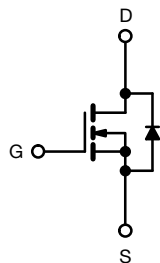
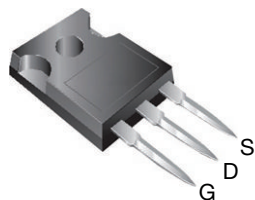


## EF Series Power MOSFET With Fast Body Diode

**TO-247AC**


N-Channel MOSFET

### FEATURES

- 4<sup>th</sup> generation E series technology
- Low figure-of-merit (FOM)  $R_{on} \times Q_g$
- Low effective capacitance ( $C_{o(er)}$ )
- Reduced switching and conduction losses
- 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
  - Solar (PV inverters)

### PRODUCT SUMMARY

|                                         |                 |       |
|-----------------------------------------|-----------------|-------|
| $V_{DS}$ (V) at $T_J$ max.              | 650             |       |
| $R_{DS(on)}$ typ. ( $\Omega$ ) at 25 °C | $V_{GS} = 10$ V | 0.088 |
| $Q_g$ max. (nC)                         | 53              |       |
| $Q_{gs}$ (nC)                           | 12              |       |
| $Q_{gd}$ (nC)                           | 11              |       |
| Configuration                           | Single          |       |

### ORDERING INFORMATION

|                                 |                  |
|---------------------------------|------------------|
| Package                         | TO-247AC         |
| Lead (Pb)-free and halogen-free | SiHG105N60EF-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>                         | $I_{DM}$         | 73             |      |
| Linear derating factor                                    |                  | 1.67           | W/°C |
| Single pulse avalanche energy <sup>b</sup>                | $E_{AS}$         | 226            | mJ   |
| Maximum power dissipation                                 | $P_D$            | 208            | 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>                        |                  |                |      |
| Soldering recommendations (peak temperature) <sup>c</sup> |                  | For 10 s       | °C   |

#### Notes

- Repetitive rating; pulse width limited by maximum junction temperature
- $V_{DD} = 120$  V, starting  $T_J = 25$  °C,  $L = 28.2$  mH,  $R_g = 25$   $\Omega$ ,  $I_{AS} = 4$  A
- 1.6 mm from case
- $I_{SD} \leq I_D$ ,  $di/dt = 400$  A/ $\mu$ s, starting  $T_J = 25$  °C

**THERMAL RESISTANCE RATINGS**

| PARAMETER                        | SYMBOL     | TYP. | MAX. | UNIT |
|----------------------------------|------------|------|------|------|
| Maximum junction-to-ambient      | $R_{thJA}$ | -    | 62   | °C/W |
| Maximum junction-to-case (drain) | $R_{thJC}$ | -    | 0.6  |      |

