HEXFET DESIGNER'S MANUAL

HDM-1, Vol. II

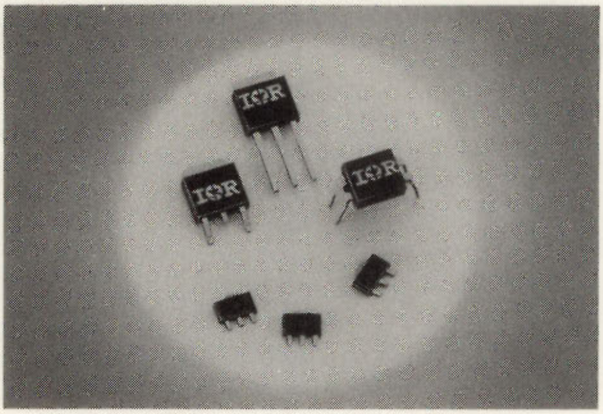
Price: $10.00

Vol. II
HDM
1

HEXFET
Power MOSFET
Designer's Manual

DIPs
D-Paks
I-Paks
SOT-89s

International Rectifier



About Volume II

This Designer's Manual is specifically dedicated to International Rectifier's commercial line of HEXFET surface mount (D-Pak, I-Pak, SOT-89) and DIP devices. These power MOSFETs are recognized throughout the world as the industry standard for ruggedness, low $R_{DS(on)}$, and consistency of mechanical and electrical specifications. To locate the device to fill your specific design needs, see the Table of Contents and/or Selector Guide section.

DATA SHEETS

The technical data sheets contained in this Volume II cover all product upgrades, as well as our new HEXFET III generation of power MOSFETs. You are invited to contact your local IR field representative or our home office for additional product data or applications assistance.

OTHER PUBLICATIONS

International Rectifier also has Designer's Manuals covering TO-220, TO-3P, FullPaks, and other HEXFET devices, as well as separate manuals for government and space products, and applications and reliability data. These and other technical publications featuring IGBTs, power ICs, etc., are listed in the Available Literature section of this Designer's Manual. For ordering information, see page 156.

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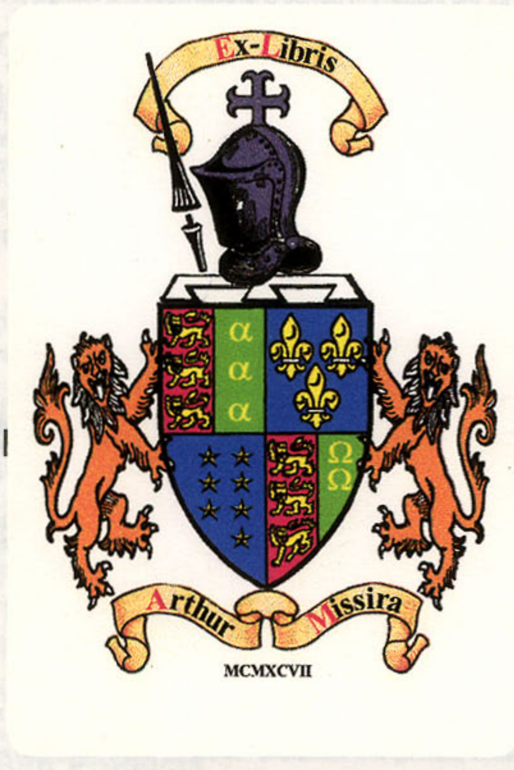
DESIGNER'S MANUAL



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HEXFET®
DESIGNER'S MANUAL

Volume II

POWER MOSFETs
DIP, D-PAK, I-PAK, and SOT-89

HDM-1
First Printing

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An Introduction to HEXFET Power MOSFETs

Foreword

Since the introduction of the HEXFET power MOSFET in 1979, International Rectifier has become the acknowledged technology and market leader in power MOSFETs worldwide. HEXFETs set the standard for the industry in device characteristics and ratings, product quality and reliability, and breadth of line.

HEXFET III devices, specially designed for high-volume low-cost manufacture at HEXFET America, are recognized as the most rugged standard-product power MOSFETs in the industry. Introduced in late 1986, HEXFET III devices are so rugged that designers can eliminate external protection circuitry and more readily use HEXFETs in such applications as motor control and power supplies. International Rectifier provides three key ruggedness ratings on HEXFET III devices:

Single-shot avalanche energy to accommodate occasional high-energy over-voltage transients.

Repetitive avalanche energy to eliminate external protection circuitry.

Dynamic dv/dt capability to withstand harsh conditions in motor control and similar applications without externally-connected diodes.

HEXFET III cell density has been optimized for each voltage range to provide lower on-resistance per unit area. HEXFET power MOSFETs remain the first choice for the full range of commercial, industrial, and aerospace/defense power supply and motor control applications.

Producing HEXFET III power MOSFETs at HEXFET America, International Rectifier integrates design, process, and manufacturing to provide the world's most reliable power MOSFET at the lowest cost-per-amp.

HEXFET Power MOSFETs

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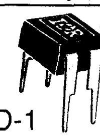
Selection Guide

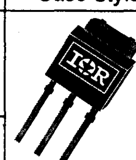
Logic Level D-Pak (5 volt gate)

Part Number	BV_{DSS} Drain-to-Source Breakdown (Volts)	$R_{DS(on)}$ Drain-to-Source On Resistance (Ω)	I_D Continuous Drain Current 25°C (Amps)	I_{DM} Max. Pulsed Drain Current (Amps)	Page Number	Case Style
IRLR014	60	0.20	8.5	31	141	 D-Pak TO-252AA
IRLR024		0.10	16	64	143	
IRLR110	100	0.54	4.6	18	145	
IRLR120		0.27	8.4	31	147	

Logic Level DIP (5 volt gate)

Part Number	BV_{DSS} Drain-to-Source Breakdown (Volts)	$R_{DS(on)}$ Drain-to-Source On Resistance (Ω)	I_D Continuous Drain Current 25°C (Amps)	I_{DM} Max. Pulsed Drain Current (Amps)	Page Number	Case Style
IRLD014	60	0.20	1.7	14	133	 HD-1
IRLD024		0.10	2.5	20	135	
IRLD110	100	0.54	1.0	8.0	137	
IRLD120		0.27	1.3	10	139	

Logic Level I-Pak (5 volt gate)

Part Number	BV_{DSS} Drain-to-Source Breakdown (Volts)	$R_{DS(on)}$ Drain-to-Source On Resistance (Ω)	I_D Continuous Drain Current 25°C (Amps)	I_{DM} Max. Pulsed Drain Current (Amps)	Page Number	Case Style
IRLU014	60	0.20	8.5	31	141	 I-Pak TO-251AA
IRLU024		0.10	16	64	143	
IRLU110	100	0.54	4.6	18	145	
IRLU120		0.27	8.4	31	147	

Selection Guide

SOT-89

Part Number	BV_{DSS} Drain-to-Source Breakdown (Volts)	$R_{DS(on)}$ Drain-to-Source On Resistance (Ω)	I_D Continuous Drain Current 25°C (Amps)	I_{DM} Max. Pulsed Drain Current (Amps)	Page Number	Case Style
IRFS1Z0	100	2.4	0.90	3.6	131	 SOT-89

D-Pak N-Channel

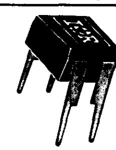
Part Number	BV_{DSS} Drain-to-Source Breakdown (Volts)	$R_{DS(on)}$ Drain-to-Source On Resistance (Ω)	I_D Continuous Drain Current 25°C (Amps)	I_{DM} Max. Pulsed Drain Current (Amps)	Page Number	Case Style
IRFR014	60	0.20	8.4	34	63	 D-Pak TO-252AA
IRFR024		0.10	16	64	69	
IRFR110	100	0.54	4.7	19	75	
IRFR120		0.27	8.4	34	81	
IRFR210	200	1.5	2.7	8.0	87	
IRFR220		0.80	4.8	18	95	
IRFR214	250	2.0	2.2	8.8	89	
IRFR224		1.1	3.8	14	97	
IRFR310	400	3.6	1.7	5.0	99	
IRFR320		1.8	3.1	11	101	
IRFR420	500	3.0	2.4	8.0	103	
IRFRC20	600	4.4	2.0	8.0	129	

D-Pak P-Channel

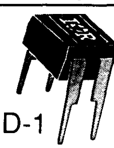
Part Number	BV_{DSS} Drain-to-Source Breakdown (Volts)	$R_{DS(on)}$ Drain-to-Source On Resistance (Ω)	I_D Continuous Drain Current 25°C (Amps)	I_{DM} Max. Pulsed Drain Current (Amps)	Page Number	Case Style
IRFR9014	-60	0.50	-5.6	-22	105	 D-Pak TO-252AA
IRFR9024		0.28	-9.6	-38	111	
IRFR9110	-100	1.2	-3.4	-14	117	
IRFR9120		0.60	-6.3	-25	119	
IRFR9210	-200	3.0	-2.0	-8.0	125	
IRFR9220		1.5	-3.6	-14	127	

Selection Guide

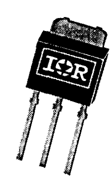
DIP N-Channel

Part Number	BV_{DSS} Drain-to-Source Breakdown (Volts)	$R_{DS(on)}$ Drain-to-Source On Resistance (Ω)	I_D Continuous Drain Current 25°C (Amps)	I_{DM} Max. Pulsed Drain Current (Amps)	Page Number	Case Style
IRFD014	60	0.20	1.7	14	1	 HD-1
IRFD024		0.10	2.5	20	7	
IRFD1Z0	100	2.4	0.50	4.0	25	
IRFD110		0.54	1.0	8.0	13	
IRFD120		0.27	1.3	10	19	
IRFD210	200	1.5	0.60	4.8	31	
IRFD220		0.80	0.80	6.4	37	

DIP P-Channel

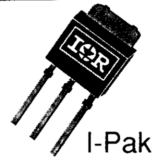
Part Number	BV_{DSS} Drain-to-Source Breakdown (Volts)	$R_{DS(on)}$ Drain-to-Source On Resistance (Ω)	I_D Continuous Drain Current 25°C (Amps)	I_{DM} Max. Pulsed Drain Current (Amps)	Page Number	Case Style
IRFD9014	-60	0.50	-1.1	-8.8	39	 HD-1
IRFD9024		0.28	-1.6	-13	41	
IRFD9110	-100	1.2	-0.70	-5.6	47	
IRFD9120		0.60	-1.0	-8.0	53	
IRFD9210	-200	3.0	-0.4	-3.2	59	
IRFD9220		1.5	-0.58	-4.6	61	

I-Pak N-Channel

Part Number	BV_{DSS} Drain-to-Source Breakdown (Volts)	$R_{DS(on)}$ Drain-to-Source On Resistance (Ω)	I_D Continuous Drain Current 25°C (Amps)	I_{DM} Max. Pulsed Drain Current (Amps)	Page Number	Case Style
IRFU014	60	0.20	8.4	34	63	 I-Pak TO-251AA
IRFU024		0.10	16	64	69	
IRFU110	100	0.54	4.7	19	75	
IRFU120		0.27	8.4	34	81	
IRFU210	200	1.5	2.7	8.0	87	
IRFU220		0.80	4.8	18	95	
IRFU214	250	2.0	2.2	8.8	89	
IRFU224		1.1	3.8	14	97	
IRFU310	400	3.6	1.7	5.0	99	
IRFU320		1.8	3.1	11	101	
IRFU420	500	3.0	2.4	8.0	103	
IRFUC20	600	4.4	2.0	8.0	129	

Selection Guide

I-Pak P-Channel

Part Number	BV_{DSS} Drain-to-Source Breakdown (Volts)	$R_{DS(on)}$ Drain-to-Source On Resistance (Ω)	I_D Continuous Drain Current 25°C (Amps)	I_{DM} Max. Pulsed Drain Current (Amps)	**Page Number**	Case Style
IRFU9014	-60	0.50	-5.6	-22	105	 I-Pak TO-251AA
IRFU9024		0.28	-9.6	-38	111	
IRFU9110	-100	1.2	-3.4	-14	117	
IRFU9120		0.60	-6.3	-25	119	
IRFU9210	-200	3.0	-2.0	-8.0	125	
IRFU9220		1.5	-3.6	-14	127	

Data Sheets

The HEXFET devices listed in this Designer's Manual represent International Rectifier's power MOSFET line as of June, 1991. The data presented in this manual supersedes all previous specifications.

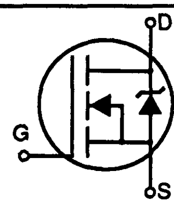
In the interest of product improvement, International Rectifier reserves the right to change specifications without notice.

International Rectifier

IRFD014

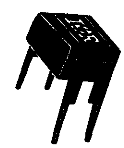
HEXFET® Power MOSFET

- Dynamic dv/dt Rated
- For Automatic Insertion
- End Stackable



n-channel

BV_{DSS} 60V
$R_{DS(on)}$ 0.20Ω
I_D 1.7A



HD-1

Description

Third Generation HEXFETs from International Rectifier provide the designer with the best combination of fast switching speed, ruggedized device design, and low on resistance.

The 4-pin DIP package is a low cost machine insertable case style which can be stacked in multiple combinations on standard 0.1 inch pin centers. The dual drain pin serves as a thermal link to the mounting surface for power dissipation levels up to 1 watt.

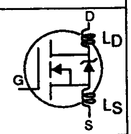
Absolute Maximum Ratings

	Parameter	Max.	Units
I_D @ T_C = 25°C	Continuous Drain Current, V_{GS}@10V	1.7	A
I_D @ T_C = 100°C	Continuous Drain Current, V_{GS}@10V	1.2	
I_{DM}	Pulsed Drain Current ①	14	
P_D@ T_C = 25°C	Maximum Power Dissipation	1.3	W
	Linear Derating Factor	0.0083	W/K⑥
V_{GS}	Gate-to-Source Breakdown Voltage	±20	V
E_{AS}	Single Pulse Avalanche Energy ②	130	mJ
dv/dt	Peak Diode Recovery dv/dt ③	4.5	V/ns
T_J T_{STG}	Operating Junction and Storage Temperature Range	-55 to +175	°C
	Soldering Temperature, for 10 sec.	300 (0.063 in. (1.6mm) from case)	

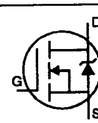
Thermal Resistance

	Parameter	Max.	Units
$R_{\theta JA}$	Junction-to-Ambient, Typical Socket Mount	120	K/W⑥

Electrical Characteristics @ T_J = 25°C (unless otherwise specified)

	Parameter	Min.	Typ.	Max.	Units	Test Conditions
BV_{DSS}	Drain-to-Source Breakdown Voltage	60	---	---	V	V_{GS}=0V, I_D=250µA
$\Delta BV_{DSS}/\Delta T_J$	Temp. Coefficient of Breakdown Voltage	---	0.063	---	V/°C	Reference to 25°C, I_D=1mA
$R_{DS(on)}$	Static Drain-to-Source On Resistance	---	---	0.20	Ω	V_{GS}=10V, I_D =1.0A④
$V_{GS(th)}$	Gate Threshold Voltage	2.0	---	4.0	V	V_{DS}=V_{GS}, I_D=250µA
g_{fs}	Forward Transconductance	1.3	---	---	S	V_{DS}=25V, I_{DS}=1.0A④
I_{DSS}	Zero Gate Voltage Collector Current	---	---	250	µA	V_{DS}=60V, V_{GS}=0V
		---	---	1000		V_{DS}=48V, V_{GS}=0V,T_J=150°C
I_{GSS}	Gate-to-Source Forward Leakage	---	---	500	nA	V_{GS}=20V
	Gate-to-Source Reverse Leakage	---	---	-500		V_{GS}=-20V
Q_g	Total Gate Charge	---	---	11	nC	I_D=10A, V_{DS}=48V, V_{GS}=10V
Q_{gs}	Gate-to-Source Charge	---	---	3.1		See Fig 6 and 13④
Q_{gd}	Gate-to-Drain ("Miller") Charge	---	---	5.8		
$t_{d(on)}$	Turn-On Delay Time	---	10	---	ns	V_{DD}=30V, I_D=10A
t_r	Rise Time	---	50	---		R_G=24Ω, R_D=2.7Ω
$t_{d(off)}$	Turn-Off Delay Time	---	13	---		See Fig. 10④
t_f	Fall Time	---	19	---		
L_D	Internal Drain Inductance	---	4.0	---	nH	Between lead, 6mm (0.25in.) from package, and center of die contact. 
L_S	Internal Source Inductance	---	6.0	---		
C_{iss}	Input Capacitance	---	310	---	pF	V_{GS}=0V, V_{DS}=25v
C_{oss}	Output Capacitance	---	160	---		f=1.0Mhz
C_{rss}	Reverse Transfer Capacitance	---	37	---		See Fig. 5

Source-Drain Diode Ratings and Characteristics

	Parameter	Min.	Typ.	Max.	Units	Test Conditions
I_S	Continuous Source Current (Body Diode)	---	---	1.7	A	MOSFET symbol showing the integral reverse p-n junction diode. 
I_{SM}	Pulsed Source Current (Body Diode) ①	---	---	14		
V_{SD}	Diode Forward Voltage	---	---	1.6	V	T_J=25°C, I_S=1.7A, V_{GS}=0V④
t_{rr}	Reverse Recovery Time	34	---	140	ns	T_J=25°C, I_F=10A,
Q_{RR}	Reverse Recovery Charge	0.090	---	0.40	µC	di/dt=100A/µS④
t_{on}	Forward Turn-On Time	Intrinsic turn-on time is negligible (turn-on is dominated by L_S + L_D)				

Notes:

① Repetitive rating; Pulse width limited by max. junction temperature (See figure 11)

② V_{DD}=25V, Starting T_J=25°C, L=55mH, R_G=25Ω, Peak I_{AS}=1.7A (See figure 12)

③ I_{SD}≤10A, di/dt≤90A/µs, V_{DD}≤BV_{DSS}, T_J≤175°C Suggested R_G=24Ω

④ Pulse width ≤ 300µs; duty Cycle ≤2%

⑤ Mounting surface: flat, smooth, greased

⑥ K/W = °C/W

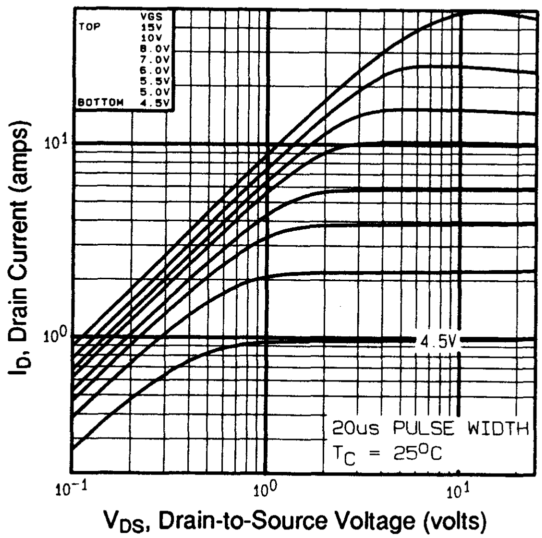


Fig 1. Typical Output Characteristics, $T_C = 25°C$

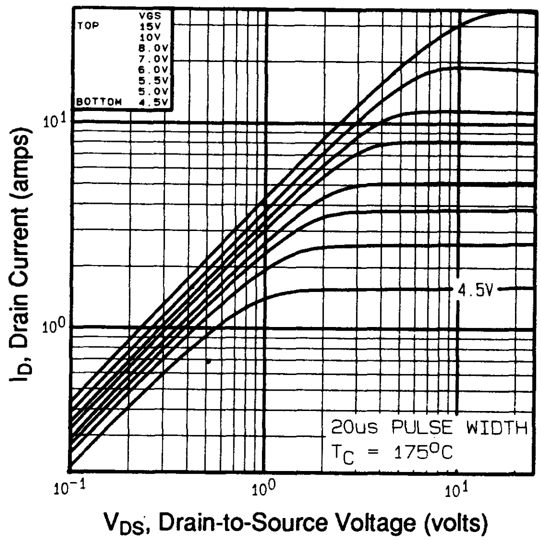


Fig 2. Typical Output Characteristics, $T_C = 150°C$

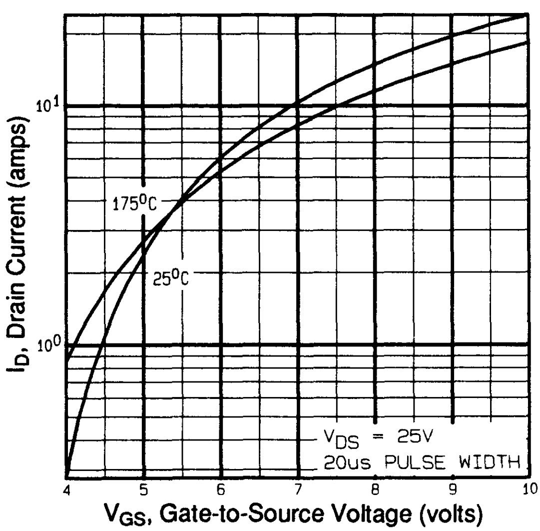


Fig 3. Typical Transfer Characteristics

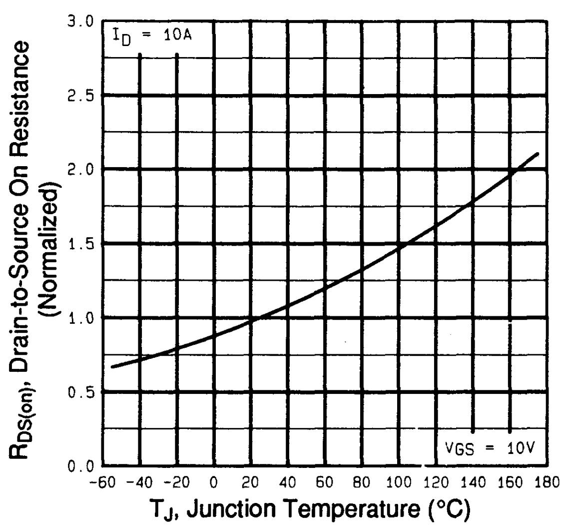


Fig 4. Normalized On-Resistance Vs. Temperature

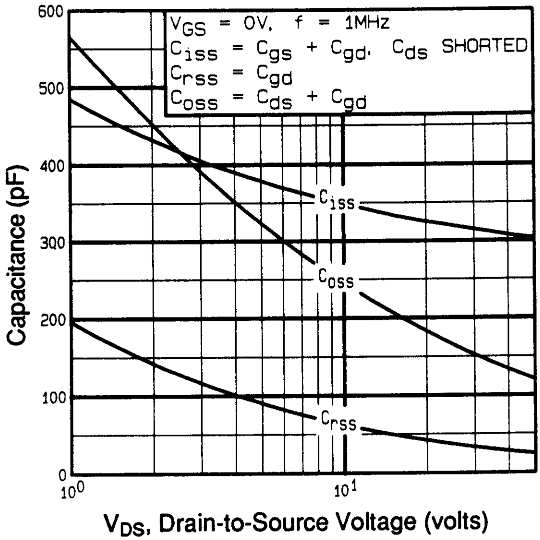


Fig 5. Typical Capacitance Vs. Drain-to-Source Voltage

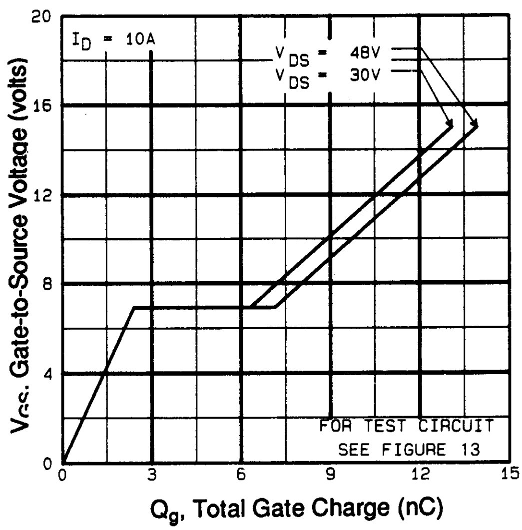


Fig 6. Typical Gate Charge Vs. Gate-to-Source Voltage

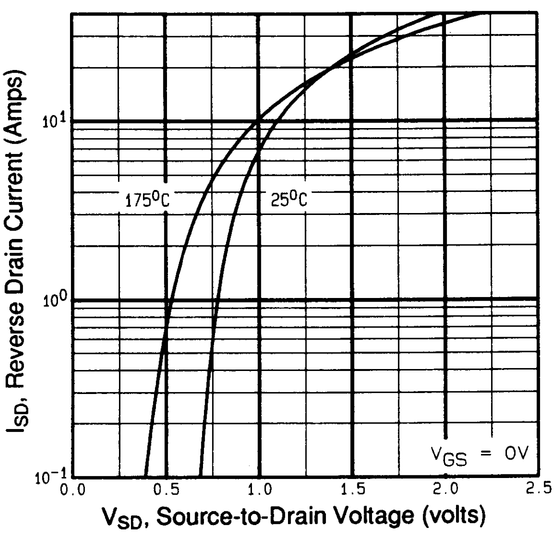


Fig 7. Typical Source-Drain Diode Forward Voltage

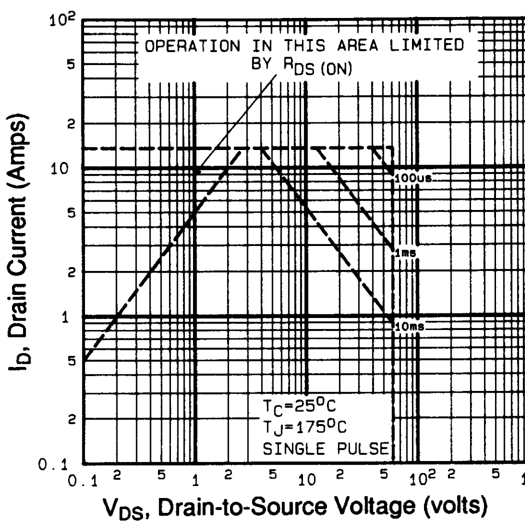


Fig 8. Maximum Safe Operating Area

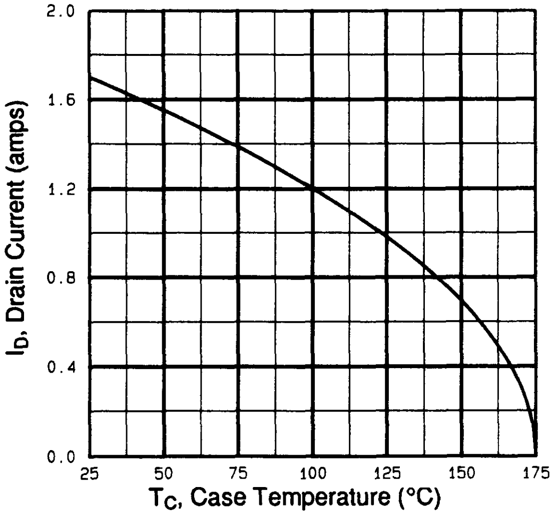


Fig 9. Maximum Drain Current Vs. Case Temperature

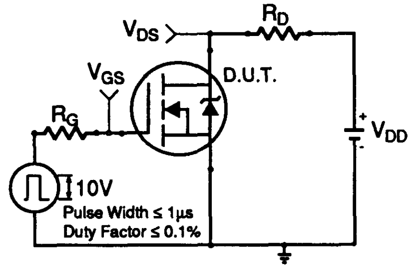


Fig 10a. Switching Time Test Circuit

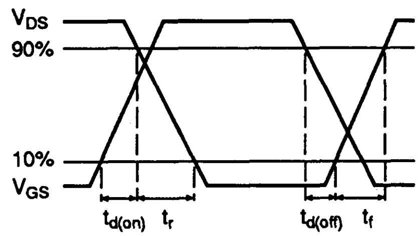


Fig 10b. Switching Time Waveforms

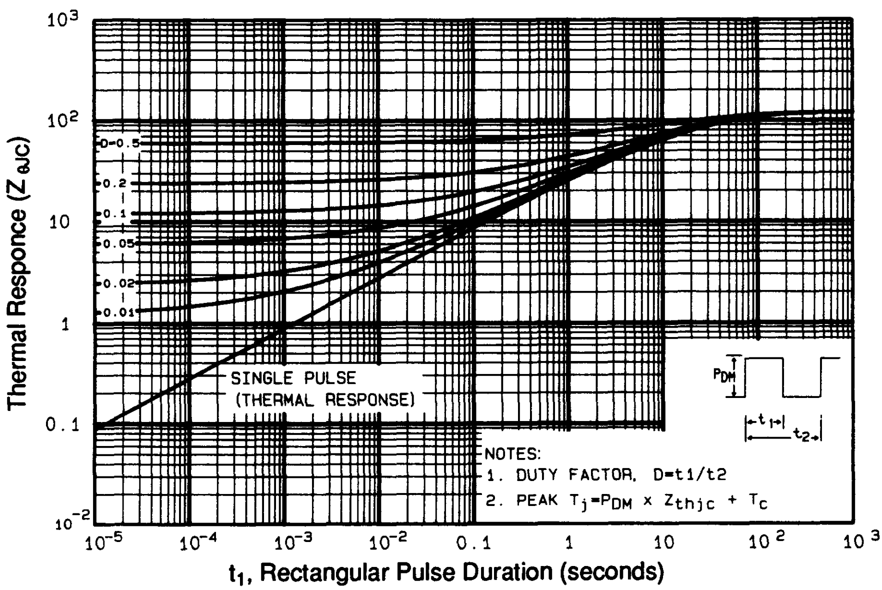


Fig 11. Maximum Effective Transient Thermal Impedance, Junction-to-Case

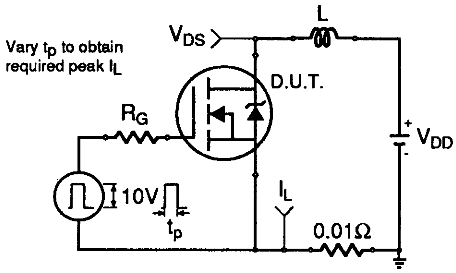


Fig 12a. Unclamped Inductive Test Circuit

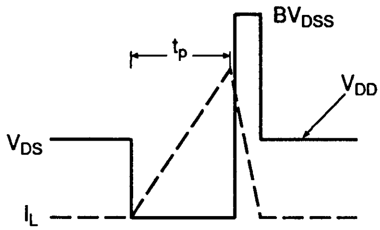


Fig 12b. Unclamped Inductive Waveforms

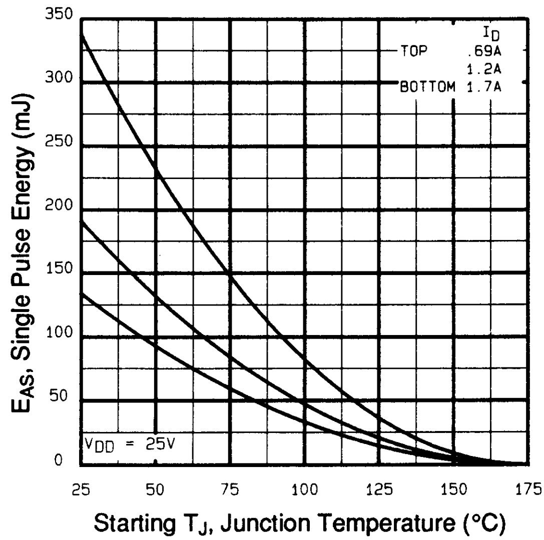


Fig 12c. Maximum Avalanche Energy vs. Drain Current

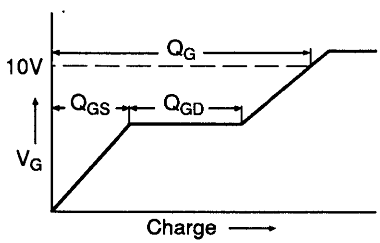


Fig 13a. Basic Gate Charge Waveform

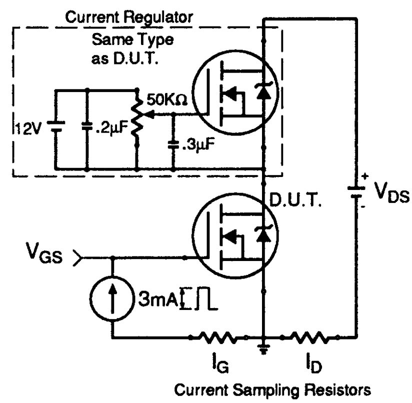


Fig 13b. Gate Charge Test Circuit

Appendix A: Figure 14, Peak Diode Recovery dv/dt Test Circuit

Appendix B: Package Outline Mechanical Drawing

Appendix D: Part Marking Information

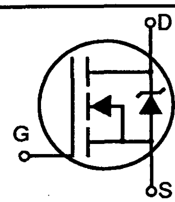
International IOR Rectifier

International Rectifier

IRFD024

HEXFET® Power MOSFET

- Repetitive Avalanche Rated
- Dynamic dv/dt Rated
- For Automatic Insertion
- End Stackable



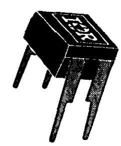
n-channel

BV_{DSS} 60V
$R_{DS(on)}$ 0.10Ω
I_D 2.5A

Description

Third Generation HEXFETs from International Rectifier provide the designer with the best combination of fast switching speed, ruggedized device design, and low on resistance.

The 4-pin DIP package is a low cost machine insertable case style which can be stacked in multiple combinations on standard 0.1 inch pin centers. The dual drain pin serves as a thermal link to the mounting surface for power dissipation levels up to 1 watt.


HD-1

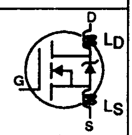
Absolute Maximum Ratings

	Parameter	Max.	Units
I_D @ T_C = 25°C	Continuous Drain Current, V_{GS}@10V	2.5	A
I_D @ T_C = 100°C	Continuous Drain Current, V_{GS}@10V	1.8	
I_{DM}	Pulsed Drain Current ①	20	
P_D@ T_C = 25°C	Maximum Power Dissipation	1.3	W
	Linear Derating Factor	0.0083	W/K⑥
V_{GS}	Gate-to-Source Breakdown Voltage	±20	V
E_{AS}	Single Pulse Avalanche Energy ②	91	mJ
dv/dt	Peak Diode Recovery dv/dt ③	5.5	V/ns
T_J T_{STG}	Operating Junction and Storage Temperature Range	-55 to +175	°C
	Soldering Temperature, for 10 sec.	300 (0.063 in. (1.6mm) from case)	

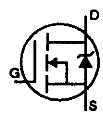
Thermal Resistance

	Parameter	Max.	Units
$R_{\theta JA}$	Junction-to-Ambient, Typical Socket Mount	120	K/W⑥

Electrical Characteristics @ T_J = 25°C (unless otherwise specified)

	Parameter	Min.	Typ.	Max.	Units	Test Conditions
BV_{DSS}	Drain-to-Source Breakdown Voltage	60	---	---	V	V_{GS}=0V, I_D=250μA
$\Delta BV_{DSS}/\Delta T_J$	Temp. Coefficient of Breakdown Voltage	---	0.061	---	V/°C	Reference to 25°C, I_D=1mA
$R_{DS(on)}$	Static Drain-to-Source On Resistance	---	---	0.10	Ω	V_{GS}=10V, I_D =1.5A④
$V_{GS(th)}$	Gate Threshold Voltage	2.0	---	4.0	V	V_{DS}=V_{GS}, I_D=250μA
g_{fs}	Forward Transconductance	2.7	---	---	S	V_{DS}=25V, I_{DS}=1.5A④
I_{DSS}	Zero Gate Voltage Collector Current	---	---	250	μA	V_{DS}=60V, V_{GS}=0V
		---	---	1000		V_{DS}=48V, V_{GS}=0V,T_J=150°C
I_{GSS}	Gate-to-Source Forward Leakage	---	---	500	nA	V_{GS}=20V
	Gate-to-Source Reverse Leakage	---	---	-500		V_{GS}=-20V
Q_g	Total Gate Charge	---	---	28	nC	I_D=14A, V_{DS}=48V, V_{GS}=10V See Fig 6 and 13④
Q_{gs}	Gate-to-Source Charge	---	---	5.4		
Q_{gd}	Gate-to-Drain ("Miller") Charge	---	---	13		
$t_{d(on)}$	Turn-On Delay Time	---	8.6	---	ns	V_{DD}=30V, I_D=14A R_G=18Ω, R_D=2.0Ω See Fig. 10④
t_r	Rise Time	---	47	---		
$t_{d(off)}$	Turn-Off Delay Time	---	27	---		
t_f	Fall Time	---	37	---		
L_D	Internal Drain Inductance	---	4.0	---	nH	Between lead, 6mm (0.25in.) from package, and center of die contact. 
L_S	Internal Source Inductance	---	6.0	---		
C_{iss}	Input Capacitance	---	640	---	pF	V_{GS}=0V, V_{DS}=25v
C_{oss}	Output Capacitance	---	360	---		*f*=1.0Mhz
C_{rss}	Reverse Transfer Capacitance	---	79	---		See Fig. 5

Source-Drain Diode Ratings and Characteristics

	Parameter	Min.	Typ.	Max.	Units	Test Conditions
I_S	Continuous Source Current (Body Diode)	---	---	2.5	A	MOSFET symbol showing the integral reverse p-n junction diode. 
I_{SM}	Pulsed Source Current (Body Diode) ①	---	---	20		
V_{SD}	Diode Forward Voltage	---	---	1.5	V	T_J=25°C, I_S=2.5A, V_{GS}=0V④
t_{rr}	Reverse Recovery Time	49	---	200	ns	T_J=25°C, I_F=14A, di/dt=100A/μS④
Q_{RR}	Reverse Recovery Charge	0.22	---	0.88	μC	
t_{on}	Forward Turn-On Time	Intrinsic turn-on time is negligible (turn-on is dominated by L_S + L_D)				

Notes:

① Repetitive rating; Pulse width limited by max. junction temperature (See figure 11)

② V_{DD}=25V, Starting T_J=25°C, L=17.5mH, R_G=25Ω, Peak I_{AS}=2.5A (See figure 12)

③ I_{SD}≤14A, di/dt≤110A/μs, V_{DD}≤BV_{DSS}, T_J≤175°C Suggested R_G=18Ω

④ Pulse width ≤ 300μs; duty Cycle ≤2%

⑤ Mounting surface: flat, smooth, greased

⑥ K/W = °C/W

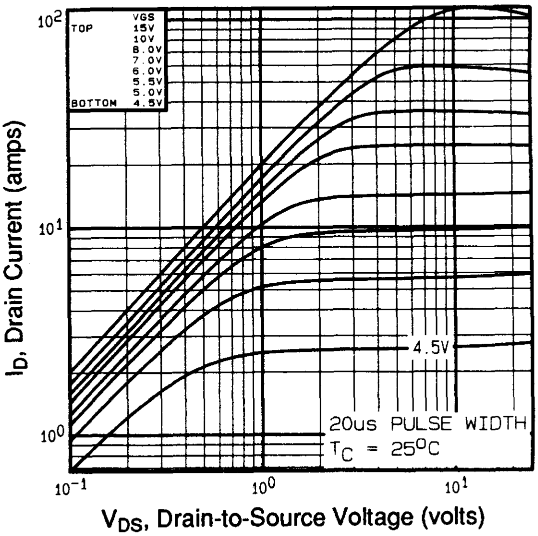


Fig 1. Typical Output Characteristics, $T_C = 25°C$

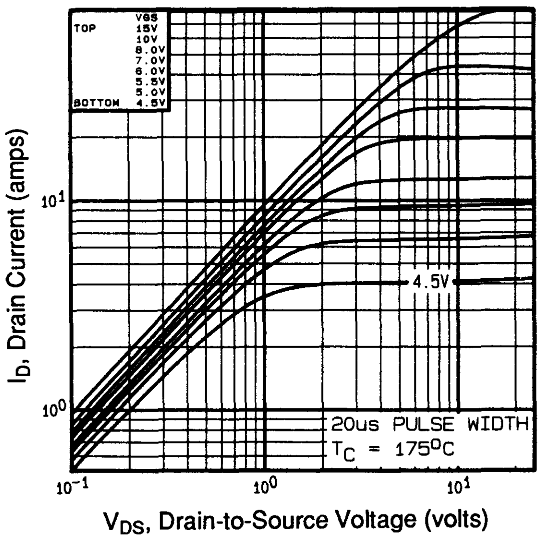


Fig 2. Typical Output Characteristics, $T_C = 150°C$

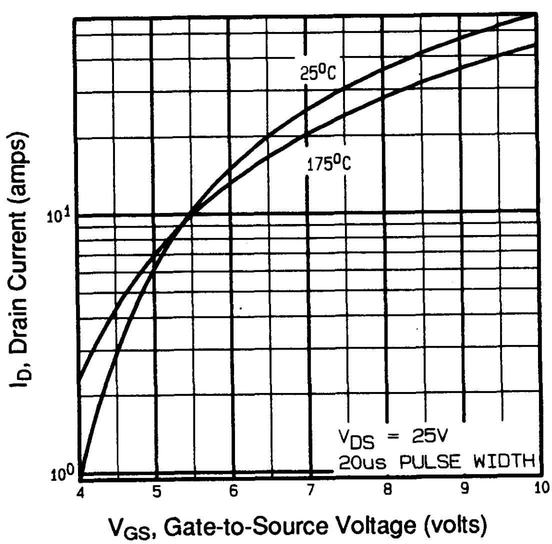


Fig 3. Typical Transfer Characteristics

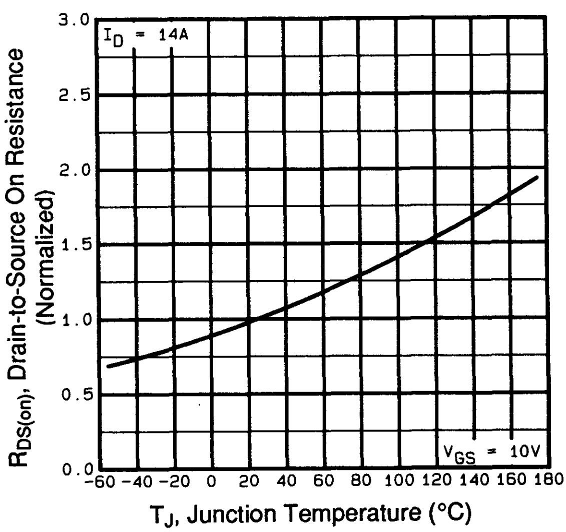


Fig 4. Normalized On-Resistance Vs. Temperature

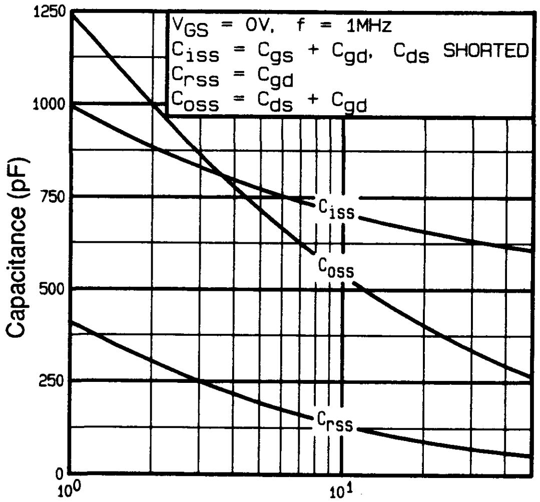


Fig 5. Typical Capacitance Vs. Drain-to-Source Voltage

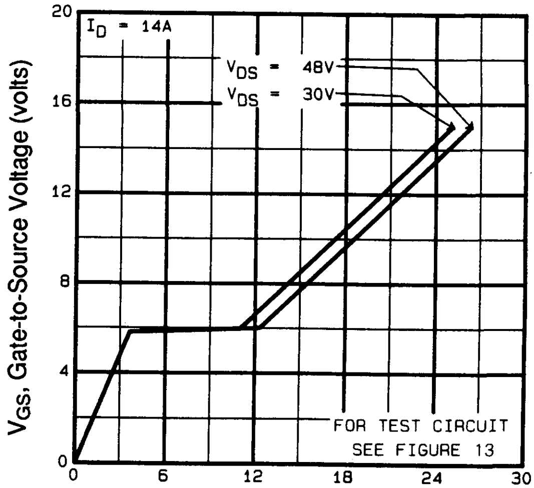


Fig 6. Typical Gate Charge Vs. Gate-to-Source Voltage

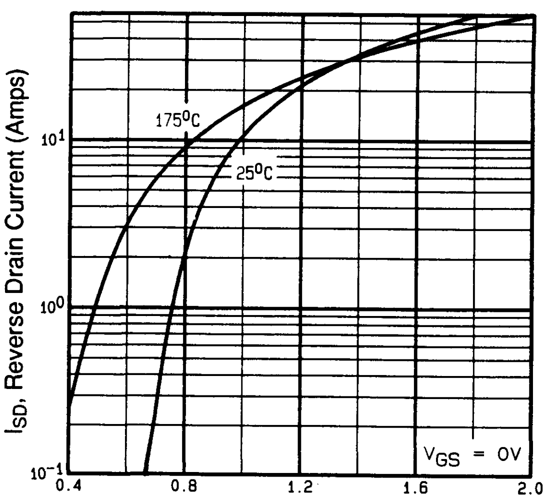


Fig 7. Typical Source-Drain Diode Forward Voltage

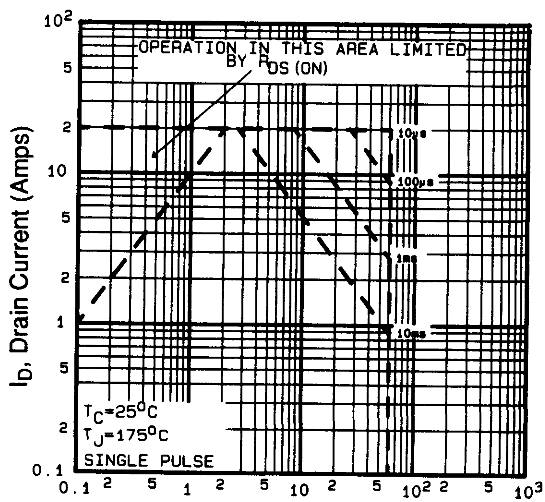


Fig 8. Maximum Safe Operating Area

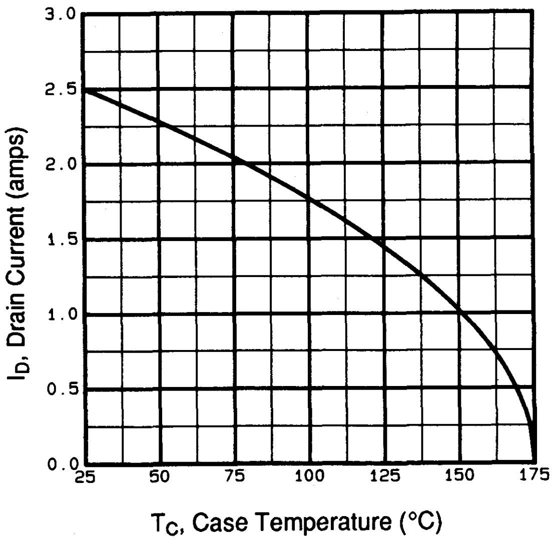


Fig 9. Maximum Drain Current Vs. Case Temperature

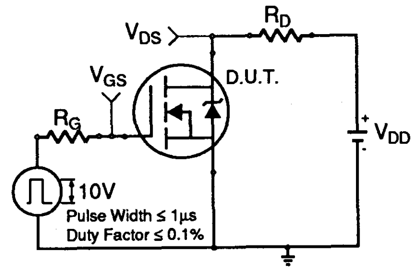


Fig 10a. Switching Time Test Circuit

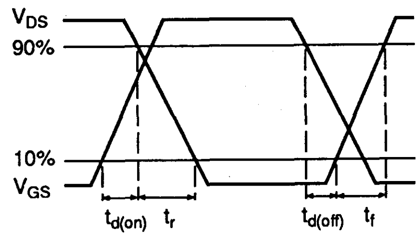


Fig 10b. Switching Time Waveforms

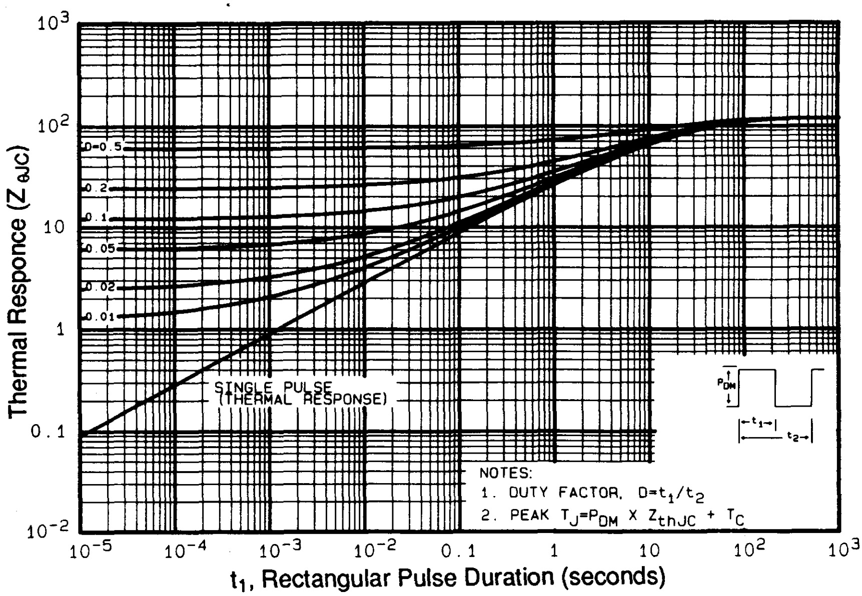


Fig 11. Maximum Effective Transient Thermal Impedance, Junction-to-Case

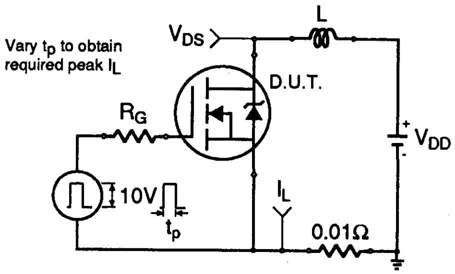


Fig 12a. Unclamped Inductive Test Circuit

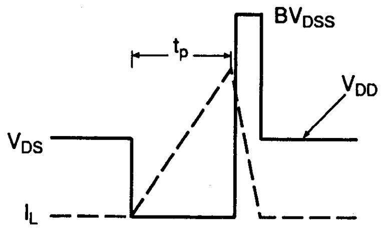


Fig 12b. Unclamped Inductive Waveforms

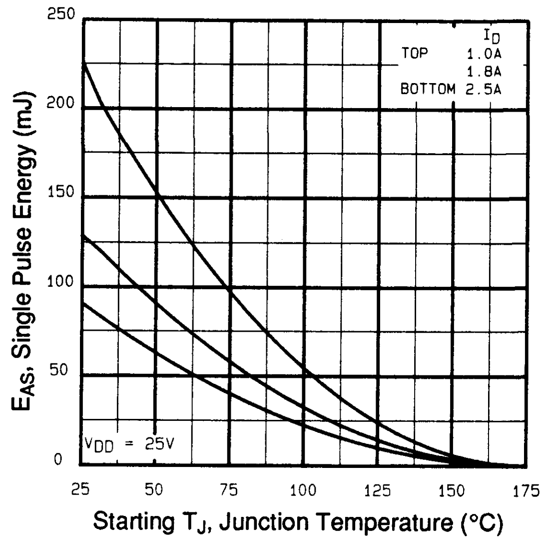


Fig 12c. Maximum Avalanche Energy vs. Drain Current

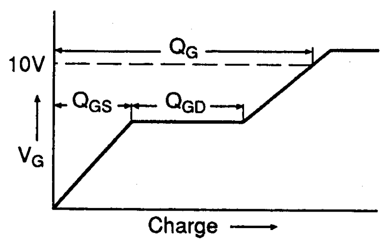


Fig 13a. Basic Gate Charge Waveform

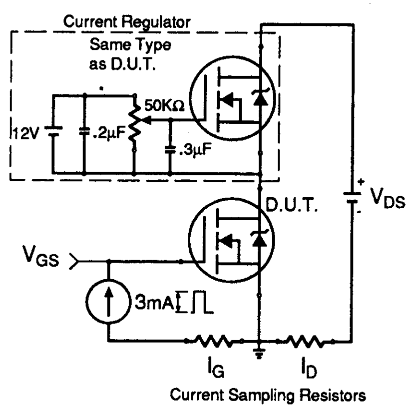


Fig 13b. Gate Charge Test Circuit

Appendix A: Figure 14, Peak Diode Recovery dv/dt Test Circuit

Appendix B: Package Outline Mechanical Drawing

Appendix D: Part Marking Information

International IOR Rectifier

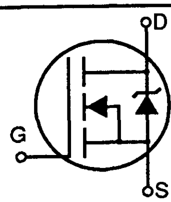
PD-9.328J

International
IOR Rectifier

IRFD110

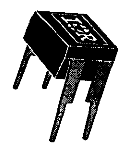
HEXFET® Power MOSFET

- Repetitive Avalanche Rated
- Dynamic dv/dt Rated
- For Automatic Insertion
- End Stackable



n-channel

BV_{DSS} 100V
$R_{DS(on)}$ 0.54Ω
I_D 1.0A


HD-1

Description

Third Generation HEXFETs from International Rectifier provide the designer with the best combination of fast switching speed, ruggedized device design, and low on resistance.

The 4-pin DIP package is a low cost machine insertable case style which can be stacked in multiple combinations on standard 0.1 inch pin centers. The dual drain pin serves as a thermal link to the mounting surface for power dissipation levels up to 1 watt.

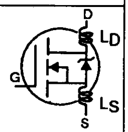
Absolute Maximum Ratings

	Parameter	Max.	Units
I_D @ T_C = 25°C	Continuous Drain Current, V_{GS}@10V	1.0	A
I_D @ T_C = 100°C	Continuous Drain Current, V_{GS}@10V	0.71	
I_{DM}	Pulsed Drain Current ①	8.0	
P_D@ T_C = 25°C	Maximum Power Dissipation	1.3	W
	Linear Derating Factor	0.0083	W/K⑥
V_{GS}	Gate-to-Source Breakdown Voltage	±20	V
E_{AS}	Single Pulse Avalanche Energy ②	140	mJ
I_{AR}	Avalanche Current ①	1.0	A
E_{AR}	Repetitive Avalanche Energy ①	0.13	mJ
dv/dt	Peak Diode Recovery dv/dt ③	5.5	V/ns
T_J T_{STG}	Operating Junction and Storage Temperature Range	-55 to +175	°C
	Soldering Temperature, for 10 sec.	300 (0.063 in. (1.6mm) from case)	

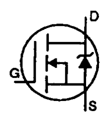
Thermal Resistance

	Parameter	Max.	Units
$R_{\theta JA}$	Junction-to-Ambient, Typical Socket Mount	120	K/W⑥

Electrical Characteristics @ T_J = 25°C (unless otherwise specified)

	Parameter	Min.	Typ.	Max.	Units	Test Conditions
BV_{DSS}	Drain-to-Source Breakdown Voltage	100	---	---	V	V_{GS}=0V, I_D=250μA
$\Delta BV_{DSS}/\Delta T_J$	Temp. Coefficient of Breakdown Voltage	---	0.12	---	V/°C	Reference to 25°C, I_D=1mA
$R_{DS(on)}$	Static Drain-to-Source On Resistance	---	---	0.54	Ω	V_{GS}=10V, I_D =0.60A④
$V_{GS(th)}$	Gate Threshold Voltage	2.0	---	4.0	V	V_{DS}=V_{GS}, I_D=250μA
g_{fs}	Forward Transconductance	0.80	---	---	S	V_{DS}=50V, I_{DS}=0.60A④
I_{DSS}	Zero Gate Voltage Collector Current	---	---	250	μA	V_{DS}=100V, V_{GS}=0V
		---	---	1000		V_{DS}=80V, V_{GS}=0V,T_J=150°C
I_{GSS}	Gate-to-Source Forward Leakage	---	---	500	nA	V_{GS}=20V
	Gate-to-Source Reverse Leakage	---	---	-500		V_{GS}=-20V
Q_g	Total Gate Charge	---	---	8.3	nC	I_D=5.6A, V_{DS}=80V, V_{GS}=10V See Fig 6 and 13④
Q_{gs}	Gate-to-Source Charge	---	---	2.3		
Q_{gd}	Gate-to-Drain ("Miller") Charge	---	---	3.8		
$t_{d(on)}$	Turn-On Delay Time	---	6.9	---	ns	V_{DD}=50V, I_D=5.6A R_G=24Ω, R_D=8.4Ω See Fig. 10④
t_r	Rise Time	---	16	---		
$t_{d(off)}$	Turn-Off Delay Time	---	15	---		
t_f	Fall Time	---	9.4	---		
L_D	Internal Drain Inductance	---	4.0	---	nH	Between lead, 6mm (0.25in.) from package, and center of die contact. 
L_S	Internal Source Inductance	---	6.0	---		
C_{iss}	Input Capacitance	---	180	---	pF	V_{GS}=0V, V_{DS}=25v *f*=1.0Mhz See Fig. 5
C_{oss}	Output Capacitance	---	81	---		
C_{rss}	Reverse Transfer Capacitance	---	15	---		

Source-Drain Diode Ratings and Characteristics

	Parameter	Min.	Typ.	Max.	Units	Test Conditions
I_S	Continuous Source Current (Body Diode)	---	---	1.0	A	MOSFET symbol showing the integral reverse p-n junction diode. 
I_{SM}	Pulsed Source Current (Body Diode) ①	---	---	8.0		
V_{SD}	Diode Forward Voltage	---	---	2.5	V	T_J=25°C, I_S=1.0A, V_{GS}=0V④
t_{rr}	Reverse Recovery Time	50	---	200	ns	T_J=25°C, I_F=5.6A, di/dt=100A/μS④
Q_{RR}	Reverse Recovery Charge	0.22	---	0.88	μC	
t_{on}	Forward Turn-On Time	Intrinsic turn-on time is negligible (turn-on is dominated by L_S + L_D)				

Notes:

① Repetitive rating; Pulse width limited by max. junction temperature (See figure 11)

② V_{DD}=25V, Starting T_J=25°C, L=52mH, R_G=25Ω, Peak I_{AS}=2.0A (See figure 12)

③ $I_{SD} \leq$ 5.6A, di/dt≤75A/μs, $V_{DD} \leq BV_{DSS}$, T_J≤175°C Suggested R_G=24Ω

④ Pulse width ≤ 300μs; duty Cycle ≤2%

⑤ Mounting surface: flat, smooth, greased

⑥ K/W = °C/W

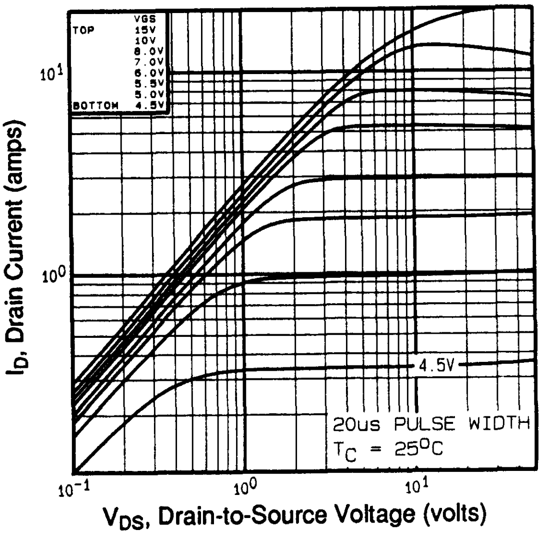


Fig 1. Typical Output Characteristics, $T_C = 25°C$

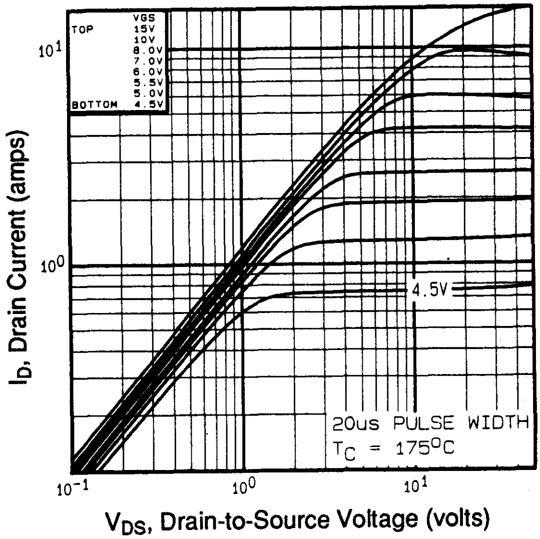


Fig 2. Typical Output Characteristics, $T_C = 150°C$

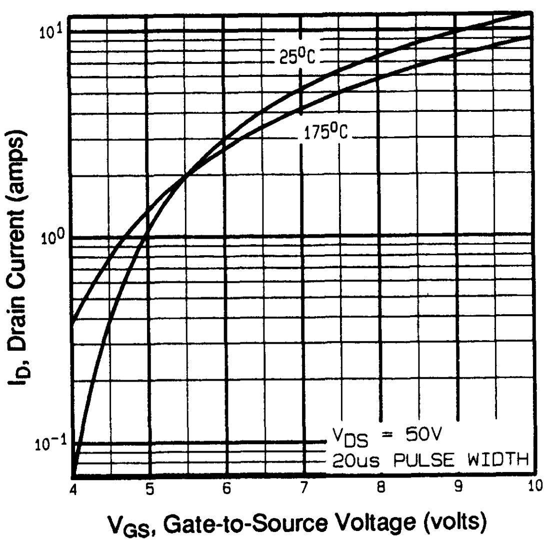


Fig 3. Typical Transfer Characteristics

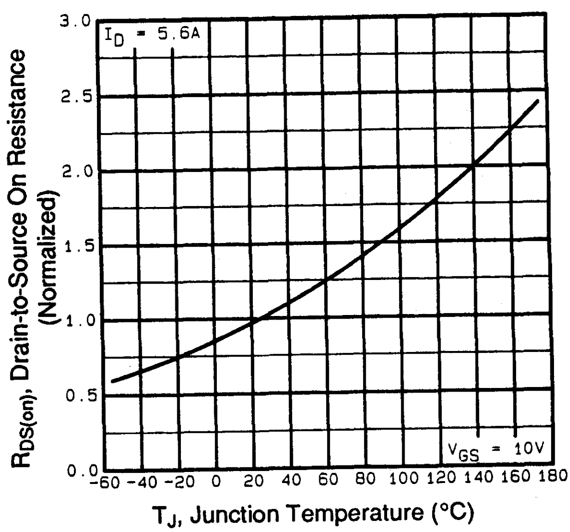


Fig 4. Normalized On-Resistance Vs. Temperature

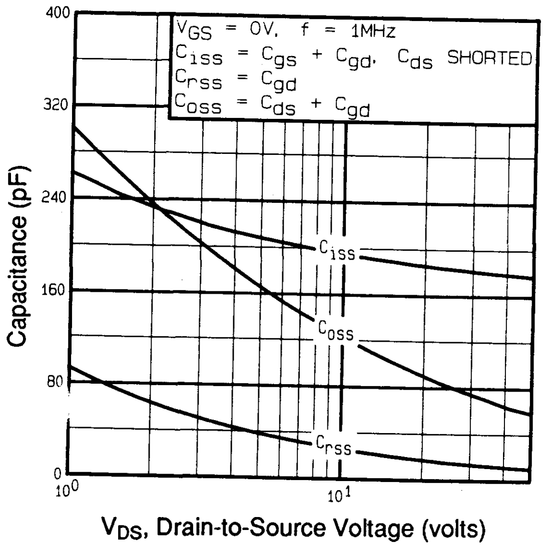


Fig 5. Typical Capacitance Vs. Drain-to-Source Voltage

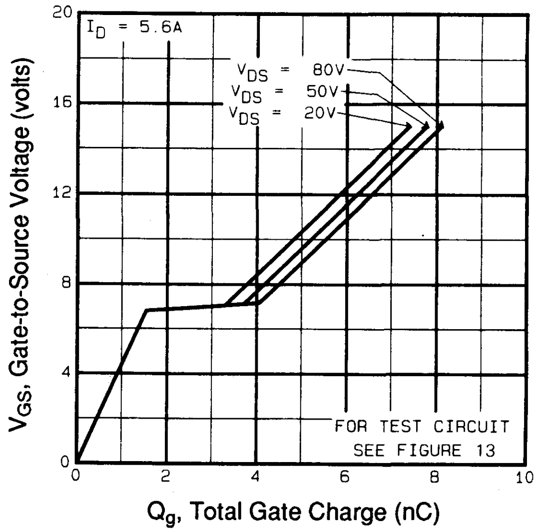


Fig 6. Typical Gate Charge Vs. Gate-to-Source Voltage

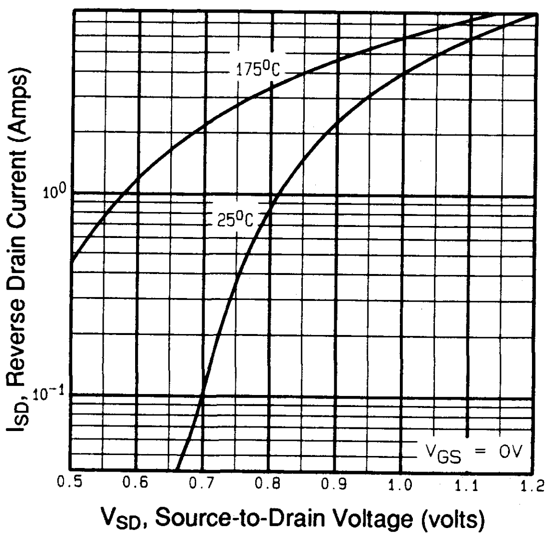


Fig 7. Typical Source-Drain Diode Forward Voltage

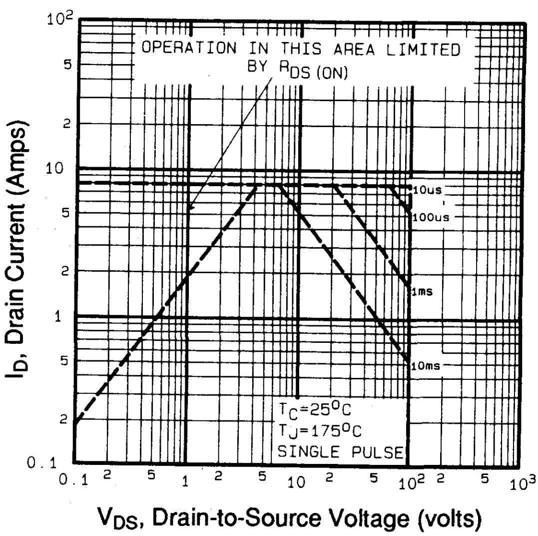


Fig 8. Maximum Safe Operating Area

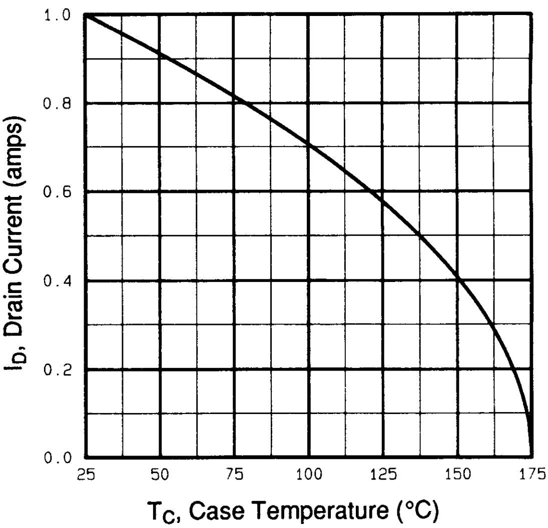


Fig 9. Maximum Drain Current Vs. Case Temperature

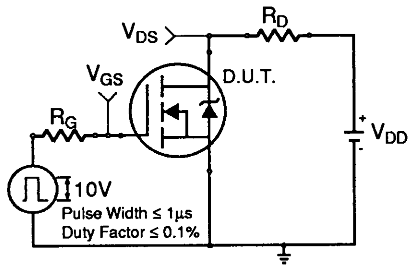


Fig 10a. Switching Time Test Circuit

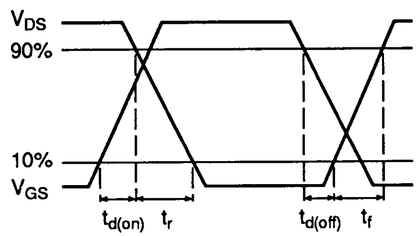


Fig 10b. Switching Time Waveforms

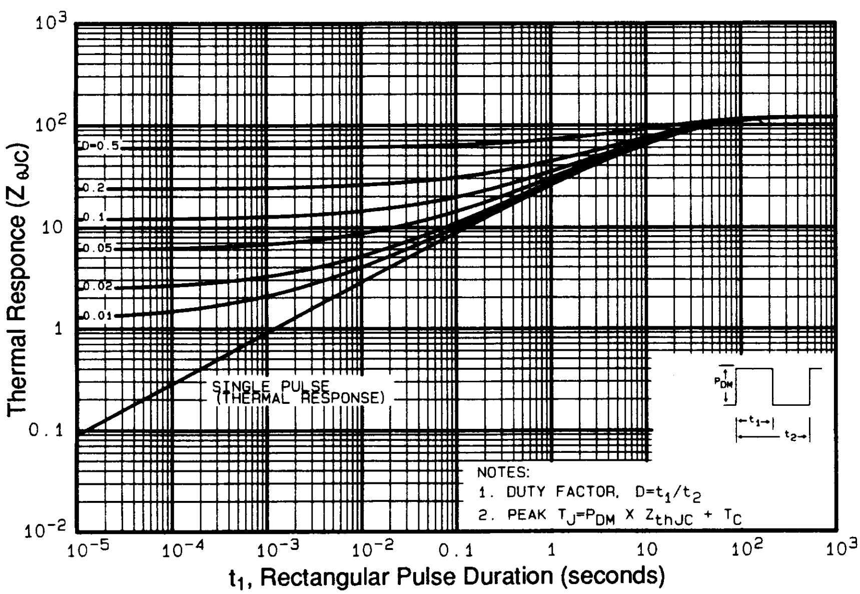


Fig 11. Maximum Effective Transient Thermal Impedance, Junction-to-Case

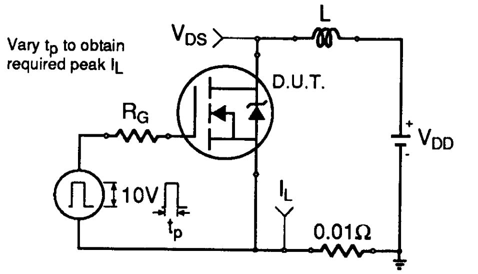


Fig 12a. Unclamped Inductive Test Circuit

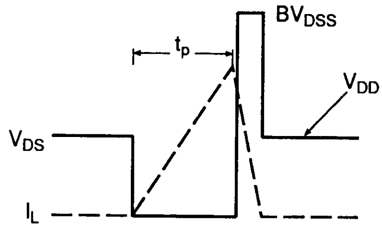


Fig 12b. Unclamped Inductive Waveforms

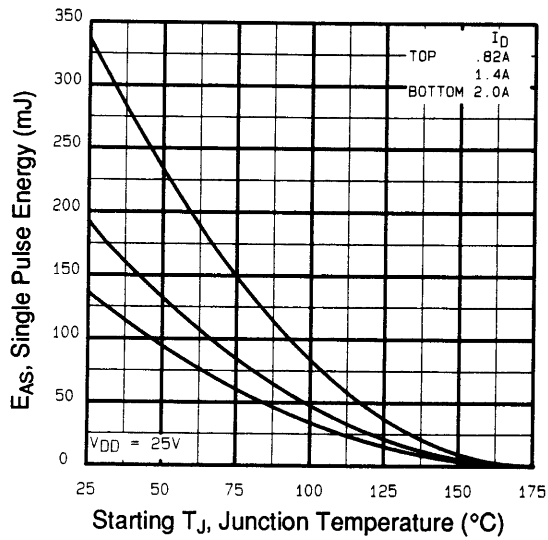


Fig 12c. Maximum Avalanche Energy vs. Drain Current

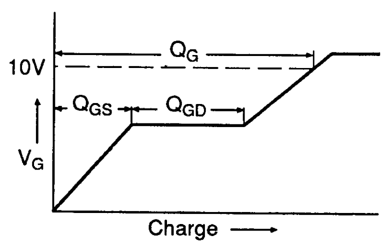


Fig 13a. Basic Gate Charge Waveform

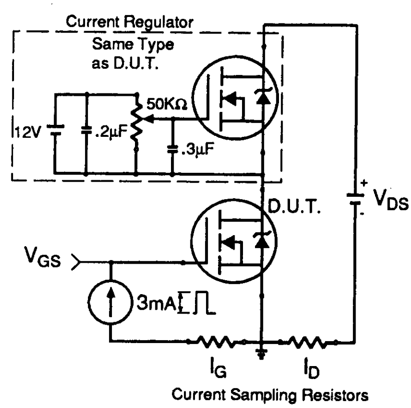


Fig 13b. Gate Charge Test Circuit

Appendix A: Figure 14, Peak Diode Recovery dv/dt Test Circuit

Appendix B: Package Outline Mechanical Drawing

Appendix D: Part Marking Information

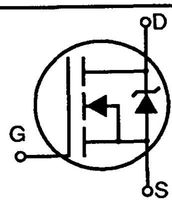
International Rectifier

International IOR Rectifier

IRFD120

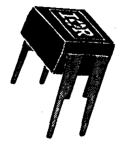
HEXFET® Power MOSFET

- Repetitive Avalanche Rated
- Dynamic dv/dt Rated
- For Automatic Insertion
- End Stackable



n-channel

BV_{DSS} 100V
$R_{DS(on)}$ 0.27Ω
I_D 1.3A


HD-1

Description

Third Generation HEXFETs from International Rectifier provide the designer with the best combination of fast switching speed, ruggedized device design, and low on resistance.

