

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

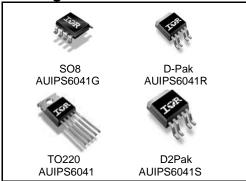
Description

The AUIPS6041(G)(R)(S) 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.

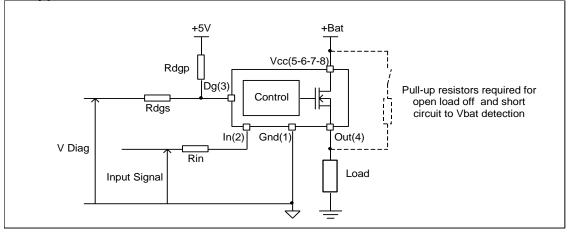
Product Summary

 $\begin{array}{ll} \text{Rds(on)} & 130\text{m}\Omega \text{ max.} \\ \text{Vclamp} & 39\text{V} \\ \text{I Limit} & 7\text{A} \\ \text{Open load} & 3\text{V} \, / \, 0.22\text{A} \end{array}$

Packages



Typical Connection



International **TOR** Rectifier

AUIPS6041(G)(R)(S)

Qualification Information[†]

		Automotive (per AEC-Q100 ^{††})				
Qualifica	tion Level	Comments: This family of ICs has passed an Automotive qualification. Industrial and Consumer qualification level is granted by extension of the h Automotive level. MSL1, 260°C				
		D2PAK-5L	MSL1, 260°C (per IPC/JEDEC J-STD-020)			
Matatana	Our although a cont	TO-220	Not applicable (non-surface mount package style)			
Moisture	Sensitivity Level	DPAK-5L	MSL1, 260°C (per IPC/JEDEC J-STD-020)			
		SOIC-8L	MSL2, 260°C (per IPC/JEDEC J-STD-020)			
	Machine Model	Class M2 (+ (per AEC-0	2100-003)			
ESD	Human Body Model	Class H1C (+ (per AEC-0	•			
ESD	Charged Device Model (SOIC, DPAK,D2PAK)	Class C4 (+ (per AEC-0	2100-011)			
	Charged Device Model (TO220)	Class C3B ((per AEC-0				
IC Latch-	-Up Test	Class II, (per AEC-0				
RoHS Co	ompliant	Ye	es ————————————————————————————————————			

[†] 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	
Vcc cont.	Maximum continuous Vcc voltage	_	28	
lin max.	Maximum IN current	-3	10	A
ldg max.	Maximum diagnostic output current	-3	10	mA
Vdg	Maximum diagnostic output voltage	-0.3	5.5	V
Pulse 2a max	Maximum voltage ISO pulse 2a x 500cy (ISO7637)	_	55	V
	Maximum power dissipation (internally limited by thermal protection)	_	1.25	
Pd	Rth=100°C/W AUIPS6041G		_	W
	Rth=50°C/W AUIPS6041R 1"sqrt. footprint	_	2.5	
Tj max.	Max. storage & operating temperature junction temperature	-40	150	°C

Thermal Characteristics

Symbol	Parameter	Тур.	Max.	Units
Rth1	Thermal resistance junction to ambient AUIPS6041G	100	_	
Rth1	Thermal resistance junction to ambient AUIPS6041R D-Pak std. footprint	70	_	
Rth2	Thermal resistance junction to ambient AUIPS6041R D-Pak 1" sqrt. footprint	50	_	
Rth3	Thermal resistance junction to case AUIPS6041(R)(S) D-Pak/D2pak/TO220	6	_	°C/W
Rth1	Thermal resistance junction to ambient AUIPS6041(S) D2Pak/TO220 std. footprint	60	_	
Rth2	Thermal resistance junction to ambient AUIPS6041S D2Pak 1" sqrt. footprint	40	_	

