International
IOR Rectifier

November, 29th 2009
Automotive grade

AUIPS7111S

CURRENT SENSE HIGH SIDE SWITCH

Features
- Suitable for 24V systems
- Over current shutdown
- Over temperature shutdown
- Current sensing
- Active clamp
- Low current
- Reverse battery
- ESD protection
- Optimized Turn On/Off for EMI

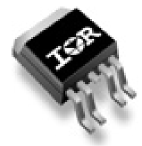
Applications
- 24V loads for trucks

Description
The AUIPS7111S is a fully protected four terminal high side switch. It features current sensing, over-current, over-temperature, ESD protection and drain to source active clamp. When the input voltage Vcc - Vin is higher than the specified threshold, the output power Mosfet is turned on. When the Vcc - Vin is lower than the specified Vil threshold, the output Mosfet is turned off. The Ifb pin is used for current sensing.

Product Summary

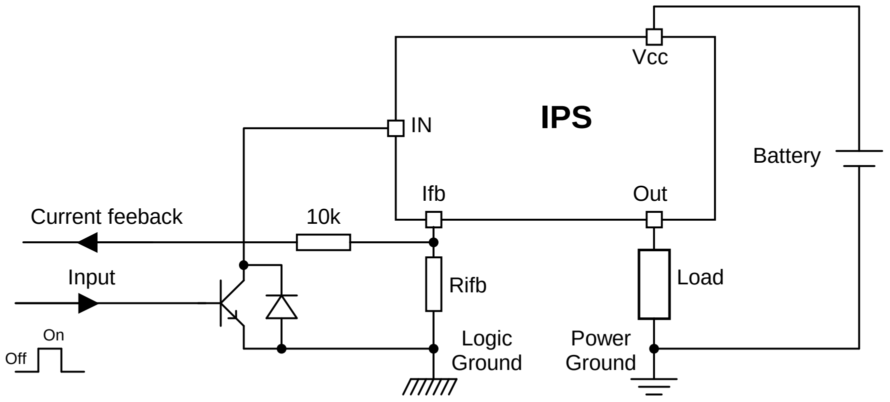
Rds(on)	7.5 mΩ max.
Vclamp	65V
Current shutdown	30A min.

Package



D²Pak-5 leads

Typical Connection



Qualification Information†

Qualification Level		Automotive (per AEC-Q100††)	
		Comments: This family of ICs has passed an Automotive qualification. IR's Industrial and Consumer qualification level is granted by extension of the higher Automotive level.	
Moisture Sensitivity Level		D2PAK-5L	MSL1, 260°C (per IPC/JEDEC J-STD-020)
ESD	Machine Model	Class M3 (300V) (per AEC-Q100-003)	
	Human Body Model	Class H2 (2,500 V) (per AEC-Q100-002)	
	Charged Device Model	Class C4 (1000 V) (per AEC-Q100-011)	
IC Latch-Up Test		Class II, Level A (per AEC-Q100-004)	
RoHS Compliant		Yes	

† Qualification standards can be found at International Rectifier's web site http://www.irf.com/

†† Exceptions to AEC-Q100 requirements are noted in the qualification report.

Absolute Maximum Ratings

Absolute maximum ratings indicate sustained limits beyond which damage to the device may occur. (Tj= -40°C..150°C, Vcc=8..50V unless otherwise specified).

Symbol	Parameter	Min.	Max.	Units
Vout	Maximum output voltage	Vcc-60	Vcc+0.3	V
Vcc-Vin max.	Maximum Vcc voltage	-32	60	V
Ifb, max.	Maximum feedback current	-50	10	mA
Pd	Maximum power dissipation (internally limited by thermal protection)			W
	Tambient=25°C, Tj=150°C Rth=50°C/W D²Pack 6cm² footprint	—	2.5	
Tj max.	Max. storage & operating junction temperature	-40	150	°C

Thermal Characteristics

Symbol	Parameter	Typ.	Max.	Units
Rth1	Thermal resistance junction to ambient D²Pak Std footprint	60	—	°C/W
Rth2	Thermal resistance junction to ambient D²pak 6cm² footprint	40	—	
Rth3	Thermal resistance junction to case D²pak	0.8	—	

Recommended Operating Conditions

These values are given for a quick design.

