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INTELLIGENT POWER HIGH SIDE SWITCH

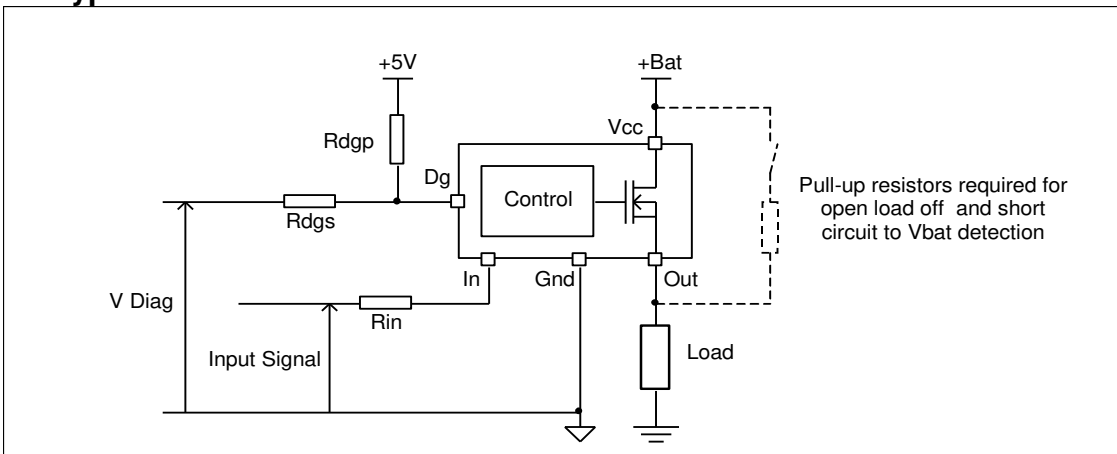
Features

- 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 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.

Typical Connection



Product Summary

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

Package



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		SOIC-28L	MSL2, 260°C (per IPC/JEDEC J-STD-020)
ESD	Machine Model	Class M2 (+/-150V) ^{†††} (per AEC-Q100-003)	
	Human Body Model	Class H1C (+/-1500V) ^{†††} (per AEC-Q100-002)	
	Charged Device Model	Class C4 (+/-900V) ^{†††} (per AEC-Q100-011)	
IC Latch-Up Test		Class II, Level A (per AEC-Q100-004)	
RoHS Compliant		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. $T_j = -40^{\circ}\text{C}..150^{\circ}\text{C}$, $V_{cc}=6..35\text{V}$ (unless otherwise specified).

Symbol	Parameter	Min.	Max.	Units
Vout	Maximum output voltage	$V_{cc}-35$	$V_{cc}+0.3$	V
Voffset	Maximum logic ground to load ground offset	$V_{cc}-35$	$V_{cc}+0.3$	
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	mA
I _{dg} max.	Maximum diagnostic output current	-3	10	
V _{dg}	Maximum diagnostic output voltage	-0.3	5.5	V
P _d	Maximum power dissipation (internally limited by thermal protection) R _{th} =130°C/W per channel	—	3.8	W
T _j 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
V _{IH}	High level input voltage	4	5.5	
V _{IL}	Low level input voltage	0	0.9	
I _{out}	Continuous drain current, R _{th} =130°C/W, T _j =150°C, 4 channels On $\frac{T_{\text{ambient}}=85^{\circ}\text{C} / 1" \text{ sqrt. footprint}}{T_{\text{ambient}}=105^{\circ}\text{C} / 1" \text{ sqrt. footprint}}$	—	1.5 1.2	A
R _{in}	Recommended resistor in series with IN pin	4	10	kΩ
R _{dgs}	Recommended resistor in series with DG pin for reverse battery protection	4	20	
R _{dgp}	Recommended pull-up resistor for DG	4	20	
R _{ol}	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 Ω	$V_{in} = 5\text{V}$, $I_{out} = 2.5\text{A}$
	ON state resistance $T_j = 150^{\circ}\text{C}(1)$	—	190	230		$V_{in} = 5\text{V}$, $I_{out} = 2.5\text{A}$
	ON state resistance $T_j = 25^{\circ}\text{C}$, $V_{cc} = 6\text{V}$	—	125	155		$V_{in} = 5\text{V}$, $I_{out} = 1.5\text{A}$
	ON state resistance during reverse battery $T_j = 25^{\circ}\text{C}$	—	140	180		$V_{cc} - Gnd = -14\text{V}$
Vcc op.	Operating voltage range	6	—	28	V	
V clamp 1	Vcc to Out clamp voltage 1	37	39	—		$I_{out} = 20\text{mA}$
V clamp 2	Vcc to Out clamp voltage 2	—	40	—		$I_{out} = 2.5\text{A}$ (see Fig. 1)
Icc Off	Supply current when Off and Vout connected to ground with $R < 4\Omega$	—	4	9	μA	$V_{in} = 0\text{V}$, $V_{out} = 0\text{V}$, $T_j = 25^{\circ}\text{C}$, $V_{cc} = 14\text{V}$
Icc On	Supply current when On	—	2.2	5	mA	$V_{in} = 5\text{V}$, $V_{cc} = 14\text{V}$
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	μA	$V_{in} = 5\text{V}$
I _{dg}	Dg leakage current	—	0.1	10		$V_{dg} = 5\text{V}$
V _{dg}	Low level DG voltage	—	0.25	0.4		V

