

IRFD1Z0, IRFD1Z1, IRFD1Z2, IRFD1Z3

0.4A and 0.5A, 60V and 100V, 2.4 and 3.2 Ohm,
N-Channel Power MOSFETs

July 1998

Features

- 0.4A and 0.5A, 60V and 100V
- $r_{DS(ON)} = 2.4\Omega$ and 3.2Ω
- SOA is Power Dissipation Limited
- Nanosecond Switching Speeds
- Linear Transfer Characteristics
- High Input Impedance
- Majority Carrier Device
- Related Literature
 - TB334 "Guidelines for Soldering Surface Mount Components to PC Boards"

Ordering Information

| PART NUMBER | PACKAGE | BRAND |
|-------------|---------|---------|
| IRFD1Z0 | HEXDIP | IRFD1Z0 |
| IRFD1Z1 | HEXDIP | IRFD1Z1 |
| IRFD1Z2 | HEXDIP | IRFD1Z2 |
| IRFD1Z3 | HEXDIP | IRFD1Z3 |

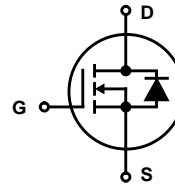
NOTE: When ordering, use the entire part number.

Description

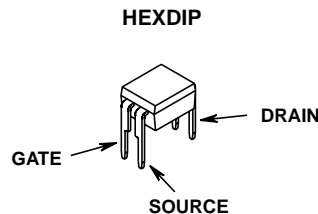
These are N-Channel enhancement mode silicon gate power field effect transistors designed for applications such as switching regulators, switching converters, motor drivers, relay drivers, and drivers for high power bipolar switching transistors requiring high speed and low gate drive power. They can be operated directly from integrated circuits.

Formerly developmental type TA17451.

Symbol



Packaging



IRFD1Z0, IRFD1Z1, IRFD1Z2, IRFD1Z3

Absolute Maximum Ratings $T_C = 25^\circ\text{C}$, Unless Otherwise Specified

| | IRFD1Z0 | IRFD1Z1 | IRFD1Z2 | IRFD1Z3 | UNITS | |
|-------------------------------------------------------------------|----------------|------------|------------|------------|------------|--------------------|
| Drain to Source (Note 1) | V_{DS} | 100 | 60 | 100 | 60 | V |
| Drain to Gate Voltage ($R_{GS} = 20k\Omega$) (Note 1) | V_{DGR} | 100 | 60 | 100 | 60 | V |
| Continuous Drain Current | I_D | 0.5 | 0.5 | 0.4 | 0.4 | A |
| Pulsed Drain Current | I_{DM} | 4.0 | 4.0 | 3.2 | 3.2 | A |
| Gate to Source Voltage | V_{GS} | ± 20 | ± 20 | ± 20 | ± 20 | V |
| Maximum Power Dissipation | P_D | 1.0 | 1.0 | 1.0 | 1.0 | W |
| Linear Derating Factor (See Figure 1) | | 0.008 | 0.008 | 0.008 | 0.008 | $W/^\circ\text{C}$ |
| Operating and Storage Temperature | T_J, T_{STG} | -55 to 150 | -55 to 150 | -55 to 150 | -55 to 150 | $^\circ\text{C}$ |
| Maximum Temperature for Soldering | | | | | | |
| Leads at 0.063in (1.6mm) from Case for 10s | T_L | 300 | 300 | 300 | 300 | $^\circ\text{C}$ |
| Package Body for 10s, See Techbrief 334 | T_{pkg} | 260 | 260 | 260 | 260 | $^\circ\text{C}$ |

CAUTION: Stresses above those listed in "Absolute Maximum Ratings" may cause permanent damage to the device. This is a stress only rating and operation of the device at these or any other conditions above those indicated in the operational sections of this specification is not implied.

NOTE:

- $T_J = 25^\circ\text{C}$ to 125°C .

