

**LOW EMI PWM INTELLIGENT POWER HIGH SIDE SWITCH**

**Features**

- Integrated bootstrap for 100kHz switching
- Optimized EMI switching
- Charge pump for DC operation
- Over temperature shutdown
- Over current shutdown
- 3.3V logic level
- Ground loss protection
- ESD protection

**Applications**

- 24V loads
- Injectors
- Valves
- DC motors

**Description**

The Device is a five terminal Intelligent Power Switch (IPS) for use in a high side configuration. It features short circuit, over-temperature, ESD protection, inductive load capability and diagnostic feedback. An integrated bootstrap diode allows fast switching.

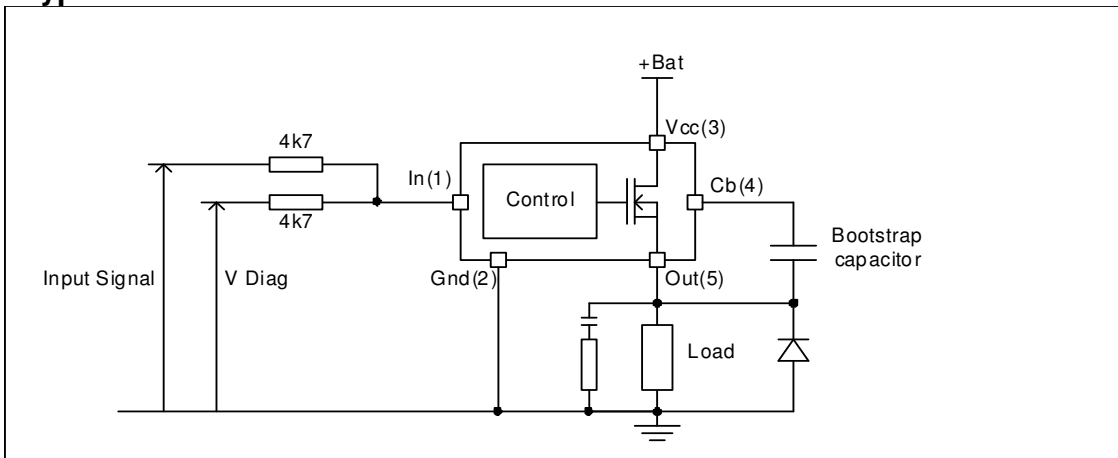
**Product Summary**

Rds(on)	35mΩ max.
Vbr	75V min.
I shutdown	20A min.

**Package**



**Typical Connection**



**Qualification Information†**

<b>Qualification Level</b>		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.
<b>Moisture Sensitivity Level</b>		<p style="text-align: center;">DPAK-5L</p> <p style="text-align: right;">MSL1, 260°C (per IPC/JEDEC J-STD-020)</p>
<b>ESD</b>	Machine Model	Class M2 (150V) (per AEC-Q100-003)
	Human Body Model	Class H1A (500V) (per AEC-Q100-002)
	Charged Device Model	Class C4 (1000V) (per AEC-Q100-011)
<b>IC Latch-Up Test</b>		Class II, Level A (per AEC-Q100-004)
<b>RoHS Compliant</b>		Yes

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

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

### Absolute Maximum Ratings

Absolute maximum ratings indicate sustained limits beyond which damage to the device may occur. (T<sub>J</sub>= -40°C..150°C, V<sub>CC</sub>=6..60V unless otherwise specified).

Symbol	Parameter	Min.	Max.	Units
V <sub>out</sub>	Maximum output voltage	Gnd-3	V <sub>CC</sub> +0.3	V
V <sub>in</sub>	Maximum input voltage	-0.3	5.5	
V <sub>CC</sub> max.	Maximum V <sub>CC</sub> voltage	—	65	mA
I <sub>in</sub> max.	Maximum input current	-3	10	
P <sub>d</sub>	Maximum power dissipation (internally limited by thermal protection) R <sub>th</sub> =50 °C/W 1"sq. footprint	—	2.5	W
T <sub>J</sub> max.	Max. storage & operating temperature junction temperature	-40	150	°C

