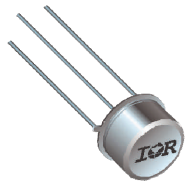
# IRHF597130

## RADIATION HARDENED POWER MOSFET THRU-HOLE TO-205AF (TO-39)

## 100V, P-CHANNEL R5 TECHNOLOGY



TO-39

### Product Summary

| Part Number | Radiation Level | $R_{DS(on)}$ | $I_D$ |
|---|---|---|---|
| IRHF597130 | 100 kRads(Si) | 0.24Ω | -6.7A |
| IRHF593130 | 300 kRads(Si) | 0.24Ω | -6.7A |

### Description

IR HiRel R5 technology provides high performance power MOSFETs for space applications. These devices have been characterized for both Total Dose and Single Event Effect (SEE) with useful performance up to LET of 80 (MeV/(mg/cm$^2$)). The combination of low $R_{DS}$(on) and low gate charge reduces the power losses in switching applications such as DC-DC converters and motor controllers. These devices retain all of the well established advantages of MOSFETs such as voltage control, fast switching and temperature stability of electrical parameters.

### Features

- Single Event Effect (SEE) Hardened
- Low RDS(on)
- Low Total Gate Charge
- Simple Drive Requirements
- Hermetically Sealed
- Electrically Isolated
- Ceramic Package
- Light Weight
- Surface Mount
- ESD Rating: Class 1B per MIL-STD-750, Method 1020

### Absolute Maximum Ratings

**Pre-Irradiation**

| Symbol | Parameter | Value | Units |
|---|---|---|---|
| $I_{D1}$ @ $V_{GS}$ = -12V, $T_C$ = 25°C | Continuous Drain Current | -6.7 | A |
| $I_{D2}$ @ $V_{GS}$ = -12V, $T_C$ = 100°C | Continuous Drain Current | -4.3 | |
| $I_{DM}$ @ $T_C$ = 25°C | Pulsed Drain Current ① | -26.8 | |
| $P_D$ @ $T_C$ = 25°C | Maximum Power Dissipation | 25 | W |
| | Linear Derating Factor | 0.2 | W/°C |
| $V_{GS}$ | Gate-to-Source Voltage | ± 20 | V |
| $E_{AS}$ | Single Pulse Avalanche Energy ② | 240 | mJ |
| $I_{AR}$ | Avalanche Current ① | -6.7 | A |
| $E_{AR}$ | Repetitive Avalanche Energy ① | 2.5 | mJ |
| dv/dt | Peak Diode Recovery dv/dt ③ | -17 | V/ns |
| $T_J$<br>$T_{STG}$ | Operating Junction and<br>Storage Temperature Range | -55 to + 150 | °C |
| | Lead Temperature | 300 (0.063 in. /1.6 mm from case for 10s) | |
| | Weight | 0.98 (Typical) | g |

For Footnotes, refer to the page 2.

