

HEXFET® Power MOSFET

Features

- Advanced Process Technology
- Ultra Low On-Resistance
- 175°C Operating Temperature
- Fast Switching
- Repetitive Avalanche Allowed up to T_{jmax}
- Lead-Free

Description

This HEXFET® Power MOSFET utilizes the latest processing techniques to achieve extremely low on-resistance per silicon area. Additional features of this design are a 175°C junction operating temperature, fast switching speed and improved repetitive avalanche rating. These features combine to make this design an extremely efficient and reliable device for use in a wide variety of applications.

S (Pin 2, 3, 5, 6, 7)
 G (Pin 1)

$V_{DSS} = 55V$
 $R_{DS(on)} = 4.9m\Omega^{\textcircled{9}}$
 $I_D = 120A$

D²Pak 7 Pin TO-263CA 7 Pin

Base part number	Package Type	Standard Pack		Orderable Part Number	Note
		Form	Quantity		
IRF1405ZS-7PPbF-	D²Pak-7Pin	Tube	50	IRF1405ZS-7PPbF	EOL notice # 289
IRF1405ZS-7PPbF		Tape and Reel Left	800	IRF1405ZSTR7PP	
IRF1405ZL-7PPbF-	TO-263CA	Tube	50	IRF1405ZL-7PPbF-	EOL notice # 288

Absolute Maximum Ratings

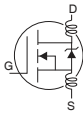
	Parameter	Max.	Units
$I_D @ T_C = 25^\circ C$	Continuous Drain Current, $V_{GS} @ 10V$ (Silicon Limited)	150	A
$I_D @ T_C = 100^\circ C$	Continuous Drain Current, $V_{GS} @ 10V$ (See Fig. 9)	100	
$I_D @ T_C = 25^\circ C$	Continuous Drain Current, $V_{GS} @ 10V$ (Package Limited)	120	
I_{DM}	Pulsed Drain Current $\textcircled{1}$	590	
$P_D @ T_C = 25^\circ C$	Maximum Power Dissipation	230	W
	Linear Derating Factor	1.5	W/°C
V_{GS}	Gate-to-Source Voltage	± 20	V
E_{AS}	Single Pulse Avalanche Energy (Thermally Limited) $\textcircled{2}$	250	mJ
$E_{AS}(\text{tested})$	Single Pulse Avalanche Energy Tested Value $\textcircled{6}$	810	
I_{AR}	Avalanche Current $\textcircled{1}$	See Fig. 12a, 12b, 15, 16	A
E_{AR}	Repetitive Avalanche Energy $\textcircled{5}$		mJ
T_J	Operating Junction and	-55 to + 175	°C
T_{STG}	Storage Temperature Range		
	Soldering Temperature, for 10 seconds		

Thermal Resistance

	Parameter	Typ.	Max.	Units
$R_{\theta JC}$	Junction-to-Case $\textcircled{3}$	—	0.65	°C/W
$R_{\theta JA}$	Junction-to-Ambient (PCB Mount, steady state) $\textcircled{7}$	—	40	

HEXFET® is a registered trademark of International Rectifier.

Static @ T_J = 25°C (unless otherwise specified)

