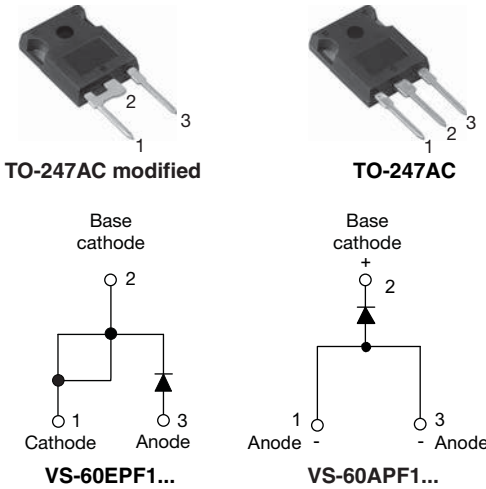


## Fast Soft Recovery Rectifier Diode, 60 A



### FEATURES

- 150 °C max. operating junction temperature
- Low forward voltage drop and short reverse recovery time
- Designed and qualified according to JEDEC®-JESD47
- Material categorization:  
For definitions of compliance please see [www.vishay.com/doc?99912](http://www.vishay.com/doc?99912)



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

### APPLICATIONS

These devices are intended for use in output rectification and freewheeling in inverters, choppers and converters as well as in input rectification where severe restrictions on conducted EMI should be met.

### DESCRIPTION

The VS-60EPF1... and VS-60APF1... soft recovery rectifier series has been optimized for combined short reverse recovery time and low forward voltage drop.

The glass passivation ensures stable reliable operation in the most severe temperature and power cycling conditions.

### PRODUCT SUMMARY

| Package         | TO-247AC modified, TO-247AC |
|-----------------|-----------------------------|
| $I_{F(AV)}$     | 60 A                        |
| $V_R$           | 1000 V, 1200 V              |
| $V_F$ at $I_F$  | 1.4 V                       |
| $I_{FSM}$       | 830 A                       |
| $t_{rr}$        | 95 ns                       |
| $T_J$ max.      | 150 °C                      |
| Diode variation | Single die                  |
| Snap factor     | 0.6                         |

### MAJOR RATINGS AND CHARACTERISTICS

| SYMBOL      | CHARACTERISTICS     | VALUES       | UNITS |
|-------------|---------------------|--------------|-------|
| $V_{RRM}$   |                     | 1000 to 1200 | V     |
| $I_{F(AV)}$ | Sinusoidal waveform | 60           | A     |
| $I_{FSM}$   |                     | 830          |       |
| $t_{rr}$    | 1 A, - 100 A/μs     | 95           | ns    |
| $V_F$       | 30 A, $T_J = 25$ °C | 1.2          | V     |
| $T_J$       | Range               | -40 to 150   | °C    |

### VOLTAGE RATINGS

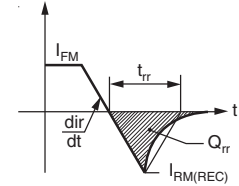
| PART NUMBER  | $V_{RRM}$ , MAXIMUM PEAK REVERSE VOLTAGE<br>V | $V_{RSM}$ , MAXIMUM NON-REPETITIVE PEAK REVERSE VOLTAGE<br>V | $I_{RRM}$ AT 150 °C<br>mA |
|--|---|--|---------------------------|
| VS-60EPF10PbF, VS-60APF10PbF<br>VS-60EPF10-M3, VS-60APF10-M3 | 1000  | 1100   | 12                        |
| VS-60EPF12PbF, VS-60APF12PbF<br>VS-60EPF12-M3, VS-60APF12-M3 | 1200  | 1300   |                           |



| ABSOLUTE MAXIMUM RATINGS                            |               |  |        |               |
|---|---------------|--|--------|---------------|
| PARAMETER   | SYMBOL        | TEST CONDITIONS  | VALUES | UNITS         |
| Maximum average forward current                     | $I_{F(AV)}$   | $T_C = 103\text{ }^\circ\text{C}$ , 180° conduction half sine wave | 60     | A             |
| Maximum peak one cycle non-repetitive surge current | $I_{FSM}$     | 10 ms sine pulse, rated $V_{RRM}$ applied                          | 700    |               |
|   |               | 10 ms sine pulse, no voltage reapplied                             | 830    |               |
| Maximum $I^2t$ for fusing                           | $I^2t$        | 10 ms sine pulse, rated $V_{RRM}$ applied                          | 2450   | $A^2s$        |
|   |               | 10 ms sine pulse, no voltage reapplied                             | 3460   |               |
| Maximum $I^2\sqrt{t}$ for fusing                    | $I^2\sqrt{t}$ | $t = 0.1\text{ ms to }10\text{ ms}$ , no voltage reapplied         | 34 600 | $A^2\sqrt{s}$ |

