

### INTELLIGENT POWER HIGH SIDE SWITCH

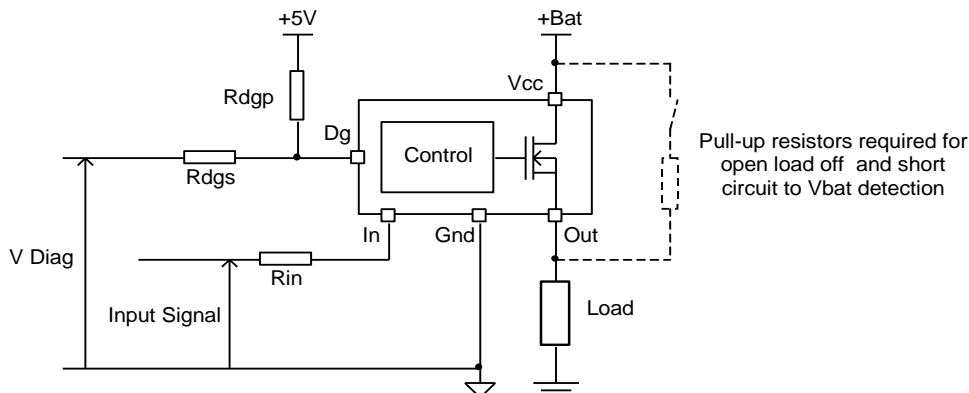
#### Features

- 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

#### Description

The AUIPS6044G is quad output 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  $I_{lim}$  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  $T_{shutdown}$  value. It will automatically restart after the junction has cooled  $7^{\circ}\text{C}$  below the  $T_{shutdown}$  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.

#### Typical Connection



#### Product Summary

$R_{ds(on)}$	130m $\Omega$ max.
$V_{clamp}$	39V
$I_{Limit}$	7A
Open load	3V / 0.22A

#### Package



SOIC28 Wide body

## Qualification Information<sup>†</sup>

<b>Qualification Level</b>		Automotive (per AEC-Q100 <sup>††</sup> )	
		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>		SOIC-28L	MSL2, 260°C (per IPC/JEDEC J-STD-020)
<b>ESD</b>	Machine Model	Class <b>M2 (+/-150V)</b> <sup>†††</sup> (per AEC-Q100-003)	
	Human Body Model	Class <b>H1C (+/-1500V)</b> <sup>†††</sup> (per AEC-Q100-002)	
	Charged Device Model	Class <b>C4 (+/-900V)</b> <sup>†††</sup> (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 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. T<sub>j</sub>= -40°C..150°C, V<sub>cc</sub>=6..35V (unless otherwise specified).

Symbol	Parameter	Min.	Max.	Units
V <sub>out</sub>	Maximum output voltage	V <sub>cc</sub> -35	V <sub>cc</sub> +0.3	V
V <sub>offset</sub>	Maximum logic ground to load ground offset	V <sub>cc</sub> -35	V <sub>cc</sub> +0.3	
V <sub>in</sub>	Maximum input voltage	-0.3	5.5	
V <sub>cc</sub> max.	Maximum V <sub>cc</sub> voltage	—	36	
V <sub>cc</sub> cont.	Maximum continuous V <sub>cc</sub> voltage	—	28	
I <sub>in</sub> max.	Maximum I <sub>N</sub> current	-3	10	mA
I <sub>dg</sub> max.	Maximum diagnostic output current	-3	10	
V <sub>dg</sub>	Maximum diagnostic output voltage	-0.3	5.5	V
P <sub>d</sub>	Maximum power dissipation (internally limited by thermal protection) R <sub>th</sub> =130°C/W per channel	—	3.8	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 1" sqrt. Footprint / 1 channel On	50	—	°C/W
R <sub>th2</sub>	Thermal resistance junction to ambient 1" sqrt. Footprint / 2 channels On	100	—	
R <sub>th3</sub>	Thermal resistance junction to ambient 1" sqrt. Footprint / 4 channels On	130	—	

