

**-4.0A, -200V, 0.800 Ohm, P-Channel Power MOSFET**

This P-Channel enhancement mode silicon gate power field effect transistor is an advanced power MOSFET 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 TA17512.

**Ordering Information**

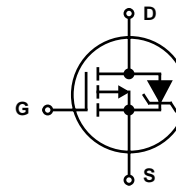
PART NUMBER	PACKAGE	BRAND
IRFF9230	TO-205AF	IRFF9230

NOTE: When ordering, use the entire part number.

**Features**

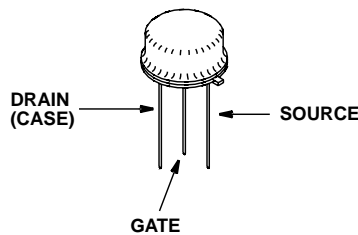
- -4.0A, -200V
- $r_{DS(ON)} = 0.800\Omega$
- Single Pulse Avalanche Energy Rated
- SOA is Power Dissipation Limited
- Nanosecond Switching Speeds
- Linear Transfer Characteristics
- High Input Impedance

**Symbol**



**Packaging**

**JEDEC TO-205AF**



# IRFF9230

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

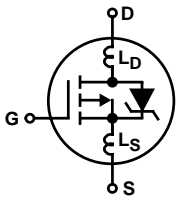
	IRFF9230	UNITS
Drain to Source Voltage (Note 1) . . . . .	$V_{DS}$	-200 V
Drain to Gate Voltage ( $R_{GS} = 20k\Omega$ ) (Note 1) . . . . .	$V_{DGR}$	-200 V
Continuous Drain Current . . . . .	$I_D$	-4.0 A
Pulsed Drain Current (Note 3) . . . . .	$I_{DM}$	-16 A
Gate to Source Voltage . . . . .	$V_{GS}$	$\pm 20$ V
Maximum Power Dissipation . . . . .	$P_D$	25 W
Dissipation Derating Factor . . . . .		0.2 W/ $^\circ\text{C}$
Single Pulse Avalanche Energy Rating (Note 4) . . . . .	$E_{AS}$	500 mJ
Operating and Storage Temperature . . . . .	$T_J, T_{STG}$	-55 to 150 $^\circ\text{C}$
Maximum Temperature for Soldering Leads at 0.063in (1.6mm) from Case for 10s. . . . .	$T_L$	300 $^\circ\text{C}$

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:**

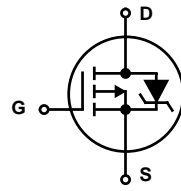
- $T_J = 25^\circ\text{C}$  to  $125^\circ\text{C}$ .

