<table>
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<th>Rectifier diodes</th>
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<td>Thyristors</td>
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# Selection Guide

## General Section

- Rectifier Diodes
- Regulator Diodes
- High-Voltage Rectifier Stacks
- Thyristors
- Triacs
- Accessories
- Heatsinks

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

**ELECTRON TUBES** BLUE

**SEMICONDUCTORS AND INTEGRATED CIRCUITS** RED

**COMPONENTS AND MATERIALS** GREEN

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

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

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

Starting in 1980, new part numbers and corresponding codes are being introduced. The former code of the preceding issue is given in brackets under the new code.

Part 1 February 1980 T1 02-80 (ET1a 12-75) Tubes for r.f. heating
Part 2 April 1980 T2 04-80 (ET1b 08-77) Transmitting tubes for communications
Part 2a November 1977 ET2a 11-77 Microwave tubes
Communication magnetrons, magnetrons for microwave heating, klystrons, travelling-wave tubes, diodes, triodes T-R switches
Part 2b May 1978 ET2b 05-78 Microwave semiconductors and components
Gunn, Impatt and noise diodes, mixer and detector diodes, backward diodes, varactor diodes, Gunn oscillators, sub-assemblies, circulators and isolators
Part 3 January 1975 ET3 01-75 Special Quality tubes, miscellaneous devices
Part 4 March 1975 ET4 03-75 Receiving tubes
Part 5a October 1979 ET5a 10-79 Cathode-ray tubes
Instrument tubes, monitor and display tubes, C.R. tubes for special applications
Part 5b December 1978 ET5b 12-78 Camera tubes and accessories, image intensifiers
Part 6 January 1977 ET6 01-77 Products for nuclear technology
Channel electron multipliers, neutron tubes, Geiger-Müller tubes
Part 7a March 1977 ET7a 03-77 Gas-filled tubes
Thyratrons, industrial rectifying tubes, ignitrons, high-voltage rectifying tubes
Part 7b May 1979 ET7b 05-79 Gas-filled tubes
Segment indicator tubes, indicator tubes, switching diodes, dry reed contact units
Part 8 July 1979 ET8 07-79 Picture tubes and components
Colour TV picture tubes, black and white TV picture tubes, monitor tubes, components for colour television, components for black and white television.
Part 9 March 1978 ET9 03-78 Photomultiplier tubes; phototubes
Starting in 1980, new part numbers and corresponding codes are being introduced. The former code of the preceding issue is given in brackets under the new code.

**Part 1** March 1980  **S1 03-80**  Diodes  
(SC1b 05-77)  Small-signal germanium diodes, small-signal silicon diodes, special diodes, voltage regulator diodes (< 1.5 W), voltage reference diodes, tuner diodes, rectifier diodes

**Part 2** May 1980  **S2 05-80**  Power diodes, thyristors, triacs  
(SC1a 08-78)  Rectifier diodes, voltage regulator diodes (> 1.5 W), rectifier stacks, thyristors, triacs

**Part 2** June 1979  **SC2 06-79**  Low-frequency power transistors

**Part 3** January 1978  **SC3 01-78**  High-frequency, switching and field-effect transistors*

**Part 3** April 1980  **S3 04-80**  Small-signal transistors  
(SC2 11-77, partly)  
(SC3 01-78, partly)

**Part 4a** December 1978  **SC4a 12-78**  Transmitting transistors and modules

**Part 4b** September 1978  **SC4b 09-78**  Devices for optoelectronics  
Photosensitive diodes and transistors, light-emitting diodes, photocouplers, infrared sensitive devices, photoconductive devices

**Part 4c** July 1978  **SC4c 07-78**  Discrete semiconductors for hybrid thick and thin-film circuits

**Part 5a** November 1976  **SC5a 11-76**  Professional analogue integrated circuits

**Part 5b** March 1977  **SC5b 03-77**  Consumer integrated circuits  
Radio, audio, television

**Part 6** October 1977  **SC6 10-77**  Digital integrated circuits  
LOCMOS HE4000B family

**Part 6b** August 1979  **SC6b 08-79**  ICs for digital systems in radio and television receivers

**Signetics integrated circuits**  
Bipolar and MOS memories 1979  
Bipolar and MOS microprocessors 1978  
Analogue circuits 1979  
Logic - TTL 1978

* Field-effect transistors and wideband transistors will be transferred to S5 and SC3c respectively. The old book SC3 01-78 should be kept until then.
COMPONENTS AND MATERIALS (GREEN SERIES)

Starting in 1980, new part numbers and corresponding codes are being introduced. The former code of the preceding issue is given in brackets under the new code.

Part 1    July 1979    CM1 07-79    Assemblies for industrial use
           PLC modules, high noise immunity logic FZ/30 series, NORbits 60-series, 61-series, 90-series, input devices, hybrid integrated circuits, peripheral devices

Part 3a   September 1978   CM3a 09-78   FM tuners, television tuners, surface acoustic wave filters

Part 3b   October 1978    CM3b 10-78   Loudspeakers

Part 4a   November 1978   CM4a 11-78   Soft Ferrites
           Ferrites for radio, audio and television, beads and chokes, Ferroxcube potcores and square cores, Ferroxcube transformer cores

Part 4b   February 1979   CM4b 02-79   Piezoelectric ceramics, permanent magnet materials

Part 6    April 1977    CM6 04-77   Electric motors and accessories
           Small synchronous motors, stepper motors, miniature direct current motors

Part 7    September 1971   CM7 09-71   Circuit blocks
          Circuit blocks 100 kHz-series, circuit blocks 1-series, circuit blocks 10-series, circuit blocks for ferrite core memory drive

Part 7a   January 1979   CM7a 01-79   Assemblies
          Circuit blocks 40-series and CSA70 (L), counter modules 50-series, input/output devices

Part 8    June 1979    CM8 06-79   Variable mains transformers

Part 9    August 1979   CM9 08-79   Piezoelectric quartz devices
          Quartz crystal units, temperature compensated crystal oscillators

Part 10   April 1978    CM10 04-78   Connectors

Part 11   December 1979   CM11 12-79   Non-linear resistors
          Voltage dependent resistors (VDR), light dependant resistors (LDR), negative temperature coefficient thermistors (NTC), positive temperature coefficient thermistors (PTC)

Part 12   November 1979   CM12 11-79   Variable resistors and test switches

Part 13   December 1979   CM13 12-79   Fixed resistors

Part 14   April 1980    C14 04-80   Electrolytic and solid capacitors
          (CM2b 02-78)

Part 15   May 1980    C15 05-80   Film capacitors, ceramic capacitors, variable capacitors
          (CM2b 02-78)
The inclusion of a type number in this publication does not necessarily imply its availability.

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FET = Field-effect transistors
GB = Germanium gold bonded diodes
Mm = Discrete semiconductors for hybrid thick and thin-film circuits
PC = Germanium point contact diodes
Sm = Small-signal transistors
Sp = Special diodes
T = Tuner diodes
Vrg = Voltage regulator diodes
WD = Silicon whiskerless diodes
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Sm = Small-signal transistors
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P = Low-frequency power transistors
PDT = Photodiodes or transistors
R = Rectifier diodes
Sm = Small-signal transistors
Th = Thyristors
Tra = Transmitting transistors and modules
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* = series.

GB = Germanium gold bonded diodes
I = Infrared devices
LED = Light-emitting diodes
Mm = Discrete semiconductors for hybrid thick and thin-film circuits

P = Low-frequency power transistors
PC = Germanium point contact diodes
Ph = Photoconductive devices
PhC = Photocouplers
R = Rectifier diodes
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* = series.

Sm = Small-signal transistors
St = Rectifier stacks
Th = Thyristors
Tri = Triacs

TS = Transient suppressor diodes
Vrf = Voltage reference diodes
Vrg = Voltage regulator diodes
WD = Silicon whiskerless diodes
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<td>2N3866</td>
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A = Accessories
DH = Diecast heatsinks
FET = Field-effect transistors
HE = Heatsink extrusions
HFSW = High-frequency and switching transistors
I = Infrared devices
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<td>56398</td>
<td>SC2</td>
<td>A</td>
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</table>

P = Low-frequency power transistors  
R = Rectifier diodes  
Sm = Small-signal transistors  
Tra = Transmitting transistors and modules  
Vrf = Voltage reference diodes  
WD = Silicon whiskerless diodes
SELECTION GUIDE
## RECTIFIER DIODES

### General purpose

<table>
<thead>
<tr>
<th>$\text{IF(\text{AV})_{\text{max}}}$ (A)</th>
<th>$\text{V_{RRM_{\text{max}}} (V)}$</th>
</tr>
</thead>
<tbody>
<tr>
<td>1.4</td>
<td>BYX22</td>
</tr>
<tr>
<td>6</td>
<td>BYX49</td>
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<tr>
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<td>BYX52</td>
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<td>150</td>
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### Avalanche

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<th>$\text{V_{RWM_{\text{max}}} (V)}$</th>
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<td>1.5</td>
<td>BYX45</td>
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<td>9.5</td>
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<td>BYX56</td>
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### Bridges

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<td>PCB-mounted types</td>
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<tr>
<td>1</td>
<td>BY179</td>
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<td>1.2</td>
<td>BY164</td>
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<td>1.5</td>
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<tr>
<td>4.8</td>
<td>BY225</td>
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<td>Bolt-down types</td>
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<td>12</td>
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### Efficiency diodes

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<th>$\text{V_{RRM_{\text{max}}} (V)}$</th>
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<tr>
<td>5</td>
<td>BY223</td>
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<tr>
<td>10</td>
<td>BY277</td>
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**Fast-recovery rectifier diodes**

**Schottky types**

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**Ultra-fast types**

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<tbody>
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<td>A 7  BYW29</td>
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<tr>
<td>12 BYW30</td>
<td></td>
</tr>
<tr>
<td>25 BYW31</td>
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</tr>
<tr>
<td>35 BYW92</td>
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</table>

**Super-fast types**

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<td>35 BYV92</td>
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**Very-fast types**

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<td>6  1N3880</td>
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<tr>
<td>6  1N3881</td>
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<tr>
<td>6  1N3882</td>
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<td>12 1N3889</td>
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<tr>
<td>12 1N3890</td>
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<tr>
<td>12 1N3891</td>
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<td>12 1N3892</td>
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<td>14 1N3899</td>
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<td>30 1N3911</td>
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**Fast types**

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*With avalanche characteristics*
## REGULATOR DIODES

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<th>Suppression stand-off voltage</th>
<th>REGULATOR SERVICE</th>
<th>SUPPRESSOR SERVICE</th>
<th>PRSM max</th>
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<td>700 W</td>
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<td>4.7 V</td>
<td>3.6 V</td>
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<td>3.9 V</td>
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<td>4.3 V</td>
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<td>4.7 V</td>
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<td>6.8 V</td>
<td>5.1 V</td>
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<td>5.6 V</td>
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<td>6.2 V</td>
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<td>6.8 V</td>
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<td>7.5 V</td>
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<td>8.2 V</td>
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<td>11 V</td>
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<td>16 V</td>
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<tr>
<td>82 V</td>
<td>62 V</td>
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</table>

Outline | Polarity | DO-1 | SOD-18 | DO-1 | SOD-38 | SOD-18 | DO-4 | DO-5 | DO-30 | DO-5 | DO-5
--------|----------|------|--------|------|--------|--------|------|------|-------|------|------
        | normal   | normal | normal | both | normal | both | both | both | both | both | both

### Transient suppressor bridges

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<th>Type No.</th>
<th>$V_I$</th>
<th>$V_O(\text{CL})$</th>
<th>$I(\text{CL})\text{SM}$</th>
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<tbody>
<tr>
<td>BZW10-12</td>
<td>12</td>
<td>30</td>
<td>50</td>
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<tr>
<td>BZW10-15</td>
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<td>34</td>
<td>40</td>
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---

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

---

January 1980
## HIGH-VOLTAGE RECTIFIER STACKS

<table>
<thead>
<tr>
<th>Type No.</th>
<th>$I_{F(AV)}$ max.</th>
<th>$V_{RWM}$ max.</th>
<th>Configuration</th>
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<tbody>
<tr>
<td>OSS9110–3 to –30</td>
<td>3.5 A (6 A in oil)</td>
<td>3 kV to 30 kV</td>
<td><img src="image1" alt="Diagram" /></td>
</tr>
<tr>
<td>OSS9210–3 to –30</td>
<td>5 A (20 A in oil)</td>
<td>3 kV to 30 kV</td>
<td><img src="image2" alt="Diagram" /></td>
</tr>
<tr>
<td>OSS9310–3 to –30</td>
<td>4 A (12 A in oil)</td>
<td>3 kV to 30 kV</td>
<td><img src="image3" alt="Diagram" /></td>
</tr>
<tr>
<td>OSS9410–3 to –30</td>
<td>10 A (30 A in oil)</td>
<td>3 kV to 30 kV</td>
<td><img src="image4" alt="Diagram" /></td>
</tr>
<tr>
<td>OSM9110–4 to –30</td>
<td>7 A (12 A in oil)</td>
<td>2 kV to 15 kV</td>
<td><img src="image5" alt="Diagram" /></td>
</tr>
<tr>
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<td>10 A (40 A in oil)</td>
<td>2 kV to 15 kV</td>
<td><img src="image6" alt="Diagram" /></td>
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<tr>
<td>OSM9310–4 to –30</td>
<td>4 A (12 A in oil)</td>
<td>2 kV to 15 kV</td>
<td><img src="image7" alt="Diagram" /></td>
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<tr>
<td>OSM9410–4 to –30</td>
<td>20 A (60 A in oil)</td>
<td>2 kV to 15 kV</td>
<td><img src="image8" alt="Diagram" /></td>
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<tr>
<td>OSM9510–8 to –12</td>
<td>1.5 A</td>
<td>8 kV to 12 kV</td>
<td><img src="image9" alt="Diagram" /></td>
</tr>
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</table>
### General purpose thyristors

| \( |T_{(RMS)}|_{\text{max}} \) | \( V_{RRM_{\text{max}}} \) (V) |
|---|---|
| 1.6 | BTX18 |
| 12  | BT151 |
| 16  | BTY79 |
| 16  | BTW38 |
| 16  | BTW42 |
| 20  | BT152 |
| 25  | BTW45 |
| 25  | BTW47 |
| 25  | BTY87 |
| 25  | BTY91 |
| 32  | BTW40 |
| 32  | BTW92 |
| 55  | BTW24 |
| 140 | BTW23 |

### Fast turn-off thyristors

| \( |T_{(RMS)}|_{\text{max}} \) | \( V_{DRM_{\text{max}}} \) (V) |
|---|---|
| 6  | BT153 |
| 8  | BT154 |
| 24 | BTW30S |
| 31 | BTW31W |
| 110| BTW33 |

Thyristor tetrode BRY39T: \( V_{RRM_{\text{max}}} = 70 \text{ V} \); \( |T_{\text{max}}| = 250 \text{ mA} \)

Bi-directional trigger device BR100/03: \( V_{(BO)} = 28 \text{ to } 36 \text{ V} \); \( |F_{RM_{\text{max}}}| = 2 \text{ A} \)
<table>
<thead>
<tr>
<th>A</th>
<th>400</th>
<th>500</th>
<th>600</th>
<th>800</th>
<th>1000</th>
<th>1200</th>
<th>1400</th>
<th>1600</th>
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<tbody>
<tr>
<td>4</td>
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<tr>
<td>25</td>
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<td></td>
</tr>
<tr>
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<td>BTW34H</td>
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</tbody>
</table>
GENERAL SECTION

Type Designation
Rating Systems
Letter Symbols
Quality Conformance and Reliability
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.

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 ($R_{thj-mb} > 15$ °C/W)
D. TRANSISTOR; power, audio frequency ($R_{thj-mb} \leq 15$ °C/W)
E. DIODE; tunnel
F. TRANSISTOR; low power, high frequency ($R_{thj-mb} > 15$ °C/W)
G. MULTIPLE OF DISSIMILAR DEVICES — MISCELLANEOUS; e.g. oscillator
H. DIODE; magnetic sensitive
L. TRANSISTOR; power, high frequency ($R_{thj-mb} \leq 15$ °C/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 ($R_{thj-mb} > 15$ °C/W)
S. TRANSISTOR; low power, switching ($R_{thj-mb} > 15$ °C/W)
T. CONTROL AND SWITCHING DEVICE; e.g. thyristor, power ($R_{thj-mb} \leq 15$ °C/W)
U. TRANSISTOR; power, switching ($R_{thj-mb} \leq 15$ °C/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.

BTW24-800R  Silicon thyristor in the BTW24 range with 800 V maximum repetitive peak voltage, reverse polarity, stud connected to anode.

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

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 AND TRIACS

LETTER SYMBOLS FOR CURRENTS, VOLTAGES AND POWERS

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

\[ I, i = \text{current} \quad V, v = \text{voltage} \quad P, p = \text{power} \]

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

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

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

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

Simplified thyristor characteristic together with an anode-cathode voltage as a function of time (no gate signal).
QUALITY CONFORMANCE AND RELIABILITY

In addition to 100% testing of all major device parameters in 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 methods used and standards applied are compatible with CECC, BS and IEC rules and procedures, and many products are available to BS9300 and CECC 50000 series detail specifications.

High reliability products, which have had special inspections and ‘burn-in’, are also available.
RECTIFIER DIODES
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 \(n^+\) 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 \(T_{J\text{ max}}\) 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 conditions which need to be specified are:

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

Fig. 2 Waveforms showing the reverse switching losses aspects.
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; $T_j = 150 \, ^\circ C$. 

4 December 1979
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.
MOUNTING CONSIDERATIONS FOR STUD-MOUNTED DIODES

Losses generated in a silicon device must flow through the case and to a lesser extent the leads. The greatest proportion of the losses flow out through the case into a heat exchanger which can be either free convection cooled, forced convection or even liquid cooled. For the majority of devices in our range natural convection is generally adequate, however, where other considerations such as space saving must be taken into account then methods such as forced convection etc. can be considered. The thermal path from junction to ambient may be considered as a number of resistances in series. The first thermal resistance will be that of junction to mounting base, usually denoted by $R_{th \ j-mb}$. The second is the contact thermal resistance $R_{th \ mb-h}$ and finally there is the thermal resistance of the heatsink $R_{th \ h-a}$.

In the rating curves, the contact thermal resistance and heatsink thermal resistances are combined as a single figure $R_{th \ mb-a}$.

In addition to the steady state thermal conditions of the system, consideration should also be given to the possibility of any transient thermal excursions. These can be caused for example by starting conditions or overloads and in order to calculate the effect on the device, a graph of transient thermal resistance $Z_{th \ j-mb}$ as a function of time is given in each data sheet.

![Thermal Resistance Diagram]

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.
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>( \frac{200I_{\text{imag}}}{V_1} )</td>
<td>( \frac{225I_{\text{imag}}T^2}{V_1} )</td>
</tr>
<tr>
<td>1.5</td>
<td>( \frac{400I_{\text{imag}}}{V_1} )</td>
<td>( \frac{450I_{\text{imag}}T^2}{V_1} )</td>
</tr>
<tr>
<td>1.25</td>
<td>( \frac{550I_{\text{imag}}}{V_1} )</td>
<td>( \frac{620I_{\text{imag}}T^2}{V_1} )</td>
</tr>
<tr>
<td>1.0</td>
<td>( \frac{800I_{\text{imag}}}{V_1} )</td>
<td>( \frac{900I_{\text{imag}}T^2}{V_1} )</td>
</tr>
</tbody>
</table>

where \( I_{\text{imag}} \) = 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)  
\( T = \frac{V_1}{V_2} \) 
\( \frac{V_{RSM}}{V_{RWM}} \) = the transient voltage peak produced by the transformer  
\( V_{RWM} \) = the actually applied crest working reverse voltage

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

\(^1\) For controlled avalanche types read: non-repetitive peak reverse power.
SILICON BRIDGE RECTIFIER

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

QUICK REFERENCE DATA

<table>
<thead>
<tr>
<th>Input</th>
<th></th>
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</thead>
<tbody>
<tr>
<td>R.M.S. voltage</td>
<td>$V_{I(RMS)}$ max. 60 V</td>
</tr>
<tr>
<td>Repetitive peak voltage</td>
<td>$V_{IRM}$ max. 120 V</td>
</tr>
<tr>
<td>Non-repetitive peak current</td>
<td>$I_{ISM}$ max. 25 A</td>
</tr>
<tr>
<td>Average current</td>
<td>$I_{O(AV)}$ max. 1.2 A</td>
</tr>
</tbody>
</table>

MECHANICAL DATA

Dimensions in mm

Fig. 1 SOD-28

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

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

## Input

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Symbol</th>
<th>Max. Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>R.M.S. voltage</td>
<td>$V_{i\text{(RMS)}}$</td>
<td>60 V</td>
</tr>
<tr>
<td>Crest working voltage</td>
<td>$V_{i\text{WM}}$</td>
<td>85 V</td>
</tr>
<tr>
<td>Repetitive peak voltage</td>
<td>$V_{i\text{RM}}$</td>
<td>120 V</td>
</tr>
<tr>
<td>Non-repetitive peak voltage; $t \leq 10$ ms</td>
<td>$V_{i\text{SM}}$</td>
<td>120 V</td>
</tr>
<tr>
<td>Non-repetitive peak current (see also Fig. 8)</td>
<td>$I_{i\text{SM}}$</td>
<td>25 A</td>
</tr>
</tbody>
</table>

## Output

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Symbol</th>
<th>Max. Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Average current with C load</td>
<td>$I_{O\text{(AV)}}$</td>
<td>1.2 A</td>
</tr>
<tr>
<td>Average current with R and L load (see also Fig. 5)</td>
<td>$I_{O\text{RM}}$</td>
<td>5 A</td>
</tr>
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</table>

## Temperatures

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Symbol</th>
<th>Range</th>
</tr>
</thead>
<tbody>
<tr>
<td>Storage temperature</td>
<td>$T_{stg}$</td>
<td>-55 to +125 °C</td>
</tr>
<tr>
<td>Junction temperature</td>
<td>$T_{j}$</td>
<td>max. 150 °C</td>
</tr>
</tbody>
</table>
THERMAL RESISTANCE

Influence of mounting method

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.

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

2. Mounted on printed-wiring board at $a = \text{maximum lead-length}$. $R_{th j-a} = 50$ °C/W

3. Mounted on printed-wiring board at a lead-length $a = 5$ mm. $R_{th j-a} = 55$ °C/W

4. Mounted on printed-wiring board at a lead-length $a = 1.5$ mm. $R_{th j-a} = 60$ °C/W
   (distance $-a-$ includes printed-wiring board thickness)

MOUNTING INSTRUCTIONS

1. The maximum permissible temperature of the soldering iron or bath is 270 °C; it must not be in contact with the joint for more than 3 seconds.

2. 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.

3. Exert no axial pull when bending.

CHARACTERISTICS

Forward voltage (2 diodes in series)

$V_F < 2.2 \text{ V}^*$

*Measured under pulse conditions to avoid excessive dissipation.
From the left-hand graph the total power dissipation can be found as a function of the average output current.

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

See Application Book: RECTIFIER DIODES.

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

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

\( R_{diff} \) is shown in Fig.4.
Example: Rectifier with C load

- Forward current versus maximum forward voltage of the assembly (two diodes in series)
  - $I_{\text{diff}} = \cot \theta = 0.17 \Omega$
- Maximum permissible average output current for $R$ and $L$ load
  - $V_{\text{RMS}} \leq 42 \text{V}$
  - $V_{\text{RMS}} \leq 60 \text{V}$

Fig. 4

Fig. 5

Fig. 6
The graph takes the possibility of the following spreads into account:
- mains voltage, +10%
- capacitance, +30%
- resistance, -10%

Each current pulse is followed by the crest working reverse voltage.

Maximum permissible non-repetitive peak input current based on sinusoidal currents (f = 50 Hz).
SILICON BRIDGE RECTIFIER

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

QUICK REFERENCE DATA

<table>
<thead>
<tr>
<th>Input</th>
<th>Symbol</th>
<th>Parameter</th>
<th>Unit</th>
</tr>
</thead>
<tbody>
<tr>
<td>R.M.S. voltage</td>
<td>$V_{I(RMS)}$</td>
<td>max.</td>
<td>280 V</td>
</tr>
<tr>
<td>Repetitive peak voltage</td>
<td>$V_{IRM}$</td>
<td>max.</td>
<td>800 V</td>
</tr>
<tr>
<td>Non-repetitive peak current</td>
<td>$I_{ISM}$</td>
<td>max.</td>
<td>25 A</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Output</th>
<th>Symbol</th>
<th>Parameter</th>
<th>Unit</th>
</tr>
</thead>
<tbody>
<tr>
<td>Average current</td>
<td>$I_{O(AV)}$</td>
<td>max.</td>
<td>1 A</td>
</tr>
</tbody>
</table>

MECHANICAL DATA

Dimensions in mm

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

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

## Input

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Symbol</th>
<th>Max Value</th>
<th>Unit</th>
</tr>
</thead>
<tbody>
<tr>
<td>R.M.S. voltage</td>
<td>$V_{I(RMS)}$</td>
<td>280</td>
<td>V</td>
</tr>
<tr>
<td>Crest working voltage</td>
<td>$V_{IWM}$</td>
<td>400</td>
<td>V</td>
</tr>
<tr>
<td>Repetitive peak voltage</td>
<td>$V_{IRM}$</td>
<td>800</td>
<td>V</td>
</tr>
<tr>
<td>Non repetitive peak voltage; $t \leq 10$ ms</td>
<td>$V_{ISM}$</td>
<td>800</td>
<td>V</td>
</tr>
<tr>
<td>Non repetitive peak current (see also Fig.8)</td>
<td>$I_{ISM}$</td>
<td>25</td>
<td>A</td>
</tr>
</tbody>
</table>

## Output

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Symbol</th>
<th>Max Value</th>
<th>Unit</th>
</tr>
</thead>
<tbody>
<tr>
<td>Average current with C load</td>
<td>$I_{O(AV)}$</td>
<td>1</td>
<td>A</td>
</tr>
<tr>
<td>Average current with R and L load up to $T_{amb} = 40$ °C (see also Fig.5)</td>
<td>$I_{ORM}$</td>
<td>5</td>
<td>A</td>
</tr>
<tr>
<td>Repetitive peak current</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

## Temperatures

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Symbol</th>
<th>Range</th>
<th>Unit</th>
</tr>
</thead>
<tbody>
<tr>
<td>Storage temperature</td>
<td>$T_{stg}$</td>
<td>-55 to +125</td>
<td>°C</td>
</tr>
<tr>
<td>Junction temperature</td>
<td>$T_{j}$</td>
<td>125</td>
<td>°C</td>
</tr>
</tbody>
</table>
THERMAL RESISTANCE

Influence of mounting method

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.

1. Mounted to solder tags at a lead-length $a > 5$ mm. $R_{th \ j-a} = 40 \ 0C/W$

2. Mounted on printed-wiring board at a = maximum lead-length. $R_{th \ j-a} = 50 \ 0C/W$

3. Mounted on printed-wiring board at a lead-length $a = 5$ mm. $R_{th \ j-a} = 55 \ 0C/W$

4. Mounted on printed-wiring board at a lead length $a = 1.5$ mm. $R_{th \ j-a} = 60 \ 0C/W$

   (distance -a- includes printed-wiring board thickness)

MOUNTING INSTRUCTIONS

1. The maximum permissible temperature of the soldering iron or bath is 270 $0C$; it must not be in contact with the joint for more than 3 seconds.

2. 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 $0C$.

3. Exert no axial pull when bending.

CHARACTERISTICS

Forward voltage (2 diodes in series)

$I_F = 2 \ A; T_j = 25 \ 0C$

$V_F < 2.2 \ V^*$

*Measured under pulse conditions to avoid excessive dissipation.
From the left-hand graph the total power dissipation can be found as a function of the average output current.

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

See Application Book: RECTIFIER DIODES

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

For the series resistance, added to limit the initial peak rectifier current, the required minimum value can be found from Fig.7.

\( R_{diff} \) is shown in Fig.4.
Example: Rectifier with C load

- Mounting method 1 (see page 3)
- Maximum permissible average output current for R and L load
- \( V_{(RMS)} \) up to 280V

**Figure 4**: Forward current versus maximum forward voltage of the assembly (two diodes in series)

**Figure 5**: Mounting method 1 (see page 3) - Maximum permissible average output current for R and L load

**Figure 6**: Example: Rectifier with C load

- Max permissible average output current for the circuit shown
- \( V_0, I_0 \) characteristics for the circuit shown
required minimum value of $R_t$

$R_t$ includes the transformer resistance

the graph takes the possibility of the following spreads into account:
mains voltage, $+10\%$
capacitance, $+30\%$
resistance, $-10\%$

Fig. 7

maximum permissible non repetitive peak input current based on sinusoidal currents ($f = 50\text{Hz}$)

each current pulse is followed by the crest working reverse voltage

$T = 125^\circ\text{C}(\text{prior to surge})$
PARALLEL-EFFICIENCY AND ENERGY-RECOVERY DIODE

Silicon double-diffused rectifier diode in a plastic envelope, intended for use as efficiency diode in transistornised horizontal deflection circuits of colour television receivers, and as an energy-recovery diode in thyristor commutation circuits such as 3-phase a.c. motor speed control inverters.

QUICK REFERENCE DATA

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Symbol</th>
<th>Maximum</th>
<th>Unit</th>
</tr>
</thead>
<tbody>
<tr>
<td>Repetitive peak reverse voltage</td>
<td>$V_{RRM}$</td>
<td>1500</td>
<td>V</td>
</tr>
<tr>
<td>Average forward current</td>
<td>$I_{F(AV)}$</td>
<td>4.5</td>
<td>A</td>
</tr>
<tr>
<td>Working peak forward current</td>
<td>$I_{FWM}$</td>
<td>5</td>
<td>A</td>
</tr>
<tr>
<td>Repetitive peak forward current (t_p = 100 μs)</td>
<td>$I_{FRM}$</td>
<td>200</td>
<td>A</td>
</tr>
<tr>
<td>Reverse recovery time</td>
<td>$t_{rr}$</td>
<td>&lt; 1.0</td>
<td>μs</td>
</tr>
</tbody>
</table>

MECHANICAL DATA

Fig.1 SOD-38

Dimensions in mm

Polarity of connections: tag 1 = anode, tag 2 = cathode

The exposed metal base-plate is directly connected to tag 1

Net mass: 2.5 g

Accessories:
supplied with the device: washer 56355
available on request: 56316 (mica insulating washer)

Torque on screw: min. 0.95 Nm (9.5 kg cm)
max. 1.5 Nm (15 kg cm)

December 1979
RATINGS
Limiting values in accordance with the Absolute Maximum System (IEC 134)

Voltages
Transient rating (subsequent to flashover) \( V_{RM \text{(flashover)}} \) max. 1650 V
Non-repetitive peak reverse voltage \( t \leq 10 \text{ ms} \) \( V_{RSM} \) max. 1500 V
Repetitive peak reverse voltage \( V_{RRM} \) max. 1500 V
Working reverse voltage* \( V_{RW} \) max. 1500 V
Continuous reverse voltage \( V_R \) max. 800 V

Currents
Average forward current (averaged over any 20 ms period) \( I_{F \text{(AV)}} \) max. 4.5 A
R.M.S. forward current \( I_{F \text{(RMS)}} \) max. 10 A
Working peak forward current (see Fig.8) \( I_{FWM} \) max. 5 A
Repetitive peak forward current \( t_p = 100 \mu\text{s} \) \( I_{FRM} \) max. 200 A
Repetitive peak forward current \( I_{FRM} \) max. 10 A
Non-repetitive peak forward current \( t = 10 \text{ ms; half-sinewave} \) \( T_j = 125 \, ^\circ\text{C} \) prior to surge \( I_{FSM} \) max. 20 A

Temperatures
Storage temperature \( T_{stg} \) from -40 to +125 \, ^\circ\text{C}
Junction temperature \( T_j \) max. 125 \, ^\circ\text{C}

THERMAL RESISTANCE
From junction to mounting base \( R_{th j-mb} \) = 4.5 \, ^\circ\text{C/W}
Transient thermal impedance; \( t = 1 \text{ ms} \) \( Z_{th j-mb} \) = 0.3 \, ^\circ\text{C/W}

Influence of mounting method
1. Heatsink mounted
   From mounting base to heatsink
   a. with heatsink compound \( R_{th mb-h} \) = 1.5 \, ^\circ\text{C/W}
   b. with heatsink compound and 56316 mica washer \( R_{th mb-h} \) = 2.7 \, ^\circ\text{C/W}
   c. without heatsink compound \( R_{th mb-h} \) = 2.7 \, ^\circ\text{C/W}
   d. without heatsink compound; with 56316 mica washer \( R_{th mb-h} \) = 5 \, ^\circ\text{C/W}

* At \( t_p \leq 20 \mu\text{s} ; \delta = t_p/T \leq 0.25 \); see Fig.8.
THERMAL RESISTANCE (continued)

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-points.

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

- a. $> 1 \, \text{cm}^2$  
  $R_{\text{th} \ j-a} = 50 \, ^\circ\text{C/W}$
  $R_{\text{th} \ j-a} = 55 \, ^\circ\text{C/W}$

- b. $< 1 \, \text{cm}^2$

At a lead length $a = 3 \, \text{mm}$ and with a copper laminate

- c. $> 1 \, \text{cm}^2$  
  $R_{\text{th} \ j-a} = 55 \, ^\circ\text{C}$
  $R_{\text{th} \ j-a} = 60 \, ^\circ\text{C}$

- d. $< 1 \, \text{cm}^2$

SOLDERING AND MOUNTING NOTES

1. Soldered joints must be at least 2.5 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. The device should not be immersed in oil, and few potting resins are suitable for re-encapsulation. Advice on these materials is available on request.
4. Leads should not be bent less than 2.5 mm from the seal. Exert no axial pull when bending.
5. For good thermal contact, heatsink compound should be used between base-plate and heatsink.

December 1979
CHARACTERISTICS

Forward voltage
\[ I_F = 20 \, \text{A}; \, T_j = 25 \, ^\circ\text{C} \]
\[ V_F < 2.3 \, \text{V}^* \]

Reverse current
\[ V_R = V_{RW \, \text{max}}; \, T_j = 125 \, ^\circ\text{C} \]
\[ I_R < 0.6 \, \text{mA} \]

Reverse recovery when switched from
\[ I_{FWM} = 4 \, \text{A}; \, -\frac{\text{d}I_F}{\text{d}t} = 0.2 \, \text{A/\mu}s; \, T_j = 125 \, ^\circ\text{C} \]
\[ t_{\text{tot}} < 20 \, \mu\text{s} \]

\[ I_F = 2 \, \text{A}; \, -\frac{\text{d}I_F}{\text{d}t} = 20 \, \text{A/\mu}s; \, T_j = 125 \, ^\circ\text{C} \]
\[ t_{\text{fr}} < 1.0 \, \mu\text{s} \]

Forward recovery time
when switched to \( I_{FRM} = 5 \, \text{A} \) with \( t_r = 0.1 \, \mu\text{s} \);
\( T_j = 125 \, ^\circ\text{C} \)
\[ t_{\text{fr}} < 1.0 \, \mu\text{s} \]

* Measured under pulse conditions to avoid excessive dissipation.
Fig. 4 Interrelationship between the power dissipation (based on the waveforms shown in Fig. 8) and the maximum permissible temperatures.

$P = \text{power dissipation including switching losses.}$
Fig. 5 The right-hand part shows the interrelationship between the power dissipation (derived from the left-hand part) and the maximum permissible temperatures. 

$P =$ power dissipation including switching losses.

$a =$ form factor $= \frac{I_F(RMS)}{I_F(AV)}$
Parallel-efficiency and energy-recovery diode

Fig. 6

Fig. 7

December 1979
APPLICATION INFORMATION

I_F

V_R

IFRM

IFWM

t_{tot}

t_p

T

E.H.T.

horizontal deflection transistor

BY223

C_T

C_S

+VS

Fig.8 Basic circuit and waveforms
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>max. 220</td>
<td>280 V</td>
</tr>
<tr>
<td>Repetitive peak voltage</td>
<td>max. 400</td>
<td>600 V</td>
</tr>
<tr>
<td>Non-repetitive peak current</td>
<td>max. 100 A</td>
<td></td>
</tr>
<tr>
<td>Peak inrush current</td>
<td>max. 200 A</td>
<td></td>
</tr>
<tr>
<td>Output</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Average current</td>
<td>max. 4.8 A</td>
<td></td>
</tr>
</tbody>
</table>

MECHANICAL DATA (see also Fig. 1a)

Dimensions in mm

Fig. 1 SOT-112.

Net mass: 6.8 g

Accessories supplied on request: 56366 (clip); for mounting instructions see data 56366.

The sealing of the plastic withstands the accelerated damp heat test of IEC recommendation 68-2 (test D, severity IV, 6 cycles).
A version with cranked pins (as shown in figure 1a) is available on request.

**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 ($t \leq 10$ ms)</td>
<td>$V_{ISM}$ max. 400</td>
<td>600 V</td>
</tr>
<tr>
<td>Repetitive peak voltage</td>
<td>$V_{IRM}$ max. 400</td>
<td>600 V</td>
</tr>
<tr>
<td>Crest working voltage</td>
<td>$V_{IWM}$ max. 350</td>
<td>400 V</td>
</tr>
<tr>
<td>R.M.S. voltage (sine-wave)</td>
<td>$V_{I(RMS)}$ max. 220</td>
<td>280 V</td>
</tr>
<tr>
<td>Non-repetitive peak current</td>
<td>$I_{ISM}$ max. 100 A</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>$I_{ISM}$ max. 85 A</td>
<td></td>
</tr>
<tr>
<td>$T_j = 150$ °C prior to surge</td>
<td>$I_{IIM}$ max. 200 A</td>
<td></td>
</tr>
<tr>
<td>Peak inrush current (see Fig. 6)</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

| Output                                          |            |     |
| Average current (averaged over any 20 ms period; see Figs 2 and 3) | $I_{O(AV)}$ max. 4,8 A |
| heatsink operation up to $T_{mb} = 90$ °C        |            |     |
| free-air operation at $T_{amb} = 45$ °C; (mounting method 1a) | $I_{O(AV)}$ max. 2,5 A |
| Repetitive peak current                         | $I_{ORM}$ max. 50 A |

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

December 1979
THERMAL RESISTANCE

From junction to mounting base

\[ R_{th\,j\,-\,mb} = 4,0 \, ^\circ\text{C/W} \]

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

\[ R_{th\,j\,-\,a} = 19,5 \, ^\circ\text{C/W} \]

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

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

2. Heatsink mounted with clip (see mounting instructions)

Thermal resistance from mounting base to heatsink

a. With zinc-oxide heatsink compound

\[ R_{th\,mb\,-\,h} = 1,0 \, ^\circ\text{C/W} \]

b. Without heatsink compound

\[ R_{th\,mb\,-\,h} = 2,0 \, ^\circ\text{C/W} \]

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 °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)

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

\[ V_F < 2,3 \, \text{V}^* \]

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 ($f = 50$ Hz); $T_j = 150^\circ C$ prior to surge; with reapplied $V_{IWM_{max}}$. 

Fig. 5 2 diodes in series, $V_F$ (V) vs. $I_F$ (A) for $T_j = 25^\circ C$ and $T_j = 150^\circ C$.
The graph takes the possibility of the following spreads into account:
mains voltage  +10%
capacitance  +50%
resistance  -10%

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

(1) External capacitor.

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

Fig. 8

CAPACITIVE LOAD

I_{D(AV)} (A)

0 5 10

overload time (min)

0 5 10 15

mounting method:

1a

1b

T_{amb} = 35 °C

T_{amb} = 65 °C

Dec 1979
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_{\text{RMS}} ) max. 50</td>
<td>80 V</td>
</tr>
<tr>
<td>Repetitive peak voltage</td>
<td>( V_{\text{RM}} ) max. 100</td>
<td>200 V</td>
</tr>
<tr>
<td>Non-repetitive peak current</td>
<td>( I_{\text{ISM}} ) max. 100</td>
<td>A</td>
</tr>
<tr>
<td>Peak inrush current</td>
<td>( I_{\text{IIM}} ) max. 200</td>
<td>A</td>
</tr>
</tbody>
</table>

Output

| Average current | \( I_{\text{O(AV)}} \) max. 4.8 | A |

MECHANICAL DATA

Dimensions in mm

Fig. 1 SOT-112.

Net mass: 6.8 g

Accessories supplied on request: 56366 (clip); for mounting instructions see data 56366.

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

January 1980
### RATINGS

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

#### Input

<table>
<thead>
<tr>
<th></th>
<th>BY225-100</th>
<th>200</th>
</tr>
</thead>
<tbody>
<tr>
<td>Non-repetitive peak voltage (t ≤ 10 ms)</td>
<td>V_{ISM}</td>
<td>max. 100</td>
</tr>
<tr>
<td>Repetitive peak voltage</td>
<td>V_{IRM}</td>
<td>max. 100</td>
</tr>
<tr>
<td>Crest working voltage</td>
<td>V_{IWM}</td>
<td>max. 70</td>
</tr>
<tr>
<td>R.M.S. voltage (sine-wave)</td>
<td>V_{I(RMS)}</td>
<td>max. 50</td>
</tr>
<tr>
<td>Non-repetitive peak current; half sine-wave; t = 20 ms; with reapplied V_{IWMmax}</td>
<td>I_{ISM}</td>
<td>max. 100 A</td>
</tr>
<tr>
<td>T_j = 25 °C prior to surge</td>
<td>I_{ISM}</td>
<td>max. 85 A</td>
</tr>
<tr>
<td>T_j = 150 °C prior to surge</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)
- heatsink operation up to T_{mb} = 115 °C | I_{O(AV)} | max. 4,8 A |
- heatsink operation at T_{mb} = 125 °C | I_{O(AV)} | max. 3,6 A |
- free-air operation at T_{amb} = 45 °C; (mounting method 1a) | I_{O(AV)} | max. 3,2 A |

Repetitive peak current | I_{ORM} | max. 50 A |

#### Temperatures

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

From junction to mounting base

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

Influence of mounting method

1. Free-air operation

The quoted values of \( R_{\text{thj-a}} \) 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

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

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

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

2. Heatsink mounted with clip (see mounting instructions)

Thermal resistance from mounting base to heatsink

a. With zinc-oxide heatsink compound

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

b. Without heatsink compound

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

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 °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)

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

Reverse current (2 diodes in parallel)

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

* 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 $a_0 = I_{O(RMS)}/I_{O(AV)} = 0.707 \times I_{F(RMS)}/I_{F(AV)}$ per diode.
Fig. 3 The right-hand part shows the interrelationship between the power (derived from the left-hand graph) and the maximum permissible temperatures.

Output form factor $a_o = \frac{I_{O(RMS)}}{I_{O(AV)}} = 0.707 \times \frac{I_{F(RMS)}}{I_{F(AV)}}$ per diode.
Fig. 4. Maximum permissible non-repetitive r.m.s. input current based on sinusoidal currents (f = 50 Hz); $T_j = 150$ °C prior to surge; with reapplied $V_{W/M\text{max}}$.

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.
FAST SOFT-RECOVERY RECTIFIER DIODES

Glass-passivated double-diffused rectifier diodes in plastic envelopes, featuring fast reverse recovery times and non-snap-off characteristics. They are intended for use in chopper applications as well as in switched-mode power supplies, as efficiency diodes and scan rectifiers in television receivers. The series consists of normal polarity (cathode to mounting base) types.

QUICK REFERENCE DATA

<table>
<thead>
<tr>
<th>Repetitive peak reverse voltage</th>
<th>$V_{RRM}$</th>
<th>BY229—200</th>
<th>400</th>
<th>600</th>
<th>800</th>
</tr>
</thead>
<tbody>
<tr>
<td>Average forward current</td>
<td>$I_{F(AV)}$</td>
<td>max.</td>
<td>7</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Non-repetitive peak forward current</td>
<td>$I_{FSM}$</td>
<td>max.</td>
<td>60</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Reverse recovery time</td>
<td>$t_{rr}$</td>
<td>&lt;</td>
<td>450</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

MECHANICAL DATA

Fig. 1 SOD—59 (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.

July 1979
RATINGS
Limiting values in accordance with the Absolute Maximum System (IEC 134)

**Voltages***

<table>
<thead>
<tr>
<th>Voltage Type</th>
<th>Symbol</th>
<th>BY229-200</th>
<th>400</th>
<th>600</th>
<th>800</th>
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</thead>
<tbody>
<tr>
<td>Non-repetitive peak reverse voltage</td>
<td>$V_{RSM}$</td>
<td>max.</td>
<td>200</td>
<td>400</td>
<td>600</td>
</tr>
<tr>
<td>Repetitive peak reverse voltage</td>
<td>$V_{RRM}$</td>
<td>max.</td>
<td>200</td>
<td>400</td>
<td>600</td>
</tr>
<tr>
<td>Crest working reverse voltage</td>
<td>$V_{RWM}$</td>
<td>max.</td>
<td>150</td>
<td>300</td>
<td>500</td>
</tr>
<tr>
<td>Continuous reverse voltage</td>
<td>$V_R$</td>
<td>max.</td>
<td>150</td>
<td>300</td>
<td>500</td>
</tr>
</tbody>
</table>

**Currents**

Average forward current assuming zero switching losses:
- Square-wave; $\delta = 0.5$; up to $T_{mb} = 100 \, ^\circ C$
  $$I_{F(AV)} \text{ max.} = 7 \, A$$
- Square-wave; $\delta = 0.5$; at $T_{mb} = 125 \, ^\circ C$
  $$I_{F(AV)} \text{ max.} = 4.1 \, A$$
- Sinusoidal; up to $T_{mb} = 101 \, ^\circ C$
  $$I_{F(AV)} \text{ max.} = 6.5 \, A$$
- Sinusoidal; at $T_{mb} = 125 \, ^\circ C$
  $$I_{F(AV)} \text{ max.} = 4 \, A$$

- R.M.S. forward current
  $$I_{F(RMS)} \text{ max.} = 10 \, A$$
- Repetitive peak forward current
  $$I_{FRM} \text{ max.} = 60 \, A$$
- Repetitive peak forward current
  $$I_{FRM} \text{ max.} = 75 \, A$$
  $t_p = 20 \, \mu s; \delta \leq 0.02$
- Non-repetitive peak forward current; $t = 10 \, ms$
  Half sine-wave; $T_j = 150 \, ^\circ C$ prior to surge; with reapplied $V_{RWM_{max}}$
  $$I_{FSM} \text{ max.} = 60 \, A$$

**Temperatures**

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

*To ensure thermal stability: $R_{th \, j-a} \leq 15 \, ^\circ C/W$ for continuous reverse voltage.
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 $a = $ any lead length.
   $$R_{th\ j-a} = 60 \degree C/W$$

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.

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. The device should not be pop-riveted to the heatsink. However, it is permissible to press-rivet providing that 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.
CHARACTERISTICS

Forward voltage
\[ I_F = 20 \text{ A}; \ T_j = 25 \degree \text{C} \]
\[ V_F < 1.85 \ \text{V}^* \]

Reverse current
\[ V_R = V_{\text{VRWMmax}}; \ T_j = 125 \degree \text{C} \]
\[ I_R < 0.4 \ \text{mA} \]

Reverse recovery when switched from
\[ I_F = 2 \text{ A to } V_R \geq 30 \text{ V with } -dI_F/dt = 20 \text{ A/\mu s}; \ T_j = 25 \degree \text{C} \]
Recovered charge
\[ Q_S < 0.7 \ \text{\mu C} \]
Recovery time
\[ t_{rr} < 450 \ \text{ns} \]

Maximum slope of the reverse recovery current
\[ I_F = 2 \text{ A}; -dI_F/dt = 20 \text{ A/\mu s} \]
\[ |dI_R/dt| < 60 \ \text{A/\mu s} \]

*Measured under pulse conditions to avoid excessive dissipation.
**SQUARE-WAVE OPERATION**

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

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

\[ I_{F(AV)} = I_{F(RMS)} \times \sqrt{\delta} \]
Fig. 5 The right-hand part shows the interrelationship between the power (derived from the left-hand part) and the maximum permissible temperatures.

P = power including reverse current losses but excluding switching losses.
a = form factor = $I_F(RMS)/I_F(AV)$. 
Fast soft-recovery rectifier diodes

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

Fig. 7 \( T_j = 25 \text{ °C} \); \( T_j = 125 \text{ °C} \)
Fig. 8 NOMOGRAM

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

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

**Fig. 9**

**Fig. 10**

$T_J = 25^\circ C$

$T_J = 150^\circ C$

$max \ values$

$max \ values$

$I_F = 10A$

$I_F = 10A$

$100$

$I_R$

$Q_s$

$Q_s$

$\frac{dI_F}{dt}$ (A/μs)
Fig. 11

Fig. 12

Fig. 13
Fig. 14 Simplified circuit diagram of practical apparatus to test softness of recovery.

NOTES
1. Duty factor of forward current should be low, <2%.
2. $dI_F/dt$ is set by $L_1$, 1.5 $\mu$H gives 20 A/µs
3. $dI_R/dt$ is measured across $L_2$, 200 nH gives 5A/µs/V.
4. Wiring shown in heavy should be kept as short as possible.
SILICON BRIDGE RECTIFIER

Ready-for-use full-wave bridge rectifier in a plastic encapsulation. The bridge is intended for use in equipment supplied from a.c. with r.m.s. voltages up to 80 V and is capable of delivering output currents up to 1.5 A.

QUICK REFERENCE DATA

<table>
<thead>
<tr>
<th>Input</th>
<th></th>
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</thead>
<tbody>
<tr>
<td>R.M.S. voltage</td>
<td>( V_{I(RMS)} ) max. 80 V</td>
</tr>
<tr>
<td>Repetitive peak voltage</td>
<td>( V_{IRM} ) max. 200 V</td>
</tr>
<tr>
<td>Non-repetitive peak current</td>
<td>( I_{ISM} ) max. 50 A</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Output</th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>Average current</td>
<td>( I_{O(AV)} ) max. 1.5 A</td>
</tr>
</tbody>
</table>

MECHANICAL DATA

Fig.1 SOD–28

Dimensions in mm

The sealing of the plastic envelope withstands the accelerated damp heat test of IEC recommendation 68–2 (test D, severity IV, 6 cycles).
RATINGS
Limiting values in accordance with the Absolute Maximum System (IEC 134)

Input
Non-repetitive peak voltage (t \leq 10 \text{ ms})
Repetitive peak voltage
Crest working voltage
R.M.S. voltage (sine-wave)
Non-repetitive peak current;
  half sine-wave; t = 20 \text{ ms}; with reapplied V_{IWMmax}
  T_j = 150^\circ C prior to surge

Output
Average current (averaged over any 20 \text{ ms period});
  see Fig.3)
  free-air operation at T_{\text{amb}} = 45^\circ C;
  (mounting method a)
Repetitive peak current

Temperatures
Storage temperature
Junction temperature

\begin{align*}
  V_{ISM} & \quad \text{max.} \quad 200 \quad \text{V} \\
  V_{IRM} & \quad \text{max.} \quad 200 \quad \text{V} \\
  V_{IWM} & \quad \text{max.} \quad 112 \quad \text{V} \\
  V_{I(RMS)} & \quad \text{max.} \quad 80 \quad \text{V} \\
  I_{ISM} & \quad \text{max.} \quad 50 \quad \text{A} \\
  I_{O(AV)} & \quad \text{max.} \quad 1.5 \quad \text{A} \\
  I_{ORM} & \quad \text{max.} \quad 10 \quad \text{A} \\
  T_{stg} & \quad -55 \text{ to } +150 \quad ^\circ \text{C} \\
  T_j & \quad \text{max.} \quad 150 \quad ^\circ \text{C}
\end{align*}
THERMAL RESISTANCE

Influence of mounting method

1. Free-air operation

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

Thermal resistance from junction to ambient in free air

a. Mounted on a printed-circuit board with 4 cm$^2$ of copper laminate to $+ \text{ and } -$ leads

$$R_{th \ j-a} = 38 \ \degree C/W$$

b. Mounted on a printed-circuit board with minimal copper laminate; 1.5 mm lead length

$$R_{th \ j-a} = 52 \ \degree C/W$$

c. Mounted on a printed-circuit board with minimal copper laminate; maximum lead length

$$R_{th \ j-a} = 44 \ \degree C/W$$

MOUNTING INSTRUCTIONS

1. The maximum permissible temperature of the soldering iron or bath is 270 $\degree$C; it must not be in contact with the joint for more than 3 seconds.

2. 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 $\degree$C

3. Exert no axial pull when bending.

CHARACTERISTICS

Forward voltage (2 diodes in series)

$I_F = 2 \ A; T_j = 25 \degree C$

$$V_F < 2.1 \ V^*$$

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

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

The thermal resistance between envelope and tie-point and between envelope and ambient depend on lead length:

<table>
<thead>
<tr>
<th>Lead length</th>
<th>1.5</th>
<th>5</th>
<th>10</th>
<th>15</th>
<th>Max.</th>
<th>mm</th>
</tr>
</thead>
<tbody>
<tr>
<td>$R_{th \text{ e-tp}}$</td>
<td>1.2</td>
<td>4</td>
<td>8</td>
<td>12</td>
<td>15.2</td>
<td>°C/W</td>
</tr>
<tr>
<td>$R_{th \text{ e-a}}$</td>
<td>110</td>
<td>87</td>
<td>73</td>
<td>65</td>
<td>60</td>
<td>°C/W</td>
</tr>
</tbody>
</table>

The thermal resistance between tie-point and ambient depends on the mounting method; for mounting on a 1.5 mm thick epoxy-glass printed-circuit board with a copper-thickness $\geq$ 40 µm, the following values apply:

1. Mounting with minimal copper laminate: $R_{th \text{ tp-a}} = 70$ °C/W
2. Mounted on a printed-circuit board with a copper laminate to the + and - lead of:
   - $1 \text{ cm}^2$: $R_{th \text{ tp-a}} = 55$ °C/W
   - $2.25 \text{ cm}^2$: $R_{th \text{ tp-a}} = 45$ °C/W
   - $4 \text{ cm}^2$: $R_{th \text{ tp-a}} = 40$ °C/W

Note: Any temperature can be calculated by using the dissipation graphs and the above thermal model.
Fig. 3 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. 4  Maximum permissible non-repetitive peak input current based on sinusoidal currents ($f = 50 \text{ Hz}$); $T_j = 150 \text{ }^\circ\text{C}$ prior to surge; with reapplied $V_{\text{RWMmax}}$.

Fig. 5  $T_j = 25 \text{ }^\circ\text{C}$; $T_j = 150 \text{ }^\circ\text{C}$; 2 diodes in series.
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.
SILICON BRIDGE RECTIFIER

Ready-for-use full-wave bridge rectifier in a plastic encapsulation. The bridge is intended for use in equipment supplied from mains with r.m.s. voltages up to 280 V and is capable of delivering output currents up to 1.5 A.

QUICK REFERENCE DATA

<table>
<thead>
<tr>
<th>Input</th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>R.M.S. voltage</td>
<td>$V_{I(RMS)}$ max. 280 V</td>
</tr>
<tr>
<td>Repetitive peak voltage</td>
<td>$V_{IRM}$ max. 600 V</td>
</tr>
<tr>
<td>Non-repetitive peak current</td>
<td>$I_{ISM}$ max. 50 A</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Output</th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>Average current</td>
<td>$I_{OA(V)}$ max. 1.5 A</td>
</tr>
</tbody>
</table>

MECHANICAL DATA

Fig. 1 SOD—28

Dimensions in mm

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

December 1979
RATINGS
Limiting values in accordance with the Absolute Maximum System (IEC 134)

Input
Non-repetitive peak voltage (t ≤ 10 ms)  \( V_{IM} \) max. 600 V
Repetitive peak voltage  \( V_{RM} \) max. 600 V
Crest working voltage  \( V_{IWM} \) max. 400 V
R.M.S. voltage (sine-wave)  \( V_{I(RMS)} \) max. 280 V
Non-repetitive peak current;* half sine-wave; \( t = 20 \) ms; with reapplied \( V_{IWM} \) max  \( I_{ISM} \) max. 50 A

Output
Average current (averaged over any 20 ms period; see Fig.3) free-air operation at \( T_{amb} = 45 \) °C;  \( I_{O(AV)} \) max. 1.5 A
Repetitive peak current  \( I_{ORM} \) max. 10 A

Temperatures
Storage temperature  \( T_{stg} \) –55 to +150 °C
Junction temperature  \( T_{j} \) max. 150 °C
THERMAL RESISTANCE

Influence of mounting method

1. Free-air operation

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

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

$$R_{th\ j-a} = 38 \degree C/W$$

b. Mounted on a printed-circuit board with minimal copper laminate; 1.5 mm lead length

$$R_{th\ j-a} = 52 \degree C/W$$

c. Mounted on a printed-circuit board with minimal copper laminate; maximum lead length

$$R_{th\ j-a} = 44 \degree C/W$$

MOUNTING INSTRUCTIONS

1. The maximum permissible temperature of the soldering iron or bath is 270 $\degree$C; it must not be in contact with the joint for more than 3 seconds.

2. 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 $\degree$C.

3. Exert no axial pull when bending.

CHARACTERISTICS

Forward voltage (2 diodes in series)

$|F| = 2 A; T_j = 25 \degree C$

$$V_F < 2.1 \text{ V}^*$$

*Measured under pulse conditions to avoid excessive dissipation.
OPERATING NOTES
The various components of junction temperature rise above ambient are illustrated below.

![Thermal Resistance Diagram](image)

The thermal resistance between envelope and tie-point and between envelope and ambient depend on lead length:

<table>
<thead>
<tr>
<th>lead length</th>
<th>1.5</th>
<th>5</th>
<th>10</th>
<th>15</th>
<th>max.</th>
<th>mm</th>
</tr>
</thead>
<tbody>
<tr>
<td>$R_{th e-tp}$</td>
<td>1.2</td>
<td>4</td>
<td>8</td>
<td>12</td>
<td>15.2</td>
<td>60 °C/W</td>
</tr>
<tr>
<td>$R_{th e-a}$</td>
<td>110</td>
<td>87</td>
<td>73</td>
<td>65</td>
<td>60</td>
<td>60 °C/W</td>
</tr>
</tbody>
</table>

The thermal resistance between tie-point and ambient depends on the mounting method. For mounting on a 1.5 mm thick epoxy-glass printed-circuit board with a copper-thickness $\geq 40 \mu m$, the following values apply:

1. Mounting with minimal copper laminate: $R_{th tp-a} = 70 \degree C/W$
2. Mounted on a printed-circuit board with a copper laminate to the $+$ and $-$ lead of:
   - $1 \text{ cm}^2$: $R_{th tp-a} = 55 \degree C/W$
   - $2.25 \text{ cm}^2$: $R_{th tp-a} = 45 \degree C/W$
   - $4 \text{ cm}^2$: $R_{th tp-a} = 40 \degree C/W$

Note: Any temperature can be calculated by using the dissipation graphs and the above thermal model.
FREE-AIR OPERATION

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

Output form factor $a_o = \frac{I_o(RMS)}{I_o(AV)} = 0.707 \times \frac{I_F(RMS)}{I_F(AV)}$ per diode.
Fig. 4 Maximum permissible non-repetitive peak input current based on sinusoidal currents (f = 50 Hz); $T_j = 150$ °C prior to surge; with reapplied $V_{IWM\text{max}}$.

Fig. 5 — $T_j = 25$ °C; — — $T_j = 150$ °C; 2 diodes in series.
The graph takes the possibility of the following spreads into account:

- Input voltage: +10%
- Capacitance: +50%
- Resistance: -10%

Fig. 6 Minimum value of the total series resistance \( R_{tot} \) (including the transformer resistance) required to limit the peak inrush current.
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 equipments 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_I(RMS)</td>
<td>max.</td>
<td>140</td>
</tr>
<tr>
<td>Repetitive peak voltage</td>
<td>V_IRM</td>
<td>max.</td>
<td>200</td>
</tr>
<tr>
<td>Non-repetitive peak current</td>
<td>IISM</td>
<td>max.</td>
<td>125</td>
</tr>
<tr>
<td>Peak inrush current</td>
<td>I_IIM</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 ≤ 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 $V_{IWM_{max}}$
  - $T_j = 25 \degree C$ prior to surge
  - $T_j = 150 \degree C$ prior to surge

Peak inrush current (see Fig. 5)

Output
Average current (averaged over any 20 ms period)
  - heatsink operation up to $T_{mb} = 60 \degree C$ (R-load)
  - heatsink operation up to $T_{mb} = 60 \degree C$ (C-load)

Repetitive peak current

Temperatures
Storage temperature $T_{stg} = -55 \text{ to } +150 \degree C$
Junction temperature $T_j$ max. $150 \degree C$

**THERMAL RESISTANCE**
From junction to mounting base $R_{th \ j-mb} = 4.5 \degree C/W$

**CHARACTERISTICS**
Forward voltage (2 diodes in series)
  - $I_F = 7 \ A; T_j = 25 \degree C$
  - $V_F < 2.0 \ V^*$
Reverse current (2 diodes in parallel)
  - $V_R = V_{IWM_{max}}; T_j = 100 \degree C$
  - $I_R < 150 \ \mu A$

*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 temperatures.
Fig. 3 Maximum permissible non-repetitive r.m.s. input current based on sinusoidal currents (f = 50 Hz); Tj = 150 °C prior to surge, with reapplied VWMmax.

Fig. 4 Two diodes in series; Tj = 25 °C; --- Tj = 150 °C
Silicon bridge rectifiers

BY260 SERIES

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

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

Fig. 5 Minimum value of the total series resistance $R_{\text{tot}}$ (including the transformer resistance) required to limit the peak inrush current.
SILICON BRIDGE RECTIFIERS

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

QUICK REFERENCE DATA

<table>
<thead>
<tr>
<th>Input</th>
<th>BY261-200</th>
<th>400</th>
<th>600</th>
</tr>
</thead>
<tbody>
<tr>
<td>R.M.S. voltage</td>
<td>V_{I(RMS)}</td>
<td>max.</td>
<td>140</td>
</tr>
<tr>
<td>Repetitive peak voltage</td>
<td>V_{IRM}</td>
<td>max.</td>
<td>200</td>
</tr>
<tr>
<td>Non-repetitive peak current</td>
<td>I_{ISM}</td>
<td>max.</td>
<td>320</td>
</tr>
<tr>
<td>Peak inrush current</td>
<td>I_{IIM}</td>
<td>max.</td>
<td>640</td>
</tr>
</tbody>
</table>

Output
Average current
| I_{O(AV)} | max. | 25 | A  |

MECHANICAL DATA

Fig. 1

Dimensions in mm

D8458

September 1979
RATINGS
Limiting values in accordance with the Absolute Maximum System (IEC134).

<table>
<thead>
<tr>
<th>Input</th>
<th>BY261—200</th>
<th>400</th>
<th>600</th>
</tr>
</thead>
<tbody>
<tr>
<td>Non-repetitive peak voltage (t ≤ 10 ms)</td>
<td>V_{ISM}</td>
<td>max.</td>
<td>200</td>
</tr>
<tr>
<td>Repetitive peak voltage</td>
<td>V_{IRM}</td>
<td>max.</td>
<td>200</td>
</tr>
<tr>
<td>Crest working voltage</td>
<td>V_{IWM}</td>
<td>max.</td>
<td>200</td>
</tr>
<tr>
<td>R.M.S. voltage (sine-wave)</td>
<td>V_{I(RMS)}</td>
<td>max.</td>
<td>140</td>
</tr>
</tbody>
</table>

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

\[ T_j = 25 \, ^\circ C \text{ prior to surge} \]
\[ T_j = 150 \, ^\circ C \text{ prior to surge} \]

Peak inrush current (see Fig. 5)

\[ I_{IIM} \text{ max.} = 640 \, A \]

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

\[ I_{O(AV)} \text{ max.} = 25 \, A \]
\[ I_{O(AV)} \text{ max.} = 18 \, A \]

Repetitive peak current

\[ I_{ORM} \text{ max.} = 75 \, A \]

Temperatures
Storage temperature

\[ T_{stg} \text{ max.} = -55 \text{ to } +175 \, ^\circ C \]

Junction temperature

\[ T_j \text{ max.} = 175 \, ^\circ C \]

THERMAL RESISTANCE
From junction to mounting base

\[ R_{th j-mb} = 2.5 \, ^\circ C/W \]

CHARACTERISTICS
Forward voltage (2 diodes in series)

\[ I_F = 12 \, A; \, T_j = 25 \, ^\circ C \]

\[ V_F < 2.3 \, V \]

Reverse current (2 diodes in parallel)

\[ V_R = V_{IWM\text{max}}; \, T_j = 100 \, ^\circ C \]

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

*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 temperatures.
Fig. 3 Maximum permissible non-repetitive r.m.s. input current based on sinusoidal currents ($f = 50$ Hz); $T_j = 150$ °C prior to surge; with reapplied $V_{IWM\text{max}}$.

Fig. 4 Two diodes in series; $T_j = 25$ °C; $T_j = 150$ °C
The graph takes the possibility of the following spreads into account:

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

Fig. 5 Minimum value of the total series resistance $R_{\text{tot}}$ (including the transformer resistance) required to limit the peak inrush current.
PARALLEL EFFICIENCY DIODES

Silicon double-diffused rectifier diodes in plastic envelopes, intended for use as efficiency diode in thyristor horizontal deflection circuits of colour television receivers. The devices feature low forward recovery voltage and non-snap-off characteristics which makes them particularly suitable for this application.

### QUICK REFERENCE DATA

<table>
<thead>
<tr>
<th>Parameter</th>
<th>BY277-600R</th>
<th>750R</th>
</tr>
</thead>
<tbody>
<tr>
<td>Repetitive peak reverse voltage</td>
<td>V_{RRM} max.</td>
<td>600 V</td>
</tr>
<tr>
<td>Working peak forward current</td>
<td>( I_{FWM} ) max.</td>
<td>10 A</td>
</tr>
<tr>
<td>Repetitive peak forward current</td>
<td>( I_{FRM} ) max.</td>
<td>20 A</td>
</tr>
<tr>
<td>Reverse recovery time</td>
<td>( t_{rr} ) &lt;</td>
<td>400 ns</td>
</tr>
</tbody>
</table>

### MECHANICAL DATA (see also page 2)

Dimensions in mm

SOD-38

Polarity of connections: tag 1 = anode, tag 2 = cathode.

The exposed metal base-plate is directly connected to tag 1.
MECHANICAL DATA (continued)

Net mass: 2.5 g

Recommended diameter of fixing screw: 3.5 mm

Torque on screw:
  when using washer and heatsink compound: min. 0.95 Nm (9.5 kg cm)
  max. 1.5 Nm (15 kg cm)

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

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

<table>
<thead>
<tr>
<th>Voltages</th>
<th>BY277-600R</th>
<th>750R</th>
</tr>
</thead>
<tbody>
<tr>
<td>Non-repetitive peak reverse voltage</td>
<td>V_RSM max.</td>
<td>600</td>
</tr>
<tr>
<td>Repetitive peak reverse voltage (δ ≤ 0.01)</td>
<td>V_RRM max.</td>
<td>600</td>
</tr>
<tr>
<td>Working reverse voltage ¹)</td>
<td>V_RW max.</td>
<td>500</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Currents</th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>R.M.S. forward current</td>
<td>I_F(RMS) max.</td>
<td>3 A</td>
</tr>
<tr>
<td>Working peak forward current up to T_{mb} = 112 °C</td>
<td>I_F(WM) max.</td>
<td>10 A</td>
</tr>
<tr>
<td>Repetitive peak forward current</td>
<td>I_FRM max.</td>
<td>20 A</td>
</tr>
<tr>
<td>Non-repetitive peak forward current</td>
<td>I_FSM max.</td>
<td>50 A</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 +125 °C</td>
</tr>
<tr>
<td>Junction temperature</td>
<td>T_j</td>
<td>max. 125 °C</td>
</tr>
</tbody>
</table>

¹) At t_p ≤ 20 μs; δ = t_p/T ≤ 0.25; see page 9.
THERMAL RESISTANCE

From junction to mounting base

Transient thermal impedance (t = 1 ms)

\[ R_{th \ j-mb} = 4.5 \, ^\circ C/W \]
\[ Z_{th \ j-mb} = 0.3 \, ^\circ C/W \]

Influence of mounting method

1. Heatsink mounted

From mounting base to heatsink

a. with heatsink compound
b. with heatsink compound and 56316 mica washer
c. without heatsink compound
d. without heatsink compound;
   with 56316 mica washer

\[ R_{th \ mb-h} = 1.5 \, ^\circ C/W \]
\[ R_{th \ mb-h} = 2.7 \, ^\circ C/W \]
\[ R_{th \ mb-h} = 2.7 \, ^\circ C/W \]
\[ R_{th \ mb-h} = 5 \, ^\circ C/W \]

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-points.

From junction to ambient in free air mounted on a printed-circuit board

at \( a = \) maximum lead length
and with a copper laminate

a. > 1 cm\(^2\)

\[ R_{th \ j-a} = 50 \, ^\circ C/W \]
\[ R_{th \ j-a} = 55 \, ^\circ C/W \]

b. < 1 cm\(^2\)

\[ R_{th \ j-a} = 55 \, ^\circ C \]
\[ R_{th \ j-a} = 60 \, ^\circ C \]

at a lead length \( a = 3 \) mm
and with a copper laminate

c. > 1 cm\(^2\)

\[ R_{th \ j-a} = 55 \, ^\circ C \]

April 1977
CHARACTERISTICS

Forward voltage
\[ I_F = 10 \, \text{A}; \, T_j = 25 \, ^\circ\text{C} \]
\[ V_F \quad < \quad 1.4 \, \text{V} \quad \text{1)} \]

Reverse current
\[ V_R = V_{RW_{\text{max}}}; \, T_j = 100 \, ^\circ\text{C} \]
\[ I_R \quad < \quad 0.2 \, \text{mA} \]

Reverse recovery when switched from
\[ I_F = 2 \, \text{A} \, \text{to} \, V_R \geq 30 \, \text{V}; \]
\[ -\frac{dI_F}{dt} = 20 \, \text{A/\mu s}; \, T_j = 25 \, ^\circ\text{C} \]
\[ Q_s \quad < \quad 0.9 \, \text{\mu C} \]

Recovery time
\[ t_{rr} \quad < \quad 400 \, \text{ns} \]

Maximum slope of the reverse recovery current
(in horizontal deflection circuits)
when switched from
\[ I_F = 5 \, \text{A} \, \text{to} \, V_R \geq 30 \, \text{V}; \, \text{with} \]
\[ -\frac{dI_F}{dt} = 1 \, \text{A/\mu s}; \, T_j = 25 \, ^\circ\text{C} \]
\[ |\frac{dI_R}{dt}| \quad < \quad 2 \, \text{A/\mu s} \]

1) Measured under pulse conditions to avoid excessive dissipation.
CHARACTERISTICS (continued)

Forward recovery when switched to

$I_F = 1 A; T_j = 25 \, ^\circ C$

Recovery time
Recovery voltage

$t_{fr} < 0.3 \, \mu s$
$V_{fr} < 13 \, V$

$I_F = 20 mA; T_j = 25 \, ^\circ C$

Recovery time
Recovery voltage

$t_{fr} < 0.3 \, \mu s$
$V_{fr} < 5 \, V$
MOUNTING INSTRUCTIONS

1. Soldered joints must be at least 2.5 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. The devices should not be immersed in oil, and few potting resins are suitable for re-encapsulation. Advice on these materials is available on request.

4. Leads should not be bent less than 2.5 mm from the seal. Exert no axial pull when bending.

5. For good thermal contact heatsink compound should be used between base-plate and heatsink.

OPERATING NOTES

Dissipation and heatsink considerations:

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

```
   junction
   +---------------------+       +---------------------+
   |                      |       |                      |
   |                      |       |                      |
   Rth_j_mb = 4.5 °C/W   +---------------------+   Rth_j-a
   |                      |       |                      |
   |                      |       |                      |
   +---------------------+       +---------------------+
      mounting base      heatsink      ambient
   +---------------------+       +---------------------+
   | Rth_mb-h             |       | Rth_h-a              |
   +---------------------+       +---------------------+
   |                      |       |                      |
   |                      |       |                      |
   +---------------------+       +---------------------+
```

b. The method of using the graph on page 7 is as follows:
Starting with the required current on the $I_{FWM}$ axis, trace upwards to meet the appropriate 625/819-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:

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

Any measurement of heatsink temperature should be made immediately adjacent to the device.
$P_{tot} = \text{power dissipation including switching losses}$

The interrelation between the dissipation (derived from the left-hand graph) and the maximum permissible temperatures.

Graph 1:
- $I_{FWM}$ (A) vs $P_{tot}$ (W)
- $T_{amb}$ (°C)

Graph 2:
- $I_F$ (A) vs $V_F$ (V)
- $T_j = 25\, ^\circ C$
- $T_j = 125\, ^\circ C$
Thermal resistance $R_{thh-a}$ from aluminium heatsink to ambient (free air) versus heatsink surface (one side). 1, 2 and 3 are thicknesses in mm, a is for a bright surface, b is for a black surface.
APPLICATION INFORMATION

Parallel efficiency diodes

BY277 SERIES

Basic circuit and waveforms
SCHOTTKY-BARRIER RECTIFIER DIODES

High-efficiency 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 low conduction and switching losses are important. The series consists of normal polarity (cathode to stud) types: BYV21–30, BYV21–35, BYV21–40 and BYV21–45.

QUICK REFERENCE DATA

<table>
<thead>
<tr>
<th>Repetitive peak reverse voltage $V_{RRM}$ max.</th>
<th>BYV21–30</th>
<th>35</th>
<th>40</th>
<th>45 V</th>
</tr>
</thead>
<tbody>
<tr>
<td>Average forward current $I_{F(AV)}$ max.</td>
<td>28 A</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Forward voltage $V_F$</td>
<td>0.55 V</td>
<td></td>
<td></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.

