Data Sheet No.PD 60155H

International
IOR Rectifier

IPS511/IPS511S

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

Product Summary

$R_{ds(on)}$	135mΩ (max)
V_{clamp}	50V
I_{Limit}	5A
$V_{open\ load}$	3V

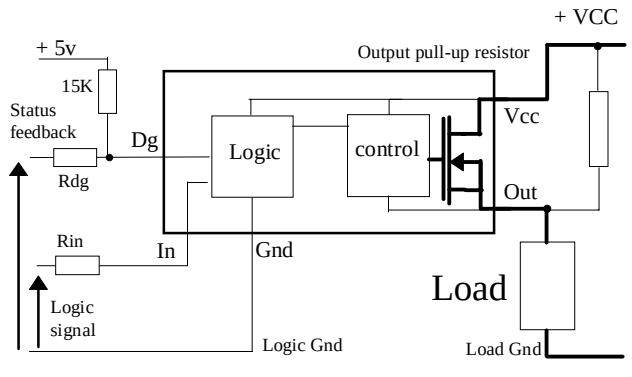
Description

The IPS511/IPS511S are fully protected five terminal high side switches 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.

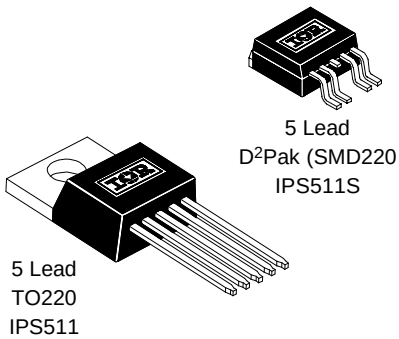
Truth Table

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



Packages



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		
$V_{cc\ max}$	Maximum Vcc voltage	—	50		
$I_{in,\ max.}$	Maximum 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)	—	2.2	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)			W	
	(TC=25°C) IPS511	—	25		
	(rth=80°C/W) IPS511S	—	1.56		
T_j max.	Max. storage & operating junction temp.	-40	+150	°C	
T_{lead}	Lead temperature (soldering 10 seconds)	—	300		

Thermal Characteristics

Symbol	Parameter	Min.	Typ.	Max.	Units	Test Conditions
R_{th} 1	Thermal resistance junction to case	—	5	—	°C/W	TO-220
R_{th} 2	Thermal resistance junction to ambient	—	60	—		
R_{th} 1	Thermal resistance with standard footprint	—	60	—		D^2PAK (SMD220)
R_{th} 2	Thermal resistance with 1" square footprint	—	40	—		
R_{th} 3	Thermal resistance junction to case	—	5	—		

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

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} Tamb=85°C	Continuous output current			A
	(TAmbient = 85°C, Tj = 125°C, R_{th} < 60°C/W) IPS511	—	1.7	
	(TAmbient = 85°C, Tj = 125°C, R_{th} = 80°C/W) IPS511	—	1.5	
R_{in}	Recommended resistor in series with IN pin	4	6	kΩ
R_{dg}	Recommended resistor in series with DG pin	10	20	

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	—	110	135	mΩ	V_{in} = 5V, I_{out} = 2.5A
$R_{ds(on)}$ (V_{cc}=6V)	ON state resistance @ V_{cc} = 6V	—	110	135		V_{in} = 5V, I_{out} = 1A
$R_{ds(on)}$ @Tj=150°C	ON state resistance Tj = 150°C	—	200	—		V_{in} = 5V, I_{out} = 2.5A
V_{cc} oper.	Operating voltage range	5.5	—	35	V	
V clamp 1	V_{cc} to OUT clamp voltage 1	50	56	—		I_d = 10mA (see Fig.1 & 2)
V clamp 2	V_{cc} to OUT clamp voltage 2	—	58	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	—	16	50	µA	V_{in} = 0V, V_{out} = 0V
I_{cc} on	Supply current when ON	—	0.7	2	mA	V_{in} = 5V
I_{cc} ac	Ripple current when ON (AC RMS)	—	20	—	µA	V_{in} = 5V
Vdgl	Low level diagnostic output voltage	—	0.15	0.4	V	I_{dg} = 1.6 mA
I_{oh}	Output leakage current	—	60	110	µA	V_{out} = 6V
I_{ol}	Output leakage current	0	—	25		V_{out} = 0V
Idg leakage	Diagnostic output leakage current	—	—	10		V_{dg} = 5.5V
V_{ih}	IN high threshold voltage	—	2.3	3	V	
V_{il}	IN low threshold voltage	1	1.95	—		
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 = 5.6Ω, T_j = 25°C, (unless otherwise specified).

