### Semiconductors

**Power diodes**

- Rectifier diodes
- Regulator diodes
- Breakover diodes
- High-voltage rectifier stacks
- Accessories
# POWER DIODES

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DATA HANDBOOK SYSTEM

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

ELECTRON TUBES BLUE

SEMICONDUCTORS RED

INTEGRATED CIRCUITS PURPLE

COMPONENTS AND MATERIALS GREEN

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

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

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

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

Information on current Data Handbooks and on how to obtain a subscription for future issues is available from any of the Organizations listed on the back cover.

Product specialists are at your service and enquiries will be answered promptly.
ELECTRON TUBES (BLUE SERIES)

The blue series of data handbooks comprises:

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

The red series of data handbooks comprises:

S1  Diodes
    Small-signal silicon diodes, voltage regulator diodes (< 1.5 W), voltage reference diodes,
    tuner diodes, rectifier diodes

S2a Power diodes
S2b Thyristors and triacs

S3 Small-signal transistors

S4a Low-frequency power transistors and hybrid modules
S4b High-voltage and switching power transistors

S5 Field-effect transistors

S6 R.F. power transistors and modules

S7 Surface mounted semiconductors

S8a Light-emitting diodes
S8b Devices for optoelectronics
    Optocouplers, photosensitive diodes and transistors, infrared light-emitting diodes and
    infrared sensitive devices, laser and fibre-optic components

S9 Power MOS transistors

S10 Wideband transistors and wideband hybrid IC modules

S11 Microwave transistors

S12 Surface acoustic wave devices

S13 Semiconductor sensors

*S14 Liquid Crystal Displays

*To be issued shortly.
INTEGRATED CIRCUITS (PURPLE SERIES)

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

The purple series of handbooks comprises:

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COMPONENTS AND MATERIALS (GREEN SERIES)

The green series of data handbooks comprises:

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

## Rectifier Diodes

### General Purpose

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### Avalanche

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## FAST RECTIFIER DIODES

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*Monolithic dual rectifier diodes.*

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October 1986 3
**SELECTION GUIDE**

**FAST RECTIFIER DIODES (Cont.)**

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**With avalanche characteristics**
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*Monolithic dual rectifier diodes
^With guaranteed reverse surge capability

### BREAKOVER DIODES

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*Monolithic dual breakover diodes.
^Asymmetrical breakover diode.
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### REGULATOR DIODES

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<td>82 V</td>
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### Outline

- Type No. BZ93 (page 713)
- Type No. BZ91 (page 669)
- Type No. BZW6 (page 659)

### Polarity

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

---

October 1986
### HIGH-VOLTAGE RECTIFIER STACKS

<table>
<thead>
<tr>
<th>Type No.</th>
<th>IF(AV) max.</th>
<th>VRWM max.</th>
<th>Page</th>
<th>Configuration</th>
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<tr>
<td>OSS9115 - 3 to -36</td>
<td>3.5 A (6 A in oil)</td>
<td>4.5 kV to 54 kV</td>
<td>733</td>
<td></td>
</tr>
<tr>
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<td>5 A (20 A in oil)</td>
<td>3 kV to 27 kV</td>
<td>743</td>
<td></td>
</tr>
<tr>
<td>OSS9415 - 3 to -36</td>
<td>10 A (30 A in oil)</td>
<td>3 kV to 27 kV</td>
<td>753</td>
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<td>OSB9115 - 4 to -36</td>
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<td>3 kV to 27 kV</td>
<td>753</td>
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<tr>
<td>OSM9115 - 4 to -36</td>
<td>3.5 A (6 A in oil)</td>
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<td>733</td>
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<tr>
<td>OSM9215 - 4 to -36</td>
<td>5 A (20 A in oil)</td>
<td>3 kV to 27 kV</td>
<td>743</td>
<td></td>
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<tr>
<td>OSM9415 - 4 to -36</td>
<td>10 A (30 A in oil)</td>
<td>3 kV to 27 kV</td>
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<td>OSM9510 - 12</td>
<td>1.5 A</td>
<td>6 kV</td>
<td>761</td>
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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-mb} > 15 K/W)
D. TRANSISTOR; power, audio frequency (R_{th j-mb} ≤ 15 K/W)
E. DIODE; tunnel
F. TRANSISTOR; low power, high frequency (R_{th j-mb} > 15 K/W)
G. MULTIPLE OF DISSIMILAR DEVICES — MISCELLANEOUS; e.g. oscillator
H. DIODE; magnetic sensitive
L. TRANSISTOR; power, high frequency (R_{th j-mb} ≤ 15 K/W)
N. PHOTO-COUPLER
P. RADIATION DETECTOR; e.g. high sensitivity phototransistor
Q. RADIATION GENERATOR; e.g. light-emitting diode (LED)
R. CONTROL AND SWITCHING DEVICE; e.g. thyristor, low power (R_{th j-mb} > 15 K/W)
S. TRANSISTOR; low power, switching (R_{th j-mb} > 15 K/W)
T. CONTROL AND SWITCHING DEVICE; e.g. thyristor, power (R_{th j-mb} ≤ 15 K/W)
U. TRANSISTOR; power, switching (R_{th j-mb} ≤ 15 K/W)
X. DIODE: multiplier, e.g. varactor, step recovery
Y. DIODE; rectifying, booster
Z. DIODE; voltage reference or regulator (transient suppressor diode, with third letter W)
The remainder of the type number is a **serial number** indicating a particular design or development and is in one of the following two groups:

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

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

### RANGE NUMBERS

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

#### RECTIFIER DIODES, THYRISTORS AND TRIACS

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

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

#### REGULATOR DIODES

A **first letter** indicating the nominal percentage tolerance in the operating voltage $V_Z$:

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

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

The **letter V** is used to denote a decimal sign.

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

**Examples:**

BYX38-600  Silicon rectifier in the BYX38 range with 600 V maximum repetitive peak voltage, normal polarity, stud connected to cathode.

BZY91-C7V5  Silicon voltage regulator diode in the BZY91 range with 7.5 V operating ± 5% tolerance, normal polarity, stud connected to cathode.
RATING SYSTEMS

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

DEFINITIONS OF TERMS USED

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

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

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

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

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

Note
Limiting conditions may be either maxima or minima.

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

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

ABSOLUTE MAXIMUM RATING SYSTEM (As used throughout this book)

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

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

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

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

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

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

DESIGN CENTRE RATING SYSTEM

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

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

The equipment manufacturer should design so that, initially, no design centre value for the intended service is exceeded with a bogey electronic device in equipment operating at the stated normal supply voltage.
LETTER SYMBOLS FOR RECTIFIER DIODES, THYRISTORS, TRIACS AND BREAKOVER DIODES

LETTER SYMBOLS FOR CURRENTS, VOLTAGES AND POWERS

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

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

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

Subscripts

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

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

---

\(^1\) For the anode-cathode voltage of thyristors and triacs, F is replaced either by D or T, to distinguish between ‘off-state’ (non-triggered) and ‘on-state’ (triggered).
Example of the use of letter symbols

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

In addition to 100% testing of all major device parameters in the production department, independently controlled statistical sampling for conformance and reliability takes place using BS6001 'Sampling Procedures and Tables'. BS6001 is consistent with MIL-STD-105D, DEF131A, ISO2859, 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.
   — gross leak test.
4. Functional electrical characteristics — within group 'A' limits.

Sequence 'D'

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

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

REVERSE RECOVERY

When a semiconductor rectifier diode has been conducting in the forward direction sufficiently long to establish the steady state, there will be a charge due to minority carriers present. Before the device can block in the reverse direction this charge must be extracted. This extraction takes the form of a transient reverse current and this, together with the reverse bias voltage results in additional power dissipation which reduces the rectification efficiency. At sine-wave frequencies up to about 400 Hz these effects can often be ignored, but at higher frequencies and for square waves the switching losses must be considered.

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

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

The conditions which need to be specified are:

a. Steady-state forward current ($I_F$); high currents increase recovery time.

b. Reverse bias voltage ($V_R$); low reverse voltage increases recovery time.

c. Rate of fall of anode current ($dI_F/dt$); high rates of fall reduce recovery time, but increase stored charge.

d. Junction temperature ($T_j$); high temperatures increase both recovery time and stored charge.

Fig. 1 Waveform showing the reverse recovery aspects.
REVERSE RECOVERY (continued)

Softness of recovery

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

DOUBLE-DIFFUSED RECTIFIER DIODES

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

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

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

ULTRA FAST RECTIFIER DIODES

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

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

SCHOTTKY-BARRIER RECTIFIER DIODES

Schottky-barrier rectifiers find application in low-voltage switched-mode power supplies (e.g. 5 V output) where they give an increase in efficiency due to the very low forward drop, and low switching losses.

Power Schottky diodes are made by a metal-semiconductor barrier process to minimise forward voltage losses, and being majority carrier devices have no stored charge. They are therefore capable of operating at extremely high speeds. Electrical performance in forward and reverse conduction is uniquely defined by the device’s metal-semiconductor ‘barrier height’. We have a process to minimise forward voltage, whilst maintaining reverse leakage current at full rated working voltage and \( T_j \max \) at an acceptable level.

To obtain the maximum benefit from the use of Schottky devices it is recommended that particular attention be paid to the adequate suppression of voltage transients in practical circuit designs.
SWITCHING LOSSES (see also Fig. 3)

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

The conditions which need to be specified are:

a. Forward current ($I_F$); high currents increase switching losses.

b. Rate of fall of anode current ($dI_F/dt$); high rates of fall increase switching losses. This is particularly important in square-wave operation. Power losses in sine-wave operation for a given frequency are considerably less due to the much lower $dI_F/dt$.

c. Frequency ($f$); high frequency means high losses.

d. Reverse bias voltage ($V_R$); high reverse bias means high losses.

e. Junction temperature ($T_J$); high temperature means high losses.

---

![Diagram showing reverse switching losses aspects](image_url)

Fig. 2 Waveforms showing the reverse switching losses aspects.
SWITCHING LOSSES (continued)

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

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

The conditions which need to be specified are:

a. Forward current ($I_F$); high currents give high recovery voltages.

b. Current pulse rise time ($t_r$); short rise times give high recovery voltages.

c. Junction temperature ($T_J$); the influence of temperature is slight.

Fig. 4 Waveforms showing the forward recovery aspects.
OPERATING NOTES

When there is a possibility that transients, due to the energy stored in the transformer, will exceed the maximum permissible non-repetitive peak reverse voltage 1), a damping circuit should be connected across the transformer.

Either a series RC circuit or a voltage dependent resistor may be used. Suitable component values for an RC circuit across the transformer primary or secondary may be calculated as follows:

<table>
<thead>
<tr>
<th>$\frac{V_{RSM}}{V_{RWM}}$</th>
<th>RC across primary of transformer</th>
<th>RC across secondary of transformer</th>
</tr>
</thead>
<tbody>
<tr>
<td>2.0</td>
<td>$C (\mu F)$</td>
<td>R (Ω)</td>
</tr>
<tr>
<td></td>
<td>$\frac{200 I_{mag}}{V_1}$</td>
<td>$\frac{225 I_{mag} T^2}{V_1}$</td>
</tr>
<tr>
<td>1.5</td>
<td>$\frac{400 I_{mag}}{V_1}$</td>
<td>$\frac{450 I_{mag} T^2}{V_1}$</td>
</tr>
<tr>
<td>1.25</td>
<td>$\frac{550 I_{mag}}{V_1}$</td>
<td>$\frac{620 I_{mag} T^2}{V_1}$</td>
</tr>
<tr>
<td>1.0</td>
<td>$\frac{800 I_{mag}}{V_1}$</td>
<td>$\frac{900 I_{mag} T^2}{V_1}$</td>
</tr>
</tbody>
</table>

|                          | R (Ω)                           | R (Ω)                           |
|                          | 150 C                           | $\frac{200}{C}$                 |
|                          | 225 C                           | $\frac{275}{C}$                 |
|                          | 260 C                           | $\frac{310}{C}$                 |
|                          | 300 C                           | $\frac{350}{C}$                 |

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

$V_1$ = transformer primary r.m.s. voltage (V)

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

$T = \frac{V_1}{V_2}$

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

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

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

1) For controlled avalanche types read: non-repetitive peak reverse power.
BREAKOVER DIODES

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

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

BREAKOVER DIODE CHARACTERISTICS

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

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

Fig.1 Breakover diode characteristics (1st quadrant).
USE OF BREAKOVER DIODES

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

In designing BOD circuits the following must be considered:

**Off-state conditions**

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

**Switching conditions**

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

**On-state conditions**

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

![Fig.2 Definition of $I_{TRM}$ waveform.](image-url)
**Thermal conditions**

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

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

**Mains contact**

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

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

Power dissipation curves are not published for BODs during avalanche breakdown. This is because individual cases will vary greatly. However, in general if the fault impedance is about \(500\Omega - 5k\Omega\) 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 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 °C/W) analogous to the electric resistance ($R$ in Ω).

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

$R_{th\ j-mb}$ The thermal resistance from junction to mounting base. Its value is given in the data sheets of a device.

$R_{th\ mb-h}$ 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.

$R_{th\ h-a}$ 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: $T_j - T_{amb} = P \times (R_{th\ j-mb} + R_{th\ mb-h} + R_{th\ h-a})$
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 and 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 $R_{thh-a}$ to keep the total thermal resistance below the maximum given for $P$ and $T_{amb}$. A larger heatsink may be necessary.

Fig. 2 Creepage distances with an insulated diode

Note: care must be taken that the creepage distances, see Fig. 2, are sufficient for the voltage involved. While $A$ and $B$ can be made large enough, $C$ and $D$ are likely to be the critical ones.
CONSTRUCTIONS

Good thermal coupling is essential to semiconductors connected in parallel to ensure good current sharing in view of the forward characteristics, and semiconductors in series in view of the reverse characteristics.

Mounting the semiconductors on the same heatsink not only saves mounting costs but also provides the needed thermal coupling.

Fig. 3 shows the construction for a plain heatsink, and Fig. 4 the construction for an extruded heatsink. The electrical connection is made with a copper strip at least 1 mm thick. For two diodes a plain heatsink should be twice the area, and an extruded heatsink twice the length needed for a single diode.

Reverse polarity devices are convenient for series connection of two diodes on a common heatsink. Figs. 5, 6 and 7 show how the use of normal polarity and reverse polarity diodes simplifies the construction of single-phase and three-phase bridge rectifiers.

Fig. 3 Plain cooling fin with two diodes

Fig. 4 Extruded aluminium heatsink with two diodes

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

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

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

1. Devices without controlled avalanche properties.
   Assume that the diode of which the outlines are shown, is used in a three phase 50 Hz
   rectifier circuit at $T_{amb} = 50$ °C. Further assume: average forward current per
diode $I_{F(AV)} = 65$ A; contact thermal resistance $R_{th \, mb-h} = 0,1 \, ^\circ C/W$.

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

![Graph showing total power dissipation and allowable temperatures as a function of $I_{F(AV)}$](image)

From the lefthand graph it follows that $P_{tot} = 90$ W per diode (point A).

From the righthand graph it follows that $R_{th \, mb-a} = 1,2 \, ^\circ C/W$.

Thus $R_{th \, h-a} = R_{th \, mb-a} - R_{th \, mb-h} = (1,2 - 0,1) \, ^\circ C/W = 1,1 \, ^\circ C/W$.

This may be achieved by different types of heatsinks as shown below.

<table>
<thead>
<tr>
<th>Type</th>
<th>Free convection</th>
<th>Forced cooling</th>
</tr>
</thead>
<tbody>
<tr>
<td>flat, blackened</td>
<td>-</td>
<td>125 cm$^2$; 2 m/s or 300 cm$^2$; 1 m/s</td>
</tr>
<tr>
<td>bright</td>
<td>-</td>
<td>175 cm$^2$; 2 m/s</td>
</tr>
<tr>
<td>diecast 56280</td>
<td>applicable</td>
<td></td>
</tr>
<tr>
<td>extrusion</td>
<td></td>
<td></td>
</tr>
<tr>
<td>56230 bright</td>
<td>$L = 12$ cm</td>
<td>$L = 5$ cm$^1$; 1 m/s</td>
</tr>
<tr>
<td>blackened</td>
<td>$L = 8$ cm</td>
<td></td>
</tr>
<tr>
<td>56231 bright</td>
<td>$L = 7$ cm</td>
<td></td>
</tr>
<tr>
<td>blackened</td>
<td>$L = 5$ cm$^1$</td>
<td></td>
</tr>
</tbody>
</table>

$^1$) Practical minimum length
EXAMPLES OF HEATSINK CALCULATION (continued)

2. Devices with controlled avalanche properties

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

$R_{th \, mb-h} = 0.5 \, \degree C/W$; repetitive peak reverse power in the avalanche region $(t = 40 \mu s)$ $P_{RRM} = 2 \, kW$ (per diode).

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

From the lefthand graph it follows that $P_{tot} = 19.5 \, W$ per diode (point A). The average reverse power in the avalanche region, averaged over any cycle, follows from

$P_R(AV) = \delta \times P_{RRM}$, where the duty cycle $\delta = \frac{40 \, \mu s}{20 \, ms} = 0.002$.

Thus $P_R(AV) = 0.002 \times 2 \, kW = 4 \, W$.

Therefore the total device power dissipation $P_{tot} = 19.5 + 4 = 23.5 \, W$ (point B). From the righthand graph it follows that $R_{th \, mb-a} = 4 \, \degree C/W$. Hence the heatsink thermal resistance should be:

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

A table of applicable heatsinks, similar to that on the foregoing page, can be 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

August 1972
Flat heatsink

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

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

Stud: M6
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

<table>
<thead>
<tr>
<th></th>
<th>BY249-300(R)</th>
<th>600(R)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Repetitive peak reverse voltage</td>
<td>$V_{RRM}$ max.</td>
<td>300</td>
</tr>
<tr>
<td>Average forward current</td>
<td>$I_{F(AV)}$ max.</td>
<td>6.5</td>
</tr>
<tr>
<td>Non-repetitive peak forward current</td>
<td>$I_{FSM}$ max.</td>
<td>60</td>
</tr>
</tbody>
</table>

MECHANICAL DATA (see next page for polarity of connections)

Fig. 1 TO-220AC

Dimensions in mm

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:

<table>
<thead>
<tr>
<th></th>
<th>BY249–300</th>
<th>BY249–300R</th>
<th>BY249–600</th>
<th>BY249–600R</th>
</tr>
</thead>
<tbody>
<tr>
<td>base plate</td>
<td>cathode</td>
<td>anode</td>
<td>cathode</td>
<td>anode</td>
</tr>
<tr>
<td>tag 1</td>
<td>cathode</td>
<td>anode</td>
<td>cathode</td>
<td></td>
</tr>
<tr>
<td>tag 2</td>
<td>anode</td>
<td>cathode</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

RATINGS

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

Voltages*

<table>
<thead>
<tr>
<th></th>
<th>BY249–300(R)</th>
<th>600(R)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Non-repetitive peak reverse voltage $V_{RSM}$ max.</td>
<td>300</td>
<td>600 V</td>
</tr>
<tr>
<td>Repetitive peak reverse voltage $V_{RRM}$ max.</td>
<td>300</td>
<td>600 V</td>
</tr>
<tr>
<td>Crest working reverse voltage $V_{RWM}$ max.</td>
<td>200</td>
<td>400 V</td>
</tr>
<tr>
<td>Continuous reverse voltage $V_{R}$ max.</td>
<td>200</td>
<td>400 V</td>
</tr>
</tbody>
</table>

Currents

<table>
<thead>
<tr>
<th></th>
<th>BY249–300(R)</th>
<th>600(R)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Average forward current; sinusoidal; up to $T_{mb} = 110 , ^\circ C$ $I_F(AV)$ max.</td>
<td>6.5</td>
<td>A</td>
</tr>
<tr>
<td>sinusoidal; at $T_{mb} = 125 , ^\circ C$ $I_F(AV)$ max.</td>
<td>4.0</td>
<td>A</td>
</tr>
<tr>
<td>R.M.S. forward current $I_{FRM}$ max.</td>
<td>9.5</td>
<td>A</td>
</tr>
<tr>
<td>Repetitive peak forward current; $t = 10 , ms$; half sine-wave $I_{RSM}$ max.</td>
<td>60</td>
<td>A</td>
</tr>
<tr>
<td>Non-repetitive peak forward current; $t = 10 , ms$; half sine-wave; $T_j = 150 , ^\circ C$ prior to surge; with re-applied $V_{RWM}^{\text{max}}$ $I_{FSM}$ max.</td>
<td>60</td>
<td>A</td>
</tr>
<tr>
<td>$I^2t$ for fusing; $t = 10 , ms$ $I^2t$ max.</td>
<td>18</td>
<td>A²s</td>
</tr>
</tbody>
</table>

Temperatures

<p>| | |</p>
<table>
<thead>
<tr>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>Storage temperature $T_{stg}$ max.</td>
<td>-40 to +150 °C</td>
</tr>
<tr>
<td>Junction temperature $T_j$ max.</td>
<td>150 °C</td>
</tr>
</tbody>
</table>

CHARACTERISTICS

Forward voltage

<p>| | |</p>
<table>
<thead>
<tr>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>$I_F = 20 , A$; $T_j = 25 , ^\circ C$ $V_F$ &lt;</td>
<td>1.6</td>
</tr>
<tr>
<td>$I_F = 5 , A$; $T_j = 100 , ^\circ C$ $V_F$ &lt;</td>
<td>1.05</td>
</tr>
</tbody>
</table>

Reverse current

<p>| | |</p>
<table>
<thead>
<tr>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>$V_R = V_{RWM}^{\text{max}}$; $T_j = 125 , ^\circ C$ $I_R$ &lt;</td>
<td>0.4</td>
</tr>
</tbody>
</table>

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

**Measured under pulse conditions to avoid excessive dissipation.
THERMAL RESISTANCE
From junction to mounting base
Transient thermal impedance; \( t = 1 \text{ ms} \)

\[
R_{th\ j-mb} = 4.2 \quad ^\circ\text{C/W} \\
Z_{th\ j-mb} = 0.46 \quad ^\circ\text{C/W}
\]

Influence of mounting method
1. Heatsink mounted with clip (see mounting instructions)
   Thermal resistance from mounting base to heatsink
   a. with heatsink compound
   b. with heatsink compound and 0.06 mm maximum mica insulator
   c. with heatsink compound and 0.1 mm maximum mica insulator (56369)
   d. with heatsink compound and 0.25 mm maximum alumina insulator (56367)
   e. without heatsink compound

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.

\[
R_{th\ j-a} = 60 \quad ^\circ\text{C/W}
\]

Fig. 2

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

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

3. It is recommended that the circuit connection be made to tag 1, rather than direct to the heatsink.

4. Mounting by means of a spring clip is the best mounting method because it offers:
   a. a good thermal contact under the crystal area and slightly lower \( R_{th\ mb-h} \) values than screw mounting.
   b. safe isolation for mains operation.

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

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

6. Rivet mounting (only possible for non-insulated mounting)
   Devices may be rivetted to flat heatsinks; such a process must neither deform the mounting tab, nor enlarge the mounting hole.
Fig. 3 The right-hand part shows the interrelationship between the power (derived from the left-hand part) and the maximum permissible temperatures.

\[ a = \text{form factor} = \frac{I_F(\text{RMS})}{I_F(\text{AV})}. \]

*\( T_{mb} \) scale is for comparison purposes and is correct only for \( R_{th\ mb-a} < 19.3 \, ^\circ C/W \).
Fig. 4 Maximum permissible non-repetitive r.m.s. forward current based on sinusoidal currents (f = 50 Hz); $T_j = 150\, \text{°C}$ prior to surge.

Fig. 5 $T_j = 25\, \text{°C}$; $T_j = 100\, \text{°C}$
Fig. 6
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

<table>
<thead>
<tr>
<th></th>
<th>BYX25-600(R)</th>
<th>800(R)</th>
<th>1000(R)</th>
<th>1200(R)</th>
<th>1400(R)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Crest working reverse voltage $V_{RWM}$ max.</td>
<td>600</td>
<td>800</td>
<td>1000</td>
<td>1200</td>
<td>1400</td>
</tr>
<tr>
<td>Reverse avalanche breakdown voltage $V_{(BR)R}$ max.</td>
<td>&gt; 750</td>
<td>1000</td>
<td>1250</td>
<td>1450</td>
<td>1650</td>
</tr>
<tr>
<td>Average forward current $I_F(AV)$ max.</td>
<td>20</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Non-repetitive peak forward current $I_{FSM}$ max.</td>
<td>360</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Non-repetitive peak reverse power $P_{RSM}$ max.</td>
<td>18</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

### MECHANICAL DATA

Fig. 1 DO-4.

- **Dimensions in mm**
  - Net mass: 7 g.
  - Diameter of clearance hole: max. 5.2 mm.
  - Accessories supplied on request: see ACCESSORIES section
  - Supplied with device: 1 nut, 1 lock washer.
  - Nut dimensions across the flats: 9.5 mm

Products approved to CECC 50 009-022 available on request.
## RATINGS

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

### Voltages

<table>
<thead>
<tr>
<th></th>
<th>BYX25-600(R)</th>
<th>800(R)</th>
<th>1000(R)</th>
<th>1200(R)</th>
<th>1400(R)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Crest working reverse voltage ( V_{RWM} ) max.</td>
<td>600</td>
<td>800</td>
<td>1000</td>
<td>1200</td>
<td>1400</td>
</tr>
<tr>
<td>Continuous reverse voltage ( V_R ) max.</td>
<td>600</td>
<td>800</td>
<td>1000</td>
<td>1200</td>
<td>1400</td>
</tr>
</tbody>
</table>

### Currents

- **Average forward current** (averaged over any 20 ms period) up to \( T_{mb} = 125 \, ^{\circ}C \)
- **Repetitive peak forward current** \( i_{F(AV)} \) max. 20 A
- **Non-repetitive peak forward current** \( i_{FRM} \) max. 440 A
- **Average forward current** \( i_{F(AV)} \) max. 20 A
- **Peak forward current** \( i_{FSM} \) max. 360 A
- **Repetitive peak reverse power dissipation** \( i^{2}t \) max. 650 A
- **Non-repetitive peak reverse power dissipation** \( i^{2}t \) max. 650 A

### Reverse power dissipation

- **Average reverse power dissipation** (averaged over any 20 ms period); \( T_{j} = 175 \, ^{\circ}C \)
- **Repetitive peak reverse power dissipation** \( P_{RRM} \) max. 3 kW
- **Non-repetitive peak reverse power dissipation** \( P_{RAM} \) max. 3 kW

### Temperatures

- **Storage temperature** \( T_{stg} \) -55 to +175 \, ^{\circ}C
- **Junction temperature** \( T_{j} \) max. 175 \, ^{\circ}C

*To ensure thermal stability: \( R_{th\,j-a} < 5 \, K/W \) (a.c.)
Controlled avalanche rectifier diodes

**BYX25 SERIES**

**THERMAL RESISTANCE**

- From junction to ambient in free air: \( R_{th\,j-a} = 50 \, ^\circ\text{C/W} \)
- From junction to mounting base: \( R_{th\,j-mb} = 1.3 \, ^\circ\text{C/W} \)
- From mounting base to heatsink: \( R_{th\,mb-h} = 0.5 \, ^\circ\text{C/W} \)

**CHARACTERISTICS**

<table>
<thead>
<tr>
<th></th>
<th>BYX25-600(R)</th>
<th>800(R)</th>
<th>1000(R)</th>
<th>1200(R)</th>
<th>1400(R)</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Forward voltage</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>( I_F = 50 , \text{A}; , T_j = 25 , ^\circ\text{C} )</td>
<td>( V_F &lt; 1.8 )</td>
<td>1.8</td>
<td>1.8</td>
<td>1.8</td>
<td>1.8</td>
</tr>
<tr>
<td><strong>Reverse avalanche</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>( I_R = 5 , \text{mA}; , T_j = 25 , ^\circ\text{C} )</td>
<td>( V_{(BR)R} &gt; 750 )</td>
<td>1000</td>
<td>1250</td>
<td>1450</td>
<td>1650 V</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>Peak reverse current</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>( V_R = V_{RWM,\text{max}}; , T_j = 125 , ^\circ\text{C} )</td>
<td>( I_R &lt; 1.0 )</td>
<td>0.8</td>
<td>0.6</td>
<td>0.5</td>
<td>0.5</td>
</tr>
</tbody>
</table>

*Measured under pulse conditions to avoid excessive dissipation.*
OPERATING NOTES

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

2. The top connector should not be bent; it should be soldered into the circuit so that there is no strain on it.
   During soldering the heat conduction to the junction should be kept to a minimum by using a thermal shunt.

Determination of the heatsink thermal resistance

Example:
Assume a diode, used in a three phase rectifier circuit.

<table>
<thead>
<tr>
<th>frequency</th>
<th>average forward current</th>
<th>ambient temperature</th>
<th>repetitive peak reverse power dissipation in the avalanche region</th>
<th>duration of ( P_{RRM} )</th>
</tr>
</thead>
<tbody>
<tr>
<td>( f = 50 \text{ Hz} )</td>
<td>( I_{FAV} = 10 \text{ A (per diode)} )</td>
<td>( T_{amb} = 40 \text{ °C} )</td>
<td></td>
<td>( t = 40 \mu\text{s} )</td>
</tr>
<tr>
<td>( P_{RRM} = 2 \text{ kW (per diode)} )</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

From the left hand part of the upper graph on page 5 it follows that at \( I_{FAV} = 10 \text{ A} \) in a three phase rectifier circuit the average forward power + average leakage power = 19.5 W per diode (point A). The average reverse power in the avalanche region, averaged over any cycle, follows from:

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

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

Therefore the total device power dissipation \( P_{tot} = (19.5 + 4) \text{ W} = 23.5 \text{ W} \) (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; \( t = 40 \mu\text{s} \); \( f = 50 \text{ Hz} \), 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

\[
R_{th,mb-a} \approx 4 \text{ °C/W}
\]

The contact thermal resistance \( R_{th,mb-h} = 0.5 \text{ °C/W} \)

Hence the heatsink thermal resistance should be:

\[
R_{th,h-a} = R_{th,mb-a} - R_{th,mb-h} = (4 - 0.5) \text{ °C/W} = 3.5 \text{ °C/W}
\]
Controlled avalanche rectifier diodes

**BYX25 SERIES**

**Fig. 2**

Interrelation between the total dissipation (derived from the left hand graph) and the max allowable ambient temperature.

**Fig. 3**

Max allowable repetitive peak reverse power dissipation versus duration (f=50Hz).

In this region a junction temperature of 175°C is allowed.
Max. allowable non repetitive peak reverse pulse power dissipation in avalanche region versus duration

- $P_{RSM}$
- $P_R$
- Pulse duration
- Time

Fig. 4

Fig. 5
Controlled avalanche rectifier diodes

Fig. 6

BYX25 SERIES

maximum permissible non-repetitive r.m.s. forward current based on sinusoidal currents (f = 50 Hz)

$I_F$ - $I_{FSM}$

with reapplied $V_{RWM_{max}}$

$T_j = 175\, ^\circ C$ prior to surge
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**

<table>
<thead>
<tr>
<th>BYX32-</th>
<th>600</th>
<th>800</th>
<th>1000</th>
<th>1200</th>
<th>1600</th>
</tr>
</thead>
<tbody>
<tr>
<td>600R</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>800R</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>1000R</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>1200R</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>1600R</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Values</th>
</tr>
</thead>
<tbody>
<tr>
<td>Crest working reverse voltage $V_{RWM}$</td>
<td>max. 600 800 1000 1200 1200 V</td>
</tr>
<tr>
<td>Repetitive peak reverse voltage $V_{RRM}$</td>
<td>max. 600 800 1000 1200 1600 V</td>
</tr>
<tr>
<td>Average forward current $I_{F(AV)}$</td>
<td>max. 150 A</td>
</tr>
<tr>
<td>Non-repetitive peak forward current $I_{FSM}$</td>
<td>max. 1600 A</td>
</tr>
</tbody>
</table>

**MECHANICAL DATA**

Dimensions in mm


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)
**BYX32 SERIES**

All information applies to frequencies up to 400 Hz.

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

<table>
<thead>
<tr>
<th>VOLTAGES 1)</th>
<th>BYX32-600R</th>
<th>800R</th>
<th>1000R</th>
<th>1200R</th>
<th>1600R</th>
</tr>
</thead>
<tbody>
<tr>
<td>Continuous reverse voltage</td>
<td>$V_R$ max.</td>
<td>600</td>
<td>800</td>
<td>1000</td>
<td>1200</td>
</tr>
<tr>
<td>Crest working reverse voltage</td>
<td>$V_{RWM}$ max.</td>
<td>600</td>
<td>800</td>
<td>1000</td>
<td>1200</td>
</tr>
<tr>
<td>Repetitive peak reverse voltage</td>
<td>$V_{RRM}$ max.</td>
<td>600</td>
<td>800</td>
<td>1000</td>
<td>1200</td>
</tr>
<tr>
<td>Non-repetitive peak reverse voltage (t ≤ 10 ms)</td>
<td>$V_{RSM}$ max.</td>
<td>650</td>
<td>900</td>
<td>1100</td>
<td>1300</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>CURRENTS</th>
<th></th>
<th>600</th>
<th>800</th>
<th>1000</th>
<th>1200</th>
<th>1600</th>
</tr>
</thead>
<tbody>
<tr>
<td>Average forward current (averaged over any 20 ms period) up to $T_{mb} = 100 , ^\circ C$</td>
<td>$I_{F(AV)}$ max.</td>
<td>150 A</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>at $T_{mb} = 125 , ^\circ C$</td>
<td>$I_{F(AV)}$ max.</td>
<td>115 A</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Forward current (d. c.)</td>
<td>$I_F$ max.</td>
<td>240 A</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>R.M.S. forward current</td>
<td>$I_{F(RMS)}$ max.</td>
<td>240 A</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Repetitive peak forward current</td>
<td>$I_{FRM}$ max.</td>
<td>750 A</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Non-repetitive peak forward current (t = 10 ms; half sine wave) $T_j = 190 , ^\circ C$ prior to surge</td>
<td>$I_{FSM}$ max.</td>
<td>1600 A</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>$I^2t$ for fusing (t = 10 ms)</td>
<td>max.</td>
<td>12800 A^2s</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>TEMPERATURES</th>
<th></th>
<th>-55 to +200 , ^\circ C</th>
</tr>
</thead>
<tbody>
<tr>
<td>Storage temperature</td>
<td>$T_{stg}$</td>
<td>190 , ^\circ C</td>
</tr>
<tr>
<td>Operating junction temperature</td>
<td>$T_j$ max.</td>
<td>190 , ^\circ C</td>
</tr>
</tbody>
</table>

**THERMAL RESISTANCE**

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

1) To ensure thermal stability: $R_{th \, j-a} < 0.75 \, ^\circ C/W$ (continuous reverse voltage)
   or $< 1.5 \, ^\circ C/W$ (a. c.)

   For smaller heatsinks $T_j$ should be derated.

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

---

June 1974
BYX38 SERIES

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

<table>
<thead>
<tr>
<th>Repetitive peak reverse voltage</th>
<th>V_{RRM}</th>
<th>300</th>
<th>600</th>
<th>1200</th>
<th>V</th>
</tr>
</thead>
<tbody>
<tr>
<td>Average forward current</td>
<td>I_{F(AV)}</td>
<td>6</td>
<td></td>
<td></td>
<td>A</td>
</tr>
<tr>
<td>Non-repetitive peak forward current</td>
<td>I_{FSM}</td>
<td>50</td>
<td></td>
<td></td>
<td>A</td>
</tr>
</tbody>
</table>

MECHANICAL DATA

DO-4

Dimensions in mm

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

Supplied with device: 1 nut, 1 lock washer
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.

April 1984
RATINGS Limiting values in accordance with the Absolute Maximum System (IEC 134)

Voltages

<table>
<thead>
<tr>
<th>Voltage Type</th>
<th>BYX38-300(R)</th>
<th>600(R)</th>
<th>1200(R)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Non-repetitive peak reverse voltage (t ≤ 10 ms)</td>
<td>V_RSM</td>
<td>max. 300</td>
<td>600</td>
</tr>
<tr>
<td>Repetitive peak reverse voltage (δ ≤ 0.01)</td>
<td>V_RRM</td>
<td>max. 300</td>
<td>600</td>
</tr>
<tr>
<td>Crest working reverse voltage</td>
<td>V_RWM</td>
<td>max. 200</td>
<td>400</td>
</tr>
<tr>
<td>Continuous reverse voltage</td>
<td>VR</td>
<td>max. 200</td>
<td>400</td>
</tr>
</tbody>
</table>

Currents

- Average forward current (averaged over any 20 ms period) up to T_mb = 110 °C at T_mb = 125 °C
  - IF(AV) max. 6 A
  - IF(AV) max. 4 A

- R.M.S. forward current
  - IF(RMS) max. 10 A

- Repetitive peak forward current
  - IFRM max. 50 A

- Non-repetitive peak forward current
  - (t = 10 ms; half sine-wave) T_j = 150 °C prior to surge; with reapplied V_RWM max
  - IFSM max. 50 A
  - \( I^2t \) max. 13 A²s

Temperatures

- Storage temperature
  - T_stg -55 to +150 °C

- Junction temperature
  - T_j max. 150 °C

THERMAL RESISTANCE

- From junction to ambient in free air
  - R_th j-a. = 50 °C/W

- From junction to mounting base
  - R_th j-mb = 4 °C/W

- From mounting base to heatsink
  - with heatsink compound
    - R_th mb-h = 0.5 °C/W
  - without heatsink compound
    - R_th mb-h = 0.6 °C/W

- Transient thermal impedance; t = 1 ms
  - Z_th j-mb = 0.3 °C/W
CHARACTERISTICS

Forward voltage

\[ I_F = 20 \text{ A}; T_j = 25 \, ^\circ\text{C} \quad V_F < 1.7 \, \text{V} \]

Reverse current

\[ V_R = V_{RWM\text{max}}; T_j = 125 \, ^\circ\text{C} \quad I_R < 200 \, \mu\text{A} \]

OPERATING NOTES

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

2. Where there is a possibility that transients, due to the energy stored in the transformer, will exceed the maximum permissible non-repetitive peak reverse voltage, see General Section for information on damping circuits.

---

1) Measured under pulse conductions to avoid excessive dissipation.
BYX38
SERIES

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

$P = \frac{IF_{RMS}}{IF_{AV}}$

interrelation between the power (derived from the left-hand graph) and the maximum permissible temperatures

$P$ (W)

$T_{mb}$ (°C)

$I_{F(AV)}$ (A)

$T_{amb}$ (°C)

$R_{th_{mb}} = 0.5$ °C/W

$I_F$ (A)

$T_J = 25$ °C

$T_J = 150$ °C

$V_F$ (V)

November 1975
maximum permissible non-repetitive r.m.s. forward current based on sinusoidal currents ( f = 50 Hz )

\[ I_F \]

\[ I_{FSM} \]

\[ I_{FS(MS)} \]

with reapplied \( V_{RWMmax} \)

\( T_J = 150^\circ C \) prior to surge
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

<table>
<thead>
<tr>
<th></th>
<th>BYX39-600(R)</th>
<th>800(R)</th>
<th>1000(R)</th>
<th>1200(R)</th>
<th>1400(R)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Crest working reverse voltage</td>
<td>max. 600</td>
<td>800</td>
<td>1000</td>
<td>1200</td>
<td>1400</td>
</tr>
<tr>
<td>Reverse avalanche breakdown voltage</td>
<td>&gt; 750</td>
<td>1000</td>
<td>1250</td>
<td>1450</td>
<td>1650</td>
</tr>
</tbody>
</table>

Average forward current: \( I_{F(AV)} \) max. 9.5 A
Non-repetitive peak forward current: \( I_{FSM} \) max. 125 A
Non-repetitive peak reverse power dissipation: \( P_{RSM} \) max. 4 kW

MECHANICAL DATA

Fig. 1 DO-4

Net mass: 6 g
Diameter of clearance hole: max. 5.2 mm
Accessories supplied on request:
see ACCESSORIES section
Supplied with device: 1 nut, 1 lock-washer.
Nut dimensions across the flats: 9.5 mm.
The mark shown applies to normal polarity types.

Dimensions in mm

Torque on nut:
min. 0.9 Nm (9 kg cm),
max. 1.7 Nm (17 kg cm).
**BYX39 SERIES**

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

<table>
<thead>
<tr>
<th>Voltages*</th>
<th>BYX39-600(R)</th>
<th>800(R)</th>
<th>1000(R)</th>
<th>1200(R)</th>
<th>1400(R)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Continuous reverse voltage $V_R$ max.</td>
<td>600</td>
<td>800</td>
<td>1000</td>
<td>1200</td>
<td>1400 V</td>
</tr>
<tr>
<td>Crest working reverse voltage $V_{RWM}$ max.</td>
<td>600</td>
<td>800</td>
<td>1000</td>
<td>1200</td>
<td>1400 V</td>
</tr>
</tbody>
</table>

**Currents**

- **Average forward current** (averaged over any 20 ms period) up to $T_{mb} = 85 \degree C$ at $T_{mb} = 125 \degree C$
  \[ I_{F(AV)} \text{ max.} = 9.5 \ A \]
  \[ I_{F(AV)} \text{ max.} = 6.0 \ A \]

- **R.M.S. forward current**
  \[ I_{F(RMS)} \text{ max.} = 15 \ A \]

- **Repetitive peak forward current**
  \[ I_{FRM} \text{ max.} = 100 \ A \]

- **Non-repetitive peak forward current**
  \[ t = 10 \, \text{ms} \text{ (half sine-wave)}; T_j = 175 \, \text{OC prior to surge}; \text{with reapplied } V_{RWM\text{max}} \]
  \[ I_{FSM} \text{ max.} = 125 \ A \]
  \[ I^2 t \text{ for fusing (} t = 10 \, \text{ms} \]
  \[ I^2 t \text{ max.} = 78 \, \text{A}^2 \text{s} \]

**Reverse power dissipation**

- **Average reverse power dissipation** (averaged over any 20 ms period); $T_j = 125 \, \text{OC}$
  \[ P_{R(AV)} \text{ max.} = 10 \, \text{W} \]

- **Repetitive peak reverse power dissipation**
  \[ t = 10 \, \mu\text{s} \text{ (square-wave)}; f = 50 \, \text{Hz}; T_j = 125 \, \text{OC} \]
  \[ P_{RRM} \text{ max.} = 2 \, \text{kW} \]

- **Non-repetitive peak reverse power dissipation**
  \[ t = 10 \, \mu\text{s} \text{ (square-wave)} \]
  \[ T_j = 25 \, \text{OC prior to surge} \]
  \[ T_j = 175 \, \text{OC prior to surge} \]
  \[ P_{RSM} \text{ max.} = 4 \, \text{kW} \]
  \[ P_{RSM} \text{ max.} = 0.8 \, \text{kW} \]

**Temperatures**

- **Storage temperature**
  \[ T_{stg} \text{ max.} = -55 \text{ to } +175 \, \text{OC} \]

- **Junction temperature**
  \[ T_j \text{ max.} = 175 \, \text{OC} \]

*To ensure thermal stability: $R_{th\,ja} \leq 5 \, \text{OC/W}$ (continuous reverse voltage) or $\leq 20 \, \text{OC/W}$ (a.c.)

September 1979
Controlled avalanche rectifier diodes

BYX39 SERIES

THERMAL RESISTANCE

From junction to ambient in free air
\[ R_{th\ j-a} = 50 \ \degree C/W \]
From junction to mounting base
\[ R_{th\ j-mb} = 4.5 \ \degree C/W \]
From mounting base to heatsink
without heatsink compound
\[ R_{th\ mb-h} = 1.0 \ \degree C/W \]
with heatsink compound
\[ R_{th\ mb-h} = 0.5 \ \degree C/W \]
with mica washer
\[ R_{th\ mb-h} = 2.0 \ \degree C/W \]
Transient thermal impedance; \( t = 1 \) ms
\[ Z_{th\ j-mb} = 0.35 \ \degree C/W \]

CHARACTERISTICS

<table>
<thead>
<tr>
<th></th>
<th>BYX39-600(R)</th>
<th>800(R)</th>
<th>1000(R)</th>
<th>1200(R)</th>
<th>1400(R)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Forward voltage ( I_F = 20 ) A; ( T_j = 25 ) °C ( V_F )</td>
<td>(&lt; 1.7)</td>
<td>1.7</td>
<td>1.7</td>
<td>1.7</td>
<td>1.7</td>
</tr>
<tr>
<td>Reverse avalanche breakdown voltage ( I_R = 5 ) mA; ( T_j = 25 ) °C ( V(BR)R )</td>
<td>( &gt; 750)</td>
<td>1000</td>
<td>1250</td>
<td>1450</td>
<td>1650</td>
</tr>
<tr>
<td>Reverse current ( V_R = V_{RWMax}; T_j = 125 ) °C ( I_R )</td>
<td>(&lt; 2400)</td>
<td>2400</td>
<td>2400</td>
<td>2400</td>
<td>2400</td>
</tr>
</tbody>
</table>

OPERATING NOTES

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

*Measured under pulse conditions to avoid excessive dissipation.
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: \( a = 2.4 \)

\( a = \frac{I_F\text{(RMS)}}{I_F\text{(AV)}} \)
Controlled avalanche rectifier diodes

**BYX39 SERIES**

Fig. 4

![Graph showing square pulse duration (s) vs. \( \Delta T_j \) (°C) with \( P_{RRM} = 2 \) kW and \( f = 50 \) Hz.]

Fig. 5

![Graph showing square pulse duration (s) vs. \( \Delta T_j \) (°C) with \( P_{RRM} = 1.5 \) kW and \( f = 400 \) Hz.]
Fig. 6

max. allowable non-repetitive peak reverse power dissipation in avalanche region versus pulse duration

\[ P_{RSM} \]

(kW)

---

10

1

10\(^{-1}\)

10\(^{-2}\)

pulse duration (s)

Fig. 6

\( T_j = 25 \, ^{\circ}C \) prior to surge

---

Fig. 7

maximum permissible non-repetitive r.m.s. forward current based on sinusoidal currents (\( f = 50 \, \text{Hz} \))

\[ I_{FSM} \]

(A)

---

Fig. 7

\( T_j = 175 \, ^{\circ}C \) prior to surge
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

<table>
<thead>
<tr>
<th></th>
<th>BYX42-300(R)</th>
<th>600(R)</th>
<th>1200(R)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Repetitive peak reverse voltage $V_{RRM}$ max.</td>
<td>300 V</td>
<td>600 V</td>
<td>1200 V</td>
</tr>
<tr>
<td>Average forward current $I_{F(AV)}$ max.</td>
<td>12 A</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Non-repetitive peak forward current $I_{FSM}$ max.</td>
<td>125 A</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

MECHANICAL DATA

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 across the flats: 9,5 mm
- The mark shown applies to normal polarity types.

Products approved to CECC 50 009-020 available on request.
RATINGS  Limiting values in accordance with the Absolute Maximum System (IEC 134)

<table>
<thead>
<tr>
<th>Voltages</th>
<th>BYX42-300(R)</th>
<th>600(R)</th>
<th>1200(R)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Non-repetitive peak reverse voltage (t ≤ 10 ms)</td>
<td>VRSM max. 300</td>
<td>600</td>
<td>1200 V</td>
</tr>
<tr>
<td>Repetitive peak reverse voltage (δ ≤ 0,01)</td>
<td>VRRM max. 300</td>
<td>600</td>
<td>1200 V</td>
</tr>
<tr>
<td>Crest working reverse voltage</td>
<td>VRWM max. 200</td>
<td>400</td>
<td>800 V</td>
</tr>
<tr>
<td>Continuous reverse voltage</td>
<td>VR max. 200</td>
<td>400</td>
<td>800 V</td>
</tr>
</tbody>
</table>

Currents

- Average forward current (averaged over any 20 ms period) up to Tmb = 115 °C at Tmb = 125 °C: IF(AV) max. 12 A
- R.M.S. forward current: IF(RMS) max. 20 A
- Repetitive peak forward current: IFRM max. 60 A
- Non-repetitive peak forward current (t = 10 ms; half sine-wave) Tj = 175 °C prior to surge; with reapplied VRWMmax: IFSM max. 125 A

Temperatures

- Storage temperature: Tstg -55 to +175 °C
- Junction temperature: Tj max. 175 °C

THERMAL RESISTANCE

- From junction to ambient in free air: Rth j-a = 50 °C/W
- From junction to mounting base: Rth j-mb = 3 °C/W
- From mounting base to heatsink: Rth mb-h = 0,5 °C/W

CHARACTERISTICS

- Forward voltage at IF = 15 A; Tj = 25 °C: VF < 1,4 V
- Reverse current at VR = VRWMmax; Tj = 125 °C: IR < 200 µA

MOUNTING INSTRUCTIONS

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

1) Measured under pulse conditions to avoid excessive dissipation.
The interrelation between the power (derived from the left-hand graph) and the maximum permissible temperatures is given by the equation:

\[ a = \frac{I_F (RMS)}{I_F (AV)} \]

where

- \( a = 4 \)
- \( P = \) power in W
- \( I_{F(AV)} = \) average current in A
- \( T_{amb} = \) ambient temperature in °C
- \( T_{mb} = \) maximum permissible temperature in °C

The diagram shows the relationship between these variables. For example, when \( a = 4 \), the power \( P \) is less than 10 W. The \( T_{mb} * \) scale is for comparison purposes only and is correct only for \( R_{th mb-a} \leq 22 \) °C/W.

The right-hand graph shows the maximum values for the current \( I_F \) and voltage \( V_F \) with different temperature limits. For instance, at \( T_j = 25 \) °C and \( 175 \) °C, the maximum values are indicated.
maximum permissible non-repetitive r.m.s. forward current based on sinusoidal currents ($f = 50 \text{ Hz}$)

$I_F$ with reapplied $V_{RWM\text{max}}$

$T_J = 175 \degree C$ prior to surge

$10^{-3}$ $10^{-2}$ $10^{-1}$ $1$ $10$ duration (s)

November 1975
Silicon rectifier diodes in D0-5 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.

**QUICK REFERENCE DATA**

<table>
<thead>
<tr>
<th>Repetitive peak reverse voltage $V_{RRM}$</th>
<th>BYX52–300(R) max. 300</th>
<th>600(R)</th>
<th>1200(R)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Average forward current $I_{F(AV)}$</td>
<td>max. 48 A</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Non-repetitive peak forward current $I_{FSM}$</td>
<td>max. 800 A</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

**MECHANICAL DATA**

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

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

The mark shown applies to the normal polarity types

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

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

<table>
<thead>
<tr>
<th>Volatages</th>
<th>BYX52—300(R)</th>
<th>600(R)</th>
<th>1200(R)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Non-repetitive peak reverse voltage (t &lt; 10 ms)</td>
<td>$V_{RSM}$</td>
<td>max. 300</td>
<td>600</td>
</tr>
<tr>
<td>Repetitive peak reverse voltage ($\delta = 0.01$)</td>
<td>$V_{RRM}$</td>
<td>max. 300</td>
<td>600</td>
</tr>
<tr>
<td>Crest working reverse voltage</td>
<td>$V_{RWM}$</td>
<td>max. 200</td>
<td>400</td>
</tr>
</tbody>
</table>

### Currents

- Average forward current (averaged over any 20 ms period) up to $T_{mb} = 112 \, ^\circ\mathrm{C}$ at $T_{mb} = 125 \, ^\circ\mathrm{C}$
  - $I_{F(AV)}$ max. 48 A
  - $I_{F(AV)}$ max. 40 A
- R.M.S. forward current
  - $I_{FRM}$ max. 75 A
- Repetitive peak forward current
  - $I_{FSM}$ max. 800 A
- Non-repetitive peak forward current (t = 10 ms; half-sinewave) $T_j = 175 \, ^\circ\mathrm{C}$ prior to surge
  - $I^2 t$ for fusing (t = 10 ms) max. 3200 A^2s

### Temperatures

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

### THERMAL RESISTANCE

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

### CHARACTERISTICS

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

### OPERATING NOTE

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

*Measured under pulse conditions to avoid excessive dissipation.
Maximum permissible non-repetitive r.m.s. forward current based on sinusoidal currents \( f = 50 \) Hz; \( T_j = 175 \) °C prior to surge; with reapplied \( V_{\text{RWMmax}} \).
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

<table>
<thead>
<tr>
<th>BYX56—600(R)</th>
<th>800(R)</th>
<th>1000(R)</th>
<th>1200(R)</th>
<th>1400(R)</th>
</tr>
</thead>
<tbody>
<tr>
<td>V_{RWM} \text{ max.}</td>
<td>600 V</td>
<td>800 V</td>
<td>1000 V</td>
<td>1200 V</td>
</tr>
<tr>
<td>V_{(BR)R} \text{ max.}</td>
<td>750 V</td>
<td>1000 V</td>
<td>1250 V</td>
<td>1450 V</td>
</tr>
<tr>
<td>I_{F(AV)} \text{ max.}</td>
<td>48 A</td>
<td>100 A</td>
<td>125 A</td>
<td>150 A</td>
</tr>
<tr>
<td>I_{FSM} \text{ max.}</td>
<td>800 A</td>
<td>1000 A</td>
<td>1200 A</td>
<td>1400 A</td>
</tr>
<tr>
<td>P_{RSM} \text{ max.}</td>
<td>40 kW</td>
<td>60 kW</td>
<td>80 kW</td>
<td>100 kW</td>
</tr>
</tbody>
</table>

MECHANICAL DATA

Fig. 1 DO—5

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.
## RATINGS

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

<table>
<thead>
<tr>
<th>Vantages*</th>
<th>BYX56-600(R)</th>
<th>800(R)</th>
<th>1000(R)</th>
<th>1200(R)</th>
<th>1400(R)</th>
</tr>
</thead>
<tbody>
<tr>
<td>V_{RWM} max.</td>
<td>600</td>
<td>800</td>
<td>1000</td>
<td>1200</td>
<td>1400 V</td>
</tr>
<tr>
<td>V_{R} max.</td>
<td>600</td>
<td>800</td>
<td>1000</td>
<td>1200</td>
<td>1400 V</td>
</tr>
</tbody>
</table>

### Currents

- **Average forward current**
  - (averaged over any 20 ms period)
  - up to \( T_{mb} = 112^\circ C \)
  - at \( T_{mb} = 125^\circ C \)
  - \( I_{F(AV)} \) max. up to \( T_{mb} = 112^\circ C \)
  - \( I_{F(AV)} \) max. at \( T_{mb} = 125^\circ C \)

- **R.M.S. forward current**
  - \( I_{F(RMS)} \) max.

- **Repetitive peak forward current**
  - \( I_{FRM} \) max.

- **Non-repetitive peak forward current**
  - \( t = 10 \, \mu s \) (half sine-wave);
  - \( T_j = 175^\circ C \) prior to surge;
  - with reapplied \( V_{RWM}_{max} \)
  - \( I_{FSM} \) max.

- **\( I^2 t \) for fusing (\( t \leq 10 \, ms \))**
  - \( I^2 t \) max.

### Reverse power dissipation

- **Repetitive peak reverse power dissipation**
  - \( t = 10 \, \mu s \) (square-wave; \( f = 50 \, Hz \));
  - \( T_j = 175^\circ C \)
  - \( P_{RRM} \) max.

- **Non-repetitive peak reverse power dissipation**
  - \( t = 10 \, \mu s \) (square-wave)
  - \( T_j = 25^\circ C \) prior to surge
  - \( T_j = 175^\circ C \) prior to surge
  - \( P_{RSM} \) max.

### Temperatures

- **Storage temperature**
  - \( T_{stg} \) max. \(-55 \) to \(+175 \,^\circ C\)

- **Junction temperature**
  - \( T_j \) max. \(175 \,^\circ C\)

### THERMAL RESISTANCE

- From junction to mounting base
  - \( R_{th \, j-mb} = 0.8 \,^\circ C/W\)

- From mounting base to heatsink
  - \( R_{th \, mb-h} = 0.2 \,^\circ C/W\)

- Transient thermal impedance; \( t = 1 \, ms \)
  - \( Z_{th \, j-h} = 0.03 \,^\circ C/W\)

*To ensure thermal stability: \( R_{th \, j-a} < 2.2 \,^\circ C/W \) (a.c.)
Controlled avalanche rectifier diodes

**BYX56 SERIES**

**CHARACTERISTICS**

<table>
<thead>
<tr>
<th></th>
<th>BYX56-600(R)</th>
<th>800(R)</th>
<th>1000(R)</th>
<th>1200(R)</th>
<th>1400(R)</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Forward voltage</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>$I_F = 150 , \text{A}; T_j = 25 , ^\circ\text{C}$</td>
<td>$V_F &lt; 1.8$</td>
<td>1.8</td>
<td>1.8</td>
<td>1.8</td>
<td>1.8</td>
</tr>
<tr>
<td><strong>Reverse avalanche breakdown voltage</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>$I_R = 5 , \text{mA}; T_j = 25 , ^\circ\text{C}$</td>
<td>$V_{(BR)R} &gt; 750$</td>
<td>1000</td>
<td>1250</td>
<td>1450</td>
<td>1650</td>
</tr>
<tr>
<td><strong>Reverse current</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>$V_R = V_{R_WMmax}; T_j = 125 , ^\circ\text{C}$</td>
<td>$I_R &lt; 1.6$</td>
<td>1.6</td>
<td>1.6</td>
<td>1.6</td>
<td>1.6</td>
</tr>
</tbody>
</table>

**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.

*Measured under pulsed conditions to avoid excessive dissipation.*
**Fig. 3**

The graph illustrates the interrelation between the power (derived from the left hand graph) and the maximum allowable temperatures. The power $P$ is expressed as excluding avalanche losses, and is given by $P = I_{F(AV)} I_{F(RMS)} \alpha$, where $\alpha$ is a constant related to the operating conditions.

The maximum allowable temperatures $T_{mb}$ are limited by the thermal resistance $R_{th \ mb} = \frac{0.2 \degree C}{W}$. The graph shows several curves for different values of $\alpha$, each representing a specific operating condition.

**Fig. 4**

This graph provides the maximum allowable non-repetitive peak reverse pulse power dissipation in the avalanche region. The power $P_R$ is plotted against pulse duration for different temperatures $T_i = 25\degree C$, $75\degree C$, $125\degree C$, $150\degree C$, and $175\degree C$. The pulse duration is shown on a logarithmic scale, while the power is plotted on a linear scale.
$\Delta T$ = necessary derating of $T_{j,max}$ to accommodate repetitive transients in the reverse direction. Allowance can be made for this by assuming the ambient temperature $\Delta T$ higher.
maximum permissible non-repetitive rms forward current based on sinusoidal currents (f=50Hz)

each current pulse is followed by the crest working reverse voltage

$T_i = 175^\circ\text{C}(\text{prior to surge})$

Fig. 7

transient thermal impedance from junction to heatsink versus time

Fig. 8
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

<table>
<thead>
<tr>
<th></th>
<th>BYX96-300(R)</th>
<th>600(R)</th>
<th>1200(R)</th>
<th>1600(R)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Repetitive peak reverse voltage $V_{RRM}$ max.</td>
<td>300</td>
<td>600</td>
<td>1200</td>
<td>1600</td>
</tr>
<tr>
<td>Average forward current $I_F(AV)$ max.</td>
<td>30</td>
<td>A</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Non-repetitive peak forward current $I_{FSM}$ max.</td>
<td>400</td>
<td>A</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

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

Torque on nut: min. 0.9 Nm (9 kg cm)
max. 1.7 Nm (17 kg cm)
RATINGS Limiting values in accordance with the Absolute Maximum System (IEC 134)

<table>
<thead>
<tr>
<th>Voltages 1)</th>
<th>BYX96-300(R)</th>
<th>600(R)</th>
<th>1200(R)</th>
<th>1600(R)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Non-repetitive peak reverse voltage ( (t \leq 10 \text{ ms}) )</td>
<td>( V_{RSM} )</td>
<td>max. 300</td>
<td>600</td>
<td>1200</td>
</tr>
<tr>
<td>Repetitive peak reverse voltage ( (\delta \leq 0,01) )</td>
<td>( V_{RRM} )</td>
<td>max. 300</td>
<td>600</td>
<td>1200</td>
</tr>
<tr>
<td>Crest working reverse voltage</td>
<td>( V_{RWM} )</td>
<td>max. 200</td>
<td>400</td>
<td>800</td>
</tr>
<tr>
<td>Continuous reverse voltage</td>
<td>( V_{R} )</td>
<td>max. 200</td>
<td>400</td>
<td>800</td>
</tr>
</tbody>
</table>

Currents

Average forward current (averaged over any 20 ms period) up to \( T_{mb} = 125 \, ^\circ C \)

\( I_{F(AV)} \) max. 30 A

R.M.S. forward current

\( I_{F(RMS)} \) max. 48 A

Repetitive peak forward current

\( I_{FRM} \) max. 400 A

Non-repetitive peak forward current

\( (t = 10 \, \text{ms}; \text{half sine-wave}) \, T_j = 175 \, ^\circ C \) prior to surge;

with reapplied \( V_{RWM\text{max}} \)

\( I_{FSM} \) max. 400 A

\( I^2t \) for fusing \( (t = 10 \, \text{ms}) \)

\( I^2t \) max. 800 A²s

Temperatures

Storage temperature

\( T_{stg} \) -55 to +175 °C

Junction temperature

\( T_j \) max. 175 °C

THERMAL RESISTANCE

From junction to mounting base

\( R_{th \, j-mb} = 1,0 \, ^\circ C/W \)

From mounting base to heatsink

without heatsink compound

\( R_{th \, mb-h} = 0,5 \, ^\circ C/W \)

with heatsink compound

\( R_{th \, mb-h} = 0,3 \, ^\circ C/W \)

Transient thermal impedance; \( t = 1 \, \text{ms} \)

\( Z_{th \, j-mb} = 0,2 \, ^\circ C/W \)

1) To ensure thermal stability: \( R_{th \, j-a} \leq 2 \, ^\circ C/W \) (continuous reverse voltage) or \( \leq 8 \, ^\circ C/W \) (a.c.)

For smaller heatsinks \( T_{j\text{max}} \) should be derated. For a.c. see page 4.

For continuous reverse voltage: if \( R_{th \, j-a} = 4 \, ^\circ C/W \), then \( T_{j\text{max}} = 138 \, ^\circ C \).

if \( R_{th \, j-a} = 6 \, ^\circ C/W \), then \( T_{j\text{max}} = 125 \, ^\circ C \).
CHARACTERISTICS

Forward voltage
\[ I_F = 100 \text{ A}; \ T_j = 25 \text{ °C} \]
\[ V_F < 1.7 \text{ V} \] \(^1\)

Reverse current
\[ V_R = V_{RWM_{\text{max}}}; \ T_j = 125 \text{ °C} \]
\[ I_R < 1 \text{ mA} \]

OPERATING NOTES

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

2. Where there is a possibility that transients, due to the energy stored in the transformer, will exceed the maximum permissible non-repetitive peak reverse voltage, see General Section for information on damping circuits.

\(^1\) Measured under pulse conditions to avoid excessive dissipation.
single phase: $a = 1.6$
3-phase : $a = 1.75$
6-phase : $a = 2.4$

interrelation between the power (derived from the left-hand graph) and the maximum permissible temperatures

*) $T_{mb}$-scale is for comparison purposes only and is correct only for $R_{th \text{ mb-a}} \leq 6.5 \, ^\circ\text{C/W}$
maximum permissible non-repetitive r.m.s. forward current based on sinusoidal currents (f = 50 Hz)

with reapplied V_{RWM_{max}}

T_j = 175°C prior to surge

T_j = 25°C

T_j = 175°C
RECTIFIER DIODES

Also available to BS9331-F130

Silicon rectifier diodes in metal envelopes similar to DO-5, intended for use in power rectifier applications.

The series consists of the following types:
Normal polarity (cathode to stud): BYX97-300 to 1600.
Reverse polarity (anode to stud): BYX97-300R to 1600R.

QUICK REFERENCE DATA

<table>
<thead>
<tr>
<th>Repetitive peak reverse voltage</th>
<th>BYX97-300(R)</th>
<th>600(R)</th>
<th>1200(R)</th>
<th>1600(R)</th>
</tr>
</thead>
<tbody>
<tr>
<td>V&lt;sub&gt;RPM&lt;/sub&gt; max.</td>
<td>300</td>
<td>600</td>
<td>1200</td>
<td>1600</td>
</tr>
<tr>
<td>Average forward current</td>
<td>F&lt;sub&gt;(AV)&lt;/sub&gt; max.</td>
<td>47</td>
<td>A</td>
<td></td>
</tr>
<tr>
<td>Non-repetitive peak forward current</td>
<td>F&lt;sub&gt;(FSM)&lt;/sub&gt; max.</td>
<td>800</td>
<td>A</td>
<td></td>
</tr>
</tbody>
</table>

MECHANICAL DATA

DO-5 (except for M6 stud); Supplied with device: 1 nut, 1 lock-washer

Nut dimensions across the flats: 10 mm

Dimensions in mm

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

Torque on nut: min. 1.7 Nm
(17 kg cm)
max. 3.5 Nm
(35 kg cm)
**RATINGS** Limiting values in accordance with the Absolute Maximum System (IEC 134)

### Voltages

<table>
<thead>
<tr>
<th></th>
<th>BYX97-300(R)</th>
<th>600(R)</th>
<th>1200(R)</th>
<th>1600(R)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Non-repetitive peak reverse voltage ((t \leq 10 \text{ ms}))</td>
<td>(V_{RSM}) max.</td>
<td>300</td>
<td>600</td>
<td>1200</td>
</tr>
<tr>
<td>Repetitive peak reverse voltage ((\delta \leq 0, 01))</td>
<td>(V_{RRM}) max.</td>
<td>300</td>
<td>600</td>
<td>1200</td>
</tr>
<tr>
<td>Crest working reverse voltage</td>
<td>(V_{RWM}) max.</td>
<td>200</td>
<td>400</td>
<td>800</td>
</tr>
<tr>
<td>Continuous reverse voltage</td>
<td>(V_R) max.</td>
<td>200</td>
<td>400</td>
<td>800</td>
</tr>
</tbody>
</table>

### Currents

- **Average forward current** (averaged over any 20 ms period) up to \(T_{mb} = 120 \degree \text{C}\)
  - at \(T_{mb} = 125 \degree \text{C}\)
  - \(I_{F(AV)}\) max. 47 A
  - \(I_{F(AV)}\) max. 40 A
- **R.M.S. forward current**
  - \(I_{F(RMS)}\) max. 75 A
- **Repetitive peak forward current**
  - \(I_{FRM}\) max. 550 A
- **Non-repetitive peak forward current**
  - \((t = 10 \text{ ms}; \text{half sine-wave}) \ T_j = 150 \degree \text{C} \text{ prior to surge; with reapplied } V_{RWM}\text{max}\)
  - \(I_{FSM}\) max. 800 A
- **\(I_{2t}\) for fusing** \((t = 10 \text{ ms})\)
  - \(I_{2t}\) max. 3200 \(A^2s\)

### Temperatures

- **Storage temperature**
  - \(T_{stg}\) -55 to +150 \degree \text{C}
- **Junction temperature**
  - \(T_j\) max. 150 \degree \text{C}

### THERMAL RESISTANCE

- **From junction to mounting base**
  - \(R_{th j-mb}\) = 0.6 \degree \text{C/W}
- **From mounting base to heatsink**
  - without heatsink compound
    - \(R_{th mb-h}\) = 0.3 \degree \text{C/W}
  - with heatsink compound
    - \(R_{th mb-h}\) = 0.2 \degree \text{C/W}
- **Transient thermal impedance** \((t = 1 \text{ ms})\)
  - \(Z_{th j-mb}\) = 0.1 \degree \text{C/W}

---

1) To ensure thermal stability: \(R_{th j-a} \leq 1 \degree \text{C/W}\) (continuous reverse voltage) or \(\leq 4 \degree \text{C/W}\) (a.c.)

For smaller heatsinks \(T_{j\text{max}}\) should be derated. For a.c. see page 90.

For continuous reverse voltage:
- if \(R_{th j-a} = 2 \degree \text{C/W}\), then \(T_{j\text{max}} = 138 \degree \text{C},\)
- if \(R_{th j-a} = 3 \degree \text{C/W}\), then \(T_{j\text{max}} = 125 \degree \text{C} .\)
CHARACTERISTICS

Forward voltage

$I_F = 150 \, A; \, T_j = 25 \, ^{\circ}C$

$V_F < 1.45 \, V$  \hspace{1cm}  \text{1)}

Reverse current

$V_R = V_{RW\text{max}}; \, T_j = 125 \, ^{\circ}C$

$I_R < 4 \, mA$

OPERATING NOTES

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

2. Where there is a possibility that transients, due to the energy stored in the transformer, will exceed the maximum permissible non-repetitive peak reverse voltage, see General Section for information on damping circuits.

\hspace{1cm} \text{1)} \text{Measured under pulse conditions to avoid excessive dissipation.}
interrelation between the power (derived from the left-hand graph) and the maximum permissible temperatures

\[ P = a \frac{I_{F(RMS)}}{I_{F(AV)}} \] for single phase: \( a = 1.6 \)

3-phase: \( a = 1.75 \)

6-phase: \( a = 2.4 \)

\( a \) is the ratio of the power derived from the left-hand graph to the maximum permissible temperatures. The \( T_{mb} \)-scale is for comparison purposes only and is correct only for \( R_{th \, mb-a} \leq 3.4 \degree C/W \)
maximum permissible non-repetitive r.m.s. forward current based on sinusoidal currents (f = 50 Hz)

with reapplied $V_{RWM\text{max}}$

$T_j = 150^\circ C$ prior to surge

$T_j = 25^\circ C$  
$T_j = 150^\circ C$
Silicon rectifier diodes in D0-4 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

<table>
<thead>
<tr>
<th>Repetitive peak reverse voltage ( V_{RRM} )</th>
<th>BYX98-300(R)</th>
<th>600(R)</th>
<th>1200(R)</th>
</tr>
</thead>
<tbody>
<tr>
<td>max.</td>
<td>300</td>
<td>600</td>
<td>1200</td>
</tr>
<tr>
<td>Average forward current ( I_{F(AV)} )</td>
<td>max.</td>
<td>10</td>
<td>A</td>
</tr>
<tr>
<td>Non-repetitive peak forward current ( I_{FSM} )</td>
<td>max.</td>
<td>75</td>
<td>A</td>
</tr>
</tbody>
</table>

### MECHANICAL DATA

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.

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

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

<table>
<thead>
<tr>
<th></th>
<th>BYX98-300(R)</th>
<th>600(R)</th>
<th>1200(R)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Non-repetitive peak reverse voltage (t \leq 10 \text{ ms})</td>
<td>(V_{RSM}) max.</td>
<td>300 V</td>
<td>600 V</td>
</tr>
<tr>
<td>Repetitive peak reverse voltage (\delta \leq 0.01)</td>
<td>(V_{RRM}) max.</td>
<td>300 V</td>
<td>600 V</td>
</tr>
<tr>
<td>Crest working reverse voltage</td>
<td>(V_{RWM}) max.</td>
<td>200 V</td>
<td>400 V</td>
</tr>
<tr>
<td>Continuous reverse voltage</td>
<td>(V_R) max.</td>
<td>200 V</td>
<td>400 V</td>
</tr>
</tbody>
</table>

#### Currents

- **Average forward current** (averaged over any 20 ms period) up to \(T_{mb} = 97 \, \text{°C}\) at \(T_{mb} = 125 \, \text{°C}\)
  
  \[
  I_{F(AV)} \text{ max.} = 10 \, \text{A} \\
  I_{F(AV)} \text{ max.} = 6 \, \text{A}
  \]

- **R.M.S. forward current**
  
  \[
  I_{F(RMS)} \text{ max.} = 16 \, \text{A}
  \]

- **Repetitive peak forward current**
  
  \[
  I_{FRM} \text{ max.} = 75 \, \text{A}
  \]

- **Non-repetitive peak forward current**
  
  \(t = 10 \text{ ms}; \text{ half sine-wave}\) \(T_j = 150 \, \text{°C}\) prior to surge;
  
  with reapplied \(V_{RWM\text{max}}\)
  
  \[
  I_{FSM} \text{ max.} = 75 \, \text{A} \\
  I_{2t} \text{ max.} = 28 \, \text{A}^2\text{s}
  \]

#### Temperatures

- **Storage temperature**
  
  \[T_{stg} = -55 \text{ to } +150 \, \text{°C}\]

- **Junction temperature**
  
  \[T_j \text{ max.} = 150 \, \text{°C}\]

#### THERMAL RESISTANCE

- **From junction to ambient in free air**
  
  \[R_{th \ j-a} = 50 \, \text{°C/W}\]

- **From junction to mounting base**
  
  \[R_{th \ j-mb} = 3 \, \text{°C/W}\]

- **From mounting base to heatsink**
  
  - with heatsink compound
    
    \[R_{th \ mb-h} = 0.5 \, \text{°C/W}\]
  
  - without heatsink compound
    
    \[R_{th \ mb-h} = 0.6 \, \text{°C/W}\]

- **Transient thermal impedance; \(t = 1 \text{ ms}\)**
  
  \[Z_{th \ j-mb} = 0.3 \, \text{°C/W}\]
CHARACTERISTICS

Forward voltage
\[ I_F = 20 \text{ A}; \ T_j = 25 \, ^\circ\text{C} \]
\[ V_F < 1.7 \text{ V} \]

Reverse current
\[ V_R = V_{RWM_{\text{max}}}; \ T_j = 125 \, ^\circ\text{C} \]
\[ I_R < 200 \, \mu\text{A} \]

OPERATING NOTES

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

2. Where there is a possibility that transients, due to the energy stored in the transformer, will exceed the maximum permissible non-repetitive peak reverse voltage, see General Section for information on damping circuits.

---

\[ a = \frac{I_F(\text{RMS})}{I_F(\text{AV})} \]

Interrelation between the power (derived from the left-hand graph) and the maximum permissible temperatures

---

1) Measured under pulse conditions to avoid excessive dissipation.
maximum permissible non-repetitive r.m.s. forward current based on sinusoidal currents (f = 50 Hz) 

$I_F$, $I_{FSM}$, $I_{FS(RMS)}$

with reapplied $V_{RWMmax}$

$T_J = 150 \, ^\circ C$ prior to surge

$T_J = 25 \, ^\circ C$

$T_J = 150 \, ^\circ C$

$V_F$ (V) vs $I_F$ (A)

$T_J = 25 \, ^\circ C$

$T_J = 150 \, ^\circ C$

typ max
Silicon rectifier diodes in D0-4 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

<table>
<thead>
<tr>
<th></th>
<th>BYX99-300(R)</th>
<th>600(R)</th>
<th>1200(R)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Repetitive peak reverse voltage $V_{RRM}$</td>
<td>max.</td>
<td>300</td>
<td>600</td>
</tr>
<tr>
<td>Average forward current $I_F(AV)$</td>
<td>max.</td>
<td>15</td>
<td>A</td>
</tr>
<tr>
<td>Non-repetitive peak forward current $I_{FSM}$</td>
<td>max.</td>
<td>180</td>
<td>A</td>
</tr>
</tbody>
</table>

### MECHANICAL DATA

- **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.

**Dimensions in mm**

- 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

April 1984
RATINGS  Limiting values in accordance with the Absolute Maximum System (IEC 134)

<table>
<thead>
<tr>
<th>Volatges</th>
<th>BYX99-300(R)</th>
<th>600(R)</th>
<th>1200(R)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Non-repetitive peak reverse voltage (t ≤ 10 ms)</td>
<td>( V_{RSM} ) max.</td>
<td>300</td>
<td>600</td>
</tr>
<tr>
<td>Repetitive peak reverse voltage (( \delta \leq 0,01 ))</td>
<td>( V_{RRM} ) max.</td>
<td>300</td>
<td>600</td>
</tr>
<tr>
<td>Crest working reverse voltage</td>
<td>( V_{RWM} ) max.</td>
<td>200</td>
<td>400</td>
</tr>
<tr>
<td>Continuous reverse voltage</td>
<td>( V_{R} ) max.</td>
<td>200</td>
<td>400</td>
</tr>
</tbody>
</table>

Currents

Average forward current (averaged over any 20 ms period) up to \( T_{mb} = 129 \, \text{oC} \)

- \( I_{F(AV)} \) max. 15 A
- \( I_{F(RMS)} \) max. 24 A
- \( I_{FRM} \) max. 180 A
- \( I_{FSM} \) max. 180 A
- \( I_{2t} \) max. 162 A²s

Temperatures

- Storage temperature \( T_{stg} \) -55 to +175 °C
- Junction temperature \( T_{j} \) max. 175 °C

THERMAL RESISTANCE

- From junction to ambient in free air \( R_{th \ j-a} = 50 \, \text{oC/W} \)
- From junction to mounting base \( R_{th \ j-mb} = 2,3 \, \text{oC/W} \)
- From mounting base to heatsink with heatsink compound \( R_{th \ mb-h} = 0,5 \, \text{oC/W} \)
- From mounting base to heatsink without heatsink compound \( R_{th \ mb-h} = 0,6 \, \text{oC/W} \)
- Transient thermal impedance; \( t = 1 \, \text{ms} \) \( Z_{th \ j-mb} = 0,13 \, \text{oC/W} \)
CHARACTERISTICS

Forward voltage

\[ I_F = 50 \text{ A}; \quad T_j = 25 \, ^\circ\text{C} \]

\[ V_F < 1.55 \, \text{V} \]  \( ^1 \)

Reverse current

\[ V_R = V_{RW\text{max}}; \quad T_j = 125 \, ^\circ\text{C} \]

\[ I_R < 200 \, \mu\text{A} \]

OPERATING NOTES

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

2. Where there is a possibility that transients, due to the energy stored in the transformer, will exceed the maximum permissible non-repetitive peak reverse voltage, see General Section for information on damping circuits.

---

\( ^1 \) Measured under pulse conductions to avoid excessive dissipation.
BYX99
SERIES

single phase: $a = 1.6$
3-phase : $a = 1.75$  $a = \frac{I_F(\text{RMS})}{I_F(\text{AV})}$
6-phase : $a = 2.4$

interrelation between the power (derived from the left-hand graph) and the maximum permissible temperatures

---

*IF(RMS)*

**P (W)**

**$I_F(\text{AV})$ (A)**

**$T_{\text{amb}}$ ($^\circ$C)**

---

*IF($TJ$)*

**$I_F$ (A)**

**$V_F$ (V)**

---

November 1975
maximum permissible non-repetitive r.m.s. forward current based on sinusoidal currents (f = 50 Hz)

with reapplied \( V_{RWM\text{max}} \)

\[ I_F \quad - - - - I_{FSM} \quad - - - - I_{FS(RMS)} \]

\( T_j = 175 \, ^\circ\text{C} \) prior to surge

\( I_{FS(RMS)} \)

\( Z_{th,j-mb} \)

(\( ^\circ\text{C}/\text{W} \))

November 1975
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

<table>
<thead>
<tr>
<th>Input</th>
<th>BY224-400</th>
<th>600 V</th>
</tr>
</thead>
<tbody>
<tr>
<td>R.M.S. voltage</td>
<td>V_{I(RMS)} max. 220 280 V</td>
<td></td>
</tr>
<tr>
<td>Repetitive peak voltage</td>
<td>V_{IRM} max. 400 600 V</td>
<td></td>
</tr>
<tr>
<td>Non-repetitive peak current</td>
<td>I_{ISM} max. 100 A</td>
<td></td>
</tr>
<tr>
<td>Peak inrush current</td>
<td>I_{IM} max. 200 A</td>
<td></td>
</tr>
</tbody>
</table>

| Output                        | I_{O(AV)} max. 4,8 A |
| Average current               | |

MECHANICAL DATA (see also Fig.1a)

Fig. 1 SOT-112.

