International
IOR Rectifier

IR3310

PROGRAMMABLE CURRENT SENSING HIGH SIDE SWITCH

Features

- Load current feedback
- Programmable over current shutdown
- Active clamp
- E.S.D protection
- Input referenced to Vcc
- Reverse battery protection (reverse current operation)

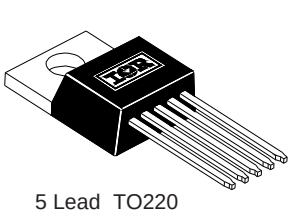
Description

The IR 3310 is a Fully Protected 4 terminal high side switch. The input signal is referenced to Vcc. When the input voltage Vcc - Vin is higher than the specified Vih threshold, the output power MOSFET is turned-on. When Vcc - Vin is lower than the specified Vil threshold, the output MOSFET is turned-off. A sense current proportional to the current in the power Mosfet is sourced to the ST pin. Over-current shutdown occurs when Vst - Vin > 4 V. Choosing Rst allows to adjust Isd. Either over-current and over-temperature latches off the switch. The device is reset by pulling the input pin high. Other integrated protections (ESD, reverse battery, active clamp) make the IR 3310 very rugged and suitable for the automotive environment.

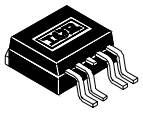
Product Summary

$R_{ds(on)}$	5mΩ typ.
$V_{cc.op.}$	5.5 to 35V
Current ratio	10 000
$I_{shutdown}$	10 to 100A
Active clamp	40V

Packages

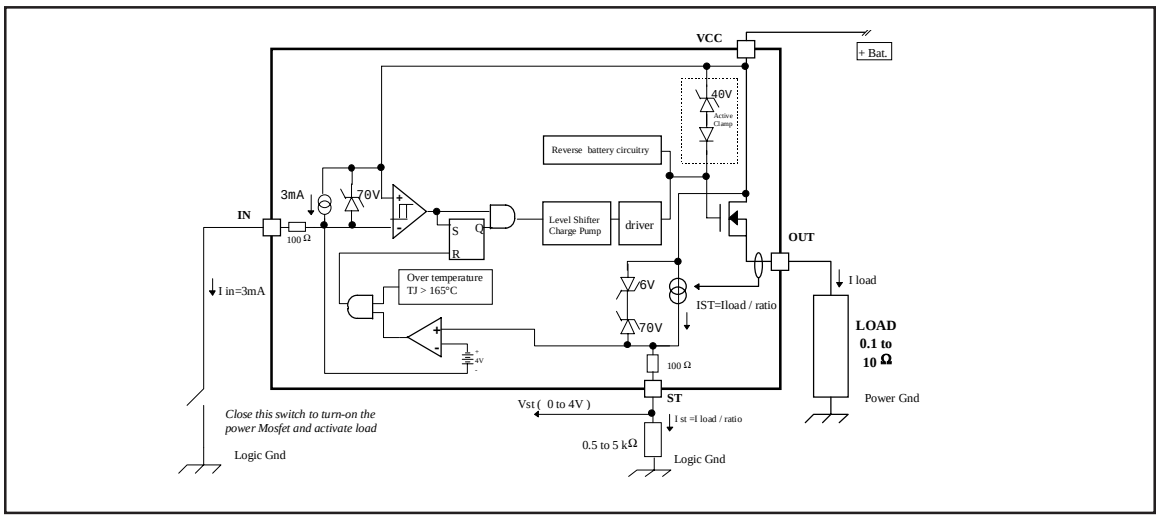


5 Lead TO220
IR3310



5 Lead D^2PAK
IR3310S

Typical Connection



Absolute Maximum Ratings

Absolute maximum ratings indicates sustained limits beyond which damage to the device may occur. All voltage parameters are referenced to Vcc lead. ($T_{Ambient}$ = 25°C unless otherwise specified).