## Electrical Characteristics @ Tj = 25°C (Unless Otherwise Specified)

| Symbol | Parameter | Min. | Typ. | Max. | Units | Test Conditions |
|---|---|---|---|---|---|---|
| $BV_{DSS}$ | Drain-to-Source Breakdown Voltage | -100 | — | — | V | $V_{GS}$ = 0V, $I_D$ = -1.0mA |
| $\Delta BV_{DSS}/\Delta T_J$ | Breakdown Voltage Temp. Coefficient | — | -0.13 | — | V/°C | Reference to 25°C, $I_D$ = -1.0mA |
| $R_{DS(on)}$ | Static Drain-to-Source On-Resistance | — | — | 0.24 | Ω | $V_{GS}$ = -12V, $I_{D2}$ = -4.3A ④ |
| $V_{GS(th)}$ | Gate Threshold Voltage | -2.0 | — | -4.0 | V | $V_{DS}$ = $V_{GS}$, $I_D$ = -1.0mA |
| Gfs | Forward Transconductance | 4.3 | — | — | S | $V_{DS}$ = -15V, $I_{D2}$ = -4.3A ④ |
| $I_{DSS}$ | Zero Gate Voltage Drain Current | — | — | -10 | μA | $V_{DS}$ = -80V, $V_{GS}$ = 0V |
| | | — | — | -25 | | $V_{DS}$ = -80V,$V_{GS}$ = 0V,$T_J$ =125°C |
| $I_{GSS}$ | Gate-to-Source Leakage Forward | — | — | -100 | nA | $V_{GS}$ = -20V |
| | Gate-to-Source Leakage Reverse | — | — | 100 | | $V_{GS}$ = 20V |
| $Q_G$ | Total Gate Charge | — | — | 40 | nC | $I_{D1}$ = -6.7A |
| $Q_{GS}$ | Gate-to-Source Charge | — | — | 16 | | $V_{DS}$ = -50V |
| $Q_{GD}$ | Gate-to-Drain ('Miller') Charge | — | — | 11 | | $V_{GS}$ = -12V |
| $t_{d(on)}$ | Turn-On Delay Time | — | — | 25 | ns | $V_{DD}$ = -50V |
| tr | Rise Time | — | — | 50 | | $I_{D1}$ = -6.7A |
| $t_{d(off)}$ | Turn-Off Delay Time | — | — | 45 | | $R_G$ = 7.5Ω |
| $t_f$ | Fall Time | — | — | 125 | | $V_{GS}$ = -12V |
| Ls +$L_D$ | Total Inductance | — | 7.0 | — | nH | Measured from Drain lead (6mm / 0.25in from package) to Source lead (6mm/ 0.25 in from package) with Source wire internally bonded from Source pin to Drain pin |
| $C_{iss}$ | Input Capacitance | — | 1250 | — | pF | $V_{GS}$ = 0V |
| $C_{oss}$ | Output Capacitance | — | 318 | — | | $V_{DS}$ = -25V |
| $C_{rss}$ | Reverse Transfer Capacitance | — | 28 | — | | $f$ = 1.0MHz |
| $R_G$ | Internal Gate Resistance | | 8.0 | | Ω | $f$ = 1.0MHz, open drain |

## Source-Drain Diode Ratings and Characteristics

| Symbol | Parameter | Min. | Typ. | Max. | Units | Test Conditions |
|---|---|---|---|---|---|---|
| $I_S$ | Continuous Source Current (Body Diode) | — | — | -6.7 | A | |
| $I_{SM}$ | Pulsed Source Current (Body Diode) ① | — | — | -26.8 | | |
| $V_{SD}$ | Diode Forward Voltage | — | — | -5.0 | V | $T_J$ =25°C,$I_S$ = -6.7A, $V_{GS}$= 0V④ |
| $t_{rr}$ | Reverse Recovery Time | — | — | 150 | ns | $T_J$=25°C, $I_F$= -6.7A, $V_{DD}$ ≤ -50V |
| $Q_{rr}$ | Reverse Recovery Charge | — | — | 408 | nC | di/dt = -100A/μs ④ |
| $t_{on}$ | Forward Turn-On Time | Intrinsic turn-on time is negligible (turn-on is dominated by $L_S$+$L_D$) | | | | |

## Thermal Resistance

| Symbol | Parameter | Min. | Typ. | Max. | Units |
|---|---|---|---|---|---|
| $R_{\theta JC}$ | Junction-to-Case | — | — | 5.0 | °C/W |
| $R_{\theta JA}$ | Junction-to-Ambiet (Typical Socket Mount) | — | — | 175 | °C/W |

**Footnotes:**

① Repetitive Rating; Pulse width limited by maximum junction temperature.

② $V_{DD}$ = -25V, starting $T_J$ = 25°C, L = 10.6mH, Peak $I_L$ = -6.7A, $V_{GS}$ = -12V

③ $I_{SD}$ ≤ -6.7A, di/dt ≤ -530A/μs, $V_{DD}$ ≤ -100V, $T_J$ ≤ 150°C

④ Pulse width ≤ 300 μs; Duty Cycle ≤ 2%

⑤ Total Dose Irradiation with $V_{GS}$ Bias. -12 volt $V_{GS}$ applied and $V_{DS}$ = 0 during irradiation per MIL-STD-750, Method 1019, condition A.

⑥ Total Dose Irradiation with $V_{DS}$ Bias. -80 volt $V_{DS}$ applied and $V_{GS}$ = 0 during irradiation per MIL-STD-750, Method 1019, condition A.

## Radiation Characteristics

IR HiRel Radiation Hardened MOSFETs are tested to verify their radiation hardness capability. The hardness assurance program at IR HiRel is comprised of two radiation environments. Every manufacturing lot is tested for total ionizing dose (per notes 5 and 6) using the TO-3 package. Both pre- and post-irradiation performance are tested and specified using the same drive circuitry and test conditions in order to provide a direct comparison.

