File Number **2309**

IRF540, IRF541, IRF542, IRF543

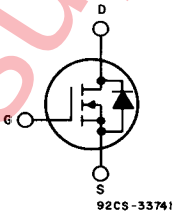
Power MOS Field-Effect Transistors

N-Channel Enhancement-Mode Power Field-Effect Transistors

24 A and 27 A, 60 V – 100 V
$r_{DS(on)}$ = 0.085 Ω and 0.11 Ω

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

N-CHANNEL ENHANCEMENT MODE

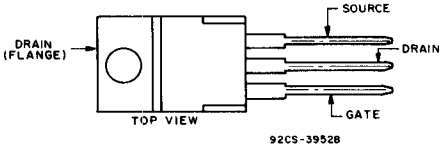


TERMINAL DIAGRAM

The IRF540, IRF541, IRF542, and IRF543 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.

TERMINAL DESIGNATION



JEDEC TO-220AB

Absolute Maximum Ratings

	Parameter	IRF540	IRF541	IRF542	IRF543	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	27	27	24	24	A
I_D @ T_C = 100°C	Continuous Drain Current	17	17	15	15	A
I_{DM}	Pulsed Drain Current ③	108	108	96	96	A
V_{GS}	Gate - Source Voltage	±20				V
P_D @ T_C = 25°C	Max. Power Dissipation	125 (See Fig. 14)				W
	Linear Derating Factor	1.0 (See Fig. 14)				W/°C
I_{LM}	Inductive Current, Clamped	(See Fig. 15 and 16) L = 100μH				A
		108	108	96	96	
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

IRF540, IRF541, IRF542, IRF543

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

Parameter		Type	Min.	Typ.	Max.	Units	Test Conditions
BV_{DSS}	Drain - Source Breakdown Voltage	IRF540 IRF542	100	–	–	V	V_{GS} = 0V
		IRF541 IRF543	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	IRF540 IRF541	27	–	–	A	V_{DS} > $I_{D(on)}$ x $R_{DS(on)}$ max., V_{GS} = 10V
		IRF542 IRF543	24	–	–	A	
$R_{DS(on)}$	Static Drain-Source On-State Resistance ②	IRF540 IRF541	–	0.07	0.085	Ω	V_{GS} = 10V, I_D = 15A
		IRF542 IRF543	–	0.09	0.11	Ω	
g_{fs}	Forward Transconductance ②	ALL	6.0	10	–	S (℧)	V_{DS} > $I_{D(on)}$ x $R_{DS(on)}$ max., I_D = 15A
C_{iss}	Input Capacitance	ALL	–	1275	—	pF	V_{GS} = 0V, V_{DS} = 25V, f = 1.0 MHz See Fig. 10
C_{oss}	Output Capacitance	ALL	–	550	—	pF	
C_{rss}	Reverse Transfer Capacitance	ALL	–	160	—	pF	
$t_{d(on)}$	Turn-On Delay Time	ALL	–	16	30	ns	V_{DD} ≈ 30V, I_D ≈ 15A, Z_o = 4.7Ω See Fig. 17 (MOSFET switching times are essentially independent of operating temperature.)
t_r	Rise Time	ALL	–	27	60	ns	
$t_{d(off)}$	Turn-Off Delay Time	ALL	–	38	80	ns	
t_f	Fall Time	ALL	–	14	30	ns	
Q_g	Total Gate Charge (Gate-Source Plus Gate-Drain)	ALL	–	38	60	nC	V_{GS} ≈ 10V, I_D ≈ 34A, 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	–	17	26	nC	
Q_{gd}	Gate-Drain ("Miller") Charge	ALL	–	21	32	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	–	–	1.0	°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)	IRF540 IRF541	–	–	27	A	Modified MOSFET symbol showing the integral reverse P-N junction rectifier.
		IRF542 IRF543	–	–	24	A	
I_{SM}	Pulse Source Current (Body Diode) ③	IRF540 IRF541	–	–	108	A	
		IRF542 IRF543	–	–	96	A	
V_{SD}	Diode Forward Voltage ②	IRF540 IRF541	–	–	2.5	V	T_C = 25°C, I_S = 27A, V_{GS} = 0V
		IRF542 IRF543	–	–	2.3	V	T_C = 25°C, I_S = 24A, V_{GS} = 0V
t_{rr}	Reverse Recovery Time	ALL	–	500	–	ns	T_J = 150°C, I_F = 27A, dI_F/dt = 100A/μs
Q_{RR}	Reverse Recovered Charge	ALL	–	2.9	–	μC	T_J = 150°C, I_F = 27A, 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).

