

REGULATOR DIODES

Also available to BS9305—F051

A range of diffused silicon diodes in DO-4 metal envelopes, intended for use as voltage regulator and transient suppressor diodes in power stabilization and transient suppression circuits.

The series consists of the following types:  
Normal polarity (cathode to stud): BZY93-C7V5 to BZY93-C75.  
Reverse polarity (anode to stud): BZY93-C7V5R to BZY93-C75R.

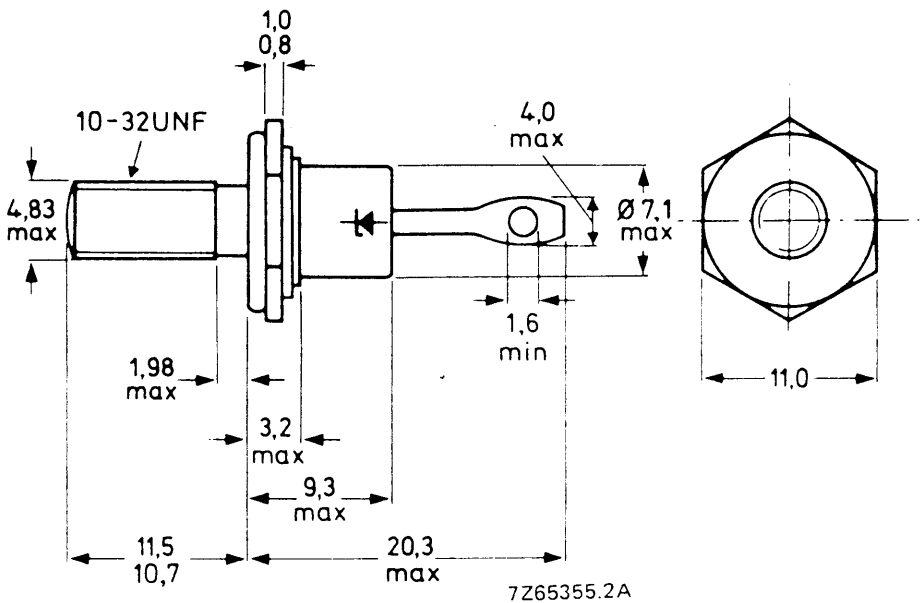
QUICK REFERENCE DATA

|                                               |           |      | voltage regulator | transient suppressor |
|-----------------------------------------------|-----------|------|-------------------|----------------------|
| Working voltage (5% range)                    | $V_Z$     | nom. | 7,5 to 75         | — V                  |
| Stand-off voltage                             | $V_R$     |      | —                 | 5,6 to 56 V          |
| Total power dissipation                       | $P_{tot}$ | max. | 20                | — W                  |
| Non-repetitive peak reverse power dissipation | $P_{RSM}$ | max. | —                 | 700 W                |

MECHANICAL DATA

Dimensions in mm

Fig. 1 DO-4.



Net mass: 6 g  
Diameter of clearance hole: max. 5,2 mm  
Accessories supplied on request:  
see ACCESSORIES section  
Supplied with device: 1 nut, 1 lock washer  
Nut dimensions across the flats: 9,5 mm

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

RATINGS

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

|                                                                                                                                                                        |           |      |                                              |
|------------------------------------------------------------------------------------------------------------------------------------------------------------------------|-----------|------|----------------------------------------------|
| Peak working current                                                                                                                                                   | $I_{ZM}$  | max. | 20 A                                         |
| Average forward current<br>(averaged over any 20 ms period)                                                                                                            | $I_F(AV)$ | max. | 5 A                                          |
| Non-repetitive peak reverse current<br>$T_j = 25\text{ }^{\circ}\text{C}$ prior to surge;<br>$t_p = 1\text{ ms}$ (exponential pulse);<br>BZY93-C7V5(R) to BZY93-C75(R) | $I_{RSM}$ | max. | 55 to 6 A                                    |
| Total power dissipation<br>up to $T_{mb} = 75\text{ }^{\circ}\text{C}$                                                                                                 | $P_{tot}$ | max. | 20 W                                         |
| Non-repetitive peak reverse power dissipation<br>$T_j = 25\text{ }^{\circ}\text{C}$ prior to surge;<br>$t_p = 1\text{ ms}$ (exponential pulse)                         | $P_{RSM}$ | max. | 700 W                                        |
| Storage temperature                                                                                                                                                    | $T_{stg}$ |      | $-55\text{ to }+175\text{ }^{\circ}\text{C}$ |
| Junction temperature                                                                                                                                                   | $T_j$     | max. | $175\text{ }^{\circ}\text{C}$                |

