HARRIS

IRF360
IRF362

N-Channel Power MOSFETs
Avalanche-Energy Rated

August 1991

Features

- 25A and 22A, 400V
- $r_{DS}(on)$ = 0.20Ω and 0.25Ω
- Single Pulse Avalanche Energy Rated
- SOA is Power-Dissipation Limited
- Nanosecond Switching Speeds
- Linear Transfer Characteristics
- High Input Impedance

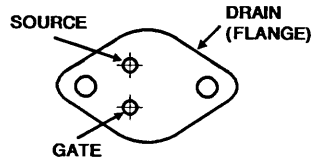
Description

The IRF360 and IRF362 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-204AE metal package.

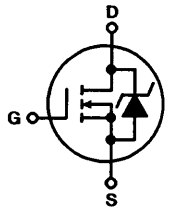
Package

TO-204AE
BOTTOM VIEW



Terminal Diagram

N-CHANNEL ENHANCEMENT MODE



Absolute Maximum Ratings (T_C = +25°C), Unless Otherwise Specified

	IRF360	IRF362	UNITS
Continuous Drain Current			
T_C = +25°C ..... I_D	25	22	A
T_C = +100°C ..... I_D	16	14	A
Pulsed Drain Current (1) ..... I_{DM}	100	88	A
Gate-Source Voltage ..... V_{GS}	±20	±20	V
Maximum Power Dissipation			
T_C = +25°C ..... P_D	300	300	W
Linear Derating Factor	2.4	2.4	W/°C
Single Pulse Avalanche Energy Rating (2) ..... E_{AS} See Figure 14	980	980	mj
Avalanche Current, Repetitive or Non-repetitive (1) ..... I_{AR}	25	25	A
Operating and Storage Junction Temperature Range ..... T_J, T_{STG}	-55 to +150	-55 to +150	°C
Maximum Lead Temperature for Soldering (0.063" (1.6mm) from case for 10s) ..... T_L	300	300	°C

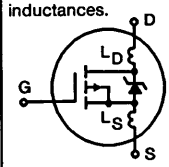
NOTES:

1. Repetitive rating: Pulse width limited by maximum junction temperature. See Transient Thermal Impedance Curve (Figure 5).
2. V_{DD} = 50V, starting T_J = +25°C, L = 2.8mH, R_{GS} = 25Ω, Peak I_L = 25A.
3. Pulse Test: Pulse width ≤ 300μs, Duty Cycle ≤ 2%.

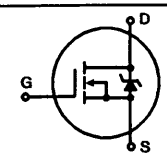
CAUTION: These devices are sensitive to electrostatic discharge. Proper I.C. handling procedures should be followed.

File Number **2276.1**

Electrical Characteristics T_C = 25°C, Unless Otherwise Specified

CHARACTERISTIC	SYMBOL	TEST CONDITIONS	LIMITS MIN	LIMITS TYP	LIMITS MAX	UNITS
Drain-Source Breakdown Voltage	BV_{DSS}	V_{GS} = 0V, I_D = 250μA	400	-	-	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	-	-	250	μA
		V_{DS} = Max Rating x 0.8, V_{GS} = 0V, T_J = +125°C	-	-	1000	μA
On-State Drain Current (Note 3) IRF360	$I_{D(ON)}$	V_{DS} > $I_{D(ON)}$ x $r_{DS(ON)}$ Max, V_{GS} = 10V	25	-	-	A
IRF362			22	-	-	A
Static Drain-Source On-State Resistance (Note 3) IRF360	$r_{DS(ON)}$	V_{GS} = 10V, I_D = 14A	-	0.18	0.20	Ω
IRF362			-	0.20	0.25	Ω
Forward Transconductance (Note 3)	g_{fs}	I_{DS} = 14A, V_{DS} ≥ 50V	14	21	-	S(℧)
Input Capacitance	C_{ISS}	V_{GS} = 0V, V_{DS} = 25V, f = 1.0MHz See Figure 10	-	4000	-	pF
Output Capacitance	C_{OSS}		-	550	-	pF
Reverse Transfer Capacitance	C_{RSS}		-	97	-	pF
Turn-On Delay Time	$t_{d(ON)}$	V_{DD} = 200V, I_D = 25A, R_G = 4.3Ω R_D = 7.5Ω. (MOSFET switching times are essentially independent of operating temperature)	-	22	33	ns
Rise Time	t_r		-	94	140	ns
Turn-Off Delay Time	$t_{d(OFF)}$		-	80	120	ns
Fall Time	t_f		-	66	99	ns
Total Gate Charge (Gate-Source + Gate-Drain)	Q_g	V_{GS} = 10V, I_D = 25A, V_{DS} = 0.8V x Max Rating. See Figure 16 for test circuit. (Gate charge is essentially independent of operating temperature.)	-	120	170	nC
Gate-Source Charge	Q_{gs}		-	19	-	nC
Gate-Drain ("Miller") Charge	Q_{gd}		-	60	-	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.	-	13	-	nH
Junction-to-Case	$R_{\theta JC}$		-	-	0.42	°C/W
Case-to-Sink	$R_{\theta CS}$	Mounting surface flat, smooth and greased	-	0.10	-	°C/W
Junction-to-Ambient	$R_{\theta JA}$	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. 	-	-	25	A
Pulse Source Current (Body Diode) (Note 3)	I_{SM}		-	-	100	A
Diode Forward Voltage (Note 2)	V_{SD}	T_J = +25°C, I_S = 25A, V_{GS} = 0V	-	-	1.8	V
Reverse Recovery Time	t_{rr}	T_J = +25°C, I_F = 25A, dI_F/dt = 100A/μs	200	460	1000	ns
Reverse Recovered Charge	Q_{RR}	T_J = +25°C, I_F = 25A, dI_F/dt = 100A/μs	3.1	7.1	16	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. Repetitive Rating: Pulse width limited by max. junction temperature. See Transient Thermal Impedance Curve (Figure 5)
2. V_{DD} = 50V, Starting T_J = +25°C, L = 2.8mH, I_L = 25A
3. Pulse Test: Pulse width ≤ 300μs, Duty Cycle ≤ 2%

