

Avalanche-Energy-Rated P-Channel Power MOSFETs

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

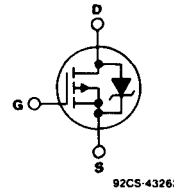
Features:

- 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.

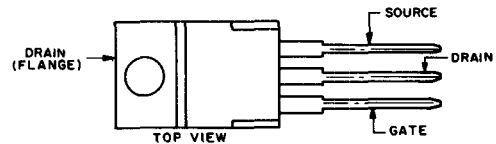
TERMINAL DIAGRAM



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}	± 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	$V_{GS} = 0$ V
	IRF9521 IRF9523	-60	—	—	V	$I_D = -250$ μ A
	ALL	-2.0	—	-4.0	V	$V_{DS} = V_{GS}$, $I_D = -250$ μ A
Gate Threshold Voltage $V_{GS(th)}$	ALL	—	—	-500	nA	$V_{GS} = -20$ V
Gate-Source Leakage Forward I_{GSS}	ALL	—	—	500	nA	$V_{GS} = 20$ V
Gate-Source Leakage Reverse I_{SS}	ALL	—	—	-250	μ A	$V_{DS} = \text{Max. Rating}$, $V_{GS} = 0$ V
Zero-Gate Voltage Drain Current I_{DSS}	ALL	—	—	-1000	μ A	$V_{DS} = \text{Max. Rating} \times 0.8$, $V_{GS} = 0$ V, $T_c = 125^\circ$ C
On-State Drain Current $I_{D(on)}$	IRF9520 IRF9521	-6	—	—	A	$V_{DS} > I_{D(on)} \times r_{DS(on) \text{ max.}}$, $V_{GS} = -10$ V
	IRF9522 IRF9523	-5	—	—	A	
	ALL	—	0.5	0.6	Ω	
Static Drain-Source On-State Resistance $r_{DS(on)}$	IRF9520 IRF9521	—	0.5	0.6	Ω	$V_{GS} = 10$ V, $I_D = -3.5$ A
	IRF9522 IRF9523	—	0.6	0.8	Ω	
Forward Transconductance g_{fs}	ALL	0.9	2	—	S(U)	$V_{DS} > I_{D(on)} \times r_{DS(on) \text{ max.}}$, $I_D = -3.5$ A
Input Capacitance C_{iss}	ALL	—	300	—	pF	$V_{GS} = 0$ V, $V_{DS} = -25$ V, $f = 1.0$ MHz
Output Capacitance C_{oss}	ALL	—	200	—	pF	See Fig. 10
Reverse Transfer Capacitance C_{rss}	ALL	—	50	—	pF	
Turn-On Delay Time $t_{d(on)}$	ALL	—	25	50	ns	$V_{DD} = 0.5 BV_{DSS}$, $I_D = -3.5$ A, $Z_\theta = 50$ Ω
Rise Time t_r	ALL	—	50	100	ns	See Fig. 17
Turn-Off Delay Time $t_{d(off)}$	ALL	—	50	100	ns	(MOSFET switching times are essentially independent of operating temperature.)
Fall Time t_f	ALL	—	50	100	ns	
Total Gate Charge (Gate-Source Plus Gate-Drain) Q_g	ALL	—	16	22	nC	$V_{GS} = -15$ V, $I_D = -8.0$ A, $V_{DS} = 0.8$ 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	$^\circ$ C/W	
Case-to-Sink $R_{\theta CS}$	ALL	—	0.1	—	$^\circ$ C/W	Mounting surface flat, smooth, and greased.
Junction-to-Ambient $R_{\theta JA}$	ALL	—	—	80	$^\circ$ C/W	Typical socket mount.