Symbol	Parameter	Min.	Max.	Units
Vcc - Vin max	Maximum input voltage	-16	50	V
Vcc-Vst max	Maximum status voltage	-16	50	
Vcc - Vout max.	Maximum output voltage	-0.3	37	
Ids cont.	Diode max. permanent current (Rth = 60 °C/W) (1)	—	2.8	A
Ids1 cont	Diode max. permanent current (Rth = 5 °C/W) (1)	—	35	
Ids pulsed	Diode max. pulsed current (1)	—	100	
ESD 1	Electrostatic discharge (human body model)	—	tbd	kV
ESD 2	Electrostatic discharge (machine model)	—	tbd	
Pd	Power dissipation (Rth = 62 °C/W)	—	2	W
TJ max.	Max. storage and junction temperature	-40	150	°C
Min R st	Minimum resistor on the ST pin	0.5	—	kΩ

Thermal Characteristics

Symbol	Parameter	Typ.	Max.	Units
R_{th} free air	Thermal resistance - free air	60	—	°C/W
R_{th} std footprint	Thermal resistance with standard footprint	80	—	°C/W
R_{th}1" footprint	Thermal resistance with 1" footprint	50	—	°C/W
R_{th} junct. to case	Thermal resistance junction to case	5	—	°C/W

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
Vcc - Vin	Continuous input voltage	6	18	V
Vcc-Vst	Continuous status voltage	0	18	
Vcc	Supply to power ground voltage	6	18	
Iout	Continuous output current (Rth/amb < 5 °C/W, Tj = 125°C)	—	35	A
Iout 85°C amb.	Continuous output current (Rth/amb < 5 °C/W, Tj = 125°C)	—	8	
Rst	ST resistor to program Isd and scale (2 & 3)	0.5	5	kΩ

Protection Characteristics

Tj = 25°C (unless otherwise specified), Rst = 500 to 5kOhm.

Symbol	Parameter	Typ.	Max.	Units	Test Conditions
Vst - Vin @ Isd	Over-current shutdown threshold	4	—	V	
Tsd	Over-temp. shutdown threshold	165	—	°C	see Fig. 4
Treset	Protection reset time	50	—	µS	see Fig. 4

1) Limited by junction temperature. Pulsed current is also limited by wiring
2) <500 Ohm or shorting ST to gnd may damage the part with Isd around 120A
3) >5000 Ohm or leaving ST open will shutdown the part. No current will flow in the load.

Static Electrical Characteristics

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

Symbol	Parameter	Min.	Typ.	Max.	Units	Test Conditions
Iq	Quiescent current	—	7	50	uA	Vcc-Vin=0, Vcc-Vout=12V
Iin	Input current	—	3	—	mA	Vcc-Vin=14V
Vih	High level input threshold voltage (4)	—	5	—	V	
Vil	Low level input threshold voltage (4)	—	4	—		
Vhys	Input hysterisis = Vih-Vil	—	1	—		
Rds1 on	ON state resistance	—	5	—	mΩ	Iout=35A, Vcc=14V
Rds2 on	ON state resistance	—	5.5	—		Iout=17A, Vcc-Vin=6V
Rds3 on	ON state resistance	—	8	—		Iout=35A, Tj = 150°C
Vclamp1	Vcc to Vout active clamp voltage	37	40	—	V	Iout = 10mA
Vclamp2	Vcc to Vout active clamp voltage	—	42	48		Iout = 35mA
Vsd	Body diode forward voltage	—	0.85	1		Id=35A, Vcc-Vin=0V

Switching Electrical Characteristics

V_{cc} = 14V, Resistive Load = 0.4Ω, T_j = 25°C, (unless otherwise specified).