| ELECTRICAL SPECIFICATIONS       |             |  |        |           |
|---------------------------------|-------------|--|--------|-----------|
| PARAMETER                       | SYMBOL      | TEST CONDITIONS                        | VALUES | UNITS     |
| Maximum forward voltage drop    | $V_{FM}$    | 60 A, $T_J = 25\text{ }^\circ\text{C}$ | 1.4    | V         |
| Forward slope resistance        | $r_t$       | $T_J = 150\text{ }^\circ\text{C}$      | 4.6    | $m\Omega$ |
| Threshold voltage               | $V_{F(TO)}$ |  | 0.9    | V         |
| Maximum reverse leakage current | $I_{RM}$    | $T_J = 25\text{ }^\circ\text{C}$       | 0.1    | mA        |
|                                 |             | $T_J = 150\text{ }^\circ\text{C}$      | 12     |           |

| RECOVERY CHARACTERISTICS |          |  |        |         |
|--------------------------|----------|--|--------|---------|
| PARAMETER                | SYMBOL   | TEST CONDITIONS                                | VALUES | UNITS   |
| Reverse recovery time    | $t_{rr}$ | $I_F$ at 60 $A_{pk}$<br>25 A/ $\mu s$<br>25 °C | 480    | ns      |
| Reverse recovery current | $I_{rr}$ |  | 8      | A       |
| Reverse recovery charge  | $Q_{rr}$ |  | 2.7    | $\mu C$ |
| Snap factor              | S        |  | 0.6    |         |



| THERMAL - MECHANICAL SPECIFICATIONS             |                |                                      |            |  |
|---|----------------|--------------------------------------|------------|--|
| PARAMETER                                       | SYMBOL         | TEST CONDITIONS                      | VALUES     | UNITS  |
| Maximum junction and storage temperature range  | $T_J, T_{Stg}$ |                                      | -40 to 150 | $^\circ\text{C}$   |
| Maximum thermal resistance, junction to case    | $R_{thJC}$     | DC operation                         | 0.4        | $^\circ\text{C/W}$   |
| Maximum thermal resistance, junction to ambient | $R_{thJA}$     |                                      | 40         |  |
| Typical thermal resistance, case to heatsink    | $R_{thCS}$     | Mounting surface, smooth and greased | 0.2        |  |
| Approximate weight                              |                |                                      | 6          | g  |
|   |                |                                      | 0.21       | oz.  |
| Mounting torque                                 | minimum        |                                      | 6 (5)      | $\text{kgf} \cdot \text{cm}$<br>$(\text{lbf} \cdot \text{in})$ |
|   | maximum        |                                      | 12 (10)    |  |
| Marking device                                  |                | Case style TO-247AC modified         | 60EPF10    |  |
|   |                |                                      | 60EPF12    |  |
|   |                | Case style TO-247AC                  | 60APF10    |  |
|   |                |                                      | 60APF12    |  |

