IRF510, IRF511, IRF512, IRF513

File Number **1573**

Power MOS Field-Effect Transistors

N-Channel Enhancement-Mode Power Field-Effect Transistors

3.5A and 4.0A, 60V-100V

$r_{DS}(on)$ = 0.6 Ω and 0.8 Ω

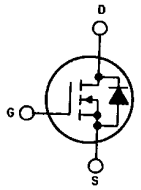
Features:

- *SOA is power-dissipation limited*
- *Nanosecond switching speeds*
- *Linear transfer characteristics*
- *High input impedance*
- *Majority carrier device*

The IRF510, IRF511, IRF512 and IRF513 are n-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.

N-CHANNEL ENHANCEMENT MODE



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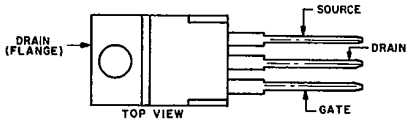
TERMINAL DIAGRAM

TERMINAL DESIGNATION



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JEDEC TO-220AB

Absolute Maximum Ratings

Parameter		IRF510	IRF511	IRF512	IRF513	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	4.0	4.0	3.5	3.5	A
I_D @ T_C = 100°C	Continuous Drain Current	2.5	2.5	2.0	2.0	A
I_{DM}	Pulsed Drain Current ③	16	16	14	14	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
I_{LM}	Inductive Current, Clamped	(See Fig. 15 and 16) L = 100μH				A
		16	16	14	14	
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

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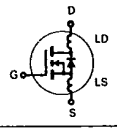
Electrical Characteristics @T_C = 25°C (Unless Otherwise Specified)

Parameter		Type	Min.	Typ	Max	Units	Test Conditions
BV_{DSS}	Drain - Source Breakdown Voltage	IRF510 IRF512	100	–	–	V	V_{GS} = 0V
		IRF511 IRF513	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_{GSS}	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	IRF510 IRF511	4.0	–	–	A	V_{DS} > $I_{D(on)}$ x $R_{DS(on)}$ max., V_{GS} = 10V
		IRF512 IRF513	3.5	–	–	A	
$R_{DS(on)}$	Static Drain-Source On State Resistance ②	IRF510 IRF511	–	0.5	0.6	Ω	V_{GS} = 10V, I_D = 2.0A
		IRF512 IRF513	–	0.6	0.8	Ω	
g_{fs}	Forward Transconductance ②	ALL	1.0	1.5	–	S (℧)	V_{DS} > $I_{D(on)}$ x $R_{DS(on)}$ max., I_D = 2.0A
C_{iss}	Input Capacitance	ALL	–	135	150	pF	V_{GS} = 0V, V_{DS} = 25V, f = 1.0 MHz See Fig. 10
C_{oss}	Output Capacitance	ALL	–	80	100	pF	
C_{rss}	Reverse Transfer Capacitance	ALL	–	20	25	pF	
$t_{d(on)}$	Turn-On Delay Time	ALL	–	10	20	ns	V_{DD} ≈ 0.5 BV_{DSS}, I_D = 2.0A, Z_O = 50Ω See Fig. 17 (MOSFET switching times are essentially independent of operating temperature.)
t_r	Rise Time	ALL	–	15	25	ns	
$t_{d(off)}$	Turn Off Delay Time	ALL	–	15	25	ns	
t_f	Fall Time	ALL	–	10	20	ns	
Q_g	Total Gate Charge (Gate-Source Plus Gate Drain)	ALL	–	5.0	7.5	nC	V_{GS} = 10V, I_D = 8.0A, V_{DS} ≈ 0.8 Max. Rating See Fig. 18 for test circuit. (Gate charge is essentially independent of operating temperature.)
Q_{gs}	Gate Source Charge	ALL	–	2.0	–	nC	
Q_{gd}	Gate Drain ("Miller") Charge	ALL	–	3.0	–	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_{thJC}	Junction to Case	ALL	–	–	6.4	°C/W	
R_{thCS}	Case to Sink	ALL	–	1.0		°C/W	Mounting surface flat, smooth, and greased
R_{thJA}	Junction to Ambient	ALL	–	–	80	°C/W	Free Air Operation

Source-Drain Diode Ratings and Characteristics

I_S	Continuous Source Current (Body Diode)	IRF510 IRF511	–	–	4.0	A	Modified MOSFET symbol showing the integral reverse P-N junction rectifier.
		IRF512 IRF513	–	–	3.5	A	
I_{SM}	Pulse Source Current (Body Diode) ③	IRF510 IRF511	–	–	16	A	
		IRF512 IRF513	–	–	14	A	
V_{SD}	Diode Forward Voltage ②	IRF510 IRF511	–	–	2.5	V	T_C = 25°C, I_S = 4.0A, V_{GS} = 0V
		IRF512 IRF513	–	–	2.0	V	T_C = 25°C, I_S = 3.5A, V_{GS} = 0V
t_{rr}	Reverse Recovery Time	ALL	–	230	–	ns	T_J = 150°C, I_F = 4.0A, di_F/dt = 100A/μs
Q_{RR}	Reverse Recovered Charge	ALL	–	1.4	–	μC	T_J = 150°C, I_F = 4.0A, di_F/dt = 100A/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.				

