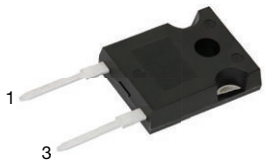
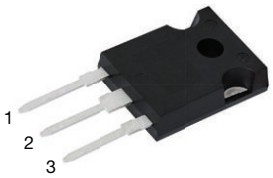
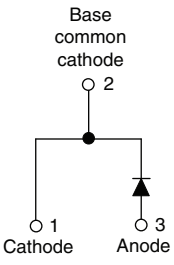
## Ultrafast Soft Recovery Diode, 60 A FRED Pt®



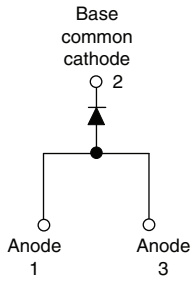

**TO-247AC 2L**




**TO-247AC 3L**




**VS-60EPU04-N3**




**VS-60APU04-N3**

### FEATURES

- Ultrafast recovery time
- Low forward voltage drop
- 175 °C operating junction temperature
- Designed and qualified according to JEDEC®-JESD 47
- Material categorization: for definitions of compliance please see www.vishay.com/doc?99912

Pb-free

RoHS COMPLIANT

HALOGEN FREE

### 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.

### MECHANICAL DATA

**Case:** TO-247AC 2L, TO-247AC 3L

Molding compound meets UL 94 V-0 flammability rating

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

### LINKS TO ADDITIONAL RESOURCES

3D Models

| PRIMARY CHARACTERISTICS | |
|---|---|
| $I_{F(AV)}$ | 60 A |
| $V_R$ | 400 V |
| $V_F$ at $I_F$ | 0.87 V |
| $t_{rr}$ typ. | See Recovery table |
| $T_J$ max. | 175 °C |
| Package | TO-247AC 2L, TO-247AC 3L |
| Circuit configuration | Single |

| ABSOLUTE MAXIMUM RATINGS | | | | |
|---|---|---|---|---|
| **PARAMETER** | **SYMBOL** | **TEST CONDITIONS** | **VALUES** | **UNITS** |
| Cathode to anode voltage | $V_R$ | | 400 | V |
| Continuous forward current | $I_{F(AV)}$ | $T_C$ = 127 °C | 60 | A |
| Single pulse forward current | $I_{FSM}$ | $T_C$ = 25 °C, $t_p$ = 10 ms | 600 | |
| 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 °C unless otherwise specified) | | | | | | |
|---|---|---|---|---|---|---|
| **PARAMETER** | **SYMBOL** | **TEST CONDITIONS** | **MIN.** | **TYP.** | **MAX.** | **UNITS** |
| Breakdown voltage, blocking voltage | $V_{BR}$, $V_R$ | $I_R$ = 100 µA | 400 | - | - | V |
| Forward voltage | $V_F$ | $I_F$ = 60 A | - | 1.05 | 1.25 | |
| | | $I_F$ = 60 A, $T_J$ = 175 °C | - | 0.87 | 1.03 | |
| | | $I_F$ = 60 A, $T_J$ = 125 °C | - | 0.93 | 1.10 | |
| Reverse leakage current | $I_R$ | $V_R$ = $V_R$ rated | - | - | 50 | µA |
| | | $T_J$ = 150 °C, $V_R$ = $V_R$ rated | - | - | 2 | mA |
| Junction capacitance | $C_T$ | $V_R$ = 400 V | - | 50 | - | pF |
| Series inductance | $L_S$ | Measured lead to lead 5 mm from package body | - | 3.5 | - | nH |