**SPECIFICATIONS** ( $T_J = 25\text{ }^{\circ}\text{C}$ , unless otherwise noted)

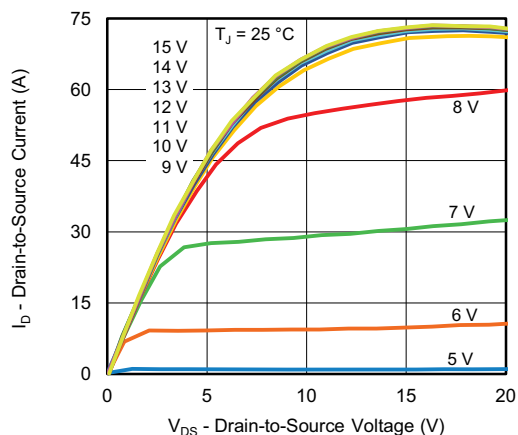
| PARAMETER                                                 | SYMBOL              | TEST CONDITIONS                                                                                                                                          |                                               | MIN. | TYP.  | MAX.      | UNIT                      |
|-----------------------------------------------------------|---------------------|----------------------------------------------------------------------------------------------------------------------------------------------------------|-----------------------------------------------|------|-------|-----------|---------------------------|
| Static                                                    |                     |                                                                                                                                                          |                                               |      |       |           |                           |
| 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 $25\text{ }^\circ\text{C}$ , $I_D = 1\text{ mA}$                                                                                            |                                               | -    | 0.63  | -         | $\text{V}/^\circ\text{C}$ |
| Gate-source threshold voltage (N)                         | $V_{GS(th)}$        | $V_{DS} = V_{GS}$ , $I_D = 250\text{ }\mu\text{A}$                                                                                                       |                                               | 3    | -     | 5         | 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                           | $I_{DSS}$           | $V_{DS} = 480\text{ V}$ , $V_{GS} = 0\text{ V}$                                                                                                          |                                               | -    | -     | 1         | $\mu\text{A}$             |
|                                                           |                     | $V_{DS} = 480\text{ V}$ , $V_{GS} = 0\text{ V}$ , $T_J = 125\text{ }^\circ\text{C}$                                                                      |                                               | -    | -     | 2         | mA                        |
| Drain-source on-state resistance                          | $R_{DS(on)}$        | $V_{GS} = 10\text{ V}$                                                                                                                                   | $I_D = 13\text{ A}$                           | -    | 0.088 | 0.102     | $\Omega$                  |
| Forward transconductance <sup>a</sup>                     | $g_{fs}$            | $V_{DS} = 20\text{ V}$ , $I_D = 13\text{ A}$                                                                                                             |                                               | -    | 8     | -         | S                         |
| Dynamic                                                   |                     |                                                                                                                                                          |                                               |      |       |           |                           |
| Input capacitance                                         | $C_{iss}$           | $V_{GS} = 0\text{ V}$ ,<br>$V_{DS} = 100\text{ V}$ ,<br>$f = 1\text{ MHz}$                                                                               |                                               | -    | 1804  | -         | pF                        |
| Output capacitance                                        | $C_{oss}$           |                                                                                                                                                          |                                               | -    | 82    | -         |                           |
| Reverse transfer capacitance                              | $C_{rss}$           |                                                                                                                                                          |                                               | -    | 6     | -         |                           |
| Effective output capacitance, energy related <sup>a</sup> | $C_{o(er)}$         | $V_{DS} = 0\text{ V to } 480\text{ V}$ , $V_{GS} = 0\text{ V}$                                                                                           |                                               | -    | 63    | -         |                           |
| Effective output capacitance, time related <sup>b</sup>   | $C_{o(tr)}$         |                                                                                                                                                          |                                               | -    | 407   | -         |                           |
| Total gate charge                                         | $Q_g$               | $V_{GS} = 10\text{ V}$                                                                                                                                   | $I_D = 11\text{ A}$ , $V_{DS} = 480\text{ V}$ | -    | 35    | 53        | nC                        |
| Gate-source charge                                        | $Q_{gs}$            |                                                                                                                                                          |                                               | -    | 12    | -         |                           |
| Gate-drain charge                                         | $Q_{gd}$            |                                                                                                                                                          |                                               | -    | 11    | -         |                           |
| Turn-on delay time                                        | $t_{d(on)}$         | $V_{DD} = 480\text{ V}$ , $I_D = 13\text{ A}$ ,<br>$V_{GS} = 10\text{ V}$ , $R_g = 9.1\text{ }\Omega$                                                    |                                               | -    | 20    | 40        | ns                        |
| Rise time                                                 | $t_r$               |                                                                                                                                                          |                                               | -    | 28    | 56        |                           |
| Turn-off delay time                                       | $t_{d(off)}$        |                                                                                                                                                          |                                               | -    | 39    | 78        |                           |
| Fall time                                                 | $t_f$               |                                                                                                                                                          |                                               | -    | 19    | 38        |                           |
| Gate input resistance                                     | $R_g$               | $f = 1\text{ MHz}$ , open drain                                                                                                                          |                                               | 0.3  | 0.7   | 1.4       | $\Omega$                  |
| Drain-Source Body Diode Characteristics                   |                     |                                                                                                                                                          |                                               |      |       |           |                           |
| Continuous source-drain diode current                     | $I_S$               | MOSFET symbol showing the integral reverse p - n junction diode<br> |                                               | -    | -     | 29        | A                         |
| Pulsed diode forward current                              | $I_{SM}$            |                                                                                                                                                          |                                               | -    | -     | 73        |                           |
| Diode forward voltage                                     | $V_{SD}$            | $T_J = 25\text{ }^\circ\text{C}$ , $I_S = 13\text{ A}$ , $V_{GS} = 0\text{ V}$                                                                           |                                               | -    | -     | 1.2       | V                         |
| Reverse recovery time                                     | $t_{rr}$            | $T_J = 25\text{ }^\circ\text{C}$ , $I_F = I_S = 13\text{ A}$ ,<br>$di/dt = 100\text{ A}/\mu\text{s}$ , $V_R = 400\text{ V}$                              |                                               | -    | 125   | 250       | ns                        |
| Reverse recovery charge                                   | $Q_{rr}$            |                                                                                                                                                          |                                               | -    | 0.8   | 1.6       | $\mu\text{C}$             |
| Reverse recovery current                                  | $I_{RRM}$           |                                                                                                                                                          |                                               | -    | 12    | -         | A                         |

