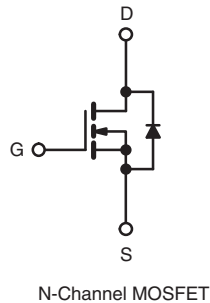
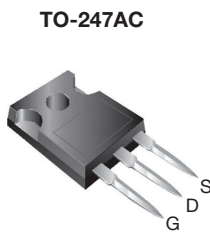


## Power MOSFET

| PRODUCT SUMMARY           |                 |      |
|---------------------------|-----------------|------|
| $V_{DS}$ (V)              | 400             |      |
| $R_{DS(on)}$ ( $\Omega$ ) | $V_{GS} = 10$ V | 0.20 |
| $Q_g$ (Max.) (nC)         | 110             |      |
| $Q_{gs}$ (nC)             | 28              |      |
| $Q_{gd}$ (nC)             | 45              |      |
| Configuration             | Single          |      |

### FEATURES

- Ultra Low Gate Charge
- Reduced Gate Drive Requirement
- Enhanced 30 V  $V_{GS}$  Rating
- Reduced  $C_{iss}$ ,  $C_{oss}$ ,  $C_{rss}$
- Isolated Central Mounting Hole
- Dynamic  $dV/dt$  Rated
- Repetitive Avalanche Rated
- Compliant to RoHS Directive 2002/95/EC



### DESCRIPTION

This new series of low charge Power MOSFETs achieve significantly lower gate charge over conventional MOSFETs. Utilizing advanced MOSFETs technology the device improvements allow for reduced gate drive requirements, faster switching speeds and increased total system savings. These device improvements combined with the proven ruggedness and reliability of MOSFETs offer the designer a new standard in power transistors for switching applications. The TO-247AC package is preferred for commercial-industrial applications where higher power levels preclude the use of TO-220AB devices. The TO-247AC is similar but superior to the earlier TO-218 package because of its isolated mounting hole.

| ORDERING INFORMATION |                               |
|----------------------|-------------------------------|
| Package              | TO-247AC                      |
| Lead (Pb)-free       | IRFP360LCPbF<br>SiHFP360LC-E3 |
| SnPb                 | IRFP360LC<br>SiHFP360LC       |

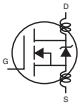

| ABSOLUTE MAXIMUM RATINGS ( $T_C = 25^\circ\text{C}$ , unless otherwise noted) |                          |                           |                     |                  |
|---|--------------------------|---------------------------|---------------------|------------------|
| PARAMETER   | SYMBOL                   | LIMIT                     | UNIT                |                  |
| Drain-Source Voltage  | $V_{DS}$                 | 400                       | V                   |                  |
| Gate-Source Voltage   | $V_{GS}$                 | $\pm 30$                  |                     |                  |
| Continuous Drain Current  | $V_{GS}$ at 10 V         | $T_C = 25^\circ\text{C}$  | 23                  | A                |
|   |                          | $T_C = 100^\circ\text{C}$ |                     |                  |
| Pulsed Drain Current <sup>a</sup>   | $I_{DM}$                 | 91                        |                     |                  |
| Linear Derating Factor  |                          | 2.2                       | W/ $^\circ\text{C}$ |                  |
| Single Pulse Avalanche Energy <sup>b</sup>                                    | $E_{AS}$                 | 1200                      | mJ                  |                  |
| Repetitive Avalanche Current <sup>a</sup>                                     | $I_{AR}$                 | 23                        | A                   |                  |
| Repetitive Avalanche Energy <sup>a</sup>                                      | $E_{AR}$                 | 28                        | mJ                  |                  |
| Maximum Power Dissipation   | $T_C = 25^\circ\text{C}$ | $P_D$                     | 280                 | W                |
| Peak Diode Recovery $dV/dt^c$   |                          | $dV/dt$                   | 4.0                 | 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 <sup>d</sup>    |                  |
| 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).
- $V_{DD} = 25$  V, starting  $T_J = 25^\circ\text{C}$ ,  $L = 4.0$  mH,  $R_g = 25 \Omega$ ,  $I_{AS} = 23$  A (see fig. 12).
- $I_{SD} \leq 23$  A,  $dI/dt \leq 170$  A/ $\mu\text{s}$ ,  $V_{DD} \leq V_{DS}$ ,  $T_J \leq 150^\circ\text{C}$ .
- 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)    | $R_{thJC}$ | -    | 0.45 |      |