Symbol	Parameter	Min.	Max.	Units
Iout	Continuous output current, Tambient=85°C, Tj=125°C			A
	Rth=40°C/W, D²pak 6cm² footprint	—	10	
Rifb		1.5	—	kΩ

Static Electrical Characteristics

Tj=-40..150°C, Vcc=8..50V (unless otherwise specified)

Symbol	Parameter	Min.	Typ.	Max.	Units	Test Conditions
Vcc op.	Operating voltage range	8	—	50	V	
Rds(on)	ON state resistance Tj=25°C	—	6	7.5	mΩ	Ids=10A
	ON state resistance Tj=150°C	—	12	15		
Icc off	Supply leakage current	—	2	6	µA	Vin=Vcc=28V,Vifb=Vgnd
Iout off	Output leakage current	—	2	6		Vout=Vgnd, Tj=25°C
V clamp1	Vcc to Vout clamp voltage 1	60	65	—	V	Id=10mA
V clamp2	Vcc to Vout clamp voltage 2	—	66	—		Id=10A see fig. 2
Vih(2)	High level Input threshold voltage	—	5.5	6.8		Id=10mA
Vil(2)	Low level Input threshold voltage	3.5	5	—		
Rds(on) rev	Reverse On state resistance Tj=25°C	—	7	10	mΩ	Isd=10A,
	Reverse On state resistance Tj=150°C	—	13	18		Vcc-Vin=7..32V
Vf	Forward body diode voltage Tj=25°C	—	0.75	0.8	V	If=10A
	Forward body diode voltage Tj=125°C	—	0.6	0.65		
Rin	Internal input resistor	180	250	350	Ω	Tj=-40°C..125°C

(2) Input thresholds are measured directly between the input pin and the tab. See also page 6

Switching Electrical Characteristics

Vcc=28V, Resistive load=3Ω, Tj=25°C

Symbol	Parameter	Min.	Typ.	Max.	Units	Test Conditions
tdon	Turn on delay time to 20%	25	35	50	µs	See fig. 1
tr	Rise time from 20% to 80% of Vcc	8	17	25		
tdoff	Turn off delay time	50	80	120	µs	
tf	Fall time from 80% to 20% of Vcc	5	13	35		

Protection Characteristics

Tj=-40..150°C, Vcc=8..50V (unless otherwise specified)

Symbol	Parameter	Min.	Typ.	Max.	Units	Test Conditions
Tsd	Over temperature threshold	150(3)	165	—	°C	See fig. 3 and fig. 10
Isd	Over-current shutdown	30	45	60	A	See fig. 3 and page 7
I fault	Ifb after an over-current or an over-temperature (latched)	2.4	4	6	mA	See fig. 3

Current Sensing Characteristics

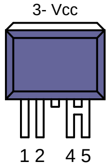
Tj=-40..150°C, Vcc=8..50V (unless otherwise specified)

Symbol	Parameter	Min.	Typ.	Max.	Units	Test Conditions
Ratio	I load / Ifb current ratio	11000	13000	14500		Iout=10A
Ratio_TC	I load / Ifb variation over temperature	-5%	0	+5	%	
I offset	Load current offset	-0.25	0	0.25	A	Iout<10A
Ifb leakage	Ifb leakage current on	0	6	15	µA	Iout=0A, Tj=25°C