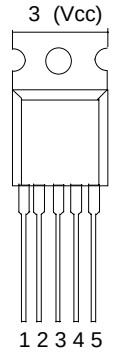
Symbol	Parameter	Min.	Typ.	Max.	Units	Test Conditions
T_{don}	Turn-on delay time	—	7	50	µs	See figure 3
T_{r1}	Rise time to V_{out} = V_{cc} - 5V	—	10	50		
T_{r2}	Rise time V_{cc} - 5V to V_{out} = 90% of V_{cc}	—	45	100		
$d_{V/dt\ (on)}$	Turn ON $d_{V/dt}$	—	1.3	4	V/µs	
E_{on}	Turn ON energy	—	400	—	µJ	
T_{doff}	Turn-off delay time	—	15	50	µs	See figure 4
T_f	Fall time to V_{out} = 10% of V_{cc}	—	10	50		
$d_{V/dt\ (off)}$	Turn OFF $d_{V/dt}$	—	2	6	V/µs	
E_{off}	Turn OFF energy	—	80	—	µJ	
T_{diag}	V_{out} to V_{diag} propagation delay	—	5	15	µs	See figure 6

Protection Characteristics

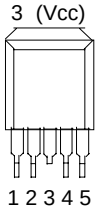
Symbol	Parameter	Min.	Typ.	Max.	Units	Test Conditions
I_{lim}	Internal current limit	3	5	7	A	V_{out} = 0V
T_{sd+}	Over-temp. positive going threshold	—	165	—	°C	See fig. 2
T_{sd-}	Over-temp. negative going threshold	—	158	—	°C	See fig. 2
V_{sc}	Short-circuit detection voltage (3)	2	3	4	V	See fig. 2
$V_{open\ load}$	Open load detection threshold	2	3	4	V	

