

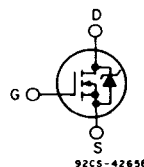
Avalanche Energy Rated N-Channel Power MOSFETs

8.0A and 9.0A, 150V-200V
 $r_{DS(on)} = 0.4\Omega$ and 0.6Ω

Features:

- Single pulse avalanche energy rated
- SOA is power-dissipation limited
- Nanosecond switching speeds
- Linear transfer characteristics
- High input impedance

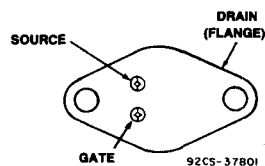
N-CHANNEL ENHANCEMENT MODE



TERMINAL DIAGRAM

6

TERMINAL DESIGNATION



JEDEC TO - 204AA

The IRF230R, IRF231R, IRF232R and IRF233R are advanced power MOSFETs designed, tested, and guaranteed to withstand a specified level of energy in the breakdown avalanche mode of operation. These 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-204AA steel package.

Absolute Maximum Ratings

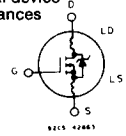
Parameter	IRF230R	IRF231R	IRF232R	IRF233R	Units
V_{DS} Drain - Source Voltage ①	200	150	200	150	V
V_{DGR} Drain - Gate Voltage ($R_{GS} = 20\text{ K}\Omega$) ①	200	150	200	150	V
I_D @ $T_c = 25^\circ\text{C}$ Continuous Drain Current	9.0	9.0	8.0	8.0	A
I_D @ $T_c = 100^\circ\text{C}$ Continuous Drain Current	6.0	6.0	5.0	5.0	A
I_{DM} Pulsed Drain Current ③	36	36	32	32	A
V_{GS} Gate - Source Voltage	± 20				V
P_D @ $T_c = 25^\circ\text{C}$ Max. Power Dissipation	75 (See Fig. 14)				W
Linear Derating Factor	0.6 (See Fig. 14)				W/ $^\circ\text{C}$
E_{AS} Single Pulse Avalanche Energy Rating ④	150				mJ
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)				$^\circ\text{C}$

IRF230R, IRF231R, IRF232R, IRF233R

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

Parameter	Type	Min.	Typ.	Max.	Units	Test Conditions
BV _{oss} Drain - Source Breakdown Voltage	IRF230R	200	—	—	V	V _{GS} = 0V
	IRF232R	—	—	—	—	—
	IRF231R IRF233R	150	—	—	V	I _D = 250 μ A
V _{GS(th)} Gate Threshold Voltage	ALL	2.0	—	4.0	V	V _{DS} = V _{GS} , I _D = 250 μ A
I _{oss} Gate-Source Leakage Forward	ALL	—	—	100	nA	V _{GS} = 20V
I _{oss} Gate-Source Leakage Reverse	ALL	—	—	-100	nA	V _{GS} = -20V
I _{oss} Zero Gate Voltage Drain Current	ALL	—	—	250	μ A	V _{DS} = Max. Rating, V _{GS} = 0V
		—	—	1000	μ A	V _{DS} = Max. Rating x 0.8, V _{GS} = 0V, T _C = 125°C
I _{D(on)} On-State Drain Current ②	IRF230R	9.0	—	—	A	V _{DS} > I _{D(on)} x R _{DS(on)} max., V _{GS} = 10V
	IRF231R	—	—	—	—	
	IRF232R IRF233R	8.0	—	—	A	
R _{DS(on)} Static Drain-Source On-State Resistance ②	IRF230R	—	0.25	0.4	Ω	V _{GS} = 10V, I _D = 5.0A
	IRF231R	—	—	—	—	
	IRF232R IRF233R	—	0.4	0.6	Ω	
g _{fs} Forward Transconductance ②	ALL	3.0	4.8	—	S (g)	V _{DS} > I _{D(on)} x R _{DS(on)} max., I _D = 5.0A
C _{iss} Input Capacitance	ALL	—	600	—	pF	V _{GS} = 0V, V _{DS} = 25V, f = 1.0 MHz
C _{oss} Output Capacitance	ALL	—	250	—	pF	See Fig. 10
C _{rss} Reverse Transfer Capacitance	ALL	—	80	—	pF	—
t _{d(on)} Turn-On Delay Time	ALL	—	—	30	ns	V _{DD} = 90V, I _D = 5.0A, Z _o = 15 Ω
t _r Rise Time	ALL	—	—	50	ns	See Fig. 17
t _{d(off)} Turn-Off Delay Time	ALL	—	—	50	ns	(MOSFET switching times are essentially independent of operating temperature.)
t _f Fall Time	ALL	—	—	40	ns	
Q _g Total Gate Charge (Gate-Source Plus Gate-Drain)	ALL	—	19	30	nC	V _{GS} = 10V, I _D = 12A, V _{DS} = 0.8V Max. Rating. See Fig. 18 for test circuit. (Gate charge is essentially independent of operating temperature.)
Q _{gs} Gate-Source Charge	ALL	—	10	—	nC	
Q _{gd} Gate-Drain ("Miller") Charge	ALL	—	9.0	—	nC	
L _D Internal Drain Inductance	ALL	—	5.0	—	nH	Measured between the contact screw on header that is closer to source and gate pins and center of die.
L _S Internal Source Inductance	ALL	—	12.5	—	nH	Measured from the source pin, 6 mm (0.25 in.) from header and source bonding pad.