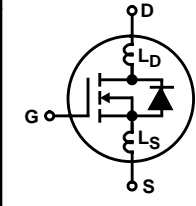
Electrical Specifications $T_C = 25^\circ\text{C}$, Unless Otherwise Specified

| PARAMETER | SYMBOL | TEST CONDITIONS | MIN | TYP | MAX | UNITS |
|------------------------------------------------------------|--------------|----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|------|------|-----------|---------------|
| Drain to Source Breakdown Voltage IRFD1Z0, IRFD1Z2 | BV_{DSS} | $I_D = 250\mu\text{A}, V_{GS} = 0\text{V}$ (See Figure 9) | 100 | - | - | V |
| | | | 60 | - | - | V |
| IRFD1Z1, IRFD1Z3 | | | | | | |
| Gate Threshold Voltage | $V_{GS(TH)}$ | $V_{GS} = V_{DS}, I_D = 250\mu\text{A}$ | 2.0 | - | 4.0 | V |
| Zero Gate Voltage Drain Current | I_{DSS} | $V_{DS} = \text{Rated } BV_{DSS}, V_{GS} = 0\text{V}$ | - | - | 25 | μA |
| | | $V_{DS} = 0.8 \times \text{Rated } BV_{DSS}, V_{GS} = 0\text{V}, T_C = 125^\circ\text{C}$ | - | - | 250 | μA |
| On-State Drain Current (Note 2) IRFD1Z0, IRFD1Z1 | $I_{D(ON)}$ | $V_{DS} > I_{D(ON)} \times r_{DS(ON)MAX}, V_{GS} = 10\text{V}$ (See Figure 6) | 0.5 | - | - | A |
| | | | 0.4 | - | - | A |
| IRFD1Z2, IRFD1Z3 | | | | | | |
| Gate to Source Leakage Current | I_{GSS} | $V_{GS} = \pm 20\text{V}$ | - | - | ± 100 | nA |
| Drain to Source On Resistance (Note 2) IRFD1Z0, IRFD1Z1 | $r_{DS(ON)}$ | $I_D = 0.25\text{A}, V_{GS} = 10\text{V}$ (See Figures 7, 8) | - | 2.2 | 2.4 | Ω |
| | | | - | 2.8 | 3.2 | Ω |
| IRFD1Z2, IRFD1Z3 | | | | | | |
| Forward Transconductance (Note 2) | g_{fs} | $V_{DS} > I_{D(ON)} \times r_{DS(ON)MAX}, I_D = 0.25\text{A}$ | 0.25 | 0.35 | - | S |
| Turn-On Delay Time | $t_{d(ON)}$ | $V_{DD} \equiv 0.5 \times \text{Rated } BV_{DSS}, I_D = 0.25\text{A}, R_G = 50\Omega$ (Figures 14, 15, 16) $R_L = 198\Omega$ for $BV_{DSS} = 100\text{V}$ $R_L = 118\Omega$ for $BV_{DSS} = 60\text{V}$ MOSFET Switching Times are Essentially Independent of Operating Temperature | - | 10 | 20 | ns |
| Rise Time | t_r | | - | 15 | 25 | ns |
| Turn-Off Delay Time | $t_{d(OFF)}$ | | - | 15 | 25 | ns |
| Fall Time | t_f | | - | 10 | 20 | ns |
| Total Gate Charge (Gate to Source + Gate to Drain) | $Q_{g(TOT)}$ | $V_{GS} = 10\text{V}, I_D = 1.2\text{A}, V_{DS} = 0.8 \times \text{Rated } BV_{DSS}$ (Figures 13, 16, 17) Gate Charge is Essentially Independent of Operating Temperature | - | 2.0 | 3.0 | nC |
| Gate to Source Charge | Q_{gs} | | - | 1.0 | - | nC |
| Gate to Drain "Miller" Charge | Q_{gd} | | - | 1.0 | - | nC |
| Input Capacitance | C_{ISS} | $V_{GS} = 0\text{V}, V_{DS} = 25\text{V}, f = 1\text{MHz}$ (Figure 10) | - | 50 | - | pF |
| Output Capacitance | C_{OSS} | | - | 20 | - | pF |
| Reverse Transfer Capacitance | C_{RSS} | | - | 5 | - | pF |

