

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 $T_{shutdown}$. It will automatically restart after the junction has cooled 7°C below $T_{shutdown}$. 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.

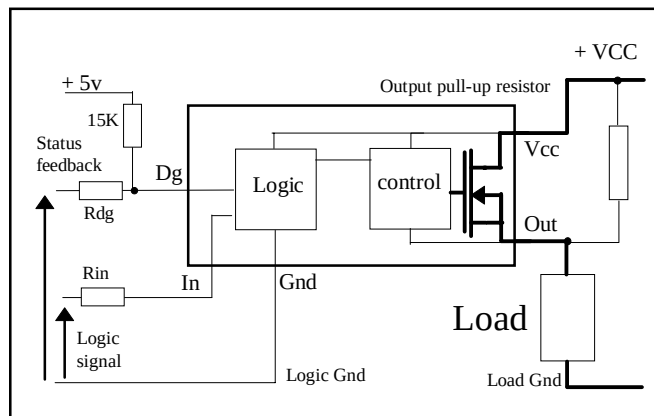
Product Summary

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

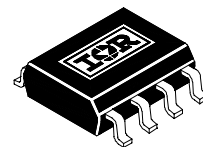
Truth Table

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



8 Lead SOIC

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. ($T_j = 25^{\circ}\text{C}$ 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⁾ ($r_{th} = 125^{\circ}\text{C/W}$)	—	1.4	A	
$I_{sd pulsed}$	Diode max. pulsed current ⁽¹⁾	—	10		
ESD1	Electrostatic discharge voltage (Human Body)	—	4	kV	C=100pF, R=1500 Ω ,
ESD2	Electrostatic discharge voltage (Machine Model)	—	0.5		C=200pF, R=0 Ω , L=10 μH
P_d	Maximum power dissipation ⁽¹⁾ ($r_{th}=125^{\circ}\text{C/W}$)	—	1		
$T_j \text{ max.}$	Max. storage & operating junction temp.	-40	+150	$^{\circ}\text{C}$	
$V_{CC \text{ max.}}$	Maximum VCC voltage	—	50	V	

Thermal Characteristics

Symbol	Parameter	Min.	Typ.	Max.	Units	Test Conditions
R_{th1}	Thermal resistance with standard footprint	—	100	—	$^{\circ}\text{C/W}$	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} $T_c=85^{\circ}\text{C}$	Continuous output current ($T_{Ambient} = 85^{\circ}\text{C}$, $T_j = 125^{\circ}\text{C}$, $R_{th} = 100^{\circ}\text{C/W}$)	—	1.6	A
R_{in}	Recommended resistor in series with IN pin	4	6	$k\Omega$
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)} @T _j =25°C	ON state resistance T _j = 25°C	—	80	100	mΩ	V _{in} = 5V, I _{out} = 5A
R _{ds(on)} (V _{CC} =6V)	ON state resistance @ V _{CC} = 6V	—	80	100		V _{in} = 5V, I _{out} = 2.5A
R _{ds(on)} @T _j =150°C	ON state resistance T _j = 150°C	—	125	160		V _{in} = 5V, I _{out} = 5A
V _{CC} oper.	Operating voltage range	5.5	—	35	V	
V _{clamp 1}	V _{CC} to OUT clamp voltage 1	50	55	—		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	μA	V _{out} = 6V
I _{ol}	Output leakage current	0	—	25		V _{out} = 0V
I _{dg} leakage	Diagnostic output leakage current	—	—	10		V _{dg} = 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
I _n 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).

