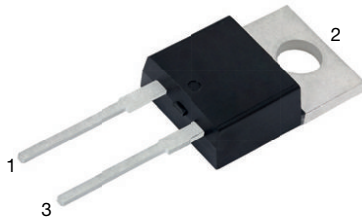
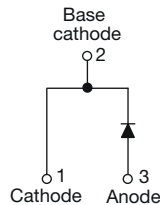


# Ultralow $V_F$ Hyperfast Rectifier for Discontinuous Mode PFC, 15 A FRED Pt®


**TO-220AC 2L**

**FEATURES**

- Hyperfast recovery time
- Benchmark ultralow forward voltage drop
- 175 °C operating junction temperature
- Low leakage current
- Designed and qualified according to JEDEC®-JESD 47
- 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 hyperfast rectifiers optimized for Discontinuous (Critical) Mode (DCM) Power Factor Correction (PFC).

The minimized conduction loss, optimized stored charge and low recovery current minimize 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 $I_F$        | 0.85 V      |
| $t_{rr}$ typ.         | 60 ns       |
| $T_J$ max.            | 175 °C      |
| Package               | TO-220AC 2L |
| Circuit configuration | Single      |

**ABSOLUTE MAXIMUM RATINGS**

| PARAMETER                                   | SYMBOL         | TEST CONDITIONS       | VALUES      | UNITS |
|---|----------------|-----------------------|-------------|-------|
| Peak repetitive reverse voltage             | $V_{RRM}$      |                       | 600         | V     |
| Average rectified forward current           | $I_{F(AV)}$    | $T_C = 154\text{ °C}$ | 15          | A     |
| Non-repetitive peak surge current           | $I_{FSM}$      | $T_J = 25\text{ °C}$  | 250         |       |
| Peak repetitive forward current             | $I_{FM}$       |                       | 30          |       |
| Operating junction and storage temperatures | $T_J, T_{Stg}$ |                       | -65 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 | $V_{BR}, V_R$ | $I_R = 100\ \mu\text{A}$                     | 600  | -    | -    | V             |
| Forward voltage                     | $V_F$         | $I_F = 15\text{ A}$                          | -    | 0.99 | 1.05 |               |
|                                     |               | $I_F = 15\text{ A}, T_J = 150\text{ °C}$     | -    | 0.85 | 0.92 |               |
| Reverse leakage current             | $I_R$         | $V_R = V_R$ rated                            | -    | 0.1  | 10   | $\mu\text{A}$ |
|                                     |               | $T_J = 150\text{ °C}, V_R = V_R$ rated       | -    | 15   | 120  |               |
| Junction capacitance                | $C_T$         | $V_R = 600\text{ V}$                         | -    | 20   | -    | pF            |
| Series inductance                   | $L_S$         | Measured lead to lead 5 mm from package body | -    | 8.0  | -    | nH            |



| DYNAMIC RECOVERY CHARACTERISTICS ( $T_C = 25\text{ }^\circ\text{C}$ unless otherwise specified) |           |  |      |      |      |               |
|---|-----------|--|------|------|------|---------------|
| PARAMETER   | SYMBOL    | TEST CONDITIONS  | MIN. | TYP. | MAX. | UNITS         |
| Reverse recovery time   | $t_{rr}$  | $I_F = 1\text{ A}$ , $dI_F/dt = 100\text{ A}/\mu\text{s}$ , $V_R = 30\text{ V}$  | -    | 60   | 120  | ns            |
|   |           | $I_F = 15\text{ A}$ , $dI_F/dt = 100\text{ A}/\mu\text{s}$ , $V_R = 30\text{ V}$ | -    | 190  | 270  |               |
|   |           | $T_J = 25\text{ }^\circ\text{C}$   | -    | 220  | -    |               |
|   |           | $T_J = 125\text{ }^\circ\text{C}$  | -    | 320  | -    |               |
| Peak recovery current   | $I_{RRM}$ | $T_J = 25\text{ }^\circ\text{C}$   | -    | 19   | -    | A             |
|   |           | $T_J = 125\text{ }^\circ\text{C}$  | -    | 26   | -    |               |
| Reverse recovery charge   | $Q_{rr}$  | $T_J = 25\text{ }^\circ\text{C}$   | -    | 2.2  | -    | $\mu\text{C}$ |
|   |           | $T_J = 125\text{ }^\circ\text{C}$  | -    | 4.3  | -    |               |

| 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            | $R_{thJC}$        |   | -            | 1.0  | 1.3        | $^\circ\text{C}/\text{W}$ |
| Thermal resistance, junction-to-ambient per leg | $R_{thJA}$        | Typical socket mount                        | -            | -    | 70         |                           |
| Thermal resistance, case-to-heatsink            | $R_{thCS}$        | Mounting surface, flat, smooth, and greased | -            | 0.5  | -          |                           |
| Weight  |                   |   | -            | 2.0  | -          | g                         |
|   |                   |   | -            | 0.07 | -          | oz.                       |
| Mounting torque                                 |                   |   | 6.0<br>(5.0) | -    | 12<br>(10) | kgf · cm<br>(lbf · in)    |
| Marking device                                  |                   | Case style TO-220AC 2L                      | 15ETL06      |      |            |                           |

