

January 1994

Features

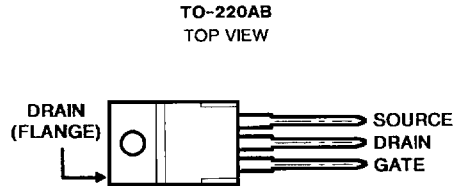
- -5A and -6A, -80V and -100V
- $r_{DS(ON)} = 0.6\Omega$ and 0.8Ω
- Single Pulse Avalanche Energy Rated
- SOA is Power-Dissipation Limited
- Nanosecond Switching Speeds
- Linear Transfer Characteristics
- High Input Impedance

Description

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.

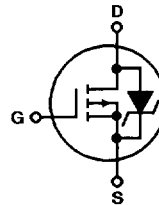
The IRF types are supplied in the JEDEC TO-220AB plastic package.

Package



Terminal Diagram

P-CHANNEL ENHANCEMENT MODE



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

	IRF9520	IRF9521	IRF9522	IRF9523	UNITS	
Drain-Source Voltage (1)	V_{DS}	-100	-80	-100	-80	V
Drain-Gate Voltage ($R_{GS} = 20k\Omega$) (1)	V_{DGR}	-100	-80	-100	-80	V
Continuous Drain Current						
$T_C = 25^\circ\text{C}$	I_D	-6	-6	-5	-5	A
$T_C = 100^\circ\text{C}$	I_D	-4	-4	-3.5	-3.5	A
Pulsed Drain Current (3)	I_{DM}	-24	-24	-20	-20	A
Gate-Source Voltage	V_{GS}	± 20	± 20	± 20	± 20	V
Maximum Power Dissipation	P_D	40	40	40	40	W
(See Figure 14)						
Linear Derating Factor		0.32	0.32	0.32	0.32	W/ $^\circ\text{C}$
(See Figure 14)						
Single Pulse Avalanche Energy Rating (4)	E_{AS}	370	370	370	370	mJ
Operating and Storage Junction	T_J, T_{STG}	-55 to +150	-55 to +150	-55 to +150	-55 to +150	$^\circ\text{C}$
Temperature Range						
Maximum Lead Temperature for Soldering	T_L	300	300	300	300	$^\circ\text{C}$
(0.063" (1.6mm) from case for 10s)						

NOTES:

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 (Figure 5)
4. $V_{DD} = 25\text{V}$, Start $T_J = +25^\circ\text{C}$, $L = 15.4\text{mH}$, $R_G = 25\Omega$, Peak $I_L = 6.0\text{A}$
(See Figures 15 and 16)