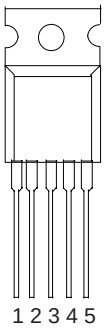
Symbol	Parameter	Min.	Typ.	Max.	Units	Test Conditions
T_{on}	Turn-on delay time to Vcc-Vout= 0.9 Vcc	—	10	—	µs	see figure 2
T_{r1}	Rise time to Vcc-Vout=5V	—	16	—		
T_{r2}	Rise time from end of Tr1 to V_{out} = 10% of V_{cc}	—	300	—		
$d_{V/dt\ (on)}$	Turn ON $d_{V/dt}$	—	1.2	—	V/µs	
E_{on}	Turn ON energy	—	40	—	mJ	see figure 3
T_{off}	Turn-off delay time	—	tbd	—	µs	
T_f	Fall time to Vcc-Vout 90% of V_{cc}	—	tbd	—		
$d_{V/dt\ (off)}$	Turn OFF $d_{V/dt}$	—	tbd	—	V/µs	
E_{off}	Turn OFF energy	—	5	—	mJ	

Current Sense Characteristics

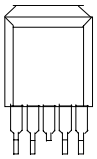
Symbol	Parameter	Min.	Typ.	Max.	Units	Test Conditions
Ratio	I load / I status	—	10,000	—	—	T_j = 25°C ,Rst = 500Ω, I = 100A
Ratio	Gain variation over temperature range error T₀C	-5	—	+5	%	T_j = 40 T₀ +150°C
offset	status current when I load = 0	-0.5	0	+0.5	mA	T_j = 25°C ,Rst = 500Ω, I = 100A
offset	Offset variation over temperature range var. T₀C	-0.4	0	0.4	mA	T_j = 40 T₀ +150°C
Trst	status response time to a small I load step		10		µs	to get 90% of the I load step

4) Input threshold are measured directly between the input pin and the tab. Any parasitic resistance in common between the load current path and the input signal path can significantly affect the thresholds.

Lead Assignments



1 - In
2 - ST
3 - Vcc (tab)
4 - NC
5 - Out



5 Lead - TO220	5 Lead - SMD220
IR3310	**IR3310S**
Part Number	

The following note applies to all curves: 1) they are all typical characteristics. 2) Operation in shaded area is not recommended. 3) Tj = 25°C, Rst=500Ohm, Vbat =14V (unless otherwise specified).

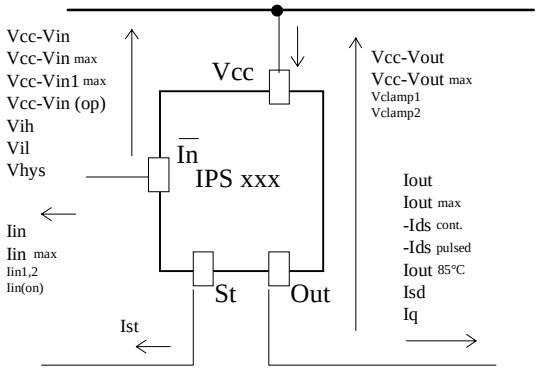


Figure 1 - Voltages and currents definition

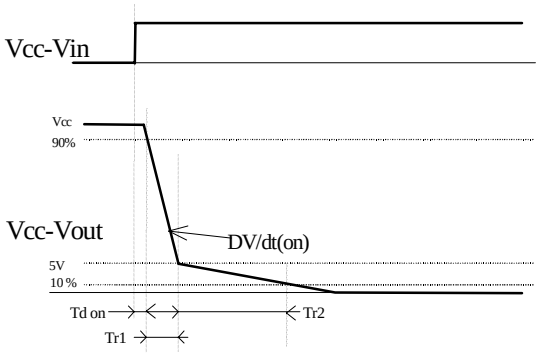


Figure 2 - Switching time definitions (turn-on)

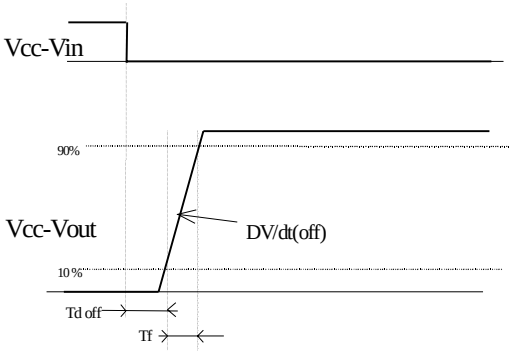


Figure 3 - Switching time definitions (turn-off)

