

# IRFD320, IRFD321, IRFD322, IRFD323

0.5A and 0.4A, 350V and 400V, 1.8 and 2.5 Ohm,  
N-Channel Power MOSFETs

January 1998

## Features

- 0.5A and 0.4A, 350V and 400V
- $r_{DS(ON)} = 1.8\Omega$  and  $2.5\Omega$
- Single Pulse Avalanche Energy Rated
- SOA is Power Dissipation Limited
- Nanosecond Switching Speeds
- Linear Transfer Characteristics
- High Input Impedance
- Related Literature
  - TB334 "Guidelines for Soldering Surface Mount Components to PC Boards"

## Ordering Information

PART NUMBER	PACKAGE	BRAND
IRFD320	HEXDIP	IRFD320
IRFD321	HEXDIP	IRFD321
IRFD322	HEXDIP	IRFD322
IRFD323	HEXDIP	IRFD323

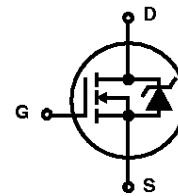
NOTE: When ordering, use the entire part number.

## Description

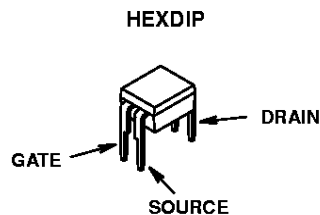
These are N-Channel enhancement mode silicon gate power field effect transistors. They are advanced power MOSFETs designed, tested, and guaranteed to withstand a specified level of energy in the breakdown avalanche mode of operation. All of these power MOSFETs are designed for applications such as switching regulators, switching converters, motor drivers, relay drivers, and drivers for high power bipolar switching transistors requiring high speed and low gate drive power. These types can be operated directly from integrated circuits.

Formerly developmental type TA17404.

## Symbol



## Packaging



## IRFD320, IRFD321, IRFD322, IRFD323

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

	IRFD320	IRFD321	IRFD322	IRFD323	UNITS
Drain to Source Voltage (Note 1) . . . . . $V_{DS}$	400	350	400	350	V
Drain to Gate Voltage ( $R_{GS} = 20\text{k}\Omega$ ) (Note 1) . . . . . $V_{DGR}$	400	350	400	350	V
Continuous Drain Current . . . . . $I_D$	0.5	0.5	0.4	0.4	A
Pulsed Drain Current (Note 3) . . . . . $I_{DM}$	2.0	2.0	1.6	1.6	A
Gate to Source Voltage . . . . . $V_{GS}$	$\pm 20$	$\pm 20$	$\pm 20$	$\pm 20$	V
Maximum Power Dissipation . . . . . $P_D$	1.0	1.0	1.0	1.0	W
Linear Derating Factor . . . . .	0.008	0.008	0.008	0.008	W/ $^\circ\text{C}$
Single Pulse Avalanche Energy Rating (Note 4) . . . . . $E_{AS}$	100	100	100	100	mJ
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 . . . . . $T_{pk}$	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:**

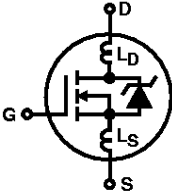
- $T_J = 25^\circ\text{C}$  to  $125^\circ\text{C}$ .