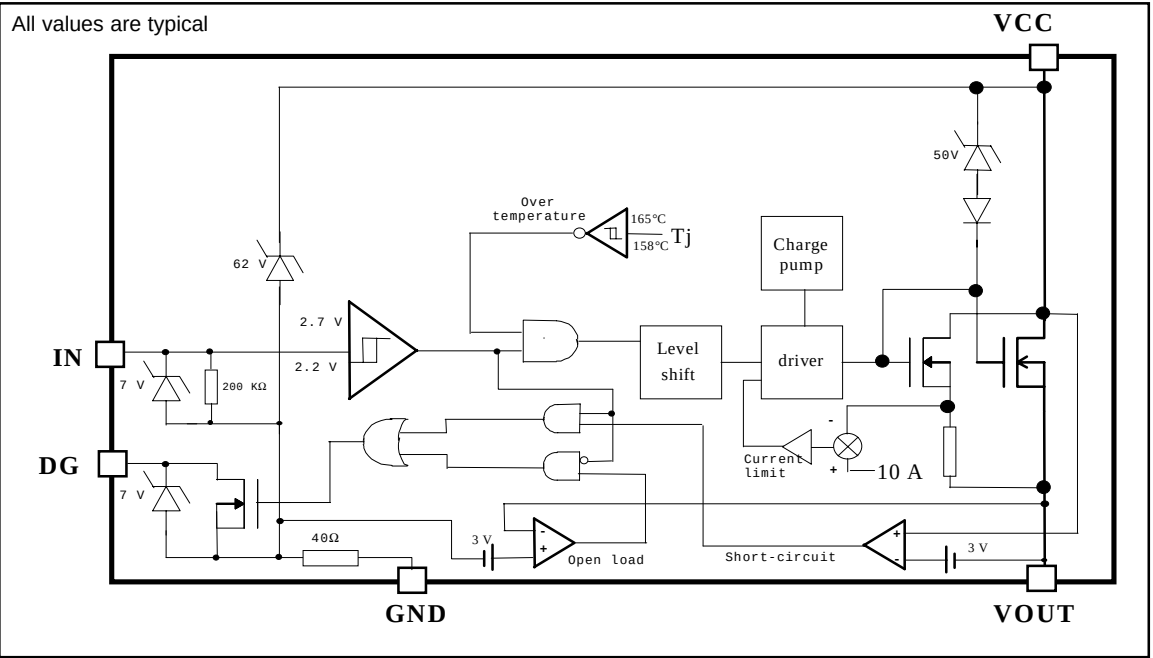
Symbol	Parameter	Min.	Typ.	Max.	Units	Test Conditions
T _{d(on)}	Turn-on delay time	—	10	40	μs	See figure 3
T _{r1}	Rise time to V _{out} = V _{CC} - 5V	—	25	60		
T _{r2}	Rise time V _{CC} - 5V to V _{out} = 90% of V _{CC}	—	130	200		
dV/dt (on)	Turn ON dV/dt	—	0.7	2	V/μs	
E _{on}	Turn ON energy	—	1500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

Protection Characteristics

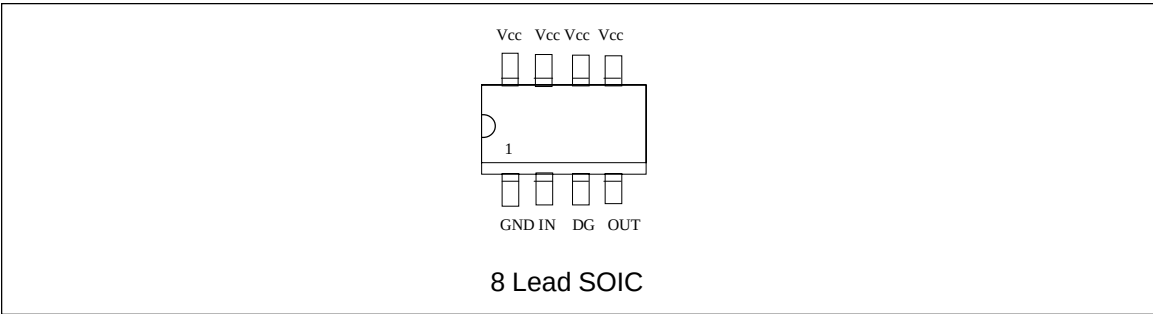
Symbol	Parameter	Min.	Typ.	Max.	Units	Test Conditions
I _{lim}	Internal current limit	7	10	14	A	V _{out} = 0V
T _{sd+}	Over-temp. positive going threshold	—	165	—	°C	See fig. 2
T _{sd-}	Over-temp. negative going threshold	—	158	—	°C	See fig. 2
V _{sc}	Short-circuit detection voltage (3)	2	3	4	V	See fig.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

