

# 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.

## Product Summary

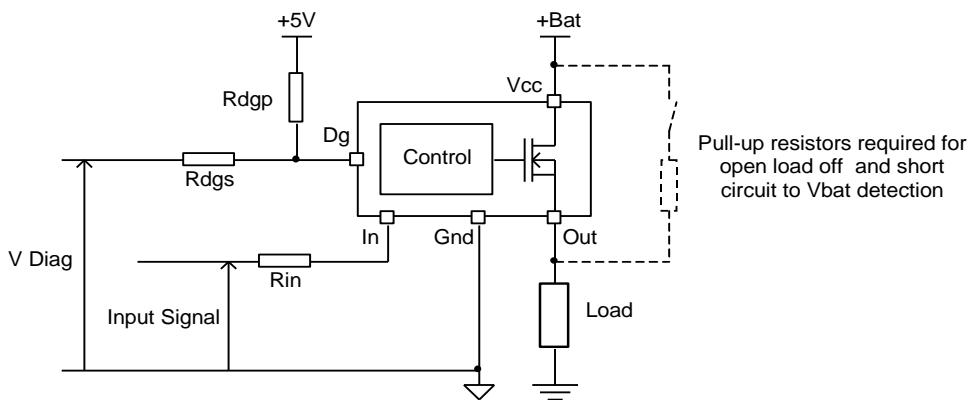
Rds(on)	130m $\Omega$ max.
Vclamp	39V
I Limit	7A
Open load	3V / 0.22A

## Package



## SOIC28 Wide body

## Typical Connection



**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 M2 (+/-150V) <sup>†††</sup> (per AEC-Q100-003)
	Human Body Model	Class H1C (+/-1500V) <sup>†††</sup> (per AEC-Q100-002)
	Charged Device Model	Class C4 (+/-900V) <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	

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

<sup>††</sup> Exceptions to AEC-Q100 requirements are noted in the qualification report.

<sup>†††</sup> 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.  $T_j = -40^\circ\text{C}..150^\circ\text{C}$ ,  $V_{cc}=6..35\text{V}$  (unless otherwise specified).

Symbol	Parameter	Min.	Max.	Units
Vout	Maximum output voltage	Vcc-35	Vcc+0.3	V
Voffset	Maximum logic ground to load ground offset	Vcc-35	Vcc+0.3	
Vin	Maximum input voltage	-0.3	5.5	
Vcc max.	Maximum Vcc voltage	—	36	
Vcc cont.	Maximum continuous Vcc voltage	—	28	
Iin max.	Maximum IN current	-3	10	
Idg max.	Maximum diagnostic output current	-3	10	
Vdg	Maximum diagnostic output voltage	-0.3	5.5	V
Pd	Maximum power dissipation (internally limited by thermal protection) Rth=130°C/W per channel	—	3.8	W
Tj max.	Max. storage & operating temperature junction temperature	-40	150	°C

## Thermal Characteristics

Symbol	Parameter	Typ.	Max.	Units
Rth1	Thermal resistance junction to ambient 1" sqrt. Footprint / 1 channel On	50	—	°C/W
Rth2	Thermal resistance junction to ambient 1" sqrt. Footprint / 2 channels On	100	—	
Rth3	Thermal resistance junction to ambient 1" sqrt. Footprint / 4 channels On	130	—	

note :  $T_j = \text{Power dissipated in one channel} \times R_{th}$

## 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	A
VIL	Low level input voltage	0	0.9	
Iout	Continuous drain current, Rth=130°C/W, $T_j=150^\circ\text{C}$ , 4 channels On Tambient=85°C / 1" sqrt. footprint	—	1.5	kΩ
	Tambient=105°C / 1" sqrt. footprint	—	1.2	
	Recomm. resistor in series with IN pin	4	10	
Rin	Recomm. resistor in series with DG pin for reverse battery protection	4	20	kHz
Rdgs	Recomm. pull-up resistor for DG	4	20	
Rdgp	Recomm. pull-up resistor for open load detection	5	100	
F max.	Max. switching frequency	—	3.5	kHz