Specifications IRF9520, IRF9521, IRF9522, IRF9523

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

CHARACTERISTIC	SYMBOL	TEST CONDITIONS	LIMITS			UNITS	
			MIN	TYP	MAX		
Drain-Source Breakdown Voltage IRF9520, IRF9522 IRF9521, IRF9523	BV _{DSS}	$V_{GS} = 0V, I_D = -250\mu A$	-100	-	-	V	
			-80	-	-	V	
Gate Threshold Voltage	$V_{GS(TH)}$	$V_{DS} = V_{GS}, I_D = -250\mu A$	-2.0	-	-4.0	V	
Gate-Source Leakage Forward	I_{GSS}	$V_{GS} = -20V$	-	-	-500	nA	
Gate-Source Leakage Reverse	I_{GSS}	$V_{GS} = 20V$	-	-	500	nA	
Zero Gate Voltage Drain Current	I_{DSS}	$V_{DS} = \text{Max Rating}, V_{GS} = 0V$	-	-	-250	μA	
		$V_{DS} = \text{Max Rating} \times 0.8, V_{GS} = 0V, T_C = +125^\circ\text{C}$	-	-	-1000	μA	
On-State Drain Current (Note 2) IRF9520, IRF9521 IRF9522, IRF9523	$I_D(ON)$	$V_{DS} > I_D(ON) \times r_{DS(ON)} \text{ Max}, V_{GS} = -10V$	-6	-	-	A	
			-5	-	-	A	
Static Drain-Source On-State Resistance (Note 2) IRF9520, IRF9521 IRF9522, IRF9523	$r_{DS(ON)}$	$V_{GS} = -10V, I_D = -3.5A$	-	0.5	0.6	Ω	
			-	0.6	0.8	Ω	
Forward Transconductance (Note 2)	g_{fs}	$V_{DS} > I_D(ON) \times r_{DS(ON)} \text{ Max}, I_D = -3.5A$	0.9	2	-	S(\bar{I})	
Input Capacitance	C_{ISS}	$V_{GS} = 0V, V_{DS} = -25V, f = 1.0\text{MHz}$	-	300	-	pF	
Output Capacitance	C_{OSS}	See Figure 10	-	200	-	pF	
Reverse Transfer Capacitance	C_{RSS}		-	50	-	pF	
Turn-On Delay Time	$t_{d(ON)}$	$V_{DD} = 0.5 BV_{DSS}, I_D = -6.0A, R_G = 50\Omega$	-	25	50	ns	
Rise Time	t_r	See Figure 17. (MOSFET switching times are essentially independent of operating temperature.)	-	50	100	ns	
Turn-Off Delay Time	$t_{d(OFF)}$		-	50	100	ns	
Fall Time	t_f		-	50	100	ns	
Total Gate Charge (Gate-Source + Gate-Drain)	Q_g		$V_{GS} = -10V, I_D = -6A, V_{DS} = 0.8 \text{ Max Rating}$. See Figure 18 for test circuit. (Gate charge is essentially independent of operating temperature.)	-	16	22	nC
Gate-Source Charge	Q_{gs}		-	9	-	nC	
Gate-Drain ("Miller") Charge	Q_{gd}		-	7	-	nC	
Internal Drain Inductance	L_D	Measured from the contact screw on tab to center of die.	Modified MOSFET symbol showing the internal device inductances.	-	3.5	-	nH
		Measured from the drain lead, 6mm (0.25") from pkg. to center of die.		-	4.5	-	nH
Internal Source Inductance	L_S	Measured from the source lead, 6mm (0.25") from pkg. to source bonding pad.		-	7.5	-	nH
Junction-to-Case	$R_{\theta JC}$		-	-	3.12	$^\circ\text{C/W}$	
Case-to-Sink	$R_{\theta CS}$	Mounting surface flat, smooth and greased	-	0.1	-	$^\circ\text{C/W}$	
Junction-to-Ambient	$R_{\theta JA}$	Typical socket mount	-	-	80	$^\circ\text{C/W}$	

Source Drain Diode Ratings and Characteristics

Continuous Source Current (Body Diode)	I_S	Modified MOSFET symbol showing the integral reverse P-N junction rectifier.	-	-	-6.0	A
Pulse Source Current (Body Diode) (Note 3)	I_{SM}		-	-	-24	A
Diode Forward Voltage (Note 2)	V_{SD}	$T_C = +25^\circ\text{C}, I_S = -6.0A, V_{GS} = 0V$	-	-	-1.5	V
Reverse Recovery Time	t_{rr}	$T_J = +150^\circ\text{C}, I_F = -6.0A, dI_F/dt = 100A/\mu s$	-	230	-	ns
Reverse Recovered Charge	Q_{RR}	$T_J = +150^\circ\text{C}, I_F = -6.0A, dI_F/dt = 100A/\mu s$	-	1.3	-	μC
Forward Turn-on Time	t_{ON}	Intrinsic turn-on time is negligible. Turn-on speed is substantially controlled by $L_S + L_D$.	-	-	-	-

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

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

4. $V_{DD} = 25V$, Start $T_J = +25^\circ\text{C}$, $L = 15.4\text{mH}$,
 $R_G = 25\Omega$, Peak $I_L = 6.0A$ (See Figures 15 and 16)

IRF9520, IRF9521, IRF9522, IRF9523

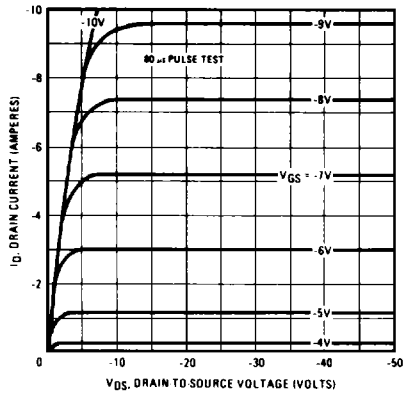


Fig. 1 - Typical output characteristics.

