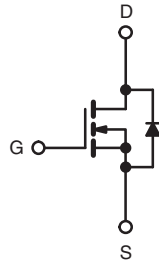
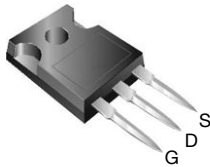


Power MOSFET

| PRODUCT SUMMARY | | |
|---------------------------|------------------------|-------|
| V_{DS} (V) | 500 | |
| $R_{DS(on)}$ (Ω) | $V_{GS} = 10\text{ V}$ | 0.190 |
| Q_g (Max.) (nC) | 150 | |
| Q_{gs} (nC) | 44 | |
| Q_{gd} (nC) | 72 | |
| Configuration | Single | |

TO-247AC



N-Channel MOSFET

FEATURES

- Superfast Body Diode Eliminates the Need for External Diodes in ZVS Applications
- Lower Gate Charge Results in Simpler Drive Requirements
- Enhanced dV/dt Capabilities Offer Improved Ruggedness
- Higher Gate Voltage Threshold Offers Improved Noise Immunity
- Compliant to RoHS Directive 2002/95/EC



RoHS*
COMPLIANT

APPLICATIONS

- Zero Voltage Switching SMPS
- Telecom and Server Power Supplies
- Uninterruptible Power Supplies
- Motor Control Applications

| ORDERING INFORMATION | |
|----------------------|----------------|
| Package | TO-247AC |
| Lead (Pb)-free | IRFP23N50LPbF |
| | SiHFP23N50L-E3 |
| SnPb | IRFP23N50L |
| | SiHFP23N50L |


| ABSOLUTE MAXIMUM RATINGS ($T_C = 25\text{ }^\circ\text{C}$, unless otherwise noted) | | | | |
|---|----------------------------------|-----------------------------------|---------------------|----------|
| PARAMETER | SYMBOL | LIMIT | UNIT | |
| Drain-Source Voltage | V_{DS} | 500 | V | |
| Gate-Source Voltage | V_{GS} | ± 30 | | |
| Continuous Drain Current | V_{GS} at 10 V | $T_C = 25\text{ }^\circ\text{C}$ | 23 | A |
| | | $T_C = 100\text{ }^\circ\text{C}$ | 15 | |
| Pulsed Drain Current ^a | I_{DM} | 92 | | |
| Linear Derating Factor | | 2.9 | W/ $^\circ\text{C}$ | |
| Single Pulse Avalanche Energy ^b | E_{AS} | 410 | mJ | |
| Repetitive Avalanche Current ^a | I_{AR} | 23 | A | |
| Repetitive Avalanche Energy ^a | E_{AR} | 37 | mJ | |
| Maximum Power Dissipation | $T_C = 25\text{ }^\circ\text{C}$ | P_D | 370 | W |
| Peak Diode Recovery dV/dt^c | dV/dt | 21 | V/ns | |
| Operating Junction and Storage Temperature Range | T_J, T_{stg} | - 55 to + 150 | $^\circ\text{C}$ | |
| Soldering Recommendations (Peak Temperature) | for 10 s | 300 ^d | | |
| Mounting Torque | 6-32 or M3 screw | | 10 | lbf · in |
| | | | 1.1 | N · m |

Notes

- Repetitive rating; pulse width limited by maximum junction temperature (see fig. 11).
- Starting $T_J = 25\text{ }^\circ\text{C}$, $L = 1.5\text{ mH}$, $R_g = 25\text{ }\Omega$, $I_{AS} = 23\text{ A}$ (see fig. 12).
- $I_{SD} \leq 23\text{ A}$, $dI/dt \leq 650\text{ A}/\mu\text{s}$, $V_{DD} \leq V_{DS}$, $T_J \leq 150\text{ }^\circ\text{C}$.
- 1.6 mm from case.

