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International
IOR Rectifier

Data Sheet No.PD 60157-H

IPS521G

FULLY PROTECTED HIGH SIDE POWER MOSFET SWITCH

Features

- Over temperature protection (with auto-restart)
- Short-circuit protection (current limit)
- Active clamp
- E.S.D protection
- Status feedback
- Open load detection
- Logic ground isolated from power ground

Description

The IPS521G is a fully protected five terminal high side switch with built in short circuit, over-temperature, ESD protection, inductive load capability and diagnostic feedback. The output current is controlled when it reaches I_{lim} value. The current limitation is activated until the thermal protection acts. The over-temperature protection turns off the high side switch if the junction temperature exceeds Tshutdown. It will automatically restart after the junction has cooled 7°C below Tshutdown. A diagnostic pin is provided for status feedback of short-circuit, over-temperature and open load detection. The double level shifter circuitry allows large offsets between the logic ground and the load ground.

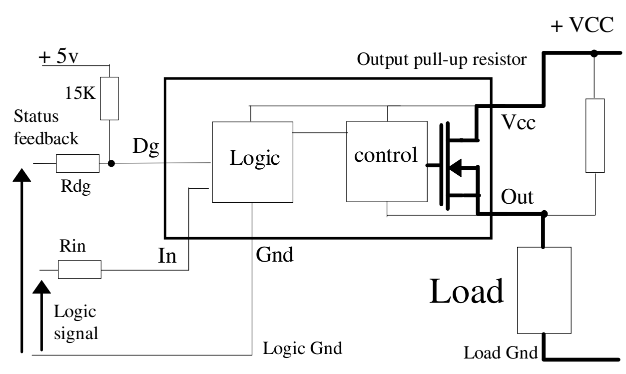
Product Summary

$R_{ds(on)}$	100mΩ (max)
V_{clamp}	50V
I_{Limit}	10A
$V_{open\ load}$	3V

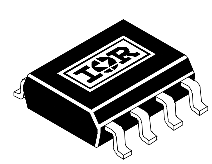
Truth Table

Op. Conditions	In	Out	Dg
Normal	H	H	H
Normal	L	L	L
Open load	H	H	H
Open load	L	H	H
Over current	H	L (limiting)	L
Over current	L	L	L
Over-temperature	H	L (cycling)	L
Over-temperature	L	L	L

Typical Connection



Package



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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 = 25°C unless otherwise specified).

Symbol	Parameter	Min.	Max.	Units	Test Conditions
V_{out}	Maximum output voltage	V_{CC}-50	V_{CC}+0.3	V	
V_{offset}	Maximum logic ground to load ground offset	V_{CC}-50	V_{CC}+0.3		
V_{in}	Maximum Input voltage	-0.3	5.5		
$I_{in, max}$	Maximum positive IN current	-5	10	mA	
V_{dg}	Maximum diagnostic output voltage	-0.3	5.5	V	
$I_{dg, max}$	Maximum diagnostic output current	-1	10	mA	
$I_{sd\ cont.}$	Diode max. permanent current (1) (rth = 125°C/W)	—	1.4	A	
$I_{sd\ pulsed}$	Diode max. pulsed current (1)	—	10		
ESD1	Electrostatic discharge voltage (Human Body)	—	4	kV	C=100pF, R=1500Ω,
ESD2	Electrostatic discharge voltage (Machine Model)	—	0.5		C=200pF, R=0Ω, L=10µH
P_d	Maximum power dissipation(1) (rth=125°C/W)	—	1		
T_j max.	Max. storage & operating junction temp.	-40	+150	°C	
Vcc max.	Maximum Vcc voltage	—	50	V	

Thermal Characteristics

Symbol	Parameter	Min.	Typ.	Max.	Units	Test Conditions
R_{th1}	Thermal resistance with standard footprint	—	100	—	°C/W	8 Lead SOIC
R_{th2}	Thermal resistance with 1" square footprint	—	80	—		