### Thermal Characteristics

Symbol	Parameter	Typ.	Max.	Units
R <sub>th1</sub>	Thermal resistance junction to ambient	50	—	°C/W
R <sub>th2</sub>	Thermal resistance junction to case	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
V <sub>IH</sub>	High level input voltage	2.7	5.5	V
V <sub>IL</sub>	Low level input voltage	0	0.9	
R <sub>in</sub>	Recommended resistor in series with IN pin	2(1)	10(2)	kΩ
R <sub>dg</sub>	Recommended resistor in series with dg pin	2(1)	10(2)	
F max.	Max. switching frequency	—	100	kHz
C <sub>boot</sub>	Bootstrap capacitor	30	50	nF

(1) Limited by the maximum input current

(2) Limited by the input capacitor

### Static Electrical Characteristics

T<sub>j</sub>=-40..150°C, V<sub>cc</sub>=6..60V (unless otherwise specified)

Symbol	Parameter	Min.	Typ.	Max.	Units	Test Conditions
R <sub>ds(on)</sub>	ON state resistance T <sub>j</sub> =25°C	—	30	35	mΩ	V <sub>in</sub> =5V, I <sub>out</sub> =5A
	ON state resistance T <sub>j</sub> =150°C	—	50	70		V <sub>in</sub> =5V, I <sub>out</sub> =5A
V <sub>cc op.</sub>	Operating voltage range with short circuit protection	6	—	60	V	
I <sub>cc Off</sub>	Supply current when Sleep mode	—	0.2	5	μA	During sleep mode V <sub>in</sub> =0V, V <sub>out</sub> =0V T <sub>j</sub> =25°C, V <sub>cc</sub> =28V
I <sub>out Off</sub>	Output leakage current	—	0.2	5		
I <sub>cc On</sub>	Supply current when On	—	4	10	mA	V <sub>in</sub> =5V T <sub>j</sub> =25°C, V <sub>cc</sub> =28V
I <sub>out On</sub>	Output current when Off	—	10	—	mA	V <sub>in</sub> =0V T <sub>j</sub> =25°C, V <sub>cc</sub> =28V
V <sub>ih</sub>	Input high threshold voltage	—	1.9	2.2	V	
V <sub>il</sub>	Input low threshold voltage	1	1.6	—		
I <sub>n hyst.</sub>	Input hysteresis	0.1	0.3	0.5		
I <sub>in, on</sub>	Input current when the part is on	—	15	30	μA	V <sub>in</sub> =5V
V <sub>in, off</sub>	Input voltage when the part is in fault mode	—	0.1	0.4	V	I <sub>in</sub> =5mA

### Switching Electrical Characteristics

V<sub>cc</sub>=28V, Resistive load=2Ω, V<sub>in</sub>=5V, T<sub>j</sub>=25°C

Symbol	Parameter	Min.	Typ.	Max.	Units	Test Conditions
T <sub>don</sub>	Turn-on delay time to 20%	—	1	—	μs	
T <sub>r</sub>	Rise time from 20% to 80% of V <sub>cc</sub>	—	0.8	—		
T <sub>doff</sub>	Turn-off delay time to 80%	—	2.2	—		
T <sub>f</sub>	Fall time from 80% to 20% of V <sub>cc</sub>	—	0.4	—		

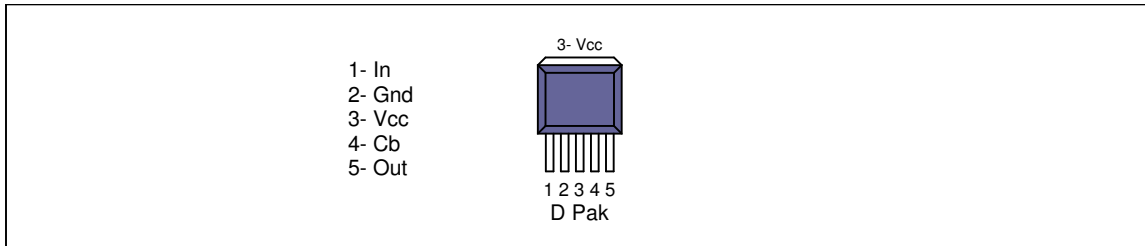
### Protection Characteristics

T<sub>j</sub>=-40..150°C, V<sub>cc</sub>=6..60V (unless otherwise specified)