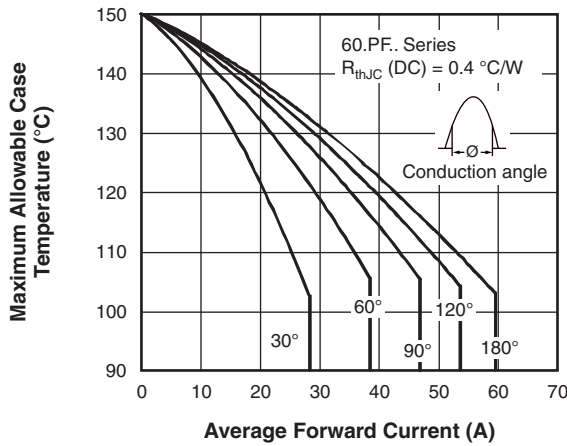


Fig. 1 - Current Rating Characteristics

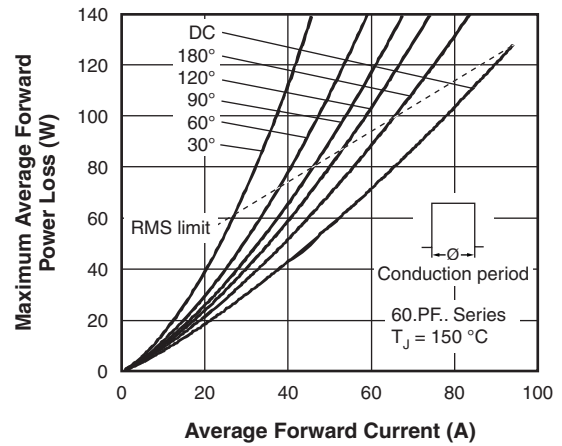


Fig. 4 - Forward Power Loss Characteristics

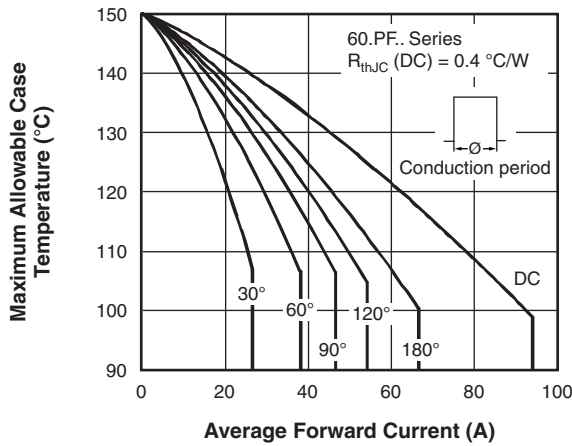


Fig. 2 - Current Rating Characteristics

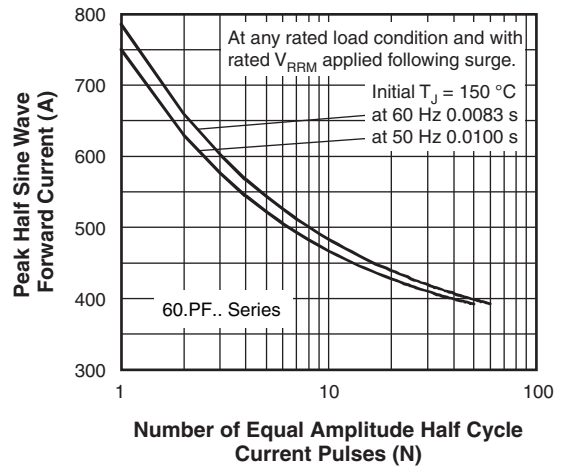


Fig. 5 - Maximum Non-Repetitive Surge Current

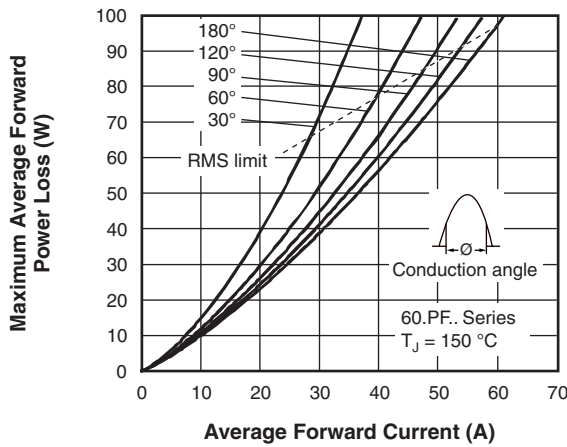


Fig. 3 - Forward Power Loss Characteristics

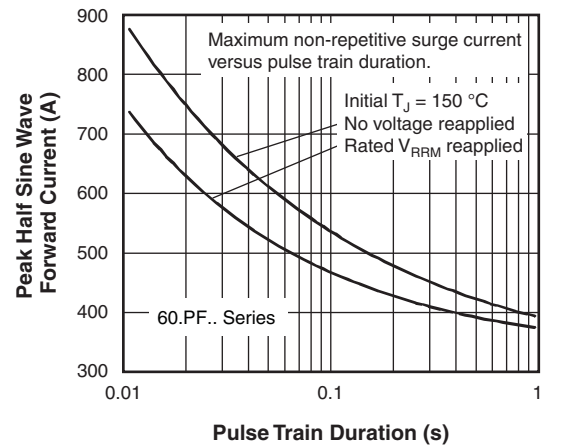


Fig. 6 - Maximum Non-Repetitive Surge Current

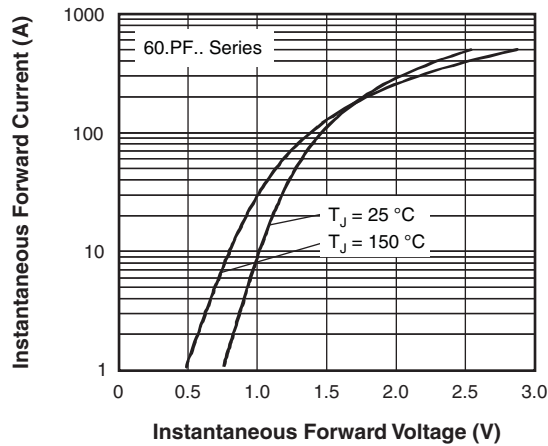