## Static Electrical 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
R <sub>ds(on)</sub>	ON state resistance T <sub>j</sub> =25°C	—	110	130	mΩ	V <sub>in</sub> =5V, I <sub>out</sub> =2.5A
	ON state resistance T <sub>j</sub> =150°C(1)	—	190	230		V <sub>in</sub> =5V, I <sub>out</sub> =2.5A
	ON state resistance T <sub>j</sub> =25°C, V <sub>cc</sub> =6V	—	125	155		V <sub>in</sub> =5V, I <sub>out</sub> =1.5A
	ON state resistance during reverse battery T <sub>j</sub> =25°C	—	140	180		V <sub>cc</sub> -Gnd=-14V
V <sub>cc</sub> op.	Operating voltage range	6	—	28	V	
V clamp 1	V <sub>cc</sub> to Out clamp voltage 1	37	39	—		I <sub>out</sub> =20mA
V clamp 2	V <sub>cc</sub> to Out clamp voltage 2	—	40	—		I <sub>out</sub> =2.5A (see Fig. 1)
I <sub>cc</sub> Off	Supply current when Off and V <sub>out</sub> connected to ground with R<4Ω	—	4	9	μA	V <sub>in</sub> =0V, V <sub>out</sub> =0V, T <sub>j</sub> =25°C, V <sub>cc</sub> =14V
I <sub>cc</sub> On	Supply current when On	—	2.2	5	mA	V <sub>in</sub> =5V, V <sub>cc</sub> =14V
V <sub>ih</sub>	Input high threshold voltage	—	2.5	3	V	
V <sub>il</sub>	Input low threshold voltage	1.5	2	—		
In hyst.	Input hysteresis	0.2	0.5	1		
I <sub>in</sub> On	Input current when device is On	—	40	100	μA	V <sub>in</sub> =5V
I <sub>dg</sub>	Dg leakage current	—	0.1	10	V	V <sub>dg</sub> =5V
V <sub>dg</sub>	Low level DG voltage	—	0.25	0.4		I <sub>dg</sub> =1.6mA

## Switching Electrical Characteristics

V<sub>cc</sub>=14V, Resistive load=6Ω, V<sub>in</sub>=5V, T<sub>j</sub>=-40°C..150°C, typical values are given for T<sub>j</sub>=25°C

Symbol	Parameter	Min.	Typ.	Max.	Units	Test Conditions
T <sub>don</sub>	Turn-on delay time	—	5	15	μs	see Fig. 3
T <sub>r1</sub>	Rise time to V <sub>out</sub> =V <sub>cc</sub> -5V	—	3	10		
T <sub>r2</sub>	Rise time to V <sub>out</sub> =0.9 x V <sub>cc</sub>	—	4	30		
dV/dt (On)	Turn On dV/dt	—	2.5	—		
E <sub>On</sub>	Turn On energy	—	100	—		
T <sub>doff</sub>	Turn-off delay time	—	10	20		
T <sub>f</sub>	Fall time to V <sub>out</sub> =0.1 x V <sub>cc</sub>	—	3	10		
dV/dt (Off)	Turn Off dV/dt	—	6.5	—		
E <sub>Off</sub>	Turn Off energy	—	50	—		

## 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		
UV+	Under voltage protection V <sub>cc</sub> going up	—	5	6.2	V	
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

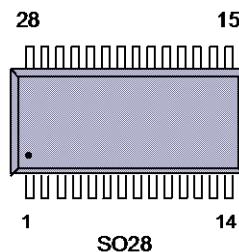
(3) With a pull-up resistor connected between the output and V<sub>cc</sub>.

