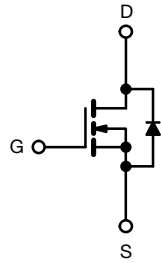
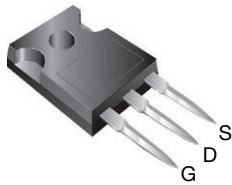


EF Series Power MOSFET With Fast Body Diode

TO-247AC


N-Channel MOSFET

FEATURES

- 4th 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


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
 - Motor drives
 - Battery chargers
 - Solar (PV inverters)

PRODUCT SUMMARY

| | | |
|---|-----------------|-------|
| V_{DS} (V) at T_J max. | 650 | |
| $R_{DS(on)}$ typ. (Ω) at 25 °C | $V_{GS} = 10$ V | 0.059 |
| Q_g max. (nC) | 77 | |
| Q_{gs} (nC) | 19 | |
| Q_{gd} (nC) | 16 | |
| Configuration | Single | |

ORDERING INFORMATION

| | |
|---------------------------------|------------------|
| Package | TO-247AC |
| Lead (Pb)-free and halogen-free | SiHG068N60EF-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} | ± 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 ^a | I_{DM} | 115 | |
| Linear derating factor | | 2 | W/°C |
| Single pulse avalanche energy ^b | E_{AS} | 226 | mJ |
| Maximum power dissipation | P_D | 250 | 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 ^d | | 100 | |
| Soldering recommendations (peak temperature) ^c | For 10 s | 260 | °C |

Notes

- Repetitive rating; pulse width limited by maximum junction temperature
- $V_{DD} = 120$ V, starting $T_J = 25$ °C, $L = 28.2$ mH, $R_g = 25$ Ω , $I_{AS} = 4$ A
- 1.6 mm from case
- $I_{SD} \leq I_D$, $di/dt = 210$ A/ μ s, starting $T_J = 25$ °C



| THERMAL RESISTANCE RATINGS | | | |
|----------------------------------|-------------------|-------|------|
| PARAMETER | SYMBOL | LIMIT | UNIT |
| Maximum junction-to-ambient | R _{thJA} | 40 | °C/W |
| Maximum junction-to-case (drain) | R _{thJC} | 0.5 | |

| SPECIFICATIONS (T _J = 25 °C, unless otherwise noted) | | | | | | |
|---|----------------------------------|---|-----------------------|-------|-------|------|
| PARAMETER | SYMBOL | TEST CONDITIONS | MIN. | TYP. | MAX. | UNIT |
| Static | | | | | | |
| Drain-source breakdown voltage | V _{DS} | V _{GS} = 0 V, I _D = 250 μA | 600 | - | - | V |
| V _{DS} temperature coefficient | ΔV _{DS} /T _J | Reference to 25 °C, I _D = 1 mA | - | 0.63 | - | V/°C |
| Gate-source threshold voltage (N) | V _{GS(th)} | V _{DS} = V _{GS} , I _D = 250 μA | 3 | - | 5 | V |
| Gate-source leakage | I _{GSS} | V _{GS} = ± 20 V | - | - | ± 100 | nA |
| | | V _{GS} = ± 30 V | - | - | ± 1 | μA |
| Zero gate voltage drain current | I _{DSS} | V _{DS} = 480 V, V _{GS} = 0 V | - | - | 1 | μA |
| | | V _{DS} = 480 V, V _{GS} = 0 V, T _J = 125 °C | - | - | 2 | mA |
| Drain-source on-state resistance | R _{DS(on)} | V _{GS} = 10 V I _D = 16 A | - | 0.059 | 0.068 | Ω |
| Forward transconductance | g _{fs} | V _{DS} = 30 V, I _D = 16 A | - | 9 | - | S |
| Dynamic | | | | | | |
| Input capacitance | C _{iSS} | V _{GS} = 0 V, V _{DS} = 100 V, f = 1 MHz | - | 2628 | - | pF |
| Output capacitance | C _{oss} | | - | 122 | - | |
| Reverse transfer capacitance | C _{rSS} | | - | 7 | - | |
| Effective output capacitance, energy related ^a | C _{o(er)} | | - | 87 | - | |
| Effective output capacitance, time related ^b | C _{o(tr)} | | - | 543 | - | |
| Total gate charge | Q _g | V _{GS} = 10 V I _D = 16 A, V _{DS} = 480 V | - | 51 | 77 | nC |
| Gate-source charge | Q _{gs} | | - | 19 | - | |
| Gate-drain charge | Q _{gd} | | - | 16 | - | |
| Turn-on delay time | t _{d(on)} | V _{DD} = 480 V, I _D = 16 A, V _{GS} = 10 V, R _g = 9.1 Ω | - | 27 | 54 | ns |
| Rise time | t _r | | - | 55 | 83 | |
| Turn-off delay time | t _{d(off)} | | - | 53 | 80 | |
| Fall time | t _f | | - | 35 | 70 | |
| Gate input resistance | R _g | | f = 1 MHz, open drain | 0.3 | 0.7 | |
| Drain-Source Body Diode Characteristics | | | | | | |
| Continuous source-drain diode current | I _S | MOSFET symbol showing the integral reverse p - n junction diode  | - | - | 41 | A |
| Pulsed diode forward current | I _{SM} | | - | - | 115 | |
| Diode forward voltage | V _{SD} | T _J = 25 °C, I _S = 16 A, V _{GS} = 0 V | - | - | 1.2 | V |
| Reverse recovery time | t _{rr} | T _J = 25 °C, I _F = I _S = 16 A, di/dt = 100 A/μs, V _R = 400 V | - | 152 | 304 | ns |
| Reverse recovery charge | Q _{rr} | | - | 1 | 2 | μC |
| Reverse recovery current | I _{RRM} | | - | 14 | - | 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)