* Pb containing terminations are not RoHS compliant, exemptions may apply

| THERMAL RESISTANCE RATINGS | | | | |
|-------------------------------------|------------|------|------|------|
| PARAMETER | SYMBOL | TYP. | MAX. | UNIT |
| Maximum Junction-to-Ambient | R_{thJA} | - | 40 | °C/W |
| Case-to-Sink, Flat, Greased Surface | R_{thCS} | 0.24 | - | |
| Maximum Junction-to-Case (Drain) | R_{thJC} | - | 0.34 | |

| 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} | $V_{GS} = 0\text{ V}, I_D = 250\text{ }\mu\text{A}$ | 500 | - | - | V |
| V_{DS} Temperature Coefficient | $\Delta V_{DS}/T_J$ | Reference to $25\text{ }^\circ\text{C}$, $I_D = 1\text{ mA}^d$ | - | 0.27 | - | V/°C |
| Gate-Source Threshold Voltage | $V_{GS(th)}$ | $V_{DS} = V_{GS}, I_D = 250\text{ }\mu\text{A}$ | 3.0 | - | 5.0 | V |
| Gate-Source Leakage | I_{GSS} | $V_{GS} = \pm 30\text{ V}$ | - | - | ± 100 | nA |
| Zero Gate Voltage Drain Current | I_{DSS} | $V_{DS} = 500\text{ V}, V_{GS} = 0\text{ V}$ | - | - | 50 | μA |
| | | $V_{DS} = 400\text{ V}, V_{GS} = 0\text{ V}, T_J = 125\text{ }^\circ\text{C}$ | - | - | 2.0 | mA |
| Drain-Source On-State Resistance | $R_{DS(on)}$ | $V_{GS} = 10\text{ V}$ $I_D = 14\text{ A}^b$ | - | 0.190 | 0.235 | Ω |
| Forward Transconductance | g_{fs} | $V_{DS} = 50\text{ V}, I_D = 14\text{ A}^b$ | 12 | - | - | S |
| Dynamic | | | | | | |
| Input Capacitance | C_{iss} | $V_{GS} = 0\text{ V},$ $V_{DS} = 25\text{ V},$ $f = 1.0\text{ MHz}$, see fig. 5 | - | 3600 | - | pF |
| Output Capacitance | C_{oss} | | - | 380 | - | |
| Reverse Transfer Capacitance | C_{rss} | | - | 37 | - | |
| Output Capacitance | C_{oss} | $V_{GS} = 0\text{ V}$ | $V_{DS} = 1.0\text{ V}, f = 1.0\text{ MHz}$ | - | 4800 | - |
| Effective Output Capacitance | $C_{oss\text{ eff.}}$ | | $V_{DS} = 400\text{ V}, f = 1.0\text{ MHz}$ | - | 100 | - |
| Effective Output Capacitance (Energy Related) | $C_{oss\text{ eff. (ER)}}$ | | $V_{DS} = 0\text{ V to } 400\text{ V}^c$ | - | 220 | - |
| | | | $V_{DS} = 0\text{ V to } 400\text{ V}^d$ | - | 160 | - |
| Internal Gate Resistance | R_G | $f = 1\text{ MHz}$, open drain | - | 1.2 | - | Ω |
| Total Gate Charge | Q_g | $V_{GS} = 10\text{ V}$ $I_D = 23\text{ A}, V_{DS} = 400\text{ V}$ see fig. 6 and 13 ^b | - | - | 150 | nC |
| Gate-Source Charge | Q_{gs} | | - | - | 44 | |
| Gate-Drain Charge | Q_{gd} | | - | - | 72 | |
| Turn-On Delay Time | $t_{d(on)}$ | $V_{DD} = 250\text{ V}, I_D = 23\text{ A}$ $R_G = 6.0, V_{GS} = 10\text{ V}$ see fig. 10 ^b | - | 26 | - | ns |
| Rise Time | t_r | | - | 94 | - | |
| Turn-Off Delay Time | $t_{d(off)}$ | | - | 53 | - | |
| Fall Time | t_f | | - | 45 | - | |
| Drain-Source Body Diode Characteristics | | | | | | |
| Continuous Source-Drain Diode Current | I_S | MOSFET symbol showing the integral reverse p - n junction diode  | - | - | 23 | A |
| Pulsed Diode Forward Current ^a | I_{SM} | | - | - | 92 | |
| Body Diode Voltage | V_{SD} | $T_J = 25\text{ }^\circ\text{C}, I_S = 14\text{ A}, V_{GS} = 0\text{ V}^b$ | - | - | 1.5 | V |
| Body Diode Reverse Recovery Time | t_{rr} | $T_J = 25\text{ }^\circ\text{C}$ | - | 170 | 250 | ns |
| | | $T_J = 125\text{ }^\circ\text{C}$ | - | 220 | 330 | |
| Body Diode Reverse Recovery Charge | Q_{rr} | $T_J = 25\text{ }^\circ\text{C}$ | - | 560 | 840 | μC |
| | | $T_J = 125\text{ }^\circ\text{C}$ | - | 980 | 1500 | |
| Reverse Recovery Current | I_{RRM} | $T_J = 25\text{ }^\circ\text{C}$ | - | 7.6 | 11 | A |
| Forward Turn-On Time | t_{on} | Intrinsic turn-on time is negligible (turn-on is dominated by L_S and L_D) | | | | |