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 1V, 6 cycles).
MECHANICAL DATA (continued)

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)

<table>
<thead>
<tr>
<th>Input</th>
<th>BY224-400</th>
<th>600</th>
</tr>
</thead>
<tbody>
<tr>
<td>Non-repetitive peak voltage (t ≤ 10 ms)</td>
<td>VISM</td>
<td>max. 400 V 600 V</td>
</tr>
<tr>
<td>Repetitive peak voltage</td>
<td>VRM</td>
<td>max. 400 V 600 V</td>
</tr>
<tr>
<td>Crest working voltage</td>
<td>VWM</td>
<td>max. 350 V 400 V</td>
</tr>
<tr>
<td>R.M.S. voltage (sine-wave)</td>
<td>VRMS</td>
<td>max. 220 V 280 V</td>
</tr>
<tr>
<td>Non-repetitive peak current</td>
<td>IISM</td>
<td>max. 100 A</td>
</tr>
<tr>
<td>half sine-wave; t = 20 ms; with reapplied VWMmax</td>
<td>IISM</td>
<td>max. 85 A</td>
</tr>
<tr>
<td>Tj = 25 °C prior to surge</td>
<td>IIM</td>
<td>max. 200 A</td>
</tr>
<tr>
<td>Tj = 150 °C prior to surge</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Peak inrush current (see Fig. 6)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Output</td>
<td>IO(AV)</td>
<td>max. 4.8 A</td>
</tr>
<tr>
<td>Average current (averaged over any 20 ms period; see Figs 2 and 3)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>heatsink operation up to Tmb = 90 °C</td>
<td></td>
<td></td>
</tr>
<tr>
<td>free-air operation at Tamb = 45 °C; (mounting method 1a)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Repetitive peak current</td>
<td>IORM</td>
<td>max. 50 A</td>
</tr>
<tr>
<td>Temperatures</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Storage temperature</td>
<td>Tstg</td>
<td>-40 to +150 °C</td>
</tr>
<tr>
<td>Junction temperature</td>
<td>Tj</td>
<td>max. 150 °C</td>
</tr>
</tbody>
</table>

March 1982
THERMAL RESISTANCE

From junction to mounting base

\[ R_{th j-mb} = 4.0 \, ^\circ C/W \]

Influence of mounting method

1. Free-air operation

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

Thermal resistance from junction to ambient in free air

a. Mounted on a printed-circuit board with 4 cm\(^2\) of copper laminate to + and − leads

\[ R_{th j-a} = 19.5 \, ^\circ C/W \]

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

\[ R_{th j-a} = 25 \, ^\circ C/W \]

2. Heatsink mounted with clip (see mounting instructions)

Thermal resistance from mounting base to heatsink

a. With zinc-oxide heatsink compound

\[ R_{th mb-h} = 1.0 \, ^\circ C/W \]

b. Without heatsink compound

\[ R_{th mb-h} = 2.0 \, ^\circ C/W \]

MOUNTING INSTRUCTIONS

1. Soldered joints must be at least 4 mm from the seal.

2. The maximum permissible temperature of the soldering iron or bath is 270°C; contact with the joint must not exceed 3 seconds.

3. Avoid hot spots due to handling or mounting; the body of the device must not come into contact with or be exposed to a temperature higher than 150°C.

4. Leads should not be bent less than 4 mm from the seal. Exert no axial pull when bending.

5. Recommended force of clip on device is 120 N (12 kgf).

6. The heatsink should be in contact with the entire mounting base of the device and heatsink compound should be used.

CHARACTERISTICS

Forward voltage (2 diodes in series)

\[ I_F = 10 \, A; \, T_j = 25 \, ^\circ C \]

\[ V_F < 2.3 \, V^* \]

Reverse current (2 diodes in parallel)

\[ V_R = V_{1WMax}; \, T_j = 25 \, ^\circ C \]

\[ I_R < 200 \, \mu A \]

* Measured under pulse conditions to avoid excessive dissipation.
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 $a_0 = \frac{I_{O(RMS)}}{I_{O(AV)}} = 0.707 \times \frac{I_F(RMS)}{I_F(AV)}$ 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 $a_0 = \frac{I_{O(RMS)}}{I_{O(AV)}} = 0.707 \times \frac{I_{F(RMS)}}{I_{F(AV)}}$ per diode.
Fig. 4 Maximum permissible non-repetitive r.m.s. input current based on sinusoidal currents (f = 50 Hz); $T_J = 150 \degree C$ prior to surge; with reapplied $V_{W_{\text{Mmax}}}$.

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 $R_{\text{tot}}$ (including the transformer resistance) required to limit the peak inrush current.
Fig. 7 Because smoothing capacitor C2 is not always connected directly across the bridge (a suppression network may be sited between capacitor and bridge as shown), it is necessary to connect a capacitor of about 1 µF, C1, between the + and – terminals of the bridge. This capacitor should be as close to the bridge as possible, to give optimum suppression of mains transients.

Fig. 8
SILICON BRIDGE RECTIFIERS

Ready-for-use full-wave bridge rectifiers in a plastic encapsulation. The bridges are intended for use in equipment supplied from a.c. with r.m.s. voltages up to 80 V and are capable of delivering output currents up to 4.8 A. They are also suitable for use in hi-fi audio equipments and low-voltage industrial power supplies. They may be used in free air or clipped to a heatsink.

QUICK REFERENCE DATA

<table>
<thead>
<tr>
<th>Input</th>
<th>BY225-100</th>
<th>200</th>
</tr>
</thead>
<tbody>
<tr>
<td>R.M.S. voltage</td>
<td>( V_{(RMS)} ) max.</td>
<td>50</td>
</tr>
<tr>
<td>Repetitive peak voltage</td>
<td>( V_{IRM} ) max.</td>
<td>100</td>
</tr>
<tr>
<td>Non-repetitive peak current</td>
<td>( I_{ISM} ) max.</td>
<td>100</td>
</tr>
<tr>
<td>Peak inrush current</td>
<td>( I_{IIM} ) max.</td>
<td>200</td>
</tr>
<tr>
<td>Output</td>
<td>( I_{O(AV)} ) max.</td>
<td>4.8</td>
</tr>
</tbody>
</table>

MECHANICAL DATA

Dimensions in mm

Fig. 1 SOT-112.

Net mass: 6.8 g

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

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

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

### Input

<table>
<thead>
<tr>
<th>Parameter</th>
<th>BY225–100</th>
<th>200</th>
</tr>
</thead>
<tbody>
<tr>
<td>Non-repetitive peak voltage ($t \leq 10$ ms)</td>
<td>$V_{ISM}$</td>
<td>max. 100 200 V</td>
</tr>
<tr>
<td>Repetitive peak voltage</td>
<td>$V_{IRM}$</td>
<td>max. 100 200 V</td>
</tr>
<tr>
<td>Crest working voltage</td>
<td>$V_{IWM}$</td>
<td>max. 70 112 V</td>
</tr>
<tr>
<td>R.M.S. voltage (sine-wave)</td>
<td>$V_{I(RMS)}$</td>
<td>max. 50 80 V</td>
</tr>
<tr>
<td>Non-repetitive peak current;</td>
<td></td>
<td></td>
</tr>
<tr>
<td>half sine-wave; $t = 20$ ms; with reapplied $V_{IWM\text{max}}$</td>
<td></td>
<td></td>
</tr>
<tr>
<td>$T_j = 25$ °C prior to surge</td>
<td>$I_{ISM}$</td>
<td>max. 100 A</td>
</tr>
<tr>
<td>$T_j = 150$ °C prior to surge</td>
<td>$I_{ISM}$</td>
<td>max. 85 A</td>
</tr>
<tr>
<td>Peak inrush current (see Fig. 6)</td>
<td>$I_{IIM}$</td>
<td>max. 200 A</td>
</tr>
</tbody>
</table>

### Output

Average current (averaged over any 20 ms period; see Figs 2 and 3)

<table>
<thead>
<tr>
<th>Parameter</th>
<th>BY225–100</th>
<th>200</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>$I_{O(AV)}$</td>
<td>max. 4,8 A</td>
</tr>
<tr>
<td></td>
<td>$I_{O(AV)}$</td>
<td>max. 3,6 A</td>
</tr>
<tr>
<td></td>
<td>$I_{O(AV)}$</td>
<td>max. 3,2 A</td>
</tr>
<tr>
<td></td>
<td>$I_{ORM}$</td>
<td>max. 50 A</td>
</tr>
</tbody>
</table>

### Temperatures

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Storage temperature</td>
<td>$T_{stg} = -40$ to $+150$ °C</td>
</tr>
<tr>
<td>Junction temperature</td>
<td>$T_j = 150$ °C</td>
</tr>
</tbody>
</table>
THERMAL RESISTANCE

From junction to mounting base

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

Influence of mounting method

1. Free-air operation

The quoted values of \( R_{\text{th,j-a}} \) 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\(^2\) of copper laminate to + and – leads

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

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

\[ R_{\text{th,j-a}} = 25 \, ^\circ\text{C/W} \]

2. Heatsink mounted with clip (see mounting instructions)

Thermal resistance from mounting base to heatsink

a. With zinc-oxide heatsink compound

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

b. Without heatsink compound

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

MOUNTING INSTRUCTIONS

1. Soldered joints must be at least 4 mm from the seal.
2. The maximum permissible temperature of the soldering iron or bath is 270 \(^\circ\text{C}\); contact with the joint must not exceed 3 seconds.
3. Avoid hot spots due to handling or mounting; the body of the device must not come into contact with or be exposed to a temperature higher than 150 \(^\circ\text{C}\).
4. Leads should not be bent less than 4 mm from the seal. Exert no axial pull when bending.
5. Recommended force of clip on device is 120 N (12 kgf).
6. The heatsink should be in contact with the entire mounting base of the device and heatsink compound should be used.

CHARACTERISTICS

Forward voltage (2 diodes in series)

\[ I_F = 10 \, \text{A} ; T_j = 25 \, ^\circ\text{C} \]

\[ V_F < 2.3 \, \text{V}^* \]

Reverse current (2 diodes in parallel)

\[ V_R = V_{IWM_{\text{max}}} ; T_j = 25 \, ^\circ\text{C} \]

\[ I_R < 200 \, \mu\text{A} \]

* 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 $a_0 = \frac{I_{O(RMS)}}{I_{O(AV)}} = 0.707 \times \frac{I_{F(RMS)}}{I_{F(AV)}}$ 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 $a_0 = \frac{I_{O(RMS)}}{I_{O(AV)}} = 0.707 \times \frac{I_{F(RMS)}}{I_{F(AV)}}$ per diode.
Fig. 4 Maximum permissible non-repetitive r.m.s. input current based on sinusoidal currents \( f = 50 \, \text{Hz} \); \( T_j = 150 \, ^\circ\text{C} \) prior to surge; with reapplied \( V_{\text{IWMmax}} \).

Fig. 5.
The graph takes the possibility of the following spreads into account:

- input voltage: +10%
- capacitance: +50%
- resistance: -10%

Fig. 6 Minimum value of the total series resistance $R_{\text{tot}}$ (including the transformer resistance) required to limit the peak inrush current.
Fig. 7.

CAPACITIVE LOAD

$T_{\text{amb}} = 35 \, ^\circ\text{C}$

$T_{\text{amb}} = 65 \, ^\circ\text{C}$

overload time (min)

$0 \quad 5 \quad 10 \quad 15$

$I_{O(\text{AV})}$ (A)

$0 \quad 5 \quad 10 \quad 15$

mounting method:

1a ----

1b ---
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 12 A. They are also suitable for use in hi-fi audio equipment and low-voltage industrial power supplies. They may be used in free air or on a heatsink.

QUICK REFERENCE DATA

<table>
<thead>
<tr>
<th>Input</th>
<th>BY260–200</th>
<th>400</th>
<th>600</th>
</tr>
</thead>
<tbody>
<tr>
<td>R.M.S. voltage</td>
<td>$V_{1(RMS)}$</td>
<td>max.</td>
<td>140</td>
</tr>
<tr>
<td>Repetitive peak voltage</td>
<td>$V_{1RM}$</td>
<td>max.</td>
<td>200</td>
</tr>
<tr>
<td>Non-repetitive peak current</td>
<td>$I_{1SM}$</td>
<td>max.</td>
<td>125</td>
</tr>
<tr>
<td>Peak inrush current</td>
<td>$I_{1IM}$</td>
<td>max.</td>
<td>250</td>
</tr>
<tr>
<td>Output</td>
<td>$I_{O(AV)}$</td>
<td>max.</td>
<td>12</td>
</tr>
</tbody>
</table>

MECHANICAL DATA

Dimensions in mm

Fig. 1.
RATINGS

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

<table>
<thead>
<tr>
<th>Input</th>
<th>BY260-200</th>
<th>400</th>
<th>600</th>
</tr>
</thead>
<tbody>
<tr>
<td>Non-repetitive peak voltage ($t \leq 10$ ms)</td>
<td>$V_{ISM}$ max.</td>
<td>200</td>
<td>400</td>
</tr>
<tr>
<td>Repetitive peak voltage</td>
<td>$V_{IRM}$ max.</td>
<td>200</td>
<td>400</td>
</tr>
<tr>
<td>Crest working voltage</td>
<td>$V_{IWM}$ max.</td>
<td>200</td>
<td>400</td>
</tr>
<tr>
<td>R.M.S. voltage (sine-wave)</td>
<td>$V_{I(RMS)}$ max.</td>
<td>140</td>
<td>280</td>
</tr>
</tbody>
</table>

Non-repetitive peak current
half-sinewave; $t = 20$ ms; with reapplied $V_{IWM_{max}}$

<table>
<thead>
<tr>
<th>$T_j$</th>
<th>$I_{ISM}$ max.</th>
</tr>
</thead>
<tbody>
<tr>
<td>25 $^\circ$C prior to surge</td>
<td>125 A</td>
</tr>
<tr>
<td>150 $^\circ$C prior to surge</td>
<td>100 A</td>
</tr>
</tbody>
</table>

Peak inrush current (see Fig. 5)

<table>
<thead>
<tr>
<th>$I_{IIM}$ max.</th>
</tr>
</thead>
<tbody>
<tr>
<td>250 A</td>
</tr>
</tbody>
</table>

Output

Average current (averaged over any 20 ms period)

<table>
<thead>
<tr>
<th>$I_{O(AV)}$ max.</th>
</tr>
</thead>
<tbody>
<tr>
<td>12 A</td>
</tr>
<tr>
<td>7.5 A</td>
</tr>
</tbody>
</table>

Repetitive peak current

<table>
<thead>
<tr>
<th>$I_{ORM}$ max.</th>
</tr>
</thead>
<tbody>
<tr>
<td>20 A</td>
</tr>
</tbody>
</table>

Temperatures

<table>
<thead>
<tr>
<th>$T_{stg}$</th>
<th>Storage temperature</th>
</tr>
</thead>
<tbody>
<tr>
<td>-55 to +150 $^\circ$C</td>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>$T_{j}$</th>
<th>Junction temperature</th>
</tr>
</thead>
<tbody>
<tr>
<td>max. 150 $^\circ$C</td>
<td></td>
</tr>
</tbody>
</table>

THERMAL RESISTANCE

From junction to mounting base

| $R_{th_{j-mb}}$ | 4.5 $^\circ$C/W |

CHARACTERISTICS

Forward voltage (2 diodes in series)

| $I_F = 7$ A; $T_j = 25$ $^\circ$C | $V_F$ | < 2.0 $V^*$ |

Reverse current (2 diodes in parallel)

| $V_R = V_{IWM_{max}}$; $T_j = 100$ $^\circ$C | $I_R$ | < 150 $\mu$A |

*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 25 A. They may be used in free air or on a heatsink.

**QUICK REFERENCE DATA**

<table>
<thead>
<tr>
<th></th>
<th>BY261-200</th>
<th>400</th>
<th>600</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Input</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>R.M.S. voltage</td>
<td>$V_{1\text{(RMS)}}$</td>
<td>max. 140</td>
<td>280</td>
</tr>
<tr>
<td>Repetitive peak voltage</td>
<td>$V_{1\text{RM}}$</td>
<td>max. 200</td>
<td>400</td>
</tr>
<tr>
<td>Non-repetitive peak current</td>
<td>$I_{1SM}$</td>
<td>max. 320</td>
<td></td>
</tr>
<tr>
<td>Peak inrush current</td>
<td>$I_{1IM}$</td>
<td>max. 640</td>
<td></td>
</tr>
<tr>
<td><strong>Output</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Average current</td>
<td>$I_{0\text{(AV)}}$</td>
<td>max. 25</td>
<td></td>
</tr>
</tbody>
</table>

**MECHANICAL DATA**

Dimensions in mm

Fig. 1
RATINGS
Limiting values in accordance with the Absolute Maximum System (IEC134).

Input

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

Non-repetitive peak current
half sinewave; t = 20 ms; with reapplied V_{IWM}max

- T_j = 25 °C prior to surge
- T_j = 150 °C prior to surge

| I_{ISM} max. | 320 | A |
| I_{ISM} max. | 250 | A |

Peak inrush current (see Fig. 5)

| I_{IIM} max. | 640 | A |

Output

Average current (averaged over any 20 ms period)
heatsink operation; up to T_{mb} = 55 °C (R-load)
heatsink operation; up to T_{mb} = 55 °C (C-load)

| I_{O(AV)} max. | 25 | A |
| I_{O(AV)} max. | 18 | A |

Repetitive peak current

| I_{ORM} max. | 75 | A |

Temperatures

| T_{stg} | -55 to +175 °C |
| T_{j} max. | 175 °C |

THERMAL RESISTANCE

From junction to mounting base

| R_{th j-mb} = | 2.5 °C/W |

CHARACTERISTICS

Forward voltage (2 diodes in series)

| I_F = 12 A; T_j = 25 °C | V_F < 2.3 V* |

Reverse current (2 diodes in parallel)

| V_R = V_{IWM}max; T_j = 100 °C | I_R < 200 μA |

*Measured under pulse conditions to avoid excessive dissipation.
FAST RECTIFIER DIODES
FAST SOFT-RECOVERY RECTIFIER DIODES

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

The series consists of the following types:
Normal polarity: BY229–200 to 800.
Reverse polarity: BY229–200R to 800R.

QUICK REFERENCE DATA

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

MECHANICAL DATA

Fig.1 TO-220AC

Dimensions in mm

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.

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BY229 SERIES

RATINGS

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

<table>
<thead>
<tr>
<th>Voltages*</th>
<th>BY229-200(R)</th>
<th>400(R)</th>
<th>600(R)</th>
<th>800(R)</th>
<th>V</th>
</tr>
</thead>
<tbody>
<tr>
<td>Non-repetitive peak reverse voltage</td>
<td>VRSM max.</td>
<td>200</td>
<td>400</td>
<td>600</td>
<td>800</td>
</tr>
<tr>
<td>Repetitive peak reverse voltage</td>
<td>VRRM max.</td>
<td>200</td>
<td>400</td>
<td>600</td>
<td>800</td>
</tr>
<tr>
<td>Crest working reverse voltage</td>
<td>VRWM max.</td>
<td>150</td>
<td>300</td>
<td>500</td>
<td>600</td>
</tr>
<tr>
<td>Continuous reverse voltage</td>
<td>VR max.</td>
<td>150</td>
<td>300</td>
<td>500</td>
<td>600</td>
</tr>
</tbody>
</table>

Currents

Average forward current assuming zero switching losses
- square-wave; \( \delta = 0.5 \); up to \( T_{mb} = 100 \) °C
  \( I_{F(AV)} \) max. 7 A
- square-wave; \( \delta = 0.5 \); at \( T_{mb} = 125 \) °C
  \( I_{F(AV)} \) max. 4.1 A
- sinusoidal; up to \( T_{mb} = 100 \) °C
  \( I_{F(AV)} \) max. 6.5 A
- sinusoidal; at \( T_{mb} = 125 \) °C
  \( I_{F(AV)} \) max. 4 A

R.M.S. forward current
\( I_{F(RMS)} \) max. 10 A

Repetitive peak forward current
\( t_p = 20 \) µs; \( \delta \leq 0.02 \)
\( I_{FRM} \) max. 135 A

Non-repetitive peak forward current
\( t = 10 \) ms; half sine-wave;
\( T_j = 150 \) °C prior to surge;
with reapplied \( V_{RWM} \) max
\( I_{FSM} \) max. 60 A

\( I^2 t \) for fusing (\( t = 10 \) ms)
\( I^2 t \) max. 18 A²s

Temperatures

Storage temperature
\( T_{stg} \) -40 to +150 °C

Junction temperature
\( T_j \) max. 150 °C

*To ensure thermal stability: \( R_{th j-a} \leq 15 \) K/W for continuous reverse voltage.

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THERMAL RESISTANCE

From junction to mounting base

\[ R_{th\ j-mb} = 4.5 \text{ K/W} \]

Influence of mounting method

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

Thermal resistance from mounting base to heatsink

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

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

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

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

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

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
  \[ R_{th\ j-a} = 60 \text{ K/W} \]

MOUNTING INSTRUCTIONS

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

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

3. It is recommended that the circuit connection be made to tag 1, rather than direct to the heatsink.

4. Mounting by means of a spring clip is the best mounting method because it offers:
   a. a good thermal contact under the crystal area and slightly lower \( R_{th\ mb-h} \) 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 base-plate and heatsink. Values of \( R_{th\ mb-h} \) given for mounting with heatsink compound refer to the use of a metallic-oxide loaded compound. Ordinary silicone grease is not recommended.

6. Rivet mounting (only possible for non-insulated mounting)

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

$T_j = 25 \, ^\circ C$ unless otherwise specified

Forward voltage

$I_F = 20 \, A$

$V_F < 1.85 \, V^*$

Reverse current

$V_R = V_{RWM_{\text{max}}}; \quad T_j = 125 \, ^\circ C$

<table>
<thead>
<tr>
<th>Normal polarity</th>
<th>Reverse polarity</th>
</tr>
</thead>
<tbody>
<tr>
<td>$I_R &lt; 0.4 , mA$</td>
<td>$I_R &lt; 0.6 , mA$</td>
</tr>
</tbody>
</table>

Reverse recovery when switched from

$I_F = 1 \, A$ to $V_R \geq 30 \, V$ with $-\frac{\Delta I_F}{\Delta t} = 50 \, A/\mu s$

$Q_s < 0.7 \, \mu C$

Recovery time $t_{rr} < 150 \, ns$

$I_F = 2 \, A$ to $V_R \geq 30 \, V$ with $-\frac{\Delta I_F}{\Delta t} = 20 \, A/\mu s$

Maximum slope of the reverse recovery current

$I_F = 2 \, A$, $-\frac{\Delta I_F}{\Delta t} = 20 \, A/\mu s$

<table>
<thead>
<tr>
<th>Normal polarity</th>
<th>Reverse polarity</th>
</tr>
</thead>
<tbody>
<tr>
<td>$</td>
<td>\frac{\Delta I_R}{\Delta t}</td>
</tr>
</tbody>
</table>

*Measured under pulse conditions to avoid excessive dissipation.
Fast soft-recovery rectifier diodes

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.

\[ P = \text{power including reverse current losses but excluding switching losses.} \]

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

---

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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 = |\text{F(RMS)}|/|\text{F(AV)}|.
Fast soft-recovery rectifier diodes

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

Fig. 7 — — Tj = 25 °C; — — — Tj = 125 °C
BY229 SERIES

Fig. 8 NOMOGRAM

Power loss $\Delta P_R(AV)$ due to switching only (to be added to steady state power losses).

$I_F =$ forward current just before switching off; $T_j = 150 \, ^\circ C$
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. $\frac{dI_F}{dt}$ is set by $L_1$, 1.5 $\mu$H gives 20 A/$\mu$s
3. $\frac{dI_R}{dt}$ is measured across $L_2$, 200 nH gives 5 A/$\mu$s/V.
4. Wiring shown in heavy should be kept as short as possible.
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**

<table>
<thead>
<tr>
<th></th>
<th>BY229F-200</th>
<th>400</th>
<th>600</th>
<th>800</th>
</tr>
</thead>
<tbody>
<tr>
<td>Repetitive peak reverse voltage</td>
<td>$V_{RRM}$ max.</td>
<td>200</td>
<td>400</td>
<td>600</td>
</tr>
<tr>
<td>Average forward current</td>
<td>$I_{F(AV)}$ max.</td>
<td>7</td>
<td>A</td>
<td></td>
</tr>
<tr>
<td>Non-repetitive peak forward current</td>
<td>$I_{FSM}$</td>
<td>&lt;</td>
<td>60</td>
<td>A</td>
</tr>
<tr>
<td>Reverse recovery time</td>
<td>$t_{rr}$ max.</td>
<td>&lt;</td>
<td>150</td>
<td>ns</td>
</tr>
</tbody>
</table>

**MECHANICAL DATA**

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

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

Voltages (Note 1)

<table>
<thead>
<tr>
<th></th>
<th>BY229F-200</th>
<th>400</th>
<th>600</th>
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<tbody>
<tr>
<td>Non-repetitive peak reverse voltage</td>
<td>V_RSM</td>
<td>max.</td>
<td>200</td>
<td>400</td>
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<tr>
<td>Repetitive peak reverse voltage</td>
<td>V_RRM</td>
<td>max.</td>
<td>200</td>
<td>400</td>
</tr>
<tr>
<td>Crest working reverse voltage</td>
<td>V_RWM</td>
<td>max.</td>
<td>150</td>
<td>300</td>
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<tr>
<td>Continuous reverse voltage</td>
<td>V_R</td>
<td>max.</td>
<td>150</td>
<td>300</td>
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Currents

Average forward current assuming zero switching losses (Note 2)
- square wave; δ = 0.5; up to T_{hs} = 90 °C
- sinusoidal; up to T_{hs} = 93 °C

<table>
<thead>
<tr>
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<tr>
<td>I_F(AV)</td>
<td>7 A</td>
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<td>I_F(AV)</td>
<td>6.25 A</td>
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R.M.S. forward current

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<tr>
<td>I_F(RMS)</td>
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Repetitive peak forward current

- t_p = 20 μs; δ = 0.02

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<tr>
<td>I_FRM</td>
<td>135 A</td>
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Non-repetitive peak forward current

- half sine-wave; T_j = 150 °C prior to surge; with reapplied V_RWM max

<table>
<thead>
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</thead>
<tbody>
<tr>
<td>I_FSM</td>
<td>60 A</td>
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<tr>
<td>i_FSM</td>
<td>65 A</td>
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</table>

\[ I^2 t \] for fusing (t = 10 ms)

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<tr>
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<tbody>
<tr>
<td>I^2 t</td>
<td>18 A^2 s</td>
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</tbody>
</table>

Temperatures

Storage temperature

T_{stg} = -40 to +150 °C

Junction temperature

T_j = max. 150 °C

ISOLATION

Peak isolation voltage from all terminals to external heatsink

V_{isol} = max. 1000 V

Isolation capacitance from cathode to external heatsink (Note 3)

C_p = typ. 12 pF

Notes

1. To ensure thermal stability: R_{th j-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.
Fast-recovery, isolated rectifier diodes

THERMAL RESISTANCE
From junction to external heatsink with minimum of 2 kgf (20 Newtons) pressure on the centre of the envelope,
without heatsink compound \( R_{th\,j-h} = 7.2 \) K/W
with heatsink compound \( R_{th\,j-h} = 5.5 \) 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 \( R_{th\,j-a} = 55 \) K/W

CHARACTERISTICS
\( T_j = 25 \) °C unless otherwise specified
Forward voltage \( I_F = 20 \) A \( V_F < 1.85 \) V*
Reverse current \( V_R = V_{RWM\,max}; T_j = 125 \) °C \( I_R < 0.4 \) mA
Reverse recovery when switched from \( I_F = 1 \) A to \( V_R \geq 30 \) V with \(-dI_F/dt = 50 \) A/µs, recovery time \( t_{rr} < 150 \) ns
\( I_F = 2 \) A to \( V_R \geq 30 \) V with \(-dI_F/dt = 20 \) A/µs recovered charge \( Q_S < 0.7 \) µC
Maximum slope of the reverse recovery current \( I_F = 2 \) A, \(-dI_F/dt = 20 \) A/µs \( |dI_R/dt| < 60 \) A/µs

*Measured under pulse conditions to avoid excessive dissipation.
MOUNTING INSTRUCTIONS

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

2. The leads should not be bent less than 2.4 mm from the seal, and should be supported during bending. The bend radius must be no less than 1 mm.

3. Mounting by means of a spring clip is the best mounting method because it offers a good thermal contact under the crystal area and slightly lower $R_{th\ j-h}$ values than screw mounting. The force exerted on the top of the device by the clip should be at least 2 kgf (20 Newtons) to ensure good thermal contact and must not exceed 3.5 kgf (35 Newtons) to avoid damage to the device.

4. If screw mounting is used, it should be M3 cross-recess pan head. Minimum torque to ensure good thermal contact: 5.5 kgf (0.55 Nm) Maximum torque to avoid damage to the device: 8.0 kgf (0.80 Nm)

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

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

7. The heatsink must have a flatness in the mounting area of 0.02 mm maximum per 10 mm. Mounting holes must be deburred.

OPERATING NOTES

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

Any measurement of heatsink temperature should be immediately adjacent to the device.
Fig.4 Simplified circuit diagram of practical apparatus to test softness of recovery.

NOTES
1. Duty factor of forward current should be low, < 2%.
2. dI_F/dt is set by L1, 1.5 µH gives 20 A/µs.
3. dI_R/dt is measured across L2, 200 nH gives 5 A/µs/V.
4. Wiring shown in heavy should be kept as short as possible.
BY229F SERIES

Fig. 5 Power rating.
The power loss in the diode should first be
determined from the required forward current
on the $I_{F(AV)}$ axis and the appropriate duty
cycle.

Having determined the power ($P$), use Fig. 7 (if
heatsink compound is not being used) or Fig. 8
(if heatsink compound is being used) to
determine the heatsink size and corresponding
maximum ambient and heatsink temperatures.

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

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

Fig. 6 Power rating.
The power loss in the diode should first be
determined from the required forward current
on the $I_{F(AV)}$ axis and the appropriate form
factor.

Having determined the power ($P$), use Fig. 7 (if
heatsink compound is not being used) or Fig. 8
(if heatsink compound is being used) to
determine the heatsink size and corresponding
maximum ambient and heatsink temperatures.

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

\[ a = \text{form factor} = \frac{I_{F(RMS)}}{I_{F(AV)}} \]
Fast-recovery, isolated rectifier diodes

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); $T_j = 150\,^\circ\text{C}$ prior to surge; with reapplied $V_{RWM_{\text{max}}}$.

Fig. 10 $T_j = 25\,^\circ\text{C}$; $T_j = 125\,^\circ\text{C}$. 

August 1986
Fig. 11 Maximum permissible repetitive peak forward current for square or sinusoidal currents; 1 $\mu$s < $t_p$ < 1 ms.

Definition of $I_{FRM}$ and $t_p/T$. 
Power loss $\Delta P_{R(AV)}$ due to switching only (to be added to steady state power losses).

$I_F =$ forward current just before switching off; $T_j = 150 ^\circ C$. 

Fig. 12 NOMOGRAM

$df_F/dt = 20A/\mu s$
Fast-recovery, isolated rectifier diodes

Figure 13.

Figure 14.

BY229F SERIES

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Fig. 15.

- 
  - 
  - 

Fig. 16.

- 

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

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<thead>
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<tbody>
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<td>max. 800</td>
<td>1000</td>
<td>1200</td>
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<tr>
<td>Average forward current $I_{F(AV)}$</td>
<td>max. 8</td>
<td>A</td>
<td></td>
</tr>
<tr>
<td>Non-repetitive peak forward current $I_{FSM}$</td>
<td>max. 80</td>
<td>A</td>
<td></td>
</tr>
<tr>
<td>Reverse recovery time $t_{rr}$</td>
<td>$&lt;$</td>
<td>150</td>
<td>ns</td>
</tr>
</tbody>
</table>

**MECHANICAL DATA**

Fig.1 TO-220AC

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**

<table>
<thead>
<tr>
<th>BY329-800</th>
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<th>V</th>
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</thead>
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<tr>
<td>Non-repetitive peak reverse voltage</td>
<td>$V_{RSM}$ max.</td>
<td>800</td>
<td>1000</td>
</tr>
<tr>
<td>Repetitive peak reverse voltage</td>
<td>$V_{RRM}$ max.</td>
<td>800</td>
<td>1000</td>
</tr>
<tr>
<td>Crest working reverse voltage</td>
<td>$V_{RWM}$ max.</td>
<td>600</td>
<td>800</td>
</tr>
</tbody>
</table>

**Currents**

Average forward current assuming zero switching losses
- square-wave; $\delta = 0.5$; up to $T_{mb} = 108 \, ^{\circ}C$
- $I_{F(AV)}$ max. $8 \, A$
- square-wave; $\delta = 0.5$; at $T_{mb} = 125 \, ^{\circ}C$
- $I_{F(AV)}$ max. $5.3 \, A$
- sinusoidal; up to $T_{mb} = 113 \, ^{\circ}C$
- $I_{F(AV)}$ max. $7 \, A$
- sinusoidal; at $T_{mb} = 125 \, ^{\circ}C$
- $I_{F(AV)}$ max. $5.2 \, A$

R.M.S. forward current
- $I_{F(RMS)}$ max. $11 \, A$

Repetitive peak forward current
- $I_{FRM}$ max. $80 \, A$

Non-repetitive peak forward current: $t = 10 \, ms$
- half sine-wave; $T_j = 150 \, ^{\circ}C$ prior to surge; with reapplied $V_{RWM}$ max
- $I_{FSM}$ max. $80 \, A$
- $I^2 t$ max. $32 \, A^2 \, s$

**Temperatures**

<p>| | | | |</p>
<table>
<thead>
<tr>
<th></th>
<th></th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>Storage temperature</td>
<td>$T_{stg}$</td>
<td>-40 to +150</td>
<td>°C</td>
</tr>
<tr>
<td>Junction temperature</td>
<td>$T_j$ max.</td>
<td>150</td>
<td>°C</td>
</tr>
</tbody>
</table>

**THERMAL RESISTANCE**

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

**Influence of mounting method**

1. Heatsink mounted with clip (see mounting instructions)

Thermal resistance from mounting base to heatsink

<p>| | | | |</p>
<table>
<thead>
<tr>
<th></th>
<th></th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>a. with heatsink compound</td>
<td>$R_{th \ mb-h}$ =</td>
<td>0.3</td>
<td>K/W</td>
</tr>
<tr>
<td>b. with heatsink compound and 0.06 mm maximum mica insulator</td>
<td>$R_{th \ mb-h}$ =</td>
<td>1.4</td>
<td>K/W</td>
</tr>
<tr>
<td>c. with heatsink compound and 0.1 mm maximum mica insulator (56369)</td>
<td>$R_{th \ mb-h}$ =</td>
<td>2.2</td>
<td>K/W</td>
</tr>
<tr>
<td>d. with heatsink compound and 0.25 mm maximum alumina insulator (56367)</td>
<td>$R_{th \ mb-h}$ =</td>
<td>0.8</td>
<td>K/W</td>
</tr>
<tr>
<td>e. without heatsink compound</td>
<td>$R_{th \ mb-h}$ =</td>
<td>1.4</td>
<td>K/W</td>
</tr>
</tbody>
</table>
Fast soft-recovery rectifier diodes

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 $a = \text{any lead length}$.

\[
R_{th\ j-a} = 60 \quad ^\circ\text{C/W}
\]

CHARACTERISTICS

Forward voltage

\[
V_F < 1.85 \quad \text{V}^* 
\]

Reverse current

\[
I_R < 1.0 \quad \text{mA} 
\]

Reverse recovery when switched from \(I_F = 2 \, \text{A} \) to \(V_R \geq 30 \, \text{V} \) with \(-dI_F/dt = 20 \, \text{A/\mu s} \); \(T_j = 25 \, ^\circ\text{C}\).

Recovered charge \(Q_s < 0.7 \, \mu\text{C}\).

Recovery time \(t_{rr} < 150 \, \text{ns}\).

Maximum slope of the reverse recovery current

\[
|dI_R/dt| < 60 \quad \text{A/\mu s} 
\]

*Measured under pulse conditions to avoid excessive dissipation
MOUNTING INSTRUCTIONS

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

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

3. It is recommended that the circuit connection be made to the cathode tag, rather than direct to the heatsink.

4. Mounting by means of a spring clip is the best mounting method because it offers:
   a. a good thermal contact under the crystal area and slightly lower $R_{th \text{ mb-h}}$ 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 base-plate and heatsink. Values of $R_{th \text{ mb-h}}$ given for mounting with heatsink compound refer to the use of a metallic-oxide loaded compound. Ordinary silicone grease is not recommended.

6. Rivet mounting (only possible for non-insulated mounting).

   Devices may be rivetted to flat heatsinks; such a process must neither deform the mounting tab, nor enlarge the mounting hole.
Fig. 4 The right-hand part shows the interrelationship between the power (derived from the left-hand part) and the maximum permissible temperatures. P = power including reverse current losses but excluding switching losses.

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

\[ \delta = \frac{t_p}{T} \]

*\( T_{mb} \) scale is for comparison purposes and is correct only for \( R_{th mb-a} < 10^\circ C/W \).
Fig. 5 The right-hand part shows the interrelationship between the power (derived from the left-hand part) and the maximum permissible temperatures.

\[ P = \text{power including reverse current losses but excluding switching losses.} \]

\[ a = \text{form factor} = \frac{I_F(\text{RMS})}{I_F(\text{AV})}. \]
Fig. 6 Maximum permissible non-repetitive r.m.s. forward current based on sinusoidal currents \((f = 50 \text{ Hz}); T_j = 150 \degree \text{C prior to surge; with reapplied } V_{RWM_{\text{max}}}.\)

Fig. 7 \(-\cdots-\) \(T_j = 25 \degree \text{C}; \quad \cdots\cdots-\cdots\cdots-\cdots\cdots\cdots\cdots-\cdots\cdOTS;
Fig. 8 NOMOGRAM

Power loss $\Delta P_{R}(AV)$ due to switching only (to be added to steady state power losses).

$I_F =$ forward current just before switching off; $T_j = 150 \, ^\circ\text{C}$
Fast soft-recovery rectifier diodes

**Fig. 9**

- $T_j = 25^\circ C$
- Max. values

**Fig. 10**

- $T_j = 150^\circ C$
- Max. values
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. $dl_F/dt$ is set by $L_1$, 1.5 $\mu$H gives 20 A/$\mu$s.
3. $dl_R/dt$ is measured across $L_2$, 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

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<th>V_{RRM}</th>
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<tbody>
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<td>Average forward current</td>
<td>I_{F(AV)}</td>
<td>max. 1000</td>
<td>1300</td>
<td>1500</td>
</tr>
<tr>
<td>Non-repetitive peak forward current</td>
<td>I_{FSM}</td>
<td>max. 6.5</td>
<td>A</td>
<td></td>
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<tr>
<td>Reverse recovery time</td>
<td>t_{rr}</td>
<td>&lt; 0.6 µs</td>
<td>A</td>
<td></td>
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</table>

MECHANICAL DATA

Fig.1 TO-220AC

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.
## BY359 SERIES

### RATINGS

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

#### Voltages*

<table>
<thead>
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<th>Voltage Description</th>
<th>BY359—1000</th>
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<th>1500</th>
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<tbody>
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<td>1500</td>
</tr>
<tr>
<td>Repetitive peak reverse voltage</td>
<td>VRRM</td>
<td>1000</td>
<td>1300</td>
</tr>
<tr>
<td>Crest working reverse voltage</td>
<td>VRWM</td>
<td>800</td>
<td>1200</td>
</tr>
<tr>
<td>Continuous reverse voltage</td>
<td>Vr</td>
<td>600</td>
<td>750</td>
</tr>
</tbody>
</table>

#### Currents

- Average forward current assuming zero switching losses sinusoidal; up to $T_{mb} = 94 \, ^\circ \text{C}$
- R.M.S. forward current
- Repetitive peak forward current
- Non-repetitive peak forward current: $t = 10 \, \text{ms}$ half sine-wave; $T_j = 125 \, ^\circ \text{C}$ prior to surge; with reapplied $V_{RWM}$ max

<table>
<thead>
<tr>
<th>Current Description</th>
<th>Symbol</th>
<th>BY359—1000</th>
<th>1300</th>
<th>1500</th>
</tr>
</thead>
<tbody>
<tr>
<td>IF(AV) max.</td>
<td>IF(AV)</td>
<td>6.5</td>
<td>A</td>
<td></td>
</tr>
<tr>
<td>IF(RMS) max.</td>
<td>IF(RMS)</td>
<td>10</td>
<td>A</td>
<td></td>
</tr>
<tr>
<td>IFRM max.</td>
<td>IFRM</td>
<td>60</td>
<td>A</td>
<td></td>
</tr>
<tr>
<td>IFSM max.</td>
<td>IFSM</td>
<td>60</td>
<td>A</td>
<td></td>
</tr>
</tbody>
</table>

#### Temperatures

- Storage temperature $T_{stg} = -40 \, \text{to} \, +150 \, ^\circ \text{C}$
- Junction temperature $T_j$ max. $125 \, ^\circ \text{C}$

### THERMAL RESISTANCE

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

#### Influence of mounting method

1. Heatsink mounted with clip (see mounting instructions)
   
   Thermal resistance from mounting base to heatsink
   
   - a. with heatsink compound
     
     $R_{th \, mb-h} = 0.3 \, ^\circ \text{C/W}$
   
   - b. with heatsink compound and 0.06 mm maximum mica insulator
     
     $R_{th \, mb-h} = 1.4 \, ^\circ \text{C/W}$
   
   - c. with heatsink compound and 0.1 mm maximum mica insulator (56369)
     
     $R_{th \, mb-h} = 2.2 \, ^\circ \text{C/W}$
   
   - d. with heatsink compound and 0.25 mm maximum alumina insulator (56367)
     
     $R_{th \, mb-h} = 0.8 \, ^\circ \text{C/W}$
   
   - e. without heatsink compound
     
     $R_{th \, mb-h} = 1.4 \, ^\circ \text{C/W}$

---

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

$I_F = 20\ A;\ T_j = 25\ ^\circ C$

Reverse current

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

Reverse recovery when switched from

$I_F = 2\ A\ to\ V_R \geq 30\ V\ with\ \frac{-dI_F}{dt} = 20\ A/\mu s;\ T_j = 25\ ^\circ C$

recovered charge

$Q_s < 2.0\ \mu C$

recovery time

$t_{rr} < 0.6\ \mu s$

Forward recovery when switched to

$I_F = 5\ A\ with\ t_r = 0.1\ \mu s;\ T_j = 25\ ^\circ C$

recovery time

$t_{fr} < 1.0\ \mu s$

*Measured under pulse conditions to avoid excessive dissipation
MOUNTING INSTRUCTIONS

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

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

3. It is recommended that the circuit connection be made to the cathode tag, rather than direct to the heatsink.

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

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

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

\( a = \text{form factor} = \frac{I_{F(RMS)}}{I_{F(AV)}} \).
Fig. 6 Maximum permissible non-repetitive peak forward current based on sinusoidal currents (f = 50 Hz); T_j = 125 °C prior to surge; with reapplied V_{RWMmax}.

Fig. 7 —— T_j = 25 °C; —— T_j = 100 °C.
Fast high-voltage rectifier diodes

BY359 SERIES

Fig. 8

Fig. 9

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Fig. 10

$Z_{th \text{ j--mb}}$ ($^\circ$C/W)

$10^{-2}$

$10^{-1}$

$10^{-0}$

$10^{0}$

$10^{2}$

$10^{-4}$ $10^{-3}$ $10^{-2}$ $10^{-1}$ $1$ $10$ times (s) $10^{2}$
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**

<table>
<thead>
<tr>
<th></th>
<th>BYP21-50</th>
<th>100</th>
<th>150</th>
<th>200</th>
</tr>
</thead>
<tbody>
<tr>
<td>Repetitive peak reverse voltage $V_{RRM}$ max.</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Average forward current $I_{F(AV)}$ max.</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Forward voltage $V_F$</td>
<td>$&lt; 0.895$ V</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Reverse recovery time $t_{RR}$</td>
<td>$&lt; 25$ ns</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Reverse leakage current $I_R$</td>
<td>$&lt; 5$ $\mu$A</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

**MECHANICAL DATA**

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).

<table>
<thead>
<tr>
<th>Voltagess</th>
<th>BYP21-50</th>
<th>100</th>
<th>150</th>
<th>200</th>
</tr>
</thead>
<tbody>
<tr>
<td>Repetitive peak reverse voltage</td>
<td>$V_{RRM}$ max.</td>
<td>50</td>
<td>100</td>
<td>150</td>
</tr>
<tr>
<td>Crest working reverse voltage</td>
<td>$V_{RWM}$ max.</td>
<td>50</td>
<td>100</td>
<td>150</td>
</tr>
<tr>
<td>Continuous reverse voltage</td>
<td>$V_R$ max.</td>
<td>50</td>
<td>100</td>
<td>150</td>
</tr>
</tbody>
</table>

**Currents**

Average forward current; switching
losses negligible up to 500 kHz
square wave; $\delta = 0.5$;
up to $T_{mb} = 150 \, ^{\circ}C$
sinusoidal; up to $T_{mb} = 150 \, ^{\circ}C$

<table>
<thead>
<tr>
<th>Currents</th>
<th>BYP21-50</th>
<th>100</th>
<th>150</th>
<th>200</th>
</tr>
</thead>
<tbody>
<tr>
<td>R.M.S. forward current</td>
<td>$I_{F(AV)}$ max.</td>
<td>8</td>
<td>A</td>
<td></td>
</tr>
<tr>
<td>Repetitive peak forward current</td>
<td>$I_{F(AV)}$ max.</td>
<td>9.4</td>
<td>A</td>
<td></td>
</tr>
<tr>
<td>Repetitive peak forward current</td>
<td>$I_{F(RMS)}$ max.</td>
<td>11.5</td>
<td>A</td>
<td></td>
</tr>
<tr>
<td>Non-repetitive peak forward current</td>
<td>$I_{FRM}$ max.</td>
<td>175</td>
<td>A</td>
<td></td>
</tr>
<tr>
<td>half sine-wave; $T_j = 175 , ^{\circ}C$ prior to surge; with reapplied $V_{RWMmax}$</td>
<td>$I_{FSM}$ max.</td>
<td>80</td>
<td>A</td>
<td></td>
</tr>
<tr>
<td>$t = 10 , ms$</td>
<td>$I_{FSM}$ max.</td>
<td>100</td>
<td>A</td>
<td></td>
</tr>
<tr>
<td>$t = 8.3 , ms$</td>
<td>$I^2t$ max.</td>
<td>32</td>
<td>A$^2$s</td>
<td></td>
</tr>
<tr>
<td>$I^2t$ for fusing ($t = 10 , ms$)</td>
<td>$T_{stg}$</td>
<td>–65 to +175</td>
<td>( ^{\circ}C )</td>
<td></td>
</tr>
<tr>
<td>Temperatures</td>
<td>$T_j$ max.</td>
<td>175</td>
<td>( ^{\circ}C )</td>
<td></td>
</tr>
</tbody>
</table>
Ultra fast-recovery rectifier diodes

THERMAL RESISTANCE

From junction to mounting base

Influence of mounting method

1. Heatsink mounted with clip (see mounting instructions)

Thermal resistance from mounting base to heatsink

\[ R_{th \text{mb}} = \begin{cases} 
2.7 & \text{K/W} \\
0.3 & \text{K/W} \\
1.4 & \text{K/W} \\
2.2 & \text{K/W} \\
0.8 & \text{K/W} \\
1.4 & \text{K/W} 
\end{cases} \]

2. Free air operation

The quoted values of \( R_{th \text{ja}} \) 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

\[ R_{th \text{ja}} = 60 \text{ K/W} \]
BYP21 SERIES

CHARACTERISTICS

Forward voltage

<table>
<thead>
<tr>
<th>Condition</th>
<th>Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>IF = 8 A; Tj = 100 °C</td>
<td>VF &lt; 0.895 V*</td>
</tr>
<tr>
<td>IF = 8 A; Tj = 25 °C</td>
<td>VF &lt; 1.045 V*</td>
</tr>
<tr>
<td>IF = 20 A; Tj = 25 °C</td>
<td>VF &lt; 1.15 V*</td>
</tr>
</tbody>
</table>

Reverse current

<table>
<thead>
<tr>
<th>Condition</th>
<th>Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>VR = VRWMmax; Tj = 175 °C</td>
<td>IR &lt; 500 µA</td>
</tr>
<tr>
<td>Tj = 125 °C</td>
<td>IR &lt; 250 µA</td>
</tr>
<tr>
<td>Tj = 100 °C</td>
<td>IR &lt; 50 µA</td>
</tr>
<tr>
<td>Tj = 25 °C</td>
<td>IR &lt; 5 µA</td>
</tr>
</tbody>
</table>

Reverse recovery when switched from
IF = 1 A to VR ≥ 30 V with -dIF/dt = 100 A/µs;
Tj = 25 °C; recovery time

| trr | < 25 ns |

Step reverse recovery when switched from
IF = 0.5 A to IR = 1 A, measured at
| trr | < 25 ns |

IF = 2 A to VR ≥ 30 V with -dIF/dt = 20 A/µs;
Tj = 25 °C; recovered charge

| Qs | < 15 nC |

IF = 10 A to VR ≥ 30 V with -dIF/dt = 50 A/µs;
Tj = 100 °C; peak recovery current

| IRRM | < 2 A |

Forward recovery when switched to IF = 1 A
with dIF/dt = 10 A/µs; Tj = 25 °C

| Vfr | typ. 0.9 V |

*Measured under pulse conditions to avoid excessive dissipation.
MOUNTING INSTRUCTIONS

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

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

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

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

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

OPERATING NOTES

Dissipation and heatsink considerations:

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

```
junction

$R_{th\ j\-mb}$
mounting base

$R_{th\ mb\-h}$
heatsink

$R_{th\ h\-a}$
ambient

Fig. 5
```

b. The method of using Figs. 6 and 7 is as follows:
   Starting with the required current on the $I_F(AV)$ axis, trace upwards to meet the appropriate duty factor or form factor curve. Trace right horizontally and upwards from the appropriate value on the $T_{amb}$ scale. The intersection determines the $R_{th\ mb\-a}$. 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.
Fig. 6 The right-hand part shows the relationship between the power (derived from the left-hand part) and the maximum permissible temperatures. Power includes reverse current losses and switching losses up to $f = 500$ kHz.

$$I_F(\text{AV}) = I_F(\text{RMS}) \times \sqrt{\delta}$$
Ultra fast-recovery rectifier diodes

BYP21 SERIES

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

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

Fig. 9 $T_j = 25 \degree C$; --- $T_j = 100 \degree C$. 

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

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Ultra fast-recovery rectifier diodes

Fig. 10 Maximum $t_{rr}$ at $T_j = 25 \, ^\circ C$.

Fig. 11 Maximum $t_{rr}$ at $T_j = 100 \, ^\circ C$.

Fig. 12 Maximum $Q_s$ at $T_j = 25 \, ^\circ C$. 
Fig. 13 Maximum $I_{RRM}$ at $T_j = 25 \, ^\circ\text{C}$.

Fig. 14 Maximum $I_{RRM}$ at $T_j = 100 \, ^\circ\text{C}$.

Fig. 15 Transient thermal impedance.
Glass-passivated, high-efficiency epitaxial rectifier diodes in plastic envelopes, featuring low reverse leakage current, low forward voltage drop, ultra fast reverse recovery times with very low stored charge and soft recovery characteristics. They are intended for use in switched-mode power supplies and high frequency circuits in general, where both low conduction and low switching losses are essential. Their single chip construction ensures excellent matching of the forward and switching characteristics of the two halves, allowing parallel operation without the need for derating. The series consists of common-cathode types.

**QUICK REFERENCE DATA**

<table>
<thead>
<tr>
<th>Per diode, unless otherwise stated</th>
<th>BYU22-50</th>
<th>100</th>
<th>150</th>
<th>200</th>
</tr>
</thead>
<tbody>
<tr>
<td>Output peak reverse voltage (both diodes conducting)</td>
<td>V_{RRM} max.</td>
<td>20</td>
<td>A</td>
<td></td>
</tr>
<tr>
<td>Forward voltage</td>
<td>V_{F} &lt;</td>
<td>0.895</td>
<td>V</td>
<td></td>
</tr>
<tr>
<td>Reverse recovery time</td>
<td>t_{rr} &lt;</td>
<td>25</td>
<td>ns</td>
<td></td>
</tr>
<tr>
<td>Reverse leakage current</td>
<td>I_{R} &lt;</td>
<td>5</td>
<td>µA</td>
<td></td>
</tr>
</tbody>
</table>

**MECHANICAL DATA**

Fig.1 TO-220AB

Net mass: 2 g

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

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

<table>
<thead>
<tr>
<th>Voltages</th>
<th>BYP22</th>
<th>50</th>
<th>100</th>
<th>150</th>
<th>200</th>
</tr>
</thead>
<tbody>
<tr>
<td>Repetitive peak reverse voltage</td>
<td>$V_{RRM}$ max.</td>
<td>50</td>
<td>100</td>
<td>150</td>
<td>200</td>
</tr>
<tr>
<td>Crest working reverse voltage</td>
<td>$V_{RWM}$ max.</td>
<td>50</td>
<td>100</td>
<td>150</td>
<td>200</td>
</tr>
<tr>
<td>Continuous reverse voltage</td>
<td>$V_R$ max.</td>
<td>50</td>
<td>100</td>
<td>150</td>
<td>200</td>
</tr>
</tbody>
</table>

**Currents** (both diodes conducting; note 1)

Output current; switching
- losses negligible up to 500 kHz;
- square wave; $\delta = 0.5$;
  - up to $T_{mb} = 150 \, ^\circ C$ $I_O$ max. 16 A
  - square wave; $\delta = 0.5$;
    - up to $T_{mb} = 143 \, ^\circ C$ $I_O$ max. 20 A
  - sinusoidal; up to $T_{mb} = 150 \, ^\circ C$ $I_O$ max. 16 A
- R.M.S. forward current $I_{F(RMS)}$ max. 20 A

Repetitive peak forward current
- $t_p = 20 \, \mu s$; $\delta = 0.02$ (note 2) $I_{FRM}$ max. 230 A

Non-repetitive peak forward current
- half sine-wave; $T_j = 175 \, ^\circ C$ prior to surge; with reapplied $V_{RWM}$ max. (note 2)
  - $t = 10 \, ms$ $I_{FSM}$ max. 140 A
  - $t = 8.3 \, ms$ $I_{FSM}$ max. 150 A
  - $I^2t$ for fusing ($t = 10 \, ms$; note 2) $I^2t$ max. 98 $A^2s$

**Temperatures**

<table>
<thead>
<tr>
<th></th>
<th>$T_{stg}$ min.</th>
<th>65 to +175</th>
<th>0°C</th>
</tr>
</thead>
<tbody>
<tr>
<td>Storage temperature</td>
<td></td>
<td>-65 to +175</td>
<td>0°C</td>
</tr>
<tr>
<td>Junction temperature</td>
<td>$T_j$ max.</td>
<td>175</td>
<td>0°C</td>
</tr>
</tbody>
</table>

**Notes**

1. The limits for both diodes apply whether both diodes conduct simultaneously or on alternate half cycles.
2. Figures apply to each diode.
Ultra fast-recovery double rectifier diodes

THERMAL RESISTANCE
From junction to mounting base; total package per diode

\[
\begin{align*}
R_{th \, j\, mb} &= 1.6 \text{ K/W} \\
R_{th \, j\, mb} &= 2.4 \text{ K/W}
\end{align*}
\]

Influence of mounting method
1. Heatsink mounted with clip (see mounting instructions)
Thermal resistance from mounting base to heatsink
a. with heatsink compound
b. with heatsink compound and 0.06 mm maximum mica insulator
c. with heatsink compound and 0.1 mm maximum mica washer (56369)
d. with heatsink compound and 0.25 mm maximum alumina insulator (56367)
e. without heatsink compound

\[
\begin{align*}
R_{th \, mb-h} &= 0.3 \text{ K/W} \\
R_{th \, mb-h} &= 1.4 \text{ K/W} \\
R_{th \, mb-h} &= 2.2 \text{ K/W} \\
R_{th \, mb-h} &= 0.8 \text{ K/W} \\
R_{th \, mb-h} &= 1.4 \text{ K/W}
\end{align*}
\]

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 lead length

\[
R_{th \, j\, a} = 60 \text{ K/W}
\]

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CHARACTERISTICS

Forward voltage

\( I_F = 8 \, \text{A}; \quad T_j = 100 \, \text{°C} \)
\( I_F = 8 \, \text{A}; \quad T_j = 25 \, \text{°C} \)
\( I_F = 20 \, \text{A}; \quad T_j = 25 \, \text{°C} \)

Reverse current

\( V_R = V_{RWM\text{max}}; \quad T_j = 175 \, \text{°C} \)
\( T_j = 125 \, \text{°C} \)
\( T_j = 100 \, \text{°C} \)
\( T_j = 25 \, \text{°C} \)

Reverse recovery when switched from

\( I_F = 1 \, \text{A} \) to \( V_R \geq 30 \, \text{V} \) with \(-dI_F/dt = 100 \, \text{A/µs}; \quad T_j = 25 \, \text{°C} \); recovery time

Step reverse recovery when switched from

\( I_F = 0.5 \, \text{A} \) to \( I_R = 1 \, \text{A} \), measured at
\( I_{RR} = 0.25 \, \text{A}; \quad \text{recovery time} \)
\( I_F = 2 \, \text{A} \) to \( V_R \geq 30 \, \text{V} \) with \(-dI_F/dt = 20 \, \text{A/µs}; \quad T_j = 25 \, \text{°C} \); recovered charge
\( I_F = 10 \, \text{A} \) to \( V_R \geq 30 \, \text{V} \) with \(-dI_F/dt = 50 \, \text{A/µs}; \quad T_j = 100 \, \text{°C} \); peak recovery current

Forward recovery when switched to \( I_F = 1 \, \text{A} \)
with \( dI_F/dt = 10 \, \text{A/µs}; \quad T_j = 25 \, \text{°C} \)

\( V_{fr} \) typ. \( 0.9 \, \text{V} \)

*Measured under pulse conditions to avoid excessive dissipation.
MOUNTING INSTRUCTIONS

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

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

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

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

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

OPERATING NOTES

Dissipation and heatsink considerations:

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

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

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

Power includes reverse current losses and switching losses up to \( f = 500 \text{ kHz} \).
Ultra fast-recovery double rectifier diodes

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.

\[ a = \text{form factor} = \frac{I_F(RMS)}{I_F(AV)} \]
Fig. 8 Maximum permissible repetitive peak forward current for either square or sinusoidal currents for $1 \mu s < t_p < 1$ ms.

Fig. 9 — $T_j = 25^\circ C$; $T_j = 100^\circ C$ per diode.
Ultra fast-recovery double rectifier diodes

Fig. 10 Maximum $t_{rr}$ at $T_j = 25 \, ^\circ C$.

Fig. 11 Maximum $t_{rr}$ at $T_j = 100 \, ^\circ C$.

Fig. 12 Maximum $Q_s$ at $T_j = 25 \, ^\circ C$.
Fig. 13 Maximum $I_{RRM}$ at $T_j = 25$ °C.

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

Fig. 15 Transient thermal impedance; one diode conducting.
ULTRA FAST RECOVERY RECTIFIER DIODES
FEATURING LOW REVERSE LEAKAGE

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

The series consists of normal polarity (cathode to stud) types.

QUICK REFERENCE DATA

<table>
<thead>
<tr>
<th>Repetitive peak reverse voltage $V_{RRM}$</th>
<th>BYP59-300</th>
<th>400</th>
</tr>
</thead>
<tbody>
<tr>
<td>max.</td>
<td>300</td>
<td>400</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Average forward current $I_{F(AV)}$ max.</th>
<th>60 A</th>
</tr>
</thead>
</table>

<table>
<thead>
<tr>
<th>Forward voltage $V_F$ &lt; 1.05 V</th>
</tr>
</thead>
</table>

<table>
<thead>
<tr>
<th>Reverse recovery time $t_{RR}$ &lt; 60 V</th>
</tr>
</thead>
</table>

<table>
<thead>
<tr>
<th>Reverse leakage current $I_R$ &lt; 25 $\mu$A</th>
</tr>
</thead>
</table>

MECHANICAL DATA

Dimensions in mm

Fig.1 DO-5: with $\frac{1}{4}$ in x 28 UNF stud (ø6.35 mm); e.g. BYP59-300U, with metric M6 stud (ø6 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:
$\frac{1}{4}$ in x 28 UNF: 11.1 mm, M6: 10.0 mm.
### RATINGS

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

#### Voltages

<table>
<thead>
<tr>
<th>Voltage</th>
<th>BYP59-300</th>
<th>400</th>
</tr>
</thead>
<tbody>
<tr>
<td>Repetitive peak reverse voltage</td>
<td>V_{RRM} max.</td>
<td>300 V</td>
</tr>
<tr>
<td>Crest working reverse voltage</td>
<td>V_{RWM} max.</td>
<td>200 V</td>
</tr>
<tr>
<td>Continuous reverse voltage</td>
<td>V_{R} max.</td>
<td>200 V</td>
</tr>
</tbody>
</table>

#### Currents

<table>
<thead>
<tr>
<th>Current Type</th>
<th>BYP59-300</th>
<th>400</th>
</tr>
</thead>
<tbody>
<tr>
<td>Average forward current; switching losses negligible up to 200 kHz; square wave; δ = 0.5; up to T_{mb} = 100 °C</td>
<td>I_{F(AV)} max.</td>
<td>60 A</td>
</tr>
<tr>
<td>Repetitive peak forward current</td>
<td>I_{F(RMS)} max.</td>
<td>85 A</td>
</tr>
<tr>
<td>Repetitive peak forward current t_{p} = 20 µs, δ = 0.02</td>
<td>I_{FRM} max.</td>
<td>1200 A</td>
</tr>
<tr>
<td>Non-repetitive peak forward current half sine-wave; T_{j} = 150 °C prior to surge; with reapplied V_{RWM} max t = 10 ms t = 8.3 ms</td>
<td>I_{FSM} max.</td>
<td>650 A</td>
</tr>
<tr>
<td>I^2t for fusing (t = 10 ms)</td>
<td>I_{FSM} max.</td>
<td>700 A</td>
</tr>
<tr>
<td>I^2t for fusing (t = 10 ms)</td>
<td>I^{2}t max.</td>
<td>2100 A²s</td>
</tr>
</tbody>
</table>

#### Temperatures

<table>
<thead>
<tr>
<th>Temperature</th>
<th>BYP59-300</th>
<th>400</th>
</tr>
</thead>
<tbody>
<tr>
<td>Storage temperature</td>
<td>T_{stg}</td>
<td>-55 to +150 °C</td>
</tr>
<tr>
<td>Junction temperature</td>
<td>T_{j} max.</td>
<td>150 °C</td>
</tr>
</tbody>
</table>

#### THERMAL RESISTANCE

<table>
<thead>
<tr>
<th>Resistance Type</th>
<th>BYP59-300</th>
<th>400</th>
</tr>
</thead>
<tbody>
<tr>
<td>From junction to mounting base</td>
<td>R_{th j-mb} =</td>
<td>0.7 K/W</td>
</tr>
<tr>
<td>From mounting base to heatsink:</td>
<td></td>
<td></td>
</tr>
<tr>
<td>a. with heatsink compound</td>
<td>R_{th mb-h} =</td>
<td>0.2 K/W</td>
</tr>
<tr>
<td>b. without heatsink compound</td>
<td>R_{th mb-h} =</td>
<td>0.3 K/W</td>
</tr>
</tbody>
</table>

#### 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.
Ultra fast recovery rectifier diodes

CHARACTERISTICS

Forward voltage
- $I_F = 60 \text{ A}; T_j = 150 \degree \text{C}$
- $I_F = 150 \text{ A}; T_j = 25 \degree \text{C}$

Reverse current
- $V_R = V_{RWM \text{ max}}; T_j = 100 \degree \text{C}$
- $V_R = V_{RWM \text{ max}}; T_j = 25 \degree \text{C}$

Reverse recovery when switched from
- $I_F = 1 \text{ A} \rightarrow V_R \geq 30 \text{ V}$ with $-\frac{dI_F}{dt} = 100 \text{ A/}\mu\text{s}$; $T_j = 25 \degree \text{C}$; recovery time
- $I_F = 2 \text{ A} \rightarrow V_R \geq 30 \text{ V}$ with $-\frac{dI_F}{dt} = 20 \text{ A/}\mu\text{s}$; $T_j = 25 \degree \text{C}$; recovered charge
- $I_F = 10 \text{ A} \rightarrow V_R \geq 30 \text{ V}$ with $-\frac{dI_F}{dt} = 50 \text{ A/}\mu\text{s}$; $T_j = 100 \degree \text{C}$; peak recovery current

Forward recovery when switched to $I_F = 10 \text{ A}$ with $\frac{dI_F}{dt} = 10 \text{ A/}\mu\text{s}$; $T_j = 25 \degree \text{C}$

BYP59 SERIES

- $V_F < 1.05 \text{ V}$
- $V_F < 1.4 \text{ V}$
- $I_R < 0.5 \text{ mA}$
- $I_F < 25 \mu\text{A}$
- $t_{rr} < 60 \text{ ns}$
- $Q_s < 100 \text{ nC}$
- $I_{RRM} < 5 \text{ A}$
- $V_{fr} \text{ typ.} < 2.5 \text{ V}$

*Measured under pulse conditions to avoid excessive dissipation
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**

<table>
<thead>
<tr>
<th>Per diode, unless otherwise stated</th>
<th>BYQ28–50</th>
<th>100</th>
<th>150</th>
<th>200</th>
</tr>
</thead>
<tbody>
<tr>
<td>Repetitive peak reverse voltage</td>
<td>$V_{RRM}$</td>
<td>max.</td>
<td>50</td>
<td>100</td>
</tr>
<tr>
<td>Output current</td>
<td>$I_o$ max.</td>
<td>10 A</td>
<td></td>
<td></td>
</tr>
<tr>
<td>(both diodes conducting)</td>
<td>V &lt; 0.85 V</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Forward voltage</td>
<td>V &lt; 20 ns</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Reverse recovery time</td>
<td>$t_{rr}$ &lt; 20 ns</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

**MECHANICAL DATA**

Fig.TO-220AB

Dimensions in mm

Net mass: 2 g

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

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

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

### Voltages (per diode)

<table>
<thead>
<tr>
<th></th>
<th>BYQ28-50</th>
<th>100</th>
<th>150</th>
<th>200</th>
</tr>
</thead>
<tbody>
<tr>
<td>Repetitive peak reverse voltage</td>
<td>$V_{RRM}$ max.</td>
<td>50</td>
<td>100</td>
<td>150</td>
</tr>
<tr>
<td>Crest working reverse voltage</td>
<td>$V_{RWM}$ max.</td>
<td>50</td>
<td>100</td>
<td>150</td>
</tr>
<tr>
<td>Continuous reverse voltage</td>
<td>$V_R$ max.</td>
<td>50</td>
<td>100</td>
<td>150</td>
</tr>
</tbody>
</table>

### Currents (both diodes conducting; note 1)

**Output current; switching losses**
- negligible up to 500 kHz; square wave; $\delta = 0.5$; up to $T_{mb} = 128 ^\circ C$
- sinusoidal; up to $T_{mb} = 130 ^\circ C$

<table>
<thead>
<tr>
<th></th>
<th>IO</th>
<th>IO</th>
<th>IF(RMS) max.</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>max.</td>
<td>10</td>
<td>10</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>14</td>
</tr>
</tbody>
</table>

**R.M.S. forward current**

<table>
<thead>
<tr>
<th></th>
<th>IFRM max.</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>80</td>
</tr>
<tr>
<td></td>
<td>A</td>
</tr>
</tbody>
</table>

**Repetitive peak forward current**

$\tau_p = 20 \mu s, \delta = 0.02$ (per diode)

<table>
<thead>
<tr>
<th></th>
<th>IFSM max.</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>50</td>
</tr>
<tr>
<td></td>
<td>A</td>
</tr>
</tbody>
</table>

**Non-repetitive peak forward current (per diode)**

half sine-wave; $T_j = 150 ^\circ C$ prior to surge; with reapplied $V_{RWM}$ max

<table>
<thead>
<tr>
<th></th>
<th>IFSM max.</th>
</tr>
</thead>
<tbody>
<tr>
<td>$t = 10 \text{ ms}$</td>
<td>60</td>
</tr>
<tr>
<td>$t = 8.3 \text{ ms}$</td>
<td>A</td>
</tr>
</tbody>
</table>

$I^2 t$ for fusing ($t = 10 \text{ ms, per diode}$)

<table>
<thead>
<tr>
<th></th>
<th>$I^2 t$ max.</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>12.5</td>
</tr>
<tr>
<td></td>
<td>A$^2$s</td>
</tr>
</tbody>
</table>

### Temperatures

<table>
<thead>
<tr>
<th></th>
<th>$T_{stg}$</th>
<th>$T_j$ max.</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>-40 to +150</td>
<td>150</td>
</tr>
<tr>
<td></td>
<td>°C</td>
<td>°C</td>
</tr>
</tbody>
</table>

### Notes:

1. The limits for both diodes apply whether both diodes conduct simultaneously or on alternate half cycles.
Ultra fast recovery double rectifier diodes

**CHARACTERISTICS** (per diode)

**Forward voltage**
- \( I_F = 5 \, \text{A}; \, T_j = 150 \, ^\circ\text{C} \)
- \( I_F = 15 \, \text{A}; \, T_j = 25 \, ^\circ\text{C} \)

**Reverse current**
- \( V_R = V_{RWM\, \text{max}}; \, T_j = 100 \, ^\circ\text{C} \)
- \( V_R = V_{RWM\, \text{max}}; \, T_j = 25 \, ^\circ\text{C} \)

**Reverse recovery when switched from**
- \( I_F = 1 \, \text{A} \) to \( V_R \geq 30 \, \text{V} \) with \(-dI_F/dt = 100 \, \text{A/\mu s}; \, T_j = 25 \, ^\circ\text{C}\)
- \( I_F = 2 \, \text{A} \) to \( V_R \geq 30 \, \text{V} \) with \(-dI_F/dt = 20 \, \text{A/\mu s}; \, T_j = 25 \, ^\circ\text{C}\)
- \( I_F = 5 \, \text{A} \) to \( V_R \geq 30 \, \text{V} \) with \(-dI_F/dt = 50 \, \text{A/\mu s}; \, T_j = 100 \, ^\circ\text{C}\)

**Peak recovery current** \( I_{RRM} < 1.2 \, \text{A} \)

**Forward recovery when switched to** \( I_F = 1 \, \text{A} \)
- \( V_{fr} \) typ. \( 1.0 \, \text{V} \)

*Measured under pulse conditions to avoid excessive dissipation.*
BYQ28 SERIES

THERMAL RESISTANCE

From junction to mounting base (both diodes conducting)
From junction to mounting base (per diode)

\[ R_{th \ j-mb} = 2.2 \text{ K/W} \]
\[ R_{th \ j-mb} = 3.0 \text{ K/W} \]

→ Influence of mounting method

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

   Thermal resistance from mounting base to heatsink
   a. with heatsink compound
   b. with heatsink compound and 0.06 mm maximum mica insulator
   c. with heatsink compound and 0.1 mm maximum mica insulator (56369)
   d. with heatsink compound and 0.25 mm maximum alumina insulator (56367)
   e. without heatsink compound

   \[ R_{th \ mb-h} = 0.3 \text{ K/W} \]
   \[ R_{th \ mb-h} = 1.4 \text{ K/W} \]
   \[ R_{th \ mb-h} = 2.2 \text{ K/W} \]
   \[ R_{th \ mb-h} = 0.8 \text{ K/W} \]
   \[ R_{th \ mb-h} = 1.4 \text{ K/W} \]

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

   \[ R_{th \ j-a} = 60 \text{ K/W} \]
MOUNTING INSTRUCTIONS

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

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

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

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

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

OPERATING NOTES

Dissipation and heatsink calculations

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

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

$$I_{F(AV)} = I_{F(RMS)} \times \sqrt{\delta}$$
Ultra fast recovery double rectifier diodes

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.

\[ a = \text{form factor} = \frac{I_F(\text{RMS})}{I_F(\text{AV})} \]
Fig. 8 Maximum permissible repetitive peak forward current for either square or sinusoidal currents for $1 \mu s < t_p < 1$ ms.

Fig. 9 $T_j = 25^\circ C$; $T_j = 150^\circ C$ per diode.
Ultra fast recovery double rectifier diodes.

Fig. 10 Maximum $t_{rr}$ at $T_j = 25 \, ^\circ C$.

Fig. 11 Maximum $t_{rr}$ at $T_j = 100 \, ^\circ C$.

Fig. 12 Maximum $Q_s$ at $T_j = 25 \, ^\circ C$. 

BYQ28 SERIES
Fig. 13 Maximum $I_{RRM}$ at $T_j = 25^\circ$C

Fig. 14 Maximum $I_{RRM}$ at $T_j = 100^\circ$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

<table>
<thead>
<tr>
<th>Repetitive peak reverse voltage (V_{RRM}) max.</th>
<th>Repetitive peak reverse voltage (V_{RRM}) max.</th>
</tr>
</thead>
<tbody>
<tr>
<td>Average forward current (I_{F(AV)}) max.</td>
<td>Average forward current (I_{F(AV)}) max.</td>
</tr>
<tr>
<td>Forward voltage (V_F) &lt;</td>
<td>Forward voltage (V_F) &lt;</td>
</tr>
<tr>
<td>Reverse recovery time (t_{rr}) &lt;</td>
<td>Reverse recovery time (t_{rr}) &lt;</td>
</tr>
<tr>
<td>BYR29-600</td>
<td>700</td>
</tr>
<tr>
<td>600</td>
<td>700</td>
</tr>
</tbody>
</table>

V_{RRM} max.  |

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 (IEC134).

#### Volatges

<table>
<thead>
<tr>
<th></th>
<th>BYR29–600</th>
<th>700</th>
<th>800</th>
<th>V</th>
</tr>
</thead>
<tbody>
<tr>
<td>Repetitive peak reverse voltage</td>
<td>$V_{RRM}$</td>
<td>max.</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Crest working reverse voltage</td>
<td>$V_{RWM}$</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Continuous reverse voltage*</td>
<td>$V_R$</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

#### Currents

- **Average forward current; switching**
  - losses negligible up to 100 kHz
  - square wave; $\delta = 0.5$; up to $T_{mb} = 117 \degree C$ up to $T_{mb} = 125 \degree C$
  - sinusoidal; up to $T_{mb} = 120 \degree C$ up to $T_{mb} = 125 \degree C$

| $I_{F(AV)}$ max. | 8 A |
| $I_{F(AV)}$ max. | 6.5 A |
| $I_{F(AV)}$ max. | 7.8 A |
| $I_{F(AV)}$ max. | 7.2 A |

- **R.M.S. forward current**
  - $I_{F(RMS)}$ max. 11.5 A

- **Repetitive peak forward current**
  - $t_p = 20 \mu s$; $\delta = 0.02$

| $I_{FRM}$ max. | 130 A |

- **Non-repetitive peak forward current**
  - half sine-wave; $T_j = 150 \degree C$ prior to surge; with reapplied $V_{RWM\text{max}}$
  - $t = 10$ ms
  - $t = 8.3$ ms

| $I_{FSM}$ max. | 60 A |
| $I_{FSM}$ max. | 72 A |

- **$I^2t$ for fusing ($t = 10$ ms)**
  - $I^2t$ max. 18 A²s

#### Temperatures

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

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

Forward voltage

\[ I_F = 10 \text{ A}; T_J = 150 \text{ °C} \]
\[ I_F = 25 \text{ A}; T_J = 25 \text{ °C} \]

\[ V_F < 1.30 \text{ V} \]

\[ V_F < 1.75 \text{ V} \]

Reverse current

\[ V_R = V_{RWM \text{ max}}; T_J = 100 \text{ °C} \]
\[ T_J = 25 \text{ °C} \]

\[ I_R < 0.2 \text{ mA} \]

\[ I_R < 10 \mu\text{A} \]

Reverse recovery when switched from

\[ I_F = 1 \text{ A} \text{ to } V_R \geq 30 \text{ V} \text{ with } -\frac{dI_F}{dt} = 100 \text{ A/µs}; \]
\[ T_J = 25 \text{ °C}; \text{ recovery time} \]

\[ t_{rr} < 75 \text{ ns} \]

\[ I_F = 2 \text{ A} \text{ to } V_R \geq 30 \text{ V} \text{ with } -\frac{dI_F}{dt} = 20 \text{ A/µs}; \]
\[ T_J = 25 \text{ °C}; \text{ recovered charge} \]

\[ Q_s < 200 \text{ nC} \]

\[ I_F = 10 \text{ A} \text{ to } V_R \geq 30 \text{ V} \text{ with } -\frac{dI_F}{dt} = 50 \text{ A/µs}; \]
\[ T_J = 100 \text{ °C}; \text{ peak recovery current} \]

\[ I_{RRM} < 6 \text{ A} \]

Forward recovery when switched to \( I_F = 10 \text{ A} \)
with \( \frac{dI_F}{dt} = 10 \text{ A/µs}; T_J = 25 \text{ °C} \)

\[ V_{fr} \text{ typ. } 5 \text{ V} \]

*Measured under pulse conditions to avoid excessive dissipation.*
THERMAL RESISTANCE

From junction to mounting base

**Influence of mounting method**

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

   Thermal resistance from mounting base to heatsink

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

2. Free air operation

   The quoted value of \( R_{th \text{ j-a}} \) 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

   \[ R_{th \text{ j-a}} = 60 \text{ K/W} \]
MOUNTING INSTRUCTIONS

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

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

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

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

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

OPERATING NOTES

Dissipation and heatsink calculations

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

![Diagram of temperature components](https://example.com/diagram.png)

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 $T_{amb}$ 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 relationship between the power (derived from the left-hand part) and the maximum permissible temperatures. Power includes reverse current losses and switching losses up to $f = 100$ kHz.

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

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

\[ a = \text{form factor} = \frac{I_F(\text{RMS})}{I_F(\text{AV})}. \]

*\( T_{mb} \) scale is for comparison purposes and is correct only for \( R_{th\ mb-a} < 16 \text{ K/W} \).
Fig. 7 Maximum permissible repetitive peak forward current for square or sinusoidal currents; $1 \mu s < t_p < 1$ ms.

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

Fig. 8 $T_j = 25^\circ C$; $\cdots$ $T_j = 150^\circ C$. 

July 1986
Ultra fast recovery rectifier diodes

**Fig. 9** Maximum $t_{rr}$ at $T_j = 25 \, ^\circ\text{C}$.

**Fig. 10** Maximum $t_{rr}$ at $T_j = 100 \, ^\circ\text{C}$.

**Fig. 11** Maximum $Q_S$ at $T_j = 25 \, ^\circ\text{C}$.

BYR 29 SERIES
Fig. 12 Maximum $I_{RRM}$ at $T_j = 25 \, ^\circ C$.

Fig. 13 Maximum $I_{RRM}$ at $T_j = 100 \, ^\circ C$.