The 4-pin DIP package is a low cost machine insertable case style which can be stacked in multiple combinations on standard 0.1 inch pin centers. The dual drain pin serves as a thermal link to the mounting surface for power dissipation levels up to 1 watt.

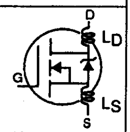
Absolute Maximum Ratings

	Parameter	Max.	Units
I_D @ T_C = 25°C	Continuous Drain Current, V_{GS}@10V	1.3	A
I_D @ T_C = 100°C	Continuous Drain Current, V_{GS}@10V	0.94	
I_{DM}	Pulsed Drain Current ①	10	
P_D@ T_C = 25°C	Maximum Power Dissipation	1.3	W
	Linear Derating Factor	0.0083	W/K⑥
V_{GS}	Gate-to-Source Breakdown Voltage	±20	V
E_{AS}	Single Pulse Avalanche Energy ②	100	mJ
I_{AR}	Avalanche Current ①	1.3	A
E_{AR}	Repetitive Avalanche Energy ①	0.13	mJ
dv/dt	Peak Diode Recovery dv/dt ③	5.5	V/ns
T_J, T_{STG}	Operating Junction and Storage Temperature Range	-55 to +175	°C
	Soldering Temperature, for 10 sec.	300 (0.063 in. (1.6mm) from case)	

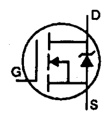
Thermal Resistance

	Parameter	Max.	Units
$R_{θJA}$	Junction-to-Ambient, Typical Socket Mount	120	K/W⑥

Electrical Characteristics @ T_J = 25°C (unless otherwise specified)

	Parameter	Min.	Typ.	Max.	Units	Test Conditions
BV_{DSS}	Drain-to-Source Breakdown Voltage	100	---	---	V	V_{GS}=0V, I_D=250µA
$\Delta BV_{DSS}/\Delta T_J$	Temp. Coefficient of Breakdown Voltage	---	0.13	---	V/°C	Reference to 25°C, I_D=1mA
$R_{DS(on)}$	Static Drain-to-Source On Resistance	---	---	0.27	Ω	V_{GS}=10V, I_D =0.78A④
$V_{GS(th)}$	Gate Threshold Voltage	2.0	---	4.0	V	V_{DS}=V_{GS}, I_D=250µA
g_{fs}	Forward Transconductance	0.80	---	---	S	V_{DS}=50V, I_{DS}=0.78A④
I_{DSS}	Zero Gate Voltage Collector Current	---	---	250	µA	V_{DS}=100V, Vgs=0V
		---	---	1000		V_{DS}=80V, V_{GS}=0V,T_J=150°C
I_{GSS}	Gate-to-Source Forward Leakage	---	---	500	nA	V_{GS}=20V
	Gate-to-Source Reverse Leakage	---	---	-500		V_{GS}=-20V
Q_g	Total Gate Charge	---	---	16	nC	I_D=9.2A, V_{DS}=80V, V_{GS}=10V See Fig 6 and 13④
Q_{gs}	Gate-to-Source Charge	---	---	4.4		
Q_{gd}	Gate-to-Drain ("Miller") Charge	---	---	7.7		
$t_{d(on)}$	Turn-On Delay Time	---	6.8	---	ns	V_{DD}=50V, I_D=9.2A R_G=18Ω, R_D=5.2Ω See Fig. 10④
t_r	Rise Time	---	27	---		
$t_{d(off)}$	Turn-Off Delay Time	---	18	---		
t_f	Fall Time	---	17	---		
L_D	Internal Drain Inductance	---	4.0	---	nH	Between lead, 6mm (0.25in.) from package, and center of die contact. 
L_S	Internal Source Inductance	---	6.0	---		
C_{iss}	Input Capacitance	---	360	---	pF	V_{GS}=0V, V_{DS}=25v f=1.0Mhz See Fig. 5
C_{oss}	Output Capacitance	---	150	---		
C_{rss}	Reverse Transfer Capacitance	---	34	---		

Source-Drain Diode Ratings and Characteristics

	Parameter	Min.	Typ.	Max.	Units	Test Conditions
I_S	Continuous Source Current (Body Diode)	---	---	1.3	A	MOSFET symbol showing the integral reverse p-n junction diode. 
I_{SM}	Pulsed Source Current (Body Diode) ①	---	---	10		
V_{SD}	Diode Forward Voltage	---	---	2.5	V	T_J=25°C, I_S=1.3A, V_{GS}=0V④
t_{rr}	Reverse Recovery Time	65	---	260	ns	T_J=25°C, I_F=9.2A,
Q_{RR}	Reverse Recovery Charge	0.33	---	1.3	µC	di/dt=100A/µS④
t_{on}	Forward Turn-On Time	Intrinsic turn-on time is negligible (turn-on is dominated by L_S + L_D)				

Notes:

① Repetitive rating; Pulse width limited by max. junction temperature (See figure 11)

② V_{DD}=25V, Starting T_J=25°C, L=24mH, R_G=25Ω, Peak I_{AS}=2.6A (See figure 12)

③ I_{SD}≤9.2A, di/dt≤110A/µs, V_{DD}≤BV_{DSS}, T_J≤175°C Suggested R_G=18Ω

④ Pulse width ≤ 300µs; duty Cycle ≤2%

⑤ Mounting surface: flat, smooth, greased

⑥ K/W = °C/W

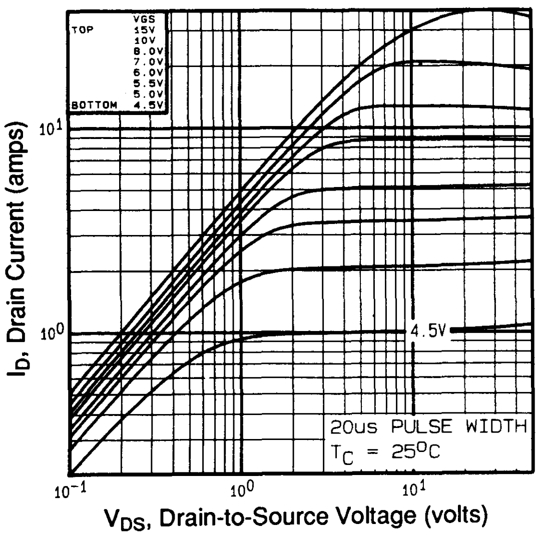


Fig 1. Typical Output Characteristics, $T_C = 25°C$

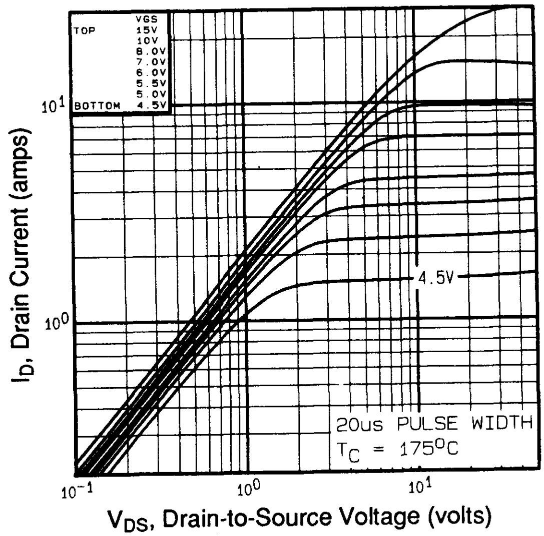


Fig 2. Typical Output Characteristics, $T_C = 150°C$

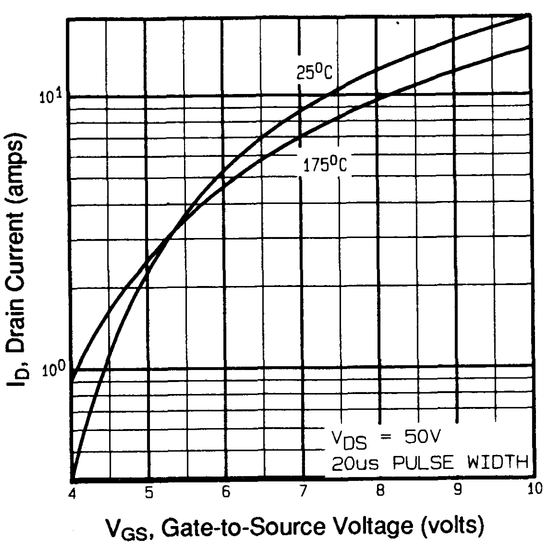


Fig 3. Typical Transfer Characteristics

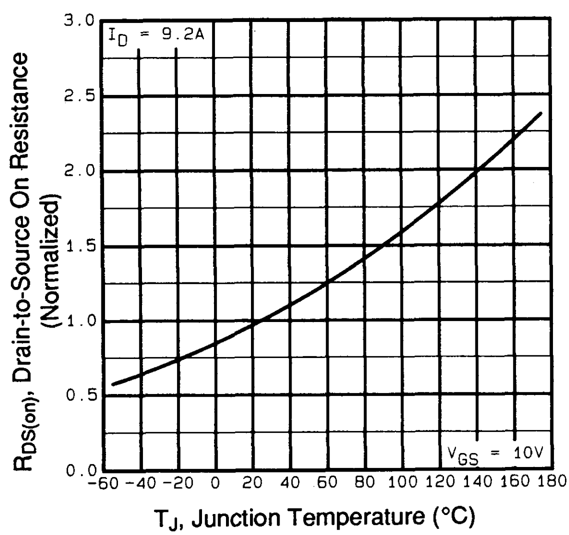


Fig 4. Normalized On-Resistance Vs. Temperature

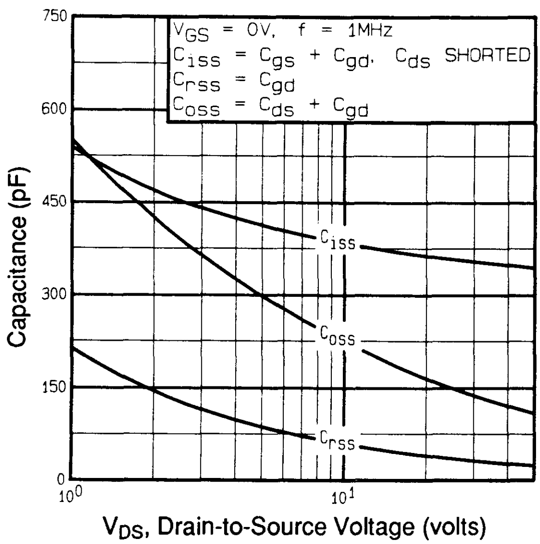


Fig 5. Typical Capacitance Vs. Drain-to-Source Voltage

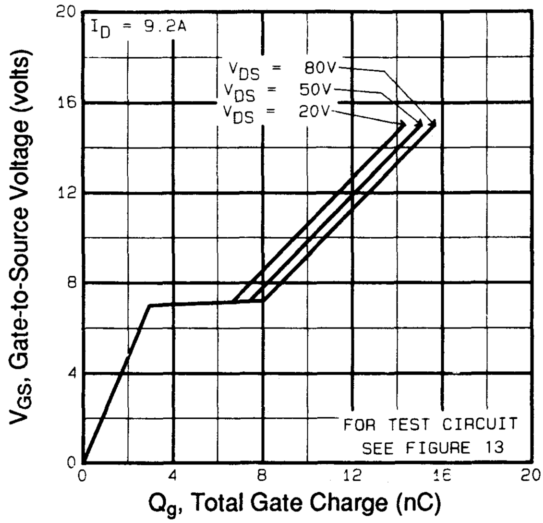


Fig 6. Typical Gate Charge Vs. Gate-to-Source Voltage

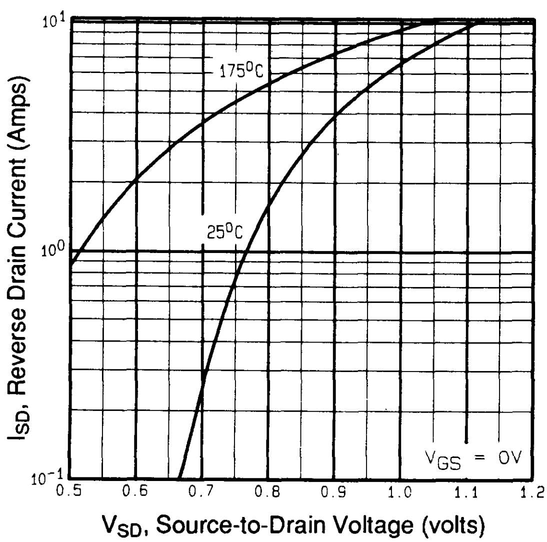


Fig 7. Typical Source-Drain Diode Forward Voltage

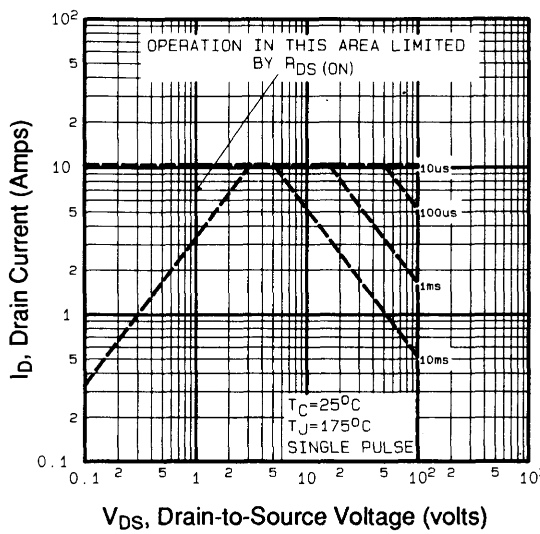


Fig 8. Maximum Safe Operating Area

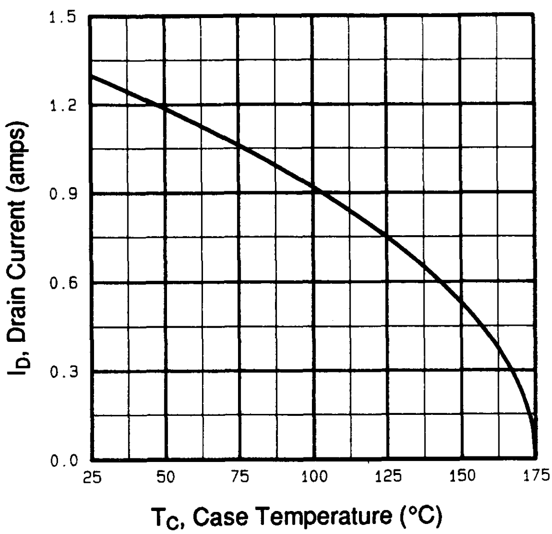


Fig 9. Maximum Drain Current Vs. Case Temperature

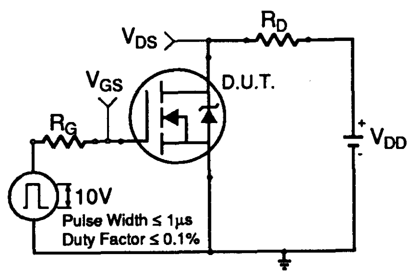


Fig 10a. Switching Time Test Circuit

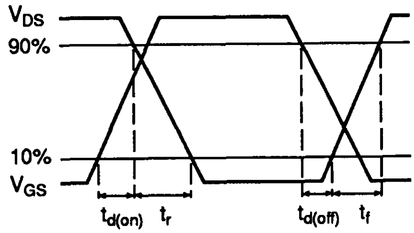


Fig 10b. Switching Time Waveforms

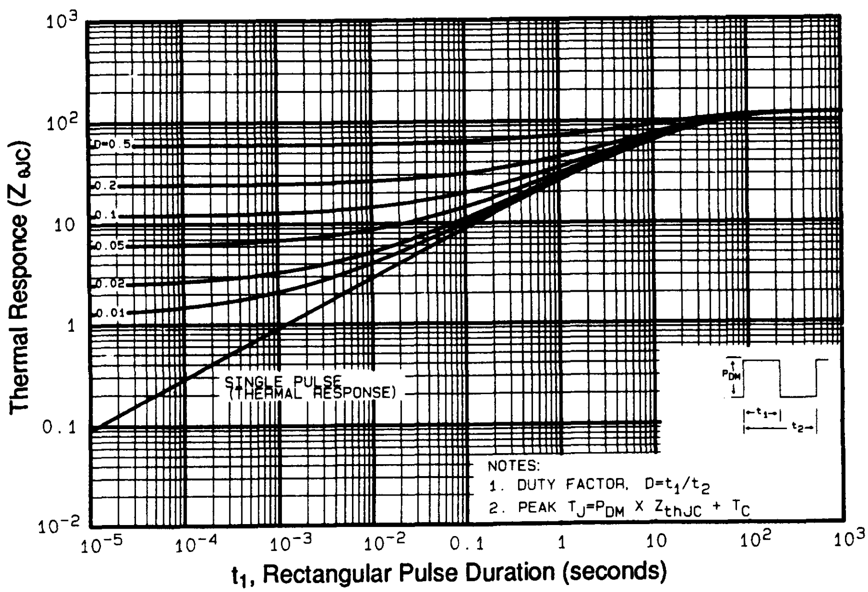


Fig 11. Maximum Effective Transient Thermal Impedance, Junction-to-Case

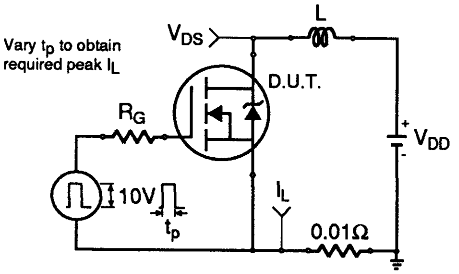


Fig 12a. Unclamped Inductive Test Circuit

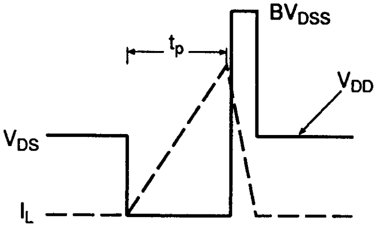


Fig 12b. Unclamped Inductive Waveforms

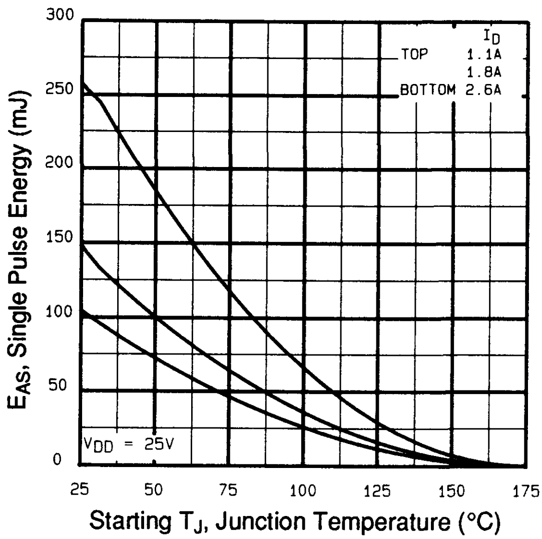


Fig 12c. Maximum Avalanche Energy vs. Drain Current

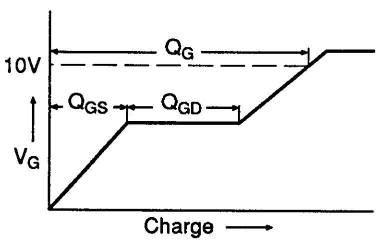


Fig 13a. Basic Gate Charge Waveform

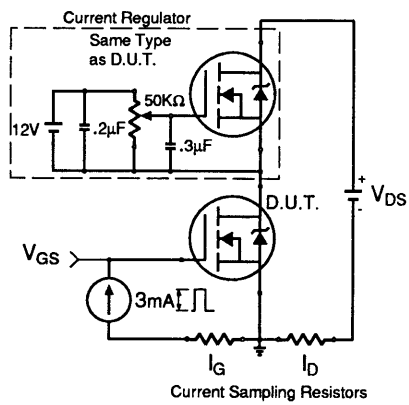


Fig 13b. Gate Charge Test Circuit

Appendix A: Figure 14, Peak Diode Recovery dv/dt Test Circuit

Appendix B: Package Outline Mechanical Drawing

Appendix D: Part Marking Information

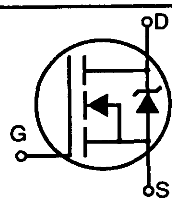
International IOR Rectifier

International Rectifier

IRFD1Z0

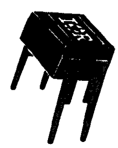
HEXFET® Power MOSFET

- Repetitive Avalanche Rated
- Dynamic dv/dt Rated
- For Automatic Insertion
- End Stackable



n-channel

BV_{DSS}	100V
$R_{DS(on)}$	2.4Ω
I_D	0.50A


HD-1

Description

Third Generation HEXFETs from International Rectifier provide the designer with the best combination of fast switching speed, ruggedized device design, and low on resistance.

The 4-pin DIP package is a low cost machine insertable case style which can be stacked in multiple combinations on standard 0.1 inch pin centers. The dual drain pin serves as a thermal link to the mounting surface for power dissipation levels up to 1 watt.

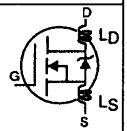
Absolute Maximum Ratings

	Parameter	Max.	Units
I_D @ T_C = 25°C	Continuous Drain Current, V_{GS}@10V	0.50	A
I_D @ T_C = 100°C	Continuous Drain Current, V_{GS}@10V	0.36	
I_{DM}	Pulsed Drain Current ①	4.0	
P_D@ T_C = 25°C	Maximum Power Dissipation	1.25	W
	Linear Derating Factor	0.10	W/K⑥
V_{GS}	Gate-to-Source Breakdown Voltage	±20	V
E_{AS}	Single Pulse Avalanche Energy ②	9.8	mJ
I_{AR}	Avalanche Current ①	0.50	A
E_{AR}	Repetitive Avalanche Energy ①	0.13	mJ
dv/dt	Peak Diode Recovery dv/dt ③	5.5	V/ns
T_J T_{STG}	Operating Junction and Storage Temperature Range	-55 to +175	°C
	Soldering Temperature, for 10 sec.	300 (0.063 in. (1.6mm) from case)	

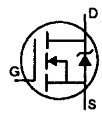
Thermal Resistance

	Parameter	Max.	Units
$R_{\theta JA}$	Junction-to-Ambient, Typical Socket Mount	120	K/W⑥

Electrical Characteristics @ T_J = 25°C (unless otherwise specified)

	Parameter	Min.	Typ.	Max.	Units	Test Conditions
BV_{DSS}	Drain-to-Source Breakdown Voltage	100	---	---	V	V_{GS}=0V, I_D=250µA
$\Delta BV_{DSS}/\Delta T_J$	Temp. Coefficient of Breakdown Voltage	---	0.12	---	V/°C	Reference to 25°C, I_D=1mA
$R_{DS(on)}$	Static Drain-to-Source On Resistance	---	---	2.4	Ω	V_{GS}=10V, I_D =0.30A④
$V_{GS(th)}$	Gate Threshold Voltage	2.0	---	4.0	V	V_{DS}=V_{GS}, I_D=250µA
g_{fs}	Forward Transconductance	0.60	---	---	S	V_{DS}=50V, I_{DS}=0.30A④
I_{DSS}	Zero Gate Voltage Collector Current	---	---	250	µA	V_{DS}=100V, V_{GS}=0V
		---	---	1000		V_{DS}=80V, V_{GS}=0V,T_J=150°C
IGSS	Gate-to-Source Forward Leakage	---	---	500	nA	V_{GS}=20V
	Gate-to-Source Reverse Leakage	---	---	-500		V_{GS}=-20V
Q_g	Total Gate Charge	---	---	1.6	nC	I_D=0.9A, V_{DS}=80V, V_{GS}=10V See Fig 6 and 13④
Q_{gs}	Gate-to-Source Charge	---	---	0.68		
Q_{gd}	Gate-to-Drain ("Miller") Charge	---	---	0.95		
$t_{d(on)}$	Turn-On Delay Time	---	7.8	---	ns	V_{DD}=50V, I_D=0.9A R_G=50Ω, R_D=55Ω See Fig. 10④
t_r	Rise Time	---	4.5	---		
$t_{d(off)}$	Turn-Off Delay Time	---	11	---		
t_f	Fall Time	---	4.7	---		
L_D	Internal Drain Inductance	---	4.0	---	nH	Between lead, 6mm (0.25in.) from package, and center of die contact. 
L_S	Internal Source Inductance	---	6.0	---		
C_{iss}	Input Capacitance	---	39	---	pF	V_{GS}=0V, V_{DS}=25v f=1.0Mhz See Fig. 5
C_{oss}	Output Capacitance	---	18	---		
C_{rss}	Reverse Transfer Capacitance	---	2.8	---		

Source-Drain Diode Ratings and Characteristics

	Parameter	Min.	Typ.	Max.	Units	Test Conditions
I_S	Continuous Source Current (Body Diode)	---	---	0.5	A	MOSFET symbol showing the integral reverse p-n junction diode. 
I_{SM}	Pulsed Source Current (Body Diode) ①	---	---	4.0		
V_{SD}	Diode Forward Voltage	---	---	1.4	V	T_J=25°C, I_S=0.5A, V_{GS}=0V④
t_{rr}	Reverse Recovery Time	42	---	71	ns	T_J=25°C, I_F=0.9A, di/dt=100A/µS④
Q_{RR}	Reverse Recovery Charge	0.14	---	0.41	µC	
t_{on}	Forward Turn-On Time	Intrinsic turn-on time is negligible (turn-on is dominated by L_S + L_D)				

Notes:

① Repetitive rating; Pulse width limited by max. junction temperature (See figure 11)

② V_{DD}=25V, Starting T_J=25°C, L=16mH, R_G=25Ω, Peak I_{AS}=1.0A (See figure 12)

③ $I_{SD} \leq$ 0.5A, di/dt≤25A/µs, $V_{DD} \leq BV_{DSS}$, T_J≤175°C Suggested R_G=50Ω

④ Pulse width ≤ 300µs; duty Cycle ≤2%

⑤ Mounting surface: flat, smooth, greased

⑥ K/W = °C/W

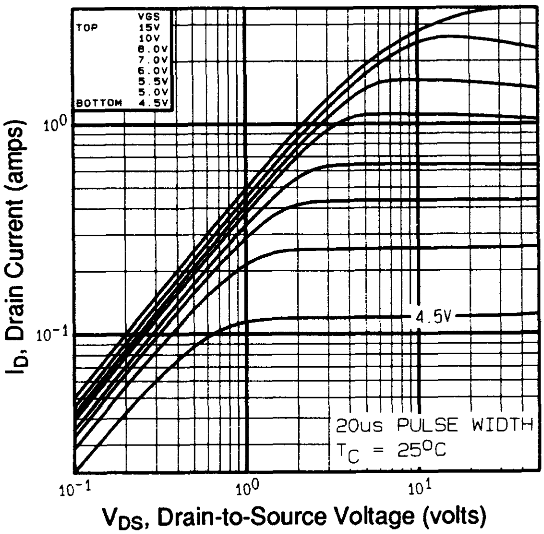


Fig 1. Typical Output Characteristics, $T_C = 25°C$

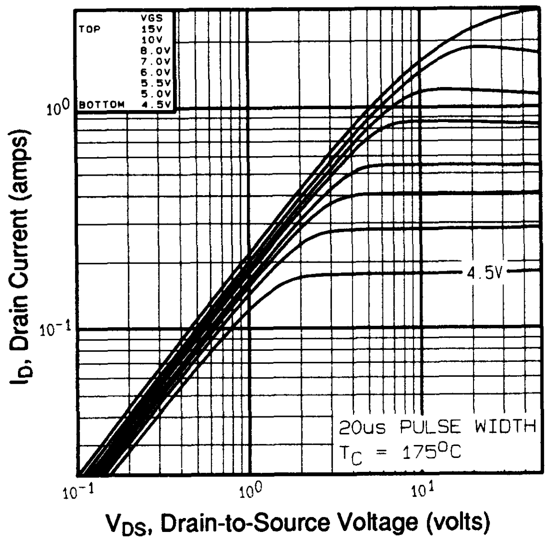


Fig 2. Typical Output Characteristics, $T_C = 150°C$

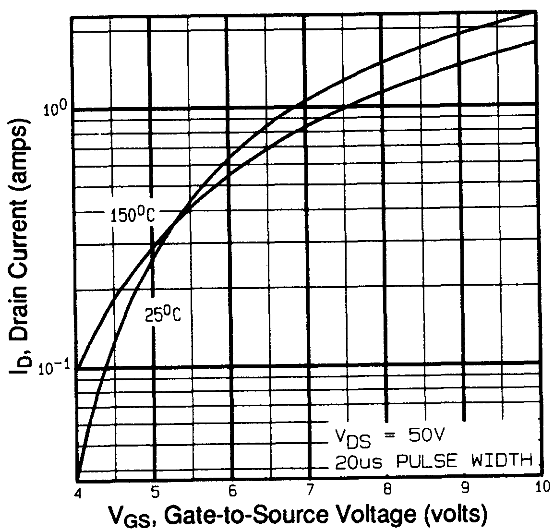


Fig 3. Typical Transfer Characteristics

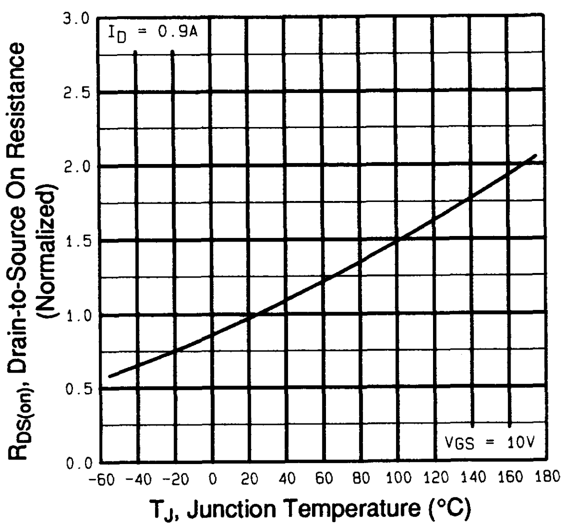


Fig 4. Normalized On-Resistance Vs. Temperature

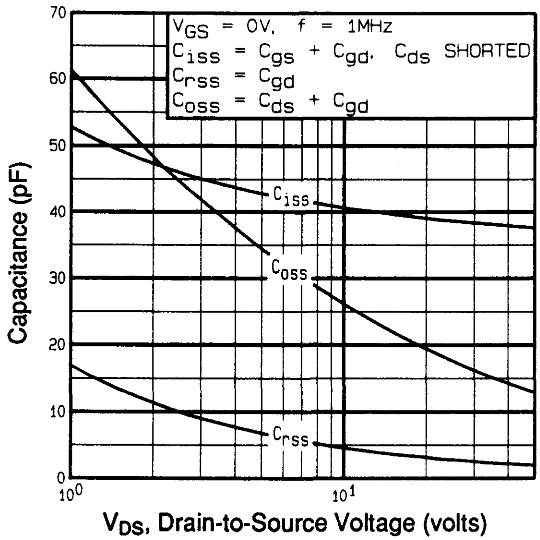


Fig 5. Typical Capacitance Vs. Drain-to-Source Voltage

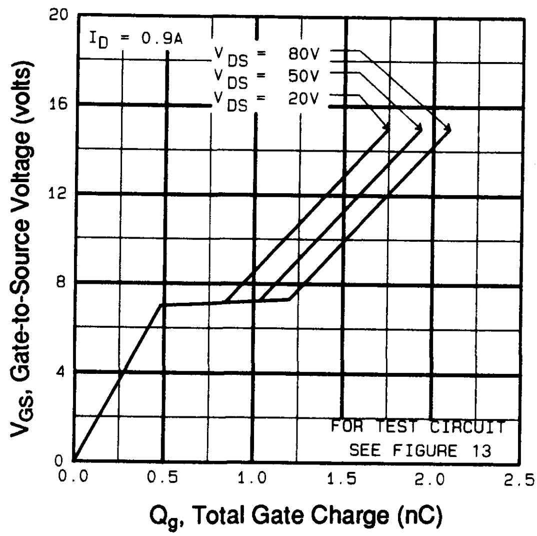


Fig 6. Typical Gate Charge Vs. Gate-to-Source Voltage

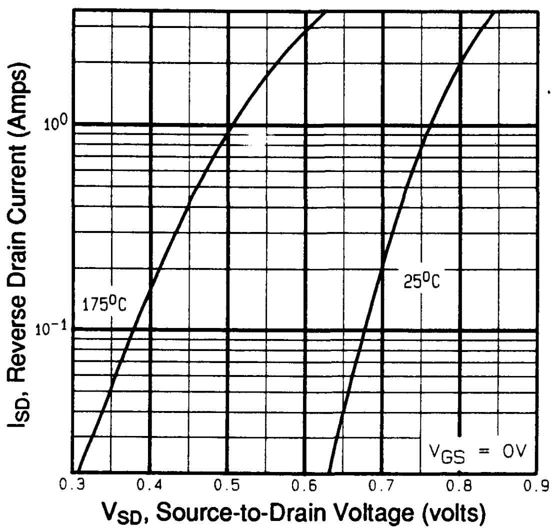


Fig 7. Typical Source-Drain Diode Forward Voltage

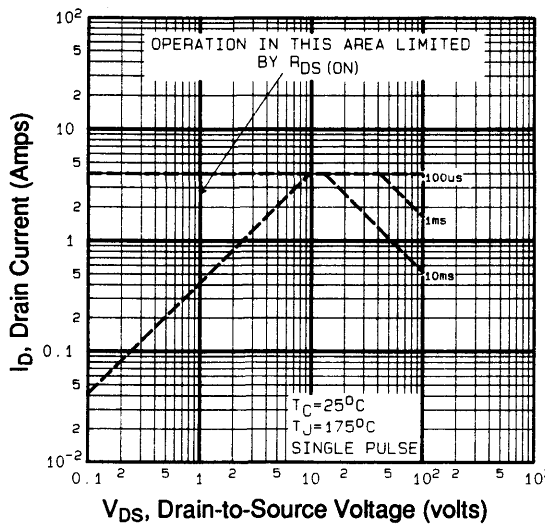


Fig 8. Maximum Safe Operating Area

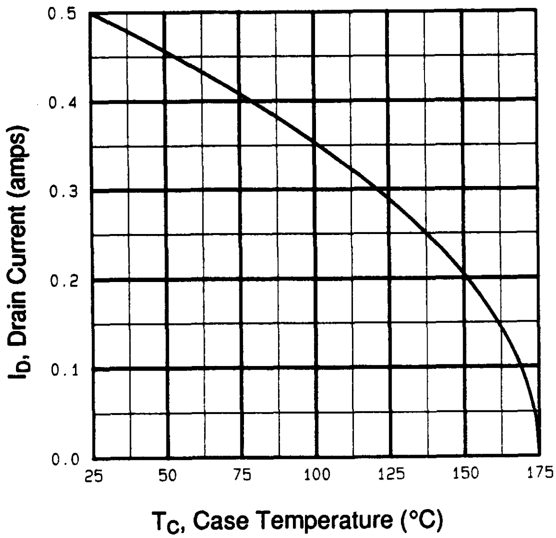


Fig 9. Maximum Drain Current Vs. Case Temperature

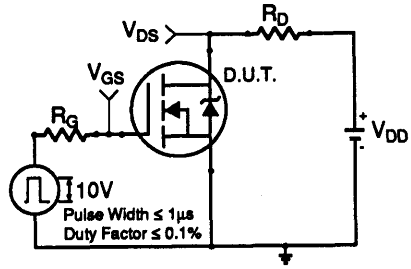


Fig 10a. Switching Time Test Circuit

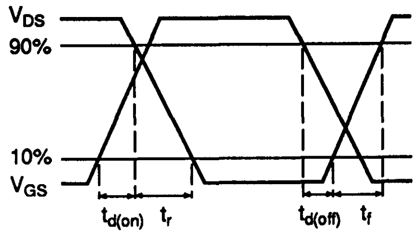


Fig 10b. Switching Time Waveforms

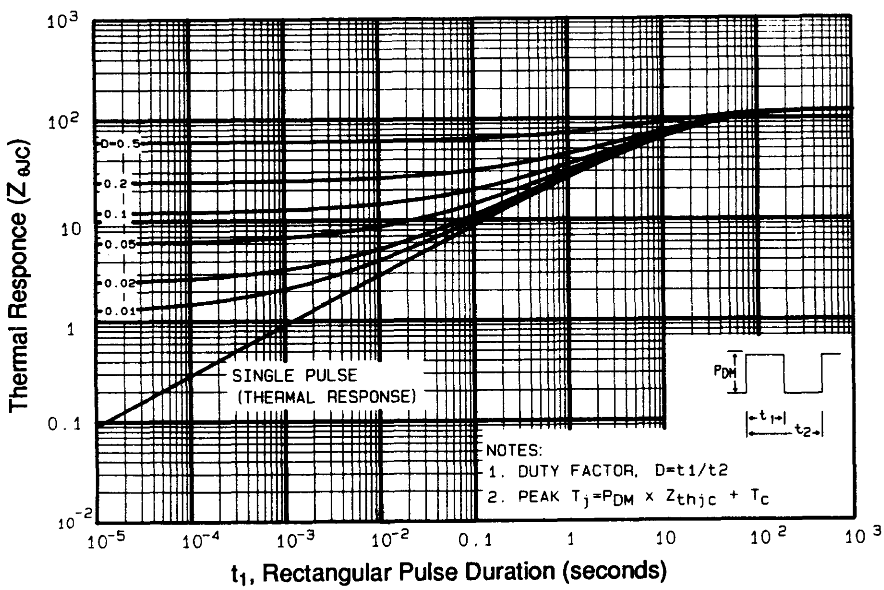


Fig 11. Maximum Effective Transient Thermal Impedance, Junction-to-Case

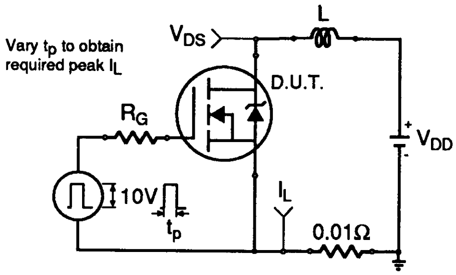


Fig 12a. Unclamped Inductive Test Circuit

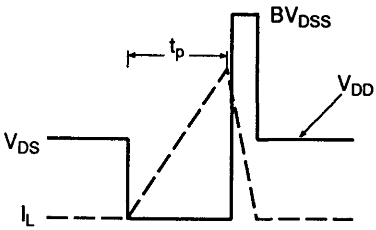


Fig 12b. Unclamped Inductive Waveforms

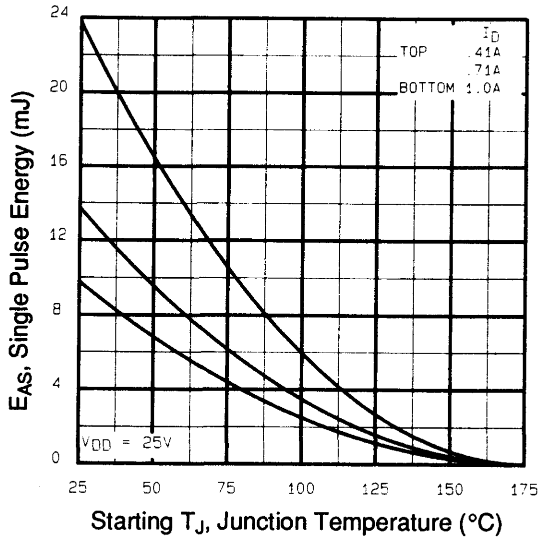


Fig 12c. Maximum Avalanche Energy vs. Drain Current

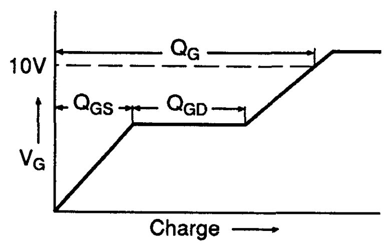


Fig 13a. Basic Gate Charge Waveform

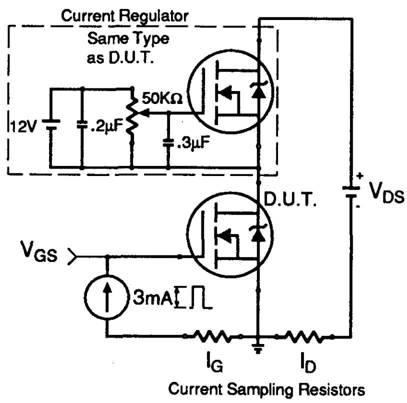


Fig 13b. Gate Charge Test Circuit

Appendix A: Figure 14, Peak Diode Recovery dv/dt Test Circuit

Appendix B: Package Outline Mechanical Drawing

Appendix D: Part Marking Information

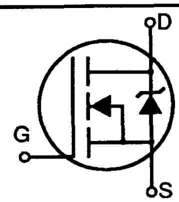
International IOR Rectifier

International Rectifier

IRFD210

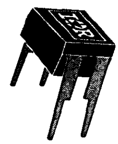
HEXFET® Power MOSFET

- Repetitive Avalanche Rated
- Dynamic dv/dt Rated
- For Automatic Insertion
- End Stackable



n-channel

BV_{DSS} 200V
$R_{DS(on)}$ 1.5Ω
I_D 0.60A


HD-1

Description

Third Generation HEXFETs from International Rectifier provide the designer with the best combination of fast switching speed, ruggedized device design, and low on resistance.

The 4-pin DIP package is a low cost machine insertable case style which can be stacked in multiple combinations on standard 0.1 inch pin centers. The dual drain pin serves as a thermal link to the mounting surface for power dissipation levels up to 1 watt.

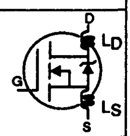
Absolute Maximum Ratings

	Parameter	Max.	Units
I_D @ T_C = 25°C	Continuous Drain Current, V_{GS}@10V	0.60	A
I_D @ T_C = 100°C	Continuous Drain Current, V_{GS}@10V	0.38	
I_{DM}	Pulsed Drain Current ①	4.8	
P_D@ T_C = 25°C	Maximum Power Dissipation	1.0	W
	Linear Derating Factor	0.0083	W/K⑥
V_{GS}	Gate-to-Source Breakdown Voltage	±20	V
E_{AS}	Single Pulse Avalanche Energy ②	79	mJ
I_{AR}	Avalanche Current ①	0.60	A
E_{AR}	Repetitive Avalanche Energy ①	0.10	mJ
dv/dt	Peak Diode Recovery dv/dt ③	5.0	V/ns
T_J, T_{STG}	Operating Junction and Storage Temperature Range	-55 to +150	°C
	Soldering Temperature, for 10 sec.	300 (0.063 in. (1.6mm) from case)	

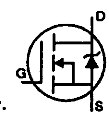
Thermal Resistance

	Parameter	Max.	Units
$R_{\theta JA}$	Junction-to-Ambient, Typical Socket Mount	120	K/W⑥

Electrical Characteristics @ T_J = 25°C (unless otherwise specified)

	Parameter	Min.	Typ.	Max.	Units	Test Conditions
BV_{DSS}	Drain-to-Source Breakdown Voltage	200	---	---	V	V_{GS}=0V, I_D=250µA
$\Delta BV_{DSS}/\Delta T_J$	Temp. Coefficient of Breakdown Voltage	---	0.30	---	V/°C	Reference to 25°C, I_D=1mA
$R_{DS(on)}$	Static Drain-to-Source On Resistance	---	---	1.5	Ω	V_{GS}=10V, I_D =0.36A④
$V_{GS(th)}$	Gate Threshold Voltage	2.0	---	4.0	V	V_{DS}=V_{GS}, I_D=250µA
g_{fs}	Forward Transconductance	0.10	---	---	S	V_{DS}=50V, I_{DS}=0.36A④
I_{DSS}	Zero Gate Voltage Collector Current	---	---	250	µA	V_{DS}=200V, V_{GS}=0V
		---	---	1000		V_{DS}=160V, V_{GS}=0V,T_J=125°C
I_{GSS}	Gate-to-Source Forward Leakage	---	---	500	nA	V_{GS}=20V
	Gate-to-Source Reverse Leakage	---	---	-500		V_{GS}=-20V
Q_g	Total Gate Charge	---	---	8.2	nC	I_D=3.3A, V_{DS}=160V, V_{GS}=10V See Fig 6 and 13④
Q_{gs}	Gate-to-Source Charge	---	---	1.8		
Q_{gd}	Gate-to-Drain ("Miller") Charge	---	---	4.5		
$t_{d(on)}$	Turn-On Delay Time	---	8.2	---	ns	V_{DD}=100V, I_D=3.3A R_G=24Ω, R_D=30Ω See Fig. 10④
t_r	Rise Time	---	17	---		
$t_{d(off)}$	Turn-Off Delay Time	---	14	---		
t_f	Fall Time	---	8.9	---		
L_D	Internal Drain Inductance	---	4.0	---	nH	Between lead, 6mm (0.25in.) from package, and center of die contact. 
L_S	Internal Source Inductance	---	6.0	---		
C_{iss}	Input Capacitance	---	140	---	pF	V_{GS}=0V, V_{DS}=25v f=1.0Mhz See Fig. 5
C_{oss}	Output Capacitance	---	53	---		
C_{rss}	Reverse Transfer Capacitance	---	15	---		

Source-Drain Diode Ratings and Characteristics

	Parameter	Min.	Typ.	Max.	Units	Test Conditions
I_S	Continuous Source Current (Body Diode)	---	---	0.60	A	MOSFET symbol showing the integral reverse p-n junction diode. 
I_{SM}	Pulsed Source Current (Body Diode) ①	---	---	4.8		
V_{SD}	Diode Forward Voltage	---	---	2.0	V	T_J=25°C, I_S=0.60A, V_{GS}=0V④
t_{rr}	Reverse Recovery Time	75	---	310	ns	T_J=25°C, I_F=3.3A, di/dt=100A/µS④
Q_{RR}	Reverse Recovery Charge	0.33	---	1.4	µC	
t_{on}	Forward Turn-On Time	Intrinsic turn-on time is negligible (turn-on is dominated by L_S + L_D)				

Notes:

① Repetitive rating; Pulse width limited by max. junction temperature (See figure 11)

② V_{DD}=50V, Starting T_J=25°C, L=82mH, R_G=25Ω, Peak I_{AS}=1.2A (See figure 12)

③ $I_{SD} \leq$ 3.3A, di/dt≤70A/µs, $V_{DD} \leq BV_{DSS}$, T_J≤150°C Suggested R_G=24Ω

④ Pulse width ≤ 300µs; duty Cycle ≤2%

⑤ Mounting surface: flat, smooth, greased

⑥ K/W = °C/W

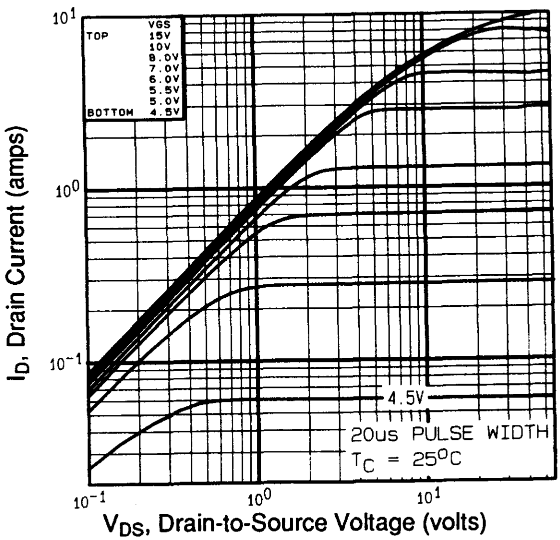


Fig 1. Typical Output Characteristics, $T_C = 25°C$

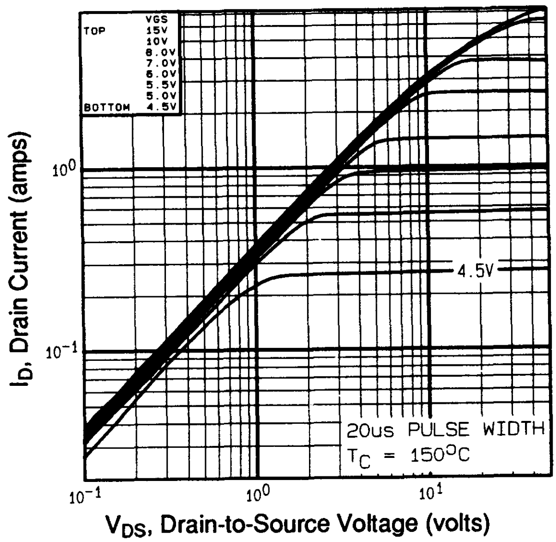


Fig 2. Typical Output Characteristics, $T_C = 150°C$

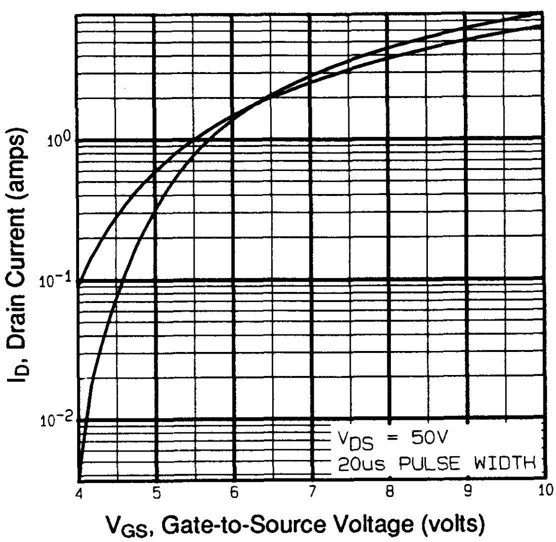


Fig 3. Typical Transfer Characteristics

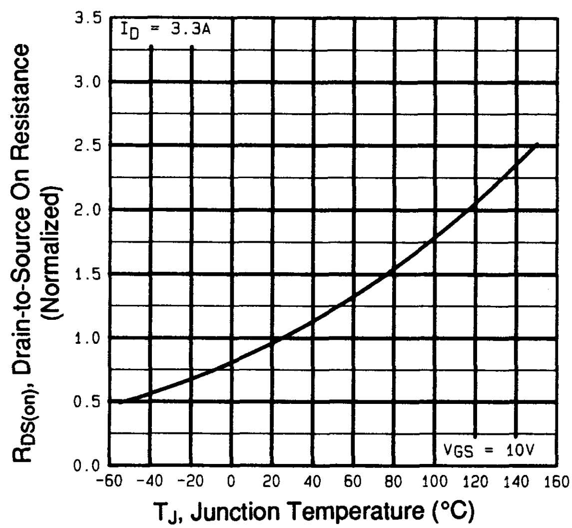


Fig 4. Normalized On-Resistance Vs. Temperature

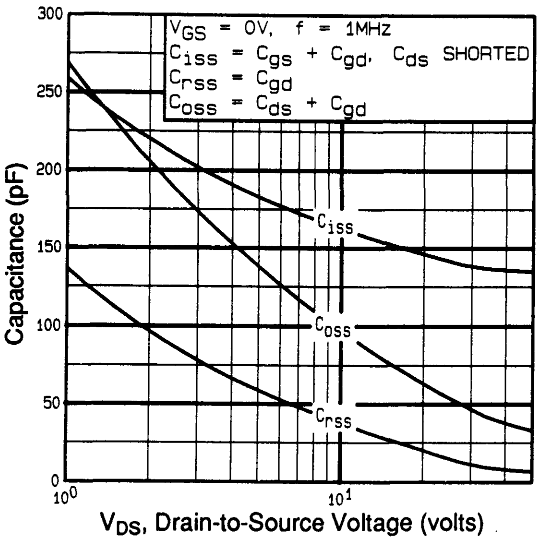


Fig 5. Typical Capacitance Vs. Drain-to-Source Voltage

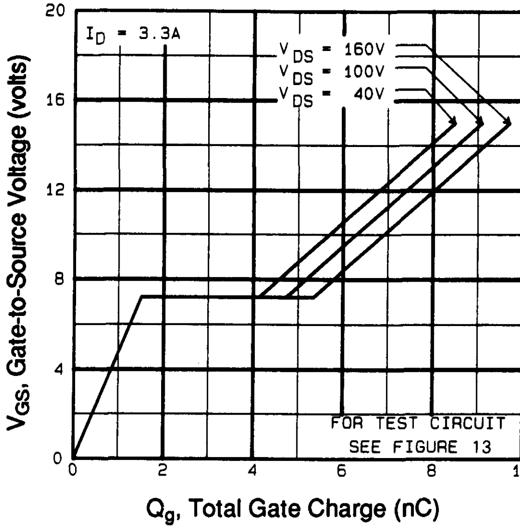


Fig 6. Typical Gate Charge Vs. Gate-to-Source Voltage

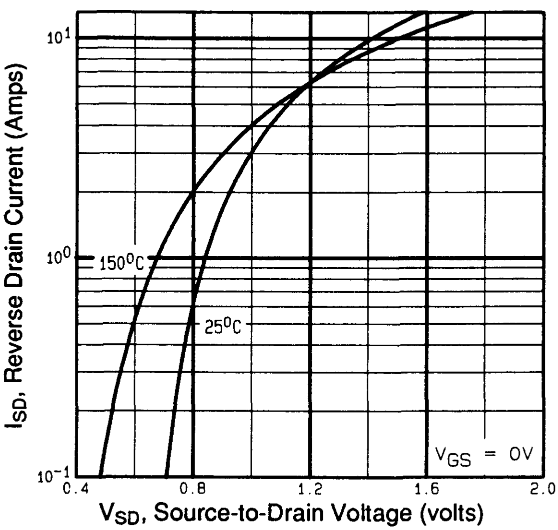


Fig 7. Typical Source-Drain Diode Forward Voltage

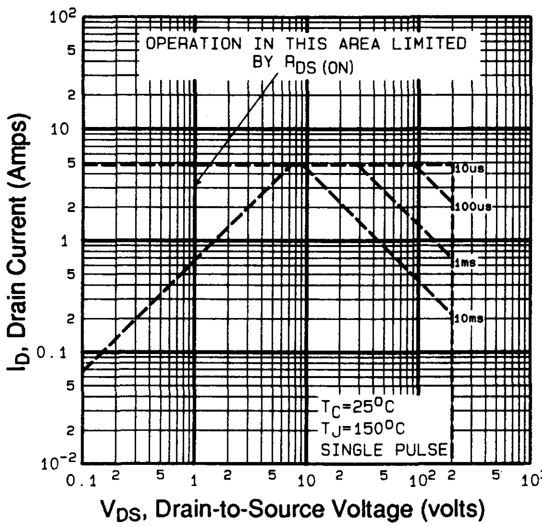


Fig 8. Maximum Safe Operating Area

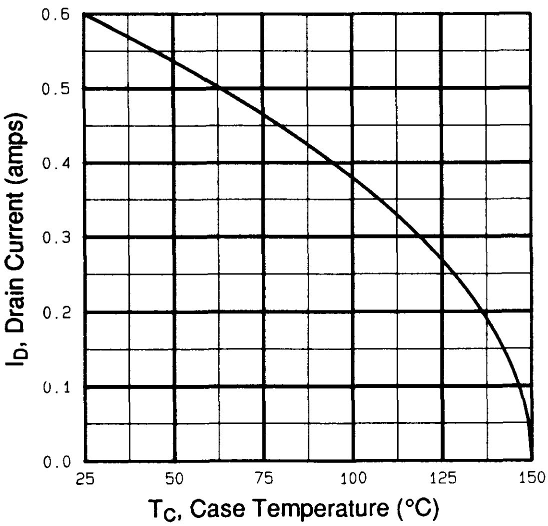


Fig 9. Maximum Drain Current Vs. Case Temperature

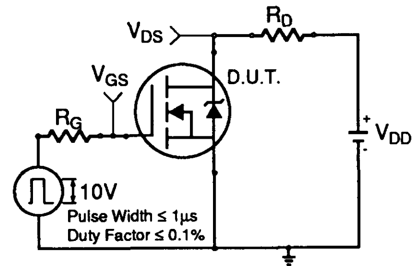


Fig 10a. Switching Time Test Circuit

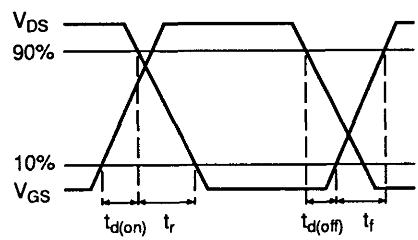


Fig 10b. Switching Time Waveforms

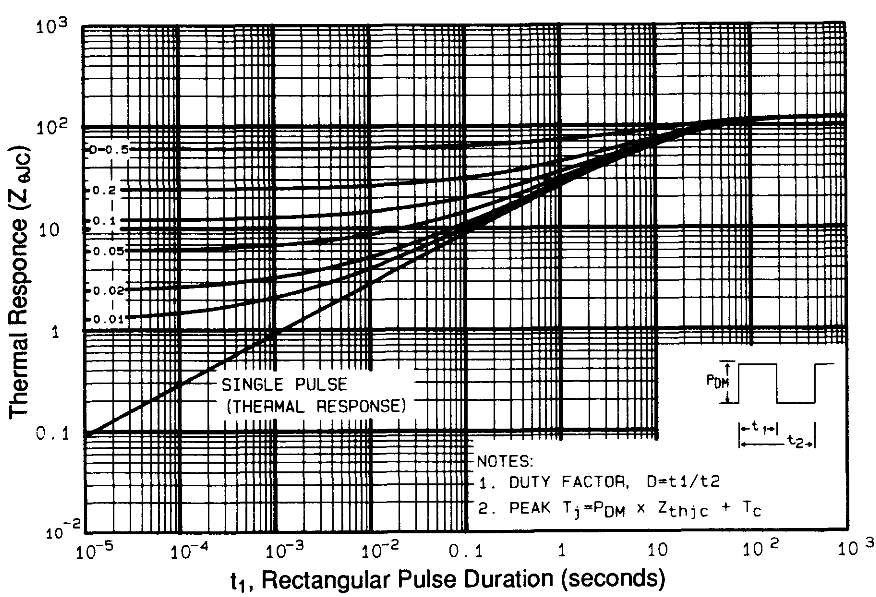


Fig 11. Maximum Effective Transient Thermal Impedance, Junction-to-Case

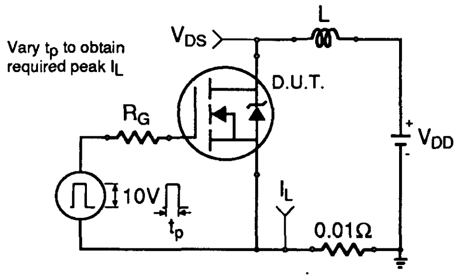


Fig 12a. Unclamped Inductive Test Circuit

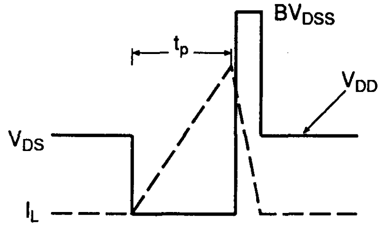


Fig 12b. Unclamped Inductive Waveforms

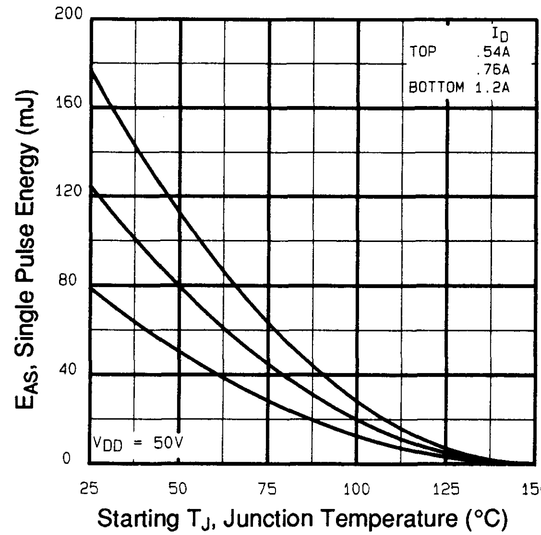


Fig 12c. Maximum Avalanche Energy vs. Drain Current

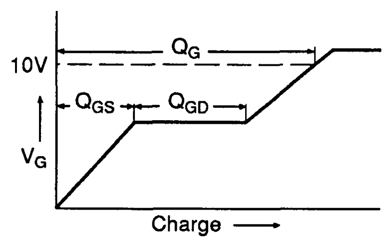


Fig 13a. Basic Gate Charge Waveform

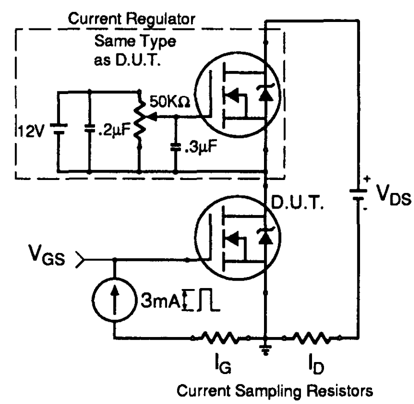


Fig 13b. Gate Charge Test Circuit

Appendix A: Figure 14, Peak Diode Recovery dv/dt Test Circuit

Appendix B: Package Outline Mechanical Drawing

Appendix D: Part Marking Information

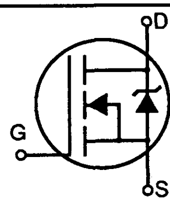
International IOR Rectifier

International Rectifier

IRFD220

HEXFET® Power MOSFET

- Repetitive Avalanche Rated
- Dynamic dv/dt Rated
- For Automatic Insertion
- End Stackable



n-channel

BV_{DSS} 200V

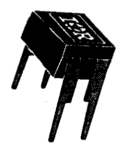
$R_{DS(on)}$ 0.80Ω

I_D 0.80A

Description

Third Generation HEXFETs from International Rectifier provide the designer with the best combination of fast switching speed, ruggedized device design, and low on resistance.