### Table1. Electrical Characteristics @ Tj = 25°C, Post Total Dose Irradiation ⑤⑥

| Symbol | Parameter | 100 kRads (Si)[1] | | 300 kRads (Si)[2] | | Units | Test Conditions |
|---|---|---|---|---|---|---|---|
| | | Min. | Max. | Min. | Max. | | |
| $BV_{DSS}$ | Drain-to-Source Breakdown Voltage | -100 | —— | -100 | —— | V | $V_{GS}$ = 0V, $I_D$ = -1.0mA |
| $V_{GS(th)}$ | Gate Threshold Voltage | -2.0 | -4.0 | -2.0 | -5.0 | V | $V_{DS}$ = $V_{GS}$, $I_D$ = -1.0mA |
| $I_{GSS}$ | Gate-to-Source Leakage Forward | —— | -100 | —— | -100 | nA | $V_{GS}$ = -20V |
| $I_{GSS}$ | Gate-to-Source Leakage Reverse | —— | 100 | —— | 100 | nA | $V_{GS}$ = 20V |
| $I_{DSS}$ | Zero Gate Voltage Drain Current | —— | -10 | —— | -10 | µA | $V_{DS}$ = -80V, $V_{GS}$ = 0V |
| $R_{DS(on)}$ | Static Drain-to-Source ④ On-State Resistance (TO-3) | —— | 0.205 | —— | 0.205 | Ω | $V_{GS}$ = -12V, $I_{D2}$ = -4.3A |
| $R_{DS(on)}$ | Static Drain-to-Source ④ On-State Resistance (TO-39) | —— | 0.24 | —— | 0.24 | Ω | $V_{GS}$ = -12V, $I_{D2}$ = -4.3A |
| $V_{SD}$ | Diode Forward Voltage ④ | —— | -5.0 | —— | -5.0 | V | $V_{GS}$ = 0V, $I_S$= -6.7A |

1. Part number IRHF597130
2. Part number IRHF593130

IR HiRel radiation hardened MOSFETs have been characterized in heavy ion environment for Single Event Effects (SEE). Single Event Effects characterization is illustrated in Fig. a and Table 2.

### Table 2. Typical Single Event Effect Safe Operating Area

| LET (MeV/(mg/cm$^2$)) | Energy (MeV) | Range (µm) | VDS (V) | | | | |
|---|---|---|---|---|---|---|---|
| | | | @ VGS = 0V | @ VGS =5V | @ VGS =10V | @ VGS =15V | @ VGS =20V |
| 38 ± 5% | 270 ± 7.5% | 35 ± 7.5% | -100 | -100 | -100 | -100 | -100 |
| 61 ± 5% | 330 ± 7.5% | 30 ± 7.5% | -100 | -100 | -100 | -100 | -25 |
| 84 ± 5% | 350 ± 7.5% | 28 ± 7.5% | -100 | -100 | -100 | -30 | —— |

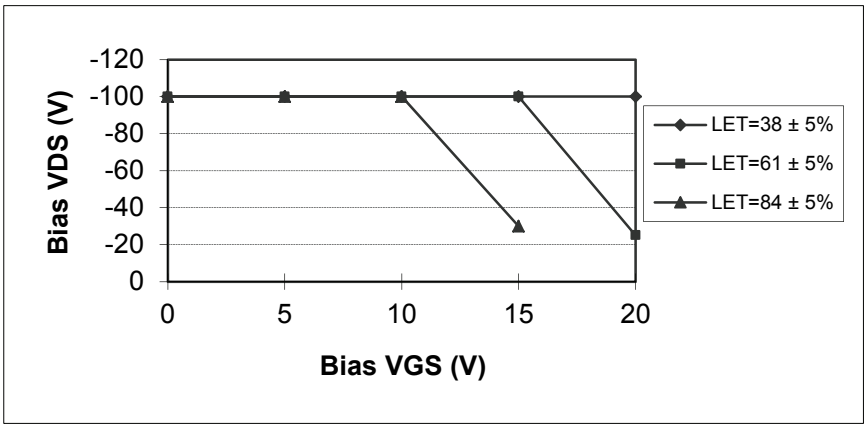



**Fig a.** Typical Single Event Effect, Safe Operating Area

For Footnotes, refer to the page 2.