Notes

- Repetitive rating; pulse width limited by maximum junction temperature (see fig. 11).
- Pulse width $\leq 300\text{ }\mu\text{s}$; duty cycle $\leq 2\%$.
- $C_{oss\text{ eff.}}$ is a fixed capacitance that gives the same charging time as C_{oss} while V_{DS} is rising from 0 % to 80 % V_{DS} .
- $C_{oss\text{ eff. (ER)}}$ is a fixed capacitance that stores the same energy time as C_{oss} while V_{DS} is rising from 0 % to 80 % V_{DS} .

TYPICAL CHARACTERISTICS (25 °C, unless otherwise noted)

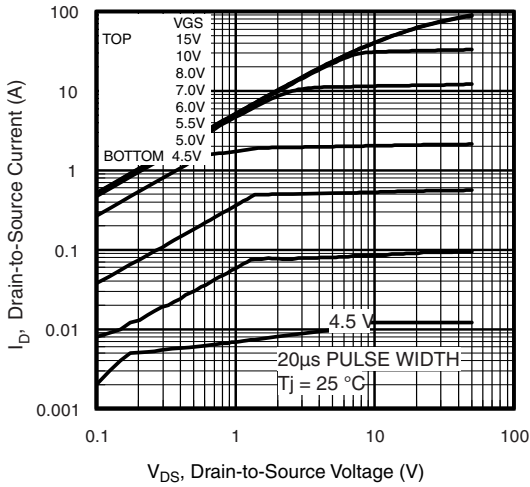


Fig. 1 - Typical Output Characteristics

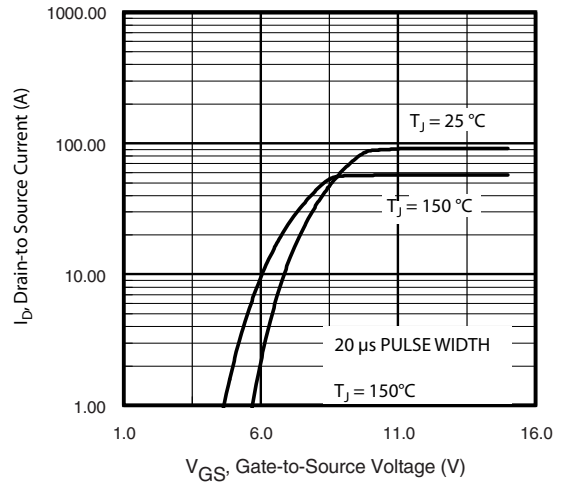


Fig. 3 - Typical Transfer Characteristics

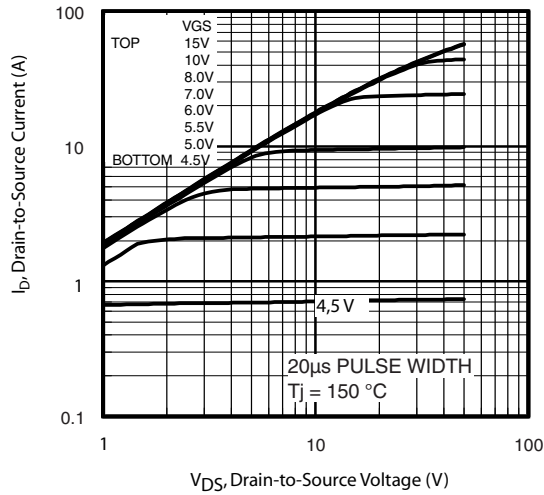


Fig. 2 - Typical Output Characteristics

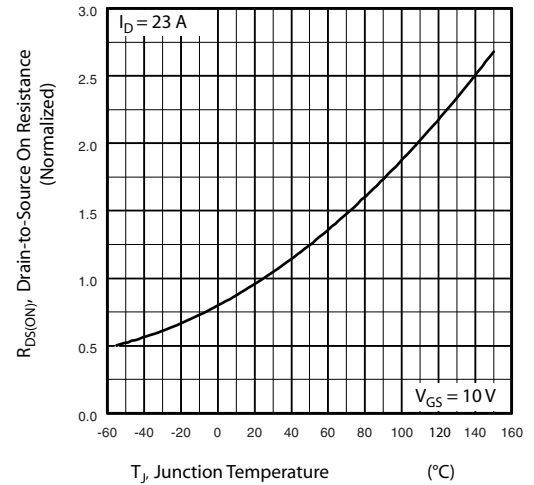


Fig. 4 - Normalized On-Resistance vs. Temperature

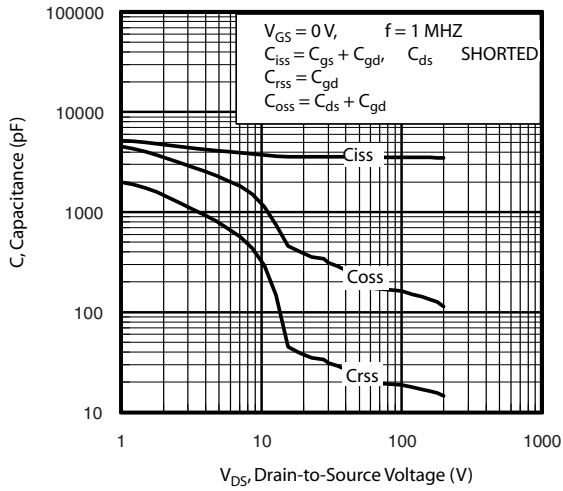