The 4-pin DIP package is a low cost machine insertable case style which can be stacked in multiple combinations on standard 0.1 inch pin centers. The dual drain pin serves as a thermal link to the mounting surface for power dissipation levels up to 1 watt.


HD-1

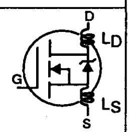
Absolute Maximum Ratings

	Parameter	Max.	Units
I_D @ T_C = 25°C	Continuous Drain Current, V_{GS}@10V	0.80	A
I_D @ T_C = 100°C	Continuous Drain Current, V_{GS}@10V	0.50	
I_{DM}	Pulsed Drain Current ①	6.4	
P_D@ T_C = 25°C	Maximum Power Dissipation	1.0	W
	Linear Derating Factor	0.0083	W/K⑥
V_{GS}	Gate-to-Source Breakdown Voltage	±20	V
E_{AS}	Single Pulse Avalanche Energy ②	59	mJ
I_{AR}	Avalanche Current ①	5.2	A
E_{AR}	Repetitive Avalanche Energy ①	0.10	mJ
dv/dt	Peak Diode Recovery dv/dt ③	5.0	V/ns
T_J T_{STG}	Operating Junction and Storage Temperature Range	-55 to +150	°C
	Soldering Temperature, for 10 sec.	300 (0.063 in. (1.6mm) from case)	

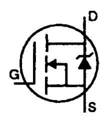
Thermal Resistance

	Parameter	Max.	Units
$R_{\theta JA}$	Junction-to-Ambient, Typical Socket Mount	120	K/W⑥

Electrical Characteristics @ $T_J = 25°C$ (unless otherwise specified)

	Parameter	Min.	Typ.	Max.	Units	Test Conditions
BV_{DSS}	Drain-to-Source Breakdown Voltage	200	---	---	V	V_{GS}=0V, I_D=250μA
$\Delta BV_{DSS}/\Delta T_J$	Temp. Coefficient of Breakdown Voltage	---	0.29	---	V/°C	Reference to 25°C, I_D=1mA
$R_{DS(on)}$	Static Drain-to-Source On Resistance	---	---	0.80	Ω	V_{GS}=10V, I_D =0.48A④
$V_{GS(th)}$	Gate Threshold Voltage	2.0	---	4.0	V	V_{DS}=V_{GS}, I_D=250μA
g_{fs}	Forward Transconductance	0.60	---	---	S	V_{DS}=50V, I_{DS}=0.48A④
I_{DSS}	Zero Gate Voltage Collector Current	---	---	250	μA	V_{DS}=200V, V_{GS}=0V
		---	---	1000		V_{DS}=160V, V_{GS}=0V,T_J=125°C
I_{GSS}	Gate-to-Source Forward Leakage	---	---	500	nA	V_{GS}=20V
	Gate-to-Source Reverse Leakage	---	---	-500		V_{GS}=-20V
Q_g	Total Gate Charge	---	---	14	nC	I_D=5.2A, V_{DS}=160V, V_{GS}=10V④
Q_{gs}	Gate-to-Source Charge	---	---	3.0		
Q_{gd}	Gate-to-Drain ("Miller") Charge	---	---	7.9		
$t_{d(on)}$	Turn-On Delay Time	---	7.2	---	ns	V_{DD}=100V, I_D=5.2A R_G=18Ω, R_D=19Ω④
t_r	Rise Time	---	22	---		
$t_{d(off)}$	Turn-Off Delay Time	---	19	---		
t_f	Fall Time	---	13	---		
L_D	Internal Drain Inductance	---	4.0	---	nH	Between lead, 6mm (0.25in.) from package, and center of die contact. 
L_S	Internal Source Inductance	---	6.0	---		
C_{iss}	Input Capacitance	---	260	---	pF	V_{GS}=0V, V_{DS}=25v f=1.0Mhz See Fig. 5
C_{oss}	Output Capacitance	---	100	---		
C_{rss}	Reverse Transfer Capacitance	---	30	---		

Source-Drain Diode Ratings and Characteristics

	Parameter	Min.	Typ.	Max.	Units	Test Conditions
I_S	Continuous Source Current (Body Diode)	---	---	0.80	A	MOSFET symbol showing the integral reverse p-n junction diode. 
I_{SM}	Pulsed Source Current (Body Diode) ①	---	---	6.4		
V_{SD}	Diode Forward Voltage	---	---	1.8	V	T_J=25°C, I_S=0.80A, V_{GS}=0V④
t_{rr}	Reverse Recovery Time	75	---	300	ns	T_J=25°C, I_F=5.2A, di/dt=100A/μS④
Q_{RR}	Reverse Recovery Charge	0.46	---	1.8	μC	
t_{on}	Forward Turn-On Time	Intrinsic turn-on time is negligible (turn-on is dominated by L_S + L_D)				

Notes:

① Repetitive rating; Pulse width limited by max. junction temperature

② V_{DD}=50V, Starting T_J=25°C, L=36mH, R_G=25Ω, Peak I_{AS}=1.6A

③ I_{SD}≤5.2A, di/dt≤95A/μs, V_{DD}≤BV_{DSS}, T_J≤150°C Suggested R_G=18Ω

④ Pulse width ≤ 300μs; duty Cycle ≤2%

⑤ Mounting surface: flat, smooth, greased

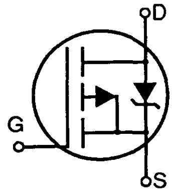
⑥ K/W = °C/W

International
IOR Rectifier

IRFD9014

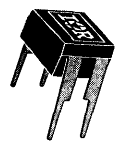
HEXFET® Power MOSFET

- Repetitive Avalanche Rated
- Dynamic dv/dt Rated
- For Automatic Insertion
- End Stackable
- P-Channel



p-channel

BV_{DSS} -60V
$R_{DS(on)}$ 0.50Ω
I_D -1.1A


HD-1

Description

Third Generation HEXFETs from International Rectifier provide the designer with the best combination of fast switching speed, ruggedized device design, and low on resistance.

The 4-pin DIP package is a low cost machine insertable case style which can be stacked in multiple combinations on standard 0.1 inch pin centers. The dual drain pin serves as a thermal link to the mounting surface for power dissipation levels up to 1 watt.

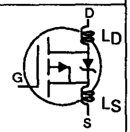
Absolute Maximum Ratings

	Parameter	Max.	Units
I_D @ T_C = 25°C	Continuous Drain Current, V_{GS}@-10V	-1.1	A
I_D @ T_C = 100°C	Continuous Drain Current, V_{GS}@-10V	-0.8	
I_{DM}	Pulsed Drain Current ①	-8.8	
P_D@ T_C = 25°C	Maximum Power Dissipation	1.3	W
	Linear Derating Factor	0.0083	W/K⑥
V_{GS}	Gate-to-Source Breakdown Voltage	±20	V
E_{AS}	Single Pulse Avalanche Energy ②	140	mJ
I_{AR}	Avalanche Current ①	-1.1	A
E_{AR}	Repetitive Avalanche Energy ①	0.13	mJ
dv/dt	Peak Diode Recovery dv/dt ③	-4.5	V/ns
T_J, T_{STG}	Operating Junction and Storage Temperature Range	-55 to +175	°C
	Soldering Temperature, for 10 sec.	300 (0.063 in. (1.6mm) from case)	

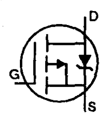
Thermal Resistance

	Parameter	Max.	Units
$R_{\theta JA}$	Junction-to-Ambient, Typical Socket Mount	120	K/W⑥

Electrical Characteristics @ T_J = 25°C (unless otherwise specified)

	Parameter	Min.	Typ.	Max.	Units	Test Conditions
BV_{DSS}	Drain-to-Source Breakdown Voltage	-60	---	---	V	V_{GS}=0V, I_D=-250µA
$\Delta BV_{DSS}/\Delta T_J$	Temp. Coefficient of Breakdown Voltage	---	0.060	---	V/°C	Reference to 25°C, I_D=-1mA
$R_{DS(on)}$	Static Drain-to-Source On Resistance	---	---	0.50	Ω	V_{GS}=-10V, I_D =-0.66A④
$V_{GS(th)}$	Gate Threshold Voltage	-2.0	---	-4.0	V	V_{DS}=V_{GS}, I_D=-250µA
g_{fs}	Forward Transconductance	0.70	---	---	S	V_{DS}=-25V, I_{DS}=-0.66A④
I_{DSS}	Zero Gate Voltage Collector Current	---	---	-250	µA	V_{DS}=-60V, V_{GS}=0V
		---	---	-1000		V_{DS}=-48V, V_{GS}=0V,T_J=150°C
I_{GSS}	Gate-to-Source Forward Leakage	---	---	-500	nA	V_{GS}=-20V
	Gate-to-Source Reverse Leakage	---	---	500		V_{GS}=20V
Q_g	Total Gate Charge	---	---	12	nC	I_D=-6.7A, V_{DS}=-48V, V_{GS}=-10V④
Q_{gs}	Gate-to-Source Charge	---	---	3.8		
Q_{gd}	Gate-to-Drain ("Miller") Charge	---	---	5.1		
$t_{d(on)}$	Turn-On Delay Time	---	11	---	ns	V_{DD}=-30V, I_D=-6.7A R_G=24Ω, R_D=4.0Ω④
t_r	Rise Time	---	6.3	---		
$t_{d(off)}$	Turn-Off Delay Time	---	10	---		
t_f	Fall Time	---	31	---		
L_D	Internal Drain Inductance	---	4.0	---	nH	Between lead, 6mm (0.25in.) from package, and center of die contact. 
L_S	Internal Source Inductance	---	6.0	---		
C_{iss}	Input Capacitance	---	270	---	pF	V_{GS}=0V, V_{DS}=-25v *f*=1.0Mhz
C_{oss}	Output Capacitance	---	170	---		
C_{rss}	Reverse Transfer Capacitance	---	31	---		

Source-Drain Diode Ratings and Characteristics

	Parameter	Min.	Typ.	Max.	Units	Test Conditions
I_S	Continuous Source Current (Body Diode)	---	---	-1.1	A	MOSFET symbol showing the integral reverse p-n junction diode. 
I_{SM}	Pulsed Source Current (Body Diode) ①	---	---	-8.8		
V_{SD}	Diode Forward Voltage	---	---	-5.5	V	T_J=25°C, I_S=-1.1A, V_{GS}=0V④
t_{rr}	Reverse Recovery Time	40	---	160	ns	T_J=25°C, I_F=-6.7A, di/dt=-100A/µS④
Q_{RR}	Reverse Recovery Charge	0.048	---	0.19	µC	
t_{on}	Forward Turn-On Time	Intrinsic turn-on time is negligible (turn-on is dominated by L_S + L_D)				

Notes:

① Repetitive rating; Pulse width limited by max. junction temperature

② V_{DD}=-25V, Starting T_J=25°C, L=51mH, R_G=25Ω, Peak I_{AS}=-2.0A

③ I_{SD}≤-6.7A, di/dt≤-90A/µs, V_{DD}≤BV_{DSS}, T_J≤175°C Suggested R_G=24Ω

④ Pulse width ≤ 300µs; duty Cycle ≤2%

⑤ Mounting surface: flat, smooth, greased

⑥ K/W = °C/W

For more information on the same die in a TO-252AA package refer to IRFR9014.

International
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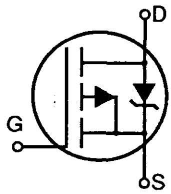
IRFD9024

HEXFET® Power MOSFET

- Repetitive Avalanche Rated
- Dynamic dv/dt Rated
- For Automatic Insertion
- End Stackable
- P-Channel



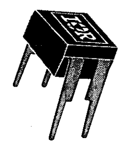
p-channel

BV_{DSS} -60V
$R_{DS(on)}$ 0.28Ω
I_D -1.6A

Description

Third Generation HEXFETs from International Rectifier provide the designer with the best combination of fast switching speed, ruggedized device design, and low on resistance.

The 4-pin DIP package is a low cost machine insertable case style which can be stacked in multiple combinations on standard 0.1 inch pin centers. The dual drain pin serves as a thermal link to the mounting surface for power dissipation levels up to 1 watt.


HD-1

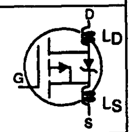
Absolute Maximum Ratings

	Parameter	Max.	Units
I_D @ T_C = 25°C	Continuous Drain Current, V_{GS}@-10V	-1.6	A
I_D @ T_C = 100°C	Continuous Drain Current, V_{GS}@-10V	-1.1	
I_{DM}	Pulsed Drain Current ①	-13	
P_D@ T_C = 25°C	Maximum Power Dissipation	1.3	W
	Linear Derating Factor	0.0083	W/K⑥
V_{GS}	Gate-to-Source Breakdown Voltage	±20	V
E_{AS}	Single Pulse Avalanche Energy ②	140	mJ
I_{AR}	Avalanche Current ①	-1.6	A
E_{AR}	Repetitive Avalanche Energy ①	0.13	mJ
dv/dt	Peak Diode Recovery dv/dt ③	-4.5	V/ns
T_J T_{STG}	Operating Junction and Storage Temperature Range	-55 to +175	°C
	Soldering Temperature, for 10 sec.	300 (0.063 in. (1.6mm) from case)	

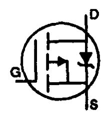
Thermal Resistance

	Parameter	Max.	Units
$R_{\theta JA}$	Junction-to-Ambient, Typical Socket Mount	120	K/W⑥

Electrical Characteristics @ T_J = 25°C (unless otherwise specified)

	Parameter	Min.	Typ.	Max.	Units	Test Conditions
BV_{DSS}	Drain-to-Source Breakdown Voltage	-60	---	---	V	V_{GS}=0V, I_D=-250µA
$\Delta BV_{DSS}/\Delta T_J$	Temp. Coefficient of Breakdown Voltage	---	0.056	---	V/°C	Reference to 25°C, I_D=-1mA
$R_{DS(on)}$	Static Drain-to-Source On Resistance	---	---	0.28	Ω	V_{GS}=-10V, I_D =-0.96A④
$V_{GS(th)}$	Gate Threshold Voltage	-2.0	---	-4.0	V	V_{DS}=V_{GS}, I_D=-250µA
g_{fs}	Forward Transconductance	1.3	---	---	S	V_{DS}=-25V, I_{DS}=-0.96A④
I_{DSS}	Zero Gate Voltage Collector Current	---	---	-250	µA	V_{DS}=-60V, V_{GS}=0V
		---	---	-1000		V_{DS}=-48V, V_{GS}=0V,T_J=150°C
I_{GSS}	Gate-to-Source Forward Leakage	---	---	-500	nA	V_{GS}=-20V
	Gate-to-Source Reverse Leakage	---	---	500		V_{GS}=20V
Q_g	Total Gate Charge	---	---	19	nC	I_D=-11A, V_{DS}=-48V, V_{GS}=-10V
Q_{gs}	Gate-to-Source Charge	---	---	5.4		See Fig 6 and 13④
Q_{gd}	Gate-to-Drain ("Miller") Charge	---	---	11		
$t_{d(on)}$	Turn-On Delay Time	---	13	---	ns	V_{DD}=-30V, I_D=-11A
t_r	Rise Time	---	68	---		R_G=18Ω, R_D=2.5Ω
$t_{d(off)}$	Turn-Off Delay Time	---	15	---		See Fig. 10④
t_f	Fall Time	---	29	---		
L_D	Internal Drain Inductance	---	4.0	---	nH	Between lead, 6mm (0.25in.) from package, and center of die contact. 
L_S	Internal Source Inductance	---	6.0	---		
C_{iss}	Input Capacitance	---	570	---	pF	V_{GS}=0V, V_{DS}=-25v
C_{oss}	Output Capacitance	---	360	---		f=1.0Mhz
C_{rss}	Reverse Transfer Capacitance	---	65	---		See Fig. 5

Source-Drain Diode Ratings and Characteristics

	Parameter	Min.	Typ.	Max.	Units	Test Conditions
I_S	Continuous Source Current (Body Diode)	---	---	-1.6	A	MOSFET symbol showing the integral reverse p-n junction diode. 
I_{SM}	Pulsed Source Current (Body Diode) ①	---	---	-13		
V_{SD}	Diode Forward Voltage	---	---	-6.3	V	T_J=25°C, I_S=-1.6A, V_{GS}=0V④
t_{rr}	Reverse Recovery Time	50	---	200	ns	T_J=25°C, I_F=-11A,
Q_{RR}	Reverse Recovery Charge	0.16	---	0.64	µC	di/dt=100A/µS④
t_{on}	Forward Turn-On Time	Intrinsic turn-on time is negligible (turn-on is dominated by L_S + L_D)				

Notes:

① Repetitive rating; Pulse width limited by max. junction temperature (See figure 11)

② V_{DD}=-25V, Starting T_J=25°C, L=17mH, R_G=25Ω, Peak I_{AS}=-3.2A

③ I_{SD}≤-11A, di/dt≤-140A/µs, V_{DD}≤BV_{DSS}, T_J≤175°C Suggested R_G=18Ω

④ Pulse width ≤ 300µs; duty Cycle ≤2%

⑤ Mounting surface: flat, smooth, greased

⑥ K/W = °C/W

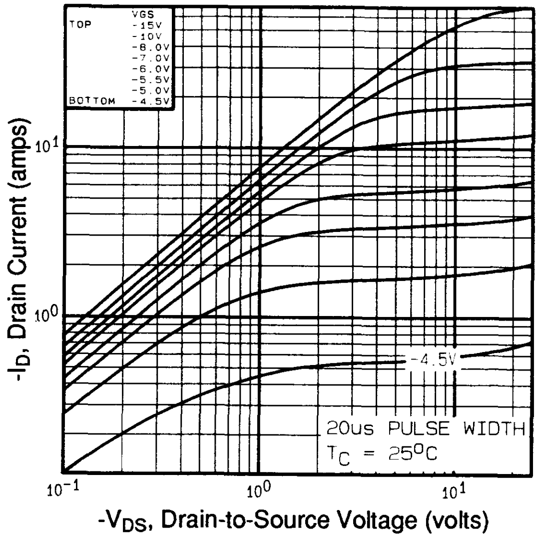


Fig 1. Typical Output Characteristics, $T_C = 25°C$

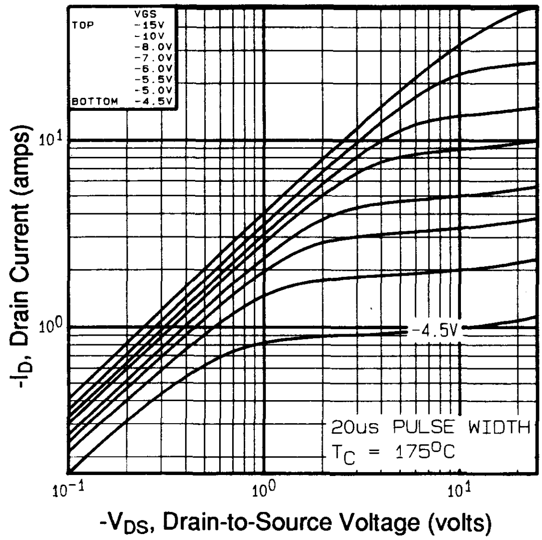


Fig 2. Typical Output Characteristics, $T_C = 150°C$

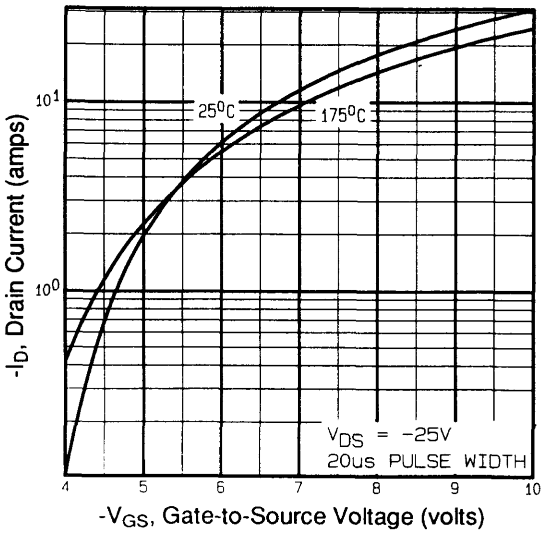


Fig 3. Typical Transfer Characteristics

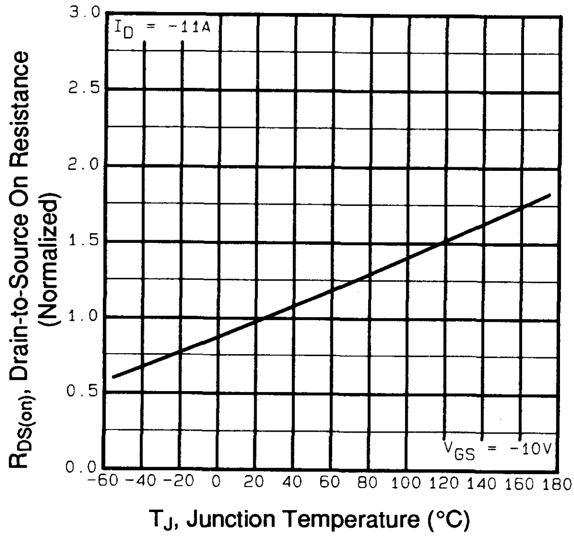


Fig 4. Normalized On-Resistance Vs. Temperature

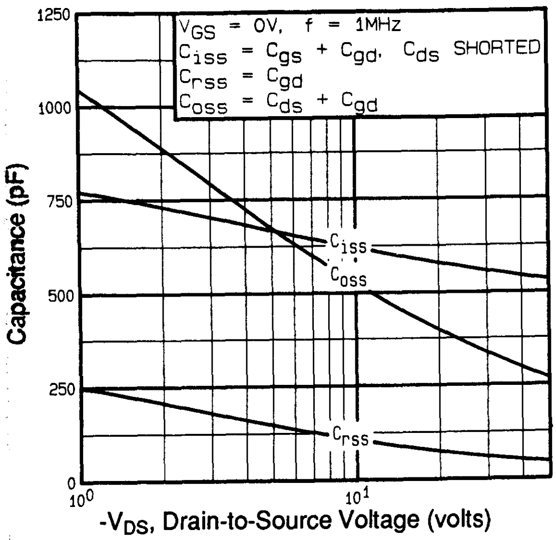


Fig 5. Typical Capacitance Vs. Drain-to-Source Voltage

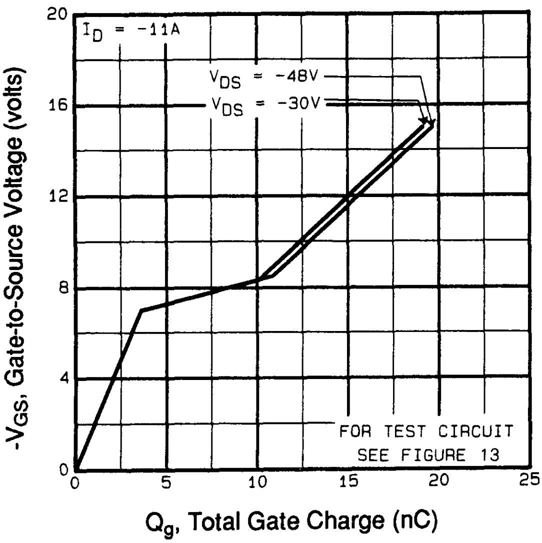


Fig 6. Typical Gate Charge Vs. Gate-to-Source Voltage

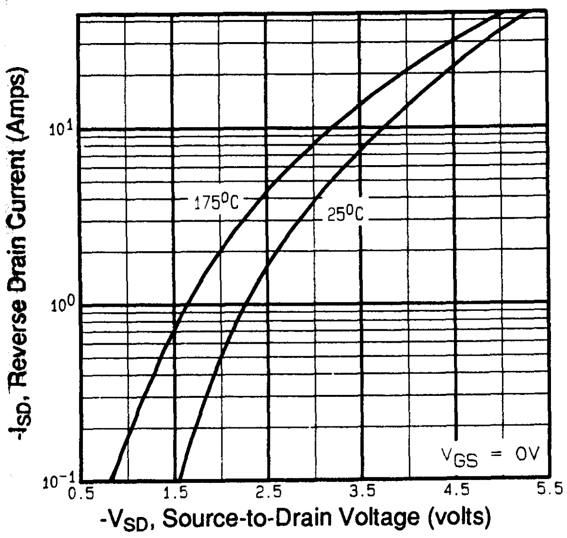


Fig 7. Typical Source-Drain Diode Forward Voltage

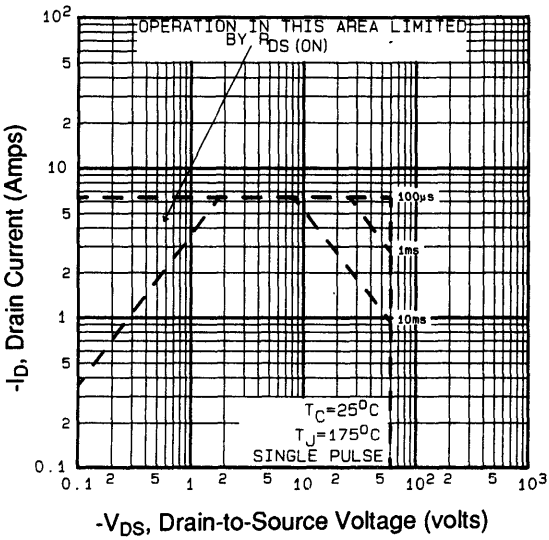


Fig 8. Maximum Safe Operating Area

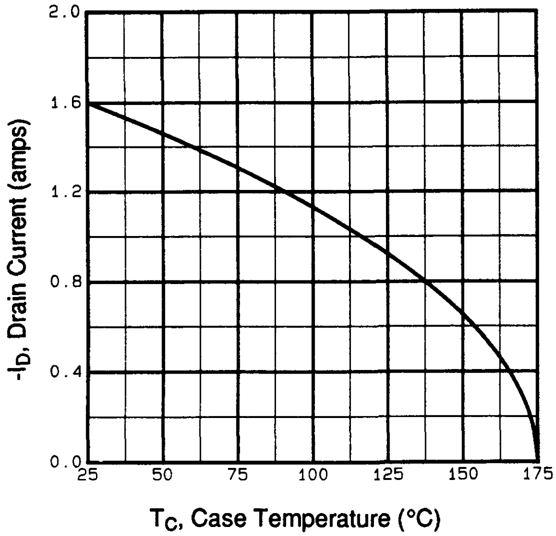


Fig 9. Maximum Drain Current Vs. Case Temperature

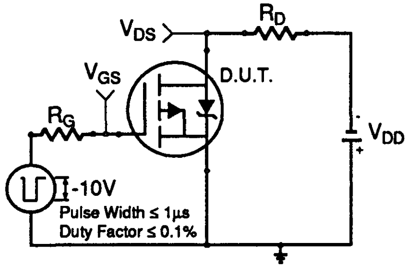


Fig 10a. Switching Time Test Circuit

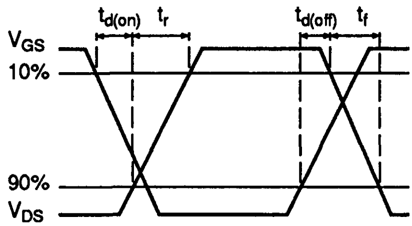


Fig 10b. Switching Time Waveforms

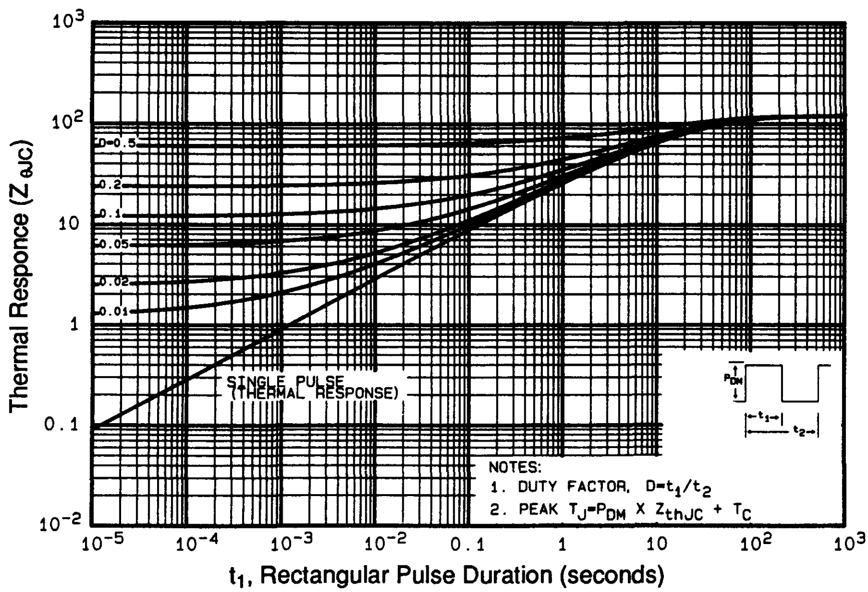


Fig 11. Maximum Effective Transient Thermal Impedance, Junction-to-Case

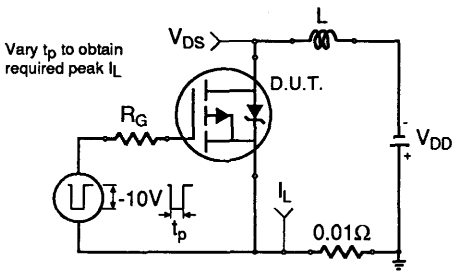


Fig 12a. Unclamped Inductive Test Circuit

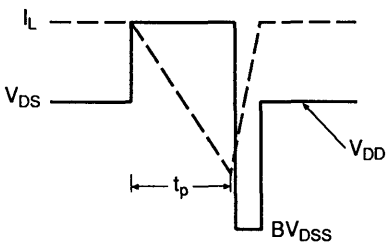


Fig 12b. Unclamped Inductive Waveforms

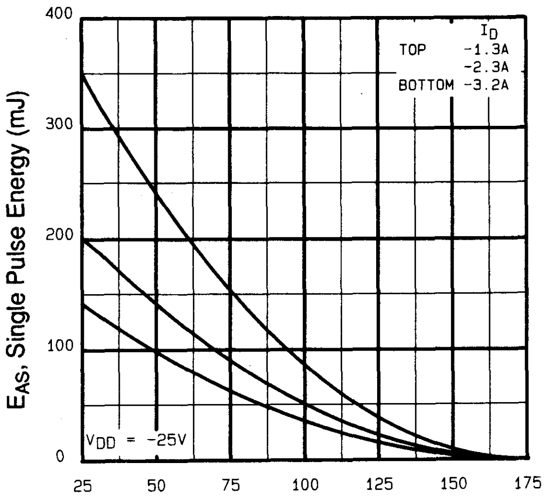


Fig 12c. Maximum Avalanche Energy vs. Drain Current

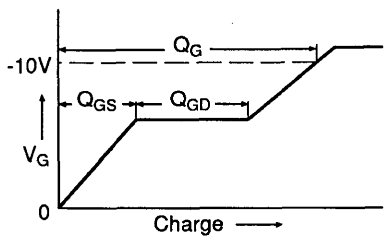


Fig 13a. Basic Gate Charge Waveform

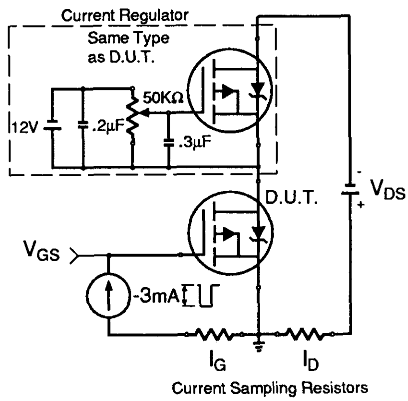


Fig 13b. Gate Charge Test Circuit

Appendix A: Figure 14, Peak Diode Recovery dv/dt Test Circuit

Appendix B: Package Outline Mechanical Drawing

Appendix D: Part Marking Information

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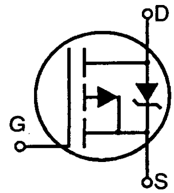
IRFD9110

HEXFET® Power MOSFET

- Repetitive Avalanche Rated
- Dynamic dv/dt Rated
- For Automatic Insertion
- End Stackable
- P-Channel



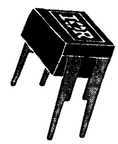
p-channel

BV_{DSS} -100V
$R_{DS(on)}$ 1.2Ω
I_D -0.70A

Description

Third Generation HEXFETs from International Rectifier provide the designer with the best combination of fast switching speed, ruggedized device design, and low on resistance.

The 4-pin DIP package is a low cost machine insertable case style which can be stacked in multiple combinations on standard 0.1 inch pin centers. The dual drain pin serves as a thermal link to the mounting surface for power dissipation levels up to 1 watt.


HD-1
Similar to M0-001AN

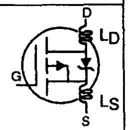
Absolute Maximum Ratings

	Parameter	Max.	Units
I_D @ T_C = 25°C	Continuous Drain Current, V_{GS}@-10V	-0.70	A
I_D @ T_C = 100°C	Continuous Drain Current, V_{GS}@-10V	-0.49	
I_{DM}	Pulsed Drain Current ①	-5.6	
P_D@ T_C = 25°C	Maximum Power Dissipation	1.3	W
	Linear Derating Factor	0.0083	W/K⑥
V_{GS}	Gate-to-Source Breakdown Voltage	±20	V
E_{AS}	Single Pulse Avalanche Energy ②	140	mJ
I_{AR}	Avalanche Current ①	-0.70	A
E_{AR}	Repetitive Avalanche Energy ①	0.13	mJ
dv/dt	Peak Diode Recovery dv/dt ③	-5.5	V/ns
T_J T_{STG}	Operating Junction and Storage Temperature Range	-55 to +175	°C
	Soldering Temperature, for 10 sec.	300 (0.063 in. (1.6mm) from case)	

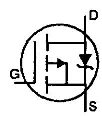
Thermal Resistance

	Parameter	Max.	Units
$R_{\theta JA}$	Junction-to-Ambient, Typical Socket Mount	120	K/W⑥

Electrical Characteristics @ T_J = 25°C (unless otherwise specified)

	Parameter	Min.	Typ.	Max.	Units	Test Conditions
BV_{DSS}	Drain-to-Source Breakdown Voltage	-100	---	---	V	V_{GS}=0V, I_D=-250µA
$\Delta BV_{DSS}/\Delta T_J$	Temp. Coefficient of Breakdown Voltage	---	0.091	---	V/°C	Reference to 25°C, I_D=-1mA
$R_{DS(on)}$	Static Drain-to-Source On Resistance	---	---	1.2	Ω	V_{GS}=-10V, I_D =-0.42A④
$V_{GS(th)}$	Gate Threshold Voltage	-2.0	---	-4.0	V	V_{DS}=V_{GS}, I_D=-250µA
g_{fs}	Forward Transconductance	0.60	---	---	S	V_{DS}=-50V, I_{DS}=-0.42A④
I_{DSS}	Zero Gate Voltage Collector Current	---	---	-250	µA	V_{DS}=-100V, V_{GS}=0V
		---	---	-1000		V_{DS}=-80V, V_{GS}=0V,T_J=150°C
I_{GSS}	Gate-to-Source Forward Leakage	---	---	-500	nA	V_{GS}=-20V
	Gate-to-Source Reverse Leakage	---	---	500		V_{GS}=20V
Q_g	Total Gate Charge	---	---	8.7	nC	I_D=-4.0A, V_{DS}=-80V, V_{GS}=-10V See Fig 6 and 13④
Q_{gs}	Gate-to-Source Charge	---	---	2.2		
Q_{gd}	Gate-to-Drain ("Miller") Charge	---	---	4.1		
$t_{d(on)}$	Turn-On Delay Time	---	10	---	ns	V_{DD}=-50V, I_D=-4.0A R_G=24Ω, R_D=11Ω See Fig. 10④
t_r	Rise Time	---	27	---		
$t_{d(off)}$	Turn-Off Delay Time	---	15	---		
t_f	Fall Time	---	17	---		
L_D	Internal Drain Inductance	---	4.0	---	nH	Between lead, 6mm (0.25in.) from package, and center of die contact. 
L_S	Internal Source Inductance	---	6.0	---		
C_{iss}	Input Capacitance	---	200	---	pF	V_{GS}=0V, V_{DS}=-25v
C_{oss}	Output Capacitance	---	94	---		f=1.0Mhz
C_{rss}	Reverse Transfer Capacitance	---	18	---		See Fig. 5

Source-Drain Diode Ratings and Characteristics

	Parameter	Min.	Typ.	Max.	Units	Test Conditions
I_S	Continuous Source Current (Body Diode)	---	---	-0.70	A	MOSFET symbol showing the integral reverse p-n junction diode. 
I_{SM}	Pulsed Source Current (Body Diode) ①	---	---	-5.6		
V_{SD}	Diode Forward Voltage	---	---	-5.5	V	T_J=25°C, I_S=-0.70A, V_{GS}=0V④
t_{rr}	Reverse Recovery Time	41	---	160	ns	T_J=25°C, I_F=-4.0A, di/dt=100A/µS④
Q_{RR}	Reverse Recovery Charge	0.075	---	0.30	µC	
t_{on}	Forward Turn-On Time	Intrinsic turn-on time is negligible (turn-on is dominated by L_S + L_D)				

Notes:

① Repetitive rating; Pulse width limited by max. junction temperature (See figure 11)

② V_{DD}=-25V, Starting T_J=25°C, L=53mH, R_G=25Ω, Peak I_{AS}=-2.0A (See figure 12)

③ I_{SD}≤-4.0A, di/dt≤-75A/µs, V_{DD}≤BV_{DSS}, T_J≤175°C Suggested R_G=24Ω

④ Pulse width ≤ 300µs; duty Cycle ≤2%

⑤ Mounting surface: flat, smooth, greased

⑥ K/W = °C/W

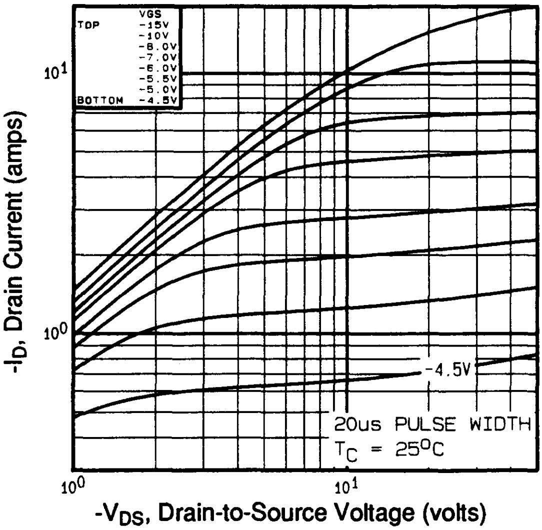


Fig 1. Typical Output Characteristics, $T_C = 25°C$

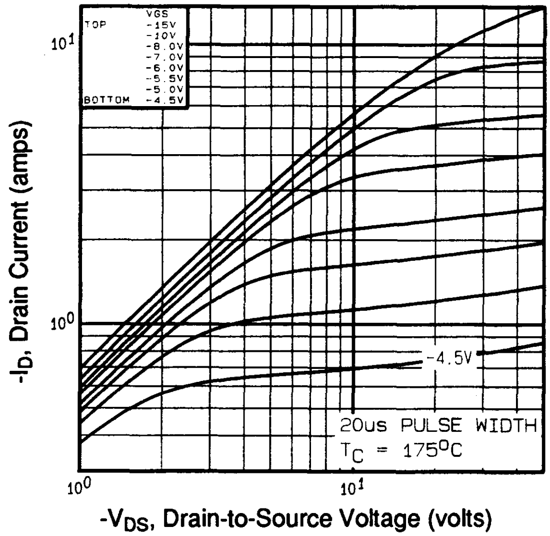


Fig 2. Typical Output Characteristics, $T_C = 150°C$

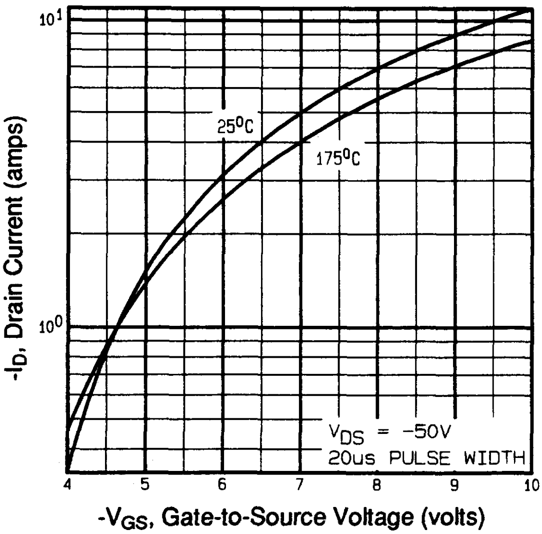


Fig 3. Typical Transfer Characteristics

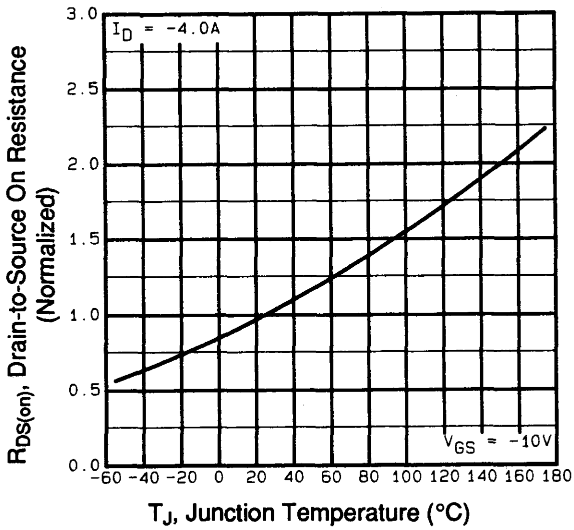


Fig 4. Normalized On-Resistance Vs. Temperature

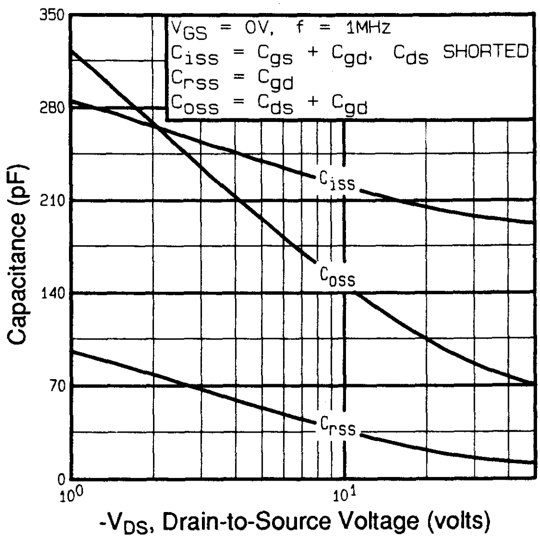


Fig 5. Typical Capacitance Vs. Drain-to-Source Voltage

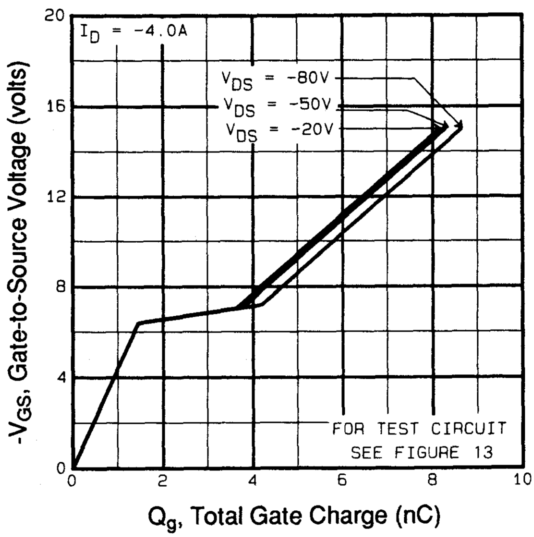


Fig 6. Typical Gate Charge Vs. Gate-to-Source Voltage

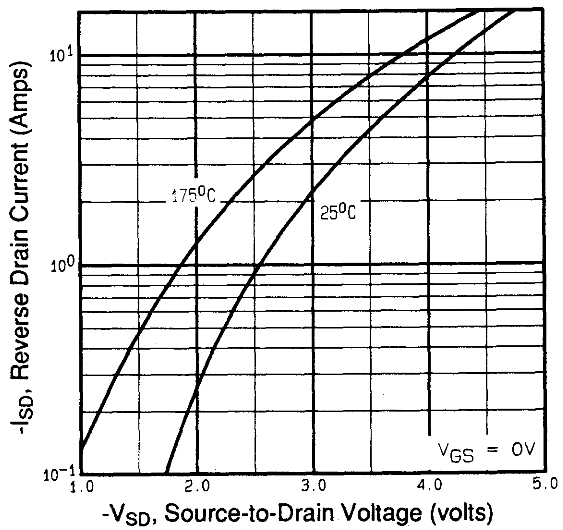


Fig 7. Typical Source-Drain Diode Forward Voltage

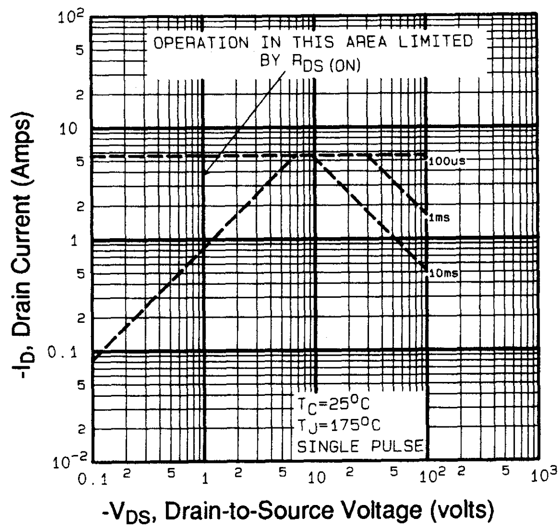


Fig 8. Maximum Safe Operating Area

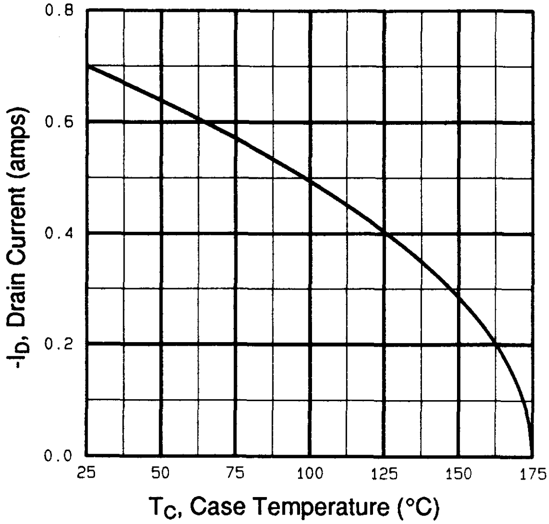


Fig 9. Maximum Drain Current Vs. Case Temperature

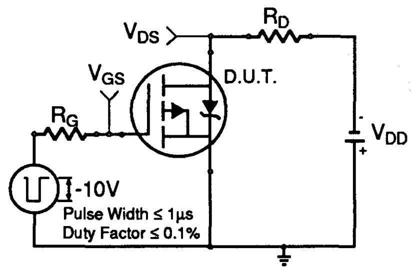


Fig 10a. Switching Time Test Circuit

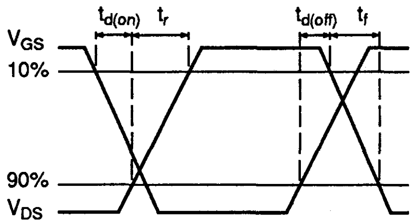


Fig 10b. Switching Time Waveforms

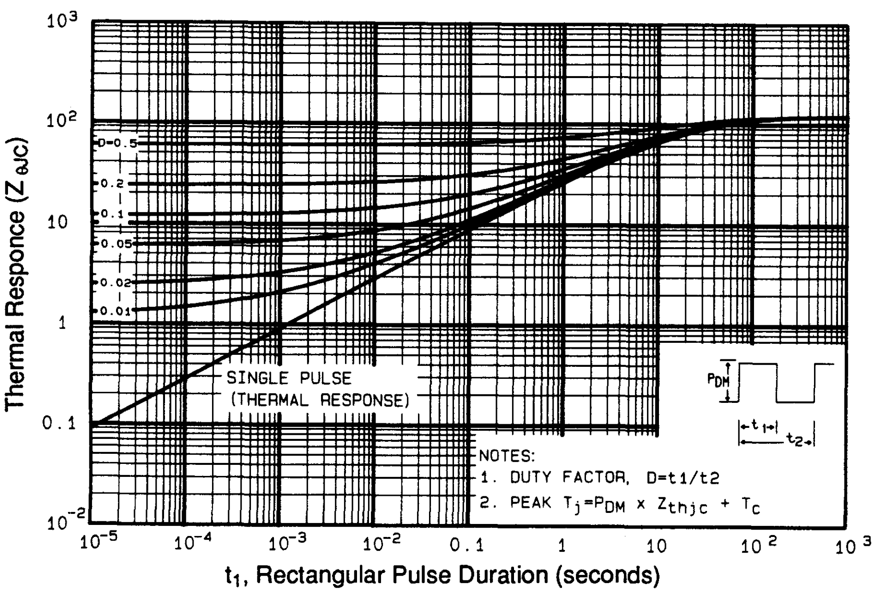


Fig 11. Maximum Effective Transient Thermal Impedance, Junction-to-Case

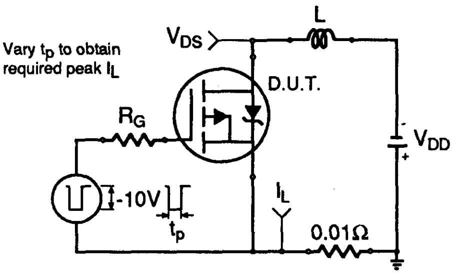


Fig 12a. Unclamped Inductive Test Circuit

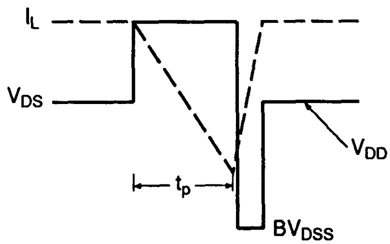


Fig 12b. Unclamped Inductive Waveforms

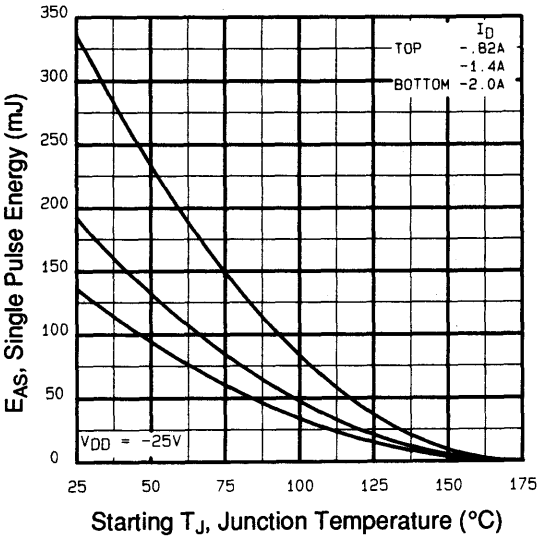


Fig 12c. Maximum Avalanche Energy vs. Drain Current

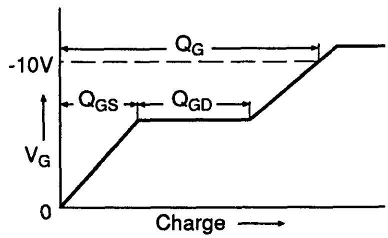


Fig 13a. Basic Gate Charge Waveform

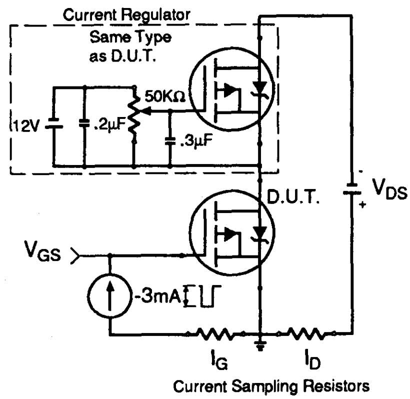


Fig 13b. Gate Charge Test Circuit

Appendix A: Figure 14, Peak Diode Recovery dv/dt Test Circuit

Appendix B: Package Outline Mechanical Drawing

Appendix D: Part Marking Information

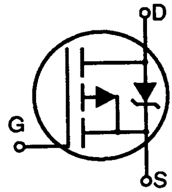
International
IOR Rectifier

International
IOR Rectifier

IRFD9120

HEXFET® Power MOSFET

- Repetitive Avalanche Rated
- Dynamic dv/dt Rated
- For Automatic Insertion
- End Stackable
- P-Channel



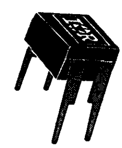
p-channel

BV_{DSS} -100V
$R_{DS(on)}$ 0.60Ω
I_D -1.0A

Description

Third Generation HEXFETs from International Rectifier provide the designer with the best combination of fast switching speed, ruggedized device design, and low on resistance.

The 4-pin DIP package is a low cost machine insertable case style which can be stacked in multiple combinations on standard 0.1 inch pin centers. The dual drain pin serves as a thermal link to the mounting surface for power dissipation levels up to 1 watt.


HD-1

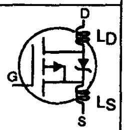
Absolute Maximum Ratings

	Parameter	Max.	Units
I_D @ T_C = 25°C	Continuous Drain Current, V_{GS}@-10V	-1.0	A
I_D @ T_C = 100°C	Continuous Drain Current, V_{GS}@-10V	-0.70	
I_{DM}	Pulsed Drain Current ①	-8.0	
P_D@ T_C = 25°C	Maximum Power Dissipation	1.25	W
	Linear Derating Factor	0.0083	W/K⑥
V_{GS}	Gate-to-Source Breakdown Voltage	±20	V
E_{AS}	Single Pulse Avalanche Energy ②	140	mJ
I_{AR}	Avalanche Current ①	-1.0	A
E_{AR}	Repetitive Avalanche Energy ①	0.13	mJ
dv/dt	Peak Diode Recovery dv/dt ③	-5.5	V/ns
T_J T_{STG}	Operating Junction and Storage Temperature Range	-55 to +175	°C
	Soldering Temperature, for 10 sec.	300 (0.063 in. (1.6mm) from case)	

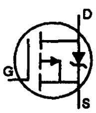
Thermal Resistance

	Parameter	Max.	Units
$R_{\theta JA}$	Junction-to-Ambient, Typical Socket Mount	120	K/W⑥

Electrical Characteristics @ T_J = 25°C (unless otherwise specified)

	Parameter	Min.	Typ.	Max.	Units	Test Conditions
BV_{DSS}	Drain-to-Source Breakdown Voltage	-100	---	---	V	V_{GS}=0V, I_D=-250μA
$\Delta BV_{DSS}/\Delta T_J$	Temp. Coefficient of Breakdown Voltage	---	0.10	---	V/°C	Reference to 25°C, I_D=-1mA
$R_{DS(on)}$	Static Drain-to-Source On Resistance	---	---	0.60	Ω	V_{GS}=-10V, I_D =-0.60A④
$V_{GS(th)}$	Gate Threshold Voltage	-2.0	---	-4.0	V	V_{DS}=V_{GS}, I_D=-250μA
g_{fs}	Forward Transconductance	0.71	---	---	S	V_{DS}=-50V, I_{DS}=-0.60A④
I_{DSS}	Zero Gate Voltage Collector Current	---	---	-250	μA	V_{DS}=-100V, V_{GS}=0V
		---	---	-1000		V_{DS}=-80V, V_{GS}=0V,T_J=150°C
I_{GSS}	Gate-to-Source Forward Leakage	---	---	-500	nA	V_{GS}=-20V
	Gate-to-Source Reverse Leakage	---	---	500		V_{GS}=20V
Q_g	Total Gate Charge	---	---	18	nC	I_D=-6.8A, V_{DS}=-80V, V_{GS}=-10V See Fig 6 and 13④
Q_{gs}	Gate-to-Source Charge	---	---	3.0		
Q_{gd}	Gate-to-Drain ("Miller") Charge	---	---	9.0		
$t_{d(on)}$	Turn-On Delay Time	---	9.6	---	ns	V_{DD}=-50V, I_D=-6.8A R_G=18Ω, R_D=7.1Ω See Fig. 10④
t_r	Rise Time	---	29	---		
$t_{d(off)}$	Turn-Off Delay Time	---	21	---		
t_f	Fall Time	---	25	---		
L_D	Internal Drain Inductance	---	4.0	---	nH	Between lead, 6mm (0.25in.) from package, and center of die contact. 
L_S	Internal Source Inductance	---	6.0	---		
C_{iss}	Input Capacitance	---	390	---	pF	V_{GS}=0V, V_{DS}=-25v f=1.0Mhz See Fig. 5
C_{oss}	Output Capacitance	---	170	---		
C_{rss}	Reverse Transfer Capacitance	---	45	---		

Source-Drain Diode Ratings and Characteristics

	Parameter	Min.	Typ.	Max.	Units	Test Conditions
I_S	Continuous Source Current (Body Diode)	---	---	-1.0	A	MOSFET symbol showing the integral reverse p-n junction diode. 
I_{SM}	Pulsed Source Current (Body Diode) ①	---	---	-8.0		
V_{SD}	Diode Forward Voltage	---	---	-6.3	V	T_J=25°C, I_S=-1.0A, V_{GS}=0V④
t_{rr}	Reverse Recovery Time	49	---	200	ns	T_J=25°C, I_F=-6.8A, di/dt=100A/μS④
Q_{RR}	Reverse Recovery Charge	0.17	---	0.66	μC	
t_{on}	Forward Turn-On Time	Intrinsic turn-on time is negligible (turn-on is dominated by L_S + L_D)				

Notes:

① Repetitive rating; Pulse width limited by max. junction temperature (See figure 11)

② V_{DD}=-25V, Starting T_J=25°C, L=55mH, R_G=25Ω, Peak I_{AS}=-2.0A (See figure 12)

③ I_{SD}≤-6.8A, di/dt≤-110A/μs, V_{DD}≤BV_{DSS}, T_J≤175°C Suggested R_G=18Ω

④ Pulse width ≤ 300μs; duty Cycle ≤2%

⑤ Mounting surface: flat, smooth, greased

⑥ K/W = °C/W

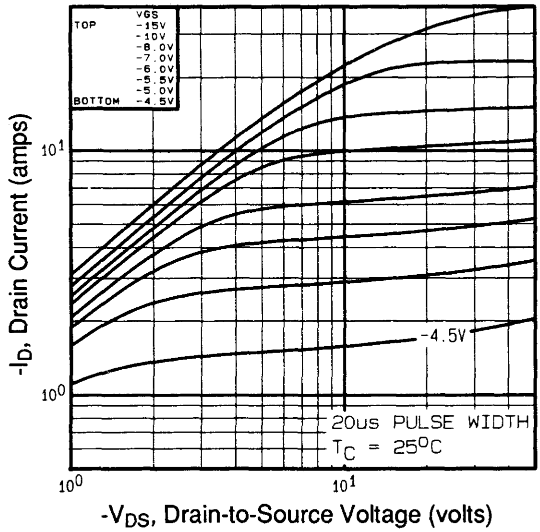


Fig 1. Typical Output Characteristics, $T_C = 25°C$

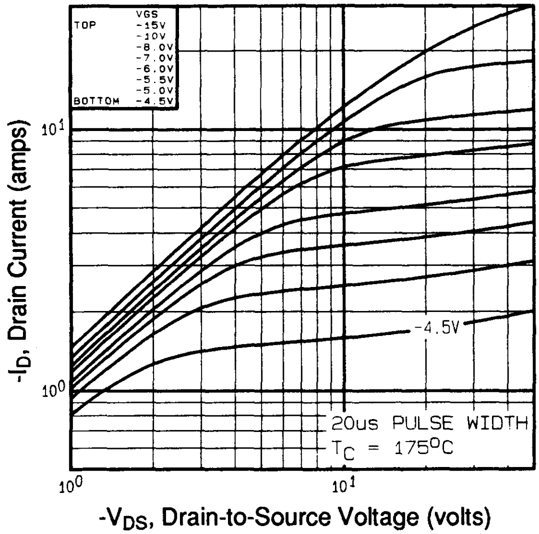


Fig 2. Typical Output Characteristics, $T_C = 150°C$

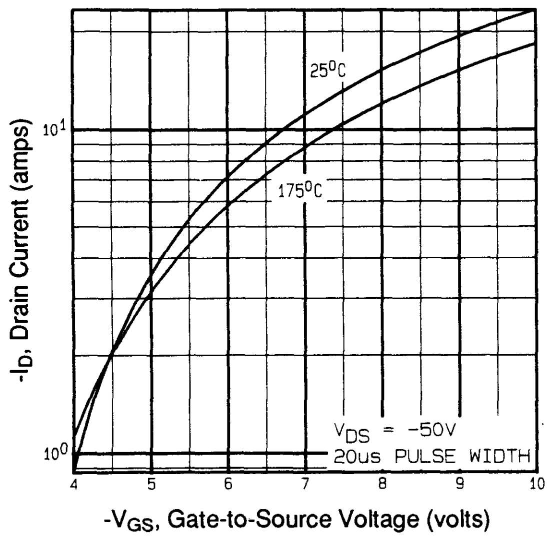


Fig 3. Typical Transfer Characteristics

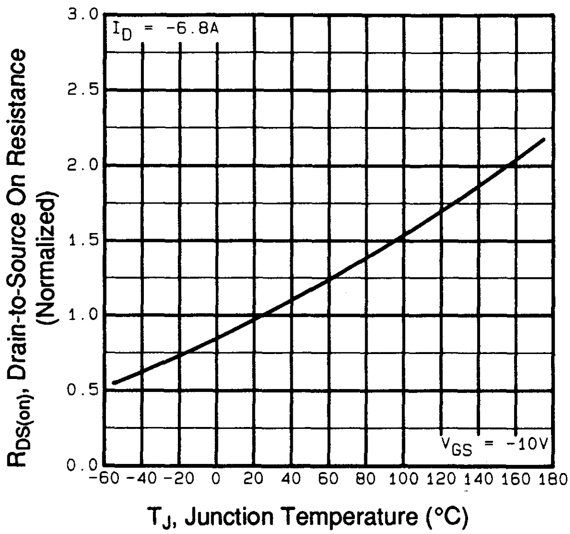


Fig 4. Normalized On-Resistance Vs. Temperature

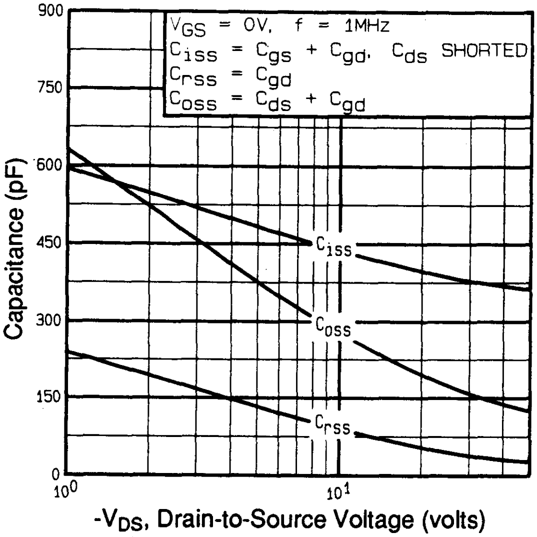


Fig 5. Typical Capacitance Vs. Drain-to-Source Voltage

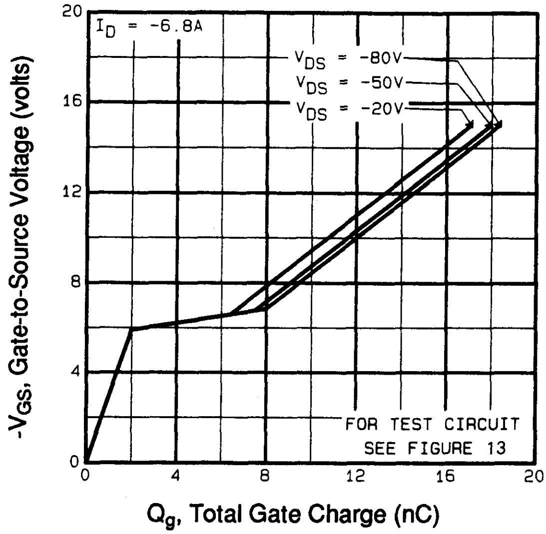


Fig 6. Typical Gate Charge Vs. Gate-to-Source Voltage

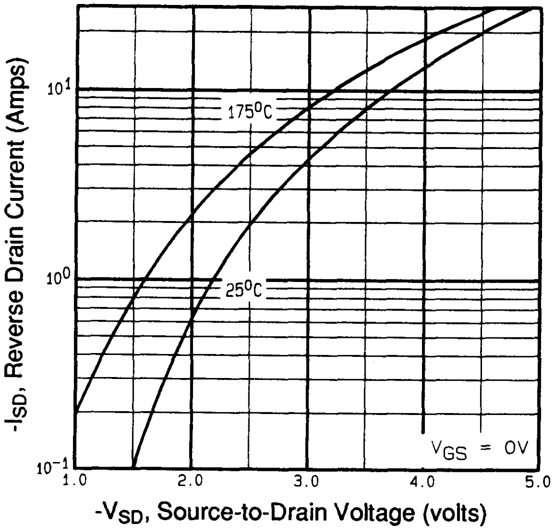


Fig 7. Typical Source-Drain Diode Forward Voltage

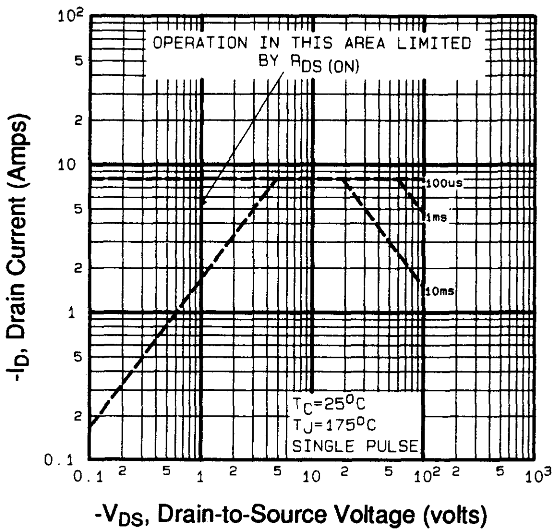


Fig 8. Maximum Safe Operating Area

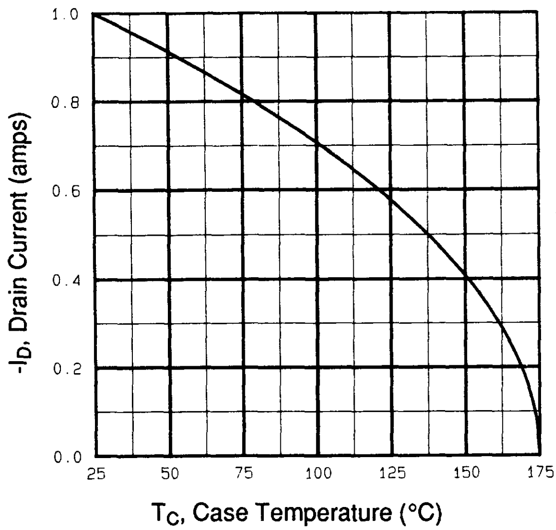


Fig 9. Maximum Drain Current Vs. Case Temperature

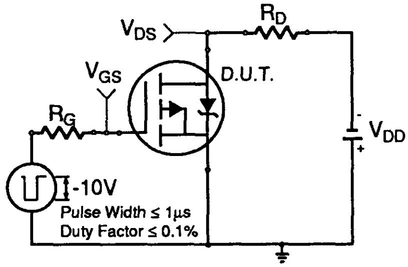


Fig 10a. Switching Time Test Circuit

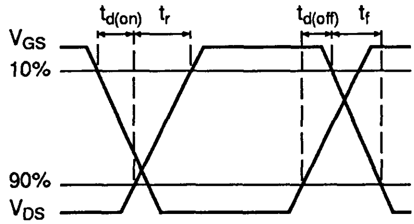


Fig 10b. Switching Time Waveforms

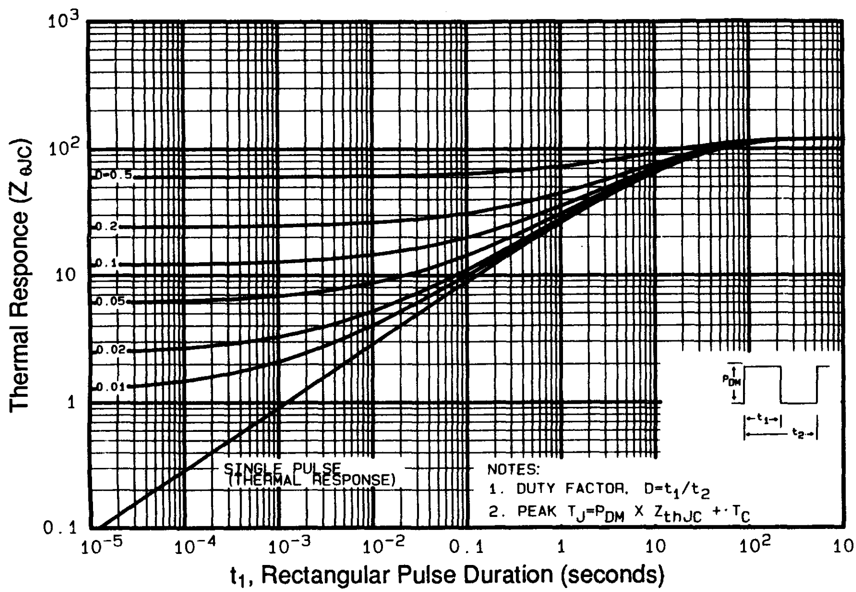


Fig 11. Maximum Effective Transient Thermal Impedance, Junction-to-Case

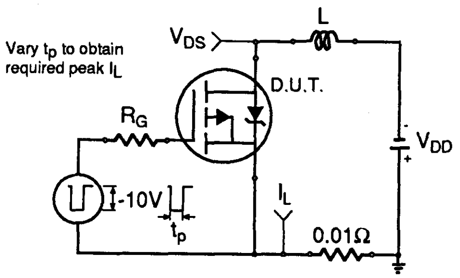


Fig 12a. Unclamped Inductive Test Circuit

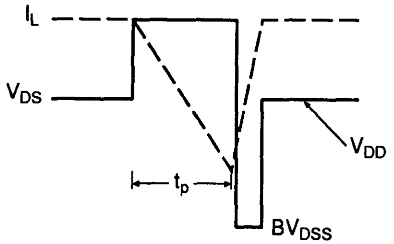


Fig 12b. Unclamped Inductive Waveforms

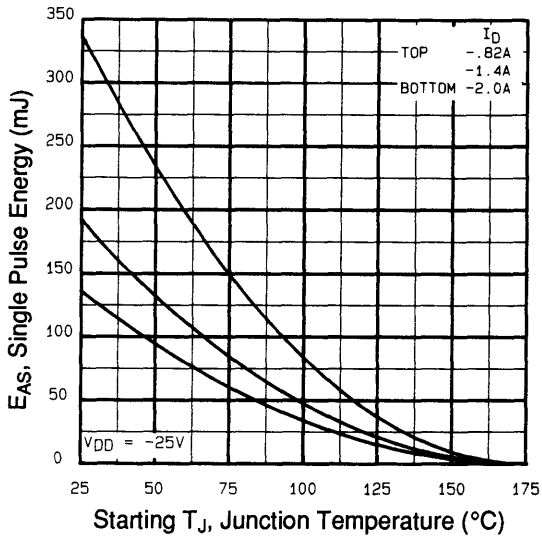


Fig 12c. Maximum Avalanche Energy vs. Drain Current

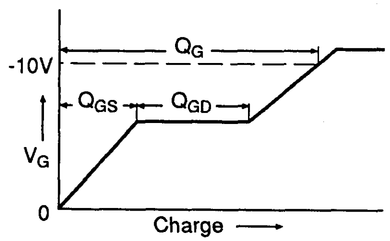


Fig 13a. Basic Gate Charge Waveform

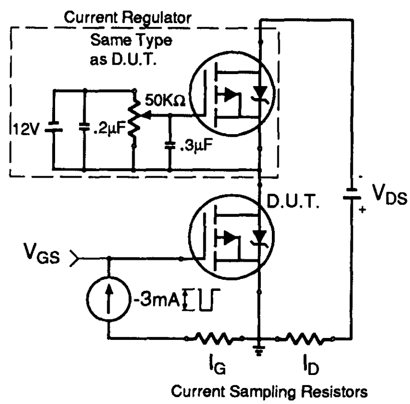


Fig 13b. Gate Charge Test Circuit

Appendix A: Figure 14, Peak Diode Recovery dv/dt Test Circuit

Appendix B: Package Outline Mechanical Drawing

Appendix D: Part Marking Information

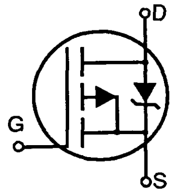
International IOR Rectifier

International Rectifier

IRFD9210

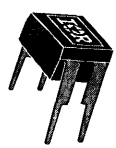
HEXFET® Power MOSFET

- Repetitive Avalanche Rated
- Dynamic dv/dt Rated
- For Automatic Insertion
- End Stackable
- P-Channel



p-channel

BV_{DSS} -200V
$R_{DS(on)}$ 3.0Ω
I_D -0.4A


HD-1

Description

Third Generation HEXFETs from International Rectifier provide the designer with the best combination of fast switching speed, ruggedized device design, and low on resistance.

