Data Sheet   **January 2002**

5.6A, 100V, 0.540 Ohm, N-Channel Power MOSFET

This N-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 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 TA17441.

Ordering Information

PART NUMBER	PACKAGE	BRAND
IRF510	TO-220AB	IRF510

NOTE: When ordering, include the entire part number.

Features

- 5.6A, 100V

- $r_{DS(ON)} = 0.540\Omega$

- 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
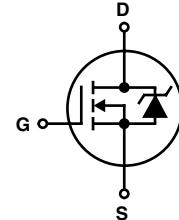
Packaging

JEDEC TO-220AB

SOURCE
DRAIN
GATE

DRAIN (FLANGE)
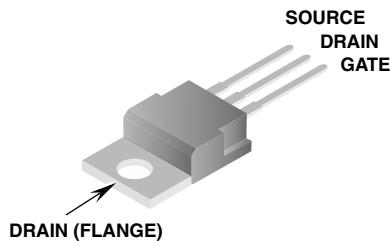
IRF510

Absolute Maximum Ratings $T_C = 25^oC$, Unless Otherwise Specified

|		IRF510	UNITS
Drain to Source Voltage (Note 1) . . . .V_{DS}		100	V
Drain to Gate Voltage ($R_{GS} = 20k\Omega$) (Note 1) . . . . V_{DGR}		100	V
Continuous Drain Current . . . . I_D		5.6	A
$T_C = 100^oC$ . . . . I_D		4	A
Pulsed Drain Current (Note 3) . . . . I_{DM}		20	A
Gate to Source Voltage . . . . V_{GS}		±20	V
Maximum Power Dissipation . . . .P_D		43	W
Linear Derating Factor		0.29	W/^oC
Single Pulse Avalanche Energy Rating (Note 4) . . . .E_{AS}		19	mJ
Operating and Storage Temperature Range . . . .T_J, T_{STG}		-55 to 175	^oC
Maximum Temperature for Soldering			
Leads at 0.063in (1.6mm) from Case for 10s . . . .T_L		300	^oC
Package Body for 10s, See Techbrief 334 . . . . T_{pkg}		260	^oC

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. $T_J = 25^oC$ to 150^oC.