Switching Electrical Characteristics

$V_{cc} = 14\text{V}$, Resistive load = 6Ω , $V_{in} = 5\text{V}$, $T_j = -40^{\circ}\text{C}..150^{\circ}\text{C}$, 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 $V_{out} = V_{cc} - 5\text{V}$	—	3	10		
Tr2	Rise time to $V_{out} = 0.9 \times V_{cc}$	—	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 $V_{out} = 0.1 \times V_{cc}$	—	3	10		
dV/dt (Off)	Turn Off dV/dt	—	6.5	—	V/ μs	
EOff	Turn Off energy	—	50	—	μJ	

Protection 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
Ilim	Internal current limit	4	7	10	A	$V_{out} = 0\text{V}$, $T_j = 25^{\circ}\text{C}$
Tsd+	Over temperature high threshold	150(1)	165	—	°C	See fig. 2
Tsd-	Over temperature low threshold	—	158	—		
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		
VOL Off	Open load detection threshold	2	3	4		
I OL On	Open load detection threshold	0.05	0.17	0.27	A	$T_j = -40..25^{\circ}\text{C}$
		0.05	0.15	0.22		$T_j = 25..150^{\circ}\text{C}$

(1) Guaranteed by design

(2) Reference to Vcc

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 Vcc	H	H	L (4)
Short circuit to Vcc (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 Vcc.

(4) Vds lower than 10mV.

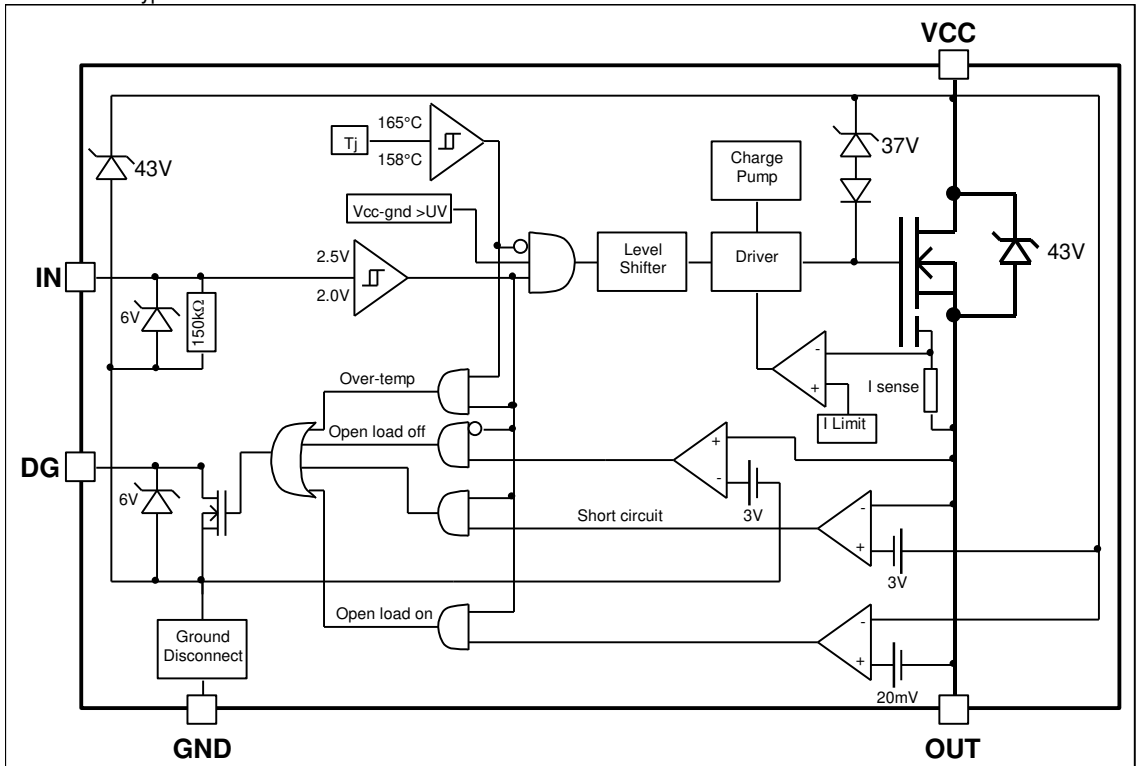
(5) Without a pull-up resistor connected between the output and Vcc.

