International
IOR Rectifier

Automotive grade

AUIPS6121R

CURRENT SENSE HIGH SIDE SWITCH

Features

- Suitable for 12V systems
- Over current shutdown
- Over temperature shutdown
- Current sensing
- Active clamp
- Low current
- Reverse battery
- ESD protection
- Optimized Turn On/Off for EMI

Product Summary

Rds(on)	5.8mΩ max.
Vclamp	39V typ.
Current shutdown	65A min.

Applications

- Glow plug
- PTC

Package

DPak – 5Leads

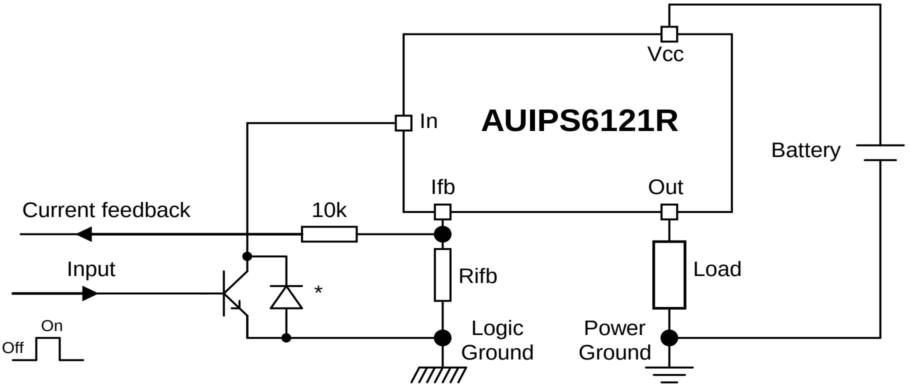
Description

The AUIPS6121R 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. Shutdown type of protection provides a good reliability under short circuit condition. The Ifb pin provides both an analog feedback during normal operation and a digital flag when the part is in protection mode.

Ordering Information

Base Part Number	Package Type	Standard Pack		Complete Part Number
		Form	Quantity	
AUIPS6121R	D-Pak-5-Leads	Tube	75	AUIPS6121R
		Tape and reel left	3000	AUIPS6121RTRL

Typical Connection



* The diode on the bipolaire NPN is necessary for reverse battery protection.

Absolute Maximum Ratings

Absolute maximum ratings indicate sustained limits beyond which damage to the device may occur. (Tambient=25°C unless otherwise specified).

Symbol	Parameter	Min.	Max.	Units
Vout	Maximum output voltage	Vcc-39	Vcc+0.3	V
Vcc-Vin max.	Maximum Vcc voltage	-18	39	
Iifb, max.	Maximum feedback current	-50	10	mA
Vcc sc	Maximum Vcc voltage with short circuit protection see page 7	—	22	V
Pd	Maximum power dissipation (internally limited by thermal protection)			W
	Rth=50°C/W Dpack 6cm² footprint	—	2.5	
Tj max.	Max. operating junction temperature	-40	150	°C
	Max. storage junction temperature	-55	150	

Thermal Characteristics

Symbol	Parameter	Typ.	Max.	Units
Rth1	Thermal resistance junction to ambient Dpak Std footprint	70	—	°C/W
Rth2	Thermal resistance junction to ambient Dpak 6cm² footprint	50	—	
Rth3	Thermal resistance junction to case Dpak	1.2	—	

Recommended Operating Conditions

These values are given for a quick design.

