IOR HiRel
An Infineon Technologies Company

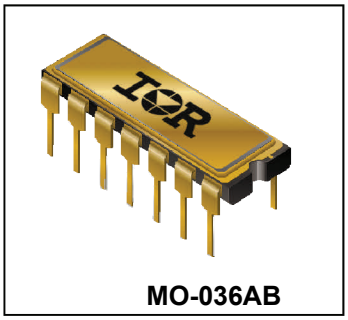
# IRHG597110

## RADIATION HARDENED POWER MOSFET THRU-HOLE (MO-036AB)

## 100V, Quad P-CHANNEL RAD-Hard™ HEXFET® TECHNOLOGY

### Product Summary

| Part Number | Radiation Level | $R_{DS(on)}$ | $I_D$ |
|---|---|---|---|
| IRHG597110 | 100 kRads(Si) | 0.96Ω | -0.96A |
| IRHG593110 | 300 kRads(Si) | 0.98Ω | -0.96A |



MO-036AB

### Description

IR HiRel RAD-Hard™ HEXFET® MOSFET Technology provides high performance power MOSFETs for space applications. This technology has over a decade of proven performance and reliability in satellite applications. These devices have been characterized for both Total Dose and Single Event Effects (SEE). The combination of low RDS (ON) and low gate charge reduces the power losses in switching applications such as DC to DC converters and motor control. 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
- Proton Tolerant
- Simple Drive Requirements
- Hermetically Sealed
- Ceramic Package
- Light Weight
- ESD Rating: Class 1A per MIL-STD-750, Method 1020

### Absolute Maximum Ratings (Per Die)

**Pre-Irradiation**

| Symbol | Parameter | Value | Units |
|---|---|---|---|
| $I_{D1}$ @ $V_{GS}$ = -12V, $T_C$ = 25°C | Continuous Drain Current | -0.96 | A |
| $I_{D2}$ @ $V_{GS}$ = -12V, $T_C$ = 100°C | Continuous Drain Current | -0.6 | |
| $I_{DM}$ @$T_C$ = 25°C | Pulsed Drain Current ① | -3.84 | |
| $P_D$ @$T_C$ = 25°C | Maximum Power Dissipation | 1.4 | W |
| | Linear Derating Factor | 0.011 | W/°C |
| $V_{GS}$ | Gate-to-Source Voltage | ± 20 | V |
| $E_{AS}$ | Single Pulse Avalanche Energy ② | 200 | mJ |
| $I_{AR}$ | Avalanche Current ① | -0.96 | A |
| $E_{AR}$ | Repetitive Avalanche Energy ① | 0.14 | mJ |
| dv/dt | Peak Diode Recovery dv/dt ③ | 7.1 | V/ns |
| $T_J$<br>$T_{STG}$ | Operating Junction and Storage Temperature Range | -55 to + 150 | °C |
| | Lead Temperature | 300 (0.063 in. /1.6 mm from case for 10s) | |
| | Weight | 1.3 (Typical) | g |

For Footnotes, refer to the page 2.

## Electrical Characteristics For Each N-Channel Device @ 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 | — | -0.14 | — | V/°C | Reference to 25°C, $I_D$ = -1.0mA |
| $R_{DS(on)}$ | Static Drain-to-Source On-Resistance | — | — | 0.96 | Ω | $V_{GS}$ = -12V, $I_{D2}$ = -0.6A ④ |
| $V_{GS(th)}$ | Gate Threshold Voltage | -2.0 | — | -4.0 | V | $V_{DS}$ = $V_{GS}$, $I_D$ = -1.0mA |
| Gfs | Forward Transconductance | 1.1 | — | — | S | $V_{DS}$ = -15V, $I_{D2}$ = -0.6A 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 | — | — | 13.4 | nC | $I_{D1}$ = -0.96A |
| $Q_{GS}$ | Gate-to-Source Charge | — | — | 3.7 | | $V_{DS}$ = -50V |
| $Q_{GD}$ | Gate-to-Drain ('Miller') Charge | — | — | 3.0 | | $V_{GS}$ = -12V |
| $t_{d(on)}$ | Turn-On Delay Time | — | — | 21 | ns | $V_{DD}$ = -50V |
| tr | Rise Time | — | — | 17 | | $I_{D1}$ = -0.96A |
| $t_{d(off)}$ | Turn-Off Delay Time | — | — | 40 | | $R_G$ = 7.5Ω |
| $t_f$ | Fall Time | — | — | 90 | | $V_{GS}$ = -12V |
| Ls +$L_D$ | Total Inductance | — | 10 | — | nH | Measured from Drain lead (6mm / 0.25 in 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 | — | 390 | — | pF | $V_{GS}$ = 0V |
| $C_{oss}$ | Output Capacitance | — | 100 | — | | $V_{DS}$ = -25V |
| $C_{rss}$ | Reverse Transfer Capacitance | — | 7.0 | — | | $f$ = 1.0MHz |

