International
IOR Rectifier

Data Sheet No. PD60235

IPS1011(S)(R)

INTELLIGENT POWER LOW SIDE SWITCH

Features

- Over temperature shutdown
- Over current shutdown
- Active clamp
- Low current & logic level input
- ESD protection
- Optimized Turn On/Off for EMI
- Diagnostic on the input current

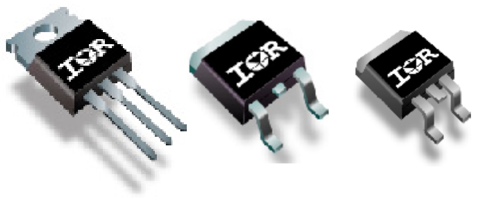
Product Summary

Rds(on)	13mΩ (max.)
Vclamp	36V
Ishutdown	85A (typ.)

Description

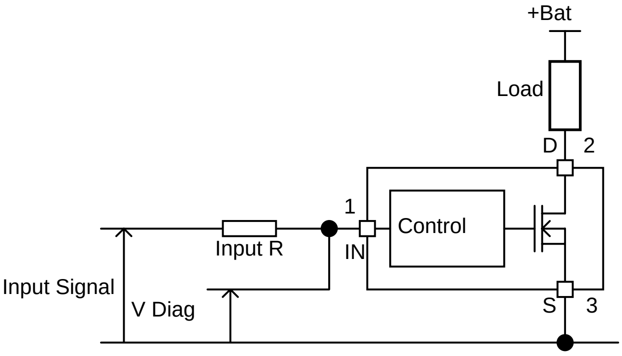
The IPS1011(S)(R) is a three terminal Intelligent Power Switch (IPS) that features a low side MOSFET with over-current, over-temperature, ESD protection and drain to source active clamp. This device offers protections and the high reliability required in harsh environments. The switch provides efficient protection by turning OFF the power MOSFET when the temperature exceeds 165°C or when the drain current reaches 85A. The device restarts once the input is cycled. A serial resistance connected to the input provides the diagnostic. The avalanche capability is significantly enhanced by the active clamp and covers most inductive load demagnetizations.

Packages



TO-220	D²Pak	D-Pak
IPS1011	IPS1011S	IPS1011R

Typical Connection



Absolute Maximum Ratings

Absolute maximum ratings indicate sustained limits beyond which damage to the device may occur. All voltage parameters are referenced to Ground lead. (Tambient=25°C unless otherwise specified).

Symbol	Parameter	Min.	Max.	Units
Vds	Maximum drain to source voltage	-0.3	36	V
Vds cont.	Maximum continuous drain to source voltage	-	28	V
Vin	Maximum input voltage	-0.3	6	V
Isd cont.	Max diode continuous current (limited by thermal dissipation)	—	5	A
Pd	Maximum power dissipation (internally limited by thermal protection)			W
	Rth=5°C/W IPS1011	—	25	
	Rth=40°C/W IPS1011S 1” sqr. footprint	—	3.1	
	Rth=50°C/W IPS1011R 1” sqr. footprint	—	2.5	
ESD	Electrostatic discharge voltage (Human body) C=100pF, R=1500Ω			kV
	Between drain and source	—	4	
	Other combinations	—	3	
	Electrostatic discharge voltage (Machine Model) C=200pF,R=0Ω			
	Between drain and source	—	0.5	
	Other combinations	—	0.3	
Tj max.	Max. storage & operating temperature junction temperature	-40	150	°C
Tsoldering	Lead soldering temperature (10 seconds)	—	300	°C

Thermal Characteristics

Symbol	Parameter	Typ.	Max.	Units
Rth1	Thermal resistance junction to ambient IPS1011 TO-220 free air	50	—	°C/W
Rth2	Thermal resistance junction to case IPS1011 TO-220	1.2	—	
Rth1	Thermal resistance junction to ambient IPS1011S D²Pak std. footprint	60	—	
Rth2	Thermal resistance junction to ambient IPS1011S D²Pak 1” sqr. footprint	40	—	
Rth3	Thermal resistance junction to case IPS1011S D²Pak	1.2	—	
Rth1	Thermal resistance junction to ambient IPS1011R D-Pak std. footprint	70	—	
Rth2	Thermal resistance junction to ambient IPS1011R D-Pak 1” sqr. footprint	50	—	
Rth3	Thermal resistance junction to case IPS1011R D-Pak	1.2	—	

Recommended Operating Conditions

These values are given for a quick design. For operation outside these conditions, please consult the application notes.

