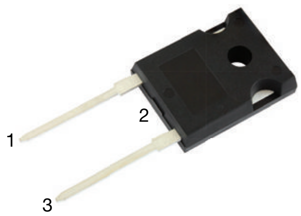
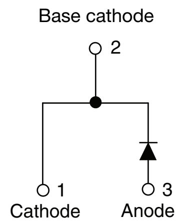
# Hyperfast Rectifier, 60 A FRED Pt® G5




TO-247AD 2L




## FEATURES

- Hyperfast and optimized $Q_{rr}$
- Best in class forward voltage drop and switching losses trade off
- Optimized for high speed operation
- 175 °C maximum operating junction temperature
- Polyimide passivation
- Material categorization: for definitions of compliance please see www.vishay.com/doc?99912

Pb-free
RoHS COMPLIANT
HALOGEN FREE

## LINKS TO ADDITIONAL RESOURCES

3D Models

## DESCRIPTION / APPLICATIONS

Featuring a unique combination of low conduction and switching losses, this rectifier is the right choice for soft switched and resonant converters, as well as medium frequency hard switching converters. This device is specifically designed to improve efficiency of high speed LLC output rectification stages of EV / HEV battery charging stations and high frequency stages of UPS applications.

| PRIMARY CHARACTERISTICS | |
|---|---|
| $I_{F(AV)}$ per leg | 60 A |
| $V_R$ | 600 V |
| $V_F$ at $I_F$ at 125 °C | 1.2 V |
| $t_{rr}$ (typ.) | 29 |
| $I_{FSM}$ | 500 |
| $T_J$ max. | 175 °C |
| Package | TO-247AD 2L |
| Circuit configuration | Single |

## MECHANICAL DATA

**Case:** TO-247AD 2L
Molding compound meets UL 94 V-0 flammability rating

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

**ABSOLUTE MAXIMUM RATINGS**

| PARAMETER | SYMBOL | TEST CONDITIONS | VALUES | UNITS |
|---|---|---|---|---|
| Repetitive peak reverse voltage | $V_{RRM}$ | | 600 | V |
| Average rectified forward current | $I_{F(AV)}$ | $T_C$ = 110 °C, D = 0.50 | 60 | A |
| Non-repetitive peak surge current | $I_{FSM}$ | $T_C$ = 25 °C, $t_p$ = 10 ms, sine wave | 500 | |
| Repetitive peak forward current | $I_{FRM}$ | $T_C$ = 110 °C, D = 0.50, f = 20 kHz | 120 | |
| Operating junction and storage temperature | $T_J$, $T_{Stg}$ | | -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 | 600 | - | - | V |
| Forward voltage | $V_F$ | $I_F$ = 60 A | - | 1.4 | 1.7 | |
| | | $I_F$ = 60 A, $T_J$ = 125 °C | - | 1.2 | - | |
| Reverse leakage current | $I_R$ | $V_R$ = $V_R$ rated | - | - | 25 | μA |
| | | $T_J$ = 125 °C, $V_R$ = $V_R$ rated | - | - | 500 | |
| Junction capacitance | $C_T$ | $V_R$ = 200 V | - | 65 | - | pF |
| Series inductance | $L_S$ | Measured to lead 5 mm from package body | - | 8 | - | nH |