The 4-pin DIP package is a low cost machine insertable case style which can be stacked in multiple combinations on standard 0.1 inch pin centers. The dual drain pin serves as a thermal link to the mounting surface for power dissipation levels up to 1 watt.

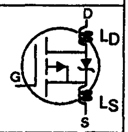
Absolute Maximum Ratings

	Parameter	Max.	Units
I_D @ T_C = 25°C	Continuous Drain Current, V_{GS}@-10V	-0.40	A
I_D @ T_C = 100°C	Continuous Drain Current, V_{GS}@-10V	-0.26	
I_{DM}	Pulsed Drain Current ①	-3.2	
P_D@ T_C = 25°C	Maximum Power Dissipation	1.0	W
	Linear Derating Factor	0.0083	W/K⑥
V_{GS}	Gate-to-Source Breakdown Voltage	±20	V
E_{AS}	Single Pulse Avalanche Energy ②	59	mJ
I_{AR}	Avalanche Current ①	-0.40	A
E_{AR}	Repetitive Avalanche Energy ①	0.10	mJ
dv/dt	Peak Diode Recovery dv/dt ③	-5.0	V/ns
T_J T_{STG}	Operating Junction and Storage Temperature Range	-55 to +150	°C
	Soldering Temperature, for 10 sec.	300 (0.063 in. (1.6mm) from case)	

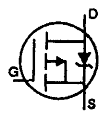
Thermal Resistance

	Parameter	Max.	Units
$R_{\theta JA}$	Junction-to-Ambient, Typical Socket Mount	120	K/W⑥

Electrical Characteristics @ T_J = 25°C (unless otherwise specified)

	Parameter	Min.	Typ.	Max.	Units	Test Conditions
BV_{DSS}	Drain-to-Source Breakdown Voltage	-200	---	---	V	V_{GS}=0V, I_D=-250µA
$\Delta BV_{DSS}/\Delta T_J$	Temp. Coefficient of Breakdown Voltage	---	n/a	---	V/°C	Reference to 25°C, I_D=-1mA
$R_{DS(on)}$	Static Drain-to-Source On Resistance	---	---	3.0	Ω	V_{GS}=-10V, I_D =-0.24A④
$V_{GS(th)}$	Gate Threshold Voltage	-2.0	---	-4.0	V	V_{DS}=V_{GS}, I_D=-250µA
g_{fs}	Forward Transconductance	n/a	---	---	S	V_{DS}=-50V, I_{DS}=-0.24A④
I_{DSS}	Zero Gate Voltage Collector Current	---	---	-250	µA	V_{DS}=-200V, V_{GS}=0V
		---	---	-1000		V_{DS}=-160V, V_{GS}=0V, T_J=125°C
I_{GSS}	Gate-to-Source Forward Leakage	---	---	-500	nA	V_{GS}=-20V
	Gate-to-Source Reverse Leakage	---	---	500		V_{GS}=20V
Q_g	Total Gate Charge	---	---	6.0	nC	I_D=-2.4A, V_{DS}=-160V, V_{GS}=-10V④
Q_{gs}	Gate-to-Source Charge	---	---	1.2		
Q_{gd}	Gate-to-Drain ("Miller") Charge	---	---	3.6		
$t_{d(on)}$	Turn-On Delay Time	---	8	---	ns	V_{DD}=-100V, I_D=-2.4A R_G=24Ω, R_D=42Ω④
t_r	Rise Time	---	15	---		
$t_{d(off)}$	Turn-Off Delay Time	---	10	---		
t_f	Fall Time	---	8	---		
L_D	Internal Drain Inductance	---	4.0	---	nH	Between lead, 6mm (0.25in.) from package, and center of die contact. 
L_S	Internal Source Inductance	---	6.0	---		
C_{iss}	Input Capacitance	---	160	---	pF	V_{GS}=0V, V_{DS}=-25v f=1.0Mhz
C_{oss}	Output Capacitance	---	50	---		
C_{rss}	Reverse Transfer Capacitance	---	12	---		

Source-Drain Diode Ratings and Characteristics

	Parameter	Min.	Typ.	Max.	Units	Test Conditions
I_S	Continuous Source Current (Body Diode)	---	---	-0.4	A	MOSFET symbol showing the integral reverse p-n junction diode. 
I_{SM}	Pulsed Source Current (Body Diode) ①	---	---	-3.2		
V_{SD}	Diode Forward Voltage	---	---	-5.8	V	T_J=25°C, I_S=-0.4A, V_{GS}=0V④
t_{rr}	Reverse Recovery Time	n/a	---	n/a	ns	T_J=25°C, I_F=-2.4A, di/dt=-100A/µS④
Q_{RR}	Reverse Recovery Charge	n/a	---	n/a	µC	
t_{on}	Forward Turn-On Time	Intrinsic turn-on time is negligible (turn-on is dominated by L_S + L_D)				

Notes:

① Repetitive rating; Pulse width limited by max. junction temperature

② V_{DD}=-50V, Starting T_J=25°C, L=140mH, R_G=25Ω, Peak I_{AS}=-0.8A

③ I_{SD}≤-2.4A, di/dt≤-90A/µs, V_{DD}≤BV_{DSS}, T_J≤150°C Suggested R_G=24Ω

④ Pulse width ≤ 300µs; duty Cycle ≤2%

⑤ Mounting surface: flat, smooth, greased

⑥ K/W = °C/W

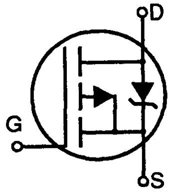
Target Data Sheet: Specification Pending; Contact Factory for Update

International IOR Rectifier

IRFD9220

HEXFET® Power MOSFET

- Repetitive Avalanche Rated
- Dynamic dv/dt Rated
- For Automatic Insertion
- End Stackable
- P-Channel



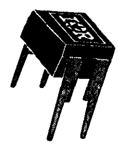
p-channel

BV_{DSS}	-200V
$R_{DS(on)}$	1.5Ω
I_D	-0.58A

Description

Third Generation HEXFETs from International Rectifier provide the designer with the best combination of fast switching speed, ruggedized device design, and low on resistance.

The 4-pin DIP package is a low cost machine insertable case style which can be stacked in multiple combinations on standard 0.1 inch pin centers. The dual drain pin serves as a thermal link to the mounting surface for power dissipation levels up to 1 watt.


HD-1

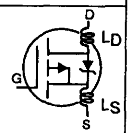
Absolute Maximum Ratings

	Parameter	Max.	Units
I_D @ T_C = 25°C	Continuous Drain Current, V_{GS}@-10V	-0.58	A
I_D @ T_C = 100°C	Continuous Drain Current, V_{GS}@-10V	-0.36	
I_{DM}	Pulsed Drain Current ①	-4.6	
P_D@ T_C = 25°C	Maximum Power Dissipation	1.0	W
	Linear Derating Factor	0.0083	W/K⑥
V_{GS}	Gate-to-Source Breakdown Voltage	±20	V
E_{AS}	Single Pulse Avalanche Energy ②	39	mJ
I_{AR}	Avalanche Current ①	-0.58	A
E_{AR}	Repetitive Avalanche Energy ①	0.10	mJ
dv/dt	Peak Diode Recovery dv/dt ③	-5.0	V/ns
T_J, T_{STG}	Operating Junction and Storage Temperature Range	-55 to +150	°C
	Soldering Temperature, for 10 sec.	300 (0.063 in. (1.6mm) from case)	

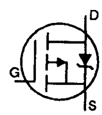
Thermal Resistance

	Parameter	Max.	Units
$R_{\theta JA}$	Junction-to-Ambient, Typical Socket Mount	120	K/W⑥

Electrical Characteristics @ T_J = 25°C (unless otherwise specified)

	Parameter	Min.	Typ.	Max.	Units	Test Conditions
BV_{DSS}	Drain-to-Source Breakdown Voltage	-200	---	---	V	V_{GS}=0V, I_D=-250μA
$\Delta BV_{DSS}/\Delta T_J$	Temp. Coefficient of Breakdown Voltage	---	n/a	---	V/°C	Reference to 25°C, I_D=-1mA
$R_{DS(on)}$	Static Drain-to-Source On Resistance	---	---	1.5	Ω	V_{GS}=-10V, I_D =-0.35A④
$V_{GS(th)}$	Gate Threshold Voltage	-2.0	---	-4.0	V	V_{DS}=V_{GS}, I_D=-250μA
g_{fs}	Forward Transconductance	n/a	---	---	S	V_{DS}=-25V, I_{DS}=-0.35A④
I_{DSS}	Zero Gate Voltage Collector Current	---	---	-250	μA	V_{DS}=-200V, V_{GS}=0V
		---	---	-1000		V_{DS}=-160V, V_{GS}=0V,T_J=125°C
IGSS	Gate-to-Source Forward Leakage	---	---	-500	nA	V_{GS}=-20V
	Gate-to-Source Reverse Leakage	---	---	500		V_{GS}=20V
Q_g	Total Gate Charge	---	---	13	nC	I_D=-4.0A, V_{DS}=-160V, V_{GS}=-10V④
Q_{gs}	Gate-to-Source Charge	---	---	2.4		
Q_{gd}	Gate-to-Drain ("Miller") Charge	---	---	7.6		
$t_{d(on)}$	Turn-On Delay Time	---	20	---	ns	V_{DD}=-100V, I_D=-4.0A R_G=18Ω, R_D=25Ω④
t_r	Rise Time	---	30	---		
$t_{d(off)}$	Turn-Off Delay Time	---	25	---		
t_f	Fall Time	---	20	---		
L_D	Internal Drain Inductance	---	4.0	---	nH	Between lead, 6mm (0.25in.) from package, and center of die contact. 
L_S	Internal Source Inductance	---	6.0	---		
C_{iss}	Input Capacitance	---	340	---	pF	V_{GS}=0V, V_{DS}=-25v *f*=1.0Mhz
C_{oss}	Output Capacitance	---	105	---		
C_{rss}	Reverse Transfer Capacitance	---	25	---		

Source-Drain Diode Ratings and Characteristics

	Parameter	Min.	Typ.	Max.	Units	Test Conditions
I_S	Continuous Source Current (Body Diode)	---	---	-0.58	A	MOSFET symbol showing the integral reverse p-n junction diode. 
I_{SM}	Pulsed Source Current (Body Diode) ①	---	---	-4.6		
V_{SD}	Diode Forward Voltage	---	---	-6.3	V	T_J=25°C, I_S=-0.6A, V_{GS}=0V④
t_{rr}	Reverse Recovery Time	n/a	---	n/a	ns	T_J=25°C, I_F=-4.0A, di/dt=-100A/μS④
Q_{RR}	Reverse Recovery Charge	n/a	---	n/a	μC	
t_{on}	Forward Turn-On Time	Intrinsic turn-on time is negligible (turn-on is dominated by L_S + L_D)				

Notes:

① Repetitive rating; Pulse width limited by max. junction temperature

② V_{DD}=-50V, Starting T_J=25°C, L=41mH, R_G=25Ω, Peak I_{AS}=-1.2A

③ I_{SD}≤-4.0A, di/dt≤-90A/μs, V_{DD}≤BV_{DSS}, T_J≤150°C Suggested R_G=24Ω

④ Pulse width ≤ 300μs; duty Cycle ≤2%

⑤ Mounting surface: flat, smooth, greased

⑥ K/W = °C/W

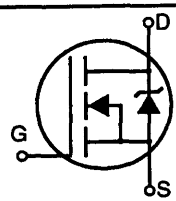
Target Data Sheet: Specification Pending; Contact Factory for Update

International IOR Rectifier

IRFR014
IRFU014

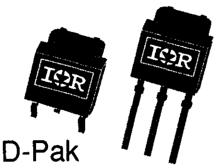
HEXFET® Power MOSFET

- Surface Mount (IRFR014)
- Straight Lead (IRFU014)
- Dynamic dv/dt Rated



n-channel

BV_{DSS}	60V
$R_{DS(on)}$	0.20Ω
I_D	8.4A



D-Pak TO-252AA
I-Pak TO-251AA

Description

Third Generation HEXFETs from International Rectifier provide the designer with the best combination of fast switching speed, ruggedized device design, and low on resistance.

The D-Pak is designed for surface mounting using vapor phase, infra red, or wave soldering techniques. The straight lead version (IRFU series) is for through hole mounting applications. Power dissipation levels up to 2 watts are possible in SMD applications.

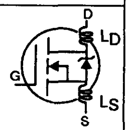
Absolute Maximum Ratings

	Parameter	Max.	Units
I_D @ T_C = 25°C	Continuous Drain Current, V_{GS}@10V	8.4	A
I_D @ T_C = 100°C	Continuous Drain Current, V_{GS}@10V	6.0	
I_{DM}	Pulsed Drain Current ①	34	
P_D@ T_C = 25°C	Maximum Power Dissipation	30	W
	Linear Derating Factor	0.20	W/K⑥
V_{GS}	Gate-to-Source Breakdown Voltage	±20	V
E_{AS}	Single Pulse Avalanche Energy ②	47	mJ
dv/dt	Peak Diode Recovery dv/dt ③	4.5	V/ns
T_J	Operating Junction and Storage Temperature Range	-55 to +175	°C
	Soldering Temperature, for 10 sec.	300 (0.063 in. (1.6mm) from case)	

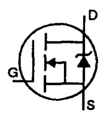
Thermal Resistance

	Parameter	Min.	Typ.	Max.	Units
$R_{\theta JC}$	Junction-to-Case	---	---	5.0	K/W⑥
$R_{\theta CS}$	Case-to-Sink ⑤	---	1.7	---	
$R_{\theta JA}$	Junction-to-Ambient, Typical Socket Mount	---	---	110	

Electrical Characteristics @ $T_J = 25°C$ (unless otherwise specified)

	Parameter	Min.	Typ.	Max.	Units	Test Conditions
BV_{DSS}	Drain-to-Source Breakdown Voltage	60	---	---	V	V_{GS}=0V, I_D=250μA
$\Delta BV_{DSS}/\Delta T_J$	Temp. Coefficient of Breakdown Voltage	---	0.63	---	V/°C	Reference to 25°C, I_D=1mA
$R_{DS(on)}$	Static Drain-to-Source On Resistance	---	---	0.20	Ω	V_{GS}=10V, I_D =5.0A④
$V_{GS(th)}$	Gate Threshold Voltage	2.0	---	4.0	V	V_{DS}=V_{GS}, I_D=250μA
g_{fs}	Forward Transconductance	2.4	---	---	S	V_{DS}=25V, I_{DS}=5.0A④
I_{DSS}	Zero Gate Voltage Collector Current	---	---	250	μA	V_{DS}=60V, V_{GS}=0V
		---	---	1000		V_{DS}=48V, V_{GS}=0V,T_J=150°C
I_{GSS}	Gate-to-Source Forward Leakage	---	---	500	nA	V_{GS}=20V
	Gate-to-Source Reverse Leakage	---	---	-500		V_{GS}=-20V
Q_g	Total Gate Charge	---	---	11	nC	I_D=10A, V_{DS}=48V, V_{GS}=10V See Fig 6 and 13④
Q_{gs}	Gate-to-Source Charge	---	---	3.1		
Q_{gd}	Gate-to-Drain ("Miller") Charge	---	---	5.8		
$t_{d(on)}$	Turn-On Delay Time	---	10	---	ns	V_{DD}=30V, I_D=10A R_G=24Ω, R_D=2.7Ω See Fig. 10④
t_r	Rise Time	---	50	---		
$t_{d(off)}$	Turn-Off Delay Time	---	13	---		
t_f	Fall Time	---	19	---		
L_D	Internal Drain Inductance	---	4.5	---	nH	Between lead, 6mm (0.25in.) from package, and center of die contact. 
L_S	Internal Source Inductance	---	7.5	---		
C_{iss}	Input Capacitance	---	300	---	pF	V_{GS}=0V, V_{DS}=2 f=1.0Mhz See Fig. 5
C_{oss}	Output Capacitance	---	160	---		
C_{rss}	Reverse Transfer Capacitance	---	29	---		

Source-Drain Diode Ratings and Characteristics

	Parameter	Min.	Typ.	Max.	Units	Test Conditions
I_S	Continuous Source Current (Body Diode)	---	---	8.4	A	MOSFET symbol showing the integral reverse p-n junction diode. 
I_{SM}	Pulsed Source Current (Body Diode) ①	---	---	34		
V_{SD}	Diode Forward Voltage	---	---	1.6	V	T_J=25°C, I_S=8.4A, V_{GS}=0V④
t_{rr}	Reverse Recovery Time	34	---	140	ns	T_J=25°C, I_F=10A, di/dt=100A/μS④
Q_{RR}	Reverse Recovery Charge	0.090	---	0.40	μC	
t_{on}	Forward Turn-On Time	Intrinsic turn-on time is negligible (turn-on is dominated by $L_S + L_D$)				

Notes:

① Repetitive rating; Pulse width limited by max. junction temperature (See figure 11)

② V_{DD}=25V, Starting T_J=25°C, L=850μH, R_G=25Ω, Peak I_{AS}=8.4A (See figure 12)

③ I_{SD}≤8.4A, di/dt≤90A/μs, V_{DD}≤BV_{DSS}, T_J≤175°C Suggested R_G=24Ω

④ Pulse width ≤ 300μs; duty Cycle ≤2%

⑤ Mounting surface: flat, smooth, greased

⑥ K/W = °C/W

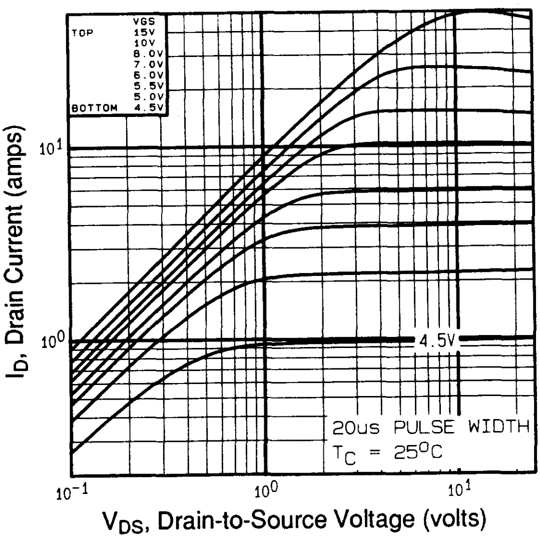


Fig 1. Typical Output Characteristics, $T_C = 25°C$

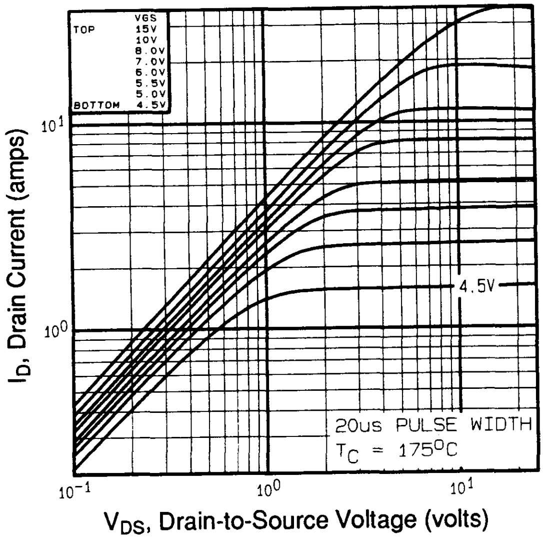


Fig 2. Typical Output Characteristics, $T_C = 150°C$

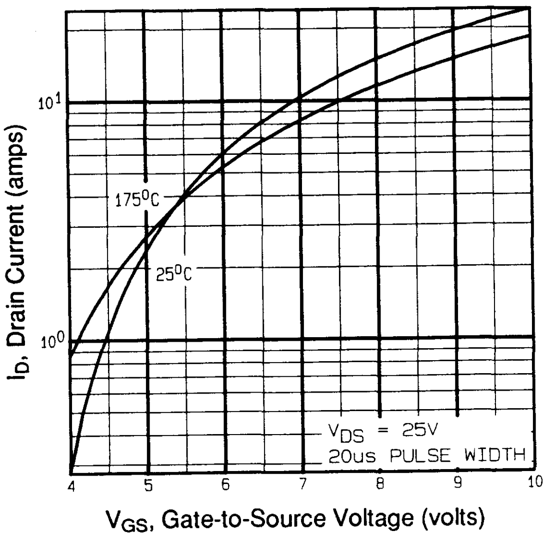


Fig 3. Typical Transfer Characteristics

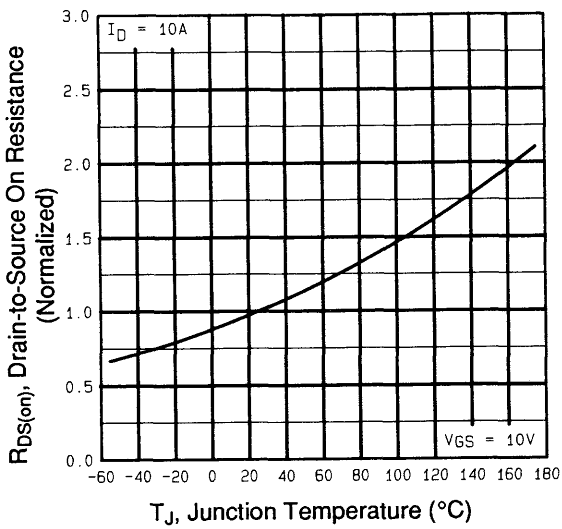


Fig 4. Normalized On-Resistance Vs. Temperature

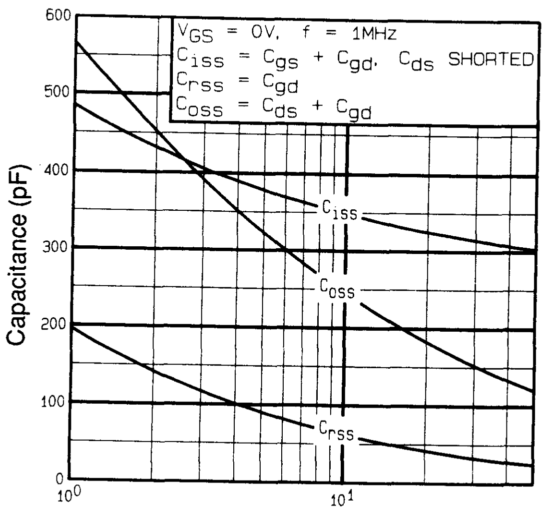


Fig 5. Typical Capacitance Vs. Drain-to-Source Voltage

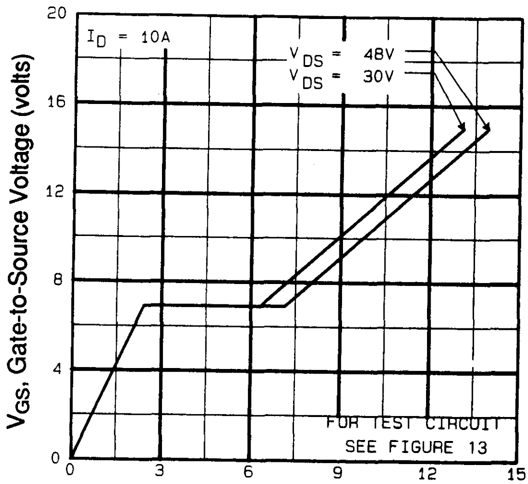


Fig 6. Typical Gate Charge Vs. Gate-to-Source Voltage

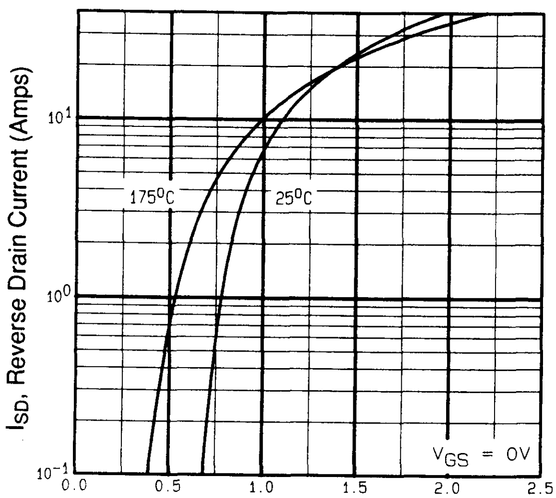


Fig 7. Typical Source-Drain Diode Forward Voltage

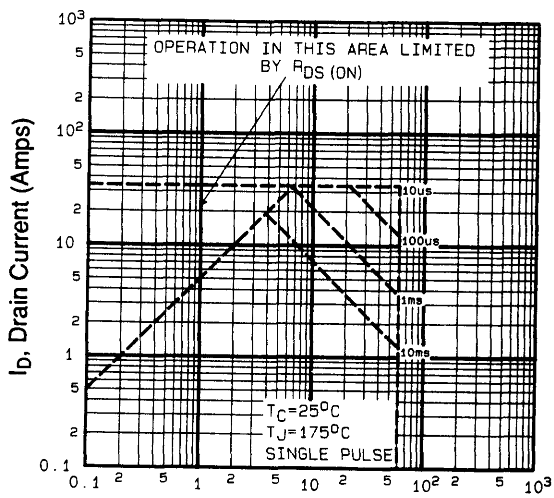


Fig 8. Maximum Safe Operating Area

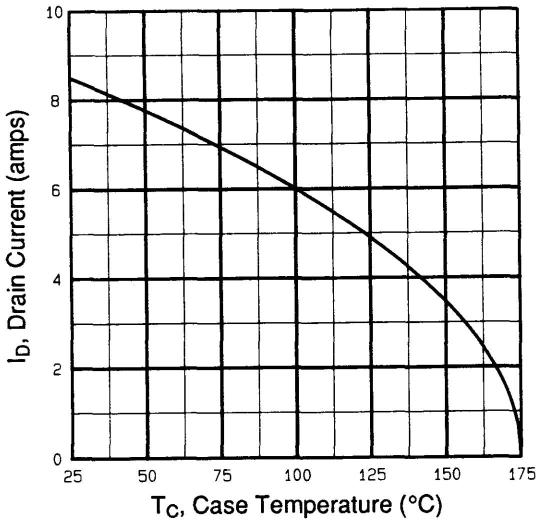


Fig 9. Maximum Drain Current Vs. Case Temperature

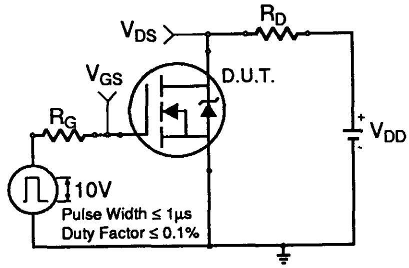


Fig 10a. Switching Time Test Circuit

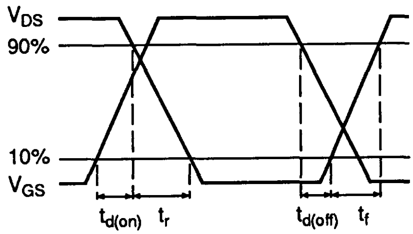


Fig 10b. Switching Time Waveforms

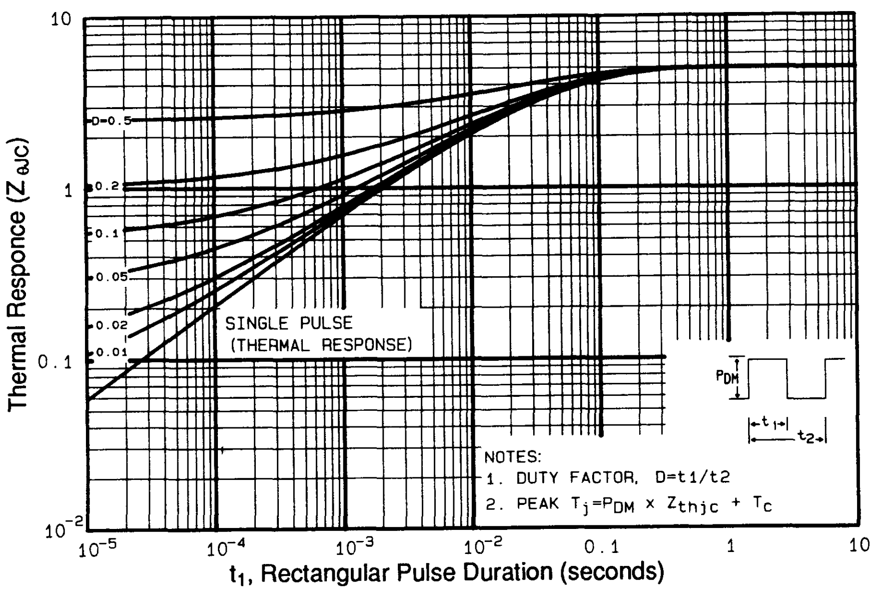


Fig 11. Maximum Effective Transient Thermal Impedance, Junction-to-Case

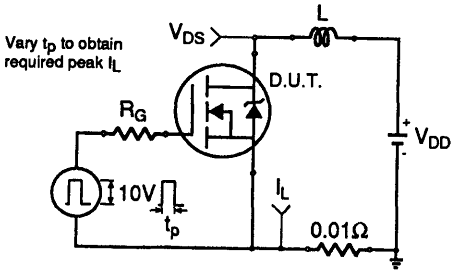


Fig 12a. Unclamped Inductive Test Circuit

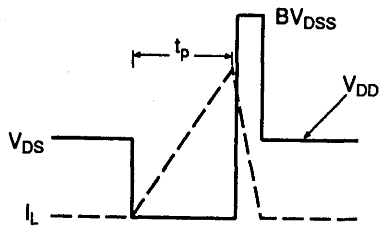


Fig 12b. Unclamped Inductive Waveforms

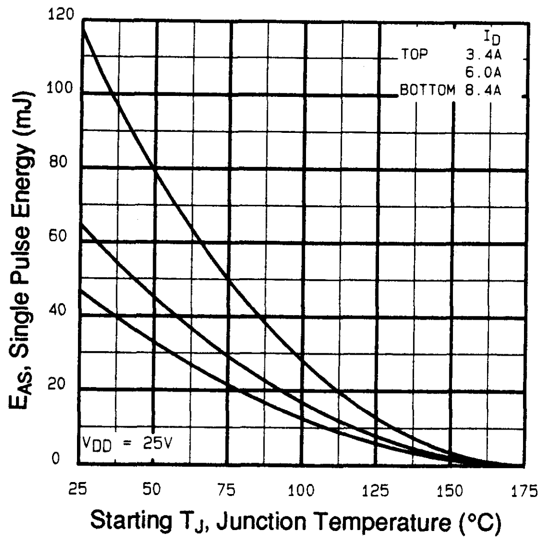


Fig 12c. Maximum Avalanche Energy vs. Drain Current

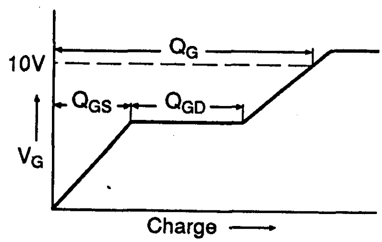


Fig 13a. Basic Gate Charge Waveform

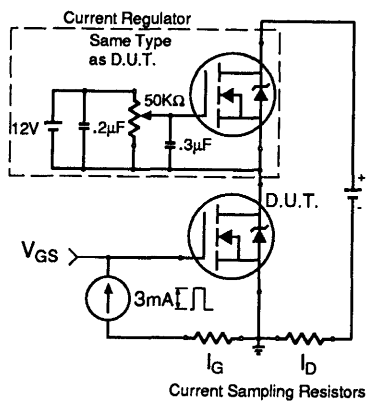


Fig 13b. Gate Charge Test Circuit

Appendix A: Figure 14, Peak Diode Recovery dv/dt Test Circuit

Appendix B: Package Outline Mechanical Drawing

Appendix C: Tape & Reel Information

Appendix D: Part Marking Information

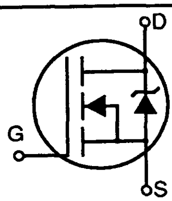
International Rectifier

International
IOR Rectifier

IRFR024
IRFU024

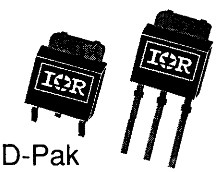
HEXFET® Power MOSFET

- Surface Mount (IRFR024)
- Straight Lead (IRFU024)
- Dynamic dv/dt Rated



n-channel

BV_{DSS}	60V
$R_{DS(on)}$	0.10Ω
I_D	16A


D-Pak
TO-252AA
I-Pak
TO-251AA

Description

Third Generation HEXFETs from International Rectifier provide the designer with the best combination of fast switching speed, ruggedized device design, and low on resistance.

The D-Pak is designed for surface mounting using vapor phase, infra red, or wave soldering techniques. The straight lead version (IRFU series) is for through hole mounting applications. Power dissipation levels up to 2 watts are possible in SMD applications.

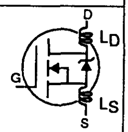
Absolute Maximum Ratings

	Parameter	Max.	Units
I_D @ T_C = 25°C	Continuous Drain Current, V_{GS}@10V	16	A
I_D @ T_C = 100°C	Continuous Drain Current, V_{GS}@10V	11	
I_{DM}	Pulsed Drain Current ①	64	
P_D@ T_C = 25°C	Maximum Power Dissipation	50	W
	Linear Derating Factor	0.33	W/K⑥
V_{GS}	Gate-to-Source Breakdown Voltage	±20	V
E_{AS}	Single Pulse Avalanche Energy ②	91	mJ
dv/dt	Peak Diode Recovery dv/dt ③	5.5	V/ns
T_J	Operating Junction and Storage Temperature Range	-55 to +175	°C
	Soldering Temperature, for 10 sec.	300 (0.063 in. (1.6mm) from case)	

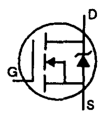
Thermal Resistance

	Parameter	Min.	Typ.	Max.	Units
$R_{\theta JC}$	Junction-to-Case	---	---	3.0	K/W⑥
$R_{\theta CS}$	Case-to-Sink ⑤	---	1.7	---	
$R_{\theta JA}$	Junction-to-Ambient, Typical Socket Mount	---	---	110	

Electrical Characteristics @ $T_J = 25°C$ (unless otherwise specified)

	Parameter	Min.	Typ.	Max.	Units	Test Conditions
BV_{DSS}	Drain-to-Source Breakdown Voltage	60	---	---	V	V_{GS}=0V, I_D=250μA
$\Delta BV_{DSS}/\Delta T_J$	Temp. Coefficient of Breakdown Voltage	---	0.061	---	V/°C	Reference to 25°C, I_D=1mA
$R_{DS(on)}$	Static Drain-to-Source On Resistance	---	---	0.10	Ω	V_{GS}=10V, I_D =9.6A④
$V_{GS(th)}$	Gate Threshold Voltage	2.0	---	4.0	V	V_{DS}=V_{GS}, I_D=250μA
g_{fs}	Forward Transconductance	6.2	---	---	S	V_{DS}=25V, I_{DS}=9.6A④
I_{DSS}	Zero Gate Voltage Collector Current	---	---	250	μA	V_{DS}=60V, V_{GS}=0V
		---	---	1000		V_{DS}=48V, V_{GS}=0V,T_J=150°C
I_{GSS}	Gate-to-Source Forward Leakage	---	---	500	nA	V_{GS}=20V
	Gate-to-Source Reverse Leakage	---	---	-500		V_{GS}=-20V
Q_g	Total Gate Charge	---	---	28	nC	I_D=14A, V_{DS}=48V, V_{GS}=10V
Q_{gs}	Gate-to-Source Charge	---	---	5.4		See Fig 6 and 13④
Q_{gd}	Gate-to-Drain ("Miller") Charge	---	---	13		
$t_{d(on)}$	Turn-On Delay Time	---	8.6	---	ns	V_{DD}=30V, I_D=14A
t_r	Rise Time	---	47	---		R_G=18Ω, R_D=2.0Ω
$t_{d(off)}$	Turn-Off Delay Time	---	27	---		See Fig. 10④
t_f	Fall Time	---	37	---		
L_D	Internal Drain Inductance	---	4.5	---	nH	Between lead, 6mm (0.25in.) from package, and center of die contact. 
L_S	Internal Source Inductance	---	7.5	---		
C_{iss}	Input Capacitance	---	640	---	pF	V_{GS}=0V, V_{DS}=2(See figure 12)
C_{oss}	Output Capacitance	---	360	---		f=1.0Mhz
C_{rss}	Reverse Transfer Capacitance	---	79	---		See Fig. 5

Source-Drain Diode Ratings and Characteristics

	Parameter	Min.	Typ.	Max.	Units	Test Conditions
I_S	Continuous Source Current (Body Diode)	---	---	16	A	MOSFET symbol showing the integral reverse p-n junction diode. 
I_{SM}	Pulsed Source Current (Body Diode) ①	---	---	64		
V_{SD}	Diode Forward Voltage	---	---	1.5	V	T_J=25°C, I_S=16A, V_{GS}=0V④
t_{rr}	Reverse Recovery Time	49	---	200	ns	T_J=25°C, I_F=14A,
Q_{RR}	Reverse Recovery Charge	0.22	---	0.88	μC	di/dt=100A/μS④
t_{on}	Forward Turn-On Time	Intrinsic turn-on time is negligible (turn-on is dominated by $L_S + L_D$)				

Notes:

① Repetitive rating; Pulse width limited by max. junction temperature (See figure 11)

② V_{DD}=25V, Starting T_J=25°C, L=450μH, R_G=25Ω, Peak I_{AS}=16A (See figure 12)

③ I_{SD}≤16A, di/dt≤110A/μs, V_{DD}≤BV_{DSS}, T_J≤175°C Suggested R_G=18Ω

④ Pulse width ≤ 300μs; duty Cycle ≤2%

⑤ Mounting surface: flat, smooth, greased

⑥ K/W = °C/W

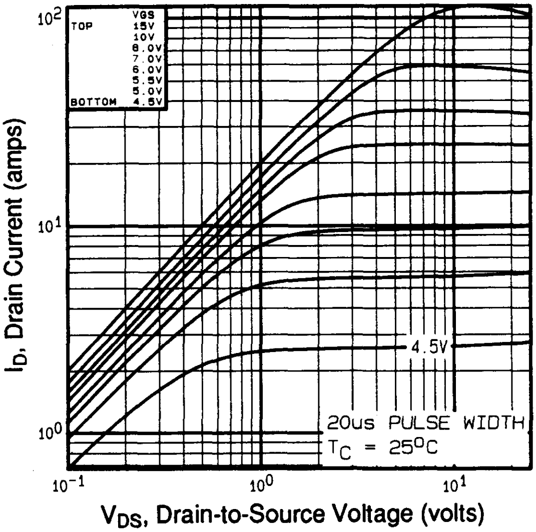


Fig 1. Typical Output Characteristics, $T_C = 25°C$

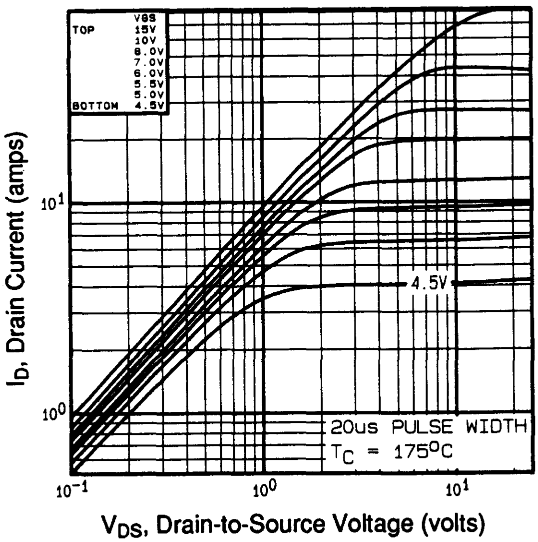


Fig 2. Typical Output Characteristics, $T_C = 150°C$

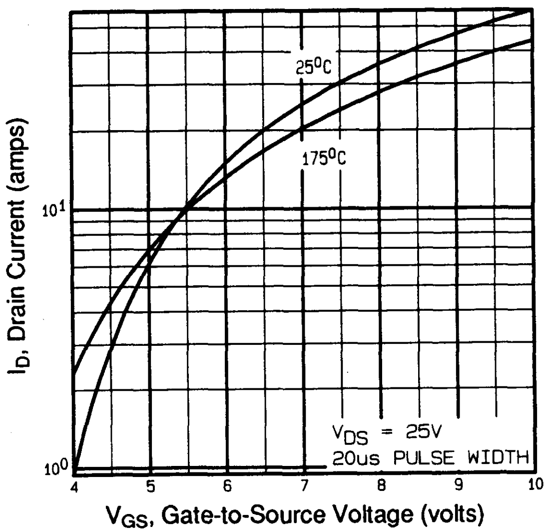


Fig 3. Typical Transfer Characteristics

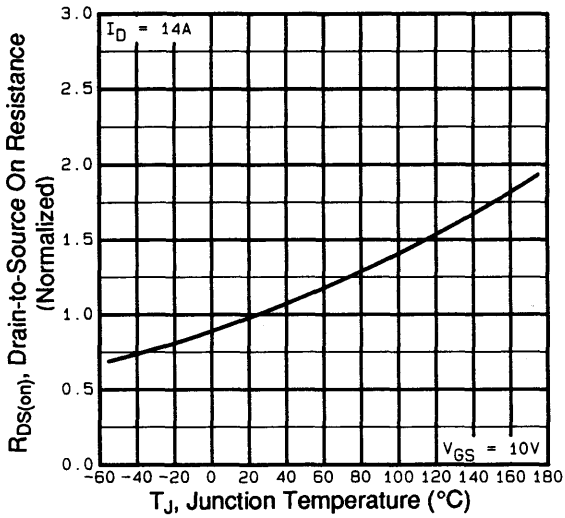


Fig 4. Normalized On-Resistance Vs. Temperature

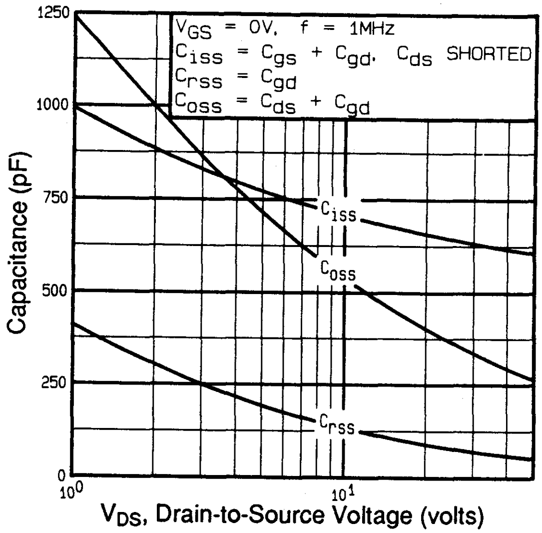


Fig 5. Typical Capacitance Vs. Drain-to-Source Voltage

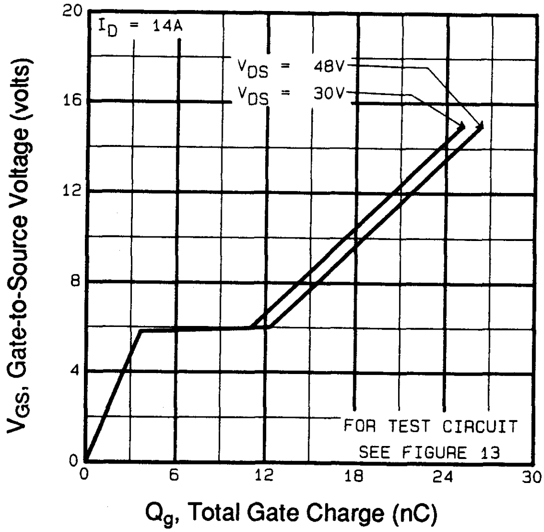


Fig 6. Typical Gate Charge Vs. Gate-to-Source Voltage

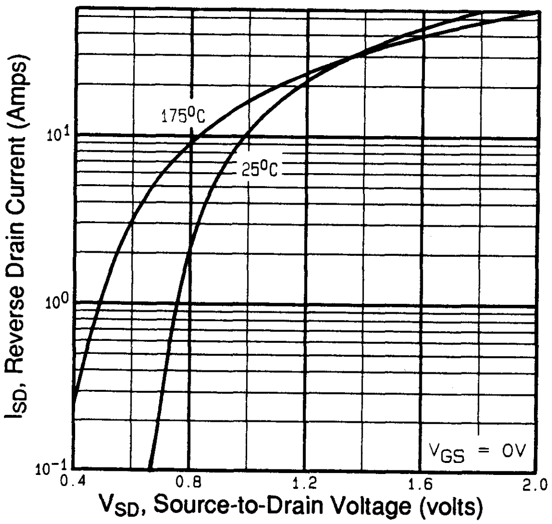


Fig 7. Typical Source-Drain Diode Forward Voltage

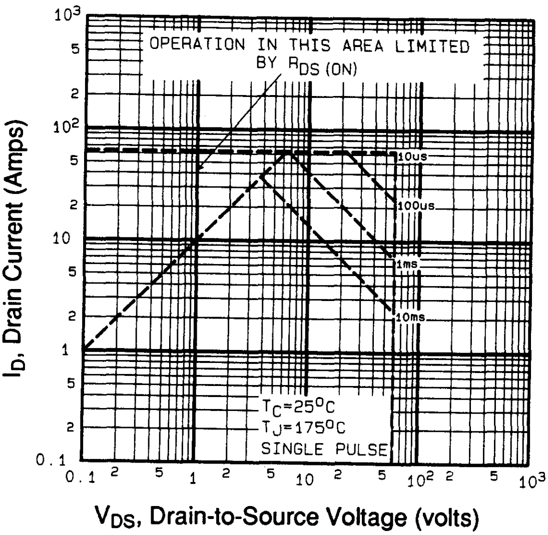


Fig 8. Maximum Safe Operating Area

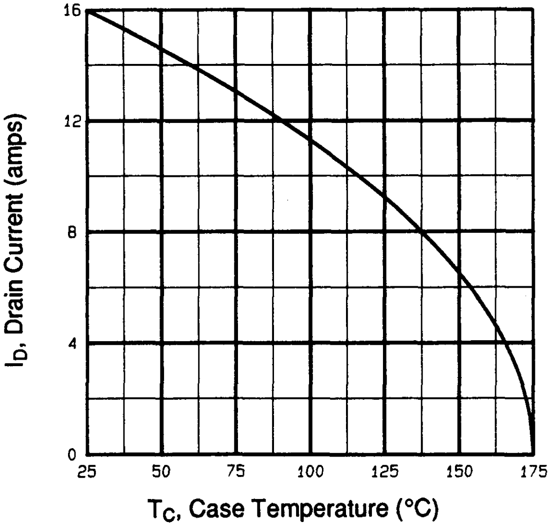


Fig 9. Maximum Drain Current Vs. Case Temperature

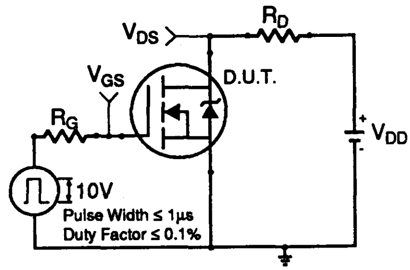


Fig 10a. Switching Time Test Circuit

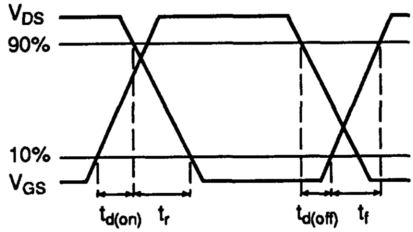


Fig 10b. Switching Time Waveforms

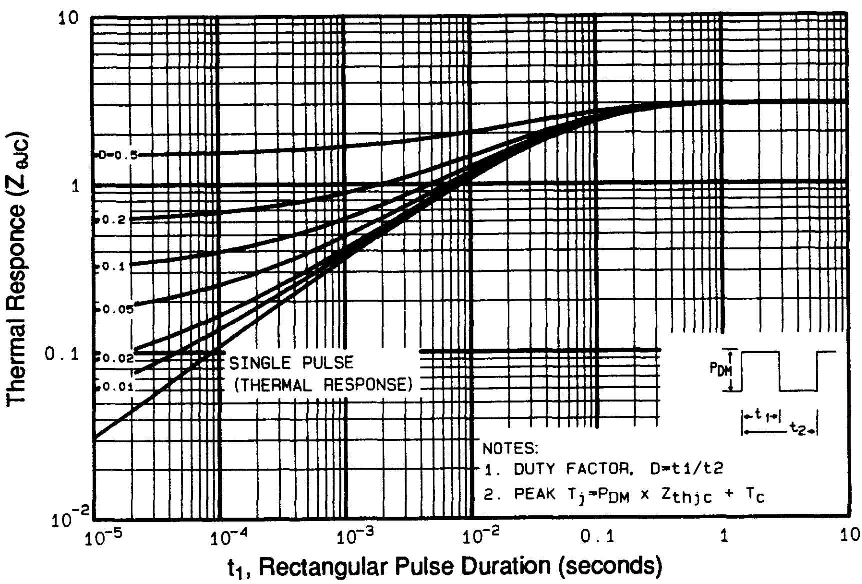


Fig 11. Maximum Effective Transient Thermal Impedance, Junction-to-Case

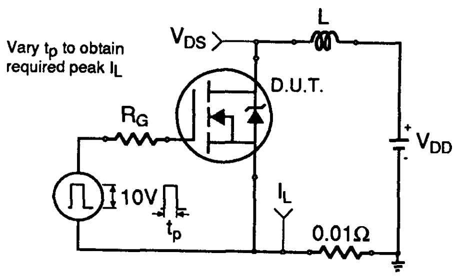


Fig 12a. Unclamped Inductive Test Circuit

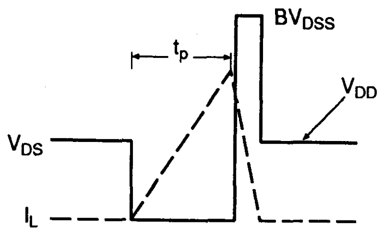


Fig 12b. Unclamped Inductive Waveforms

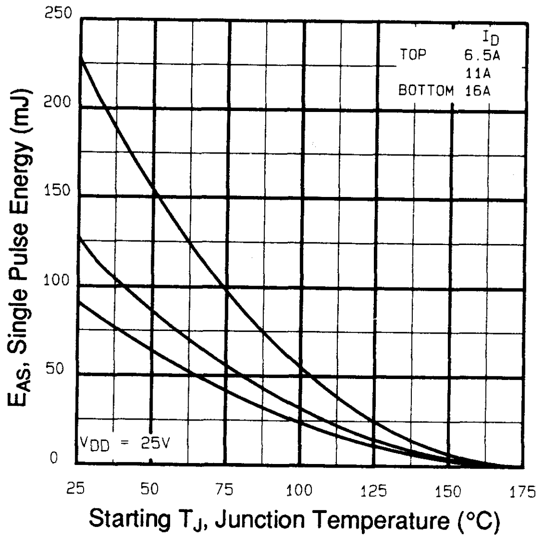


Fig 12c. Maximum Avalanche Energy vs. Drain Current

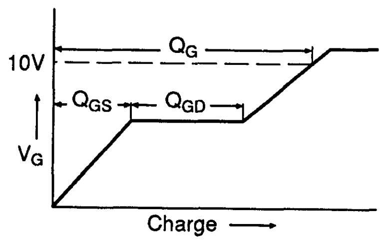


Fig 13a. Basic Gate Charge Waveform

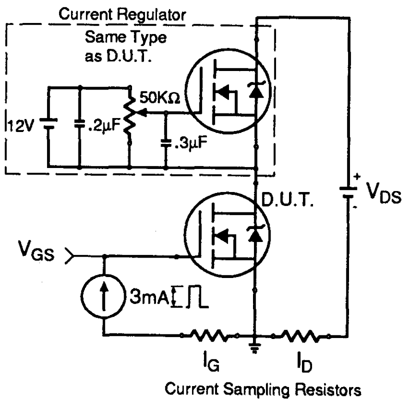


Fig 13b. Gate Charge Test Circuit

Appendix A: Figure 14, Peak Diode Recovery dv/dt Test Circuit

Appendix B: Package Outline Mechanical Drawing

Appendix C: Tape & Reel Information

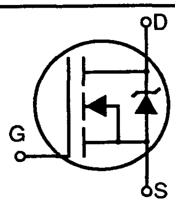
Appendix D: Part Marking Information

International
IOR Rectifier

IRFR110
IRFU110

HEXFET® Power MOSFET

- Surface Mount (IRFR110)
- Straight Lead (IRFU110)
- Repetitive Avalanche Rated
- Dynamic dv/dt Rated



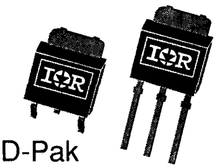
n-channel

BV_{DSS}	100V
$R_{DS(on)}$	0.54Ω
I_D	4.7A

Description

Third Generation HEXFETs from International Rectifier provide the designer with the best combination of fast switching speed, ruggedized device design, and low on resistance.

The D-Pak is designed for surface mounting using vapor phase, infra red, or wave soldering techniques. The straight lead version (IRFU series) is for through hole mounting applications. Power dissipation levels up to 2 watts are possible in SMD applications.