Symbol	Parameter	Min.	Max.	Units
VIH	High level input voltage	4.5	5.5	A
VIL	Low level input voltage	0	0.5	
Ids	Continuous drain current, Tambient=85°C, Tj=125°C, Vin=5V			
	Rth=5°C/W IPS1011	—	18	
	Rth=40°C/W IPS1011S 1” sqr. Footprint	—	6.5	
	Rth=50°C/W IPS1011R 1” sqr. Footprint	—	6	
Rin	Recommended resistor in series with IN pin to generate a diagnostic	0.5	10	kΩ
Max L	Max recommended load inductance (including line inductance) (1)	—	5	µH
Max F	Max frequency (switching losses = conduction losses)	—	200	Hz
Max t rise	Max Input rising time	—	1	µs

(1) Higher inductance is possible if maximum load current is limited - see figure 11

Static Electrical Characteristics

Tj=25°C, Vcc=14V (unless otherwise specified)

Symbol	Parameter	Min.	Typ.	Max.	Units	Test Conditions
Rds(on)	ON state resistance Tj=25°C	—	10	13	mΩ	Vin=5V, Ids=30A
	ON state resistance Tj=150°C (2)	—	19	25		
Idss1	Drain to source leakage current	—	0.1	10	µA	Vcc=14V, Tj=25°C
Idss2	Drain to source leakage current	—	0.2	20		Vcc=28V, Tj=25°C
V clamp1	Drain to source clamp voltage 1	36	39	—	V	Id=20mA
V clamp2	Drain to source clamp voltage 2	—	40	42		Id=5A
Vin clamp	IN to source pin clamp voltage	5.5	6.5	7.5		Iin=1mA
Vth	Input threshold voltage	—	1.7	—		Id=10mA

Switching Electrical Characteristics

Vcc=14V, Resistive load=0.5Ω, Rinput=50Ω, Vin=5V, Tj=25°C

Symbol	Parameter	Min.	Typ.	Max.	Units	Test Conditions
Tdon	Turn-on delay time to 20%	15	50	150	µs	See figure 2
Tr	Rise time 20% to 80%	20	50	100		
Tdoff	Turn-off delay time to 80%	100	330	1000		
Tf	Fall time 80% to 20%	30	70	150		
Eon + Eoff	Turn on and off energy	—	5	—	mJ	

Protection Characteristics

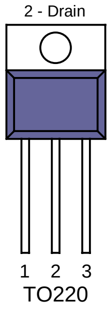
Symbol	Parameter	Min.	Typ.	Max.	Units	Test Conditions
Tsd	Over temperature threshold	150(2)	165	—	°C	See figure 1
Isd	Over current threshold	60	85	110	A	See figure 1
OV	Over voltage protection (not active when the device is ON)	34	37	—	V	
Vreset	IN protection reset threshold	—	1.7	—	V	
Treset	Time to reset protection	15(2)	50	200	µs	Vin=0V

Diagnostic

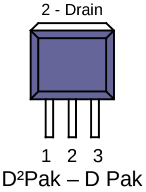
Symbol	Parameter	Min.	Typ.	Max.	Units	Test Conditions
Iin, on	ON state IN positive current	15	32	70	µA	Vin=5V
Iin, off	OFF state IN positive current (after protection latched)	150	230	350		Vin=5V