note : T<sub>j</sub>=Power dissipated in one channel x R<sub>th</sub>

## 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	4	5.5	
V <sub>IL</sub>	Low level input voltage	0	0.9	
I <sub>out</sub>	Continuous drain current, R <sub>th</sub> =130°C/W, T <sub>j</sub> =150°C, 4 channels On T <sub>ambient</sub> =85°C / 1" sqrt. footprint T <sub>ambient</sub> =105°C / 1" sqrt. footprint	—	1.5 1.2	A
R <sub>in</sub>	Recommended resistor in series with I <sub>N</sub> pin	4	10	kΩ
R <sub>dg</sub> s	Recommended resistor in series with DG pin for reverse battery protection	4	20	
R <sub>dg</sub> p	Recommended pull-up resistor for DG	4	20	
R <sub>ol</sub>	Recommended pull-up resistor for open load detection	5	100	
F max.	Max. switching frequency	—	3.5	kHz

## Static Electrical Characteristics

$T_j = -40^{\circ}\text{C}..150^{\circ}\text{C}$ ,  $V_{cc} = 6..28\text{V}$  (unless otherwise specified), typical values are given for  $V_{cc} = 14\text{V}$  and  $T_j = 25^{\circ}\text{C}$

Symbol	Parameter	Min.	Typ.	Max.	Units	Test Conditions
Rds(on)	ON state resistance $T_j = 25^{\circ}\text{C}$	—	110	130	m $\Omega$	Vin=5V, Iout=2.5A
	ON state resistance $T_j = 150^{\circ}\text{C}(1)$	—	190	230		Vin=5V, Iout=2.5A
	ON state resistance $T_j = 25^{\circ}\text{C}$ , $V_{cc} = 6\text{V}$	—	125	155		Vin=5V, Iout=1.5A
	ON state resistance during reverse battery $T_j = 25^{\circ}\text{C}$	—	140	180		Vcc-Gnd=-14V
Vcc op.	Operating voltage range	6	—	28	V	
V clamp 1	Vcc to Out clamp voltage 1	37	39	—		Iout=20mA
V clamp 2	Vcc to Out clamp voltage 2	—	40	—		Iout=2.5A (see Fig. 1)
Icc Off	Supply current when Off and Vout connected to ground with $R < 4\Omega$	—	4	9	$\mu\text{A}$	Vin=0V, Vout=0V, $T_j = 25^{\circ}\text{C}$ , $V_{cc} = 14\text{V}$
Icc On	Supply current when On	—	2.2	5	mA	Vin=5V, Vcc=14V
Vih	Input high threshold voltage	—	2.5	3	V	
Vil	Input low threshold voltage	1.5	2	—		
In hyst.	Input hysteresis	0.2	0.5	1		
Iin On	Input current when device is On	—	40	100	$\mu\text{A}$	Vin=5V
I <sub>dg</sub>	Dg leakage current	—	0.1	10		V <sub>dg</sub> =5V
V <sub>dg</sub>	Low level DG voltage	—	0.25	0.4	V	I <sub>dg</sub> =1.6mA

## Switching Electrical Characteristics

$V_{cc} = 14\text{V}$ , Resistive load=6 $\Omega$ , Vin=5V,  $T_j = -40^{\circ}\text{C}..150^{\circ}\text{C}$ , typical values are given for  $T_j = 25^{\circ}\text{C}$

Symbol	Parameter	Min.	Typ.	Max.	Units	Test Conditions
Tdon	Turn-on delay time	—	5	15	μs	see Fig. 3
Tr1	Rise time to Vout=Vcc-5V	—	3	10		
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	
Tdoff	Turn-off delay time	—	10	20	μs	
Tf	Fall time to Vout=0.1 x Vcc	—	3	10		
dV/dt (Off)	Turn Off dV/dt	—	6.5	—		
EOff	Turn Off energy	—	50	—	μJ	

