

IRFR420, IRFR421, IRFR422, IRFU420, IRFU421, IRFU422

2.2A and 2.5A, 450V and 500V, 3.0 and 4.0 Ohm,
N-Channel Power MOSFETs

January 1998

Features

- 2.2A and 2.5A, 450V and 500V
- $r_{DS(ON)} = 3.0\Omega$ and 4.0Ω
- 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
IRFR420	TO-252AA	IRFR420
IRFR421	TO-252AA	IRFR421
IRFR422	TO-252AA	IRFR422
IRFU420	TO-251AA	IRFU420
IRFU421	TO-251AA	IRFU421
IRFU422	TO-251AA	IRFU422

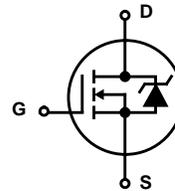
NOTE: When ordering, use the entire part number.

Description

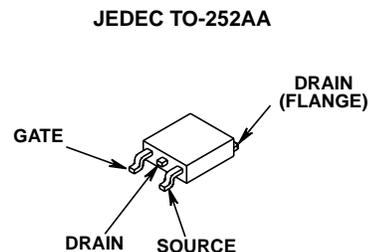
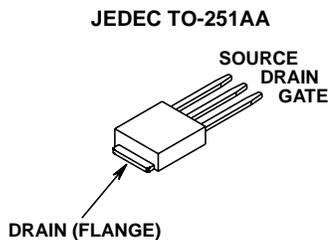
These are N-Channel enhancement mode silicon gate power field effect transistors. They are advanced power MOSFETs designed, tested, and guaranteed to withstand a specified level of energy in the breakdown avalanche mode of operation. All of these power MOSFETs are designed for applications such as switching 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 TA17405.

Symbol



Packaging



IRFR420, IRFR421, IRFR422, IRFU420, IRFU421, IRFU422

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

	IRFR420 IRFU420	IRFR421 IRFU421	IRFR422 IRFU422	UNITS	
Drain to Source Voltage (Note 1)	V_{DS}	500	450	500	V
Drain to Gate Voltage ($R_{GS} = 20\text{k}\Omega$) (Note 1)	V_{DGR}	500	450	500	V
Continuous Drain Current	I_D	2.5	2.5	2.2	A
$T_C = 100^\circ\text{C}$	I_D	1.6	1.6	1.4	A
Pulsed Drain Current (Note 3)	I_{DM}	8	8	7	A
Gate to Source Voltage	V_{GS}	± 20	± 20	± 20	V
Maximum Power Dissipation	P_D	50	50	50	W
Linear Derating Factor		0.4	0.4	0.4	W/ $^\circ\text{C}$
Single Pulse Avalanche Energy Rating (Note 4)	E_{AS}	210	210	210	mJ
Operating and Storage Temperature	T_J, T_{STG}	-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	$^\circ\text{C}$
Package Body for 10s, See Techbrief 334	T_{pkg}	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:

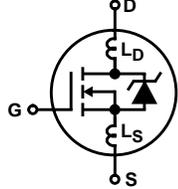
- $T_J = 25^\circ\text{C}$ to 125°C .