Electrical Specifications $T_C = 25^oC$, Unless Otherwise Specified

PARAMETER	SYMBOL	TEST CONDITIONS	MIN	TYP	MAX	UNITS
Drain to Source Breakdown Voltage	BV_{DSS}	$V_{GS} = 0V$, $I_D = 250\mu A$, (Figure 10)	100	-	-	V
Gate to Threshold Voltage	$V_{GS(TH)}$	$V_{GS} = V_{DS}$, $I_D = 250\mu A$	2.0	-	4.0	V
Zero-Gate Voltage Drain Current	I_{DSS}	$V_{DS} = 95V$, $V_{GS} = 0V$	-	-	25	µA
		$V_{DS} = 0.8$ x Rated BV_{DSS}, $V_{GS} = 0V$, $T_J = 150^oC$	-	-	250	µA
On-State Drain Current (Note 2)	$I_{D(ON)}$	$V_{DS} > I_{D(ON)}$ x $r_{DS(ON)MAX}$, $V_{GS} = 10V$ (Figure 7)	5.6	-	-	A
Gate to Source Leakage Current	I_{GSS}	$V_{GS} = ±20V$	-	-	±100	nA
Drain to Source On Resistance (Note 2)	$r_{DS(ON)}$	$V_{GS} = 10V$, $I_D = 3.4A$ (Figures 8, 9)	-	0.4	0.54	Ω
Forward Transconductance (Note 2)	g_{fs}	$V_{GS} = 50V$, $I_D = 3.4A$ (Figure 12)	1.3	2.0	-	S
Turn-On Delay Time	$t_{d(ON)}$	$I_D \approx 5.6A$, $R_{GS} = 24\Omega$, $V_{DD} = 50V$, $R_L = 9\Omega$, $V_{DD} = 50V$, $V_{GS} = 10V$ MOSFET switching times are essentially independent of operating temperature	-	8	12	ns
Rise Time	t_r		-	25	63	ns
Turn-Off Delay Time	$t_{d(OFF)}$		-	15	7	ns
Fall Time	t_f		-	12	59	ns
Total Gate Charge (Gate to Source + Gate to Drain)	$Q_{g(TOT)}$	$V_{GS} = 10V$, $I_D = 5.6A$, $V_{DS} = 0.8$ x Rated BV_{DSS}, $I_{G(REF)} = 1.5mA$ (Figure 14) Gate charge is essentially independent of operating temperature.	-	5.0	30	nC
Gate to Source Charge	Q_{gs}		-	2.0	-	nC
Gate to Drain "Miller" Charge	Q_{gd}		-	3.0	-	nC
Input Capacitance	C_{ISS}	$V_{GS} = 0V$, $V_{DS} = 25V$, $f = 1.0MHz$ (Figure 11)	-	135	-	pF
Output Capacitance	C_{OSS}		-	80	-	pF
Reverse-Transfer Capacitance	C_{RSS}		-	20	-	pF
Internal Drain Inductance	L_D	Measured From the Contact Screw On Tab To Center of Die	-	3.5	-	nH
		Measured From the Drain Lead, 6mm (0.25in) From Package to Center of Die	-	4.5	-	nH
Internal Source Inductance	L_S	Measured From The Source Lead, 6mm (0.25in) From Header to Source Bonding Pad	-	7.5	-	nH
Junction to Case	$R_{\theta JC}$		-	-	3.5	$^oC/W$
Junction to Ambient	$R_{\theta JA}$	Free air operation	-	-	80	$^oC/W$
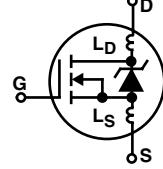
Modified MOSFET Symbol Showing the Internal Devices Inductances

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 Diode		-	-	5.6	A
Pulse Source to Drain Current (Note 3)	I_{SDM}			-	-	20	A
Source to Drain Diode Voltage (Note 2)	V_{SD}	$T_J = 25^oC$, $I_{SD} = 5.6A$, $V_{GS} = 0V$ (Figure 13)		-	-	2.5	V
Reverse Recovery Time	t_{rr}	$T_J = 25^oC$, $I_{SD} = 5.6A$, $dI_{SD}/d_t = 100A/\mu s$		4.6	96	200	ns
Reverse Recovered Charge	Q_{RR}	$T_J = 25^oC$, $I_{SD} = 5.6A$, $dI_{SD}/d_t = 100A/\mu s$		0.17	0.4	0.83	μC

NOTES:

2. Pulse test: pulse width ≤ 300μs, duty cycle ≤ 2%.

3. Repetitive rating: pulse width limited by max junction temperature. See Transient Thermal Impedance curve (Figure 3).

4. $V_{DD} = 25V$, start $T_J = 25^oC$, L = 910μH, $R_G = 25\Omega$, peak $I_{AS} = 5.6A$.

