

## Avalanche-Energy-Rated P-Channel Power MOSFETs

-5 A and -6 A, -60 V and -100 V  
 $r_{DS(on)}$  = 0.60  $\Omega$  and 0.80  $\Omega$

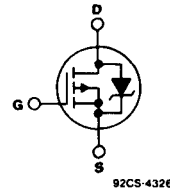
### Features:

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

The IRF9520, IRF9521, IRF9522 and IRF9523 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.

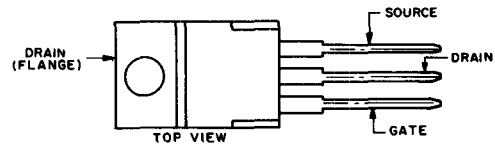
### TERMINAL DIAGRAM



92CS-43262

### P-CHANNEL ENHANCEMENT MODE

### TERMINAL DESIGNATION



92CS-39528

### JEDEC TO-220AB

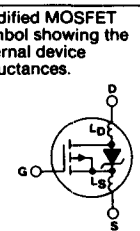
### ABSOLUTE-MAXIMUM RATINGS

CHARACTERISTIC		IRF9520	IRF9521	IRF9522	IRF9523	UNITS
Drain-Source Voltage $\text{\textcircled{1}}$	$V_{DS}$	-100	-60	-100	-60	V
Drain-Gate Voltage ( $R_{GS} = 20 \text{ k}\Omega$ ) $\text{\textcircled{1}}$	$V_{DGR}$	-100	-60	-100	-60	V
Continuous Drain Current	$I_D @ T_C = 25^\circ\text{C}$	-6	-6	-5	-5	A
Continuous Drain Current	$I_D @ T_C = 100^\circ\text{C}$	-4	-4	-3.5	-3.5	A
Pulsed Drain Current $\text{\textcircled{2}}$	$I_{DM}$	-24	-24	-20	-20	A
Gate-Source Voltage	$V_{GS}$	$\pm 20$				V
Maximum Power Dissipation	$P_D @ T_C = 25^\circ\text{C}$	40 (See Fig. 14)				W
Linear Derating Factor		0.32 (See Fig. 14)				W/ $^\circ\text{C}$
Single-Pulse Avalanche Energy Rating $\text{\textcircled{3}}$	$E_{as}$	370				mJ
Operating Junction and Storage Temperature Range	$T_J$ $T_{stg}$	-55 to +150				$^\circ\text{C}$
Lead Temperature		300 (0.063 in. [1.6 mm] from case for 10 s)				$^\circ\text{C}$

ELECTRICAL CHARACTERISTICS At Case Temperature ( $T_c$ ) = 25°C Unless Otherwise Specified