| 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  | $V_{DS}$            | $V_{GS} = 0\text{ V}$ , $I_D = 250\text{ }\mu\text{A}$  | 400  | -    | -         | V             |
| $V_{DS}$ Temperature Coefficient  | $\Delta V_{DS}/T_J$ | Reference to $25\text{ }^\circ\text{C}$ , $I_D = 1\text{ mA}$   | -    | 0.49 | -         | V/°C          |
| Gate-Source Threshold Voltage   | $V_{GS(th)}$        | $V_{DS} = V_{GS}$ , $I_D = 250\text{ }\mu\text{A}$  | 2.0  | -    | 4.0       | V             |
| Gate-Source Leakage   | $I_{GSS}$           | $V_{GS} = \pm 20\text{ V}$  | -    | -    | $\pm 100$ | nA            |
| Zero Gate Voltage Drain Current   | $I_{DSS}$           | $V_{DS} = 400\text{ V}$ , $V_{GS} = 0\text{ V}$   | -    | -    | 25        | $\mu\text{A}$ |
|   |                     | $V_{DS} = 320\text{ V}$ , $V_{GS} = 0\text{ V}$ , $T_J = 125\text{ }^\circ\text{C}$   | -    | -    | 250       |               |
| Drain-Source On-State Resistance  | $R_{DS(on)}$        | $V_{GS} = 10\text{ V}$   $I_D = 14\text{ A}^b$  | -    | -    | 0.20      | $\Omega$      |
| Forward Transconductance  | $g_{fs}$            | $V_{DS} = 50\text{ V}$ , $I_D = 14\text{ A}^b$  | 13   | -    | -         | S             |
| <b>Dynamic</b>  |                     |   |      |      |           |               |
| Input Capacitance   | $C_{iss}$           | $V_{GS} = 0\text{ V}$ ,<br>$V_{DS} = 25\text{ V}$ ,<br>$f = 1.0\text{ MHz}$ , see fig. 5  | -    | 3400 | -         | pF            |
| Output Capacitance  | $C_{oss}$           |   | -    | 540  | -         |               |
| Reverse Transfer Capacitance  | $C_{rss}$           |   | -    | 42   | -         |               |
| Total Gate Charge   | $Q_g$               | $V_{GS} = 10\text{ V}$   $I_D = 23\text{ A}$ , $V_{DS} = 320\text{ V}$ ,<br>see fig. 6 and 13 <sup>b</sup>  | -    | -    | 110       | nC            |
| Gate-Source Charge  | $Q_{gs}$            |   | -    | -    | 28        |               |
| Gate-Drain Charge   | $Q_{gd}$            |   | -    | -    | 45        |               |
| Turn-On Delay Time  | $t_{d(on)}$         | $V_{DD} = 200\text{ V}$ , $I_D = 23\text{ A}$ ,<br>$R_g = 4.3\text{ }\Omega$ , $R_D = 7.9\text{ }\Omega$ , see fig. 10 <sup>b</sup>                             | -    | 16   | -         | ns            |
| Rise Time   | $t_r$               |   | -    | 75   | -         |               |
| Turn-Off Delay Time   | $t_{d(off)}$        |   | -    | 42   | -         |               |
| Fall Time   | $t_f$               |   | -    | 50   | -         |               |
| Internal Drain Inductance   | $L_D$               | Between lead,<br>6 mm (0.25") from<br>package and center of<br>die contact  | -    | 5.0  | -         | nH            |
| Internal Source Inductance  | $L_S$               |   | -    | 13   | -         |               |
| <b>Drain-Source Body Diode Characteristics</b>                              |                     |   |      |      |           |               |
| Continuous Source-Drain Diode Current                                       | $I_S$               | MOSFET symbol<br>showing the<br>integral reverse<br>p - n junction diode    | -    | -    | 23        | A             |
| Pulsed Diode Forward Current <sup>a</sup>                                   | $I_{SM}$            |   | -    | -    | 92        |               |
| Body Diode Voltage  | $V_{SD}$            | $T_J = 25\text{ }^\circ\text{C}$ , $I_S = 23\text{ A}$ , $V_{GS} = 0\text{ V}^b$  | -    | -    | 1.8       | V             |
| Body Diode Reverse Recovery Time  | $t_{rr}$            | $T_J = 25\text{ }^\circ\text{C}$ , $I_F = 23\text{ A}$ , $di/dt = 100\text{ A}/\mu\text{s}^b$   | -    | 400  | 600       | ns            |
| Body Diode Reverse Recovery Charge  | $Q_{rr}$            |   | -    | 5.7  | 8.6       | $\mu\text{C}$ |
| 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  $\leq 2\%$ .

