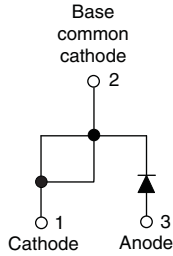
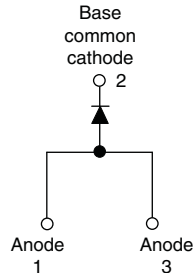


## Ultrafast Soft Recovery Diode, 60 A FRED Pt<sup>®</sup>


**TO-247AC modified**

**VS-60EPU02PbF**

**TO-247AC**

**VS-60APU02PbF**

### FEATURES

- Ultrafast recovery time
- Low forward voltage drop
- 175 °C operating junction temperature
- Output rectification
- Compliant to RoHS Directive 2002/95/EC
- Designed and qualified for industrial level


**RoHS  
COMPLIANT**

### BENEFITS

- Reduced RFI and EMI
- Higher frequency operation
- Reduced snubbing
- Reduced parts count

### DESCRIPTION/APPLICATIONS

These diodes are optimized to reduce losses and EMI/RFI in high frequency power conditioning systems.

The softness of the recovery eliminates the need for a snubber in most applications. These devices are ideally suited for HF welding, power converters and other applications where switching losses are not significant portion of the total losses.

### PRODUCT SUMMARY

|                 |   |
|-----------------|---|
| Package         | TO-247AC,<br>TO-247AC modified (2 pins) |
| $I_{F(AV)}$     | 60 A                                    |
| $V_R$           | 200 V                                   |
| $V_F$ at $I_F$  | 1.08 V                                  |
| $t_{rr}$ typ.   | See Recovery table                      |
| $T_J$ max.      | 175 °C                                  |
| Diode variation | Single die                              |

### ABSOLUTE MAXIMUM RATINGS

| PARAMETER                                   | SYMBOL         | TEST CONDITIONS       | VALUES      | UNITS |
|---|----------------|-----------------------|-------------|-------|
| Cathode to anode voltage                    | $V_R$          |                       | 200         | V     |
| Continuous forward current                  | $I_{F(AV)}$    | $T_C = 127\text{ °C}$ | 60          | A     |
| Single pulse forward current                | $I_{FSM}$      | $T_C = 25\text{ °C}$  | 800         |       |
| Maximum repetitive forward current          | $I_{FRM}$      | Square wave, 20 kHz   | 120         |       |
| Operating junction and storage temperatures | $T_J, T_{Stg}$ |                       | - 55 to 175 | °C    |

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

| PARAMETER                              | SYMBOL        | TEST CONDITIONS   | MIN. | TYP.         | MAX.         | UNITS               |
|--|---------------|---|------|--------------|--------------|---------------------|
| Breakdown voltage,<br>blocking voltage | $V_{BR}, V_R$ | $I_R = 100\ \mu\text{A}$  | 200  | -            | -            | V                   |
| Forward voltage                        | $V_F$         | $I_F = 60\text{ A}$<br>$I_F = 60\text{ A}, T_J = 175\text{ °C}$ | -    | 0.98<br>0.81 | 1.08<br>0.88 |                     |
| Reverse leakage current                | $I_R$         | $V_R = V_R$ rated<br>$T_J = 150\text{ °C}, V_R = V_R$ rated     | -    | -            | 50<br>2      | $\mu\text{A}$<br>mA |
| Junction capacitance                   | $C_T$         | $V_R = 200\text{ V}$  | -    | 87           | -            | pF                  |
| Series inductance                      | $L_S$         | Measured lead to lead 5 mm from package body                    | -    | 8.0          | -            | nH                  |

