

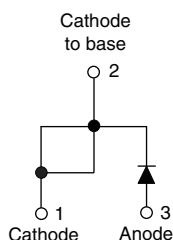
# Ultrafast Soft Recovery Diode, 60 A FRED Pt®



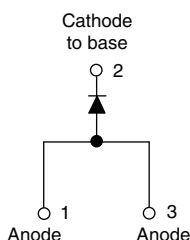
TO-247AC modified



TO-247AC



VS-60EPU06HN3



VS-60APU06HN3

## FEATURES

- Ultrafast recovery time
- Low forward voltage drop
- 175 °C operating junction temperature
- AEC-Q101 qualified, meets JESD 201 class 1A 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**

## 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 modified (2 pins), TO-247AC |
| $I_{F(AV)}$     | 60 A                                 |
| $V_R$           | 600 V                                |
| $V_F$ at $I_F$  | 1.11 V                               |
| $t_{rr}$ typ.   | See Recovery table                   |
| $T_J$ max.      | 175 °C                               |
| Diode variation | Single die                           |

## ABSOLUTE MAXIMUM RATINGS

| PARAMETER                                   | SYMBOL         | TEST CONDITIONS       | MAX.        | UNITS |
|---------------------------------------------|----------------|-----------------------|-------------|-------|
| Cathode to anode voltage                    | $V_R$          |                       | 600         | V     |
| Continuous forward current                  | $I_{F(AV)}$    | $T_C = 116\text{ °C}$ | 60          | A     |
| Single pulse forward current                | $I_{FSM}$      | $T_C = 25\text{ °C}$  | 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 ( $T_J = 25\text{ °C}$ unless otherwise specified)

| PARAMETER                           | SYMBOL        | TEST CONDITIONS                          | MIN. | TYP. | MAX. | UNITS         |
|-------------------------------------|---------------|------------------------------------------|------|------|------|---------------|
| Breakdown voltage, blocking voltage | $V_{BR}, V_R$ | $I_R = 100\text{ }\mu\text{A}$           | 600  | -    | -    | V             |
| Forward voltage                     | $V_F$         | $I_F = 60\text{ A}$                      | -    | 1.35 | 1.68 |               |
|                                     |               | $I_F = 60\text{ A}, T_J = 125\text{ °C}$ | -    | 1.20 | 1.42 |               |
|                                     |               | $I_F = 60\text{ A}, T_J = 175\text{ °C}$ | -    | 1.11 | 1.30 |               |
| Reverse leakage current             | $I_R$         | $V_R = V_R$ rated                        | -    | -    | 50   | $\mu\text{A}$ |
|                                     |               | $T_J = 150\text{ °C}, V_R = V_R$ rated   | -    | -    | 500  |               |
| Junction capacitance                | $C_T$         | $V_R = 600\text{ V}$                     | -    | 39   | -    | pF            |



| DYNAMIC RECOVERY CHARACTERISTICS ( $T_J = 25\text{ }^{\circ}\text{C}$ unless otherwise specified) |           |                                                                                 |      |      |      |       |
|---------------------------------------------------------------------------------------------------|-----------|---------------------------------------------------------------------------------|------|------|------|-------|
| PARAMETER                                                                                         | SYMBOL    | TEST CONDITIONS                                                                 | MIN. | TYP. | MAX. | UNITS |
| Reverse recovery time                                                                             | $t_{rr}$  | $I_F = 1\text{ A}$ , $dI_F/dt = 200\text{ A}/\mu\text{s}$ , $V_R = 30\text{ V}$ | -    | 34   | 45   | ns    |
|                                                                                                   |           | $T_J = 25\text{ }^{\circ}\text{C}$                                              | -    | 81   | -    |       |
|                                                                                                   |           | $T_J = 125\text{ }^{\circ}\text{C}$                                             | -    | 164  | -    |       |
| Peak recovery current                                                                             | $I_{RRM}$ | $T_J = 25\text{ }^{\circ}\text{C}$                                              | -    | 7.4  | -    | A     |
|                                                                                                   |           | $T_J = 125\text{ }^{\circ}\text{C}$                                             | -    | 17.0 | -    |       |
| Reverse recovery charge                                                                           | $Q_{rr}$  | $T_J = 25\text{ }^{\circ}\text{C}$                                              | -    | 300  | -    | nC    |
|                                                                                                   |           | $T_J = 125\text{ }^{\circ}\text{C}$                                             | -    | 1394 | -    |       |

