

INTELLIGENT POWER HIGH SIDE SWITCH

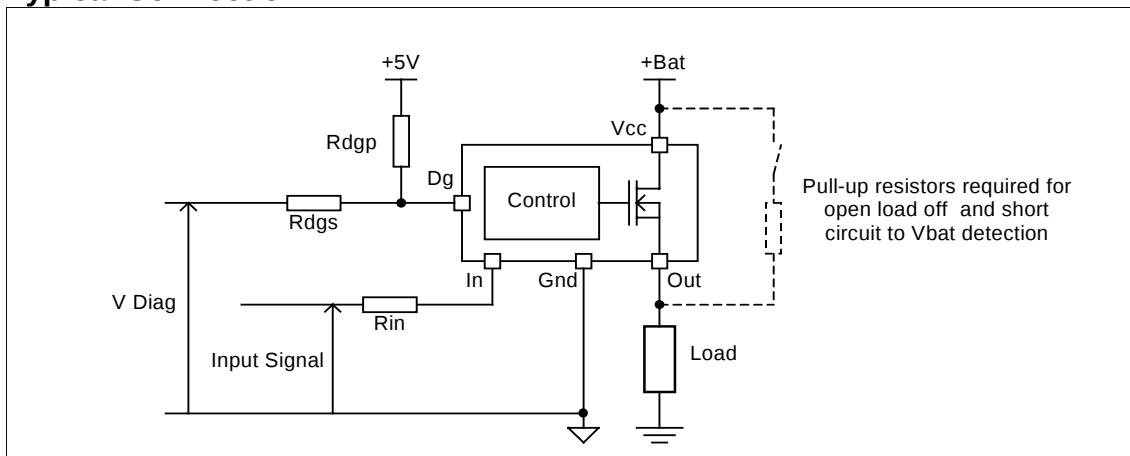
Features

- 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 IPS6044GPbF 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



SO28 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		SOIC28W	MSL2, 260°C (per IPC/JEDEC J-STD-020)
ESD	Machine Model	Class B (per JEDEC standard JESD22-A115)	
	Human Body Model	Class 1C (per EIA/JEDEC standard EIA/JESD22-A114)	
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.

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. (Tambient=25°C 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
ESD	Electrostatic discharge voltage (Human body) C=100pF, R=1500Ω Between In and Vcc	—	1500	V
	Other combinations	—	4000	
	Electrostatic discharge voltage (Machine Model) C=200pF, R=0Ω, L=10μH Between In and Vcc	—	100	
	Other combinations	—	500	
Tj max.	Max. storage & operating temperature junction temperature	-40	150	°C
Tsoldering	Soldering temperature (10 seconds)	—	300	°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	kHz
F max.	Max. switching frequency	—	3.5	

Static Electrical Characteristics

T_j=25°C, V_{cc}=14V (unless otherwise specified)

Symbol	Parameter	Min.	Typ.	Max.	Units	Test Conditions
R _{ds(on)}	ON state resistance T _j =25°C	—	110	130	mΩ	V _{in} =5V, I _{out} =2.5A
	ON state resistance T _j =150°C(1)	—	190	230		V _{in} =5V, I _{out} =2.5A
	ON state resistance T _j =25°C, V _{cc} =6V	—	125	155		V _{in} =5V, I _{out} =1.5A
	ON state resistance during reverse battery	—	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	42		I _{out} =2.5A (see Fig. 1)
I _{cc Off}	Supply current when Off	—	4	9	μA	V _{in} =0V, V _{out} =0V
I _{cc On}	Supply current when On	—	2.2	5	mA	V _{in} =5V
V _{ih}	Input high threshold voltage	—	2.5	2.9	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	—	45	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}=14V, Resistive load=6Ω, V_{in}=5V, T_j=25°C

