IRFR014, IRFU014, SiHFR014, SiHFU014

Vishay Siliconix

Power MOSFET

PRODUCT SUMMARY

V_{DS} (V)		60
$R_{DS(on)}$ (Ω)	V_{GS} = 10 V	0.20
Q_g (Max.) (nC)		11
Q_{gs} (nC)		3.1
Q_{gd} (nC)		5.8
Configuration		Single

DPAK (TO-252)

IPAK (TO-251)

N-Channel MOSFET

FEATURES

- Dynamic dV/dt Rating
- Surface Mount (IRFR014, SiHFR014)
- Straight Lead (IRFU014, SiHFU014)
- Available in Tape and Reel
- Fast Switching
- Ease of Paralleling
- Simple Drive Requirements
- Material categorization: For definitions of compliance please see www.vishay.com/doc?99912
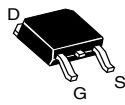
RoHS COMPLIANT

HALOGEN FREE Available

DESCRIPTION

Third generation power MOSFETs from Vishay provide the designer with the best combination of fast switching, ruggedized device design, low on-resistance and cost-effectiveness.

The DPAK is designed for surface mounting using vapor phase, infrared, or wave soldering techniques. The straight lead version (IRFU, SiHFU series) is for through-hole mounting applications. Power dissipation levels up to 1.5 W are possible in typical surface mount applications.
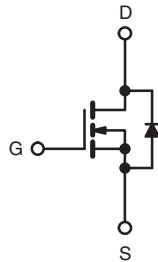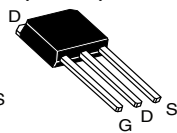
ORDERING INFORMATION

Package	DPAK (TO-252)	DPAK (TO-252)	DPAK (TO-252)	IPAK (TO-251)
Lead (Pb)-free and Halogen-free	SiHFR014-GE3	SiHFR014TRL-GE3	SiHFR014TR-GE3	SIHFU014-GE3
Lead (Pb)-free	IRFR014PbF	IRFR014TRLPbF[a]	IRFR014TRPbF[a]	IRFU014PbF
	SiHFR014-E3	SiHFR014TL-E3[a]	SiHFR014T-E3[a]	SiHFU014-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}	60	V
Gate-Source Voltage			V_{GS}	± 20	
Continuous Drain Current	V_{GS} at 10 V	T_C = 25 °C	I_D	7.7	A
		T_C = 100 °C		4.9	
Pulsed Drain Current[a]			I_{DM}	31	
Linear Derating Factor				0.20	W/°C
Linear Derating Factor (PCB Mount)[e]				0.020	
Single Pulse Avalanche Energy[b]			E_{AS}	27.4	mJ
Maximum Power Dissipation	T_C = 25 °C		P_D	25	W
Maximum Power Dissipation (PCB Mount)[e]	T_A = 25 °C			2.5	
Peak Diode Recovery dV/dt[c]			dV/dt	4.5	V/ns
Operating Junction and Storage Temperature Range			T_J, T_{stg}	- 55 to + 150	°C
Soldering Recommendations (Peak Temperature)[d]	for 10 s			260	

Notes

a. Repetitive rating; pulse width limited by maximum junction temperature (see fig. 11).

b. V_{DD} = 25 V, starting T_J = 25 °C, L = 924 µH, R_g = 25 Ω, I_{AS} = 7.7 A (see fig. 12).

c. $I_{SD} \leq$ 10 A, dI/dt $\leq$ 90 A/µs, $V_{DD} \leq V_{DS}$, $T_J \leq$ 150 °C.

d. 1.6 mm from case.