(3) Guaranteed by design

Lead Assignments

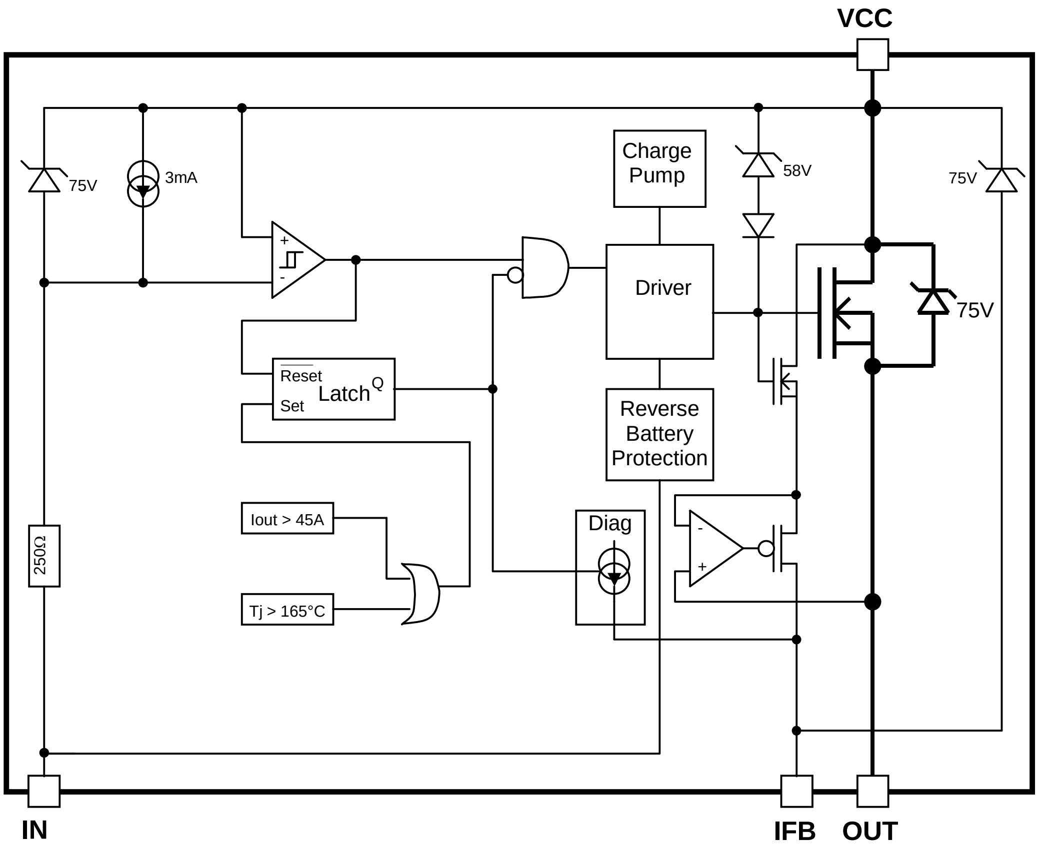
1- In
2- Ifb
3- Vcc
4- Out
5- Out



D²Pak - 5 leads

Functional Block Diagram

All values are typical



Truth Table

Op. Conditions	Input	Output	Ifb pin voltage
Normal mode	H	L	0V
Normal mode	L	H	I load x Rfb / Ratio
Open load	H	L	0V
Open load	L	H	Ifb leakage x Rifb
Short circuit to GND	H	L	0V
Short circuit to GND	L	L	I fault x Rifb (latched)
Over temperature	H	L	0V
Over temperature	L	L	I fault x Rifb (latched)

Operating voltage

Maximum Vcc voltage : this is the maximum voltage before the breakdown of the IC process.
Operating voltage : This is the Vcc range in which the functionality of the part is guaranteed. The AEC-Q100 qualification is run at the maximum operating voltage specified in the datasheet.

Reverse battery

During the reverse battery the Mosfet is turned on if the input pin is powered with a diode in parallel of the input transistor.
Power dissipation in the IPS : P = Rdson rev * I load² + Vcc² / 250 (internal input resistor).
If the power dissipation I too hight in Rifb, a diode in serial can be added to block the current.

Active clamp

The purpose of the active clamp is to limit the voltage across the MOSFET to a value below the body diode break down voltage to reduce the amount of stress on the device during switching.
The temperature increase during active clamp can be estimated as follows:

$$\Delta_{Tj} = P_{CL} \cdot Z_{TH}(t_{CLAMP})$$

Where: $Z_{TH}(t_{CLAMP})$ is the thermal impedance at t_{CLAMP} and can be read from the thermal impedance curves given in the data sheets.