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

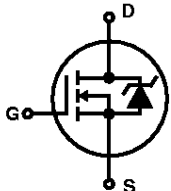
PARAMETER	SYMBOL	TEST CONDITIONS	MIN	TYP	MAX	UNITS
Drain to Source Breakdown Voltage IRFD320, IRFD322	$BV_{DSS}$	$I_D = 250\mu\text{A}, V_{GS} = 0\text{V}$ , (Figure 9)	400	-	-	V
			IRFD321, IRFD323	350	-	-
Gate Threshold Voltage	$V_{GS(TH)}$	$V_{GS} = V_{DS}, I_D = 250\mu\text{A}$	2.0	-	4.0	V
Zero Gate Voltage Drain Current	$I_{DSS}$	$V_{DS} = \text{Rated } BV_{DSS}, V_{GS} = 0\text{V}$	-	-	25	$\mu\text{A}$
		$V_{DS} = 0.8 \times \text{Rated } BV_{DSS}, V_{GS} = 0\text{V}, T_C = 125^\circ\text{C}$	-	-	250	$\mu\text{A}$
On-State Drain Current (Note 2) IRFD320, IRFD321	$I_{D(ON)}$	$V_{DS} > I_{D(ON)} \times r_{DS(ON)MAX}, V_{GS} = 10\text{V}$	0.5	-	-	A
			IRFD322, IRFD323	0.4	-	-
Gate to Source Leakage Current	$I_{GSS}$	$V_{GS} = \pm 20\text{V}$	-	-	$\pm 100$	nA
Drain to Source On Resistance (Note 2) IRFD320, IRFD321	$r_{DS(ON)}$	$I_D = 0.25\text{A}, V_{GS} = 10\text{V}$ , (Figures 7, 8)	-	1.5	1.8	$\Omega$
			IRFD322, IRFD323	-	1.8	2.5
Forward Transconductance (Note 2)	$g_{fs}$	$V_{DS} > I_{D(ON)} \times r_{DS(ON)MAX}, I_D = 0.25\text{A}$ , (Figure 11)	1.0	2.0	-	S
Turn-On Delay Time	$t_{d(ON)}$	$V_{DD} = 0.5 \times \text{Rated } BV_{DSS}, I_D \approx 0.5\text{A}, R_G = 9.1\Omega, V_{GS} = 10\text{V}$ (Figures 16, 17) $R_L = 398\Omega$ for $V_{DSS} = 200\text{V}$ $R_L = 347\Omega$ for $V_{DSS} = 175\text{V}$ MOSFET Switching Times are Essentially Independent of Operating Temperature	-	20	40	ns
Rise Time	$t_r$		-	25	50	ns
Turn-Off Delay Time	$t_{d(OFF)}$		-	50	100	ns
Fall Time	$t_f$		-	25	50	ns
Total Gate Charge (Gate to Source + Gate to Drain)	$Q_g(\text{TOT})$	$V_{GS} = 10\text{V}, I_D = 0.5\text{A}, V_{DS} = 0.8 \times \text{Rated } BV_{DSS}, I_{G(\text{REF})} = 1.5\mu\text{A}$ , (Figures 13, 18, 19), Gate Charge is Essentially Independent of Operating Temperature	-	12	15	nC
Gate to Source Charge	$Q_{gs}$		-	6.0	-	nC
Gate to Drain "Miller" Charge	$Q_{gd}$		-	6.0	-	nC
Input Capacitance	$C_{ISS}$	$V_{DS} = 25\text{V}, V_{GS} = 0\text{V}, f = 1\text{MHz}$ , (Figure 10)	-	455	-	pF
Output Capacitance	$C_{OSS}$		-	100	-	pF
Reverse Transfer Capacitance	$C_{RSS}$		-	20	-	pF

## IRFD320, IRFD321, IRFD322, IRFD323

### 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 Drain Lead, 2.0mm (0.08in) From Package to Center of Die	Modified MOSFET Symbol Showing the Internal Device Inductances 	-	4.0	-	nH
Internal Source Inductance	$L_S$	Measured From the Source Lead, 2.0mm (0.08in) From Package to Source Bonding Pad		-	6.0	-	nH
Thermal Resistance Junction to Ambient	$R_{\theta JA}$	Free Air Operation		-	-	120	$^\circ\text{C/W}$

### Source to Drain Diode Specifications

PARAMETER	SYMBOL	TEST CONDITIONS		MIN	TYP	MAX	UNITS
Continuous Source to Drain Current	$I_{SD}$	Modified MOSFET Symbol Showing the Integral Reverse P-N Junction Rectifier 		-	-	0.5	A
Pulse Source to Drain Current (Note 3)	$I_{SDM}$			-	-	2.0	A
Source to Drain Diode Voltage (Note 2)	$V_{SD}$	$T_J = 25^\circ\text{C}$ , $I_{SD} = 2.0\text{A}$ , $V_{GS} = 0\text{V}$ , (Figure 12)		-	-	1.6	V
Reverse Recovery Time	$t_{rr}$	$T_J = 150^\circ\text{C}$ , $I_{SD} = 2.0\text{A}$ , $dI_{SD}/dt = 100\text{A}/\mu\text{s}$		-	450	-	ns
Reverse Recovery Charge	$Q_{RR}$	$T_J = 150^\circ\text{C}$ , $I_{SD} = 2.0\text{A}$ , $dI_{SD}/dt = 100\text{A}/\mu\text{s}$		-	3.1	-	$\mu\text{C}$

