6	RFP
BGY55	510	WBM	BLU53	S6	RFP	BLW6OC	S6	RFP
BGY56	S10	WBM	BLU60/12		RFP	BLW76	56	RFP
BGY57	s10	WBM	BLU97	s6	RFP	BLW77	S6	RFP
BGY58	S10	WBM	BLU98	<b>S</b> 6	RFP	BLW78	S6	RFP
BGY58A	510	WBM	BLU99	56	RFP	BLW79	S6	RFP
BGY59	S10	WBM	BLV10	56	RFP	BLW80	S6	RFP
BGY60	S10	WBM	BLV11	S6	RFP	BLW81	56	RFP
BGY61	S10	WBM	BLV20	s6	RFP	BLW83	S6	RFP
BGY65	S10	WBM	BLV21	s6	RFP	BLW84	S6:	RFP
BGY67	S10	WBM	BLV25	S6	RFP	BLW85	56	RFP
BGY67A	S10	WBM	BLV30	S6	RFP	BLW86	S6	RFP
BGY70	S10	WBM	BLV30/1		RFP	BLW87	56	RFP
BGY71	510	WBM	BLV31	S6	RFP	BLW89	S6	RFP
BGY74	S10	WBM	BLV32F	s6	RFP	BLW90	s6	RFP
BGY75	S10	WBM	BLV32F	S6	RFP	BLW91	S6	RFP
BGY84	S10	WBM WBM	BLV33F	S6	RFP	BLW95	S6	RFP
	S10 S10	WBM WBM	BLV33F	56 56	RFP	BLW95	56 56	RFP
BGY84A			BLV36		RFP	BLW97	S6	RFP
BGY85	S10	WBM	DDV45/1	2 30	KIL	DD#3/	20	KrP

<sup>\* =</sup> series

FET = Field-effect transistors

RFP = R.F. power transistors and modules

WMB = Wideband hybrid IC modules

			T			T		
type	no. book	section	type no.	book	section	type no.	book	section
BLW9	8 S6	RFP	BPW71	S8b	PDT	BSR30	s7	M
BLW9		RFP	BPX25	S8b				Mm
BLX1		RFP	BPX29	S8b	PDT	BSR31	S7	Mm
BLX1		RFP			PDT	BSR32	S7	Mm
BLX1			BPX40	S8b	PDT	BSR33	s7	Mm
PLY	4 56	RFP	BPX41	S8b	PDT	BSR40	S7	Mm
BLX1	5 S6	RFP	BPX42	S8b	PDT	BSR41	s7	Mm
BLX3		RFP	BPX61	S8b	PDT	BSR42	s7	Mm
BLX6	5 S6	RFP	BPX61P	S8b	PDT	BSR43	s7	Mm
BLX6	5E S6	RFP	BPX71	S8b	PDT	BSR50	<b>S</b> 3	Sm
BLX6	SES S6	RFP	BPX72	S8b	PDT	BSR51	S3	Sm
BLX6	7 S6	RFP	PD 100 (03	S2b	m\-	22250	-0	
1			BR100/03		Th	BSR52	<b>S</b> 3	Sm
BLX69		RFP	BR101	S3	Sm	BSR56	S7/S5	Mm/FET
		RFP	BR210*	S2a	Th	BSR57	S7/S5	Mm/FET
BLX9		RFP	BR216*	S2a	Th	BSR58	S7/S5	Mm/FET
BLX9	1CB S6	RFP	BR220*	S2a	Th	BSR60	s3	Sm
BLX92	2A S6	RFP	BRY39	<b>S</b> 3	Sm	BSR61	<b>S</b> 3	Sm
BLX93	3A S6	RFP	BRY56	S3	Sm	BSR62	\$3	Sm
BLX94	1A S6	RFP	BRY61	<b>S</b> 7	Mm	BSS38	\$3	Sm
BLX94		RFP	BRY62	S7	Mm	BSS50	<b>S</b> 3	Sm
BLX95		RFP	BS107	S5	FET	BSS51	S3	Sm
BLX96	5 S6	RFP	BS170	<b>S</b> 5	P.P.M	2000		_
BLX97		RFP	BSD10	S5	FET	BSS52	S3	Sm
BLX98					FET	BSS60	53	Sm
BLY87		RFP	BSD12	S5	FET	BSS61	<b>S</b> 3	Sm
BLY87		RFP	BSD20	S5/7	FET	BSS62	S3	Sm
BLIGA	C 56	RFP	BSD22	S5/7	FET	BSS63;R	s7	Mm
BLY88		RFP	BSD212	S5	FET	BSS64;R	S7	Mm
BLY88	SC 56	RFP	BSD213	S5	FET	BSS68	53	Sm
BLY89	A S6	RFP	BSD214	S5	FET	BSS83	S5/7	FET/Mm
BLY89	C S6	RFP	BSD215	S5	FET	BST15	S7	Mm
BLY90	) S6	RFP	BSR12;R	<b>S</b> 7	Mm	BST16	s7	Mm
BLY91	A S6	RFP	BSR13:R	<b>S</b> 7	Mm	DCTTO	C7	34
BLY91		RFP	BSR14:R	S7		BST39	S7	Mm
BLY92					Mm M	BST40	S7	Mm
BLY92		RFP	BSR15;R	S7	Mm	BST50	S7	Mm
		RFP	BSR16;R	S7	Mm	BST51	S7	Mm
BLY93	A S6	RFP	BSR17;R	<b>S</b> 7	Mm	BST52	s7	Mm
BLY93		RFP	BSR17A;R	<b>S</b> 7	Mm	BST60	s7	Mm
BLY94		RFP	BSR18;R	S7	Mm	BST61	s7	Mm
BPF24	S8b	PDT	BSR18A;R	<b>S</b> 7	Mm	BST62	s7	Mm
BPW22	A S8a/b	PDT	BSR19; A		Mm	BST70A	S5	FET
BPW50	S8a/b	PDT	BSR20; A	S7	Mm	BST72A	S5	FET
L								

