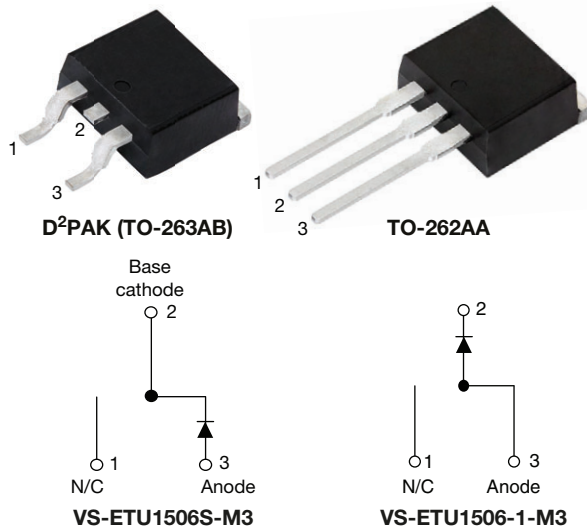


## Ultra Fast Rectifier, 15 A FRED Pt®



### FEATURES

- Low forward voltage drop
- Ultrafast recovery time
- 175 °C operating junction temperature
- Low leakage current
- Designed and qualified according to JEDEC®-JESD 47
- Meets MSL level 1, per J-STD-020, LF maximum peak of 245 °C
- Material categorization: for definitions of compliance please see [www.vishay.com/doc?99912](http://www.vishay.com/doc?99912)



**RoHS**  
COMPLIANT  
HALOGEN  
**FREE**

### DESCRIPTION

State of the art, ultralow  $V_F$ , soft-switching ultrafast rectifiers optimized for discontinuous (critical) mode (DCM) power factor correction (PFC).

The minimized conduction loss, optimized stored charge and low recovery current minimized the switching losses and reduce over dissipation in the switching element and snubbers.

The device is also intended for use as a freewheeling diode in power supplies and other power switching applications.

### APPLICATIONS

AC/DC SMPS 70 W to 400 W  
e.g. laptop and printer AC adaptors, desktop PC, TV and monitor, games units, and DVD AC/DC power supplies.

| PRIMARY CHARACTERISTICS |   |
|-------------------------|---|
| $I_{F(AV)}$             | 15 A                                    |
| $V_R$                   | 600 V                                   |
| $V_F$ at $I_F$          | 1.1 V                                   |
| $t_{rr}$ (typ.)         | 24 ns                                   |
| $T_J$ max.              | 175 °C                                  |
| Package                 | D <sup>2</sup> PAK (TO-263AB), TO-262AA |
| Circuit configuration   | Single                                  |

| ABSOLUTE MAXIMUM RATINGS                    |                |                 |             |       |
|---|----------------|-----------------|-------------|-------|
| PARAMETER                                   | SYMBOL         | TEST CONDITIONS | MAX.        | UNITS |
| Repetitive peak reverse voltage             | $V_{RRM}$      |                 | 600         | V     |
| Average rectified forward current           | $I_{F(AV)}$    | $T_C = 143$ °C  | 15          | A     |
| Non-repetitive peak surge current           | $I_{FSM}$      | $T_C = 25$ °C   | 160         |       |
| Operating junction and storage temperatures | $T_J, T_{Stg}$ |                 | -65 to +175 | °C    |

| ELECTRICAL SPECIFICATIONS ( $T_J = 25$ °C unless otherwise specified) |               |  |      |      |      |         |
|---|---------------|--|------|------|------|---------|
| PARAMETER   | SYMBOL        | TEST CONDITIONS                              | MIN. | TYP. | MAX. | UNITS   |
| Breakdown voltage, blocking voltage                                   | $V_{BR}, V_R$ | $I_R = 100$ $\mu$ A                          | 600  | -    | -    | V       |
|   |               |  |      |      |      |         |
| Forward voltage   | $V_F$         | $I_F = 15$ A                                 | -    | 1.35 | 1.9  | V       |
|   |               | $I_F = 15$ A, $T_J = 150$ °C                 | -    | 1.1  | 1.3  |         |
| Reverse leakage current   | $I_R$         | $V_R = V_R$ rated                            | -    | 0.01 | 15   | $\mu$ A |
|   |               | $T_J = 150$ °C, $V_R = V_R$ rated            | -    | 20   | 200  |         |
| Junction capacitance  | $C_T$         | $V_R = 600$ V                                | -    | 12   | -    | pF      |
| Series inductance   | $L_S$         | Measured lead to lead 5 mm from package body | -    | 8.0  | -    | nH      |



| DYNAMIC RECOVERY CHARACTERISTICS ( $T_J = 25\text{ }^\circ\text{C}$ unless otherwise specified) |           |  |   |      |      |       |    |
|---|-----------|--|---|------|------|-------|----|
| PARAMETER   | SYMBOL    | TEST CONDITIONS  | MIN.  | TYP. | MAX. | UNITS |    |
| Reverse recovery time   | $t_{rr}$  | $I_F = 1\text{ A}$ , $di_F/dt = 100\text{ A}/\mu\text{s}$ , $V_R = 30\text{ V}$  | -   | 24   | 28   | ns    |    |
|   |           | $I_F = 15\text{ A}$ , $di_F/dt = 100\text{ A}/\mu\text{s}$ , $V_R = 30\text{ V}$ | -   | 36   | 47   |       |    |
|   |           | $T_J = 25\text{ }^\circ\text{C}$   | -   | 40   | -    |       |    |
|   |           | $T_J = 125\text{ }^\circ\text{C}$  | -   | 87   | -    |       |    |
| Peak recovery current   | $I_{RRM}$ | $T_J = 25\text{ }^\circ\text{C}$   | -   | 5    | -    | A     |    |
|   |           | $T_J = 125\text{ }^\circ\text{C}$  | -   | 9.0  | -    |       |    |
| Reverse recovery charge   | $Q_{rr}$  | $T_J = 25\text{ }^\circ\text{C}$   | -   | 107  | -    | C     |    |
|   |           | $T_J = 125\text{ }^\circ\text{C}$  | -   | 430  | -    |       |    |
| Reverse recovery time   | $t_{rr}$  | $T_J = 125\text{ }^\circ\text{C}$  | $I_F = 15\text{ A}$<br>$di_F/dt = 800\text{ A}/\mu\text{s}$<br>$V_R = 390\text{ V}$ | -    | 53   | -     | ns |
| Peak recovery current   | $I_{RRM}$ |  |   | -    | 25   | -     | A  |
| Reverse recovery charge   | $Q_{rr}$  |  |   | -    | 730  | -     | nC |