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			
lout	Rth=100°C/W AUIPS6041G	_	1.6	Α
	Rth=50°C/W AUIPS6041R 1" sqrt. footprint	_	2.3	_ A
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	_	3.5	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
	ON state resistance Tj=25°C	_	110	130		Vin=5V, lout=2.5A
	ON state resistance Tj=150°C	_	190	230		Vin=5V, lout=2.5A
Rds(on)	ON state resistance Tj=25°C, Vcc=6V	_	125	155	$m\Omega$	Vin=5V, lout=1.5A
	ON state resistance during reverse battery Tj=25°C	_	140	180		Vcc-Gnd=-14V
Vcc op.	Operating voltage range	6	_	28		
V clamp 1	Vcc to Out clamp voltage 1	37	39	43	V	lout=20mA
V clamp 2	Vcc to Out clamp voltage 2	_	40	_		lout=2.5A (see Fig. 1)
Icc Off	Supply current when Off and with Vout connected to ground Rconnection $<4\Omega$	_	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	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	_	5	15		
Tr1	Rise time to Vout=Vcc-5V	_	3	10	μs	
Tr2	Rise time to Vout=0.9 x Vcc	_	4	30		
dV/dt (On)	Turn On dV/dt	_	2.5	_	V/µs	
EOn	Turn On energy	_	100	_	μJ	see Fig. 3
Tdoff	Turn-off delay time	_	10	20	110	
Tf	Fall time to Vout=0.1 x Vcc	_	3	10	μs	
dV/dt (Off)	Turn Off dV/dt	_	6.5	_	V/µs	I
EOff	Turn Off energy	_	50	_	μJ	



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	4	7	10	Α	Vout=0V, Tj=25°C
Tsd+	Over temperature high threshold	150(1)	165	_	°C	See fig. 2
Tsd-	Over temperature low threshold	_	158	_	C	See lig. 2
Vsc	Short-circuit detection voltage(2)	2	3	4		
UV+		_	5	6.2	.,	
UV -		_	4.5	5.8	V	
VOL Off	Open load detection threshold	2	3	4		
I OL On	Open load detection threshold	0.05	0.17	0.27	Α	Tj=-4025°C
TOLON		0.05	0.15	0.22		Tj=25150°C

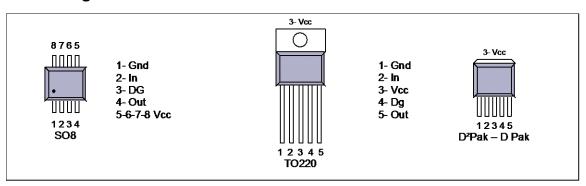
⁽¹⁾ Guaranteed by design

True Table

Operating Conditions	IN	OUT	DG
Normal	Н	Н	Н
Normal	L	L	Н
Open Load	Н	Н	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	Н	Ĺ	L
Over-temperature	L	L	Н

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

Lead Assignments

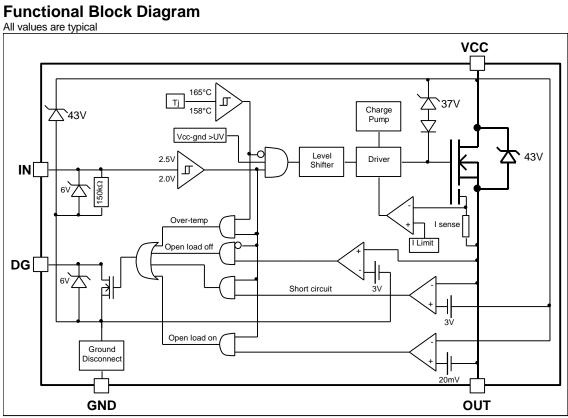


⁽²⁾ Reference to Vcc

⁽⁴⁾ Vds lower than 10mV.

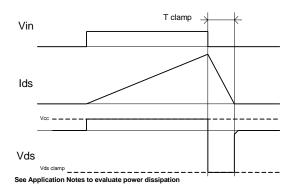
⁽⁵⁾ Without a pull-up resistor connected between the output and Vcc.