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	type no.	book	section	type no.	book	section
BST74A	S5	FET	BT139*	S2b	Tri	BU508D	S4b	SP
BST76A	<b>S</b> 5	FET	BT139F*	S2b	Tri	BU705	S4b	SP
BST78	S5	FET	BT145*	S2b	Tri	BU706	S4b	SP
BST80	S5/S7	FET/Mm	BT149*	S2b	Th	BU706D	S4b	SP
BST82	s5/s7	FET/Mm	BT150	S2b	Th	BU806	S4b	SP
BST84	S5/S7	FET/Mm	BT151*	S2b	Th	BU807	S4b	SP
BST86	S5/S7	FET/Mm	BT151F*	S2b	Th	BU808	S4b	SP
BST90	S5	FET	BT152*	S2b	Th	BU824	S4b	SP
BST97	S5	FET	BT153	S2b	Th	BU826	S4b	SP
BST100	S5	FET	BT157*	S2b	Th	BUP22*	S4b	SP
BST110	S5	FET	BT169*	S2b	Th	BUP23*	S4b	SP
BST120	S5/S7	FET/Mm	BTA140*	S2b	Tri	BUS11; A	S4b	SP
BST122	S5/S7	FET/Mm	BTR59*	S2b	Tri	BUS12; A	S4b	SP
BSV15	s3	Sm	BTS59*	S2b	Tri	BUS13;A	S4b	SP
BSV16	\$3	Sm	BTV58*	S2b	Th	BUS14;A	S4b	SP
BSV17	s3	Sm	BTV59*	S2b	Th	BUS21*	s4b	SP
BSV52;R	S7	Mm	BTV59D*	S2b	Th	BUS22*	S4b	SP
BSV64	\$3	Sm	BTV60*	S2b	Th	BUS23*	S4b	SP
BSV78	<b>S</b> 5	FET	BTV6OD*	S2b	Th	BUT11; A	S4b	SP
BSV79	S5	FET	BTV70*	S2b	Th	BUT11A	S4b	SP
BSV80	S5	FET	BTV7OD*	S2b	Th	BUT11AF	S4b	SP
BSV81	S5	FET	BTW23*	S2b	Th	BUV82	S4b	SP
BSW66A	S3	Sm	BTW38*	S2b	Th	BUV83	S4b	SP
BSW67A	53	Sm	BTW40*	S2b	Th	BUV89	S4b	SP
BSW68A	\$3	Sm	BTW42*	S2b	Th	BUV90; A	S4b	SP
BSX19	<b>S</b> 3	Sm	BTW43*	S2b	Tri	BUW11:A	s4b	SP
BSX20	\$3	Sm	BTW45*	S2b	Th	BUW12;A	S4b	SP
BSX45	\$3	Sm	BTW58*	S2b	Th	BUW13;A	S4b	SP
BSX46	\$3	Sm	BTW62*	S2b	Th	BUW84	S4b	SP
BSX47	<b>S</b> 3	Sm	BTW62D*	S2b	Th	BUW85	S4b	SP
BSX59	<b>s</b> 3	Sm	BTW63*	S2b	Th	BUX46; A	S4b	SP
BSX60	S3	Sm	BTY79*	S2b	Th	BUX47; A	S4b	SP
BSX61	\$3	Sm	BTY91*	S2b	Th	BUX48; A	S4b	SP
BSY95A	S3	Sm	BU426	S4b	SP	BUX80	54b	SP
BT136*	S2b	Tri	BU426A	S4b	SP	BUX81	S4b	SP
BT136F*	S2b	Tri	BU433	S4b	SP	BUX82	S4b	SP
BT137*	S2b	Tri	BU505	S4b	SP	BUX83	S4b	SP
BT137F*	S2b	Tri	BU506	S4b	SP	BUX84	S4b	SP
BT138*	S2b	Tri	BU506D	S4b	SP	BUX84F	54b	SP
BT138F*	S2b	Tri	BU508A	S4b	SP	BUX85	54b	SP