| THERMAL - MECHANICAL SPECIFICATIONS            |                |   |           |      |            |                           |
|--|----------------|---|-----------|------|------------|---------------------------|
| PARAMETER                                      | SYMBOL         | TEST CONDITIONS                             | MIN.      | TYP. | MAX.       | UNITS                     |
| Maximum junction and storage temperature range | $T_J, T_{Stg}$ |   | -65       | -    | 175        | $^\circ\text{C}$          |
| Thermal resistance, junction-to-case           | $R_{thJC}$     |   | -         | 1.3  | 1.51       | $^\circ\text{C}/\text{W}$ |
| Thermal resistance, junction-to-ambient        | $R_{thJA}$     | Typical socket mount                        | -         | -    | 70         |                           |
| Thermal resistance, case-to-heat sink          | $R_{thCS}$     | Mounting surface, flat, smooth, and greased | -         | 0.5  | -          |                           |
| Weight   |                |   | -         | 2.0  | -          | g                         |
|  |                |   | -         | 0.07 | -          | oz.                       |
| Mounting torque                                |                |   | 6<br>(5)  | -    | 12<br>(10) | kgf · cm<br>(lbf · in)    |
| Marking device                                 |                | Case style D <sup>2</sup> PAK (TO-263AB)    | ETU1506S  |      |            |                           |
|  |                | Case style TO-262                           | ETU1506-1 |      |            |                           |