(3) Referenced to V_{cc}

Lead Assignments



1 - Ground
2 - In
3 - Vcc
4 - DG
5 - Out



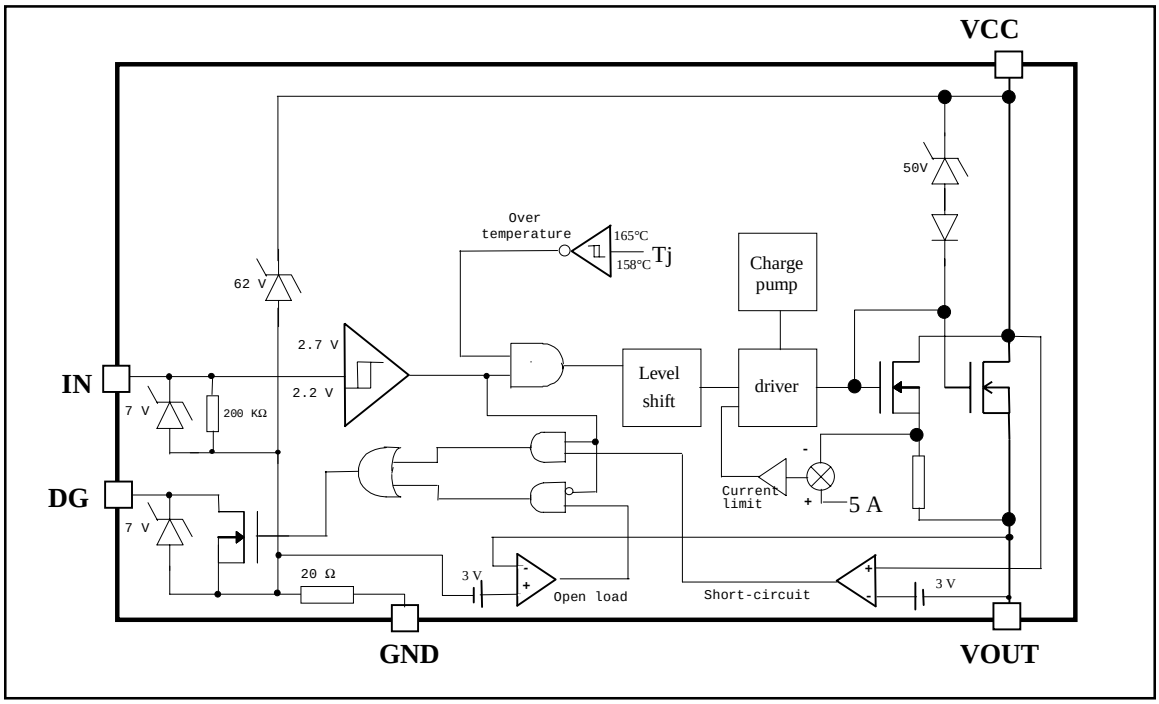
5 Lead - TO220

5 Lead - D²PAK (SMD220)

IPS511	IPS511S
Part Number	

Functional Block Diagram

All values are typical



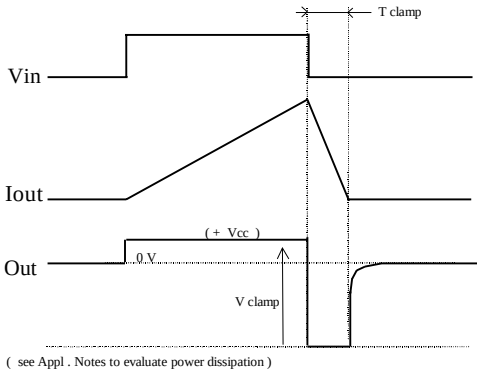


Figure 1 - Active clamp waveforms

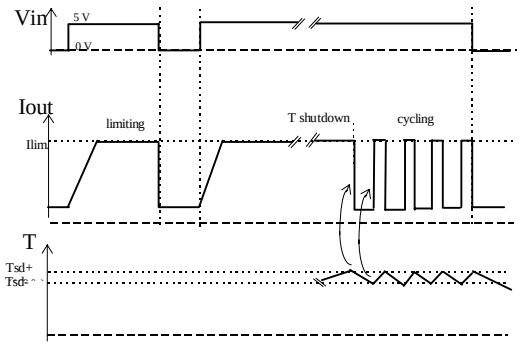


Figure 2 - Protection timing diagram

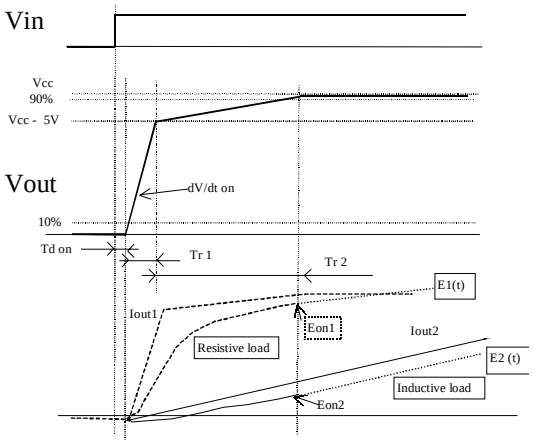


Figure 3 - Switching times definition (turn-on)
Turn on energy with a resistive or an inductive load

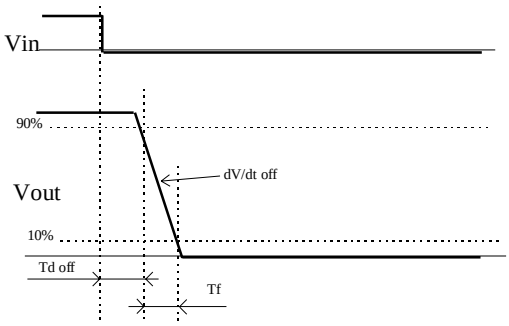


Figure 4 - Switching times definition (turn-off)

