Data Sheet No.PD60159-K

International
IOR Rectifier

IPS5451/IPS5451S

FULLY PROTECTED HIGH SIDE POWER MOSFET SWITCH

Features

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

Product Summary

$R_{ds(on)}$	25mΩ (max)
V_{clamp}	50V
$I_{shutdown}$	35A
$I_{open\ load}$	1A

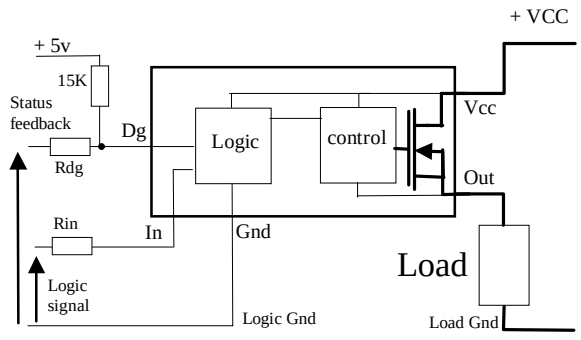
Description

The IPS5451/IPS5451S are fully protected five terminal high side switch with built in short circuit, over-temperature, ESD protection, inductive load capability and diagnostic feedback. The over-current protection latches off the device if the output current exceeds Ishutdown. It can be reset by turning the input pin low. The over-temperature protection turns off the high side switches 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 over-current, over-temperature and open load detection. The double level shifter circuitry allows large offsets between the logic ground and the load ground.

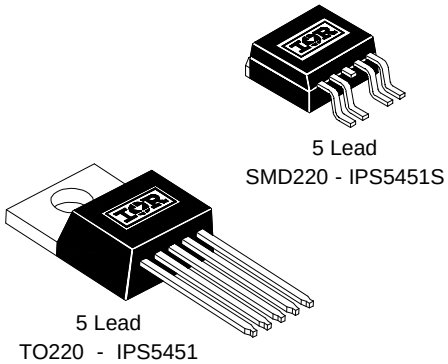
Truth Table

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

Typical Connection



Packages



5 Lead
SMD220 - IPS5451S

5 Lead
TO220 - IPS5451

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. ($T_{Ambient}$ = 25°C unless otherwise specified).

Symbol	Parameter	Min.	Max.	Units	Test Conditions
V_{out}	Maximum output voltage	V_{cc}-45	V_{cc}+0.3	V	
V_{offset}	Maximum logic ground to load ground offset	V_{cc}-45	V_{cc}+0.3		
V_{in}	Maximum Input voltage	-0.3	5.5		
$I_{in, max}$	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. continuous current (1)			A	
	(rth=62°C/W) IPS5451	—	2.8		
	(rth=80°C/W) IPS5451S	—	2.2		
$I_{sd\ pulsed}$	Diode max. pulsed current (1)	—	45		
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	
	(rth=62°C/W) IPS5451	—	2		
	(rth=80°C/W) IPS5451S	—	1.56		
T_j max.	Max. storage & operating junction temp.	-40	+150	°C	
T_{lead}	Lead temperature (soldering 10 seconds)	—	300		
Vcc max.	Maximum Vcc voltage	—	45	V	

