

Power MOS Field-Effect Transistors

N-Channel Enhancement-Mode Power Field-Effect Transistors

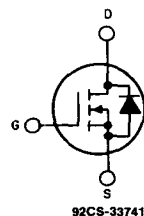
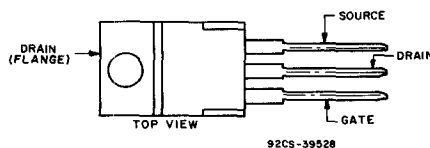
2.0A and 2.5A, 150V-200V

 $r_{DS(on)} = 1.5 \Omega$ and 2.4Ω **Features:**

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

The IRF610, IRF611, IRF612 and IRF613 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**TERMINAL DIAGRAM****TERMINAL DESIGNATION****JEDEC TO-220AB****Absolute Maximum Ratings**

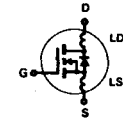
Parameter	IRF610	IRF611	IRF612	IRF613	Units
V_{DS} Drain - Source Voltage ①	200	150	200	150	V
V_{DGR} Drain - Gate Voltage ($R_{GS} = 20 \text{ K}\Omega$) ①	200	150	200	150	V
I_D @ $T_C = 25^\circ\text{C}$ Continuous Drain Current	2.5	2.5	2.0	2.0	A
I_D @ $T_C = 100^\circ\text{C}$ Continuous Drain Current	1.5	1.5	1.25	1.25	A
I_{DM} Pulsed Drain Current ③	10	10	8.0	8.0	A
V_{GS} Gate - Source Voltage	± 20				V
P_D @ $T_C = 25^\circ\text{C}$ Max. Power Dissipation	20 (See Fig. 14)				W
Linear Derating Factor	0.16 (See Fig. 14)				W/ $^\circ\text{C}$
I_{LM} Inductive Current, Clamped	10	(See Fig. 15 and 16) $L = 100 \mu\text{H}$ 10	8.0	8.0	A
T_J Operating Junction and T_{stg} Storage Temperature Range	-55 to 150				$^\circ\text{C}$
Lead Temperature	300 (0.063 in. (1.6mm) from case for 10s)				$^\circ\text{C}$

IRF610, IRF611, IRF612, IRF613

Electrical Characteristics @ $T_C = 25^\circ\text{C}$ (Unless Otherwise Specified)

Parameter	Type	Min.	Typ.	Max.	Units	Test Conditions
BV_{DS} Drain-Source Breakdown Voltage	IRF610 IRF612	200	—	—	V	$V_{GS} = 0\text{V}$
	IRF611 IRF613	150	—	—	V	$I_D = 250\mu\text{A}$
$V_{GS(th)}$ Gate Threshold Voltage	ALL	2.0	—	4.0	V	$V_{DS} = V_{GS}$, $I_D = 250\mu\text{A}$
I_{GSS} Gate-Source Leakage Forward	ALL	—	—	500	nA	$V_{GS} = 20\text{V}$
I_{GSS} Gate-Source Leakage Reverse	ALL	—	—	500	nA	$V_{GS} = -20\text{V}$
I_{DSS} Zero-Gate Voltage Drain Current	ALL	—	—	250	μA	$V_{DS} = \text{Max. Rating}$, $V_{GS} = 0\text{V}$
		—	—	1000	μA	$V_{DS} = \text{Max. Rating} \times 0.8$, $V_{GS} = 0\text{V}$, $T_C = 125^\circ\text{C}$
$I_{D(on)}$ On-State Drain Current ②	IRF610 IRF611	2.5	—	—	A	$V_{DS} > I_{D(on)} \times R_{DS(on) \text{ max.}}$, $V_{GS} = 10\text{V}$
	IRF612 IRF613	2.0	—	—	A	
$R_{DS(on)}$ Static Drain-Source On-State Resistance ②	IRF610 IRF611	—	1.0	1.5	Ω	$V_{GS} = 10\text{V}$, $I_D = 1.25\text{A}$
	IRF612 IRF613	—	1.5	2.4	Ω	
g_{fs} Forward Transconductance ②	ALL	0.8	1.3	—	S (Ω)	$V_{DS} > I_{D(on)} \times R_{DS(on) \text{ max.}}$, $I_D = 1.25\text{A}$
C_{iss} Input Capacitance	ALL	—	135	—	pF	$V_{GS} = 0\text{V}$, $V_{DS} = 25\text{V}$, $f = 1.0\text{MHz}$
C_{oss} Output Capacitance	ALL	—	60	—	pF	See Fig. 10
C_{riss} Reverse Transfer Capacitance	ALL	—	16	—	pF	
$t_{d(on)}$ Turn-On Delay Time	ALL	—	8.0	15	ns	$V_{DD} = 0.5 BV_{DS}$, $I_D = 1.25\text{A}$, $Z_\theta = 50\Omega$
t_r Rise Time	ALL	—	15	25	ns	See Fig. 17
$t_{d(off)}$ Turn-Off Delay Time	ALL	—	10	15	ns	(MOSFET switching times are essentially independent of operating temperature.)
t_f Fall Time	ALL	—	8.0	15	ns	
Q_g Total Gate Charge (Gate-Source Plus Gate-Drain)	ALL	—	5.0	7.5	nC	$V_{GS} = 10\text{V}$, $I_D = 3.0\text{A}$, $V_{DS} = 0.8 \text{ Max. Rating}$. See Fig. 18 for test circuit. (Gate charge is essentially independent of operating temperature.)
Q_{gs} Gate-Source Charge	ALL	—	2.0	3.5	nC	
Q_{gd} Gate-Drain ("Miller") Charge	ALL	—	3.0	4.5	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	$^\circ\text{C/W}$	
R_{thCS} Case-to-Sink	ALL	—	1.0	—	$^\circ\text{C/W}$	Mounting surface flat, smooth, and greased.
R_{thJA} Junction-to-Ambient	ALL	—	—	80	$^\circ\text{C/W}$	Free Air Operation