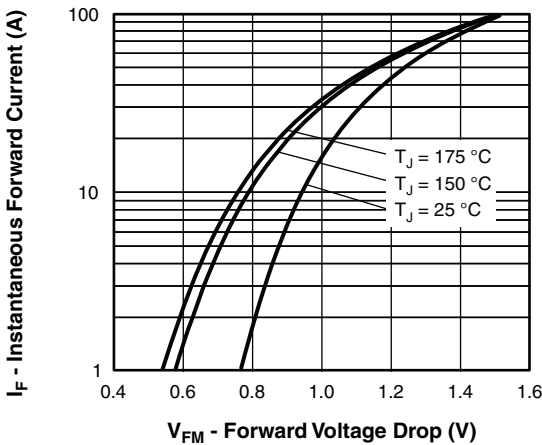


Fig. 1 - Maximum Forward Voltage Drop Characteristics

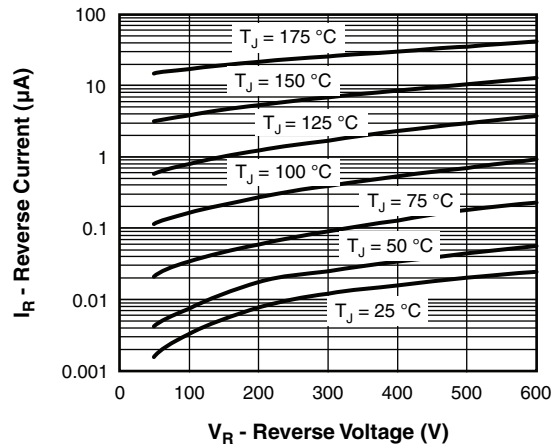


Fig. 2 - Typical Values of Reverse Current vs. Reverse Voltage

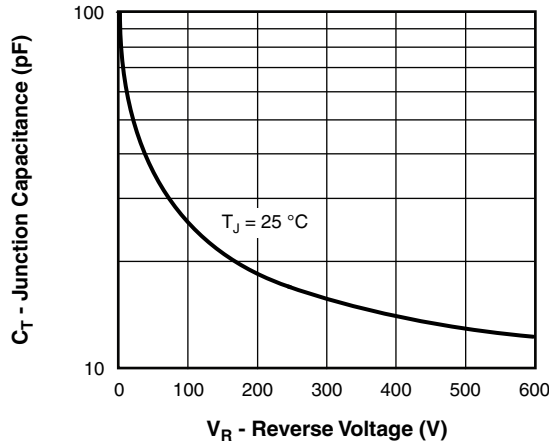


Fig. 3 - Typical Junction Capacitance vs. Reverse Voltage

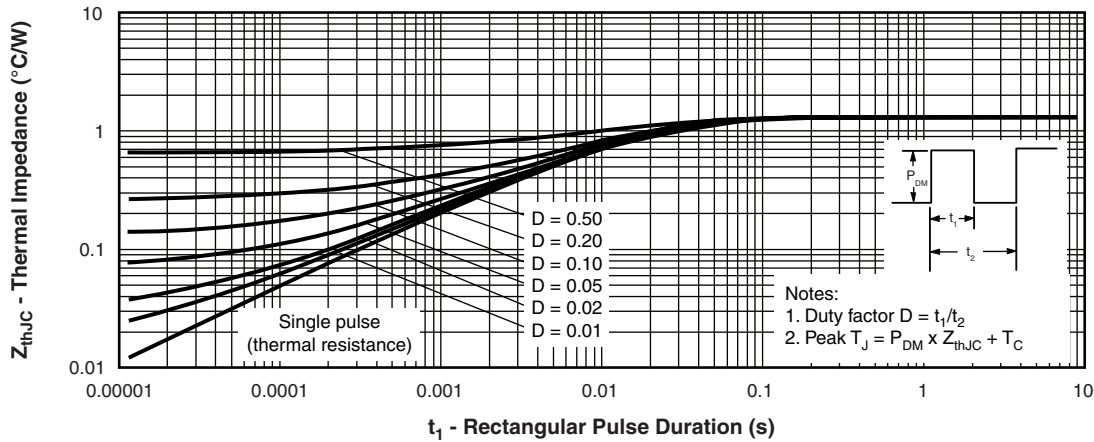


Fig. 4 - Maximum Thermal Impedance  $Z_{thJC}$  Characteristics

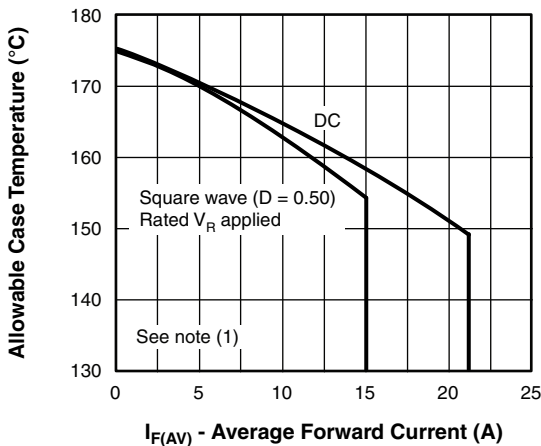


Fig. 5 - Maximum Allowable Case Temperature vs. Average Forward Current