## Source-Drain Diode Ratings and Characteristics (Per Die)

| Symbol | Parameter | Min. | Typ. | Max. | Units | Test Conditions |
|---|---|---|---|---|---|---|
| $I_S$ | Continuous Source Current (Body Diode) | — | — | -0.96 | A | |
| $I_{SM}$ | Pulsed Source Current (Body Diode) ① | — | — | -3.84 | | |
| $V_{SD}$ | Diode Forward Voltage | — | — | -5.0 | V | $T_J$ =25°C,$I_S$ = -0.96A, $V_{GS}$ = 0V④ |
| $t_{rr}$ | Reverse Recovery Time | — | — | 86 | ns | $T_J$ = 25°C, $I_F$ =-0.96A, $V_{DD}$ ≤ -25V ,di/dt = -100A/µs ④ |
| $Q_{rr}$ | Reverse Recovery Charge | — | — | 240 | nC | |
| $t_{on}$ | Forward Turn-On Time | Intrinsic turn-on time is negligible (turn-on is dominated by $L_S$+$L_D$) | | | | |

## Thermal Resistance (Per Die)

| Symbol | Parameter | Min. | Typ. | Max. | Units |
|---|---|---|---|---|---|
| $R_{\theta JA}$ | Junction-to-Ambient (Typical socket mount) | — | — | 90 | °C/W |

**Footnotes:**

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

② $V_{DD}$ = -25V, starting $T_J$ = 25°C, L = 430mH, Peak $I_L$ = -0.96A, $V_{GS}$ = -12V

③ $I_{SD}$ ≤ -0.96A, di/dt ≤ -290A/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.

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 (Per Die)

| 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 | -4.0 | 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) | —— | 0.916 | —— | 0.936 | Ω | $V_{GS}$ = -12V, $I_{D2}$ = -0.6A |
| $R_{DS(on)}$ | Static Drain-to-Source ④ On-State Resistance (MO-036AB) | —— | 0.96 | —— | 0.98 | Ω | $V_{GS}$ = -12V, $I_{D2}$ = -0.6A |
| $V_{SD}$ | Diode Forward Voltage④ | —— | -3.5 | —— | -3.5 | V | $V_{GS}$ = 0V, $I_S$ = -0.96A |

1. Part number IRHG597110
2. Part numbers IRHG593110

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 (Per Die)

| LET (MeV/(mg/cm²)) | 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 | —— |

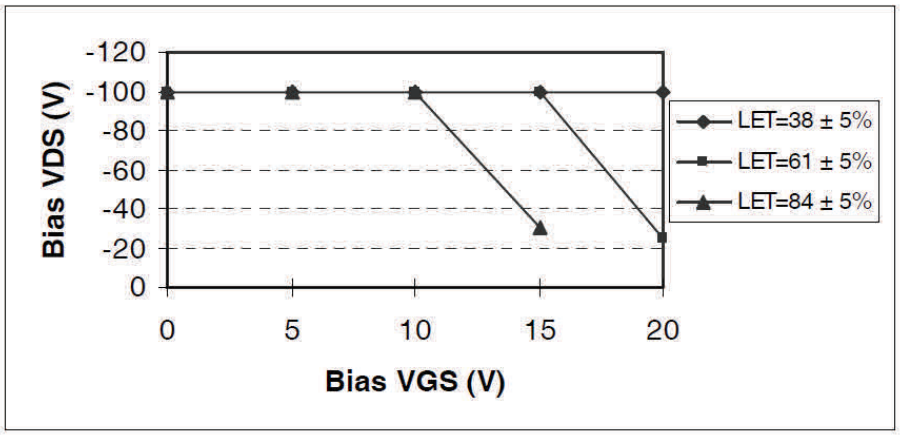



**Fig a.** Typical Single Event Effect, Safe Operating Area

For Footnotes, refer to the page 2.