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

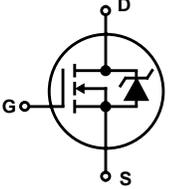
PARAMETER	SYMBOL	TEST CONDITIONS	MIN	TYP	MAX	UNITS
Drain to Source Breakdown Voltage IRFR420, IRFU420, IRFR422, IRFU422	BV_{DSS}	$I_D = 250\mu\text{A}, V_{GS} = 0\text{V}$ (Figure 10)	500	-	-	V
IRFR421, IRFU421			450	-	-	V
Gate Threshold Voltage	$V_{GS(TH)}$	$V_{GS} = V_{DS}, I_D = 250\mu\text{A}$	2.0	-	4.0	V
Zero Gate Voltage Drain Current	I_{DSS}	$V_{DS} = \text{Rated } BV_{DSS}, V_{GS} = 0\text{V}$	-	-	25	μA
		$V_{DS} = 0.8 \times \text{Rated } BV_{DSS}, V_{GS} = 0\text{V}$ $T_J = 125^\circ\text{C}$	-	-	250	μA
On-State Drain Current (Note 2) IRFR420, IRFU420, IRFR421, IRFU421	$I_{D(ON)}$	$V_{DS} > I_{D(ON)} \times r_{DS(ON)MAX}, V_{GS} = 10\text{V}$	2.5	-	-	A
IRFR422, IRFU422			2.2	-	-	V
Gate to Source Leakage Current	I_{GSS}	$V_{GS} = \pm 20\text{V}$	-	-	± 100	nA
Drain to Source On Resistance (Note 2) IRFR420, IRFU420, IRFR421, IRFU421	$r_{DS(ON)}$	$I_D = 1.3\text{A}, V_{GS} = 10\text{V}$ (Figures 8, 9)	-	2.9	3.0	Ω
IRFR422, IRFU422			-	-	4.0	Ω
Forward Transconductance (Note 2)	g_{fs}	$V_{DS} \geq 50\text{V}, I_D = 1.4\text{A}$ (Figure 12)	1.5	2.2	-	S
Turn-On Delay Time	$t_{d(ON)}$	$V_{DD} = 250\text{V}, I_D \approx 2.5\text{A}, R_G = 18\Omega, R_L = 100\Omega,$ $V_{GS} = 10\text{V}$ (Figures 17, 18) MOSFET Switching Times are Essentially Independent of Operating Temperature	-	10	15	ns
Rise Time	t_r		-	12	18	ns
Turn-Off Delay Time	$t_{d(OFF)}$		-	28	42	ns
Fall Time	t_f		-	12	18	ns
Total Gate Charge (Gate to Source + Gate to Drain)	$Q_{g(TOT)}$		$V_{GS} = 10\text{V}, I_D = 2.5\text{A}, V_{DS} = 0.8 \times \text{Rated } BV_{DSS}$ $I_{G(REF)} = 1.5\text{mA}$ (Figures 14, 19, 20) Gate Charge is Essentially Independent of Operating Temperature	-	13	19
Gate to Source Charge	Q_{gs}		-	2.2	3.3	nC
Gate to Drain "Miller" Charge	Q_{gd}		-	6.8	10	nC

IRFR420, IRFR421, IRFR422, IRFU420, IRFU421, IRFU422

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

PARAMETER	SYMBOL	TEST CONDITIONS		MIN	TYP	MAX	UNITS
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}			-	54	-	pF
Reverse Transfer Capacitance	C_{RSS}			-	9.6	-	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	$R_{\theta JA}$	Mounted on FR-4 Board with Minimum Mounting pad		-	-	110	$^\circ\text{C/W}$

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 	-	-	2.5	A	
Pulse Source to Drain Current (Note 3)	I_{SDM}		-	-	8	A	
Source to Drain Diode Voltage (Note 2)	V_{SD}	$T_J = 25^\circ\text{C}$, $I_{SD} = 2.5\text{A}$, $V_{GS} = 0\text{V}$ (Figure 13)		-	-	1.6	V
Reverse Recovery Time	t_{rr}	$T_J = 25^\circ\text{C}$, $I_{SD} = 2.5\text{A}$, $dI_{SD}/dt = 100\text{A}/\mu\text{s}$		130	270	540	ns
Reverse Recovery Charge	Q_{RR}	$T_J = 25^\circ\text{C}$, $I_{SD} = 2.5\text{A}$, $dI_{SD}/dt = 100\text{A}/\mu\text{s}$		0.57	1.2	2.3	μC

NOTES:

- Pulse test: pulse width $\leq 300\mu\text{s}$, duty cycle $\leq 2\%$.
- Repetitive rating: pulse width limited by maximum junction temperature. See Transient Thermal Impedance curve (Figure 3).
- $V_{DD} = 50\text{V}$, starting $T_J = 25^\circ\text{C}$, $L = 60\text{mH}$, $R_G = 25\Omega$, peak $I_{AS} = 2.5\text{A}$.