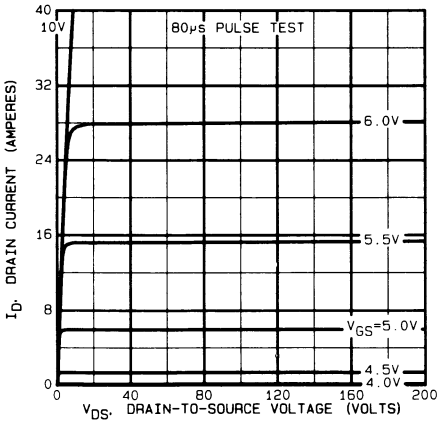


Fig. 1 - Typical output characteristics.

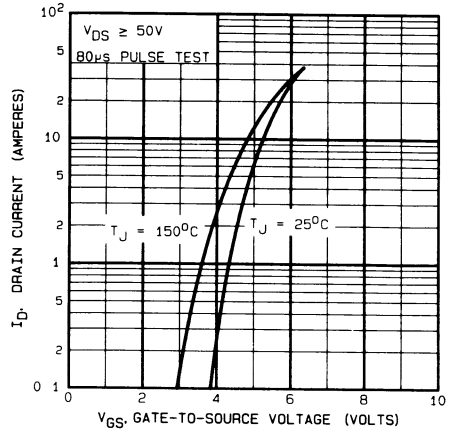


Fig. 2 - Typical transfer characteristics.

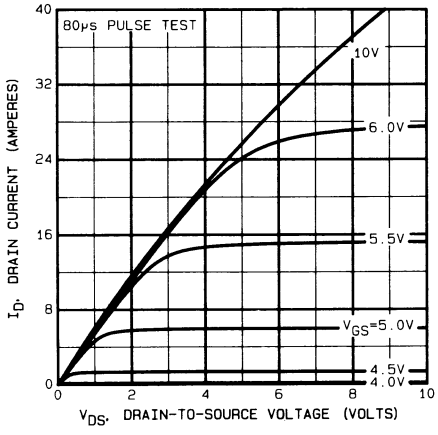


Fig. 3 - Typical saturation characteristics.

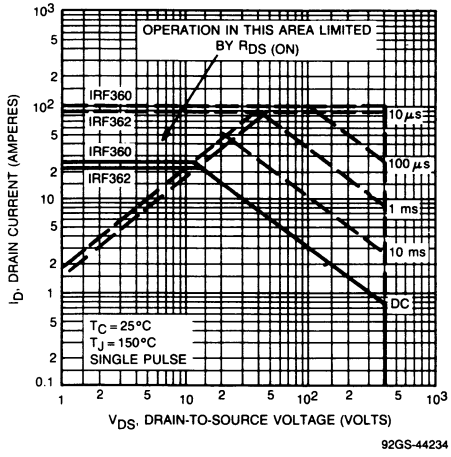
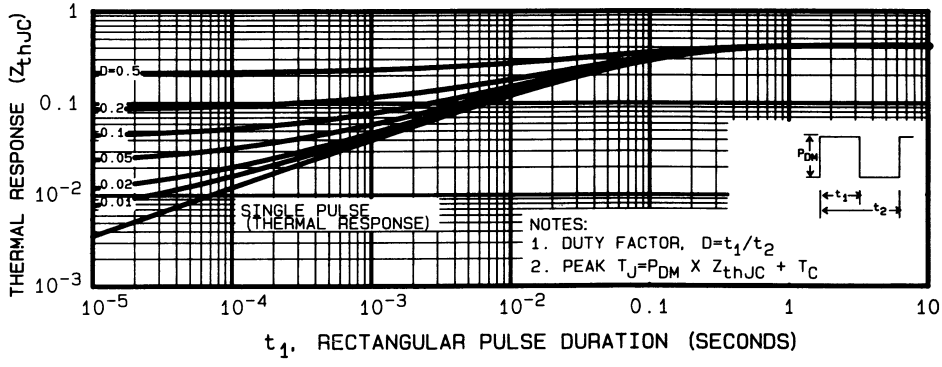


Fig. 4 - Maximum safe operating area.