IRFD1Z0, IRFD1Z1, IRFD1Z2, IRFD1Z3

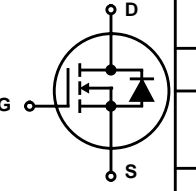
Electrical Specifications $T_C = 25^\circ\text{C}$, Unless Otherwise Specified (Continued)

| PARAMETER | SYMBOL | TEST CONDITIONS | MIN | TYP | MAX | UNITS |
|----------------------------------------|-----------------|-------------------------------------------------------------------------------|-----|-----|-----|---------------------------|
| Internal Drain Inductance | L_D | Measured From The Drain Lead, 2mm (0.08in) From Package to Center of Die | - | 4.0 | - | nH |
| Internal Source Inductance | L_S | Measured From The Source Lead, 2mm (0.08in) From Header to Source Bonding Pad | - | 6.0 | - | nH |
| Thermal Resistance Junction to Ambient | $R_{\theta JA}$ | Free Air Operation | - | - | 120 | $^\circ\text{C}/\text{W}$ |



Source to Drain Diode Specifications

| PARAMETER | SYMBOL | TEST CONDITIONS | MIN | TYP | MAX | UNITS |
|------------------------------------------------------------|-----------|---------------------------------------------------------------------------------------------|-----|-----|-----|---------------|
| Continuous Source to Drain Current IRFD1Z0, IRFD1Z1 | I_{SD} | Modified MOSFET Symbol Showing the Integral Reverse P-N Junction Diode | - | - | 0.5 | A |
| IRFD1Z2, IRFD1Z3 | | | - | - | 0.4 | A |
| Pulse Source to Drain Current IRFD1Z0, IRFD1Z1 | I_{SDM} | | - | - | 4.0 | A |
| IRFD1Z2, IRFD1Z3 | | | - | - | 3.2 | A |
| Source to Drain Diode Voltage (Note 2) IRFD1Z0, IRFD1Z1 | V_{SD} | $T_A = 25^\circ\text{C}$, $I_{SD} = 0.5\text{A}$, $V_{GS} = 0\text{V}$ | - | - | 1.4 | V |
| IRFD1Z2, IRFD1Z3 | | $T_A = 25^\circ\text{C}$, $I_{SD} = 0.4\text{A}$, $V_{GS} = 0\text{V}$ | - | - | 1.3 | V |
| Reverse Recovery Time | t_{rr} | $T_J = 150^\circ\text{C}$, $I_{SD} = 0.5\text{A}$, $dI_{SD}/dt = 100\text{A}/\mu\text{s}$ | - | 100 | - | ns |
| Reverse Recovery Charge | Q_{RR} | $T_J = 150^\circ\text{C}$, $I_{SD} = 0.5\text{A}$, $dI_{SD}/dt = 100\text{A}/\mu\text{s}$ | - | 0.2 | - | μC |



NOTES:

2. Pulse test: pulse width $\leq 300\mu\text{s}$, duty cycle $\leq 2\%$.
3. Repetitive rating: pulse width limited by maximum junction temperature.