Symbol	Parameter	Min.	Max.	Units
Iout	Continuous output current, Tambient=85°C, Tj=150°C Rth=50°C/W, Dpak 6cm² footprint	—	12	A
F	Maximum frequency	—	50	Hz

Static Electrical Characteristics

Tj=-40°C..150°C, Vcc=6..18V (unless otherwise specified)

Symbol	Parameter	Min.	Typ.	Max.	Units	Test Conditions
Vcc op.	Operating voltage range	5.8	—	35	V	
Rds(on)	ON state resistance Tj=25°C	—	4.8	5.8	mΩ	Ids=10A
	ON state resistance Tj=150°C (2)	—	7.5	9		
Icc off	Supply leakage current	—	1	3	µA	Vin=Vcc=14V,Vifb=Vgnd Vout=Vgnd, Tj=25°C
Iout off	Output leakage current	—	1	3		
Iin on	Input current when device on	1	2.7	6	mA	Vcc-Vin=14V
V clamp	Vcc to Vout clamp voltage	37	39	44	V	Id=20mA
Vih(1)	High level Input threshold voltage	4.5	5.4	6.2		
Vil(1)	Low level Input threshold voltage	4	5	5.8		
Rds(on) rev	Reverse On state resistance Tj=25°C	—	6	8	mΩ	Isd=10A, Vin-Vcc>8V
Vf	Forward body diode voltage Tj=25°C	—	0.8	0.9	V	If=10A
	Forward body diode voltage Tj=125°C	—	0.6	0.8		
Rin	Input resistor	115	200	300	Ω	Built-in resistor

(1) Input thresholds are measured directly between the input pin and the tab.
(2) Guaranteed by design

Switching Electrical Characteristics

Vcc=14V, Resistive load=1Ω, Tj=25°C

Symbol	Parameter	Min.	Typ.	Max.	Units	Test Conditions
Tdon	Turn on delay time	20	50	150	µs	See fig. 1
Tr	Rise time from 20% to 80% of Vcc	15	35	100		
Tdoff	Turn off delay time	20	100	250		
Tf	Fall time from 80% to 20% of Vcc	15	35	100		

Protection Characteristics

Tj=-40°C..150°C, Vcc=6..18V (unless otherwise specified)

Symbol	Parameter	Min.	Typ.	Max.	Units	Test Conditions
Tsd	Over temperature threshold(2)	150	165	—	°C	See fig. 3
Isd	Over-current shutdown	65	90	120	A	
I fault	Ifb after an over-current or an over-temperature (latched)	15	20	27	mA	
OV	Over-voltage protection	18	20	22	V	Vcc-Vin
Psd rst	Time to reset Psd	12	26	60	ms	
Psd_UV	Time to shutdown when Vcc-Out=UV (3)	0.3	0.7	2		

(3) See explanation page 8

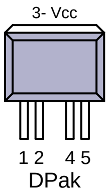
Current Sensing Characteristics

Tj=-40°C..150°C, Vcc=6..18V (unless otherwise specified), Vcc-Vifb>3.5V

Symbol	Parameter	Min.	Typ.	Max.	Units	Test Conditions
Ratio	I load / Ifb current ratio	5000	6300	7600		Iload=60A at Vcc=14V, Iload=30A at Vcc=6V, after 1.5ms,See page 7
Ratio_Cold	Ratio drift between 25°C to -40°C	-6.6	-2.2	2.1	%	Ratio@-40°/Ratio@25°
Ratio_Hot	Ratio drift between 25°C to 125°C	-1.6	3	7.7		Ratio@125°/Ratio@25°
I offset	Load current offset	-0.15	0	0.15	A	After 1.5ms
Ifb leakage	Ifb leakage current	0	0.5	25	µA	Iout=0A, Vcc-Vin=14V