#### NOTES:

- Pulse test: pulse width  $\leq 300\mu\text{s}$ , duty cycle  $\leq 2\%$ .
- Repetitive rating: pulse width limited by maximum junction temperature.
- $V_{DD} = 40\text{V}$ , starting  $T_J = 25^\circ\text{C}$ ,  $L = 29.09\text{mH}$ ,  $R_G = 50\Omega$ , peak  $I_{AS} = 2.5\text{A}$ . (Figures 14, 15).

### Typical Performance Curves Unless Otherwise Specified

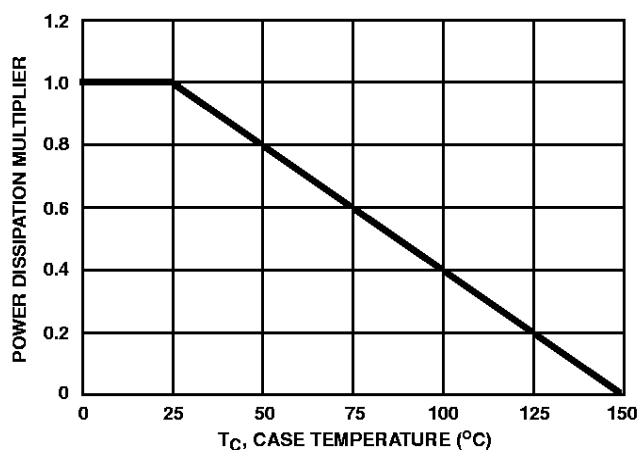


FIGURE 1. NORMALIZED POWER DISSIPATION vs CASE TEMPERATURE

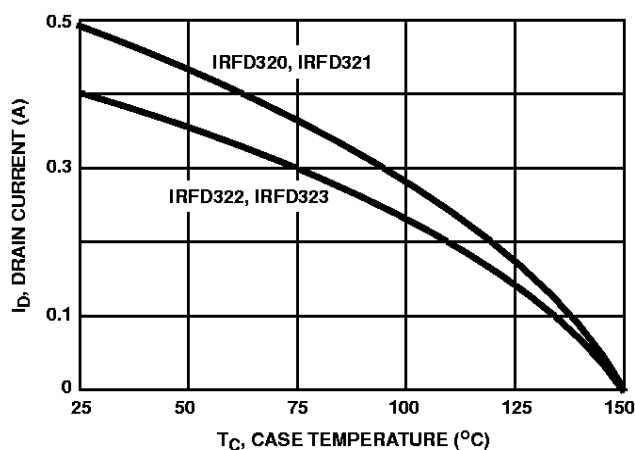


FIGURE 2. MAXIMUM CONTINUOUS DRAIN CURRENT vs CASE TEMPERATURE

Typical Performance Curves Unless Otherwise Specified (Continued)

