

**3.1A, 400V, 1.800 Ohm, N-Channel Power MOSFETs**

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 convertors, 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.

**Ordering Information**

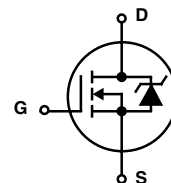
PART NUMBER	PACKAGE	BRAND
IRFR320	TO-252AA	IFR320
IRFU320	TO-251AA	IFU320

NOTE: When ordering, use the entire part number. Add the suffix 9A to obtain the TO-252AA variant in tape and reel, i.e., IRFR3209A.

**Features**

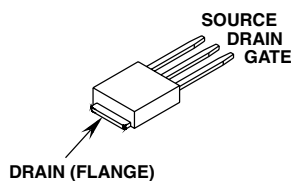
- 3.1A, 400V
- $r_{DS(ON)} = 1.800\Omega$
- Single Pulse Avalanche Energy Rated
- SOA is Power Dissipation Limited
- Nanosecond Switching Speeds
- Linear Transfer Characteristics
- High Input Impedance
- Related Literature
  - TB334 "Guidelines for Soldering Surface Mount Components to PC Boards"

**Symbol**

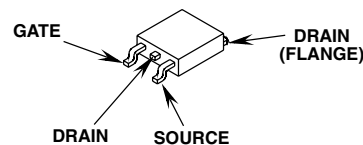


**Packaging**

JEDEC TO-251AA



JEDEC TO-252AA



# IRFR320, IRFU320

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

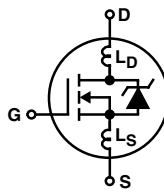
	IRFR320, IRFU320	UNITS
Drain to Source Voltage (Note 1) . . . . .	400	V
Drain to Gate Voltage ( $R_{GS} = 20k\Omega$ ) (Note 1) . . . . .	400	V
Continuous Drain Current . . . . .	3.1	A
$T_C = 100^\circ\text{C}$ . . . . .	2.0	A
Pulsed Drain Current (Note 3) . . . . .	12	A
Gate to Source Voltage . . . . .	$\pm 20$	V
Maximum Power Dissipation . . . . .	50	W
Linear Derating Factor . . . . .	0.4	W/ $^\circ\text{C}$
Single Pulse Avalanche Energy Rating (Note 4) . . . . .	190	mJ
Operating and Storage Temperature . . . . .	-55 to 150	$^\circ\text{C}$
Maximum Temperature for Soldering		
Leads at 0.063in (1.6mm) from Case for 10s. . . . .	300	$^\circ\text{C}$
Package Body for 10s, See Techbrief 334 . . . . .	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:**

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

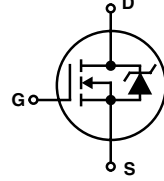
## Electrical Specifications $T_C = 25^\circ\text{C}$ , Unless Otherwise Specified