Typical Performance Curves Unless Otherwise Specified
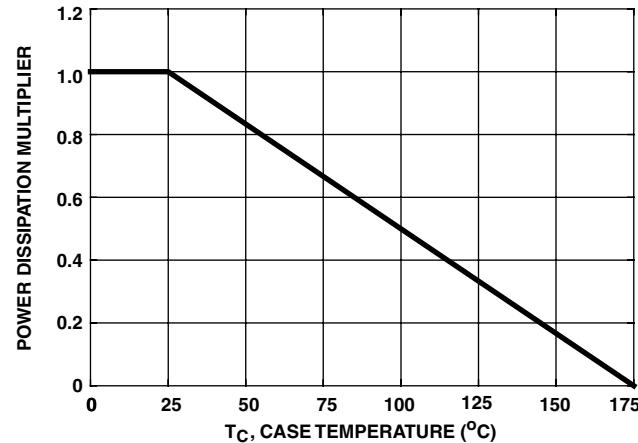
FIGURE 1. NORMALIZED POWER DISSIPATION vs CASE TEMPERATURE
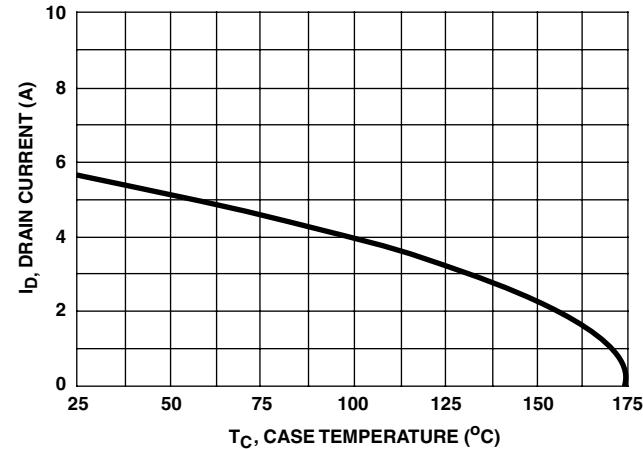
FIGURE 2. MAXIMUM CONTINUOUS DRAIN CURRENT vs CASE TEMPERATURE

NOTES:
DUTY FACTOR: D = t_1/t_2
PEAK T_J = P_{DM} x $Z_{\theta JC}$ + T_C
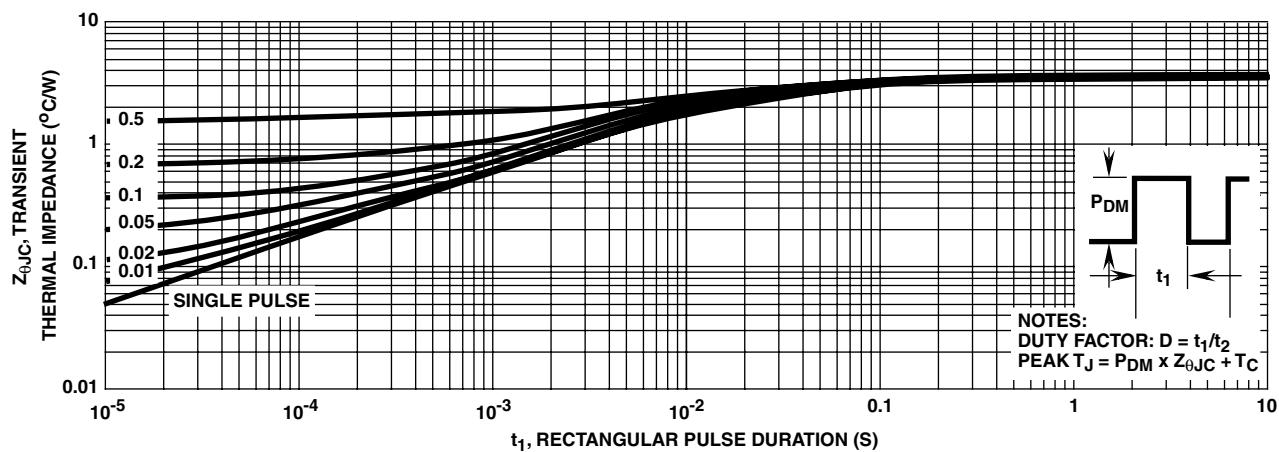
FIGURE 3. MAXIMUM TRANSIENT THERMAL IMPEDANCE

Typical Performance Curves Unless Otherwise Specified **(Continued)**

OPERATION IN THIS REGION IS LIMITED BY r$_{DS(ON)}$

10μs

100μs

1ms

T$_C$ = 25°C
T$_J$ = 175°C
SINGLE PULSE

I$_D$, DRAIN CURRENT (A)