$P_{CL} = V_{CL} \cdot I_{CLavg}$: Power dissipation during active clamp

$V_{CL} = 39V$: Typical V_{CLAMP} value

$I_{CLavg} = \frac{I_{CL}}{2}$: Average current during active clamp

$t_{CL} = \frac{I_{CL}}{\left|\frac{di}{dt}\right|}$: Active clamp duration

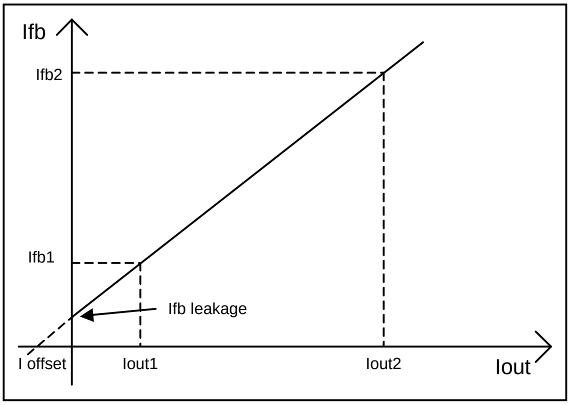
$\frac{di}{dt} = \frac{V_{Battery} - V_{CL}}{L}$: Demagnetization current

Figure 9 gives the maximum inductance versus the load current in the worst case : the part switch off after an over temperature detection. If the load inductance exceed the curve, a free wheeling diode is required.

Input level VIH/VIL

The input level are referenced to Vcc. When Vcc-Vin exceed VIH the part turns on and when Vcc-Vin goes below VIL the part turns off

Current sensing accuracy



The current sensing is specified by measuring 3 points :
- Ifb1 for Iout1
- Ifb2 for Iout2
- Ifb leakage for Iout=0

The parameters in the datasheet are computed with the following formula :
Ratio = (Iout2 – Iout1)/(Ifb2 – Ifb1)
I offset = Ifb1 x Ratio – Iout1

This allows the designer to evaluate the Ifb for any Iout value using :
Ifb = (Iout + I offset) / Ratio if Ifb > Ifb leakage

For some applications, a calibration is required. In that case, the accuracy of the system will depends on the variation of the I offset and the ratio over the temperature range. The ratio variation is given by Ratio_TC specified in page 4.
The Ioffset variation depends directly of the Rdson :
I offset@-40°C= I offset@25°C / 0.7
I offset@150°C= I offset@25°C / 1.9

Over-current protection

The threshold of the over-current protection is set in order to guaranteed that the device is able to turn on a load with an inrush current lower than the minimum of Isd. Nevertheless for high current and high temperature the device may switch off for a lower current due to the over-temperature protection (see Figure 10).