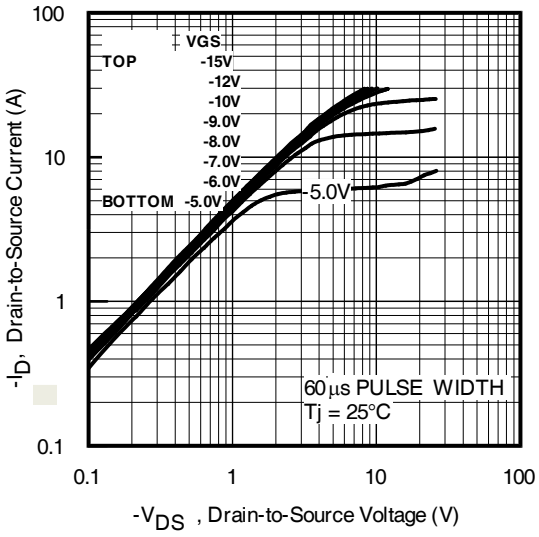



**Fig 1.** Typical Output Characteristics

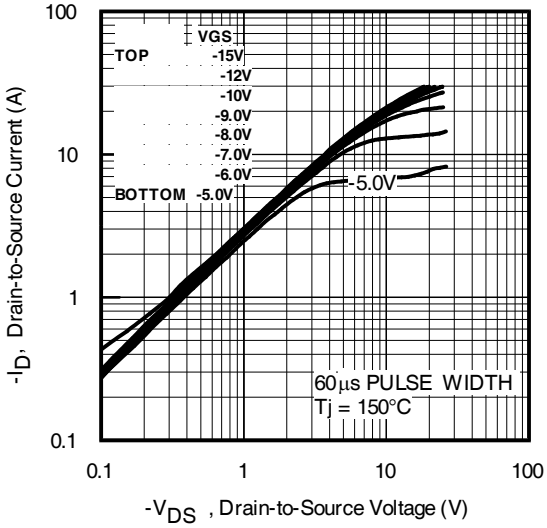



**Fig 2.** Typical Output Characteristics

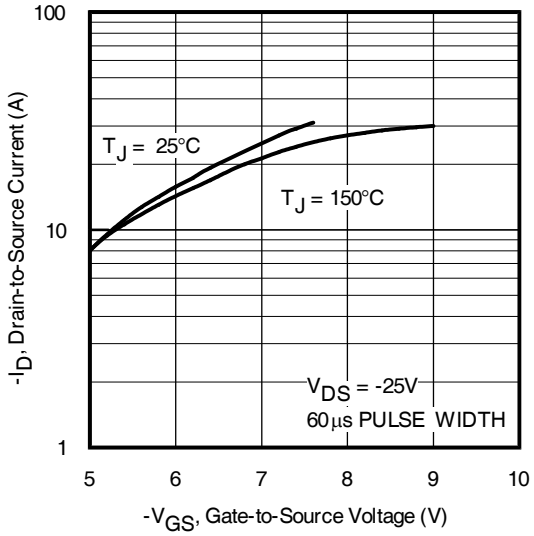



**Fig 3.** Typical Transfer Characteristics

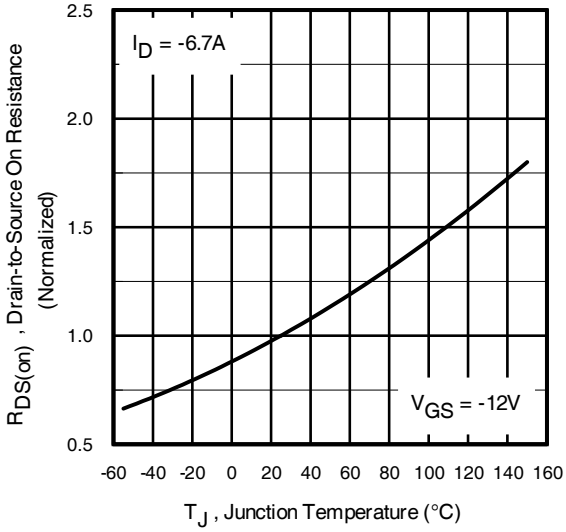



**Fig 4.** Normalized On-Resistance Vs. Temperature

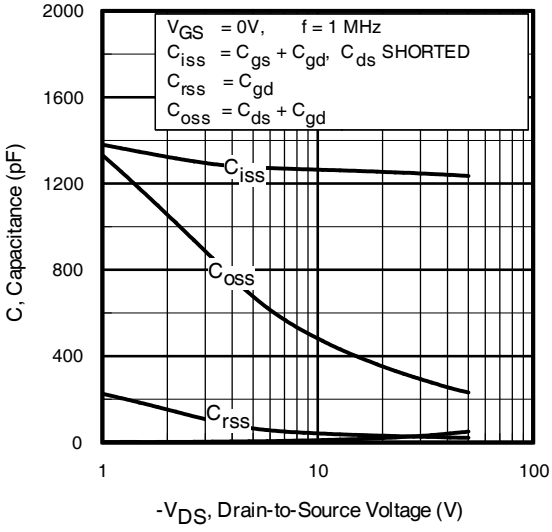



**Fig 5.** Typical Capacitance Vs. Drain-to-Source Voltage

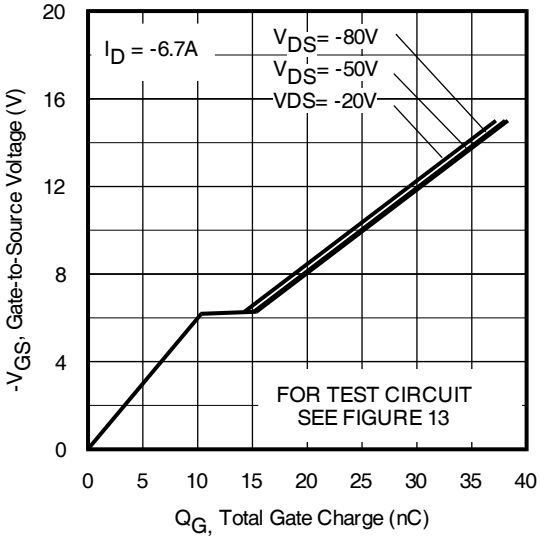



