

INTELLIGENT POWER HIGH SIDE SWITCH

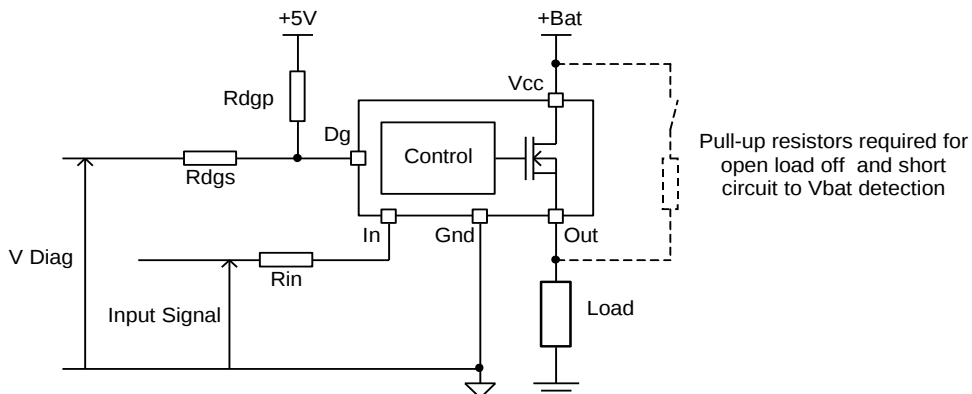
Features

- 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°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 Ω max.
V_{clamp}	39V
I_{Limit}	7A
Open load	3V / 0.22A

Package



SOIC28 Wide body

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. 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	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	mA
I _{dg} max.	Maximum diagnostic output current	-3	10	
V _{dg}	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 : Tj=Power dissipated in one channel x Rth

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	
Iout	Continuous drain current, Rth=130°C/W, Tj=150°C, 4 channels On Tambient=85°C / 1" sqrt. footprint Tambient=105°C / 1" sqrt. footprint	— —	1.5 1.2	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	
Rol	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
R _{ds(on)}	ON state resistance $T_j = 25^{\circ}\text{C}$	—	110	130	m Ω	V _{in} =5V, I _{out} =2.5A
	ON state resistance $T_j = 150^{\circ}\text{C}(1)$	—	190	230		V _{in} =5V, I _{out} =2.5A
	ON state resistance $T_j = 25^{\circ}\text{C}$, $V_{cc} = 6\text{V}$	—	125	155		V _{in} =5V, I _{out} =1.5A
	ON state resistance during reverse battery $T_j = 25^{\circ}\text{C}$	—	140	180		V _{cc} -Gnd=-14V
V _{cc op.}	Operating voltage range	6	—	28	V	
V clamp 1	V _{cc} to Out clamp voltage 1	37	39	—		I _{out} =20mA
V clamp 2	V _{cc} to Out clamp voltage 2	—	40	—		I _{out} =2.5A (see Fig. 1)
I _{cc Off}	Supply current when Off	—	4	9	μA	V _{in} =0V, V _{out} =0V, $T_j = 25^{\circ}\text{C}$, $V_{cc} = 14\text{V}$
I _{cc On}	Supply current when On	—	2.2	5	mA	V _{in} =5V, $V_{cc} = 14\text{V}$
V _{ih}	Input high threshold voltage	—	2.5	3	V	
V _{il}	Input low threshold voltage	1.5	2	—		
I _{n hyst.}	Input hysteresis	0.2	0.5	1		
I _{in On}	Input current when device is On	—	40	100	μA	V _{in} =5V
I _{dg}	Dg leakage current	—	0.1	10		V _{dg} =5V
V _{dg}	Low level DG voltage	—	0.25	0.4	V	I _{dg} =1.6mA

Switching Electrical Characteristics

$V_{cc} = 14\text{V}$, Resistive load=6 Ω , V_{in}=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	—	V/μs	
EOff	Turn Off energav	—	50	—	μJ	