IRFR420, IRFR421, IRFR422, IRFU420, IRFU421, IRFU422

Typical Performance Curves Unless Otherwise Specified

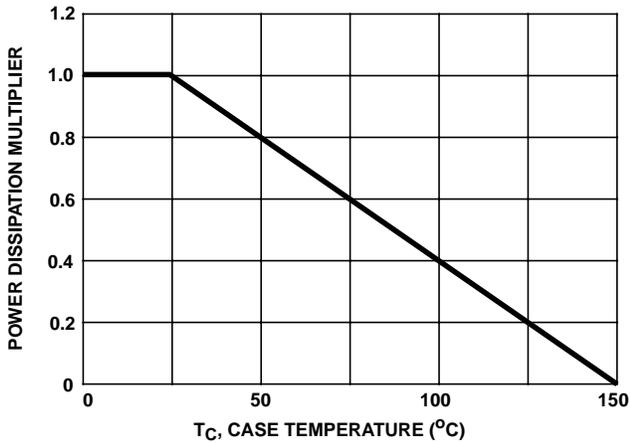


FIGURE 1. NORMALIZED POWER DISSIPATION vs CASE TEMPERATURE

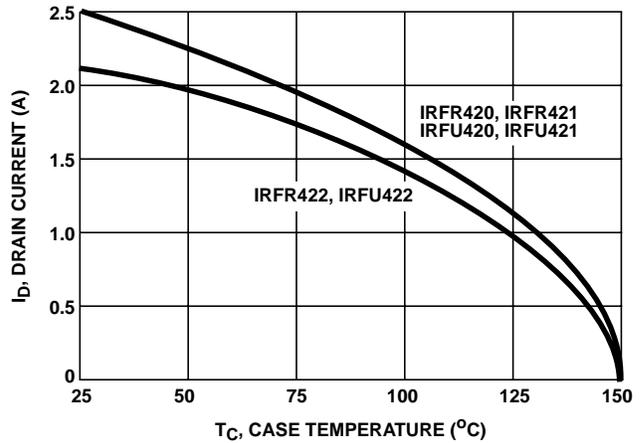


FIGURE 2. MAXIMUM CONTINUOUS DRAIN CURRENT vs CASE TEMPERATURE

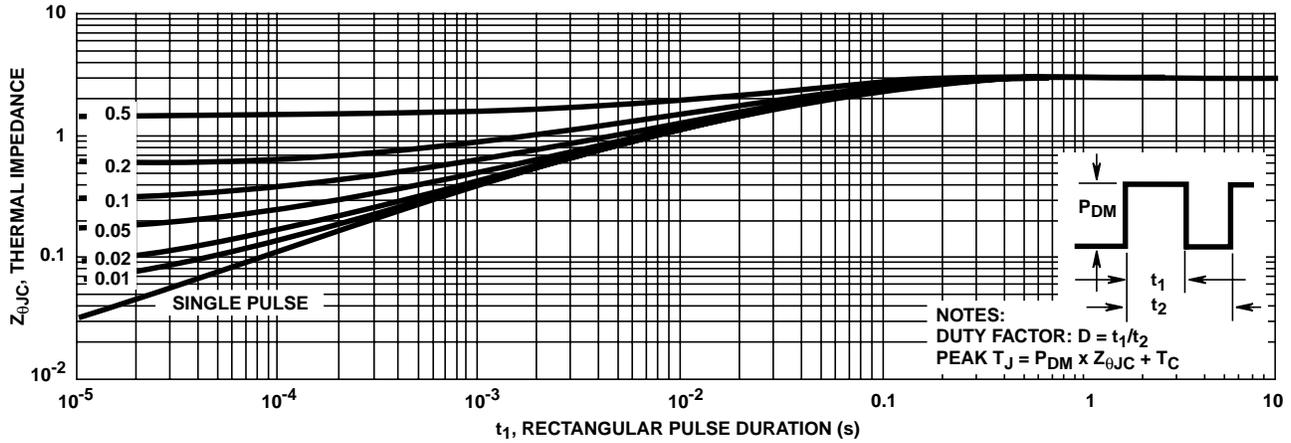


FIGURE 3. MAXIMUM TRANSIENT THERMAL IMPEDANCE

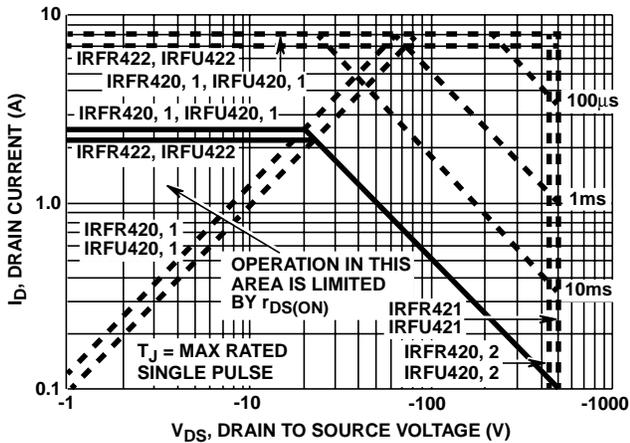


FIGURE 4. FORWARD BIAS SAFE OPERATING AREA

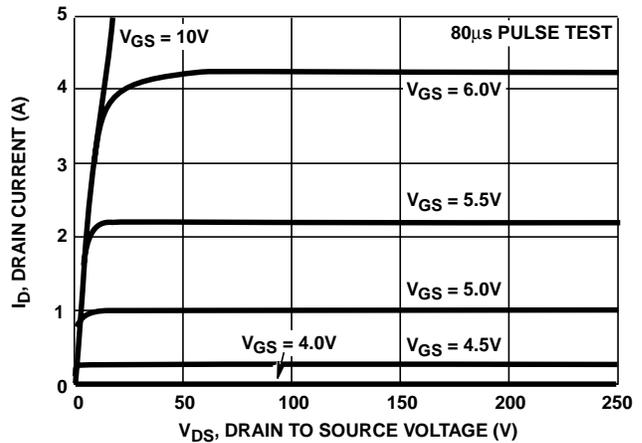


FIGURE 5. OUTPUT CHARACTERISTICS

Typical Performance Curves Unless Otherwise Specified (Continued)