| DYNAMIC RECOVERY CHARACTERISTICS ($T_C$ = 25 °C unless otherwise specified) | | | | | | | |
|---|---|---|---|---|---|---|---|
| PARAMETER | SYMBOL | TEST CONDITIONS | | MIN. | TYP. | MAX. | UNITS |
| Reverse recovery time | $t_{rr}$ | $I_F$ = 1 A, $di_F/dt$ = 200 A/μs, $V_R$ = 30 V | | - | 50 | 60 | ns |
| | | $T_J$ = 25 °C | $I_F$ = 60 A<br>$di_F/dt$ = 200 A/μs<br>$V_R$ = 200 V | - | 85 | - | |
| | | $T_J$ = 125 °C | | - | 145 | - | |
| Peak recovery current | $I_{RRM}$ | $T_J$ = 25 °C | | - | 8.8 | - | A |
| | | $T_J$ = 125 °C | | - | 15.4 | - | |
| Reverse recovery charge | $Q_{rr}$ | $T_J$ = 25 °C | | - | 375 | - | nC |
| | | $T_J$ = 125 °C | | - | 1120 | - | |

| THERMAL - MECHANICAL SPECIFICATIONS | | | | | | |
|---|---|---|---|---|---|---|
| PARAMETER | SYMBOL | TEST CONDITIONS | MIN. | TYP. | MAX. | UNITS |
| Thermal resistance, junction to case | $R_{thJC}$ | | - | - | 0.70 | K/W |
| Thermal resistance, junction to ambient per leg | $R_{thJA}$ | Typical socket mount | - | - | 40 | °C/W |
| Thermal resistance, case to heatsink | $R_{thCS}$ | Mounting surface, flat, smooth, and greased | - | 0.2 | - | K/W |
| Weight | | | - | 5.5 | - | g |
| | | | - | 0.2 | - | oz. |
| Mounting torque | | | 1.2 | - | 2.4 | N · m |
| | | | 10 | - | 20 | lbf · in |
| Marking device | | Case style TO-247AC 2L | 60EPU04 | | | |
| | | Case style TO-247AC 3L | 60APU04 | | | |