## Protection Characteristics

T<sub>j</sub>=-40°C..150°C, V<sub>cc</sub>=6..28V (unless otherwise specified), typical values are given for V<sub>cc</sub>=14V and T<sub>j</sub>=25°C

Symbol	Parameter	Min.	Typ.	Max.	Units	Test Conditions
I <sub>lim</sub>	Internal current limit	4	7	10	A	V <sub>out</sub> =0V, T <sub>j</sub> =25°C
T <sub>sd+</sub>	Over temperature high threshold	150(1)	165	—	°C	See fig. 2
T <sub>sd-</sub>	Over temperature low threshold	—	158	—		
V <sub>sc</sub>	Short-circuit detection voltage(2)	2	3	4	V	
UV+	Under voltage protection V <sub>cc</sub> going up	—	5	6.2		
UV-	Under voltage protection V <sub>cc</sub> going down	—	4.5	5.8		
VOL Off	Open load detection threshold	2	3	4		
I <sub>OL</sub> On	Open load detection threshold	0.05	0.17	0.27	A	T <sub>j</sub> =-40..25°C
		0.05	0.15	0.22		T <sub>j</sub> =25..150°C

(1) Guaranteed by design

(2) Reference to V<sub>cc</sub>

## True Table

Operating Conditions	IN	OUT	DG
Normal	H	H	H
Normal	L	L	H
Open Load	H	H	L
Open Load (3)	L	H	L
Short circuit to Gnd	H	L	L
Short circuit to Gnd	L	L	H
Short circuit to V <sub>cc</sub>	H	H	L (4)
Short circuit to V <sub>cc</sub> (5)	L	H	L
Over-temperature	H	L	L
Over-temperature	L	L	H

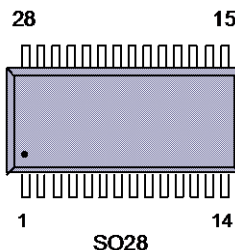
(3) With a pull-up resistor connected between the output and V<sub>cc</sub>.

(4) V<sub>ds</sub> lower than 10mV.

(5) Without a pull-up resistor connected between the output and V<sub>cc</sub>.