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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	
	IRF9520 IRF9521	—	—	-24	A	
Pulse Source Current (Body Diode) I_{SM}	IRF9522 IRF9523	—	—	-20	A	
	IRF9520 IRF9521	—	—	-1.5	V	$T_c = 25^\circ$ C, $I_S = -6$ A, $V_{AS} = 0$ V
Diode Forward Voltage V_{SD}	IRF9520 IRF9521	—	—	-1.5	V	$T_c = 25^\circ$ C, $I_S = -5$ A, $V_{AS} = 0$ V
	IRF9522 IRF9523	—	—	-1.5	V	
Reverse Recovery Time t_{rr}	ALL	—	230	—	ns	$T_J = 150^\circ$ C, $I_F = -6$ A, $dI_F/dt = 100$ A/ μ s
Reverse Recovered Charge Q_{RR}	ALL	—	1.3	—	μ C	$T_J = 150^\circ$ C, $I_F = -6$ A, $dI_F/dt = 100$ A/ μ 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 $T_J = 25^\circ$ C to 150° C.② Pulse Test: Pulse width ≤ 300 μ s, Duty Cycle $\leq 2\%$.

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

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

IRF9520, IRF9521
IRF9522, IRF9523

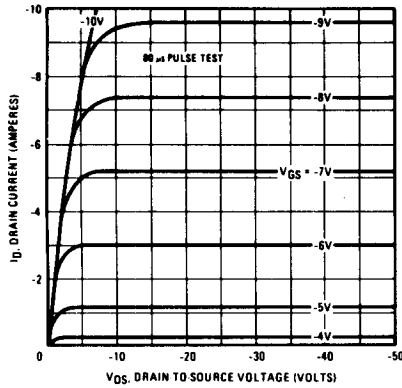


Fig. 1 - Typical output characteristics.

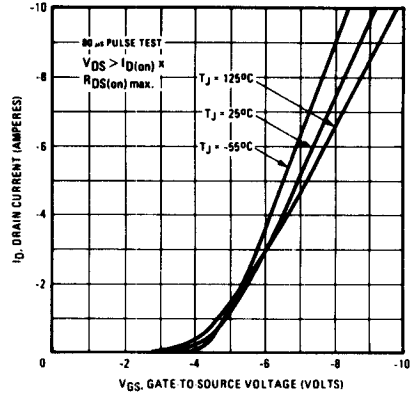


Fig. 2 - Typical transfer characteristics.

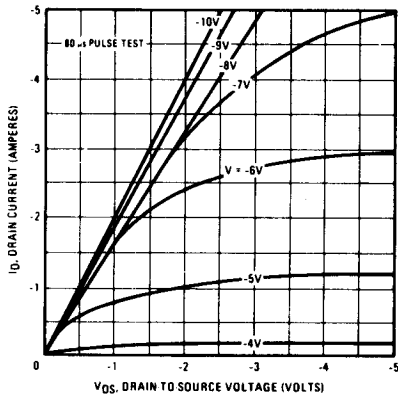


Fig. 3 - Typical saturation characteristics.

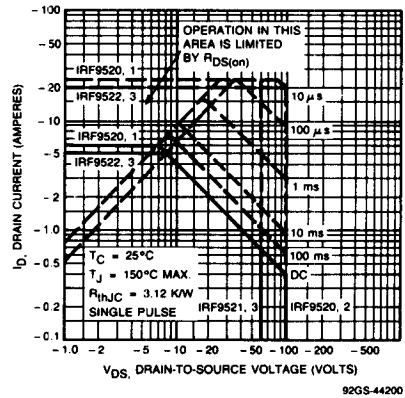


Fig. 4 - Maximum safe operating area.

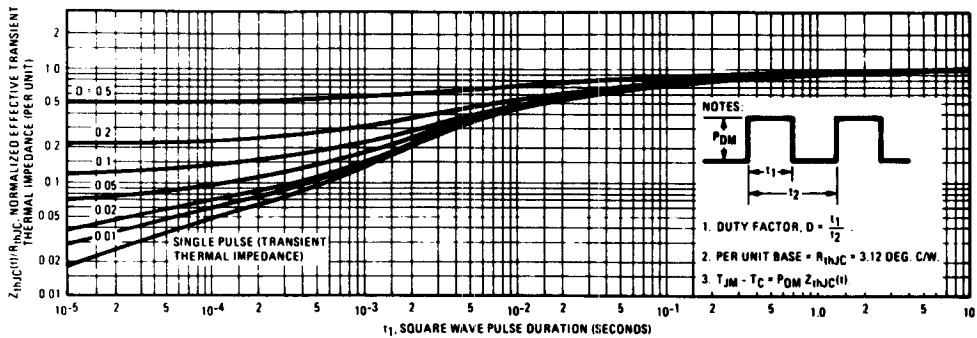


Fig. 5 - Maximum effective transient thermal impedance, junction-to-case vs. pulse duration.

