

## Excellent Integrated System Limited

Stocking Distributor

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[Vishay Semiconductor/Diodes Division](#)  
[VS-60CPU04-N3](#)

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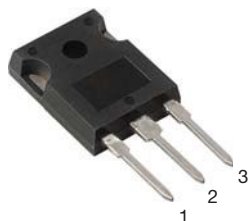


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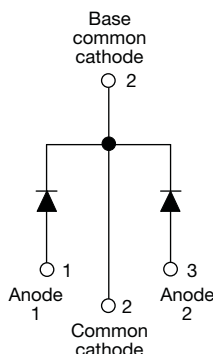
## VS-60CPU04-F3, VS-60CPU04-N3

Vishay Semiconductors

### Ultrafast Rectifier, 2 x 30 A FRED Pt®



TO-247AC



#### FEATURES

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

#### DESCRIPTION/APPLICATIONS

VS-60CPU04... series are the state of the art ultrafast recovery rectifiers 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, welding, UPS, DC/DC converters as well as freewheeling diodes 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.

#### PRODUCT SUMMARY

|                 |            |
|-----------------|------------|
| Package         | TO-247AC   |
| $I_{F(AV)}$     | 2 x 30 A   |
| $V_R$           | 400 V      |
| $V_F$ at $I_F$  | 1.30 V     |
| $t_{rr}$ typ.   | 37 ns      |
| $T_J$ max.      | 175 °C     |
| Diode variation | Single die |

#### ABSOLUTE MAXIMUM RATINGS

| PARAMETER                                   | SYMBOL         | TEST CONDITIONS                                   | VALUES      | UNITS |
|---------------------------------------------|----------------|---------------------------------------------------|-------------|-------|
| Peak repetitive reverse voltage             | $V_{RRM}$      |                                                   | 400         | V     |
| Average rectified forward current           | $I_{F(AV)}$    | Rated $V_R$ , $T_C = 134$ °C                      | 30<br>60    | A     |
| Non-repetitive peak surge current per leg   | $I_{FSM}$      | $T_J = 25$ °C                                     | 300         |       |
| Peak repetitive forward current per leg     | $I_{FM}$       | Rated $V_R$ , square wave, 20 kHz, $T_C = 134$ °C | 60          |       |
| Operating junction and storage temperatures | $T_J, T_{Stg}$ |                                                   | - 65 to 175 | °C    |

#### ELECTRICAL SPECIFICATIONS ( $T_J = 25$ °C unless otherwise specified)

| PARAMETER                           | SYMBOL        | TEST CONDITIONS                              | MIN. | TYP. | MAX. | UNITS   |
|-------------------------------------|---------------|----------------------------------------------|------|------|------|---------|
| Breakdown voltage, blocking voltage | $V_{BR}, V_R$ | $I_R = 100$ $\mu$ A                          | 400  | -    | -    |         |
| Forward voltage                     | $V_F$         | $I_F = 30$ A                                 | -    | 1.10 | 1.30 | V       |
|                                     |               | $I_F = 30$ A, $T_J = 150$ °C                 | -    | 0.92 | 1.10 |         |
|                                     |               | $I_F = 60$ A                                 | -    | 1.25 | 1.6  |         |
|                                     |               | $I_F = 60$ A, $T_J = 150$ °C                 | -    | 1.10 | 1.4  |         |
| Reverse leakage current             | $I_R$         | $V_R = V_R$ rated                            | -    | -    | 10   | $\mu$ A |
|                                     |               | $T_J = 150$ °C, $V_R = V_R$ rated            | -    | -    | 100  |         |
| Junction capacitance                | $C_T$         | $V_R = 400$ V                                | -    | 40   | -    | pF      |
| Series inductance                   | $L_S$         | Measured lead to lead 5 mm from package body | -    | 12   | -    | nH      |