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

THERMAL RESISTANCE RATINGS

PARAMETER	SYMBOL	MIN.	TYP.	MAX.	UNIT
Maximum Junction-to-Ambient	R_{thJA}	-	-	110	
Maximum Junction-to-Ambient (PCB Mount)[a]	R_{thJA}	-	-	50	°C/W
Maximum Junction-to-Case (Drain)	R_{thJC}	-	-	5.0	

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	60	-	-	V
V_{DS} Temperature Coefficient	$\Delta V_{DS}/T_J$	Reference to 25 °C, I_D = 1 mA	-	0.068	-	V/°C
Gate-Source Threshold Voltage	$V_{GS(th)}$	V_{DS} = V_{GS}, I_D = 250 µA	2.0	-	4.0	V
Gate-Source Leakage	I_{GSS}	V_{GS} = ± 20 V	-	-	± 100	nA
Zero Gate Voltage Drain Current	I_{DSS}	V_{DS} = 60 V, V_{GS} = 0 V	-	-	25	µA
		V_{DS} = 48 V, V_{GS} = 0 V, T_J = 125 °C	-	-	250	
Drain-Source On-State Resistance	$R_{DS(on)}$	V_{GS} = 10 V | I_D = 4.6 A[b]	-	-	0.20	Ω
Forward Transconductance	g_{fs}	V_{DS} = 25 V, I_D = 4.6 A	2.4	-	-	S
Dynamic						
Input Capacitance	C_{iss}	V_{GS} = 0 V, V_{DS} = 25 V, f = 1.0 MHz, see fig. 5	-	300	-	pF
Output Capacitance	C_{oss}		-	160	-	
Reverse Transfer Capacitance	C_{rss}		-	29	-	
Total Gate Charge	Q_g	V_{GS} = 10 V | I_D = 10 A, V_{DS} = 48 V, see fig. 6 and 13[b]	-	-	11	nC
Gate-Source Charge	Q_{gs}		-	-	3.1	
Gate-Drain Charge	Q_{gd}		-	-	5.8	
Turn-On Delay Time	$t_{d(on)}$	V_{DD} = 30 V, I_D = 10 A, R_g = 24 Ω, R_D = 2.7 Ω, see fig. 10[b]	-	10	-	ns
Rise Time	t_r		-	50	-	
Turn-Off Delay Time	$t_{d(off)}$		-	13	-	
Fall Time	t_f		-	19	-	
Internal Drain Inductance	L_D	Between lead, 6 mm (0.25") from package and center of die contact[c]	-	4.5	-	nH
Internal Source Inductance	L_S		-	7.5	-	
Drain-Source Body Diode Characteristics						
Continuous Source-Drain Diode Current	I_S	MOSFET symbol showing the integral reverse p - n junction diode	-	-	7.7	A
Pulsed Diode Forward Current[a]	I_{SM}		-	-	31	
Body Diode Voltage	V_{SD}	T_J = 25 °C, I_S = 7.7 A, V_{GS} = 0 V[b]	-	-	1.6	V
Body Diode Reverse Recovery Time	t_{rr}	T_J = 25 °C, I_F = 10 A, dI/dt = 100 A/µs[b]	-	70	140	ns
Body Diode Reverse Recovery Charge	Q_{rr}		-	0.20	0.40	µC
Forward Turn-On Time	t_{on}	Intrinsic turn-on time is negligible (turn-on is dominated by L_S and L_D)				

Notes

a. Repetitive rating; pulse width limited by maximum junction temperature (see fig. 11).