| **DYNAMIC RECOVERY CHARACTERISTICS** ($T_J$ = 25 °C unless otherwise specified) | | | | | | | |
|---|---|---|---|---|---|---|---|
| **PARAMETER** | **SYMBOL** | **TEST CONDITIONS** | | **MIN.** | **TYP.** | **MAX.** | **UNITS** |
| Reverse recovery time | $t_{rr}$ | $I_F$ = 1.0 A, $dI_F/dt$ = 100 A/μs, $V_R$ = 30 V | | - | 29 | - | ns |
| | | $T_J$ = 25 °C | $I_F$ = 40 A<br>$dI_F/dt$ = 1000 A/μs<br>$V_R$ = 400 V | - | 49 | - | |
| | | $T_J$ = 125 °C | | - | 74 | - | |
| Peak recovery current | $I_{RRM}$ | $T_J$ = 25 °C | | - | 21 | - | A |
| | | $T_J$ = 125 °C | | - | 43 | - | |
| Reverse recovery charge | $Q_{rr}$ | $T_J$ = 25 °C | | - | 640 | - | nC |
| | | $T_J$ = 125 °C | | - | 1979 | - | |
| Reverse recovery time | $t_{rr}$ | $T_J$ = 25 °C | $I_F$ = 60 A<br>$dI_F/dt$ = 1000 A/μs<br>$V_R$ = 400 V | - | 54 | - | ns |
| | | $T_J$ = 125 °C | | - | 82 | - | |
| Peak recovery current | $I_{RRM}$ | $T_J$ = 25 °C | | - | 22 | - | A |
| | | $T_J$ = 125 °C | | - | 47 | - | |
| Reverse recovery charge | $Q_{rr}$ | $T_J$ = 25 °C | | - | 790 | - | nC |
| | | $T_J$ = 125 °C | | - | 2385 | - | |

| **THERMAL - MECHANICAL SPECIFICATIONS** | | | | | | |
|---|---|---|---|---|---|---|
| **PARAMETER** | **SYMBOL** | **TEST CONDITIONS** | **MIN.** | **TYP.** | **MAX.** | **UNITS** |
| Thermal resistance, junction-to-case | $R_{thJC}$ | | - | - | 0.63 | °C/W |
| Weight | | | - | 5.5 | - | g |
| | | | - | 0.2 | - | oz. |
| Mounting torque | | | 6<br>(5.0) | - | 12<br>(10) | kgf · cm<br>(lbf · in) |
| Maximum junction and storage temperature range | $T_J$, $T_{Stg}$ | | -55 | - | 175 | °C |
| Marking device | | Case style TO-247AD 2L | E5PH6006L | | | |