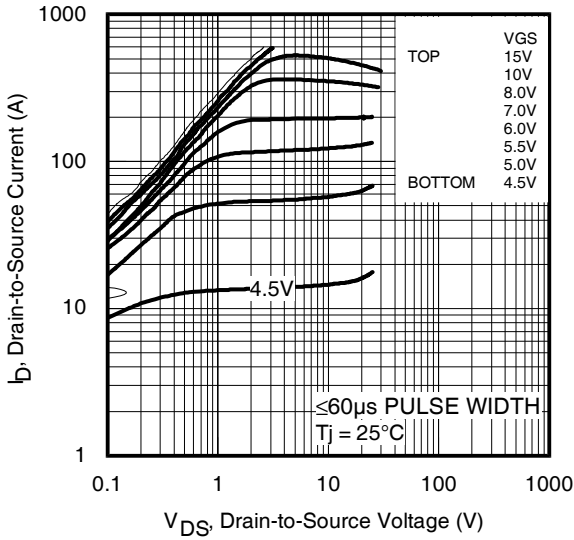
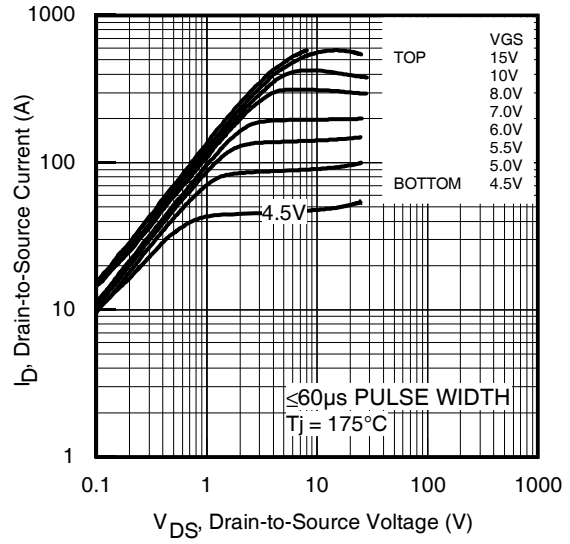
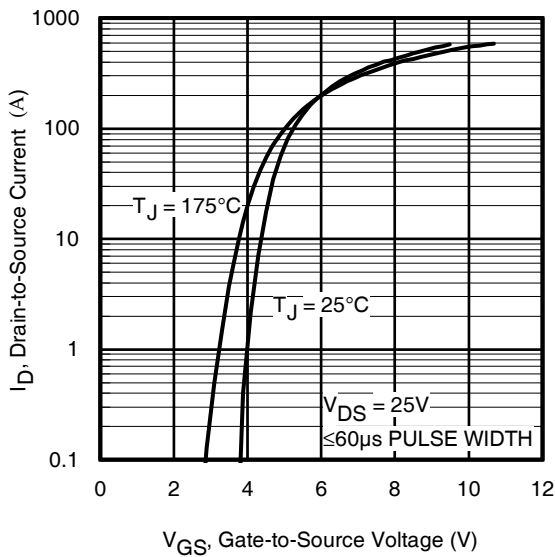
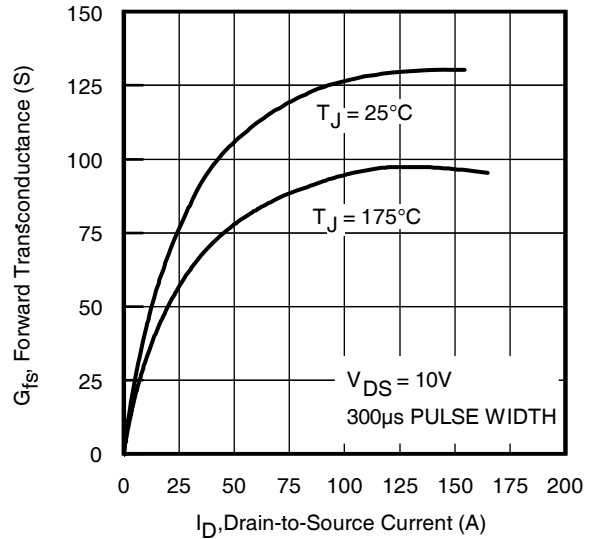
	Parameter	Min.	Typ.	Max.	Units	Conditions
V _{(BR)DSS}	Drain-to-Source Breakdown Voltage	55	—	—	V	V _{GS} = 0V, I _D = 250μA
ΔBV _{DSS} /ΔT _J	Breakdown Voltage Temp. Coefficient	—	0.054	—	V/°C	Reference to 25°C, I _D = 1mA
R _{DS(on)} SMD	Static Drain-to-Source On-Resistance	—	3.7	4.9	mΩ	V _{GS} = 10V, I _D = 88A ③
V _{GS(th)}	Gate Threshold Voltage	2.0	—	4.0	V	V _{DS} = V _{GS} , I _D = 150μA
g _{fs}	Forward Transconductance	150	—	—	S	V _{DS} = 25V, I _D = 88A
I _{DSS}	Drain-to-Source Leakage Current	—	—	20	μA	V _{DS} = 55V, V _{GS} = 0V
		—	—	250		V _{DS} = 55V, V _{GS} = 0V, T _J = 125°C
I _{GSS}	Gate-to-Source Forward Leakage	—	—	200	nA	V _{GS} = 20V
	Gate-to-Source Reverse Leakage	—	—	-200		V _{GS} = -20V
Q _g	Total Gate Charge	—	150	230	nC	I _D = 88A
Q _{gs}	Gate-to-Source Charge	—	37	—		V _{DS} = 44V
Q _{gd}	Gate-to-Drain ("Miller") Charge	—	64	—		V _{GS} = 10V ③
t _{d(on)}	Turn-On Delay Time	—	16	—	ns	V _{DD} = 28V
t _r	Rise Time	—	140	—		I _D = 88A
t _{d(off)}	Turn-Off Delay Time	—	170	—		R _θ = 5.0Ω
t _f	Fall Time	—	130	—		V _{GS} = 10V ②
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	—	5360	—	pF	V _{GS} = 0V
C _{oss}	Output Capacitance	—	1310	—		V _{DS} = 25V
C _{rss}	Reverse Transfer Capacitance	—	340	—		f = 1.0MHz, See Fig. 5
C _{oss}	Output Capacitance	—	6080	—		V _{GS} = 0V, V _{DS} = 1.0V, f = 1.0MHz
C _{oss}	Output Capacitance	—	920	—		V _{GS} = 0V, V _{DS} = 44V, f = 1.0MHz
C _{oss} eff.	Effective Output Capacitance	—	1700	—		V _{GS} = 0V, V _{DS} = 0V to 44V

Diode Characteristics

	Parameter	Min.	Typ.	Max.	Units	Conditions
I _S	Continuous Source Current (Body Diode)	—	—	150	A	MOSFET symbol showing the integral reverse p-n junction diode.
I _{SM}	Pulsed Source Current (Body Diode) ①	—	—	590		
V _{SD}	Diode Forward Voltage	—	—	1.3	V	T _J = 25°C, I _S = 88A, V _{GS} = 0V ③
t _{rr}	Reverse Recovery Time	—	63	95	ns	T _J = 25°C, I _F = 88A, V _{DD} = 28V
Q _{rr}	Reverse Recovery Charge	—	160	240	nC	di/dt = 100A/μs ③

Notes:

- ① Repetitive rating; pulse width limited by max. junction temperature. (See fig. 11).
- ② Limited by T_{Jmax}, starting T_J = 25°C, L=0.064mH, R_G = 25Ω, I_{AS} = 88A, V_{GS} = 10V. Part not recommended for use above this value.
- ③ Pulse width ≤ 1.0ms; duty cycle ≤ 2%.
- ④ C_{oss} eff. is a fixed capacitance that gives the same charging time as C_{oss} while V_{DS} is rising from 0 to 80% V_{DSS}.
- ⑤ Limited by T_{Jmax}, see Fig.12a, 12b, 15, 16 for typical repetitive avalanche performance.
- ⑥ This value determined from sample failure population. 100% tested to this value in production.
- ⑦ This is applied to D²Pak, when mounted on 1" square PCB (FR-4 or G-10 Material). For recommended footprint and soldering techniques refer to application note #AN-994.
- ⑧ R_θ is measured at T_J of approximately 90°C.
- ⑨ Solder mounted on IMS substrate.