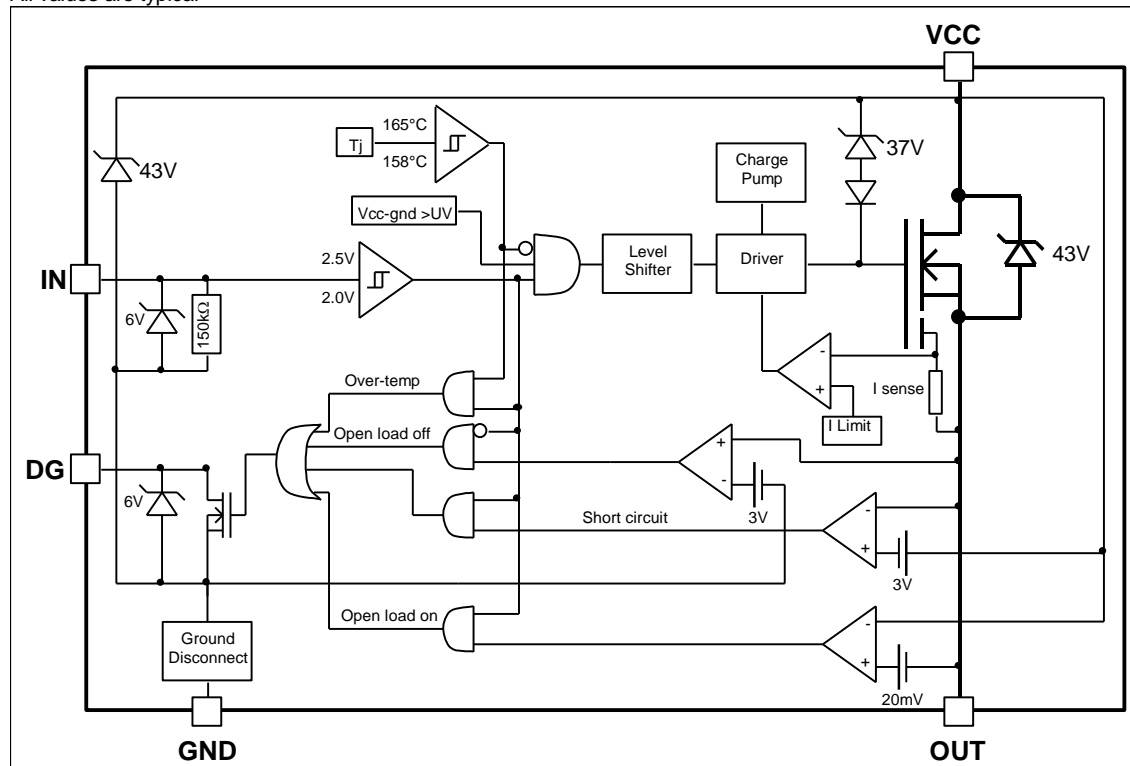
## Lead Assignments

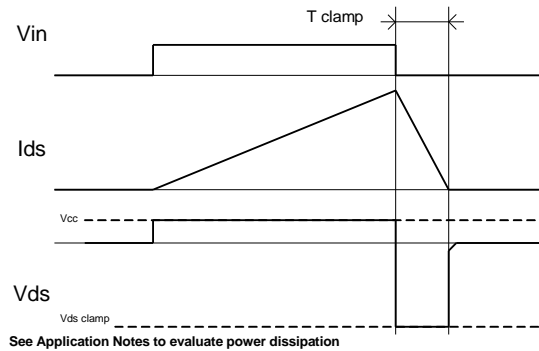
1- Vcc	15- Vcc
2- GND1	16- OUT4
3- IN1	17- OUT4
4- DG1	18- OUT4
5- DG2	19- OUT3
6- IN2	20- OUT3
7- GND2	21- OUT3
8- GND3	22- OUT2
9- IN3	23- OUT2
10- DG3	24- OUT2
11- DG4	25- OUT1
12- IN4	26- OUT1
13- GND4	27- OUT1
14- VCC	28- Vcc