Symbol	Parameter	Min.	Typ.	Max.	Units	Test Conditions
I <sub>sd on</sub>	Over current shutdown	20	30	40	A	V <sub>out</sub> =0V
T <sub>sd</sub>	Over temperature threshold	150(3)	165	—	°C	
UV H	Under voltage during turn on	—	5	6.2	V	
UV L	Under voltage during turn off	—	4	5		
T <sub>diag</sub>	Diagnostic time	—	10	—	ms	see figure 1
T <sub>sleep</sub>	Time to enter in sleep mode	7	15	30		see figure 2
T <sub>reset</sub>	Time to enter in sleep mode and reset the fault	—	5	—		see figure 1
T <sub>wkp</sub>	Time to leave the sleep mode	—	0.05	0.5	μs	R <sub>in</sub> =4k7
T <sub>pw on rst</sub>	Power on reset duration	4	8	12		see figure 2 & 3

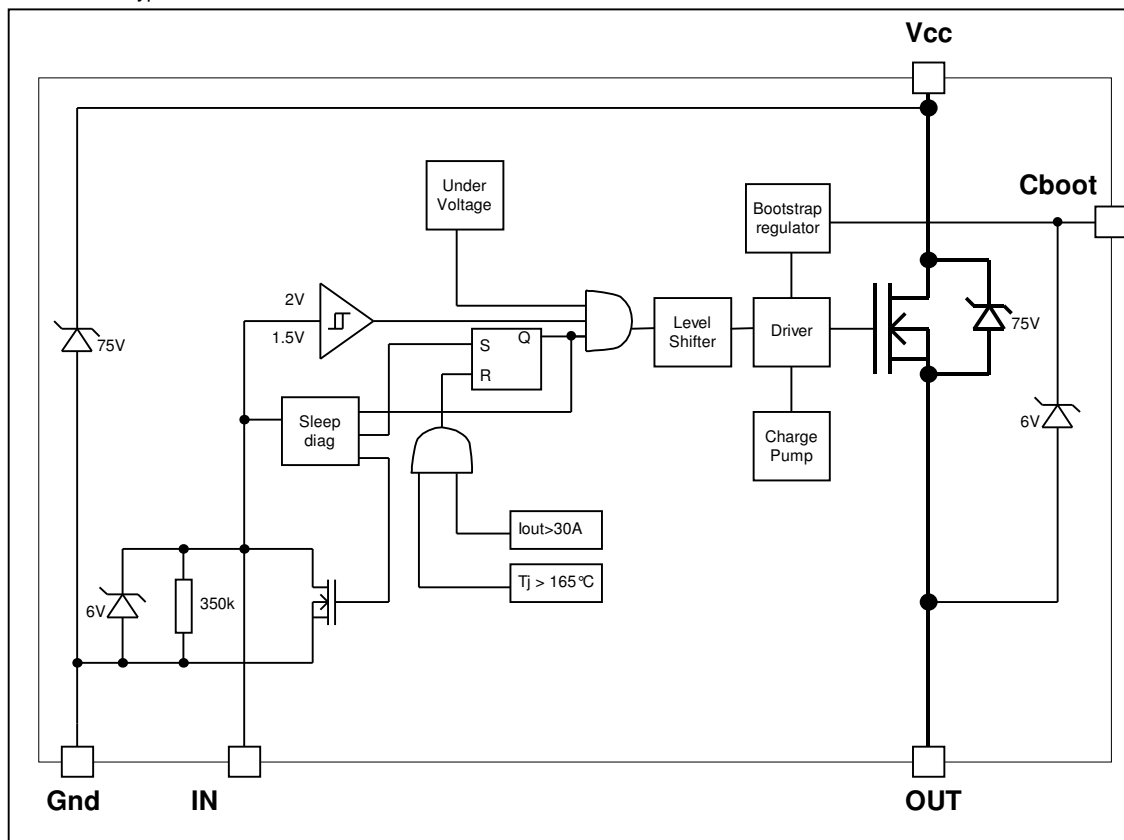