Fig. 7 - Forward Voltage Drop Characteristics

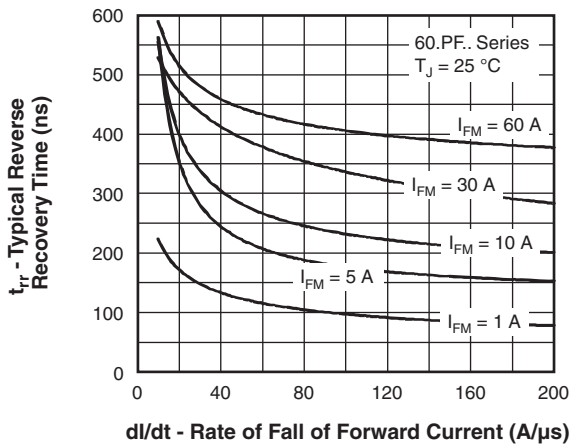


Fig. 8 - Recovery Time Characteristics,  $T_J = 25\text{ }^\circ\text{C}$

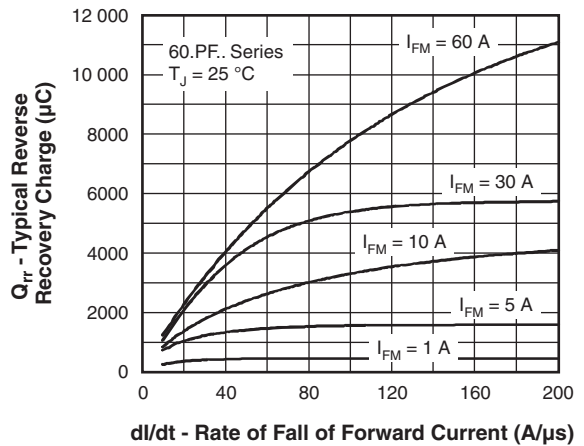


Fig. 10 - Recovery Charge Characteristics,  $T_J = 25\text{ }^\circ\text{C}$

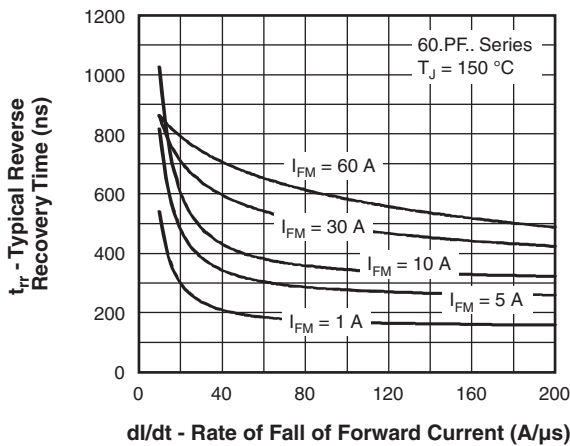


Fig. 9 - Recovery Time Characteristics,  $T_J = 150\text{ }^\circ\text{C}$

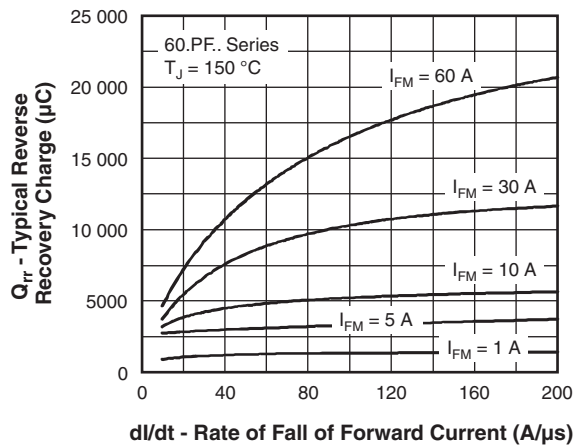


Fig. 11 - Recovery Charge Characteristics,  $T_J = 150\text{ }^\circ\text{C}$