Symbol	Parameter	Min.	Typ.	Max.	Units	Test Conditions
T _{don}	Turn-on delay time	—	5	15	μs	see Fig. 3
Tr1	Rise time to V _{out} =V _{cc} -5V	—	3	10		
Tr2	Rise time to V _{out} =0.9 x V _{cc}	—	4	20		
dV/dt (On)	Turn On dV/dt	—	2.5	5	V/μs	
E _{On}	Turn On energy	—	100	—	μJ	
T _{doff}	Turn-off delay time	—	10	20	μs	
T _f	Fall time to V _{out} =0.1 x V _{cc}	—	3	10		
dV/dt (Off)	Turn Off dV/dt	—	6.5	20	V/μs	
E _{Off}	Turn Off energy	—	50	—	μJ	

Protection Characteristics

T_J=25°C, V_{CC}=14V (unless otherwise specified)

Symbol	Parameter	Min.	Typ.	Max.	Units	Test Conditions
I _{lim}	Internal current limit	4	7	10	A	V _{out} =0V
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		
UV		—	5	5.9	V	
UV hyst.		0.25	—	1.6		
VOL Off	Open load detection threshold	2	3	4		
I _{OL} On	Open load detection threshold	0.05	0.15	0.22	A	

(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

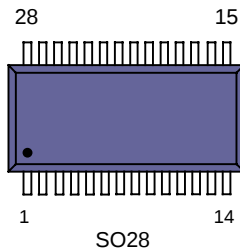
(3) With a pull-up resistor connected between the output and V_{CC}.