V$_{DS}$, DRAIN TO SOURCE VOLTAGE (V)
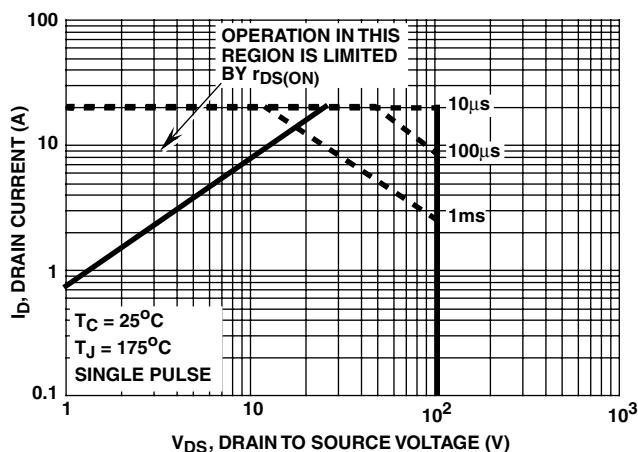
FIGURE 4. FORWARD BIAS SAFE OPERATING AREA

PULSE DURATION = 80μs
DUTY CYCLE = 0.5% MAX

V$_{GS}$ = 10V
V$_{GS}$ = 8V
V$_{GS}$ = 7V
V$_{GS}$ = 6V
V$_{GS}$ = 5V
V$_{GS}$ = 4V

I$_D$, DRAIN CURRENT (A)

V$_{DS}$, DRAIN TO SOURCE VOLTAGE (V)
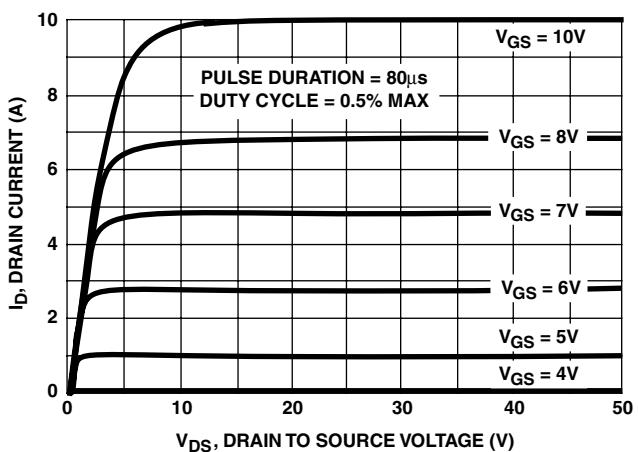
FIGURE 5. OUTPUT CHARACTERISTICS

PULSE DURATION = 80μs
DUTY CYCLE = 0.5% MAX

V$_{GS}$ = 10V
V$_{GS}$ = 8V
V$_{GS}$ = 7V
V$_{GS}$ = 6V
V$_{GS}$ = 5V
V$_{GS}$ = 4V

I$_D$, DRAIN CURRENT (A)