(3) Referenced to V_{CC}

Functional Block Diagram



Lead Assignments



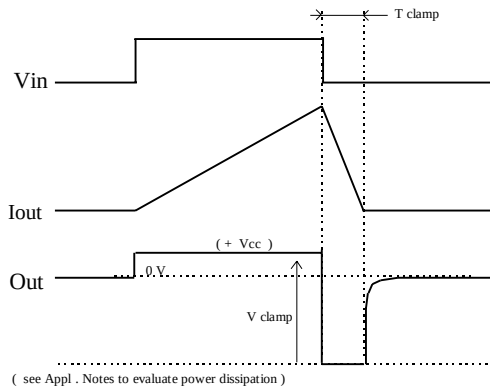


Figure 1 - Active clamp waveforms

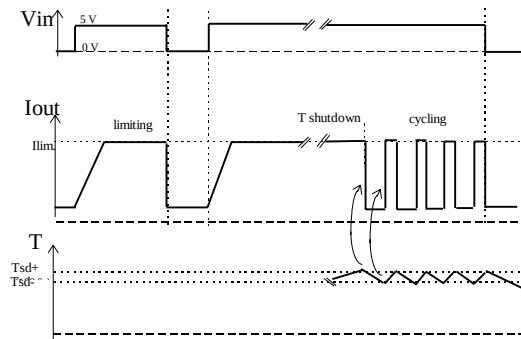


Figure 2 - Protection timing diagram

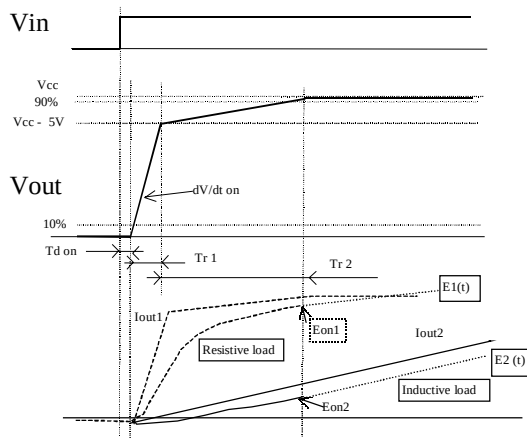


Figure 3 - Switching times definition (turn-on)
Turn on energy with a resistive or an
inductive load

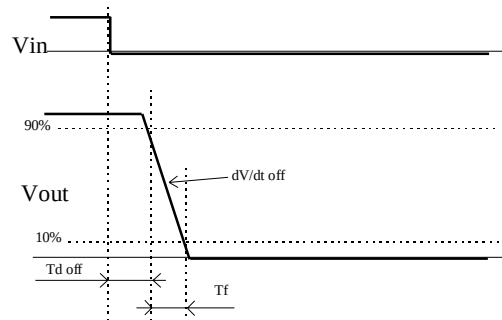


Figure 4 - Switching times definition (turn-off)