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

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

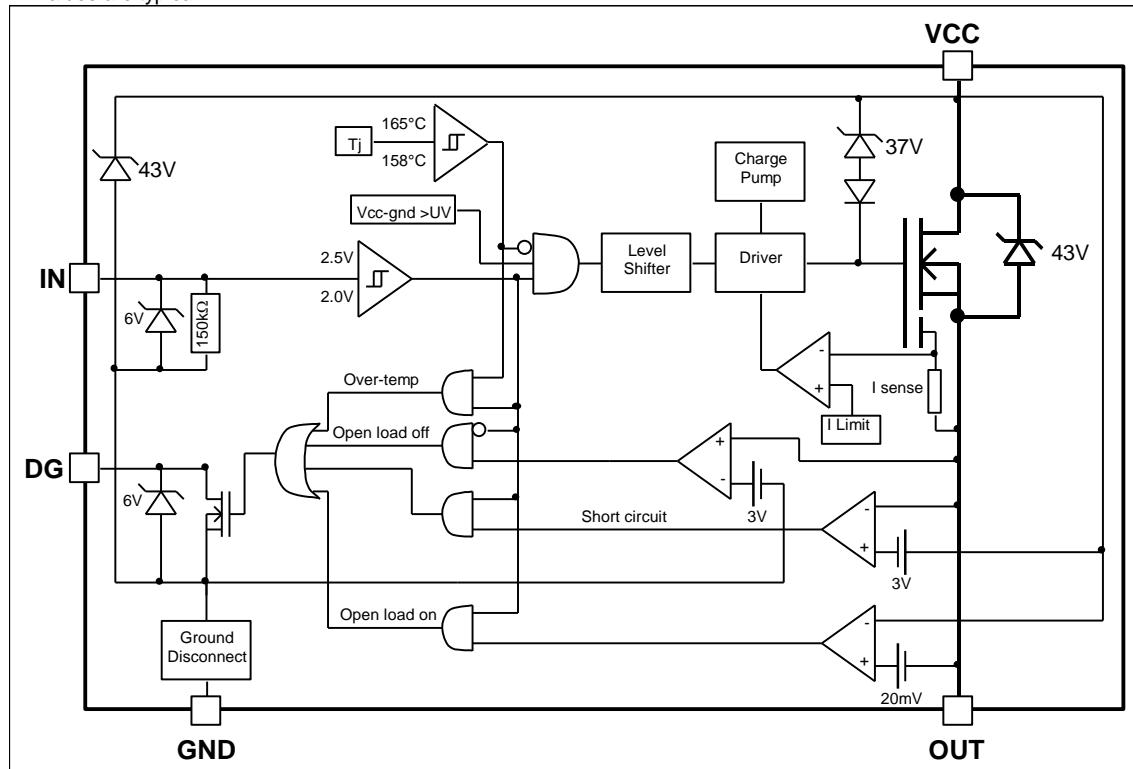
## Lead Assignments

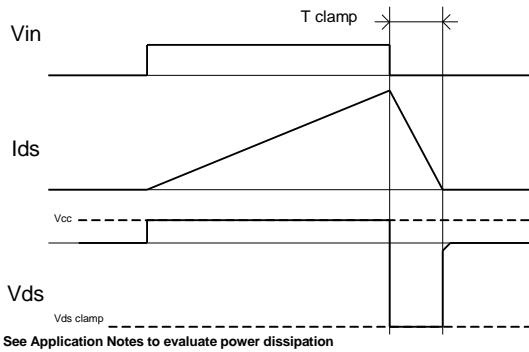
1- V <sub>cc</sub>	15- V <sub>cc</sub>
2- GND1	16- OUT4
3- IN1	17- OUT4
4- DG1	18- OUT4
5- DG2	19- OUT3
6- IN2	20- OUT3
7- GND2	21- OUT3
8- GND3	22- OUT2
9- IN3	23- OUT2
10- DG3	24- OUT2
11- DG4	25- OUT1
12- IN4	26- OUT1
13- GND4	27- OUT1
14- VCC	28- V <sub>cc</sub>