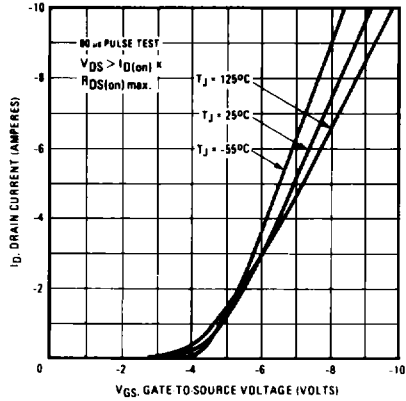


Fig. 2 - Typical transfer characteristics.

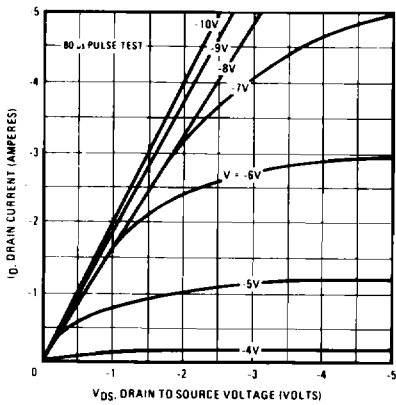


Fig. 3 - Typical saturation characteristics.

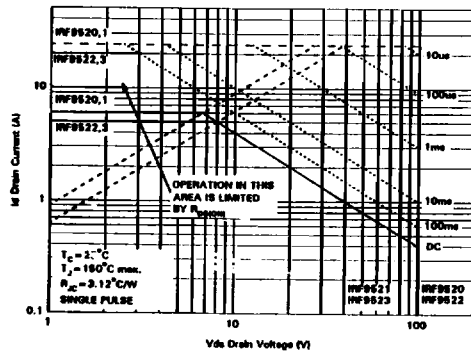


Fig. 4 - Maximum safe operating area.

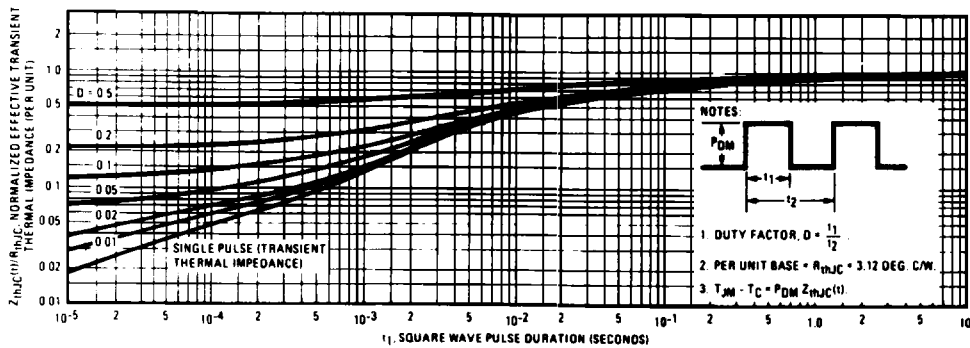


Fig. 5 - Maximum effective transient thermal impedance, junction-to-case vs. pulse duration.