D-Pak TO-252AA

I-Pak TO-251AA

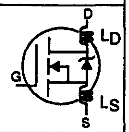
Absolute Maximum Ratings

	Parameter	Max.	Units
I_D @ T_C = 25°C	Continuous Drain Current, V_{GS}@10V	4.7	A
I_D @ T_C = 100°C	Continuous Drain Current, V_{GS}@10V	3.3	
I_{DM}	Pulsed Drain Current ①	19	
P_D@ T_C = 25°C	Maximum Power Dissipation	30	W
	Linear Derating Factor	0.20	W/K⑥
V_{GS}	Gate-to-Source Breakdown Voltage	±20	V
E_{AS}	Single Pulse Avalanche Energy ②	100	mJ
I_{AR}	Avalanche Current ①	4.7	A
E_{AR}	Repetitive Avalanche Energy ①	3.0	mJ
dv/dt	Peak Diode Recovery dv/dt ③	5.5	V/ns
T_J T_{STG}	Operating Junction and Storage Temperature Range	-55 to +175	°C
	Soldering Temperature, for 10 sec.	300 (0.063 in. (1.6mm) from case)	

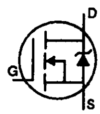
Thermal Resistance

	Parameter	Min.	Typ.	Max.	Units
$R_{\theta JC}$	Junction-to-Case	---	---	5.0	K/W⑥
$R_{\theta CS}$	Case-to-Sink ⑤	---	1.7	---	
$R_{\theta JA}$	Junction-to-Ambient, Typical Socket Mount	---	---	110	

Electrical Characteristics @ T_J = 25°C (unless otherwise specified)

	Parameter	Min.	Typ.	Max.	Units	Test Conditions
BV_{DSS}	Drain-to-Source Breakdown Voltage	100	---	---	V	V_{GS}=0V, I_D=250µA
$\Delta BV_{DSS}/\Delta T_J$	Temp. Coefficient of Breakdown Voltage	---	0.12	---	V/°C	Reference to 25°C, I_D=1mA
$R_{DS(on)}$	Static Drain-to-Source On Resistance	---	---	0.54	Ω	V_{GS}=10V, I_D =2.8A④
$V_{GS(th)}$	Gate Threshold Voltage	2.0	---	4.0	V	$V_{DS}=V_{GS}$, I_D=250µA
g_{fs}	Forward Transconductance	1.6	---	---	S	V_{DS}=50V, I_{DS}=2.8A④
I_{DSS}	Zero Gate Voltage Collector Current	---	---	250	µA	V_{DS}=100V, V_{GS}=0V
		---	---	1000		V_{DS}=80V, V_{GS}=0V, T_J=150°C
I_{GSS}	Gate-to-Source Forward Leakage	---	---	500	nA	V_{GS}=20V
	Gate-to-Source Reverse Leakage	---	---	-500		V_{GS}=-20V
Q_g	Total Gate Charge	---	---	8.3	nC	I_D=5.6A, V_{DS}=80V, V_{GS}=10V See Fig 6 and 13④
Q_{gs}	Gate-to-Source Charge	---	---	2.3		
Q_{gd}	Gate-to-Drain ("Miller") Charge	---	---	3.8		
$t_{d(on)}$	Turn-On Delay Time	---	6.9	---	ns	V_{DD}=50V, I_D=5.6A R_G=24Ω, R_D=8.4Ω See Fig. 10④
t_r	Rise Time	---	16	---		
$t_{d(off)}$	Turn-Off Delay Time	---	15	---		
t_f	Fall Time	---	9.4	---		
L_D	Internal Drain Inductance	---	4.5	---	nH	Between lead, 6mm (0.25in.) from package, and center of die contact. 
L_S	Internal Source Inductance	---	7.5	---		
C_{iss}	Input Capacitance	---	180	---	pF	V_{GS}=0V, V_{DS}=25V f=1.0Mhz See Fig. 5
C_{oss}	Output Capacitance	---	80	---		
C_{rss}	Reverse Transfer Capacitance	---	15	---		

Source-Drain Diode Ratings and Characteristics

	Parameter	Min.	Typ.	Max.	Units	Test Conditions
I_S	Continuous Source Current (Body Diode)	---	---	4.7	A	MOSFET symbol showing the integral reverse p-n junction diode. 
I_{SM}	Pulsed Source Current (Body Diode) ①	---	---	19		
V_{SD}	Diode Forward Voltage	---	---	2.5	V	T_J=25°C, I_S=4.7A, V_{GS}=0V④
t_{rr}	Reverse Recovery Time	50	---	200	ns	T_J=25°C, I_F=5.6A, di/dt=100A/µS④
Q_{RR}	Reverse Recovery Charge	0.22	---	0.88	µC	
t_{on}	Forward Turn-On Time	Intrinsic turn-on time is negligible (turn-on is dominated by $L_S + L_D$)				

Notes:

① Repetitive rating; Pulse width limited by max. junction temperature (See figure 11)

② V_{DD}=25V, Starting T_J=25°C, L=7.4mH, R_G=25Ω, Peak I_{AS}=4.7A (See figure 12)

③ $I_{SD} \leq$4.7A, di/dt≤75A/µs, $V_{DD} \leq BV_{DSS}$, $T_J \leq$175°C Suggested R_G=24Ω

④ Pulse width ≤ 300µs; duty Cycle ≤2%

⑤ Mounting surface: flat, smooth, greased

⑥ K/W = °C/W

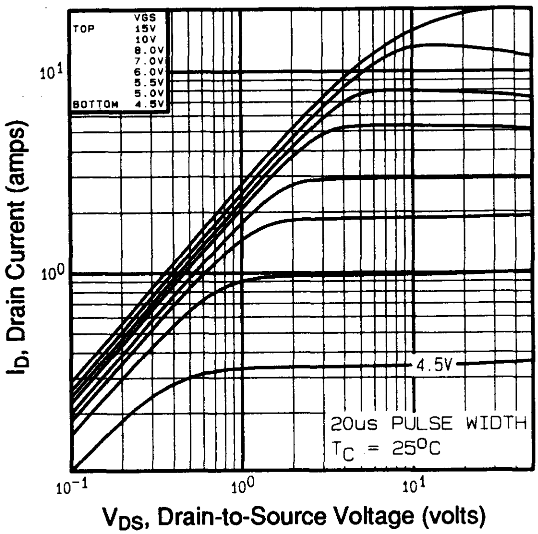


Fig 1. Typical Output Characteristics, $T_C = 25°C$

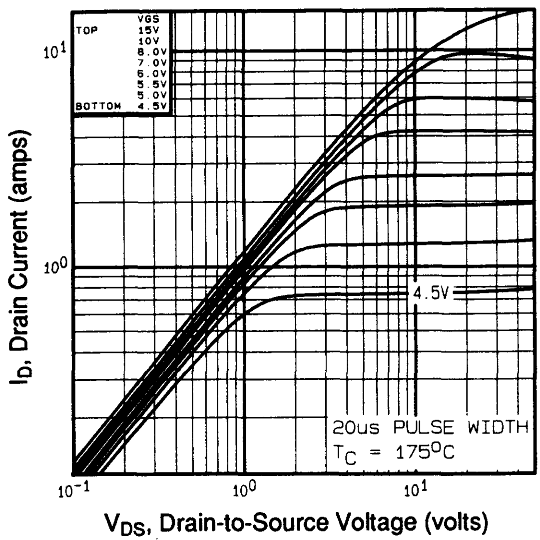


Fig 2. Typical Output Characteristics, $T_C = 150°C$

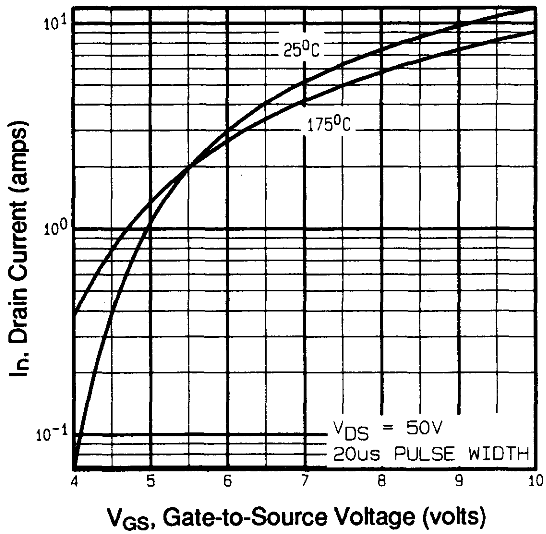


Fig 3. Typical Transfer Characteristics

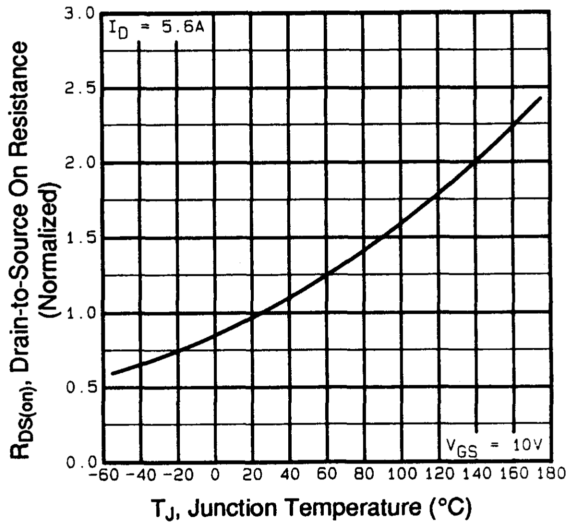


Fig 4. Normalized On-Resistance Vs. Temperature

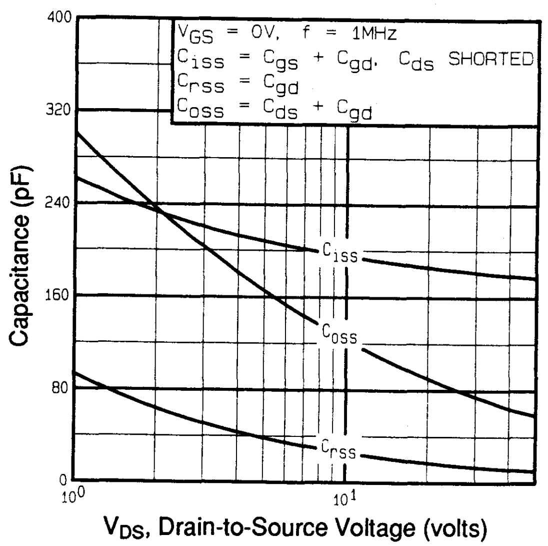


Fig 5. Typical Capacitance Vs. Drain-to-Source Voltage

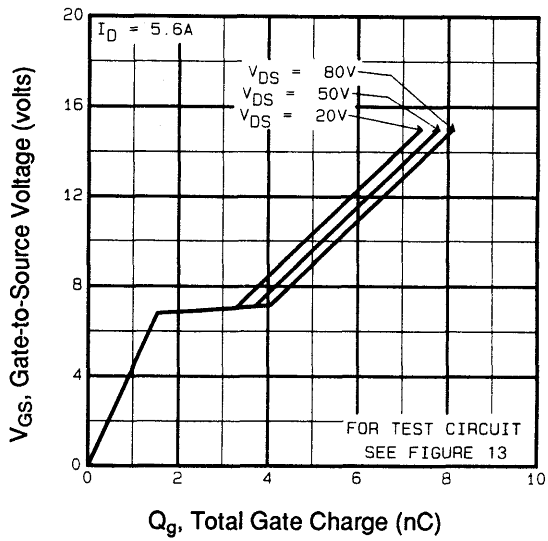


Fig 6. Typical Gate Charge Vs. Gate-to-Source Voltage

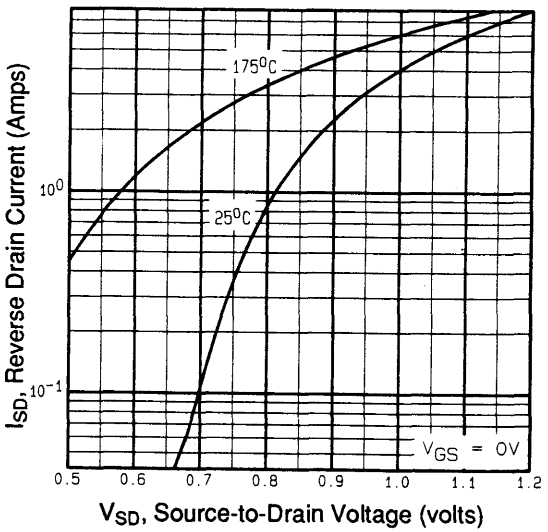


Fig 7. Typical Source-Drain Diode Forward Voltage

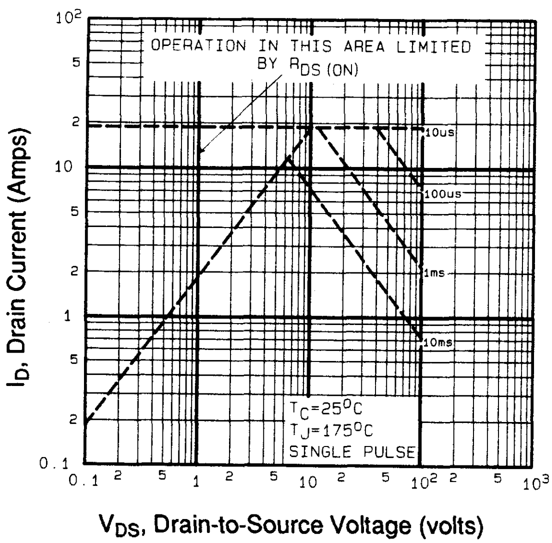


Fig 8. Maximum Safe Operating Area

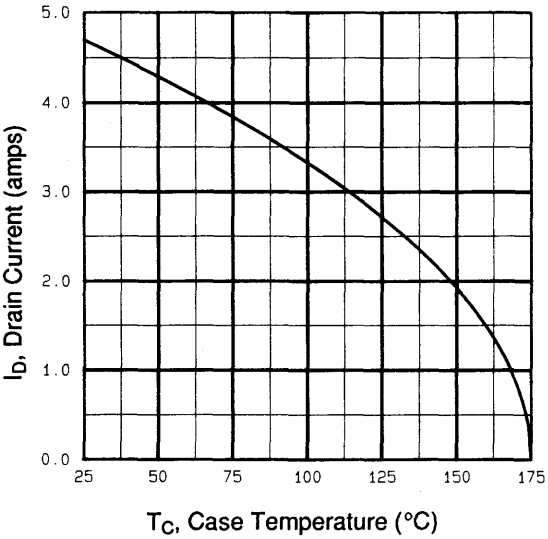


Fig 9. Maximum Drain Current Vs. Case Temperature

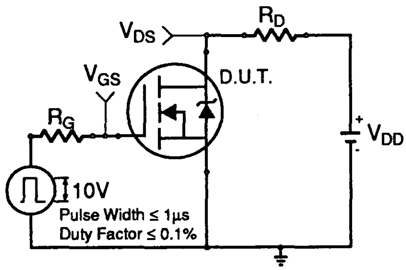


Fig 10a. Switching Time Test Circuit

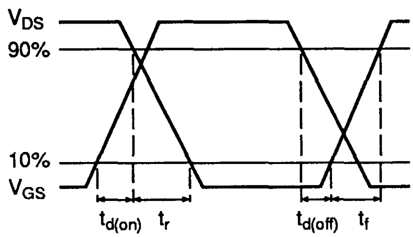


Fig 10b. Switching Time Waveforms

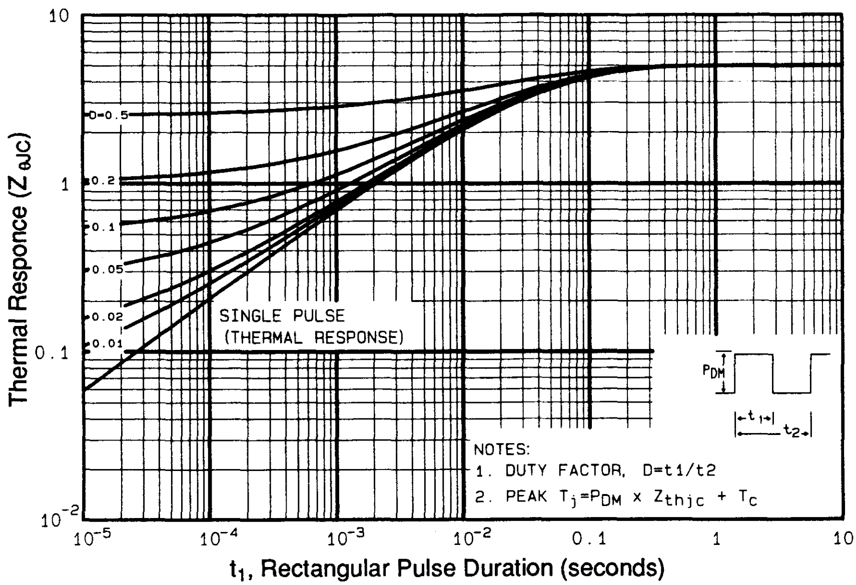


Fig 11. Maximum Effective Transient Thermal Impedance, Junction-to-Case

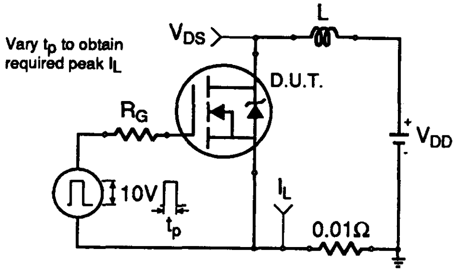


Fig 12a. Unclamped Inductive Test Circuit

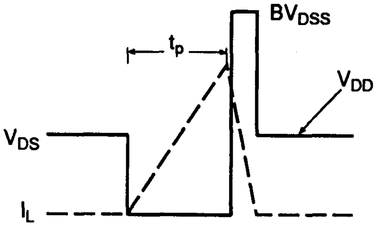


Fig 12b. Unclamped Inductive Waveforms

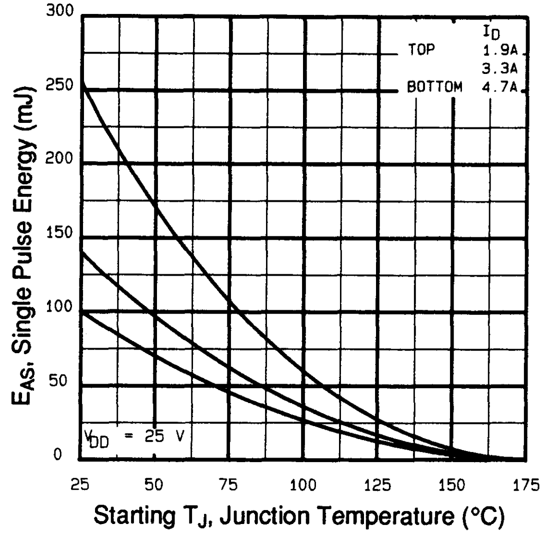


Fig 12c. Maximum Avalanche Energy vs. Drain Current

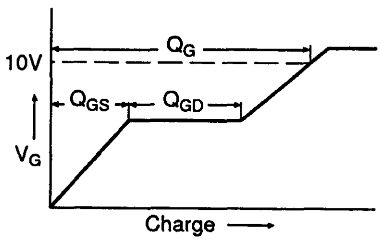


Fig 13a. Basic Gate Charge Waveform

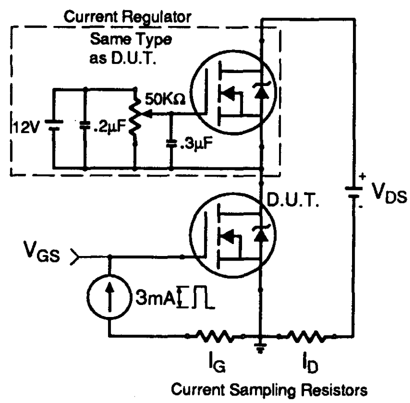


Fig 13b. Gate Charge Test Circuit

Appendix A: Figure 14, Peak Diode Recovery dv/dt Test Circuit

Appendix B: Package Outline Mechanical Drawing

Appendix C: Tape & Reel Information

Appendix D: Part Marking Information

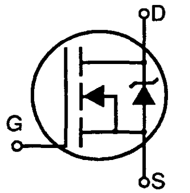
International IOR Rectifier

International Rectifier

IRFR120
IRFU120

HEXFET® Power MOSFET

- Surface Mount (IRFR120)
- Straight Lead (IRFU120)
- Repetitive Avalanche Rated
- Dynamic dv/dt Rated



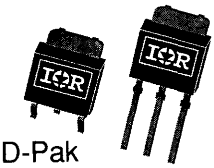
n-channel

BV_{DSS}	100V
$R_{DS(on)}$	0.27Ω
I_D	8.4A

Description

Third Generation HEXFETs from International Rectifier provide the designer with the best combination of fast switching speed, ruggedized device design, and low on resistance.

The D-Pak is designed for surface mounting using vapor phase, infra red, or wave soldering techniques. The straight lead version (IRFU series) is for through hole mounting applications. Power dissipation levels up to 2 watts are possible in SMD applications.



D-Pak
TO-252AA
I-Pak
TO-251AA

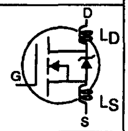
Absolute Maximum Ratings

	Parameter	Max.	Units
I_D @ T_C = 25°C	Continuous Drain Current, V_{GS}@10V	8.4	A
I_D @ T_C = 100°C	Continuous Drain Current, V_{GS}@10V	6.0	
I_{DM}	Pulsed Drain Current ①	34	
P_D@ T_C = 25°C	Maximum Power Dissipation	50	W
	Linear Derating Factor	0.33	W/K⑥
V_{GS}	Gate-to-Source Breakdown Voltage	±20	V
E_{AS}	Single Pulse Avalanche Energy ②	210	mJ
I_{AR}	Avalanche Current ①	8.4	A
E_{AR}	Repetitive Avalanche Energy ①	5.0	mJ
dv/dt	Peak Diode Recovery dv/dt ③	5.5	V/ns
T_J T_{STG}	Operating Junction and Storage Temperature Range	-55 to +175	°C
	Soldering Temperature, for 10 sec.	300 (0.063 in. (1.6mm) from case)	

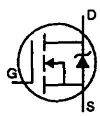
Thermal Resistance

	Parameter	Min.	Typ.	Max.	Units
$R_{\theta JC}$	Junction-to-Case	---	---	3.0	K/W⑥
$R_{\theta CS}$	Case-to-Sink ⑤	---	1.7	---	
$R_{\theta JA}$	Junction-to-Ambient, Typical Socket Mount	---	---	110	

Electrical Characteristics @ T_J = 25°C (unless otherwise specified)

	Parameter	Min.	Typ.	Max.	Units	Test Conditions
BV_{DSS}	Drain-to-Source Breakdown Voltage	100	---	---	V	V_{GS}=0V, I_D=250μA
$\Delta BV_{DSS}/\Delta T_J$	Temp. Coefficient of Breakdown Voltage	---	0.13	---	V/°C	Reference to 25°C, I_D=1mA
$R_{DS(on)}$	Static Drain-to-Source On Resistance	---	---	0.27	Ω	V_{GS}=10V, I_D =5.0A④
$V_{GS(th)}$	Gate Threshold Voltage	2.0	---	4.0	V	V_{DS}=V_{GS}, I_D=250μA
g_{fs}	Forward Transconductance	1.6	---	---	S	V_{DS}=50V, I_{DS}=5.0A④
I_{DSS}	Zero Gate Voltage Collector Current	---	---	250	μA	V_{DS}=100V, V_{GS}=0V
		---	---	1000		V_{DS}=80V, V_{GS}=0V,T_J=150°C
I_{GSS}	Gate-to-Source Forward Leakage	---	---	500	nA	V_{GS}=20V
	Gate-to-Source Reverse Leakage	---	---	-500		V_{GS}=-20V
Q_g	Total Gate Charge	---	---	16	nC	I_D=9.2A, V_{DS}=80V, V_{GS}=10V See Fig 6 and 13④
Q_{gs}	Gate-to-Source Charge	---	---	4.4		
Q_{gd}	Gate-to-Drain ("Miller") Charge	---	---	7.7		
$t_{d(on)}$	Turn-On Delay Time	---	6.8	---	ns	V_{DD}=50V, I_D=9.2A R_G=18Ω, R_D=5.2Ω See Fig. 10④
t_r	Rise Time	---	27	---		
$t_{d(off)}$	Turn-Off Delay Time	---	18	---		
t_f	Fall Time	---	17	---		
L_D	Internal Drain Inductance	---	4.5	---	nH	Between lead, 6mm (0.25in.) from package, and center of die contact. 
L_S	Internal Source Inductance	---	7.5	---		
C_{iss}	Input Capacitance	---	360	---	pF	V_{GS}=0V, V_{DS}=25V
C_{oss}	Output Capacitance	---	150	---		f=1.0Mhz
C_{rss}	Reverse Transfer Capacitance	---	34	---		See Fig. 5

Source-Drain Diode Ratings and Characteristics

	Parameter	Min.	Typ.	Max.	Units	Test Conditions
I_S	Continuous Source Current (Body Diode)	---	---	8.4	A	MOSFET symbol showing the integral reverse p-n junction diode. 
I_{SM}	Pulsed Source Current (Body Diode) ①	---	---	34		
V_{SD}	Diode Forward Voltage	---	---	2.5	V	T_J=25°C, I_S=8.4A, V_{GS}=0V④
t_{rr}	Reverse Recovery Time	65	---	260	ns	T_J=25°C, I_F=9.2A,
Q_{RR}	Reverse Recovery Charge	0.33	---	1.3	μC	di/dt=100A/μS④
t_{on}	Forward Turn-On Time	Intrinsic turn-on time is negligible (turn-on is dominated by L_S + L_D)				

Notes:

① Repetitive rating; Pulse width limited by max. junction temperature (See figure 11)

② V_{DD}=50V, Starting T_J=25°C, L=4.4mH, R_G=25Ω, Peak I_{AS}=8.4A (See figure 12)

③ I_{SD}≤8.4A, di/dt≤110A/μs, V_{DD}≤BV_{DSS}, T_J≤175°C Suggested R_G=18Ω

④ Pulse width ≤ 300μs; duty Cycle ≤2%

⑤ Mounting surface: flat, smooth, greased

⑥ K/W = °C/W

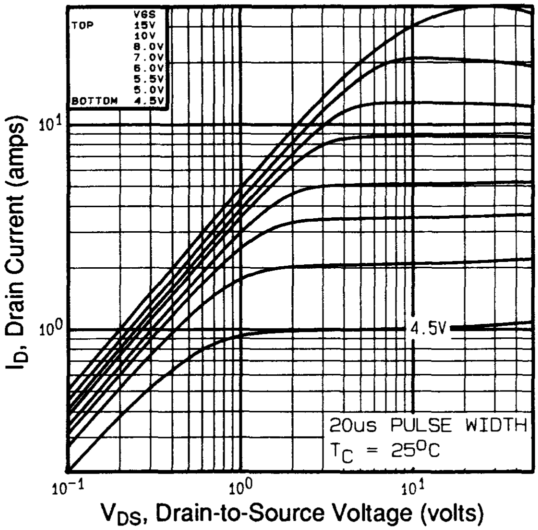


Fig 1. Typical Output Characteristics, $T_C = 25°C$

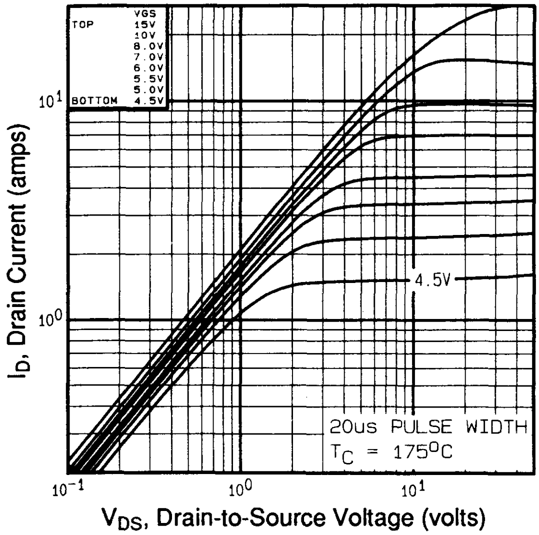


Fig 2. Typical Output Characteristics, $T_C = 150°C$

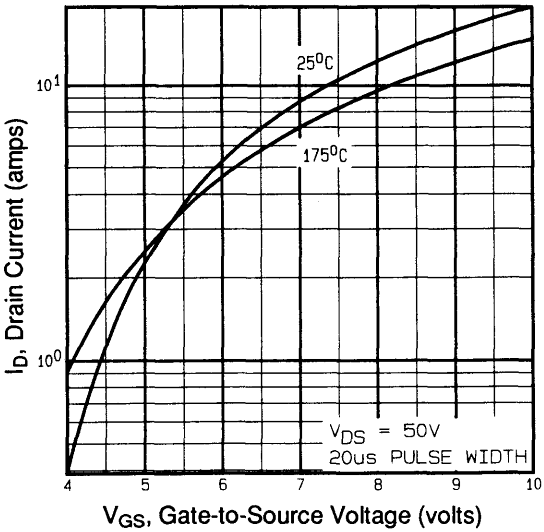


Fig 3. Typical Transfer Characteristics

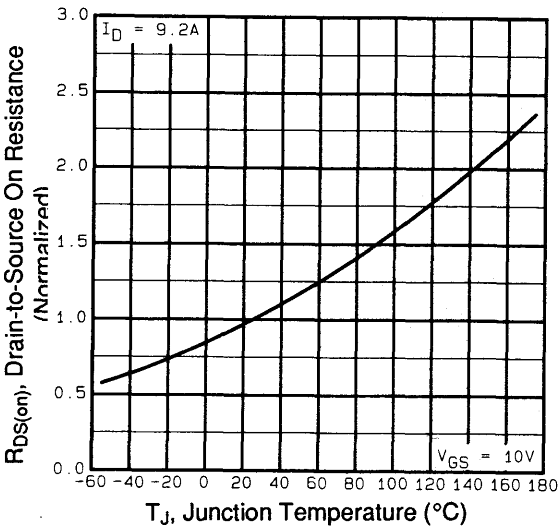


Fig 4. Normalized On-Resistance Vs. Temperature

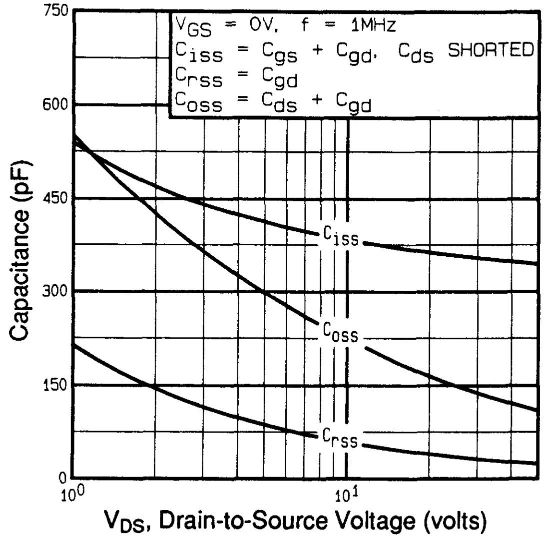


Fig 5. Typical Capacitance Vs. Drain-to-Source Voltage

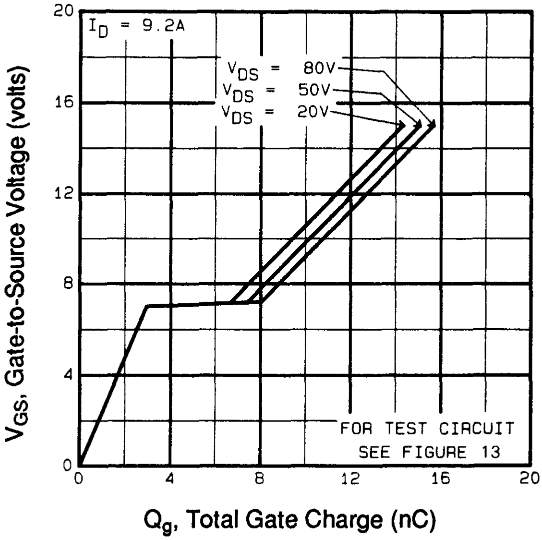


Fig 6. Typical Gate Charge Vs. Gate-to-Source Voltage

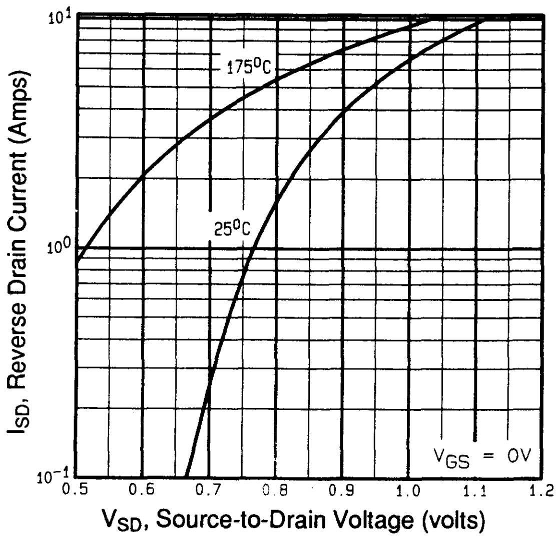


Fig 7. Typical Source-Drain Diode Forward Voltage

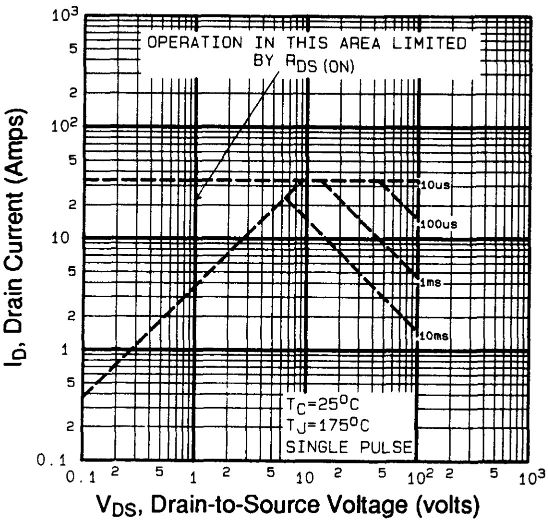


Fig 8. Maximum Safe Operating Area

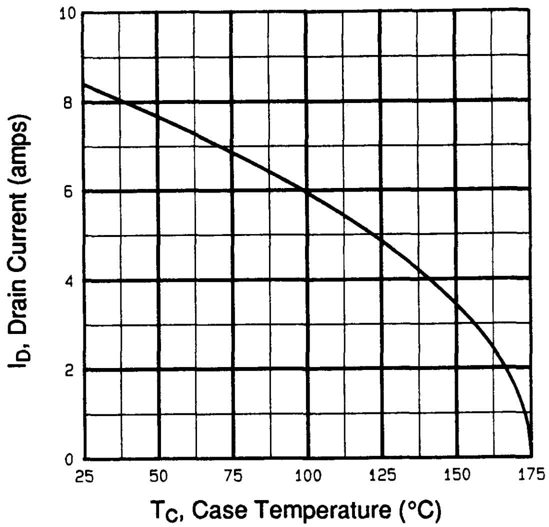


Fig 9. Maximum Drain Current Vs. Case Temperature

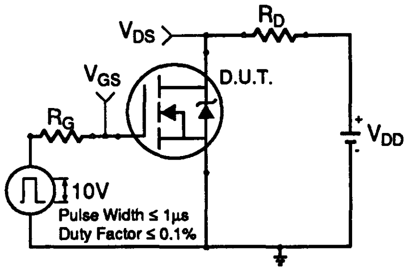


Fig 10a. Switching Time Test Circuit

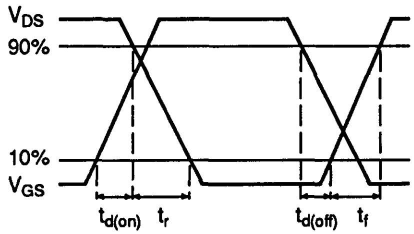


Fig 10b. Switching Time Waveforms

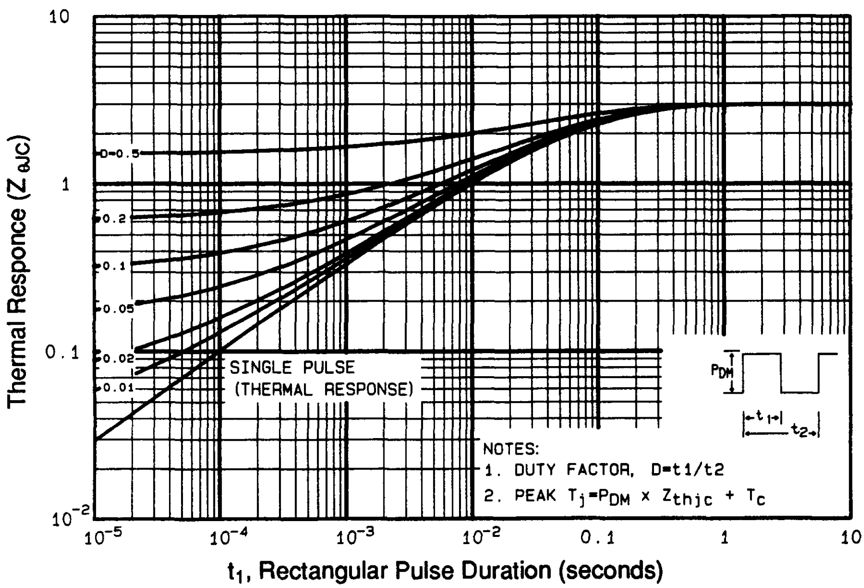


Fig 11. Maximum Effective Transient Thermal Impedance, Junction-to-Case

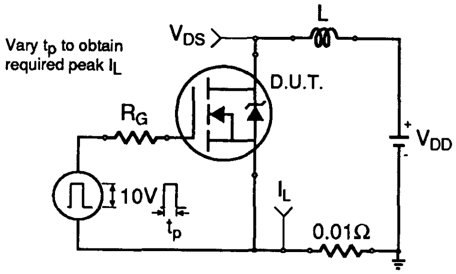


Fig 12a. Unclamped Inductive Test Circuit

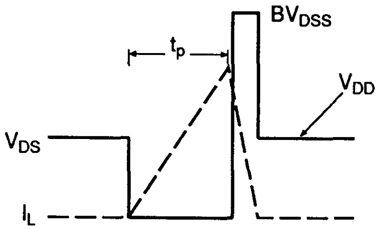


Fig 12b. Unclamped Inductive Waveforms

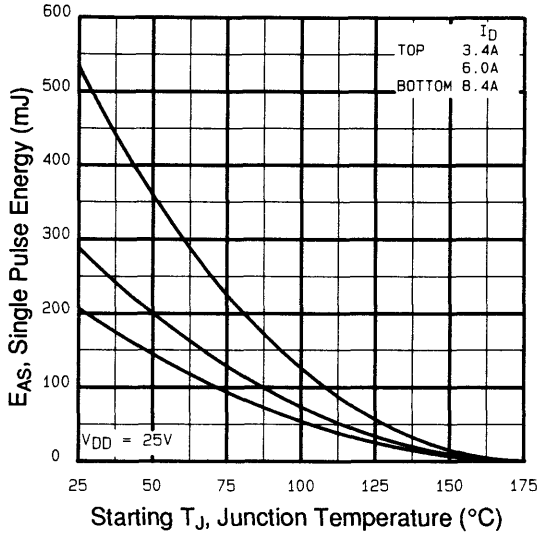


Fig 12c. Maximum Avalanche Energy vs. Drain Current

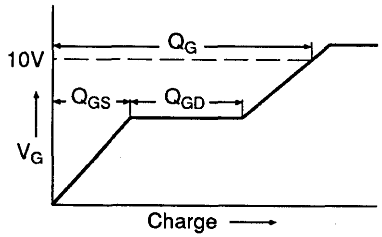


Fig 13a. Basic Gate Charge Waveform

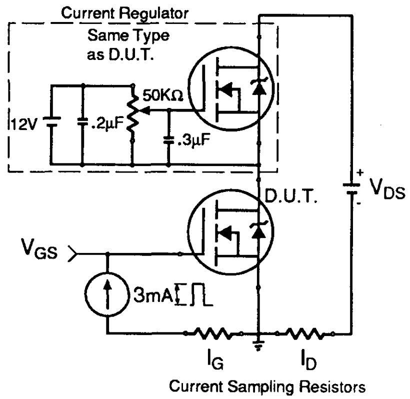


Fig 13b. Gate Charge Test Circuit

Appendix A: Figure 14, Peak Diode Recovery dv/dt Test Circuit

Appendix B: Package Outline Mechanical Drawing

Appendix C: Tape & Reel Information

Appendix D: Part Marking Information

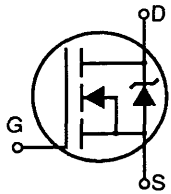
International
IOR Rectifier

International Rectifier

IRFR210
IRFU210

HEXFET® Power MOSFET

- Surface Mount (IRFR210)
- Straight Lead (IRFU210)
- Repetitive Avalanche Rated
- Dynamic dv/dt Rated



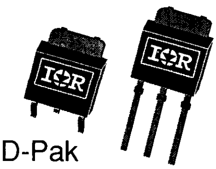
n-channel

BV_{DSS}	200V
$R_{DS(on)}$	1.5Ω
I_D	2.6A

Description

Third Generation HEXFETs from International Rectifier provide the designer with the best combination of fast switching speed, ruggedized device design, and low on resistance.

The D-Pak is designed for surface mounting using vapor phase, infra red, or wave soldering techniques. The straight lead version (IRFU series) is for through hole mounting applications. Power dissipation levels up to 2 watts are possible in SMD applications.


D-Pak TO-252AA I-Pak TO-251AA

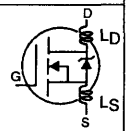
Absolute Maximum Ratings

	Parameter	Max.	Units
I_D @ T_C = 25°C	Continuous Drain Current, V_{GS}@10V	2.6	
I_D @ T_C = 100°C	Continuous Drain Current, V_{GS}@10V	1.7	A
I_{DM}	Pulsed Drain Current ①	8.0	
P_D@ T_C = 25°C	Maximum Power Dissipation	25	W
	Linear Derating Factor	0.20	W/K⑥
V_{GS}	Gate-to-Source Breakdown Voltage	±20	V
E_{AS}	Single Pulse Avalanche Energy ②	64	mJ
I_{AR}	Avalanche Current ①	2.7	A
E_{AR}	Repetitive Avalanche Energy ①	2.5	mJ
dv/dt	Peak Diode Recovery dv/dt ③	5.0	V/ns
T_J T_{STG}	Operating Junction and Storage Temperature Range	-55 to +150	°C
	Soldering Temperature, for 10 sec.	300 (0.063 in. (1.6mm) from case)	

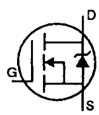
Thermal Resistance

	Parameter	Min.	Typ.	Max.	Units
$R_{\theta JC}$	Junction-to-Case	---	---	5.0	
$R_{\theta CS}$	Case-to-Sink ⑤	---	1.7	---	K/W⑥
$R_{\theta JA}$	Junction-to-Ambient, Typical Socket Mount	---	---	110	

Electrical Characteristics @ T_J = 25°C (unless otherwise specified)

	Parameter	Min.	Typ.	Max.	Units	Test Conditions
BV_{DSS}	Drain-to-Source Breakdown Voltage	200	---	---	V	V_{GS}=0V, I_D=250µA
$\Delta BV_{DSS}/\Delta T_J$	Temp. Coefficient of Breakdown Voltage	---	0.30	---	V/°C	Reference to 25°C, I_D=1mA
$R_{DS(on)}$	Static Drain-to-Source On Resistance	---	---	1.5	Ω	V_{GS}=10V, I_D =1.6A④
$V_{GS(th)}$	Gate Threshold Voltage	2.0	---	4.0	V	V_{DS}=V_{GS}, I_D=250µA
g_{fs}	Forward Transconductance	1.2	---	---	S	V_{DS}=50V, I_{DS}=1.6A④
I_{DSS}	Zero Gate Voltage Collector Current	---	---	250	µA	V_{DS}=200V, V_{GS}=0V
		---	---	1000		V_{DS}=160V, V_{GS}=0V, T_J=125°C
I_{GSS}	Gate-to-Source Forward Leakage	---	---	500	nA	V_{GS}=20V
	Gate-to-Source Reverse Leakage	---	---	-500		V_{GS}=-20V
Q_g	Total Gate Charge	---	---	8.2	nC	I_D=3.3A, V_{DS}=160V, V_{GS}=10V④
Q_{gs}	Gate-to-Source Charge	---	---	1.8		
Q_{gd}	Gate-to-Drain ("Miller") Charge	---	---	4.5		
$t_{d(on)}$	Turn-On Delay Time	---	8.2	---	ns	V_{DD}=100V, I_D=3.3A R_G=24Ω, R_D=30Ω④
t_r	Rise Time	---	17	---		
$t_{d(off)}$	Turn-Off Delay Time	---	14	---		
t_f	Fall Time	---	8.9	---		
L_D	Internal Drain Inductance	---	4.5	---	nH	Between lead, 6mm (0.25in.) from package, and center of die contact. 
L_S	Internal Source Inductance	---	7.5	---		
C_{iss}	Input Capacitance	---	140	---	pF	V_{GS}=0V, V_{DS}=25 *f*=1.0Mhz
C_{oss}	Output Capacitance	---	53	---		
C_{rss}	Reverse Transfer Capacitance	---	15	---		

Source-Drain Diode Ratings and Characteristics

	Parameter	Min.	Typ.	Max.	Units	Test Conditions
I_S	Continuous Source Current (Body Diode)	---	---	2.7	A	MOSFET symbol showing the integral reverse p-n junction diode. 
I_{SM}	Pulsed Source Current (Body Diode) ①	---	---	8.0		
V_{SD}	Diode Forward Voltage	---	---	2.0	V	T_J=25°C, I_S=2.7A, V_{GS}=0V④
t_{rr}	Reverse Recovery Time	75	---	310	ns	T_J=25°C, I_F=3.3A, di/dt=100A/µS④
Q_{RR}	Reverse Recovery Charge	0.33	---	1.4	µC	
t_{on}	Forward Turn-On Time	Intrinsic turn-on time is negligible (turn-on is dominated by L_S + L_D)				

Notes:

① Repetitive rating; Pulse width limited by max. junction temperature

② V_{DD}=50V, Starting T_J=25°C, L=16mH, R_G=25Ω, Peak I_{AS}=2.6A

③ I_{SD}≤2.7A, di/dt≤70A/µs, V_{DD}≤BV_{DSS}, T_J≤150°C Suggested R_G=24Ω

④ Pulse width ≤ 300µs; duty Cycle ≤2%

⑤ Mounting surface: flat, smooth, greased

⑥ K/W = °C/W

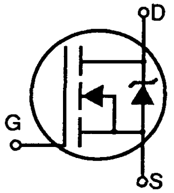
For more information on the same die in a HD-1 package refer to IRFD210.

International Rectifier

IRFR214
IRFU214

HEXFET® Power MOSFET

- Surface Mount (IRFR214)
- Straight Lead (IRFU214)
- Repetitive Avalanche Rated
- Dynamic dv/dt Rated



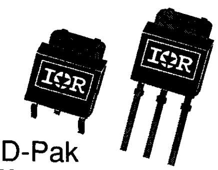
n-channel

BV_{DSS} 250V
$R_{DS(on)}$ 2.0Ω
I_D 2.2A

Description

Third Generation HEXFETs from International Rectifier provide the designer with the best combination of fast switching speed, ruggedized device design, and low on resistance.

The D-Pak is designed for surface mounting using vapor phase, infra red, or wave soldering techniques. The straight lead version (IRFU series) is for through hole mounting applications. Power dissipation levels up to 2 watts are possible in SMD applications.



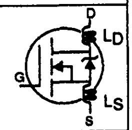
D-Pak TO-252AA
I-Pak TO-251AA

Absolute Maximum Ratings

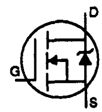
	Parameter	Max.	Units
I_D @ T_C = 25°C	Continuous Drain Current, V_{GS}@10V	2.2	A
I_D @ T_C = 100°C	Continuous Drain Current, V_{GS}@10V	1.4	
I_{DM}	Pulsed Drain Current ①	8.8	
P_D@ T_C = 25°C	Maximum Power Dissipation	25	W
	Linear Derating Factor	0.20	W/K⑥
V_{GS}	Gate-to-Source Breakdown Voltage	±20	V
E_{AS}	Single Pulse Avalanche Energy ②	61	mJ
I_{AR}	Avalanche Current ①	2.2	A
E_{AR}	Repetitive Avalanche Energy ①	2.5	mJ
dv/dt	Peak Diode Recovery dv/dt ③	2.0	V/ns
T_J T_{STG}	Operating Junction and Storage Temperature Range	-55 to +150	°C
	Soldering Temperature, for 10 sec.	300 (0.063 in. (1.6mm) from case)	

Thermal Resistance

	Parameter	Min.	Typ.	Max.	Units
$R_{θJC}$	Junction-to-Case	---	---	5.0	K/W⑥
$R_{θCS}$	Case-to-Sink ⑤	---	1.7	---	
$R_{θJA}$	Junction-to-Ambient, Typical Socket Mount	---	---	110	

	Parameter	Min.	Typ.	Max.	Units	Test Conditions
BV_{DSS}	Drain-to-Source Breakdown Voltage	250	---	---	V	V_{GS}=0V, I_D=250µA
$\Delta BV_{DSS}/\Delta T_J$	Temp. Coefficient of Breakdown Voltage	---	0.39	---	V/°C	Reference to 25°C, I_D=1mA
$R_{DS(on)}$	Static Drain-to-Source On Resistance	---	---	2.0	Ω	V_{GS}=10V, I_D =1.3A④
$V_{GS(th)}$	Gate Threshold Voltage	2.0	---	4.0	V	V_{DS}=V_{GS}, I_D=250µA
g_{fs}	Forward Transconductance	1.2	---	---	S	V_{DS}=50V, I_{DS}=1.3A④
I_{DSS}	Zero Gate Voltage Collector Current	---	---	250	µA	V_{DS}=250V, V_{GS}=0V
		---	---	1000		V_{DS}=200V, V_{GS}=0V,T_J=125°C
I_{GSS}	Gate-to-Source Forward Leakage	---	---	500	nA	V_{GS}=20V
	Gate-to-Source Reverse Leakage	---	---	-500		V_{GS}=-20V
Q_g	Total Gate Charge	---	---	8.2	nC	I_D=2.7A, V_{DS}=200V, V_{GS}=10V④
Q_{gs}	Gate-to-Source Charge	---	---	1.8		
Q_{gd}	Gate-to-Drain ("Miller") Charge	---	---	4.5		
$t_{d(on)}$	Turn-On Delay Time	---	7.0	---	ns	V_{DD}=125V, I_D=2.7A R_G=24Ω, R_D=45Ω④
t_r	Rise Time	---	7.6	---		
$t_{d(off)}$	Turn-Off Delay Time	---	16	---		
t_f	Fall Time	---	7.0	---		
L_D	Internal Drain Inductance	---	4.5	---	nH	Between lead, 6mm (0.25in.) from package, and center of die contact. 
L_S	Internal Source Inductance	---	7.5	---		
C_{iss}	Input Capacitance	---	140	---	pF	V_{GS}=0V, V_{DS}=25V f=1.0Mhz
C_{oss}	Output Capacitance	---	42	---		
C_{rss}	Reverse Transfer Capacitance	---	9.6	---		

Source-Drain Diode Ratings and Characteristics

	Parameter	Min.	Typ.	Max.	Units	Test Conditions
I_S	Continuous Source Current (Body Diode)	---	---	2.2	A	MOSFET symbol showing the integral reverse p-n junction diode. 
I_{SM}	Pulsed Source Current (Body Diode) ①	---	---	8.8		
V_{SD}	Diode Forward Voltage	---	---	2.0	V	T_J=25°C, I_S=2.2A, V_{GS}=0V④
t_{rr}	Reverse Recovery Time	97	---	390	ns	T_J=25°C, I_F=2.7A, di/dt=100A/µS④
Q_{RR}	Reverse Recovery Charge	0.32	---	1.3	µC	
t_{on}	Forward Turn-On Time	Intrinsic turn-on time is negligible (turn-on is dominated by L_S + L_D)				

Notes:

① Repetitive rating; Pulse width limited by max. junction temperature (See figure 11)

② V_{DD}=50V, Starting T_J=25°C, L=21mH, R_G=25Ω, Peak I_{AS}=2.2A

③ I_{SD}≤2.2A, di/dt≤65A/µs, V_{DD}≤BV_{DSS}, T_J≤150°C Suggested R_G=24Ω

④ Pulse width ≤ 300µs; duty Cycle ≤2%

⑤ Mounting surface: flat, smooth, greased

⑥ K/W = °C/W

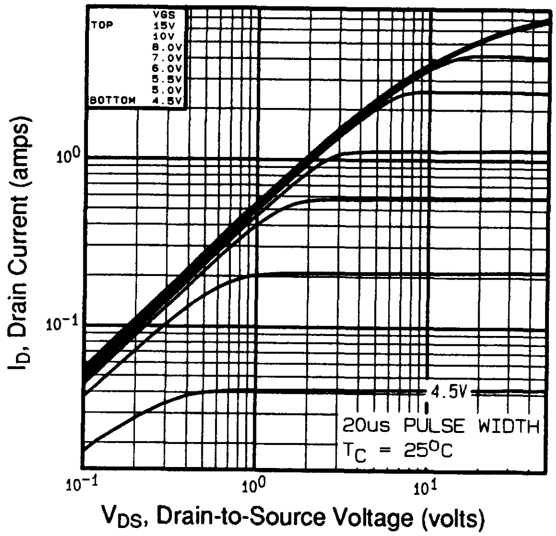


Fig 1. Typical Output Characteristics, $T_C = 25°C$

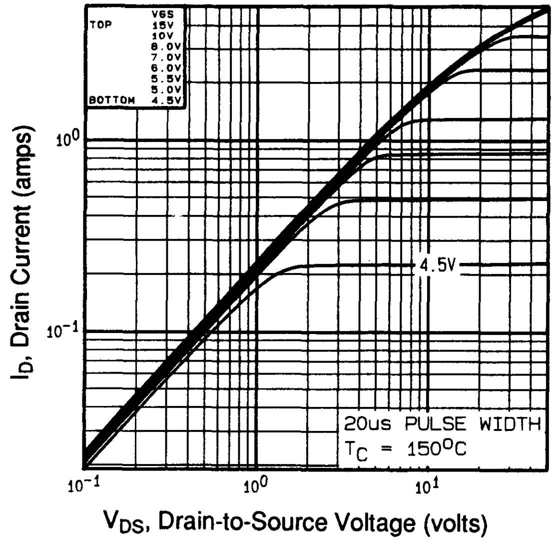


Fig 2. Typical Output Characteristics, $T_C = 150°C$

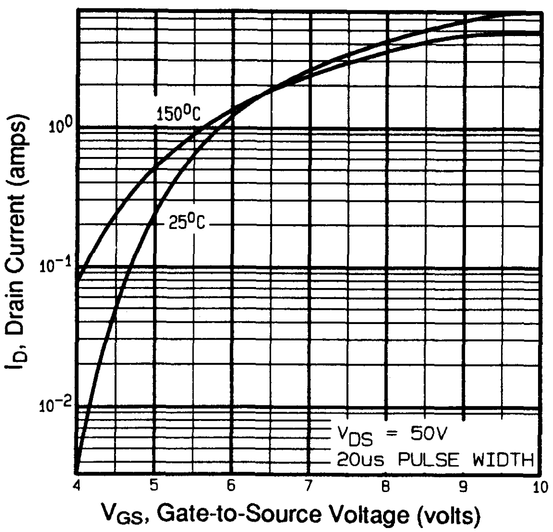


Fig 3. Typical Transfer Characteristics

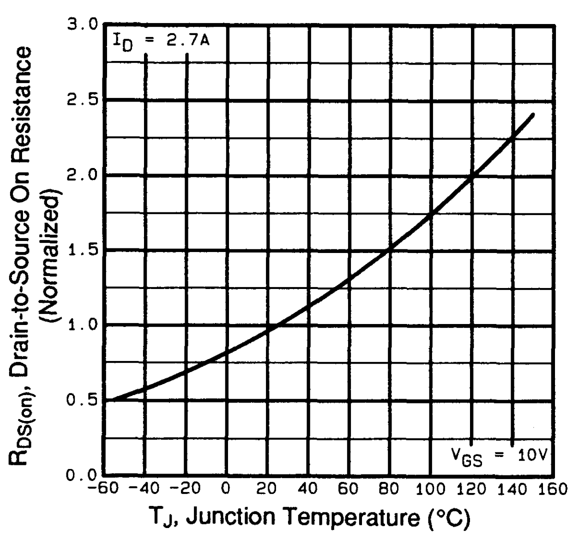


Fig 4. Normalized On-Resistance Vs. Temperature

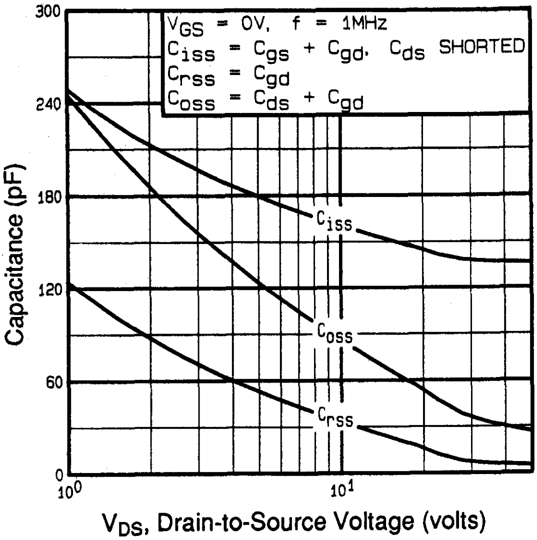


Fig 5. Typical Capacitance Vs. Drain-to-Source Voltage

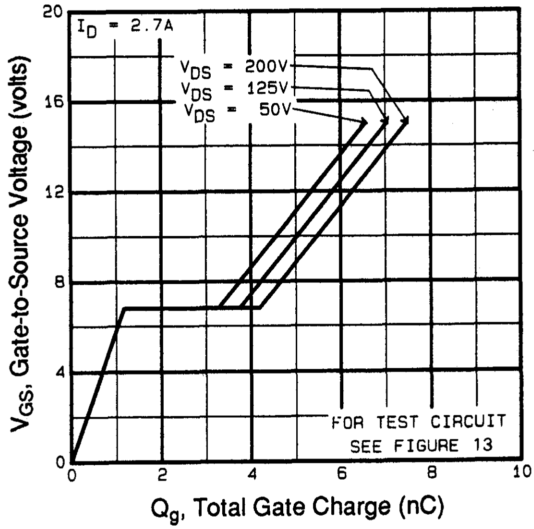


Fig 6. Typical Gate Charge Vs. Gate-to-Source Voltage

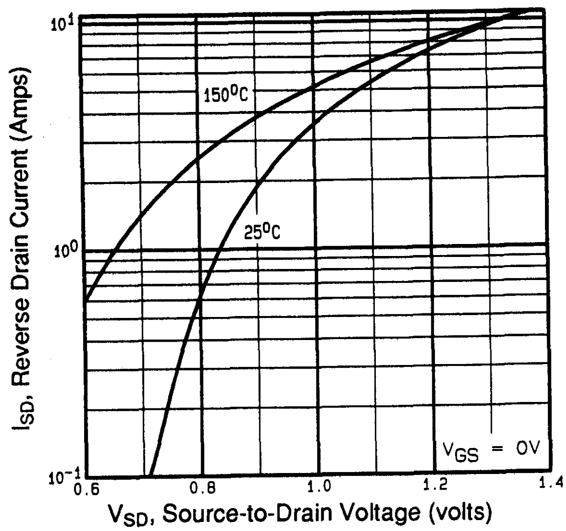


Fig 7. Typical Source-Drain Diode Forward Voltage

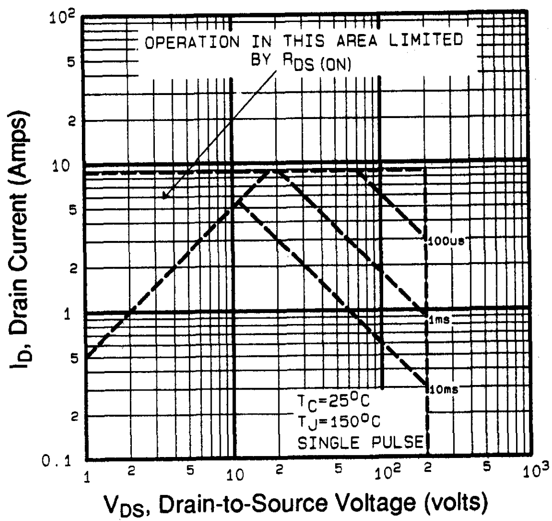


Fig 8. Maximum Safe Operating Area

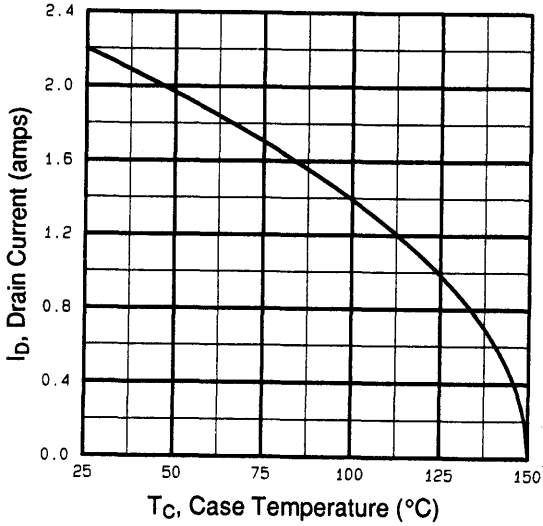


Fig 9. Maximum Drain Current Vs. Case Temperature

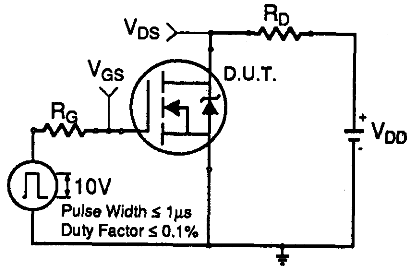


Fig 10a. Switching Time Test Circuit

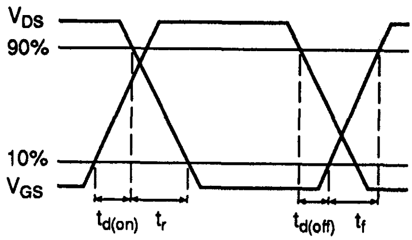


Fig 10b. Switching Time Waveforms

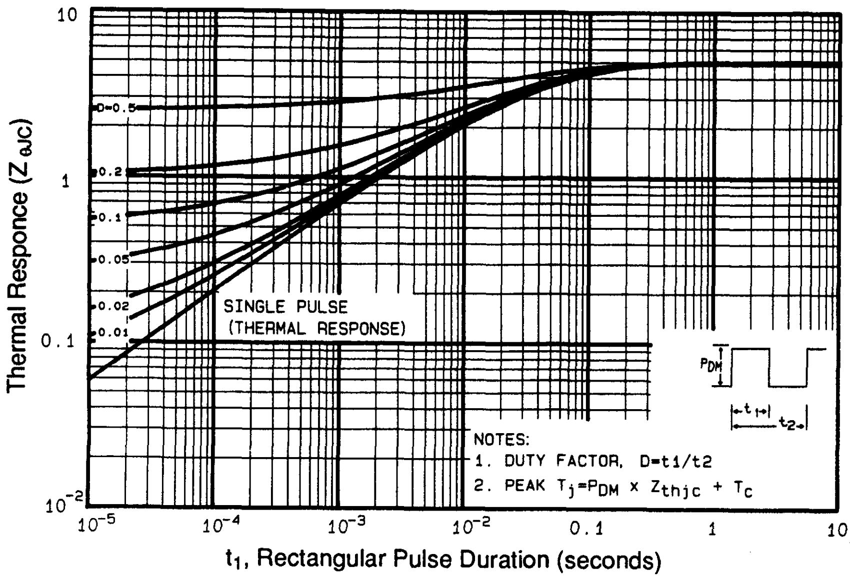


Fig 11. Maximum Effective Transient Thermal Impedance, Junction-to-Case

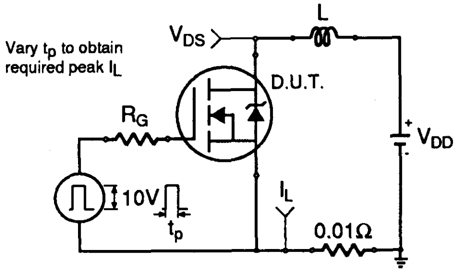


Fig 12a. Unclamped Inductive Test Circuit

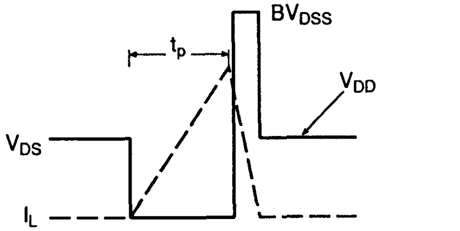


Fig 12b. Unclamped Inductive Waveforms

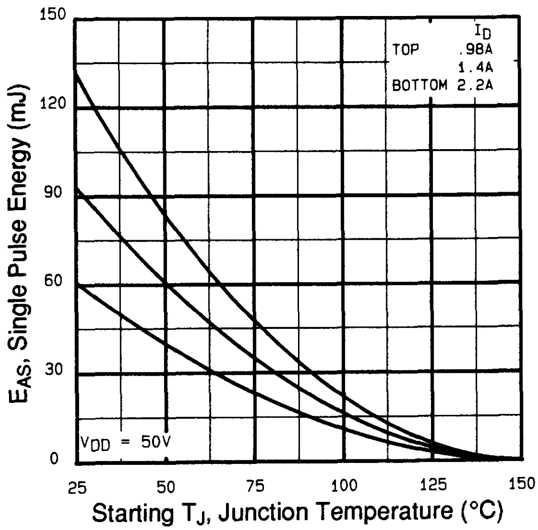


Fig 12c. Maximum Avalanche Energy vs. Drain Current

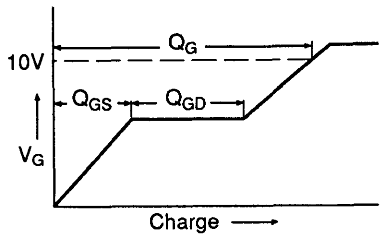


Fig 13a. Basic Gate Charge Waveform

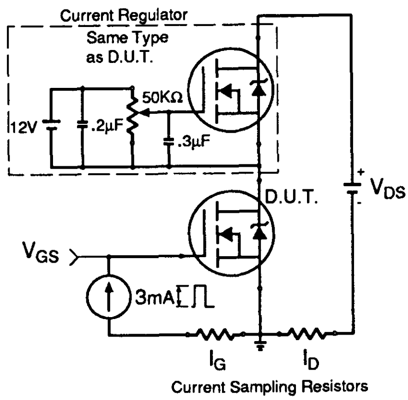


Fig 13b. Gate Charge Test Circuit

Appendix A: Figure 14, Peak Diode Recovery dv/dt Test Circuit

Appendix B: Package Outline Mechanical Drawing

Appendix C: Tape & Reel Information

Appendix D: Part Marking Information

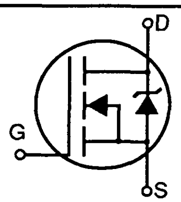
International IOR Rectifier

International
IOR Rectifier

IRFR220
IRFU220

HEXFET® Power MOSFET

- Surface Mount (IRFR220)
- Straight Lead (IRFU220)
- Repetitive Avalanche Rated
- Dynamic dv/dt Rated



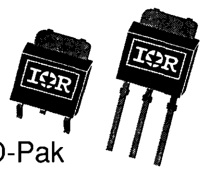
n-channel

BV_{DSS}	200V
$R_{DS(on)}$	0.80Ω
I_D	4.8A

Description

Third Generation HEXFETs from International Rectifier provide the designer with the best combination of fast switching speed, ruggedized device design, and low on resistance.

The D-Pak is designed for surface mounting using vapor phase, infra red, or wave soldering techniques. The straight lead version (IRFU series) is for through hole mounting applications. Power dissipation levels up to 2 watts are possible in SMD applications.



D-Pak
TO-252AA
I-Pak
TO-251AA

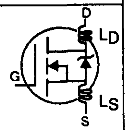
Absolute Maximum Ratings

	Parameter	Max.	Units
I_D @ T_C = 25°C	Continuous Drain Current, V_{GS}@10V	4.8	A
I_D @ T_C = 100°C	Continuous Drain Current, V_{GS}@10V	3.0	
I_{DM}	Pulsed Drain Current ①	18	
P_D@ T_C = 25°C	Maximum Power Dissipation	42	W
	Linear Derating Factor	0.33	W/K⑥
V_{GS}	Gate-to-Source Breakdown Voltage	±20	V
E_{AS}	Single Pulse Avalanche Energy ②	130	mJ
I_{AR}	Avalanche Current ①	4.8	A
E_{AR}	Repetitive Avalanche Energy ①	4.2	mJ
dv/dt	Peak Diode Recovery dv/dt ③	5.0	V/ns
T_J T_{STG}	Operating Junction and Storage Temperature Range	-55 to +150	°C
	Soldering Temperature, for 10 sec.	300 (0.063 in. (1.6mm) from case)	

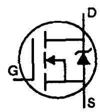
Thermal Resistance

	Parameter	Min.	Typ.	Max.	Units
$R_{\theta JC}$	Junction-to-Case	---	---	3.0	K/W⑥
$R_{\theta CS}$	Case-to-Sink ⑤	---	1.7	---	
$R_{\theta JA}$	Junction-to-Ambient, Typical Socket Mount	---	---	110	

Electrical Characteristics @ T_J = 25°C (unless otherwise specified)

	Parameter	Min.	Typ.	Max.	Units	Test Conditions
BV_{DSS}	Drain-to-Source Breakdown Voltage	200	---	---	V	V_{GS}=0V, I_D=250µA
$\Delta BV_{DSS}/\Delta T_J$	Temp. Coefficient of Breakdown Voltage	---	0.29	---	V/°C	Reference to 25°C, I_D=1mA
$R_{DS(on)}$	Static Drain-to-Source On Resistance	---	---	0.80	Ω	V_{GS}=10V, I_D =2.9A④
$V_{GS(th)}$	Gate Threshold Voltage	2.0	---	4.0	V	V_{DS}=V_{GS}, I_D=250µA
g_{fs}	Forward Transconductance	1.7	---	---	S	V_{DS}=50V, I_{DS}=2.9A④
I_{DSS}	Zero Gate Voltage Collector Current	---	---	250	µA	V_{DS}=200V, V_{GS}=0V
		---	---	1000		V_{DS}=160V, V_{GS}=0V,T_J=125°C
I_{GSS}	Gate-to-Source Forward Leakage	---	---	500	nA	V_{GS}=20V
	Gate-to-Source Reverse Leakage	---	---	-500		V_{GS}=-20V
Q_g	Total Gate Charge	---	---	14	nC	I_D=5.2A, V_{DS}=160V, V_{GS}=10V④
Q_{gs}	Gate-to-Source Charge	---	---	3.0		
Q_{gd}	Gate-to-Drain ("Miller") Charge	---	---	7.9		
$t_{d(on)}$	Turn-On Delay Time	---	7.2	---	ns	V_{DD}=100V, I_D=5.2A R_G=18Ω, R_D=19Ω④
t_r	Rise Time	---	22	---		
$t_{d(off)}$	Turn-Off Delay Time	---	19	---		
t_f	Fall Time	---	13	---		
L_D	Internal Drain Inductance	---	4.5	---	nH	Between lead, 6mm (0.25in.) from package, and center of die contact. 
L_S	Internal Source Inductance	---	7.5	---		
C_{iss}	Input Capacitance	---	260	---	pF	V_{GS}=0V, V_{DS}=25V f=1.0Mhz
C_{oss}	Output Capacitance	---	100	---		
C_{rss}	Reverse Transfer Capacitance	---	30	---		

Source-Drain Diode Ratings and Characteristics

	Parameter	Min.	Typ.	Max.	Units	Test Conditions
I_S	Continuous Source Current (Body Diode)	---	---	4.8	A	MOSFET symbol showing the integral reverse p-n junction diode. 
I_{SM}	Pulsed Source Current (Body Diode) ①	---	---	18		
V_{SD}	Diode Forward Voltage	---	---	1.8	V	T_J=25°C, I_S=4.8A, V_{GS}=0V④
t_{rr}	Reverse Recovery Time	75	---	300	ns	T_J=25°C, I_F=5.2A, di/dt=100A/µS④
Q_{RR}	Reverse Recovery Charge	0.46	---	1.8	µC	
t_{on}	Forward Turn-On Time	Intrinsic turn-on time is negligible (turn-on is dominated by L_S + L_D)				

Notes:

① Repetitive rating; Pulse width limited by max. junction temperature

② V_{DD}=50V, Starting T_J=25°C, L=8.5mH, R_G=25Ω, Peak I_{AS}=4.8A

③ I_{SD}≤4.8A, di/dt≤95A/µs, V_{DD}≤BV_{DSS}, T_J≤150°C Suggested R_G=18Ω

④ Pulse width ≤ 300µs; duty Cycle ≤2%

⑤ Mounting surface: flat, smooth, greased

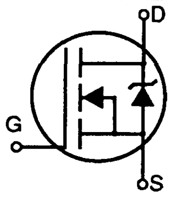
⑥ K/W = °C/W

International IOR Rectifier

IRFR224
IRFU224

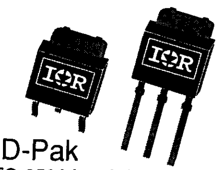
HEXFET® Power MOSFET

- Surface Mount (IRFR224)
- Straight Lead (IRFU224)
- Repetitive Avalanche Rated
- Dynamic dv/dt Rated



n-channel

BV_{DSS}	250V
$R_{DS(on)}$	1.1Ω
I_D	3.8A



D-Pak TO-252AA

I-Pak TO-251AA

Description

Third Generation HEXFETs from International Rectifier provide the designer with the best combination of fast switching speed, ruggedized device design, and low on resistance.

The D-Pak is designed for surface mounting using vapor phase, infra red, or wave soldering techniques. The straight lead version (IRFU series) is for through hole mounting applications. Power dissipation levels up to 2 watts are possible in SMD applications.