Thermal Characteristics

Symbol	Parameter	Min.	Typ.	Max.	Units	Test Conditions
R_{th} 1	Thermal resistance junction to case	—	2	—	°C/W	TO-220
R_{th} 2	Thermal resistance junction to ambient	—	55	—		
R_{th} 1	Thermal resistance with standard footprint	—	60	—		D^2PAK (SMD220)
R_{th} 2	Thermal resistance with 1" square footprint	—	35	—		
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	18	V
V_{IH}	High level input voltage	4	5.5	
$V_{IL\ 1}$	Low level input voltage	-0.3	0.9	
I_{out}	Continuous output current			A
	(TAmbient = 85°C, Tj = 125°C, R_{th} = 62°C/W) IPS5451	—	4	
	(TAmbient = 85°C, Tj = 125°C, R_{th} = 80°C/W) IPS5451S	—	3.5	
I_{out} Tc=85°C	Continuous output current (TCase = 85°C, IN = 5V, Tj = 125°C, R_{th} = 5°C/W)	—	14	
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	—	19	25	mΩ	V_{in} = 5V, I_{out} = 14A
$R_{ds(on)}$ (V_{cc}=6V)	ON state resistance @ V_{cc} = 6V	—	22	30		V_{in} = 5V, I_{out} = 7A
$R_{ds(on)}$ @Tj=150°C	ON state resistance Tj = 150°C	—	32	—		V_{in} = 5V, I_{out} = 14A
$V_{cc\ oper.}$	Functional operating range	5.5	—	18	V	
V clamp 1	V_{cc} to OUT clamp voltage 1	45	49	—		I_d = 10mA (see Fig.1 & 2)
V clamp 2	V_{cc} to OUT clamp voltage 2	—	50	60		I_d = $I_{shutdown}$ (see Fig.1 & 2)
V_f	Body diode forward voltage	—	0.9	1.2		I_d = 14A, V_{in} = 0V
$I_{out\ leakage}$	Output leakage current	—	10	50	µA	V_{out} = 0V, Tj = 25°C
$I_{cc\ off}$	Supply current when OFF	—	10	50		V_{in} = 0V, V_{out} = 0V
$I_{cc\ on}$	Supply current when ON	—	3.5	10	mA	V_{in} = 5V
$I_{cc\ ac}$	Ripple current when ON (AC RMS)	—	20	—	µA	V_{in} = 5V
Vdgl	Low level diagnostic output voltage	—	0.1	0.4	V	I_{dg} = 1.6 mA
Idg leakage	Diagnostic output leakage current	—	1.5	10	µA	V_{dg} = 4.5V
V_{ih}	IN high threshold voltage	—	2.7	3.4	V	
V_{il}	IN low threshold voltage	1	2.0	—		
$I_{in,\ on}$	On state IN positive current	—	30	80	µA	V_{in} = 4V
V_{ccuv+}	V_{cc} UVLO positive going threshold	—	4.7	5.5	V	
V_{ccuv-}	V_{cc} UVLO negative going threshold	3.0	4.4	—		
$In_{hyst.}$	Input hysteresis	0.2	0.6	1.5		

Switching Electrical Characteristics

V_{cc} = 14V, Resistive Load = 1Ω, T_j = 25°C, (unless otherwise specified).

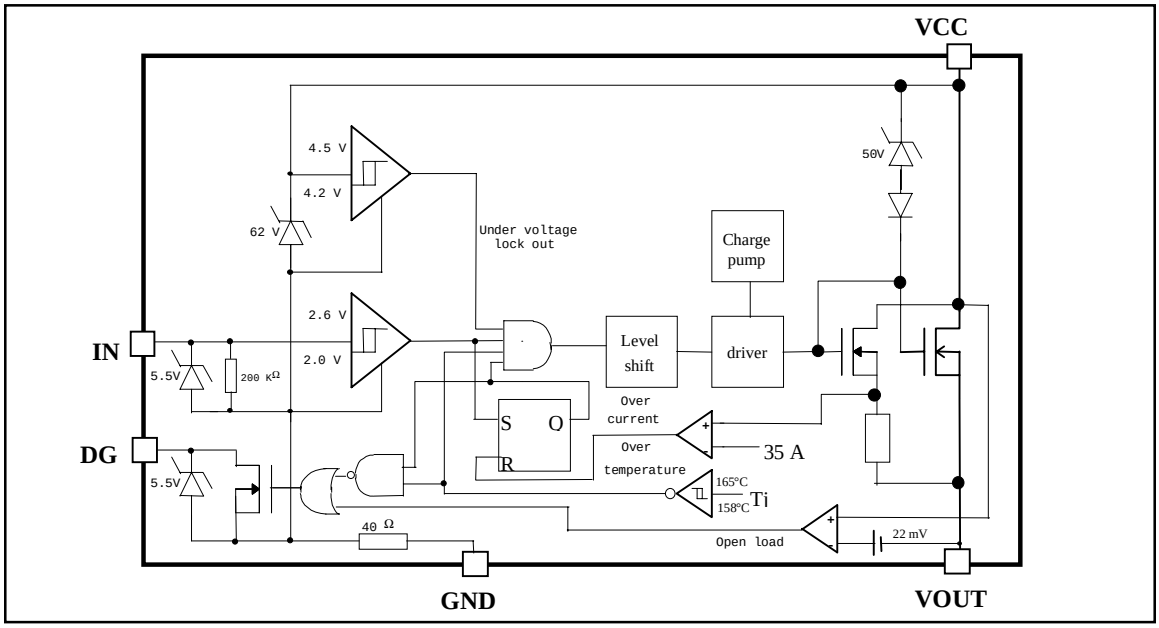
Symbol	Parameter	Min.	Typ.	Max.	Units	Test Conditions
Td_{on}	Turn-on delay time	—	5	20	µs	See figure 3
T_{r1}	Rise time to V_{out} = V_{cc} - 5V	—	4	20		
T_{r2}	Rise time from the end of Tr1 to V_{out} = 90% of V_{cc}	—	65	150		
dV/dt (on)	Turn ON dV/dt	—	3	6	V/µs	
E_{on}	Turn ON energy	—	3	—	mJ	See figure 4
Td_{off}	Turn-off delay time	—	65	150	µs	
T_f	Fall time to V_{out} = 10% of V_{cc}	—	8	20		
dV/dt (off)	Turn OFF dV/dt	—	5	10	V/µs	
E_{off}	Turn OFF energy	—	0.75	—	mJ	