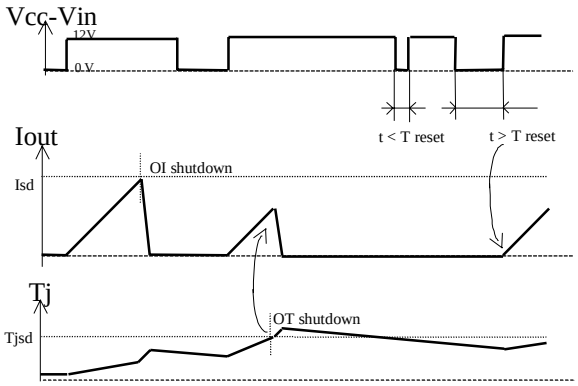
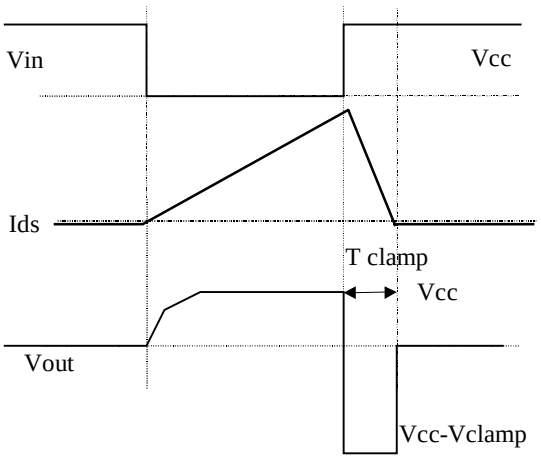


Figure 4 - Protection timing diagram



(see Design tip to evaluate power dissipation)

Figure 5 - Active clamp waveform

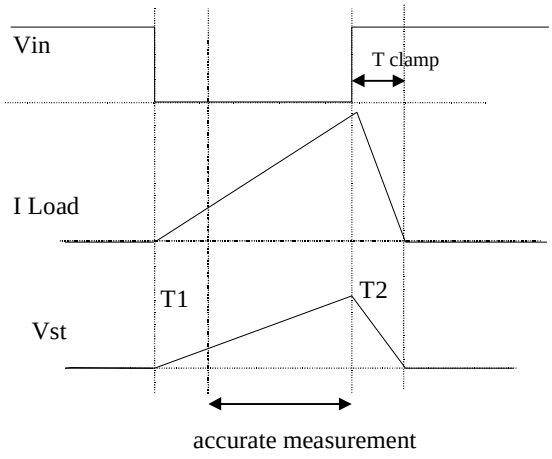


Fig 6 - Current sensing accuracy:
Measurement is accurate only when the power Mosfet is fully on (outside T1=Tdon + Tr1+Tr2) and when the part is not in the active clamp (outside T2).

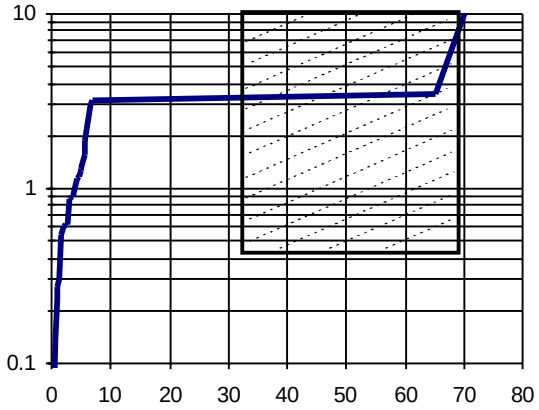


Figure 7 - Icc (mA) vs Vcc-Vin (V)