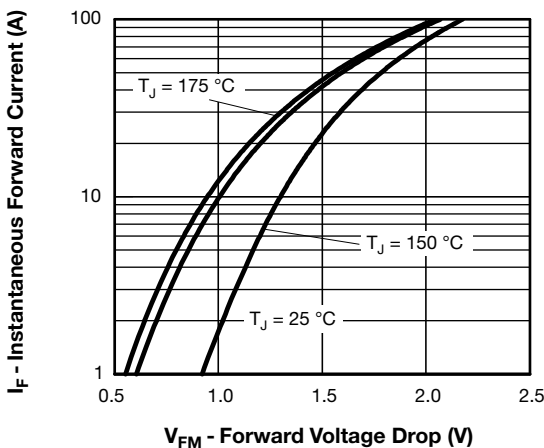


Fig. 1 - Typical Forward Voltage Drop Characteristics

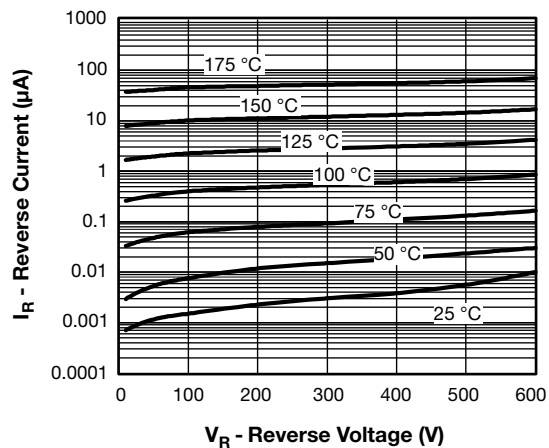


Fig. 2 - Typical Values of Reverse Current vs. Reverse Voltage

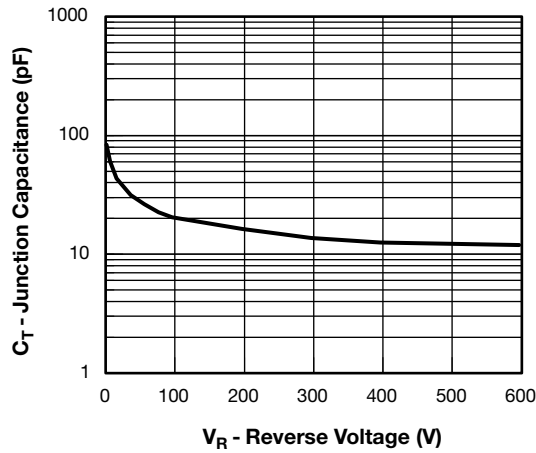


Fig. 3 - Typical Junction Capacitance vs. Reverse Voltage

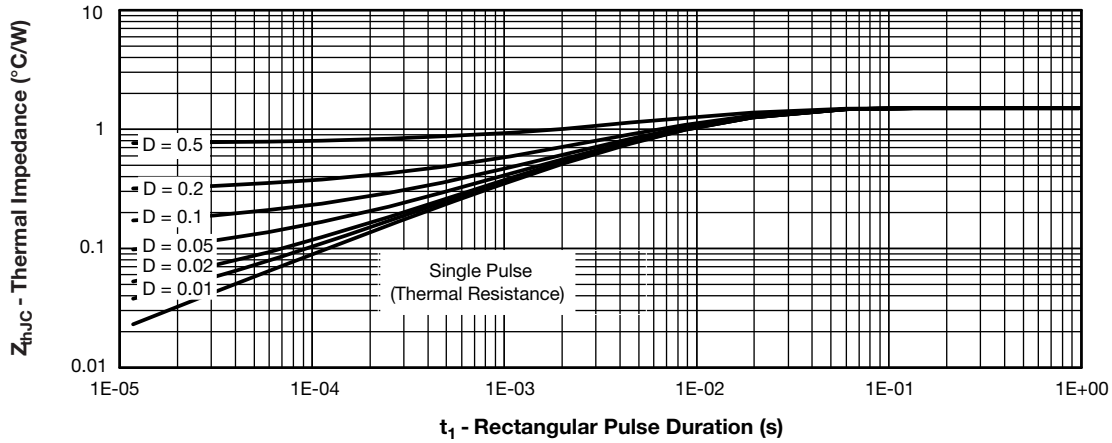


Fig. 4 - Max. Thermal Impedance  $Z_{thJC}$  Characteristics

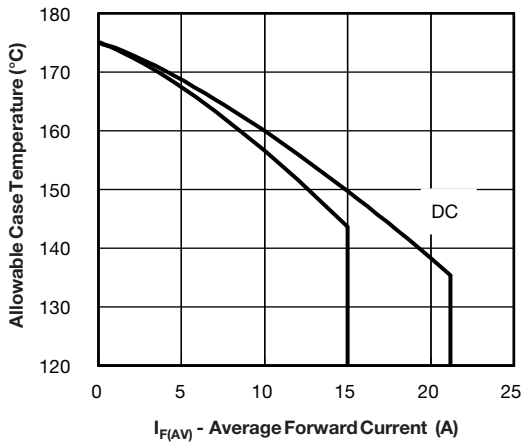


Fig. 5 - Maximum Allowable Case Temperature vs. Average Forward Current

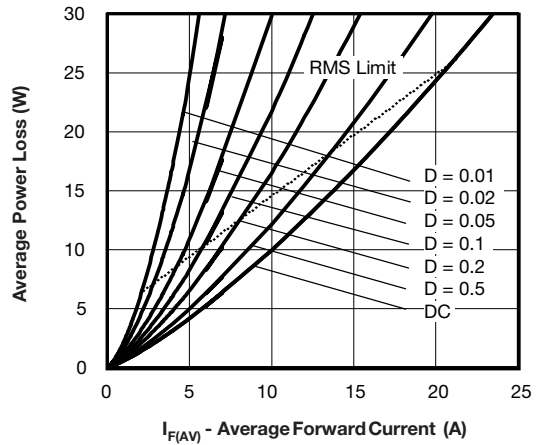


Fig. 6 - Forward Power Loss Characteristics

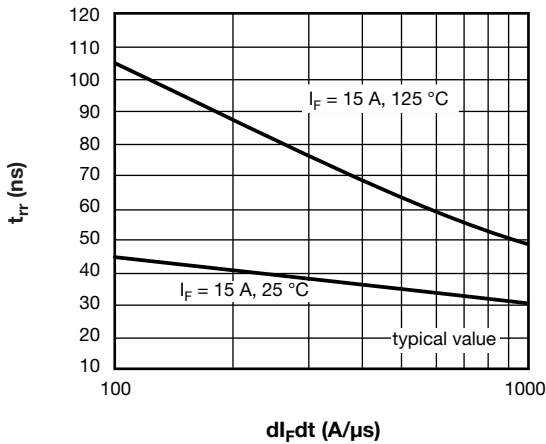


Fig. 7 - Typical Reverse Recovery Time vs.  $di/dt$

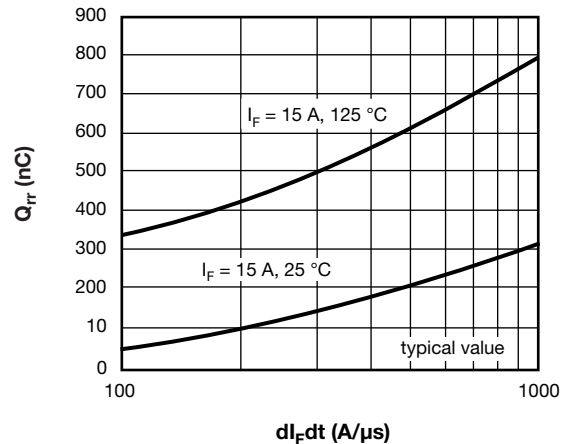
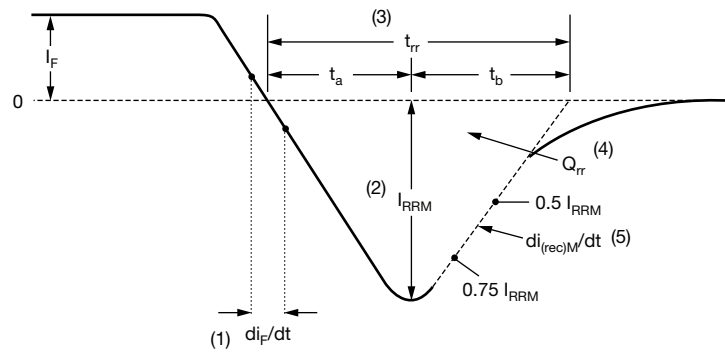