THERMAL RESISTANCE

|                                                            |                |   |                                 |
|------------------------------------------------------------|----------------|---|---------------------------------|
| From junction to mounting base                             | $R_{th\ j-mb}$ | = | $5\text{ }^{\circ}\text{C/W}$   |
| From junction to ambient                                   | $R_{th\ j-a}$  | = | $50\text{ }^{\circ}\text{C/W}$  |
| From mounting base to heatsink<br>(minimum torque: 0,9 Nm) | $R_{th\ mb-h}$ | = | $0,6\text{ }^{\circ}\text{C/W}$ |

CHARACTERISTICS

|                                                                            |       |   |                |
|----------------------------------------------------------------------------|-------|---|----------------|
| Forward voltage<br>$I_F = 5\text{ A}; T_{mb} = 25\text{ }^{\circ}\text{C}$ | $V_F$ | < | $1,5\text{ V}$ |
|----------------------------------------------------------------------------|-------|---|----------------|

OPERATION AS A VOLTAGE REGULATOR

Dissipation and heatsink considerations

a. Steady-state conditions

The maximum permissible steady-state dissipation  $P_{s\ max}$  is given by the relationship

$$P_{s\ max} = \frac{T_{j\ max} - T_{amb}}{R_{th\ j-a}}$$

where:  $T_{j\ max}$  is the maximum permissible operating junction temperature

$T_{amb}$  is the ambient temperature

$R_{th\ j-a}$  is the total thermal resistance from junction to ambient

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

$R_{th\ mb-h}$  is the thermal resistance from mounting base to heatsink, that is,  $0,6\text{ }^{\circ}\text{C/W}$ .

$R_{th\ h-a}$  is the thermal resistance of the heatsink.

b. Pulse conditions (see Fig. 2)

The maximum permissible pulse power  $P_{p\ max}$  is given by the formula

$$P_{p\ max} = \frac{(T_{j\ max} - T_{amb}) - (P_s \cdot R_{th\ j-a})}{R_{th\ t} + \delta \cdot R_{th\ mb-a}}$$

where:  $P_s$  is any steady-state dissipation excluding that in pulses

$R_{th\ t}$  is the effective transient thermal resistance of the device between junction and mounting base. It is a function of the pulse duration  $t_p$  and duty factor  $\delta$ .

$\delta$  is duty factor ( $t_p/T$ )

$R_{th\ mb-a}$  is the total thermal resistance between the mounting base and ambient

( $R_{th\ mb-a} = R_{th\ mb-h} + R_{th\ h-a}$ ).

The steady-state power  $P_s$  when biased in the zener direction at a given zener current can be found from Fig. 14. With the additional pulse power dissipation  $P_{p\ max}$  calculated from the above expression, the total peak zener power dissipation  $P_{tot} = P_{ZRM} = P_s + P_p$ . From Fig. 14 the corresponding maximum repetitive peak zener current at  $P_{ZRM}$  can now be read. This repetitive peak zener current is subject to the absolute maximum rating. For pulse durations larger than the temperature stabilization time of the diode  $t_{stab}$ , the maximum permissible repetitive peak dissipation  $P_{ZRM}$  is equal to the steady-state power  $P_s$ . The temperature stabilization time for the BZY93 is 5 seconds.

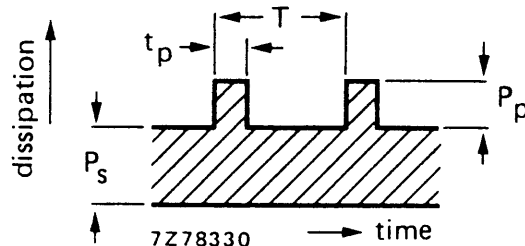


Fig. 2.

## OPERATION AS A TRANSIENT SUPPRESSOR

### Heatsink considerations

- For non-repetitive transients, the device may be used without a heatsink for pulses up to 10 ms in duration.
- For repetitive transients which fall within the permitted operating range shown in Figs 19 and 20 the required heatsink is found as follows:

$$R_{th\ j-mb} + R_{th\ mb-h} + R_{th\ h-a} = \frac{T_{j\ max} - T_{amb}}{P_s + \delta \cdot P_{RRM}}$$

where:  $T_{j\ max} = 175\ ^\circ\text{C}$

$T_{amb}$  = ambient temperature

$P_s$  = any steady-state dissipation excluding that in pulses

$\delta$  = duty factor ( $t_p/T$ )

$R_{th\ j-mb} = 5\ ^\circ\text{C/W}$

$R_{th\ mb-h} = 0,6\ ^\circ\text{C/W}$

Thus  $R_{th\ h-a}$  can be found.