International **TOR** Rectifier

AUIPS6041(G)(R)(S)

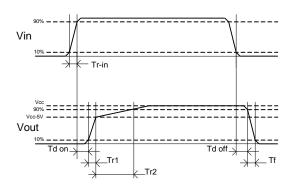


Vin lout limiting Thermal cycling

Ti Tsd+
TsdDG

Figure 1 - Active clamp waveforms

Figure 2 - Protection timing diagram



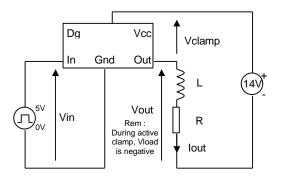


Figure 3 - Switching times definitions

Figure 4 - Active clamp test circuit

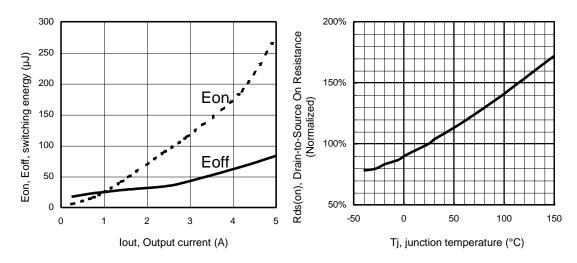


Figure 5 - Switching energy (µJ) Vs Output current (A)

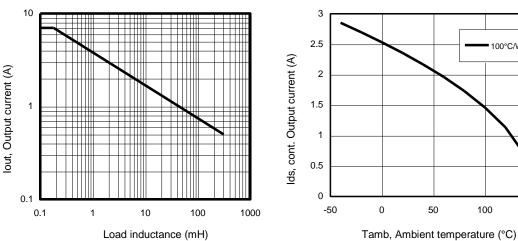


Figure 7 - Max. Output current (A) Vs Load inductance (mH)

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

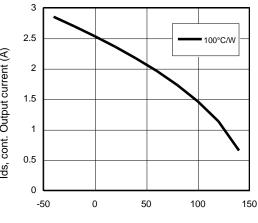
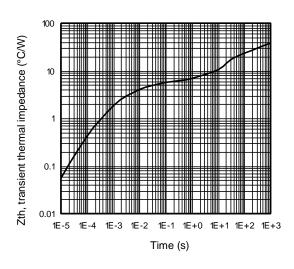


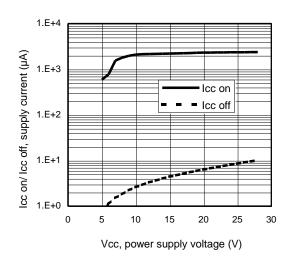
Figure 8 - Max. ouput current (A) Vs Ambient temperature (°C)



8
6
2
2
0
-50
0
50
100
Tj, junction temperature (°C)

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

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



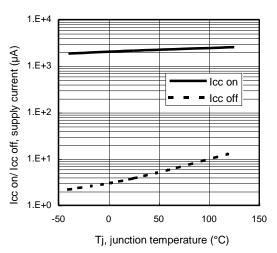


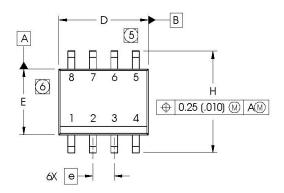
Figure 11 - Icc on/ Icc off (µA) Vs Vcc (V)*

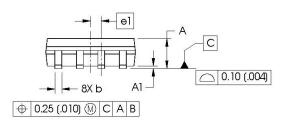
Figure 12 - Icc on/ Icc off (µA) Vs Tj (°C)*

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

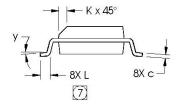
Case Outline - SO8

Dimensions are shown in millimeters (inches)



