File Number **2214**

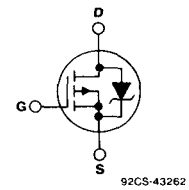
IRF9510, IRF9511
IRF9512, IRF9513

Avalanche-Energy-Rated P-Channel Power MOSFETs

-2.5A, and -3.0A, -60V and -100V
$r_{DS(on)}$ = 1.2Ω and 1.6Ω

Features:
- *Single pulse avalanche energy rated*
- *SOA is power-dissipation limited*
- *Nanosecond switching speeds*
- *Linear transfer characteristics*
- *High input impedance*

TERMINAL DIAGRAM



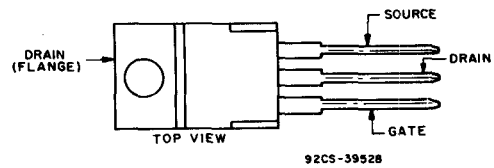
P-CHANNEL ENHANCEMENT MODE

6

The IRF9510, IRF9511, IRF9512 and IRF9513 are advanced power MOSFETs designed, tested, and guaranteed to withstand a specified level of energy in the breakdown avalanche mode of operation. These are p-channel enhancement-mode silicon-gate power field-effect transistors 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.

The IRF-types are supplied in the JEDEC TO-220AB plastic package.

TERMINAL DESIGNATION



JEDEC TO-220AB

Absolute Maximum Ratings

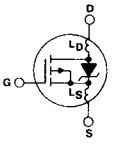
	Parameter	IRF9510	IRF9511	IRF9512	IRF9513	Units
V_{DS}	Drain - Source Voltage ①	-100	-60	-100	-60	V
V_{DGR}	Drain - Gate Voltage (R_{GS} = 20 kΩ) ①	-100	-60	-100	-60	V
I_D @ T_C = 25°C	Continuous Drain Current	-3.0	-3.0	-2.5	-2.5	A
I_D @ T_C = 100°C	Continuous Drain Current	-2.0	-2.0	-1.5	-1.5	A
I_{DM}	Pulsed Drain Current ③	-12	-12	-10	-10	A
V_{GS}	Gate - Source Voltage	±20				V
P_D @ T_C = 25°C	Max. Power Dissipation	20 (See Fig. 14)				W
	Linear Derating Factor	0.16 (See Fig. 14)				W/°C
E_{AS}	Single Pulse Avalanche Energy ④	190				mJ
T_J T_{stg}	Operating Junction and Storage Temperature Range	-55 to 150				°C
	Lead Temperature	300 (0.063 in. (1.6mm) from case for 10s)				°C

IRF9510, IRF9511, IRF9512, IRF9513

Electrical Characteristics @T_C = 25°C (Unless Otherwise Specified)

