

AUIPS6021(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 AUIPS6021(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.

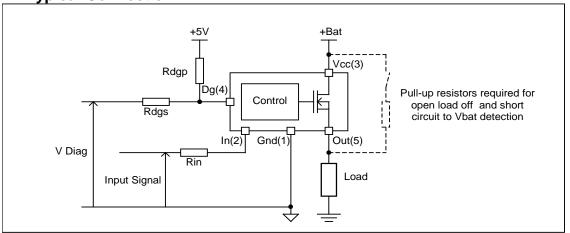
Product Summary

 $\begin{array}{ll} \text{Rds(on)} & 30\text{m}\Omega\,\text{max.} \\ \text{Vclamp} & 39\text{V} \\ \text{I Limit} & 32\text{A} \\ \text{Open load} & 3\text{V} \, / \, 1.1\text{A} \end{array}$

Packages



Typical Connection



February 3, 2013



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 (+ (per AEC-0		
ESD	Human Body Model	Class H1C (+ (per AEC-0	*.	
ESD	Charged Device Model (DPAK,D2PAK)	Class C4 (+ (per AEC-0		
Charged Device Model (TO220)		Class C3B (+/-750V) ^{†††} (per AEC-Q100-011)		
IC Latch-	Up Test	Class II, Level A (per AEC-Q100-004)		
RoHS Co	mpliant	Yes		

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

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	_	28	
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)			
Pd	Rth=5°C/W AUIPS6021		25	W
Pu	Rth=40°C/W AUIPS6021S 1"sqrt. footprint	_	3.1	VV
	Rth=50°C/W AUIPS6021R 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 AUIPS6021 TO220 free air	50	_	
Rth2	Thermal resistance junction to case AUIPS6021 TO220	2.6	_	
Rth1	Thermal resistance junction to ambient AUIPS6021S D ² Pak std. footprint	60	_	
Rth2	Thermal resistance junction to ambient AUIPS6021S D ² Pak 1" sqrt. Footprint	40	_	°C/W
Rth3	Thermal resistance junction to case AUIPS6021S D2Pak	2.6	_	C/VV
Rth1	Thermal resistance junction to ambient AUIPS6021R D-Pak std. footprint	70	_	
Rth2	Thermal resistance junction to ambient AUIPS6021R D-Pak 1" sqrt. Footprint	50	_	
Rth3	Thermal resistance junction to case AUIPS6021R D-Pak	2.6	_	

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 AUIPS6021	_	12	Α
	Rth=40°C/W AUIPS6021S 1" sqrt. footprint	_	4.3	
	Rth=50°C/W AUIPS6021R 1" sqrt. footprint	_	3.9	
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	K22
Rol	Recommended pull-up resistor for open load detection	5	100	
F max.	Max. switching frequency	_	1.5	kHz

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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	_	24	30		Vin=5V, lout=10A
	ON state resistance Tj=150°C	_	42	52		Vin=5V, Iout=10A
	ON state resistance Tj=25°C, Vcc=6V	_	29	36	mΩ	Vin=5V, Iout=5A
	ON state resistance during reverse battery Tj=25°C	_	31	39		Vcc-Gnd=-14V
Vcc op.	Operating voltage range with short circuit protection	6	_	28	V	
V clamp 1	Vcc to Out clamp voltage 1	37	39	43	V	lout=40mA
V clamp 2	Vcc to Out clamp voltage 2	_	40	_		lout=8A (see Fig. 1)
Icc Off	Supply current when Off and Vout connected to ground with $R<4\Omega$	_	4	9	μA	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	μA	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	_	14	40		
Tr1	Rise time to Vout=Vcc-5V	_	10	35	μs	
Tr2	Rise time to Vout=0.9 x Vcc	_	18	65		
dV/dt (On)	Turn On dV/dt	_	0.8	_	V/µs	
EOn	Turn On energy	_	250	_	μJ	see Fig. 3
Tdoff	Turn-off delay time	_	40	80	110	
Tf	Fall time to Vout=0.1 x Vcc	_	15	35	μs	
dV/dt (Off)	Turn Off dV/dt	_	1.5	_	V/µs	
EOff	Turn Off energy	_	100	_	μJ	

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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
llim	Internal current limit	19	32	50	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		
1.01.0	Open load detection threshold		0.8	1.25	۸	Tj=-4025°C
I OL On		0.3	0.7	1.1	Α	Tj=25150°C