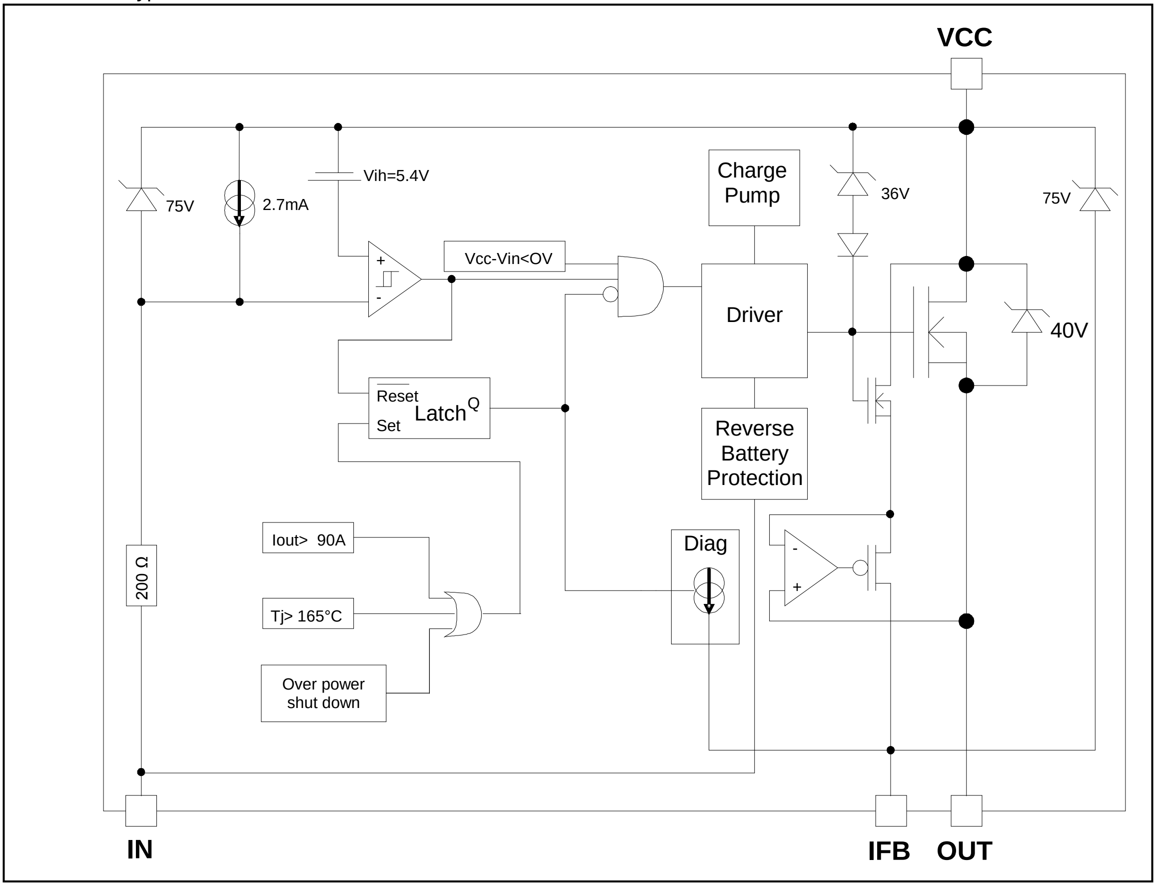
Lead Assignments

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



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 / 200ohm (internal input resistor).
If the power dissipation is too high 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

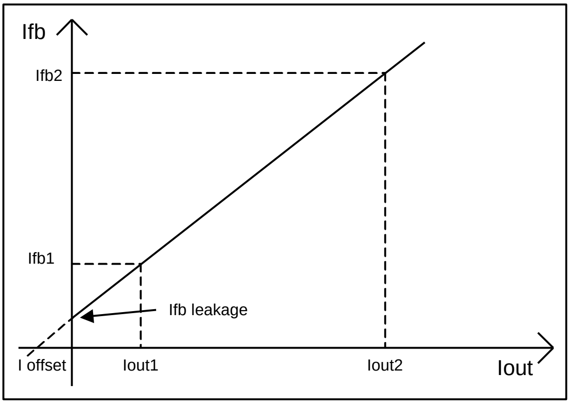
$\frac{di}{dt} = \frac{V_{Battery} - V_{CL}}{L}$: Demagnetization current

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

Over-current protection

The threshold of the over-current protection is set in order to guarantee 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.