V$_{DS}$, DRAIN TO SOURCE VOLTAGE (V)
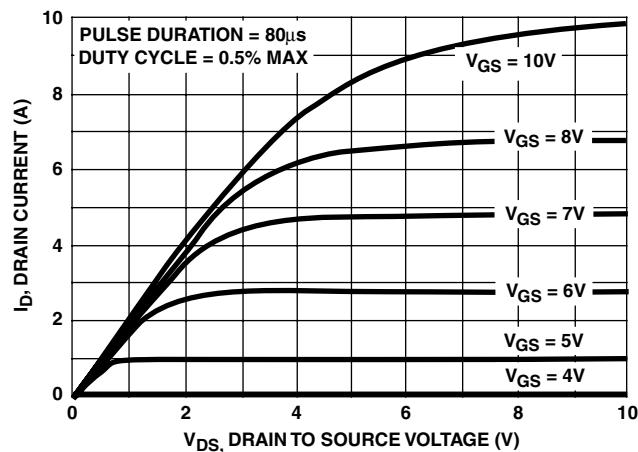
FIGURE 6. SATURATION CHARACTERISTICS

V$_{DS}$ ≥ 50V
PULSE DURATION = 80μs
DUTY CYCLE = 0.5% MAX

T$_J$ = 175°C   T$_J$ = 25°C

I$_{D(ON)}$, ON-STATE DRAIN CURRENT (A)

V$_{GS}$, GATE TO SOURCE VOLTAGE (V)
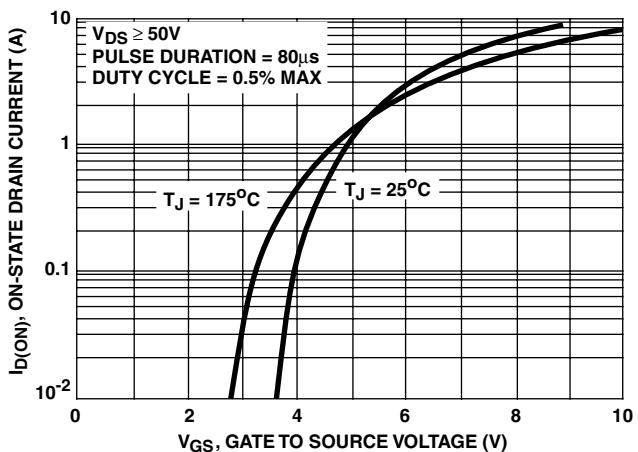
FIGURE 7. TRANSFER CHARACTERISTICS

PULSE DURATION = 80μs
DUTY CYCLE = 0.5% MAX

V$_{GS}$ = 10V
V$_{GS}$ = 20V

r$_{DS(ON)}$, DRAIN TO SOURCE ON RESISTANCE (Ω)
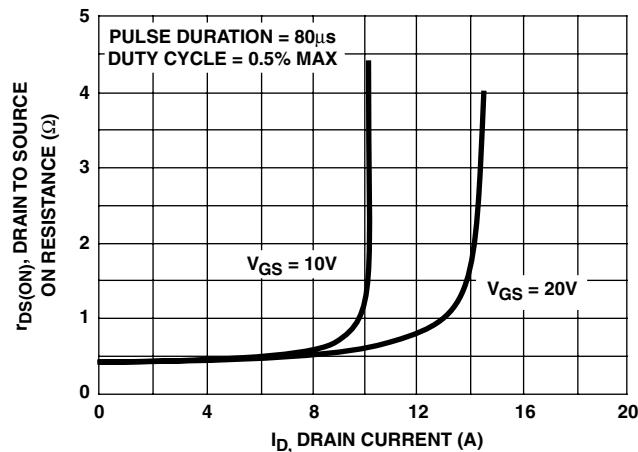
I$_D$, DRAIN CURRENT (A)

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

I$_D$ = 3.4A, V$_{GS}$ = 10V
PULSE DURATION = 80μs
DUTY CYCLE = 0.5% MAX

NORMALIZED ON RESISTANCE

T$_J$, JUNCTION TEMPERATURE (^{o}C)
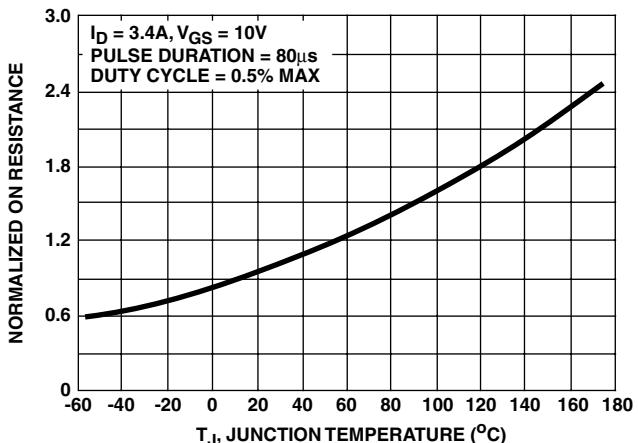
FIGURE 9. NORMALIZED DRAIN TO SOURCE ON RESISTANCE vs JUNCTION TEMPERATURE