(3) Guaranteed by design

## Lead Assignments



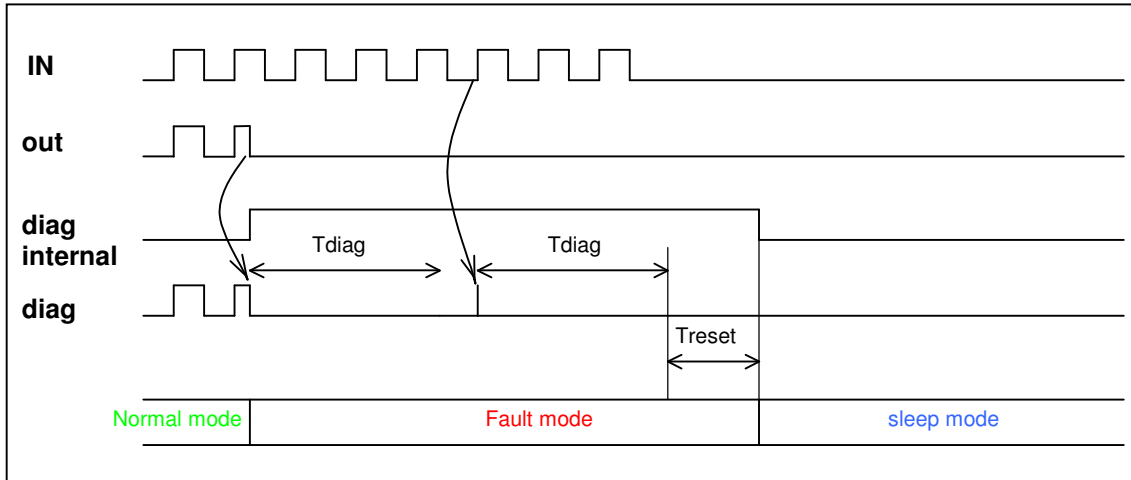
## Functional Block Diagram

All values are typical



**Sleep\_mode / Diagnostic**

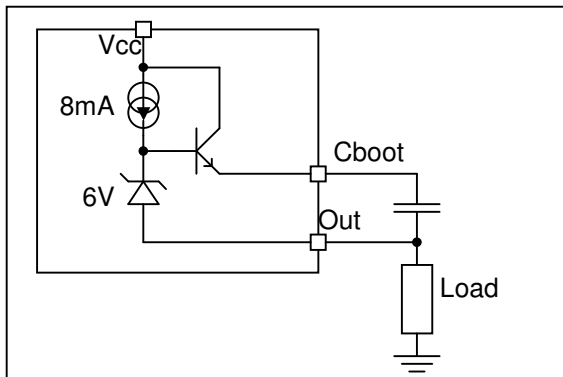
Sleep\_mode block manages the diagnostic and the sleep\_mode. The device enters in sleep mode if input is inactive during a delay higher than Tsleep.



**Figure 1**

**Bootstrap**

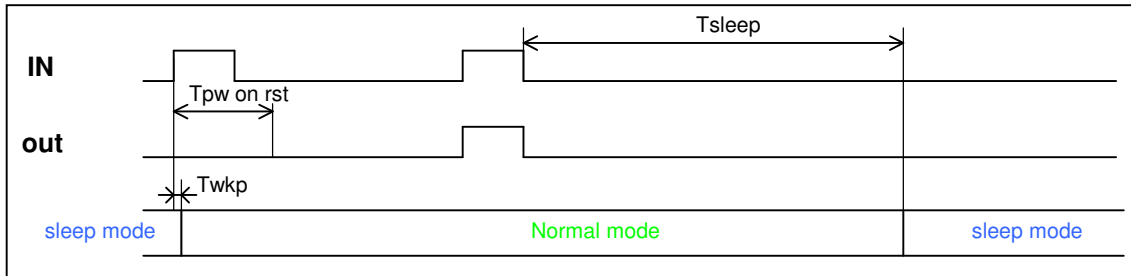
The AUIPS7221 integrates a bootstrap regulator to maintain a fixed voltage on the bootstrap capacitor for any battery voltage. The regulator is off during the sleep mode to reduce the current consumption.