Fig. 8 - Typical Stored Charge vs.  $di/dt$



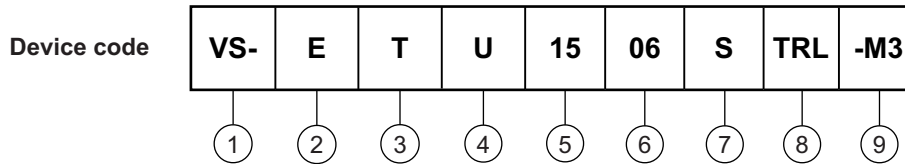
- (1)  $di_F/dt$  - rate of change of current through zero crossing
- (2)  $I_{RRM}$  - peak reverse recovery current
- (3)  $t_{rr}$  - reverse recovery time measured from zero crossing point of negative going  $I_F$  to point where a line passing through  $0.75 I_{RRM}$  and  $0.50 I_{RRM}$  extrapolated to zero current.
- (4)  $Q_{rr}$  - area under curve defined by  $t_{rr}$  and  $I_{RRM}$
- (5)  $di_{(rec)M}/dt$  - peak rate of change of current during  $t_b$  portion of  $t_{rr}$

$$Q_{rr} = \frac{t_{rr} \times I_{RRM}}{2}$$

Fig. 9 - Reverse Recovery Waveform and Definitions



## ORDERING INFORMATION TABLE

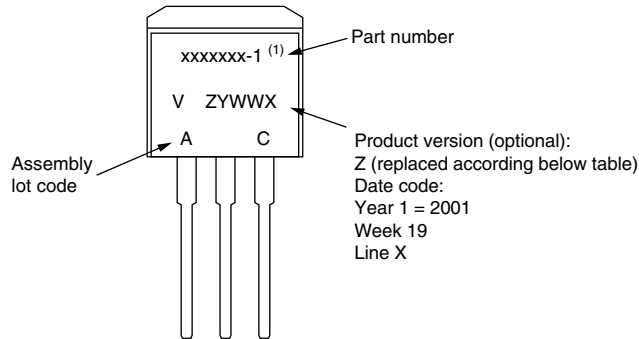


- 1** - Vishay Semiconductors product
- 2** - Circuit configuration  
E = single diode
- 3** - T = TO-220
- 4** - U = ultrafast recovery time
- 5** - Current code (15 = 15 A)
- 6** - Voltage code (06 = 600 V)
- 7** - • S = D<sup>2</sup>PAK (TO-263AB)  
• -1 = TO-262AA
- 8** - • None = tube (50 pieces)  
• TRL = tape and reel (left oriented, for D<sup>2</sup>PAK (TO-263AB) package)  
• TRR = tape and reel (right oriented, for D<sup>2</sup>PAK (TO-263AB) package)
- 9** - -M3 = halogen-free, RoHS-compliant, and terminations lead (Pb)-free

| ORDERING INFORMATION (Example) |                   |                        |                         |
|--------------------------------|-------------------|------------------------|-------------------------|
| PREFERRED P/N                  | QUANTITY PER TUBE | MINIMUM ORDER QUANTITY | PACKAGING DESCRIPTION   |
| VS-ETU1506S-M3                 | 50                | 1000                   | Antistatic plastic tube |
| VS-ETU1506-1-M3                | 50                | 1000                   | Antistatic plastic tube |
| VS-ETU1506STRR-M3              | 800               | 800                    | 13" diameter reel       |
| VS-ETU1506STRL-M3              | 800               | 800                    | 13" diameter reel       |

| LINKS TO RELATED DOCUMENTS |                               |  |
|----------------------------|-------------------------------|--|
| Dimensions                 | D <sup>2</sup> PAK (TO-263AB) | <a href="http://www.vishay.com/doc?96164">www.vishay.com/doc?96164</a> |
|                            | TO-262AA                      | <a href="http://www.vishay.com/doc?96165">www.vishay.com/doc?96165</a> |
| Part marking information   | D <sup>2</sup> PAK (TO-263AB) | <a href="http://www.vishay.com/doc?95444">www.vishay.com/doc?95444</a> |
|                            | TO-262AA                      | <a href="http://www.vishay.com/doc?95443">www.vishay.com/doc?95443</a> |
| Packaging information      | D <sup>2</sup> PAK (TO-263AB) | <a href="http://www.vishay.com/doc?96424">www.vishay.com/doc?96424</a> |
| SPIICE model               |                               | <a href="http://www.vishay.com/doc?96132">www.vishay.com/doc?96132</a> |

## TO-262



Example: This is a xxxxxx-1 <sup>(1)</sup> with assembly lot code AC, assembled on WW 19, 2001 in the assembly line "X"

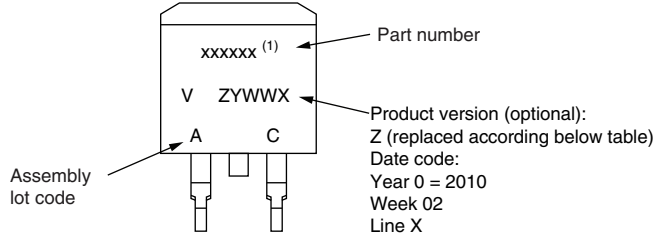
### Note

<sup>(1)</sup> If part number contain "H" as last digit, product is AEC-Q101 qualified

| ENVIRONMENTAL NAMING CODE (Z) | PRODUCT DEFINITION  |
|-------------------------------|---|
| A                             | Termination lead (Pb)-free                                  |
| B                             | Totally lead (Pb)-free                                      |
| E                             | RoHS-compliant and termination lead (Pb)-free               |
| F                             | RoHS-compliant and totally lead (Pb)-free                   |
| M                             | Halogen-free, RoHS-compliant and termination lead (Pb)-free |
| N                             | Halogen-free, RoHS-compliant and totally lead (Pb)-free     |
| G                             | Green   |