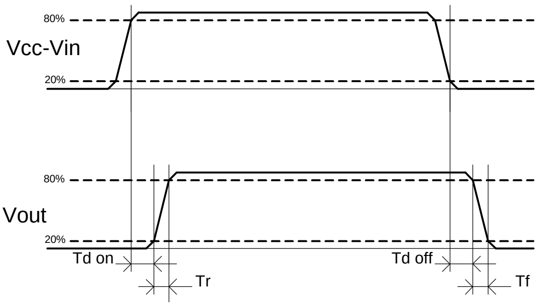


Figure 1 – IN rise time & switching definitions

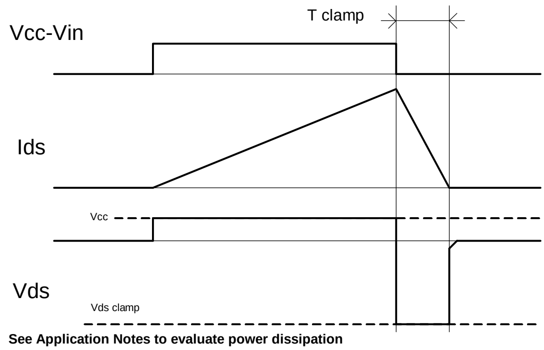


Figure 2 – Active clamp waveforms

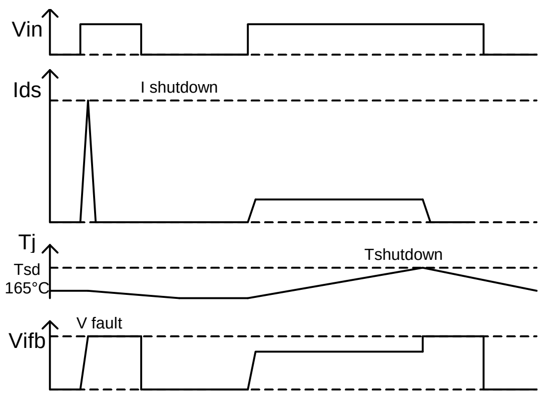


Figure 3 – Protection timing diagram

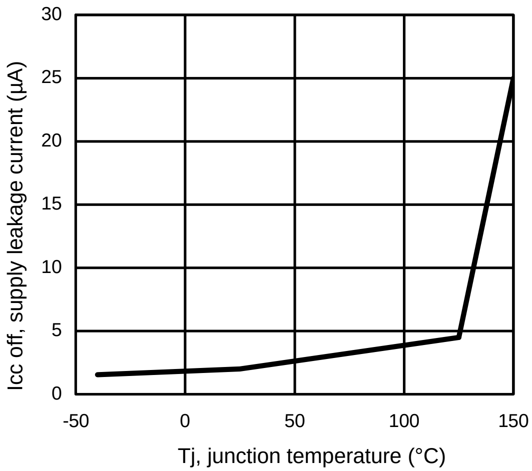


Figure 4 – Icc off (µA) Vs Tj (°C)

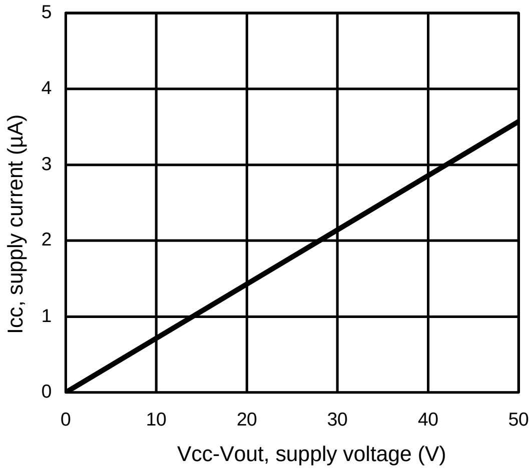


Figure 5 – Icc Off(µA) Vs Vcc-Vout (V)

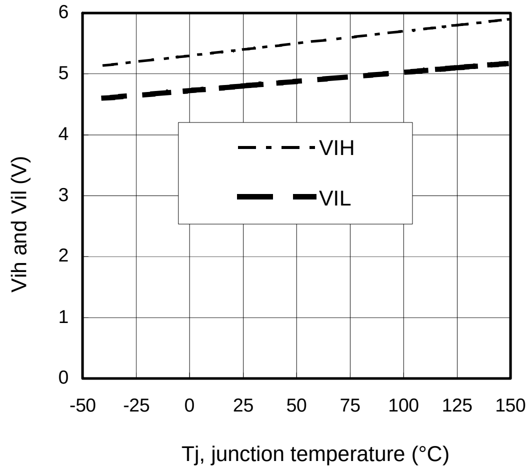


Figure 6 – Vih and Vil (V) Vs Tj (°C)

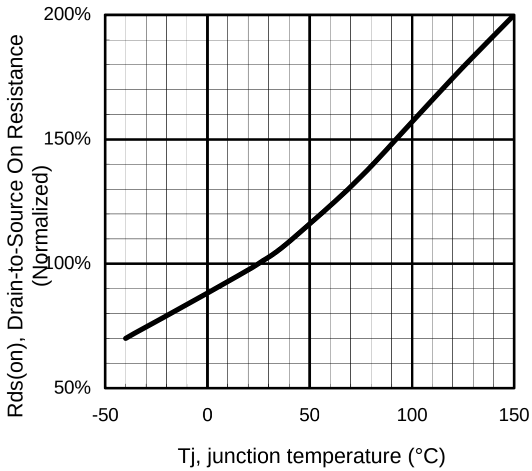


Figure 7 - Normalized Rds(on) (%) Vs Tj (°C)

