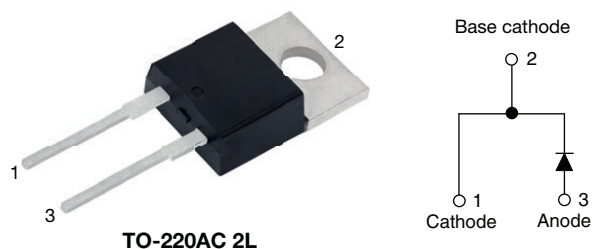


# Hyperfast Rectifier, 15 A FRED Pt® G5



## FEATURES

- Best in class forward voltage drop and switching losses trade off
- Optimized for high speed operation
- 175 °C maximum operating junction temperature
- Polyimide passivation
- AEC-Q101 qualified, meets JESD 201 class 2 whisker test
- Material categorization: for definitions of compliance please see [www.vishay.com/doc?99912](http://www.vishay.com/doc?99912)



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

## LINKS TO ADDITIONAL RESOURCES



| PRIMARY CHARACTERISTICS  |             |
|--------------------------|-------------|
| $I_{F(AV)}$              | 15 A        |
| $V_R$                    | 600 V       |
| $V_F$ at $I_F$ at 125 °C | 1.15 V      |
| $t_{rr}$ (typ.)          | 22 ns       |
| $T_J$ max.               | 175 °C      |
| Package                  | TO-220AC 2L |
| Circuit configuration    | Single      |

## DESCRIPTION / APPLICATIONS

Featuring a unique combination of low conduction and switching losses, this rectifier is the right choice for soft switched and resonant converters, as well as medium frequency hard switching converters. This device is specifically designed to improve efficiency of high speed LLC output rectification stages of EV / HEV on-board battery chargers

## MECHANICAL DATA

**Case:** TO-220AC 2L

Molding compound meets UL 94 V-0 flammability rating

**Terminals:** matte tin plated leads, solderable per J-STD-002

| ABSOLUTE MAXIMUM RATINGS                   |                   |  |             |       |
|--|-------------------|--|-------------|-------|
| PARAMETER                                  | SYMBOL            | TEST CONDITIONS  | VALUES      | UNITS |
| Repetitive peak reverse voltage            | $V_{RRM}$         |  | 600         | V     |
| Average rectified forward current          | $I_{F(AV)}$       | $T_C = 136\text{ °C}$ , $D = 0.50$                       | 15          | A     |
| Repetitive peak forward current            | $I_{FRM}$         | $T_C = 136\text{ °C}$ , $D = 0.50$ , $f = 20\text{ kHz}$ | 30          |       |
| Non-repetitive peak surge current          | $I_{FSM}$         | $T_C = 25\text{ °C}$ , $t_p = 10\text{ ms}$ , sine wave  | 200         |       |
| Operating junction and storage temperature | $T_J$ , $T_{Stg}$ |  | -55 to +175 | °C    |

