

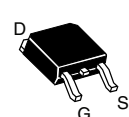
IRFR1N60A, IRFU1N60A, SiHFR1N60A, SiHFU1N60A

Yixinwei Technology

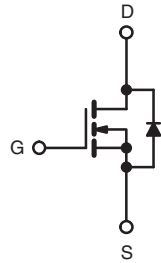
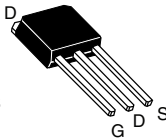
Power MOSFET

PRODUCT SUMMARY		
V_{DS} (V)	600	
$R_{DS(on)}$ (Max.) (Ω)	$V_{GS} = 10\text{ V}$	7.0
Q_g (Max.) (nC)	14	
Q_{gs} (nC)	2.7	
Q_{gd} (nC)	8.1	
Configuration	Single	

DPAK
(TO-252)



IPAK
(TO-251)



N-Channel MOSFET

FEATURES

- Low Gate Charge Q_g Results in Simple Drive Requirement
- Improved Gate, Avalanche and Dynamic dV/dt Ruggedness
- Fully Characterized Capacitance and Avalanche Voltage and Current
- Material categorization: For definitions of

APPLICATIONS

- Switch Mode Power Supply (SMPS)
- Uninterruptible Power Supply
- Power Factor Correction

TYPICAL SMPS TOPOLOGIES

- Low Power Single Transistor Flyback



RoHS
COMPLIANT
HALOGEN
FREE
Available

ORDERING INFORMATION					
Package	DPAK (TO-252)	DPAK (TO-252)	DPAK (TO-252)	DPAK (TO-252)	IPAK (TO-251)
Lead (Pb)-free and Halogen-free	SiHFR1N60A-GE3	SiHFR1N60ATRL-GE3 ^a	SiHFR1N60ATR-GE3 ^a	SiHFR1N60ATRR-GE3 ^a	SiHFU1N60A-GE3
Lead (Pb)-free	IRFR1N60APbF	IRFR1N60ATRLPbF ^a	IRFR1N60ATRPbF ^a	IRFR1N60ATRRPbF ^a	IRFU1N60APbF
	SiHFR1N60A-E3	SiHFR1N60ATL-E3 ^a	SiHFR1N60AT-E3 ^a	SiHFR1N60ATR-E3 ^a	SiHFU1N60A-E3

Note

a. See device orientation.

ABSOLUTE MAXIMUM RATINGS (T _C = 25 °C, unless otherwise noted)					
PARAMETER			SYMBOL	LIMIT	UNIT
Drain-Source Voltage			V _{DS}	600	V
Gate-Source Voltage			V _{GS}	± 30	
Continuous Drain Current	V _{GS} at 10 V	T _C = 25 °C	I _D	1.4	A
		T _C = 100 °C		0.89	
Pulsed Drain Current ^a			I _{DM}	5.6	
Linear Derating Factor				0.28	W/°C
Single Pulse Avalanche Energy ^b			E _{AS}	93	mJ
Repetitive Avalanche Current ^a			I _{AR}	1.4	A
Repetitive Avalanche Energy ^a			E _{AR}	3.6	mJ
Maximum Power Dissipation	T _C = 25 °C		P _D	36	W
Peak Diode Recovery dV/dt ^c			dV/dt	3.8	V/ns
Operating Junction and Storage Temperature Range			T _J , T _{stg}	- 55 to + 150	°C
Soldering Recommendations (Peak Temperature) ^d	for 10 s			300	

Notes

- Repetitive rating; pulse width limited by maximum junction temperature (see fig. 11).
- Starting $T_J = 25\text{ }^\circ\text{C}$, $L = 95\text{ mH}$, $R_g = 25\text{ }\Omega$, $I_{AS} = 1.4\text{ A}$ (see fig. 12).
- $I_{SD} \leq 1.4\text{ A}$, $dI/dt \leq 180\text{ A}/\mu\text{s}$, $V_{DD} \leq V_{DS}$, $T_J \leq 150\text{ }^\circ\text{C}$.
- 1.6 mm from case.

IRFR1N60A, IRFU1N60A, SiHFR1N60A, SiHFU1N60A

THERMAL RESISTANCE RATINGS				
PARAMETER	SYMBOL	TYP.	MAX.	UNIT
Maximum Junction-to-Ambient	R_{thJA}	-	110	°C/W
Maximum Junction-to-Ambient (PCB Mount) ^a	R_{thJA}	-	50	
Maximum Junction-to-Case (Drain)	R_{thJC}	-	3.5	

Note

a. When mounted on 1" square PCB (FR-4 or G-10 material).