# VS-60EPU02PbF, VS-60APU02PbF



Vishay Semiconductors Ultrafast Soft Recovery Diode,  
60 A FRED Pt®

| DYNAMIC RECOVERY CHARACTERISTICS (T <sub>C</sub> = 25 °C unless otherwise specified) |                  |   |      |      |      |       |
|--|------------------|---|------|------|------|-------|
| PARAMETER  | SYMBOL           | TEST CONDITIONS   | MIN. | TYP. | MAX. | UNITS |
| Reverse recovery time  | t <sub>rr</sub>  | I <sub>F</sub> = 1.0 A, di <sub>F</sub> /dt = 200 A/μs, V <sub>R</sub> = 30 V | -    | -    | 35   | ns    |
|  |                  | T <sub>J</sub> = 25 °C  | -    | 28   | -    |       |
|  |                  | T <sub>J</sub> = 125 °C   | -    | 50   | -    |       |
| Peak recovery current  | I <sub>RRM</sub> | T <sub>J</sub> = 25 °C  | -    | 4    | -    | A     |
|  |                  | T <sub>J</sub> = 125 °C   | -    | 8    | -    |       |
| Reverse recovery charge  | Q <sub>rr</sub>  | T <sub>J</sub> = 25 °C  | -    | 59   | -    | nC    |
|  |                  | T <sub>J</sub> = 125 °C   | -    | 220  | -    |       |

| THERMAL - MECHANICAL SPECIFICATIONS  |                   |  |         |      |      |       |
|--------------------------------------|-------------------|--|---------|------|------|-------|
| PARAMETER                            | SYMBOL            | TEST CONDITIONS                            | MIN.    | TYP. | MAX. | UNITS |
| Thermal resistance, junction to case | R <sub>thJC</sub> |  | -       | -    | 0.70 | K/W   |
| Thermal resistance, case to heatsink | R <sub>thCS</sub> | Mounting surface, flat, smooth and greased | -       | 0.2  | -    |       |
| Weight                               |                   |  | -       | 5.5  | -    | g     |
|                                      |                   |  | -       | 0.2  | -    | oz.   |
| Mounting torque                      |                   |  | -       | -    | 1.2  | N · m |
| Marking device                       |                   | Case style TO-247AC modified               | 60EPU02 |      |      |       |
|                                      |                   | Case style TO-247AC                        | 60APU02 |      |      |       |