Modified MOSFET symbol showing the internal device inductances

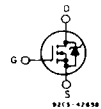


Thermal Resistance

R _{thJC} Junction-to-Case	ALL	—	—	1.67	°C/W	
R _{thCS} Case-to-Sink	ALL	—	0.1	—	°C/W	Mounting surface flat, smooth, and greased.
R _{thJA} Junction-to-Ambient	ALL	—	—	30	°C/W	Free Air Operation

Source-Drain Diode Ratings and Characteristics

I _S Continuous Source Current (Body Diode)	IRF230R	—	—	9.0	A	Modified MOSFET symbol showing the integral reverse P-N junction rectifier.
	IRF231R	—	—	—	—	
	IRF232R IRF233R	—	—	8.0	A	
I _{SM} Pulse Source Current (Body Diode) ③	IRF230R	—	—	36	A	
	IRF231R	—	—	—	—	
	IRF232R IRF233R	—	—	32	A	
V _{SD} Diode Forward Voltage ②	IRF230R	—	—	2.0	V	T _C = 25°C, I _S = 9.0A, V _{GS} = 0V
	IRF231R	—	—	—	—	—
	IRF232R IRF233R	—	—	1.8	V	T _C = 25°C, I _S = 8.0A, V _{GS} = 0V
t _{rr} Reverse Recovery Time	ALL	—	450	—	ns	T _J = 150°C, I _F = 9.0A, dI _F /dt = 100A/ μ s
Q _{RR} Reverse Recovered Charge	ALL	—	3.0	—	μ C	T _J = 150°C, I _F = 9.0A, dI _F /dt = 100A/ μ 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°C to 150°C. ② Pulse Test: Pulse width $\leq$ 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} = 20V, starting T_J = 25°C, L = 3.37mH, R_{DS} = 50 Ω , I_{peak} = 9A. See figures 15, 16.

