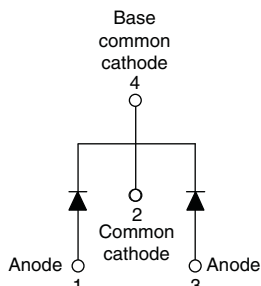
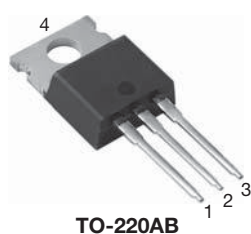


# Ultrafast Rectifier, 16 A FRED Pt®



## FEATURES

- Ultrafast recovery time
- Low forward voltage drop
- 175 °C operating junction temperature
- Low leakage current
- 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**

## DESCRIPTION / APPLICATIONS

FRED Pt® series are the state of the art ultrafast recovery rectifiers specifically designed with optimized performance of forward voltage drop and ultrafast recovery time. The planar structure and the platinum doped life time control, guarantee the best overall performance, ruggedness and reliability characteristics.

These devices are intended for use in the output rectification stage of SMPS, UPS, DC/DC converters as well as freewheeling diode in low voltage inverters and chopper motor drives.

Their extremely optimized stored charge and low recovery current minimize the switching losses and reduce over dissipation in the switching element and snubbers.

## PRIMARY CHARACTERISTICS

|                       |                |
|-----------------------|----------------|
| $I_{F(AV)}$           | 2 x 8 A        |
| $V_R$                 | 400 V          |
| $V_F$ at $I_F$        | 0.94 V         |
| $t_{rr}$ (typ.)       | 24 ns          |
| $T_J$ max.            | 175 °C         |
| Package               | TO-220AB       |
| Circuit configuration | Common cathode |

## ABSOLUTE MAXIMUM RATINGS

| PARAMETER                                   | SYMBOL         | TEST CONDITIONS                                           | VALUES      | UNITS |
|---------------------------------------------|----------------|-----------------------------------------------------------|-------------|-------|
| Peak repetitive reverse voltage             | $V_{RRM}$      |                                                           | 400         | V     |
| Average rectified forward current           | $I_{F(AV)}$    | per leg                                                   | 8           | A     |
|                                             |                | total device                                              | 16          |       |
| Non-repetitive peak surge current           | $I_{FSM}$      | $T_C = 25\text{ °C}$                                      | 100         |       |
| Peak repetitive forward current             | $I_{FRM}$      | $T_C = 155\text{ °C}$ , rated $V_R$ , square wave, 20 kHz | 16          |       |
| Operating junction and storage temperatures | $T_J, T_{Stg}$ |                                                           | -65 to +175 | °C    |

## ELECTRICAL SPECIFICATIONS PER LEG ( $T_J = 25\text{ °C}$ unless otherwise specified)

| PARAMETER                           | SYMBOL        | TEST CONDITIONS                              | MIN. | TYP. | MAX. | UNITS         |
|-------------------------------------|---------------|----------------------------------------------|------|------|------|---------------|
| Breakdown voltage, blocking voltage | $V_{BR}, V_R$ | $I_R = 100\text{ }\mu\text{A}$               | 400  | -    | -    | V             |
| Forward voltage                     | $V_F$         | $I_F = 8\text{ A}$                           | -    | 1.19 | 1.3  |               |
|                                     |               | $I_F = 8\text{ A}, T_J = 150\text{ °C}$      | -    | 0.94 | 1.0  |               |
| Reverse leakage current             | $I_R$         | $V_R = V_R$ rated                            | -    | 0.2  | 10   | $\mu\text{A}$ |
|                                     |               | $T_J = 150\text{ °C}, V_R = V_R$ rated       | -    | 20   | 500  |               |
| Junction capacitance                | $C_T$         | $V_R = 400\text{ V}$                         | -    | 14   | -    | pF            |
| Series inductance                   | $L_S$         | Measured lead to lead 5 mm from package body | -    | 8.0  | -    | nH            |