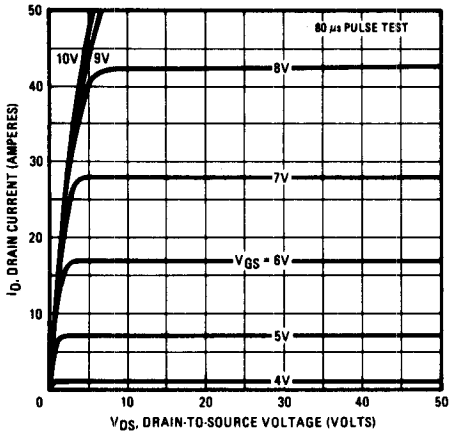


Fig. 1 – Typical Output Characteristics

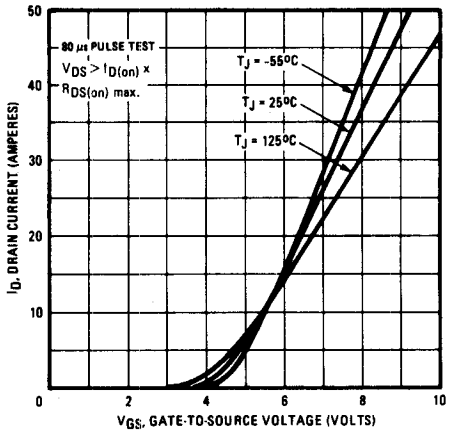


Fig. 2 – Typical Transfer Characteristics

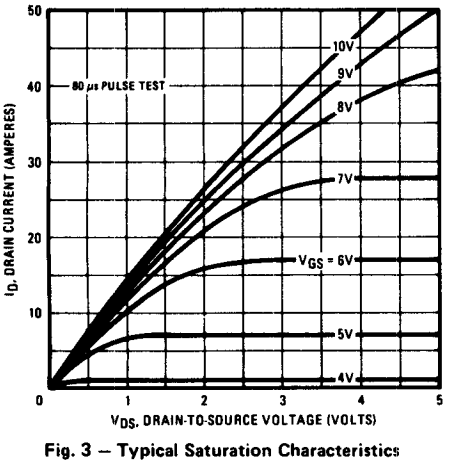


Fig. 3 – Typical Saturation Characteristics

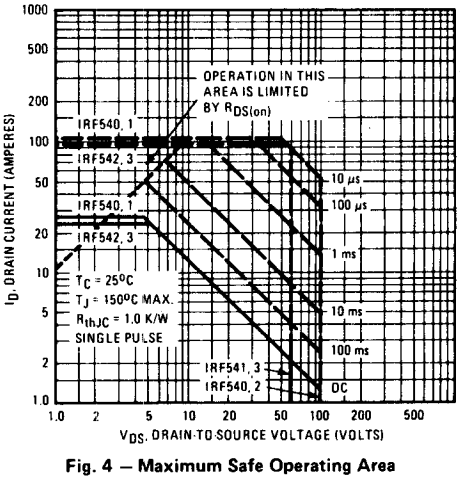


Fig. 4 – Maximum Safe Operating Area

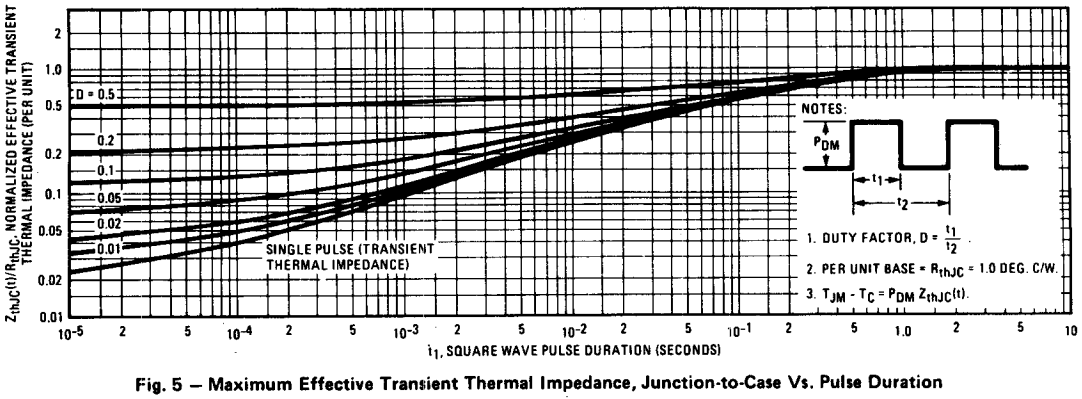


Fig. 5 – Maximum Effective Transient Thermal Impedance, Junction-to-Case Vs. Pulse Duration