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_{CC}	Continuous V_{CC} voltage	5.5	35	V
V_{IH}	High level input voltage	4	5.5	
V_{IL}	Low level input voltage	-0.3	0.9	
I_{out} Tc=85°C	Continuous output current (TAmbient = 85°C, Tj = 125°C, R_{th} = 100°C/W)	—	1.6	A
R_{in}	Recommended resistor in series with IN pin	4	6	kΩ
R_{dg}	Recommended resistor in series with DG pin	10	20	

(1) Limited by junction temperature (pulsed current limited also by internal wiring)

Static Electrical Characteristics

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

Symbol	Parameter	Min.	Typ.	Max.	Units	Test Conditions
$R_{ds(on)}$ @Tj=25°C	ON state resistance T_j = 25°C	—	80	100		V_{in} = 5V, I_{out} = 5A
$R_{ds(on)}$ (V_{CC}=6V)	ON state resistance @ V_{CC} = 6V	—	80	100	mΩ	V_{in} = 5V, I_{out} = 2.5A
$R_{ds(on)}$ @Tj=150°C	ON state resistance Tj = 150°C	—	125	160		V_{in} = 5V, I_{out} = 5A
V_{CC} oper.	Operating voltage range	5.5	—	35		
V clamp 1	V_{CC} to OUT clamp voltage 1	50	55	—	V	I_d = 10mA (see Fig.1 & 2)
V clamp 2	V_{CC} to OUT clamp voltage 2	—	56	65		I_d = I_{sd} (see Fig.1 & 2)
V_f	Body diode forward voltage	—	0.9	1.2		I_d = 2.5A, V_{in} = 0V
$I_{CC\ off}$	Supply current when OFF	—	13	50	µA	V_{in} = 0V, V_{out} = 0V
$I_{CC\ on}$	Supply current when ON	—	0.6	2	mA	V_{in} = 5V
$I_{CC\ ac}$	Ripple current when ON (AC RMS)	—	20	—	µA	V_{in} = 5V
V_{dgl}	Low level diagnostic output voltage	—	0.4	—	V	I_{dg} = 1.6 mA
I_{oh}	Output leakage current	—	50	120		V_{out} = 6V
I_{ol}	Output leakage current	0	—	25	µA	V_{out} = 0V
Idg leakage	Diagnostic output leakage current	—	—	10		Vdg = 5.5V
V_{ih}	IN high threshold voltage	—	2.2	3	V	
V_{il}	IN low threshold voltage	1	1.9	—		
$I_{in,\ on}$	On state IN positive current	—	70	200	µA	V_{in} = 5V
In hyst.	Input hysteresis	0.1	0.25	0.5	V	

Switching Electrical Characteristics

V_{CC} = 14V, Resistive Load = 2.8Ω, T_j = 25°C, (unless otherwise specified).

Symbol	Parameter	Min.	Typ.	Max.	Units	Test Conditions
Td_{on}	Turn-on delay time	—	10	40		
T_{r1}	Rise time to V_{out} = V_{CC} - 5V	—	25	60	µs	
T_{r2}	Rise time V_{CC} - 5V to V_{out} = 90% of V_{CC}	—	130	200		See figure 3
dV/dt (on)	Turn ON dV/dt	—	0.7	2	V/µs	
E_{on}	Turn ON energy	—	1500	—	µJ	
Td_{off}	Turn-off delay time	—	35	70	µs	
T_f	Fall time to V_{out} = 10% of V_{CC}	—	16	50		See figure 4
dV/dt (off)	Turn OFF dV/dt	—	0.9	3	V/µs	
E_{off}	Turn OFF energy	—	250	—	µJ	
T_{diag}	V_{out} to V_{diag} propagation delay	—	5	15	µs	See figure 6