Protection Characteristics

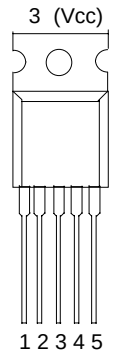
Symbol	Parameter	Min.	Typ.	Max.	Units	Test Conditions
T_{sd+}	Over-temp. positive going threshold	—	165	—	°C	See fig. 2
T_{sd-}	Over-temp. negative going threshold	—	158	—	°C	See fig. 2
I_{sd}	Over-current threshold	22	35	50	A	See fig. 2
$I_{open\ load}$	Open load detection threshold	0.3	1	2	A	
T_{reset}	Minimum time to reset protections	—	50	—	µs	V_{in} = 0V
T_{dg}	Blanking time before considering Dg	—	7	100	µs	Part turned on with Vin =5V

Functional Block Diagram

All values are typical

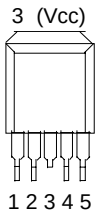


Lead Assignments



5 Lead - TO220

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



5 Lead - D²PAK (SMD220)

IPS5451	IPS5451S
Part Number	

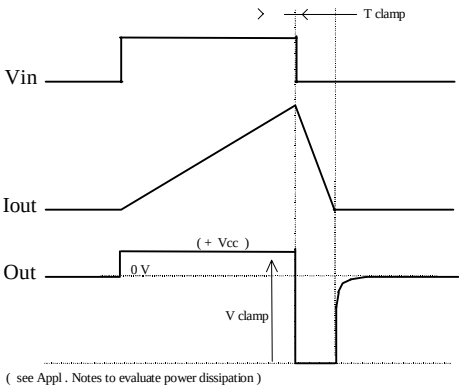


Figure 1 - Active clamp waveforms

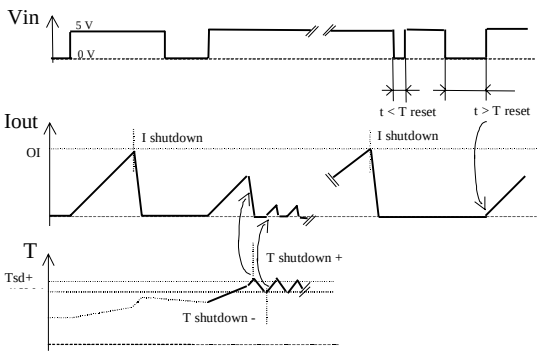


Figure 2 - Protection timing diagram

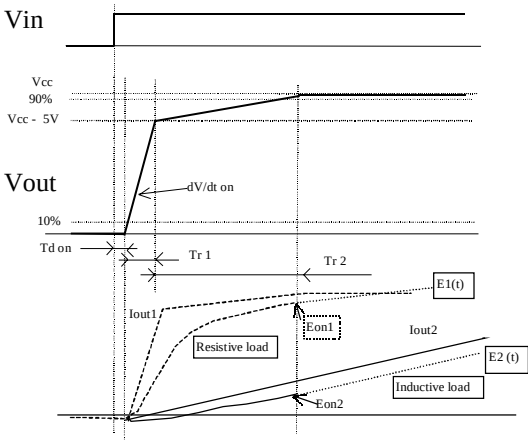


Figure 3 - Switching times definition (turn-on)
Turn on energy with a resistive or an inductive load

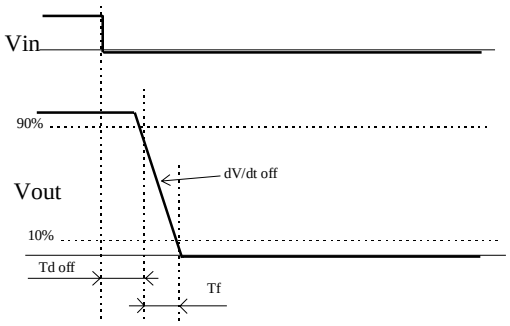


Figure 4 - Switching times definition (turn-off)