(2) Guaranteed by design

Lead Assignments

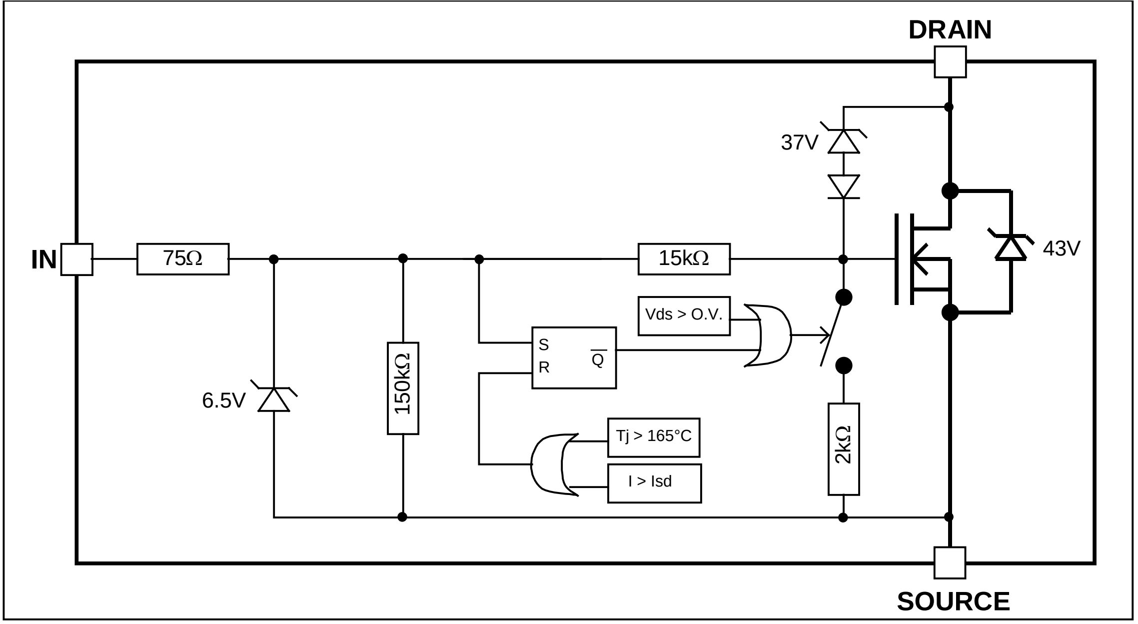


1- In
2- D
3- S



Functional Block Diagram

All values are typical



All curves are typical values. Operating in the shaded area is not recommended.

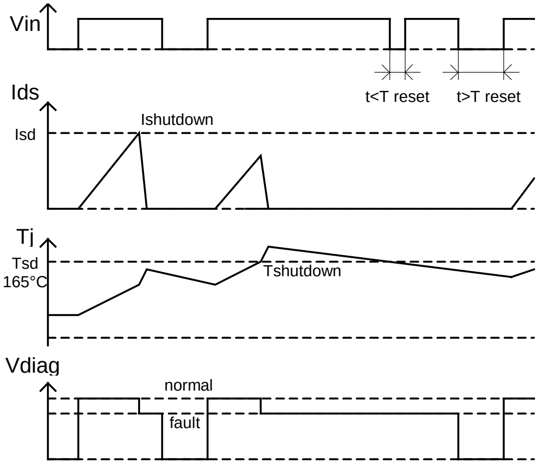


Figure 1 – Timing diagram

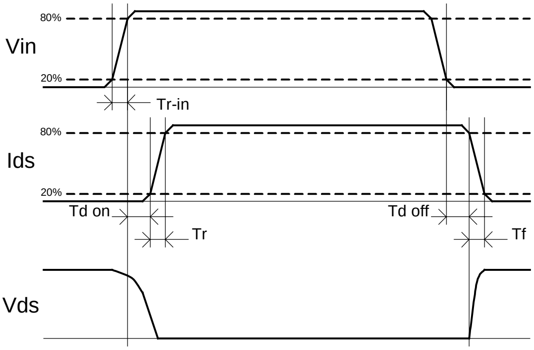
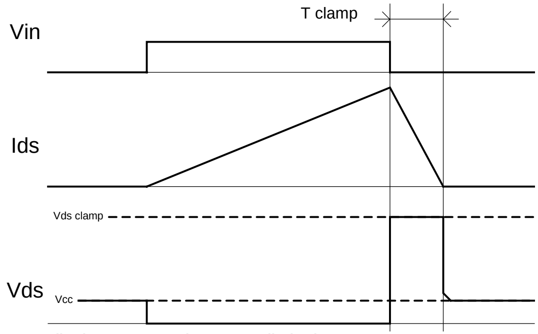
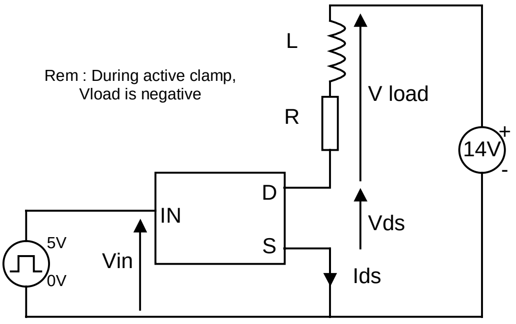