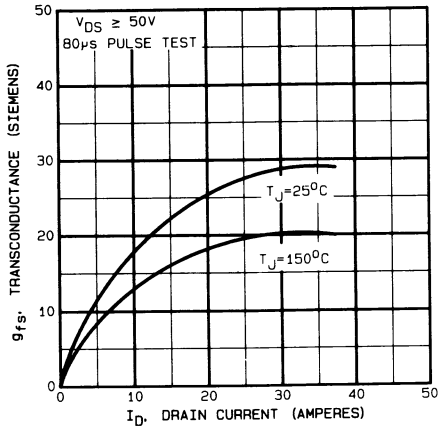


Fig. 6 - Typical transconductance vs. drain current.

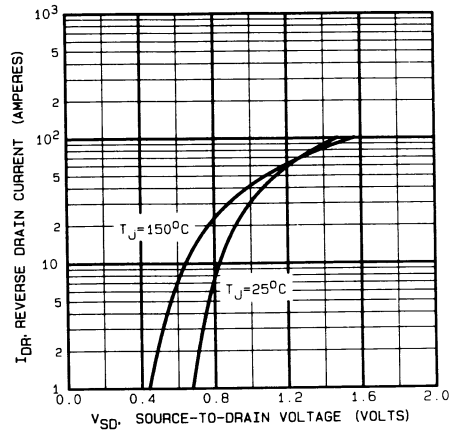


Fig. 7 - Typical source-drain diode forward voltage.

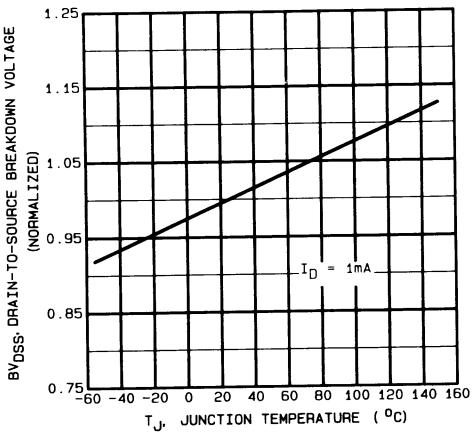


Fig. 8 - Breakdown voltage vs. temperature.

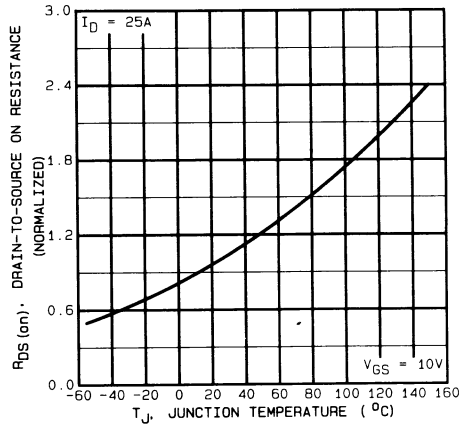


Fig. 9 - Normalized on-resistance vs. temperature.

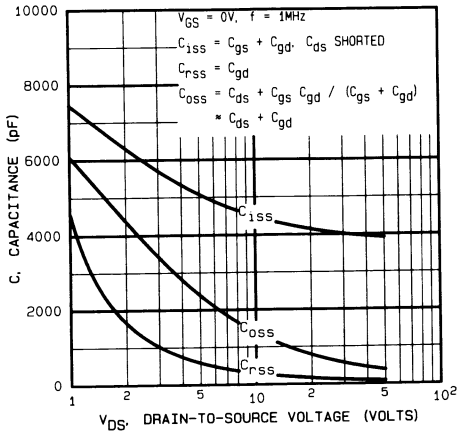


Fig. 10 - Typical capacitance vs. drain-to-source voltage.

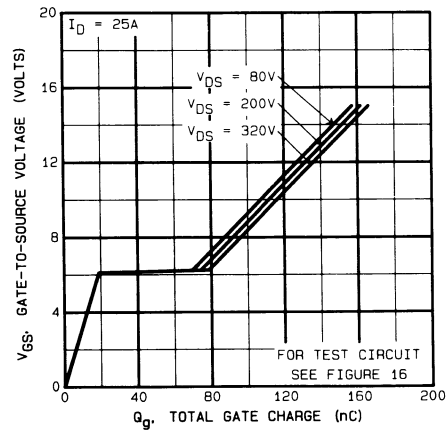


Fig. 11 - Typical gate charge vs. gate-to-source voltage.