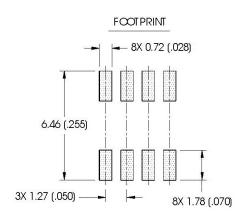


DIM	INC	HES	MILLIMETERS		
DIIVI	MIN	MAX	MIN	MAX	
Α	.0532	.0688	1.35	1.75	
A1	.0040	.0098	0.10	0.25	
b	.013	.020	0.33	0.51	
С	.0075	.0098	0.19	0.25	
D	.189	.1968	4.80	5.00	
Е	.1497	.1574	3.80	4.00	
е	.050 B	ASIC	1.27 B	ASIC	
е1	.025 BASIC		0.635	BASIC	
Н	.2284	.2440	5.80	6.20	
Κ	.0099	.0196	0.25	0.50	
L	.016	.050	0.40	1.27	
У	0°	8°	0°	8°	

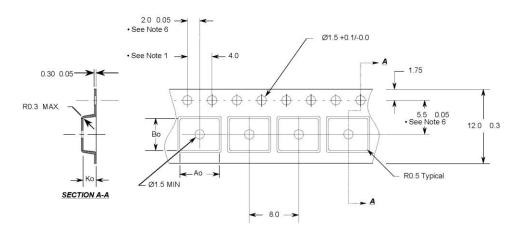


NOTES:

- 1. DIMENSIONING & TOLERANGING PER ASME Y14.5M-1994.
- 2. CONTROLLING DIMENSION: MILLIMETER
- 3. DIMENSIONS ARE SHOWN IN MILLIMETERS (INCHES).
- 4. OUTLINE CONFORMS TO JEDEC OUTLINE MS-012AA.
- (5) DIMENSION DOES NOT INCLUDE MOLD PROTRUSIONS. MOLD PROTRUSIONS NOT TO EXCEED 0.15 (.006).
- (6) DIMENSION DOES NOT INCLUDE MOLD PROTRUSIONS. MOLD PROTRUSIONS NOT TO EXCEED 0.25 (.010).
- DIMENSION IS THE LENGTH OF LEAD FOR SOLDERINGTO A SUBSTRATE.



Tape & Reel - SO8



Notes:

- 1. 10 sprocket hole pitch cumulative tolerance 0.2
- 2. Camber not to exceed 1mm in 100mm
- Material: Black Conductive Advantek Polystyrene
 Ao and Bo measured on a plane 0.3mm above the
- 4. 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 position relative to sprocket hole measured as true position of pocket, not pocket hole.

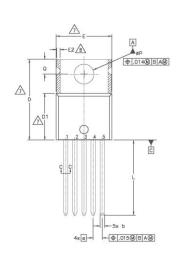
Ao = 6.4 mm

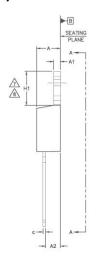
Bo = 5.2 mm

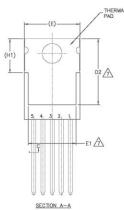
Ko = 2.1 mm

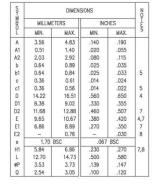
- All Dimensions in Millimeters -

Case Outline - TO220 (5 leads)









PLATING-	b	BASE
(c)		c1 5
	SECTION C	

- 1.— DIMENSIONING AND TOLERANCING AS PER ASME Y14.5 M— 1994.
 2.— DIMENSIONS ARE SHOWN IN INCHES [MILLIMETERS].
 3.— LEAD DIMENSION AND FINISH UNCONTROLLED IN 1.1.

 DIMENSION D, D1 & E DO NOT MANIME WITH 1.1.
- 1.— DIMENSIONING AND TOLERANCING AS PER ASME "11.5 M— 1994.

 DIMENSIONS ARE SHOWN IN INCHES [MILLIBETERS].

 3.— LEAD DIMENSION AND FINISH UNCONTROLLED IN U.