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

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

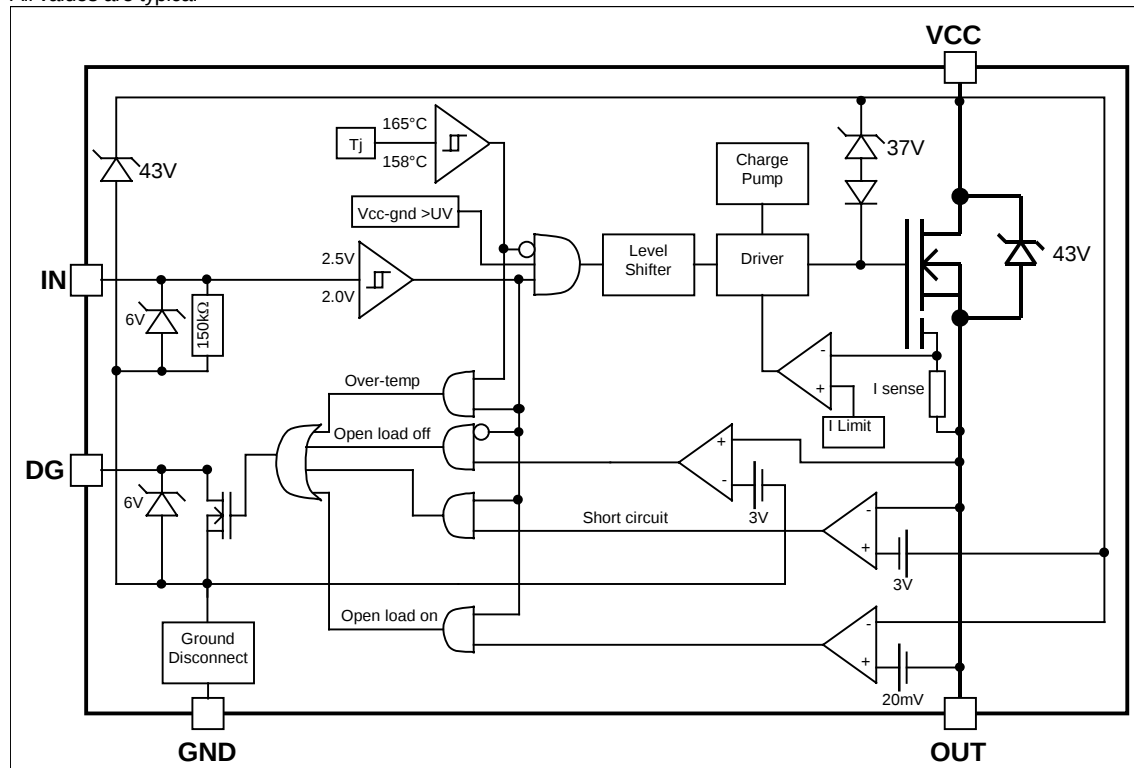
Lead Assignments

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



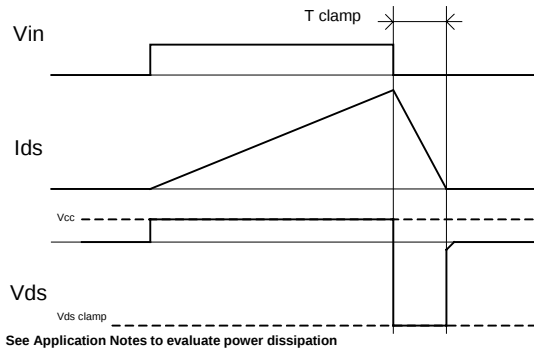


Figure 1 – Active clamp waveforms

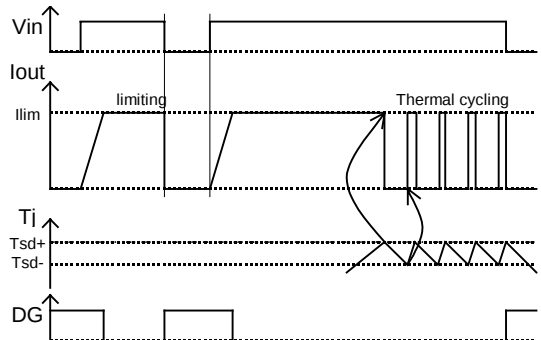


Figure 2 – Protection timing diagram

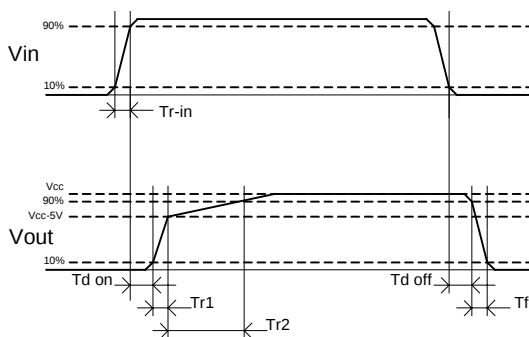


Figure 3 – Switching times definitions

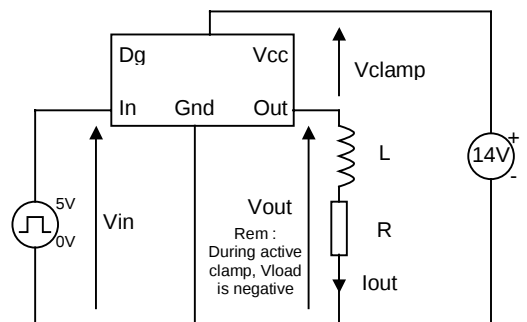


Figure 4 – Active clamp test circuit

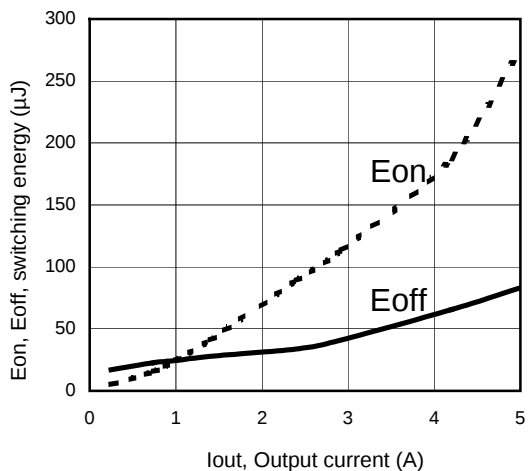


Figure 5 – Switching energy (μJ) Vs Output current (A)