Figure 2 – IN rise time & switching definitions



See Application Notes to evaluate power dissipation

Figure 3 – Active clamp waveforms



Rem : During active clamp,
Vload is negative

Figure 4 – Active clamp test circuit

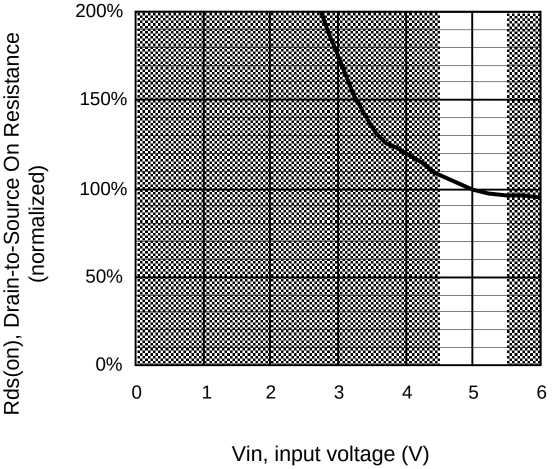


Figure 5 – Normalized Rds(on) (%) Vs Input voltage (V)

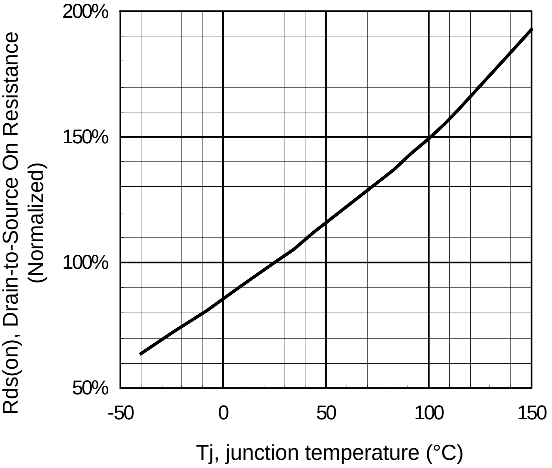


Figure 6 - Normalized Rds(on) (%) Vs Tj (°C)

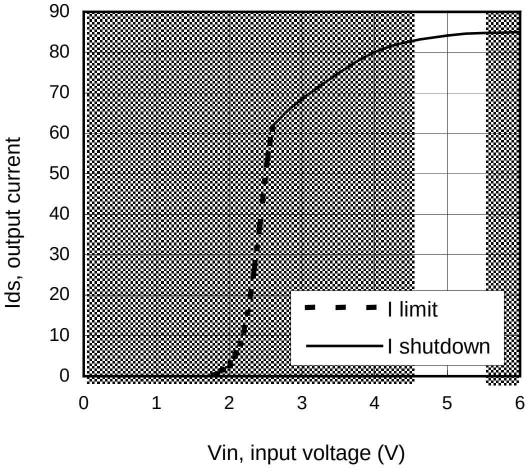


Figure 7 – Current limitation and current shutdown Vs Input voltage (V)

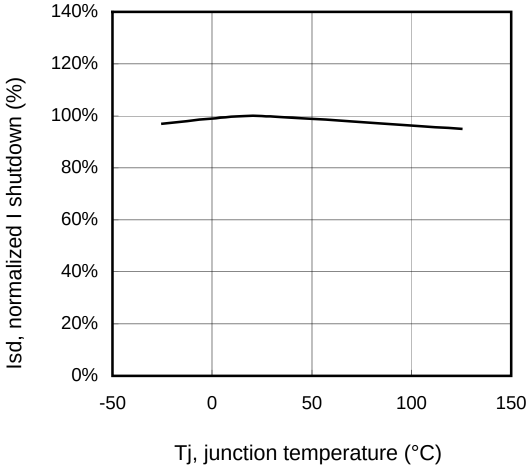


Figure 8 – Normalized I shutdown (%) Vs junction temperature (°C)