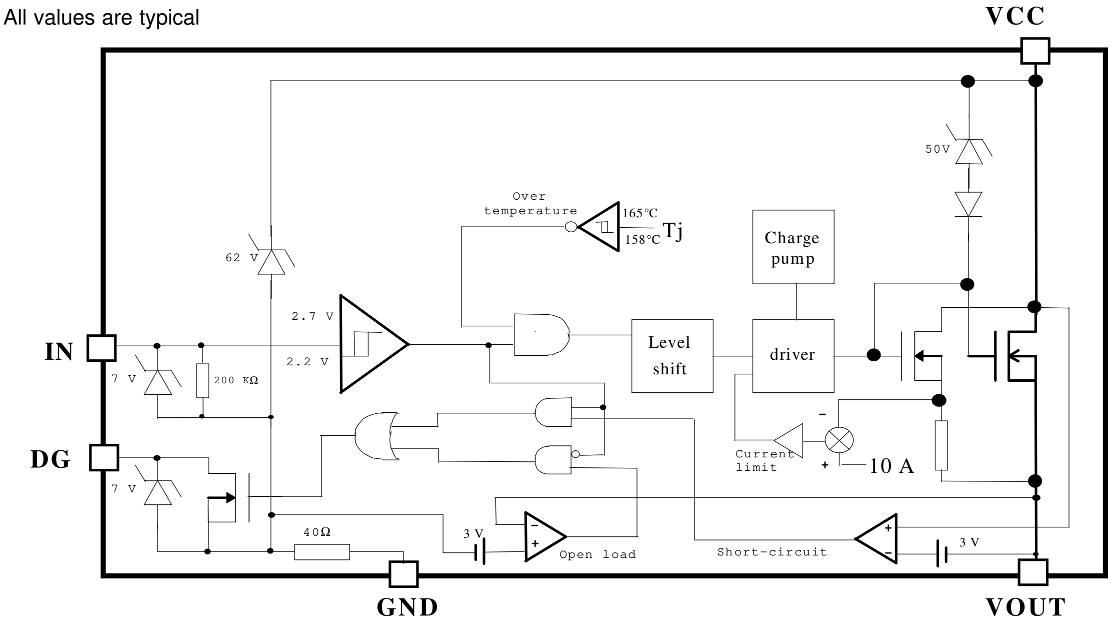
Protection Characteristics

Symbol	Parameter	Min.	Typ.	Max.	Units	Test Conditions
I_{lim}	Internal current limit	7	10	14	A	V_{out} = 0V
T_{sd+}	Over-temp. positive going threshold	—	165	—	°C	See fig. 2
T_{sd-}	Over-temp. negative going threshold	—	158	—	°C	See fig. 2
V_{sc}	Short-circuit detection voltage (3)	2	3	4	V	See fig. 2
$V_{open\ load}$	Open load detection threshold	2	3	4	V	