<sup>\* =</sup> series

SP = Low-frequency switching power transistors

Th = Thyristors

Tri = Triacs

FET = Field-effect transistors

Mm = Microminiature semiconductors

for hybrid circuits

Sm = Small-signal transistors

type no.	book	section	type no.	book	section	type no.	book	sectio
BUX85F	S4b	SP	BUZ54	S9	PM	BY609	S1	R
BUX86	S4b	SP	BUZ54A	59	PM	BY610	S1	R
BUX87	S4b	SP	BUZ60	59	PM	BY614	<b>S</b> 1	R
BUX88	S4b	SP	BUZ 60B	59	P <b>M</b>	BY619	S1	R
BUX90	S4b	SP	BUZ63	S 9	P <b>M</b>	BY620	S1	R
D111100	g 41	an.						_
BUX98	S4b	SP	BUZ63B	S9	PM	BY627	S1	R
BUX98A	S4b	SP	BUZ64	S9	P <b>M</b>	BY707	S1	R
BUX99	S4b	SP	BUZ71	S9	P <b>M</b>	BY708	S1	R
BUY89	S4b	SP	BUZ71A	S9	P <b>M</b>	BY709	S1	R
BU7.10	S9	PM	BUZ72	59	PM	BY710	S1	R
BUZ 10A	S9	PM	BUZ72A	<b>S</b> 9	PM	BY711	S1	R
BUZ11	S 9	PM	BUZ73A	S9	PM	BY712	S1	R
BUZ11A	S9	PM	BUZ74	S9	PM	BY713	S1	R
BUZ14	S9	PM	BUZ74A	59	PM	BY714	S1	R
BUZ15	59	P <b>M</b>	BUZ76	S 9	PM	BYD13*	S1	R
BUZ2O	S9	P <b>M</b>	BUZ76A	S9	P <b>M</b>	DWD44*	94	
	S9	PM PM				BYD14	51	R
BUZ21	59 59		BUZ8O	S9	PM	BYD17	S1	R
BUZ23		PM	BUZ8OA	S9	PM	BYD33*	S1	R
BU7.24	S9	PM	BUZ83	S9	PM	I BYD3/	S1	R
BUZ25	S9	PM	BUZ83A	S9	PM	BYD73*	S1	R
BUZ3O	S9	PM	BUZ84	S9	P <b>M</b>	BYD74*	51	R
BUZ31	59	PM	BUZ84A	S9	PM	BYD77*	S1	R
BUZ32	S9	PM	BY224*	S2a	R	BYM26*	S1	R
BUZ33	59	PM	BY225*	S2a	R	BYM36*	S1	R
BUZ34	<b>S</b> 9	PM	BY228	S1	R	BYM56*	S1	R
BUZ35	S9	P <b>M</b>	BY229*	S2a	R	BYP21*	S2a	R
BUZ36	S 9	PM	BY229F*	S2a S2a	R	BYP22*	S2a S2a	R
BUZ4O	S9	PM	BY249*	52a 52a	R	BYP59*	S2a S2a	R
BUZ41A	59	PM	BY260*	S2a	R	BYQ28*	52a 52a	R
BUZ42	S9	PM	BY261*	S2a S2a	R	BYR29*	S2a S2a	R R
50242	57	r rı	B1201	32a	K	BIR29"	sza	K
BUZ43	S9	PM	BY329*	S2a	R	BYR29F*	S2a	R
BUZ44A	S9	PM	BY359*	S2a	R	BYT28*	S2a	R
BUZ45	S9	PM	BY438	S1	R	BYT79*	S2a	R
BUZ45A	S9	PM .	BY448	S1	R	BYV10	S1	R
BUZ45B	S9	PM	BY458	S1	R	BYV18*	S2a	R
BU245C	S9	PM	BY505	S1	R	BYV19*	S2a	R
BUZ46	S9	PM	BY509	S1	R	BYV20*	S2a	R
BUZ5OA	S 9	PM	BY527	S1	R	BYV21*	S2a	R
BUZ5OB	59	PM PM	BY584	S1	R	BYV22*	S2a S2a	R
BUADUB								