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)	400	-	-	V		
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	$\mu\text{A}$		
		$V_{DS} = 0.8 \times \text{Rated } BV_{DSS}$ , $V_{GS} = 0\text{V}$ , $T_J = 125^\circ\text{C}$	-	-	250	$\mu\text{A}$		
On-State Drain Current (Note 2)	$I_{D(ON)}$	$V_{DS} > I_{D(ON)} \times r_{DS(ON)MAX}$ , $V_{GS} = 10\text{V}$ , (Figure 7)	3.1	-	-	A		
Gate to Source Leakage Current	$I_{GSS}$	$V_{GS} = \pm 20\text{V}$	-	-	$\pm 100$	nA		
Drain to Source On Resistance (Note 2)	$r_{DS(ON)}$	$I_D = 1.7\text{A}$ , $V_{GS} = 10\text{V}$ , (Figures 8, 9)	-	1.600	1.800	$\Omega$		
Forward Transconductance (Note 2)	$g_{fs}$	$V_{DS} \geq 10\text{V}$ , $I_D = 2.0\text{A}$ , (Figure 12)	1.7	2.6	-	S		
Turn-On Delay Time	$t_{d(ON)}$	$V_{DD} = 200\text{V}$ , $I_D \approx 3.1\text{A}$ , $R_{GS} = 18\Omega$ , $R_L = 63\Omega$ , $V_{GS} = 10\text{V}$ MOSFET Switching Times are Essentially Independent of Operating Temperature	-	10	15	ns		
Rise Time	$t_r$		-	14	21	ns		
Turn-Off Delay Time	$t_{d(OFF)}$		-	30	45	ns		
Fall Time	$t_f$		-	13	20	ns		
Total Gate Charge (Gate to Source + Gate to Drain)	$Q_{g(TOT)}$	$V_{GS} = 10\text{V}$ , $I_D = 3.1\text{A}$ , $V_{DS} = 0.8 \times \text{Rated } BV_{DSS}$ , $I_{G(REF)} = 1.5\text{mA}$ , (Figure 14)	-	13	20	nC		
Gate to Source Charge	$Q_{gs}$	Gate Charge is Essentially Independent of Operating Temperature	-	2.2	3.3	nC		
Gate to Drain "Miller" Charge	$Q_{gd}$		-	7.2	11	nC		
Input Capacitance	$C_{ISS}$	$V_{DS} = 25\text{V}$ , $V_{GS} = 0\text{V}$ , $f = 1\text{MHz}$ , (Figure 11)	-	350	-	pF		
Output Capacitance	$C_{OSS}$		-	64	-	pF		
Reverse Transfer Capacitance	$C_{RSS}$		-	8.1	-	pF		
Internal Drain Inductance	$L_D$	Measured From the Drain Lead, 6.0mm (0.25in) from Package to Center of Die	Modified MOSFET Symbol Showing the Internal Device Inductances 		-	4.5	-	nH
Internal Source Inductance	$L_S$	Measured From the Source Lead, 6.0mm (0.25in) from Package to Source Bonding Pad			-	7.5	-	nH
Thermal Resistance, Junction to Case	$R_{\theta JC}$		-	-	2.5	$^\circ\text{C/W}$		
Thermal Resistance, Junction to Ambient	$R_{\theta JA}$	Typical Solder Mount	-	-	110	$^\circ\text{C/W}$		

# IRFR320, IRFU320

## Source to Drain Diode Specifications

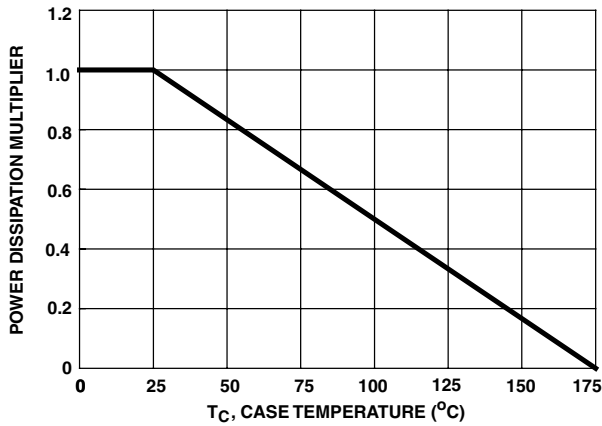
PARAMETER	SYMBOL	TEST CONDITIONS	MIN	TYP	MAX	UNITS
Continuous Source to Drain Current	$I_{SD}$	Modified MOSFET Symbol Showing the Integral Reverse P-N Junction Rectifier	-	-	3.1	A
Pulse Source to Drain Current (Note 3)	$I_{SDM}$		-	-	12	A
Source to Drain Diode Voltage (Note 2)	$V_{SD}$	$T_J = 25^\circ\text{C}$ , $I_{SD} = 3.1\text{A}$ , $V_{GS} = 0\text{V}$ , (Figure 13)	-	-	1.6	V
Reverse Recovery Time	$t_{rr}$	$T_J = 25^\circ\text{C}$ , $I_{SD} = 3.1\text{A}$ , $dI_{SD}/dt = 100\text{A}/\mu\text{s}$	120	270	600	ns
Reverse Recovery Charge	$Q_{RR}$	$T_J = 25^\circ\text{C}$ , $I_{SD} = 3.1\text{A}$ , $dI_{SD}/dt = 100\text{A}/\mu\text{s}$	0.64	1.4	3.0	$\mu\text{C}$