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

<table>
<thead>
<tr>
<th></th>
<th>BYR29F-600</th>
<th>700</th>
<th>800</th>
</tr>
</thead>
<tbody>
<tr>
<td>Repetitive peak reverse voltage</td>
<td>V_{RRM} max.</td>
<td>600</td>
<td>700</td>
</tr>
<tr>
<td>Average forward current</td>
<td>I_{F(AV)} max.</td>
<td>8</td>
<td>A</td>
</tr>
<tr>
<td>Forward voltage</td>
<td>V_{F} &lt; 1.3</td>
<td>V</td>
<td></td>
</tr>
<tr>
<td>Reverse recovery time</td>
<td>t_{rr} &lt; 75</td>
<td>ns</td>
<td></td>
</tr>
</tbody>
</table>

MECHANICAL DATA

Fig. 1 SOT-186 (full-pack)

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).
### RATINGS

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

<table>
<thead>
<tr>
<th>Voltages</th>
<th>VRRM</th>
<th>BYR29F-600</th>
<th>700</th>
<th>800</th>
<th>V</th>
</tr>
</thead>
<tbody>
<tr>
<td>Repetitive peak reverse voltage</td>
<td>max.</td>
<td>600</td>
<td>700</td>
<td>800</td>
<td></td>
</tr>
<tr>
<td>Crest working reverse voltage</td>
<td>VRWM</td>
<td>max.</td>
<td>500</td>
<td>500</td>
<td>600</td>
</tr>
<tr>
<td>Continuous reverse voltage (note 1)</td>
<td>VR</td>
<td>max.</td>
<td>500</td>
<td>500</td>
<td>600</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Currents</th>
<th>IF(AV) max.</th>
<th>8</th>
<th>A</th>
</tr>
</thead>
<tbody>
<tr>
<td>Average forward current; switching losses negligible up to 100 kHz (note 2); square wave; δ = 0.5; up to Tmb = 79°C sinusoidal; up to Tmb = 87°C</td>
<td>IF(AV) max.</td>
<td>7.2</td>
<td>A</td>
</tr>
<tr>
<td>R.M.S. forward current</td>
<td>IF(RMS) max.</td>
<td>11.5</td>
<td>A</td>
</tr>
<tr>
<td>Repetitive peak forward current</td>
<td>IFRM max.</td>
<td>130</td>
<td>A</td>
</tr>
<tr>
<td>Non-repetitive peak forward current</td>
<td>IFSM max.</td>
<td>60</td>
<td>A</td>
</tr>
<tr>
<td>half sine-wave; Tj = 150°C prior to surge; with reapplied VRWM max t = 10 ms</td>
<td>IFSM max.</td>
<td>72</td>
<td>A</td>
</tr>
<tr>
<td>t = 8.3 ms</td>
<td>I^2 t max.</td>
<td>18</td>
<td>A^2 s</td>
</tr>
<tr>
<td>I^2 t for fusing (t = 10 ms)</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Temperatures</th>
<th>Tstg</th>
<th>-40 to +150</th>
<th>°C</th>
</tr>
</thead>
<tbody>
<tr>
<td>Storage temperature</td>
<td>Tj</td>
<td>max.</td>
<td>150</td>
</tr>
</tbody>
</table>

| ISOLATION                      | Visol max. | 1000 | V |
|---------------------------------|            |      |    |
| Peak isolation voltage from all terminals to external heatsink |           |      |    |
| Isolation capacitance from cathode to external heatsink (note 3) | Cp typ. | 12 | pF |

### Notes:

1. To ensure thermal stability: Rth 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 envelope.
THERMAL RESISTANCE

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

Free air operation
The quoted value of R\text{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\text{th j-a} = 55 \text{ K/W}

CHARACTERISTICS
T\text{j} = 25°C unless otherwise stated

Forward voltage
\begin{align*}
  I_F = 10 \text{ A}; T = 150°C & \quad V_F < 1.3 \text{ V*} \\
  I_F = 25 \text{ A} & \quad V_F < 1.75 \text{ V*}
\end{align*}

Reverse current
\begin{align*}
  V_R = V_{RWM \text{ max}}; T_j = 100°C & \quad I_R < 0.2 \text{ mA} \\
  V_R = V_{RWM \text{ max}} & \quad I_R < 10 \text{ µA}
\end{align*}

Reverse recovery when switched from
\begin{align*}
  I_F = 1 \text{ A} & \quad V_F < 1.3 \text{ V*} \\
  I_F = 2 \text{ A} & \quad Q_S < 200 \text{ nC} \\
  I_F = 10 \text{ A} & \quad I_{RRM} < 6 \text{ A}
\end{align*}

Forward recovery when switched to \(I_F = 10 \text{ A}\) with \(dI_F/dt = 10 \text{ A/µs}\)
\(V_{fr} \text{ typ.} = 5 \text{ V}\)

*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 $R_{\text{th j-h}}$ values than screw mounting. The force exerted on the top of the device by the clip should be at least 2 kgf (20 Newtons) to ensure good thermal contact and must not exceed 3.5 kgf (35 Newtons) to avoid damage to the device.

4. If screw mounting is used, it should be M3 cross-recess pan head.
   - Minimum torque to ensure good thermal contact: 5.5 kgf (0.55 Nm)
   - Maximum torque to avoid damage to the device: 8.0 kgf (0.80 Nm)

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

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

7. The heatsink must have a flatness in the mounting area of 0.02 mm maximum per 10 mm. Mounting holes must be deburred.

OPERATING NOTES

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

Any measurement of heatsink temperature should be immediately adjacent to the device.
Ultra fast recovery isolated rectifier diodes

SQUARE-WAVE OPERATION

Fig. 5 Power rating.

The power loss in the diode should first be determined from the required forward current on the \( I_F(AV) \) axis and the appropriate duty cycle.

Having determined the power \( P \), use Fig. 7 (if heatsink compound is not being used) or Fig. 8 (if heatsink compound is being used) to determine the heatsink size and corresponding maximum ambient and heatsink temperatures.

\[ \delta = \frac{t_p}{T} \]

\[ I_F(AV) = I_F(RMS) \times \sqrt{\delta} \]

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.

\[ a = \text{form factor} = \frac{I_F(RMS)}{I_F(AV)} \]
Fig. 7 Heatsink rating; without heatsink compound.

Fig. 8 Heatsink rating; with heatsink compound.
Ultra fast recovery isolated rectifier diodes

BYR29F SERIES

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

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

Definition of I_FRM and t_p/T.
Fig. 11 Maximum $t_{rr}$ at $T_j = 25^\circ C$.

Fig. 12 Maximum $t_{rr}$ at $T_j = 100^\circ C$.

Fig. 13 Maximum $Q_s$ at $T_j = 25^\circ C$. 
Ultra fast recovery isolated rectifier diodes

BYR29F SERIES

Fig. 14 Maximum $I_{RRM}$ at $T_j = 25^\circ C$.

Fig. 15 Maximum $I_{RRM}$ at $T_j = 100^\circ C$.

Fig. 16 Transient thermal impedance; — with heatsink compound; — — without heatsink compound.
ULTRA FAST RECOVERY DOUBLE RECTIFIER DIODES

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

<table>
<thead>
<tr>
<th>Per diode, unless otherwise stated</th>
<th>BYT28-300</th>
<th>400</th>
<th>500</th>
</tr>
</thead>
<tbody>
<tr>
<td>Repetitive peak reverse voltage</td>
<td>( V_{RRM} ) max.</td>
<td>300</td>
<td>400</td>
</tr>
<tr>
<td>Output current</td>
<td>( I_O ) max.</td>
<td>10</td>
<td></td>
</tr>
<tr>
<td>(both diodes conducting)</td>
<td>( V_F )</td>
<td>1.05</td>
<td></td>
</tr>
<tr>
<td>Forward voltage</td>
<td>( t_{rr} )</td>
<td>50</td>
<td></td>
</tr>
<tr>
<td>Reverse recovery time</td>
<td></td>
<td></td>
<td>ns</td>
</tr>
</tbody>
</table>

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 sheet Mounting Instructions and accessories for TO-220 envelopes.
BYT28 SERIES

RATINGS

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

Volatges (per diode)

<table>
<thead>
<tr>
<th></th>
<th>BYT28-300</th>
<th>400</th>
<th>500</th>
<th>V</th>
</tr>
</thead>
<tbody>
<tr>
<td>Repetitive peak reverse voltage $V_{RRM}$</td>
<td>max.</td>
<td>300</td>
<td>400</td>
<td>500</td>
</tr>
<tr>
<td>Crest working reverse voltage $V_{RWM}$</td>
<td>max.</td>
<td>200</td>
<td>300</td>
<td>400</td>
</tr>
<tr>
<td>Continuous reverse voltage $V_R$</td>
<td>max.</td>
<td>200</td>
<td>300</td>
<td>400</td>
</tr>
</tbody>
</table>

Currents (both diodes conducting; note 1)

Output current; switching losses negligible up to 200 kHz;
- square wave; $\delta = 0.5$; up to $T_{mb} = 117 \, ^{\circ}C$
- sinusoidal; up to $T_{mb} = 120 \, ^{\circ}C$

R.M.S. forward current $I_{O}$ max. 10 A

Repetitive peak forward current $I_{FRM}$ max. 80 A

Non-repetitive peak forward current (per diode)
- half sine-wave; $T_j = 150 \, ^{\circ}C$ prior to surge with re-applied $V_{RWM}$ max
  - $t = 10 \, ms$
  - $t = 8.3 \, ms$

$I^2 t$ for fusing ($t = 10 \, ms$; per diode)

Temperatures

Storage temperature $T_{stg}$ -40 to +150 $^{\circ}C$

Junction temperature $T_j$ max. 150 $^{\circ}C$

Notes

1. The limits for both diodes apply whether both diodes conduct simultaneously or on alternate half cycles.
### CHARACTERISTICS (per diode)

**Forward voltage**

<table>
<thead>
<tr>
<th>IF</th>
<th>TJ</th>
<th>VF</th>
</tr>
</thead>
<tbody>
<tr>
<td>5 A</td>
<td>150 °C</td>
<td>&lt; 1.05 V*</td>
</tr>
<tr>
<td>15 A</td>
<td>25 °C</td>
<td>&lt; 1.4 V*</td>
</tr>
</tbody>
</table>

**Reverse current**

<table>
<thead>
<tr>
<th>VRWM max</th>
<th>IR</th>
</tr>
</thead>
<tbody>
<tr>
<td>100 °C</td>
<td>&lt; 0.2 mA</td>
</tr>
<tr>
<td>25 °C</td>
<td>&lt; 10 µA</td>
</tr>
</tbody>
</table>

**Reverse recovery when switched from**

1. IF = 1 A to VR > 30 V with \(-dI_F/dt = 100\ A/\mu s; TJ = 25\ °C\)
   - Recovery time \(t_{rr} < 50\ \text{ns}\)
2. IF = 2 A to VR > 30 V with \(-dI_F/dt = 20\ A/\mu s; TJ = 25\ °C\)
   - Recovered charge \(Q_s < 50\ \text{nC}\)
3. IF = 5 A to VR > 30 V with \(-dI_F/dt = 50\ A/\mu s; TJ = 100\ °C\)
   - Peak recovery current \(I_{RRM} < 3.0\ \text{A}\)

**Forward recovery when switched to IF = 1 A**

- with \(dI_F/dt = 10\ A/\mu s; TJ = 25\ °C\)
  - Recovery voltage \(V_{fr}\) typ. 2.5 V

---

*Measured under pulse conditions to avoid excessive dissipation.*

---

![Fig.2 Definition of \(t_{rr}, Q_s\) and \(I_{RRM}\).](M1247)

![Fig.3 Definition of \(V_{fr}\).](MS0-1319/3)
THERMAL RESISTANCE

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

→ Influence of mounting method

1. Heatsink-mounted with clip (see mounting instructions)  
Thermal resistance from mounting base to heatsink  
   a. with heatsink compound  
   \[ R_{th \ mb-h} = 0.3 \ \text{K/W} \]
   b. with heatsink compound and 0.06 mm maximum mica insulator  
   \[ R_{th \ mb-h} = 1.4 \ \text{K/W} \]
   c. with heatsink compound and 0.1 mm maximum mica insulator (56369)  
   \[ R_{th \ mb-h} = 2.2 \ \text{K/W} \]
   d. with heatsink compound and 0.25 mm maximum alumina insulator (56367)  
   \[ R_{th \ mb-h} = 0.8 \ \text{K/W} \]
   e. without heatsink compound  
   \[ R_{th \ mb-h} = 1.4 \ \text{K/W} \]

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  
\[ R_{th \ j-a} = 60 \ \text{K/W} \]
MOUNTING INSTRUCTIONS

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

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

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

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

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

OPERATING NOTES

Dissipation and heatsink calculations

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

![Diagram](image)

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

\[ I_{F(AV)} = I_{F(RMS)} \times \sqrt{\delta} \]
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.

$$a = \frac{I_F(RMS)}{I_F(AV)}$$
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 $T_j = 25^\circ C$; $-- -- T_j = 150^\circ C$ per diode.
Ultra fast recovery double rectifier diodes

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

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

Fig. 12 Maximum $Q_s$ at $T_j = 25$ °C; per diode.
Fig. 13 Maximum $I_{RRM}$ at $T_j = 25°C$; per diode.

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

Fig. 15 Transient thermal impedance (one diode conducting).
ULTRA FAST RECOVERY RECTIFIER DIODES

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

QUICK REFERENCE DATA

<table>
<thead>
<tr>
<th></th>
<th>BYT79-300</th>
<th>400</th>
<th>500</th>
</tr>
</thead>
<tbody>
<tr>
<td>Repetitive peak reverse voltage $V_{RRM}$ max.</td>
<td>300</td>
<td>400</td>
<td>500</td>
</tr>
<tr>
<td>Average forward current $I_F(\text{AV})$ max.</td>
<td>14 A</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Forward voltage $V_F$ $&lt;$</td>
<td>1.05 V</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Reverse recovery time $t_{rr}$ $&lt;$</td>
<td>50 ns</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

MECHANICAL DATA

Fig.1 TO-220AC

Net mass: 2 g

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

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

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

<table>
<thead>
<tr>
<th>Volatages</th>
<th>BYT79-300</th>
<th>400</th>
<th>500</th>
</tr>
</thead>
<tbody>
<tr>
<td>Repetitive peak reverse voltage</td>
<td>$V_{RRM}$</td>
<td>max.</td>
<td>300</td>
</tr>
<tr>
<td>Crest working reverse voltage</td>
<td>$V_{RWM}$</td>
<td>max.</td>
<td>200</td>
</tr>
<tr>
<td>Continuous reverse voltage*</td>
<td>$V_R$</td>
<td>max.</td>
<td>200</td>
</tr>
</tbody>
</table>

**Currents**

Average forward current; switching losses negligible up to 200 kHz;
- square wave; $\delta = 0.5$; up to $T_{mb} = 113 \, ^\circ C$
- up to $T_{mb} = 125 \, ^\circ C$
- sinusoidal; up to $T_{mb} = 118 \, ^\circ C$
- up to $T_{mb} = 125 \, ^\circ C$

<table>
<thead>
<tr>
<th>R.M.S. forward current</th>
<th>$I_F(AV)$</th>
<th>max.</th>
<th>14</th>
<th>A</th>
</tr>
</thead>
<tbody>
<tr>
<td>Repetitive peak forward current</td>
<td>$I_F(AV)$</td>
<td>max.</td>
<td>10</td>
<td>A</td>
</tr>
<tr>
<td>Non-repetitive peak forward current</td>
<td>$I_F(AV)$</td>
<td>max.</td>
<td>12.5</td>
<td>A</td>
</tr>
<tr>
<td>$I_F(AV)$</td>
<td>max.</td>
<td>10</td>
<td>A</td>
<td></td>
</tr>
</tbody>
</table>

$1F(RMS)$ max. 20 A

$IFRM$ max. 320 A

$IFT$ for fusing ($t = 10 \, ms$)

$IFSM$ max. 150 A

$IFSM$ max. 180 A

$1^2t$ for fusing ($t = 10 \, ms$)

$1^2t$ for fusing ($t = 10 \, ms$)

**Temperatures**

<table>
<thead>
<tr>
<th>Storage temperature</th>
<th>$T_{stg}$</th>
<th>-40 to +150</th>
<th>$^\circ C$</th>
</tr>
</thead>
<tbody>
<tr>
<td>Junction temperature</td>
<td>$T_j$</td>
<td>max. 150</td>
<td>$^\circ C$</td>
</tr>
</tbody>
</table>

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

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Ultra fast recovery rectifier diodes

BYT79 SERIES

CHARACTERISTICS

Forward voltage

- $I_F = 15 \text{ A}; T_j = 150 \degree \text{C}$
- $I_F = 50 \text{ A}; T_j = 25 \degree \text{C}$

Forward voltage

- $V_F < 1.05 \text{ V}^*$
- $V_F < 1.40 \text{ V}^*$

Reverse current

- $V_R = V_{RWM \ max}; T_j = 100 \degree \text{C}$
- $I_R < 0.8 \text{ mA}$
- $T_j = 25 \degree \text{C}$
- $I_R < 50 \mu\text{A}$

Reverse recovery when switched from

- $I_F = 1 \text{ A to } V_R \geq 30 \text{ V with } -\frac{dI_F}{dt} = 100 \text{ A/\mu s}$
- $T_j = 25 \degree \text{C}$; recovery time
- $t_{rr} < 50 \text{ ns}$
- $Q_S < 50 \text{ nC}$

Reverse recovery when switched from

- $I_F = 2 \text{ A to } V_R \geq 30 \text{ V with } -\frac{dI_F}{dt} = 20 \text{ A/\mu s}$
- $T_j = 25 \degree \text{C}$; recovered charge
- $I_{RRM} < 5.2 \text{ A}$

Forward recovery when switched to $I_F = 10 \text{ A}$ with $\frac{dI_F}{dt} = 10 \text{ A/\mu s}$; $T_j = 25 \degree \text{C}$

- $V_{fr} \text{ typ. } = 2.5 \text{ V}$

*M*Measured under pulse conditions to avoid excessive dissipation.
BYT79 SERIES

THERMAL RESISTANCE
From junction to mounting base

Influence of mounting method
1. Heatsink-mounted with clip (see mounting instructions)
Thermal resistance from mounting base to heatsink
a. with heatsink compound
b. with heatsink compound and 0.06 mm maximum mica insulator
c. with heatsink compound and 0.1 mm maximum mica insulator (56369)
d. with heatsink compound and 0.25 mm maximum alumina insulator (56367)
e. without heatsink compound

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

$R_{th \, j-mb} = 2 \text{ K/W}$

$R_{th \, mb-h} = 0.3 \text{ K/W}$

$R_{th \, mb-h} = 1.4 \text{ K/W}$

$R_{th \, mb-h} = 2.2 \text{ K/W}$

$R_{th \, mb-h} = 0.8 \text{ K/W}$

$R_{th \, mb-h} = 1.4 \text{ K/W}$

$R_{th \, j-a} = 60 \text{ K/W}$
MOUNTING INSTRUCTIONS

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

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

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

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

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

OPERATING NOTES

Dissipation and heatsink calculations

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

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

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

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

* August 1986
Fig. 6 The right-hand part shows the interrelationship between the power (derived from the left-hand part) and the maximum permissible temperatures.

\[ a = \text{form factor} = \frac{I_{F(RMS)}}{I_{F(AV)}} \]
Fig. 7 Maximum permissible repetitive peak forward current for square or sinusoidal currents; $1 \, \mu s < t_p < 1 \, \text{ms}$.

Fig. 8 $T_j = 25 \, ^\circ \text{C}$; $T_j = 150 \, ^\circ \text{C}$. Definition of $I_{FRM}$ and $t_p/T$. 

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Ultra fast recovery rectifier diodes

Fig. 9 Maximum $t_{rr}$ at $T_j = 25 \, ^\circ C$.

Fig. 10 Maximum $t_{rr}$ at $T_j = 100 \, ^\circ C$.

Fig. 11 Maximum $Q_s$ at $T_j = 25 \, ^\circ C$. 

BYT79 SERIES
Fig. 12 Maximum $I_{RRM}$ at $T_j = 25 ^\circ C$.

Fig. 13 Maximum $I_{RRM}$ at $T_j = 100 ^\circ C$.

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

<table>
<thead>
<tr>
<th>Parameter</th>
<th>BYV24-800(R)</th>
<th>1000(R)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Repetitive peak reverse voltage</td>
<td>V_{RRM}</td>
<td>max. 800</td>
</tr>
<tr>
<td>Average forward current</td>
<td>I_F(AV)</td>
<td>max. 12</td>
</tr>
<tr>
<td>Non-repetitive peak forward current</td>
<td>I_{FSM}</td>
<td>max. 150</td>
</tr>
<tr>
<td>Reverse recovery time</td>
<td>t_{rr}</td>
<td>&lt; 450</td>
</tr>
</tbody>
</table>

MECHANICAL DATA

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

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

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

The mark shown applies to the normal polarity types.
## Ratings

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

### Voltages*

<table>
<thead>
<tr>
<th>Voltage Type</th>
<th>Symbol</th>
<th>BYV24-800(R)</th>
<th>1000(R)</th>
<th>Unit</th>
</tr>
</thead>
<tbody>
<tr>
<td>Non-repetitive peak reverse voltage</td>
<td>V_{RSM}</td>
<td>max.</td>
<td>1000</td>
<td>1200</td>
</tr>
<tr>
<td>Repetitive peak reverse voltage</td>
<td>V_{RRM}</td>
<td>max.</td>
<td>800</td>
<td>1000</td>
</tr>
<tr>
<td>Crest working reverse voltage</td>
<td>V_{RWM}</td>
<td>max.</td>
<td>650</td>
<td>850</td>
</tr>
<tr>
<td>Continuous reverse voltage</td>
<td>V_{R}</td>
<td>max.</td>
<td>650</td>
<td>850</td>
</tr>
</tbody>
</table>

### Currents

<table>
<thead>
<tr>
<th>Current Type</th>
<th>Symbol</th>
<th>BYV24-800(R)</th>
<th>1000(R)</th>
<th>Unit</th>
</tr>
</thead>
<tbody>
<tr>
<td>Average forward current</td>
<td>I_{F(AV)}</td>
<td>max.</td>
<td>12</td>
<td>A</td>
</tr>
<tr>
<td>- sinusoidal; up to T_{mb} = 103 °C</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>- sinusoidal; at T_{mb} = 125 °C</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>- square-wave; δ = 0.5; up to T_{mb} = 103 °C</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>- square-wave; δ = 0.5; at T_{mb} = 125 °C</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>R.M.S. forward current</td>
<td>I_{F(RMS)}</td>
<td>max.</td>
<td>20</td>
<td>A</td>
</tr>
<tr>
<td>Repetitive peak forward current</td>
<td>I_{FRM}</td>
<td>max.</td>
<td>120</td>
<td>A</td>
</tr>
<tr>
<td>Non-repetitive peak forward current</td>
<td>I_{FSM}</td>
<td>max.</td>
<td>150</td>
<td>A</td>
</tr>
<tr>
<td>- t = 10 ms; half sine-wave</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>- T_{j} = 150 °C prior to surge;</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>- without re-applied voltage</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>- with re-applied V_{RWMmax}</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>I^2 t for fusing (t = 10 ms)</td>
<td>I^2 t</td>
<td>max.</td>
<td>72</td>
<td>A^2 s</td>
</tr>
</tbody>
</table>

### Temperatures

<table>
<thead>
<tr>
<th>Temperature Type</th>
<th>Symbol</th>
<th>BYV24-800(R)</th>
<th>1000(R)</th>
<th>Unit</th>
</tr>
</thead>
<tbody>
<tr>
<td>Storage temperature</td>
<td>T_{stg}</td>
<td></td>
<td>-55 to +150</td>
<td>°C</td>
</tr>
<tr>
<td>Junction temperature</td>
<td>T_{j}</td>
<td>max.</td>
<td>150</td>
<td>°C</td>
</tr>
</tbody>
</table>

### Thermal Resistance

<table>
<thead>
<tr>
<th>Resistance Type</th>
<th>Symbol</th>
<th>Formula</th>
<th>BYV24-800(R)</th>
<th>1000(R)</th>
<th>Unit</th>
</tr>
</thead>
<tbody>
<tr>
<td>From junction to mounting base</td>
<td>R_{th j-mb}</td>
<td>= 2.0</td>
<td>2.0</td>
<td>°C/W</td>
<td></td>
</tr>
<tr>
<td>From mounting base to heatsink</td>
<td>R_{th mb-h}</td>
<td>= 0.3</td>
<td>0.3</td>
<td>°C/W</td>
<td></td>
</tr>
<tr>
<td>with heatsink compound</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>without heatsink compound</td>
<td>R_{th mb-h}</td>
<td>= 0.5</td>
<td>0.5</td>
<td>°C/W</td>
<td></td>
</tr>
<tr>
<td>Transient thermal impedance; t = 1 ms</td>
<td>Z_{th j-mb}</td>
<td>= 0.85</td>
<td>0.85</td>
<td>°C/W</td>
<td></td>
</tr>
</tbody>
</table>

### Mounting Instructions

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

*To ensure thermal stability: R_{th j-a} ≪ 8 °C/W (continuous reverse voltage).
Fast soft-recovery rectifier diodes

CHARACTERISTICS

Forward voltage
\[ I_F = 20 \text{ A}; \ T_j = 25 \text{ °C} \]
\[ V_F < 1.7 \text{ V}^* \]

Reverse current
\[ V_R = V_{RWM_{\text{max}}}; \ T_j = 125 \text{ °C} \]
\[ I_R < 1.5 \text{ mA} \]

Reverse recovery when switched from
\[ I_F = 10 \text{ A to } V_R \geqslant 30 \text{ V with } -\frac{dI_F}{dt} = 10 \text{ A/µs}; \ T_j = 25 \text{ °C} \]
\[ t_{rr} < 450 \text{ ns} \]

Recovery time
\[ I_F = 2 \text{ A to } V_R \geqslant 30 \text{ V with } -\frac{dI_F}{dt} = 20 \text{ A/µs}; \ T_j = 25 \text{ °C} \]
\[ Q_s < 800 \text{ nC} \]

Recovery charge
\[ \text{Maximum slope of the reverse recovery current} \]
\[ \text{when switched from } I_F = 2 \text{ A to } V_R \geqslant 30 \text{ V;} \]
\[ \text{with } -\frac{dI_F}{dt} = 2 \text{ A/µs}; \ T_j = 25 \text{ °C} \]
\[ |\frac{dI_R}{dt}| < 7 \text{ A/µs} \]

Fig.2 Definition of \( t_{rr} \) and \( Q_s \).

*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 = \( \frac{I_F(RMS)}{I_F(AV)} \). 

*\( T_{mb} \) scale is for comparison purposes and is correct only for \( R_{th \, mb-a} < 8 \degree C/W \).
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); Tj = 150 °C prior to surge.

Fig. 6. —— Tj = 25 °C; ——— Tj = 100 °C.
Fast soft-recovery rectifier diodes

BYV24 SERIES

Fig. 7
VERY FAST SOFT-RECOVERY AVALANCHE RECTIFIER DIODES

Glass passivated rectifier diodes in hermetically sealed axial-leded 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

<table>
<thead>
<tr>
<th></th>
<th>BYV26A</th>
<th>26B</th>
<th>26C</th>
<th>26D</th>
<th>26E</th>
</tr>
</thead>
<tbody>
<tr>
<td>Repetitive peak reverse voltage</td>
<td>V_{RRM} max.</td>
<td>200</td>
<td>400</td>
<td>600</td>
<td>800</td>
</tr>
<tr>
<td>Continuous reverse voltage</td>
<td>V_R max.</td>
<td>200</td>
<td>400</td>
<td>600</td>
<td>800</td>
</tr>
<tr>
<td>Average forward current</td>
<td>I_{F(AV)} max.</td>
<td>1</td>
<td>1</td>
<td>1</td>
<td>1</td>
</tr>
<tr>
<td>Non-repetitive peak forward current</td>
<td>I_{FSM} max.</td>
<td>30</td>
<td>30</td>
<td>30</td>
<td>30</td>
</tr>
<tr>
<td>Non-repetitive peak reverse energy</td>
<td>E_{RSM} max.</td>
<td>10</td>
<td>10</td>
<td>10</td>
<td>10</td>
</tr>
<tr>
<td>Reverse recovery time</td>
<td>t_{rr} &lt; 30</td>
<td>30</td>
<td>30</td>
<td>75</td>
<td>75 ns</td>
</tr>
</tbody>
</table>

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)

<table>
<thead>
<tr>
<th></th>
<th>BYV26A</th>
<th>26B</th>
<th>26C</th>
<th>26D</th>
<th>26E</th>
</tr>
</thead>
<tbody>
<tr>
<td>Repetitive peak reverse voltage</td>
<td>V_RRM max.</td>
<td>200</td>
<td>400</td>
<td>600</td>
<td>800</td>
</tr>
<tr>
<td>Continuous reverse voltage</td>
<td>V_R max.</td>
<td>200</td>
<td>400</td>
<td>600</td>
<td>800</td>
</tr>
</tbody>
</table>

Average forward current
averaged over any 20 ms period
T_amb = 60 °C; see Fig. 2

<table>
<thead>
<tr>
<th>I_F(AV) max.</th>
<th>A</th>
</tr>
</thead>
<tbody>
<tr>
<td>800 v</td>
<td></td>
</tr>
<tr>
<td>1000 v</td>
<td></td>
</tr>
</tbody>
</table>

Repetitive peak forward current; see Figs 11 and 12

<table>
<thead>
<tr>
<th>I_FRM max.</th>
<th>A</th>
</tr>
</thead>
<tbody>
<tr>
<td>800 v</td>
<td></td>
</tr>
<tr>
<td>1000 v</td>
<td></td>
</tr>
</tbody>
</table>

Non-repetitive peak forward current

t = 10 ms; half-sinewave; T_j = T_j max prior to surge; V_R = V_RRM max

<table>
<thead>
<tr>
<th>I_FSM max.</th>
<th>A</th>
</tr>
</thead>
<tbody>
<tr>
<td>800 v</td>
<td></td>
</tr>
<tr>
<td>1000 v</td>
<td></td>
</tr>
</tbody>
</table>

Non-repetitive peak reverse avalanche energy

<table>
<thead>
<tr>
<th>E_RSM max.</th>
<th>mJ</th>
</tr>
</thead>
<tbody>
<tr>
<td>800 v</td>
<td></td>
</tr>
<tr>
<td>1000 v</td>
<td></td>
</tr>
</tbody>
</table>

Storage temperature

<table>
<thead>
<tr>
<th>T_stg</th>
<th>°C</th>
</tr>
</thead>
<tbody>
<tr>
<td>-65 to + 175</td>
<td></td>
</tr>
</tbody>
</table>

Junction temperature

<table>
<thead>
<tr>
<th>T_j max.</th>
<th>°C</th>
</tr>
</thead>
<tbody>
<tr>
<td>175</td>
<td></td>
</tr>
</tbody>
</table>

THERMAL RESISTANCE

Influence of mounting method

1. Thermal resistance from junction to tie-point at a lead length of 10 mm

\[ R_{th j-tp} = 46 \text{ K/W} \]

2. Thermal resistance from junction to ambient; device mounted on an 1,5 mm thick epoxy-glass printed-circuit board; Cu-thickness > 40 µm; Fig. 2

\[ R_{th j-a} = 100 \text{ K/W} \]

Fig. 2 Mounted on a printed-circuit board.
Very fast soft-recovery avalanche rectifier diodes

CHARACTERISTICS

$T_j = 25 \, ^\circ\text{C}$ unless otherwise specified

<table>
<thead>
<tr>
<th></th>
<th>BYV26A</th>
<th>26B</th>
<th>26C</th>
<th>26D</th>
<th>26E</th>
</tr>
</thead>
<tbody>
<tr>
<td>Forward voltage*</td>
<td>$V_F$</td>
<td>1,3</td>
<td>1,3</td>
<td>1,3</td>
<td>1,3</td>
</tr>
<tr>
<td>$I_F = 1 , \text{A}$; $T_j = 175 , ^\circ\text{C}$</td>
<td>$V_F$</td>
<td>2,5</td>
<td>2,5</td>
<td>2,5</td>
<td>2,5</td>
</tr>
<tr>
<td>Reverse avalanche breakdown voltage</td>
<td>$V_{(BR)}R$</td>
<td>$&gt; 300$</td>
<td>500</td>
<td>700</td>
<td>900</td>
</tr>
<tr>
<td>$I_R = 0,1 , \text{mA}$</td>
<td>$I_R$</td>
<td>5</td>
<td>5</td>
<td>5</td>
<td>5</td>
</tr>
<tr>
<td>Reverse current</td>
<td>$V_R = V_{RR\text{Max}}$</td>
<td>$I_R$</td>
<td>150</td>
<td>150</td>
<td>150</td>
</tr>
<tr>
<td>$V_R = V_{RR\text{Max}}$; $T_j = 165 , ^\circ\text{C}$</td>
<td>$I_R$</td>
<td>5</td>
<td>5</td>
<td>5</td>
<td>5</td>
</tr>
</tbody>
</table>

Reverse recovery time when switched from $I_F = 0,5 \, \text{A}$ to $I_R = 1 \, \text{A}$; measured at $I_R = 0,25 \, \text{A}$

for definition see Figs 3 and 4

$t_{rr}$ $< 30$ $30$ $30$ $75$ $75 \, \text{ns}$

![Test circuit diagram](image)

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

![Reverse recovery time characteristic graph](image)

Fig. 4 Reverse recovery time characteristic.

* Measured under pulse conditions to avoid excessive dissipation.
Fig. 5 Maximum forward voltage at
- \( T_j = 25 ^\circ C \)
- \( T_j = 175 ^\circ C \).

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.
\[ a = \frac{I_F(RMS)}{I_F(AV)} \]
\[ V_R = V_{RRM_{max}}, \delta = 0.5 \]

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. \( V_R = V_{RRM_{max}}, \delta = 0.5 \);
\[ a = 1.42 \]
Very fast soft-recovery avalanche rectifier diodes

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 $T_{tp} = 85^\circ$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 $T_{amb} = 60^\circ$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.
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**

<table>
<thead>
<tr>
<th>Repetitive peak reverse voltage</th>
<th>$V_{RRM}$</th>
<th>BYV27-50</th>
<th>100</th>
<th>150</th>
<th>200</th>
</tr>
</thead>
<tbody>
<tr>
<td>Continuous reverse voltage</td>
<td>$V_R$</td>
<td>max.</td>
<td>50</td>
<td>100</td>
<td>150</td>
</tr>
<tr>
<td>Average forward current</td>
<td>$I_F(AV)$</td>
<td>max.</td>
<td>2</td>
<td>A</td>
<td></td>
</tr>
<tr>
<td>Non-repetitive peak reverse energy</td>
<td>$E_{RSM}$</td>
<td>max.</td>
<td>40</td>
<td>mJ</td>
<td></td>
</tr>
<tr>
<td>Reverse recovery time</td>
<td>$t_{rr}$</td>
<td>&lt;</td>
<td>25</td>
<td>ns</td>
<td></td>
</tr>
</tbody>
</table>

**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)

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Repetitive peak reverse voltage</td>
<td>V_{RRM}</td>
</tr>
<tr>
<td>Continuous reverse voltage</td>
<td>V_{R}</td>
</tr>
<tr>
<td>Repetitive peak reverse voltage max.</td>
<td>50 V</td>
</tr>
<tr>
<td>Continuous reverse voltage max.</td>
<td>100 V</td>
</tr>
<tr>
<td>Average forward current (switching losses negligible up to 200 kHz)</td>
<td>I_F(AV) max. 2 A</td>
</tr>
<tr>
<td>T_{tp} = 85 °C; lead length = 10 mm</td>
<td>T_{amb} = 60 °C; Fig. 2</td>
</tr>
<tr>
<td>Repetitive peak forward current max.</td>
<td>I_{FRM} max. 15 A</td>
</tr>
<tr>
<td>Non-repetitive peak forward current max.</td>
<td>I_{FSM} max. 50 A</td>
</tr>
<tr>
<td>Non-repetitive peak reverse avalanche energy; I_{R} = 600 mA; prior to surge; with inductive load switched off:</td>
<td>E_{RSM} max. 40 mJ</td>
</tr>
<tr>
<td>Storage temperature</td>
<td>T_{stg} = -65 to +175 °C</td>
</tr>
<tr>
<td>Junction temperature</td>
<td>T_{j} max. 175 °C</td>
</tr>
</tbody>
</table>

THERMAL RESISTANCE

Influence of mounting method

1. Thermal resistance from junction to tie-point at a lead length of 10 mm
   \[ R_{th\ j-tp} = 46 \text{ K/W} \]

2. Thermal resistance from junction to ambient when mounted on a 1.5 mm thick epoxy-glass printed-circuit board; Cu-thickness \( \geq 40 \mu m \); Fig. 2
   \[ R_{th\ j-a} = 100 \text{ K/W} \]

---

Fig. 2 Mounted on a printed-circuit board.
Epitaxial avalanche diodes

BYV27 SERIES

CHARACTERISTICS

$T_J = 25\, ^\circ C$ unless otherwise specified

<table>
<thead>
<tr>
<th>BYV27-50</th>
<th>100</th>
<th>150</th>
<th>200</th>
</tr>
</thead>
<tbody>
<tr>
<td>$V_{BR}$</td>
<td>55</td>
<td>110</td>
<td>165</td>
</tr>
</tbody>
</table>

Reverse avalanche breakdown voltage

$V_{(BR)R} < 0.1 \, mA$

Forward voltage*

- $I_F = 3 \, A; \, T_J = T_{j\text{max}}$
- $V_F < 0.88 \, V$
- $V_F < 1.07 \, V$

Reverse current

- $V_R = V_{RR\text{max}}$
- $I_R < 150 \, \mu A$

Reverse recovery time when switched from

- $I_F = 0.5 \, A$ to $I_R = 1 \, A$; measured at $I_R = 0.25 \, A$

$t_{rr} < 25 \, \text{ns}$

* Measured under pulse conditions to avoid excessive dissipation.

Fig. 3 Test circuit.

Input impedance oscilloscope 1 M\(\Omega\); 22 pF. Rise time $\leq 7 \, \text{ns}$.

Source impedance 50 \(\Omega\). Rise time $\leq 15 \, \text{ns}$.

Fig. 4 Reverse recovery time characteristic.
Reverse recovery when switched from $I_F = 1 \text{ A}$ to $V_R \geq 30 \text{ V}$ with $-dI_F/dt = 20 \text{ A/\mu s}$ (see Fig. 5)

- recovered charge $Q_s$
- recovery time $t_{rr}$

$$Q_s < 15 \text{ nC}$$
$$t_{rr} < 50 \text{ ns}$$

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

Fig. 6 Maximum forward voltage.

Fig. 7 $a = I_{F(RMS)}/I_{F(AV)}$; $V_R = V_{RRMmax}$
- Pulsed reverse voltage; $\delta = 0.5$
- Including reverse current losses and switching losses up to $f = 200 \text{ kHz}$.
Fig. 8 Maximum average forward current. The curves include losses due to reverse current and switching up to $f = 200$ kHz. Pulsed reverse voltage, $\delta = 0.5$. $V_R = V_{RRM_{max}}$. 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, $\delta = 0.5$. $V_R = V_{RRM_{max}}$. 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.
Epitaxial avalanche diodes

Fig. 12 Typical values diode capacitance at $f = 1$ MHz; $T_j = 25 \, ^\circ C$.

![Graph](image1)

Fig. 13 Maximum values reverse current.

![Graph](image2)
EPITAXIAL AVALANCHE DIODES

Glass passivated epitaxial rectifier diodes in hermetically sealed axial-ledged 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

<table>
<thead>
<tr>
<th></th>
<th>BYV28-50</th>
<th>100</th>
<th>150</th>
<th>200</th>
</tr>
</thead>
<tbody>
<tr>
<td>Repetitive peak reverse voltage</td>
<td>$V_{RRM}$</td>
<td>50</td>
<td>100</td>
<td>150</td>
</tr>
<tr>
<td>Continuous reverse voltage</td>
<td>$V_R$</td>
<td>max.</td>
<td>50</td>
<td>100</td>
</tr>
<tr>
<td>Average forward current</td>
<td>$I_{F(AV)}$</td>
<td>max.</td>
<td>3.5</td>
<td>A</td>
</tr>
<tr>
<td>Non-repetitive peak reverse energy</td>
<td>$E_{RSM}$</td>
<td>max.</td>
<td>40</td>
<td>mJ</td>
</tr>
<tr>
<td>Reverse recovery time</td>
<td>$t_{rr}$</td>
<td>&lt;</td>
<td>30</td>
<td>ns</td>
</tr>
</tbody>
</table>

MECHANICAL DATA

Dimensions in mm

Fig. 1 SOD-64.

The marking band indicates the cathode.

The diodes are type-branded.
## RATINGS

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

<table>
<thead>
<tr>
<th></th>
<th>BYV28-50</th>
<th>100</th>
<th>150</th>
<th>200</th>
</tr>
</thead>
<tbody>
<tr>
<td>Repetitive peak reverse voltage</td>
<td>$V_{RRM}$ max.</td>
<td>50</td>
<td>100</td>
<td>150</td>
</tr>
<tr>
<td>Continuous reverse voltage</td>
<td>$V_R$ max.</td>
<td>50</td>
<td>100</td>
<td>150</td>
</tr>
<tr>
<td>Average forward current (averaged over any 20 ms period)</td>
<td>$I_F(AV)$ max.</td>
<td>3.5</td>
<td>A</td>
<td></td>
</tr>
<tr>
<td>$T_{tp} = 85 , ^\circ C$; lead length $= 10 , mm$</td>
<td>$I_F(AV)$ max.</td>
<td>1.9</td>
<td>A</td>
<td></td>
</tr>
<tr>
<td>$T_{amb} = 60 , ^\circ C$; p.c.b. mounting (see Fig. 2)</td>
<td>$I_{FRM}$ max.</td>
<td>25</td>
<td>A</td>
<td></td>
</tr>
<tr>
<td>Repetitive peak forward current &amp; Non-repetitive peak forward current (t = 10 ms; half sine-wave) $T_J = T_j$ max prior to surge; with reapplied $V_{RRM}$</td>
<td>$I_{FSM}$ max.</td>
<td>90</td>
<td>A</td>
<td></td>
</tr>
<tr>
<td>Non-repetitive peak reverse avalanche energy; $I_R = 600 , mA$; with inductive load switched off</td>
<td>$E_{RSM}$ max.</td>
<td>40</td>
<td>mJ</td>
<td></td>
</tr>
<tr>
<td>$T_J = 25 , ^\circ C$, prior to surge</td>
<td>$E_{RSM}$ max.</td>
<td>20</td>
<td>mJ</td>
<td></td>
</tr>
<tr>
<td>$T_J = T_j$ max., prior to surge</td>
<td>$T_{stg}$</td>
<td>-65 to +175</td>
<td>°C</td>
<td></td>
</tr>
<tr>
<td>Storage temperature</td>
<td>$T_J$ max.</td>
<td>175</td>
<td>°C</td>
<td></td>
</tr>
</tbody>
</table>

## THERMAL RESISTANCE

### Influence of mounting method

1. Thermal resistance from junction to tie-point at a lead length of 10 mm
   
   $R_{th \, j-tp} = 25 \, K/W$

2. Thermal resistance from junction to ambient when mounted on a 1.5 mm thick epoxy-glass printed-circuit board; Cu-thickness $\geq 40 \, \mu m$; Fig. 2
   
   $R_{th \, j-a} = 75 \, K/W$

---

**Fig. 2** Mounted on a printed-circuit board.
Epitaxial avalanche diodes

CHARACTERISTICS

$T_j = 25 \, ^\circ C$, unless otherwise specified

Reverse avalanche breakdown voltage
$I_R = 0.1 \, mA$

Forward voltage
$I_F = 5 \, A$
$I_F = 5 \, A; \, T_j = T_j \, max$

Reverse current
$V_R = V_{RRM max}$
$V_R = V_{RRM max}; \, T_j = 165 \, ^\circ C$

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

$V_{(BR)R}$

<table>
<thead>
<tr>
<th>BYV28 50</th>
<th>100</th>
<th>150</th>
<th>200</th>
</tr>
</thead>
<tbody>
<tr>
<td>$V_{F}$</td>
<td>1.10</td>
<td>V</td>
<td></td>
</tr>
<tr>
<td>$V_{F}$</td>
<td>0.89</td>
<td>V</td>
<td></td>
</tr>
<tr>
<td>$I_R$</td>
<td>1</td>
<td>$\mu A$</td>
<td></td>
</tr>
<tr>
<td>$I_R$</td>
<td>150</td>
<td>$\mu A$</td>
<td></td>
</tr>
<tr>
<td>$t_{rr}$</td>
<td>&lt;</td>
<td>30 ns</td>
<td></td>
</tr>
</tbody>
</table>

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.

* Measured under pulse conditions to avoid excessive dissipation.
Reverse recovery when switched from
\( I_F = 1 \text{ A} \) to \( V_R \geq 30 \text{ V} \) with
\(-dI_F/dt = 20 \text{ A/µs} \) (see Fig. 5)
recovered charge
recovery time

Fig. 5 Definitions of \( t_{rr} \) and \( Q_S \).

Fig. 6 Maximum forward voltage.

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

Fig. 9 Maximum average forward current. The curves include losses due to reverse current and switching up to \( f = 200 \text{ kHz} \).
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 \( f = 200 \text{ kHz} \); mounting method see Fig. 2.
Pulsed reverse voltage; \( \delta = 0.5 \ V_R = V_{RRM \max} \).
Square-wave current; \( a = 1.42 \).

Fig. 11 Typical values diode capacitance at \( f = 1 \text{ MHz} \). \( T_J = 25 \text{ \degree C} \).
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

<table>
<thead>
<tr>
<th></th>
<th>BYV29—300</th>
<th>400</th>
<th>500</th>
</tr>
</thead>
<tbody>
<tr>
<td>Repetitive peak reverse voltage $V_{RRM}$ max.</td>
<td>300</td>
<td>400</td>
<td>500 V</td>
</tr>
<tr>
<td>Average forward current $I_F(AV)$ max.</td>
<td></td>
<td>9 A</td>
<td></td>
</tr>
<tr>
<td>Forward voltage $V_F$ &lt;</td>
<td></td>
<td>1.05 V</td>
<td></td>
</tr>
<tr>
<td>Reverse recovery time $t_{rr}$ &lt;</td>
<td></td>
<td>50 ns</td>
<td></td>
</tr>
</tbody>
</table>

MECHANICAL DATA

Fig.1 TO-220AC

Net mass: 2 g
Note: The exposed metal mounting base is directly connected to the cathode.
Accessories supplied on request: see data sheets Mounting instructions and accessories for TO-220 envelopes.
RATINGS

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

<table>
<thead>
<tr>
<th>Voltages</th>
<th>BYV29—300</th>
<th>400</th>
<th>500</th>
</tr>
</thead>
<tbody>
<tr>
<td>Repetitive peak reverse voltage</td>
<td>V_{RRM}</td>
<td>max. 300</td>
<td>400</td>
</tr>
<tr>
<td>Crest working reverse voltage</td>
<td>V_{RWM}</td>
<td>max. 200</td>
<td>300</td>
</tr>
<tr>
<td>Continuous reverse voltage (note 1)</td>
<td>V_{R}</td>
<td>max. 200</td>
<td>300</td>
</tr>
</tbody>
</table>

Currents

Average forward current; switching losses negligible up to 200 kHz;
- square wave; \( \delta = 0.5 \); up to \( T_{mb} = 116 \, ^\circ C \)
- sinusoidal; up to \( T_{mb} = 125 \, ^\circ C \)

\[
I_{F(AV)} \quad \text{(max.)} \quad 9 \quad A
\]
\[
I_{F(AV)} \quad \text{(max.)} \quad 7.4 \quad A
\]

R.M.S. forward current

\[
I_{F(RMS)} \quad \text{(max.)} \quad 13 \quad A
\]

Repetitive peak forward current

\[
t_p = 20 \, \mu s; \delta = 0.02
\]

Non-repetitive peak forward current
- half sine-wave; \( T_j = 150 \, ^\circ C \) prior to surge; with reapplied \( V_{RWM} \) max
- \( t = 10 \, ms \)
- \( t = 8.3 \, ms \)

\[
I_{FSM} \quad \text{(max.)} \quad 100 \quad A
\]
\[
I_{FSM} \quad \text{(max.)} \quad 110 \quad A
\]

\[
I^2t \text{ for fusing (t = 10 ms)} \quad \text{(max.)} \quad 50 \quad A^2s
\]

Temperatures

Storage temperature

\( T_{stg} \quad -40 \text{ to } +150 \, ^\circ C \)

Junction temperature

\( T_j \quad \text{(max.)} \quad 150 \, ^\circ C \)

Notes:

1. To ensure thermal stability: \( R_{th \, j-a} < 6.8 \, K/W \).
**Ultra fast recovery rectifier diodes**

**BYV29 SERIES**

**CHARACTERISTICS**

$T_j = 25 \, ^\circ C$ unless otherwise stated

**Forward voltage**

- $I_F = 5 \, A; \, T_j = 100 \, ^\circ C$
- $I_F = 20 \, A$

**Reverse current**

- $VR = VR_{WM\text{ max}}; \, T_j = 100 \, ^\circ C$
- $VR = VR_{WM\text{ max}}$

**Reverse recovery when switched from**

- $I_F = 1 \, A$ to $VR \geq 30 \, V$ with $-dI_F/dt = 100 \, A/\mu s$; recovery time $t_{rr} < 50 \, \text{ns}$
- $I_F = 2 \, A$ to $VR \geq 30 \, V$ with $-dI_F/dt = 20 \, A/\mu s$; recovered charge $Q_s < 55 \, \text{nC}$
- $I_F = 10 \, A$ to $VR \geq 30 \, V$ with $-dI_F/dt = 50 \, A/\mu s$; $T_j = 100 \, ^\circ C$; peak recovery current $I_{RRM} < 5.5 \, A$

**Forward recovery when switched to $I_F = 10 \, A$**

- with $dI_F/dt = 10 \, A/\mu s$ $V_{fr} \text{ typ.} 2.5 \, V$

*Measured under pulse conditions to avoid excessive dissipation.*

---

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

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

*Measured under pulse conditions to avoid excessive dissipation.*
THERMAL RESISTANCE
From junction to mounting base

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

Thermal resistance from mounting base to heatsink
a. with heatsink compound
b. with heatsink compound and 0.06 mm maximum mica insulator
c. with heatsink compound and 0.1 mm maximum mica insulator (56369)
d. with heatsink compound and 0.25 mm maximum alumina insulator (56367)
e. without heatsink compound

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

$R_{th\ j-mb} = 2.5 \text{ K/W}$

$R_{th\ mb-h} = 0.3 \text{ K/W}$

$R_{th\ mb-h} = 1.4 \text{ K/W}$

$R_{th\ mb-h} = 2.2 \text{ K/W}$

$R_{th\ mb-h} = 0.8 \text{ K/W}$

$R_{th\ mb-h} = 1.4 \text{ K/W}$

$R_{th\ j-a} = 60 \text{ K/W}$
MOUNTING INSTRUCTIONS

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

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

3. Mounting by means of a spring clip is the best mounting method because it offers:
   a. a good thermal contact under the crystal area and slightly lower $R_{th mb-h}$ values than does screw mounting.
   b. safe isolation for mains operation.

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

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

5. Rivet mounting (only possible for non-insulated mounting).

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

OPERATING NOTES

Dissipation and heatsink calculations

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

![Diagram](attachment:fig4.png)

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 relationship between the power (derived from the left-hand part) and the maximum permissible temperatures.

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

*The \( T_{mb} \) scale is for comparison purposes and is correct only for \( R_{th \ mb-a} < 4.1 \, {^\circ}K/W \).
Fig. 6 The right-hand part shows the interrelationship between the power (derived from the left-hand part) and the maximum permissible temperatures.

\[ a = \text{form factor} = \frac{I_F(\text{RMS})}{I_F(\text{AV})} \]
Fig. 7 Maximum permissible repetitive peak forward current for square or sinusoidal currents; $1 \mu s < t_p < 1\, ms$.

Fig. 8 — $T_j = 25\, ^\circ C$; $T_j = 100\, ^\circ C$.

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

Typical $V_F$ and maximum $V_F$. 
Ultra fast recovery rectifier diodes

Fig. 9 Maximum $t_{rr}$ at $T_j = 25 \, ^\circ C$.

Fig. 10 Maximum $t_{rr}$ at $T_j = 100 \, ^\circ C$.

Fig. 11 Maximum $Q_s$ at $T_j = 25 \, ^\circ C$. 

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

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

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

<table>
<thead>
<tr>
<th>Repetitive peak reverse voltage</th>
<th>V_{RRM}</th>
<th>BYV29F-300</th>
<th>400</th>
<th>500</th>
</tr>
</thead>
<tbody>
<tr>
<td>Average forward current</td>
<td>I_{F(AV)} max.</td>
<td>9</td>
<td>A</td>
<td></td>
</tr>
<tr>
<td>Forward voltage</td>
<td>V_F max.</td>
<td>&lt; 1.05 V</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Reverse recovery time</td>
<td>t_{rr} max.</td>
<td>&lt; 50 ns</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

MECHANICAL DATA

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

Net mass: 2 g.
The seating plane is electrically isolated from all terminals.
Accessories supplied on request (see data sheets Mounting instructions for F-pack devices and Accessories for SOT-186 envelopes).
RATINGS
Limiting values in accordance with the Absolute Maximum System (IEC 134).

<table>
<thead>
<tr>
<th>VOLTAGES</th>
<th>BYV29F- 300</th>
<th>400</th>
<th>500</th>
</tr>
</thead>
<tbody>
<tr>
<td>Repetitive peak reverse voltage</td>
<td>( V_{RRM} ) max.</td>
<td>300</td>
<td>400</td>
</tr>
<tr>
<td>Crest working reverse voltage</td>
<td>( V_{RWM} ) max.</td>
<td>200</td>
<td>300</td>
</tr>
<tr>
<td>Continuous reverse voltage (note 1)</td>
<td>( V_R ) max.</td>
<td>200</td>
<td>300</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>CURRENTS</th>
<th></th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>Average forward current; switching losses negligible up to 200 kHz (note 2); square wave; ( \delta = 0.5 ); up to ( T_{mb} = 76 , ^{\circ}C ); sinusoidal; up to ( T_{mb} = 87 , ^{\circ}C )</td>
<td>( I_{(AV)} ) max.</td>
<td>9</td>
<td>A</td>
</tr>
<tr>
<td>R.M.S. forward current</td>
<td>( I_{(AV)} ) max.</td>
<td>8</td>
<td>A</td>
</tr>
<tr>
<td>Repetitive peak forward current ( t_p = 20 , \mu s; \delta = 0.02 )</td>
<td>( I_{(RM)} ) max.</td>
<td>200</td>
<td>A</td>
</tr>
<tr>
<td>Non-repetitive peak forward current half sine-wave; ( T_j = 150 , ^{\circ}C ) prior to surge; with reapplied ( V_{RWM} ) max ( t = 10 , ms )</td>
<td>( I_{FSM} ) max.</td>
<td>100</td>
<td>A</td>
</tr>
<tr>
<td>( t = 8.3 , ms )</td>
<td>( I_{FSM} ) max.</td>
<td>110</td>
<td>A</td>
</tr>
<tr>
<td>( I^2 , t ) for fusing (( t = 10 , ms ))</td>
<td>( I^2 , t ) max.</td>
<td>50</td>
<td>A²s</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>TEMPERATURES</th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>Storage temperature</td>
<td>( T_{stg} )</td>
<td>-40 to +150 °C</td>
</tr>
<tr>
<td>Junction temperature</td>
<td>( T_j ) max.</td>
<td>150 °C</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>ISOLATION</th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>Peak isolation voltage from all terminals to external heatsink</td>
<td>( V_{isol} ) max.</td>
<td>1000 V</td>
</tr>
<tr>
<td>Isolation capacitance from cathode to external heatsink (note 3)</td>
<td>( C_p ) typ.</td>
<td>12 pF</td>
</tr>
</tbody>
</table>

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.
Ultra fast recovery isolated rectifier diodes

BYV29F SERIES

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

<table>
<thead>
<tr>
<th></th>
<th>$R_{th , j-h}$</th>
<th>$R_{th , j-h}$</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>5.5 K/W</td>
<td>7.2 K/W</td>
</tr>
</tbody>
</table>

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

<table>
<thead>
<tr>
<th></th>
<th>$R_{th , j-a}$</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>55 K/W</td>
</tr>
</tbody>
</table>

CHARACTERISTICS
Forward voltage
$I_F = 5 \, A; \, T_j = 100 \, ^{\circ}C$
$I_F = 20 \, A; \, T_j = 25 \, ^{\circ}C$

<table>
<thead>
<tr>
<th></th>
<th>$V_F$</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>$&lt; , 1.05 , V^*$</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th></th>
<th>$V_F$</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>$&lt; , 1.4 , V^*$</td>
</tr>
</tbody>
</table>

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

<table>
<thead>
<tr>
<th></th>
<th>$I_R$</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>$&lt; , 0.35 , mA$</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th></th>
<th>$I_R$</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>$&lt; , 10 , \mu A$</td>
</tr>
</tbody>
</table>

Reverse recovery when switched from
$I_F = 1 \, A$ to $V_R \geq 30 \, V$ with $-dI_F/dt = 100 \, A/\mu s$;
$T_j = 25 \, ^{\circ}C$; recovery time

<table>
<thead>
<tr>
<th></th>
<th>$t_{rr}$</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>$&lt; , 50 , ns$</td>
</tr>
</tbody>
</table>

$Q_S < 55 \, nC$;

$V_R = 10 \, A$ to $V_R \geq 30 \, V$ with $-dI_F/dt = 50 \, A/\mu s$;
$T_j = 100 \, ^{\circ}C$; peak recovery current

<table>
<thead>
<tr>
<th></th>
<th>$I_{RRM}$</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>$&lt; , 5.5 , A$</td>
</tr>
</tbody>
</table>

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

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

*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 $R_{\text{th j-h}}$ values than screw mounting. The force exerted on the top of the device by the clip should be at least 2 kgf (20 Newtons) to ensure good thermal contact and must not exceed 3.5 kgf (35 Newtons) to avoid damage to the device.

4. If screw mounting is used, it should be M3 cross-recess pan head.
   - Minimum torque to ensure good thermal contact: 5.5 kgf (0.55 Nm)
   - Maximum torque to avoid damage to the device: 8.0 kgf (0.80 Nm)

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

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

7. The heatsink must have a flatness in the mounting area of 0.02 mm maximum per 10 mm.
   - Mounting holes must be deburred.

OPERATING NOTES

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

Any measurement of heatsink temperature should be immediately adjacent to the device.
Ultra fast recovery isolated rectifier diodes

Fig. 5 Power rating.

The power loss in the diode should first be determined from the required forward current on the $I_{F(AV)}$ axis and the appropriate duty cycle.

Having determined the power (P), use Fig. 7 (if heatsink compound is not being used) or Fig. 8 (if heatsink compound is being used) to determine the heatsink size and corresponding maximum ambient and heatsink temperatures.

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

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

Fig. 6 Power rating.

The power loss in the diode should first be determined from the required forward current on the $I_{F(AV)}$ axis and the appropriate form factor.

Having determined the power (P), use Fig. 7 (if heatsink compound is not being used) or Fig. 8 (if heatsink compound is being used) to determine the heatsink size and corresponding maximum ambient and heatsink temperatures.

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

$$a = \text{form factor} = \frac{I_{F(RMS)}}{I_{F(AV)}}$$
Fig. 7 Heatsink rating; without heatsink compound.

Fig. 8 Heatsink rating; with heatsink compound.
Ultra fast recovery isolated rectifier diodes

BYV29F SERIES

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

Fig. 10 —— T_j = 25 °C; ——— T_j = 100 °C.
Fig. 11 Maximum $t_{rr}$ at $T_j = 25^\circ C$.

Fig. 12 Maximum $t_{rr}$ at $T_j = 100^\circ C$.

Fig. 13 Maximum $Q_s$ at $T_j = 25^\circ C$. 
Ultra fast recovery isolated rectifier diodes

BYV29F SERIES

Fig. 14 Maximum \( I_{RRM} \) at \( T_j = 25 \, ^\circ\text{C} \).

Fig. 15 Maximum \( I_{RRM} \) at \( T_j = 100 \, ^\circ\text{C} \).

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

<table>
<thead>
<tr>
<th>Repetitive peak reverse voltage $V_{RRM}$</th>
<th>BYV30—300</th>
<th>400</th>
<th>500</th>
</tr>
</thead>
<tbody>
<tr>
<td>Repetitive peak reverse voltage $V_{RRM}$ max.</td>
<td>300</td>
<td>400</td>
<td>500</td>
</tr>
<tr>
<td>Average forward current $I_F(AV)$ max.</td>
<td>14</td>
<td>A</td>
<td></td>
</tr>
<tr>
<td>Forward voltage $V_F$</td>
<td>&lt;</td>
<td>1.05</td>
<td>V</td>
</tr>
<tr>
<td>Reverse recovery time $t_{rr}$</td>
<td>&lt;</td>
<td>50</td>
<td>ns</td>
</tr>
</tbody>
</table>

MECHANICAL DATA

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).

<table>
<thead>
<tr>
<th>Volatges</th>
<th>BYV30-300</th>
<th>400</th>
<th>500</th>
<th>V</th>
</tr>
</thead>
<tbody>
<tr>
<td>Repetitive peak reverse voltage</td>
<td>V_{RRM}</td>
<td>max.</td>
<td>300</td>
<td>400</td>
</tr>
<tr>
<td>Crest working reverse voltage</td>
<td>V_{RWM}</td>
<td>max.</td>
<td>200</td>
<td>300</td>
</tr>
<tr>
<td>Continuous reverse voltage*</td>
<td>V_{R}</td>
<td>max.</td>
<td>200</td>
<td>300</td>
</tr>
</tbody>
</table>

Currents

Average forward current; switching losses negligible up to 100 kHz square wave; \( \delta = 0.5 \); up to \( T_{mb} = 113 \, ^\circ C \)
up to \( T_{mb} = 125 \, ^\circ C \)

<table>
<thead>
<tr>
<th>IF(AV) max.</th>
<th>14 A</th>
</tr>
</thead>
<tbody>
<tr>
<td>IF(AV) max.</td>
<td>10 A</td>
</tr>
</tbody>
</table>

sinusoidal; up to \( T_{mb} = 118 \, ^\circ C \)
up to \( T_{mb} = 125 \, ^\circ C \)

<table>
<thead>
<tr>
<th>IF(AV) max.</th>
<th>12.5 A</th>
</tr>
</thead>
<tbody>
<tr>
<td>IF(AV) max.</td>
<td>10 A</td>
</tr>
</tbody>
</table>

R.M.S. forward current

| IF(RMS) max. | 20 A |

Repetitive peak forward current

\( t_p = 20 \, \mu s; \delta = 0.02 \)

| IF(RM) max. | 320 A |

Non-repetitive peak forward current

half sine-wave; \( T_j = 150 \, ^\circ C \) prior to surge;
with reapplied \( V_{RWMmax} \)
\( t = 10 \, ms \)
\( t = 8.3 \, ms \)

<table>
<thead>
<tr>
<th>IF(SM) max.</th>
<th>150 A</th>
</tr>
</thead>
<tbody>
<tr>
<td>IF(SM) max.</td>
<td>180 A</td>
</tr>
</tbody>
</table>

\( I^2t \) for fusing \(( t = 10 \, ms \)\)

| \( I^2t \) max. | 112 A²s |

Temperatures

Storage temperature

| \( T_{stg} \) | -65 to +175 °C |

Junction temperature

| \( T_j \) max. | 150 °C |

THERMAL RESISTANCE

From junction to mounting base

| \( R_{th j-mb} = \) | 2.0 K/W |

From mounting base to heatsink
with heatsink compound

| \( R_{th mb-h} = \) | 0.3 K/W |

From junction to ambient
in free air

| \( R_{th j-a} = \) | 50 K/W |

*To ensure thermal stability: \( R_{th j-a} \leq 4.6 \, K/W \).

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CHARACTERISTICS

Forward voltage
IF = 15 A; TJ = 150 °C
IF = 50 A; TJ = 25 °C

VF < 1.05 V*
VF < 1.40 V*

Reverse current
VR = VRWM max; TJ = 100 °C
TJ = 25 °C
IR < 0.8 mA
IR < 50 µA

Reverse recovery when switched from
IF = 1 A to VR > 30 V with -dIF/dt = 100 A/µs;
TJ = 25 °C; recovery time

trr < 50 ns

IF = 2 A to VR > 30 V with -dIF/dt = 20 A/µs;
TJ = 25 °C; recovered charge

Qs < 50 nC

IF = 10 A to VR > 30 V with -dIF/dt = 50 A/µs;
TJ = 100 °C; peak recovery current

IRRM < 5.2 A

Forward recovery when switched to IF = 10 A
with dIF/dt = 10 A/µs; TJ = 25 °C

Vfr typ. 2.5 V

*Measured under pulse conditions to avoid excessive dissipation.
Fig. 4 The right-hand part shows the relationship between the power (derived from the left-hand part) and the maximum permissible temperatures. Power includes reverse current losses and switching losses up to $f = 100$ kHz.

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

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

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

\[ a = \text{form factor} = \frac{I_F(\text{RMS})}{I_F(\text{AV})}. \]
Fig. 6 Maximum permissible repetitive peak forward current for square or sinusoidal currents; $1 \mu s < t_p < 1$ ms.

Fig. 7 $T_j = 25^\circ C$; $T_j = 150^\circ C$. 

Definition of $I_{FRM}$ and $t_p/T$. 
Ultra fast recovery rectifier diodes

Fig. 8 Maximum $t_{rr}$ at $T_j = 25 \, ^\circ C$

Fig. 9 Maximum $t_{rr}$ at $T_j = 100 \, ^\circ C$

Fig. 10 Maximum $Q_s$ at $T_j = 25 \, ^\circ C$
Fig. 11 Maximum $I_{RRM}$ at $T_j = 25^\circ C$

Fig. 12 Maximum $I_{RRM}$ at $T_j = 100^\circ C$.

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

<table>
<thead>
<tr>
<th>Parameter</th>
<th>BYV31—300</th>
<th>400</th>
<th>500</th>
</tr>
</thead>
<tbody>
<tr>
<td>Repetitive peak reverse voltage</td>
<td>$V_{RRM}$</td>
<td>max</td>
<td></td>
</tr>
<tr>
<td>Average forward current</td>
<td>$I_F(AV)$</td>
<td>max</td>
<td>A</td>
</tr>
<tr>
<td>Forward voltage</td>
<td>$V_F$</td>
<td>&lt;</td>
<td>V</td>
</tr>
<tr>
<td>Reverse recovery time</td>
<td>$t_{RR}$</td>
<td>&lt;</td>
<td>ns</td>
</tr>
</tbody>
</table>

MECHANICAL DATA

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 g
Diameter of clearance hole: max. 5.2 mm
Accessories supplied on request:
mica washer (56295a);
PTFE ring (56295b); insulating bush (56295c).

Supplied with device: 1 nut, 1 lock washer
Torque on nut: min. 0.9 Nm (9 kg cm)
max. 1.7 Nm (17 kg cm)
Nut dimensions across the flats;
M5: 8.0 mm, 10-32 UNF: 9.5 mm
RATINGS
Limiting values in accordance with the Absolute Maximum System (IEC 134).

### Voltages

<table>
<thead>
<tr>
<th></th>
<th>BYV31—300</th>
<th>400</th>
<th>500</th>
</tr>
</thead>
<tbody>
<tr>
<td>Repetitive peak reverse voltage</td>
<td>V_{RRM}</td>
<td>max.</td>
<td>300</td>
</tr>
<tr>
<td>Crest working reverse voltage</td>
<td>V_{RWM}</td>
<td>max.</td>
<td>200</td>
</tr>
<tr>
<td>Continuous reverse voltage*</td>
<td>V_{R}</td>
<td>max.</td>
<td>200</td>
</tr>
</tbody>
</table>

### Currents

#### Average forward current, switching

- losses negligible up to 100 kHz
- square wave; \(\delta = 0.5\); up to \(T_{mb} = 114 \, ^\circ C\)
- up to \(T_{mb} = 125 \, ^\circ C\)

| \(I_{F(AV)}\) | max. | 28 | A |
| \(I_{F(AV)}\) | max. | 20 | A |

#### Sinusoidal

- up to \(T_{mb} = 119 \, ^\circ C\)
- up to \(T_{mb} = 125 \, ^\circ C\)

| \(I_{F(AV)}\) | max. | 25 | A |
| \(I_{F(AV)}\) | max. | 21 | A |

#### R.M.S. forward current

| \(I_{F(RMS)}\) | max. | 40 | A |

#### Repetitive peak forward current

- \(t_p = 20 \, \mu s\); \(\delta = 0.02\)
- half sine-wave; \(T_j = 150 \, ^\circ C\) prior to surge

| \(I_{FRM}\) | max. | 550 | A |

#### Non-repetitive peak forward current

- half sine-wave; \(T_j = 150 \, ^\circ C\) prior to surge
- with reapplied \(V_{RWM\,\text{max}}\)

| \(I_{FSM}\) | max. | 300 | A |
| \(I_{FSM}\) | max. | 360 | A |

#### \(I^2t\) for fusing (\(t = 10 \, ms\))

| \(I^2t\) | max. | 450 | A^2s |

### Temperatures

#### Storage temperature

- \(T_{stg} = -55\) to +150 \(^\circ C\)

#### Junction temperature

- \(T_j = 150 \, ^\circ C\)

### THERMAL RESISTANCE

#### From junction to mounting base

- \(R_{th \, j-mb} = 1.0 \, K/W\)

#### From mounting base to heatsink

- a. with heatsink compound
- b. without heatsink compound

| \(R_{th \, mb-h}\) | = | 0.3 | K/W |
| \(R_{th \, mb-h}\) | = | 0.5 | K/W |

### MOUNTING INSTRUCTIONS

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

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

*To ensure thermal stability: \(R_{th \, j-a} \leq 3.4 \, K/W\).*
Ultra fast recovery rectifier diodes

BYV31 SERIES

CHARACTERISTICS

Forward voltage
\[ I_F = 30 \text{ A}; \ T_j = 150 \text{ °C} \]
\[ I_F = 100 \text{ A}; \ T_j = 25 \text{ °C} \]
\[ V_F < 1.05 \text{ V}^* \]
\[ V_F < 1.4 \text{ V}^* \]

Reverse current
\[ V_R = V_{RWM \ max}; \ T_j = 100 \text{ °C} \]
\[ I_R < 2.0 \text{ mA} \]
\[ I_R < 50 \mu\text{A} \]

Reverse recovery when switched from
\[ I_F = 1 \text{ A to } V_R \geq 30 \text{ V with } -\text{d}I_F/\text{d}t = 100 \text{ A/µs}; \ T_j = 25 \text{ °C}; \text{ recovery time} \]
\[ t_{rr} < 50 \text{ ns} \]
\[ I_F = 2 \text{ A to } V_R \geq 30 \text{ V with } -\text{d}I_F/\text{d}t = 20 \text{ A/µs}; \ T_j = 25 \text{ °C}; \text{ recovered charge} \]
\[ Q_s < 75 \text{ nC} \]
\[ I_F = 10 \text{ A to } V_R \geq 30 \text{ V with } -\text{d}I_F/\text{d}t = 50 \text{ A/µs}; \ T_j = 100 \text{ °C}; \text{ peak recovery current} \]
\[ I_{RRM} < 4 \text{ A} \]

Forward recovery when switched to \( I_F = 10 \text{ A} \)
with \( \text{d}I_F/\text{d}t = 10 \text{ A/µs}; \ T_j = 25 \text{ °C} \)
\[ V_{fr} \ \text{typ.} < 2.5 \text{ V} \]

*Measured under pulse conditions to avoid excessive dissipation.

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

Fig. 3 Definition of \( V_{fr} \).
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.

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

$T_{mb}$ scale is for comparison purposes and is correct only for $R_{th \, mb-a} < 2.4 \, K/W$. 

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

\( a = \text{form factor} = \frac{I_F(\text{RMS})}{I_F(\text{AV})} \).
Fig. 6 Maximum permissible repetitive peak forward current for square or sinusoidal currents; 
$1 \mu s < t_p < 1 \text{ms.}$

Fig. 7 — $T_j = 25 \, ^{\circ}\text{C}; \quad \text{---} \quad T_j = 150 \, ^{\circ}\text{C}.$
Ultra fast recovery rectifier diodes

Fig. 8 Maximum $t_{rr}$ at $T_j = 25 \, ^{\circ}C$.

Fig. 9 Maximum $t_{rr}$ at $T_j = 100 \, ^{\circ}C$.

Fig. 10 Maximum $Q_s$ at $T_j = 25 \, ^{\circ}C$.
Fig. 11 Maximum I_RRM at $T_j = 25^\circ$C

Fig. 12 Maximum I_RRM at $T_j = 100^\circ$C.

Fig. 13 Transient thermal impedance
BYV32 SERIES

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

<table>
<thead>
<tr>
<th>Per diode, unless otherwise stated</th>
<th>BYV32</th>
<th>50</th>
<th>100</th>
<th>150</th>
<th>200</th>
</tr>
</thead>
<tbody>
<tr>
<td>Repetitive peak reverse voltage</td>
<td>V_{RRM} max.</td>
<td>50</td>
<td>100</td>
<td>150</td>
<td>200 V</td>
</tr>
<tr>
<td>Output current</td>
<td>I_o max.</td>
<td>20 A</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>(both diodes conducting)</td>
<td>V_F &lt;</td>
<td>0.85 V</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Forward Voltage</td>
<td>t_{rr} &lt;</td>
<td>25 ns</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

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.
### RATINGS

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

#### Voltages (per diode)

<table>
<thead>
<tr>
<th></th>
<th>BYV32-50</th>
<th>100</th>
<th>150</th>
<th>200</th>
</tr>
</thead>
<tbody>
<tr>
<td>Repetitive peak reverse voltage</td>
<td>V_{RRM} max.</td>
<td>50</td>
<td>100</td>
<td>150</td>
</tr>
<tr>
<td>Crest working reverse voltage</td>
<td>V_{RWM} max.</td>
<td>50</td>
<td>100</td>
<td>150</td>
</tr>
<tr>
<td>Continuous reverse voltage (note 1)</td>
<td>V_{R} max.</td>
<td>50</td>
<td>100</td>
<td>150</td>
</tr>
</tbody>
</table>

#### Currents (both diodes conducting; note 2)

- **Output current; switching**
  - losses negligible up to 500 kHz:
    - square wave; $\delta = 0.5$; up to $T_{mb} = 118^\circ C$
    - square wave; $\delta = 0.5$; up to $T_{mb} = 125^\circ C$
    - sinusoidal; up to $T_{mb} = 120^\circ C$
    - sinusoidal; up to $T_{mb} = 125^\circ C$
  - $I_O$ max. 20 A
  - $I_O$ max. 16.5 A
  - $I_O$ max. 18 A
  - $I_O$ max. 16 A

- **R.M.S. forward current**
  - $I_{F(RMS)}$ max. 28 A

- **Repetitive peak forward current**
  - $t_p = 20 \mu s$, $\delta = 0.02$ (per diode)
  - $I_{FRM}$ max. 230 A

- **Non-repetitive peak forward current (per diode)**
  - half sine-wave; $T_j = 150^\circ C$ prior to surge; with reapplied $V_{RWM}$ max
    - $t = 10$ ms
    - $I_{FSM}$ max. 150 A
    - $I_{FSM}$ max. 160 A
  - $I^2 t$ for fusing (t = 10ms; per diode)
    - $I^2 t$ max. 112 A^2 s

#### Temperatures

- **Storage temperature**
  - $T_{stg}$ \(-40 to +150^\circ C\)

- **Junction temperature**
  - $T_j$ max. \(150^\circ C\)

#### 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.

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Ultra fast recovery double rectifier diodes

BYV32 SERIES

CHARACTERISTICS (per diode)

Forward voltage
\[ I_F = 5 \text{ A; } T_j = 100 \text{ °C} \]
\[ I_F = 20 \text{ A; } T_j = 25 \text{ °C} \]

Reverse current
\[ V_R = V_{RWM \text{ max}; } T_j = 100 \text{ °C} \]
\[ V_R = V_{RWM \text{ max}; } T_j = 25 \text{ °C} \]

Reverse recovery when switched from
\[ I_F = 1 \text{ A to } V_R > 30 \text{ V with } -\frac{dI_F}{dt} = 100 \text{ A/µs; } T_j = 25 \text{ °C; recovery time} \]
\[ t_{rr} < 25 \text{ ns} \]

\[ I_F = 2 \text{ A to } V_R > 30 \text{ V with } -\frac{dI_F}{dt} = 20 \text{ A/µs; } T_j = 25 \text{ °C; recovered charge} \]
\[ Q_s < 12.5 \text{ nC} \]

\[ I_F = 10 \text{ A to } V_F > 30 \text{ V with } -\frac{dI_F}{dt} = 50 \text{ A/µs; } T_j = 100 \text{ °C; peak recovery current} \]
\[ I_{RRM} < 2 \text{ A} \]

Forward recovery when switched to \( I_F = 1\text{A} \)
with \( \frac{dI_F}{dt} = 10 \text{ A/µs; } T_j = 25 \text{ °C} \)
\[ V_{fr} \text{ typ. } 0.9 \text{ V} \]

*Mesured under pulse conditions to avoid excessive dissipation

Fig.2 Definition of \( t_{rr}, Q_s \text{ and } I_{RRM} \).

Fig.3 Definition of \( V_{fr} \).
### THERMAL RESISTANCE

From junction to mounting base (both diodes conducting)

\[ R_{th \, j-mb} = 1.6 \text{ K/W} \]

From junction to mounting base (per diode)

\[ R_{th \, j-mb} = 2.4 \text{ K/W} \]

**Influence of mounting method**

1. Heatsink mounted with clip (see mounting instructions)

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

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

   \[ R_{th \, j-a} = 60 \text{ K/W} \]
MOUNTING INSTRUCTIONS

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

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

3. Mounting by means of a spring clip is the best mounting method because it offers:
   a. a good thermal contact under the crystal area and slightly lower $R_{th \text{ mb-h}}$ 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 $R_{th \text{ mb-h}}$ given for mounting with heatsink compound refer to the use of a metallic oxide-loaded compound. Ordinary silicone grease is not recommended.

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

OPERATING NOTES

Dissipation and heatsink calculations

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

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

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

Power includes reverse current losses and switching losses up to $f = 500$ kHz.
Ultra fast-recovery double rectifier diodes

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.

\[ a = \text{form factor} = \frac{I_F(RMS)}{I_F(AV)} \]
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 $T_j = 25^\circ C$; $-- T_j = 100^\circ C$; per diode.
Ultra fast-recovery double rectifier diodes

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

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

Fig.12 Maximum $Q_s$ at $T_j = 25^\circ$C; per diode.
Fig. 13 Maximum $I_{RRM}$ at $T_j = 25 \, ^\circ C$; per diode.

Fig. 14 Maximum $I_{RRM}$ at $T_j = 100 \, ^\circ C$; per diode.

Fig. 15 Transient thermal impedance; one diode conducting.
ULTRA FAST–RECOVERY ELECTRICALLY–ISOLATED DOUBLE RECTIFIER DIODES

Glass-passivated, high-efficiency epitaxial double rectifier diodes in SOT-186 (full-pack) plastic envelopes, featuring low forward voltage drop, very fast reverse recovery times and soft-recovery characteristic. Their electrical isolation makes them ideal for mounting on a common heatsink alongside other components without the need for additional insulators. They are intended for use in switched-mode power supplies and high-frequency circuits in general, where both low conduction and switching losses are essential. Their single chip construction ensures excellent matching of the forward and switching characteristics of the two halves, allowing parallel operation without the need for derating. The series consists of common cathode types.