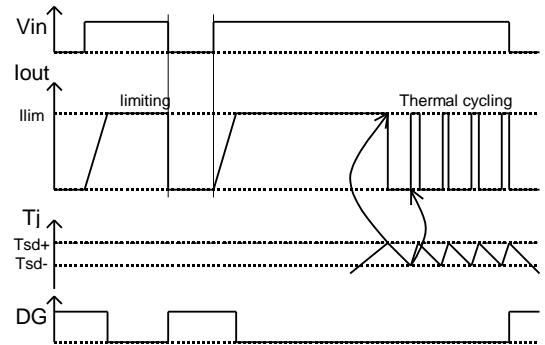
## Functional Block Diagram

All values are typical

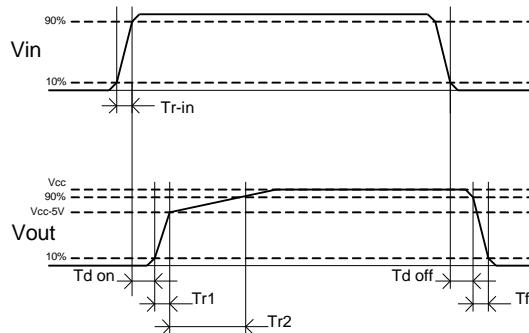




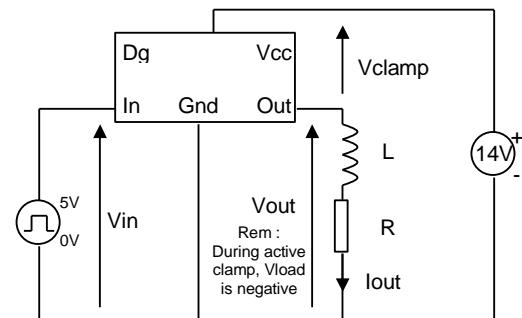
**Figure 1 – Active clamp waveforms**



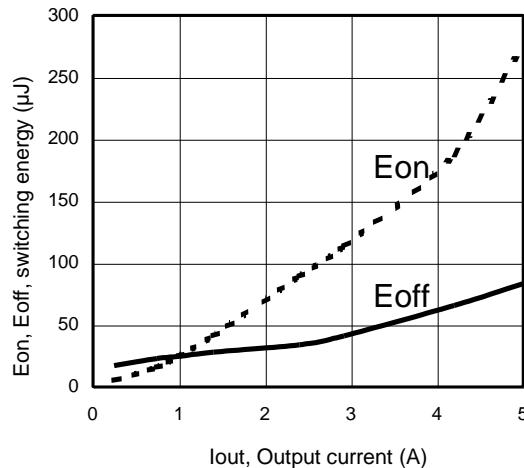
**Figure 2 – Protection timing diagram**



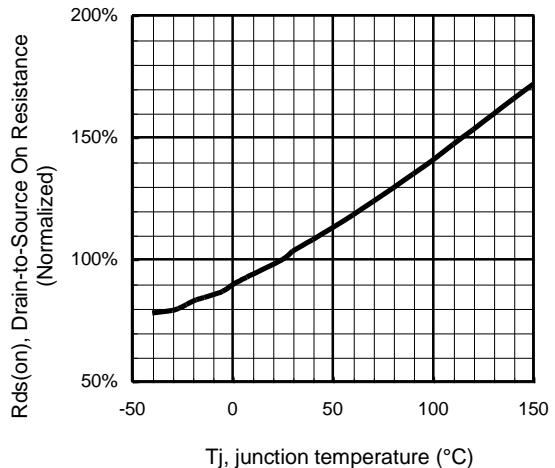
**Figure 3 – Switching times definitions**