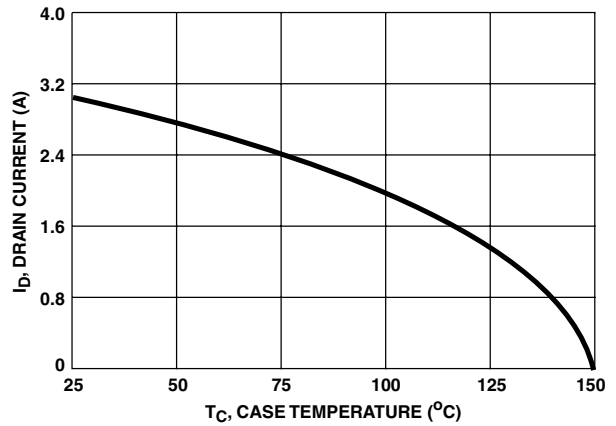
**NOTES:**

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  $T_J = 25^\circ\text{C}$ ,  $L = 3.1\text{mH}$ ,  $R_{GS} = 25\Omega$ , peak  $I_{AS} = 3.1\text{A}$ .

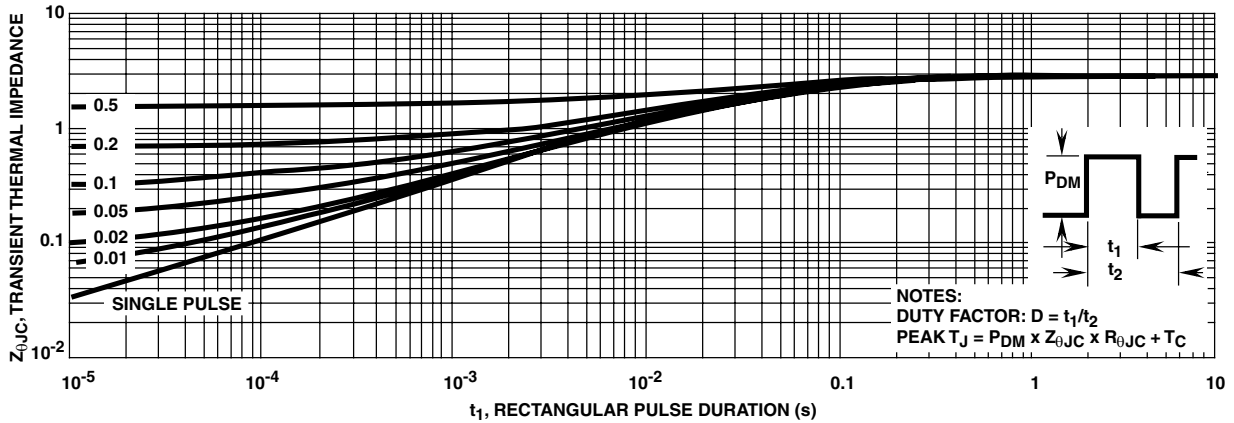
## Typical Performance Curves Unless Otherwise Specified



**FIGURE 1. NORMALIZED POWER DISSIPATION vs CASE TEMPERATURE**



**FIGURE 2. MAXIMUM CONTINUOUS DRAIN CURRENT vs CASE TEMPERATURE**



**NOTES:**  
 DUTY FACTOR:  $D = t_1/t_2$   
 PEAK  $T_J = P_{DM} \times Z_{\theta JC} \times R_{\theta JC} + T_C$

**FIGURE 3. MAXIMUM TRANSIENT THERMAL IMPEDANCE**

Typical Performance Curves Unless Otherwise Specified (Continued)

