

August 1991

Features

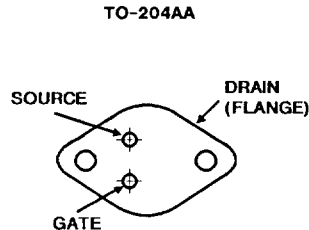
- 13A and 15.0A, 350V - 400V
- $r_{DS(on)} = 0.3\Omega$ and 0.4Ω
- Single Pulse Avalanche Energy Rated*
- SOA is Power-Dissipation Limited
- Nanosecond Switching Speeds
- Linear Transfer Characteristics
- High Input Impedance

Description

The IRF350, IRF351, IRF352, and IRF353 are n-channel enhancement-mode silicon-gate power field-effect transistors. IRF350R, IRF351R, IRF352R and IRF353R types are advanced power MOSFETs designed, tested, and guaranteed to withstand a specified level of energy in the breakdown avalanche mode of operation. All of these power MOSFETs are 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.

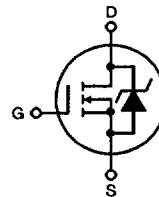
The IRF types are supplied in the JEDEC TO-204AA steel package.

Package



Terminal Diagram

N-CHANNEL ENHANCEMENT MODE



4
N-CHANNEL
POWER MOSFETs

Absolute Maximum Ratings ($T_C = +25^\circ\text{C}$), Unless Otherwise Specified

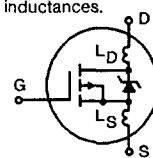
	IRF350 IRF350R	IRF351 IRF351R	IRF352 IRF352R	IRF353 IRF353R	UNITS
Drain-Source Voltage (1)	V_{DS} 400	350	400	350	V
Drain-Gate Voltage ($R_{GS} = 20k\Omega$) (1)	V_{DGR} 400	350	400	350	V
Continuous Drain Current					
$T_C = +25^\circ\text{C}$	I_D 15	15	13	13	A
$T_C = +100^\circ\text{C}$	I_D 9.0	9.0	8.0	8.0	A
Pulsed Drain Current (3)	I_{DM} 60	60	52	52	A
Gate-Source Voltage	V_{GS} ± 20	± 20	± 20	± 20	V
Maximum Power Dissipation					
$T_C = +25^\circ\text{C}$	P_D 150	150	150	150	W
Linear Derating Factor	1.2	1.2	1.2	1.2	W/ $^\circ\text{C}$
Inductive Current, Clamped	I_{LM} 60	60	52	52	A
(See Figure 14, $L = 100\mu\text{H}$)					
Single Pulse Avalanche Energy Rating (4)	E_{AS}^* 700	700	700	700	mJ
Operating and Storage Junction	T_J, T_{STG} -55 to +150	-55 to +150	-55 to +150	-55 to +150	$^\circ\text{C}$
Temperature Range					
Maximum Lead Temperature for Soldering	T_L 300	300	300	300	$^\circ\text{C}$
(0.063" (1.6mm) from case for 10s)					

NOTES:

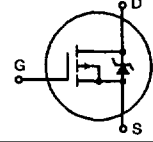
- $T_J = +25^\circ\text{C}$ to $+150^\circ\text{C}$.
 - Pulse Test: Pulse width $\leq 300\mu\text{s}$, Duty Cycle $\leq 2\%$.
 - Repetitive rating: Pulse width limited by maximum junction temperature. See Transient Thermal Impedance Curve (Figure 5).
 - $V_{DD} = 40\text{V}$, starting $T_J = +25^\circ\text{C}$, $L = 5.66\text{mH}$, $R_{GS} = 50\Omega$, $I_{PEAK} = 15\text{A}$. See Figure 15.
- *R Suffix Types Only