| ELECTRICAL SPECIFICATIONS ( $T_J = 25\text{ °C}$ unless otherwise specified) |                  |   |      |      |      |               |
|--|------------------|---|------|------|------|---------------|
| PARAMETER  | SYMBOL           | TEST CONDITIONS                             | MIN. | TYP. | MAX. | UNITS         |
| Breakdown voltage, blocking voltage  | $V_{BR}$ , $V_R$ | $I_R = 100\text{ }\mu\text{A}$              | 600  | -    | -    | V             |
| Forward voltage  | $V_F$            | $I_F = 15\text{ A}$                         | -    | 1.3  | 1.6  |               |
|  |                  | $I_F = 15\text{ A}$ , $T_J = 125\text{ °C}$ | -    | 1.15 | -    |               |
| Reverse leakage current  | $I_R$            | $V_R = V_R$ rated                           | -    | -    | 10   | $\mu\text{A}$ |
|  |                  | $T_J = 125\text{ °C}$ , $V_R = V_R$ rated   | -    | -    | 500  |               |
| Junction capacitance   | $C_T$            | $V_R = 200\text{ V}$                        | -    | 25   | -    | pF            |
| Series inductance  | $L_S$            | Measured to lead 5 mm from package body     | -    | 8    | -    | 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   | $t_{rr}$  | $I_F = 1.0\text{ A}$ , $di_F/dt = 100\text{ A}/\mu\text{s}$ , $V_R = 30\text{ V}$ | -    | 22   | -    | ns    |
|                         |           | $T_J = 25\text{ }^{\circ}\text{C}$  | -    | 31   | -    |       |
|                         |           | $T_J = 125\text{ }^{\circ}\text{C}$   | -    | 43   | -    |       |
| Peak recovery current   | $I_{RRM}$ | $T_J = 25\text{ }^{\circ}\text{C}$  | -    | 15   | -    | A     |
|                         |           | $T_J = 125\text{ }^{\circ}\text{C}$   | -    | 22   | -    |       |
| Reverse recovery charge | $Q_{rr}$  | $T_J = 25\text{ }^{\circ}\text{C}$  | -    | 255  | -    | nC    |
|                         |           | $T_J = 125\text{ }^{\circ}\text{C}$   | -    | 622  | -    |       |
| Reverse recovery time   | $t_{rr}$  | $T_J = 25\text{ }^{\circ}\text{C}$  | -    | 38   | -    | ns    |
|                         |           | $T_J = 125\text{ }^{\circ}\text{C}$   | -    | 49   | -    |       |
| Peak recovery current   | $I_{RRM}$ | $T_J = 25\text{ }^{\circ}\text{C}$  | -    | 16   | -    | A     |
|                         |           | $T_J = 125\text{ }^{\circ}\text{C}$   | -    | 24   | -    |       |
| Reverse recovery charge | $Q_{rr}$  | $T_J = 25\text{ }^{\circ}\text{C}$  | -    | 316  | -    | nC    |
|                         |           | $T_J = 125\text{ }^{\circ}\text{C}$   | -    | 782  | -    |       |

**THERMAL - MECHANICAL SPECIFICATIONS**

| PARAMETER                                      | SYMBOL            | TEST CONDITIONS        | MIN.       | TYP. | MAX.       | UNITS                       |
|--|-------------------|------------------------|------------|------|------------|-----------------------------|
| Thermal resistance, junction-to-case           | $R_{thJC}$        |                        | -          | -    | 1.72       | $^{\circ}\text{C}/\text{W}$ |
| Weight   |                   |                        | -          | 2.0  | -          | g                           |
| Mounting torque                                |                   |                        | 6.0<br>(5) | -    | 12<br>(10) | kgf · cm<br>(lbf · in)      |
| Maximum junction and storage temperature range | $T_J$ , $T_{Stg}$ |                        | -55        | -    | 175        | $^{\circ}\text{C}$          |
| Marking device                                 |                   | Case style TO-220AC 2L | E5TH1506TH |      |            |                             |