**Notes**

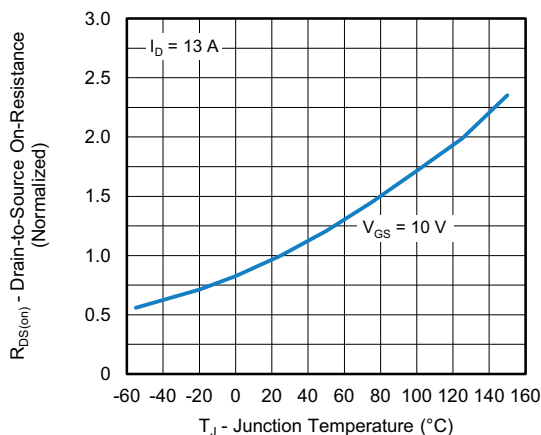
- a.  $C_{oss(er)}$  is a fixed capacitance that gives the same energy as  $C_{oss}$  while  $V_{DS}$  is rising from 0 % to 80 %  $V_{DSS}$   
b.  $C_{oss(tr)}$  is a fixed capacitance that gives the same charging time as  $C_{oss}$  while  $V_{DS}$  is rising from 0 % to 80 %  $V_{DSS}$



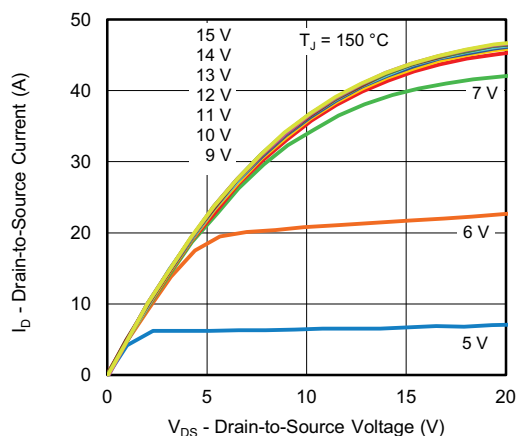
**TYPICAL CHARACTERISTICS** (25 °C, unless otherwise noted)



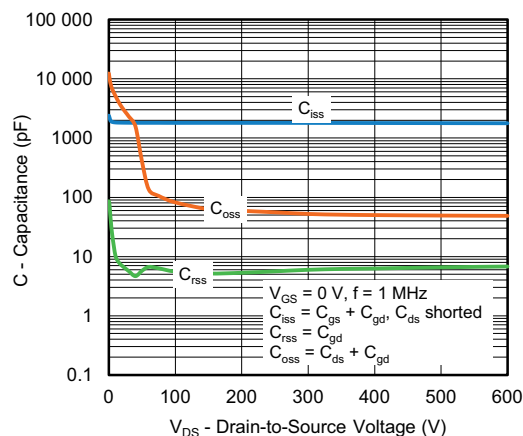
**Fig. 1 - Typical Output Characteristics**