b. Pulse width ≤ 300 µs; duty cycle ≤ 2 %.
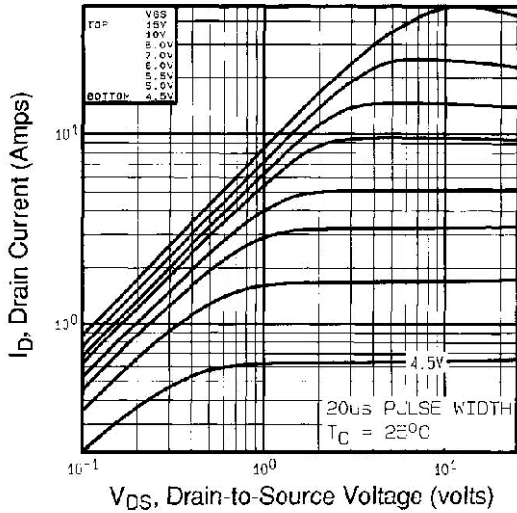
TYPICAL CHARACTERISTICS (25 °C, unless otherwise noted)
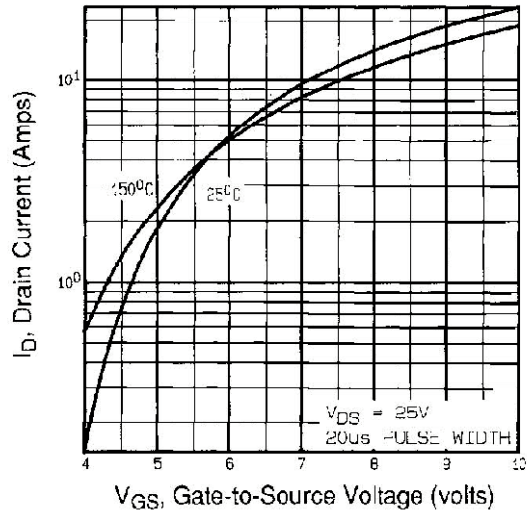

Fig. 1 - Typical Output Characteristics, T$_C$ = 25 °C
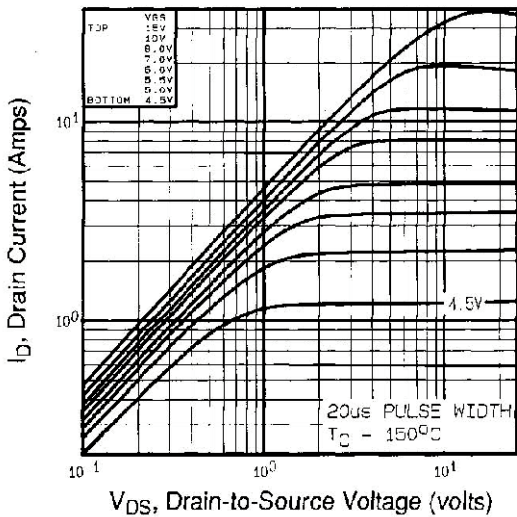

Fig. 3 - Typical Transfer Characteristics

Fig. 2 - Typical Output Characteristics, T$_C$ = 150 °C
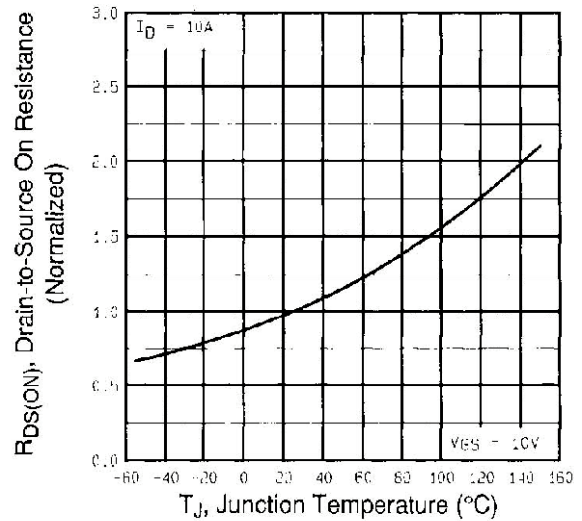
Fig. 4 - Normalized On-Resistance vs. Temperature

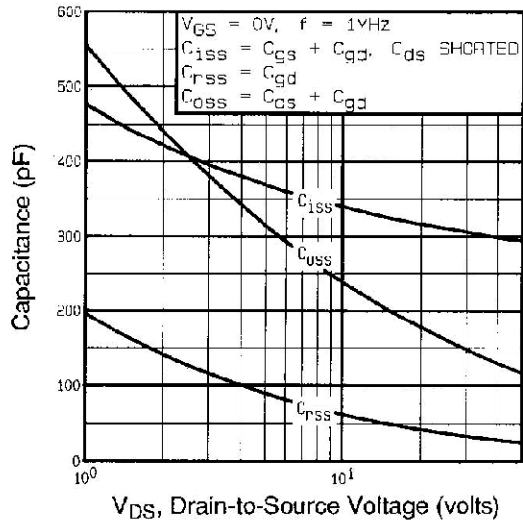For technical questions, contact: hvm@vishay.com