Parameter		Type	Min.	Typ.	Max.	Units	Test Conditions
BV_{DSS}	Drain - Source Breakdown Voltage	IRF9510 IRF9512	-100	–	–	V	V_{GS} = 0V
		IRF9511 IRF9513	-60	–	–	V	I_D = -250μA
$V_{GS(th)}$	Gate Threshold Voltage	ALL	-2.0	–	-4.0	V	V_{DS} = V_{GS}, I_D = -250μA
I_{GSS}	Gate - Source Leakage Forward	ALL	–	–	-500	nA	V_{GS} = -20V
I_{GDS}	Gate - Source Leakage Reverse	ALL	–	–	500	nA	V_{GS} = 20V
I_{DSS}	Zero Gate Voltage Drain Current	ALL	–	–	-250	μA	V_{DS} = Max. Rating, V_{GS} = 0V
			–	–	-1000	μA	V_{DS} = Max. Rating x 0.8, V_{GS} = 0V, T_C = 125°C
$I_{D(on)}$	On-State Drain Current ②	IRF9510 IRF9511	-3.0	–	–	A	V_{DS} > $I_{D(on)}$ x $R_{DS(on)}$ max., V_{GS} = -10V
		IRF9512 IRF9513	-2.5	–	–	A	
$R_{DS(on)}$	Static Drain-Source On-State Resistance ②	IRF9510 IRF9511	–	1.0	1.2	Ω	V_{GS} = -10V, I_D = -1.5A
		IRF9512 IRF9513	–	1.2	1.6	Ω	
g_{fs}	Forward Transconductance ②	ALL	0.8	1.1	–	S(℧)	V_{DS} > $I_{D(on)}$ x $R_{DS(on)max.}$, I_D = -1.5A
C_{iss}	Input Capacitance	ALL	–	180	—	pF	V_{GS} = 0V, V_{DS} = -25V, f = 1.0 MHz See Fig. 10
C_{oss}	Output Capacitance	ALL	–	85	—	pF	
C_{rss}	Reverse Transfer Capacitance	ALL	–	30	—	pF	
$t_{d(on)}$	Turn-On Delay Time	ALL	–	15	30	ns	V_{DD} = -50V, I_D = -1.5A, Z_o = 50Ω See Fig. 17 (MOSFET switching times are essentially independent of operating temperature.)
t_r	Rise Time	ALL	–	30	60	ns	
$t_{d(off)}$	Turn-Off Delay Time	ALL	–	20	40	ns	
t_f	Fall Time	ALL	–	20	40	ns	
Q_g	Total Gate Charge (Gate-Source Plus Gate-Drain)	ALL	–	8.5	11	nC	V_{GS} = -15V, I_D = -4A, V_{DS} = 0.8V Max. Rating. See Fig. 18 for test circuit. (Gate charge is essentially independent of operating temperature.)
Q_{gs}	Gate-Source Charge	ALL	–	3.8	4.9	nC	
Q_{gd}	Gate-Drain ("Miller") Charge	ALL	–	4.7	6.1	nC	
L_D	Internal Drain Inductance	ALL	–	3.5	–	nH	Measured from the contact screw on tab to center of die.
			–	4.5	–	nH	Measured from the drain lead, 6mm (0.25 in.) from package to center of die.
L_S	Internal Source Inductance	ALL	–	7.5	–	nH	Measured from the source lead, 6mm (0.25 in.) from package to source bonding pad.

Modified MOSFET symbol showing the internal device inductances.

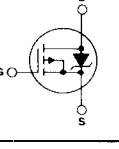


Thermal Resistance

$R_{\theta JC}$	Junction-to-Case	ALL	–	–	6.4	°C/W	
$R_{\theta CS}$	Case-to-Sink	ALL	–	1.0	–	°C/W	Mounting surface flat, smooth, and greased.
$R_{\theta JA}$	Junction-to-Ambient	ALL	–	–	80	°C/W	Typical socket mount

Source-Drain Diode Ratings and Characteristics

I_S	Continuous Source Current (Body Diode)	IRF9510 IRF9511	–	–	-3.0	A	Modified MOSFET symbol showing the integral reverse P-N junction rectifier.
		IRF9512 IRF9513	–	–	-2.5	A	
I_{SM}	Pulse Source Current (Body Diode) ③	IRF9510 IRF9511	–	–	-12	A	
		IRF9512 IRF9513	–	–	-10	A	
V_{SD}	Diode Forward Voltage ②	IRF9510 IRF9511	–	–	-1.5	V	T_C = 25°C, I_S = -3.0A, V_{GS} = 0V
		IRF9512 IRF9513	–	–	-1.5	V	T_C = 25°C, I_S = -2.5A, V_{GS} = 0V
t_{rr}	Reverse Recovery Time	ALL	–	120	–	ns	T_J = 150°C, I_F = -3.0A, dI_F/dt = 100 A/μs
Q_{RR}	Reverse Recovered Charge	ALL	–	6.0	–	μC	T_J = 150°C, I_F = -3.0A, dI_F/dt = 100 A/μs
t_{on}	Forward Turn-on Time	ALL	Intrinsic turn-on time is negligible. Turn-on speed is substantially controlled by L_S + L_D.				



①T_J = 25°C to 150°C.