Net mass: 7 g
Diameter of clearance hole: 5.2 mm
Accessories supplied on request: 56295
(PTFE bush, 2 mica washers, plain washer, tag).
Supplied with device: 1 nut, 1 lock washer.
Nut dimensions across the flats: M5, 8.0 mm
10–32 UNF, 9.5 mm

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

January 1980
RATINGS

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

<table>
<thead>
<tr>
<th>Voltagess</th>
<th>BYV21-30</th>
<th>35</th>
<th>40</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>
<td>48</td>
</tr>
<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</td>
<td>$V_{RWM}$ max.</td>
<td>30</td>
<td>35</td>
<td>40</td>
</tr>
<tr>
<td>Continuous reverse voltage**</td>
<td>$V_R$ max.</td>
<td>30</td>
<td>35</td>
<td>40</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Currents</th>
</tr>
</thead>
<tbody>
<tr>
<td>Average forward current; switching losses negligible</td>
</tr>
<tr>
<td>sinusoidal; up to $T_{mb} = 100$ °C</td>
</tr>
<tr>
<td>square-wave; up to $T_{mb} = 100$ °C; $\delta = 0.5$</td>
</tr>
<tr>
<td>$I_{F(AV)}$ max.</td>
</tr>
<tr>
<td>$I_{F(RMS)}$ max.</td>
</tr>
<tr>
<td>Non-repetitive peak forward current</td>
</tr>
<tr>
<td>$t = 10$ ms; half sine-wave; $T_j = 125$ °C prior to surge; with reapplied $V_{RWM}_{max}$</td>
</tr>
<tr>
<td>$I_{FSM}$ max.</td>
</tr>
<tr>
<td>$I^2t$ for fusing</td>
</tr>
<tr>
<td>$T_{stg}$</td>
</tr>
<tr>
<td>$T_j$ max.</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Temperatures</th>
</tr>
</thead>
<tbody>
<tr>
<td>Storage temperature</td>
</tr>
<tr>
<td>Junction temperature; with full applied continuous reverse voltage $V_{Rmax}$</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>THERMAL RESISTANCE</th>
</tr>
</thead>
<tbody>
<tr>
<td>From junction to mounting base</td>
</tr>
<tr>
<td>$R_{th j-mb}$</td>
</tr>
<tr>
<td>From mounting base to heatsink</td>
</tr>
<tr>
<td>with heatsink compound</td>
</tr>
<tr>
<td>without heatsink compound</td>
</tr>
<tr>
<td>$R_{th mb-h}$</td>
</tr>
<tr>
<td>$R_{th mb-h}$</td>
</tr>
<tr>
<td>Transient thermal impedance; $t = 1$ ms</td>
</tr>
<tr>
<td>$Z_{th j-mb}$</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>MOUNTING INSTRUCTIONS</th>
</tr>
</thead>
<tbody>
<tr>
<td>The top connector should be neither bent nor twisted; it should be soldered into the circuit so that there is no strain on it.</td>
</tr>
<tr>
<td>During soldering the heat conduction to the junction should be kept to a minimum.</td>
</tr>
</tbody>
</table>

* For $t_p = 200$ ns a 20% increase in $V_{RRM}$ is allowed.

** To ensure thermal stability: $R_{th j-a} < 2$ °C/W
Schottky-barrier rectifier diodes

BYV21 SERIES

CHARACTERISTICS

Forward voltage

\[ I_F = 30 \text{ A; } T_j = 100 \text{ °C} \]
\[ I_F = 80 \text{ A; } T_j = 25 \text{ °C} \]

\[ V_F < 0.55 \text{ V}^* \]
\[ V_F < 0.88 \text{ V}^* \]

Rate of rise of reverse voltage

\[ V_R = V_{RWM_{max}} \]
\[ \frac{dV_R}{dt} < 1500 \text{ V/\mu s} \]

Reverse current

\[ V_R = V_{RWM_{max}}; \ T_j = 125 \text{ °C} \]

\[ I_R < 150 \text{ mA} \]

Capacitance at \( f = 1 \text{ MHz} \)

\[ V_R = 5 \text{ V; } T_j = 25 \text{ to } 125 \text{ °C} \]

\[ C_d \text{ typ. } 900 \text{ pF} \]

*Measured under pulse conditions to avoid excessive dissipation.
Fig. 2 The right-hand part shows the interrelationship between the power (derived from the left-hand part) and the maximum permissible temperatures.

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

\[ T_{mb^*} \text{ scale is for comparison purpose and is correct only for } R_{th \ mb-a} \leq 6.4 \, ^\circ\text{C/W.} \]
Fig. 3 The right-hand part shows the interrelationship between the power (derived from the left-hand part) and the maximum permissible temperatures.

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

*The \( T_{\text{mb}} \) scale is for comparison purpose and is correct only for \( R_{\text{th \ mb-a}} < 6.4 \, \text{°C/W} \).
Fig. 4 Maximum permissible non-repetitive r.m.s. forward current based on sinusoidal currents (f = 50 Hz); \( T_j = 125 \, ^\circ\text{C} \) prior to surge; with reapplied \( V_{RWMmax} \).

Fig. 5 ——— \( T_j = 25 \, ^\circ\text{C} \); — — \( T_j = 100 \, ^\circ\text{C} \).
Schottky-barrier rectifier diodes

Fig. 6  f = 1 MHz; T_j = 25 to 125 °C

Fig. 7  Z_{th j-mb} (°C/W)
VERY FAST SOFT-RECOVERY RECTIFIER DIODES

High-efficiency rectifier diodes in DO-4 metal envelopes, featuring low forward voltage drop, high reverse voltage capability, very fast reverse recovery times and non-snap-off characteristics. They are intended for use in switched-mode power supplies and high-frequency inverter circuits, in general, where high output voltages and low conduction and switching losses are essential. The series consists of the following types:

Normal polarity (cathode to stud): BYV30-200, BYV30-300 and BYV30-400.
Reverse polarity (anode to stud): BYV30-200R, BYV30-300R, and BYV30-400R.

QUICK REFERENCE DATA

<table>
<thead>
<tr>
<th>Repetitive peak reverse voltage</th>
<th>BYV30-200(R)</th>
<th>300(R)</th>
<th>400(R)</th>
</tr>
</thead>
<tbody>
<tr>
<td>V_{RRM} max.</td>
<td>200</td>
<td>300</td>
<td>400</td>
</tr>
<tr>
<td>Average forward current</td>
<td>I_F(AV) max.</td>
<td>12</td>
<td>A</td>
</tr>
<tr>
<td>Forward voltage</td>
<td>V_F &lt; 1.05</td>
<td>V</td>
<td></td>
</tr>
<tr>
<td>Reverse recovery time</td>
<td>t_{rr} &lt; 100 ns</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

MECHANICAL DATA

Fig.1 DO-4

Dimensions in mm

Net mass: 6 g
Diameter of clearance hole: max. 5.2 mm
Accessories supplied on request:
56295 (PTFE bush, 2 mica washers, plain washer, tag).
Supplied with device: 1 nut, 1 lock washer.
Nut dimensions across the flats: 9.5 mm
Torque on nut:
min. 0.9 Nm (9 kg cm),
max. 1.7 Nm (17 kg cm)
The mark shown applies to the normal polarity types.

September 1979
RATINGS

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

Voltages

<table>
<thead>
<tr>
<th></th>
<th>BYV30-200(R)</th>
<th>300(R)</th>
<th>400(R)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Non-repetitive peak reverse voltage</td>
<td>V_{RSM}</td>
<td>max. 250</td>
<td>350</td>
</tr>
<tr>
<td>Repetitive peak reverse voltage</td>
<td>V_{RRM}</td>
<td>max. 200</td>
<td>300</td>
</tr>
<tr>
<td>Crest working reverse voltage</td>
<td>V_{RWM}</td>
<td>max. 200</td>
<td>300</td>
</tr>
</tbody>
</table>

Currents

Average forward current assuming zero switching losses (averaged over any 20 ms period)

<table>
<thead>
<tr>
<th></th>
<th>BYV30-200(R)</th>
<th>300(R)</th>
<th>400(R)</th>
</tr>
</thead>
<tbody>
<tr>
<td>up to T_{mb} = 100 °C</td>
<td>I_{F(AV)}</td>
<td>max. 12</td>
<td>A</td>
</tr>
<tr>
<td>at T_{mb} = 125 °C</td>
<td>I_{F(AV)}</td>
<td>max. 7</td>
<td>A</td>
</tr>
<tr>
<td>R.M.S. forward current</td>
<td>I_{F(RMS)}</td>
<td>max. 20</td>
<td>A</td>
</tr>
<tr>
<td>Repetitive peak forward current</td>
<td>I_{FRM}</td>
<td>max. 140</td>
<td>A</td>
</tr>
<tr>
<td>Non-repetitive peak forward current</td>
<td>I_{FSM}</td>
<td>max. 140</td>
<td>A</td>
</tr>
<tr>
<td>T_{j} = 150 °C prior to surge; half sine-wave with reapplied V_{RWM,max}; t = 10 ms</td>
<td>I_{FSM}</td>
<td>max. 140</td>
<td>A</td>
</tr>
<tr>
<td>t = 8.3 ms</td>
<td>I_{FSM}</td>
<td>max. 150</td>
<td>A</td>
</tr>
<tr>
<td>I^2t for fusing (t = 10 ms)</td>
<td>I_{FSM}</td>
<td>max. 100</td>
<td>A^2s</td>
</tr>
</tbody>
</table>

Temperatures

Storage temperature

<p>| | |</p>
<table>
<thead>
<tr>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>T_{stg}</td>
<td>−65 to +175 °C</td>
</tr>
</tbody>
</table>

Operating junction temperature

<p>| | |</p>
<table>
<thead>
<tr>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>T_{j}</td>
<td>max. 150 °C</td>
</tr>
</tbody>
</table>

THERMAL RESISTANCE

<p>| | |</p>
<table>
<thead>
<tr>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>From junction to ambient in free air</td>
<td>R_{th j-a}</td>
</tr>
<tr>
<td>From junction to mounting base</td>
<td>R_{th j-mb}</td>
</tr>
<tr>
<td>From mounting base to heatsink</td>
<td>R_{th mb-h}</td>
</tr>
<tr>
<td>Transient thermal impedance; t = 1 ms</td>
<td>Z_{th j-mb}</td>
</tr>
</tbody>
</table>
Very fast soft-recovery rectifier diodes

BYV30 SERIES

CHARACTERISTICS

Forward voltage

IF = 10 A; Tj = 25 °C
V_F < 1.35 V*

IF = 10 A; Tj = 150 °C
V_F < 1.05 V*

Reverse current

V_R = V_RWMmax; Tj = 125 °C
I_R < 3 mA

Reverse recovery when switched from

IF = 1 A to V_R = 30 V;
−dIF/dt = 35 A/μs; Tj = 25 °C
Recovery time

I_R < 100 ns

IF = 2 A to V_R = 30 V;
−dIF/dt = 20 A/μs; Tj = 25 °C
Recovery charge

Q_s < 125 nC

IF = 1 A to V_R = 30 V;
−dIF/dt = 2 A/μs; Tj = 25 °C
Max. slope of the reverse recovery current

|dI_R/dt| < 5 A/μs

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

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

Fig. 4

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

with reapplied \( V_{RWMmax} \)

\( T_j = 150 \, ^\circ C \) (prior to surge)
Very fast soft-recovery rectifier diodes

Fig. 5

Fig. 6 Maximum values; $T_j = 150 \, ^\circ\text{C}$.

Fig. 7

$Z_{th\ j-mb}$

$Z_{th\ j-mb}$

$\delta = 1$

$\delta = 0$
VERY FAST SOFT-RECOVERY DIODES

High-efficiency rectifier diodes in DO-5 metal envelopes, featuring low forward voltage drop, high reverse voltage capability, very fast reverse recovery times and non-snap-off characteristics. They are intended for use in switched-mode power supplies and high-frequency inverter circuits, in general, where high output voltages and low conduction and switching losses are essential.

The series consists of the following types:
Normal polarity (cathode to stud): BYV92–200, BYV92–300 and BYV92–400.
Reverse polarity (anode to stud): BYV92–200R, BYV92–300R and BYV92–400R.

QUICK REFERENCE DATA

<table>
<thead>
<tr>
<th></th>
<th>BYV92–200(R)</th>
<th>300(R)</th>
<th>400(R)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Repetitive peak reverse voltage</td>
<td>V_{RRM} \text{ max.}</td>
<td>200</td>
<td>300</td>
</tr>
<tr>
<td>Average forward current</td>
<td>I_{F(AV)} \text{ max.}</td>
<td>35</td>
<td></td>
</tr>
<tr>
<td>Forward voltage</td>
<td>V_F &lt;</td>
<td>1.05</td>
<td></td>
</tr>
<tr>
<td>Reverse recovery time</td>
<td>t_{rr} &lt;</td>
<td>100</td>
<td>ns</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:
56264A (mica washer, insulating ring, tag)

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

December 1979
RATINGS
Limiting values in accordance with the Absolute Maximum System (IEC 134)

Voltages*

<table>
<thead>
<tr>
<th>Voltage Type</th>
<th>Symbol</th>
<th>BYV92–200(R)</th>
<th>300(R)</th>
<th>400(R)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Non-repetitive peak reverse voltage</td>
<td>$V_{RSM}$ max.</td>
<td>200</td>
<td>300</td>
<td>400</td>
</tr>
<tr>
<td>Repetitive peak reverse voltage</td>
<td>$V_{RRM}$ max.</td>
<td>200</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>
<td>400</td>
</tr>
<tr>
<td>Continuous reverse voltage</td>
<td>$V_R$ max.</td>
<td>200</td>
<td>300</td>
<td>400</td>
</tr>
</tbody>
</table>

Currents

- Average forward current assuming zero switching losses:
  - sinusoidal; up to $T_{mb} = 100$ °C
  - sinusoidal; at $T_{mb} = 125$ °C
  - square wave; $\delta = 0.5$; up to $T_{mb} = 95$ °C
  - square wave; $\delta = 0.5$; at $T_{mb} = 125$ °C

  - R.M.S. forward current
  - Repetitive peak forward current
  - Non-repetitive peak forward current
    - $t = 10$ ms; half sine-wave; $T_j = 150$ °C prior to surge; with re-applied $V_{RWM\text{max}}$
    - $I^2t$ for fusing ($t = 10$ ms)

- Transient thermal impedance; $t = 1$ ms

Temperatures

- Storage temperatures
- Junction temperature

THERMAL RESISTANCE

- From junction to mounting base
- From mounting base to heatsink
  - with heatsink compound
  - without heatsink compound
- Transient thermal impedance; $t = 1$ ms

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: $R_{th\ j-a} \leq 6$ °C/W (continuous reverse voltage) up to $T_{amb} = 110$ °C
Very fast soft-recovery rectifier diodes

CHARACTERISTICS

Forward voltage

\[ I_F = 100 \text{ A; } T_j = 25 ^\circ \text{C} \]
\[ I_F = 35 \text{ A; } T_j = 100 ^\circ \text{C} \]

\[ V_F < 1.4 \text{ V}^* \]
\[ V_F < 1.05 \text{ V}^* \]

Reverse current

\[ V_R = V_{RWM_{\text{max}}}; T_j = 100 ^\circ \text{C} \]

\[ I_R < 1.5 \text{ mA} \]

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

Recovery time

\[ t_{rr} < 100 \text{ ns} \]

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

Recovered charge

\[ Q_s < 100 \text{ nC} \]

Maximum slope of the reverse recovery current

when switched from \( I_F = 1 \text{ A to } V_R \geq 30 \text{ V} \);

\[ |dI_R/dt| < 5 \text{ A/\mu s} \]

\[ I_F \quad dI_F \quad dI_R \quad Q_s \]

\[ I_R \quad t_{rr} \quad \text{time} \]

Fig. 2 Definitions 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.

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

\[ I_{F(AV)} = I_{F(RMS)} \times \sqrt{\delta} \]
Fig. 4 The right-hand part shows the interrelationship between the power (derived from the left-hand part) and the maximum permissible temperatures.

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

\[ a = \text{form factor} = \frac{I_F(\text{RMS})}{I_F(\text{AV})}. \]
Fig. 5 Maximum permissible non-repetitive r.m.s. forward current based on sinusoidal currents ($f = 50$ Hz); $T_j = 150^\circ$C prior to surge; with reapplied $V_{RWM\text{max}}$. 

$I_{FSM}$ 

$I_{FS(RMS)}$ 

Time
Very fast soft-recovery rectifier diodes

Fig. 6 — $T_j = 25 \degree C$; $---- T_j = 100 \degree C$

Fig. 7
FAST SOFT-RECOVERY RECTIFIER DIODES

Silicon double-diffused rectifier diodes in plastic envelopes. They are intended for use as clamp diode, dV/dt limiter and output rectifier diodes in professional and consumer switched-mode power supply applications and as scan rectifier diodes in television receivers. The devices feature non-snap-off characteristics and a very fast turn-on behaviour, which makes them extremely suitable for clamp and dV/dt limiting applications.

QUICK REFERENCE DATA

<table>
<thead>
<tr>
<th>Parameter</th>
<th>BYW19-800(R)</th>
<th>1000(R)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Repetitive peak reverse voltage</td>
<td>VRRM max</td>
<td>800 V</td>
</tr>
<tr>
<td>Average forward current</td>
<td>IF(AV) max</td>
<td>7 A</td>
</tr>
<tr>
<td>Non-repetitive peak forward current</td>
<td>IFSM max</td>
<td>40 A</td>
</tr>
<tr>
<td>Reverse recovery time</td>
<td>trr &lt;</td>
<td>450 ns</td>
</tr>
</tbody>
</table>

MECHANICAL DATA (see also page 2)

Dimensions in mm

SOD-38

The exposed metal base-plate is directly connected to tag 1.

July 1977

1
MECHANICAL DATA

Net mass: 2,5 g
Recommended diameter of fixing screw: 3,5 mm
Torque on screw
  when using washer and heatsink compound: min 0,95 Nm (9,5 kg cm)
    max 1,5 Nm (15 kg cm)

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

POLARITY OF CONNECTIONS

<table>
<thead>
<tr>
<th>BYW19-800 and BYW19-1000</th>
<th>BYW19-800R and BYW19-1000R</th>
</tr>
</thead>
<tbody>
<tr>
<td>Base-plate</td>
<td>cathode</td>
</tr>
<tr>
<td>Tag 1</td>
<td>cathode</td>
</tr>
<tr>
<td>Tag 2</td>
<td>anode</td>
</tr>
<tr>
<td></td>
<td>anode</td>
</tr>
<tr>
<td></td>
<td>cathode</td>
</tr>
</tbody>
</table>

RATINGS

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

VOLTS

<table>
<thead>
<tr>
<th>Non-repetitive peak reverse voltage</th>
<th>BYW19-800(R)</th>
<th>1000(R)</th>
</tr>
</thead>
<tbody>
<tr>
<td>VRSM</td>
<td>max 1000</td>
<td>1000 V</td>
</tr>
<tr>
<td>VR RM</td>
<td>max 800</td>
<td>1000 V</td>
</tr>
<tr>
<td>VR RW</td>
<td>max 800</td>
<td>800 V</td>
</tr>
<tr>
<td>VR</td>
<td>max 800</td>
<td>800 V</td>
</tr>
</tbody>
</table>

CURRENTS

Average forward current assuming zero switching losses (averaged over any 20 ms period; see page 7)
- square-wave; δ = 0,5; up to Tmb = 98 °C
- square-wave; δ = 0,5; at Tmb = 125 °C
- sinusoidal; up to Tmb = 98 °C
- sinusoidal; at Tmb = 125 °C

IF(AV) max 7 A
IF(AV) max 4 A
IF(AV) max 7 A
IF(AV) max 4 A

Repetitive peak forward current; tP = 20 μs; δ ≤ 0,02
IFRM max 75 A

Non-repetitive peak forward current
- square-wave; t = 10 ms; Tj = 150 °C prior to surge; with reapplied VRWmax
IFSM max 40 A

Temperatures

Storage temperature
Tstg -40 to +125 °C

Junction temperature
Tj max 150 °C

October 1979
Fast soft-recovery rectifier diodes

BYW19 SERIES

THERMAL RESISTANCE

From junction to mounting base
Transient thermal impedance (t = 1 ms)

\[ R_{th \, j-mb} = 4.5 \, ^\circ C/W \]
\[ Z_{th \, j-mb} = 0.3 \, ^\circ C/W \]

Influence of mounting method

1. Heatsink mounted
Thermal resistance from mounting base to heatsink
a. with heatsink compound
b. with heatsink compound and 56316 mica washer
c. without heatsink compound
d. without heatsink compound with 56316 mica washer

\[ R_{th \, mb-h} = 1.5 \, ^\circ C/W \]
\[ R_{th \, mb-h} = 2.7 \, ^\circ C/W \]
\[ R_{th \, mb-h} = 2.7 \, ^\circ C/W \]
\[ R_{th \, mb-h} = 5 \, ^\circ C/W \]

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-points.
Thermal resistance from junction to ambient in free air:
mounted on a printed-circuit board at a = maximum lead length and with a copper laminate
a. > 1 cm\(^2\) \[ R_{th \, j-a} = 50 \, ^\circ C/W \]
b. < 1 cm\(^2\) \[ R_{th \, j-a} = 55 \, ^\circ C/W \]

mounted on a printed-circuit board at a lead length a = 3 mm and with a copper laminate
c. > 1 cm\(^2\) \[ R_{th \, j-a} = 55 \, ^\circ C/W \]
d. < 1 cm\(^2\) \[ R_{th \, j-a} = 60 \, ^\circ C/W \]
CHARACTERISTICS

Forward voltage
\[ I_F = 20 \text{ A}; \quad T_j = 25 \, ^\circ\text{C} \]
\[ V_F \quad < \quad 2,3 \, \text{V} \quad * \]

Reverse current
\[ V_R = V_{RW_{\text{max}}}; \quad T_j = 125 \, ^\circ\text{C} \]
\[ I_R \quad < \quad 0,6 \, \text{mA} \]

Reverse recovery when switched from
\[ I_F = 2 \, \text{A} \text{ to } V_R \geq 30 \, \text{V}; \quad -\frac{dI_F}{dt} = 20 \, \text{A/}\mu\text{s}; \quad T_j = 25 \, ^\circ\text{C} \]
Recovered charge
\[ Q_s \quad < \quad 0,7 \, \mu\text{C} \]
Recovery time
\[ t_{rr} \quad < \quad 450 \, \text{ns} \]

Maximum slope of the reverse recovery current
when switched from \[ I_F = 2 \, \text{A} \text{ to } V_R \geq 30 \, \text{V}; \]
with \[ -\frac{dI_F}{dt} = 2 \, \text{A/}\mu\text{s}; \quad T_j = 25 \, ^\circ\text{C} \]
\[ \left| \frac{dI_R}{dt} \right| \quad < \quad 5 \, \text{A/}\mu\text{s} \]

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

CHARACTERISTICS (continued)

Forward recovery when switched to

$I_F = 10$ A with $t_r = 1 \mu s$ at $T_j = 25 \, ^\circ C$

Recovery time
Recovery voltage

$t_{fr} < 1 \, \mu s$
$V_{fr} < 15 \, V$

Forward output waveform
MOUNTING INSTRUCTIONS
1. Soldered joints must be at least 2.5 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. The devices should not be immersed in oil, and few potting resins are suitable for re-encapsulation. Advice on these materials is available on request.
4. Leads should not be bent less than 2.5 mm from the seal. Exert no axial pull when bending.
5. For good thermal contact heatsink compound should be used between base-plate and heatsink.

OPERATING NOTES
Dissipation and heatsink considerations:

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

\[ R_{thj-mb} = 4.5 \, {\text{°C/W}} \]

\[ R_{thmb-h} \]

\[ R_{thh-a} \]

b. The method of using the graphs on page 7 is as follows:
Starting with the required current on the \( I_F(A) \) axis, trace upwards to meet the appropriate form factor curve. Trace right horizontally and upwards from the appropriate value on the \( T_{amb} \) scale. The intersection determines the \( R_{thmb-a} \). The heatsink thermal resistance value \( (R_{thh-a}) \) can now be calculated from:

\[ R_{thh-a} = R_{thmb-a} - R_{thmb-h} \]

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

c. The heatsink curves are optimized to allow the junction temperature to run up to a maximum of 150 °C (\( T_{j_{max}} \)) whilst limiting \( T_{mb} \) to 125 °C (or less).
Fast soft-recovery rectifier diodes

**SINUSOIDAL OPERATION**

\[ V_{RW} = 800 \text{ V} \]

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

\[ P = \text{power excluding switching losses} \]

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

**SQUARE-WAVE OPERATION**

\[ P = \text{power excluding switching losses} \]

Interrelation between the power and the maximum permissible temperatures.

*July 1977*
maximum permissible non-repetitive r.m.s. forward current based on sinusoidal currents (f = 50 Hz)

$I_{FS}$ (RMS) (A)

with reapplied $V_{RW_{max}}$

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

$T_j = 25^\circ C$

$T_j = 125^\circ C$

$V_F$ (V)
NOMOGRAM

Power loss $\Delta P_R(\text{AV})$ 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

**BYW19 SERIES**

![Graphs showing the relationship between $V_{fr}$ and $\frac{dI_F}{dt}$ for various $I_F$ values.](image)

$max value T_j = 25 \, ^\circ C$

$max values T_j = 150 \, ^\circ C$

---

July 1977
FAST SOFT-RECOVERY RECTIFIER DIODE

The BYW25 is a fast soft-recovery rectifier diode in a DO-5 metal envelope especially suitable for operation as main and commutating diode in 3-phase a.c. motor speed control inverters and in high frequency power supplies in general.

Two polarity versions are available:
Normal polarity (cathode to stud); BYW25.
Reverse polarity (anode to stud); BYW25R.

QUICK REFERENCE DATA

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Repetitive peak reverse voltage</td>
<td>V_{RRM} max. 800 V</td>
</tr>
<tr>
<td>Average forward current</td>
<td>I_{F(AV)} max. 40 A</td>
</tr>
<tr>
<td>Repetitive peak forward current</td>
<td>I_{FRM} max. 600 A</td>
</tr>
<tr>
<td>Reverse recovery time</td>
<td>t_{rr} &lt; 450 ns</td>
</tr>
</tbody>
</table>

MECHANICAL DATA

Fig. 1 DO-5: with metric M6 stud (φ6 mm)

Net mass: 22 g
Diameter of clearance hole: max. 6,5 mm
Torque on nut: min. 1,7 Nm (17 kg cm)
max. 3,5 Nm (35 kg cm)

Supplied with device: 1 nut, 1 lock washer
Nut dimensions across the flats: 10 mm
Supplied on request: accessories 56264A
(mica washer, insulating ring, tag)

January 1980
RATINGS
Limiting values in accordance with the Absolute Maximum System (IEC 134)

Voltages *
- Non-repetitive peak reverse voltage
  \[ V_{RSM} \text{ max. } 1000 \text{ V} \]
- Repetitive peak reverse voltage
  \[ V_{RRM} \text{ max. } 800 \text{ V} \]
- Continuous reverse voltage
  \[ V_{R} \text{ max. } 650 \text{ V} \]

Currents
- Average forward current;
  switching losses negligible up to 20 kHz
  \[ I_{F(AV)} \text{ max. } 40 \text{ A} \]
- Repetitive peak forward current
  \[ I_{FRM} \text{ max. } 600 \text{ A} \]
- Non-repetitive peak forward current;
  \[ I_{FSM} \text{ max. } 550 \text{ A} \]
  \[ i^2t \text{ for fusing (} t = 10 \text{ ms)} \]

\[ I_{F(RMS)} \text{ max. } 60 \text{ A} \]

Temperatures
- Storage temperature
  \[ T_{stg} \text{ -55 to + 150 } \text{ °C} \]
- Junction temperature
  \[ T_{j} \text{ max. } 150 \text{ °C} \]

THERMAL RESISTANCE
- From junction to mounting base
  \[ R_{th j-mb} = 0.6 \text{ °C/W} \]
- From mounting base to heatsink
  with heatsink compound
  \[ R_{th mb-h} = 0.3 \text{ °C/W} \]
  without heatsink compound
  \[ R_{th mb-h} = 0.5 \text{ °C/W} \]

* To ensure thermal stability: \( R_{th j-a} \leq 1 \text{ °C/W} \) (continuous reverse voltage).
Fast recovery rectifier diode

CHARACTERISTICS

Forward voltage
\[ I_F = 35 \text{ A}; \quad T_j = 25 \text{ °C} \]
\[ I_F = 150 \text{ A}; \quad T_j = 25 \text{ °C} \]

Reverse current
\[ V_R = 650 \text{ V}; \quad T_j = 125 \text{ °C} \]

Reverse recovery when switched from
\[ I_F = 10 \text{ A} \text{ to } V_R = 30 \text{ V} \text{ with } -dI_F/dt = 50 \text{ A/μs}; \quad T_j = 25 \text{ °C} \]

Recovery time
\[ t_{rr} < 450 \text{ ns} \]

Maximum slope of the reverse recovery current
when switched from \[ I_F = 600 \text{ A} \text{ to } V_R > 30 \text{ V} \text{ with } -dI_F/dt = 70 \text{ A/μs}; \quad T_{mb} = 85 \text{ °C} \]

Recovery time
\[ t_{rr} < 1 \mu s \]

Maximum slope of the reverse recovery current
when switched from \[ I_F = 600 \text{ A} \text{ to } V_R > 30 \text{ V} \text{ with } -dI_F/dt = 35 \text{ A/μs}; \quad T_j = 25 \text{ °C} \]

\[ \left| dI_R/dt \right| < 100 \text{ A/μs} \]

* Measured under pulse conditions to avoid excessive dissipation.

Fig. 2 Definitions of \( Q_s \), \( t_{rr} \) and \( dI_R/dt \).

Fig. 3 --- \( T_j = 25 \text{ °C} \); --- \( T_j = 150 \text{ °C} \).
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 $f = 20 \text{ kHz}$.

$a = \frac{IF(\text{RMS})}{IF(\text{AV})}$. 
Fig. 5 One phase of a three-phase inverter for a.c. motor speed control. D1 to D4 are BYW25 types.
Glass-passivated, high-efficiency, eutectically-bonded rectifier diodes in plastic envelopes, featuring low forward voltage drop, very fast reverse recovery times, very low stored charge and non-snap-off. 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 mounting base) types.

**QUICK REFERENCE DATA**

<table>
<thead>
<tr>
<th>Parameter</th>
<th>BYW29-50</th>
<th>100</th>
<th>150</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>Average forward current</td>
<td>$I_{F(AV)}$ max.</td>
<td>7 A</td>
<td></td>
</tr>
<tr>
<td>Forward voltage</td>
<td>$V_F$ &lt;</td>
<td>0,85 V</td>
<td></td>
</tr>
<tr>
<td>Reverse recovery time</td>
<td>$t_{rr}$ &lt;</td>
<td>35 ns</td>
<td></td>
</tr>
</tbody>
</table>

**MECHANICAL DATA**

Dimensions in mm

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

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

Products approved to CECC 50 009-014, available on request.

January 1980
BYW29 SERIES

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>
</tr>
</thead>
<tbody>
<tr>
<td>Non-repetitive peak reverse voltage</td>
<td>V_{RSM} max.</td>
<td>50</td>
<td>100</td>
</tr>
<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</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
  - sinusoidal; up to T_{mb} = 125 °C
  - square-wave; δ = 0,5; up to T_{mb} = 125 °C
  - R.M.S. forward current
    - IF(AV) max. | 7 A |
  - Repetitive peak forward current
    - IF(RMS) max. | 12 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. | 80 A |
  - I^2 t for fusing (t = 10 ms)
    - I^2 t max. | 32 A^2 s |

Temperatures

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

* To ensure thermal stability: R_{th j-a} ≤ 16 °C/W (continuous reverse voltage).
THERMAL RESISTANCE

From junction to mounting base

$R_{th\ j\-mb} = 2.7 \degree C/W$

$Z_{th\ j\-mb} = 0.26 \degree C/W$

Transient thermal impedance; $t = 1\ ms$

Influence of mounting method

1. Heatsink mounted with clip (see mounting instructions)

Thermal resistance from mounting base to heatsink

a. with heatsink compound

$R_{th\ mb\-h} = 0.3 \degree C/W$

b. with heatsink compound and 0.06 mm maximum mica insulator

$R_{th\ mb\-h} = 1.4 \degree C/W$

c. with heatsink compound and 0.1 mm maximum mica insulator (56369)

$R_{th\ mb\-h} = 2.2 \degree C/W$

d. with heatsink compound and 0.25 mm maximum alumina insulator (56367)

$R_{th\ mb\-h} = 0.8 \degree C/W$

e. without heatsink compound

$R_{th\ mb\-h} = 1.4 \degree C/W$

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 $a = \text{any lead length and with copper laminate}$

$R_{th\ j\-a} = 60 \degree C/W$

Fig. 2.
CHARACTERISTICS

Forward voltage
I_F = 5 A; T_j = 100 °C
I_F = 20 A; T_j = 25 °C

Reverse current
V_R = V_{RWMax}; T_j = 100 °C

Reverse recovery when switched from
I_F = 1 A to V_R > 30 V with -dI_F/dt = 50 A/μs; T_j = 25 °C

Recovery time

I_F = 2 A to V_R > 30 V with -dI_F/dt = 20 A/μs; T_j = 25 °C

Recovered charge
Recovery time

Forward recovery when switched to I_F = 1 A
with dI_F/dt = 10 A/μs

Recovery voltage
V_{fr} typ. 1,0 V

\[ V_F < 0,85 \text{ V*} \]
\[ V_F < 1,3 \text{ V*} \]
\[ I_R < 0,6 \text{ mA} \]
\[ t_{rr} < 35 \text{ ns} \]
\[ Q_{S} < 15 \text{ nC} \]
\[ t_{rr} < 50 \text{ ns} \]

Fig. 3 Definitions of t_{rr} and Q_{S}.

Fig. 4 Definition of V_{fr}.

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

1. The device may be soldered directly into the circuit, but the maximum permissible temperature of the soldering iron or bath is 275 °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 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. The device should not be pop-riveted to the heatsink. However, it is permissible to press-rivet providing that 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.

OPERATING NOTES

Dissipation and heatsink considerations:

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

   ![Diagram](https://via.placeholder.com/150)

   - $R_{th\, j-mb}$
   - $R_{th\, mb-h}$
   - $R_{th\, h-a}$

   b. 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 form factor or duty 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:
     $$R_{th\, h-a} = R_{th\, mb-a} - R_{th\, mb-h}$$
   - Any measurement of heatsink temperature should be made immediately adjacent to the device.
Fig. 5 The right-hand part shows the interrelationship between the power (derived from the left-hand part) and the maximum permissible temperatures.

P = power including reverse current losses and switching losses up to f = 500 kHz.
a = form factor = \( I_{F(RMS)} / I_{F(AV)} \).
Fig. 6 The right-hand part shows the interrelationship between the power (derived from the left-hand part) and the maximum permissible temperatures.

\[ P = \text{power including reverse current losses and switching losses up to } f = 500 \text{ kHz.} \]

\[
IF(\text{AV}) = IF(\text{RMS}) \times \sqrt{\delta}
\]
Fig. 7 Maximum permissible non-repetitive r.m.s. forward current based on sinusoidal currents (f = 50 Hz); T_j = 150°C prior to surge; with reapplied V_RWMmax.

Fig. 8.
Very fast recovery rectifier diodes

Fig. 9  $T_j = 25^\circ C$; maximum values.

Fig. 10  $T_j = 100^\circ C$; maximum values.

Fig. 11  Maximum values; $T_j = 25^\circ C$; $T_j = 100^\circ C$. 

Definition of $Q_s$ in Figs 9 and 10.
Fig. 12  $f = 1$ MHz; $T_j = 25$ °C.

Fig. 13.
VERY FAST RECOVERY RECTIFIER DIODES

Glass-passivated, high-efficiency rectifier diodes in DO-4 metal envelopes, featuring low forward voltage drop, very fast reverse recovery times, very low stored charge and non-snap-off. 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</th>
<th>BYW30-50 50</th>
<th>100</th>
<th>150</th>
</tr>
</thead>
<tbody>
<tr>
<td>Average forward current</td>
<td>IF(AV) max.</td>
<td>12</td>
<td>A</td>
</tr>
<tr>
<td>Forward voltage</td>
<td>VF &lt;</td>
<td>0,85 V</td>
<td></td>
</tr>
<tr>
<td>Reverse recovery time</td>
<td>t_{rr} &lt;</td>
<td>35 ns</td>
<td></td>
</tr>
</tbody>
</table>

MECHANICAL DATA

Fig. 1 DO-4: with metric M5 stud (φ5 mm); e.g. BYW30-50.
with 10-32 UNF stud (φ4,83 mm); e.g. BYW30-50U.

Net mass: 6 g
Diameter of clearance hole: max. 5,2 mm
Accessories supplied on request: 56295
(PTFE bush, 2 mica washers, plain washer, tag)
Supplied with device: 1 nut, 1 lock washer
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.

January 1980
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>
</tr>
</thead>
<tbody>
<tr>
<td>Non-repetitive peak reverse voltage</td>
<td>$V_{RSM}$ max.</td>
<td>50</td>
<td>100</td>
</tr>
<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</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
sinusoidal; up to $T_{mb} = 120 \, ^\circ C$
$IF(AV)_{max}$

$IF(AV)_{max}$ max. | 12 A |

sinusoidal; at $T_{mb} = 125 \, ^\circ C$
$IF(AV)_{max}$ max. | 10 A |

square-wave; $\delta = 0,5$; up to $T_{mb} = 114 \, ^\circ C$
$IF(AV)_{max}$ max. | 14 A |

square-wave; $\delta = 0,5$; at $T_{mb} = 125 \, ^\circ C$
$IF(AV)_{max}$ max. | 10 A |

R.M.S. forward current
$IF(RMS)_{max}$ max. | 20 A |

Repetitive peak forward current
$IF_{max}$ | 200 A |

Non-repetitive peak forward current
$t = 10 \, ms$; half sine-wave; $T_j = 150 \, ^\circ C$ prior to surge
with reapplied $V_{RWM, max}$
$IF_{FSM}$ max. | 200 A |

$I^2 \, t$ for fusing ($t = 10 \, ms$)
$I^2 \, t$ max. | 200 A² s |

Temperatures

Storage temperature
$T_{stg}$ | -55 to +150 °C |

Junction temperature
$T_j$ | max. 150 °C |

THERMAL RESISTANCE

From junction to mounting base
$R_{th \, j-mb}$ = 2,2 °C/W |

From mounting base to heatsink
a. with heatsink compound
$R_{th \, mb-h}$ = 0,5 °C/W |

b. 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 |

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: $R_{th \, j-a} < 8,2 \, ^\circ C/W$ (continuous reverse voltage).
CHARACTERISTICS

Forward voltage

- $I_F = 10\ A; \ T_j = 100\ ^\circ C$
- $I_F = 50\ A; \ T_j = 25\ ^\circ C$

Reverse current

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

Reverse recovery when switched from

- $I_F = 1\ A$ to $V_R \geq 30\ V$ with $-\frac{dI_F}{dt} = 20\ A/\mu s; \ T_j = 25\ ^\circ C$
- Recovery time
- $I_F = 2\ A$ to $V_R \geq 30\ V$ with $-\frac{dI_F}{dt} = 20\ A/\mu s; \ T_j = 25\ ^\circ C$
- Recovery charge
- Recovery time

Forward recovery when switched to $I_F = 10\ A$

- with $\frac{dI_F}{dt} = 10\ A/\mu s$

*Measured under pulse conditions to avoid excessive dissipation.*
SINUSOIDAL OPERATION

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

P = power excluding switching losses but including reverse current losses

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

Fig. 4.
Very fast recovery rectifier diodes

**BYW30 SERIES**

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

\[ P = \text{power including reverse current losses and switching losses up to } f = 500 \text{ kHz.} \]

\[ I_F(AV) = I_F(RMS) \times \sqrt{\delta} \]
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 \( V_{RWM_{max}} \).

Fig. 7.
Very fast recovery rectifier diodes

BYW30 SERIES

Fig. 8 $T_j = 25^\circ C$; maximum values.

Fig. 9 $T_j = 100^\circ C$; maximum values.

Definition of $Q_s$ in Figs 8 and 9.

Fig. 10 Maximum values; $T_j = 25^\circ C$; $T_j = 100^\circ C$. 

March 1978
Fig. 11  \( f = 1 \text{ MHz}; T_j = 25 \text{ °C}. \)

Fig. 12.
VERY FAST RECOVERY RECTIFIER DIODES

Glass-passivated, high-efficiency rectifier diodes in DO-4 metal envelopes, featuring low forward voltage drop, very fast reverse recovery times, very low stored charge and non-snap-off. 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>BYW31-50</th>
<th>100</th>
<th>150</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>Average forward current</td>
<td>I_{F(AV)} max.</td>
<td>25</td>
<td>A</td>
</tr>
<tr>
<td>Forward voltage</td>
<td>V_F &lt; 0,85</td>
<td>V</td>
<td></td>
</tr>
<tr>
<td>Reverse recovery time</td>
<td>t_{rr} &lt; 50 ns</td>
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</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

Products available to CECC 50 009-002, available on request.

January 1980
RATINGS
Limiting values in accordance with the Absolute Maximum System (IEC 134)

### Voltages *

<table>
<thead>
<tr>
<th></th>
<th>BYW31-50</th>
<th>100</th>
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<tbody>
<tr>
<td>Non-repetitive peak reverse voltage</td>
<td>$V_{RSM}$</td>
<td>max.</td>
<td>50</td>
</tr>
<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
- sinusoidal; up to $T_{mb} = 120 \, ^\circ \text{C}$
- sinusoidal; at $T_{mb} = 125 \, ^\circ \text{C}$
- square-wave; $\delta = 0,5$; up to $T_{mb} = 119 \, ^\circ \text{C}$
- square-wave; $\delta = 0,5$; at $T_{mb} = 125 \, ^\circ \text{C}$

<table>
<thead>
<tr>
<th>Type</th>
<th>Symbol</th>
<th>Max. Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Currents</td>
<td>$I_{F(AV)}$</td>
<td>25 A</td>
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<tr>
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<td>$I_{F(AV)}$</td>
<td>23 A</td>
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<tr>
<td></td>
<td>$I_{F(AV)}$</td>
<td>28 A</td>
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<tr>
<td></td>
<td>$I_{F(AV)}$</td>
<td>23 A</td>
</tr>
<tr>
<td>R.M.S. forward current</td>
<td>$I_{F(RMS)}$</td>
<td>40 A</td>
</tr>
<tr>
<td>Non-repetitive peak forward current</td>
<td>$I_{FSM}$</td>
<td>320 A</td>
</tr>
<tr>
<td>Repetitive peak forward current</td>
<td>$I_{F}$</td>
<td>max. 500 A²s</td>
</tr>
</tbody>
</table>

### Temperatures

<table>
<thead>
<tr>
<th>Type</th>
<th>Symbol</th>
<th>Min. to Max. Value</th>
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</thead>
<tbody>
<tr>
<td>Storage temperature</td>
<td>$T_{stg}$</td>
<td>-55 to +150 °C</td>
</tr>
<tr>
<td>Junction temperature</td>
<td>$T_{j}$</td>
<td>max. 150 °C</td>
</tr>
</tbody>
</table>

### THERMAL RESISTANCE

- From junction to mounting base: $R_{th \, j-mb} = 1,0 \, ^\circ \text{C/W}$
- From mounting base to heatsink:
  - With heatsink compound: $R_{th \, mb-h} = 0,3 \, ^\circ \text{C/W}$
  - Without heatsink compound: $R_{th \, mb-h} = 0,5 \, ^\circ \text{C/W}$
- Transient thermal impedance: $t = 1 \, \text{ms}$
  - $Z_{th \, j-mb} = 0,2 \, ^\circ \text{C/W}$

### MOUNTING INSTRUCTIONS

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

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

* To ensure thermal stability: $R_{th \, j-a} \leq 6 \, ^\circ \text{C/W}$ (continuous reverse voltage).
CHARACTERISTICS

Forward voltage
\[ I_F = 20 \text{ A}; \ T_j = 100 \ ^\circ\text{C} \]
\[ I_F = 100 \text{ A}; \ T_j = 25 \ ^\circ\text{C} \]

Reverse current
\[ V_R = V_{RWMmax}; \ T_j = 100 \ ^\circ\text{C} \]

Reverse recovery when switched from
\[ I_F = 1 \text{ A to } V_R \geq 30 \text{ V with } -\frac{dI_F}{dt} = 50 \text{ A/\mu s}; \ T_j = 25 \ ^\circ\text{C} \]

Recovery time
\[ t_{tr} < 50 \text{ ns} \]

Recovered charge
\[ Q_s < 20 \text{ nC} \]

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

Recovery voltage
\[ V_{fr} \text{ typ. } 1.0 \text{ V} \]

* 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.

\[ P = \text{power including reverse current losses and switching losses up to } f = 500 \text{ kHz}. \]

\[ a = \text{form factor} = \frac{I_F(\text{RMS})}{I_F(\text{AV})}. \]
Fig. 5 The right-hand part shows the interrelationship between the power (derived from the left-hand part) and the maximum permissible temperatures.

P = power including reverse current losses and switching losses up to $f = 500$ kHz.

$$I_{F(AV)} = I_{F(RMS)} \times \sqrt{\delta}$$
Fig. 6. maximum permissible non-repetitive r.m.s. forward current based on sinusoidal currents (f = 50 Hz)

Fig. 7. T_j = 150 °C prior to surge

T_j = 25 °C; T_j = 100 °C.
Very fast recovery rectifier diodes

Fig. 8 $T_j = 25 \, ^\circ C$; maximum values.

Fig. 9 $T_j = 100 \, ^\circ C$; maximum values.

Definition of $Q_s$ in Figs 8 and 9.

Fig. 10 Maximum values; $T_j = 25 \, ^\circ C$; $T_j = 100 \, ^\circ C$. 
Fig. 11  $f = 1$ MHz; $T_j = 25 \, ^\circ$C.

Fig. 12. $Z_{th_{j-mb}}$ ($^\circ$C/W) vs. time (s).
VERY FAST RECOVERY RECTIFIER DIODES

Glass-passivated, high-efficiency rectifier diodes in DO-5 metal envelopes, featuring low forward voltage drop, very fast reverse recovery times, very low stored charge and non-snap-off. They are intended for use in switched-mode power supplies and high-frequency inverter 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>BYW92-50</th>
<th>100</th>
<th>150</th>
</tr>
</thead>
<tbody>
<tr>
<td>Repetitive peak reverse voltage</td>
<td>V_{RRM}</td>
<td>max.</td>
<td>50</td>
</tr>
<tr>
<td>Average forward current</td>
<td>I_{F(AV)}</td>
<td>max.</td>
<td>35</td>
</tr>
<tr>
<td>Forward voltage</td>
<td>V_{F}</td>
<td>&lt;</td>
<td>0,95</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 DO-5: with metric M6 stud (\(\phi 6\) mm); e.g. BYW92-50.
with \(\frac{1}{8}\) in x 28UNF stud (\(\phi 6,35\) mm); e.g. BYW92-50U.

Net mass: 22 g
Diameter of clearance hole: max. 6,5 mm
Torque on nut: min. 1,7 Nm (17 kg cm)
max. 3,5 Nm (35 kg cm)

Supplied with device: 1 nut, 1 lock washer
Nut dimensions across the flats;
M6: 10 mm
\(\frac{1}{8}\) in x 28UNF: 11,1 mm
Supplied on request: accessories 56264A
(mica washer, insulating ring, tag)

Products approved to CECC 50 009-003, available on request.
RATINGS
Limiting values in accordance with the Absolute Maximum System (IEC 134)

<table>
<thead>
<tr>
<th>Volts</th>
<th>BYW92-50</th>
<th>100</th>
<th>150</th>
</tr>
</thead>
<tbody>
<tr>
<td>Non-repetitive peak reverse voltage</td>
<td>$V_{RSM}$</td>
<td>max.</td>
<td>50</td>
</tr>
<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
sinusoidal; up to $T_{mb} = 105 \, ^\circ C$

$\bar{I}_{F(AV)}$ (max.)

- $I_{F(AV)}$ max. 35 A
- $I_{F(AV)}$ max. 23 A
- $I_{F(AV)}$ max. 40 A
- $I_{F(AV)}$ max. 23 A

R.M.S. forward current

$I_{FRM}$ max. 500 A

Non-repetitive peak forward current; $t = 10 \, ms$; half sine-wave;
$T_j = 150 \, ^\circ C$ prior to surge; with re-applied $V_{RWM}$

$I^2 t$ for fusing ($t = 10 \, ms$)

$T_{stg}$ -55 to +150 °C

Junction temperature

- $T_{j}$ max. 150 °C

THERMAL RESISTANCE
From junction to mounting base

- $R_{thj-mb} = 1,0 \, ^\circ C/W$

From mounting base to heatsink

- $R_{thmb-h} = 0,3 \, ^\circ C/W$
- $R_{thmb-h} = 0,5 \, ^\circ C/W$

Transient thermal impedance; $t = 1 \, ms$

Z$_{thj-mb}$ = 0,2 °C/W

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

* To ensure thermal stability: $R_{thj-a} \leq 6 \, ^\circ C/W$ (continuous reverse voltage).
Characteristics

Forward voltage
- $I_F = 35$ A; $T_j = 100$ °C
- $I_F = 100$ A; $T_j = 25$ °C

Reverse current
- $V_R = V_{RWM_{\text{max}}}$; $T_j = 100$ °C

Reverse recovery when switched from $I_F = 1$ A to $V_R \geq 30$ V with $-dI_F/dt = 50$ A/$\mu$s; $T_j = 25$ °C
- Recovery time $t_{rr} < 50$ ns
- Recovered charge $Q_s < 20$ nC

Forward recovery when switched to $I_F = 10$ A with $dI_F/dt = 10$ A/$\mu$s
- Recovery voltage $V_{fr}$ typ. $1,0$ V

* Measured under pulse conditions to avoid excessive dissipation.
Fig. 4  \( P = \) power including reverse current losses and switching losses up to \( f = 500 \text{ kHz} \).
\( a = \) form factor \( = \frac{I_F(\text{RMS})}{I_F(\text{AV})} \).
Very fast recovery rectifier diodes

**SQUARE-WAVE OPERATION**

![Graph](image)

Fig. 5. $P =$ power including reverse current losses and switching losses up to $f = 500$ kHz.

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

**Fig. 6.**

![Graph](image)

BYW92 SERIES
Fig. 7 Maximum permissible non-repetitive r.m.s. forward current based on sinusoidal currents (f = 50 Hz); T_j = 150 °C prior to surge; with reapplyed V_{RWMmax}. 
Very fast recovery rectifier diodes

Fig. 8 \( T_j = 25 \, ^\circ\text{C} \); maximum values.

Fig. 9 \( T_j = 100 \, ^\circ\text{C} \); maximum values.

Definition of \( Q_s \) in Figs 8 and 9.

Fig. 10 Maximum values; \( \cdots \cdots T_j = 25 \, ^\circ\text{C} \); 
\( \cdots \cdots T_j = 100 \, ^\circ\text{C} \).
Fig. 11  $f = 1 \text{ MHz}; T_j = 25 ^\circ \text{C}.$

Fig. 12.
SILICON RECTIFIER DIODES

Also available to BS9331-F131

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

QUICK REFERENCE DATA

<table>
<thead>
<tr>
<th></th>
<th>BYX22–600</th>
<th>1200</th>
</tr>
</thead>
<tbody>
<tr>
<td>Crest working reverse voltage</td>
<td>VRWM max.</td>
<td>400 V</td>
</tr>
<tr>
<td>Repetitive peak reverse voltage</td>
<td>VRRM max.</td>
<td>600 V</td>
</tr>
<tr>
<td>Average forward current</td>
<td>IF(AV) max.</td>
<td>1.4 A</td>
</tr>
<tr>
<td>Non-repetitive peak forward current</td>
<td>IFSM max.</td>
<td>40 A</td>
</tr>
</tbody>
</table>

MECHANICAL DATA

Dimensions in mm

MOUNTING METHODS see page 3
RATINGS  Limiting values in accordance with the Absolute Maximum System (IEC 134)
All information applies to frequencies up to 400Hz

Voltages

<table>
<thead>
<tr>
<th>BYX22-600</th>
<th>1200</th>
</tr>
</thead>
<tbody>
<tr>
<td>$V_{RWM}$ max. 400</td>
<td>800 V</td>
</tr>
<tr>
<td>$V_{RRM}$ max. 600</td>
<td>1200 V</td>
</tr>
<tr>
<td>$V_{RSM}$ max. 600</td>
<td>1200 V</td>
</tr>
</tbody>
</table>

Currents

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

Temperatures

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

THERMAL RESISTANCE

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

CHARACTERISTICS

Forward voltage at $I_{F} = 5$A; $T_{amb} = 25^\circ C$ $V_{F}$ < 1.5 V 1)
Reverse current at $V_{R} = V_{RWM\text{max}}$; $T_{amb} = 125^\circ C$ $I_{R}$ < 120 $\mu$A

1) Measured under pulsed conditions to avoid excessive dissipation.
THERMAL RESISTANCE

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

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

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

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

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

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

SOLDERING AND MOUNTING NOTES

1. At a soldering iron or bath temperature of up to 245 °C, the maximum permissible soldering time is 10 s if the joint is 5 mm from the seal, 3 s if it is 1.5 mm from the seal.

2. At a temperature between 245 °C and 400 °C (max.), the joint must be more than 5 mm from the seal and soldering time must not exceed 5 s.

3. Leads should not be bent less than 1.5 mm from the seal; exert no axial pull when bending.
The form factor $a = \frac{I_{F(RMS)} \text{ per diode}}{I_{FAV} \text{ per diode}}$ depends on $n \omega R_L C_L$ and $\frac{R_t + R_{diff}}{n R_L}$ and can be found from existing graphs.

See Application Book: RECTIFIER DIODES.
Required minimum value of $R_t$

$R_t$ includes the transformer resistance.

The graph takes the possibility of the following spreads into account:
- mains voltage, +10%
- capacitance, +30%
- resistance, -10%

$T_j = 25^\circ C$ to $150^\circ C$

$R_{diff} (\cot \Theta) = 0.01 \Omega$

$I_F (A)$

$V_F (V)$
maximum permissible non-repetitive peak forward current based on sinusoidal currents, f = 50 Hz

Each current pulse is followed by the crest working reverse voltage

$T_f = 150^\circ C$ (prior to surge)
CONTROLLED AVALANCHE RECTIFIER DIODES

Also available to BS9333—F003

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 $V_{RWM}$</td>
<td>max. 600</td>
<td>800</td>
<td>1000</td>
<td>1200</td>
<td>1400</td>
</tr>
<tr>
<td>Reverse avalanche breakdown voltage $V_{(BR)R}$</td>
<td>&gt; 750</td>
<td>1000</td>
<td>1250</td>
<td>1450</td>
<td>1650</td>
</tr>
<tr>
<td>Average forward current $I_{F(AV)}$</td>
<td>max. 20</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Non-repetitive peak forward current $I_{FSM}$</td>
<td>max. 360</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Non-repetitive peak reverse power $P_{RSM}$</td>
<td>max. 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:
56295 (PTFE bush, 2 mica washers, plain washer, tag).
56262A (mica washer, insulating ring, plain washer).
Supplied with device: 1 nut, 1 lock washer.
Nut dimensions across the flats: 9.5 mm

The mark shown applies to the normal polarity types.
RATINGS

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

<table>
<thead>
<tr>
<th>VOLTAGES*</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) \( I_{F(AV)} \) max. 20 A
- Repetitive peak forward current \( I_{FRM} \) max. 440 A
- Non-repetitive peak forward current \( I_{FSM} \) max. 360 A
- \( I^2 t \) for fusing \( I^2 t \) max. 650 A²s

**Reverse power dissipation**

- Average reverse power dissipation (averaged over any 20 ms period); \( T_J = 175 \, ^\circ C \) \( P_{R(AV)} \) max. 38 W
- Repetitive peak reverse power dissipation \( t = 10 \, \mu s \) (square-wave); \( f = 50 \, Hz \); \( T_J = 175 \, ^\circ C \) \( P_{RRM} \) max. 3 kW
- Non-repetitive peak reverse power dissipation \( t = 10 \, \mu s \) (square-wave) \( T_J = 25 \, ^\circ C \) prior to surge \( P_{RSM} \) max. 18 kW
  \( T_J = 175 \, ^\circ C \) prior to surge \( P_{RSM} \) max. 3 kW

**Temperatures**

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

*To ensure thermal stability: \( R_{th \, j-a} < 5 \, ^\circ C/W \) (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>Forward voltage</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>$V_F &lt; 1.8 \text{ V}$</td>
<td>$1.8 \text{ V}$</td>
<td>$1.8 \text{ V}$</td>
<td>$1.8 \text{ V}$</td>
<td>$1.8 \text{ V}$</td>
</tr>
<tr>
<td>Reverse avalanche</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>breakdown voltage</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>$V_{(BR)R} &gt; 750 \text{ V}$</td>
<td>$1000 \text{ V}$</td>
<td>$1250 \text{ V}$</td>
<td>$1450 \text{ V}$</td>
<td>$1650 \text{ V}$</td>
</tr>
<tr>
<td>Peak reverse current</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>$V_R = V_{RWM\max}; T_j = 125 \ ^\circ\text{C}$</td>
<td>$I_R &lt; 1.0 \text{ mA}$</td>
<td>$0.8 \text{ mA}$</td>
<td>$0.6 \text{ mA}$</td>
<td>$0.5 \text{ mA}$</td>
<td>$0.5 \text{ mA}$</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>Parameter</th>
<th>Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Frequency</td>
<td>f = 50 Hz</td>
</tr>
<tr>
<td>Average forward current</td>
<td>I_{FAV} = 10 A (per diode)</td>
</tr>
<tr>
<td>Ambient temperature</td>
<td>T_{amb} = 40 °C</td>
</tr>
<tr>
<td>Repetitive peak reverse power dissipation in the avalanche region</td>
<td>P_{RRM} = 2 kW (per diode)</td>
</tr>
<tr>
<td>Duration of P_{RRM}</td>
<td>t = 40 μs</td>
</tr>
</tbody>
</table>

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

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

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; \( t = 40 \mu s; f = 50 \text{ Hz}, \) the maximum allowable junction temperature should be 163 °C instead of 175 °C, thus 12 °C lower (see the lower graph on page 5).

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

Using this in the curve leads to a thermal resistance

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

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

Hence the heatsink thermal resistance should be:
\[ R_{th \text{ h-a}} = R_{th \text{ mb-a}} - R_{th \text{ mb-h}} = (4 - 0.5) \text{ °C/W} = 3.5 \text{ °C/W} \]
Controlled avalanche rectifier diodes

BYX25 SERIES

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

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

Operation in this region is not allowed.

In this region a junction temperature of 175°C is allowed.

Fig. 2

Fig. 3

September 1979
Max. allowable non repetitive peak reverse pulse power dissipation in avalanche region versus duration.
Controlled avalanche rectifier diodes

 FYX25 SERIES

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

$I_F$  

with reapplied $V_{RWM_{max}}$

$T_j = 175°C$ prior to surge
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>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 ( \text{V}_{\text{RWM}} )</td>
<td>max. 200</td>
<td>300</td>
<td>400</td>
<td>500</td>
</tr>
<tr>
<td>Reverse avalanche breakdown voltage ( \text{V}_{\text{(BR)}} )</td>
<td>&gt; 250</td>
<td>375</td>
<td>500</td>
<td>625</td>
</tr>
<tr>
<td>Average forward current ( \text{I}_{\text{F(AV)}} )</td>
<td>max. 14 A</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Non-repetitive peak forward current ( \text{I}_{\text{FSM}} )</td>
<td>max. 250 A</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Non-repetitive peak reverse power ( \text{P}_{\text{RSM}} )</td>
<td>max. 18 kW</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Reverse recovery time ( \text{t}_{\text{rr}} )</td>
<td>&lt; 200 ns</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: 56295 (PTFE bush, 2 mica washers, plain washer, tag)

The mark shown applies to the normal polarity types.

January 1980
RATINGS  Limiting values in accordance with the Absolute Maximum System (IEC134)

<table>
<thead>
<tr>
<th>Voltages 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>Crest working reverse voltage $V_{RWM}$ max.</td>
<td>200</td>
<td>300</td>
<td>400</td>
<td>500</td>
<td>600</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</td>
</tr>
</tbody>
</table>

Currents

Average forward current (averaged over any 20 ms period) up to $T_{mb} = 100 \, ^\circ C$

at $T_{mb} = 125 \, ^\circ C$ $I_{F(AV)}$ max. 14 A

R.M.S. forward current $I_{F(RMS)}$ max. 22 A

Repetitive peak forward current $I_{FRM}$ max. 310 A

Non-repetitive peak forward current

$t = 10 \, ms$; half-sinewave $T_j = 150 \, ^\circ C$ prior to surge; with reapplied $V_{RWM}$ max. $I_{FSM}$ max. 250 A

$I^2t$ for fusing ($t = 10 \, ms$) $I^2t$ max. 312 A$^2s$

Reverse power dissipation

Repetitive peak reverse power dissipation

t = 10 $\mu$s (square wave; $f = 50 \, Hz$) $T_j = 150 \, ^\circ C$ $P_{RRM}$ max. 5.5 kW

Non-repetitive peak reverse power dissipation

t = 10 $\mu$s (square wave) $T_j = 25 \, ^\circ C$ prior to surge $T_j = 150 \, ^\circ C$ prior to surge $P_{RSM}$ max. 18 kW

Temperatures

Storage temperature $T_{stg}$ -55 to +150 $^\circ C$

Junction temperature $T_j$ max. 150 $^\circ C$

THERMAL RESISTANCE

From junction to ambient in free air $R_{th \, j-a} = 50 \, ^\circ C/W$

From junction to mounting base $R_{th \, j-mb} = 1.3 \, ^\circ C/W$

From mounting base to heatsink $R_{th \, mb-h} = 0.5 \, ^\circ C/W$

1) 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 5.

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 = 120 $^\circ C$. 

March 1978
Fast soft-recovery rectifier diodes with controlled avalanche

BYX30 SERIES

CHARACTERISTICS

<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>Forward voltage</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>$I_F = 50 \text{ A} ; T_j = 25 \degree \text{C}$</td>
<td>$V_F &lt; 3.2$</td>
<td>$3.2$</td>
<td>$3.2$</td>
<td>$3.2$</td>
<td>$3.2$</td>
</tr>
<tr>
<td>Reverse breakdown voltage</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>$I_R = 5 \text{ mA} ; T_j = 25 \degree \text{C}$</td>
<td>$V_{(BR)R} &gt; 250$</td>
<td>$375$</td>
<td>$500$</td>
<td>$625$</td>
<td>$750$</td>
</tr>
<tr>
<td>Reverse current</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>$V_R = V_{RWM\text{max}} ; T_j = 125 \degree \text{C}$</td>
<td>$I_R &lt; 4.0$</td>
<td>$4.0$</td>
<td>$4.0$</td>
<td>$4.0$</td>
<td>$4.0$</td>
</tr>
</tbody>
</table>

Reverse recovery charge when switched from

$Q_S < 0.70 \mu\text{C}$

Reverse recovery time when switched from

$t_{rr} < 200 \text{ ns}$

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 10.

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.

| frequency | f = 20 kHz |
| duty cycle | δ = 0.5 |
| ambient temperature switched from | Tamb = 45 °C |
| to | IF = 12 A |
| at a rate | VR = 400 V |
| - dl/dt | = 20 A/μs |

At a duty cycle δ = 0.5 the average forward current IF AV = 6 A.

From the upper graph on page 5 it follows that at IF AV = 6 A the average forward power + average leakage power = 15 W (point A). Starting from IF = 12 A on the horizontal scale trace upwards until the appropriate line - 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 VR = 400 V and ultimately trace horizontally to the left and on the vertical axis read the additional average power dissipation PRAV = 4 W.

Therefore the total power dissipation Ptot = 15 W + 4 W = 19 W (point B of the upper graph on page 5). From the right hand part follows the thermal resistance, required at Tamb = 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 applicable heatsink(s) may then be found in the Section HEATSINKS.
$P = \text{power dissipation, exclusive the reverse power in the avalanche region and switching losses}$

<table>
<thead>
<tr>
<th>$T_{mb}$</th>
<th>Interrelation between the total dissipation (derived from the left hand graph) and the max. allowable temperatures</th>
</tr>
</thead>
<tbody>
<tr>
<td>$(^\circ\text{C})$</td>
<td></td>
</tr>
<tr>
<td>70</td>
<td></td>
</tr>
<tr>
<td>90</td>
<td></td>
</tr>
<tr>
<td>110</td>
<td></td>
</tr>
<tr>
<td>130</td>
<td></td>
</tr>
<tr>
<td>150</td>
<td></td>
</tr>
</tbody>
</table>

Graph showing $P$ vs. $I_{FAV}$ with various lines indicating different $T_{mb}$ values.

Graph showing max. allowable repetitive peak reverse power dissipation versus duration ($f=50\text{Hz}$).

In this region a junction temperature of 150$^\circ\text{C}$ is allowed.
Max. allowable non repetitive peak reverse pulse power dissipation in avalanche region versus duration

Max. allowable non repetitive peak reverse pulse power dissipation in avalanche region versus duration.
Fast soft-recovery rectifier diodes with controlled avalanche

**BYX30 SERIES**

Maximum permissible non-repetitive rms forward current based on sinusoidal currents (f=50Hz)

IFM = 150°C prior to surge

---

Zth(t) (°C/W)

0.01 0.1 1.0 10 100μs 1ms 10ms 100ms 1s 5s 10s

---

March 1978
Fast soft-recovery rectifier diodes with controlled avalanche

BYX30 SERIES

Maximum values; \( T_j = 25 \, ^\circ\text{C} \); switched from \( I_F \) to \( V_R \geq 30 \, \text{V} \).

Maximum values; \( T_j = 150 \, ^\circ\text{C} \); switched from \( I_F \) to \( V_R \geq 30 \, \text{V} \).
Nomogram: Power loss $P_{RAV}$ due to switching only (square wave operation)
SILICON RECTIFIER DIODES

Diffused silicon diodes in metal envelopes with ceramic insulation, intended for power rectifier application. The series consists of the following types:
Normal polarity (cathode to stud): BYX32–600 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>1200</th>
<th>1600</th>
<th>1600R</th>
</tr>
</thead>
<tbody>
<tr>
<td>V_{RWM}</td>
<td>max.</td>
<td>600</td>
<td>800</td>
<td>1000</td>
<td>1200</td>
<td>1200</td>
<td>V</td>
</tr>
<tr>
<td>V_{RRM}</td>
<td>max.</td>
<td>600</td>
<td>800</td>
<td>1000</td>
<td>1200</td>
<td>1600</td>
<td>V</td>
</tr>
<tr>
<td>I_{F(AV)}</td>
<td>max.</td>
<td>150</td>
<td>A</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>I_{FSM}</td>
<td>max.</td>
<td>1600</td>
<td>A</td>
<td></td>
<td></td>
<td></td>
<td></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)

October 1979
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>

Currents

Average forward current (averaged over any 20 ms period) up to $T_{mb} = 100 \degree C$

<table>
<thead>
<tr>
<th>IF(AV) max.</th>
<th>150 A</th>
</tr>
</thead>
</table>

Forward current (d. c.)

<table>
<thead>
<tr>
<th>$I_F$ max.</th>
<th>240 A</th>
</tr>
</thead>
</table>

R. M. S. forward current

<table>
<thead>
<tr>
<th>$I_{F(RMS)}$ max.</th>
<th>240 A</th>
</tr>
</thead>
</table>

Repetitive peak forward current

<table>
<thead>
<tr>
<th>$I_{FRM}$ max.</th>
<th>750 A</th>
</tr>
</thead>
</table>

Non-repetitive peak forward current (t = 10 ms; half sine wave) $T_j = 190 \degree C$ prior to surge

<table>
<thead>
<tr>
<th>$I_{FSM}$ max.</th>
<th>1600 A</th>
</tr>
</thead>
</table>

$I^2t$ for fusing (t = 10 ms)

<table>
<thead>
<tr>
<th>$I^2t$ max. $12800 A^2s$</th>
</tr>
</thead>
</table>

Temperatures

Storage temperature

<table>
<thead>
<tr>
<th>$T_{stg}$</th>
<th>-55 to +200 °C</th>
</tr>
</thead>
</table>

Operating junction temperature

<table>
<thead>
<tr>
<th>$T_j$ max.</th>
<th>190 °C</th>
</tr>
</thead>
</table>

THERMAL RESISTANCE

From junction to mounting base

<table>
<thead>
<tr>
<th>$R_{th \ j-mb}$ = 0.4 °C/W</th>
</tr>
</thead>
</table>

From mounting base to heatsink without heatsink compound

<table>
<thead>
<tr>
<th>$R_{th \ mb-h}$ = 0.1 °C/W</th>
</tr>
</thead>
</table>

From mounting base to heatsink with heatsink compound (Dow Corning 340)

<table>
<thead>
<tr>
<th>$R_{th \ mb-h}$ = 0.04 °C/W</th>
</tr>
</thead>
</table>

Transient thermal impedance; t = 1 ms

<table>
<thead>
<tr>
<th>$Z_{th \ j-mb}$ = 0.025 °C/W</th>
</tr>
</thead>
</table>

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

For smaller heatsinks $T_j$ should be derated. For a. c. see graph on page 3.

For continuous reverse voltage: $R_{th \ j-a} = 1 \degree C/W$, then $T_{j\max} = 184 \degree C$

$R_{th \ j-a} = 1.2 \degree C/W$, then $T_{j\max} = 180 \degree C$

$R_{th \ j-a} = 1.5 \degree C/W$, then $T_{j\max} = 175 \degree C$
**CHARACTERISTICS**

<table>
<thead>
<tr>
<th>Forward voltage</th>
<th>BYX32- 600(R)</th>
<th>800(R)</th>
<th>1000(R)</th>
<th>1200(R)</th>
<th>1600(R)</th>
</tr>
</thead>
<tbody>
<tr>
<td>IF = 500 A; Tj = 25 °C</td>
<td>V_F &lt; 1.6</td>
<td>1.6</td>
<td>1.6</td>
<td>1.6</td>
<td>1.6</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Peak reverse current</th>
<th>VRM = VRWMmax</th>
<th>TJ = 175 °C</th>
</tr>
</thead>
<tbody>
<tr>
<td>IRM &lt; 24</td>
<td>18</td>
<td>15</td>
</tr>
</tbody>
</table>

![Graph showing the interrelation between power and max. allowable temperatures](image)

* Tmb-scale is for comparison purposes only and is correct only for Rth mb-a ≤ 1.1 °C/W

**APPLICATION INFORMATION AND OPERATING NOTES**

See general pages at the beginning of this section.

---

1) Measured under pulse conditions to avoid excessive dissipation.
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

$T_j = 190^\circ$C (prior to surge)
transient thermal impedance from junction to mounting base versus time
SILICON RECTIFIER DIODES

Also available to BS9331-F127

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></th>
<th>BYX38-300(R)</th>
<th>600(R)</th>
<th>1200(R)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Repetitive peak reverse voltage</td>
<td>max. 300 V</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Average forward current</td>
<td>max. 6 A</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Non-repetitive peak forward current</td>
<td>max. 50 A</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

MECHANICAL DATA

Dimensions in mm

Net mass: 6 g
Diameter of clearance hole: max. 5,2 mm
Accessories supplied on request:
56295 (PTFE bush, 2 mica washers, plain washer, tag)
56262A (mica washer, insulating ring, plain washer)
Supplied with device: 1 nut, 1 lock washer
Nut dimensions across the flats: 9,5 mm
The mark shown applies to normal polarity types.

January 1980
RATINGS Limiting values in accordance with the Absolute Maximum System (IEC 134)

<table>
<thead>
<tr>
<th>Voltagess</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 \leq 10 \text{ 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 \(T_{mb} = 110 \degree C\) \(T_{mb} = 125 \degree C\)

\(I_{F(AV)}\) max. | 6 A | 4 A |

R. M. S. forward current

\(I_{F(RMS)}\) max. | 10 A |

Repetitive peak forward current

\(I_{FRM}\) max. | 50 A |

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

\(I_{FSM}\) max. | 50 A |

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

\(I^2t\) max. | 13 A² s |

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

\(R_{th \; j-a}\) = | 50 \degree C/W |

From junction to mounting base

\(R_{th \; j-mb}\) = | 4 \degree C/W |

From mounting base to heatsink with heatsink compound

\(R_{th \; mb-h}\) = | 0.5 \degree C/W |

without heatsink compound

\(R_{th \; mb-h}\) = | 0.6 \degree C/W |

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

\(Z_{th \; j-mb}\) = | 0.3 \degree C/W |
CHARACTERISTICS

Forward voltage

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

Reverse current

\[ V_R = V_{RWM_{\text{max}}}; \, T_j = 125 \, ^\circ C \], \quad I_R < 200 \, \mu 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 in Data Handbook Part SC1a.

1) Measured under pulse conduction 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

\[
R_{th mb-a} = \frac{10}{1,8'} + 0,5°C/W
\]

\[
T_{mb} (°C)
\]

\[
P (W)
\]

\[
I_{F(AV)} (A)
\]

\[
T_{amb} (°C)
\]

\[
V_F (V)
\]

\[
I_F (A)
\]

\[
typ\ max
\]

\[
T_j = 25°C
\]

\[
T_j = 150°C
\]

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

$I_{FS(RMS)}$ (A)

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

$V_{RWMmax}$
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 $V_{RWM}$ max.</td>
<td>600</td>
<td>800</td>
<td>1000</td>
<td>1200</td>
<td>1400</td>
</tr>
<tr>
<td>Reverse avalanche breakdown voltage $V_{(BR)R}$</td>
<td>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>9.5</td>
<td>A</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Non-repetitive peak forward current $I_{FSM}$ max.</td>
<td>125</td>
<td>A</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Non-repetitive peak reverse power dissipation $P_{RSM}$ max.</td>
<td>4</td>
<td>kW</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

MECHANICAL DATA

Fig. 1 DO—4

Dimensions in mm

Net mass: 6 g
Diameter of clearance hole: max. 5.2 mm
Accessories supplied on request:
56295 (PTFE bush, 2 mica washers, plain washer, tag).
Supplied with device: 1 nut, 1 lock-washer.
Nut dimensions across the flats: 9.5 mm.
The mark shown applies to normal polarity types.