Current sensing accuracy



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

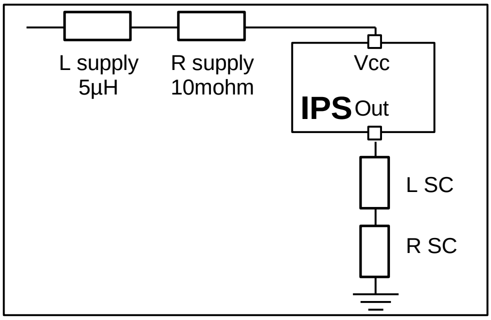
The parameters in the datasheet are computed with the following formula :
Ratio = (Iout2 – Iout1)/(Ifb2 – Ifb1)
I offset = Ifb1 x Ratio – Iout1

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_Hot and Ratio_Cold specified in page 4.
The Ioffset variation depends directly on the Rdson:
I offset@-40°C= I offset@25°C / 0.8
I offset@150°C= I offset@25°C / 1.9

Maximum Vcc voltage with short circuit protection

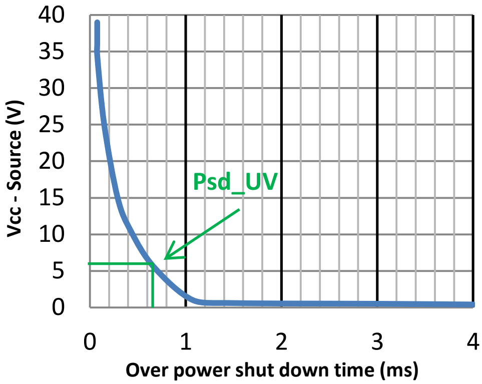
The maximum Vcc voltage with short circuit is the maximum voltage for which the part is able to protect itself under test conditions representative of the application. 2 kind of short circuits are considered: terminal and load short circuit.

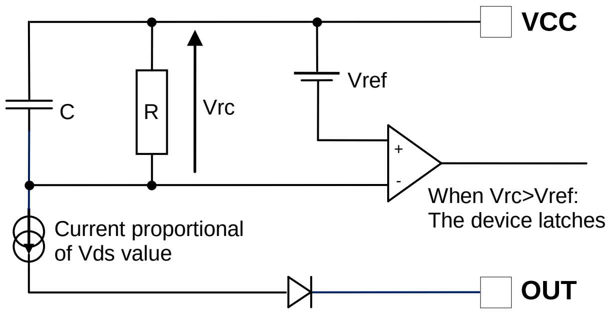


	L SC	R SC
TerminalSC	0.1 µH	10 mohm
LoadSC	L supply + L SC = 5 µH	100 mohm

Over power shut down protection

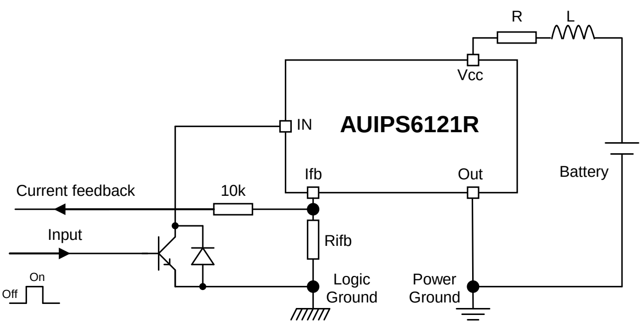
The AUIPS6121R integrates an over-power protection in order to limit the thermal stress in the mosfet during certain conditions like overload or under voltage. The power is measured by monitoring the voltage between Vcc and Source. The device latches more quickly when the power is higher.