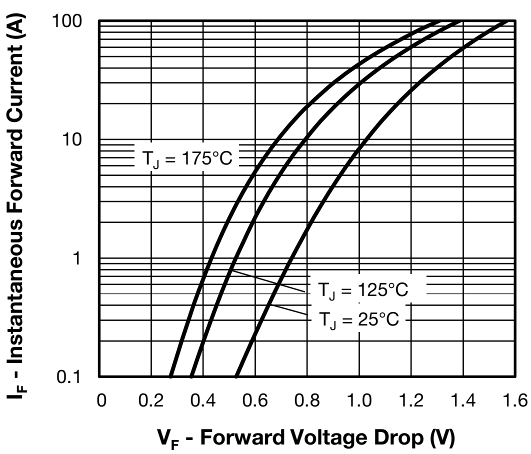



Fig. 1 - Typical Forward Voltage Drop Characteristics

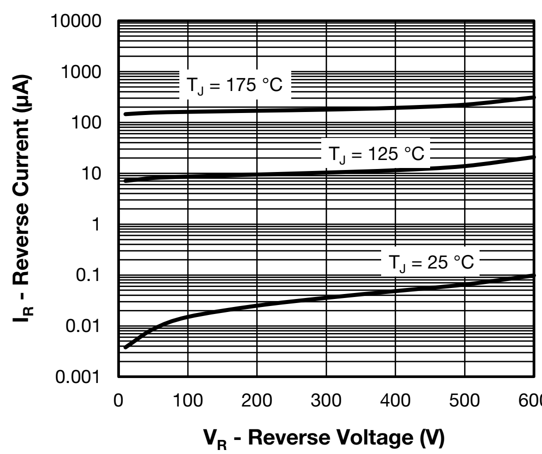



Fig. 2 - Typical Values of Reverse Current vs. Reverse Voltage

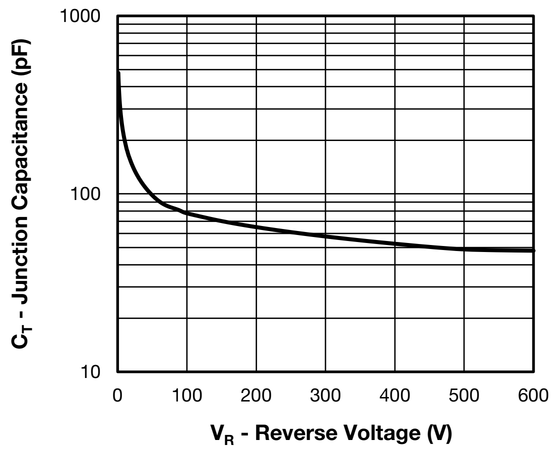



Fig. 3 - Typical Junction Capacitance vs. Reverse Voltage

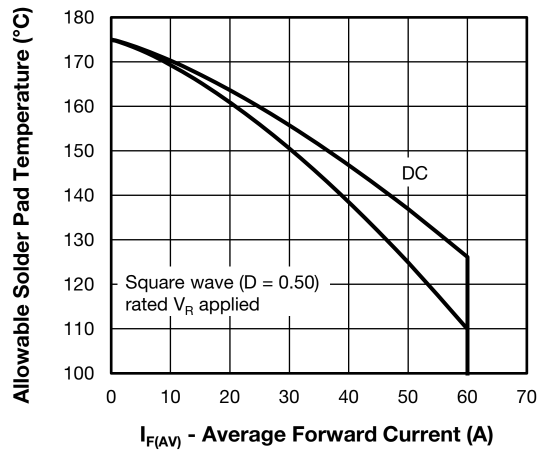



Fig. 4 - Maximum Allowable Case Temperature vs. Average Forward Current

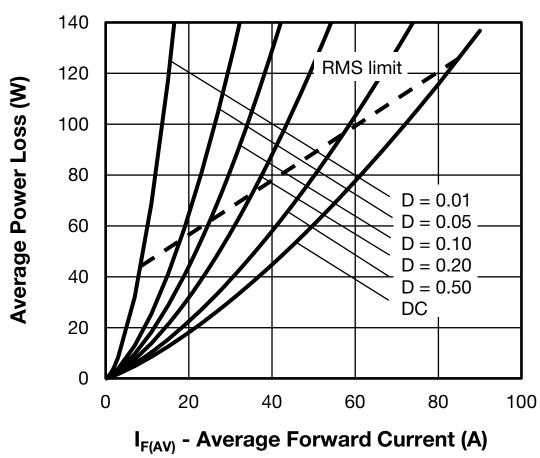



Fig. 5 - Average Power Loss vs. Average Forward Current

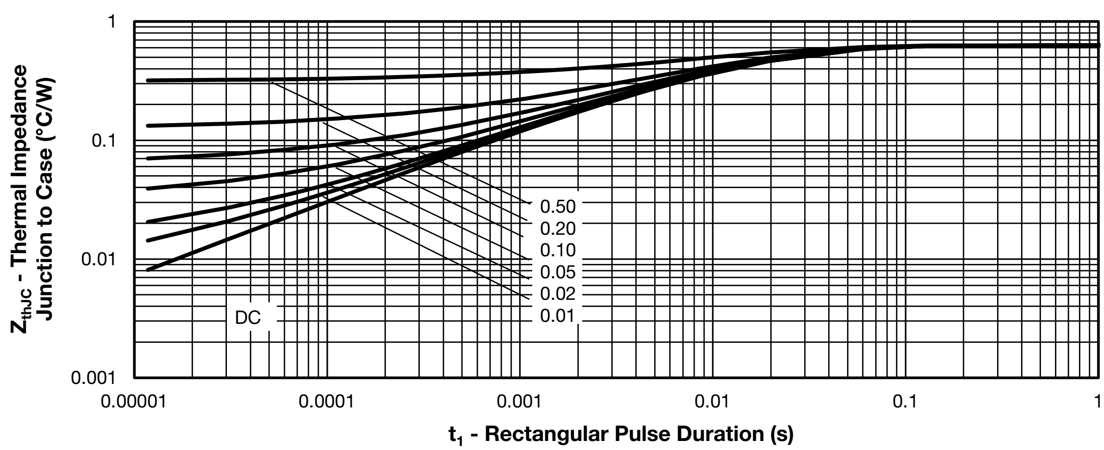



Fig. 6 - Thermal Impedance $Z_{thJC}$ Characteristics