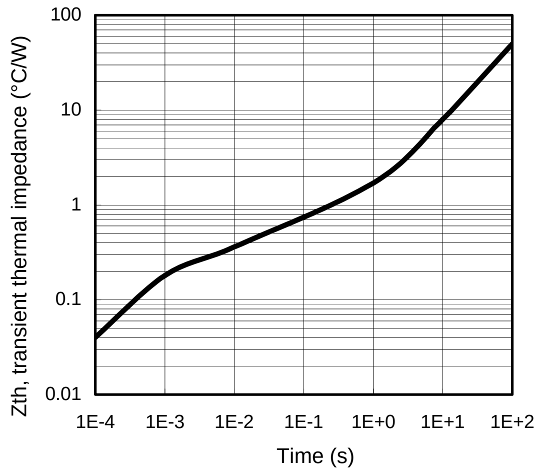


Figure 8 – Transient thermal impedance (°C/W) Vs time (s)

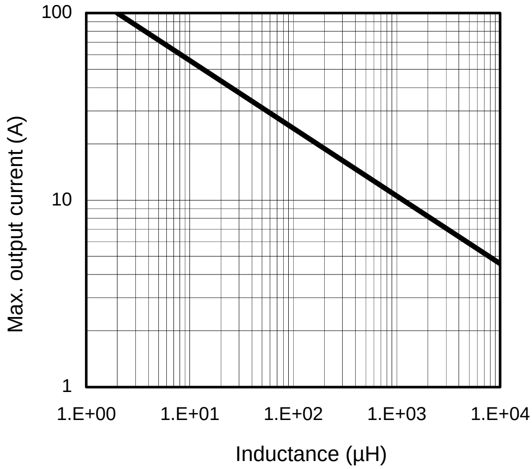


Figure 9 – Max. Iout (A) Vs inductance (µH)

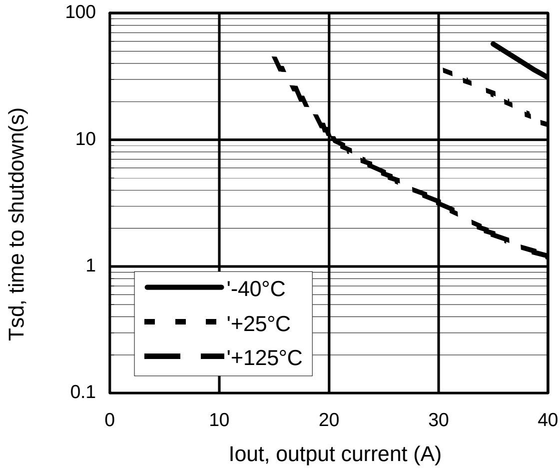
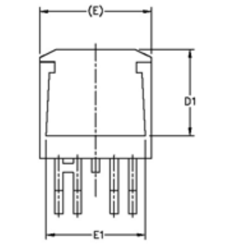
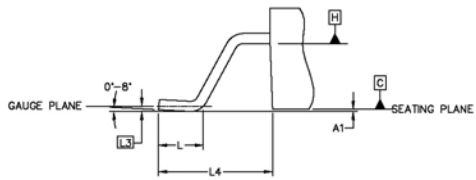


