

## E Series Power MOSFET

| PRODUCT SUMMARY                         |                         |
|---|-------------------------|
| $V_{DS}$ (V) at $T_J$ max.              | 650                     |
| $R_{DS(on)}$ typ. ( $\Omega$ ) at 25 °C | $V_{GS} = 10$ V   0.065 |
| $Q_g$ max. (nC)                         | 197                     |
| $Q_{gs}$ (nC)                           | 33                      |
| $Q_{gd}$ (nC)                           | 54                      |
| Configuration                           | Single                  |

### FEATURES

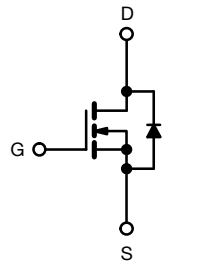
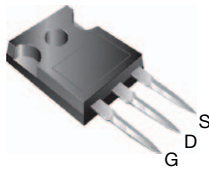
- Low figure-of-merit (FOM)  $R_{on} \times Q_g$
- Low input capacitance ( $C_{iss}$ )
- Reduced switching and conduction losses
- Ultra low gate charge ( $Q_g$ )
- Avalanche energy rated (UIS)
- Material categorization: for definitions of compliance please see [www.vishay.com/doc?99912](http://www.vishay.com/doc?99912)



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

### APPLICATIONS

- Server and telecom power supplies
- Switch mode power supplies (SMPS)
- Power factor correction power supplies (PFC)
- Lighting
  - High-intensity discharge (HID)
  - Fluorescent ballast lighting
- Industrial
  - Welding
  - Induction heating
  - Motor drives
  - Battery chargers
  - Renewable energy
  - Solar (PV inverters)

**TO-247AC**


N-Channel MOSFET

| ORDERING INFORMATION            |                |
|---------------------------------|----------------|
| Package                         | TO-247AC       |
| Lead (Pb)-free and Halogen-free | SiHG40N60E-GE3 |


| ABSOLUTE MAXIMUM RATINGS ( $T_C = 25$ °C, unless otherwise noted) |                  |                |      |
|---|------------------|----------------|------|
| PARAMETER   | SYMBOL           | LIMIT          | UNIT |
| Drain-Source Voltage  | $V_{DS}$         | 600            | V    |
| Gate-Source Voltage   | $V_{GS}$         | $\pm 30$       |      |
| Continuous Drain Current ( $T_J = 150$ °C)                        | $V_{GS}$ at 10 V | $T_C = 25$ °C  | A    |
|   |                  | $T_C = 100$ °C |      |
| Pulsed Drain Current <sup>a</sup>                                 | $I_{DM}$         | 123            |      |
| Linear Derating Factor  |                  | 2.63           | W/°C |
| Single Pulse Avalanche Energy <sup>b</sup>                        | $E_{AS}$         | 691            | mJ   |
| Maximum Power Dissipation   | $P_D$            | 329            | W    |
| Operating Junction and Storage Temperature Range                  | $T_J, T_{stg}$   | -55 to +150    | °C   |
| Drain-Source Voltage Slope  | $dV/dt$          | $T_J = 125$ °C | V/ns |
| Reverse Diode $dV/dt$ <sup>d</sup>                                |                  | 4.5            |      |
| Soldering Recommendations (Peak temperature) <sup>c</sup>         | for 10 s         | 300            | °C   |

#### Notes

- Repetitive rating; pulse width limited by maximum junction temperature.
- $V_{DD} = 140$  V, starting  $T_J = 25$  °C,  $L = 28.2$  mH,  $R_g = 25$   $\Omega$ ,  $I_{AS} = 7$  A.
- 1.6 mm from case.
- $I_{SD} \leq I_D$ ,  $dI/dt = 100$  A/ $\mu$ s, starting  $T_J = 25$  °C.