CHARACTERISTIC	TYPE	MIN.	TYP.	MAX.	UNITS	TEST CONDITIONS
Drain-Source Breakdown Voltage $BV_{DSS}$	IRF9520 IRF9522	-100	—	—	V	$V_{GS} = 0\text{ V}$
	IRF9521 IRF9523	-60	—	—	V	$I_D = -250\ \mu\text{A}$
	ALL	-2.0	—	-4.0	V	$V_{DS} = V_{GS}$ , $I_D = -250\ \mu\text{A}$
Gate Threshold Voltage $V_{GS(th)}$	ALL	—	—	-500	nA	$V_{GS} = -20\text{ V}$
Gate-Source Leakage Forward $I_{GSS}$	ALL	—	—	500	nA	$V_{GS} = 20\text{ V}$
Gate-Source Leakage Reverse $I_{SS}$	ALL	—	—	-250	$\mu\text{A}$	$V_{DS} = \text{Max. Rating}$ , $V_{GS} = 0\text{ V}$
Zero-Gate Voltage Drain Current $I_{DSS}$	ALL	—	—	-1000	$\mu\text{A}$	$V_{DS} = \text{Max. Rating} \times 0.8$ , $V_{GS} = 0\text{ V}$ , $T_c = 125^\circ\text{C}$
On-State Drain Current $I_{D(on)}$	IRF9520 IRF9521	-6	—	—	A	$V_{DS} > I_{D(on)} \times r_{DS(on)\text{ max.}}$ , $V_{GS} = -10\text{ V}$
	IRF9522 IRF9523	-5	—	—	A	
	ALL	—	0.5	0.6	$\Omega$	
Static Drain-Source On-State Resistance $r_{DS(on)}$	IRF9520 IRF9521	—	0.5	0.6	$\Omega$	$V_{GS} = 10\text{ V}$ , $I_D = -3.5\text{ A}$
	IRF9522 IRF9523	—	0.6	0.8	$\Omega$	
	ALL	0.9	2	—	S(U)	
Forward Transconductance $g_{fs}$	ALL	—	300	—	pF	$V_{GS} = 0\text{ V}$ , $V_{DS} = -25\text{ V}$ , $f = 1.0\text{ MHz}$
Input Capacitance $C_{iss}$	ALL	—	200	—	pF	See Fig. 10
Output Capacitance $C_{oss}$	ALL	—	50	—	pF	
Reverse Transfer Capacitance $C_{rss}$	ALL	—	25	50	ns	$V_{DD} = 0.5 BV_{DSS}$ , $I_D = -3.5\text{ A}$ , $Z_0 = 50\ \Omega$
Turn-On Delay Time $t_{d(on)}$	ALL	—	50	100	ns	See Fig. 17
Rise Time $t_r$	ALL	—	50	100	ns	(MOSFET switching times are essentially independent of operating temperature.)
Turn-Off Delay Time $t_{d(off)}$	ALL	—	50	100	ns	
Fall Time $t_f$	ALL	—	50	100	ns	
Total Gate Charge (Gate-Source Plus Gate-Drain) $Q_g$	ALL	—	16	22	nC	$V_{GS} = -15\text{ V}$ , $I_D = -8.0\text{ A}$ , $V_{DS} = 0.8\text{ Max. Rating}$ . See Fig. 18 for test circuit. (Gate charge is essentially independent of operating temperature.)
Gate-Source Charge $Q_{gs}$	ALL	—	9	13.5	nC	
Gate-Drain ("Miller") Charge $Q_{gd}$	ALL	—	7	10.5	nC	
Internal Drain Inductance $L_D$	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.
Internal Source Inductance $L_S$	ALL	—	7.5	—	nH	Measured from the source lead, 6 mm (0.25 in.) from package to source bonding pad.
Junction-to-Case $R_{\theta JC}$	ALL	—	—	3.12	$^\circ\text{C/W}$	
Case-to-Sink $R_{\theta CS}$	ALL	—	0.1	—	$^\circ\text{C/W}$	Mounting surface flat, smooth, and greased.
Junction-to-Ambient $R_{\theta JA}$	ALL	—	—	80	$^\circ\text{C/W}$	Typical socket mount.

6



SOURCE-DRAIN DIODE RATINGS AND CHARACTERISTICS

Continuous Source Current (Body Diode) $I_S$	IRF9520 IRF9521	—	—	-6	A	Modified MOSFET symbol showing the integral reverse P-N junction rectifier.
	IRF9522 IRF9523	—	—	-5	A	
Pulse Source Current (Body Diode) $I_{SM}$	IRF9520 IRF9521	—	—	-24	A	
	IRF9522 IRF9523	—	—	-20	A	
Diode Forward Voltage $V_{SD}$	IRF9520 IRF9521	—	—	-1.5	V	$T_c = 25^\circ\text{C}$ , $I_S = -6\text{ A}$ , $V_{GS} = 0\text{ V}$
	IRF9522 IRF9523	—	—	-1.5	V	$T_c = 25^\circ\text{C}$ , $I_S = -5\text{ A}$ , $V_{GS} = 0\text{ V}$
Reverse Recovery Time $t_{rr}$	ALL	—	230	—	ns	$T_J = 150^\circ\text{C}$ , $I_F = -6\text{ A}$ , $dI_F/dt = 100\text{ A}/\mu\text{s}$
Reverse Recovered Charge $Q_{RR}$	ALL	—	1.3	—	$\mu\text{C}$	$T_J = 150^\circ\text{C}$ , $I_F = -6\text{ A}$ , $dI_F/dt = 100\text{ A}/\mu\text{s}$
Forward Turn-on Time $t_{on}$	ALL	Intrinsic turn-on time is negligible. Turn-on speed is substantially controlled by $L_S$ & $L_D$ .				