<sup>\* =</sup> series

PM = Power MOS transistors

R = Rectifier diodes

SP = Low-frequency switching power transistors

type no.	book	section	type no.	book	section	type no.	book	section
BYV24*	S2a	R	BYW95A	S1	R	BZX70*	S2a	Vrg
BYV26 <sup>*</sup>	S1/S2a	R	BYW95B	S1	R	BZX75*	S1	Vrg
BYV27*	S1/S2a	R	BYW95C	S1	R	BZX79*	S1	Vrg
BYV28*	S1/S2a	R	BYW96D	S1	R	BZX84*	S7/S1	Mm/Vrg
BYV29*	S2a	R	BYW96E	S1	R	BZY91*	S2a	Vrg
BYV29F*	S2a	R	BYX 10G	S1	R	BZY93*	S2a	Vrg
BYV30*	S2a	R	BYX25*	S2a	R	CFX13	S11	M
BYV31*	S2a	R	BYX30*	S2a	R	CFX21	S11	M
BYV32*	S2a	R	BYX32*	S2a	R	CFX30	S11	M
BYV32F*	S2a	R	BYX38*	S2a	R	CFX31	S11	M
BYV33*	S2a	R	BYX39*	S2a	R	CFX32	S11	М
BYV33F*	S2a	R	BYX42*	S2a	R	CFX33	S11	M
BYV34*	S2a	R	BYX46*	S2a	R	CNG35	S8b	PhC
BYV36*	S1	R	BYX50*	S2a	R	CNG36	S8b	PhC
BYV39*	S2a	R	BYX52*	S2a	R	CNR36	S8b	PhC
BYV42*	S2a	R	BYX56*	S2a	R	CNX21	S8b	PhC
BYV43*	S2a	R	BYX90G	S1	R	CNX35	S8b	PhC
BYV43F*	S2a	R	BYX96*	S2a	R	CNX35U	S8b	PhC
BYV44*	S2a	R	BYX97*	S2a	R	CNX36	S8b	PhC
BYV60*	S2a	R	BYX98*	S2a	R	CNX36U	S8b	PhC
BYV72*	S2a	R	BYX99*	S2a	R	CNX38	S8b	PhC
BYV73*	S2a	R	BZD23	S1	Vrg	CNX38U	S8b	PhC
BYV74*	S2a	R	BZD27	S1	Vrg	CNX39	S8b	PhC
BYV79*	S2a	R	BZTO3	S1	Vrg	CNX39U	S8b	PhC
BYV92*	S2a	R	BZV10	S1	Vrf	CNX44	58b	PhC
BYV95A	S1	R	BZV11	S1	Vrf	CNX44A	S8b	PhC
BYV95B	S1	R	BZV12	S1	Vrf	CNX46	58b	PhC
BYV95C	S1	R	BZV13	S1	Vrf	CNX48	S8b	PhC
BYV96D	S1	R	BZV13	S1	Vrf	CNX48U	S8b	PhC
BYV96E	s1	R	BZV37	S1	Vrf	CNX62	S8b	PhC
BYW25*	S2a	R	BZV46	S1	Vrg	CNX72	S8b	PhC
BYW29*	S2a	R	BZV49*	S1/S7	Vrg/Mm	CNX/2	S8b	PhC
BYW29F*	S2a	R	BZV55*	\$1/\$7 \$7	Mm	CNX83	S8b	PhC
BYW30*	S2a S2a	R	BZV80	S1	Vrf	1		
BYW30^	S2a S2a	r R	BZV80 BZV81	S1	vri Vrf	CNX91 CNX92	S8b S8b	PhC PhC
BYW54	S1	R	BZV85*	S1	Vrg	CNY17-1	S8b	PhC
BYW55	S1	R	BZW03	S1	Vrg	CNY17-2	S8b	PhC
BYW56	S1	R	BZW14	S1	Vrg	CNY17-3	S8b	PhC
BYW92*	S2a	R	BZW86*	S2a	TS	CNY50	S8b	PhC
BYW93*	S2a	R	BZX55	S1	Vrg	CNY57	S8b	PhC