| THERMAL - MECHANICAL SPECIFICATIONS  |            |                                            |             |      |             |                     |
|--------------------------------------|------------|--------------------------------------------|-------------|------|-------------|---------------------|
| PARAMETER                            | SYMBOL     | TEST CONDITIONS                            | MIN.        | TYP. | MAX.        | UNITS               |
| Thermal resistance, junction to case | $R_{thJC}$ |                                            | -           | -    | 0.63        | K/W                 |
| Thermal resistance, case to heatsink | $R_{thCS}$ | Mounting surface, flat, smooth and greased | -           | 0.2  | -           |                     |
| Weight                               |            |                                            | -           | 5.5  | -           | g                   |
|                                      |            |                                            | -           | 0.2  | -           | oz.                 |
| Mounting torque                      |            |                                            | 1.2<br>(10) | -    | 2.4<br>(20) | N · m<br>(lbf · in) |
| Marking device                       |            | Case style TO-247AC modified               | 60EPU06H    |      |             |                     |
|                                      |            | Case style TO-247AC                        | 60APU06H    |      |             |                     |

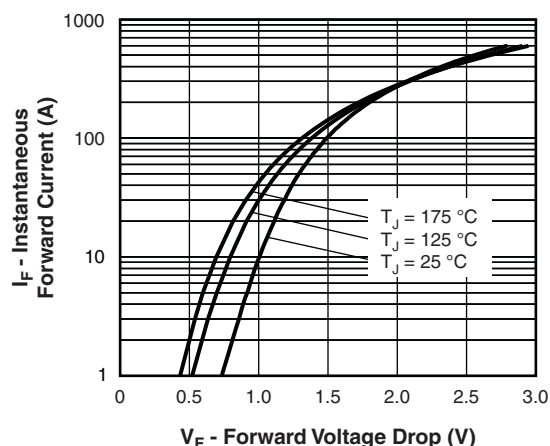


Fig. 1 - Typical Forward Voltage Drop Characteristics

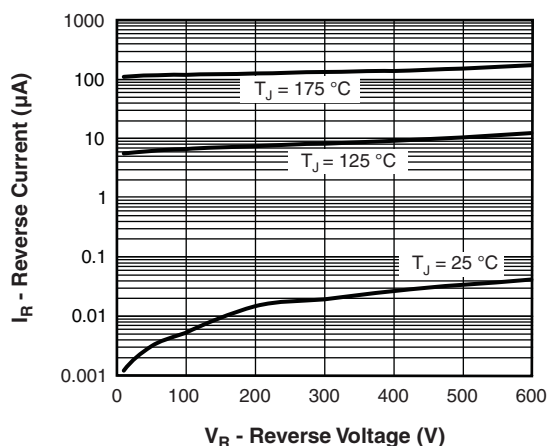


Fig. 2 - Typical Values of Reverse Current vs. Reverse Voltage

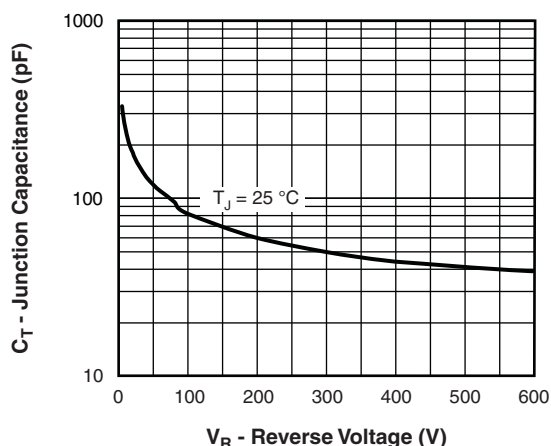


Fig. 3 - Typical Junction Capacitance vs. Reverse Voltage

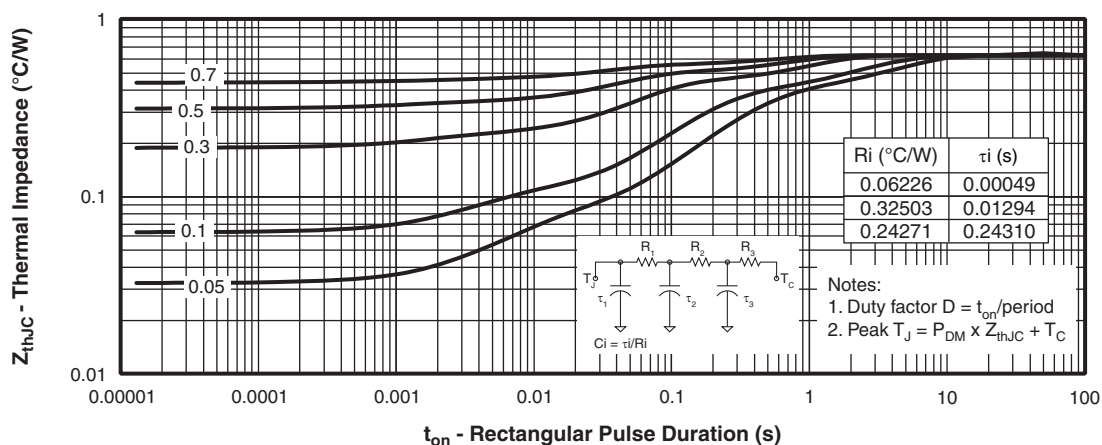
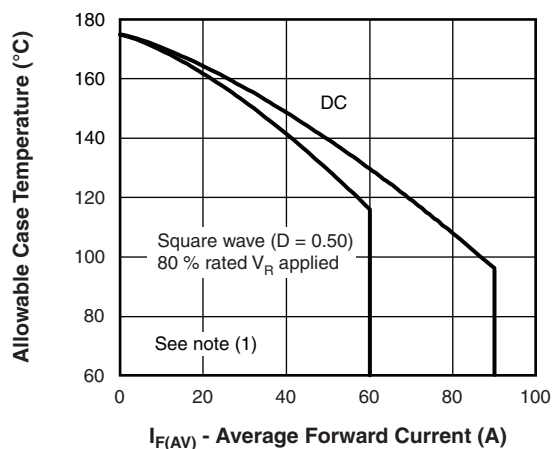

Fig. 4 - Maximum Thermal Impedance  $Z_{thJC}$  Characteristics


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

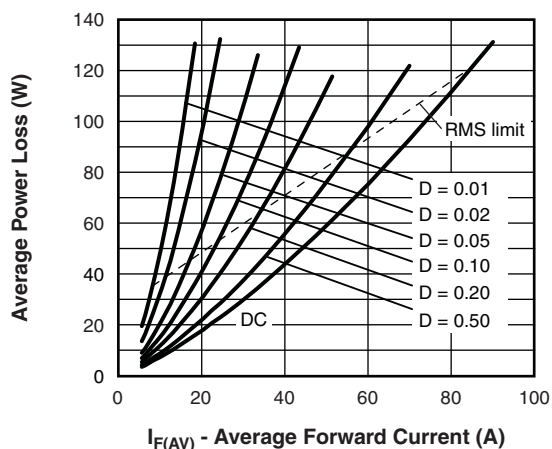
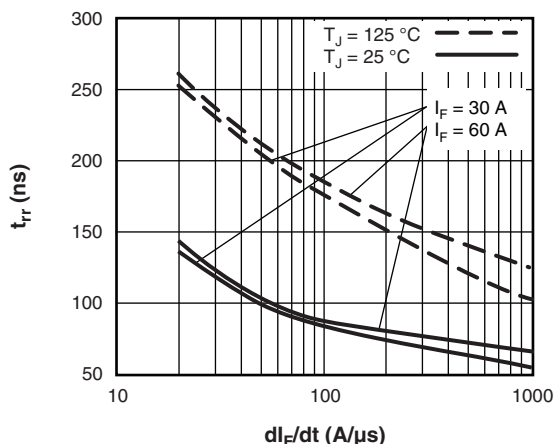
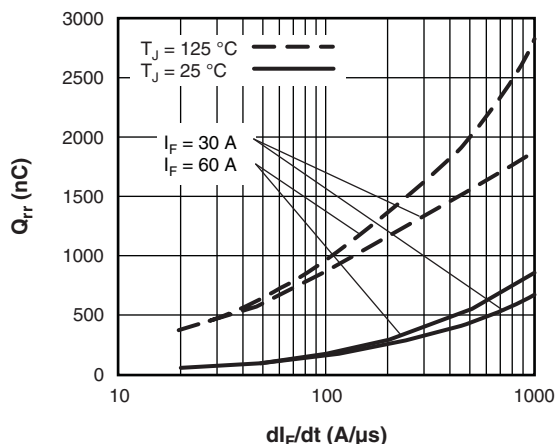