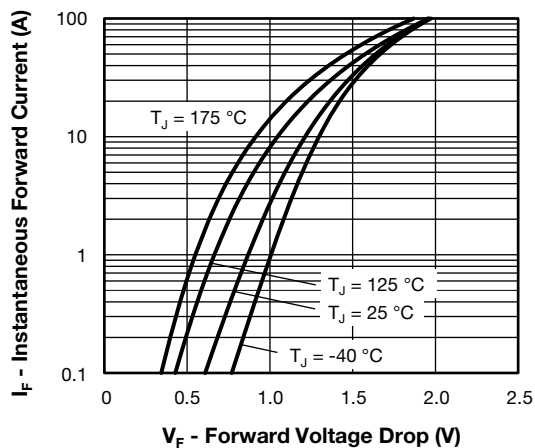


Fig. 1 - Forward Voltage Drop Characteristics, Per Leg

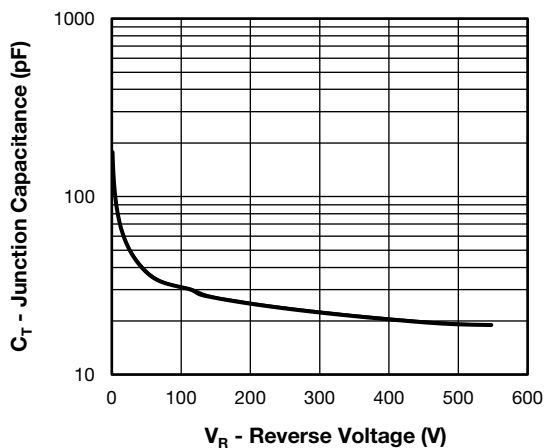


Fig. 3 - Typical Junction Capacitance vs. Reverse Voltage, Per Leg

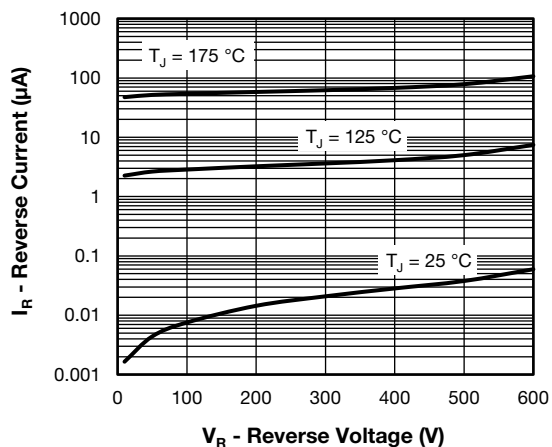


Fig. 2 - Typical Values of Reverse Current vs. Reverse Voltage, Per Leg

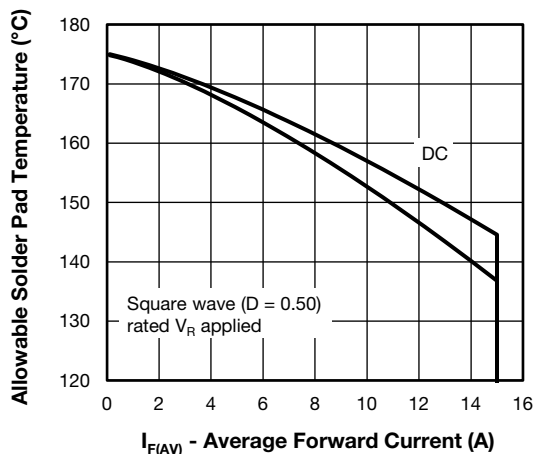