QUICK REFERENCE DATA

<table>
<thead>
<tr>
<th>Per diode, unless otherwise stated</th>
<th>( V_{RRM} ) max.</th>
<th>( I_O ) max.</th>
<th>( V_F )</th>
<th>( t_{rr} ) ns</th>
</tr>
</thead>
<tbody>
<tr>
<td>Repetitive peak reverse voltage</td>
<td>( BYV32F-50 )</td>
<td>( 100 )</td>
<td>( 150 )</td>
<td>( 200 )</td>
</tr>
<tr>
<td>Output current (both diodes conducting)</td>
<td>( &lt; ) 12 A</td>
<td>( &lt; ) 0.85 V</td>
<td>( &lt; ) 25</td>
<td></td>
</tr>
<tr>
<td>Forward voltage</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Reverse recovery time</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

MECHANICAL DATA

Fig.1 SOT-186 (full-pack)

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).
### RATINGS

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

#### Voltages (per diode; see note 1)

<table>
<thead>
<tr>
<th>Repetitive peak reverse voltage</th>
<th>BYV32F-50</th>
<th>100</th>
<th>150</th>
<th>200</th>
</tr>
</thead>
<tbody>
<tr>
<td>$V_{RRM}$ max.</td>
<td>50</td>
<td>100</td>
<td>150</td>
<td>200</td>
</tr>
<tr>
<td>Crest working reverse voltage</td>
<td>$V_{RWM}$ max.</td>
<td>50</td>
<td>100</td>
<td>150</td>
</tr>
<tr>
<td>Continuous reverse voltage</td>
<td>$V_R$ max.</td>
<td>50</td>
<td>100</td>
<td>150</td>
</tr>
</tbody>
</table>

#### Currents (see notes 2 and 3)

- **Output current, switching losses**
  - negligible up to 500 kHz square wave; $\delta = 0.5$; up to $T_H = 92 \, ^\circ C$
  - sinusoidal; up to $T_H = 100 \, ^\circ C$
  - $I_O$ max. 12 A
  - $I_O$ max. 10.6 A

- **R.M.S. forward current**
  - $I_{F(RMS)}$ max. 12 A

- **Repetitive peak forward current**
  - $t_p = 20 \, \mu s$, $\delta = 0.02$ (per diode)
  - $I_{FRM}$ max. 155 A

- **Non-repetitive peak forward current**
  - half sine-wave; $T_j = 150 \, ^\circ C$ prior to surge; with reapplied $V_{RWM}$ max
  - $t = 10 \, ms$ (per diode)
  - $I_{FSM}$ max. 150 A
  - $I_{FSM}$ max. 160 A

- **$I^2t$ for fusing ($t = 10 \, ms$; per diode)**
  - $I^2t$ max. 112 A

#### Temperatures

- **Storage temperature** $T_{stg}$
  - -40 to +150 $^\circ C$
- **Junction temperature** $T_j$
  - max. 150 $^\circ C$

#### ISOLATION

- **Peak isolation voltage from all terminals to external heatsink** $V_{isol}$
  - max. 1000 V
- **Isolation capacitance from cathode to external heatsink (see note 4)** $C_p$
  - typ. 12 pF

#### Notes

1. To ensure thermal stability: $R_{th \, j-a} < 6.3 \, K/W$ for continuous reverse voltage.
2. The limits for both diodes apply whether both diodes conduct simultaneously or on alternate half cycles.
3. The quoted temperatures assume heatsink compound is used.
4. Mounted without heatsink compound and with 20 Newtons pressure on the centre of the envelope.
Ultra fast-recovery, isolated double rectifier diodes

BYV32F SERIES

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

\[ R_{th \ j-h} = \begin{cases} 7.0 \ K/W \\ 5.0 \ K/W \end{cases} \]

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, device mounted on a printed
circuit board

\[ R_{th \ j-a} = 55 \ K/W \]

CHARACTERISTICS
Forward voltage
\[ I_F = 5 \ A; \ T_j = 100 \ °C \]
\[ V_F < 0.85 \ V^* \]
\[ I_F = 20 \ A; \ T_j = 25 \ °C \]
\[ V_F < 1.15 \ V^* \]

Reverse current
\[ V_R = V_{RWM \ max}; \ T_j = 100 \ °C \]
\[ I_R < 0.6 \ mA \]
\[ V_R = V_{RWM \ max}; \ T_j = 25 \ °C \]
\[ I_R < 10 \ \mu A \]

Reverse recovery when switched from
\[ I_F = 1 \ A \text{ to } V_R \geq 30 \ V \text{ with } -dI_F/dt = 100 \ A/\mu s; \quad T_j = 25 \ °C; \text{ recovery time} \]
\[ t_{rr} < 25 \ ns \]
\[ Q_S < 12.5 \ nC \]
\[ I_{RRM} < 2 \ A \]

Forward recovery when switched to \( I_F = 1 \ A \)
with \( dI_F/dt = 10 \ A/\mu s; \ T_j = 25 \ °C \)
\( V_{fr} \ \text{typ.} \quad 1 \ V \)

*Measured under pulse conditions to avoid excessive dissipation.

Fig.2 Definition of \( t_{rr}, Q_S \) and \( I_{RRM} \).

Fig.3 Definition of \( V_{fr} \).

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MOUNTING INSTRUCTIONS

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

2. The leads should not be bent less than 2.4 mm from the seal, and should be supported during bending. The bend radius must be no less than 1 mm.

3. Mounting by means of a spring clip is the best mounting method because it offers a good thermal contact under the crystal area and slightly lower $R_{th,j-h}$ values than screw mounting. The force exerted on the top of the device by the clip should be at least 2 kgf (20 Newtons) to ensure good thermal contact and must not exceed 3.5 kgf (35 Newtons) to avoid damage to the device.

4. If screw mounting is used, it should be M3 cross-recess pan head.
   - Minimum torque to ensure good thermal contact: 5.5 kgf (0.55 Nm)
   - Maximum torque to avoid damage to the device: 8.0 kgf (0.80 Nm)

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

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

7. The heatsink must have a flatness in the mounting area of 0.02 mm maximum per 10 mm. Mounting holes must be deburred.

OPERATING NOTES

Dissipation and heatsink considerations:

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

b. Any measurement of heatsink temperature should be immediately adjacent to the device.
Ultra fast-recovery, isolated double rectifier diodes

**SQUARE-WAVE OPERATION**

![Graph showing power rating for square-wave operation](image)

**Fig. 5** Power rating.

The individual power loss in each diode should first be determined from the required forward current on the $I_{F(AV)}$ axis and the appropriate duty cycle, then both added together to give a total power loss for the whole device.

Having determined this power ($P$), use Fig. 7 (if heatsink compound is not being used) or Fig. 8 (if heatsink compound is being used) to determine the heatsink size and corresponding maximum ambient and heatsink temperatures.

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

![Diagram showing duty cycle](image)

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

**SINUSOIDAL OPERATION**

![Graph showing power rating for sinusoidal operation](image)

**Fig. 6** Power rating.

The individual power loss in each diode should first be determined from the required forward current on the $I_{F(AV)}$ axis and the appropriate form factor, then both added together to give a total power loss for the whole device.

Having determined this power ($P$), use Fig. 7 (if heatsink compound is not being used) or Fig. 8 (if heatsink compound is being used) to determine the heatsink size and corresponding maximum ambient and heatsink temperatures.

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

\[ a = \text{form factor} = \frac{I_{F(RMS)}}{I_{F(AV)}} \]
BYV32F SERIES

Fig. 7 Heatsink rating. Without heatsink compound.

Fig. 8 Heatsink rating. With heatsink compound.
Ultra fast-recovery, isolated double rectifier diodes

BYV32F SERIES

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

Fig. 10 — $T_j = 25^\circ \text{C}$; $- - - T_j = 150^\circ \text{C}$ per diode.
Fig. 11 Maximum $t_{rr}$ at $T_j = 25$ °C.

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

Fig. 13 Maximum $Q_s$ at $T_j = 25$ °C.
Ultra fast-recovery, isolated double rectifier diodes

BYV32F SERIES

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

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

Fig. 16 One diode conducting; —— with heatsink compound; ——— without heatsink compound.
ULTRA FAST RECOVERY DOUBLE RECTIFIER DIODES

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

QUICK REFERENCE DATA

<table>
<thead>
<tr>
<th>Per diode, unless otherwise stated</th>
<th>BYV34</th>
<th>300</th>
<th>400</th>
<th>500</th>
</tr>
</thead>
<tbody>
<tr>
<td>Repetitive peak reverse voltage</td>
<td>$V_{RRM}$</td>
<td>max.</td>
<td>300</td>
<td>400</td>
</tr>
<tr>
<td>Output current</td>
<td>$I_O$</td>
<td>max.</td>
<td>20</td>
<td></td>
</tr>
<tr>
<td>(both diodes conducting)</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Forward voltage</td>
<td>$V_F$</td>
<td>&lt;</td>
<td>0.93</td>
<td></td>
</tr>
<tr>
<td>Reverse recovery time</td>
<td>$t_{rr}$</td>
<td>&lt;</td>
<td>50</td>
<td></td>
</tr>
</tbody>
</table>

MECHANICAL DATA

Fig.1 TO-220AB

Dimensions in mm

Net mass: 2 g
Note: the exposed metal mounting base is directly connected to the common cathode.
Accessories supplied on request: see data sheets Mounting Instructions and accessories for TO-220 envelopes.
RATINGS
Limiting values in accordance with the Absolute Maximum System (IEC134).

Voltages (per diode)

<table>
<thead>
<tr>
<th></th>
<th>BYV34-300</th>
<th>400</th>
<th>500</th>
</tr>
</thead>
<tbody>
<tr>
<td>Repetitive peak reverse voltage</td>
<td>$V_{RRM}$ max.</td>
<td>300</td>
<td>400</td>
</tr>
<tr>
<td>Crest working reverse voltage</td>
<td>$V_{RWM}$ max.</td>
<td>200</td>
<td>300</td>
</tr>
<tr>
<td>Continuous reverse voltage (note 1)</td>
<td>$V_{R}$ max.</td>
<td>200</td>
<td>300</td>
</tr>
</tbody>
</table>

Currents (both diodes conducting; note 2)

Output current; switching

- losses negligible up to 200 kHz;
  - square wave; $\delta = 0.5$; up to $T_{mb} = 113 \, ^\circ\text{C}$
    - $I_{O}$ max. | 20 A
  - up to $T_{mb} = 125 \, ^\circ\text{C}$
    - $I_{O}$ max. | 14 A
- sinusoidal; up to $T_{mb} = 120 \, ^\circ\text{C}$
  - $I_{O}$ max. | 17.5 A
  - up to $T_{mb} = 125 \, ^\circ\text{C}$
    - $I_{O}$ max. | 14 A

R.M.S. forward current

- Repeatably peak forward current $t_{p} = 20 \, \mu\text{s}; \delta = 0.02$ (note 3)
  - $I_{FRM}$ max. | 240 A

Non-repetitive peak forward current (per diode)

- half sine-wave; $T_{j} = 150 \, ^\circ\text{C}$ prior to surge
  - with re-applied $V_{RWM}$ max
  - $t = 10 \, \text{ms}$
    - $I_{FSM}$ max. | 120 A
  - $t = 8.3 \, \text{ms}$
    - $I_{FSM}$ max. | 150 A
  - $I_{2} \, t$ for fusing ($t = 10 \, \text{ms}$; per diode)
    - $I_{2} \, t$ max. | 72 A²s

Temperatures

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

Notes

1. To ensure thermal stability: $R_{th \, j-a} < 4.5 \, \text{K/W}$.
2. The limits for both diodes apply whether both diodes conduct simultaneously or on alternate half cycles.
CHARACTERISTICS (per diode)

Forward voltage
- \( I_F = 10 \, \text{A}; \, T_j = 150 \, ^\circ\text{C} \)
- \( I_F = 30 \, \text{A}; \, T_j = 25 \, ^\circ\text{C} \)

\[ V_F < 0.93 \, \text{V}^* \]

\[ V_F < 1.4 \, \text{V}^* \]

Reverse current
- \( V_R = V_{RWM \text{ max}}; \, T_j = 100 \, ^\circ\text{C} \)
- \( V_R = V_{RWM \text{ max}}; \, T_j = 25 \, ^\circ\text{C} \)

\[ I_R < 0.6 \, \text{mA} \]

\[ I_R < 50 \, \mu\text{A} \]

Reverse recovery when switched from
- \( I_F = 1 \, \text{A} \) to \( V_R \geq 30 \, \text{V} \) with \( -\frac{dI_F}{dt} = 100 \, \text{A}/\mu\text{s}; \, T_j = 25 \, ^\circ\text{C} \)
  \[ t_{rr} < 50 \, \text{ns} \]
- \( I_F = 2 \, \text{A} \) to \( V_R \geq 30 \, \text{V} \) with \( -\frac{dI_F}{dt} = 20 \, \text{A}/\mu\text{s}; \, T_j = 25 \, ^\circ\text{C} \)
  recovered charge
  \[ Q_S < 45 \, \text{nC} \]
- \( I_F = 10 \, \text{A} \) to \( V_R \geq 30 \, \text{V} \) with \( -\frac{dI_F}{dt} = 50 \, \text{A}/\mu\text{s}; \, T_j = 100 \, ^\circ\text{C} \)
  peak recovery current
  \[ I_{RRM} < 5.0 \, \text{A} \]

Forward recovery when switched to \( I_F = 10 \, \text{A} \)
with \( dI_F/dt = 10 \, \text{A}/\mu\text{s}; \, T_j = 25 \, ^\circ\text{C} \)
recovery voltage

\[ V_{fr} \text{ typ.} = 2.5 \, \text{V} \]

*Measured under pulse conditions to avoid excessive dissipation.
THERMAL RESISTANCE

From junction to mounting base (both diodes conducting)

From junction to mounting base (per diode)

\[ \text{R}_{\text{th j-mb}} = 1.6 \text{ K/W} \]
\[ \text{R}_{\text{th j-mb}} = 2.3 \text{ K/W} \]

Influence of mounting method

1. Heatsink-mounted with clip (see mounting instructions)
   Thermal resistance from mounting base to heatsink
   a. with heatsink compound
   \[ \text{R}_{\text{th mb-h}} = 0.3 \text{ K/W} \]
   b. with heatsink compound and 0.06 mm maximum mica insulator
   \[ \text{R}_{\text{th mb-h}} = 1.4 \text{ K/W} \]
   c. with heatsink compound and 0.1 mm maximum mica insulator (56369)
   \[ \text{R}_{\text{th mb-h}} = 2.2 \text{ K/W} \]
   d. with heatsink compound and 0.25 mm maximum alumina insulator (56367)
   \[ \text{R}_{\text{th mb-h}} = 0.8 \text{ K/W} \]
   e. without heatsink compound
   \[ \text{R}_{\text{th mb-h}} = 1.4 \text{ K/W} \]

2. Free air operation
   The quoted value of \( \text{R}_{\text{th j-a}} \) 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
   \[ \text{R}_{\text{th j-a}} = 60 \text{ K/W} \]
MOUNTING INSTRUCTIONS

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

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

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

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

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

OPERATING NOTES

Dissipation and heatsink calculations

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

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

![Fig.4](image-url)
Fig.5 Power rating per diode. The individual power loss in each diode should first be determined then both added together. The resulting total power loss is then used in conjunction with Fig.6 to determine the heatsink size and corresponding maximum ambient and mounting base temperatures.

\[ I_{F(AV)} = I_{F(RMS)} \times \sqrt{\delta} \]
Ultra fast recovery double rectifier diodes

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.

\[ a = \text{form factor} = \frac{I_{\text{RMS}}}{I_{\text{AV}}} \]
Fig. 8 Maximum permissible repetitive peak forward current for either square or sinusoidal currents for $1 \mu s < t_p < 1 \text{ms}$ (per diode).

Fig. 9 — $T_j = 25 ^\circ \text{C}$; $T_j = 150 ^\circ \text{C}$ (per diode).
Ultra fast recovery double rectifier diodes

Fig. 10 Maximum $t_{rr}$ at $T_j = 25 \, ^\circ\text{C}$. (per diode).

Fig. 11 Maximum $t_{rr}$ at $T_j = 100 \, ^\circ\text{C}$. (per diode).

Fig. 12 Maximum $Q_s$ at $T_j = 25 \, ^\circ\text{C}$. (per diode.)
Fig. 13 Maximum $I_{RRM}$ at $T_j = 25$ °C. (per diode).

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

Fig. 15 One diode conducting (per diode).
ULTRA FAST RECOVERY DOUBLE RECTIFIER DIODES

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

QUICK REFERENCE DATA

<table>
<thead>
<tr>
<th>Per diode, unless otherwise stated</th>
<th>BYV42-50</th>
<th>100</th>
<th>150</th>
<th>200</th>
</tr>
</thead>
<tbody>
<tr>
<td>Repetitive peak reverse voltage</td>
<td>V_{RRM}</td>
<td>max.</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Output current (both diodes</td>
<td>I_0</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>conducting)</td>
<td>&lt; max.</td>
<td>A</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Forward voltage</td>
<td>V_F</td>
<td></td>
<td>0.85</td>
<td>V</td>
</tr>
<tr>
<td>Reverse recovery time</td>
<td>t_{rr}</td>
<td></td>
<td>28</td>
<td>ns</td>
</tr>
</tbody>
</table>

MECHANICAL DATA

Fig.1 TO-220AB

Dimensions in mm

Net mass: 2 g

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

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

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

### Voltages (per diode)

<table>
<thead>
<tr>
<th>Repetitive peak reverse voltage</th>
<th>BYV42—50</th>
<th>100</th>
<th>150</th>
<th>200</th>
</tr>
</thead>
<tbody>
<tr>
<td>V&lt;sub&gt;RRM&lt;/sub&gt; max.</td>
<td>50</td>
<td>100</td>
<td>150</td>
<td>200</td>
</tr>
<tr>
<td>Crest working reverse voltage</td>
<td>V&lt;sub&gt;RWM&lt;/sub&gt; max.</td>
<td>50</td>
<td>100</td>
<td>150</td>
</tr>
<tr>
<td>Continuous reverse voltage</td>
<td>V&lt;sub&gt;R&lt;/sub&gt; max.</td>
<td>50</td>
<td>100</td>
<td>150</td>
</tr>
</tbody>
</table>

### Currents (both diodes conducting: note 1)

- **Output current; switching**
  - losses negligible up to 500 kHz; square wave; \( \delta = 0.5 \);
  - up to \( T_{mb} = 104 \, ^\circ C \) (note 2)
- **R.M.S. forward current (note 2)**
- **Repetitive peak forward current**
  - \( t_p = 20 \, \mu s; \delta = 0.02 \) (per diode)
- **Non-repetitive peak forward current (per diode)**
  - half sine-wave; \( T_j = 150 \, ^\circ C \) prior to surge; with reapplied \( V_{RWM} \) max
  - \( t = 10 \) ms
  - \( t = 8.3 \) ms
  - \( I^2 t \) for fusing (t = 10 ms; per diode)

### Temperatures

- **Storage temperature**
  - \( T_{stg} \) \(-40 \) to \(+150 \) \(^\circ C\)
- **Junction temperature**
  - \( T_j \) \(150 \) \(^\circ C\)

### Notes:

1. The limits for both diodes apply whether both diodes conduct simultaneously or on alternate half cycles.
2. For output currents in excess of 20 A, connection should be made to the exposed metal mounting base.
Ultra fast recovery double rectifier diodes

BYV42 SERIES

CHARACTERISTICS

$T_j = 25 \, ^\circ C$ unless otherwise stated

Forward voltage

$IF = 10 \, A; \ T_j = 100 \, ^\circ C$

$IF = 30 \, A$

Reverse current

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

$V_R = V_{RWM \, max}$

Reverse recovery when switched from

$IF = 1 \, A \text{ to } V_R \geq 30 \, V \text{ with } -\frac{dI_F}{dt} = 100 \, A/\mu s;$

recovery time

$IF = 2 \, A \text{ to } V_R \geq 30 \, V \text{ with } -\frac{dI_F}{dt} = 20 \, A/\mu s;$

recovered charge

$IF = 10 \, A \text{ to } V_R \geq 30 \, V \text{ with } -\frac{dI_F}{dt} = 50 \, A/\mu s;$

$T_j = 100 \, ^\circ C; \text{ peak recovery current}$

Forward recovery when switched to $IF = 1 \, A$

with $\frac{dI_F}{dt} = 10 \, A/\mu s$

*Measured under pulse conditions to avoid excessive dissipation.*
THERMAL RESISTANCE

From junction to mounting base (both diodes conducting)

From junction to mounting base (per diode)

Influence of mounting method

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

Thermal resistance from mounting base to heatsink

- with heatsink compound
- with heatsink compound and 0.06 mm maximum mica insulator
- with heatsink compound and 0.1 mm maximum mica insulator (56369)
- with heatsink compound and 0.25 mm maximum alumina insulator (56367)
- without heatsink compound

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

$R_{th \ j-a} = 60 \ K/W$
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 $R_{th\ mb-h}$ 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 $R_{th\ mb-h}$ given for mounting with heatsink compound refer to the use of a metallic oxide loaded compound. Ordinary silicone grease is not recommended.

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

OPERATING NOTES

Dissipation and heatsink calculations

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

![Diagram of heat dissipation and heatsink calculations](image)

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

\[ P = \frac{I F(AV)}{T} \times V \]

\[ I F(AV) = I F(RMS) \times \sqrt{\delta} \]

Power includes reverse current losses and switching losses up to \( f = 500 \) kHz.
Ultra fast recovery double rectifier diodes

BYV42 SERIES

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

Fig. 8 — $T_j = 25 \degree \text{C}$; $T_j = 100 \degree \text{C}$; per diode.
Fig. 9 Maximum $t_{rr}$ at $T_j = 25 \, ^\circ C$; per diode.

Fig. 10 Maximum $t_{rr}$ at $T_j = 100 \, ^\circ C$; per diode.

Fig. 11 Maximum $Q_s$ at $T_j = 25 \, ^\circ C$; per diode.
Ultra fast recovery double rectifier diodes

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

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

Fig. 14 Transient thermal impedance; one diode conducting.
ULTRA FAST RECOVERY DOUBLE RECTIFIER DIODES

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

QUICK REFERENCE DATA

<table>
<thead>
<tr>
<th>Per diode, unless otherwise stated</th>
<th>( V_{RRM} )</th>
<th>BYV44—300</th>
<th>400</th>
<th>500</th>
<th>V</th>
</tr>
</thead>
<tbody>
<tr>
<td>Repetitive peak reverse voltage</td>
<td>( I_{O} ) max.</td>
<td>30</td>
<td>A</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Output current</td>
<td>( V_{F} ) (&lt;)</td>
<td>1.05</td>
<td>V</td>
<td></td>
<td></td>
</tr>
<tr>
<td>(both diodes conducting)</td>
<td>( t_{rr} ) (&lt;)</td>
<td>50</td>
<td>ns</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

MECHANICAL DATA

Fig. TO—220AB

Net mass: 2 g

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

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

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

### Voltages (per diode)

<table>
<thead>
<tr>
<th></th>
<th>BYV44-300</th>
<th>400</th>
<th>500</th>
</tr>
</thead>
<tbody>
<tr>
<td>Repetitive peak reverse voltage</td>
<td>$V_{RRM}$</td>
<td>max. 300</td>
<td>400</td>
</tr>
<tr>
<td>Crest working reverse voltage</td>
<td>$V_{RWM}$</td>
<td>max. 200</td>
<td>300</td>
</tr>
<tr>
<td>Continuous reverse voltage (note 1)</td>
<td>$V_R$</td>
<td>max. 200</td>
<td>300</td>
</tr>
</tbody>
</table>

### Currents (both diodes conducting; note 2)

#### Output current; switching losses
- negligible up to 200 kHz;
- square wave; $\delta = 0.5$; up to $T_{mb} = 92 \, ^\circ C$ (note 3)
- sinusoidal; up to $T_{mb} = 103 \, ^\circ C$ (note 3)

- $I_O$ max. 30 A
- $I_O$ max. 26 A

#### R.M.S. forward current (note 3)

- $I_{F(RMS)}$ max. 43 A

#### Repetitive peak forward current

- $t_p = 20 \, \mu s; \delta = 0.02$ (per diode)

- $I_{FRM}$ max. 320 A

#### Non-repetitive peak forward current (per diode)

- half sine-wave; $T_j = 150 \, ^\circ C$ prior to surge; with reapplied $V_{RWM}$ max

- $t = 10 \, ms$; $I_{FSM}$ max. 150 A

- $t = 8.3 \, ms$; $I_{FSM}$ max. 180 A

- $I^2 t$ for fusing ($t = 10 \, ms$; per diode); $I^2 t$ max. 112 A²s

### Temperatures

<p>| | |</p>
<table>
<thead>
<tr>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>Storage temperature</td>
<td>$T_{stg}$</td>
</tr>
<tr>
<td></td>
<td>-40 to +150 $^\circ C$</td>
</tr>
<tr>
<td>Junction temperature</td>
<td>$T_j$</td>
</tr>
<tr>
<td></td>
<td>max. 150 $^\circ C$</td>
</tr>
</tbody>
</table>

### Notes:

1. To ensure thermal stability: $R_{th \, j-a} < 9.3 \, K/W$.
2. The limits for both diodes apply whether both diodes conduct simultaneously or on alternate half cycles.
3. For output currents in excess of 20 A, connection should be made to the exposed metal mounting base.
Ultra fast recovery double rectifier diodes

BYV44 SERIES

CHARACTERISTICS (per diode; Tj = 25 °C unless otherwise stated)

Forward voltage

IF = 15 A; TJ = 150 °C
IF = 50 A

V F < 1.05 V*
V F < 1.4 V*

Reverse current

VR = VRWM max; TJ = 100 °C
VR = VRWM max

IR < 0.8 mA
IR < 50 μA

Reverse recovery when switched from

IF = 1 A to VR ≥ 30 V with −dIF/dt = 100 A/μs; recovery time
IF = 2 A to VR ≥ 30 V with −dIF/dt = 20 A/μs; recovered charge
IF = 10 A to VR ≥ 30 V with −dIF/dt = 50 A/μs; TJ = 100 °C; peak recovery current

TRR < 50 ns
Qs < 50 nC
IRR < 5.2 A

Forward recovery when switched to IF = 10 A with dIF/dt = 10 A/μs; recovery voltage

Vfr typ. 2.5 V

*Measured under pulse conditions to avoid excessive dissipation.
THERMAL RESISTANCE

From junction to mounting base (both diodes conducting)
From junction to mounting base (per diode)

\[ R_{th \ j-mb} = 1.4 \text{ K/W} \]
\[ R_{th \ j-mb} = 2.0 \text{ K/W} \]

→ Influence of mounting method

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

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

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.

\[ R_{th \ j-a} = 60 \text{ K/W} \]
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.

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

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

OPERATING NOTES

Dissipation and heatsink calculations

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

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

Power includes reverse current losses and switching losses up to $f = 100$ kHz.

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

\[ a = \text{form factor} = \frac{I_{\text{F(RMS)}}}{I_{\text{F(AV)}}}. \]
Fig. 8 Maximum permissible repetitive peak forward current for square or sinusoidal currents; 
$1 \mu s < t_p < 1 \text{ms.}$

Fig. 9 — $T_j = 25 ^\circ \text{C}; \quad \ldots \quad T_j = 150 ^\circ \text{C.}$
Ultra fast recovery double rectifier diodes

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

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

Fig. 12 Maximum $Q_s$ at $T_j = 25$ °C.
**Fig. 13** Maximum $I_{RRM}$ at $T_j = 25^\circ C$.

**Fig. 14** Maximum $I_{RRM}$ at $T_j = 100^\circ C$.

**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

<table>
<thead>
<tr>
<th>Parameter</th>
<th>BYV60—850</th>
<th>1000</th>
<th>1200</th>
</tr>
</thead>
<tbody>
<tr>
<td>Repetitive peak reverse voltage ( V_{RRM} )</td>
<td>max. 850</td>
<td>1000</td>
<td>1200</td>
</tr>
<tr>
<td>Average forward current ( I_{F(AV)} )</td>
<td>max.</td>
<td>15</td>
<td>A</td>
</tr>
<tr>
<td>Non-repetitive peak forward current ( I_{FSM} )</td>
<td>max.</td>
<td>150</td>
<td>A</td>
</tr>
<tr>
<td>Reverse recovery time ( t_{rr} )</td>
<td>&lt;</td>
<td>0.6</td>
<td>( \mu s )</td>
</tr>
</tbody>
</table>

### MECHANICAL DATA

Fig.1 TO-238 (2-pin)

```
Dimensions in mm

<table>
<thead>
<tr>
<th>Measurement</th>
<th>Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Pin 1 = cathode (AMO 250 series)</td>
<td>Net mass = 16.5 g</td>
</tr>
<tr>
<td>2 = anode (AMP 250 series)</td>
<td></td>
</tr>
<tr>
<td>Baseplate is electrically isolated.</td>
<td></td>
</tr>
</tbody>
</table>
```

Net mass = 16.5 g
RATINGS
Limiting values in accordance with the Absolute Maximum System (IEC 134)

<table>
<thead>
<tr>
<th>Voltagdes</th>
<th>BYV60-850</th>
<th>1000</th>
<th>1200</th>
</tr>
</thead>
<tbody>
<tr>
<td>Non-repetitive peak reverse voltage</td>
<td>VRSM</td>
<td>max. 1000</td>
<td>1100</td>
</tr>
<tr>
<td>Repetitive peak reverse voltage</td>
<td>VRRM</td>
<td>max. 850</td>
<td>1000</td>
</tr>
<tr>
<td>Crest working reverse voltage</td>
<td>VRWM</td>
<td>max. 600</td>
<td>800</td>
</tr>
<tr>
<td>Continuous reverse voltage</td>
<td>VR</td>
<td>max. 500</td>
<td>650</td>
</tr>
</tbody>
</table>

**Currents**

Average forward current assuming zero switching losses
- square-wave; \( \delta = 0.5 \); up to \( T_{mb} = 76 \) °C
- sinusoidal; up to \( T_{mb} = 81 \) °C
- R.M.S. forward current
  - IF(AV) max. 15 A
  - IF(AV) max. 13.5 A
- Repetitive peak forward current;
  - 1 \( \mu s < t_p < 1 \) ms; \( \delta = 0.02 \)
  - IF(RMS) max. 21 A
  - IFRMM max. 300 A
- Non-repetitive peak forward current; \( t = 10 \) ms
  - half sine-wave; \( T_j = 125 \) °C prior to surge;
  - with reapplied \( V_{RWM} \) max
  - IFSM max. 150 A

**Temperatures**

- Storage temperature \( T_{stg} \) -40 to +125 °C
- Junction temperature \( T_j \) max. 125 °C

**THERMAL RESISTANCE**

- From mounting base to heatsink;
  - with heatsink compound
  - \( R_{th mb-h} \) = 0.3 K/W
- From junction to mounting base
  - \( R_{th j-mb} \) = 2 K/W

**ISOLATION**

- R.M.S. isolation voltage
  - \( V_{isol} \) min. 2500 V

*From baseplate to terminals strapped together.*
Fast high-voltage rectifier diodes

CHARACTERISTICS

Forward voltage
\[ I_F = 50 \text{ A}; \ T_j = 25 \ ^\circ\text{C} \]

Reverse current
\[ V_R = V_{RWM\text{max}}; \ T_j = 100 \ ^\circ\text{C} \]

Reverse recovery when switched from
\[ I_F = 2 \text{ A} \text{ to} \ V_R \geq 30 \text{ V} \text{ with} \ -dI_F/dt = 20 \text{ A/µs}; \ T_j = 25 \ ^\circ\text{C} \]

recovered charge
\[ Q_s < 2.0 \ \mu\text{C} \]

recovery time
\[ t_{rr} < 0.6 \ \mu\text{s} \]

Forward recovery when switched to
\[ I_F = 5 \text{ A} \text{ with} \ t_r = 0.1 \mu\text{s}; \ T_j = 25 \ ^\circ\text{C} \]

recovery time
\[ t_{fr} < 1.0 \ \mu\text{s} \]

*Measured under pulse conditions to avoid excessive dissipation.

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

Fig.3 Definition of t_{fr}.

BYV60 SERIES
Fig. 4 The right-hand part shows the interrelationship between the power (derived from the left-hand part) and the maximum permissible temperatures.

\( P = \text{power including reverse current losses but excluding switching losses.} \)

\( a = \text{form factor} = \frac{I_{F(RMS)}}{I_{F(AV)}}. \)
Fig. 5 The right-hand part shows the interrelationship between the power (derived from the left-hand part) and the maximum permissible temperatures.

$P = \text{power including reverse current losses but excluding switching losses.}$

$I_{F(\text{AV})} = I_{F(\text{RMS})} \times \sqrt{\delta}$
Fig. 6 Maximum permissible repetitive peak forward current based on sinusoidal currents; $1 \mu s < t_p < 1 \text{ ms}$.

Fig. 7 $T_j = 25 \degree \text{C}$; $T_j = 100 \degree \text{C}$. 
Fast high-voltage rectifier diodes

**BYV60 SERIES**

**Fig. 8**

![Graph of Q_s (µC) vs. -dI_F/dt (A/µs) for different currents and temperatures.]

**Fig. 9**

![Graph of t_{tr} (µs) vs. -dI_F/dt (A/µs) for different currents and temperatures.]

- **25°C**
- **100°C**
- **max values**
Fig. 10

$\frac{dI_F}{dt}$ (A/µs) $10^3$

$M_{2213}$

$I_{RRM}$ (A)

$I_F = 5\text{A}$
$10\text{A}$
$20\text{A}$
$40\text{A}$
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**

<table>
<thead>
<tr>
<th>Per diode, unless otherwise stated</th>
<th>BYV72-50</th>
<th>100</th>
<th>150</th>
<th>200</th>
</tr>
</thead>
<tbody>
<tr>
<td>Repetitive peak reverse voltage</td>
<td>$V_{RRM}$ max.</td>
<td>50</td>
<td>100</td>
<td>150</td>
</tr>
<tr>
<td>Output current (both diodes conducting)</td>
<td>$I_O$ max.</td>
<td>30</td>
<td>A</td>
<td></td>
</tr>
<tr>
<td>Forward voltage</td>
<td>$V_F$</td>
<td>&lt;</td>
<td>0.85</td>
<td>V</td>
</tr>
<tr>
<td>Reverse recovery time</td>
<td>$t_{rr}$</td>
<td>&lt;</td>
<td>28</td>
<td>ns</td>
</tr>
</tbody>
</table>

**MECHANICAL DATA**

Fig.1 SOT-93

Dimensions in mm

Net mass: 5 g

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

Accessories supplied on request: see data sheets Mounting instructions and accessories for SOT-93 envelopes.
### RATINGS

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

#### Voltages (per diode)

<table>
<thead>
<tr>
<th>Repetitive peak reverse voltage</th>
<th>BYV72–50</th>
<th>100</th>
<th>150</th>
<th>200</th>
</tr>
</thead>
<tbody>
<tr>
<td>$V_{RRM}$ max.</td>
<td>50</td>
<td>100</td>
<td>150</td>
<td>200</td>
</tr>
<tr>
<td>Crest working reverse voltage</td>
<td>$V_{RWM}$ max.</td>
<td>50</td>
<td>100</td>
<td>150</td>
</tr>
<tr>
<td>Continuous reverse voltage</td>
<td>$V_R$ max.</td>
<td>50</td>
<td>100</td>
<td>150</td>
</tr>
</tbody>
</table>

#### Currents (both diodes conducting; note 1)

<table>
<thead>
<tr>
<th>Output current; switching</th>
<th>IO max.</th>
<th>30</th>
<th>A</th>
</tr>
</thead>
<tbody>
<tr>
<td>losses negligible up to 500 kHz; square wave; $\delta = 0.5$; up to $T_{mb} = 104 , ^\circ C$ (note 2)</td>
<td>$I_{F(RMS)}$ max.</td>
<td>43</td>
<td>A</td>
</tr>
<tr>
<td>Repetitive peak forward current $t_p = 20 , \mu s$; $\delta = 0.02$ (per diode)</td>
<td>$I_{FRM}$ max.</td>
<td>320</td>
<td>A</td>
</tr>
<tr>
<td>Non-repetitive peak forward current (per diode) half sine-wave; $T_j = 150 , ^\circ C$ prior to surge; with reapplied $V_{RWM}$ max</td>
<td>$I_{FSM}$ max.</td>
<td>150</td>
<td>A</td>
</tr>
<tr>
<td>$t = 10 , ms$</td>
<td>$I_{FSM}$ max.</td>
<td>160</td>
<td>A</td>
</tr>
<tr>
<td>$t = 8.3 , ms$</td>
<td>$I^2t$ max.</td>
<td>112</td>
<td>$A^2s$</td>
</tr>
</tbody>
</table>

#### Temperatures

<table>
<thead>
<tr>
<th>Storage temperature</th>
<th>$T_{stg}$</th>
<th>–40 to +150 $^\circ C$</th>
</tr>
</thead>
<tbody>
<tr>
<td>Junction temperature</td>
<td>$T_j$ max.</td>
<td>150 $^\circ C$</td>
</tr>
</tbody>
</table>

**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.
Ultra fast recovery double rectifier diodes

BYV72 SERIES

CHARACTERISTICS

$T_j = 25 \, ^\circ\text{C}$ unless otherwise stated

Forward voltage

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

$I_F = 30 \, \text{A}$

Reverse current

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

$I_R < 1.0 \quad \text{mA}$

$I_R < 25 \quad \mu\text{A}$

Reverse recovery when switched from $I_R = 1 \, \text{A}$ to $V_R \geq 30 \, \text{V}$ with $-\frac{dI_F}{dt} = 100 \, \text{A/µs}$;

recovery time

$\tau_{rr} < 28 \quad \text{ns}$

$Q_s < 15 \quad \text{nC}$

$I_{RRM} < 2.4 \quad \text{A}$

Forward recovery when switched to $I_F = 1 \, \text{A}$

with $dI_F/dt = 10 \, \text{A/µs}$

$V_{fr} \quad \text{typ.} \quad 1.0 \quad \text{V}$

*Measured under pulse conditions to avoid excessive dissipation.

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THERMAL RESISTANCE

From junction to mounting base (both diodes conducting)

From junction to mounting base (per diode)

Influence of mounting method

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

Thermal resistance from mounting base to heatsink

a. with heatsink compound

b. with heatsink compound and 0.06 mm maximum mica
   insulator (56378)

c. with heatsink compound and 0.1 mm maximum mica
   insulator

d. with heatsink compound and 0.25 mm maximum
   alumina insulator

e. without heatsink compound

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

$R_{th \ j-a} = 60$ 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 $R_{th_{mb-h}}$ 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 $R_{th_{mb-h}}$ given for mounting with heatsink compound refer to the use of a metallic-oxide loaded compound. Ordinary silicone grease is not recommended.
5. Rivet mounting (only possible for non-insulated mounting).
   Devices may be rivetted to flat heatsinks; such a process must neither deform the mounting tab, nor enlarge the mounting hole.

OPERATING NOTES
Dissipation and heatsink calculations
The various components of junction temperature rise above ambient are illustrated in Fig.4

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

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

Power includes reverse current losses and switching losses up to \( f = 500 \text{ kHz} \).
Ultra fast-recovery double rectifier diodes

BYV72 SERIES

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

Fig. 8 —— $T_j = 25$ °C; ——— $T_j = 100$ °C. per diode.
Fig. 9 Maximum $t_{rr}$ at $T_j = 25 \, ^\circ\text{C}$; per diode.

Fig. 10 Maximum $t_{rr}$ at $T_j = 100 \, ^\circ\text{C}$; per diode.

Fig. 11 Maximum $Q_s$ at $T_j = 25 \, ^\circ\text{C}$; per diode.
Ultra fast recovery double rectifier diodes

Fig. 12 Maximum $I_{RRM}$ at $T_j = 25 \, ^\circ C$; per diode.

Fig. 13 Maximum $I_{RRM}$ at $T_j = 100 \, ^\circ C$; 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**

<table>
<thead>
<tr>
<th>Per diode, unless otherwise stated</th>
<th>BYV74-300</th>
<th>400</th>
<th>500</th>
</tr>
</thead>
<tbody>
<tr>
<td>Repetitive peak reverse voltage</td>
<td>V_{RRM}</td>
<td>max.</td>
<td>300</td>
</tr>
<tr>
<td>Output current</td>
<td>I_{O}</td>
<td>max.</td>
<td>30</td>
</tr>
<tr>
<td>(both diodes conducting)</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Forward voltage</td>
<td>V_{F}</td>
<td>&lt;</td>
<td>1.05</td>
</tr>
<tr>
<td>Reverse recovery time</td>
<td>t_{rr}</td>
<td>&lt;</td>
<td>50</td>
</tr>
</tbody>
</table>

**MECHANICAL DATA**

Fig. 1 SOT-93

Dimensions in mm

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).

Volatges (per diode)

<table>
<thead>
<tr>
<th>BYV74—300</th>
<th>400</th>
<th>500</th>
</tr>
</thead>
<tbody>
<tr>
<td>Repetitive peak reverse voltage</td>
<td>V_{RRM}</td>
<td>max.</td>
</tr>
<tr>
<td>Crest working reverse voltage</td>
<td>V_{RWM}</td>
<td>max.</td>
</tr>
<tr>
<td>Continuous reverse voltage (note 1)</td>
<td>V_{R}</td>
<td>max.</td>
</tr>
</tbody>
</table>

Currents (both diodes conducting; note 2)

<table>
<thead>
<tr>
<th>BYV74—300</th>
<th>400</th>
<th>500</th>
</tr>
</thead>
<tbody>
<tr>
<td>Output current (note 3)</td>
<td>I_{O}</td>
<td>max.</td>
</tr>
<tr>
<td>square wave; ( \delta = 0.5 ); up to ( T_{mb} = 92 , ^{\circ}C )</td>
<td>I_{O}</td>
<td>max.</td>
</tr>
<tr>
<td>sinusoidal; up to ( T_{mb} = 103 , ^{\circ}C )</td>
<td>I_{FRM}</td>
<td>max.</td>
</tr>
<tr>
<td>R.M.S. forward current</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Repetitive peak forward current</td>
<td></td>
<td></td>
</tr>
<tr>
<td>( t_p = 20 , \mu s; \delta = 0.02 ) (note 4)</td>
<td>I_{FRM}</td>
<td>max.</td>
</tr>
<tr>
<td>Non-repetitive peak forward current</td>
<td></td>
<td></td>
</tr>
<tr>
<td>half sine-wave; ( T_j = 150 , ^{\circ}C ) prior to surge; with reapplied ( V_{RWM} ) max (note 4)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>( t = 10 , ms )</td>
<td>I_{FSM}</td>
<td>max.</td>
</tr>
<tr>
<td>( t = 8.3 , ms )</td>
<td>I_{FSM}</td>
<td>max.</td>
</tr>
<tr>
<td>( I^2 t ) for fusing (( t = 10 , ms ); note 4)</td>
<td>I_{FSM}</td>
<td>max.</td>
</tr>
</tbody>
</table>

Temperatures

<table>
<thead>
<tr>
<th>BYV74—300</th>
<th>400</th>
<th>500</th>
</tr>
</thead>
<tbody>
<tr>
<td>Storage temperature</td>
<td>T_{stg}</td>
<td>-40 to +150</td>
</tr>
<tr>
<td>Junction temperature</td>
<td>T_{j}</td>
<td>max.</td>
</tr>
</tbody>
</table>

Notes:

1. To ensure thermal stability: \( R_{th \, j-a} < 9.3 \, K/W \).
2. The limits for both diodes apply whether both diodes conduct simultaneously or on alternate half cycles.
3. For output currents in excess of 20 A, connection should be made to the exposed metal mounting base.
4. Figures apply to each diode.
Ultra fast recovery double rectifier diodes

BYV74 SERIES

CHARACTERISTICS (per diode)

$T_J = 25 \, ^\circ C$ unless otherwise stated

Forward voltage

$I_F = 15 \, A; \, T_J = 150 \, ^\circ C$
$I_F = 50 \, A$

Forward voltage

$V_F < 1.05 \, V^*$
$V_F < 1.6 \, V^*$

Reverse current

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

Reverse current

$I_R < 0.8 \, mA$
$I_R < 50 \, \mu A$

Reverse recovery when switched from

$I_F = 1 \, A$ to $V_R \geq 30 \, V$ with $-\frac{dI_F}{dt} = 100 \, A/\mu s$; recovery time

$t_{rr} < 50 \, ns$

Reverse recovery when switched from

$I_F = 2 \, A$ to $V_R \geq 30 \, V$ with $-\frac{dI_F}{dt} = 20 \, A/\mu s$; recovered charge

$Q_S < 50 \, nC$

Reverse recovery when switched from

$I_F = 10 \, A$ to $V_R \geq 30 \, V$ with $-\frac{dI_F}{dt} = 50 \, A/\mu s$; $T_J = 100 \, ^\circ C$; peak recovery current

$I_{RRM} < 5.2 \, A$

Forward recovery when switched to $I_F = 10 \, A$

forward recovery voltage

$V_{fr} \text{ typ.} 2.5 \, V$

*Measured under pulse conditions to avoid excessive dissipation.
THERMAL RESISTANCE
From junction to mounting base; total package per diode

\[
\begin{align*}
R_{th \, j \rightarrow mb} &= 1.4 \text{ K/W} \\
R_{th \, j \rightarrow mb} &= 2.0 \text{ K/W}
\end{align*}
\]

Influence of mounting method
1. Heatsink-mounted with clip (see mounting instructions)
   Thermal resistance from mounting base to heatsink
   a. with heatsink compound
   \[
   R_{th \, mb \rightarrow h} = 0.2 \text{ K/W}
   \]
   b. with heatsink compound and 0.06 mm maximum mica insulator (56378)
   \[
   R_{th \, mb \rightarrow h} = 1.4 \text{ K/W}
   \]
   c. without heatsink compound
   \[
   R_{th \, mb \rightarrow h} = 1.4 \text{ K/W}
   \]
2. Free air operation
   The quoted value of \( R_{th \, j \rightarrow a} \) 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
   \[
   R_{th \, j \rightarrow a} = 60 \text{ K/W}
   \]
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 $R_{\text{th mb-h}}$ 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 $R_{\text{th mb-h}}$ given for mounting with heatsink compound refer to the use of a metallic oxide-loaded compound. Ordinary silicone grease is not recommended.

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

OPERATING NOTES

Dissipation and heatsink calculations

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

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

\[ I_{F(AV)} = I_{F(RMS)} \times \sqrt{\delta} \]
Ultra fast recovery double rectifier diodes

BYV74 SERIES

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).

\[ a = \text{form factor} = \frac{I_{F(RMS)}}{I_{F(AV)}} \]
Fig. 7: Maximum permissible repetitive peak forward current for square or sinusoidal currents; $1 \mu s < t_p < 1$ ms (per diode).

Fig. 8: $T_j = 25$ °C; $T_j = 150$ °C (per diode).
Ultra fast recovery double rectifier diodes

**BYV74 SERIES**

Fig. 9 Maximum $t_{rr}$ at $T_j = 25 \, ^\circ\text{C}$.
(per diode).

Fig. 10 Maximum $t_{rr}$ at $T_j = 100 \, ^\circ\text{C}$.
(per diode).

Fig. 11 Maximum $Q_s$ at $T_j = 25 \, ^\circ\text{C}$.
(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

<table>
<thead>
<tr>
<th>Repetitive peak reverse voltage</th>
<th>BYV79-50 VRRM max.</th>
<th>100</th>
<th>150</th>
<th>200</th>
</tr>
</thead>
<tbody>
<tr>
<td>Average forward current</td>
<td>I_F(AV) max.</td>
<td>14 A</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Forward voltage</td>
<td>V_F &lt;</td>
<td>0.85 V</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Reverse recovery time</td>
<td>t_rr &lt;</td>
<td>30 ns</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

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.
BYV79 SERIES

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

Voltages

<table>
<thead>
<tr>
<th>BYV79—50</th>
<th>100</th>
<th>150</th>
<th>200</th>
</tr>
</thead>
<tbody>
<tr>
<td>Repetitive peak reverse voltage</td>
<td>( V_{RRM} ) max.</td>
<td>50</td>
<td>100</td>
</tr>
<tr>
<td>Crest working reverse voltage</td>
<td>( V_{RWM} ) max.</td>
<td>50</td>
<td>100</td>
</tr>
<tr>
<td>Continuous reverse voltage (note 1)</td>
<td>( V_{R} ) max.</td>
<td>50</td>
<td>100</td>
</tr>
</tbody>
</table>

Currents

Average forward current; switching losses negligible up to 500 kHz;
square wave; \( \delta = 0.5 \); up to \( T_{mb} = 115 \) °C
sinusoidal; up to \( T_{mb} = 122 \) °C
R.M.S. forward current

<table>
<thead>
<tr>
<th>BYV79—50</th>
<th>100</th>
<th>150</th>
<th>200</th>
</tr>
</thead>
<tbody>
<tr>
<td>Repetitive peak forward current</td>
<td>( I_{F(AV)} ) max.</td>
<td>14</td>
<td>A</td>
</tr>
<tr>
<td>( t_p = 20 \mu s; \delta = 0.02 )</td>
<td>( I_{FRM} ) max.</td>
<td>420</td>
<td>A</td>
</tr>
<tr>
<td>Non-repetitive peak forward current</td>
<td>( I_{F(RMS)} ) max.</td>
<td>20</td>
<td>A</td>
</tr>
<tr>
<td>half sine-wave; ( T_j = 150 ) °C prior to surge; with reapplied ( V_{RWM} ) max</td>
<td>( I_{FSM} ) max.</td>
<td>180</td>
<td>A</td>
</tr>
<tr>
<td>( t = 10 ) ms</td>
<td>( I_{FSM} ) max.</td>
<td>200</td>
<td>A</td>
</tr>
<tr>
<td>( t = 8.3 ) ms</td>
<td>( I^2 t ) max.</td>
<td>160</td>
<td>A^2s</td>
</tr>
<tr>
<td>( I^2 t ) for fusing (( t = 10 ) ms)</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Temperatures

<table>
<thead>
<tr>
<th>BYV79—50</th>
<th>100</th>
<th>150</th>
<th>200</th>
</tr>
</thead>
<tbody>
<tr>
<td>Storage temperature</td>
<td>( T_{stg} ) max.</td>
<td>-40 to +150</td>
<td>°C</td>
</tr>
<tr>
<td>Junction temperature</td>
<td>( T_j ) max.</td>
<td>150</td>
<td>°C</td>
</tr>
</tbody>
</table>

Notes:

1. To ensure thermal stability: \( R_{th \cdot j-a} \leq 8 \) K/W.
Ultra fast recovery rectifier diodes

BYV79 SERIES

CHARACTERISTICS

$T_j = 25 \, ^\circ\text{C}$ unless otherwise stated

Forward voltage

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

$I_F = 50 \, \text{A}$

Reverse current

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

$V_R = V_{RWM\, max}$

Reverse recovery when switched from

$I_F = 1 \, \text{A} \text{ to } V_R \geq 30 \, \text{V} \text{ with } -\frac{dI_F}{dt} = 100 \, \text{A/\mu s};$

recovery time

$t_{rr} < 30 \, \text{ns}$

$Q_s < 15 \, \text{nC}$

$I_{RRM} < 4 \, \text{A}$

Forward recovery when switched to $I_F = 10 \, \text{A}$

with $\frac{dI_F}{dt} = 10 \, \text{A/\mu s}$

$V_{fr}$ typ. $1.0 \, \text{V}$

*Measured under pulse conditions to avoid excessive dissipation.*
THERMAL RESISTANCE
From junction to mounting base

Influence of mounting method
1. Heatsink-mounted with clip (see mounting instructions)
   Thermal resistance from mounting base to heatsink
   a. with heatsink compound
   b. with heatsink compound and 0.06 mm maximum mica insulator
   c. with heatsink compound and 0.1 mm maximum mica insulator (56369)
   d. with heatsink compound and 0.25 mm maximum alumina insulator (56367)
   e. without heatsink compound

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

\[
R_{th \ j-mb} = 2 \ \text{K/W}
\]
\[
R_{th \ mb-h} = 0.3 \ \text{K/W}
\]
\[
R_{th \ mb-h} = 1.4 \ \text{K/W}
\]
\[
R_{th \ mb-h} = 2.2 \ \text{K/W}
\]
\[
R_{th \ mb-h} = 0.8 \ \text{K/W}
\]
\[
R_{th \ mb-h} = 1.4 \ \text{K/W}
\]
\[
R_{th \ j-a} = 60 \ \text{K/W}
\]
MOUNTING INSTRUCTIONS

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

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

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

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

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

OPERATING NOTES

Dissipation and heatsink calculations

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

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.

\[ P = \text{power including reverse current losses and switching losses up to } f = 500 \text{ kHz}. \]

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

\[ \delta = \frac{t_p}{T} \]
Ultra fast recovery rectifier diodes

SINUSOIDAL OPERATION

\[ a = \frac{I_F(\text{RMS})}{I_F(\text{AV})} \]

- \( P \) = power excluding switching losses but including reverse current losses

Interrelation between the power (derived from the left-hand graph) and the maximum permissible temperatures

\[ P = \text{power excluding switching losses but including reverse current losses} \]

\[ P \text{ (W)} \]

\[ I_F(\text{AV}) \text{ (A)} \]

\[ T_{\text{amb}} (\text{°C}) \]

Fig.6

August 1986
Fig. 7 Maximum permissible repetitive peak forward current for square or sinusoidal currents; 
1 µs < t_p < 1 ms.

Fig. 8. Definition of I_{FRM} and t_p/T.
Ultra fast recovery rectifier diodes

Fig. 9 Maximum $t_{rr}$ at $T_j = 25 \, ^\circ\text{C}$.

Fig. 10 Maximum $t_{rr}$ at $T_j = 100 \, ^\circ\text{C}$.

Fig. 11 Maximum $Q_s$ at $T_j = 25 \, ^\circ\text{C}$.
Fig. 12 Maximum $I_{RRM}$ at $T_j = 25^\circ$C.

Fig. 13 Maximum $I_{RRM}$ at $T_j = 100^\circ$C.

Fig. 14 Transient thermal impedance.
ULTRA FAST RECOVERY RECTIFIER DIODES

Glass-passivated, high-efficiency epitaxial rectifier diodes in D0-5 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

<table>
<thead>
<tr>
<th>Repetitive peak reverse voltage $V_{RRM}$</th>
<th>BYV92-300</th>
<th>400</th>
<th>500</th>
</tr>
</thead>
<tbody>
<tr>
<td>max.</td>
<td>300</td>
<td>400</td>
<td>500</td>
</tr>
<tr>
<td>Average forward current $I_F(\text{AV})$ max.</td>
<td>35 A</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Forward voltage $V_F$ &lt; 1.05 V</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Reverse recovery time $t_{rr}$ &lt; 50 ns</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

MECHANICAL DATA

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

<table>
<thead>
<tr>
<th></th>
<th>BYV92-300</th>
<th>400</th>
<th>500</th>
</tr>
</thead>
<tbody>
<tr>
<td>Repetitive peak reverse voltage</td>
<td>$V_{RRM}$ max.</td>
<td>300</td>
<td>400</td>
</tr>
<tr>
<td>Crest working reverse voltage</td>
<td>$V_{RWM}$ max.</td>
<td>200</td>
<td>300</td>
</tr>
<tr>
<td>Continuous reverse voltage*</td>
<td>$V_R$ max.</td>
<td>200</td>
<td>300</td>
</tr>
</tbody>
</table>

### Currents

<table>
<thead>
<tr>
<th></th>
<th>BYV92-300</th>
<th>400</th>
<th>500</th>
</tr>
</thead>
<tbody>
<tr>
<td>Average forward current; switching losses negligible up to 100 kHz square wave, $\delta = 0.5$, up to $T_{mb} = 100 \degree C$</td>
<td>$I_{F(AV)}$ max.</td>
<td>38</td>
<td>A</td>
</tr>
<tr>
<td>up to $T_{mb} = 125 \degree C$</td>
<td>$I_{F(AV)}$ max.</td>
<td>21</td>
<td>A</td>
</tr>
<tr>
<td>sinusoidal, up to $T_{mb} = 106 \degree C$</td>
<td>$I_{F(AV)}$ max.</td>
<td>34</td>
<td>A</td>
</tr>
<tr>
<td>up to $T_{mb} = 125 \degree C$</td>
<td>$I_{F(AV)}$ max.</td>
<td>21</td>
<td>A</td>
</tr>
<tr>
<td>R.M.S. forward current</td>
<td>$I_{F(RMS)}$ max.</td>
<td>55</td>
<td>A</td>
</tr>
<tr>
<td>Repetitive peak forward current</td>
<td>$I_{FRM}$ max.</td>
<td>800</td>
<td>A</td>
</tr>
<tr>
<td>Non-repetitive peak forward current half sine-wave, $T_j = 150 \degree C$ prior to surge</td>
<td>$I_{FSM}$ max.</td>
<td>500</td>
<td>A</td>
</tr>
<tr>
<td>$t = 10 \text{ ms}$</td>
<td>$I_{FSM}$ max.</td>
<td>600</td>
<td>A</td>
</tr>
<tr>
<td>$t = 8.3 \text{ ms}$</td>
<td>$I_{FSM}$ max.</td>
<td>350</td>
<td>A</td>
</tr>
<tr>
<td>with reapplied $V_{RWM}$ max</td>
<td>$I_{FSM}$ max.</td>
<td>440</td>
<td>A</td>
</tr>
<tr>
<td>$t = 10 \text{ ms}$</td>
<td>$I_{FSM}$ max.</td>
<td>610</td>
<td>A</td>
</tr>
<tr>
<td>$t = 8.3 \text{ ms}$</td>
<td>$I_{FSM}$ max.</td>
<td>610</td>
<td>A</td>
</tr>
<tr>
<td>$I^2 t$ for fusing ($t = 10 \text{ ms}$)</td>
<td>$I^2 t$ max.</td>
<td>610</td>
<td>$A^2 \text{s}$</td>
</tr>
</tbody>
</table>

### Temperatures

<p>| | |</p>
<table>
<thead>
<tr>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>Storage temperature</td>
<td>$T_{stg}$</td>
</tr>
<tr>
<td>Junction temperature</td>
<td>$T_j$</td>
</tr>
</tbody>
</table>

### THERMAL RESISTANCE

<p>| | |</p>
<table>
<thead>
<tr>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>From junction to mounting base</td>
<td>$R_{th j-mb}$ = 1.0 $\text{K/W}$</td>
</tr>
<tr>
<td>From mounting base to heatsink with heatsink compound</td>
<td>$R_{th mb-h}$ = 0.3 $\text{K/W}$</td>
</tr>
<tr>
<td>without heatsink compound</td>
<td>$R_{th mb-h}$ = 0.5 $\text{K/W}$</td>
</tr>
</tbody>
</table>

### MOUNTING INSTRUCTIONS

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

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

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*400 September 1985*
Ultra fast recovery rectifier diodes

BYV92 SERIES

CHARACTERISTICS

Forward voltage
- $I_F = 35$ A; $T_j = 150$ °C
- $I_F = 100$ A; $T_j = 25$ °C

Reverse current
- $V_R = V_{RWM_{\text{max}}}; T_j = 100$ °C
- $T_j = 25$ °C

Reverse recovery when switched from
- $I_F = 1$ A to $V_R \geq 30$ V with $-\frac{dI_F}{dt} = 100$ A/µs;
  $T_j = 25$ °C; recovery time
- $I_F = 2$ A to $V_R \geq 30$ V with $-\frac{dI_F}{dt} = 20$ A/µs;
  $T_j = 25$ °C; recovered charge
- $I_F = 10$ A to $V_R \geq 30$ V with $-\frac{dI_F}{dt} = 50$ A/µs;
  $T_j = 100$ °C; peak recovery current

Forward recovery when switched to $I_F = 10$ A
with $\frac{dI_F}{dt} = 10$ A/µs; $T_j = 25$ °C

*Measured under pulse conditions to avoid excessive dissipation.
Fig. 4 The right-hand part shows the relationship between the power (derived from the left-hand part) and the maximum permissible temperatures. Power includes reverse current losses and switching losses up to $f = 100$ kHz.

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

$T_{mb}$ scale is for comparison purposes and is correct only for $R_{th \: mb-a} < 2.4 \: K/W$. 

September 1985
Fig. 5 The right-hand part shows the interrelationship between the power (derived from the left-hand part) and the maximum permissible temperatures.

\[ a = \text{form factor} = \frac{I_F(\text{RMS})}{I_F(\text{AV})} \]
Fig. 6 Maximum permissible repetitive peak forward current for square or sinusoidal currents; $1 \mu s < t_p < 1 \text{ ms}$.

Fig. 7 — $T_j = 25 \text{ °C}; \ldots \ldots T_j = 150 \text{ °C}$.
Ultra fast recovery rectifier diodes

BYV92 SERIES

Fig. 8 Maximum $t_{rr}$ at $T_j = 25^\circ C$.

Fig. 9 Maximum $t_{rr}$ at $T_j = 100^\circ C$.

Fig. 10 Maximum $Q_s$ at $T_j = 25^\circ C$. 

$10^{-3}$ $t_{rr}$ (ns)

$10^{-2}$

$10^{-1}$

$10^0$

$10^1$

$10^2$

$10^3$

$10^{-2}$ $-dI_F/dt$ (A/µs) $10^2$

$10^{-1}$

$10^0$

$10^1$

$10^2$

$10^3$

$10^{-2}$ $-dI_F/dt$ (A/µs) $10^2$

$10^{-1}$

$10^0$

$10^1$

$10^2$

$10^3$
Fig. 11 Maximum $I_{RRM}$ at $T_j = 25 \, ^\circ C$.

Fig. 12 Maximum $I_{RRM}$ at $T_j = 100 \, ^\circ C$.

Fig. 13 Transient thermal impedance.
FAST SOFT-RECOVERY RECTIFIER DIODES

Fast soft-recovery diodes in D0-5 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:
Reverse polarity (anode to stud): BYW25–800R and BYW25–1000R.

QUICK REFERENCE DATA

<table>
<thead>
<tr>
<th></th>
<th>BYW25–800(R)</th>
<th>1000(R)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Repetitive peak reverse voltage</td>
<td></td>
<td></td>
</tr>
<tr>
<td>$V_{RRM}$ max.</td>
<td>800</td>
<td>1000</td>
</tr>
<tr>
<td>Average forward current</td>
<td></td>
<td></td>
</tr>
<tr>
<td>$I_{F(AV)}$ max.</td>
<td>40</td>
<td>A</td>
</tr>
<tr>
<td>Repetitive peak forward current</td>
<td></td>
<td></td>
</tr>
<tr>
<td>$I_{FRM}$ max.</td>
<td>600</td>
<td>A</td>
</tr>
<tr>
<td>Reverse recovery time</td>
<td></td>
<td></td>
</tr>
<tr>
<td>$t_{rr}$ &lt;</td>
<td>450</td>
<td>ns</td>
</tr>
</tbody>
</table>

MECHANICAL DATA

Fig. 1 DO-5: with metric M6 stud (Ø6 mm)

Dimensions in mm

Net mass: 22 g
Diameter of clearance hole: max. 6.5 mm
Accessories supplied on request:
see ACCESSORIES section
The mark shown applies to normal polarity types.

Supplied with device: 1 nut, 1 lock washer
Torque on nut: min. 1.7 Nm (17 kg cm)
max. 3.5 Nm (35 kg cm)
Nut dimensions across the flats: 10 mm
RATINGS
Limiting values in accordance with the Absolute Maximum System (IEC 134)

<table>
<thead>
<tr>
<th>Voltages*</th>
<th>BYW25–800(R)</th>
<th>1000(R)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Non-repetitive peak reverse voltage</td>
<td>$V_{RSM}$  max.</td>
<td>1000    V</td>
</tr>
<tr>
<td>Repetitive peak reverse voltage</td>
<td>$V_{RRM}$  max.</td>
<td>800     V</td>
</tr>
<tr>
<td>Crest working reverse voltage</td>
<td>$V_{RWM}$  max.</td>
<td>650     V</td>
</tr>
<tr>
<td>Continuous reverse voltage</td>
<td>$V_R$       max.</td>
<td>650     V</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Currents</th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>Average forward current;</td>
<td></td>
<td></td>
</tr>
<tr>
<td>switching losses negligible up to 20 kHz</td>
<td>$I_{F(AV)}$ max.</td>
<td>40 A</td>
</tr>
<tr>
<td>sinusoidal; up to $T_{mb} = 100 , ^\circ C$</td>
<td>$I_{F(AV)}$ max.</td>
<td>23 A</td>
</tr>
<tr>
<td>sinusoidal; at $T_{mb} = 125 , ^\circ C$</td>
<td>$I_{F(RMS)}$ max.</td>
<td>60 A</td>
</tr>
<tr>
<td>Repetitive peak forward current</td>
<td>$I_{FRM}$ max.</td>
<td>600 A</td>
</tr>
<tr>
<td>Non-repetitive peak forward current;</td>
<td>$I_{FSM}$ max.</td>
<td>550 A</td>
</tr>
<tr>
<td>$t = 10 , ms$; half sine-wave;</td>
<td>$I^2 t$ max.</td>
<td>1500 $A^2$ s</td>
</tr>
<tr>
<td>$T_j = 150 , ^\circ C$ prior to surge</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

| Temperatures                  |            |         |
| Storage temperature           | $T_{stg}$  | $-55$ to $+150 \, ^\circ C$ |
| Junction temperature          | $T_j$      | max.    | $150 \, ^\circ C$ |

THERMAL RESISTANCE

| From junction to mounting base | $R_{th \, j-mb}$ | 0.6 $^\circ C/W$ |
| From mounting base to heatsink | $R_{th \, mb-h}$ | 0.3 $^\circ C/W$ |
| with heatsink compound         |            |         |
| without heatsink compound      | $R_{th \, mb-h}$ | 0.5 $^\circ C/W$ |

*To ensure thermal stability: $R_{th \, j-a} \leq 1 \, ^\circ C/W$ (continuous reverse voltage).
CHARACTERISTICS

Forward voltage

<table>
<thead>
<tr>
<th>$I_F$</th>
<th>$V_F$</th>
<th>$T_j$</th>
</tr>
</thead>
<tbody>
<tr>
<td>35 A</td>
<td>&lt; 1.55 V</td>
<td>25 °C</td>
</tr>
<tr>
<td>150 A</td>
<td>&lt; 2.25 V</td>
<td>25 °C</td>
</tr>
</tbody>
</table>

Reverse current

$V_R = 650$ V; $T_j = 125$ °C

$|I_R| < 7$ mA

Reverse recovery when switched from $I_F = 10$ A to $V_R = 30$ V with $-dI_F/dt = 50$ A/µs; $T_j = 25$ °C

$\tau_{rr} < 450$ ns

$I_F = 600$ A to $V_R > 30$ V with $-dI_F/dt = 70$ A/µs; $T_{mb} = 85$ °C

$\tau_{rr} < 1$ µs

Maximum slope of the reverse recovery current when switched from $I_F = 600$ A to $V_R > 30$ V; with $-dI_F/dt = 35$ A/µs; $T_j = 25$ °C

$\left| \frac{dI_R}{dt} \right| < 100$ A/µs

---

* Measured under pulse conditions to avoid excessive dissipation.
Fig. 4 The right-hand part shows the interrelationship between the power (derived from the left-hand part) and the maximum permissible temperatures.

$P =$ power including reverse current losses and switching losses up to $f = 20 \text{ kHz}$.

$a = \frac{I_{F(RMS)}}{I_{F(AV)}}$.
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

<table>
<thead>
<tr>
<th></th>
<th>BYW29-50</th>
<th>100</th>
<th>150</th>
<th>200</th>
</tr>
</thead>
<tbody>
<tr>
<td>Repetitive peak reverse voltage</td>
<td>V_{RRM}</td>
<td>max.</td>
<td>50</td>
<td>100</td>
</tr>
<tr>
<td>Average forward current</td>
<td>I_{F(AV)}</td>
<td>max.</td>
<td>8</td>
<td>A</td>
</tr>
<tr>
<td>Forward voltage</td>
<td>V_{F}</td>
<td>&lt;</td>
<td>0.8</td>
<td>V</td>
</tr>
<tr>
<td>Reverse recovery time</td>
<td>t_{rr}</td>
<td>&lt;</td>
<td>25</td>
<td>ns</td>
</tr>
</tbody>
</table>

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.

Products approved to CECC 50 009-014 available on request.
RATINGS
Limiting values in accordance with the Absolute Maximum System (IEC 134).

<table>
<thead>
<tr>
<th>Voltages</th>
<th>BYW29-50</th>
<th>100</th>
<th>150</th>
<th>200</th>
<th>V</th>
</tr>
</thead>
<tbody>
<tr>
<td>Repetitive peak reverse voltage $V_{RRM}$</td>
<td>max.</td>
<td>50</td>
<td>100</td>
<td>150</td>
<td>200</td>
</tr>
<tr>
<td>Crest working reverse voltage $V_{RWM}$</td>
<td>max.</td>
<td>50</td>
<td>100</td>
<td>150</td>
<td>200</td>
</tr>
<tr>
<td>Continuous reverse voltage (note 1) $V_R$</td>
<td>max.</td>
<td>50</td>
<td>100</td>
<td>150</td>
<td>200</td>
</tr>
</tbody>
</table>

Currents
Average forward current; switching losses negligible up to 500 kHz square wave; $\delta = 0.5$; up to $T_{mb} = 125 ^\circ C$

- $I_{F(AV)}$ max. 8 A
- $I_{F(AV)}$ max. 7.3 A

R.M.S. forward current
- $I_{FRM}$ max. 240 A

Repetitive peak forward current $t_p = 20 \mu s; \delta = 0.02$
- $I_{FSM}$ max. 80 A
- $I_{FSM}$ max. 100 A

Non-repetitive peak forward current half sine-wave; $T_j = 150 ^\circ C$ prior to surge; with reapplied $V_{RWM}$ max:
- $t = 10 \text{ ms}$
- $I_{FSM}$ max. 80 A
- $I_{FSM}$ max. 100 A

$I^2t$ for fusing ($t = 10 \text{ ms}$)
- $I^2t$ max. 32 A^2s

Temperatures
Storage temperature
- $T_{stg}$ -40 to +150 °C

Junction temperature
- $T_j$ max. 150 °C

Notes:
1. To ensure thermal stability: $R_{thj-a} < 11.6 \text{ K/W}$
Ultra fast recovery rectifier diodes

BYW29 SERIES

CHARACTERISTICS

Forward voltage

\[ I_F = 8 \text{ A}; \ T_j = 150 \ ^\circ\text{C} \]
\[ I_F = 20 \text{ A}; \ T_j = 25 \ ^\circ\text{C} \]
\[ V_F < 0.8 \ \text{V}^* \]
\[ V_F < 1.3 \ \text{V}^* \]

Reverse current

\[ V_R = V_{RWM\ max}; \ T_j = 100 \ ^\circ\text{C} \]
\[ I_R < 0.6 \ \text{mA} \]
\[ I_R < 10 \ \mu\text{A} \]

Reverse recovery when switched from

\[ I_F = 1 \text{ A} \text{ to } V_R \geq 30 \text{ V} \text{ with } -\frac{dI_F}{dt} = 100 \text{ A/µs}; \]
\[ T_j = 25 \ ^\circ\text{C} \]; recovery time
\[ t_{rr} < 25 \ \text{ns} \]

\[ I_F = 2 \text{ A} \text{ to } V_R \geq 30 \text{ V} \text{ with } -\frac{dI_F}{dt} = 20 \text{ A/µs}; \]
\[ T_j = 25 \ ^\circ\text{C} \]; recovered charge
\[ Q_s < 11 \ \text{nC} \]

\[ I_F = 10 \text{ A} \text{ to } V_R \geq 30 \text{ V} \text{ with } -\frac{dI_F}{dt} = 50 \text{ A/µs}; \]
\[ T_j = 100 \ ^\circ\text{C} \]; peak recovery current
\[ I_{RRM} < 2 \ \text{A} \]

Forward recovery when switched to \( I_F = 1 \text{ A} \)
with \( \frac{dI_F}{dt} = 10 \text{ A/µs}; \ T_j = 25 \ ^\circ\text{C} \)
\[ V_{fr} \text{ typ.} < 0.9 \ \text{V} \]

*Measured under pulse conditions to avoid excessive dissipation.
THERMAL RESISTANCE

From junction to mounting base

\[ R_{th \ j-mb} = 2.7 \text{ K/W} \]

Influence of mounting method

1. Heatsink mounted with clip (see mounting instructions)

Thermal resistance from mounting base to heatsink

\[ R_{th \ mb-h} = \]

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

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

\[ R_{th \ j-a} = 60 \text{ K/W} \]
MOUNTING INSTRUCTIONS

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

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

3. Mounting by means of a spring clip is the best mounting method because it offers:
   a. a good thermal contact under the crystal area and slightly lower $R_{th \, mb-h}$ values than does
      screw mounting.
   b. safe isolation for mains operation.

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

4. For good thermal contact, heatsink compound should be used between mounting base and heatsink.

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

5. Rivet mounting (only possible for non-insulated mounting).

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

OPERATING NOTES

Dissipation and heatsink calculations

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

\[
\begin{align*}
R_{th \, j-mb} & \quad \text{junction} \\
R_{th \, mb-h} & \quad \text{mounting base} \\
R_{th \, h-a} & \quad \text{heatsink} \\
\text{ambient} & \quad \text{Fig. 4.}
\end{align*}
\]

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. Power includes reverse current losses and switching losses up to $f = 500 \, \text{kHz}$.

$$I_F(\text{AV}) = I_F(\text{RMS}) \times \sqrt{\delta}$$

$^*T_{mb}$ scale is for comparison purposes and is correct only for $R_{th \, mb-a} < 8.9 \, \text{K/W}$. 

---

**BYW29 SERIES**

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

\[ a = \text{form factor} = \frac{I_F(\text{RMS})}{I_F(\text{AV})}. \]
Fig. 7 Maximum permissible repetitive peak forward current for square or sinusoidal currents; 1 µs < t_p < 1 ms.

Fig. 8 — T_j = 25 °C; — — — T_j = 150 °C.
Ultra fast recovery rectifier diodes

Fig. 9 Maximum $t_{rr}$ at $T_j = 25^\circ C$.

Fig. 10 Maximum $t_{rr}$ at $T_j = 100^\circ C$.

Fig. 11 Maximum $Q_s$ at $T_j = 25^\circ C$. 

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Fig. 12 Maximum $I_{RRM}$ at $T_j = 25^\circ C$.

Fig. 13 Maximum $I_{RRM}$ at $T_j = 100^\circ C$.

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

<table>
<thead>
<tr>
<th>Parameter</th>
<th>BYW29F-50</th>
<th>100</th>
<th>150</th>
<th>200</th>
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</thead>
<tbody>
<tr>
<td>Repetitive peak reverse voltage</td>
<td>VRRM max.</td>
<td>50</td>
<td>100</td>
<td>150</td>
</tr>
<tr>
<td>Average forward current</td>
<td>IF(AV) max.</td>
<td>8</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Forward voltage</td>
<td>VF</td>
<td>&lt;</td>
<td>0.8</td>
<td></td>
</tr>
<tr>
<td>Reverse recovery time</td>
<td>t_{rr}</td>
<td>&lt;</td>
<td>25</td>
<td></td>
</tr>
</tbody>
</table>

MECHANICAL DATA

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

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).
**RATINGS**

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

<table>
<thead>
<tr>
<th>Volatges</th>
<th>BYW29F-50</th>
<th>100</th>
<th>150</th>
<th>200</th>
</tr>
</thead>
<tbody>
<tr>
<td>Repetitive peak reverse voltage</td>
<td>$V_{RRM}$ max.</td>
<td>50</td>
<td>100</td>
<td>150</td>
</tr>
<tr>
<td>Crest working reverse voltage</td>
<td>$V_{RWM}$ max.</td>
<td>50</td>
<td>100</td>
<td>150</td>
</tr>
<tr>
<td>Continuous reverse voltage (note 1)</td>
<td>$V_R$ max.</td>
<td>50</td>
<td>100</td>
<td>150</td>
</tr>
</tbody>
</table>

**Currents**

Average forward current; switching losses negligible up to 500 kHz (note 2);
- square wave; $\delta = 0.5$; up to $T_{mb} = 108 \, ^oC$
- sinusoidal; up to $T_{mb} = 114 \, ^oC$

<table>
<thead>
<tr>
<th>Currents</th>
<th>(I_F(AV)) max.</th>
<th>8 A</th>
</tr>
</thead>
<tbody>
<tr>
<td>(I_F(AV)) max.</td>
<td>7.3 A</td>
<td></td>
</tr>
</tbody>
</table>

R.M.S. forward current

<table>
<thead>
<tr>
<th>Currents</th>
<th>(I_{FRM}) max.</th>
<th>240 A</th>
</tr>
</thead>
</table>

Repetitive peak forward current

<table>
<thead>
<tr>
<th>Currents</th>
<th>(I_{FSM}) max.</th>
<th>80 A</th>
</tr>
</thead>
<tbody>
<tr>
<td>(I_{FSM}) max.</td>
<td>100 A</td>
<td></td>
</tr>
</tbody>
</table>

\(I^2 t\) for fusing (t = 10 ms)

<table>
<thead>
<tr>
<th>Currents</th>
<th>(I^2 t) max.</th>
<th>32 A^2 s</th>
</tr>
</thead>
</table>

**Temperatures**

<table>
<thead>
<tr>
<th>Temperatures</th>
<th>(T_{stg})</th>
<th>-40 to +150 °C</th>
</tr>
</thead>
<tbody>
<tr>
<td>Junction temperature</td>
<td>(T_j) max.</td>
<td>150 °C</td>
</tr>
</tbody>
</table>

**ISOLATION**

Peak isolation voltage from all terminals to external heatsink

<table>
<thead>
<tr>
<th>Isolation voltage</th>
<th>(V_{isol}) max.</th>
<th>1000 V</th>
</tr>
</thead>
</table>

Isolation capacitance from cathode to external heatsink (note 3)

<table>
<thead>
<tr>
<th>Isolation capacitance</th>
<th>(C_p) typ.</th>
<th>12 pF</th>
</tr>
</thead>
</table>

**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.
Ultra fast recovery, isolated rectifier diodes

**BYW29F SERIES**

**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

\[
\begin{align*}
R_{th \, j-h} & = 5.5 \text{ K/W} \\
R_{th \, j-h} & = 7.2 \text{ K/W}
\end{align*}
\]

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

\[
R_{th \, j-a} = 55 \text{ K/W}
\]

**CHARACTERISTICS**

\( T_j = 25 \degree C \) unless otherwise stated

**Forward voltage**

\[
\begin{align*}
I_F & = 8 \, A; \ T_j = 150 \degree C \\
I_F & = 20 \, A
\end{align*}
\]

**Reverse current**

\[
\begin{align*}
V_R & = V_{RWM \, max}; \ T_j = 100 \degree C \\
V_R & = V_{RWM \, max}
\end{align*}
\]

Reverse recovery when switched from

\[
\begin{align*}
I_F & = 1 \, A \text{ to } V_R \geq 30 \, V \text{ with } \frac{-dI_F}{dt} = 100 \, A/\mu s; \text{ recovery time} \\
I_F & = 2 \, A \text{ to } V_R \geq 30 \, V \text{ with } \frac{-dI_F}{dt} = 20 \, A/\mu s; \text{ recovered charge} \\
I_F & = 10 \, A \text{ to } V_R \geq 30 \, V \text{ with } \frac{-dI_F}{dt} = 50 \, A/\mu s; \text{ } T_j = 100 \degree C; \text{ peak recovery current}
\end{align*}
\]

Forward recovery when switched to \( I_F = 1 \, A \) with \( \frac{dI_F}{dt} = 10 \, A/\mu s \)

\[
\begin{align*}
V_f & < 0.8 \, V^* \\
V_f & < 1.3 \, V^*
\end{align*}
\]

\[
\begin{align*}
I_R & < 0.6 \, mA \\
I_R & < 10 \, \mu A
\end{align*}
\]

\[
\begin{align*}
t_{rr} & < 25 \, ns \\
Q_s & < 11 \, nC \\
I_{RRM} & < 2 \, A \\
V_{fr} & \text{ typ. } 0.9 \, V
\end{align*}
\]

*Measured under pulse conditions to avoid excessive dissipation.*
MOUNTING INSTRUCTIONS

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

2. The leads should not be bent less than 2.4 mm from the seal, and should be supported during bending. The bend radius must be no less than 1 mm.

3. Mounting by means of a spring clip is the best mounting method because it offers a good thermal contact under the crystal area and slightly lower $R_{th\ j-h}$ values than screw mounting. The force exerted on the top of the device by the clip should be at least 2 kgf (20 Newtons) to ensure good thermal contact and must not exceed 3.5 kgf (35 Newtons) to avoid damage to the device.