Fig. 5 - Typical Capacitance vs. Drain-to-Source Voltage

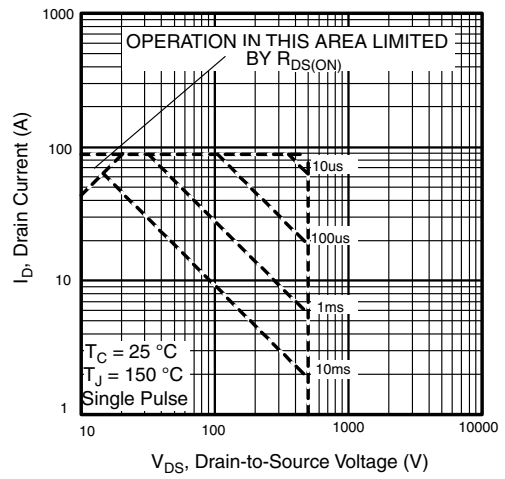


Fig. 7 - Maximum Safe Operating Area

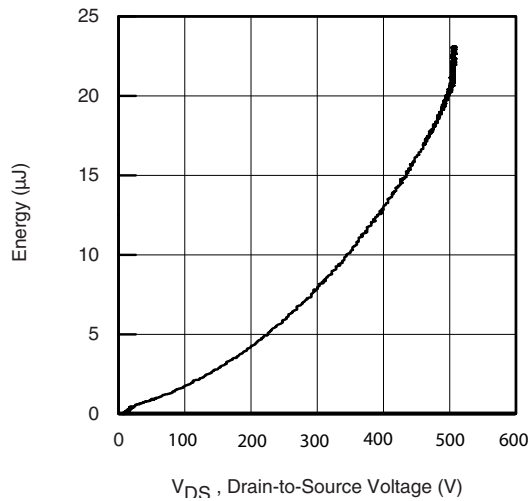


Fig. 6 - Typical Gate Charge vs. Gate-to-Source Voltage

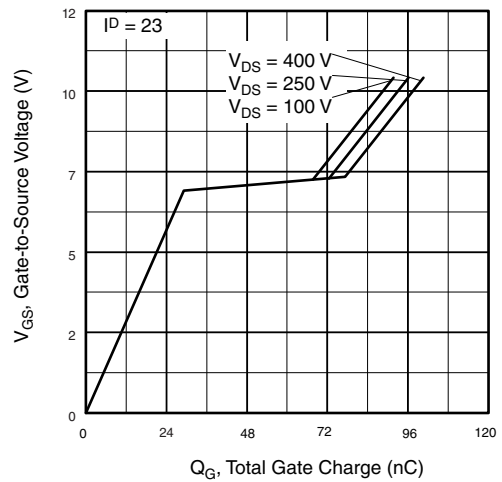


Fig. 8 - Typical Gate Charge vs. Gate-to-Source Voltage

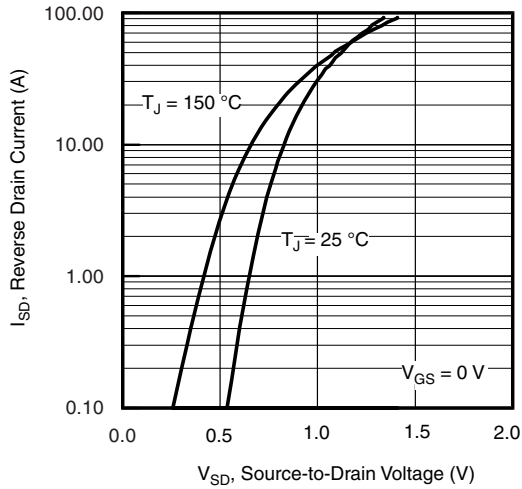


Fig. 9 - Typical Source-Drain Diode Forward Voltage

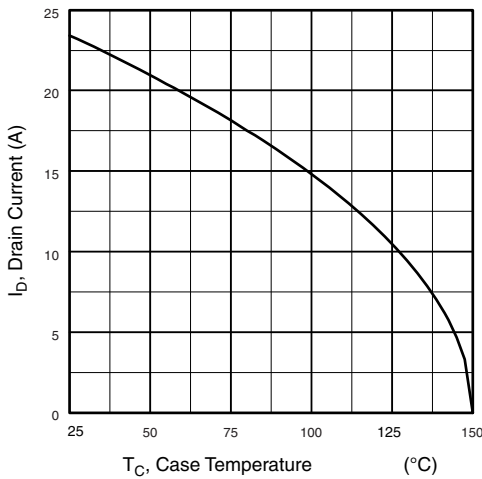