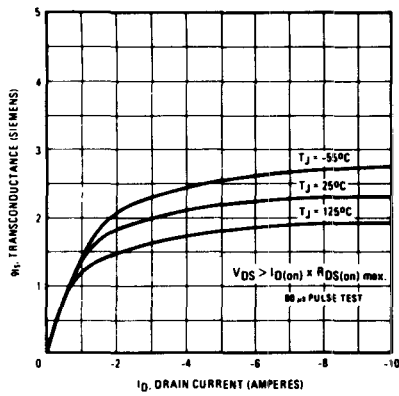


Fig. 6 - Typical transconductance vs. drain current.

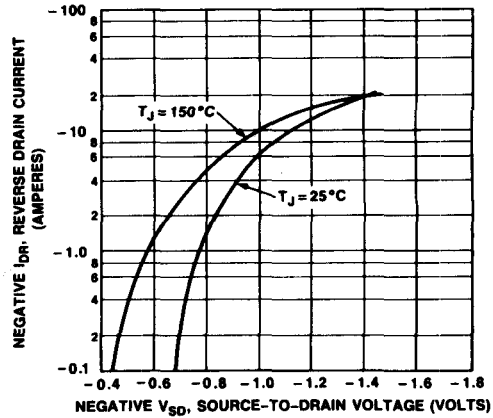


Fig. 7 - Typical source-drain diode forward voltage.

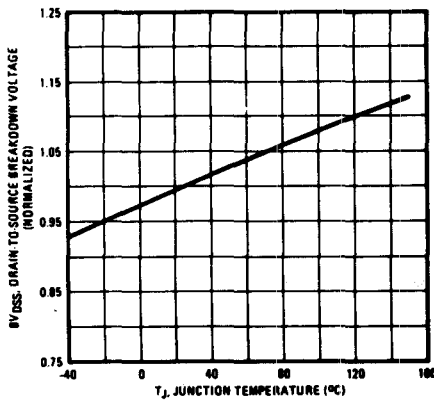


Fig. 8 - Breakdown voltage vs. temperature.

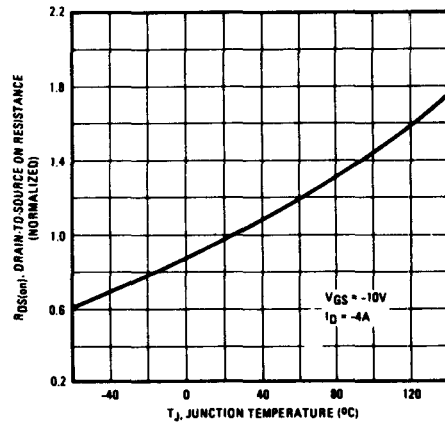


Fig. 9 - Normalized on-resistance vs. temperature.

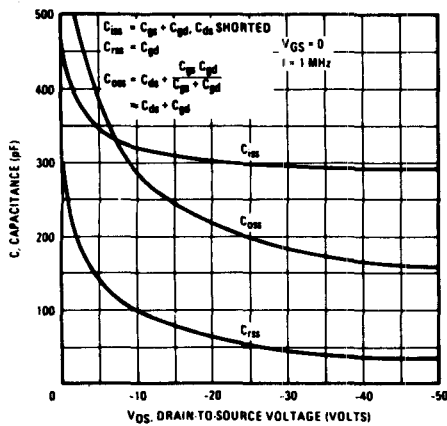


Fig. 10 - Typical capacitance vs. drain-to-source voltage.

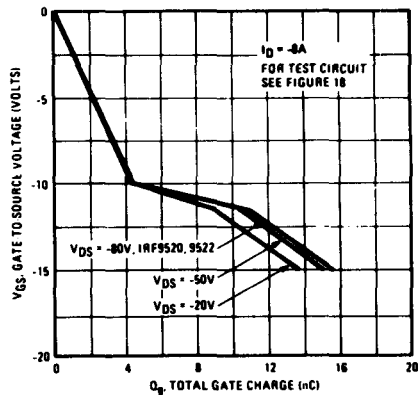


Fig. 11 - Typical gate charge vs. gate-to-source voltage.

