

AUIPS6011(S)(R)

INTELLIGENT POWER HIGH SIDE SWITCH

Features

- Over temperature shutdown (with auto-restart)
- Short circuit protection (current limit)
- Reverse battery protection (turns On the MOSFET)
- Full diagnostic capability (short circuit to battery)
- Active clamp
- Open load detection in On and Off state
- Ground loss protection
- · Logic ground isolated from power ground
- ESD protection
- Lead Free and RoHS compliant

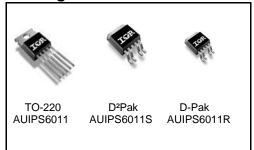
Description

The AUIPS6011(S)(R) 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. The output current is limited to the Ilim value. The current limitation is activated until the thermal protection acts. The over-temperature protection turns off the device if the junction temperature exceeds the Tshutdown value. It will automatically restart after the junction has cooled 7°C below the Tshutdown value. The reverse battery protection turns On the MOSFET. A diagnostic pin provides different voltage levels for each fault condition. The double level shifter circuitry will allow large offsets between the logic and load ground.

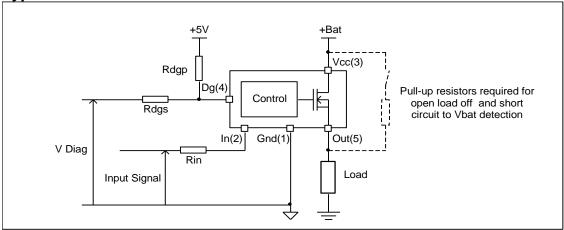
Product Summary

 $\begin{array}{lll} \text{Rds(on)} & 14\text{m}\Omega \text{ max.} \\ \text{Vclamp} & 39\text{V} \\ \text{I Limit} & 60\text{A} \\ \text{Open load} & 3\text{V} \, / \, 2.4\text{A} \end{array}$

Packages



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)		
		TO-220	Not applicable (non-surface mount package style)		
		DPAK-5L	MSL1, 260°C (per IPC/JEDEC J-STD-020)		
	Machine Model		Class M2 (+/-150V) ^{†††} (per AEC-Q100-003)		
ESD	Human Body Model	(per AEC-0	Class H1C (+/-1500V) ^{†††} (per AEC-Q100-002)		
LSD	Charged Device Model (DPAK,D2PAK)		Class C4 (+/-900V) **** (per AEC-Q100-011)		
	Charged Device Model (TO220)	Class C3B (+/-750V) *** (per AEC-Q100-011)			
IC Latch	-Up Test	Class II, Level A (per AEC-Q100-004)			
RoHS C	ompliant	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.

^{†††} Passing voltage level



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. Tj= -40°C..150°C, Vcc=6..35V (unless otherwise specified).

Symbol	Parameter	Min.	Max.	Units
Vout	Maximum output voltage	Vcc-35	Vcc+0.3	
Voffset	Maximum logic ground to load ground offset	Vcc-35	Vcc+0.3	
Vin	Maximum input voltage	-0.3	5.5	V
Vcc max.	Maximum Vcc voltage	_	36	V
Vcc cont.	Maximum continuous Vcc voltage	_	28	
Vcc sc.	Maximum Vcc voltage with short circuit protection	_	24	
lin max.	Maximum IN current	-3	10	m Λ
ldg max.	Maximum diagnostic output current	-3	10	mA
Vdg	Maximum diagnostic output voltage	-0.3	5.5	V
	Maximum power dissipation (internally limited by thermal protection)			
D4	Rth=5°C/W AUIPS6011	_	25	W
Pd	Rth=40°C/W AUIPS6011S 1"sqrt. footprint	_	3.1	VV
	Rth=50°C/W AUIPS6011R 1"sqrt. footprint	_	2.5	
Tj max.	Max. storage & operating temperature junction temperature	-40	150	°C
Tsoldering	Soldering temperature (10 seconds)	_	300	°C