SPECIFICATIONS (T _J = 25 °C, unless otherwise noted)							
PARAMETER	SYMBOL	TEST CONDITIONS		MIN.	TYP.	MAX.	UNIT
Static							
Drain-Source Breakdown Voltage	V _{DS}	V _{GS} = 0 V, I _D = 250 μA		600	-	-	V
Gate-Source Threshold Voltage	V _{GS(th)}	V _{DS} = V _{GS} , I _D = 250 μA		2.0	-	4.0	
Gate-Source Leakage	I _{GSS}	V _{GS} = ± 30 V		-	-	± 100	nA
Zero Gate Voltage Drain Current	I _{DSS}	V _{DS} = 600 V, V _{GS} = 0 V		-	-	25	μA
		V _{DS} = 480 V, V _{GS} = 0 V, T _J = 150 °C		-	-	250	
Drain-Source On-State Resistance	R _{DS(on)}	V _{GS} = 10 V	I _D = 0.84 A ^b	-	-	7.0	Ω
Forward Transconductance	g _{fs}	V _{DS} = 50 V, I _D = 0.84 A		0.88	-	-	S
Dynamic							
Input Capacitance	C _{iss}	V _{GS} = 0 V, V _{DS} = 25 V, f = 1.0 MHz, see fig. 5		-	229	-	pF
Output Capacitance	C _{oss}			-	32.6	-	
Reverse Transfer Capacitance	C _{rss}			-	2.4	-	
Output Capacitance	C _{oss}	V _{GS} = 0 V	V _{DS} = 1.0 V, f = 1.0 MHz	-	320	-	nF
			V _{DS} = 480 V, f = 1.0 MHz	-	11.5	-	
Effective Output Capacitance	C _{oss eff.}	V _{DS} = 0 V to 480 V ^c		-	130	-	
Total Gate Charge	Q _g	V _{GS} = 10 V	I _D = 1.4 A, V _{DS} = 400 V, see fig. 6 and 13 ^b	-	-	14	nC
Gate-Source Charge	Q _{gs}			-	-	2.7	
Gate-Drain Charge	Q _{gd}			-	-	8.1	
Turn-On Delay Time	t _{d(on)}	V _{DD} = 250 V, I _D = 1.4 A, R _g = 2.15 Ω, R _D = 178 Ω, see fig. 10 ^b		-	9.8	-	ns
Rise Time	t _r			-	14	-	
Turn-Off Delay Time	t _{d(off)}			-	18	-	
Fall Time	t _f			-	20	-	
Drain-Source Body Diode Characteristics							
Continuous Source-Drain Diode Current	I _S	MOSFET symbol showing the integral reverse p - n junction diode 		-	-	1.4	A
Pulsed Diode Forward Current ^a	I _{SM}			-	-	5.6	
Body Diode Voltage	V _{SD}	T _J = 25 °C, I _S = 1.4 A, V _{GS} = 0 V ^b		-	-	1.6	V
Body Diode Reverse Recovery Time	t _{rr}	T _J = 25 °C, I _F = 1.4 A, dI/dt = 100 A/μs ^b		-	290	440	ns
Body Diode Reverse Recovery Charge	Q _{rr}			-	510	760	μC
Forward Turn-On Time	t _{on}	Intrinsic turn-on time is negligible (turn-on is dominated by L _S and L _D)					

Notes

- Repetitive rating; pulse width limited by maximum junction temperature (see fig. 11).
- Pulse width $\leq 300\text{ }\mu\text{s}$; duty cycle $\leq 2\%$.
- $C_{oss\text{ eff.}}$ is a fixed capacitance that gives the same charging time as C_{oss} while V_{DS} is rising from 0 to 80 % V_{DS} .

IRFR1N60A, IRFU1N60A, SiHFR1N60A, SiHFU1N60A

TYPICAL CHARACTERISTICS (25 °C, unless otherwise noted)