# VS-60EPU02PbF, VS-60APU02PbF

Ultrafast Soft Recovery Diode,  
60 A FRED Pt®

Vishay Semiconductors

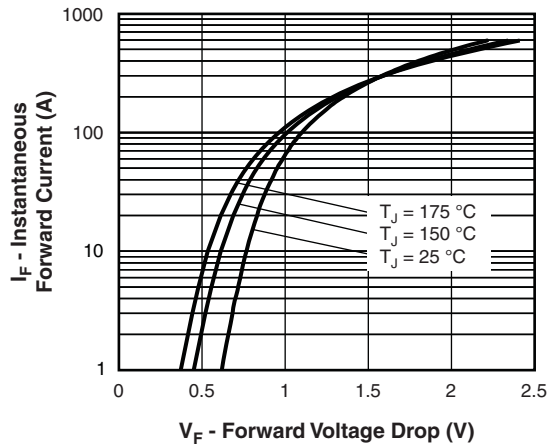


Fig. 1 - Typical Forward Voltage Drop Characteristics

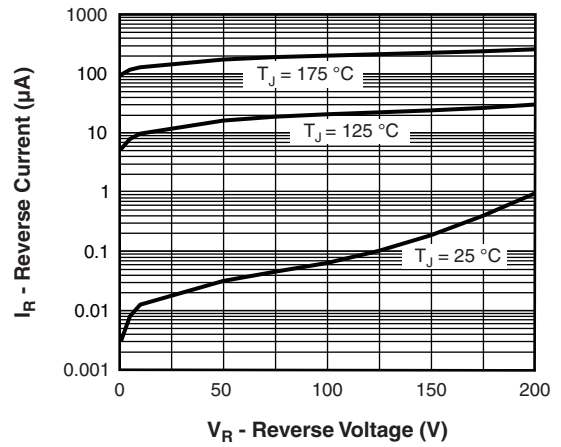


Fig. 2 - Typical Values of Reverse Current vs. Reverse Voltage

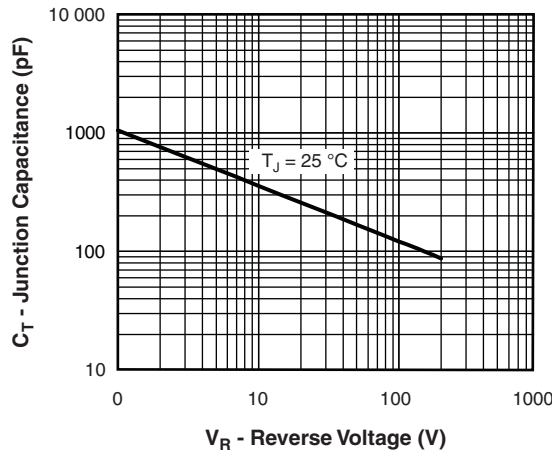


Fig. 3 - Typical Junction Capacitance vs. Reverse Voltage

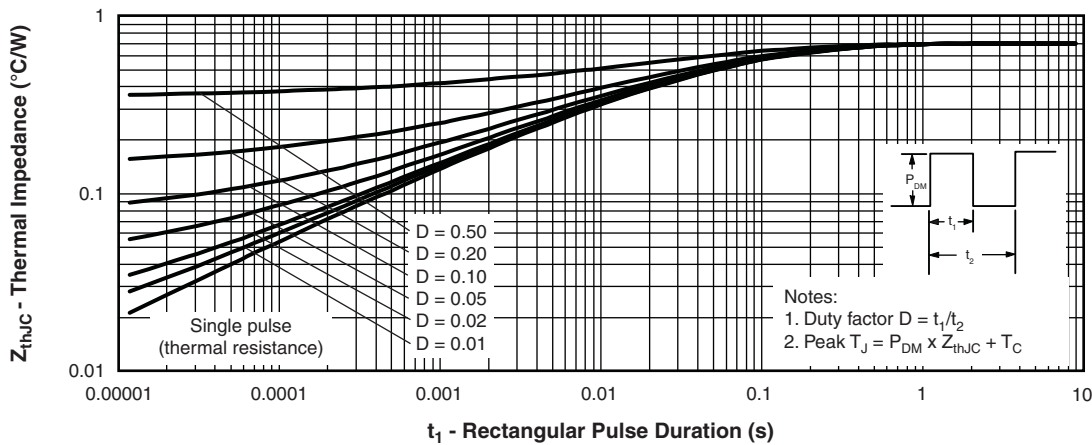


Fig. 4 - Maximum Thermal Impedance  $Z_{thJC}$  Characteristics

# VS-60EPU02PbF, VS-60APU02PbF



Vishay Semiconductors Ultrafast Soft Recovery Diode,  
60 A FRED Pt®

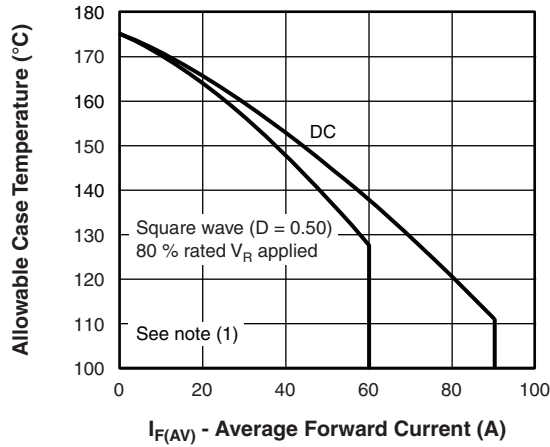


Fig. 5 - Maximum Allowable Case Temperature vs. Average Forward Current

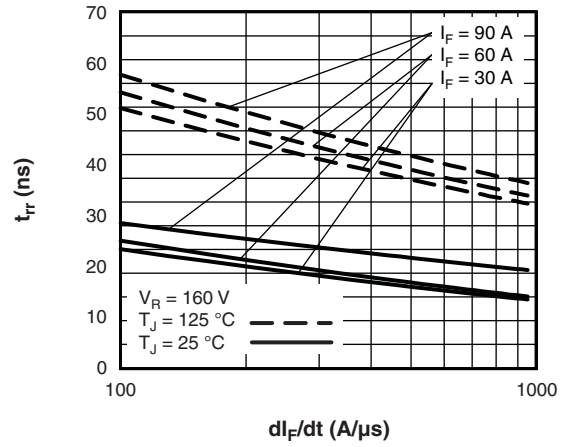


Fig. 7 - Typical Reverse Recovery Time vs.  $di_F/dt$

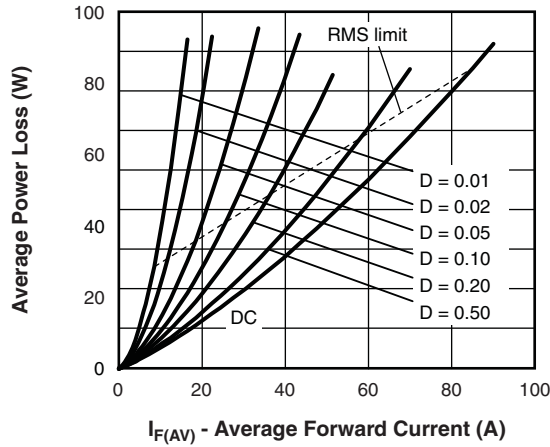


Fig. 6 - Forward Power Loss Characteristics

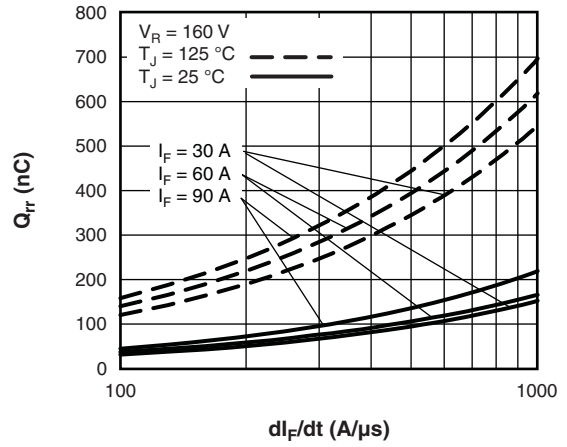


Fig. 8 - Typical Stored Charge vs.  $di_F/dt$