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

September 1979
RATINGS
Limiting values in accordance with the Absolute Maximum System (IEC134)

<table>
<thead>
<tr>
<th>Voltagess*</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 $T_{mb} = 85^\circ C$

- at $T_{mb} = 125^\circ C$: $I_{F(AV)}$ max. 9.5 A
- $I_{F(AV)}$ max. 6.0 A

R.M.S. forward current $I_{F(RMS)}$ max. 15 A

Repetitive peak forward current $I_{FRM}$ max. 100 A

Non-repetitive peak forward current $I_{FSM}$ max. 125 A

RMS value for fusing ($t = 10$ ms): $I^2 t$ max. 78 A²s

**Reverse power dissipation**

Average reverse power dissipation (averaged over any 20 ms period); $T_{j} = 125^\circ C$

- $P_{R(AV)}$ max. 10 W

Repetitive peak reverse power dissipation

- $P_{RRM}$ max. 2 kW

Non-repetitive peak reverse power dissipation

- $P_{RSM}$ max. 4 kW
- $P_{RSM}$ max. 0.8 kW

**Temperatures**

Storage temperature $T_{stg}$ -55 to +175 °C

Junction temperature $T_{j}$ max. 175 °C

*To ensure thermal stability: $R_{th j-a} \leq 5 \degree C/W$ (continuous reverse voltage) or $\leq 20 \degree C/W$ (a.c.)
THERMAL RESISTANCE

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

From junction to mounting base
\[ R_{th\ j-mb} = 4.5 \, ^\circ C/W \]

From mounting base to heatsink
without heatsink compound
\[ R_{th\ mb-h} = 1.0 \, ^\circ C/W \]

with heatsink compound
\[ R_{th\ mb-h} = 0.5 \, ^\circ C/W \]

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

Transient thermal impedance; \( t = 1 \, \text{ms} \)
\[ Z_{th\ j-mb} = 0.35 \, ^\circ C/W \]

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</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>( I_F = 20 , A; T_j = 25 , ^\circ C )</td>
<td>( V_F ) ( &lt; ) 1.7 1.7 1.7 1.7 1.7 V*</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Reverse avalanche breakdown voltage</td>
<td>( V_{(BR)R} ) ( &lt; ) 2000 2000 2000 2200 2400 V</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Reverse current</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>( V_R = V_{RWM\text{max}}; T_j = 125 , ^\circ C )</td>
<td>( I_R ) ( &lt; ) 200 200 200 200 200 ( \mu A )</td>
<td></td>
<td></td>
<td></td>
<td></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 inter-relationship 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 : \( a = 2.4 \)

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

Fig. 4

Fig. 5

September 1979
max. allowable non-repetitive peak reverse power dissipation in avalanche region versus pulse duration

$P_{RSM}$ (kW)

$T_j = 25 \, ^\circ C$ prior to surge

$I_{FS(RMS)}$ (A)

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

$T_j = 175 \, ^\circ C$ prior to surge
SILICON RECTIFIER DIODES

Also available to BS9331-F128

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</td>
<td>V_{RRM} max.</td>
<td>300 V</td>
<td>600 V</td>
</tr>
<tr>
<td>Average forward current</td>
<td>I_{F(AV)} max.</td>
<td>12 A</td>
<td>12 A</td>
</tr>
<tr>
<td>Non-repetitive peak forward current</td>
<td>I_{FSM} max.</td>
<td>125 A</td>
<td>125 A</td>
</tr>
</tbody>
</table>

MECHANICAL DATA

Dimensions in mm

Net mass: 6 g
Diameter of clearance hole: 5,2 mm

Accessories supplied on request:
56295 (PTFE bush, 2 mica washers, plain washer, tag)
56262A (mica washer, insulating ring, plain washer)

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

The mark shown applies to normal polarity types.
RATINGS Limiting values in accordance with the Absolute Maximum System (IEC 134)

### Voltages

<table>
<thead>
<tr>
<th>Voltage Type</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>V_{RSM} max.</td>
<td>300</td>
<td>600</td>
</tr>
<tr>
<td>Repetitive peak reverse voltage (δ ≤ 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} = 115 °C at T_{mb} = 125 °C:
  - \( I_{F(AV)} \) max. = 12 A
  - \( I_{F(AV)} \) max. = 10 A
- **R. M. S. forward current**:
  - \( I_{F(RMS)} \) max. = 20 A
- **Repetitive peak forward current**:
  - \( I_{FRM} \) max. = 60 A
- **Non-repetitive peak forward current** (t = 10 ms; half sine-wave) \( T_j = 175 °C \) prior to surge; with reapplied \( V_{RWM\text{max}} \):
  - \( I_{FSM} \) max. = 125 A

### Temperatures

- **Storage temperature**:
  - \( T_{stg} \) = -55 to +175 °C
- **Junction temperature**:
  - \( T_j \) max. = 175 °C

### THERMAL RESISTANCE

- From junction to ambient in free air:
  - \( R_{th\ j-a} = 50 \ °C/W \)
- From junction to mounting base:
  - \( R_{th\ j-mb} = 3 \ °C/W \)
- From mounting base to heatsink:
  - \( R_{th\ mb-h} = 0.5 \ °C/W \)

### CHARACTERISTICS

- **Forward voltage** at \( I_F = 15 \ A; T_j = 25 °C \):
  - \( V_F < 1.4 \ V \)
- **Reverse current** at \( V_R = V_{RWM\text{max}}; T_j = 125 °C \):
  - \( I_R < 200 \ \mu A \)

### 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.
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 $R_{th \ mb-a} \leq 22 \, ^\circ C/W$
maximum permissible non-repetitive r.m.s. forward current based on sinusoidal currents \( f = 50 \text{ Hz} \)

\[ I_F \]

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

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

Also available to BS9333—F004

Diffused silicon diodes in a DO—1 metal envelope, capable of absorbing transients. They are intended for rectifier applications and particularly suited for series operation. The series consists of the following reverse polarity types (anode to case): BYX45—600R, BYX45—800R, BYX45—1000R, BYX45—1200R and BYX45—1400R.

QUICK REFERENCE DATA

<table>
<thead>
<tr>
<th></th>
<th>BYX45—600R</th>
<th>800R</th>
<th>1000R</th>
<th>1200R</th>
<th>1400R</th>
</tr>
</thead>
<tbody>
<tr>
<td>Crest working reverse voltage</td>
<td>V_{RWM} max.</td>
<td>600 V</td>
<td>800 V</td>
<td>1000 V</td>
<td>1200 V</td>
</tr>
<tr>
<td>Reverse breakdown voltage</td>
<td>V_{(BR)}R &gt;</td>
<td>750 V</td>
<td>1000 V</td>
<td>1250 V</td>
<td>1450 V</td>
</tr>
<tr>
<td>Average forward current</td>
<td>I_{F(AV)} max.</td>
<td>1.5 A</td>
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<td></td>
<td></td>
</tr>
<tr>
<td>Non repetitive peak forward current</td>
<td>I_{FSM} max.</td>
<td>40 A</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Non repetitive peak reverse power</td>
<td>P_{RSM} max.</td>
<td>2.5 kW</td>
<td></td>
<td></td>
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</tr>
</tbody>
</table>

MECHANICAL DATA

Fig. 1 DO—1

Dimensions in mm

September 1979
## RATINGS

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

### Voltages

<table>
<thead>
<tr>
<th></th>
<th>BYX45-600R</th>
<th>800R</th>
<th>1000R</th>
<th>1200R</th>
<th>1400R</th>
</tr>
</thead>
<tbody>
<tr>
<td>Crest working reverse voltage</td>
<td>$V_{\text{RWM}}$ max.</td>
<td>600</td>
<td>800</td>
<td>1000</td>
<td>1200</td>
</tr>
<tr>
<td>Continuous reverse voltage</td>
<td>$V_R$ max.</td>
<td>600</td>
<td>800</td>
<td>1000</td>
<td>1200</td>
</tr>
</tbody>
</table>

### Currents

- **Average forward current**
  
  (averaged over any 20 ms period) $I_{\text{F(AV)}}$ max. 1.5 A

- **R.M.S. forward current** $I_{\text{F(RMS)}}$ max. 2.4 A

- **Repetitive peak forward current** $I_{\text{FRM}}$ max. 15 A

- **Non-repetitive peak forward current**
  
  $t = 10$ ms (half sine-wave); $T_j = 150$ °C prior to surge;
  
  with reapplied $V_{\text{RWMmax}}$.

  $I_{\text{FSM}}$ max. 40 A

  $I^2t$ for fusing ($t = 10$ ms) $I_{\text{FSM}}$ max. 8 A²s

### Reverse power dissipation

- **Repetitive peak reverse power dissipation**
  
  $t = 10$ µs (square-wave; $f = 50$ Hz); $T_j = 125$ °C

  $P_{\text{PRM}}$ max. 800 W

- **Non-repetitive peak reverse power dissipation**
  
  $t = 10$ µs (square-wave)

  $T_j = 25$ °C prior to surge

  $T_j = 150$ °C prior to surge

  $P_{\text{PRSM}}$ max. 2.5 kW

  $P_{\text{PRSM}}$ max. 800 W

### Temperatures

- **Storage temperature** $T_{\text{STG}}$ -55 to +150 °C

- **Junction temperature** $T_j$ max. 150 °C
THERMAL RESISTANCE

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

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

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

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

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

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

SOLDERING AND MOUNTING NOTES

1. At a soldering iron or bath temperature of up to 245 °C, the maximum permissible soldering time is 10 s if the joint is 5 mm from the seal, 3 s if it is 1.5 mm from the seal.

2. At a temperature between 245 °C and 400 °C (max.), the joint must be more than 5 mm from the seal and soldering time must not exceed 5 s.

3. Leads should not be bent less than 1.5 mm from the seal; exert no axial pull when bending.
## CHARACTERISTICS

<table>
<thead>
<tr>
<th></th>
<th>BYX45-600R</th>
<th>800R</th>
<th>1000R</th>
<th>1200R</th>
<th>1400R</th>
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</thead>
<tbody>
<tr>
<td><strong>Forward voltage</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>$I_F = 5 \text{ A;} T_j = 25 ^\circ \text{C}$</td>
<td>$V_F$</td>
<td>1.45</td>
<td>1.45</td>
<td>1.45</td>
<td>1.45  $V^*$</td>
</tr>
<tr>
<td><strong>Reverse avalanche breakdown voltage</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>$I_R = 1 \text{ mA;} T_j = 25 ^\circ \text{C}$</td>
<td>$V(BR)R$</td>
<td>750</td>
<td>1000</td>
<td>1250</td>
<td>1450</td>
</tr>
<tr>
<td><strong>Reverse current</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>$V_R = V_{RWM_{max}}; T_j = 125 ^\circ \text{C}$</td>
<td>$I_R$</td>
<td>100</td>
<td>100</td>
<td>100</td>
<td>100   $\mu A$</td>
</tr>
</tbody>
</table>

*Measured under pulse conditions to avoid excessive dissipation.*
Controlled avalanche rectifier diodes

\[ P = \text{power dissipation, excluding the reverse power in the avalanche region} \]
\[ a = \frac{I_F(RMS)}{I_{FAV}} \]

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

Fig. 2

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

Fig. 3
Fig. 4: Max. permissible non-repetitive root mean square (RMS) forward current based on sinusoidal currents (f = 50Hz).

Fig. 5: Maximum values of reverse voltage (V_F) at different temperatures (T_j = 150°C and 25°C).
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</td>
<td>max.</td>
<td>200</td>
<td>300</td>
<td>400</td>
</tr>
<tr>
<td>Reverse avalanche breakdown voltage</td>
<td>V_(BR)R</td>
<td>&gt; 250</td>
<td>375</td>
<td>500</td>
<td>625</td>
</tr>
<tr>
<td>Average forward current</td>
<td>I_F(AV)</td>
<td>max.</td>
<td>22</td>
<td></td>
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</tr>
<tr>
<td>Non-repetitive peak forward current</td>
<td>I_FSM</td>
<td>max.</td>
<td>300</td>
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</tr>
<tr>
<td>Non-repetitive peak reverse power</td>
<td>P_RSM</td>
<td>max.</td>
<td>18</td>
<td></td>
<td></td>
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<tr>
<td>Reverse recovery time</td>
<td>t_rr</td>
<td>&lt; 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: 56295
(PTFE bush, 2 mica washers, plain washer, tag)

The mark shown applies to the normal polarity types.
BYX46 SERIES

RATINGS

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

<table>
<thead>
<tr>
<th>Voltages *</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>$V_{RWM \text{ max.}}$</td>
<td>200</td>
<td>300</td>
<td>400</td>
<td>500</td>
</tr>
<tr>
<td>Continuous reverse voltage</td>
<td>$V_R \text{ max.}$</td>
<td>200</td>
<td>300</td>
<td>400</td>
<td>500</td>
</tr>
</tbody>
</table>

**Currents**

- Average forward current (averaged over any 20 ms period)
  - up to $T_{mb} = 100$ °C: $I_{F(AV)} \text{ max.}$ = 22 A
  - at $T_{mb} = 125$ °C: $I_{F(AV)} \text{ max.}$ = 15 A
- R.M.S. forward current: $I_{F(RMS)} \text{ max.}$ = 35 A
- Repetitive peak forward current: $I_{FRM} \text{ max.}$ = 400 A
- Non-repetitive peak forward current (t = 10 ms; half-sinewave) $T_j = 165$ °C before surge; with reapplied
  - $V_{RWM\text{max}}$: $I_{FSM} \text{ max.}$ = 300 A
  - $I^2 t$ for fusing (t = 10 ms): $I^2 t \text{ max.}$ = 450 A$^2 s$

**Reverse power dissipation**

- Repetitive peak reverse power dissipation
  - $t = 10 \mu s$ (square wave; $f = 50$ Hz) $T_j = 100$ °C $P_{RRM} \text{ max.}$ = 9,5 kW
- Non-repetitive peak reverse power dissipation $t = 10 \mu s$ (square wave)
  - $T_j = 25$ °C before surge $P_{RSM} \text{ max.}$ = 18 kW
  - $T_j = 165$ °C before surge $P_{RSM} \text{ max.}$ = 4 kW

**Temperatures**

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

**THERMAL RESISTANCE**

- From junction to ambient in free air $R_{th\,j-a}$ = 50 °C/W
- From junction to mounting base $R_{th\,j-mb}$ = 1,3 °C/W
- From mounting base to heatsink $R_{th\,mb-h}$ = 0,5 °C/W

* To ensure thermal stability: $R_{th\,j-a} < 2,5$ °C/W (continuous reverse voltage) or < 5 °C/W (a.c.). For smaller heatsinks $T_j \text{ max}$ should be derated. For a.c. see page 5. For continuous reverse voltage: if $R_{th\,j-a} = 5$ °C/W, then $T_j \text{ max} = 135$ °C; if $R_{th\,j-a} = 10$ °C/W, then $T_j \text{ max} = 125$ °C.

March 1978
CHARACTERISTICS

<table>
<thead>
<tr>
<th>Description</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>VF</td>
<td>&lt; 2.0</td>
<td>2.0</td>
<td>2.0</td>
<td>2.0 V *</td>
</tr>
<tr>
<td>Reverse breakdown voltage</td>
<td>V(BR)R</td>
<td>&gt; 250</td>
<td>375</td>
<td>500</td>
<td>625</td>
</tr>
<tr>
<td>Reverse current</td>
<td>IR</td>
<td>&lt; 1050</td>
<td>1050</td>
<td>1050</td>
<td>1050</td>
</tr>
</tbody>
</table>

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

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

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 10.

* 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\text{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 | \( T_{\text{amb}} = 40 ^{\circ} \text{C} \) |
| switched from | \( I_F = 12 \text{ A} \) |
| to | \( V_R = 300 \text{ V} \) |
| at a rate | \( -\frac{dI}{dt} = 50 \text{ A/\mu s} \) |

At a duty cycle \( \delta = 0.5 \) the average forward current \( I_{FAV} = 6 \text{ A} \).

From the upper graph on page 5 it follows, that at \( I_{FAV} = 6 \text{ A} \) the average forward power + average leakage power = 13 W (point A).

The additional power losses due to switching-off can be read from the nomogram on page 10 (the example being based on optimum use, i.e. \( T_j = 165 ^{\circ} \text{C} \)). Starting from \( I_F = 12 \text{ A} \) on the horizontal scale trace upwards until the appropriate line \( -\frac{dI}{dt} = 50 \text{ A/\mu s} \). From the intersection trace horizontally to the right until the line for \( f = 20 \text{ kHz} \). Then trace downwards to the line \( V_R = 300 \text{ V} \) and ultimately trace horizontally to the left and on the vertical axis read the additional average power dissipation \( P_{RAV} = 6 \text{ W} \).

Therefore the total power dissipation \( P_{\text{tot}} = 13 \text{ W} + 6 \text{ W} = 19 \text{ W} \) (point B of the upper graph on page 5).

From the right hand part of the upper graph on page 5 follows the thermal resistance, required at \( T_{\text{amb}} = 40 ^{\circ} \text{C} \).

\[ R_{\text{th mb-a}} = 5 ^{\circ} \text{C/W} \]

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

Hence the heatsink thermal resistance should be:

\[ R_{\text{th h-a}} = R_{\text{th mb-a}} - R_{\text{th mb-h}} = (5 - 0.5) ^{\circ} \text{C/W} = 4.5 ^{\circ} \text{C/W} \]

The applicable heatsink(s) may then be found in the Section HEATSINKS.
The diagram shows the interrelation between the power (derived from the left hand graph) and the maximum allowable temperatures.

- **Single phase**: \( a = 1.6 \)
- **3-phase**: \( a = 1.75 \)
- **6-phase**: \( a = 2.4 \)

The graph illustrates the maximum allowable repetitive peak reverse power dissipation versus duration \( (f = 50 \text{ Hz}) \).

- **Maximum allowable repetitive peak reverse power dissipation**:
  - \( P_{\text{RRM}} \) in kW
  - \( T_j = 110^\circ \text{C} \), 120°C, 130°C, 140°C, 150°C, 160°C, 165°C

In this region, a junction temperature of 165°C is allowed.

---

May 1970
Max. allowable non-repetitive peak reverse pulse power dissipation in avalanche region

\[ P_{RSM} \] (kW)

- 10
- 5
- 2
- 1
- 0.5
- 0.2
- 0.1

\[ P_R \]

Duration (ms)

- 0.001
- 0.1
- 1
- 10
- 100

VR (V)

- 1000
- 500
- 200
- 100
- 50
- 20
- 10
- 5
- 2
- 1

Typical values

BYX46-200(R)
- 300(R)
- 400(R)
- 500(R)
- 600(R)
VR increases by about 0.1%/°C with increasing Tj.
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.

**Graph 1:**
- $I_{FS(MS)}$ (A) vs. Surge duration (s)
- $T_i = 165^\circ C$ prior surge

**Graph 2:**
- $I_F$ (A) vs. $V_F$ (V)
- $T_i = 25^\circ C$ and $T_i = 165^\circ C$
- $I_{typ}$, $I_{max}$, $V_F$, $V_{F_{max}}$
Fast soft-recovery rectifier diodes with controlled avalanche

BYX46 SERIES

**Graphs:***

- **Graphs 1 & 2:**
  - **Qs (μC)** vs. **- dI/dt (A/μs)**
  - For **7Z10043** and **7Z10044**
  - Curves for different **IF** values:
    - **1A**, **2A**, **5A**, **10A**, **14A**, **22A**

- **Graphs 3 & 4:**
  - **trr (ns)** vs. **- dIE/dt (A/μs)**
  - For **Max values Tj = 25°C** and **Tj = 150 °C**
  - Curves for different **IF** values:
    - **1A**, **2A**, **5A**, **10A**, **14A**, **22A**

*March 1978*
Nomogram: Power loss $P_{RAV}$ due to switching only (square wave operation)
Fast soft-recovery rectifier diodes with controlled avalanche

\[ Z_{th(t)} \quad (^\circ C/W) \]

- \( Z_{th(t)} \) is the thermal impedance of the device.
- The graph shows the thermal impedance over time for different time intervals:
  - \( t = 10\mu s \)
  - \( t = 50\mu s \)
  - \( t = 100\mu s \)
  - \( t = 1\ms \)
  - \( t = 10\ms \)
  - \( t = 100\ms \)
  - \( t = 1\s \)
  - \( t = 10\s \)

March 1978
Plastic-encapsulated rectifier diodes intended for power rectifier applications. Normal and reverse polarity types are available.

<table>
<thead>
<tr>
<th>QUICK REFERENCE DATA</th>
<th>BYX49-300(R)</th>
<th>600(R)</th>
<th>1200(R)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Repetitive peak reverse voltage</td>
<td>V&lt;sub&gt;RRM&lt;/sub&gt; max.</td>
<td>300</td>
<td>600</td>
</tr>
<tr>
<td>Average forward current</td>
<td>I&lt;sub&gt;AV&lt;/sub&gt; max.</td>
<td>6</td>
<td>A</td>
</tr>
<tr>
<td>Non-repetitive peak forward current</td>
<td>I&lt;sub&gt;FSM&lt;/sub&gt; max.</td>
<td>40</td>
<td>A</td>
</tr>
</tbody>
</table>

MECHANICAL DATA (see also page 2)

SOD-38

Dimensions in mm

The exposed metal base-plate is directly connected to tag 1.

Products approved to CECC 50 009-011, available on request

January 1980
MECHANICAL DATA (continued)

Net mass: 2.5 g

Recommended diameter of fixing screw: 3.5 mm

Torque on screw
  when using washer and heatsink compound: min. 0.95 Nm (9.5 kg cm)
    max. 1.5 Nm (15 kg cm)

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

POLARITY OF CONNECTIONS

<table>
<thead>
<tr>
<th>BYX 49-300 to BYX 49-1200</th>
<th>BYX 49-300R to BYX 49-1200R</th>
</tr>
</thead>
<tbody>
<tr>
<td>Base-plate: cathode</td>
<td>anode</td>
</tr>
<tr>
<td>Tag 1 : cathode</td>
<td>anode</td>
</tr>
<tr>
<td>Tag 2 : anode</td>
<td>cathode</td>
</tr>
</tbody>
</table>

November 1975
All information applies to frequencies up to 400 Hz.

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

### Voltages

<table>
<thead>
<tr>
<th>Description</th>
<th>BYX49-300(R)</th>
<th>600(R)</th>
<th>1200(R)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Continuous reverse voltage</td>
<td>$V_R$</td>
<td>max. 200</td>
<td>400</td>
</tr>
<tr>
<td>Crest working reverse voltage</td>
<td>$V_{RWM}$</td>
<td>max. 200</td>
<td>400</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>Non-repetitive peak reverse voltage ($t \leq 10$ ms)</td>
<td>$V_{RSM}$</td>
<td>max. 300</td>
<td>600</td>
</tr>
</tbody>
</table>

### Currents

- **Average forward current** (averaged over any 20 ms period) up to $T_{mb} = 85$ °C
  - at $T_{mb} = 120$ °C
  - without heatsink; at $T_{amb} = 50$ °C
  - $I_{F(AV)}$ max. 6.0 A
  - $I_{F(AV)}$ max. 3.0 A
  - $I_{F(AV)}$ max. 1.1 A
- **Forward current (d.c.)**
  - $I_F$ max. 9.5 A
- **R.M.S. forward current**
  - $I_{F(RMS)}$ max. 9.5 A
- **Repetitive peak forward current**
  - $I_{FRM}$ max. 20 A
- **Non-repetitive peak forward current**
  - ($t = 10$ ms; half sine wave)
  - $T_j = 150$ °C prior to surge
  - $I_{FSM}$ max. 40 A
  - $I^2t$ for fusing ($t = 10$ ms)
  - $I^2t$ max. 8.0 A²s

### Temperatures

- **Storage temperature**
  - $T_{stg}$ -55 to +125 °C
- **Junction temperature**
  - $T_j$ max. 150 °C
THERMAL RESISTANCE

From junction to mounting base

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

Influence of mounting method:

1. Heatsink mounted
   
   From mounting base to heatsink
   a. with heatsink compound
   b. with heatsink compound and 56316 mica washer
   c. without heatsink compound
   d. without heatsink compound; with 56316 mica washer

   \[ R_{\text{th } j-mb} = 4.5 \text{ °C/W} \]
   \[ Z_{\text{th } j-mb} = 0.3 \text{ °C/W} \]

   \[ R_{\text{th } mb-h} = 1.5 \text{ °C/W} \]
   \[ R_{\text{th } mb-h} = 2.7 \text{ °C/W} \]
   \[ R_{\text{th } mb-h} = 2.7 \text{ °C/W} \]
   \[ R_{\text{th } mb-h} = 5 \text{ °C/W} \]

2. Free air operation

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

   From junction to ambient in free air mounted on a printed circuit board
   at \( a = \text{ maximum lead length} \)
   and with a copper laminate
   a. > 1 cm²
   b. < 1 cm²

   \[ R_{\text{th } j-a} = 50 \text{ °C/W} \]
   \[ R_{\text{th } j-a} = 55 \text{ °C/W} \]

   \[ R_{\text{th } j-a} = 55 \text{ °C/W} \]
   \[ R_{\text{th } j-a} = 60 \text{ °C/W} \]
CHARACTERISTICS

Forward voltage
\[ I_F = 20 \, \text{A}; \quad T_j = 25 \, ^\circ\text{C} \quad \therefore \quad V_F < 2.3 \, \text{V} \]

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

SOLDERING AND MOUNTING NOTES

1. Soldered joints must be at least 2.5 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. The devices should not be immersed in oil, and few potting resins are suitable for re-encapsulation. Advice on these materials is available on request.

4. Leads should not be bent less than 2.5 mm from the seal; exert no axial pull when bending.

5. For good thermal contact heatsink compound should be used between base-plate and heatsink.

1) Measured under pulse conditions to avoid excessive dissipation.
OPERATING NOTES

Dissipation and heatsink considerations:

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

![Diagram showing dissipation components]

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

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

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

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

c. The heatsink curves are optimised to allow the junction temperature to run up to 150 °C ($T_{j max}$) whilst limiting $T_{mb}$ to 125 °C (or less).
interrelation between the power (derived from the left-hand graph) and the maximum permissible temperatures

\[ P_{tot} (W) \]

\[ I_{F(AV)} (A) \]

\[ T_{mb} (^{\circ}C) \]

\[ T_{amb} (^{\circ}C) \]

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

\[ P (W) \]

\[ I_{F(AV)} (A) \]

\[ T_{amb} (^{\circ}C) \]
maximum permissible non-repetitive peak forward current based on sinusoidal currents ($f = 50\text{Hz}$)

$I_F$ (time)
each current pulse is followed by the crest working reverse voltage

$T_i = 125^\circ\text{C}$ (prior to surge)

- $T_j = 25^\circ\text{C}$
- $T_j = 150^\circ\text{C}$

$typ + max$
FAST SOFT-RECOVERY RECTIFIER DIODES

Also available to BS9331-F028

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
Reverse polarity (anode to stud): BYX50-200R, 300R
These devices feature non-snap-off characteristics.

QUICK REFERENCE DATA

<table>
<thead>
<tr>
<th>Repetitive peak reverse voltage</th>
<th>( V_{RRM} )</th>
<th>BYX50-200(R)</th>
<th>300(R)</th>
</tr>
</thead>
<tbody>
<tr>
<td>max.</td>
<td>200</td>
<td>300</td>
<td>V</td>
</tr>
<tr>
<td>Average forward current</td>
<td>( I_F(AV) )</td>
<td>max. 7</td>
<td>A</td>
</tr>
<tr>
<td>Non-repetitive peak forward current</td>
<td>( I_{FSM} )</td>
<td>max. 80</td>
<td>A</td>
</tr>
<tr>
<td>Reverse recovery time</td>
<td>( t_{rr} )</td>
<td>&lt; 100</td>
<td>ns</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: 6 g
Diameter of clearance hole: max. 5.2 mm
Accessories supplied on request:
56295 (PTFE bush, 2 mica washers, plain washer, tag)

The mark shown applies to the normal polarity types.

January 1980
RATINGS  Limiting values in accordance with the Absolute Maximum System (IEC 134)

<table>
<thead>
<tr>
<th>Voltages</th>
<th>BYX50-200(R)</th>
<th>300(R)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Non-repetitive peak reverse voltage; t ≤ 10 ms</td>
<td>V_{RSM} max.</td>
<td>250 V</td>
</tr>
<tr>
<td>Repetitive peak reverse voltage</td>
<td>V_{RRM} max.</td>
<td>200 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

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
R. M. S. forward current
Repetitive peak forward current
Non-repetitive peak forward current
Repetitive peak forward current up to T_{mb} = 103 °C or T_{j} = 150 °C prior to surge with reapplied V_{RWM} max
l^2t for fusing (t = 10 ms)
Rate of change of commutation current

Temperatures

Storage temperature
Junction temperature

THERMAL RESISTANCE

From junction to ambient in free air
From junction to mounting base
From mounting base to heatsink
Transient thermal impedance; t = 1 ms

<table>
<thead>
<tr>
<th></th>
<th>T_{stg}</th>
<th>T_{j}</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>-55 to +150 °C</td>
<td>max. 150 °C</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th></th>
<th>R_{th j-a} = 50 °C/W</th>
</tr>
</thead>
<tbody>
<tr>
<td>From junction to mounting base</td>
<td>R_{th j-mb} = 3,5 °C/W</td>
</tr>
<tr>
<td>From mounting base to heatsink</td>
<td>R_{th mb-h} = 0,5 °C/W</td>
</tr>
<tr>
<td>Transient thermal impedance; t = 1 ms</td>
<td>Z_{th j-mb} = 1 °C/W</td>
</tr>
</tbody>
</table>
CHARACTERISTICS

Forward voltage

\[ I_F = 20 \, A; \, T_j = 25 \, ^\circ C \quad V_F < 1.95 \, V \, ^1) \]

Reverse current

\[ V_R = V_R \text{WMmax}; \, T_j = 125 \, ^\circ C \quad I_R < 3 \, mA \]

Reverse recovery when switched from

\[ I_F = 1 \, A \, \text{to} \, V_R = 30 \, V; \quad -dI_F/dt = 100 \, A/\mu s; \, T_j = 25 \, ^\circ C \quad t_{rr} < 100 \, \text{ns} \]

\[ I_F = 1 \, A \, \text{to} \, V_R = 30 \, V; \quad -dI_F/dt = 35 \, A/\mu s; \, T_j = 25 \, ^\circ C \quad t_{rr} < 150 \, \text{ns} \]

\[ I_F = 2 \, A \, \text{to} \, V_R = 30 \, V; \quad -dI_F/dt = 20 \, A/\mu s; \, T_j = 25 \, ^\circ C \quad t_{rr} < 150 \, \text{ns} \]

\[ I_F = 2 \, A \, \text{to} \, V_R = 50 \, V; \quad -dI_F/dt = 2 \, A/\mu s; \, T_j = 25 \, ^\circ C \quad Q_s < 250 \, \text{nC} \]

Max. slope of the reverse recovery current

\[ |dI_R/dt| < 5 \, A/\mu s \]

---

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

\[ P = \text{power dissipation excluding switching losses} \]

\[ a = \frac{F_{\text{RMS}}}{F_{\text{AV}}} \]

\[ a = 2.4 \]

\[ I_F, I_{F\text{typ}}, I_{F\text{max}}, V_F, T_j = 25 \, ^\circ\text{C}, T_j = 150 \, ^\circ\text{C} \]
maximum allowable non-repetitive r.m.s. forward current based on sinusoidal currents (f=50Hz)

each current pulse is followed by the crest working reverse voltage

Tj=150°C (prior to surge)

-dI/dt = 5 A/μs

IF = forward current just before switching off; Tj = 150 °C

February 1978
Transient thermal impedance from junction to mounting base versus time.

February 1973
Silicon rectifier diodes in DO-5 metal envelopes, intended for use in power rectifier applications.

The series consists of the following types:
Normal polarity (cathode to stud): BYX52-300, BYX52-600, BYX52-1200.
Reverse polarity (anode to stud): BYX52-300R, BYX52-600R, BYX52-1200R.

### Quick Reference Data

<table>
<thead>
<tr>
<th>Repetitive peak reverse voltage $V_{RRM}$</th>
<th>BYX52-300(R)</th>
<th>600(R)</th>
<th>1200(R)</th>
</tr>
</thead>
<tbody>
<tr>
<td>max. 300</td>
<td></td>
<td></td>
<td></td>
</tr>
<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

DO-5: Supplied with device: 1 nut, 1 lock-washer
Nut dimensions across the flats: 11,1 mm

Net mass: 22 g
Diameter of clearance hole: max. 6,5 mm
Accessories supplied on request:
56264A (mica washer, insulating ring, tag)

The mark shown applies to the normal polarity types.
RATINGS  Limiting values in accordance with the Absolute Maximum System (IEC 134)

<table>
<thead>
<tr>
<th>VOLTAGES</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 ≤ 10 ms)</td>
<td>VRSM</td>
<td>max. 300</td>
<td>600</td>
</tr>
<tr>
<td>Repetitive peak reverse voltage (δ = 0.01)</td>
<td>VRRM</td>
<td>max. 300</td>
<td>600</td>
</tr>
<tr>
<td>Crest working reverse voltage</td>
<td>VRWM</td>
<td>max. 200</td>
<td>400</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>CURRENTS</th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>Average forward current (averaged over any 20 ms period) up to Tmb = 112 °C at Tmb = 125 °C</td>
<td>IF(AV)</td>
</tr>
<tr>
<td>R.M.S. forward current</td>
<td>IF(RMS)</td>
</tr>
<tr>
<td>Repetitive peak forward current</td>
<td>IFRM</td>
</tr>
<tr>
<td>Non-repetitive peak forward current (t = 10 ms; half-sinewave) Tj = 175 °C prior to surge</td>
<td>IFSM</td>
</tr>
<tr>
<td>1²t for fusing (t = 10 ms)</td>
<td>I²t</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>TEMPERATURES</th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>Storage temperature</td>
<td>Tstg</td>
</tr>
<tr>
<td>Junction temperature</td>
<td>Tj</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>THERMAL RESISTANCE</th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>From junction to mounting base</td>
<td>Rth j-mb</td>
</tr>
<tr>
<td>From mounting base to heatsink</td>
<td>Rth mb-h</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>CHARACTERISTICS</th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>Forward voltage</td>
<td>IF = 150 A; Tj = 25 °C</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>REVERSE CURRENT</th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>VR = VRWmmax; Tj = 125 °C</td>
<td>IR</td>
</tr>
</tbody>
</table>

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

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); 
$T_j = 175 \, ^\circ C$ prior to surge; with reapplied $V_{RWMmax}$. 
CONTROLLED AVALANCHE RECTIFIER DIODES

Silicon diodes in a DO–5 metal envelope, capable of absorbing transients and intended for power rectifier applications.

The series consists of the following types:
- Normal polarity (cathode to stud): BYX56–600 to BYX56–1400.
- Reverse polarity (anode to stud): BYX56–600R to BYX56–1400R.

QUICK REFERENCE DATA

<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>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</td>
<td>&gt; 750</td>
<td>1000</td>
<td>1250</td>
<td>1450</td>
<td>1650</td>
</tr>
<tr>
<td>Average forward current I_(AV) max.</td>
<td>48</td>
<td>A</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Non-repetitive peak forward current I_FSM max.</td>
<td>800</td>
<td>A</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Non-repetitive peak reverse power dissipation P_RSM max.</td>
<td>40</td>
<td>kW</td>
<td></td>
<td></td>
<td></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:
56264A (mica washer, insulating ring, tag).
Supplied with device: 1 nut, 1 lock washer.
Nut dimensions across the flats: 11.1 mm.
The mark shown applies to normal polarity types.
RATINGS

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

→ Voltages*  

<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><strong>V_{RWM} max.</strong></td>
<td>600</td>
<td>800</td>
<td>1000</td>
<td>1200</td>
</tr>
<tr>
<td><strong>V_{R} max.</strong></td>
<td>600</td>
<td>800</td>
<td>1000</td>
<td>1200</td>
</tr>
</tbody>
</table>

Currents

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

R.M.S. forward current  
\[ I_{F(RMS)} \, \text{max.} \]

Repetitive peak forward current  
\[ I_{FRM} \, \text{max.} \]

Non-repetitive peak forward current  
\( t = 10 \, \text{ms} \) (half sine-wave);  
\( T_{j} = 175 \, ^\circ C \) prior to surge;  
with reapplied \( V_{RWM\text{max}} \)  
\[ I_{FSM} \, \text{max.} \]

\( I^2 t \) for fusing (\( t \leq 10 \, \text{ms} \))  
\[ I^2 t \, \text{max.} \]

Reverse power dissipation

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

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  
\[ P_{RSM} \, \text{max.} \]

Temperatures

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

Junction temperature  
\( T_{j} \)  
max. 175 \( ^\circ C \)

THERMAL RESISTANCE

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

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

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

*To ensure thermal stability: \( R_{th \, j-a} < 2.2 \, ^\circ C/\text{W} \) (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>Forward voltage</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>$I_F = 150 , A; , T_j = 25 , ^\circ C$</td>
<td>$V_F$</td>
<td>1.8</td>
<td>1.8</td>
<td>1.8</td>
<td>1.8</td>
</tr>
<tr>
<td>Reverse avalanche breakdown voltage</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>$I_R = 5 , mA; , T_j = 25 , ^\circ C$</td>
<td>$V_{(BR)R}$</td>
<td>750</td>
<td>1000</td>
<td>1250</td>
<td>1450</td>
</tr>
<tr>
<td>Reverse current</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>$V_R = V_{RWMmax}$;</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>$T_j = 125 , ^\circ C$</td>
<td>$I_R$</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.
$P =$ power excluding avalanche losses

\[
\alpha = \frac{I_{F(RMS)}}{I_{F(AV)}}
\]

interrelation between the power (derived from the left hand graph) and the max. allowable temperatures

$T_{mb}$ (°C)

Fig. 3

maximum allowable non repetitive peak reverse pulse power dissipation in avalanche region

$P_{RSM}$ (kW)

Fig. 4
ΔT = necessary derating of $T_{j\text{MAX}}$ to accommodate repetitive transients in the reverse direction. Allowance can be made for this by assuming the ambient temperature $ΔT$ higher.
maximum permissible non-repetitive r.m.s. forward current based on sinusoidal currents (f=50Hz)

\[ I_F \]

duration

each current pulse is followed by the crest working reverse voltage

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

transient thermal impedance from junction to heatsink versus time

**Fig. 7**

**Fig. 8**
FAST SOFT-RECOVERY RECTIFIER DIODES

Silicon double-diffused rectifier diodes in plastic envelopes. 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 devices feature non-snap-off characteristics. Normal and reverse polarity types are available.

| QUICK REFERENCE DATA |
|----------------------|------------------|------------------|
| Repetitive peak reverse voltage V_{RRM} max. | BYX71-350(R) 350 | 600(R) 600 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} < | 450 ns |

MECHANICAL DATA (see also page 2)

Dimensions in mm

The exposed metal base-plate is directly connected to tag 1.
MECHANICAL DATA (continued)

Net mass: 2.5 g

Recommended diameter of fixing screw: 3.5 mm

Torque on screw
  when using washer and heatsink compound: min. 0.95 Nm (9.5 kg cm)
  max. 1.5 Nm (15 kg cm)

Accessories:
  supplied with the device: 56355 (washer)
  available on request: 56316 (mica insulating washer)

POLARITY OF CONNECTIONS

<table>
<thead>
<tr>
<th>BYX71-350 and BYX71-600</th>
<th>BYX71-350R and BYX71-600R</th>
</tr>
</thead>
<tbody>
<tr>
<td>Base-plate:</td>
<td></td>
</tr>
<tr>
<td>Tag 1</td>
<td>cathode</td>
</tr>
<tr>
<td>Tag 2</td>
<td>anode</td>
</tr>
<tr>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>cathode</td>
</tr>
<tr>
<td></td>
<td>anode</td>
</tr>
<tr>
<td></td>
<td>cathode</td>
</tr>
</tbody>
</table>
RATINGS  Limiting values in accordance with the Absolute Maximum System (IEC134)

<table>
<thead>
<tr>
<th></th>
<th>BYX71-350(R)</th>
<th>600(R)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Continuous reverse voltage</td>
<td>$V_R$ max. 300</td>
<td>500 V</td>
</tr>
<tr>
<td>Working reverse voltage</td>
<td>$V_{RW}$ max. 300</td>
<td>500 V</td>
</tr>
<tr>
<td>Repetitive peak reverse voltage ($\delta \leq 0.01$)</td>
<td>$V_{RRM}$ max. 350</td>
<td>600 V</td>
</tr>
<tr>
<td>Non-repetitive peak reverse voltage ($t \leq 10$ ms)</td>
<td>$V_{RSM}$ max. 350</td>
<td>600 V</td>
</tr>
</tbody>
</table>

Currents

Average on-state current assuming zero switching losses
(averaged over any 20 ms period)
- square wave: $\delta = 0.5$; up to $T_{mb} = 85$ °C
  without heatsink at $T_{amb} = 50$ °C
  $I_{F(AV)}$ max. 7 A
- sinusoidal:
  at $T_{mb} = 85$ °C
  $I_{F(AV)}$ max. 6.5 A

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

Repetitive peak forward current
- $I_{FRM}$ max. 25 A

Non-repetitive peak forward current
- half sine wave; $t = 10$ ms; $T_j = 150$ °C prior to surge
  $I_{FSM}$ max. 60 A
- square pulse; $t = 5$ ms; $T_j = 150$ °C prior to surge
  $I_{FSM}$ max. 60 A

Rate of change of commutation current
- $\frac{di}{dt}$ max. 50 A/μs

Temperatures

- Storage temperature
  $T_{stg}$ -55 to +125 °C

- Junction temperature
  $T_j$ max. 150 °C
THERMAL RESISTANCE

From junction to mounting base

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

\[ R_{\text{th j-mb}} = 6.5 \, ^\circ\text{C}/\text{W} \]
\[ Z_{\text{th j-mb}} = 0.3 \, ^\circ\text{C}/\text{W} \]

Influence of mounting method

1. Heatsink mounted
   
   From mounting base to heatsink:
   a. with heatsink compound
   b. with heatsink compound and 56316 mica washer
   c. without heatsink compound
   d. without heatsink compound; with 56316 mica washer

   \[ R_{\text{th mb-h}} = 1.5 \, ^\circ\text{C}/\text{W} \]
   \[ R_{\text{th mb-h}} = 2.7 \, ^\circ\text{C}/\text{W} \]
   \[ R_{\text{th mb-h}} = 2.7 \, ^\circ\text{C}/\text{W} \]
   \[ R_{\text{th mb-h}} = 5 \, ^\circ\text{C}/\text{W} \]

2. Free air operation

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

   From junction to ambient in free air mounted on a printed circuit board at \( a = \) maximum lead length and with a copper laminate
   a. > 1 cm\(^2\)
   b. < 1 cm\(^2\)

   \[ R_{\text{th j-a}} = 50 \, ^\circ\text{C}/\text{W} \]
   \[ R_{\text{th j-a}} = 55 \, ^\circ\text{C}/\text{W} \]

   at a lead-length \( a = 3 \text{ mm} \) and with a copper laminate
   c. > 1 cm\(^2\)
   d. < 1 cm\(^2\)

   \[ R_{\text{th j-a}} = 55 \, ^\circ\text{C}/\text{W} \]
   \[ R_{\text{th j-a}} = 60 \, ^\circ\text{C}/\text{W} \]
SOLDERING AND MOUNTING NOTES

1. Soldered joints must be at least 2.5 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. The device should not be immersed in oil, and few potting resins are suitable for re-encapsulation. Advice on these materials is available on request.
4. Leads should not be bent less than 2.5 mm from the seal; exert no axial pull when bending.
5. For good thermal contact heatsink compound should be used between base-plate and heatsink.

CHARACTERISTICS

Forward voltage
\[ I_F = 5 \text{ A; } T_j = 25 \text{ °C} \]
\[ V_F < 1.25 \text{ V} \]

Reverse current
\[ V_R = V_R \text{ Wmax; } T_j = 125 \text{ °C} \]
\[ I_R < 0.4 \text{ mA} \]

Reverse recovery when switched from
\[ I_F = 2 \text{ A to } V_R = 30 \text{ V with } -dI_F/dt = 20 \text{ A/μs; } T_j = 25 \text{ °C} \]

Recovery charge
\[ Q_S < 700 \text{ nC} \]

Recovery time
\[ t_{rr} < 450 \text{ ns} \]

Max. slope of the reverse recovery current
\[ |dI_R/dt| < 5 \text{ A/μs} \]

1) Measured under pulse conditions to avoid excessive dissipation.
CHARACTERISTICS (continued)

Forward recovery when switched to

IF = 25 A with tr = 0, 5 μs at Tj = 25 °C

Recovery time

Recovery voltage

\[
\begin{align*}
t_{fr} & < 0,8 \ \mu s \\
V_{fr} & < 3,5 \ V
\end{align*}
\]

Forward output waveform
OPERATING NOTES

Dissipation and heatsink considerations:

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

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

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

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

\[ \delta = 0, 0.25, 0.50, 0.75, 1 \]

\[ P (W) \]

\[ P = \text{power excluding switching losses} \]

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

\[ I_F(AV) \text{ per diode} \]
SWITCHED-MODE APPLICATION

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

mounting method 2a
2b; 2c
2d

SCAN RECTIFICATION

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

mounting method 2a
2b; 2c
2d
maximum permissible non-repetitive peak forward current based on sinusoidal currents (f = 50 Hz)

IFSM, time

each current pulse is followed by the working reverse voltage

Tj = 150 °C prior to surge

IF (A)

IF (A)

Tj = 25 °C

Tj = 150 °C

VF (V)

0

1

2

0

10^{-2}

10^{-1}

1

10

10^{2}

duration (s)

VF (V)

0

1

2

0

10^{-2}

10^{-1}

1

10

10^{2}

duration (s)
Nomogram: power loss $\Delta P_{R(AV)}$ due to switching only (to be added to forward and reverse power losses).
T<sub>j</sub> = 25 °C
max. values

T<sub>j</sub> = 150 °C
max. values
RECTIFIER DIODES

Also available to BS9331-F129

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

<table>
<thead>
<tr>
<th>QUICK REFERENCE DATA</th>
</tr>
</thead>
<tbody>
<tr>
<td>Repetitive peak reverse voltage ( V_{RRM} )</td>
</tr>
<tr>
<td>BYX96-300</td>
</tr>
<tr>
<td>BYX96-300R</td>
</tr>
<tr>
<td>max. 300</td>
</tr>
</tbody>
</table>

| Average forward current \( I_{F(AV)} \) max. 30 A |

| Non-repetitive peak forward current \( I_{FSM} \) max. 400 A |

<table>
<thead>
<tr>
<th>MECHANICAL DATA</th>
</tr>
</thead>
<tbody>
<tr>
<td>Dimensions in mm</td>
</tr>
<tr>
<td>Fig. 1 DO-4: with metric M5 stud (φ 5 mm); e.g. BYX96-300(R).</td>
</tr>
<tr>
<td>Types with 10-32 UNF stud (φ 4.83 mm) are available on request. These are indicated by the suffix U; e.g. BYX96-300U(RU).</td>
</tr>
</tbody>
</table>

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: accessories 56295
(PTFE bush, 2 mica washers, plain washer, tag)
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) |

January 1980
### RATINGS

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

<table>
<thead>
<tr>
<th>Voltagess 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 ≤ 10 ms)</td>
<td>$V_{RSM}$ max.</td>
<td>300</td>
<td>600</td>
<td>1200</td>
</tr>
<tr>
<td>Repetitive peak reverse voltage (5 ≤ 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 $T_{mb} = 125$ °C
  - $I_{F(AV)}$ max. 30 A
- R.M.S. forward current
  - $I_{F(RMS)}$ max. 48 A
- Repetitive peak forward current
  - $I_{F(RM)}$ max. 400 A
- Non-repetitive peak forward current
  - (t = 10 ms; half sine-wave) $T_j = 175$ °C prior to surge;
    - with reapplied $V_{RWM\max}$
  - $I_{FSM}$ max. 400 A
- $I^2t$ for fusing (t = 10 ms)
  - $I^2t$ max. 800 $A^2s$

### Temperatures

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

### THERMAL RESISTANCE

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

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

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

For continuous reverse voltage:
- if $R_{th\ j-a} = 4$ °C/W, then $T_{j\ max} = 138$ °C,
- if $R_{th\ j-a} = 6$ °C/W, then $T_{j\ max} = 125$ °C.
CHARACTERISTICS

Forward voltage

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

$V_F < 1.7 \, \text{V}$ \(^1\)

Reverse current

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

$I_R < 1 \, \text{mA}$

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 in Data Handbook Part SC1a.

---

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

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

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 \( R_{th} \) mb-a \( \leq 6.5 \degree C/W \)

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

$I_F$  
$\cdot I_{FSM}$  
$\cdot I_{FS(RMS)}$

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

$T_J = 175 \, ^\circ C$ prior to surge

$T_J = 25 \, ^\circ C$  
$T_J = 175 \, ^\circ C$

$V_F$ (V)  
$I_F$ (A)
RECTIFIER DIODES

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>BYX97-300</th>
<th>600</th>
<th>1200</th>
<th>1600</th>
</tr>
</thead>
<tbody>
<tr>
<td>Repetitive peak reverse voltage VRRM max.</td>
<td>300</td>
<td>600</td>
<td>1200</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>BYX97-300R</th>
<th>600R</th>
<th>1200R</th>
<th>1600R</th>
</tr>
</thead>
<tbody>
<tr>
<td>Repetitive peak reverse voltage VRRM max.</td>
<td>300R</td>
<td>600R</td>
<td>1200R</td>
</tr>
</tbody>
</table>

Average forward current $I_{F(AV)}$ max. 47 A
Non-repetitive peak forward current $I_{FSM}$ max. 800 A

### MECHANICAL DATA

**Dimensions in mm**

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

Net mass: 22 g
Diameter of clearance hole: max. 6.5 mm
Supplied on request: accessories 56264A
(mica washer, insulating ring, tag)
a version with insulated flying leads
The mark shown applies to normal polarity types

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

January 1980
### RATINGS

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

#### Voltages 1)

<table>
<thead>
<tr>
<th>Parameter</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 ≤ 10 ms)</td>
<td>$V_{RSM}$ max.</td>
<td>300</td>
<td>600</td>
<td>1200</td>
</tr>
<tr>
<td>Repetitive peak reverse voltage ($t ≤ 0.01$)</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

<table>
<thead>
<tr>
<th>Current</th>
<th>BYX97-300(R)</th>
<th>600(R)</th>
<th>1200(R)</th>
<th>1600(R)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Average forward current (averaged over any 20 ms period) up to $T_{mb} = 120 , ^\circ\text{C}$ at $T_{mb} = 125 , ^\circ\text{C}$</td>
<td>$I_{F(AV)}$ max.</td>
<td>47</td>
<td>40</td>
<td></td>
</tr>
<tr>
<td>R.M.S. forward current</td>
<td>$I_{F(RMS)}$ max.</td>
<td>75</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Repetitive peak forward current</td>
<td>$I_{FRM}$ max.</td>
<td>550</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Non-repetitive peak forward current</td>
<td>$I_{FSM}$ max.</td>
<td>800</td>
<td></td>
<td></td>
</tr>
<tr>
<td>$I_{2t}$ for fusing (t = 10 ms)</td>
<td>$I_{2t}$ max.</td>
<td>3200</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

#### Temperatures

<table>
<thead>
<tr>
<th>Temperature</th>
<th>BYX97-300(R)</th>
<th>600(R)</th>
<th>1200(R)</th>
<th>1600(R)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Storage temperature</td>
<td>$T_{stg}$</td>
<td>-55 to +150</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Junction temperature</td>
<td>$T_j$ max.</td>
<td>150</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

#### THERMAL RESISTANCE

<table>
<thead>
<tr>
<th>Resistance</th>
<th>BYX97-300(R)</th>
<th>600(R)</th>
<th>1200(R)</th>
<th>1600(R)</th>
</tr>
</thead>
<tbody>
<tr>
<td>From junction to mounting base</td>
<td>$R_{th, j-mb}$ =</td>
<td>0.6</td>
<td></td>
<td></td>
</tr>
<tr>
<td>From mounting base to heatsink without heatsink compound</td>
<td>$R_{th, mb-h}$ =</td>
<td>0.3</td>
<td></td>
<td></td>
</tr>
<tr>
<td>with heatsink compound</td>
<td>$R_{th, mb-h}$ =</td>
<td>0.2</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Transient thermal impedance; t = 1 ms</td>
<td>$Z_{th, j-mb}$ =</td>
<td>0.1</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

1) To ensure thermal stability: $R_{th\, j-a} ≤ 1 \, ^\circ\text{C/W}$ (continuous reverse voltage) or ≤ 4 \, ^\circ\text{C/W} (a.c.).

For smaller heatsinks $T_j$ max should be derated. For a.c. see page 4.

For continuous reverse voltage: if $R_{th\, j-a} = 2 \, ^\circ\text{C/W}$, then $T_j$ max = 138 \, ^\circ\text{C},

if $R_{th\, j-a} = 3 \, ^\circ\text{C/W}$, then $T_j$ max = 125 \, ^\circ\text{C}.

February 1978
CHARACTERISTICS

Forward voltage
\[ I_F = 150 \text{ A; } T_j = 25 \text{ °C} \]
\[ V_F < 1.45 \text{ V} \]

Reverse current
\[ V_R = V_{RWM_{\text{max}}} \text{; } T_j = 125 \text{ °C} \]
\[ I_R < 4 \text{ mA} \]

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 in Data Handbook Part SC1a.

\[ 1) \text{ Measured under pulse conditions to avoid excessive dissipation.} \]
single phase: \( a = 1.6 \)

3-phase : \( a = 1.75 \)  \( a = \frac{I_F(RMS)}{I_F(AV)} \)

6-phase : \( a = 2.4 \)  \( I_F(AV) \)

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 \( R_{th mb-a} \leq 3.4 \) °C/W

November 1975
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

- \( T_j = 25^\circ C \)
- \( T_j = 150^\circ C \)
$Z_{th,j-mb}$

($^\circ$C/W)

10

1

$10^{-1}$

$10^{-2}$

$10^{-3}$

$10^{-4}$

$10^{-5}$

time (s)

10

November 1975
Silicon rectifier diodes in DO-4 metal envelopes, intended for use in power rectifier applications.

The series consists of the following types:
- Normal polarity (cathode to stud): BYX98-300 to 1200.
- Reverse polarity (anode to stud): BYX98-300R to 1200R.

### QUICK REFERENCE DATA

<table>
<thead>
<tr>
<th></th>
<th>BYX98-300</th>
<th>600</th>
<th>1200</th>
</tr>
</thead>
<tbody>
<tr>
<td>Repetitive peak reverse voltage $V_{RRM}$ max.</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Average forward current $I_{F(AV)}$ max.</td>
<td>10 A</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Non-repetitive peak forward current $I_{FSM}$ max.</td>
<td>75 A</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
- Diameter of clearance hole: max. 5.2 mm

Torque on nut: min. 0.9 Nm
max. 1.7 Nm

Products approved to CECC 50 009-004, available on request
RATINGS  Limiting values in accordance with the Absolute Maximum System (IEC 134)

<table>
<thead>
<tr>
<th>Voltages</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 ≤ 10 ms)</td>
<td>$V_{RSM}$ max.</td>
<td>300</td>
<td>600</td>
</tr>
<tr>
<td>Repetitive peak reverse voltage (δ ≤ 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 $T_{mb} = 97 \, ^\circ C$

- $I_{F(AV)}$ max. 10 A
- $I_{F(AV)}$ max. 6 A

R.M.S. forward current

- $I_{F(RMS)}$ max. 16 A
- $I_{FRM}$ max. 75 A

Repetitive peak forward current

Non-repetitive peak forward current

- $I_{FSM}$ max. 75 A
- $I^2t$ max. 28 $A^2s$

Temperatures

- Storage temperature $T_{stg}$
  - -55 to +150 $^\circ C$

- Junction temperature $T_j$
  - max. 150 $^\circ C$

THERMAL RESISTANCE

- From junction to ambient in free air $R_{th\ j-a} = 50 \, ^\circ C/W$
- From junction to mounting base $R_{th\ j-mb} = 3 \, ^\circ C/W$
- From mounting base to heatsink with heatsink compound $R_{th\ mb-h} = 0.5 \, ^\circ C/W$
- From mounting base to heatsink without heatsink compound $R_{th\ mb-h} = 0.6 \, ^\circ C/W$
- Transient thermal impedance; t = 1 ms $Z_{th\ j-mb} = 0.3 \, ^\circ C/W$
CHARACTERISTICS

Forward voltage

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

\[ V_F < 1.7 \, \text{V} \]

Reverse current

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

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

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 in Data Handbook Part SC1a.

1) Measured under pulse conditions to avoid excessive dissipation.

---

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

<table>
<thead>
<tr>
<th>single phase: ( a = 1.6 )</th>
<th>3-phase: ( a = 1.75 )</th>
<th>6-phase: ( a = 2.4 )</th>
<th>( I_F (\text{RMS}) ) ( I_F (\text{AV}) )</th>
</tr>
</thead>
</table>

---

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

$I_F$ — $I_{FS(M)}$ — $I_{FS(RMS)}$ with reapplied $V_{RWMmax}$

$T_j = 150 \degree C$ prior to surge

$T_j = 25 \degree C$ — $T_j = 150 \degree C$
RECTIFIER DIODES

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

The series consists of the following types:
Normal polarity (cathode to stud): BYX99-300 to 1200.
Reverse polarity (anode to stud): BYX99-300R to 1200R.

QUICK REFERENCE DATA

| Repetitive peak reverse voltage $V_{RRM}$ max. | BYX99-300 | 600 | 1200 |
| BYX99-300R | 600R | 1200 |

Average forward current $I_{F(AV)}$ max. 15 A
Non-repetitive peak forward current $I_{FSM}$ max. 180 A

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:
56295 (PTFE bush, 2 mica washers, plain washer, tag)

The mark shown applies to the normal polarity types

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

January 1980
RATINGS  Limiting values in accordance with the Absolute Maximum System (IEC 134)

### Voltages

<table>
<thead>
<tr>
<th></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 ($t ≤ 0.01$)</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

<table>
<thead>
<tr>
<th></th>
<th>BYX99-300(R)</th>
<th>600(R)</th>
<th>1200(R)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Average forward current (averaged over any 20 ms period) up to $T_{mb} = 129 ^\circ C$</td>
<td>$I_{F(AV)}$ max.</td>
<td>15 A</td>
<td></td>
</tr>
<tr>
<td>R.M.S. forward current</td>
<td>$I_{F(RMS)}$ max.</td>
<td>24 A</td>
<td></td>
</tr>
<tr>
<td>Repetitive peak forward current</td>
<td>$I_{FRM}$ max.</td>
<td>180 A</td>
<td></td>
</tr>
<tr>
<td>Non-repetitive peak forward current (t = 10 ms; half sine-wave) $T_j = 175 ^\circ C$ prior to surge; with reapplied $V_{RWM}$max</td>
<td>$I_{FSM}$ max.</td>
<td>180 A</td>
<td></td>
</tr>
<tr>
<td>$I^2t$ for fusing (t = 10 ms)</td>
<td>$I^2t$ max.</td>
<td>162 $A^2s$</td>
<td></td>
</tr>
</tbody>
</table>

### Temperatures

<table>
<thead>
<tr>
<th></th>
<th>BYX99-300(R)</th>
<th>600(R)</th>
<th>1200(R)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Storage temperature</td>
<td>$T_{stg}$</td>
<td>-55 to +175 $^\circ C$</td>
<td></td>
</tr>
<tr>
<td>Junction temperature</td>
<td>$T_j$</td>
<td>max. 175 $^\circ C$</td>
<td></td>
</tr>
</tbody>
</table>

### THERMAL RESISTANCE

<table>
<thead>
<tr>
<th></th>
<th>BYX99-300(R)</th>
<th>600(R)</th>
<th>1200(R)</th>
</tr>
</thead>
<tbody>
<tr>
<td>From junction to ambient in free air</td>
<td>$R_{th j-a}$ =</td>
<td>50 $^\circ C/W$</td>
<td></td>
</tr>
<tr>
<td>From junction to mounting base</td>
<td>$R_{th j-mb}$ =</td>
<td>2,3 $^\circ C/W$</td>
<td></td>
</tr>
<tr>
<td>From mounting base to heatsink with heatsink compound</td>
<td>$R_{th mb-h}$ =</td>
<td>0,5 $^\circ C/W$</td>
<td></td>
</tr>
<tr>
<td>without heatsink compound</td>
<td>$R_{th mb-h}$ =</td>
<td>0,6 $^\circ C/W$</td>
<td></td>
</tr>
<tr>
<td>Transient thermal impedance; t = 1 ms</td>
<td>$R_{th mb}$ =</td>
<td>0,13 $^\circ C/W$</td>
<td></td>
</tr>
</tbody>
</table>
CHARACTERISTICS

Forward voltage

\[ I_F = 50 \, A; \, T_j = 25 \, ^\circ C \]

\[ V_F < 1.55 \, V \]

Reverse current

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

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

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 in Data Handbook Part SC1a.

\[ 1) \text{Measured under pulse conduction to avoid excessive dissipation.} \]
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.

$P (W)$

$IF_{(AV)} (A)$

$T_{amb} (°C)$

$IF_{(RMS)} (A)$

$T_{mb} (°C)$
maximum permissible non-repetitive r.m.s. forward current based on sinusoidal currents (f = 50 Hz)

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

time

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

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

$10^{-2}$  
$10^{-1}$  
$10^{-4}$  
$10^{-3}$  
$10^{-2}$

time (s)  
10
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 and 1N3882.
Reverse polarity (anode to stud): 1N3879R, 1N3880R, 1N3881R and 1N3882R.

QUICK REFERENCE DATA

<table>
<thead>
<tr>
<th></th>
<th>1N3879(R)</th>
<th>1N3880(R)</th>
<th>1N3881(R)</th>
<th>1N3882(R)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Repetitive peak reverse voltage</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>$V_{RRM}$ max. 50</td>
<td>100</td>
<td>200</td>
<td>300</td>
<td>V</td>
</tr>
<tr>
<td>Average forward current</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>$I_{F(AV)}$ max. 6 A</td>
<td></td>
<td></td>
<td></td>
<td>A</td>
</tr>
<tr>
<td>Non-repetitive peak forward current</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>$I_{FSM}$ max. 80 A</td>
<td></td>
<td></td>
<td></td>
<td>A</td>
</tr>
<tr>
<td>Reverse recovery time</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>$t_{rr}$ &lt; 200 ns</td>
<td></td>
<td></td>
<td></td>
<td>ns</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:
56295 (PTFE bush, 2 mica washers, plain washer, tag)
Supplied with device: 1 nut, 1 lock washer
Nut dimensions across the flats: 9,5 mm
The mark shown applies to the normal polarity types.

Products approved to CECC 50 009-006, available on request.

January 1980
RATINGS Limiting values in accordance with the Absolute Maximum System (IEC 134)

Voltages

<table>
<thead>
<tr>
<th></th>
<th>1N3879(R)</th>
<th>1N3880(R)</th>
<th>1N3881(R)</th>
<th>1N3882(R)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Non-repeatitive peak reverse voltage</td>
<td>VRSM max.</td>
<td>100</td>
<td>150</td>
<td>250</td>
</tr>
<tr>
<td>(t ≤ 10 ms)</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Repetitive peak reverse voltage</td>
<td>VRRM max.</td>
<td>50</td>
<td>100</td>
<td>200</td>
</tr>
<tr>
<td>(δ ≤ 0.01)</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Crest working reverse voltage</td>
<td>VRWM max.</td>
<td>50</td>
<td>100</td>
<td>200</td>
</tr>
</tbody>
</table>

Currents

Average on-state current assuming zero switching losses (averaged over any 20 ms period)

- up to T_{mb} = 100 °C
- at T_{mb} = 125 °C

R. M. S. forward current

If(RMS) max. 10 A

Repetitive peak forward current

If(RM) max. 75 A

Non-repeatitive peak forward current

- T_j = 150 °C prior to surge;
- half sine-wave with reapplied V_{RWMmax};

- t = 10 ms
- t = 8.3 ms

I^2t for fusing (t = 10 ms)

Temperatures

- Storage temperature T_{stg} -65 to +175 °C
- Operating junction temperature T_j max. 150 °C

THERMAL RESISTANCE

- From junction to ambient in free air R_{th j-a} = 50 °C/W
- From junction to mounting base R_{th j-mb} = 4.4 °C/W
- From mounting base to heatsink R_{th mb-h} = 0.5 °C/W
- Transient thermal impedance; t = 1 ms; δ = 0 Z_{th j-mb} = 1 °C/W

February 1978
CHARACTERISTICS

Forward voltage \(^1\)

\[ I_F = 6 \text{ A}; T_j = 25 \, \text{°C} \]

\[ V_F < 1.4 \, \text{V} \]

Reverse current

\[ V_R = V_{RWM} \text{max}; T_j = 125 \, \text{°C} \]

\[ I_R < 3 \, \text{mA} \]

Reverse recovery when switched from

\[ I_F = 1 \, \text{A to} \, V_R = 30 \, \text{V}; \]
\[ -\frac{dI_F}{dt} = 35 \, \text{A/μs}; T_j = 25 \, \text{°C} \]

Recovery time

\[ t_{rr} < 200 \, \text{ns} \]

\[ I_F = 2 \, \text{A to} \, V_R = 30 \, \text{V}; \]
\[ -\frac{dI_F}{dt} = 20 \, \text{A/μs}; T_j = 25 \, \text{°C} \]

Recovery charge

\[ Q_s < 250 \, \text{nC} \]

\[ I_F = 1 \, \text{A to} \, V_R = 30 \, \text{V}; \]
\[ -\frac{dI_F}{dt} = 2 \, \text{A/μs}; T_j = 25 \, \text{°C} \]

Max. slope of the reverse recovery current

\[ |\frac{dI_R}{dt}| < 5 \, \text{A/μs} \]

---

\(^1\) Measured under pulse conditions to avoid excessive dissipation.
$P = \text{power dissipation excluding switching losses}$

$\alpha = \frac{I_F^{(RMS)}}{I_F^{(AV)}}$

Interrelation between the power (derived from the left-hand graph) and the maximum permissible temperatures.
maximum permissible non-repetitive r.m.s. forward current based on sinusoidal currents (f = 50 Hz)

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

with reapplied \( V_{RWMmax} \)

\[ T_j = 150°C \text{ (prior to surge)} \]

\[ Z_{th j-mb} (°C/W) \]

\[ \delta = 1 \]

\[ \delta = 0 \]

February 1978
NOMOGRAM
Power loss $\Delta P_{R(AV)}$ due to switching only (to be added to steady state power losses).
FAST SOFT-RECOVERY RECTIFIER DIODES

Silicon diodes, each in a DO-4 metal envelope, featuring non-snap-off characteristics, and intended for use in high-frequency power supplies, thyristor inverters and multi-phase power rectifier applications. The series consists of the following types:
Normal polarity (cathode to stud): 1N3889, 1N3890, 1N3891 and 1N3892.
Reverse polarity (anode to stud): 1N3889R, 1N3890R, 1N3891R and 1N3892R.

QUICK REFERENCE DATA

<table>
<thead>
<tr>
<th>Repetitive peak reverse voltage</th>
<th>V_{RRM}</th>
<th>1N3889(R)</th>
<th>1N3890(R)</th>
<th>1N3891(R)</th>
<th>1N3892(R)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Max.</td>
<td>50</td>
<td>100</td>
<td>200</td>
<td>300</td>
<td></td>
</tr>
<tr>
<td>Average forward current</td>
<td>I_{F(AV)}</td>
<td>12 A</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Non-repetitive peak forward current</td>
<td>I_{FSM}</td>
<td>150 A</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Reverse recovery time</td>
<td>t_{rr}</td>
<td>&lt;</td>
<td>200 ns</td>
<td></td>
<td></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:
56295 (PTFE bush, 2 mica washers, plain washer, tag)
Supplied with device: 1 nut, 1 lock washer
Nut dimensions across the flats: 9,5 mm
The mark shown applies to the normal polarity types.

Products approved to CECC 50 009-007, available on request

January 1980
**RATINGS** Limiting values in accordance with the Absolute Maximum System (IEC134)

### Voltages

<table>
<thead>
<tr>
<th></th>
<th>VRSM</th>
<th>VRSMmax</th>
<th>VRSMmax</th>
<th>VRSMmax</th>
<th>VRSMmax</th>
</tr>
</thead>
<tbody>
<tr>
<td>Non-repetitive peak reverse voltage ((t \leq 10 \text{ ms}))</td>
<td>100</td>
<td>150</td>
<td>250</td>
<td>350</td>
<td></td>
</tr>
<tr>
<td>Repetitive peak reverse voltage ((\delta \leq 0,01))</td>
<td>50</td>
<td>100</td>
<td>200</td>
<td>300</td>
<td></td>
</tr>
<tr>
<td>Crest working reverse voltage (V_{RWM}) max.</td>
<td>50</td>
<td>100</td>
<td>200</td>
<td>300</td>
<td></td>
</tr>
</tbody>
</table>

### Currents

Average on-state current assuming zero switching losses (averaged over any 20 ms period)
- up to \(T_{mb} = 100 \degree \text{C}\)
- at \(T_{mb} = 125 \degree \text{C}\)
- \(I_{F(AV)}\) max. \(12 \text{ A}\)
- \(I_{F(AV)}\) max. \(7 \text{ A}\)
- \(I_{F(RMS)}\) max. \(20 \text{ A}\)
- \(I_{FRM}\) max. \(140 \text{ A}\)
- \(I_{FSM}\) max. \(140 \text{ A}\)
- \(I_{FSM}\) max. \(150 \text{ A}\)
- \(I^{2}\) max. \(100 \text{ A}^2\text{s}\)

### Temperatures

- **Storage temperature** \(T_{stg}\) \(-65\) to \(+175 \degree \text{C}\)
- **Operating junction temperature** \(T_{j}\) max. \(150 \degree \text{C}\)

### THERMAL RESISTANCE

- From junction to ambient in free air \(R_{th\ j-a}\) \(=\) \(50 \degree \text{C/W}\)
- From junction to mounting base \(R_{th\ j-mb}\) \(=\) \(2,2 \degree \text{C/W}\)
- From mounting base to heatsink \(R_{th\ mb-h}\) \(=\) \(0,5 \degree \text{C/W}\)
- Transient thermal impedance; \(t = 1 \text{ ms}; \delta = 0\)
  - \(Z_{th\ j-mb}\) \(=\) \(0,8 \degree \text{C/W}\)

**February 1978**
CHARACTERISTICS

Forward voltage 1)

\[ I_F = 12 \text{ A}; T_j = 25 \, ^\circ \text{C} \]
\[ V_F < 1.4 \, \text{V} \]

Reverse current

\[ V_R = V_{RW\text{Max}}; T_j = 125 \, ^\circ \text{C} \]
\[ I_R < 3 \, \text{mA} \]

Reverse recovery when switched from

\[ I_F = 1 \, \text{A to } V_R = 30 \, \text{V}; \]
\[ -\frac{dI_F}{dt} = 35 \, \text{A/μs}; T_j = 25 \, ^\circ \text{C} \]

Recovery time
\[ t_{rr} < 200 \, \text{ns} \]

\[ I_F = 2 \, \text{A to } V_R = 30 \, \text{V}; \]
\[ -\frac{dI_F}{dt} = 20 \, \text{A/μs}; T_j = 25 \, ^\circ \text{C} \]

Recovery charge
\[ Q_s < 250 \, \text{nC} \]

\[ I_F = 1 \, \text{A to } V_R = 30 \, \text{V}; \]
\[ -\frac{dI_F}{dt} = 2 \, \text{A/μs}; T_j = 25 \, ^\circ \text{C} \]

Max. slope of the reverse recovery current
\[ |\frac{dI_R}{dt}| < 5 \, \text{A/μ} \]

1) Measured under pulse conditions to avoid excessive dissipation.
P = power dissipation excluding switching losses

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

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

\[ I_F(AV) \text{ (A)} \]

\[ P \text{ (W)} \]

\[ T_{mb} \text{ (°C)} \]

\[ T_{amb} \text{ (°C)} \]
maximum permissible non-repetitive r.m.s. forward current based on sinusoidal currents (f = 50 Hz)

$I_F$ with reapplied $V_{RWM_{max}}$

$T_j = 150 \, ^\circ \text{C} \text{ (prior to surge)}$

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

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

February 1978
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

Silicon diodes in DO–5 metal envelopes, featuring non-snap-off characteristics. They are intended for use in high-frequency power supplies, thyristor inverters and multi-phase power rectifier applications.

The series consists of the following types:
Normal polarity (cathode to stud): 1N3899, 1N3900, 1N3901, 1N3902, 1N3903,
Reverse polarity (anode to stud), 1N3899R, 1N3900R, 1N3901R, 1N3902R, 1N3903R.

QUICK REFERENCE DATA

<table>
<thead>
<tr>
<th></th>
<th>1N3899(R)</th>
<th>3900(R)</th>
<th>3901(R)</th>
<th>3902(R)</th>
<th>3903(R)</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>20 A</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Non-repetitive peak forward current</td>
<td>$I_{FSM}$ max.</td>
<td>225 A</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Reverse recovery time</td>
<td>$t_{rr}$ &lt;</td>
<td>200 ns</td>
<td></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:
56264A (mica washer, insulating ring, tag)
The mark shown applies to normal polarity types.