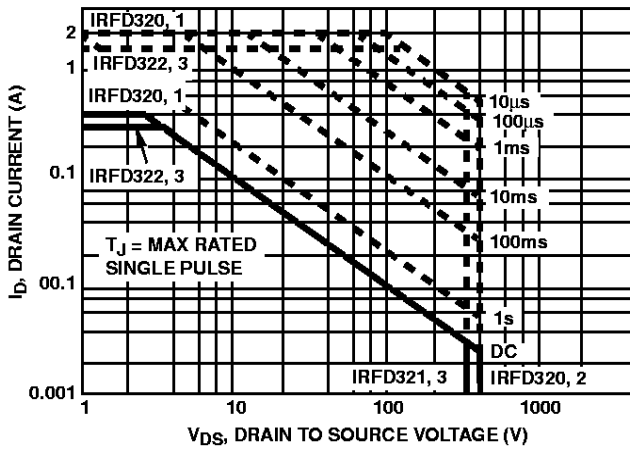


FIGURE 3. FORWARD BIAS SAFE OPERATING AREA

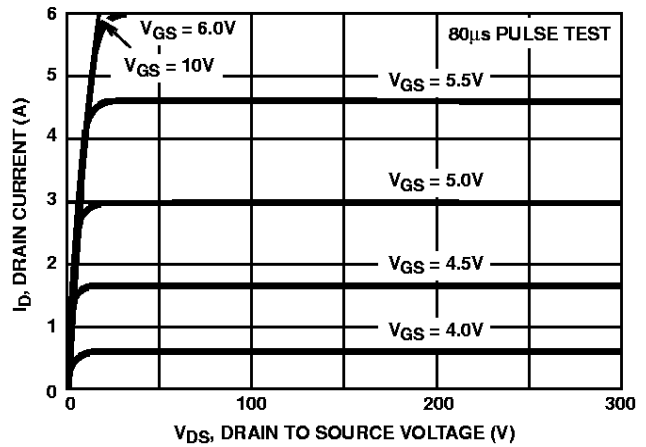


FIGURE 4. OUTPUT CHARACTERISTICS

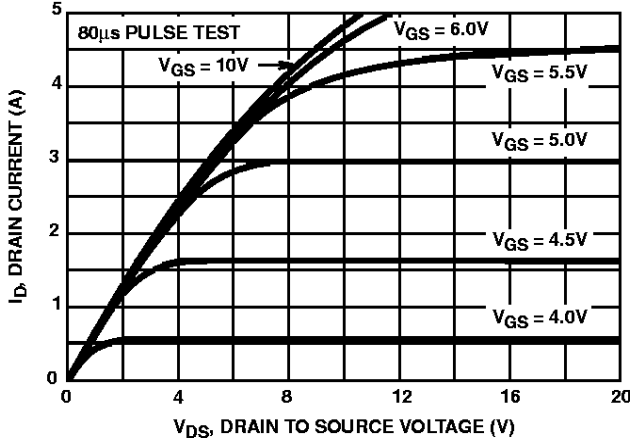


FIGURE 5. SATURATION CHARACTERISTICS

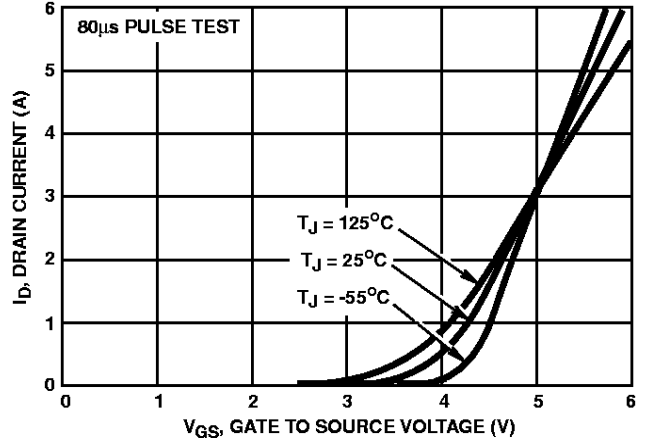
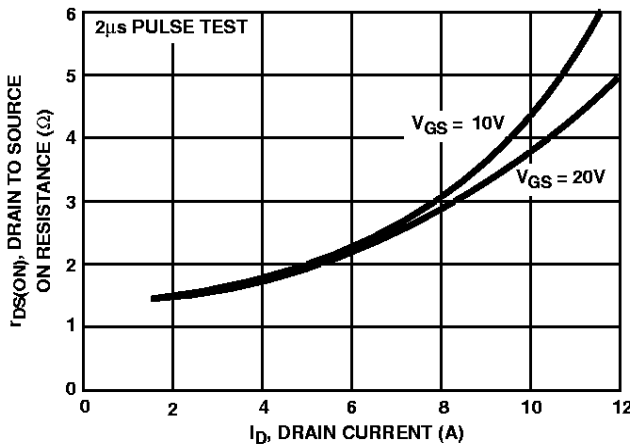


FIGURE 6. TRANSFER CHARACTERISTICS



NOTE: Heating effect of 2µs pulse is minimal.