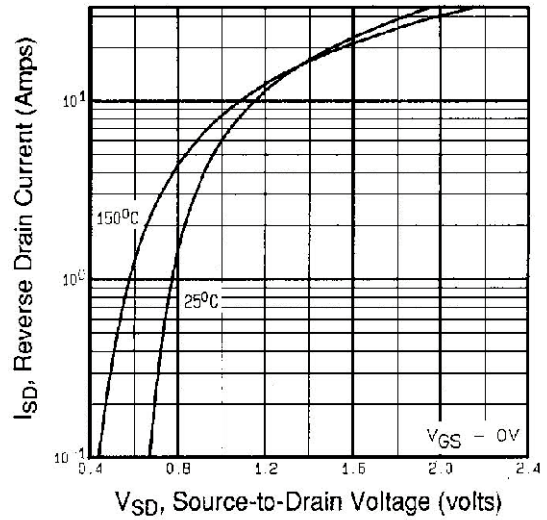**Fig. 5 - Typical Capacitance vs. Drain-to-Source Voltage**

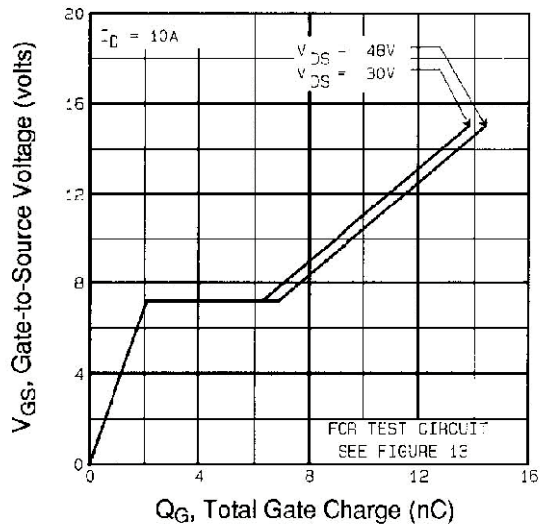**Fig. 7 - Typical Source-Drain Diode Forward Voltage**

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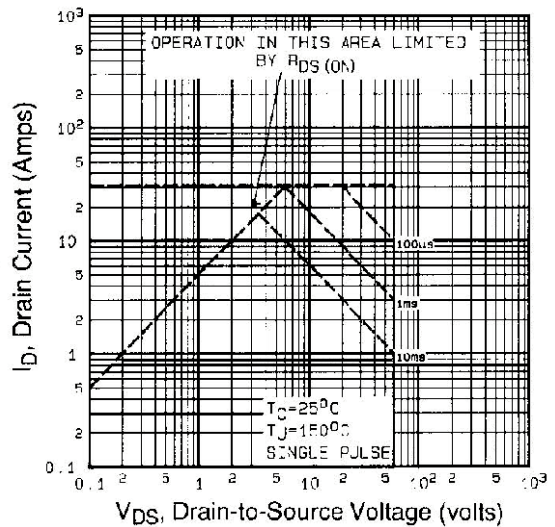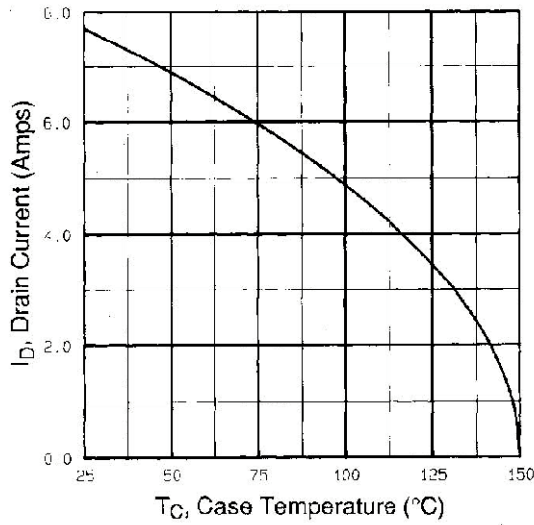