IRF350, IRF351, IRF352, IRF353 IRF350R, IRF351R, IRF352R, IRF353R

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

CHARACTERISTIC	SYMBOL	TEST CONDITIONS	LIMITS			UNITS	
			MIN	TYP	MAX		
Drain-Source Breakdown Voltage IRF350/352, IRF350R/352R IRF351/353, IRF351R/353R	BV _{DSS}	V _{GS} = 0V, I _D = -250μA	400	-	-	V	
			350	-	-	V	
Gate Threshold Voltage	V _{GS(TH)}	V _{DS} = V _{GS} , I _D = 250μA	2.0	-	4.0	V	
Gate-Source Leakage Forward	I _{GSS}	V _{GS} = 20V	-	-	100	nA	
Gate-Source Leakage Reverse	I _{GSS}	V _{GS} = -20V	-	-	-100	nA	
Zero Gate Voltage Drain Current	I _{DSS}	V _{DS} = Max Rating, V _{GS} = 0V V _{DS} = Max Rating x 0.8, V _{GS} = 0V, T _J = +125°C	-	-	250	μA	
			-	-	1000	μA	
On-State Drain Current (Note 2) IRF350/351, IRF350R/351R IRF352/353, IRF352R/353R	I _{D(ON)}	V _{DS} > I _{D(ON)} × r _{DS(ON)} Max, V _{GS} = 10V	15	-	-	A	
			13	-	-	A	
Static Drain-Source On-State Resistance (Note 2) IRF350/351, IRF350R/351R IRF352/353, IRF352R/353R	r _{DS(ON)}	V _{GS} = 10V, I _D = 8.0A	-	0.25	0.3	Ω	
			-	0.3	0.4	Ω	
Forward Transconductance (Note 2)	g _{fs}	V _{DS} > I _{D(ON)} × r _{DS(ON)} Max, I _D = 8.0A	8.0	10	-	S(Ω)	
Input Capacitance	C _{ISS}	V _{GS} = 0V, V _{DS} = 25V, f = 1.0MHz See Figure 10	-	2000	-	pF	
Output Capacitance	C _{OSS}	See Figure 10	-	400	-	pF	
Reverse Transfer Capacitance	C _{RSS}		-	100	-	pF	
Turn-On Delay Time	t _{d(ON)}	V _{DD} ≈ 180V, I _D = 8.0A, Z _o = 4.7Ω	-	-	35	ns	
Rise Time	t _r	See Figure 16. (MOSFET switching times are essentially independent of operating temperature)	-	-	65	ns	
Turn-Off Delay Time	t _{d(OFF)}		-	-	150	ns	
Fall Time	t _f		-	-	75	ns	
Total Gate Charge (Gate-Source + Gate-Drain)	Q _g		V _{GS} = 10V, I _D = 18A, V _{DS} = 0.8V Max Rating. See Figure 17 for test circuit. (Gate charge is essentially independent of operating temperature.)	-	79	120	nC
Gate-Source Charge	Q _{gs}		-	38	-	nC	
Gate-Drain ("Miller") Charge	Q _{gd}		-	41	-	nC	
Internal Drain Inductance	L _D	Measured between the contact screw on header that is closer to source and gate pins and center of center of die.	Modified MOSFET symbol showing the internal device inductances.		-	5.0	nH
Internal Source Inductance	L _S	Measured from the source lead, 6mm (0.25") from header and source bonding pad.			-	12.5	nH
Junction-to-Case	R _{θJC}		-	-	0.83	°C/W	
Case-to-Sink	R _{θCS}	Mounting surface flat, smooth and greased	-	0.1	-	°C/W	
Junction-to-Ambient	R _{θJA}	Free air operation	-	-	30	°C/W	

Source Drain Diode Ratings and Characteristics

Continuous Source Current (Body Diode)	I _S	Modified MOSFET symbol showing the integral reverse P-N junc. rectifier.		-	-	15	A
Pulse Source Current (Body Diode) (Note 3)	I _{SM}			-	-	60	A
Diode Forward Voltage (Note 2)	V _{SD}	T _J = +25°C, I _S = 15A, V _{GS} = 0V	-	-	1.6	V	
Reverse Recovery Time	t _{rr}	T _J = +150°C, I _F = 15A, dI _F /dt = 100A/μs	-	1000	-	ns	
Reverse Recovered Charge	Q _{RR}	T _J = +150°C, I _F = 15A, dI _F /dt = 100A/μs	-	6.6	-	μC	
Forward Turn-on Time	t _{ON}	Intrinsic turn-on time is negligible. Turn-on speed is substantially controlled by L _S + L _D .	-	-	-	-	

NOTES: 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 (Figure 5)