**DYNAMIC RECOVERY CHARACTERISTICS PER LEG** ( $T_J = 25\text{ }^{\circ}\text{C}$  unless otherwise specified)

| PARAMETER               | SYMBOL    | TEST CONDITIONS                                                                   | MIN. | TYP. | MAX. | UNITS |
|-------------------------|-----------|-----------------------------------------------------------------------------------|------|------|------|-------|
| Reverse recovery time   | $t_{rr}$  | $I_F = 1.0\text{ A}$ , $dI_F/dt = 50\text{ A}/\mu\text{A}$ , $V_R = 30\text{ V}$  | -    | 35   | -    | ns    |
|                         |           | $I_F = 1.0\text{ A}$ , $dI_F/dt = 100\text{ A}/\mu\text{A}$ , $V_R = 30\text{ V}$ | -    | 24   | -    |       |
|                         |           | $T_J = 25\text{ }^{\circ}\text{C}$                                                | -    | 43   | -    |       |
|                         |           | $T_J = 125\text{ }^{\circ}\text{C}$                                               | -    | 67   | -    |       |
| Peak recovery current   | $I_{RRM}$ | $T_J = 25\text{ }^{\circ}\text{C}$                                                | -    | 2.8  | -    | A     |
|                         |           | $T_J = 125\text{ }^{\circ}\text{C}$                                               | -    | 6.3  | -    |       |
| Reverse recovery charge | $Q_{rr}$  | $T_J = 25\text{ }^{\circ}\text{C}$                                                | -    | 60   | -    | nC    |
|                         |           | $T_J = 125\text{ }^{\circ}\text{C}$                                               | -    | 210  | -    |       |

**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,<br>junction to case<br>per leg<br>per device | $R_{thJC}$     |                                                | -            | 3.6  | 4          | $^{\circ}\text{C}/\text{W}$ |
|                                                                  |                |                                                | -            | 1.8  | 2          |                             |
| Thermal resistance,<br>junction to ambient                       | $R_{thJA}$     | Typical socket mount                           | -            | -    | 50         |                             |
| Thermal resistance,<br>case to heatsink                          | $R_{thCS}$     | Mounting surface, flat, smooth,<br>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-220AB                            | 16CTU04H     |      |            |                             |

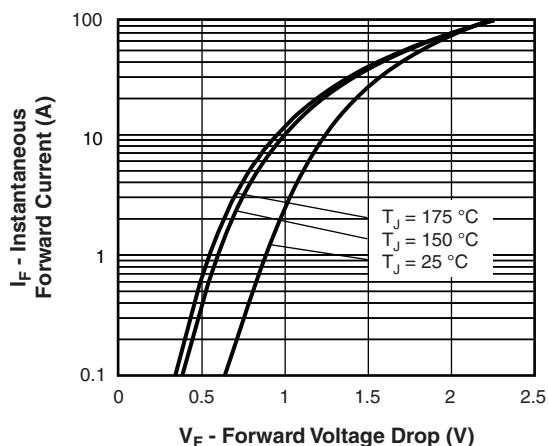


Fig. 1 - Typical Forward Voltage Drop Characteristics

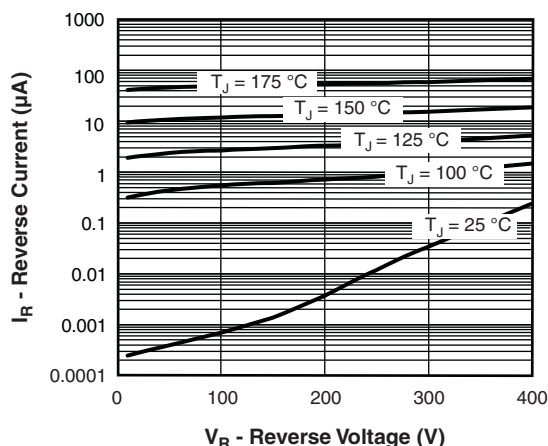


Fig. 2 - Typical Values of Reverse Current vs. Reverse Voltage

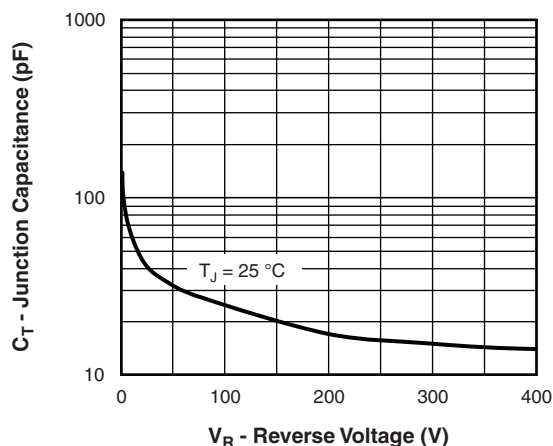
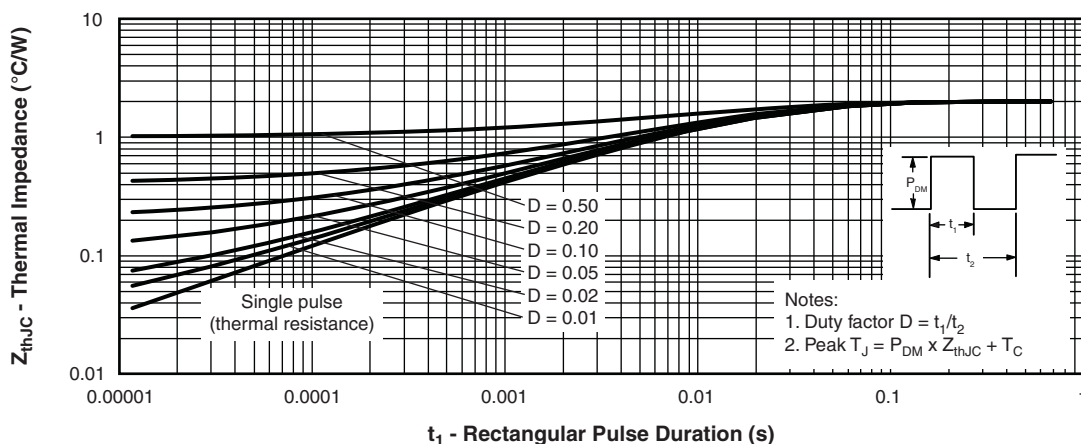