Source-Drain Diode Ratings and Characteristics

I_S Continuous Source Current (Body Diode)	IRF610 IRF611	—	—	2.5	A	Modified MOSFET symbol showing the integral reverse P-N junction rectifier.
	IRF612 IRF613	—	—	2.0	A	
I_{SM} Pulse Source Current (Body Diode) ③	IRF610 IRF611	—	—	10	A	
	IRF612 IRF613	—	—	8.0	A	
V_{SD} Diode Forward Voltage ②	IRF610 IRF611	—	—	2.0	V	$T_C = 25^\circ\text{C}$, $I_S = 2.5\text{A}$, $V_{GS} = 0\text{V}$
	IRF612 IRF613	—	—	1.8	V	$T_C = 25^\circ\text{C}$, $I_S = 2.0\text{A}$, $V_{GS} = 0\text{V}$
t_{rr} Reverse Recovery Time	ALL	—	290	—	ns	$T_J = 150^\circ\text{C}$, $I_F = 2.5\text{A}$, $dI_F/dt = 100\text{A}/\mu\text{s}$
Q_{RR} Reverse Recovered Charge	ALL	—	2.0	—	μC	$T_J = 150^\circ\text{C}$, $I_F = 2.5\text{A}$, $dI_F/dt = 100\text{A}/\mu\text{s}$
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 $T_J = 25^\circ\text{C}$ to 150°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).