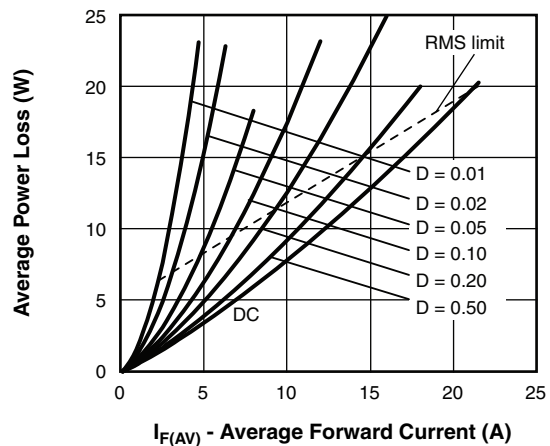


Fig. 6 - Forward Power Loss Characteristics

**Note**

- (1) Formula used:  $T_C = T_J - (P_d + P_{dREV}) \times R_{thJC}$ ;  
 $P_d$  = forward power loss =  $I_{F(AV)} \times V_{FM}$  at  $(I_{F(AV)}/D)$  (see fig. 5);  
 $P_{dREV}$  = inverse power loss =  $V_{R1} \times I_R (1 - D)$ ;  $I_R$  at  $V_{R1}$  = rated  $V_R$

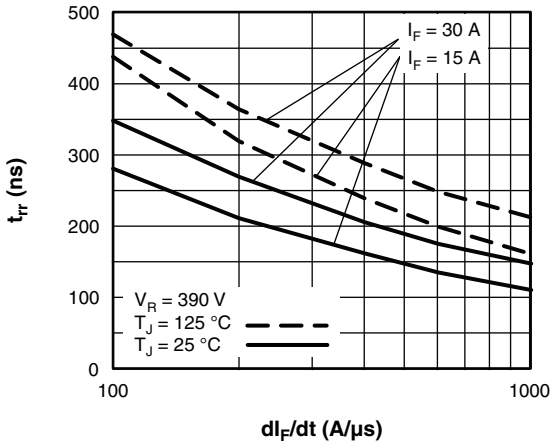


Fig. 7 - Typical Reverse Recovery Time vs.  $di_F/dt$

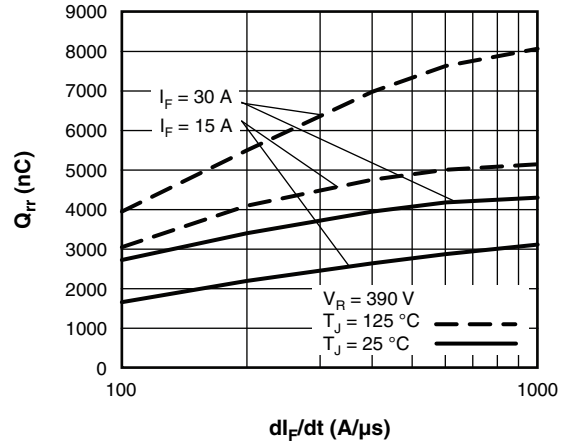
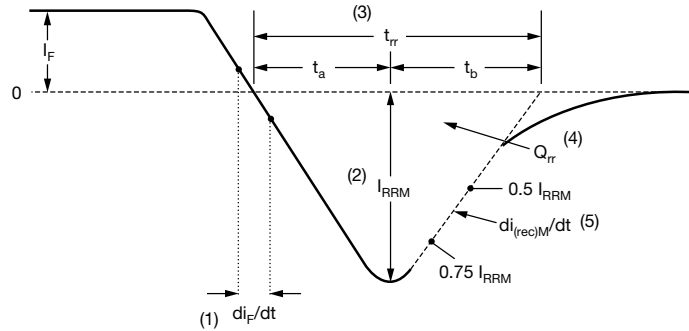