4. If screw mounting is used, it should be M3 cross-recess pan head.
   Minimum torque to ensure good thermal contact: 5.5 kgf (0.55 Nm)
   Maximum torque to avoid damage to the device: 8.0 kgf (0.80 Nm)

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

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

7. The heatsink must have a flatness in the mounting area of 0.02 mm maximum per 10 mm. Mounting holes must be deburred.

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

![Diagram](https://via.placeholder.com/150)

Any measurement of heatsink temperature should be immediately adjacent to the device.
Ultra fast recovery, isolated rectifier diodes

**SQUARE-WAVE OPERATION**

Fig.5 Power rating.
The power loss in the diode should first be determined from the required forward current on the $I_{F(AV)}$ axis and the appropriate duty cycle.

Having determined the power ($P$), use Fig.7 (if heatsink compound is not being used) or Fig.8 (if heatsink compound is being used) to determine the heatsink size and corresponding maximum ambient and heatsink temperatures.

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

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

**SINUSOIDAL OPERATION**

Fig.6 Power rating.
The power loss in the diode should first be determined from the required forward current on the $I_{F(AV)}$ axis and the appropriate form factor.

Having determined the power ($P$), use Fig.7 (if heatsink compound is not being used) or Fig.8 (if heatsink compound is being used) to determine the heatsink size and corresponding maximum ambient and heatsink temperatures.

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

$$a = \text{form factor} = \frac{I_{F(RMS)}}{I_{F(AV)}}$$
Fig. 7 Heatsink rating; without heatsink compound.

Fig. 8 Heatsink rating; with heatsink compound.
Ultra fast recovery, isolated rectifier diodes

BYW29F SERIES

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

Fig. 10 $T_j = 25 \text{ °C}$; $\ldots$ $T_j = 150 \text{ °C}$. 

Definition of $I_{FRM}$ and $t_p/T$. 
Fig. 11 Maximum \( t_{rr} \) at \( T_j = 25°C \).

Fig. 12 Maximum \( t_{rr} \) at \( T_j = 100°C \).

Fig. 13 Maximum \( Q_s \) at \( T_j = 25°C \).
Ultra fast recovery, isolated rectifier diodes

**BYW29F SERIES**

![Graphs](image)

**Fig. 14** Maximum $I_{RRM}$ at $T_j = 25 \degree C$.

**Fig. 15** Maximum $I_{RRM}$ at $T_j = 100 \degree C$.

**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

<table>
<thead>
<tr>
<th></th>
<th>BYW30-50</th>
<th>100</th>
<th>150</th>
<th>200</th>
</tr>
</thead>
<tbody>
<tr>
<td>Repetitive peak reverse voltage ( V_{RRM} ) max.</td>
<td>50</td>
<td>100</td>
<td>150</td>
<td>200</td>
</tr>
<tr>
<td>Average forward current ( I_{F(AV)} ) max.</td>
<td>14</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Forward voltage ( V_F ) &lt;</td>
<td>0.8</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Reverse recovery time t(_r) &lt;</td>
<td>30</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

MECHANICAL DATA

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)

<table>
<thead>
<tr>
<th>Voltages*</th>
<th>BYW30-50</th>
<th>100</th>
<th>150</th>
<th>200</th>
</tr>
</thead>
<tbody>
<tr>
<td>Repetitive peak reverse voltage</td>
<td>$V_{RRM}$</td>
<td>max. 50</td>
<td>100</td>
<td>150</td>
</tr>
<tr>
<td>Crest working reverse voltage</td>
<td>$V_{RWM}$</td>
<td>max. 50</td>
<td>100</td>
<td>150</td>
</tr>
<tr>
<td>Continuous reverse voltage</td>
<td>$V_R$</td>
<td>max. 50</td>
<td>100</td>
<td>150</td>
</tr>
</tbody>
</table>

Currents

Average forward current; switching losses negligible up to 500 kHz

- square wave; $\delta = 0.5$; up to $T_{mb} = 120 \, ^{\circ}C$
- up to $T_{mb} = 125 \, ^{\circ}C$

- sinusoidal; up to $T_{mb} = 125 \, ^{\circ}C$

R.M.S. forward current

Repetitive peak forward current

$tp = 20 \, \mu s; \delta = 0.02$

Non-repetitive peak forward current

- half sine-wave; $T_j = 150 \, ^{\circ}C$ prior to surge;
- with reapplied $V_{RWM\text{max}}$

- $t = 10 \, ms$
- $t = 8.3 \, ms$

$1^2 t$ for fusing ($t = 10 \, ms$)

Temperatures

Storage temperature $T_{stg}$

Junction temperature $T_j$

<table>
<thead>
<tr>
<th>Temperatures</th>
<th>$T_{stg}$</th>
<th>$T_j$</th>
</tr>
</thead>
<tbody>
<tr>
<td>-55 to +150 $^{\circ}C$</td>
<td>max. 150 $^{\circ}C$</td>
<td></td>
</tr>
</tbody>
</table>

THERMAL RESISTANCE

From junction to mounting base $R_{th j-mb} = 2.2 \, K/W$

From mounting base to heatsink

- a. with heatsink compound $R_{th mb-h} = 0.5 \, K/W$
- b. without heatsink compound $R_{th mb-h} = 0.6 \, K/W$

Transient thermal impedance; $t = 1 \, ms$

$Z_{th j-mb} = 0.3 \, K/W$

MOUNTING INSTRUCTIONS

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

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

*To ensure thermal stability: $R_{th j-a} \leq 5.6 \, K/W$ (continuous reverse voltage).
Ultra fast recovery rectifier diodes

BYW30 SERIES

CHARACTERISTICS

Forward voltage

\[ V_F \leq 0.8 \text{ V}^* \]
\[ V_F \leq 1.3 \text{ V}^* \]

Reverse current

\[ I_R \leq 1.3 \text{ mA} \]
\[ I_R \leq 50 \text{ } \mu\text{A} \]

Reverse recovery when switched from

\[ I_F = 1 \text{ A to } V_R \geq 30 \text{ V with } -dI_F/dt = 100 \text{ A/µs}; \]
\[ T_j = 25 \text{ °C}; \text{ recovery time} \]
\[ t_{rr} \leq 30 \text{ ns} \]

\[ I_F = 2 \text{ A to } V_R \geq 30 \text{ V with } -dI_F/dt = 20 \text{ A/µs}; \]
\[ T_j = 25 \text{ °C}; \text{ recovered charge} \]
\[ Q_s \leq 15 \text{ nC} \]

\[ I_F = 10 \text{ A to } V_R \geq 30 \text{ V with } -dI_F/dt = 50 \text{ A/µs}; \]
\[ T_j = 100 \text{ °C}; \text{ peak recovery current} \]
\[ I_{RRM} \leq 4 \text{ A} \]

Forward recovery when switched to \( I_F = 10 \text{ A} \)

\[ V_{fr} \text{ typ. } 1.0 \text{ V} \]

*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.

\[
I_F^{(AV)} = I_F^{(RMS)} \times \sqrt{\delta}
\]

\( T_{mb} \) scale is for comparison purposes and is correct only for \( R_{th \ mb-a} < 3.1 \) K/W.
Ultra fast recovery rectifier diodes

BYW 30 SERIES

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.

\[ a = \text{form factor} = \frac{I_{F(RMS)}}{I_{F(AV)}}. \]

*The Tmb scale is for comparison purposes and is correct only for \( R_{th mb-a} < 17 \text{ K/W}. \)
Fig. 6 Maximum permissible repetitive peak forward current for square or sinusoidal currents; $1 \mu s < t_p < 1$ ms.

Fig. 7 $T_j = 25^\circ C$; $T_j = 150^\circ C$. 

Definition of $I_{FRM}$ and $t_p/T$. 
Ultra fast recovery rectifier diodes

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

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

Fig. 10 Maximum $Q_s$ at $T_j = 25$ °C.
Fig. 11 Maximum $I_{RRM}$ at $T_j = 25 \, ^\circ C$.

Fig. 12 Maximum $I_{RRM}$ at $T_j = 100 \, ^\circ C$.

Fig. 13 Transient thermal impedance.
ULTRA FAST RECOVERY RECTIFIER DIODES

Glass-passivated, high-efficiency epitaxial rectifier diodes in DO-4 metal envelopes, featuring low forward voltage drop, ultra fast reverse recovery times, very low stored charge and soft recovery characteristic. They are intended for use in switched-mode power supplies and high-frequency circuits in general, where low conduction and switching losses are essential. The series consists of normal polarity (cathode to stud) types.

QUICK REFERENCE DATA

<table>
<thead>
<tr>
<th>Parameter</th>
<th>BYW31-50</th>
<th>100</th>
<th>150</th>
<th>200</th>
</tr>
</thead>
<tbody>
<tr>
<td>Repetitive peak reverse voltage</td>
<td>V_{RRM}</td>
<td>max.</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Average forward current</td>
<td>I_{F(AV)}</td>
<td>max.</td>
<td>28</td>
<td>A</td>
</tr>
<tr>
<td>Forward voltage</td>
<td>V_F</td>
<td>&lt;</td>
<td>0.8</td>
<td>V</td>
</tr>
<tr>
<td>Reverse recovery time</td>
<td>t_{rr}</td>
<td>&lt;</td>
<td>40</td>
<td>ns</td>
</tr>
</tbody>
</table>

MECHANICAL DATA

Fig.1 DO-4; with metric M5 stud (φ5 mm); e.g. BYW31-50.
with 10-32 UNF stud (φ4.83 mm); e.g. BYW31-50U.

Net mass: 7 g
Diameter of clearance hole: max. 5.2 mm

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)

Accessories supplied on request:
see ACCESSORIES section.

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.

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RATINGS

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

**Voltages**

<table>
<thead>
<tr>
<th>BYW31—50</th>
<th>100</th>
<th>150</th>
<th>200</th>
</tr>
</thead>
<tbody>
<tr>
<td>REPETITIVE PEAK REVERSE VOLTAGE</td>
<td>( V_{RRM} )</td>
<td>max.</td>
<td>50</td>
</tr>
<tr>
<td>CREST WORKING REVERSE VOLTAGE</td>
<td>( V_{RWM} )</td>
<td>max.</td>
<td>50</td>
</tr>
<tr>
<td>CONTINUOUS REVERSE VOLTAGE*</td>
<td>( V_R )</td>
<td>max.</td>
<td>50</td>
</tr>
</tbody>
</table>

**Currents**

Average forward current; switching

- losses negligible up to 500 kHz
- square wave; \( \delta = 0.5 \); up to \( T_{mb} = 122 \, \text{°C} \)
- up to \( T_{mb} = 125 \, \text{°C} \)

- sinusoidal; up to \( T_{mb} = 127 \, \text{°C} \)

- R.M.S. forward current

<table>
<thead>
<tr>
<th>IF(AV)</th>
<th>max.</th>
<th>28</th>
<th>A</th>
</tr>
</thead>
<tbody>
<tr>
<td>IF(AV)</td>
<td>max.</td>
<td>26</td>
<td>A</td>
</tr>
<tr>
<td>IF(AV)</td>
<td>max.</td>
<td>25</td>
<td>A</td>
</tr>
</tbody>
</table>

Repetitive peak forward current

- \( t_p = 20 \, \mu s; \delta = 0.02 \)

<table>
<thead>
<tr>
<th>IF(RMS)</th>
<th>max.</th>
<th>40</th>
<th>A</th>
</tr>
</thead>
<tbody>
<tr>
<td>FRM</td>
<td>max.</td>
<td>550</td>
<td>A</td>
</tr>
</tbody>
</table>

Non-repetitive peak forward current

- half sine-wave; \( T_j = 150 \, \text{°C} \) prior to surge;
- with reapplied \( V_{RWM\text{max}} \)
- \( t = 10 \, ms \)
- \( t = 8.3 \, ms \)

<table>
<thead>
<tr>
<th>IFSM</th>
<th>max.</th>
<th>320</th>
<th>A</th>
</tr>
</thead>
<tbody>
<tr>
<td>IFSM</td>
<td>max.</td>
<td>380</td>
<td>A</td>
</tr>
<tr>
<td>IF^2t</td>
<td>max.</td>
<td>500</td>
<td>A^2s</td>
</tr>
</tbody>
</table>

**Temperatures**

- Storage temperature \( T_{stg} \) \(-55\) to \(+150\) °C
- Junction temperature \( T_j \) \(\) \max. \(150\) °C

**THERMAL RESISTANCE**

- From junction to mounting base \( R_{th \ j-mb} \) \(=\) \(1.0\) K/W
- From mounting base to heatsink
  - a. with heatsink compound \( R_{th \ mb-h} \) \(=\) \(0.3\) K/W
  - b. without heatsink compound \( R_{th \ mb-h} \) \(=\) \(0.5\) K/W
- Transient thermal impedance: \( t = 1 \, ms \)

| Z_{th \ j-mb} | \(=\) | 0.2 | K/W |

**MOUNTING INSTRUCTIONS**

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

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

*To ensure thermal stability: \( R_{th \ j-a} \leq 4.9 \) K/W (continuous reverse voltage).
Ultra fast recovery rectifier diodes

BYW31 SERIES

CHARACTERISTICS

Forward voltage

\[ I_F = 30 \, \text{A}; \quad T_j = 150 \, \text{°C} \]
\[ I_F = 100 \, \text{A}; \quad T_j = 25 \, \text{°C} \]

\[ V_F < 0.8 \, \text{V}^* \]
\[ V_F < 1.3 \, \text{V}^* \]

Reverse current

\[ V_R = V_{RWM} \, \text{max}; \quad T_j = 100 \, \text{°C} \]
\[ I_R < 1.5 \, \text{mA} \]
\[ I_R < 100 \, \mu\text{A} \]

Reverse recovery when switched from

\[ I_F = 1 \, \text{A} \text{ to } V_R \geq 30 \, \text{V} \text{ with } -dI_F/dt = 100 \, \text{A/μs}; \]
\[ T_j = 25 \, \text{°C} \text{; recovery time} \]
\[ Q_S < 20 \, \text{nC} \]
\[ I_{RRM} < 4 \, \text{A} \]

Forward recovery when switched to \( I_F = 10 \, \text{A} \)
with \( dI_F/dt = 10 \, \text{A/μs}; \quad T_j = 25 \, \text{°C} \)

\[ V_{fr} \text{ typ. } 1 \, \text{V} \]

*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.

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

* $T_{mb}$ scale is for comparison purposes and is correct only for $R_{th \ mb-a} < 3.6 \, K/W$. 
Ultra fast recovery rectifier diodes

BYW31 SERIES

SINUSOIDAL OPERATION

Fig. 5 The right-hand part shows the interrelationship between the power (derived from the left-hand part) and the maximum permissible temperatures. Power includes reverse current losses and switching losses up to \( f = 500 \) kHz.

\[ a = \text{form factor} = \frac{I_{F(RMS)}}{I_{F(AV)}}. \]
Fig. 6 Maximum permissible repetitive peak forward current for square or sinusoidal currents; 
$1 \mu s < t_p < 1$ ms.

Fig. 7 --- $T_j = 25 \degree C$; --- $T_j = 150 \degree C.$

Definition of $I_{FRM}$ and $t_p/T.$
Ultra fast recovery rectifier diodes

Fig. 8 Maximum $t_{rr}$ at $T_j = 25^\circ$C.

Fig. 9 Maximum $t_{rr}$ at $T_j = 100^\circ$C.

Fig. 10 Maximum $Q_s$ at $T_j = 25^\circ$C.
Fig. 11 Maximum $I_{RRM}$ at $T_j = 25\, ^\circ C$.

Fig. 12 Maximum $I_{RRM}$ at $T_j = 100\, ^\circ C$.

Fig. 13 Transient thermal impedance.
ULTRA FAST RECOVERY RECTIFIER DIODES

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

QUICK REFERENCE DATA

<table>
<thead>
<tr>
<th>Repetitive peak reverse voltage ( V_{RRM} )</th>
<th>BYW92–50</th>
<th>100</th>
<th>150</th>
<th>200</th>
</tr>
</thead>
<tbody>
<tr>
<td>max.</td>
<td>50</td>
<td>100</td>
<td>150</td>
<td>200</td>
</tr>
<tr>
<td>Average forward current ( I_{F(AV)} )</td>
<td>max.</td>
<td>40</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Forward voltage ( V_F )</td>
<td>&lt;</td>
<td>0.8</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Reverse recovery time ( t_{rr} )</td>
<td>&lt;</td>
<td>40</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

MECHANICAL DATA

Fig. 1 DO-5: with metric M6 stud (φ 6 mm); e.g. BYW92–50.
with ¼ in x 28 UNF stud (φ 6.35 mm); e.g. BYW92–50U.

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

Supplied with device: 1 nut. 1 lock washer
Torque on nut: min. 1.7 Nm (17 kg cm)
max. 3.5 Nm (35 kg cm)
Nut dimensions across the flats:
M6: 10 mm; ¼ in x 28 UNF: 11.1 mm

Products approved to CECC 50 009-003, available on request.

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# RATINGS

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

## Voltages

<table>
<thead>
<tr>
<th>Repetitive peak reverse voltage $V_{RRM}$</th>
<th>BYW92–50</th>
<th>100</th>
<th>150</th>
<th>200</th>
<th>V</th>
</tr>
</thead>
<tbody>
<tr>
<td>Vrrm max.</td>
<td>50</td>
<td>100</td>
<td>150</td>
<td>200</td>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Crest working reverse voltage $V_{RWM}$</th>
<th>BYW92–50</th>
<th>100</th>
<th>150</th>
<th>200</th>
<th>V</th>
</tr>
</thead>
<tbody>
<tr>
<td>Vrwm max.</td>
<td>50</td>
<td>100</td>
<td>150</td>
<td>200</td>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Continuous reverse voltage $V_R$</th>
<th>BYW92–50</th>
<th>100</th>
<th>150</th>
<th>200</th>
<th>V</th>
</tr>
</thead>
<tbody>
<tr>
<td>Vr max.</td>
<td>50</td>
<td>100</td>
<td>150</td>
<td>200</td>
<td></td>
</tr>
</tbody>
</table>

## Currents

### Average forward current; switching
- Losses negligible up to 500 kHz
- Square wave; $\delta = 0.5$; up to $T_{mb} = 110 \degree C$
- Up to $T_{mb} = 125 \degree C$

<table>
<thead>
<tr>
<th>Average forward current $I_{F(AV)}$</th>
<th>up to $T_{mb} = 110 \degree C$</th>
<th>max.</th>
<th>40</th>
<th>A</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>up to $T_{mb} = 125 \degree C$</td>
<td>max.</td>
<td>27</td>
<td>A</td>
</tr>
</tbody>
</table>

### Sinusoidal
- Up to $T_{mb} = 115 \degree C$
- Up to $T_{mb} = 125 \degree C$

<table>
<thead>
<tr>
<th>Average forward current $I_{F(AV)}$</th>
<th>up to $T_{mb} = 115 \degree C$</th>
<th>max.</th>
<th>35</th>
<th>A</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>up to $T_{mb} = 125 \degree C$</td>
<td>max.</td>
<td>26</td>
<td>A</td>
</tr>
</tbody>
</table>

### R.M.S. forward current $I_{F(RMS)}$

<table>
<thead>
<tr>
<th>R.M.S. forward current</th>
<th>max.</th>
</tr>
</thead>
<tbody>
<tr>
<td>$I_{F(RMS)}$</td>
<td>55</td>
</tr>
</tbody>
</table>

### Repetitive peak forward current $I_{FRM}$

- $t_p = 20 \mu s; \delta = 0.02$

<table>
<thead>
<tr>
<th>Repetitive peak forward current $I_{FRM}$</th>
<th>max.</th>
</tr>
</thead>
<tbody>
<tr>
<td>$I_{FRM}$</td>
<td>800</td>
</tr>
</tbody>
</table>

### Non-repetitive peak forward current $I_{FSM}$

- Half sine-wave; $T_j = 150 \degree C$ prior to surge
- With reapplied $V_{RWM}$ max.

<table>
<thead>
<tr>
<th>Non-repetitive peak forward current $I_{FSM}$</th>
<th>t = 10 ms</th>
<th>max.</th>
<th>500</th>
<th>A</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>t = 8.3 ms</td>
<td>max.</td>
<td>600</td>
<td>A</td>
</tr>
</tbody>
</table>

### $I^2$t for fusing ($t = 10$ ms)

<table>
<thead>
<tr>
<th>$I^2t$ for fusing ($t = 10$ ms)</th>
<th>max.</th>
<th>1250</th>
<th>A$^2$s</th>
</tr>
</thead>
</table>

## Temperatures

### Storage temperature $T_{stg}$

- $-55$ to $+150 \degree C$

### Junction temperature $T_j$

<table>
<thead>
<tr>
<th>Junction temperature $T_j$</th>
<th>max.</th>
<th>150</th>
<th>\degree C</th>
</tr>
</thead>
</table>

## THERMAL RESISTANCE

### From junction to mounting base $R_{th j-mb}$

| $R_{th j-mb}$ | = | 1.0 | K/W |

### From mounting base to heatsink

- With heatsink compound $R_{th mb-h}$
- Without heatsink compound $R_{th mb-h}$

<table>
<thead>
<tr>
<th>$R_{th mb-h}$</th>
<th>=</th>
<th>0.3</th>
<th>K/W</th>
</tr>
</thead>
<tbody>
<tr>
<td>$R_{th mb-h}$</td>
<td>=</td>
<td>0.5</td>
<td>K/W</td>
</tr>
</tbody>
</table>

### Transient thermal impedance; $t = 1$ ms $Z_{th j-mb}$

| $Z_{th j-mb}$ | = | 0.2 | K/W |

## MOUNTING INSTRUCTIONS

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

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

*To ensure thermal stability: $R_{th j-a} \leq 4.9$ K/W*
### Ultra fast recovery rectifier diodes

#### BYW92 SERIES

### CHARACTERISTICS

#### Forward voltage

<table>
<thead>
<tr>
<th>IF</th>
<th>Vf</th>
<th>Tj</th>
</tr>
</thead>
<tbody>
<tr>
<td>35 A</td>
<td>&lt; 0.8 V*</td>
<td>150 °C</td>
</tr>
<tr>
<td>100 A</td>
<td>&lt; 1.3 V*</td>
<td>25 °C</td>
</tr>
</tbody>
</table>

#### Reverse current

<table>
<thead>
<tr>
<th>VR</th>
<th>IR</th>
<th>Tj</th>
</tr>
</thead>
<tbody>
<tr>
<td>VRRMmax</td>
<td>&lt; 2.5 mA</td>
<td>100 °C</td>
</tr>
<tr>
<td></td>
<td>&lt; 100 µA</td>
<td>25 °C</td>
</tr>
</tbody>
</table>

#### Reverse recovery when switched from

- IF = 1 A to V_R ≥ 30 V with -diF/dt = 100 A/µs; T_j = 25 °C; recovery time
- IF = 2 A to V_R ≥ 30 V with -diF/dt = 20 A/µs; T_j = 25 °C; recovered charge
- IF = 10 A to V_R ≥ 30 V with -diF/dt = 50 A/µs; T_j = 100 °C; peak recovery current

<table>
<thead>
<tr>
<th>t_rr</th>
<th>Q_s</th>
<th>I_RRM</th>
</tr>
</thead>
<tbody>
<tr>
<td>&lt; 40 ns</td>
<td>&lt; 20 nC</td>
<td>&lt; 4.5 A</td>
</tr>
</tbody>
</table>

#### Forward recovery when switched to IF = 10 A with diF/dt = 10 A/µs; T_j = 25 °C

<table>
<thead>
<tr>
<th>Vfr</th>
<th>typ.</th>
</tr>
</thead>
<tbody>
<tr>
<td>1.0 V</td>
<td></td>
</tr>
</tbody>
</table>

---

*Measured under pulse conditions to avoid excessive dissipation.*

---

*Fig. 2 Definition of t_rr, Q_s and I_RRM.*

*Fig. 3 Definition of Vfr.*

---

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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.

For the waveform shown:

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

* $T_{mb}$ scale is for comparison purposes and is correct only for $R_{th\ mb-a} < 3.6$ K/W.
Ultra fast recovery rectifier diodes

BYW92 SERIES

SINUSOIDAL OPERATION

Fig. 5 The right-hand part shows the interrelationship between the power (derived from the left-hand part) and the maximum permissible temperatures. Power includes reverse current losses and switching losses up to $f = 500 \text{ kHz}$.

$a = \text{form factor} = \frac{|I_{F}(\text{RMS})|}{|I_{F}(\text{AV})|}$. 

$R_{th \text{-mb}} = a \times 0.5 \text{ K/W}$
Fig. 6 Maximum permissible repetitive peak forward current for square or sinusoidal currents; $1 \mu s < t_p < 1 \text{ ms}$.

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

Fig. 7 $T_j = 25 \degree C; \quad \cdots\cdots T_j = 150 \degree C$. 

M1576

M1246
Ultra fast recovery rectifier diodes

Fig. 8 Maximum $t_{rr}$ at $T_j = 25 \, ^\circ\text{C}$.

Fig. 9 Maximum $t_{rr}$ at $T_j = 100 \, ^\circ\text{C}$.

Fig. 10 Maximum $Q_s$ at $T_j = 25 \, ^\circ\text{C}$.
Fig. 11 Maximum $I_{RRM}$ at $T_j = 25^\circ$C.

Fig. 12 Maximum $I_{RRM}$ at $T_j = 100^\circ$C.

Fig. 13 Transient thermal impedance.
ULTRA FAST RECOVERY RECTIFIER DIODES

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

QUICK REFERENCE DATA

<table>
<thead>
<tr>
<th></th>
<th>BYW93-50</th>
<th>100</th>
<th>150</th>
<th>200</th>
</tr>
</thead>
<tbody>
<tr>
<td>Repetitive peak reverse voltage $V_{RRM}$</td>
<td>max. 50</td>
<td>100</td>
<td>150</td>
<td>200</td>
</tr>
<tr>
<td>Average forward current $I_{F(AV)}$</td>
<td>max. 60</td>
<td>100</td>
<td>150</td>
<td>200</td>
</tr>
<tr>
<td>Forward voltage $V_F$</td>
<td>&lt; 0.8</td>
<td>150</td>
<td>200</td>
<td></td>
</tr>
<tr>
<td>Reverse recovery time $t_{rr}$</td>
<td>&lt; 45 ns</td>
<td>150</td>
<td>200</td>
<td></td>
</tr>
</tbody>
</table>

MECHANICAL DATA

Fig.1 DO-5; with metric M6 stud ($\phi$ 6 mm): e.g. BYW93-50 with $\frac{1}{4}$ in x 28 UNF stud ($\phi$ 6.35 mm); e.g. BYW93-50U

Net mass: 22 g
Diameter of clearance hole: max. 6.5 mm

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,$$
\frac{1}{4}$$ in x 28 UNF: 11.1 mm

Products approved to CECC 50 009-028, available on request.
RATINGS

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

<table>
<thead>
<tr>
<th>Volatges</th>
<th>BYW93–50</th>
<th>100</th>
<th>150</th>
<th>200</th>
</tr>
</thead>
<tbody>
<tr>
<td>Repetitive peak reverse voltage $V_{RRM}$ max.</td>
<td>50</td>
<td>100</td>
<td>150</td>
<td>200</td>
</tr>
<tr>
<td>Crest working reverse voltage $V_{RWM}$ max.</td>
<td>50</td>
<td>100</td>
<td>150</td>
<td>200</td>
</tr>
<tr>
<td>Continuous reverse voltage* $V_R$ max.</td>
<td>50</td>
<td>100</td>
<td>150</td>
<td>200</td>
</tr>
</tbody>
</table>

**Currents**

Average forward current; switching losses negligible up to 500 kHz

- square wave; $\delta = 0.5$; up to $T_{mb} = 110 \, ^\circ C$
- up to $T_{mb} = 125 \, ^\circ C$
- sinusoidal; up to $T_{mb} = 115 \, ^\circ C$
- up to $T_{mb} = 125 \, ^\circ C$

<table>
<thead>
<tr>
<th>Currents</th>
<th>BYW93–50</th>
<th>100</th>
<th>150</th>
<th>200</th>
</tr>
</thead>
<tbody>
<tr>
<td>$I_{F(AV)}$ max.</td>
<td>60</td>
<td>A</td>
<td></td>
<td></td>
</tr>
<tr>
<td>$I_{F(AV)}$ max.</td>
<td>40</td>
<td>A</td>
<td></td>
<td></td>
</tr>
<tr>
<td>$I_{F(AV)}$ max.</td>
<td>50</td>
<td>A</td>
<td></td>
<td></td>
</tr>
<tr>
<td>$I_{F(AV)}$ max.</td>
<td>38</td>
<td>A</td>
<td></td>
<td></td>
</tr>
<tr>
<td>$I_{F(RMS)}$ max.</td>
<td>85</td>
<td>A</td>
<td></td>
<td></td>
</tr>
<tr>
<td>$I_{FRM}$ max.</td>
<td>1500</td>
<td>A</td>
<td></td>
<td></td>
</tr>
<tr>
<td>$I_{FSM}$ max.</td>
<td>800</td>
<td>A</td>
<td></td>
<td></td>
</tr>
<tr>
<td>$I_{FSM}$ max.</td>
<td>1000</td>
<td>A</td>
<td></td>
<td></td>
</tr>
<tr>
<td>$I^2 t$ for fusing ($t = 10 , ms$)</td>
<td>3200</td>
<td>A^2s</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

**Temperatures**

<table>
<thead>
<tr>
<th>Temperatures</th>
<th>BYW93–50</th>
<th>100</th>
<th>150</th>
<th>200</th>
</tr>
</thead>
<tbody>
<tr>
<td>Storage temperature $T_{stg}$</td>
<td>-55 to +150</td>
<td>^\circ C</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Junction temperature $T_j$ max.</td>
<td>150</td>
<td>^\circ C</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

**THERMAL RESISTANCE**

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

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

*To ensure thermal stability: $R_{th \, j-a} \leq 3.0 \, K/W$. 

---

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May 1984
Ultra fast recovery rectifier diodes

BYW93 SERIES

CHARACTERISTICS

Forward voltage
\[ I_F = 50 \text{ A; } T_j = 150 \text{ °C} \]
\[ I_F = 150 \text{ A; } T_j = 25 \text{ °C} \]
\[ V_F < 0.8 \text{ V}^* \]
\[ V_F < 1.3 \text{ V}^* \]

Reverse current
\[ V_R = V_{RWM \max}; \ T_j = 100 \text{ °C} \]
\[ I_R < 5 \text{ mA} \]
\[ I_R < 250 \mu\text{A} \]

Reverse recovery when switched from
\[ I_F = 1 \text{ A to } V_R \geq 30 \text{ V with } -\frac{dI_F}{dt} = 100 \text{ A/µs; } T_j = 25 \text{ °C}; \text{ recovery time} \]
\[ t_{rr} < 45 \text{ ns} \]
\[ I_F = 2 \text{ A to } V_R \geq 30 \text{ V with } -\frac{dI_F}{dt} = 20 \text{ A/µs} \]
\[ Q_S < 35 \text{ nC} \]
\[ I_F = 10 \text{ A to } V_R \geq 30 \text{ V with } -\frac{dI_F}{dt} = 50 \text{ A/µs;} \]
\[ T_j = 100 \text{ °C}; \text{ peak recovery current} \]
\[ I_{RRM} < 6 \text{ A} \]

Forward recovery when switched to \[ I_F = 10 \text{ A} \]
\[ \text{with } -\frac{dI_F}{dt} = 10 \text{ A/µs}; T_j = 25 \text{ °C} \]
\[ V_{fr} \text{ typ. } 1.0 \text{ V} \]

*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.

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

*\( T_{mb} \) scale is for comparison purposes and is correct only for \( R_{th\ mb-a} < 2.1 \) K/W
Ultra fast recovery rectifier diodes

BYW93 SERIES

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. 

\[ a = \text{form factor} = \frac{I_{F(RMS)}}{I_{F(AV)}} \]
Fig. 6 Maximum permissible repetitive peak forward current for square or sinusoidal currents; $1 \mu s < t_p < 1$ ms.

Fig. 7 —— $T_j = 25\, ^\circ\mathrm{C}$; —— $T_j = 150\, ^\circ\mathrm{C}$.
Ultra fast recovery rectifier diodes

Fig. 8 Maximum $t_{rr}$ at $T_j = 25 \, ^\circ C$.

Fig. 9 Maximum $t_{rr}$ at $T_j = 100 \, ^\circ C$.

Fig. 10 Maximum $Q_s$ at $T_j = 25 \, ^\circ C$. 

May 1984
Fig. 11 Maximum $I_{RRM}$ at $T_j = 25^\circ$C.

Fig. 12 Maximum $I_{RRM}$ at $T_j = 100^\circ$C.

Fig. 13 Transient thermal impedance.
FAST SOFT-RECOVERY RECTIFIER DIODES

- With controlled avalanche  
Also available to BS9333-F002

Diffused silicon diodes in DO-4 metal envelopes, capable of absorbing transients. They are primarily intended for use in high-frequency power supplies, thyristor inverters and multi-phase power rectifier applications.
The series consists of the following types:
Normal polarity (cathode to stud): BYX30-200 to BYX30-600
Reverse polarity (anode to stud): BYX30-200R to BYX30-600R.

### QUICK REFERENCE DATA

<table>
<thead>
<tr>
<th></th>
<th>BYX30-200(R)</th>
<th>300(R)</th>
<th>400(R)</th>
<th>500(R)</th>
<th>600(R)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Crest working reverse voltage $V_{RWM}$</td>
<td>max. 200 V</td>
<td>300 V</td>
<td>400 V</td>
<td>500 V</td>
<td>600 V</td>
</tr>
<tr>
<td>Reverse avalanche breakdown voltage $V_{(BR)R}$</td>
<td>$&gt; 250$ V</td>
<td>$375$ V</td>
<td>$500$ V</td>
<td>$625$ V</td>
<td>$750$ V</td>
</tr>
<tr>
<td>Average forward current $I_{F(AV)}$</td>
<td>max. 14 A</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Non-repetitive peak forward current $I_{FSM}$</td>
<td>max. 250 A</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Non-repetitive peak reverse power $P_{RSM}$</td>
<td>max. 18 kW</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Reverse recovery time $t_{rr}$</td>
<td>$&lt; 200$ ns</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

### MECHANICAL DATA

DO-4; Supplied with device: 1 nut, 1 lock-washer

Nut dimensions across the flats: 9.5 mm

Dimensions in mm

Net mass: 7 g
Diameter of clearance hole: max. 5.2 mm
Accessories supplied on request:
see ACCESSORIES section

The mark shown applies to the normal polarity types.

Net mass: 7 g
Diameter of clearance hole: max. 5.2 mm
Accessories supplied on request:
see ACCESSORIES section

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

April 1984
RATINGS  Limiting values in accordance with the Absolute Maximum System (IEC134)

<table>
<thead>
<tr>
<th>Vottages 1)</th>
<th>BYX30-200(R)</th>
<th>300(R)</th>
<th>400(R)</th>
<th>500(R)</th>
<th>600(R)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Cre&amp;$\text{s}$ working reverse voltage $V_{RWM}$ max.</td>
<td>200</td>
<td>300</td>
<td>400</td>
<td>500</td>
<td>600 V</td>
</tr>
<tr>
<td>Continuous reverse voltage $V_R$ max.</td>
<td>200</td>
<td>300</td>
<td>400</td>
<td>500</td>
<td>600 V</td>
</tr>
</tbody>
</table>

Currents

Average forward current (averaged over any 20 ms period) up to $T_{mb} = 100 \degree C$

- at $T_{mb} = 125 \degree C$

$\text{I}_{F(AV)}$ max. 14 A

R.M.S. forward current

- $\text{I}_{F(RMS)}$ max. 22 A

Repetitive peak forward current

- $\text{I}_{FRM}$ max. 310 A

Non-repetitive peak forward current

- $(t = 10 \text{ ms}; \text{ half-sinewave})$ $T_j = 150 \degree C$ prior to surge;
- with reapplied $V_{RWM}$max.

- $\text{I}_{FSM}$ max. 250 A

- $I^2t$ for fusing $(t = 10 \text{ ms})$

- $\text{I}^2t$ max. 312 $\text{A}^2$\text{s}$

Reverse power dissipation

Repetitive peak reverse power dissipation

- $t = 10 \mu s$ (square wave; $f = 50 \text{ Hz}$) $T_j = 150 \degree C$

- $\text{P}_{RRM}$ max. 5.5 kW

Non-repetitive peak reverse power dissipation

- $t = 10 \mu s$ (square wave) $T_j = 25 \degree C$ prior to surge
- $T_j = 150 \degree C$ prior to surge

- $\text{P}_{RSM}$ max. 18 kW

- $\text{P}_{RSM}$ max. 5.5 kW

Temperatures

- Storage temperature $T_{stg}$ -55 to +150 \degree C

- Junction temperature $T_j$ max. 150 \degree C

THERMAL RESISTANCE

- From junction to ambient in free air

- From junction to mounting base

- From mounting base to heatsink

- $R_{th j-a} = 50 \degree C/W$

- $R_{th j-mb} = 1.3 \degree C/W$

- $R_{th mb-h} = 0.5 \degree C/W$

1) To ensure thermal stability: $R_{th j-a} < 2.5 \degree C/W$ (continuous reverse voltage) or $< 5 \degree C/W$ (a.c.).

For smaller heatsinks $T_j$ max should be derated. For a.c. see page 469.

For continuous reverse voltage:

- if $R_{th j-a} = 5 \degree C/W$, then $T_j$ max $= 135 \degree C$.
- if $R_{th j-a} = 10 \degree C/W$, then $T_j$ max $= 120 \degree C$.
Fast soft-recovery rectifier diodes with controlled avalanche

BYX30 SERIES

CHARACTERISTICS

<table>
<thead>
<tr>
<th>Byx30-200(R)</th>
<th>300(R)</th>
<th>400(R)</th>
<th>500(R)</th>
<th>600(R)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Forward voltage</td>
<td>V_F</td>
<td>3.2</td>
<td>3.2</td>
<td>3.2</td>
</tr>
<tr>
<td>I_F = 50 A; T_j = 25 °C</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Reverse breakdown voltage</td>
<td>V(BR)_r</td>
<td>&gt; 250</td>
<td>375</td>
<td>500</td>
</tr>
<tr>
<td>I_R = 5 mA; T_j = 25 °C</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Reverse current</td>
<td>I_R</td>
<td>&lt; 4.0</td>
<td>4.0</td>
<td>4.0</td>
</tr>
<tr>
<td>V_R = V_RWM_max; T_j = 125 °C</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Reverse recovery charge when switched from

I_F = 2 A to V_R ≥ 30 V;
with \(-dI_F/dt = 100 A/\mu s; T_j = 25 °C\)

Q_s < 0.70 \(\mu\)C

Reverse recovery time when switched from

I_F = 1 A to V_R ≥ 30 V;
-\(dI_F/dt = 50 A/\mu s; T_j = 25 °C\)

t_rr < 200 ns

OPERATING NOTES

1. Square-wave operation

When I_F has been flowing sufficiently long for the steady state to be established, there will be a charge due to minority carriers present. Before the device can block in the reverse direction this charge must be extracted. This extraction takes the form of a reverse transient (see figure above). The majority of the power dissipation due to the reverse transient occurs during fall time as the rectifier gradually becomes reverse biased, and the mean power will be proportional to the operating frequency. The mean value of this power loss can be derived from the graphs on page 474.

1) Measured under pulse conditions to avoid excessive dissipation.
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 IRRM), so that power loss due to reverse recovery may be safely ignored for frequencies up to 20 kHz.

3. Determination of the heatsink thermal resistance

Example:
Assume a diode, used in an inverter.

<table>
<thead>
<tr>
<th>frequency</th>
<th>f</th>
<th>20 kHz</th>
</tr>
</thead>
<tbody>
<tr>
<td>duty cycle</td>
<td>$\delta$</td>
<td>0.5</td>
</tr>
<tr>
<td>ambient temperature</td>
<td>$T_{amb}$</td>
<td>45 °C</td>
</tr>
<tr>
<td>switched from</td>
<td>$I_F$</td>
<td>12 A</td>
</tr>
<tr>
<td>to</td>
<td>$V_R$</td>
<td>400 V</td>
</tr>
<tr>
<td>at a rate</td>
<td>$-\frac{dl}{dt}$</td>
<td>20 A/µs</td>
</tr>
</tbody>
</table>

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. $T_i = 150$ °C). Starting from $I_F = 12$ A on the horizontal scale trace upwards until the appropriate line $-\frac{dl}{dt} = 20$ A/µs. From the intersection trace horizontally to the right until the line for $f = 20$ kHz. Then trace downwards to the line $V_R = 400$ V and ultimately trace horizontally to the left and on the vertical axis read the additional average power dissipation $P_{RAV} = 4$ W.

Therefore the total power dissipation $P_{tot} = 15$ W + 4 W = 19 W (point B of the upper graph on page 469). From the right hand part follows the thermal resistance required at $T_{amb} = 45$ °C.

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

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

Hence the heatsink thermal resistance should be:

$$R_{th h-a} = R_{th mb-a} - R_{th mb-h} = (4 - 0.5) \, ^{\circ}C/W = 3.5 \, ^{\circ}C/W.$$
The diagram illustrates the interrelation between the total dissipation (derived from the left hand graph) and the max. allowable temperatures. The graph shows the power dissipation, exclusive the reverse power in the avalanche region and switching losses, as a function of the ambient temperature. The diagram also provides information on the max. allowable repetitive peak reverse power dissipation versus duration at different junction temperatures.

- The graph is labeled with various power dissipation levels, such as 24°C/W, 20°C/W, and 8°C/W, indicating the thermal resistance.
- The ambient temperature (Tamb) is plotted on the y-axis, ranging from 0°C to 150°C.
- The current (I_FAV) is plotted on the x-axis, ranging from 0A to 10A.
- The power dissipation (P) is shown on the graph, with values ranging from 0W to 60W.
- The max. allowable temperature is indicated for different power dissipation levels, showing the relationship between the two variables.
Fast soft-recovery rectifier diodes with controlled avalanche

BYX30 SERIES

Maximum permissible non-repetitive r.m.s. forward current based on sinusoidal currents (f=50Hz)

Each current pulse is followed by the crest working reverse voltage

$I_F$ time

$I_{FSM}$

$T_J = 150°C$ prior to surge

Maximum permissible non-repetitive r.m.s. forward current based on sinusoidal currents (f=50Hz)

Each current pulse is followed by the crest working reverse voltage

$I_F$ time

$I_{FSM}$

$T_J = 150°C$ prior to surge

March 1978

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Fast soft-recovery rectifier diodes with controlled avalanche

BYX30 SERIES

Maximum values; $T_j = 25 \, ^\circ\mathrm{C}$; switched from $I_F$ to $V_R \geq 30 \, \mathrm{V}$.

Maximum values; $T_j = 150 \, ^\circ\mathrm{C}$; switched from $I_F$ to $V_R \geq 30 \, \mathrm{V}$.
Nomogram: Power loss $P_{RAV}$ due to switching only (square wave operation)
FAST SOFT-RECOVERY RECTIFIER DIODES

• With controlled avalanche

Diffused silicon diodes in DO-4 metal envelopes, capable of absorbing transients. They are primarily intended for use in high-frequency power supplies, thyristor inverters and multi-phase power rectifier applications.

The series consists of the following types:
Normal polarity (cathode to stud): BYX46-200 to BYX46-600.
Reverse polarity (anode to stud):  BYX46-200R to BYX46-600R

QUICK REFERENCE DATA

<table>
<thead>
<tr>
<th></th>
<th>BYX46-200(R)</th>
<th>300(R)</th>
<th>400(R)</th>
<th>500(R)</th>
<th>600(R)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Crest working reverse voltage</td>
<td>V_{RWM} max.</td>
<td>200</td>
<td>300</td>
<td>400</td>
<td>500</td>
</tr>
<tr>
<td>Reverse avalanche breakdown voltage</td>
<td>V_{(BR)R} &gt;</td>
<td>250</td>
<td>375</td>
<td>500</td>
<td>625</td>
</tr>
<tr>
<td>Average forward current</td>
<td>I_{F(AV)} max.</td>
<td>22</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Non-repetitive peak forward current</td>
<td>I_{FSM} max.</td>
<td>300</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Non-repetitive peak reverse power</td>
<td>P_{RSM} max.</td>
<td>18</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Reverse recovery time</td>
<td>t_{rr} &lt;</td>
<td>200</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

MECHANICAL DATA

DO-4  Supplied with device: 1 nut, 1 lock-washer
Nut dimensions across the flats: 9,5 mm

Net mass: 7 g
Diameter of clearance hole: max. 5,2 mm
Accessories supplied on request: see ACCESSORIES section

The mark shown applies to the normal polarity types.
## RATINGS

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

### Voltages *

<table>
<thead>
<tr>
<th>BYX46-200(R)</th>
<th>300(R)</th>
<th>400(R)</th>
<th>500(R)</th>
<th>600(R)</th>
</tr>
</thead>
<tbody>
<tr>
<td>VRWM max.</td>
<td>200 V</td>
<td>300 V</td>
<td>400 V</td>
<td>500 V</td>
</tr>
<tr>
<td>VR max.</td>
<td>200 V</td>
<td>300 V</td>
<td>400 V</td>
<td>500 V</td>
</tr>
</tbody>
</table>

### Currents

- **Average forward current (averaged over any 20 ms period)**
  - up to $T_{mb} = 100 \, ^\circ C$
  - at $T_{mb} = 125 \, ^\circ C$
- **R.M.S. forward current**
- **Repetitive peak forward current**
- **Non-repetitive peak forward current**
  - $t = 10 \, ms$; half-sinewave
  - $T_j = 165 \, ^\circ C$
  - prior to surge; with reapplied $V_{RWM}$
- **$I^2t$ for fusing**
  - $t = 10 \, ms$

### Reverse power dissipation

- **Repetitive peak reverse power dissipation**
  - $t = 10 \, \mu s$ (square wave; $f = 50 \, Hz$)
  - $T_j = 100 \, ^\circ C$
- **Non-repetitive peak reverse power dissipation**
  - $t = 10 \, \mu s$
  - $T_j = 25 \, ^\circ C$
  - prior to surge
  - $T_j = 165 \, ^\circ C$

### Temperatures

- **Storage temperature**
- **Junction temperature**
  - $T_{j\, max.} = 165 \, ^\circ C$

### THERMAL RESISTANCE

- **From junction to ambient in free air**
- **From junction to mounting base**
- **From mounting base to heatsink**

*To ensure thermal stability: $R_{th\, j-a} < 2,5 \, ^\circ C/W$ (continuous reverse voltage) or $< 5 \, ^\circ C/W$ (a.c.). For smaller heatsinks $T_{j\, max}$ should be derated. For a.c. see page 479. For continuous reverse voltage: if $R_{th\, j-a} = 5 \, ^\circ C/W$, then $T_{j\, max} = 135 \, ^\circ C$; if $R_{th\, j-a} = 10 \, ^\circ C/W$, then $T_{j\, max} = 125 \, ^\circ C$. 

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476 March 1978
Fast soft-recovery rectifier diodes with controlled avalanche

BYX46 SERIES

CHARACTERISTICS

<table>
<thead>
<tr>
<th></th>
<th>BYX46-200(R)</th>
<th>300(R)</th>
<th>400(R)</th>
<th>500(R)</th>
<th>600(R)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Forward voltage</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>$I_F = 50$ A; $T_j = 25$ °C</td>
<td>$V_F$</td>
<td>$2,0$</td>
<td>$2,0$</td>
<td>$2,0$</td>
<td>$2,0$</td>
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<tr>
<td>Reverse breakdown voltage</td>
<td>$V_{(BR)R}$</td>
<td>$&gt;250$</td>
<td>$375$</td>
<td>$500$</td>
<td>$625$</td>
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<tr>
<td>Reverse current</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>$V_R = V_{RWMmax}$; $T_j = 125$ °C</td>
<td>$I_R$</td>
<td>$&lt;4,0$</td>
<td>$4,0$</td>
<td>$4,0$</td>
<td>$4,0$</td>
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<tr>
<td>Reverse recovery charge when switched from $I_F = 2$ A to $V_R \geq 30$ V; $-dI_F/dt = 100$ A/µs; $T_j = 25$ °C</td>
<td>$Q_s$</td>
<td>$&lt;0,70$</td>
<td>µC</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Reverse recovery time when switched from $I_F = 1$ A to $V_R \geq 30$ V; $-dI_F/dt = 50$ A/µs; $T_j = 25$ °C</td>
<td>$t_{rr}$</td>
<td>$&lt;200$</td>
<td>ns</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

OPERATING NOTES

1. Square-wave operation

When $I_F$ has been flowing sufficiently long for the steady state to be established, there will be a charge due to minority carriers present. Before the device can block in the reverse direction this charge must be extracted. This extraction takes the form of a reverse transient (see figure above). The majority of the power dissipation due to the reverse transient occurs during fall time as the rectifier gradually becomes reverse biased, and the mean power will be proportional to the operating frequency. The mean value of this power loss can be derived from the graphs on page 484.

* Measured under pulse conditions to avoid excessive dissipation.
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 | \( \delta \) = 0.5 |
| ambient temperature | \( T_{\text{amb}} \) = 40 °C |
| switched from | \( I_F \) = 12 A |
| to | \( V_R \) = 300 V |
| at a rate | \(-\frac{dl}{dt}\) = 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 \(-\frac{dl}{dt}\) = 50 A/µs. From the intersection trace horizontally to the right until the line for \( f = 20 \) kHz. Then trace downwards to the line \( V_R = 300 \) V and ultimately trace horizontally to the left and on the vertical axis read the additional average power dissipation \( P_{RAV} = 6 \) W.

Therefore the total power dissipation \( P_{\text{tot}} = 13 \) W + 6 W = 19 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 \( T_{\text{amb}} = 40 \) °C.

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

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

Hence the heatsink thermal resistance should be:

\[
R_{\text{th h-a}} = R_{\text{th mb-a}} - R_{\text{th mb-h}} = (5 - 0.5) \text{ °C/W} = 4.5 \text{ °C/W}.
\]
P: power excluding avalanche and switching losses

- Single phase: \( a = 1.6 \)
- 3-phase: \( a = 1.75 \)
- 6-phase: \( a = 2.4 \)

\[ a = \frac{I_{F(RMS)}}{I_{F(AV)}} \]

Interrelation between the power (derived from the left-hand graph) and the max. allowable temperatures

\[ R_{th mb} = a \times 0.5°C/W \]

Maximum allowable repetitive peak reverse power dissipation versus duration (\( f = 50 \text{ Hz} \))

In this region, repetitive operation is not allowed.
Max. allowable non repetitive peak reverse pulse power dissipation in avalanche region

Typical values

BYX46-200(R), -300(R), -400(R), -500(R), -600(R)
Maximum permissible non-repetitive rms forward current based on sinusoidal currents (f = 50Hz)

each current pulse is followed by the crest working reverse voltage

<table>
<thead>
<tr>
<th>Surge duration (s)</th>
<th>( I_{FSM} ) (A)</th>
</tr>
</thead>
<tbody>
<tr>
<td>0.001</td>
<td>600</td>
</tr>
<tr>
<td>0.01</td>
<td>400</td>
</tr>
<tr>
<td>0.1</td>
<td>200</td>
</tr>
<tr>
<td>1</td>
<td>0</td>
</tr>
</tbody>
</table>

\( T_j = 165^\circ C \) prior surge
Fast soft-recovery rectifier diodes with controlled avalanche

**BYX46 SERIES**

### Graphs

1. **Graph 1**
   - Title: 7Z10043
   - Description: Graph showing Qs (µC) vs. -dI/dt (A/µs) for different current values.

2. **Graph 2**
   - Title: 7Z10044
   - Description: Graph showing Qs (µC) vs. -dI/dt (A/µs) for different current values.

3. **Graph 3**
   - Description: Graph showing t_{rr} (ns) vs. -dI/dt (A/µs) for different current values and max values at Tj = 25°C.

4. **Graph 4**
   - Description: Graph showing t_{rr} (ns) vs. -dI/dt (A/µs) for different current values and max values at Tj = 150°C.
Nomogram: Power loss $P_{RAV}$ due to switching only (square wave operation)
Fast soft-recovery rectifier diodes with controlled avalanche

BYX46 SERIES

$Z_{th(t)}$ ($^\circ\text{C} / \text{W}$)

$0.01$ $0.1$ $1.0$ $10.0$

$10\mu s$ $100\mu s$ $1\text{ms}$ $10\text{ms}$ $100\text{ms}$ $1\text{s}$ $10\text{s}$

March 1978 485
FAST SOFT-RECOVERY RECTIFIER DIODES

Silicon diodes in DO-4 metal envelopes, intended for use in high-frequency power supplies, thyristor inverters and multi-phase power rectifier applications. The series consists of the following types:

Normal polarity (cathode to stud): BYX50—200, 300.

These devices feature non-snap-off characteristics.

QUICK REFERENCE DATA

<table>
<thead>
<tr>
<th></th>
<th>BYX50—200</th>
<th>300</th>
</tr>
</thead>
<tbody>
<tr>
<td>Repetitive peak reverse voltage</td>
<td>$V_{RRM}$</td>
<td>max. 200</td>
</tr>
<tr>
<td>Average forward current</td>
<td>$I_F(AV)$</td>
<td>max. 7</td>
</tr>
<tr>
<td>Non-repetitive peak forward current</td>
<td>$I_{FSM}$</td>
<td>max. 80</td>
</tr>
<tr>
<td>Reverse recovery time</td>
<td>$t_{rr}$</td>
<td>&lt; 100</td>
</tr>
</tbody>
</table>

MECHANICAL DATA

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
max. 1.7 Nm
(9 kg cm)
(17 kg cm)
RATINGS  Limiting values in accordance with the Absolute Maximum System (IEC134).

### Ratings

#### Voltages

- **Non-repetitive peak reverse voltage:**
  - $t \leq 10$ ms
  - $V_{RSM}$ max. 250 V

- **Repetitive peak reverse voltage**
  - $V_{RRM}$ max. 200 V

- **Crest working reverse voltage**
  - $V_{RWM}$ max. 200 V

- **Continuous reverse voltage**
  - $V_R$ max. 200 V

#### Currents

- **Average on-state current assuming zero switching losses (averaged over any 20 ms period)**
  - up to $T_{mb} = 103$ °C
  - at $T_{mb} = 125$ °C
  - $I_{F(AV)}$ max. 7 A
  - $I_{F(AV)}$ max. 4 A

- **R.M.S. forward current**
  - $I_{F(RMS)}$ max. 11 A

- **Repetitive peak forward current**
  - $I_{FRM}$ max. 80 A

- **Non-repetitive peak forward current**
  - $t = 10$ ms; $T_j = 150$ °C prior to surge with reapplied $V_{RWM \text{max}}$
  - $I_{FSM}$ max. 80 A
  - $I^2t$ max. 32 A²s

- **Rate of change of commutation current**
  - See nomogram (Fig.6)

#### Temperatures

- **Storage temperature**
  - $T_{stg}$ -55 to +150 °C

- **Junction temperature**
  - $T_j$ max. 150 °C

#### Thermal Resistance

- **From junction to ambient in free air**
  - $R_{th \text{ j-a}}$ = 50 K/W

- **From junction to mounting base**
  - $R_{th \text{ j-mb}}$ = 3.5 K/W

- **From mounting base to heatsink**
  - $R_{th \text{ mb-h}}$ = 0.5 K/W

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

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BYX50 SERIES

---

488  June 1985
**Fast soft-recovery rectifier diodes**

**BYX50 SERIES**

**CHARACTERISTICS**

**Forward voltage**

\[ I_F = 20 \text{ A}; T_j = 25 \text{ °C} \]

\[ V_F < 1.95 \text{ V}^* \]

**Reverse current**

\[ V_R = V_{RWM_{\text{max}}}; T_j = 125 \text{ °C} \]

\[ I_R < 3 \text{ mA} \]

**Reverse recovery** when switched from

\[ I_F = 1 \text{ A} \text{ to } V_R = 30 \text{ V}; \]
\[ -\frac{dI_F}{dt} = 100 \text{ A/µs}; T_j = 25 \text{ °C} \]

Rec. time \[ t_{rr} < 100 \text{ ns} \]

\[ I_F = 1 \text{ A} \text{ to } V_R = 30 \text{ V}; \]
\[ -\frac{dI_F}{dt} = 35 \text{ A/µs}; T_j = 25 \text{ °C} \]

Rec. time \[ t_{rr} < 150 \text{ ns} \]

\[ I_F = 2 \text{ A} \text{ to } V_R = 30 \text{ V}; \]
\[ -\frac{dI_F}{dt} = 20 \text{ A/µs}; T_j = 25 \text{ °C} \]

Rec. Charge \[ Q_s < 250 \text{ nC} \]

\[ I_F = 2 \text{ A} \text{ to } V_R = 50 \text{ V}; \]
\[ -\frac{dI_F}{dt} = 2 \text{ A/µs}; T_j = 25 \text{ °C} \]

Max. slope of the reverse recovery current \[ |\frac{dI_R}{dt}| < 5 \text{ A/µs} \]

*Measured under pulse conditions to avoid excessive dissipation.*

---

**Fig.2 Definition of** \( t_{rr} \) **and** \( Q_s \).
P = power dissipation excluding switching losses

\[ a = \frac{I_{F(RMS)}}{I_{F(AV)}} \]

Fig. 3

interrelation between the power (derived from the left-hand graph) and the maximum permissible temperatures

Fig. 4

\[ R_{mb} = \frac{0.5 \text{ K/W}}{T_{j} - 25 \text{ oC}} \]
Fast soft-recovery rectifier diodes

BYX50 SERIES

maximum allowable non-repetitive r.m.s. forward current based on sinusoidal currents (f=50Hz)

$\text{IF} = \text{IFSM}$

each current pulse is followed by the crest working reverse voltage

$T_j = 150°C$ (prior to surge)

$\text{dI}/\text{dt} = 5 \text{A/µs}$

$\Delta P_{AV} (W)$

$\Delta P_{AV} = 7.5$

$V_{RW} = 100 \text{V}$

$200 \text{V}$

$300 \text{V}$

$\text{IF} = \text{forward current just before switching off; } T_j = 150 °C$

Fig. 5

Fig. 6
transient thermal impedance from junction to mounting base versus time

Fig. 11
FAST SOFT-RECOVERY RECTIFIER DIODES

Silicon diodes, each in a DO-4 metal envelope, featuring non-snap-off characteristics, and intended for use in high-frequency power supplies, thyristor inverters and multi-phase power rectifier applications. The series consists of the following types:

Normal polarity (cathode to stud): 1N3879, 1N3880, 1N3881, 1N3882 and 1N3883.

QUICK REFERENCE DATA

<table>
<thead>
<tr>
<th>Repetitive peak reverse voltage $V_{RRM}$</th>
<th>1N3879</th>
<th>1N3880</th>
<th>1N3881</th>
<th>1N3882</th>
<th>1N3883</th>
</tr>
</thead>
<tbody>
<tr>
<td>max.</td>
<td>50</td>
<td>100</td>
<td>200</td>
<td>300</td>
<td>400</td>
</tr>
<tr>
<td>Repetitive peak reverse voltage $V_{RRM}$</td>
<td>max. 50</td>
<td>100</td>
<td>200</td>
<td>300</td>
<td>400</td>
</tr>
<tr>
<td>Average forward current $I_{F(AV)}$</td>
<td>max. 6</td>
<td>A</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Non-repetitive peak forward current $I_{FSM}$</td>
<td>max. 80</td>
<td>A</td>
<td></td>
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</tr>
<tr>
<td>Reverse recovery time $t_{rr}$</td>
<td>&lt; 200 ns</td>
<td></td>
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</tbody>
</table>

MECHANICAL DATA

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

Dimensions in 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)

Voltagess

<table>
<thead>
<tr>
<th></th>
<th>1N3879</th>
<th>1N3880</th>
<th>1N3881</th>
<th>1N3882</th>
<th>1N3883</th>
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<tbody>
<tr>
<td>Non-repetitive peak reverse voltage</td>
<td>$V_{RSM \text{ max}}$</td>
<td>100</td>
<td>150</td>
<td>250</td>
<td>350</td>
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<tr>
<td>Repetitive peak reverse voltage</td>
<td>$V_{RRM \text{ max}}$</td>
<td>50</td>
<td>100</td>
<td>200</td>
<td>300</td>
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<tr>
<td>Crest working reverse voltage</td>
<td>$V_{RWM \text{ max}}$</td>
<td>50</td>
<td>100</td>
<td>200</td>
<td>300</td>
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Currents

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<tr>
<th></th>
<th></th>
<th>1F(AV)</th>
<th>1F(AV)</th>
<th>1F(RMS)</th>
<th>1F(RMS)</th>
<th>1F(RMS)</th>
<th>1F(RMS)</th>
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<tbody>
<tr>
<td>Average on-state current assuming zero</td>
<td></td>
<td>max.</td>
<td>6</td>
<td>max.</td>
<td>3,5</td>
<td>max.</td>
<td>10</td>
<td>max.</td>
<td>75</td>
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<tr>
<td>switching losses (averaged over any 20 ms period)</td>
<td>up to $T_{mb} = 100 \degree C$</td>
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<td></td>
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<tr>
<td>at $T_{mb} = 125 \degree C$</td>
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<tr>
<td>R.M.S. forward current</td>
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<tr>
<td>Repetitive peak forward current</td>
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<tr>
<td>Non-repetitive peak forward current</td>
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<tr>
<td>$T_{j} = 150 \degree C$ prior to surge;</td>
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<tr>
<td>half sine-wave with reapplied $V_{RWM \text{ max}}$;</td>
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<td></td>
<td></td>
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<td></td>
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<tr>
<td>$t = 10$ ms</td>
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<td></td>
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<tr>
<td>$t = 8,3$ ms</td>
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<tr>
<td>$I^2t$ for fusing ($t = 10$ ms)</td>
<td></td>
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Temperatures

<table>
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<tr>
<th></th>
<th></th>
<th>$T_{stg}$</th>
<th>$T_{j}$</th>
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</thead>
<tbody>
<tr>
<td>Storage temperature</td>
<td></td>
<td>$-65$ to $+175$</td>
<td>$150$</td>
<td>Operating junction temperature</td>
<td></td>
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<td></td>
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THERMAL RESISTANCE

<table>
<thead>
<tr>
<th></th>
<th>$R_{th j-a}$</th>
<th>$R_{th j-mb}$</th>
<th>$R_{th mb-h}$</th>
<th>$Z_{th j-mb}$</th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>From junction to ambient in free air</td>
<td>= 50</td>
<td>= 4,4</td>
<td>= 0,5</td>
<td>= 1</td>
<td>K/W</td>
</tr>
<tr>
<td>From junction to mounting base</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>From mounting base to heatsink</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Transient thermal impedance; $t = 1$ ms; $\delta = 0$</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
Fast soft-recovery rectifier diodes

CHARACTERISTICS

Forward voltage

\[ I_F = 6 \text{ A}; T_j = 25 \, ^\circ\text{C} \]

\[ V_F < 1.4 \, \text{V}^* \]

Reverse current

\[ V_R = V_{RWM_{\text{max}}}; \ T_j = 125 \, ^\circ\text{C} \]

\[ I_R < 3 \, \text{mA} \]

Reverse recovery when switched from

\[ I_F = 1 \text{ A to } V_R = 30 \, \text{V}; \]
\[-dI_F/dt = 35 \text{ A/µs}; \ T_j = 25 \, ^\circ\text{C}\]

Recovery time

\[ t_{rr} < 200 \, \text{ns} \]

\[ I_F = 2 \text{ A to } V_R = 30 \, \text{V}; \]
\[-dI_F/dt = 20 \text{ A/µs}; \ T_j = 25 \, ^\circ\text{C}\]

Recovery charge

\[ Q_s < 250 \, \text{nC} \]

\[ I_F = 1 \text{ A to } V_R = 30 \, \text{V}; \]
\[-dI_F/dt = 2 \text{ A/µs}; \ T_j = 25 \, ^\circ\text{C}\]

Max. slope of the reverse recovery current

\[ |dI_R/dt| < 5 \, \text{A/µs} \]

*Measured under pulse conditions to avoid excessive dissipation

Fig. 2 Definition of \( t_{rr} \) and \( Q_s \).

1N3879 to 1N3883
1N3879 to 1N3883

Fig. 3

\[ P = \text{power dissipation excluding switching losses} \]

\[ a = \frac{I_{F(RMS)}}{I_{F(AV)}} \]

interrelation between the power (derived from the left-hand graph) and the maximum permissible temperatures

Fig. 4

\[ I_{F(AV)} \text{ (A)} \]

\[ T_{mb} \text{ (°C)} \]

\[ I_{F} \text{ (A)} \]

\[ V_{F} \text{ (V)} \]

\[ T_{j} = 25^\circ C \]

\[ T_{j} = 150^\circ C \]

Typical

Maximum
Fast soft-recovery rectifier diodes

1N3879 to 1N3883

maximum permissible non-repetitive r.m.s. forward current based on sinusoidal currents (f = 50 Hz)

$I_F$ - $I_{FSM}$

with reapplied $V_{RWMmax}$

$T_J = 150^\circ C$ (prior to surge)

Fig. 5

$Z_{th\ j-mb}$

$\delta = 1$,

$\delta = 0$

Fig. 6
NOMOGRAM

Power loss $\Delta P_{R(\text{AV})}$ 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

<table>
<thead>
<tr>
<th></th>
<th>1N3889</th>
<th>1N3890</th>
<th>1N3891</th>
<th>1N3892</th>
<th>1N3893</th>
</tr>
</thead>
<tbody>
<tr>
<td>Repetitive peak reverse voltage $V_{RRM}$ max.</td>
<td>50 V</td>
<td>100 V</td>
<td>200 V</td>
<td>300 V</td>
<td>400 V</td>
</tr>
<tr>
<td>Average forward current $I_{F(AV)}$ max.</td>
<td>12 A</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Non-repetitive peak forward current $I_{FSM}$ max.</td>
<td>150 A</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Reverse recovery time $t_{rr}$ &lt;</td>
<td>200 ns</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

MECHANICAL DATA

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).

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

Volatges

<table>
<thead>
<tr>
<th></th>
<th>1N3889</th>
<th>1N3890</th>
<th>1N3891</th>
<th>1N3892</th>
<th>1N3893</th>
</tr>
</thead>
<tbody>
<tr>
<td>Non-repetitive peak reverse voltage</td>
<td>V_{RSM} max.</td>
<td>100</td>
<td>150</td>
<td>250</td>
<td>350</td>
</tr>
<tr>
<td>(t ≤ 10 ms)</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Repetitive peak reverse voltage</td>
<td>V_{RRM} max.</td>
<td>50</td>
<td>100</td>
<td>200</td>
<td>300</td>
</tr>
<tr>
<td>(δ ≤ 0,01)</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Crest working reverse voltage</td>
<td>V_{RWM} max.</td>
<td>50</td>
<td>100</td>
<td>200</td>
<td>300</td>
</tr>
</tbody>
</table>

Currents

Average on-state current assuming zero switching losses (averaged over any 20 ms period)

<table>
<thead>
<tr>
<th></th>
<th>IF(AV) max.</th>
<th>12</th>
<th>A</th>
</tr>
</thead>
<tbody>
<tr>
<td>up to T_{mb} = 100 °C</td>
<td>IF(AV) max.</td>
<td>7</td>
<td>A</td>
</tr>
<tr>
<td>at T_{mb} = 125 °C</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

R.M.S. forward current

IF(RMS) max. 20 A

Repetitive peak forward current

IFRM max. 140 A

Non-repetitive peak forward current

Tj = 150 °C prior to surge; half sine-wave with reapplied V_{RWM}max:

<table>
<thead>
<tr>
<th></th>
<th>IFSM max.</th>
<th>140</th>
<th>A</th>
</tr>
</thead>
<tbody>
<tr>
<td>t = 10 ms</td>
<td>IFSM max.</td>
<td>150</td>
<td>A</td>
</tr>
<tr>
<td>t = 8,3 ms</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

I^2 t for fusing (t = 10 ms)

<table>
<thead>
<tr>
<th></th>
<th>I^2 t max.</th>
<th>100</th>
<th>A^2 s</th>
</tr>
</thead>
</table>

Temperatures

Storage temperature

T_{stg} -65 to +175 °C

Operating junction temperature

Tj max. 150 °C

THERMAL RESISTANCE

From junction to ambient in free air

R_{th j-a} = 50 K/W

From junction to mounting base

R_{th j-mb} = 2,2 K/W

From mounting base to heatsink

R_{th mb-h} = 0,5 K/W

Transient thermal impedance; t = 1 ms; δ = 0

Z_{th j-mb} = 0,8 K/W
CHARACTERISTICS

Forward voltage
\[ I_F = 12 \, A; \quad T_j = 25 \, ^\circ\text{C} \]
\[ V_F \quad < \quad 1.4 \, \text{V}^* \]

Reverse current
\[ V_R = V_{R WM_{\text{max}}}; \quad T_j = 125 \, ^\circ\text{C} \]
\[ I_R \quad < \quad 3 \, \text{mA} \]

Reverse recovery when switched from
\[ I_F = 1 \, A \text{ to } V_R = 30 \, V; \]
\[ -\frac{dI_F}{dt} = 35 \, A/\mu s; \quad T_j = 25 \, ^\circ\text{C} \]
\[ t_{rr} \quad < \quad 200 \, \text{ns} \]

Recovery charge
\[ I_F = 2 \, A \text{ to } V_R = 30 \, V; \]
\[ -\frac{dI_F}{dt} = 20 \, A/\mu s; \quad T_j = 25 \, ^\circ\text{C} \]
\[ Q_S \quad < \quad 250 \, \text{nC} \]

Max. slope of the reverse recovery current
\[ I_F = 1 \, A \text{ to } V_R = 30 \, V; \]
\[ -\frac{dI_F}{dt} = 2 \, A/\mu s; \quad T_j = 25 \, ^\circ\text{C} \]
\[ |\frac{dI_R}{dt}| \quad < \quad 5 \, A/\mu s \]

* Measured under pulse conditions to avoid excessive dissipation.
\[ P = \text{power dissipation excluding switching losses} \]

\[ a = \frac{I_F^{(\text{RMS})}}{I_F^{(\text{AV})}} \]

Interrelation between the power (derived from the left-hand graph) and the maximum permissible temperatures.

**Fig. 3**

![Graph showing power dissipation and maximum permissible temperatures](image)

**Fig. 4**

![Graph showing voltage vs. current](image)
Fast soft-recovery rectifier diodes

1N3889 to 1N3893

maximum permissible non-repetitive r.m.s. forward current based on sinusoidal currents (f = 50 Hz)

\[ I_F \]

\[ I_{FSRMS} \]

time

with reapplied \( V_{RWM\text{max}} \)

\( T_J = 150^\circ C \) (prior to surge)

Fig. 5

\[ Z_{th j\text{-mb}} \]

\( \delta = 1 \)

\( \delta = 0 \)

Fig. 6
Fig. 7

**NOMOGRAM**

Power loss $\Delta P_{R(AV)}$ due to switching only (to be added to steady state power losses).

$I_F =$ forward current just before switching off; $T_j =$ 150 °C

---

**Figure 7**

- Nomogram for power loss due to switching.
- Parameters include forward current ($I_F$), time ($t$), and voltage ($V_R$).
- Illustrates the relationship between transient and steady-state power losses.
FAST SOFT-RECOVERY RECTIFIER DIODES

Silicon diodes in D0-5 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

<table>
<thead>
<tr>
<th></th>
<th>1N3909</th>
<th>3910</th>
<th>3911</th>
<th>3912</th>
<th>3913</th>
</tr>
</thead>
<tbody>
<tr>
<td>Repetitive peak reverse voltage</td>
<td>$V_{RRM}$ max.</td>
<td>50</td>
<td>100</td>
<td>200</td>
<td>300</td>
</tr>
<tr>
<td>Average forward current</td>
<td>$I_{F(AV)}$ max.</td>
<td>30</td>
<td>A</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Non-repetitive peak forward current</td>
<td>$I_{FSM}$ max.</td>
<td>300</td>
<td>A</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Reverse recovery time</td>
<td>$t_{rr}$ &lt;</td>
<td>200</td>
<td>ns</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

MECHANICAL DATA

Fig.1 D0—5; Supplied with device: 1 nut, 1 lock-washer
Nut dimensions across the flats: 11.1 mm

Dimensions in 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)

August 1986
RATINGS

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

<table>
<thead>
<tr>
<th></th>
<th>1N3909</th>
<th>3910</th>
<th>3911</th>
<th>3912</th>
<th>3913</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Voltages</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Non-repetitive peak reverse voltage ( t = 10 \text{ ms} ) ( V_{RSM} ) max.</td>
<td>75</td>
<td>200</td>
<td>300</td>
<td>400</td>
<td>500</td>
</tr>
<tr>
<td>Repetitive peak reverse voltage ( \delta \leq 0.01 ) ( V_{RRM} ) max.</td>
<td>50</td>
<td>100</td>
<td>200</td>
<td>300</td>
<td>400</td>
</tr>
<tr>
<td>Crest working voltage ( V_{RWM} ) max.</td>
<td>50</td>
<td>100</td>
<td>200</td>
<td>300</td>
<td>400</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th></th>
<th>1N3909</th>
<th>3910</th>
<th>3911</th>
<th>3912</th>
<th>3913</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Currents</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Average on-state current assuming zero switching losses (averaged over any 20 ms period) up to ( T_{mb} = 100 ^\circ\text{C} ) at ( T_{mb} = 125 ^\circ\text{C} ) ( I_{F(AV)} ) max.</td>
<td>30</td>
<td>15</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>R.M.S. forward current ( I_{F(RMS)} ) max.</td>
<td>45</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Repetitive peak forward current ( I_{FRM} ) max.</td>
<td>125</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Non-repetitive peak forward current ( T_j = 150 ^\circ\text{C} ) prior to surge; half sine-wave with reapplied ( V_{RWM} ) max; ( t = 10 \text{ ms} ) ( t = 8.3 \text{ ms} ) ( I_{FSM} ) max.</td>
<td>275</td>
<td>300</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>( I^2 t ) for fusing ( t = 10 \text{ ms} ) ( I_{FSM} ) max.</td>
<td>375</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

|                |        |      |      |      |      |
| **Temperatures** |        |      |      |      |      |
| Storage temperature \( T_{stg} \) | -65 to 175 \( ^\circ\text{C} \) |      |      |      |      |
| Operating junction temperature \( T_j \) max. | 150 \( ^\circ\text{C} \) |      |      |      |      |

|                |        |      |      |      |      |
| **THERMAL RESISTANCE** |        |      |      |      |      |
| From junction to mounting base \( R_{th j-mb} \) | 1.0 \( \text{K/W} \) |      |      |      |      |
| From mounting base to heatsink with heatsink compound \( R_{th mb-h} \) | 0.3 \( \text{K/W} \) |      |      |      |      |
| Transient thermal impedance; \( t = 1 \text{ ms} \) \( Z_{th j-mb} \) | 0.2 \( \text{K/W} \) |      |      |      |      |
Fast soft-recovery rectifier diodes

CHARACTERISTICS

Forward voltage
\[ I_F = 30 \text{ A}; \quad T_j = 25 \degree \text{C} \quad \Rightarrow \quad V_F < 1.4 \text{ V}^* \]

Reverse current
\[ V_R = V_{RWMmax}; \quad T_j = 100 \degree \text{C} \quad \Rightarrow \quad I_R < 10 \text{ mA} \]

Reverse recovery when switched from
\[ I_F = 1 \text{ A to } V_R \gg 30 \text{ V}; \quad -dI_F/dt = 35 \text{ A/µs}; \quad T_j = 25 \degree \text{C} \quad \Rightarrow \quad t_{rr} < 200 \text{ ns} \]

Recovery time
\[ I_F = 2 \text{ A to } V_R \gg 30 \text{ V}; \quad -dI_F/dt = 20 \text{ A/µs}; \quad T_j = 25 \degree \text{C} \quad \Rightarrow \quad Q_s < 250 \text{ nC} \]

Maximum slope of the reverse recovery current
when switched from \( I_F = 1 \text{ A to } V_R \gg 30 \text{ V}; \quad -dI_F/dt = 2 \text{ A/µs}; \quad T_j = 25 \degree \text{C} \quad \Rightarrow \quad |dI_R/dt| < 5 \text{ A/µs} \]

*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.

$P = \text{power dissipation excluding switching losses.}$

$a = \text{form factor} = \frac{I_F(\text{RMS})}{I_F(\text{AV})}$. 
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.

\[ P = \text{power dissipation excluding switching losses.} \]

\[ I_F(\text{AV}) = I_F(\text{RMS}) \times \sqrt{\delta} \]
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}.
Fast soft-recovery rectifier diodes

Fig. 6 — $T_j = 25 \, ^\circ C; \; \cdots \cdots T_j = 150 \, ^\circ C$

Fig. 7
SCHOTTKY RECTIFIER DIODES
BYV18 SERIES

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

<table>
<thead>
<tr>
<th>Per diode, unless otherwise stated</th>
<th>BYV18-30</th>
<th>35</th>
<th>40(A)</th>
<th>45</th>
</tr>
</thead>
<tbody>
<tr>
<td>Repetitive peak reverse voltage</td>
<td>V_{RRM}</td>
<td>max.</td>
<td>30</td>
<td>35</td>
</tr>
<tr>
<td>Output current</td>
<td>I_{O}</td>
<td>max.</td>
<td>10</td>
<td>A</td>
</tr>
<tr>
<td>(both diodes conducting)</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Forward voltage</td>
<td>V_{F}</td>
<td>&lt;</td>
<td>0.6</td>
<td>V</td>
</tr>
<tr>
<td>Junction temperature</td>
<td>T_{J}</td>
<td>&lt;</td>
<td>150</td>
<td>^{\circ}C</td>
</tr>
</tbody>
</table>

MECHANICAL DATA

Fig.1 TO-220AB

Dimensions in mm

Net mass: 2 g

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

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

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

### Voltages (per diode)

<table>
<thead>
<tr>
<th>Repetitive peak reverse voltage</th>
<th>$V_{RRM}$ max.</th>
<th>BYV18-30</th>
<th>35</th>
<th>40(A)</th>
<th>45</th>
<th>V</th>
</tr>
</thead>
<tbody>
<tr>
<td>Crest working reverse voltage (note 1)</td>
<td>$V_{RWM}$ max.</td>
<td>30</td>
<td>35</td>
<td>40</td>
<td>45</td>
<td>V</td>
</tr>
<tr>
<td>Continuous reverse voltage (note 1)</td>
<td>$V_R$ max.</td>
<td>30</td>
<td>35</td>
<td>40</td>
<td>45</td>
<td>V</td>
</tr>
</tbody>
</table>

### Currents (both diodes conducting; note 2)

Output current:
- square wave; $\delta = 0.5$;
- up to $T_{mb} = 136\, ^\circ C$ (note 3)
- sinusoidal;
- up to $T_{mb} = 137\, ^\circ C$ (note 3)

| R.M.S. forward current | $I_{O}$ max. | 10 | A  |
| Repetitive peak forward current | $I_{O}$ max. | 8.8 | A  |
| $t_p = 20\, \mu s$; $\delta = 0.02$ (per diode) | $I_{FRM}$ max. | 90 | A  |

R.M.S. forward current
- square wave: $\delta = 0.5$;
- up to $T_{mb} = 136\, ^\circ C$ (note 3)
- sinusoidal:
- up to $T_{mb} = 137\, ^\circ C$ (note 3)

- $t = 10\, ms$
- $t = 8.3\, ms$
- $t^2$ for fusing ($t = 10\, ms$, per diode)

| Non-repetitive peak forward current (per diode) half sine-wave; $T_j = 125\, ^\circ C$ prior to surge; with reapplied $V_{RWM}$max | $I_{FSM}$ max. | 100 | A  |
| $t_p = 100\, \mu s$ | $I_{FSM}$ max. | 110 | A  |

| $I^2t$ for fusing ($t = 10\, ms$, per diode) | $I_{FSM}$ max. | 50 | $A^2s$ |

Reverse surge current (BYV18-40A only)

| $t_p = 100\, \mu s$ | $I_{RSN}$ max. | 0.5 | A  |

### Temperatures

- Storage temperature $T_{stg}$: $-40$ to $+150\, ^\circ C$
- Junction temperature $T_j$: $150\, ^\circ C$

### Notes

1. Up to $T_j = 125\, ^\circ C$; see derating curve for higher temperature operation.
2. The limits for both diodes apply whether both diodes conduct simultaneously or on alternate half cycles.
3. Assuming no reverse leakage current losses.
Schottky-barrier, double rectifier diodes

BYV18 SERIES

CHARACTERISTICS (per diode)

Forward voltage
\[ V_F \leq \begin{cases} 0.6 & \text{V}^* \\ 1.05 & \text{V}^* \end{cases} \]
\[ I_F = 5 \text{ A}; T_j = 100 \degree \text{C} \]
\[ I_F = 15 \text{ A}; T_j = 25 \degree \text{C} \]

Reverse current
\[ I_R < 30 \text{ mA} \]
\[ V_R = V_{RWM_{\text{max}}}; T_j = 125 \degree \text{C} \]

Junction capacitance at \( f = 1 \text{ MHz} \)
\[ C_d = \text{typ.} 200 \text{ pF} \]
\[ V_R = 5 \text{ V}; T_j = 25 \text{ to } 125 \degree \text{C} \]

THERMAL RESISTANCE

From junction to mounting base (both diodes conducting)
\[ R_{\text{th j mb}} = 1.7 \text{ K/W} \]
From junction to mounting base (per diode)
\[ R_{\text{th j mb}} = 2.7 \text{ K/W} \]

Influence of mounting method

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

Thermal resistance from mounting base to heatsink
\[ R_{\text{th mb-h}} = \begin{cases} 0.3 & \text{K/W} \\ 1.4 & \text{K/W} \\ 2.2 & \text{K/W} \\ 0.8 & \text{K/W} \\ 1.4 & \text{K/W} \end{cases} \]

a. with heatsink compound
b. with heatsink compound and 0.06 mm maximum mica insulator
c. with heatsink compound and 0.1 mm maximum mica insulator (56369)
d. with heatsink compound and 0.25 mm maximum alumina insulator (56367)
e. without heatsink compound

2. Free air operation

The quoted values of \( R_{\text{th j-a}} \) 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
\[ R_{\text{th j-a}} = 60 \text{ K/W} \]

*Measured under pulse conditions to avoid excessive dissipation.
MOUNTING INSTRUCTIONS

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

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

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

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

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

OPERATING NOTES

Dissipation and heatsink calculations

The various components of junction temperature rise above ambient are illustrated in Fig.2.
OPERATING NOTES

Dissipation and heatsink calculations

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 or form factor of forward current (\( \delta \) or \( a \))
(iii) average forward current per diode
(iv) crest working reverse voltage (\( V_{RWM} \))

The total power dissipation in the diode has two components:

\[
\begin{align*}
PR & \quad \text{reverse leakage dissipation} \\
PF & \quad \text{forward conduction dissipation}
\end{align*}
\]

From the above it can be seen that:

\[
R_{th \, h-a} = \frac{T_{jmax} - T_{amb}}{PF + PR} - (R_{th \, j-mb} + R_{th \, mb-h})
\]

Values for \( R_{th \, j-mb} \) and \( R_{th \, mb-h} \) 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 \( V_{RWM} \) axis of Fig.3 (or Fig.5), and from a knowledge of the required \( V_{RWM} \), trace upwards to meet the curve that matches the required \( T_{j \, max} \). From this point trace horizontally left until the curve of the voltage grade of the device being used is met. From this point trace downwards to meet the required duty cycle (\( \delta \)) or form factor (\( a \)). From this point trace right and read the actual reverse power dissipation on the \( PR \) axis. From this calculation, \( PR = PR \, (\text{diode 1}) + PR \, (\text{diode 2}) \) (equation 3).