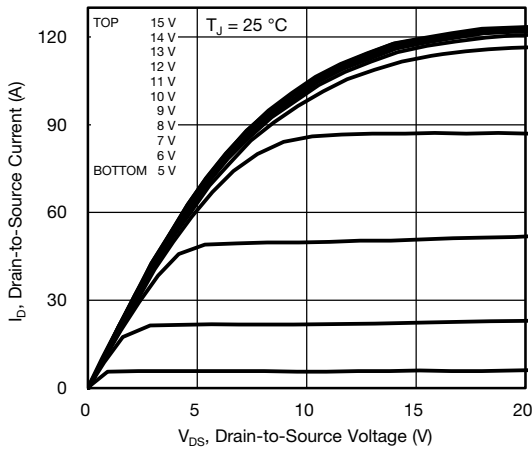
| THERMAL RESISTANCE RATINGS       |            |      |      |      |
|----------------------------------|------------|------|------|------|
| PARAMETER                        | SYMBOL     | TYP. | MAX. | UNIT |
| Maximum Junction-to-Ambient      | $R_{thJA}$ | -    | 40   | °C/W |
| Maximum Junction-to-Case (Drain) | $R_{thJC}$ | -    | 0.38 |      |

| SPECIFICATIONS ( $T_J = 25\text{ }^\circ\text{C}$ , unless otherwise noted) |                     |   |      |       |           |               |
|---|---------------------|---|------|-------|-----------|---------------|
| PARAMETER   | SYMBOL              | TEST CONDITIONS   | MIN. | TYP.  | MAX.      | UNIT          |
| <b>Static</b>   |                     |   |      |       |           |               |
| Drain-Source Breakdown Voltage  | $V_{DS}$            | $V_{GS} = 0\text{ V}, I_D = 250\text{ }\mu\text{A}$   | 600  | -     | -         | V             |
| $V_{DS}$ Temperature Coefficient  | $\Delta V_{DS}/T_J$ | Reference to $25\text{ }^\circ\text{C}, I_D = 1\text{ mA}$  | -    | 0.70  | -         | V/°C          |
| Gate-Source Threshold Voltage (N)   | $V_{GS(th)}$        | $V_{DS} = V_{GS}, I_D = 250\text{ }\mu\text{A}$   | 2    | -     | 4         | V             |
| Gate-Source Leakage   | $I_{GSS}$           | $V_{GS} = \pm 20\text{ V}$  | -    | -     | $\pm 100$ | nA            |
|   |                     | $V_{GS} = \pm 30\text{ V}$  | -    | -     | $\pm 1$   | $\mu\text{A}$ |
| Zero Gate Voltage Drain Current   | $I_{DSS}$           | $V_{DS} = 600\text{ V}, V_{GS} = 0\text{ V}$  | -    | -     | 1         | $\mu\text{A}$ |
|   |                     | $V_{DS} = 480\text{ V}, V_{GS} = 0\text{ V}, T_J = 125\text{ }^\circ\text{C}$   | -    | -     | 10        |               |
| Drain-Source On-State Resistance  | $R_{DS(on)}$        | $V_{GS} = 10\text{ V}, I_D = 20\text{ A}$   | -    | 0.065 | 0.075     | $\Omega$      |
| Forward Transconductance  | $g_{fs}$            | $V_{DS} = 30\text{ V}, I_D = 20\text{ A}$   | -    | 13.5  | -         | S             |
| <b>Dynamic</b>  |                     |   |      |       |           |               |
| Input Capacitance   | $C_{iss}$           | $V_{GS} = 0\text{ V}, V_{DS} = 100\text{ V}, f = 1\text{ MHz}$  | -    | 4436  | -         | pF            |
| Output Capacitance  | $C_{oss}$           |   | -    | 208   | -         |               |