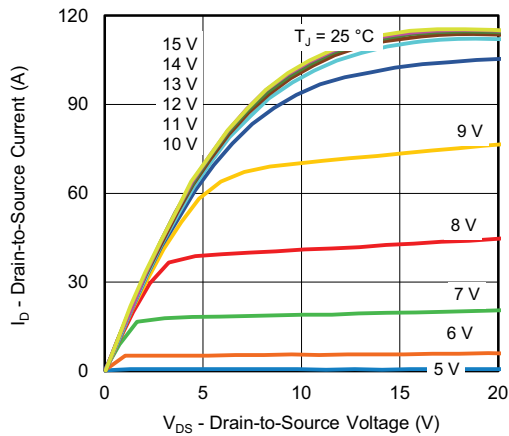


Fig. 1 - Typical Output Characteristics

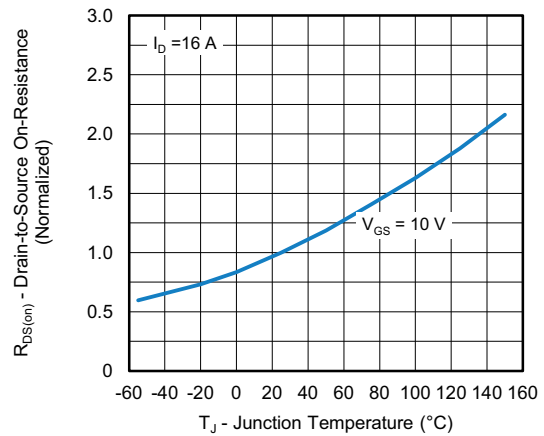


Fig. 4 - Normalized On-Resistance vs. Temperature

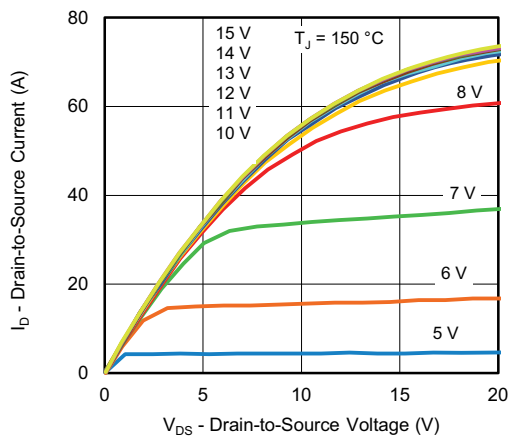


Fig. 2 - Typical Output Characteristics

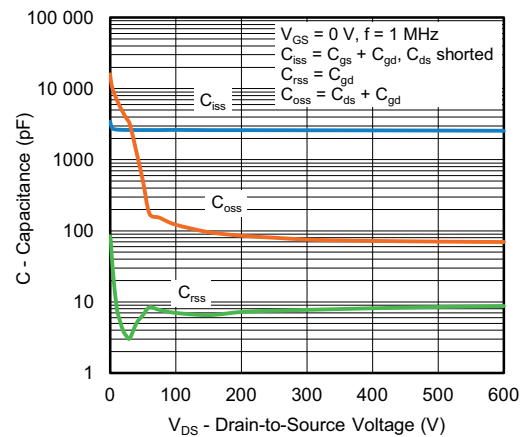


Fig. 5 - Typical Capacitance vs. Drain-to-Source Voltage

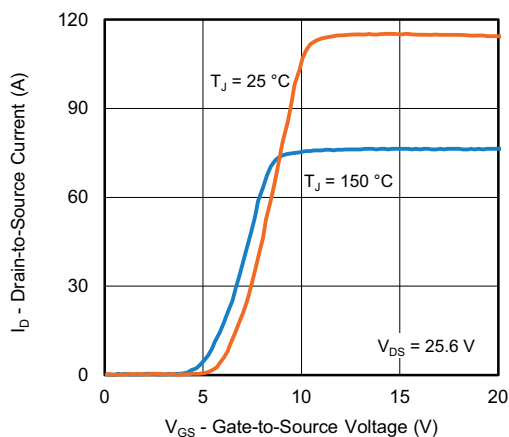


Fig. 3 - Typical Transfer Characteristics

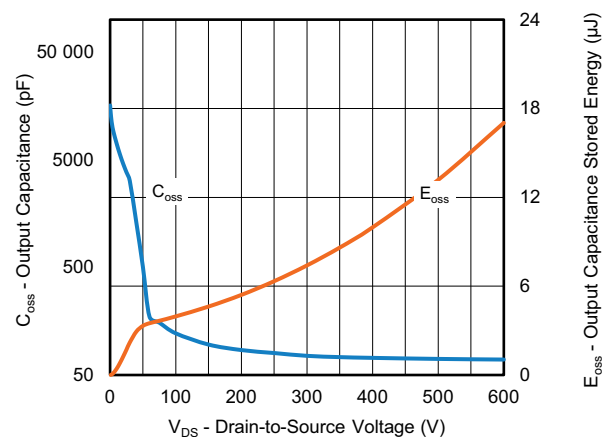