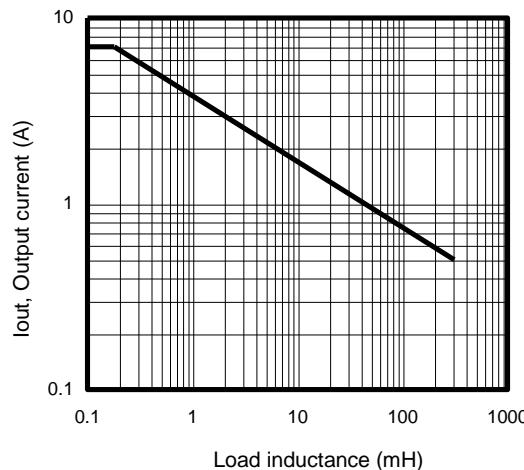
**Figure 4 – Active clamp test circuit**



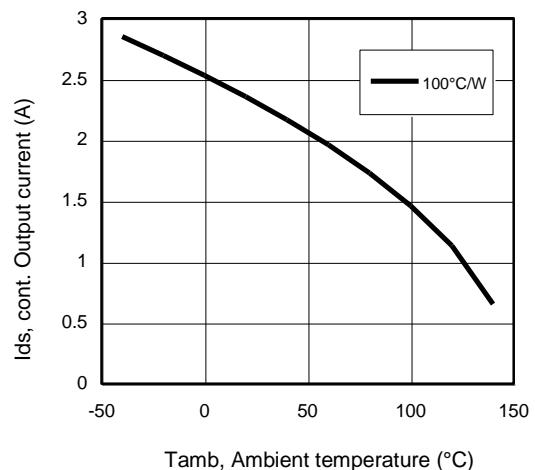
**Figure 5 – Switching energy ( $\mu$ J) Vs Output current (A)**



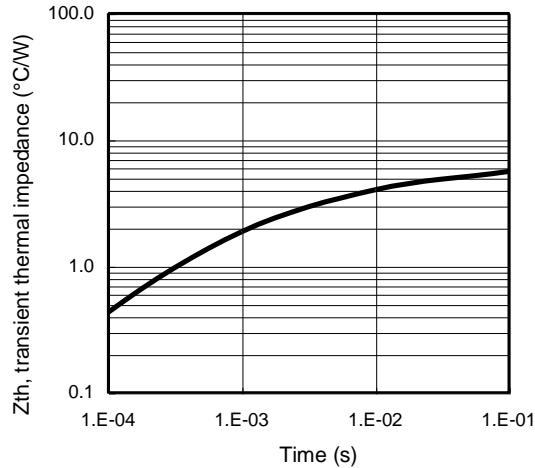
**Figure 6 - Normalized  $R_{ds(on)}$  (%) Vs  $T_j$  (°C)**



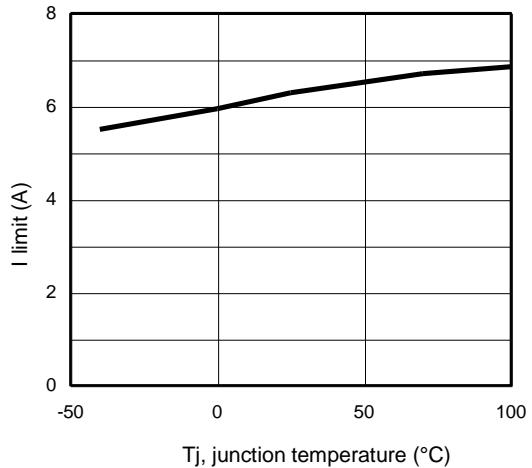
**Figure 7 – Max. Output current (A) Vs Load inductance (mH)**



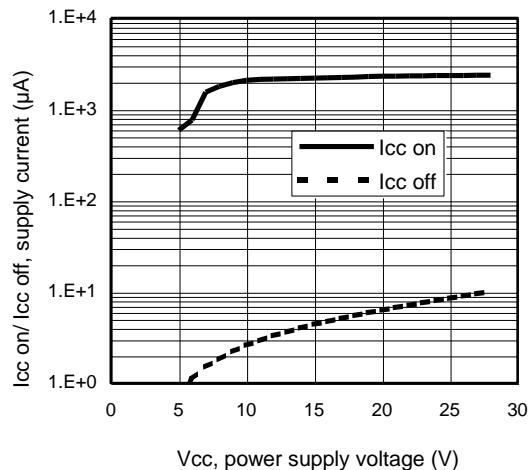
**Figure 8 – Max. output current (A) Vs Ambient temperature (°C)**