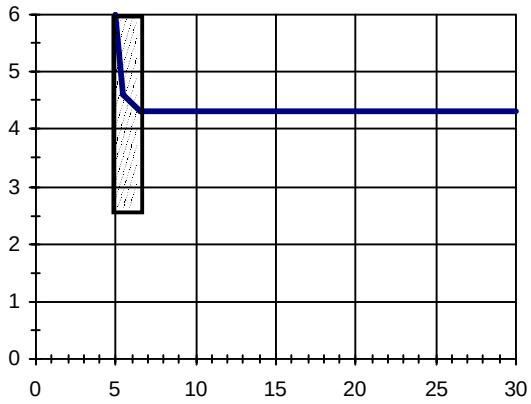


Figure 8 - Rds_{on} (mΩ) vs Vcc-Vin (V)

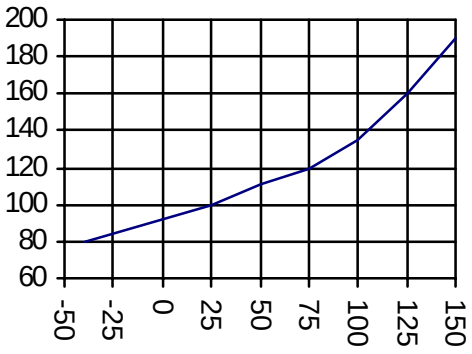


Figure 9 - Normalized Rdson (%) vs Tj (^{o}C)

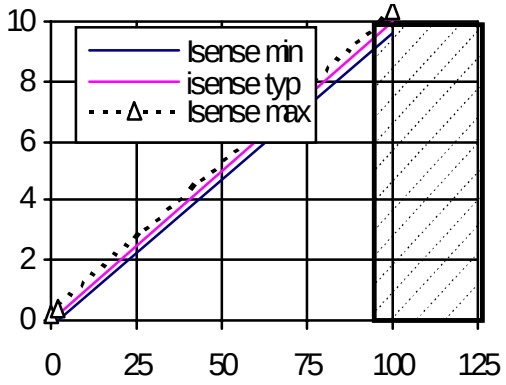


Figure 10 - I sense (mA) vs I load (A)

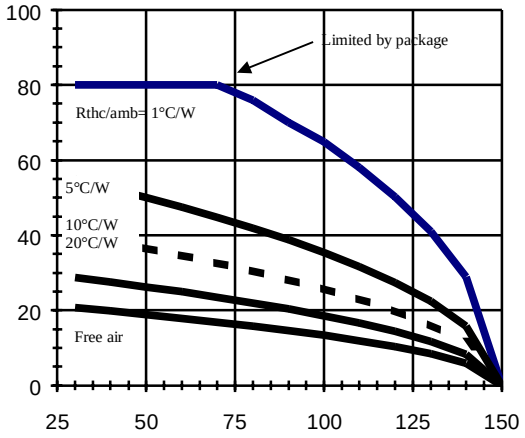


Figure 11 -Isd (A) vs Rst (Ω)

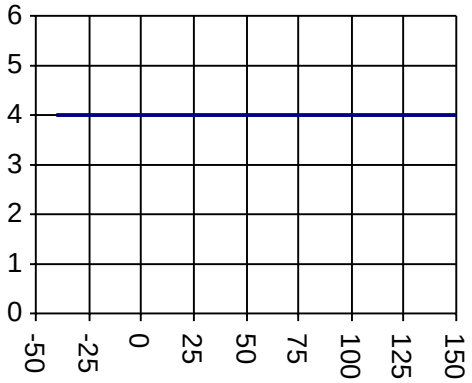


Figure 12 - Vst -Vin (V) vs Tj (^{o}C)

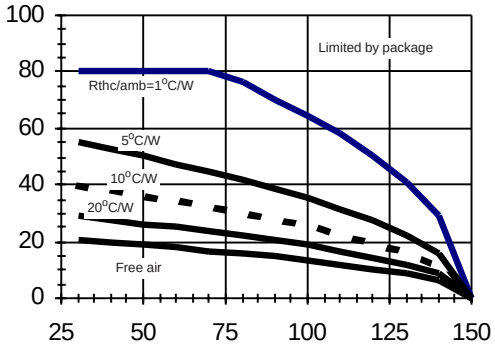


Figure 13 - Max. Cont. Iout (A) vs Temp. (°C)