Fig 1. Typical Output Characteristics

Fig 2. Typical Output Characteristics

Fig 3. Typical Transfer Characteristics

Fig 4. Typical Forward Transconductance vs. Drain Current

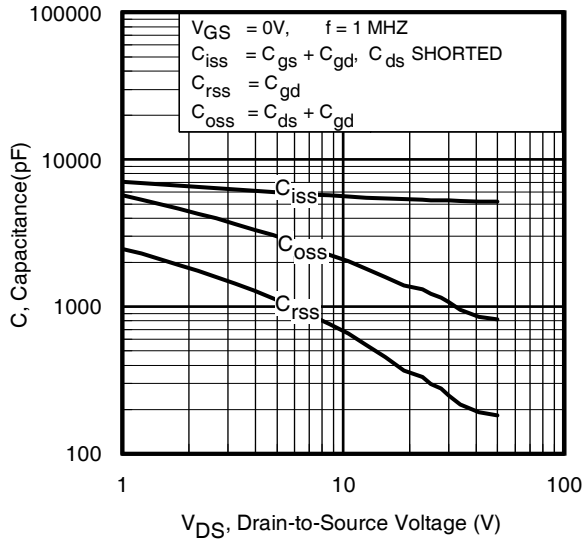


Fig 5. Typical Capacitance vs. Drain-to-Source Voltage

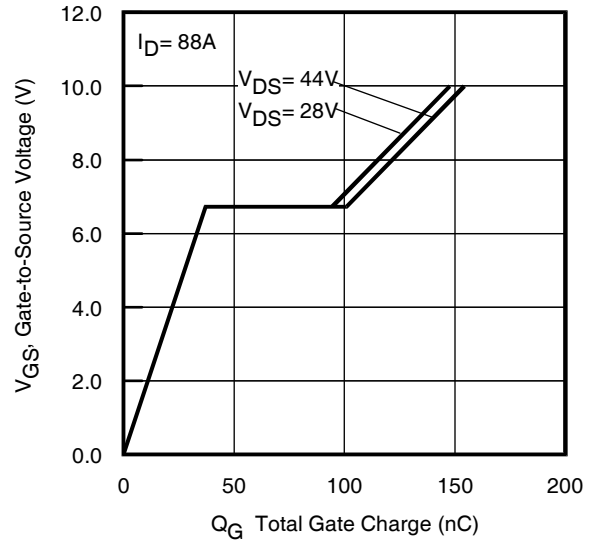


Fig 6. Typical Gate Charge vs. Gate-to-Source Voltage

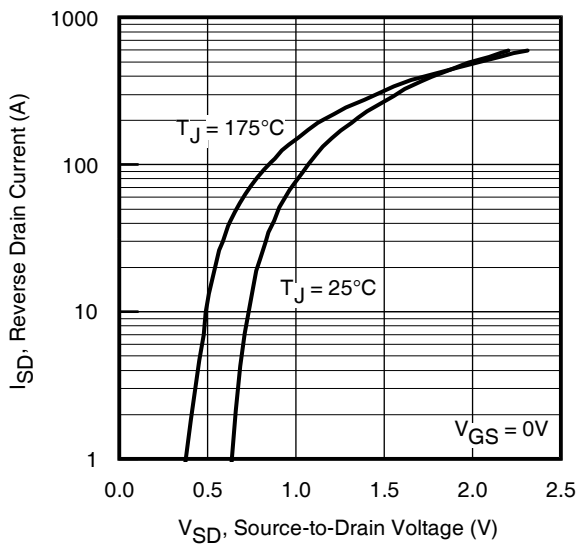


Fig 7. Typical Source-Drain Diode Forward Voltage

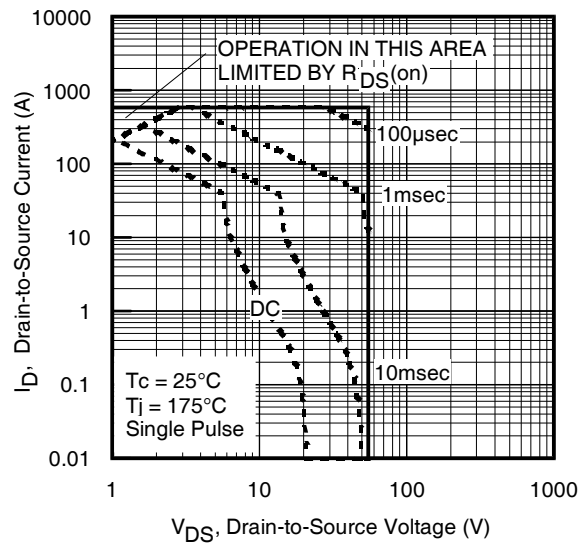