**Fig 6.** Typical Gate Charge Vs. Gate-to-Source Voltage

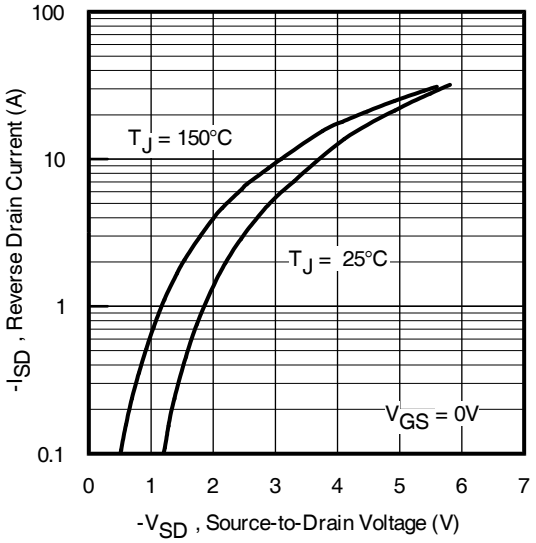



**Fig 7.** Typical Source-Drain Diode Forward Voltage

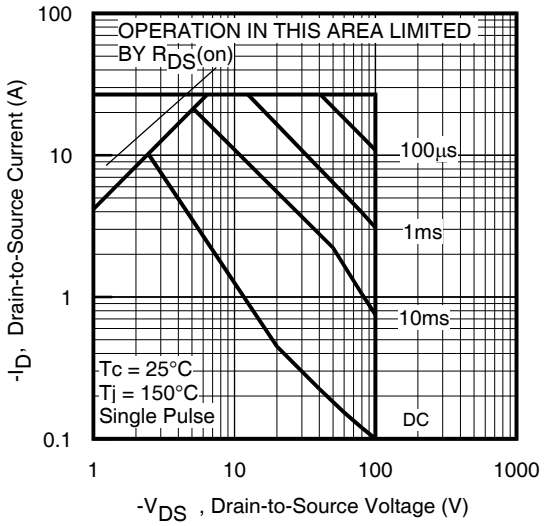



**Fig 8.** Maximum Safe Operating Area

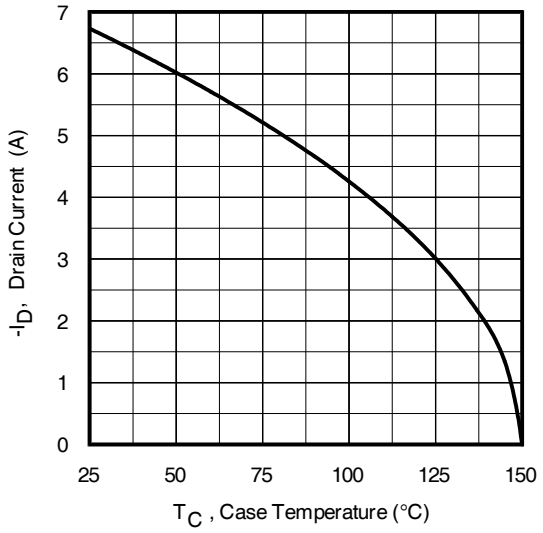



**Fig 9.** Maximum Drain Current Vs. Case Temperature

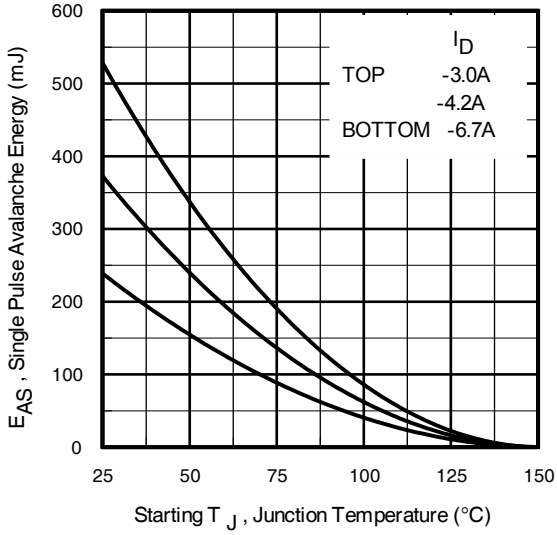



**Fig 10.** Maximum Avalanche Energy Vs. Drain Current

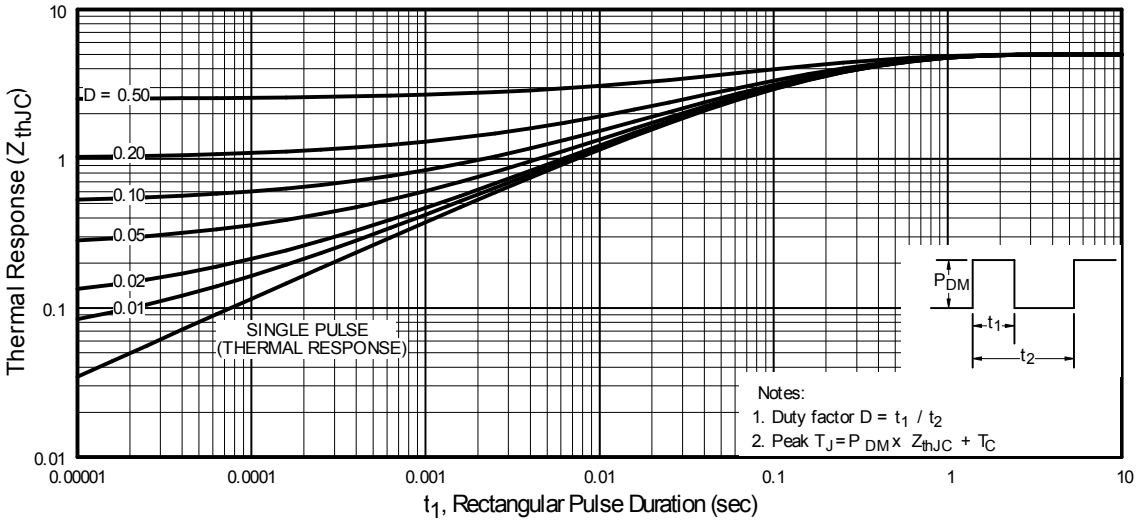