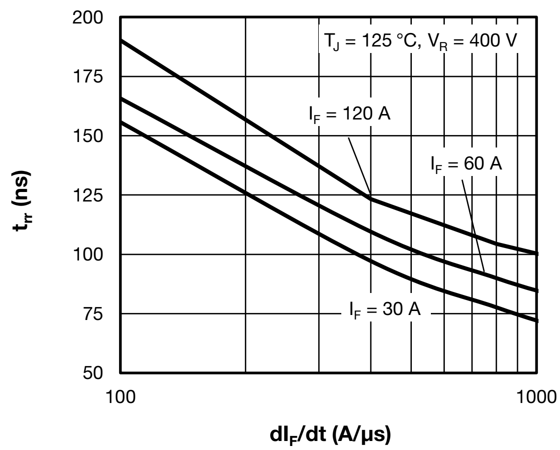



Fig. 7 - Typical Reverse Recovery Time vs. $dI_F/dt$

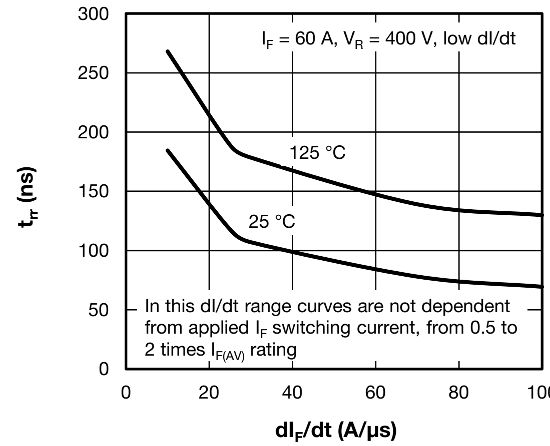



Fig. 10 - Typical Reverse Recovery Time vs. $dI_F/dt$

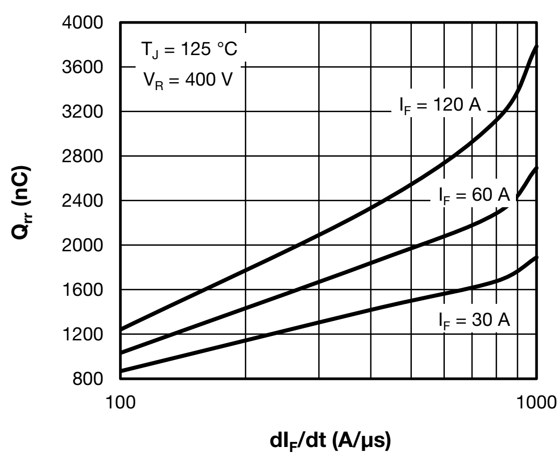



Fig. 8 - Typical Reverse Recovery Charge vs. $dI_F/dt$

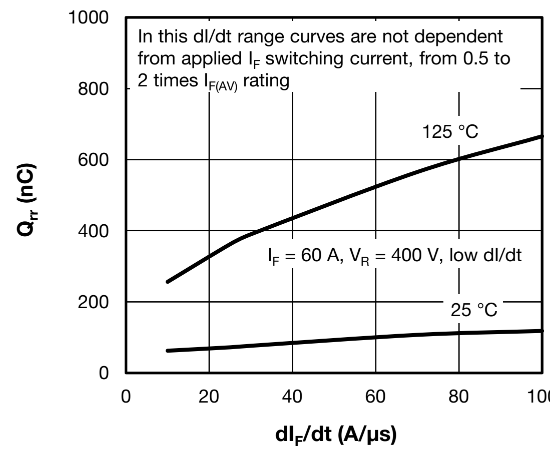



Fig. 11 - Typical Reverse Recovery Charge vs. $dI_F/dt$

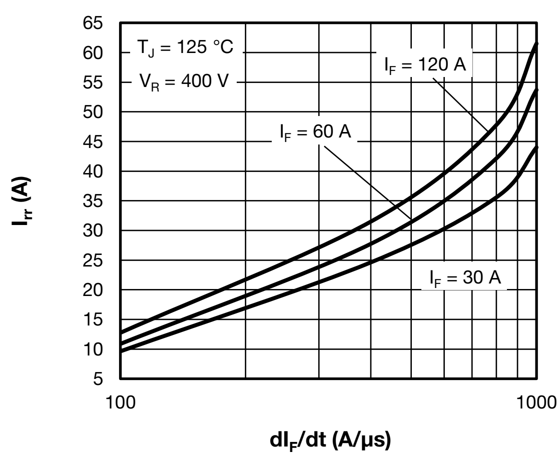



Fig. 9 - Typical Reverse Recovery Current vs. $dI_F/dt$

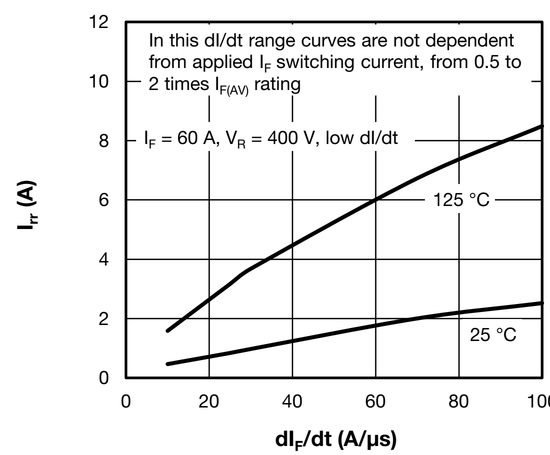



Fig. 12 - Typical Reverse Recovery Current vs. $dI_F/dt$