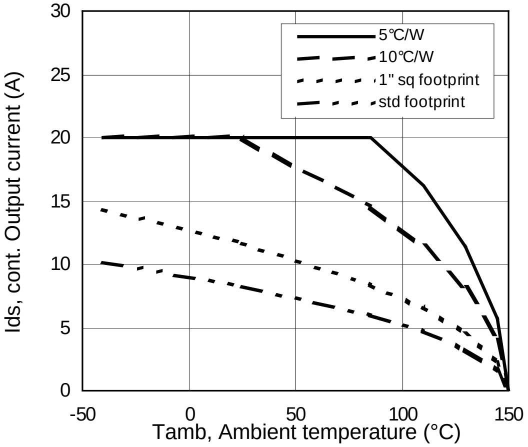


Figure 9 – Max. continuous output current (A) Vs Ambient temperature (°C)

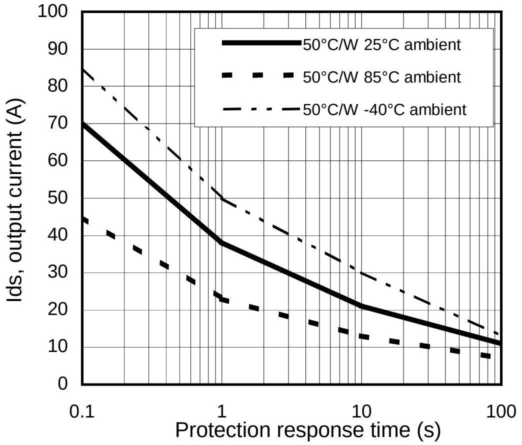


Figure 10 – Ids (A) Vs over temperature protection response time (s)

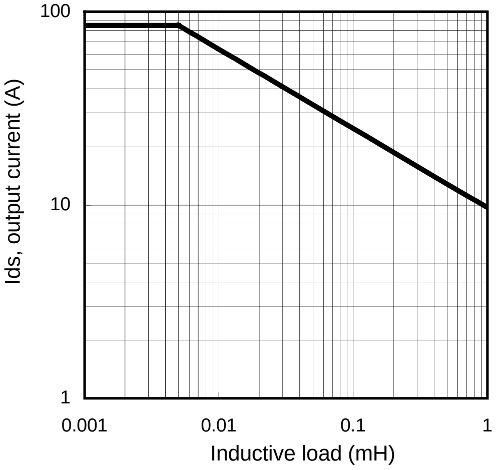


Figure 11 – Max. ouput current (A) Vs Inductive load (mH)

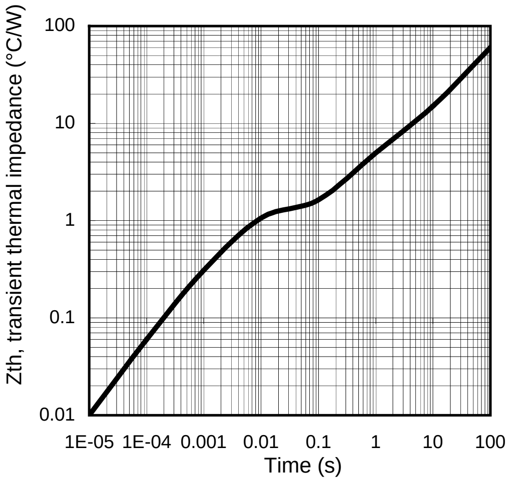
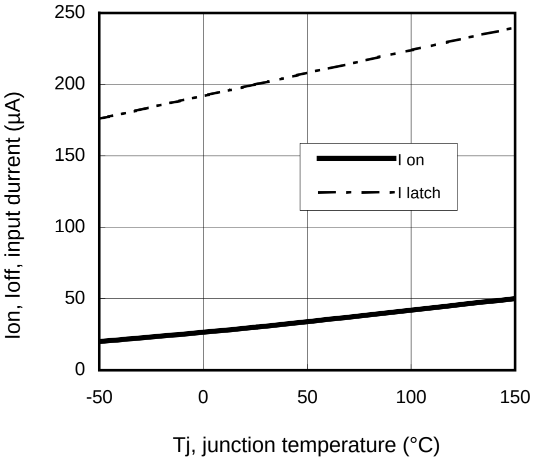