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

| PARAMETER               | SYMBOL    | TEST CONDITIONS                                                                   | MIN. | TYP. | MAX. | UNITS |
|-------------------------|-----------|-----------------------------------------------------------------------------------|------|------|------|-------|
| Reverse recovery time   | $t_{rr}$  | $I_F = 1.0\text{ A}$ , $dI_F/dt = 100\text{ A}/\mu\text{s}$ , $V_R = 30\text{ V}$ | -    | 37   | 40   | ns    |
|                         |           | $I_F = 1.0\text{ A}$ , $dI_F/dt = 50\text{ A}/\mu\text{s}$ , $V_R = 30\text{ V}$  | -    | 46   | -    |       |
|                         |           | $T_J = 25\text{ }^{\circ}\text{C}$                                                | -    | 65   | -    |       |
|                         |           | $T_J = 125\text{ }^{\circ}\text{C}$                                               | -    | 119  | -    |       |
| Peak recovery current   | $I_{RRM}$ | $T_J = 25\text{ }^{\circ}\text{C}$                                                | -    | 6.4  | -    | A     |
|                         |           | $T_J = 125\text{ }^{\circ}\text{C}$                                               | -    | 14.7 | -    |       |
| Reverse recovery charge | $Q_{rr}$  | $T_J = 25\text{ }^{\circ}\text{C}$                                                | -    | 206  | -    | nC    |
|                         |           | $T_J = 125\text{ }^{\circ}\text{C}$                                               | -    | 874  | -    |       |

### 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, junction to case per leg    | $R_{thJC}$        |                                            | -            | 0.6  | 1.0        | $^{\circ}\text{C}/\text{W}$ |
| Thermal resistance, junction to ambient per leg | $R_{thJA}$        | Typical socket mount                       | -            | -    | 40         |                             |
| Thermal resistance, case to heatsink            | $R_{thCS}$        | Mounting surface, flat, smooth and greased | -            | 0.5  | -          |                             |
| Weight                                          |                   |                                            | -            | 6    | -          | g                           |
|                                                 |                   |                                            | -            | 0.21 | -          | oz.                         |
| Mounting torque                                 |                   |                                            | 6.0<br>(5.0) | -    | 12<br>(10) | kgf · cm<br>(lbf · in)      |
| Marking device                                  |                   | Case style TO-247AC                        | 60CPU04      |      |            |                             |



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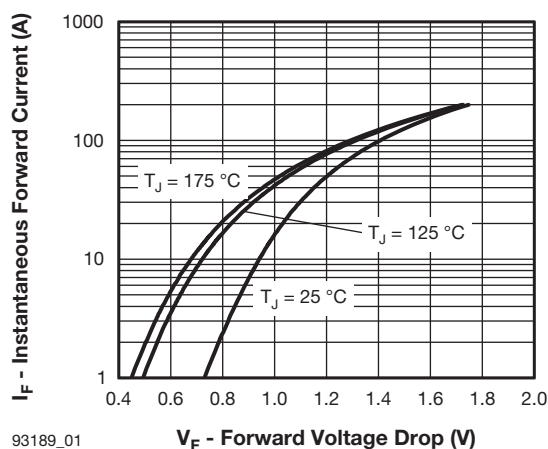