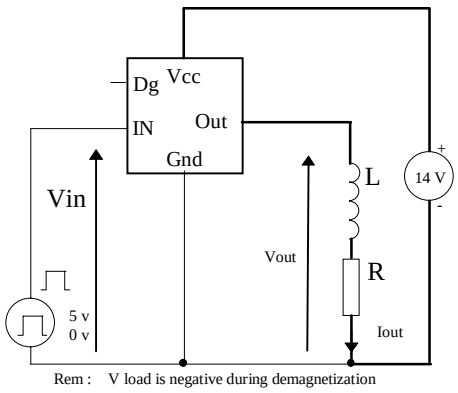


Figure 5 - Active clamp test circuit

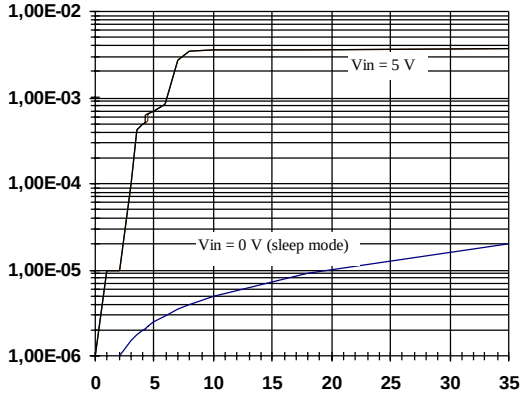


Figure 6 - I_{CC} (mA) Vs V_{CC} (V)

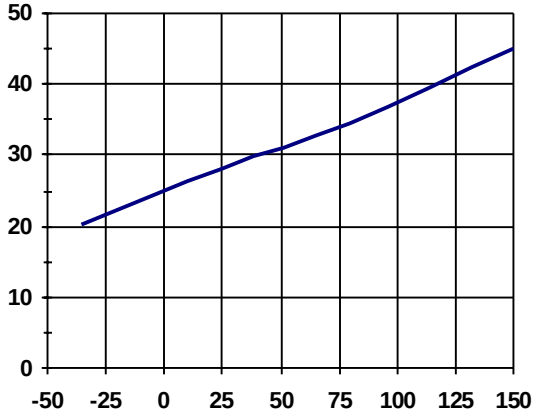


Figure 7 - Iin (µA) Vs Tj (°C)

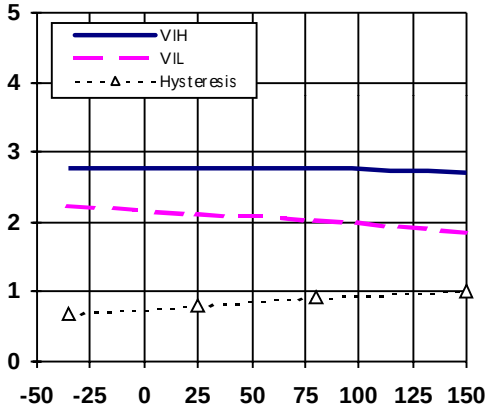


Figure 8 - VIH, VIL threshold (V) Vs Tj (°C)

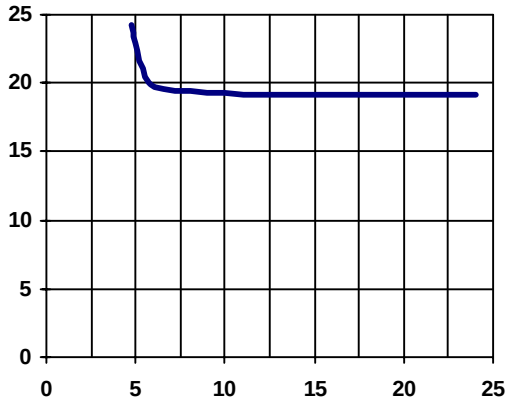


Figure 9 - Rdson (mΩ) vs Vcc (V)

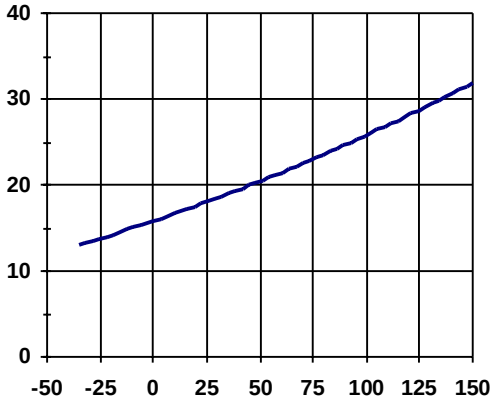


Figure 10 - Rdson (mΩ) vs Tj (°C)