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

July 1979
RATINGS

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

Voltages

<table>
<thead>
<tr>
<th></th>
<th>$V_{RSM}$ max.</th>
<th>$V_{RRM}$ max.</th>
<th>$V_{RWM}$ max.</th>
</tr>
</thead>
<tbody>
<tr>
<td>$1N3899(R)$</td>
<td>75</td>
<td>50</td>
<td>50</td>
</tr>
<tr>
<td>$3900(R)$</td>
<td>200</td>
<td>100</td>
<td>100</td>
</tr>
<tr>
<td>$3901(R)$</td>
<td>300</td>
<td>200</td>
<td>200</td>
</tr>
<tr>
<td>$3902(R)$</td>
<td>400</td>
<td>300</td>
<td>300</td>
</tr>
<tr>
<td>$3903(R)$</td>
<td>500</td>
<td>400</td>
<td>400</td>
</tr>
</tbody>
</table>

Currents

Average on-state current assuming zero switching losses (averaged over any 20 ms period)
up to $T_{mb} = 100 \, ^\circ C$
at $T_{mb} = 125 \, ^\circ C$

<table>
<thead>
<tr>
<th></th>
<th>$I_{F(\text{AV})}$ max.</th>
<th>$I_{F(\text{AV})}$ max.</th>
</tr>
</thead>
<tbody>
<tr>
<td>$1N3899(R)$</td>
<td>20</td>
<td>10</td>
</tr>
<tr>
<td>$3900(R)$</td>
<td></td>
<td></td>
</tr>
<tr>
<td>$3901(R)$</td>
<td></td>
<td></td>
</tr>
<tr>
<td>$3902(R)$</td>
<td></td>
<td></td>
</tr>
<tr>
<td>$3903(R)$</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

R.M.S. forward current

<table>
<thead>
<tr>
<th></th>
<th>$I_{F(RMS)}$ max.</th>
<th>$I_{FRM}$ max.</th>
</tr>
</thead>
<tbody>
<tr>
<td>$1N3899(R)$</td>
<td>30</td>
<td>100</td>
</tr>
<tr>
<td>$3900(R)$</td>
<td></td>
<td></td>
</tr>
<tr>
<td>$3901(R)$</td>
<td></td>
<td></td>
</tr>
<tr>
<td>$3902(R)$</td>
<td></td>
<td></td>
</tr>
<tr>
<td>$3903(R)$</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Non-repetitive peak forward current

$T_j = 150 \, ^\circ C$ prior to surge; half sine-wave; with reapplied $V_{RWM}\text{max}$:
$t = 10 \, ms$
$t = 8.3 \, ms$

<table>
<thead>
<tr>
<th></th>
<th>$I_{FSM}$ max.</th>
<th>$I_{FSM}$ max.</th>
<th>$I^2t$ max.</th>
</tr>
</thead>
<tbody>
<tr>
<td>$1N3899(R)$</td>
<td>200</td>
<td>225</td>
<td>210</td>
</tr>
<tr>
<td>$3900(R)$</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>$3901(R)$</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>$3902(R)$</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>$3903(R)$</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

$I^2t$ for fusing ($t = 10 \, ms$)

Temperatures

<table>
<thead>
<tr>
<th></th>
<th>$T_{stg}$</th>
<th>$T_j$ max.</th>
</tr>
</thead>
<tbody>
<tr>
<td>$1N3899(R)$</td>
<td>-65 to 175</td>
<td>150</td>
</tr>
<tr>
<td>$3900(R)$</td>
<td></td>
<td></td>
</tr>
<tr>
<td>$3901(R)$</td>
<td></td>
<td></td>
</tr>
<tr>
<td>$3902(R)$</td>
<td></td>
<td></td>
</tr>
<tr>
<td>$3903(R)$</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

THERMAL RESISTANCE

From junction to mounting base
From mounting base to heatsink with heatsink compound
Transient thermal impedance; $t = 1 \, ms$
Fast soft-recovery rectifier diodes

**CHARACTERISTICS**

Forward voltage

\[ I_F = 20 \, A; \, T_j = 25 \, ^\circ C \]

\[ V_F < 1.4 \, V^* \]

Reverse current

\[ V_R = V_{RWM_{\text{max}}}; \, T_j = 100 \, ^\circ C \]

\[ I_R < 6 \, mA \]

Reverse recovery when switched from

\[ I_F = 1A \, \text{to} \, V_R \geq 30 \, V; \, -dI_F/dt = 35 \, A/\mu s; \, T_j = 25 \, ^\circ C \]

Recovery time

\[ t_{rr} < 200 \, ns \]

\[ I_F = 2 \, A \, \text{to} \, V_R \geq 30 \, V; \, -dI_F/dt = 20 \, A/\mu s; \, T_j = 25 \, ^\circ C \]

Recovered charge

\[ Q_s < 250 \, nC \]

Maximum slope of the reverse recovery current

when switched from \( I_F = 1 \, A \, \text{to} \, V_R \geq 30 \, V; \)

\[ -dI_F/dt = 2 \, A/\mu s; \, T_j = 25 \, ^\circ C \]

\[ |dI_R/dt| < 5 \, A/\mu s \]

*Measured under pulse conditions to avoid excessive dissipation.

![Diagram](image)

Fig.2 Definitions of \( t_{rr} \) and \( Q_s \).

July 1979
Fig. 3 The right-hand part shows the interrelationship between the power (derived from the left-hand part) and the maximum permissible temperatures.

P = power dissipation excluding switching losses.

a = form factor = $|I_F|_{RMS}/|I_F|_{AV}$. 

---

SINUSOIDAL OPERATION

P (W) vs. $I_F|_{AV}$(A) vs. $T_{amb}$(°C)
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. 

\[ P = \text{power dissipation excluding switching losses.} \]

\[ IF(\text{AV}) = IF(\text{RMS}) \times \sqrt{\delta} \]
Fig.5 Maximum permissible non-repetitive r.m.s. forward current based on sinusoidal currents
(\(f = 50\ \text{Hz}\)); \(T_j = 150\ \text{°C}\) prior to surge; with reapplied \(V_{\text{RWMmax}}\).
Fast soft-recovery rectifier diodes

Fig. 6 — $T_j = 25^\circ\text{C}$; $- - - T_j = 150^\circ\text{C}$

Fig. 7
FAST SOFT-RECOVERY RECTIFIER DIODES

Silicon diodes in DO—5 metal envelopes, featuring non-snap-off characteristics. They are intended for use in high-frequency power supplies, thyristor inverters and multi-phase power rectifier applications. The series consists of the following types:
Normal polarity (cathode to stud): 1N3909, 1N3910, 1N3911, 1N3912, 1N3913,
Reverse polarity (anode to stud): 1N3909R, 1N3910R, 1N3911R, 1N3912R, 1N3913R.

QUICK REFERENCE DATA

<table>
<thead>
<tr>
<th></th>
<th>1N3909(R)</th>
<th>3910(R)</th>
<th>3911(R)</th>
<th>3912(R)</th>
<th>3913(R)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Repetitive peak reverse voltage V_{RRM} max.</td>
<td>50</td>
<td>100</td>
<td>200</td>
<td>300</td>
<td>400 V</td>
</tr>
<tr>
<td>Average forward current I_{F(AV)} max.</td>
<td>30</td>
<td>A</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Non-repetitive peak forward current I_{FSM} max.</td>
<td>300</td>
<td>A</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Reverse recovery time ( t_{rr} ) &lt;</td>
<td>200</td>
<td>ns</td>
<td></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:
56264A (mica washer, insulating ring, tag)
The mark shown applies to normal polarity types.

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

July 1979
## RATINGS

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

### Voltages

<table>
<thead>
<tr>
<th></th>
<th>1N3909(R)</th>
<th>3910(R)</th>
<th>3911(R)</th>
<th>3912(R)</th>
<th>3913(R)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Non-repetitive peak reverse voltage ( (t = 10\ 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>

### Currents

- **Average on-state current assuming zero switching losses (averaged over any 20 ms period)**
  - up to \( T_{mb} = 100\ °C \)
  - at \( T_{mb} = 125\ °C \)
  - \( \bar{I}_{F(AV)} \) max. 30 A
  - \( \bar{I}_{F(AV)} \) max. 15 A
- **R.M.S. forward current**
  - \( I_{FRM} \) max. 45 A
- **Repetitive peak forward current**
  - \( I_{FRM} \) max. 125 A
- **Non-repetitive peak forward current**
  - \( T_j = 150\ °C \) prior to surge;
  - half sine-wave with reapplied \( V_{RWM_{\text{max}}} \);
  - \( t = 10\ ms \)
  - \( t = 8.3\ ms \)
  - \( I_{FSM} \) max. 275 A
  - \( I_{FSM} \) max. 300 A
- **\( I^2t \) for fusing \( (t = 10\ ms) \)**
  - \( I^2t \) max. 375 A²s

### Temperatures

- **Storage temperature**
  - \( T_{stg} \) max. \(-65\ to \ 175\ °C\)
- **Operating junction temperature**
  - \( T_{j} \) max. 150 °C

### THERMAL RESISTANCE

- From junction to mounting base
  - \( R_{th\ j-mb} = 1.0\ °C/W\)
- From mounting base to heatsink with heatsink compound
  - \( R_{th\ mb-h} = 0.3\ °C/W\)
- Transient thermal impedance; \( t = 1\ ms \)
  - \( Z_{th\ j-mb} = 0.2\ °C/W\)
Fast soft-recovery rectifier diodes

CHARACTERISTICS

Forward voltage
\[ I_F = 30 \text{ A}; T_j = 25 \degree \text{C} \]
\[ V_F \quad < \quad 1.4 \quad \text{V}^* \]

Reverse current
\[ V_R = V_{RWM\text{max}}; T_j = 100 \degree \text{C} \]
\[ I_R \quad < \quad 10 \quad \text{mA} \]

Reverse recovery when switched from
\[ I_F = 1 \text{ A to } V_R \geq 30 \text{ V}; -\frac{dI_F}{dt} = 35 \text{ A/\mu s}; T_j = 25 \degree \text{C} \]
\[ t_{rr} \quad < \quad 200 \quad \text{ns} \]

Recovery time
\[ I_F = 2 \text{ A to } V_R \geq 30 \text{ V}; -\frac{dI_F}{dt} = 20 \text{ A/\mu s}; T_j = 25 \degree \text{C} \]
\[ Q_s \quad < \quad 250 \quad \text{nC} \]

Recovered charge
Maximum slope of the reverse recovery current
\[ \frac{|dI_R|}{dt} \quad < \quad 5 \quad \text{A/\mu s} \]

Fig. 2 Definitions of \( t_{rr} \) and \( Q_s \).

*Measured under pulse conditions to avoid excessive dissipation.
SINUSOIDAL OPERATION

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

\[ P = \text{power dissipation excluding switching losses.} \]
\[ a = \text{form factor} = \frac{I_F (\text{RMS})}{I_F (\text{AV})}. \]
Fig. 4 The right-hand part shows the interrelationship between the power (derived from the left-hand part) and the maximum permissible temperatures. 
P = power dissipation excluding switching losses.

\[ I_{F(AV)} = I_{F(RMS)} \times \sqrt{\delta} \]
Fig. 5 Maximum permissible non-repetitive r.m.s. forward current based on sinusoidal currents ($f = 50$ Hz); $T_j = 150 \, ^\circ C$ prior to surge; with reapplied $V_{RWM\text{max}}$. 

$I_{FSM}$

$I_{FS(RMS)}$ 

$I_F$ 

duration (s) 

time 

$1N3909$ to $1N3913$
Fast soft-recovery rectifier diodes

1N3909 to 1N3913

Fig. 6 — $T_j = 25 \, ^\circ C$; — — $T_j = 150 \, ^\circ C$

Fig. 7
REGULATOR DIODES
VOLTAGE REGULATOR DIODES

A range of voltage regulator diodes in plastic envelopes intended for use as voltage stabilizers in power supply circuits.

Normal and reverse polarity types are available: BZV15-C10(R) to C75(R).

<table>
<thead>
<tr>
<th>QUICK REFERENCE DATA</th>
</tr>
</thead>
<tbody>
<tr>
<td>Working voltage range (5% range)</td>
</tr>
<tr>
<td>Total power dissipation at ( T_{\text{amb}} = 25 , ^\circ\text{C} )</td>
</tr>
<tr>
<td>at ( T_{\text{mb}} = 82 , ^\circ\text{C} )</td>
</tr>
<tr>
<td>Junction temperature</td>
</tr>
</tbody>
</table>

MECHANICAL DATA

SOD-38

Dimensions in mm

Net mass: 2.5 g
Accessories:
- supplied with device: washer
- available on request: 56316 (mica insulating washer)

Tag 1 is connected to the metal base-plate, which should be mounted in contact with the heatsink used.
POLARITY OF CONNECTIONS

<table>
<thead>
<tr>
<th>BZV15-C10</th>
<th>BZV15-C10R</th>
</tr>
</thead>
<tbody>
<tr>
<td>to C75</td>
<td>to C75R</td>
</tr>
</tbody>
</table>

- Base-plate: cathode anode
- Tag 1: cathode anode
- Tag 2: anode cathode

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

Currents

- Average forward current (averaged over any 20 ms period) at \( T_{mb} = 82 \, ^\circ C \): \( I_{F(AV)} \) max. 7.5 A
- Repetitive peak forward current \( I_{FRM} \) max. 50 A

Power dissipation

- Total power dissipation at \( T_{amb} = 25 \, ^\circ C \) (method a): \( P_{tot} \) max. 2.2 W
- Total power dissipation at \( T_{mb} = 82 \, ^\circ C \): \( P_{tot} \) max. 15 W
- Non-repetitive peak reverse power dissipation at \( T_{amb} = 25 \, ^\circ C \); \( t = 1 \, ms \) (square pulse): \( P_{ZSM} \) max. 400 W

 Temperatures

- Storage temperature \( T_{stg} \) -55 to +125 \( ^\circ C \)
- Junction temperature \( T_j \) max. 150 \( ^\circ C \)

SOLDERING AND MOUNTING NOTES

1. The devices may be soldered directly into the circuit.
2. The maximum permissible temperature of the soldering iron or bath is 270 \( ^\circ C \); contact with the joint must not exceed 3 seconds.
3. The devices should not be immersed in oil, and few potting resins are suitable for re-encapsulation. Advice on these materials is available on request.
4. Leads should not be bent less than 2.5 mm from the seal; exert no axial pull when bending.
5. Soldered joints must be at least 2.5 mm from the seal.
6. For good thermal contact heatsink compound should be used between base-plate and heatsink.
THERMAL RESISTANCE

From junction to mounting base

Transient thermal impedance; t = 1 ms

R_{th j-mb} = 4.5 °C/W
Z_{th j-mb} = 0.3 °C/W

Influence of mounting method

1. Heatsink operation

From mounting base to heatsink

a. With heatsink compound
R_{th mb-h} = 1.5 °C/W

b. With heatsink compound and 56316 mica washer
R_{th mb-h} = 2.7 °C/W

R_{th mb-h} = 2.7 °C/W

c. Without heatsink compound
R_{th mb-h} = 5 °C/W

d. Without heatsink compound with 56316 mica washer

2. Free air operation

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

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

a. > 1 cm²
R_{th j-a} = 50 °C/W

b. < 1 cm²
R_{th j-a} = 55 °C/W

c. > 1 cm²
R_{th j-a} = 55 °C/W

d. < 1 cm²
R_{th j-a} = 60 °C/W

November 1975
### CHARACTERISTICS

<table>
<thead>
<tr>
<th>BZV15-...</th>
<th>Working voltage $V_Z$ (V)</th>
<th>Differential resistance $r_{\text{diff}}$ (Ω)</th>
<th>Temperature coefficient $S_Z$ (mV/°C)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>min.</td>
<td>max.</td>
<td>at $I_Z = 1$ A</td>
</tr>
<tr>
<td>C10(R)</td>
<td>9.4</td>
<td>10.6</td>
<td>0.5</td>
</tr>
<tr>
<td>C11(R)</td>
<td>10.4</td>
<td>11.6</td>
<td>1.0</td>
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<td>C12(R)</td>
<td>11.4</td>
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</tr>
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<td>C56(R)</td>
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</tr>
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<td>C62(R)</td>
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<td>C68(R)</td>
<td>64</td>
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<tr>
<td>C75(R)</td>
<td>70</td>
<td>79</td>
<td>10.5</td>
</tr>
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</table>

1) Measured by a pulse method with $t_p \leq 100 \mu s$, duty cycle $\delta \leq 0.001$ and $T_j \approx 25$ °C.
TRANSIENT SUPPRESSOR BRIDGES

Plastic encapsulated bridge assembly comprising four silicon double diffused transient suppressor diodes. It is specifically intended for use as line polarity guard and transient protection element in telephony equipment, and as suppressor element in electrical and electronic equipment in general.

QUICK REFERENCE DATA

<table>
<thead>
<tr>
<th></th>
<th>BZW10—12</th>
<th>15</th>
</tr>
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<tbody>
<tr>
<td>Input stand-off voltage</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Output clamping voltage</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Non-repetitive peak clamping current</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Output voltage</td>
<td></td>
<td></td>
</tr>
<tr>
<td>( V_I ) max.</td>
<td>12</td>
<td>15</td>
</tr>
<tr>
<td>( V_{O(CL)} ) &lt;</td>
<td>30</td>
<td>34</td>
</tr>
<tr>
<td>( I_{(CL)SM} ) max.</td>
<td>50</td>
<td>40</td>
</tr>
<tr>
<td>( V_O ) &gt;</td>
<td>10</td>
<td>13</td>
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</tbody>
</table>

MECHANICAL DATA

Fig. 1 SOD–28

Dimensions in mm

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

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

<table>
<thead>
<tr>
<th></th>
<th>BZW10-12</th>
<th>15</th>
</tr>
</thead>
<tbody>
<tr>
<td>Input stand-off voltage (note 1)</td>
<td>( V_I ) max.</td>
<td>12</td>
</tr>
<tr>
<td>Average output current (averaged over any 20 ms period)</td>
<td>( I_{O(AV)} ) max.</td>
<td>150</td>
</tr>
<tr>
<td>Non-repetitive peak clamping current full load prior to surge (see note 2)</td>
<td>( I_{(CL)SM} ) max.</td>
<td>50</td>
</tr>
<tr>
<td>→ Storage temperature</td>
<td>( T_{stg} )</td>
<td>(-55) to (+150) °C</td>
</tr>
<tr>
<td>→ Operating ambient temperature</td>
<td>( T_{amb} )</td>
<td>(-25) to (+85) °C</td>
</tr>
</tbody>
</table>

**THERMAL RESISTANCE**

From junction to ambient

\[ R_{th j-a} = 60 \text{ °C/W} \]

**CHARACTERISTICS**

\[ T_{amb} = -25 \text{ to } +85 \text{ °C} \]

- Output voltage
  \[ V_O > 10 | 13 \text{ V} \]
- Output clamping voltage at \( I_{(CL)SM} \) at rated load conditions
  \[ V_{O(CL)} < 30 | 34 \text{ V} \]
- Leakage current
  \[ I_R < 40 | 40 \mu A \]

**MOUNTING INSTRUCTIONS**

1. The maximum permissible temperature of the soldering iron or bath is 270 °C; it must not be in contact with the joint for more than 3 seconds.
2. 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.
3. Exert no axial pull when bending the leads.

**Notes**

1. The stand-off voltage is the maximum bridge input voltage permitted for continuous operation.
2. In accordance with F.T.Z. requirement 10/700 with 2 kV test voltage: BZW10-12 and 1.6 kV: BZW10-15 (see also page 3).
Transient suppressor bridges

Fig. 2 Test set-up in accordance with F.T.Z. 10/700

Fig. 3 Output clamping current as a function of time.
TRANSIENT SUPPRESSOR DIODES

A range of diffused silicon diodes in a plastic envelope intended for use in the protection of electrical and electronic equipment against voltage transients. The series consists of the following types: BZW70-5V6 to BZW70-62.

QUICK REFERENCE DATA

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Stand-off voltage (15% range)</td>
<td>$V_R$ 5.6 to 62 V</td>
</tr>
<tr>
<td>Reverse breakdown voltage</td>
<td>$V_{(BR)R}$ 6.4 to 70 V</td>
</tr>
<tr>
<td>Non-repetitive peak reverse power dissipation; exponential pulse</td>
<td>$P_{RSM}$ max. 700 W</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

SOD-18

Dimensions in mm

The rounded end indicates the cathode.

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

- **WHEN USED AS TRANSIENT SUPPRESSOR DIODES; \( T_{\text{amb}} = 25 \, ^\circ\text{C} \)**

<table>
<thead>
<tr>
<th>( V_{\text{(CL)R}} ) (V)</th>
<th>( I_{\text{RSM}} ) (mA)</th>
<th>( I_{\text{R}} ) (mA)</th>
<th>( V_{\text{R}} ) (V)</th>
<th>BZW70-...</th>
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</thead>
<tbody>
<tr>
<td>typ.</td>
<td>max.</td>
<td>max.</td>
<td></td>
<td></td>
</tr>
<tr>
<td>9</td>
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<tr>
<td>10</td>
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</tr>
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<td>11</td>
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<td>0.5</td>
<td>6.8</td>
</tr>
<tr>
<td>12</td>
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<td>20</td>
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<td>13.5</td>
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<td>8.2</td>
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<td>15</td>
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<td>9.1</td>
</tr>
<tr>
<td>17</td>
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<td>63</td>
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<td>104</td>
<td>116</td>
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<td>0.1</td>
<td>62</td>
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</table>
TRANSIENT SUPPRESSOR DIODES

A range of diffused silicon diodes in a DO-30 metal envelope intended for use in the protection of the electrical and electronic equipment against voltage transients.

The series consists of the following types:
Normal polarity (cathode to stud): BZW86-7V5 to 56
Reverse polarity (anode to stud): BZW86-7V5R to 56R

<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

Dimensions in mm

Supply 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)

May 1978
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

\[ T_j = 25 \, ^\circ C \text{ prior to surge} \]

\[ t_p = 10 \, \mu s; \text{ square pulse} \]

- BZW86-9V1(R)  
  \[ IRSM \text{ max.} = 3700 \, A \]
- BZW86-27(R)  
  \[ IRSM \text{ max.} = 1200 \, A \]
- BZW86-56(R)  
  \[ IRSM \text{ max.} = 700 \, A \]

\[ t_p = 1 \, ms; \text{ exponential pulse} \]

- BZW86-9V1(R)  
  \[ IRSM \text{ max.} = 1200 \, A \]
- BZW86-27(R)  
  \[ IRSM \text{ max.} = 400 \, A \]
- BZW86-56(R)  
  \[ IRSM \text{ max.} = 250 \, A \]

Power dissipation

Repetitive peak reverse power dissipation

\[ T_{mb} = 65 \, ^\circ C; \, f = 50 \, Hz; t_p = 10 \, \mu s \text{ (square pulse; see also graphs on page 6)} \]

\[ P_{RRM} \text{ max.} = 50 \, kW \]

Non-repetitive peak reverse power dissipation

\[ T_j = 25 \, ^\circ C \text{ prior to surge; exponential pulse: see also graph on page 5} \]

\[ t_p = 100 \, \mu s \]

- \[ P_{RSM} \text{ max.} = 60 \, kW \]
- \[ P_{RSM} \text{ max.} = 25 \, kW \]

\[ t_p = 1 \, ms \]

Temperatures

Storage temperature \[ T_{stg} = -55 \text{ to } +175 \, ^\circ C \]

Junction temperature \[ T_j \text{ max.} = 175 \, ^\circ C \]

THERMAL RESISTANCE

- From junction to mounting base  
  \[ R_{th \ j-mb} = 0,3 \, ^\circ C/W \]
- From mounting base to heatsink  
  \[ R_{th \ mb-h} = 0,1 \, ^\circ C/W \]

CHARACTERISTICS

Forward voltage

\[ I_F = 500 \, A \text{ at } T_j = 25 \, ^\circ C \]

\[ V_F < 1,5 \, V \]

* The stand-off voltage is the maximum reverse voltage recommended for continuous operation; at this value non-conduction is ensured.

** Measured under pulse condition.
### CHARACTERISTICS (continued)

<table>
<thead>
<tr>
<th>Clamping voltages (exp. pulse) at $T_j = 25,^\circ\text{C}$ prior to surge; $t_p = 500,\mu\text{s}$</th>
<th>Reverse breakdown voltage at $T_j = 25,^\circ\text{C}$</th>
</tr>
</thead>
<tbody>
<tr>
<td>$V_{(CL)R}$ (V)</td>
<td>$V_{(BR)R}$ (V)</td>
</tr>
<tr>
<td>typ.</td>
<td>max.</td>
</tr>
<tr>
<td>BZW86 -7V5(R)</td>
<td>12</td>
</tr>
<tr>
<td>-8V2(R)</td>
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<td>-9V1(R)</td>
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</tr>
<tr>
<td>-10(R)</td>
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<tr>
<td>-56(R)</td>
<td>85</td>
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</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 8 and 9 for square pulses and pages 10 and 11 for exponential pulses.
CHARACTERISTICS  (continued)  

Peak reverse current

\[ V_{RM} = \text{recommended stand-off voltage} \]
\[ I_{RM} \leq 2 \text{ mA} \]

Temperature coefficient of clamping voltage
\[ S \text{ typ. } +0.1 \%/^\circ C \]

OPERATING NOTES

Heatsink considerations

(a) For non-repetitive transients, the device may be used without a heatsink for pulses up to 10 ms in duration.

(b) For repetitive transients which fall within the permitted operating range shown in the curves on page 6 the required heatsink is found as follows:

\[
R_{th \ j-mb} + R_{th \ mb-h} + R_{th \ h-a} = \frac{T_{j \ max} - T_{amb}}{P_S + \delta \cdot P_{SRM}}
\]

where

- \( T_{j \ max} = 175 \, ^\circ C \)
- \( T_{amb} = \text{ambient temperature} \)
- \( P_S = \text{any steady state dissipation excluding that in pulses} \)
- \( \delta = \text{duty factor (t_p/T)} \)
- \( R_{th \ j-mb} = 0.3 \, ^\circ C/W \)
- \( R_{th \ mb-h} = 0.1 \, ^\circ C/W \)

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.
BZW86
SERIES

$P_{RRM}$ (kW) vs. repetition frequency (Hz)

- **square current pulses**
- **exponential current pulses**

$T_{mb} = 65^\circ C$

$T_{mb} = 125^\circ C$

$tp = 10 \mu s$

$tp = 10 \mu s$

July 1972
at $V_R = \text{stand-off voltage}$

$\mathcal{I}_R$ (mA)

$10^{-1}$

$10$

$T_J (^\circ \text{C})$

$0$

$50$

$100$

$150$

$200$

max

typ
BZW86
SERIES

\[ V_{(CL)R} (V) \]

125 100 75 50 25

max. values
\( T_j = 25 \degree C \) prior
to pulse
intermediate voltage types may be
interpolated

\[ t_p = 10 \text{ ms} \]

\[ = 1 \text{ ms} \]

\[ = 100 \mu s \]

\[ = 10 \mu s \]

square pulses

BZW86-99
BZW86-5
BZW86-27
BZW86-30
BZW86-24
BZW86-20
BZW86-18
BZW86-16

July 1972
$V_{(CL)R} \text{(V)}$

- Max. values
- $T_j = 25 \degree C$ prior to pulse
- Intermediate voltage types may be interpolated

$T_p = 10 \text{ ms}$

$= 1 \text{ ms}$

$= 100 \mu s$

$\leq 10 \mu s$

$V_{(CL)R}$ vs. $I_{RSM}$

Square pulses

July 1972
max. values
$T_j = 25 \, ^\circ C$ prior
to pulse
intermediate vol-
tage types may be
interpolated

exponential pulses
max. values
$T_j = 25 \, ^\circ\text{C}$ prior to pulse
intermediate voltage types may be interpolated

exponential pulses
TRANSPORT SUPPRESSOR DIODES

A range of diffused silicon diodes in a DO-5 metal envelope intended for use in the protection of the electrical and electronic equipment against voltage transients.

The series consists of the following types:
Normal polarity (cathode to stud): BZW91-6V2 to 62
Reverse polarity (anode to stud): BZW91-6V2R to 62R

QUICK REFERENCE DATA

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Symbol</th>
<th>Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Stand-off voltage (15% range)</td>
<td>$V_R$</td>
<td>6.2 to 62 V</td>
</tr>
<tr>
<td>Reverse breakdown voltage</td>
<td>$V_{(BR)R}$</td>
<td>7.0 to 70 V</td>
</tr>
<tr>
<td>Non-repetitive peak reverse power dissipation</td>
<td>$P_{RSM}$</td>
<td>max. 27 kW</td>
</tr>
</tbody>
</table>

$\text{* The stand-off voltage is the maximum reverse voltage recommended for continuous operation; at this value non-conduction is ensured.}$

MECHANICAL DATA

<table>
<thead>
<tr>
<th>Dimension</th>
<th>Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>$1\frac{1}{4}$ in x 28 UNF</td>
<td></td>
</tr>
<tr>
<td>$6.35$ max</td>
<td></td>
</tr>
<tr>
<td>$2.2$ max</td>
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</tr>
<tr>
<td>$11.5$ max</td>
<td></td>
</tr>
<tr>
<td>$10.7$ max</td>
<td></td>
</tr>
<tr>
<td>$5.0$ max (flat)</td>
<td></td>
</tr>
<tr>
<td>$3.0$ min (flat)</td>
<td></td>
</tr>
<tr>
<td>$25.4$ max</td>
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<tr>
<td>$3.8$ min</td>
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</tr>
<tr>
<td>$8.0$ max</td>
<td></td>
</tr>
<tr>
<td>$17.0$</td>
<td></td>
</tr>
</tbody>
</table>

Dimensions in mm

Supplied with device: 1 nut, 1 lock washer
Nut dimensions across the flats: 11.1 mm
Diameter of clearance hole: max. 6.5 mm
Net mass: 16.5 kg
Accessories available: 56264A; 56309B; 56309R
The mark shown applies to the normal polarity types.

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

December 1979
### CHARACTERISTICS – WHEN USED AS TRANSIENT SUPPRESSOR DIODES; $T_{mb} = 25^\circ C$

<table>
<thead>
<tr>
<th>$V_{(CL)R}$</th>
<th>$I_{RSM}$</th>
<th>$I_R$</th>
<th>$V_R$</th>
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<td>$mA$</td>
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</table>

$V_{(CL)R}$ is the clamping voltage at non-repetitive peak reverse current. $I_{RSM}$ is the reverse current stand-off voltage at recommended pulse. $I_R$ is the reverse current. $V_R$ is the voltage at recommended stand-off voltage.
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></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 V</td>
</tr>
<tr>
<td>Stand-off voltage</td>
<td>$V_R$</td>
<td>-</td>
</tr>
<tr>
<td>Total power dissipation</td>
<td>$P_{tot}$ max.</td>
<td>2.5 W</td>
</tr>
<tr>
<td>Non-repetitive peak reverse power dissipation</td>
<td>$P_{RSM}$ max.</td>
<td>-</td>
</tr>
</tbody>
</table>

MECHANICAL DATA

Fig. 1 SOD-18.

The rounded end indicates the cathode.
RATINGS
Limiting values in accordance with the Absolute Maximum System (IEC 134)

Peak working current
IZM max. 5 A

Average forward current
(averaged over any 20 ms period)
IF(AV) max. 1 A

Non-repetitive peak reverse current
Tj = 25 °C prior to surge;
tp = 1 ms (exponential pulse);
BZX70-C7V5 to BZX70-C75
IRSM max. 44 to 6 A

Total power dissipation
at Tamb = 25 °C; with 10 mm tie-points; Fig. 5
Ptot max. 2.5 W

Non-repetitive peak reverse power dissipation
Tj = 25 °C prior to surge;
tp = 1 ms (exponential pulse)
PRSM max. 700 W

Storage temperature
Tstg -55 to +150 °C

Junction temperature
Tj max. 150 °C

THERMAL RESISTANCE
From junction to ambient in free air
see Figs 4 and 5

CHARACTERISTICS
Forward voltage
IF = 1 A; Tamb = 25 °C
VF < 1.5 V

December 1979
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 $P_{\text{tot}} = P_{Z\text{RM}} = P_s + P_p$. 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 $P_{Z\text{RM}}$ is equal to the steady-state power $P_s$. The temperature stabilization time for the BZX70 is 100 seconds (see Figs 17 and 18).

![Diagram](image)

**Fig. 2.**

NOTES WHEN OPERATING AS A TRANSIENT SUPPRESSOR (see page 5)

1. Recommended stand-off voltage is defined as being the maximum reverse voltage to be applied without causing conduction in the avalanche mode or significant reverse dissipation.

2. Maximum clamping voltage is the maximum reverse avalanche breakdown voltage which will appear across the diode at the specified pulse duration and junction temperature. For square pulses see Figs 19 and 20, for exponential pulses see Figs 21 and 22.

3. Duration of an exponential pulse is defined as the time taken for the pulse to fall to 37% of its initial value. It is assumed that energy content does not continue beyond twice this time.
## CHARACTERISTICS - WHEN USED AS VOLTAGE REGULATOR DIODES; \( T_{\text{amb}} = 25^\circ\text{C} \)

<table>
<thead>
<tr>
<th>BZX70...</th>
<th>working voltage ( *V_Z ) V</th>
<th>differential resistance ( *r_Z ) Ω</th>
<th>temperature coefficient ( *S_Z ) mV/°C</th>
<th>test ( I_Z ) A</th>
<th>reverse current ( I_R ) μA</th>
<th>reverse voltage ( V_R ) V</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>min.</td>
<td>max.</td>
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*At test \( I_Z \); measured using a pulse method with \( t_p \leq 100\) μs and \( \delta \leq 0.001 \) so that the values correspond to a \( T_j \) of approximately 25 °C.
Regulator diodes

**BZX70 SERIES**

**CHARACTERISTICS — WHEN USED AS TRANSIENT SUPPRESSOR DIODES; \( T_{\text{amb}} = 25^\circ\text{C} \)**

<table>
<thead>
<tr>
<th>clamping at voltage ( V_{(CL)R} ) at non-repetitive peak reverse current ( I_{RSM} )</th>
<th>reverse current at recommended stand-off voltage ( I_R )</th>
<th>( V_R )</th>
<th>BZX70-...</th>
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\( t_{\text{p}} = 500 \mu\text{s} \) exp. pulse.
SOLDERING AND MOUNTING INSTRUCTIONS

1. When using a soldering iron, diodes may be soldered directly into the circuit, but heat conducted to the junction should be kept to a minimum.

2. Diodes may be dip-soldered at a solder temperature of 245 °C for a maximum soldering time of 5 seconds. The case temperature during dip-soldering must not at any time exceed the maximum storage temperature. These recommendations apply to a diode with the anode end mounted flush on a printed-circuit board having punched-through holes. For mounting the anode end onto a printed-circuit board, the diode must be spaced at least 5 mm from the underside of the printed-circuit board having punched-through holes, or 5 mm from the top of the printed circuit board having plated-through holes.

3. Care should be taken not to bend the leads nearer than 1.5 mm from the seal; exert no axial pull when bending.
Fig. 3 Maximum permissible repetitive peak dissipation ($P_{\text{tot}} = P_{ZRM}$).
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.
Fig. 6 Typical static zener characteristics.
Fig. 7 Typical dynamic zener characteristics for BZX70-C7V5.

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

**Fig. 13.**

*Fig. 13.*

**Fig. 14.**

*Fig. 14.*
Fig. 15 Typical values.

Fig. 16 Typical values.
Regulator diodes

**BZX70 SERIES**

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

---

V(CL)R (V)

max. values
$T_j = 25^\circ C$ prior
to pulse
intermediate voltage types may
be interpolated

$t_p = 10 \text{ ms}$

$t_p = 10 \text{ ms}$

$t_p = 10 \text{ ms}$

$t_p = 10 \text{ ms}$

$I_{RSM}$ (A)

Fig. 20 Square pulses.
Fig. 21 Exponential pulses.
Fig. 22 Exponential pulses.
Fig. 23.  
Fig. 24.  
Fig. 25.

BZX70 SERIES
Regulator diodes

BZX70 SERIES

Fig. 26.

Tj = 25 °C
65 °C
125 °C

prior to surge

square current pulse
exponential current pulse

P_{RSM} (W)

10^3

10^2

10^1

10^0

10^{-1}

10^{-2}

duration (ms)

10

10^2

Dec. 1979 21
REGULATOR DIODES

Also available to BS9305–F052

A range of diffused silicon diodes in DO-5 metal envelopes, intended for use as voltage regulator and transient suppressor diodes in power stabilization and transient suppression circuits.

The series consists of the following types:
Normal polarity (cathode to stud): BZY91-C7V5 to BZY91-C75.
Reverse polarity (anode to stud): BZY91-C7V5R to BZY91-C75R.

QUICK REFERENCE DATA

<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>$V_R$</td>
<td>—</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>—</td>
</tr>
</tbody>
</table>

|                        | 5,6 to 56 V       |
| Stand-off voltage (5% range) | $V_R$ nom.  | 7,5 to 75 |
| Total power dissipation | $P_{tot}$ max.  | 100       |
| Non-repetitive peak reverse power dissipation | $P_{RSM}$ max. | 9,5 kW |

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: 56264A
(mica washer, insulating ring, tag)

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)

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RATINGS

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

Peak working current
\[ I_{ZM} \text{ max.} = 400 \text{ A} \]

Average forward current (averaged over any 20 ms period)
\[ I_{F(AV)} \text{ max.} = 20 \text{ A} \]

Non-repetitive peak reverse current
\[ I_{RSM} \text{ max.} = 1000 \text{ to } 85 \text{ A} \]

Total power dissipation
up to \( T_{mb} = 25 \degree C \)
\[ P_{tot} \text{ max.} = 100 \text{ W} \]
at \( T_{mb} = 65 \degree C \)
\[ P_{tot} \text{ max.} = 75 \text{ W} \]

Non-repetitive peak reverse power dissipation
\[ P_{RSM} \text{ max.} = 9.5 \text{ kW} \]

Storage temperature
\[ T_{stg} = -55 \text{ to } +175 \degree C \]

Junction temperature
\[ T_{j} \text{ max.} = 175 \degree C \]

THERMAL RESISTANCE

From junction to mounting base
\[ R_{th j-mb} = 1.5 \degree C/W \]

From mounting base to heatsink
\[ R_{th mb-h} = 0.2 \degree C/W \]

CHARACTERISTICS

Forward voltage
\[ I_{F} = 10 \text{ A}; T_{mb} = 25 \degree C \]
\[ V_{F} < 1.5 \text{ V} \]

OPERATION AS A VOLTAGE REGULATOR (see page 4)

Dissipation and heatsink considerations
a. Steady-state conditions

The maximum permissible steady-state dissipation \( P_{s max} \) is given by the relationship

\[ P_{s max} = \frac{T_{j max} - T_{amb}}{R_{th j-a}} \]

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
- \( R_{th j-mb} \) is the thermal resistance from junction to mounting base
- \( R_{th mb-h} \) is the thermal resistance from mounting base to heatsink
- \( R_{th h-a} \) is the thermal resistance of the heatsink.

b. Pulse conditions (see Fig. 2)

The heating effect of repetitive power pulses can be found from the curves in Figs 5 and 6 which are given for operation as a transient suppressor at 50 Hz and 400 Hz respectively. This value \( \Delta T \) is in addition to the mean heating effect. The value of \( \Delta T \) found from the curves for the particular operating condition should be added to the known value for ambient temperature used in calculating the required heatsink.

The value of the peak power for a given peak zener current is found from the curves in Figs 3 and 4.
The required heatsink is calculated as follows:

\[ R_{th\,j-a} = \frac{T_{j\,max} - T_{amb} - \Delta T}{P_s + \delta \cdot P_p} \]

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 5)

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:

\[ R_{th\,j-mb} + R_{th\,mb-h} + R_{th\,h-a} = \frac{T_{j\,max} - T_{amb}}{P_s + \delta \cdot P_{PRRM}} \]

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.
### CHARACTERISTICS – WHEN USED AS VOLTAGE REGULATOR DIODES; $T_{mb} = 25 ^\circ C$

<table>
<thead>
<tr>
<th>BZY91...</th>
<th>working voltage $V_Z$</th>
<th>differential resistance $I_Z$</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>max.</td>
<td>typ.</td>
<td>max.</td>
<td>mA</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>5.0</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>1.0</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>1.0</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>1.0</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>1.0</td>
</tr>
<tr>
<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>1.0</td>
</tr>
<tr>
<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>1.0</td>
</tr>
<tr>
<td>C18(R)</td>
<td>16.8</td>
<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>
<td>18.8</td>
<td>21.2</td>
<td>0.8</td>
<td>0.075</td>
<td>1.0</td>
<td>1.0</td>
</tr>
<tr>
<td>C22(R)</td>
<td>20.8</td>
<td>23.3</td>
<td>0.8</td>
<td>0.075</td>
<td>1.0</td>
<td>1.0</td>
</tr>
<tr>
<td>C24(R)</td>
<td>22.7</td>
<td>25.9</td>
<td>0.9</td>
<td>0.08</td>
<td>1.0</td>
<td>1.0</td>
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<tr>
<td>C27(R)</td>
<td>25.1</td>
<td>28.9</td>
<td>1.0</td>
<td>0.082</td>
<td>1.0</td>
<td>1.0</td>
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<tr>
<td>C30(R)</td>
<td>28</td>
<td>32</td>
<td>1.1</td>
<td>0.085</td>
<td>1.0</td>
<td>1.0</td>
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<tr>
<td>C33(R)</td>
<td>31</td>
<td>35</td>
<td>1.2</td>
<td>0.088</td>
<td>1.0</td>
<td>1.0</td>
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<tr>
<td>C36(R)</td>
<td>34</td>
<td>38</td>
<td>1.3</td>
<td>0.09</td>
<td>1.0</td>
<td>1.0</td>
</tr>
<tr>
<td>C39(R)</td>
<td>37</td>
<td>41</td>
<td>1.4</td>
<td>0.09</td>
<td>0.5</td>
<td>1.0</td>
</tr>
<tr>
<td>C43(R)</td>
<td>40</td>
<td>46</td>
<td>1.5</td>
<td>0.092</td>
<td>0.5</td>
<td>1.0</td>
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<tr>
<td>C47(R)</td>
<td>44</td>
<td>50</td>
<td>1.7</td>
<td>0.093</td>
<td>0.5</td>
<td>1.0</td>
</tr>
<tr>
<td>C51(R)</td>
<td>48</td>
<td>54</td>
<td>1.8</td>
<td>0.093</td>
<td>0.5</td>
<td>1.0</td>
</tr>
<tr>
<td>C56(R)</td>
<td>52</td>
<td>60</td>
<td>2.0</td>
<td>0.094</td>
<td>0.5</td>
<td>1.0</td>
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<tr>
<td>C62(R)</td>
<td>58</td>
<td>66</td>
<td>2.2</td>
<td>0.094</td>
<td>0.5</td>
<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>
<td>0.5</td>
<td>1.0</td>
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<tr>
<td>C75(R)</td>
<td>70</td>
<td>79</td>
<td>2.6</td>
<td>0.095</td>
<td>0.5</td>
<td>1.0</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 $25 ^\circ C$. 

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### CHARACTERISTICS – WHEN USED AS TRANSIENT SUPPRESSOR DIODES; $T_{mb} = 25 ^\circ C$

<table>
<thead>
<tr>
<th>Clamping voltage at non-repetitive peak reverse current</th>
<th>Reverse current at recommended stand-off voltage</th>
<th>BZY91...</th>
</tr>
</thead>
<tbody>
<tr>
<td>$V_{(CL)R}$</td>
<td>$I_{RSM}$</td>
<td>$I_R$</td>
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<tr>
<td>---</td>
<td>---</td>
<td>---</td>
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<tr>
<td>–</td>
<td>–</td>
<td>–</td>
</tr>
<tr>
<td>9.5</td>
<td>10.5</td>
<td>150</td>
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<tr>
<td>10</td>
<td>11</td>
<td>150</td>
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<tr>
<td>11</td>
<td>12.5</td>
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<td>50</td>
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<tr>
<td>60</td>
<td>72</td>
<td>50</td>
</tr>
<tr>
<td>66</td>
<td>79</td>
<td>50</td>
</tr>
<tr>
<td>72</td>
<td>87</td>
<td>50</td>
</tr>
<tr>
<td>79</td>
<td>97</td>
<td>50</td>
</tr>
</tbody>
</table>
BZY91 SERIES

MOUNTING INSTRUCTIONS

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

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

BZY91 SERIES

Fig. 3.

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. 4.
Fig. 5.

Repetitive operation in this area is not permissible.

Fig. 6.

Repetitive operation in this area is not permitted.
Regulator diodes

BZY91 SERIES

Fig. 7. Typical zener characteristics.

Fig. 8 Typical dynamic zener characteristics.
Fig. 9 Typical static zener characteristics.
Regulator diodes

**BZY91 Series**

- $I_Z = 2.0A$
- $T_{mb} = 25$ to $100^\circ C$

Fig. 10.

- $I_Z = 1.0A$
- $T_{mb} = 25$ to $100^\circ C$

- $I_Z = 0.5A$
- $T_{mb} = 25$ to $100^\circ C$
Fig. 11.
Regulator diodes

BZY91 SERIES

Fig. 12.

Fig. 13.

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Fig. 14.

Fig. 15.

Fig. 16.

Fig. 17.
Regulator diodes

BZY91 SERIES

Fig. 18.

Fig. 19.

Fig. 20.

Fig. 21.

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Square pulses
$T_j = 25^\circ C$ prior to pulse
Intermediate voltage types may be interpolated

- **BZY 91-C15**
  - $t_p=10\text{ms}$
  - $t_p=1\text{ms}$
  - $t_p=100\mu\text{s}$

- **BZY 91-C9V1**
  - $t_p=10\text{ms}$
  - $t_p=1\text{ms}$
  - $t_p=100\mu\text{s}$

- $t_p\leq 10\mu\text{s}$
Regulator diodes

BZY91 SERIES

$V_{(CL)R_{\text{max}}}$

125 (V) 100 75 50 25

Square pulses
$T_j = 25^\circ C$ prior to pulse
Intermediate voltage types may be interpolated

$t_p = 10\text{ms}$

BZY91-C75

$t_p = 1\text{ms}$

BZY91-C51

$t_p = 100\mu s$

BZY91-C24

Fig. 23.
### BZY91 SERIES

<table>
<thead>
<tr>
<th>$V_{(CL)R}^{\text{max}}$ (V)</th>
<th>25</th>
<th>20</th>
<th>15</th>
<th>10</th>
<th>5</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>20</td>
<td>18</td>
<td>16</td>
<td>13</td>
<td>12</td>
</tr>
</tbody>
</table>

Exponential pulses

- $T_j = 25°C$ prior to pulse
- Intermediate voltage types may be interpolated

**Figure 24.**

- **BZY 91-C15**
  - $t_p = 10\,\text{ms}$
  - $t_p = 1\,\text{ms}$
  - $t_p = 10\,\mu\text{s}$

- **BZY 91-C9V1**
  - $t_p = 10\,\text{ms}$
  - $t_p = 1\,\text{ms}$
  - $t_p \leq 10\,\mu\text{s}$
Regulator diodes

BZY91 SERIES

Exponential pulses

$T_j = 25^\circ C$ prior to pulse

Intermediate voltage types may be interpolated

$V_{(CL)}R_{\text{max}}$

$t_p = 10\,\text{ms}$

BZY91-C75

$t_p = 1\,\text{ms}$

BZY91-C51

$t_p = 1\,\text{ms}$

BZY91-C24

$t_p = 100\,\mu\text{s}$

$t_p = 1\,\text{ms}$

$t_p = 10\,\mu\text{s}$

$t_p = 1\,\text{ms}$

$t_p = 10\,\mu\text{s}$

Fig. 25.
Fig. 26.

Fig. 27.

Fig. 28.
REGULATOR DIODES

Also available to BS9305–F051

A range of diffused silicon diodes in DO-4 metal envelopes, intended for use as voltage regulator and transient suppressor diodes in power stabilization and transient suppression circuits.

The series consists of the following types:
Normal polarity (cathode to stud): BZY93-C7V5 to BZY93-C75.
Reverse polarity (anode to stud): BZY93-C7V5R to BZY93-C75R.

QUICK REFERENCE DATA

<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>20</td>
</tr>
<tr>
<td>Non-repetitive peak reverse power dissipation</td>
<td>$P_{RSM}$ max.</td>
<td>700</td>
</tr>
</tbody>
</table>

MECHANICAL DATA

Fig. 1 DO-4.

Dimensions in mm

Net mass: 6 g
Diameter of clearance hole: max. 5.2 mm
Accessories supplied on request: 56295
(PTFE bush, 2 mica washers, plain washer, tag)
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)

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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
\( T_{j} = 25 \, ^{\circ}C \) prior to surge;
\( t_{p} = 1 \, \text{ms (exponential pulse)} \);
BZY93-C7V5(R) to BZY93-C75(R)

Total power dissipation
up to \( T_{mb} = 75 \, ^{\circ}C \)

Non-repetitive peak reverse power dissipation
\( T_{j} = 25 \, ^{\circ}C \) prior to surge;
\( t_{p} = 1 \, \text{ms (exponential pulse)} \)

Storage temperature \( T_{stg} = -55 \) to +175 \( ^{\circ}C \)

Junction temperature

THERMAL RESISTANCE
From junction to mounting base
From junction to ambient
From mounting base to heatsink
(minimum torque: 0,9 Nm)

CHARACTERISTICS
Forward voltage
\( I_{F} = 5 \, \text{A}; \ T_{mb} = 25 \, ^{\circ}C \)

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
\[
P_{s\, \text{max}} = \frac{T_{j\, \text{max}} - T_{amb}}{R_{th \, j-a}}
\]
where:
\( T_{j\, \text{max}} \) 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 \( P_{p\, \text{max}} \) is given by the formula
\[
P_{p\, \text{max}} = \frac{(T_{j\, \text{max}} - T_{amb}) - (P_{s} \cdot R_{th \, j-a})}{R_{th \, t} + \delta \cdot R_{th \, mb-a}}
\]
Regulator diodes

**BZY93 SERIES**

where: \( P_s \) is any steady-state dissipation excluding that in pulses

\[
R_{th \, t} = \text{the effective transient thermal resistance of the device between junction and mounting base. It is a function of the pulse duration } t_p \text{ and duty factor } \delta.
\]

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

\( R_{th \, mb-a} \) is the total thermal resistance between the mounting base and ambient

\[
(R_{th \, mb-a} = R_{th \, mb-h} + R_{th \, h-a}).
\]

The steady-state power \( P_s \) when biased in the zener direction at a given zener current can be found from Fig. 14. With the additional pulse power dissipation \( P_{p \, \text{max}} \) calculated from the above expression, the total peak zener power dissipation \( P_{\text{tot}} = P_{ZRM} = P_s + P_p \). 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 \( t_{\text{stab}} \), 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 5)

**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:

\[
R_{th \, j-mb} + R_{th \, mb-h} + R_{th \, h-a} = \frac{T_{j \, \text{max}} - T_{\text{amb}}}{P_s + \delta \cdot P_{ZRM}}
\]

where:

\[
T_{j \, \text{max}} = 175 \text{°C}
\]

\[
T_{\text{amb}} = \text{ambient temperature}
\]

\[
P_s = \text{any steady-state dissipation excluding that in pulses}
\]

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

\[
R_{th \, j-mb} = 5 \text{°C/W}
\]

\[
R_{th \, mb-h} = 0,6 \text{°C/W}
\]

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 $V_R$</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>min.</td>
<td>max.</td>
<td>typ.</td>
<td>max.</td>
<td>min.</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>
</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>
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<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>
</tr>
<tr>
<td>C10(R)</td>
<td>9.4</td>
<td>10.6</td>
<td>0.07</td>
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<td>7.0</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>
</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>
</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>
</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>
</tr>
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<td>C16(R)</td>
<td>15.3</td>
<td>17.1</td>
<td>0.18</td>
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<td>C18(R)</td>
<td>16.8</td>
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<td>12.0</td>
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<td>C20(R)</td>
<td>18.8</td>
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<td>C51(R)</td>
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<td>60.0</td>
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<td>C68(R)</td>
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<td>C75(R)</td>
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<td>79</td>
<td>2.0</td>
<td>10.5</td>
<td>70.0</td>
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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 $25 \, ^\circ C$. 
### CHARACTERISTICS – WHEN USED AS TRANSIENT SUPPRESSOR DIODES; \( T_{mb} = 25 \degree C \)

<table>
<thead>
<tr>
<th>( V_{(CL)R} )</th>
<th>( I_{RSM} )</th>
<th>( I_R )</th>
<th>( V_R )</th>
<th>BZY93-...</th>
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<td>( V )</td>
<td>( mA )</td>
<td>( V )</td>
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<tr>
<td>90</td>
<td>105</td>
<td>5</td>
<td>0.1</td>
<td>56</td>
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</table>

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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

**BZY93 SERIES**

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Fig. 6 Typical dynamic zener characteristics for BZY93-C10.

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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.

The graph shows the relationship between the transient thermal resistance ($R_{th t}$) and the pulse duration, with different curves representing various temperature stabilisation times ($\delta$) in °C/W.
Regulator diodes

**BZY93 SERIES**

**Fig. 10.**

- **BZY93 Series**
- **Typical curves**
- \( I_Z = 0.01 \text{A} \)
- \( I_Z = 0.05 \text{A} \)
- \( I_Z = 0.1 \text{A} \)
- \( I_Z = 0.2 \text{A} \)
- \( I_Z = 0.5 \text{A} \)
- \( I_Z = 1.0 \text{A} \)

\[ Z (V) \]

\[ 0 \quad 25 \quad 50 \quad 75 \]

**Fig. 11.**

- **BZY93 Series**
- **Typical curves**
- \( T_{mb} = 25 \degree C \)
- \( C10 \)
- \( C33 \)
- \( C75 \)
- \( C75 \)

\[ Z (V) \]

\[ 0 \quad 25 \quad 50 \quad 75 \]

**Fig. 12.**

- **BZY93 Series**
- **Typical curves**
- \( I_Z = 2.0 \text{A} \)
- \( =50 \text{mA} \)

\[ T_{mb} = 25 \degree C \]

\[ 0 \quad 25 \quad 50 \quad 75 \]

**Fig. 13.**

- **Permissible area of operation**

\[ P_{tot} \text{ max} (W) \]

\[ T_{mb} (\degree C) \]

\[ 0 \quad 55 \quad 100 \quad 200 \]

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Fig. 14 Maximum permissible repetitive peak dissipation ($P_{\text{tot}} = P_{\text{ZRM}}$).
Regulator diodes

BZY93 SERIES

$V_{CL}R_{max}^{\text{max}}$

25 (V) 20 15 10 5

Square pulses
$T_j = 25^\circ C$ prior to pulse
Intermediate voltage types may be interpolated

$t_p = 10 \text{ ms}$
$t_p = 1 \text{ ms}$
$t_p = 100 \mu\text{s}$
$t_p \leq 10 \mu\text{s}$

BZY93 - C15
BZY93 - C9V1

$\text{I}_{RSM} (\text{A})$

1000

Fig. 15.
Fig. 16.

Square pulses
Tj = 25°C prior to pulse
Intermediate voltage types may be interpolated

- tp = 10 ms
  - BZY93-C75
  - BZY93-C51
  - BZY93-C24

- tp = 1 ms
  - BZY93-C75
  - BZY93-C51
  - BZY93-C24

- tp = 100 μs
  - tp ≤ 10 μs

- tp ≤ 10 μs
  - tp = 100 μs

1. Square pulses
2. Tj = 25°C prior to pulse
3. Intermediate voltage types may be interpolated
4. tp = 10 ms
5. tp = 1 ms
6. tp = 100 μs
7. tp ≤ 10 μs
Regulator diodes

BZY93 SERIES

$V_{(CL)R}^{\text{max}}$

Exponential pulses

$T_j = 25^\circ\text{C}$ prior to pulse

Intermediate voltage types may be interpolated

$\tau_p = 10\text{ms}$

$\tau_p = 1\text{ms}$

$\tau_p = 100\mu\text{s}$

BZY93-C15

BZY93-C9V1

$\tau_p \leq 10\mu\text{s}$

$\tau_p \leq 10\mu\text{s}$

Fig. 17.
Fig. 18.

Exponential pulses

$T_j = 25^\circ C$ prior to pulse

Intermediate voltage types may be interpolated.
Square pulse
$\text{tp} = \text{t}$

Exponential pulse
$\text{tp} = \text{CR}; I = 0$ after 2CR

$T_J = 25^\circ C$
$T_J = 65^\circ C$
$T_J = 125^\circ C$

Prior to surge

Fig. 22.
REGULATOR DIODES

Also available to BS9305-F050

A range of diffused silicon diodes in DO-1 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: BZY95-C10 to BZY95-C75.

QUICK REFERENCE DATA

<table>
<thead>
<tr>
<th>Working voltage (5% range)</th>
<th>$V_Z$ nom.</th>
<th>10 to 75</th>
<th>transient suppressor</th>
<th>$V_R$</th>
<th>7.5 to 56</th>
</tr>
</thead>
<tbody>
<tr>
<td>Stand-off voltage</td>
<td>$V_R$</td>
<td>—</td>
<td>—</td>
<td>$P_{RSM}$ max.</td>
<td>—</td>
</tr>
<tr>
<td>Total power dissipation</td>
<td>$P_{tot}$ max.</td>
<td>2.5</td>
<td>700 W</td>
<td></td>
<td></td>
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<tr>
<td>Non-repetitive peak reverse power dissipation</td>
<td>$P_{RSM}$ max.</td>
<td>—</td>
<td>—</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

MECHANICAL DATA

Fig. 1 DO-1.

Dimensions in mm

September 1979
BZY95 SERIES

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

Peak working current
IZM max. 5 A

Average forward current
(averaged over any 20 ms period)
IF(AV) max. 1 A

Non-repetitive peak reverse current
Tj = 25 °C prior to surge;
tp = 1 ms (exponential pulse);
BZY95-C10 to BZY95-C75
IRSM max. 70 to 5 A

Total power dissipation
up to Tamb = 25 °C
Ptot max. 2.5 W
at Tamb = 75 °C
Ptot max. 1.67 W

Non-repetitive peak reverse power dissipation
Tj = 25 °C prior to surge;
tp = 1 ms (exponential pulse)
PRSM max. 700 W

Storage temperature
Tstg -65 to +175 °C
Tj max. 175 °C

Junction temperature

THERMAL RESISTANCE

The quoted values of Rth j-a should be used only when no leads of other dissipating components run to the same tie-points.

Thermal resistance from junction to ambient in free air:
mounted on soldering tags
at lead length a = 10 mm
Rth j-a = 60 °C/W
at lead length a = maximum
Rth j-a = 70 °C/W

mounted on a printed-circuit board
at lead length a = maximum
Rth j-a = 80 °C/W
at lead length a = 10 mm
Rth j-a = 90 °C/W

Fig.2

CHARACTERISTICS

Forward voltage
IF = 1 A; Tamb = 25 °C
VF < 1.5 V

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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.3)

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. 4. With the additional pulse power dissipation $P_p\text{ max}$ calculated from the above expression, the total peak zener power dissipation $P_{\text{tot}} = P_{ZRM} = P_s + P_p$. From Fig. 4 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 $P_{ZRM}$ is equal to the steady-state power $P_s$. The temperature stabilization time for the BZY95 is 100 seconds (see Fig. 10).

Fig. 3.

NOTES WHEN OPERATING AS A TRANSIENT SUPPRESSOR (see page 5)

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 14 and 15, for exponential pulses see Figs 16 and 17.

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.
### BZY95 SERIES

#### CHARACTERISTICS – WHEN USED AS VOLTAGE REGULATOR DIODES; $T_{mb} = 25 \, ^\circ C$

<table>
<thead>
<tr>
<th>BZY95...</th>
<th>working voltage $V_Z$ V</th>
<th>differential resistance $R_Z$ Ω</th>
<th>temperature coefficient $S_Z$ mV/°C</th>
<th>test $I_Z$ mA</th>
<th>reverse current $I_R$ μA</th>
<th>reverse voltage $V_R$ V</th>
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<tbody>
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<td>9.4</td>
<td>0.75 4.0</td>
<td>7.0</td>
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<td>10</td>
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<td>C11</td>
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<td>0.8 4.5</td>
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<td>10</td>
<td>7.5</td>
</tr>
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<td>C24</td>
<td>22.7</td>
<td>3.4 14</td>
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<tr>
<td>C27</td>
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<td>10</td>
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<td>C39</td>
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<td>C51</td>
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<td>10</td>
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<td>C56</td>
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<td>17 63</td>
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<td>10</td>
<td>39</td>
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<td>58</td>
<td>18 75</td>
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<td>43</td>
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<td>18 90</td>
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<td>70</td>
<td>10</td>
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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.
Regulator diodes

**CHARACTERISTICS** – WHEN USED AS TRANSIENT SUPPRESSOR DIODES; \( T_{mb} = 25 ^\circ C \)

<table>
<thead>
<tr>
<th>( V_{(CL)}R ) ( V )</th>
<th>( I_{RSM} ) mA</th>
<th>( I_R ) mA</th>
<th>( V_R ) V</th>
<th>BZY95-...</th>
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<td>typ.</td>
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<td>max.</td>
<td>max.</td>
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<td>0.1</td>
<td>9.1</td>
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<td>0.1</td>
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<td>90</td>
<td>105</td>
<td>5</td>
<td>0.1</td>
<td>56</td>
</tr>
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</table>
SOLDERING AND MOUNTING INSTRUCTIONS

1. When using a soldering iron, diodes may be soldered directly into the circuit, but heat conducted to the junction should be kept to a minimum.

2. Diodes may be dip-soldered at a solder temperature of 245 °C for a maximum soldering time of 5 seconds. The case temperature during dip-soldering must not at any time exceed the maximum storage temperature. These recommendations apply to a diode with the anode end mounted flush on a printed-circuit board having punched-through holes. For mounting the anode end onto a printed-circuit board, the diode must be spaced at least 5 mm from the underside of the printed-circuit board having punched-through holes, or 5 mm from the top of the printed-circuit board having plated-through holes.

3. Care should be taken not to bend the leads nearer than 1.5 mm from the seal; exert no axial pull when bending.
Regulator diodes

**BZY95 SERIES**

**Fig. 4** Maximum permissible repetitive peak dissipation ($P_{\text{tot}} = P_{ZRM}$).

**Fig. 5** Maximum permissible total power dissipation versus ambient temperature.
Fig. 6 Typical static zener characteristics.
Regulator diodes

**Fig. 7** Typical dynamic zener characteristics for BZY95-C10.

**Fig. 8** Typical dynamic zener characteristics for BZY95-C33.
Fig. 9 Typical dynamic zener characteristics for BZY95-C75.

Fig. 10.

\[ R_{th} = \frac{1}{T \cdot \alpha} \]
Regulator diodes

Fig. 11.
Fig. 12.
Regulator diodes

BZY95 Series

$\text{BZY95 Series} \quad B5606$

$T_{\text{amb}} = 25^\circ\text{C}$

typical curves

Fig. 13.
Square pulses $T_j=25°C$ prior to pulse
Intermediate voltage types may be interpolated
$\tau_p=10\text{ ms}$
$\tau_p=1\text{ ms}$
$\tau_p=100\mu\text{s}$

BZY95-C15

Fig. 14.
Regulator diodes

\[ V_{(CL)}R_{\text{max}} \]

<table>
<thead>
<tr>
<th>125 (V)</th>
<th>100</th>
</tr>
</thead>
<tbody>
<tr>
<td>68</td>
<td>62</td>
</tr>
<tr>
<td>56</td>
<td>47</td>
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<tr>
<td>30</td>
<td>27</td>
</tr>
<tr>
<td>22</td>
<td></td>
</tr>
</tbody>
</table>

Square pulses

\( T_J = 25^\circ \text{C} \) prior to pulse

Intermediate voltage types may be interpolated

- \( t_p = 10 \text{ms} \)
- \( t_p = 1 \text{ms} \)
- \( t_p = 100 \mu \text{s} \)
- \( t_p \leq 10 \mu \text{s} \)

BZY95-C75
BZY95-C51
BZY95-C24

Fig. 15.
Exponential pulses

$T_j = 25^\circ C$ prior to pulse

Intermediate voltage types may be interpolated

$t_p = 10\text{ms}$

$t_p = 1\text{ms}$

$t_p = 100\mu s$

BZY95-C15

$t_p \leq 10\mu s$

Fig. 16.
Regulator diodes

BZY95 SERIES

Exponential pulses

$T_j = 25^\circ C$ prior to pulse
Intermediate voltage types may be interpolated

Fig. 17.
Fig. 18.

Fig. 19.

Fig. 20.
Regulator diodes

BZY95 SERIES

Fig. 21.
REGULATOR DIODES

Also available to BS9305–F049

A range of alloyed silicon diodes in DO-1 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: BZY96-C4V7 to BZY96-C9V1.

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>VZ nom.</td>
<td>4,7 to 9,1</td>
<td>–</td>
</tr>
<tr>
<td>VR</td>
<td>–</td>
<td>3,6 to 6,8</td>
</tr>
<tr>
<td>P_{tot} max.</td>
<td>2,5</td>
<td>–</td>
</tr>
<tr>
<td>P_{RSM} max.</td>
<td>–</td>
<td>190</td>
</tr>
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</table>

MECHANICAL DATA

Fig. 1 DO-1.

Dimensions in mm

September 1979
RATINGS

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

Peak working current

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Symbol</th>
<th>Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Peak working current</td>
<td>$I_{ZM}$ max.</td>
<td>3.5 A</td>
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</table>

Average forward current

(averaged over any 20 ms period)

<table>
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<tr>
<th>Parameter</th>
<th>Symbol</th>
<th>Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Average forward current</td>
<td>$I_{F(AV)}$ max.</td>
<td>1 A</td>
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</tbody>
</table>

Non-repetitive peak reverse current

$T_j = 25^\circ C$ prior to surge;

$T_p = 1$ ms (exponential pulse);

BZY96-C4V7 to BZY96-C9V1

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Symbol</th>
<th>Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Non-repetitive peak reverse current</td>
<td>$I_{RSM}$ max.</td>
<td>22 to 12 A</td>
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</table>

Total power dissipation

up to $T_{amb} = 25^\circ C$

at $T_{amb} = 75^\circ C$

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Symbol</th>
<th>Value</th>
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<tbody>
<tr>
<td>Total power dissipation</td>
<td>$P_{tot}$ max.</td>
<td>2.5 W</td>
</tr>
<tr>
<td>at $T_{amb} = 75^\circ C$</td>
<td>$P_{tot}$ max.</td>
<td>1.67 W</td>
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Non-repetitive peak reverse power dissipation

$T_j = 25^\circ C$ prior to surge;

$T_p = 1$ ms (exponential pulse)

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Symbol</th>
<th>Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Non-repetitive peak reverse power dissipation</td>
<td>$P_{RSM}$ max.</td>
<td>190 W</td>
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</table>

Storage temperature

$T_{stg} = -65$ to $+ 175^\circ C$

Junction temperature

$T_j$ max. $175^\circ C$

THERMAL RESISTANCE

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

Thermal resistance from junction to ambient in free air:

mounted on soldering tags

<table>
<thead>
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<th>Parameter</th>
<th>Symbol</th>
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<tbody>
<tr>
<td>mounted on soldering tags</td>
<td>$R_{th , j-a}$</td>
<td>60°C/W</td>
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<tr>
<td>at lead length $a = 10$ mm</td>
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<td></td>
</tr>
<tr>
<td>at lead length $a = maximum$</td>
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<td></td>
</tr>
<tr>
<td></td>
<td>$R_{th , j-a}$</td>
<td>70°C/W</td>
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mounted on a printed-circuit board

<table>
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<td>mounted on a printed-circuit board</td>
<td>$R_{th , j-a}$</td>
<td>80°C/W</td>
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<td>at lead length $a = maximum$</td>
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<tr>
<td>at lead length $a = 10$ mm</td>
<td>$R_{th , j-a}$</td>
<td>90°C/W</td>
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CHARACTERISTICS

Forward voltage

$I_F = 1$ A; $T_{amb} = 25^\circ C$

<table>
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<tr>
<th>Parameter</th>
<th>Value</th>
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<tbody>
<tr>
<td>$V_F$</td>
<td>$&lt; 1.5$ V</td>
</tr>
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</table>
**CHARACTERISTICS**

\[ T_{\text{amb}} = 25 \, ^\circ\text{C} \]

**WHEN USED AS VOLTAGE REGULATOR DIODES**

<table>
<thead>
<tr>
<th>BZY96...</th>
<th>working voltage</th>
<th>differential resistance</th>
<th>temperature coefficient</th>
<th>test ( I_Z )</th>
<th>reverse current ( I_R )</th>
<th>reverse voltage ( V_R )</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>( V_Z ) ( V )</td>
<td>( \Omega ) min. max.</td>
<td>typ. max. typ.</td>
<td>mA</td>
<td>( \mu A )</td>
<td>V</td>
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<tr>
<td>C4V7</td>
<td>4.4 5.0</td>
<td>2.5 10</td>
<td>-0.6</td>
<td>100</td>
<td>20</td>
<td>1.0</td>
</tr>
<tr>
<td>C5V1</td>
<td>4.8 5.4</td>
<td>1.0 5.0</td>
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<td>100</td>
<td>20</td>
<td>1.0</td>
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<td>5.2 6.0</td>
<td>0.7 4.0</td>
<td>+1.0</td>
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<td>2.0</td>
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<td>3.0</td>
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<td>+5.0</td>
<td>50</td>
<td>20</td>
<td>5.6</td>
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<td>C9V1</td>
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<td>+6.4</td>
<td>50</td>
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**WHEN USED AS TRANSIENT SUPPRESSOR DIODES**

<table>
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<tr>
<th>clamping voltage at</th>
<th>non-repetitive peak reverse current</th>
<th>reverse current at recommended stand-off voltage</th>
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<tbody>
<tr>
<td>( V_{(CL)R} )</td>
<td>( I_{RSM} )</td>
<td>( I_R ) at ( V_R )</td>
</tr>
<tr>
<td>V</td>
<td>mA</td>
<td>max.</td>
</tr>
<tr>
<td>C4V7</td>
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<td>7.0 8.2</td>
<td>10</td>
</tr>
<tr>
<td>C5V6</td>
<td>7.5 8.8</td>
<td>10</td>
</tr>
<tr>
<td>C6V2</td>
<td>8.0 9.4</td>
<td>10</td>
</tr>
<tr>
<td>C6V8</td>
<td>8.5 10</td>
<td>10</td>
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<td>C7V5</td>
<td>9.5 11</td>
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</tr>
<tr>
<td>C8V2</td>
<td>11 13</td>
<td>10</td>
</tr>
<tr>
<td>C9V1</td>
<td>13 15</td>
<td>10</td>
</tr>
</tbody>
</table>

*At test \( I_Z \); using a pulse method with \( t_p \approx 100 \mu s \) and \( \delta \approx 0.001 \) so that the values correspond to a \( T_j \) of approximately 25 \(^\circ\text{C}\)*
OPERATION AS A VOLTAGE REGULATOR
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. 3)

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. 4. With the additional pulse power dissipation $P_{p\text{max}}$ calculated from the above expression, the total peak zener power dissipation $P_{\text{tot}} = P_{ZRM} = P_{s} + P_{p}$. From Fig. 4 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 $P_{ZRM}$ is equal to the steady-state power $P_{s}$. The temperature stabilization time for the BZY96 is 100 seconds (see Fig. 10).

![Diagram](image-url)
NOTES WHEN OPERATING AS A TRANSIENT SUPPRESSOR

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 Fig. 13 and for exponential pulses see Fig. 14.

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.

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.

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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. 4 Maximum permissible repetitive peak dissipation ($P_{tot} = P_{ZRM}$).

Fig. 5 Maximum permissible total power dissipation versus ambient temperature.
Regulator diodes

BZY96 SERIES

Fig. 6 Typical static zener characteristics.
Fig. 7 Typical dynamic zener characteristics for BZY96-C4V7.

Fig. 8 Typical dynamic zener characteristics for BZY96-C6V8.
### Fig. 9 Typical dynamic zener characteristics for BZY96-C9V1.

<table>
<thead>
<tr>
<th>Vz (V)</th>
<th>BZY96</th>
<th>B5735</th>
</tr>
</thead>
<tbody>
<tr>
<td>11-5</td>
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<tr>
<td>10-5</td>
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<td>8-5</td>
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</table>

<table>
<thead>
<tr>
<th>Iz (A)</th>
</tr>
</thead>
<tbody>
<tr>
<td>0-001</td>
</tr>
<tr>
<td>0-01</td>
</tr>
<tr>
<td>0-1</td>
</tr>
<tr>
<td>1-0</td>
</tr>
</tbody>
</table>

- **Tamb = 150°C**
- **Tamb = 25°C**

### Fig. 10

\[
R_{th t} = R_{ths} \cdot \frac{d}{1} + R_{th to}
\]

- **Rth t**: Transient thermal resistance
- **Rth s**: Steady state thermal resistance
- **d**: Duty cycle
- **t**: Pulse duration
- **Rth to**: Transient thermal resistance at 0
Typical curves

Fig. 11.
Regulator diodes

BZY96 SERIES

TZ (Ω)

100
7
5
3
1
0

10
7
5
3
1

1

50mA
100mA
500mA
10mA

Iz = 10mA

Tamb = 25°C

Typical curves

Fig. 12.
Square pulses $T_j = 25^\circ C$ prior to pulse
Intermediate voltage types may be interpolated

Fig. 13.
Regulator diodes

BZY96 SERIES

Exponential pulses

\( V_{(CL)R}^{\text{max}} \)

Intermediate voltage types may be interpolated

BZY96-C9V1
\( t_p = 10 \text{ms} \)

BZY96-C5V1
\( t_p = 10 \text{ms} \)

\( V(\text{CL}) \)

Prior to pulse

\( I_{RSM} \)

(A)

0

0.1

1

10

100

Fig. 14.
Fig. 15.

Fig. 16.

Fig. 17.
Fig. 18.

- Square current pulse
  \[ t_p = t \]
- Exponential current pulse
  \[ t_p = CR \]

Prior to surge:

- \( T_j = 25^\circ C \)
- \( T_j = 65^\circ C \)
- \( T_j = 125^\circ C \)
HIGH-VOLTAGE RECTIFIER STACKS
The OSB9110, OSM9110 and OSS9110 series are ranges of high voltage rectifier assemblies, incorporating controlled avalanche diodes mounted on fire proof triangular formers. The OSB9110 series is intended for application in two phase half wave rectifier circuits. The OSM9110 series is intended for application in single phase or three phase bridges or in voltage doubler circuits. The OSS9110 series is intended for all kinds of high voltage rectification. The assemblies are supplied with M6 studs or with standard valve bases. The OSB9110 series and OSM9110 series are supplied with a centre tap (8-32UNC). The maximum crest working voltages of the OSB9110 and OSM9110 series cover the range from 2 kV to 15 kV, and of the OSS9110 series the range from 3 kV to 30 kV, in 1 kV steps.