Protection Characteristics

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

Symbol	Parameter	Min.	Typ.	Max.	Units	Test Conditions
I _{lim}	Internal current limit	4	7	10	A	V _{out} = 0V, T _j = 25°C
T _{sd+}	Over temperature high threshold	150(1)	165	—	°C	See fig. 2
T _{sd-}	Over temperature low threshold	—	158	—		
V _{sc}	Short-circuit detection voltage(2)	2	3	4	V	
UV+	Under voltage protection V _{cc} going up	—	5	6.2		
UV-	Under voltage protection V _{cc} 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°C
		0.05	0.15	0.22		T _j = 25..150°C

(1) Guaranteed by design

(2) Reference to V_{cc}

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 _{cc}	H	H	L (4)
Short circuit to V _{cc} (5)	L	H	L
Over-temperature	H	L	L
Over-temperature	L	L	H

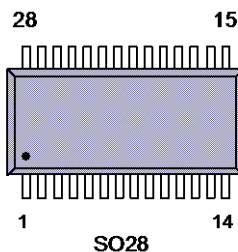
(3) With a pull-up resistor connected between the output and V_{cc}.

(4) V_{ds} lower than 10mV.

(5) Without a pull-up resistor connected between the output and V_{cc}.

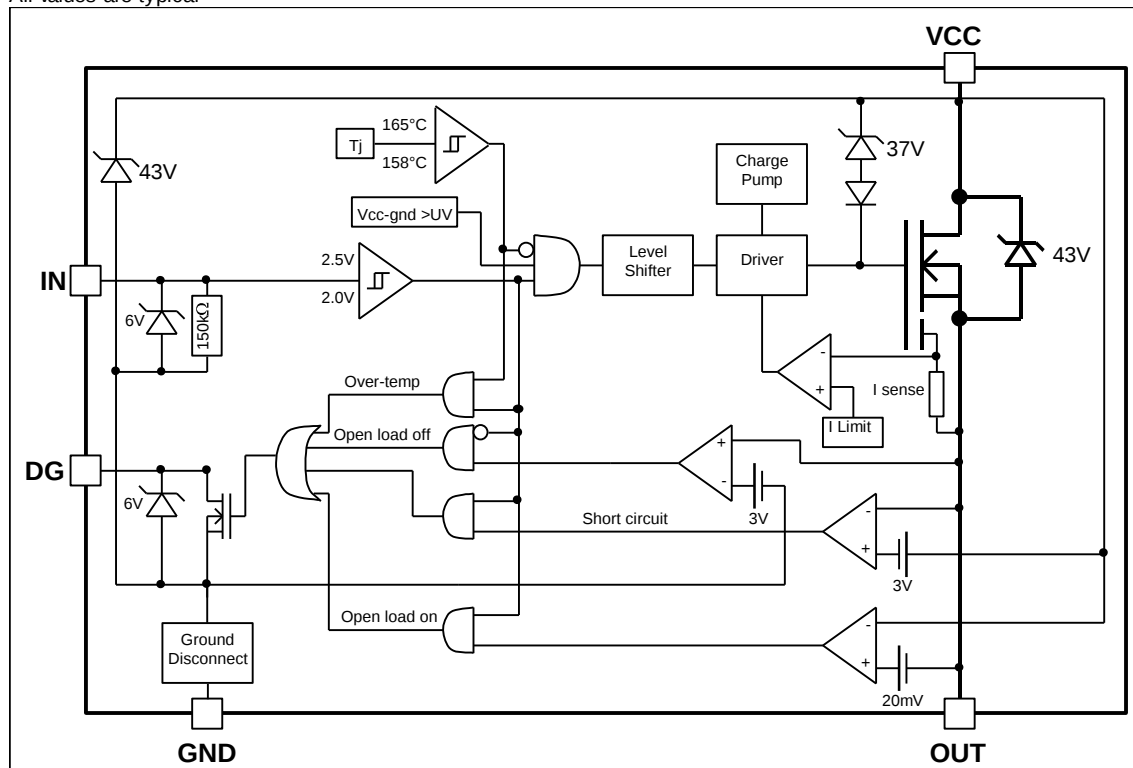
Lead Assignments

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



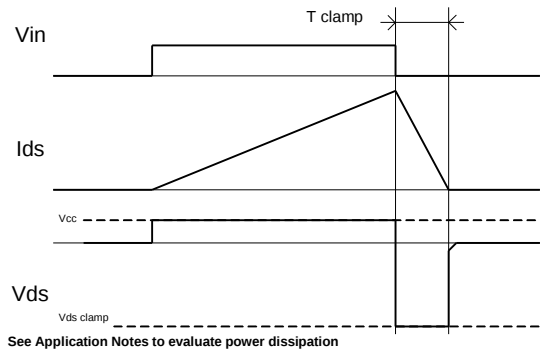


Figure 1 – Active clamp waveforms

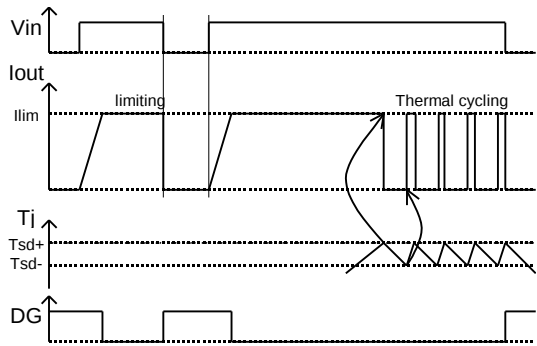


Figure 2 – Protection timing diagram

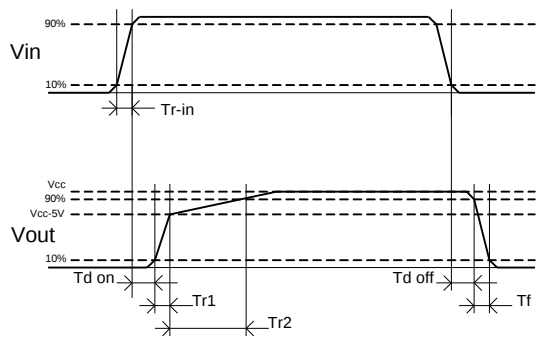


Figure 3 – Switching times definitions

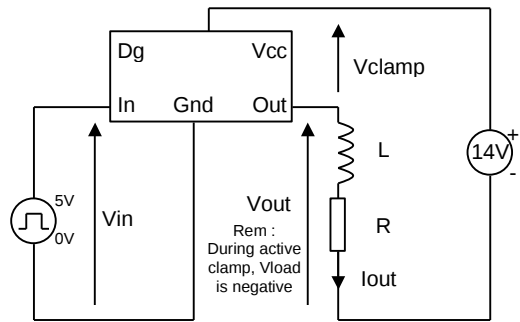


Figure 4 – Active clamp test circuit

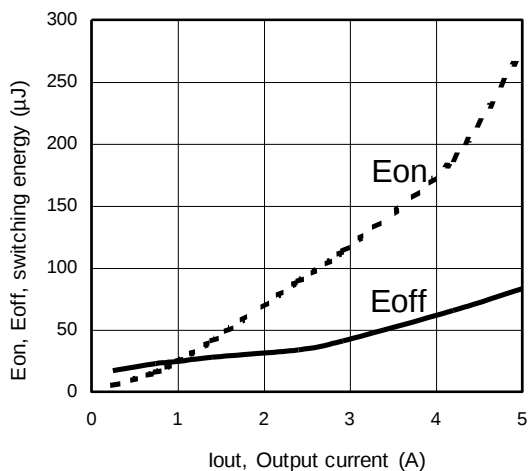


Figure 5 – Switching energy (μJ) Vs Output current (A)

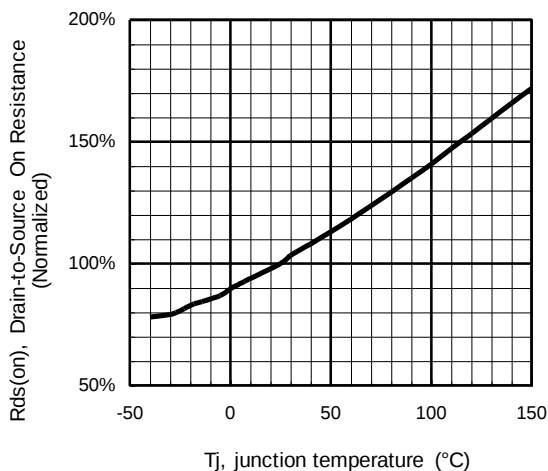


Figure 6 - Normalized Rds(on) (%) Vs Tj (°C)