Fig. 1 - Typical Forward Voltage Drop Characteristics

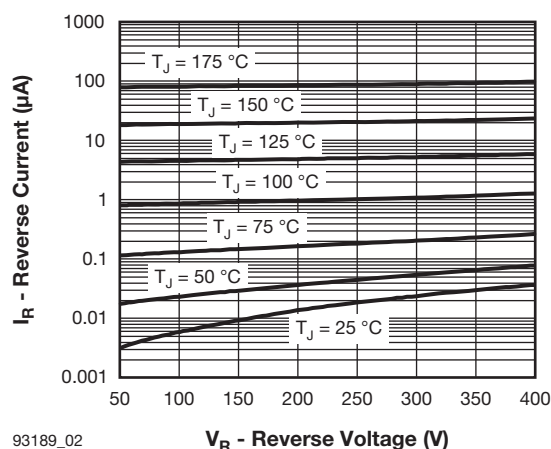


Fig. 2 - Typical Values of Reverse Current vs. Reverse Voltage

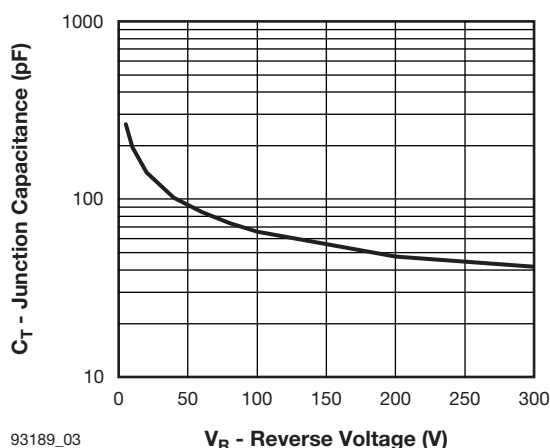


Fig. 3 - Typical Junction Capacitance vs. Reverse Voltage

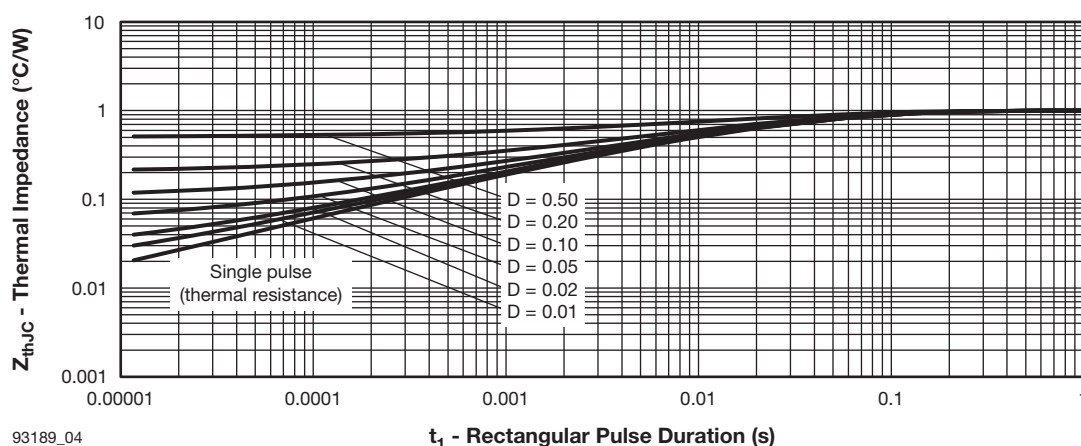


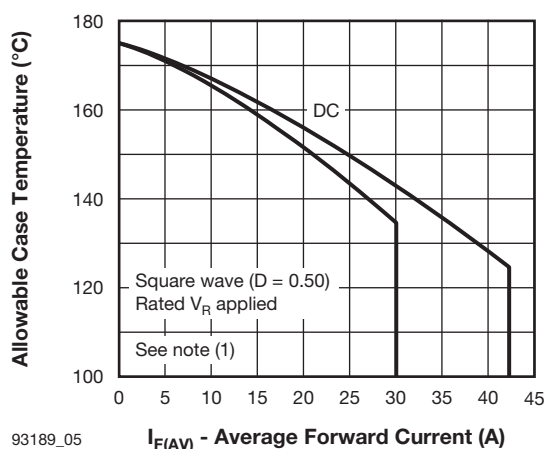
Fig. 4 - Maximum Thermal Impedance  $Z_{thJC}$  Characteristics



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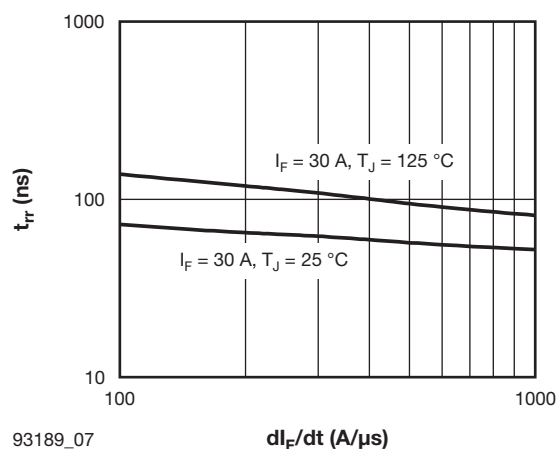
## VS-60CPU04-F3, VS-60CPU04-N3