QUICK REFERENCE DATA

<table>
<thead>
<tr>
<th></th>
<th>OSB9110</th>
<th>OSM9110</th>
</tr>
</thead>
<tbody>
<tr>
<td>Crest working reverse voltage from centre tap to end</td>
<td>V_{RWM}</td>
<td>max. 2 3 ... 14 15 kV</td>
</tr>
<tr>
<td>Crest working reverse voltage</td>
<td>V_{RWM}</td>
<td>max. 3 4 ... 29 30 kV</td>
</tr>
</tbody>
</table>

Average forward current with R and L load (averaged over any 20 ms period)
- in free air up to \( T_{amb} = 35 ^\circ C \) \( I_{F(AV)} \) max. 3.5 A
- in oil up to \( T_{oil} = 100 ^\circ C \) \( I_{F(AV)} \) max. 6 A

Non-repetitive peak forward current \( t = 10 \text{ ms}; \text{half sine wave}; T_j = 175 ^\circ C \) prior to surge \( I_{FSM} \) max. 125 A

MECHANICAL DATA see pages 4 and 5.
### RATINGS

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

<table>
<thead>
<tr>
<th>Volatges</th>
<th>OSB9110 -4 -6</th>
<th>OSM9110-4 -6</th>
<th>OSS9110 -3 -4</th>
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<tbody>
<tr>
<td>Crest working reverse voltage</td>
<td>VRWM</td>
<td>max. 2 3</td>
<td>14 15 kV</td>
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</tbody>
</table>

<table>
<thead>
<tr>
<th>Currents</th>
<th>OSB9110 -4 -6</th>
<th>OSM9110-4 -6</th>
<th>OSS9110 -3 -4</th>
</tr>
</thead>
<tbody>
<tr>
<td>Average forward current (averaged over any 20 ms period)</td>
<td>I_F(AV)</td>
<td>max. 3.5 A</td>
<td>max. 6 A</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>Repetitive peak forward current</td>
<td>I_FRM</td>
<td>max. 120 A</td>
<td></td>
</tr>
<tr>
<td>Non-repetitive peak forward current</td>
<td>I_FSM</td>
<td>max. 125 A</td>
<td></td>
</tr>
<tr>
<td>t = 10 ms; half sine wave; T_j = 175 °C prior to surge</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

### Reverse power dissipation

<table>
<thead>
<tr>
<th>Repetitive peak reverse power</th>
<th>OSB9110 -4 -6</th>
<th>OSM9110-4 -6</th>
<th>OSS9110 -3 -4</th>
</tr>
</thead>
<tbody>
<tr>
<td>t = 10 μs (square wave; f = 50 Hz)</td>
<td>P_RRM</td>
<td>max. 1.2 1.8</td>
<td>8.4 9 kW</td>
</tr>
<tr>
<td>T_j = 175 °C</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Non-repetitive peak reverse power</td>
<td>P_RSM</td>
<td>max. 6 9</td>
<td>42 45 kW</td>
</tr>
<tr>
<td>t = 10 μs (square wave)</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>T_j = 25 °C prior to surge</td>
<td>max. 1.2 1.8</td>
<td>8.4 9 kW</td>
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</tr>
<tr>
<td>T_j = 125 °C prior to surge</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Repetitive peak reverse power dissipation</th>
<th>OSS9110 -3 -4</th>
</tr>
</thead>
<tbody>
<tr>
<td>t = 10 μs (square wave; f = 50 Hz)</td>
<td>P_RRM</td>
</tr>
<tr>
<td>T_j = 175 °C</td>
<td></td>
</tr>
<tr>
<td>Non-repetitive peak reverse power dissipation</td>
<td>P_RSM</td>
</tr>
<tr>
<td>t = 10 μs (square wave)</td>
<td></td>
</tr>
<tr>
<td>T_j = 25 °C prior to surge</td>
<td>max. 1.8 2.4</td>
</tr>
<tr>
<td>T_j = 175 °C prior to surge</td>
<td></td>
</tr>
</tbody>
</table>

### Temperatures

<table>
<thead>
<tr>
<th>Storage temperature</th>
<th>T_stg</th>
<th>-55 to +175 °C</th>
</tr>
</thead>
<tbody>
<tr>
<td>Junction temperature</td>
<td>T_j</td>
<td>max. 175 °C</td>
</tr>
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</table>
### CHARACTERISTICS (See note 1)

<table>
<thead>
<tr>
<th>Type</th>
<th>Forward Voltage</th>
<th>Reverse Avalanche Breakdown Voltage</th>
<th>Reverse Current</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>OSB9110-4</strong></td>
<td>( I_F = 20 \text{ A}; T_j = 25^\circ \text{C} )</td>
<td>( V_F &lt; 4 ) 6 ... 28 30 ( V )</td>
<td>( V_{BR} &lt; 3.75 ) 5.0 ... 36.25 37.5 ( \text{kV} )</td>
</tr>
<tr>
<td><strong>OSM9110-4</strong></td>
<td>( I_F = 20 \text{ A}; T_j = 25^\circ \text{C} )</td>
<td>( V_F &lt; 6 ) 8 ... 58 60 ( V )</td>
<td>( V_{BR} &lt; 5.64 ) 7.52 ... 54.52 56.4 ( \text{kV} )</td>
</tr>
</tbody>
</table>

Reverse current

\[ V_{RM} = V_{RWMmax}; T_j = 125^\circ \text{C} \]

\[ I_{RM} < 0.6 \text{ mA} \]

### NOTES

1. The Ratings and Characteristics given apply from centre tap to end. (Not for OSS9110 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.

---

1) The breakdown voltage increases by approximately 0.1% per \( ^\circ \text{C} \) with increasing junction temperature.
MECHANICAL DATA

n = total number of diodes

OSM9110-nA

OSM9110-nB

OSM9110-nC

Dimensions in mm

The drawings show the OSM9110 series; the OSB9110 and OSS9110 series differ in the following respects:

OSB9110 series - terminals marked a(-) and k(+) in the drawings are both marked \( \wedge \); the centre-tap is marked + (instead of \( \wedge \) as in the drawings).

OSS9110 series - has no centre-tap.
MECHANICAL DATA (continued)

\[ n = \text{total number of diodes.} \]

For lengths and weights see table on page 6.
<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>
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<tbody>
<tr>
<td>maximum lengths</td>
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<td>L_B</td>
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<td>188</td>
<td>228</td>
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<td>L_C</td>
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<td>239</td>
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<td>L_E</td>
<td>132</td>
<td>173</td>
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<td>L_F</td>
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<td>225</td>
<td>265</td>
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<td>346</td>
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<tr>
<td>weights</td>
<td>W_B</td>
<td>153</td>
<td>286</td>
<td>419</td>
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<td>685</td>
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<tr>
<td></td>
<td>W_C</td>
<td>218</td>
<td>351</td>
<td>484</td>
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<td></td>
<td>W_E</td>
<td>379</td>
<td>512</td>
<td>645</td>
<td>778</td>
<td>911</td>
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<tr>
<td></td>
<td>W_F</td>
<td>345</td>
<td>385</td>
<td>426</td>
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<tr>
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<td>L_B</td>
<td>349</td>
<td>389</td>
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<td>470</td>
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<td>L_C</td>
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<td>507</td>
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<td>W_B</td>
<td>883</td>
<td>1016</td>
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<td>1282</td>
<td>1415</td>
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<tr>
<td></td>
<td>W_C</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>
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</table>
maximum permissible non-repetitive r.m.s. forward current based on sinusoidal currents (f = 50 Hz)

$I_F$ and $I_{FSM}$

with reapplied $V_{RWMmax}$

$T_j = 175\,^\circ C$ prior to surge
maximum allowable average forward current versus ambient temperature

maximum allowable average output current versus ambient temperature
APPLICATION INFORMATION

OSB9110-4

I_O = 2I_F(AV)

OSM9110 series

I_O = 2I_F(AV)

I_O = 3I_F(AV)

Voltage doubler
1x OSM 9110

Rectifier circuits with respectively
2x OSM 9110 and 3x OSM 9110

June 1970
HIGH VOLTAGE RECTIFIER STACKS

The OSB9210, OSM9210 and OSS9210 series are ranges of high voltage rectifier assemblies, incorporating controlled avalanche diodes mounted on fireproof triangular formers. The OSB9210 series is intended for application in two phase half wave rectifier circuits. The OSM9210 series is intended for application in single phase or three phase bridges or in voltage doubler circuits. The OSS9210 series is intended for all kinds of high voltage rectification. The assemblies are supplied with M6 studs or with standard valve bases. The OSB9210 series and OSM9210 series are supplied with a centre tap (8-32 UNC). The maximum crest working voltages of the OSB9210 and OSM9210 series cover the range from 2 kV to 15 kV, and of the OSS9210 series the range from 3 kV to 30 kV, in 1 kV steps.

<table>
<thead>
<tr>
<th>CIRCUIT</th>
<th>OSB9210</th>
<th>CIRCUIT</th>
<th>OSM9210</th>
<th>CIRCUIT</th>
<th>OSS9210</th>
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<td><img src="image2.png" alt="Image" /></td>
<td><img src="image3.png" alt="Image" /></td>
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</table>

QUICK REFERENCE DATA

<table>
<thead>
<tr>
<th></th>
<th>OSB9210</th>
<th>OSM9210</th>
<th>OSS9210</th>
</tr>
</thead>
<tbody>
<tr>
<td>Crest working reverse voltage from centre tap to end</td>
<td>VRWM</td>
<td>max. 2 3 ... 14 15 kV</td>
<td>VRWM</td>
</tr>
<tr>
<td>Average forward current with R and L load (averaged over any 20 ms period) in free air up to Tamb = 35 °C</td>
<td>IF(AV)</td>
<td>max. 5 A</td>
<td>IF(AV)</td>
</tr>
<tr>
<td>Average forward current with R and L load (averaged over any 20 ms period) in oil up to Toil = 30 °C</td>
<td>IF(AV)</td>
<td>max. 5 A</td>
<td>IF(AV)</td>
</tr>
<tr>
<td>Non-repetitive peak forward current t = 10 ms; half sine wave; TJ = 175 °C prior to surge</td>
<td>IFSM</td>
<td>max. 360 A</td>
<td>IFSM</td>
</tr>
</tbody>
</table>

MECHANICAL DATA see page 4 and 5
All information applies to frequencies up to 400 Hz

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

<table>
<thead>
<tr>
<th>Volumes</th>
<th>OSB9210</th>
<th>OSM9210</th>
<th>IEC 134</th>
</tr>
</thead>
<tbody>
<tr>
<td>Crest working reverse voltage</td>
<td>VRWM</td>
<td>max. 2 3 ... 14 15 kV</td>
<td></td>
</tr>
<tr>
<td>Crest working reverse voltage</td>
<td>VRWM</td>
<td>max. 3 4 ... 29 30 kV</td>
<td></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 $T_{oil} = 30 \, ^{\circ}C$
  - $I_{F(AV)}$ max. 5 A
  - $I_{F(AV)}$ max. 20 A

- Repetitive peak forward current
  - $I_{FRM}$ max. 440 A

- Non-repetitive peak forward current
  - $t = 10 \, ms; \text{ half sine wave;} \quad T_j = 175 \, ^{\circ}C \text{ prior to surge}$
  - $I_{FSM}$ max. 360 A

**Reverse power dissipation**

<table>
<thead>
<tr>
<th>Volumes</th>
<th>OSB9210</th>
<th>OSM9210</th>
<th>IEC 134</th>
</tr>
</thead>
<tbody>
<tr>
<td>Repetitive peak reverse power</td>
<td>$P_{RRM}$</td>
<td>max. 4 6 ... 28 30 kW</td>
<td></td>
</tr>
<tr>
<td>Non-repetitive peak reverse power</td>
<td>$P_{RSM}$</td>
<td>max. 26 39 ... 182 195 kW</td>
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</tr>
<tr>
<td>Repetitive peak reverse power dissipation</td>
<td>$P_{RRM}$</td>
<td>max. 6 8 ... 58 60 kW</td>
<td></td>
</tr>
<tr>
<td>Non-repetitive peak reverse power dissipation</td>
<td>$P_{RSM}$</td>
<td>max. 39 52 ... 377 390 kW</td>
<td></td>
</tr>
</tbody>
</table>

**Temperatures**

- Storage temperature: $T_{stg}$ from $-55 \, ^{\circ}C$ to $+175 \, ^{\circ}C$
- Junction temperature: $T_j$ max. $175 \, ^{\circ}C$
### CHARACTERISTICS (See note 1)

<table>
<thead>
<tr>
<th></th>
<th>OSB9210 -4 -6</th>
<th></th>
<th>OSM9210-4 -6</th>
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<th>-28</th>
<th>-30</th>
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<tbody>
<tr>
<td><strong>Forward voltage</strong></td>
<td></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>&lt; 3.6</td>
<td>5.4</td>
<td></td>
<td>25.2</td>
<td>27</td>
</tr>
<tr>
<td><strong>Reverse breakdown voltage</strong> (^1)</td>
<td>( I_R = 5 ) mA; ( T_j = 25 ) °C</td>
<td>( V_{(BR)R} )</td>
<td>&gt; 2.5</td>
<td>3.75</td>
<td>17.5</td>
<td>18.75</td>
</tr>
<tr>
<td></td>
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<td></td>
<td></td>
<td></td>
<td>26.32</td>
<td>28.2</td>
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<tr>
<td><strong>Forward voltage</strong></td>
<td></td>
<td></td>
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<td></td>
<td>-29</td>
<td>-30</td>
</tr>
<tr>
<td>( I_F = 50 ) A; ( T_j = 25 ) °C</td>
<td>( V_F )</td>
<td>&lt; 5.4</td>
<td>7.2</td>
<td></td>
<td>52.2</td>
<td>54</td>
</tr>
<tr>
<td><strong>Reverse breakdown voltage</strong> (^1)</td>
<td>( I_R = 5 ) mA; ( T_j = 25 ) °C</td>
<td>( V_{(BR)R} )</td>
<td>&gt; 3.75</td>
<td>5.0</td>
<td>36.25</td>
<td>37.5</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>54.52</td>
<td>56.4</td>
</tr>
<tr>
<td><strong>Reverse current</strong></td>
<td>( V_{RM} = V_{RW} ) max; ( T_j = 125 ) °C</td>
<td>( I_{RM} )</td>
<td>&lt; 0.6</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

### NOTES

1. The Ratings and Characteristics given apply from centre tap to end. (Not for OSS9210 series).

2. **Type number suffix**

   The suffix consists of a figure indicating the total number of diodes, followed by a letter indicating the base.
   - \( A \) = \text{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.

---

\(^1\) The breakdown voltage increases by approximately 0.1% per °C with increasing junction temperature.
MECHANICAL DATA

\( n = \text{total number of diodes} \)

OSM9210-nA

Dimensions in mm

OSM9210-nB

OSM9210-nC

The drawings show the OSM9210 series; the OSB9210 and OSS9210 series differ in the following respects:

OSB9210 series - terminals marked \( a(-) \) and \( k(+) \) in the drawings are both marked \( \sim \); the centre-tap is marked + (instead of \( \sim \) as in the drawings).

OSS9210 series - has no centre-tap.
MECHANICAL DATA

\( n = \text{total number of diodes.} \)

**OSM9210-nE**

For lengths and weights see table on page 6.
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>
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<td>685</td>
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<td>379</td>
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<tr>
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<th>n</th>
<th>16 to 18</th>
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<th>28 to 30</th>
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<td>1044</td>
<td>1177</td>
<td>1310</td>
<td>1443</td>
<td>1576</td>
</tr>
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</table>
maximum allowable non-repetitive peak forward current based on sinusoidal currents, f=50Hz

each current pulse is followed by the crest working reverse voltage

$T_j = 175^\circ C$ (prior to surge)
maximum allowable average forward current versus ambient temperature

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

0  10  20

$T_{amb}$ (°C)  0  100  200

- oil cooled
- forced air 2.5 m/s
- forced air 1 m/s
- free convection

maximum allowable average output current versus ambient temperature

$I_o$ (A)

0  10  20  25  30  35  40  50

$T_{amb}$ (°C)  0  100  200

- oil cooled
- forced air 2.5 m/s
- forced air 1 m/s
- free convection

June 1970
APPLICATION INFORMATION

OSM9210-4

Voltage doubler
1x OSM9210

Rectifier circuits with respectively
2x OSM9210 and 3x OSM9210
HIGH VOLTAGE RECTIFIER STACKS

The OSB9310, OSM9310 and OSS9310 series are ranges of high voltage rectifier assemblies, incorporating controlled avalanche diodes mounted on fire proof triangular formers. The OSB9310 series is intended for application in two phase half wave rectifier circuits. The OSM9310 series is intended for application in single phase or three phase bridges or in voltage doubler circuits. The OSS9310 series is intended for all kinds of high voltage rectification. The assemblies are supplied with M6 studs or with standard valve bases. The OSB9310 series and OSM9310 series are supplied with a centre tap (8-32UNC). The maximum crest working voltages of the OSB9310 and OSM9310 series cover the range from 2 kV to 15 kV, and of the OSS9310 series the range from 3 kV to 30 kV, in 1 kV steps.

**Quick Reference Data**

<table>
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<tr>
<th></th>
<th>OSB9310</th>
<th>OSM9310</th>
<th>OSS9310</th>
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<td>Crest working reverse voltage from centre tap to end</td>
<td>VRWM max. 2</td>
<td>3</td>
<td>14</td>
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<tr>
<td>Crest working reverse voltage</td>
<td>VRWM max. 3</td>
<td>4</td>
<td>...</td>
</tr>
<tr>
<td>Average forward current with R and L load (averaged over any 20 ms period)</td>
<td>IF(AV) max. 4 A</td>
<td></td>
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<tr>
<td>in free air up to $T_{amb} = 35^\circ C$</td>
<td></td>
<td></td>
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<tr>
<td>in oil up to $T_{oil} = 65^\circ C$</td>
<td>IF(AV) max. 12 A</td>
<td></td>
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</tr>
<tr>
<td>Non-repetitive peak forward current</td>
<td>IFSM max. 180 A</td>
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<td>$t = 10 \text{ms; half sine wave; } T_j = 175^\circ C$ prior to surge</td>
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**Mechanical Data** see page 4 and 5

May 1978
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>Voltagess</th>
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<th>-28</th>
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<td>-30</td>
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<td>Crest working reverse voltage $V_{RWM}$</td>
<td>max.</td>
<td>2</td>
<td>3</td>
<td>...</td>
<td>14</td>
<td>15 kV</td>
</tr>
<tr>
<td>OSS9310</td>
<td>-3</td>
<td>-4</td>
<td>...</td>
<td>-29</td>
<td>-30</td>
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</thead>
<tbody>
<tr>
<td>OS9310</td>
<td>-4</td>
<td>-6</td>
<td>...</td>
<td>-28</td>
<td>-30</td>
<td></td>
</tr>
<tr>
<td>Average forward current (averaged over any 20 ms period)</td>
<td>IF(AV) max.</td>
<td>4 A</td>
<td></td>
<td></td>
<td></td>
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<tr>
<td>in free air up to $T_{amb} = 35$ °C</td>
<td>IF(AV) max.</td>
<td>12 A</td>
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<td>in oil up to $T_{oil} = 65$ °C</td>
<td>IFRM max.</td>
<td>250 A</td>
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</table>

**Repetitive peak forward current**

$t = 10$ ms; half sine wave; $Tj = 175$ °C prior to surge | IF$_{FSM}$ max. | 180 A |

<table>
<thead>
<tr>
<th>Reverse power dissipation</th>
<th>OSB9310</th>
<th>-4</th>
<th>-6</th>
<th>...</th>
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<th>-30</th>
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<td>-6</td>
<td>...</td>
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<td>-30</td>
<td></td>
</tr>
<tr>
<td>Repetitive peak reverse power dissipation</td>
<td>PR$_{RRM}$ max.</td>
<td>2</td>
<td>3</td>
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<td>14</td>
<td>15 kW</td>
</tr>
<tr>
<td>$t = 10$ μs (square wave; $f = 50$ Hz)</td>
<td>PR$_{RRM}$ max.</td>
<td>2</td>
<td>3</td>
<td>...</td>
<td>14</td>
<td>15 kW</td>
</tr>
</tbody>
</table>

**Non-repetitive peak reverse power dissipation**

$t = 10$ μs (square wave) | PR$_{RSM}$ max. | 18 | 24 | ... | 174 | 180 kW |
| $Tj = 25$ °C prior to surge | PR$_{RSM}$ max. | 3 | 4 | ... | 29 | 30 kW |

<table>
<thead>
<tr>
<th>Repetitive peak reverse power dissipation</th>
<th>OSS9310</th>
<th>-3</th>
<th>-4</th>
<th>...</th>
<th>-29</th>
<th>-30</th>
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<tbody>
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<td>...</td>
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<tr>
<td>$t = 10$ μs (square wave; $f = 50$ Hz)</td>
<td>PR$_{RRM}$ max.</td>
<td>3</td>
<td>4</td>
<td>...</td>
<td>29</td>
<td>30 kW</td>
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</tbody>
</table>

<table>
<thead>
<tr>
<th>Non-repetitive peak reverse power dissipation</th>
<th>OSS9310</th>
<th>-3</th>
<th>-4</th>
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<th>-29</th>
<th>-30</th>
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<td>-30</td>
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<tr>
<td>$t = 10$ μs (square wave)</td>
<td>FR$_{RSM}$ max.</td>
<td>18</td>
<td>24</td>
<td>...</td>
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<td>180 kW</td>
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<tr>
<td>$Tj = 25$ °C prior to surge</td>
<td>FR$_{RSM}$ max.</td>
<td>3</td>
<td>4</td>
<td>...</td>
<td>29</td>
<td>30 kW</td>
</tr>
</tbody>
</table>

**Temperatures**

- Storage temperature $T_{stg}$: -55 to +175 °C
- Junction temperature $Tj$: max. 175 °C
CHARACTERISTICS (See note 1)

Forward voltage

<table>
<thead>
<tr>
<th></th>
<th>OSB9310 -4</th>
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<th>...</th>
<th>-28</th>
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<tbody>
<tr>
<td>IF = 50 A; Tj = 25 °C</td>
<td>V_F</td>
<td>&lt;</td>
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<td>7.5</td>
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Reverse breakdown voltage 1)

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<td>V(BR)R</td>
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Forward voltage

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Reverse breakdown voltage 1)

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<td>V(BR)R</td>
<td>&gt;</td>
<td>3.75</td>
<td>5</td>
<td>...</td>
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</tbody>
</table>

Reverse current

\[ V_{RM} = V_{RWM_{max}}; T_{j} = 125 \, ^{\circ}\text{C} \]

\[ I_{RM} < 0.3 \, \text{mA} \]

NOTES

1. The Ratings and Characteristics given apply from centre tap to end. (Not for OSS9310 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.

1) The breakdown voltage increases by approximately 0.1% per °C with increasing junction temperature.
MECHANICAL DATA

n = total number of diodes

OSM9310-nA

OSM9310-nB

OSM9310-nC

The drawings show the OSM9310 series; the OSB9310 and OSS9310 series differ in the following respects:

OSB9310 series - terminals marked a(-) and k(+) in the drawings are both marked ~; the centre-tap is marked + (instead of ~ as in the drawings).

OSS9310 series - has no centre-tap.
MECHANICAL DATA

n = total number of diodes

OSM9310-nE

For lengths and weights see table on page 6.
Table of lengths and weights (mm and g)

<table>
<thead>
<tr>
<th>number of diodes</th>
<th>n</th>
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<td>LA</td>
<td>143</td>
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</table>
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

maximum allowable non-repetitive
r.m.s. forward current (sub cycle
surge curve)

Tj = 175°C prior to surge
maximum allowable average forward current versus ambient temperature

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

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

- Oil-cooled
- Forced air 2.5mls
- Forced air 1mls
- Free convection

maximum allowable average output current versus ambient temperature

$I_{O}$ (A)

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

- Oil-cooled
- Forced air 2.5mls
- Forced air 1mls
- Free convection
APPLICATION INFORMATION

**OSB9310series**

![Diagram of voltage doubler circuit with OSM9310 series](image)

**OSM9310series**

![Diagram of rectifier circuits with OSM9310 series](image)

Voltage doubler
- 1x OSM9310

Rectifier circuits with respectively
- 2x OSM9310 and 3x OSM9310

August 1970
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 OSB9410 series is intended for application in two phase half wave rectifier circuits. The OSM9410 series is intended for application in single phase or three phase bridges or in voltage doubler circuits.

The OSS9410 series is intended for all kinds of high voltage rectification. The OSB9410 series and OSM9410 series are supplied with a centre tap (8-32UNC). The maximum crest working voltages of the OSB9410 and OSM9410 series cover the range from 2 kV to 15 kV, and of the OSS9410 series the range from 3 kV to 30 kV, in 1 kV steps.

CIRCUIT OSB9410

CIRCUIT OSM9410

CIRCUIT OSS9410

QUICK REFERENCE DATA

<table>
<thead>
<tr>
<th></th>
<th>OSB9410</th>
<th>OSM9410</th>
<th>OSS9410</th>
</tr>
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<tbody>
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<td>Crest working reverse voltage from centre tap to end $V_{RWM}$ max.</td>
<td>-4</td>
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<td>-3</td>
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<td>-6</td>
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<td>Average forward current with $R$ and $L$ load (averaged over any 20 ms period)</td>
<td>2</td>
<td>3</td>
<td>4</td>
</tr>
<tr>
<td>in free air up to $T_{amb} = 35 , ^{\circ}C$</td>
<td>14</td>
<td>15</td>
<td>29</td>
</tr>
<tr>
<td>in oil up to $T_{oil} = 35 , ^{\circ}C$</td>
<td>10 A</td>
<td>30 A</td>
<td>800 A</td>
</tr>
</tbody>
</table>

Non-repetitive peak forward current $t = 10 \, ms$; half sine wave; $T_j = 175 \, ^{\circ}C$ prior to surge $I_{FSM}$ max.
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></th>
<th>OSB9410 -4</th>
<th>-6</th>
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<td>-28</td>
<td>-30</td>
</tr>
<tr>
<td>Crest working reverse voltage $V_{RWM}$ max.</td>
<td>2</td>
<td>3</td>
<td>...</td>
<td>14</td>
<td>15 kV</td>
</tr>
<tr>
<td></td>
<td>OSS9410 -3</td>
<td>-4</td>
<td>...</td>
<td>-29</td>
<td>-30</td>
</tr>
<tr>
<td>Crest working reverse voltage $V_{RWM}$ max.</td>
<td>3</td>
<td>4</td>
<td>...</td>
<td>29</td>
<td>30 kV</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 $T_{oil} = 35 \, ^\circ C$

<p>| | | | |</p>
<table>
<thead>
<tr>
<th></th>
<th></th>
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<th></th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>$I_{F(AV)}$ max.</td>
<td>10 A</td>
<td>30 A</td>
</tr>
<tr>
<td></td>
<td>$I_{F(AV)}$ max.</td>
<td>450 A</td>
<td></td>
</tr>
</tbody>
</table>

- **Repetitive peak forward current**
  - $t = \text{10 ms; half sine wave; } T_j = 175 \, ^\circ C$ prior to surge
  - $I_{FSM}$ max. 800 A

- **Reverse power dissipation**
  - OSB9410 -4  | -6 | ... | -28 | -30 |
  - OSM9410 -4  | -6 | ... | -28 | -30 |

<p>| | | | | |</p>
<table>
<thead>
<tr>
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<th></th>
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</thead>
<tbody>
<tr>
<td>Repetitive peak reverse power dissipation</td>
<td>$P_{RRM}$ max.</td>
<td>9</td>
<td>13.5</td>
<td>...</td>
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<td>Repetitive peak reverse power dissipation</td>
<td>$P_{RRM}$ max.</td>
<td>13.5</td>
<td>18</td>
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</tbody>
</table>

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<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>Non-repetitive peak reverse power dissipation</td>
<td>$P_{RSM}$ max.</td>
<td>55</td>
<td>80</td>
<td>...</td>
</tr>
<tr>
<td>Non-repetitive peak reverse power dissipation</td>
<td>$P_{RSM}$ max.</td>
<td>8.5</td>
<td>13</td>
<td>...</td>
</tr>
</tbody>
</table>

<p>| | | | | |</p>
<table>
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<td>$P_{RRM}$ max.</td>
<td>55</td>
<td>80</td>
<td>...</td>
</tr>
<tr>
<td>Repetitive peak reverse power dissipation</td>
<td>$P_{RRM}$ max.</td>
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<td>13</td>
<td>...</td>
</tr>
</tbody>
</table>

<p>| | | | | |</p>
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<thead>
<tr>
<th></th>
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<th></th>
</tr>
</thead>
<tbody>
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<td>Non-repetitive peak reverse power dissipation</td>
<td>$P_{RSM}$ max.</td>
<td>55</td>
<td>80</td>
<td>...</td>
</tr>
<tr>
<td>Non-repetitive peak reverse power dissipation</td>
<td>$P_{RSM}$ max.</td>
<td>8.5</td>
<td>13</td>
<td>...</td>
</tr>
</tbody>
</table>

**Temperatures**

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

*August 1970*
### CHARACTERISTICS (See note 1)

<table>
<thead>
<tr>
<th></th>
<th>OSB9410 -4</th>
<th>-6 ...</th>
<th>-28</th>
<th>-30</th>
</tr>
</thead>
<tbody>
<tr>
<td>Forward voltage</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>$I_F = 150 \text{A}; T_j = 25 \degree \text{C}$</td>
<td>$V_F$</td>
<td>&lt; 3.6</td>
<td>5.4</td>
<td>...</td>
</tr>
<tr>
<td>Reverse avalanche breakdown voltage 1)</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>$I_R = 5 \text{mA}; T_j = 25 \degree \text{C}$</td>
<td>$V(BR)R$</td>
<td>&gt; 2.5</td>
<td>3.75</td>
<td>...</td>
</tr>
<tr>
<td></td>
<td></td>
<td>&lt; 4</td>
<td>6</td>
<td>...</td>
</tr>
<tr>
<td>Forward voltage</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>$I_F = 150 \text{A}; T_j = 25 \degree \text{C}$</td>
<td>$V_F$</td>
<td>&lt; 5.4</td>
<td>7.2</td>
<td>...</td>
</tr>
<tr>
<td>Reverse avalanche breakdown voltage 1)</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>$I_R = 5 \text{mA}; T_j = 25 \degree \text{C}$</td>
<td>$V(BR)R$</td>
<td>&gt; 3.75</td>
<td>5</td>
<td>...</td>
</tr>
<tr>
<td></td>
<td></td>
<td>&lt; 6</td>
<td>8</td>
<td>...</td>
</tr>
<tr>
<td>Reverse current</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>$V_{RM} = V_{RW\text{Mmax}}; T_j = 125 \degree \text{C}$</td>
<td>$I_{RM}$</td>
<td>&lt; 1.6 mA</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

### NOTES

1. The Ratings and Characteristics given apply from centre tap to end. (Not for OSS9410 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.

---

1) The breakdown voltage increases, by approximately 0.1% per \degree \text{C} with increasing junction temperature.
MECHANICAL DATA

n = total number of diodes.

OSS9410-nA

The drawing shows the OSS9410 series.

The OSB9410 and OSM9410 series differ in the following respects:

OSB9410 series – has a centre tap marked +; anode and cathode terminals are both marked ♥.

OSM9410 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>
</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>
</tr>
<tr>
<td>weights W_A</td>
<td>1208</td>
<td>1406</td>
<td>1604</td>
<td>1802</td>
<td>2000</td>
</tr>
</tbody>
</table>

Dimensions in mm

August 1970
maximum permissible non-repetitive peak forward current based on sinusoidal currents (f=50Hz)

I_F

each current pulse is followed by the crest working reverse voltage

T_J=175°C prior to surge

maximum allowable non-repetitive r.m.s. forward current (sub cycle surge curve)

T_J=175°C prior to surge
APPLICATION INFORMATION

OSB9410 series

![Diagram of voltage doubler:]

\[ I_0 = 2I_{F(AV)} \]

OSM9410 series

![Diagram of rectifier circuits with:
1x OSM9410
2x OSM9410
3x OSM9410]

Voltage doubler

rectifier circuits with respectively

1x OSM9410
2x OSM9410
3x OSM9410

August 1970
HIGH-VOLTAGE RECTIFIER STACK

The OSM9510-12 is a silicon rectifier stack for high voltage applications, up to 12kV in half-wave circuits, or up to 6kV as one of the arms of a bridge configuration, where the centre-tap is utilised. Because of its controlled avalanche characteristics it is capable of withstanding reverse transients generated in the circuit.

QUICK REFERENCE DATA

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>$V_{RWM}$ max.</td>
<td>12 kV</td>
</tr>
<tr>
<td>$V_{(BR)R}$ min.</td>
<td>15 kV</td>
</tr>
<tr>
<td>$I_F(\text{AV})$ max., in free air, $T_{amb} = 50^\circ C$</td>
<td>1.5 A</td>
</tr>
<tr>
<td>$P_{RSM}$ 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 3

CIRCUIT DIAGRAM

Also available: 8 kV type with $V_{(BR)R}$ min. = 12.5 kV
RATINGS

Limiting values of operation according to the absolute maximum system. These ratings apply for the frequency range 50 to 400Hz. Simultaneous application of all ratings is inferred unless otherwise stated.

Electrical

- $V_{RWM_{max.}}$: Crest working reverse voltage
  - 12 kV
- $I_{F(AV)_{max.}}$: Mean forward current in free air,
  - $T_{amb} < 50 \degree C$, 180\degree conduction
  - 1.5 A
- $I_{FRM_{max.}}$: Repetitive peak forward current, 30\degree conduction
  - 15 A
- $I_{FSM_{max.}}$: Surge forward current, 1 cycle (10ms peak of half sinewave)
  - 35 A
- $P_{RSM_{max.}}$: Non-repetitive peak reverse power (10\mu s square wave, $T_j = 25 \degree C$)
  - 20 kW
- $P_{RRM_{max.}}$: 50Hz repetitive peak reverse transient power (10\mu s square wave, $T_j = 150 \degree C$)
  - 5.0 kW

Temperature

- $T_{stg}$: Storage temperature
  - -55 to 150 \degree C
- $T_j$: Junction temperature
  - -55 to 150 \degree C

ELECTRICAL CHARACTERISTICS ($T_j = 25 \degree C$ unless otherwise stated)

<table>
<thead>
<tr>
<th>Min.</th>
<th>Max.</th>
</tr>
</thead>
<tbody>
<tr>
<td>$V_F$ Forward voltage at $I_F = 5A$</td>
<td>-</td>
</tr>
<tr>
<td>$I_R$ Reverse current at $V_{RWM_{max.}}$, $T_j = 125 \degree C$</td>
<td>-</td>
</tr>
<tr>
<td>$V_{(BR)R}$ Avalanche breakdown voltage, $I_{(BR)R} = 1mA$</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

Millimetres

<table>
<thead>
<tr>
<th>A</th>
<th>B</th>
<th>C</th>
<th>D</th>
<th>E</th>
<th>F</th>
<th>G</th>
<th>H</th>
</tr>
</thead>
<tbody>
<tr>
<td>8.0</td>
<td>18.5</td>
<td>5.3</td>
<td>26</td>
<td>10</td>
<td>50</td>
<td>165</td>
<td></td>
</tr>
</tbody>
</table>

C.T.

4mm thread

December 1979
MAXIMUM MEAN FORWARD CURRENT AS A FUNCTION OF AMBIENT TEMPERATURE AND CONDUCTION ANGLE
MAXIMUM FORWARD CONDUCTION CHARACTERISTICS
MAXIMUM R.M.S. SURGE CURRENT PLOTTED AGAINST SURGE DURATION

NON-REPETITIVE PEAK REVERSE POWER PLOTTED AGAINST SQUARE PULSE DURATION

December 1979
THYRISTORS

SWITCHING CHARACTERISTICS
Thyristors are not perfect switches. They take a finite time to go from the off to the on-state and vice-versa. At frequencies up to about 400 Hz these effects can often be ignored, but in many applications involving fast switching action the departure from the ideal is important.

Gate-controlled turn-on time
Anode current does not commence flowing at the instant the gate current is applied. There is a period which elapses between the application of gate current and the onset of anode current known as delay time \( t_d \). The rise time of anode current is known as \( t_r \) and is measured as the time taken for the anode voltage to fall from 90% to 10% of its initial value. The conditions which need to be specified are:

a) Off-state voltage \( V_D \).

b) On-state current \( I_T \).

c) Gate trigger current \( I_G \) — high gate currents reduce turn-on time.

d) Rate of rise of gate trigger current \( dI_G/dt \) — high values reduce turn-on time.

e) Junction temperature \( T_j \) — high temperatures reduce turn-on time.

The waveforms are shown in the following diagram:
CIRCUIT-COMMUTATED TURN-OFF TIME

When a thyristor has been conducting and is reverse biased it cannot go immediately into the forward blocking state. Thyristors exhibit a stored charge in a similar fashion to rectifiers; it is only after this charge has been recombined or been swept out that the device can block reapplied off-state voltage.

The turn-off time ($t_q$) is measured from the instant the anode current passes through zero to the instant the thyristor is capable of blocking reapplied off-state voltage.

The conditions which need to be specified are:

a) On-state current ($I_T$) — high peak currents mean longer turn-off times.

b) Reverse voltage ($V_R$) — low reverse voltages mean longer turn-off times.

An example of this is when the thyristor is in anti-parallel with a diode, limiting the reverse voltage to a volt or so.

c) Rate of fall of anode current ($dl/dt$) — high rates mean shorter turn-off times.

d) Rate of rise of reapplied off-state voltage ($dV_D/dt$) — high rates mean longer turn-off times.

e) Temperature ($T_J$ or $T_{mb}$) — high temperatures mean longer turn-off times.

f) Gate conditions ($-V_{GG}$, $R_{tot}$) — the application of a negative gate voltage during reverse recovery can be used to reduce the turn-off time. Care must be taken not to exceed the reverse gate voltage rating ($V_{RGM_{max}}$).

The waveforms are shown in the following diagram:

![Waveform Diagram](image-url)
MOUNTING INSTRUCTIONS FOR TO-220 ENVELOPES

GENERAL DATA AND INSTRUCTIONS FOR HEATSINK OPERATION

General rules
1. First fasten the devices to the heatsink before soldering the leads.
2. Use of heatsink compound is recommended.
3. Avoid axial stress to the leads.
4. Keep mounting tool (e.g. screwdriver) clear of the plastic body.
5. It is recommended that the circuit connections be made to the leads rather than direct to the heatsink.

Heatsink requirements
Flatness in the mounting area: 0,02 mm maximum per 10 mm. Mounting holes must be deburred.

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. The compound should be an electrical insulator and be applied sparingly and evenly to both interfaces. 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 thyristors and triacs
1. Clip mounting.
   Mounting by means of spring clip offers:
   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.
   Recommended force of clip on device is 120 N (12 kgf).
2. M3 screw mounting.
   Care should be taken to avoid damage to the plastic body. It is therefore recommended that a cross-recess pan-headed screw be used. Do not use self-tapping screws.
   Mounting torque for screw mounting:
   Minimum torque (for good heat transfer) 0,55 Nm (5,5 kgcm)
   Maximum torque (to avoid damaging the device) 0,80 Nm (8,0 kgcm)
   N.B.: When a nut or screw is not driven direct against a curved spring washer or lock washer, the torques are as follows:
   Minimum torque (for good heat transfer) 0,4 Nm (4 kgcm)
   Maximum torque (to avoid damaging the device) 0,6 Nm (6 kgcm)
   N.B.: Data on accessories are given in separate data sheets.
3. 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.
GENERAL DATA AND INSTRUCTIONS FOR HEATSINK OPERATION (continued)

Thermal data

<table>
<thead>
<tr>
<th>Thermal resistance 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>( 0,5 , ^\circ\text{C/W} )</td>
</tr>
<tr>
<td>without heatsink compound, direct mounting</td>
<td>( R_{th , mb-h} = 1,4 )</td>
<td>( 1,4 , ^\circ\text{C/W} )</td>
</tr>
<tr>
<td>with heatsink compound and mica insulator 56369</td>
<td>( R_{th , mb-h} = 2,2 )</td>
<td>( - , ^\circ\text{C/W} )</td>
</tr>
<tr>
<td>with heatsink compound and alumina insulator 56367</td>
<td>( R_{th , mb-h} = 0,8 )</td>
<td>( - , ^\circ\text{C/W} )</td>
</tr>
</tbody>
</table>

Lead bending

Maximum permissible tensile force on the body, for 5 seconds is 5 N (0,5 kgf).
The leads can be bent through 90° maximum, twisted or straightened. To keep forces within the above-mentioned limits, the leads are generally clamped near the body. The leads should neither be bent nor twisted less than 2,4 mm from the body.

Soldering

Lead soldering temperature at 4,7 mm from the body; \( t_{slid} < 5 \, \text{s} \): \( T_{slid \, max} = 275 \, ^\circ\text{C} \).
Avoid any force on body and leads during or after soldering: do not move the device or 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.
INSTRUCTIONS FOR CLIP MOUNTING (TO-220 envelopes)

Direct mounting with clip 56363
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 30° to the vertical (see Fig. 1).
3. Push down the clip over the device until the long end of the clip snaps into the wide slot in the heatsink. The clip should bear on the plastic body, not on the tab (see Fig. 1(c)).

![Fig. 1](image1)

(a) Heatsink requirements; (b) mounting (1 = spring clip); (c) position of the device (top view).

Insulated mounting with clip 56364
With the insulators 56367 or 56369 insulation up to 2 kV 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 30° to the vertical (see Fig. 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. 2(c)). There should be minimum 3 mm distance between the device and the edge of the insulator for adequate creepage.

![Fig. 2](image2)

(a) Heatsink requirements; (b) mounting (1 = spring clip, 2 = insulator 56369 or 56367); (c) position of the device (top view).
INSTRUCTIONS FOR SCREW MOUNTING (TO-220 envelopes)

Direct mounting with screw
- *into tapped heatsink*

![Diagram of direct mounting with screw](image)

heatsink; hole drilled 2.70 mm dia

• *through heatsink with nut*

![Diagram of through heatsink with nut](image)

M3 hexagon nut

D7510A

December 1979
Mounting Considerations for Stud-Mounted Thyristors

Losses generated in a silicon device must flow through the case and to a lesser extent the leads. The greatest proportion of the losses flow out through the case into a heat exchanger which can be either free convection cooled, forced convection or even liquid cooled. For the majority of devices in our range natural convection is generally adequate, however, where other considerations such as space saving must be taken into account then methods such as forced convection etc. can be considered. The thermal path from junction to ambient may be considered as a number of resistances in series. The first thermal resistance will be that of junction to mounting base, usually denoted by $R_{th \, j-mb}$. The second is the contact thermal resistance $R_{th \, mb-h}$ and finally there is the thermal resistance of the heatsink $R_{th \, h-a}$.

In the rating curves, the contact thermal resistance and heatsink thermal resistances are combined as a single figure - $R_{th \, mb-a}$. In addition to the steady state thermal conditions of the system, consideration should also be given to the possibility of any transient thermal excursions. These can be caused for example by starting conditions or overloads and in order to calculate the effect on the device, a graph of transient thermal resistance $Z_{th \, j-mb}$ 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.
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, 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></td>
<td>$C \ (\mu F)$</td>
<td>$R \ (\Omega)$</td>
</tr>
<tr>
<td>2.0</td>
<td>$\frac{200 \ I_{mag}}{V_1}$</td>
<td>$150 \ \frac{\Omega}{C}$</td>
</tr>
<tr>
<td>1.5</td>
<td>$\frac{400 \ I_{mag}}{V_1}$</td>
<td>$225 \ \frac{\Omega}{C}$</td>
</tr>
<tr>
<td>1.25</td>
<td>$\frac{550 \ I_{mag}}{V_1}$</td>
<td>$260 \ \frac{\Omega}{C}$</td>
</tr>
<tr>
<td>1.0</td>
<td>$\frac{800 \ I_{mag}}{V_1}$</td>
<td>$300 \ \frac{\Omega}{C}$</td>
</tr>
</tbody>
</table>

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.
SILICON BI-DIRECTIONAL TRIGGER DEVICE

Silicon bi-directional trigger device intended for use in triac and thyristor trigger circuits.

QUICK REFERENCE DATA

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Symbol</th>
<th>Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Breakover voltage</td>
<td>$V_{(BO)}$</td>
<td>28 to 36 V</td>
</tr>
<tr>
<td>Output voltage</td>
<td>$V_O$</td>
<td>&gt; 5 V</td>
</tr>
<tr>
<td>Repetitive peak current</td>
<td>$I_{FRM}$</td>
<td>max. 2 A</td>
</tr>
</tbody>
</table>

MECHANICAL DATA

Fig. 1

Dimensions in mm

RATINGS

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

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Symbol</th>
<th>Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Total power dissipation up to $T_{amb} = 50 , ^\circ C$</td>
<td>$P_{tot}$</td>
<td>max. 150 mW</td>
</tr>
<tr>
<td>Repetitive peak current ($t \leq 20 , \mu s$)</td>
<td>$I_{FRM}$</td>
<td>max. 2 A</td>
</tr>
<tr>
<td>Storage temperature</td>
<td>$T_{stg}$</td>
<td>-55 to +125 , ^\circ C</td>
</tr>
<tr>
<td>Junction temperature</td>
<td>$T_j$</td>
<td>max. 100 , ^\circ C</td>
</tr>
</tbody>
</table>

THERMAL RESISTANCE

From junction to ambient in free air

$R_{th \, j-a} = 0.33 \, K/mW$
CHARACTERISTICS

$T_j = 25 \, ^\circ\text{C}$

Breakover voltage at $\frac{dV}{dt} = 10 \, \text{V/ms}$

$$V_{(BO)} \quad 28 \text{ to } 36 \, \text{V}$$

Breakover voltage symmetry

$$|V_{(BO)\,I} - V_{(BO)\,III}| < 3 \, \text{V}$$

Output voltage at $\frac{dV}{dt} = 10 \, \text{V/ms}$

$$V_O \quad > \quad 5 \, \text{V}$$

Breakover current at $V = 0.98 \, V_{(BO)}$

$$I_{(BO)} \quad < \quad 100 \, \mu\text{A}$$

---

**Fig. 2**

**Fig. 3 Test circuit for output voltage**
The BRY39T is a planar p-n-p-n trigger device in a TO-72 metal envelope, intended for use in low-power switching applications such as relay and lamp drivers, sensing network for temperature and as a trigger device for thyristors and triacs.

For BRY39P and BRY39S see ‘Small signal transistors’ handbook.

**QUICK REFERENCE DATA**

<table>
<thead>
<tr>
<th>Description</th>
<th>Symbol</th>
<th>Unit</th>
<th>Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Repetitive peak voltages</td>
<td>V_{DRM} = V_{RRM}</td>
<td>max.</td>
<td>70 V</td>
</tr>
<tr>
<td>Average on-state current</td>
<td>I_{T(AV)}</td>
<td>max.</td>
<td>250 mA</td>
</tr>
<tr>
<td>Non-repetitive peak on-state current</td>
<td>I_{TSM}</td>
<td>max.</td>
<td>3 A</td>
</tr>
</tbody>
</table>

**MECHANICAL DATA**

Fig.1 TO-72; Anode gate connected to case.

![Mechanical Diagram]

Accessories supplied on request: 56246 (distance disc)

October 1979
RATINGS
Limiting values in accordance with the Absolute Maximum System (IEC 134)

Anode to cathode
Non-repetitive peak voltages
Repetitive peak voltages
Continuous voltages
Average on-state current up to $T_{case} = 85 \, ^\circ C$
Non-repetitive peak on-state current
Repetitive peak on-state current
Continuous voltages
Average on-state current up to $T_{case} = 85 \, ^\circ C$
Repetitive peak on-state current
Non-repetitive peak on-state current
Rate of rise of on-state current after triggering to $I_T = 2.5 \, A$

Cathode gate to cathode
Peak reverse voltage
Peak forward current

Anode gate to anode
Peak reverse voltage
Peak forward current

Temperatures
Storage temperature
Junction temperature

THERMAL RESISTANCE
From junction to ambient in free air
From junction to case

*These ratings apply for zero or negative bias on the cathode gate with respect to the cathode, and when a resistor $R \leq 10 \, k\Omega$ is connected between cathode gate and cathode.
CHARACTERISTICS

Anode to cathode

On-state voltage
\[ I_T = 100 \, mA; T_j = 25 \, ^\circ C \]

Rate of rise of off-state voltage that will not trigger any device
\[ \frac{dV_D^{**}}{dt} \]

Reverse current
\[ V_R = 70 \, V; T_j = 25 \, ^\circ C \]
\[ I_R \text{ typ.} < 100 \, nA \]
\[ I_R < 2 \, \mu A \]

Off-state current
\[ V_D = 70 \, V; T_j = 25 \, ^\circ C \]
\[ I_D < 100 \, nA \]
\[ I_D < 2 \, \mu A \]

Reverse current
\[ V_R = 70 \, V; T_j = 25 \, ^\circ C \]
\[ I_R < 100 \, nA \]
\[ I_R < 2 \, \mu A \]

Holding current
\[ R_{GK} = 10 \, k\Omega; R_{GA} = 220 \, k\Omega; T_j = 25 \, ^\circ C \]
\[ I_H < 250 \, \mu A \]

Cathode gate to cathode

Voltage that will trigger all devices
\[ V_D = 6 \, V; T_j = 25 \, ^\circ C \]
\[ V_{GKT} > 0.5 \, V \]

Current that will trigger all devices
\[ V_D = 6 \, V; T_j = 25 \, ^\circ C \]
\[ I_{GKT} > 1 \, \mu A \]

Anode gate to anode

Voltage that will trigger all devices
\[ V_D = 6 \, V; T_j = 25 \, ^\circ C \]
\[ -V_{GAT} > 1 \, V \]

Current that will trigger all devices
\[ V_D = 6 \, V; R_{GK} = 10 \, k\Omega; T_j = 25 \, ^\circ C \]
\[ -I_{GAT} > 100 \, \mu A \]

*Measured under pulse conditions to avoid excessive dissipation.

**The \( dV_D/dt \) is unlimited when the anode gate lead is returned to the supply voltage through a current limiting resistor.
Switching characteristics

Gate-controlled turn-on time \( t_{gt} = t_d + t_r \)
when switched from \( V_D = 15 \text{ V} \)
to \( I_T = 150 \text{ mA} \); \( I_{GK} = 5 \mu \text{A} \);
\( \text{d}I_{GK}/\text{d}t = 5 \mu \text{A/\mu s} \); \( T_j = 25 ^\circ \text{C} \)

\[ t_{gt} < 300 \text{ ns} \]

Circuit-commutated turn-off time
when switched from \( I_T = 150 \text{ mA} \)
to \( V_R = 15 \text{ V} \); \( -\text{d}I_T/\text{d}t = 3 \text{ A/\mu s} \);
\( \text{d}V_D/\text{d}t = 70 \text{ V/\mu s} \); \( V_D = 15 \text{ V} \)

\[ t_q < 3 \mu \text{s} \]

Fig. 2 Gate-controlled turn-on time definition.

Fig. 3 Circuit-commutated turn-off time definition.
APPLICATION INFORMATION

Sensing network

Rs must be chosen in accordance with the light, temperature, or radiation intensity to be sensed; its resistance should be of the same order as that of the potentiometer.

In the arrangement shown, a decline in resistance of Rs triggers the thyristor, closing the relay that activates the warning system. If the positions of Rs and the potentiometer are interchanged, an increase in the resistance of Rs triggers the thyristor.
Glass-passivated thyristors in TO-220AB envelopes, featuring eutectic bonding, thus being particularly suitable in situations creating high fatigue stresses involved in thermal cycling and repeated switching. Applications include temperature control, motor control, regulators in transformerless power supply applications, relay and coil pulsing and power supply crowbar protection circuits.

**QUICK REFERENCE DATA**

<table>
<thead>
<tr>
<th></th>
<th>BT151-500R</th>
<th>650R</th>
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</thead>
<tbody>
<tr>
<td>Repetitive peak voltages</td>
<td>V_DRM/V_RRM</td>
<td>max. 500 650 V</td>
</tr>
<tr>
<td>Average on-state current</td>
<td>I_T(AV)</td>
<td>max. 7.5 A</td>
</tr>
<tr>
<td>R.M.S. on-state current</td>
<td>I_T(RMS)</td>
<td>max. 12 A</td>
</tr>
<tr>
<td>Non-repetitive peak on-state current</td>
<td>I_TSM</td>
<td>max. 100 A</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 anode.

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

October 1979 1
BT151 SERIES

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

Anode to cathode

<table>
<thead>
<tr>
<th>BT151-500R</th>
<th>650R</th>
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</thead>
<tbody>
<tr>
<td>V\textsubscript{DSM} / V\textsubscript{RSM} max.</td>
<td>500</td>
</tr>
<tr>
<td>V\textsubscript{DRM} / V\textsubscript{RRM} max.</td>
<td>500</td>
</tr>
<tr>
<td>V\textsubscript{DWM} / V\textsubscript{RWM} max.</td>
<td>400</td>
</tr>
<tr>
<td>V\textsubscript{D} / V\textsubscript{R} max.</td>
<td>400</td>
</tr>
</tbody>
</table>

Non-repetitive peak voltages \( t \leq 10 \text{ ms} \)
Repetitive peak voltages \( \delta \leq 0.01 \)
Crest working voltages
Continuous voltages
Average on-state current (averaged over any 20 ms period) up to \( T_{mb} = 95 \degree C \)
R.M.S. on-state current
Repetitive peak on-state current
Non-repetitive peak on-state current; \( t = 10 \text{ ms} \)
R.M.S. on-state current
Non-repetitive peak on-state current; \( t = 10 \text{ ms} \); half sine-wave; \( T_j = 110 \degree C \) prior to surge; with reapplied \( V_{RW} \) max
\( I^2 t \) for fusing \( (t = 10 \text{ ms}) \)
Rate of rise of on-state current after triggering with \( I_G = 50 \text{ mA} \) to \( I_T = 20 \text{ A} \); \( dI_G / dt = 50 \text{ mA} / \mu \text{ s} \)

Gate to cathode

| \( I_{T(AV)} \) max. | 7.5 A |
| \( I_{T(RMS)} \) max. | 12 A |
| \( I_{TRM} \) max. | 65 A |
| \( I_{TS} \) max. | 100 A |
| \( I^2 t \) max. | 50 A$^2$s |

Reverse peak voltage
Average power dissipation (averaged over any 20 ms period)
Peak power dissipation

Temperatures
Storage temperature
Operating junction temperature

\( T_{stg} \quad -40 \text{ to } +125 \degree C \)
\( T_j \quad \text{max. } 110 \degree C \)

* Although not recommended, higher off-state voltages may be applied without damage, but the thyristor may switch into the on-state. The rate of rise of on-state current should not exceed 15 A/\mu s.
THERMAL RESISTANCE

From junction to mounting base
Transient thermal impedance; $t = 1$ ms

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 max. 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 $a = \text{any lead length}$
and with copper laminate

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

Anode to cathode

On-state voltage
\[ I_T = 23 \text{ A}; T_j = 25^\circ C \]

Rate of rise of off-state voltage that will not trigger any device; \( T_j = 110^\circ C \); see Fig.10
\[ \frac{dV_D}{dt} < 50 \text{ V/\mu s} \]
\[ \frac{dV_D}{dt} < 200 \text{ V/\mu s} \]

RGK = open circuit
RGK = 100 \( \Omega \)

Reverse current
\[ V_R = V_{RWM\max}; T_j = 110^\circ C \]
\[ I_R < 0.5 \text{ mA} \]

Off-state current
\[ V_D = V_{DWM\max}; T_j = 110^\circ C \]
\[ I_D < 0.5 \text{ mA} \]
\[ I_L < 40 \text{ mA} \]
\[ I_H < 20 \text{ mA} \]

Gate to cathode

Voltage that will trigger all devices
\[ V_D = 6 \text{ V}; T_j = 25^\circ C \]
\[ V_D = 6 \text{ V}; T_j = -40^\circ C \]

Voltage that will not trigger any device
\[ V_D = V_{DRM\max}; T_j = 110^\circ C \]

Current that will trigger all devices
\[ V_D = 6 \text{ V}; T_j = 25^\circ C \]
\[ V_D = 6 \text{ V}; T_j = -40^\circ C \]

Switching characteristics

Gate-controlled turn-on time \( t_{gt} = t_d + t_r \) when switched from \( V_D = V_{DWM\max} \) to \( I_T = 40 \text{ A} \);
\[ I_{GT} = 100 \text{ mA}; \frac{dI_G}{dt} = 5 \text{ A/\mu s}; T_j = 25^\circ C \]
\[ t_{gt} \text{ typ. } 2 \mu s \]

*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.

3. It is recommended that the circuit connection be made to the anode 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 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. The device should not be pop-riveted to the heatsink. However, it is permissible to press-rivet providing that 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.

OPERATING NOTES

Dissipation and heatsink considerations:

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

b. The method of using Fig. 4 is as follows:
   Starting with the required current on the $I_{T(\ AV)}$ axis, trace upwards to meet the appropriate 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. 4 The right-hand part shows the interrelationship between the power (derived from the left-hand part) and the maximum permissible temperatures.

\[ \alpha = \text{conduction angle per half cycle} \]

\[ a = \text{form factor} = \frac{I_{\text{RMS}}}{I_{\text{AV}}} \]

<table>
<thead>
<tr>
<th>( \alpha )</th>
<th>( a )</th>
</tr>
</thead>
<tbody>
<tr>
<td>300</td>
<td>4</td>
</tr>
<tr>
<td>600</td>
<td>2,8</td>
</tr>
<tr>
<td>900</td>
<td>2,2</td>
</tr>
<tr>
<td>1200</td>
<td>1,9</td>
</tr>
<tr>
<td>1800</td>
<td>1,57</td>
</tr>
</tbody>
</table>
Fig. 5 Maximum permissible non-repetitive r.m.s. on-state current based on sinusoidal currents
(f = 50 Hz); $T_j = 110 \, ^\circ\text{C}$ prior to surge; with reapplied $V_{RWM_{\text{max}}}$.
Fig. 6 Minimum gate voltage that will trigger all devices as a function of junction temperature.

Fig. 7 Minimum gate current that will trigger all devices as a function of junction temperature.

Fig. 8.
Fig. 9. 

Fig. 10 Maximum rate of rise of off-state voltage that will not trigger any device (exponential method) as a function of junction temperature.
Glass-passivated thyristors in TO–220AB envelopes, featuring eutectic bonding, thus being particularly suitable in situations creating high fatigue stresses involved in thermal cycling and repeated switching. Applications include temperature control, motor control, regulators in transformerless power supply applications, relay and coil pulsing and power supply crowbar protection circuits.

**QUICK REFERENCE DATA**

<table>
<thead>
<tr>
<th>Repetitive peak voltages</th>
<th>$V_{DRM/V_{RRM}}$</th>
<th>BT152–400R</th>
<th>600R</th>
<th>800R</th>
</tr>
</thead>
<tbody>
<tr>
<td>max.</td>
<td>400</td>
<td>max.</td>
<td>13</td>
<td>A</td>
</tr>
<tr>
<td>Average on-state current</td>
<td>$I_{T(AV)}$</td>
<td>max.</td>
<td>20</td>
<td>A</td>
</tr>
<tr>
<td>R.M.S. on-state current</td>
<td>$I_{T(RMS)}$</td>
<td>max.</td>
<td>200</td>
<td>A</td>
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<tr>
<td>Non-repetitive peak on-state current</td>
<td>$I_{TSM}$</td>
<td></td>
<td></td>
<td></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 anode.

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

October 1979
RATINGS
Limiting values in accordance with the Absolute Maximum System (IEC 134)

<table>
<thead>
<tr>
<th>Anode to cathode</th>
<th>VTSM/VRSM</th>
<th>VRDM/VRRM</th>
<th>VDWM/VRWM</th>
</tr>
</thead>
<tbody>
<tr>
<td>Non-repetitive peak voltages</td>
<td>max. 450</td>
<td>650</td>
<td>850</td>
</tr>
<tr>
<td>Repetitive peak voltages</td>
<td>max. 400</td>
<td>600</td>
<td>800</td>
</tr>
<tr>
<td>Crest working voltages</td>
<td>max. 400</td>
<td>400</td>
<td>400</td>
</tr>
</tbody>
</table>

Average on-state current (averaged over any 20 ms period) up to $T_{mb} = 93 \, ^\circ C$

- $I_{T(AV)}$ max. 13 A
- $I_{T(RMS)}$ max. 20 A
- $I_{TRM}$ max. 200 A

Non-repetitive peak on-state current; $t = 10 \, ms$

- $I_{TSM}$ max. 200 A
- $I^2 t$ max. 200 $A^2 s$

Rate of rise of on-state current after triggering with $I_G = 160 \, mA$ to $I_T = 50 \, A$; $dI_G/dt = 160 \, A/\mu s$

- $dI/dt$ max. 200 $A/\mu s$

Gate to cathode

- Reverse peak voltage
- Average power dissipation (averaged over any 20 ms period)
- Peak power dissipation; $t \leq 10 \, \mu s$

Temperature

- Storage temperature $T_{stg}$ -40 to +150 $^\circ C$
- Junction temperature $T_j$ max. 115 $^\circ C$

THERMAL RESISTANCE

- From junction to mounting base $R_{th \, j-mb} = 1.1 \, ^\circ C/W$
- From mounting base to heatsink with heatsink compound $R_{th \, mb-h} = 0.3 \, ^\circ C/W$
Thyristors

CHARACTERISTICS

Anode to cathode

On-state voltage (measured under pulse conditions)

\[ I_T = 40 \, \text{A}; \, T_j = 25 \, \text{°C} \]

\[ V_T < 1.75 \, \text{V} \]

Rate of rise of off-state voltage

\[ dV_D/dt < 200 \, \text{V/\mu s} \]

that will not trigger any device

\[ T_j = 115 \, \text{°C}; \, R_{\text{GK}} = \text{open circuit} \]

Reverse current

\[ V_R = V_{\text{RWMmax}}; \, T_j = 115 \, \text{°C} \]

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

Off-state current

\[ V_D = V_{\text{DWMmax}}; \, T_j = 115 \, \text{°C} \]

\[ I_D < 1.0 \, \text{mA} \]

Latching current; \( T_j = 25 \, \text{°C} \)

\[ I_L < 80 \, \text{mA} \]

Holding current; \( T_j = 25 \, \text{°C} \)

\[ I_H < 60 \, \text{mA} \]

Gate to cathode

Voltage that will trigger all devices

\[ V_D = 12 \, \text{V}; \, T_j = -40 \, \text{°C} \]

\[ V_D = 12 \, \text{V}; \, T_j = 25 \, \text{°C} \]

\[ V_{\text{GT}} > 1.5 \, \text{V} \]

\[ V_{\text{GT}} > 1.0 \, \text{V} \]

Voltage that will not trigger any device

\[ V_D = V_{\text{DRMmax}}; \, T_j = 115 \, \text{°C} \]

\[ V_{\text{GD}} < 0.25 \, \text{V} \]

Current that will trigger all devices

\[ V_D = 12 \, \text{V}; \, T_j = -40 \, \text{°C} \]

\[ V_D = 12 \, \text{V}; \, T_j = 25 \, \text{°C} \]

\[ I_{\text{GT}} > 50 \, \text{mA} \]

\[ I_{\text{GT}} > 32 \, \text{mA} \]

Switching characteristics

Gate-controlled turn-on time \( (t_{\text{gt}} = t_d + t_r) \) when

switched from \( V_D = V_{\text{DRMmax}} \) to \( I_T = 40 \, \text{A}; \, I_{\text{GT}} = 100 \, \text{mA}; \, dI_{\text{G}}/dt = 5 \, \text{A/\mu s}; \, T_j = 25 \, \text{°C} \)

\[ t_{\text{gt}} \, \text{typ.} = 2 \, \mu \text{s} \]

Circuit-commutated turn-off time when switched

from \( I_T = 40 \, \text{A} \) to \( V_R > 50 \, \text{V} \) with \( -dI_T/dt = 10 \, \text{A/\mu s}; \, dV_D/dt = 50 \, \text{V/\mu s}; \, T_j = 115 \, \text{°C} \)

\[ t_{\text{q}} \, \text{typ.} = 35 \, \mu \text{s} \]

---

Fig. 2 Gate-controlled turn-on time definition.

Fig. 3 Circuit-commutated turn-off time definition.
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 anode 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 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. The device should not be pop-rivetted to the heatsink. However, it is permissible to press-rivet providing that 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.

OPERATING NOTES

Dissipation and heatsink considerations:

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

b. The method of using Fig.5 is as follows:
   Starting with the required current on the $I_{T(AV)}$ axis, trace upwards to meet the appropriate 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. 5 The right-hand part shows the interrelationship between the power (derived from the left-hand part) and the maximum permissible temperatures.

\[ \alpha = \text{conduction angle per half cycle} \]

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

<table>
<thead>
<tr>
<th>( \alpha )</th>
<th>( a )</th>
</tr>
</thead>
<tbody>
<tr>
<td>30°</td>
<td>4</td>
</tr>
<tr>
<td>60°</td>
<td>2.8</td>
</tr>
<tr>
<td>90°</td>
<td>2.2</td>
</tr>
<tr>
<td>120°</td>
<td>1.9</td>
</tr>
<tr>
<td>180°</td>
<td>1.57</td>
</tr>
</tbody>
</table>
Fig. 6 Maximum permissible non-repetitive r.m.s. on-state current based on sinusoidal currents \( f = 50 \text{ Hz} \); \( T_j = 115 \text{ °C} \) prior to surge; with reapplied \( V_{RWM_{\text{max}}} \).
Fig. 7 Minimum gate current that will trigger all devices as a function of junction temperature.

Fig. 8 Maximum rate of rise of off-state voltage that will not trigger any device as a function of junction temperature.

Fig. 9 —— T_j = 25 °C; —— T_j = 115 °C
FAST TURN-OFF THYRISTOR

Glass-passivated, eutectically bonded, fast turn-off thyristor in a TO-220AB envelope, intended for use in inverter, pulse and switching applications. Its characteristics make the device extremely suitable for use in regulator, vertical deflection, and east/west correction circuits of colour television receivers.

QUICK REFERENCE DATA

<table>
<thead>
<tr>
<th>Characteristic</th>
<th>Symbol</th>
<th>Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Repetitive peak off-state voltage</td>
<td>V_{DRM}</td>
<td>500 V</td>
</tr>
<tr>
<td>Average on-state current</td>
<td>I_{T(AV)}</td>
<td>4 A</td>
</tr>
<tr>
<td>R.M.S. on-state current</td>
<td>I_{T(RMS)}</td>
<td>6 A</td>
</tr>
<tr>
<td>Repetitive peak on-state current</td>
<td>I_{TRM}</td>
<td>30 A</td>
</tr>
<tr>
<td>Circuit-commutated turn-off time</td>
<td>t_q</td>
<td>&lt; 20 μs</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 anode.

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)

Anode to cathode
Non-repetitive peak voltages (t ≤ 10 ms)
Repetitive peak voltages
Working voltages
Average on-state current (averaged over any 20 ms period) up to $T_{mb} = 95 \, ^\circ C$
R.M.S. on-state current
Working peak on-state current
Repetitive peak on-state current
Non-repetitive peak on-state current; t = 10 ms; half sine-wave; $T_j = 110 \, ^\circ C$ prior to surge; with reapplied $V_{RW\text{max}}$
$I_t$ for fusing; t = 10 ms; $T_j = 25 \, ^\circ C$
Rate of rise of on-state current after triggering up to $f = 20 \, kHz$; $V_{DM} = 300 \, V$ to $I_{TM} = 6 \, A$

Gate to cathode
Average power dissipation (averaged over any 20 ms period)
Peak power dissipation; t = 10 $\mu s$

Temperatures
Storage temperature
Operating junction temperature

\begin{align*}
V_{DSM}/V_{RSM} & \quad \text{max.} \quad 550 \, V \\
V_{DRM}/V_{RRM} & \quad \text{max.} \quad 500 \, V \\
V_{DW}/V_{RW} & \quad \text{max.} \quad 400 \, V \, * \\
I_{T(AV)} & \quad \text{max.} \quad 4 \, A \\
I_{T(RMS)} & \quad \text{max.} \quad 6 \, A \\
I_{TWM} & \quad \text{max.} \quad 10 \, A \\
I_{TRM} & \quad \text{max.} \quad 30 \, A \\
I_{TSM} & \quad \text{max.} \quad 40 \, A \\
I^2t & \quad \text{max.} \quad 10 \, A^2s \\
\frac{dI_t}{dt} & \quad \text{max.} \quad 200 \, A/\mu s \\
P_{G(AV)} & \quad \text{max.} \quad 1 \, W \\
P_{GM} & \quad \text{max.} \quad 25 \, W \\
T_{stg} & \quad \text{max.} \quad -40 \text{ to } +125 \, ^\circ C \\
T_j & \quad \text{max.} \quad 110 \, ^\circ C \\
\end{align*}

* Voltage shapes as occurring in the intended application.
Fast turn-off thyristor

THERMAL RESISTANCE
From junction to mounting base
Transient thermal impedance; \( t = 1 \) ms

\[ R_{\text{th} \ j-mb} = 1.5 \ ^\circ\text{C/W} \]
\[ Z_{\text{th} \ j-mb} = 0.2 \ ^\circ\text{C/W} \]

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 max. 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 \( a = \) any lead length and with copper laminate

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

![Diagram](7275493)

Fig. 2.
CHARACTERISTICS

Anode to cathode

On-state voltage

\[ I_T = 10 \text{ A}; \ T_j = 25 \degree \text{C} \]

Rate of rise of off-state voltage that will not trigger any device; \( T_j \leq 110 \degree \text{C} \)

\[ \frac{dV_D}{dt} < 200 \text{ V/\mu s} \]

Off-state current

\[ V_D = V_{DRM_{\text{max}}}; \ T_j = 110 \degree \text{C} \]

\[ I_D < 1.5 \text{ mA} \]

Holding current; \( T_j = 25 \degree \text{C} \)

\[ I_H < 100 \text{ mA} \]

Gate to cathode

Voltage that will trigger all devices

\[ V_D = 6 \text{ V}; \ T_j = 25 \degree \text{C}; \ t_p \geq 5 \mu \text{s} \]

\[ V_{GT} > 2.5 \text{ V} \]

Current that will trigger all devices

\[ V_D = 6 \text{ V}; \ T_j = 25 \degree \text{C}; \ t_p \geq 5 \mu \text{s} \]

\[ I_{GT} > 40 \text{ mA} \]

Switching characteristics

Circuit-commutated turn-off time (in regulating circuits)

when switched from \( I_T = 6 \text{ A} \) to \( V_R \geq 50 \text{ V} \) with

\[ -\frac{dI_T}{dt} = 10 \text{ A/\mu s}; \ \frac{dV_D}{dt} = 200 \text{ V/\mu s}; \ V_{DM} = 500 \text{ V}; \]

\[ R_{GK} = 68 \text{ \Omega}; \ T_{mb} = 80 \degree \text{C}; \ t_p \leq 50 \mu \text{s} \]

\[ t_q < 20 \mu \text{s} \]

* 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.

3. It is recommended that the circuit connection be made to the anode 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 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. The device should not be pop-riveted to the heatsink. However, it is permissible to press-rivet providing that 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.

OPERATING NOTES

Dissipation and heatsink considerations:

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

b. The method of using Fig. 5 is as follows:
   Starting with the required current on the $I_{T(AV)}$ axis, trace upwards to meet the appropriate 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. 5 The right-hand part shows the interrelationship between the power (derived from the left-hand part) and the maximum permissible temperatures.

\[ \alpha = \text{conduction angle per half cycle} \]

\[ a = \frac{T_{\text{RMS}}}{T_{\text{AV}}} \]

<table>
<thead>
<tr>
<th>( \alpha )</th>
<th>( a )</th>
</tr>
</thead>
<tbody>
<tr>
<td>30°</td>
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</tr>
<tr>
<td>120°</td>
<td>1,9</td>
</tr>
<tr>
<td>180°</td>
<td>1,57</td>
</tr>
</tbody>
</table>
Fig. 6 The right-hand part shows the interrelationship between the power (derived from the left-hand part) and the maximum permissible temperatures.

\[ P_{\text{tot}} = \text{maximum power dissipation including gate and switching losses.} \]

\[ I_{\text{TWM}} = \text{maximum working peak on-state current.} \]

Fig. 7 Waveform defining \( I_{\text{TWM}} \).

Fig. 8 Basic circuit of a vertical deflection system.
Fig. 9 Maximum permissible non-repetitive r.m.s. on-state current based on sinusoidal currents (f = 50 Hz); $T_j = 110\, ^\circ\text{C}$ prior to surge; with reapplied $V_{RWM\text{max}}$. 
Fast turn-off thyristor

**Fig. 10** Minimum gate voltage that will trigger all devices as a function of junction temperature.

**Fig. 11** Minimum gate current that will trigger all devices as a function of junction temperature.

**Fig. 12** $T_j = 25 \, ^\circ\text{C}$; $T_j = 110 \, ^\circ\text{C}$.

**Fig. 13**
Fig. 14 Gate current that will trigger all devices as a function of rectangular pulse width; $T_j = 25 \, ^\circ\text{C}$. 
Fast turn-off thyristor

Fig. 15.
FAST TURN-OFF THYRISTOR

Glass-passivated, eutectically bonded, fast turn-off forward blocking thyristor in a TO-220AB envelope, intended for use in high-frequency inverters, power supply, motor control, electronic flash systems and for horizontal deflection circuits of colour television receivers.

QUICK REFERENCE DATA

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Specification</th>
</tr>
</thead>
<tbody>
<tr>
<td>Repetitive peak off-state voltage</td>
<td>V_{DRM} max. 750 V</td>
</tr>
<tr>
<td>Average on-state current</td>
<td>I_{T(AV)} max. 5 A</td>
</tr>
<tr>
<td>R.M.S. on-state current</td>
<td>I_{T(RMS)} max. 8 A</td>
</tr>
<tr>
<td>Repetitive peak on-state current</td>
<td>I_{TRM} max. 60 A</td>
</tr>
<tr>
<td>Circuit-commutated turn-off time</td>
<td>t_{q} &lt; 2.4 \mu s</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 anode.