Fig 8. Maximum Safe Operating Area

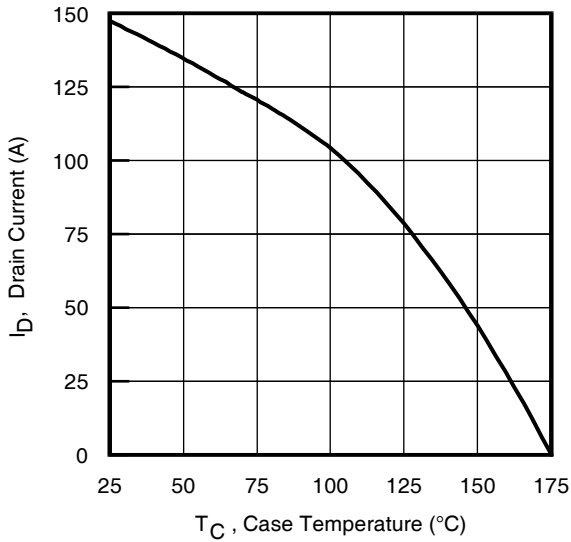


Fig 9. Maximum Drain Current vs. Case Temperature

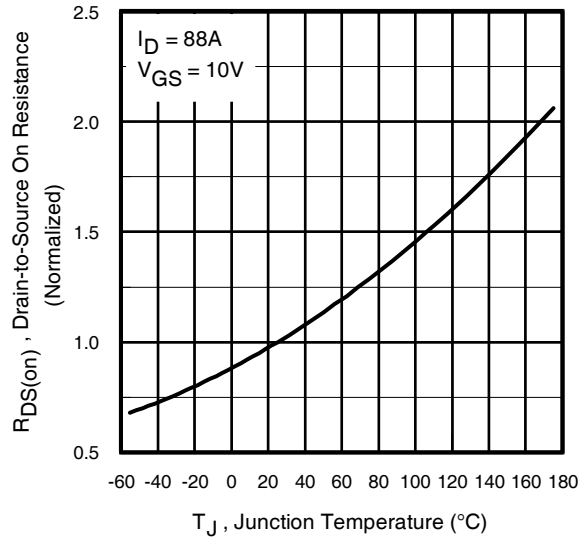


Fig 10. Normalized On-Resistance vs. Temperature

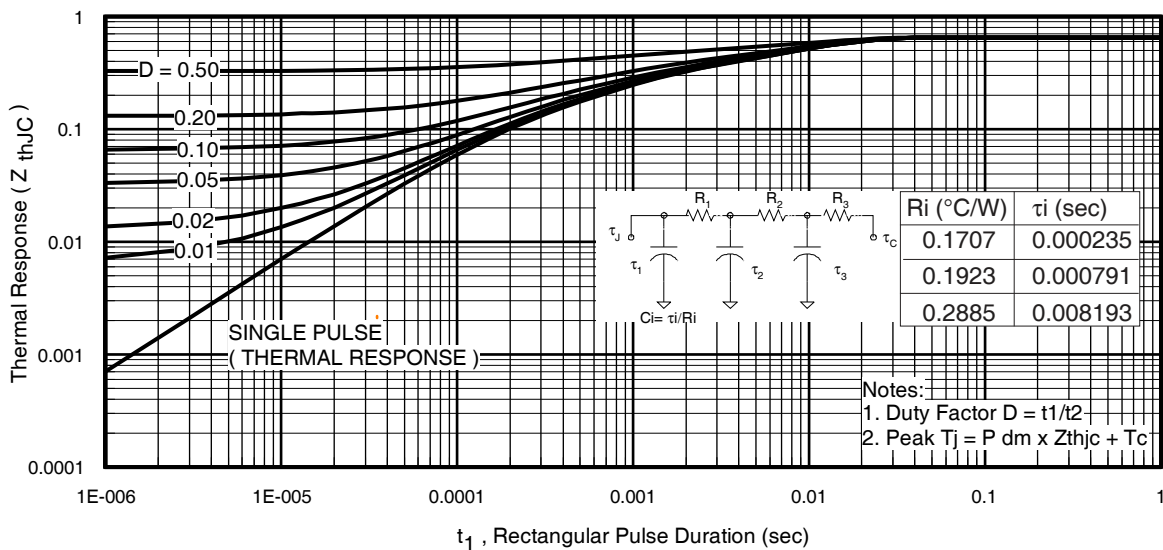
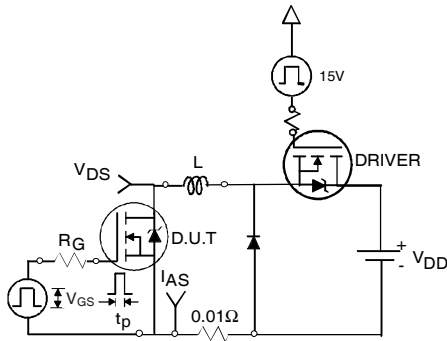
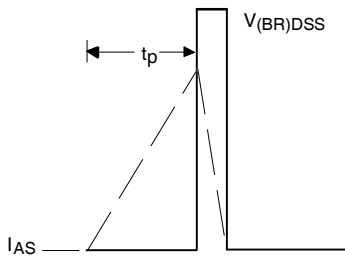
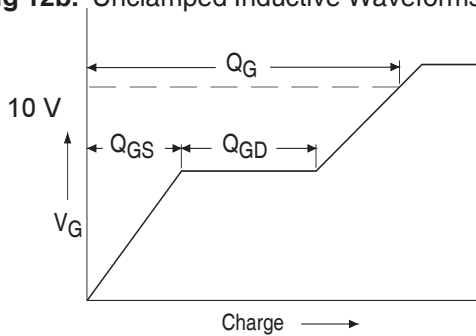
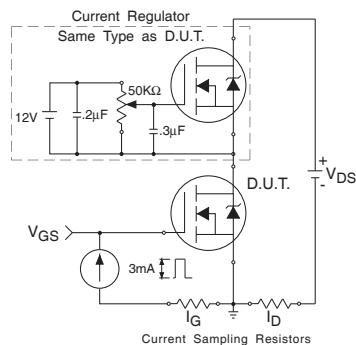
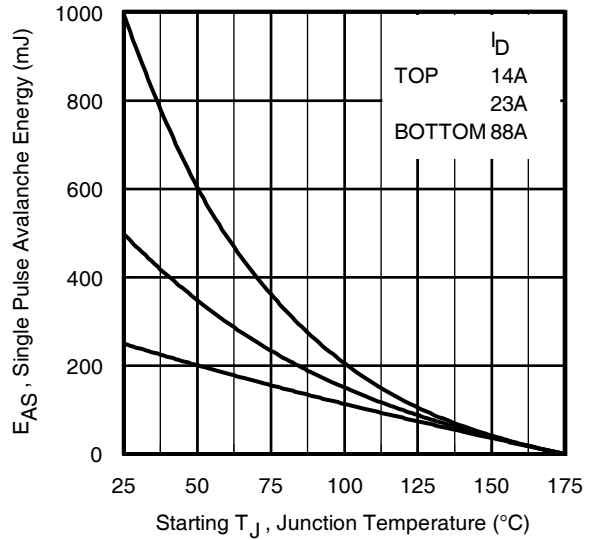
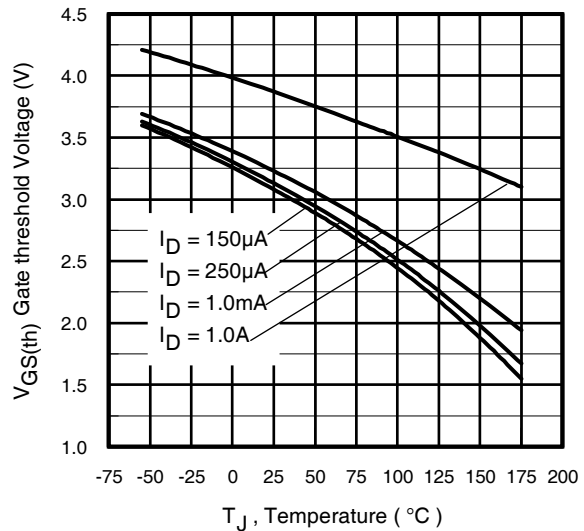