5
P-CHANNEL
POWER MOSFETS

IRF9520, IRF9521, IRF9522, IRF9523

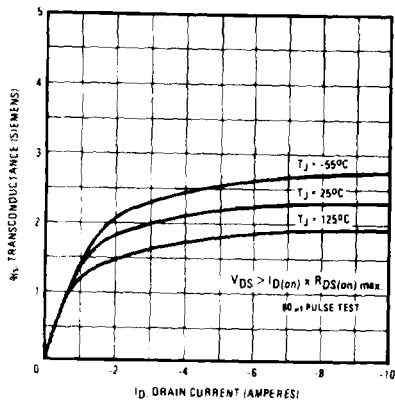


Fig. 6 - Typical transconductance vs. drain current.

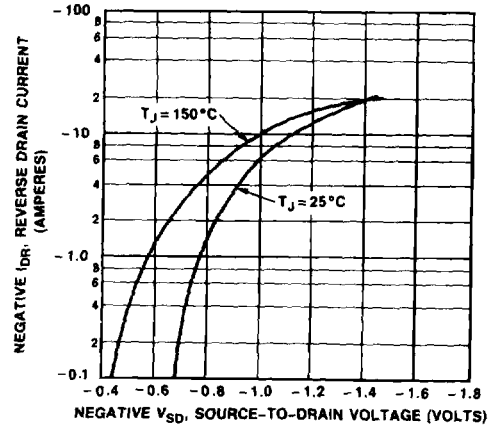


Fig. 7 - Typical source-drain diode forward voltage. ^{92GS-44168}

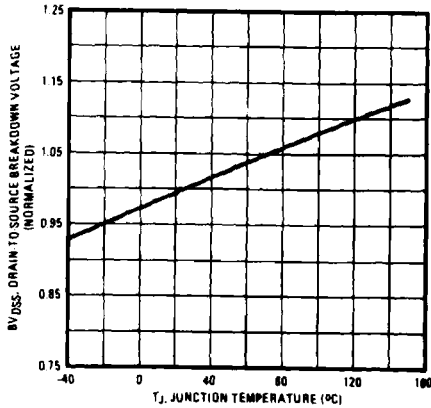


Fig. 8 - Breakdown voltage vs. temperature.

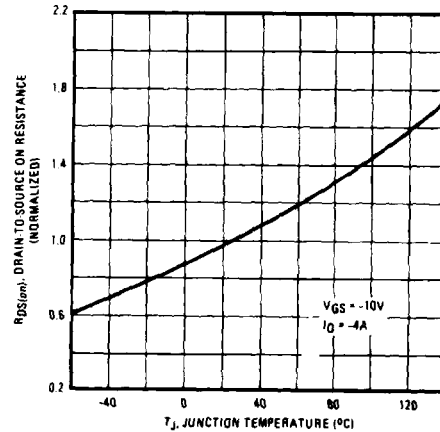


Fig. 9 - Normalized on-resistance vs. temperature.

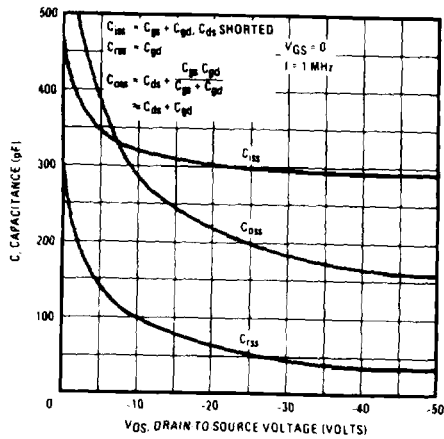


Fig. 10 - Typical capacitance vs. drain-to-source voltage.

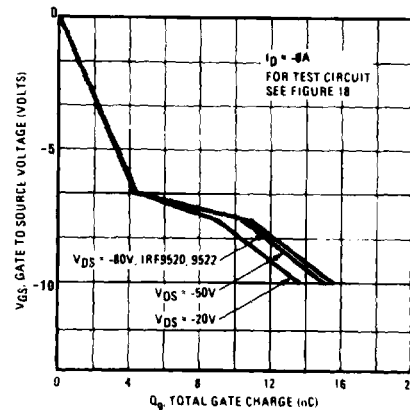


Fig. 11 - Typical gate charge vs. gate-to-source voltage.