① T_J = 25°C to 150°C. ② Pulse Test: Pulse width ≤ 300μs, Duty Cycle ≤ 2%. ③ Repetitive Rating: Pulse width limited by max. junction temperature. See Transient Thermal Impedance Curve (Fig. 5).

IRF510, IRF511, IRF512, IRF513

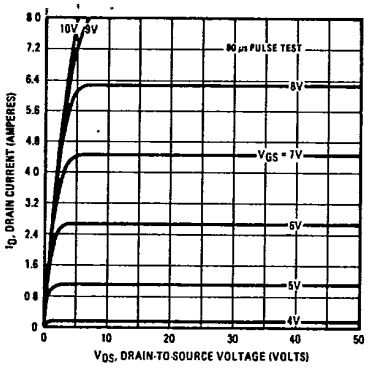


Fig. 1 – Typical Output Characteristics

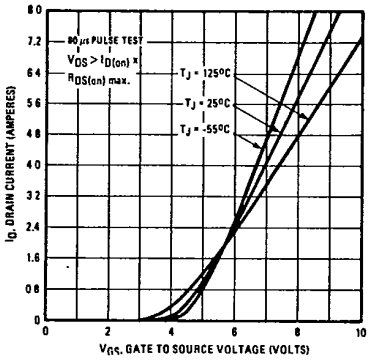


Fig. 2 – Typical Transfer Characteristics

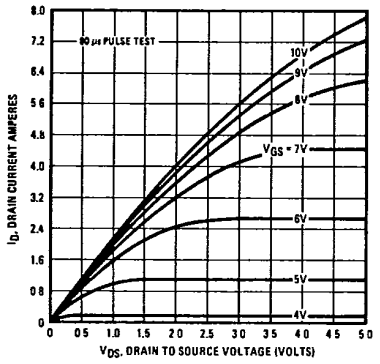


Fig. 3 – Typical Saturation Characteristics

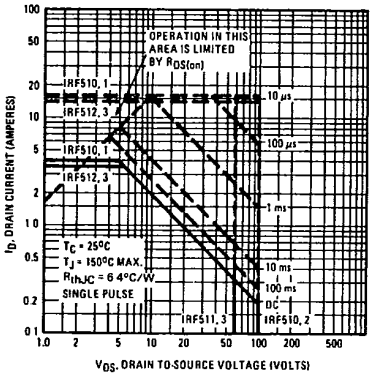


Fig. 4 – Maximum Safe Operating Area

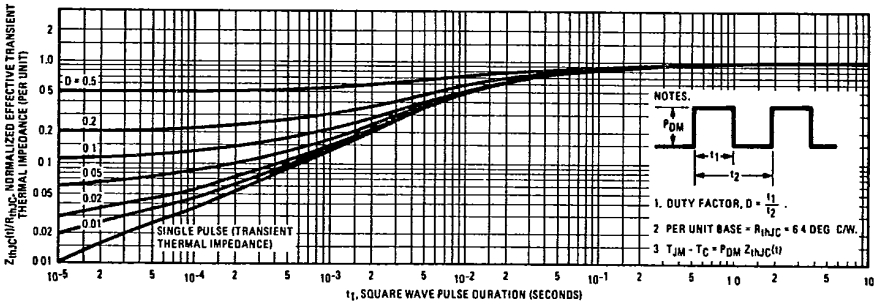


Fig. 5 – Maximum Effective Transient Thermal Impedance, Junction-to-Case Vs. Pulse Duration