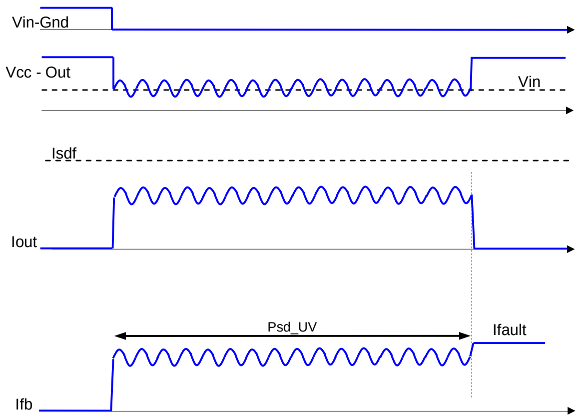




When the device is latched: VRC is discharge with an internal constant (Psd rst).

Typical in low voltage condition with a short circuit on the output, the voltage on the Vcc pin will oscillate around the under voltage protection and the 'over-current shut down' will not be triggered.
The 'Over power shut down' protection will turn off the part after the time 'Psd_UV' for preventing thermal stress of the device.





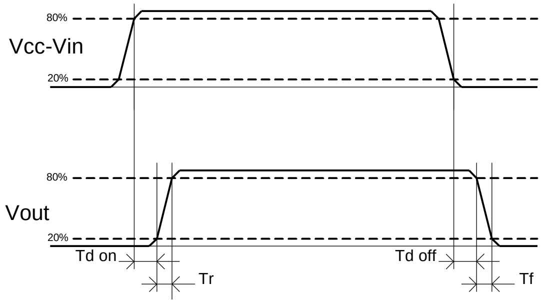
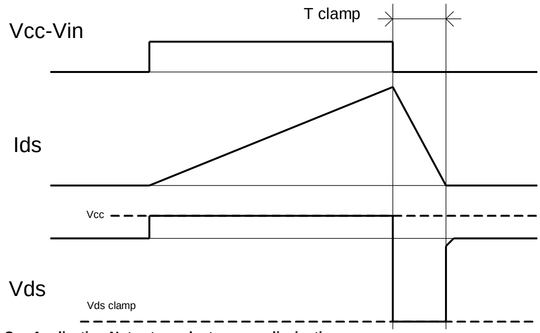


Figure 1 – IN rise time & switching definitions



See Application Notes to evaluate power dissipation

Figure 2 – Active clamp waveforms

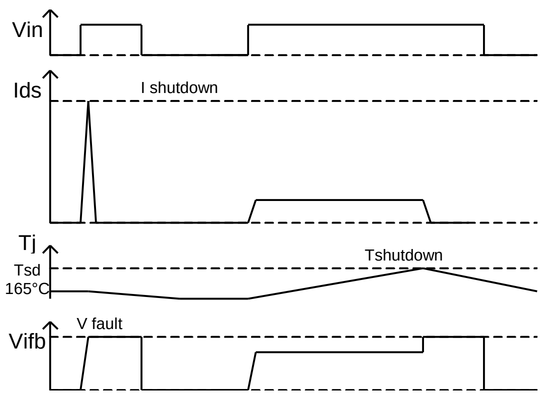


Figure 3 – Protection timing diagram

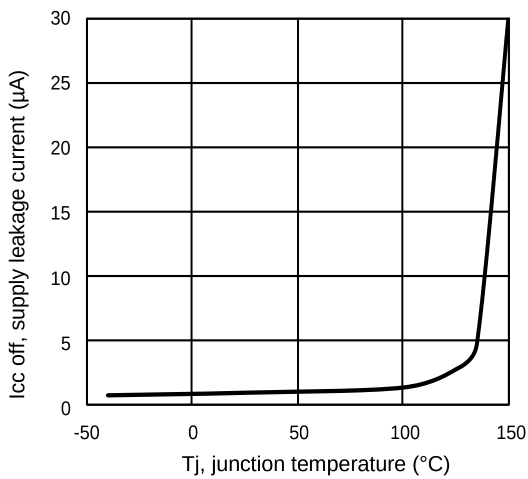


Figure 4 – Icc off (µA) VsTj (°C)

