International **I☼R** Rectifier

# IR3316(S)PbF

LOW EMI CURRENT SENSE HIGH SIDE SWITCH

Features

- Load current feedback
- Programmable over current shutdown
- Active clamp
- ESD protection
- Input referenced to Vcc
- Over temperature shutdown
- Switching time optimized for low EMI
- Reverse battery protection

Description

The IR3316(S)PbF is a fully protected 4 terminals high side switch. The input signal is referenced to Vcc. When the input voltage Vcc - Vin is higher than the specified threshold, the output power Mosfet is turned on. When the Vcc - Vin is lower than the specified Vil threshold, the output Mosfet is turned off. A current proportional to the power Mosfet current is sourced to the Ifb pin. Over current shutdown occurs when Vst-Vin > 4.5V. The current shutdown threshold is adjusted by selecting the proper RIfb. 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 switch very rugged in automotive environment.
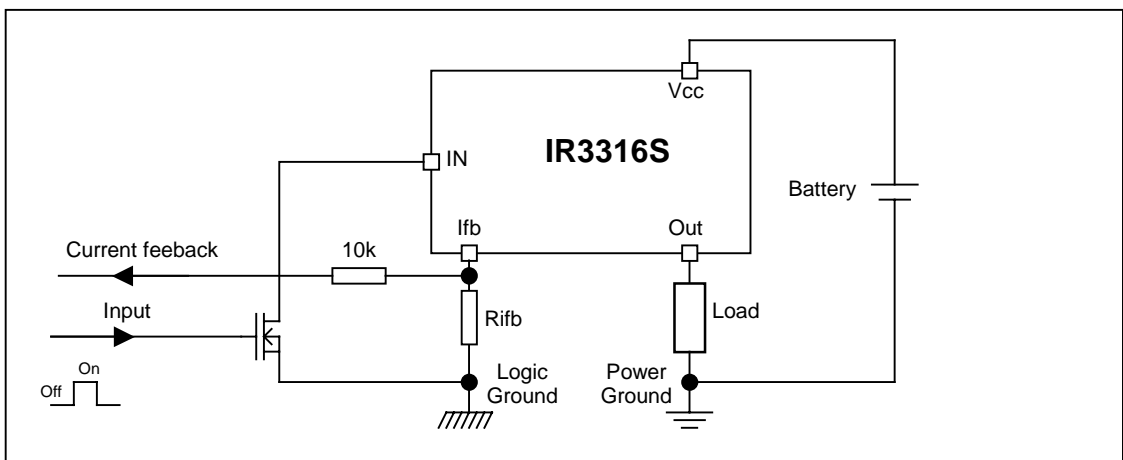
Product Summary

Rds(on)	7 mΩ max.
Vcc op.	6 to 26V
Current Ratio	8800
Prog. Ishutdown	10 to 90A
Vclamp	40V

Packages

TO-220
IR3316

D²Pak
Pin 4 and 5 fused
IR3316S

Typical Connection

Absolute Maximum Ratings

Absolute maximum ratings indicate sustained limits beyond which damage to the device may occur. All voltage parameters are referenced to Vcc lead. (Tambient=25°C unless otherwise specified).

Symbol	Parameter	Min.	Max.	Units
Vcc-Vin	Maximum Vcc voltage	-16	37	V
Vcc-Vin cont.	Maximum continuous Vcc voltage	-16	26	
Vcc-Vfb	Maximum Ifb voltage	-16	33	
Vcc-Vout	Maximum output voltage	-0.3	37	
Ids cont.	Maximum body diode continuous current Rth=60°C/W (1)	—	2.8	A
Ids pulsed	Maximum body diode pulsed current (1)	—	100	
Pd	Maximum power dissipation Rth=60°C/W	—	2	W
ESD1	Electrostatic discharge voltage (Human body) C=100pF, R=1500Ω	—	4	kV
ESD2	Electrostatic discharge voltage (Machine Model) C=200pF,R=0Ω	—	0.5	
Tj max.	Max. storage & operating temperature junction temperature	-40	150	°C
Min Rfb	Minimum on the resistor on Ifb pin	0.3	—	kΩ
Ifb max.	Max. Ifb current	-50	50	mA

(1) Limited by junction temperature. Pulsed is also limited by wiring

Thermal Characteristics

Symbol	Parameter	Typ.	Max.	Units
Rth1	Thermal resistance junction to ambient D²-Pak Std footprint	60	—	°C/W
Rth2	Thermal resistance junction to case D²-Pak	0.7	—	
Rth2	Thermal resistance junction to case TO220	0.7	—	

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
Iout	Continuous output current			A
	Tambient=85°C, Rth=5°C/W, Tj=125°C	—	23	
	Tambient=85°C, Rth=60°C/W, Tj=125°C		7	
Rifb	Recommended Ifb resistor (2)(3)	0.5	3.5	kΩ
Pulse min.	Minimum turn-on pulse width	1	—	ms
Fmax.	Maximum operating frequency	—	200	Hz

2) If Rifb is too low, the device can be damaged.
3) If Rifb is too high, the device may not switch on.