Typical Performance Curves Unless Otherwise Specified

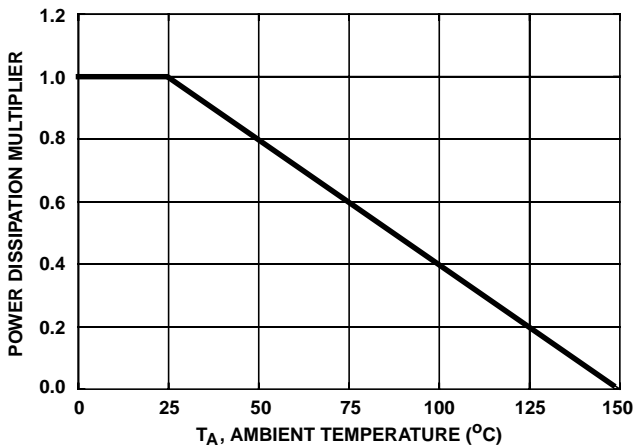


FIGURE 1. NORMALIZED POWER DISSIPATION vs AMBIENT TEMPERATURE

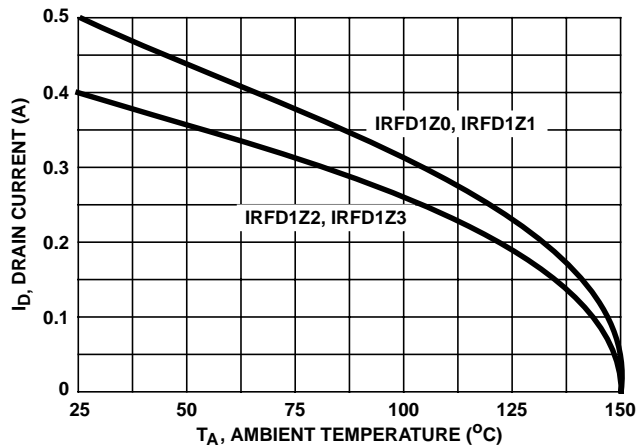


FIGURE 2. MAXIMUM CONTINUOUS DRAIN CURRENT vs AMBIENT TEMPERATURE

IRFD1Z0, IRFD1Z1, IRFD1Z2, IRFD1Z3

Typical Performance Curves Unless Otherwise Specified (Continued)