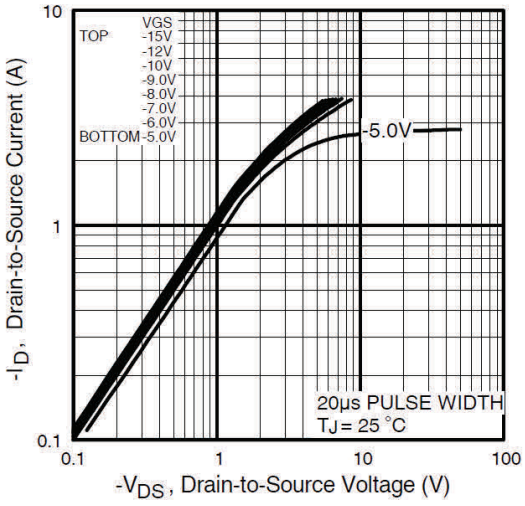



**Fig 1.** Typical Output Characteristics

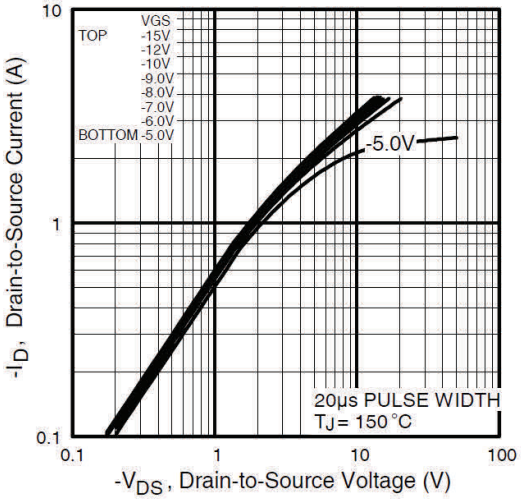



**Fig 2.** Typical Output Characteristics

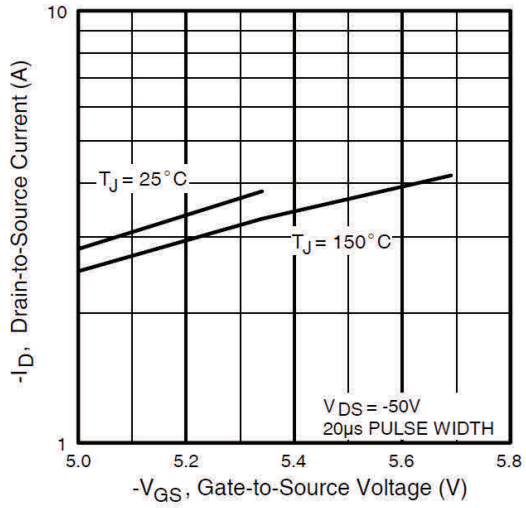



**Fig 3.** Typical Transfer Characteristics

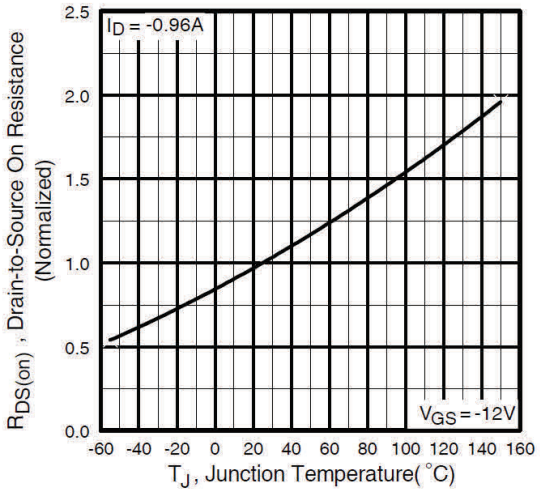



**Fig 4.** Normalized On-Resistance Vs. Temperature

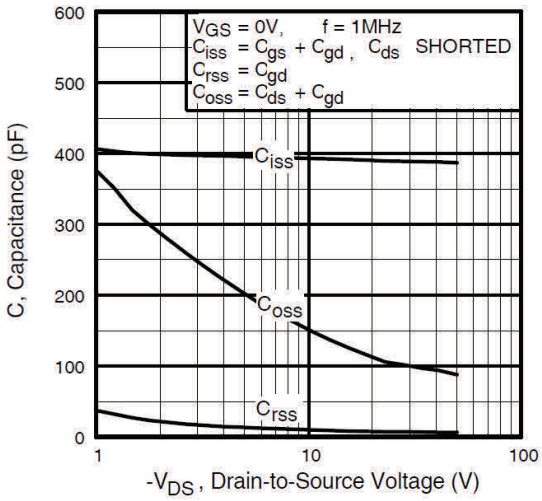