## *Typical Performance Curves* Unless Otherwise Specified **(Continued)**
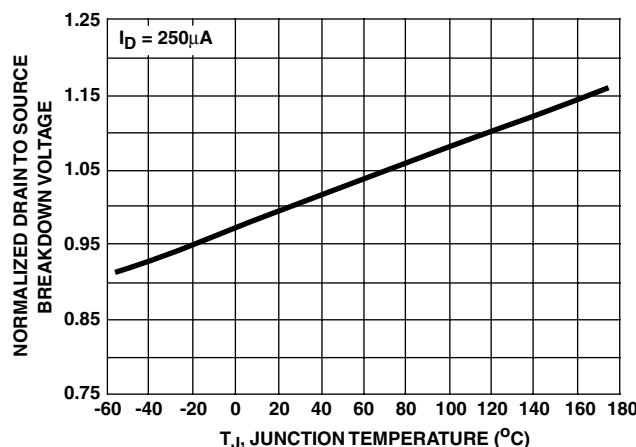
FIGURE 10. NORMALIZED DRAIN TO SOURCE BREAKDOWN VOLTAGE vs JUNCTION TEMPERATURE
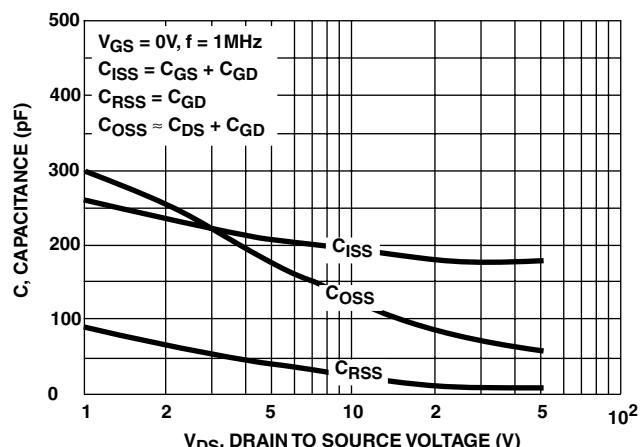
FIGURE 11. CAPACITANCE vs DRAIN TO SOURCE VOLTAGE
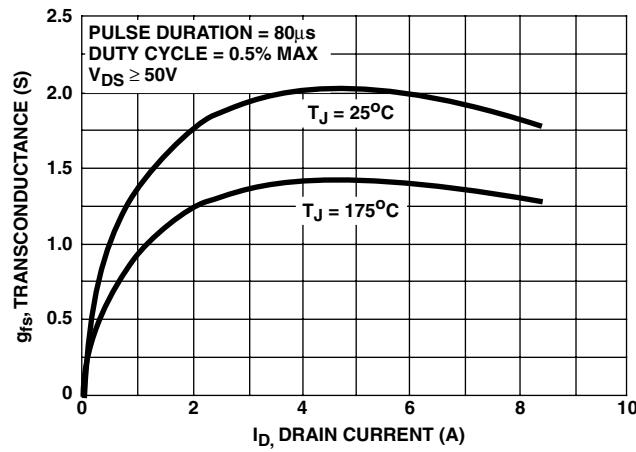
FIGURE 12. TRANSCONDUCTANCE vs DRAIN CURRENT
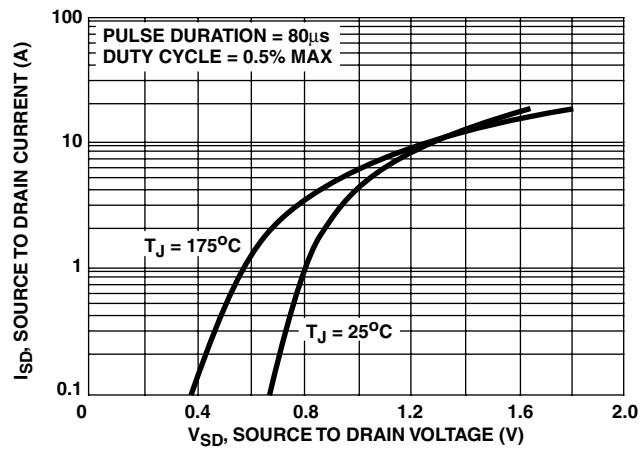
FIGURE 13. SOURCE TO DRAIN DIODE VOLTAGE
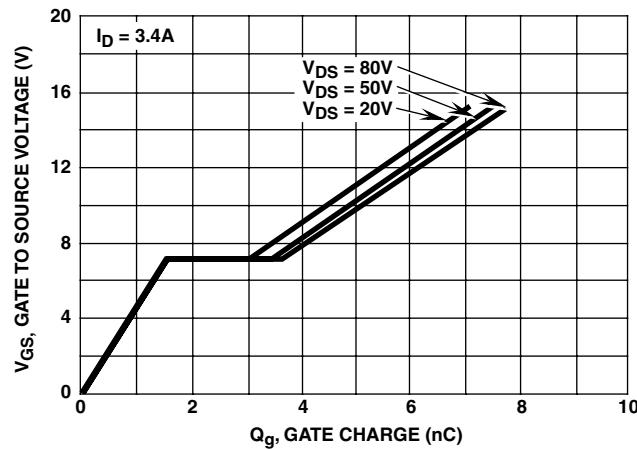
**FIGURE 14. GATE TO SOURCE VOLTAGE vs GATE CHARGE**