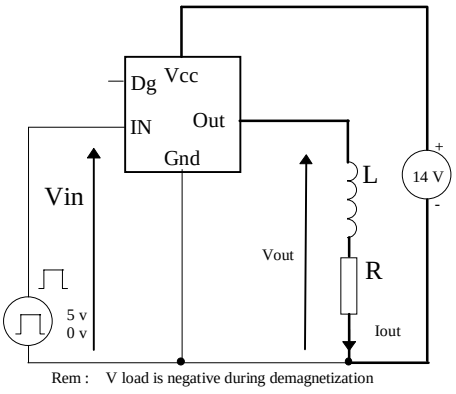


Figure 5 - Active clamp test circuit

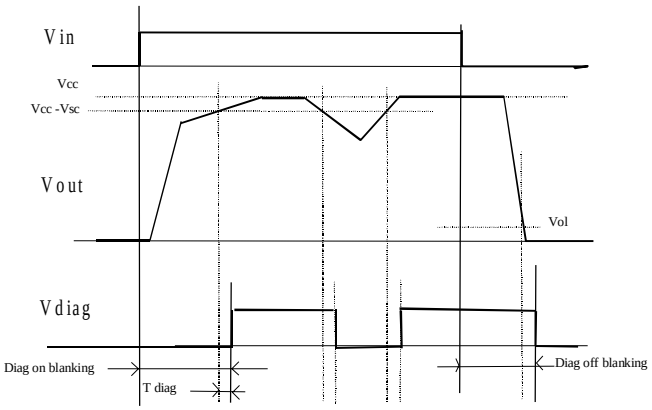


Figure 6 - Diagnostic delay definitions

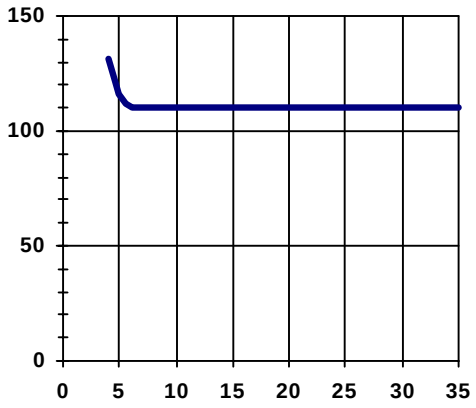


Figure 7 - $R_{ds(on)}$ (mΩ) Vs V_{cc} (V)

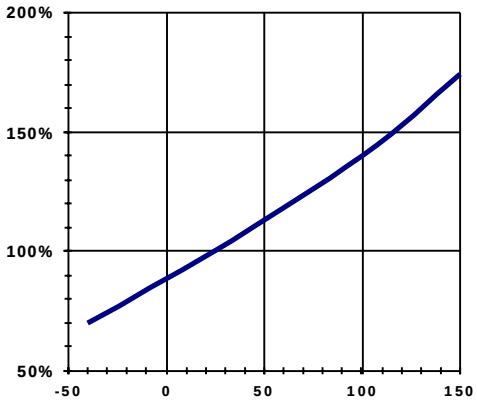


Figure 8 - Normalized $R_{ds(on)}$ (%) Vs T_j (^oC)

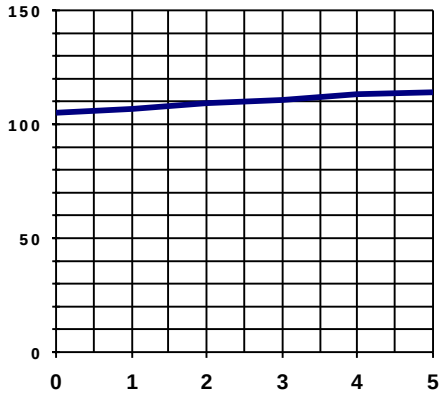


Figure 9 - Rds(on) (mΩ) Vs I_{out} (A)

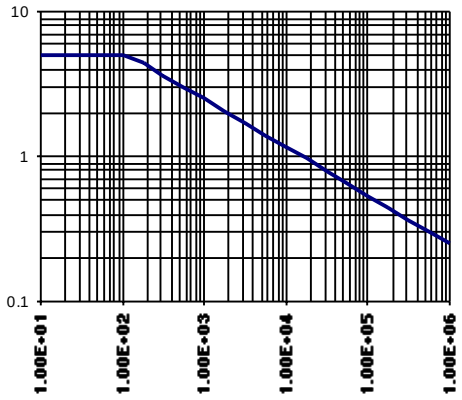


Figure 10 - Max. I_{out} (A) Vs Load Inductance (uH)