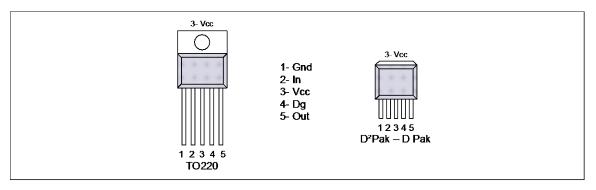
⁽¹⁾ Guaranteed by design

True Table

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

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

Lead Assignments



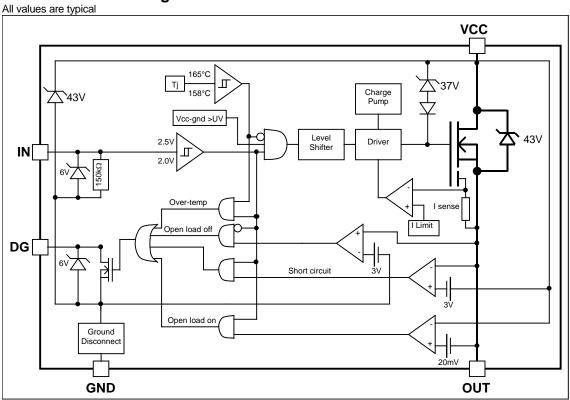
⁽²⁾ Reference to Vcc

⁽⁴⁾ Vds lower than 10mV.

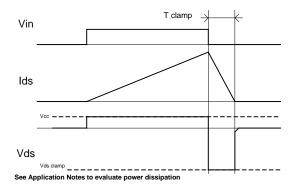
⁽⁵⁾ Without a pull-up resistor connected between the output and Vcc.



Functional Block Diagram







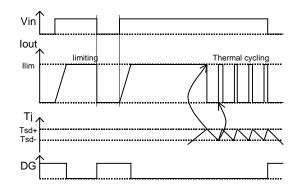
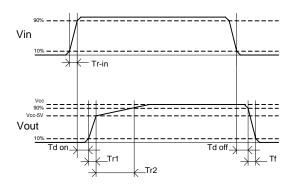


Figure 1 - Active clamp waveforms

Figure 2 - Protection timing diagram



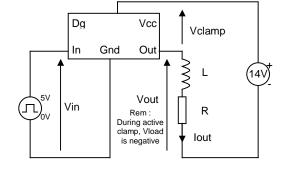


Figure 3 - Switching times definitions

Figure 4 - Active clamp test circuit



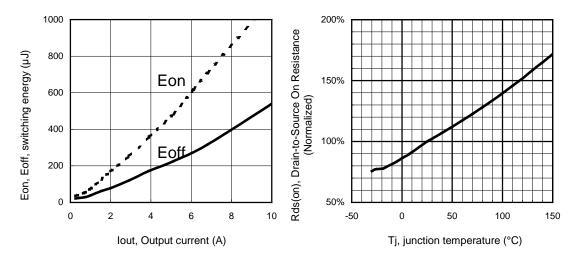


Figure 5 – Switching energy (µJ) Vs Output current (A)

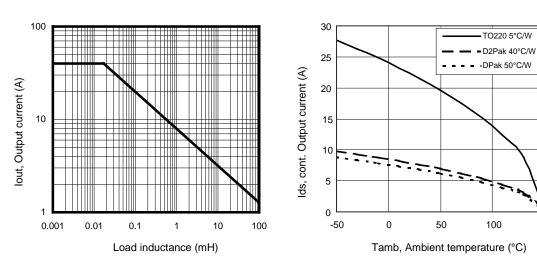


Figure 7 – Max. Output current (A) Vs Load inductance (mH)

Figure 8 – Max. ouput current (A) Vs Ambient temperature (°C)

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

150



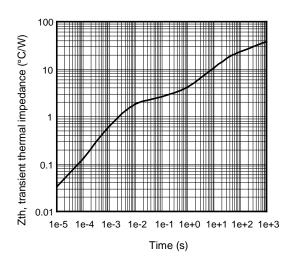


Figure 9 – Transient thermal impedance (°C/W) Vs time (s)

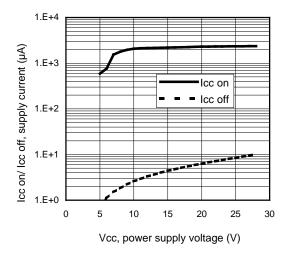


Figure 11 - Icc on/ Icc off (µA) Vs Vcc (V)*

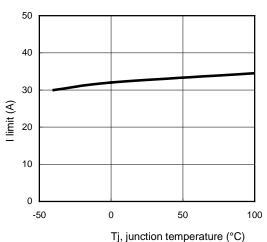


Figure 10 –I limit (A)
Vs junction temperature (°C)

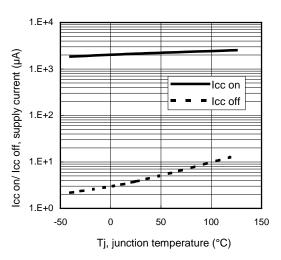
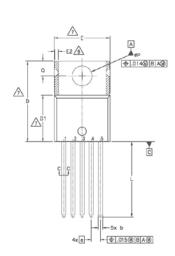