## Note

- (1) Formula used:  $T_C = T_J - (P_d + P_{d_{REV}}) \times R_{thJC}$ ;  
 $P_d$  = Forward power loss =  $I_{F(AV)} \times V_{FM}$  at  $(I_{F(AV)}/D)$  (see fig. 6);  
 $P_{d_{REV}}$  = Inverse power loss =  $V_{R1} \times I_R (1 - D)$ ;  $I_R$  at  $V_{R1} = 80\%$  rated  $V_R$

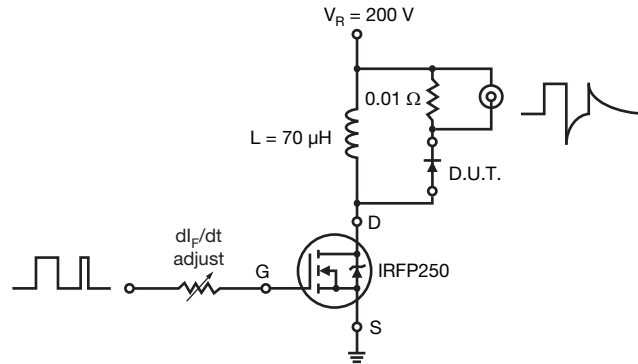
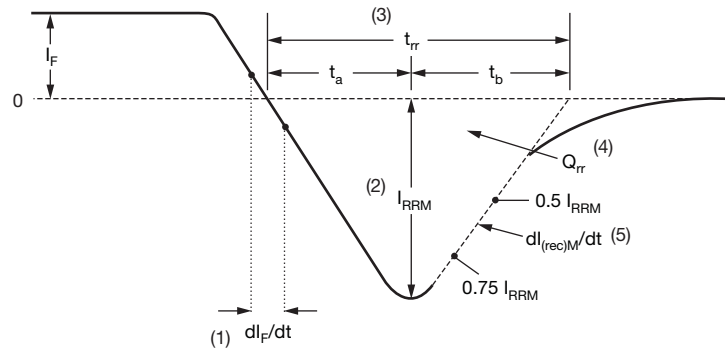


Fig. 9 - Reverse Recovery Parameter Test Circuit



(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. 10 - Reverse Recovery Waveform and Definitions

# VS-60EPU02PbF, VS-60APU02PbF



Vishay Semiconductors Ultrafast Soft Recovery Diode,  
60 A FRED Pt®

## ORDERING INFORMATION TABLE

|             |            |           |          |          |          |           |            |
|-------------|------------|-----------|----------|----------|----------|-----------|------------|
| Device code | <b>VS-</b> | <b>60</b> | <b>E</b> | <b>P</b> | <b>U</b> | <b>02</b> | <b>PbF</b> |
|             | 1          | 2         | 3        | 4        | 5        | 6         | 7          |