Fig. 10 - Maximum Drain Current vs. Case Temperature

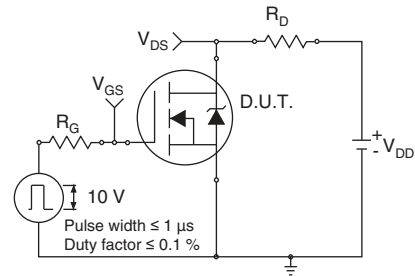


Fig. 11a - Switching Time Test Circuit

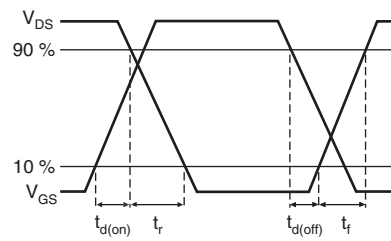


Fig. 11b - Switching Time Waveforms

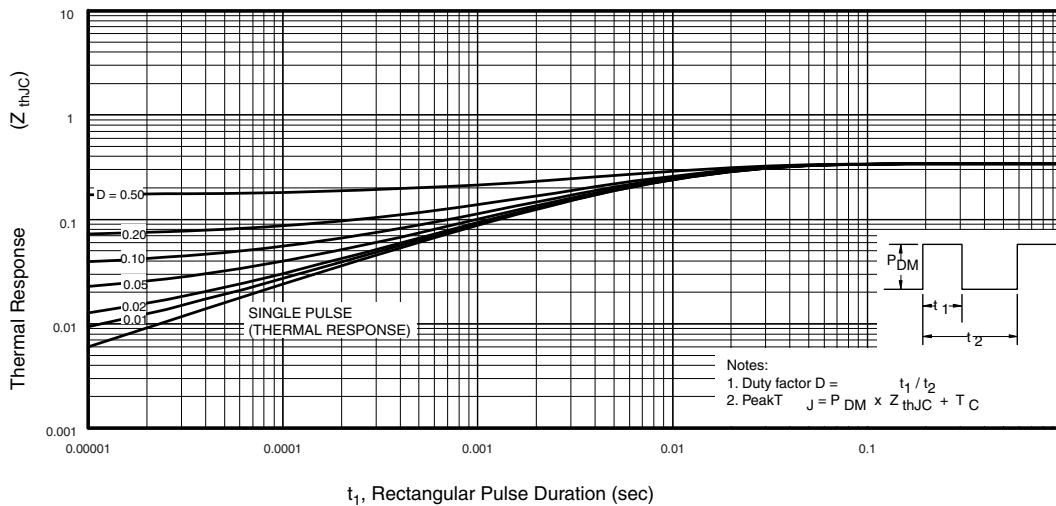


Fig. 12 - Maximum Effective Transient Thermal Impedance, Junction-to-Case

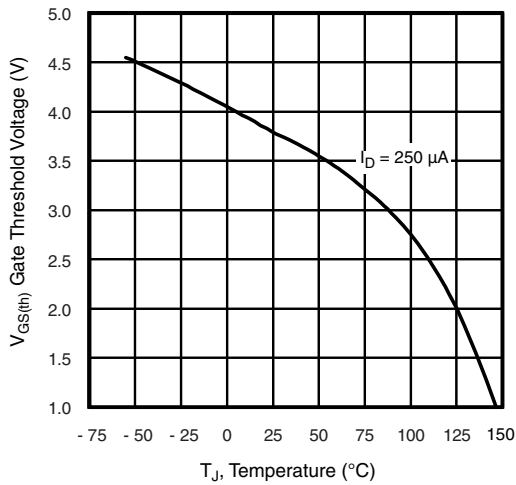


Fig. 13 - Threshold Voltage vs. Temperature