| Reverse Transfer Capacitance  | $C_{rss}$           |   | -    | 6     | -         |               |
| Effective Output Capacitance, Energy Related <sup>a</sup>                   | $C_{o(er)}$         |   | -    | 126   | -         |               |
| Effective Output Capacitance, Time Related <sup>b</sup>                     | $C_{o(tr)}$         | $V_{DS} = 0\text{ V to } 480\text{ V}, V_{GS} = 0\text{ V}$   | -    | 542   | -         |               |
| Total Gate Charge   | $Q_g$               | $V_{GS} = 10\text{ V}, I_D = 20\text{ A}, V_{DS} = 480\text{ V}$  | -    | 131   | 197       | nC            |
| Gate-Source Charge  | $Q_{gs}$            |   | -    | 33    | -         |               |
| Gate-Drain Charge   | $Q_{gd}$            |   | -    | 54    | -         |               |
| Turn-On Delay Time  | $t_{d(on)}$         | $V_{DD} = 480\text{ V}, I_D = 20\text{ A}, V_{GS} = 10\text{ V}, R_g = 9.1\text{ }\Omega$   | -    | 35    | 70        | ns            |
| Rise Time   | $t_r$               |   | -    | 71    | 107       |               |
| Turn-Off Delay Time   | $t_{d(off)}$        |   | -    | 127   | 191       |               |
| Fall Time   | $t_f$               |   | -    | 66    | 99        |               |
| Gate Input Resistance   | $R_g$               | $f = 1\text{ MHz}, \text{open drain}$   | 0.3  | 0.6   | 1.2       | $\Omega$      |
| <b>Drain-Source Body Diode Characteristics</b>                              |                     |   |      |       |           |               |
| Continuous Source-Drain Diode Current                                       | $I_S$               | MOSFET symbol showing the integral reverse p - n junction diode  | -    | -     | 40        | A             |
| Pulsed Diode Forward Current  | $I_{SM}$            |   | -    | -     | 123       |               |
| Diode Forward Voltage   | $V_{SD}$            | $T_J = 25\text{ }^\circ\text{C}, I_S = 6.5\text{ A}, V_{GS} = 0\text{ V}$   | -    | -     | 1.2       | V             |
| Reverse Recovery Time   | $t_{rr}$            | $T_J = 25\text{ }^\circ\text{C}, I_F = I_S = 20\text{ A}, di/dt = 100\text{ A}/\mu\text{s}, V_R = 25\text{ V}$  | -    | 595   | 1190      | ns            |
| Reverse Recovery Charge   | $Q_{rr}$            |   | -    | 9.9   | 19.8      | $\mu\text{C}$ |
| Reverse Recovery Current  | $I_{RRM}$           |   | -    | 26    | 52        | A             |