Fig. 3 - Typical Junction Capacitance vs. Reverse Voltage


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

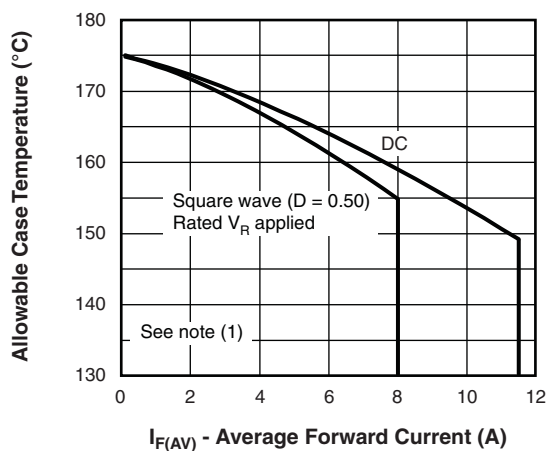


Fig. 5 - Maximum Allowable Case Temperature vs. Average Forward Current

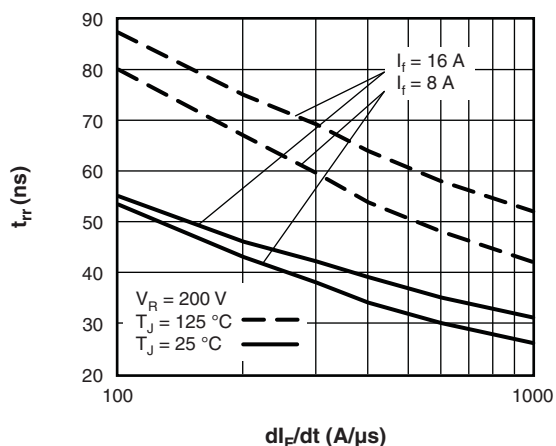


Fig. 7 - Typical Reverse Recovery Time vs.  $dI_F/dt$

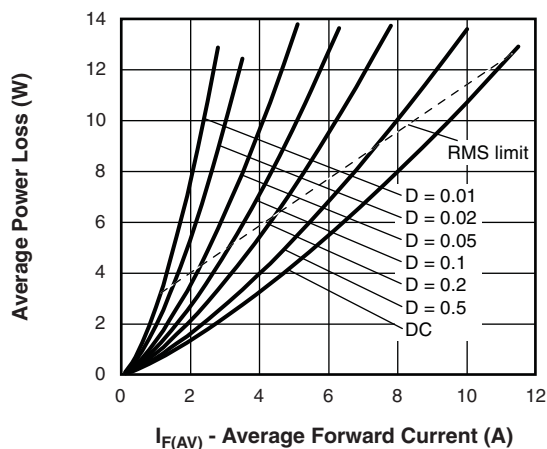


Fig. 6 - Forward Power Loss Characteristics

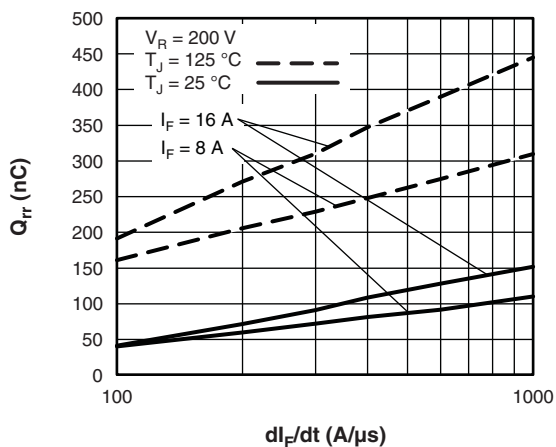


Fig. 8 - Typical Stored Charge vs.  $dI_F/dt$

#### 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. 6);  
 $P_{dREV}$  = inverse power loss =  $V_{R1} \times I_R (1 - D)$ ;  $I_R$  at  $V_{R1}$  = rated  $V_R$