4. V_{DD} = 40V, Start T_J = +25°C, L = 5.66mH, R_{GS} = 50Ω, I_{pPEAK} = 15A (See Figure 15)

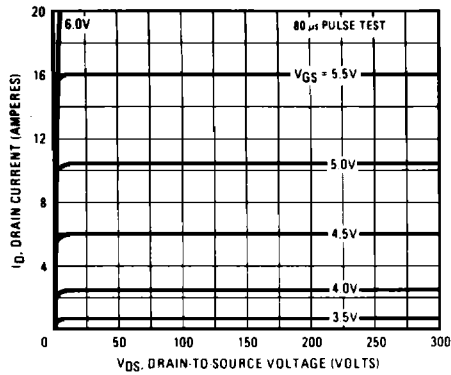


Fig. 1 - Typical Output Characteristics

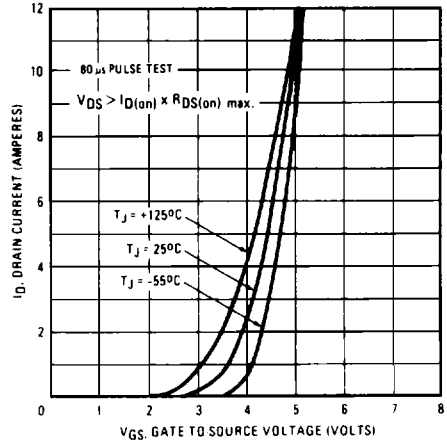


Fig. 2 - Typical Transfer Characteristics

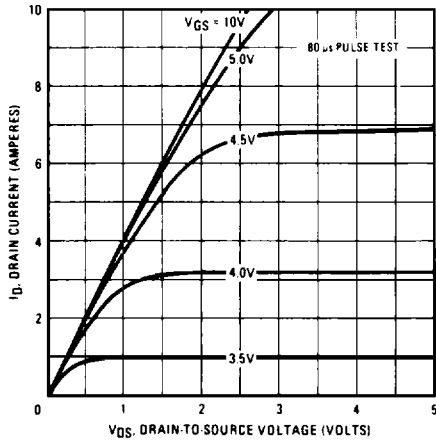


Fig. 3 - Typical Saturation Characteristics

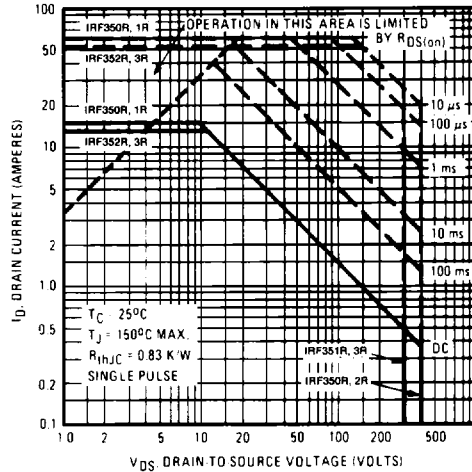


Fig. 4 - Maximum Safe Operating Area

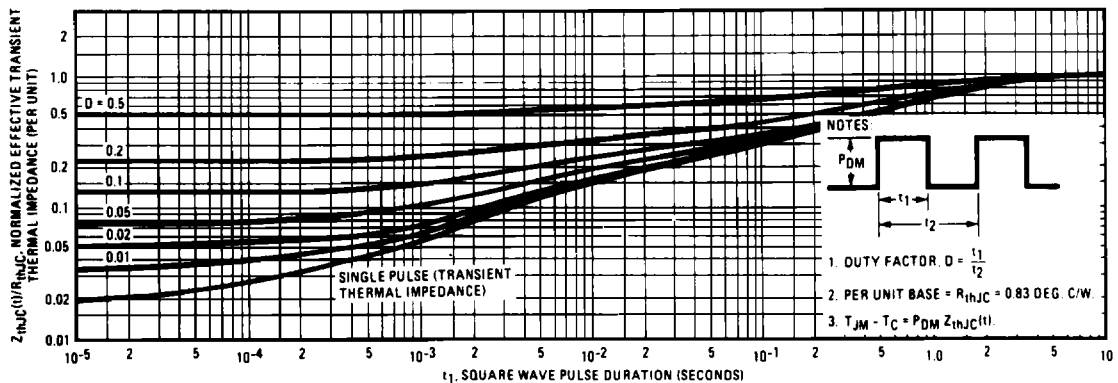


Fig. 5 - Maximum Effective Transient Thermal Impedance, Junction-to-Case Vs. Pulse Duration