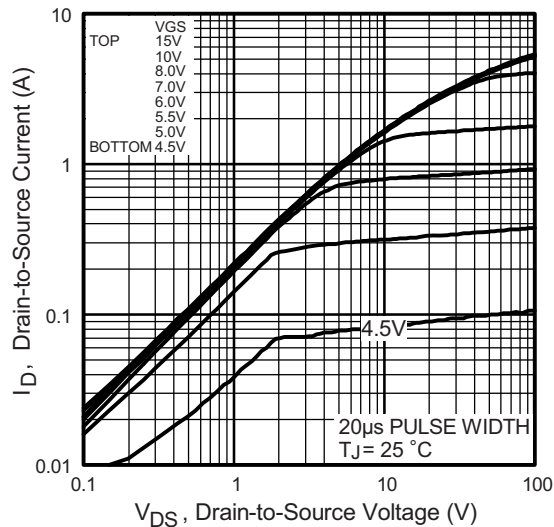


Fig. 1 - Typical Output Characteristics

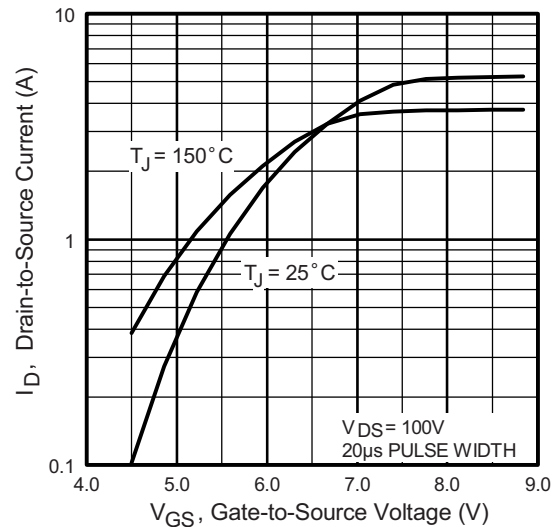


Fig. 3 - Typical Transfer Characteristics

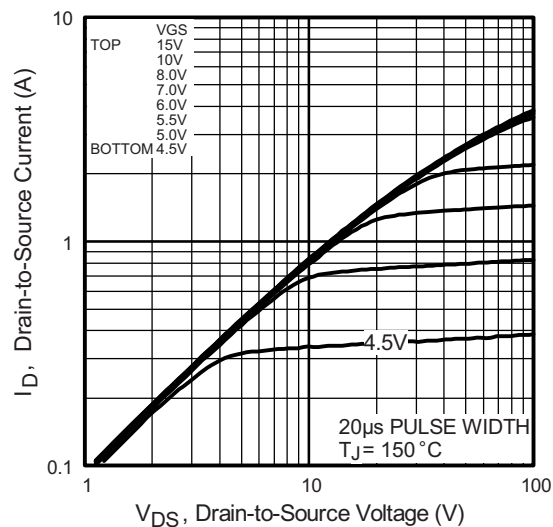


Fig. 2 - Typical Output Characteristics

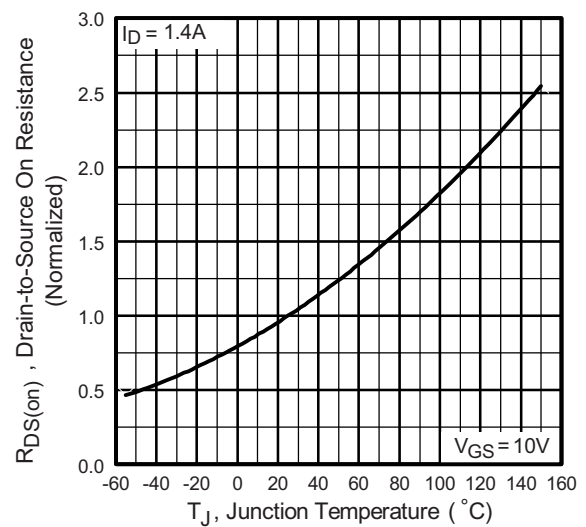


Fig. 4 - Normalized On-Resistance vs. Temperature

IRFR1N60A, IRFU1N60A, SiHFR1N60A, SiHFU1N60A

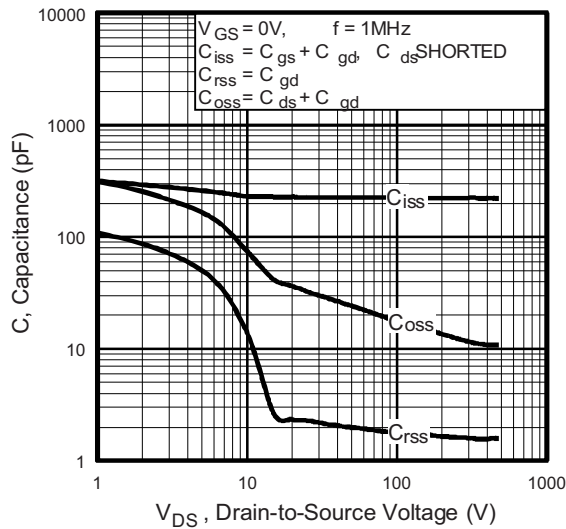


Fig. 5 - Typical Capacitance vs. Drain-to-Source Voltage