Forward conduction dissipation (\( PF \)) for the known average current \( I_F(AV) \) and duty cycle (or form factor) for each diode is easily derived from Fig.4 (or Fig.6).

Similarly, \( PF = PF \, (\text{diode 1}) + PF \, (\text{diode 2}) \) (equation 4).

Substituting equations 3) and 4) into equation 2) enables the calculation of the required heatsink.

NOTE:— If both halves of the diode are being used (as is assumed above), the value of \( R_{th \, j-mb} = 1.7 \, K/W \). If only one half of the diode is used, follow the above procedure for one diode only, and use the value of \( R_{th \, j-mb} \) of 2.7 \, K/W.

To ensure thermal stability, \( (R_{th \, j-mb} + R_{th \, mb-h} + R_{th \, h-a}) \times PR \) 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 BYV18-35 and heatsink compound;

\[
\begin{align*}
T_{amb} &= 50 \, ^\circ C; \, \delta (\text{diode 1}) = 0.5; \, \delta (\text{diode 2}) = 0.5; \\
I_F(AV) \, (\text{diode 1}) &= 5 \, A; \, I_F(AV) \, (\text{diode 2}) = 5 \, A; \\
V_{RWM} \, (both \, diodes) &= 12 \, V; \, \text{voltage grade of device} = 35 \, V. \\
\end{align*}
\]

From data, \( R_{th \, j-mb} = 1.7 \, K/W \) and \( R_{th \, mb-h} = 0.3 \, K/W \).

For each diode from Fig.4, it is found that \( PF = 3.5 \, W \);

hence total \( PF = 2 \times 3.5 = 7 \, W \). (from equation 4)

If desired \( T_{j \, max} \) is chosen to be 130 \, °C, then, from Fig.3, \( PR \, (\text{per diode}) = 0.1 \, W \)

Therefore total \( PR = 2 \times 0.1 = 0.2 \, W \). (from equation 3)

Using equation 2) we have:

\[
R_{th \, h-a} = \frac{130 \, ^\circ C - 50 \, ^\circ C}{7 \, W + 0.2 \, W} = 9.1 \, K/W
\]

To check for thermal stability:

\[
(R_{th \, j-a}) \times PR = (1.7 + 0.3 + 9.1) \times 0.2 = 2.2 \, ^\circ C.
\]

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 $T_j \text{max.}$, $V_{RWM}$ applied, voltage grade and duty cycle (per diode).

Fig. 4 Forward current power rating (per diode).

$$I_{F(AV)} = I_{F(RMS)} \times \sqrt{\delta}$$
SINUSOIDAL OPERATION (Figs. 5 and 6)

Fig. 5 NOMOGRAM: for calculation of $P_R$ (reverse leakage power dissipation) for a given $T_j_{\text{max}}$, $V_{RWM}$ applied, voltage grade and form factor (per diode).

$$a = \text{form factor} = \frac{I_F(RMS)}{I_F(AV)}.$$  

Fig. 6 Forward current power rating (per diode).
Fig. 7 Maximum permissible repetitive peak forward current for either square or sinusoidal current for $1 \mu s < t_p < 1 \text{ ms}$.

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

Fig. 8 — $T_j = 25^\circ\text{C}$; $--- T_j = 100^\circ\text{C}$.
Schottky-barrier double rectifier diodes

**BYV18 SERIES**

Fig. 9: $f = 1$ MHz; $T_j = 25$ to 125 °C.

Fig. 10: Typical values.

Fig. 11: Transient thermal impedance (per diode).

April 1986
BYV19 SERIES

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

<table>
<thead>
<tr>
<th>Repetitive peak reverse voltage $V_{RRM}$ max.</th>
<th>BYV19—30</th>
<th>35</th>
<th>40(A)</th>
<th>45</th>
</tr>
</thead>
<tbody>
<tr>
<td>Average forward current $I_{F(AV)}$ max.</td>
<td>10</td>
<td>A</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Forward voltage $V_F$ &lt;</td>
<td>0.6</td>
<td>V</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Junction temperature $T_j$ max.</td>
<td>150</td>
<td>°C</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

MECHANICAL DATA

Fig. 1 TO-220AC

Note: The exposed metal mounting base is directly connected to cathode. Accessories supplied on request: see data sheets Mounting instructions and accessories for TO-220 envelopes.
BYV19 SERIES

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

Voltages

<table>
<thead>
<tr>
<th></th>
<th>BYV19-30</th>
<th>35</th>
<th>40(A)</th>
<th>45</th>
</tr>
</thead>
<tbody>
<tr>
<td>Repetitive peak reverse voltage</td>
<td>$V_{RRM}$ max.</td>
<td>30</td>
<td>35</td>
<td>40</td>
</tr>
<tr>
<td>Crest working reverse voltage (note 1)</td>
<td>$V_{RWM}$ max.</td>
<td>30</td>
<td>35</td>
<td>40</td>
</tr>
<tr>
<td>Continuous reverse voltage (note 1)</td>
<td>$V_R$ max.</td>
<td>30</td>
<td>35</td>
<td>40</td>
</tr>
</tbody>
</table>

Currents

Average forward current

- square wave; $\delta = 0.5$; up to $T_{mb} = 124 \degree C$ (note 2)
  $I_{F(AV)}$ max. | 10   | A   |
- sinusoidal; up to $T_{mb} = 124 \degree C$ (note 2)
  $I_{F(AV)}$ max. | 9    | A   |

R.M.S. forward current

$I_{FRM}$ max. | 14   | A   |

Repetitive peak forward current

$t_p = 20 \mu s$; $\delta = 0.02$

$I_{FSM}$ max. | 150  | A   |
$t = 8.3 \, ms$

$1^2 t$ for fusing ($t = 10 \, ms$)

$I_{FSM}$ max. | 165  | A   |

Non-repetitive peak forward current

-half sine-wave; $T_j = 125 \degree C$ prior to surge; with reapplied $V_{RWM}$ max:

$1^2 t$ for fusing ($t = 10 \, ms$)

$t = 10 \, ms$

$I_{FSM}$ max. | 112  | A$^2 s$ |

$t = 8.3 \, ms$

$I_{FSM}$ max. | 165  | A   |

Temperatures

Storage temperature

$T_{stg}$ | -40 to +150 °C |

Junction temperature

$T_j$ max. | 150 °C |

CHARACTERISTICS

Forward voltage

- $I_F = 5 \, A$; $T_j = 100 \degree C$ (note 3)
  $V_F < 0.6 \, V$
- $I_F = 20 \, A$; $T_j = 25 \degree C$ (note 3)
  $V_F < 1.10 \, V$

Reverse current

- $V_R = V_{RWM}$ max; $T_j = 125 \degree C$
  $I_R < 30 \, mA$

Junction capacitance at $f = 1 \, MHz$

$V_R = 5 \, V$; $T_j = 25$ to $125 \degree C$

$C_d$ typ. | 200 pF |

Notes:
1. Up to $T_j = 125 \degree C$; see derating curve for higher temperature operation.
2. Assuming no reverse leakage current losses.
3. Measured under pulse conditions to avoid excessive dissipation.
Schottky-barrier rectifier diodes

BYV19 SERIES

THERMAL RESISTANCE
From junction to mounting base

\[ R_{th\ j-mb} = 2.7 \text{ K/W} \]

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

Thermal resistance from mounting base to heatsink

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

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

\[ R_{th\ j-a} = 60 \text{ K/W} \]

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

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

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

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

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

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

1. Overall thermal resistance, $R_{th\, j-a} = R_{th\, j-mb} + R_{th\, mb-h} + R_{th\, h-a}$
2. 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 ($V_{RWM}$)
3. The total power dissipation in the diode has two components:
   - $P_R$ - reverse leakage dissipation
   - $P_F$ - forward conduction dissipation
4. From the above it can be seen that:
   - $T_{jmax} - T_{amb}$

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 BYV19-35 and heatsink compound;
- $T_{amb} = 50$ °C; $\delta = 0.5$; $I_F(AV) = 8$ A
- $V_{RWM} = 12$ V; voltage grade of device = 35 V
- From data, $R_{th\, j-mb} = 2.7$ K/W and $R_{th\, mb-h} = 0.3$ K/W.
- From Fig.4, it is found that $P_F = 7$ W

If the desired $T_{jmax}$ is chosen to be 130 °C, then from Fig.3, $P_R = 0.1$ W

Using equation 2) we have:

$$R_{th\, h-a} = \frac{130 \,^\circ C - 50 \,^\circ C}{7 \, W + 0.1 \, W} - (2.7 + 0.3) = 8.3 \, K/W$$

To check for thermal stability:

$$(R_{th\, j-a}) \times P_R = (2.7 + 0.3 + 8.3) \times 0.1 = 1.1 \,^\circ C.$$"
Schottky-barrier rectifier diodes

BYV19 SERIES

SQUARE WAVE OPERATION (Figs.3 and 4)

Fig.3 NOMOGRAM: for calculation of \( P_R \) (reverse leakage power dissipation) for a given \( T_j \text{ max.} \), \( V_{RWM} \) applied, voltage grade and duty cycle.

Fig.4 Forward current power rating.

\[ I_{F(\text{AV})} = I_{F(\text{RMS})} \times \sqrt{\delta} \]
SINUSOIDAL OPERATION (Figs. 5 and 6)

Fig. 5 NOMOGRAM: for calculation of $P_R$ (reverse leakage power dissipation) for a given $T_{j \text{ max}}$, $V_{RWM}$ applied, voltage grade and form factor.

$$a = \frac{I_F(RMS)}{I_F(AV)}$$

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.

Fig. 8 —— $T_j = 25$ °C; ——— $T_j = 100$ °C.
Fig. 9 $f = 1$ MHz, $T_j = 25$ to $125$ °C.

Fig. 10 Typical values.

Fig. 11 Transient thermal impedance.
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**

<table>
<thead>
<tr>
<th>Repetitive peak reverse voltage</th>
<th>V_{RRM}</th>
<th>BYV20-30</th>
<th>35</th>
<th>40(A)</th>
<th>45</th>
</tr>
</thead>
<tbody>
<tr>
<td>Average forward current</td>
<td>I_{F(AV)}</td>
<td>max.</td>
<td>15</td>
<td>A</td>
<td></td>
</tr>
<tr>
<td>Forward voltage</td>
<td>V_{F}</td>
<td>&lt;</td>
<td>0.6</td>
<td>V</td>
<td></td>
</tr>
<tr>
<td>Junction temperature</td>
<td>T_{j}</td>
<td>max.</td>
<td>150</td>
<td>°C</td>
<td></td>
</tr>
</tbody>
</table>

**MECHANICAL DATA**

Fig. 1 DO-4 with 10-32 UNF stud (φ4.83 mm) as standard. Metric M5 stud (φ5 mm) is available on request, eg. BYV20-30M.

- Net mass: 6 g
- Diameter of clearance hole: 5.2 mm
- Accessories supplied on request:
  - 56295a (mica washer); 56295b (PTFE ring);
  - 56295c (insulating bush).

Supplied with device: 1 nut, 1 lock washer.
Torque on nut:
- min. 0.9 Nm (9 kg cm),
- max. 1.7 Nm (17 kg cm).
Nut dimensions across the flats:
- 10-32 UNF, 9.5 mm; M5, 8.0 mm.

Products approved to CECC 50 009-033 available on request.
BYV20 SERIES

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

**Voltages**

<table>
<thead>
<tr>
<th>BYV20–30</th>
<th>35</th>
<th>40(A)</th>
<th>45</th>
</tr>
</thead>
<tbody>
<tr>
<td>Non-repetitive peak reverse voltage</td>
<td>$V_{RSM}$ max.</td>
<td>36</td>
<td>42</td>
</tr>
<tr>
<td>Repetitive peak reverse voltage (note 1)</td>
<td>$V_{RRM}$ max.</td>
<td>30</td>
<td>35</td>
</tr>
<tr>
<td>Crest working reverse voltage</td>
<td>$V_{RWM}$ max.</td>
<td>30</td>
<td>35</td>
</tr>
<tr>
<td>Continuous reverse voltage</td>
<td>$V_R$ max.</td>
<td>30</td>
<td>35</td>
</tr>
</tbody>
</table>

**Currents**

<table>
<thead>
<tr>
<th></th>
<th>BYV20–30</th>
<th>35</th>
<th>40(A)</th>
<th>45</th>
</tr>
</thead>
<tbody>
<tr>
<td>Average forward current</td>
<td>$I_{F(\text{AV})}$ max.</td>
<td>15</td>
<td>A</td>
<td></td>
</tr>
<tr>
<td>square wave; $\delta = 0.5$; up to</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>$T_{\text{mb}} = 121$ °C (note 2)</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>sinusoidal; up to $T_{\text{mb}} = 124$ °C (note 2)</td>
<td>$I_{F(\text{AV})}$ max.</td>
<td>12.5</td>
<td>A</td>
<td></td>
</tr>
<tr>
<td>R.M.S. forward current</td>
<td>$I_{F(\text{RMS})}$ max.</td>
<td>21</td>
<td>A</td>
<td></td>
</tr>
<tr>
<td>Repetitive peak forward current</td>
<td>$I_{FRM}$ max.</td>
<td>260</td>
<td>A</td>
<td></td>
</tr>
<tr>
<td>$t_p = 20$ $\mu$s; $\delta = 0.02$</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Non-repetitive peak forward current</td>
<td>$I_{FSM}$ max.</td>
<td>300</td>
<td>A</td>
<td></td>
</tr>
<tr>
<td>half sine-wave; $T_j = 125$ °C prior to surge; with reapplied $V_{RWM}$ max;</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>$t = 10$ ms</td>
<td>$I_{FSM}$ max.</td>
<td>330</td>
<td>A</td>
<td></td>
</tr>
<tr>
<td>$t = 8.3$ ms</td>
<td>$I^2t$ max.</td>
<td>450</td>
<td>$A^2$s</td>
<td></td>
</tr>
<tr>
<td>$I^2t$ for fusing ($t = 10$ ms)</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Reverse surge current (BYV20-40A only)</td>
<td>$I_{RSM}$ max.</td>
<td>1.0</td>
<td>A</td>
<td></td>
</tr>
<tr>
<td>$t_p = 100$ $\mu$s</td>
<td></td>
<td></td>
<td></td>
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</tr>
</tbody>
</table>

**Temperatures**

<table>
<thead>
<tr>
<th></th>
<th>BYV20–30</th>
<th>35</th>
<th>40(A)</th>
<th>45</th>
</tr>
</thead>
<tbody>
<tr>
<td>Storage temperature</td>
<td>$T_{\text{stg}}$</td>
<td>-55 to +150</td>
<td>°C</td>
<td></td>
</tr>
<tr>
<td>Junction temperature</td>
<td>$T_j$ max.</td>
<td>150</td>
<td>°C</td>
<td></td>
</tr>
</tbody>
</table>

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

<table>
<thead>
<tr>
<th>Description</th>
<th>Value</th>
<th>Unit</th>
</tr>
</thead>
<tbody>
<tr>
<td>From junction to mounting base</td>
<td>$R_{th , j-mb}$</td>
<td>2.2</td>
</tr>
<tr>
<td>From mounting base to heatsink with heatsink compound</td>
<td>$R_{th , mb-h}$</td>
<td>0.5</td>
</tr>
<tr>
<td>Transient thermal impedance; $t = 1$ ms</td>
<td>$Z_{th , j-mb}$</td>
<td>0.85</td>
</tr>
</tbody>
</table>

### CHARACTERISTICS

<table>
<thead>
<tr>
<th>Description</th>
<th>Value</th>
<th>Unit</th>
</tr>
</thead>
<tbody>
<tr>
<td>Forward voltage</td>
<td>$I_F = 15$ A; $T_j = 100$ °C</td>
<td>$V_F$</td>
</tr>
<tr>
<td></td>
<td>$I_F = 40$ A; $T_j = 25$ °C</td>
<td>$V_F$</td>
</tr>
<tr>
<td>Rate of rise of reverse voltage</td>
<td>$V_R = V_{RWM_{max}}$</td>
<td>$\frac{dV_R}{dt}$</td>
</tr>
<tr>
<td>Reverse current</td>
<td>$V_R = V_{RWM_{max}}$; $T_j = 125$ °C</td>
<td>$I_R$</td>
</tr>
<tr>
<td>Capacitance at $f = 1$ MHz</td>
<td>$V_R = 5$ V; $T_j$ = 25 to 125 °C</td>
<td>$C_d$</td>
</tr>
</tbody>
</table>

*Measured under pulse conditions to avoid excessive dissipation.*
Dissipation and Heatsink Calculations

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

\[ R_{th \ j-mb} = 2.2 \text{K/W} \]
\[ R_{th \ mb-h} = 0.5 \text{K/W} \]

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 (\( V_{RWM} \))

The total power dissipation in the diode has two components:

\[ P_R - \text{reverse leakage dissipation} \]
\[ P_F - \text{forward conduction dissipation} \]

From the above it can be seen that:

\[ R_{th \ h-a} = \frac{T_{jmax} - T_{amb}}{P_R + P_F} - (R_{th \ j-mb} + R_{th \ mb-h}) \]

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 BYV20-35 and heatsink compound;

\( T_{amb} = 50 \text{°C} \); \( \delta = 0.5 \); \( I_{F(AV)} = 12 \text{A} \)
\( V_{RWM} = 12 \text{V} \); voltage grade of device = 35 \text{V} \)

From data, \( R_{th \ j-mb} = 2.2 \text{K/W} \) and \( R_{th \ mb-h} = 0.5 \text{K/W} \).

Using equation 2) we have:

\[ R_{th \ h-a} = \frac{130 \text{°C} - 50 \text{°C} - (2.2 + 0.5)}{9.2 \text{W} + 0.3 \text{W}} = 5.7 \text{K/W} \]

To check for thermal stability:

\( (R_{th \ j-mb}) \times P_R = (2.2 + 0.5 + 5.7) \times 0.3 = 2.5 \text{°C}. \)

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.

Fig. 4.

$P_F (W)$

$V$

$T$

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

$1_{F(AV)} = 1_{F(RMS)} \times \sqrt{\delta}$
Fig. 5 NOMOGRAM: for calculation of $P_R$ (reverse leakage power dissipation) for a given $T_{j,\text{max}}$, $V_{RWM}$ applied, voltage grade and form factor.

$a = \text{form factor} = \frac{I_F(\text{RMS})}{I_F(\text{AV})}$. 

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: $T_j = 25$ °C; $T_j = 100$ °C.
Fig. 9 $f = 1$ MHz; $T_j = 25$ to $125$ °C.

Fig. 10 Typical values.

Fig. 11 Transient thermal impedance.
SCHOTTKY-BARRIER RECTIFIER DIODES

High-efficiency schottky-barrier rectifier diodes in DO–4 metal envelopes, featuring low forward voltage drop, low capacitance, absence of stored charge and high temperature stability. They are intended for use in low output voltage switched-mode power supplies and high-frequency circuits in general, where both low conduction losses and zero switching losses are important. They can also withstand reverse voltage transients. The series consists of normal polarity (cathode to stud) types. A version with guaranteed reverse surge capability, BYV21-40A, is also available.

QUICK REFERENCE DATA

<table>
<thead>
<tr>
<th>Repetitive peak reverse voltage $V_{RRM}$ max.</th>
<th>BYV21–30</th>
<th>35</th>
<th>40(A)</th>
<th>45</th>
</tr>
</thead>
<tbody>
<tr>
<td>Average forward current $I_{F(AV)}$ max.</td>
<td>$V$</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>$I_{F(AV)}$ max.</td>
<td>30</td>
<td>40(A)</td>
<td>45</td>
<td></td>
</tr>
<tr>
<td>Forward voltage $V_F$ &lt;</td>
<td>0.55</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Junction temperature $T_j$ max.</td>
<td>150</td>
<td></td>
<td></td>
<td>0°C</td>
</tr>
</tbody>
</table>

MECHANICAL DATA

Fig.1 DO–4 with 10–32 UNF stud (φ4.83 mm) as standard. Metric M5 stud (φ5 mm) is available on request, e.g. BYV21–30M.

Net mass: 7 g
Diameter of clearance hole: 5.2 mm
Accessories supplied on request:
56295a (mica washer), 56295b (PTFE ring), 56295c (insulating bush).

Supplied with device: 1 nut, 1 lock washer.
Torque on nut:
min. 0.9 Nm (9 kg cm),
max. 1.7 Nm (17 kg cm).
Nut dimensions across the flats:
10–32 UNF, 9.5 mm; M5, 8.0 mm.

Products approved to CECC 50 009-018 available on request.
RATINGS

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

<table>
<thead>
<tr>
<th>Voltages</th>
<th>BYV21-30</th>
<th>35</th>
<th>40(A)</th>
<th>45</th>
</tr>
</thead>
<tbody>
<tr>
<td>Non-repetitive peak reverse voltage V_RSM</td>
<td>max.</td>
<td>36</td>
<td>42</td>
<td>48</td>
</tr>
<tr>
<td>Repetitive peak reverse voltage (note 1) V_RRM</td>
<td>max.</td>
<td>30</td>
<td>35</td>
<td>40</td>
</tr>
<tr>
<td>Crest working reverse voltage V_RWM</td>
<td>max.</td>
<td>30</td>
<td>35</td>
<td>40</td>
</tr>
<tr>
<td>Continuous reverse voltage V_R</td>
<td>max.</td>
<td>30</td>
<td>35</td>
<td>40</td>
</tr>
</tbody>
</table>

Currents

Average forward current; switching losses negligible
square wave; δ = 0.5; up to
T_mb = 124 °C (note 2)
in sinusoidal; up to T_mb = 125 °C (note 2)
R.M.S. forward current
I_F(AV) max. 30 A

Repetitive peak forward current
I_FRM max. 500 A

Non-repetitive peak forward current
half sine-wave; T_j = 125 °C prior to surge; with reapplied V_RWM max:
t = 10 ms
I_FSM max. 600 A
t = 8.3 ms
I_FSM max. 650 A
I^2 t for fusing (t = 10 ms)
I^2 t max. 1800 A^2 s

Reverse surge current (BYV21-40A only)
t_p = 100 µs
I_RSM max. 1.0 A

Temperatures

Storage temperature T_stg -55 to +150 °C
Junction temperature T_j max. 150 °C

MOUNTING INSTRUCTIONS

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

Notes:
1. For t_p = 200 ns a 20% increase in V_RRM is allowed.
2. Assuming no reverse leakage current losses.
Schottky-barrier rectifier diodes

BYV21 SERIES

THERMAL RESISTANCE

From junction to mounting base

\[ R_{th\ j-mb} = 1 \text{ K/W} \]

From mounting base to heatsink

\[ R_{th\ mb-h} = 0.3 \text{ K/W} \]

\[ R_{th\ mb-h} = 0.5 \text{ K/W} \]

Transient thermal impedance; \( t = 1 \text{ ms} \)

\[ Z_{th\ j-mb} = 0.15 \text{ K/W} \]

CHARACTERISTICS

Forward voltage

\[ I_F = 30 \text{ A}; T_j = 100 \text{ °C} \quad V_F < 0.55 \text{ V*} \]

\[ I_F = 80 \text{ A}; T_j = 25 \text{ °C} \quad V_F < 0.88 \text{ V*} \]

Rate of rise of reverse voltage

\[ \frac{dV_R}{dt} < 1500 \text{ V/µs} \]

Reverse current

\[ V_R = V_{RWM\max}; T_j = 125 \text{ °C} \quad I_R < 150 \text{ mA} \]

Capacitance at \( f = 1 \text{ MHz} \)

\[ V_R = 5 \text{ V}; T_j = 25 \text{ to } 125 \text{ °C} \quad C_d \text{ typ. } 1150 \text{ pF} \]

*Measured under pulse conditions to avoid excessive dissipation.
Dissipation and heatsink calculations

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

\[
\begin{align*}
R_{th\ j-mb} & = 1.0 \text{ K/W} \\
R_{th\ mb-h} & = 0.3 \text{ K/W} \\
R_{th\ h-a} & = \text{ mounting base heatsink}
\end{align*}
\]

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 (\( V_{RWM} \))

The total power dissipation in the diode has two components:

- \( P_R \) – reverse leakage dissipation
- \( P_F \) – forward conduction dissipation

From the above, it can be seen that:

\[
R_{th\ h-a} = \frac{T_{j\ max} - T_{amb}}{P_R + P_F} - (R_{th\ j-mb} + R_{th\ mb-h})
\]

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 \( T_{j\ max} \). From this point trace horizontally left until the curve of the voltage grade of the device being used is met. From this point trace downwards to meet the required duty cycle (\( \delta \)) 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 BYV21-35 and heatsink compound;

\( T_{amb} = 30 \text{ °C}; \ 8 = 0.5; \ I_F(AV) = 20 \text{ A}; \ V_{RWM} = 12 \text{ V}; \) voltage grade of device = 35 V.

From data, \( R_{th\ j-mb} = 1.0 \text{ K/W} \) and \( R_{th\ mb-h} = 0.3 \text{ K/W} \).

From Fig.4, it is found that \( P_F = 14 \text{ W} \)

If desired \( T_{j\ max} \) is chosen to be 120 °C, then, from Fig.3, \( P_R = 0.35 \text{ W} \)

Using equation 2) we have:

\[
R_{th\ h-a} = \frac{120 \text{ °C} - 30 \text{ °C}}{14 \text{ W} + 0.35 \text{ W}} - (1.0 + 0.3) = 5 \text{ K/W}
\]

To check for thermal stability: \( (R_{th\ j-a}) \times P_R = (1.0 + 0.3 + 5) \times 0.35 = 2.2 \text{ °C} \).

This is less than 12 °C, hence thermal stability is ensured.
Fig. 3 Maximum permissible junction temperature as a function of crest working reverse voltage and duty cycle of forward conduction.

\[ I_{F(\text{AV})} = I_{F(\text{RMS})} \times \sqrt{\delta} \]
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.

\[ a = \text{form factor} = \frac{I_F(RMS)}{I_F(AV)} \]
Schottky-barrier rectifier diodes

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

**Fig. 8** — $T_j = 25 \degree C$; $T_j = 100 \degree C$. 

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

$V_F$, $V_{F,max}$, $V_{F,typ}$.
Fig. 9: $f = 1 \text{ MHz}$; $T_j = 25$ to $125 \degree C$

Fig. 10: Typical values

Fig. 11: $Z_{th\ j-mb}$

$Z_{th\ j-mb}$ ($\text{K/W}$)

$10^{-3}$  $10^{-2}$  $10^{-1}$  $1$  $10$  $10^{-1}$  $10^{-2}$  $10^{-3}$  $10^{-4}$  $10^{-5}$

$10^{-5}$  $10^{-4}$  $10^{-3}$  $10^{-2}$  $10^{-1}$  $1$  $10$  $10^{-1}$  $10^{-2}$  $10^{-3}$  $10^{-4}$  $10^{-5}$

Time (s)
BYV22 SERIES

SCHOTTKY-BARRIER RECTIFIER DIODES

High-efficiency schottky-barrier rectifier diodes in D0-5 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

<table>
<thead>
<tr>
<th></th>
<th>BYV22—30</th>
<th>35</th>
<th>40(A)</th>
<th>45</th>
</tr>
</thead>
<tbody>
<tr>
<td>Repetitive peak reverse voltage $V_{RRM}$ max.</td>
<td>30</td>
<td>35</td>
<td>40</td>
<td>45</td>
</tr>
<tr>
<td>Average forward current $I_{F(AV)}$ max.</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Forward voltage $V_F$ &lt;</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Junction temperature $T_j$ max.</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Repetitive peak reverse voltage $V_{RRM}$ max.</td>
<td>30</td>
<td>35</td>
<td>40</td>
<td>45</td>
</tr>
<tr>
<td>Average forward current $I_{F(AV)}$ max.</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Forward voltage $V_F$ &lt;</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Junction temperature $T_j$ max.</td>
<td></td>
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</tr>
<tr>
<td>Repetitive peak reverse voltage $V_{RRM}$ max.</td>
<td>30</td>
<td>35</td>
<td>40</td>
<td>45</td>
</tr>
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<td>Average forward current $I_{F(AV)}$ max.</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Forward voltage $V_F$ &lt;</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Junction temperature $T_j$ max.</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Repetitive peak reverse voltage $V_{RRM}$ max.</td>
<td>30</td>
<td>35</td>
<td>40</td>
<td>45</td>
</tr>
<tr>
<td>Average forward current $I_{F(AV)}$ max.</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Forward voltage $V_F$ &lt;</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Junction temperature $T_j$ max.</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

MECHANICAL DATA

Fig.1 D0—5 with ¼" x 28 UNF stud (ø6.35 mm)
Types with metric M6 stud (ø6 mm) are available on request; e.g. BYV22—30M.

Net mass: 22 g
Diameter of clearance hole: 6.5 mm
Accessories supplied on request:
56264a (mica washer)
56264b (insulating bush).

Supplied with device: 1 nut, 1 lock washer
Torque on nut:
min. 1.7 Nm (17 kg cm),
max. 3.5 Nm (35 kg cm),
Nut dimensions across the flats
¼" x 28 UNF, 11.1 mm; M6, 10 mm.

Products approved to CECC 50 009-034 available on request

May 1986
551
BYV22 SERIES

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

<table>
<thead>
<tr>
<th>VOLTAGES</th>
<th>BYV22-30</th>
<th>35</th>
<th>40(A)</th>
<th>45</th>
</tr>
</thead>
<tbody>
<tr>
<td>Non-repetitive peak reverse voltage</td>
<td>VRSM</td>
<td>max.</td>
<td>36</td>
<td>42</td>
</tr>
<tr>
<td>Repetitive peak reverse voltage (note 1)</td>
<td>VRRM</td>
<td>max.</td>
<td>30</td>
<td>35</td>
</tr>
<tr>
<td>Crest working reverse voltage</td>
<td>VRWM</td>
<td>max.</td>
<td>30</td>
<td>35</td>
</tr>
<tr>
<td>Continuous reverse voltage</td>
<td>VR</td>
<td>max.</td>
<td>30</td>
<td>35</td>
</tr>
</tbody>
</table>

CURRENTS
Average forward current
- square wave; \( \delta = 0.5 \); up to \( T_{mb} = 124 \, ^\circ\text{C} \) (note 2)
- sinusoidal; up to \( T_{mb} = 127 \, ^\circ\text{C} \) (note 2)
- R.M.S. forward current
- Repetitive peak forward current \( t_p = 20 \, \mu\text{s}; \delta = 0.02 \)
- Non-repetitive peak forward current
  - half sine-wave; \( T_j = 125 \, ^\circ\text{C} \) prior to surge; with reapplied \( VRWM \) max
  - \( t = 10 \, \text{ms} \)
  - \( t = 8.3 \, \text{ms} \)
  - \( I^2 t \) for fusing \( (t = 10 \, \text{ms}) \)
  - Reverse surge current (BYV22-40A only)
    - \( t_p = 100 \, \mu\text{s} \)
  - \( IFSM \) max. | 1000 | A |
  - \( IFSM \) max. | 1100 | A |
  - \( I^2 t \) max. | 5000 | A^2 s |
  - \( IRSM \) max. | 2.0 | A |

Temperatures
- Storage temperature \( T_{stg} \) | \(-55\) to +150 | oC |
- Junction temperature \( T_j \) | 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 \( t_p = 200 \, \text{ns} \) a 20% increase in \( V_{RRM} \) is allowed.
2. Assuming no reverse leakage current losses.
**Schottky-barrier rectifier diodes**

**BYV22 SERIES**

**THERMAL RESISTANCE**

<table>
<thead>
<tr>
<th>Description</th>
<th>Resistance (R)</th>
<th>Unit</th>
</tr>
</thead>
<tbody>
<tr>
<td>From junction to mounting base</td>
<td>$R_{th \ j-mb}$</td>
<td>0.6 K/W</td>
</tr>
<tr>
<td>From mounting base to heatsink</td>
<td>$R_{th \ mb-h}$ with heatsink compound</td>
<td>0.3 K/W</td>
</tr>
<tr>
<td></td>
<td>$R_{th \ mb-h}$ without heatsink compound</td>
<td>0.5 K/W</td>
</tr>
<tr>
<td>Transient thermal impedance; $t = 1$ ms</td>
<td>$Z_{th \ j-mb}$</td>
<td>0.072 K/W</td>
</tr>
</tbody>
</table>

**CHARACTERISTICS**

**Forward voltage**

- $I_F = 50$ A; $T_j = 100$ °C
  - $V_F < 0.55$ V*
- $I_F = 150$ A; $T_j = 25$ °C
  - $V_F < 0.9$ V*

**Rate of rise of reverse voltage**

- $V_R = V_{RWMmax}$
  - $\frac{dV_R}{dt} < 1500$ V/µs

**Reverse current**

- $V_R = V_{RWMmax}; T_j = 125$ °C
  - $I_R < 250$ mA

**Capacitance at $f = 1$ MHz**

- $V_R = 5$ V; $T_j = 25$ to 125 °C
  - $C_d$ typ. 2100 pF

*Measured under pulse conditions to avoid excessive dissipation.
Dissipation and Heatsink Calculations

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

\[
\text{junction} \quad R_{th\ j\ -mb} = 0.6 \text{K/W} \quad \text{mounting base} \quad R_{th\ mb\ -h} = 0.3 \text{K/W} \quad \text{heatsink} \quad R_{th\ h\ -a} \quad \text{ambient}
\]

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 (\( V_{RWM} \))

The total power dissipation in the diode has two components:
- \( P_R \) — reverse leakage dissipation
- \( P_F \) — forward conduction dissipation

From the above it can be seen that:

\[
T_{j\ max} - T_{amb} = R_{th\ h\ -a} - (R_{th\ j\ -mb} + R_{th\ mb\ -h})
\]

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 \( T_{j\ max} \). From this point trace horizontally left until the curve of the voltage grade of the device being used is met. From this point trace downwards to meet the required duty cycle (\( \delta \) 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;

\( T_{amb} = 40 \text{ OC}; \delta = 0.5; I_F(AV) = 30 \text{ A} \)
\( V_{RWM} = 12 \text{ V}; \) 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 \( T_{j\ max} \) is chosen to be 130 °C, then from Fig.3, \( P_R = 0.9 \text{ W} \).

Using equation 2) we have:

\[
R_{th\ h\ -a} = \frac{130 \text{ OC} - 40 \text{ OC}}{18 \text{ W} + 0.9 \text{ W}} - (0.6 + 0.3) = 3.9 \text{ K/W}
\]

To check for thermal stability:

\((R_{th\ j\ -a}) \times P_R = (0.6 + 0.3 + 3.9) \times 0.9 = 4.3 \text{ OC} \).

This is less than 12 °C, hence thermal stability is ensured.
Schottky-barrier rectifier diodes

SQUARE-WAVE OPERATION (Figs.3 and 4)

Fig.3 NOMOGRAM: for calculation of $P_R$ (reverse leakage power dissipation) for a given $T_j$ max., $V_{RWM}$ applied, voltage grade and duty cycle.

Fig.4. $I_F(AV) = I_F(RMS) \times \sqrt{\delta}$
SINE-WAVE OPERATION (Figs. 5 and 6)

Fig. 5 NOMOGRAM: for calculation of $P_R$ (reverse leakage power dissipation) for a given $T_{j\text{ max}}$, $V_{RWM}$ applied, voltage grade and form factor.

$a = \text{form factor} = \frac{I_F(\text{RMS})}{I_F(\text{AV})}$. 

Fig. 6.
Schottky-barrier rectifier diodes

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

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

Fig. 8 —— $T_j = 25^\circ\text{C}$; ——— $T_j = 100^\circ\text{C}$. 

May 1986
Fig. 9 $f = 1$ MHz; $T_j = 25$ to $125$ °C.

Fig. 10 Typical values.

Fig. 11 Transient thermal impedance.
SCHOTTKY-BARRIER RECTIFIER DIODES

High-efficiency schottky-barrier rectifier diodes in DO–5 metal envelopes, featuring low forward voltage drop, low capacitance, absence of stored charge and high temperature stability. They are intended for use in low output voltage switched-mode power supplies and high-frequency circuits in general, where low conduction losses and switching losses are important. They can also withstand reverse voltage transients. The series consists of normal polarity (cathode to stud) types. A version with guaranteed reverse surge capability, BYV23–40A, is also available.

QUICK REFERENCE DATA

| Repetitive peak reverse voltage | $V_{RRM}$ max. | BYV23–30 | 35 | 40(A) | 45 | V |
| Average forward current        | $I_{F(AV)}$ max. | 80         | A |
| Forward voltage                | $V_F$ <         | 0.55       | V |
| Junction temperature           | $T_j$ max.      | 150        | °C |

MECHANICAL DATA

Dimensions in mm

Fig.1 DO–5 with ¾” x 28 UNF stud (ϕ6.35 mm)

Types with metric M6 stud (ϕ6 mm) are available on request; e.g. BYV23–30M.

Net mass: 22 g
Diameter of clearance hole: 6.5 mm
Accessories supplied on request:
56264a (mica washer),
56264b (insulating bush).

Supplied with device: 1 nut, 1 lock washer
Torque on nut:
min. 1.7 Nm (17 kg cm),
max. 3.5 Nm (35 kg cm).

Nut dimensions across the flats:
¾” x 28 UNF, 11.1 mm; M6, 10 mm.

Products approved to CECC 50 009-036 available on request
RATINGS

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

<table>
<thead>
<tr>
<th>Vottages</th>
<th>BYV23-30</th>
<th>35</th>
<th>40(A)</th>
<th>45</th>
</tr>
</thead>
<tbody>
<tr>
<td>Non-repetitive peak reverse voltage</td>
<td>V_{RSM}</td>
<td>max.</td>
<td>36</td>
<td>42</td>
</tr>
<tr>
<td>Repetitive peak reverse voltage (note 1)</td>
<td>V_{RRM}</td>
<td>max.</td>
<td>30</td>
<td>35</td>
</tr>
<tr>
<td>Crest working reverse voltage</td>
<td>V_{RWM}</td>
<td>max.</td>
<td>30</td>
<td>35</td>
</tr>
<tr>
<td>Continuous reverse voltage</td>
<td>V_{R}</td>
<td>max.</td>
<td>30</td>
<td>35</td>
</tr>
</tbody>
</table>

Currents

Average forward current
square wave; \( \delta = 0.5 \);
up to \( T_{mb} = 115 \, ^{\circ}C \) (note 2)
\( I_{F(AV)} \) max. 80 A
sinusoidal;
up to \( T_{mb} = 116 \, ^{\circ}C \) (note 2)
\( I_{F(AV)} \) max. 70 A
R.M.S. forward current
\( I_{F(RMS)} \) max. 113 A
Repetitive peak forward current
\( t_{p} = 20 \, \mu s; \delta = 0.02 \)
\( I_{FRM} \) max. 1500 A
Non-repetitive peak forward current
half sine-wave;
\( T_{j} = 125 \, ^{\circ}C \) prior to surge;
with reapplied \( V_{RWMmax} \)
\( t = 10 \, ms \)
\( I_{FSM} \) max. 1500 A
\( t = 8.3 \, ms \)
\( I_{FSM} \) max. 1650 A
\( I^{2}t \) for fusing (\( t = 10 \, ms \))
\( I^{2}t \) max. 11250 A^{2}s
Reverse surge current (BYV23-40A only)
\( t_{p} = 100 \, \mu s \)
\( I_{RSM} \) max. 2.0 A

Temperatures

Storage temperature \( T_{stg} \) -55 to +150 \, ^{\circ}C
Junction temperature \( T_{j} \) max. 150 \, ^{\circ}C

MOUNTING INSTRUCTIONS

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

Notes:
1. For \( t_{p} = 200 \, ns \) a 20% increase in \( V_{RRM} \) is allowed.
2. Assuming no reverse leakage current losses.
Schottky-barrier rectifier diodes

BYV23 SERIES

THERMAL RESISTANCE

From junction to mounting base
\[ R_{th \ j-mb} = 0.6 \ \text{K/W} \]

From mounting base to heatsink
with heatsink compound
\[ R_{th \ mb-h} = 0.3 \ \text{K/W} \]
without heatsink compound
\[ R_{th \ mb-h} = 0.5 \ \text{K/W} \]

Transient thermal impedance; \( t = 1 \text{ ms} \)
\[ Z_{th \ j-mb} = 0.07 \ \text{K/W} \]

CHARACTERISTICS

Forward voltage
\[ I_F = 70 \text{ A}; T_j = 100 \text{ °C} \]
\[ V_F < 0.55 \text{ V*} \]
\[ I_F = 200 \text{ A}; T_j = 25 \text{ °C} \]
\[ V_F < 0.95 \text{ V*} \]

Rate of rise of reverse voltage
\[ V_R = V_{RWMmax} \]
\[ \frac{dV_R}{dt} < 1500 \text{ V/µs} \]

Reverse current
\[ V_R = V_{RWMmax} ; T_j = 125 \text{ °C} \]
\[ I_R < 350 \text{ mA} \]

Capacitance at \( f = 1 \text{ MHz} \)
\[ V_R = 5 \text{ V} ; T_j = 25 \text{ to 125 °C} \]
\[ C_d \text{ typ.} = 2500 \text{ pF} \]

*Measured under pulse conditions to avoid excessive dissipation.
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 ($V_{RWM}$)

The total power dissipation in the diode has two components:

$P_R$ – reverse leakage dissipation

$P_F$ – forward conduction dissipation

From the above it can be seen that:

$T_{j\;max} - T_{amb} = R_{th\;h-a} \left( R_{th\;j-mb} + R_{th\;mb-h} \right)$

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 $T_{j\;max}$. From this point trace horizontally left until the curve of the voltage grade of the device being used is met. From this point trace downwards to meet the required duty cycle ($\delta$) 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;

$T_{amb} = 40 \; ^\circ C; \; \delta = 0.5; \; I_F(AV) = 50 \; A$

$V_{RWM} = 12 \; V; \; \text{voltage grade of device} = 35 \; V$

From data, $R_{th\;j-mb} = 0.6 \; K/W$ and $R_{th\;mb-h} = 0.3 \; K/W$.

From Fig.4, it is found that $P_F = 35 \; W$

If the desired $T_{j\;max}$ is chosen to be 140 °C, then from Fig.3, $P_R = 2.4 \; W$

Using equation 2) we have:

$R_{th\;h-a} = \frac{140 \; ^\circ C - 40 \; ^\circ C}{35 \; W + 2.4 \; W} = \frac{100}{37.4} = 1.8 \; K/W$

To check for thermal stability:

$(R_{th\;j-a}) \times P_R = (0.6 + 0.3 + 1.8) \times 2.4 = 6.5 \; ^\circ C$.

This is less than 12 °C, hence thermal stability is ensured.
SCHOTTKY-BARRIER RECTIFIER DIODES

BYV23 SERIES

SQUARE-WAVE OPERATION (Figs.3 and 4)

Fig.3 NOMOGRAM: for calculation of $P_R$ (reverse leakage power dissipation) for a given $T_{j\text{max}}$, $V_{RWM}$ applied, voltage grade and duty cycle.

$|F(\text{AV})| = |F(\text{RMS})| \times \sqrt{\delta}$
SINE-WAVE OPERATION (Figs. 5 and 6)

Fig. 5 NOMOGRAM: for calculation of $P_R$ (reverse leakage power dissipation) for a given $T_{j\text{max}}$, $V_{RWM}$ applied, voltage grade and form factor.

$$a = \text{form factor} = \frac{I_F(RMS)}{I_F(AV)}.$$
Fig. 7 Maximum permissible repetitive peak forward current for either square or sinusoidal current for $1 \mu s < t_p < 1 \text{ ms}$.

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

Fig. 8 — $T_j = 25^\circ \text{C}; \ldots - - - - T_j = 100^\circ \text{C}$.
Fig. 9 $f = 1 \text{ MHz}; T_j = 25 \text{ to } 125 \degree \text{C}$.

Fig. 10 Typical values.

Fig. 11 Transient thermal impedance.
SCHOTTKY—BARRIER DOUBLE RECTIFIER DIODES

High-efficiency schottky-barrier double rectifier diodes in plastic envelopes, featuring low forward voltage drop, low capacitance and absence of stored charge. They are intended for use in switched-mode power supplies and high-frequency circuits in general, where both low conduction losses and low switching losses are essential. The single chip (monolithic) construction allows both diodes to be paralleled without the need for derating. They can also withstand reverse voltage transients. The series consists of common-cathode types. A version with guaranteed reverse surge capability, BYV33–40A, is also available.

QUICK REFERENCE DATA

<table>
<thead>
<tr>
<th>Per diode, unless otherwise stated</th>
<th>BYV33–30</th>
<th>35</th>
<th>40(A)</th>
<th>45</th>
</tr>
</thead>
<tbody>
<tr>
<td>Repetitive peak reverse voltage</td>
<td>$V_{RRM}$ max.</td>
<td>30</td>
<td>35</td>
<td>40</td>
</tr>
<tr>
<td>Average forward current (both diodes conducting)</td>
<td>$I_F(AV)$ max.</td>
<td>20</td>
<td>A</td>
<td></td>
</tr>
<tr>
<td>Forward voltage</td>
<td>$V_F$ $&lt;$</td>
<td>0.6</td>
<td>V</td>
<td></td>
</tr>
<tr>
<td>Junction temperature</td>
<td>$T_j$ max.</td>
<td>150</td>
<td>°C</td>
<td></td>
</tr>
</tbody>
</table>

MECHANICAL DATA

Fig.1 TO-220AB

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 (per diode)

<table>
<thead>
<tr>
<th>Voltage Type</th>
<th>BYV33-30</th>
<th>35</th>
<th>40</th>
<th>45</th>
</tr>
</thead>
<tbody>
<tr>
<td>Repetitive peak reverse voltage</td>
<td>V_{RRM}</td>
<td>30</td>
<td>35</td>
<td>40</td>
</tr>
<tr>
<td>Crest working reverse voltage (note 1)</td>
<td>V_{RWM}</td>
<td>30</td>
<td>35</td>
<td>40</td>
</tr>
<tr>
<td>Continuous reverse voltage (note 1)</td>
<td>V_{R}</td>
<td>30</td>
<td>35</td>
<td>40</td>
</tr>
</tbody>
</table>

#### Currents (both diodes conducting; note 2)

Output current:
- square-wave; \( \delta = 0.5; \)
- up to \( T_{mb} = 122 \degree C \) (note 3)

<table>
<thead>
<tr>
<th>Current Type</th>
<th>BYV33-30</th>
<th>35</th>
<th>40</th>
<th>45</th>
</tr>
</thead>
<tbody>
<tr>
<td>I_{O} max.</td>
<td>20 A</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>R.M.S. forward current</td>
<td>I_{FRM}</td>
<td>200 A</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Non-repetitive peak forward current (per diode)
- half sine-wave; \( T_{j} = 125 \degree C \)
- surge; with reapplied \( V_{RWMmax} \)

<table>
<thead>
<tr>
<th>Current Type</th>
<th>BYV33-30</th>
<th>35</th>
<th>40</th>
<th>45</th>
</tr>
</thead>
<tbody>
<tr>
<td>I_{FSM} max.</td>
<td>200 A</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>I_{FSM max.}</td>
<td>220 A</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Reverse surge current (BYV33–40A only)
- \( t_{p} = 100 \mu s \)

<table>
<thead>
<tr>
<th>Current Type</th>
<th>BYV33-30</th>
<th>35</th>
<th>40</th>
<th>45</th>
</tr>
</thead>
<tbody>
<tr>
<td>I_{RSM} max.</td>
<td>0.5 A</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

#### Temperatures

<table>
<thead>
<tr>
<th>Temperature Type</th>
<th>BYV33-30</th>
<th>35</th>
<th>40</th>
<th>45</th>
</tr>
</thead>
<tbody>
<tr>
<td>Storage temperature</td>
<td>( T_{stg} )</td>
<td>-40 to +150 °C</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Junction temperature</td>
<td>( T_{j} )</td>
<td>max.</td>
<td>150 °C</td>
<td></td>
</tr>
</tbody>
</table>

#### Notes:
1. Up to \( T_{j} = 125 \degree C \); 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
IF = 7 A; TJ = 100 °C
IF = 20 A; TJ = 25 °C
V_F < 0.6 V*  
V_F < 1.0 V*

Reverse current
VR = VRWMM; TJ = 125 °C
IR < 40 mA

Junction capacitance at f = 1 MHz
VR = 5 V; TJ = 25 to 125 °C
C_d typ. = 300 pF

THERMAL RESISTANCE

From junction to mounting base (both diodes conducting)
R_th j-mb = 1.6 K/W

From junction to mounting base (per diode)
R_th j-mb = 2.6 K/W

Influence of mounting method

1. Heatsink mounted with clip (see mounting instructions)

Thermal resistance from mounting base to heatsink
a. with heatsink compound
R_th mb-h = 0.2 K/W

b. with heatsink compound and 0.06 mm maximum mica insulator
R_th mb-h = 1.4 K/W

c. with heatsink compound and 0.1 mm maximum mica insulator (56369)
R_th mb-h = 2.2 K/W

d. with heatsink compound and 0.25 mm maximum alumina insulator (56367)
R_th mb-h = 0.8 K/W

e. without heatsink compound
R_th mb-h = 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 j-a = 60 K/W

*Measured under pulse conditions to avoid excessive dissipation.
MOUNTING INSTRUCTIONS

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

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

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

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

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

OPERATING NOTES

Dissipation and heatsink calculations.

The various components of junction temperature rise above ambient are illustrated in Fig.2.
OPERATING NOTES

Dissipation and heatsink calculations (continued)

Overall thermal resistance, \( R_{\text{th} \ j-a} = R_{\text{th} \ j-mb} + R_{\text{th} \ mb-h} + R_{\text{th} \ h-a} \)

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 or form factor of forward current (\( \delta \) or \( a \))
- (iii) average forward current per diode
- (iv) crest working reverse voltage (\( V_{\text{RWM}} \))

The total power dissipation in the diode has two components:

\[ P_R = \text{reverse leakage dissipation} \]
\[ P_F = \text{forward conduction dissipation} \]

From the above it can be seen that:
\[ P_{\text{tot}} = P_R + P_F \]

\[ R_{\text{th} \ h-a} = \frac{T_{\text{jmax}} - T_{\text{amb}}}{P_F + P_R} \]

Values for \( R_{\text{th} \ j-mb} \) and \( R_{\text{th} \ mb-h} \) 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:

Look at each half of the dual diode separately; for each diode, starting at the \( V_{\text{RWM}} \) axis of Fig.3 (or Fig.5), and from a knowledge of the required \( V_{\text{RWM}} \), trace upwards to meet the curve that matches the required \( T_{\text{jmax}} \). 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. From this calculation, \( P_R = P_R \) (diode 1) + \( P_R \) (diode 2) (equation 3). Forward conduction dissipation (\( P_F \)) for the known average current \( I_F(AV) \) and duty cycle (or form factor) for each diode is easily derived from Fig.4 (or Fig.6).

Similarly, \( P_F = P_F \) (diode 1) + \( P_F \) (diode 2) (equation 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 \( R_{\text{th} \ j-mb} = 1.6 \text{ K/W} \). If only one half of the diode is used, follow the above procedure for one diode only, and use the value of \( R_{\text{th} \ j-mb} \) of 2.6 K/W.

To ensure thermal stability, \((R_{\text{th} \ j-mb} + R_{\text{th} \ mb-h} + R_{\text{th} \ h-a}) \times P_R \) must be less than 12 °C.

If the calculated value of \( R_{\text{th} \ h-a} \) does not permit this, then it must be reduced (heatsink size increased or \( R_{\text{th} \ mb-h} \) improved) to enable this criterion to be met.

EXAMPLE:— square-wave operation, using BYV33-35 and heatsink compound;

\[ T_{\text{amb}} = 50 \text{ °C}; \delta \text{ (diode 1)} = 0.5; \delta \text{ (diode 2)} = 0.5; \]
\[ I_F(AV) \text{ (diode 1)} = 7 \text{ A}; I_F(AV) \text{ (diode 2)} = 7 \text{ A}; \]
\[ V_{\text{RWM}} \text{ (both diodes)} = 12 \text{ V}; \text{ voltage grade of device = 35 V.} \]

From data, \( R_{\text{th} \ j-mb} = 1.6 \text{ K/W} \) and \( R_{\text{th} \ mb-h} = 0.2 \text{ K/W} \).

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 \( T_{\text{jmax}} \) 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:

\[ R_{\text{th} \ h-a} = \frac{130 \text{ °C} - 50 \text{ °C}}{11 \text{ W} + 0.34 \text{ W}} = \frac{80}{11.34} = 7.01 \text{ K/W} \]

To check for thermal stability:

\[
(R_{\text{th} \ j-a} \times P_R = (1.6 + 0.2 + 5.3) \times 0.34 = 2.4 \text{ °C.} \]

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 \( T_{j\text{max}} \), \( V_{RWM} \) applied, voltage grade and duty cycle (per diode).

\[
I_F(\text{AV}) = I_F(\text{RMS}) \times \sqrt{\delta}
\]

Fig. 4.
**Schottky-barrier double rectifier diodes**

**BYV33 SERIES**

### SINE-WAVE OPERATION (Figs.5 and 6)

<table>
<thead>
<tr>
<th>Grade</th>
<th>Reverse Voltage (V)</th>
</tr>
</thead>
<tbody>
<tr>
<td>45V</td>
<td></td>
</tr>
<tr>
<td>40V</td>
<td></td>
</tr>
<tr>
<td>35V</td>
<td></td>
</tr>
<tr>
<td>30V</td>
<td></td>
</tr>
</tbody>
</table>

Fig.5 NOMOGRAM: for calculation of $P_R$ (reverse leakage power dissipation) for a given $T_{j\text{max}}$, $V_{RWM}$ applied, voltage grade and form factor (per diode).

$$a = \frac{F_{(RMS)}}{F_{(AV)}}$$

![NOMOGRAM](image1.png)

Fig.6.

![Graph](image2.png)

May 1986
Fig. 7 Maximum permissible repetitive peak forward current for either square or sinusoidal currents for $1 \mu s < t_p < 1 \text{ ms}$.

Fig. 8 — $T_j = 25 ^\circ \text{C}; \quad - - - \quad T_j = 100 ^\circ \text{C};$

per diode.
Schottky-barrier double rectifier diodes

Fig. 9 $f = 1 \text{ MHz}; T_j = 25 \text{ to } 125 \text{ °C};$
per diode.

Fig. 10 Typical values; per diode.

Fig. 11 Transient thermal impedance; one diode conducting.
SCHOTTKY-BARRIER, ELECTRICALLY-ISOLATED DOUBLE RECTIFIER DIODES

High-efficiency schottky-barrier double rectifier diodes in SOT-186 (full-pack) plastic envelopes, featuring very low forward voltage drop, low capacitance and absence of stored charge. Their electrical isolation makes them ideal for mounting on a common heatsink alongside other components without the need for additional insulators. They are intended for use in switched-mode power supplies and high-frequency circuits in general, where low conduction losses and absence of stored charge are essential. The single chip (monolithic) construction allows both diodes to be paralleled without the need for derating. The series consists of common-cathode types.

A version with guaranteed reverse surge capability, BYV33F-40A is available.

QUICK REFERENCE DATA

<table>
<thead>
<tr>
<th>Per diode, unless otherwise stated</th>
<th>BYV33F-30</th>
<th>35</th>
<th>40(A)</th>
<th>45</th>
</tr>
</thead>
<tbody>
<tr>
<td>Repetitive peak reverse voltage</td>
<td>max.</td>
<td>30</td>
<td>35</td>
<td>40</td>
</tr>
<tr>
<td>V&lt;sub&gt;RRM&lt;/sub&gt;</td>
<td></td>
<td>V</td>
<td>V</td>
<td>V</td>
</tr>
<tr>
<td>Output current</td>
<td>I&lt;sub&gt;O&lt;/sub&gt; max.</td>
<td>20</td>
<td>A</td>
<td></td>
</tr>
<tr>
<td>(both diodes conducting)</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Forward voltage</td>
<td>V&lt;sub&gt;F&lt;/sub&gt; &lt;</td>
<td>0.6</td>
<td>V</td>
<td></td>
</tr>
<tr>
<td>Junction temperature</td>
<td>T&lt;sub&gt;j&lt;/sub&gt; &lt;</td>
<td>150</td>
<td>°C</td>
<td></td>
</tr>
</tbody>
</table>

MECHANICAL DATA

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

Net mass: 2 g.
The seating plane is electrically isolated from all terminals.
Accessories supplied on request (see data sheets Mounting instructions for F-pack devices and Accessories for SOT-186 envelopes).
RATINGS

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

### Voltages (per diode)

<table>
<thead>
<tr>
<th></th>
<th>BYV33F-30</th>
<th>35</th>
<th>40(A)</th>
<th>45</th>
</tr>
</thead>
<tbody>
<tr>
<td>Repetitive peak reverse voltage</td>
<td>V_{RRM} max.</td>
<td>30</td>
<td>35</td>
<td>40</td>
</tr>
<tr>
<td>Crest working reverse voltage (note 1)</td>
<td>V_{RWM} max.</td>
<td>30</td>
<td>35</td>
<td>40</td>
</tr>
<tr>
<td>Continuous reverse voltage (note 1)</td>
<td>V_{R} max.</td>
<td>30</td>
<td>35</td>
<td>40</td>
</tr>
</tbody>
</table>

### Currents (both diodes conducting; notes 2 and 4)

**Output current:**
- square wave; \( \delta = 0.5 \); up to \( T_h = 65 \degree C \) (note 3)
- sinusoidal; up to \( T_h = 71 \degree C \) (note 3)

**R.M.S. forward current**

<table>
<thead>
<tr>
<th></th>
<th>IF(RMS) max.</th>
<th>20</th>
<th>A</th>
</tr>
</thead>
</table>

**Repetitive peak forward current**

- \( t_p = 20 \mu s; \delta = 0.02 \) (per diode)
- \( t_p = 20 \mu s; \delta = 0.02 \) (per diode)

**Non-repetitive peak forward current (per diode)**

- half sine-wave; \( T_j = 150 \degree C \) prior to surge; with reapplied \( V_{RWM} \) max

<table>
<thead>
<tr>
<th></th>
<th>IFSM max.</th>
<th>150</th>
<th>A</th>
</tr>
</thead>
</table>

**Reverse surge current (BYV33F-40A only)**

- \( t_p = 100 \mu s \)

<table>
<thead>
<tr>
<th></th>
<th>IRSM max.</th>
<th>0.5</th>
<th>A</th>
</tr>
</thead>
</table>

### Temperatures

**Storage temperature**

<table>
<thead>
<tr>
<th></th>
<th>T_{stg}</th>
<th>-40 to +150</th>
<th>OC</th>
</tr>
</thead>
</table>

**Junction temperature**

<table>
<thead>
<tr>
<th></th>
<th>T_{j} max.</th>
<th>150</th>
<th>OC</th>
</tr>
</thead>
</table>

### ISOLATION

**Peak isolation voltage from all terminals to external heatsink**

<table>
<thead>
<tr>
<th></th>
<th>V_{isol} max.</th>
<th>1000</th>
<th>V</th>
</tr>
</thead>
</table>

**Isolation capacitance from centre lead to external heatsink (note 5)**

<table>
<thead>
<tr>
<th></th>
<th>C_{p} typ.</th>
<th>12</th>
<th>pF</th>
</tr>
</thead>
</table>

**Notes:**

1. Up to \( T_j = 125 \degree C \); see derating curve for higher temperature operation.
2. The limits for both diodes apply whether both diodes conduct simultaneously or on alternate half cycles.
3. Assuming no reverse leakage current losses.
4. The quoted temperatures assume heatsink compound is used.
5. Mounted without heatsink compound and 20 Newtons pressure on the centre of the envelope.
CHARACTERISTICS (per diode)

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

**Forward voltage**

- I<sub>F</sub> = 7 A; T<sub>j</sub> = 100 °C
- I<sub>F</sub> = 20 A

\[ V_F < 0.6 \text{ V}^{*} \]
\[ V_F < 1.0 \text{ V}^{*} \]

**Reverse current**

\[ V_R = V_{RWM \text{ max}}; T_j = 125 \text{ °C} \]

\[ I_R < 40 \text{ mA} \]

**Junction capacitance at f = 1 MHz**

\[ C_j \text{ typ.} = 300 \text{ pF} \]

**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
  - without heatsink compound

\[ R_{th \text{ j-h}} = 5.0 \text{ K/W} \]
\[ R_{th \text{ j-h}} = 7.0 \text{ K/W} \]

- b. per diode:
  - with heatsink compound
  - without heatsink compound

\[ R_{th \text{ j-h}} = 6.0 \text{ K/W} \]
\[ R_{th \text{ j-h}} = 8.0 \text{ K/W} \]

**Free air operation**

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

**Thermal resistance from junction to ambient**

- in free air, mounted on a printed circuit board

\[ R_{th \text{ j-a}} = 55 \text{ K/W} \]

*Measured under pulse conditions to avoid excessive dissipation.*
MOUNTING INSTRUCTIONS

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

2. The leads should not be bent less than 2.4 mm from the seal, and should be supported during bending. The bend radius must be no less than 1 mm.

3. Mounting by means of a spring clip is the best mounting method because it offers a good thermal contact under the crystal area and slightly lower $R_{th\ j-h}$ values than screw mounting. The force exerted on the top of the device by the clip should be at least 2 kgf (20 Newtons) to ensure good thermal contact and must not exceed 3.5 kgf (35 Newtons) to avoid damage to the device.

4. If screw mounting is used, it should be M3 cross-recess pan head.
   - Minimum torque to ensure good thermal contact: 5.5 kgf (0.55 Nm)
   - Maximum torque to avoid damage to the device: 8.0 kgf (0.80 Nm)

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

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

7. The heatsink must have a flatness in the mounting area of 0.02 mm maximum per 10 mm. Mounting holes must be deburred.

OPERATING NOTES

The various components of junction temperature rise above ambient are illustrated in Fig.2.

---

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

Dissipation and heatsink calculations (continued)

Overall thermal resistance, \( R_{th\hspace{0.1cm}j-a} = R_{th\hspace{0.1cm}j-h} + R_{th\hspace{0.1cm}h-a} \)

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 (\( V_{RWM} \))

The total power dissipation in the diode has two components:
- \( P_R \) - reverse leakage dissipation
- \( P_F \) - forward conduction dissipation

From the above it can be seen that:
\[
P_{tot} = P_R + P_F  \hspace{1cm} 1).
\]

\[
T_j^{\text{max}} - T_{amb} \hspace{1cm} 2).
\]

The value of \( R_{th\hspace{0.1cm}j-h} \) 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:

Look at each half of the dual diode separately; for each diode, starting at the \( V_{RWM} \) axis of Fig.3 (or Fig.5), and from a knowledge of the required \( V_{RWM} \), trace upwards to meet the curve that matches the required \( T_j^{\text{max}} \). 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 \( P_R \) axis. From this calculation, \( P_R = P_R \) (diode 1) + \( P_R \) (diode 2) ................................................... 3).

Forward conduction dissipation (\( P_F \)) for the known average current \( I_F(AV) \) and duty cycle (or form factor) for each diode is easily derived from Fig.4 (or Fig.6).

Similarly, \( P_F = P_F \) (diode 1) + \( P_F \) (diode 2) ....................................................... 4).

Substituting equations 3) and 4) into equation 2) enables the calculation of the required heatsink.

NOTE:—  If both halves of the diode are being used (as is assumed above), the value of \( R_{th\hspace{0.1cm}j-h} = 5 \text{ K/W (with heatsink compound)} \) 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 \( R_{th\hspace{0.1cm}j-h} \) of 6 K/W (with heatsink compound) or 8 K/W (without heatsink compound).

To ensure thermal stability, \( (R_{th\hspace{0.1cm}j-h} + R_{th\hspace{0.1cm}h-a}) \times P_R \) must be less than 12 °C. If the calculated value of \( R_{th\hspace{0.1cm}j-a} \) does not permit this, then it must be reduced (heatsink size increased or \( R_{th\hspace{0.1cm}j-a} \) improved) to enable this citerion to be met.

EXAMPLE: square wave operation, using BYV33F-35 and heatsink compound;

- \( T_{amb} = 40 \degree C; \delta \) (diode 1) = 0.5; \( \delta \) (diode 2) = 0.5;
- \( I_F(AV) \) (diode 1) = 7 A; \( I_F(AV) \) (diode 2) = 7 A;
- \( V_{RWM} \) (both diodes) = 12 V; voltage grade of device = 35 V.

From data, \( R_{th\hspace{0.1cm}j-h} = 5 \text{ K/W} \).

For each diode from Fig.4, it is found that \( P_F = 5.5 \text{ W} \);

\[
\text{hence total } P_F = 2 \times 5.5 = 11 \text{ W. (from equation 4) }
\]

If the desired \( T_j^{\text{max}} \) is chosen to be 130 °C, then, from Fig.3, \( P_R \) (per diode) = 0.17 W.

Therefore total \( P_R = 2 \times 0.17 = 0.34 \text{ W. (from equation 3) }
\]

Using equation 2) we have:
\[
R_{th\hspace{0.1cm}h-a} = \frac{130 \degree C - 40 \degree C}{11 \text{ W} + 0.34 \text{ W}} = (5.0) = 2.9 \text{ K/W}
\]

To check for thermal stability:
\[
(R_{th\hspace{0.1cm}j-a}) \times P_R = (5.0 + 2.9) \times 0.34 = 2.69 \degree C \hspace{1cm} \text{ This is less than 12 °C, hence thermal stability is ensured.}
\]
SQUARE-WAVE OPERATION (Figs.3 and 4)

Fig.3 NOMOGRAM: for calculation of $P_R$ (reverse leakage power dissipation) for a given $T_{j\,\text{max}}$, $V_{RWM}$ applied, voltage grade and duty cycle (per diode).

$$I_F(\text{AV}) = I_F(\text{RMS}) \times \sqrt{\delta}$$
Schottky-barrier, isolated double rectifier diodes

SINE-WAVE OPERATION (Figs. 5 and 6)

**Fig. 5** NOMOGRAM: for calculation of $P_R$ (reverse leakage power dissipation) for a given $T_{j\text{max}}$, $V_{RWM}$ applied, voltage grade and form factor (per diode).

$$a = \text{form factor} = \frac{I_F(\text{RMS})}{I_F(\text{AV})}.$$
Fig. 7 Maximum permissible repetitive peak forward current for either square or sinusoidal currents for $1 \mu s < t_p < 1 \text{ ms}$, per diode.

Fig. 8 — $T_j = 25 \degree C$; — $T_j = 100 \degree C$; per diode.
Schottky-barrier, isolated double rectifier diodes

BYV33F SERIES

Fig. 9 $f = 1 \text{ MHz; } T_j = 25$ to $125 \degree \text{C; per diode.}$

Fig. 10 Typical values; per diode.

Fig. 11 Transient thermal impedance; one diode conducting; —— with heatsink compound; — — — without heatsink compound.
BYV39 SERIES

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

<table>
<thead>
<tr>
<th></th>
<th>BYV39-30</th>
<th>35</th>
<th>40(A)</th>
<th>45</th>
</tr>
</thead>
<tbody>
<tr>
<td>Repetitive peak reverse voltage V_{RRM} max.</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Average forward current I_{F(AV)} max.</td>
<td></td>
<td>16</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Forward voltage V_F &lt;</td>
<td></td>
<td>0.6</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Junction temperature T_j max.</td>
<td></td>
<td>150</td>
<td></td>
<td>0°C</td>
</tr>
</tbody>
</table>

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.
BYV39 SERIES

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

→ VOLTAGES

<table>
<thead>
<tr>
<th>Limiting Values</th>
<th>BYV39-30</th>
<th>35</th>
<th>40(A)</th>
<th>45</th>
</tr>
</thead>
<tbody>
<tr>
<td>Repetitive peak reverse voltage</td>
<td>( V_{RRM} ) max.</td>
<td>30</td>
<td>35</td>
<td>40</td>
</tr>
<tr>
<td>Crest working reverse voltage (note 1)</td>
<td>( V_{RWM} ) max.</td>
<td>30</td>
<td>35</td>
<td>40</td>
</tr>
<tr>
<td>Continuous reverse voltage (note 1)</td>
<td>( V_R ) max.</td>
<td>30</td>
<td>35</td>
<td>40</td>
</tr>
</tbody>
</table>

→ CURRENTS

Average forward current
- square wave; \( \delta = 0.5 \);
  up to \( T_{mb} = 119 \, ^\circ\text{C} \) (note 2)
  sinusoidal; up to \( T_{mb} = 124 \, ^\circ\text{C} \) (note 2)
| \( I_{FAV} \) max. | 16 | A |
| \( I_{FAV} \) max. | 12.5 | A |

R.M.S. forward current
| \( I_{FRM} \) max. | 22 | A |

Repetitive peak forward current
\( t_p = 20 \, \mu\text{s}; \delta = 0.02 \)
| \( I_{FRM} \) max. | 260 | A |

Non-repetitive peak forward current
half sine-wave; \( T_j = 125 \, ^\circ\text{C} \) prior to surge; with reapplied \( V_{RWM} \) max
- \( t = 10 \, \text{ms} \)
  | \( I_{FSM} \) max. | 150 | A |
- \( t = 8.3 \, \text{ms} \)
  | \( I_{FSM} \) max. | 165 | A |
| \( I^2 t \) for fusing (\( t = 10 \, \text{ms} \)) | \( I_{RSM} \) max. | 112 | A^2 \text{s} |

Reverse surge current (BYV39-40A only)
\( t_p = 100 \, \mu\text{s} \)
| \( I_{RSM} \) max. | 1.0 | A |

Temperatures
- Storage temperature \( T_{stg} \) max. -40 to +150 \( ^\circ\text{C} \)
- Junction temperature \( T_j \) max. 150 \( ^\circ\text{C} \)

CHARACTERISTICS

Forward voltage
- \( I_F = 15 \, \text{A}; T_j = 100 \, ^\circ\text{C} \) (note 3)
  | \( V_F \) | < | 0.6 | V |
- \( I_F = 40 \, \text{A}; T_j = 25 \, ^\circ\text{C} \) (note 3)
  | \( V_F \) | < | 1.0 | V |

Reverse current
\( V_R = V_{RWM} \) max; \( T_j = 125 \, ^\circ\text{C} \)
| \( I_R \) | < | 55 | mA |

Junction capacitance at \( f = 1\text{MHz} \)
\( V_R = 5 \, \text{V}; T_j = 25 \text{ to } 125 \, ^\circ\text{C} \)
| \( C_d \) typ. | 520 | pF |

Notes:
1. Up to \( T_j = 125 \, ^\circ\text{C} \); see derating curve for higher temperature operation.
2. Assuming no reverse leakage current losses.
3. Measured under pulse conditions to avoid excessive dissipation.
Schottky-barrier rectifier diodes

BYV39 SERIES

THERMAL RESISTANCE
From junction to mounting base

Influence of mounting method
1. Heatsink-mounted with clip (see mounting instructions)
Thermal resistance from mounting base to heatsink
a. with heatsink compound
b. with heatsink compound and 0.06 mm maximum mica insulator
c. with heatsink compound and 0.1 mm maximum mica insulator (56369)
d. with heatsink compound and 0.25 mm maximum alumina insulator (56367)
e. without heatsink compound

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

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

**Dissipation and Heatsink Calculations**

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

\[
R_{th\ j-mb} = 2.2\,\text{K/W} \\
R_{th\ mb-h} = 0.5\,\text{K/W} \\
R_{th\ h-a} = \text{mounting base heatsink} \\\n\text{ambient}
\]

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 (\( V_{RWM} \))

The total power dissipation in the diode has two components:

\[ P_R - \text{reverse leakage dissipation} \]
\[ P_F - \text{forward conduction dissipation} \]

\[ P_{tot} = P_R + P_F \] .......................... 1).

\[ \frac{T_{j\ max} - T_{amb}}{P_R + P_F} = R_{th\ h-a} \] .......................... 2).

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 \( T_{j\ max} \). From this point trace horizontally left until the curve of the voltage grade of the device being used is met. From this point trace downwards to meet the required duty cycle (\( \delta \)) 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 BYV39-35 and heatsink compound;

\[ T_{amb} = 50 \,\text{°C}; \delta = 0.5; I_{F(AV)} = 12 \,\text{A} \]
\[ V_{RWM} = 12 \,\text{V}; \text{voltage grade of device} = 35 \,\text{V} \]

From data, \( R_{th\ j-mb} = 2.2 \,\text{K/W} \) and \( R_{th\ mb-h} = 0.5 \,\text{K/W} \).

From Fig.4, it is found that \( P_F = 9.2 \,\text{W} \)

If the desired \( T_{j\ max} \) is chosen to be 130 °C, then from Fig.3, \( P_R = 0.23 \,\text{W} \)

Using equation 2) we have:

\[ R_{th\ h-a} = \frac{130 \,\text{°C} - 50 \,\text{°C}}{9.2 \,\text{W} + 0.23 \,\text{W}} = 5.8 \,\text{K/W} \]

To check for thermal stability:

\[(R_{th\ j-a}) \times P_R = (2.2 + 0.5 + 5.8) \times 0.23 = 2 \,\text{°C} \]

This is less than 12 °C, hence thermal stability is ensured.
Schottky-barrier rectifier diodes

SQUARE-WAVE OPERATION (Figs 3 and 4)

Fig. 3 NOMOGRAM: for calculation of $P_R$ (reverse leakage power dissipation) for a given $T_{j\text{max}}$, $V_{RWM}$ applied, voltage grade and duty cycle.

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

Fig. 4
Fig. 5 NOMOGRAM: for calculation of $P_R$ (reverse leakage power dissipation) for a given $T_{j\text{max}}$, $V_{RWM}$ applied, voltage grade and form factor.

$a =$ form factor $= |I_F|_{\text{RMS}} / |I_F|_{\text{AV}}$
Fig. 7 Maximum permissible repetitive peak forward current for either square or sinusoidal currents for $1 \mu s < t_p < 1$ ms.

Fig. 8 $T_j = 25 \, ^\circ C$; $T_j = 100 \, ^\circ C$
Fig. 9: $f = 1$ MHz; $T_j = 25$ to $125$ °C

Fig. 10: Typical values

Fig. 11: Transient thermal impedance
BYV43 SERIES

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

<table>
<thead>
<tr>
<th>Per diode, unless otherwise stated</th>
<th>Repetitive peak reverse voltage</th>
<th>BYV43-30</th>
<th>35</th>
<th>40(A)</th>
<th>45</th>
</tr>
</thead>
<tbody>
<tr>
<td>V_{RRM} max.</td>
<td></td>
<td>30</td>
<td>35</td>
<td>40</td>
<td>45</td>
</tr>
<tr>
<td>Output current (both diodes conducting)</td>
<td>I_{O} max.</td>
<td>30</td>
<td>A</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Forward voltage</td>
<td>V_{F} &lt;</td>
<td>0.6</td>
<td>V</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Junction temperature</td>
<td>T_{J} &lt;</td>
<td>150</td>
<td>°C</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

MECHANICAL DATA

Fig.1 TO-220AB

Net mass: 2g

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

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

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

#### VOLTAGES (per diode)

<table>
<thead>
<tr>
<th>BYV43-</th>
<th>30</th>
<th>35</th>
<th>40(A)</th>
<th>45</th>
</tr>
</thead>
<tbody>
<tr>
<td>V&lt;sub&gt;RRM&lt;/sub&gt;</td>
<td>max.</td>
<td>30</td>
<td>35</td>
<td>40</td>
</tr>
<tr>
<td>V&lt;sub&gt;RWM&lt;/sub&gt;</td>
<td>max.</td>
<td>30</td>
<td>35</td>
<td>40</td>
</tr>
<tr>
<td>V&lt;sub&gt;R&lt;/sub&gt;</td>
<td>max.</td>
<td>30</td>
<td>35</td>
<td>40</td>
</tr>
</tbody>
</table>

#### CURRENTS (both diodes conducting; note 2)

- **Output current:**
  - square wave; \( \delta = 0.5 \);
  - up to \( T_{mb} = 112 \, ^{\circ}C \) (note 3)
  - R.M.S. forward current
  - Repetitive peak forward current \( t_p = 20 \mu s, \delta = 0.02 \) (per diode)
  - Non-repetitive peak forward current (per diode)
    - half sine-wave; \( T_j = 125 \, ^{\circ}C \) prior to surge; with reapplied \( V_{RWM} \) max
      - \( t = 10 \, ms \)
      - \( t = 8.3 \, ms \)
      - \( I^2 \, t \) for fusing (\( t = 10 \, ms \), per diode)
      - Reverse surge current (BYV43-40A only)
        - \( t_p = 100 \, \mu s \)

- **Temperatures**
  - Storage temperature \( T_{stg} \)
  - Junction temperature \( T_j \)

### Notes:

1. Up to \( T_j = 125 \, ^{\circ}C \); see derating curve for higher temperature operation.
2. The limits for both diodes apply whether both diodes conduct simultaneously or on alternate half cycles.
3. Assuming no reverse leakage current losses.
CHARACTERISTICS (per diode)

Forward voltage
- $I_F = 15 \text{ A}; T_j = 125 ^\circ \text{C}$
- $I_F = 30 \text{ A}; T_j = 25 ^\circ \text{C}$

Reverse current
- $V_R = V_{RWM \text{ max}}; T_j = 125 ^\circ \text{C}$

Junction capacitance at $f = 1 \text{MHz}$
- $V_R = 5 \text{ V}; T_j = 25 \text{ to } 125 ^\circ \text{C}$

THERMAL RESISTANCE

- From junction to mounting base (both diodes conducting)
- From junction to mounting base (per diode)

Influence of mounting method

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

   Thermal resistance from mounting base to heatsink
   - a. with heatsink compound
   - b. with heatsink compound and 0.06mm maximum mica insulator
   - c. with heatsink compound and 0.1mm maximum mica insulator (56369)
   - d. with heatsink compound and 0.25mm maximum alumina insulator (56367)
   - e. without heatsink compound

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

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

*Measured under pulse conditions to avoid excessive dissipation.*
MOUNTING INSTRUCTIONS

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

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

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

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

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

OPERATING NOTES

Dissipation and heatsink calculations.