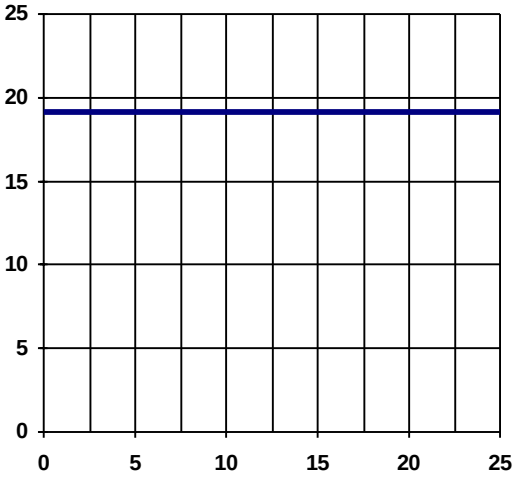


Figure 11 - Rdson (mΩ) vs Iout (A)

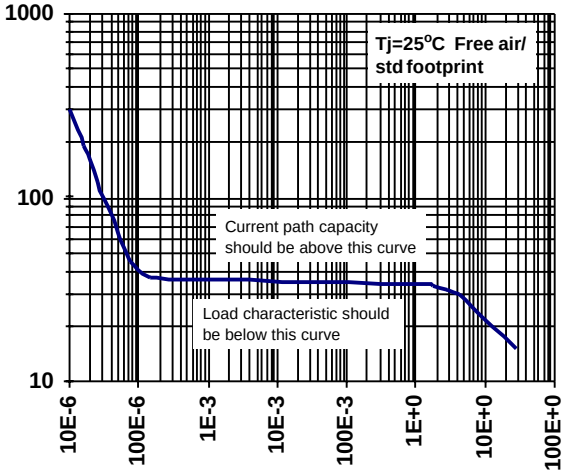


Figure 12 - Isd (A) vs Time (S)

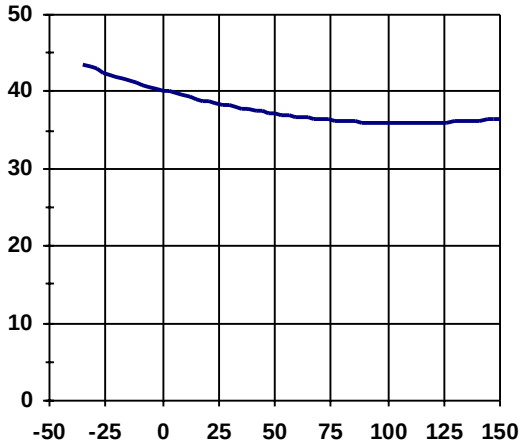


Figure 13 - Isd (A) vs Tj (°C)

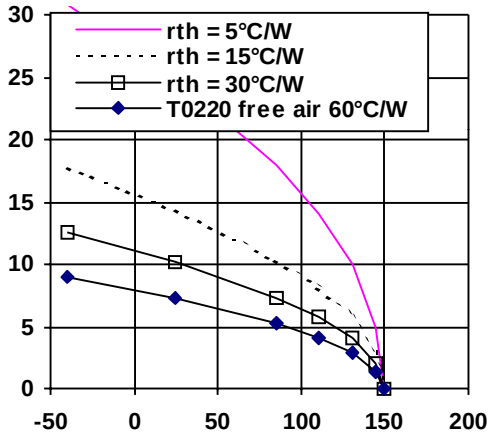


Figure 14 - Max. Cont. Ids (A) Vs
Amb. Temperature (°C)

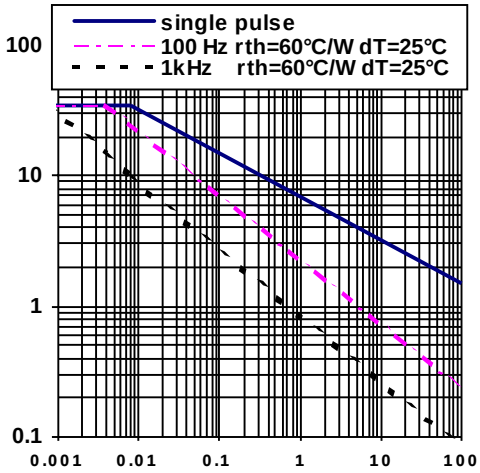


Figure 15 -Max. I clamp (A) Vs Inductive Load (m H)

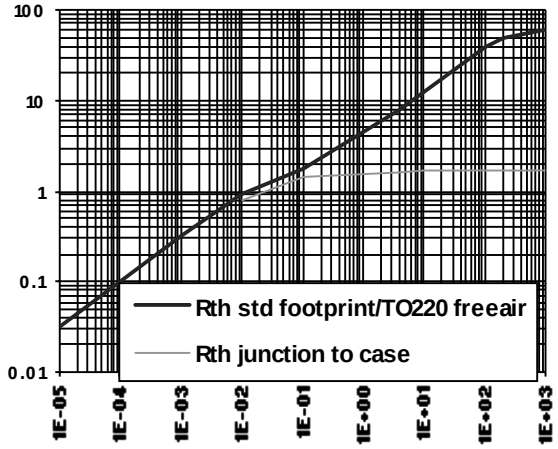


Figure 16 - Transient Rth (°C/W) Vs Time (s)