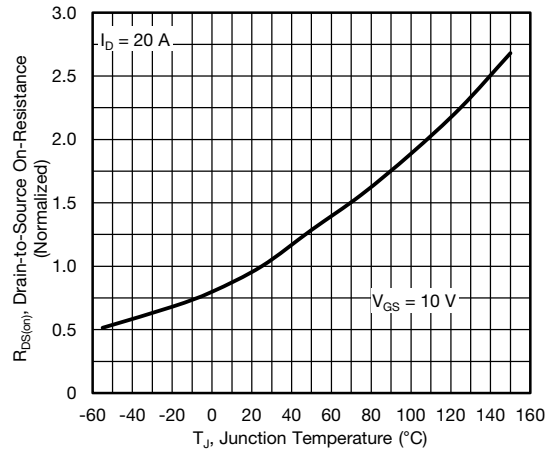
**Notes**

- a.  $C_{o(er)}$  is a fixed capacitance that gives the same energy as  $C_{oss}$  while  $V_{DS}$  is rising from 0 % to 80 %  $V_{DSS}$ .
- b.  $C_{o(tr)}$  is a fixed capacitance that gives the same charging time as  $C_{oss}$  while  $V_{DS}$  is rising from 0 % to 80 %  $V_{DSS}$ .

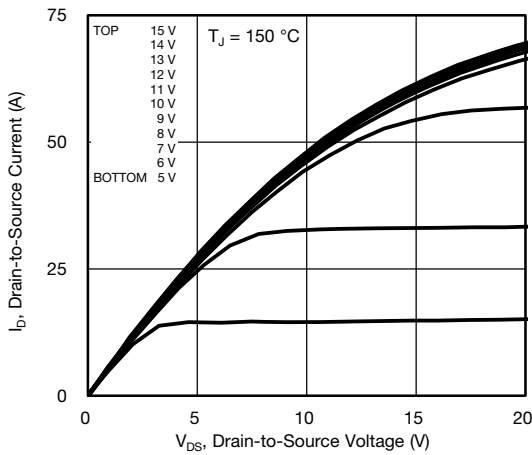
**TYPICAL CHARACTERISTICS** (25 °C, unless otherwise noted)



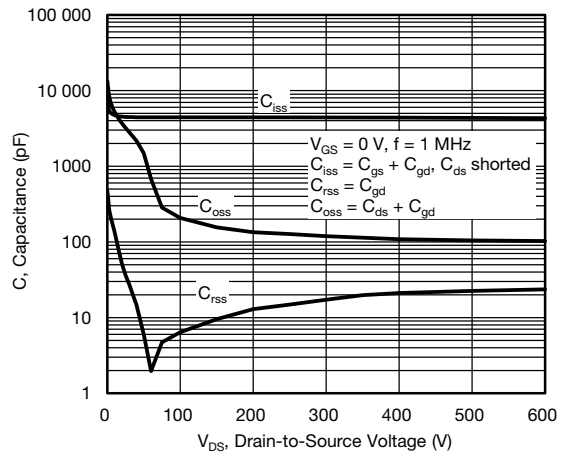
**Fig. 1 - Typical Output Characteristics**



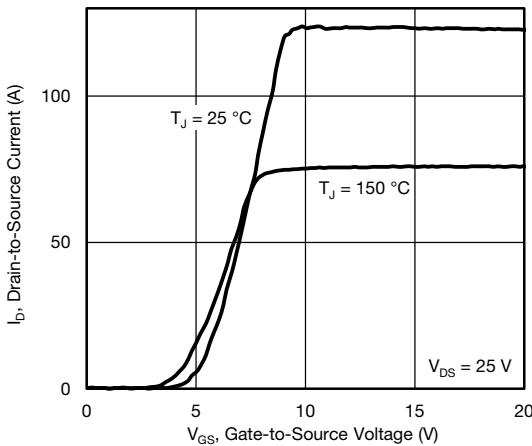
**Fig. 4 - Normalized On-Resistance vs. Temperature**



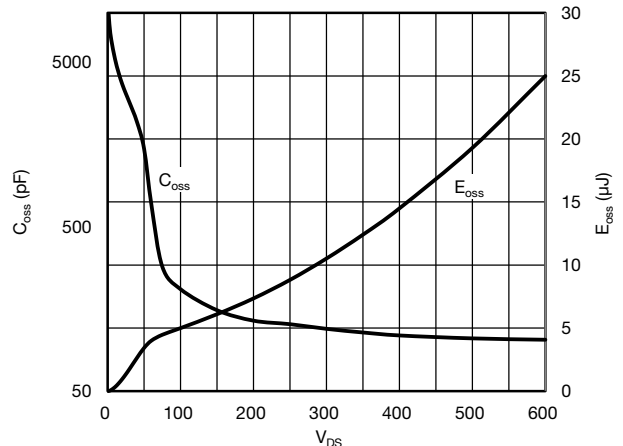
**Fig. 2 - Typical Output Characteristics**