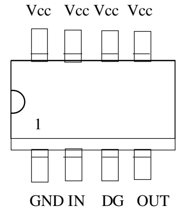
(3) Referenced to V_{CC}

Functional Block Diagram

All values are typical



Lead Assignments



8 Lead SOIC

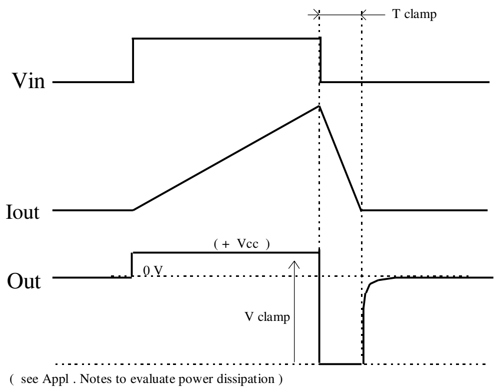


Figure 1 - Active clamp waveforms

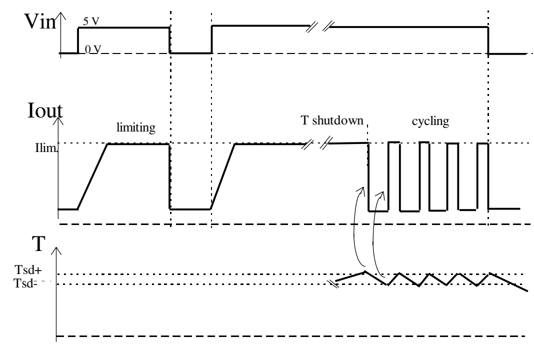


Figure 2 - Protection timing diagram

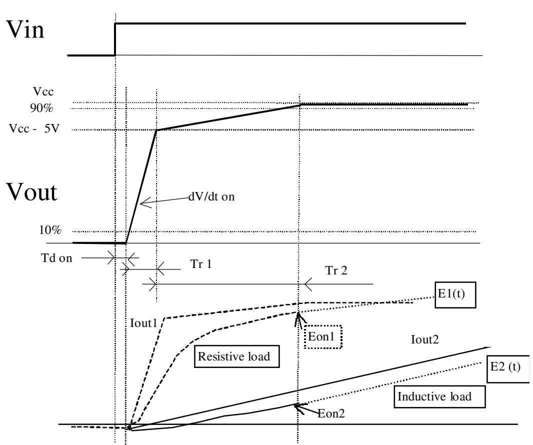


Figure 3 - Switching times definition (turn-on)
Turn on energy with a resistive or an
inductive load

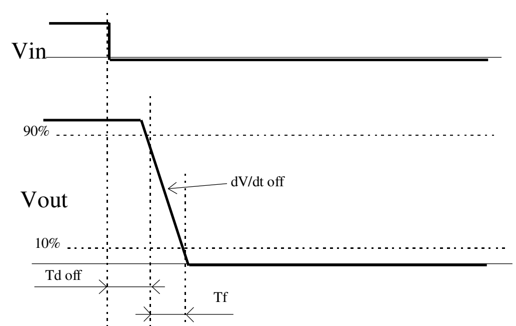


Figure 4 - Switching times definition (turn-off)

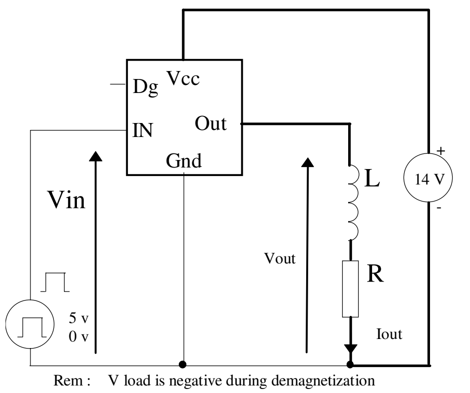


Figure 5 - Active clamp test circuit

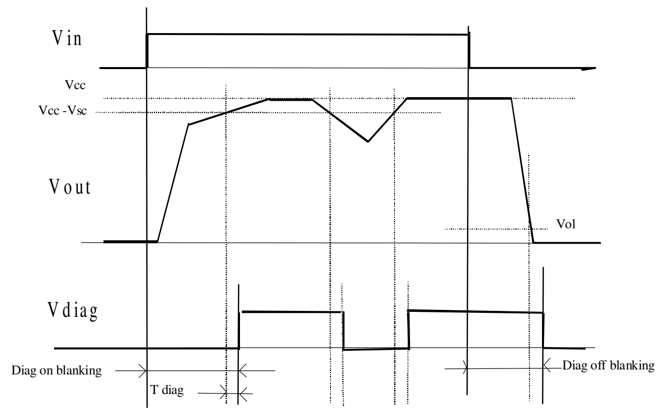


Figure 6 - Diagnostic delay definitions

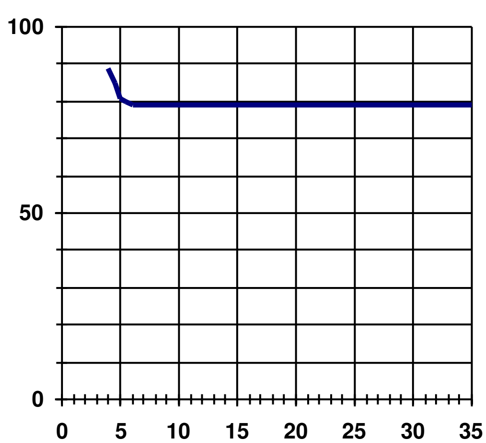


Figure 7 - $R_{ds(on)}$ (mΩ) Vs V_{cc} (V)