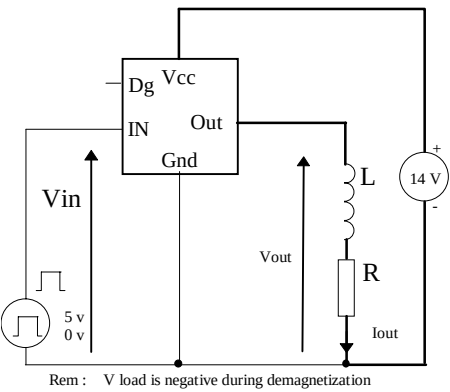


Figure 5 - Active clamp test circuit

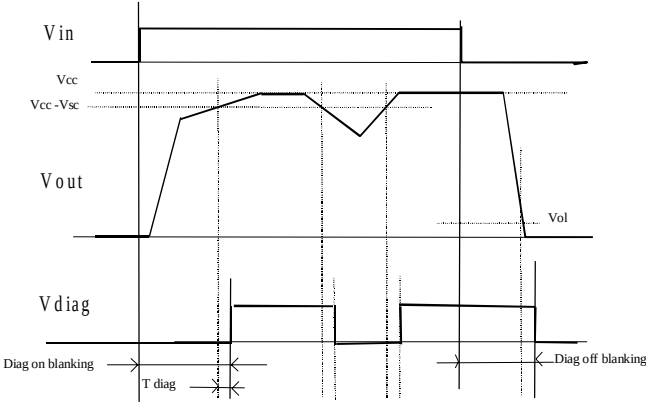


Figure 6 - Diagnostic delay definitions

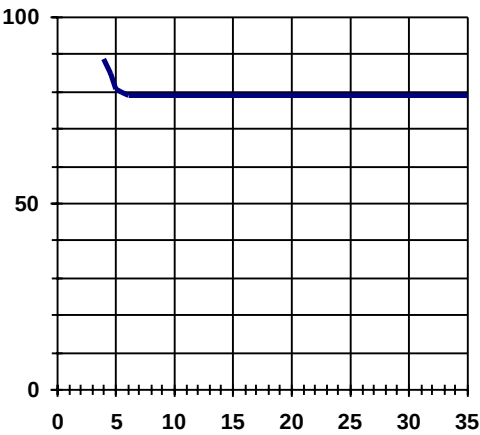


Figure 7 - Rds(on) (mΩ) Vs Vcc (V)

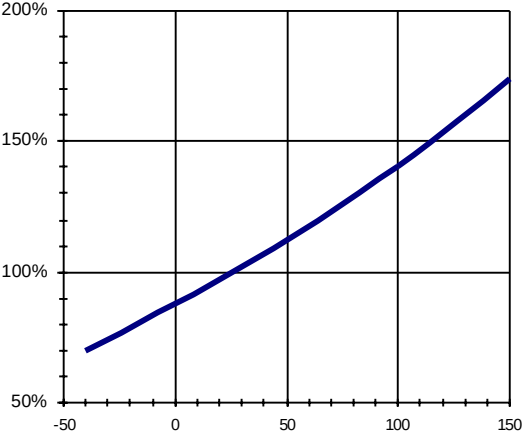


Figure 8 - Normalized Rds(on) (mΩ) Vs Tj (°C)

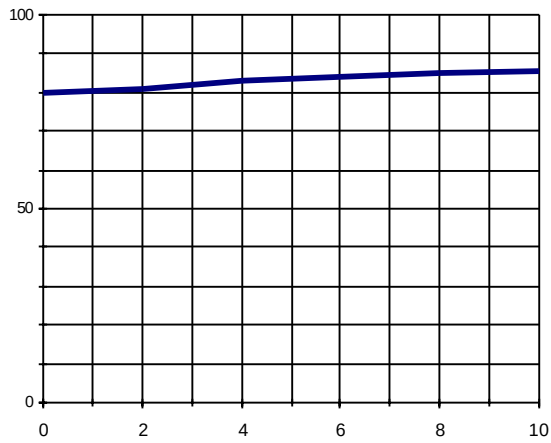


Figure 9 - $R_{ds(on)}$ (mΩ) Vs I_{out} (A)

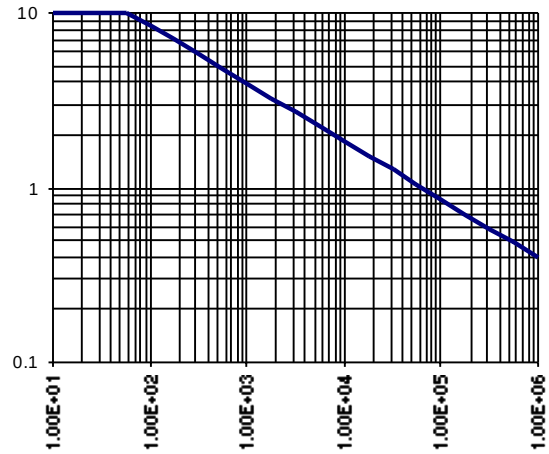


Figure 10 - Max. I_{out} (A) Vs Load Inductance (μH)

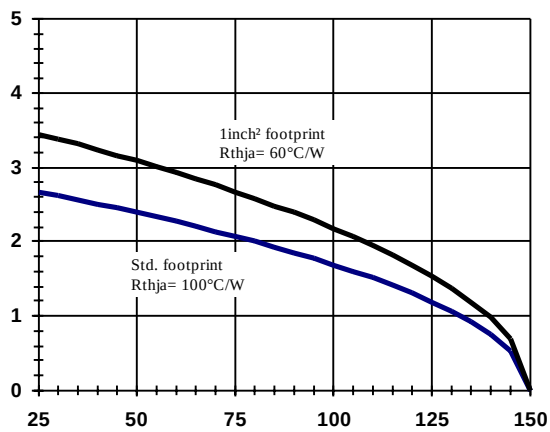


Figure 11 - Max load current (A) Vs T_{amb} (°C)