<sup>\* =</sup> 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

type no.	book	section	type no. book	section	type no.	book	section
CNY57A	S8b	PhC	CQW10B(L)S8a	LED	COY97A	S8a	LED
CNY57AU	S8b	PhC	CQW10U(L)S8a	LED	Fresnel-	S8b	A
CNY57U	S8b	PhC	CQW11B(L)S8a	LED	lens		
CNY62	S8b	PhC	CQW12B(L)S8a	LED	H11A1	s8b	PhC
CNY63	S8b	PhC	CQW2OA S8a	LED	H11A2	S8b	PhC
CQF24	S8b	Ph	CQW21 S8a	LED	H11A3	S8b	PhC
CQL10A	S8b	Ph	CQW22 S8a	LED	H11A4	S8b	PhC
CQL13A	S8b	Ph	CQW24(L) S8a	LED	H11A5	S8b	PhC
CQL16	S8b	Ph	CQW54 S8a	LED	H11B1	S8b	PhC
CQS51L	S8a	LED	CQW6O(L) S8a	LED	H11B2	S8b	PhC
CQS54	S8a	LED	CQW6OA(L)S8a	LED	H11B3	S8b	PhC
CQS82L	S8a	LED	CQW6OU(L)S8a	LED	H11B255	S8b	PhC
CQS82AL	S8a	LED	CQW61(L) S8a	LED	KMZ 10A	S13	SEN
CQS84L	S8a	I,ED	CQW62(L) S8a	LED	KMZ 10B	S13	SEN
CQS86L	S8a	LED	CQW89A S8a/l	o I	KMZ 10C	S13	SEN
CQS93	S8a	I.ED	CQW93 S8a	LED	KP100A	S13	SEN
CQS93E	S8a	LED	CQW95 S8a	LED	KP101A	S13	SEN
CQS93L	S8a	LED	CQW97 58a	LED	KPZ2OG	S13	SEN
CQS95	S8a	LED	CQX24(L) S8a	LED	KPZ21G	S13	SEN
CQS95E	S8a	LED	CQX51(L) S8a	LED	KTY81*	S13	SEN
CQS95L	S8a	LED	CQX54(L) S8a	LED	KTY83*	S13	SEN
cõs97	S8a	LED	COX54D S8a	LED	KTY84*	S13	SEN
CÕS97E	S8a	LED	CQX64(L) S8a	LED	LAE2001R	S11	M
CQS97L	S8a	LED	COX64D S8a	LED	LAE40010	S11	М
CQT 10B	S8a	LED	CQX74(L) S8a	LED	LAE4001R	S11	M
CQT24	S8a	LED	COX74D S8a	LED	LAE4002S	S11	M
CQT60	S8a	LED	CQY11B S8b	LED	LAE6000Q	S11	M
CQT70	S8a	LED	CQY11C S8b	LED	LBE1004R	S11	M
CQT8OL	S8a	LED	CQY24B(L)S8a	LED	LBE1010R	S11	M
CQV70(L)	S8a	LED	CQY49B S8b	LED	LBE2003S	S11	M
CQV70A(L	) S8a	LED	CQY49C S8b	LED	LBE2005Q	S11	М
CQV70U(L		LED	COY50 S8b	LED	LBE2008T	S11	M
CQV71A(L		LED	CQY52 S8b	LED	LBE2009S	S11	M
CQV72(L)		LED	COY53S S8b	LED	LCE1010R	S11	M
CON80F	S8a	LED	CQY54A S8a	LED	LCE2003S	S11	M
CQV8OAL	S8a	LED	CQY58A S8a/h	o I	LCE2005Q	S11	M
COV8OUL	S8a	LED	COY89A S8a/k		LCE2008T	S11	M
CQV81L	S8a	LED	CQY94B(L)S8a	LED	LCE2009S	S11	M
COV82L	S8a	LED	COY95B S8a	LED	LJE42002T	511	M
CQW10A(L		I.ED	CQY96(L) S8a	LED	LKE1004R	S11	М