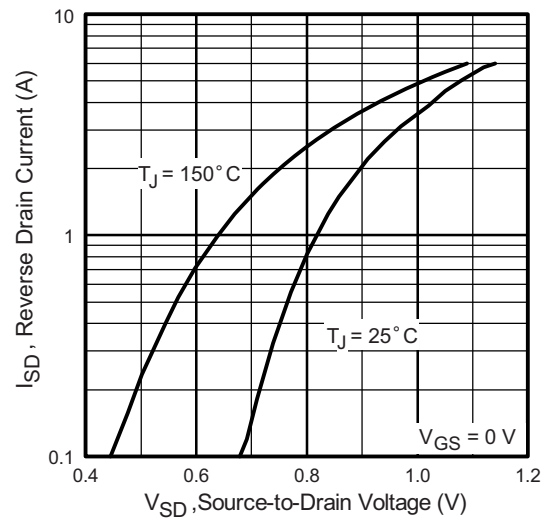


Fig. 7 - Typical Source-Drain Diode Forward Voltage

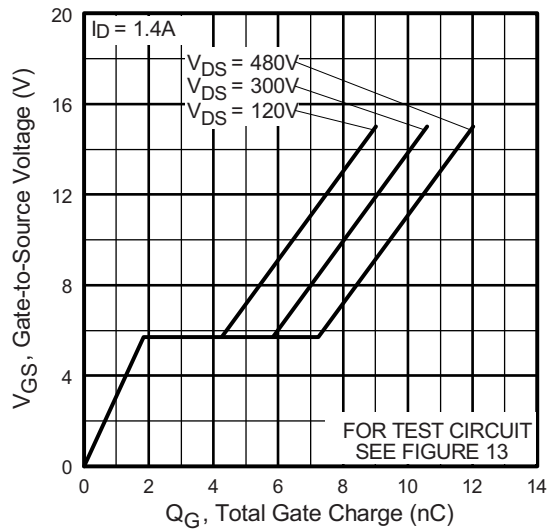


Fig. 6 - Typical Gate Charge vs. Gate-to-Source Voltage

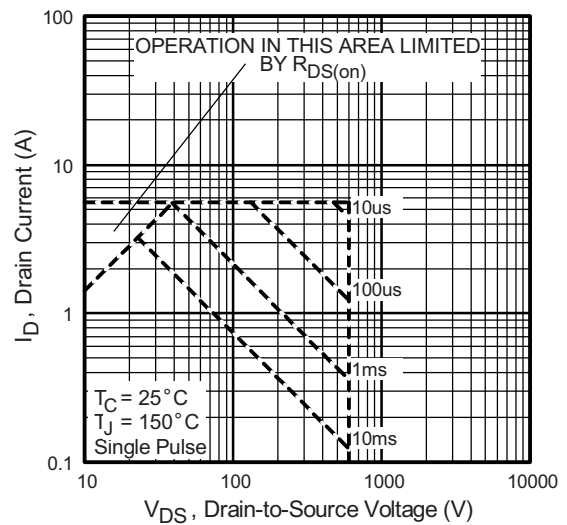


Fig. 8 - Maximum Safe Operating Area

IRFR1N60A, IRFU1N60A, SiHFR1N60A, SiHFU1N60A

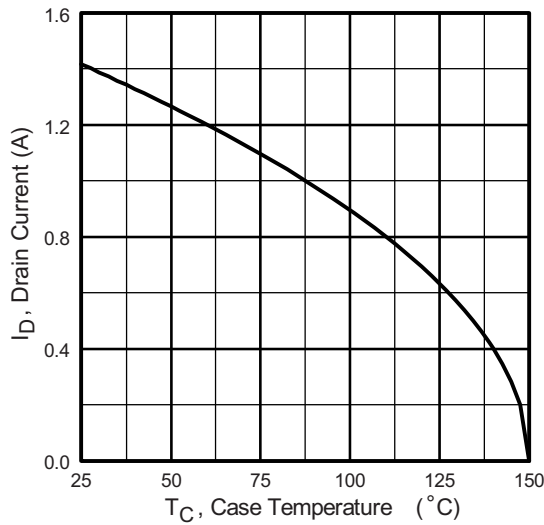


Fig. 9 - Maximum Drain Current vs. Case Temperature

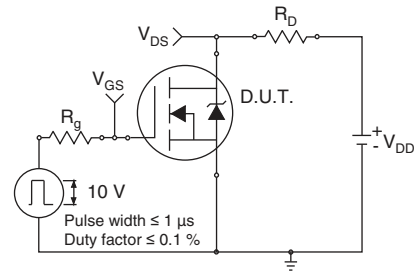