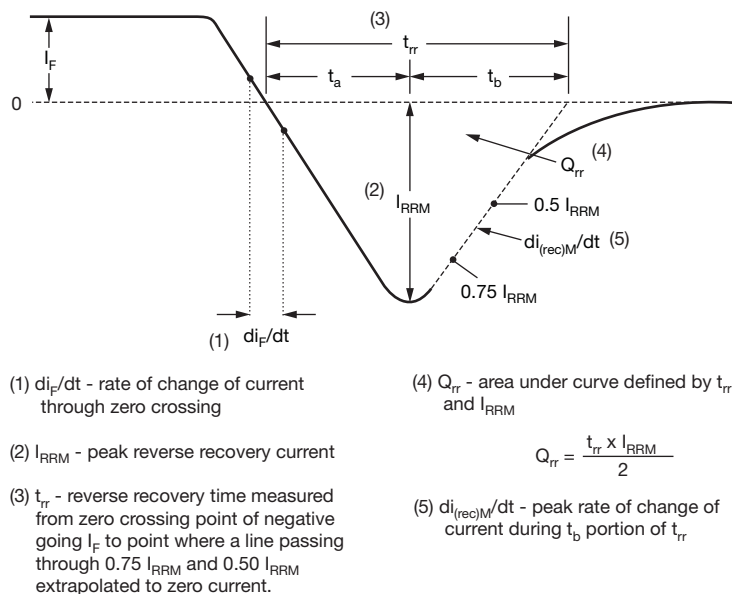


Fig. 1 - Reverse Recovery Waveform and Definitions

## ORDERING INFORMATION TABLE

| Device code | VS- | 16 | C | T | U | 04 | H | N3 |
|-------------|-----|----|---|---|---|----|---|----|
|             | 1   | 2  | 3 | 4 | 5 | 6  | 7 | 8  |

- 1** - Vishay Semiconductors product
- 2** - Current rating (16 = 16 A)
- 3** - Circuit configuration:  
C = Common cathode
- 4** - Package:  
T = TO-220
- 5** - Ultrafast recovery
- 6** - Voltage rating (04 = 400 V)
- 7** - H = AEC-Q101 qualified
- 8** - Environmental digit:  
N3 = Halogen-free, RoHS-compliant, and totally lead (Pb)-free

| ORDERING INFORMATION (Example) |                  |                        |                         |
|--------------------------------|------------------|------------------------|-------------------------|
| PREFERRED P/N                  | QUANTITY PER T/R | MINIMUM ORDER QUANTITY | PACKAGING DESCRIPTION   |
| VS-16CTU04HN3                  | 50               | 1000                   | Antistatic plastic tube |

| LINKS TO RELATED DOCUMENTS |                                                                        |
|----------------------------|------------------------------------------------------------------------|
| Dimensions                 | <a href="http://www.vishay.com/doc?95222">www.vishay.com/doc?95222</a> |
| Part marking information   | <a href="http://www.vishay.com/doc?95028">www.vishay.com/doc?95028</a> |
| SPIICE model               | <a href="http://www.vishay.com/doc?96565">www.vishay.com/doc?96565</a> |

## TO-220AB

**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     |

| SYMBOL | MILLIMETERS |       | INCHES     |       | NOTES |
|--------|-------------|-------|------------|-------|-------|
|        | MIN.        | MAX.  | MIN.       | MAX.  |       |
| E      | 10.11       | 10.51 | 0.398      | 0.414 | 3, 6  |
| E1     | 6.86        | 8.89  | 0.270      | 0.350 | 6     |
| E2     | -           | 0.76  | -          | 0.030 | 7     |
| e      | 2.41        | 2.67  | 0.095      | 0.105 |       |
| e1     | 4.88        | 5.28  | 0.192      | 0.208 |       |
| H1     | 6.09        | 6.48  | 0.240      | 0.255 | 6, 7  |
| L      | 13.52       | 14.02 | 0.532      | 0.552 |       |
| L1     | 3.32        | 3.82  | 0.131      | 0.150 | 2     |
| Ø P    | 3.54        | 3.73  | 0.139      | 0.147 |       |
| Q      | 2.60        | 3.00  | 0.102      | 0.118 |       |
| θ      | 90° to 93°  |       | 90° to 93° |       |       |

### 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) Dimensions E2 x H1 define a zone where stamping and singulation irregularities are allowed
- (8) Outline conforms to JEDEC TO-220, except A2 (maximum) and D2 (minimum) where dimensions are derived from the actual package outline



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