Fig. 6 - C_{oss} and E_{oss} vs. V_{DS}

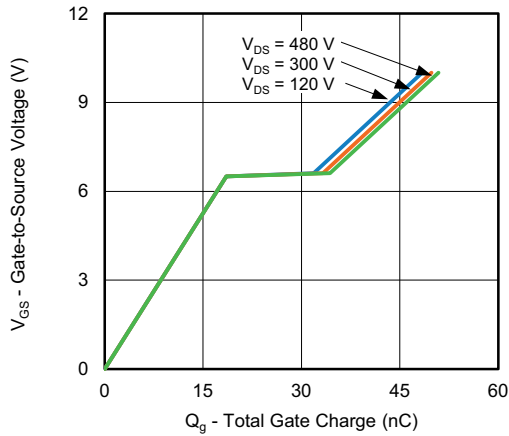


Fig. 7 - Typical Gate Charge vs. Gate-to-Source Voltage

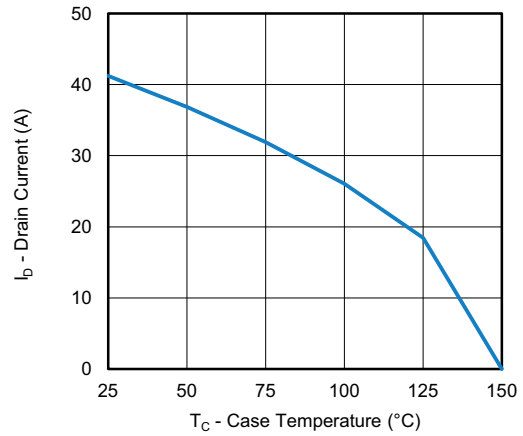


Fig. 10 - Maximum Drain Current vs. Case Temperature

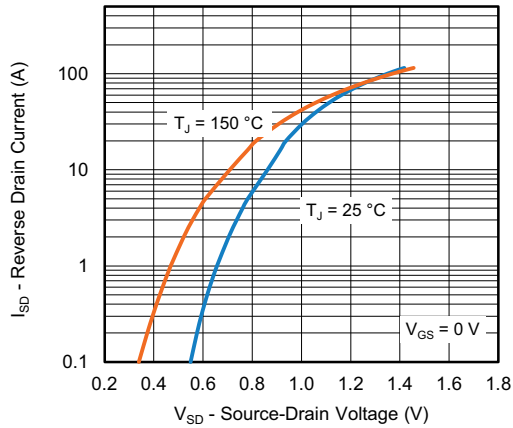


Fig. 8 - Typical Source-Drain Diode Forward Voltage

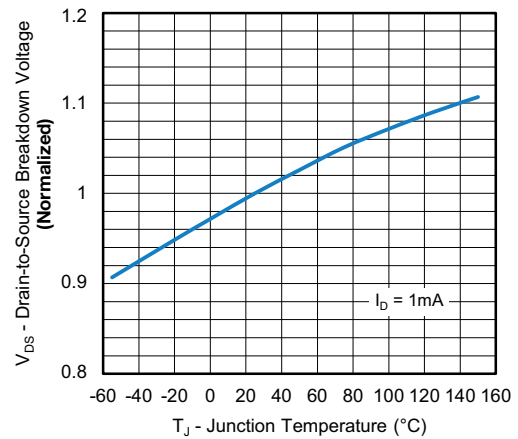


Fig. 11 - Temperature vs. Drain-to-Source Voltage

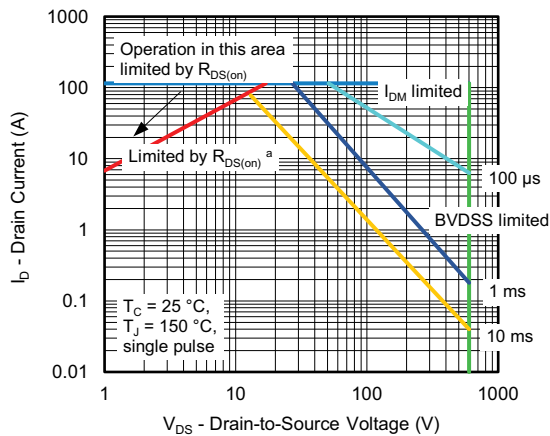