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

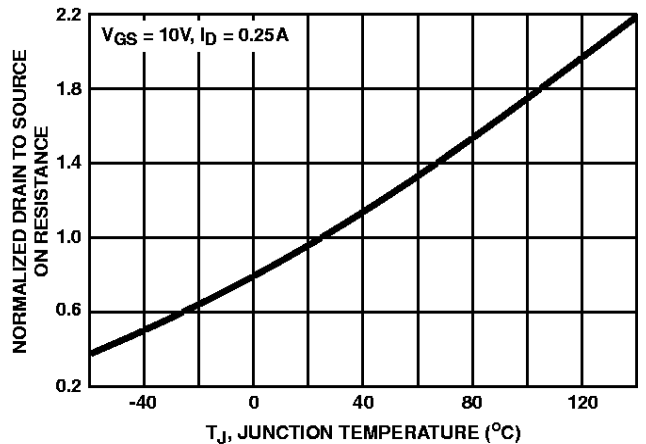


FIGURE 8. NORMALIZED DRAIN TO SOURCE ON RESISTANCE vs JUNCTION TEMPERATURE

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## Typical Performance Curves Unless Otherwise Specified (Continued)

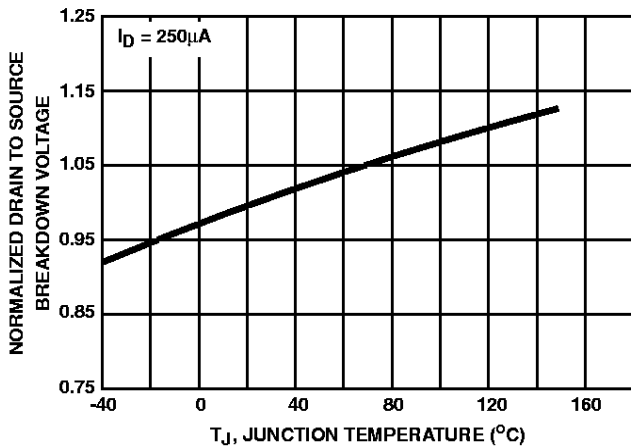


FIGURE 9. NORMALIZED DRAIN TO SOURCE BREAKDOWN VOLTAGE vs JUNCTION TEMPERATURE