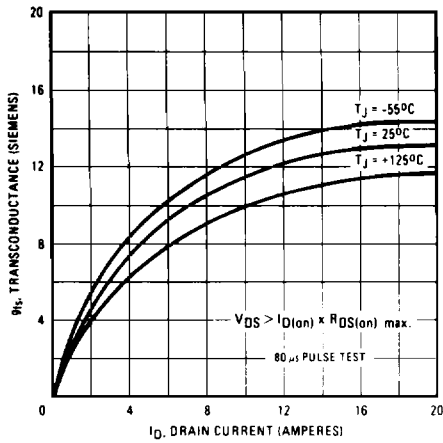


Fig. 6 – Typical Transconductance Vs. Drain Current

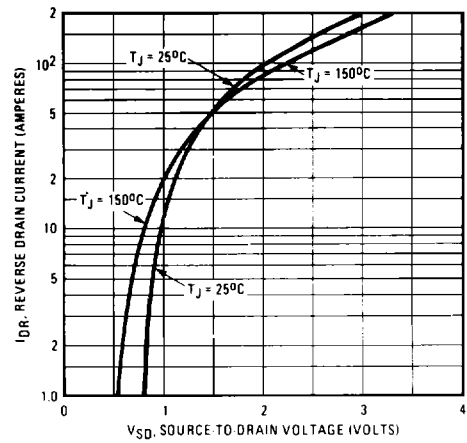


Fig. 7 – Typical Source-Drain Diode Forward Voltage

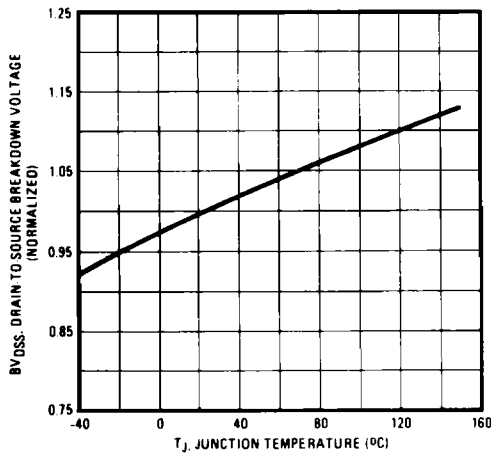


Fig. 8 – Breakdown Voltage Vs. Temperature

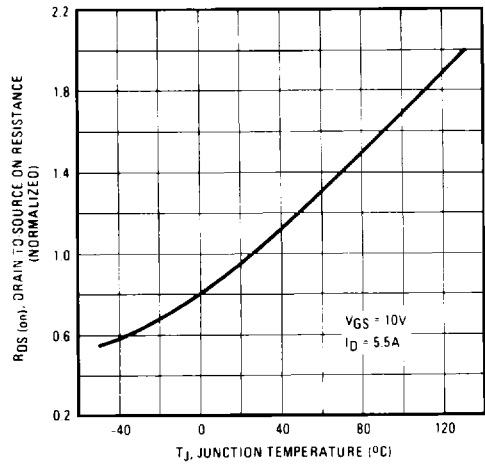


Fig. 9 – Normalized On-Resistance Vs. Temperature

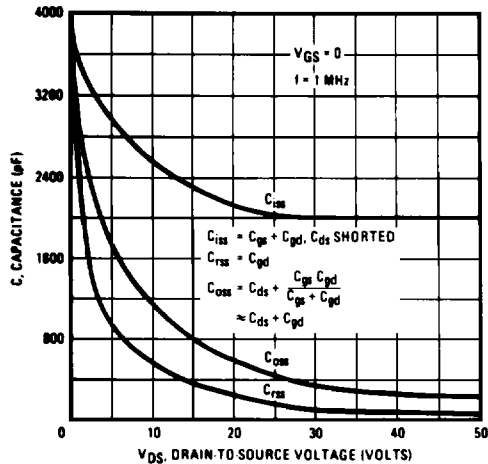


Fig. 10 – Typical Capacitance Vs. Drain-to-Source Voltage

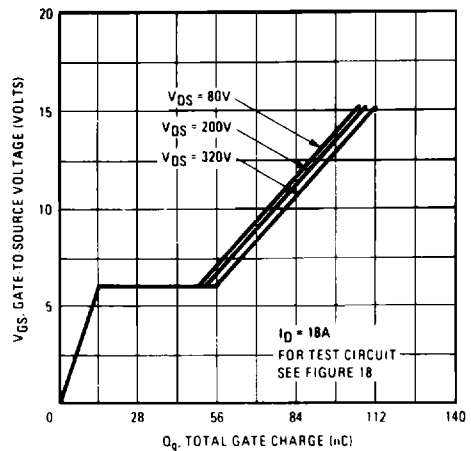


Fig. 11 – Typical Gate Charge Vs. Gate-to-Source Voltage

IRF350, IRF351, IRF352, IRF353 IRF350R, IRF351R, IRF352R, IRF353R

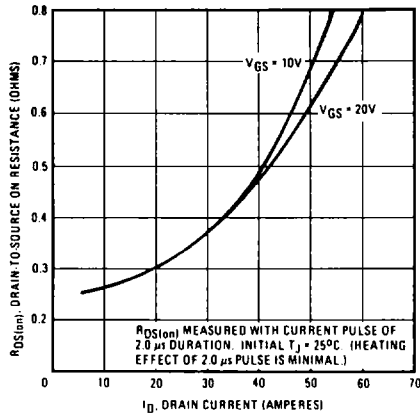