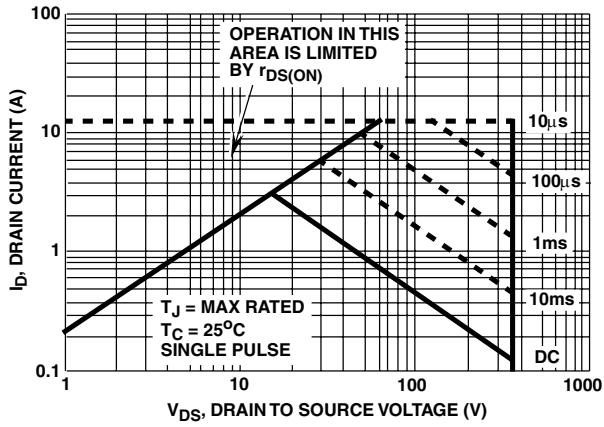


FIGURE 4. FORWARD BIAS SAFE OPERATING AREA

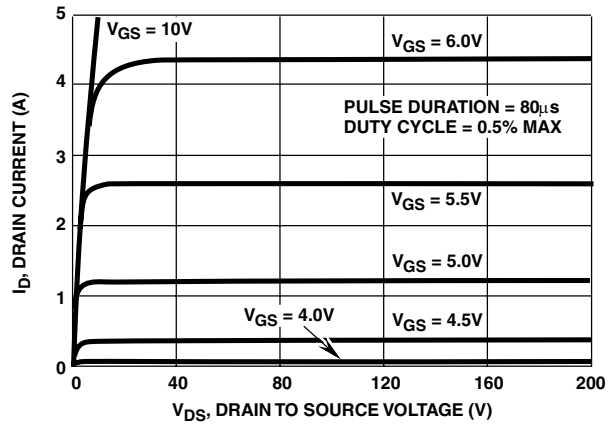


FIGURE 5. OUTPUT CHARACTERISTICS

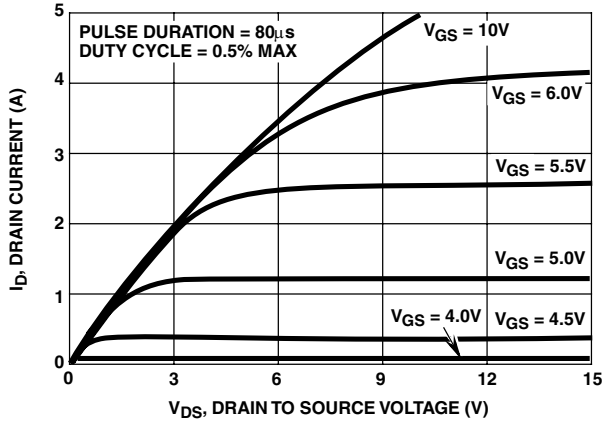


FIGURE 6. SATURATION CHARACTERISTICS

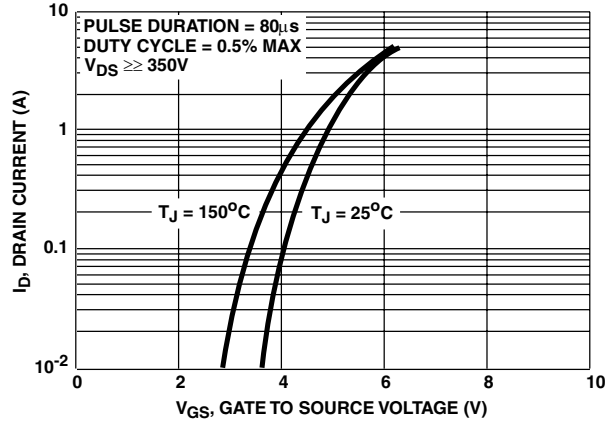


FIGURE 7. TRANSFER CHARACTERISTICS

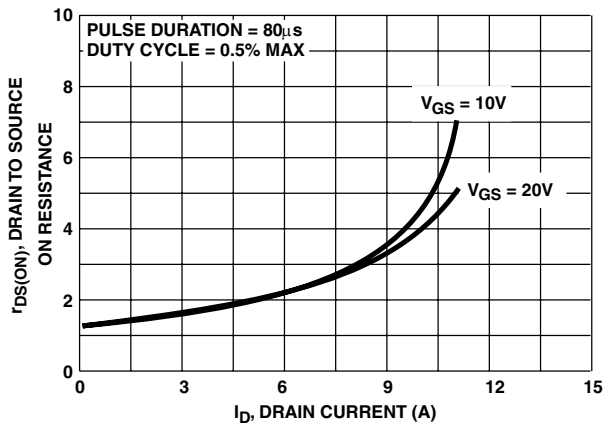


FIGURE 8. DRAIN TO SOURCE ON RESISTANCE vs GATE VOLTAGE AND DRAIN CURRENT

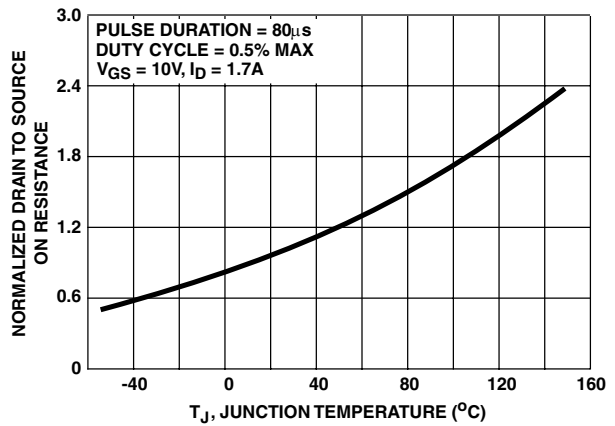


FIGURE 9. NORMALIZED DRAIN TO SOURCE ON RESISTANCE vs JUNCTION TEMPERATURE