①  $T_J = 25^\circ\text{C}$  to  $150^\circ\text{C}$ .  
② Pulse Test: Pulse width  $\leq 300\ \mu\text{s}$ ,  
Duty Cycle  $\leq 2\%$ .

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

④  $V_{DD} = 25\text{ V}$ , Starting  $T_J = 25^\circ\text{C}$ ,  $L = 15.4\text{ mH}$ ,  
 $R_0 = 25\ \Omega$ , Peak  $I_L = 6\text{ A}$  (See Figs. 15 & 16).

IRF9520, IRF9521  
IRF9522, IRF9523

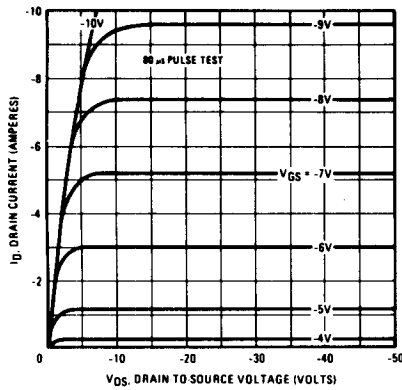


Fig. 1 - Typical output characteristics.

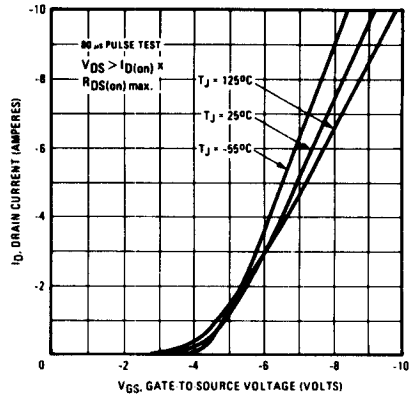


Fig. 2 - Typical transfer characteristics.

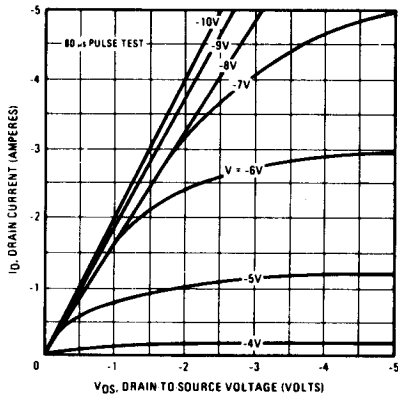


Fig. 3 - Typical saturation characteristics.

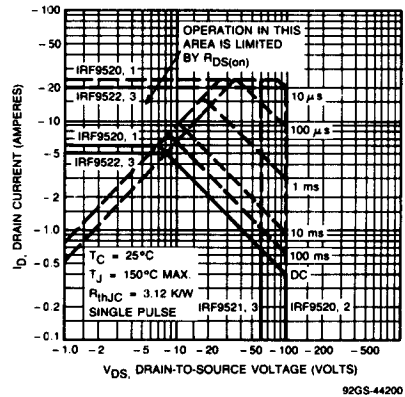


Fig. 4 - Maximum safe operating area.

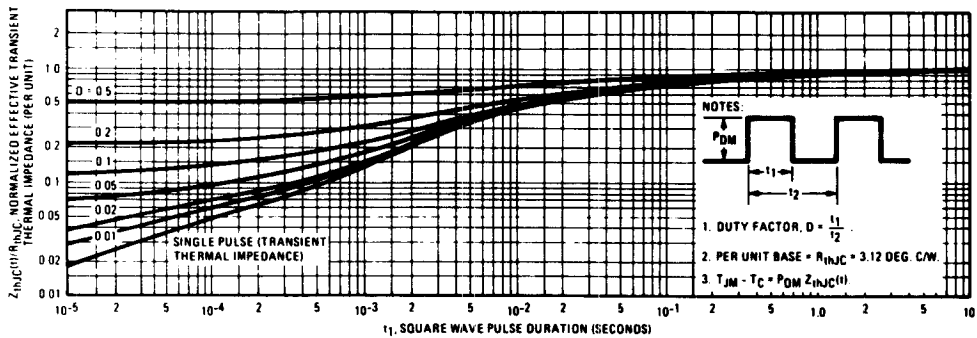


Fig. 5 - Maximum effective transient thermal impedance, junction-to-case vs. pulse duration.