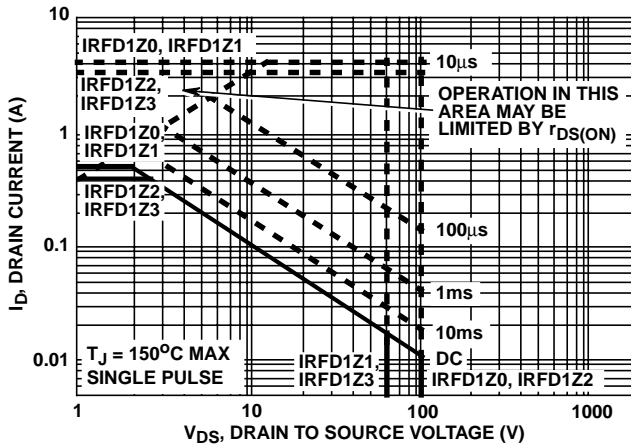


FIGURE 3. FORWARD BIAS SAFE OPERATING AREA

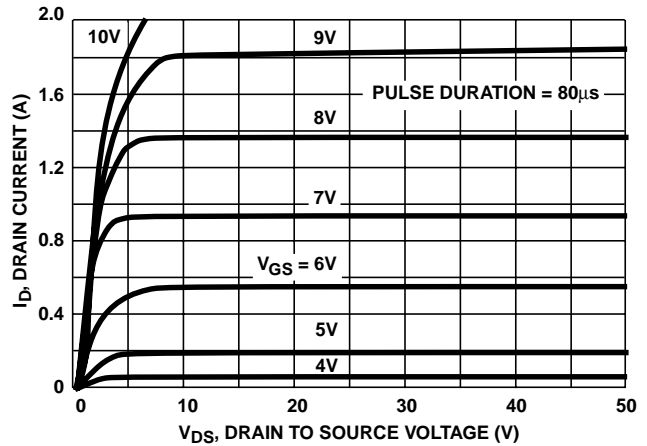


FIGURE 4. OUTPUT CHARACTERISTICS

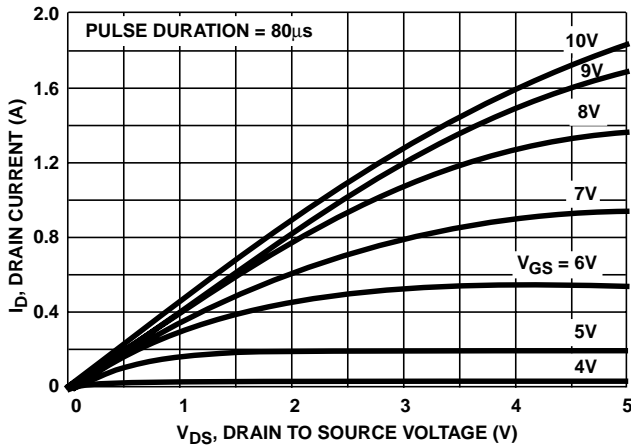


FIGURE 5. SATURATION CHARACTERISTICS

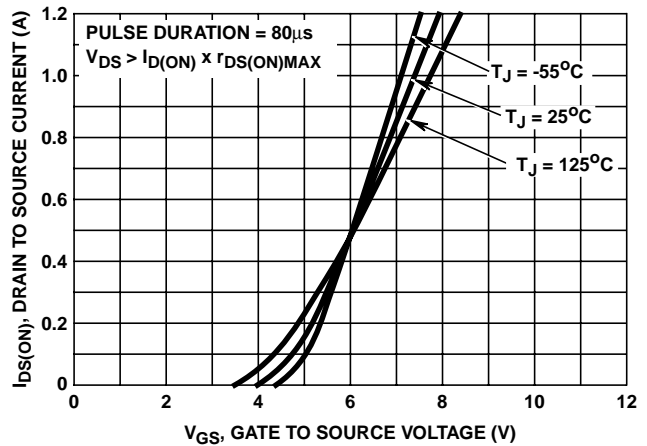
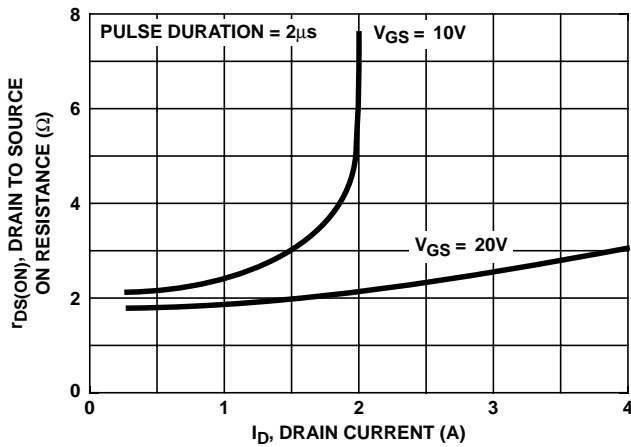


FIGURE 6. TRANSFER CHARACTERISTICS



NOTE: Heating effect of 2µs pulse is minimal.

FIGURE 7. DRAIN TO SOURCE ON RESISTANCE vs GATE VOLTAGE AND DRAIN CURRENT

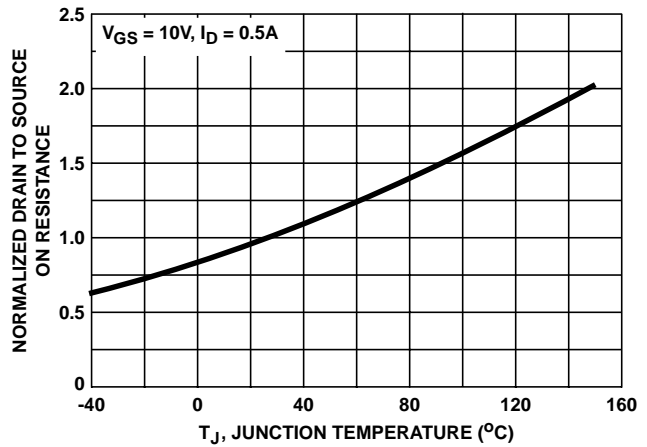


FIGURE 8. NORMALIZED DRAIN TO SOURCE ON RESISTANCE vs JUNCTION TEMPERATURE

IRFD1Z0, IRFD1Z1, IRFD1Z2, IRFD1Z3

Typical Performance Curves Unless Otherwise Specified (Continued)