The various components of junction temperature rise above ambient are illustrated in Fig.2.

Fig.2.
OPERATING NOTES

Dissipation and heatsink calculations (continued)

Overall thermal resistance, \( R_{th\, j-a} = R_{th\, j-mb} + R_{th\, mb-h} + R_{th\, h-a} \)

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 (\( V_{RWM} \))

The total power dissipation in the diode has two components:

\[ P_R \quad - \quad \text{reverse leakage dissipation} \]

\[ P_F \quad - \quad \text{forward conduction dissipation} \]

From the above it can be seen that:

\[ R_{th\, h-a} = \frac{T_{jmax} - T_{amb}}{P_F + P_R} \quad - \quad (R_{th\, j-mb} + R_{th\, mb-h}) \]

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 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. From this calculation, \( P_R = P_R \) (diode 1) + \( P_R \) (diode 2)

Forward conduction dissipation (\( P_F \)) for the known average current \( I_F(AV) \) and duty cycle for each diode is easily derived from Fig.4.

Similarly, \( P_F = P_F \) (diode 1) + \( P_F \) (diode 2)

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 \( R_{th\, j-mb} \) = 1.4 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 2.3 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 \( R_{th\, h-a} \) 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 BYV43-35 and heatsink compound;

\( T_{amb} = 50 \degree C; \delta \) (diode 1) = 0.5; \( \delta \) (diode 2) = 0.5;
\( I_F(AV) \) (diode 1) = 12 A; \( I_F(AV) \) (diode 2) = 12 A;
\( V_{RWM} \) (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 \( P_F = 9.3 \, \text{W} \);

hence total \( P_F = 2 \times 9.3 = 18.6 \, \text{W} \). (from equation 4)

If the desired \( T_{jmax} \) 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:

\[ R_{th\, h-a} = \frac{130 \degree C - 50 \degree C}{18.6 \, \text{W} + 0.88 \, \text{W}} - (1.4 + 0.2) = 2.5 \, \text{K/W} \]

To check for thermal stability:

\( (R_{th\, j-a}) \times P_R = (1.4 + 0.2 + 2.5) \times 0.88 = 3.6 \degree C \).

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 $T_j\text{max}$., $V_{RWM}$ applied, voltage grade and duty cycle (per diode).

Fig.4.

$I_{F(AV)} = I_{F(RMS)} \times \sqrt{\delta}$
Fig. 5 Maximum permissible repetitive peak forward current for either square or sinusoidal currents for \(1 \mu s < t_p < 1\) ms.

Fig. 6 —— \(T_j = 25^\circ\text{C}; \quad T_j = 125^\circ\text{C}\); 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.
BYV43F SERIES

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

<table>
<thead>
<tr>
<th>Per diode, unless otherwise stated</th>
<th>BYV43F-30</th>
<th>35</th>
<th>40(A)</th>
<th>45</th>
</tr>
</thead>
<tbody>
<tr>
<td>Repetitive peak reverse voltage</td>
<td>$V_{RRM}$</td>
<td>max.</td>
<td>30</td>
<td>35</td>
</tr>
<tr>
<td>Output current</td>
<td>$I_o$</td>
<td>max.</td>
<td>26</td>
<td>A</td>
</tr>
<tr>
<td>(both diodes conducting)</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Forward voltage</td>
<td>$V_F$</td>
<td>&lt;</td>
<td>0.6</td>
<td>V</td>
</tr>
<tr>
<td>Junction temperature</td>
<td>$T_j$</td>
<td>&lt;</td>
<td>150</td>
<td>°C</td>
</tr>
</tbody>
</table>

MECHANICAL DATA

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

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).
RATINGS

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

**Voltages** (per diode)

<table>
<thead>
<tr>
<th></th>
<th>BYV43F—30</th>
<th>35</th>
<th>40(A)</th>
<th>45</th>
</tr>
</thead>
<tbody>
<tr>
<td>Repetitive peak reverse voltage</td>
<td>$V_{RRM}$ max.</td>
<td>30</td>
<td>35</td>
<td>40</td>
</tr>
<tr>
<td>Crest working reverse voltage (note 1)</td>
<td>$V_{RWM}$ max.</td>
<td>30</td>
<td>35</td>
<td>40</td>
</tr>
<tr>
<td>Continuous reverse voltage (note 1)</td>
<td>$V_R$ max.</td>
<td>30</td>
<td>35</td>
<td>40</td>
</tr>
</tbody>
</table>

**Currents** (both diodes conducting; notes 2, 4)

Output current:
- square wave; $\delta = 0.5$; up to $T_h = 49^\circ C$ (note 3)
- R.M.S. forward current
- Repetitive peak forward current $t_p = 20 \mu s; \delta = 0.02$ (per diode)
- Non-repetitive peak forward current (per diode) half sine-wave; $T_j = 150^\circ C$ prior to surge; with reapplied $V_{RWM}$ max
  - $t = 10$ ms
  - $t = 8.3$ ms
- $I^2t$ for fusing ($t = 10$ ms, per diode)
- Reverse surge current (BYV43F—40A only) $t_p = 100 \mu s$

<table>
<thead>
<tr>
<th></th>
<th>I_O max.</th>
<th>I_{F(RMS)} max.</th>
<th>I_{FRM} max.</th>
<th>I_{FSM} max.</th>
<th>I_{FSM} max.</th>
<th>I_{2t} max.</th>
<th>I_{RSM} max.</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>26 A</td>
<td>37 A</td>
<td>250 A</td>
<td>200 A</td>
<td>220 A</td>
<td>200 A $A^2s$</td>
<td>0.5 A</td>
</tr>
</tbody>
</table>

**Temperatures**

<table>
<thead>
<tr>
<th></th>
<th>$T_{stg}$</th>
<th>$T_j$ max.</th>
</tr>
</thead>
<tbody>
<tr>
<td>Storage temperature</td>
<td>—40 to +150 $^\circ C$</td>
<td>150 $^\circ C$</td>
</tr>
<tr>
<td>Junction temperature</td>
<td>—</td>
<td>—</td>
</tr>
</tbody>
</table>

**ISOLATION**

<table>
<thead>
<tr>
<th></th>
<th>$V_{isol}$ max.</th>
<th>$C_p$ typ.</th>
</tr>
</thead>
<tbody>
<tr>
<td>Peak isolation voltage from all terminals to external heatsink</td>
<td>1000 V</td>
<td>12 pF</td>
</tr>
<tr>
<td>Isolation capacitance from centre lead to external heatsink (note 5)</td>
<td>—</td>
<td>—</td>
</tr>
</tbody>
</table>

Notes:
1. Up to $T_j = 125^\circ C$; see derating curve for higher temperature operation.
2. The limits for both diodes apply whether both diodes conduct simultaneously or on alternate half cycles.
3. Assuming no reverse leakage current losses.
4. The quoted temperatures assume heatsink compound is used.
5. Mounted without heatsink compound and 20 Newtons pressure on the centre of the envelope.
CHARACTERISTICS (per diode)

$T_j = 25 \, ^\circ C$ unless otherwise stated

Forward voltage

- $I_F = 15 \, A; \ T_j = 125 \, ^\circ C$
- $I_F = 30 \, A$

$V_F < 0.6 \, V^*$

Reverse current

- $V_R = V_{RWM \, max}; \ T_j = 125 \, ^\circ C$

$I_R < 100 \, mA$

Junction capacitance at $f = 1 \, MHz$

- $V_R = 5 \, V; \ T_j = 25 \, ^\circ C$ to $125 \, ^\circ C$

$C_j \, \text{typ.} = 500 \, pF$

THERMAL RESISTANCE

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

a. both diodes conducting:
   - with heatsink compound $R_{th \, j-h} = 4.8 \, K/W$
   - without heatsink compound $R_{th \, j-h} = 6.8 \, K/W$

b. per diode:
   - with heatsink compound $R_{th \, j-h} = 5.7 \, K/W$
   - without heatsink compound $R_{th \, j-h} = 7.7 \, K/W$

Free air operation

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

Thermal resistance from junction to ambient

in free air, mounted on a printed circuit board $R_{th \, j-a} = 55 \, K/W$

*Measured under pulse conditions to avoid excessive dissipation.
MOUNTING INSTRUCTIONS

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

2. The leads should not be bent less than 2.4 mm from the seal, and should be supported during
bending. The bend radius must be no less than 1 mm.

3. Mounting by means of a spring clip is the best mounting method because it offers a good thermal
contact under the crystal area and slightly lower $R_{th\ j-h}$ values than screw mounting. The force
exerted on the top of the device by the clip should be at least 2 kgf (20 Newtons) to ensure good
thermal contact and must not exceed 3.5 kgf (35 Newtons) to avoid damage to the device.

4. If screw mounting is used, it should be M3 cross-recess pan head.

   Minimum torque to ensure good thermal contact: 5.5 kgf (0.55 Nm)
   Maximum torque to avoid damage to the device: 8.0 kgf (0.80 Nm)

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

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

7. The heatsink must have a flatness in the mounting area of 0.02 mm maximum per 10 mm.
   Mounting holes must be deburred.

OPERATING NOTES

The various components of junction temperature rise above ambient are illustrated in Fig.2.

![Diagram](https://example.com/diagram.png)

Fig.2.

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

Dissipation and heatsink calculations (continued)

Overall thermal resistance, $R_{\text{th j-a}} = R_{\text{th j-h}} + R_{\text{th h-a}}$

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 ($V_{\text{RWM}}$)

The total power dissipation in the diode has two components:

$P_R$ — reverse leakage dissipation
$P_F$ — forward conduction dissipation

$P_{\text{tot}} = P_R + P_F$ ....................................... 1).

From the above it can be seen that:

$R_{\text{th h-a}} = \frac{T_{j_{\text{max}}} - T_{\text{amb}}}{P_F + P_R} - (R_{\text{th j-h}})$ ............................................... 2).

The value of $R_{\text{th j-h}}$ 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 as follows:

Look at each half of the dual diode separately; for each diode, starting at the $V_{\text{RWM}}$ axis of Fig.3, and from a knowledge of the required $V_{\text{RWM}}$, trace upwards to meet the curve that matches the required $T_{j_{\text{max}}}$. 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 ($\delta$). From this point trace right and read the actual reverse power dissipation on the $P_R$ axis. From this calculation,

$P_R = P_R \ (\text{diode 1}) + P_R \ (\text{diode 2})$ ................................................................. 3).

Forward conduction dissipation ($P_F$) for the known average current $I_F(\text{AV})$ and duty cycle for each diode is easily derived from Fig.4.

Similarly, $P_F = P_F \ (\text{diode 1}) + P_F \ (\text{diode 2})$ ....................................................... 4).

Substituting equations 3) and 4) into equation 2) enables the calculation of the required heatsink.

NOTE:— If both halves of the diode are being used (as is assumed above), the value of $R_{\text{th j-h}} = 4.8 \text{ K/W}$ (with heatsink compound) or $6.8 \text{ K/W}$ (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 $R_{\text{th j-h}}$ of $5.7 \text{ K/W}$ (with heatsink compound) or $7.7 \text{ K/W}$ (without heatsink compound).

To ensure thermal stability, $(R_{\text{th j-h}} + R_{\text{th h-a}}) \times P_R$ must be less than $12 \degree \text{C}$. If the calculated value of $R_{\text{th h-a}}$ does not permit this, then it must be reduced (heatsink size increased or $R_{\text{th j-a}}$ improved) to enable this criterion to be met.

EXAMPLE: square wave operation, using BYV43F–35 and heatsink compound;

$T_{\text{amb}} = 40 \degree \text{C}; \delta \ (\text{diode 1}) = 0.5; \delta \ (\text{diode 2}) = 0.5; \newline I_F(\text{AV}) \ (\text{diode 1}) = 9 \text{ A}; I_F(\text{AV}) \ (\text{diode 2}) = 9 \text{ A}; \newline V_{\text{RWM}} \ (\text{both diodes}) = 12 \text{ V}; \text{ voltage grade of device} = 35 \text{ V}. \newline$ From data, $R_{\text{th j-h}} = 4.8 \text{ K/W}$.

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 $T_{j_{\text{max}}}$ is chosen to be $130 \degree \text{C}$, then, from Fig.3, $P_R \ (\text{per diode}) = 0.44 \text{ W}$. Therefore total $P_R = 2 \times 0.44 = 0.88 \text{ W}$. (from equation 3)

Using equation 2) we have:

$R_{\text{th h-a}} = \frac{130 \degree \text{C} - 40 \degree \text{C}}{12 \text{ W} + 0.88 \text{ W}} - (4.8) = 2.2 \text{ K/W}$

To check for thermal stability:

$(R_{\text{th j-a}}) \times P_R = (4.8 + 2.2) \times 0.88 = 6.16 \degree \text{C}$. This is less than $12 \degree \text{C}$, 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 $T_{j\text{max}}$, $V_{RWM}$ applied, voltage grade and duty cycle (per diode).

\[ I_F(\text{AV}) = I_F(\text{RMS}) \times \sqrt{\delta} \]
Fig. 5 Maximum permissible repetitive peak forward current for either square or sinusoidal currents for $1 \mu s < t_p < 1$ ms, per diode.

Fig. 6 — $T_j = 25$ °C; $T_j = 125$ °C; per diode.
Fig. 7 $f = 1$ MHz; $T_j = 25$ to $125 \, ^\circ C$; per diode.

Fig. 8 Typical values; per diode.

Fig. 9 Transient thermal impedance; one diode conducting; — with heatsink compound; — — — without heatsink compound.
BYV73 SERIES

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

<table>
<thead>
<tr>
<th></th>
<th>BYV73–30</th>
<th>35</th>
<th>40(A)</th>
<th>45</th>
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</thead>
<tbody>
<tr>
<td>Repetitive peak reverse voltage</td>
<td>V_RRM max.</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Output current</td>
<td>I_o max.</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Forward voltage</td>
<td>V_F &lt;</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Junction temperature</td>
<td>T_j &lt;</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

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<td>V_RRM</td>
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<td>Output current</td>
<td>I_o</td>
<td></td>
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<td>Forward voltage</td>
<td>V_F</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Junction temperature</td>
<td>T_j</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

MECHANICAL DATA

Fig.1 SOT-93

Dimensions in mm

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)

<table>
<thead>
<tr>
<th></th>
<th>BYV73–30</th>
<th>35</th>
<th>40(A)</th>
<th>45</th>
</tr>
</thead>
<tbody>
<tr>
<td>Repetitive peak reverse voltage</td>
<td>V_{RRM} max.</td>
<td>30</td>
<td>35</td>
<td>40</td>
</tr>
<tr>
<td>Crest working reverse voltage (note 1)</td>
<td>V_{RWM} max.</td>
<td>30</td>
<td>35</td>
<td>40</td>
</tr>
<tr>
<td>Continuous voltage (note 1)</td>
<td>V_{R} max.</td>
<td>30</td>
<td>35</td>
<td>40</td>
</tr>
</tbody>
</table>

→ **Currents** (both diodes conducting; note 2)

Output current:
- square wave; \( \delta = 0.5 \);
- up to \( T_{mb} = 112 \, ^{\circ}C \) (note 3)

<table>
<thead>
<tr>
<th></th>
<th>( I_{O} ) max.</th>
<th>30</th>
<th>A</th>
</tr>
</thead>
</table>

R.M.S. forward current

<table>
<thead>
<tr>
<th></th>
<th>( I_{FRM} ) max.</th>
<th>250</th>
<th>A</th>
</tr>
</thead>
</table>

Repetitive peak forward current

\( t_{p} = 20 \, \mu s; \delta = 0.02 \) (per diode)

<table>
<thead>
<tr>
<th></th>
<th>( I_{FSM} ) max.</th>
<th>150</th>
<th>A</th>
</tr>
</thead>
</table>

Non-repetitive peak forward current (per diode)

- half sine-wave; \( T_{j} = 125 \, ^{\circ}C \) prior to surge;
- with reapplied \( V_{RWM} \) max;

<table>
<thead>
<tr>
<th></th>
<th>( I_{FSM} ) max.</th>
<th>165</th>
<th>A</th>
</tr>
</thead>
</table>

\( I_{FSM} \) for fusing (\( t = 10 \, ms, \) per diode)

<table>
<thead>
<tr>
<th></th>
<th>( I_{RSM} ) max.</th>
<th>0.5</th>
<th>A</th>
</tr>
</thead>
</table>

Reverse surge current (BYV73–40A only)

\( t_{p} = 100 \, \mu s \)

<table>
<thead>
<tr>
<th></th>
<th>( T_{stg} )</th>
<th>–40 to +150</th>
<th>{^{\circ}C}</th>
</tr>
</thead>
</table>

<table>
<thead>
<tr>
<th></th>
<th>( T_{j} ) max.</th>
<th>150</th>
<th>{^{\circ}C}</th>
</tr>
</thead>
</table>

Notes:
1. Up to \( T_{j} = 125 \, ^{\circ}C \); see derating curve for higher temperature operation.
2. The limits for both diodes apply whether both diodes conduct simultaneously or on alternate half cycles.
3. Assuming no reverse leakage current losses.
## CHARACTERISTICS (per diode)

### Forward voltage
- \( I_F = 15 \, A; \, T_j = 125 \, ^\circ C \)  
  \( V_F < 0.6 \, V^* \)
- \( I_F = 30 \, A; \, T_j = 25 \, ^\circ C \)  
  \( V_F < 0.87 \, V^* \)

### Reverse current
- \( V_R = V_RWM \, \text{max}; \, T_j = 125 \, ^\circ C \)  
  \( I_R < 100 \, mA \)

### Junction capacitance at \( f = 1 \, \text{MHz} \)
- \( V_R = 5 \, V; \, T_j = 25 \, \text{to} \, 125 \, ^\circ C \)  
  \( C_d \, \text{typ.} = 500 \, \mu F \)

## THERMAL RESISTANCE

### From junction to mounting base (both diodes conducting)
- \( R_{th \, j-mb} = 1.4 \, K/W \)

### From junction to mounting base (per diode)
- \( R_{th \, j-mb} = 2.4 \, K/W \)

### Influence of mounting method

1. Heatsink-mounted with clip (see mounting instructions)
   - Thermal resistance from mounting base to heatsink
     - a. with heatsink compound  
       \( R_{th \, mb-h} = 0.2 \, K/W \)
     - b. with heatsink compound and 0.06 mm maximum mica insulator (56378)  
       \( R_{th \, mb-h} = 1.4 \, K/W \)
     - c. with heatsink compound and 0.1 mm maximum mica insulator  
       \( R_{th \, mb-h} = 2.2 \, K/W \)
     - d. with heatsink compound and 0.25 mm maximum alumina insulator  
       \( R_{th \, mb-h} = 0.8 \, K/W \)
     - e. without heatsink compound  
       \( R_{th \, mb-h} = 1.4 \, K/W \)

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  
     \( R_{th \, j-a} = 60 \, K/W \)

*Measured under pulse conditions to avoid excessive dissipation.*
MOUNTING INSTRUCTIONS
1. The device may be soldered directly into the circuit, but the maximum permissible temperature of the soldering iron or bath is 275 °C; the heat source must not be in contact with the joint for more than 5 seconds. Soldered joints must be at least 4.7 mm from the seal.
2. The leads should not be bent less than 2.4 mm from the seal, and should be supported during bending. The bend radius must be no less than 1.0 mm.
3. Mounting by means of a spring clip is the best mounting method because it offers:
   a. a good thermal contact under the crystal area and slightly lower $R_{th \, mb-h}$ values than does screw mounting.
   b. safe isolation for mains operation.
   However, if a screw is used, it should be M4 cross-recess pan head. Care should be taken to avoid damage to the plastic body.
4. For good thermal contact, heatsink compound should be used between mounting base and heatsink. Values of $R_{th \, mb-h}$ given for mounting with heatsink compound refer to the use of a metallic oxide-loaded compound. Ordinary silicone grease is not recommended.
5. Rivet mounting (only possible for non-insulated mounting).
   Devices may be rivetted to flat heatsinks; such a process must neither deform the mounting tab, nor enlarge the mounting hole.

OPERATING NOTES
Dissipation and heatsink calculations.
The various components of junction temperature rise above ambient are illustrated in Fig.2.
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 (\( V_{RWM} \))

The total power dissipation in the diode has two components:

\[ P_R \quad \text{reverse leakage dissipation} \]
\[ P_F \quad \text{forward conduction dissipation} \]

From the above it can be seen that:

\[ R_{th\ h-a} = \frac{T_{j\max} - T_{amb}}{P_F + P_R} - (R_{th\ j-mb} + R_{th\ mb-h}) \]

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 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 \( T_{j\max} \). From this point trace horizontally left until the curve of the voltage grade of the device being used is met. From this point trace downwards to meet the required duty cycle (\( \delta \)). From this point trace right and read the actual reverse power dissipation on the \( P_R \) axis.

From this calculation, \( P_R = P_R \) (diode 1) + \( P_R \) (diode 2) ........................................ 3).

Forward conduction dissipation \( (P_F) \) for the known average current \( I_F(AV) \) and duty cycle for each diode is easily derived from Fig.4.

Similarly, \( P_F = P_F \) (diode 1) + \( P_F \) (diode 2) ......................................................... 4).

Substituting equations 3) and 4) into equation 2) enables the calculation of the required heatsink.

NOTE: If both halves of the diode are being used (as is assumed above), the value of \( R_{th\ j-mb} = 1.4 \) 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, \( (R_{th\ j-mb} + R_{th\ mb-h} + R_{th\ h-a}) \times P_R \) must be less than 12 \( ^\circ \)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;
\( V_{RWM} \) (both diodes) = 12 V; voltage grade of device = 35 V.

From data, \( R_{th\ j-mb} = 1.4 \) K/W and \( R_{th\ mb-h} = 0.2 \) K/W.

For each diode from Fig.4, it is found that \( P_F = 9.3 \) W;

hence total \( P_F = 2 \times 9.3 = 18.6 \) W. (from equation 4)

If the desired \( T_{j\max} \) is chosen to be 130 \( ^\circ \)C, then, from Fig.3, \( P_R \) (per diode) = 0.44W

Therefore total \( P_R = 2 \times 0.44 = 0.88 \) W. (from equation 3)

Using equation 2) we have:

\[ R_{th\ h-a} = \frac{130 \circ C - 50 \circ C}{18.6 \ W + 0.88 \ W} = 2.5 \ K/W \]

To check for thermal stability:

\( (R_{th\ j-a} \times P_R = 1.4 + 0.2 + 2.5) \times 0.88 = 3.6 \) \( ^\circ \)C.

This is less than 12 \( ^\circ \)C, hence thermal stability is ensured.
BYV73 SERIES

SQUARE-WAVE OPERATION (Figs. 3 and 4)

Fig. 3 NOMOGRAM: for calculation of $P_R$ (reverse leakage power dissipation) for a given $T_{j\text{max}}$, $V_{RWM}$ applied, voltage grade and duty cycle (per diode).

$$I_{F(\text{AV})} = I_{F(\text{RMS})} \times \sqrt{\delta}$$
Fig. 5 Maximum permissible repetitive peak forward current for either square or sinusoidal currents for $1 \mu s < t_p < 1 \text{ ms}$.

Fig. 6 — $T_j = 25^\circ \text{C}; -- -- T_j = 125^\circ \text{C}$; per diode.
Fig. 7 $f = 1$ MHz; $T_j = 25$ to $125$ °C; per diode.

Fig. 8 Typical values; per diode.

Fig. 9 Transient thermal impedance; one diode conducting.
SCHOTTKY—BARRIER RECTIFIER DIODE

High-efficiency rectifier diode in a DO–5 metal envelope, featuring low forward voltage drop, low capacitance, absence of stored charge and high temperature stability. It is intended for use in low output voltage switched-mode power supplies and high-frequency circuits in general, where low conduction and switching losses are important. It can also withstand reverse voltage transients. The diode is of normal polarity (cathode to stud).

QUICK REFERENCE DATA

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Symbol</th>
<th>Min.</th>
<th>Max.</th>
<th>Unit</th>
</tr>
</thead>
<tbody>
<tr>
<td>Repetitive peak reverse voltage</td>
<td>( V_{RRM} )</td>
<td>8.0</td>
<td>45</td>
<td>( V )</td>
</tr>
<tr>
<td>Average forward current</td>
<td>( I_{F(AV)} )</td>
<td>3.0</td>
<td>60</td>
<td>( A )</td>
</tr>
<tr>
<td>Forward voltage</td>
<td>( V_F )</td>
<td>&lt; 0.6</td>
<td>150</td>
<td>( V )</td>
</tr>
<tr>
<td>Junction temperature</td>
<td>( T_j )</td>
<td>max. 12.7</td>
<td>45</td>
<td>( ^\circ C )</td>
</tr>
</tbody>
</table>

MECHANICAL DATA

Fig.1 DO–5 with \( \frac{3}{8}'' \times 28 \) 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:
\( \frac{3}{8}'' \times 28 \) UNF, 11.1 mm
RATINGS  Limiting values in accordance with the Absolute Maximum System (IEC134)

Voltages

Repetitive peak reverse voltage \( V_{RRM} \)

Crest working reverse voltage \( V_{RWM} \)

Continuous reverse voltage \( V_R \)

\[ \begin{align*}
\text{max.} & \quad 45 \text{ V} \\
\text{max.} & \quad 35 \text{ V} \\
\text{max.} & \quad 35 \text{ V}
\end{align*} \]

Currents

Average forward current; switching losses negligible

R.M.S. forward current \( I_F(\text{AV}) \)

Non-repetitive peak forward current

\[ \begin{align*}
\text{max.} & \quad 60 \text{ A} \\
\text{max.} & \quad 85 \text{ A} \\
\text{max.} & \quad 700 \text{ A} \\
\text{max.} & \quad 2450 \text{ A}^2\text{s}
\end{align*} \]

I\(^2\)t for fusing (t = 10 ms)

Temperatures

Storage temperature \( T_{\text{stg}} \)

Junction temperature \( T_j \)

\[ \begin{align*}
-55 \text{ to } +150 \text{ °C} \\
150 \text{ °C}
\end{align*} \]

THERMAL RESISTANCE

From junction to mounting base \( R_{\text{th j-mb}} \)

From mounting base to heatsink

with heatsink compound \( R_{\text{th mb-h}} \)

without heatsink compound \( R_{\text{th mb-h}} \)

Transient thermal impedance; t = 1 ms \( Z_{\text{th j-mb}} \)

\[ \begin{align*}
1 \text{ °C/W} \\
0.3 \text{ °C/W} \\
0.5 \text{ °C/W} \\
0.15 \text{ °C/W}
\end{align*} \]

CHARACTERISTICS

Forward voltage

\[ \begin{align*}
I_F = 60 \text{ A}; & \quad T_j = 125 \text{ °C} \\
I_F = 120 \text{ A}; & \quad T_j = 125 \text{ °C}
\end{align*} \]

\[ \begin{align*}
V_F & < 0.6 \text{ V*} \\
V_F & < 0.84 \text{ V*}
\end{align*} \]

Rate of rise of reverse voltage

\[ \frac{dV_R}{dt} < 1500 \text{ V/μs} \]

Reverse current

\( V_R = V_{RWM\text{max}}; T_j = 125 \text{ °C} \)

\[ I_R < 200 \text{ mA} \]

Capacitance at f = 1 MHz

\( V_R = 5 \text{ V}; T_j = 25 \text{ to } 125 \text{ °C} \)

\[ C_d \text{ typ. } 2100 \text{ pF} \]

MOUNTING INSTRUCTIONS

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

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

*Measured under pulse conditions to avoid excessive dissipation.
Schottky-barrier rectifier diode

Fig. 2 Maximum permissible average forward current versus mounting-base temperature at $V_{RWM} = 35$ 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); $T_J = 125$ °C prior to surge; with reapplied $V_{RWM\max}$.

Fig. 5 —— $T_J = 25$ °C; —— $T_J = 125$ °C
Schottky-barrier rectifier diode

Fig. 6: $f = 1 \text{ MHz; } T_j = 25 \text{ to } 125 \degree \text{C}$

Fig. 7: Typical values

Fig. 8: $Z_{th,j-mb}$ ($\degree \text{C/W}$)
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

<table>
<thead>
<tr>
<th></th>
<th>BR210-100 to 280</th>
</tr>
</thead>
<tbody>
<tr>
<td>Breakover voltage</td>
<td>V&lt;sub&gt;BO&lt;/sub&gt; nom. 100 to 280 V</td>
</tr>
<tr>
<td>Holding current</td>
<td>I&lt;sub&gt;H&lt;/sub&gt; &gt; 150 mA</td>
</tr>
<tr>
<td>Transient peak current</td>
<td>I&lt;sub&gt;TRM&lt;/sub&gt; max. 40 A</td>
</tr>
</tbody>
</table>

(10/320 μs impulse)

MECHANICAL DATA

Fig.1 TO-220AC

Dimensions in mm

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).

Currents
(in either direction)

- Transient peak current (8/20 µs impulse) \( I_{TRM1} \) max. 150 A
- Transient peak current (10/320 µs impulse)
equivalent to 10/700 µs 1.6 kV voltage impulse (CCITT K17); (see Fig.3) \( I_{TRM2} \) max. 40 A
- Average on-state current (averaged over any 20 ms period); up to \( T_{mb} = 75 \) °C \( I_{T(AV)} \) max. 5 A
- R.M.S. a.c. on-state current \( I_{T(RMS)} \) max. 8 A
- Non-repetitive peak on-state current;
\( T_j = 100 \) °C prior to surge;
\( t = 10 \) ms; half sine-wave \( I_{TSM} \) max. 40 A
- \( I^2 t \) for fusing (t = 10 ms) \( I^2 t \) max. 8 A²s
- Rate of rise of on-state current after \( V_{BO} \) turn-on (\( t_p = 10 \) µs) \( \text{di/dt} \) max. 50 A/µs

Temperatures

- Storage temperature \( T_{stg} \) -40 to +150 °C
- Operating temperature (off-state) \( T_j \) max. 125 °C
- Overload temperature (on-state) \( T_{vj} \) max. 150 °C

THERMAL RESISTANCE

- From junction to ambient in free air mounted on a printed circuit board at any lead length \( R_{th \ j-amb} = 60 \) K/W
- From junction to mounting base
  - One line conducting bidirectional operation \( R_{th \ j-mb} = 2.0 \) K/W
  - Unidirectional operation \( R_{th \ j-mb} = 2.4 \) K/W
  - Both lines conducting bidirectional operation \( R_{th \ j-mb} = 1.5 \) K/W
- Transient thermal impedance (t = 1 ms) \( Z_{th \ j-mb} = 0.3 \) K/W
CHARACTERISTICS

$T_j = 25 \, ^\circ\text{C}$ unless otherwise stated; each line to centre lead.

Voltages and currents (in either direction)

On-state voltage (note 1)

$V_{TM} = 10 \, \text{A}$

| $V_{TM}$ | $< 2.5 \, \text{V}$ |

Avalanche voltage $V_{BR}$; ($I_{BR} = 10 \, \text{mA}$), and
Breakover voltage $V_{BO}$; ($I = I_S$):

(100 $\mu$s pulsed)

<table>
<thead>
<tr>
<th>$V_{BR}$ min.</th>
<th>$V_{BO}$ max.</th>
</tr>
</thead>
<tbody>
<tr>
<td>BR210 -100</td>
<td>88</td>
</tr>
<tr>
<td>-120</td>
<td>105</td>
</tr>
<tr>
<td>-140</td>
<td>123</td>
</tr>
<tr>
<td>-160</td>
<td>140</td>
</tr>
<tr>
<td>-180</td>
<td>158</td>
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<tr>
<td>-200</td>
<td>176</td>
</tr>
<tr>
<td>-220</td>
<td>193</td>
</tr>
<tr>
<td>-240</td>
<td>211</td>
</tr>
<tr>
<td>-260</td>
<td>228</td>
</tr>
<tr>
<td>-280</td>
<td>246</td>
</tr>
</tbody>
</table>

Temperature coefficient of $V_{BR}$

$S_{br}$ typ. $+0.1 \, \%/\text{K}$

Holding current (note 2)

$T_j = 25 \, ^\circ\text{C}$

$I_H > 150 \, \text{mA}$

$T_j = 70 \, ^\circ\text{C}$

$I_H > 100 \, \text{mA}$

Switching current (note 3)

$T_j = 25 \, ^\circ\text{C}$

$I_S > 10 \, \text{mA}$

(100 $\mu$s pulsed)

$I_S$ typ. $200 \, \text{mA}$

$I_S$ $< 500 \, \text{mA}$

Off-state current; $V_D = 85\% \, V_{BR}_{min}$ (note 4)

$T_j = 70 \, ^\circ\text{C}$

$I_D < 50 \, \mu\text{A}$

$T_j = 125 \, ^\circ\text{C}$

$I_D < 250 \, \mu\text{A}$

Linear rate of rise of off-state voltage

that will not trigger any device;

$T_j = 70 \, ^\circ\text{C}$; $V_{DM} = 85\%V_{BR}_{min}$

$dV_D/dt < 2000 \, \text{V}/\mu\text{s}$

Off-state capacitance

$V_D = 0 \, ; f = 1 \, \text{kHz} \, \text{to} \, 1 \, \text{MHz}$

$C_j < 350 \, \text{pF}$

Notes:

1. Measured under pulsed conditions to avoid excessive dissipation.
2. Defined as the minimum current which the device can conduct before switching back to the off-state.
3. Defined as the maximum instantaneous current that the device can sustain in the avalanche breakdown state before it switches to a low voltage.
4. I.e., at maximum recommended d.c. stand-off voltage.
The 10/700 μs Impulse Waveform is defined for the voltage across the test fixture when the device under test is replaced with an open circuit. Clearly, once a breakover device has switched on to a low voltage, the current waveform will have a shorter fall-time, since the 15Ω + 25Ω output impedance becomes effectively in parallel with the 50 Ω.
MOUNTING INSTRUCTIONS
1. The device may be soldered directly into the circuit, but the maximum permissible temperature of the soldering iron or bath is 275 °C; it must not be in contact with the joint for more than 5 seconds. Soldered joints must be at least 4.7 mm from the seal.
2. The leads should not be bent less than 2.4 mm from the seal, and should be supported during bending. The leads can be bent, twisted or straightened by 90° maximum. The minimum bending radius is 1 mm.
3. It is recommended that the circuit connection be made to T1, 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 $R_{\text{th mb-h}}$ values than the screw mounting.
   b. safe isolation for mains operation.
   However, if a screw is used, it should be M3 cross-recess pan head. Care should be taken to avoid damage to the plastic body.
5. For good thermal contact heatsink compound should be used between base-plate and heatsink. Values of $R_{\text{th mb-h}}$ given for mounting with heatsink compound refer to the use of a metallic oxide-loaded compound. Ordinary silicone grease is not recommended.
6. Rivet mounting (only possible for non-insulated mounting).
   Devices may be rivetted to flat heatsinks; such a process must neither deform the mounting tab, nor enlarge the mounting hole.
7. The heatsink must have a flatness in the mounting area of 0.02 mm maximum per 10 mm. Mounting holes must be deburred.

OPERATING NOTES
Dissipation and heatsink considerations:
   a. The various components of junction temperature rise above ambient are illustrated below:

   ![Diagram showing dissipation and heatsink considerations]

   b. Any measurement of heatsink temperature should be made immediately adjacent to the device.
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 $T_{\text{amb}}$ scale. The intersection determines the required $R_{\text{th mb-a}}$. The heatsink thermal resistance value ($R_{\text{th h-a}}$) can now be calculated from:

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

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

- with heatsink compound $R_{\text{th mb-h}} = 0.3 \, \text{K/W}$
- with heatsink compound and 0.06 mm maximum mica insulator $R_{\text{th mb-h}} = 1.4 \, \text{K/W}$
- with heatsink compound and 0.1 mm max. mica insulator (56369) $R_{\text{th mb-h}} = 2.2 \, \text{K/W}$
- with heatsink compound and 0.25 mm max. alumina insulator (56367) $R_{\text{th mb-h}} = 0.8 \, \text{K/W}$
- without heatsink compound $R_{\text{th mb-h}} = 1.4 \, \text{K/W}$
Fig.5 The right-hand part shows the interrelationship between the power (derived from the left-hand part) and the maximum permissible temperatures.

\[ \alpha = 180^\circ \]

This figure applies for a low resistance load. It does not include any avalanche dissipation.
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), Tj = 125 °C prior to surge.

Fig. 8 Maximum non-repetitive exponential waveform Impulse Current rating as a function of pulse duration.
Fig. 9 On-state voltage as a function of on-state current. (200 µs pulsed condition to avoid excessive dissipation)

- $T_i = 25$, --- $T_i = 125$ °C.

Fig. 10 Maximum off-state current as a function of temperature.

Fig. 11 Switching current as a function of temperature;

- $T_i = 25$ °C;

--- $T_i = 125$ °C.

Fig. 12 Minimum holding current as a function of temperature.
Fig. 13 Normalised avalanche breakdown voltage as a function of temperature. Note: this figure may also be used to derive normalised $V_{BO}$. 

Fig. 14 Typical junction capacitance as a function of off-state voltage; $T_j = 25 \, ^\circ\text{C}$; $f = 1 \, \text{MHz}$. 
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 breakover voltage and peak current handling capability together with high holding current make it suitable for two-line to earth transient overvoltage protection in applications such as telephony equipment and remote instrumentation lines.

QUICK REFERENCE DATA

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Symbol</th>
<th>Units</th>
</tr>
</thead>
<tbody>
<tr>
<td>Breakover voltage per line</td>
<td>V(BO)</td>
<td>&lt; 78 V</td>
</tr>
<tr>
<td>Breakdown voltage per line</td>
<td>V(BR)</td>
<td>&gt; 58 V</td>
</tr>
<tr>
<td>Holding current</td>
<td>I_H</td>
<td>&gt; 150 mA</td>
</tr>
<tr>
<td>Transient peak current (10/320 µs)</td>
<td>I_TRM</td>
<td>max. 40 A</td>
</tr>
</tbody>
</table>

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 T2.

Accessories supplied on request: see data sheet Mounting instructions and accessories for TO-220 envelopes.
RATINGS
Limiting values in accordance with the Absolute Maximum System (IEC 134).

Currents
Transient peak current (8/20 µs impulse)  \( I_{TRM1}/I_{FRM1} \) max. 150 A
Transient peak current (10/320 µs impulse) equivalent to 10/700 µs 1.6 kV voltage impulse (CCITT K17)  \( I_{TRM2}/I_{FRM2} \) max. 40 A
Average on-state current  \( I_T(AV) \) max. 5 A
Average forward current (averaged over any 20 ms period); up to \( T_{mb} = 75 \) °C  \( I_F(AV) \) max. 5 A
R.M.S. a.c. on-state current  \( I_T(RMS) \) max. 8 A
Non-repetitive peak current; \( T_j = 100 \) °C prior to surge; \( t = 10 \) ms; half sine-wave  \( I_{TSM}/I_{FSM} \) max. 40 A
\( I^2t \) for fusing (\( t = 10 \) ms)  \( I_T(AV) \) max. 8 \( A^2s \)
Rate of rise of on-state current after \( V(BO) \) turn-on (\( t_p = 10 \) µs)  \( dI_T/dt \) max. 50 A/µs

Temperatures
Storage temperature  \( T_{stg} \) max. 150°C
Operating temperature (off-state)  \( T_j \) max. 125°C
Overload temperature (on-state)  \( T_{vj} \) max. 150°C

THERMAL RESISTANCE
From junction to ambient in free air mounted on a printed circuit board at any lead length  \( R_{th \ j-amb} \) = 60 K/W
From junction to mounting base
One line conducting bidirectional operation  \( R_{th \ j-mb} \) = 4.0 K/W
unidirectional operation  \( R_{th \ j-mb} \) = 5.0 K/W
Both lines conducting bidirectional operation  \( R_{th \ j-mb} \) = 3.0 K/W
Transient thermal impedance (\( t = 1 \) ms)  \( Z_{th \ j-mb} \) = 1.0 K/W
CHARACTERISTICS

$T_j = 25 \, ^\circ C$ unless otherwise stated; each line to centre lead.

On-state voltage (note 1)

$V_{TM} < 3.0 \, V$

Forward voltage (note 1)

$V_{FM} < 3.0 \, V$

Avalanche voltage

$V_{BR} > 58 \, V$

Breakover voltage

$V_{BO} < 78 \, V$

Temperature coefficient of $V_{BR}$

$S_{br} \text{ typ.} +0.1 \, \%/K$

Holding current (note 2)

$T_j = 25 \, ^\circ C$

$I_H > 150 \, mA$

$T_j = 70 \, ^\circ C$

$I_H > 100 \, mA$

Switching current (note 3)

$I_S > 10 \, mA$

$I_S \text{ typ.} 400 \, mA$

$I_S < 830 \, mA$

Off-state current; $V_D = 50 \, V$ (note 4)

$T_j = 70 \, ^\circ C$

$I_D < 0.5 \, mA$

$T_j = 125 \, ^\circ C$

$I_D < 5.0 \, mA$

Linear rate of rise of off-state voltage

$dV_D/dt < 2000 \, V/\mu s$

Off-state capacitance

$C_j < 500 \, pF$

Notes:

1. Measured under pulsed conditions to avoid excessive dissipation.
2. Defined as the minimum current which the device can conduct before switching back to the off-state.
3. Defined as the maximum instantaneous current that the device can sustain in the avalanche breakdown state before it switches to a low voltage.
4. i.e., at maximum recommended d.c. stand-off voltage.
Fig. 2 Breakover diode characteristics.
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**

<table>
<thead>
<tr>
<th>Parameter</th>
<th>BR220 - 100 to 280</th>
</tr>
</thead>
<tbody>
<tr>
<td>Breakover voltage per line</td>
<td>V&lt;sub&gt;BO&lt;/sub&gt; nom.</td>
</tr>
<tr>
<td>Holding current</td>
<td>I&lt;sub&gt;H&lt;/sub&gt; &gt;</td>
</tr>
<tr>
<td>Transient peak current (10/320 µs impulse)</td>
<td>I&lt;sub&gt;TRM&lt;/sub&gt; max.</td>
</tr>
</tbody>
</table>

**MECHANICAL DATA**

Fig. 1 TO-220AB; centre lead connected to tab.

**Dimensions in mm**

Net mass: 2 g

Note: The exposed metal mounting base is directly connected to terminal T2. 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).

Currents
(Individually for each line in either direction)

- Transient peak current (8/20 µs impulse)
- Transient peak current (10/320 µs impulse) equivalent to 10/700 µs 1.6 kV voltage impulse (CCITT K17); (see Fig.3)
- Average on-state current (averaged over any 20 ms period); up to \( T_{mb} = 75 \, ^\circ C \)
- R.M.S. a.c. on-state current
- Non-repetitive peak on-state current; \( T_j = 100 \, ^\circ C \) prior to surge; \( t = 10 \, ms \); half sine-wave
- \( I^2t \) for fusing (\( t = 10 \, ms \))
- Rate of rise of on-state current after \( V_{BO} \) turn-on (\( t_p = 10 \, \mu s \))

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Symbol</th>
<th>Maximum</th>
<th>Unit</th>
</tr>
</thead>
<tbody>
<tr>
<td>Transient peak current</td>
<td>( I_{TRM1} )</td>
<td>150</td>
<td>A</td>
</tr>
<tr>
<td>Transient peak current</td>
<td>( I_{TRM2} )</td>
<td>40</td>
<td>A</td>
</tr>
<tr>
<td>Average on-state current</td>
<td>( I_{T(AV)} )</td>
<td>5</td>
<td>A</td>
</tr>
<tr>
<td>R.M.S. a.c. on-state current</td>
<td>( I_{T(RMS)} )</td>
<td>8</td>
<td>A</td>
</tr>
<tr>
<td>Non-repetitive peak on-state current</td>
<td>( I_{TSM} )</td>
<td>40</td>
<td>A</td>
</tr>
<tr>
<td>Rate of rise of on-state current</td>
<td>( I^2t )</td>
<td>8</td>
<td>A²s</td>
</tr>
</tbody>
</table>

Temperatures

- Storage temperature \( T_{stg} \)
- Operating temperature (off-state) \( T_j \)
- Overload temperature (on-state) \( T_{vj} \)

<table>
<thead>
<tr>
<th>Temperature</th>
<th>Symbol</th>
<th>Maximum</th>
<th>Unit</th>
</tr>
</thead>
<tbody>
<tr>
<td>Storage</td>
<td>( T_{stg} )</td>
<td>-40 to +150</td>
<td>°C</td>
</tr>
<tr>
<td>Operating</td>
<td>( T_j )</td>
<td>125</td>
<td>°C</td>
</tr>
<tr>
<td>Overload</td>
<td>( T_{vj} )</td>
<td>150</td>
<td>°C</td>
</tr>
</tbody>
</table>

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 bidirectional operation
- Transient thermal impedance (\( t = 1 \, ms \))

<table>
<thead>
<tr>
<th>Resistance</th>
<th>Symbol</th>
<th>Value</th>
<th>Unit</th>
</tr>
</thead>
<tbody>
<tr>
<td>Junction to ambient</td>
<td>( R_{th j-amb} )</td>
<td>60</td>
<td>K/W</td>
</tr>
<tr>
<td>Junction to mounting base</td>
<td>( R_{th j-mb} )</td>
<td>2.0</td>
<td>K/W</td>
</tr>
<tr>
<td>Junction to mounting base</td>
<td>( R_{th j-mb} )</td>
<td>2.4</td>
<td>K/W</td>
</tr>
<tr>
<td>Junction to mounting base</td>
<td>( R_{th j-mb} )</td>
<td>1.5</td>
<td>K/W</td>
</tr>
<tr>
<td>Junction to mounting base</td>
<td>( Z_{th j-mb} )</td>
<td>0.3</td>
<td>K/W</td>
</tr>
</tbody>
</table>
Dual breakover diodes

CHARACTERISTICS

T<sub>j</sub> = 25 °C unless otherwise stated; each line to centre lead.

Voltages and currents (in either direction)

On-state voltage (note 1)

ITM = 10 A

V<sub>TM</sub> < 2.5 V

Avalanche voltage V<sub>BR</sub>; (I<sub>BR</sub> = 10 mA), and

Breakover voltage V<sub>BO</sub>; (I = I<sub>S</sub>):

(100 µs pulsed)

<table>
<thead>
<tr>
<th>V&lt;sub&gt;BR&lt;/sub&gt;&lt;br&gt;min.</th>
<th>V&lt;sub&gt;BR&lt;/sub&gt;&lt;br&gt;max.</th>
<th>V&lt;sub&gt;BO&lt;/sub&gt;&lt;br&gt;min.</th>
<th>V&lt;sub&gt;BO&lt;/sub&gt;&lt;br&gt;max.</th>
</tr>
</thead>
<tbody>
<tr>
<td>BR220 -100</td>
<td>88</td>
<td>112</td>
<td>V</td>
</tr>
<tr>
<td>-120</td>
<td>105</td>
<td>135</td>
<td>V</td>
</tr>
<tr>
<td>-140</td>
<td>123</td>
<td>157</td>
<td>V</td>
</tr>
<tr>
<td>-160</td>
<td>140</td>
<td>180</td>
<td>V</td>
</tr>
<tr>
<td>-180</td>
<td>158</td>
<td>202</td>
<td>V</td>
</tr>
<tr>
<td>-200</td>
<td>176</td>
<td>224</td>
<td>V</td>
</tr>
<tr>
<td>-220</td>
<td>193</td>
<td>247</td>
<td>V</td>
</tr>
<tr>
<td>-240</td>
<td>211</td>
<td>269</td>
<td>V</td>
</tr>
<tr>
<td>-260</td>
<td>228</td>
<td>292</td>
<td>V</td>
</tr>
<tr>
<td>-280</td>
<td>246</td>
<td>314</td>
<td>V</td>
</tr>
</tbody>
</table>

Temperature coefficient of V<sub>BR</sub>

S<sub>BR</sub> typ. +0.1 %/K

Holding current (note 2)

T<sub>j</sub> = 25 °C

I<sub>H</sub> > 150 mA

T<sub>j</sub> = 70 °C

I<sub>H</sub> > 100 mA

Switching current (note 3)

(100 µs pulsed)

I<sub>S</sub> > 10 mA

I<sub>S</sub> typ. 200 mA

I<sub>S</sub> < 500 mA

Off-state current; V<sub>D</sub> = 85% V<sub>BR</sub><sub>min</sub> (note 4)

T<sub>j</sub> = 70 °C

I<sub>D</sub> < 50 µA

T<sub>j</sub> = 125 °C

I<sub>D</sub> < 250 µA

Linear rate of rise of off-state voltage

that will not trigger any device;

T<sub>j</sub> = 70 °C; V<sub>DM</sub> = 85% V<sub>BR</sub><sub>min</sub>

dV<sub>D</sub>/dt < 2000 V/µs

Off-state capacitance

V<sub>D</sub> = 0 ; f = 1 kHz to 1 MHz

C<sub>j</sub> < 350 pF

Notes:

1. Measured under pulsed conditions to avoid excessive dissipation.
2. Defined as the minimum current which the device can conduct before switching back to the
   off-state.
3. Defined as the maximum instantaneous current that the device can sustain in the avalanche
   breakdown state before it switches to a low voltage.
4. I.e., at maximum recommended d.c. stand-off voltage.
BR220 SERIES

Fig. 2 Breakover diode characteristics.

Fig. 3 Test circuit for high voltage impulse (I_{TRM2})
(according to CCITT vol. IX-Rec. K17)

Notes:
The 10/700 $\mu$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 $15\Omega + 25\Omega$ output impedance becomes effectively in parallel with the $50\Omega$. 
MOUNTING INSTRUCTIONS

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

2. The leads should not be bent less than 2.4 mm from the seal, and should be supported during bending.

3. It is recommended that the circuit connection be made to the centre tag, rather than direct to the heatsink.

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

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

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

OPERATING NOTES

Dissipation and heatsink considerations:

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

b. Any measurement of heatsink temperature should be made immediately adjacent to the device.
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 Tamb 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
   \[ R_{th\ mb-h} = 0.3 \ \text{K/W} \]

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

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

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

   e. without heatsink compound
   \[ R_{th\ mb-h} = 1.4 \ \text{K/W} \]
Fig. 5 The right-hand part shows the interrelationship between the power (derived from the left-hand part) and the maximum permissible temperatures.

$\alpha = \text{conduction angle.}$

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.

\[ \alpha = 180^\circ \]

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.
Fig. 7 The right-hand part shows the interrelationship between the power (derived from the left-hand part) and the maximum permissible temperatures. 

$\alpha = \text{conduction angle.}$

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.
Fig. 8 Maximum permissible duration of steady overload (provided that $T_{mb}$ does not exceed 120 °C during and after overload) expressed as a percentage of the steady state r.m.s. rated current. For high r.m.s. overload currents precautions should be taken so that the temperature of the terminals does not exceed 125 °C. During these overload conditions the BOD may lose control. Therefore the overload should be terminated by a separate protection device.

This figure applies to one half of the dual device conducting.
Fig. 9 Maximum permissible non-repetitive r.m.s. on-state current based on sinusoidal currents (f = 50 Hz), $T_j = 125^\circ$C prior to surge.

Fig. 10 Maximum non-repetitive exponential waveform Impulse Current rating as a function of pulse duration.
Fig. 11 On-state voltage as a function of on-state current. (200 µs pulsed condition to avoid excessive dissipation)

- - - $T_j = 25$, — — $T_j = 125 \, ^\circ\text{C}$.

Fig. 12 Maximum off-state current as a function of temperature.

Fig. 13 Switching current as a function of temperature;

- - - $T_j = 25 \, ^\circ\text{C}$;
- — - $T_j = 125 \, ^\circ\text{C}$.

Fig. 14 Minimum holding current as a function of temperature.
Fig. 15 Normalised avalanche breakdown voltage as a function of temperature. Note: this figure may also be used to derive normalised $V_{BO}$.  

Fig. 16 Typical junction capacitance as a function of off-state voltage; $T_j = 25 \, ^\circ \text{C}; f = 1 \, \text{MHz}$.  

Dual breakover diodes
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 D0-30 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

<table>
<thead>
<tr>
<th>QUICK REFERENCE DATA</th>
</tr>
</thead>
<tbody>
<tr>
<td>Stand-off voltage (15% range) *</td>
</tr>
<tr>
<td>Reverse breakdown voltage</td>
</tr>
<tr>
<td>Non-repetitive peak reverse power dissipation; exponential pulse</td>
</tr>
</tbody>
</table>

\* The stand-off voltage is the maximum reverse voltage recommended for continuous operation; at this value non-conduction is ensured.

MECHANICAL DATA

DO-30

Supplied with device: 1 nut, 1 lock washer
Nut dimensions across the flats: 19 mm
Diameter of clearance hole: max. 13 mm
Net weight: 123 g
The mark shown applies to the normal polarity types.

Torque on nut: min. 9 Nm (90 kgcm)
max. 17.5 Nm (175 kgcm)
**RATINGS** Limiting values in accordance with the Absolute Maximum System (IEC134)

Stand-off voltage

$$V_R = \text{equal to type number suffix}$$

**Currents**

Non-repetitive peak reverse current

$$T_j = 25 \, ^\circ\text{C} \text{ prior to surge}$$

<table>
<thead>
<tr>
<th>Current Type</th>
<th>Symbol</th>
<th>Max Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>BZW86-9V1(R)</td>
<td>$I_{RSM}$</td>
<td>3700 A</td>
</tr>
<tr>
<td>BZW86-27(R)</td>
<td>$I_{RSM}$</td>
<td>1200 A</td>
</tr>
<tr>
<td>BZW86-56(R)</td>
<td>$I_{RSM}$</td>
<td>700 A</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Current Type</th>
<th>Symbol</th>
<th>Max Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>BZW86-9V1(R)</td>
<td>$I_{RSM}$</td>
<td>1200 A</td>
</tr>
<tr>
<td>BZW86-27(R)</td>
<td>$I_{RSM}$</td>
<td>400 A</td>
</tr>
<tr>
<td>BZW86-56(R)</td>
<td>$I_{RSM}$</td>
<td>250 A</td>
</tr>
</tbody>
</table>

**Power dissipation**

Repetitive peak reverse power dissipation

$$T_{mb} = 65 \, ^\circ\text{C}; f = 50 \, Hz; t_p = 10 \, \mu\text{s} \text{ (square pulse; see also graphs on page 664)}$$

$$P_{PRRM} = \text{max.} \quad 50 \, \text{kW}$$

Non-repetitive peak reverse power dissipation

$$T_j = 25 \, ^\circ\text{C} \text{ prior to surge; exponential pulse; see also graph on page 663}$$

<table>
<thead>
<tr>
<th>Current Type</th>
<th>Symbol</th>
<th>Max Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>BZW86-9V1(R)</td>
<td>$P_{PRSM}$</td>
<td>60 kW</td>
</tr>
<tr>
<td>BZW86-27(R)</td>
<td>$P_{PRSM}$</td>
<td>25 kW</td>
</tr>
</tbody>
</table>

**Temperatures**

Storage temperature

$$T_{stg} = -55 \text{ to } +175 \, ^\circ\text{C}$$

Junction temperature

$$T_j = \text{max.} \quad 175 \, ^\circ\text{C}$$

**THERMAL RESISTANCE**

From junction to mounting base

$$R_{th \ j-mb} = 0,3 \, ^\circ\text{C/W}$$

From mounting base to heatsink

$$R_{th \ mb-h} = 0,1 \, ^\circ\text{C/W}$$

**CHARACTERISTICS**

Forward voltage

$$I_F = 500 \, A \text{ at } T_j = 25 \, ^\circ\text{C}$$

$$V_F < 1,5 \, V \quad **$$

---

* The stand-off voltage is the maximum reverse voltage recommended for continuous operation; at this value non-conduction is ensured.

** Measured under pulse condition.
<table>
<thead>
<tr>
<th>BZW86</th>
<th>V(CL)R (V)</th>
<th>V(BR)R (V)</th>
</tr>
</thead>
<tbody>
<tr>
<td>typ.</td>
<td>max.</td>
<td>min.</td>
</tr>
<tr>
<td>-7V5(R)</td>
<td>12</td>
<td>14</td>
</tr>
<tr>
<td>-8V2(R)</td>
<td>13</td>
<td>15,5</td>
</tr>
<tr>
<td>-9V1(R)</td>
<td>14</td>
<td>17</td>
</tr>
<tr>
<td>-10(R)</td>
<td>15,5</td>
<td>18,5</td>
</tr>
<tr>
<td>-11(R)</td>
<td>17</td>
<td>20</td>
</tr>
<tr>
<td>-12(R)</td>
<td>18,5</td>
<td>22</td>
</tr>
<tr>
<td>-13(R)</td>
<td>20</td>
<td>24</td>
</tr>
<tr>
<td>-15(R)</td>
<td>23</td>
<td>27</td>
</tr>
<tr>
<td>-16(R)</td>
<td>27</td>
<td>32</td>
</tr>
<tr>
<td>-18(R)</td>
<td>31</td>
<td>36</td>
</tr>
<tr>
<td>-20(R)</td>
<td>34</td>
<td>40</td>
</tr>
<tr>
<td>-22(R)</td>
<td>37</td>
<td>43</td>
</tr>
<tr>
<td>-24(R)</td>
<td>40</td>
<td>47</td>
</tr>
<tr>
<td>-27(R)</td>
<td>44</td>
<td>52</td>
</tr>
<tr>
<td>-30(R)</td>
<td>47</td>
<td>55</td>
</tr>
<tr>
<td>-33(R)</td>
<td>51</td>
<td>60</td>
</tr>
<tr>
<td>-36(R)</td>
<td>55</td>
<td>65</td>
</tr>
<tr>
<td>-39(R)</td>
<td>60</td>
<td>70</td>
</tr>
<tr>
<td>-43(R)</td>
<td>66</td>
<td>77</td>
</tr>
<tr>
<td>-47(R)</td>
<td>72</td>
<td>84</td>
</tr>
<tr>
<td>-51(R)</td>
<td>78</td>
<td>92</td>
</tr>
<tr>
<td>-56(R)</td>
<td>85</td>
<td>102</td>
</tr>
</tbody>
</table>

The maximum clamping voltage is the maximum reverse voltage which appear across the diode at the specified pulse duration and junction temperature.

See curves on pages 666 and 667 for square pulses and pages 668 and 669 for exponential pulses.
CHARACTERISTICS (continued)  

Peak reverse current

\[ V_{RM} = \text{recommended stand-off voltage} \]

\[ I_{RM} < 2 \text{ mA} \]

Temperature coefficient of clamping voltage

\[ T = \text{typ.} \quad +0.1 \%/\degree C \]

OPERATING NOTES

Heatsink considerations

(a) For non-repetitive transients, the device may be used without a heatsink for pulses up to 10 ms in duration.

(b) For repetitive transients which fall within the permitted operating range shown in the curves on page 664 the required heatsink is found as follows:

\[
R_{th j-mb} + R_{th m-h} + R_{th h-a} = \frac{T_{j \text{ max}} - T_{\text{amb}}}{P_s + \delta} \cdot P_{RRM}
\]

where

\[ T_{j \text{ max}} = 175 \degree C \]

\[ T_{\text{amb}} = \text{ambient temperature} \]

\[ P_s = \text{any steady state dissipation excluding that in pulses} \]

\[ \delta = \text{duty factor (t_p/T)} \]

\[ R_{th j-mb} = 0.3 \degree C/W \]

\[ R_{th m-h} = 0.1 \degree C/W \]

thus \[ R_{th h-a} \] 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

BZW86 SERIES

10^2

P_{RRM} (kW)

10

1

10^{-1}

0 100 200 300 400

repetition frequency (Hz)

T_{mb} = 65 \degree C

100 \mu s

1 ms

10 ms

T_{mb} = 125 \degree C

100 \mu s

1 ms

10 ms

July 1972
at $V_R$ = stand-off voltage

$I_R$ (mA)

10

1

$10^{-1}$

0 50 100 150 200 $T_j$ (°C)

max

typ

BZW86 SERIES
BZW86 SERIES

V(\text{CL}\text{R}) (V)

max. values
\(T_j = 25\ ^\circ\text{C}\) prior to pulse
intermediate voltage types may be interpolated

\(t_p = 10\ \text{ms}\)
\(t_p = 1\ \text{ms}\)
\(t_p = 0.1\ \text{ms}\)

\(I_{\text{RSM}} (A)\)

square pulses

max. values
\(T_j = 25\ ^\circ\text{C}\) prior to pulse
intermediate voltage types may be interpolated
max. values
$T_j = 25 \, ^\circ C$ prior
to pulse
intermediate v
oltage types may be
interpolated

square pulses
max. values
\( T_j = 25 \, ^\circ\!\!\mathrm{C} \) prior to pulse
intermediate voltage types may be interpolated

exponential pulses
max. values
$T_j = 25 \, ^\circ C$ prior to pulse
intermediate voltage types may be interpolated

exponential pulses
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**

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Voltage Regulator</th>
<th>Transient Suppressor</th>
</tr>
</thead>
<tbody>
<tr>
<td>Working voltage (5% range)</td>
<td>$V_Z$ nom.</td>
<td>7.5 to 75</td>
</tr>
<tr>
<td>Stand-off voltage</td>
<td>$V_R$ max.</td>
<td>5.6 to 56</td>
</tr>
<tr>
<td>Total power dissipation</td>
<td>$P_{tot}$ max.</td>
<td>2.5</td>
</tr>
<tr>
<td>Non-repetitive peak reverse power dissipation</td>
<td>$P_{PRSM}$ max.</td>
<td>700</td>
</tr>
<tr>
<td></td>
<td></td>
<td>W</td>
</tr>
</tbody>
</table>

**MECHANICAL DATA**

Fig. 1 SOD-18.

The rounded end indicates the cathode.

Products approved to CECC 50 005-015 available on request.
RATINGS

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

Peak working current

Average forward current
(averaged over any 20 ms period)

Non-repetitive peak reverse current

Tj = 25 °C prior to surge;

tp = 1 ms (exponential pulse);

BZX70-C7V5 to BZX70-C75

Total power dissipation
at T_amb = 25 °C; with 10 mm tie-points; Fig. 5

Non-repetitive peak reverse power dissipation

Tj = 25 °C prior to surge;

tp = 1 ms (exponential pulse)

Storage temperature

Junction temperature

THERMAL RESISTANCE

From junction to ambient in free air

see Figs 4 and 5

CHARACTERISTICS

Forward voltage

IF = 1 A; T_amb = 25 °C

V_F < 1.5 V
OPERATION AS A VOLTAGE REGULATOR (see page 4)

Dissipation and heatsink considerations

a. Steady-state conditions

The maximum permissible steady-state dissipation $P_s \text{max}$ is given by the relationship

$$P_s \text{max} = \frac{T_{j \text{max}} - T_{\text{amb}}}{R_{\text{th j-a}}}$$

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

b. Pulse conditions (see Fig. 2)

The maximum permissible pulse power $P_p \text{max}$ is given by the formula

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

where:
- $P_s$ is any steady-state dissipation excluding that in pulses
- $R_{\text{th t}}$ is the effective transient thermal resistance of the device between junction and ambient.
- It is a function of the pulse duration $t_p$ and duty factor $\delta$.
- $\delta$ is the duty factor ($t_p/T$)

The steady-state power $P_s$ when biased in the zener direction at a given zener current can be found from Fig. 3. With the additional pulse power dissipation $P_p \text{max}$ calculated from the above expression, the total peak zener power dissipation $P_{\text{tot}} = P_{\text{ZRM}} = P_s + P_p$. From Fig. 3 the corresponding maximum repetitive peak zener current at $P_{\text{tot}}$ 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 $t_{\text{stab}}$, the maximum permissible repetitive peak dissipation $P_{\text{ZRM}}$ 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.](image)

NOTES WHEN OPERATING AS A TRANSIENT SUPPRESSOR (see page 675)

1. Recommended stand-off voltage is defined as being the maximum reverse voltage to be applied without causing conduction in the avalanche mode or significant reverse dissipation.
2. Maximum clamping voltage is the maximum reverse avalanche breakdown voltage which will appear across the diode at the specified pulse duration and junction temperature. For square pulses see Figs 19 and 20, for exponential pulses see Figs 21 and 22.
3. Duration of an exponential pulse is defined as the time taken for the pulse to fall to 37% of its initial value. It is assumed that energy content does not continue beyond twice this time.
**BZX70 SERIES**

**CHARACTERISTICS – WHEN USED AS VOLTAGE REGULATOR DIODES; Tamb = 25 °C**

| BZX70... | working voltage \( V_{\text{Z}} \) | differential resistance \( r_{\text{Z}} \) | temperature coefficient \( S_{\text{Z}} \) | test \( I_Z \) | reverse current at voltage
<table>
<thead>
<tr>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>min.</td>
<td>max.</td>
<td>typ.</td>
<td>max.</td>
<td>typ.</td>
</tr>
<tr>
<td>C7V5</td>
<td>7.0</td>
<td>7.9</td>
<td>0.45</td>
<td>3.5</td>
<td>3.0</td>
</tr>
<tr>
<td>C8V2</td>
<td>7.7</td>
<td>8.7</td>
<td>0.45</td>
<td>3.5</td>
<td>4.0</td>
</tr>
<tr>
<td>C9V1</td>
<td>8.5</td>
<td>9.6</td>
<td>0.55</td>
<td>4.0</td>
<td>5.5</td>
</tr>
<tr>
<td>C10</td>
<td>9.4</td>
<td>10.6</td>
<td>0.75</td>
<td>4.0</td>
<td>7.0</td>
</tr>
<tr>
<td>C11</td>
<td>10.4</td>
<td>11.6</td>
<td>0.8</td>
<td>4.5</td>
<td>7.5</td>
</tr>
<tr>
<td>C12</td>
<td>11.4</td>
<td>12.7</td>
<td>0.85</td>
<td>5.0</td>
<td>8.0</td>
</tr>
<tr>
<td>C13</td>
<td>12.4</td>
<td>14.1</td>
<td>0.9</td>
<td>6.0</td>
<td>8.5</td>
</tr>
<tr>
<td>C15</td>
<td>13.8</td>
<td>15.6</td>
<td>1.0</td>
<td>8.0</td>
<td>10</td>
</tr>
<tr>
<td>C16</td>
<td>15.3</td>
<td>17.1</td>
<td>2.4</td>
<td>9.0</td>
<td>11</td>
</tr>
<tr>
<td>C18</td>
<td>16.8</td>
<td>19.1</td>
<td>2.5</td>
<td>11</td>
<td>12</td>
</tr>
<tr>
<td>C20</td>
<td>18.8</td>
<td>21.2</td>
<td>2.8</td>
<td>12</td>
<td>14</td>
</tr>
<tr>
<td>C22</td>
<td>20.8</td>
<td>23.3</td>
<td>3.0</td>
<td>13</td>
<td>16</td>
</tr>
<tr>
<td>C24</td>
<td>22.7</td>
<td>25.9</td>
<td>3.4</td>
<td>14</td>
<td>18</td>
</tr>
<tr>
<td>C27</td>
<td>25.1</td>
<td>28.9</td>
<td>3.8</td>
<td>18</td>
<td>20</td>
</tr>
<tr>
<td>C30</td>
<td>28</td>
<td>32</td>
<td>4.5</td>
<td>22</td>
<td>25</td>
</tr>
<tr>
<td>C33</td>
<td>31</td>
<td>35</td>
<td>5.0</td>
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<td>30</td>
</tr>
<tr>
<td>C36</td>
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<td>38</td>
<td>5.5</td>
<td>30</td>
<td>32</td>
</tr>
<tr>
<td>C39</td>
<td>37</td>
<td>41</td>
<td>12</td>
<td>35</td>
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</tr>
<tr>
<td>C43</td>
<td>40</td>
<td>46</td>
<td>13</td>
<td>40</td>
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<tr>
<td>C47</td>
<td>44</td>
<td>50</td>
<td>14</td>
<td>50</td>
<td>45</td>
</tr>
<tr>
<td>C51</td>
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<td>54</td>
<td>15</td>
<td>55</td>
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<tr>
<td>C56</td>
<td>52</td>
<td>60</td>
<td>17</td>
<td>63</td>
<td>55</td>
</tr>
<tr>
<td>C62</td>
<td>58</td>
<td>66</td>
<td>18</td>
<td>75</td>
<td>60</td>
</tr>
<tr>
<td>C68</td>
<td>64</td>
<td>72</td>
<td>18</td>
<td>90</td>
<td>65</td>
</tr>
<tr>
<td>C75</td>
<td>70</td>
<td>79</td>
<td>20</td>
<td>100</td>
<td>70</td>
</tr>
</tbody>
</table>

*At test \( I_Z \); measured using a pulse method with \( t_p \leq 100 \mu s \) and \( \delta \leq 0.001 \) so that the values correspond to a \( T_J \) of approximately 25 °C.*
CHARACTERISTICS – WHEN USED AS TRANSIENT SUPPRESSOR DIODES; $T_{\text{amb}} = 25^\circ\text{C}$

<table>
<thead>
<tr>
<th>$V_{(CL)R}$</th>
<th>$I_{RSM}$</th>
<th>$I_R$</th>
<th>$V_R$</th>
<th>BZX70-...</th>
</tr>
</thead>
<tbody>
<tr>
<td>V</td>
<td>A</td>
<td>mA</td>
<td>V</td>
<td></td>
</tr>
<tr>
<td>typ.</td>
<td>max.</td>
<td>max.</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

| 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 |
BZX70 SERIES

SOLDERING AND MOUNTING INSTRUCTIONS

1. When using a soldering iron, diodes may be soldered directly into the circuit, but heat conducted to the junction should be kept to a minimum.

2. Diodes may be dip-soldered at a solder temperature of 245 ºC for a maximum soldering time of 5 seconds. The case temperature during dip-soldering must not at any time exceed the maximum storage temperature. These recommendations apply to a diode with the anode end mounted flush on a printed-circuit board having punched-through holes. For mounting the anode end onto a printed-circuit board, the diode must be spaced at least 5 mm from the underside of the printed-circuit board having punched-through holes, or 5 mm from the top of the printed circuit board having plated-through holes.

3. Care should be taken not to bend the leads nearer than 1.5 mm from the seal; exert no axial pull when bending.
Fig. 3 Maximum permissible repetitive peak dissipation ($P_{\text{tot}} = P_{ZRM}$).
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.
BZX70 SERIES

Regulator diodes

Fig. 6 Typical static zener characteristics.
Fig. 7

Fig. 8 Typical dynamic zener characteristics for BZX70-C7V5.
Regulator diodes

**BZX70 SERIES**

Fig. 9 Typical dynamic zener characteristics for BZX70-C10.

Fig. 10 Typical dynamic zener characteristics for BZX70-C33.
Fig. 11 Typical dynamic zener characteristics for BZX70-C75.

Fig. 12.
Regulator diodes

**BZX70 SERIES**

![Graph](image_url)

**Fig. 13.**

**BZX70 Series**

- \( T_{\text{amb}} = 25^\circ\text{C} \)
- \( I_Z = 10\,\text{mA} \)
- \( I_Z = 20\,\text{mA} \)
- \( I_Z = 50\,\text{mA} \)
- \( I_Z = 100\,\text{mA} \)
- \( I_Z = 200\,\text{mA} \)

\[ r_Z (\Omega) \]

\[ V_Z (V) \]

---

**Fig. 14.**

**BZX70 Series**

- \( T_{\text{amb}} = 25^\circ\text{C} \)

\[ r_Z (\Omega) \]

\[ I_Z (A) \]

December 1979
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.
Regulator diodes

Fig. 20 Square pulses.
max. values
$T_j = 25 \, ^\circ C$ prior to pulse
intermediate voltage types may be interpolated

$t_p = 10 \, ms$
$= 1 \, ms$
$= 100 \, \mu s$
$\leq 10 \, \mu s$

$I_{RSM} (A)$

Fig. 21 Exponential pulses.
Fig. 22 Exponential pulses.
Fig. 23.

Fig. 24.

Fig. 25.

at $V_R$ = stand-off voltage
max. values
Regulator diodes

BZX70 SERIES

Fig. 26.
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

<table>
<thead>
<tr>
<th></th>
<th>voltage regulator</th>
<th>transient suppressor</th>
</tr>
</thead>
<tbody>
<tr>
<td>Working voltage (5% range)</td>
<td>$V_Z$ nom.</td>
<td>7.5 to 75</td>
</tr>
<tr>
<td>Stand-off voltage</td>
<td>$V_R$ max.</td>
<td>5.6 to 56</td>
</tr>
<tr>
<td>Total power dissipation</td>
<td>$P_{tot}$ max.</td>
<td>100</td>
</tr>
<tr>
<td>Non-repetitive peak reverse power dissipation</td>
<td>$P_{RSM}$ max.</td>
<td>9.5 kW</td>
</tr>
</tbody>
</table>

MECHANICAL DATA

Fig. 1 DO-5.

Net mass: 22 g
Diameter of clearance hole: max. 6.5 mm

Accessories supplied on request:
see ACCESSORIES section

Supplied with device: 1 nut, 1 lock washer
Nut dimensions across the flats: 11.1 mm

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

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

Peak working current $I_{ZM} \max. = 400 \, \text{A}$

Average forward current $I_{F(AV)} \max. = 20 \, \text{A}$

Non-repetitive peak reverse current
- $T_j = 25 \, \degree\text{C}$ prior to surge;
- $t_p = 1 \, \text{ms}$ (exponential pulse);
- BZY91-C7V5(R) to BZY91-C75(R)

$IR_{RSM} \max. = 1000 \text{ to } 85 \, \text{A}$

Total power dissipation
- up to $T_{mb} = 25 \, \degree\text{C}$
- at $T_{mb} = 65 \, \degree\text{C}$

Non-repetitive peak reverse power dissipation
- $T_j = 25 \, \degree\text{C}$ prior to surge;
- $t_p = 1 \, \text{ms}$ (exponential pulse)

$PR_{RSM} \max. = 9.5 \, \text{kW}$

Storage temperature $T_{stg}$

Junction temperature $T_j \max. = 175 \, \degree\text{C}$

THERMAL RESISTANCE

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

From mounting base to heatsink $R_{th\, mb-h} = 0.2 \, \degree\text{C/W}$

CHARACTERISTICS

Forward voltage

$I_F = 10 \, \text{A}; \, T_{mb} = 25 \, \degree\text{C}$

$V_F < 1.5 \, \text{V}$

OPERATION AS A VOLTAGE REGULATOR (see page 696)

Dissipation and heatsink considerations

a. Steady-state conditions

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

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

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

$$R_{th\, j-a} = R_{th\, j-mb} + R_{th\, mb-h} + R_{th\, h-a}$$

$r_{th\, mb-h}$ is the thermal resistance from mounting base to heatsink, that is, $0.2 \, \degree\text{C/W}$.

$b. Pulse conditions (see Fig. 2)$

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.
Regulator diodes

The required heatsink is calculated as follows:

\[ R_{th \ j-a} = \frac{T_{j \ max} - T_{amb} - \Delta T}{P_s + \delta \cdot P_p} \]

where: 
- \( T_{j \ max} = 175 \degree C \) 
- \( T_{amb} = \) ambient temperature 
- \( \Delta T = \) from Fig. 5 or 6 
- \( P_s = \) any steady-state dissipation excluding that in pulses 
- \( P_p = \) peak pulse power 
- \( \delta = \) duty factor (\( t_p/T \)) 

\[ R_{th \ j-a} = R_{th \ j-mb} + R_{th \ mb-h} + R_{th \ h-a} = 1.5 + 0.2 + R_{th \ h-a} \degree C/W. \]

Thus \( R_{th \ h-a} \) 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:

\[ R_{th \ j-mb} + R_{th \ mb-h} + R_{th \ h-a} = \frac{T_{j \ max} - T_{amb}}{P_s + \delta \cdot P_{PRM}} \]

where: 
- \( T_{j \ max} = 175 \degree C \) 
- \( T_{amb} = \) ambient temperature 
- \( P_s = \) any steady-state dissipation excluding that in pulses 
- \( \delta = \) duty factor (\( t_p/T \)) 

\( R_{th \ j-mb} = 1.5 \degree C/W \)  
\( R_{th \ mb-h} = 0.2 \degree C/W \)

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.
2. The maximum clamping voltage is the maximum reverse voltage which appears across the diode at the specified pulse duration and junction temperature. For square pulses see Figs 22 and 23, for exponential pulses see Figs 24 and 25.
3. Duration of an exponential pulse is defined as the time taken for the pulse to fall to 37% of its initial value. It is assumed that the energy content does not continue beyond twice this time.
4. Surge suppressor diodes are extremely fast in clamping, switching on in less than 5 ns.
## BZY91 SERIES

### CHARACTERISTICS – WHEN USED AS VOLTAGE REGULATOR DIODES; $T_{mb} = 25 \degree C$

<table>
<thead>
<tr>
<th>BZY91...</th>
<th>working voltage $V_Z^*$ (V)</th>
<th>differential resistance $r_Z$ (Ω)</th>
<th>temperature coefficient $S_Z$ (%/°C)</th>
<th>test $I_Z$ (mA)</th>
<th>reverse current $I_R$ (mA)</th>
<th>reverse voltage $V_R$ (V)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>min.</td>
<td>max.</td>
<td>max.</td>
<td>typ.</td>
<td>max.</td>
<td>max.</td>
</tr>
<tr>
<td>C7V5(R)</td>
<td>7.0</td>
<td>7.9</td>
<td>0.2</td>
<td>0.09</td>
<td>5.0</td>
<td>5.0</td>
</tr>
<tr>
<td>C8V2(R)</td>
<td>7.7</td>
<td>8.7</td>
<td>0.3</td>
<td>0.09</td>
<td>5.0</td>
<td>5.0</td>
</tr>
<tr>
<td>C9V1(R)</td>
<td>8.5</td>
<td>9.6</td>
<td>0.4</td>
<td>0.07</td>
<td>2.0</td>
<td>2.0</td>
</tr>
<tr>
<td>C10(R)</td>
<td>9.4</td>
<td>10.6</td>
<td>0.4</td>
<td>0.07</td>
<td>2.0</td>
<td>2.0</td>
</tr>
<tr>
<td>C11(R)</td>
<td>10.4</td>
<td>11.6</td>
<td>0.4</td>
<td>0.07</td>
<td>2.0</td>
<td>2.0</td>
</tr>
<tr>
<td>C12(R)</td>
<td>11.4</td>
<td>12.7</td>
<td>0.5</td>
<td>0.07</td>
<td>2.0</td>
<td>2.0</td>
</tr>
<tr>
<td>C13(R)</td>
<td>12.4</td>
<td>14.1</td>
<td>0.5</td>
<td>0.07</td>
<td>2.0</td>
<td>2.0</td>
</tr>
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<td>C15(R)</td>
<td>13.8</td>
<td>15.6</td>
<td>0.6</td>
<td>0.075</td>
<td>2.0</td>
<td>2.0</td>
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<td>C16(R)</td>
<td>15.3</td>
<td>17.1</td>
<td>0.6</td>
<td>0.075</td>
<td>2.0</td>
<td>2.0</td>
</tr>
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<td>C18(R)</td>
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<td>19.1</td>
<td>0.7</td>
<td>0.075</td>
<td>2.0</td>
<td>1.0</td>
</tr>
<tr>
<td>C20(R)</td>
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<td>0.8</td>
<td>0.075</td>
<td>1.0</td>
<td>1.0</td>
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<tr>
<td>C22(R)</td>
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<td>23.3</td>
<td>0.8</td>
<td>0.075</td>
<td>1.0</td>
<td>1.0</td>
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<td>C24(R)</td>
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<td>0.08</td>
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<td>C27(R)</td>
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<td>1.0</td>
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<td>0.085</td>
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<td>1.0</td>
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<td>C33(R)</td>
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<td>1.0</td>
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<td>C36(R)</td>
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<td>C39(R)</td>
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<td>C43(R)</td>
<td>40</td>
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<td>1.5</td>
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<td>1.0</td>
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<td>C47(R)</td>
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<td>1.7</td>
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<td>1.0</td>
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<td>C51(R)</td>
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<td>54</td>
<td>1.8</td>
<td>0.093</td>
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<td>1.0</td>
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<td>C56(R)</td>
<td>52</td>
<td>60</td>
<td>2.0</td>
<td>0.094</td>
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<td>1.0</td>
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<td>C62(R)</td>
<td>58</td>
<td>66</td>
<td>2.2</td>
<td>0.094</td>
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<td>1.0</td>
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<tr>
<td>C68(R)</td>
<td>64</td>
<td>72</td>
<td>2.4</td>
<td>0.094</td>
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<td>1.0</td>
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<td>C75(R)</td>
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<td>79</td>
<td>2.6</td>
<td>0.095</td>
<td>0.5</td>
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</tbody>
</table>

*At test $I_Z$: measured using a pulse method with $t_p \leq 100 \mu s$ and $\delta \leq 0.001$ so that the values correspond to a $T_j$ of approximately 25 °C.
Regulator diodes

**CHARTERISTICS** – WHEN USED AS TRANSIENT SUPPRESSOR DIODES; $T_{mb} = 25$ °C

<table>
<thead>
<tr>
<th>$V_{(CL)R}$</th>
<th>$I_{RSM}$</th>
<th>$I_R$</th>
<th>$V_R$</th>
<th>BZY91...</th>
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<td>$V$</td>
<td>$mA$</td>
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<td>typ.</td>
<td>max.</td>
<td>max.</td>
<td>V</td>
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<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
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.
Regulator diodes

BZY91 SERIES

At any point on the curves, the device is shown dissipating its maximum peak power for the maximum allowed time.