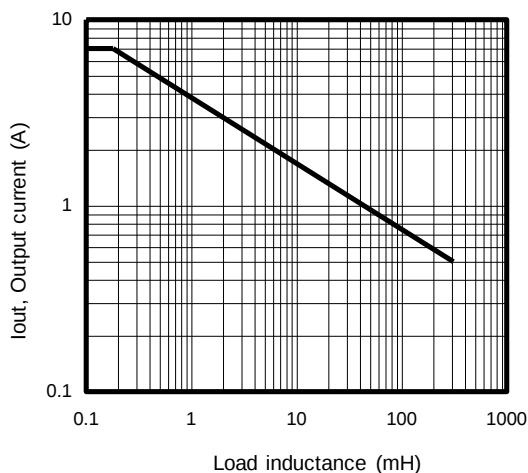


Figure 7 – Max. Output current (A) Vs Load inductance (mH)

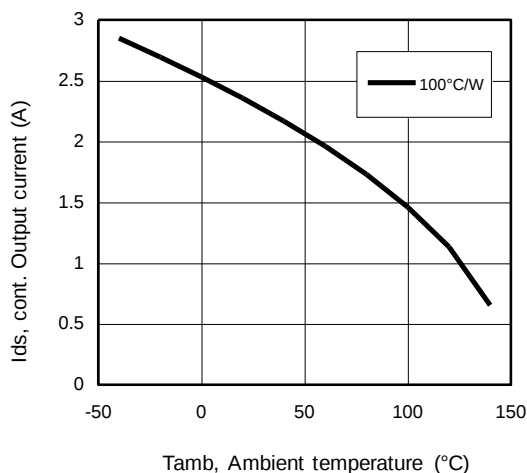
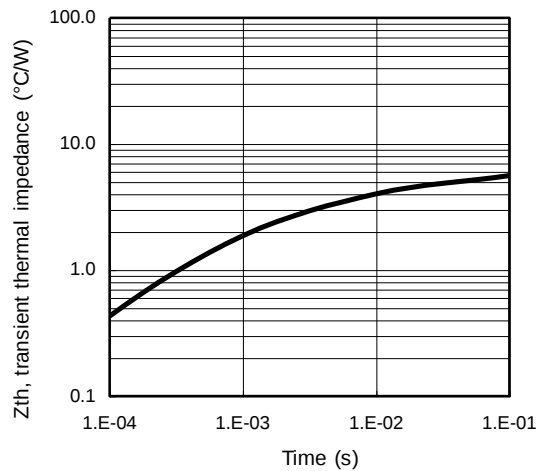
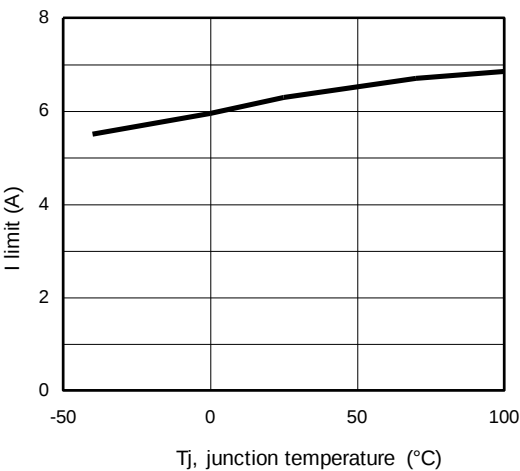


Figure 8 – Max. output current (A) Vs Ambient temperature (°C)