Figure 12 – Transient thermal impedance (°C/W) Vs time (s)



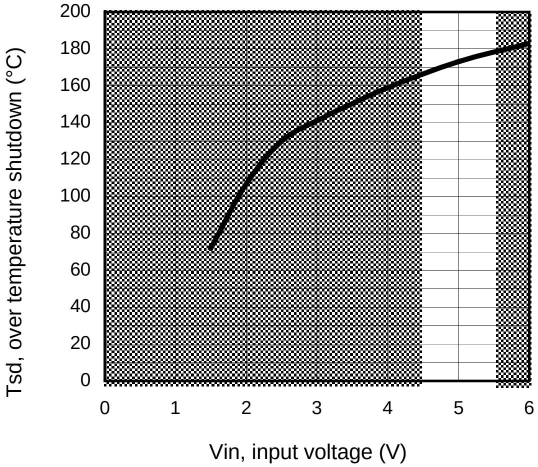
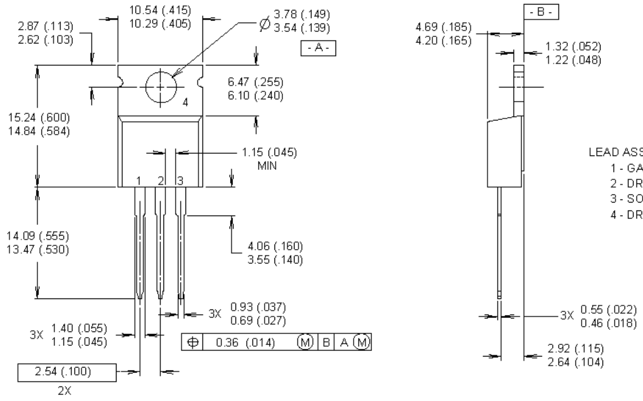


Figure 13 – Input current (µA) On and Off Vs junction temperature (°C)

Figure 14 – Over temperature shutdown (°C) Vs input voltage (V)

Case Outline – TO-220 AB

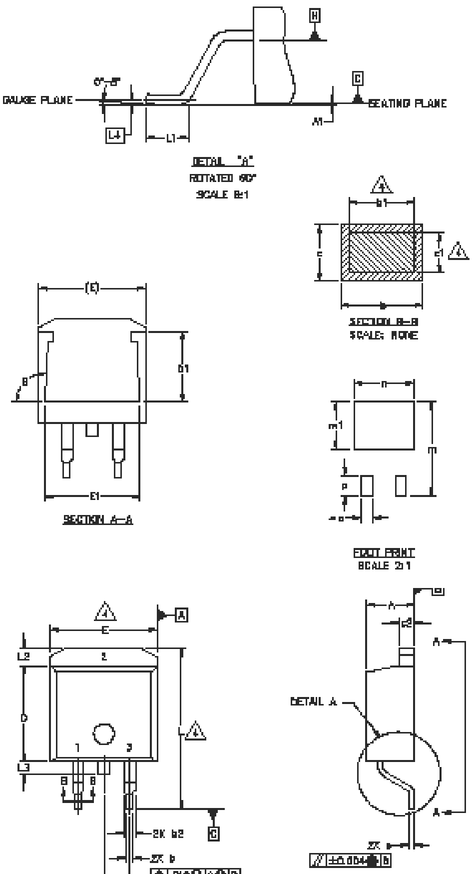


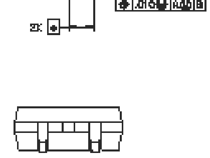
LEAD ASSIGNMENTS
1 - GATE
2 - DRAIN
3 - SOURCE
4 - DRAIN

NOTES:

1 DIMENSIONING & TOLERANCING PER ANSI Y14.5M, 1982.
2 CONTROLLING DIMENSION : INCH
3 OUTLINE CONFORMS TO JEDEC OUTLINE TO-220-AB.
4 HEATSINK & LEAD MEASUREMENTS DO NOT INCLUDE BURRS.
5 LEADS ARE SOLDER DIPPED: 63%/37% Sn/Pb; DRAIN CONTACT IS NICKEL PLATED.