### Notes

- The stand-off voltage is the maximum reverse voltage recommended for continuous operation; at this value non-conduction is ensured.
- The maximum clamping voltage is the maximum reverse voltage which appears across the diode at the specified pulse duration and junction temperature.
- 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.
- Surge suppressor diodes are extremely fast in clamping, switching on in less than 5 ns.

CHARACTERISTICS – WHEN USED AS VOLTAGE REGULATOR DIODES;  $T_{mb} = 25\text{ }^{\circ}\text{C}$ 

| BZY93-... | working voltage<br>* $V_Z$<br>V |      | differential resistance<br>* $r_Z$<br>$\Omega$ |      | temperature coefficient<br>* $S_Z$<br>mV/ $^{\circ}\text{C}$ | test $I_Z$<br>A | reverse current<br>$I_R$<br>$\mu\text{A}$ | reverse voltage<br>at $V_R$<br>V |
|-----------|---------------------------------|------|------------------------------------------------|------|--------------------------------------------------------------|-----------------|-------------------------------------------|----------------------------------|
|           | min.                            | max. | typ.                                           | max. | typ.                                                         |                 | max.                                      |                                  |
| C7V5(R)   | 7.0                             | 7.9  | 0.04                                           | 0.3  | 3.0                                                          | 2.0             | 100                                       | 2.0                              |
| C8V2(R)   | 7.7                             | 8.7  | 0.05                                           | 0.3  | 4.0                                                          | 2.0             | 100                                       | 5.6                              |
| C9V1(R)   | 8.5                             | 9.6  | 0.07                                           | 0.5  | 5.0                                                          | 1.0             | 50                                        | 6.2                              |
| C10(R)    | 9.4                             | 10.6 | 0.07                                           | 0.5  | 7.0                                                          | 1.0             | 50                                        | 6.8                              |
| C11(R)    | 10.4                            | 11.6 | 0.08                                           | 1.0  | 7.5                                                          | 1.0             | 50                                        | 7.5                              |
| C12(R)    | 11.4                            | 12.7 | 0.08                                           | 1.0  | 8.0                                                          | 1.0             | 50                                        | 8.2                              |
| C13(R)    | 12.4                            | 14.1 | 0.08                                           | 1.0  | 8.5                                                          | 1.0             | 50                                        | 9.1                              |
| C15(R)    | 13.8                            | 15.6 | 0.10                                           | 1.2  | 10                                                           | 1.0             | 50                                        | 10                               |
| C16(R)    | 15.3                            | 17.1 | 0.18                                           | 1.2  | 11                                                           | 0.5             | 50                                        | 11                               |
| C18(R)    | 16.8                            | 19.1 | 0.2                                            | 1.5  | 12                                                           | 0.5             | 50                                        | 12                               |
| C20(R)    | 18.8                            | 21.2 | 0.2                                            | 1.5  | 14                                                           | 0.5             | 50                                        | 13                               |
| C22(R)    | 20.8                            | 23.3 | 0.21                                           | 1.8  | 16                                                           | 0.5             | 50                                        | 15                               |
| C24(R)    | 22.7                            | 25.9 | 0.22                                           | 2.0  | 18                                                           | 0.5             | 50                                        | 16                               |
| C27(R)    | 25.1                            | 28.9 | 0.25                                           | 2.0  | 21                                                           | 0.5             | 50                                        | 18                               |
| C30(R)    | 28                              | 32   | 0.3                                            | 2.5  | 25                                                           | 0.5             | 50                                        | 20                               |
| C33(R)    | 31                              | 35   | 0.32                                           | 3.0  | 30                                                           | 0.5             | 50                                        | 22                               |
| C36(R)    | 34                              | 38   | 0.75                                           | 4.0  | 32                                                           | 0.2             | 50                                        | 24                               |
| C39(R)    | 37                              | 41   | 0.85                                           | 5.0  | 35                                                           | 0.2             | 50                                        | 27                               |
| C43(R)    | 40                              | 46   | 0.90                                           | 6.5  | 40                                                           | 0.2             | 50                                        | 30                               |
| C47(R)    | 44                              | 50   | 1.0                                            | 7.0  | 45                                                           | 0.2             | 50                                        | 33                               |
| C51(R)    | 48                              | 54   | 1.2                                            | 7.5  | 50                                                           | 0.2             | 50                                        | 36                               |
| C56(R)    | 52                              | 60   | 1.3                                            | 8.0  | 55                                                           | 0.2             | 50                                        | 39                               |
| C62(R)    | 58                              | 66   | 1.5                                            | 9.0  | 60                                                           | 0.2             | 50                                        | 43                               |
| C68(R)    | 64                              | 72   | 1.8                                            | 10   | 65                                                           | 0.2             | 50                                        | 47                               |
| C75(R)    | 70                              | 79   | 2.0                                            | 10.5 | 70                                                           | 0.2             | 50                                        | 51                               |