Figure 10 – Tsd (s) Vs I out (A)
SMD with 6cm²

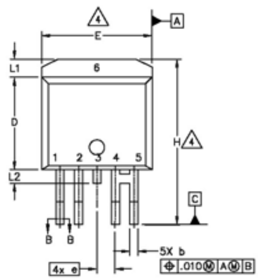
Case Outline D2PAK - 5 Leads

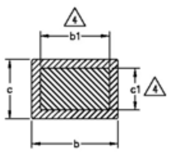


VIEW A-A



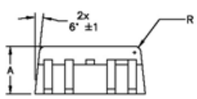
DETAIL "A"
ROTATED 90°
SCALE 8:1

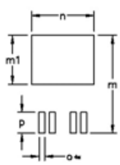




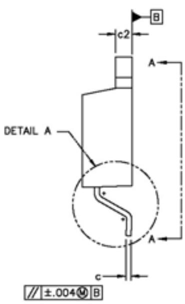
SECTION B-B
SCALE: NONE

SYMBOL	DIMENSIONS				NOTES
	MILLIMETERS		INCHES		
	MIN.	MAX.	MIN.	MAX.	
A	4.06	4.83	.160	.190	
A1		0.254		.010	
b	0.66	0.91	.026	.036	4
b1	0.66	0.81	.026	.032	
c	0.38	0.74	.015	.029	
c1	0.38	0.58	.015	.023	4
c2	1.14	1.65	.045	.065	
D	8.51	9.65	.335	.380	3
D1	6.86		.270		
E	9.65	10.67	.380	.420	3
E1	6.22		.245		
e	1.70 BSC		.067 BSC		
H	14.73	15.49	.580	.609	
L	1.14	1.39	.045	.055	
L1		1.65		.065	
L2	1.27	1.78	.050	.070	
L3	0.25 BSC		.010 BSC		
L4	4.78	5.28	.188	.208	
m	17.78		.700		
m1	8.89		.350		
n	11.43		.450		
o	1.93		.076		
p	3.81		.150		
R	0.51	0.71	.020	.028	