IRF9520, IRF9521, IRF9522, IRF9523

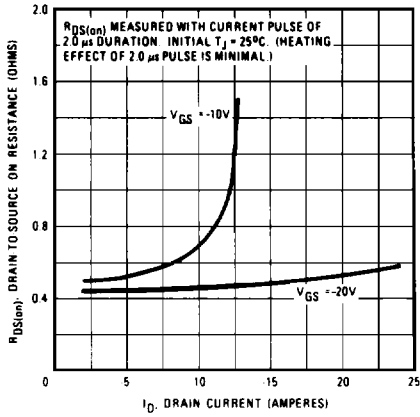


Fig. 12 - Typical on-resistance vs. drain current.

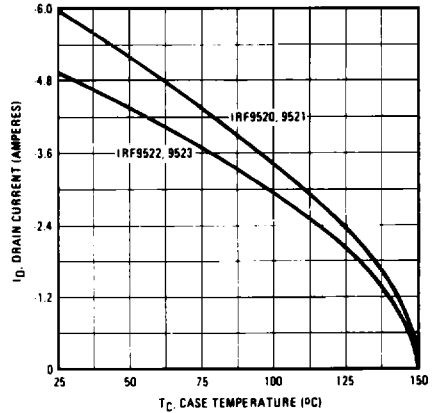


Fig. 13 - Maximum drain current vs. case temperature.

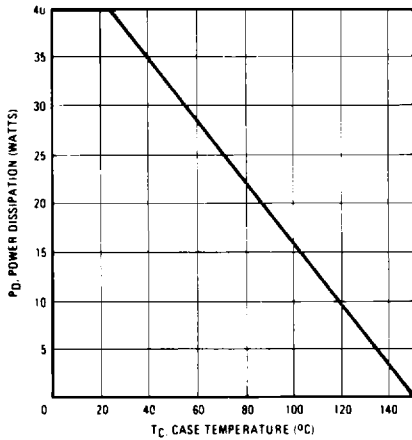


Fig. 14 - Power vs. temperature derating curve.

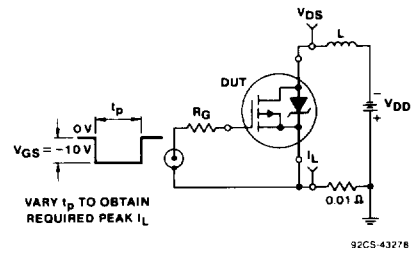


Fig. 15 - Unclamped inductive test circuit.

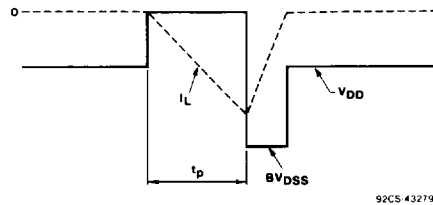


Fig. 16 - Unclamped inductive waveforms.

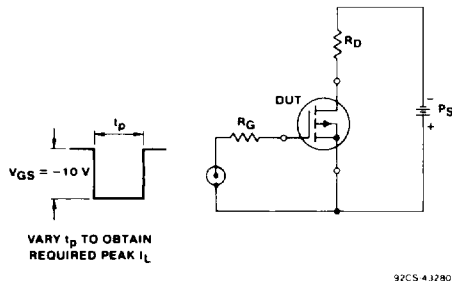


Fig. 17 - Switching time test circuit.

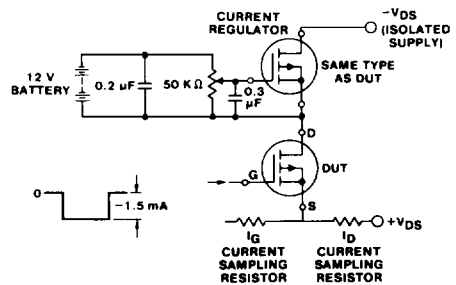


Fig. 18 - Gate charge test circuit.

5
P-CHANNEL
POWER MOSFETS