Thermal Characteristics

Symbol	Parameter	Тур.	Max.	Units
Rth1	Thermal resistance junction to ambient AUIPS6011 TO220 free air	50	_	
Rth2	Thermal resistance junction to case AUIPS6011 TO220	1.2	_	
Rth1	Thermal resistance junction to ambient AUIPS6011S D ² Pak std. footprint	60	_	
Rth2	Thermal resistance junction to ambient AUIPS6011S D²Pak 1" sqrt.	40	_	
11012	Footprint	.0		°C/W
Rth3	Thermal resistance junction to case AUIPS6011S D ² Pak	1.2	_	C/VV
Rth1	Thermal resistance junction to ambient AUIPS6011R D-Pak std. footprint	70	_	
Rth2	Thermal resistance junction to ambient AUIPS6011R D-Pak 1" sqrt.	50		
IXIIIZ	Footprint	30	_	
Rth3	Thermal resistance junction to case AUIPS6011R 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	
VIL	Low level input voltage	0	0.9	
lout	Continuous drain current, Tambient=85°C, Tj=125°C, Vin=5V			
	Rth=5°C/W IPS6011	_	18	Α
	Rth=40°C/W IPS6011S 1" sqrt. footprint	_	6.3	
	Rth=50°C/W IPS6011R 1" sqrt. footprint	_	5.6	
Rin	Recommended resistor in series with IN pin	4	10	
Rdgs	Recommended resistor in series with DG pin for reverse battery protection	4	20	kΩ
Rdgp	Recommended pull-up resistor for DG	4	20	K12
Rol	Recommended pull-up resistor for open load detection	5	100	
F max.	Max. switching frequency	_	0.3	kHz



Static Electrical Characteristics

Tj=-40°C..150°C, Vcc=6..28V (unless otherwise specified), typical values are given for Vcc=14V and Tj=25°C

Symbol	Parameter	Min.	Тур.	Max.	Units	Test Conditions
Rds(on)	ON state resistance Tj=25°C	_	11	14		Vin=5V, lout=20A
	ON state resistance Tj=150°C	_	19.5	25		Vin=5V, lout=20A
	ON state resistance Tj=25°C, Vcc=6V	_	12	17	mΩ	Vin=5V, lout=20A
	ON state resistance during reverse battery Tj=25°C	_	15	20		Vcc-Gnd=-14V
Vcc op.	Operating voltage range with short circuit protection	6	_	24	V	
V clamp 1	Vcc to Out clamp voltage 1	36.5	39	43	V	Iout=50mA
V clamp 2	Vcc to Out clamp voltage 2	_	40	_		lout=16A (see Fig. 1)
Icc Off	Supply current when Off and Vout connected to ground with $R<4\Omega$	_	4	9	μΑ	Vin=0V, Vout=0V, Tj=25°C, Vcc=14V
Icc On	Supply current when On	_	2.2	5	mA	Vin=5V, Vcc=14V
Vih	Input high threshold voltage	_	2.5	3		
Vil	Input low threshold voltage	1.5	2	_	V	
In hyst.	Input hysteresis	0.2	0.5	1		
lin On	Input current when device is On	_	40	100		Vin=5V
ldg	Dg leakage current	_	0.1	10	μΑ	Vdg=5V
Vdg	Low level DG voltage	_	0.25	0.4	V	ldg=1.6mA

Switching Electrical Characteristics

Vcc=14V. Resistive load=6Ω, Vin=5V, Tj=-40°C..150°C, typical values are given for Tj=25°C

Symbol	Parameter	Min.	Тур.	Max.	Units	Test Conditions
Tdon	Turn-on delay time	_	30	80		
Tr1	Rise time to Vout=Vcc-5V	_	25	80		
Tr2	Rise time to Vout=0.9 x Vcc	_	80	300	μs	
	Tj=-40°C25°C					
	Tj=25°C150°C		40	100		
dV/dt (On)	Turn On dV/dt	_	0.3	_	V/µs	see Fig. 3
EOn	Turn On energy	_	4	_	mJ	
Tdoff	Turn-off delay time	_	70	150	110	
Tf	Fall time to Vout=0.1 x Vcc	_	30	80	μs	
dV/dt (Off)	Turn Off dV/dt		0.7	_	V/µs	
EOff	Turn Off energy	_	1.5	_	mJ	