Fig. 6 - Forward Power Loss Characteristics


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

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  $V_{R1} = 80\%$  rated  $V_R$

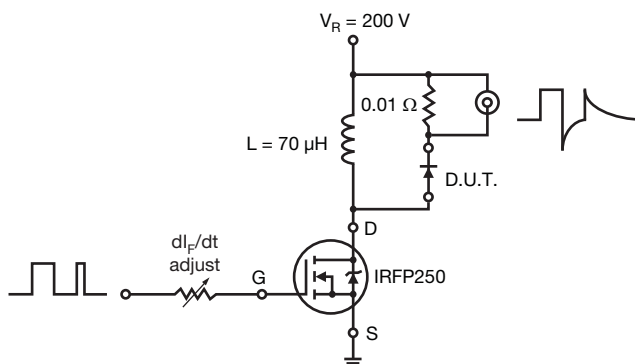


Fig. 9 - Reverse Recovery Parameter Test Circuit

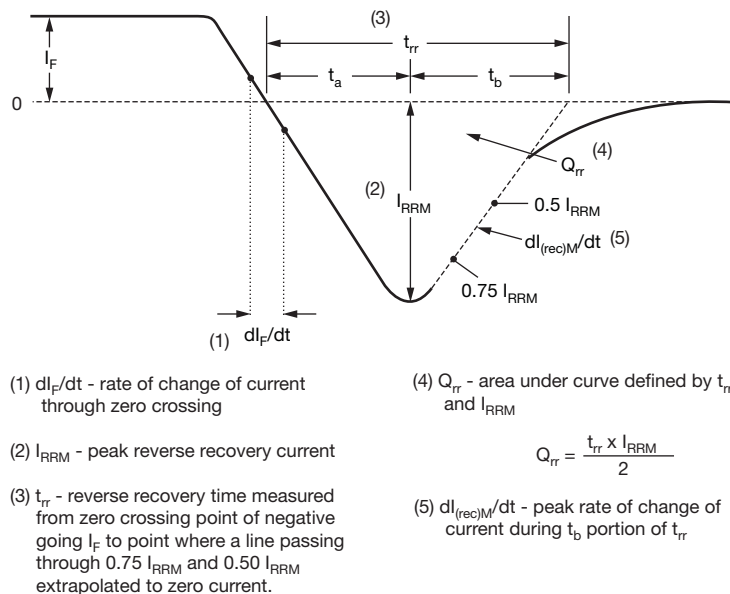


Fig. 10 - Reverse Recovery Waveform and Definitions

**ORDERING INFORMATION TABLE**

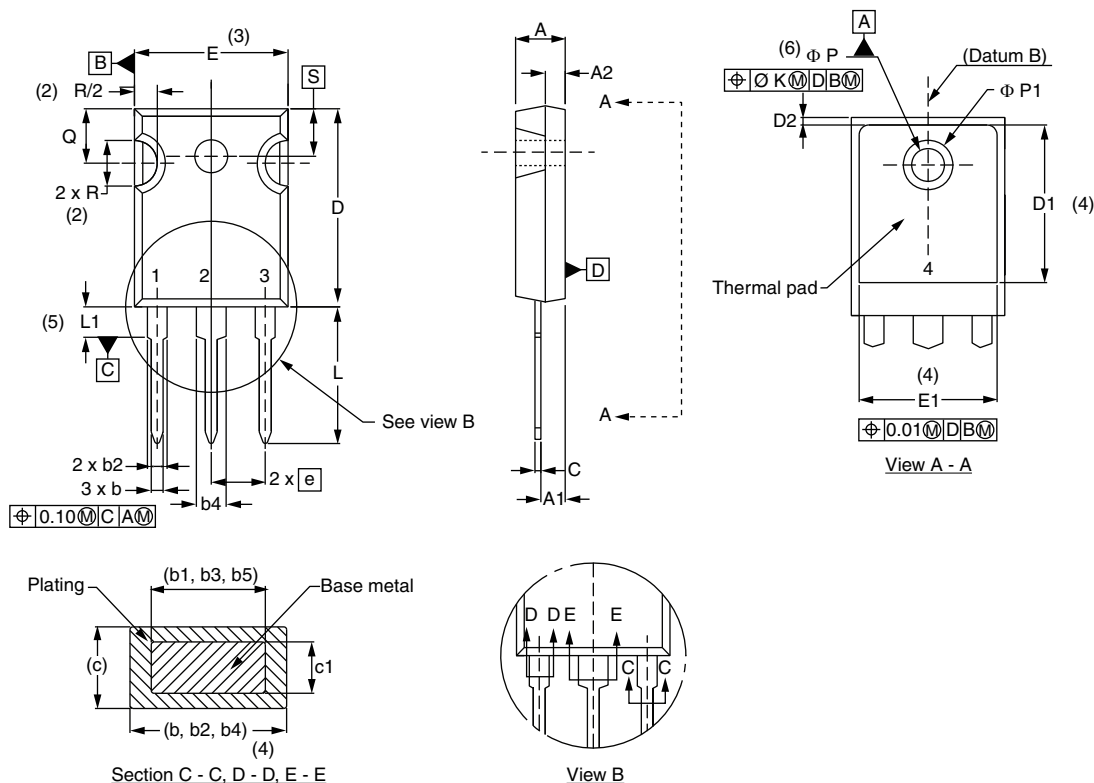
| Device code | VS- | 60                                                                                                                       | E | P | U | 06 | H | N3 |
|-------------|-----|--------------------------------------------------------------------------------------------------------------------------|---|---|---|----|---|----|
|             | 1   | 2                                                                                                                        | 3 | 4 | 5 | 6  | 7 | 8  |
| 1           | -   | Vishay Semiconductors product                                                                                            |   |   |   |    |   |    |
| 2           | -   | Current rating (60 = 60 A)                                                                                               |   |   |   |    |   |    |
| 3           | -   | Circuit configuration: <ul style="list-style-type: none"><li>E = single diode</li><li>A = single diode, 3 pins</li></ul> |   |   |   |    |   |    |
| 4           | -   | P = TO-247AC (modified)                                                                                                  |   |   |   |    |   |    |
| 5           | -   | U = ultrafast recovery                                                                                                   |   |   |   |    |   |    |