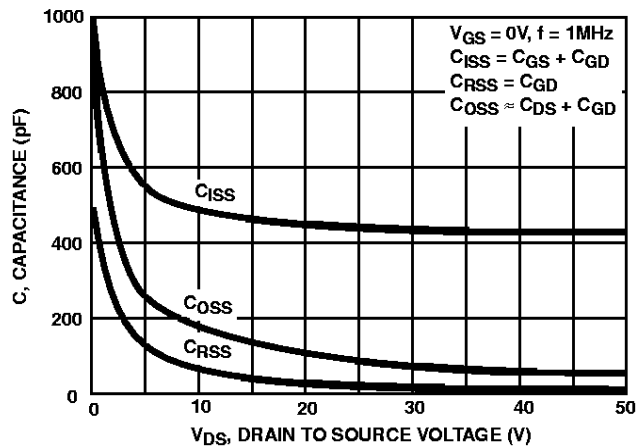


FIGURE 10. CAPACITANCE vs DRAIN TO SOURCE VOLTAGE

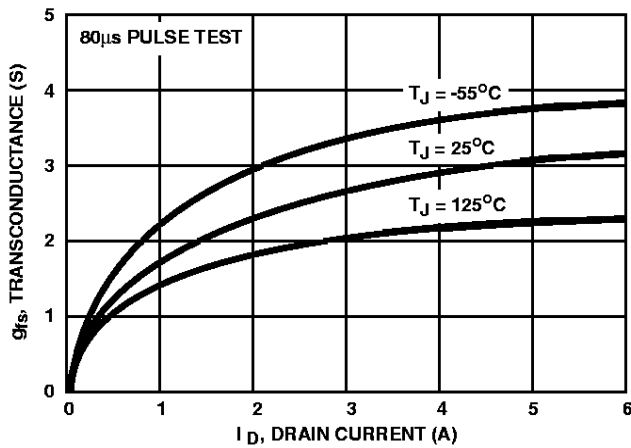


FIGURE 11. TRANSCONDUCTANCE vs DRAIN CURRENT

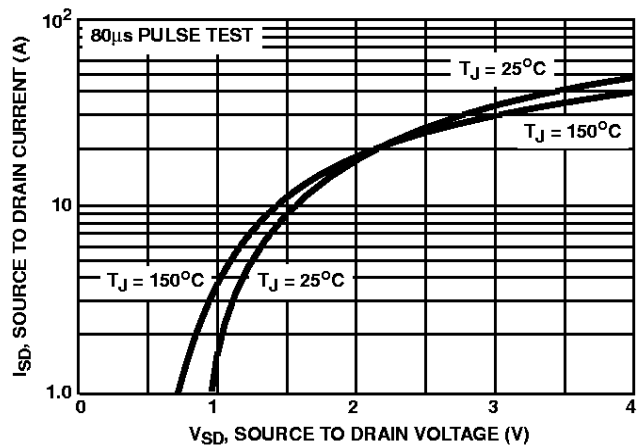


FIGURE 12. SOURCE TO DRAIN DIODE VOLTAGE

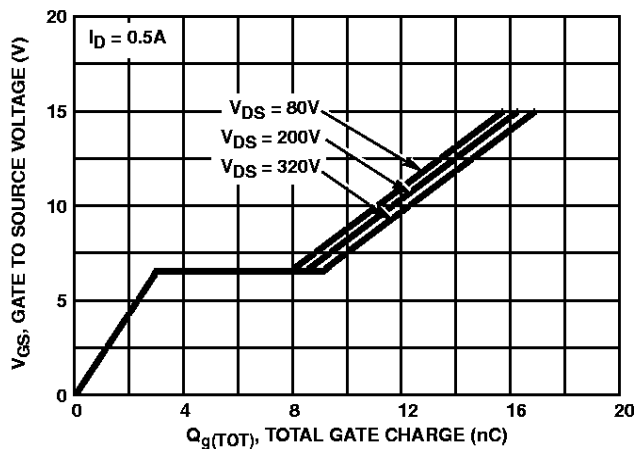


FIGURE 13. GATE TO SOURCE VOLTAGE vs GATE CHARGE

Test Circuits and Waveforms

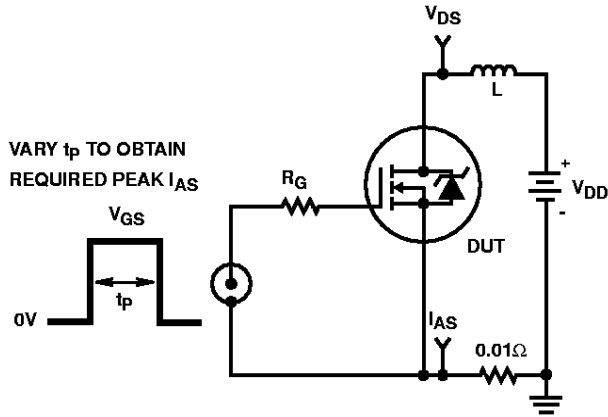