**Fig 11.** Maximum Effective Transient Thermal Impedance, Junction-to-Case

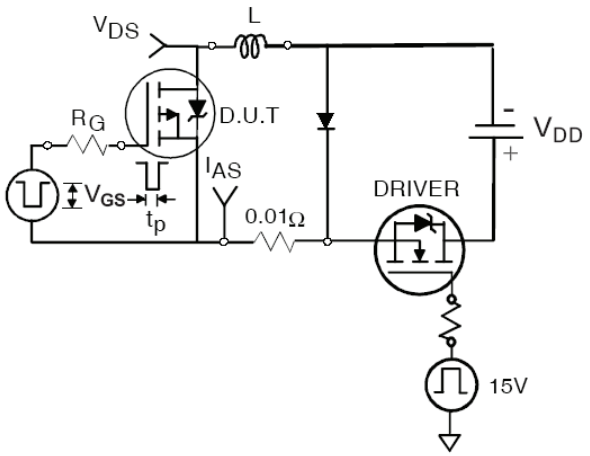



**Fig 12a.** Unclamped Inductive Test Circuit

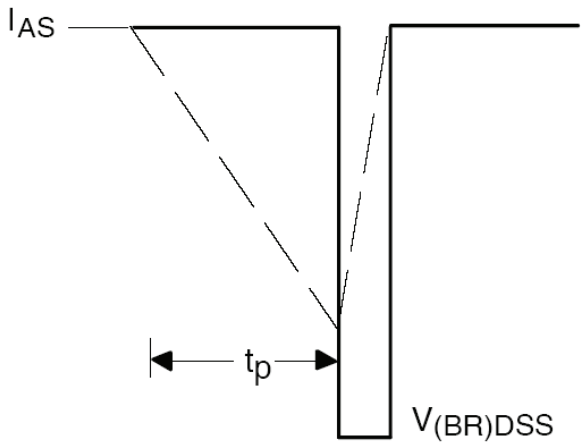



**Fig 12b.** Unclamped Inductive Waveforms

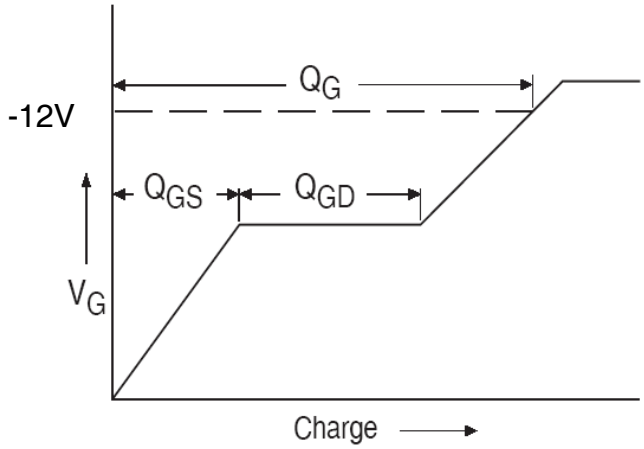



**Fig 13a.** Basic Gate Charge Waveform

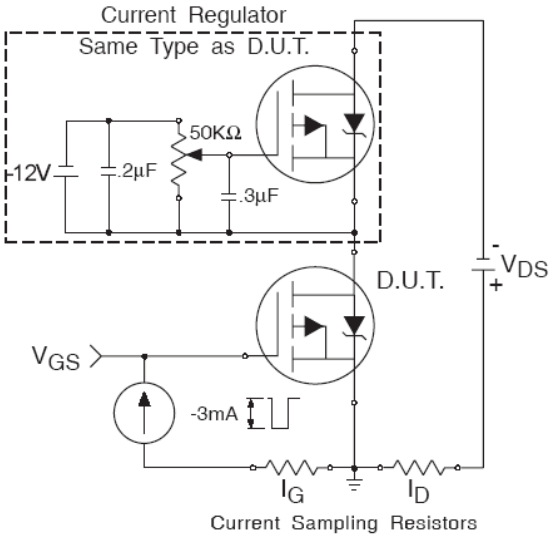



**Fig 13b.** Gate Charge Test Circuit

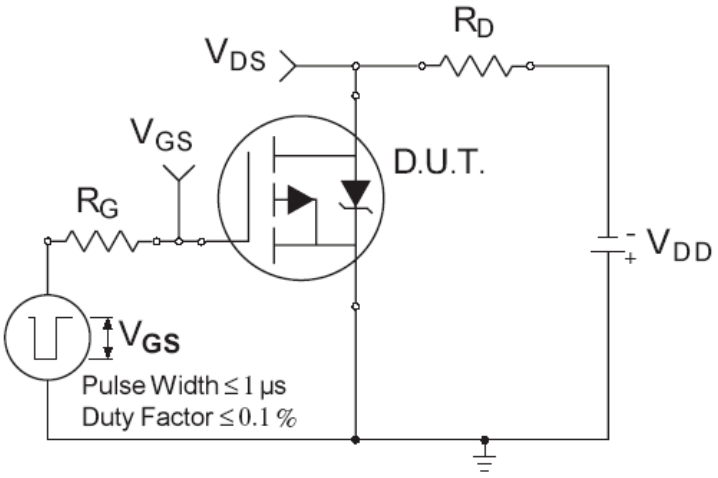



**Fig 14a.** Switching Time Test Circuit

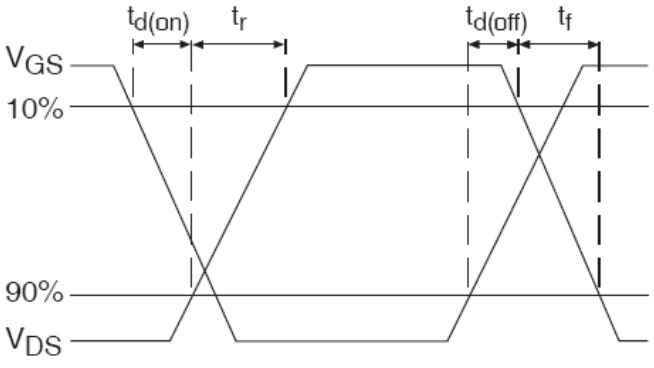