IRF9520, IRF9521
IRF9522, IRF9523

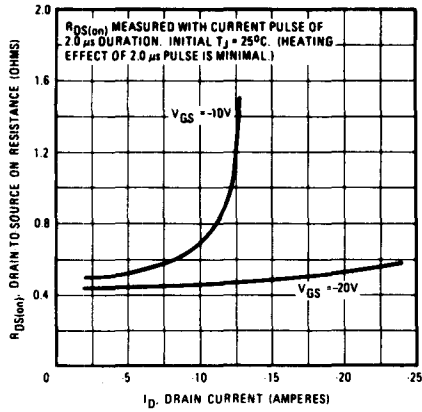


Fig. 12 - Typical on-resistance vs. drain current.

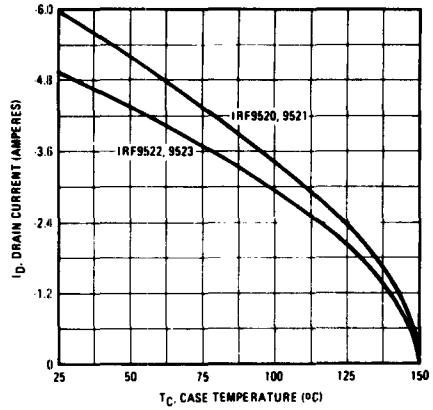


Fig. 13 - Maximum drain current vs. case temperature.

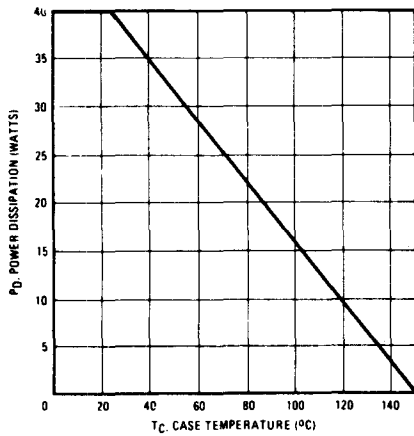


Fig. 14 - Power vs. temperature derating curve.

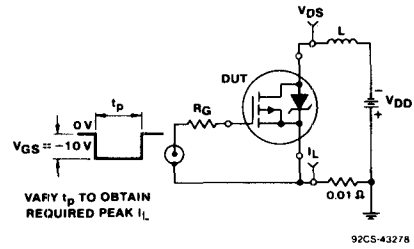


Fig. 15 - Unclamped inductive test circuit.

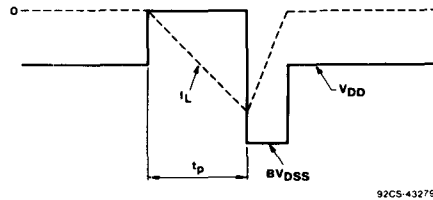


Fig. 16 - Unclamped inductive waveforms.

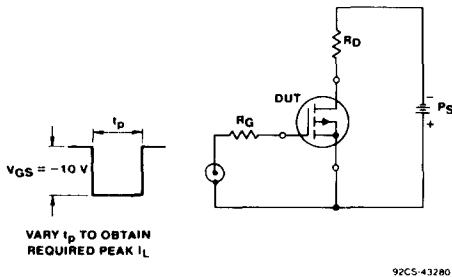


Fig. 17 - Switching time test circuit.

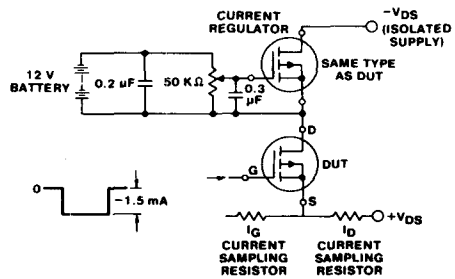


Fig. 18 - Gate charge test circuit.