FIGURE 12. TYPICAL ON RESISTANCE vs DRAIN CURRENT

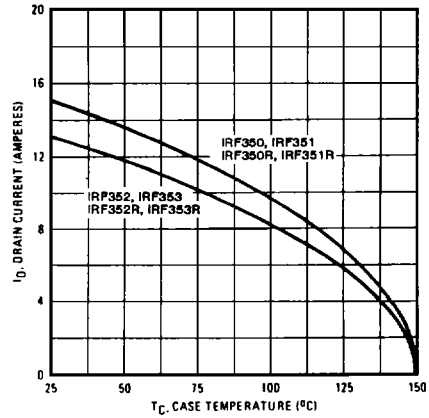


FIGURE 13. MAXIMUM DRAIN CURRENT vs CASE TEMPERATURE

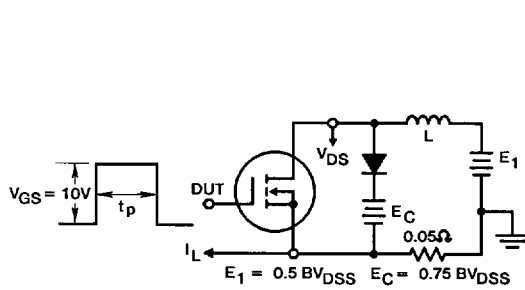


FIGURE 14a. CLAMPED INDUCTIVE TEST CIRCUIT

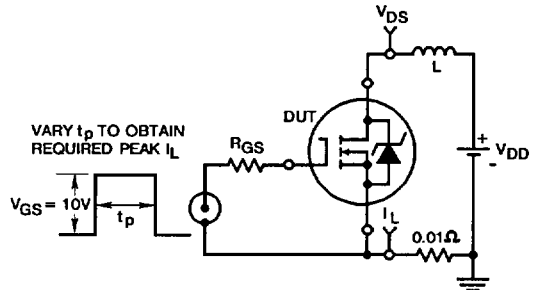


FIGURE 15a. UNCLAMPED ENERGY TEST CIRCUIT

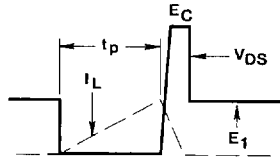


FIGURE 14b. CLAMPED INDUCTIVE WAVEFORMS

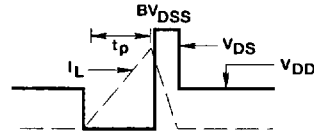


FIGURE 15b. UNCLAMPED ENERGY WAVEFORMS

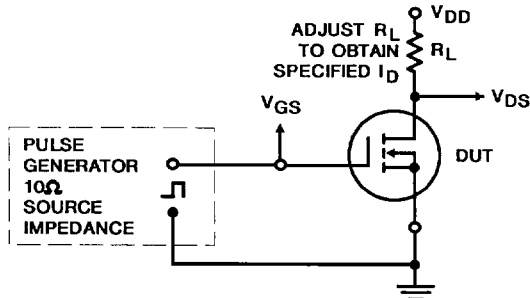


FIGURE 16. SWITCHING TIME TEST CIRCUIT

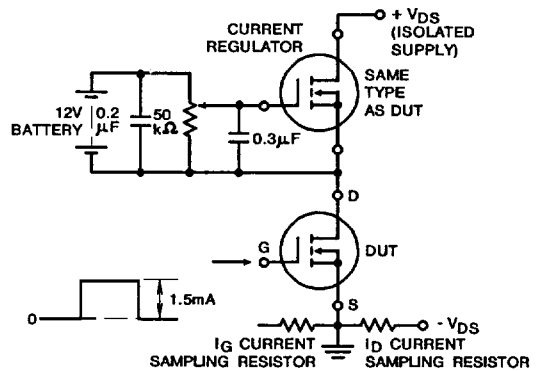


FIGURE 17. GATE CHARGE TEST CIRCUIT