Protection Characteristics

Tj=-40°C..150°C, Vcc=6..28V (unless otherwise specified), typical values are given for Vcc=14V and Tj=25°C

Symbol	Parameter	Min.	Тур.	Max.	Units	Test Conditions
Ilim	Internal current limit	35	60	85	Α	Vout=0V, Tj=25°C
Tsd+	Over temperature high threshold	150(1)	165	_	°C	See fig. 2
Tsd-	Over temperature low threshold	_	158	_	٥	See lig. 2
Vsc	Short-circuit detection voltage(2)	2	3	4		
UV+	Under voltage protection Vcc going up	_	5	6.2	V	
UV -	Under voltage protection Vcc going down	_	4.5	5.8	V	
VOL Off	Open load detection threshold	2	3	4		
I OL On	Open load detection threshold	0.5	2	3	^	Tj=-4025°C
		0.5	1.6	2.4	Α	Tj=25150°C

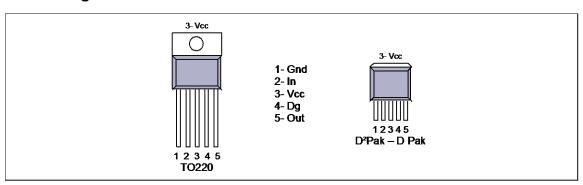
⁽¹⁾ Guaranteed by design

True Table

Operating Conditions	IN	OUT	DG
Normal	Н	Н	Н
Normal	L	L	Н
Open Load	Н	Н	L
Open Load (3)	L	Н	L
Short circuit to Gnd	Н	L	L
Short circuit to Gnd	L	L	Н
Short circuit to Vcc	Ι	Η	L (4)
Short circuit to Vcc (5)	L	Η	Ш
Over-temperature	Н	Ĺ	L
Over-temperature	L	L	Н

⁽³⁾ With a pull-up resistor connected between the output and Vcc.

Lead Assignments

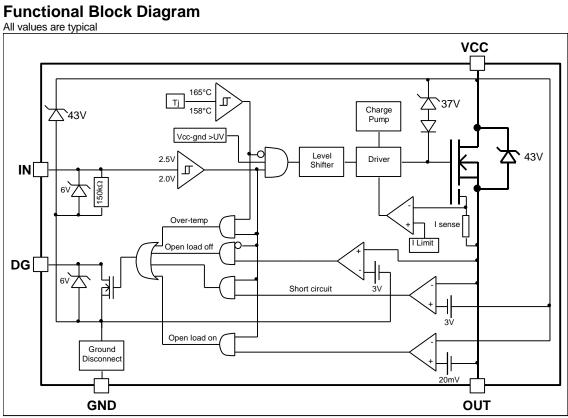


⁽²⁾ Reference to Vcc

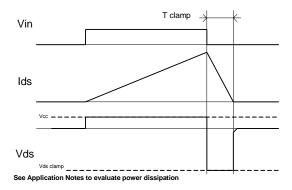
⁽⁴⁾ Vds lower than 10mV.

⁽⁵⁾ Without a pull-up resistor connected between the output and Vcc.







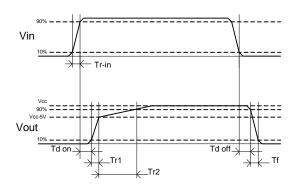


Vin lout limiting Thermal cycling

Tj
Tsd+
TsdTsdDG

Figure 1 - Active clamp waveforms

Figure 2 - Protection timing diagram



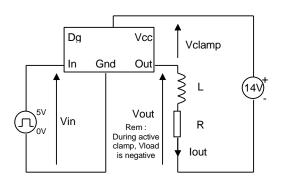


Figure 3 - Switching times definitions

Figure 4 - Active clamp test circuit

100

lout, Output current (A)