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



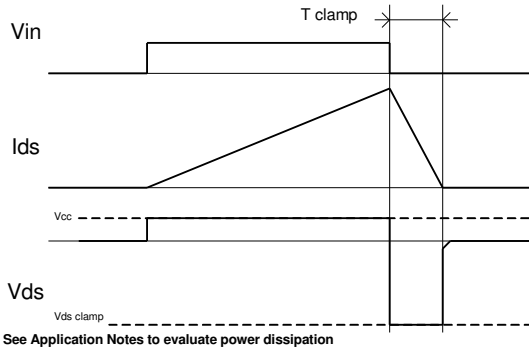


Figure 1 – Active clamp waveforms

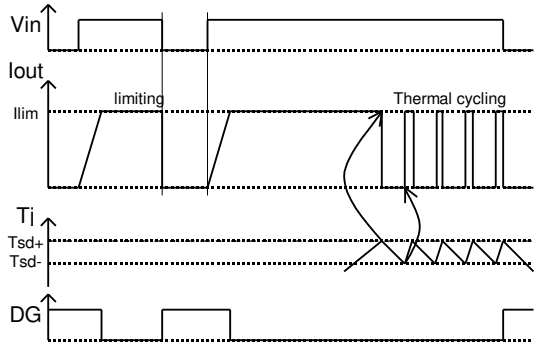


Figure 2 – Protection timing diagram

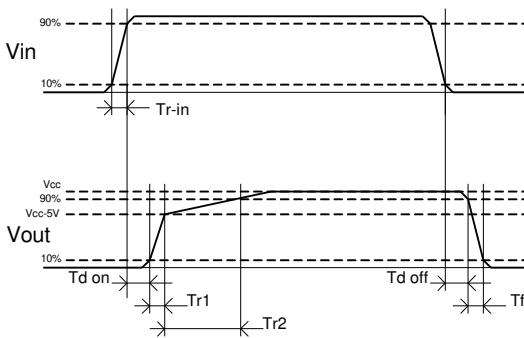


Figure 3 – Switching times definitions

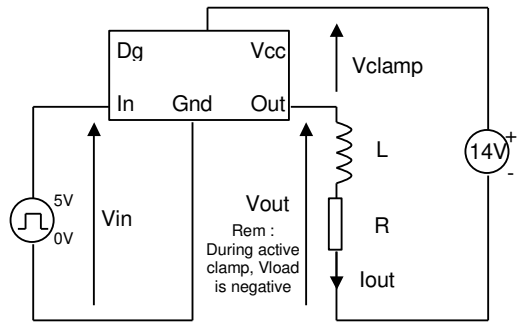


Figure 4 – Active clamp test circuit

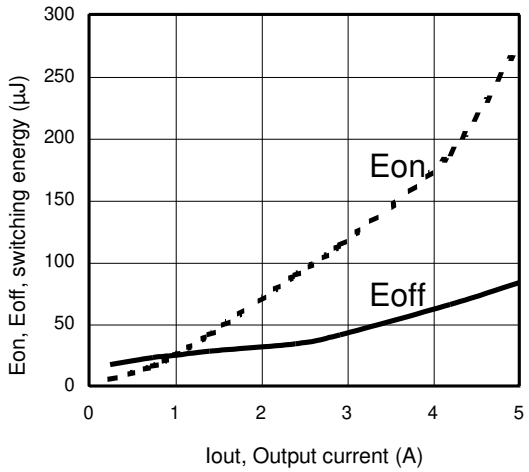


Figure 5 – Switching energy (μJ) Vs Output current (A)