 DIMENSION D, II & E DO NOT INCLUE MOLD FLASH MOLD FLASH

 SHALL NOT EXCEED .005" (0.127) PER SIDE. THESE DIMENSIONS ARE

 MESSURED AT THE OLITEMIST EXTREMES OF THE PLASTIC BODY.

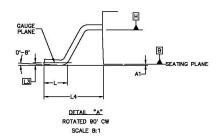
 DIMENSION IN & c. I APPLY TO BASE METAL ONLY.

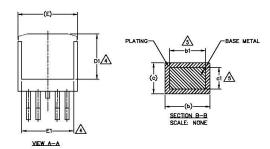
 CONTROLLING DIMENSION F. KONES.

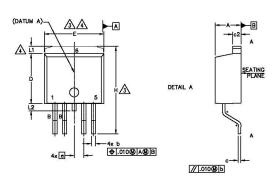
 7.— THERMAL PAD CONTOUR OPTIONAL WITHIN DIMENSIONS EH.10.2 & E1

- DIBENSION 22 X H1 DEFINE A ZONE MHERE STAMPING AND SINGULATION IRREGULARITIES ARE ALLOWED. OUTLINE CONFORMS TO JEDEC TO –220, EXCEPT A2 (max.) AND D2 (min.) WHERE DIMENSIONS ARE DERIVED FROM THE ACTUAL PACKAGE OUTLINE.
- 10.- LEADS AND DRAIN ARE PLATED WITH 100% Sn

Case Outline 5 Leads - D2PAK







NOTES:

- 1. DIMENSIONING AND TOLERANCING AS PER ASME Y14.5M-1994
- 2. DIMENSIONS ARE SHOWN IN MILLIMETERS [INCHES].
- △3\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.

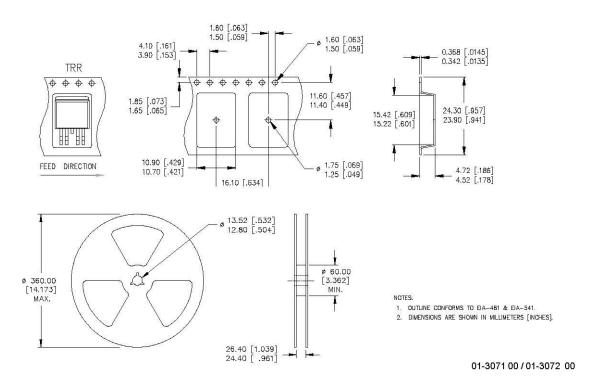
THERMAL PAD CONTOUR OPTIONAL WITHIN DIMENSION E, L1, D1 & E1.

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

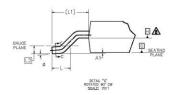
S Y M	DIMENSIONS					
	MILLIMETERS		INC	O T E S		
B O L	MIN.	MAX.	MIN.	MAX.	S	
Α	4.06	4.83	.160	.190		
A1	-	0.254	=	.010		
ь	0.51	0.99	.020	.039	4	
b1	0.51	0.89	.020	.035		
c	0.38	0.74	.015	.029		
c1	0.38	0.58	.015	.023	4	
c2	1.14	1.65	.045	.065		
D	8.38	9.65	.330	.380	3	
D1	6.86	-	.270	-		
E	9.65	10.67	.380	.420	3	
E1	6.22	-	.245	_		
e	1.70 BSC		.067			
н	14.61	15.88	.575	.625		
L	1.78	2.79	.070	.110		
L1	-	1.68	-	.066		
L2	1	1.78	-	.070		
L3	0.25	BSC	.010	BSC		
L4	4.78	5.28	.188	.208		