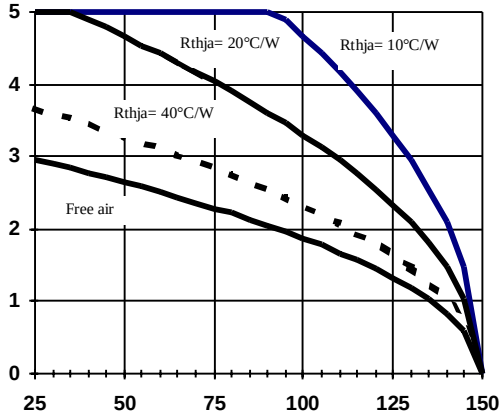


Figure 11a - Max load current (A) Vs Tamb (^{o}C)
IPS511

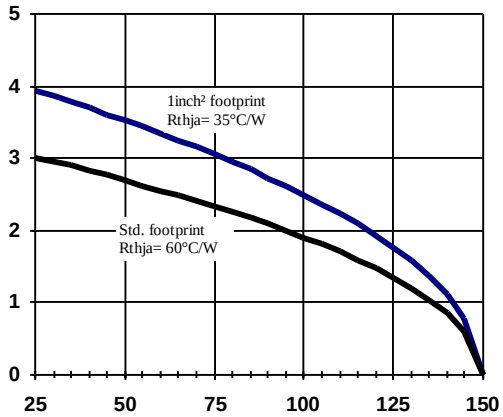


Figure 11b - Max load current (A) Vs Tamb (^{o}C)
IPS511S

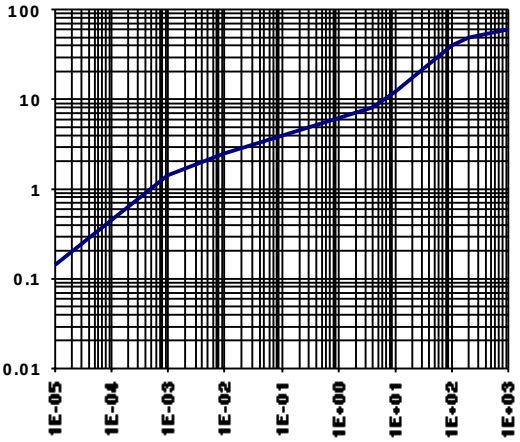


Figure 12 - Transient Thermal Impedance (^{o}C/W)
Vs Time (S)

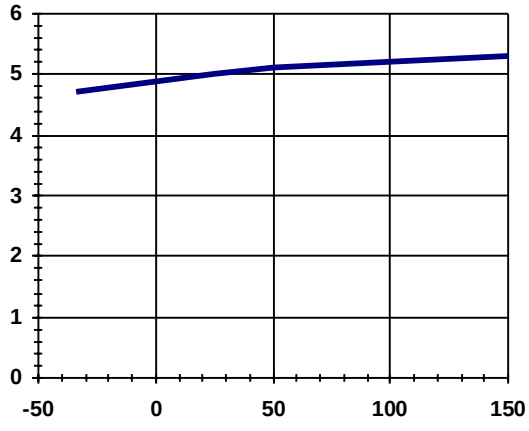


Figure 13 - I_{lim} (A) Vs T_j (^{o}C)

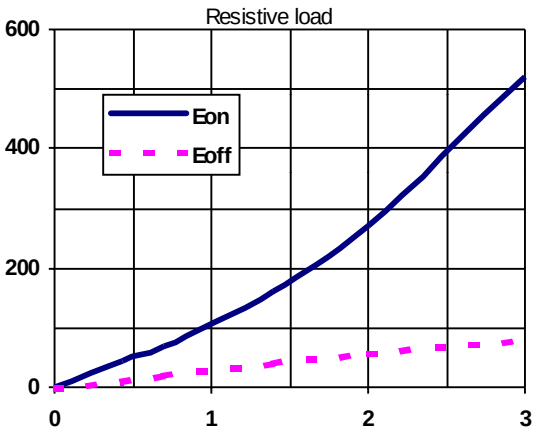


Figure 14 - E_{on}, E_{off} (µJ) (A) Vs I_{out} (A)