Fig. 8 - Maximum Safe Operating Area

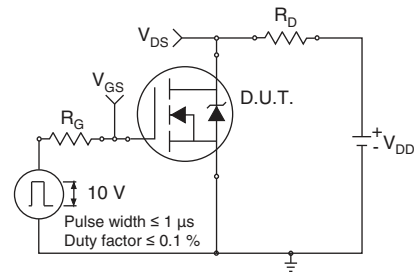Fig. 9 - Maximum Drain Current vs. Case Temperature

Fig. 10a - Switching Time Test Circuit
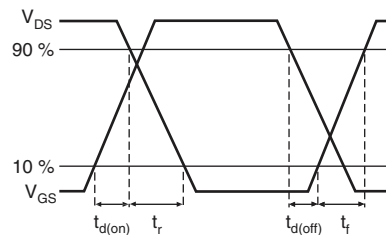
Fig. 10b - Switching Time Waveforms
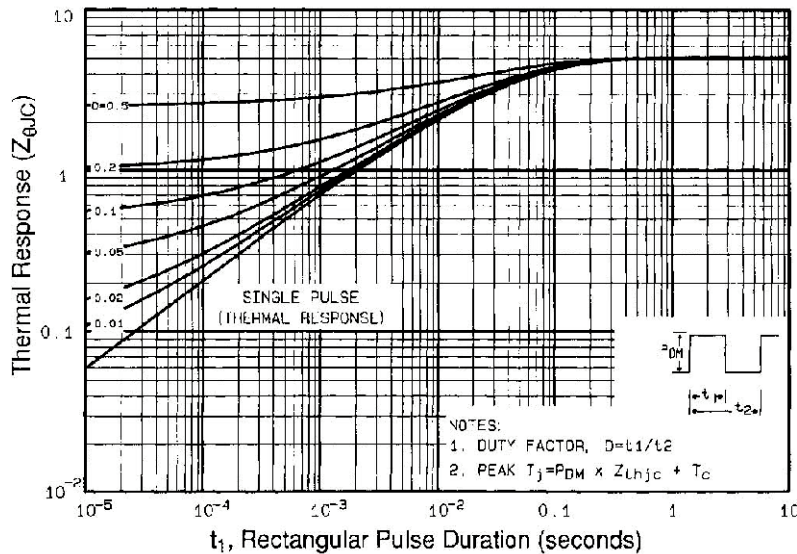
Fig. 11 - Maximum Effective Transient Thermal Impedance, Junction-to-Case