②Pulse Test: Pulse width ≤ 300μs, Duty Cycle ≤ 2%.

③ Repetitive Rating: Pulse width limited by max. junction temperature. See Transient Thermal Impedance Curve (Fig. 5).

④ V_{DD} = 25V, Starting T_J = 25°C, L = 31.7 mH, R_G = 25Ω, Peak I_L = 3.0A, (See Fig. 15 and 16).

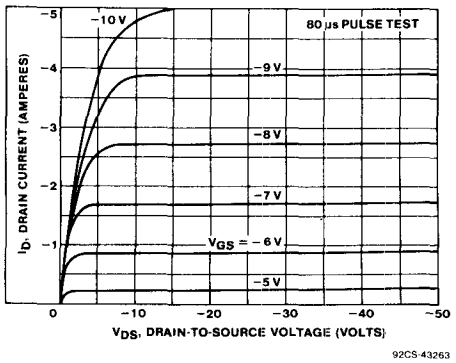


Fig. 1 - Typical Output Characteristics

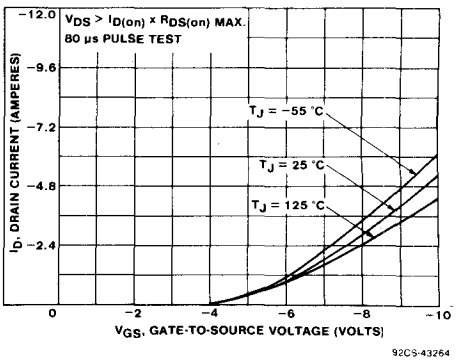


Fig. 2 - Typical Transfer Characteristics

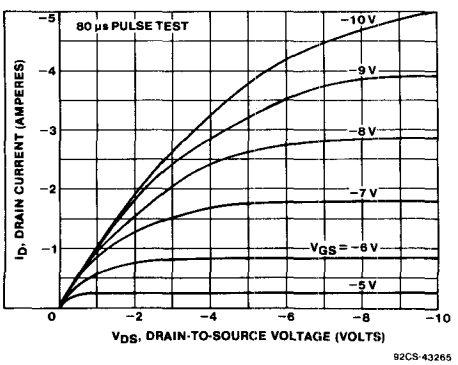


Fig. 3 - Typical saturation characteristic.

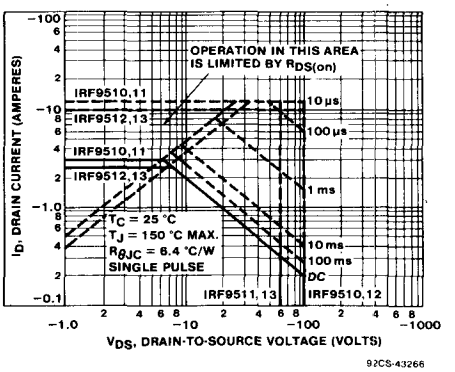


Fig. 4 - Maximum safe operating area.

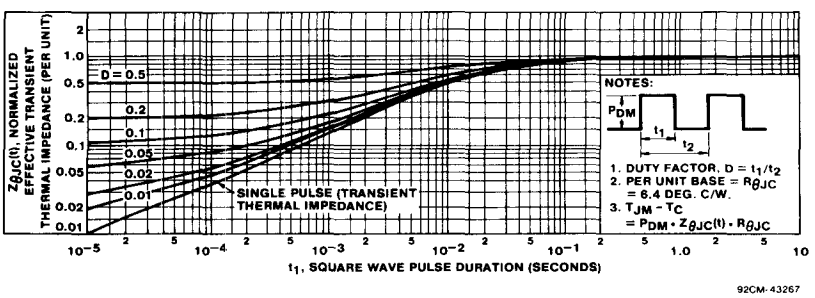


Fig. 5 - Maximum effective transient thermal impedance, junction-to-case vs. pulse duration.