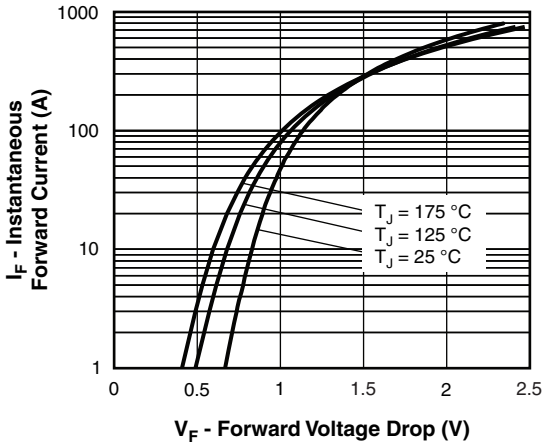



Fig. 1 - Typical Forward Voltage Drop Characteristics

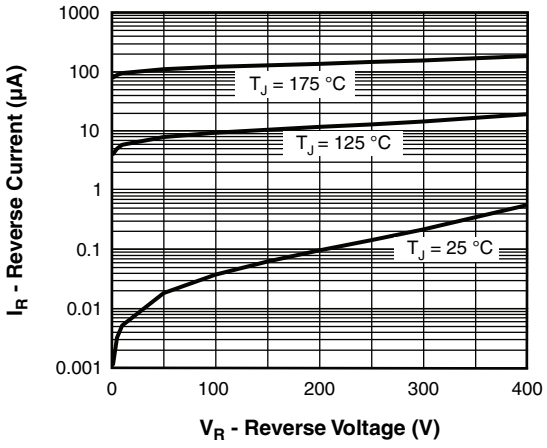



Fig. 2 - Typical Values of Reverse Current vs. Reverse Voltage

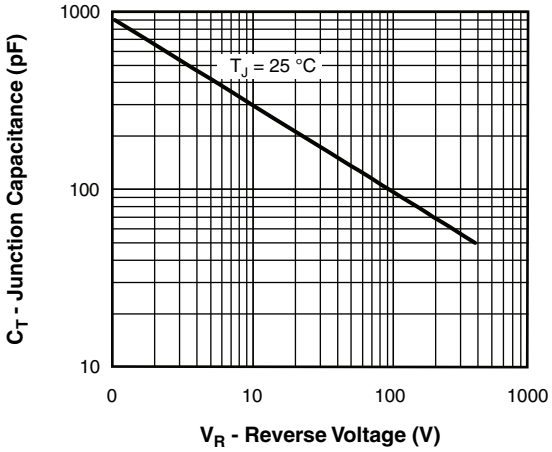



Fig. 3 - Typical Junction Capacitance vs. Reverse Voltage

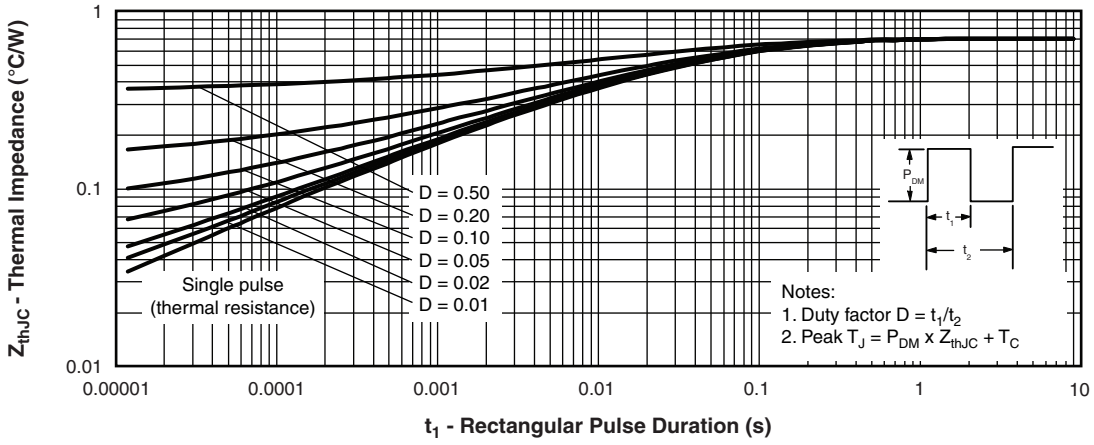



Fig. 4 - Maximum Thermal Impedance $Z_{thJC}$ Characteristics

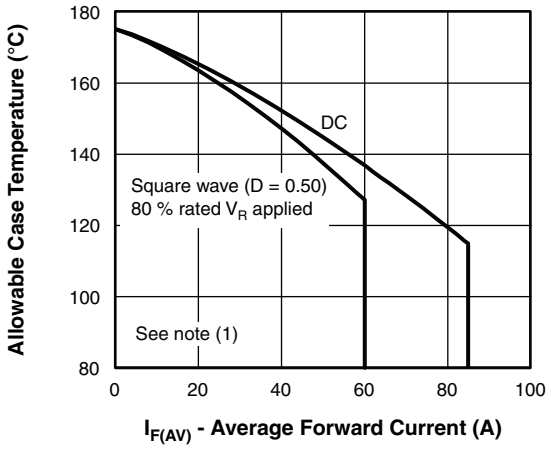



Fig. 5 - Maximum Allowable Case Temperature vs. Average Forward Current

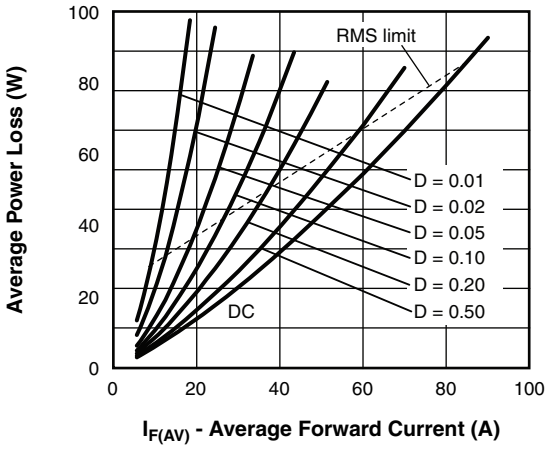



Fig. 6 - Forward Power Loss Characteristics

**Note**

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

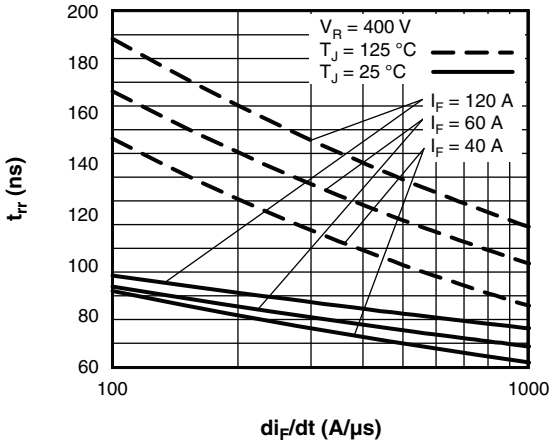



Fig. 7 - Typical Reverse Recovery Time vs. $di_F/dt$

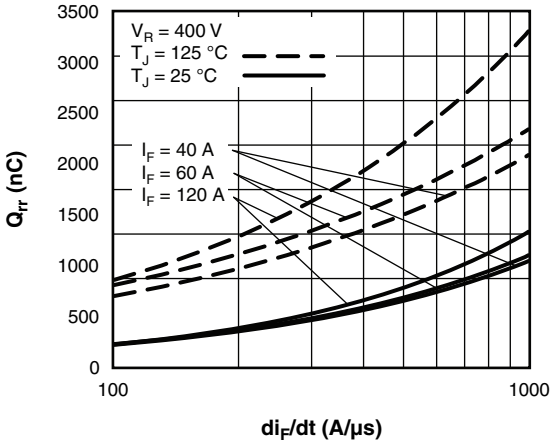
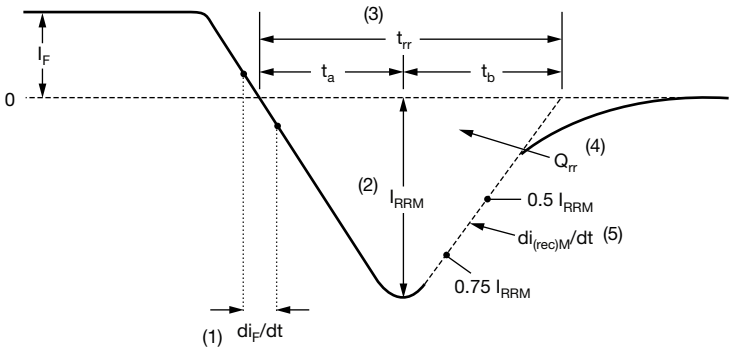



Fig. 8 - Typical Stored Charge vs. $di_F/dt$




(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 $I_{RRM}$