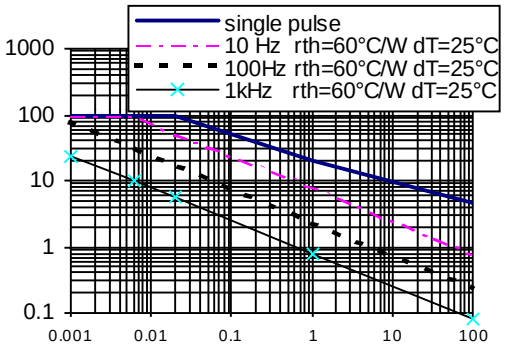


Figure 14 - Max. Iout (A) vs load inductance (uH)

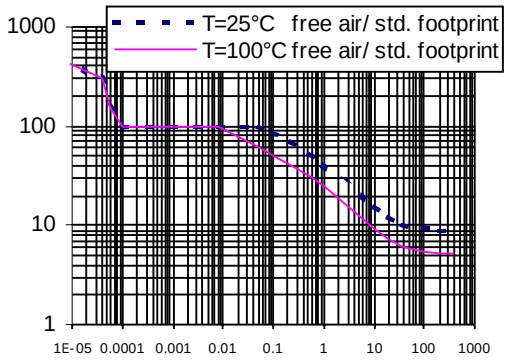


Figure 15 - I out (A) vs Protection resp. Time (s)

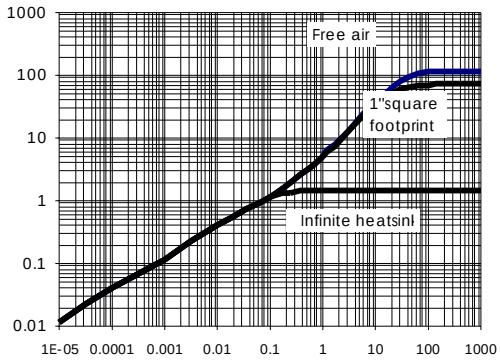


Figure 16 - Transient Rth (^{O}C) vs Time (s)

How to use the IR 3310 device

- Check max. continuous power dissipation :

  Use figure 11 to check that max. continuous load current does not exceed the device capability in worst case ambient temperature.

- Choose Isd so that it exceeds the maximum transient current with a sufficient margin.
  I max. load shall not exceed 100A.

- Choose Rst to get Isd by mean of fig. 10 curve or using the following formula

  Isd = (Vst-Vin @ Isd) * gain / Rst = 4V*10000 / Rst.

  This ensures optimum protection and full scale of Vst signal (0V for I load=0 and 4V for I load = Isd).

- To reduce power dissipation during reverse battery operation, the inner circuitry takes the potential available on ST pin in order to turn on the power MOSFET. This principle works only if Rst is within the recommended range (0.5 to 5 kΩ) and Rev.bat. voltage > 5V.

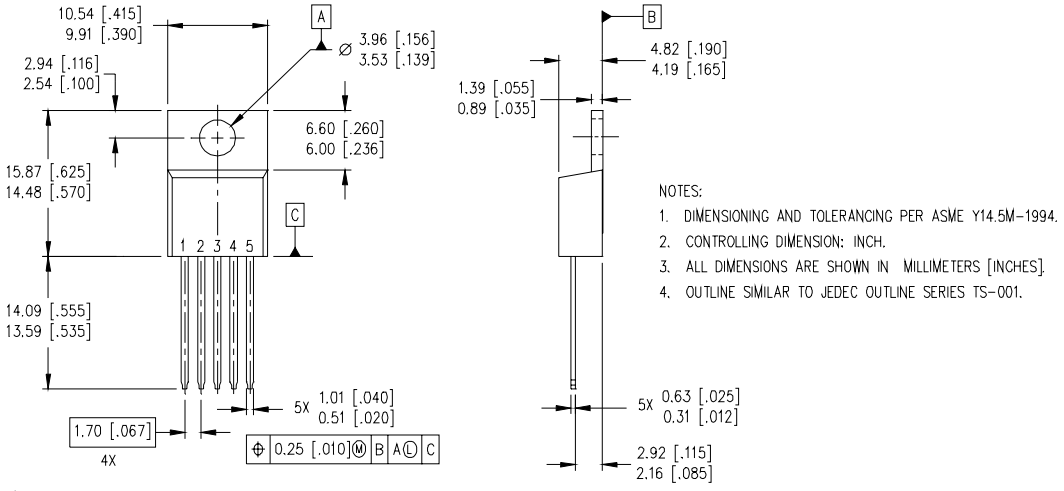
Also, the logic Gnd must not be disconnected from the Power Gnd (due to another reverse battery protection circuitry for example).