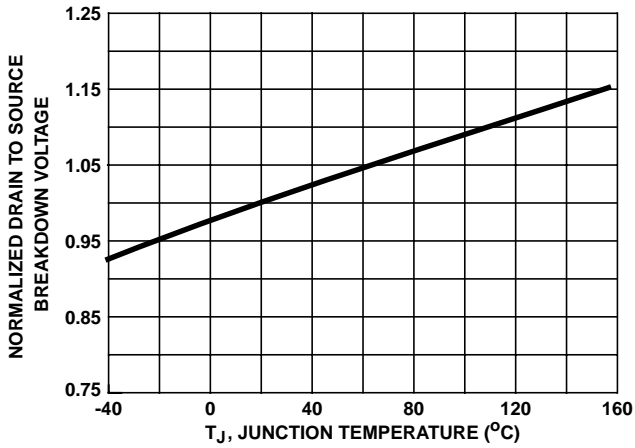


FIGURE 9. NORMALIZED DRAIN TO SOURCE BREAKDOWN VOLTAGE vs JUNCTION TEMPERATURE

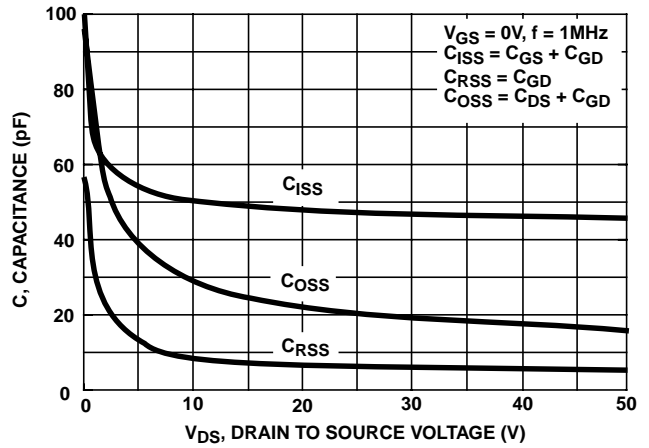


FIGURE 10. CAPACITANCE vs DRAIN TO SOURCE VOLTAGE

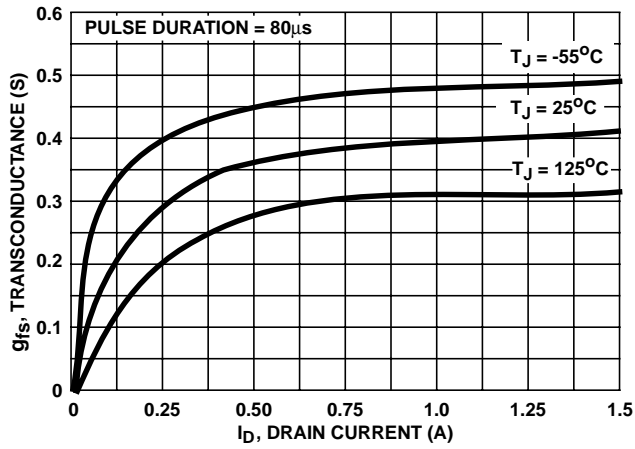


FIGURE 11. TRANSCONDUCTANCE vs DRAIN CURRENT

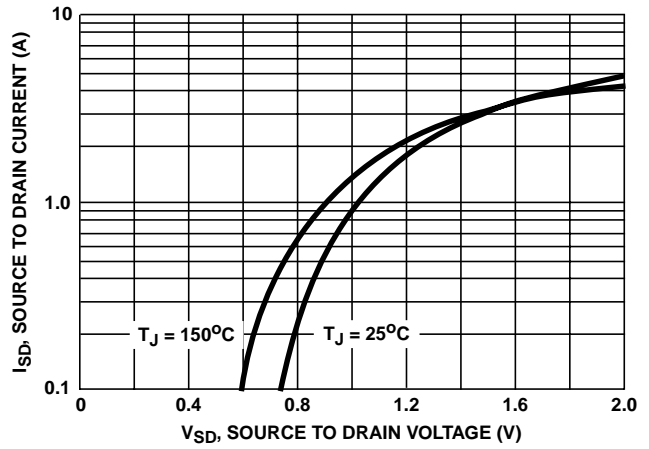


FIGURE 12. SOURCE TO DRAIN DIODE VOLTAGE

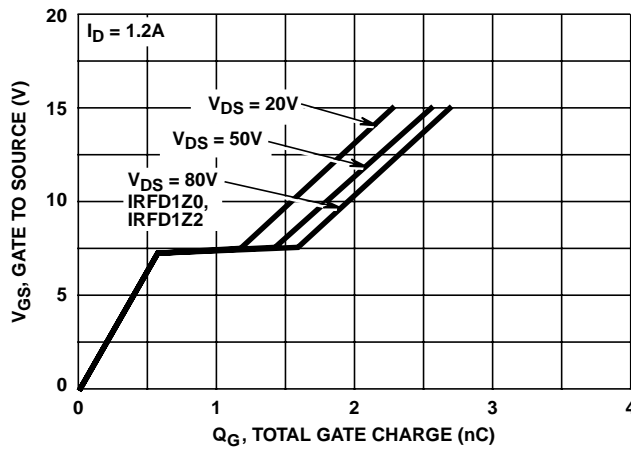