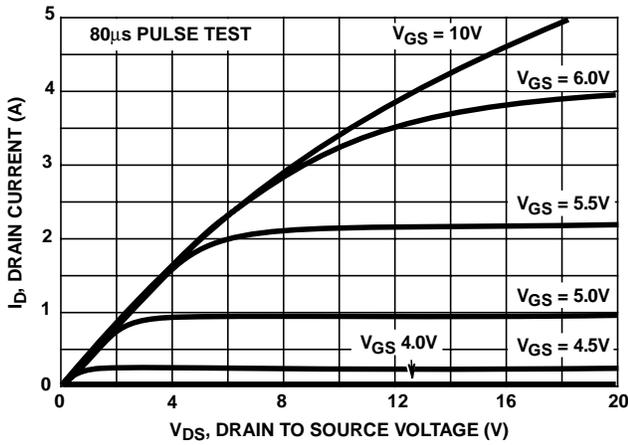


FIGURE 6. SATURATION CHARACTERISTICS

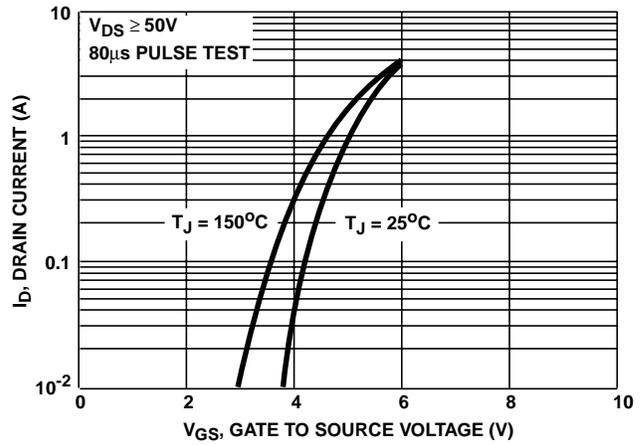


FIGURE 7. TRANSFER CHARACTERISTICS

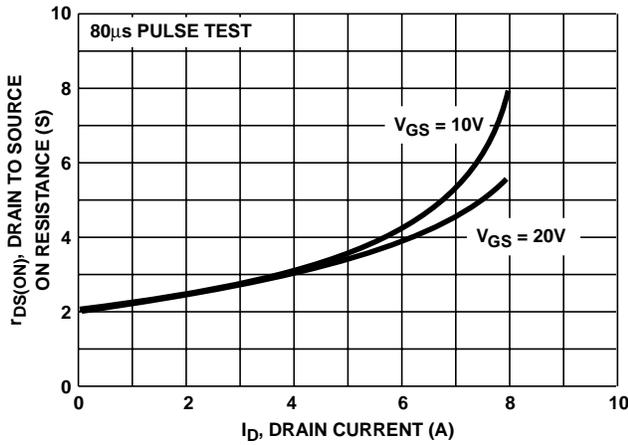


FIGURE 8. DRAIN TO SOURCE ON RESISTANCE vs GATE VOLTAGE AND DRAIN CURRENT

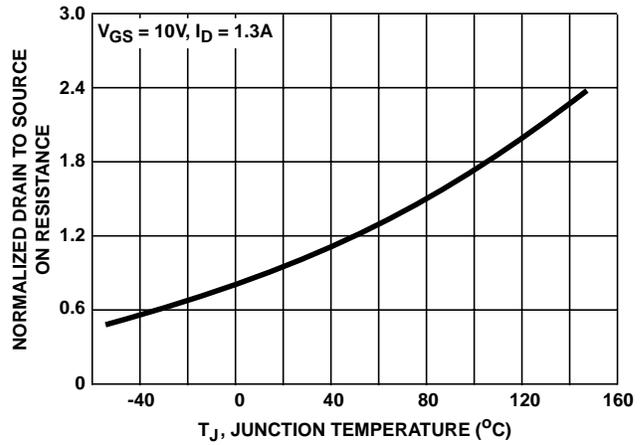