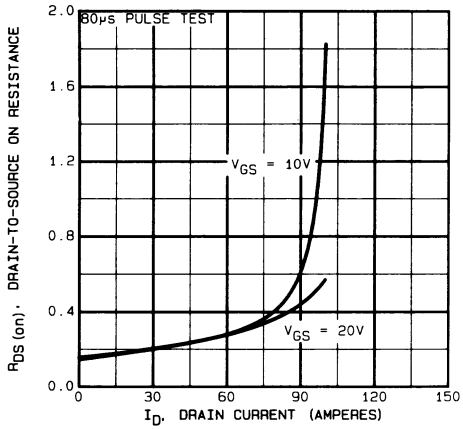


Fig. 12 - Typical on-resistance vs. drain current.

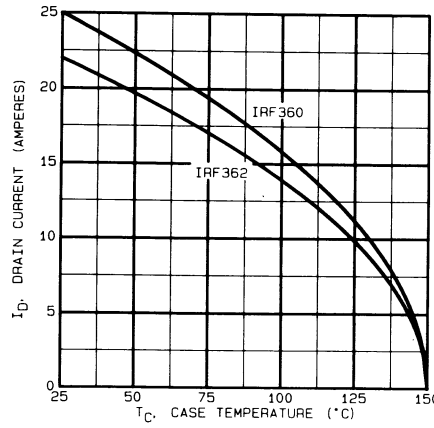


Fig. 13 - Maximum drain current vs. case temperature.

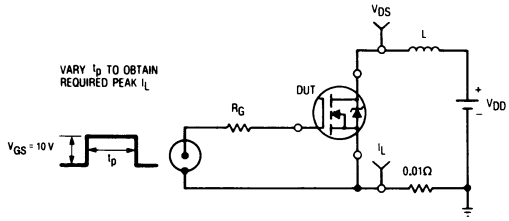


Fig. 14a - Unclamped inductive test circuit.

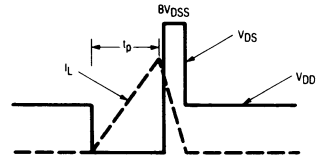


Fig. 14b - Unclamped inductive waveforms.

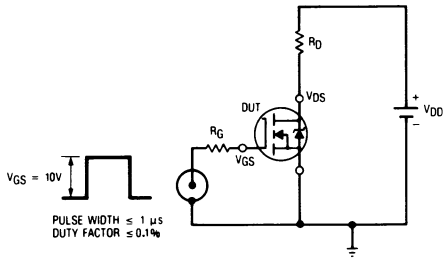


Fig. 15a - Switching time test circuit.

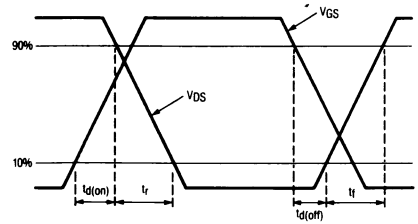


Fig. 15b - Switching time waveforms.

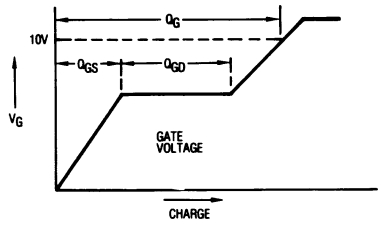


Fig. 16a - Basic gate charge waveform.

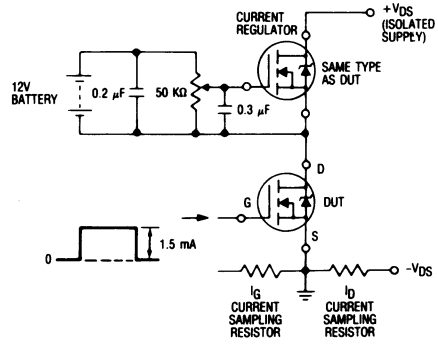


Fig. 16b - Gate charge test circuit.

HARRIS

IRF460
IRF462

N-Channel Power MOSFETs
Avalanche-Energy Rated

August 1991

Features

- 21A and 19A, 500V
- $r_{DS}(on)$ = 0.27Ω and 0.35Ω
- Single Pulse Avalanche Energy Rated
- SOA is Power-Dissipation Limited
- Nanosecond Switching Speeds
- Linear Transfer Characteristics
- High Input Impedance

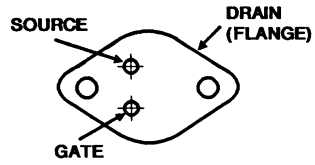
Description

The IRF460 and IRF462 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-204AE metal package.