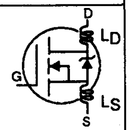
Absolute Maximum Ratings

	Parameter	Max.	Units
I_D @ T_C = 25°C	Continuous Drain Current, V_{GS}@10V	3.8	A
I_D @ T_C = 100°C	Continuous Drain Current, V_{GS}@10V	2.4	
I_{DM}	Pulsed Drain Current ①	14	
P_D@ T_C = 25°C	Maximum Power Dissipation	42	W
	Linear Derating Factor	0.33	W/K⑥
V_{GS}	Gate-to-Source Breakdown Voltage	±20	V
E_{AS}	Single Pulse Avalanche Energy ②	130	mJ
I_{AR}	Avalanche Current ①	3.8	A
E_{AR}	Repetitive Avalanche Energy ①	4.2	mJ
dv/dt	Peak Diode Recovery dv/dt ③	4.8	V/ns
T_J T_{STG}	Operating Junction and Storage Temperature Range	-55 to +150	°C
	Soldering Temperature, for 10 sec.	300 (0.063 in. (1.6mm) from case)	

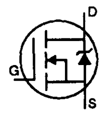
Thermal Resistance

	Parameter	Min.	Typ.	Max.	Units
$R_{\theta JC}$	Junction-to-Case	---	---	3.0	K/W⑥
$R_{\theta CS}$	Case-to-Sink ⑤	---	1.7	---	
$R_{\theta JA}$	Junction-to-Ambient, Typical Socket Mount	---	---	110	

Electrical Characteristics @ $T_J = 25°C$ (unless otherwise specified)

	Parameter	Min.	Typ.	Max.	Units	Test Conditions
BV_{DSS}	Drain-to-Source Breakdown Voltage	250	---	---	V	V_{GS}=0V, I_D=250μA
$\Delta BV_{DSS}/\Delta T_J$	Temp. Coefficient of Breakdown Voltage	---	0.36	---	V/°C	Reference to 25°C, I_D=1mA
$R_{DS(on)}$	Static Drain-to-Source On Resistance	---	---	1.1	Ω	V_{GS}=10V, I_D =2.3A④
$V_{GS(th)}$	Gate Threshold Voltage	2.0	---	4.0	V	V_{DS}=V_{GS}, I_D=250μA
g_{fs}	Forward Transconductance	1.7	---	---	S	V_{DS}=5.0V, I_{DS}=2.3A④
I_{DSS}	Zero Gate Voltage Collector Current	---	---	250	μA	V_{DS}=250V, V_{GS}=0V
		---	---	1000		V_{DS}=200V, V_{GS}=0V,T_J=125°C
I_{GSS}	Gate-to-Source Forward Leakage	---	---	500	nA	V_{GS}=20V
	Gate-to-Source Reverse Leakage	---	---	-500		V_{GS}=-20V
Q_g	Total Gate Charge	---	---	14	nC	I_D=4.4A, V_{DS}=200V, V_{GS}=10V④
Q_{gs}	Gate-to-Source Charge	---	---	2.7		
Q_{gd}	Gate-to-Drain ("Miller") Charge	---	---	7.8		
$t_{d(on)}$	Turn-On Delay Time	---	7.0	---	ns	V_{DD}=125V, I_D=4.4A R_G=18Ω, R_D=28Ω④
t_r	Rise Time	---	13	---		
$t_{d(off)}$	Turn-Off Delay Time	---	20	---		
t_f	Fall Time	---	12	---		
L_D	Internal Drain Inductance	---	4.5	---	nH	Between lead, 6mm (0.25in.) from package, and center of die contact. 
L_S	Internal Source Inductance	---	7.5	---		
C_{iss}	Input Capacitance	---	260	---	pF	V_{GS}=0V, V_{DS}=25V f=1.0Mhz
C_{oss}	Output Capacitance	---	77	---		
C_{rss}	Reverse Transfer Capacitance	---	15	---		

Source-Drain Diode Ratings and Characteristics

	Parameter	Min.	Typ.	Max.	Units	Test Conditions
I_S	Continuous Source Current (Body Diode)	---	---	3.8	A	MOSFET symbol showing the integral reverse p-n junction diode. 
I_{SM}	Pulsed Source Current (Body Diode) ①	---	---	14		
V_{SD}	Diode Forward Voltage	---	---	1.8	V	T_J=25°C, I_S=3.8A, V_{GS}=0V④
t_{rr}	Reverse Recovery Time	100	---	400	ns	T_J=25°C, I_F=4.4A, di/dt=100A/μS④
Q_{RR}	Reverse Recovery Charge	0.47	---	1.9	μC	
t_{on}	Forward Turn-On Time	Intrinsic turn-on time is negligible (turn-on is dominated by L_S + L_D)				

Notes:

① Repetitive rating; Pulse width limited by max. junction temperature

② V_{DD}=50V, Starting T_J=25°C, L=14mH, R_G=25Ω, Peak I_{AS}=3.8A

③ I_{SD}≤3.8A, di/dt≤90A/μs, V_{DD}≤BV_{DSS}, T_J≤150°C Suggested R_G=18Ω

④ Pulse width ≤ 300μs; duty Cycle ≤2%

⑤ Mounting surface: flat, smooth, greased

⑥ K/W = °C/W

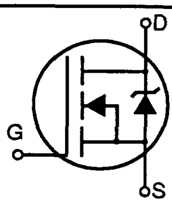
PD-9.597

International
IOR Rectifier

IRFR310
IRFU310

HEXFET® Power MOSFET

- Surface Mount (IRFR310)
- Straight Lead (IRFU310)
- Repetitive Avalanche Rated
- Dynamic dv/dt Rated



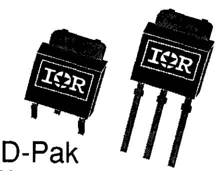
n-channel

BV_{DSS} 400V
$R_{DS(on)}$ 3.6Ω
I_D 1.7A

Description

Third Generation HEXFETs from International Rectifier provide the designer with the best combination of fast switching speed, ruggedized device design, and low on resistance.

The D-Pak is designed for surface mounting using vapor phase, infra red, or wave soldering techniques. The straight lead version (IRFU series) is for through hole mounting applications. Power dissipation levels up to 2 watts are possible in SMD applications.


D-Pak
TO-252AA
I-Pak
TO-251AA

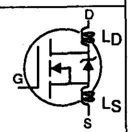
Absolute Maximum Ratings

	Parameter	Max.	Units
I_D @ T_C = 25°C	Continuous Drain Current, V_{GS}@10V	1.7	A
I_D @ T_C = 100°C	Continuous Drain Current, V_{GS}@10V	1.1	
I_{DM}	Pulsed Drain Current ①	5.0	
P_D@ T_C = 25°C	Maximum Power Dissipation	25	W
	Linear Derating Factor	0.20	W/K⑥
V_{GS}	Gate-to-Source Breakdown Voltage	±20	V
E_{AS}	Single Pulse Avalanche Energy ②	86	mJ
I_{AR}	Avalanche Current ①	1.7	A
E_{AR}	Repetitive Avalanche Energy ①	2.5	mJ
dv/dt	Peak Diode Recovery dv/dt ③	4.0	V/ns
T_J T_{STG}	Operating Junction and Storage Temperature Range	-55 to +150	°C
	Soldering Temperature, for 10 sec.	300 (0.063 in. (1.6mm) from case)	

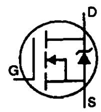
Thermal Resistance

	Parameter	Min.	Typ.	Max.	Units
$R_{θJC}$	Junction-to-Case	---	---	5.0	K/W⑥
$R_{θCS}$	Case-to-Sink ⑤	---	1.7	---	
$R_{θJA}$	Junction-to-Ambient, Typical Socket Mount	---	---	110	

Electrical Characteristics @ T_J = 25°C (unless otherwise specified)

	Parameter	Min.	Typ.	Max.	Units	Test Conditions
BV_{DSS}	Drain-to-Source Breakdown Voltage	400	---	---	V	V_{GS}=0V, I_D=250μA
$\Delta BV_{DSS}/\Delta T_J$	Temp. Coefficient of Breakdown Voltage	---	0.47	---	V/°C	Reference to 25°C, I_D=1mA
$R_{DS(on)}$	Static Drain-to-Source On Resistance	---	---	3.6	Ω	V_{GS}=10V, I_D =1.0A④
$V_{GS(th)}$	Gate Threshold Voltage	2.0	---	4.0	V	V_{DS}=V_{GS}, I_D=250μA
g_{fs}	Forward Transconductance	0.97	---	---	S	V_{DS}=50V, I_{DS}=1.0A④
I_{DSS}	Zero Gate Voltage Collector Current	---	---	250	μA	V_{DS}=400V, V_{GS}=0V
		---	---	1000		V_{DS}=320V, V_{GS}=0V, T_J=125°C
I_{GSS}	Gate-to-Source Forward Leakage	---	---	500	nA	V_{GS}=20V
	Gate-to-Source Reverse Leakage	---	---	-500		V_{GS}=-20V
Q_g	Total Gate Charge	---	---	12	nC	I_D=2.0A, V_{DS}=320V, V_{GS}=10V④
Q_{gs}	Gate-to-Source Charge	---	---	1.9		
Q_{gd}	Gate-to-Drain ("Miller") Charge	---	---	6.5		
$t_{d(on)}$	Turn-On Delay Time	---	7.9	---	ns	V_{DD}=200V, I_D=2.0A R_G=24Ω, R_D=95Ω④
t_r	Rise Time	---	9.9	---		
$t_{d(off)}$	Turn-Off Delay Time	---	21	---		
t_f	Fall Time	---	11	---		
L_D	Internal Drain Inductance	---	4.5	---	nH	Between lead, 6mm (0.25in.) from package, and center of die contact. 
L_S	Internal Source Inductance	---	7.5	---		
C_{iss}	Input Capacitance	---	170	---	pF	V_{GS}=0V, V_{DS}=25V *ƒ*=1.0Mhz
C_{oss}	Output Capacitance	---	34	---		
C_{rss}	Reverse Transfer Capacitance	---	6.3	---		

Source-Drain Diode Ratings and Characteristics

	Parameter	Min.	Typ.	Max.	Units	Test Conditions
I_S	Continuous Source Current (Body Diode)	---	---	1.7	A	MOSFET symbol showing the integral reverse p-n junction diode. 
I_{SM}	Pulsed Source Current (Body Diode) ①	---	---	4.3		
V_{SD}	Diode Forward Voltage	---	---	1.6	V	T_J=25°C, I_S=1.7A, V_{GS}=0V④
t_{rr}	Reverse Recovery Time	120	---	540	ns	T_J=25°C, I_F=2.0A, di/dt=100A/μS④
Q_{RR}	Reverse Recovery Charge	0.32	---	1.6	μC	
t_{on}	Forward Turn-On Time	Intrinsic turn-on time is negligible (turn-on is dominated by L_S + L_D)				

Notes:

① Repetitive rating; Pulse width limited by max. junction temperature

② V_{DD}=50V, Starting T_J=25°C, L=32mH, R_G=25Ω, Peak I_{AS}=1.7A

③ I_{SD}≤1.7A, di/dt≤40A/μs, V_{DD}≤BV_{DSS}, T_J≤150°C Suggested R_G=24Ω

④ Pulse width ≤ 300μs; duty Cycle ≤2%

⑤ Mounting surface: flat, smooth, greased

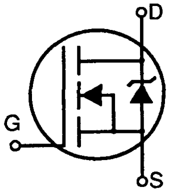
⑥ K/W = °C/W

International
IOR Rectifier

IRFR320
IRFU320

HEXFET® Power MOSFET

- Surface Mount (IRFR320)
- Straight Lead (IRFU320)
- Repetitive Avalanche Rated
- Dynamic dv/dt Rated



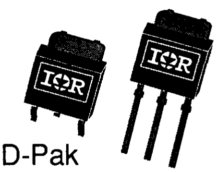
n-channel

BV_{DSS}	400V
$R_{DS(on)}$	1.8Ω
I_D	3.1A

Description

Third Generation HEXFETs from International Rectifier provide the designer with the best combination of fast switching speed, ruggedized device design, and low on resistance.

The D-Pak is designed for surface mounting using vapor phase, infra red, or wave soldering techniques. The straight lead version (IRFU series) is for through hole mounting applications. Power dissipation levels up to 2 watts are possible in SMD applications.



D-Pak
TO-252AA
I-Pak
TO-251AA

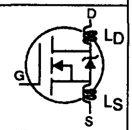
Absolute Maximum Ratings

	Parameter	Max.	Units
I_D @ T_C = 25°C	Continuous Drain Current, V_{GS}@10V	3.1	A
I_D @ T_C = 100°C	Continuous Drain Current, V_{GS}@10V	2.0	
I_{DM}	Pulsed Drain Current ①	11	
P_D@ T_C = 25°C	Maximum Power Dissipation	42	W
	Linear Derating Factor	0.33	W/K⑥
V_{GS}	Gate-to-Source Breakdown Voltage	±20	V
E_{AS}	Single Pulse Avalanche Energy ②	160	mJ
I_{AR}	Avalanche Current ①	3.1	A
E_{AR}	Repetitive Avalanche Energy ①	4.2	mJ
dv/dt	Peak Diode Recovery dv/dt ③	4.0	V/ns
T_J T_{STG}	Operating Junction and Storage Temperature Range	-55 to +150	°C
	Soldering Temperature, for 10 sec.	300 (0.063 in. (1.6mm) from case)	

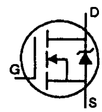
Thermal Resistance

	Parameter	Min.	Typ.	Max.	Units
$R_{\theta JC}$	Junction-to-Case	---	---	3.0	K/W⑥
$R_{\theta CS}$	Case-to-Sink ⑤	---	1.7	---	
$R_{\theta JA}$	Junction-to-Ambient, Typical Socket Mount	---	---	110	

Electrical Characteristics @ T_J = 25°C (unless otherwise specified)

	Parameter	Min.	Typ.	Max.	Units	Test Conditions
BV_{DSS}	Drain-to-Source Breakdown Voltage	400	---	---	V	V_{GS}=0V, I_D=250µA
$\Delta BV_{DSS}/\Delta T_J$	Temp. Coefficient of Breakdown Voltage	---	0.51	---	V/°C	Reference to 25°C, I_D=1mA
$R_{DS(on)}$	Static Drain-to-Source On Resistance	---	---	1.8	Ω	V_{GS}=10V, I_D =1.9A④
$V_{GS(th)}$	Gate Threshold Voltage	2.0	---	4.0	V	V_{DS}=V_{GS}, I_D=250µA
g_{fs}	Forward Transconductance	1.5	---	---	S	V_{DS}=50V, I_{DS}=1.9A④
I_{DSS}	Zero Gate Voltage Collector Current	---	---	250	µA	V_{DS}=400V, V_{GS}=0V
		---	---	1000		V_{DS}=320V, V_{GS}=0V,T_J=125°C
I_{GSS}	Gate-to-Source Forward Leakage	---	---	500	nA	V_{GS}=20V
	Gate-to-Source Reverse Leakage	---	---	-500		V_{GS}=-20V
Q_g	Total Gate Charge	---	---	20	nC	I_D=3.3A, V_{DS}=320V, V_{GS}=10V④
Q_{gs}	Gate-to-Source Charge	---	---	3.3		
Q_{gd}	Gate-to-Drain ("Miller") Charge	---	---	11		
$t_{d(on)}$	Turn-On Delay Time	---	10	---	ns	V_{DD}=200V, I_D=3.3A R_G=18Ω, R_D=56Ω④
t_r	Rise Time	---	14	---		
$t_{d(off)}$	Turn-Off Delay Time	---	30	---		
t_f	Fall Time	---	13	---		
L_D	Internal Drain Inductance	---	4.5	---	nH	Between lead, 6mm (0.25in.) from package, and center of die contact. 
L_S	Internal Source Inductance	---	7.5	---		
C_{iss}	Input Capacitance	---	350	---	pF	V_{GS}=0V, V_{DS}=25V f=1.0Mhz
C_{oss}	Output Capacitance	---	64	---		
C_{rss}	Reverse Transfer Capacitance	---	8.1	---		

Source-Drain Diode Ratings and Characteristics

	Parameter	Min.	Typ.	Max.	Units	Test Conditions
I_S	Continuous Source Current (Body Diode)	---	---	3.1	A	MOSFET symbol showing the integral reverse p-n junction diode. 
I_{SM}	Pulsed Source Current (Body Diode) ①	---	---	11		
V_{SD}	Diode Forward Voltage	---	---	1.6	V	T_J=25°C, I_S=3.1A, V_{GS}=0V④
t_{rr}	Reverse Recovery Time	120	---	600	ns	T_J=25°C, I_F=3.3A, di/dt=100A/µS④
Q_{RR}	Reverse Recovery Charge	0.64	---	3.0	µC	
t_{on}	Forward Turn-On Time	Intrinsic turn-on time is negligible (turn-on is dominated by L_S + L_D)				

Notes:

① Repetitive rating; Pulse width limited by max. junction temperature

② V_{DD}=50V, Starting T_J=25°C, L=20mH, R_G=25Ω, Peak I_{AS}=3.1A

③ I_{SD}≤3.1A, di/dt≤65A/µs, V_{DD}≤BV_{DSS}, T_J≤150°C Suggested R_G=18Ω

④ Pulse width ≤ 300µs; duty Cycle ≤2%

⑤ Mounting surface: flat, smooth, greased

⑥ K/W = °C/W

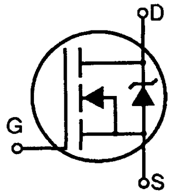
For more information on the same die in a TO-220 package refer to IRF720.

International
IOR Rectifier

IRFR420
IRFU420

HEXFET® Power MOSFET

- Surface Mount (IRFR420)
- Straight Lead (IRFU420)
- Repetitive Avalanche Rated
- Dynamic dv/dt Rated



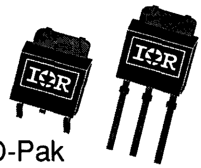
n-channel

BV_{DSS}	500V
$R_{DS(on)}$	3.0Ω
I_D	2.4A

Description

Third Generation HEXFETs from International Rectifier provide the designer with the best combination of fast switching speed, ruggedized device design, and low on resistance.

The D-Pak is designed for surface mounting using vapor phase, infra red, or wave soldering techniques. The straight lead version (IRFU series) is for through hole mounting applications. Power dissipation levels up to 2 watts are possible in SMD applications.



D-Pak TO-252AA
I-Pak TO-251AA

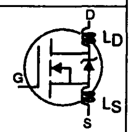
Absolute Maximum Ratings

	Parameter	Max.	Units
I_D @ T_C = 25°C	Continuous Drain Current, V_{GS}@10V	2.4	A
I_D @ T_C = 100°C	Continuous Drain Current, V_{GS}@10V	1.5	
I_{DM}	Pulsed Drain Current ①	8.0	
P_D@ T_C = 25°C	Maximum Power Dissipation	42	W
	Linear Derating Factor	0.33	W/K⑥
V_{GS}	Gate-to-Source Breakdown Voltage	±20	V
E_{AS}	Single Pulse Avalanche Energy ②	170	mJ
I_{AR}	Avalanche Current ①	2.4	A
E_{AR}	Repetitive Avalanche Energy ①	4.2	mJ
dv/dt	Peak Diode Recovery dv/dt ③	3.5	V/ns
T_J T_{STG}	Operating Junction and Storage Temperature Range	-55 to +150	°C
	Soldering Temperature, for 10 sec.	300 (0.063 in. (1.6mm) from case)	

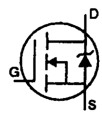
Thermal Resistance

	Parameter	Min.	Typ.	Max.	Units
$R_{\theta JC}$	Junction-to-Case	---	---	3.0	K/W⑥
$R_{\theta CS}$	Case-to-Sink ⑤	---	1.7	---	
$R_{\theta JA}$	Junction-to-Ambient, Typical Socket Mount	---	---	110	

Electrical Characteristics @ T_J = 25°C (unless otherwise specified)

	Parameter	Min.	Typ.	Max.	Units	Test Conditions
BV_{DSS}	Drain-to-Source Breakdown Voltage	500	---	---	V	V_{GS}=0V, I_D=250µA
$\Delta BV_{DSS}/\Delta T_J$	Temp. Coefficient of Breakdown Voltage	---	0.59	---	V/°C	Reference to 25°C, I_D=1mA
$R_{DS(on)}$	Static Drain-to-Source On Resistance	---	---	3.0	Ω	V_{GS}=10V, I_D =1.4A④
$V_{GS(th)}$	Gate Threshold Voltage	2.0	---	4.0	V	V_{DS}=V_{GS}, I_D=250µA
g_{fs}	Forward Transconductance	1.0	---	---	S	V_{DS}=50V, I_{DS}=1.4A④
I_{DSS}	Zero Gate Voltage Collector Current	---	---	250	µA	V_{DS}=500V, V_{GS}=0V
		---	---	1000		V_{DS}=400V, V_{GS}=0V, T_J=125°C
I_{GSS}	Gate-to-Source Forward Leakage	---	---	500	nA	V_{GS}=20V
	Gate-to-Source Reverse Leakage	---	---	-500		V_{GS}=-20V
Q_g	Total Gate Charge	---	---	19	nC	I_D=2.1A, V_{DS}=400V, V_{GS}=10V④
Q_{gs}	Gate-to-Source Charge	---	---	3.3		
Q_{gd}	Gate-to-Drain ("Miller") Charge	---	---	13		
$t_{d(on)}$	Turn-On Delay Time	---	8.0	---	ns	V_{DD}=250V, I_D=2.1A R_G=18Ω, R_D=120Ω④
t_r	Rise Time	---	8.6	---		
$t_{d(off)}$	Turn-Off Delay Time	---	33	---		
t_f	Fall Time	---	16	---		
L_D	Internal Drain Inductance	---	4.5	---	nH	Between lead, 6mm (0.25in.) from package, and center of die contact. 
L_S	Internal Source Inductance	---	7.5	---		
C_{iss}	Input Capacitance	---	360	---	pF	V_{GS}=0V, V_{DS}=25V f=1.0Mhz
C_{oss}	Output Capacitance	---	92	---		
C_{rss}	Reverse Transfer Capacitance	---	37	---		

Source-Drain Diode Ratings and Characteristics

	Parameter	Min.	Typ.	Max.	Units	Test Conditions
I_S	Continuous Source Current (Body Diode)	---	---	2.4	A	MOSFET symbol showing the integral reverse p-n junction diode. 
I_{SM}	Pulsed Source Current (Body Diode) ①	---	---	8.0		
V_{SD}	Diode Forward Voltage	---	---	1.6	V	T_J=25°C, I_S=2.4A, V_{GS}=0V④
t_{rr}	Reverse Recovery Time	130	---	520	ns	T_J=25°C, I_F=2.1A, di/dt=100A/µS④
Q_{RR}	Reverse Recovery Charge	0.35	---	1.4	µC	
t_{on}	Forward Turn-On Time	Intrinsic turn-on time is negligible (turn-on is dominated by L_S + L_D)				

Notes:

① Repetitive rating; Pulse width limited by max. junction temperature

② V_{DD}=50V, Starting T_J=25°C, L=34mH, R_G=25Ω, Peak I_{AS}=2.4A

③ I_{SD}≤2.4A, di/dt≤50A/µs, V_{DD}≤BV_{DSS}, T_J≤150°C Suggested R_G=18Ω

④ Pulse width ≤ 300µs; duty Cycle ≤2%

⑤ Mounting surface: flat, smooth, greased

⑥ K/W = °C/W

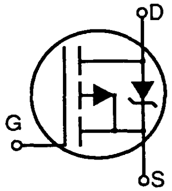
For more information on the same die in a TO-220 package refer to IRF820.

International
IOR Rectifier

IRFR9014
IRFU9014

HEXFET® Power MOSFET

- Surface Mount (IRFR9014)
- Straight Lead (IRFU9014)
- Repetitive Avalanche Rated
- Dynamic dv/dt Rated
- P-Channel



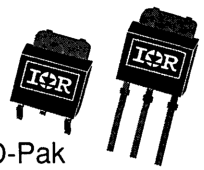
p-channel

BV_{DSS} = -60V
$R_{DS(on)}$ = 0.50Ω
I_D = -5.6A

Description

Third Generation HEXFETs from International Rectifier provide the designer with the best combination of fast switching speed, ruggedized device design, and low on resistance.

The D-Pak is designed for surface mounting using vapor phase, infra red, or wave soldering techniques. The straight lead version (IRFU series) is for through hole mounting applications. Power dissipation levels up to 2 watts are possible in SMD applications.



D-Pak
TO-252AA
I-Pak
TO-251AA

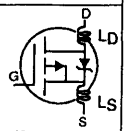
Absolute Maximum Ratings

	Parameter	Max.	Units
I_D @ T_C = 25°C	Continuous Drain Current, V_{GS}@-10V	-5.6	A
I_D @ T_C = 100°C	Continuous Drain Current, V_{GS}@-10V	-3.9	
I_{DM}	Pulsed Drain Current ①	-22	
P_D@ T_C = 25°C	Maximum Power Dissipation	30	W
	Linear Derating Factor	0.20	W/K⑥
V_{GS}	Gate-to-Source Breakdown Voltage	±20	V
E_{AS}	Single Pulse Avalanche Energy ②	140	mJ
I_{AR}	Avalanche Current ①	-5.6	A
E_{AR}	Repetitive Avalanche Energy ①	3.0	mJ
dv/dt	Peak Diode Recovery dv/dt ③	-4.5	V/ns
T_J T_{STG}	Operating Junction and Storage Temperature Range	-55 to +175	°C
	Soldering Temperature, for 10 sec.	300 (0.063 in. (1.6mm) from case)	

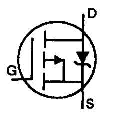
Thermal Resistance

	Parameter	Min.	Typ.	Max.	Units
$R_{\theta JC}$	Junction-to-Case	---	---	5.0	K/W⑥
$R_{\theta CS}$	Case-to-Sink ⑤	---	1.7	---	
$R_{\theta JA}$	Junction-to-Ambient, Typical Socket Mount	---	---	110	

Electrical Characteristics @ T_J = 25°C (unless otherwise specified)

	Parameter	Min.	Typ.	Max.	Units	Test Conditions
BV_{DSS}	Drain-to-Source Breakdown Voltage	-60	---	---	V	V_{GS}=0V, I_D=-250µA
$\Delta BV_{DSS}/\Delta T_J$	Temp. Coefficient of Breakdown Voltage	---	0.061	---	V/°C	Reference to 25°C, I_D=-1mA
$R_{DS(on)}$	Static Drain-to-Source On Resistance	---	---	0.50	Ω	V_{GS}=-10V, I_D =-3.4A④
$V_{GS(th)}$	Gate Threshold Voltage	-2.0	---	-4.0	V	V_{DS}=V_{GS}, I_D=-250µA
g_{fs}	Forward Transconductance	1.4	---	---	S	V_{DS}=-25V, I_{DS}=-3.4A④
I_{DSS}	Zero Gate Voltage Collector Current	---	---	-250	µA	V_{DS}=-60V, V_{GS}=0V
		---	---	-1000		V_{DS}=-48V, V_{GS}=0V,T_J=150°C
I_{GSS}	Gate-to-Source Forward Leakage	---	---	-500	nA	V_{GS}=-20V
	Gate-to-Source Reverse Leakage	---	---	500		V_{GS}=20V
Q_g	Total Gate Charge	---	---	10	nC	I_D=-5.6A, V_{DS}=-48V, V_{GS}=-10V See Fig 6 and 13④
Q_{gs}	Gate-to-Source Charge	---	---	2.6		
Q_{gd}	Gate-to-Drain ("Miller") Charge	---	---	5.7		
$t_{d(on)}$	Turn-On Delay Time	---	11	---	ns	V_{DD}=-30V, I_D=-5.6A R_G=24Ω, R_D=4.9Ω See Fig. 10④
t_r	Rise Time	---	40	---		
$t_{d(off)}$	Turn-Off Delay Time	---	13	---		
t_f	Fall Time	---	17	---		
L_D	Internal Drain Inductance	---	4.5	---	nH	Between lead, 6mm (0.25in.) from package, and center of die contact. 
L_S	Internal Source Inductance	---	7.5	---		
C_{iss}	Input Capacitance	---	280	---	pF	V_{GS}=0V, V_{DS}=-25V
C_{oss}	Output Capacitance	---	170	---		f=1.0Mhz
C_{rss}	Reverse Transfer Capacitance	---	37	---		See Fig. 5

Source-Drain Diode Ratings and Characteristics

	Parameter	Min.	Typ.	Max.	Units	Test Conditions
I_S	Continuous Source Current (Body Diode)	---	---	-5.6	A	MOSFET symbol showing the integral reverse p-n junction diode. 
I_{SM}	Pulsed Source Current (Body Diode) ①	---	---	-22		
V_{SD}	Diode Forward Voltage	---	---	-5.5	V	T_J=25°C, I_S=-5.6A, V_{GS}=0V④
t_{rr}	Reverse Recovery Time	35	---	140	ns	T_J=25°C, I_F=-5.6A,
Q_{RR}	Reverse Recovery Charge	0.049	---	0.20	µC	di/dt=-100A/µS④
t_{on}	Forward Turn-On Time	Intrinsic turn-on time is negligible (turn-on is dominated by L_S + L_D)				

Notes:

① Repetitive rating; Pulse width limited by max. junction temperature (See figure 11)

② V_{DD}=-25V, Starting T_J=25°C, L=5.3mH, R_G=25Ω, Peak I_{AS}=-5.6A (See figure 12)

③ I_{SD}≤-5.6A, di/dt≤-90A/µs, V_{DD}≤BV_{DSS}, T_J≤175°C Suggested R_G=24Ω

④ Pulse width ≤ 300µs; duty Cycle ≤2%

⑤ Mounting surface: flat, smooth, greased

⑥ K/W = °C/W

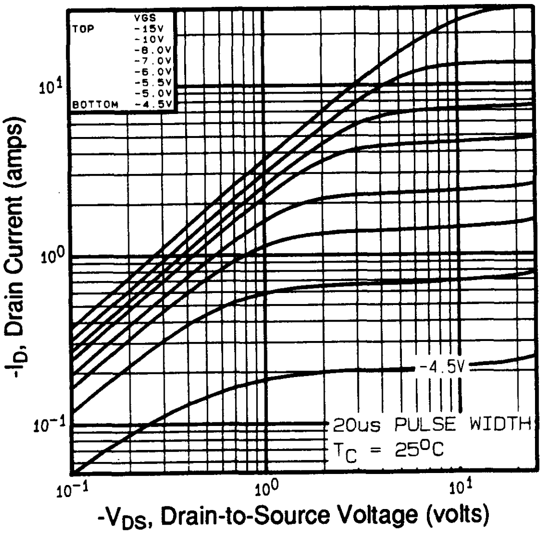


Fig 1. Typical Output Characteristics, $T_C = 25°C$

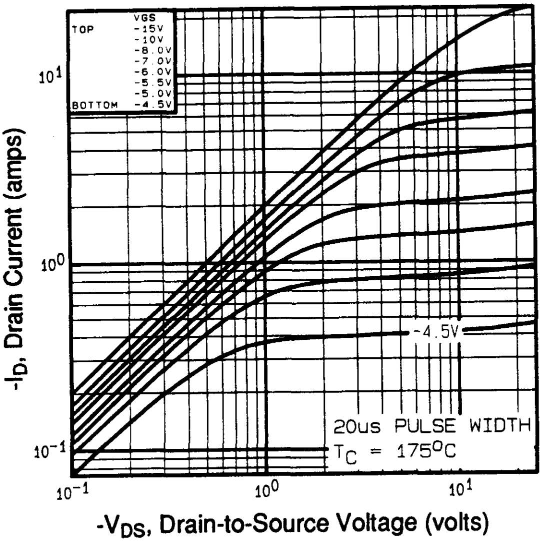


Fig 2. Typical Output Characteristics, $T_C = 150°C$

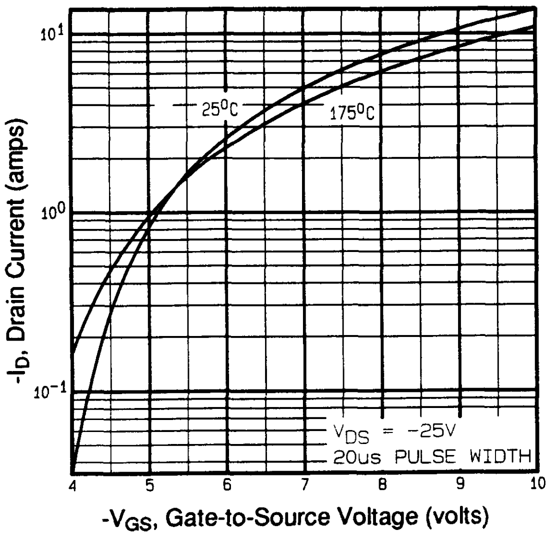


Fig 3. Typical Transfer Characteristics

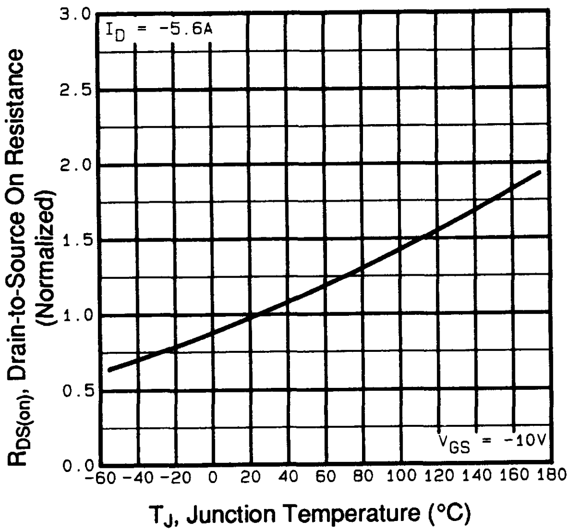


Fig 4. Normalized On-Resistance Vs. Temperature

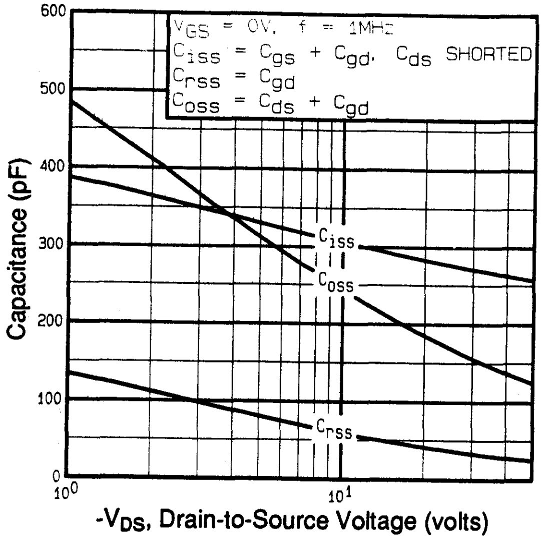


Fig 5. Typical Capacitance Vs. Drain-to-Source Voltage

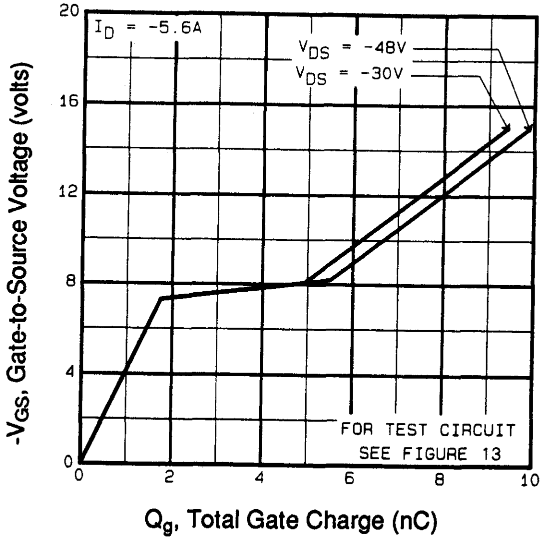


Fig 6. Typical Gate Charge Vs. Gate-to-Source Voltage

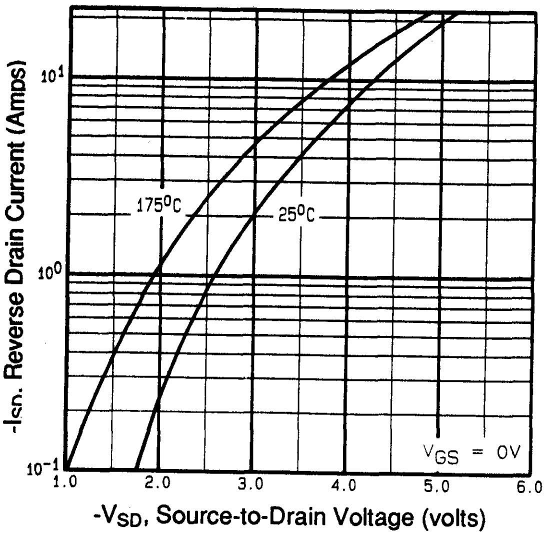


Fig 7. Typical Source-Drain Diode Forward Voltage

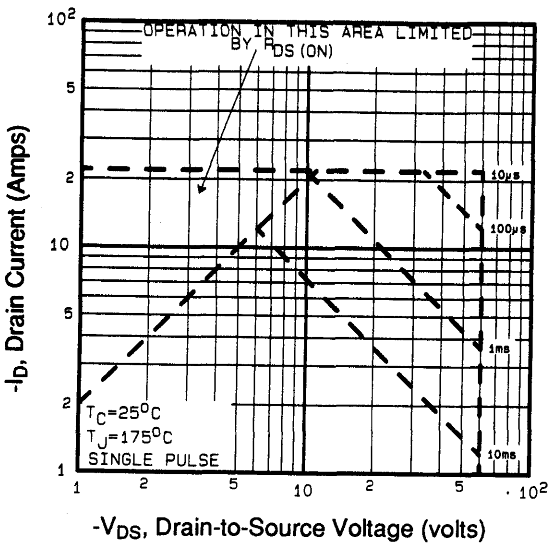


Fig 8. Maximum Safe Operating Area

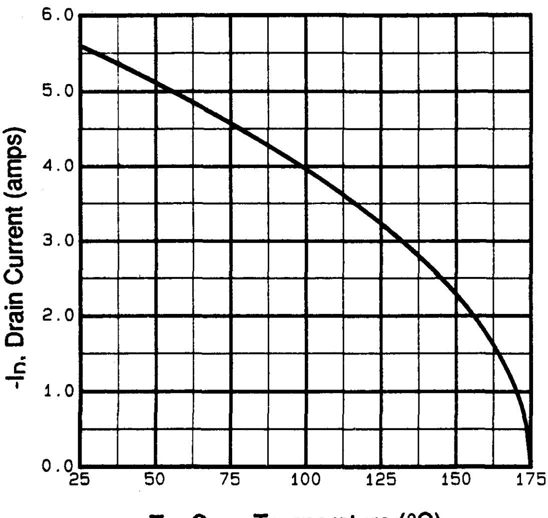


Fig 9. Maximum Drain Current Vs. Case Temperature

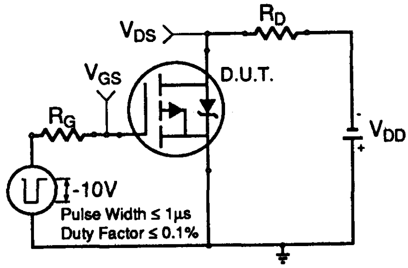


Fig 10a. Switching Time Test Circuit

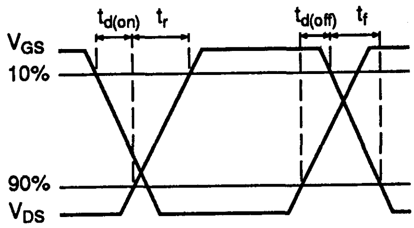


Fig 10b. Switching Time Waveforms

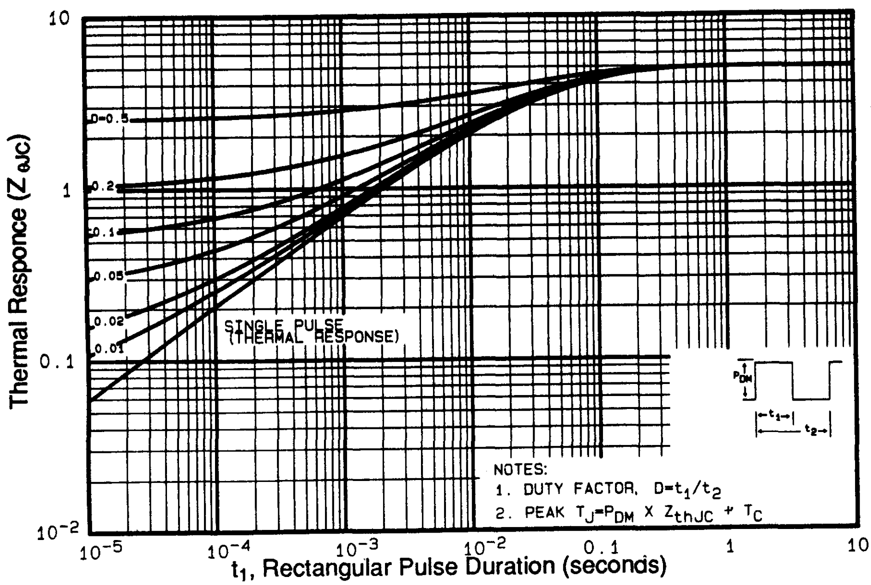


Fig 11. Maximum Effective Transient Thermal Impedance, Junction-to-Case

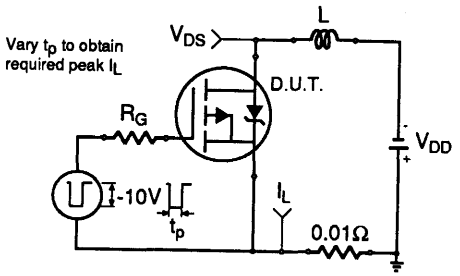


Fig 12a. Unclamped Inductive Test Circuit

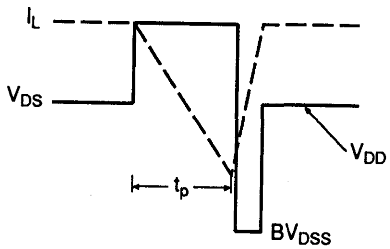


Fig 12b. Unclamped Inductive Waveforms

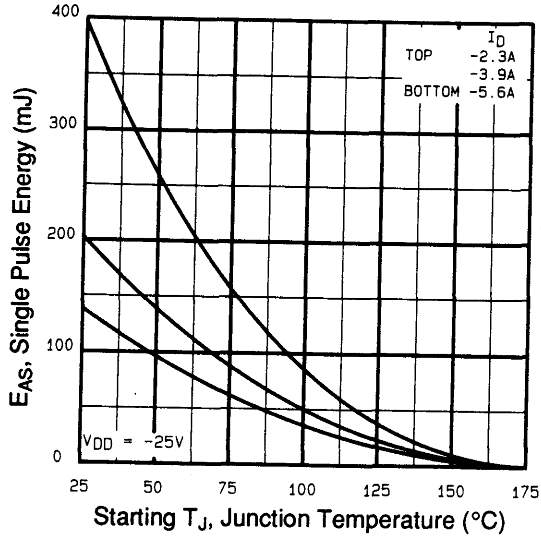


Fig 12c. Maximum Avalanche Energy vs. Drain Current

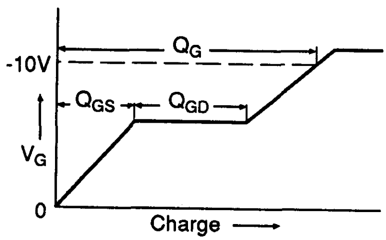


Fig 13a. Basic Gate Charge Waveform

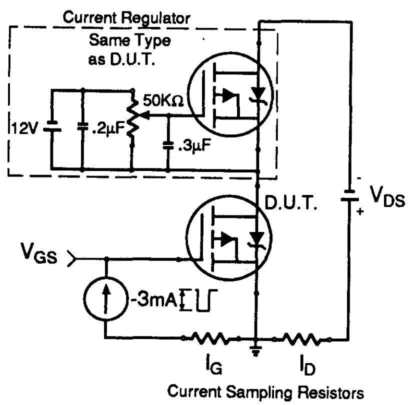


Fig 13b. Gate Charge Test Circuit

Appendix A: Figure 14, Peak Diode Recovery dv/dt Test Circuit

Appendix B: Package Outline Mechanical Drawing

Appendix C: Tape & Reel Information

Appendix D: Part Marking Information

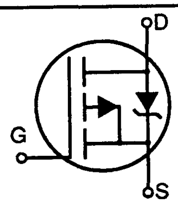
International
IOR Rectifier

International Rectifier

IRFR9024
IRFU9024

HEXFET® Power MOSFET

- Surface Mount (IRFR9024)
- Straight Lead (IRFU9024)
- Repetitive Avalanche Rated
- Dynamic dv/dt Rated
- P-Channel

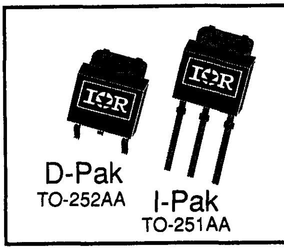


BV_{DSS}	-60V
$R_{DS(on)}$	0.28Ω
I_D	-9.6A

Description

Third Generation HEXFETs from International Rectifier provide the designer with the best combination of fast switching speed, ruggedized device design, and low on resistance.

The D-Pak is designed for surface mounting using vapor phase, infra red, or wave soldering techniques. The straight lead version (IRFU series) is for through hole mounting applications. Power dissipation levels up to 2 watts are possible in SMD applications.



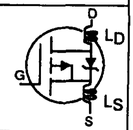
Absolute Maximum Ratings

	Parameter	Max.	Units
I_D @ T_C = 25°C	Continuous Drain Current, V_{GS}@-10V	-9.6	A
I_D @ T_C = 100°C	Continuous Drain Current, V_{GS}@-10V	-6.8	
I_{DM}	Pulsed Drain Current ①	-38	
P_D@ T_C = 25°C	Maximum Power Dissipation	50	W
	Linear Derating Factor	0.33	W/K⑥
V_{GS}	Gate-to-Source Breakdown Voltage	±20	V
E_{AS}	Single Pulse Avalanche Energy ②	300	mJ
I_{AR}	Avalanche Current ①	-9.6	A
E_{AR}	Repetitive Avalanche Energy ①	5.0	mJ
dv/dt	Peak Diode Recovery dv/dt ③	-4.5	V/ns
T_J, T_{STG}	Operating Junction and Storage Temperature Range	-55 to +175	°C
	Soldering Temperature, for 10 sec.	300 (0.063 in. (1.6mm) from case)	

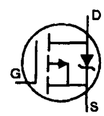
Thermal Resistance

	Parameter	Min.	Typ.	Max.	Units
$R_{\theta JC}$	Junction-to-Case	---	---	3.0	K/W⑥
$R_{\theta CS}$	Case-to-Sink ⑤	---	1.7	---	
$R_{\theta JA}$	Junction-to-Ambient, Typical Socket Mount	---	---	110	

Electrical Characteristics @ T_J = 25°C (unless otherwise specified)

	Parameter	Min.	Typ.	Max.	Units	Test Conditions
BV_{DSS}	Drain-to-Source Breakdown Voltage	-60	---	---	V	V_{GS}=0V, I_D=-250µA
$\Delta BV_{DSS}/\Delta T_J$	Temp. Coefficient of Breakdown Voltage	---	0.056	---	V/°C	Reference to 25°C, I_D=-1mA
$R_{DS(on)}$	Static Drain-to-Source On Resistance	---	---	0.28	Ω	V_{GS}=-10V, I_D =-5.8A④
$V_{GS(th)}$	Gate Threshold Voltage	-2.0	---	-4.0	V	V_{DS}=V_{GS}, I_D=-250µA
g_{fs}	Forward Transconductance	3.9	---	---	S	V_{DS}=-25V, I_{DS}=-5.8A④
I_{DSS}	Zero Gate Voltage Collector Current	---	---	-250	µA	V_{DS}=-60V, V_{GS}=0V
		---	---	-1000		V_{DS}=-48V, V_{GS}=0V,T_J=150°C
I_{GSS}	Gate-to-Source Forward Leakage	---	---	-500	nA	V_{GS}=-20V
	Gate-to-Source Reverse Leakage	---	---	500		V_{GS}=20V
Q_g	Total Gate Charge	---	---	19	nC	I_D=-11A, V_{DS}=-48V, V_{GS}=-10V See Fig 6 and 13④
Q_{gs}	Gate-to-Source Charge	---	---	5.4		
Q_{gd}	Gate-to-Drain ("Miller") Charge	---	---	11		
$t_{d(on)}$	Turn-On Delay Time	---	13	---	ns	V_{DD}=-30V, I_D=-11A R_G=18Ω, R_D=2.5Ω See Fig. 10④
t_r	Rise Time	---	68	---		
$t_{d(off)}$	Turn-Off Delay Time	---	15	---		
t_f	Fall Time	---	29	---		
L_D	Internal Drain Inductance	---	4.5	---	nH	Between lead, 6mm (0.25in.) from package, and center of die contact. 
L_S	Internal Source Inductance	---	7.5	---		
C_{iss}	Input Capacitance	---	570	---	pF	V_{GS}=0V, V_{DS}=-25V *f*=1.0Mhz See Fig. 5
C_{oss}	Output Capacitance	---	360	---		
C_{rss}	Reverse Transfer Capacitance	---	65	---		

Source-Drain Diode Ratings and Characteristics

	Parameter	Min.	Typ.	Max.	Units	Test Conditions
I_S	Continuous Source Current (Body Diode)	---	---	-9.6	A	MOSFET symbol showing the integral reverse p-n junction diode. 
I_{SM}	Pulsed Source Current (Body Diode) ①	---	---	-38		
V_{SD}	Diode Forward Voltage	---	---	-6.3	V	T_J=25°C, I_S=-9.6A, V_{GS}=0V④
t_{rr}	Reverse Recovery Time	50	---	200	ns	T_J=25°C, I_F=-11A, di/dt=-100A/µS④
Q_{RR}	Reverse Recovery Charge	0.16	---	0.64	µC	
t_{on}	Forward Turn-On Time	Intrinsic turn-on time is negligible (turn-on is dominated by L_S + L_D)				

Notes:

① Repetitive rating; Pulse width limited by max. junction temperature (See figure 11)

② V_{DD}=-25V, Starting T_J=25°C, L=4.0mH, R_G=25Ω, Peak I_{AS}=-9.6A (See figure 12)

③ I_{SD}≤-9.6A, di/dt≤-140A/µs, V_{DD}≤BV_{DSS}, T_J≤175°C Suggested R_G=18Ω

④ Pulse width ≤ 300µs; duty Cycle ≤2%

⑤ Mounting surface: flat, smooth, greased

⑥ K/W = °C/W

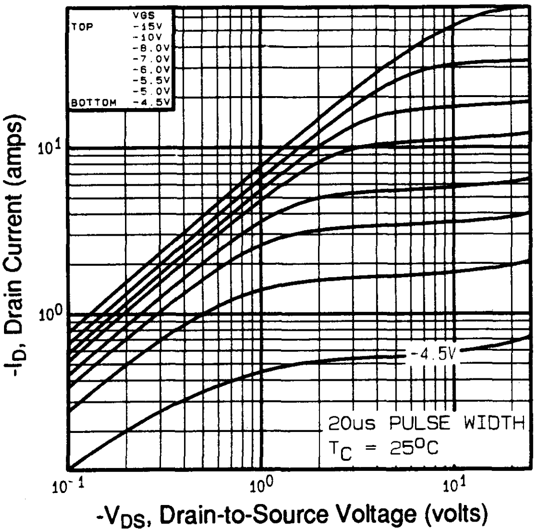


Fig 1. Typical Output Characteristics, $T_C = 25°C$

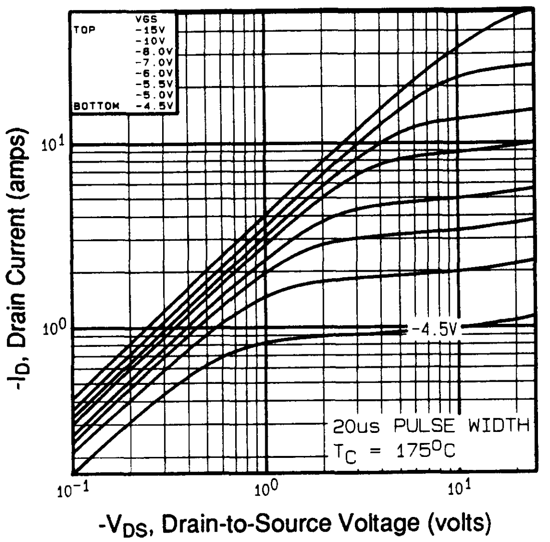


Fig 2. Typical Output Characteristics, $T_C = 150°C$

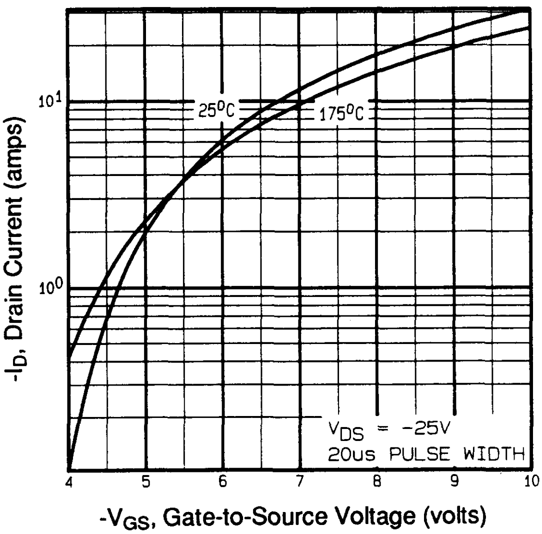


Fig 3. Typical Transfer Characteristics

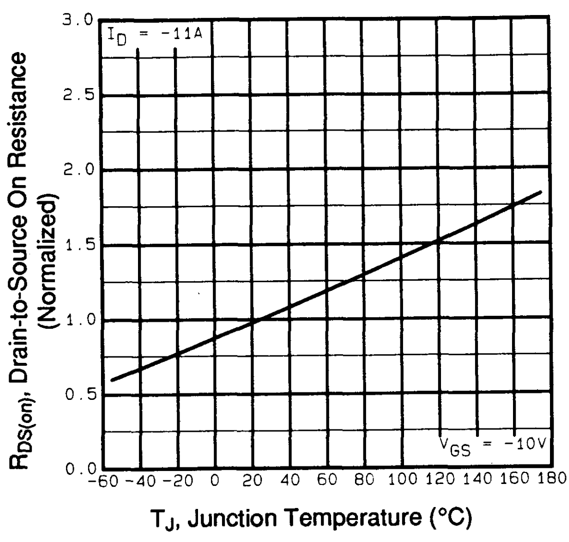


Fig 4. Normalized On-Resistance Vs. Temperature

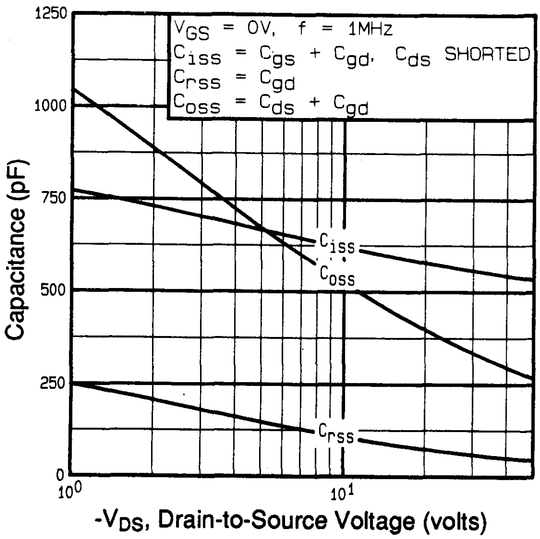


Fig 5. Typical Capacitance Vs. Drain-to-Source Voltage

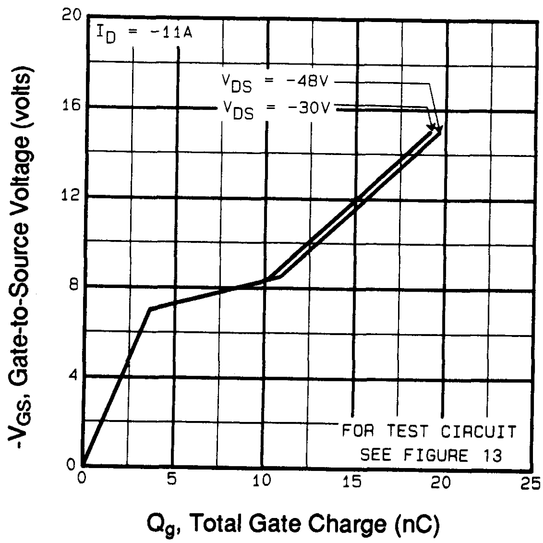


Fig 6. Typical Gate Charge Vs. Gate-to-Source Voltage

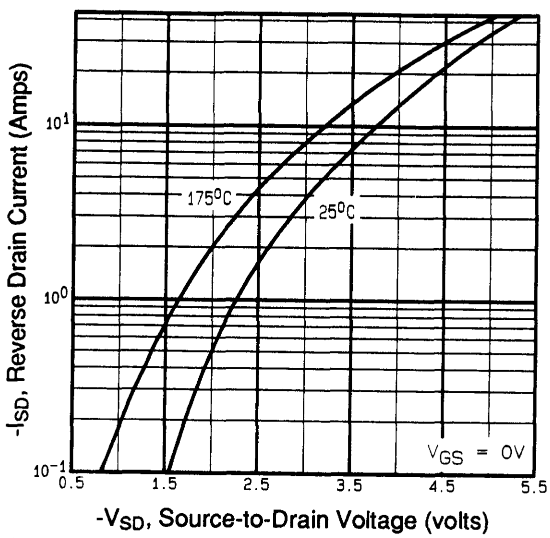


Fig 7. Typical Source-Drain Diode Forward Voltage

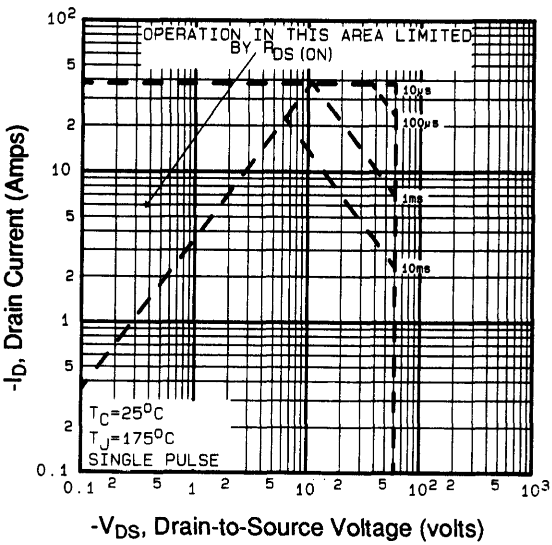


Fig 8. Maximum Safe Operating Area

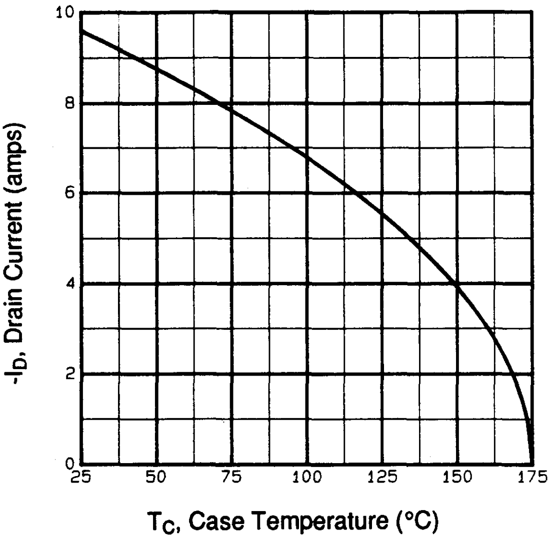


Fig 9. Maximum Drain Current Vs. Case Temperature

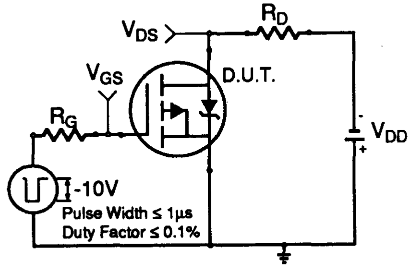


Fig 10a. Switching Time Test Circuit

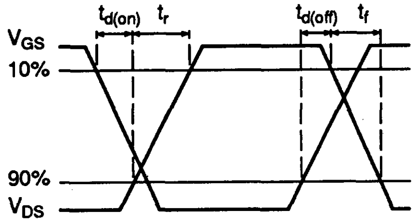


Fig 10b. Switching Time Waveforms

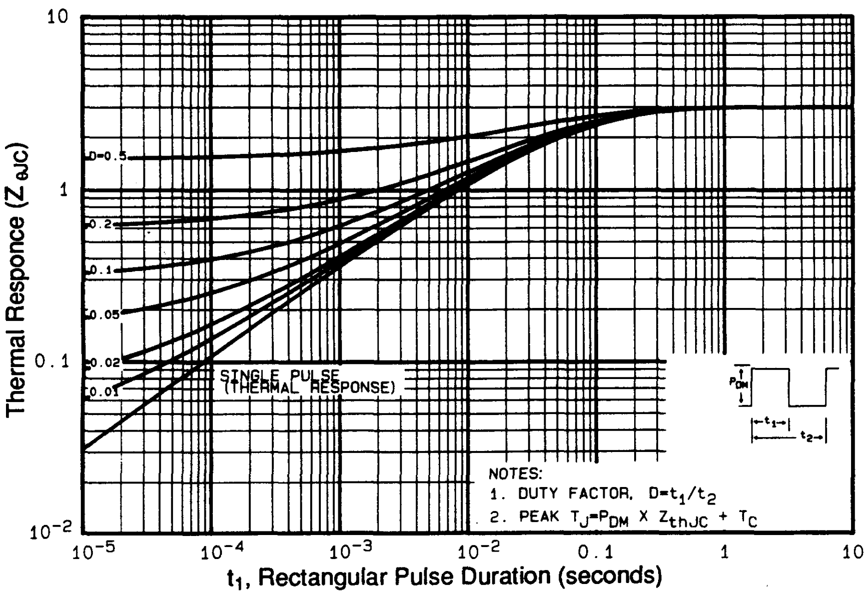


Fig 11. Maximum Effective Transient Thermal Impedance, Junction-to-Case

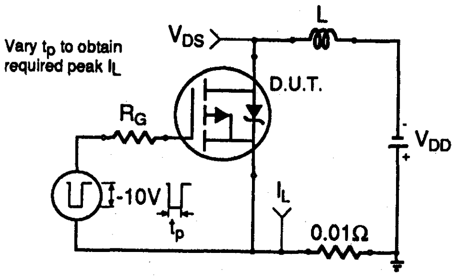


Fig 12a. Unclamped Inductive Test Circuit

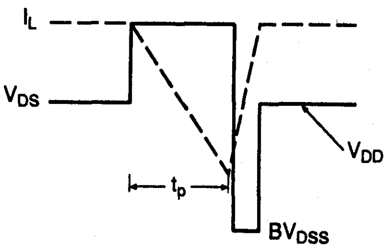


Fig 12b. Unclamped Inductive Waveforms

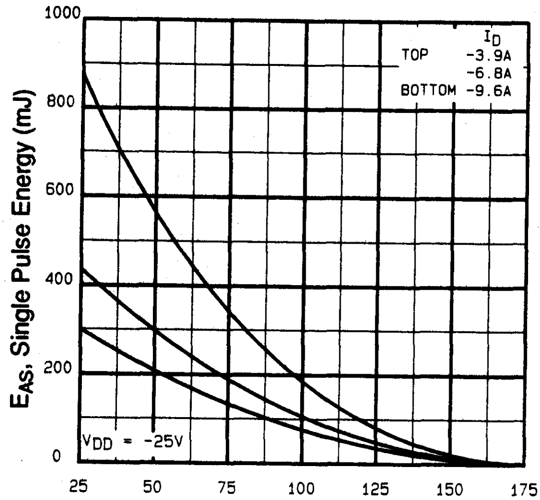


Fig 12c. Maximum Avalanche Energy vs. Drain Current

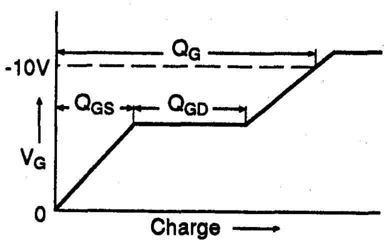


Fig 13a. Basic Gate Charge Waveform

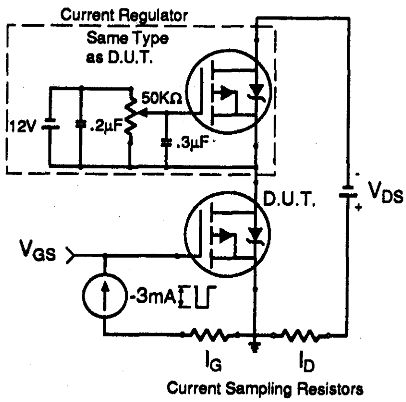


Fig 13b. Gate Charge Test Circuit

Appendix A: Figure 14, Peak Diode Recovery dv/dt Test Circuit

Appendix B: Package Outline Mechanical Drawing

Appendix C: Tape & Reel Information

Appendix D: Part Marking Information

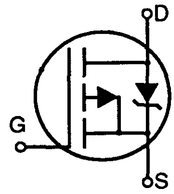
International Rectifier

International Rectifier

IRFR9110
IRFU9110

HEXFET® Power MOSFET

- Surface Mount (IRFR9110)
- Straight Lead (IRFU9110)
- Repetitive Avalanche Rated
- Dynamic dv/dt Rated
- P-Channel



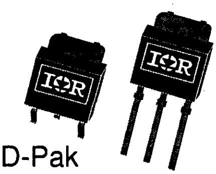
p-channel

BV_{DSS} = -100V
$R_{DS(on)}$ = 1.2Ω
I_D = -3.4A

Description

Third Generation HEXFETs from International Rectifier provide the designer with the best combination of fast switching speed, ruggedized device design, and low on resistance.

The D-Pak is designed for surface mounting using vapor phase, infra red, or wave soldering techniques. The straight lead version (IRFU series) is for through hole mounting applications. Power dissipation levels up to 2 watts are possible in SMD applications.