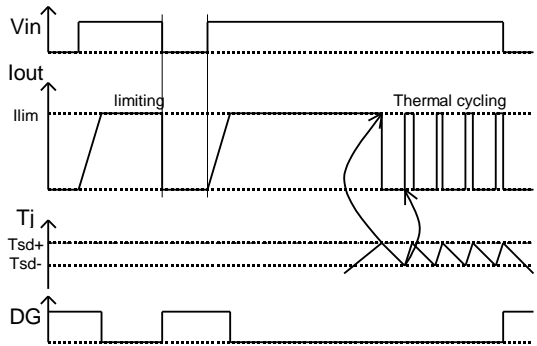
## Functional Block Diagram

All values are typical

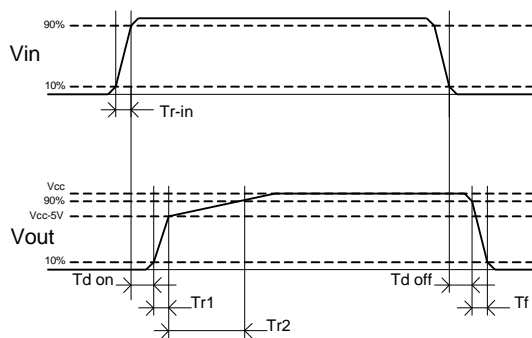




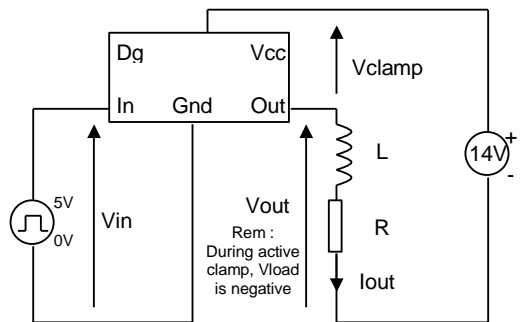
**Figure 1 – Active clamp waveforms**



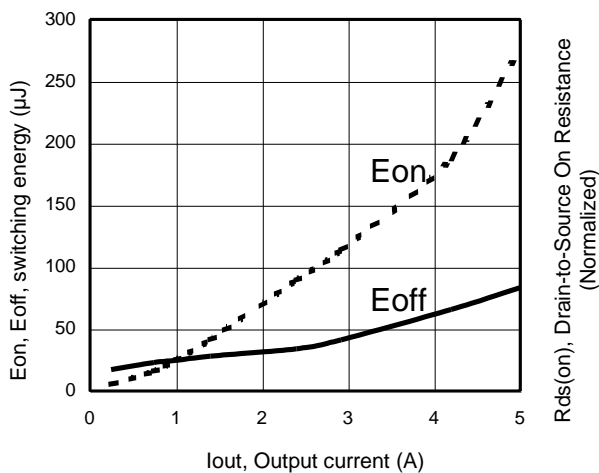
**Figure 2 – Protection timing diagram**



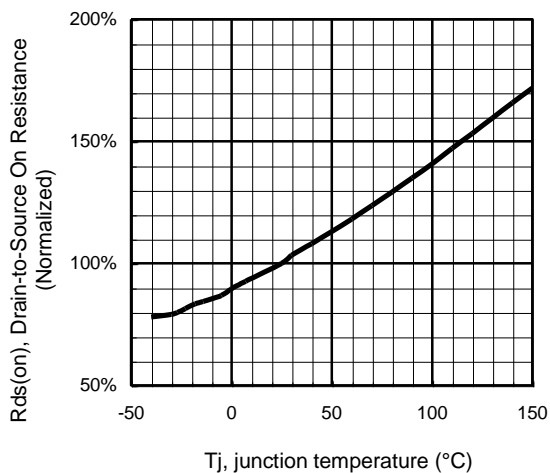
**Figure 3 – Switching times definitions**



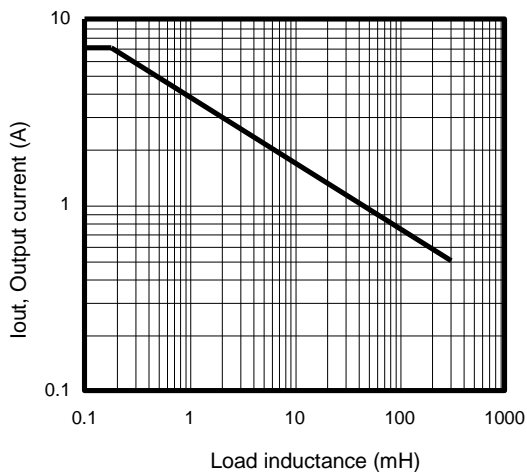
**Figure 4 – Active clamp test circuit**



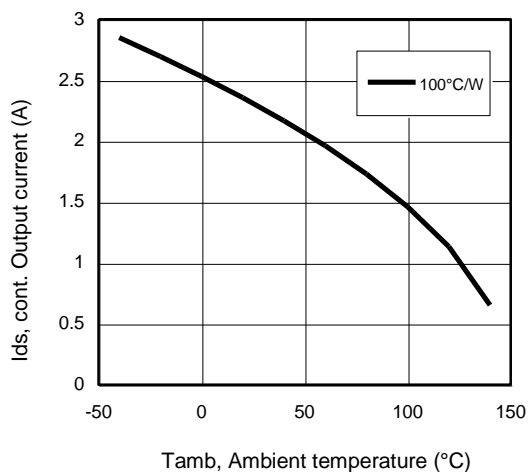
**Figure 5 – Switching energy (μJ) Vs Output current (A)**