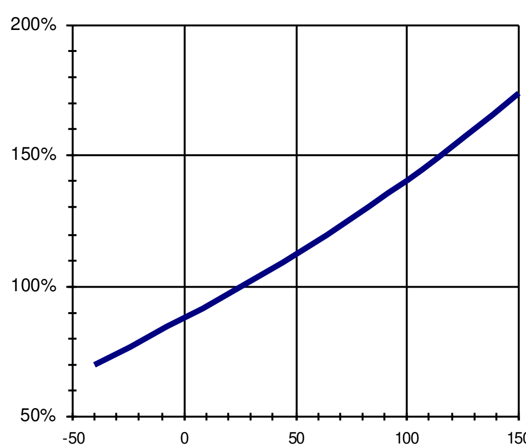


Figure 8 - Normalized $R_{ds(on)}$ (mΩ) Vs T_j (^oC)

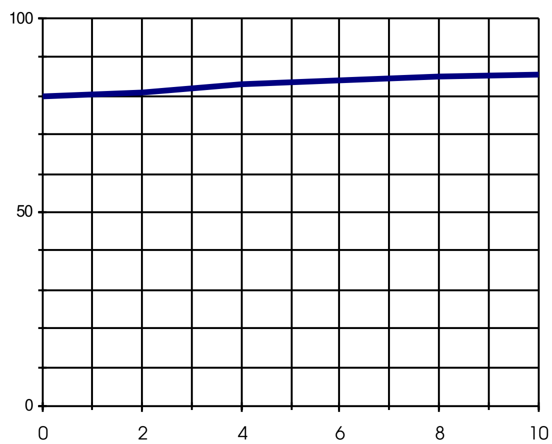


Figure 9 - Rds(on) (mΩ) Vs I_{out} (A)

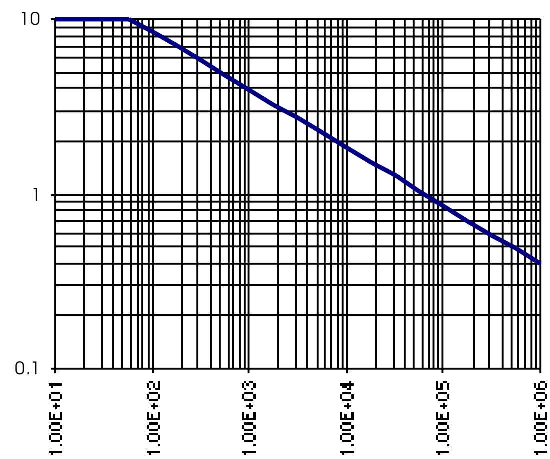


Figure 10 - Max. I_{out} (A) Vs Load Inductance (uH)

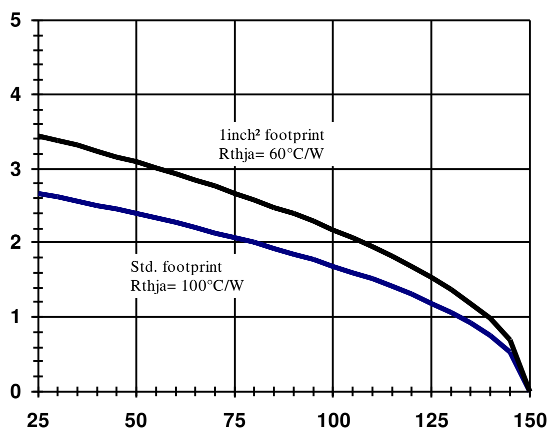


Figure 11 - Max load current (A) Vs Tamb (°C)