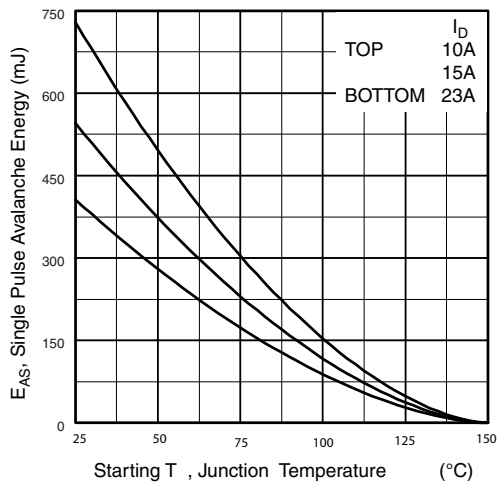


Fig. 14 - Maximum Avalanche Energy s. Drain Current

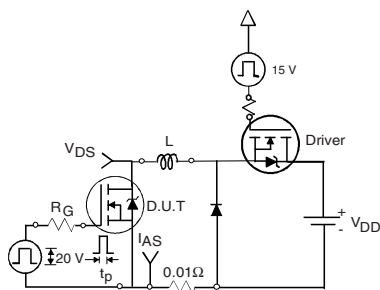


Fig. 15a - Unclamped Inductive Test Circuit

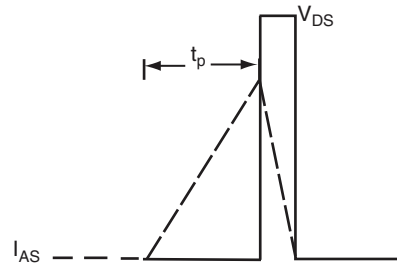


Fig. 15b - Unclamped Inductive Waveforms

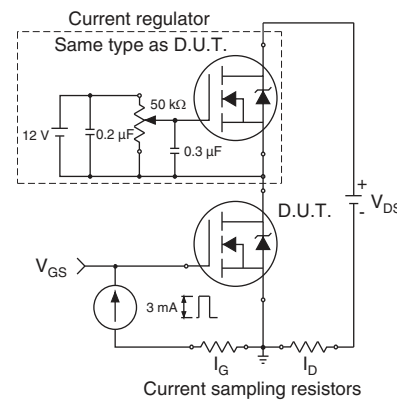


Fig. 16a - Gate Charge Test Circuit

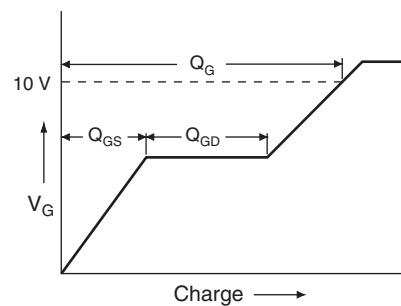
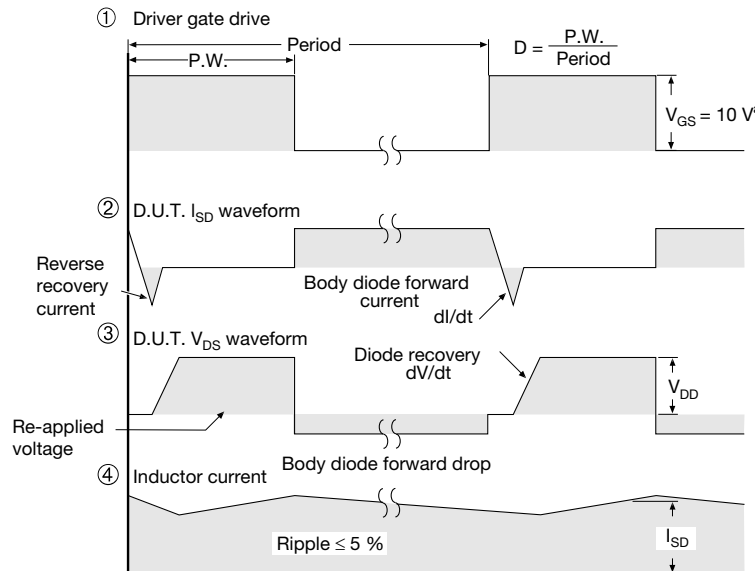
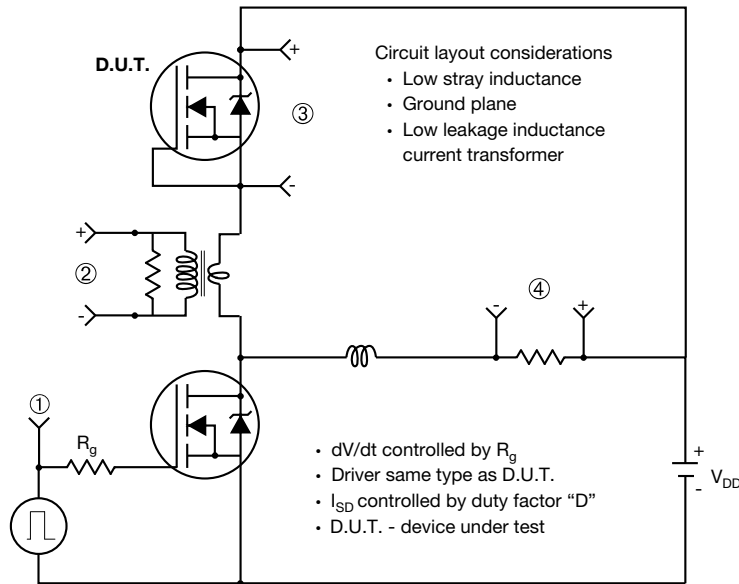