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

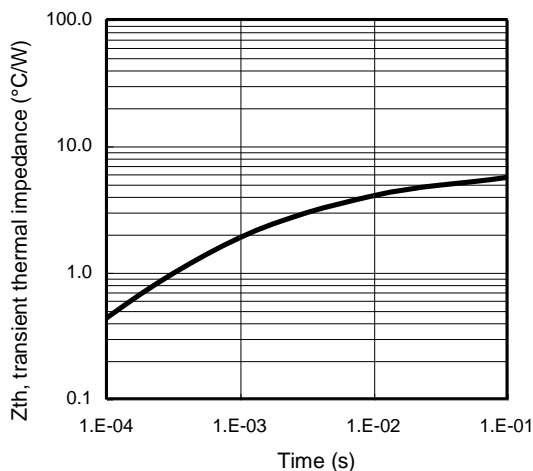


**Figure 7 – Max. Output current (A) Vs Load inductance (mH)**

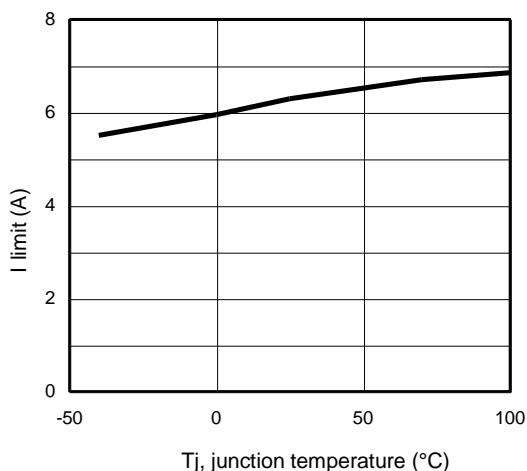


**Figure 8 – Max. output current (A) Vs Ambient temperature (°C)**

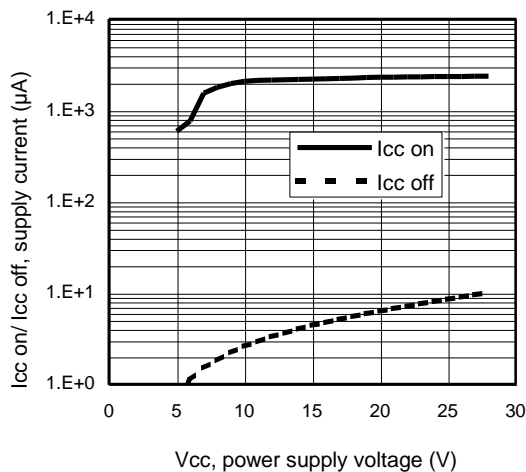




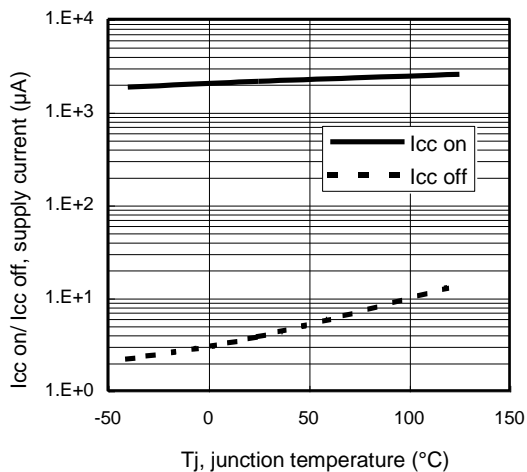
**Figure 9 – Transient thermal impedance (°C/W)  
Vs time (s)**