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

January 1980
# RATINGS

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

## Anode to cathode

<table>
<thead>
<tr>
<th>Voltage Type</th>
<th>Symbol</th>
<th>Maximum Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Non-repetitive peak off-state voltage; ( t \leq 10 \text{ ms} )</td>
<td>( V_{DSSM} )</td>
<td>800 V</td>
</tr>
<tr>
<td>Repetitive peak off-state voltage</td>
<td>( V_{DRM} )</td>
<td>750 V</td>
</tr>
<tr>
<td>Working off-state voltage</td>
<td>( V_{DW} )</td>
<td>600 V</td>
</tr>
<tr>
<td>( t_p \leq 20 \mu s; \delta = t_p/T \leq 0.25 )</td>
<td>( V_{DSM} )</td>
<td>800 V</td>
</tr>
</tbody>
</table>

Average on-state current (averaged over any 20 ms period) up to \( T_{mb} = 77 \text{ °C} \):

<table>
<thead>
<tr>
<th>Current Type</th>
<th>Symbol</th>
<th>Maximum Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Working off-state voltage</td>
<td>( I_{T(AV)} )</td>
<td>5 A</td>
</tr>
<tr>
<td>Repetitive peak on-state current</td>
<td>( I_{T(RMS)} )</td>
<td>8 A</td>
</tr>
<tr>
<td>Peak pulse on-state current</td>
<td>( I_{T(RM)} )</td>
<td>60 A</td>
</tr>
<tr>
<td>( I^2t ) for fusing; ( t = 10 \text{ ms}; T_j = 25 \text{ °C} )</td>
<td>( I_{T(M)} )</td>
<td>240 A</td>
</tr>
<tr>
<td>Rate of rise of on-state current</td>
<td>( dI_T/dt )</td>
<td>60 A/μs</td>
</tr>
</tbody>
</table>

## Gate to cathode

<table>
<thead>
<tr>
<th>Power Dissipation</th>
<th>Symbol</th>
<th>Maximum Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Peak power dissipation</td>
<td>( P_{GM})</td>
<td>25 W</td>
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</tbody>
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## Temperatures

<table>
<thead>
<tr>
<th>Temperature Type</th>
<th>Symbol</th>
<th>Range</th>
</tr>
</thead>
<tbody>
<tr>
<td>Storage temperature</td>
<td>( T_{stg} )</td>
<td>-40 to +125 °C</td>
</tr>
<tr>
<td>Operating junction temperature</td>
<td>( T_j )</td>
<td>110 °C</td>
</tr>
</tbody>
</table>
THERMAL RESISTANCE
From junction to mounting base
Transient thermal impedance; \( t = 1 \text{ ms} \)

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 max. 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 \( a = \) any lead length
and with copper laminate

\[
\begin{align*}
R_{\text{th j-mb}} &= 2,5 \, ^{\circ}\text{C/W} \\
Z_{\text{th j-mb}} &= 0,24 \, ^{\circ}\text{C/W}
\end{align*}
\]

\[
\begin{align*}
R_{\text{th mb-h}} &= 0,3 \, ^{\circ}\text{C/W} \\
R_{\text{th mb-h}} &= 1,4 \, ^{\circ}\text{C/W} \\
R_{\text{th mb-h}} &= 2,2 \, ^{\circ}\text{C/W} \\
R_{\text{th mb-h}} &= 0,8 \, ^{\circ}\text{C/W} \\
R_{\text{th mb-h}} &= 1,4 \, ^{\circ}\text{C/W}
\end{align*}
\]

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

Fig. 2.
CHARACTERISTICS

Anode to cathode

On-state voltage
\[ I_T = 20 \, \text{A}; \, T_j = 25 \, ^\circ\text{C} \]

Rate of rise of off-state voltage that will not trigger any device; exponential method;
\[ V_D = \frac{2}{3} V_{DRM\text{max}}; \, T_j \leq 110 \, ^\circ\text{C} \]
\[ V_{\text{GK}} = 0 \, \text{V} \]
\[ -V_{\text{GK}} = 6 \, \text{V} \]

Off-state current
\[ V_D = V_{DRM\text{max}}; \, T_j = 110 \, ^\circ\text{C} \]
\[ I_D < 1.5 \, \text{mA} \]

Gate to cathode

Voltage that will trigger all devices
\[ V_D = 6 \, \text{V}; \, T_j = 25 \, ^\circ\text{C} \]
\[ V_{\text{GT}} > 2.5 \, \text{V} \]

Current that will trigger all devices
\[ V_D = 6 \, \text{V}; \, T_j = 25 \, ^\circ\text{C} \]
\[ I_{\text{GT}} > 40 \, \text{mA} \]

Switching characteristics

Circuit-commutated turn-off time (in horizontal deflection trace switch) when switched from
\[ I_T = 8 \, \text{A} \, \text{to} \, V_R = 0.8 \, \text{V}; \, V_{\text{DM}} = 700 \, \text{V}; \, -V_{\text{GG}} = 25 \, \text{V} \]
from \[ R_{\text{tot}} = 62 \, \Omega^{**}; \, T_{\text{mb}} = 80 \, ^\circ\text{C} \]; see also Fig. 11
\[ t_p < 30 \, \mu\text{s} \]
\[ t_p < 150 \, \mu\text{s} \]
\[ t_q < 2.4 \, \mu\text{s} \]
\[ t_q < 4.8 \, \mu\text{s} \]

* Measured under pulse conditions to avoid excessive dissipation.
** \( R_{\text{tot}} \) is the total series resistance including source resistance.

Fig. 3 Circuit-commutated turn-off time definition.
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 anode 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 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.

6. The device should not be pop-rivetted to the heatsink. However, it is permissible to press-rivet providing that 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.

OPERATING NOTES

Dissipation and heatsink considerations:

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

b. The method of using Fig. 5 is as follows:

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

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

   c. Any measurement of heatsink temperature should be made immediately adjacent to the device.
Fig. 5 The right-hand part shows the interrelationship between the power (derived from the left-hand part) and the maximum permissible temperatures.

\[ \alpha = \text{conduction angle per half cycle} \]

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

<table>
<thead>
<tr>
<th>( \alpha )</th>
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</tr>
</thead>
<tbody>
<tr>
<td>30°</td>
<td>4</td>
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<tr>
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</tr>
<tr>
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<td>2,2</td>
</tr>
<tr>
<td>120°</td>
<td>1,9</td>
</tr>
<tr>
<td>180°</td>
<td>1,57</td>
</tr>
</tbody>
</table>
Fast turn-off thyristor

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

Fig. 7.
Fig. 8 Minimum gate voltage that will trigger all devices as a function of junction temperature.

Fig. 9 Minimum gate current that will trigger all devices as a function of junction temperature.

Fig. 10 $T_j = 25^\circ C$; $T_j = 110^\circ C$. 
Fig. 11 Typical variation of $t_q$ with $I_{TM}$ and $-V_{GG}$ at $-dI_T/dt = 10 \text{ A/\mu s}$; $dV_D/dt = 200 \text{ to } 700 \text{ V/\mu s}$; $t_p = 150 \text{ \mu s}$. 
APPLICATION INFORMATION

Note
For reverse blocking operation use a series diode, for reverse conducting operation use an anti-parallel diode.

Fig. 12 Basic circuit and waveforms.
THYRISTORS

Silicon thyristors in metal envelopes, intended for general purpose single-phase or three-phase mains operation.
The series consists of reverse polarity types (anode to stud) identified by a suffix R: BTW23-600R to 1600R.

QUICK REFERENCE DATA

<table>
<thead>
<tr>
<th></th>
<th>BTW23-600R</th>
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<th>1000R</th>
<th>1200R</th>
<th>1400R</th>
<th>1600R</th>
</tr>
</thead>
<tbody>
<tr>
<td>Repetitive peak voltages</td>
<td>600</td>
<td>800</td>
<td>1000</td>
<td>1200</td>
<td>1400</td>
<td>1600</td>
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<tr>
<td>V_{DRM} = V_{RRM} max.</td>
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<td>max.</td>
<td>max.</td>
<td>max.</td>
<td>max.</td>
<td>max.</td>
</tr>
<tr>
<td>Average on-state current</td>
<td>I_{T(AV)} max.</td>
<td>90 A</td>
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<tr>
<td>R.M.S. on-state current</td>
<td>I_{T(RMS)} max.</td>
<td>140 A</td>
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<td>Non-repetitive peak on-state current</td>
<td>I_{TSM} max.</td>
<td>2000 A</td>
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<tr>
<td>Rate of rise of off-state voltage that will not trigger any device</td>
<td>dV_{D}/dt &lt;</td>
<td>200 V/μs</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>On request (see ordering note on page 4)</td>
<td>dV_{D}/dt &lt;</td>
<td>1000 V/μs</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

MECHANICAL DATA

Fig. 1 TO-94: with metric M12 stud (Ø 12 mm); e.g. BTW23-600R.
Types with ½ in x 20 UNF stud (Ø 12.7 mm) are available on request. These are indicated by the suffix U: e.g. BTW23-600RU.

Net mass: 134 g
Diameter of clearance hole: max. 13.0 mm
Torque on nut: min. 9 Nm (90 kg cm)
max. 17.5 Nm (175 kg cm)

Supplied with device: 1 nut, 1 lock washer
Nut dimensions across the flats:
M12: 19 mm
½ in x 20 UNF: 19 mm

April 1978
RATINGS
Limiting values in accordance with the Absolute Maximum System (IEC 134)

Anode to cathode

<table>
<thead>
<tr>
<th>BTW23-600R</th>
<th>800R</th>
<th>1000R</th>
<th>1200R</th>
<th>1400R</th>
<th>1600R</th>
</tr>
</thead>
<tbody>
<tr>
<td>V_DSM/V_RSM</td>
<td>max.</td>
<td>600</td>
<td>800</td>
<td>1000</td>
<td>1200</td>
</tr>
<tr>
<td>V_DRM/V_RRM</td>
<td>max.</td>
<td>600</td>
<td>800</td>
<td>1000</td>
<td>1200</td>
</tr>
<tr>
<td>V_DWM/V_RWM</td>
<td>max.</td>
<td>400</td>
<td>600</td>
<td>700</td>
<td>800</td>
</tr>
</tbody>
</table>

Average on-state current (averaged over any 20 ms period) up to T_mb = 85 °C
I_T(AV) max. 90 A
I_T(RMS) max. 140 A
I_TRM max. 1250 A

R.M.S. on-state current

Repellent peak on-state current

Non-repetitive peak on-state current; t = 10 ms;
with reapplyed V_RWM max
I_TSM max. 2000 A
I_TRMS max. 76 A

Average power dissipation (averaged over any 20 ms period)
P_G(AV) max. 2 W
P_GM max. 10 W

Peak power dissipation

Gate to cathode

Reverse peak voltage
V_RGM max. 10 V

Average power dissipation (averaged over any 20 ms period)
P_G(AV) max. 2 W
P_GM max. 10 W

Temperatures

Storage temperature
T_stg -55 to + 125 °C

Junction temperature
T_j max. 125 °C

THERMAL RESISTANCE

From junction to mounting base
R_Th_j-mb = 0,3 °C/W
From mounting base to heatsink
R_Th_mb-h = 0,1 °C/W
Transient thermal impedance (t = 1 ms)
Z_Th_j-mb = 0,015 °C/W

* To ensure thermal stability: R_th_j-a < 0,75 °C/W (d.c. blocking) or < 1,5 °C/W (a.c.). For smaller heatsinks T_j_max should be derated. For a.c. see Fig. 4.
CHARACTERISTICS

Anode to cathode

On-state voltage
\[ I_T = 500 \text{ A}; \quad T_j = 25 \text{ °C} \]

Rate of rise of off-state voltage that will not trigger any device; exponential method; \( V_D = 2/3 \ V_{DRM \text{ max}} \); \( T_j = 125 \text{ °C} \)

Reverse current
\[ V_R = V_{RWM \text{ max}}; \quad T_j = 125 \text{ °C} \]

Off-state current
\[ V_D = V_{DWM \text{ max}}; \quad T_j = 125 \text{ °C} \]

Holding current; \( T_j = 25 \text{ °C} \)

Gate to cathode

Voltage that will trigger all devices
\[ V_D = 6 \text{ V}; \quad T_j = 25 \text{ °C} \]

Voltage that will not trigger any device
\[ V_D = V_{DRM \text{ max}}; \quad T_j = 125 \text{ °C} \]

Current that will trigger any device
\[ V_D = 6 \text{ V}; \quad T_j = 25 \text{ °C} \]

Switching characteristics

Gate-controlled turn-on time (\( t_{gt} = t_d + t_r \)) when switched from \( V_D = V_{DWM \text{ max}} \) to \( I_T = 100 \text{ A} \);
\[ I_{GT} = 200 \text{ mA}; \quad dlG/dt = 1 \text{ A/µs}; \quad T_j = 25 \text{ °C} \]

\[ t_{gt} < 2.5 \text{ µs} \]
\[ t_r \text{ typ.} < 1 \text{ µs} \]

* Measured under pulse conditions to avoid excessive dissipation.

Fig. 2 Gate-controlled turn-on time definitions.
CHARACTERISTICS (continued)

Circuit-commutated turn-off when switched
from $I_T = 50$ A to $V_R \geq 50$ V with $-dI_T/dt = 50$ A/$\mu$s;
$\frac{dV_D}{dt} = 200$ V/$\mu$s;
$T_j = 125 \, ^\circ\text{C}$

$t_q$ typ. 100 $\mu$s

$T_j = 25 \, ^\circ\text{C}$

$t_q$ typ. 60 $\mu$s

$< 200 \, \mu$s

$< 120 \, \mu$s

Fig. 3 Circuit-commutated turn-off time definition.

OPERATING NOTE

Switching losses in commutation

For applications in which the thyristor is forced to switch from an on-state current $I_{TRM}$ to a high reverse voltage at a high commutation rate ($-dI_T/dt$), consult Fig. 14 (nomogram) to find the increase in total average power. This increase must be added to the loss from the curves in Fig. 4.

ORDERING NOTE

Types with $dV_D/dt$ of 1000 V/$\mu$s are available on request. Add suffix C to the type number when ordering; e.g. BTW23-600RC.
Thyristors

Fig. 4.

Fig. 5.

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

interrelation between the power (derived from the left hand graph) and the max. permissible temperatures

Thyristors

BTW23 SERIES

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Fig. 6. 
Minimum gate voltage that will trigger all devices plotted against junction temperature.

Fig. 7. 
Minimum gate current that will trigger all devices plotted against junction temperature.

Fig. 8. 
Minimum gate current plotted against junction temperature for different temperatures.
Thyristors

**Fig. 9.**

max. rate of rise of off-state voltage that will not trigger any device (exp. method) plotted against junction temp.

**Fig. 10.**

max. rate of rise of off-state voltage that will not trigger any device (exp. method) plotted against applied voltage

**Fig. 11.**

$Z_{th,j-mb}$ (°C/W)
Fig. 12 Intermittent overload capability of two BTW23 thyristors in anti-parallel connection in a single phase a.c. control circuit (e.g. welding); conduction angle 360°.
In this area is not allowed.

**Fig. 13.**

**NOMOGRAM:** power loss $\Delta P_{AV}$ due to switching on: $T_j=125°C$

$I_G = 750 mA; \frac{dI_G}{dt} = 1A/\mu s$

$\Delta P_{AV} (W)$ due to switching on:

$T_j=125°C$

$V_{DWM} = 600V, 800, 1000, 1200$

**Fig. 14.**

**NOMOGRAM:** power loss $\Delta P_{AV}$ due to switching off: $T_j=125°C$

$I_{TRM} = \frac{1}{2} \frac{dI}{dt}$

$V_{RRM} = 100V$

$\Delta P_{AV} (W)$ due to switching off:

$T_j=125°C$

$V_{RRM} = 100V$
For safe operation at a given temperature, the average current envelope of successive cycles (see drawing above) must lie within the region bounded by the curve shown below for that temperature.

Fig. 15 Limits for starting or inrush currents.
THYRISTORS

Silicon thyristors in metal envelopes, intended for general purpose single-phase or three-phase mains operation. The series consists of reverse polarity types (anode to stud) identified by a suffix R: BTW24-600R to 1600R.

QUICK REFERENCE DATA

<table>
<thead>
<tr>
<th>Repetitive peak voltages $V_{DRM} = V_{RRM}$</th>
<th>BTW24-600R</th>
<th>800R</th>
<th>1000R</th>
<th>1200R</th>
<th>1400R</th>
<th>1600R</th>
</tr>
</thead>
<tbody>
<tr>
<td>max.</td>
<td>600</td>
<td>800</td>
<td>1000</td>
<td>1200</td>
<td>1400</td>
<td>1600</td>
</tr>
<tr>
<td>V</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Average on-state current
R.M.S. on-state current
Non-repetitive peak on-state current
Rate of rise of off-state voltage that will not trigger any device
On request (see ordering note on page 4)

<table>
<thead>
<tr>
<th>$I_T(AV)$ max.</th>
<th>$I_{T(RMS)}$ max.</th>
<th>$I_{TSM}$ max.</th>
<th>$dV_D/dt &lt;$</th>
</tr>
</thead>
<tbody>
<tr>
<td>35 A</td>
<td>55 A</td>
<td>800 A</td>
<td>200 V/μs</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>1000 V/μs</td>
</tr>
</tbody>
</table>

MECHANICAL DATA

Fig. 1 TO-103.

Dimensions in mm

Net mass: 46 g
Diameter of clearance hole: 8,5 mm
Torque on nut: min. 4 Nm (40 kg cm)
max. 6 Nm (60 kg cm)

Supplied with device: 1 nut, 1 lock washer
Nut dimensions across the flats: 13 mm

April 1978
RATINGS
Limiting values in accordance with the Absolute Maximum System (IEC 134)

<table>
<thead>
<tr>
<th>Anode to cathode</th>
<th>BTW24-600R</th>
<th>800R</th>
<th>1000R</th>
<th>1200R</th>
<th>1400R</th>
<th>1600R</th>
</tr>
</thead>
<tbody>
<tr>
<td>Non-repetitive peak voltages</td>
<td>V_{DSM/V_{RSM}}</td>
<td>max.</td>
<td>600</td>
<td>800</td>
<td>1000</td>
<td>1200</td>
</tr>
<tr>
<td>Repetitive peak voltages</td>
<td>V_{DRM/V_{RRM}}</td>
<td>max.</td>
<td>600</td>
<td>800</td>
<td>1000</td>
<td>1200</td>
</tr>
<tr>
<td>Crest working voltages</td>
<td>V_{DWM/V_{RWM}}</td>
<td>max.</td>
<td>400</td>
<td>600</td>
<td>700</td>
<td>800</td>
</tr>
</tbody>
</table>

Average on-state current (averaged over any 20 ms period) up to T_{mb} = 85 °C
| \( I_T(AV) \) max. | 35 A |
| \( I_T(RMS) \) max. | 55 A |
| \( I_{TRM} \) max. | 450 A |

Non-repetitive peak on-state current; \( t = 10 \) ms;
half sine-wave; \( T_j = 125 \) °C prior to surge;
with reapplied \( V_{RWM\text{max}} \)
| \( I_{TSM} \) max. | 800 A |
| \( I^2t \) max. | 3200 A²s |

Rate of rise of on-state current after triggering
with \( I_G = 500 \) mA to \( I_T = 100 \) A; \( dl_G/dt = 1 \) A/μs
| \( dI_T/dt \) max. | 300 A/μs |

Rate of change of commutation current
see Fig. 14

Gate to cathode
Reverse peak voltage
| \( V_{RGM} \) max. | 10 V |

Average power dissipation (averaged over any 20 ms period)
| \( P_{G(AV)} \) max. | 1 W |
| \( P_{GM} \) max. | 5 W |

Peak power dissipation

Temperatures
Storage temperature
| \( T_{stg} \) | -55 to + 125 °C |

Junction temperature
| \( T_j \) max. | 125 °C |

THERMAL RESISTANCE
From junction to mounting base
| \( R_{th \ j \ - \ mb} \) = | 0,6 °C/W |
From mounting base to heatsink
| \( R_{th \ mb \ - \ h} \) = | 0,2 °C/W |
Transient thermal impedance (\( t = 1 \) ms)
| \( Z_{th \ j \ - \ mb} \) = | 0,04 °C/W |

* To ensure thermal stability: \( R_{th \ j \ - \ a} < 1 \) °C/W (d.c. blocking) or \( < 2 \) °C/W (a.c.). For smaller heatsinks \( T_{j \ max} \) should be derated. For a.c. see Fig. 4.
CHARACTERISTICS

Anode to cathode

On-state voltage
\( I_T = 100 \, A; \, T_j = 25 \, ^\circ C \)

Rate of rise of off-state voltage that will not trigger any device; exponential method; \( V_D = 2/3 \, V_{DRM_{\text{max}}}; \)
\( T_j = 125 \, ^\circ C \)

Reverse current
\( V_R = V_{RWM_{\text{max}}}; \, T_j = 125 \, ^\circ C \)

Off-state current
\( V_D = V_{DWM_{\text{max}}}; \, T_j = 125 \, ^\circ C \)

Latching current; \( T_j = 25 \, ^\circ C \)

Holding current; \( T_j = 25 \, ^\circ C \)

Gate to cathode

Voltage that will trigger all devices
\( V_D = 6 \, V; \, T_j = 25 \, ^\circ C \)

Voltage that will not trigger any device
\( V_D = V_{DRM_{\text{max}}}; \, T_j = 125 \, ^\circ C \)

Current that will trigger all devices
\( V_D = 6 \, V; \, T_j = 25 \, ^\circ C \)

Switching characteristics

Gate-controlled turn-on time \((t_{gt} = t_d + t_r)\) when switched from \( V_D = V_{DWM_{\text{max}}} \) to \( I_T = 100 \, A; \, I_{GT} = 150 \, mA; \, dI_G/dt = 1 \, A/\mu s; \, T_j = 25 \, ^\circ C \)

\( t_{gt} \) typ. \( 2 \, \mu s \)

\( t_r \) typ. \( 1 \, \mu s \)

* Measured under pulse conditions to avoid excessive dissipation.
CHARACTERISTICS (continued)

Circuit-commutated turn-off time when switched
from $I_T = 30$ A to $V_R \geq 50$ V with $-dI_T/dt = 30$ A/$\mu$s;
$dV_D/dt = 100$ V/$\mu$s;

$T_j = 125$ °C

$T_j = 25$ °C

Fig. 3 Circuit-commutated turn-off time definition.

OPERATING NOTE

Switching losses in commutation

For applications in which the thyristor is forced to switch from an on-state current $I_{TRM}$ to a high reverse voltage at a high commutation rate ($-dI_T/dt$), consult Fig. 14 (nomogram) to find the increase in total average power. This increase must be added to the loss from the curves in Fig. 4.

ORDERING NOTE

Types with $dV_D/dt$ of 1000 V/$\mu$s are available on request. Add suffix C to the type number when ordering; e.g. BTW24-600RC.
Thyristors

BTW24 SERIES

Fig. 4.

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

with reapplied \( V_{RWM} \) max

\( T_j = 125^\circ C \) prior to surge

interrelation between the power (derived from the left hand graph) and the max. allowable temperatures
Fig. 6 Minimum gate voltage that will trigger all devices plotted against junction temperature.

Fig. 7 Minimum gate current that will trigger all devices plotted against junction temperature.

Fig. 8.
Thyristors

**Fig. 9.**

max. rate of rise of off-state voltage that will not trigger any device (exp. method) plotted against junction temp.

**Fig. 10.**

max. rate of rise of off-state voltage that will not trigger any device (exp. method) plotted against applied voltage

**Fig. 11.**

$Z_{th,j-mb}$ (°C/W)

$V_{OIM_{max}}$ (V)

$V_{OIM}$ (V)

$V_{OIM}$ = 100 V

$T_j$ = 125°C

$Z_{th,j-mb}$ (°C/W) vs. time (s)
Fig. 12 Intermittent overload capability of two BTW24 thyristors in anti-parallel connection in a single phase a.c. control circuit (e.g. welding); conduction angle: 360°.
Fig. 13 Power loss $\Delta P_{(AV)}$ due to switching-on; $T_j = 125$ °C; $I_G = 500$ mA; $dI_G/dt = 1$ A/μs.

Fig. 14.
for safe operation at a given temperature, the average current envelope of successive cycles (see drawing above) must lie within the region bounded by the curve shown below for that temperature.

Fig. 15 Limits for starting or inrush currents.
FAST TURN-OFF THYRISTORS

A range of medium current fast turn-off thyristors in metal envelopes, intended for use in inverter applications.

The series consists of reverse polarity types (anode to stud) identified by a suffix R: BTW30-800RS to 1200RS.

QUICK REFERENCE DATA

<table>
<thead>
<tr>
<th></th>
<th>BTW30-800RS</th>
<th>1000RS</th>
<th>1200RS</th>
</tr>
</thead>
<tbody>
<tr>
<td>Repetitive peak voltages</td>
<td>V\text{DRM}/V\text{RRM} max.</td>
<td>800</td>
<td>1000</td>
</tr>
<tr>
<td>Average on-state current</td>
<td>I\text{T(AV)} max.</td>
<td>16 A</td>
<td></td>
</tr>
<tr>
<td>R.M.S. on-state current</td>
<td>I\text{T(RMS)} max.</td>
<td>24 A</td>
<td></td>
</tr>
<tr>
<td>Non-repetitive peak on-state current</td>
<td>I\text{TSM} max.</td>
<td>150 A</td>
<td></td>
</tr>
<tr>
<td>Rate of rise of on-state current</td>
<td>dI\text{T}/dt max.</td>
<td>100 A/\mu s</td>
<td></td>
</tr>
<tr>
<td>Rate of rise of off-state voltage that will not trigger any device</td>
<td>dV\text{D}/dt &lt;</td>
<td>200 V/\mu s</td>
<td></td>
</tr>
<tr>
<td>Circuit-commutated turn-off time t\text{q} &lt;</td>
<td>15 \mu s</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

MECHANICAL DATA

Fig. 1 TO-48: with metric M6 stud (\phi 6 mm)

Dimensions in mm

Net mass: 14 g
Diameter of clearance hole: max. 6,5 mm
Accessories supplied on request: 56264A
(mica washer, insulating ring, soldering tag)

Torque on nut: min. 1,7 Nm (17 kg cm)
max. 3,5 Nm (35 kg cm)

Supplied with device:
1 nut, 1 lock washer
Nut dimensions across the flats: 10 mm

April 1978
RATINGS

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

Anode to cathode

<table>
<thead>
<tr>
<th>BTW30-800RS</th>
<th>1000RS</th>
<th>1200RS</th>
</tr>
</thead>
<tbody>
<tr>
<td>max.</td>
<td>800</td>
<td>1000</td>
</tr>
<tr>
<td>max.</td>
<td>800</td>
<td>1000</td>
</tr>
<tr>
<td>max.</td>
<td>600</td>
<td>800</td>
</tr>
</tbody>
</table>

Non-repetitive peak voltages

\( V_{DSM}^{**}/V_{RSM} \)

\( V_{DRM}/V_{RRM} \)

Repetitive peak voltages

Crest working off-state voltage

\( V_{DWM} \)

Average on-state current assuming zero switching losses (averaged over any 20 ms period)

\( I_T(AV) \)

\( I_T(AV) \)

\( I_T(AV) \)

\( I_T(RMS) \)

Repetitive peak on-state current

Non-repetitive peak on-state current

\( I_{TRM} \)

\( I_{TSM} \)

\( I_{TSM} \)

\( I^2 t \)

Rate of rise of on-state current after triggering with \( I_G = 1 \text{ A to } I_T = 50 \text{ A; } dI_G/dt = 1 \text{ A/} \mu\text{s} \)

\( dI_T/dt \)

Gate to cathode

Reverse peak voltage

\( V_{RGM} \)

Average power dissipation (averaged over any 20 ms period)

\( P_{G(AV)} \)

Peak power dissipation

Temperatures

Storage temperature

\( T_{stg} \)

Junction temperature

\( T_j \)

THERMAL RESISTANCE

From junction to mounting base

\( R_{th j-mb} \)

From mounting base to heatsink

\( R_{th mb-h} \)

Transient thermal impedance (t = 1 ms)

\( Z_{th j-mb} \)

* To ensure thermal stability: \( R_{th j-a} < 3 \text{ °C/W (d.c. blocking) or } < 6 \text{ °C/W (square-wave; } \delta = 0.5) \).

For smaller heatsinks \( T_j \text{ max} \) should be derated. For square-wave see Fig. 5.

** Although not recommended, higher off-state voltages may be applied without damage, but the thyristor may switch into the on-state. The rate of rise of on-state current should not exceed 30 A/\mu s.

\( \Delta \) Thermal stability at higher voltage ratings is dependent on duty factor. See Figs 15 and 16.
Fast turn-off thyristors

CHARACTERISTICS

Anode to cathode

On-state voltage
\[ I_T = 20 \, \text{A}; \, T_j = 25 \, ^\circ\text{C} \]

Rate of rise of off-state voltage that will not trigger
\[ \frac{dV_D}{dt} < 200 \, \text{V/\mu s} \]

any device; exponential method; \[ V_D = \frac{2}{3} V_{DRM \text{ max}}; \, T_j = 125 \, ^\circ\text{C} \]

Off-state current
\[ V_D = V_{DWM \text{ max}}; \, T_j = 125 \, ^\circ\text{C} \]

Holding current; \[ T_j = 25 \, ^\circ\text{C} \]

Gate to cathode

Voltage that will trigger all devices
\[ V_D = 6 \, \text{V}; \, T_j = 25 \, ^\circ\text{C} \]

Voltage that will not trigger any device
\[ V_D = V_{DRM \text{ max}}; \, T_j = 125 \, ^\circ\text{C} \]

Current that will trigger all devices
\[ V_D = 6 \, \text{V}; \, T_j = 25 \, ^\circ\text{C} \]

Switching characteristics

Gate-controlled turn-on time \( t_{\text{gt}} = t_d + t_r \) when

switched from \( V_D = V_{DWM \text{ max}} \) to \[ I_T = 50 \, \text{A}; \, I_{\text{GT}} = 200 \, \text{mA}; \, \frac{dI_G}{dt} = 1 \, \text{A/\mu s}; \, T_j = 25 \, ^\circ\text{C} \]

\[ t_d < 1 \, \mu\text{s} \]
\[ t_r < 1 \, \mu\text{s} \]

* Measured under pulse conditions to avoid excessive dissipation.
CHARACTERISTICS (continued)

Circuit-commutated turn-off time when switched
from $I_T = 10$ A to $V_R \geq 50$ V with $-\frac{dI_T}{dt} = 10$ A/$\mu$s;
$dV_D/dt = 50$ V/$\mu$s; $T_j = 125$ °C

$$t_q < 15 \mu s$$

![Diagram](image)

**Fig. 3** Circuit-commutated turn-off time definitions.

**OPERATING NOTES**

1. The terminals should neither be bent nor twisted; they should be soldered into the circuit so that there is no strain on them.

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

2. High frequency operation.

   a. The curves in Figs 13 and 14 show the additional average power losses due to turning on and turning off the thyristor in square pulse operation. This power should be added to that derived from the curves in Fig. 5.

   b. Power loss due to turn-off may be discounted if an inverse parallel diode is connected across the thyristor to clip any reverse voltage which may occur following commutation. Note should be taken of the consequent increase in turn-off time (see Fig. 11).
Fast turn-off thyristors

**BTW30 S SERIES**

---

interrelation between the power (derived from the left hand graph) and the max. allowable temperatures

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

**Fig. 4.**

---

interrelation between the power (derived from the left hand graph) and the max. allowable temperatures

* $T_{mb}$ scale is for comparison purposes only and is correct only for $R_{th,mb-a} \leq 2^\circ C/W$

**Fig. 5.**

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Fig. 6. Maximum permissible non-repetitive peak on-state current for one square pulse.

Fig. 7. Minimum gate voltage that will trigger all devices plotted against junction temperature.

Fig. 8. Minimum gate current that will trigger all devices plotted against junction temperature.
Fast turn-off thyristors

BTW30
S SERIES

max. rate of rise of off-state voltage that will not trigger any device (exp. method) plotted against junction temp.

Fig. 9.

max. rate of rise of off-state voltage that will not trigger any device (exp. method) plotted against applied voltage

Tj = 125°C

Fig. 10.

Fig. 11.

Fig. 12.
BTW30
S SERIES

Fig. 13.

Fig. 14.
Fast turn-off thyristors

Fig. 15.

Fig. 16.
Fig. 17.

Transient thermal impedance from junction to mounting base versus time.

$Z_{thj-mb}$ ($^\circ$C/W) vs. time (s)
FAST TURN-OFF THYRISTORS

A range of medium current fast turn-off thyristors in metal envelopes, intended for use in inverter applications.

The series consists of reverse polarity types (anode to stud) identified by a suffix R: BTW31-800RW to 1200RW.

QUICK REFERENCE DATA

<table>
<thead>
<tr>
<th>Repetitive peak voltages</th>
<th>BTW31-800RW</th>
<th>1000RW</th>
<th>1200RW</th>
</tr>
</thead>
<tbody>
<tr>
<td>V_{DRM}/V_{RRM} max.</td>
<td>800</td>
<td>1000</td>
<td>1200</td>
</tr>
<tr>
<td>Average on-state current</td>
<td>lT(AV) max.</td>
<td>22 A</td>
<td></td>
</tr>
<tr>
<td>R.M.S. on-state current</td>
<td>lT(RMS) max.</td>
<td>31 A</td>
<td></td>
</tr>
<tr>
<td>Non-repetitive peak on-state current</td>
<td>lTSM max.</td>
<td>240 A</td>
<td></td>
</tr>
<tr>
<td>Rate of rise of on-state current</td>
<td>dlT/dt max.</td>
<td>100 A/μs</td>
<td></td>
</tr>
<tr>
<td>Rate of rise of off-state voltage that will not trigger any device</td>
<td>dVD/dt &lt;</td>
<td>200 V/μs</td>
<td></td>
</tr>
<tr>
<td>Circuit-commutated turn-off time</td>
<td>tq &lt;</td>
<td>20 μs</td>
<td></td>
</tr>
</tbody>
</table>

MECHANICAL DATA

Fig. 1 TO-48: with metric M6 stud (φ 6 mm)

Net mass: 14 g
Diameter of clearance hole: max. 6,5 mm
Accessories supplied on request: 56264A (mica washer, insulating ring, soldering tag)

Torque on nut: min. 1,7 Nm (17 kg cm) max. 3,5 Nm (35 kg cm)
Supplied with device:
1 nut, 1 lock washer
Nut dimensions across the flats: 10 mm

April 1978
**RATINGS**

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

<table>
<thead>
<tr>
<th>Anode to cathode</th>
<th>BTW31-800RW</th>
<th>1000RW</th>
<th>1200RW</th>
</tr>
</thead>
<tbody>
<tr>
<td>Non-repetitive peak voltages (t &lt; 10 ms)</td>
<td>V_{DSM}^{**}/V_{RSM}</td>
<td>max. 800</td>
<td>1000</td>
</tr>
<tr>
<td>Repetitive peak voltages</td>
<td>V_{DRM}/V_{RRM}</td>
<td>max. 800</td>
<td>1000</td>
</tr>
<tr>
<td>Crest working off-state voltage square-wave; δ = 0,5</td>
<td>V_{DWM}</td>
<td>max. 600</td>
<td>800</td>
</tr>
</tbody>
</table>

Average on-state current assuming zero switching losses (averaged over any 20 ms period)
- square-wave; δ = 0,5; up to T_{mb} = 65 °C: I_{T(AV)} max. 22 A
- square-wave; δ = 0,5; at T_{mb} = 85 °C: I_{T(AV)} max. 16 A
- sinusoidal; at T_{mb} = 85 °C: I_{T(AV)} max. 15 A
- R.M.S. on-state current: I_{T(RMS)} max. 31 A
- Repetitive peak on-state current: I_{TRM} max. 240 A

Non-repetitive peak on-state current
- T_{j} = 125 °C prior to surge (see Fig. 6)
- t = 10 ms; half sine-wave: I_{TSM} max. 240 A
- t = 5 ms; square pulse: I_{TSM} max. 240 A
- I^2 t for fusing (t = 10 ms): max. 290 A

Rate of rise of on-state current after triggering with I_{G} = 1 A to I_{T} = 50 A;
\[ \frac{dI_{T}}{dt} = 1 \frac{A}{\mu s} \]
\[ \frac{dI_{G}}{dt} = 1 \frac{A}{\mu s} \]

**Gate to cathode**

- Reverse peak voltage: V_{RGM} max. 10 V
- Average power dissipation (averaged over any 20 ms period): P_{G(AV)} max. 1 W
- Peak power dissipation: P_{GM} max. 5 W

**Temperatures**

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

**THERMAL RESISTANCE**

- From junction to mounting base: R_{th j-mb} = 1 °C/W
- From mounting base to heatsink: R_{th mb-h} = 0,2 °C/W
- Transient thermal impedance (t = 1 ms): Z_{th j-mb} = 0,06 °C/W

* To ensure thermal stability: R_{th j-a} < 3 °C/W (d.c. blocking) or < 6 °C/W (square-wave; δ = 0,5).
For smaller heatsinks T_{j} max should be derated. For square-wave see Fig. 5.
** Although not recommended, higher off-state voltages may be applied without damage, but the thyristor may switch into the on-state. The rate of rise of on-state current should not exceed 30 A/\mu s.
^ Thermal stability at higher voltage ratings is dependent on duty factor. See Figs 15 and 16.
CHARACTERISTICS

Anode to cathode

On-state voltage

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

Rate of rise of off-state voltage that will not trigger any device; exponential method;

\[ V_D = \frac{2}{3} V_{DRM\text{max}}; \quad T_j = 125 \text{ } ^\circ\text{C} \]

Off-state current

\[ V_D = V_{DWM\text{max}}; \quad T_j = 125 \text{ } ^\circ\text{C} \]

Holding current; \( T_j = 25 \text{ } ^\circ\text{C} \)

\[ I_D < 7 \text{ mA} \]

\[ I_H < 200 \text{ mA} \]

Gate to cathode

Voltage that will trigger all devices

\[ V_D = 6 \text{ V}; \quad T_j = 25 \text{ } ^\circ\text{C} \]

Voltage that will not trigger any device

\[ V_D = V_{DRM\text{max}}; \quad T_j = 125 \text{ } ^\circ\text{C} \]

Current that will trigger all devices

\[ V_D = 6 \text{ V}; \quad T_j = 25 \text{ } ^\circ\text{C} \]

Switching characteristics

Gate-controlled turn-on time \( (t_{gt} = t_d + t_r) \) when switched from \( V_D = V_{DWM\text{max}} \) to \( I_T = 50 \text{ A}; \)

\[ I_{GT} = 200 \text{ mA}; \quad dI_G/dt = 1 \text{ A/\mu s}; \quad T_j = 25 \text{ } ^\circ\text{C} \]

\[ t_d < 1 \mu s \]

\[ t_r < 0.7 \mu s \]

* Measured under pulse conditions to avoid excessive dissipation.
CHARACTERISTICS (continued)
Circuit-commutated turn-off time when switched
from $I_T = 10\,\text{A}$ to $V_R \geq 50\,\text{V}$ with $-\frac{dI_T}{dt} = 10\,\text{A/\mu s}$; $dV_D/dt = 50\,\text{V/\mu s}$; $T_j = 125\,\text{°C}$

\[ t_q < 20\,\mu\text{s} \]

Fig. 3 Circuit-commutated turn-off time definitions.

OPERATING NOTES
1. The terminals should neither be bent nor twisted; they should be soldered into the circuit so that there is no strain on them. During soldering the heat conduction to the junction should be kept to a minimum.

2. High frequency operation.
   a. The curves in Figs 13 and 14 show the additional average power losses due to turning on and turning off the thyristor in square pulse operation. This power should be added to that derived from the curves in Fig. 5.
   b. Power loss due to turn-off may be discounted if an inverse parallel diode is connected across the thyristor to clip any reverse voltage which may occur following commutation. Note should be taken of the consequent increase in turn-off time (see Fig. 11).
Fast turn-off thyristors

interrelation between the power (derived from the left hand graph) and the max. allowable temperatures

Fig. 4.

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

interrelation between the power (derived from the left hand graph) and the max. allowable temperatures

Fig. 5.

* $T_{mb}$-scale is for comparison purposes only and is correct only for $R_{th\,mb-a} \leq 2^\circ\text{C/W}$

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maximum permissible non-repetitive peak on-state current for one square pulse

in the case of re-applied off-state voltage the thyristor may temporarily lose control

Fig. 6.

Fig. 7.

Fig. 8.
Fast turn-off thyristors

**Fig. 9.**

<table>
<thead>
<tr>
<th>$\frac{dV_D}{dt}$ (V/μs)</th>
<th>2000</th>
<th>1500</th>
<th>1000</th>
<th>500</th>
<th>20</th>
<th>10</th>
</tr>
</thead>
<tbody>
<tr>
<td>$T_j$ (°C)</td>
<td>0</td>
<td>50</td>
<td>100</td>
<td>150</td>
<td>50</td>
<td>100</td>
</tr>
</tbody>
</table>

Max. rate of rise of off-state voltage that will not trigger any device (exp. method) plotted against junction temp.

**Fig. 10.**

<table>
<thead>
<tr>
<th>$\frac{dV_D}{dt}$ (V/μs)</th>
<th>1500</th>
<th>1000</th>
<th>500</th>
<th>100</th>
</tr>
</thead>
<tbody>
<tr>
<td>$V_{DRM_{max}}$ (%)</td>
<td>0</td>
<td>50</td>
<td>100</td>
<td></td>
</tr>
</tbody>
</table>

$V_{DRM_{max}}$ (%) plotted against applied voltage

**Fig. 11.**

<table>
<thead>
<tr>
<th>$t_d$ (μs)</th>
<th>40</th>
<th>30</th>
<th>20</th>
<th>10</th>
<th>5</th>
</tr>
</thead>
<tbody>
<tr>
<td>$T_j$ (°C)</td>
<td>0</td>
<td>50</td>
<td>100</td>
<td>150</td>
<td></td>
</tr>
</tbody>
</table>

- $V_R \geq 50$ V
- $V_R = 1.5$ V

$V_{DRM_{max}}$ = $V_R - V_{TM}$

$dV_D/dt = 50$ V/μs

**Fig. 12.**

<table>
<thead>
<tr>
<th>$t_d$ (μs)</th>
<th>1.2</th>
<th>0.8</th>
<th>0.4</th>
<th>0.2</th>
</tr>
</thead>
<tbody>
<tr>
<td>$I_{GT}$ (mA)</td>
<td>0</td>
<td>500</td>
<td>1000</td>
<td></td>
</tr>
</tbody>
</table>

$T_j = 25$ °C

$T_j = 125$ °C

$dI/dt = I_{TM}/μs$
Fig. 13.

NOMOGRAM: power loss $\Delta P_{(AV)}$ due to switching-on; $T_j=125^\circ C$

$I_G=1A; \frac{dI_G}{dt}=1A/\mu s$

$I_{TRM}$

definition: $\frac{dI}{dt} = \frac{1}{2} \frac{I_{TRM}}{\Delta t}$

Fig. 14.

NOMOGRAM: power loss $\Delta P_{(AV)}$ due to switching-off; $T_j=125^\circ C$

$I_{TRM}$

$\frac{dI}{dt} = 100A/\mu s$
Fast turn-off thyristors

Fig. 15.

Fig. 16.

April 1978
Fig. 17. Transient thermal impedance from junction to mounting base versus time.
FAST TURN-OFF THYRISTORS

A range of fast turn-off thyristors in metal envelopes, intended for use in inverter applications. The series consists of reverse polarity types (anode to stud) identified by a suffix R: BTW33-800R to 1200R.

QUICK REFERENCE DATA

<table>
<thead>
<tr>
<th>Repetitive peak voltages</th>
<th>V_{DRM}/V_{RRM}</th>
<th>BTW33-800R</th>
<th>1000R</th>
<th>1200R</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>max.</td>
<td>800</td>
<td>1000</td>
<td>1200</td>
</tr>
<tr>
<td>I_T(peak)</td>
<td>max.</td>
<td>80 A</td>
<td>100 A</td>
<td>1200 A</td>
</tr>
<tr>
<td>I_T(RMS)</td>
<td>max.</td>
<td>110 A</td>
<td></td>
<td></td>
</tr>
<tr>
<td>I_T(ON)</td>
<td>max.</td>
<td>1500 A</td>
<td></td>
<td></td>
</tr>
<tr>
<td>q</td>
<td>&lt;</td>
<td>25 μs</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

MECHANICAL DATA

Fig. 1 TO-94; with metric M12 stud (φ 12 mm)

Dimensions in mm

- Net mass: 108 g
- Diameter of clearance hole: max. 13.0 mm
- Torque on nut: min. 9 Nm (90 kg cm) max. 17.5 Nm (175 kg cm)
- Supplied with device: 1 nut, 1 lock washer
- Nut dimensions across the flats; M12: 19 mm

April 1978
BTW33 SERIES

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

Anode to cathode

<table>
<thead>
<tr>
<th></th>
<th>BTW33-800R</th>
<th>1000R</th>
<th>1200R</th>
</tr>
</thead>
<tbody>
<tr>
<td>Non-repetitive peak voltages (t ≤ 10 ms)</td>
<td>V_{DSM}***/V_{RSM}</td>
<td>max. 800</td>
<td>1000</td>
</tr>
</tbody>
</table>
| Repetitive peak voltages | V_{DRM}/V_{RRM} | max. 800 | 1000 | 1200 V
| Crest working off-state voltage | V_{DWM} | max. 600 | 800 | 1000 V *

Average on-state current assuming zero switching losses (averaged over any 20 ms period)
- square-wave; δ = 0.5; up to T_{mb} = 70 °C
- square-wave; δ = 0.5; at T_{mb} = 85 °C
- sinusoidal; at T_{mb} = 85 °C

R.M.S. on-state current

Repetitive peak on-state current

Non-repetitive peak on-state current
- T_j = 125 °C prior to surge
- t = 10 ms; half sine-wave (see Fig. 8)
- t = 5 ms; square pulse (see Fig. 7)

I^2t for fusing (t = 10 ms)

Rate of rise of on-state current after triggering with I_g = 750 mA to I_T = 200 A; dl_g/dt = 1 A/μs

Gate to cathode

Reverse peak voltage

Average power dissipation (averaged over any 20 ms period)

Peak power dissipation

Temperatures

Storage temperature

Junction temperature

THERMAL RESISTANCE

From junction to mounting base

From mounting base to heatsink

Transient thermal impedance (t = 1 ms)

* To ensure thermal stability: R_{th,j-a} < 0.75 °C/W (d.c. blocking) or < 1.5 °C/W (square-wave; δ = 0.5). For smaller heatsinks T_j max should be derated. For square-wave see Fig. 6.

** Although not recommended, higher off-state voltages may be applied without damage, but the thyristor may switch into the on-state. The rate of rise of on-state current should not exceed 20 A/μs.

△ Thermal stability at higher voltage ratings is dependent on duty factor. See Figs 19 and 20.
**CHARACTERISTICS**

**Anode to cathode**

- **On-state voltage**
  \[ I_T = 200 \text{ A}; \ T_j = 25 \text{ °C} \]

- **Rate of rise of off-state voltage that will not trigger any device; exponential method**
  \[ V_D = 2/3 \ V_{DRM_{max}}; \quad T_j = 125 \text{ °C} \]

- **Off-state current**
  \[ V_D = V_{DWM_{max}}; \ T_j = 125 \text{ °C} \]

- **Holding current**
  \[ T_j = 25 \text{ °C} \]

- **Latching current**
  \[ T_j = 25 \text{ °C} \]

**Gate to cathode**

- **Voltage that will trigger all devices**
  \[ V_D = 6 \text{ V}; \ T_j = 25 \text{ °C} \]

- **Voltage that will not trigger any device**
  \[ V_D = V_{DRM_{max}}; T_j = 125 \text{ °C} \]

- **Current that will trigger all devices**
  \[ V_D = 6 \text{ V}; T_j = 25 \text{ °C} \]

**Switching characteristics**

- **Gate-controlled turn-on time** (tg \text{t} = \text{t}_d + \text{t}_r) when switched from \[ V_D = V_{DWM_{max}} \text{ to } I_T = 200 \text{ A}; I_{GT} = 200 \text{ mA}; dI_G/dt = 1 \text{ A/μs}; T_j = 25 \text{ °C} \]
  \[ t_d < 2 \mu \text{s}; \quad t_r < 2 \mu \text{s} \]

---

*Measured under pulse conditions to avoid excessive dissipation.*

---

*Fig. 2 Gate-controlled turn-on time definitions.*

---

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Circuit-commutated turn-off time when switched from $I_T = 50$ A to $V_R \geq 50$ V with $-\frac{dI_T}{dt} = 50$ A/μs; $\frac{dV_D}{dt} = 25$ V/μs; $T_j = 125$ °C

\[ t_q < 25 \mu s \]

Fig. 3 Circuit-commutated turn-off time definitions.

Fig. 4.
$P = \text{dissipation excluding switching losses}$

$$\frac{I_{T(RMS)}}{I_{T(AV)}} = \frac{1}{\sqrt{\delta}}$$

$\alpha = 30^\circ$  
$60^\circ$  
$90^\circ$  
$120^\circ$  
$160^\circ$

$\frac{1}{T_{mb}}$  
$\frac{1}{T_{amb}}$  
$\frac{1}{T_{av}}$

interrelation between the power (derived from the left-hand graph) and the max. allowable temperatures.

$P = \text{dissipation excluding switching losses}$

$R_{th mb-a} = 0.1 \text{ °C/W}$

$R_{th mb-a} = 0.2 \text{ °C/W}$

$R_{th mb-a} = 0.6 \text{ °C/W}$

$R_{th mb-a} = 1.0 \text{ °C/W}$

$\delta = 0.1$

$\delta = 0.2$

$\delta = 0.4$

$\delta = 0.8$

$\delta = 1.0$

$T_{mb}$-scale is for comparison purposes only and is correct only for $R_{th mb-a} \leq 1.0 \text{ °C/W}$. 

Fig. 5.

Fig. 6.
**SQUARE WAVE OPERATION**

- Max. permissible non-repetitive peak on-state current for one square pulse
- Pulse duration
- In the case of re-applied off-state voltage the thyristor may temporarily lose control

- $T_j = 125 \, ^\circ$C prior to surge

**Fig. 7.**

**SINE WAVE OPERATION**

- The device may temporarily lose control following the surge

- $T_j = 125 \, ^\circ$C prior to surge

**Fig. 8.**
Fast turn-off thyristors

**DT499**

Minimum gate voltage that will trigger all devices plotted against junction temperature

**DT500**

Minimum gate current that will trigger all devices plotted against junction temperature

![Graph showing minimum gate voltage](image)

**Fig. 9.**

![Graph showing minimum gate current](image)

**Fig. 10.**

**DT52537**

Max. rate of rise of off-state voltage that will not trigger any device (exp. method) plotted against junction temperature

**DT52538**

Max. rate of rise of off-state voltage that will not trigger any device (exp. method) plotted against applied voltage

![Graph showing max. rate of rise of off-state voltage](image)

**Fig. 11.**

![Graph showing max. rate of rise of off-state voltage vs. applied voltage](image)

**Fig. 12.**
max. turn-off time when switched from $I_T$ to $V_R \geq 50$ V; $T_j = 125$ °C; $-dI_T/dt = 50$ A/µs

$$I_T = \{100$ A
$$50$ A
$$20$ A
$$10$ A

$$dV_D/dt = 25$ V/µs
$$-dI/dt = I_T/\mu s$$

Fig. 13.

max. $V_T$ values

$$T_j = \{25$ °C
$$125$ °C

Fig. 15.
Fast turn-off thyristors

**Fig. 17.**

![Diagram 17: NOMOGRAM: power loss $\Delta P_{(AV)}$ due to switching on. $T_j = 125^\circ C$. $I_G = 750\, mA; \, \text{d}I/\text{d}t = 1\, A/\mu s$.](image1)

**Fig. 18.**

![Diagram 18: NOMOGRAM: power loss $\Delta P_{(AV)}$ due to switching off. $T_j = 125^\circ C$.](image2)
Fig. 19.

Fig. 20.
THYRISTORS

Also available to BS9341-F082

Silicon thyristors in metal envelopes, intended for use in power control circuits (e.g. light and motor control) and power switching systems.

The series consists of reverse polarity types (anode to stud) identified by a suffix R: BTW38-600R to 1200R.

QUICK REFERENCE DATA

<table>
<thead>
<tr>
<th>Repetitive peak voltages</th>
<th>V_{DRM}/V_{RRM}</th>
<th>BTW38-600R</th>
<th>800R</th>
<th>1000R</th>
<th>1200R</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>max.</td>
<td>600</td>
<td>800</td>
<td>1000</td>
<td>1200</td>
</tr>
<tr>
<td>Average on-state current</td>
<td>I_T(AV)</td>
<td>max.</td>
<td>10 A</td>
<td>10 A</td>
<td>10 A</td>
</tr>
<tr>
<td>R.M.S. on-state current</td>
<td>I_T(RMS)</td>
<td>max.</td>
<td>16 A</td>
<td>16 A</td>
<td>16 A</td>
</tr>
<tr>
<td>Non-repetitive peak on-state current</td>
<td>I_TSM</td>
<td>max.</td>
<td>150 A</td>
<td>150 A</td>
<td>150 A</td>
</tr>
</tbody>
</table>

MECHANICAL DATA

Fig. 1 TO-64: with metric M5 stud (ϕ 5 mm); e.g. BTW38-600R.

Dimensions in mm

Net mass: 7 g
Diameter of clearance hole: max. 5,2 mm
Accessories supplied on request:
56295 (PTFE bush, 2 mica washers, plain washer, tag)
56262A (mica washer, insulating ring, plain washer)

Supplied with device: 1 nut, 1 lock washer
Nut dimensions: across the flats; M5: 8,0 mm

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

December 1979
RATINGS
Limiting values in accordance with the Absolute Maximum System (IEC 134)

Anode to cathode

<table>
<thead>
<tr>
<th></th>
<th>BTW38-600R</th>
<th>800R</th>
<th>1000R</th>
<th>1200R</th>
</tr>
</thead>
<tbody>
<tr>
<td>Non-repetitive peak voltages (t ≤ 10 ms) V_{DSM}/V_{RSM} max.</td>
<td>600 V</td>
<td>800 V</td>
<td>1000 V</td>
<td>1200 V</td>
</tr>
<tr>
<td>Repetitive peak voltages V_{DRM}/V_{RRM} max.</td>
<td>600 V</td>
<td>800 V</td>
<td>1000 V</td>
<td>1200 V</td>
</tr>
<tr>
<td>Crest working voltages V_{DWM}/V_{RWM} max.</td>
<td>400 V</td>
<td>600 V</td>
<td>700 V</td>
<td>800 V *</td>
</tr>
</tbody>
</table>

Average on-state current (averaged over any 20 ms period) up to T_{mb} = 85 °C
\[ I_{T(AV)} \text{ max.} = 10 \text{ A} \]
R.M.S. on-state current
\[ I_{T(RMS)} \text{ max.} = 16 \text{ A} \]
Repetitive peak on-state current
\[ I_{TRM} \text{ max.} = 75 \text{ A} \]
Non-repetitive peak on-state current; t = 10 ms;
half sine-wave; T_j = 125 °C prior to surge;
with reapplied V_{RWM max}
\[ I_{TSM} \text{ max.} = 150 \text{ A} \]
\[ I^2 t \text{ max.} = 112 \text{ A}^2 \text{s} \]
Rate of rise of on-state current after triggering
with I_G = 250 mA to I_T = 25 A; dI_G/dt = 0.25 A/μs
\[ dI_T/dt \text{ max.} = 50 \text{ A/μs} \]

Gate to cathode
Average power dissipation (averaged over any 20 ms period)
\[ P_{G(AV)} \text{ max.} = 0.5 \text{ W} \]
Peak power dissipation
\[ P_{GM} \text{ max.} = 5 \text{ W} \]

Temperatures
Storage temperature
\[ T_{stg} = -55 \text{ to } +125 \text{ °C} \]
Junction temperature
\[ T_j \text{ max.} = 125 \text{ °C} \]

THERMAL RESISTANCE
From junction to mounting base
\[ R_{th \, j-mb} = 1.8 \text{ °C/W} \]
From mounting base to heatsink with heatsink compound
\[ R_{th \, mb-h} = 0.5 \text{ °C/W} \]
From junction to ambient in free air
\[ R_{th \, j-a} = 45 \text{ °C/W} \]
Transient thermal impedance (t = 1 ms)
\[ Z_{th \, j-mb} = 0.1 \text{ °C/W} \]

OPERATING NOTE
The terminals should neither be bent nor twisted; they should be soldered into the circuit so that there is no strain on them.
During soldering the heat conduction to the junction should be kept to a minimum.

* To ensure thermal stability: \( R_{th \, j-a} < 4 \text{ °C/W (d.c. blocking)} \) or \(< 8 \text{ °C/W (a.c.)} \). For smaller heatsinks \( T_{j \text{ max}} \) should be derated. For a.c. see Fig. 3.
CHARACTERISTICS

Anode to cathode

On-state voltage
\[ I_T = 20 \text{ A; } T_j = 25 \text{ °C} \]

Rate of rise of off-state voltage that will not trigger any device; exponential method; \( V_D = 2/3 \times V_{DRM_{max}}; \)
\[ T_j = 125 \text{ °C} \]

Reverse current
\[ V_R = V_{RW_{max}}; T_j = 125 \text{ °C} \]

Off-state current
\[ V_D = V_{DWM_{max}}; T_j = 125 \text{ °C} \]

Latchig current; \( T_j = 25 \text{ °C} \)
Holding current; \( T_j = 25 \text{ °C} \)

Gate to cathode

Voltage that will trigger all devices
\[ V_D = 6 \text{ V; } T_j = 25 \text{ °C} \]

Voltage that will not trigger any device
\[ V_D = V_{DRM_{max}}; T_j = 125 \text{ °C} \]

Current that will trigger all devices
\[ V_D = 6 \text{ V; } T_j = 25 \text{ °C} \]

Switching characteristics

Gate-controlled turn-on time (\( t_{gt} = t_d + t_r \)) when switched from \( V_D = 800 \text{ V to } I_T = 25 \text{ A; } \)
\[ I_{GT} = 250 \text{ mA; } dI_{G}/dt = 0.25 \text{ A}/\mu s; T_j = 25 \text{ °C} \]

\[ t_{gt} < 1.5 \mu s \]
\[ t_r \text{ typ. } 0.2 \mu s \]

* Measured under pulse conditions to avoid excessive dissipation.
interrelation between the power (derived from the left-hand graph) and the maximum permissible temperatures

Fig. 3 (1) $T_{mb}$ scale is for comparison purposes only and is correct only for $R_{th mb-a} \leq 6 \, ^\circ C/W$.

maximum allowable non-repetitive r.m.s. on state current based on sinusoidal currents ($f = 50 \, Hz$)

with reapplied $V_{RWMmax}$

$T_j = 125 \, ^\circ C$ prior to surge

April 1978
Thyristors

Fig. 5 Minimum gate voltage that will trigger all devices as a function of $T_j$.

Fig. 6 Minimum gate current that will trigger all devices as a function of $T_j$.

Fig. 7.
Fig. 8 Maximum rate of rise of off-state voltage that will not trigger any device (exponential method) as a function of $T_J$.

Fig. 9 Maximum rate of rise of off-state voltage that will not trigger any device (exponential method) as a function of applied voltage.
envelope of average output current
for safe operation at a given temperature, the average current envelope of successive cycles (see drawing above) must lie within the region bounded by the curve shown below for that temperature.

\[ T_j = T_{mb} = 25^\circ C \text{ prior to starting} \]

\[ 65^\circ C \]
\[ 85^\circ C \]
\[ 105^\circ C \]

Fig. 10 Limits for starting or inrush currents.
For safe operation at a given temperature, the average current envelope of successive cycles (see drawing above) must lie within the region bounded by the curve shown below for that temperature.

$T_j = T_{mb} = 25 \degree C$ prior to starting.

Fig. 11 Limits for starting or inrush currents.

Fig. 12.
Silicon thyristors in metal envelopes, intended for use in power control applications in general, and lighting control (in a.c. controller circuit) up to 2.5 kW in particular. A feature of the thyristors is their high surge rating.

The series consists of reverse polarity types (anode to stud) identified by a suffix R: BTW40-400R to 800R.

**QUICK REFERENCE DATA**

<table>
<thead>
<tr>
<th>Parameter</th>
<th>BTW40-400R</th>
<th>600R</th>
<th>800R</th>
</tr>
</thead>
<tbody>
<tr>
<td>Repetitive peak voltages</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Average on-state current</td>
<td>$I_{(AV)}$</td>
<td>20 A</td>
<td></td>
</tr>
<tr>
<td>R.M.S. on-state current</td>
<td>$I_{(RMS)}$</td>
<td>32 A</td>
<td></td>
</tr>
<tr>
<td>Non-repetitive peak on-state current</td>
<td>$I_{SM}$</td>
<td>400 A</td>
<td></td>
</tr>
</tbody>
</table>

**MECHANICAL DATA**

Fig. 1 TO-48: with metric M6 stud ($\phi 6$ mm); e.g. BTW40-400R.

Types with $\%$ in x 28 UNF stud ($\phi 6.35$ mm) are available on request. These are indicated by the suffix U: e.g. BTW40-400RU.

Net mass: 14 g
Diameter of clearance hole: max. 6.5 mm
Accessories supplied on request: 56264A (mica washer, insulating ring, soldering tag)

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

Supplied with the device:
1 nut, 1 lock washer
Nut dimensions across the flats:
M6: 10 mm
$\%$ in x 28 UNF: 11.1 mm
BTW40 SERIES

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

Anode to cathode

<table>
<thead>
<tr>
<th>Non-repetitive peak voltages (t ≤ 10 ms)</th>
<th>BTW40-400R</th>
<th>600R</th>
<th>800R</th>
</tr>
</thead>
<tbody>
<tr>
<td>V_DSM/V_RSM</td>
<td>max. 400</td>
<td>600</td>
<td>800</td>
</tr>
<tr>
<td>V_DRM/V_RRM</td>
<td>max. 400</td>
<td>600</td>
<td>800</td>
</tr>
<tr>
<td>V_DWM/V_RWM</td>
<td>max. 300</td>
<td>400</td>
<td>600</td>
</tr>
</tbody>
</table>

Limitations:
- 1_T(AV) max. 20 A
- 1_T(RMS) max. 32 A
- 1_TRM max. 200 A
- 1_TSM max. 400 A
- 1^2t max. 800 A^2 s
- dI_T/dt max. 100 A/μs

Gate to cathode

- Reverse peak voltage
  V_RGM max. 10 V
- Average power dissipation (averaged over any 20 ms period)
  P_G(AV) max. 1 W
- Peak power dissipation
  P_GM max. 5 W

Temperatures
- Storage temperature
  T_stg -55 to +125 °C
- Junction temperature
  T_j max. 125 °C

THERMAL RESISTANCE

- From junction to mounting base
  R_th_j-mb = 1 °C/W
- From mounting base to heatsink with heatsink compound
  R_th_mb-h = 0,2 °C/W
- Transient thermal impedance (t = 1 ms)
  Z_th_j-mb = 0,1 °C/W

OPERATING NOTE

The terminals should neither be bent nor twisted; they should be soldered into the circuit so that there is no strain on them.

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

* To ensure thermal stability: R_th_j-a < 6,5 °C/W (d.c. blocking) or < 13 °C/W (a.c.). For smaller heatsinks T_j max should be derated. For a.c. see Fig. 3.
CHARACTERISTICS

Anode to cathode

On-state voltage
\[ V_T \] \(<\) 2.1 V *

Rate of rise of off-state voltage that will not trigger any device; exponential method;
\[ \frac{dV_D}{dt} \] \(<\) 100 V/\(\mu\)s

Reverse current
\[ V_R = V_{RWMmax}; T_j = 125 \, ^\circ C \]
\[ I_R \] \(<\) 3 mA

Off-state current
\[ V_D = V_{DWMmax}; T_j = 125 \, ^\circ C \]
\[ I_D \] \(<\) 3 mA

Latching current; \( T_j = 25 \, ^\circ C \)
\[ I_L \] \(<\) 150 mA

Holding current; \( T_j = 25 \, ^\circ C \)
\[ I_H \] \(<\) 75 mA

Gate to cathode

Voltage that will trigger all devices
\[ V_D = 6 \, V; T_j = 25 \, ^\circ C \]
\[ V_{GT} \] \(>\) 1.5 V

Voltage that will not trigger any device
\[ V_D = V_{DRMmax}; T_j = 125 \, ^\circ C \]
\[ V_{GD} \] \(<\) 200 mV

Current that will trigger all devices
\[ V_D = 6 \, V; T_j = 25 \, ^\circ C \]
\[ I_{GT} \] \(>\) 75 mA

Switching characteristics

Gate-controlled turn-on time \( t_{gt} = t_d + t_r \) when switched from \( V_D = V_{DWMmax} \) to \( I_T = 100 \, A; \)
\[ \frac{dI_G}{dt} = 1 \, A/\mu s; T_j = 25 \, ^\circ C \]
\[ t_{gt} \] \(<\) 1 \( \mu \)s
\[ t_r \] \(<\) 0.5 \( \mu \)s

Gate-controlled turn-on time definition

*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 shown in Fig. 2.

Fig. 2.

The maximum permissible non-repetitive r.m.s. on-state current based on sinusoidal currents (f = 50 Hz) is shown in Fig. 3.

Fig. 3.
Thyristors

BTW40 SERIES

Fig. 4 Maximum rate of rise of off-state voltage that will not trigger any device (exponential method) as a function of $T_j$.

Fig. 5 Maximum rate of rise of off-state voltage that will not trigger any device (exponential method) as a function of applied voltage.

Fig. 6.
Fig. 7 Minimum gate voltage that will trigger all devices as a function of $T_j$.

Fig. 8 Minimum gate current that will trigger all devices as a function of $T_j$.

Fig. 9.
Silicon thyristors in metal envelopes with high $dV_d/dt$ capabilities. They are intended for use in power control circuits and switching systems where high transients can occur (e.g. phase control in three-phase systems).

The series consists of reverse polarity types (anode to stud) identified by a suffix R: BTW42-600R to 1200R.

**QUICK REFERENCE DATA**

<table>
<thead>
<tr>
<th>Repetitive peak voltages</th>
<th>$V_{DRM}/V_{RRM}$ max.</th>
<th>BTW42-600R</th>
<th>800R</th>
<th>1000R</th>
<th>1200R</th>
</tr>
</thead>
<tbody>
<tr>
<td>Average on-state current</td>
<td>$I(T_{AV})$ max.</td>
<td>10 A</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>R.M.S. on-state current</td>
<td>$I(T_{RMS})$ max.</td>
<td>16 A</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Non-repetitive peak on-state current</td>
<td>$I_{TSM}$ max.</td>
<td>150 A</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Rate of rise of off-state voltage that will not trigger any device</td>
<td>$dV_d/dt$</td>
<td>$&lt; 200$ V/μs</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>On request (see ordering note on page 2)</td>
<td>$dV_d/dt$</td>
<td>$&lt; 1000$ V/μs</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

**MECHANICAL DATA**

Fig. 1 TO-64: with metric M5 stud (φ5 mm); e.g. BTW42-600R.

Net mass: 7 g

Diameter of clearance hole: max. 5,2 mm

Accessories supplied on request:

- 56295 (PTFE bush, 2 mica washers, plain washer, tag)
- 56262A (mica washer, insulating ring, plain washer)

Supplied with device: 1 nut, 1 lock washer

Nut dimensions across the flats; M5: 8,0 mm

Torque on nut: min. 0,9 Nm (9 kg cm)

max. 1,7 Nm (17 kg cm)

Dimensions in mm

Net mass: 7 g

Diameter of clearance hole: max. 5,2 mm

Accessories supplied on request:

- 56295 (PTFE bush, 2 mica washers, plain washer, tag)
- 56262A (mica washer, insulating ring, plain washer)

Supplied with device: 1 nut, 1 lock washer

Nut dimensions across the flats; M5: 8,0 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)

Anode to cathode

<table>
<thead>
<tr>
<th></th>
<th>BTW42-600R</th>
<th>800R</th>
<th>1000R</th>
<th>1200R</th>
</tr>
</thead>
<tbody>
<tr>
<td>Non-repetitive peak voltages (t ≤ 10 ms)</td>
<td>V_DS/M/V_RSM max.</td>
<td>600</td>
<td>800</td>
<td>1000</td>
</tr>
<tr>
<td>Repetitive peak voltages</td>
<td>V_DRM/V_RRM max.</td>
<td>600</td>
<td>800</td>
<td>1000</td>
</tr>
<tr>
<td>Crest working voltages</td>
<td>V_DWM/V_RWM max.</td>
<td>400</td>
<td>600</td>
<td>700</td>
</tr>
<tr>
<td>Average on-state current (averaged over any 20 ms period) up to ( T_{mb} = 85 , {^\circ}C )</td>
<td>( I_{T(AV)} ) max.</td>
<td>10 A</td>
<td></td>
<td></td>
</tr>
<tr>
<td>R.M.S. on-state current</td>
<td>( I_{T(RMS)} ) max.</td>
<td>16 A</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Repetitive peak on-state current</td>
<td>( I_{TRM} ) max.</td>
<td>75 A</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Non-repetitive peak on-state current; ( t = 10 , ms ); half sine-wave; ( T_j = 125 , {^\circ}C ) prior to surge; with reapplied ( V_{RWM_{max}} )</td>
<td>( I_{TSM} ) max.</td>
<td>150 A</td>
<td></td>
<td></td>
</tr>
<tr>
<td>( I^2t ) for fusing (( t = 10 , ms ))</td>
<td>( I^2t ) max.</td>
<td>112 A^2s</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Rate of rise of on-state current after triggering with ( I_G = 250 , mA ) to ( I_T = 25 , A ); ( dl_G/dt = 0,25 , A/\mu s )</td>
<td>( dl_T/dt ) max.</td>
<td>50 A/\mu s</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Gate to cathode

<table>
<thead>
<tr>
<th></th>
<th>BTW42-600R</th>
<th>800R</th>
<th>1000R</th>
<th>1200R</th>
</tr>
</thead>
<tbody>
<tr>
<td>Average power dissipation (averaged over any 20 ms period)</td>
<td>( P_{G(AV)} ) max.</td>
<td>0,5 W</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Peak power dissipation</td>
<td>( P_{GM} ) max.</td>
<td>5 W</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Temperatures

<table>
<thead>
<tr>
<th></th>
<th>BTW42-600R</th>
<th>800R</th>
<th>1000R</th>
<th>1200R</th>
</tr>
</thead>
<tbody>
<tr>
<td>Storage temperature</td>
<td>( T_{stg} )</td>
<td>-55 to +125 , {^\circ}C</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Junction temperature</td>
<td>( T_j ) max.</td>
<td>125 , {^\circ}C</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

THERMAL RESISTANCE

<table>
<thead>
<tr>
<th></th>
<th>BTW42-600R</th>
<th>800R</th>
<th>1000R</th>
<th>1200R</th>
</tr>
</thead>
<tbody>
<tr>
<td>From junction to mounting base</td>
<td>( R_{th j-mb} )</td>
<td>1,8 , {^\circ}C/W</td>
<td></td>
<td></td>
</tr>
<tr>
<td>From mounting base to heatsink with heatsink compound</td>
<td>( R_{th mb-h} )</td>
<td>0,5 , {^\circ}C/W</td>
<td></td>
<td></td>
</tr>
<tr>
<td>From junction to ambient in free air</td>
<td>( R_{th j-a} )</td>
<td>45 , {^\circ}C/W</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Transient thermal impedance (( t = 1 , ms ))</td>
<td>( Z_{th j-mb} )</td>
<td>0,1 , {^\circ}C/W</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

OPERATING NOTE

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

ORDERING NOTE

Types with \( dV_{D}/dt \) of \( 1000 \, V/\mu s \) are available on request. Add suffix C to the type number when ordering; e.g. BTW42-600RC.

* To ensure thermal stability: \( R_{th j-a} < 4 \, {^\circ}C/W \) (d.c. blocking) or \( < 8 \, {^\circ}C/W \) (a.c.). For smaller heatsinks \( T_{jmax} \) should be derated. For a.c. see Fig. 3.
CHARACTERISTICS

Anode to cathode

On-state voltage
\[ I_T = 20 \, A; \, T_j = 25 \, ^\circ C \]

Rate of rise of off-state voltage that will not trigger any device; exponential method; \[ V_D = \frac{2}{3} V_{DRM_{\text{max}}}; \, T_j = 125 \, ^\circ C \]

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

Off-state current
\[ V_D = V_{DWM_{\text{max}}}; \, T_j = 125 \, ^\circ C \]

Latchin current; \( T_j = 25 \, ^\circ C \)

Holding current; \( T_j = 25 \, ^\circ C \)

Gate to cathode

Voltage that will trigger all devices
\[ V_D = 6 \, V; \, T_j = 25 \, ^\circ C \]

Voltage that will not trigger any device
\[ V_D = V_{DRM_{\text{max}}}; \, T_j = 125 \, ^\circ C \]

Current that will trigger all devices
\[ V_D = 6 \, V; \, T_j = 25 \, ^\circ C \]

Switching characteristics

Gate-controlled turn-on time (\( t_{gt} = t_d + t_r \)) when switched from \( V_D = 800 \, V \) to \( I_T = 25 \, A \);
\[ I_{GT} = 250 \, mA; \, dI_G/dt = 0,25 \, A/\mu s; \, T_j = 25 \, ^\circ C \]

\[ t_{gt} \quad < \quad 1,5 \, \mu s \]

\[ t_r \quad \text{typ.} \quad 0,2 \, \mu s \]

* Measured under pulse conditions to avoid excessive dissipation.
interrelation between the power (derived from the left-hand graph) and the maximum permissible temperatures

Fig. 3 (1) $T_{mb}$-scale is for comparison purposes only and is correct only for $R_{th \, mb-a} \leq 6 ^\circ$C/W.

maximum allowable non-repetitive r.m.s. on state current based on sinusoidal currents ($f = 50$ Hz)

with reapplied $VRWM_{max}$

$T_j = 125 ^\circ$C prior to surge

Fig. 4.
Fig. 5 Minimum gate voltage that will trigger all devices as a function of $T_j$.

Fig. 6 Minimum gate current that will trigger all devices as a function of $T_j$.

Fig. 7
Fig. 8 Maximum rate of rise of off-state voltage that will not trigger any device (exponential method) as a function of $T_j$.

Fig. 9 Maximum rate of rise of off-state voltage that will not trigger any device (exponential method) as a function of applied voltage.
for safe operation at a given temperature, the average current envelope of successive cycles (see drawing above) must lie within the region bounded by the curve shown below for that temperature.

Fig. 10 Limits for starting or inrush currents.
Fig. 11 Limits for starting or inrush currents.

Tj = Tmb = 25 °C prior to starting

Zth j-mb (°C/W)

Fig. 12.
THYRISTORS

Silicon thyristors in metal envelopes, intended for power control applications.
The series consists of reverse polarity types (anode to stud) identified by a suffix R: BTW45-400R to 1200R.

QUICK REFERENCE DATA

<table>
<thead>
<tr>
<th>Repetitive peak voltages $V_{DRM} = V_{RRM}$</th>
<th>BTW45-400R</th>
<th>600R</th>
<th>800R</th>
<th>1000R</th>
<th>1200R</th>
</tr>
</thead>
<tbody>
<tr>
<td>max.</td>
<td>400</td>
<td>600</td>
<td>800</td>
<td>1000</td>
<td>1200</td>
</tr>
</tbody>
</table>

- Average on-state current $I_T^{AV}$ max. 16 A
- R.M.S. on-state current $I_T^{RMS}$ max. 25 A
- Non-repetitive peak on-state current $I_{TSM}$ max. 300 A
- Rate of rise of off-state voltage $dV_D/dt < 200 \text{ V/\mu s}$
- On request (see ordering note on page 3) $dV_D/dt < 1000 \text{ V/\mu s}$

MECHANICAL DATA

Fig. 1 TO-48: with metric M6 stud ($\phi$ 6 mm); e.g. BTW45-400R.
Types with $\frac{3}{8}$ in x 28 UNF stud ($\phi$ 6,35 mm) are available on request. These are indicated by the suffix U: BTW45-400RU.