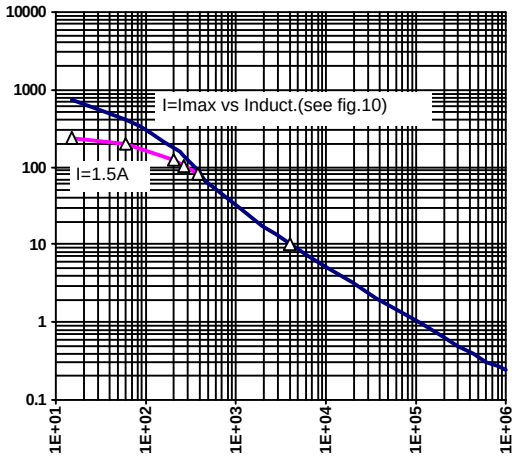


Figure 15 - E_{on} (µJ) Vs Load Inductance (µH)
(see Fig. 3)

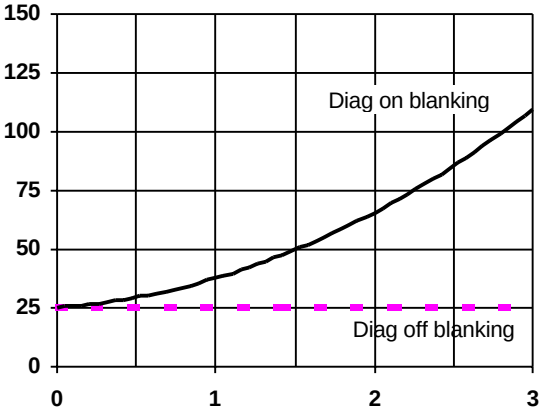


Figure 16 - Diag Blanking time (µS) Vs I_{out} (A)
(resistive load - see Fig. 6)

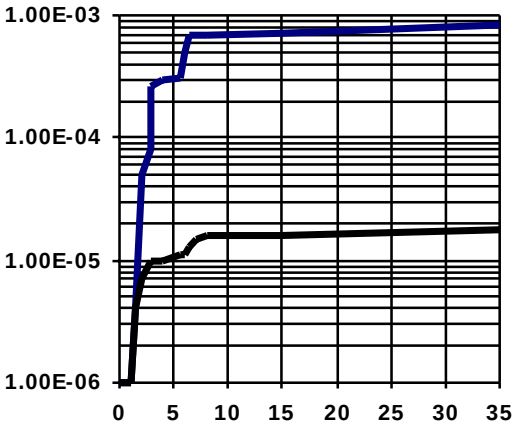


Figure 17 - I_{cc} (mA) Vs V_{cc} (V)