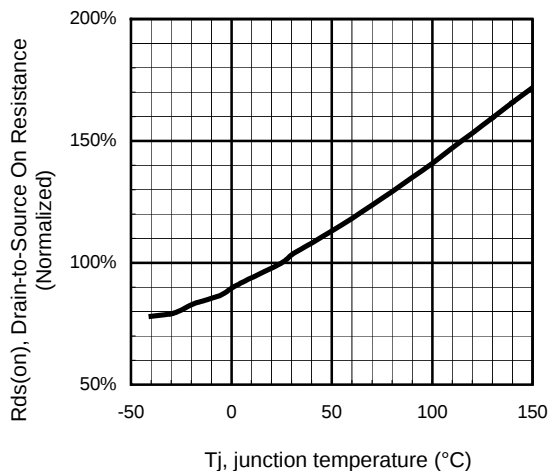


Figure 6 - Normalized Rds(on) (%) Vs Tj (°C)

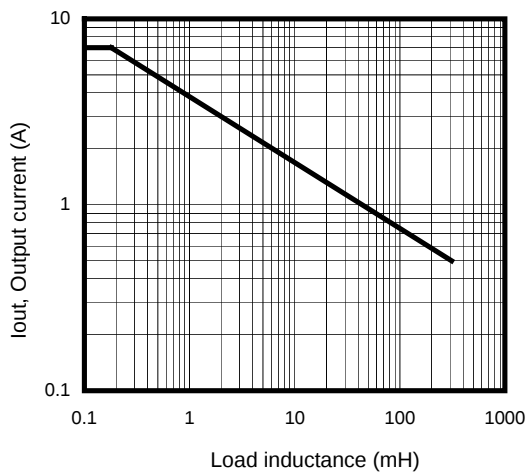


Figure 7 – Max. Output current (A) Vs Load inductance (mH)

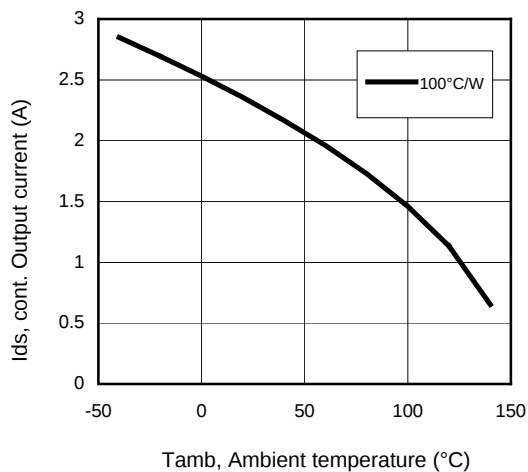
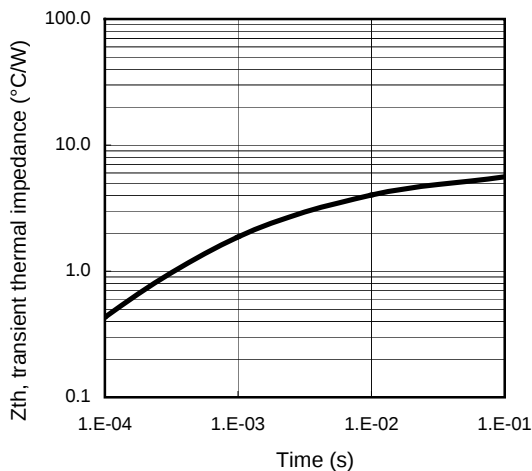
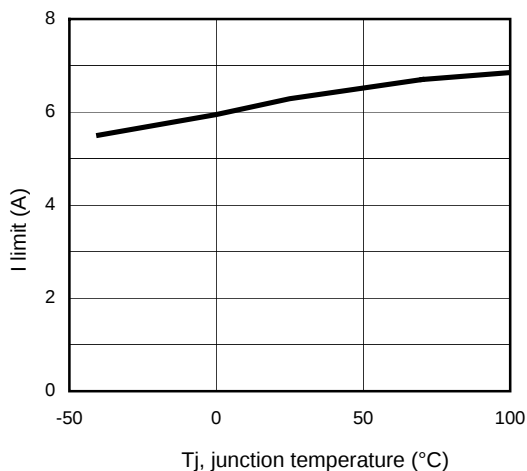


Figure 8 – Max. output current (A) Vs Ambient temperature (°C)