Test Circuits and Waveforms
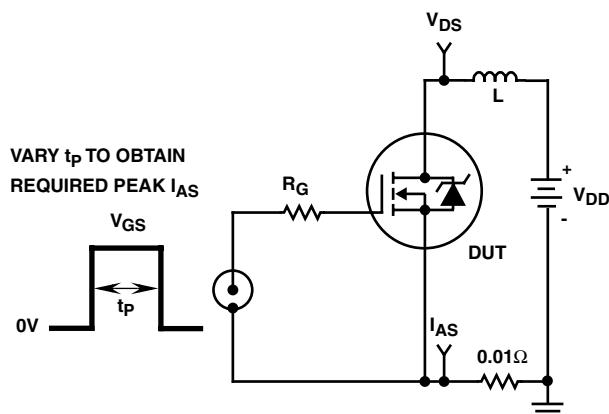
FIGURE 15. UNCLAMPED ENERGY TEST CIRCUIT
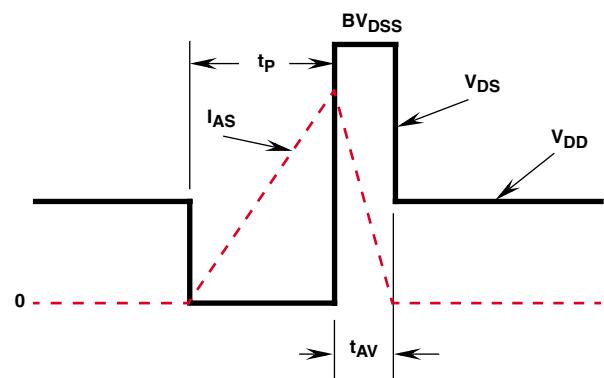
FIGURE 16. UNCLAMPED ENERGY WAVEFORMS
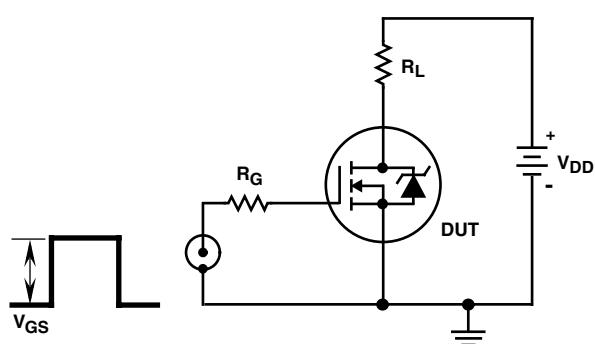
**FIGURE 17. SWITCHING TIME TEST CIRCUIT**
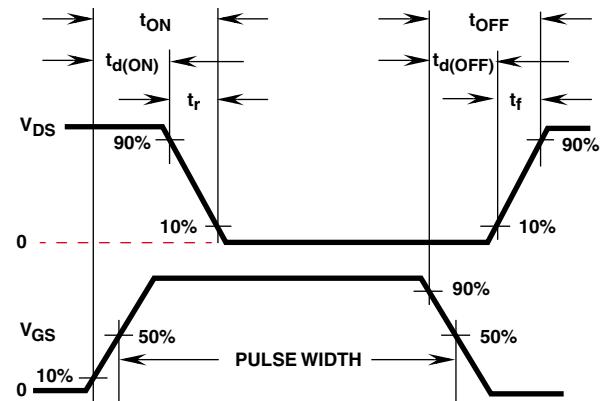