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

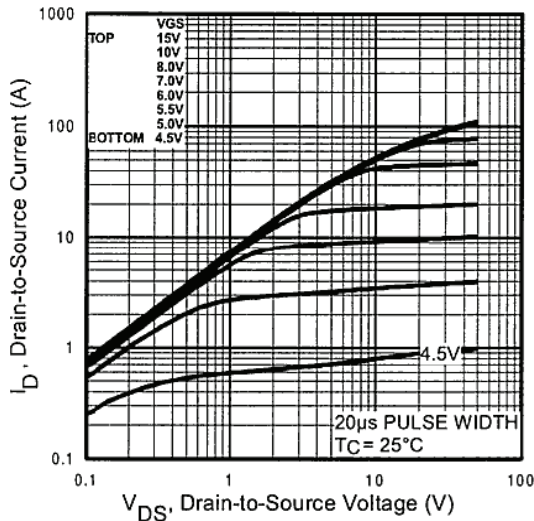


Fig. 1 - Typical Output Characteristics,  $T_C = 25\text{ }^\circ\text{C}$

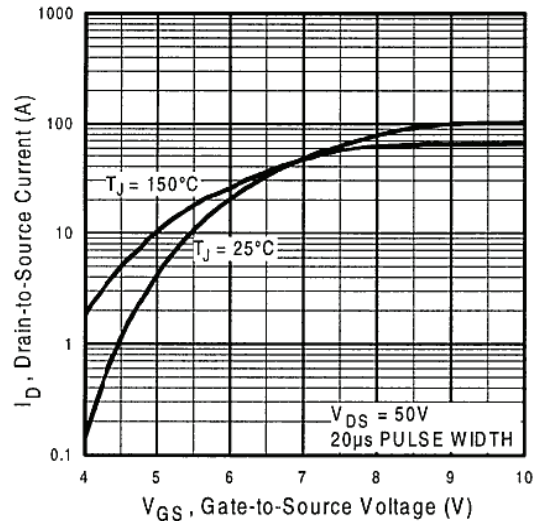


Fig. 3 - Typical Transfer Characteristics

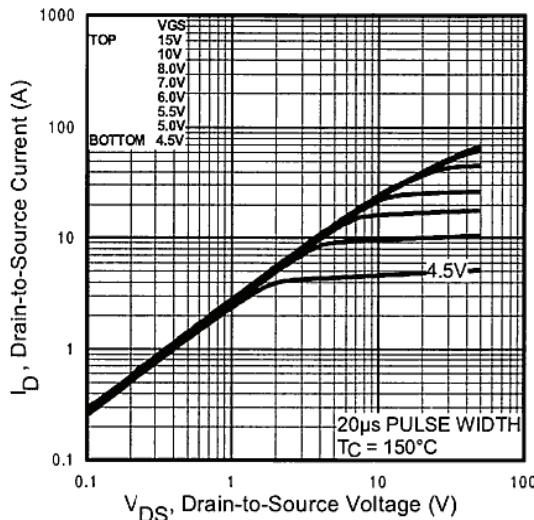


Fig. 2 - Typical Output Characteristics,  $T_C = 150\text{ }^\circ\text{C}$

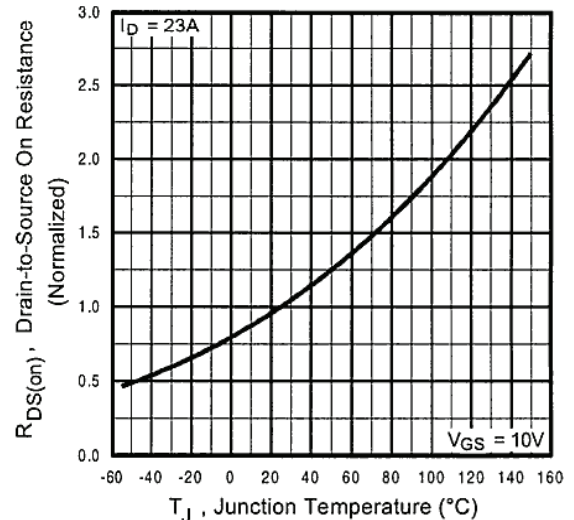


Fig. 4 - Normalized On-Resistance vs. Temperature

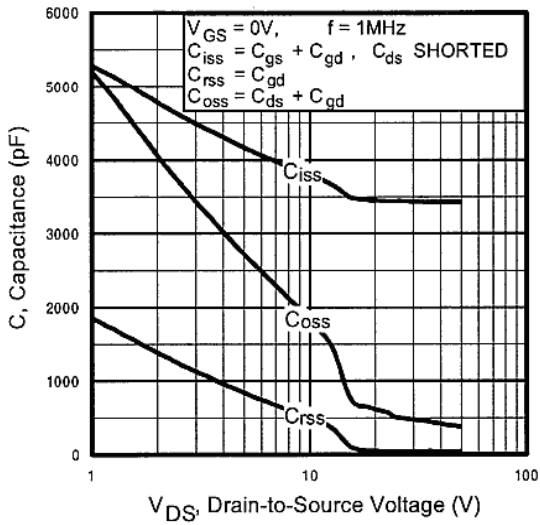


Fig. 5 - Typical Capacitance vs. Drain-to-Source Voltage

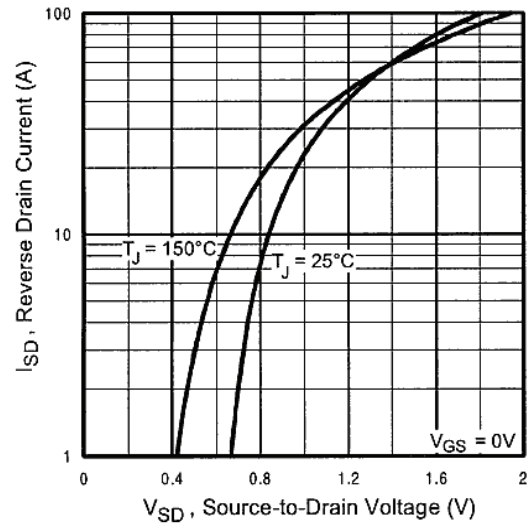


Fig. 7 - Typical Source-Drain Diode Forward Voltage

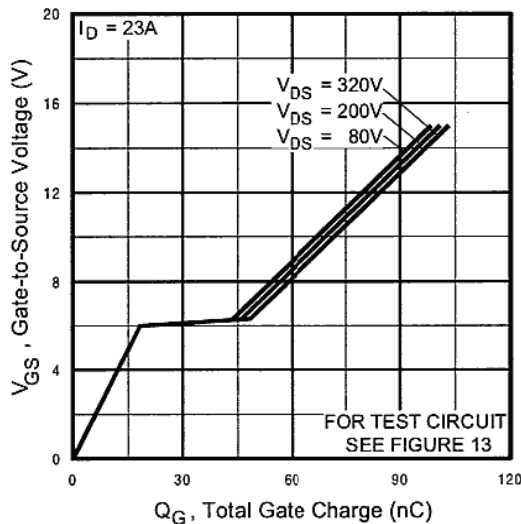