- 1** - Vishay Semiconductors product
- 2** - Current rating (60 = 60 A)
- 3** - Circuit configuration:
  - E = Single diode
  - A = Single diode, 3 pins
- 4** - Package:
  - P = TO-247AC (modified)
- 5** - Type of silicon:
  - U = Ultrafast recovery
- 6** - Voltage rating (02 = 200 V)
- 7** - PbF = Lead (Pb)-free

Tube standard pack quantity: 25 pieces

| LINKS TO RELATED DOCUMENTS |                   |  |
|----------------------------|-------------------|--|
| Dimensions                 | TO-247AC modified | <a href="http://www.vishay.com/doc?95253">www.vishay.com/doc?95253</a> |
|                            | TO-247AC          | <a href="http://www.vishay.com/doc?95223">www.vishay.com/doc?95223</a> |
| Part marking information   | TO-247AC modified | <a href="http://www.vishay.com/doc?95255">www.vishay.com/doc?95255</a> |
|                            | TO-247AC          | <a href="http://www.vishay.com/doc?95226">www.vishay.com/doc?95226</a> |
| SPICE model                |                   | <a href="http://www.vishay.com/doc?95416">www.vishay.com/doc?95416</a> |



### DIMENSIONS in millimeters and inches



#### Lead assignments

- Diodes**  
 1. - Anode/open  
 2. - Cathode  
 3. - Anode

| SYMBOL | MILLIMETERS |       | INCHES |       | NOTES | SYMBOL | MILLIMETERS |       | INCHES    |       | NOTES |
|--------|-------------|-------|--------|-------|-------|--------|-------------|-------|-----------|-------|-------|
|        | MIN.        | MAX.  | MIN.   | MAX.  |       |        | MIN.        | MAX.  | MIN.      | MAX.  |       |
| A      | 4.65        | 5.31  | 0.183  | 0.209 |       | D2     | 0.51        | 1.30  | 0.020     | 0.051 |       |
| A1     | 2.21        | 2.59  | 0.087  | 0.102 |       | E      | 15.29       | 15.87 | 0.602     | 0.625 | 3     |
| A2     | 1.50        | 2.49  | 0.059  | 0.098 |       | E1     | 13.72       | -     | 0.540     | -     |       |
| b      | 0.99        | 1.40  | 0.039  | 0.055 |       | e      | 5.46 BSC    |       | 0.215 BSC |       |       |
| b1     | 0.99        | 1.35  | 0.039  | 0.053 |       | FK     | 2.54        |       | 0.010     |       |       |
| b2     | 1.65        | 2.39  | 0.065  | 0.094 |       | L      | 14.20       | 16.10 | 0.559     | 0.634 |       |
| b3     | 1.65        | 2.37  | 0.065  | 0.094 |       | L1     | 3.71        | 4.29  | 0.146     | 0.169 |       |
| b4     | 2.59        | 3.43  | 0.102  | 0.135 |       | N      | 7.62 BSC    |       | 0.3       |       |       |
| b5     | 2.59        | 3.38  | 0.102  | 0.133 |       | ΦP     | 3.56        | 3.66  | 0.14      | 0.144 |       |
| c      | 0.38        | 0.86  | 0.015  | 0.034 |       | ΦP1    | -           | 6.98  | -         | 0.275 |       |
| c1     | 0.38        | 0.76  | 0.015  | 0.030 |       | Q      | 5.31        | 5.69  | 0.209     | 0.224 |       |
| D      | 19.71       | 20.70 | 0.776  | 0.815 | 3     | R      | 4.52        | 5.49  | 1.78      | 0.216 |       |
| D1     | 13.08       | -     | 0.515  | -     | 4     | S      | 5.51 BSC    |       | 0.217 BSC |       |       |

#### Notes

- (1) Dimensioning and tolerancing per ASME Y14.5M-1994
- (2) Contour of slot optional
- (3) 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 outermost extremes of the plastic body
- (4) Thermal pad contour optional with dimensions D1 and E1
- (5) Lead finish uncontrolled in L1
- (6) Ø P to have a maximum draft angle of 1.5 to the top of the part with a maximum hole diameter of 3.91 mm (0.154")
- (7) Outline conforms to JEDEC outline TO-247 with exception of dimension c



**DIMENSIONS** in millimeters and inches



| SYMBOL | MILLIMETERS |       | INCHES |       | NOTES |
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