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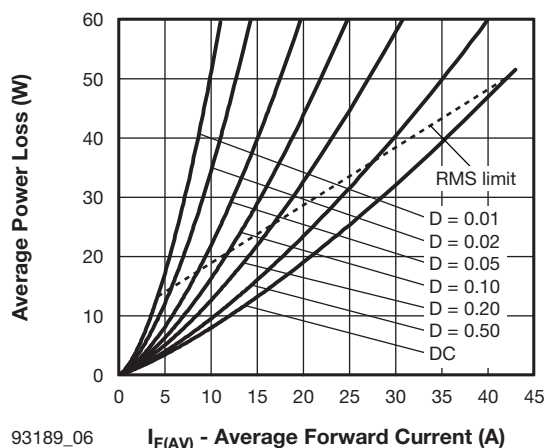
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Fig. 5 - Maximum Allowable Case Temperature vs. Average Forward Current



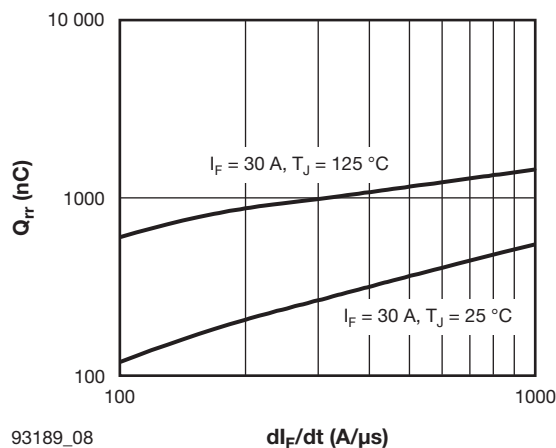
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Fig. 7 - Typical Reverse Recovery Time vs.  $dI_F/dt$



93189\_06

Fig. 6 - Forward Power Loss Characteristics



93189\_08

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  $V_R$

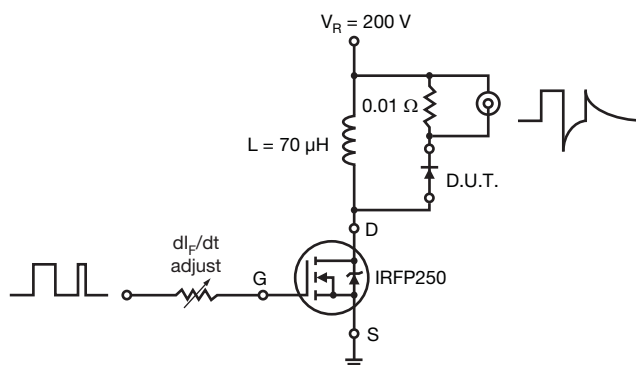


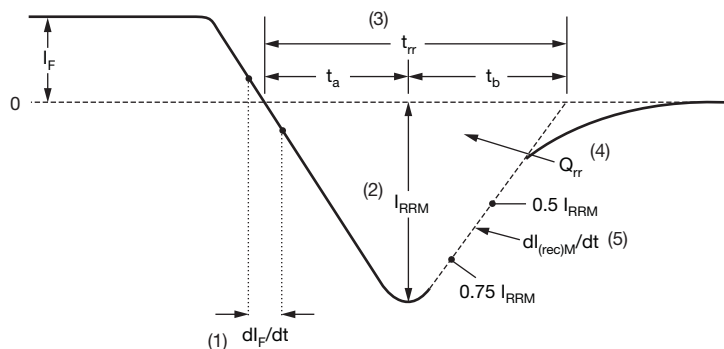
Fig. 9 - Reverse Recovery Parameter Test Circuit



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(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

### ORDERING INFORMATION TABLE

| Device code | VS- | 60 | C | P | U | 04 | -F3 |
|-------------|-----|----|---|---|---|----|-----|
|             | 1   | 2  | 3 | 4 | 5 | 6  | 7   |

- 1** - Vishay Semiconductors product
- 2** - Current rating (60 = 60 A)
- 3** - Circuit configuration: C = Common cathode
- 4** - P = TO-247AC
- 5** - U = Ultrafast rectifier
- 6** - Voltage rating (04 = 400 V)
- 7** - Environmental digit:
  - F3 = RoHS compliant and totally lead (Pb)-free
  - N3 = Halogen-free, RoHS compliant and totally lead (Pb)-free