Fig 11. Maximum Effective Transient Thermal Impedance, Junction-to-Case


Fig 12a. Unclamped Inductive Test Circuit

Fig 12b. Unclamped Inductive Waveforms

Fig 13a. Basic Gate Charge Waveform

Fig 13b. Gate Charge Test Circuit

Fig 12c. Maximum Avalanche Energy vs. Drain Current

Fig 14. Threshold Voltage vs. Temperature

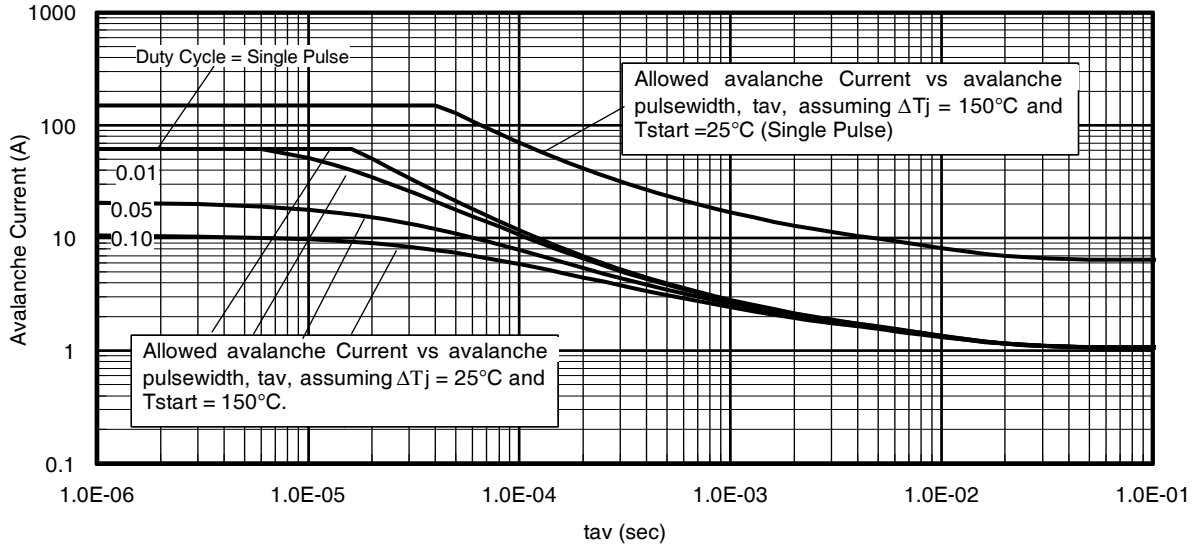


Fig 15. Typical Avalanche Current vs. Pulsewidth

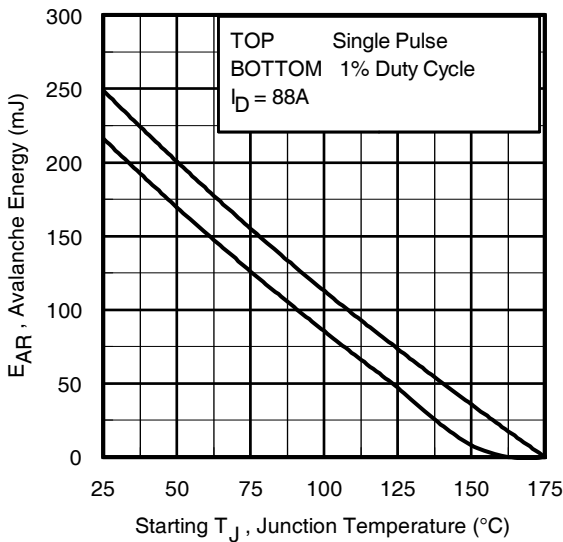


Fig 16. Maximum Avalanche Energy vs. Temperature

Notes on Repetitive Avalanche Curves , Figures 15, 16:
(For further info, see AN-1005 at www.irf.com)