Fig. 9 - Maximum Safe Operating Area

Note

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

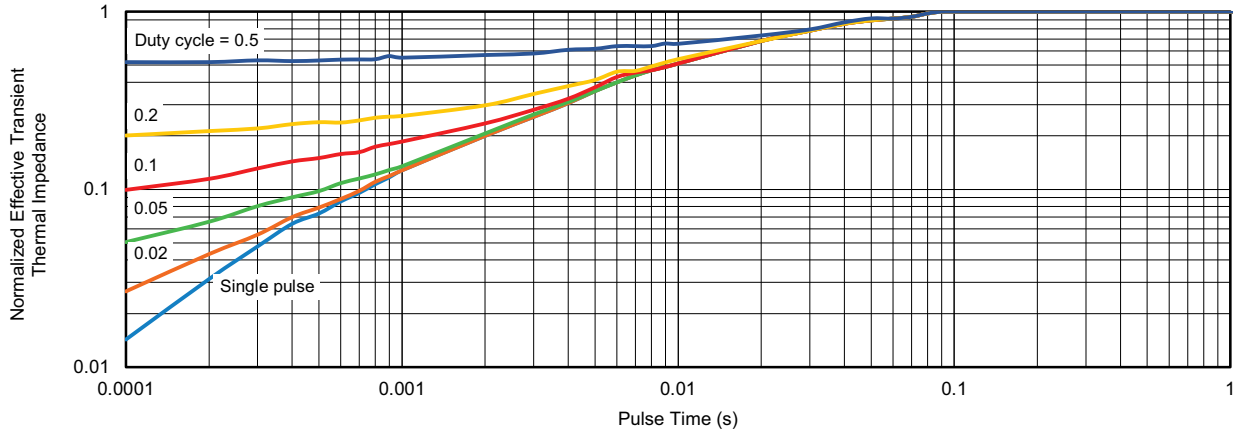


Fig. 12 - Normalized Thermal Transient Impedance, Junction-to-Case

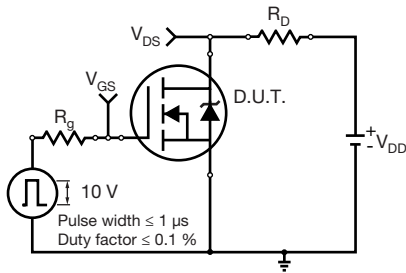


Fig. 13 - Switching Time Test Circuit

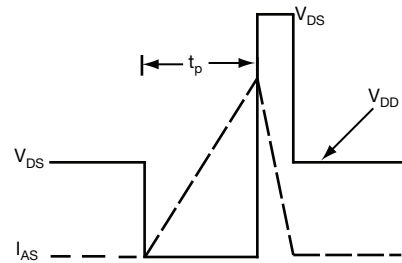


Fig. 16 - Unclamped Inductive Waveforms

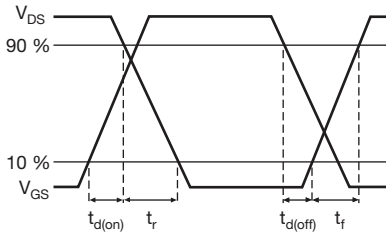


Fig. 14 - Switching Time Waveforms

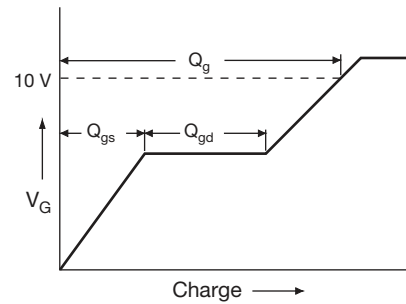