Fig. 6 - Typical Gate Charge vs. Gate-to-Source Voltage

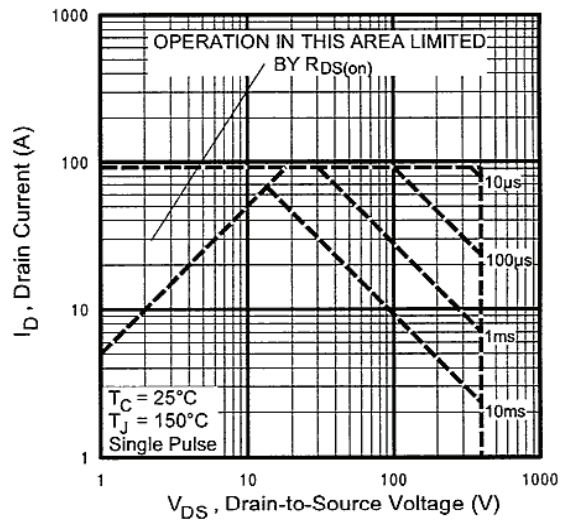


Fig. 8 - Maximum Safe Operating Area

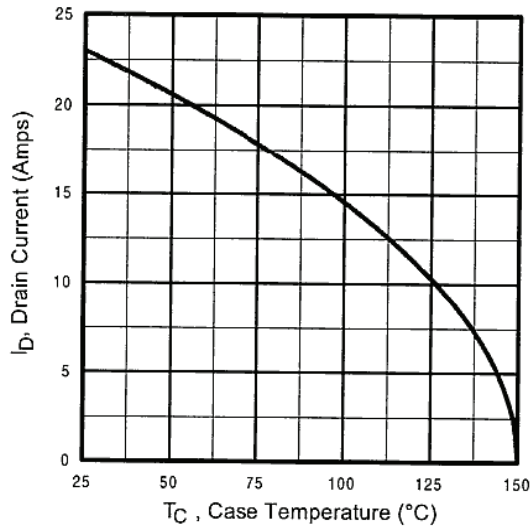


Fig. 9 - Maximum Drain Current vs. Case Temperature



Fig. 10a - Switching Time Test Circuit

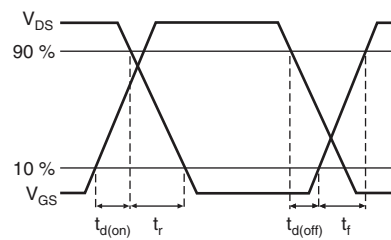


Fig. 10b - Switching Time Waveforms

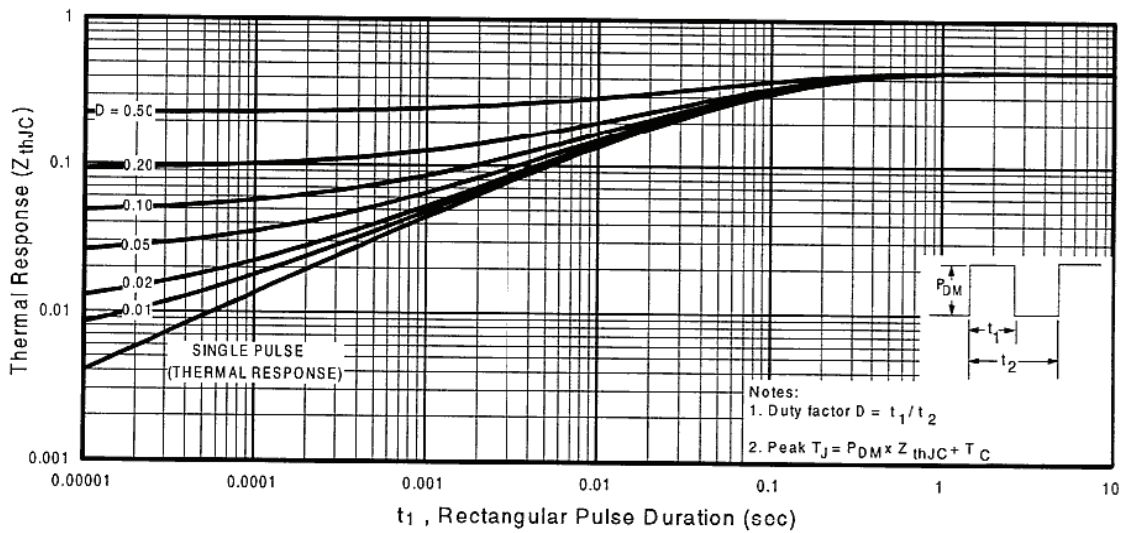


Fig. 11 - Maximum Effective Transient Thermal Impedance, Junction-to-Case

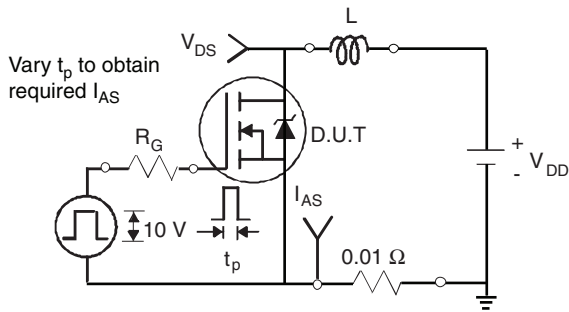


Fig. 12a - Unclamped Inductive Test Circuit

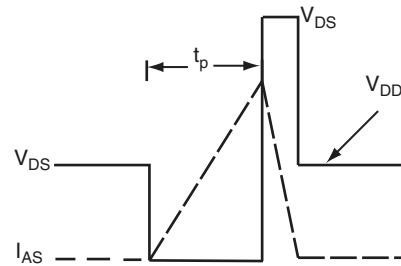


Fig. 12b - Unclamped Inductive Waveforms

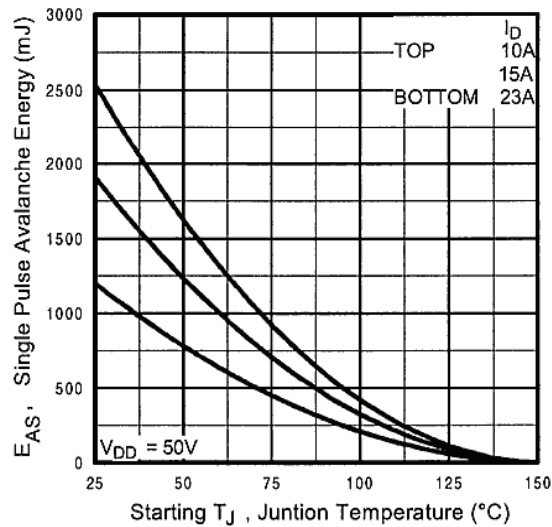


Fig. 12c - Maximum Avalanche Energy vs. Drain Current