Fig. 10a - Switching Time Test Circuit

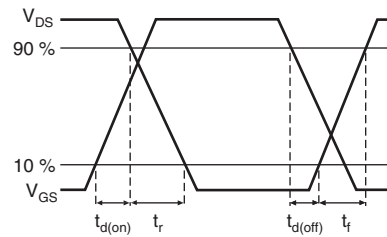


Fig. 10b - Switching Time Waveforms

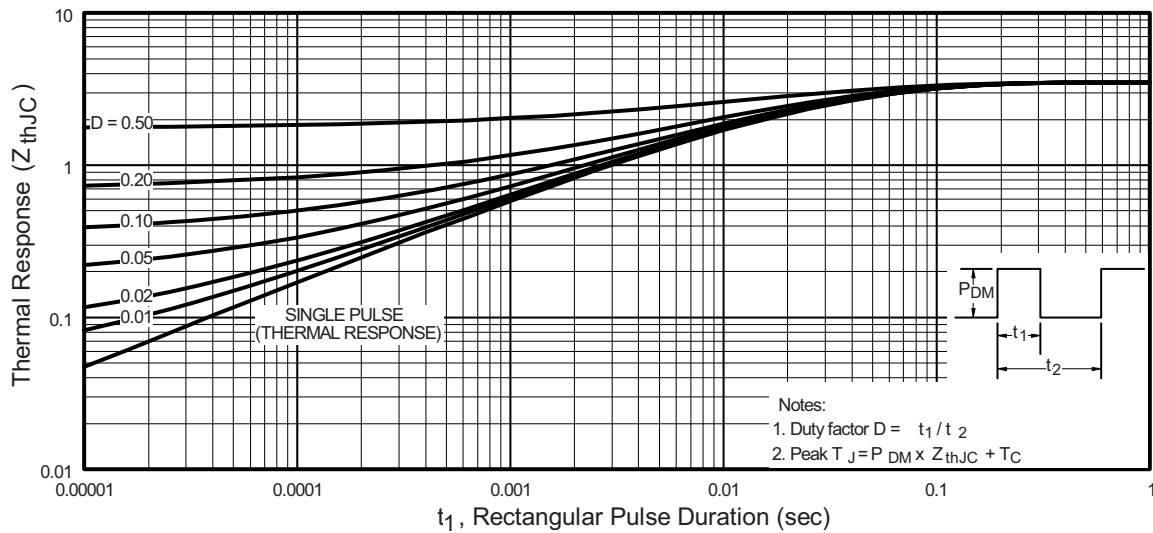


Fig. 11 - Maximum Effective Transient Thermal Impedance, Junction-to-Case

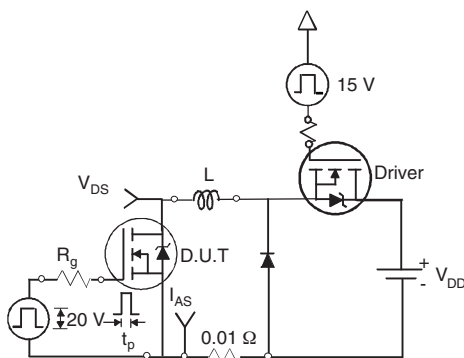


Fig. 12a - Unclamped Inductive Test Circuit

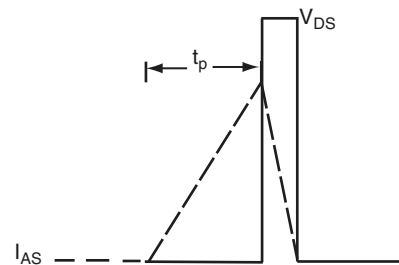


Fig. 12b - Unclamped Inductive Waveforms

IRFR1N60A, IRFU1N60A, SiHFR1N60A, SiHFU1N60A