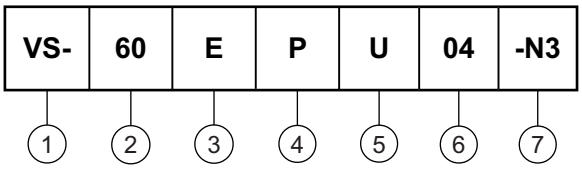
$$Q_{rr} = \frac{t_{rr} \times I_{RRM}}{2}$$

(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




1 - Vishay Semiconductors product

2 - Current rating (60 = 60 A)

3 - Circuit configuration:

- E = single diode, 2 pins
- A = single diode, 3 pins

4 - Package:

P = TO-247AC

5 - Type of silicon:

U = ultrafast recovery

6 - Voltage rating (04 = 400 V)

7 - 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-60EPU04-N3 | 25 | 500 | Antistatic plastic tube |
| VS-60APU04-N3 | 25 | 500 | Antistatic plastic tube |

| **LINKS TO RELATED DOCUMENTS** | | |
|---|---|---|
| Dimensions | TO-247AC 2L | www.vishay.com/doc?96144 |
| | TO-247AC 3L | www.vishay.com/doc?96138 |
| Part marking information | TO-247AC 2L | www.vishay.com/doc?95648 |
| | TO-247AC 3L | www.vishay.com/doc?95007 |
| SPICE model | | www.vishay.com/doc?96899 |

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