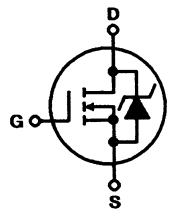
Package

TO-204AE
BOTTOM VIEW



Terminal Diagram

N-CHANNEL ENHANCEMENT MODE



Absolute Maximum Ratings (T_C = +25°C), Unless Otherwise Specified

	IRF460	IRF462	UNITS
Continuous Drain Current			
T_C = +25°C ..... I_D	21	19	A
T_C = +100°C ..... I_D	14	12	A
Pulsed Drain Current (1) ..... I_{DM}	84	76	A
Gate-Source Voltage ..... V_{GS}	±20	±20	V
Maximum Power Dissipation			
T_C = +25°C ..... P_D	300	300	W
Linear Derating Factor	2.4	2.4	W/°C
Single Pulse Avalanche Energy Rating (2) ..... E_{AS}*	1200	1200	mj
See Figure 14			
Avalanche Current, Repetitive or Non-repetitive (1) ..... I_{AR}	21	21	A
Operating and Storage Junction ..... T_J, T_{STG}	-55 to +150	-55 to +150	°C
Temperature Range			
Maximum Lead Temperature for Soldering ..... T_L	300	300	°C
(0.063" (1.6mm) from case for 10s)			

NOTES:

1. Repetitive rating: Pulse width limited by maximum junction temperature. See Transient Thermal Impedance Curve (Figure 5).
2. V_{DD} = 50V, starting T_J = +25°C, L = 4.9mH, R_{GS} = 25Ω, Peak I_L = 21A.
3. Pulse Test: Pulse width ≤ 300μs, Duty Cycle ≤ 2%.

File Number 2277.1

ELECTRICAL CHARACTERISTICS *At Case Temperature (T_J) = 25°C Unless Otherwise Specified*

Parameter		Type	Min.	Typ.	Max.	Units	Test Conditions
BV_{DSS}	Drain-to-Source Breakdown Voltage	ALL	500	–	–	V	V_{GS} = 0V, I_D = 250 μA
$R_{DS(on)}$	Static Drain-to-Source On-State Resistance ③	IRF460	–	0.24	0.27	Ω	V_{GS} = 10V, I_D = 12A
		IRF462	–	0.27	0.35		
$I_{D(on)}$	On-State Drain Current ③	IRF460	21	–	–	A	V_{DS} > $I_{D(on)}$ X $R_{DS(on)}$ Max.
		IRF462	19	–	–		V_{GS} = 10V
$V_{GS(th)}$	Gate Threshold Voltage	ALL	2.0	–	4.0	V	V_{DS} = V_{GS}, I_D = 250μA
g_{fs}	Forward Transconductance ③	ALL	13	20	–	S (℧)	V_{DS} ≥ 50V, I_{DS} = 12A
I_{DSS}	Zero Gate Voltage Drain Current	ALL	–	–	250	μA	V_{DS} = Max. Rating, V_{GS} = 0V
			–	–	1000		V_{DS} = 0.8 x Max. Rating V_{GS} = 0V, T_J = 125°C
I_{GSS}	Gate-to-Source Leakage Forward	ALL	–	–	100	nA	V_{GS} = 20V
I_{GSS}	Gate-to-Source Leakage Reverse	ALL	–	–	−100	nA	V_{GS} = −20V
Q_g	Total Gate Charge	ALL	–	120	190	nC	V_{GS} = 10V, I_D = 21A
Q_{gs}	Gate-to-Source Charge	ALL	–	18	—	nC	V_{DS} = 0.8 x Max. Rating See Fig. 16
Q_{gd}	Gate-to-Drain ("Miller") Charge	ALL	–	62	—	nC	(Independent of operating temperature)
$t_{d(on)}$	Turn-On Delay Time	ALL	–	23	35	ns	V_{DD} = 250V, I_D ≈ 21A, R_G = 4.3Ω
t_r	Rise Time	ALL	–	81	120	ns	R_D = 12Ω
$t_{d(off)}$	Turn-Off Delay Time	ALL	–	85	130	ns	See Fig. 15
t_f	Fall Time	ALL	–	65	98	ns	(Independent of operating temperature)
L_D	Internal Drain Inductance	ALL	–	5.0	–	nH	Measured from the drain lead, 6mm (0.25 in.) from package to center of die.
L_S	Internal Source Inductance	ALL	–	13	–	nH	Measured from the source lead, 6mm (0.25 in.) from package to source bonding pad.
C_{iss}	Input Capacitance	ALL	–	4100	–	pF	V_{GS} = 0V, V_{DS} = 25V
C_{oss}	Output Capacitance	ALL	–	480	–	pF	f = 1.0 MHz
C_{rss}	Reverse Transfer Capacitance	ALL	–	84	–	pF	See Fig. 10
R_{thJC}	Junction-to-Case	ALL	–	–	0.42	°C/W	
R_{thJS}	Case-to-Sink	ALL	–	0.10	–	°C/W	Mounting surface flat, smooth, and greased
R_{thJA}	Junction-to-Ambient	ALL	–	–	30	°C/W	Typical socket mount

Modified MOSFET symbol showing the internal inductances.