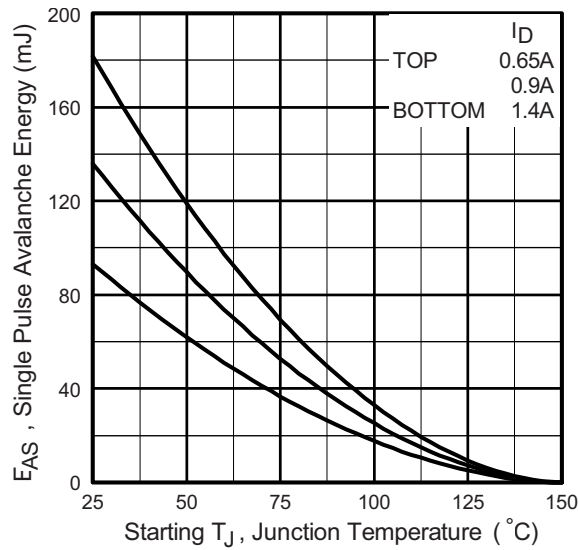


Fig. 12c - Maximum Avalanche Energy vs. Drain Current

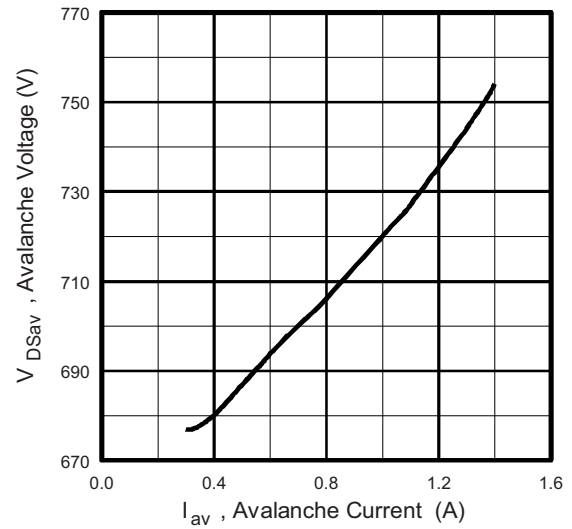


Fig. 12d - Basic Gate Charge Waveform

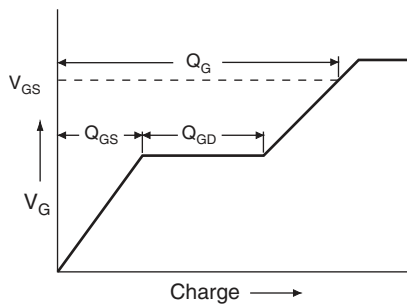


Fig. 13a - Maximum Avalanche Energy vs. Drain Current

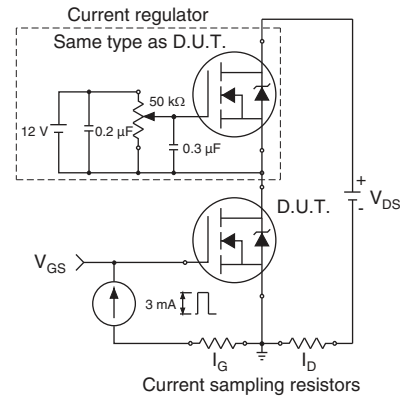


Fig. 13b - Gate Charge Test Circuit

IRFR1N60A, IRFU1N60A, SiHFR1N60A, SiHFU1N60A

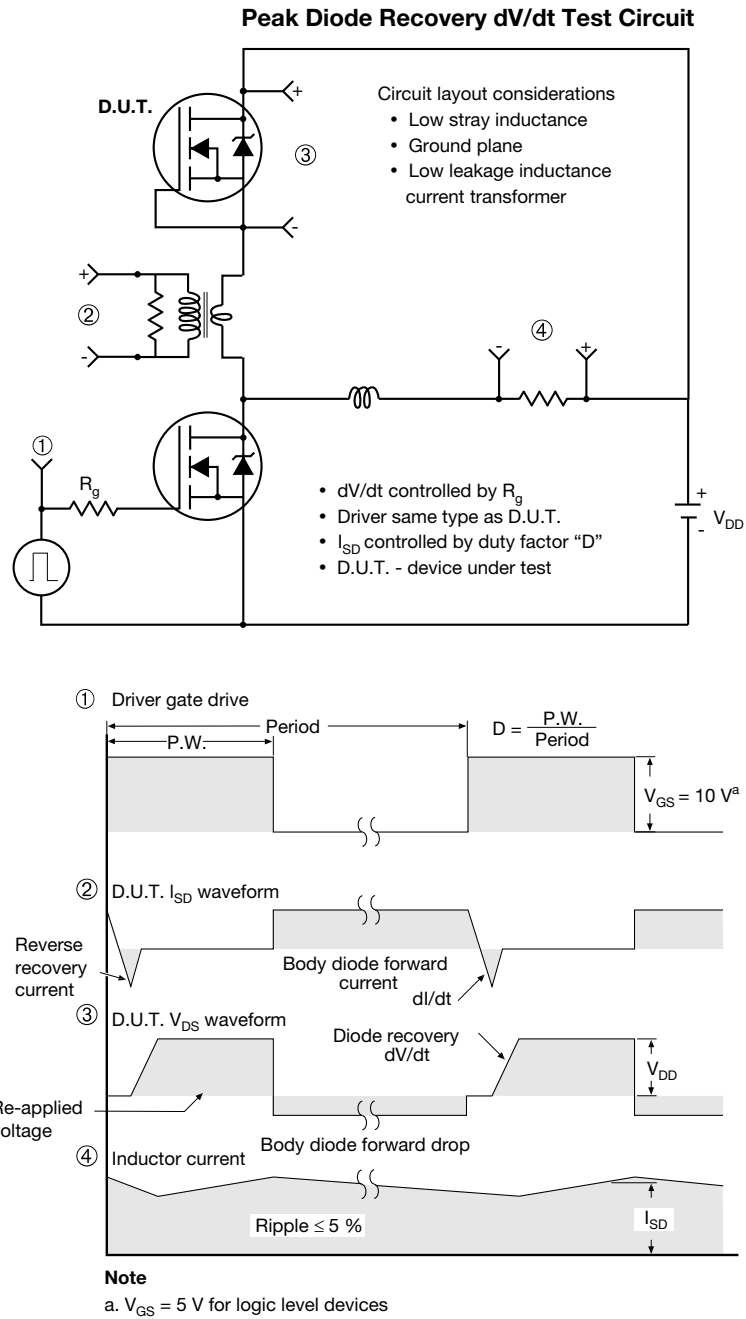
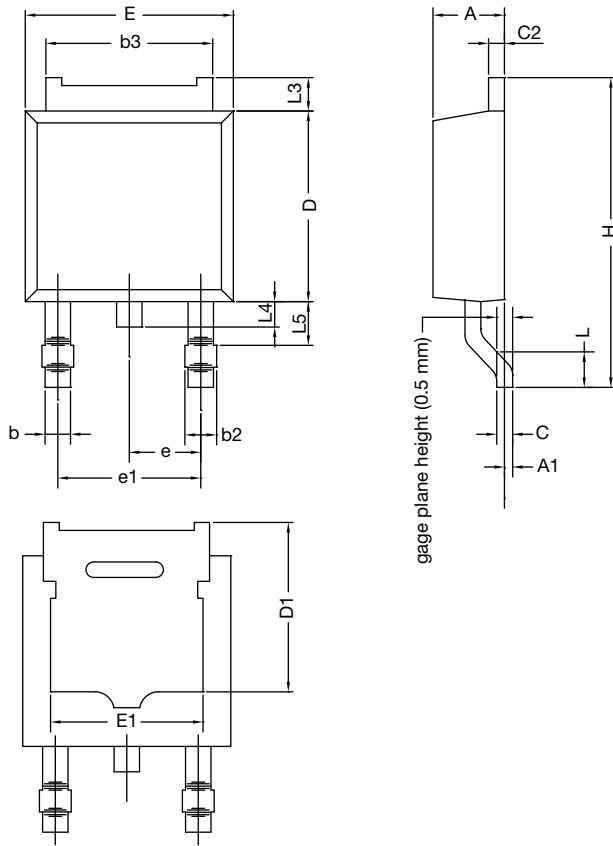