Case Outline - D²Pak (SMD-220)





SYMBOL	DIMENSIONS				NOTES
	MILLIMETERS		INCHES		
	MIN.	MAX.	MIN.	MAX.	
A	4.06	4.83	.160	.190	
A1		0.127		.005	
b	0.51	0.99	.020	.039	
b1	0.51	0.89	.020	.035	4
b2	1.14	1.40	.045	.055	
c	0.38	0.74	.015	.029	
c1	0.43	0.63	.017	.025	4
c2	1.14	1.40	.045	.055	
D	8.51	9.65	.335	.380	3
D1	5.33		.210		
E	9.65	10.67	.380	.420	3
E1	6.22		.245		
e	2.54 BSC		.100 BSC		
L	14.61	15.88	.575	.625	
L1	1.78	2.79	.070	.110	
L2		1.65		.065	
L3	1.27	1.78	.050	.070	
L4	0.25 BSC		.010 BSC		
m	17.78		.700		
m1	8.89		.350		
n	11.43		.450		
o	2.08		.082		
p	3.81		.150		
θ	90°	93°	90°	93°	

LEAD ASSIGNMENTS

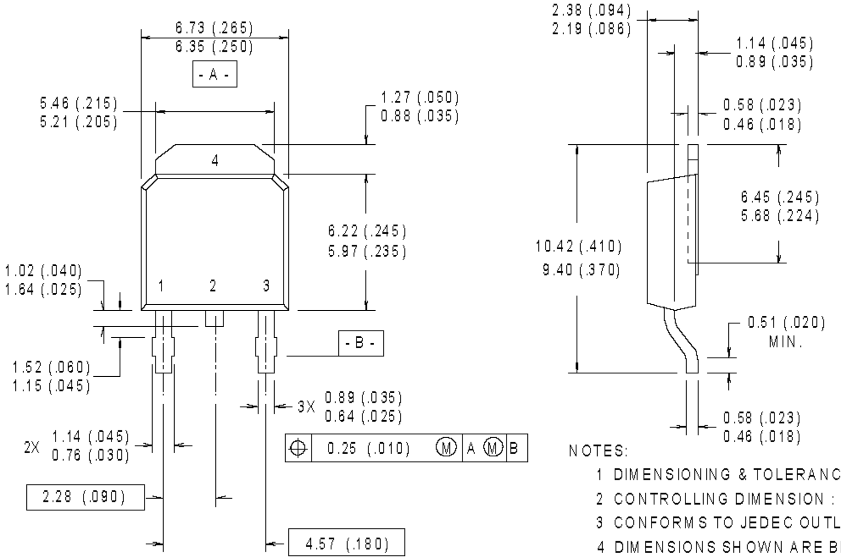
HEXFET	IGBTs, CoPACK	DIODES
1.- GATE	1.- GATE	1.- ANODE *
2.- DRAIN	2.- COLLECTOR	2.- CATHODE
3.- SOURCE	3.- EMITTER	3.- ANODE

* PART DEPENDENT.

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 [.005"] PER SIDE. THESE DIMENSIONS ARE MEASURED AT THE OUTMOST EXTREMES OF THE PLASTIC BODY.
4. DIMENSION b1 AND c1 APPLY TO BASE METAL ONLY.
5. CONTROLLING DIMENSION: INCH.