FIGURE 13. GATE TO SOURCE VOLTAGE vs GATE VOLTAGE

Test Circuits and Waveforms

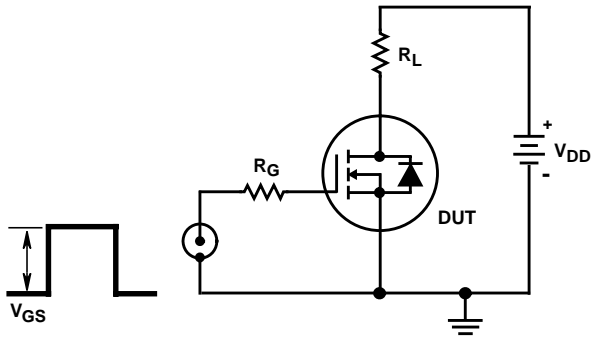


FIGURE 14. SWITCHING TIME TEST CIRCUIT

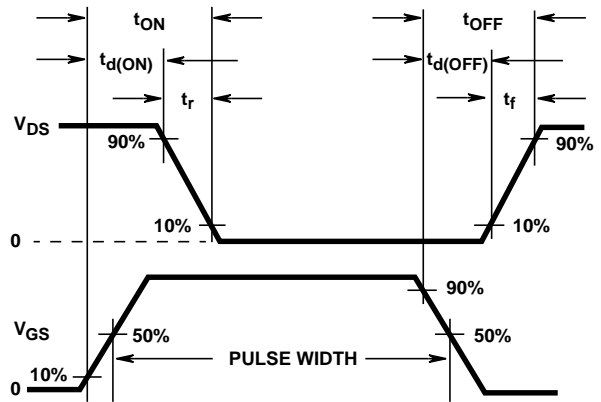


FIGURE 15. RESISTIVE SWITCHING WAVEFORMS

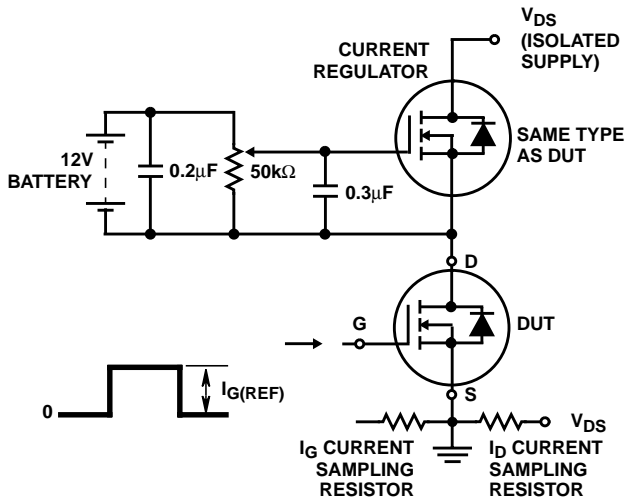


FIGURE 16. GATE CHARGE TEST CIRCUIT

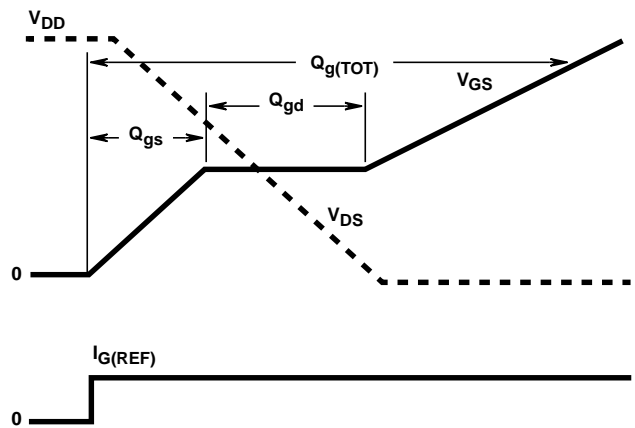


FIGURE 17. GATE CHARGE WAVEFORMS