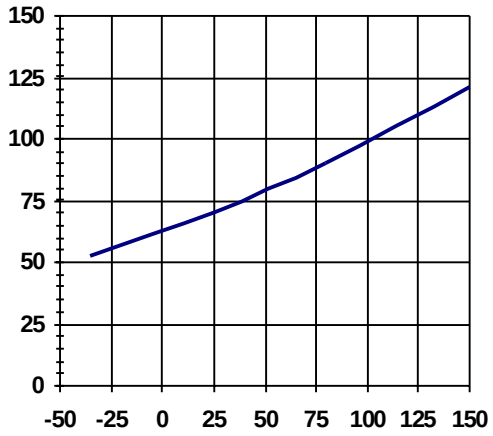
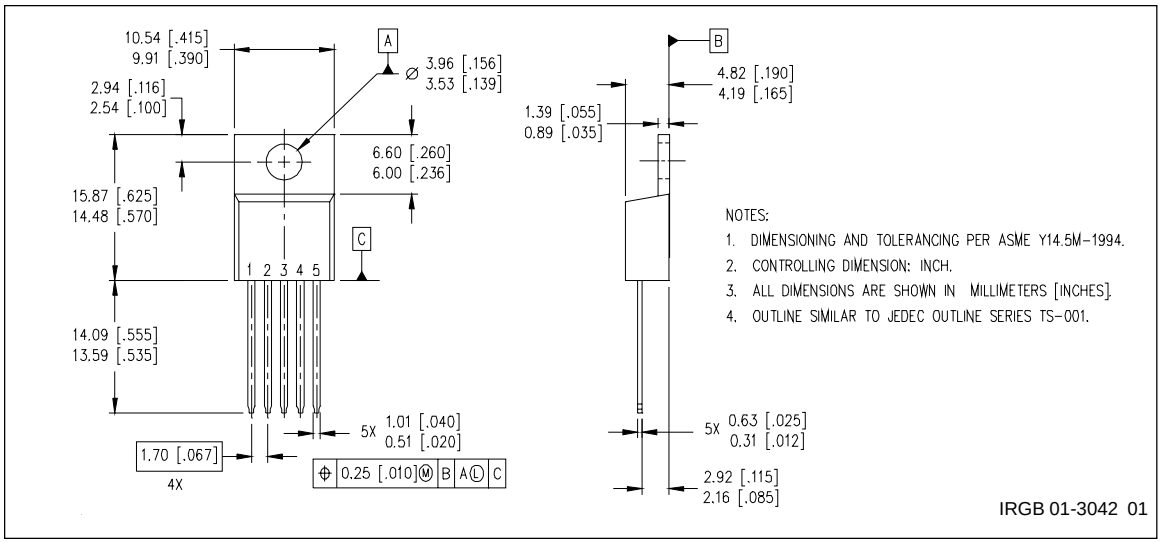
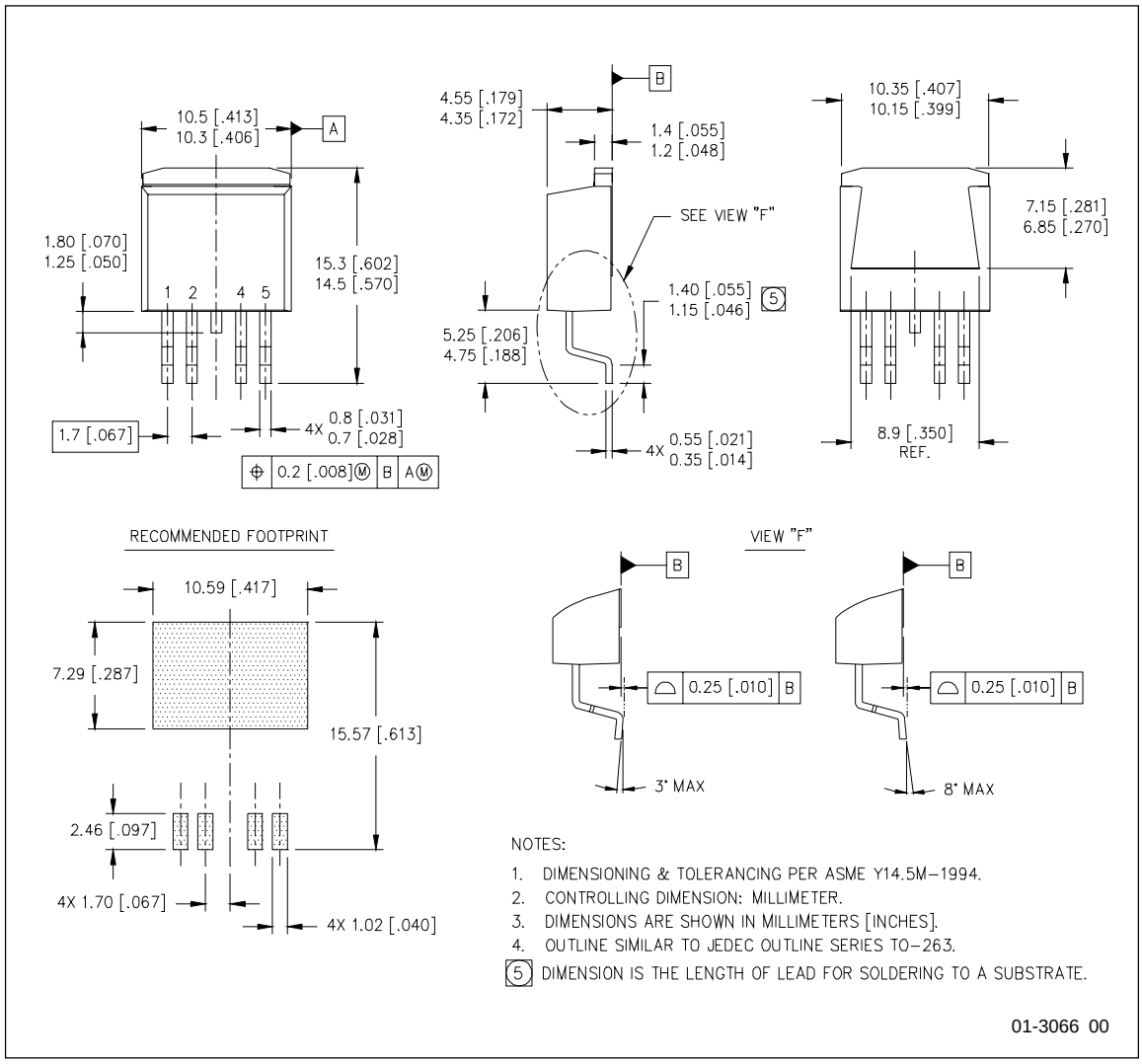