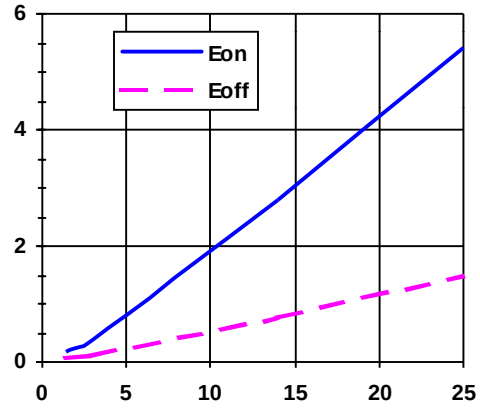


Figure 17 - Eon, Eoff (mJ) vs I_{out} (A)

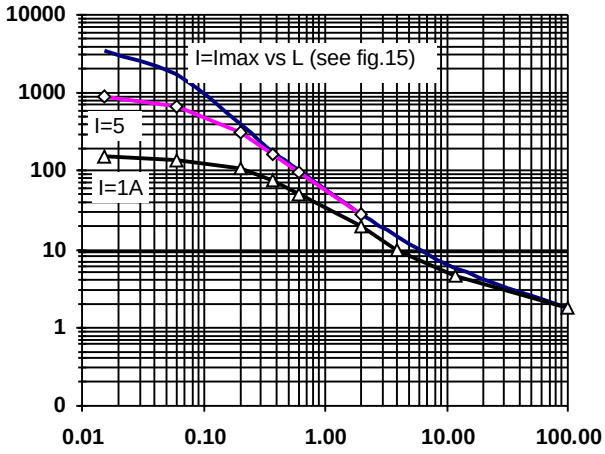


Figure 18 - Eon @ Vcc=14V (mJ) vs Inductance (mH)

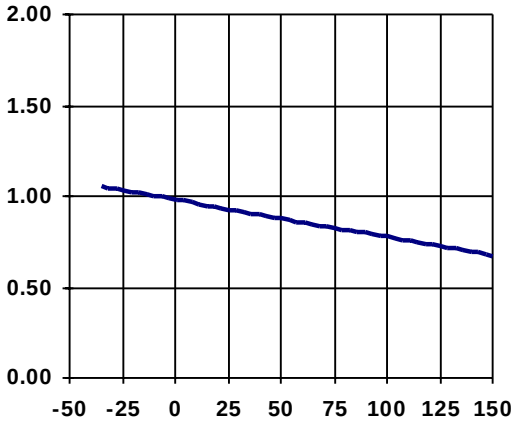


Figure 19 - I open load (A) vs Tj (°C)