① Repetitive Rating; Pulse width limited by maximum junction temperature (see figure 5) Refer to current HEXFET reliability report

② @ V_{DD} = 50V, Starting T_J = 25°C, L = 4.9 μH, R_G = 25Ω, Peak I_L = 21A.

③ Pulse width ≤ 300 μs; Duty Cycle ≤ 2%

SOURCE-DRAIN DIODE RATINGS AND CHARACTERISTICS

Parameter		Type	Min.	Typ.	Max.	Units	Test Conditions
I_S	Continuous Source Current (Body Diode)	ALL	–	–	21	A	Modified MOSFET symbol showing the integral Reverse p-n junction rectifier.
I_{SM}	Pulsed Source Current (Body Diode) ①	ALL	–	–	84	A	
V_{SD}	Diode Forward Voltage ③	ALL	–	–	1.8	V	T_J = 25°C, I_S = 21A, V_{GS} = 0V
t_{rr}	Reverse Recovery Time	ALL	280	580	1200	ns	T_J = 25°C, I_F = 21A, di/dt = 100 A/μs
Q_{RR}	Reverse Recovery Charge	ALL	3.8	8.1	18	μC	
t_{on}	Forward Turn-On Time	ALL	Intrinsic turn-on time is negligible. Turn-on speed is substantially controlled by L_S + L_D.				

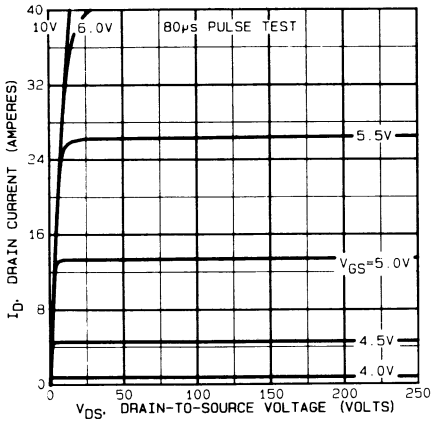


Fig. 1 - Typical output characteristics.

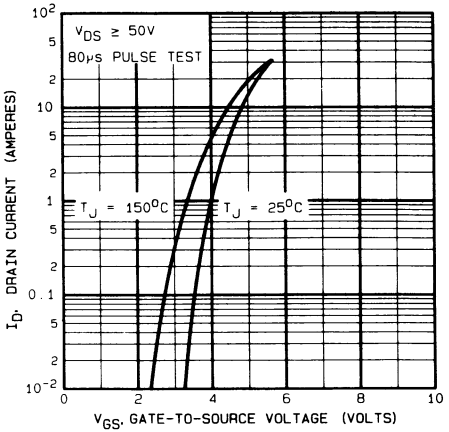


Fig. 2 - Typical transfer characteristics.

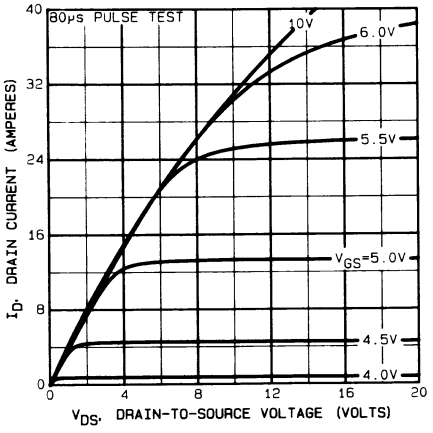


Fig. 3 - Typical saturation characteristics.

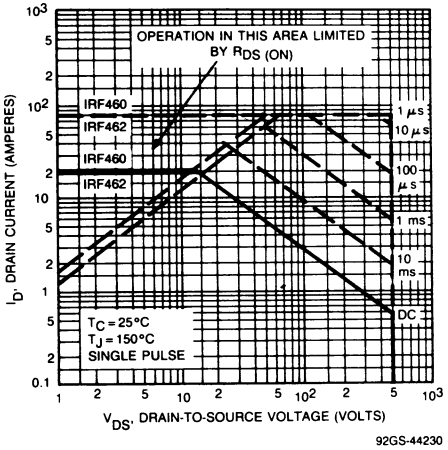


Fig. 4 - Maximum safe operating area.