**Fig 5.** Typical Capacitance Vs. Drain-to-Source Voltage

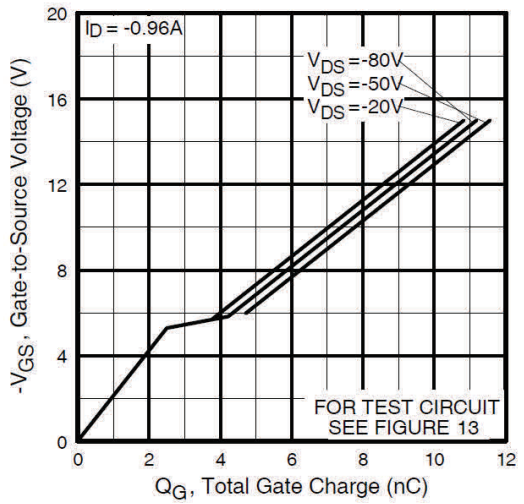



**Fig 6.** Typical Gate Charge Vs. Gate-to-Source Voltage

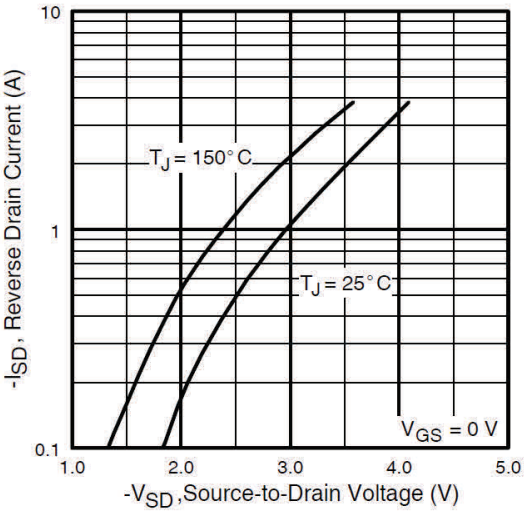



**Fig 7.** Typical Source-Drain Diode Forward Voltage

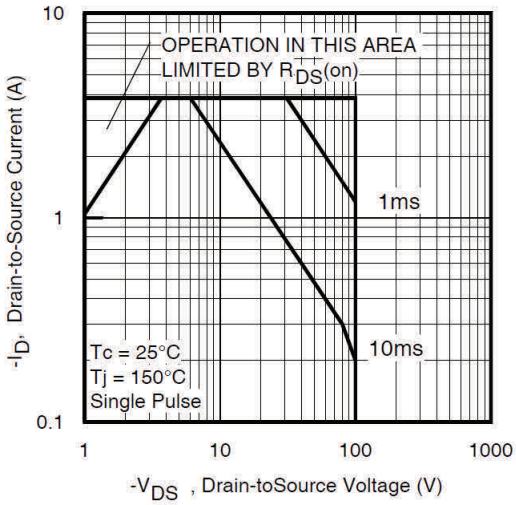



**Fig 8.** Maximum Safe Operating Area

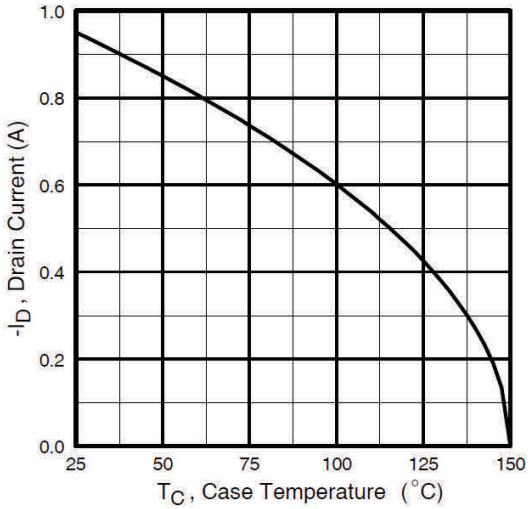