IRF610, IRF611, IRF612, IRF613

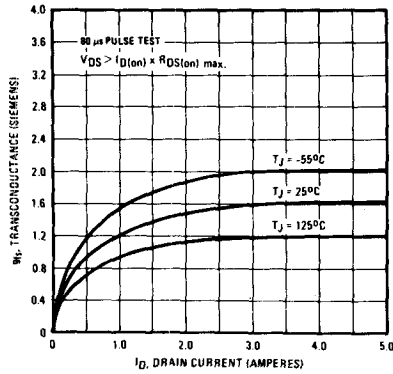


Fig. 6 — Typical Transconductance Vs. Drain Current

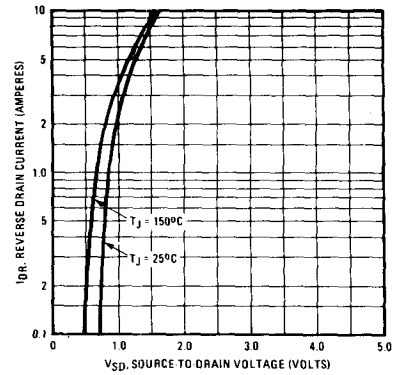


Fig. 7 — Typical Source-Drain Diode Forward Voltage

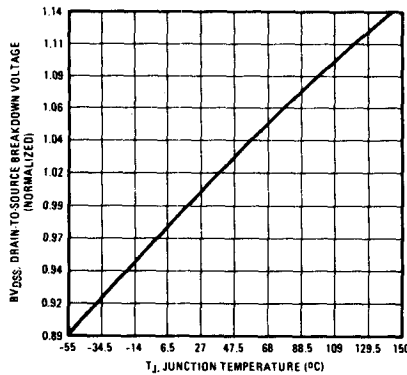


Fig. 8 — Breakdown Voltage Vs. Temperature

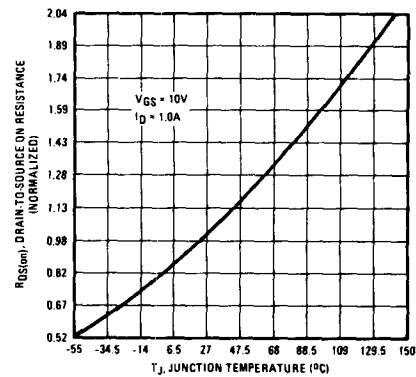


Fig. 9 — Normalized On-Resistance Vs. Temperature

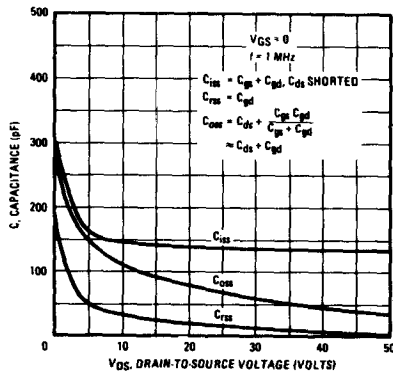


Fig. 10 — Typical Capacitance Vs. Drain-to-Source Voltage

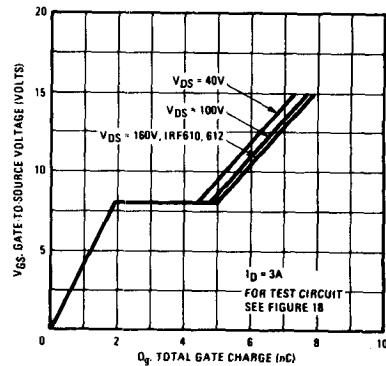


Fig. 11 — Typical Gate Charge Vs. Gate-to-Source Voltage

IRF610, IRF611, IRF612, IRF613

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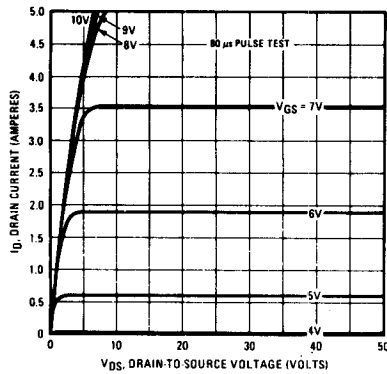