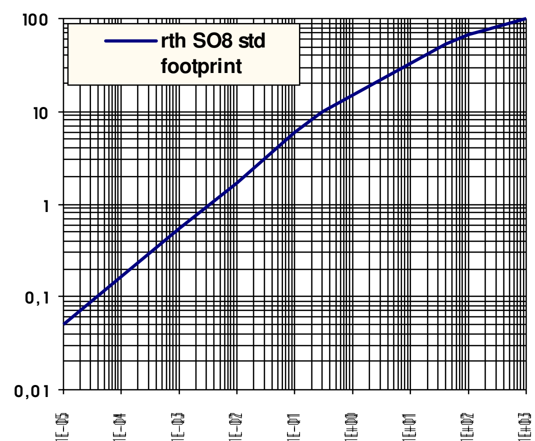


Figure 12 - Transient Thermal Impedance (°C/W) Vs Time (s)

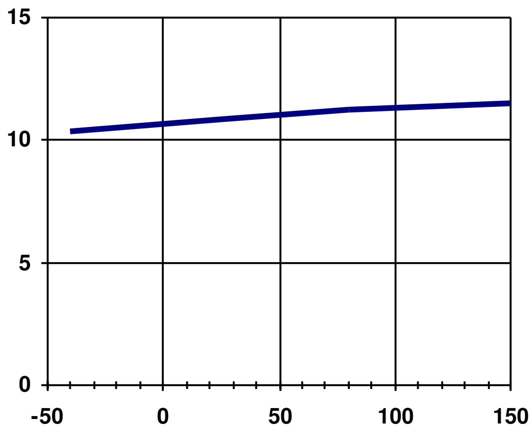


Figure 13 - I_{lim} (A) Vs Tj (°C)

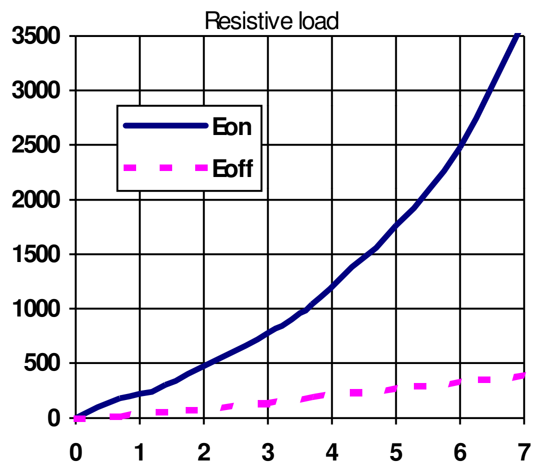


Figure 14 - E_{on}, E_{off} (µJ) Vs I_{out} (A)

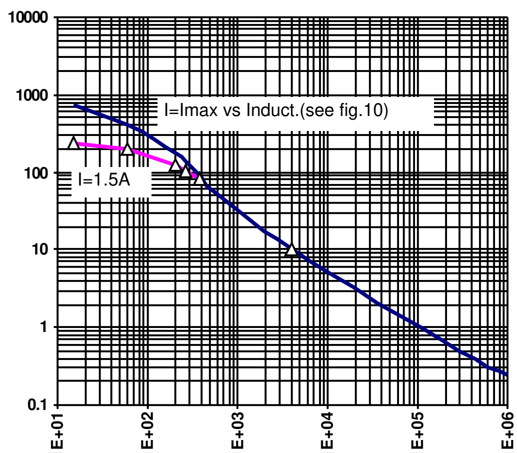


Figure 15 - E_{on} (µJ) Vs Load Inductance (µH)
(see Fig. 3)

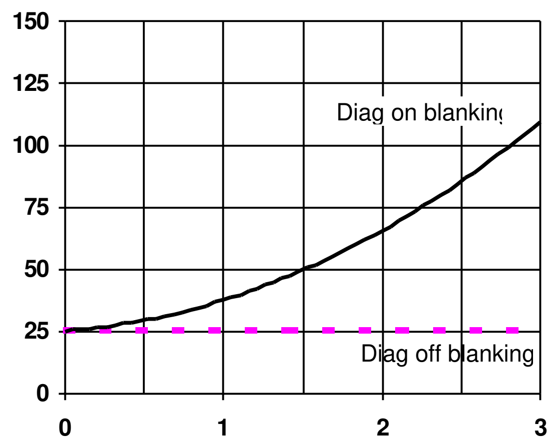


Figure 16 - Diag Blanking time (µS) Vs I_{out} (A)
(resistive load - see Fig. 6)