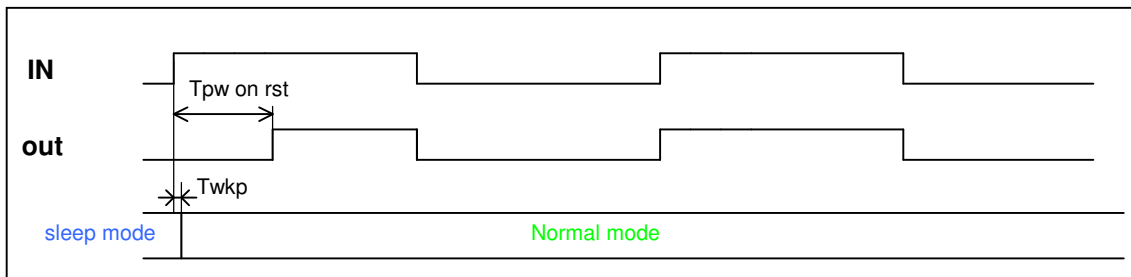
The 8mA current source flows permanently on the output when the output is off and the part is not in sleep mode. In case of an open load condition, the output voltage will be at Vcc-6V.

**Wake up sequence**

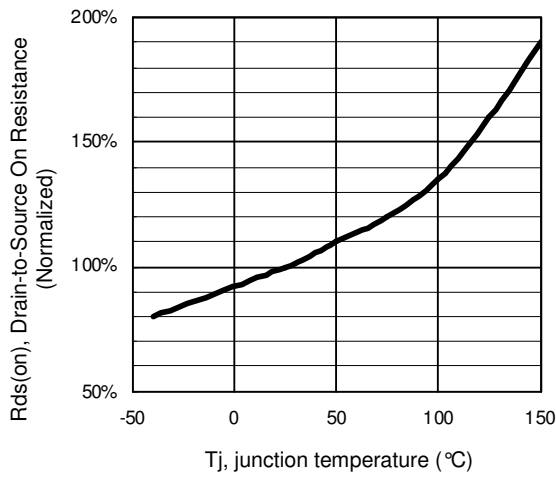
To wake up the part from the sleep mode, the input must be activated at least during  $T_{wkp}$ , then the bootstrap regulator is switched on and the bootstrap capacitor is charged. The output will be not activated during  $T_{pw\ on\ rst}$ .