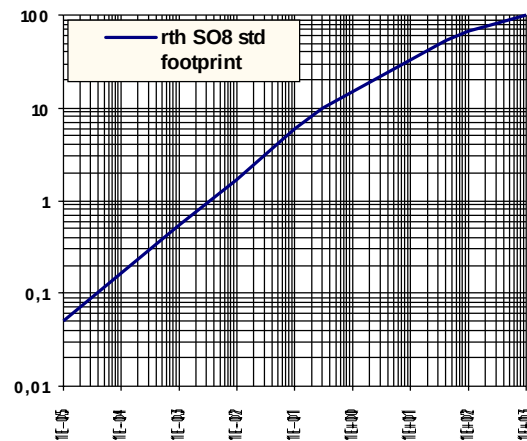


Figure 12 - Transient Thermal Impedance (°C/W) Vs Time (s)

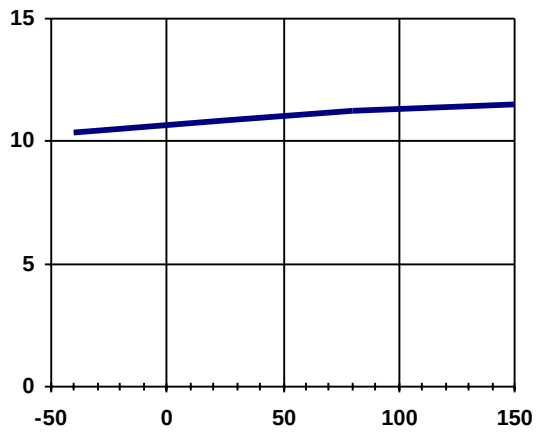


Figure 13 - I_{lim} (A) Vs T_j (°C)

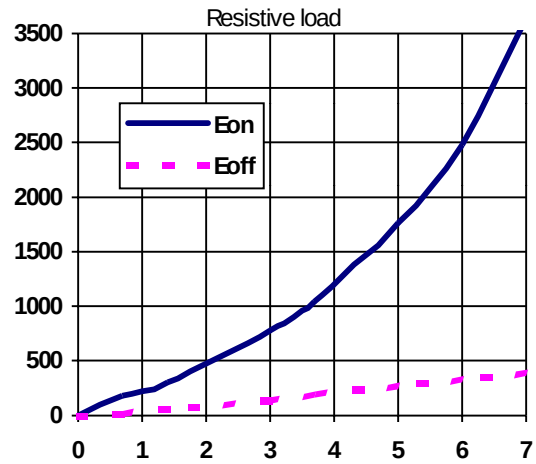


Figure 14 - E_{on} , E_{off} (μJ) Vs I_{out} (A)

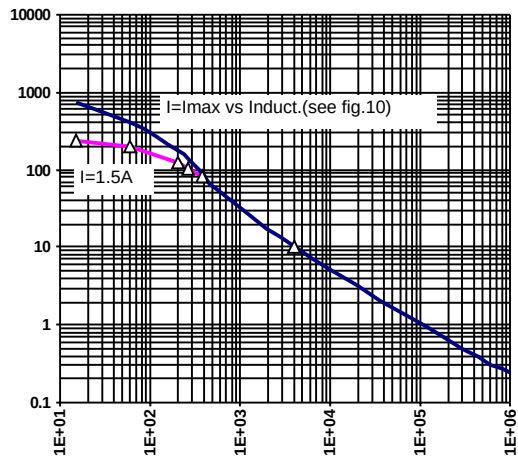


Figure 15 - E_{on} (μJ) Vs Load Inductance (μH)
(see Fig. 3)