## D<sup>2</sup>PAK



Example: This is a xxxxxx (1) with assembly lot code AC, assembled on WW 02, 2010

### Note

(1) If part number contain "H" as last digit, product is AEC-Q101 qualified

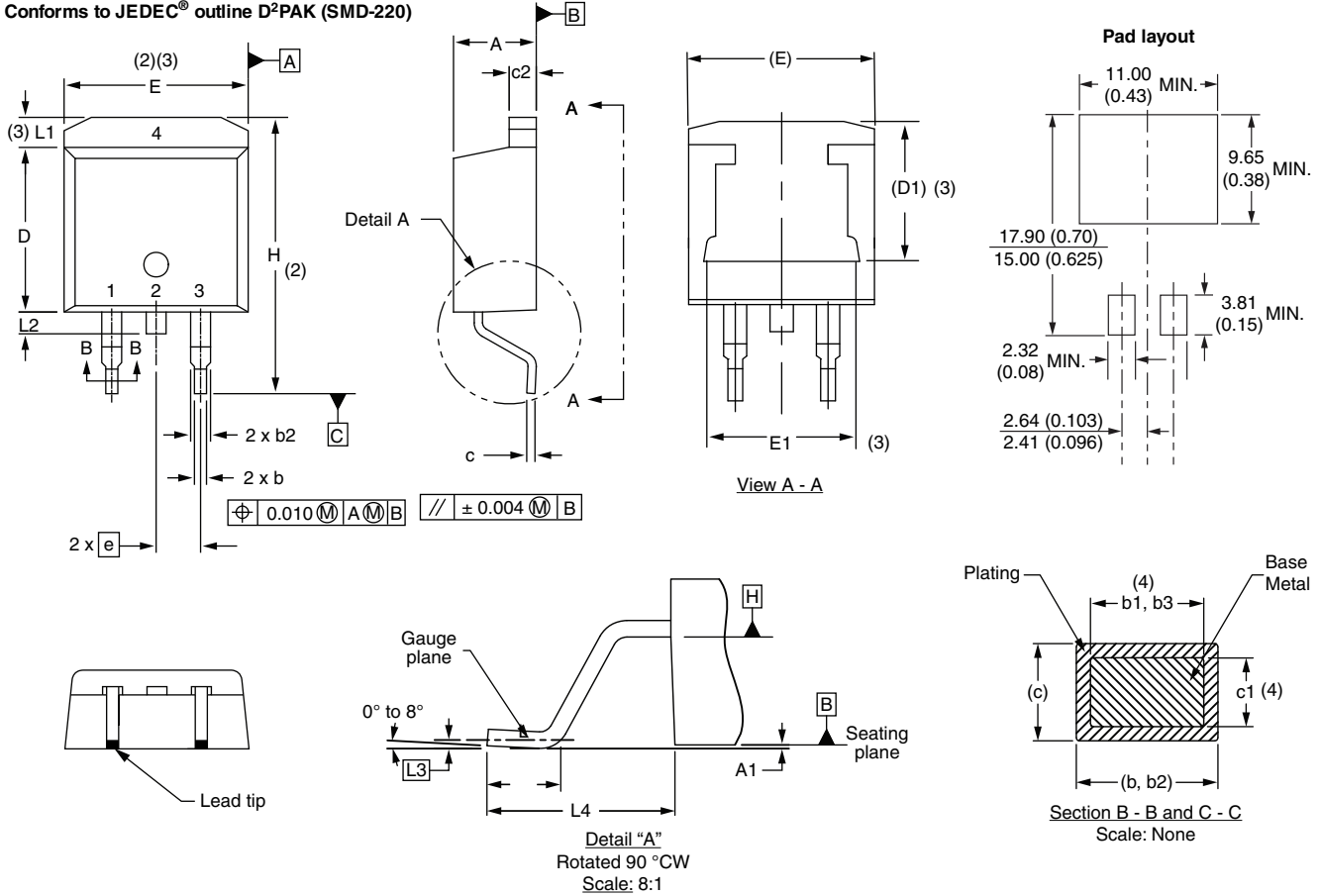
| ENVIRONMENTAL NAMING CODE (Z) | PRODUCT DEFINITION   |
|-------------------------------|--|
| A                             | Termination lead (Pb)-free                                   |
| B                             | Totally lead (Pb)-free                                       |
| E                             | RoHS-compliant and termination lead (Pb)-free                |
| F                             | RoHS-compliant and totally lead (Pb)-free                    |
| M                             | Halogen-free, RoHS-compliant, and termination lead (Pb)-free |
| N                             | Halogen-free, RoHS-compliant, and totally lead (Pb)-free     |
| G                             | Green  |



# D<sup>2</sup>PAK

**DIMENSIONS** in millimeters and inches

Conforms to JEDEC® outline D<sup>2</sup>PAK (SMD-220)