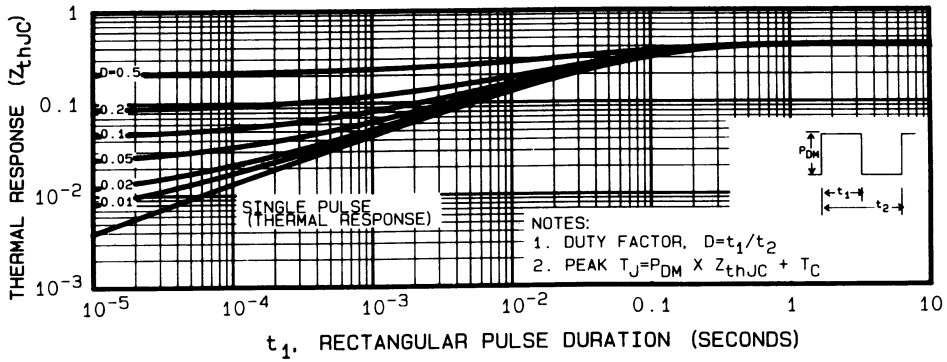


Fig. 5 - Maximum effective transient thermal impedance, junction-to-case vs. pulse duration.

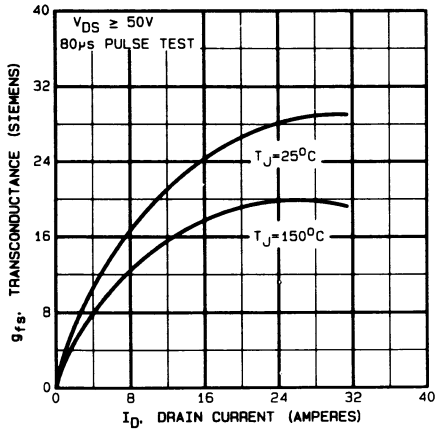


Fig. 6 - Typical transconductance vs. drain current.

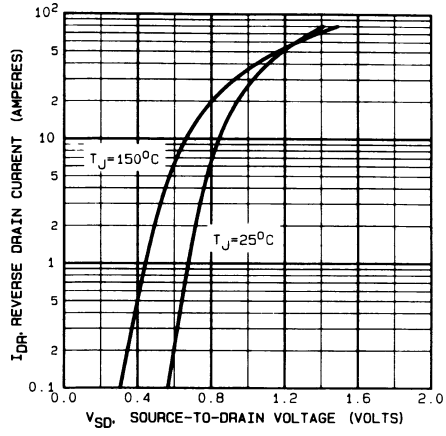


Fig. 7 - Typical source-drain diode forward voltage.

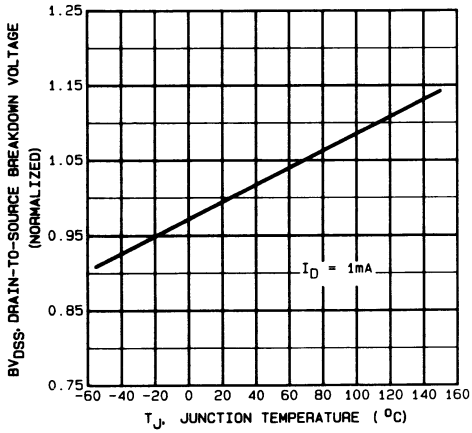


Fig. 8 - Breakdown voltage vs. temperature.

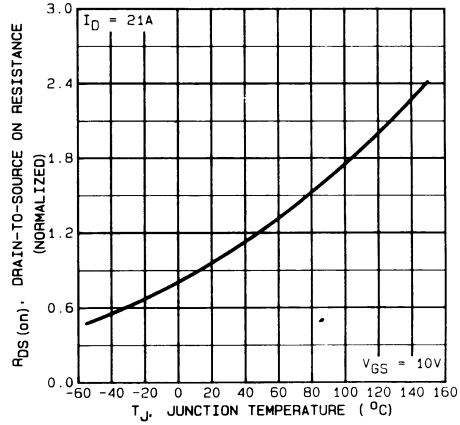


Fig. 9 - Normalized on-resistance vs. temperature.

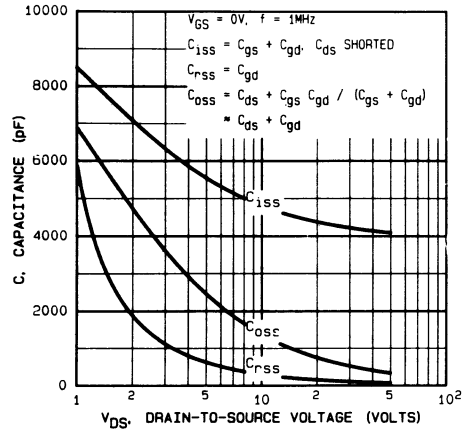


Fig. 10 - Typical capacitance vs. drain-to-source voltage.