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



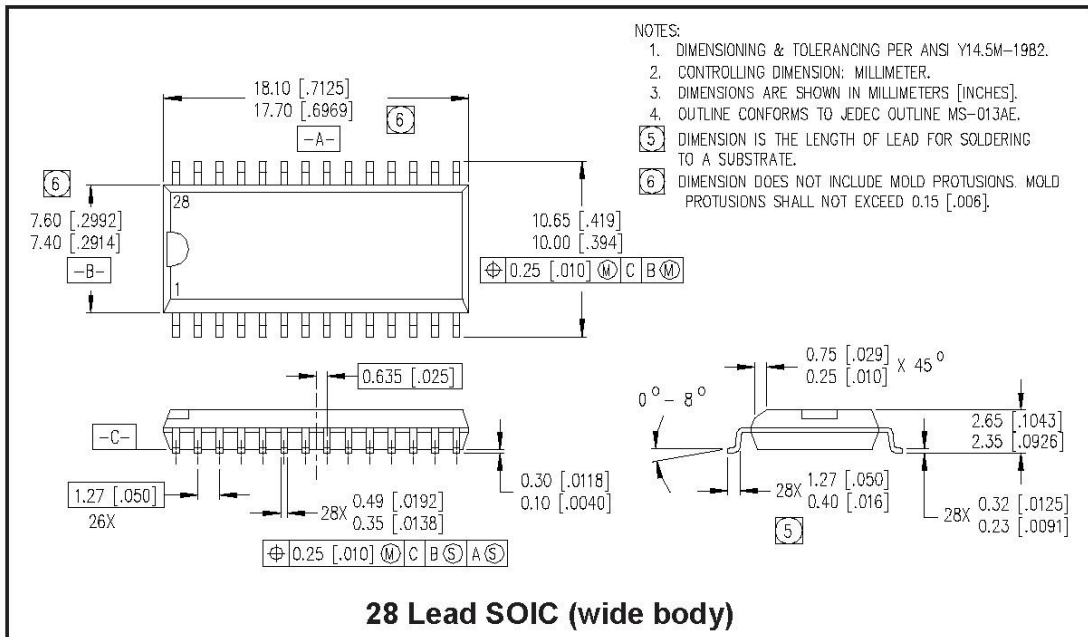
**Figure 11 – I<sub>cc on</sub>/ I<sub>cc off</sub> (µA) Vs V<sub>cc</sub> (V)\***



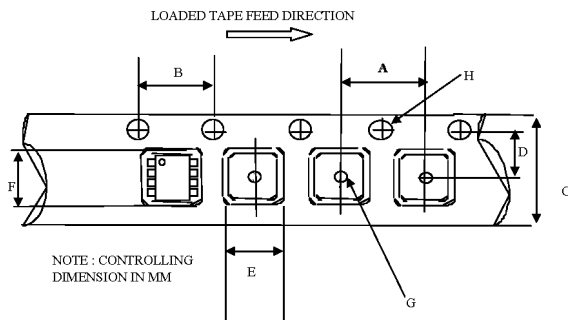
**Figure 12 – I<sub>cc on</sub>/ I<sub>cc off</sub> (µA) Vs T<sub>j</sub> (°C)\***