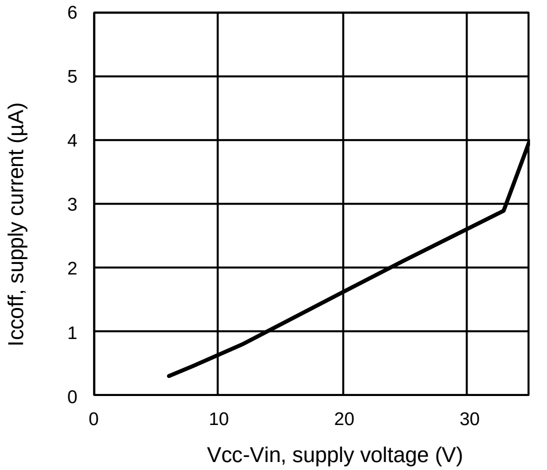


Figure 5 – Icc off (µA) VsVcc-Vin (V)

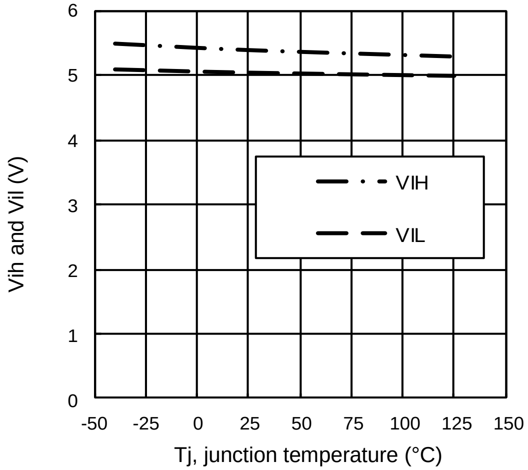


Figure 6 – Vih and Vil (V) VsTj (°C)

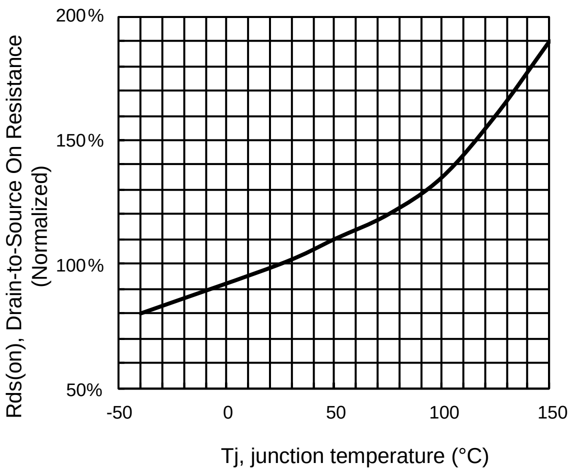


Figure 7 - Normalized Rds(on) (%) Vs Tj (°C)

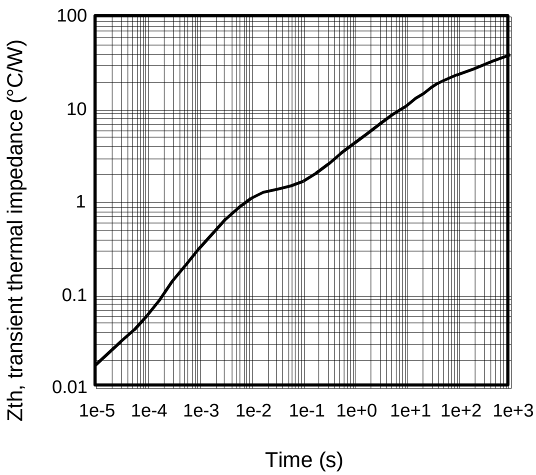


Figure 8 – Transient thermal impedance (°C/W) Vs time (s)