| SYMBOL | MILLIMETERS |       | INCHES |       | NOTES | SYMBOL | MILLIMETERS |       | INCHES    |       | NOTES |
|--------|-------------|-------|--------|-------|-------|--------|-------------|-------|-----------|-------|-------|
|        | MIN.        | MAX.  | MIN.   | MAX.  |       |        | MIN.        | MAX.  | MIN.      | MAX.  |       |
| A      | 4.06        | 4.83  | 0.160  | 0.190 |       | D1     | 6.86        | 8.00  | 0.270     | 0.315 | 3     |
| A1     | 0.00        | 0.254 | 0.000  | 0.010 |       | E      | 9.65        | 10.67 | 0.380     | 0.420 | 2, 3  |
| b      | 0.51        | 0.99  | 0.020  | 0.039 |       | E1     | 7.90        | 8.80  | 0.311     | 0.346 | 3     |
| b1     | 0.51        | 0.89  | 0.020  | 0.035 | 4     | e      | 2.54 BSC    |       | 0.100 BSC |       |       |
| b2     | 1.14        | 1.78  | 0.045  | 0.070 |       | H      | 14.61       | 15.88 | 0.575     | 0.625 |       |
| b3     | 1.14        | 1.73  | 0.045  | 0.068 | 4     | L      | 1.78        | 2.79  | 0.070     | 0.110 |       |
| c      | 0.38        | 0.74  | 0.015  | 0.029 |       | L1     | -           | 1.65  | -         | 0.066 | 3     |
| c1     | 0.38        | 0.58  | 0.015  | 0.023 | 4     | L2     | 1.27        | 1.78  | 0.050     | 0.070 |       |
| c2     | 1.14        | 1.65  | 0.045  | 0.065 |       | L3     | 0.25 BSC    |       | 0.010 BSC |       |       |
| D      | 8.51        | 9.65  | 0.335  | 0.380 | 2     | L4     | 4.78        | 5.28  | 0.188     | 0.208 |       |

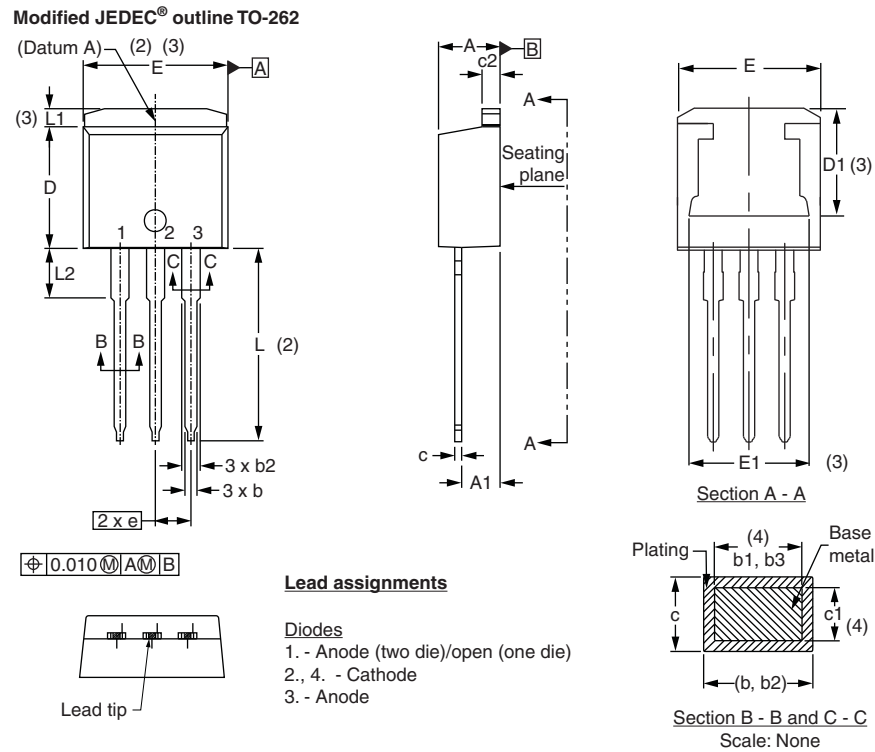
**Notes**

- (1) Dimensioning and tolerancing per ASME Y14.5 M-1994
- (2) Dimension D and E do not include mold flash. Mold flash shall not exceed 0.127 mm (0.005") per side. These dimensions are measured at the outmost extremes of the plastic body
- (3) Thermal pad contour optional within dimension E, L1, D1 and E1
- (4) Dimension b1 and c1 apply to base metal only
- (5) Datum A and B to be determined at datum plane H
- (6) Controlling dimension: inches
- (7) Outline conforms to JEDEC® outline TO-263AB