Fig. 4 - Maximum Allowable Case Temperature vs. Average Forward Current, Per Leg

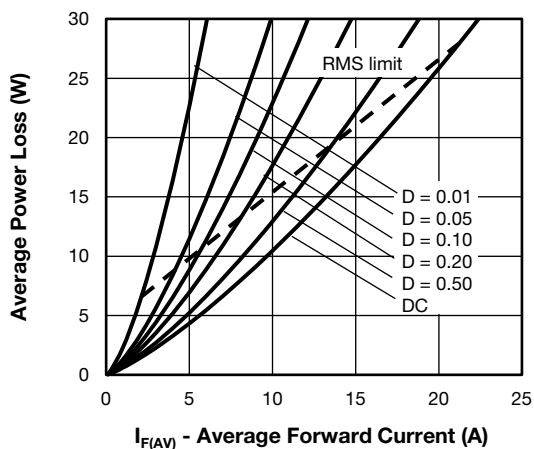


Fig. 5 - Forward Power Loss Characteristics, Per Leg

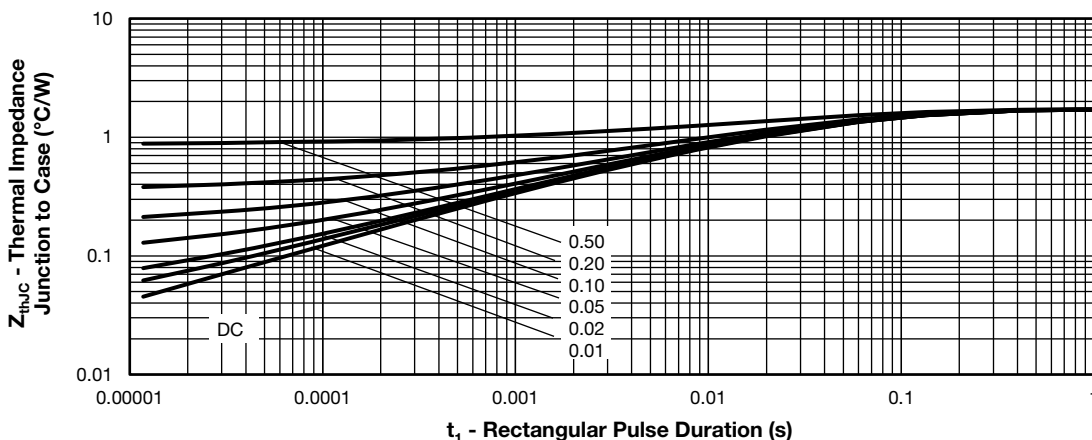
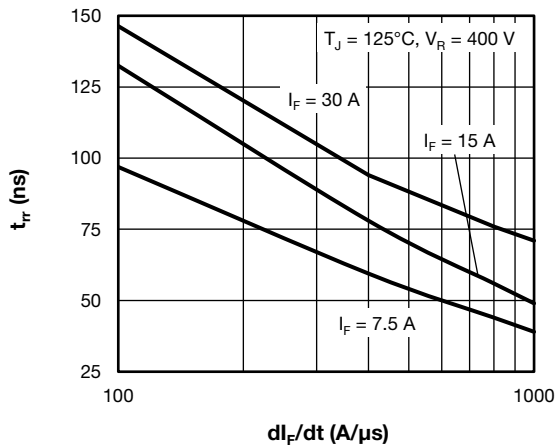
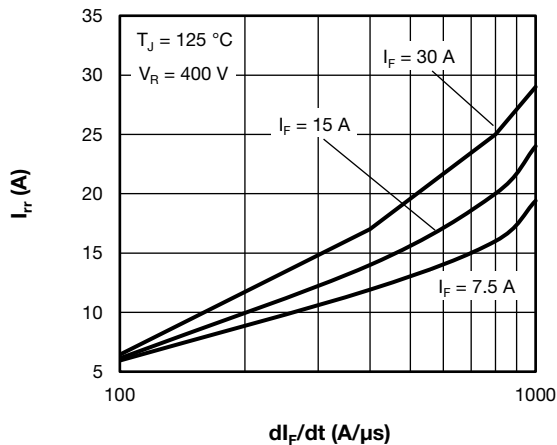
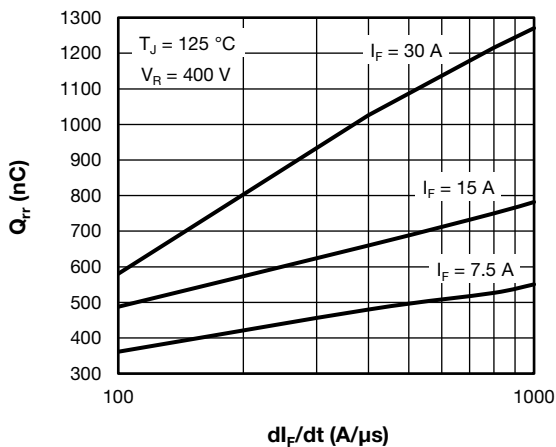
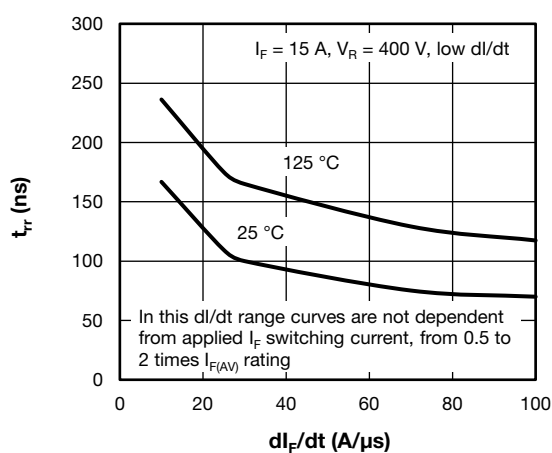