# IRFR320, IRFU320

## Typical Performance Curves Unless Otherwise Specified (Continued)

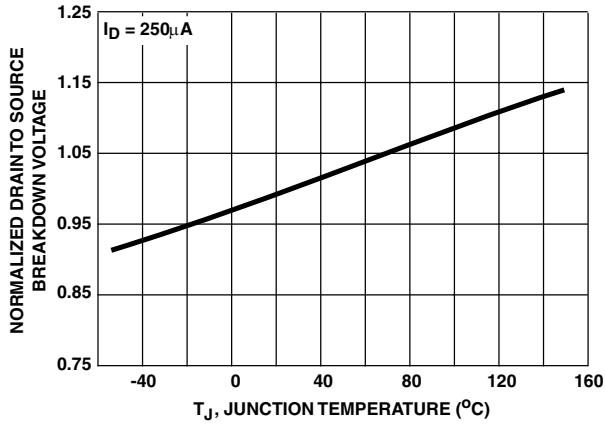


FIGURE 10. NORMALIZED DRAIN TO SOURCE BREAKDOWN VOLTAGE vs JUNCTION TEMPERATURE

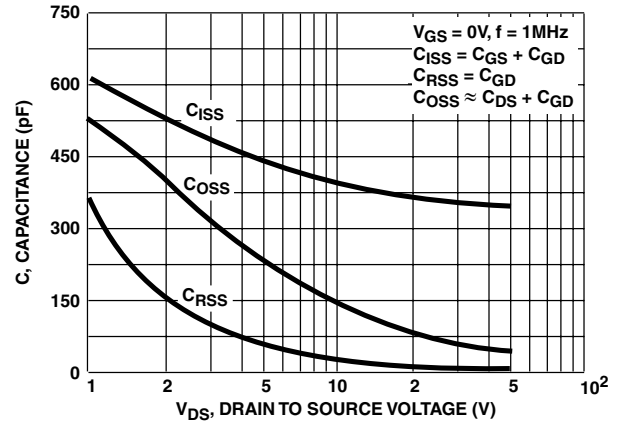


FIGURE 11. CAPACITANCE vs DRAIN TO SOURCE VOLTAGE

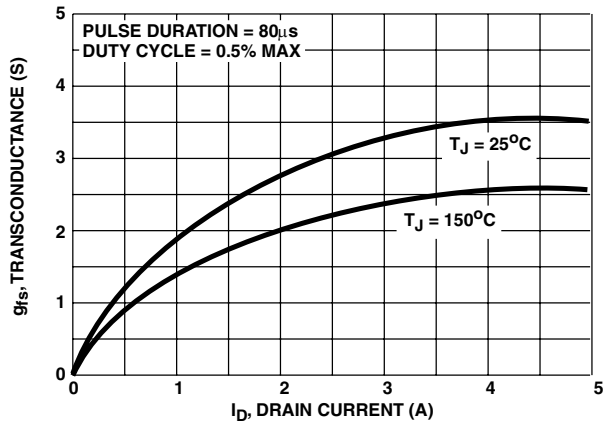


FIGURE 12. TRANSCONDUCTANCE vs DRAIN CURRENT

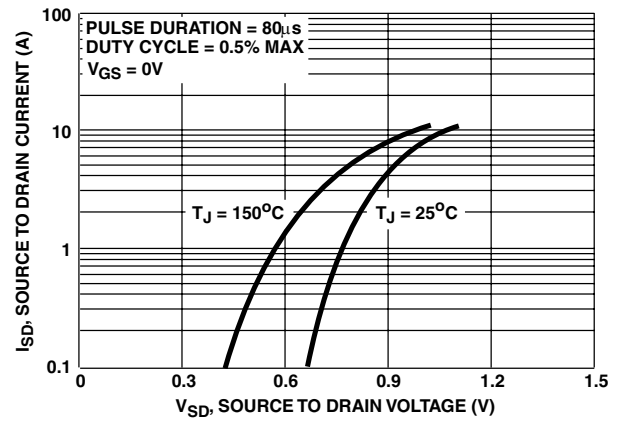


FIGURE 13. SOURCE TO DRAIN DIODE VOLTAGE

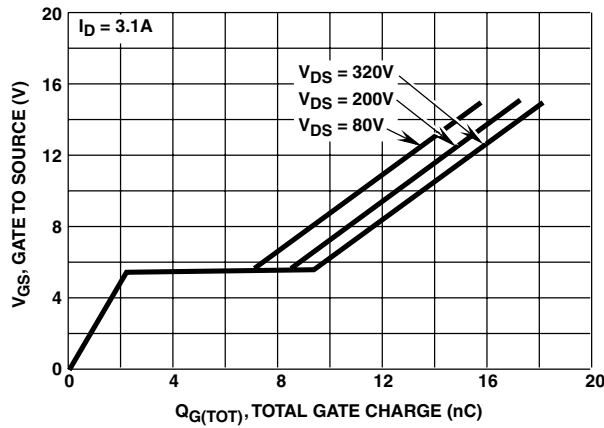


