

IRFF9230, IRFF9231, IRFF9232, IRFF9233

**Avalanche-Energy-Rated
 P-Channel Power MOSFETs**

-3.5 A and -4.0 A, -150 V and -200 V
 $r_{DS(on)} = 0.8 \Omega$ and 1.2Ω

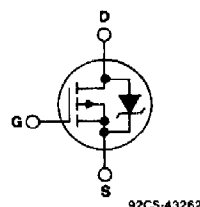
Features:

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

The IRFF9230, IRFF9231, IRFF9232 and IRFF9233 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.

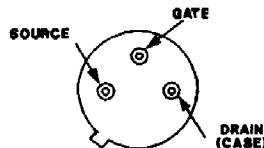
The IRFF-types are supplied in the JEDEC TO-205AF (Low-Profile TO-39) metal package.

TERMINAL DIAGRAM



P-CHANNEL ENHANCEMENT MODE

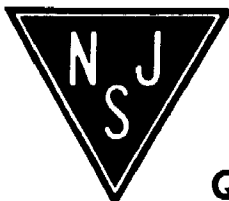
TERMINAL DESIGNATION



JEDEC TO-205AF

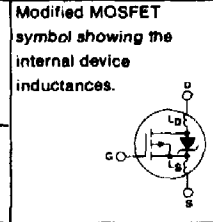
ABSOLUTE-MAXIMUM RATINGS

CHARACTERISTIC		IRFF9230	IRFF9231	IRFF9232	IRFF9233	UNITS
Drain-Source Voltage ①	V_{DS}	-200	-150	-200	-150	V
Drain-Gate Voltage ($R_{DS} = 20 \text{ k}\Omega$) ①	V_{DG}	-200	-150	-200	-150	V
Continuous Drain Current	$I_D @ T_C = 25^\circ\text{C}$	-4.0	-4.0	-3.5	-3.5	A
Pulsed Drain Current ②	I_{DM}	-16	-16	-14	-14	A
Gate-Source Voltage	V_{GS}	± 20				V
Maximum Power Dissipation	$P_D @ T_C = 25^\circ\text{C}$	25 (See Fig. 14)				W
Linear Derating Factor		0.2 (See Fig. 14)				W/°C
Single-Pulse Avalanche Energy Rating ④	E_{AS}	500				mJ
Operating Junction and Storage Temperature Range	T_J, T_{STG}	-55 to +150				°C
Lead Temperature		300 (0.063 in. (1.6 mm) from case for 10s)				°C



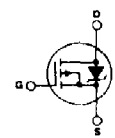
ELECTRICAL CHARACTERISTICS, At T_c = 25°C (Unless Otherwise Specified)