**Fig. 5 - Typical Capacitance vs. Drain-to-Source Voltage**



**Fig. 3 - Typical Transfer Characteristics**



**Fig. 6 -  $C_{oss}$  and  $E_{oss}$  vs.  $V_{DS}$**

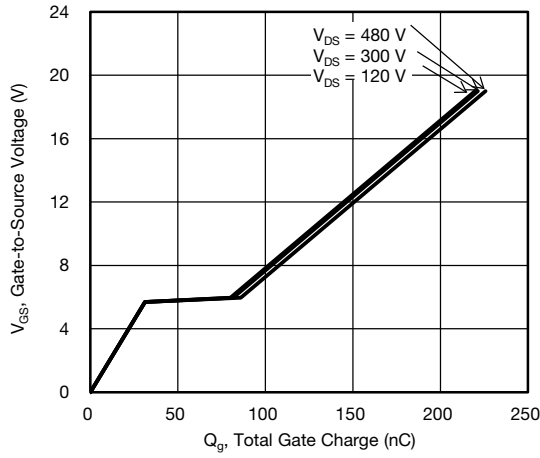


Fig. 7 - Typical Gate Charge vs. Gate-to-Source Voltage

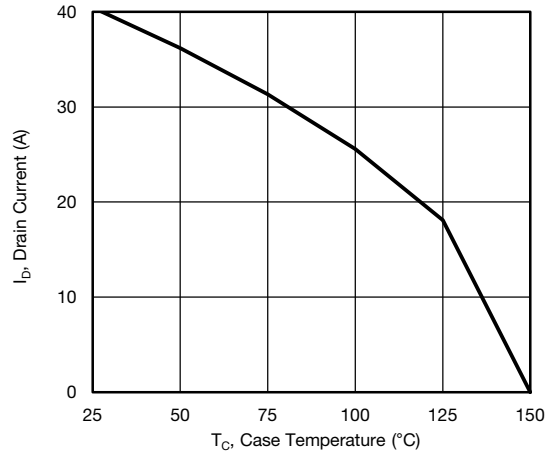


Fig. 10 - Maximum Drain Current vs. Case Temperature

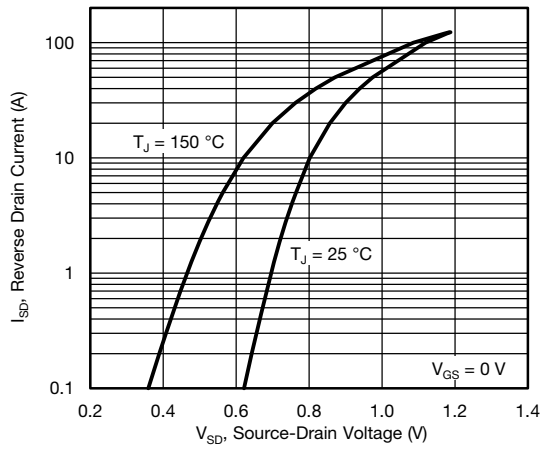


Fig. 8 - Typical Source-Drain Diode Forward Voltage