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

PARAMETER	SYMBOL	TEST CONDITIONS	MIN	TYP	MAX	UNITS	
Drain to Source Breakdown Voltage	$BV_{DSS}$	$I_D = -250\mu\text{A}$ , $V_{GS} = 0\text{V}$ , (Figure 10)	-200	-	-	V	
Gate Threshold Voltage	$V_{GS(TH)}$	$V_{GS} = V_{DS}$ , $I_D = -250\mu\text{A}$	-2	-	-4	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)	$I_{D(ON)}$	$V_{DS} > I_{D(ON)} \times r_{DS(ON)MAX}$ , $V_{GS} = -10\text{V}$	-4.0	-	-	A	
Gate to Source Leakage Current	$I_{GSS}$	$V_{GS} = \pm 20\text{V}$	-	-	$\pm 100$	nA	
Drain to Source On Resistance (Note 2)	$r_{DS(ON)}$	$I_D = -2.0\text{A}$ , $V_{GS} = -10\text{V}$ , (Figures 8, 9)	-	0.5	0.800	$\Omega$	
Forward Transconductance (Note 2)	$g_{fs}$	$V_{DS} > I_{D(ON)} \times r_{DS(ON)MAX}$ , $I_D = -2.0\text{A}$ , (Figure 12)	2.2	3.5	-	S	
Turn-On Delay Time	$t_{d(ON)}$	$V_{DD} = 0.5BV_{DSS}$ , $I_D \approx -4.0\text{A}$ , $R_G = 9.1\Omega$ , $R_L = 2.5\Omega$ for $BV_{DSS} = -200\text{V}$ $R_L = 18.7\Omega$ for $BV_{DSS} = -150\text{V}$ (Figures 17, 18) MOSFET Switching Times are Essentially Independent of Operating Temperature	-	30	50	ns	
Rise Time	$t_r$		-	50	100	ns	
Turn-Off Delay Time	$t_{d(OFF)}$		-	50	100	ns	
Fall Time	$t_f$		-	40	80	ns	
Total Gate Charge (Gate to Source + Gate to Drain)	$Q_{g(TOT)}$	$V_{GS} = -10\text{V}$ , $I_D = -4.0\text{A}$ , $V_{DS} = 0.8 \times \text{Rated } BV_{DSS}$ , $I_{G(REF)} = -1.5\text{mA}$ , (Figures 14, 19, 20) Gate Charge is Essentially Independent of Operating Temperature	-	31	45	nC	
Gate to Source Charge	$Q_{gs}$		-	18	-	nC	
Gate to Drain "Miller" Charge	$Q_{gd}$		-	13	-	nC	
Input Capacitance	$C_{ISS}$	$V_{DS} = -25\text{V}$ , $V_{GS} = 0\text{V}$ , $f = 1\text{MHz}$ , (Figure 11)	-	550	-	pF	
Output Capacitance	$C_{OSS}$		-	170	-	pF	
Reverse Transfer Capacitance	$C_{RSS}$		-	50	-	pF	
Internal Drain Inductance	$L_D$	Measured From the Drain Lead, 5mm (0.2in) From Package to Center of Die	Modified MOSFET Symbol Showing the Internal Devices Inductances 	-	5.0	-	nH
Internal Source Inductance	$L_S$	Measured From the Source Lead, 5mm (0.2in) From Header to Source Bonding Pad		-	15	-	nH
Thermal Resistance Junction to Case	$R_{\theta JC}$		-	-	5.0	$^\circ\text{C/W}$	
Thermal Resistance Junction to Ambient	$R_{\theta JA}$	Typical Socket Mount	-	-	175	$^\circ\text{C/W}$	

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	-	-	-4.0	A
Pulse Source to Drain Current (Note 3)	$I_{SM}$		-	-	-16	A
Source to Drain Diode Voltage (Note 2)	$V_{SD}$	$T_C = 25^{\circ}\text{C}$ , $I_{SD} = -4.0\text{A}$ , $V_{GS} = 0\text{V}$ , (Figure 13)	-	-	-1.5	V
Reverse Recovery Time	$t_{rr}$	$T_J = 150^{\circ}\text{C}$ , $I_{SD} = -4.0\text{A}$ , $dI_{SD}/dt = 100\text{A}/\mu\text{s}$	-	400	-	ns
Reverse Recovery Charge	$Q_{RR}$	$T_J = 150^{\circ}\text{C}$ , $I_{SD} = -4.0\text{A}$ , $dI_{SD}/dt = 100\text{A}/\mu\text{s}$	-	2.6	-	$\mu\text{C}$



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. See Transient Thermal Impedance curve (Figure 3).
4.  $V_{DD} = 50\text{V}$ , starting  $T_J = 25^{\circ}\text{C}$ ,  $L = 46.9\text{mH}$ ,  $R_G = 25\Omega$ , peak  $I_{AS} = 4.0\text{A}$  (Figures 15, 16).