| 6           | -   | Voltage rating (06 = 600 V)                                                                                              |   |   |   |    |   |    |
| 7           | -   | H = AEC-Q101 qualified                                                                                                   |   |   |   |    |   |    |
| 8           | -   | Environmental digit:<br>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-60EPU06HN3                  | 25               | 500                    | Antistatic plastic tube |
| VS-60APU06HN3                  | 25               | 500                    | Antistatic plastic tube |

| 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?95442">www.vishay.com/doc?95442</a> |
|                            | TO-247AC          | <a href="http://www.vishay.com/doc?95007">www.vishay.com/doc?95007</a> |
| SPIICE model               |                   | <a href="http://www.vishay.com/doc?95545">www.vishay.com/doc?95545</a> |

### TO-247AC

**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     | 1.50        | 2.49  | 0.059  | 0.098 |       |
| 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        | 2.34  | 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        | 1.30  | 0.020     | 0.051 |       |
| E         | 15.29       | 15.87 | 0.602     | 0.625 | 3     |
| E1        | 13.72       | -     | 0.540     | -     |       |
| e         | 5.46 BSC    |       | 0.215 BSC |       |       |
| $\Phi K$  | 2.54        |       | 0.010     |       |       |
| L         | 14.20       | 16.10 | 0.559     | 0.634 |       |
| L1        | 3.71        | 4.29  | 0.146     | 0.169 |       |
| $\Phi P$  | 3.56        | 3.66  | 0.14      | 0.144 |       |
| $\Phi P1$ | -           | 6.98  | -         | 0.275 |       |
| 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 |       |       |