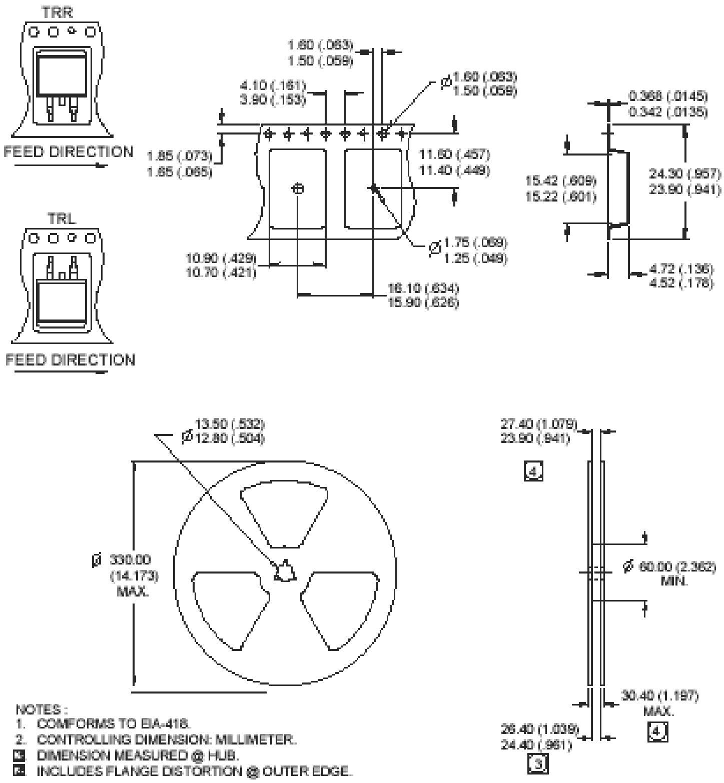
Case Outline – D-Pak



LEAD ASSIGNMENTS
1 - GATE
2 - DRAIN
3 - SOURCE
4 - DRAIN

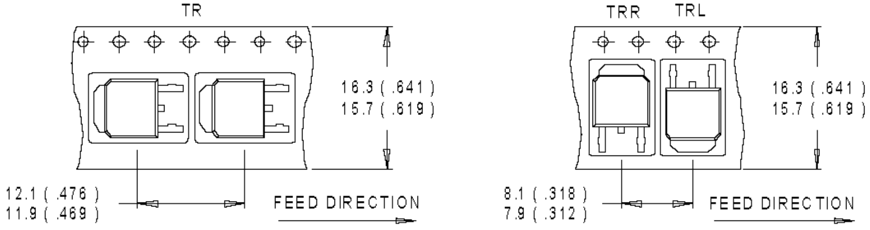
NOTES:
1 DIMENSIONING & TOLERANCING PER ANSI Y14.5M, 1982.
2 CONTROLLING DIMENSION : INCH.
3 CONFORMS TO JEDEC OUTLINE TO-252AA.
4 DIMENSIONS SHOWN ARE BEFORE SOLDER DIP,
SOLDER DIP MAX. +0.16 (.006).
5 LEADS & DRAIN CONTACT ARE PLATED: 85%/15% Sn/Pb NOMINAL.

Tape & Reel - D^{2}Pak (SMD220)

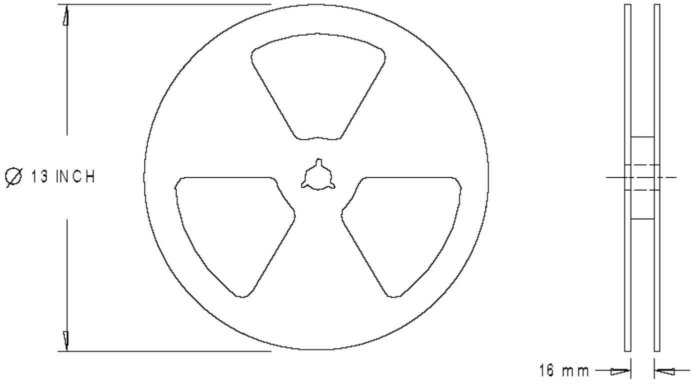


NOTES :
1. COMFORMS TO EIA-418.
2. CONTROLLING DIMENSION: MILLIMETER.
3. DIMENSION MEASURED @ HUB.
4. INCLUDES FLANGE DISTORTION @ OUTER EDGE.

Tape & Reel - D-Pak



NOTES :
1. CONTROLLING DIMENSION : MILLIMETER.
2. ALL DIMENSIONS ARE SHOWN IN MILLIMETERS (INCHES).
3. OUTLINE CONFORMS TO EIA-481 & EIA-541.



NOTES :
1. OUTLINE CONFORMS TO EIA-481.

Dimensions are shown in millimeters (inches)