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

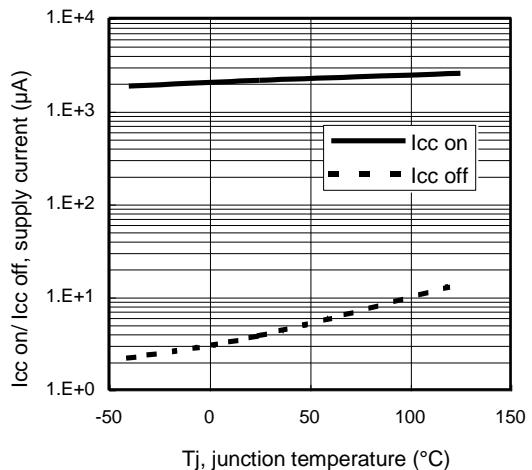


**Figure 10 –I limit (A)**  
**Vs junction temperature (°C)**



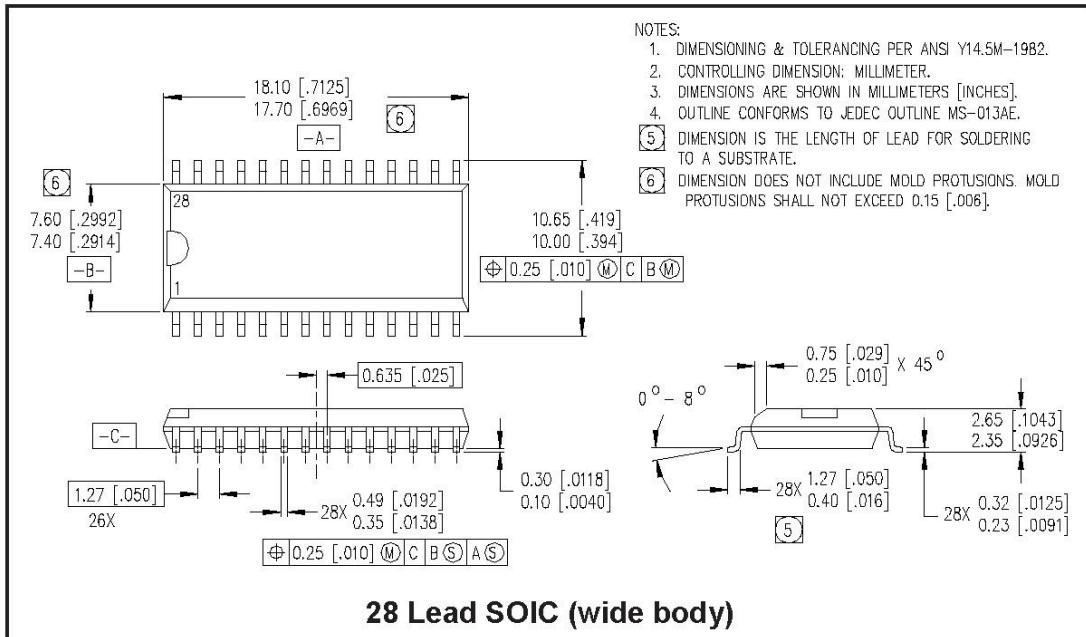
**Figure 11 – Icc on/ Icc off (µA) Vs Vcc (V)\***