Fig. 1 - Typical Output Characteristics

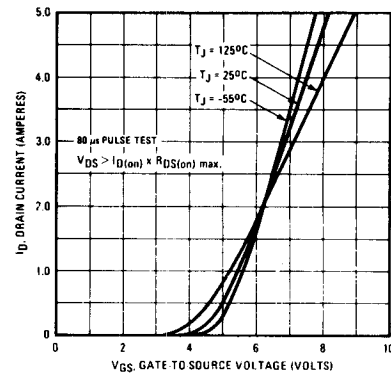


Fig. 2 - Typical Transfer Characteristics

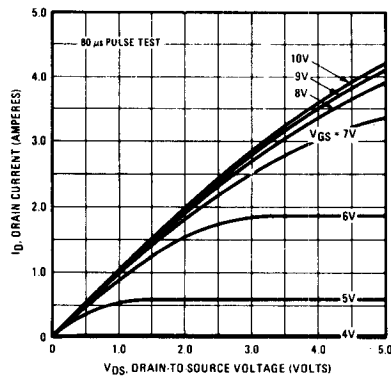


Fig. 3 - Typical Saturation Characteristics

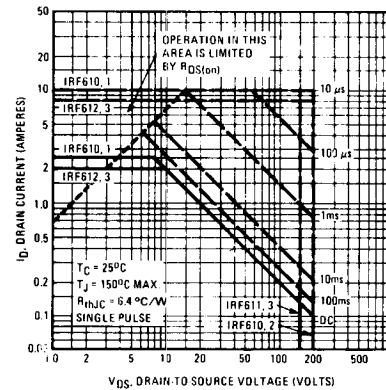


Fig. 4 - Maximum Safe Operating Area

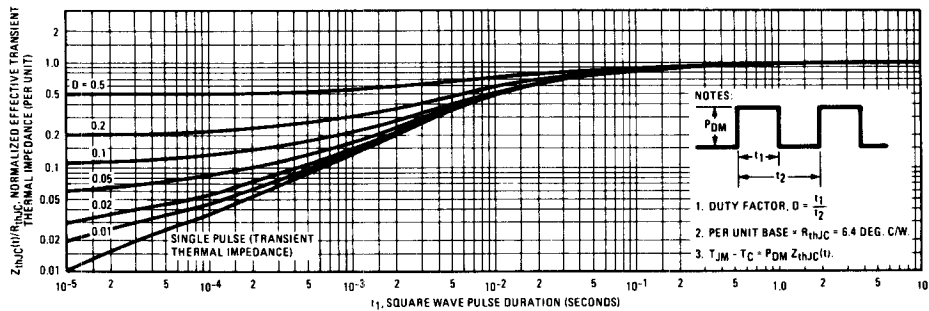


Fig. 5 - Maximum Effective Transient Thermal Impedance, Junction-to-Case Vs. Pulse Duration

IRF610, IRF611, IRF612, IRF613

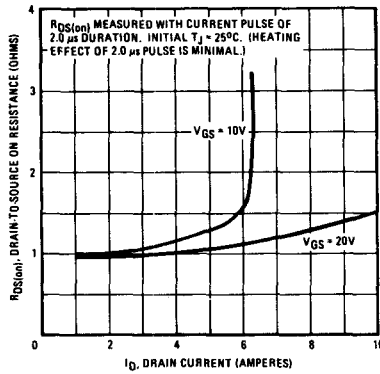


Fig. 12 - Typical On-Resistance Vs. Drain Current

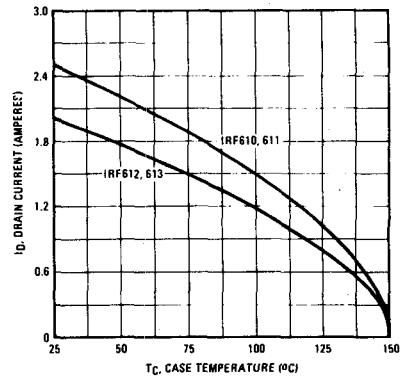


Fig. 13 - Maximum Drain Current Vs. Case Temperature

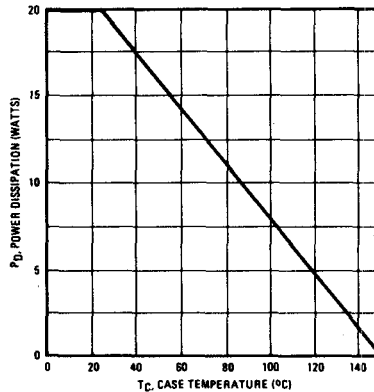


Fig. 14 - Power Vs. Temperature Derating Curve

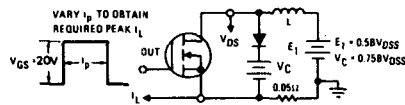


Fig. 15 - Clamped Inductive Test Circuit



Fig. 16 - Clamped Inductive Waveforms

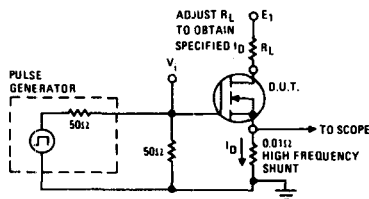


Fig. 17 - Switching Time Test Circuit

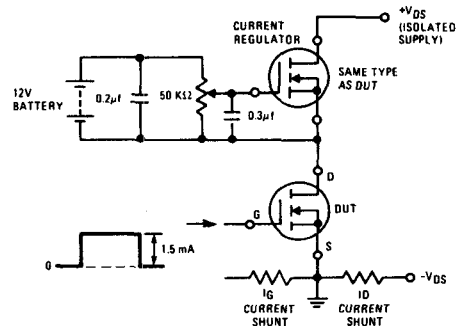


Fig. 18 - Gate Charge Test Circuit