- Net mass: 14 g
- Diameter of clearance hole: max. 6,5 mm
- Accessories supplied on request: 56264A (mica washer, insulating ring, soldering tag)
- Torque on nut: min. 1,7 Nm (17 kg cm)
- max. 3,5 Nm (35 kg cm)
- Supplied with the device:
  - 1 nut, 1 lock washer
  - Nut dimensions across the flats:
    - M6: 10 mm
    - $\frac{3}{8}$ in x 28 UNF: 11,1 mm

Products approved to CECC 50 011-002, available on request

January 1980
### RATINGS

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

#### Anode to cathode

<table>
<thead>
<tr>
<th></th>
<th>BTW45-400R</th>
<th>600R</th>
<th>800R</th>
<th>1000R</th>
<th>1200R</th>
</tr>
</thead>
<tbody>
<tr>
<td>Non-repetitive peak voltages</td>
<td>V&lt;sub&gt;DSM&lt;/sub&gt;/V&lt;sub&gt;RSM&lt;/sub&gt; max.</td>
<td>400</td>
<td>600</td>
<td>800</td>
<td>1000</td>
</tr>
<tr>
<td>Repetitive peak voltages</td>
<td>V&lt;sub&gt;DRM&lt;/sub&gt;/V&lt;sub&gt;RRM&lt;/sub&gt; max.</td>
<td>400</td>
<td>600</td>
<td>800</td>
<td>1000</td>
</tr>
<tr>
<td>Crest working voltages</td>
<td>V&lt;sub&gt;DWM&lt;/sub&gt;/V&lt;sub&gt;RWM&lt;/sub&gt; max.</td>
<td>300</td>
<td>400</td>
<td>600</td>
<td>700</td>
</tr>
</tbody>
</table>

Average on-state current (averaged over any 20 ms period) up to T<sub>mb</sub> = 85 °C

<table>
<thead>
<tr>
<th></th>
<th>max.</th>
</tr>
</thead>
<tbody>
<tr>
<td>I&lt;sub&gt;T&lt;/sub&gt;(AV)</td>
<td>16 A</td>
</tr>
<tr>
<td>I&lt;sub&gt;T&lt;/sub&gt;(RMS)</td>
<td>25 A</td>
</tr>
<tr>
<td>I&lt;sub&gt;TRM&lt;/sub&gt;</td>
<td>200 A</td>
</tr>
<tr>
<td>I&lt;sub&gt;TSM&lt;/sub&gt;</td>
<td>300 A</td>
</tr>
<tr>
<td>I&lt;sup&gt;2&lt;/sup&gt;t for fusing (t = 10 ms)</td>
<td>450 A&lt;sup&gt;2&lt;/sup&gt;s</td>
</tr>
<tr>
<td>Rate of rise of on-state current after triggering with I&lt;sub&gt;G&lt;/sub&gt; = 400 mA to I&lt;sub&gt;T&lt;/sub&gt; = 60 A; dI&lt;sub&gt;G&lt;/sub&gt;/dt = 0.4 A/μs</td>
<td>max.</td>
</tr>
<tr>
<td>dl&lt;sub&gt;T&lt;/sub&gt;/dt</td>
<td>100 A/μs</td>
</tr>
</tbody>
</table>

#### Gate to cathode

<table>
<thead>
<tr>
<th></th>
<th>max.</th>
</tr>
</thead>
<tbody>
<tr>
<td>V&lt;sub&gt;RGM&lt;/sub&gt;</td>
<td>10 V</td>
</tr>
<tr>
<td>P&lt;sub&gt;G&lt;/sub&gt;(AV)</td>
<td>1 W</td>
</tr>
<tr>
<td>P&lt;sub&gt;GM&lt;/sub&gt;</td>
<td>5 W</td>
</tr>
</tbody>
</table>

#### Temperatures

<p>| | |</p>
<table>
<thead>
<tr>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>Storage temperature</td>
<td>T&lt;sub&gt;stg&lt;/sub&gt;</td>
</tr>
<tr>
<td>Junction temperature</td>
<td>T&lt;sub&gt;j&lt;/sub&gt;</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&lt;sub&gt;th j-mb&lt;/sub&gt;</td>
</tr>
<tr>
<td>From mounting base to heatsink; with heatsink compound</td>
<td>R&lt;sub&gt;th mb-h&lt;/sub&gt;</td>
</tr>
<tr>
<td>Transient thermal impedance (t = 1 ms)</td>
<td>Z&lt;sub&gt;th j-mb&lt;/sub&gt;</td>
</tr>
</tbody>
</table>

#### OPERATING NOTE

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

* To ensure thermal stability: R<sub>th j-a</sub> < 6.5 °C/W (d.c. blocking) or < 13 °C/W (a.c.). For smaller heatsinks T<sub>j max</sub> should be derated. For a.c. see Fig. 2.
CHARACTERISTICS

Anode to cathode

On-state voltage
\[ I_T = 50 \, A; \, T_j = 25 \, ^\circ C \]

Rate of rise of off-state voltage that will not trigger any device; exponential method; \( V_D = 2/3 \, V_{D \text{RM max}}; \) \( T_j = 125 \, ^\circ C \)

Reverse current
\[ V_R = V_{R \text{RM max}}; \, T_j = 125 \, ^\circ C \]

Off-state current
\[ V_D = V_{D \text{WM max}}; \, T_j = 125 \, ^\circ C \]

Latching current; \( T_j = 25 \, ^\circ C \)

Holding current; \( T_j = 25 \, ^\circ C \)

Gate to cathode

Voltage that will trigger all devices
\[ V_D = 6 \, V; \, T_j = 25 \, ^\circ C \]

Voltage that will not trigger any device
\[ V_D = V_{D \text{RM max}}; \, T_j = 125 \, ^\circ C \]

Current that will trigger all devices
\[ V_D = 6 \, V; \, T_j = 25 \, ^\circ C \]

Switching characteristics

Gate-controlled turn-on time (\( t_{gt} = t_d + t_r \)) when switched from \( V_D = V_{D \text{WM max}} \) to \( I_T = 100 \, A; \) \( I_{GT} = 400 \, mA; \) \( dI_G/dt = 1 \, A/\mu s; T_j = 25 \, ^\circ C \)

\[ t_{gt} < 1 \, \mu s \]
\[ t_r < 0.5 \, \mu s \]

ORDERING NOTE

Types with \( dV_D/dt \) of 1000 V/\( \mu s \) are available on request. Add suffix C to the type number when ordering; e.g. BTW45-400RC.

*Measured under pulse conditions to avoid excessive dissipation.
Fig. 2.

Maximum permissible non-repetitive r.m.s. on-state current based on sinusoidal currents (f = 50 Hz), with reapplied V_{RWMmax}.

T_I = 125°C prior to surge.

Fig. 3.
Fig. 4 Maximum rate of rise of off-state voltage that will not trigger any device (exponential method) as a function of $T_j$.

Fig. 5 Maximum rate of rise of off-state voltage that will not trigger any device (exponential method) as a function of applied voltage.

Fig. 6.
Fig. 7 Minimum gate voltage that will trigger all devices as a function of $T_j$.

Fig. 8 Minimum gate current that will trigger all devices as a function of $T_j$.

Fig. 9.
THYRISTORS

Silicon thyristors in metal envelopes, primarily intended for three-phase mains operation. The series consists of reverse polarity types (anode to stud) identified by a suffix R: BTW47-800R to 1600R.

QUICK REFERENCE DATA

<table>
<thead>
<tr>
<th>Repetitive peak voltages $V_{DRM} = V_{RRM}$</th>
<th>BTW47-800R</th>
<th>1000R</th>
<th>1200R</th>
<th>1400R</th>
<th>1600R</th>
</tr>
</thead>
<tbody>
<tr>
<td>max.</td>
<td>800</td>
<td>1000</td>
<td>1200</td>
<td>1400</td>
<td>1600</td>
</tr>
</tbody>
</table>

Average on-state current
R.M.S. on-state current
Non-repetitive peak on-state current
Rate of rise of off-state voltage that will not trigger any device
On request (see ordering note on page 4)

MECHANICAL DATA

Dimensions in mm

Fig. 1 TO-48: with metric M6 stud (Ø 6 mm); e.g. BTW47-800R.

Types with ¼ in x 28UNF stud (Ø 6.35 mm) are available on request. These are indicated by the suffix U: BTW47-800RU.

Net mass: 14 g
Diameter of clearance hole: max. 6.5 mm
Accessories supplied on request: 56264A
(mica washer, insulating ring, soldering tag)

Torque on nut: min. 1.7 Nm (17 kg cm)
max. 3.5 Nm (35 kg cm)
Supplied with the device:
1 nut, 1 lock washer
Nut dimensions across the flats;
M6: 10 mm
¼ in x 28 UNF: 11,1 mm

April 1978
RATINGS

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

Anode to cathode

<table>
<thead>
<tr>
<th></th>
<th>BTW47-800R</th>
<th>1000R</th>
<th>1200R</th>
<th>1400R</th>
<th>1600R</th>
</tr>
</thead>
<tbody>
<tr>
<td>Non-repetitive peak voltages</td>
<td>VDSM/VRSN</td>
<td>max. 800</td>
<td>1000</td>
<td>1200</td>
<td>1400</td>
</tr>
<tr>
<td>(t ≤ 10 ms)</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Repetitive peak voltages</td>
<td>VDRM/VRRM</td>
<td>max. 800</td>
<td>1000</td>
<td>1200</td>
<td>1400</td>
</tr>
<tr>
<td>Crest working voltages</td>
<td>VDWM/VRWM</td>
<td>max. 600</td>
<td>700</td>
<td>800</td>
<td>800</td>
</tr>
</tbody>
</table>

Average on-state current (averaged over any 20 ms period) up to T_{mb} = 77 °C

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</thead>
<tbody>
<tr>
<td>at T_{mb} = 85 °C</td>
<td>I_{T(AV)}</td>
<td>max. 16 A</td>
<td>14 A</td>
<td>25 A</td>
<td>150 A</td>
</tr>
<tr>
<td>R.M.S. on-state current</td>
<td>I_{T(RMS)}</td>
<td>max. 300 A</td>
<td>450 A²s</td>
<td>200 A/μs</td>
<td></td>
</tr>
<tr>
<td>Repetitive peak on-state current</td>
<td>I_{TRM}</td>
<td>max. 150 A</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Non-repetitive peak on-state current; t = 10 ms; half sine-wave; T_j = 125 °C prior to surge; with reapplied V_{RWM} max</td>
<td>I_{TSM}</td>
<td>max. 300 A</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. 450 A²s</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Rate of rise of on-state current after triggering with I_G = 500 mA to I_T = 50 A; see Fig. 9</td>
<td>dI_T/dt</td>
<td>max. 200 A/μs</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Rate of change of commutation current</td>
<td></td>
<td></td>
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</tbody>
</table>

Gate to cathode

<p>| | | | | | |</p>
<table>
<thead>
<tr>
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<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>Reverse peak voltage</td>
<td>V_{RGM}</td>
<td>max. 10 V</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Average power dissipation (averaged over any 20 ms period)</td>
<td>P_{G(AV)}</td>
<td>max. 1 W</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Peak power dissipation</td>
<td>P_{GM}</td>
<td>max. 5 W</td>
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</tr>
</tbody>
</table>

Temperatures

<p>| | | | | | |</p>
<table>
<thead>
<tr>
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<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>Storage temperature</td>
<td>T_{stg}</td>
<td>-55 to +125 °C</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Junction temperature</td>
<td>T_J</td>
<td>max. 125 °C</td>
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<td></td>
</tr>
</tbody>
</table>

THERMAL RESISTANCE

<p>| | | | | |</p>
<table>
<thead>
<tr>
<th></th>
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<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>From junction to mounting base</td>
<td>R_{th j-mb}</td>
<td>= 1 °C/W</td>
<td></td>
<td></td>
</tr>
<tr>
<td>From mounting base to heatsink</td>
<td>R_{th mb-h}</td>
<td>= 0.2 °C/W</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Transient thermal impedance (t = 1 ms)</td>
<td>Z_{th j-mb}</td>
<td>= 0.06 °C/W</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

* To ensure thermal stability: R_{th j-a} < 1.5 °C/W (d.c. blocking) or < 3 °C/W (a.c.). For smaller heatsinks T_j max should be derated. For a.c. see Fig. 3.
CHARACTERISTICS

Anode to cathode

On-state voltage
\[ \text{I}_T = 50 \text{ A}; \text{T}_j = 25 \text{ °C} \]

Rate of rise of off-state voltage that will not trigger any device; exponential method; \( \text{V}_D = 2/3 \text{V}_{\text{DRMmax}} \); \( \text{T}_j = 125 \text{ °C} \)

Reverse current
\[ \text{V}_R = \text{V}_{\text{RWMmax}}; \text{T}_j = 125 \text{ °C} \]

Off-state current
\[ \text{V}_D = \text{V}_{\text{DWMmax}}; \text{T}_j = 125 \text{ °C} \]

Latching current; \( \text{T}_j = 25 \text{ °C} \)

Holding current; \( \text{T}_j = 25 \text{ °C} \)

Gate to cathode

Voltage that will trigger all devices
\[ \text{V}_D = 6 \text{ V}; \text{T}_j = 25 \text{ °C} \]

Voltage that will not trigger any device
\[ \text{V}_D = \text{V}_{\text{DRMmax}}; \text{T}_j = 125 \text{ °C} \]

Current that will trigger all devices
\[ \text{V}_D = 6 \text{ V}; \text{T}_j = 25 \text{ °C} \]

Switching characteristics

Gate-controlled turn-on time \( \text{t}_{\text{gt}} = \text{t}_d + \text{t}_r \) when switched from \( \text{V}_D = \text{V}_{\text{DWMmax}} \) to \( \text{I}_T = 10 \text{ A}; \text{I}_{\text{GT}} = 150 \text{ mA}; \text{dI}_G/\text{dt} = 1 \text{ A/μs}; \text{T}_j = 25 \text{ °C} \)

\[ \text{t}_{\text{gt}} \text{ typ.} = 2 \text{ μs} \]

\[ \text{t}_r \text{ typ.} = 1,2 \text{ μs} \]

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

1. The terminals should neither be bent nor twisted; they should be soldered into the circuit so that there is no strain on them.

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

2. Switching losses in commutation

   For applications in which the thyristor is forced to switch from an on-state current $I_{TRM}$ to a high reverse voltage at a high commutation rate ($-dIT/dt$), consult Fig. 9 (nomogram) to find the increase in total average power. This increase must be added to the loss from the curves in Fig. 3.

ORDERING NOTE

Types with $dV_p/dt$ of 1000 V/$\mu$s are available on request. Add suffix C to the type number when ordering; e.g. BTW47-800RC.
maximum permissible non-repetitive r.m.s. on-state current based on sinusoidal currents (f = 50 Hz)

Fig. 4.

-- $I_{TSM}$
-- $I_{TS(RMS)}$

$T_j = 125^\circ C$ prior to surge

with reapplied $V_{RWMax}$

Fig. 5.

max. $V_T$ values

$T_j = 25^\circ C$
$125^\circ C$

Fig. 6.
Fig. 7 Maximum rate of rise of off-state voltage that with not trigger any device (exponential method) as a function of $T_j$. 

Fig. 8 Maximum rate of rise of off-state voltage that with not trigger any device (exponential method) as a function of applied voltage.

Fig. 9.
Fig. 10 Minimum gate voltage that will trigger all devices as a function of $T_j$.

Fig. 11 Minimum gate current that will trigger all devices as a function of $T_j$.

Fig. 12. Transient thermal impedance from junction to mounting base versus time.
Fig. 13 Limits for starting or inrush currents.

For safe operation at a given temperature, the average current envelope of successive cycles (see drawing above) must lie within the region bounded by the curve shown below for that temperature.
THYRISTORS

Also available to BS9341-F039

Silicon thyristors in metal envelopes, intended for use in general purpose three-phase power control circuits.

The series consists of reverse polarity types (anode to stud) identified by a suffix R: BTW92-800R to 1600R.

QUICK REFERENCE DATA

<table>
<thead>
<tr>
<th>Repetitive peak voltages $V_{DRM}/V_{RRM}$ max.</th>
<th>BTW92-800R</th>
<th>1000R</th>
<th>1200R</th>
<th>1400R</th>
<th>1600R</th>
</tr>
</thead>
<tbody>
<tr>
<td>Average on-state current $I_{TAV}$ max.</td>
<td>20 A</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>R.M.S. on-state current $I_{T(RMS)}$ max.</td>
<td>31 A</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Non-repetitive peak on-state current $I_{TSM}$ max.</td>
<td>400 A</td>
<td></td>
<td></td>
<td></td>
<td></td>
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<tr>
<td>Rate of rise of off-state voltage $dV_D/dt$ &lt; 300 V/$\mu$s</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>On request (see ordering note on page 4)</td>
<td></td>
<td></td>
<td></td>
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<td></td>
</tr>
</tbody>
</table>

MECHANICAL DATA

Fig. 1 TO-48: with metric M6 stud (φ 6 mm); e.g. BTW92-800R.

Types with ¼ in x 28 UNF stud (φ 6,35 mm) are available on request. These are indicated by the suffix U: BTW92-800RU.

Net mass: 14 g
Diameter of clearance hole: max. 6,5 mm
Accessories supplied on request: 56264A (mica washer, insulating ring, soldering tag)

Torque on nut: min. 1,7 Nm (17 kg cm)
max. 3,5 Nm (35 kg cm)

Supplied with the device:
1 nut, 1 lock washer
Nut dimensions across the flats;
M6: 10 mm
¼ in x 28 UNF: 11,1 mm

April 1978
RATINGS
Limiting values in accordance with the Absolute Maximum System (IEC 134)

Anode to cathode

<table>
<thead>
<tr>
<th></th>
<th>BTW92-800R</th>
<th>1000R</th>
<th>1200R</th>
<th>1400R</th>
<th>1600R</th>
</tr>
</thead>
<tbody>
<tr>
<td>Non-repetitive peak</td>
<td>max.</td>
<td>800</td>
<td>1000</td>
<td>1200</td>
<td>1400</td>
</tr>
<tr>
<td>voltages (t &lt; 10 ms)</td>
<td>V_{DSM}/V_{RSM}</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Repetitive peak</td>
<td>max.</td>
<td>800</td>
<td>1000</td>
<td>1200</td>
<td>1400</td>
</tr>
<tr>
<td>voltages</td>
<td>V_{DRM}/V_{RRM}</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Crest working voltages</td>
<td>max.</td>
<td>600</td>
<td>700</td>
<td>800</td>
<td>800</td>
</tr>
<tr>
<td>V_{DWM}/V_{RWM}</td>
<td>max.</td>
<td>600</td>
<td>700</td>
<td>800</td>
<td>800</td>
</tr>
</tbody>
</table>

Average on-state current (averaged over any 20 ms period) up to T_{mb} = 85 °C
\[ I_{(AV)} \text{ max.} = 20 \text{ A} \]

R.M.S. on-state current
\[ I_{(RMS)} \text{ max.} = 31 \text{ A} \]

Repetitive peak on-state current
\[ I_{TRM} \text{ max.} = 200 \text{ A} \]

Non-repetitive peak on-state current; t = 10 ms; half sine-wave; T_j = 125 °C prior to surge; with re-applied \( V_{RWM}^{\text{max}} \)
\[ I_{TSM} \text{ max.} = 400 \text{ A} \]
\[ I^2 t \text{ max.} = 800 \text{ A}^2 s \]

Rate of rise of on-state current after triggering with \( I_{G} = 500 \text{ mA} \) to \( I_{T} = 60 \text{ A} \)
\[ dI_{T}/dt \text{ max.} = 300 \text{ A/\mu s} \]

Rate of change of commutation current
see Fig. 9

Gate to cathode

Reverse peak voltage
\[ V_{RGM} \text{ max.} = 10 \text{ V} \]

Average power dissipation (averaged over any 20 ms period)
\[ P_{G(AV)} \text{ max.} = 1 \text{ W} \]

Peak power dissipation
\[ P_{GM} \text{ max.} = 5 \text{ W} \]

Temperatures

Storage temperature
\[ T_{stg} \text{ max.} = -55 \text{ to } +125 \text{ °C} \]

Junction temperature
\[ T_j \text{ max.} = 125 \text{ °C} \]

THERMAL RESISTANCE

From junction to mounting base
\[ R_{th \ j-mb} = 1 \text{ °C/W} \]

From mounting base to heatsink
\[ R_{th \ mb-h} = 0,2 \text{ °C/W} \]

Transient thermal impedance (t = 1 ms)
\[ Z_{th \ j-mb} = 0,06 \text{ °C/W} \]

* To ensure thermal stability: \( R_{th \ j-a} < 1,5 \text{ °C/W (d.c. blocking or } < 3 \text{ °C/W (a.c.). For smaller heatsinks } T_j \text{ max should be derated. For a.c. see Fig. 3.} \)
CHARACTERISTICS

Anode to cathode

On-state voltage

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

Rate of rise of off-state voltage that will not trigger any device; exponential method; \( V_D = \frac{2}{3} V_{D\text{RMmax}} \):

\[ \begin{align*}
    I_R &= \frac{2}{3} V_{R\text{RWMmax}}; \quad T_j = 125 ^\circ \text{C} \\
    I_D &= \frac{2}{3} V_{D\text{RWMmax}}; \quad T_j = 125 ^\circ \text{C} \\
    I_L &= \frac{2}{3} V_{D\text{WMmax}}; \quad T_j = 125 ^\circ \text{C} \\
    I_H &= \frac{2}{3} V_{D\text{WMmax}}; \quad T_j = 125 ^\circ \text{C}
\end{align*} \]

Off-state current

\[ \begin{align*}
    V_R &= V_{R\text{RWMmax}}; \quad T_j = 125 ^\circ \text{C} \\
    V_D &= V_{D\text{RWMmax}}; \quad T_j = 125 ^\circ \text{C}
\end{align*} \]

Gate to cathode

Voltage that will trigger all devices

\[ V_D = 6 \text{ V}; \quad T_j = 25 ^\circ \text{C} \]

Voltage that will not trigger any device

\[ V_D = V_{D\text{RWMmax}}; \quad T_j = 125 ^\circ \text{C} \]

Current that will trigger all devices

\[ V_D = 6 \text{ V}; \quad T_j = 25 ^\circ \text{C} \]

Switching characteristics

Gate-controlled turn-on time (\( t_{gt} = t_d + t_r \)) when switched from \( V_D = V_{D\text{WMmax}} \) to \( I_T = 10 \text{ A}; I_{GT} = 150 \text{ mA}; \frac{dI_G}{dt} = 1 \text{ A/µs}; T_j = 25 ^\circ \text{C} \):

\[ \begin{align*}
    t_{gt} &= \text{typ.} \quad 2 \mu\text{s} \\
    t_r &= \text{typ.} \quad 1.2 \mu\text{s}
\end{align*} \]

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

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

2. Switching losses in commutation.

For applications in which the thyristor is forced to switch from an on-state current $I_{TRM}$ to a high reverse voltage at a high commutation rate ($-dI/dt$), consult Fig. 9 (nomogram) to find the increase in total average power. This increase must be added to the loss from the curves in Fig. 3.

ORDERING NOTE

Types with $dV_d/dt$ of 1000 V/μs are available on request. Add suffix C to the type number when ordering; e.g. BTW92-800RC.

![Fig. 3.](image-url)
Thyristors

BTW92 SERIES

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

with reapplied \( V_{\text{RWMmax}} \)

Fig. 4.

Fig. 5.

Fig. 6.
Fig. 7 Maximum rate of rise of off-state voltage that will not trigger any device (exponential method) as a function of $T_j$.

Fig. 8 Maximum rate of rise of off-state voltage that will not trigger any device (exponential method) as a function of applied voltage.

Fig. 9.
Fig. 10 Minimum gate voltage that will trigger all devices as a function of $T_j$.

Fig. 11 Minimum gate current that will trigger all devices as a function of $T_j$.

Fig. 12. Transient thermal impedance from junction to mounting base versus time.
for safe operation at a given temperature, the average current envelope of successive cycles (see drawing above) must lie within the region bounded by the curve shown below for that temperature.

$T_j = T_{mb} = 65^\circ C$ prior to starting

85°C

105°C

Fig. 13 Limits for starting or inrush currents.
The BTX18 series is a range of p-gate reverse blocking thyristors, in a TO-5 metal envelope, intended for use in general low power applications up to 1 A average on-state current.

### QUICK REFERENCE DATA

<table>
<thead>
<tr>
<th></th>
<th>BTX18-100</th>
<th>200</th>
<th>300</th>
<th>400</th>
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<tr>
<td>Crest working reverse voltage ($V_{RWM}$) max.</td>
<td>100</td>
<td>200</td>
<td>300</td>
<td>400</td>
<td>500</td>
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<tr>
<td>Crest working off-state voltage ($V_{DWM}$) max.</td>
<td>100</td>
<td>200</td>
<td>300</td>
<td>400</td>
<td>500</td>
</tr>
<tr>
<td>Average on-state current up to $T_{case} = 105 , ^{\circ}C$</td>
<td>$I_{T(AV)}$ max.</td>
<td>1.0</td>
<td>A</td>
<td></td>
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</tr>
<tr>
<td>$T_{amb} = 60 , ^{\circ}C$; in free air</td>
<td>$I_{T(AV)}$ max.</td>
<td>250</td>
<td>mA</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Non-repetitive peak on-state current</td>
<td>$I_{TSM}$ max.</td>
<td>10</td>
<td>A</td>
<td></td>
<td></td>
</tr>
<tr>
<td>$t = 10 , ms$; $T_{j} = 125 , ^{\circ}C$ prior to surge</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Junction temperature</td>
<td>$T_{j}$ max.</td>
<td>125</td>
<td>$^\circ$C</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

### MECHANICAL DATA

Anode connected to the case

TO-39

Accessories supplied on request: 56218; 56245.
All information applies to frequencies up to 400 Hz

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

**ANODE TO CATHODE**

<table>
<thead>
<tr>
<th>Votages 1)</th>
<th>BTX18-100</th>
<th>200</th>
<th>300</th>
<th>400</th>
<th>500</th>
</tr>
</thead>
<tbody>
<tr>
<td>Continuous reverse voltage</td>
<td>$V_R$</td>
<td>max. 100</td>
<td>200</td>
<td>300</td>
<td>400</td>
</tr>
<tr>
<td>Crest working reverse voltage</td>
<td>$V_{RWM}$</td>
<td>max. 100</td>
<td>200</td>
<td>300</td>
<td>400</td>
</tr>
<tr>
<td>Repetitive peak reverse voltage ($\delta = 0.01; f = 50$ Hz)</td>
<td>$V_{RRM}$</td>
<td>max. 120</td>
<td>240</td>
<td>350</td>
<td>500</td>
</tr>
<tr>
<td><strong>Non-repetitive</strong> peak reverse voltage ($t \leq 10$ ms)</td>
<td>$V_{RSM}$</td>
<td>max. 120</td>
<td>240</td>
<td>350</td>
<td>500</td>
</tr>
<tr>
<td>Continuous off-state voltage</td>
<td>$V_D$</td>
<td>max. 100</td>
<td>200</td>
<td>300</td>
<td>400</td>
</tr>
<tr>
<td>Crest working off-state voltage</td>
<td>$V_{DWM}$</td>
<td>max. 100</td>
<td>200</td>
<td>300</td>
<td>400</td>
</tr>
<tr>
<td>Repetitive peak off-state voltage ($\delta = 0.01; f = 50$ Hz)</td>
<td>$V_{DRM}$</td>
<td>max. 120</td>
<td>240</td>
<td>350</td>
<td>500</td>
</tr>
<tr>
<td><strong>Non-repetitive</strong> peak off-state voltage ($t \leq 10$ ms)</td>
<td>$V_{DSM}$</td>
<td>max. 120</td>
<td>240</td>
<td>350</td>
<td>500</td>
</tr>
</tbody>
</table>

**Currents**

**Average on-state current (averaged over any 20 ms period) up to $T_{case} = 105$ °C**

| $I_{T(AV)}$ | max. 1.0 A |
| $I_{T(AV)}$ | max. 250 mA |

at $T_{amb} = 60$ °C

**On-state current (d.c.)**

| $I_T$ | max. 1.6 A |
| $I_{T(RMS)}$ | max. 1.6 A |

**R.M.S. on-state current**

| $I_{TRM}$ | max. 10 A |

**Repetitive peak on-state current**

| $I_{TSM}$ | max. 10 A |

**Non-repetitive** peak on-state current

($t = 10$ ms, half sinewave)

---

1) These ratings apply for zero or negative bias on the gate with respect to the cathode, and when a resistor $R \leq 1$ k$\Omega$ is connected between gate and cathode.

2) The device is not suitable for operation in the forward breakover mode.
# RATINGS

**GATE TO CATHODE** (with 1 kΩ resistor between gate and cathode)

### Voltages
- **Forward peak voltage** \( V_{FGM} \) max. 10 V
- **Reverse peak voltage** \( V_{RGM} \) max. 5 V

### Current
- **Forward peak current** \( I_{FGM} \) max. 0.2 A

### Power dissipation
- **Average power dissipation** (averaged over any 20 ms period) \( P_{G(AV)} \) max. 0.05 W
- **Peak power dissipation** \( P_{GM} \) max. 0.5 W

### TEMPERATURES
- **Storage temperature** \( T_{stg} \) -55 to +125 °C
- **Junction temperature** \( T_j \) max. 125 °C

### THERMAL RESISTANCE
- **From junction to case** \( R_{th j-c} \) = 10 °C/W
- **From junction to ambient** \( R_{th j-a} \) = 200 °C/W
- **Transient thermal resistance** (t = 10 ms) \( Z_{th j-c} \) = 2.5 °C/W

### CHARACTERISTICS

**ANODE TO CATHODE**

### Voltages
- **On-state voltage**
  - \( I_T = 1.0 \) A; \( T_j = 25 \) °C
  - \( V_T \) ≤ 1.5 V

- **Rate of rise of off-state voltage that will not trigger any device**
  - \( R_{GK} = 1 \) kΩ; \( T_j = 125 \) °C
  - \( \frac{dV_D}{dt} \)

### Currents
- **Peak reverse current** \( V_{RM} = V_{RWMmax}; T_j = 125 \) °C
  - \( I_{RM} \) ≤ 800, 400, 275, 200, 160 μA

- **Peak off-state current** \( V_{DM} = V_{DWMmax}; T_j = 125 \) °C
  - \( I_{DM} \) ≤ 800, 400, 275, 200, 160 μA

1) \( V_T \) is measured along the leads at 1 cm from the case.
CHARACTERISTICS (continued)

Latching current; $T_j = 125 \, ^\circ\text{C}$  
Holding current; $T_j = 25 \, ^\circ\text{C}$

GATE TO CATHODE

Voltages

Voltage that will trigger all devices; $T_j = 25 \, ^\circ\text{C}$  
Voltage that will not trigger any device; $T_j = 125 \, ^\circ\text{C}$

Current

Current that will trigger all devices; $T_j = 25 \, ^\circ\text{C}$

SWITCHING CHARACTERISTICS

Turn off time when switched from

$I_T = 300 \, \text{mA} \text{ to } I_R = 175 \, \text{mA}; T_j = 25 \, ^\circ\text{C}$  
$t_q \text{ typ. } 20 \, \mu\text{s}$  
$t_q \text{ typ. } 35 \, \mu\text{s}$

NOTES

1. When using a soldering iron the thyristor may be soldered directly into the circuit, but the heat conduction to the junction should be kept to a minimum by using a thermal shunt.

2. Thyristors may be dip soldered at a solder temperature of 245 °C, for a maximum soldering time of 5 seconds. The case temperature during dip soldering must not at any time exceed the maximum storage temperature. These recommendations apply to a thyristor mounted flush on a board with punched-through holes, or spaced 1.5 mm above a board having plated-through holes.

3. Care should be taken not to bend the leads nearer than 1.5 mm from the seal.

1) Measured under the following conditions: Anode supply voltage = +6.0 V.

Initial on-state current after gate triggering = 50 mA.

The current is reduced until the device turns off.
interrelation between the power (derived from the left hand graph) and the max. allowable temperatures

for operation in this area refer to curve below
max. rate of rise of forward off-state voltage not to trigger any device against junction temperature

max. rate of rise of forward off-state voltage not to trigger any device plotted against gate to cathode resistance

typical turn off time when switched from $I_T = 300$ mA to $I_R = 175$ mA versus junction temperature
Gate characteristics with curves

\[ P_{GM \text{ max}} = 0.5 \text{W} \]

area of certain triggering

\[ \delta = 1.0 \]

min. gate current to trigger all devices at \( T_j = 25 \text{ to } 125^\circ \text{C} \)

min. gate voltage to trigger all devices

max. gate voltage not to trigger any device at \( T_j = 125^\circ \text{C} \)

\[ T_j = 25 \text{ to } 125^\circ \text{C} \]
transient thermal resistance from junction to case versus time

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

$10^{-1}$ $10^{-2}$ $10^{-3}$ $10^{-4}$ $10^{-5}$ $10^{-6}$

time (s)

max. permissible non repetitive r.m.s on-state current

$IT_{S(RMS)}$ (A)

$T_j = 125^\circ$C (prior to surge)

duration of surge (ms)

June 1969
THYRISTORS

Also available to BS9341-F001 to F009

Silicon thyristors in metal envelopes, intended for use in power control circuits (e.g. light and motor control) and power switching systems.
The series consists of reverse polarity types (anode to stud) identified by a suffix R: BTY79-400R to 1000R.

QUICK REFERENCE DATA

<table>
<thead>
<tr>
<th>Repetitive peak voltages $V_{DRM/VRM}$ max.</th>
<th>400</th>
<th>500</th>
<th>600</th>
<th>800</th>
<th>1000</th>
</tr>
</thead>
</table>

| Average on-state current $I_{T(AV)}$ max. | 10 A |
| R.M.S. on-state current $I_{T(RMS)}$ max. | 16 A |
| Non-repetitive peak on-state current $I_{TSM}$ max. | 150 A |

MECHANICAL DATA

Fig. 1 TO-64: with 10-32 UNF stud ($\phi$ 4,83 mm).

- Net mass: 7 g
- Diameter of clearance hole: max. 5,2 mm
- Accessories supplied on request:
  - 56295 (PTFE bush, 2 mica washers, plain washer, tag)
  - 56262A (mica washer, insulating ring, plain washer)

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)

April 1978
### RATINGS

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

<table>
<thead>
<tr>
<th>Anode to cathode</th>
<th>BTY79-400R</th>
<th>500R</th>
<th>600R</th>
<th>800R</th>
<th>1000R</th>
</tr>
</thead>
<tbody>
<tr>
<td>Non-repetitive peak off-state voltage</td>
<td>V_DSM** max.</td>
<td>500</td>
<td>1100</td>
<td>1100</td>
<td>1100 V</td>
</tr>
<tr>
<td>(t ≤ 10 ms)</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Non-repetitive peak reverse voltage</td>
<td>V_RSM max.</td>
<td>500</td>
<td>600</td>
<td>720</td>
<td>960</td>
</tr>
<tr>
<td>(t ≤ 5 ms)</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Repetitive peak voltages</td>
<td>V_DRM/V_RRM max.</td>
<td>400</td>
<td>500</td>
<td>600</td>
<td>800</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Crest working voltages</td>
<td>V_DWM/V_RWM max.</td>
<td>400</td>
<td>500</td>
<td>600</td>
<td>800</td>
</tr>
</tbody>
</table>

Average on-state current (averaged over any 20 ms period) up to T_{mb} = 85 °C

R.M.S. on-state current

Repetitive peak on-state current

Non-repetitive peak on-state current; t = 10 ms;
half sine-wave; T_j = 125 °C prior to surge;
with reapplied V_{RWMI}max

I_T^TSM max. 150 A

I^2 t for fusing (t = 10 ms)

dI_T/dt max. 50 A/μs

Gate to cathode

Average power dissipation (averaged over any 20 ms period)
P_{G(AV)} max. 0,5 W

Peak power dissipation

P_{GM} max. 5 W

Temperatures

Storage temperature

T_{stg} -55 to +125 °C

Junction temperature

T_j max. 125 °C

### THERMAL RESISTANCE

From junction to mounting base

R_{th j-mb} = 1,8 °C/W

From mounting base to heatsink with heatsink compound

R_{th mb-h} = 0,5 °C/W

From junction to ambient in free air

R_{th j-a} = 45 °C/W

Transient thermal impedance (t = 1 ms)

Z_{th j-mb} = 0,1 °C/W

* To ensure thermal stability: R_{th j-a} < 4 °C/W (d.c. blocking) or < 8 °C/W (a.c.). For smaller heatsinks T_j max should be derated. For a.c. see Fig. 3.

** Although not recommended, higher off-state voltages may be applied without damage, but the thyristor may switch into the on-state. The rate of rise of on-state current should not exceed 100 A/μs.
CHARACTERISTICS

Anode to cathode

On-state voltage

\[ I_T = 20 \text{ A}; \quad T_j = 25^\circ\text{C} \]

Rate of rise of off-state voltage that will not trigger any device; exponential method;

\[ V_D = 2/3 \cdot V_{\text{DRMmax}}; \quad T_j = 125^\circ\text{C} \]

Reverse current

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

Off-state current

\[ V_D = V_{\text{DWMmax}}; \quad T_j = 125^\circ\text{C} \]

Latching current; \( T_j = 25^\circ\text{C} \)

Holding current; \( T_j = 25^\circ\text{C} \)

Gate to cathode

Voltage that will trigger all devices

\[ V_D = 6 \text{ V}; \quad T_j = 25^\circ\text{C} \]

Voltage that will not trigger any device

\[ V_D = V_{\text{DRMmax}}; \quad T_j = 125^\circ\text{C} \]

Current that will trigger all devices

\[ V_D = 6 \text{ V}; \quad T_j = 25^\circ\text{C} \]

On request (see ordering note on page 4)

Switching characteristics

Gate-controlled turn-on time (\( t_{\text{gt}} = t_d + t_r \)) when switched from \( V_D = 800 \text{ V} \) to \( I_T = 25 \text{ A} \); \( I_{\text{GT}} = 250 \text{ mA} \);

\[ \frac{dI_G}{dt} = 0.25 \text{ A/\mu s}; \quad T_j = 25^\circ\text{C} \]

\[ t_{\text{gt}} < 1.5 \text{ \mu s} \]

\[ t_r \text{ typ. } 0.2 \text{ \mu s} \]

* Measured under pulse conditions to avoid excessive dissipation.
OPERATING NOTE
The terminals should neither be bent nor twisted; they should be soldered into the circuit so that there is no strain on them.
During soldering the heat conduction to the junction should be kept to a minimum.

ORDERING NOTE
Types with low gate trigger current, $I_{GT} > 20$ mA, are available on request. Add suffix A to the type number when ordering: e.g. BTY79A-400R.

---

$P \quad 30$
$\alpha \quad a$
$\frac{1}{T(RMS)} \quad T(AV)$
$\frac{4}{190} \quad 2.8$
$0.2 \quad 2.2$
$1.9 \quad 1.6$
$1.9 \quad 1.6$
$a = 4$

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

Fig. 3 (1) $T_{mb}$ scale is for comparison purposes only and is correct only for $R_{th mb-a} \leq 6$ °C/W.
maximum allowable non-repetitive r.m.s. on state current based on sinusoidal currents ($f = 50$ Hz)

with reapplied $V_{RWMmax}$

Fig. 4.

Fig. 5.
Fig. 6 Minimum gate voltage that will trigger all devices as a function of $T_j$.

Fig. 7 Minimum gate current that will trigger all devices as a function of $T_j$. 
Fig. 8 Maximum rate of rise of off-state voltage that will not trigger any device (exponential method) as a function of $T_j$.

Fig. 9 Maximum rate of rise of off-state voltage that will not trigger any device (exponential method) as a function of applied voltage.
for safe operation at a given temperature, the average current envelope of successive cycles (see drawing above) must lie within the region bounded by the curve shown below for that temperature.

Fig. 10 Limits for starting or inrush currents.
Thyristors

Fig. 11 Limits for starting or inrush currents.

Fig. 12.
THYRISTORS

Silicon thyristors in metal envelopes, intended for power control and power switching applications. The series consists of reverse polarity types (anode to stud) identified by a suffix R: BTY87-400R to 800R.

QUICK REFERENCE DATA

<table>
<thead>
<tr>
<th>Parameter</th>
<th>BTY87-400R</th>
<th>500R</th>
<th>600R</th>
<th>800R</th>
</tr>
</thead>
<tbody>
<tr>
<td>Average on-state current</td>
<td>16 A</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>R.M.S. on-state current</td>
<td>25 A</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Non-repetitive peak on-state current</td>
<td>140 A</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

MECHANICAL DATA

Fig. 1 TO-48: with ¼ in x 28 UNF stud (Ø 6.35 mm).

Net mass: 14 g
Diameter of clearance hole: max. 6.5 mm
Accessories supplied on request: 56264A (mica washer, insulating ring, soldering tag)

Torque on nut: min. 1.7 Nm (17 kg cm)
max. 3.5 Nm (35 kg cm)
Supplied with the device:
1 nut, 1 lock washer
Nut dimensions across the flats: 11.1 mm

April 1978
RATINGS

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

<table>
<thead>
<tr>
<th>Parameter</th>
<th>BTY87-400R</th>
<th>500R</th>
<th>600R</th>
<th>800R</th>
</tr>
</thead>
<tbody>
<tr>
<td>Anode to cathode</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Non-repetitive peak off-state voltage</td>
<td>max. 500</td>
<td>850</td>
<td>850</td>
<td>850</td>
</tr>
<tr>
<td>(t ≤ 10 ms)</td>
<td>V_{DSM}</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Non-repetitive peak reverse voltage</td>
<td>max. 500</td>
<td>600</td>
<td>850</td>
<td>960</td>
</tr>
<tr>
<td>(t ≤ 5 ms)</td>
<td>V_{RSM}</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Repetitive peak voltages</td>
<td>max. 400</td>
<td>500</td>
<td>600</td>
<td>800</td>
</tr>
<tr>
<td>Crest working voltages</td>
<td>max. 400</td>
<td>500</td>
<td>600</td>
<td>800</td>
</tr>
<tr>
<td>Average on-state current (averaged over</td>
<td>I_{T(AV)} max. 16 A</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>any 20 ms period) up to T_{mb} = 52 °C</td>
<td>I_T(AV) max. 10 A</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>at T_{mb} = 85 °C</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>R.M.S. on-state current</td>
<td>I_T(RMS) max. 25 A</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Repetitive peak on-state current</td>
<td>I_{TRM} max. 140 A</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Non-repetitive peak on-state current;</td>
<td>I_TSM max. 140 A</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>t = 10 ms; half sine-wave; T_j = 125 °C</td>
<td>I^2 t max. 100 A^2 s</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>with reapplied V_{RWM}max</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>I^2 t for fusing (t = 10 ms)</td>
<td>dI_T/dt max. 20 A/μs</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Rate of rise of on-state current after</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>triggering with I_C = 325 mA to I_T = 50 A</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Gate to cathode</td>
<td>V_{RGM} max. 5 V</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Reverse peak voltage</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Average power dissipation (averaged over</td>
<td>P_{G(AV)} max. 0.5 W</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>any 20 ms period)</td>
<td>P_{GM} max. 5 W</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Peak power dissipation</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Temperatures</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Storage temperature</td>
<td>T_{stg} -55 to + 125 °C</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Junction temperature</td>
<td>T_j max. 125 °C</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>THERMAL RESISTANCE</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>From junction to mounting base</td>
<td>R_{th j-mb} = 1.6 °C/W</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>From mounting base to heatsink</td>
<td>R_{th mb-h} = 0.2 °C/W</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>with heatsink compound</td>
<td>Z_{th j-mb} = 0.09 °C/W</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Transient thermal impedance (t = 1 ms)</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>OPERATING NOTE</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>The terminals should neither be bent</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>nor twisted; they should be soldered</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>into the circuit so that there is</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>no strain on them.</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>During soldering the heat conduction</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>to the junction should be kept to a</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>minimum.</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

* To ensure thermal stability: R_{th j-a} < 4.5 °C/W (d.c. blocking) or < 9 °C/W (a.c.). For smaller heatsinks T_{j max} should be derated. For a.c. see Fig. 3.
CHARACTERISTICS

Anode to cathode

On-state voltage
\[ I_T = 50 \text{ A}; T_j = 25 \text{ °C} \]

Rate of rise of off-state voltage that will not trigger any device;
exponential method; \( V_D = \frac{2}{3} V_{DRM\text{max}}; T_j = 125 \text{ °C} \)

Reverse current
\[ V_R = V_{RWM\text{max}}; T_j = 125 \text{ °C} \]

Off-state current
\[ \frac{dV_D}{dt} < 20 \text{ V/\mu s} \]

Reverse current
\[ I_R < 3 \text{ mA} \]

Off-state current
\[ I_D < 3 \text{ mA} \]

Latching current; \( T_j = 25 \text{ °C} \)
\[ I_L \text{ typ.} = 20 \text{ mA} \]

Holding current; \( T_j = 25 \text{ °C} \)
\[ I_H \text{ typ.} = 10 \text{ mA} \]

Gate to cathode

Voltage that will trigger all devices
\[ V_D = 6 \text{ V}; T_j = 25 \text{ °C} \]

Voltage that will not trigger any device
\[ V_D = V_{DRM\text{max}}; T_j = 125 \text{ °C} \]

Current that will trigger all devices
\[ V_D = 6 \text{ V}; T_j = 25 \text{ °C} \]

Swapping characteristics

Gate-controlled turn-on time \( t_{gt} = t_d + t_r \) when switched
from \( V_D = 400 \text{ V} \) to \( I_T = 50 \text{ A} \);
\( I_{GT} = 200 \text{ mA}; T_j = 25 \text{ °C} \)

\[ t_{gt} \text{ typ.} = 2 \mu s \]

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

Interrelation between the power (derived from the left hand graph) and the max. allowable temperatures

<table>
<thead>
<tr>
<th>$\alpha$ (deg)</th>
<th>Form angle factor</th>
</tr>
</thead>
<tbody>
<tr>
<td>30°</td>
<td>2.8</td>
</tr>
<tr>
<td>60°</td>
<td>2.2</td>
</tr>
<tr>
<td>90°</td>
<td>1.9</td>
</tr>
<tr>
<td>120°</td>
<td>1.6</td>
</tr>
</tbody>
</table>

$P (W)$

$\alpha =$ Conduction angle

Fig. 4.

Max. permissible non repetitive peak on-state current based on sinusoidal currents ($f = 50$ Hz)

Each current pulse is followed by the crest working reverse voltage

$I_{TSN}$

$T_j = 125^\circ C$ (prior to surge)

Number of cycles
Typical turn on characteristics when switched from $V_D = 400\,\text{V}$ or $50\,\text{V}$ respectively to $I_T = 1\,\text{A}, 10\,\text{A}$ or $50\,\text{A}$

Gate source $5\,\text{V}, 25\,\Omega$

Fig. 5.

Fig. 6.
Gate characteristics with curves $P_{GA} = 0.5W$.
Thyristors

Fig. 8. transient thermal resistance from junction to mounting base versus time

Fig. 9.
maximum allowable starting and inrush currents for various mounting base temperatures versus time in a single phase bridge.

Fig. 10.

maximum allowable starting and inrush currents for various mounting base temperatures versus time in a three phase bridge.

Fig. 11.
THYRISTORS

Silicon thyristors in metal envelopes, intended for power control and power switching applications. The series consists of reverse polarity types (anode to stud) identified by a suffix R: BTY91-400R to 800R.

QUICK REFERENCE DATA

<table>
<thead>
<tr>
<th>Repetitive peak voltages</th>
<th>$V_{DRM}/V_{RRM}$</th>
</tr>
</thead>
<tbody>
<tr>
<td>BTY91-400R</td>
<td>400</td>
</tr>
<tr>
<td>$V_{DRM}$ max.</td>
<td>$V_{RRM}$ max.</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Average on-state current</th>
<th>$I_T^{(AV)}$ max.</th>
</tr>
</thead>
<tbody>
<tr>
<td>16 A</td>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>R.M.S. on-state current</th>
<th>$I_T^{(RMS)}$ max.</th>
</tr>
</thead>
<tbody>
<tr>
<td>25 A</td>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Non-repetitive peak on-state current</th>
<th>$I_{TSM}$ max.</th>
</tr>
</thead>
<tbody>
<tr>
<td>200 A</td>
<td></td>
</tr>
</tbody>
</table>

MECHANICAL DATA

Fig. 1 TO-48: with ¼ in x 28 UNF stud (ø 6,35 mm).

Dimensions in mm

- Net mass: 14 g
- Diameter of clearance hole: max. 6,5 mm
- Accessories supplied on request: 56264A
  (mica washer, insulating ring, soldering tag)
- Torque on nut: min. 1,7 Nm (17 kg cm)
  max. 3,5 Nm (35 kg cm)
- Supplied with the device:
  1 nut, 1 lock washer
- Nut dimensions across the flats: 11,1 mm

April 1978
RATINGS

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

<table>
<thead>
<tr>
<th>Anode to cathode</th>
<th>BTY91-400R</th>
<th>500R</th>
<th>600R</th>
<th>800R</th>
</tr>
</thead>
<tbody>
<tr>
<td>Non-repetitive peak off-state voltage (t ≤ 10 ms)</td>
<td>V_{DSM}</td>
<td>max.</td>
<td>500</td>
<td>850</td>
</tr>
<tr>
<td>Non-repetitive peak reverse voltage (t ≤ 5 ms)</td>
<td>V_{RSM}</td>
<td>max.</td>
<td>500</td>
<td>600</td>
</tr>
<tr>
<td>Repetitive peak voltages</td>
<td>V_{DRM}/V_{RRM}</td>
<td>max.</td>
<td>400</td>
<td>500</td>
</tr>
<tr>
<td>Crest working voltages</td>
<td>V_{DWM}/V_{RWM}</td>
<td>max.</td>
<td>400</td>
<td>500</td>
</tr>
<tr>
<td>Average on-state current (averaged over any 20 ms period) up to $T_{mb} = 77 , ^\circ C$ at $T_{mb} = 85 , ^\circ C$</td>
<td>$I_{(AV)} , \text{max.}$</td>
<td>16</td>
<td>A</td>
<td></td>
</tr>
<tr>
<td>R.M.S. on-state current</td>
<td>$I_{(AV)} , \text{max.}$</td>
<td>14</td>
<td>A</td>
<td></td>
</tr>
<tr>
<td>Repetitive peak on-state current</td>
<td>$I_{(RMS)} , \text{max.}$</td>
<td>25</td>
<td>A</td>
<td></td>
</tr>
<tr>
<td>Non-repetitive peak on-state current; t = 10 ms; half sine-wave; $T_j = 125 , ^\circ C$ prior to surge; with reapplied $V_{RWM , \text{max}}$</td>
<td>$I_{TSM} , \text{max.}$</td>
<td>200</td>
<td>A</td>
<td></td>
</tr>
<tr>
<td>$I^2 t$ for fusing (t = 10 ms)</td>
<td>$I^2 t , \text{max.}$</td>
<td>200</td>
<td>A^2 s</td>
<td></td>
</tr>
<tr>
<td>Rate of rise of on-state current after triggering with $I_G = 200 , \text{mA}$ to $I_T = 50 , \text{A}$</td>
<td>$dI_T/dt , \text{max.}$</td>
<td>20</td>
<td>A/μs</td>
<td></td>
</tr>
<tr>
<td>Gate to cathode</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Reverse peak voltage</td>
<td>$V_{RGM} , \text{max.}$</td>
<td>5</td>
<td>V</td>
<td></td>
</tr>
<tr>
<td>Average power dissipation (averaged over any 20 ms period)</td>
<td>$P_{G , \text{(AV)}} , \text{max.}$</td>
<td>0,5</td>
<td>W</td>
<td></td>
</tr>
<tr>
<td>Peak power dissipation</td>
<td>$P_{GM} , \text{max.}$</td>
<td>5</td>
<td>W</td>
<td></td>
</tr>
<tr>
<td>Temperatures</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Storage temperature</td>
<td>$T_{stg} , \text{max.}$</td>
<td>-55 to + 125</td>
<td>°C</td>
<td></td>
</tr>
<tr>
<td>Junction temperature</td>
<td>$T_j , \text{max.}$</td>
<td>125</td>
<td>°C</td>
<td></td>
</tr>
</tbody>
</table>

**THERMAL RESISTANCE**

| From junction to mounting base | $R_{th \, j-mb} \, \text{max.}$ | 1,6 | °C/W |
| From mounting base to heatsink with heatsink compound | $R_{th \, mb-h} \, \text{max.}$ | 0,2 | °C/W |
| Transient thermal impedance (t = 1 ms) | $Z_{th \, j-mb} \, \text{max.}$ | 0,09 | °C/W |

**OPERATING NOTE**

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

* To ensure thermal stability: $R_{th \, j-a} < 4,5 \, \text{°C/W}$ (d.c. blocking) or $< 9 \, \text{°C/W}$ (a.c.). For smaller heatsinks $T_j \, \text{max.}$ should be derated. For a.c. see Fig. 3.

April 1978
CHARACTERISTICS

Anode to cathode

On-state voltage

\[ I_T = 50 \, A; \, T_j = 25 \, ^\circ C \]

Rate of rise of off-state voltage that will not trigger any device;
exponential method; \( V_D = 2/3 \, V_{DRM\text{max}}; \, T_j = 125 \, ^\circ C \)

Reverse current

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

Off-state current

\[ V_D = V_{DWM\text{max}}; \, T_j = 125 \, ^\circ C \]

Latching current; \( T_j = 25 \, ^\circ C \)

Holding current; \( T_j = 25 \, ^\circ C \)

Gate to cathode

Voltage that will trigger all devices

\[ V_D = 6 \, V; \, T_j = 25 \, ^\circ C \]

Voltage that will not trigger any device

\[ V_D = V_{DRM\text{max}}; \, T_j = 125 \, ^\circ C \]

Current that will trigger all devices

\[ V_D = 6 \, V; \, T_j = 25 \, ^\circ C \]

Switching characteristics

Gate-controlled turn-on time (\( t_{gt} = t_d + t_r \)) when switched
from \( V_D = 400 \, V \) to \( I_T = 10 \, A; \, I_{GT} = 200 \, mA; \, T_j = 25 \, ^\circ C \)

\[ t_{gt} \, \text{typ.} = 2 \, \mu s \]

* Measured under pulse conditions to avoid excessive dissipation.
The interrelation between the power and the max. allowable temperatures is derived from the left hand graph.

- Cond. angle factor:
  - $30^\circ$: 2.8
  - $60^\circ$: 2.2
  - $90^\circ$: 1.9
  - $120^\circ$: 1.6
  - $150^\circ$: 1.2
  - $180^\circ$: 1.0

Fig. 3.

The max. permissible non-repetitive peak on-state current based on sinusoidal currents ($f = 50$ Hz) is shown in Fig. 4.

- Each current pulse is followed by the crest working reverse voltage.

$T_j = 125^\circ$C (prior to surge)

Fig. 4.
Typical turn on characteristics when switched from $V_D = 400V$ or $50V$ respectively to $I_T = 1A, 10A$ or $50A$ 
Gate source $5V, 25\Omega$.

Fig. 5.

Fig. 6.
Gate characteristics with curves $P_{GAV} = 0.5W$

$V_{FGM_{max}} = 10V$

$P_{GMax} = 5W$

$IFG_{Max} = 2A$

Area of certain triggering

Fig. 7.
Min. gate current to trigger all devices at $T = 77^\circ C$.

Max. gate voltage not to trigger any device at $T = -55^\circ C$ to $+125^\circ C$.

Area of possible triggering.

**Fig. 8.**

Transient thermal resistance from junction to mounting base versus time.

**Fig. 9.**
Average output current of the bridge

maximum allowable starting and inrush currents for various mounting base temperatures versus time in a single phase bridge.

Fig. 10.

maximum allowable starting and inrush currents for various mounting base temperatures versus time in a three phase bridge.

Fig. 11.
SWITCHING CHARACTERISTICS

Triacs are not perfect switches. They take a finite time to go from the off to the on-state and vice-versa. At frequencies up to about 400 Hz these effects can often be ignored, but in many applications involving fast switching action the departure from the ideal is important.

Gate-controlled turn-on time

Anode current does not commence flowing at the instant the gate current is applied. There is a period which elapses between the application of gate current and the onset of anode current known as delay time \( t_d \). The rise time of anode current is known as \( t_r \) and is measured as the time for the anode voltage to fall from 90% to 10% of its initial value.

The conditions which need to be specified are:

a) Off-state voltage \( V_{DI} \).

b) On-state current \( I_T \).

c) Gate trigger current \( I_G \) — high gate currents reduce turn-on time.

d) Rate of rise of gate trigger current \( dI_G/dt \) — high values reduce turn-on time.

e) Junction temperature \( T_j \) — high temperatures reduce turn-on time.

The waveforms are shown in the following diagram:
COMMUTATION $dV_{com}/dt$

When a triac has been conducting current in one direction and is then required to block voltage in the other, it is faced with a difficult task. Reverse recovery current adds to the capacitive current from the reapplied $dV_D/dt$ in such a fashion that the device's ability to withstand high rates of reapplication of voltage is impaired. For this reason the commutation $dV_D/dt$ is invariably worse than the static $dV_D/dt$.

The conditions which need to be specified are:

a) R.M.S. current ($I_{RMS}$) — high currents make commutation harder.
b) Re-applied off-state voltage ($V_D$), normally $V_{DRM\ max}$ — high voltage will make commutation harder.
c) Temperature ($T_j$ or $T_{mb}$) — high temperatures make commutation harder.
d) $-dl/dt$ — high rates of change make commutation harder.

The waveforms are shown in the following diagram:
MOUNTING INSTRUCTIONS FOR TO-220 ENVELOPES

GENERAL DATA AND INSTRUCTIONS FOR HEATSINK OPERATION

General rules
1. First fasten the devices to the heatsink before soldering the leads.
2. Use of heatsink compound is recommended.
3. Avoid axial stress to the leads.
4. Keep mounting tool (e.g. screwdriver) clear of the plastic body.
5. It is recommended that the circuit connections be made to the leads rather than direct to the heatsink.

Heatsink requirements
Flatness in the mounting area: 0,02 mm maximum per 10 mm.
Mounting holes must be deburred.

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. The compound should be an electrical insulator and be applied sparingly and evenly to both interfaces. 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 thyristors and triacs
1. Clip mounting.
   Mounting by means of spring clip offers:
   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.
   Recommended force of clip on device is 120 N (12 kgf).

2. M3 screw mounting.
   Care should be taken to avoid damage to the plastic body. It is therefore recommended that a cross-recess pan-headed screw be used. Do not use self-tapping screws.
   Mounting torque for screw mounting:
   Minimum torque (for good heat transfer) 0,55 Nm (5,5 kgcm)
   Maximum torque (to avoid damaging the device) 0,80 Nm (8,0 kgcm)
   N.B.: When a nut or screw is not driven direct against a curved spring washer or lock washer, the torques are as follows:
   Minimum torque (for good heat transfer) 0,4 Nm (4 kgcm)
   Maximum torque (to avoid damaging the device) 0,6 Nm (6 kgcm)
   N.B.: Data on accessories are given in separate data sheets.

3. 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.
GENERAL DATA AND INSTRUCTIONS FOR HEATSINK OPERATION (continued)

Thermal data

<table>
<thead>
<tr>
<th>Thermal resistance 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>$0.5$ °C/W</td>
</tr>
<tr>
<td>without heatsink compound, direct mounting</td>
<td>$R_{th\ mb-h} = 1.4$</td>
<td>$1.4$ °C/W</td>
</tr>
<tr>
<td>with heatsink compound and mica insulator 56369</td>
<td>$R_{th\ mb-h} = 2.2$</td>
<td>$-$ °C/W</td>
</tr>
<tr>
<td>with heatsink compound and alumina insulator 56367</td>
<td>$R_{th\ mb-h} = 0.8$</td>
<td>$-$ °C/W</td>
</tr>
</tbody>
</table>

Lead bending

Maximum permissible tensile force on the body, for 5 seconds is 5 N (0.5 kgf).

The leads can be bent through 90° maximum, twisted or straightened. To keep forces within the above-mentioned limits, the leads are generally clamped near the body. The leads should neither be bent nor twisted less than 2.4 mm from the body.

Soldering

Lead soldering temperature at 4.7 mm from the body: $t_{sld} < 5$ s: $T_{sld\ max} = 275$ °C.

Avoid any force on body and leads during or after soldering: do not move the device or 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.
INSTRUCTIONS FOR CLIP MOUNTING (TO–220 envelopes)

Direct mounting with clip 56363
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 30° to the vertical (see Fig. 1).
3. Push down the clip over the device until the long end of the clip snaps into the wide slot in the heatsink. The clip should bear on the plastic body, not on the tab (see Fig. 1(c)).

![](image1)

Fig. 1 (a) Heatsink requirements; (b) mounting (1 = spring clip); (c) position of the device (top view).

Insulated mounting with clip 56364
With the insulators 56367 or 56369 insulation up to 2 kV 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 30° to the vertical (see Fig. 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. 2(c)). There should be minimum 3 mm distance between the device and the edge of the insulator for adequate creepage.

![](image2)

Fig. 2 (a) Heatsink requirements; (b) mounting (1 = spring clip, 2 = insulator 56369 or 56367); (c) position of the device (top view).
INSTRUCTIONS FOR SCREW MOUNTING (TO-220 envelopes)

Direct mounting with screw
- into tapped heatsink

```
TO-220 device

cross-recess pan-head screw; M3 (6 mm long)

heatsink; hole drilled 2.70 mm dia
```

- through heatsink with nut

```
TO-220 device

cross-recess pan-head screw; M3 (8 mm long)

heatsink; hole drilled for M3 clearance
```

M3 hexagon nut
MOUNTING CONSIDERATIONS FOR STUD-MOUNTED TRIACS

Losses generated in a silicon device must flow through the case and to a lesser extent the leads. The greatest proportion of the losses flow out through the case into a heat exchanger which can be either free convection cooled, forced convection or even liquid cooled. For the majority of devices in our range natural convection is generally adequate, however, where other considerations such as space saving must be taken into account then methods such as forced convection etc. can be considered. The thermal path from junction to ambient may be considered as a number of resistances in series. The first thermal resistance will be that of junction to mounting base, usually denoted by $R_{th\, j-mb}$. The second is the contact thermal resistance $R_{th\, mb-h}$ and finally there is the thermal resistance of the heatsink $R_{th\, h-a}$. In the rating curves, the contact thermal resistance and heatsink thermal resistances are combined as a single figure - $R_{th\, mb-a}$. In addition to the steady state thermal conditions of the system, consideration should also be given to the possibility of any transient thermal excursions. These can be caused for example by starting conditions or overloads and in order to calculate the effect on the device, a graph of transient thermal resistance $Z_{th\, j-mb}$ 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.
Glass-passivated, eutectic-bonded triacs intended for use in applications requiring high bidirectional transient and blocking voltage capability, and high thermal cycling performance with very low thermal resistances, e.g. a.c. power control applications such as lighting, industrial and domestic heating, motor control and switching systems.

QUICK REFERENCE DATA

| Repetitive peak off-state voltage | \( V_{\text{DRM}} \) max. | BT136-500 | 600 |
| R.M.S. on-state current | \( I_{T\text{(RMS)}} \) max. | 4 | A |
| Non-repetitive peak on-state current | \( I_{\text{TSM}} \) max. | 25 | A |

MECHANICAL DATA

Fig. 1 TO-220AB

Dimensions in mm

Net mass: 2 g

Note: The exposed metal mounting base is directly connected to terminal \( T_2 \).

Supplied on request: accessories (see data sheets Mounting instructions and accessories for TO-220 envelopes)
BT136 SERIES

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

<table>
<thead>
<tr>
<th>Voltages (in either direction)</th>
<th>BT136-500</th>
<th>600</th>
</tr>
</thead>
<tbody>
<tr>
<td>Non-repetitive peak off-state voltage (t \leq 10 ms)</td>
<td>( V_{DSM} ) max.</td>
<td>500</td>
</tr>
<tr>
<td>Repetitive peak off-state voltage (( \delta \leq 0.01 ))</td>
<td>( V_{DRM} ) max.</td>
<td>500</td>
</tr>
<tr>
<td>Crest working off-state voltage</td>
<td>( V_{DWM} ) max.</td>
<td>400</td>
</tr>
</tbody>
</table>

| Currents (in either direction) | |
|-------------------------------|-----------|-----|
| R.M.S. on-state current (conduction angle 360\(^\circ\)) up to \( T_{mb} = 102 \) °C | \( I_T(RMS) \) max. | 4 | A |
| Average on-state current for half-cycle operation (averaged over any 20 ms period) up to \( T_{mb} = 92 \) °C | \( I_T(AV) \) max. | 2.5 | A |
| Repetitive peak on-state current | \( I_{TRM} \) max. | 25 | A |
| Non-repetitive peak on-state current; \( T_j = 120 \) °C prior to surge; t = 20 ms; full sine-wave | \( I_{TSM} \) max. | 25 | A |
| \( I^2 t \) for fusing (t = 10 ms) | \( I^2 t \) max. | 4 | A²s |
| Rate of rise of on-state current after triggering with \( I_G = 200 \) mA to \( I_T = 6 \) A; \( dI_G/dt = 0.2 \) A/\( \mu \)s | \( dI_T/dt \) max. | 10 | A/\( \mu \)s |

Gate to terminal 1

POWER DISSIPATION
Average power dissipation (averaged over any 20 ms period) | \( P_{G(AV)} \) max. | 0.5 | W |
| Peak power dissipation | \( P_{GM} \) max. | 5 | W |

Temperatures
Storage temperature | \( T_{stg} \) | -40 to +125 °C |
| Operating junction temperature full-cycle operation | \( T_j \) max. | 120 °C |
| half-cycle operation | \( T_j \) max. | 110 °C |

*Although not recommended, off-state voltages up to 800 V may be applied without damage, but the triac may switch into the on-state. The rate of rise of on-state current should not exceed 3 A/\( \mu \)s.
THERMAL RESISTANCE

From junction to mounting base
- full-cycle operation
- half-cycle operation

Transient thermal impedance; $t = 1\ \text{ms}$

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 max. mica insulator (56369)
- d. with heatsink compound and 0.25 mm max. 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 $a = \text{any lead length}$

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

Notes

1. Values of $R_{th\ mb-h}$ given for mounting with heatsink compound refer to the use of a zinc-oxide-loaded compound. Ordinary silicone grease is not recommended.

2. 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.

January 1980
CHARACTERISTICS

Polarities, positive or negative, are identified with respect to $T_1$.

**Voltages and currents** (in either direction)

**On-state voltage** (Note 1)

\[ V_T < 1.70 \, \text{V} \]

On-state voltage (Note 1)

\[ I_T = 5 \, \text{A}; \, T_J = 25 \, ^\circ\text{C} \]

Rate of rise of off-state voltage that will not trigger any device; $T_J = 120 \, ^\circ\text{C}$; see also Figs. 9 and 10; gate open circuit

\[ \frac{dV_D}{dt} < 50 \, \text{V/\mu s} \]

Rate of rise of commutating voltage that will not trigger any device;

\[ IT(\text{RMS}) = 4 \, \text{A}; \, V_D = V_{DWM \, \text{max}}; \, T_J = 120 \, ^\circ\text{C}; \, \text{gate open circuit}; \]

\[ \text{BT136 series} \quad -\frac{dI}{dt} = 2.5 \, \text{A/\mu s} \]

\[ \text{BT136 series F} \quad -\frac{dI}{dt} = 2.5 \, \text{A/\mu s} \]

\[ \text{BT136 series E} \quad -\frac{dI}{dt} = 1.25 \, \text{A/\mu s} \]

**Off-state current**

\[ V_D = V_{DWM \, \text{max}}; \, T_J = 120 \, ^\circ\text{C} \]

\[ I_D < 0.5 \, \text{mA} \]

**Holding current**; $T_J = 25 \, ^\circ\text{C}$

\[ I_H < 15 \, \text{mA} \]

**Gate voltage and current that will trigger all devices**

**Latching current**

\[ V_D = 12 \, \text{V}; \, T_J = 25 \, ^\circ\text{C} \]


\[
\begin{array}{|c|c|c|c|c|}
\hline
 & T_{2+} & T_{2+} & T_{2-} & T_{2-} \\
 & G+ & G- & G- & G+ \\
\hline
\text{BT136 series} & G \rightarrow T_1 & \{V_{GT} > 1.5 \} & 1.5 & 1.5 & 1.5 \, \text{V} \\
 & \{I_{GT} > 35 \} & 35 & 35 & 70 \, \text{mA} \\
 & I_{L} < 20 \} & 30 & 20 & 30 \, \text{mA} \\
\hline
\text{BT136 series F} & G \rightarrow T_1 & \{V_{GT} > 1.5 \} & 1.5 & 1.5 & 1.5 \, \text{V} \\
 & e.g. BT136-500F & \{I_{GT} > 25 \} & 25 & 25 & 70 \, \text{mA} \\
 & & I_{L} < 20 \} & 30 & 20 & 30 \, \text{mA} \\
\hline
\text{BT136 series E} & G \rightarrow T_1 & \{V_{GT} > 1.5 \} & 1.5 & 1.5 & 1.5 \, \text{V} \\
 & & \{I_{GT} > 15 \} & 15 & 15 & 50 \, \text{mA} \\
 & & I_{L} < 20 \} & 20 & 20 & 20 \, \text{mA} \\
\hline
\text{BT136 series D (Note 2)} & G \rightarrow T_1 & \{V_{GT} > 1.5 \} & 1.5 & 1.5 & ** \, \text{V} \\
 & & \{I_{GT} > 8 \} & 8 & 8 & ** \, \text{mA} \\
 & & I_{L} < 15 \} & 20 & 15 & ** \, \text{mA} \\
\hline
\end{array}
\]

**Gate to terminal 1**

Voltage that will not trigger any device $V_D = V_{DWM \, \text{max}}$; $T_J = 120 \, ^\circ\text{C}; \, T_2$ and G positive or negative

\[ V_{GD} < 250 \, \text{mV} \]

**Note 1.** Measured under pulse conditions to avoid excessive dissipation.

**Note 2.** A version with $I_{GT} = 5 \, \text{mA}$ max. is available on request.

****Triggerable**

January 1980
MOUNTING INSTRUCTIONS
1. The triac 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 tag T2, rather than direct to the heatsink.

4. Clip mounting offers lower thermal resistance than screw mounting. However, if a screw is used, it should be M3. Care should be taken to avoid damage to the plastic body.

5. The device should not be pop-riveted to the heatsink. However, it is permissible to press-rivet providing that 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.

OPERATING NOTES
Dissipation and heatsink considerations:

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

![Fig.3](image)

b. The method of using Figs 4 and 5 is as follows:

Starting with the required current on the $I_{T(AV)}$ or $I_{T(RMS)}$ axis, trace upwards to meet the appropriate form factor or conduction angle 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 ($R_{th ha}$) can now be calculated from:

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

c. Any measurement of heatsink temperature should be made immediately adjacent to the device.
Fig. 4 The right-hand part shows the interrelationship between the power (derived from the left-hand part) and the maximum permissible temperatures.

α = α₁ = α₂: conduction angle per half cycle
Fig. 5 The right-hand part shows the interrelationship between the power (derived from the left-hand part) and the maximum permissible temperatures.

\[ \alpha = \text{conduction angle per half cycle} \]

\[ a = \text{form factor} = \frac{I_{\text{RMS}}}{I_{\text{AV}}} \]

<table>
<thead>
<tr>
<th>( \alpha )</th>
<th>( a )</th>
</tr>
</thead>
<tbody>
<tr>
<td>30°</td>
<td>4</td>
</tr>
<tr>
<td>60°</td>
<td>2.8</td>
</tr>
<tr>
<td>90°</td>
<td>2.2</td>
</tr>
<tr>
<td>120°</td>
<td>1.9</td>
</tr>
<tr>
<td>180°</td>
<td>1.57</td>
</tr>
</tbody>
</table>
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 triac may lose control. Therefore the overload should be terminated by a separate protection device.
Fig. 7 Maximum permissible non-repetitive r.m.s. on-state current based on sinusoidal currents $f = 50$ Hz; $T_j = 120$ °C prior to surge. The triac may temporarily lose control following the surge.

Fig. 8 $T_j = 25$ °C; $-$ $-$ $T_j = 120$ °C
Fig. 9 Limit commutation $dV/dt$ for BT136 and F series versus $T_\text{j}$. The triac should commutate when the $dV/dt$ is below the value on the appropriate curve for pre-commutation $-dI_\text{T}/dt$.

Fig. 10 Limit commutation $dV/dt$ for BT136E series versus $T_\text{j}$. The triac should commutate when the $dV/dt$ is below the value on the appropriate curve for pre-commutation $-dI_\text{T}/dt$. 
Fig. 11 Minimum gate voltage that will trigger all devices; all conditions

Fig. 12 Minimum gate current that will trigger all devices

Fig. 13
TRIACS

Glass-passivated, eutectic-bonded triacs intended for use in applications requiring high bidirectional transient and blocking voltage capability, and high thermal cycling performance with very low thermal resistances, e.g. a.c. power control applications such as lighting, industrial and domestic heating and motor control and switching systems.

QUICK REFERENCE DATA

<table>
<thead>
<tr>
<th></th>
<th>BT137-500</th>
<th>600</th>
</tr>
</thead>
<tbody>
<tr>
<td>Repetitive peak off-state voltage</td>
<td>V_{DRM}</td>
<td>max. 500 V</td>
</tr>
<tr>
<td>R.M.S. on-state current</td>
<td>I_{T(RMS)}</td>
<td>max. 8 A</td>
</tr>
<tr>
<td>Non-repetitive peak on-state current</td>
<td>I_{TSM}</td>
<td>max. 55 A</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 terminal T2.