Fig. 17 - Basic Gate Charge Waveform

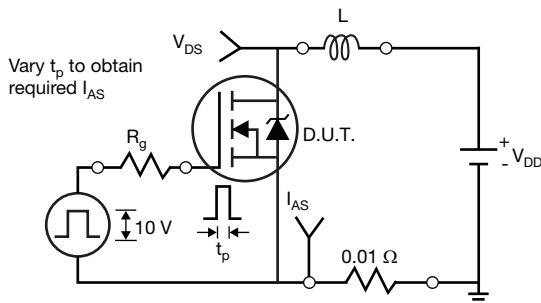


Fig. 15 - Unclamped Inductive Test Circuit

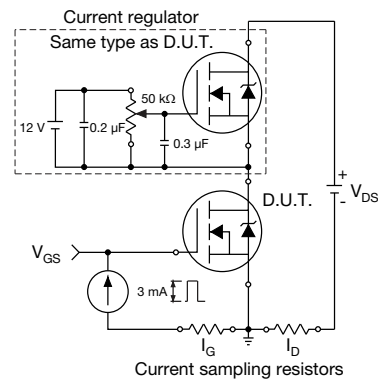


Fig. 18 - Gate Charge Test Circuit

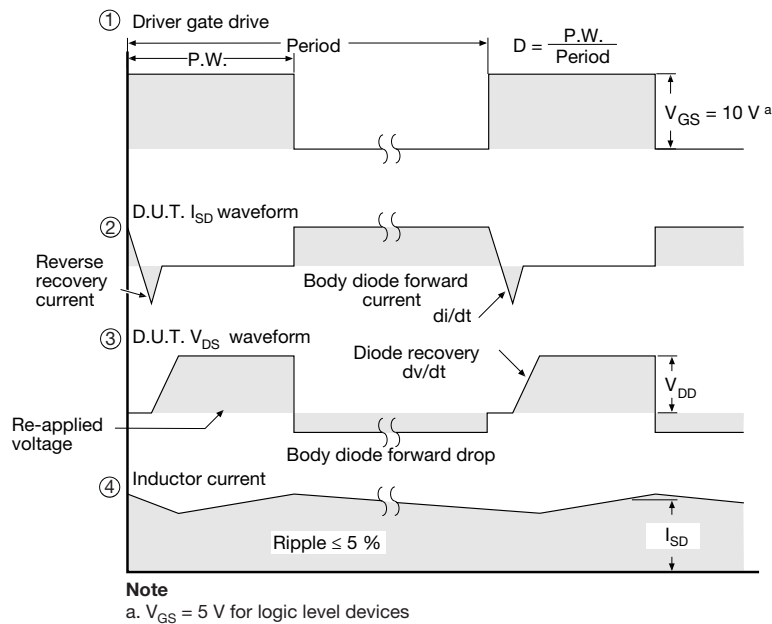
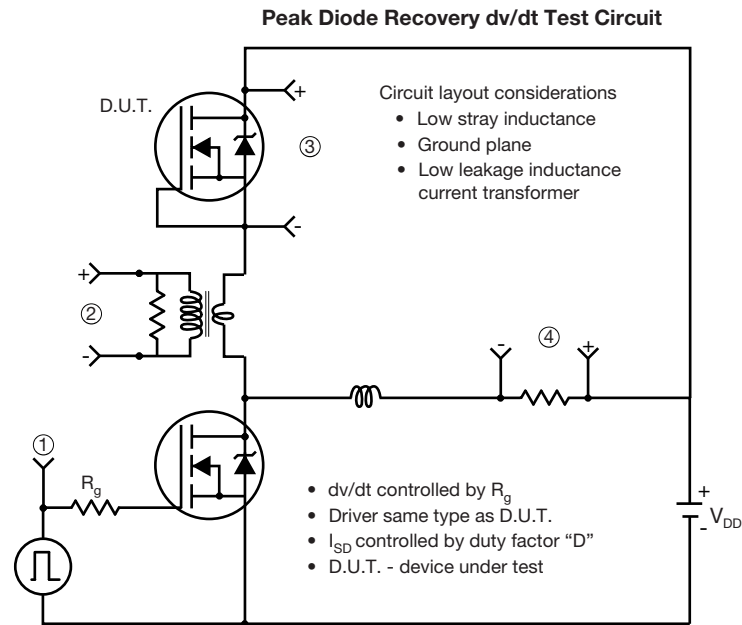


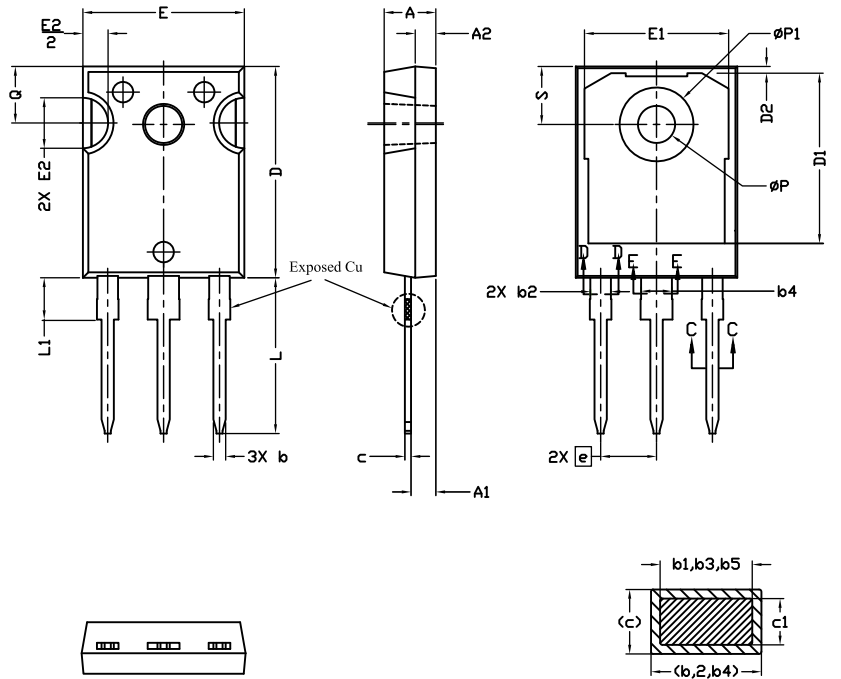
Fig. 19 - For N-Channel

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TO-247AC (High Voltage)

VERSION 1: FACILITY CODE = 9



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

| DIM. | MILLIMETERS | | NOTES |
|------|-------------|-------|-------|
| | MIN. | MAX. | |
| 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 |

| DIM. | MILLIMETERS | | NOTES |
|------|-------------|-------|-------|
| | MIN. | MAX. | |
| 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

- (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: 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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