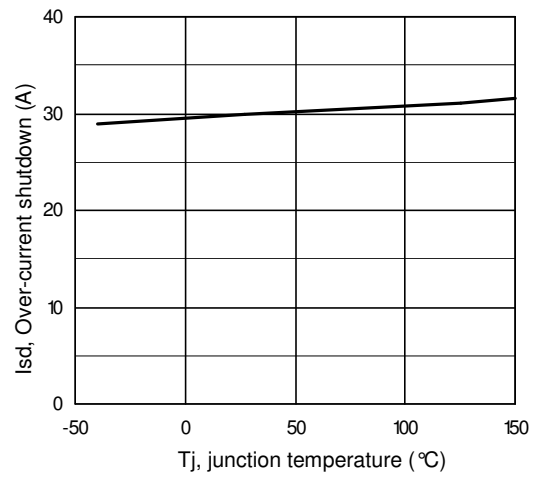
**Figure 2**



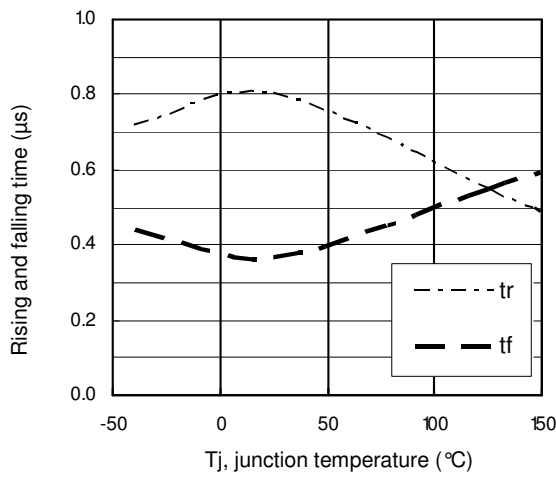
**Figure 3**



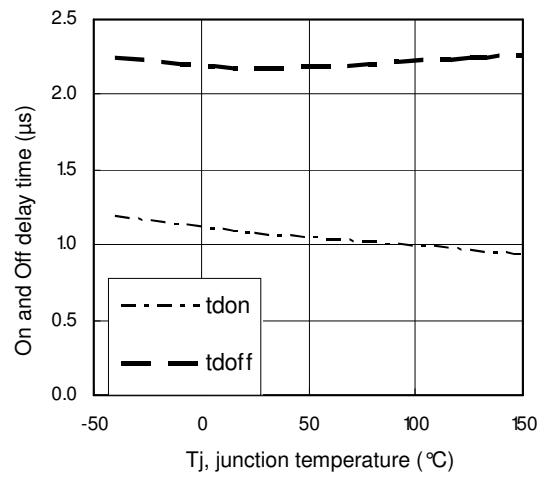
**Figure 5 - Normalized Rds(on) (%) Vs Tj (°C)**



**Figure 6 – Isd (A) Vs Tj (°C)**

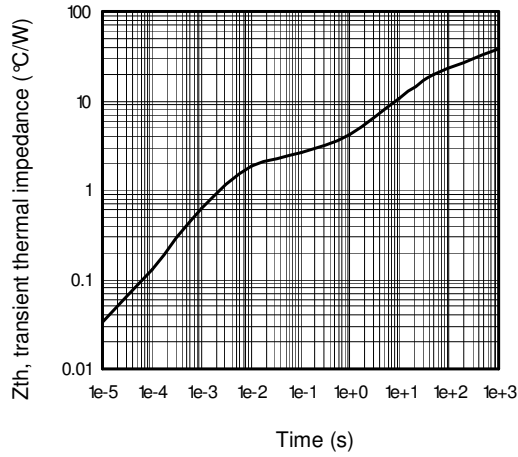


**Figure 7 – tr / tf (µs) Vs Tj (°C)**

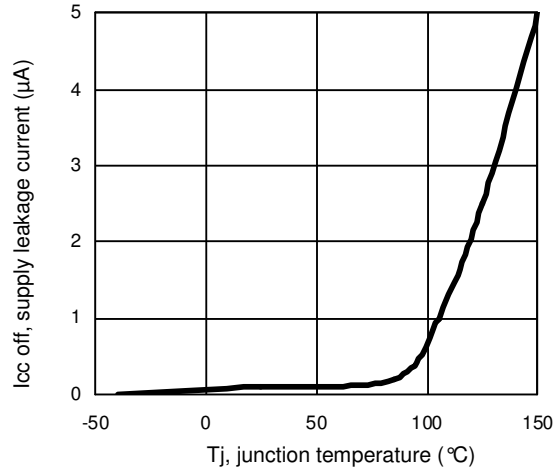


**Figure 8 – tdon / tdoff (µs) Vs Tj (°C)**

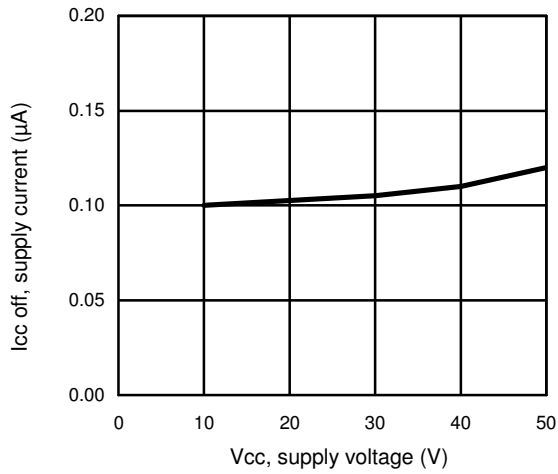




**Figure 9 – Transient thermal impedance (°C/W) Vs time (s)**

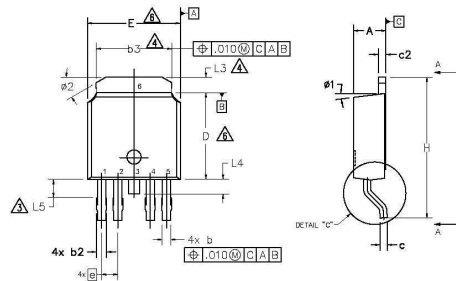
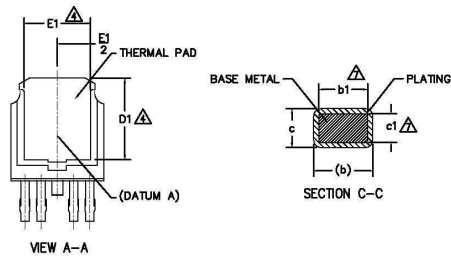
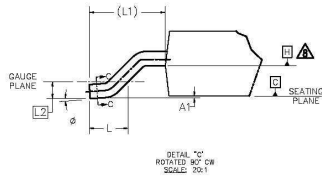