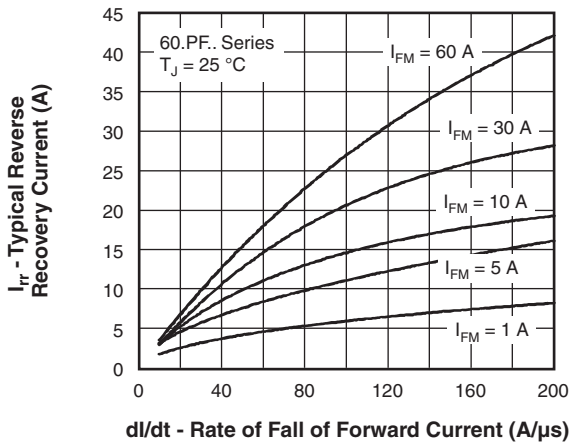


Fig. 12 - Recovery Current Characteristics, T<sub>J</sub> = 25 °C

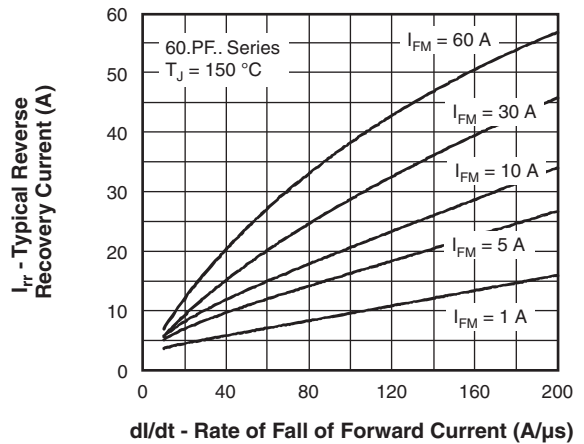


Fig. 13 - Recovery Current Characteristics, T<sub>J</sub> = 150 °C

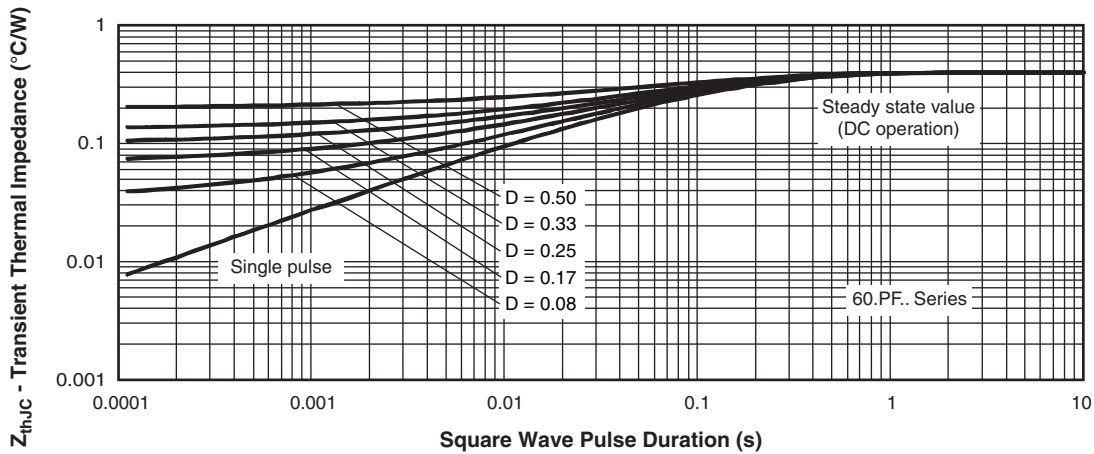
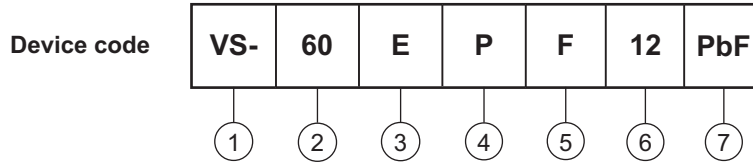


Fig. 14 - Thermal Impedance Z<sub>thJC</sub> Characteristics



## ORDERING INFORMATION TABLE



- 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/TO-247AC modified
- 5** - Type of silicon:  
F = Fast recovery
- 6** - Voltage code x 100 =  $V_{RRM}$ 