CHARACTERISTIC	TYPE	MIN.	TYP.	MAX.	UNITS	TEST CONDITIONS	
Drain-Source Breakdown Voltage	BV _{DS}	IRFF9230	-200	—	—	V	V _{GS} = 0 V I _D = -250 μA
		IRFF9232	—	—	—	—	
		IRFF9231	-150	—	—	V	
		IRFF9233	—	—	—	—	
Gate Threshold Voltage	V _{GS(th)}	ALL	-2.0	—	-4.0	V	V _{DS} = V _{GS} , I _D = -250 μA
Gate-Source Leakage Forward	I _{GSS}	ALL	—	—	-100	nA	V _{GS} = -20 V
Gate-Source Leakage Reverse	I _{GSS}	ALL	—	—	100	nA	V _{GS} = 20 V
Zero-Gate Voltage Drain Current	I _{OSS}	ALL	—	—	-250	μA	V _{DS} = Max. Rating, V _{GS} = 0 V
			—	—	-1000	μA	V _{DS} = Max. Rating x 0.8, V _{GS} = 0 V, T _C = 125°C
On-State Drain Current ②	I _{D(on)}	IRFF9230	-4.0	—	—	A	V _{DS} > I _{D(on)} x r _{DS(on)} max., V _{GS} = -10 V
		IRFF9231	—	—	—	—	
		IRFF9232	-3.5	—	—	A	
		IRFF9233	—	—	—	—	
Static Drain-Source On-State Resistance ③	r _{DS(on)}	IRFF9230	—	0.5	0.8	Ω	V _{GS} = -10 V, I _D = -2.0 A
		IRFF9231	—	—	—	—	
		IRFF9232	—	0.8	1.2	Ω	
		IRFF9233	—	—	—	—	
Forward Transconductance ③	g _{fs}	ALL	2.2	3.5	—	S (Ω)	V _{GS} > I _{D(on)} x r _{DS(on)} max., I _D = 2.0 A
Input Capacitance	C _{iss}	ALL	—	550	—	pF	V _{GS} = 0 V, V _{DS} = -25 V, f = 1.0 MHz
Output Capacitance	C _{oss}	ALL	—	170	—	pF	See Fig. 10
Reverse Transfer Capacitance	C _{rss}	ALL	—	50	—	pF	
Turn-On Delay Time	t _{d(on)}	ALL	—	30	50	ns	V _{DD} = 0.5 BV _{DS} , I _D = 2.0 A, Z ₀ = 50 Ω
Rise Time	t _r	ALL	—	50	100	ns	See Fig. 17
Turn-Off Delay Time	t _{d(off)}	ALL	—	50	100	ns	(MOSFET switching times are essentially independent of operating temperature.)
Fall Time	t _f	ALL	—	40	80	ns	
Total Gate Charge (Gate-Source Plus Gate-Drain)	Q _g	ALL	—	31	45	nC	V _{GS} = -15 V, I _D = -8.0 A, V _{DS} = 0.8 Max. Rating. See Fig. 18 for test circuit. (Gate charge is essentially independent of operating temperature.)
Gate-Source Charge	Q _{gs}	ALL	—	18	26	nC	
Gate-Drain ("Miller") Charge	Q _{gd}	ALL	—	13	19	nC	
Internal Drain Inductance	L _D	ALL	—	5.0	—	nH	Measured from the drain lead, 5mm (0.2 in.) from header to center of die.
Internal Source Inductance	L _S	ALL	—	15.0	—	nH	Measured from the source lead, 5mm (0.2 in.) from header to source bonding pad.
Junction-to-Case	R _{θJC}	ALL	—	—	5.0	°C/W	Typical socket mount.
Junction-to-Ambient	R _{θJA}	ALL	—	—	175	°C/W	



SOURCE-DRAIN DIODE RATINGS AND CHARACTERISTICS

Continuous Source Current (Body Diode)	I _S	IRFF9230	—	—	-4.0	A	Modified MOSFET symbol showing the integral reverse P-N junction rectifier.
		IRFF9231	—	—	-3.5	A	
		IRFF9232	—	—	-3.5	A	
		IRFF9233	—	—	-3.5	A	
Pulse Source Current (Body Diode) ③	I _{SM}	IRFF9230	—	—	-16	A	
		IRFF9231	—	—	-16	A	
		IRFF9232	—	—	-14	A	
		IRFF9233	—	—	-14	A	
Diode Forward Voltage ③	V _{SD}	IRFF9230	—	—	-1.5	V	T _C = 25°C, I _S = -4.0 A, V _{GS} = 0 V
		IRFF9231	—	—	-1.5	V	T _C = 25°C, I _S = -3.5 A, V _{GS} = 0 V
		IRFF9232	—	—	-1.5	V	T _C = 25°C, I _S = -3.5 A, V _{GS} = 0 V
		IRFF9233	—	—	-1.5	V	T _C = 25°C, I _S = -3.5 A, V _{GS} = 0 V
Reverse Recovery Time	t _r	ALL	—	400	—	ns	T _J = 150°C, I _F = -4.0 A, di/dt = 100 A/μs
Reverse Recovered Charge	Q _{rr}	ALL	—	2.8	—	μC	T _J = 150°C, I _F = -4.0 A, di/dt = 100 A/μs
Forward Turn-On Time	t _{on}	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 Repetitive Rating; Pulse width limited by max. junction temperature

③ V_{DS} = 50 V, Starting T_J = 25°C, L = 46.9 mH, R_θ = 25 Ω, Peak I_L = 4.0 A (See Figs. 15 & 16).

③ Pulse Test: Pulse width ≤ 300 μs. Duty Cycle ≤ 2%

See Transient Thermal Impedance Curve (Fig. 5).