\*V<sub>out</sub> connected to ground with R<4Ω

## Case Outline – SO28

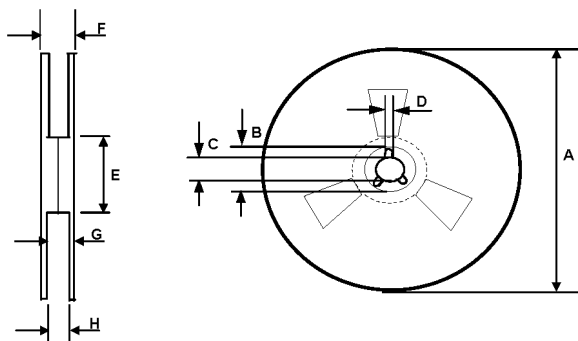


## Tape & Reel – SO28



CARRIER TAPE DIMENSION FOR 28SOICW

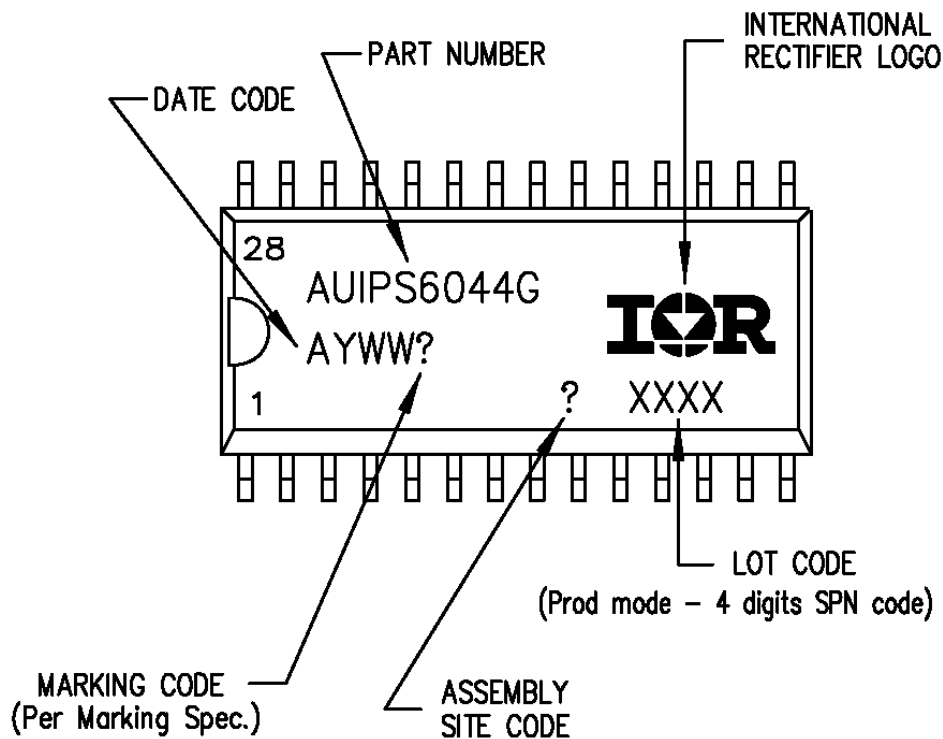
Code	Metric		Imperial	
	Min	Max	Min	Max
A	11.90	12.10	0.468	0.476
B	3.90	4.10	0.153	0.161
C	23.70	24.30	0.933	0.956
D	11.40	11.60	0.448	0.456
E	10.80	11.00	0.425	0.433
F	18.20	18.40	0.716	0.724
G	1.50	n/a	0.059	n/a
H	1.50	1.60	0.059	0.062



REEL DIMENSIONS FOR 28SOICW

Code	Metric		Imperial	
	Min	Max	Min	Max
A	329.60	330.25	12.976	13.001
B	20.95	21.45	0.824	0.844
C	12.80	13.20	0.503	0.519
D	1.95	2.45	0.767	0.096
E	98.00	102.00	3.858	4.015
F	n/a	30.40	n/a	1.196
G	26.50	29.10	1.04	1.145
H	24.40	26.40	0.96	1.039

## Part Marking Information



## Ordering Information

Base Part Number	Package Type	Standard Pack		Complete Part Number
		Form	Quantity	
AUIPS6044G	SOIC-28	Tube	30	AUIPS6044G
		Tape and reel	1000	AUIPS6044GTR

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**WORLD HEADQUARTERS:**

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## Revision History

Revision	Date	Notes/Changes
B2	September, 12th 2011	AU release
B3	December, 10 <sup>th</sup> 2011	Update qualification page
C	May 15, 2012	Add the test condition for the ICC (off) parameters

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