<sup>\* =</sup> series

Ph = Photoconductive devices

PhC = Photocouplers

SEN = Sensors

A = Accessories

I = Infrared devices

LED = Light-emitting diodes

M = Microwave transistors

type no.	book	section	type no.	book	section	type no.	book	section
LKE2002T	S11	M	OM320	S10	WBM	PDE1003U	S11	M
LKE2004T	S11	М	OM321	S10	WBM	PDE 1005U	S11	M
LKE2015T	S11	М	OM322	S10	WBM	PDE1010U	S11	M
LKE21004R	S11	М	OM323	S10	WBM	PEE 1001U	S11	M
LKE21015T	S11	M	OM323A	S10	WBM	PEE1003U	S11	M
LKE21050T	S11	M	OM335	S10	WBM	PEE 1005U	S11	M
LKE27010R	S11	M	OM336	S10	WBM	PEE1010U	S11	M
LKE27025R	511	М	OM337	S10	WBM	PH2222;R	s3	Sm
LKE32002T	S11	M	OM337A	S10	WBM	PH2222A;R	<b>S</b> 3	Sm
LKE32004T	S11	M	OM339	S10	WBM	PH2369	<b>S</b> 3	Sm
LTE42005S	S11	M	OM345	S10	WBM	PH2907;R	s3	Sm
LTE42008R	S11	M	OM350	S10	WBM	PH2907A;R	53	Sm
LTE42012R	S11	М	OM360	S10	WBM	PH2955T	S4a	P
LV1721E50R	S11	М	OM361	S10	WBM	PH3055T	S4a	P
LV2024E45R		M	OM370	S10	WBM	PH5415	<b>S</b> 3	Sm
LV2327E40R	S11	М	0М386В	S13	SEN	PH5416	<b>S</b> 3	Sm
LV3742E16R		M	OM386M	S13	SEN	PH13002	S4b	SP
LV3742E24R		M	OM387B	513	SEN	PH13003	S4b	SP
LWE2015R	S11	M	OM387M	513	SEN	PHSD51	S2a	R
LWE2025R	S11	M	OM388B	S13	SEN	PKB3001U	S11	M
LZ1418E100	RS11	М	ом389В	S13	SEN	PKB3003U	S11	М
MCA230.	S8b	PhC	OM931	S4a	P	PKB3005U	S11	M
MCA231	S8b	PhC	OM961	S4a	P	PKB12005U	S11	М
MCA255	S8b	PhC	OSB9115	S2a	St	PKB20010U	511	M
MCT2	S8b	PhC	OSB9215	S2a	St	PKB23001U	S11	M
MCT26	S8b	PhC	OSB9415	S2a	St	PKB23003U	S11	M
MKB12040WS		М	OSM9115	S2a	St	PKB23005U	S11	M
MKB12100WS		М	OSM9215	S2a	St	PKB25006T	S11	M
MKB12140W	S11	М	OSM9415	S2a	St.	PKB32001U	S11	M
M06075B200		M	OSM9510	S2a	St	PKB32003U	S11	M
M06075B400	ZS11	М	OSM9511	52a	St	PKB32005U	S11	M
MRB12175YR		М	OSM9512	S2a	St	PMBF4391	<b>S</b> 7	Mm
MRB12350YR		M	0559115	S2a	St.	PMBF4392	<b>S</b> 7	Mm
MS1011B700		М	0559215	S2a	St	PMBF4392	S7	Mm
MS6075B800		М	0559415	S2a	St	PMLL4148	S1	SD
MSB12900Y	S11	М	P2105	S8b	I	PMLL4150	<b>S</b> 1	SD
MZO912B75Y		М	PBMF4391	S5	FET	PMLL4151	S1	SD
MZ0912B150		М	PBMF4392	S5	FET	PMLL4153	S1	SD
OM286; M	S13	SEN	PBMF4393	S5	FET	PMLL4446	S1	SD
OM287: M	S13	SEN	PDE 100 1U	S11	M	PMLL4448	S1	SD