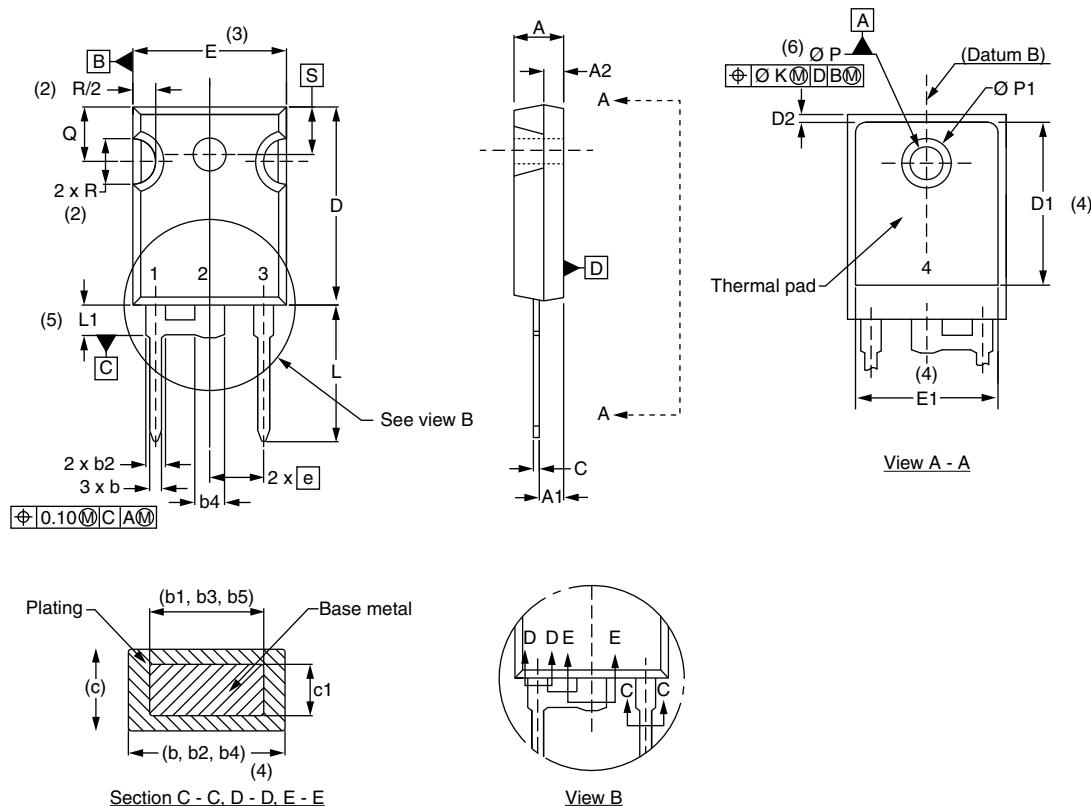
#### Notes

- (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)  $\Phi P$  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



## TO-247AC 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 |       |
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| 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        | 1.30  | 0.020     | 0.051 |       |
| E      | 15.29       | 15.87 | 0.602     | 0.625 | 3     |
| E1     | 13.72       | -     | 0.540     | -     |       |
| e      | 5.46 BSC    |       | 0.215 BSC |       |       |
| Ø K    | 2.54        |       | 0.010     |       |       |
| L      | 14.20       | 16.10 | 0.559     | 0.634 |       |
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| Ø P1   | -           | 6.98  | -         | 0.275 |       |
| Q      | 5.31        | 5.69  | 0.209     | 0.224 |       |
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| S      | 5.51 BSC    |       | 0.217 BSC |       |       |

### Notes

- (1) Dimensioning and tolerance per ASME Y14.5M-1994
- (2) Contour of slot optional
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- (7) Outline conforms to JEDEC® outline TO-247 with exception of dimension c



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