Fig. 6 - Transient Thermal Impedance, Junction to Case, Per Leg


Fig. 7 - Typical Reverse Recovery Time vs.  $dI_F/dt$ , Per Leg

Fig. 9 - Typical Reverse Recovery Current vs.  $dI_F/dt$ , Per Leg

Fig. 8 - Typical Reverse Recovery Charge vs.  $dI_F/dt$ , Per Leg

Fig. 10 - Typical Reverse Recovery Time vs.  $dI_F/dt$ , Per Leg

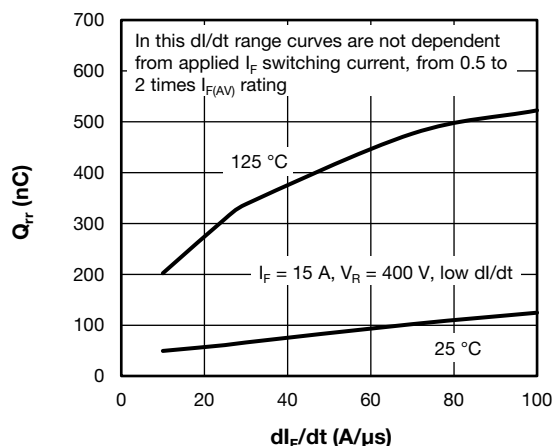
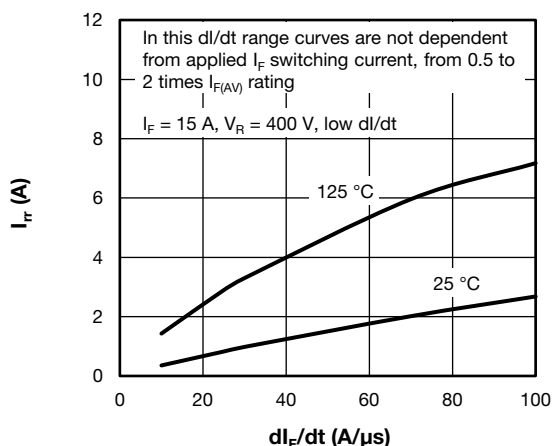
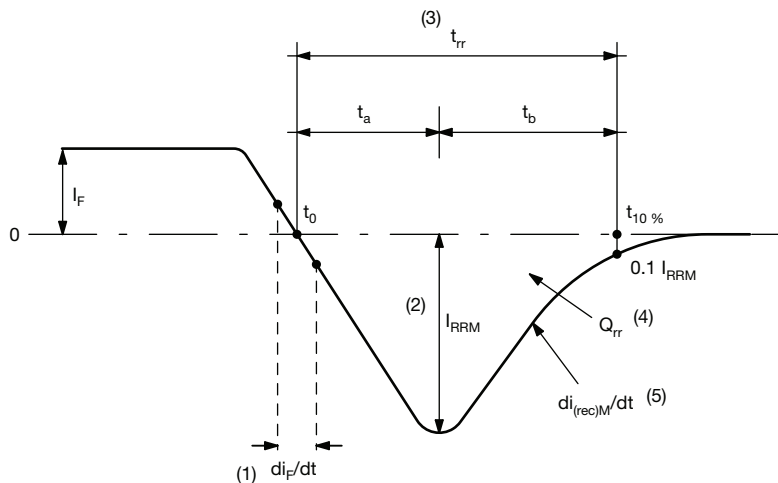