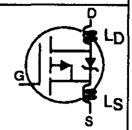
Absolute Maximum Ratings

	Parameter	Max.	Units
I_D @ T_C = 25°C	Continuous Drain Current, V_{GS}@-10V	-3.4	A
I_D @ T_C = 100°C	Continuous Drain Current, V_{GS}@-10V	-2.4	
I_{DM}	Pulsed Drain Current ①	-14	
P_D@ T_C = 25°C	Maximum Power Dissipation	30	W
	Linear Derating Factor	0.20	W/K⑥
V_{GS}	Gate-to-Source Breakdown Voltage	±20	V
E_{AS}	Single Pulse Avalanche Energy ②	140	mJ
I_{AR}	Avalanche Current ①	-3.4	A
E_{AR}	Repetitive Avalanche Energy ①	3.0	mJ
dv/dt	Peak Diode Recovery dv/dt ③	-5.5	V/ns
T_J T_{STG}	Operating Junction and Storage Temperature Range	-55 to +175	°C
	Soldering Temperature, for 10 sec.	300 (0.063 in. (1.6mm) from case)	

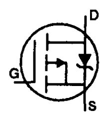
Thermal Resistance

	Parameter	Min.	Typ.	Max.	Units
$R_{\theta JC}$	Junction-to-Case	---	---	5.0	K/W⑥
$R_{\theta CS}$	Case-to-Sink ⑤	---	1.7	---	
$R_{\theta JA}$	Junction-to-Ambient, Typical Socket Mount	---	---	110	

Electrical Characteristics @ T_J = 25°C (unless otherwise specified)

	Parameter	Min.	Typ.	Max.	Units	Test Conditions
BV_{DSS}	Drain-to-Source Breakdown Voltage	-100	---	---	V	V_{GS}=0V, I_D=-250µA
$\Delta BV_{DSS}/\Delta T_J$	Temp. Coefficient of Breakdown Voltage	---	0.091	---	V/°C	Reference to 25°C, I_D=-1mA
$R_{DS(on)}$	Static Drain-to-Source On Resistance	---	---	1.2	Ω	V_{GS}=-10V, I_D =-2.0A④
$V_{GS(th)}$	Gate Threshold Voltage	-2.0	---	-4.0	V	V_{DS}=V_{GS}, I_D=-250µA
g_{fs}	Forward Transconductance	1.3	---	---	S	V_{DS}=-50V, I_{DS}=-2.0A④
I_{DSS}	Zero Gate Voltage Collector Current	---	---	-250	µA	V_{DS}=-100V, V_{GS}=0V
		---	---	-1000		V_{DS}=-80V, V_{GS}=0V,T_J=150°C
I_{GSS}	Gate-to-Source Forward Leakage	---	---	-500	nA	V_{GS}=-20V
	Gate-to-Source Reverse Leakage	---	---	500		V_{GS}=20V
Q_g	Total Gate Charge	---	---	8.7	nC	I_D=-4.0A, V_{DS}=-80V, V_{GS}=-10V④
Q_{gs}	Gate-to-Source Charge	---	---	2.2		
Q_{gd}	Gate-to-Drain ("Miller") Charge	---	---	4.1		
$t_{d(on)}$	Turn-On Delay Time	---	10	---	ns	V_{DD}=-50V, I_D=-4.0A R_G=11Ω, R_D=24Ω④
t_r	Rise Time	---	27	---		
$t_{d(off)}$	Turn-Off Delay Time	---	15	---		
t_f	Fall Time	---	17	---		
L_D	Internal Drain Inductance	---	4.5	---	nH	Between lead, 6mm (0.25in.) from package, and center of die contact. 
L_S	Internal Source Inductance	---	7.5	---		
C_{iss}	Input Capacitance	---	200	---	pF	V_{GS}=0V, V_{DS}=-25V f=1.0Mhz
C_{oss}	Output Capacitance	---	94	---		
C_{rss}	Reverse Transfer Capacitance	---	18	---		

Source-Drain Diode Ratings and Characteristics

	Parameter	Min.	Typ.	Max.	Units	Test Conditions
I_S	Continuous Source Current (Body Diode)	---	---	-3.4	A	MOSFET symbol showing the integral reverse p-n junction diode. 
I_{SM}	Pulsed Source Current (Body Diode) ①	---	---	-14		
V_{SD}	Diode Forward Voltage	---	---	-5.5	V	T_J=25°C, I_S=-3.4A, V_{GS}=0V④
t_{rr}	Reverse Recovery Time	41	---	160	ns	T_J=25°C, I_F=-4.0A, di/dt=-100A/µS④
Q_{RR}	Reverse Recovery Charge	0.075	---	0.30	µC	
t_{on}	Forward Turn-On Time	Intrinsic turn-on time is negligible (turn-on is dominated by L_S + L_D)				

Notes:

① Repetitive rating; Pulse width limited by max. junction temperature

② V_{DD}=-25V, Starting T_J=25°C, L=20mH, R_G=25Ω, Peak I_{AS}=-3.4A

③ I_{SD}≤-3.4A, di/dt≤-75A/µs, V_{DD}≤BV_{DSS}, T_J≤175°C Suggested R_G=24Ω

④ Pulse width ≤ 300µs; duty Cycle ≤2%

⑤ Mounting surface: flat, smooth, greased

⑥ K/W = °C/W

For more information on the same die in a HD-1 package refer to IRFD9110.

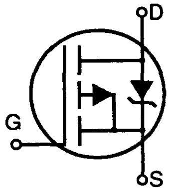
PD-9.520D

International
IOR Rectifier

IRFR9120
IRFU9120

HEXFET® Power MOSFET

- Surface Mount (IRFR9120)
- Straight Lead (IRFU9024)
- Repetitive Avalanche Rated
- Dynamic dv/dt Rated
- P-Channel



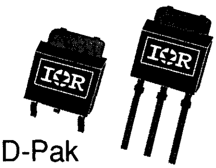
p-channel

BV_{DSS}	-100V
$R_{DS(on)}$	0.6Ω
I_D	-6.3A

Description

Third Generation HEXFETs from International Rectifier provide the designer with the best combination of fast switching speed, ruggedized device design, and low on resistance.

The D-Pak is designed for surface mounting using vapor phase, infra red, or wave soldering techniques. The straight lead version (IRFU series) is for through hole mounting applications. Power dissipation levels up to 2 watts are possible in SMD applications.



D-Pak
TO-252AA
I-Pak
TO-251AA

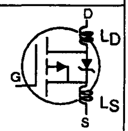
Absolute Maximum Ratings

	Parameter	Max.	Units
I_D @ T_C = 25°C	Continuous Drain Current, V_{GS}@-10V	-6.3	A
I_D @ T_C = 100°C	Continuous Drain Current, V_{GS}@-10V	-4.5	
I_{DM}	Pulsed Drain Current ①	-25	
P_D@ T_C = 25°C	Maximum Power Dissipation	50	W
	Linear Derating Factor	0.33	W/K⑥
V_{GS}	Gate-to-Source Breakdown Voltage	±20	V
E_{AS}	Single Pulse Avalanche Energy ②	270	mJ
I_{AR}	Avalanche Current ①	-6.3	A
E_{AR}	Repetitive Avalanche Energy ①	5.0	mJ
dv/dt	Peak Diode Recovery dv/dt ③	-5.5	V/ns
T_J T_{STG}	Operating Junction and Storage Temperature Range	-55 to +175	°C
	Soldering Temperature, for 10 sec.	300 (0.063 in. (1.6mm) from case)	

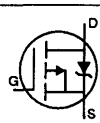
Thermal Resistance

	Parameter	Min.	Typ.	Max.	Units
$R_{\theta JC}$	Junction-to-Case	---	---	3.0	K/W⑥
$R_{\theta CS}$	Case-to-Sink ⑤	---	1.7	---	
$R_{\theta JA}$	Junction-to-Ambient, Typical Socket Mount	---	---	110	

Electrical Characteristics @ T_J = 25°C (unless otherwise specified)

	Parameter	Min.	Typ.	Max.	Units	Test Conditions
BV_{DSS}	Drain-to-Source Breakdown Voltage	-100	---	---	V	V_{GS}=0V, I_D=-250μA
$\Delta BV_{DSS}/\Delta T_J$	Temp. Coefficient of Breakdown Voltage	---	0.10	---	V/°C	Reference to 25°C, I_D=-1mA
$R_{DS(on)}$	Static Drain-to-Source On Resistance	---	---	0.60	Ω	V_{GS}=-10V, I_D =-3.8A④
$V_{GS(th)}$	Gate Threshold Voltage	-2.0	---	-4.0	V	V_{DS}=V_{GS}, I_D=-250μA
g_{fs}	Forward Transconductance	1.7	---	---	S	V_{DS}=-50V, I_{DS}=-3.8A④
I_{DSS}	Zero Gate Voltage Collector Current	---	---	-250	μA	V_{DS}=-100V, V_{GS}=0V
		---	---	-1000		V_{DS}=-80V, V_{GS}=0V, T_J=150°C
I_{GSS}	Gate-to-Source Forward Leakage	---	---	-500	nA	V_{GS}=-20V
	Gate-to-Source Reverse Leakage	---	---	500		V_{GS}=20V
Q_g	Total Gate Charge	---	---	18	nC	I_D=-6.8A, V_{DS}=-80V, V_{GS}=-10V See Fig 6 and 13④
Q_{gs}	Gate-to-Source Charge	---	---	3.0		
Q_{gd}	Gate-to-Drain ("Miller") Charge	---	---	9.0		
$t_{d(on)}$	Turn-On Delay Time	---	9.6	---	ns	V_{DD}=-50V, I_D=-6.8A R_G=18Ω, R_D=7.1Ω See Fig. 10④
t_r	Rise Time	---	29	---		
$t_{d(off)}$	Turn-Off Delay Time	---	21	---		
t_f	Fall Time	---	25	---		
L_D	Internal Drain Inductance	---	4.5	---	nH	Between lead, 6mm (0.25in.) from package, and center of die contact. 
L_S	Internal Source Inductance	---	7.5	---		
C_{iss}	Input Capacitance	---	390	---	pF	V_{GS}=0V, V_{DS}=-25V f=1.0Mhz See Fig. 5
C_{oss}	Output Capacitance	---	170	---		
C_{rss}	Reverse Transfer Capacitance	---	45	---		

Source-Drain Diode Ratings and Characteristics

	Parameter	Min.	Typ.	Max.	Units	Test Conditions
I_S	Continuous Source Current (Body Diode)	---	---	-6.3	A	MOSFET symbol showing the integral reverse p-n junction diode. 
I_{SM}	Pulsed Source Current (Body Diode) ①	---	---	-25		
V_{SD}	Diode Forward Voltage	---	---	-6.3	V	T_J=25°C, I_S=-6.3A, V_{GS}=0V④
t_{rr}	Reverse Recovery Time	49	---	200	ns	T_J=25°C, I_F=-6.8A, di/dt=-100A/μS④
Q_{RR}	Reverse Recovery Charge	0.17	---	0.66	μC	
t_{on}	Forward Turn-On Time	Intrinsic turn-on time is negligible (turn-on is dominated by L_S + L_D)				

Notes:

① Repetitive rating; Pulse width limited by max. junction temperature (See figure 11)

② V_{DD}=-25V, Starting T_J=25°C, L=11mH, R_G=25Ω, Peak I_{AS}=-6.3A (See figure 12)

③ I_{SD}≤-6.3A, di/dt≤-110A/μs, V_{DD}≤BV_{DSS}, T_J≤175°C Suggested R_G=18Ω

④ Pulse width ≤ 300μs; duty Cycle ≤2%

⑤ Mounting surface: flat, smooth, greased

⑥ K/W = °C/W

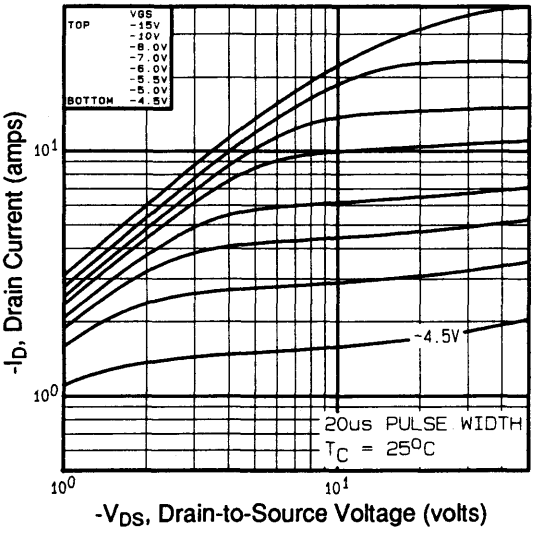


Fig 1. Typical Output Characteristics, $T_C = 25°C$

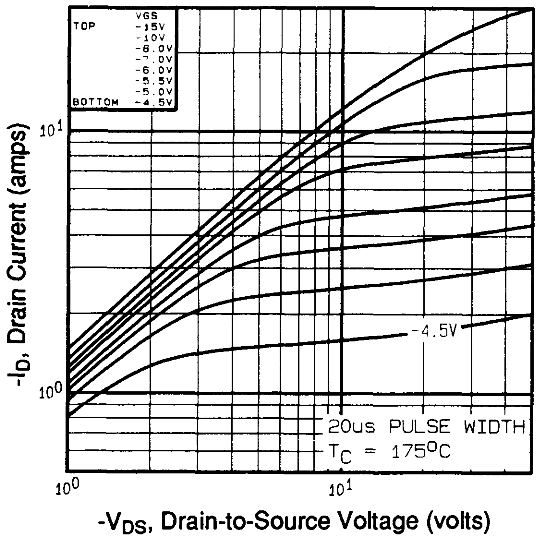


Fig 2. Typical Output Characteristics, $T_C = 150°C$

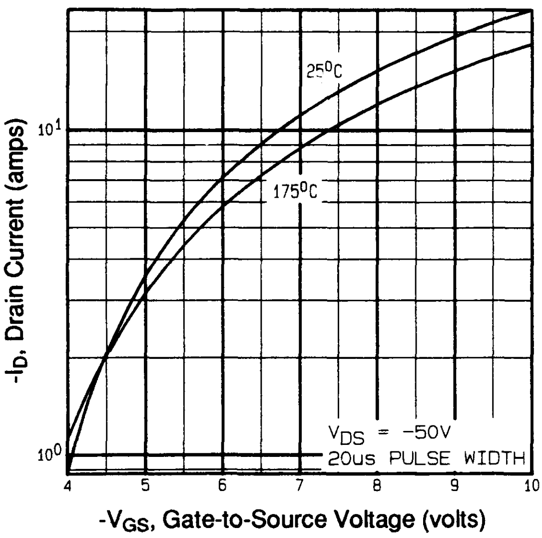


Fig 3. Typical Transfer Characteristics

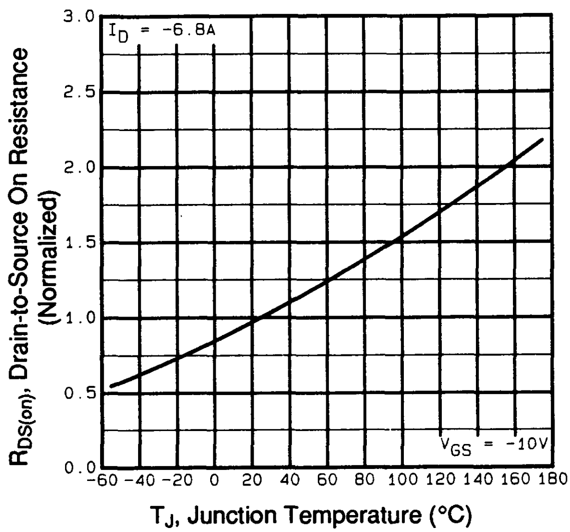


Fig 4. Normalized On-Resistance Vs. Temperature

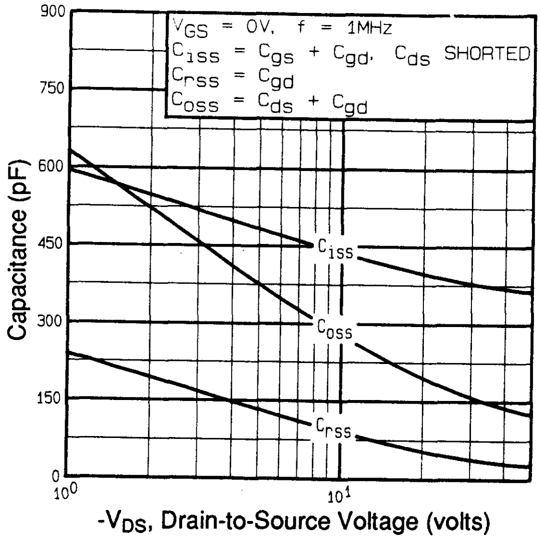


Fig 5. Typical Capacitance Vs. Drain-to-Source Voltage

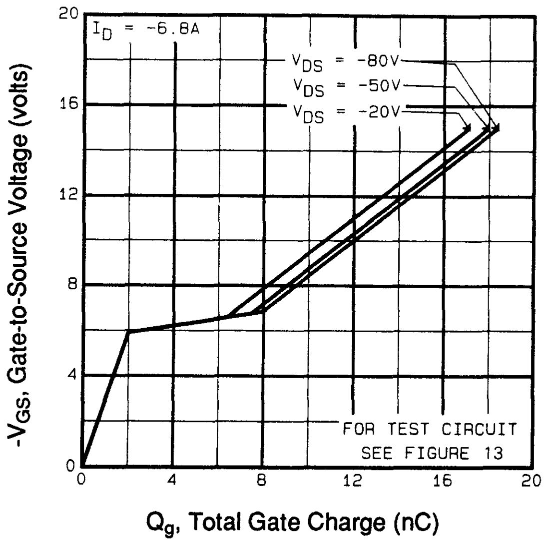


Fig 6. Typical Gate Charge Vs. Gate-to-Source Voltage

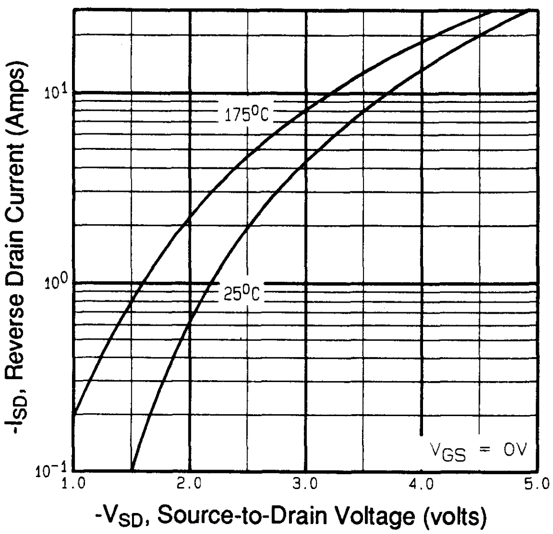


Fig 7. Typical Source-Drain Diode Forward Voltage

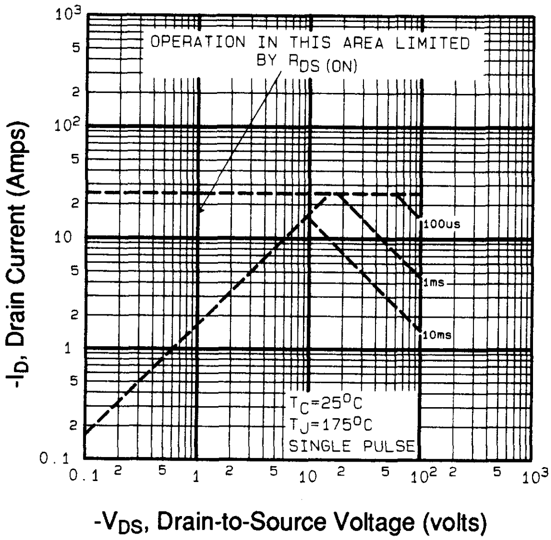


Fig 8. Maximum Safe Operating Area

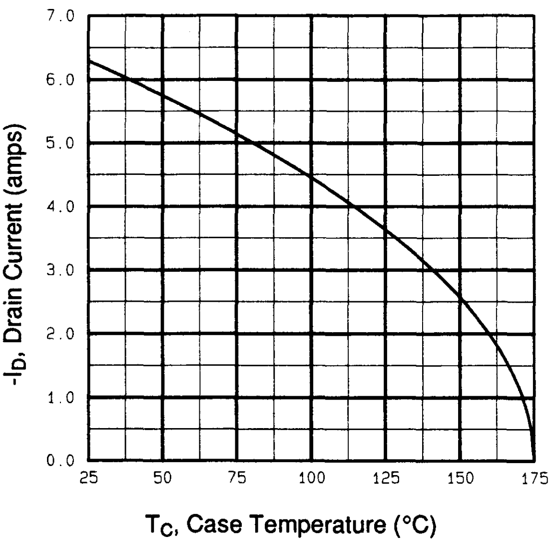


Fig 9. Maximum Drain Current Vs. Case Temperature

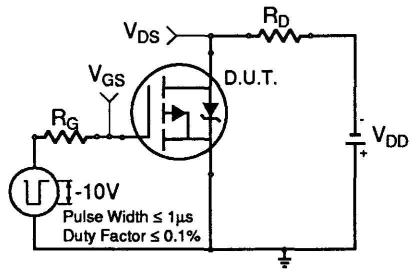


Fig 10a. Switching Time Test Circuit

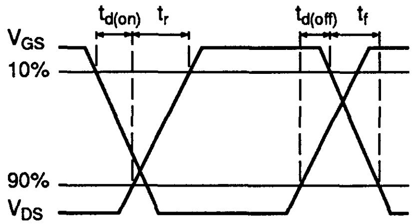


Fig 10b. Switching Time Waveforms

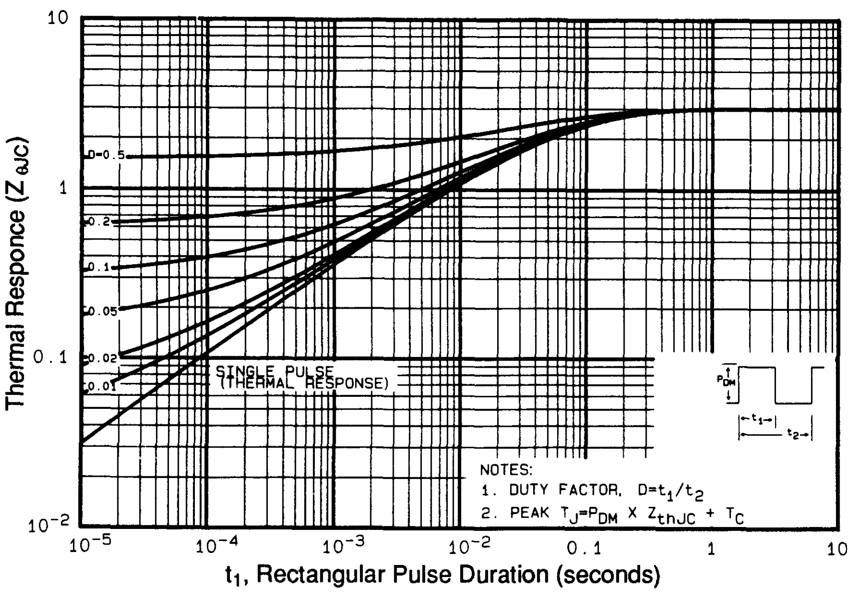


Fig 11. Maximum Effective Transient Thermal Impedance, Junction-to-Case

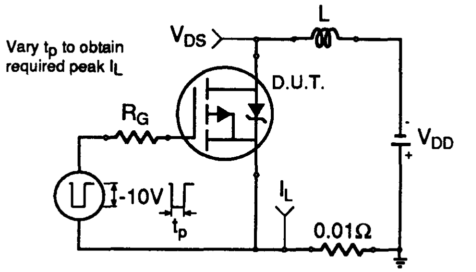


Fig 12a. Unclamped Inductive Test Circuit

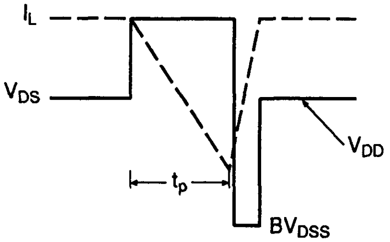


Fig 12b. Unclamped Inductive Waveforms

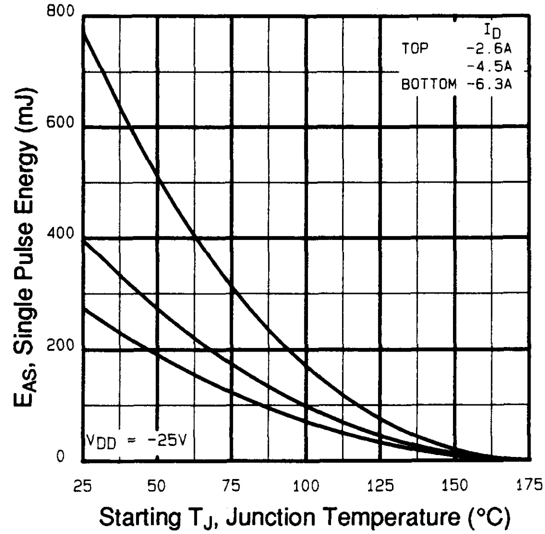


Fig 12c. Maximum Avalanche Energy vs. Drain Current

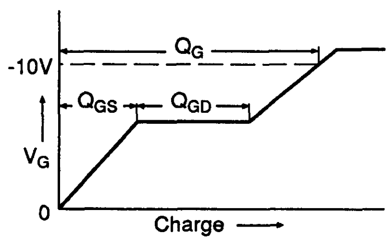


Fig 13a. Basic Gate Charge Waveform

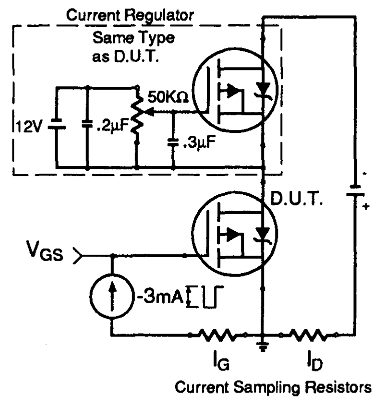


Fig 13b. Gate Charge Test Circuit

Appendix A: Figure 14, Peak Diode Recovery dv/dt Test Circuit

Appendix B: Package Outline Mechanical Drawing

Appendix C: Tape & Reel Information

Appendix D: Part Marking Information

International IOR Rectifier

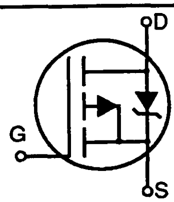
Target Data Sheet PD-9.521C

International Rectifier

IRFR9210
IRFU9210

HEXFET® Power MOSFET

- Surface Mount (IRFR9210)
- Straight Lead (IRFU9210)
- Repetitive Avalanche Rated
- Dynamic dv/dt Rated
- P-Channel



p-channel

BV_{DSS} -200V

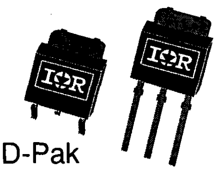
$R_{DS(on)}$ 3.0Ω

I_D -2.0A

Description

Third Generation HEXFETs from International Rectifier provide the designer with the best combination of fast switching speed, ruggedized device design, and low on resistance.

The D-Pak is designed for surface mounting using vapor phase, infra red, or wave soldering techniques. The straight lead version (IRFU series) is for through hole mounting applications. Power dissipation levels up to 2 watts are possible in SMD applications.


D-Pak
TO-252AA
I-Pak
TO-251AA

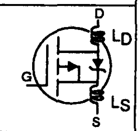
Absolute Maximum Ratings

	Parameter	Max.	Units
I_D @ T_C = 25°C	Continuous Drain Current, V_{GS}@-10V	-2.0	A
I_D @ T_C = 100°C	Continuous Drain Current, V_{GS}@-10V	-1.3	
I_{DM}	Pulsed Drain Current ①	-8.0	
P_D@ T_C = 25°C	Maximum Power Dissipation	25	W
	Linear Derating Factor	0.20	W/K⑥
V_{GS}	Gate-to-Source Breakdown Voltage	±20	V
E_{AS}	Single Pulse Avalanche Energy ②	41	mJ
I_{AR}	Avalanche Current ①	-2.0	A
E_{AR}	Repetitive Avalanche Energy ①	2.5	mJ
dv/dt	Peak Diode Recovery dv/dt ③	-5.0	V/ns
T_J T_{STG}	Operating Junction and Storage Temperature Range	-55 to +150	°C
	Soldering Temperature, for 10 sec.	300 (0.063 in. (1.6mm) from case)	

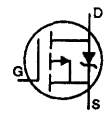
Thermal Resistance

	Parameter	Min.	Typ.	Max.	Units
$R_{\theta JC}$	Junction-to-Case	---	---	5.0	K/W⑥
$R_{\theta CS}$	Case-to-Sink ⑤	---	1.7	---	
$R_{\theta JA}$	Junction-to-Ambient, Typical Socket Mount	---	---	110	

Electrical Characteristics @ T_J = 25°C (unless otherwise specified)

	Parameter	Min.	Typ.	Max.	Units	Test Conditions
BV_{DSS}	Drain-to-Source Breakdown Voltage	-200	---	---	V	V_{GS}=0V, I_D=-250μA
$\Delta BV_{DSS}/\Delta T_J$	Temp. Coefficient of Breakdown Voltage	---	n/a	---	V/°C	Reference to 25°C, I_D=-1mA
$R_{DS(on)}$	Static Drain-to-Source On Resistance	---	---	3.0	Ω	V_{GS}=-10V, I_D =-1.2A④
$V_{GS(th)}$	Gate Threshold Voltage	-2.0	---	-4.0	V	V_{DS}=V_{GS}, I_D=-250μA
g_{fs}	Forward Transconductance	n/a	---	---	S	V_{DS}=-50V, I_{DS}=-1.2A④
I_{DSS}	Zero Gate Voltage Collector Current	---	---	-250	μA	V_{DS}=-200V, V_{GS}=0V
		---	---	-1000		V_{DS}=-160V, V_{GS}=0V,T_J=125°C
IGSS	Gate-to-Source Forward Leakage	---	---	-500	nA	V_{GS}=-20V
	Gate-to-Source Reverse Leakage	---	---	500		V_{GS}=20V
Q_g	Total Gate Charge	---	---	6.0	nC	I_D=-2.4A, V_{DS}=-160V, V_{GS}=-10V④
Q_{gs}	Gate-to-Source Charge	---	---	1.2		
Q_{gd}	Gate-to-Drain ("Miller") Charge	---	---	3.6		
$t_{d(on)}$	Turn-On Delay Time	---	8	---	ns	V_{DD}=-100V, I_D=-2.4A R_G=24Ω, R_D=42Ω④
t_r	Rise Time	---	15	---		
$t_{d(off)}$	Turn-Off Delay Time	---	10	---		
t_f	Fall Time	---	8	---		
L_D	Internal Drain Inductance	---	4.5	---	nH	Between lead, 6mm (0.25in.) from package, and center of die contact. 
L_S	Internal Source Inductance	---	7.5	---		
C_{iss}	Input Capacitance	---	160	---	pF	V_{GS}=0V, V_{DS}=-25V *f*=1.0Mhz
C_{oss}	Output Capacitance	---	50	---		
C_{rss}	Reverse Transfer Capacitance	---	12	---		

Source-Drain Diode Ratings and Characteristics

	Parameter	Min.	Typ.	Max.	Units	Test Conditions
I_S	Continuous Source Current (Body Diode)	---	---	-2.0	A	MOSFET symbol showing the integral reverse p-n junction diode. 
I_{SM}	Pulsed Source Current (Body Diode) ①	---	---	-8.0		
V_{SD}	Diode Forward Voltage	---	---	-5.8	V	T_J=25°C, I_S=-2.0A, V_{GS}=0V④
t_{rr}	Reverse Recovery Time	n/a	---	n/a	ns	T_J=25°C, I_F=-2.4A, di/dt=-100A/μS④
Q_{RR}	Reverse Recovery Charge	n/a	---	n/a	μC	
t_{on}	Forward Turn-On Time	Intrinsic turn-on time is negligible (turn-on is dominated by L_S + L_D)				

Notes:

① Repetitive rating; Pulse width limited by max. junction temperature

② V_{DD}=-50V, Starting T_J=25°C, L=15mH, R_G=25Ω, Peak I_{AS}=-2.0A

③ I_{SD}≤-2.0A, di/dt≤-90A/μs, V_{DD}≤BV_{DSS}, T_J≤150°C Suggested R_G=24Ω

④ Pulse width ≤ 300μs; duty Cycle ≤2%

⑤ Mounting surface: flat, smooth, greased

⑥ K/W = °C/W

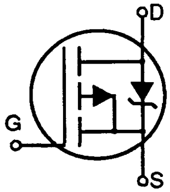
Target Data Sheet: Specification Pending; Contact Factory for Update

International
IOR Rectifier

IRFR9220
IRFU9220

HEXFET® Power MOSFET

- Surface Mount (IRFR9220)
- Straight Lead (IRFU9220)
- Repetitive Avalanche Rated
- Dynamic dv/dt Rated
- P-Channel



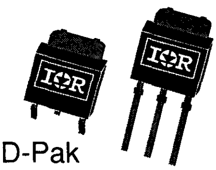
p-channel

BV_{DSS} = -200V
$R_{DS(on)}$ = 1.5Ω
I_D = -3.6A

Description

Third Generation HEXFETs from International Rectifier provide the designer with the best combination of fast switching speed, ruggedized device design, and low on resistance.

The D-Pak is designed for surface mounting using vapor phase, infra red, or wave soldering techniques. The straight lead version (IRFU series) is for through hole mounting applications. Power dissipation levels up to 2 watts are possible in SMD applications.



D-Pak TO-252AA
I-Pak TO-251AA

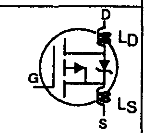
Absolute Maximum Ratings

	Parameter	Max.	Units
I_D @ T_C = 25°C	Continuous Drain Current, V_{GS}@-10V	-3.6	A
I_D @ T_C = 100°C	Continuous Drain Current, V_{GS}@-10V	-2.3	
I_{DM}	Pulsed Drain Current ①	-14	
P_D@ T_C = 25°C	Maximum Power Dissipation	42	W
	Linear Derating Factor	0.33	W/K⑥
V_{GS}	Gate-to-Source Breakdown Voltage	±20	V
E_{AS}	Single Pulse Avalanche Energy ②	84	mJ
I_{AR}	Avalanche Current ①	-3.6	A
E_{AR}	Repetitive Avalanche Energy ①	4.2	mJ
dv/dt	Peak Diode Recovery dv/dt ③	-5.0	V/ns
T_J T_{STG}	Operating Junction and Storage Temperature Range	-55 to +150	°C
	Soldering Temperature, for 10 sec.	300 (0.063 in. (1.6mm) from case)	

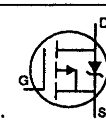
Thermal Resistance

	Parameter	Min.	Typ.	Max.	Units
$R_{\theta JC}$	Junction-to-Case	---	---	3.0	K/W⑥
$R_{\theta CS}$	Case-to-Sink ⑤	---	1.7	---	
$R_{\theta JA}$	Junction-to-Ambient, Typical Socket Mount	---	---	110	

Electrical Characteristics @ T_J = 25°C (unless otherwise specified)

	Parameter	Min.	Typ.	Max.	Units	Test Conditions
BV_{DSS}	Drain-to-Source Breakdown Voltage	-200	---	---	V	V_{GS}=0V, I_D=-250µA
$\Delta BV_{DSS}/\Delta T_J$	Temp. Coefficient of Breakdown Voltage	---	n/a	---	V/°C	Reference to 25°C, I_D=-1mA
$R_{DS(on)}$	Static Drain-to-Source On Resistance	---	---	1.5	Ω	V_{GS}=-10V, I_D =-2.2A④
$V_{GS(th)}$	Gate Threshold Voltage	-2.0	---	-4.0	V	V_{DS}=V_{GS}, I_D=-250µA
g_{fs}	Forward Transconductance	n/a	---	---	S	V_{DS}=-50V, I_{DS}=-2.2A④
I_{DSS}	Zero Gate Voltage Collector Current	---	---	-250	µA	V_{DS}=-200V, V_{GS}=0V
		---	---	-1000		V_{DS}=-160V, V_{GS}=0V,T_J=125°C
IGSS	Gate-to-Source Forward Leakage	---	---	-500	nA	V_{GS}=-20V
	Gate-to-Source Reverse Leakage	---	---	500		V_{GS}=20V
Q_g	Total Gate Charge	---	---	13	nC	I_D=-4.0A, V_{DS}=-160V, V_{GS}=-10V④
Q_{gs}	Gate-to-Source Charge	---	---	2.4		
Q_{gd}	Gate-to-Drain ("Miller") Charge	---	---	7.6		
$t_{d(on)}$	Turn-On Delay Time	---	15	---	ns	V_{DD}=-100V, I_D=-4.0A R_G=18Ω, R_D=25Ω④
t_r	Rise Time	---	35	---		
$t_{d(off)}$	Turn-Off Delay Time	---	15	---		
t_f	Fall Time	---	25	---		
L_D	Internal Drain Inductance	---	4.5	---	nH	Between lead, 6mm (0.25in.) from package, and center of die contact. 
L_S	Internal Source Inductance	---	7.5	---		
C_{iss}	Input Capacitance	---	340	---	pF	V_{GS}=0V, V_{DS}=-25V *f*=1.0Mhz
C_{oss}	Output Capacitance	---	105	---		
C_{rss}	Reverse Transfer Capacitance	---	25	---		

Source-Drain Diode Ratings and Characteristics

	Parameter	Min.	Typ.	Max.	Units	Test Conditions
I_S	Continuous Source Current (Body Diode)	---	---	-3.6	A	MOSFET symbol showing the integral reverse p-n junction diode. 
I_{SM}	Pulsed Source Current (Body Diode) ①	---	---	-14		
V_{SD}	Diode Forward Voltage	---	---	-6.3	V	T_J=25°C, I_S=-3.6A, V_{GS}=0V④
t_{rr}	Reverse Recovery Time	n/a	---	n/a	ns	T_J=25°C, I_F=-4.0A, di/dt=-100A/µS④
Q_{RR}	Reverse Recovery Charge	n/a	---	n/a	µC	
t_{on}	Forward Turn-On Time	Intrinsic turn-on time is negligible (turn-on is dominated by L_S + L_D)				

Notes:

① Repetitive rating; Pulse width limited by max. junction temperature

② V_{DD}=-50V, Starting T_J=25°C, L=9.7mH, R_G=25Ω, Peak I_{AS}=-3.6A

③ I_{SD}≤-3.6A, di/dt≤-90A/µs, V_{DD}≤BV_{DSS}, T_J≤150°C Suggested R_G=24Ω

④ Pulse width ≤ 300µs; duty Cycle ≤2%

⑤ Mounting surface: flat, smooth, greased

⑥ K/W = °C/W

Target Data Sheet: Specification Pending; Contact Factory for Update

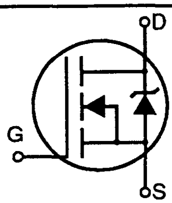
PD-9.637B

International Rectifier

IRFRC20
IRFUC20

HEXFET® Power MOSFET

- Surface Mount (IRFRC20)
- Straight Lead (IRFUC20)
- Repetitive Avalanche Rated
- Dynamic dv/dt Rated



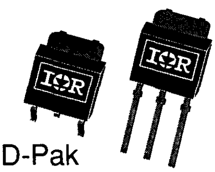
n-channel

BV_{DSS}	600V
$R_{DS(on)}$	4.4Ω
I_D	2.0A

Description

Third Generation HEXFETs from International Rectifier provide the designer with the best combination of fast switching speed, ruggedized device design, and low on resistance.

The D-Pak is designed for surface mounting using vapor phase, infra red, or wave soldering techniques. The straight lead version (IRFU series) is for through hole mounting applications. Power dissipation levels up to 2 watts are possible in SMD applications.



D-Pak
TO-252AA
I-Pak
TO-251AA

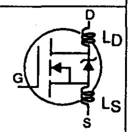
Absolute Maximum Ratings

	Parameter	Max.	Units
I_D @ T_C = 25°C	Continuous Drain Current, V_{GS}@10V	2.0	A
I_D @ T_C = 100°C	Continuous Drain Current, V_{GS}@10V	1.3	
I_{DM}	Pulsed Drain Current ①	8.0	
P_D@ T_C = 25°C	Maximum Power Dissipation	42	W
	Linear Derating Factor	0.33	W/K⑥
V_{GS}	Gate-to-Source Breakdown Voltage	±20	V
E_{AS}	Single Pulse Avalanche Energy ②	100	mJ
I_{AR}	Avalanche Current ①	2.0	A
E_{AR}	Repetitive Avalanche Energy ①	4.2	mJ
dv/dt	Peak Diode Recovery dv/dt ③	3.0	V/ns
T_J T_{STG}	Operating Junction and Storage Temperature Range	-55 to +150	°C
	Soldering Temperature, for 10 sec.	300 (0.063 in. (1.6mm) from case)	

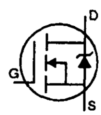
Thermal Resistance

	Parameter	Min.	Typ.	Max.	Units
$R_{\theta JC}$	Junction-to-Case	---	---	3.0	K/W⑥
$R_{\theta CS}$	Case-to-Sink ⑤	---	1.7	---	
$R_{\theta JA}$	Junction-to-Ambient, Typical Socket Mount	---	---	110	

Electrical Characteristics @ T_J = 25°C (unless otherwise specified)

	Parameter	Min.	Typ.	Max.	Units	Test Conditions
BV_{DSS}	Drain-to-Source Breakdown Voltage	600	---	---	V	V_{GS}=0V, I_D=250μA
$\Delta BV_{DSS}/\Delta T_J$	Temp. Coefficient of Breakdown Voltage	---	0.88	---	V/°C	Reference to 25°C, I_D=1mA
$R_{DS(on)}$	Static Drain-to-Source On Resistance	---	---	4.4	Ω	V_{GS}=10V, I_D =1.2A④
$V_{GS(th)}$	Gate Threshold Voltage	2.0	---	4.0	V	V_{DS}=V_{GS}, I_D=250μA
g_{fs}	Forward Transconductance	1.0	---	---	S	V_{DS}=100V, I_{DS}=1.2A④
I_{DSS}	Zero Gate Voltage Collector Current	---	---	250	μA	V_{DS}=600V, V_{GS}=0V
		---	---	1000		V_{DS}=480V, V_{GS}=0V,T_J=125°C
I_{GSS}	Gate-to-Source Forward Leakage	---	---	500	nA	V_{GS}=20V
	Gate-to-Source Reverse Leakage	---	---	-500		V_{GS}=-20V
Q_g	Total Gate Charge	---	---	18	nC	I_D=2.0A, V_{DS}=480V, V_{GS}=10V④
Q_{gs}	Gate-to-Source Charge	---	---	3.0		
Q_{gd}	Gate-to-Drain ("Miller") Charge	---	---	8.9		
$t_{d(on)}$	Turn-On Delay Time	---	10	---	ns	V_{DD}=300V, I_D=2.0A R_G=18Ω, R_D=150Ω④
t_r	Rise Time	---	23	---		
$t_{d(off)}$	Turn-Off Delay Time	---	30	---		
t_f	Fall Time	---	25	---		
L_D	Internal Drain Inductance	---	4.5	---	nH	Between lead, 6mm (0.25in.) from package, and center of die contact. 
L_S	Internal Source Inductance	---	7.5	---		
C_{iss}	Input Capacitance	---	350	---	pF	V_{GS}=0V, V_{DS}=25V f=1.0Mhz
C_{oss}	Output Capacitance	---	48	---		
C_{rss}	Reverse Transfer Capacitance	---	8.6	---		

Source-Drain Diode Ratings and Characteristics

	Parameter	Min.	Typ.	Max.	Units	Test Conditions
I_S	Continuous Source Current (Body Diode)	---	---	2.0	A	MOSFET symbol showing the integral reverse p-n junction diode. 
I_{SM}	Pulsed Source Current (Body Diode) ①	---	---	8.0		
V_{SD}	Diode Forward Voltage	---	---	1.6	V	T_J=25°C, I_S=2.0A, V_{GS}=0V④
t_{rr}	Reverse Recovery Time	140	---	580	ns	T_J=25°C, I_F=2.2A, di/dt=100A/μS④
Q_{RR}	Reverse Recovery Charge	0.34	---	1.3	μC	
t_{on}	Forward Turn-On Time	Intrinsic turn-on time is negligible (turn-on is dominated by L_S + L_D)				

Notes:

① Repetitive rating; Pulse width limited by max. junction temperature

② V_{DD}=50V, Starting T_J=25°C, L=49mH, R_G=25Ω, Peak I_{AS}=2.0A

③ I_{SD}≤2.0A, di/dt≤40A/μs, V_{DD}≤BV_{DSS}, T_J≤150°C Suggested R_G=18Ω

④ Pulse width ≤ 300μs; duty Cycle ≤2%

⑤ Mounting surface: flat, smooth, greased

⑥ K/W = °C/W

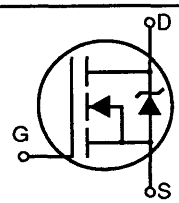
PD-9.438C

International
IOR Rectifier

IRFS1Z0

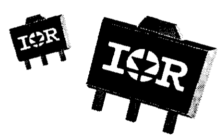
HEXFET® Power MOSFET

- Repetitive Avalanche Rated
- Dynamic dv/dt Rated
- Surface Mount



n-channel

BV_{DSS}	100V
$R_{DS(on)}$	2.4Ω
I_D	0.90A


SOT-89

Description

Third Generation HEXFETs from International Rectifier provide the designer with the best combination of fast switching speed, ruggedized device design, and low on resistance.

The SOT-89 package is a sub-compact surface mount case style designed for vapor phase, infra red, or wave soldering production processes. Power dissipation levels up to 2 watts are possible in SMD applications.

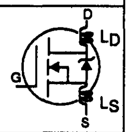
Absolute Maximum Ratings

	Parameter	Max.	Units
I_D @ T_C = 25°C	Continuous Drain Current, V_{GS}@10V	0.90	A
I_D @ T_C = 100°C	Continuous Drain Current, V_{GS}@10V	0.64	
I_{DM}	Pulsed Drain Current ①	3.6	
P_D@ T_C = 25°C	Maximum Power Dissipation	4.3	W
	Linear Derating Factor	0.29	W/K⑥
V_{GS}	Gate-to-Source Breakdown Voltage	±20	V
E_{AS}	Single Pulse Avalanche Energy ②	9.8	mJ
I_{AR}	Avalanche Current ①	0.90	A
E_{AR}	Repetitive Avalanche Energy ①	0.43	mJ
dv/dt	Peak Diode Recovery dv/dt ③	5.5	V/ns
T_J T_{STG}	Operating Junction and Storage Temperature Range	-55 to +175	°C

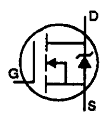
Thermal Resistance

	Parameter	Min.	Typ.	Max.	Units
$R_{\theta JC}$	Junction-to-Case	---	---	35	
$R_{\theta CS}$	Case-to-Sink ⑤	---	5.0	---	K/W⑥

Electrical Characteristics @ T_J = 25°C (unless otherwise specified)

	Parameter	Min.	Typ.	Max.	Units	Test Conditions
BV_{DSS}	Drain-to-Source Breakdown Voltage	100	---	---	V	V_{GS}=0V, I_D=250µA
$\Delta BV_{DSS}/\Delta T_J$	Temp. Coefficient of Breakdown Voltage	---	0.12	---	V/°C	Reference to 25°C, I_D=1mA
$R_{DS(on)}$	Static Drain-to-Source On Resistance	---	---	2.4	Ω	V_{GS}=10V, I_D =0.54A④
$V_{GS(th)}$	Gate Threshold Voltage	2.0	---	4.0	V	V_{DS}=V_{GS}, I_D=250µA
g_{fs}	Forward Transconductance	0.24	---	---	S	V_{DS}=50V, I_{DS}=0.54A④
I_{DSS}	Zero Gate Voltage Collector Current	---	---	250	µA	V_{DS}=100V, V_{GS}=0V
		---	---	1000		V_{DS}=80V, V_{GS}=0V,T_J=150°C
IGSS	Gate-to-Source Forward Leakage	---	---	500	nA	V_{GS}=20V
	Gate-to-Source Reverse Leakage	---	---	-500		V_{GS}=-20V
Q_g	Total Gate Charge	---	---	1.6	nC	I_D=0.90A, V_{DS}=80V, V_{GS}=10V④
Q_{gs}	Gate-to-Source Charge	---	---	0.68		
Q_{gd}	Gate-to-Drain ("Miller") Charge	---	---	0.95		
$t_{d(on)}$	Turn-On Delay Time	---	7.8	---	ns	V_{DD}=50V, I_D=0.90A R_G=50Ω, R_D=55Ω④
t_r	Rise Time	---	4.5	---		
$t_{d(off)}$	Turn-Off Delay Time	---	11	---		
t_f	Fall Time	---	4.7	---		
L_D	Internal Drain Inductance	---	2.0	---	nH	Between lead, 6mm (0.25in.) from package, and center of die contact. 
L_S	Internal Source Inductance	---	3.0	---		
C_{iss}	Input Capacitance	---	39	---	pF	V_{GS}=0V, V_{DS}=25V *f*=1.0Mhz
C_{oss}	Output Capacitance	---	18	---		
C_{rss}	Reverse Transfer Capacitance	---	2.8	---		

Source-Drain Diode Ratings and Characteristics

	Parameter	Min.	Typ.	Max.	Units	Test Conditions
I_S	Continuous Source Current (Body Diode)	---	---	0.9	A	MOSFET symbol showing the integral reverse p-n junction diode. 
I_{SM}	Pulsed Source Current (Body Diode) ①	---	---	3.6		
V_{SD}	Diode Forward Voltage	---	---	1.4	V	T_J=25°C, I_S=0.9A, V_{GS}=0V④
t_{rr}	Reverse Recovery Time	42	---	71	ns	T_J=25°C, I_F=0.9A, di/dt=100A/µS④
Q_{RR}	Reverse Recovery Charge	0.14	---	0.41	µC	
t_{on}	Forward Turn-On Time	Intrinsic turn-on time is negligible (turn-on is dominated by L_S + L_D)				

Notes:

① Repetitive rating; Pulse width limited by max. junction temperature

② V_{DD}=25V, Starting T_J=25°C, L=16mH, R_G=25Ω, Peak I_{AS}=1.0A

③ I_{SD}≤0.9A, di/dt≤25A/µs, V_{DD}≤BV_{DSS}, T_J≤175°C Suggested R_G=50Ω

④ Pulse width ≤ 300µs; duty Cycle ≤2%

⑤ Mounting surface: flat, smooth, greased

⑥ K/W = °C/W

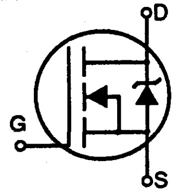
For more information on the same die in a HD-1 package refer to IRFD1Z0.

International
IOR Rectifier

IRLD014

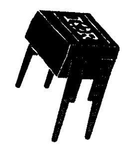
HEXFET® Power MOSFET

- Dynamic dv/dt Rated
- For Automatic Insertion
- End Stackable
- Logic Level Gate



n-channel

BV_{DSS} 60V
$R_{DS(on)}$ 0.20Ω
I_D 1.7A


HD-1

Description

Third Generation HEXFETs from International Rectifier provide the designer with the best combination of fast switching speed, ruggedized device design, and low on resistance.

The 4-pin DIP package is a low cost machine insertable case style which can be stacked in multiple combinations on standard 0.1 inch pin centers. The dual drain pin serves as a thermal link to the mounting surface for power dissipation levels up to 1 watt.

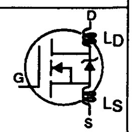
Absolute Maximum Ratings

	Parameter	Max.	Units
I_D @ T_C = 25°C	Continuous Drain Current, V_{GS}@5V	1.7	A
I_D @ T_C = 100°C	Continuous Drain Current, V_{GS}@5V	1.2	
I_{DM}	Pulsed Drain Current ①	14	
P_D@ T_C = 25°C	Maximum Power Dissipation	1.3	W
	Linear Derating Factor	0.0083	W/K⑥
V_{GS}	Gate-to-Source Breakdown Voltage	±10	V
E_{AS}	Single Pulse Avalanche Energy ②	130	mJ
dv/dt	Peak Diode Recovery dv/dt ③	4.5	V/ns
T_J T_{STG}	Operating Junction and Storage Temperature Range	-55 to +175	°C
	Soldering Temperature, for 10 sec.	300 (0.063 in. (1.6mm) from case)	

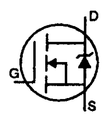
Thermal Resistance

	Parameter	Max.	Units
$R_{θJA}$	Junction-to-Ambient, Typical Socket Mount	120	K/W⑥

Electrical Characteristics @ T_J = 25°C (unless otherwise specified)

	Parameter	Min.	Typ.	Max.	Units	Test Conditions
BV_{DSS}	Drain-to-Source Breakdown Voltage	60	---	---	V	V_{GS}=0V, I_D=250μA
$\Delta BV_{DSS}/\Delta T_J$	Temp. Coefficient of Breakdown Voltage	---	0.070	---	V/°C	Reference to 25°C, I_D=1mA
$R_{DS(on)}$	Static Drain-to-Source On Resistance	---	---	0.20	Ω	V_{GS}=5.0V, I_D =1.0A④
		---	---	0.28		V_{GS}=4.0V, I_D =0.85A④
$V_{GS(th)}$	Gate Threshold Voltage	1.0	---	2.0	V	V_{DS}=V_{GS}, I_D=250μA
g_{fs}	Forward Transconductance	1.0	---	---	S	V_{DS}=25V, I_{DS}=1.0A④
I_{DSS}	Zero Gate Voltage Collector Current	---	---	250	μA	V_{DS}=60V, V_{GS}=0V
		---	---	1000		V_{DS}=48V, V_{GS}=0V,T_J=150°C
IGSS	Gate-to-Source Forward Leakage	---	---	500	nA	V_{GS}=10V
	Gate-to-Source Reverse Leakage	---	---	-500		V_{GS}=-10V
Q_g	Total Gate Charge	---	---	8.4	nC	I_D=10A, V_{DS}=48V, V_{GS}=5.0V④
Q_{gs}	Gate-to-Source Charge	---	---	2.6		
Q_{gd}	Gate-to-Drain ("Miller") Charge	---	---	6.4		
$t_{d(on)}$	Turn-On Delay Time	---	9.3	---	ns	V_{DD}=30V, I_D=10A
t_r	Rise Time	---	110	---		R_G=12Ω, R_D=2.8Ω④
$t_{d(off)}$	Turn-Off Delay Time	---	17	---		
t_f	Fall Time	---	26	---		
L_D	Internal Drain Inductance	---	4.0	---	nH	Between lead, 6mm (0.25in.) from package, and center of die contact. 
L_S	Internal Source Inductance	---	6.0	---		
C_{iss}	Input Capacitance	---	400	---	pF	V_{GS}=0V, V_{DS}=25v
C_{oss}	Output Capacitance	---	170	---		f=1.0Mhz
C_{rss}	Reverse Transfer Capacitance	---	42	---		

Source-Drain Diode Ratings and Characteristics

	Parameter	Min.	Typ.	Max.	Units	Test Conditions
I_S	Continuous Source Current (Body Diode)	---	---	1.7	A	MOSFET symbol showing the integral reverse p-n junction diode. 
I_{SM}	Pulsed Source Current (Body Diode) ①	---	---	14		
V_{SD}	Diode Forward Voltage	---	---	1.6	V	T_J=25°C, I_S=1.7A, V_{GS}=0V④
t_{rr}	Reverse Recovery Time	73	---	130	ns	T_J=25°C, I_F=10A,
Q_{RR}	Reverse Recovery Charge	0.10	---	0.65	μC	di/dt=100A/μS④
t_{on}	Forward Turn-On Time	Intrinsic turn-on time is negligible (turn-on is dominated by L_S + L_D)				

Notes:

① Repetitive rating; Pulse width limited by max. junction temperature

② V_{DD}=25V, Starting T_J=25°C, L=55mH, R_G=25Ω, Peak I_{AS}=1.7A

③ I_{SD}≤10A, di/dt≤90A/μs, V_{DD}≤BV_{DSS}, T_J≤175°C Suggested R_G=12Ω

④ Pulse width ≤ 300μs; duty Cycle ≤2%

⑤ Mounting surface: flat, smooth, greased

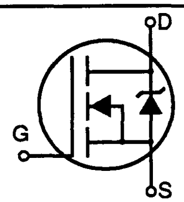
⑥ K/W = °C/W

International Rectifier

IRLD024

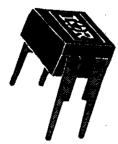
HEXFET® Power MOSFET

- Dynamic dv/dt Rated
- For Automatic Insertion
- End Stackable
- Logic Level Gate



n-channel

BV_{DSS} 60V
$R_{DS(on)}$ 0.10Ω
I_D 2.5A


HD-1

Description

Third Generation HEXFETs from International Rectifier provide the designer with the best combination of fast switching speed, ruggedized device design, and low on resistance.

The 4-pin DIP package is a low cost machine insertable case style which can be stacked in multiple combinations on standard 0.1 inch pin centers. The dual drain pin serves as a thermal link to the mounting surface for power dissipation levels up to 1 watt.

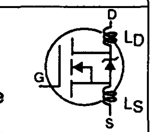
Absolute Maximum Ratings

	Parameter	Max.	Units
I_D @ T_C = 25°C	Continuous Drain Current, V_{GS}@5V	2.5	A
I_D @ T_C = 100°C	Continuous Drain Current, V_{GS}@5V	1.8	
I_{DM}	Pulsed Drain Current ①	20	
P_D@ T_C = 25°C	Maximum Power Dissipation	1.3	W
	Linear Derating Factor	0.0083	W/K⑥
V_{GS}	Gate-to-Source Breakdown Voltage	±10	V
E_{AS}	Single Pulse Avalanche Energy ②	91	mJ
dv/dt	Peak Diode Recovery dv/dt ③	4.5	V/ns
T_J T_{STG}	Operating Junction and Storage Temperature Range	-55 to +175	°C
	Soldering Temperature, for 10 sec.	300 (0.063 in. (1.6mm) from case)	

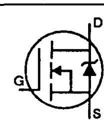
Thermal Resistance

	Parameter	Max.	Units
$R_{\theta JA}$	Junction-to-Ambient, Typical Socket Mount	120	K/W⑥

Electrical Characteristics @ T_J = 25°C (unless otherwise specified)

	Parameter	Min.	Typ.	Max.	Units	Test Conditions
BV_{DSS}	Drain-to-Source Breakdown Voltage	60	---	---	V	V_{GS}=0V, I_D=250μA
$\Delta BV_{DSS}/\Delta T_J$	Temp. Coefficient of Breakdown Voltage	---	0.060	---	V/°C	Reference to 25°C, I_D=1mA
$R_{DS(on)}$	Static Drain-to-Source On Resistance	---	---	0.10	Ω	V_{GS}=5.0V, I_D =1.5A④
		---	---	0.14		V_{GS}=4.0V, I_D =1.3A④
$V_{GS(th)}$	Gate Threshold Voltage	1.0	---	2.0	V	V_{DS}=V_{GS}, I_D=250μA
g_{fs}	Forward Transconductance	1.4	---	---	S	V_{DS}=25V, I_{DS}=1.5A④
I_{DSS}	Zero Gate Voltage Collector Current	---	---	250	μA	V_{DS}=60V, V_{GS}=0V
		---	---	1000		V_{DS}=48V, V_{GS}=0V, T_J=150°C
I_{GSS}	Gate-to-Source Forward Leakage	---	---	500	nA	V_{GS}=10V
	Gate-to-Source Reverse Leakage	---	---	-500		V_{GS}=-10V
Q_g	Total Gate Charge	---	---	18	nC	I_D=16A, V_{DS}=48V, V_{GS}=5.0V④
Q_{gs}	Gate-to-Source Charge	---	---	4.5		
Q_{gd}	Gate-to-Drain ("Miller") Charge	---	---	12		
$t_{d(on)}$	Turn-On Delay Time	---	11	---	ns	V_{DD}=30V, I_D=16A
t_r	Rise Time	---	110	---		R_G=9.0Ω, R_D=1.7Ω④
$t_{d(off)}$	Turn-Off Delay Time	---	23	---		
t_f	Fall Time	---	41	---		
L_D	Internal Drain Inductance	---	4.0	---	nH	Between lead, 6mm (0.25in.) from package, and center of die contact. 
L_S	Internal Source Inductance	---	6.0	---		
C_{iss}	Input Capacitance	---	880	---	pF	V_{GS}=0V, V_{DS}=25v
C_{oss}	Output Capacitance	---	350	---		f=1.0Mhz
C_{rss}	Reverse Transfer Capacitance	---	54	---		

Source-Drain Diode Ratings and Characteristics

	Parameter	Min.	Typ.	Max.	Units	Test Conditions
I_S	Continuous Source Current (Body Diode)	---	---	2.5	A	MOSFET symbol showing the integral reverse p-n junction diode. 
I_{SM}	Pulsed Source Current (Body Diode) ①	---	---	20		
V_{SD}	Diode Forward Voltage	---	---	1.5	V	T_J=25°C, I_S=2.5A, V_{GS}=0V④
t_{rr}	Reverse Recovery Time	70	---	140	ns	T_J=25°C, I_F=16A, di/dt=100A/μS④
Q_{RR}	Reverse Recovery Charge	0.19	---	0.78	μC	
t_{on}	Forward Turn-On Time	Intrinsic turn-on time is negligible (turn-on is dominated by L_S + L_D)				

Notes:

① Repetitive rating; Pulse width limited by max. junction temperature

② V_{DD}=25V, Starting T_J=25°C, L=17.5mH, R_G=25Ω, Peak I_{AS}=2.5A

③ I_{SD}≤17A, di/dt≤140A/μs, V_{DD}≤BV_{DSS}, T_J≤175°C Suggested R_G=9.0Ω

④ Pulse width ≤ 300μs; duty Cycle ≤2%

⑤ Mounting surface: flat, smooth, greased

⑥ K/W = °C/W

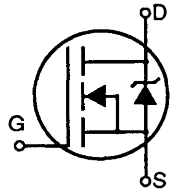
For more information on the same die in a TO-220 package refer to IRLZ24.

International
IOR Rectifier

IRLD110

HEXFET® Power MOSFET

- Repetitive Avalanche Rated
- Dynamic dv/dt Rated
- For Automatic Insertion
- End Stackable
- Logic Level Gate



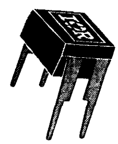
n-channel

BV_{DSS}	100V
$R_{DS(on)}$	0.54Ω
I_D	1.0A

Description

Third Generation HEXFETs from International Rectifier provide the designer with the best combination of fast switching speed, ruggedized device design, and low on resistance.

The 4-pin DIP package is a low cost machine insertable case style which can be stacked in multiple combinations on standard 0.1 inch pin centers. The dual drain pin serves as a thermal link to the mounting surface for power dissipation levels up to 1 watt.


HD-1

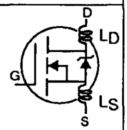
Absolute Maximum Ratings

	Parameter	Max.	Units
I_D @ T_C = 25°C	Continuous Drain Current, V_{GS}@5V	1.0	A
I_D @ T_C = 100°C	Continuous Drain Current, V_{GS}@5V	0.70	
I_{DM}	Pulsed Drain Current ①	8.0	
P_D@ T_C = 25°C	Maximum Power Dissipation	1.3	W
	Linear Derating Factor	0.0083	W/K⑥
V_{GS}	Gate-to-Source Breakdown Voltage	±10	V
E_{AS}	Single Pulse Avalanche Energy ②	140	mJ
I_{AR}	Avalanche Current ①	1.0	A
E_{AR}	Repetitive Avalanche Energy ①	0.13	mJ
dv/dt	Peak Diode Recovery dv/dt ③	5.5	V/ns
T_J T_{STG}	Operating Junction and Storage Temperature Range	-55 to +175	°C
	Soldering Temperature, for 10 sec.	300 (0.063 in. (1.6mm) from case)	

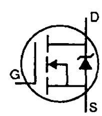
Thermal Resistance

	Parameter	Max.	Units
$R_{θJA}$	Junction-to-Ambient, Typical Socket Mount	120	K/W⑥

Electrical Characteristics @ T_J = 25°C (unless otherwise specified)

	Parameter	Min.	Typ.	Max.	Units	Test Conditions
BV_{DSS}	Drain-to-Source Breakdown Voltage	100	---	---	V	V_{GS}=0V, I_D=250µA
$\Delta BV_{DSS}/\Delta T_J$	Temp. Coefficient of Breakdown Voltage	---	0.12	---	V/°C	Reference to 25°C, I_D=1mA
$R_{DS(on)}$	Static Drain-to-Source On Resistance	---	---	0.54	Ω	V_{GS}=5.0V, I_D =0.6A④
		---	---	0.76		V_{GS}=4.0V, I_D =0.50A④
$V_{GS(th)}$	Gate Threshold Voltage	1.0	---	2.0	V	V_{DS}=V_{GS}, I_D=250µA
g_{fs}	Forward Transconductance	0.8	---	---	S	V_{DS}=50V, I_{DS}=0.60A④
I_{DSS}	Zero Gate Voltage Collector Current	---	---	250	µA	V_{DS}=100V, V_{GS}=0V
		---	---	1000		V_{DS}=80V, V_{GS}=0V,T_J=150°C
IGSS	Gate-to-Source Forward Leakage	---	---	500	nA	V_{GS}=10V
	Gate-to-Source Reverse Leakage	---	---	-500		V_{GS}=-10V
Q_g	Total Gate Charge	---	---	6.1	nC	I_D=5.6A, V_{DS}=80V, V_{GS}=5.0V④
Q_{gs}	Gate-to-Source Charge	---	---	2.6		
Q_{gd}	Gate-to-Drain ("Miller") Charge	---	---	3.3		
$t_{d(on)}$	Turn-On Delay Time	---	9.3	---	ns	V_{DD}=50V, I_D=5.6A
t_r	Rise Time	---	47	---		R_G=12Ω, R_D=8.4Ω④
$t_{d(off)}$	Turn-Off Delay Time	---	16	---		
t_f	Fall Time	---	17	---		
L_D	Internal Drain Inductance	---	4.0	---	nH	Between lead, 6mm (0.25in.) from package, and center of die contact. 
L_S	Internal Source Inductance	---	6.0	---		
C_{iss}	Input Capacitance	---	250	---	pF	V_{GS}=0V, V_{DS}=25v
C_{oss}	Output Capacitance	---	80	---		f=1.0Mhz
C_{rss}	Reverse Transfer Capacitance	---	15	---		

Source-Drain Diode Ratings and Characteristics

	Parameter	Min.	Typ.	Max.	Units	Test Conditions
I_S	Continuous Source Current (Body Diode)	---	---	5.6	A	MOSFET symbol showing the integral reverse p-n junction diode. 
I_{SM}	Pulsed Source Current (Body Diode) ①	---	---	18		
V_{SD}	Diode Forward Voltage	---	---	2.5	V	T_J=25°C, I_S=1.0A, V_{GS}=0V④
t_{rr}	Reverse Recovery Time	89	---	130	ns	T_J=25°C, I_F=5.6A,
Q_{RR}	Reverse Recovery Charge	0.35	---	0.65	µC	di/dt=100A/µS④
t_{on}	Forward Turn-On Time	Intrinsic turn-on time is negligible (turn-on is dominated by L_S + L_D)				

Notes:

① Repetitive rating; Pulse width limited by max. junction temperature

② V_{DD}=25V, Starting T_J=25°C, L=52mH, R_G=25Ω, Peak I_{AS}=2.0A

③ I_{SD}≤5.6A, di/dt≤75A/µs, V_{DD}≤BV_{DSS}, T_J≤175°C Suggested R_G=12Ω

④ Pulse width ≤ 300µs; duty Cycle ≤2%

⑤ Mounting surface: flat, smooth, greased

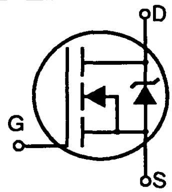
⑥ K/W = °C/W

International
IOR Rectifier

IRLD120

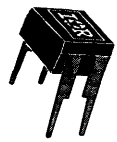
HEXFET® Power MOSFET

- Repetitive Avalanche Rated
- Dynamic dv/dt Rated
- For Automatic Insertion
- End Stackable
- Logic Level Gate



n-channel

BV_{DSS}	100V
$R_{DS(on)}$	0.27Ω
I_D	1.3A


HD-1

Description

Third Generation HEXFETs from International Rectifier provide the designer with the best combination of fast switching speed, ruggedized device design, and low on resistance.