Check that junction temperature does not exceed the max. value (165°C) :

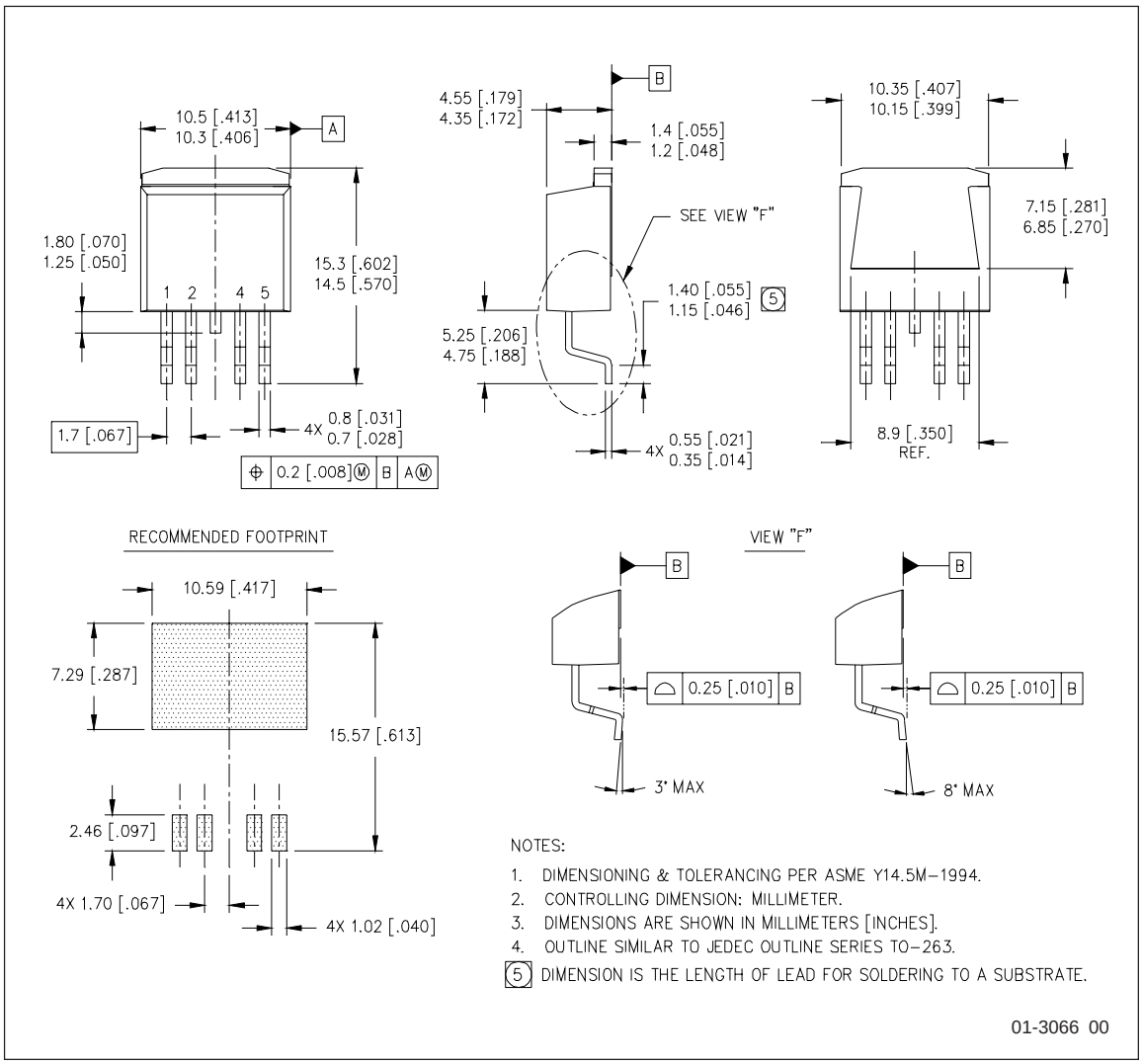
(losses multiplied by rth + max. ambient) <165°C.