FIGURE 9. NORMALIZED DRAIN TO SOURCE ON RESISTANCE vs JUNCTION TEMPERATURE

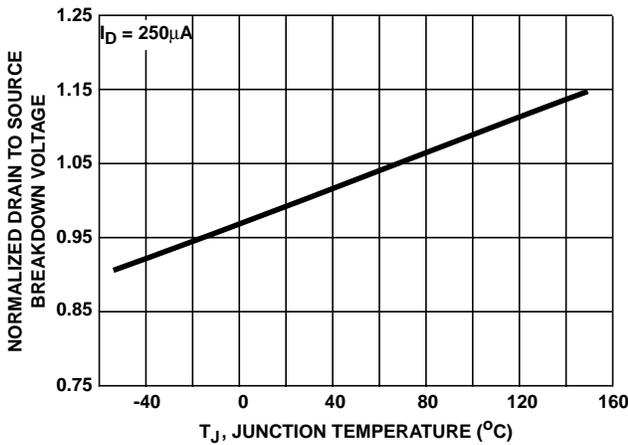


FIGURE 10. NORMALIZED DRAIN TO SOURCE BREAKDOWN VOLTAGE vs JUNCTION TEMPERATURE

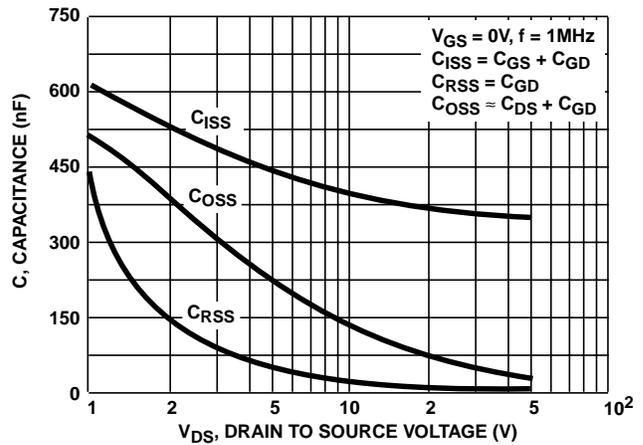


FIGURE 11. CAPACITANCE vs DRAIN TO SOURCE VOLTAGE

Typical Performance Curves Unless Otherwise Specified (Continued)