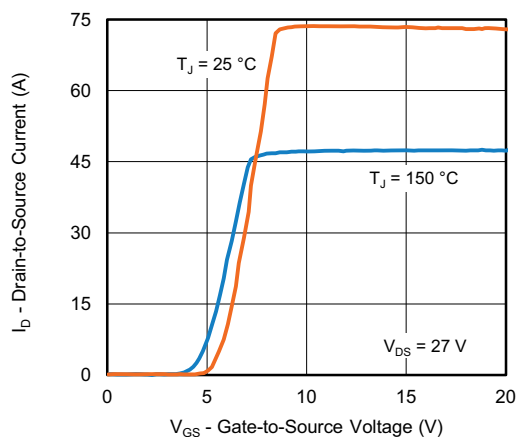
**Fig. 4 - Normalized On-Resistance vs. Temperature**



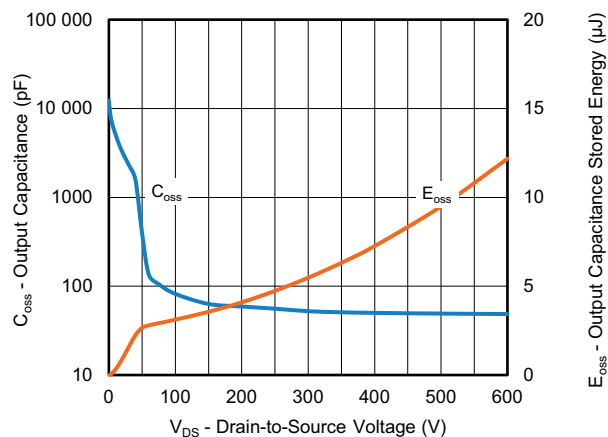
**Fig. 2 - Typical Output Characteristics**



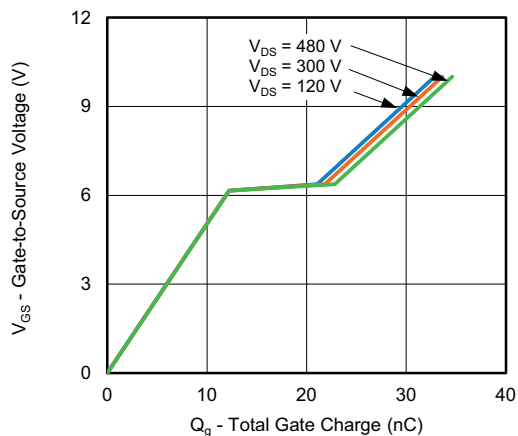
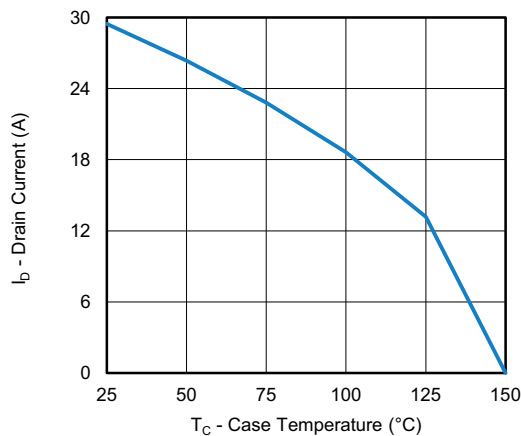
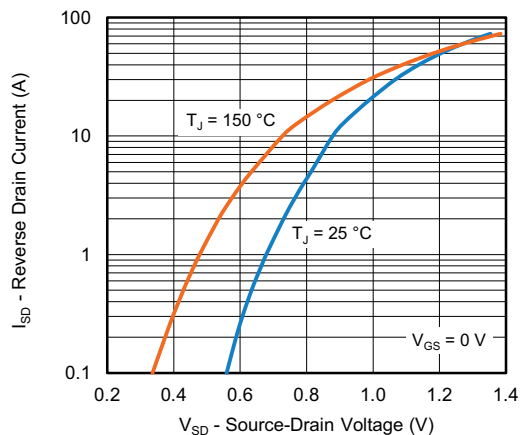
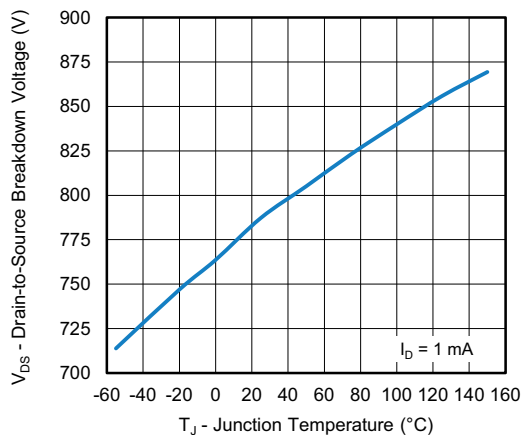
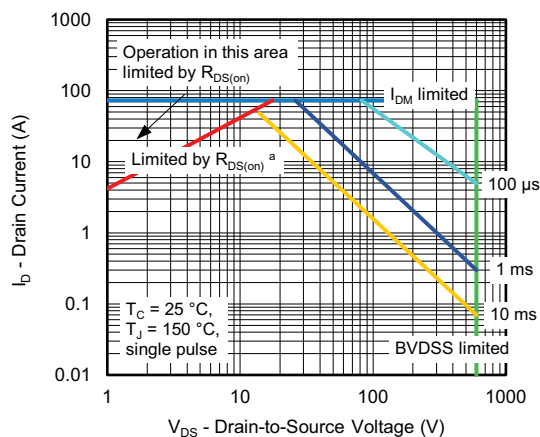
**Fig. 5 - Typical Capacitance vs. Drain-to-Source Voltage**