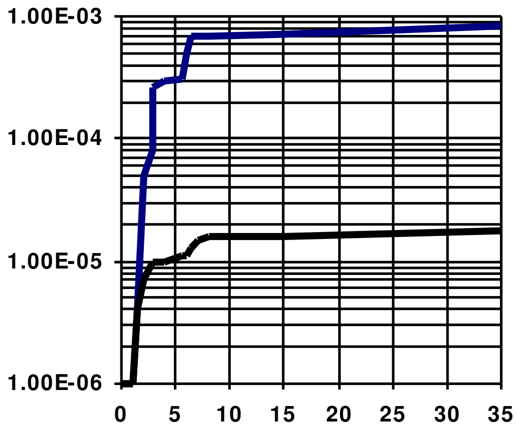
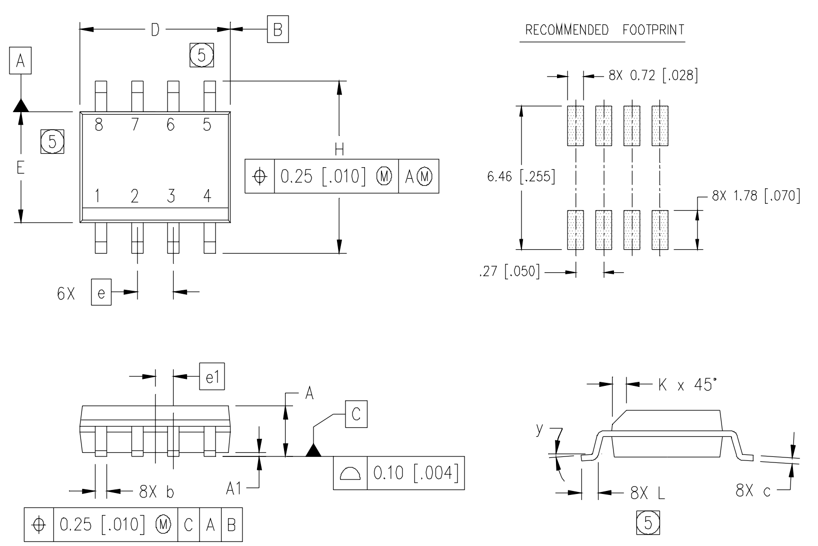


Figure 17 - I_{CC} (mA) Vs V_{CC} (V)

Case Outline - 8 Lead SOIC



DIM	INCHES		MILLIMETERS	
	MIN	MAX	MIN	MAX
A	.0532	.0688	1.35	1.75
A1	.0040	.0098	0.10	0.25
b	.014	.018	0.36	0.46
c	.0075	.0098	0.19	0.25
D	.189	.196	4.80	4.98
E	.150	.157	3.81	3.99
e	.050 BASIC		1.27 BASIC	
e 1	.025 BASIC		0.635 BASIC	
H	.2284	.2440	5.80	6.20
K	.011	.019	0.28	0.48
L	.016	.050	0.41	1.27
y	0°	8°	0°	8°

NOTES:

1. DIMENSIONING & TOLERANCING PER ASME Y14.5M-1994.
2. CONTROLLING DIMENSION: MILLIMETER.
3. DIMENSIONS ARE SHOWN IN MILLIMETERS [INCHES].
4. OUTLINE CONFORMS TO JEDEC OUTLINE MS-012AA.

5 DIMENSION DOES NOT INCLUDE MOLD PROTRUSIONS. MOLD PROTRUSIONS NOT TO EXCEED 0.25 [.006].

6 DIMENSION IS THE LENGTH OF LEAD FOR SOLDERING TO A SUBSTRATE.

(MS-012AA) 01-0021 09

4/11/2000