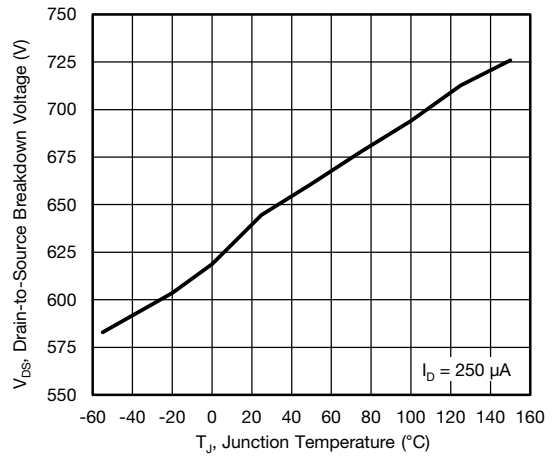


Fig. 11 - Temperature vs. Drain-to-Source Voltage

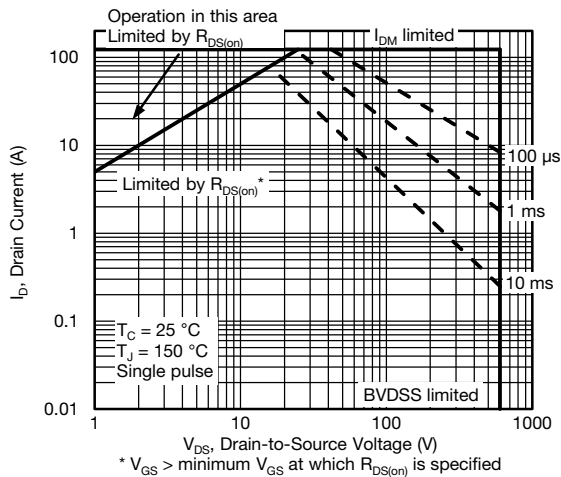
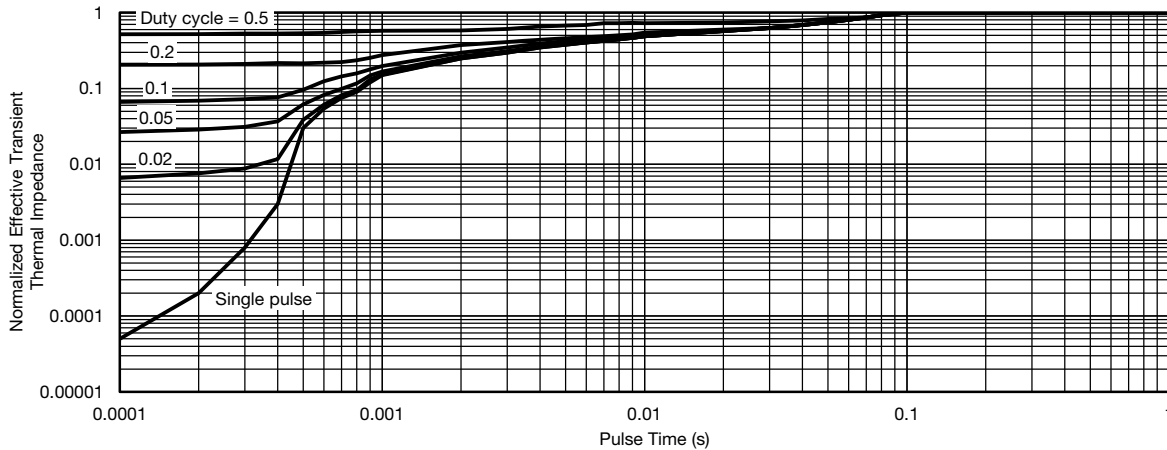
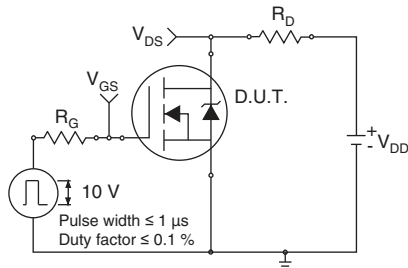


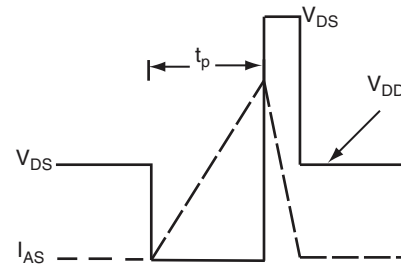
Fig. 9 - Maximum Safe Operating Area



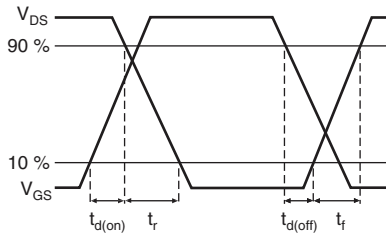
**Fig. 12 - Normalized Thermal Transient Impedance, Junction-to-Case**