FIGURE 14. UNCLAMPED ENERGY TEST CIRCUIT

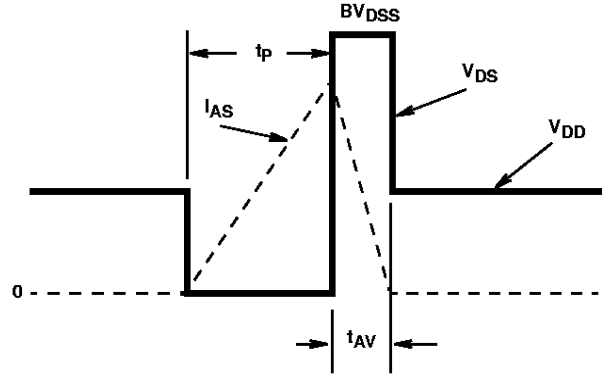


FIGURE 15. UNCLAMPED ENERGY WAVEFORMS

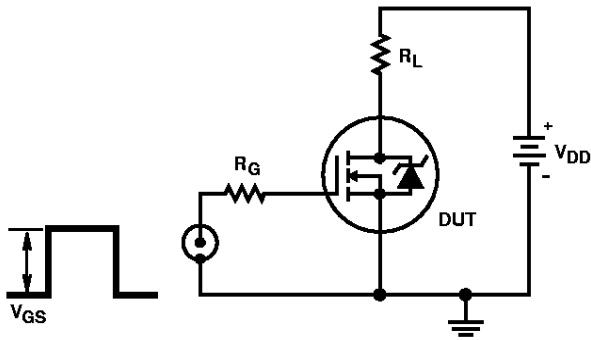


FIGURE 16. SWITCHING TIME TEST CIRCUIT

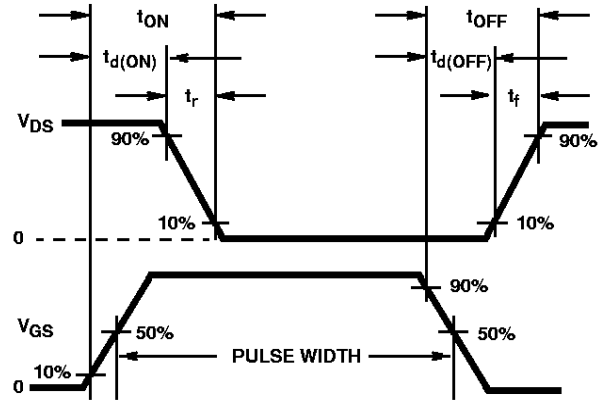


FIGURE 17. RESISTIVE SWITCHING WAVEFORMS

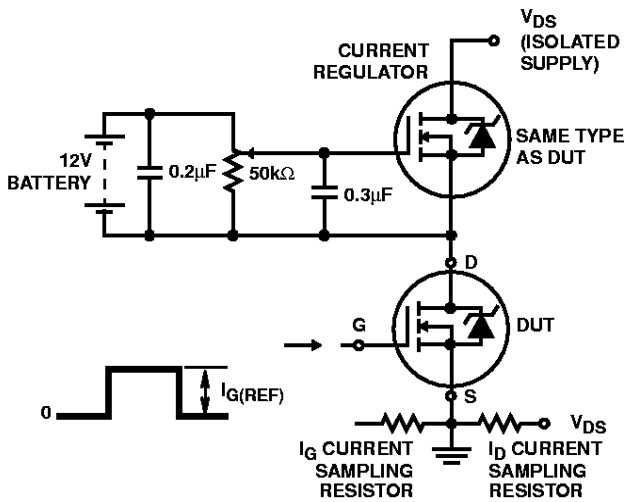


FIGURE 18. GATE CHARGE TEST CIRCUIT

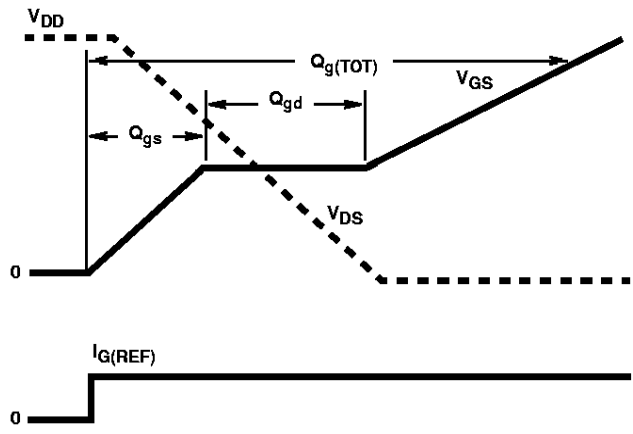


FIGURE 19. GATE CHARGE WAVEFORMS