Fig. 11 - Typical Reverse Recovery Charge vs.  $di_F/dt$ , Per Leg

Fig. 12 - Typical Reverse Recovery Current vs.  $di_F/dt$ , Per Leg


Fig. 13 - Reverse Recovery Waveform and Definitions

#### Notes

- (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  $t_0$ , crossing point of negative going  $I_F$ , to point  $t_{10\%}$ ,  $0.1 I_{RRM}$
- (4)  $Q_{rr}$  - area under curve defined by  $t_0$  and  $t_{10\%}$

$$Q_{rr} = \int_{t_0}^{t_{10\%}} I(t) dt$$

- (5)  $di_{(rec)M}/dt$  - peak rate of change of current during  $t_b$  portion of  $t_{rr}$

**ORDERING INFORMATION TABLE**

|             |   |          |          |          |          |           |           |          |          |           |
|-------------|---|----------|----------|----------|----------|-----------|-----------|----------|----------|-----------|
| Device code | <b>VS-</b>  | <b>E</b> | <b>5</b> | <b>T</b> | <b>H</b> | <b>15</b> | <b>06</b> | <b>T</b> | <b>H</b> | <b>N3</b> |
|             | ①   | ②        | ③        | ④        | ⑤        | ⑥         | ⑦         | ⑧        | ⑨        | ⑩         |
| ①           | - Vishay Semiconductors product   |          |          |          |          |           |           |          |          |           |
| ②           | - E = single diode  |          |          |          |          |           |           |          |          |           |
| ③           | - 5 = FRED generation 5   |          |          |          |          |           |           |          |          |           |
| ④           | - Package:<br>T = TO-220AC 2L   |          |          |          |          |           |           |          |          |           |
| ⑤           | - H = hyperfast recovery  |          |          |          |          |           |           |          |          |           |
| ⑥           | - Current rating (15 = 15 A)  |          |          |          |          |           |           |          |          |           |
| ⑦           | - Voltage rating (06 = 600 V)   |          |          |          |          |           |           |          |          |           |
| ⑧           | - T = true pin TO-220   |          |          |          |          |           |           |          |          |           |
| ⑨           | - H = AEC-Q101 qualified  |          |          |          |          |           |           |          |          |           |
| ⑩           | - Environmental digit:<br>N3 = halogen-free, RoHS-compliant, and totally lead (Pb)-free |          |          |          |          |           |           |          |          |           |