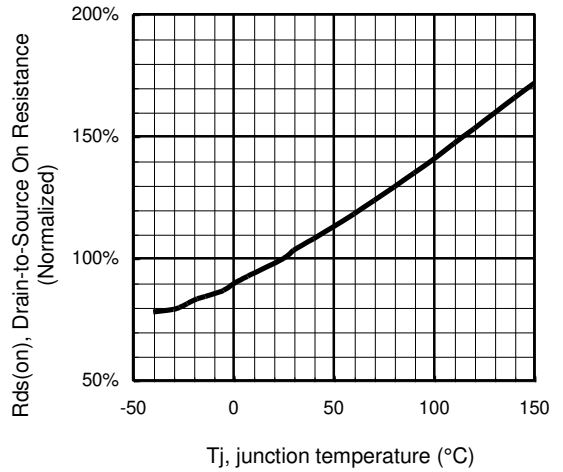


Figure 6 - Normalized R_{ds(on)} (%) Vs T_j (°C)

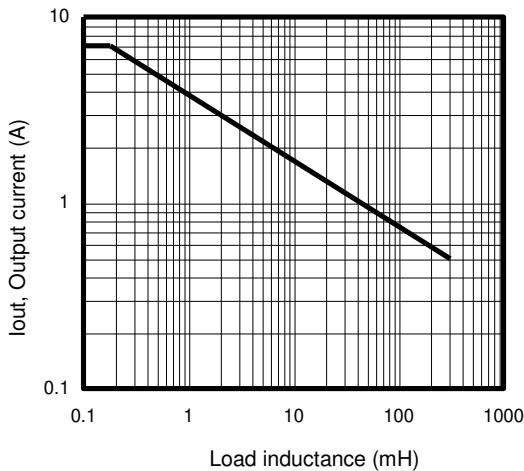


Figure 7 – Max. Output current (A) Vs Load inductance (mH)

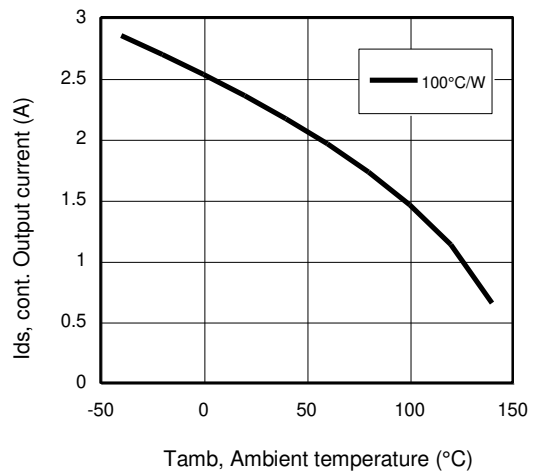


Figure 8 – Max. output current (A) Vs Ambient temperature (°C)

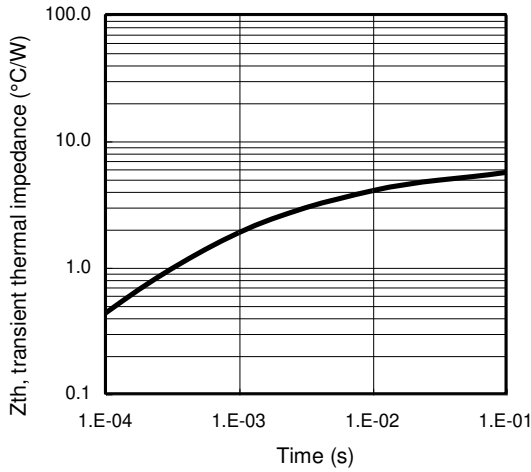


Figure 9 – Transient thermal impedance (°C/W) Vs time (s)

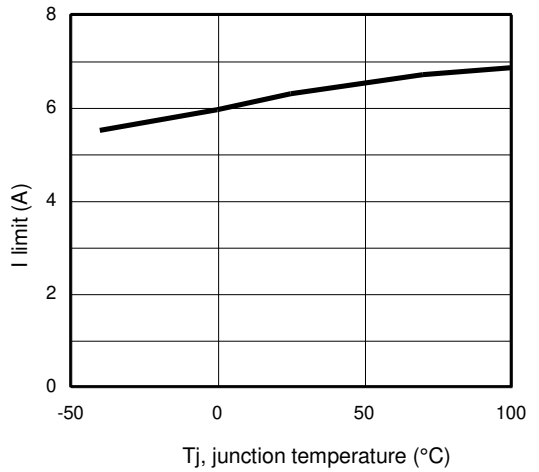


Figure 10 – I limit (A) Vs junction temperature (°C)