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



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

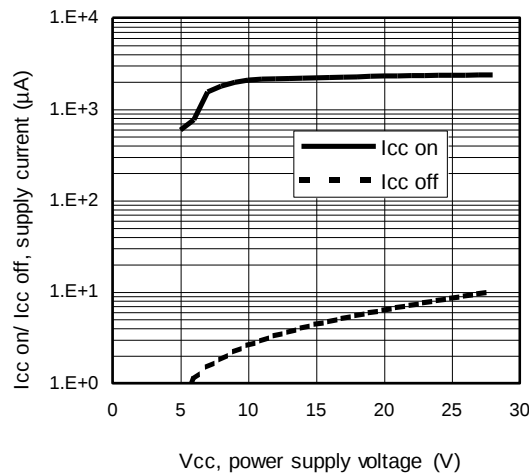


Figure 11 – Icc on/ Icc off (µA) Vs Vcc (V)

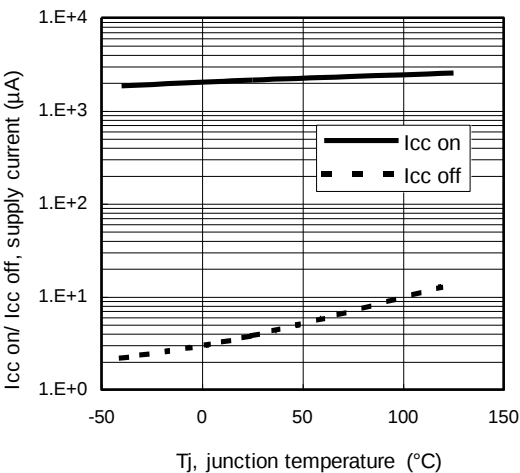
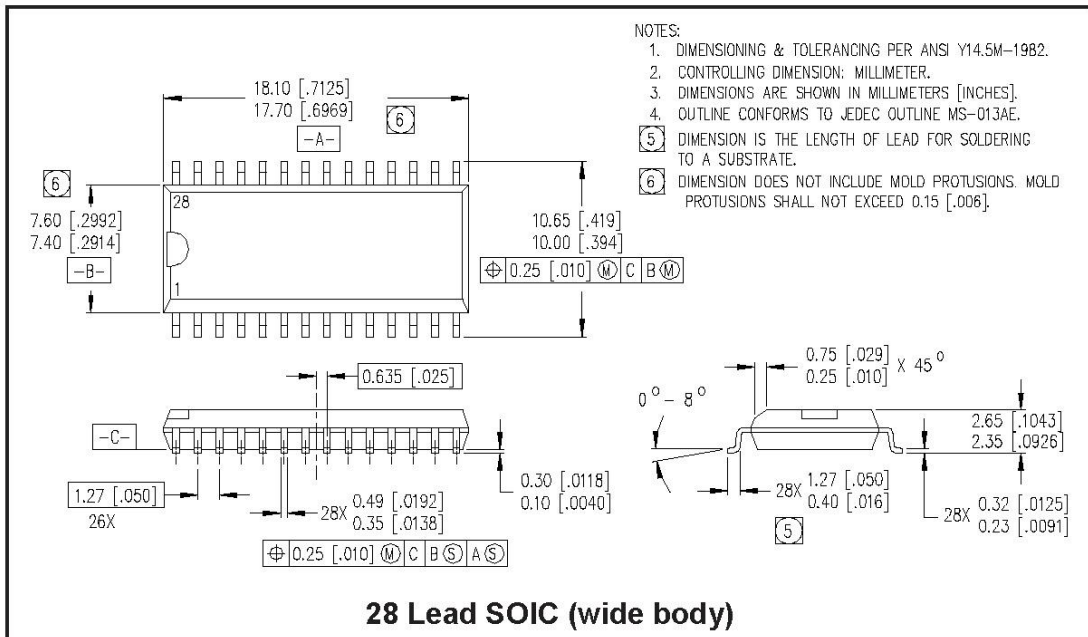
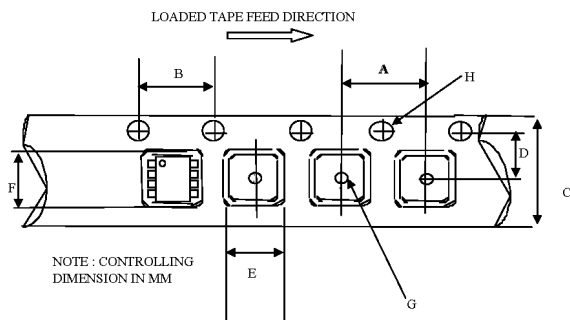