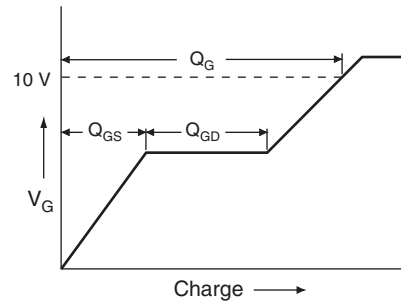
**Fig. 13 - Switching Time Test Circuit**



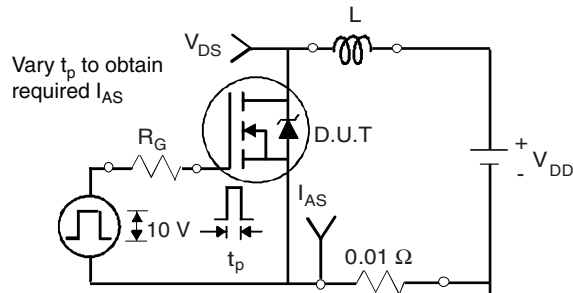
**Fig. 16 - Unclamped Inductive Waveforms**



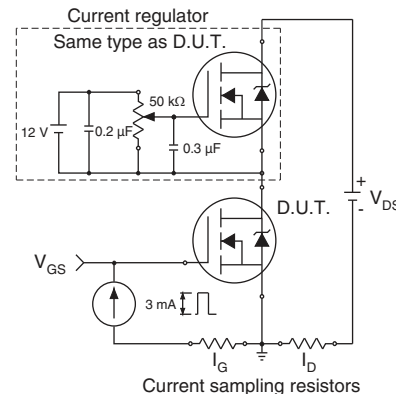
**Fig. 14 - Switching Time Waveforms**



**Fig. 17 - Basic Gate Charge Waveform**



**Fig. 15 - Unclamped Inductive Test Circuit**



**Fig. 18 - Gate Charge Test Circuit**

Peak Diode Recovery dV/dt Test Circuit



Note

a.  $V_{GS} = 5\text{ V}$  for logic level devices

Fig. 19 - For N-Channel

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# TO-247AC (High Voltage)

VERSION 1: FACILITY CODE = 9



| DIM. | MILLIMETERS |       |       | NOTES |
|------|-------------|-------|-------|-------|
|      | MIN.        | NOM.  | MAX.  |       |
| A    | 4.83        | 5.02  | 5.21  |       |
| A1   | 2.29        | 2.41  | 2.55  |       |
| A2   | 1.17        | 1.27  | 1.37  |       |
| b    | 1.12        | 1.20  | 1.33  |       |
| b1   | 1.12        | 1.20  | 1.28  |       |
| b2   | 1.91        | 2.00  | 2.39  | 6     |
| b3   | 1.91        | 2.00  | 2.34  |       |
| b4   | 2.87        | 3.00  | 3.22  | 6, 8  |
| b5   | 2.87        | 3.00  | 3.18  |       |
| c    | 0.40        | 0.50  | 0.60  | 6     |
| c1   | 0.40        | 0.50  | 0.56  |       |
| D    | 20.40       | 20.55 | 20.70 | 4     |

| DIM. | MILLIMETERS |       |       | NOTES |
|------|-------------|-------|-------|-------|
|      | MIN.        | NOM.  | MAX.  |       |
| D1   | 16.46       | 16.76 | 17.06 | 5     |
| D2   | 0.56        | 0.66  | 0.76  |       |
| E    | 15.50       | 15.70 | 15.87 | 4     |
| E1   | 13.46       | 14.02 | 14.16 | 5     |
| E2   | 4.52        | 4.91  | 5.49  | 3     |
| e    | 5.46 BSC    |       |       |       |
| L    | 14.90       | 15.15 | 15.40 |       |
| L1   | 3.96        | 4.06  | 4.16  | 6     |
| Ø P  | 3.56        | 3.61  | 3.65  | 7     |
| Ø P1 | 7.19 ref.   |       |       |       |
| Q    | 5.31        | 5.50  | 5.69  |       |
| S    | 5.51 BSC    |       |       |       |