Typical Performance Curves Unless Otherwise Specified

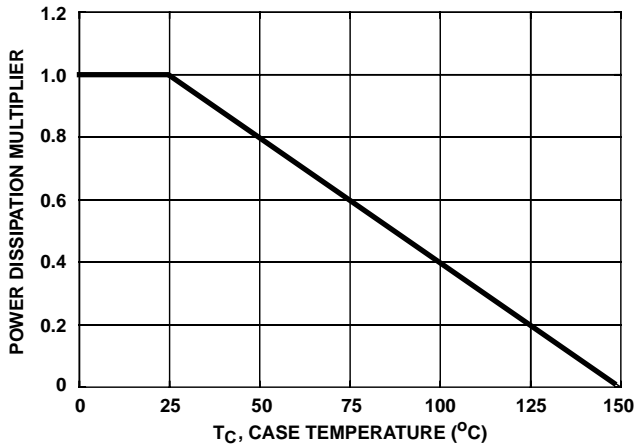


FIGURE 1. NORMALIZED POWER DISSIPATION vs CASE TEMPERATURE

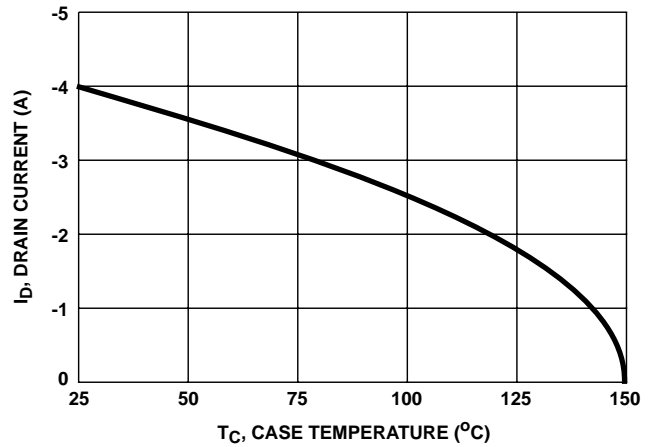


FIGURE 2. MAXIMUM CONTINUOUS DRAIN CURRENT vs CASE TEMPERATURE

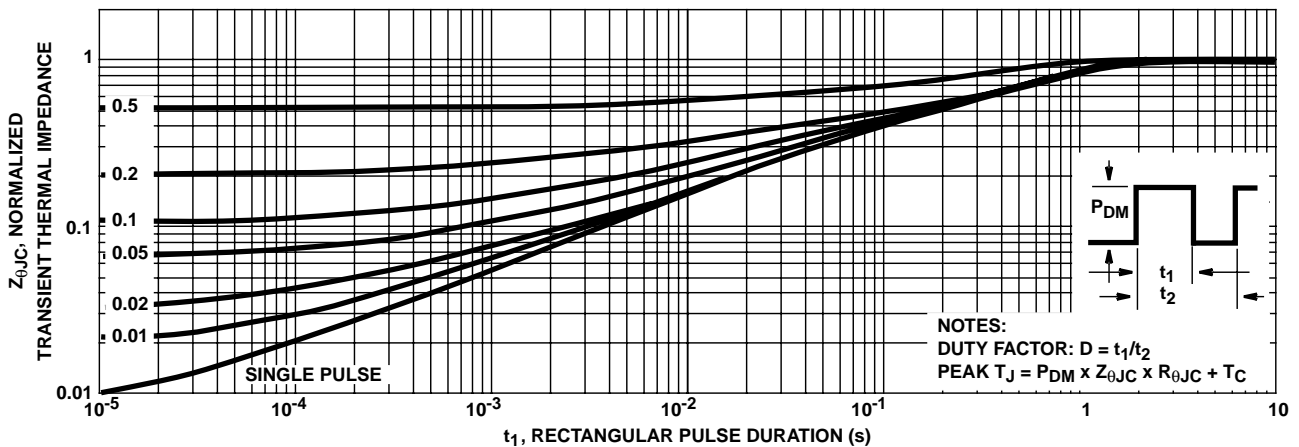


FIGURE 3. NORMALIZED TRANSIENT THERMAL IMPEDANCE

Typical Performance Curves Unless Otherwise Specified (Continued)