FIGURE 14. GATE TO SOURCE VOLTAGE vs GATE CHARGE

Test Circuits and Waveforms

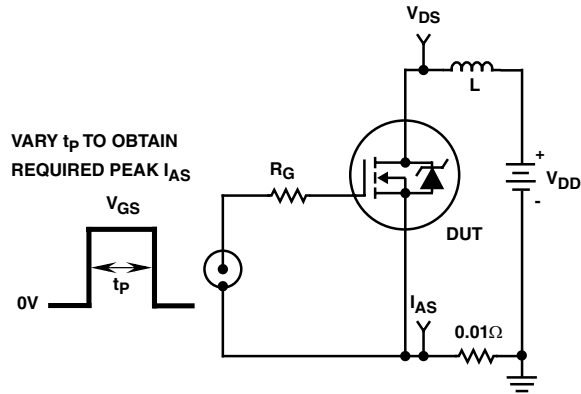


FIGURE 15. UNCLAMPED ENERGY TEST CIRCUIT

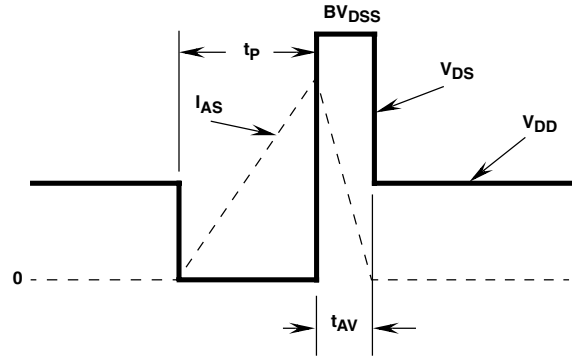


FIGURE 16. UNCLAMPED ENERGY WAVEFORMS

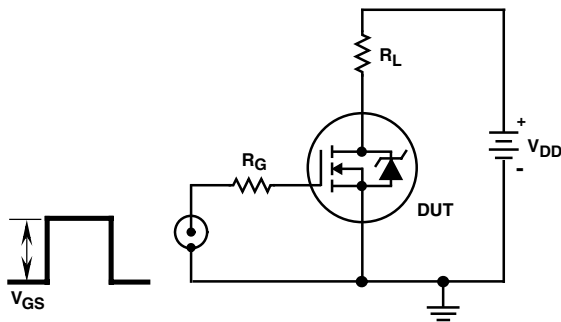


FIGURE 17. SWITCHING TIME TEST CIRCUIT

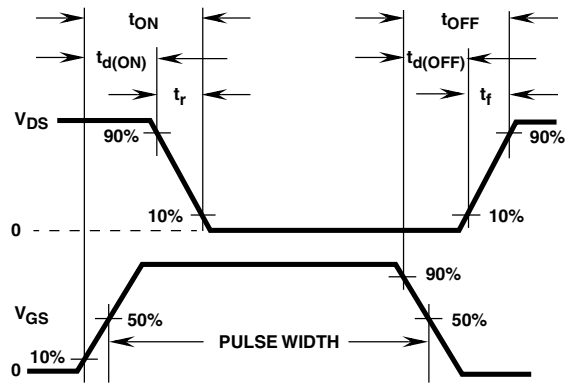


FIGURE 18. RESISTIVE SWITCHING WAVEFORMS

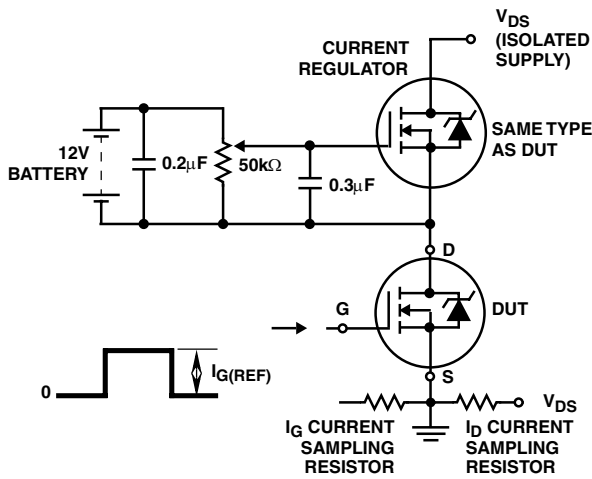


FIGURE 19. GATE CHARGE TEST CIRCUIT

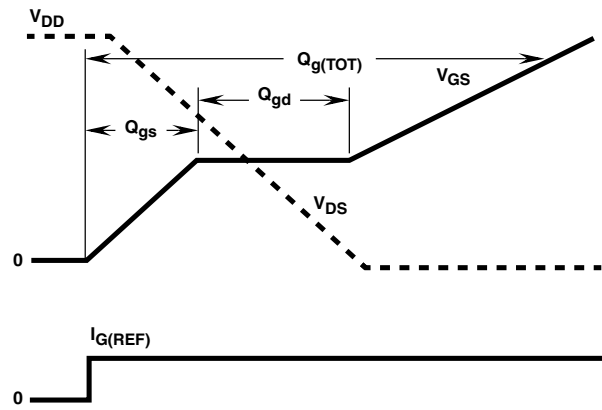


FIGURE 20. GATE CHARGE WAVEFORMS

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Bottomless <sup>TM</sup>	FAST <sub>r</sub> <sup>TM</sup>	POP <sup>TM</sup>	SuperSOT <sup>TM</sup> -6
CoolFET <sup>TM</sup>	GlobalOptoisolator <sup>TM</sup>	PowerTrench <sup>®</sup>	SuperSOT <sup>TM</sup> -8
CROSSVOLT <sup>TM</sup>	GTO <sup>TM</sup>	QFET <sup>TM</sup>	SyncFET <sup>TM</sup>
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## PRODUCT STATUS DEFINITIONS

### Definition of Terms

Datasheet Identification	Product Status	Definition
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