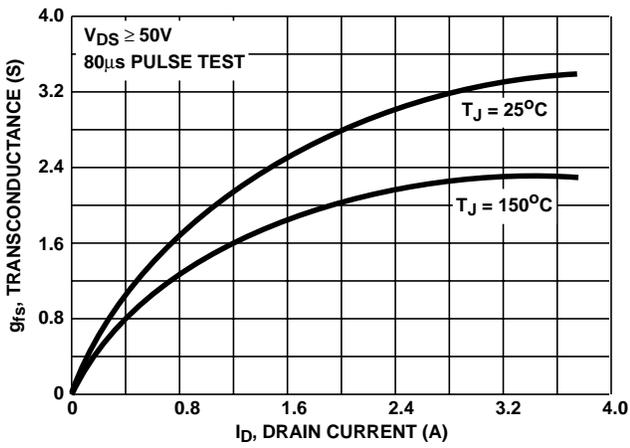


FIGURE 12. TRANSCONDUCTANCE vs DRAIN CURRENT

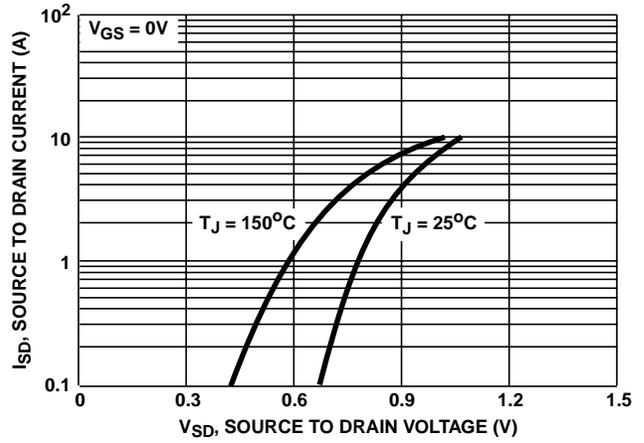


FIGURE 13. SOURCE TO DRAIN DIODE VOLTAGE

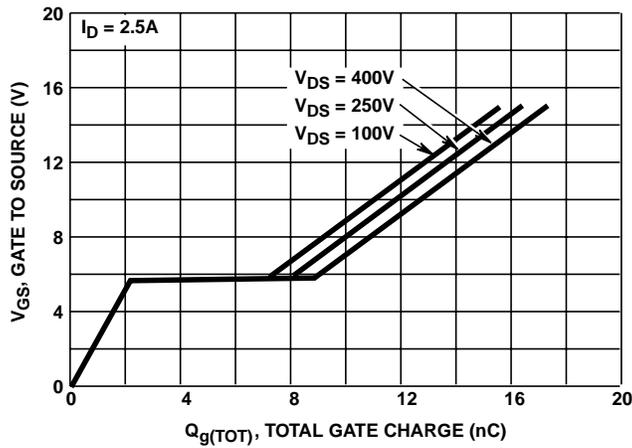


FIGURE 14. GATE TO SOURCE VOLTAGE vs GATE CHARGE

Test Circuits and Waveforms

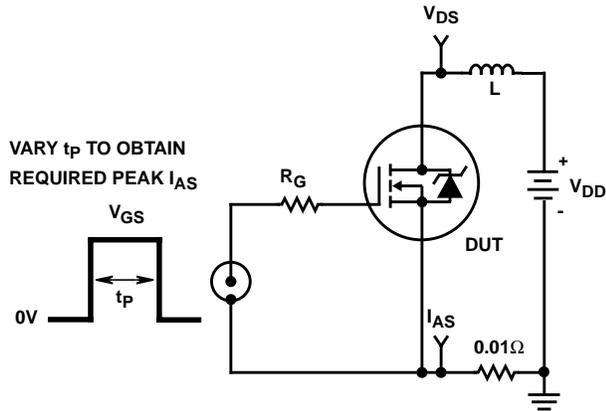


FIGURE 15. UNCLAMPED ENERGY TEST CIRCUIT