Supplied on request: accessories (see data sheets Mounting instructions and accessories for TO-220 envelopes)
### RATINGS

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

#### Voltages (in either direction)

<table>
<thead>
<tr>
<th></th>
<th>BT137-500</th>
<th>600</th>
</tr>
</thead>
<tbody>
<tr>
<td>$V_{DSM}$ max.</td>
<td>500 V</td>
<td>600 V*</td>
</tr>
<tr>
<td>$V_{DRM}$ max.</td>
<td>500 V</td>
<td>600 V</td>
</tr>
<tr>
<td>$V_{DWM}$ max.</td>
<td>400 V</td>
<td>400 V</td>
</tr>
</tbody>
</table>

- **Non-repetitive peak off-state voltage** ($t \leq 10$ ms)
- **Repetitive peak off-state voltage** ($\delta \leq 0,01$)
- **Crest working off-state voltage**

#### Currents (in either direction)

<table>
<thead>
<tr>
<th></th>
<th>BT137-500</th>
<th>600</th>
</tr>
</thead>
<tbody>
<tr>
<td>$I_{T(RMS)}$ max.</td>
<td>8 A</td>
<td></td>
</tr>
<tr>
<td>$I_{T(AV)}$ max.</td>
<td>5 A</td>
<td></td>
</tr>
<tr>
<td>$I_{TRM}$ max.</td>
<td>55 A</td>
<td></td>
</tr>
<tr>
<td>$I_{TSM}$ max.</td>
<td>55 A</td>
<td></td>
</tr>
<tr>
<td>$I^2 t$ max.</td>
<td>15 A$^2$s</td>
<td></td>
</tr>
<tr>
<td>$dI_T/dt$ max.</td>
<td>20 A/$\mu$s</td>
<td></td>
</tr>
</tbody>
</table>

- **R.M.S. on-state current** (conduction angle $360^\circ$)
  
  up to $T_{mb} = 97 ^\circ$C
- **Average on-state current for half-cycle operation**
  
  (averaged over any 20 ms period) up to $T_{mb} = 87 ^\circ$C
- **Repetitive peak on-state current**
- **Non-repetitive peak on-state current**; $T_j = 120 ^\circ$C prior to surge; $t = 20$ ms; full sine-wave
- **$I^2 t$ for fusing** ($t = 10$ ms)
- **Rate of rise of on-state current after triggering** with
  
  $I_G = 200$ mA to $I_T = 12$ A; $dI_G/dt = 0,2$ A/$\mu$s

**Gate to terminal 1**

#### POWER DISSIPATION

<table>
<thead>
<tr>
<th></th>
<th>BT137-500</th>
<th>600</th>
</tr>
</thead>
<tbody>
<tr>
<td>$P_{G(AV)}$ max.</td>
<td>0,5 W</td>
<td></td>
</tr>
<tr>
<td>$P_{GM}$ max.</td>
<td>5 W</td>
<td></td>
</tr>
</tbody>
</table>

- **Average power dissipation** (averaged over any 20 ms period)
- **Peak power dissipation**

#### Temperatures

<p>| | | |</p>
<table>
<thead>
<tr>
<th></th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>$T_{stg}$</td>
<td>-40 to +125 $^\circ$C</td>
<td></td>
</tr>
<tr>
<td>$T_j$ max.</td>
<td>120 $^\circ$C</td>
<td></td>
</tr>
<tr>
<td>$T_j$ max.</td>
<td>110 $^\circ$C</td>
<td></td>
</tr>
</tbody>
</table>

- **Storage temperature**
- **Operating junction temperature**
  
  full-cycle operation
  
  half-cycle operation

*Although not recommended, off-state voltages up to 800 V may be applied without damage, but the triac may switch into the on-state. The rate of rise of on-state current should not exceed 6 A/$\mu$s.*
THERMAL RESISTANCE

From junction to mounting base
  full-cycle operation
  half-cycle operation
Transient thermal impedance; t = 1 ms

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 max. mica insulator (56369)
   d. with heatsink compound and 0,25 mm max. 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 $a =$ any lead length

\[
\begin{align*}
R_{th\ j-mb} & = 2.0 \ ^\circ C/W \\
R_{th\ j-mb} & = 2.4 \ ^\circ C/W \\
Z_{th\ j-mb} & = 0.3 \ ^\circ C/W \\
R_{th\ mb-h} & = 0.3 \ ^\circ C/W \\
R_{th\ mb-h} & = 1.4 \ ^\circ C/W \\
R_{th\ mb-h} & = 2.2 \ ^\circ C/W \\
R_{th\ mb-h} & = 0.8 \ ^\circ C/W \\
R_{th\ mb-h} & = 1.4 \ ^\circ C/W \\
R_{th\ j-a} & = 60 \ ^\circ C/W 
\end{align*}
\]
CHARACTERISTICS

Polarities, positive or negative, are identified with respect to T1.

Voltages and currents (in either direction)

On-state voltage (Note 1)

\[ I_T = 10 \text{ A}; \ T_j = 25 \text{ °C} \]

\[ V_T \quad < \quad 1.65 \text{ V} \]

Rate of rise of off-state voltage that will not trigger any device; \( T_j = 120 \text{ °C} \); see also Figs. 9 and 10; gate open circuit

\[ \frac{dV_D}{dt} \quad < \quad 50 \text{ V/µs} \]

Rate of rise of commutating voltage that will not trigger any device; \( I_T^{(\text{RMS})} = 8 \text{ A}; \ V_D = V_{D\text{WM max}} \); \( T_j = 120 \text{ °C} \); gate open circuit; see also Figs. 9 and 10

\begin{align*}
\text{BT137 series} & \quad -\frac{dI_T}{dt} = 4.2 \text{ A/µs} \\
\text{BT137 series F} & \quad -\frac{dI_T}{dt} = 4.2 \text{ A/µs} \\
\text{BT137 series E} & \quad -\frac{dI_T}{dt} = 2.1 \text{ A/µs}
\end{align*}

Off-state current

\[ V_D = V_{D\text{WM max}}; \ T_j = 120 \text{ °C} \]

\[ I_D \quad < \quad 0.5 \text{ mA} \]

Holding current; \( T_j = 25 \text{ °C} \)

\( T_2 \) and \( G \) positive or negative

\begin{align*}
\text{BT137, F and E series} & \quad I_H \quad < \quad 20 \text{ mA} \\
\text{BT137 D series} & \quad I_H \quad < \quad 15 \text{ mA}
\end{align*}

Gate voltage and current that will trigger all devices

Latching current

\[ V_D = 12 \text{ V}; \ T_j = 25 \text{ °C} \]

\[ I_{GR} \quad G+ \quad G- \quad G+ \quad G+ \quad G- \quad G- \quad G- \]

\begin{align*}
\text{BT137 series} & \quad G \text{ to } T_1 \quad | \quad V_{GT} \quad > \quad 1.5 \\
& \quad \quad \quad | \quad I_{GT} \quad > \quad 1.5 \\
& \quad \quad \quad | \quad I_L \quad < \quad 30
\end{align*}

\begin{align*}
\text{BT137 series E} & \quad G \text{ to } T_1 \quad | \quad V_{GT} \quad > \quad 1.5 \\
& \quad \quad \quad | \quad I_{GT} \quad > \quad 1.5 \\
& \quad \quad \quad | \quad I_L \quad < \quad 25
\end{align*}

\begin{align*}
\text{BT137 series D (Note 2)} & \quad G \text{ to } T_1 \quad | \quad V_{GT} \quad > \quad 1.5 \\
& \quad \quad \quad | \quad I_{GT} \quad > \quad 1.5 \\
& \quad \quad \quad | \quad I_L \quad < \quad 15
\end{align*}

Gate to terminal 1

Voltage that will not trigger any device \( V_D = V_{D\text{RM max}} \);

\( T_j = 120 \text{ °C} \); \( T_2 \) and \( G \) positive or negative

\[ V_{GD} \quad < \quad 250 \text{ mV} \]

Note 1. Measured under pulse conditions to avoid excessive dissipation.

Note 2. A version with \( I_{GT} = 5 \text{ mA max.} \) is available on request.

**Triggerable

January 1980
MOUNTING INSTRUCTIONS

1. The triac 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 tag T2, 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. The device should not be pop-rivetted to the heatsink. However, it is permissible to press-rivet providing that 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.

OPERATING NOTES

Dissipation and heatsink considerations:

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

b. The method of using Figs 4 and 5 is as follows:
   Starting with the required current on the $I_T(\text{AV})$ or $I_T(\text{RMS})$ axis, trace upwards to meet the appropriate form factor or conduction angle 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.
FULL-CYCLE OPERATION

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

\[ \alpha = \alpha_1 = \alpha_2: \text{conduction angle per half cycle} \]
Fig. 5 The right-hand part shows the interrelationship between the power (derived from the left-hand part) and the maximum permissible temperatures.

\[ \alpha = \text{conduction angle per half cycle} \]

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

<table>
<thead>
<tr>
<th>( \alpha )</th>
<th>( a )</th>
</tr>
</thead>
<tbody>
<tr>
<td>30°</td>
<td>4</td>
</tr>
<tr>
<td>60°</td>
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<td>120°</td>
<td>1.9</td>
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<tr>
<td>180°</td>
<td>1.57</td>
</tr>
</tbody>
</table>
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 triac 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 = 120 °C prior to surge. The triac may temporarily lose control following the surge.

Fig. 8
Fig. 9 Limit commutation $dV/dt$ for BT137 and F series versus $T_j$. The triac should commutate when the $dV/dt$ is below the value on the appropriate curve for pre-commutation $dI_T/dt$.

Fig. 10 Limit commutation $dV/dt$ for BT137E series versus $T_j$. The triac should commutate when the $dV/dt$ is below the value on the appropriate curve for pre-commutation $dI_T/dt$. 
Fig. 11 Minimum gate voltage that will trigger all devices; all conditions.

Fig. 12 Minimum gate current that will trigger all devices.

Fig. 13
TRIACS

Glass-passivated, eutectic-bonded triacs intended for use in applications requiring high bidirectional transient and blocking voltage capability, and high thermal cycling performance with very low thermal resistances, e.g. a.c. power control applications such as motor, industrial lighting, industrial and domestic heating control and static switching systems.

QUICK REFERENCE DATA

<table>
<thead>
<tr>
<th>Repetitive peak off-state voltage</th>
<th>BT138-500</th>
<th>600</th>
</tr>
</thead>
<tbody>
<tr>
<td>R.M.S. on-state current</td>
<td>max. 500</td>
<td>600 V</td>
</tr>
<tr>
<td>Non-repetitive peak on-state current</td>
<td>max. 12 A</td>
<td></td>
</tr>
<tr>
<td></td>
<td>max. 90 A</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 terminal T2.

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

January 1980
RATINGS
Limiting values in accordance with the Absolute Maximum System (IEC134)

Voltages (in either direction)  
<table>
<thead>
<tr>
<th>BT138-500</th>
<th>600</th>
</tr>
</thead>
<tbody>
<tr>
<td>V_{DSM}</td>
<td>max. 500 V*</td>
</tr>
<tr>
<td>V_{DRM}</td>
<td>max. 500 V</td>
</tr>
<tr>
<td>V_{DWM}</td>
<td>max. 400 V</td>
</tr>
</tbody>
</table>

→ Currents (in either direction)
R.M.S. on-state current (conduction angle 360°) up to T_{mb} = 95 °C
   | IT(RMS) | max. 12 A |
Average on-state current for half-cycle operation (averaged over any 20 ms period) up to T_{mb} = 83 °C
   | IT(AV)  | max. 7,5 A |
Repetitive peak on-state current
   | ITRM    | max. 90 A  |
Non-repetitive peak on-state current; T_{j} = 120 °C prior to surge; t = 20 ms; full sine-wave
   | ITSM    | max. 90 A  |
I^2t for fusing (t = 10 ms)
   | dI_{T}/dt | max. 30 A/μs |
Rate of rise of on-state current after triggering with I_{G} = 200 mA to I_{T} = 20 A; dI_{G}/dt = 0,2 A/μs

Gate to terminal 1

Power dissipation
Average power dissipation (averaged over any 20 ms period)
   | P_{G(AV)} | max. 0,5 W  |
Peak power dissipation
   | P_{GM}    | max. 5,0 W  |

Temperatures
Storage temperature
   | T_{stg}   | -40 to +125 °C |
→ Operating junction temperature
   | T_{j}     | max. 120 °C  |
   | T_{j}     | max. 110 °C  |

* Although not recommended, off-state voltages up to 800 V may be applied without damage, but the triac may switch into the on-state. The rate of rise of on-state current should not exceed 15 A/μs.
THERMAL RESISTANCE

From junction to mounting base
  full-cycle operation
  half-cycle operation
  Transient thermal impedance; t = 1 ms

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 $R_{\text{th j-a}}$ 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 $a =$ any lead length

$$ R_{\text{th j-a}} = 60 \, ^\circ\text{C/W} $$
**CHARACTERISTICS**

Polarities, positive or negative, are identified with respect to T₁.

**Voltages and currents** (in either direction)

**On-state voltage (Note 1)**

\[ I_T = 15 \text{ A; } T_j = 25 \degree \text{C} \]

On-state voltage that will not trigger any device:

\[ T_j = 120 \degree \text{C; see also Figs. 9 and 10; gate open circuit} \]

\[ dV_D/dt < 50 \text{ V/μs} \]

**Rate of rise of commutating voltage that will not trigger any device:**

\[ I_T \text{(RMS)} = 12 \text{ A; } V_D = V_D \text{WM max;} \]

\[ T_j = 120 \degree \text{C; gate open circuit; see also Figs. 9 and 10} \]

BT138 series \[ -dI_T/dt = 4,2 \text{ A/ms} \]

BT138 series F \[ -dI_T/dt = 4,2 \text{ A/ms} \]

BT138 series E \[ -dI_T/dt = 2,1 \text{ A/ms} \]

\[ dV_{\text{com}}/dt < 6 \text{ V/μs} \]

**Off-state current**

\[ V_D = V_D \text{WM max;} T_j = 120 \degree \text{C} \]

\[ I_D < 0,5 \text{ mA} \]

**Holding current; \( T_j = 25 \degree \text{C} \)**

\[ T_2 \text{ and G positive or negative} \]

BT138, F and E series \[ I_H < 30 \text{ mA} \]

BT138 D series \[ I_H < 20 \text{ mA} \]

**Gate voltage and current that will trigger all devices**

**Latching current**

\[ V_D = 12 \text{ V; } T_j = 25 \degree \text{C} \]

<table>
<thead>
<tr>
<th>( V_D )</th>
<th>( T_2^+ )</th>
<th>( T_2^+ )</th>
<th>( T_2^- )</th>
<th>( T_2^- )</th>
</tr>
</thead>
<tbody>
<tr>
<td>( V_D )</td>
<td>( I_G )</td>
<td>( I_L )</td>
<td>( G^+ )</td>
<td>( G^- )</td>
</tr>
<tr>
<td>BT138 series</td>
<td>G to T₁</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>( V_G ) &gt; 1,5</td>
<td>( I_G ) &gt; 35</td>
<td>( I_L ) &lt; 40</td>
<td>1,5</td>
</tr>
<tr>
<td></td>
<td>( I_G ) &gt; 35</td>
<td>( I_G ) &gt; 40</td>
<td>35</td>
<td>35</td>
</tr>
<tr>
<td></td>
<td>( I_L ) &lt; 1,5</td>
<td>1,5</td>
<td>70</td>
<td>1,5</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>50</td>
<td></td>
</tr>
<tr>
<td>BT138 series F</td>
<td>G to T₁</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>e.g. BT138-500F</td>
<td>( V_G ) &gt; 1,5</td>
<td>( I_G ) &gt; 25</td>
<td>( I_L ) &lt; 40</td>
<td>1,5</td>
</tr>
<tr>
<td></td>
<td>( I_G ) &gt; 25</td>
<td>( I_G ) &gt; 40</td>
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</tr>
<tr>
<td></td>
<td>( I_L ) &lt; 1,5</td>
<td>1,5</td>
<td>70</td>
<td>1,5</td>
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<td></td>
<td></td>
<td>50</td>
<td></td>
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<td>BT138 series E</td>
<td>G to T₁</td>
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<td>( I_L ) &lt; 30</td>
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<tr>
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<tr>
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<td>( I_L ) &lt; 1,5</td>
<td>1,5</td>
<td>50</td>
<td>1,5</td>
</tr>
<tr>
<td></td>
<td></td>
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<td>30</td>
<td></td>
</tr>
<tr>
<td>BT138 series D (Note 2)</td>
<td>G to T₁</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>( V_G ) &gt; 1,5</td>
<td>( I_G ) &gt; 8</td>
<td>( I_L ) &lt; 25</td>
<td>1,5</td>
</tr>
<tr>
<td></td>
<td>( I_G ) &gt; 8</td>
<td>( I_G ) &gt; 25</td>
<td>8</td>
<td>8</td>
</tr>
<tr>
<td></td>
<td>( I_L ) &lt; 1,5</td>
<td>1,5</td>
<td>30</td>
<td>1,5</td>
</tr>
</tbody>
</table>

**Gate to terminal 1**

Voltage that will not trigger any device \( V_D = V_D \text{WM max;} \)

\[ T_j = 120 \degree \text{C; } T_2 \text{ and G positive or negative} \]

\[ V_{GD} < 250 \text{ mV} \]

**Note 1.** Measured under pulse conditions to avoid excessive dissipation.

**Note 2.** A version with \( I_G = 5 \text{ mA max.} \) is available on request.

**** Triggerable
MOUNTING INSTRUCTIONS

1. The triac 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 tag T2, 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. The device should not be pop-rivetted to the heatsink. However, it is permissible to press-rivet providing that 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.

OPERATING NOTES

Dissipation and heatsink considerations:

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

b. The method of using Figs. 4 and 5 is as follows:
   Starting with the required current on the $I_{T(AV)}$ or $I_{T(RMS)}$ axis, trace upwards to meet the appropriate form factor or conduction angle 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. 4 The right-hand part shows the interrelationship between the power (derived from the left-hand part) and the maximum permissible temperatures.

\[ \alpha = \alpha_1 = \alpha_2: \text{conduction angle per half cycle} \]
Fig. 5 The right-hand part shows the interrelationship between the power (derived from the left-hand part) and the maximum permissible temperatures.

\[ \alpha = \text{conduction angle per half cycle} \]

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

<table>
<thead>
<tr>
<th>( \alpha )</th>
<th>( a )</th>
</tr>
</thead>
<tbody>
<tr>
<td>30°</td>
<td>4</td>
</tr>
<tr>
<td>60°</td>
<td>2,8</td>
</tr>
<tr>
<td>90°</td>
<td>2,2</td>
</tr>
<tr>
<td>120°</td>
<td>1,9</td>
</tr>
<tr>
<td>180°</td>
<td>1,57</td>
</tr>
</tbody>
</table>

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

Free-air operation
Fig. 6 Maximum permissible duration of steady overload (provided that $T_{mb}$ does not exceed 120 °C during and after overload) expressed as a percentage of the steady state r.m.s. rated current. For high r.m.s. overload currents precautions should be taken so that the temperature of the terminals does not exceed 125 °C. During these overload conditions the triac may lose control. Therefore the overload should be terminated by a separate protection device.
Maximum permissible non-repetitive r.m.s. on-state current based on sinusoidal currents (f = 50 Hz):

\[ I_{TS(RMS)} \]

The triac may temporarily lose control following the surge when

\[ T_j = 120 \, ^\circ C \] prior to surge.
Fig. 9 Limit commutation $dV/dt$ for BT138 and F series versus $T_j$. The triac should commutate when $dV/dt$ is below the value on the appropriate curve for pre-commutation $-dI_T/dt$.

Fig. 10 Limit commutation $dV/dt$ for BT138E series versus $T_j$. The triac should commutate when the $dV/dt$ is below the value on the appropriate curve for pre-commutation $-dI_T/dt$. 
minimum gate voltage that will trigger all devices all conditions

minimum gate current that will trigger all devices

T2 neg., gate pos. to T1

all other conditions

Fig. 11

Fig. 12

unidirectional

bidirectional

Fig. 13

January 1980
LIMITS FOR STARTING OR INRUSH CURRENTS – FULL-CYCLE OPERATION

For safe operation at a given temperature the r.m.s. of successive cycles (see drawing above) must lie within the region bounded by the curve shown below for that temperature.

\[ I_{r}(\text{RMS}) \]

\[ I_{r}(\text{AV}) \]

LIMITS FOR STARTING OR INRUSH CURRENTS – HALF-CYCLE OPERATION

For safe operation at a given temperature the average of successive cycles (see drawing above) must lie within the region bounded by the curve shown below for that temperature.

\[ I_{r}(\text{AV}) \]
TRIACS

Glass-passivated eutectic-bonded triacs intended for use in applications requiring high bidirectional transient and blocking voltage capability, and high thermal cycling performance with very low thermal resistances, e.g. a.c. power control applications such as motor, industrial lighting, industrial and domestic heating control and static switching systems.

QUICK REFERENCE DATA

<table>
<thead>
<tr>
<th>Repetitive peak off-state voltage</th>
<th>$V_{DRM}$ max.</th>
</tr>
</thead>
<tbody>
<tr>
<td>R.M.S. on-state current</td>
<td>16 A</td>
</tr>
<tr>
<td>Non-repetitive peak on-state current</td>
<td>115 A</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 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)

**Voltages** (in either direction)

<table>
<thead>
<tr>
<th>Description</th>
<th>BT139-500</th>
<th>BT139-600</th>
</tr>
</thead>
<tbody>
<tr>
<td>Non-repetitive peak off-state voltage (t ≤ 10 ms)</td>
<td>500 V</td>
<td>600 V*</td>
</tr>
<tr>
<td>Repetitive peak off-state voltage (δ ≤ 0.01)</td>
<td>500 V</td>
<td>600 V</td>
</tr>
<tr>
<td>Crest working off-state voltage</td>
<td>400 V</td>
<td>400 V</td>
</tr>
</tbody>
</table>

**Currents** (in either direction)

<table>
<thead>
<tr>
<th>Description</th>
<th>BT139-500</th>
<th>BT139-600</th>
</tr>
</thead>
<tbody>
<tr>
<td>R.M.S. on-state current (conduction angle 360°)</td>
<td>16 A</td>
<td></td>
</tr>
<tr>
<td>up to Tmb = 93 °C</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Average on-state current for half-cycle operation</td>
<td>10 A</td>
<td></td>
</tr>
<tr>
<td>(averaged over any 20 ms period) up to Tmb = 79 °C</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Repetitive peak on-state current</td>
<td>115 A</td>
<td></td>
</tr>
<tr>
<td>Non-repetitive peak on-state current; Tj = 120 °C</td>
<td>115 A</td>
<td></td>
</tr>
<tr>
<td>prior to surge; t = 20 ms; full sine-wave</td>
<td></td>
<td></td>
</tr>
<tr>
<td>I^2 t for fusing (t = 10 ms)</td>
<td>65 A^2 s</td>
<td></td>
</tr>
<tr>
<td>Rate of rise of on-state current after triggering with</td>
<td>30 A/μs</td>
<td></td>
</tr>
<tr>
<td>I_G = 200 mA to I_T = 20 A; dI_G/dt = 0.2 A/μs</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

**Gate to terminal 1**

**Power dissipation**

<table>
<thead>
<tr>
<th>Description</th>
<th>BT139-500</th>
<th>BT139-600</th>
</tr>
</thead>
<tbody>
<tr>
<td>Average power dissipation (averaged over any 20 ms period)</td>
<td>0.5 W</td>
<td></td>
</tr>
<tr>
<td>Peak power dissipation</td>
<td>5 W</td>
<td></td>
</tr>
</tbody>
</table>

**Temperatures**

<table>
<thead>
<tr>
<th>Description</th>
<th>BT139-500</th>
<th>BT139-600</th>
</tr>
</thead>
<tbody>
<tr>
<td>Storage temperature</td>
<td>-40 to +125 °C</td>
<td></td>
</tr>
<tr>
<td>Operating junction temperature</td>
<td></td>
<td></td>
</tr>
<tr>
<td>full-cycle operation</td>
<td>120 °C</td>
<td></td>
</tr>
<tr>
<td>half-cycle operation</td>
<td>110 °C</td>
<td></td>
</tr>
</tbody>
</table>

* Although not recommended, off-state voltages up to 800 V may be applied without damage, but the triac may switch into the on-state. The rate of rise of on-state current should not exceed 15 A/μs.
THERMAL RESISTANCE

From junction to mounting base

- full-cycle operation
- half-cycle operation

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

\[
\begin{align*}
R_{\text{th} \ j-mb} &= 1,2 \ ^{\circ}\text{C/W} \\
R_{\text{th} \ j-mb} &= 1,7 \ ^{\circ}\text{C/W} \\
Z_{\text{th} \ j-mb} &= 0,1 \ ^{\circ}\text{C/W}
\end{align*}
\]

Influence of mounting method

1. Heatsink mounted with clip (see mounting instructions)

   Thermal resistance from mounting base to heatsink
   a. with heatsink compound
   \( R_{\text{th} \ mb-h} = 0,3 \ ^{\circ}\text{C/W} \)
   b. with heatsink compound and 0,06 mm maximum mica insulator
   \( R_{\text{th} \ mb-h} = 1,4 \ ^{\circ}\text{C/W} \)
   c. with heatsink compound and 0,1 mm maximum mica insulator (56369)
   \( R_{\text{th} \ mb-h} = 2,2 \ ^{\circ}\text{C/W} \)
   d. with heatsink compound and 0,25 mm maximum alumina
      insulator (56367)
   \( R_{\text{th} \ mb-h} = 0,8 \ ^{\circ}\text{C/W} \)
   e. without heatsink compound
   \( R_{\text{th} \ mb-h} = 1,4 \ ^{\circ}\text{C/W} \)

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 \( a = \) any lead length
   \( R_{\text{th} \ j-a} = 60 \ ^{\circ}\text{C/W} \)

---

Fig.2
### CHARACTERISTICS

Polarities, positive or negative, are identified with respect to $T_1$.

**Volatages and currents (in either direction)**

**On-state voltage (Note 1)**

$V_T < 1.6 \text{ V}$

<table>
<thead>
<tr>
<th>$I_T = 20 \text{ A; } T_j = 25 \text{ °C}$</th>
</tr>
</thead>
</table>

**Rate of rise of off-state voltage that will not trigger any device;**

$T_j = 120 \text{ °C; see also Figs.9 and 10; gate open circuit}$

$dV_D/dt < 50 \text{ V/μs}$

**Rate of rise of commutating voltage that will not trigger any device;**

$T_j = 120 \text{ °C; gate open circuit; see also Figs.9 and 10}$

$dV_{com}/dt < 6 \text{ V/μs}$

**Off-state current**

$V_D = V_{DWM_{max}}; T_j = 120 \text{ °C}$

$I_D < 0.5 \text{ mA}$

**Holding current; $T_j = 25 \text{ °C}$**

- $T_2$ and $G$ positive or negative: $I_H < 30 \text{ mA}$
- $BT139$, $F$ and $E$ series: $I_H < 20 \text{ mA}$
- $BT139$ $D$ series: $I_H < 20 \text{ mA}$

**Gate voltage and current that will trigger all devices**

**Latching current**

$V_D = 12 \text{ V; } T_j = 25 \text{ °C}$

<table>
<thead>
<tr>
<th>$V_D = 12 \text{ V; } T_j = 25 \text{ °C}$</th>
<th>$V_{GD} &gt; 1,5$</th>
<th>$I_{GT} &gt; 1,5$</th>
<th>$I_L &lt; 40$</th>
</tr>
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<tbody>
<tr>
<td>$BT139$ series</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>$G$ to $T_1$</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>$V_{GT} &gt; 35$</td>
<td>1,5</td>
<td>35</td>
<td>60</td>
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<tr>
<td>$I_{GT} &gt; 35$</td>
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<td>$I_L &lt; 40$</td>
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<td>40</td>
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<tr>
<td></td>
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<td></td>
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</tr>
<tr>
<td>$BT139$ series $F$</td>
<td></td>
<td></td>
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<tr>
<td>$G$ to $T_1$</td>
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<td></td>
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</tr>
<tr>
<td>$V_{GT} &gt; 35$</td>
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<td>60</td>
</tr>
<tr>
<td>$I_{GT} &gt; 25$</td>
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<td>25</td>
<td>40</td>
</tr>
<tr>
<td>$I_L &lt; 40$</td>
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<td>60</td>
<td>40</td>
</tr>
<tr>
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</tr>
<tr>
<td>$BT139$ series $E$</td>
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<td></td>
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</tr>
<tr>
<td>$G$ to $T_1$</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>$V_{GT} &gt; 35$</td>
<td>1,5</td>
<td>15</td>
<td>60</td>
</tr>
<tr>
<td>$I_{GT} &gt; 15$</td>
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<td>15</td>
<td>40</td>
</tr>
<tr>
<td>$I_L &lt; 30$</td>
<td></td>
<td>60</td>
<td>40</td>
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<tr>
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<tr>
<td>$BT139$ series $D$ (Note 2)</td>
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<tr>
<td>$G$ to $T_1$</td>
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</tr>
<tr>
<td>$V_{GT} &gt; 35$</td>
<td>1,5</td>
<td>8</td>
<td>40</td>
</tr>
<tr>
<td>$I_{GT} &gt; 35$</td>
<td></td>
<td>8</td>
<td>30</td>
</tr>
<tr>
<td>$I_L &lt; 25$</td>
<td></td>
<td>40</td>
<td>30</td>
</tr>
</tbody>
</table>

**Gate to terminal 1**

Voltage that will not trigger any device $V_D = V_{DWM_{max}}$;

$T_j = 120 \text{ °C}; T_2$ and $G$ positive or negative

$V_{GD} < 250 \text{ mV}$

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   Starting with the required current on the $I_T(\overline{AV})$ or $I_T(\overline{RMS})$ axis, trace upwards to meet the appropriate from factor or conduction angle curve. Trace right horizontally and upwards from the appropriate 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 now be calculated from:
   \[ R_{\text{th h-a}} = R_{\text{th mb-a}} - R_{\text{th mb-h}} \]

c. Any measurement of heatsink temperature should be made immediately adjacent to the device.
Fig. 4 The right-hand part shows the interrelationship between the power (derived from the left-hand part) and the maximum permissible temperatures.

\[ \alpha = \alpha_1 = \alpha_2 : \text{conduction angle per half cycle} \]
Fig. 5 The right-hand part shows the interrelationship between the power (derived from the left-hand part) and the maximum permissible temperatures.

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

<table>
<thead>
<tr>
<th>( \alpha )</th>
<th>( a )</th>
</tr>
</thead>
<tbody>
<tr>
<td>300°</td>
<td>4</td>
</tr>
<tr>
<td>60°</td>
<td>2.8</td>
</tr>
<tr>
<td>90°</td>
<td>2.2</td>
</tr>
<tr>
<td>120°</td>
<td>1.9</td>
</tr>
<tr>
<td>180°</td>
<td>1.57</td>
</tr>
</tbody>
</table>
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 triac may lose control. Therefore the overload should be terminated by a separate protection device.
maximum permissible non-repetitive r.m.s. on-state current based on sinusoidal currents (f = 50 Hz)

the triac may temporarily lose control following the surge

$T_j = 120^\circ C$ prior to surge
Fig. 9 Limit commutation $dV/dt$ for BT139 and F series versus $T_j$. The triac should commutate when the $dV/dt$ is below the value on the appropriate curve for pre-commutation $dT/dt$.

Fig. 10 Limit commutation $dV/dt$ for BT139E series versus $T_j$. The triac should commutate when the $dV/dt$ is below the value on the appropriate curve for pre-commutation $dT/dt$. 

$-dT/dt = 25, 19, 15, 11, 8.7, 6.7 \text{ A/ ms}$

$-dT/dt = 12, 9.5, 7.3, 5.7, 4.4, 3.4 \text{ A/ ms}$
minimum gate voltage
that will trigger all devices
all conditions

minimum gate current that
will trigger all devices

$T_2$ neg., gate pos. to $T_1$

all other conditions

Fig. 11

Fig. 12

Fig. 13

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

unidirectional

bidirectional

$10^{-3}$
$10^{-2}$
$10^{-1}$
$10^0$
$10^1$
$10^2$
$10^3$
$10^4$
$10^5$

$10^{-5}$
$10^{-4}$
$10^{-3}$

time (s)

January 1980
LIMITS FOR STARTING OR INRUSH CURRENTS – FULL-CYCLE OPERATION

For safe operation at a given temperature the r.m.s. of successive cycles (see drawing above) must lie within the region bounded by the curve shown below for that temperature.

LIMITS FOR STARTING OR INRUSH CURRENTS – HALF-CYCLE OPERATION

For safe operation at a given temperature the average of successive cycles (see drawing above) must lie within the region bounded by the curve shown below for that temperature.
TRIACS

Silicon triacs in metal envelopes, intended for industrial a.c. power control, and are particularly suitable for static switching of 3-phase induction motors. They may also be used for furnace control, lighting control and other static switching applications up to an r.m.s. on-state current of 55 A.

Two grades of commutation performance are available, 30 V/μs at 25 A/ms (suffix G) and 30 V/μs at 50 A/ms (suffix H).

**QUICK REFERENCE DATA**

<table>
<thead>
<tr>
<th>Repetitive peak off-state voltage</th>
<th>V_{DRM}</th>
<th>BTW34-600</th>
<th>800</th>
<th>1000</th>
<th>1200</th>
<th>1400</th>
<th>1600</th>
</tr>
</thead>
<tbody>
<tr>
<td>R.M.S. on-state current</td>
<td>I_{T(RMS)}</td>
<td>max. 55 A</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Non-repetitive peak on-state current</td>
<td>I_{TSM}</td>
<td>max. 400 A</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Rate of rise of commutating voltage</td>
<td>dV_{com}/dt</td>
<td>&lt; 30 V/μs</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

**MECHANICAL DATA**

Fig. 1 TO-103.

Dimensions in mm:
- Net mass: 46 g
- Diameter of clearance hole: 8.5 mm
- Torque on nut: min. 4 Nm (40 kg cm) max. 6 Nm (60 kg cm)

Supplied with device: 1 nut, 1 lock washer
Nut dimensions across the flats: 13 mm

D3357

April 1978
RATINGS

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

**Volatges** (in either direction)*

<table>
<thead>
<tr>
<th>Description</th>
<th>BTW34-600</th>
<th>800</th>
<th>1000</th>
<th>1200</th>
<th>1400</th>
<th>1600</th>
</tr>
</thead>
<tbody>
<tr>
<td>Non-repetitive peak off-state voltage (t ≤ 10 ms)</td>
<td>max.</td>
<td>700</td>
<td>900</td>
<td>1100</td>
<td>1300</td>
<td>1400</td>
</tr>
<tr>
<td>Repetitive peak off-state voltage</td>
<td>max.</td>
<td>600</td>
<td>800</td>
<td>1000</td>
<td>1200</td>
<td>1400</td>
</tr>
<tr>
<td>Crest working off-state voltage</td>
<td>max.</td>
<td>400</td>
<td>600</td>
<td>700</td>
<td>800</td>
<td>800</td>
</tr>
</tbody>
</table>

**Currents** (in either direction)

<table>
<thead>
<tr>
<th>Description</th>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>R.M.S. on-state current (conduction angle 360°)</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>up to $T_{mb} = 75 , ^\circ C$</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>at $T_{mb} = 85 , ^\circ C$</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Average on-state current for half-cycle operation (averaged over any 20 ms period) at $T_{mb} = 85 , ^\circ C$</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Repetitive peak on-state current</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Non-repetitive peak on-state current</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>$T_j = 125 , ^\circ C$ prior to surge; $t = 20 , ms$; full sine-wave</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>$I^2 t$ for fusing ($t = 10 , ms$)</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Rate of rise of on-state current after triggering with $I_G = 1 , A$ to $I_T = 100 , A$; $dI_G/dt = 1 , A/\mu s$</td>
<td></td>
<td></td>
<td></td>
<td></td>
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</tbody>
</table>

**Gate to terminal 1**

**Power dissipation**

<table>
<thead>
<tr>
<th>Description</th>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>Average power dissipation (averaged over any 20 ms period)</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Peak power dissipation</td>
<td></td>
<td></td>
<td></td>
<td></td>
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</tbody>
</table>

**Temperatures**

<table>
<thead>
<tr>
<th>Description</th>
<th></th>
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<th></th>
<th></th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>Storage temperature</td>
<td>$T_{stg}$</td>
<td>-55 to + 125 , ^\circ C</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Junction temperature</td>
<td>$T_j$</td>
<td>max. 125 , ^\circ C</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

**THERMAL RESISTANCE**

<table>
<thead>
<tr>
<th>Description</th>
<th></th>
<th></th>
<th></th>
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</tr>
</thead>
<tbody>
<tr>
<td>From junction to mounting base full-cycle operation</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>half-cycle operation</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>From mounting base to heatsink with heatsink compound</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Transient thermal impedance; $t = 1 , ms$</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Description</th>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>$R_{thj-mb}$</td>
<td>= 0,6 , ^\circ C/W</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>$R_{thj-mb}$</td>
<td>= 1,2 , ^\circ C/W</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>$R_{thmb-h}$</td>
<td>= 0,2 , ^\circ C/W</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>$Z_{thj-mb}$</td>
<td>= 0,08 , ^\circ C/W</td>
<td></td>
<td></td>
<td></td>
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<td></td>
</tr>
</tbody>
</table>

* To ensure thermal stability: $R_{thj-a} < 2 \, ^\circ C/W$ (full-cycle or half-cycle operation). For smaller heatsinks $T_{j \, max}$ should be derated (see Figs 2 and 3).

** Although not recommended, higher off-state voltages may be applied without damage, but the triac may switch into the on-state. The rate of rise of on-state current should not exceed 20 A/\mu s.
CHARACTERISTICS

Polarities, positive or negative, are identified with respect to $T_1$.

**Voltages** (in either direction)

On-state voltage

\[ I_T = 65 \text{ A}; \quad T_j = 25 \degree \text{C} \]

Rate of rise of off-state voltage that will not trigger any device;

exponential method; \[ V_D = 2/3 \ V_{\text{DRM}} \text{ max}; \quad T_j = 125 \degree \text{C} \]

Rate of rise of commutating voltage that will not trigger any device;

\[ I_T(\text{RMS}) = 45 \text{ A}; \quad V_D = V_{\text{DRM}} \text{ max}; \quad T_{\text{mb}} = 85 \degree \text{C} \]

<table>
<thead>
<tr>
<th>BTW34-600G to 1600G</th>
<th>BTW34-600H to 1600H</th>
</tr>
</thead>
<tbody>
<tr>
<td>$dV_D/dt &lt; 200 \ V/\mu s$</td>
<td>$dV_{\text{com}}/dt (V/\mu s) &lt; 30$</td>
</tr>
<tr>
<td>$&lt; 30$</td>
<td>$25$</td>
</tr>
<tr>
<td>$&lt; 30$</td>
<td>$50$</td>
</tr>
</tbody>
</table>

**Currents** (in either direction)

Off-state current

\[ V_D = V_{\text{DWM}} \text{ max}; \quad T_j = 125 \degree \text{C} \]

Latching current; \[ T_j = 25 \degree \text{C} \]

\[ G \text{ positive} \]

\[ I_L < 250 \text{ mA} \]

\[ G \text{ negative} \]

\[ I_L < 500 \text{ mA} \]

Holding current; \[ T_j = 25 \degree \text{C} \]

\[ G \text{ positive or negative} \]

\[ I_H < 200 \text{ mA} \]

**Gate to terminal 1**

Voltage and current that will trigger all devices

\[ V_D = 12 \text{ V}; \quad T_j = 25 \degree \text{C} \]

\[ G \text{ positive} \]

\[ V_{GT} > 2,5 \quad \text{V} \]

\[ I_{GT} > 200 \text{ mA} \]

\[ G \text{ negative} \]

\[ -V_{GT} > 2,5 \text{ V} \]

\[ -I_{GT} > 200 \text{ mA} \]

Voltage that will not trigger any device

\[ V_D = V_{\text{DRM}} \text{ max}; \quad T_j = 125 \degree \text{C}; \ G \text{ positive or negative} \]

\[ V_{GD} < 0,2 \text{ V} \]

* Measured under pulse conditions to avoid excessive dissipation.
**FULL CYCLE OPERATION**

Conduction angle per half cycle:

- \( \alpha = \alpha_1 = \alpha_2 \)

Interrelation between the power (derived from the left hand graph) and the max. allowable temperatures.

\[ \alpha = 180^\circ \]

\[ \alpha = 120^\circ \]

\[ \alpha = 60^\circ \]

\[ \alpha = 30^\circ \]

\[ \alpha = 90^\circ \]

\[ \alpha = 120^\circ \]

\[ \alpha = 180^\circ \]

* \( T_{mb} \) scale is for comparison purposes only and is correct only for \( R_{th mb-a} \leq 1.4^\circ C/W \)

**HALF CYCLE OPERATION**

Conduction angle:

- \( \alpha = 30^\circ \)
- \( \alpha = 60^\circ \)
- \( \alpha = 90^\circ \)
- \( \alpha = 120^\circ \)
- \( \alpha = 180^\circ \)

Form factor:

- \( \alpha = 30^\circ \):
  - \( a = 4 \)
  - \( a = 2.8 \)
  - \( a = 2.2 \)
  - \( a = 1.5 \)
  - \( a = 1.6 \)

Interrelation between the power (derived from the left hand graph) and the max. allowable temperatures.

\[ T_{mb} \]

* \( T_{mb} \) scale is for comparison purposes only and is correct only for \( R_{th mb-a} \leq 0.8^\circ C/W \)
maximum permissible non-repetitive r.m.s. on-state current based on sinusoidal currents (f=50Hz)

the triac may temporarily lose control following the surge

Fig. 4.

Fig. 5.
**Fig. 6.**

Max. rate of rise of off-state voltage that will not trigger any device (exp.-method) plotted against junction temperature.

**Fig. 7.**

Max. rate of rise of off-state voltage that will not trigger any device (exp.-method) plotted against applied voltage.

**Fig. 8.**

Minimum trigger voltage versus junction temperature.

**Fig. 9.**

Minimum trigger current versus junction temperature.
for safe operation at a given temperature the r.m.s. of successive cycles (see drawing above) must lie within the region bounded by the curve shown below for that temperature.

Fig. 10.

for safe operation at a given temperature the r.m.s. of successive cycles (see drawing above) must lie within the region bounded by the curve shown below for that temperature.

Fig. 11.
Fig. 12 Intermittent overload capability of one triac in a single phase a.c. control circuit.

Fig. 13.
TRIACS

A range of glass-passivated triacs in plastic envelopes with push-on connectors. They are intended for use in industrial a.c. power control applications such as motor and heating controls, and switching systems.

QUICK REFERENCE DATA

<table>
<thead>
<tr>
<th>Parameter</th>
<th>BTW41-500G</th>
<th>600G</th>
<th>800G</th>
</tr>
</thead>
<tbody>
<tr>
<td>$V_{DRM}$ max.</td>
<td>500 V</td>
<td>600 V</td>
<td>800 V</td>
</tr>
<tr>
<td>$I_{T(RMS)}$ max.</td>
<td>40 A</td>
<td></td>
<td></td>
</tr>
<tr>
<td>$I_{TSM}$ max.</td>
<td>260 A</td>
<td></td>
<td></td>
</tr>
<tr>
<td>$dV_{com/dt}$</td>
<td>&lt; 5 V/$\mu$s</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

MECHANICAL DATA

Fig.1 SOT-80

Recommended diameter of fixing screws: 4 mm

$T_1$ and $T_2$: AMP250 series

$g$: AMP110 series

The exposed metal base-plate is electrically connected to main terminal $T_2$.

Net mass: 15 g

Torque on fixing screws:
- min. 0.8 Nm (8 kg cm)
- max. 1.5 Nm (15 kg cm)

December 1979
TRIACS

Also available to BS9343-F001

Silicon triacs in metal envelopes, intended for industrial a.c. power control and are particularly suitable for static switching of 3-phase induction motors. They may also be used for furnace control, lighting control and other static switching applications up to an r.m.s. on-state current of 15 A.

Two grades of commutation performance are available, 10 V/μs at 5 A/ms (suffix G) and 10 V/μs at 12 A/ms (suffix H).

QUICK REFERENCE DATA

<table>
<thead>
<tr>
<th></th>
<th>BTW43-600</th>
<th>800</th>
<th>1000</th>
<th>1200</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>V_{DRM} max.</strong></td>
<td>600</td>
<td>800</td>
<td>1000</td>
<td>1200</td>
</tr>
<tr>
<td><strong>I_{T(RMS)} max.</strong></td>
<td>15 A</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>I_{TSM} max.</strong></td>
<td>120 A</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>dV_{com}/dt &lt;</strong></td>
<td>10 V/μs</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

MECHANICAL DATA

Fig. 1 TO-64: with metric M5 stud (φ 5 mm).

Net mass: 7 g
Diameter of clearance hole: max. 5,2 mm
Accessories supplied on request: 56295 (PTFE bush, 2 mica washers, plain washer, tag)

Supplied with the device: 1 nut, 1 lock washer
Nut dimensions across the flats: 8,0 mm

Torque on nut: min. 0,9 Nm (9 kg cm)
max. 1,7 Nm (17 kg cm)
RATINGS
Limiting values in accordance with the Absolute Maximum System (IEC 134)

Voltages (in either direction)*

<table>
<thead>
<tr>
<th></th>
<th>BTW43-600</th>
<th>800</th>
<th>1000</th>
<th>1200</th>
</tr>
</thead>
<tbody>
<tr>
<td>Non-repetitive peak off-state voltage</td>
<td>VDSM</td>
<td>max. 600</td>
<td>800</td>
<td>1000</td>
</tr>
<tr>
<td>Repetitive peak off-state voltage</td>
<td>VDRM</td>
<td>max. 600</td>
<td>800</td>
<td>1000</td>
</tr>
<tr>
<td>Crest working off-state voltage</td>
<td>VDWM</td>
<td>max. 400</td>
<td>600</td>
<td>700</td>
</tr>
</tbody>
</table>

Currents (in either direction)

R.M.S. on-state current (conduction angle 360°)
up to $T_{mb} = 75 \, ^\circ C$
at $T_{mb} = 85 \, ^\circ C$

Average on-state current for half-cycle operation
(averaged over any 20 ms period)
up to $T_{mb} = 35 \, ^\circ C$
at $T_{mb} = 85 \, ^\circ C$

Repetitive peak on-state current

Non-repetitive peak on-state current

$T_j = 125 \, ^\circ C$ prior to surge; $t = 20 \, ms$; full sine-wave

Rate of rise of on-state current after triggering with

$|I_G| = 0,5 \, A$ to $I_T = 25 \, A$; $dl_T/dt = 0,5 \, A/\mu s$

Gate to terminal 1

Power dissipation

Average power dissipation (averaged over any 20 ms period)

Peak power dissipation

Temperatures

Storage temperature

Junction temperature

THERMAL RESISTANCE

From junction to mounting base

full-cycle operation

half-cycle operation

From mounting base to heatsink with heatsink compound

Transient thermal impedance; $t = 1 \, ms$

* To ensure thermal stability: $R_{th \, j-a} < 6 \, ^\circ C/W$ (full-cycle or half-cycle operation). For smaller heatsinks $T_{j \, max}$ should be derated (see Figs 2 and 3).
CHARACTERISTICS

Polarities positive or negative, are identified with respect to T_1.

**Voltages (in either direction)**

On-state voltage
\[ V_T < 2.2 \text{ V}^* \]
\[ dV_T/dt < 200 \text{ V/\mu s} \]

Rate of rise of off-state voltage that will not trigger any device;
\[ dV_D/dt < 200 \text{ V/\mu s} \]
\[ dV_{com}/dt (V/\mu s) \]
\[ dI_{T}/dt (A/\mu s) \]

<table>
<thead>
<tr>
<th>BTW43-600G to 1200G</th>
<th>BTW43-600H to 1200H</th>
</tr>
</thead>
<tbody>
<tr>
<td>&lt; 10</td>
<td>&lt; 10</td>
</tr>
<tr>
<td>5</td>
<td>12</td>
</tr>
</tbody>
</table>

**Rates of rise of commutating voltage that will not trigger any device:**
\[ I_T^{(RMS)} = 12 \text{ A}; V_D = V_{DWM\text{max}}; T_{mb} = 85 \text{ °C} \]

**Currents (in either direction)**

Off-state current
\[ V_D = V_{DWM\text{max}}; T_j = 125 \text{ °C} \]
\[ I_D < 5 \text{ mA} \]

Latching current; \( T_j = 25 \text{ °C} \)
\[ I_L < 200 \text{ mA} \]
\[ I_L < 200 \text{ mA} \]

Holding current; \( T_j = 25 \text{ °C} \)
\[ I_H < 100 \text{ mA} \]
\[ I_H < 100 \text{ mA} \]

Gate to terminal 1

Voltage and current that will trigger all devices
\[ V_D = 12 \text{ V}; T_j = 25 \text{ °C} \]
\[ |V_{GT}| > 2.5 \text{ V} \]
\[ |I_{GT}| > 100 \text{ mA} \]
\[ |V_{GT}| > 2.5 \text{ V} \]
\[ |I_{GT}| > 100 \text{ mA} \]

Voltage that will not trigger any device
\[ V_D = V_{DR\text{max}}; T_j = 125 \text{ °C}; G \text{ positive or negative} \]
\[ V_{GD} < 0.2 \text{ V} \]

*Measured under pulse conditions to avoid excessive dissipation.
Fig. 2. FULL CYCLE OPERATION

![Graph showing the interrelation between the power and the max. allowable temp.](image)

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

Fig. 3. HALF-CYCLE OPERATION

![Graph showing the interrelation between the power and the max. allowable temp.](image)

* $T_{mb}$-scale is for comparison purposes only and is correct only for $R_{th mb-a} < 2 \, ^\circ C/W$. 
max. allowable non-repetitive r.m.s. on-state current based on sinusoidal currents (f = 50 Hz)

\[ I_{TS} \]
\[ I_{TS(RMS)} \]

the triac may temporarily lose control following the surge

\[ T_j = 125 \, ^\circ\text{C} \] prior to surge

**Fig. 4.**

**Fig. 5.**
Fig. 6 Minimum gate voltage that will trigger all devices as a function of $T_j$.

Conditions for Figs 6 and 7:

- $T_2$ negative, gate positive with respect to $T_1$
- All other conditions
Fig. 8 Maximum rate of rise of commutating voltage that will not trigger any device as a function of rate of fall of on-state current; \( |I_{T(RMS)}| = 12 \text{ A}; V_D = V_{DWMmax}\).
for safe operation at a given temperature the r.m.s. of successive cycles (see drawing below) must lie within the region bounded by the curve shown below for that temperature.

\[ T_j = T_{mb} = 45^\circ C \] prior to starting.

Fig. 10.

for safe operation at a given temperature the average level of successive cycles (see drawing below) must lie within the region bounded by the curve shown below for that temperature.

\[ T_j = T_{mb} = 45^\circ C \] prior to starting.

Fig. 11.
TRIACS

Silicon triacs in metal envelopes, intended for industrial single-phase and three-phase inductive load applications such as regenerative motor control systems. They are also suitable for furnace temperature control and static switching systems.

Two grades of commutation performance are available, 30 V/μs at 25 A/ms (suffix H) and 30 V/μs at 50 A/ms (suffix J).

QUICK REFERENCE DATA

<table>
<thead>
<tr>
<th>Repetitive peak off-state voltage</th>
<th>V_{DRM}</th>
<th>BTX94-400</th>
<th>600</th>
<th>800</th>
<th>1000</th>
<th>1200</th>
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<td>I_{(RMS)} max.</td>
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<td>Non-repetitive peak on-state current</td>
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<td>Rate of rise of commutating voltage that will not trigger any device (see page 3)</td>
<td>dV_{COM}/dt &lt;</td>
<td>30 V/μs</td>
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</table>

MECHANICAL DATA

Fig. 1 TO-48.

Net mass: 14 g
Diameter of clearance hole: max. 6.5 mm
Accessories supplied on request: 56264A (mica washer, insulating ring, soldering tag)

Torque on nut: min. 1.7 Nm (17 kg cm)
max. 3.5 Nm (35 kg cm)
Supplied with the device:
1 nut, 1 lock washer
Nut dimensions across the flats; 11.1 mm

April 1978
BTX94 SERIES

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

Voltages (in either direction) *

<table>
<thead>
<tr>
<th>VDSM max.</th>
<th>400</th>
<th>600</th>
<th>800</th>
<th>1000</th>
<th>1200 V **</th>
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<td>VDRM max.</td>
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<td>1000</td>
<td>1200 V</td>
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<tr>
<td>VDWM max.</td>
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<td>400</td>
<td>600</td>
<td>700</td>
<td>800 V</td>
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Repetitive peak off-state voltage

Non-repetitive peak off-state voltage (t ≤ 10 ms)

Crest working off-state voltage

Currents (in either direction)

R.M.S. on-state current (conduction angle 360°)

<table>
<thead>
<tr>
<th>IT(RMS) max.</th>
<th>25 A</th>
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<tr>
<td>ITRM max.</td>
<td>100 A</td>
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Repetitive peak on-state current

Non-repetitive peak on-state current

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

Rate of rise of on-state current after triggering with

\[ I_G = 750 \text{ mA to } I_T = 100 \text{ A} \]

| dIT/dt max. | 50 A/μs |

Gate to terminal 1

Power dissipation

Average power dissipation (averaged over any 20 ms period)

<table>
<thead>
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<th>PG(AV) max.</th>
<th>1 W</th>
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<tr>
<td>PGM max.</td>
<td>5 W</td>
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Temperatures

Storage temperature

<table>
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<tr>
<th>Tstg</th>
<th>−55 to + 125 °C</th>
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Junction temperature

<table>
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<tr>
<th>Tj</th>
<th>max. 125 °C</th>
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</table>

THERMAL RESISTANCE

From junction to mounting base

full-cycle operation

half-cycle operation

From mounting base to heatsink with heatsink compound

Transient thermal impedance; t = 1 ms

\[ R_{th \ j-mb} = 1,0 \text{ °C/W} \]
\[ R_{th \ j-mb} = 2,0 \text{ °C/W} \]
\[ R_{th \ mb-h} = 0,2 \text{ °C/W} \]
\[ Z_{th \ j-mb} = 0,12 \text{ °C/W} \]

* To ensure thermal stability: \( R_{th \ j-a} < 3,5 \text{ °C/W} \) (full-cycle or half-cycle operation). For smaller heatsinks \( T_{j \ max} \) should be derated (see Figs 2 and 3).

** Although not recommended, higher off-state voltages may be applied without damage, but the triac may switch into the on-state. The rate of rise of on-state current should not exceed 50 A/μs.
**CHARACTERISTICS**

Polarities, positive or negative, are identified with respect to $T_1$.

**Voltages** (in either direction)

On-state voltage

$$I_T = 50 \text{ A}; \ T_j = 25 \ ^\circ\text{C}$$

Rate of rise of off-state voltage that will not trigger any device; exponential method;

$$V_D = \frac{2}{3} V_{DRMmax}; \ T_j = 125 \ ^\circ\text{C}$$

Rate of rise of commutating voltage that will not trigger any device;

$$I_T(\text{RMS}) = 25 \text{ A}; \ V_D = V_{DMWmax}; \ T_{mb} = 85 \ ^\circ\text{C}$$

<table>
<thead>
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<th>Voltage ($V_D$)</th>
<th>BTX94-400H to 1200H</th>
<th>BTX94-400J to 1200J</th>
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</thead>
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<tr>
<td>$dV_D/dt$ ($\text{V/\mu s}$)</td>
<td>$&lt; 2 \text{ V}$</td>
<td>$&lt; 2 \text{ V}$</td>
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<tr>
<td>$dV_{\text{com}}/dt$ ($\text{V/\mu s}$)</td>
<td>$&lt; 30$</td>
<td>$&lt; 30$</td>
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<tr>
<td>$-dI_T/dt$ ($\text{A/\mu s}$)</td>
<td>$25$</td>
<td>$50$</td>
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**Currents** (in either direction)

Off-state current

$$V_D = V_{DMWmax}; \ T_j = 125 \ ^\circ\text{C}$$

<table>
<thead>
<tr>
<th>Current ($I_D$)</th>
<th>$&lt; 5 \text{ mA}$</th>
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</table>

Latching current; $T_j = 25 \ ^\circ\text{C}$

G positive

<table>
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<tr>
<th>$I_L$</th>
<th>$&lt; 150$</th>
<th>$150 \text{ mA}$</th>
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</table>
| G negative

| $I_L$ | $< 350$ | $150 \text{ mA}$ |

**Gate to terminal 1**

Voltage and current that will trigger all devices

$$V_D = 12 \text{ V}; \ T_j = 25 \ ^\circ\text{C}$$

G positive

<table>
<thead>
<tr>
<th>$V_{GT}$</th>
<th>$&gt; 3,0$</th>
<th>$5,0 \text{ V}$</th>
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<tbody>
<tr>
<td>$I_{GT}$</td>
<td>$&gt; 150$</td>
<td>$200 \text{ mA}$</td>
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</table>

G negative

<table>
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<tr>
<th>$-V_{GT}$</th>
<th>$&gt; 3,0$</th>
<th>$3,0 \text{ V}$</th>
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</thead>
<tbody>
<tr>
<td>$-I_{GT}$</td>
<td>$&gt; 150$</td>
<td>$150 \text{ mA}$</td>
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</tbody>
</table>

* Measured under pulse conditions to avoid excessive dissipation.
FULL-CYCLE OPERATION

- \( \alpha = \alpha_1 = \alpha_2 \)
- conduction angle per half cycle

interrelation between the power (derived from the left hand graph) and the max. allowable temperatures

\( T_{mb} * \)
(°C)

\begin{align*}
0 &< 0 < 1 \\
0 < 2
\end{align*}

\( \text{Rth mb-a} = 0 < 0.2°C/W \)

\( \text{Rth mb-a} = 180°/2.2 \)

\( \text{Rth mb-a} = 90°/1.9 \)

\( \text{Rth mb-a} = 60°/1.6 \)

\( \text{Rth mb-a} = 30°/2.8 \)

\( \text{Rth mb-a} = 120°/1.9 \)

\( \text{Rth mb-a} = 180°/1.6 \)

* \( T_{mb} - \text{scale is for comparison purposes only and is correct only for } R_{th mb-a} < 2.5°C/W \)

Fig. 2.

HALF-CYCLE OPERATION

- \( \alpha = \text{conduction angle} \)

interrelation between the power (derived from the left hand graph) and the max. allowable temperatures

\( T_{mb} * \)
(°C)

\begin{align*}
0 &< 0 < 1 \\
0 < 2
\end{align*}

\( \text{Rth mb-a} = 0 < 0.2°C/W \)

\( \text{Rth mb-a} = 180°/2.2 \)

\( \text{Rth mb-a} = 90°/1.9 \)

\( \text{Rth mb-a} = 60°/1.6 \)

\( \text{Rth mb-a} = 30°/2.8 \)

\( \text{Rth mb-a} = 120°/1.9 \)

\( \text{Rth mb-a} = 180°/1.6 \)

* \( T_{mb} - \text{scale is for comparison purposes only and is correct only for } R_{th mb-a} < 1.5°C/W \)

Fig. 3.
maximum permissible non-repetitive r.m.s. on-state current based on sinusoidal currents (f=50Hz)

Fig. 4.

Fig. 5.
Fig. 6  Minimum gate voltage that will trigger all devices as a function of $T_j$.

Conditions for Figs 6 and 7:
- $T_2$ negative, gate positive with respect to $T_1$
- - - all other conditions

Fig. 7  Minimum gate current that will trigger all devices as a function of $T_j$. 
Triacs

BTX94 SERIES

HALF-CYCLE OPERATION

For safe operation at a given temperature, the r.m.s. of successive cycles (see drawing above) must lie within the region bounded by the curve shown below for that temperature.

\[ T_j = T_{mb} = 85°C \] prior to starting

Fig. 8.

FULL-CYCLE OPERATION

For safe operation at a given temperature, the r.m.s. of successive cycles (see drawing above) must lie within the region bounded by the curve shown below for that temperature.

\[ T_j = T_{mb} = 85°C \] prior to starting

Fig. 9.
Fig. 10 Maximum rate of rise of off-state voltage that will not trigger any device (exponential method) as a function of $T_j$.

Fig. 11.
ACCESSORIES
DISTANCE DISC

For use with BRY39T

MECHANICAL DATA

Dimensions in mm

TEMPERATURE

Maximum allowable temperature

$T_{\text{max}} = 100 \, ^\circ\text{C}$
MOUNTING ACCESSORIES

MECHANICAL DATA

Dimensions in mm

---

mica washer

insulating ring

plain washer

material: brass, nickel plated

-- THERMAL RESISTANCE

From mounting base to heatsink (with mica washer)
without heatsink compound
with heatsink compound

$R_{th\ mb-h} = 5\ \degree C/W$

$R_{th\ mb-h} = 2.5\ \degree C/W$

---

TEMPERATURE

Maximum permissible temperature

$T_{max.} = 125\ \degree C$

---

MOUNTING INSTRUCTIONS

Note: When using a tag for electrical contact, insert tag between nut and plain washer or replace plain washer by tag.

December 1979
MOUNTING ACCESSORIES

MECHANICAL DATA

Dimensions in mm

THERMAL RESISTANCE

From mounting base to heatsink
- with mica washer, without heatsink compound
- with mica washer; with heatsink compound

TEMPERATURE

Maximum allowable temperature

MOUNTING INSTRUCTIONS
MOUNTING ACCESSORIES

MECHANICAL DATA

Dimensions in mm

THERMAL RESISTANCE

From mounting base to heatsink
without heatsink compound \( R_{th \, mb-h} = 5 \, ^\circ C/W \)
with heatsink compound \( R_{th \, mb-h} = 2.5 \, ^\circ C/W \)

TEMPERATURE

Maximum allowable temperature \( T_{max} = 175 \, ^\circ C \)

MOUNTING INSTRUCTIONS
MOUNTING ACCESSORIES

MECHANICAL DATA

Dimensions in mm

THERMAL RESISTANCE
From mounting base to heatsink
with heatsink compound
without heatsink compound

\[ R_{th \ mb-h} = 1.2 \quad ^{\circ}C/W \]
\[ R_{th \ mb-h} = 2.3 \quad ^{\circ}C/W \]

MOUNTING INSTRUCTIONS

screw M3
washer
device (SOD-38)
mica washer
heatsink
nut
MOUNTING ACCESSORIES

<table>
<thead>
<tr>
<th>QUANTITY</th>
<th>DESCRIPTION</th>
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<tbody>
<tr>
<td>2</td>
<td>Steel washers, cadmium plated, I.D. 4.3 x O.D. 9.0 x 0.8 thick.</td>
</tr>
<tr>
<td>1</td>
<td>Hex. full nut, steel, cadmium plated 6-32 UNC.</td>
</tr>
<tr>
<td>1</td>
<td>Pan head screw, slotted, steel, cadmium plated, 6-32 UNC x 5/8&quot; long.</td>
</tr>
</tbody>
</table>

Mounting method for plastic devices (Insulating method illustrated)
CLIPS FOR TO-220 ENVELOPES

MECHANICAL DATA

56363

Dimensions in mm

Spring clip for direct mounting on heatsink of 1,0 to 2,0 mm; material: steel, zinc-chromate passivated.

56364

To be used in conjunction with insulators 56367 or 56369.

Spring clip for insulated mounting on heatsink of 1,0 to 2,5 mm; material: steel, zinc-chromate passivated.

Mounting instructions with $R_{th}$ values are given separately.
INSULATORS FOR TO-220 ENVELOPES

MECHANICAL DATA

Dimensions in mm

56367

Alumina insulator (up to 2 kV) to be used in conjunction with spring clip 56364; material: 96-alumina.*

THERMAL RESISTANCE

→ From mounting base to heatsink, with heatsink compound

\[ R_{th\ mb-h} = 0.82 \^\circ\text{C/W} \]

56369

Mica insulator (up to 2 kV) to be used in conjunction with spring clip 56364.

THERMAL RESISTANCE

→ From mounting base to heatsink, with heatsink compound

\[ R_{th\ mb-h} = 2.2 \^\circ\text{C/W} \]

*Because alumina is brittle, extreme care must be taken, when mounting devices, not to crack the alumina, particularly when used without heatsink compound.
CLIP FOR SOT-112 ENVELOPE

MECHANICAL DATA

Fig. 1 Clip; material: steel, blackened (zinc-chromate passivated).

THERMAL RESISTANCE

From mounting base to heatsink

with a metallic oxide-loaded compound

without heatsink compound

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

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

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 10° to 30° to the vertical.
3. Push down the clip over the device until the long end of the clip snaps into the wide slot. The clip should bear on the middle of the plastic body.

Fig. 2 Hole pattern for clip in heatsink.

Fig. 3 Mounting of the clip.
HEATSINKS
Selection Guide
General
Flat Heatsinks
Diecast Heatsinks
Heatsink Extrusions
### Rectifier diodes

- BYX38
- BYX39
- BYX50
- 1N3879 to 3882
- 1N3889 to 3892
- BYX98
- BYX42
- BYX99
- BYX30
- BYX25
- BYX46
- BYW30
- BYV30
- BYW31
- BYV21
- BYX96
- BYW92
- BYV92
- BYW93
- BYX56
- BYX97
- BYX32
- BYX52
- 1N3899 to 3903
- 1N3909 to 3913

### Thyristors

- BYW25
- BTY79
- BTW38
- BTW42
- BTY87
- BTY91
- BTW47
- BTW30S
- BTW45
- BTW40
- BTW92
- BTW31W
- BTW24
- BTW33
- BTW23
- BTW43
- BTX94
- BTW34

### K-code to DIN-41882

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</table>
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:

$$\begin{align*}
R_{th\ j-mb} & \quad \text{The thermal resistance from junction to mounting base. Its value is given in the data sheets of a device.} \\
R_{th\ mb-h} & \quad \text{The thermal resistance from mounting base to heatsink (contact thermal resistance). It is caused by the imperfect nature and limited size of the contact between the two. Its value is also given in the data sheets.} \\
R_{th\ h-a} & \quad \text{The thermal resistance between the contact surface mentioned above and the ambient air.}
\end{align*}$$

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 $R_{th-a}$ 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](image)

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.

January 1980
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 $T_{amb} = 50 \degree C$. Further assume: average forward current per diode $I_F(AV) = 65 \ A$; contact thermal resistance $R_{th mb-h} = 0.1 \ DegreeC/W$.

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

   From the lefthand graph it follows that $P_{tot} = 90 \ W$ per diode (point A).
   From the righthand graph it follows that $R_{th mb-a} \approx 1.2 \ DegreeC/W$.
   Thus $R_{th h-a} = R_{th mb-a} - R_{th mb-h} = (1.2 - 0.1) \ DegreeC/W = 1.1 \ DegreeC/W$.
   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</td>
<td>applicable</td>
<td></td>
</tr>
<tr>
<td>56280</td>
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<tr>
<td>extrusion</td>
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<td></td>
</tr>
<tr>
<td>56230</td>
<td>$t = 12 \ cm$</td>
<td>$t = 5 \ cm$ (1); 1 m/s</td>
</tr>
<tr>
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<tr>
<td>blackened</td>
<td>$t = 7 \ cm$</td>
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<td>56231</td>
<td>$t = 5 \ cm$</td>
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<tr>
<td>bright</td>
<td></td>
<td></td>
</tr>
<tr>
<td>blackened</td>
<td></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 $T_{amb} = 40$ °C. Further assume: average forward current per diode $I_{F(AV)} = 10$ A; contact thermal resistance: $R_{th mb-h} = 0,5$ °C/W; repetitive peak reverse power in the avalanche region ($t = 40 \mu s$) $P_{RRM} = 2$ 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 $R_{th mb-a} = 4$ °C/W. Hence the heatsink thermal resistance should be: $R_{th h-a} = R_{th mb-a} - R_{th mb-h} = (4 - 0,5)$ °C/W = 3,5 °C/W.

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

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: M8
Mounting base, across the flats: max. 19 mm

Stud: $\frac{1}{4}"$ x 28 UNF
Mounting base, across the flats: max. 14.0 mm

\[ R_{thh-a} (\degree C/W) \]

Heatsink area (cm²; one side)

August 1972
# RECTIFIER CIRCUITS ON SINGLE HEATSINKS

<table>
<thead>
<tr>
<th>Single phase half wave</th>
<th>Two phase half wave</th>
<th>Single phase full wave (Single phase bridge)</th>
<th>Three phase half wave (Three phase star)</th>
</tr>
</thead>
<tbody>
<tr>
<td><img src="image1" alt="Circuit Diagram" /></td>
<td><img src="image2" alt="Circuit Diagram" /></td>
<td><img src="image3" alt="Circuit Diagram" /></td>
<td><img src="image4" alt="Circuit Diagram" /></td>
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<tr>
<td>Three phase full wave (Three phase bridge)</td>
<td>Six phase half wave (Six phase star)</td>
<td>Three phase double Y with interphase transformer</td>
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<tr>
<td><img src="image5" alt="Circuit Diagram" /></td>
<td><img src="image6" alt="Circuit Diagram" /></td>
<td><img src="image7" alt="Circuit Diagram" /></td>
<td></td>
</tr>
</tbody>
</table>

- Diecast heatsink without insulator
- Diecast heatsink with insulator

August 1972
MOUNTING INSTRUCTION FOR DIECAST HEATSINKS

1. At free convection cooling or forced air flow < 0,5 m/s the heatsinks should be mounted with the fins vertical and with a distance to the chassis bottom > 100 mm.

2. At forced air flow > 0,5 m/s the heatsinks may be mounted in any position.

3. Minimum distance between heatsinks in a row.

4. The rectifier devices should be fixed to their heatsinks with the torques specified in the relevant published data. Use the torque spanner.

5. For insulated mounting of heatsinks two sizes of mounting strips made of insulating material are available.

6. Mounting holes to be made in the strips:
56233

MOUNTING STRIPS

MECHANICAL DATA

Dimensions in mm

mounting strip of insulating material
Weight with cover: 330 g

insulating plate (cover)

56234

MECHANICAL DATA

Dimensions in mm

mounting strip of insulating material
Weight with cover: 615 g

insulating plate (cover)
DIECAST HEATSINK

Diecast heatsink of aluminium alloy, painted black, with ¼” x 28 UNF tap hole for devices in DO-5 or TO-48 envelopes.

Weight: 305 g

Dimensions in mm

Fig. 1
The graphs are valid for the combination of device and heatsink.

Fig. 2

Fig. 3
DIECAST HEATSINK

Diecast heatsink of aluminium alloy, painted black, with 10-32 UNF tap hole for devices in DO-4 or TO-64 envelopes.

Weight: 55 g

Dimensions in mm

Fig. 1
The graphs are valid for the combination of device and heatsink.
DIECAST HEATSINK

Diecast heatsink of aluminium alloy, painted black, with 10-32 UNF tap hole for devices in DO-4 or TO-64 envelopes.

Weight: 33 g

Dimensions in mm

Fig. 1
The graphs are valid for the combination of device and heatsink.
Diecast heatsink of aluminium alloy, painted black, with M8 tap hole for rectifier device.

Weight: 270 g

Dimensions in mm

Fig. 1
DIECAST HEATSINK

Diecast heatsink of aluminium alloy, painted black, with $\frac{3}{4}''$ x 28 UNF tap hole for rectifier device.

Weight: 690 g

Dimensions in mm

Fig. 1
DIECAST HEATSink

Diecast heatsink of aluminium alloy, painted black, with M12 tap hole for rectifier device.

Weight: 690 g

Fig. 1
DIECAST HEATSINK

For DO-5 rectifier diodes and TO-48 thyristors and triacs.

Weight: 270 g

Dimensions in mm

Fig. 1

Tap hole for fixing the heatsink: M6
The graphs are valid for the combination of device and heatsink.

---

**Fig. 2**

<table>
<thead>
<tr>
<th>$R_{\text{thh-a}}$ ($^\circ\text{C}/\text{W}$)</th>
<th>$P_{\text{tot}}$ (W)</th>
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<td>4</td>
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<td>3.2</td>
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<td>2</td>
<td>0-60</td>
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<tr>
<td>1.5</td>
<td>0-60</td>
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Free convection

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**Fig. 3**

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<tr>
<th>$R_{\text{thh-a}}$ ($^\circ\text{C}/\text{W}$)</th>
<th>Air velocity (m/s)</th>
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<td>0-5</td>
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<tr>
<td>0.5</td>
<td>0-5</td>
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</table>

Forced cooling
DIECAST HEATSINK

For DO-5 rectifiers and TO-48 thyristors and triacs.

Weight: 690 g

Fig. 1

Dimensions in mm
The graphs are valid for the combination of device and heatsink.

**Fig. 2**

**Fig. 3**

<table>
<thead>
<tr>
<th>$R_{th h-o}$ $(°C/W)$</th>
<th>$P_{tot}(W)$</th>
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<tbody>
<tr>
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**Fig. 3**

<table>
<thead>
<tr>
<th>$R_{th h-o}$ $(°C/W)$</th>
<th>air velocity (m/s)</th>
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</table>
DIECAST HEATSINK

For DO-5 rectifiers and TO-48 thyristors and triacs.

Weight: 690 g

Dimensions in mm

Fig. 1

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Weight: 690 g

Dimensions in mm

---

December 1979
The graphs are valid for the combination of device and heatsink.

Fig. 2

Fig. 3
DIECAST HEATSINK

Weight: 1.9 kg

Dimensions in mm

Fig. 1
DIECAST HEATSINK

Weight: 1.9 kg

Dimensions in mm

Fig.1
DIECAST HEATSINK

Weight: 270 g

Dimensions in mm

Fig. 1

Tap hole for fixing the heatsink: M8
Diecast heatsink of aluminium alloy, painted black, with 10-32 UNF tap hole for rectifier device.

Weight: 135 g
DIECAST HEATSINK

For DO-4 and TO-64 devices with M5 stud

Weight: 270 g

Dimensions in mm

Tap hole for fixing the heatsink: M6

December 1979
The graphs are valid for the combination of device and heatsink.
Diecast heatsink of aluminium alloy, painted black, with M5 tap hole for rectifier device.

Weight: 135 g

Dimensions in mm

Fig. 1
Diecast heatsink of aluminium alloy, painted black, with M5 tap hole for devices in DO-4 and TO-64 envelopes.

Weight: 55 g

Dimensions in mm

Fig. 1

Tap hole for fixing the heatsink: M4
The graphs are valid for the combination of device and heatsink.

Fig. 2

Fig. 3
EXTRUDED ALUMINIUM HEATSINK

Extruded heatsink of aluminium alloy.
The extrusion is supplied unpainted, in lengths of 1.5 m.

Weight: 4 kg per 1.5 m.

Dimensions in mm

[Diagram of heatsink dimensions]
The graphs are valid for the combination of device and heatsink.
EXTRUDED ALUMINIUM HEATSINK

Extruded heatsink of aluminium alloy. The extrusion is supplied unpainted, in lengths of 1.5 m.

Weight: 6 kg per 1.5 m. Dimensions in mm
The graphs are valid for the combination of device and heatsink.
EXTRUDED ALUMINIUM HEATSINK

Extruded heatsink of aluminium alloy.
The extrusion is supplied unpainted, in lengths of 1,5 m.

**Weight:** 2,4 kg per 1,5 m.  

**Dimensions in mm**

[Diagram showing dimensions]
The graphs are valid for the combination of device and heatsink.
EXTRUDED ALUMINIUM HEATSINK

Extruded heatsink of aluminium alloy.
The extrusion is supplied unpainted, in lengths of 1.5 m.

Weight: 16.2 kg per 1.5 m.

Dimensions in mm

Fig. 1
INDEX
<table>
<thead>
<tr>
<th>Rectifier diodes</th>
<th>Regulator diodes</th>
<th>Thyristors</th>
<th>Accessories</th>
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