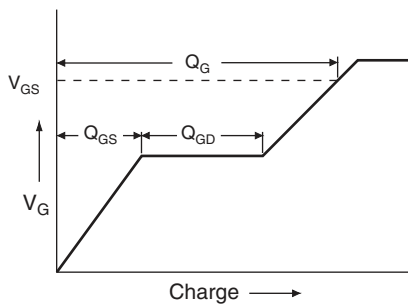


Fig. 13a - Basic Gate Charge Waveform

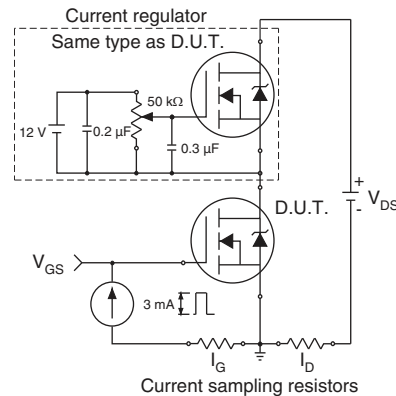
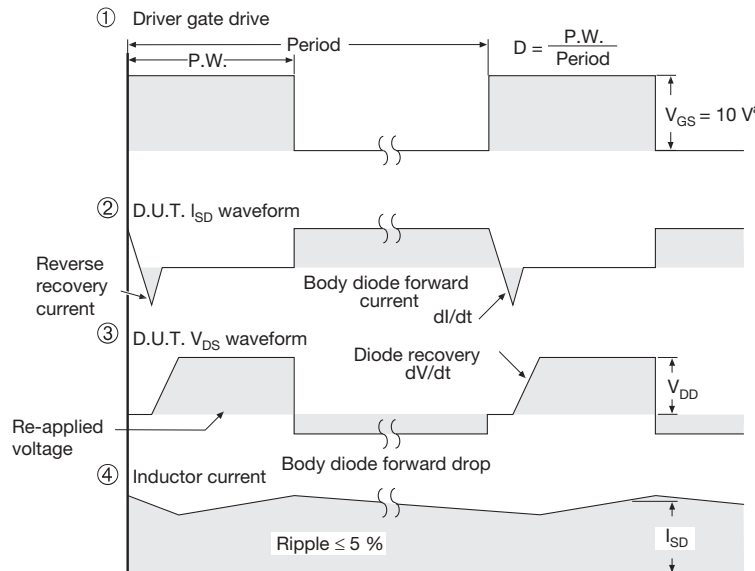
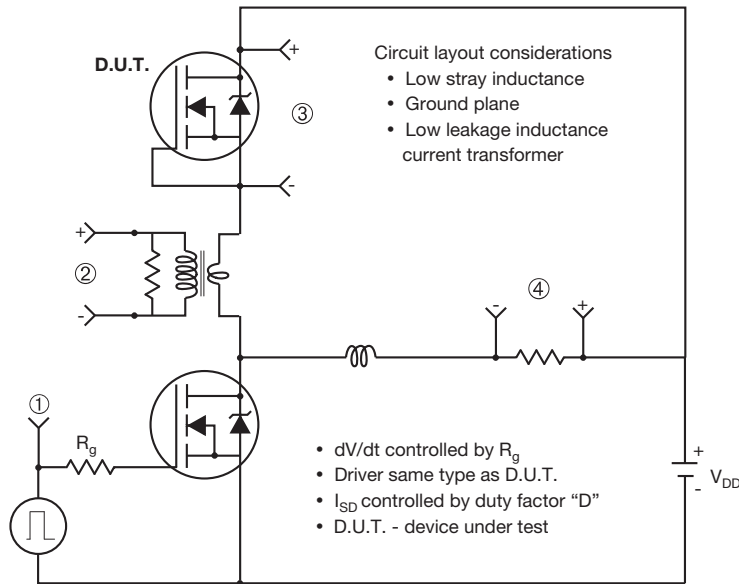


Fig. 13b - Gate Charge Test Circuit

### Peak Diode Recovery dV/dt Test Circuit



**Note**

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

**Fig. 14 - For N-Channel**

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# TO-247AC (High Voltage)



| DIM. | MILLIMETERS |       | INCHES |       |
|------|-------------|-------|--------|-------|
|      | MIN.        | MAX.  | MIN.   | MAX.  |
| A    | 4.58        | 5.31  | 0.180  | 0.209 |
| A1   | 2.21        | 2.59  | 0.087  | 0.102 |
| A2   | 1.17        | 2.49  | 0.046  | 0.098 |