**Figure 10 – Icc off (µA) Vs Tj (°C)**



**Figure 11 – Icc off(A) Vs Vcc (V)**

**Case Outline 5 Lead – DPAK**

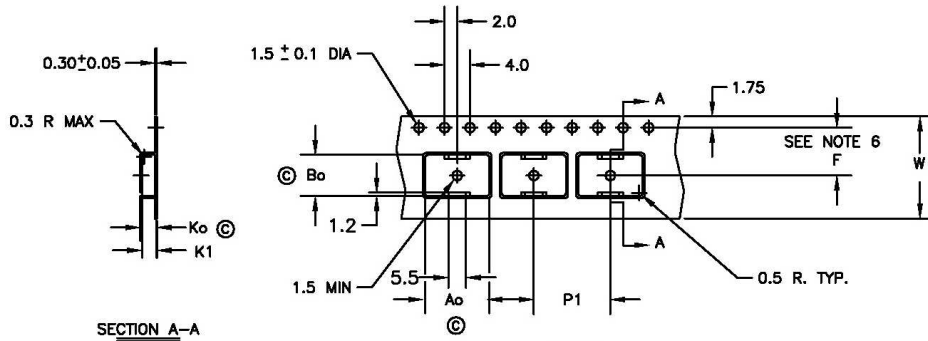


SYMBOL	DIMENSIONS				NOTES
	MILLIMETERS		INCHES		
	MIN.	MAX.	MIN.	MAX.	
A	2.18	2.39	.086	.094	2
A1	—	0.13	—	.005	
b	0.56	0.79	.022	.031	2
b1	.056	0.74	.022	.029	
b2	0.65	0.89	.026	.035	2
b3	4.95	5.46	.195	.215	
c	0.46	0.61	.018	.024	2
c1	0.41	0.56	.016	.022	
c2	0.46	0.89	.018	.035	3
D	5.97	6.22	.235	.245	
D1	5.21	—	.205	—	3
E	6.35	6.73	.250	.265	
E1	4.32	—	.170	—	3
e	1.14 BSC		.045 BSC		
H	9.40	10.41	.370	.410	3
L	1.40	1.78	.055	.070	
L1	2.74 BSC		.108 REF.		3
L2	0.51 BSC		.020 BSC		
L3	0.89	1.27	.035	.050	3
L4	—	1.02	—	.040	
L5	1.14	1.52	.045	.060	3
∅	0"	10"	0"	10"	
∅1	0"	15"	0"	15"	3
∅2	28"	32"	28"	32"	

**NOTES:**

- 1.— DIMENSIONING AND TOLERANCING AS PER ASME Y14.5M-1994
- 2.— DIMENSION ARE SHOWN IN INCHES [MILLIMETERS].
- 3.— LEAD DIMENSION UNCONTROLLED IN L5.
- 4.— DIMENSION D1, E1, L3 & b3 ESTABLISH A MINIMUM MOUNTING SURFACE FOR THERMAL PAD.
- 5.— SECTION C-C DIMENSIONS APPLY TO THE FLAT SECTION OF THE LEAD BETWEEN .005 AND 0.10 [0.13 AND 0.25] FROM THE LEAD TIP.
- 6.— DIMENSION D & E DO NOT INCLUDE MOLD FLASH. MOLD FLASH SHALL NOT EXCEED .005 [0.13] PER SIDE. THESE DIMENSIONS ARE MEASURED AT THE OUTMOST EXTREMES OF THE PLASTIC BODY.
- 7.— DIMENSION b1 & c1 APPLIED TO BASE METAL ONLY.
- 8.— DATUM A & B TO BE DETERMINED AT DATUM PLANE H.
- 9.— OUTLINE CONFORMS TO JEDEC OUTLINE TO-252.
10. LEADS AND DRAIN ARE PLATED WITH 100% Sn