### ORDERING INFORMATION (Example)

| PREFERRED P/N | QUANTITY PER TUBE | MINIMUM ORDER QUANTITY | PACKAGING DESCRIPTION   |
|---------------|-------------------|------------------------|-------------------------|
| VS-60CPU04-F3 | 25                | 500                    | Antistatic plastic tube |
| VS-60CPU04-N3 | 25                | 500                    | Antistatic plastic tube |

### LINKS TO RELATED DOCUMENTS

|                          |                                                                        |
|--------------------------|------------------------------------------------------------------------|
| Dimensions               | <a href="http://www.vishay.com/doc?95542">www.vishay.com/doc?95542</a> |
| Part marking information | <a href="http://www.vishay.com/doc?95007">www.vishay.com/doc?95007</a> |
| SPICE model              | <a href="http://www.vishay.com/doc?95398">www.vishay.com/doc?95398</a> |



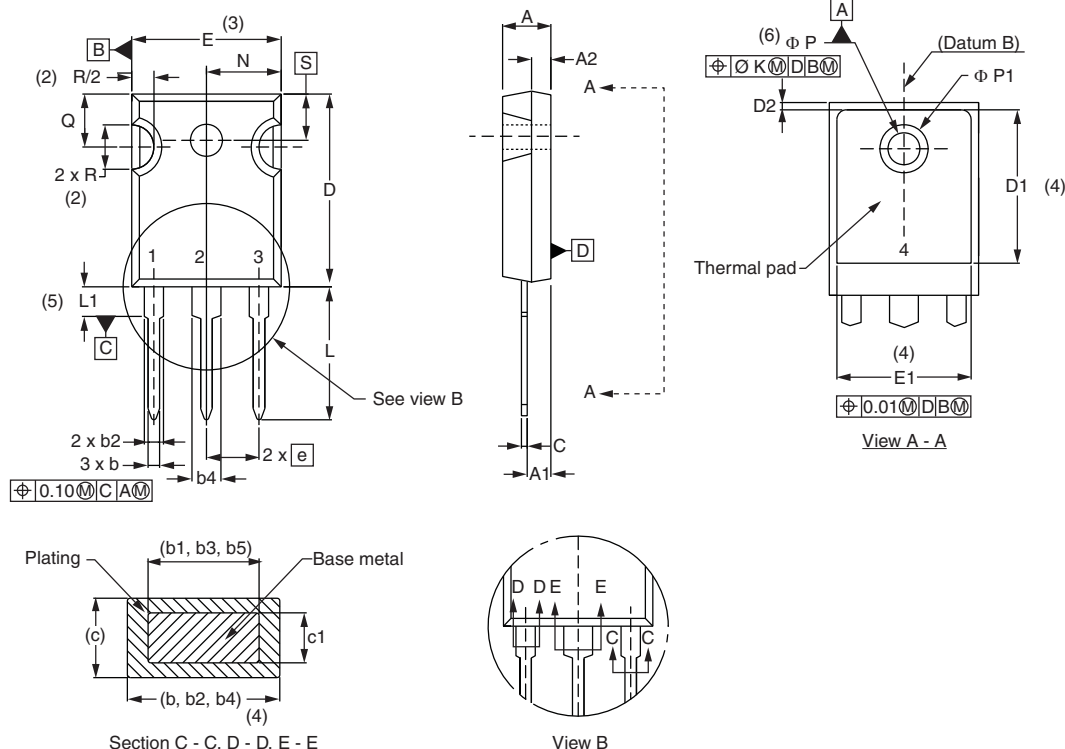
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## Outline Dimensions

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### TO-247 - 50 mils L/F

**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        | 2.34  | 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        | 1.35  | 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

- Dimensioning and tolerancing per ASME Y14.5M-1994
- Contour of slot optional
- 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
- Thermal pad contour optional with dimensions D1 and E1
- Lead finish uncontrolled in L1
- 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")
- Outline conforms to JEDEC® outline TO-247 with exception of dimension c and Q



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