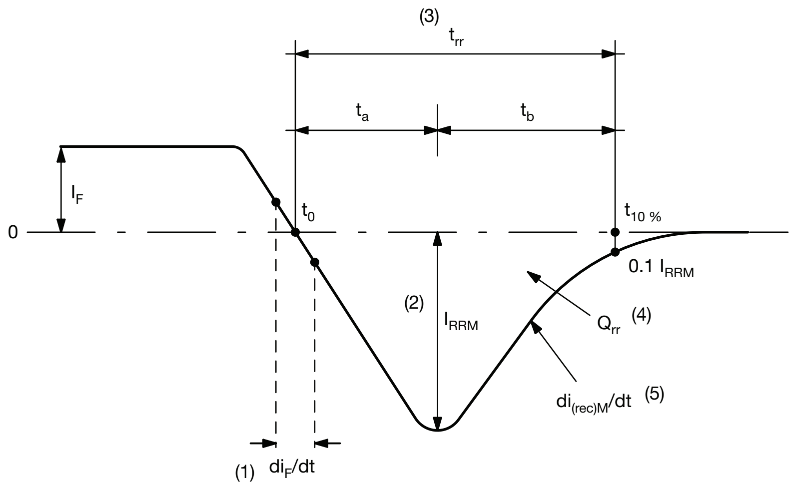



Fig. 13 - Reverse Recovery Waveform and Definitions

**Notes**

(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 $t_0$, crossing point of negative going $I_F$, to point $t_{10\%}$, 0.1 $I_{RRM}$

(4) $Q_{rr}$ - area under curve defined by $t_0$ and $t_{10\ \%}$

$$Q_{rr} = \int_{t_0}^{t_{10\ \%}} I(t)dt$$

(5) $di_{(rec)}M/dt$ - peak rate of change of current during $t_b$ portion of $t_{rr}$

## ORDERING INFORMATION TABLE

| Device code | VS- | E | 5 | P | H | 60 | 06 | L | -N3 |
|---|---|---|---|---|---|---|---|---|---|
| | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 |