IRF510, IRF511, IRF512, IRF513

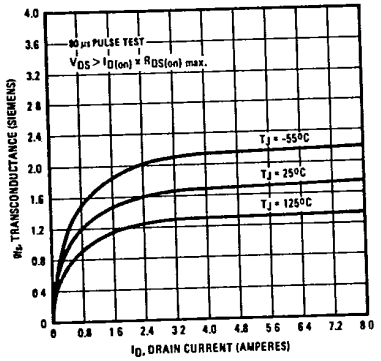


Fig. 6 – Typical Transconductance Vs. Drain Current

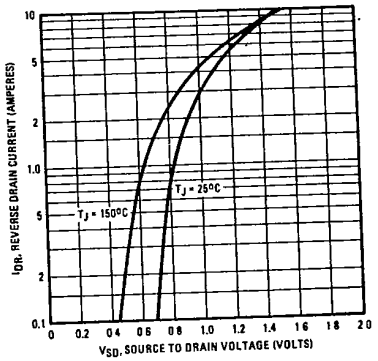


Fig. 7 – Typical Source-Drain Diode Forward Voltage

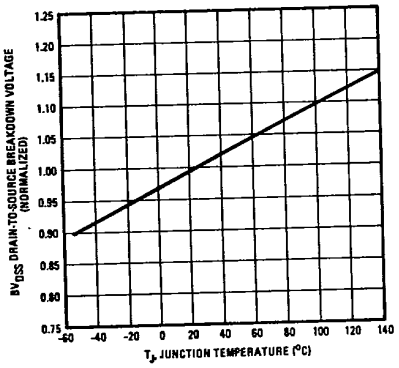


Fig. 8 – Breakdown Voltage Vs. Temperature

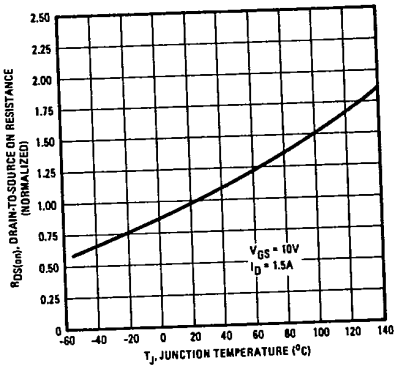


Fig. 9 – Normalized On-Resistance Vs. Temperature

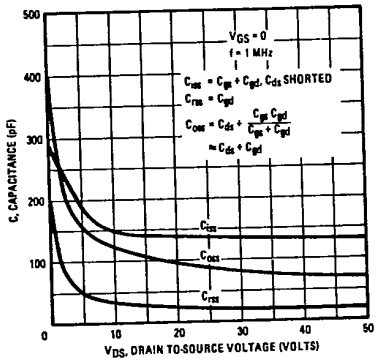


Fig. 10 – Typical Capacitance Vs. Drain-to-Source Voltage

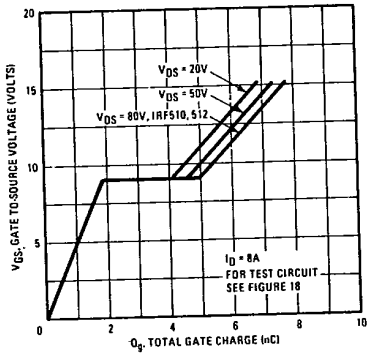


Fig. 11 – Typical Gate Charge Vs. Gate-to-Source Voltage

IRF510, IRF511, IRF512, IRF513

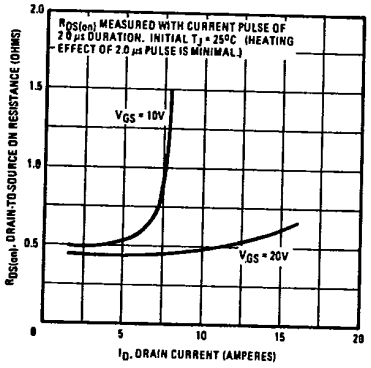


Fig. 12 – Typical On-Resistance Vs. Drain Current

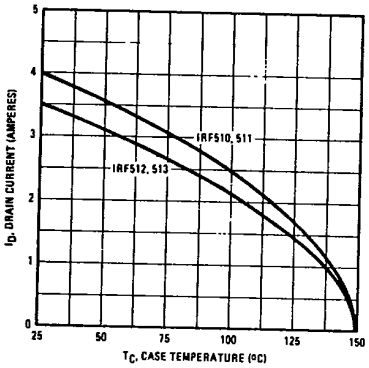


Fig. 13 – Maximum Drain Current Vs. Case Temperature

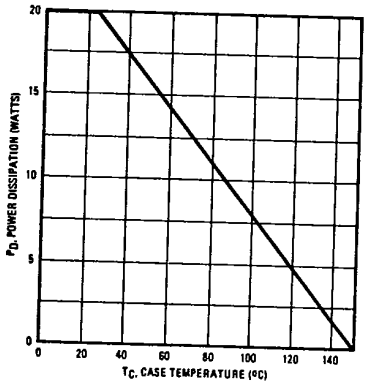


Fig. 14 – Power Vs. Temperature Derating Curve

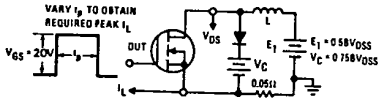


Fig. 15 – Clamped Inductive Test Circuit

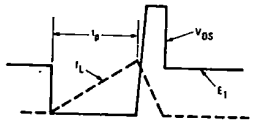


Fig. 16 – Clamped Inductive Waveforms

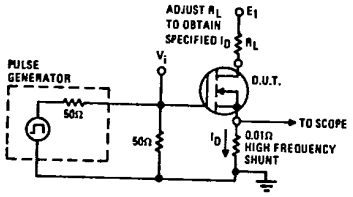


Fig. 17 – Switching Time Test Circuit

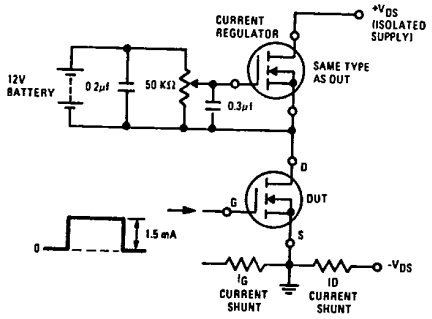


Fig. 18 – Gate Charge Test Circuit