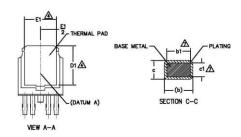
Tape & Reel 5 Leads - D2PAK

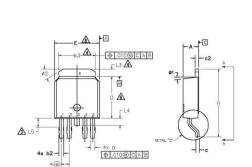




Case Outline 5 Leads - DPAK







N		SIONS	DIMEN		Y
O	HES	INC	ETERS	MILLIM	M B O
Ė	MAX.	MIN.	MAX.	MIN.	L L
	.094	.086	2.39	2.18	Α
	.005	-	0.13	_	A1
	.031	.022	0.79	0.56	ь
2	.029	.022	0.74	.056	b 1
	.035	.026	0.89	0.65	b2
2	.215	.195	5.46	4.95	b3
	.024	.018	0.61	0.46	С
2	.022	.016	0.56	0.41	c1
	.035	.018	0.89	0.46	c2
3	.245	.235	6.22	5.97	D
	-	.205	-	5.21	D1
3	.265	.250	6.73	6.35	E
	_	.170	_	4.32	E1
	.045 BSC		1.14 BSC		e
	.410	.370	10.41	9.40	н
	.070	.055	1.78	1.40	L
	REF.	.108	BSC	2.74	L1
	BSC	.020	BSC	0.51	L2
	.050	.035	1.27	0.89	L3
	.040		1.02	1020	L4
	.060	.045	1.52	1.14	L5
	10*	0.	10°	0*	ø
	15°	0.	15*	0.	ø1
	32*	28*	32*	28*	ø2

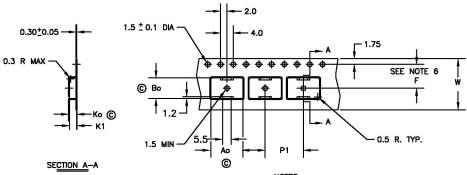
NOTES

- 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.
- 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.

S

- 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 5 Leads - 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 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.

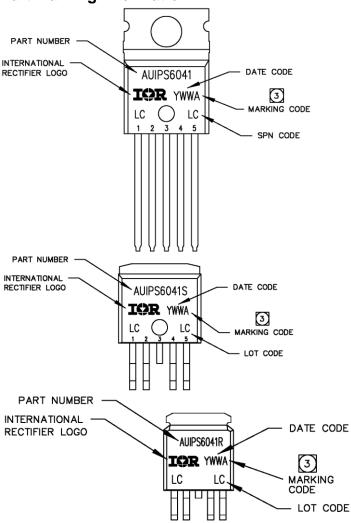
 9. TOLERANCE TO BE MANUFACTURER STANDARD

 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.)

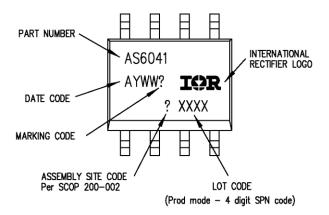
 11. TOTAL LENGTH PER REEL MUST BE 79 METERS
- 12. C CRITICAL DIMENSION



Part Marking Information







Ordering Information

Base Part Number	Package Type	Standard Pack		
		Form	Quantity	Complete Part Number
AUIPS6041	TO220-5-Leads	Tube	50	AUIPS6041
AUIPS6041S	D2-Pak-5-Leads	Tube	50	AUIPS6041S
		Tape and reel left	800	AUIPS6041STRL
		Tape and reel right	800	AUIPS6041STRR
AUIPS6041R	D-Pak-5-Leads	Tube	75	AUIPS6041R
		Tape and reel	2000	AUIPS6041RTR
		Tape and reel left	3000	AUIPS6041RTRL
		Tape and reel right	3000	AUIPS6041RTRR
AUIPS6041G	SOIC-8	Tube	95	AUIPS6041G
		Tape and reel	2500	AUIPS6041GTR

International Rectifier

AUIPS6041(G)(R)(S)

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WORLD HEADQUARTERS:

101 N Sepulbeda Blvd., El Segundo, California 90245 Tel: (310) 252-7105

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Revision History

Revision	Date	Notes/Changes
С	Februrary, 28th 2009	AU number update
D	March, 14th 2011	AU release
F	May 15, 2012	Add the test condition for the ICC (off) parameters