1. Avalanche failures assumption:
Purely a thermal phenomenon and failure occurs at a temperature far in excess of T_{jmax} . This is validated for every part type.
2. Safe operation in Avalanche is allowed as long as T_{jmax} is not exceeded.
3. Equation below based on circuit and waveforms shown in Figures 12a, 12b.
4. $P_{D(ave)}$ = Average power dissipation per single avalanche pulse.
5. BV = Rated breakdown voltage (1.3 factor accounts for voltage increase during avalanche).
6. I_{av} = Allowable avalanche current.
7. ΔT = Allowable rise in junction temperature, not to exceed T_{jmax} (assumed as 25°C in Figure 15, 16).
 t_{av} = Average time in avalanche.
 D = Duty cycle in avalanche = $t_{av} \cdot f$
 $Z_{thJC}(D, t_{av})$ = Transient thermal resistance, see figure 11)

$$P_{D(ave)} = 1/2 (1.3 \cdot BV \cdot I_{av}) = \Delta T / Z_{thJC}$$

$$I_{av} = 2\Delta T / [1.3 \cdot BV \cdot Z_{th}]$$

$$E_{AS(AR)} = P_{D(ave)} \cdot t_{av}$$

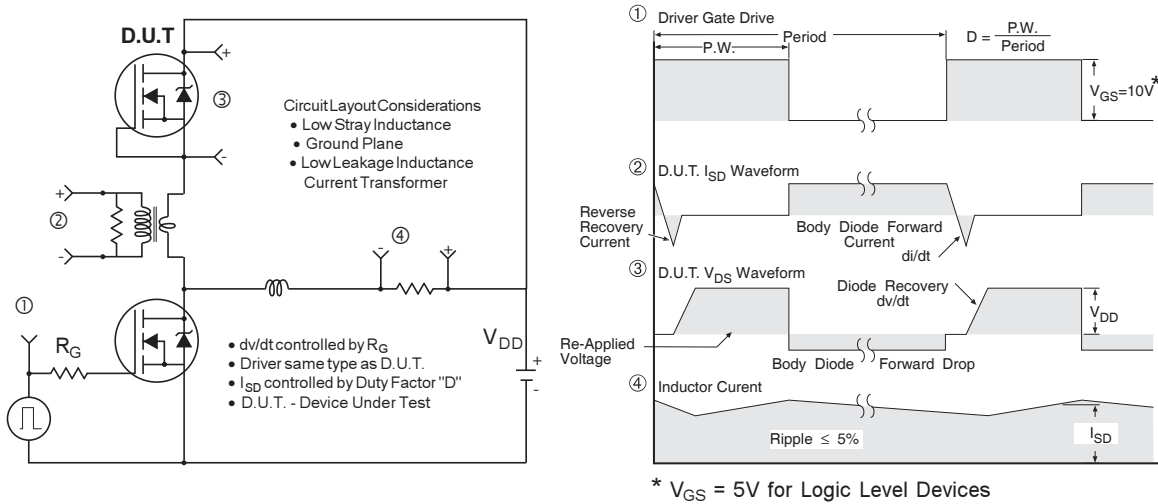


Fig 17. Peak Diode Recovery dv/dt Test Circuit for N-Channel HEXFET® Power MOSFETs

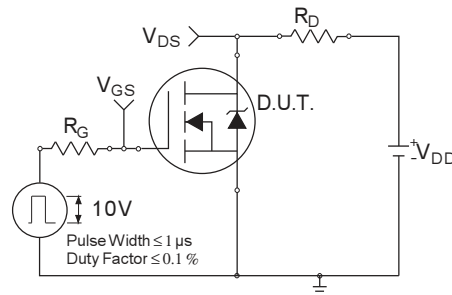


Fig 18a. Switching Time Test Circuit

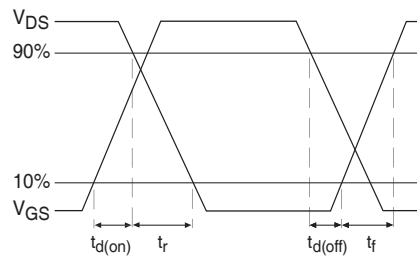
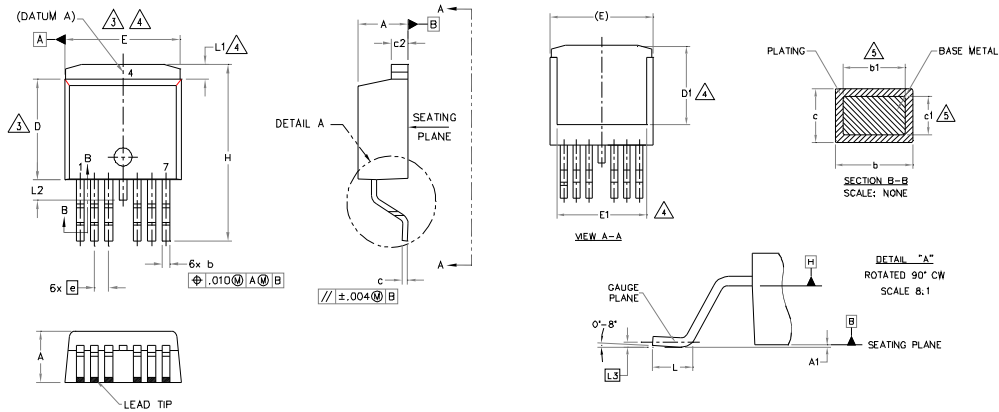