Fig. 16b - Basic Gate Charge Waveform

Peak Diode Recovery dV/dt Test Circuit



Note

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

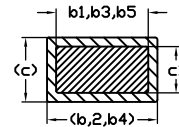
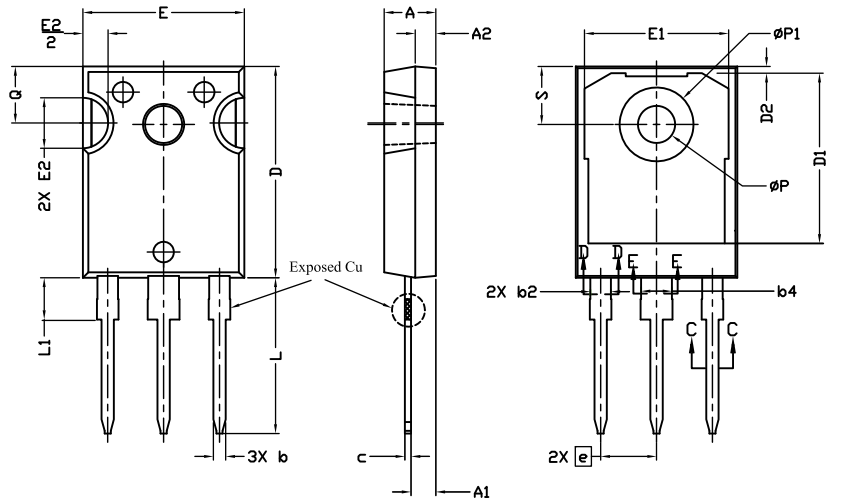
Fig. 17 - For N-Channel

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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 | - | |

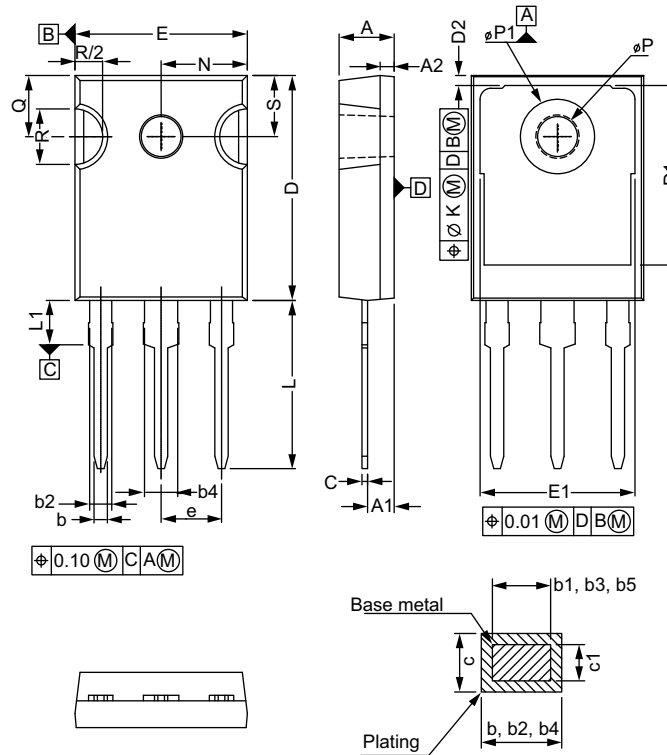
| DIM. | MILLIMETERS | | NOTES |
|------|-------------|-------|-------|
| | MIN. | MAX. | |
| D2 | 0.51 | 1.30 | |
| E | 15.29 | 15.87 | |
| E1 | 13.72 | - | |
| e | 5.46 BSC | | |
| Ø k | 0.254 | | |
| L | 14.20 | 16.25 | |
| L1 | 3.71 | 4.29 | |
| Ø P | 3.51 | 3.66 | |
| Ø P1 | - | 7.39 | |
| Q | 5.31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