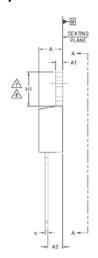
Figure 12 – Icc on/ Icc off (μA) Vs Tj (°C)*

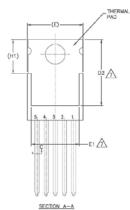
^{*}Vout connected to ground with R<4Ω



Case Outline - TO220 (5 leads)







SYMBOL	DIMENSIONS					
B	MILLIM	ETERS	INC	HES	NOT ES	
Ľ	MN.	NAX.	MIN.	MAX.	S	
A	3.58	4.83	.140	.190		
A1	0.51	1.40	.020	.055		
A2	2.03	2.92	.080	.115		
ь	0.64	0.89	.025	.035		
b1	0.64	0.84	.025	.033	5	
c	0.36	0.61	.014	.024		
c1	0.36	0.56	.014	.022	5	
D	14.22	16.51	.560	.650	4	
D1	8.38	9.02	.330	.355		
D2	11.68	12.88	.460	.507	7	
E	9.65	10.67	.380	.420	4,7	
E1	6.86	8.89	.270	.350	7	
E2	-	0.76	-	.030	8	
0	1.70	BSC	.067 BSC			
H1	5.84	6.86	.230	.270	7,8	
L	12.70	14.73	.500	.580		
φP	3.53	3.73	.139	.147		
Q	2.54	3.05	.100	.120		

PLATING -	b	BASE
(c)		01

- SE

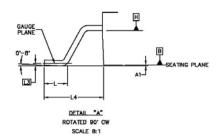
 DIADISIONNO AND TELERAKUNG AS PER ASME Y14.5 M— 1994.
 DIMENSIONS ARE SHOWN IN INCHES [MILLIMETERS].
 LEAD DIMENSION AND PRISE INCONTRICULE MO.D PLASH.
 BOMENSION O, DIE E DO NOT NEUDO MO.D PLASH. MOLD PLASH
 SHALL NOT EXCELD 4005 (10.72) PLR 30C. THESE DIMENSIONS ARE
 MERCHIERD AT THE OUTERWISE SHEMENS OF THE PLASTIC 5009.
 DIMENSION BY ACCOUNTAGE SHEMENS OF THE PLASTIC 5009.
 DIMENSION BY ACCOUNTAGE AND METAL OILY.
 CONTROLLED OMNESON: NINGES.
 THERWAY PAD CONTOR OFFICIAL WITHIN DIMENSIONS E.H.D.2 & E.I.
 DIMENSION E.Y. HE DETINE A ZONE WHERE STAMPING
 AND SHOULATION INFECULATIES ARE ALLOND.

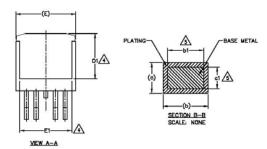
 OUTLINE CONTROLST TO LEBECT TO ACC, DICEPT AS (PICAL) AND D.2 (min.)
 WHERE DIMENSIONS ARE DERIVED FROM THE ACTUAL PACKAGE QUILLIKE.

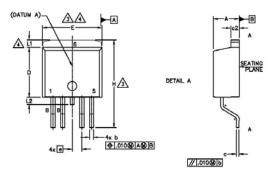
- 10.- LEADS AND DRAIN ARE PLATED WITH 100% Sn



Case Outline D2PAK - 5 Leads







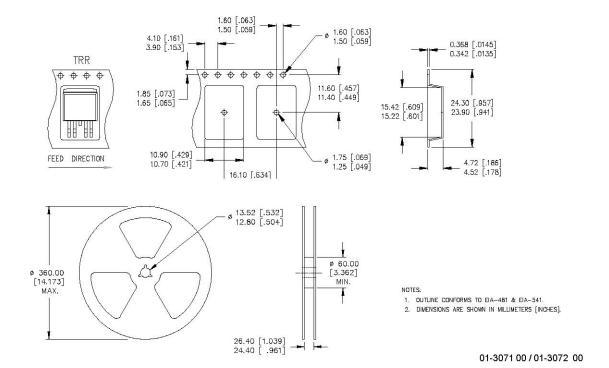
NOTES:

- 1. DIMENSIONING AND TOLERANCING AS PER ASME Y14.5M-1994
- 2. DIMENSIONS ARE SHOWN IN MILLIMETERS [INCHES].
- (2.5) DIMENSION D & E DO NOT INCLUDE MOLD FLASH. MOLD FLASH SHALL NOT EXCEED 0.127 (.008") 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 61 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