**Notes**

- (1) Package reference: JEDEC® TO247, variation AC
- (2) All dimensions are in mm
- (3) Slot required, notch may be rounded
- (4) Dimension D and E do not include mold flash. Mold flash shall not exceed 0.127 mm per side. These dimensions are measured at the outermost extremes of the plastic body
- (5) Thermal pad contour optional with dimensions D1 and E1
- (6) Lead finish uncontrolled in L1
- (7) 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
- (8) Dimension b2 and b4 does not include dambar protrusion. Allowable dambar protrusion shall be 0.1 mm total in excess of b2 and b4 dimension at maximum material condition



**VERSION 2: FACILITY CODE = Y**



| DIM. | MILLIMETERS |       | NOTES |
|------|-------------|-------|-------|
|      | MIN.        | MAX.  |       |
| A    | 4.58        | 5.31  |       |
| A1   | 2.21        | 2.59  |       |
| A2   | 1.17        | 2.49  |       |
| b    | 0.99        | 1.40  |       |
| b1   | 0.99        | 1.35  |       |
| b2   | 1.53        | 2.39  |       |
| b3   | 1.65        | 2.37  |       |
| b4   | 2.42        | 3.43  |       |
| b5   | 2.59        | 3.38  |       |
| c    | 0.38        | 0.86  |       |
| c1   | 0.38        | 0.76  |       |
| D    | 19.71       | 20.82 |       |
| D1   | 13.08       | -     |       |

| DIM. | MILLIMETERS |       | NOTES |
|------|-------------|-------|-------|
|      | MIN.        | MAX.  |       |
| D2   | 0.51        | 1.30  |       |
| E    | 15.29       | 15.87 |       |
| E1   | 13.72       | -     |       |
| e    | 5.46 BSC    |       |       |
| Ø k  | 0.254       |       |       |
| L    | 14.20       | 16.25 |       |
| L1   | 3.71        | 4.29  |       |
| Ø P  | 3.51        | 3.66  |       |
| Ø P1 | -           | 7.39  |       |
| Q    | 5.31        | 5.69  |       |
| R    | 4.52        | 5.49  |       |
| S    | 5.51 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





**VERSION 3: FACILITY CODE = N**



| MILLIMETERS |       |       |
|-------------|-------|-------|
| DIM.        | MIN.  | MAX.  |
| A           | 4.65  | 5.31  |
| A1          | 2.21  | 2.59  |
| A2          | 1.17  | 1.37  |
| b           | 0.99  | 1.40  |
| b1          | 0.99  | 1.35  |
| b2          | 1.65  | 2.39  |
| b3          | 1.65  | 2.34  |
| b4          | 2.59  | 3.43  |
| b5          | 2.59  | 3.38  |
| c           | 0.38  | 0.89  |
| c1          | 0.38  | 0.84  |
| D           | 19.71 | 20.70 |
| D1          | 13.08 | -     |

| MILLIMETERS |          |       |
|-------------|----------|-------|
| DIM.        | MIN.     | MAX.  |
| D2          | 0.51     | 1.35  |
| E           | 15.29    | 15.87 |
| E1          | 13.46    | -     |
| e           | 5.46 BSC |       |
| k           | 0.254    |       |
| L           | 14.20    | 16.10 |
| L1          | 3.71     | 4.29  |
| N           | 7.62 BSC |       |
| P           | 3.56     | 3.66  |
| P1          | -        | 7.39  |
| Q           | 5.31     | 5.69  |
| R           | 4.52     | 5.49  |
| S           | 5.51 BSC |       |

ECN: E22-0452-Rev. G, 31-Oct-2022  
 DWG: 5971

**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")



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