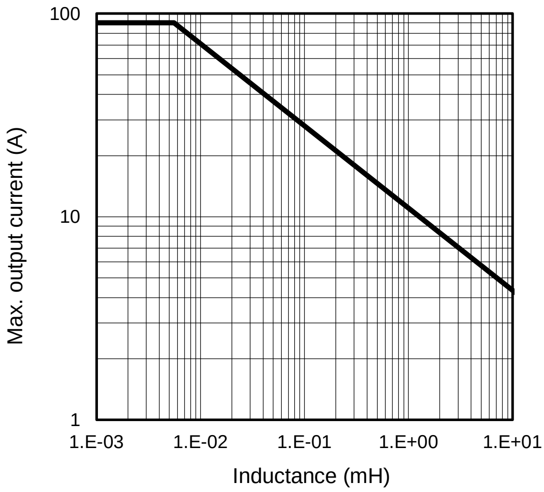


Figure 9 – Max. Iout (A) Vs inductance (mH)

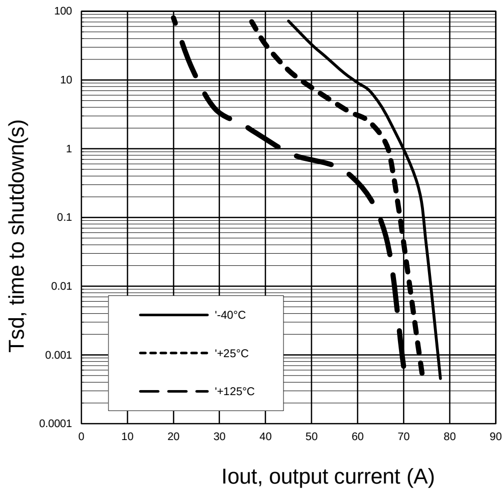
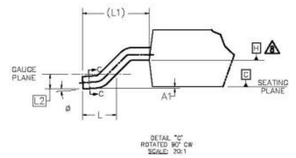
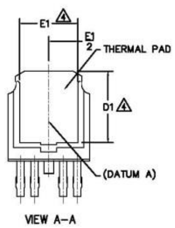
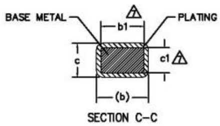


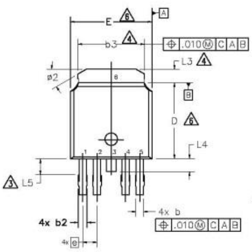
Figure 10 – Tsd (s) Vs I out (A)
SMD with 6cm²