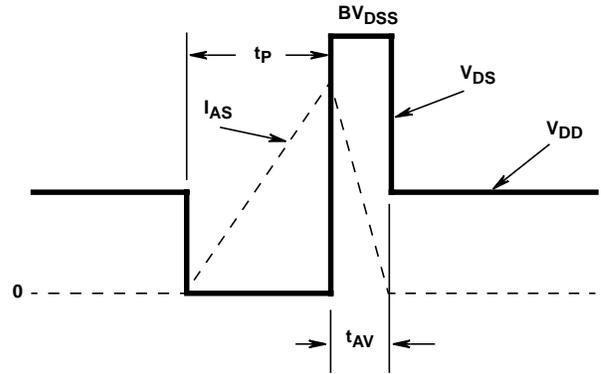


FIGURE 16. UNCLAMPED ENERGY WAVEFORMS

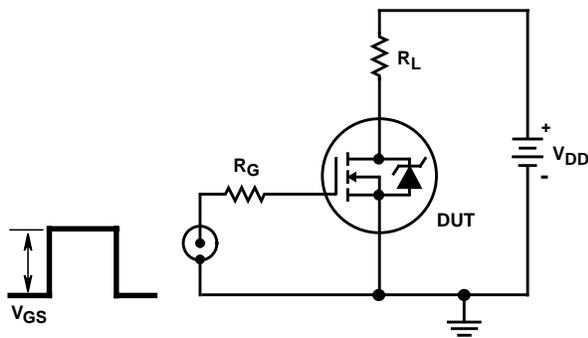


FIGURE 17. SWITCHING TIME TEST CIRCUIT

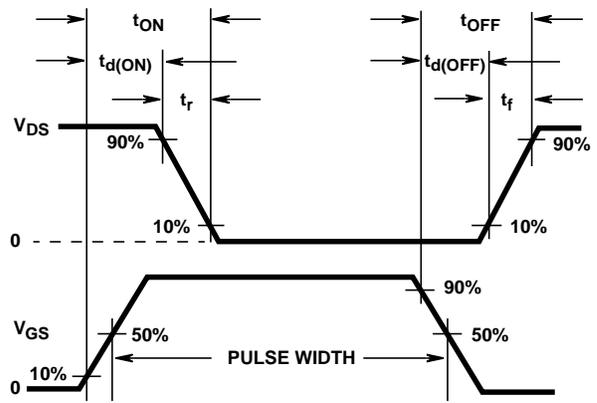


FIGURE 18. RESISTIVE SWITCHING WAVEFORMS

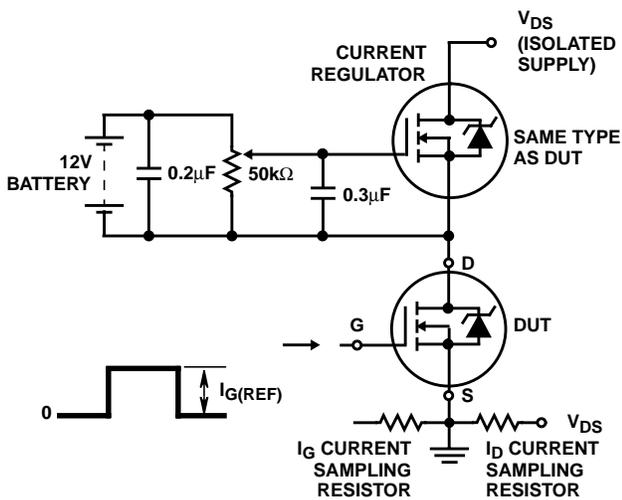


FIGURE 19. GATE CHARGE TEST CIRCUIT

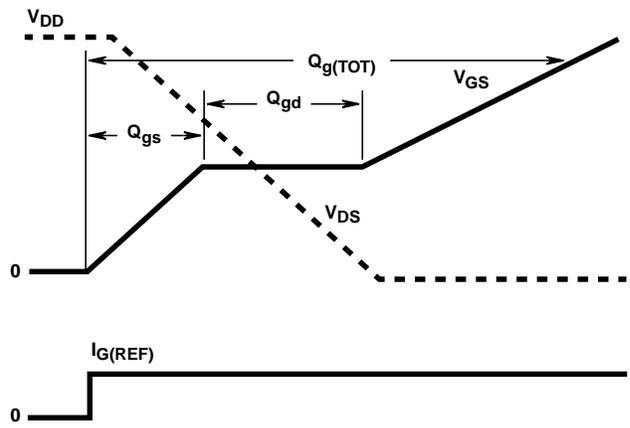


FIGURE 20. GATE CHARGE WAVEFORMS