For technical questions, contact: hvm@vishay.com
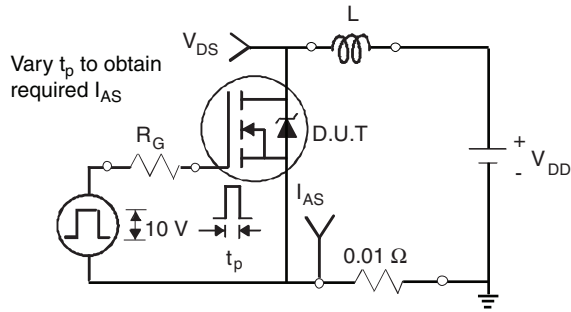
Fig. 12a - Unclamped Inductive Test Circuit
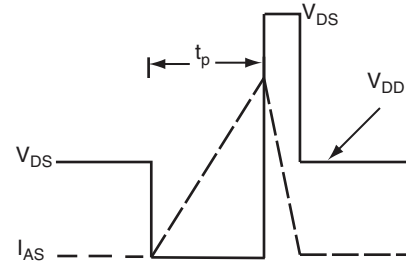
Fig. 12b - Unclamped Inductive Waveforms
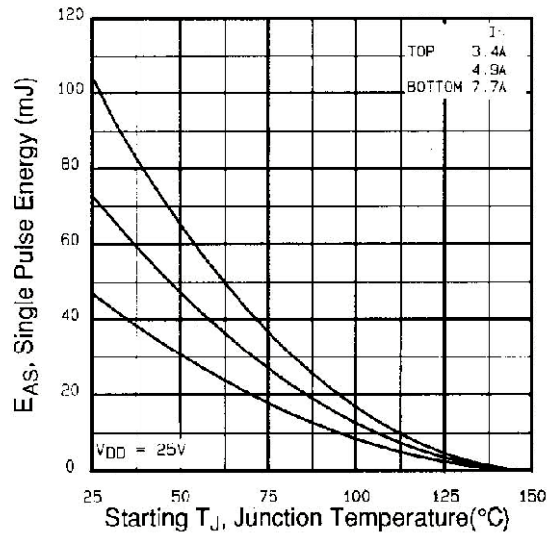
Fig. 12c - Maximum Avalanche Energy vs. Drain Current
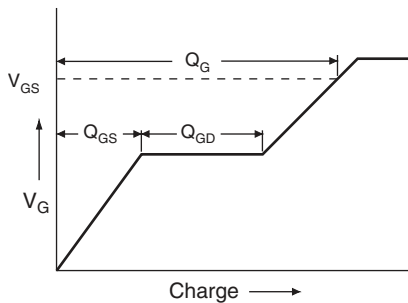
Fig. 13a - Basic Gate Charge Waveform
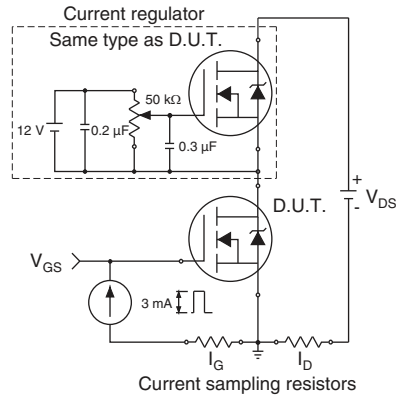
Fig. 13b - Gate Charge Test Circuit

For technical questions, contact: hvm@vishay.com

Peak Diode Recovery dV/dt Test Circuit

D.U.T.

Circuit layout considerations
• Low stray inductance
• Ground plane
• Low leakage inductance current transformer

• dV/dt controlled by R_g
• Driver same type as D.U.T.
• I_{SD} controlled by duty factor "D"
• D.U.T. - device under test

① Driver gate drive

$$D = \frac{P.W.}{Period}$$

$V_{GS} = 10\ V^a$

② D.U.T. I_{SD} waveform

Reverse recovery current

Body diode forward current

dI/dt

③ D.U.T. V_{DS} waveform

Diode recovery dV/dt

V_{DD}

Re-applied voltage

Body diode forward drop

④ Inductor current

Ripple ≤ 5 %

I_{SD}

Note

a. $V_{GS} = 5\ V$ for logic level devices

Fig. 14 - For N-Channel

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.

For technical questions, contact: pmostechsupport@vishay.com

TO-251AA (HIGH VOLTAGE)

View A - A

Lead tip

Section B - B and C - C

	MILLIMETERS		INCHES	
DIM.	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

	MILLIMETERS		INCHES	
DIM.	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
$\theta1$	0'	15'	0'	15'
$\theta2$	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.

RECOMMENDED MINIMUM PADS FOR DPAK (TO-252)

Recommended Minimum Pads
Dimensions in Inches/(mm)

Return to Index

APPLICATION NOTE

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[IRFU014PBF](#)