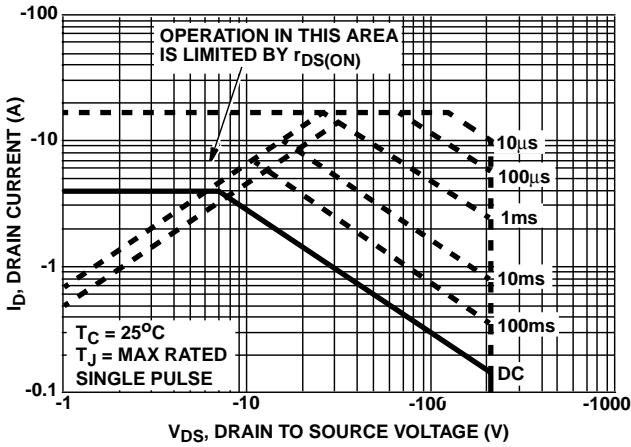


FIGURE 4. FORWARD BIAS SAFE OPERATING AREA

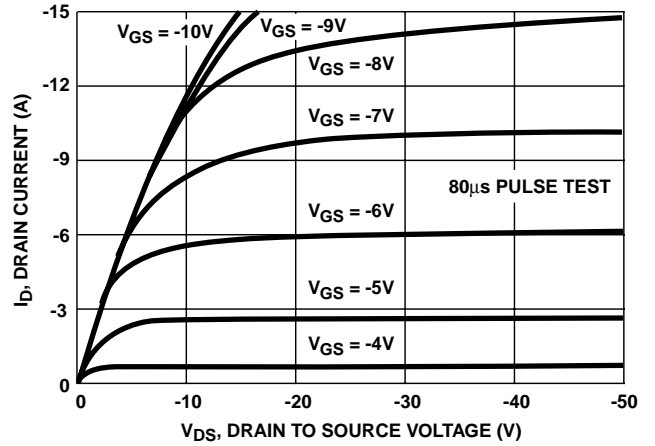


FIGURE 5. OUTPUT CHARACTERISTICS

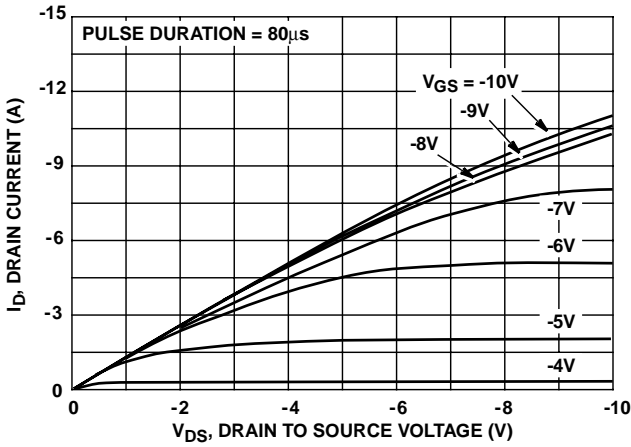


FIGURE 6. SATURATION CHARACTERISTICS

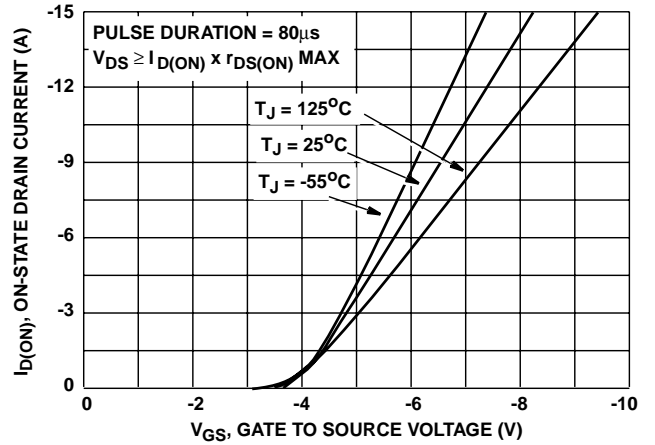
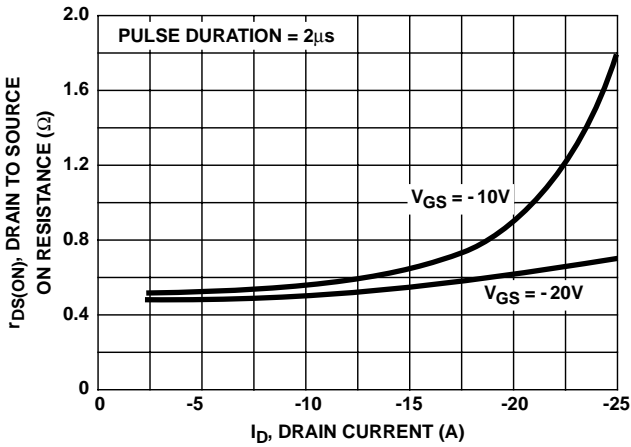


FIGURE 7. TRANSFER CHARACTERISTICS



NOTE: Heating effect of 2µs pulse is minimal.