**Fig 9.** Maximum Drain Current Vs. Case Temperature

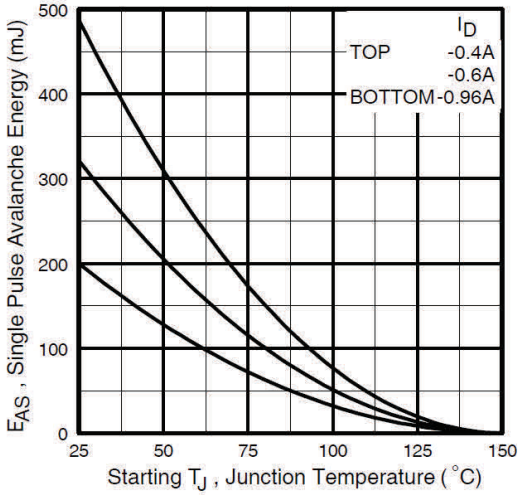



**Fig 10.** Maximum Avalanche Energy Vs. Drain Current

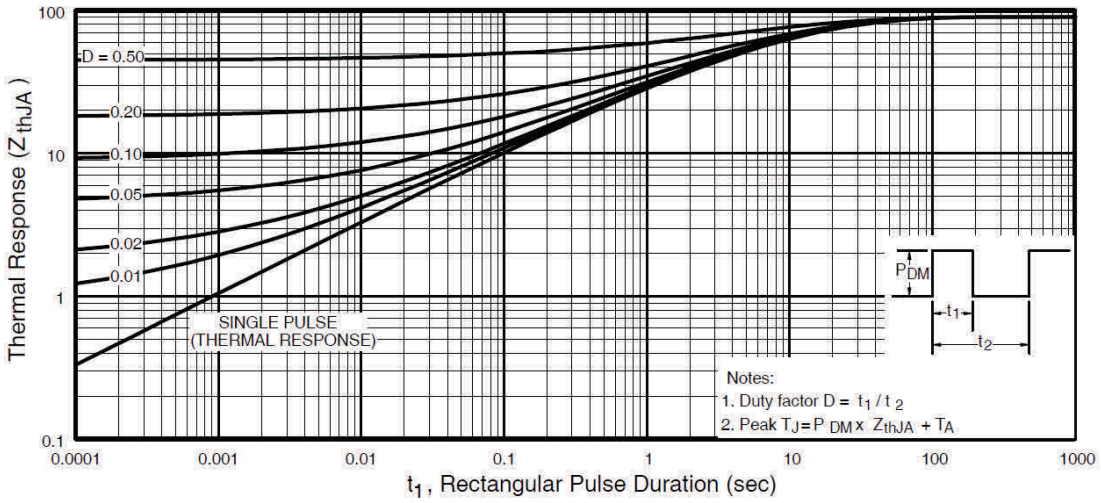



**Fig 11.** Maximum Effective Transient Thermal Impedance, Junction-to-Ambient

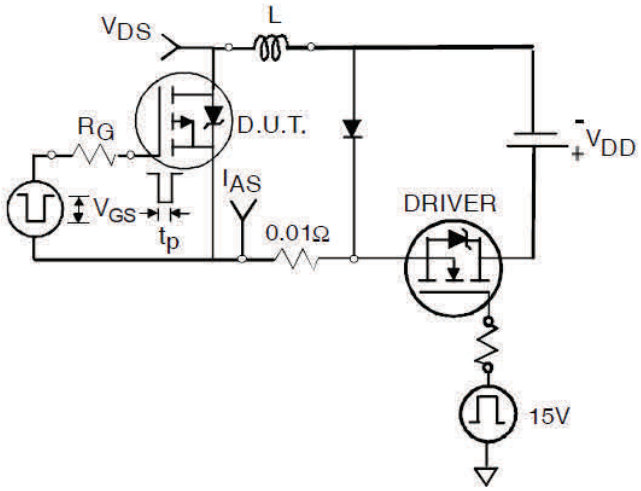



**Fig 12a.** Unclamped Inductive Test Circuit

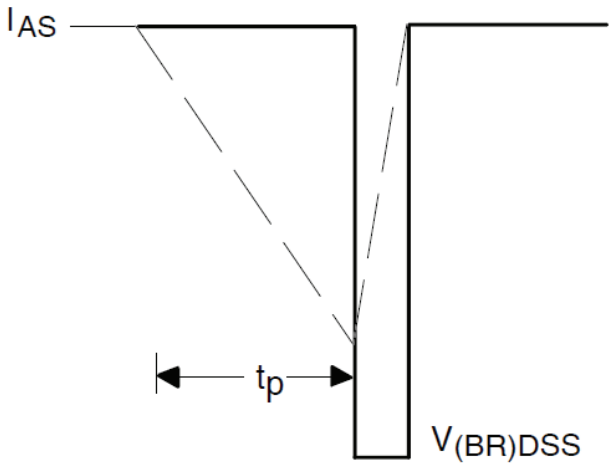