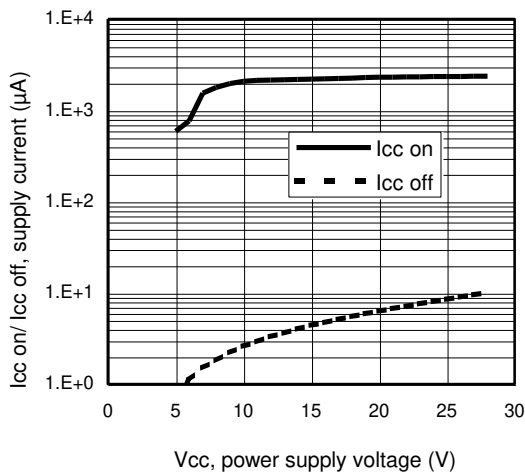


Figure 11 – Icc on/ Icc off (µA) Vs Vcc (V)*

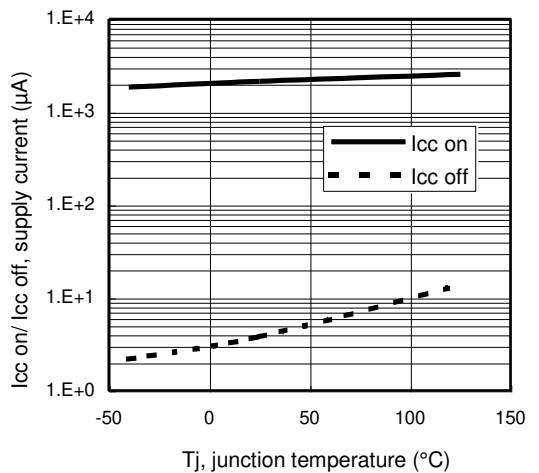
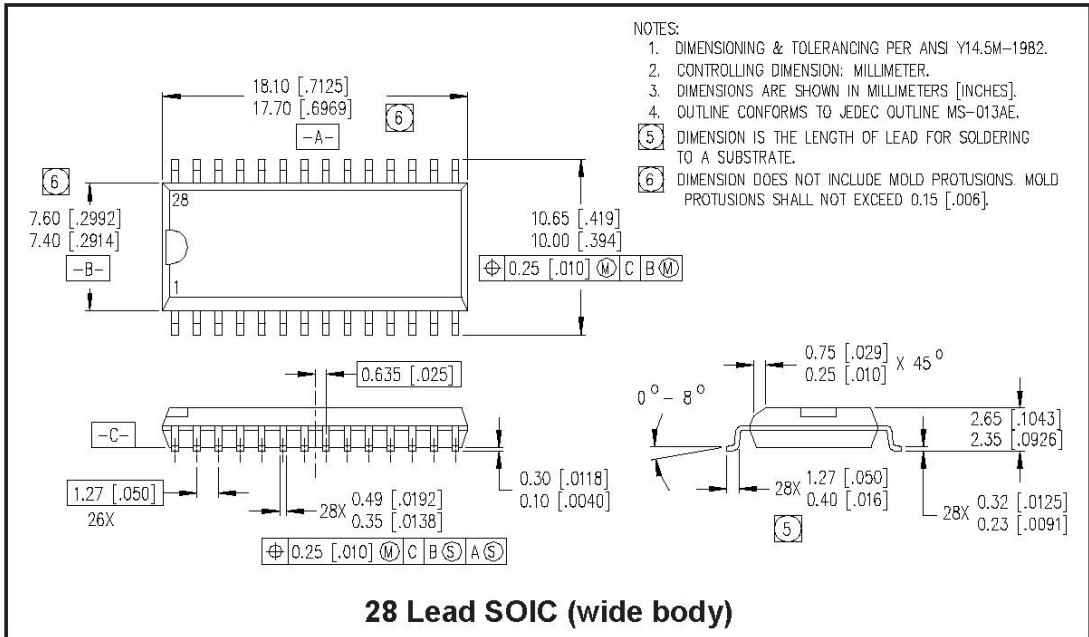