FIGURE 8. DRAIN TO SOURCE ON RESISTANCE vs GATE VOLTAGE AND DRAIN CURRENT

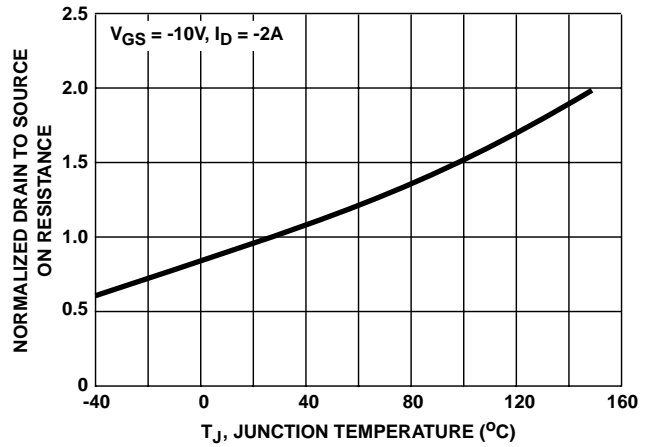


FIGURE 9. NORMALIZED DRAIN TO SOURCE ON RESISTANCE vs JUNCTION TEMPERATURE

Typical Performance Curves Unless Otherwise Specified (Continued)