**Tape & Reel 5 Lead – DPAK**



SECTION A-A

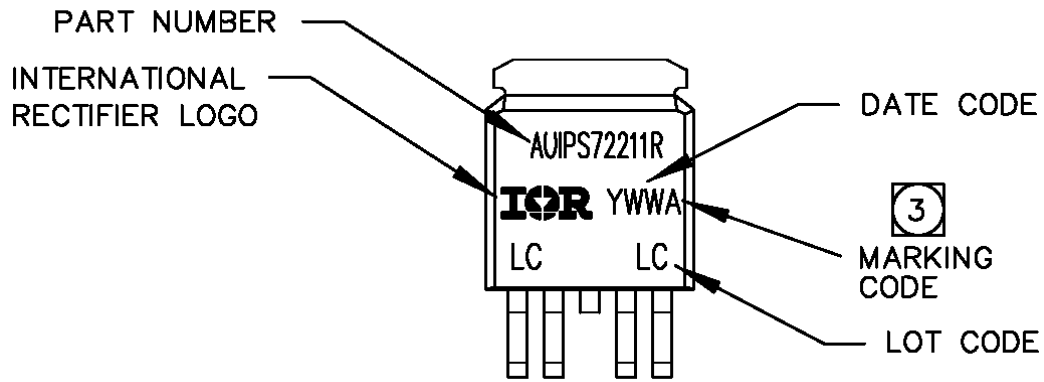


$A_o = 10.5 \text{ mm}$   
 $B_o = 7.0 \text{ mm}$   
 $K_o = 2.8 \text{ mm}$   
 $K_1 = 2.4 \text{ mm}$   
 $F = 7.5 \text{ mm}$   
 $P_1 = 12.0 \text{ mm}$   
 $W = 16.0 \pm .3 \text{ mm}$

NOTES:

1. 10 SPROCKET HOLE PUNCH CUMULATIVE TOLERANCE  $\pm .02$
2. CAMBER NOT TO EXCEED 1mm IN 100mm
3. MATERIAL: CONDUCTIVE BLACK POLYSTYRENE
4.  $A_o$  AND  $B_o$  MEASURED ON A PLANE 0.3mm ABOVE THE BOTTOM OF THE POCKET
5.  $K_o$  MEASURED FROM A PLANE ON THE INSIDE BOTTOM OF THE POCKET TO THE TOP SURFACE OF THE CARRIER
6. POCKET POSITION RELATIVE TO THE SPROCKET HOLE MEASURED AS TRUE POSITION OF POCKET, NOT POCKET HOLE
7. VENDOR: (OPTIONAL)
8. MUST ALSO MEET REQUIREMENTS OF EIA STANDARD #EIA-481A, TAPING OF SURFACE-MOUNT COMPONENTS FOR AUTOMATIC PLACEMENT.
9. TOLERANCE TO BE MANUFACTURER STANDARD
10. SURFACE RESISTIVITY OF MOLDED MATL: MUST MEASURE LESS THAN OR EQUAL TO  $10^8$  OHMS PER SQUARE. MEASURED IN ACCORDANCE TO PROCEDURE GIVEN IN ASTM D-257 & ASTM D-991 (REF. C-9000 SPEC.)
11. TOTAL LENGTH PER REEL MUST BE 79 METERS
12. © CRITICAL DIMENSION

## Part Marking Information



## Ordering Information

Base Part Number	Package Type	Standard Pack		Complete Part Number
		Form	Quantity	
AUIPS72211R	D-Pak-5-Lead	Tube	75	AUIPS72211R
		Tape and reel	2000	AUIPS72211RTR
		Tape and reel left	3000	AUIPS72211RTRL
		Tape and reel right	3000	AUIPS72211RTRR

**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.

Only products certified as military grade by the Defense Logistics Agency (DLA) of the US Department of Defense, are designed and manufactured to meet DLA military specifications required by certain military, aerospace or other applications. Buyers acknowledge and agree that any use of IR products not certified by DLA as military-grade, in applications requiring military grade products, is solely at the Buyer's own 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:**  
101 N. Sepulveda Blvd., El Segundo, California 90245  
Tel: (310) 252-7105