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



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

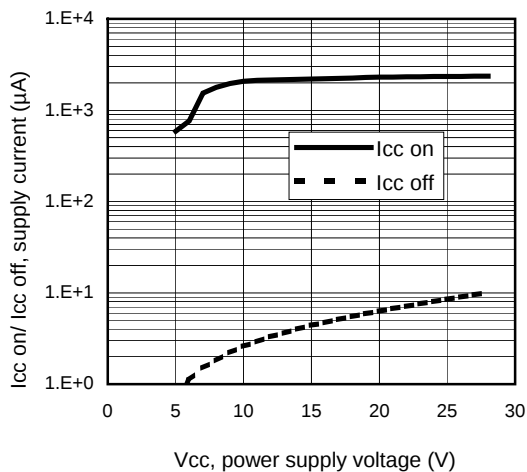


Figure 11 – I_{cc on}/ I_{cc off} (µA) Vs V_{cc} (V)

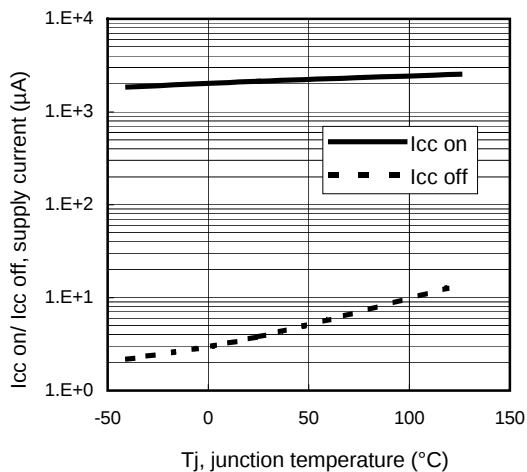
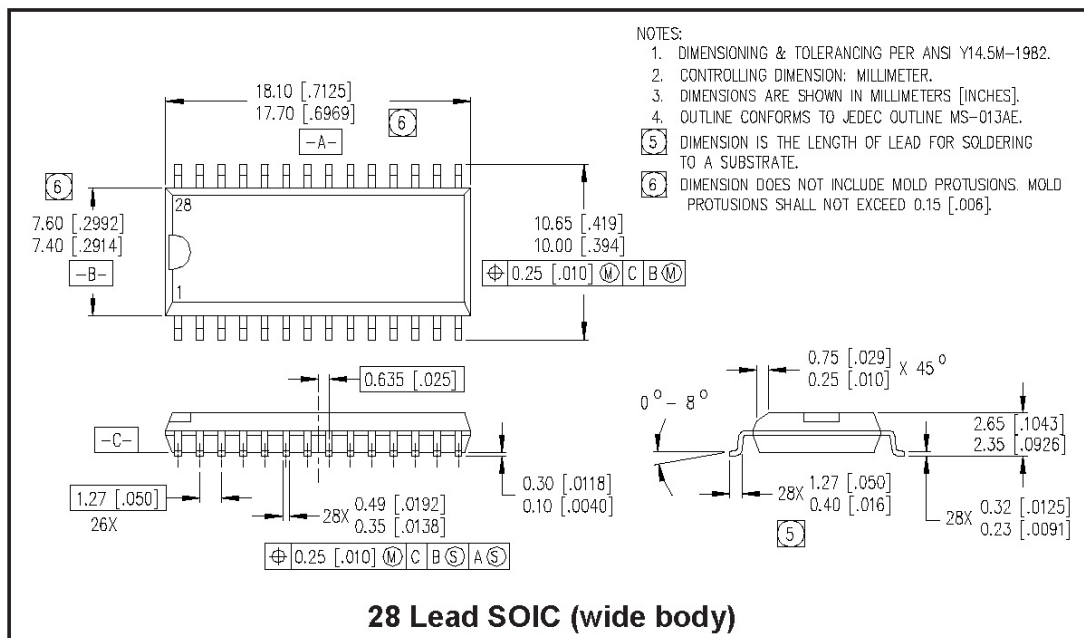


Figure 12 – I_{cc on}/ I_{cc off} (µA) Vs T_j (°C)

Case Outline – SO28



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Revision History

Revision	Date	Notes/Changes
A	25/04/08	First release