\*At test  $I_Z$ ; measured using a pulse method with  $t_p \leq 100\text{ }\mu\text{s}$  and  $\delta \leq 0.001$  so that the values correspond to a  $T_j$  of approximately  $25\text{ }^{\circ}\text{C}$ .

CHARACTERISTICS – WHEN USED AS TRANSIENT SUPPRESSOR DIODES;  $T_{mb} = 25\text{ }^{\circ}\text{C}$

| clamping voltage at<br>$t_p = 500\text{ }\mu\text{s}$<br>exp. pulse<br>$V_{(CL)R}$<br>V |      | non-repetitive<br>peak reverse<br>current<br>$I_{RSM}$<br>A | reverse current<br>at recommended<br>stand-off voltage<br>$I_R$<br>mA |  | $V_R$<br>V | BZY93-... |
|-----------------------------------------------------------------------------------------|------|-------------------------------------------------------------|-----------------------------------------------------------------------|--|------------|-----------|
| typ.                                                                                    | max. |                                                             | max.                                                                  |  |            |           |
| 8                                                                                       | 9.2  | 20                                                          | 0.5                                                                   |  | 5.6        | C7V5(R)   |
| 9                                                                                       | 10.2 | 20                                                          | 0.5                                                                   |  | 6.2        | C8V2(R)   |
| 10                                                                                      | 11.5 | 20                                                          | 0.5                                                                   |  | 6.8        | C9V1(R)   |
| 11                                                                                      | 12.5 | 20                                                          | 0.1                                                                   |  | 7.5        | C10(R)    |
| 12.3                                                                                    | 14   | 20                                                          | 0.1                                                                   |  | 8.2        | C11(R)    |
| 14                                                                                      | 16   | 20                                                          | 0.1                                                                   |  | 9.1        | C12(R)    |
| 15.3                                                                                    | 17.5 | 20                                                          | 0.1                                                                   |  | 10         | C13(R)    |
| 17                                                                                      | 19.5 | 20                                                          | 0.1                                                                   |  | 11         | C15(R)    |
| 19.3                                                                                    | 22   | 20                                                          | 0.1                                                                   |  | 12         | C16(R)    |
| 21                                                                                      | 24   | 20                                                          | 0.1                                                                   |  | 13         | C18(R)    |
| 23                                                                                      | 27   | 10                                                          | 0.1                                                                   |  | 15         | C20(R)    |
| 26                                                                                      | 30   | 10                                                          | 0.1                                                                   |  | 16         | C22(R)    |
| 29                                                                                      | 34   | 10                                                          | 0.1                                                                   |  | 18         | C24(R)    |
| 33                                                                                      | 39   | 10                                                          | 0.1                                                                   |  | 20         | C27(R)    |
| 38                                                                                      | 44   | 10                                                          | 0.1                                                                   |  | 22         | C30(R)    |
| 42                                                                                      | 50   | 10                                                          | 0.1                                                                   |  | 24         | C33(R)    |
| 47                                                                                      | 56   | 10                                                          | 0.1                                                                   |  | 27         | C36(R)    |
| 40                                                                                      | 47   | 5                                                           | 0.1                                                                   |  | 30         | C39(R)    |
| 45                                                                                      | 52   | 5                                                           | 0.1                                                                   |  | 33         | C43(R)    |
| 51                                                                                      | 59   | 5                                                           | 0.1                                                                   |  | 36         | C47(R)    |
| 57                                                                                      | 66   | 5                                                           | 0.1                                                                   |  | 39         | C51(R)    |
| 64                                                                                      | 75   | 5                                                           | 0.1                                                                   |  | 43         | C56(R)    |
| 73                                                                                      | 85   | 5                                                           | 0.1                                                                   |  | 47         | C62(R)    |
| 81                                                                                      | 94   | 5                                                           | 0.1                                                                   |  | 51         | C68(R)    |
| 90                                                                                      | 105  | 5                                                           | 0.1                                                                   |  | 56         | C75(R)    |

MOUNTING INSTRUCTIONS

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

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