IRF230R, IRF231R, IRF232R, IRF233R

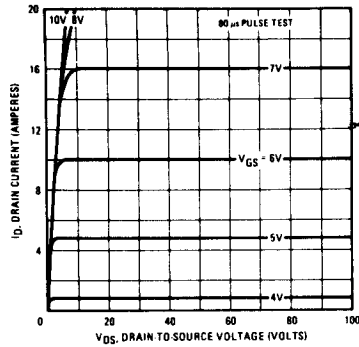


Fig. 1 - Typical Output Characteristics

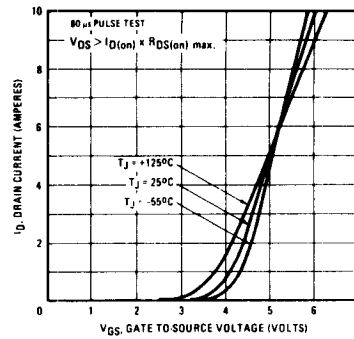


Fig. 2 - Typical Transfer Characteristics

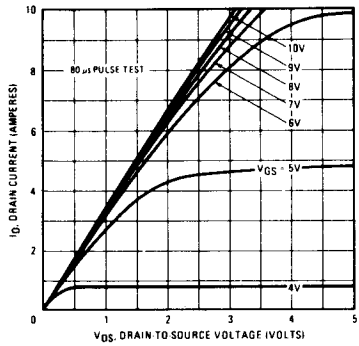


Fig. 3 - Typical Saturation Characteristics

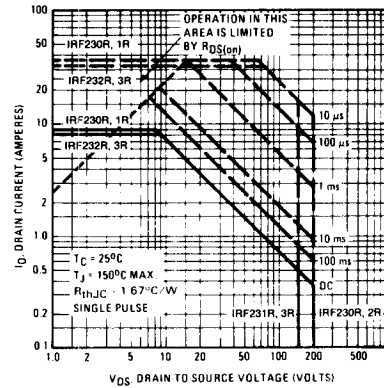


Fig. 4 - Maximum Safe Operating Area

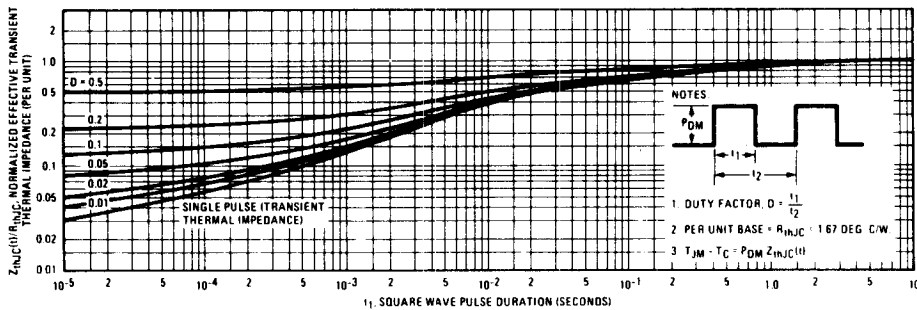


Fig. 5 - Maximum Effective Transient Thermal Impedance, Junction-to-Case Vs. Pulse Duration