**ORDERING INFORMATION** (Example)

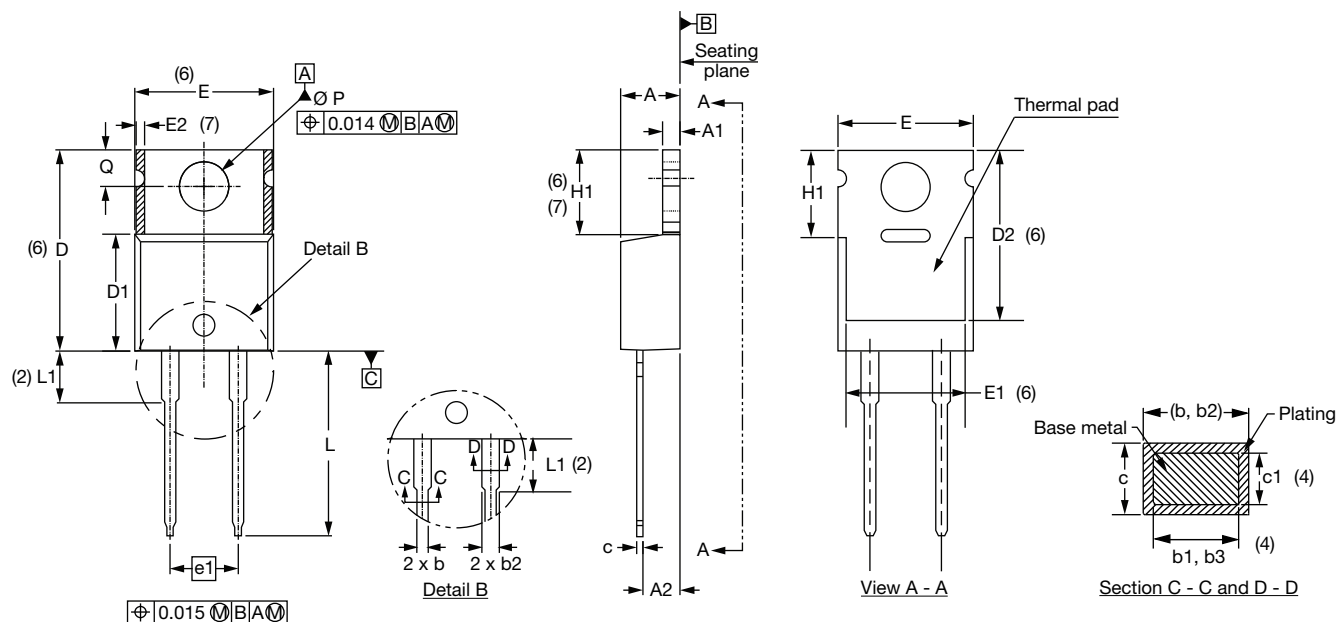
| PREFERRED P/N   | QUANTITY PER TUBE | MINIMUM ORDER QUANTITY | PACKAGING DESCRIPTION   |
|-----------------|-------------------|------------------------|-------------------------|
| VS-E5TH1506THN3 | 50                | 1000                   | Antistatic plastic tube |

**LINKS TO RELATED DOCUMENTS**

|                          |  |
|--------------------------|--|
| Dimensions               | <a href="http://www.vishay.com/doc?96069">www.vishay.com/doc?96069</a> |
| Part marking information | <a href="http://www.vishay.com/doc?95391">www.vishay.com/doc?95391</a> |

# TO-220AC 2L

**DIMENSIONS** in millimeters and inches



| SYMBOL | MILLIMETERS |       | INCHES |       | NOTES |
|--------|-------------|-------|--------|-------|-------|
|        | MIN.        | MAX.  | MIN.   | MAX.  |       |
| A      | 4.25        | 4.65  | 0.167  | 0.183 |       |
| A1     | 1.14        | 1.40  | 0.045  | 0.055 |       |
| A2     | 2.56        | 2.92  | 0.101  | 0.115 |       |
| b      | 0.69        | 1.01  | 0.027  | 0.040 |       |
| b1     | 0.38        | 0.97  | 0.015  | 0.038 | 4     |
| b2     | 1.20        | 1.73  | 0.047  | 0.068 |       |
| b3     | 1.14        | 1.73  | 0.045  | 0.068 | 4     |
| c      | 0.36        | 0.61  | 0.014  | 0.024 |       |
| c1     | 0.36        | 0.56  | 0.014  | 0.022 | 4     |
| D      | 14.85       | 15.25 | 0.585  | 0.600 | 3     |
| D1     | 8.38        | 9.02  | 0.330  | 0.355 |       |
| D2     | 11.68       | 12.88 | 0.460  | 0.507 | 6     |
| E      | 10.11       | 10.51 | 0.398  | 0.414 | 3, 6  |

## Notes

- (1) Dimensioning and tolerancing as per ASME Y14.5M-1994
- (2) Lead dimension and finish uncontrolled in L1
- (3) Dimension D, D1 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 outermost extremes of the plastic body
- (4) Dimension b1, b3 and c1 apply to base metal only
- (5) Controlling dimension: inches
- (6) Thermal pad contour optional within dimensions E, H1, D2 and E1
- (7) Dimension E2 x H1 define a zone where stamping and singulation irregularities are allowed
- (8) Outline conforms to JEDEC® TO-220, except D2, where JEDEC® minimum is 0.480"



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