**FIGURE 18. RESISTIVE SWITCHING WAVEFORMS**
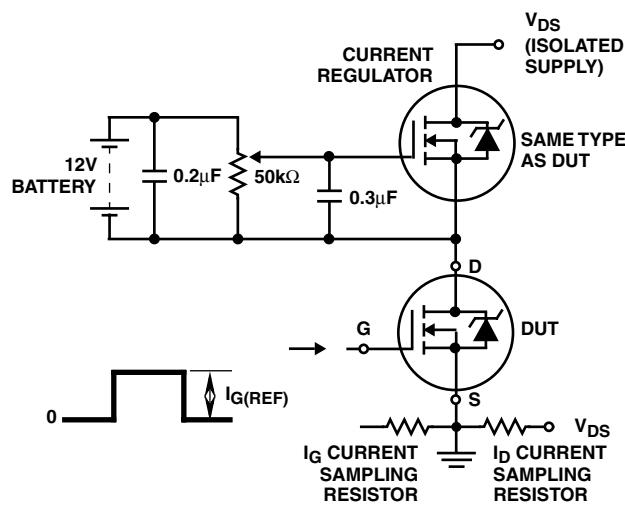
**FIGURE 19. GATE CHARGE TEST CIRCUIT**
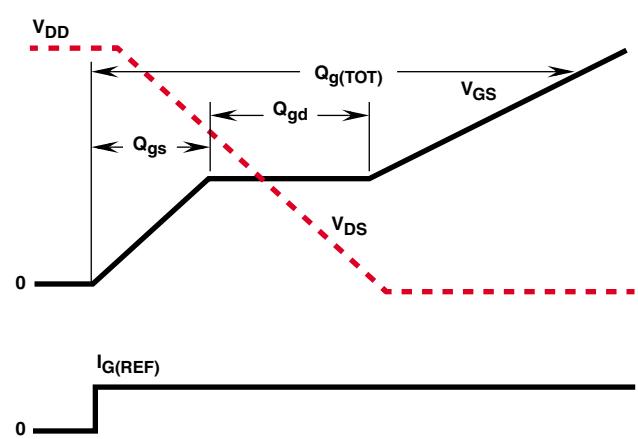
FIGURE 20. GATE CHARGE WAVEFORM

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