Fig. 14 - For N-Channel

IRFR1N60A, IRFU1N60A, SiHFR1N60A, SiHFU1N60A

TO-252AA Case Outline



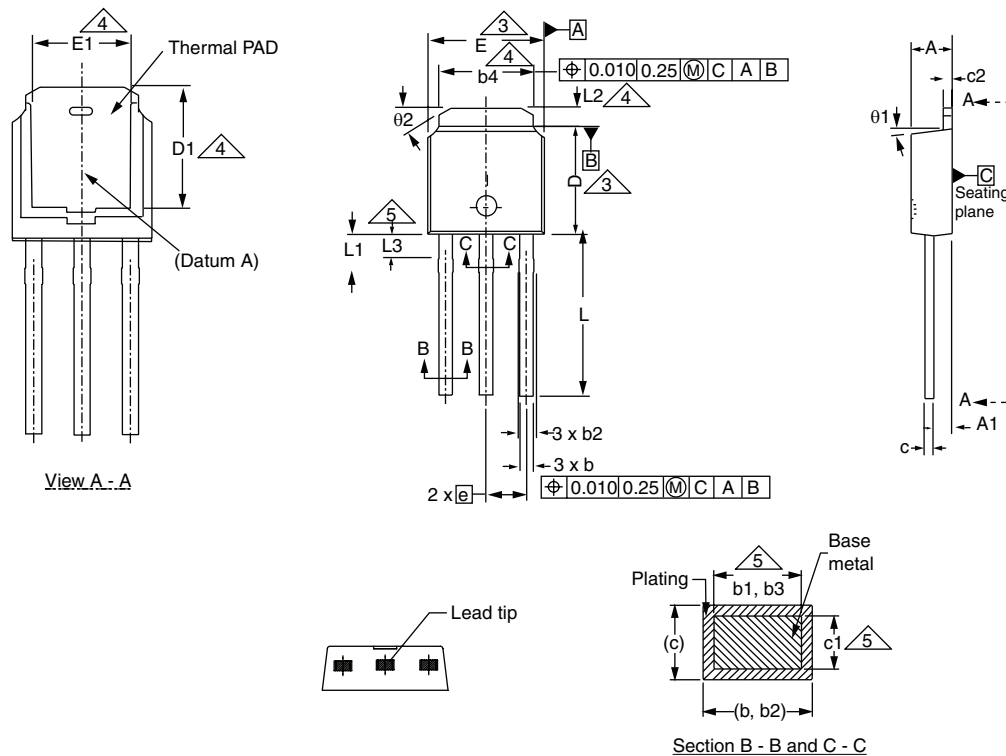
DIM.	MILLIMETERS		INCHES	
	MIN.	MAX.	MIN.	MAX.
A	2.18	2.38	0.086	0.094
A1	-	0.127	-	0.005
b	0.64	0.88	0.025	0.035
b2	0.76	1.14	0.030	0.045
b3	4.95	5.46	0.195	0.215
C	0.46	0.61	0.018	0.024
C2	0.46	0.89	0.018	0.035
D	5.97	6.22	0.235	0.245
D1	4.10	-	0.161	-
E	6.35	6.73	0.250	0.265
E1	4.32	-	0.170	-
H	9.40	10.41	0.370	0.410
e	2.28 BSC		0.090 BSC	
e1	4.56 BSC		0.180 BSC	
L	1.40	1.78	0.055	0.070
L3	0.89	1.27	0.035	0.050
L4	-	1.02	-	0.040
L5	1.01	1.52	0.040	0.060
ECN: T16-0236-Rev. P, 16-May-16 DWG: 5347				