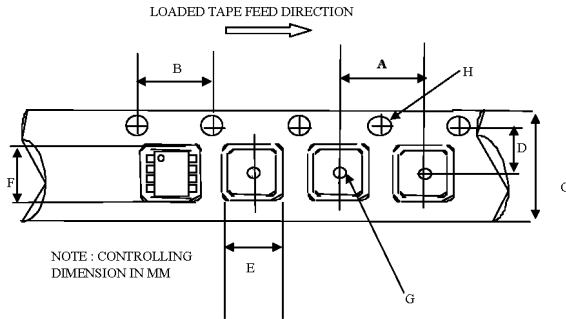
Figure 12 – Icc on/ Icc off (µA) Vs Tj (°C)*

*Vout connected to ground with R<4Ω

Case Outline – SO28

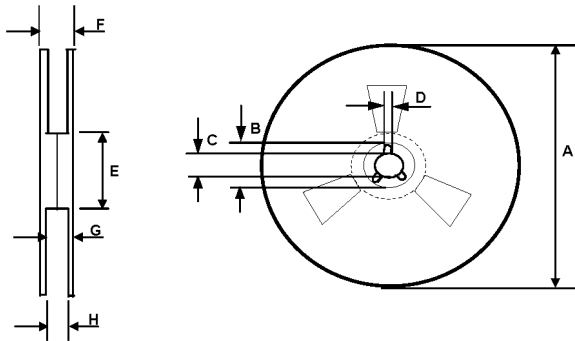


Tape & Reel – SO28



CARRIER TAPE DIMENSION FOR 28SOICW

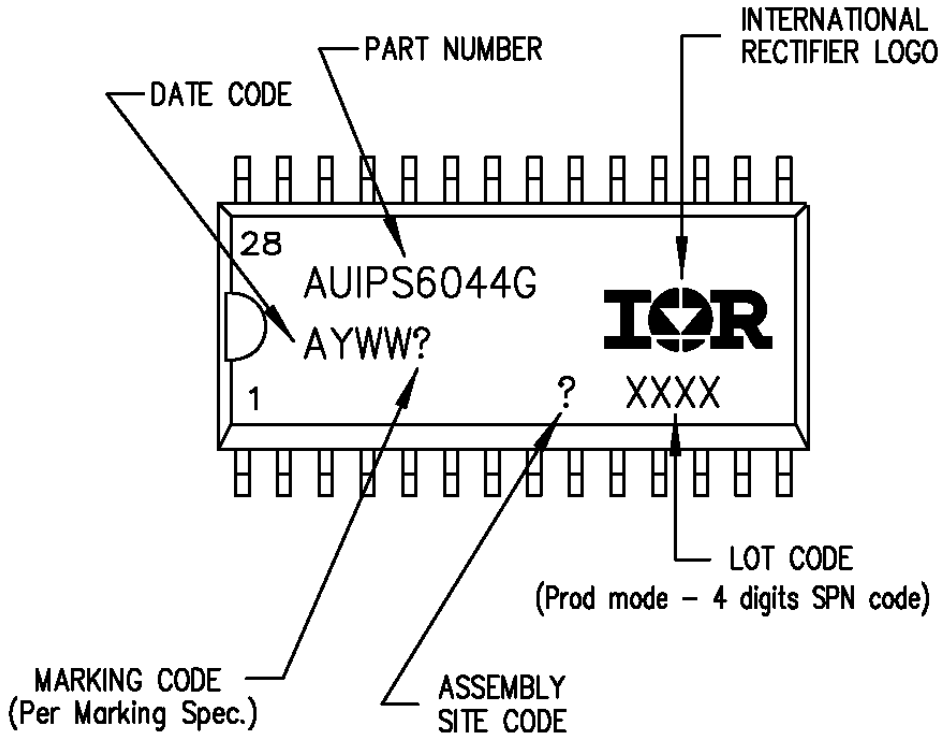
Code	Metric		Imperial	
	Min	Max	Min	Max
A	11.90	12.10	0.468	0.476
B	3.90	4.10	0.153	0.161
C	23.70	24.30	0.933	0.956
D	11.40	11.60	0.448	0.456
E	10.80	11.00	0.425	0.433
F	18.20	18.40	0.716	0.724
G	1.50	n/a	0.059	n/a
H	1.50	1.60	0.059	0.062



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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Revision History

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