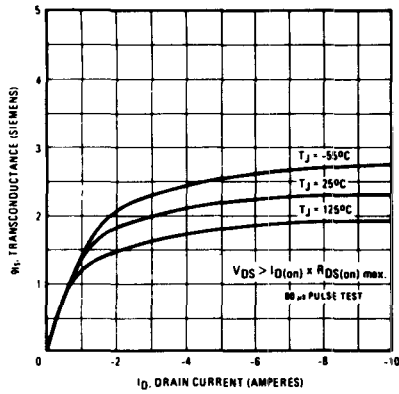


Fig. 6 - Typical transconductance vs. drain current.

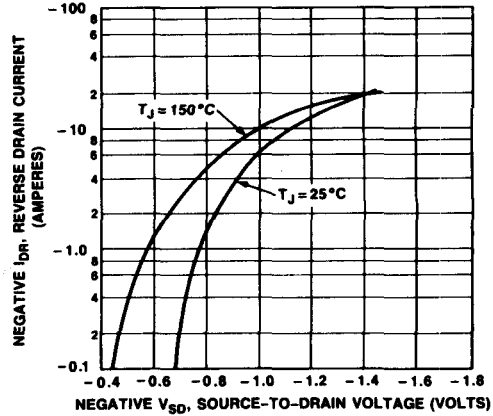


Fig. 7 - Typical source-drain diode forward voltage.

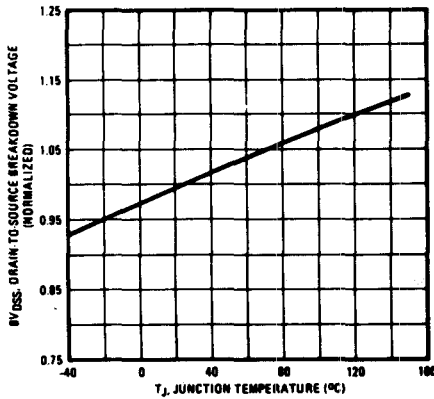


Fig. 8 - Breakdown voltage vs. temperature.

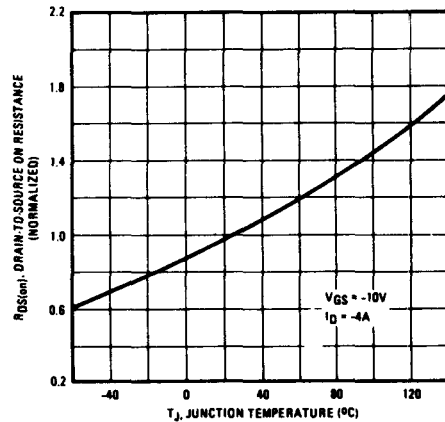


Fig. 9 - Normalized on-resistance vs. temperature.

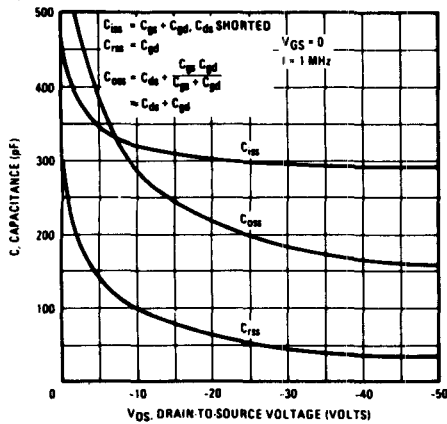


Fig. 10 - Typical capacitance vs. drain-to-source voltage.

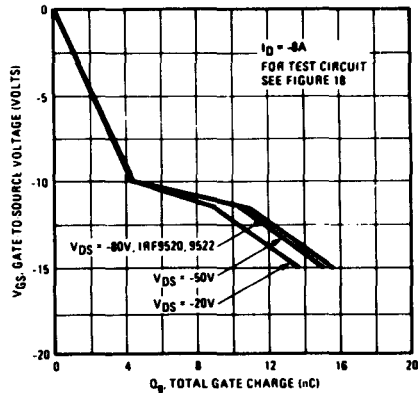


Fig. 11 - Typical gate charge vs. gate-to-source voltage.