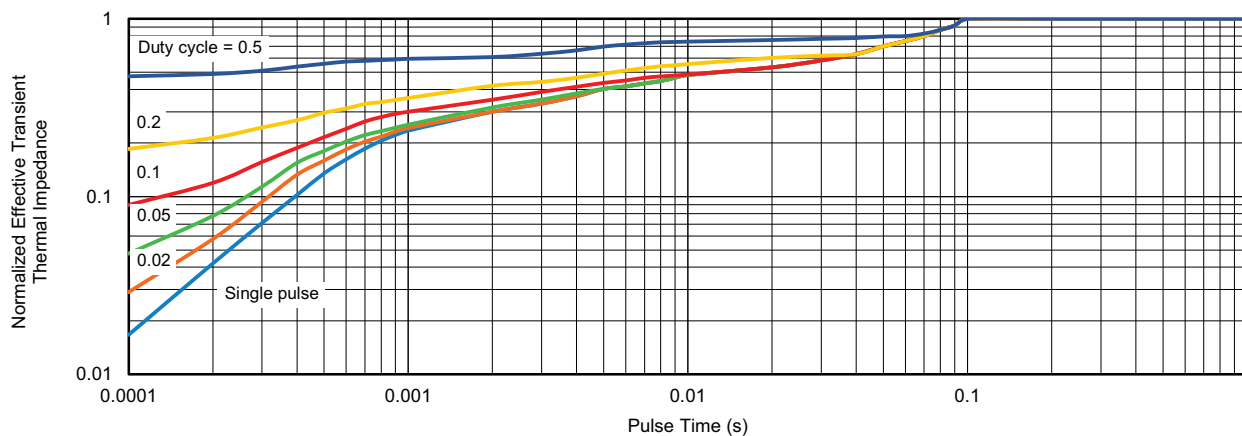
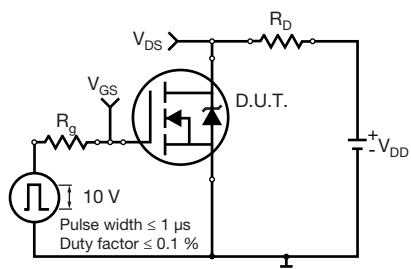
**Fig. 3 - Typical Transfer Characteristics**