### TO-262AA

**DIMENSIONS** in millimeters and inches



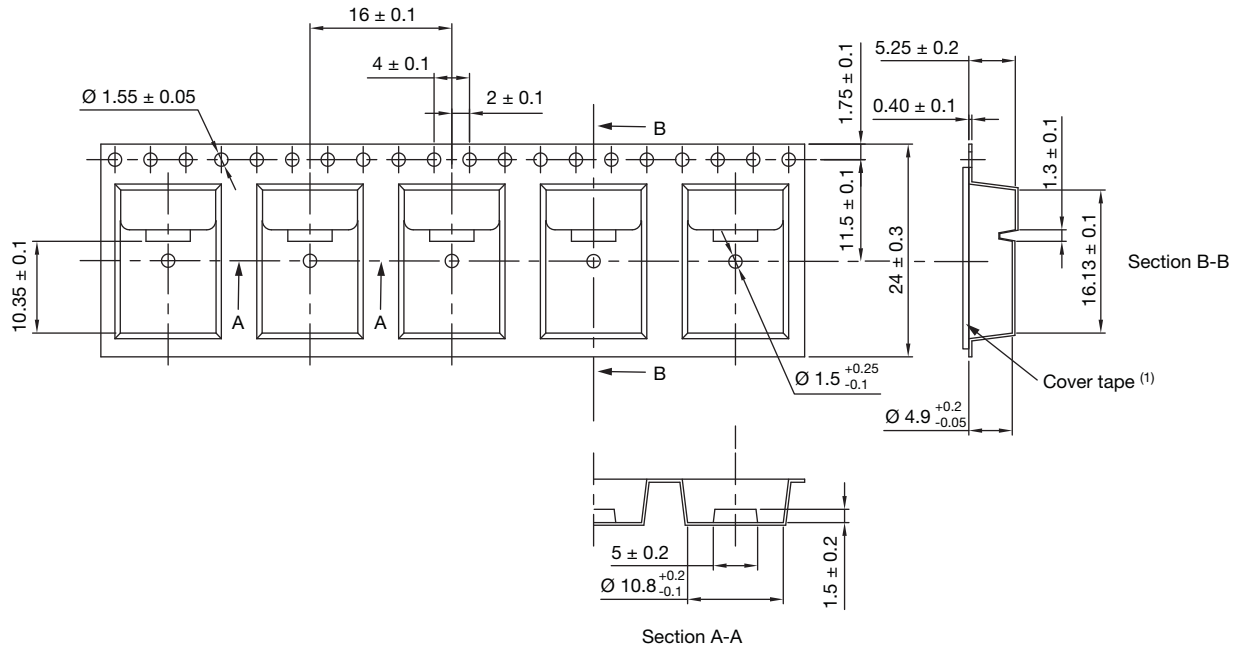
| SYMBOL | MILLIMETERS |       | INCHES    |       | NOTES |
|--------|-------------|-------|-----------|-------|-------|
|        | MIN.        | MAX.  | MIN.      | MAX.  |       |
| A      | 4.06        | 4.83  | 0.160     | 0.190 |       |
| A1     | 2.03        | 3.02  | 0.080     | 0.119 |       |
| b      | 0.51        | 0.99  | 0.020     | 0.039 |       |
| b1     | 0.51        | 0.89  | 0.020     | 0.035 | 4     |
| b2     | 1.14        | 1.78  | 0.045     | 0.070 |       |
| b3     | 1.14        | 1.73  | 0.045     | 0.068 | 4     |
| c      | 0.38        | 0.74  | 0.015     | 0.029 |       |
| c1     | 0.38        | 0.58  | 0.015     | 0.023 | 4     |
| c2     | 1.14        | 1.65  | 0.045     | 0.065 |       |
| D      | 8.51        | 9.65  | 0.335     | 0.380 | 2     |
| D1     | 6.86        | 8.00  | 0.270     | 0.315 | 3     |
| E      | 9.65        | 10.67 | 0.380     | 0.420 | 2, 3  |
| E1     | 7.90        | 8.80  | 0.311     | 0.346 | 3     |
| e      | 2.54 BSC    |       | 0.100 BSC |       |       |
| L      | 13.46       | 14.10 | 0.530     | 0.555 |       |
| L1     | -           | 1.65  | -         | 0.065 | 3     |
| L2     | 3.56        | 3.71  | 0.140     | 0.146 |       |

**Notes**

- (1) Dimensioning and tolerancing as per ASME Y14.5M-1994
- (2) Dimension D and E do not include mold flash. Mold flash shall not exceed 0.127 mm (0.005") per side. These dimensions are measured at the outmost extremes of the plastic body
- (3) Thermal pad contour optional within dimension E, L1, D1 and E1
- (4) Dimension b1 and c1 apply to base metal only
- (5) Controlling dimension: inches
- (6) Outline conform to JEDEC® TO-262 except A1 (max.), b (min., max.), b1 (min.), b2 (max.), c (min.), c1 (min.), c2 (max.), D (min.), E (max.), L1 (max.), L2 (min., max.)

# D<sup>2</sup>PAK (TO-263AB)

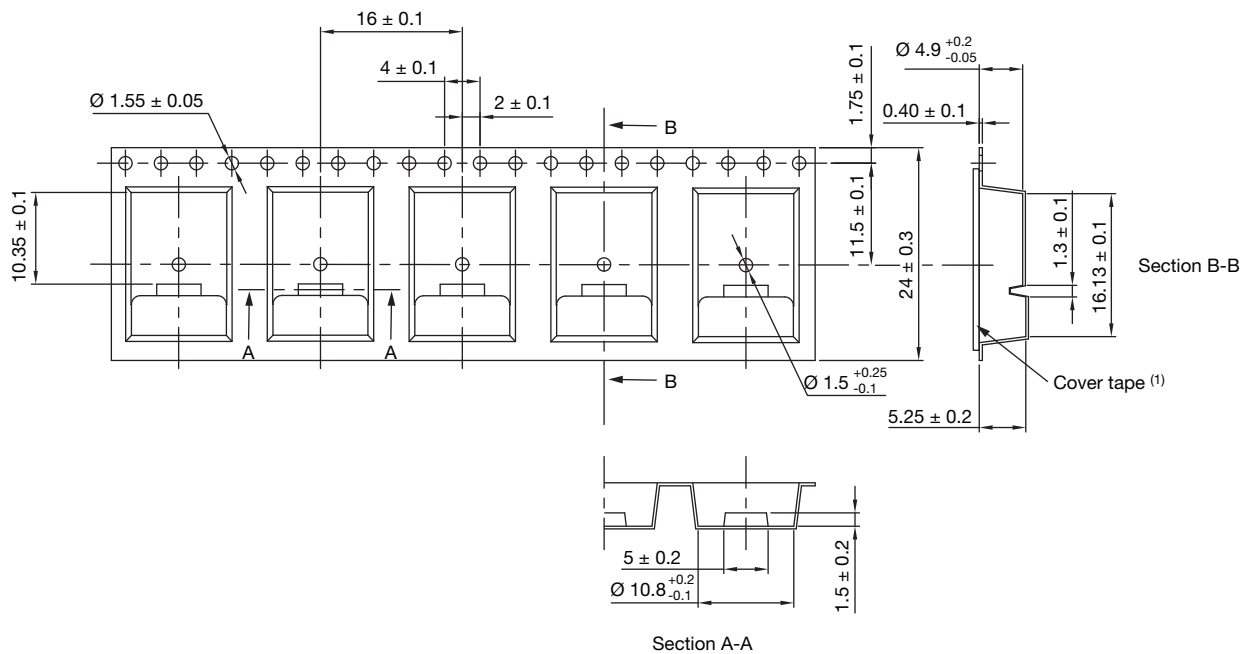
## CARRIER TAPE FOR TAPE AND REEL LEFT in millimeters