**Fig 12b.** Unclamped Inductive Waveforms

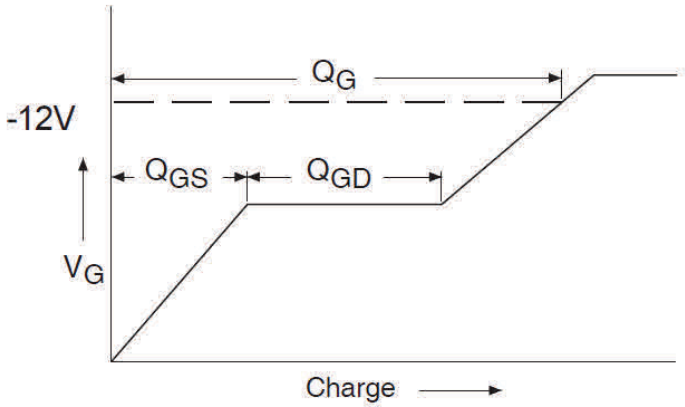



**Fig 13a.** Gate Charge Waveform

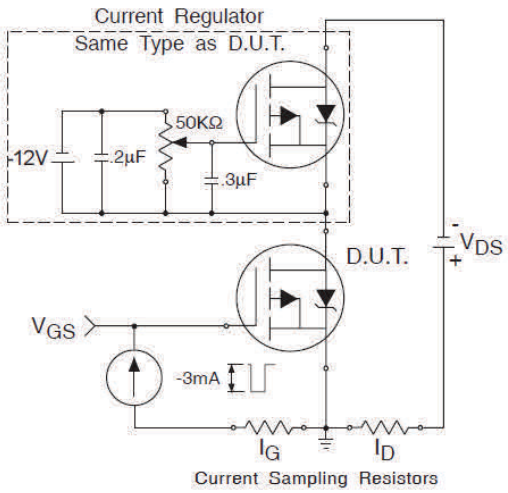



**Fig 13b.** Gate Charge Test Circuit

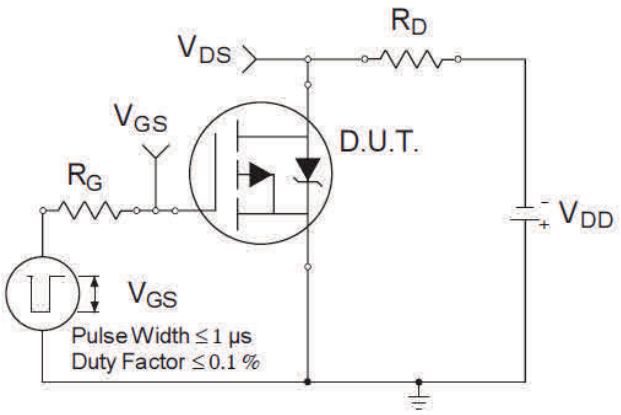



**Fig 14a.** Switching Time Test Circuit

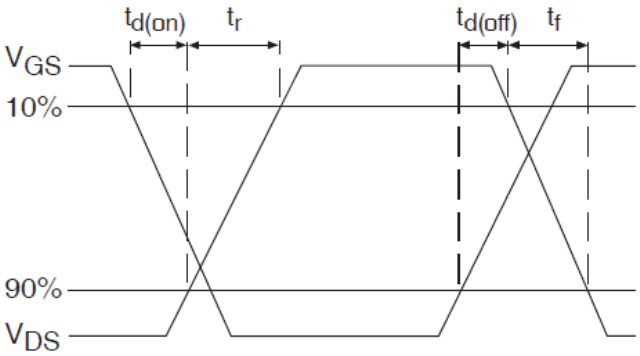
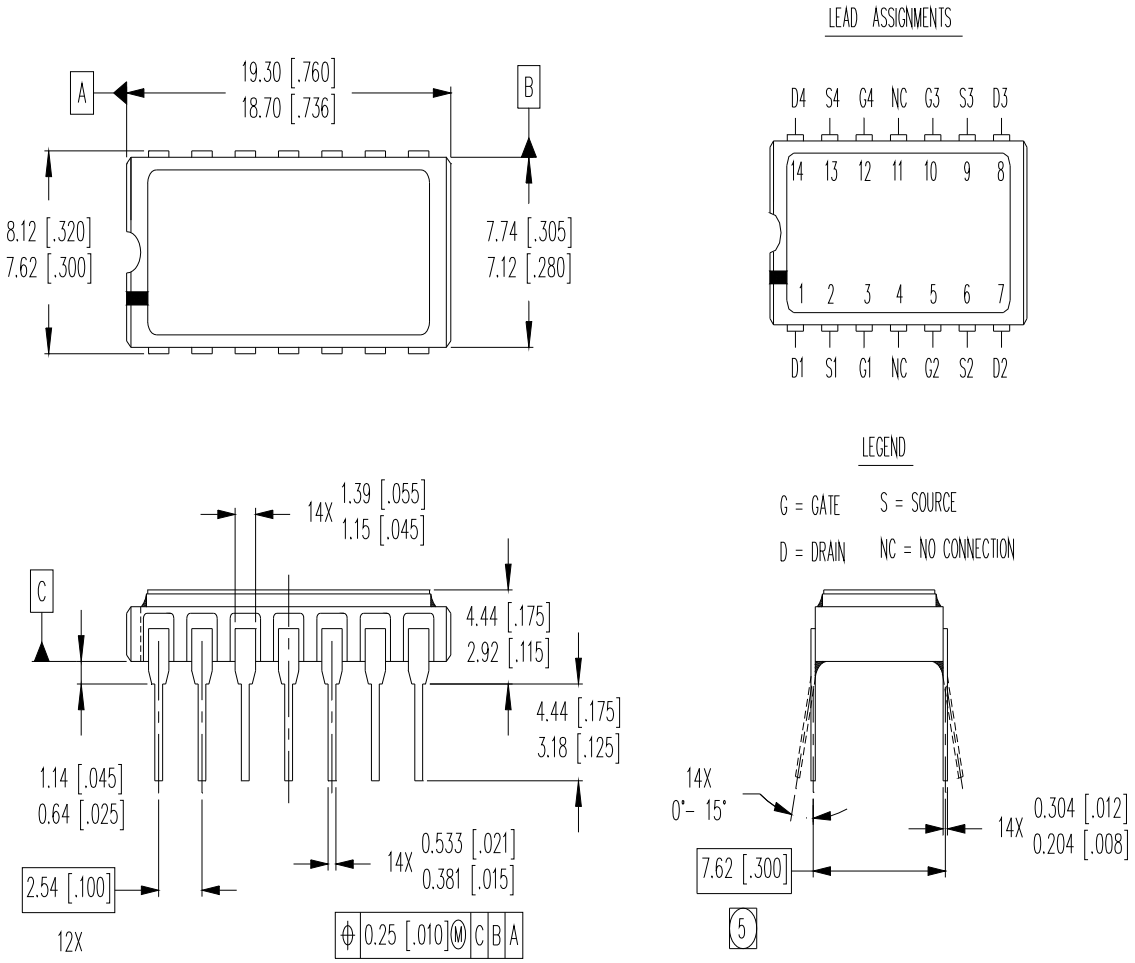



**Fig 14b.** Switching Time Waveforms

## Case Outline and Dimensions - MO-036AB




NOTES:

1. DIMENSIONING & TOLERANCING PER ASME Y14.5M–1994.
2. CONTROLLING DIMENSION: INCH.
3. DIMENSIONS ARE SHOWN IN MILLIMETERS [INCHES].
4. OUTLINE CONFORMS TO JEDEC OUTLINE MO–036AB.
5. MEASURED WITH THE LEADS CONSTRAINED TO BE PERPENDICULAR TO DATUM PLANE C.

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