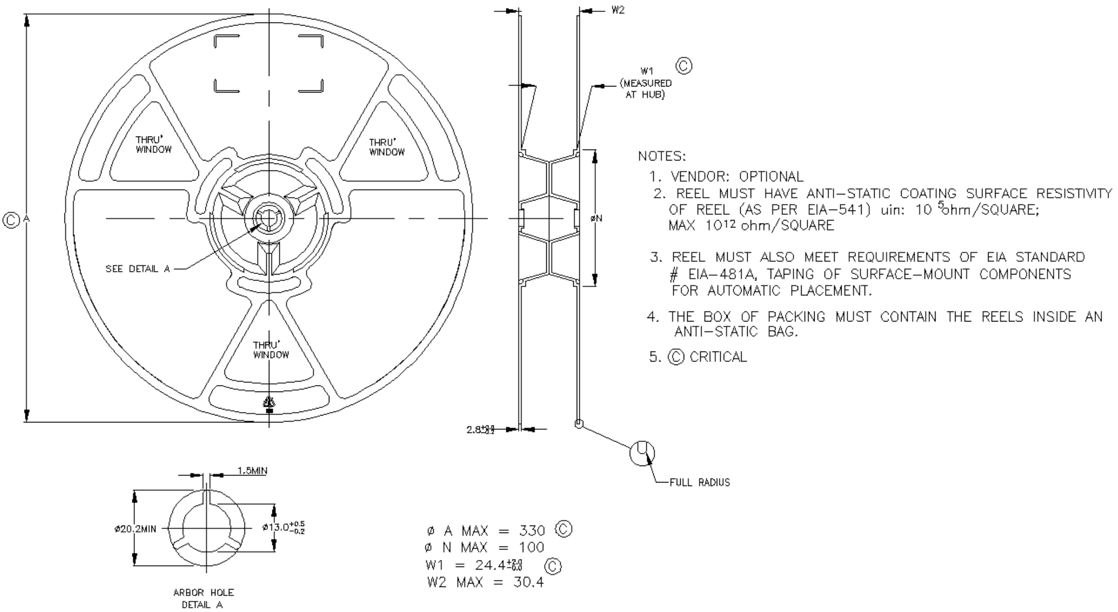
FOOT PRINT
SCALE 2:1



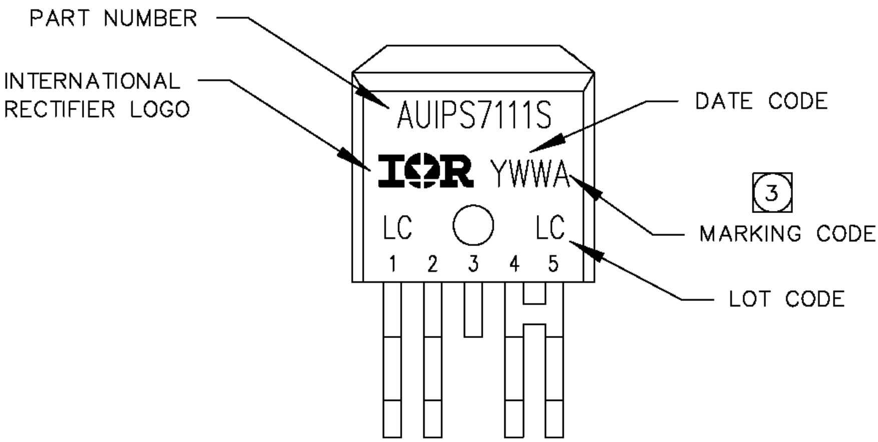
NOTES:

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: MILLIMETERS
6. LEADS AND DRAIN ARE PLTED WITH 100% Sn

Tape & Reel D2PAK - 5 Leads



Part Marking Information



Ordering Information

Base Part Number	Package Type	Standard Pack		Complete Part Number
		Form	Quantity	
AUIPS7111R	D2-Pak-5-Leads	Tube	50	AUIPS7111S
		Tape and reel left	800	AUIPS7111STRL
		Tape and reel right	800	AUIPS7111STRR

IMPORTANT NOTICE

Unless specifically designated for the automotive market, International Rectifier Corporation and its subsidiaries (IR) reserve the right to make corrections, modifications, enhancements, improvements, and other changes to its products and services at any time and to discontinue any product or services without notice. Part numbers designated with the “AU” prefix follow automotive industry and / or customer specific requirements with regards to product discontinuance and process change notification. All products are sold subject to IR’s terms and conditions of sale supplied at the time of order acknowledgment.

IR warrants performance of its hardware products to the specifications applicable at the time of sale in accordance with IR’s standard warranty. Testing and other quality control techniques are used to the extent IR deems necessary to support this warranty. Except where mandated by government requirements, testing of all parameters of each product is not necessarily performed.

IR assumes no liability for applications assistance or customer product design. Customers are responsible for their products and applications using IR components. To minimize the risks with customer products and applications, customers should provide adequate design and operating safeguards.

Reproduction of IR information in IR data books or data sheets is permissible only if reproduction is without alteration and is accompanied by all associated warranties, conditions, limitations, and notices. Reproduction of this information with alterations is an unfair and deceptive business practice. IR is not responsible or liable for such altered documentation. Information of third parties may be subject to additional restrictions.

Resale of IR products or serviced with statements different from or beyond the parameters stated by IR for that product or service voids all express and any implied warranties for the associated IR product or service and is an unfair and deceptive business practice. IR is not responsible or liable for any such statements.

IR products are not designed, intended, or authorized for use as components in systems intended for surgical implant into the body, or in other applications intended to support or sustain life, or in any other application in which the failure of the IR product could create a situation where personal injury or death may occur. Should Buyer purchase or use IR products for any such unintended or unauthorized application, Buyer shall indemnify and hold International Rectifier and its officers, employees, subsidiaries, affiliates, and distributors harmless against all claims, costs, damages, and expenses, and reasonable attorney fees arising out of, directly or indirectly, any claim of personal injury or death associated with such unintended or unauthorized use, even if such claim alleges that IR was negligent regarding the design or manufacture of the product.

IR products are neither designed nor intended for use in military/aerospace applications or environments unless the IR products are specifically designated by IR as military-grade or “enhanced plastic.” Only products designated by IR as military-grade meet military specifications. Buyers acknowledge and agree that any such use of IR products which IR has not designated as military-grade is solely at the Buyer’s risk, and that they are solely responsible for compliance with all legal and regulatory requirements in connection with such use.

IR products are neither designed nor intended for use in automotive applications or environments unless the specific IR products are designated by IR as compliant with ISO/TS 16949 requirements and bear a part number including the designation “AU”. Buyers acknowledge and agree that, if they use any non-designated products in automotive applications, IR will not be responsible for any failure to meet such requirements.

For technical support, please contact IR’s Technical Assistance Center
http://www.irf.com/technical-info/

WORLD HEADQUARTERS:
233 Kansas St., El Segundo, California 90245
Tel: (310) 252-7105