Fig 18b. Switching Time Waveforms

D²Pak - 7 Pin Package Outline

Dimensions are shown in millimeters (inches)



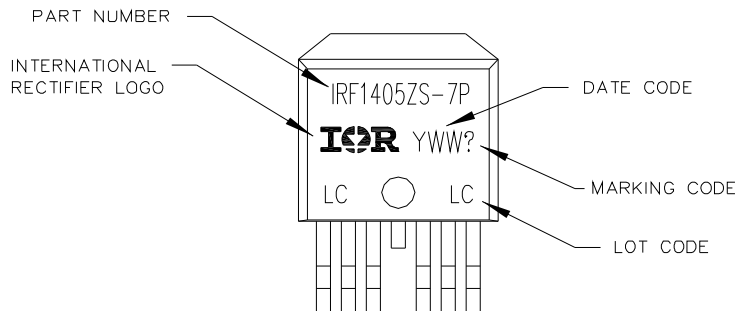
SYMBOL	DIMENSIONS				NOTES
	MILLIMETERS		INCHES		
	MIN.	MAX.	MIN.	MAX.	
A	4.06	4.83	.160	.190	5
A1	—	0.254	—	.010	
b	0.51	0.99	.020	.036	
b1	0.51	0.89	.020	.032	
c	0.38	0.74	.015	.029	
c1	0.38	0.58	.015	.023	
c2	1.14	1.65	.045	.065	
D	8.38	9.65	.330	.380	
D1	6.86	7.42	.270	.292	
E	9.65	10.54	.380	.415	
E1	6.22	8.48	.245	.334	4
e	1.27 BSC		.050 BSC		
H	14.61	15.88	.575	.625	4
L	1.78	2.79	.070	.110	
L1	—	1.68	—	.066	
L2	—	1.78	—	.070	
L3	0.25 BSC		.010 BSC		

NOTES:

- DIMENSIONING AND TOLERANCING AS PER ASME Y14.5M-1994
- DIMENSIONS ARE SHOWN IN MILLIMETERS [INCHES].
- $\Delta 3$ DIMENSION D & E DO NOT INCLUDE MOLD FLASH. MOLD FLASH SHALL NOT EXCEED 0.127 [.005"] PER SIDE. THESE DIMENSIONS ARE MEASURED AT THE OUTMOST EXTREMES OF THE PLASTIC BODY AT DATUM H.
- $\Delta 4$ THERMAL PAD CONTOUR OPTIONAL WITHIN DIMENSION E, L1, D1 & E1.
- $\Delta 5$ DIMENSION b1 AND c1 APPLY TO BASE METAL ONLY.
- DATUM A & B TO BE DETERMINED AT DATUM PLANE H.
- CONTROLLING DIMENSION: INCH.
- OUTLINE CONFORMS TO JEDEC OUTLINE TO-263CB. EXCEPT FOR DIMS. E, E1 & D1.

Note: For the most current drawing please refer to IR website at: <http://www.irf.com/package/>

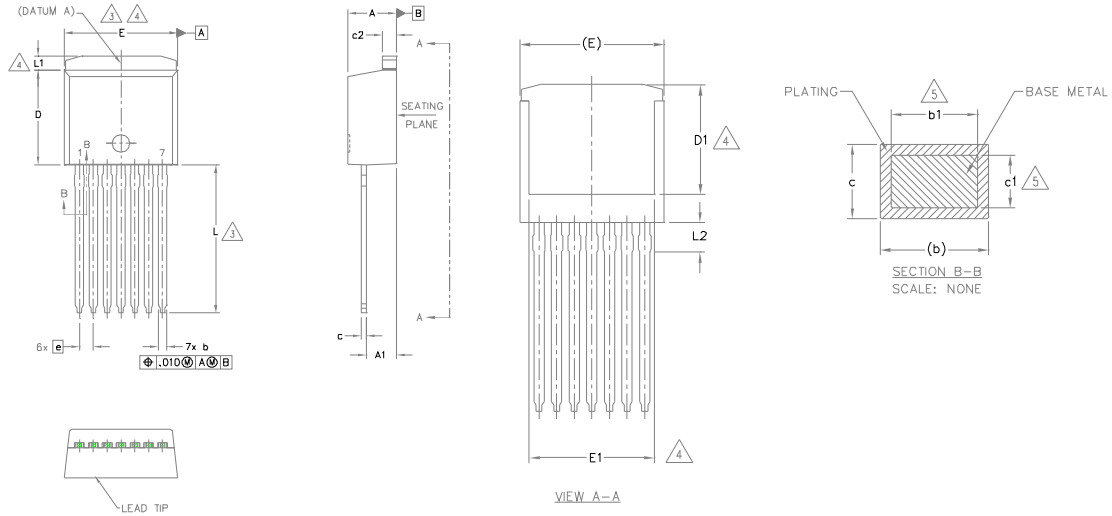
D²Pak - 7 Pin Part Marking Information



Note: For the most current drawing please refer to IR website at: <http://www.irf.com/package/>

TO-263CA 7 Pin Long Leads Package Outline

Dimensions are shown in millimeters (inches)



NOTES:

1. DIMENSIONING AND TOLERANCING PER ASME Y14.5M-1994
2. DIMENSIONS ARE SHOWN IN MILLIMETERS [INCHES].
3. DIMENSION D & E DO NOT INCLUDE MOLD FLASH. MOLD FLASH SHALL NOT EXCEED 0.127 [0.005"] PER SIDE. THESE DIMENSIONS ARE MEASURED AT THE OUTMOST EXTREMES OF THE PLASTIC BODY.
4. THERMAL PAD CONTOUR OPTIONAL WITHIN DIMENSION E, L1, D1 & E1.
5. DIMENSION b1 AND c1 APPLY TO BASE METAL ONLY.
6. CONTROLLING DIMENSION: INCH.
- 7.- OUTLINE CONFORM TO JEDEC TO-263 CA EXCEPT FOR DIMS. E, E1 & D1.