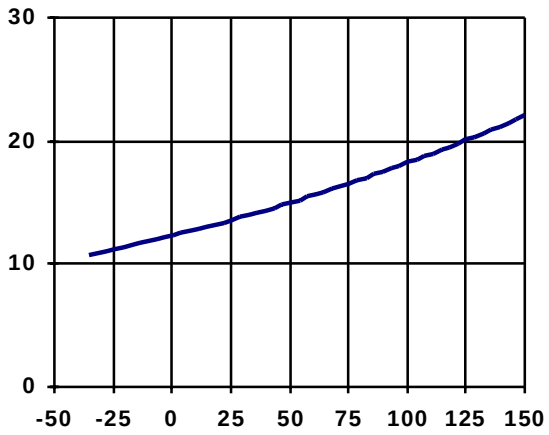
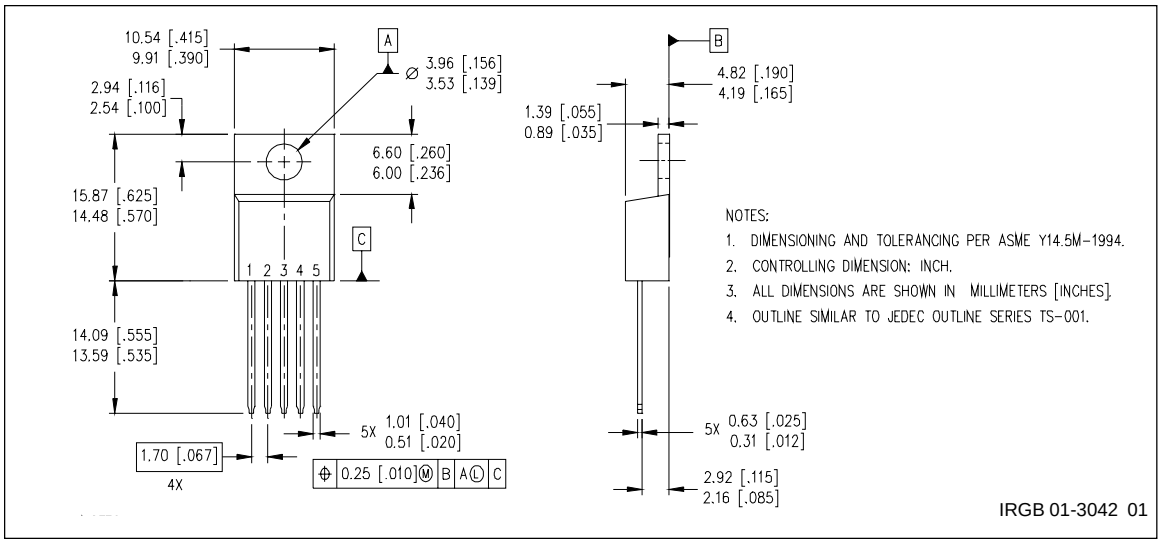
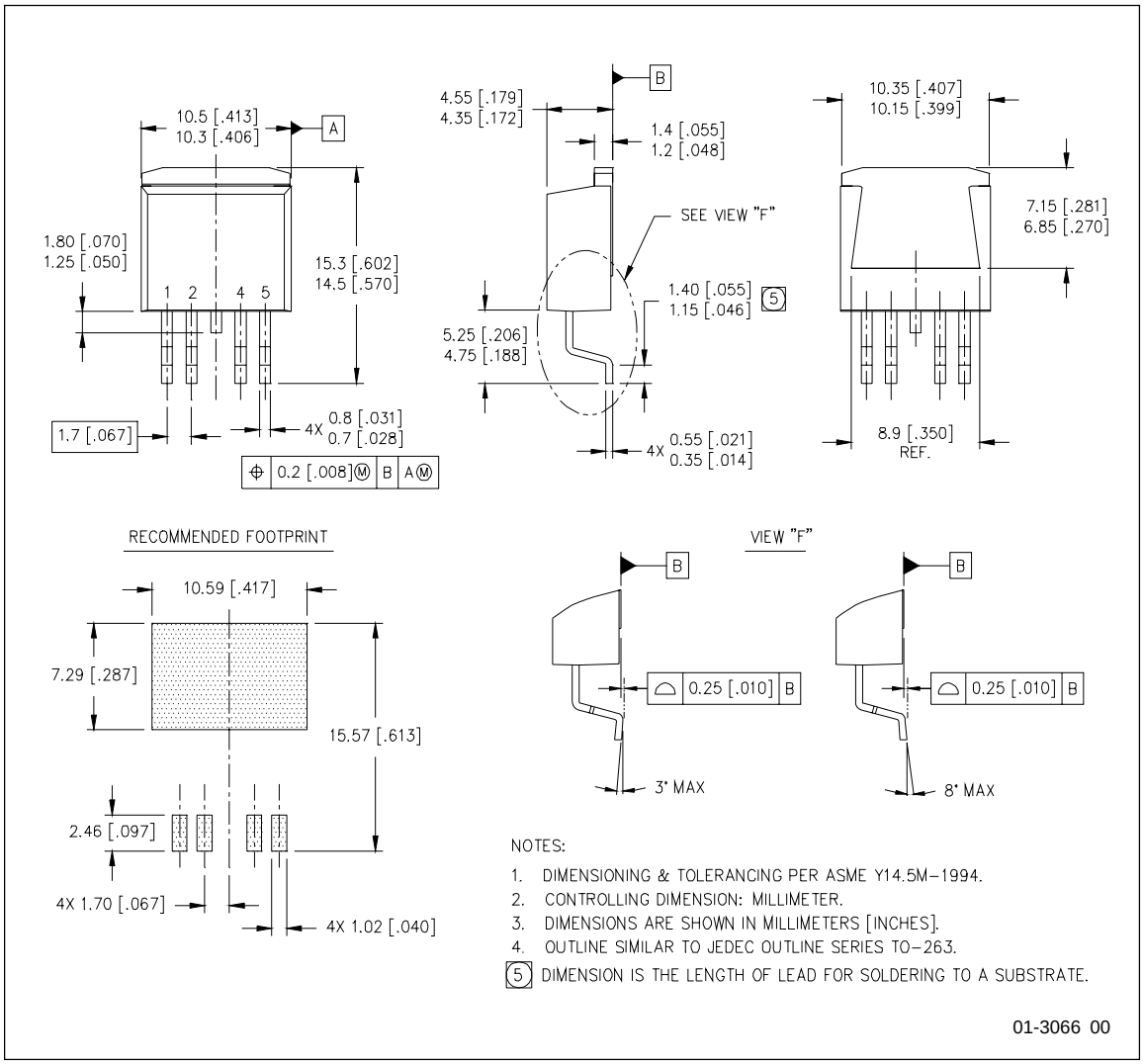