Fig. 8 - Typical Stored Charge vs.  $di_F/dt$



- (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  $I_{RRM}$

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

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

Fig. 9 - Reverse Recovery Waveform and Definitions



### ORDERING INFORMATION TABLE

|             |            |           |          |          |          |           |            |
|-------------|------------|-----------|----------|----------|----------|-----------|------------|
| Device code | <b>VS-</b> | <b>15</b> | <b>E</b> | <b>T</b> | <b>L</b> | <b>06</b> | <b>-M3</b> |
|             | ①          | ②         | ③        | ④        | ⑤        | ⑥         | ⑦          |

- 1** - Vishay Semiconductors product
- 2** - Current rating (15 = 15 A)
- 3** - E = single diode
- 4** - T = TO-220, D<sup>2</sup>PAK (TO-263AB)
- 5** - L = ultralow V<sub>F</sub> hyperfast recovery
- 6** - Voltage rating (06 = 600 V)
- 7** - Environmental digit:  
-M3 = halogen-free, RoHS-compliant, and termination lead (Pb)-free

| ORDERING INFORMATION (Example) |               |                          |
|--------------------------------|---------------|--------------------------|
| PREFERRED P/N                  | BASE QUANTITY | PACKAGING DESCRIPTION    |
| VS-15ETL06-M3                  | 50            | Antistatic plastic tubes |

| LINKS TO RELATED DOCUMENTS |  |
|----------------------------|--|
| Dimensions                 | <a href="http://www.vishay.com/doc?96156">www.vishay.com/doc?96156</a> |
| Part marking information   | <a href="http://www.vishay.com/doc?95391">www.vishay.com/doc?95391</a> |
| SPIICE model               | <a href="http://www.vishay.com/doc?96051">www.vishay.com/doc?96051</a> |



# 2L TO-220AC

**DIMENSIONS** in millimeters and inches



Conforms to JEDEC® outline TO-220AC

| SYMBOL | MILLIMETERS |       | INCHES |       | NOTES | SYMBOL | MILLIMETERS |       | INCHES |       | NOTES |
|--------|-------------|-------|--------|-------|-------|--------|-------------|-------|--------|-------|-------|
|        | MIN.        | MAX.  | MIN.   | MAX.  |       |        | MIN.        | MAX.  | MIN.   | MAX.  |       |
| A      | 4.25        | 4.65  | 0.167  | 0.183 |       | D2     | 11.68       | 13.30 | 0.460  | 0.524 | 6, 7  |
| A1     | 1.14        | 1.40  | 0.045  | 0.055 |       | E      | 10.11       | 10.51 | 0.398  | 0.414 | 3, 6  |
| A2     | 2.50        | 2.92  | 0.098  | 0.115 |       | E1     | 6.86        | 8.89  | 0.270  | 0.350 | 6     |
| b      | 0.69        | 1.01  | 0.027  | 0.040 |       | e      | 2.41        | 2.67  | 0.095  | 0.105 |       |
| b1     | 0.38        | 0.97  | 0.015  | 0.038 | 4     | e1     | 4.88        | 5.28  | 0.192  | 0.208 |       |
| b2     | 1.20        | 1.73  | 0.047  | 0.068 |       | H1     | 6.09        | 6.48  | 0.240  | 0.255 | 6     |
| b3     | 1.14        | 1.73  | 0.045  | 0.068 | 4     | L      | 13.52       | 14.02 | 0.532  | 0.552 |       |
| c      | 0.36        | 0.61  | 0.014  | 0.024 |       | L1     | 3.32        | 3.82  | 0.131  | 0.150 | 2     |
| c1     | 0.36        | 0.56  | 0.014  | 0.022 | 4     | ∅ P    | 3.54        | 3.91  | 0.139  | 0.154 |       |
| D      | 14.85       | 15.35 | 0.585  | 0.604 | 3     | Q      | 2.60        | 3.00  | 0.102  | 0.118 |       |
| D1     | 8.38        | 9.02  | 0.330  | 0.355 |       |        |             |       |        |       |       |

**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 dimensions: inches
- (6) Thermal pad contour optional within dimensions E, H1, D2, and E1
- (7) Outline conforms to JEDEC® TO-220, except D2



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