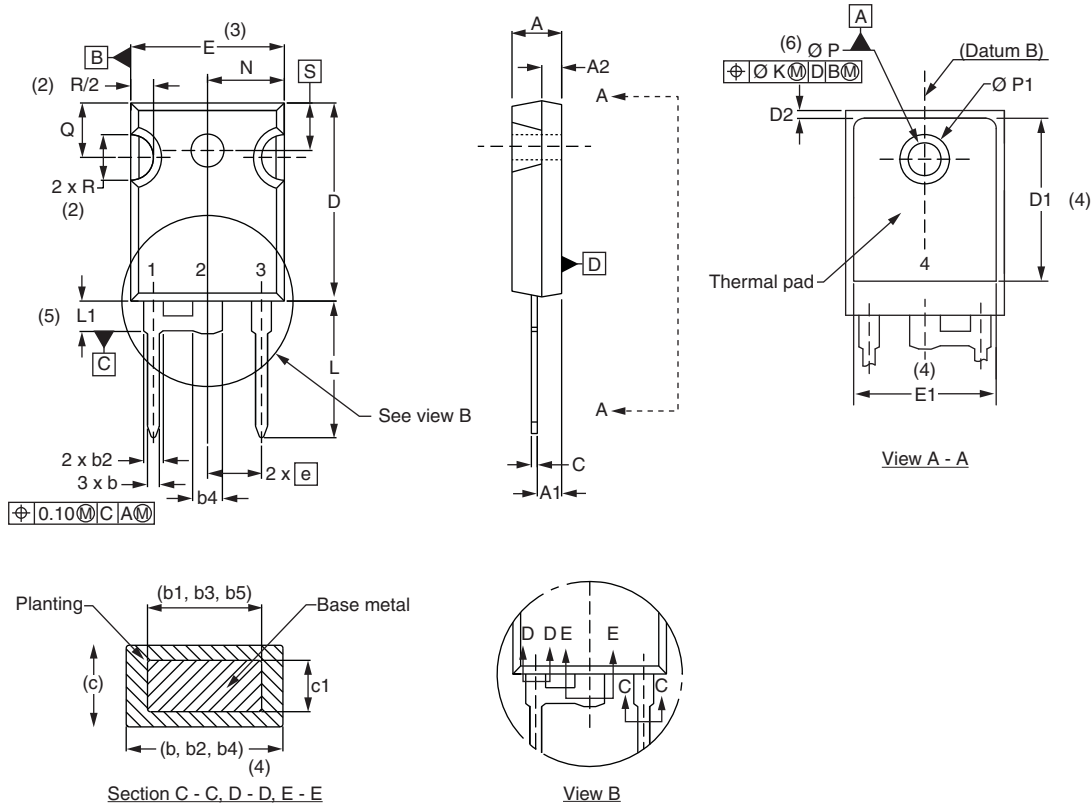
|             |
|-------------|
| 10 = 1000 V |
| 12 = 1200 V |
- 7** - Environmental digit:
  - PbF = Lead (Pb)-free and RoHS compliant
  - -M3 = Halogen-free, RoHS compliant and terminations lead (Pb)-free

| ORDERING INFORMATION (Example) |                  |                        |                          |
|--------------------------------|------------------|------------------------|--------------------------|
| PREFERRED P/N                  | QUANTITY PER T/R | MINIMUM ORDER QUANTITY | PACKAGING DESCRIPTION    |
| VS-60EPF10PbF                  | 25               | 500                    | Antistatic plastic tubes |
| VS-60EPF10-M3                  | 25               | 500                    | Antistatic plastic tubes |
| VS-60APF10PbF                  | 25               | 500                    | Antistatic plastic tubes |
| VS-60APF10-M3                  | 25               | 500                    | Antistatic plastic tubes |
| VS-60EPF12PbF                  | 25               | 500                    | Antistatic plastic tubes |
| VS-60EPF12-M3                  | 25               | 500                    | Antistatic plastic tubes |
| VS-60APF12PbF                  | 25               | 500                    | Antistatic plastic tubes |
| VS-60APF12-M3                  | 25               | 500                    | Antistatic plastic tubes |

| LINKS TO RELATED DOCUMENTS |                       |  |
|----------------------------|-----------------------|--|
| Dimensions                 | TO-247AC modified     | <a href="http://www.vishay.com/doc?95541">www.vishay.com/doc?95541</a> |
|                            | TO-247AC              | <a href="http://www.vishay.com/doc?95542">www.vishay.com/doc?95542</a> |
| Part marking information   | TO-247AC modified PbF | <a href="http://www.vishay.com/doc?95255">www.vishay.com/doc?95255</a> |
|                            | TO-247AC modified -M3 | <a href="http://www.vishay.com/doc?95442">www.vishay.com/doc?95442</a> |
|                            | TO-247AC PbF          | <a href="http://www.vishay.com/doc?95226">www.vishay.com/doc?95226</a> |
|                            | TO-247AC -M3          | <a href="http://www.vishay.com/doc?95007">www.vishay.com/doc?95007</a> |