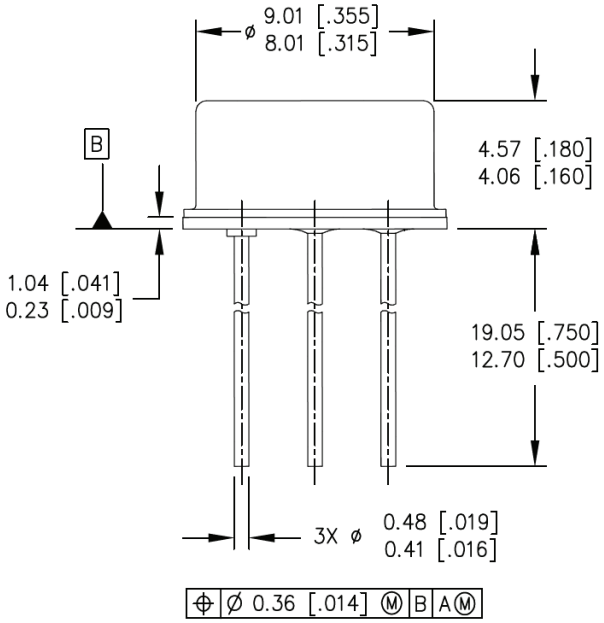
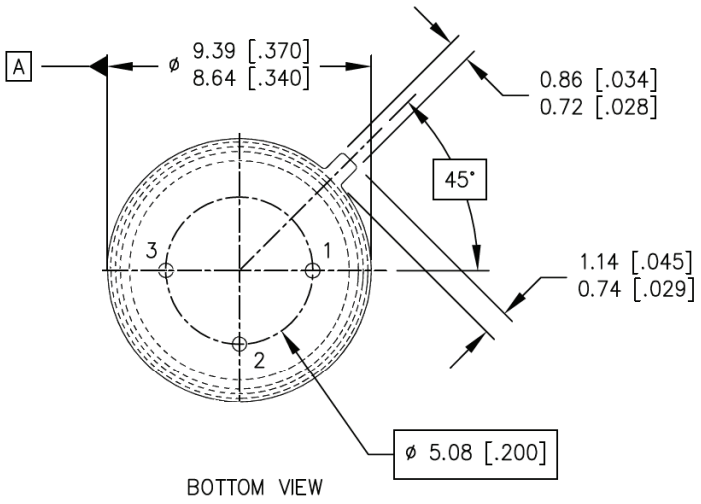



**Fig 14b.** Switching Time Waveforms

## Case Outline and Dimensions - TO-205AF (TO-39)




SIDE VIEW




BOTTOM VIEW

NOTES:

1. DIMENSIONING AND TOLERANCING PER ASME 14.5M–1994.
2. DIMENSIONS ARE SHOWN IN MILLIMETERS [INCHES].
3. CONTROLLING DIMENSION: INCH.
4. CONFORMS TO JEDEC OUTLINE TO–205AF (TO–39).

LEGEND
1- SOURCE
2- GATE
3- DRAIN (CONNECTED TO THE CASE)

**IMPORTANT NOTICE**

The information given in this document shall be in no event regarded as guarantee of conditions or characteristic. The data contained herein is a characterization of the component based on internal standards and is intended to demonstrate and provide guidance for typical part performance. It will require further evaluation, qualification and analysis to determine suitability in the application environment to confirm compliance to your system requirements.

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