**Note**

(1) For dimensions, see next pages

## CARRIER TAPE FOR TAPE AND REEL RIGHT in millimeters

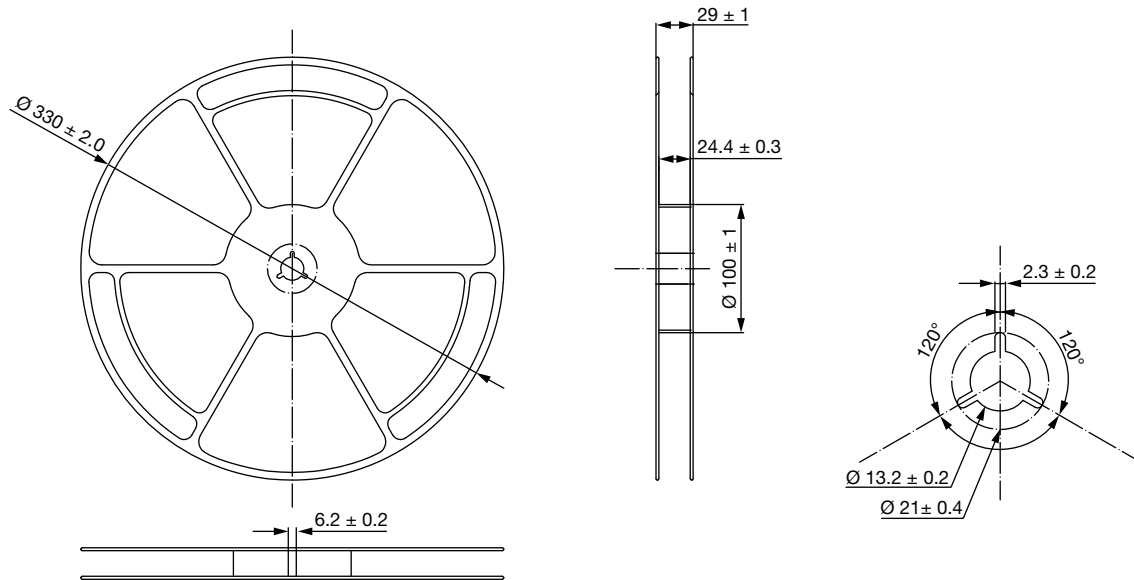


**Note**

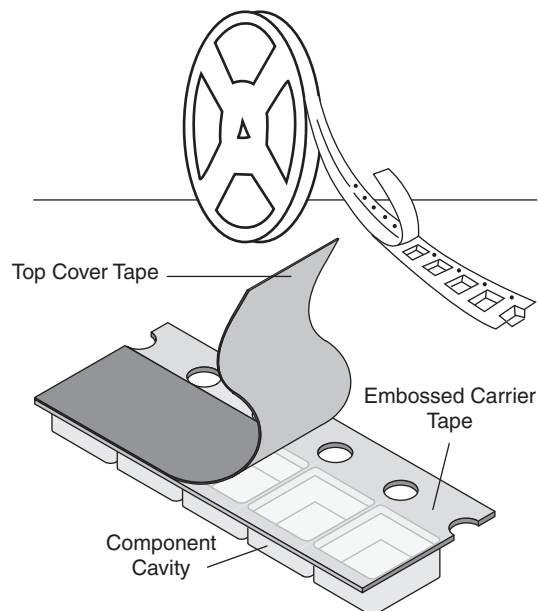
(1) For dimensions, see next pages



## REEL FOR CARRIER TAPE in millimeters

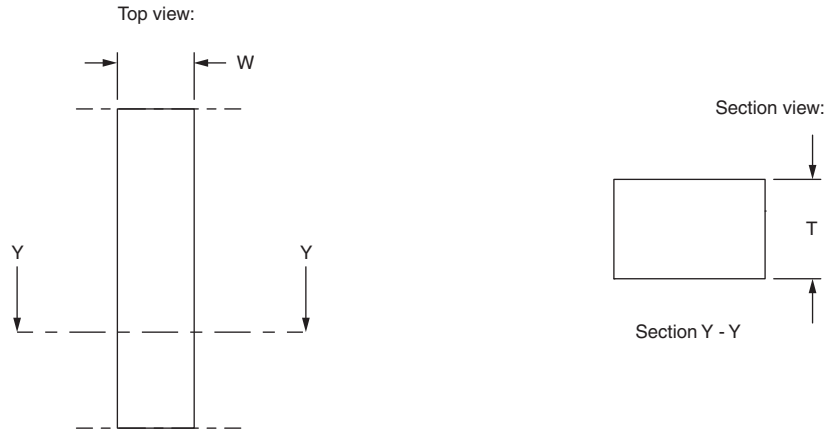


## CARRIER TAPE AND REEL PACKAGING D<sup>2</sup>PAK (TO-263AB)





### COVER TAPE FOR CARRIER TAPE in millimeters



| APPLICATION                      | COVER TAPE WIDTH<br>W | COVER TAPE THICKNESS<br>T | CARRIER TAPE WIDTH | MATERIAL                                 |
|----------------------------------|-----------------------|---------------------------|--------------------|--|
| D <sup>2</sup> PAK<br>(TO-263AB) | 21.3 ± 0.1            | 0.060 ± 0.01              | 24                 | Antistatic/treated/transparent/polyester |



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