| b    | 0.99        | 1.40  | 0.039  | 0.055 |
| b1   | 0.99        | 1.35  | 0.039  | 0.053 |
| b2   | 1.53        | 2.39  | 0.060  | 0.094 |
| b3   | 1.65        | 2.37  | 0.065  | 0.093 |
| b4   | 2.42        | 3.43  | 0.095  | 0.135 |
| b5   | 2.59        | 3.38  | 0.102  | 0.133 |
| c    | 0.38        | 0.86  | 0.015  | 0.034 |
| c1   | 0.38        | 0.76  | 0.015  | 0.030 |
| D    | 19.71       | 20.82 | 0.776  | 0.820 |
| D1   | 13.08       | -     | 0.515  | -     |

| DIM. | MILLIMETERS |       | INCHES    |       |
|------|-------------|-------|-----------|-------|
|      | MIN.        | MAX.  | MIN.      | MAX.  |
| D2   | 0.51        | 1.30  | 0.020     | 0.051 |
| E    | 15.29       | 15.87 | 0.602     | 0.625 |
| E1   | 13.72       | -     | 0.540     | -     |
| e    | 5.46 BSC    |       | 0.215 BSC |       |
| Ø k  | 0.254       |       | 0.010     |       |
| L    | 14.20       | 16.25 | 0.559     | 0.640 |
| L1   | 3.71        | 4.29  | 0.146     | 0.169 |
| N    | 7.62 BSC    |       | 0.300 BSC |       |
| Ø P  | 3.51        | 3.66  | 0.138     | 0.144 |
| Ø P1 | -           | 7.39  | -         | 0.291 |
| 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 |       |

ECN: X13-0103-Rev. D, 01-Jul-13  
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").
7. Outline conforms to JEDEC outline TO-247 with exception of dimension c.
8. Xian and Mingxin actually photo.







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