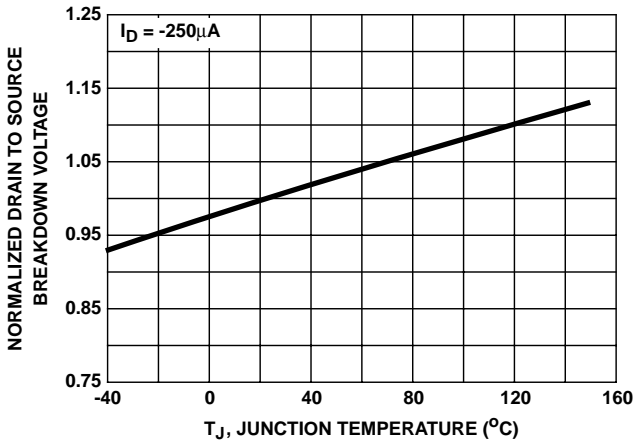


FIGURE 10. NORMALIZED DRAIN TO SOURCE BREAKDOWN VOLTAGE vs JUNCTION TEMPERATURE

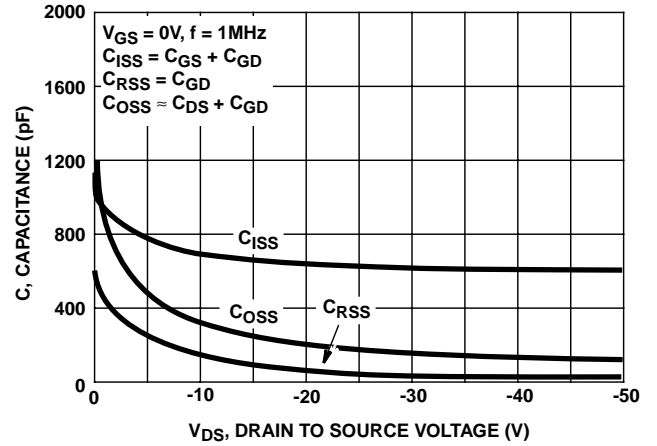


FIGURE 11. CAPACITANCE vs DRAIN TO SOURCE VOLTAGE

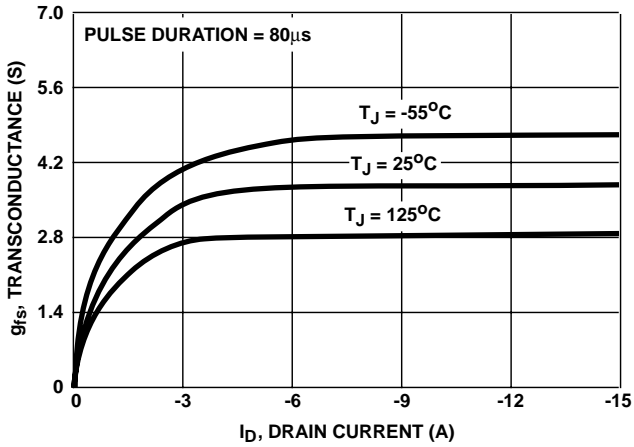


FIGURE 12. TRANSCONDUCTANCE vs DRAIN CURRENT

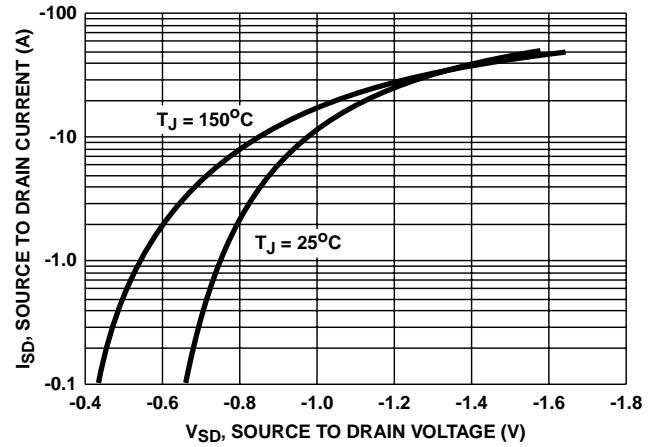


FIGURE 13. SOURCE TO DRAIN DIODE VOLTAGE

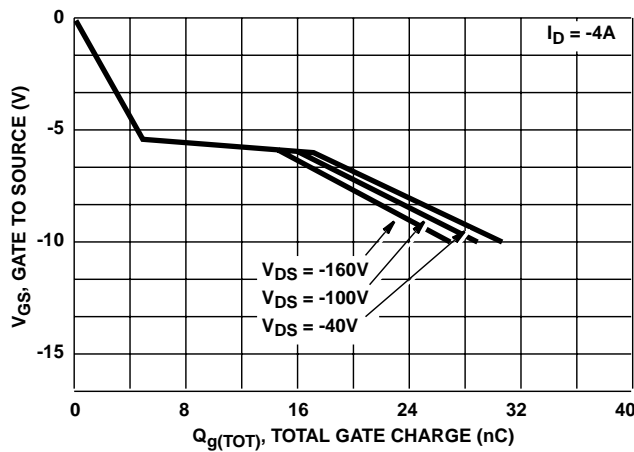


FIGURE 14. GATE TO SOURCE VOLTAGE vs GATE CHARGE

Test Circuits and Waveforms