### TO-247 modified

**DIMENSIONS** in millimeters and inches



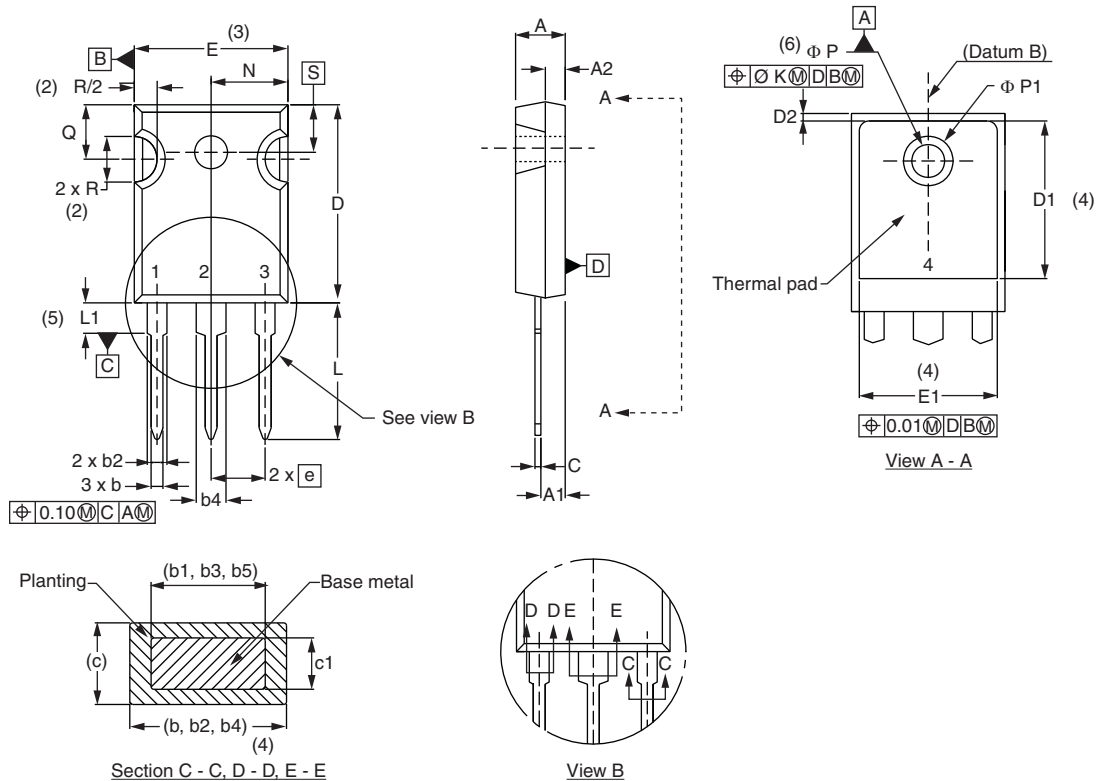
| SYMBOL           | MILLIMETERS |       | INCHES    |       | NOTES |
|------------------|-------------|-------|-----------|-------|-------|
|                  | MIN.        | MAX.  | MIN.      | MAX.  |       |
| A                | 4.65        | 5.31  | 0.183     | 0.209 |       |
| A1               | 2.21        | 2.59  | 0.087     | 0.102 |       |
| A2               | 1.17        | 1.37  | 0.046     | 0.054 |       |
| b                | 0.99        | 1.40  | 0.039     | 0.055 |       |
| b1               | 0.99        | 1.35  | 0.039     | 0.053 |       |
| b2               | 1.65        | 2.39  | 0.065     | 0.094 |       |
| b3               | 1.65        | 2.33  | 0.065     | 0.092 |       |
| b4               | 2.59        | 3.43  | 0.102     | 0.135 |       |
| b5               | 2.59        | 3.38  | 0.102     | 0.133 |       |
| c                | 0.38        | 0.89  | 0.015     | 0.035 |       |
| c1               | 0.38        | 0.84  | 0.015     | 0.033 |       |
| D                | 19.71       | 20.70 | 0.776     | 0.815 | 3     |
| D1               | 13.08       | -     | 0.515     | -     | 4     |
| D2               | 0.51        | 1.35  | 0.020     | 0.053 |       |
| E                | 15.29       | 15.87 | 0.602     | 0.625 | 3     |
| E1               | 13.46       | -     | 0.53      | -     |       |
| e                | 5.46 BSC    |       | 0.215 BSC |       |       |
| $\varnothing K$  | 0.254       |       | 0.010     |       |       |
| L                | 14.20       | 16.10 | 0.559     | 0.634 |       |
| L1               | 3.71        | 4.29  | 0.146     | 0.169 |       |
| N                | 7.62 BSC    |       | 0.3       |       |       |
| $\varnothing P$  | 3.56        | 3.66  | 0.14      | 0.144 |       |
| $\varnothing P1$ | -           | 7.39  | -         | 0.291 |       |
| Q                | 5.31        | 5.69  | 0.209     | 0.224 |       |
| R                | 4.52        | 5.49  | 0.178     | 0.216 |       |
| S                | 5.51 BSC    |       | 0.217 BSC |       |       |