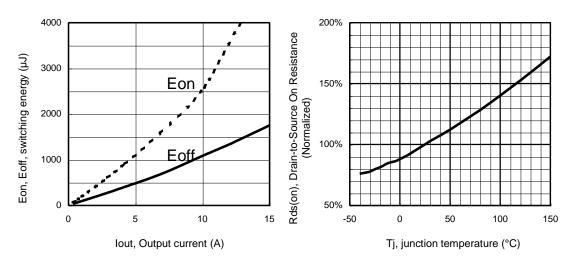


Figure 5 - Switching energy (µJ) Vs Output current (A)

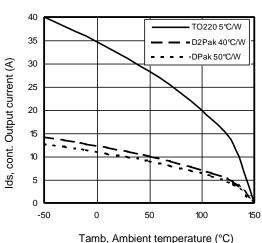
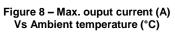
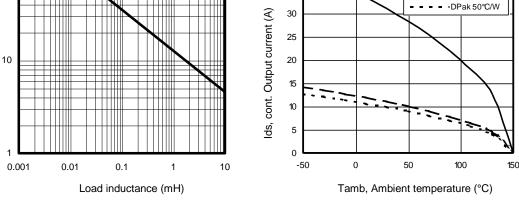


Figure 6 - Normalized Rds(on) (%) Vs Tj (°C)

Figure 7 - Max. Output current (A) Vs Load inductance (mH)





1.E+4

1.E+3

1.E+2

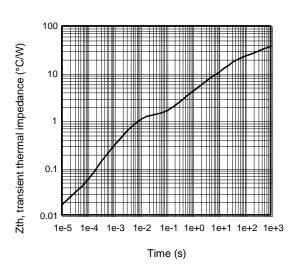
1.E+1

1.E+0

0

5

lcc on/ lcc off, supply current (µA)



80 70 60 50 I limit (A) 40 30 20 10 0 -50 50 100 Tj, junction temperature (°C)

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



Icc on

Icc off

Figure 10 -I limit (A) Vs junction temperature (°C)

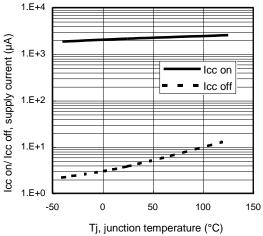


Figure 11 - Icc on/ Icc off (µA) Vs Vcc (V)*

10

15

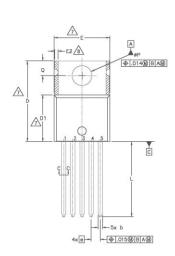
Vcc, power supply voltage (V)

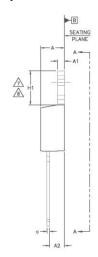
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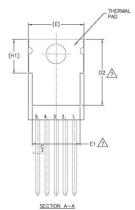
Figure 12 - Icc on/ Icc off (µA) Vs Tj (°C)*

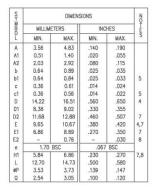
^{*}Vout connected to ground with R<4Ω

Case Outline - TO220 (5 leads)









PLATING \	b	BASE
(c)		c1 5
	SECTION C-C	<u>/</u> 5\

- SIX DIDENSIONING AND TOLERANCING AS PER ASME Y14.5 M- 1994.
 DIMENSIONING AND TOLERANCING AS PER ASME Y14.5 M- 1994.
 DIMENSIONIS ARE SHOWN IN INCHES [MILLIMETERS].
 LEAD DIMENSION AD PINSH INCONTROLLED IN LIT.
 DIMENSION D, DI & E DO NOTI INCLIDE MILD FLASH MILD FLASH
 SHALL NOT ELECTED ONG "(147.79 PRO SIC. THESE DIMENSIONIS ARE
 MEASURED AT THE OUTERWOST EXTREMES OF THE PLASTIC BODY.
 DIMENSIONAL SH. DIMENSION 61 & c1 APPLY TO BASE METAL ONLY.

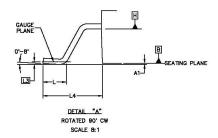
 CONTROLLING DIMENSION: INCHES.