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

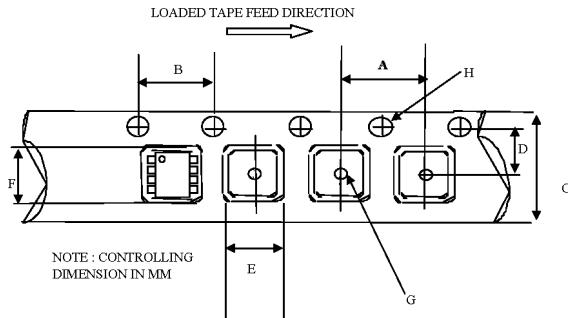


**Figure 12 – Icc on/ Icc off (µA) Vs T<sub>j</sub> (°C)\***

**Case Outline – SO28**

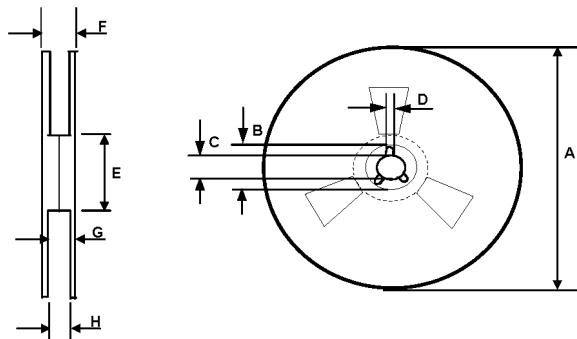


**Tape & Reel – SO28**



CARRIER TAPE DIMENSION FOR 28SOICW

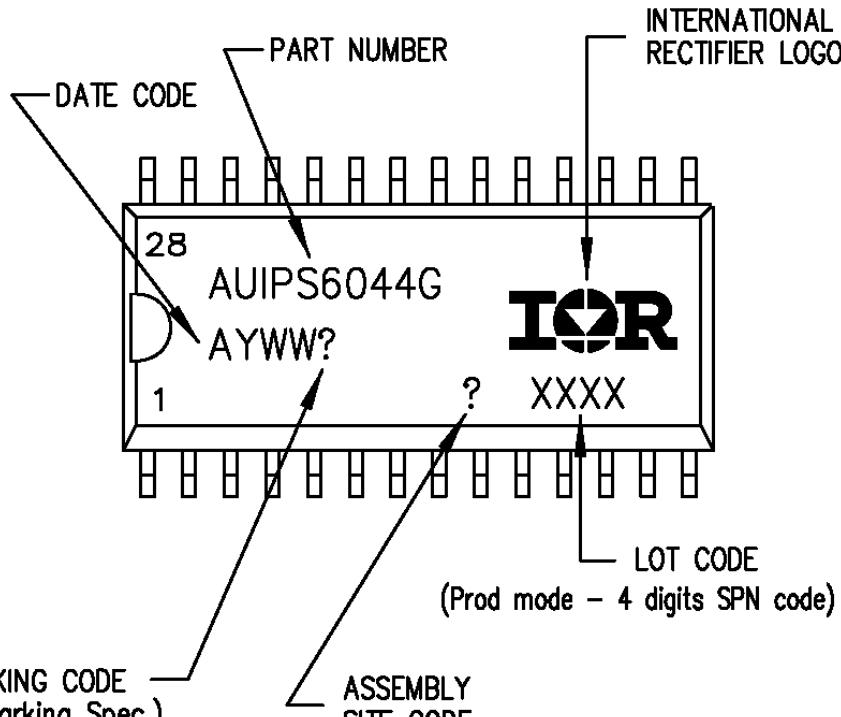
Code	Metric		Imperial	
	Min	Max	Min	Max
A	11.90	12.10	0.468	0.476
B	3.90	4.10	0.153	0.161
C	23.70	24.30	0.933	0.956
D	11.40	11.60	0.448	0.456
E	10.80	11.00	0.425	0.433
F	18.20	18.40	0.716	0.724
G	1.50	n/a	0.059	n/a
H	1.50	1.60	0.059	0.062



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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## Revision History

<b>Revision</b>	<b>Date</b>	<b>Notes/Changes</b>
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