Figure 18 - I_{in} @ V_{in} = 5V (µA) Vs T_j (^oC)

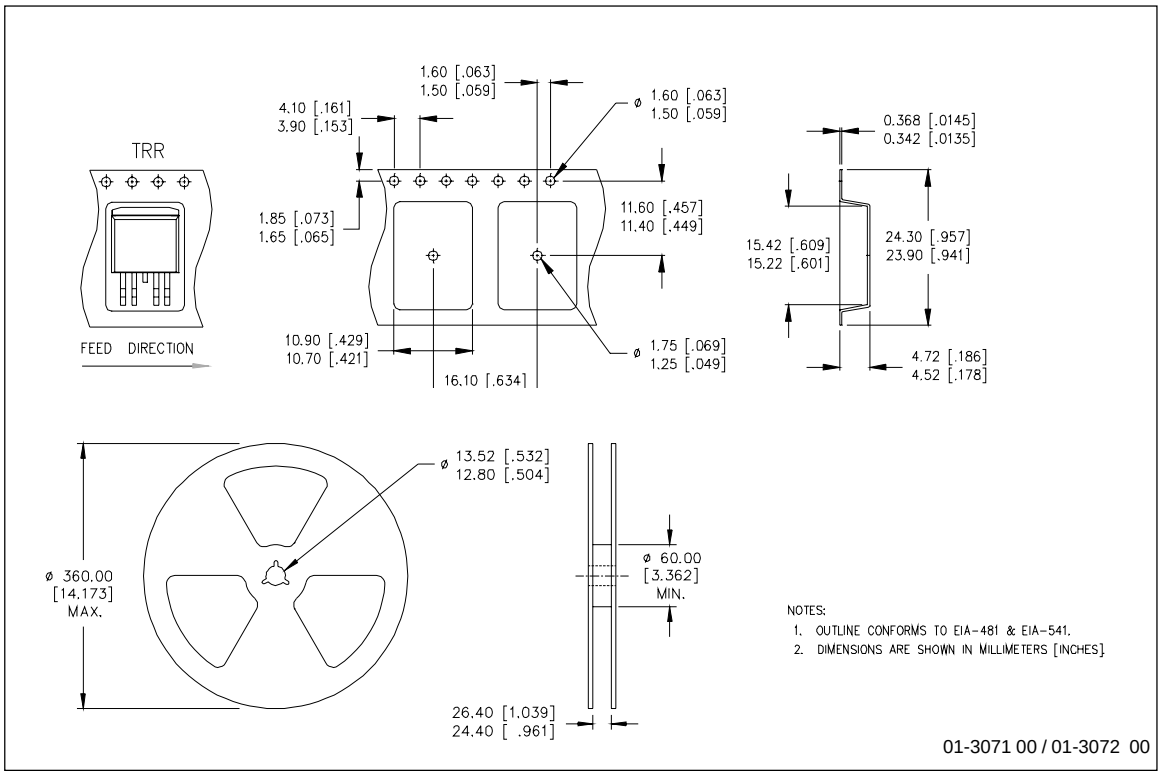
Case Outline 5 Lead - TO220



Case Outline 5 Lead - D²PAK (SMD220)



Tape & Reel 5 Lead - D²PAK (SMD220)



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