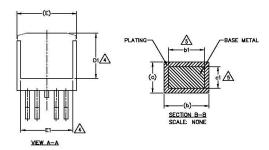
 THERMAL PAD CONTOUR OPTIONAL WITHIN DIMENSIONS E,H1,02 & E1

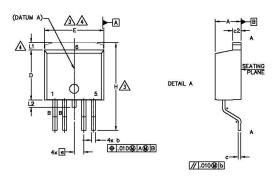
- DIMENSION E Z X H1 DETNIE A ZONE WHERE STAMPING AND SNGULATION IRREQULARITIES AND ALLOWED. OUTLINE CONFORMS TO JEDEC TO 220, EXCEPT A2 (max.) AND D2 (min.) WHERE DIMENSIONS AND DETRIED FROM THE ACTUAL PACKAGE OUTLINE.

10.- LEADS AND DRAIN ARE PLATED WITH 100% Sn

Case Outline D2PAK - 5 Leads





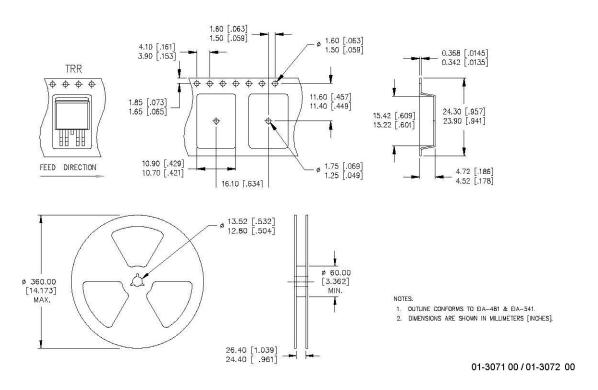


NOTES:

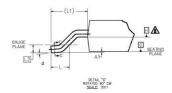
- 1. DIMENSIONING AND TOLERANCING AS PER ASME Y14.5M-1994
- 2. DIMENSIONS ARE SHOWN IN MILLIMETERS [INCHES].
- △ DIMENSION D & E DD NOT INCLUDE MOLD FLASH. MOLD FLASH SHALL NOT EXCEED 0.127 [.005*] PER SIDE. THESE DIMENSIONS ARE MEASURED AT THE OUTMOST EXTREMES OF THE PLASTIC BODY AT DATUM H.
- THERMAL PAD CONTOUR OPTIONAL WITHIN DIMENSION E, L1, D1 & E1.
- 5 DIMENSION 61 AND c1 APPLY TO BASE METAL ONLY.
- 6. DATUM A & B TO BE DETERMINED AT DATUM PLANE H.
- 7. CONTROLLING DIMENSION: INCH.
- 8. OUTLINE CONFORMS TO JEDEC OUTLINE TO-263BA.
- 9 LEADS AND DRAIN ARE PLATED : 100% Sn

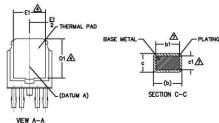
5 Y		DIMEN	SIONS		N
M B O L	МІШМ	ETERS	INC	HES	N O T E S
L	MIN.	MAX.	MIN.	MAX.	S
Α	4.06	4.83	.160	.190	
A1	-	0.254	_	.010	
Ь	0.51	0.99	.020	.039	4
b1	0.51	0.89	.020	.035	
C	0.38	0.74	.015	.029	
c1	0.38	0.58	.015	.023	4
c2	1.14	1.65	.045	.065	
D	8.38	9.65	.330	.380	3
D1	6.86	-	.270	-	
Ε	9.65	10.67	.380	.420	3
E1	6.22	-	.245	-	
е	1.70	BSC	.067	BSC	
н	14.61	15.88	.575	.625	
L	1.78	2.79	.070	.110	
L1	-	1.68	-	.066	
L2	1.000	1.78	-	.070	
L3	0.25 BSC		.010	BSC	
L4	4.78	5.28	.188	.208	