IRF540, IRF541, IRF542, IRF543

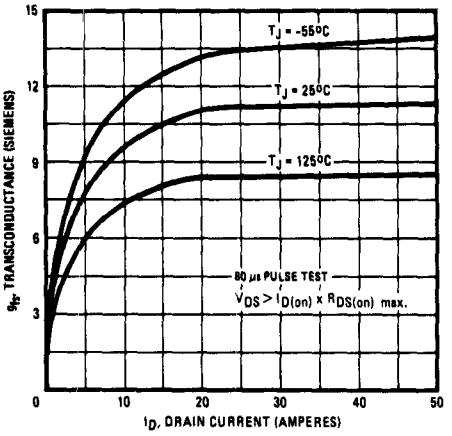


Fig. 6 – Typical Transconductance Vs. Drain Current

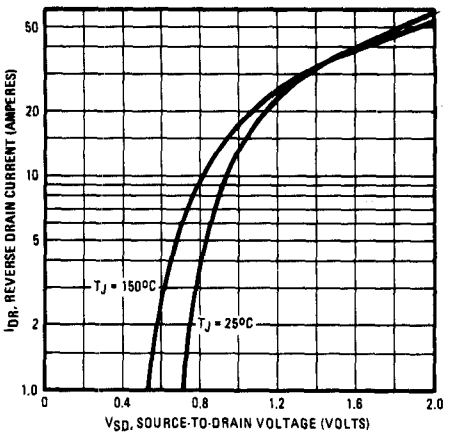


Fig. 7 – Typical Source-Drain Diode Forward Voltage

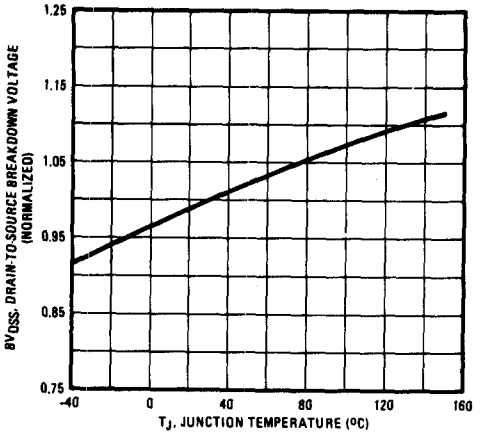


Fig. 8 – Breakdown Voltage Vs. Temperature

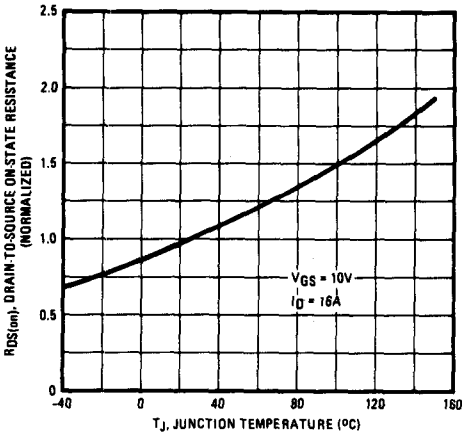


Fig. 9 – Normalized On-Resistance Vs. Temperature

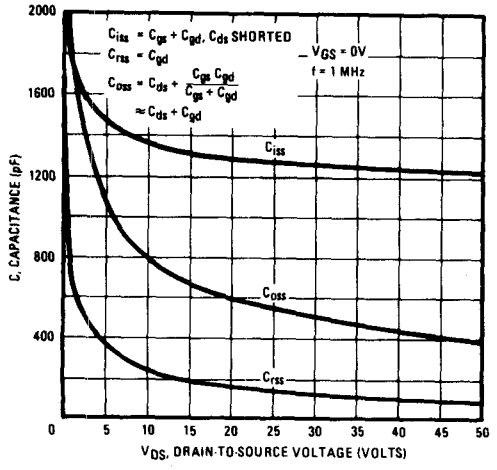


Fig. 10 – Typical Capacitance Vs. Drain-to-Source Voltage

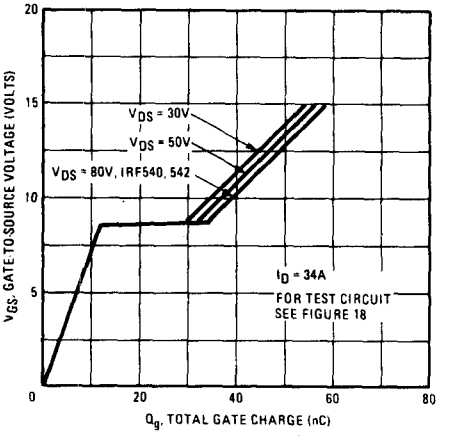


Fig. 11 – Typical Gate Charge Vs. Gate-to-Source Voltage