The 4-pin DIP package is a low cost machine insertable case style which can be stacked in multiple combinations on standard 0.1 inch pin centers. The dual drain pin serves as a thermal link to the mounting surface for power dissipation levels up to 1 watt.

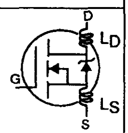
Absolute Maximum Ratings

	Parameter	Max.	Units
I_D @ T_C = 25°C	Continuous Drain Current, V_{GS}@5V	1.3	A
I_D @ T_C = 100°C	Continuous Drain Current, V_{GS}@5V	0.94	
I_{DM}	Pulsed Drain Current ①	10	
P_D@ T_C = 25°C	Maximum Power Dissipation	1.3	W
	Linear Derating Factor	0.0083	W/K⑥
V_{GS}	Gate-to-Source Breakdown Voltage	±10	V
E_{AS}	Single Pulse Avalanche Energy ②	100	mJ
I_{AR}	Avalanche Current ①	1.3	V
E_{AR}	Repetitive Avalanche Energy ①	0.13	mJ
dv/dt	Peak Diode Recovery dv/dt ③	5.5	V/ns
T_J T_{STG}	Operating Junction and Storage Temperature Range	-55 to +175	°C
	Soldering Temperature, for 10 sec.	300 (0.063 in. (1.6mm) from case)	

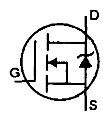
Thermal Resistance

	Parameter	Max.	Units
$R_{\theta JA}$	Junction-to-Ambient, Typical Socket Mount	120	K/W⑥

Electrical Characteristics @ T_J = 25°C (unless otherwise specified)

	Parameter	Min.	Typ.	Max.	Units	Test Conditions
BV_{DSS}	Drain-to-Source Breakdown Voltage	100	---	---	V	V_{GS}=0V, I_D=250µA
$\Delta BV_{DSS}/\Delta T_J$	Temp. Coefficient of Breakdown Voltage	---	0.12	---	V/°C	Reference to 25°C, I_D=1mA
$R_{DS(on)}$	Static Drain-to-Source On Resistance	---	---	0.27	Ω	V_{GS}=5.0V, I_D =0.78A④
		---	---	0.38		V_{GS}=4.0V, I_D =0.65A④
$V_{GS(th)}$	Gate Threshold Voltage	1.0	---	2.0	V	V_{DS}=V_{GS}, I_D=250µA
g_{fs}	Forward Transconductance	0.92	---	---	S	V_{DS}=50V, I_{DS}=0.78A④
I_{DSS}	Zero Gate Voltage Collector Current	---	---	250	µA	V_{DS}=100V, V_{GS}=0V
		---	---	1000		V_{DS}=80V, V_{GS}=0V,T_J=150°C
IGSS	Gate-to-Source Forward Leakage	---	---	500	nA	V_{GS}=10V
	Gate-to-Source Reverse Leakage	---	---	-500		V_{GS}=-10V
Q_g	Total Gate Charge	---	---	12	nC	I_D=9.2A, V_{DS}=80V, V_{GS}=5.0V④
Q_{gs}	Gate-to-Source Charge	---	---	3.0		
Q_{gd}	Gate-to-Drain ("Miller") Charge	---	---	7.1		
$t_{d(on)}$	Turn-On Delay Time	---	9.8	---	ns	V_{DD}=50V, I_D=9.2A
t_r	Rise Time	---	64	---		R_G=9.0Ω, R_D=5.2Ω④
$t_{d(off)}$	Turn-Off Delay Time	---	21	---		
t_f	Fall Time	---	27	---		
L_D	Internal Drain Inductance	---	4.0	---	nH	Between lead, 6mm (0.25in.) from package, and center of die contact. 
L_S	Internal Source Inductance	---	6.0	---		
C_{iss}	Input Capacitance	---	490	---	pF	V_{GS}=0V, V_{DS}=25v
C_{oss}	Output Capacitance	---	150	---		f=1.0Mhz
C_{rss}	Reverse Transfer Capacitance	---	30	---		

Source-Drain Diode Ratings and Characteristics

	Parameter	Min.	Typ.	Max.	Units	Test Conditions
I_S	Continuous Source Current (Body Diode)	---	---	1.3	A	MOSFET symbol showing the integral reverse p-n junction diode. 
I_{SM}	Pulsed Source Current (Body Diode) ①	---	---	10		
V_{SD}	Diode Forward Voltage	---	---	2.5	V	T_J=25°C, I_S=1.3A, V_{GS}=0V④
t_{rr}	Reverse Recovery Time	82	---	140	ns	T_J=25°C, I_F=9.2A,
Q_{RR}	Reverse Recovery Charge	0.64	---	1.0	µC	di/dt=100A/µS④
t_{on}	Forward Turn-On Time	Intrinsic turn-on time is negligible (turn-on is dominated by L_S + L_D)				

Notes:

① Repetitive rating; Pulse width limited by max. junction temperature

② V_{DD}=25V, Starting T_J=25°C, L=24mH, R_G=25Ω, Peak I_{AS}=2.6A

③ I_{SD}≤9.2A, di/dt≤110A/µs, V_{DD}≤BV_{DSS}, T_J≤175°C Suggested R_G=9.0Ω

④ Pulse width ≤ 300µs; duty Cycle ≤2%

⑤ Mounting surface: flat, smooth, greased

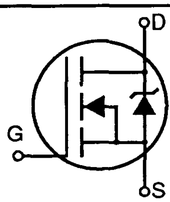
⑥ K/W = °C/W

International Rectifier

IRLR014
IRLU014

HEXFET® Power MOSFET

- Surface Mount (IRLR014)
- Straight Lead (IRLU014)
- Dynamic dv/dt Rated
- Logic Level Gate



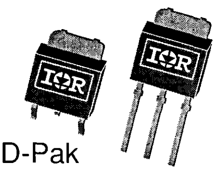
n-channel

BV_{DSS} 60V
$R_{DS(on)}$ 0.20Ω
I_D 8.5A

Description

Third Generation HEXFETs from International Rectifier provide the designer with the best combination of fast switching speed, ruggedized device design, and low on resistance.

The D-Pak is designed for surface mounting using vapor phase, infra red, or wave soldering techniques. The straight lead version (IRFU series) is for through hole mounting applications. Power dissipation levels up to 2 watts are possible in SMD applications.


D-Pak TO-252AA I-Pak TO-251AA

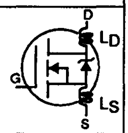
Absolute Maximum Ratings

	Parameter	Max.	Units
I_D @ T_C = 25°C	Continuous Drain Current, V_{GS}@5V	8.5	A
I_D @ T_C = 100°C	Continuous Drain Current, V_{GS}@5V	6.0	
I_{DM}	Pulsed Drain Current ①	31	
P_D@ T_C = 25°C	Maximum Power Dissipation	30	W
	Linear Derating Factor	0.20	W/K⑥
V_{GS}	Gate-to-Source Breakdown Voltage	±10	V
E_{AS}	Single Pulse Avalanche Energy ②	47	mJ
dv/dt	Peak Diode Recovery dv/dt ③	4.5	V/ns
T_J, T_{STG}	Operating Junction and Storage Temperature Range	-55 to +175	°C
	Soldering Temperature, for 10 sec.	300 (0.063 in. (1.6mm) from case)	

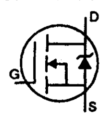
Thermal Resistance

	Parameter	Min.	Typ.	Max.	Units
$R_{\theta JC}$	Junction-to-Case	---	---	5.0	K/W⑥
$R_{\theta CS}$	Case-to-Sink ⑤	---	1.7	---	
$R_{\theta JA}$	Junction-to-Ambient, Typical Socket Mount	---	---	110	

Electrical Characteristics @ T_J = 25°C (unless otherwise specified)

	Parameter	Min.	Typ.	Max.	Units	Test Conditions
BV_{DSS}	Drain-to-Source Breakdown Voltage	60	---	---	V	V_{GS}=0V, I_D=250µA
$\Delta BV_{DSS}/\Delta T_J$	Temp. Coefficient of Breakdown Voltage	---	0.070	---	V/°C	Reference to 25°C, I_D=1mA
$R_{DS(on)}$	Static Drain-to-Source On Resistance	---	---	0.20	Ω	V_{GS}=5.0V, I_D =5.1A④
		---	---	0.28		V_{GS}=4.0V, I_D =4.3A④
$V_{GS(th)}$	Gate Threshold Voltage	1.0	---	2.0	V	V_{DS}=V_{GS}, I_D=250µA
g_{fs}	Forward Transconductance	3.7	---	---	S	V_{DS}=25V, I_{DS}=5.1A④
I_{DSS}	Zero Gate Voltage Collector Current	---	---	250	µA	V_{DS}=60V, V_{GS}=0V
		---	---	1000		V_{DS}=48V, V_{GS}=0V,T_J=150°C
IGSS	Gate-to-Source Forward Leakage	---	---	500	nA	V_{GS}=10V
	Gate-to-Source Reverse Leakage	---	---	-500		V_{GS}=-10V
Q_g	Total Gate Charge	---	---	8.4	nC	I_D=10A, V_{DS}=48V, V_{GS}=5.0V④
Q_{gs}	Gate-to-Source Charge	---	---	2.6		
Q_{gd}	Gate-to-Drain ("Miller") Charge	---	---	6.4		
$t_{d(on)}$	Turn-On Delay Time	---	9.3	---	ns	V_{DD}=30V, I_D=10A
t_r	Rise Time	---	110	---		R_G=12Ω, R_D=2.8Ω④
$t_{d(off)}$	Turn-Off Delay Time	---	17	---		
t_f	Fall Time	---	26	---		
L_D	Internal Drain Inductance	---	4.5	---	nH	Between lead, 6mm (0.25in.) from package, and center of die contact. 
L_S	Internal Source Inductance	---	7.5	---		
C_{iss}	Input Capacitance	---	400	---	pF	V_{GS}=0V, V_{DS}=25v
C_{oss}	Output Capacitance	---	170	---		*f*=1.0Mhz
C_{rss}	Reverse Transfer Capacitance	---	42	---		

Source-Drain Diode Ratings and Characteristics

	Parameter	Min.	Typ.	Max.	Units	Test Conditions
I_S	Continuous Source Current (Body Diode)	---	---	8.5	A	MOSFET symbol showing the integral reverse p-n junction diode. 
I_{SM}	Pulsed Source Current (Body Diode) ①	---	---	31		
V_{SD}	Diode Forward Voltage	---	---	1.6	V	T_J=25°C, I_S=8.5A, V_{GS}=0V④
t_{rr}	Reverse Recovery Time	73	---	130	ns	T_J=25°C, I_F=10A,
Q_{RR}	Reverse Recovery Charge	0.10	---	0.65	µC	di/dt=100A/µS④
t_{on}	Forward Turn-On Time	Intrinsic turn-on time is negligible (turn-on is dominated by L_S + L_D)				

Notes:

① Repetitive rating; Pulse width limited by max. junction temperature

② V_{DD}=25V, Starting T_J=25°C, L=850µH, R_G=25Ω, Peak I_{AS}=8.5A

③ I_{SD}≤8.5A, di/dt≤90A/µs, V_{DD}≤BV_{DSS}, T_J≤175°C Suggested R_G=12Ω

④ Pulse width ≤ 300µs; duty Cycle ≤2%

⑤ Mounting surface: flat, smooth, greased

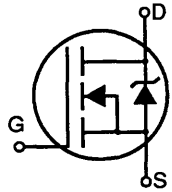
⑥ K/W = °C/W

International
IOR Rectifier

IRLR024
IRLU024

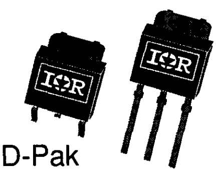
HEXFET® Power MOSFET

- Surface Mount (IRLR024)
- Straight Lead (IRLU024)
- Dynamic dv/dt Rated
- Logic Level Gate



n-channel

BV_{DSS} 60V
$R_{DS(on)}$ 0.10Ω
I_D 16A


D-Pak
TO-252AA
I-Pak
TO-251AA

Description

Third Generation HEXFETs from International Rectifier provide the designer with the best combination of fast switching speed, ruggedized device design, and low on resistance.

The D-Pak is designed for surface mounting using vapor phase, infra red, or wave soldering techniques. The straight lead version (IRFU series) is for through hole mounting applications. Power dissipation levels up to 2 watts are possible in SMD applications.

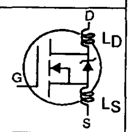
Absolute Maximum Ratings

	Parameter	Max.	Units
I_D @ T_C = 25°C	Continuous Drain Current, V_{GS}@5V	16	A
I_D @ T_C = 100°C	Continuous Drain Current, V_{GS}@5V	11	
I_{DM}	Pulsed Drain Current ①	64	
P_D@ T_C = 25°C	Maximum Power Dissipation	50	W
	Linear Derating Factor	0.33	W/K⑥
V_{GS}	Gate-to-Source Breakdown Voltage	±10	V
E_{AS}	Single Pulse Avalanche Energy ②	91	mJ
dv/dt	Peak Diode Recovery dv/dt ③	4.5	V/ns
T_J T_{STG}	Operating Junction and Storage Temperature Range	-55 to +175	°C
	Soldering Temperature, for 10 sec.	300 (0.063 in. (1.6mm) from case)	

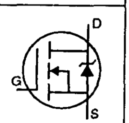
Thermal Resistance

	Parameter	Min.	Typ.	Max.	Units
$R_{θJC}$	Junction-to-Case	---	---	3.0	K/W⑥
$R_{θCS}$	Case-to-Sink ⑤	---	1.7	---	
$R_{θJA}$	Junction-to-Ambient, Typical Socket Mount	---	---	110	

Electrical Characteristics @ T_J = 25°C (unless otherwise specified)

	Parameter	Min.	Typ.	Max.	Units	Test Conditions
BV_{DSS}	Drain-to-Source Breakdown Voltage	60	---	---	V	V_{GS}=0V, I_D=250μA
$\Delta BV_{DSS}/\Delta T_J$	Temp. Coefficient of Breakdown Voltage	---	0.060	---	V/°C	Reference to 25°C, I_D=1mA
$R_{DS(on)}$	Static Drain-to-Source On Resistance	---	---	0.10	Ω	V_{GS}=5.0V, I_D =9.6A④
		---	---	0.14		V_{GS}=4.0V, I_D =8.0A④
$V_{GS(th)}$	Gate Threshold Voltage	1.0	---	2.0	V	V_{DS}=V_{GS}, I_D=250μA
g_{fs}	Forward Transconductance	7.9	---	---	S	V_{DS}=25V, I_{DS}=9.6A④
I_{DSS}	Zero Gate Voltage Collector Current	---	---	250	μA	V_{DS}=60V, V_{GS}=0V
		---	---	1000		V_{DS}=48V, V_{GS}=0V,T_J=150°C
I_{GSS}	Gate-to-Source Forward Leakage	---	---	500	nA	V_{GS}=10V
	Gate-to-Source Reverse Leakage	---	---	-500		V_{GS}=-10V
Q_g	Total Gate Charge	---	---	18	nC	I_D=16A, V_{DS}=48V, V_{GS}=5.0V④
Q_{gs}	Gate-to-Source Charge	---	---	4.5		
Q_{gd}	Gate-to-Drain ("Miller") Charge	---	---	12		
$t_{d(on)}$	Turn-On Delay Time	---	11	---	ns	V_{DD}=30V, I_D=16A
t_r	Rise Time	---	110	---		R_G=9.0Ω, R_D=1.7Ω④
$t_{d(off)}$	Turn-Off Delay Time	---	23	---		
t_f	Fall Time	---	41	---		
L_D	Internal Drain Inductance	---	4.5	---	nH	Between lead, 6mm (0.25in.) from package, and center of die contact. 
L_S	Internal Source Inductance	---	7.5	---		
C_{iss}	Input Capacitance	---	880	---	pF	V_{GS}=0V, V_{DS}=25v
C_{oss}	Output Capacitance	---	350	---		f=1.0Mhz
C_{rss}	Reverse Transfer Capacitance	---	54	---		

Source-Drain Diode Ratings and Characteristics

	Parameter	Min.	Typ.	Max.	Units	Test Conditions
I_S	Continuous Source Current (Body Diode)	---	---	16	A	MOSFET symbol showing the integral reverse p-n junction diode. 
I_{SM}	Pulsed Source Current (Body Diode) ①	---	---	64		
V_{SD}	Diode Forward Voltage	---	---	1.5	V	T_J=25°C, I_S=16A, V_{GS}=0V④
t_{rr}	Reverse Recovery Time	70	---	140	ns	T_J=25°C, I_F=16A,
Q_{RR}	Reverse Recovery Charge	0.19	---	0.78	μC	di/dt=100A/μS④
t_{on}	Forward Turn-On Time	Intrinsic turn-on time is negligible (turn-on is dominated by L_S + L_D)				

Notes:

① Repetitive rating; Pulse width limited by max. junction temperature

② V_{DD}=25V, Starting T_J=25°C, L=450μH, R_G=25Ω, Peak I_{AS}=16A

③ I_{SD}≤16A, di/dt≤140A/μs, V_{DD}≤BV_{DSS}, T_J≤175°C Suggested R_G=9.0Ω

④ Pulse width ≤ 300μs; duty Cycle ≤2%

⑤ Mounting surface: flat, smooth, greased

⑥ K/W = °C/W

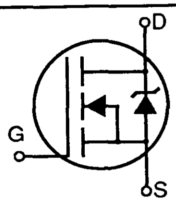
For more information on the same die in a TO-220 package refer to IRLZ24.

International Rectifier

IRLR110
IRLU110

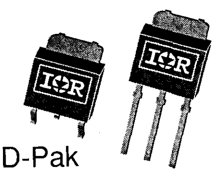
HEXFET® Power MOSFET

- Surface Mount (IRLR110)
- Straight Lead (IRLU110)
- Repetitive Avalanche Rated
- Dynamic dv/dt Rated
- Logic Level Gate



n-channel

BV_{DSS}	100V
$R_{DS(on)}$	0.54Ω
I_D	4.6A



D-Pak
TO-252AA

I-Pak
TO-251AA

Description

Third Generation HEXFETs from International Rectifier provide the designer with the best combination of fast switching speed, ruggedized device design, and low on resistance.

The D-Pak is designed for surface mounting using vapor phase, infra red, or wave soldering techniques. The straight lead version (IRFU series) is for through hole mounting applications. Power dissipation levels up to 2 watts are possible in SMD applications.

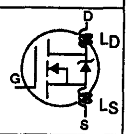
Absolute Maximum Ratings

	Parameter	Max.	Units
I_D @ T_C = 25°C	Continuous Drain Current, V_{GS}@5V	4.6	A
I_D @ T_C = 100°C	Continuous Drain Current, V_{GS}@5V	3.3	
I_{DM}	Pulsed Drain Current ①	18	
P_D@ T_C = 25°C	Maximum Power Dissipation	30	W
	Linear Derating Factor	0.20	W/K⑥
V_{GS}	Gate-to-Source Breakdown Voltage	±10	V
E_{AS}	Single Pulse Avalanche Energy ②	100	mJ
I_{AR}	Avalanche Current ①	4.6	A
E_{AR}	Repetitive Avalanche Energy ①	3.0	mJ
dv/dt	Peak Diode Recovery dv/dt ③	5.5	V/ns
T_J T_{STG}	Operating Junction and Storage Temperature Range	-55 to +175	°C
	Soldering Temperature, for 10 sec.	300 (0.063 in. (1.6mm) from case)	

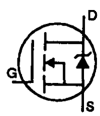
Thermal Resistance

	Parameter	Min.	Typ.	Max.	Units
$R_{\theta JC}$	Junction-to-Case	---	---	5.0	K/W⑥
$R_{\theta CS}$	Case-to-Sink ⑤	---	1.7	---	
$R_{\theta JA}$	Junction-to-Ambient, Typical Socket Mount	---	---	110	

Electrical Characteristics @ T_J = 25°C (unless otherwise specified)

	Parameter	Min.	Typ.	Max.	Units	Test Conditions
BV_{DSS}	Drain-to-Source Breakdown Voltage	100	---	---	V	V_{GS}=0V, I_D=250μA
$\Delta BV_{DSS}/\Delta T_J$	Temp. Coefficient of Breakdown Voltage	---	0.12	---	V/°C	Reference to 25°C, I_D=1mA
$R_{DS(on)}$	Static Drain-to-Source On Resistance	---	---	0.54	Ω	V_{GS}=5.0V, I_D =2.7A④
		---	---	0.76		V_{GS}=4.0V, I_D =2.3A④
$V_{GS(th)}$	Gate Threshold Voltage	1.0	---	2.0	V	V_{DS}=V_{GS}, I_D=250μA
g_{fs}	Forward Transconductance	2.3	---	---	S	V_{DS}=50V, I_{DS}=2.7A④
I_{DSS}	Zero Gate Voltage Collector Current	---	---	250	μA	V_{DS}=100V, V_{GS}=0V
		---	---	1000		V_{DS}=80V, V_{GS}=0V, T_J=150°C
IGSS	Gate-to-Source Forward Leakage	---	---	500	nA	V_{GS}=10V
	Gate-to-Source Reverse Leakage	---	---	-500		V_{GS}=-10V
Q_g	Total Gate Charge	---	---	6.1	nC	I_D=5.6A, V_{DS}=80V, V_{GS}=5.0V④
Q_{gs}	Gate-to-Source Charge	---	---	2.0		
Q_{gd}	Gate-to-Drain ("Miller") Charge	---	---	3.3		
$t_{d(on)}$	Turn-On Delay Time	---	9.3	---	ns	V_{DD}=50V, I_D=5.6A
t_r	Rise Time	---	47	---		R_G=12Ω, R_D=8.4Ω④
$t_{d(off)}$	Turn-Off Delay Time	---	16	---		
t_f	Fall Time	---	17	---		
L_D	Internal Drain Inductance	---	4.5	---	nH	Between lead, 6mm (0.25in.) from package, and center of die contact. 
L_S	Internal Source Inductance	---	7.5	---		
C_{iss}	Input Capacitance	---	250	---	pF	V_{GS}=0V, V_{DS}=25v
C_{oss}	Output Capacitance	---	80	---		f=1.0Mhz
C_{rss}	Reverse Transfer Capacitance	---	15	---		

Source-Drain Diode Ratings and Characteristics

	Parameter	Min.	Typ.	Max.	Units	Test Conditions
I_S	Continuous Source Current (Body Diode)	---	---	4.6	A	MOSFET symbol showing the integral reverse p-n junction diode. 
I_{SM}	Pulsed Source Current (Body Diode) ①	---	---	18		
V_{SD}	Diode Forward Voltage	---	---	2.5	V	T_J=25°C, I_S=4.6A, V_{GS}=0V④
t_{rr}	Reverse Recovery Time	89	---	130	ns	T_J=25°C, I_F=5.6A,
Q_{RR}	Reverse Recovery Charge	0.35	---	0.65	μC	di/dt=100A/μS④
t_{on}	Forward Turn-On Time	Intrinsic turn-on time is negligible (turn-on is dominated by L_S + L_D)				

Notes:

① Repetitive rating; Pulse width limited by max. junction temperature

② V_{DD}=25V, Starting T_J=25°C, L=7.4mH, R_G=25Ω, Peak I_{AS}=4.6A

③ I_{SD}≤4.6A, di/dt≤75A/μs, V_{DD}≤BV_{DSS}, T_J≤175°C Suggested R_G=12Ω

④ Pulse width ≤ 300μs; duty Cycle ≤2%

⑤ Mounting surface: flat, smooth, greased

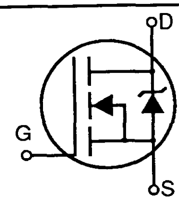
⑥ K/W = °C/W

International IOR Rectifier

IRLR120
IRLU120

HEXFET® Power MOSFET

- Surface Mount (IRLR120)
- Straight Lead (IRLU120)
- Repetitive Avalanche Rated
- Dynamic dv/dt Rated
- Logic Level Gate



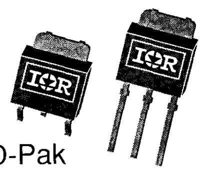
n-channel

BV_{DSS} 100V
$R_{DS(on)}$ 0.27Ω
I_D 8.4A

Description

Third Generation HEXFETs from International Rectifier provide the designer with the best combination of fast switching speed, ruggedized device design, and low on resistance.

The D-Pak is designed for surface mounting using vapor phase, infra red, or wave soldering techniques. The straight lead version (IRFU series) is for through hole mounting applications. Power dissipation levels up to 2 watts are possible in SMD applications.



D-Pak
TO-252AA

I-Pak
TO-251AA

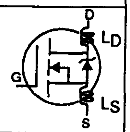
Absolute Maximum Ratings

	Parameter	Max.	Units
I_D @ T_C = 25°C	Continuous Drain Current, V_{GS}@5V	8.4	A
I_D @ T_C = 100°C	Continuous Drain Current, V_{GS}@5V	5.9	
I_{DM}	Pulsed Drain Current ①	31	
P_D@ T_C = 25°C	Maximum Power Dissipation	50	W
	Linear Derating Factor	0.33	W/K⑥
V_{GS}	Gate-to-Source Breakdown Voltage	±10	V
E_{AS}	Single Pulse Avalanche Energy ②	210	mJ
I_{AR}	Avalanche Current ①	8.4	A
E_{AR}	Repetitive Avalanche Energy ①	5.0	mJ
dv/dt	Peak Diode Recovery dv/dt ③	5.5	V/ns
T_J T_{STG}	Operating Junction and Storage Temperature Range	-55 to +175	°C
	Soldering Temperature, for 10 sec.	300 (0.063 in. (1.6mm) from case)	

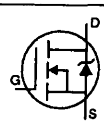
Thermal Resistance

	Parameter	Min.	Typ.	Max.	Units
$R_{\theta JC}$	Junction-to-Case	---	---	3.0	K/W⑥
$R_{\theta CS}$	Case-to-Sink ⑤	---	1.7	---	
$R_{\theta JA}$	Junction-to-Ambient, Typical Socket Mount	---	---	110	

Electrical Characteristics @ T_J = 25°C (unless otherwise specified)

	Parameter	Min.	Typ.	Max.	Units	Test Conditions
BV_{DSS}	Drain-to-Source Breakdown Voltage	100	---	---	V	V_{GS}=0V, I_D=250μA
$\Delta BV_{DSS}/\Delta T_J$	Temp. Coefficient of Breakdown Voltage	---	0.12	---	V/°C	Reference to 25°C, I_D=1mA
$R_{DS(on)}$	Static Drain-to-Source On Resistance	---	---	0.27	Ω	V_{GS}=5.0V, I_D =5.0A④
		---	---	0.38		V_{GS}=4.0V, I_D =4.2A④
$V_{GS(th)}$	Gate Threshold Voltage	1.0	---	2.0	V	V_{DS}=V_{GS}, I_D=250μA
g_{fs}	Forward Transconductance	4.8	---	---	S	V_{DS}=50V, I_{DS}=5.0A④
I_{DSS}	Zero Gate Voltage Collector Current	---	---	250	μA	V_{DS}=100V, V_{GS}=0V
		---	---	1000		V_{DS}=80V, V_{GS}=0V, T_J=150°C
IGSS	Gate-to-Source Forward Leakage	---	---	500	nA	V_{GS}=10V
	Gate-to-Source Reverse Leakage	---	---	-500		V_{GS}=-10V
Q_g	Total Gate Charge	---	---	12	nC	I_D=9.2A, V_{DS}=80V, V_{GS}=5.0V④
Q_{gs}	Gate-to-Source Charge	---	---	3.0		
Q_{gd}	Gate-to-Drain ("Miller") Charge	---	---	7.1		
$t_{d(on)}$	Turn-On Delay Time	---	9.8	---	ns	V_{DD}=50V, I_D=9.2A
t_r	Rise Time	---	64	---		R_G=9.0Ω, R_D=5.2Ω④
$t_{d(off)}$	Turn-Off Delay Time	---	21	---		
t_f	Fall Time	---	27	---		
L_D	Internal Drain Inductance	---	4.5	---	nH	Between lead, 6mm (0.25in.) from package, and center of die contact. 
L_S	Internal Source Inductance	---	7.5	---		
C_{iss}	Input Capacitance	---	490	---	pF	V_{GS}=0V, V_{DS}=25v
C_{oss}	Output Capacitance	---	150	---		f=1.0Mhz
C_{rss}	Reverse Transfer Capacitance	---	30	---		

Source-Drain Diode Ratings and Characteristics

	Parameter	Min.	Typ.	Max.	Units	Test Conditions
I_S	Continuous Source Current (Body Diode)	---	---	8.4	A	MOSFET symbol showing the integral reverse p-n junction diode. 
I_{SM}	Pulsed Source Current (Body Diode) ①	---	---	31		
V_{SD}	Diode Forward Voltage	---	---	2.5	V	T_J=25°C, I_S=8.4A, V_{GS}=0V④
t_{rr}	Reverse Recovery Time	82	---	140	ns	T_J=25°C, I_F=9.2A,
Q_{RR}	Reverse Recovery Charge	0.64	---	1.0	μC	di/dt=100A/μS④
t_{on}	Forward Turn-On Time	Intrinsic turn-on time is negligible (turn-on is dominated by L_S + L_D)				

Notes:

① Repetitive rating; Pulse width limited by max. junction temperature

② V_{DD}=25V, Starting T_J=25°C, L=4.4mH, R_G=25Ω, Peak I_{AS}=8.4A

③ I_{SD}≤8.4A, di/dt≤110A/μs, V_{DD}≤BV_{DSS}, T_J≤175°C Suggested R_G=9.0Ω

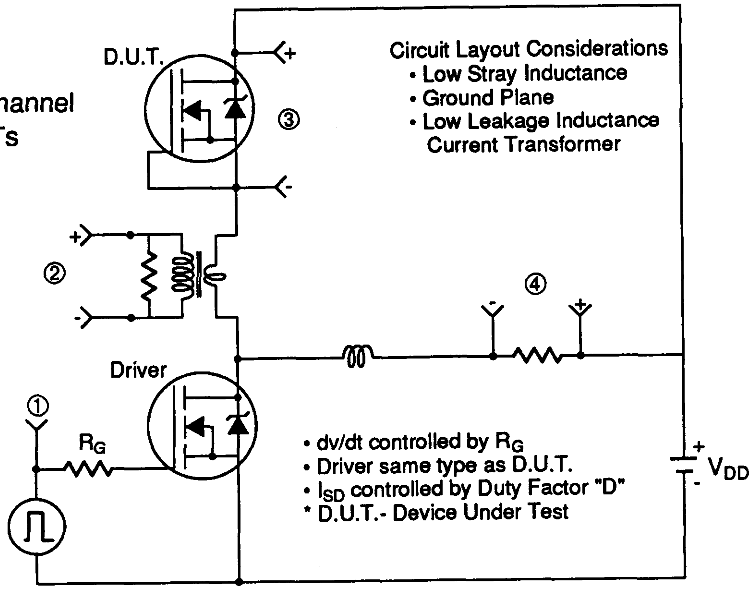
④ Pulse width ≤ 300μs; duty Cycle ≤2%

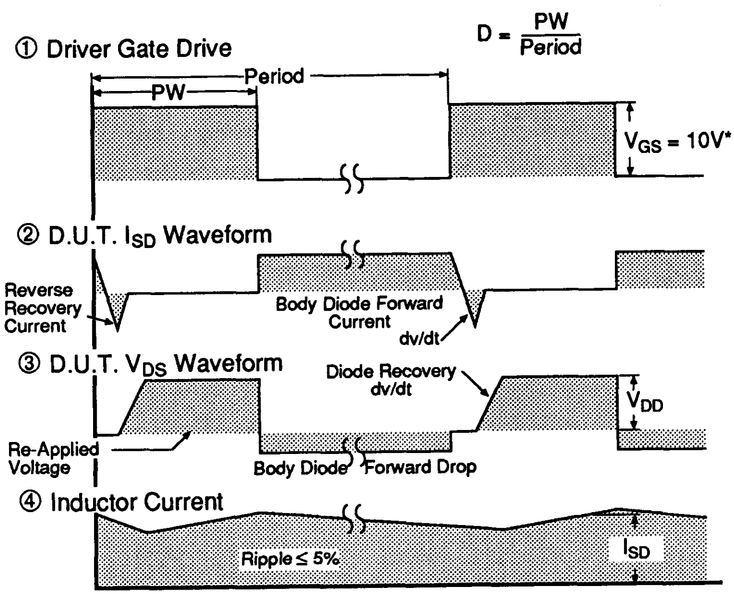
⑤ Mounting surface: flat, smooth, greased

⑥ K/W = °C/W

Peak Diode Recovery dv/dt Test Circuit

Fig 14. For N-Channel HEXFETs

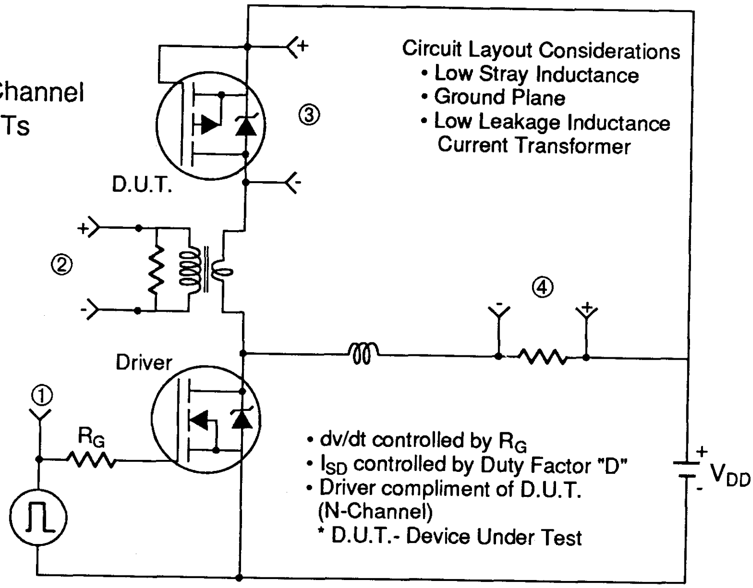


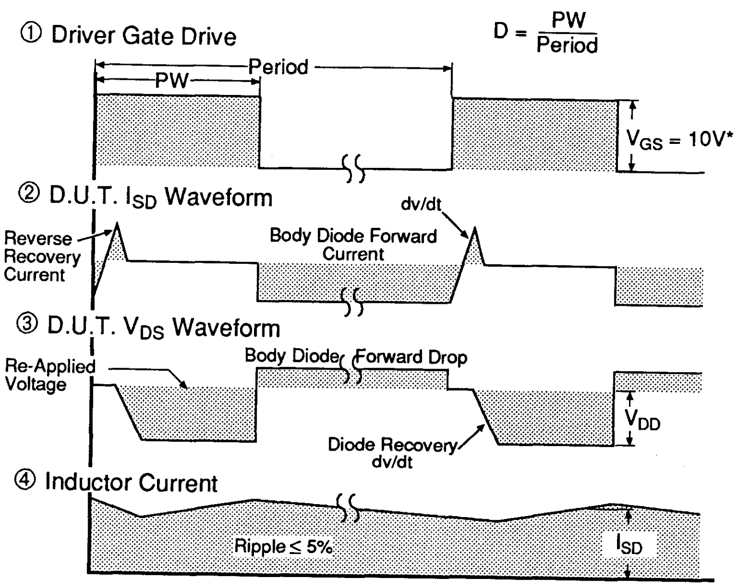


* V_{GS} = 5V for Logic Level Devices

Peak Diode Recovery dv/dt Test Circuit

Fig 14. For P-Channel HEXFETs

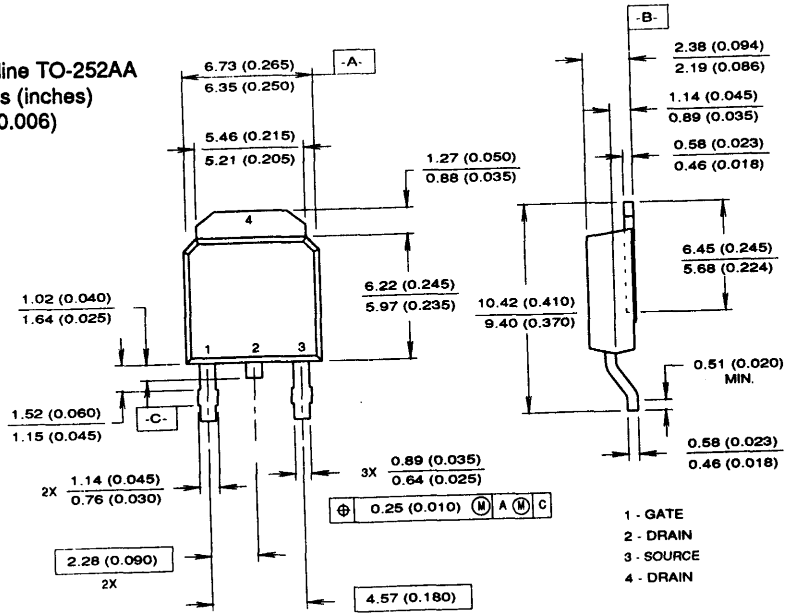




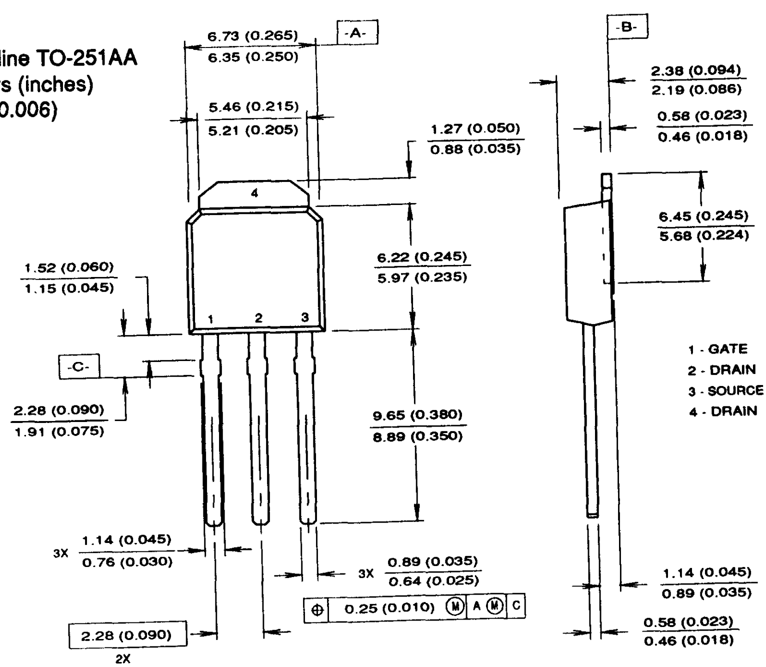
* V_{GS} = 5V for Logic Level Devices

International IOR Rectifier

TO-252AA Outline
Conforms to JEDEC outline TO-252AA
Dimensions in millimeters (inches)
Solder dip max. + 0.16 (0.006)

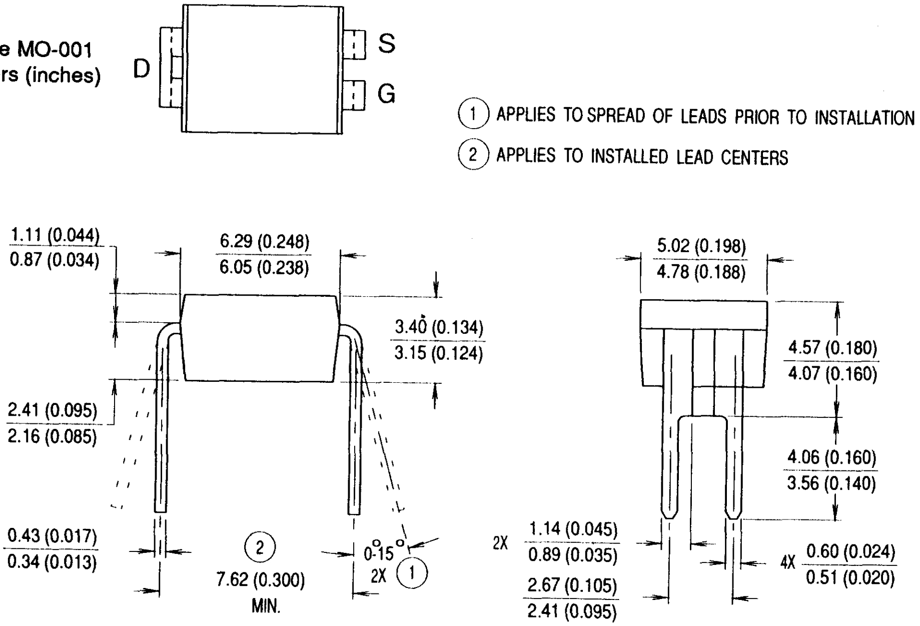


TO-251AA Outline
Conforms to JEDEC outline TO-251AA
Dimensions in millimeters (inches)
Solder dip max. + 0.16 (0.006)



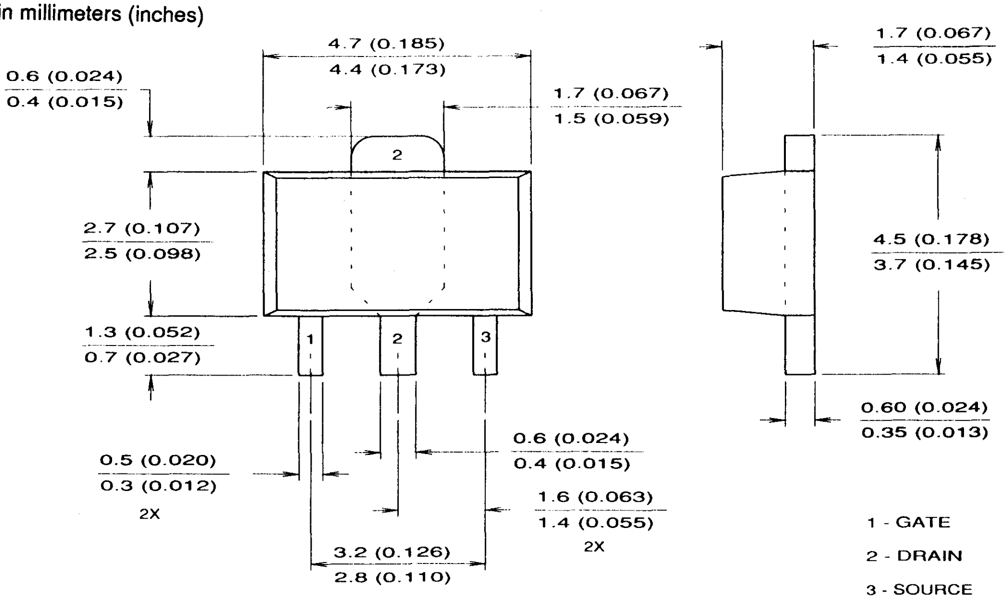
HD-1 Outline

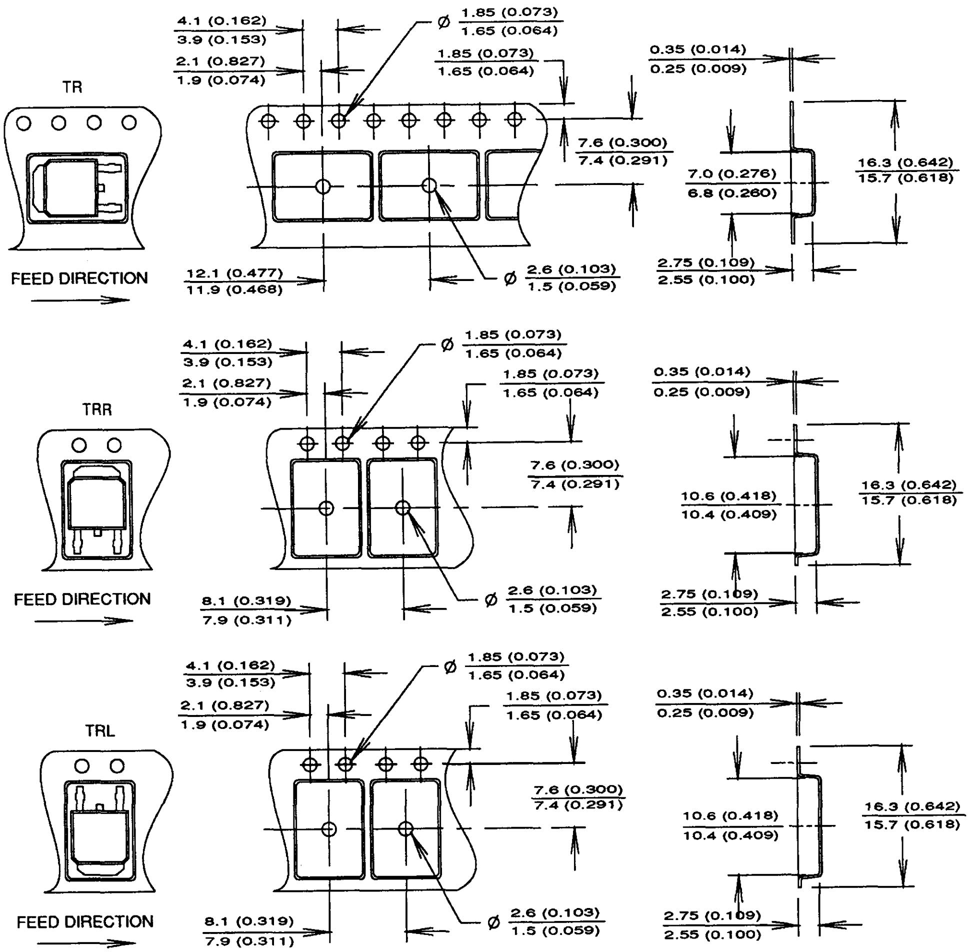
Similar to JEDEC outline MO-001
Dimensions in millimeters (inches)

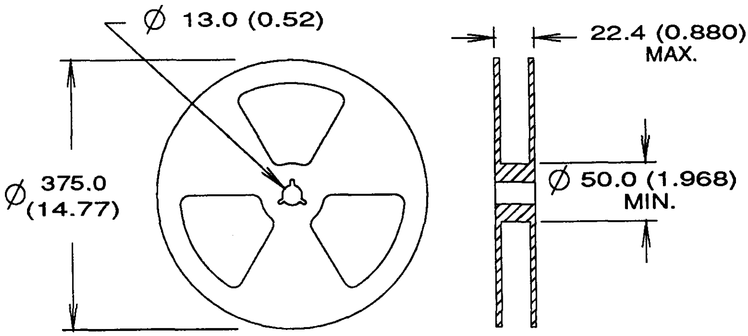


SOT-89 Outline

Dimensions in millimeters (inches)



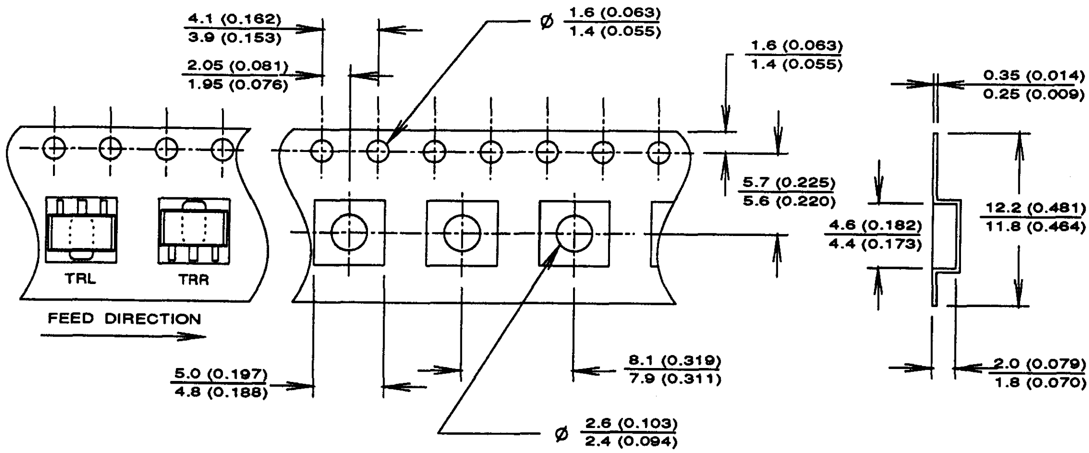


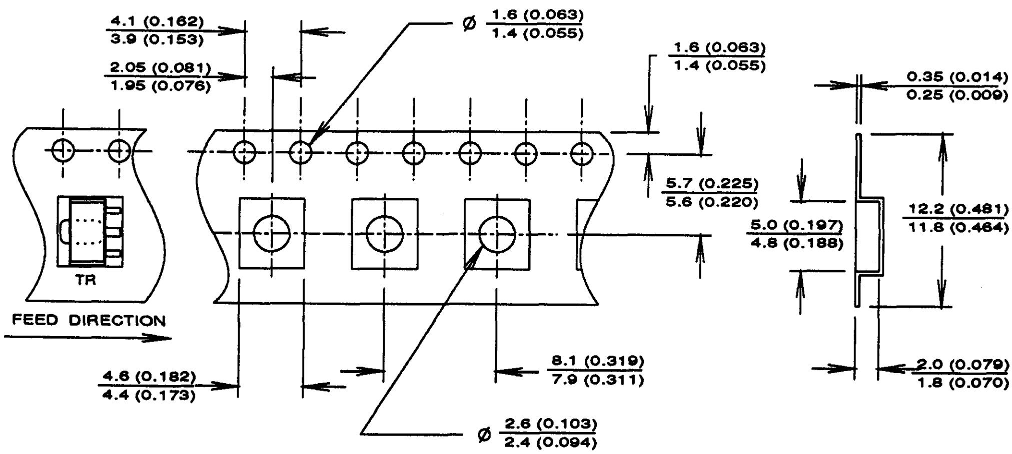


TO-252AA Tape & Reel

When ordering, indicate the part number, part orientation, and the quantity. Quantities are in multiples of 2,000 pieces per reel for TR and multiples of 3,000 pieces per reel for both TRL and TRR.

e.g., IRFR9014TRL three-reel order is 9,000 pieces.

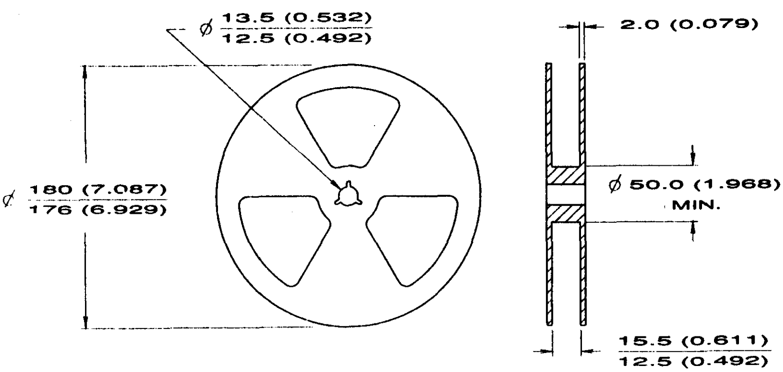




SOT-89 Tape & Reel

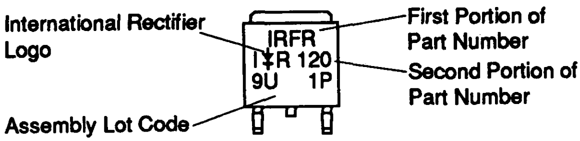
When ordering, indicate the part number, part orientation, and the quantity. Quantities are in multiples of 1,000 pieces per reel for TR, TRL, and TRR.

e.g., IRFS120TRL three-reel order is 3,000 pieces.



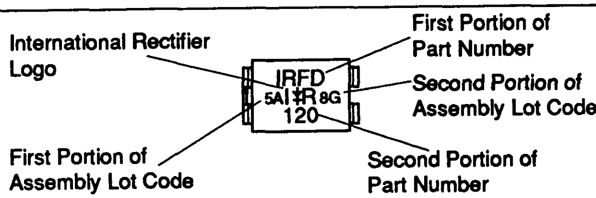
TO-252AA (D-Pak)

Example: This is an IRFR120 with Assembly Lot Code 9U1P.



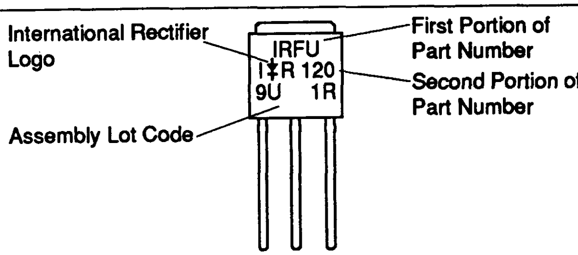
HD-1 (HEXDIP)

Example: This is an IRFD120 with Assembly Lot Code 5A8G.



TO-251AA (I-Pak)

Example: This is an IRFU120 with Assembly Lot Code 9U1R.



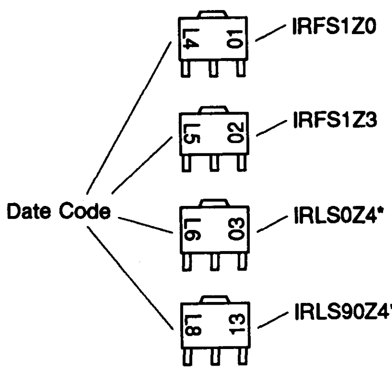
SOT-89

The two letters on the right hand side of the device specify the part number.

The two numbers on the left hand side of the device specify the date code.

Both sets of characters facing outward indicate that the SOT-89 is a HEXFET.

* Product not yet available at the publishing date of this document.



Appendix E

Other Catalogs

Order No.	Description
GSP-1	Government and Space Products - Power Semiconductors Designer's Manual
HDM-1, Vol. 1	Application Notes and Reliability Data - HEXFET Designer's Manual
HDM-1, Vol. 2	DIPs, D-Paks, I-Paks, Logic Level Devices - HEXFET Designer's Manual
HDM-1, Vol. 3	TO-220, TO-247, FullPaks, Current-Sensing Devices - HEXFET Designer's Manual
HDM-1, Vol. 4	Power Modules - HEXFET Designer's Manual
IGBT-2	Insulated Gate Bipolar Transistors (IGBTs) Designer's Manual
MGD-I	MOS Gate Drivers - Power Integrated Circuits Designer's Manual
MPIC-4	Microelectronic Relays Designer's Manual
PIP-90	Power Interface Products Designer's Manual
PMD-I	Power Modules Designer's Manual (Medium and High Power Rectifiers/Thyristors)
SDM-1	Schottky Rectifiers Designer's Manual
NRPM-2	Rectifiers, Standard Recovery Type
SHVR-1	Rectifiers, Standard Recovery Type - High Power
FRPM-1	Rectifiers, Fast Recovery Type
NTPM-2	Thyristors, Phase Control Type
IPM-1	Thyristors, Inverter Type
SFC	Short Form Catalog - Power Semiconductors Product Digest

Other Surface Mount Devices

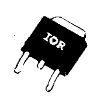
Power Integrated Circuits

International IOR Rectifier

Part Number	V_S Offset Supply Voltage (V)	V_{BS}, V_{CC} Output Voltage (V)	I_{OUT} Sink/ Source (A)	P_D Max Power Dissipation (Watts)	Description	Case Style
IR2110E	10 - 500	10 - 20	2	10	High Voltage Gate Driver	LCC
IR2110S	10 - 500	10 - 20	2	1.25	High Voltage Gate Driver	16 PIN DIP
IR2125S	10 - 500	10 - 20	1A/2A	—	Current Limiting High Side MGD	8 PIN DIP 
IR2121S	10 - 20	10 - 20	1A/2A	—	Current Limiting Low Side MGD	8 PIN DIP
IR8400S	6 - 28	-	1 A per chan	—	Quad High Side Switch	20 PIN DIP
					MGD = MOS GATE DRIVER	

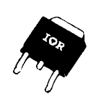
Schottky Rectifiers

0.7 - 6.6 Amps

Part Number	VRRM (V)	$I_{F(AV)}$ @ T_C (A)	(°C)	V_{FM} @ I_{FM} T_J = 25°C (V)	I_{FSM} 50 Hz (A)	60 Hz (A)	I_{RM} @ T_J = 125°C & Rated V_{RRM} (mA)	Max. T_J (°C)	Case Style
10MQ040	40	1.1	90	0.55	30	32	50	125	D-64 
10MQ060	60	0.77	110	0.62	10	11	7.5		
10MQ090	90	0.77	110	0.81	10	11	5.0		
15MQ040	40	1.7		0.55	60	64	50	125	
30WQ03F	30	3.3	109	0.63	40	42	8.5	125	TO-252 D-PAK
30WQ04F	40	3.3	109	0.63			12.0		
30WQ05F	50	3.3	108	0.71			12.2		
30WQ06F	60	3.3	108	0.71			16.0		
30WQ09F	90	3.3	107	0.92			1.75		
30WQ10F	100	3.3	107	0.92			2.00		
50WQ03F	30	5.5	97	0.67	45	47	14.1	125	
50WQ04F	40	5.5	97	0.67			20.0		
50WQ05F	50	5.5	95	0.72			24.0		
50WQ06F	60	5.5	95	0.72			30.0		
50WQ09F	90	5.5	95	0.95			2.6		
50WQ10F	100	5.5	95	0.95			3.0		
6CWQ03F	30	6.6	101	0.55	45	47	14.1	125	
6CWQ04F	40	6.6	101	0.55			20.0		
6CWQ05F	50	6.6	98	0.58			24.0		
6CWQ06F	60	6.6	98	0.58			30.0		
6CWQ09F	90	6.6	98	0.85			2.6		
6CWQ10F	100	6.6	98	0.85			3.0		

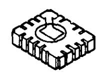
Ultra-Fast Recovery Rectifiers

1 to 6.6 Amps

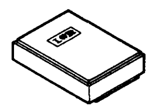
Part Number	V_{RWM} (V)	$I_{F(AV)}$ @ T_C (A)	(°C)	V_{FM} @ T_J = 25°C $I_{F(AV)}$ (V)	I_{FSM} 50 Hz (A)	60 Hz (A)	R_{thJC} DC (°C/W)	Max. t_{rr} (ns)	Case Style
10MF2	200	1	122	0.98	25	28	160	50	D-64 
30WF10F	100	3.3	104	1.35	30	31.4	8	30	TO-252 D-PAK
30WF20F	200	3.3	104	1.35	30	31.4	8	30	
30WF30F	300	3.3	104	1.35	30	31.4	8	30	
30WF40F	400	3.3	104	1.35	30	31.4	8	30	
50WF10F	100	5.5	104	1.1	45	47	6	40	
50WF20F	200	5.5	104	1.1	45	47	6	40	
50WF30F	300	5.5	104	1.1	45	47	6	40	
50WF40F	400	5.5	104	1.1	45	47	6	40	
6CWF10F	100	6.6	117	0.98	45	47	5	30	
6CWF20F	200	6.6	117	0.98	45	47	5	30	

Power MOSFETS High Reliability

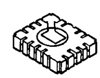
IRFE Series — N-Channel

Part Number	BV_{DSS} Drain Source Voltage (Volts)	$R_{DS(on)}$ On-State Resistance (Ohms)	I_D Continuous Drain Current 25°C Case (Amps)	I_{DM} Pulse Drain Current (Amps)	P_D Max Power Dissipation (Watts)	Case Style
IRFE024	60	0.17	8.0	32	20	LCC 
IRFE110	100	0.6	3.5	14	15	
IRFE120	100	0.30	6.0	24	20	
IRFE130	100	0.18	8.0	32	25	
IRFE210	200	1.5	2.25	9	15	
IRFE220	200	0.80	3.5	14	20	
IRFE230	200	0.4	5.5	22	25	
IRFE310	400	3.6	1.25	5.5	15	
IRFE320	400	1.8	2.0	8	20	
IRFE330	400	1.0	3.0	12	25	
IRFE420	500	3.0	1.5	6	20	
IRFE430	500	1.3	2.5	10	25	

IRFN Series — N-Channel

IRFN044	60	0.40	34	136	75	SMD-1 
IRFN054	60	0.27	45	180	100	
IRFN140	100	0.100	22	88	75	
IRFN150	100	0.073	27	108	100	
IRFN240	200	0.18	14	56	75	
IRFN250	200	0.100	22	88	100	
IRFN340	400	0.55	8.0	32	75	
IRFN350	400	0.315	11	44	100	
IRFN440	500	0.89	6.0	24	75	
IRFN450	500	0.415	10.4	41	100	
IRFNG40	1000	3.5	3.0	12	75	
IRFNG50	1000	2.0	4.5	18	100	

IRFE Series — P-Channel

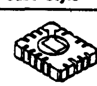
IRFE9024	-60	0.28	-6.0	-24	20	LCC 
IRFE9110	-100	1.2	-2.6	-10	15	
IRFE9120	-100	0.6	-4.0	-16	20	
IRFE9130	-100	0.3	-6.5	-25	25	
IRFE9210	-200	3.0	-1.6	-6.5	15	
IRFE9220	-200	1.5	-2.5	-10	20	
IRFE9230	-200	0.8	-4.0	-16	25	

IRFN Series P-Channel

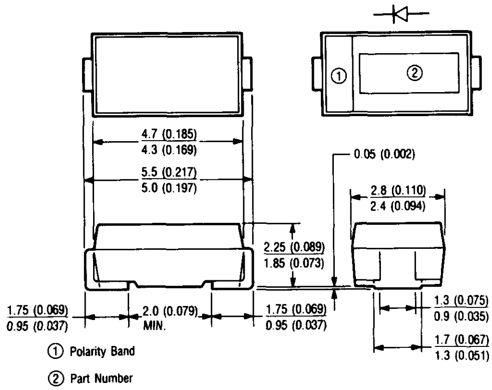
IRFN9140	-100	0.20	-17	-68	75	SMD-1 
IRFN9240	-200	0.51	-8	-32	75	

Radiation Hard HEXFETs

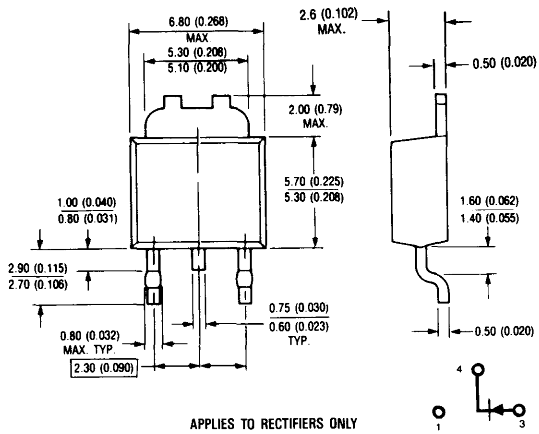
N-Channel

Part Number	V_{DS} Drain Source Voltage (Volts)	R_{DS} (on) On-State Resistance (Ohms)	I_D Continuous Drain Current 25°C Case (Amps)	I_{DM} Pulse Drain Current (Amps)	P_D Max Power Dissipation (Watts)	Case Outline Number (2)	Notes	Case Style
IRHE7110	100	0.6	6	20	20	H22		LCC 
IRHE8110	100	0.6	6	20				
IRHE7130	100	0.18	8	25				
IRHE8130	100	0.18	8	25				

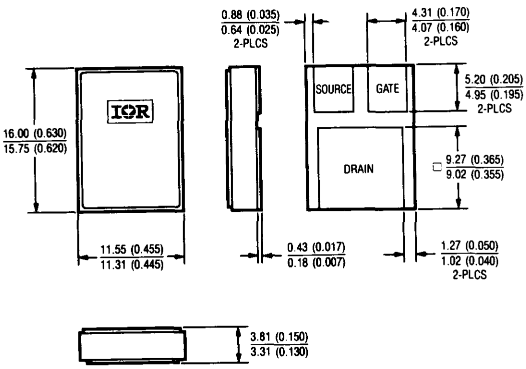
International
IOR Rectifier



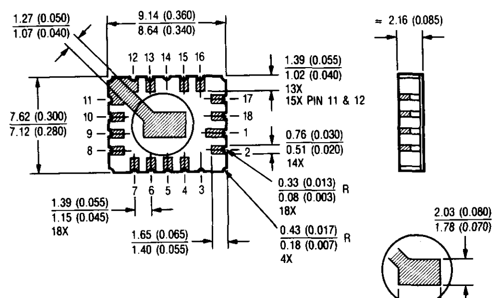
IR Case Style D-64



Conforms to JEDEC Outline TO-252AA

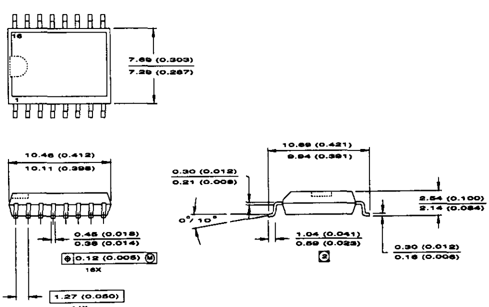


SMD-1



LEGEND:
GATE: PINS 4 & 5
DRAIN: PINS 1, 2, 15, 16, 17 & 18
SOURCE: PINS 6, 7, 8, 9, 10, 11, 12 & 13
NO CONNECTION: PINS 3 & 14

LCC

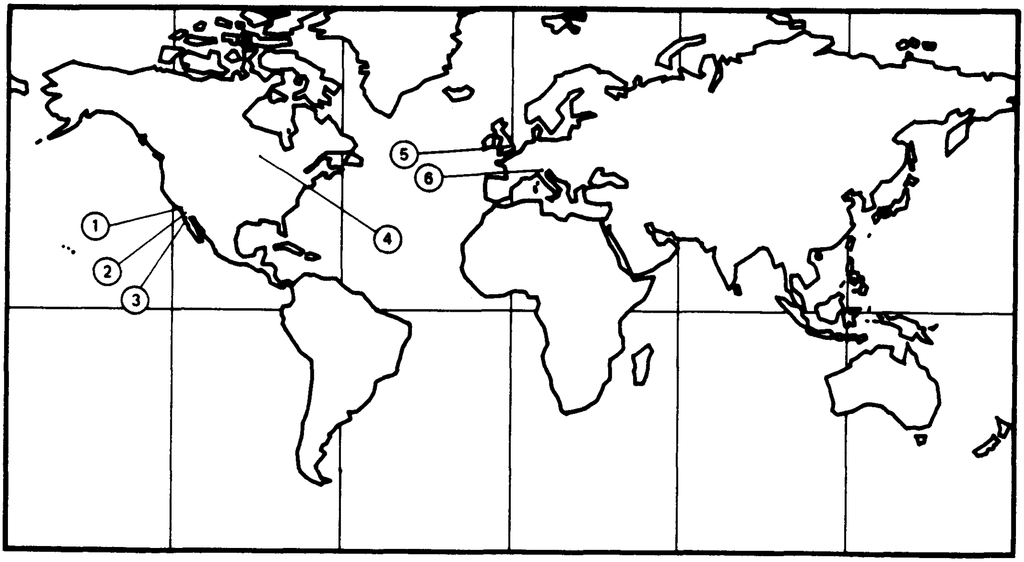


16 Pin Surface Mount Package

Dimensions in Millimeters and (Inches)

International Rectifier

...around-the-world manufacturing to serve worldwide needs.



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- Power MOSFETs, power modules, alloyed rectifiers

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HEXFET DESIGNER'S MANUAL HDM-1, Vol. II

International Rectifier

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