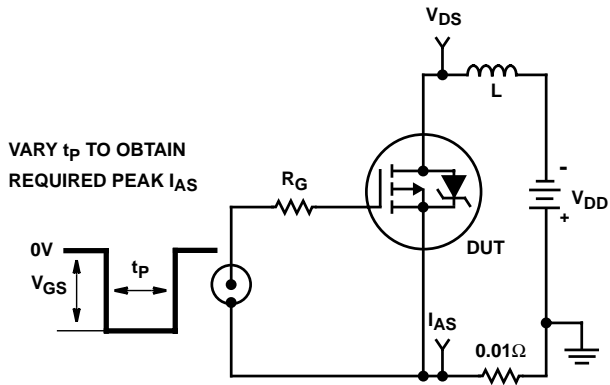


FIGURE 15. UNCLAMPED ENERGY TEST CIRCUIT

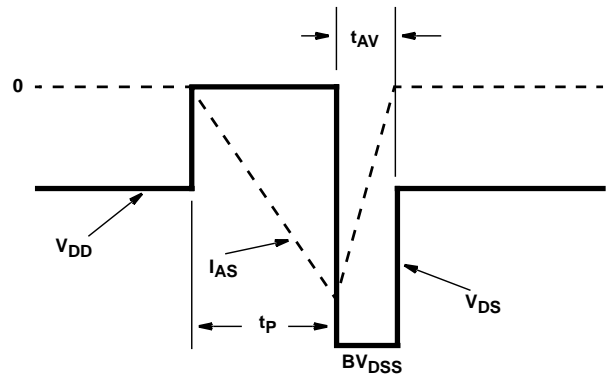


FIGURE 16. UNCLAMPED ENERGY WAVEFORMS

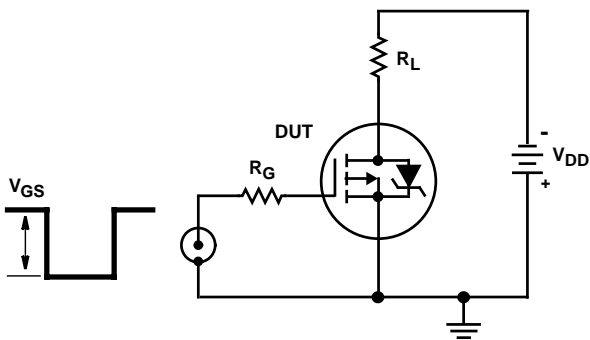


FIGURE 17. SWITCHING TIME TEST CIRCUIT

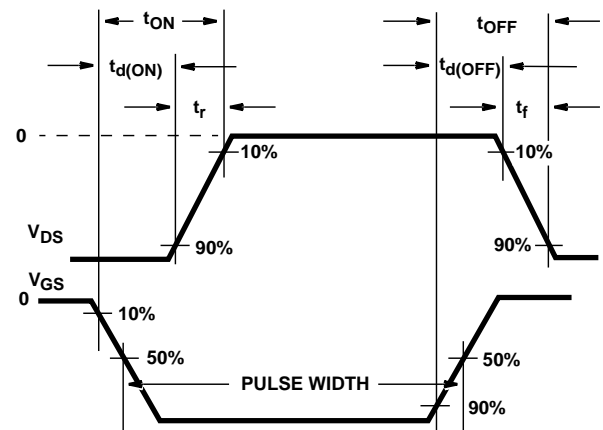


FIGURE 18. RESISTIVE SWITCHING WAVEFORMS

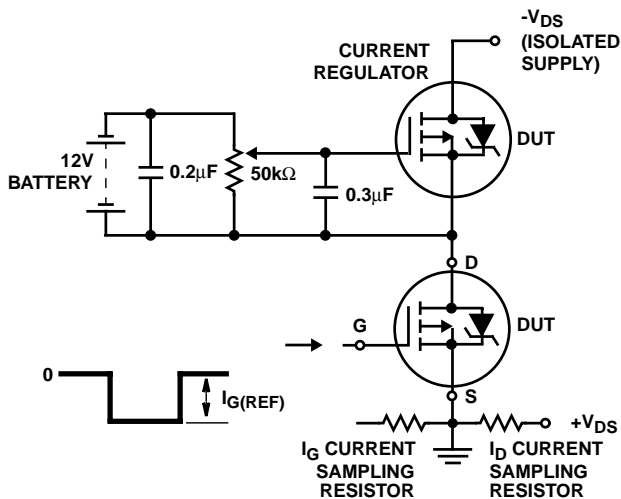


FIGURE 19. GATE CHARGE TEST CIRCUIT

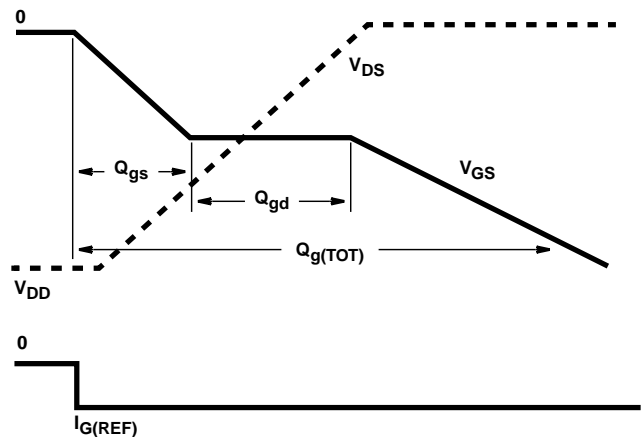


FIGURE 20. GATE CHARGE WAVEFORMS

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