Figure 12 – Icc on/ Icc off (µA) Vs Tj (°C)

Case Outline – SO28

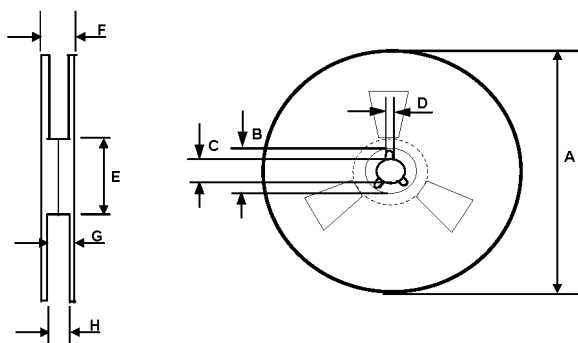


Tape & Reel – SO28



CARRIER TAPE DIMENSION FOR 28SOICW

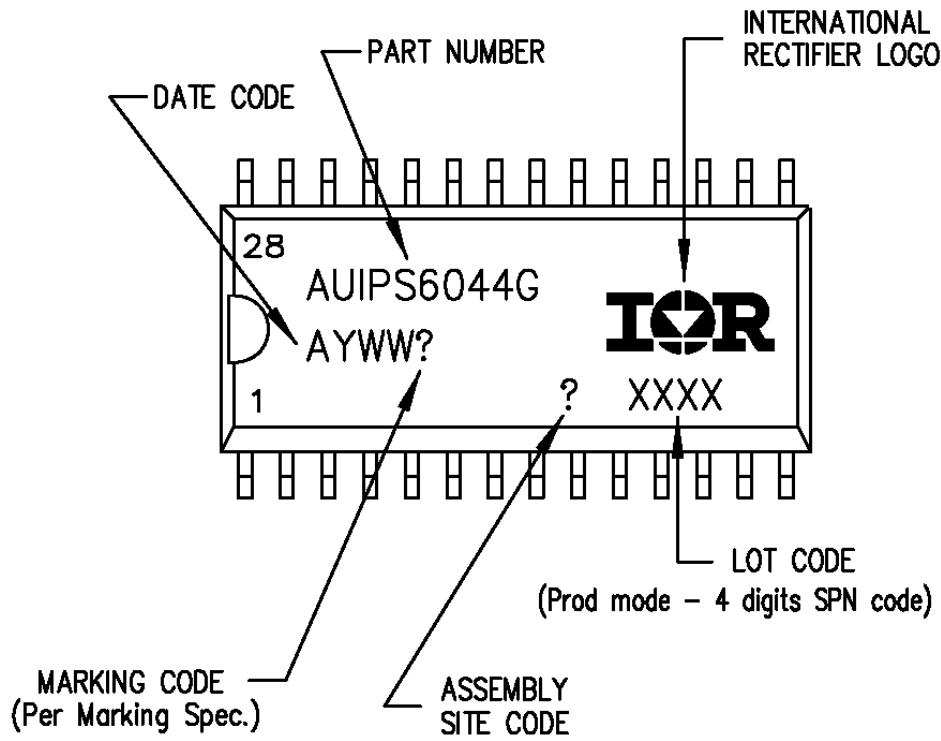
Code	Metric		Imperial	
	Min	Max	Min	Max
A	11.90	12.10	0.468	0.476
B	3.90	4.10	0.153	0.161
C	23.70	24.30	0.933	0.956
D	11.40	11.60	0.448	0.456
E	10.80	11.00	0.425	0.433
F	18.20	18.40	0.716	0.724
G	1.50	n/a	0.059	n/a
H	1.50	1.60	0.059	0.062



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

Revision	Date	Notes/Changes
B2	September, 12th 2011	AU release
B3	December, 10 th 2011	Update qualification page