Total Losses (w) = Ppower Mosfet + P (in) + P (st)

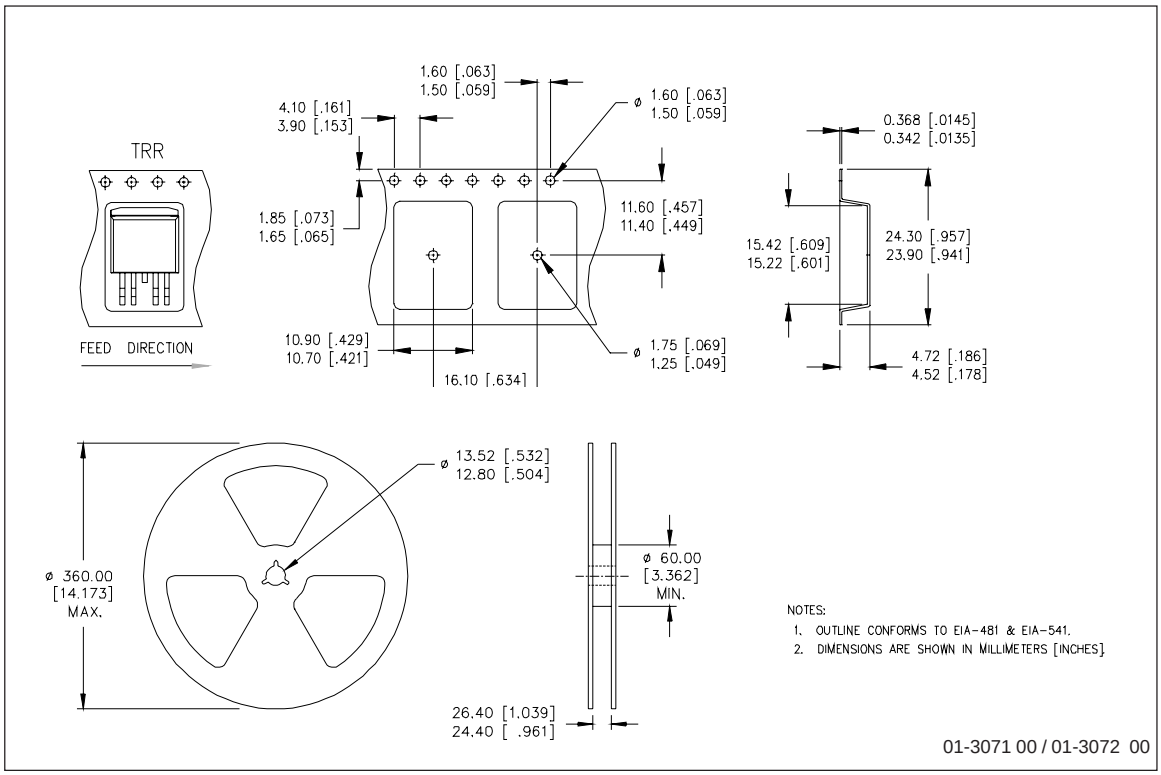
Case Outline - TO220 (5 lead)



Case Outline - D²PAK (SMD220) - 5 Lead



Tape & Reel - SMD220 - 5 Lead



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