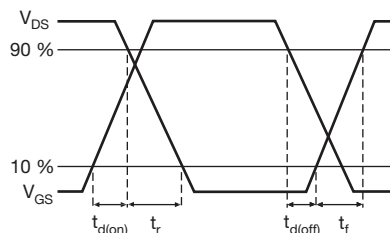
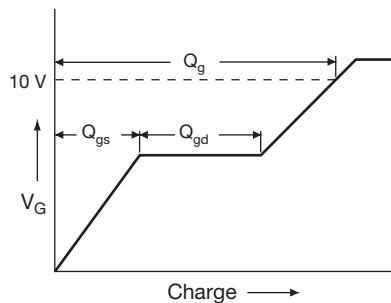
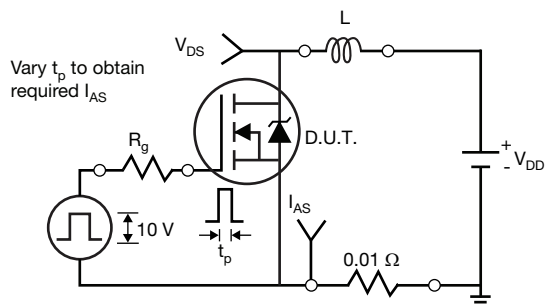
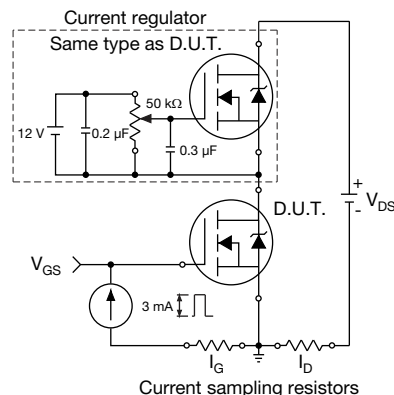


**Fig. 6 - C<sub>oss</sub> and E<sub>oss</sub> vs. V<sub>DS</sub>**


**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**
**Note**

a.  $V_{GS} >$  minimum  $V_{GS}$  at which  $R_{DS(on)}$  is specified


**Fig. 12 - Normalized Transient Thermal 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**


**Fig. 19 - For N-Channel**

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## TO-247AC (High Voltage)

### VERSION 1: FACILITY CODE = 9



Section C---C, D---D, E---E

| MILLIMETERS |       |       |       |
|-------------|-------|-------|-------|
| DIM.        | MIN.  | MAX.  | NOTES |
| A           | 4.83  | 5.21  |       |
| A1          | 2.29  | 2.55  |       |
| A2          | 1.50  | 2.49  |       |
| b           | 1.12  | 1.33  |       |
| b1          | 1.12  | 1.28  |       |
| b2          | 1.91  | 2.39  | 6     |
| b3          | 1.91  | 2.34  |       |
| b4          | 2.87  | 3.22  | 6, 8  |
| b5          | 2.87  | 3.18  |       |
| c           | 0.55  | 0.69  | 6     |
| c1          | 0.55  | 0.65  |       |
| D           | 20.40 | 20.70 | 4     |