Notes

- Dimension L3 is for reference only.

IRFR1N60A, IRFU1N60A, SiHFR1N60A, SiHFU1N60A

TO-251AA (HIGH VOLTAGE)



DIM.	MILLIMETERS		INCHES	
	MIN.	MAX.	MIN.	MAX.
A	2.18	2.39	0.086	0.094
A1	0.89	1.14	0.035	0.045
b	0.64	0.89	0.025	0.035
b1	0.65	0.79	0.026	0.031
b2	0.76	1.14	0.030	0.045
b3	0.76	1.04	0.030	0.041
b4	4.95	5.46	0.195	0.215
c	0.46	0.61	0.018	0.024
c1	0.41	0.56	0.016	0.022
c2	0.46	0.86	0.018	0.034
D	5.97	6.22	0.235	0.245

DIM.	MILLIMETERS		INCHES	
	MIN.	MAX.	MIN.	MAX.
D1	5.21	-	0.205	-
E	6.35	6.73	0.250	0.265
E1	4.32	-	0.170	-
e	2.29 BSC		2.29 BSC	
L	8.89	9.65	0.350	0.380
L1	1.91	2.29	0.075	0.090
L2	0.89	1.27	0.035	0.050
L3	1.14	1.52	0.045	0.060
01	0'	15'	0'	15'
02	25'	35'	25'	35'

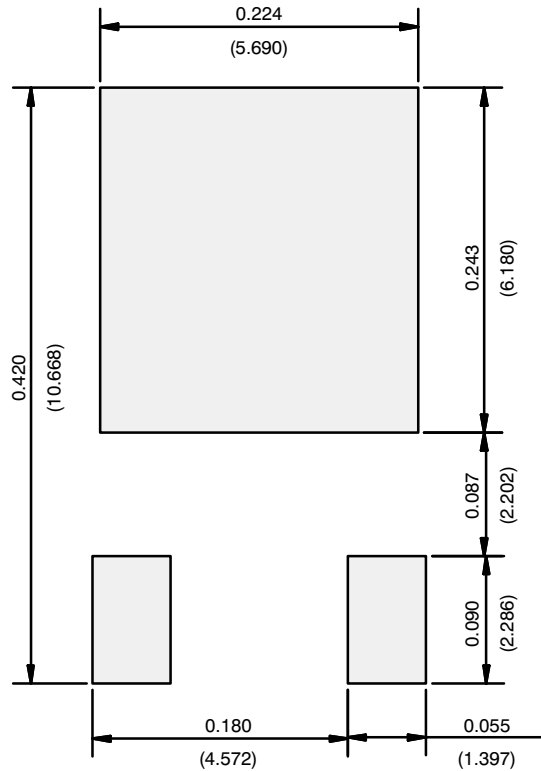
ECN: S-82111-Rev. A, 15-Sep-08
DWG: 5968

Notes

1. Dimensioning and tolerancing per ASME Y14.5M-1994.
2. Dimension are shown in inches and millimeters.
3. Dimension D and E do not include mold flash. Mold flash shall not exceed 0.13 mm (0.005") per side. These dimensions are measured at the outermost extremes of the plastic body.
4. Thermal pad contour optional with dimensions b4, L2, E1 and D1.
5. Lead dimension uncontrolled in L3.
6. Dimension b1, b3 and c1 apply to base metal only.
7. Outline conforms to JEDEC outline TO-251AA.

IRFR1N60A, IRFU1N60A, SiHFR1N60A, SiHFU1N60A

RECOMMENDED MINIMUM PADS FOR DPAK (TO-252)



Recommended Minimum Pads
Dimensions in Inches/(mm)

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