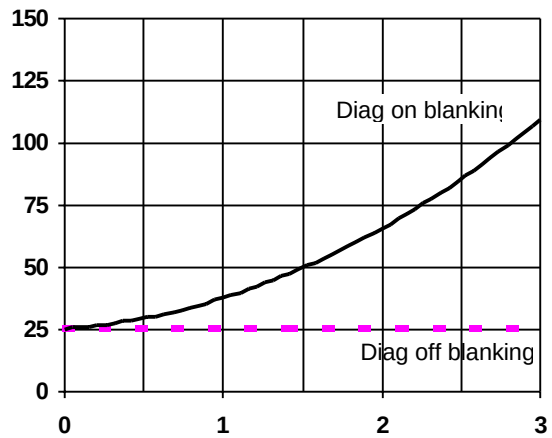


Figure 16 - Diag Blanking time (μs) Vs I_{out} (A)
(resistive load - see Fig. 6)

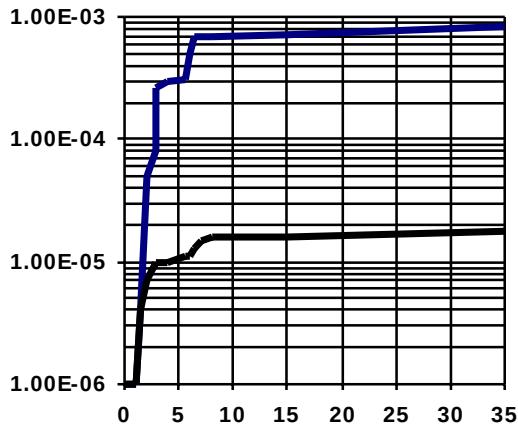
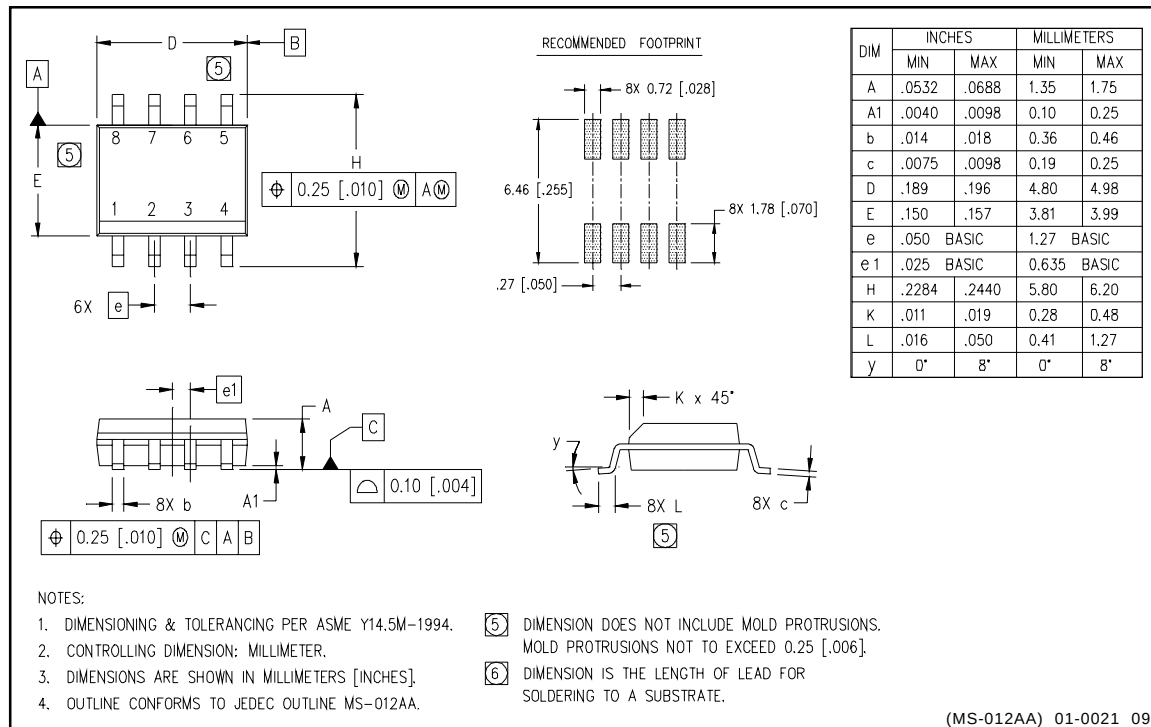


Figure 17 - I_{CC} (mA) Vs V_{CC} (V)

Case Outline - 8 Lead SOIC



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