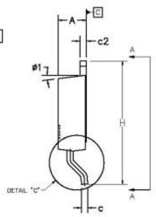
Case Outline 5 Lead – DPAK









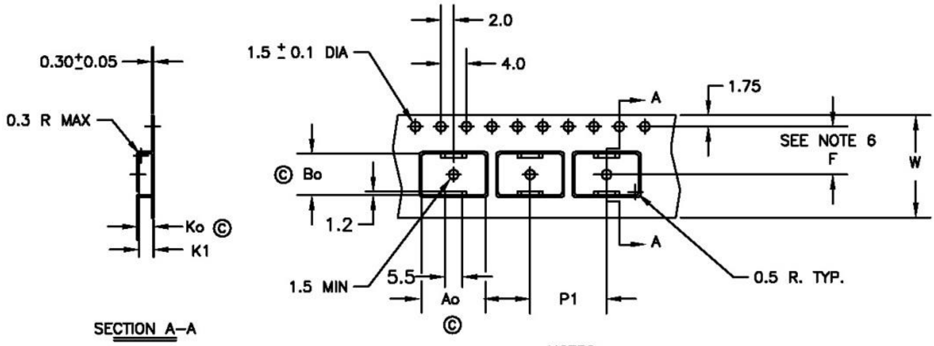


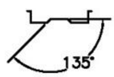
SYMBOL	DIMENSIONS				NOTES
	MILLIMETERS		INCHES		
	MIN.	MAX.	MIN.	MAX.	
A	2.18	2.39	.086	.094	
A1	–	0.13	–	.005	
b	0.56	0.79	.022	.031	
b1	.056	0.74	.022	.029	2
b2	0.65	0.89	.026	.035	
b3	4.95	5.46	.195	.215	2
c	0.46	0.61	.018	.024	
c1	0.41	0.56	.016	.022	2
c2	0.46	0.89	.018	.035	
D	5.97	6.22	.235	.245	3
D1	5.21	–	.205	–	
E	6.35	6.73	.250	.265	3
E1	4.32	–	.170	–	
e	1.14 BSC		.045 BSC		
H	9.40	10.41	.370	.410	
L	1.40	1.78	.055	.070	
L1	2.74 BSC		.108 REF.		
L2	0.51 BSC		.020 BSC		
L3	0.89	1.27	.035	.050	
L4	–	1.02	–	.040	
L5	1.14	1.52	.045	.060	
ø	0°	10°	0°	10°	
ø1	0°	15°	0°	15°	
ø2	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

Note: For the most current drawings please refer to the IR website at:
http://www.irf.com/package/

Tape & Reel 5 Lead – DPAK





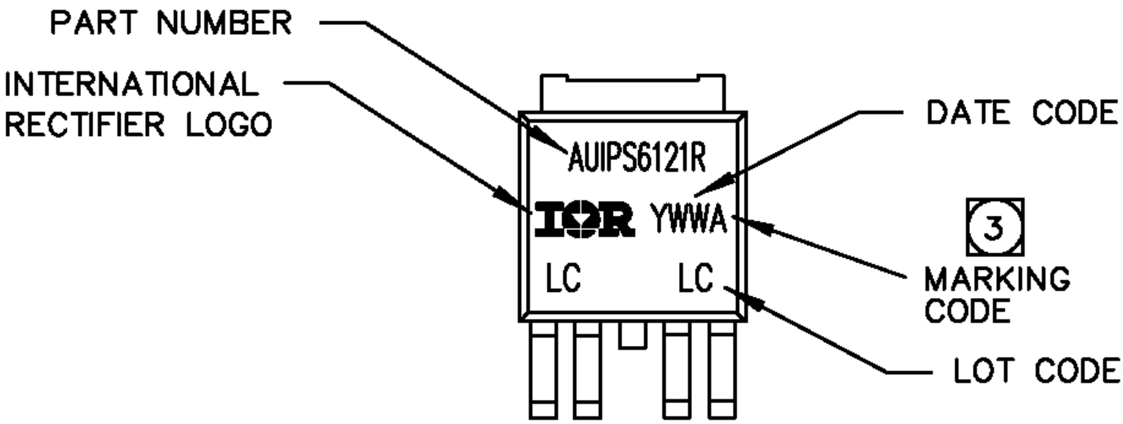
Ao = 10.5 mm
Bo = 7.0 mm
Ko = 2.8 mm
K1 = 2.4 mm
F = 7.5 mm
P1 = 12.0 mm
W = 16.0 ± .3 mm

NOTES:

1. 10 SPROCKET HOLE PUNCH CUMULATIVE TOLERANCE ±.02
2. CAMBER NOT TO EXCEED 1mm IN 100mm
3. MATERIAL: CONDUCTIVE BLACK POLYSTYRENE
4. Ao AND Bo MEASURED ON A PLANE 0.3mm ABOVE THE BOTTOM OF THE POCKET
5. Ko 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

Note: For the most current drawings please refer to the IR website at:
http://www.irf.com/package/

Part Marking Information



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	DPAK-5L	MSL2,260°C (per IPC/JEDEC J-STD-020)
ESD	Machine Model	Class M3 (+/-300V) (per AEC-Q100-003)
	Human Body Model	Class 2 (+/-3000V) (per AEC-Q100-002)
	Charged Device Model	Class C6 (+/-1000V) (per AEC-Q100-011)
IC Latch-Up Test		Class II (per AEC-Q100-004)
RoHS Compliant		Yes

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

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