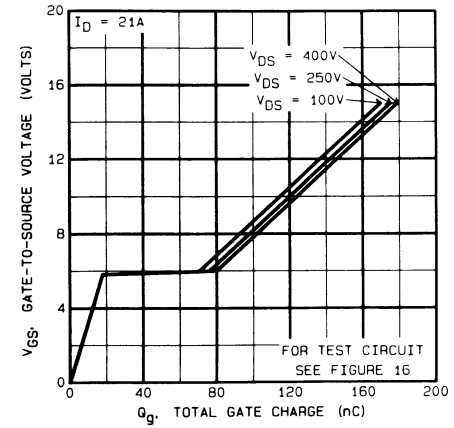


Fig. 11 - Typical gate charge vs. gate-to-source voltage.

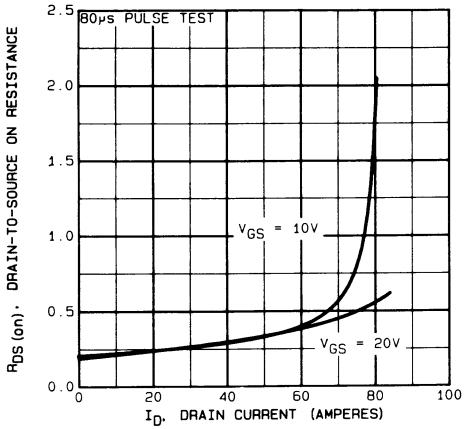


Fig. 12 - Typical on-resistance vs. drain current.

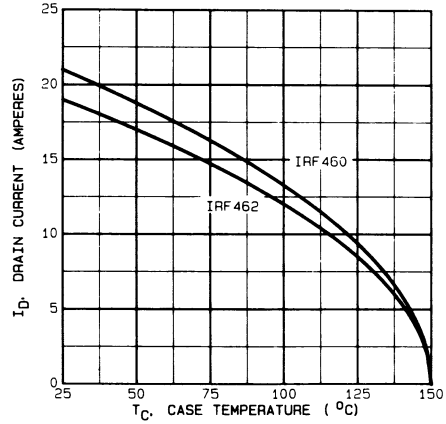


Fig. 13 - Maximum drain current vs. case temperature.

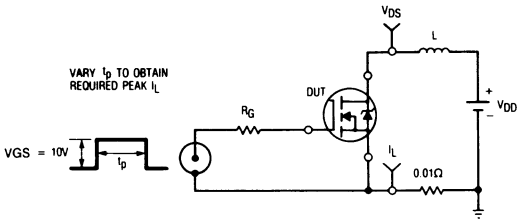


Fig. 14a - Unclamped inductive test circuit.

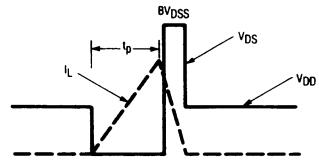


Fig. 14b - Unclamped inductive waveforms.

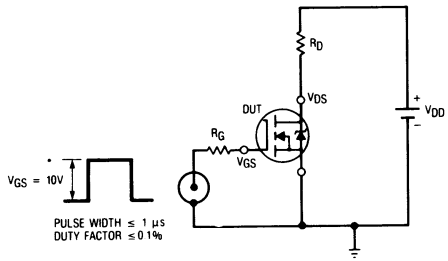


Fig. 15a - Switching time test circuit.

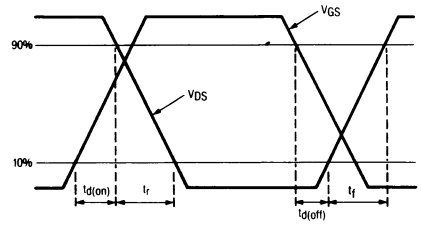


Fig. 15b - Switching time waveforms.

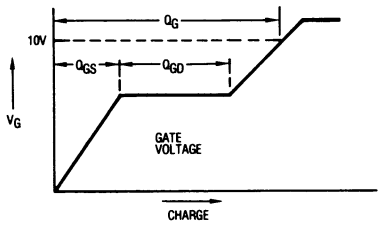


Fig. 16a - Basic gate charge waveform.

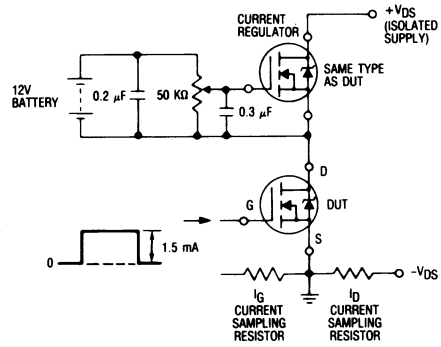


Fig. 16b - Gate charge test circuit.