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

= Rectifier stacks

WBM = Wideband hybrid IC modules

type no.	book	section	type no.	book	section	type no.	book	section
PMLL5225B			RZ1214B12	5VC11	M	TIP127	S4a	P
to	S1	SD	RZ1214B15		M	TIP130	S4a	P
PMLL5267B	~ .	-	RZ2833B45		M	1		
PO44	S8b	PhC	RZ3135B15		M	TIP131	S4a	P
PO44A	S8b	PhC	RZ3135B15			TIP132	S4a	P
IOIIA		FIIC	K43133B13	W 511	М	TIP135	S4a	P
PPC5001T	S11	M	RZ3135B25	U S11	M	TIP136	S4a	P
PQC5001T	S11	M	RZ3135B30	W S11	M	TIP137	S4a	P
PTB23001X	S11	M	RZB12100Y	S11	M	TIP140	S4a	P
PTB23003X	S11	M	RZB12350Y	S11	M	TIP141	S4a	P
PTB23005X	S11	M	RZZ1214B30	00YS11	M	TIP145	54a	P
PTB32001X	S11	М	SL5500	S8b	PhC	WID146	0.4-	_
PTB32003X	S11	M	SL5500	S8b	PhC	TIP146	S4a	P
PTB32005X	S11	M	SL5501 SL5502R	S8b	PhC	TIP147	S4a	P
PTB42001X	S11	M	SL5502R	S8b		TIP2955	S4a	P
PTB42002X	S11	M	,		PhC	TIP3055	S4a	P
F1D42002X	311	M	SL5504S	S8b	PhC	1N821; A	S1	Vrf
PTB42003X	S11	M	SL5505S	S8b	PhC	1N823;A	S1	Vrf
PV3742B4X	S11	М	SL5511	S8b	PhC	1N825;A	S1	Vrf
PVB42004X	S11	M	TIP29*	S4a	P	1N827;A	S 1	Vrf
PZ1418B15U	S11	M	TIP30*	S4a	P	1N829;A	S1	Vrf
PZ1418B30U	S11	M	TIP31*	S4a	P	1N914	S 1	SD
PZ 1721B12U	S11	М	TIP32*	S4a	P	1N916	S1	SD
PZ1721B25U		M	TIP33*	S4a	P	1N3879	S2a	R
PZ2024B10U	S11	M	TIP34*	S4a	P	1N3880	S2a S2a	R
PZ2024B20U		M	TIP41*	S4a	P	1N3881	S2a S2a	R
PZB16035U	S11	M	TIP42*	S4a	P	1N3882	S2a S2a	R
202.0000		••	111.42	Jaa	r	183002	52 <b>a</b>	ĸ
PZB27020U	S11	M	TIP47	S4a	P	1N3883	S2a	R
RPY97	S8b	I	TIP48	S4a	P	1N3889	S2a	R
RPY100	S8b	I	TIP49	S4a	P	1N3890	S2a	R
RPY 10 1	S8b	I	TIP50	S4a	P	1N3891	S2a	R
RPY102	S8b	I	TIP110	S4a	P	1N3892	S2a	R
RPY103	S8b	I	TIP111	S4a	P	1N3893	S2a	R
RPY107	S8b	Ī	TIP112	S4a	P P	1N3909	S2a S2a	R R
RPY 109	S8b	Ī	TIP115	S4a	P	1N3909		
RV3135B5X	S11	M	TIP116	S4a	P P	1N3910	S2a S2a	R R
RX1214B300		M	TIP117	S4a	P P	1N3911		
12 1 10 000		••	TIETIT	Jaa	r	1113912	S2a	R
RXB12350Y	S11	M	TIP120	S4a	P	1N3913	S2a	R
RZ1214B35Y		M	TIP121	S4a	P	1N4001G	S1	R
RZ1214B60W	S11	M	TIP122	S4a	P	1N4002G	S1	R
RZ1214B65Y		M	TIP125	S4a	P	1N4003G	S1	R
RZ1214B125V	JC 1 1	M	TIP126	S4a	P	1N4004G	S1	R