IRF230R, IRF231R, IRF232R, IRF233R

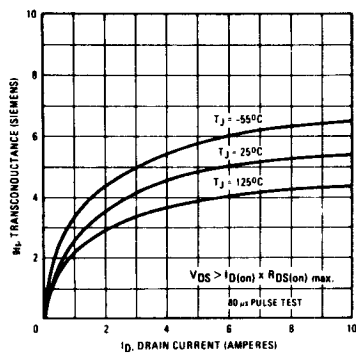


Fig. 6 - Typical Transconductance Vs. Drain Current

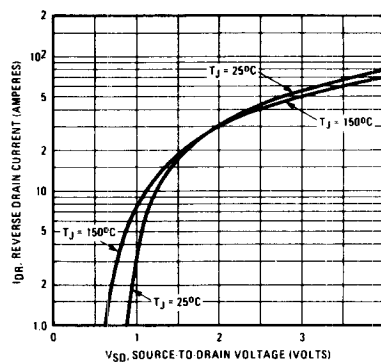


Fig. 7 - Typical Source-Drain Diode Forward Voltage

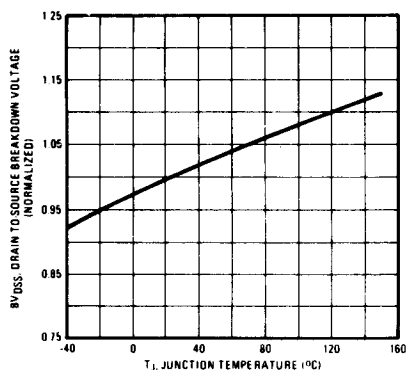


Fig. 8 - Breakdown Voltage Vs. Temperature

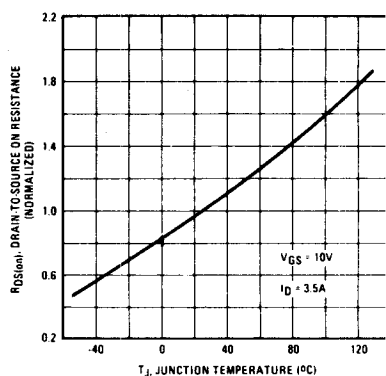


Fig. 9 - Normalized On-Resistance Vs. Temperature

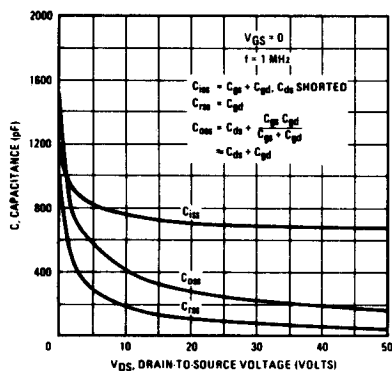


Fig. 10 - Typical Capacitance Vs. Drain-to-Source Voltage

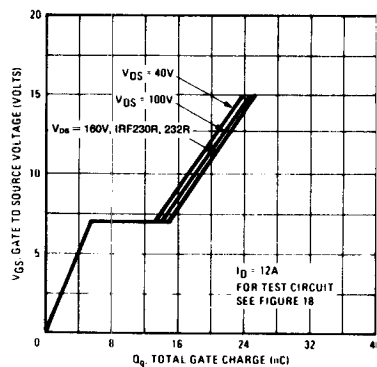


Fig. 11 - Typical Gate Charge Vs. Gate-to-Source Voltage

IRF230R, IRF231R, IRF232R, IRF233R

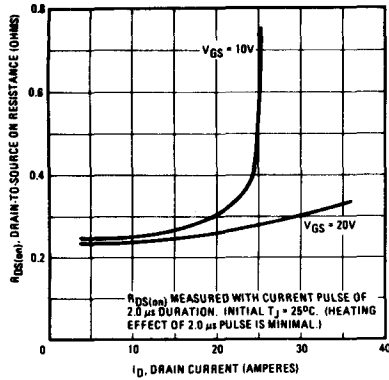


Fig. 12 - Typical On-Resistance Vs. Drain Current

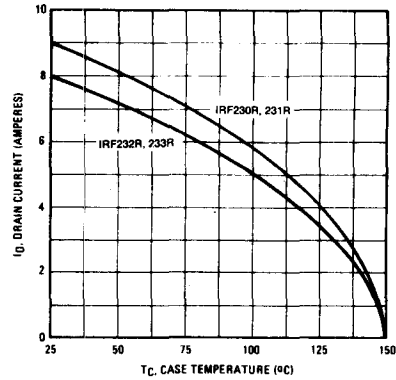


Fig. 13 - Maximum Drain Current Vs. Case Temperature

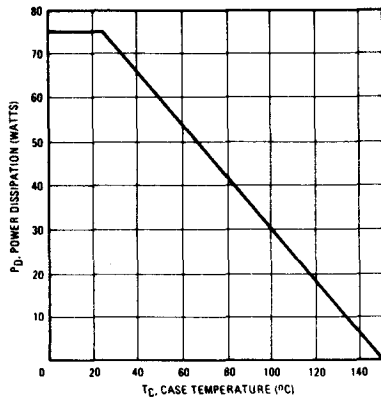


Fig. 14 - Power Vs. Temperature Derating Curve

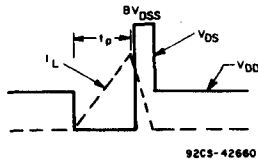


Fig. 16 - Unclamped Energy Waveforms

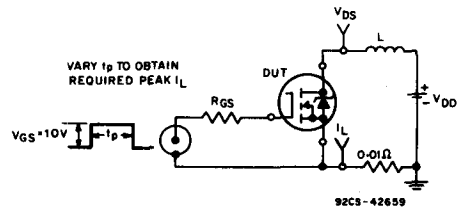


Fig. 15 - Unclamped Energy Test Circuit

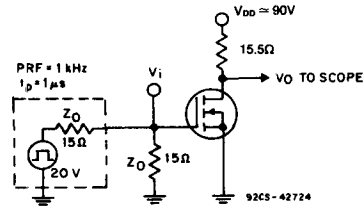


Fig. 17 - Switching Time Test Circuit

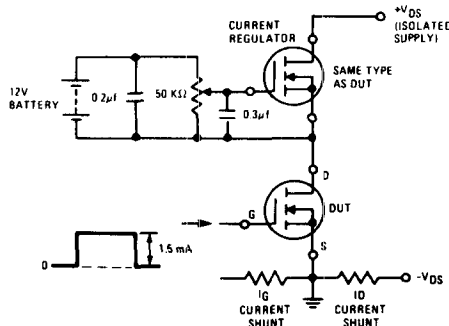


Fig. 18 - Gate Charge Test Circuit