S Y M	DIMENSIONS					
В	МШМ	ETERS	INC	HES	Ö	
O L	MIN.	MAX.	MIN.	MAX.	Ė	
Α	4.06	4.83	.160	.190		
A1	12	0.254	-	.010		
ь	0.51	0.99	.020	.039	4	
ь1	0.51	0.89	.020	.035		
c	0.38	0.74	.015	.029		
e1	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	-		
e	1.70	1.70 BSC		.067 BSC		
н	14.61	15.88	.575	.625	1	
L	1.78	2.79	.070	.110		
L1	1-	1.68		.066		
L2	1-	1.78	-	.070		
L3	0.25	BSC	.010	1		
L4	4.78	5.28	.188	.208		

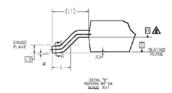


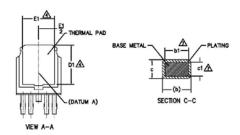
Tape & Reel D2PAK - 5 Leads

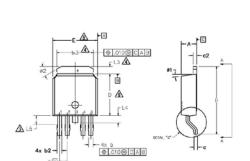




Case Outline DPAK - 5 Leads







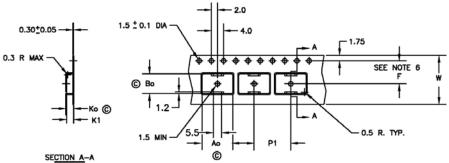
S Y M		DIMENSIONS					
BO	MILLIM	MILLIMETERS INCHES		HES	O Ţ		
L	MIN.	MAX.	MIN.	MAX.	Ē		
Α	2.18	2.39	.086	.094			
A1	-	0.13	-	.005			
b	0.56	0.79	.022	.031			
ь1	.056	0.74	.022	.029	2		
b2	0.65	0.89	.026	.035			
ь3	4.95	5.46	.195	.215	2		
С	0.46	0.61	.018	.024			
c1	0.41	0.56	.016	.022	2		
c2	0.46	0.89	.018	.035			
D	5.97	6.22	.235	.245	3		
D1	5.21	-	.205	-			
Ε	6.35	6.73	.250	.265	3		
E1	4.32	-	.170	-			
e	1.14	BSC	.045	BSC			
Н	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].
- 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.
- MENTION 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 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 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:

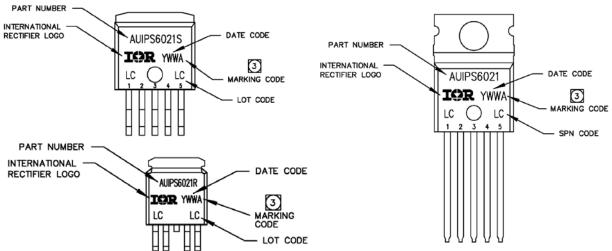
- - 5.
- 10 SPROCKET HOLE PUNCH CUMULATIVE TOLERANCE ±.02
 CAMBER NOT TO EXCEED 1mm IN 100mm
 MATERIAL: CONDUCTIVE BLACK POLYSTYRENE
 AO AND BO MEASURED ON A PLANE 0.3mm ABOVE THE
 BOTTOM OF THE POCKET
 KO MEASURED FROM A PLANE ON THE INSIDE BOTTOM OF THE
 POCKET TO THE TOP SURFACE OF THE CARRIER
 POCKET POSTION RELATIVE TO THE SPROCKET HOLE MEASURED AS
 TRUE POSITION OF POCKET, NOT POCKET HOLE MEASURED AS

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

 - PLACEMENT.
 TOLERANCE TO BE MANUFACTURER STANDARD
 SURFACE RESISTIVITY OF MOLDED MATL: MUST MEASURE
 LESS THAN OR EQUAL TO 10* OHMS PER SQUARE. MEASI
 IN ACCORDANCE TO PROCEDURE GIVEN IN ASTM D-257 &
 ASTM D-991 (REF. C-9000 SPEC.)
 TOTAL LENGTH PER REEL MUST BE 79 METERS
- 12. C CRITICAL DIMENSION







Ordering Information

Base Part Number	Package Type	Standard Pack		
		Form	Quantity	Complete Part Number
AUIPS6021	TO220-5-Leads	Tube	50	AUIPS6021
AUIPS6021S	D2-Pak-5-Leads	Tube	50	AUIPS6021S
		Tape and reel left	800	AUIPS6021STRL
		Tape and reel right	800	AUIPS6011STRR
AUIPS6021R	D-Pak-5-Leads	Tube	75	AUIPS6021R
		Tape and reel	2000	AUIPS6021RTR
		Tape and reel left	3000	AUIPS6021RTRL
		Tape and reel right	3000	AUIPS6021RTRR



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Revision History

Revision	Date	Notes/Changes
В	September, 12th 2011	AU release
С	May 15, 2012	Add the test condition for the ICC (off) parameters
D	Tuesday, October 16, 2012	Update the date in the front page

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