1 - Vishay Semiconductors product

2 - Circuit configuration
E = single diode

3 - 5 = Fred generation 5

4 - Package:
P = TO-247 package

5 - H = hyperfast recovery

6 - Current rating (60 = 60 A)

7 - Voltage rating (06 = 600 V)

8 - Package: L = long lead (TO-247AD)

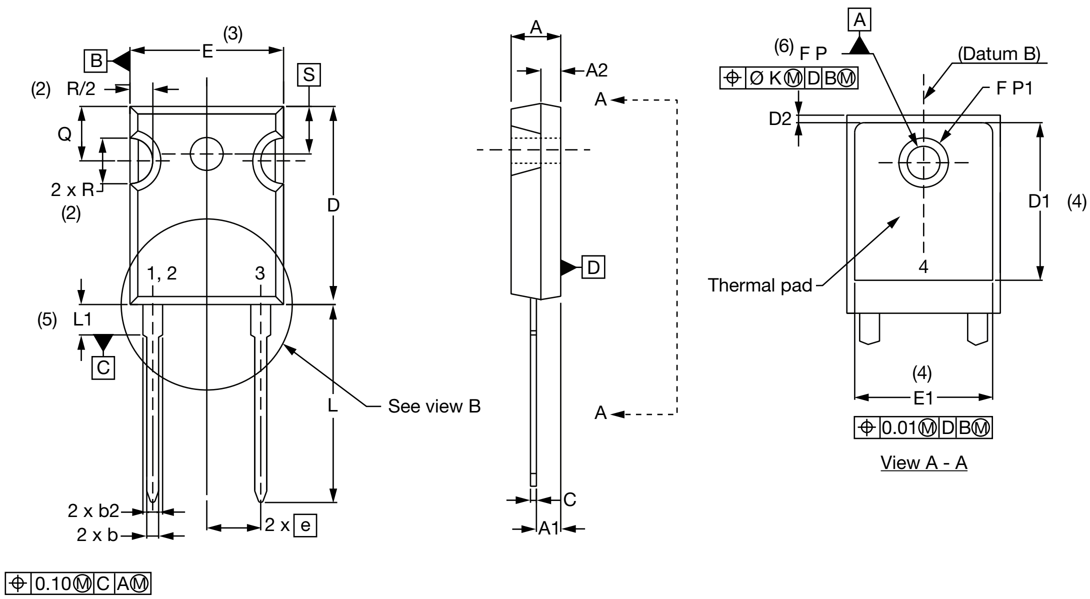
9 - Environmental digit:
-N3 = halogen-free, RoHS-compliant, and totally lead (Pb)-free

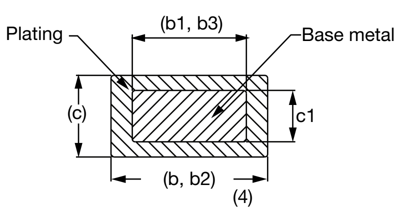
| **ORDERING INFORMATION** (Example) | | | |
|---|---|---|---|
| **PREFERRED P/N** | **QUANTITY PER TUBE** | **MINIMUM ORDER QUANTITY** | **PACKAGING DESCRIPTION** |
| VS-E5PH6006L-N3 | 25 | 500 | Antistatic plastic tube |

| **LINKS TO RELATED DOCUMENTS** | |
|---|---|
| Dimensions | www.vishay.com/doc?95536 |
| Part marking information | www.vishay.com/doc?95648 |

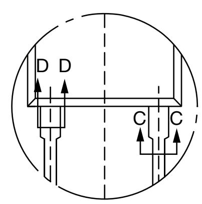
# TO-247AD 2L

**DIMENSIONS** in millimeters and inches




Section C - C, D - D




View B

| 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 | |
| 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 | | |
| Ø K | 0.254 | | 0.010 | | |
| L | 19.81 | 20.32 | 0.780 | 0.800 | |
| L1 | 3.71 | 4.29 | 0.146 | 0.169 | |
| Ø P | 3.56 | 3.66 | 0.14 | 0.144 | |
| Ø 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. 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 A min., D, E min., Q min., S, and note 4

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