<sup>\* =</sup> series

R = Rectifier diodes

SD = Small-signal diodes

Vrf = Voltage reference diodes

I = Infrared devices

M = Microwave transistors

P = Low-frequency power transistors

PhC = Photocouplers

type no.	book	section	type no.	book	section	type no.	book	section
1N4005G	<b>S</b> 1	R	2N2907	<b>S</b> 3	Sm	2N5400	<b>s</b> 3	Sm
1N4006G	S1	R	2N2907A	\$3	Sm	2N54O1	S3	Sm
1N4007G	51	R	2N3O19	<b>S</b> 3	Sm	2N5415	<b>S</b> 3	Sm
1N4148	<b>S1</b>	SD	2N3O2O	53	Sm	2N5416	\$3	Sm
1 <b>N4</b> 150	<b>S1</b>	SD	2N3O53	<b>S</b> 3	Sm	2N5550	<b>S</b> 3	Sm
1N4151	S1	SD	2N3375	S6	RFP	2N5551	<b>S</b> 3	Sm
1N4153	S1	SD	2N3553	<b>S6</b>	RFP	2N6659	S5	FET
1N4446	S1	SD	2N3632	s6	RFP	2N6660	S5	FET
1N4448	S1	SD	2N3822	<b>S</b> 5	FET	2N6661	S5	FET
1N4531	S1	SD	2N3823	<b>S</b> 5	FET	4N25	S8b	PhC
1N4532	<b>S1</b>	SD	2N3866	s6	RFP	4N25A	S8b	PhC
1N5059	S1	R	2N39O3	<b>S</b> 3	Sm	4N26	S8b	PhC
1N5060	S1	R	2N39O4	<b>S</b> 3	Sm	4N27	S8b	PhC
1N5061	S1	R	2N3905	<b>S</b> 3	Sm	4N28	S8b	PhC
1N5062	S1	R	2N3906	<b>S</b> 3	Sm	4N35	S8b	PhC
1N5225B			2N3924	S6	RFP	4N36	S8b	PhC
to	S1	SD	2N3926	S6	RFP	4N37	58b	PhC
1N5267B			2N3927	S6	RFP	4N38	S8b	PhC
2N918	S10	WBT	2N3966	<b>S</b> 5	FET	4N38A	S8b	PhC
2N929	<b>S</b> 3	Sm	2N4O3O	s3	Sm	502CQF	S8b	Ph
2 <b>N</b> 930	<b>S</b> 3	Sm	2N4O31	<b>S</b> 3	Sm	503CQF	S8b	Ph
2N1613	<b>S</b> 3	Sm	2N4O32	S3	Sm	504CQL	S8b	Ph
2N1711	s3	Sm	2N4O33	53	Sm	516CQF-B	S8b	Ph
2N1893	53	Sm	2N4091	<b>S</b> 5	FET	56201d	S4b	A
2N2219	53	Sm	2N4092	\$5	FET	56201j	S4b	A
2N2219A	<b>s</b> 3	Sm	2N4O93	S5	FET	56245	s3,	IO A
2N2222	53	Sm	2N4123	s3	Sm	56246	S3,1	10 A
2N2222A	53	Sm	2N4124	<b>S</b> 3	Sm	56261a	S4b	A
2N2297	<b>S</b> 3	Sm	2N4125	\$3	Sm	56264	S2a	/b A
2N2368	<b>S</b> 3	Sm	2N4126	<b>S</b> 3	Sm	56295	S2a,	/b A
2N2369	<b>S</b> 3	Sm	2N4391	<b>S</b> 5	FET	56326	S4b	A
2N2369A	<b>S</b> 3	Sm	2N4392	\$5	FET	56339	S4b	A
2N2303A 2N2483	S3	Sm	2N4393	S5	FET	56352	S4b	A
2N2483	s3	Sm	2N4427	56	RFP	56353	S4b	A
2N2404 2N2904	s3	Sm	2N4856	S5	FET	56354	S4b	A
21120242	<b>C</b> 2	C m	2N4857	<b>S</b> 5	FET	56359b	52	4b A
2N2904A	53	Sm S-	1	S5	FET	56359c		4b A
2N2905	S3	Sm C	2N4858 2N4859		FET	56359d		4b A
2N2905A	S3	Sm	1	S5 S5	FET	56360a		4b A
2N2906	53	Sm	2N4860	S5 S5	FET	56363		4b A
2N2906A	<b>S</b> 3	Sm	2N4861	53	LCI	1 20202	341	7 D D

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

## **INDEX**

type no.	book	section
56364	S2,4b	A
56367	S2a/b	A
56368b	52,4b	A
56368c	52,4b	A
56369	S2,4b	A
56378	S2,4b	A
56379	S2,4b	A
56387a,b	S4b	Α
56397	S8b	A

A = Accessories

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