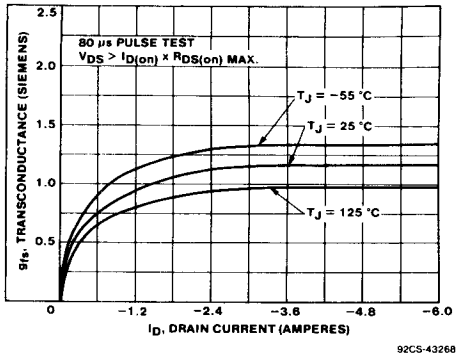


Fig. 6 - Typical transconductance vs. drain current.

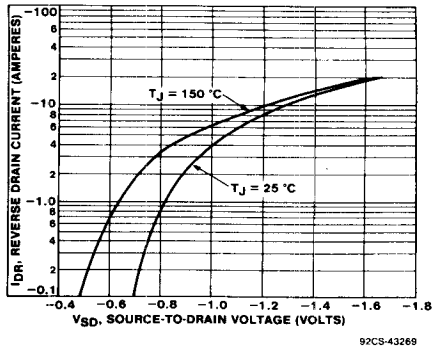


Fig. 7 - Typical source-drain diode forward voltage.

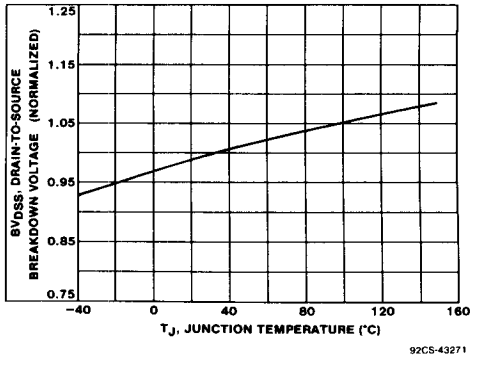


Fig. 8 - Breakdown voltage vs. temperature.

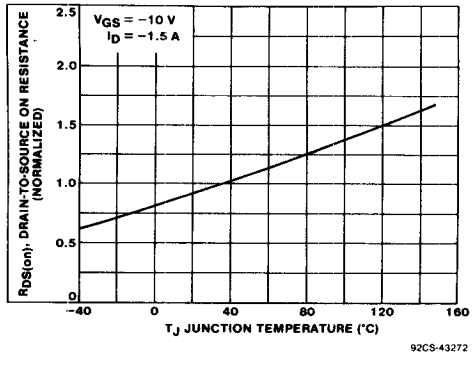


Fig. 9 - Normalized on-resistance vs. temperature.

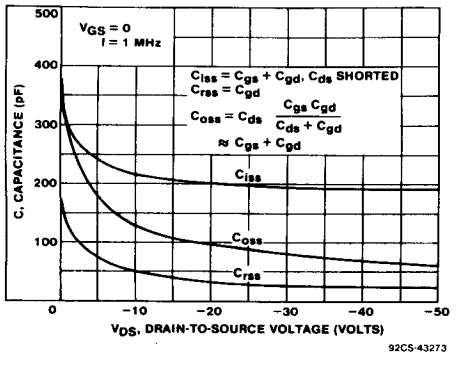


Fig. 10 - Typical capacitance vs. drain-to-source voltage.

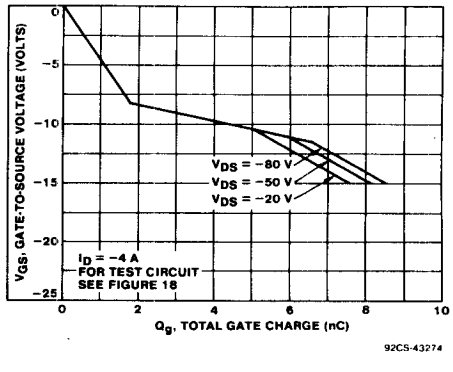


Fig. 11 - Typical gate charge vs. gate-to-source voltage.