SYMBOL	DIMENSIONS				NOTES
	MILLIMETERS		INCHES		
	MIN.	MAX.	MIN.	MAX.	
A	4.06	4.83	.160	.190	
A1	2.03	3.02	.080	.119	
b	0.51	0.91	.020	.036	
b1	0.51	0.81	.020	.032	5
c	0.38	0.74	.015	.029	
c1	0.38	0.58	.015	.023	5
c2	1.14	1.65	.045	.065	
D	8.51	9.65	.335	.380	3
D1	6.86	7.42	.270	.292	4
E	9.65	10.54	.380	.415	3,4
E1	6.22	8.48	.245	.334	4
e	1.27 BSC		.050 BSC		
L	13.46	14.10	.530	.555	
L1	-	1.65	-	.065	4
L2	-	6.35	-	.250	

LEAD ASSIGNMENTS

HEXFET

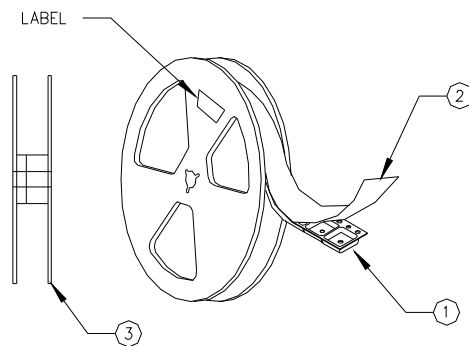
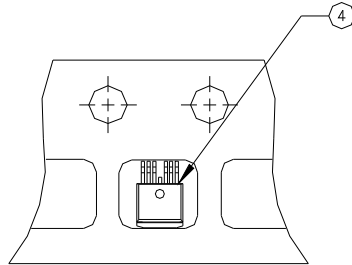
- 1.- GATE
- 2.- SOURCE
- 3.- SOURCE
- 4.- DRAIN
- 5.- SOURCE
- 6.- SOURCE
- 7.- SOURCE

Note: For the most current drawing please refer to IR website at: <http://www.irf.com/package/>

D²Pak - 7 Pin Tape and Reel

NOTES, TAPE & REEL, LABELLING:

1. TAPE AND REEL.
 - 1.1 REEL SIZE 13 INCH DIAMETER.
 - 1.2 EACH REEL CONTAINING 800 DEVICES.
 - 1.3 THERE SHALL BE A MINIMUM OF 42 SEALED POCKETS CONTAINED IN THE LEADER AND A MINIMUM OF 15 SEALED POCKETS IN THE TRAILER.
 - 1.4 PEEL STRENGTH MUST CONFORM TO THE SPEC. NO. 71-9667.
 - 1.5 PART ORIENTATION SHALL BE AS SHOWN BELOW.
 - 1.6 REEL MAY CONTAIN A MAXIMUM OF TWO UNIQUE LOT CODE/DATE CODE COMBINATIONS. REWORKED REELS MAY CONTAIN A MAXIMUM OF THREE UNIQUE LOT CODE/DATE CODE COMBINATIONS. HOWEVER, THE LOT CODES AND DATE CODES WITH THEIR RESPECTIVE QUANTITIES SHALL APPEAR ON THE BAR CODE LABEL FOR THE AFFECTED REEL.
2. LABELLING (REEL AND SHIPPING BAG).
 - 2.1 CUST. PART NUMBER (BAR CODE): IRFXXXXSTRL-7P
 - 2.2 CUST. PART NUMBER (TEXT CODE): IRFXXXXSTRL-7P
 - 2.3 I.R. PART NUMBER: IRFXXXXSTRL-7P
 - 2.4 QUANTITY:
 - 2.5 VENDOR CODE: IR
 - 2.6 LOT CODE:
 - 2.7 DATE CODE:



Note: For the most current drawing please refer to IR website at: <http://www.irf.com/package/>

Qualification information[†]

Qualification level	Industrial ^{††}	
	(per JEDEC JESD47F ^{†††} guidelines)	
Moisture Sensitivity Level	D ² Pak-7PIN	MSL1 (per JEDEC J-STD-020D ^{††})
	TO-263CA 7Pin	
RoHS compliant	Yes	

† Qualification standards can be found at International Rectifier's web site:

<http://www.irf.com/product-info/reliability>

†† Applicable version of JEDEC standard at the time of product release.

Revision History

Date	Comments
10/29/2014	<ul style="list-style-type: none"> • Updated data sheet with IR corporate template. • Updated D2-Pak 7-Pin ordering information to reflect the End-Of-life of the Tube packaging option (EOL notice #289) • Removed TO-263CA package (EOL notice # 288). • Removed $R_{\theta JA} = 62 \text{ }^{\circ}\text{C/W}$ & $R_{\theta CS} = 0.5 \text{ }^{\circ}\text{C/W}$ from thermal resistance table on page 1(does not apply to D2-Pak 7- Pin). • Updated part marking on page 9 .

International
 Rectifier

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To contact International Rectifier, please visit <http://www.irf.com/whoto-call/>