IRF9520, IRF9521  
IRF9522, IRF9523

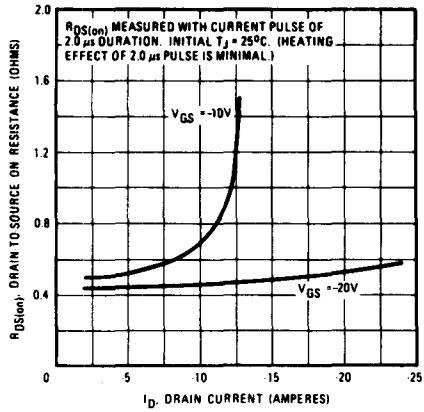


Fig. 12 - Typical on-resistance vs. drain current.

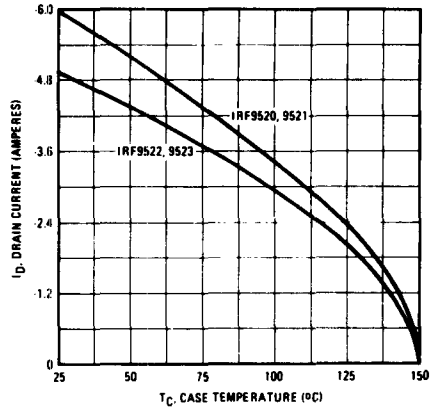


Fig. 13 - Maximum drain current vs. case temperature.

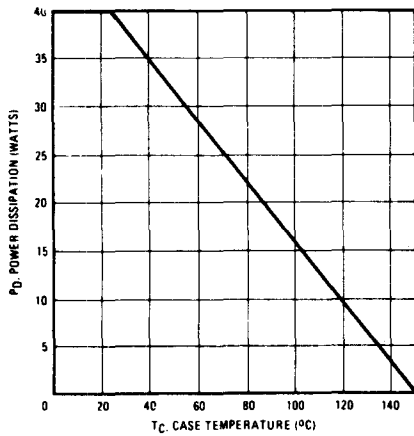


Fig. 14 - Power vs. temperature derating curve.

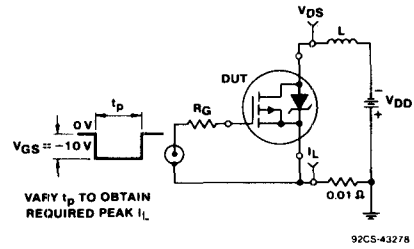


Fig. 15 - Unclamped inductive test circuit.

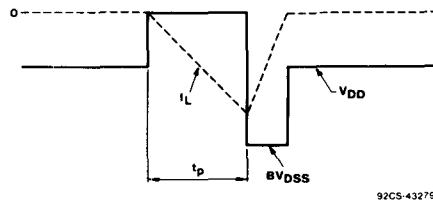


Fig. 16 - Unclamped inductive waveforms.

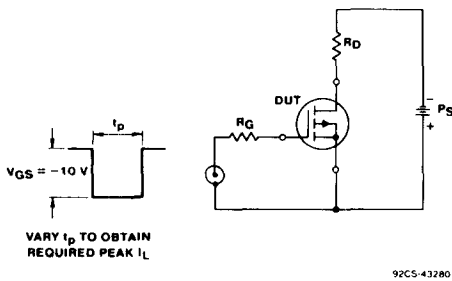


Fig. 17 - Switching time test circuit.

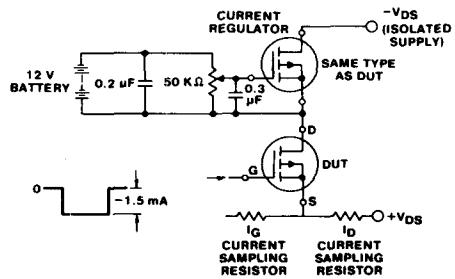


Fig. 18 - Gate charge test circuit.