Other devices may be interpolated.

Fig. 3.

Fig. 4.

T_j = 25°C
= 65°C
= 125°C
= 175°C
BZY91 SERIES

Fig. 5.

Fig. 6.
Regulator diodes

BZY91 SERIES

Fig. 7. Permissible area of operation

![Permissible area of operation graph](image)

Fig. 8 Typical dynamic zener characteristics.

![Dynamic zener characteristics graph](image)
Fig. 9 Typical static zener characteristics, $T_{mb} = 25^\circ C$
Regulator diodes

Fig. 10.

BZY91 SERIES

$S_Z$ (%/°C)

$I_Z = 2.0A$

$T_{mb} = 25\text{ to } 100^\circ C$

$I_Z = 1.0A$

$T_{mb} = 25\text{ to } 100^\circ C$

$I_Z = 0.5A$

$T_{mb} = 25\text{ to } 100^\circ C$

Figure 10.
BZY91 SERIES

Fig. 11.

- $I_Z = 0.5A$
- $T_{mb} = 25^\circ C$

- $I_Z = 1.0A$
- $T_{mb} = 25^\circ C$

- $I_Z = 2.0A$
- $T_{mb} = 25^\circ C$

Graphs showing the relationship between $r_Z$ (resistance) and $V_Z$ (voltage) for different current levels and temperature conditions.
Regulator diodes

BZY91 SERIES

---

Fig. 12.

Typical curves

Fig. 13.

Square current pulse

Exponential current pulse

I = 0 after 2CR

Pulse duration
Fig. 14.

Fig. 15.

Fig. 16.

Fig. 17.
Regulator diodes

BZY91 SERIES

Fig. 18.

Fig. 19.

Fig. 20.

Fig. 21.

September 1979 707
Square pulses
$T_j = 25^\circ C$ prior to pulse
Intermediate voltage types may be interpolated

BZY 91-C15
$\tau_p = 10 \text{ms}$

BZY 91-C9V1
$\tau_p = 10 \text{ms}$

$\tau_p = 1 \text{ms}$

$\tau_p = 100 \mu\text{s}$

$\tau_p \leq 10 \mu\text{s}$

Fig. 22.
Regulator diodes

$V_{(CL)R_{max}}$

Square pulses
$T_j = 25°C$ prior to pulse
Intermediate voltage types may be interpolated

$\tau_p = 10\,\text{ms}$

$\tau_p = 1\,\text{ms}$

$\tau_p = 100\,\mu\text{s}$

$\tau_p \leq 10\,\mu\text{s}$

BZY91-C75

BZY91-C51

BZY91-C24

Fig. 23.
Exponential pulses

$T_j = 25^\circ C$ prior to pulse

Intermediate voltage types may be interpolated

Fig. 24.
Regulator diodes

BZY91 SERIES

$V_{(CL)_{max}}$

125 (V) 100 75 50 25

Exponential pulses

$T_j = 25°C$ prior to pulse

Intermediate voltage types may be interpolated

1

$t_p = 10\,\text{ms}$

$t_p = 1\,\text{ms}$

$t_p = 100\,\mu\text{s}$

$t_p \leq 10\,\mu\text{s}$

$t_p = 100\,\mu\text{s}$

$t_p \leq 10\,\mu\text{s}$

Fig. 25.
Fig. 26.

Fig. 27.

Fig. 28.
REGULATOR DIODES

Also available to BS9305–F051

A range of diffused silicon diodes in D0-4 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

<table>
<thead>
<tr>
<th>Working voltage (5% range)</th>
<th>Voltage regulator</th>
<th>Transient suppressor</th>
</tr>
</thead>
<tbody>
<tr>
<td>$V_Z$ nom.</td>
<td>7.5 to 75</td>
<td>–</td>
</tr>
<tr>
<td>$V_R$</td>
<td>–</td>
<td>5.6 to 56</td>
</tr>
<tr>
<td>$P_{tot}$ max.</td>
<td>20</td>
<td>–</td>
</tr>
<tr>
<td>$P_{RSM}$ max.</td>
<td>–</td>
<td>700</td>
</tr>
</tbody>
</table>

MECHANICAL DATA

Fig. 1 D0-4.

Dimensions in mm

Net mass: 6 g
Diameter of clearance hole: max. 5.2 mm
Accessories supplied on request:
see ACCESSORIES section
Supplied with device: 1 nut, 1 lock washer
Nut dimensions across the flats: 9.5 mm

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

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

Peak working current \( I_{ZM} \) max. 20 A

Average forward current (averaged over any 20 ms period) \( I_{F(AV)} \) max. 5 A

Non-repetitive peak reverse current
- \( T_j = 25 \, ^\circ C \) prior to surge;
- \( t_p = 1 \, ms \) (exponential pulse);
- BZY93-C7V5(R) to BZY93-C75(R) \( I_{RSM} \) max. 55 to 6 A

Total power dissipation
- up to \( T_{mb} = 75 \, ^\circ C \) \( P_{tot} \) max. 20 W

Non-repetitive peak reverse power dissipation
- \( T_j = 25 \, ^\circ C \) prior to surge;
- \( t_p = 1 \, ms \) (exponential pulse) \( P_{RSM} \) max. 700 W

Storage temperature \( T_{stg} \) -55 to +175 \, ^\circ C

Junction temperature \( T_j \) max. 175 \, ^\circ C

THERMAL RESISTANCE

- From junction to mounting base \( R_{th \, j-mb} \) = 5 \, ^\circ C/W
- From junction to ambient \( R_{th \, j-a} \) = 50 \, ^\circ C/W
- From mounting base to heatsink (minimum torque: 0,9 Nm) \( R_{th \, mb-h} \) = 0,6 \, ^\circ C/W

CHARACTERISTICS

Forward voltage
- \( I_F = 5 \, A; T_{mb} = 25 \, ^\circ C \) \( V_F \) < 1,5 V

OPERATION AS A VOLTAGE REGULATOR (see page 716)

Dissipation and heatsink considerations

a. Steady-state conditions

The maximum permissible steady-state dissipation \( P_{s \, max} \) is given by the relationship

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

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

\[
R_{th \, j-a} = R_{th \, j-mb} + R_{th \, mb-h} + R_{th \, h-a}
\]

\( R_{th \, mb-h} \) is the thermal resistance from mounting base to heatsink, that is, 0,6 \, ^\circ C/W.
\( R_{th \, h-a} \) is the thermal resistance of the heatsink.

b. Pulse conditions (see Fig. 2)

The maximum permissible pulse power \( P_{p \, max} \) is given by the formula

\[
P_{p \, max} = \frac{(T_{j \, max} - T_{amb}) - (P_s \cdot R_{th \, j-a})}{R_{th \, t + \delta \cdot R_{th \, mb-a}}}
\]
where: $P_s$ is any steady-state dissipation excluding that in pulses

- $R_{th t}$ is the effective transient thermal resistance of the device between junction and mounting base. It is a function of the pulse duration $t_p$ and duty factor $\delta$.
- $\delta$ is duty factor $(t_p/T)$
- $R_{th mb-a}$ is the total thermal resistance between the mounting base and ambient

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).

**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:

$$R_{th j-mb} + R_{th mb-h} + R_{th h-a} = \frac{T_{j max} - T_{amb}}{P_s + \delta \cdot P_{RRM}}$$

where:
- $T_{j max} = 175 \degree C$
- $T_{amb} = $ ambient temperature
- $P_s = $ any steady-state dissipation excluding that in pulses
- $\delta = $ duty factor $(t_p/T)$
- $R_{th j-mb} = 5 \degree C/W$
- $R_{th mb-h} = 0.6 \degree C/W$

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.
2. The maximum clamping voltage is the maximum reverse voltage which appears across the diode at the specified pulse duration and junction temperature. For square pulses see Figs 15 and 16, for exponential pulses see Figs 17 and 18.
3. Duration of an exponential pulse is defined as the time taken for the pulse to fall to 37% of its initial value. It is assumed that the energy content does not continue beyond twice this time.
4. Surge suppressor diodes are extremely fast in clamping, switching on in less than 5 ns.
CHARACTERISTICS – WHEN USED AS VOLTAGE REGULATOR DIODES; $T_{mb} = 25 \, ^\circ C$

<table>
<thead>
<tr>
<th>BZY93...</th>
<th>working voltage $V_z$</th>
<th>differential resistance $R_Z$</th>
<th>temperature coefficient $S_Z$</th>
<th>test $I_Z$</th>
<th>reverse current at voltage $I_R$</th>
<th>reverse voltage $V_R$</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>min.</td>
<td>max.</td>
<td>typ.</td>
<td>max.</td>
<td>typ.</td>
<td>max.</td>
</tr>
<tr>
<td>C7V5(R)</td>
<td>7.0</td>
<td>7.9</td>
<td>0.04</td>
<td>0.3</td>
<td>3.0</td>
<td>2.0</td>
</tr>
<tr>
<td>C8V2(R)</td>
<td>7.7</td>
<td>8.7</td>
<td>0.05</td>
<td>0.3</td>
<td>4.0</td>
<td>2.0</td>
</tr>
<tr>
<td>C9V1(R)</td>
<td>8.5</td>
<td>9.6</td>
<td>0.07</td>
<td>0.5</td>
<td>5.0</td>
<td>1.0</td>
</tr>
<tr>
<td>C10(R)</td>
<td>9.4</td>
<td>10.6</td>
<td>0.07</td>
<td>0.5</td>
<td>7.0</td>
<td>1.0</td>
</tr>
<tr>
<td>C11(R)</td>
<td>10.4</td>
<td>11.6</td>
<td>0.08</td>
<td>1.0</td>
<td>7.5</td>
<td>1.0</td>
</tr>
<tr>
<td>C12(R)</td>
<td>11.4</td>
<td>12.7</td>
<td>0.08</td>
<td>1.0</td>
<td>8.0</td>
<td>1.0</td>
</tr>
<tr>
<td>C13(R)</td>
<td>12.4</td>
<td>14.1</td>
<td>0.08</td>
<td>1.0</td>
<td>8.5</td>
<td>1.0</td>
</tr>
<tr>
<td>C15(R)</td>
<td>13.8</td>
<td>15.6</td>
<td>0.10</td>
<td>1.2</td>
<td>10.0</td>
<td>1.0</td>
</tr>
<tr>
<td>C16(R)</td>
<td>15.3</td>
<td>17.1</td>
<td>0.18</td>
<td>1.2</td>
<td>11.0</td>
<td>0.5</td>
</tr>
<tr>
<td>C18(R)</td>
<td>16.8</td>
<td>19.1</td>
<td>0.2</td>
<td>1.5</td>
<td>12.0</td>
<td>0.5</td>
</tr>
<tr>
<td>C20(R)</td>
<td>18.8</td>
<td>21.2</td>
<td>0.2</td>
<td>1.5</td>
<td>14.0</td>
<td>0.5</td>
</tr>
<tr>
<td>C22(R)</td>
<td>20.8</td>
<td>23.3</td>
<td>0.21</td>
<td>1.8</td>
<td>16.0</td>
<td>0.5</td>
</tr>
<tr>
<td>C24(R)</td>
<td>22.7</td>
<td>25.9</td>
<td>0.22</td>
<td>2.0</td>
<td>18.0</td>
<td>0.5</td>
</tr>
<tr>
<td>C27(R)</td>
<td>25.1</td>
<td>28.9</td>
<td>0.25</td>
<td>2.0</td>
<td>21.0</td>
<td>0.5</td>
</tr>
<tr>
<td>C30(R)</td>
<td>28</td>
<td>32</td>
<td>0.3</td>
<td>2.5</td>
<td>25.0</td>
<td>0.5</td>
</tr>
<tr>
<td>C33(R)</td>
<td>31</td>
<td>35</td>
<td>0.32</td>
<td>3.0</td>
<td>30.0</td>
<td>0.5</td>
</tr>
<tr>
<td>C36(R)</td>
<td>34</td>
<td>38</td>
<td>0.75</td>
<td>4.0</td>
<td>32.0</td>
<td>0.2</td>
</tr>
<tr>
<td>C39(R)</td>
<td>37</td>
<td>41</td>
<td>0.85</td>
<td>5.0</td>
<td>35.0</td>
<td>0.2</td>
</tr>
<tr>
<td>C43(R)</td>
<td>40</td>
<td>46</td>
<td>0.90</td>
<td>6.5</td>
<td>40.0</td>
<td>0.2</td>
</tr>
<tr>
<td>C47(R)</td>
<td>44</td>
<td>50</td>
<td>1.0</td>
<td>7.0</td>
<td>45.0</td>
<td>0.2</td>
</tr>
<tr>
<td>C51(R)</td>
<td>48</td>
<td>54</td>
<td>1.2</td>
<td>7.5</td>
<td>50.0</td>
<td>0.2</td>
</tr>
<tr>
<td>C56(R)</td>
<td>52</td>
<td>60</td>
<td>1.3</td>
<td>8.0</td>
<td>55.0</td>
<td>0.2</td>
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<tr>
<td>C62(R)</td>
<td>58</td>
<td>66</td>
<td>1.5</td>
<td>9.0</td>
<td>60.0</td>
<td>0.2</td>
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<tr>
<td>C68(R)</td>
<td>64</td>
<td>72</td>
<td>1.8</td>
<td>10.0</td>
<td>65.0</td>
<td>0.2</td>
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<tr>
<td>C75(R)</td>
<td>70</td>
<td>79</td>
<td>2.0</td>
<td>10.5</td>
<td>70.0</td>
<td>0.2</td>
</tr>
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</table>

*At test $I_Z$: measured using a pulse method with $t_p \leq 100 \, \mu s$ and $\delta \leq 0.001$ so that the values correspond to a $T_j$ of approximately 25 °C.
CHARACTERISTICS – WHEN USED AS TRANSIENT SUPPRESSOR DIODES; $T_{mb} = 25 \, ^{\circ}C$

<table>
<thead>
<tr>
<th>V(CL)R</th>
<th>IRSM</th>
<th>$I_R$</th>
<th>VR</th>
<th>BZY93-...</th>
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<tbody>
<tr>
<td>typ.</td>
<td>max.</td>
<td>max.</td>
<td></td>
<td></td>
</tr>
<tr>
<td>8</td>
<td>9.2</td>
<td>20</td>
<td>0.5</td>
<td>5.6</td>
</tr>
<tr>
<td>9</td>
<td>10.2</td>
<td>20</td>
<td>0.5</td>
<td>6.2</td>
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<tr>
<td>10</td>
<td>11.5</td>
<td>20</td>
<td>0.5</td>
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</tr>
<tr>
<td>11</td>
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<td>20</td>
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<td>57</td>
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<td>0.1</td>
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<td>64</td>
<td>75</td>
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<td>73</td>
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<td>81</td>
<td>94</td>
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<td>0.1</td>
<td>51</td>
</tr>
<tr>
<td>90</td>
<td>105</td>
<td>5</td>
<td>0.1</td>
<td>56</td>
</tr>
</tbody>
</table>
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.
Regulator diodes

Fig. 6 Typical dynamic zener characteristics for BZY93-C10.

Fig. 7 Typical dynamic zener characteristics for BZY93-C33.
Fig. 8 Typical dynamic zener characteristics for BZY93-C75.

Fig. 9 Transient thermal resistance from junction to mounting base versus pulse duration temperature stabilisation time.
Regulator diodes

BZY93 SERIES

Fig. 10.

Fig. 11.

Fig. 12.

Fig. 13.

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Fig. 14  Maximum permissible repetitive peak dissipation ($P_{\text{tot}} = P_{ZRM}$).
Regulator diodes

BZY93 SERIES

Square pulses $T_J = 25°C$ prior to pulse. Intermediate voltage types may be interpolated.

$t_p = 10\text{ ms}$

$t_p = 1\text{ ms}$

$t_p = 100\mu\text{s}$

$t_p \leq 10\mu\text{s}$

Fig. 15.
BZY93 SERIES

V(CL) max

Fig. 16.

Square pulses
Tj = 25°C prior to pulse
Intermediate voltage types may be interpolated

IRSM (A)

0.1

1.0

10

100

tp = 10ms

BZY93-C75

tp = 1ms

BZY93-C51

tp = 100μs

BZY93-C24

tp ≤ 10μs

tp ≤ 10μs

tp = 100μs

tp ≤ 10μs

125 (V) 100 75 50 25

68 62 56 47 43 39 36 33 27 22
Regulator diodes

J BZY93 SERIES

- V(CURmax 25 (V) 20

Exponential pulses

\[ I_t = 25 \, ^\circ C \text{ prior to pulse} \]

Intermediate voltage types may be interpolated

**Fig. 17.**
Exponential pulses

\[ T_j = 25^\circ C \] prior to pulse

Intermediate voltage types may be interpolated

Fig. 18.
Regulator diodes

BZY93 SERIES

Fig. 19.

Fig. 20.

Fig. 21.

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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:

Fig.1 OSB9115  Fig.2 OSM9115  Fig.3 OSS9115

QUICK REFERENCE DATA

<table>
<thead>
<tr>
<th></th>
<th>OSB9115</th>
<th>OSM9115</th>
<th>OSS9115</th>
</tr>
</thead>
<tbody>
<tr>
<td>Crest working reverse voltage from centre tap to end</td>
<td>VRWM</td>
<td>max.</td>
<td>3 4.5 25.5 27 kV</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Crest working reverse voltage</td>
<td>VRWM</td>
<td>max.</td>
<td>4.5 6 52.5 54 kV</td>
</tr>
<tr>
<td>Average forward current with R and L load</td>
<td>IF(AV)</td>
<td>max.</td>
<td>3.5 A</td>
</tr>
<tr>
<td>(averaged over any 20 ms period)</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>in free air up to T_{amb} = 35 °C</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>in oil up to T_{oil} = 100 °C</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Non-repetitive peak forward current</td>
<td>IFSM</td>
<td>max.</td>
<td>125 A</td>
</tr>
<tr>
<td>t = 10 ms; half sine-wave; T_j = 175 °C prior to surge</td>
<td></td>
<td></td>
<td></td>
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</table>

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)

<table>
<thead>
<tr>
<th>Voltages</th>
<th>OSB9115</th>
<th>3</th>
<th>-6</th>
<th>-34</th>
<th>-36</th>
</tr>
</thead>
<tbody>
<tr>
<td>Crest working reverse voltage $V_{RWM}$ max.</td>
<td>3</td>
<td>4.5</td>
<td>25.5</td>
<td>27</td>
<td>kV</td>
</tr>
<tr>
<td>OSM9115</td>
<td>3</td>
<td>-6</td>
<td>-34</td>
<td>-36</td>
<td></td>
</tr>
<tr>
<td>OSS9115</td>
<td>3</td>
<td>-4</td>
<td>-35</td>
<td>-36</td>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Currents</th>
<th>OSB9115</th>
<th>3</th>
<th>-6</th>
<th>-34</th>
<th>-36</th>
</tr>
</thead>
<tbody>
<tr>
<td>Average forward current (averaged over any 20 ms period)</td>
<td>$I_F(AV)$ max.</td>
<td>3.5</td>
<td>A</td>
<td></td>
<td></td>
</tr>
<tr>
<td>in free air up to $T_{amb} = 35^\circ C$</td>
<td>$I_F(AV)$ max.</td>
<td>6</td>
<td>A</td>
<td></td>
<td></td>
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<tr>
<td>in oil up to $T_{oil} = 100^\circ C$</td>
<td>Repetitive peak forward current</td>
<td>$I_{FRM}$ max.</td>
<td>120</td>
<td>A</td>
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</tr>
<tr>
<td>Non-repetitive peak forward current</td>
<td>$I_{FSM}$ max.</td>
<td>125</td>
<td>A</td>
<td></td>
<td></td>
</tr>
<tr>
<td>$t = 10$ ms; half sine-wave; $T_j = 175^\circ C$ prior to surge</td>
<td></td>
<td></td>
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</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Reverse power dissipation</th>
<th>OSB9115</th>
<th>3</th>
<th>-6</th>
<th>-34</th>
<th>-36</th>
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</thead>
<tbody>
<tr>
<td>Repetitive peak reverse power</td>
<td>$P_{RRM}$ max.</td>
<td>1.2</td>
<td>1.8</td>
<td>10.2</td>
<td>10.8</td>
</tr>
<tr>
<td>$t = 10 \mu s$ (square-wave; $f = 50$ Hz)</td>
<td>$T_j = 175^\circ C$</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Non-repetitive peak reverse power</td>
<td>$P_{PRM}$ max.</td>
<td>6</td>
<td>9</td>
<td>51</td>
<td>54</td>
</tr>
<tr>
<td>$t = 10 \mu s$ (square-wave)</td>
<td>$T_j = 25^\circ C$ prior to surge</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>$T_j = 125^\circ C$ prior to surge</td>
<td></td>
<td></td>
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</tbody>
</table>

<table>
<thead>
<tr>
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<th>OSS9115</th>
<th>3</th>
<th>-4</th>
<th>-35</th>
<th>-36</th>
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</thead>
<tbody>
<tr>
<td>Repetitive peak reverse power</td>
<td>$P_{RRM}$ max.</td>
<td>1.8</td>
<td>2.4</td>
<td>21</td>
<td>21.6</td>
</tr>
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<td>$t = 10 \mu s$ (square-wave; $f = 50$ Hz)</td>
<td>$T_j = 175^\circ C$</td>
<td></td>
<td></td>
<td></td>
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</tr>
<tr>
<td>Non-repetitive peak reverse power</td>
<td>$P_{PRM}$ max.</td>
<td>9</td>
<td>12</td>
<td>105</td>
<td>108</td>
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<tr>
<td>$t = 10 \mu s$ (square-wave)</td>
<td>$T_j = 25^\circ C$ prior to surge</td>
<td></td>
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</tr>
<tr>
<td></td>
<td>$T_j = 175^\circ C$ prior to surge</td>
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<table>
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<th>-55 to +150</th>
<th>°C</th>
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<td>Junction temperature</td>
<td>$T_j$</td>
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CHARACTERISTICS (See note 1)

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<th>OSB9115</th>
<th>OSM9115</th>
<th>OSS9115</th>
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<tr>
<td><strong>Forward voltage</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>$I_F = 20,A;,T_j = 25,^\circ C$</td>
<td>$V_F &lt; 4\ldots 34,\text{V}$</td>
<td>$V_F &lt; 4\ldots 34,\text{V}$</td>
<td>$V_F &lt; 3.3\ldots 28,\text{V}$</td>
</tr>
<tr>
<td><strong>Reverse avalanche breakdown voltage</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>$I_R = 5,\text{mA};,T_j = 25,^\circ C$</td>
<td>$V_{(BR)R} &lt; 4.8\ldots 40.8,\text{kV}$</td>
<td>$V_{(BR)R} &lt; 4.8\ldots 40.8,\text{kV}$</td>
<td>$V_{(BR)R} &lt; 4.8\ldots 40.8,\text{kV}$</td>
</tr>
<tr>
<td><strong>Reverse current</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>$V_{RM} = V_{RWM,\text{max}};,T_j = 125,^\circ C$</td>
<td>$I_{RM} &lt; 0.6,\text{mA}$</td>
<td>$I_{RM} &lt; 0.6,\text{mA}$</td>
<td>$I_{RM} &lt; 0.6,\text{mA}$</td>
</tr>
</tbody>
</table>

NOTES

1. The Ratings and Characteristics given apply from centre tap to end. (Not for OSS9115 series).

2. **Type number suffix**
   The suffix consists of a figure indicating the total number of diodes, followed by a letter indicating the base.
   - A = M6 studs at the ends
   - B = 4 pin Super Jumbo (B4D)
   - C = Goliath
   - E = 4 pin Jumbo (B4F)
   - F = A3–20

3. **Operating position**
   The rectifier units can be operated at their maximum ratings when mounted in any position.

*The breakdown voltage increases by approximately 0.1% per °C with increasing junction temperature.*
The drawings show the OSM9115 series; the OSB9115 and OSS9115 series differ in the following respects:

OSB9115 series — terminals marked a (−) and k (+) in the drawings are both marked ~; the centre-tap is marked + (instead of ~ as in the drawings).

OSS9115 series — has no centre-tap.
High-voltage rectifier stacks

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)

<table>
<thead>
<tr>
<th>number of diodes</th>
<th>n</th>
<th>3</th>
<th>4 to 6</th>
<th>7 to 9</th>
<th>10 to 12</th>
<th>13 to 15</th>
</tr>
</thead>
<tbody>
<tr>
<td>maximum lengths</td>
<td></td>
<td></td>
<td></td>
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<td></td>
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<tr>
<td>L_A</td>
<td>143</td>
<td>184</td>
<td>224</td>
<td>264</td>
<td>305</td>
<td></td>
</tr>
<tr>
<td>L_B</td>
<td>147</td>
<td>188</td>
<td>228</td>
<td>268</td>
<td>309</td>
<td></td>
</tr>
<tr>
<td>L_C</td>
<td>159</td>
<td>199</td>
<td>239</td>
<td>279</td>
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<td></td>
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<tr>
<td>L_E</td>
<td>132</td>
<td>173</td>
<td>213</td>
<td>253</td>
<td>294</td>
<td></td>
</tr>
<tr>
<td>L_F</td>
<td>184</td>
<td>225</td>
<td>265</td>
<td>305</td>
<td>346</td>
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</tr>
<tr>
<td>weights</td>
<td>W_A</td>
<td>153</td>
<td>286</td>
<td>419</td>
<td>552</td>
<td>685</td>
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<tr>
<td></td>
<td>W_B = W_C = W_E</td>
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<td>351</td>
<td>484</td>
<td>617</td>
<td>750</td>
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<tr>
<td></td>
<td>W_F</td>
<td>379</td>
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<table>
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<tr>
<th>number of diodes</th>
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<th>16 to 18</th>
<th>19 to 21</th>
<th>22 to 24</th>
<th>25 to 27</th>
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<tbody>
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<td></td>
<td></td>
</tr>
<tr>
<td>L_A</td>
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<td>385</td>
<td>426</td>
<td>466</td>
<td>506</td>
<td></td>
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<tr>
<td>L_B</td>
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<td>389</td>
<td>430</td>
<td>470</td>
<td>510</td>
<td></td>
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<tr>
<td>L_C</td>
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<td>400</td>
<td>441</td>
<td>481</td>
<td>521</td>
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<td>415</td>
<td>455</td>
<td>495</td>
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<td>426</td>
<td>467</td>
<td>507</td>
<td>547</td>
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<td>951</td>
<td>1048</td>
<td>1217</td>
<td>1350</td>
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<tr>
<td></td>
<td>W_B = W_C = W_E</td>
<td>883</td>
<td>1016</td>
<td>1149</td>
<td>1282</td>
<td>1415</td>
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<td></td>
<td>W_F</td>
<td>1044</td>
<td>1177</td>
<td>1310</td>
<td>1443</td>
<td>1576</td>
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<th>34 to 36</th>
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<tr>
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<tr>
<td>L_B</td>
<td>550</td>
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<tr>
<td>L_C</td>
<td>561</td>
<td>601</td>
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<tr>
<td>L_E</td>
<td>535</td>
<td>575</td>
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<tr>
<td>L_F</td>
<td>587</td>
<td>627</td>
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<td>1616</td>
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<td></td>
<td>W_B = W_C = W_E</td>
<td>1548</td>
<td>1681</td>
</tr>
<tr>
<td></td>
<td>W_F</td>
<td>1709</td>
<td>1842</td>
</tr>
</tbody>
</table>
maximum permissible non-repetitive r.m.s. forward current based on sinusoidal currents (f = 50 Hz)

with reapplied $V_{RWMmax}$

$T_j = 175 \degree C$ prior to surge

Fig.9
Fig. 10

Fig. 11

Fig. 12
High-voltage rectifier stacks

APPLICATION INFORMATION

Fig.13 OSB9115 → 4

Fig.14 OSM9115 series

voltage doubler
1 x OSM9115

rectifier circuits with respectively
2 x OSM9115 and 3 x OSM9115

February 1983
HIGH-VOLTAGE RECTIFIER STACKS

The OSB9215, OSM9215 and OSS9215 series are ranges of high-voltage rectifier assemblies, incorporating controlled avalanche diodes mounted on fire-proof triangular formers. The OSB9215 series is intended for application in two-phase half-wave rectifier circuits. The OSM9215 series is intended for application in single-phase or three-phase bridges or in voltage doubler circuits. The OSS9215 series is intended for all kinds of high-voltage rectification. The assemblies are supplied with M6 studs or with standard valve bases. The OSB9215 series and OSM9215 series are supplied with a centre tap (8-32UNC). The maximum crest working voltages of the OSB9215 and OSM9215 series cover the range from 3 kV to 27 kV, and of the OSS9215 series the range from 4.5 kV to 54 kV in 1.5 kV steps.

Configuration:

Fig. 1 OSB9215

Fig. 2 OSM9215

Fig. 3 OSS9215

QUICK REFERENCE DATA

<table>
<thead>
<tr>
<th>Series</th>
<th>Crest Working Reverse Voltage from Centre Tap to End</th>
<th>Crest Working Reverse Voltage</th>
<th>Average Forward Current with R and L Load</th>
<th>Non-Repetitive Peak Forward Current</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>VRWM max.</td>
<td>VRWM max.</td>
<td>IF(AV) max.</td>
<td>IF5M max.</td>
</tr>
<tr>
<td>OSB9215</td>
<td>3 4.5 25.5 27 kV</td>
<td></td>
<td>5 A</td>
<td>360 A</td>
</tr>
<tr>
<td>OSM9215</td>
<td>3 4.5 25.5 27 kV</td>
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<td>20 A</td>
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<td>OSS9215</td>
<td>4.5 6 52.5 54 kV</td>
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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)

<table>
<thead>
<tr>
<th>OSB9215</th>
<th>-4 -6</th>
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<td>34 -36</td>
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</tbody>
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<table>
<thead>
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<th>Currents</th>
<th>VRWM</th>
<th>OSB9215</th>
<th>-4 -6</th>
<th>4 -36</th>
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<td>OSB9215</td>
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<td>OSM9215</td>
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<td>-36</td>
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<td>OSS9215</td>
<td>4.5</td>
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<td>OSM9215</td>
<td>6</td>
<td>34</td>
<td>36</td>
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<th>Currents</th>
<th>VRWM</th>
<th>OSB9215</th>
<th>-4 -6</th>
<th>4 -36</th>
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<td>5</td>
<td>10</td>
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<td>OSS9215</td>
<td>20</td>
<td>10</td>
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<th>Currents</th>
<th>VRWM</th>
<th>OSB9215</th>
<th>-4 -6</th>
<th>4 -36</th>
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<th>OSB9215</th>
<th>-4 -6</th>
<th>4 -36</th>
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<tr>
<th>Reverse power dissipation</th>
<th>OSB9215</th>
<th>-4 -6</th>
<th>4 -36</th>
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</thead>
<tbody>
<tr>
<td>Repetitive peak reverse power</td>
<td>t = 10 µs (square-wave; f = 50 Hz)</td>
<td>4</td>
<td>34</td>
</tr>
<tr>
<td>PRRM</td>
<td>max.</td>
<td>6</td>
<td>34</td>
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</tbody>
</table>

<table>
<thead>
<tr>
<th>Reverse power dissipation</th>
<th>OSB9215</th>
<th>-4 -6</th>
<th>4 -36</th>
</tr>
</thead>
<tbody>
<tr>
<td>Repetitive peak reverse power</td>
<td>t = 10 µs (square-wave)</td>
<td>26</td>
<td>221</td>
</tr>
<tr>
<td>PRRM</td>
<td>max.</td>
<td>39</td>
<td>234</td>
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</table>

<table>
<thead>
<tr>
<th>Reverse power dissipation</th>
<th>OSS9215</th>
<th>-3 -4</th>
<th>35 -36</th>
</tr>
</thead>
<tbody>
<tr>
<td>Repetitive peak reverse power</td>
<td>t = 10 µs (square-wave; f = 50 Hz)</td>
<td>6</td>
<td>70</td>
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<tr>
<td>PRRM</td>
<td>max.</td>
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<td>72</td>
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<table>
<thead>
<tr>
<th>Reverse power dissipation</th>
<th>OSS9215</th>
<th>-3 -4</th>
<th>35 -36</th>
</tr>
</thead>
<tbody>
<tr>
<td>Repetitive peak reverse power</td>
<td>t = 10 µs (square-wave)</td>
<td>39</td>
<td>455</td>
</tr>
<tr>
<td>PRRM</td>
<td>max.</td>
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<td>468</td>
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<table>
<thead>
<tr>
<th>Temperatures</th>
<th>OSB9215</th>
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<th>4 -36</th>
</tr>
</thead>
<tbody>
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<td>Tstg</td>
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</tr>
<tr>
<td>Tj</td>
<td>175</td>
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<table>
<thead>
<tr>
<th>Temperatures</th>
<th>OSS9215</th>
<th>-3 -4</th>
<th>35 -36</th>
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</thead>
<tbody>
<tr>
<td>Tstg</td>
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<tr>
<td>Tj</td>
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CHARACTERISTICS (see note 1)

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<td>-4</td>
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<tr>
<td>Forward voltage</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>$I_F = 50 , A; , T_j = 25 , ^\circ C$</td>
<td>$V_F$</td>
<td>$&lt; $</td>
<td>3.6</td>
<td>5.4</td>
<td>...</td>
<td>30.6</td>
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<tr>
<td>Reverse breakdown voltage*</td>
<td>$V_{(BR)R}$</td>
<td>$&lt; $</td>
<td>4.8</td>
<td>7.2</td>
<td>...</td>
<td>40.8</td>
</tr>
<tr>
<td>$I_R = 5 , mA; , T_j = 25 , ^\circ C$</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Reverse breakdown voltage*</td>
<td>$V_{(BR)R}$</td>
<td>$&lt; $</td>
<td>4.8</td>
<td>7.2</td>
<td>...</td>
<td>40.8</td>
</tr>
<tr>
<td>OSS9215</td>
<td>-3</td>
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<td>...</td>
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<tr>
<td>Forward voltage</td>
<td></td>
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<td></td>
</tr>
<tr>
<td>$I_F = 50 , A; , T_j = 25 , ^\circ C$</td>
<td>$V_F$</td>
<td>$&lt; $</td>
<td>5.4</td>
<td>7.2</td>
<td>...</td>
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<tr>
<td>Reverse breakdown voltage*</td>
<td>$V_{(BR)R}$</td>
<td>$&lt; $</td>
<td>7.2</td>
<td>9.6</td>
<td>...</td>
<td>84</td>
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<tr>
<td>Reverse current</td>
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<td></td>
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<td>$&lt; $</td>
<td>0.6</td>
<td>mA</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Notes
1. The Ratings and Characteristics given apply from centre tap to end. (Not for OSS9215 series).
2. Type number suffix
   The suffix consists of a figure indicating the total number of diodes, followed by a letter indicating the base.
   A = M6 studs at the ends
   B = 4 pin Super Jumbo (B4D)
   C = Goliath
   E = 4 pin Jumbo (B4F)
   F = A3-20
3. Operating position
   The rectifier units can be operated at their maximum ratings when mounted in any position.

*The breakdown voltage increases by approximately 0.1% per °C with increasing junction temperature.
The drawings show the OSM9215 series; the OSB9215 and OSS9215 series differ in the following respects:

OSB9215 series — terminals marked a(−) and k(+) in the drawings are both marked ~; the centre-tap is marked + (instead of ~ as in the drawings).

OSS9215 series — has no centre-tap.
MECHANICAL DATA (continued)

n = total number of diodes.

Fig. 7 OSM9215-nE

Fig. 8 OSM9215-nF

For lengths and weights see table on page 748.
Table of lengths and weights (mm and g)

<table>
<thead>
<tr>
<th>number of diodes</th>
<th>n</th>
<th>3</th>
<th>4 to 6</th>
<th>7 to 9</th>
<th>10 to 12</th>
<th>13 to 15</th>
</tr>
</thead>
<tbody>
<tr>
<td>maximum lengths</td>
<td>L_A</td>
<td>143</td>
<td>184</td>
<td>224</td>
<td>264</td>
<td>305</td>
</tr>
<tr>
<td></td>
<td>L_B</td>
<td>147</td>
<td>188</td>
<td>228</td>
<td>268</td>
<td>309</td>
</tr>
<tr>
<td></td>
<td>L_C</td>
<td>159</td>
<td>199</td>
<td>239</td>
<td>279</td>
<td>320</td>
</tr>
<tr>
<td></td>
<td>L_E</td>
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<td>173</td>
<td>213</td>
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<td>294</td>
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<tr>
<td></td>
<td>L_F</td>
<td>184</td>
<td>225</td>
<td>265</td>
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<td>346</td>
</tr>
<tr>
<td>weight</td>
<td>W_A</td>
<td>153</td>
<td>286</td>
<td>419</td>
<td>552</td>
<td>685</td>
</tr>
<tr>
<td></td>
<td>W_B = W_C = W_E</td>
<td>218</td>
<td>351</td>
<td>484</td>
<td>617</td>
<td>750</td>
</tr>
<tr>
<td></td>
<td>W_F</td>
<td>379</td>
<td>512</td>
<td>645</td>
<td>778</td>
<td>911</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>number of diodes</th>
<th>n</th>
<th>16 to 18</th>
<th>19 to 21</th>
<th>22 to 24</th>
<th>25 to 27</th>
<th>28 to 30</th>
</tr>
</thead>
<tbody>
<tr>
<td>maximum lengths</td>
<td>L_A</td>
<td>345</td>
<td>386</td>
<td>426</td>
<td>466</td>
<td>506</td>
</tr>
<tr>
<td></td>
<td>L_B</td>
<td>349</td>
<td>389</td>
<td>430</td>
<td>470</td>
<td>510</td>
</tr>
<tr>
<td></td>
<td>L_C</td>
<td>360</td>
<td>400</td>
<td>441</td>
<td>481</td>
<td>521</td>
</tr>
<tr>
<td></td>
<td>L_E</td>
<td>334</td>
<td>374</td>
<td>415</td>
<td>455</td>
<td>495</td>
</tr>
<tr>
<td></td>
<td>L_F</td>
<td>386</td>
<td>426</td>
<td>467</td>
<td>507</td>
<td>547</td>
</tr>
<tr>
<td>weights</td>
<td>W_A</td>
<td>818</td>
<td>951</td>
<td>1084</td>
<td>1217</td>
<td>1350</td>
</tr>
<tr>
<td></td>
<td>W_B = W_C = W_E</td>
<td>883</td>
<td>1016</td>
<td>1149</td>
<td>1282</td>
<td>1415</td>
</tr>
<tr>
<td></td>
<td>W_F</td>
<td>1044</td>
<td>1177</td>
<td>1310</td>
<td>1443</td>
<td>1576</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>number of diodes</th>
<th>n</th>
<th>31 to 33</th>
<th>34 to 36</th>
</tr>
</thead>
<tbody>
<tr>
<td>maximum lengths</td>
<td>L_A</td>
<td>546</td>
<td>586</td>
</tr>
<tr>
<td></td>
<td>L_B</td>
<td>550</td>
<td>590</td>
</tr>
<tr>
<td></td>
<td>L_C</td>
<td>561</td>
<td>601</td>
</tr>
<tr>
<td></td>
<td>L_E</td>
<td>535</td>
<td>575</td>
</tr>
<tr>
<td></td>
<td>L_F</td>
<td>587</td>
<td>627</td>
</tr>
<tr>
<td>weights</td>
<td>W_A</td>
<td>1483</td>
<td>1616</td>
</tr>
<tr>
<td></td>
<td>W_B = W_C = W_E</td>
<td>1548</td>
<td>1681</td>
</tr>
<tr>
<td></td>
<td>W_F</td>
<td>1709</td>
<td>1842</td>
</tr>
</tbody>
</table>
High-voltage rectifier stacks

maximum allowable non repetitive peak forward current based on sinusoidal currents, $f=50\text{Hz}$

Fig. 9

maximum allowable non repetitive r.m.s. forward current (sub cycle surge curve)

Fig. 10
maximum allowable average forward current versus ambient temperature

Fig. 11

maximum allowable average output current versus ambient temperature

Fig. 12

maximum allowable average output current versus ambient temperature

Fig. 13

750 February 1983
APPLICATION INFORMATION

Fig. 14 OSB9215—4

\[ I_D = 2I_{F(AV)} \]

Fig. 15 OSM9215 series

- Voltage doubler
  - 1x OSM9215

- Rectifier circuits with respectively
  - 2x OSM9215
  - 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

<table>
<thead>
<tr>
<th></th>
<th>OSB9415</th>
<th>OSM9415</th>
<th>OSS9415</th>
</tr>
</thead>
<tbody>
<tr>
<td>Crest working reverse voltage from centre tap to end</td>
<td>$V_{RWM}$ max.</td>
<td>3</td>
<td>4.5</td>
</tr>
<tr>
<td></td>
<td></td>
<td>-6</td>
<td>-34</td>
</tr>
<tr>
<td>Crest working reverse voltage</td>
<td>$V_{RWM}$ max.</td>
<td>-4</td>
<td>-6</td>
</tr>
<tr>
<td></td>
<td></td>
<td>-6</td>
<td>-34</td>
</tr>
<tr>
<td>Average forward current with R and L load</td>
<td>$I_{F(AV)}$ max.</td>
<td>10</td>
<td>30</td>
</tr>
<tr>
<td>(averaged over any 20 ms period)</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>in free air up to $T_{amb} = 35 ,^\circ C$</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>in oil up to $T_{oil} = 35 ,^\circ C$</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Non-repetitive peak forward current</td>
<td>$I_{FSM}$ max.</td>
<td>800</td>
<td></td>
</tr>
<tr>
<td>$t = 10 , ms$; half sine wave; $T_j = 175 ,^\circ C$ prior to surge</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

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)

<table>
<thead>
<tr>
<th>VOLTAGES</th>
<th>OSB9415</th>
<th>OSM9415</th>
<th>OSS9415</th>
</tr>
</thead>
<tbody>
<tr>
<td>-4</td>
<td>-6</td>
<td>-34</td>
<td>-36</td>
</tr>
<tr>
<td>-4</td>
<td>-6</td>
<td>-34</td>
<td>-36</td>
</tr>
</tbody>
</table>

Crest working reverse voltage

<table>
<thead>
<tr>
<th>VRWM max.</th>
<th>OSB9415</th>
<th>OSM9415</th>
<th>OSS9415</th>
</tr>
</thead>
<tbody>
<tr>
<td>3</td>
<td>4.5</td>
<td>25.5</td>
<td>27</td>
</tr>
<tr>
<td>-3</td>
<td>-4</td>
<td>-35</td>
<td>-36</td>
</tr>
</tbody>
</table>

Crest working reverse voltage

<table>
<thead>
<tr>
<th>VRWM max.</th>
<th>OSB9415</th>
<th>OSM9415</th>
<th>OSS9415</th>
</tr>
</thead>
<tbody>
<tr>
<td>4.5</td>
<td>6</td>
<td>52.5</td>
<td>54</td>
</tr>
</tbody>
</table>

**CURRENTS**

Average forward current (averaged over any 20 ms period)
- in free air up to $T_{amb} = 35\, ^\circ C$
- in oil up to $T_{oil} = 35\, ^\circ C$

<table>
<thead>
<tr>
<th>IF(AV) max.</th>
<th>OSB9415</th>
<th>OSM9415</th>
<th>OSS9415</th>
</tr>
</thead>
<tbody>
<tr>
<td>10A</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>30A</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Repetitive peak forward current

<table>
<thead>
<tr>
<th>IFRM max.</th>
<th>OSB9415</th>
<th>OSM9415</th>
<th>OSS9415</th>
</tr>
</thead>
<tbody>
<tr>
<td>450A</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Non-repetitive peak forward current
- $t = 10\, ms$; half sine-wave;
- $T_j = 175\, ^\circ C$ prior to surge

<table>
<thead>
<tr>
<th>IFSM max.</th>
<th>OSB9415</th>
<th>OSM9415</th>
<th>OSS9415</th>
</tr>
</thead>
<tbody>
<tr>
<td>800A</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

**Reverse power dissipation**

<table>
<thead>
<tr>
<th>PRRM max.</th>
<th>OSB9415</th>
<th>OSM9415</th>
<th>OSS9415</th>
</tr>
</thead>
<tbody>
<tr>
<td>9</td>
<td>13.5</td>
<td>76.5</td>
<td>81</td>
</tr>
<tr>
<td></td>
<td>10 µs</td>
<td>9</td>
<td>13.5</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>PRSM max.</th>
<th>OSB9415</th>
<th>OSM9415</th>
<th>OSS9415</th>
</tr>
</thead>
<tbody>
<tr>
<td>55</td>
<td>82</td>
<td>467</td>
<td>495 kW</td>
</tr>
<tr>
<td></td>
<td>10 µs</td>
<td>8.5</td>
<td>13</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>PRSM max.</th>
<th>OSS9415</th>
<th>OSB9415</th>
<th>OSM9415</th>
</tr>
</thead>
<tbody>
<tr>
<td>80</td>
<td>105</td>
<td>919</td>
<td>945 kW</td>
</tr>
<tr>
<td></td>
<td>10 µs</td>
<td>13</td>
<td>17</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>PRSM max.</th>
<th>OSS9415</th>
<th>OSB9415</th>
<th>OSM9415</th>
</tr>
</thead>
<tbody>
<tr>
<td>80</td>
<td>105</td>
<td>919</td>
<td>945 kW</td>
</tr>
<tr>
<td></td>
<td>10 µs</td>
<td>13</td>
<td>17</td>
</tr>
</tbody>
</table>

**Temperatures**

- Storage temperature $T_{stg} = -55\, ^\circ C$ to $+150\, ^\circ C$
- Junction temperature $T_j$ max. $175\, ^\circ C$
High-voltage rectifier stacks

CHARACTERISTICS (See note 1)

Forward voltage

\( I_F = 150 \text{ A}; T_j = 25 \text{ °C} \)

<table>
<thead>
<tr>
<th></th>
<th>OSB9415</th>
<th>OSB9415</th>
<th>OSM9415</th>
<th>OSM9415</th>
</tr>
</thead>
<tbody>
<tr>
<td>( V_F )</td>
<td>&lt; 3.6</td>
<td>3.6</td>
<td>5.4</td>
<td>5.4</td>
</tr>
<tr>
<td></td>
<td>. . .</td>
<td>30.6</td>
<td>. .</td>
<td>30.6</td>
</tr>
<tr>
<td></td>
<td>. .</td>
<td>32.4</td>
<td>. .</td>
<td>32.4</td>
</tr>
<tr>
<td></td>
<td>V</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Reverse avalanche breakdown voltage*

\( I_R = 5 \text{ mA}; T_j = 25 \text{ °C} \)

\[ V_{(BR)R} \]

<table>
<thead>
<tr>
<th></th>
<th>OSS9415</th>
<th>OSS9415</th>
<th>OSS9415</th>
<th>OSS9415</th>
</tr>
</thead>
<tbody>
<tr>
<td>( V_{(BR)R} )</td>
<td>&gt; 3.3</td>
<td>3.3</td>
<td>4.95</td>
<td>4.95</td>
</tr>
<tr>
<td></td>
<td>. .</td>
<td>28</td>
<td>. .</td>
<td>28</td>
</tr>
<tr>
<td></td>
<td>. .</td>
<td>29.7</td>
<td>. .</td>
<td>29.7</td>
</tr>
<tr>
<td></td>
<td>kV</td>
<td></td>
<td></td>
<td>kV</td>
</tr>
</tbody>
</table>

Reverse current

\[ V_{RM} = V_{RWM\text{max}}; T_j = 125 \text{ °C} \]

\[ I_{RM} < 1.6 \text{ mA} \]

NOTES

1. The Ratings and Characteristics given apply from centre tap to end. (Not for OSS9415 series).

2. Type number suffix

The suffix consists of a figure indicating the total number of diodes, followed by a letter indicating the base.

A = M6 studs at the ends.

3. Operating position

The rectifier units can be operated at their maximum ratings when mounted in any position.

* The breakdown voltage increases, by approximately 0.1% per °C with increasing junction temperature.
MECHANICAL DATA

\( n \) = total number of diodes.

Fig. 4 OSS9415-nA

The drawing shows the OSS9415 series.
The OSB9415 and OSM9415 series differ in the following respects:
OSB9415 series — has a centre tap marked +; anode and cathode terminals are both marked ∨.
OSM9415 series — has a centre tap marked ∨.

**Table of lengths and weights (mm and g)**

<table>
<thead>
<tr>
<th>number of diodes (n)</th>
<th>3</th>
<th>4 to 6</th>
<th>7 to 9</th>
<th>10 to 12</th>
<th>13 to 15</th>
</tr>
</thead>
<tbody>
<tr>
<td>maximum lengths (L_A)</td>
<td>143</td>
<td>184</td>
<td>224</td>
<td>264</td>
<td>305</td>
</tr>
<tr>
<td>weights (W_A)</td>
<td>215</td>
<td>413</td>
<td>611</td>
<td>809</td>
<td>1007</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>number of diodes (n)</th>
<th>16 to 18</th>
<th>19 to 21</th>
<th>22 to 24</th>
<th>25 to 27</th>
<th>28 to 30</th>
<th>31 to 33</th>
<th>34 to 36</th>
</tr>
</thead>
<tbody>
<tr>
<td>maximum lengths (L_A)</td>
<td>345</td>
<td>385</td>
<td>426</td>
<td>466</td>
<td>506</td>
<td>546</td>
<td>586</td>
</tr>
<tr>
<td>weights (W_A)</td>
<td>1208</td>
<td>1406</td>
<td>1604</td>
<td>1802</td>
<td>2000</td>
<td>2198</td>
<td>2396</td>
</tr>
</tbody>
</table>
High-voltage rectifier stacks

1-------+---+---+--+--+---+----+--+-1---l maximum permissible non-repetitive
H
>-------+---+--+-+--+--+---+-~>---t
214x490 peak forward current based on
IFSM 1-------t>----+--+-+---+---+--+-+-1>---t
215x475 sinusoidal currents (f=50Hz)
251x475 each current pulse is followed by
223x460 the crest working reverse voltage
299x460

Tj=175°C prior to surge

Fig.5

maximum allowable non-repetitive
r.m.s. forward current (sub cycle
surge curve)

IFSIR (A)

maximum permissible non-repetitive peak forward current based on sinusoidal currents (f=50Hz)

I_F

Tj=175°C prior to surge

IFSIR (RMS) (A)

Tj=175°C prior to surge

Fig.6
maximum allowable average forward current versus ambient temperature

Fig. 7

maximum allowable average output current versus ambient temperature

Fig. 8

Fig. 9
High-voltage rectifier stacks

APPLICATION INFORMATION

Fig. 10 OSB9415 series

Voltage doubler
1 x OSM9415

Fig. 11 OSM9415 series

Rectifier circuits with respectively
2 x OSM9415 and 3 x OSM9415

\[ I_o = 2I_{F(AV)} \]

\[ I_o = 3I_{F(AV)} \]
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**

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>$V_{RWM}^{\text{max.}}$</td>
<td>12 kV</td>
</tr>
<tr>
<td>$V_{(BR)R}^{\text{min.}}$</td>
<td>15 kV</td>
</tr>
<tr>
<td>$I_{F(AV)}^{\text{max., in free air, } T_{amb}=50^\circ C}$</td>
<td>1.5 A</td>
</tr>
<tr>
<td>$P_{RSM}^{\text{max., } t=10\mu s, T_{amb}=25^\circ C}$</td>
<td>20 kW</td>
</tr>
</tbody>
</table>

**OUTLINE AND DIMENSIONS**

For details see page 763

**CIRCUIT DIAGRAM**

![Circuit Diagram](image)
RATINGS

Limiting values of operation according to the absolute maximum system. These ratings apply for the frequency range 50 to 400Hz. Simultaneous application of all ratings is inferred unless otherwise stated.

Electrical

- $V_{RWM}^{\text{max.}}$: Crest working reverse voltage, 12 kV
- $I_{F(AV)}^{\text{max.}}$: Mean forward current in free air, $T_{\text{amb}} \leq 50^\circ \text{C}$, 180° conduction, 1.5 A
  
  See derating curves on page 764

- $I_{FRM}^{\text{max.}}$: Repetitive peak forward current, 30° conduction, 15 A
- $I_{FSM}^{\text{max.}}$: Surge forward current, 1 cycle (10ms peak of half sinewave), 35 A
- $P_{RSM}^{\text{max.}}$: Non-repetitive peak reverse power (10µs square wave, $T_j = 25^\circ \text{C}$), 20 kW
- $P_{RRM}^{\text{max.}}$: 50Hz repetitive peak reverse transient power (10µs square wave, $T_j = 150^\circ \text{C}$), 5.0 kW

Temperature

- $T_{\text{stg}}$: Storage temperature, -55 to 150°C
- $T_j$: Junction temperature, -55 to 150°C

ELECTRICAL CHARACTERISTICS ($T_j = 25^\circ \text{C}$ unless otherwise stated)

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Min.</th>
<th>Max.</th>
</tr>
</thead>
<tbody>
<tr>
<td>$V_F$</td>
<td>-</td>
<td>17.5 V</td>
</tr>
<tr>
<td>$I_R$</td>
<td>-</td>
<td>100 µA</td>
</tr>
<tr>
<td>$V_{(BR)R}$</td>
<td>**Avalanche breakdown voltage, $I_{(BR)R} = 1\text{mA}$</td>
<td>15</td>
</tr>
</tbody>
</table>

*Measured under pulsed conditions so that $T_j$ is at, or near, the stated value.

**The avalanche voltage increases by approximately 0.1%/degC with increasing $T_j$.

MECHANICAL DATA

Weight 130 g

MOUNTING POSITION

The rectifier units can be operated at their maximum ratings when mounted in any position.
OUTLINE AND DIMENSIONS

<table>
<thead>
<tr>
<th>Millimetres</th>
<th>A</th>
<th>C</th>
<th>D</th>
<th>E</th>
<th>F</th>
<th>G</th>
<th>H</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>8.0</td>
<td>16.5</td>
<td>5.3</td>
<td>26</td>
<td>10</td>
<td>50</td>
<td>165</td>
</tr>
</tbody>
</table>

C.T. 4 mm thread
MAXIMUM MEAN FORWARD CURRENT AS A FUNCTION OF AMBIENT TEMPERATURE AND CONDUCTION ANGLE
MAXIMUM FORWARD CONDUCTION CHARACTERISTICS

$IF$ (A)

$V_F$ (V)

$J_F = 150°C$

$25°C$
MAXIMUM R.M.S. SURGE CURRENT PLOTTED AGAINST SURGE DURATION

NON-REPETITIVE PEAK REVERSE POWER PLOTTED AGAINST SQUARE PULSE DURATION
ACCESSORIES
## TYPE NUMBER SUMMARY

<table>
<thead>
<tr>
<th>type number</th>
<th>description</th>
<th>envelope</th>
</tr>
</thead>
<tbody>
<tr>
<td>56264a</td>
<td>mica washer (up to 2000 V)</td>
<td>DO-5, TO-48</td>
</tr>
<tr>
<td>56264b</td>
<td>insulating bush</td>
<td>DO-5, TO-48</td>
</tr>
<tr>
<td>56295a</td>
<td>mica washer (up to 2000 V)</td>
<td>DO-4, TO-64</td>
</tr>
<tr>
<td>56295b</td>
<td>PTFE ring</td>
<td>DO-4, TO-64</td>
</tr>
<tr>
<td>56295c</td>
<td>insulating bush</td>
<td>DO-4, TO-64</td>
</tr>
<tr>
<td>56359b</td>
<td>mica washer (up to 1000 V)</td>
<td>TO-220</td>
</tr>
<tr>
<td>56359c</td>
<td>insulating bush (up to 800 V)</td>
<td>TO-220</td>
</tr>
<tr>
<td>56359d</td>
<td>rectangular insulating bush (up to 1000 V)</td>
<td>TO-220</td>
</tr>
<tr>
<td>56360a</td>
<td>rectangular washer</td>
<td>TO-220</td>
</tr>
<tr>
<td>56363</td>
<td>spring clip (direct mounting)</td>
<td>TO-220, SOT-186</td>
</tr>
<tr>
<td>56364</td>
<td>spring clip (insulated mounting)</td>
<td>TO-220</td>
</tr>
<tr>
<td>56367</td>
<td>alumina insulator (up to 2000 V)</td>
<td>TO-220</td>
</tr>
<tr>
<td>56368b</td>
<td>insulating bush (up to 800 V)</td>
<td>SOT-93</td>
</tr>
<tr>
<td>56368c</td>
<td>mica insulator (up to 800 V)</td>
<td>SOT-93</td>
</tr>
<tr>
<td>56369</td>
<td>mica insulator (up to 2000 V)</td>
<td>TO-220</td>
</tr>
<tr>
<td>56378</td>
<td>mica insulator (up to 1500 V)</td>
<td>SOT-93</td>
</tr>
<tr>
<td>56379</td>
<td>spring clip</td>
<td>SOT-93, SOT-112</td>
</tr>
</tbody>
</table>
ACCESSORIES for DO-5 and TO-48

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

\[ R_{\text{th mb-h}} = 5 \text{ K/W} \]
\[ R_{\text{th mb-h}} = 2.5 \text{ K/W} \]

TEMPERATURE

Maximum allowable temperature

\[ T_{\text{max}} = 175 \text{ °C} \]
56295a MICA WASHER

Insulator up to 2 kV.

MECHANICAL DATA

Dimensions in mm

56295b PTFE RING

MECHANICAL DATA

Dimensions in mm

56295c INSULATING BUSH

MECHANICAL DATA

Dimensions in mm

THERMAL RESISTANCE

From mounting base to heatsink
without heatsink compound
with heatsink compound

\[
\begin{align*}
R_{th \ mb-h} &= 5 \text{ K/W} \\
R_{th \ mb-h} &= 2.5 \text{ K/W}
\end{align*}
\]

TEMPERATURE

Maximum allowable temperature

\[
T_{\text{max}} = 175 \text{ °C}
\]
56359b
MICA WASHER

Insulator up to 1000 V.

MECHANICAL DATA

Dimensions in mm

56359c
INSULATING BUSH

Insulator up to 800 V.

MECHANICAL DATA

Material: polyester

TEMPERATURE

Maximum permissible temperature

$T_{\text{max}} = 150 \, ^{\circ}\text{C}$

56359d
RECTANGULAR INSULATING BUSH

Insulator up to 1000 V.

MECHANICAL DATA

Dimensions in mm

TEMPERATURE

Maximum permissible temperature

$T_{\text{max}} = 150 \, ^{\circ}\text{C}$
56360a RECTANGULAR WASHER (For TO-220)
For direct and insulated mounting.

**MECHANICAL DATA**
Material: brass; nickel platted.

**Dimensions in mm**
- Width: 3.1
- Height: 10
- Thickness: 5.8

56363 SPRING CLIP (For TO-220 and SOT-186)
For direct mounting.

**MECHANICAL DATA**
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).

**Dimensions in mm**
- Width: 15
- Height: 4.5
- Thickness: 3.5

56364 SPRING CLIP (For TO-220)
For insulated mounting.

**MECHANICAL DATA**
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).

**Dimensions in mm**
- Width: 17
- Height: 4.5
- Thickness: 3.5

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.

*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**
56368b  INSULATING BUSH

For insulated screw mounting up to 800 V.

MECHANICAL DATA

Material: polyester

TEMPERATURE

Maximum permissible temperature

$T_{\text{max}} = 150 \, ^\circ\text{C}$

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

For insulated mounting, the compound should be applied to the bottom of both device and insulator.

Mounting methods for power devices
1. Clip mounting
   Mounting with a spring clip gives:
   a. A good thermal contact under the crystal area, and slightly lower $R_{th \, mb-h}$ values than screw mounting.
   b. Safe insulation for mains operation.
2. M3 screw mounting
   It is recommended that the rectangular spacing washer is inserted between screw head and mounting tab.

Mounting torque for screw mounting:
(For thread-forming screws these are final values. Do not use self-tapping screws.)

<table>
<thead>
<tr>
<th>Torque Type</th>
<th>Minimum (Nm)</th>
<th>Maximum (Nm)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Minimum torque (for good heat transfer)</td>
<td>0,55</td>
<td>0,80</td>
</tr>
<tr>
<td>Maximum torque (to avoid damaging the device)</td>
<td></td>
<td>0,80</td>
</tr>
</tbody>
</table>

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:

<table>
<thead>
<tr>
<th>Torque Type</th>
<th>Minimum (Nm)</th>
<th>Maximum (Nm)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Minimum torque (for good heat transfer)</td>
<td>0,4</td>
<td>0,6</td>
</tr>
<tr>
<td>Maximum torque (to avoid damaging the device)</td>
<td></td>
<td>0,6</td>
</tr>
</tbody>
</table>
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).

<table>
<thead>
<tr>
<th>From mounting base to heatsink</th>
<th>clip mounting</th>
<th>screw mounting</th>
</tr>
</thead>
<tbody>
<tr>
<td>with heatsink compound, direct mounting</td>
<td>$R_{th\ mb-h} = 0,3$</td>
<td>$R_{th\ mb-h} = 0,5$</td>
</tr>
<tr>
<td>without heatsink compound, direct mounting</td>
<td>$R_{th\ mb-h} = 1,4$</td>
<td>$R_{th\ mb-h} = 1,4$</td>
</tr>
<tr>
<td>with heatsink compound and 0,1 mm maximum mica washer</td>
<td>$R_{th\ mb-h} = 2,2$</td>
<td>—</td>
</tr>
<tr>
<td>with heatsink compound and 0,25 mm maximum alumina insulator</td>
<td>$R_{th\ mb-h} = 0,8$</td>
<td>—</td>
</tr>
<tr>
<td>with heatsink compound and 0,05 mm mica washer</td>
<td>$R_{th\ mb-h} = 1,4$</td>
<td>$R_{th\ mb-h} = 1,6$</td>
</tr>
<tr>
<td>insulated up to 500 V</td>
<td>$R_{th\ mb-h} = 1,4$</td>
<td>$R_{th\ mb-h} = 4,5$</td>
</tr>
<tr>
<td>insulated up to 800 V/1000 V</td>
<td>$R_{th\ mb-h} = 3,0$</td>
<td>$R_{th\ mb-h} = 4,5$</td>
</tr>
<tr>
<td>without heatsink compound and 0,05 mm mica washer</td>
<td>$R_{th\ mb-h} = 1,4$</td>
<td>$R_{th\ mb-h} = 4,5$</td>
</tr>
</tbody>
</table>

**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 $T_j \text{ max} \leq 175 ^\circ$C, soldering temperature $T_{sld \ max} = 275 ^\circ$C.
- Devices with $T_j \text{ max} \leq 110 ^\circ$C, soldering temperature $T_{sld \ max} = 240 ^\circ$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 Sn/36 Pb/2 Ag or 60 Sn/40 Pb.

- Maximum soldering temperature $\leq 200 ^\circ$C (tab-temperature).

- Soldering cycle duration including pre-heating $\leq 30$ sec.

For good soldering and avoiding damage to the encapsulation pre-heating is recommended to a temperature $\leq 165 ^\circ$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 $10^\circ$ to $30^\circ$ 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.

Insulated mounting with clip 56364

With the insulators 56367 or 56369 insulation up to 2 kV is obtained.

1. Apply heatsink compound to the bottom of both device and insulator, then place the device with the insulator on the heatsink.
2. Push the short end of the clip into the narrow slot in the heatsink with the clip at an angle of $10^\circ$ to $30^\circ$ 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. 1 Heatsink requirements.  Fig. 2 Mounting.  (1) spring clip 56363.  Fig. 2a Position of device (top view).

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

Fig. 5 Assembly.

(1) M3 screw.
(2) rectangular washer (56360a).
(3) lock washer.
(4) M3 nut.
(5) heatsink.
(8) plain washer.

- into tapped heatsink

Fig. 7 Assembly.

(1) M3 screw.
(2) rectangular washer 56360a.
(5) heatsink.

Fig. 6 Heatsink requirements.

Dimensions in mm

Fig. 8 Heatsink requirements.
Insulated mounting with screw and spacing washer (not recommended where mounting tab is on mains voltage)

- through heatsink with nut

- into tapped heatsink

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.

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 acquaint 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 “Accessories 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 “Accessories 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° maximum. The minimum bending radius is 1mm.

![Fig.1 Lead bending of devices.](image)

**Soldering**

Lead soldering temperature at >3mm from body for $t_{sld} < 5$ seconds:

- Devices with $T_j$ max. $< 175$ °C, $T_{sld}$ max. $= 275$ °C.
- Devices with $T_j$ max. $< 110$ °C, $T_{sld}$ 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° to 30° to the vertical (see Figs.2 & 3).
3. Push down the clip over the device until the long end of the clip snaps into the wide slot in the heatsink. The clip should bear down on the main part of the body, not on the tab (see Fig.3a).

![Fig.2 Heatsink requirements](image)

![Fig.3 Mounting.](image)

![Fig.3a Position of device (top view).](image)
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

Into tapped heatsink

Fig.5 Heatsink requirements.

Fig.6 Assembly.
(1) M3 screw
(5) heatsink

Fig.7 Heatsink requirements.
MOUNTING REQUIREMENTS FOR VOLTAGE ISOLATION

Full-pack devices may be used to maintain voltage isolation between the heatsink and the electrical circuit. However, users must ensure that there is a sufficient creepage distance between the exposed metal of the device (at both the lead and tab ends) and the heatsink. The distance required will vary according to the application and the regulations that may apply.

To increase the creepage distances the heatsink may be formed with slots or holes around the lead and tab ends of the device. The dimensions of the holes will vary according to the creepage distances required. For detail see Fig.8.

![Fig.8 Slots formed in heatsink to increase creepage distance.](image-url)
GENERAL DATA AND INSTRUCTIONS

General rule
Avoid any sudden forces on leads and body; these forces, such as from falling on a hard surface, are easily underestimated. In the direct screw mounting an M4 screw must be used; an M3 screw in the insulating mounting.

Heatsink requirements
Flatness in the mounting area: 0,02 mm maximum per 10 mm. The mounting hole must be deburred.

Heatsink compound
The thermal resistance from mounting base to heatsink \( R_{th \text{mb-h}} \) can be reduced by applying a metallic-oxide heatsink compound between the contact surfaces. For insulated mounting the compound should be applied to the bottom of both device and insulator.

Maximum play
The bush or the washer may only just touch the plastic part of the body, but should not exert any force on that part. Keep mounting tool (e.g. screwdriver) clear of the plastic body.

Mounting torques
For M3 screw (insulated mounting):
- Minimum torque (for good heat transfer) 0,4 Nm (4 kgcm)
- Maximum torque (to avoid damaging the device) 0,6 Nm (6 kgcm)

For M4 screw (direct mounting only):
- Minimum torque (for good heat transfer) 0,4 Nm (4 kgcm)
- Maximum torque (to avoid damaging the device) 1,0 Nm (10 kgcm)

Note: The M4 screw head should not touch the plastic part of the envelope.

Lead bending
Maximum permissible tensile force on the body for 5 s 20 N (2 kgf)
No torsion is permitted at the emergence of the leads.
Bending or twisting is not permitted within a lead length of 0,3 mm from the body of the device.
The leads can be bent through 90° maximum, twisted or straightened; to keep forces within the above-mentioned limits, the leads should be clamped near the body.
Soldering

Recommendations for devices with a maximum junction temperature rating ≤ 175 °C:

a. Dip or wave soldering

Maximum permissible solder temperature is 260 °C at a distance from the body of > 5 mm and for a total contact time with soldering bath or waves of < 7 s.

b. Hand soldering

Maximum permissible temperature is 275 °C at a distance from the body of > 3 mm and for a total contact time with the soldering iron of < 5 s.

The body of the device must not touch anything with a temperature > 200 °C.

It is not permitted to solder the metal tab of the device to a heatsink, otherwise the junction temperature rating will be exceeded.

Avoid any force on body and leads during or after soldering; do not correct the position of the device or of its leads after soldering.

Thermal data

(Typical figures, for exact figures see data for each device type).

<table>
<thead>
<tr>
<th>Clip mounting</th>
<th>Screw mounting</th>
</tr>
</thead>
<tbody>
<tr>
<td>Direct mounting with heatsink compound</td>
<td>R&lt;sub&gt;th mb-h&lt;/sub&gt; = 0.3 K/W</td>
</tr>
<tr>
<td>Direct mounting without heatsink compound</td>
<td>R&lt;sub&gt;th mb-h&lt;/sub&gt; = 1.5 K/W</td>
</tr>
<tr>
<td>Direct mounting with 0.05 mm mica washer with heatsink compound</td>
<td>R&lt;sub&gt;th mb-h&lt;/sub&gt; = 0.8 K/W</td>
</tr>
<tr>
<td>Direct mounting without heatsink compound</td>
<td>R&lt;sub&gt;th mb-h&lt;/sub&gt; = 3.0 K/W</td>
</tr>
</tbody>
</table>

INSTRUCTIONS FOR CLIP MOUNTING

Direct mounting with clip 56379

1. Place the device on the heatsink, applying heatsink compound to the mounting base.

2. Push the short end of the clip into the narrow slot in the heatsink with the clip at an angle of 10° to 20° to the vertical (see Fig. 1b).

3. Push down the clip over the device until the long end of the clip snaps into the wide slot in the heatsink. The clip should bear on the plastic body, not on the tab (see Fig. 1c).

Fig. 1a Heatsink requirements.
Fig. 1b Mounting. (1) = spring clip 56379.
Fig. 1c Position of the device.
Mounting instructions for SOT-93 envelopes

Insulated mounting with clip 56379
With the mica 56378 insulation up to 1500 V is obtained.

1. Place the device with the insulator on the heatsink, applying heatsink compound to the bottom of both device and insulator.
2. Push the short end of the clip into the narrow slot in the heatsink with the clip at an angle of 10° to 20° to the vertical (see Figs 2a and 2b).
3. Push down the clip over the device until the long end of the clip snaps into the wide slot in the heatsink. The clip should bear on the plastic body, not on the tab (see Fig. 2c). There should be minimum 3 mm distance between the device and the edge of the insulator for adequate creepage.

INSTRUCTIONS FOR SCREW MOUNTING

Direct mounting

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.
MOUNTING INSTRUCTIONS
SOT-93

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

Insulated screw mounting with tapped hole; up to 800 V.

Fig. 6 Assembly. See also Fig. 9.

Fig. 5 Heatsink requirements up to 800 V insulation.

Fig. 7 Heatsink requirements up to 800 V insulation.

(1) M3 screw
(2) plain washer
(3) insulating bush (56368b)
(4) mica insulator (56368c)
(5) lock washer
Mounting instructions for SOT-93 envelopes

Insulated screw mounting with insert nut; up to 500 V

Fig. 8 Assembly and heatsink requirements for 500 V insulation. See also Fig. 3.

(1) M3 screw
(2) plain washer
(3) insulating bush (56368b)
(4) mica insulator (56368c)
(5) lock washer

Fig. 9 Mica insulator.

The axial deviation (α) between SOT-93 and mica should not exceed 5°.
MOUNTING CONSIDERATIONS FOR STUD-MOUNTED DEVICES

Losses generated in a silicon device must flow through the case and to a lesser extent the leads. The greatest proportion of the losses flow out through the case into a heat exchanger which can be either free convection cooled, forced convection or even liquid cooled. For the majority of devices in our range natural convection is generally adequate, however, where other considerations such as space saving must be taken into account then methods such as forced convection etc. can be considered. The thermal path from junction to ambient may be considered as a number of resistances in series. The first thermal resistance will be that of junction to mounting base, usually denoted by $R_{\text{th j-mb}}$. The second is the contact thermal resistance $R_{\text{th mb-h}}$ and finally there is the thermal resistance of the heatsink $R_{\text{th h-a}}$.

In the rating curves, the contact thermal resistance and heatsink thermal resistances are combined as a single figure - $R_{\text{th mb-a}}$.

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 $Z_{\text{th j-mb}}$ 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.

HEAT SINK REQUIREMENTS
Mounting holes must be deburred.

MOUNTING TORQUES
Minimum torque (for good heat transfer) 0.9 Nm (9 kg cm)
Maximum torque (to avoid damaging device) 1.7 Nm (17 kg cm)

THERMAL DATA
The thermal resistance from mounting base to heatsink ($R_{th \ mb-h}$) 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

\[
\begin{align*}
R_{th \ mb-h} &= 5 \quad \text{K/W} \\
R_{th \ mb-h} &= 2.5 \quad \text{K/W}
\end{align*}
\]

MOUNTING INSTRUCTIONS FOR UP TO 2000 V INSULATION
Using 56295c insulating bush and 56295a mica washer.

---

Fig. 1
(1a);(1b) tag — alternative positions
(2) mica washer 56295a
(3) insulating bush 56295c
(4) plain washer (may be omitted if tag used in position 1b)
(5) toothed lock washer (supplied with device)
(6) 10-32 UNF nut (supplied with device)
MOUNTING INSTRUCTIONS FOR UP TO 2000 V INSULATION

Using insulating ring 56295b and two mica washers 56295a.

Fig. 2

(1a); (1b) tag — alternative positions
(2) mica washer 56295a
(3) insulating ring 56295b
(4) mica washer 56295a
(5) plain washer (may be omitted if tag used in position 1b)
(6) toothed lock washer (supplied with device)
(7) 10-32 nut (supplied with device)
GENERAL DATA AND INSTRUCTIONS
Mounting instructions for up to 2000 V insulation using 56264b insulating bush and 56264a mica washer.

HEATSINK REQUIREMENTS
Mounting holes must be deburred.

MOUNTING TORQUES
Minimum torque (for good heat transfer) 1.7 Nm (17 kg cm)
Maximum torque (to avoid damaging device) 3.5 Nm (35 kg cm)

THERMAL DATA
The thermal resistance from mounting base to heatsink \( R_{th \ mb-h} \) can be reduced by applying a heat conducting compound between device and heatsink. For insulated mounting the compound should be applied to the bottom of both device and insulator.

Thermal resistance from mounting base to heatsink (insulated mounting using 56264a mica washer)
without heatsink compound \[ R_{th \ mb-h} = 5 \text{ K/W} \]
with heatsink compound \[ R_{th \ mb-h} = 2.5 \text{ K/W} \]

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) \( \frac{1}{4}'' \times 28 \text{ UNF} \) 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

\[
R_{th \ mb-h} = \begin{cases} 
1.0 & \text{K/W} \\
2.0 & \text{K/W} 
\end{cases}
\]

INSTRUCTIONS FOR MOUNTING
1. Place the device on the heatsink, applying a metallic oxide loaded compound to the mounting base.
2. Push the short end of the clip into the narrow slot of the heatsink with the clip at an angle of 10° to 30° to the vertical (see Fig.1b).
3. Push down the clip over the device until the long end of the clip snaps into the wide slot. The clip should bear down on the middle of the plastic body.

Fig. 1a Heatsink requirements.  
Fig. 1b Mounting.  
Fig. 1c Position of the device.
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Mm = Microminiature semiconductors for hybrid circuits  
SD = Small-signal diodes  
Sp = Special diodes  
T = Tuner diodes  
Vrg = Voltage regulator diodes  

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Mm = Microminiature semiconductors for hybrid circuits
Sm = Small-signal transistors
T = Tuner diodes
P = Low-frequency power transistors
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P = Low-frequency power transistors

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FET = Field-effect transistors  
P    = Low-frequency power transistors  
HVP = High-voltage power transistors  
Sm   = Small-signal transistors  
Mm   = Microminiature semiconductors for hybrid circuits  
WBT  = Wideband transistors
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FET = Field-effect transistors  
Mm = Microminiature semiconductors for hybrid circuits  
Sm = Small-signal transistors  
RFP = R.F. power transistors and modules  
RT = Tripler  
WBM = Wideband hybrid IC modules  
WBT = Wideband transistors
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FET = Field-effect transistors
RFP = R.F. power transistors and modules
WBM = Wideband hybrid IC modules
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**FET** = Field-effect transistors  
**RFP** = R.F. power transistors and modules  
**Mm** = Microminiature semiconductors for hybrid circuits  
**Sm** = Small-signal transistors  
**PDT** = Photodiodes or transistors  
**Th** = Thyristors
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* = series  
FET = Field-effect transistors  
Mm = Microminiature semiconductors for hybrid circuits  
Sm = Small-signal transistors  
SP = Low-frequency switching power transistors  
Th = Thyristors  
Tri = Triacs
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* = series  
PM = Power MOS transistors  
R = Rectifier diodes  
SP = Low-frequency switching power transistors
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* = 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
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A = Accessories
I = Infrared devices
LED = Light-emitting diodes
M = Microwave transistors
Ph = Photoconductive devices
PhC = Photocouplers
SEN = Sensors
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* = series  
I = Infrared devices  
M = Microwave transistors  
P = Low-frequency power transistors  
PhC = Photocouplers  
R = Rectifier diodes  
SD = Small-signal diodes  
Vrf = Voltage reference diodes
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FET = Field-effect transistors
I = Infrared devices
M = Microwave transistors
Mm = Microminiature semiconductors
PhC = Photocouplers
P = Low-frequency power transistors
R = Rectifier diodes
SD = Small-signal diodes
SEN = Sensors
Sm = Small-signal transistors
SP = Low-frequency switching power transistors
St = Rectifier stacks
WBM = Wideband hybrid IC modules

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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
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