Figure 20 - Icc off (µA) vs Tj (°C)

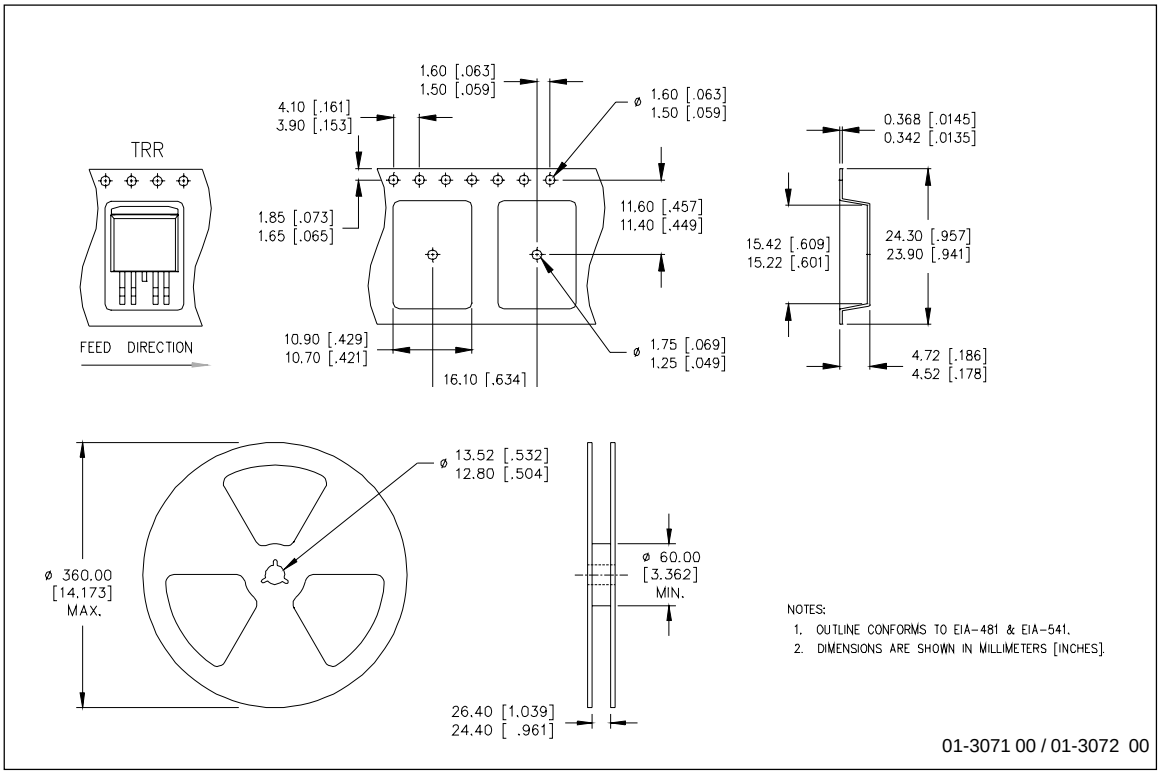
Case Outline - TO220 (5 lead)



Case Outline - D²PAK (SMD220) - 5 Lead



Tape & Reel - D²PAK (SMD220) - 5 Lead



IR WORLD HEADQUARTERS: 233 Kansas St., El Segundo, California 90245 Tel: (310) 252-7105
IR EUROPEAN REGIONAL CENTRE: 439/445 Godstone Rd., Whyteleafe, Surrey CR3 0BL, United Kingdom
Tel: ++ 44 (0) 20 8645 8000
IR JAPAN: K&H Bldg., 2F, 30-4 Nishi-Ikebukuro 3-Chome, Toshima-Ku, Tokyo, Japan 171-0021 Tel: 8133 983 0086
IR HONG KONG: Unit 308, #F, New East Ocean Centre, No. 9 Science Museum Road, Tsimshatsui East, Kowloon
Hong Kong Tel: (852) 2803-7380

Note: For the most current drawings please refer to the IR website at:
http://www.irf.com/package/