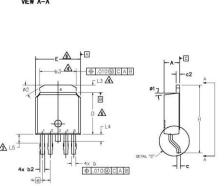
Tape & Reel D2PAK - 5 Leads



Case Outline DPAK - 5 Leads





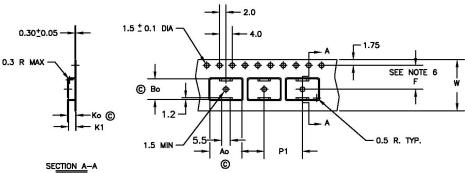


S	DIMENSIONS				
МВО	MILLIM	ETERS	INC	O	
L	MIN.	MAX.	MIN.	MAX.	Ė
Α	2.18	2.39	.086	.094	
A1	_	0.13	-	.005	
ь	0.56	0.79	.022	.031	
b1	.056	0.74	.022	.029	2
b 2	0.65	0.89	.026	.035	
b3	4.95	5.46	.195	.215	2
c	0.46	0.61	.018	.024	
c1	0.41	0.56	.016	.022	2
c2	0.46	0.89	.018	.035	
D	5.97	6.22	.235	.245	3
D1	5.21	-	.205	-	
E	6.35	6.73	.250	.265	3
E1	4.32		.170	_	
е	1.14	BSC	.045	BSC	
Н	9.40	10.41	.370	.410	
L	1.40	1.78	.055	.070	
L1	2.74	2.74 BSC		REF.	
L2	0.51	0.51 BSC		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].
- A- LEAD DIMENSION UNCONTROLLED IN L5.
- A- 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.
- LIMENSION 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.
- A- DIMENSION 61 & 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 DPAK - 5 Leads



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:

- 10 SPROCKET HOLE PUNCH CUMULATIVE TOLERANCE ±.02
 CAMBER NOT TO EXCEED 1mm IN 100mm
 MATERIAL: CONDUCTIVE BLACK POLYSTYRENE
 A6 AND B6 MEASURED ON A PLANE 0.3mm ABOVE THE
 BOTTOM OF THE POCKET
 K6 MEASURED FROM A PLANE ON THE INSIDE BOTTOM OF THE
 POCKET TO THE TOP SURFACE OF THE CARRIER
 POCKET POSITION RELATIVE TO THE SPROCKET HOLE MEASURED AS
 TRUE POSITION OF POCKET, NOT POCKET HOLE

- TRUE POSITION OF POCKET, NOT POCKET HOLE

 7. VENDOR: (OPTIONAL)

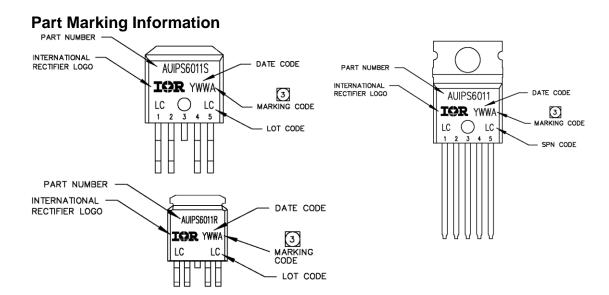
 8. MUST ALSO MEET REQUIREMENTS OF EIA STANDARD #EIA-481A,
 TAPING OF SURFACE-MOUNT COMPONENTS FOR AUTOMATIC
 PLACEMENT.

 9. TOLERANCE TO BE MANUFACTURER STANDARD

 10. SURFACE RESISTIVITY OF MOLDED MATL: MUST MEASURE
 LESS THAN OR EQUAL TO 10* 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. C CRITICAL DIMENSION





Ordering Information

Base Part Number		Standard Pack		
base Fait Number	Package Type	Form	Quantity	Complete Part Number
AUIPS6011	TO220-5-Leads	Tube	50	AUIPS6011
		Tube	50	AUIPS6011S
AUIPS6011S	D2-Pak-5-Leads	Tape and reel left	800	AUIPS6011STRL
		Tape and reel right	800	AUIPS6011STRR
	D-Pak-5-Leads	Tube	75	AUIPS6011R
AUIPS6011R		Tape and reel	2000	AUIPS6011RTR
AUPSOUTR		Tape and reel left	3000	AUIPS6011RTRL
		Tape and reel right	3000	AUIPS6011RTRR



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Revision History

Revision	Date	Notes/Changes
E	September, 12th 2011	AU release
F	May 15, 2012	Add the test condition for the ICC (off) parameters

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