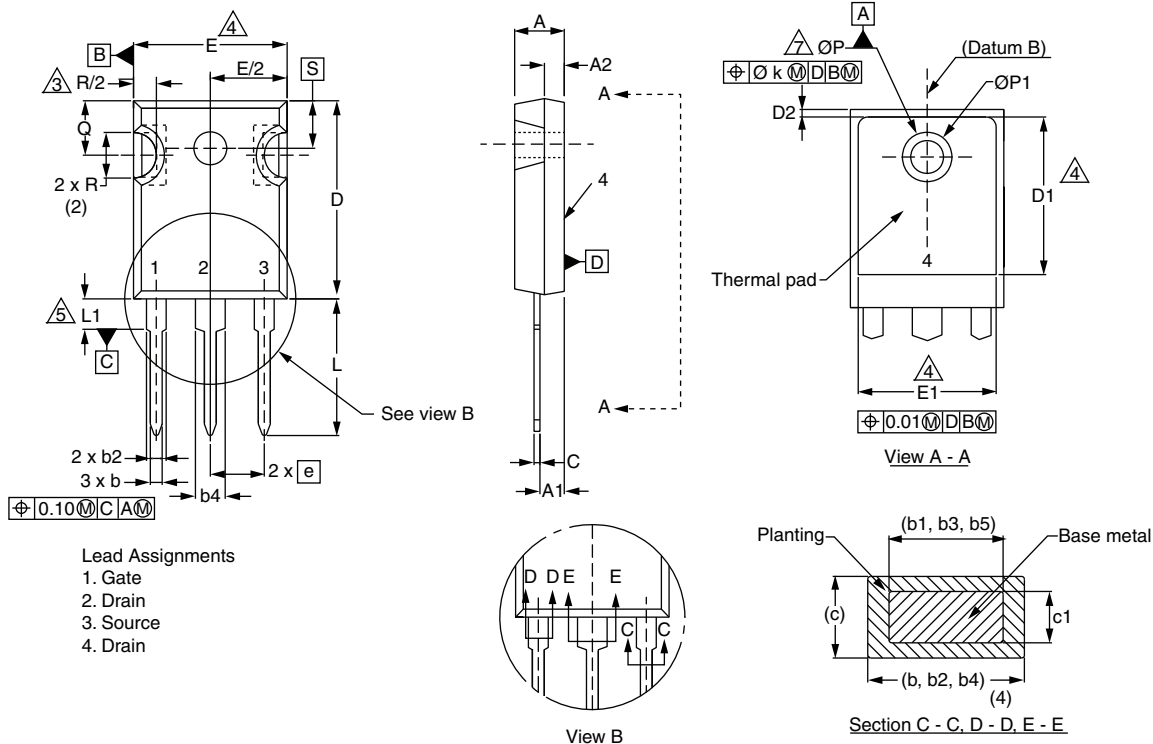
| MILLIMETERS |           |       |       |
|-------------|-----------|-------|-------|
| DIM.        | MIN.      | MAX.  | NOTES |
| D1          | 16.25     | 16.85 | 5     |
| D2          | 0.56      | 0.76  |       |
| E           | 15.50     | 15.87 | 4     |
| E1          | 13.46     | 14.16 | 5     |
| E2          | 4.52      | 5.49  | 3     |
| e           | 5.44 BSC  |       |       |
| L           | 14.90     | 15.40 |       |
| L1          | 3.96      | 4.16  | 6     |
| Ø P         | 3.56      | 3.65  | 7     |
| Ø P1        | 7.19 ref. |       |       |
| Q           | 5.31      | 5.69  |       |
| S           | 5.54      | 5.74  |       |

#### Notes

- Package reference: JEDEC® TO247, variation AC
- All dimensions are in mm
- Slot required, notch may be rounded
- 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
- 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
- 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       | -     |       |

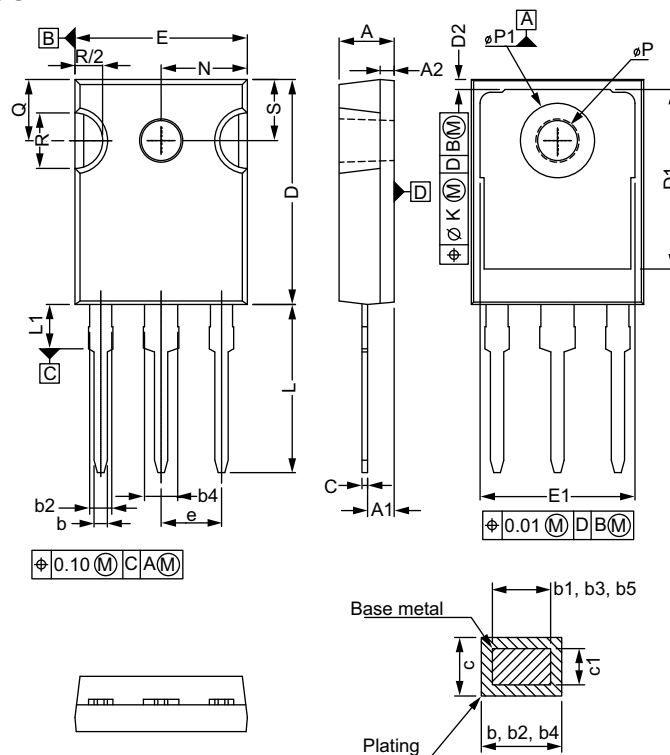
| DIM. | MILLIMETERS |       | NOTES |
|------|-------------|-------|-------|
|      | MIN.        | MAX.  |       |
| D2   | 0.51        | 1.30  |       |
| E    | 15.29       | 15.87 |       |
| E1   | 13.72       | -     |       |
| e    | 5.46 BSC    |       |       |
| Ø k  | 0.254       |       |       |
| 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: E20-0545-Rev. F, 19-Oct-2020  
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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