**Notes**

- (1) Dimensioning and tolerance 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)  $\varnothing P$  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 and Q

## TO-247

**DIMENSIONS** in millimeters and inches



| SYMBOL | MILLIMETERS |       | INCHES |       | NOTES |
|--------|-------------|-------|--------|-------|-------|
|        | MIN.        | MAX.  | MIN.   | MAX.  |       |
| A      | 4.65        | 5.31  | 0.183  | 0.209 |       |
| A1     | 2.21        | 2.59  | 0.087  | 0.102 |       |
| A2     | 1.17        | 1.37  | 0.046  | 0.054 |       |
| b      | 0.99        | 1.40  | 0.039  | 0.055 |       |
| b1     | 0.99        | 1.35  | 0.039  | 0.053 |       |
| b2     | 1.65        | 2.39  | 0.065  | 0.094 |       |
| b3     | 1.65        | 2.33  | 0.065  | 0.092 |       |
| b4     | 2.59        | 3.43  | 0.102  | 0.135 |       |
| b5     | 2.59        | 3.38  | 0.102  | 0.133 |       |
| c      | 0.38        | 0.89  | 0.015  | 0.035 |       |
| c1     | 0.38        | 0.84  | 0.015  | 0.033 |       |
| D      | 19.71       | 20.70 | 0.776  | 0.815 | 3     |
| D1     | 13.08       | -     | 0.515  | -     | 4     |

| SYMBOL | MILLIMETERS |       | INCHES    |       | NOTES |
|--------|-------------|-------|-----------|-------|-------|
|        | MIN.        | MAX.  | MIN.      | MAX.  |       |
| D2     | 0.51        | 1.35  | 0.020     | 0.053 |       |
| E      | 15.29       | 15.87 | 0.602     | 0.625 | 3     |
| E1     | 13.46       | -     | 0.53      | -     |       |
| e      | 5.46 BSC    |       | 0.215 BSC |       |       |
| Ø K    | 0.254       |       | 0.010     |       |       |
| L      | 14.20       | 16.10 | 0.559     | 0.634 |       |
| L1     | 3.71        | 4.29  | 0.146     | 0.169 |       |
| N      | 7.62 BSC    |       | 0.3       |       |       |
| Ø P    | 3.56        | 3.66  | 0.14      | 0.144 |       |
| Ø P1   | -           | 7.39  | -         | 0.291 |       |
| Q      | 5.31        | 5.69  | 0.209     | 0.224 |       |
| R      | 4.52        | 5.49  | 0.178     | 0.216 |       |
| 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 and Q



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**Please note that some Vishay documentation may still make reference to RoHS Directive 2002/95/EC. We confirm that all the products identified as being compliant to Directive 2002/95/EC conform to Directive 2011/65/EU.**

**Vishay Intertechnology, Inc. hereby certifies that all its products that are identified as Halogen-Free follow Halogen-Free requirements as per JEDEC JS709A standards. Please note that some Vishay documentation may still make reference to the IEC 61249-2-21 definition. We confirm that all the products identified as being compliant to IEC 61249-2-21 conform to JEDEC JS709A standards.**