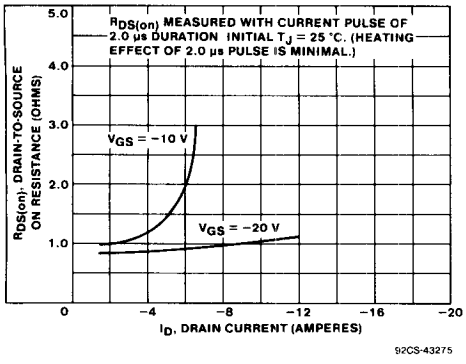


Fig. 12 - Typical on-resistance vs. drain current.

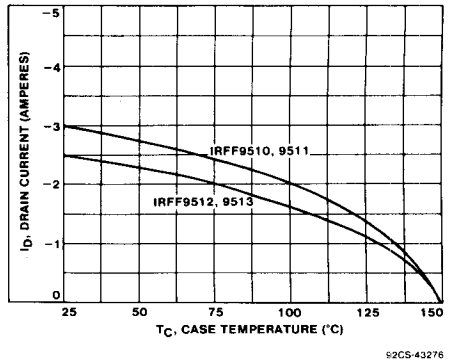


Fig. 13 - Maximum drain current vs. case temperature.

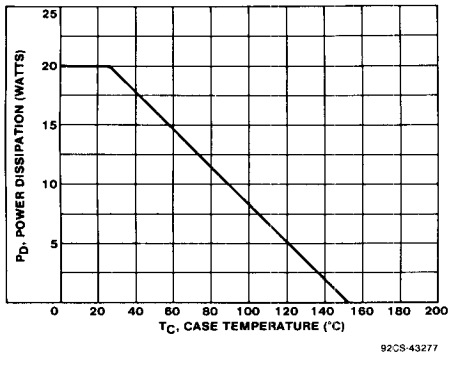


Fig. 14 - Power vs. temperature derating curve.

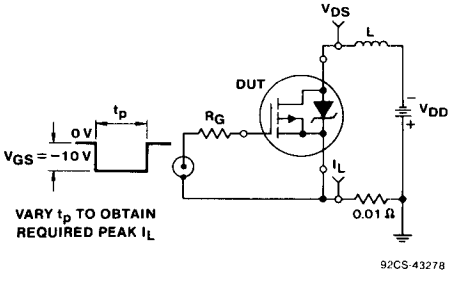


Fig. 15 - Unclamped inductive test circuit.

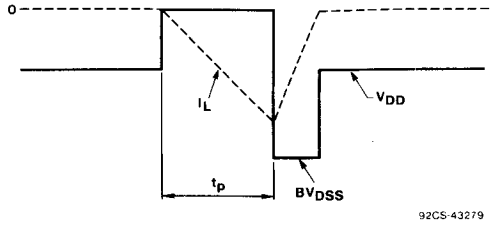


Fig. 16 - Unclamped inductive waveforms.

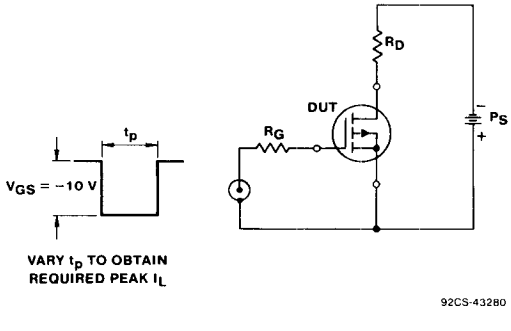


Fig. 17 - Switching time test circuit.

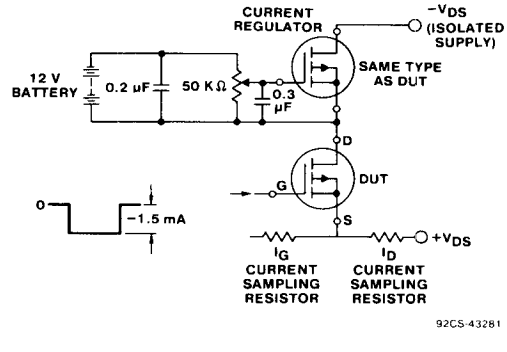


Fig. 18 - Gate charge test circuit.