Protection Characteristics

Tj=25°C, Rifb=500 to 5kΩ

Symbol	Parameter	Min.	Typ.	Max.	Units	Test Conditions
Vifb-Vin@Isd	Over-current shutdown threshold	4	4.7	5.6	V	
Tsd	Over temperature threshold	—	165	—	°C	See fig. 5
OV	Over voltage protection (not latched)	26	29	33	V	
Isdf	Fixed over current shutdown	90	120	140	A	Vifb<Vifb-Vin@Isd
Isd_1k	Programmable over current shutdown 1k	30	40	50		Rifb=1kΩ
Treset	Time to reset protection	—	50	500	µs	See fig. 5
Min. pulse	Min. pulse width (no WAIT state)	400	900	2000		
WAIT	WAIT function timer	0.4	1	2	ms	See fig. 4 and 5
Rds(on) rev.	Reverse battery On state resistance	4	6.7	10	mΩ	Vcc-Vin=-14V, Iout=30A

Static Electrical Characteristics

Tj=25°C, Vcc=14V (unless otherwise specified)

Symbol	Parameter	Min.	Typ.	Max.	Units	Test Conditions
Vcc op.	Operating Voltage range	6	—	26	V	
Icc off	Supply leakage current	—	1.5	5	µA	Vin=Vcc, Vcc-Vout=14V, Vcc-Vifb=14V
Iin, on	On state IN positive current	1.5	3	6	mA	Vcc-Vin=14V
Vih	High level Input threshold voltage (4)	—	5.4	6.2		
Vil	Low level Input threshold voltage (4)	4	4.9	5.8	V	
Vhyst	Input hysteresis Vih-Vil	0.2	0.4	1		
Iout	Drain to source leakage current	—	1.2	5	µA	Vin=Vcc, Vcc-Vifb=0V, Vcc-Vout=14V
Rds(on)	On state resistance (5) Tj=25°C	4	5.5	7		Iout=30A, Vcc-Vin=14V
	On state resistance (5) Tj=25°C	4	6	10	mΩ	Iout=17A, Vcc-Vin=6V
	On state resistance (5)(6) Tj=150°C	7	10.5	13.5		Iout=30A, Vcc-Vin=14V
V clamp1	Vcc to Vout clamp voltage 1	36	39	—	V	Iout=50mA
V clamp2	Vcc to Vout clamp voltage 2	—	40	43		Iout=30A

(4) Input thresholds 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.
(5) Rdson is measured between the tab and the Out pin, 5mm away from the package.
(6) Guaranteed by design

Switching Electrical Characteristics

Vcc=14V, Resistive load=0.5Ω, Tj=25°C

Symbol	Parameter	Min.	Typ.	Max.	Units	Test Conditions
Tdon	Turn on delay time to 10% Vcc	30	120	300		
Tr1	Rise time to Vcc-Vout=5V	20	50	125	µs	
Tr2	Rise time to Vcc-Vout=0.1Vcc	30	80	200		
Eon	Turn on energy	—	14	—	mJ	See figure 2
Tdoff	Turn off delay time	30	140	350		
Tf	Fall time to Vout=10% of Vcc	35	100	250	µs	
Eoff	Turn off energy	—	7	—	mJ	

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Current Sense Characteristics

Symbol	Parameter	Min.	Typ.	Max.	Units	Test Conditions
Ratio	I Load/Iifb current ratio	7,500	8,800	9,950	—	Tj=25°C, Rfb=500Ω, Iout=60A
Ratio_TC	I Load/Iifb variation aver temperature(6)	-5	—	+5	%	Tj=-40°C to 150°C
Offset	Load current diagnostic offset	-0.22	0	+0.2	A	Iout=2A
Trst	Ifb response time (low signal)	—	1	—	µs	90% of the Iout step

Functional Block Diagram

All values are typical

IR3316(S)PbF

Lead Assignments

3- Vcc

1- In
2- Ifb
3- Vcc (tab)
4- Out(TO220 NC)
5- Out

1 2 3 4 5
TO220

3- Vcc

1 2   4 5
D²Pak

Figure 1 – Voltages and current definitions

Figure 2 – Switching time definitions

Vin

T clamp

Iout

Vcc

Vout

Vcc - V clamp

See Application Notes to evaluate power dissipation

Vcc-Vin

T min. pulse   T min. pulse

Iout

Wait

Figure 3 – Active clamp waveforms
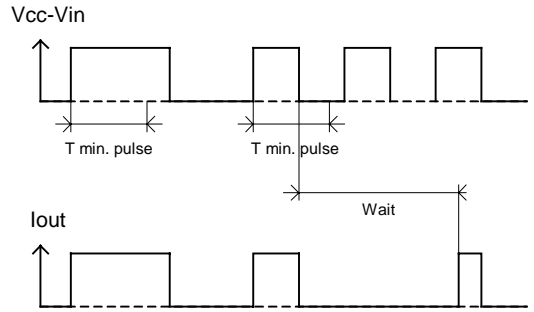
Figure 4 – Min. pulse and Wait function

Vcc-Vin

t < T reset   t > T reset   t < T reset   t > T reset

Wait   Wait

Over-current shutdown

Iout

Over-temperature shutdown

Tj
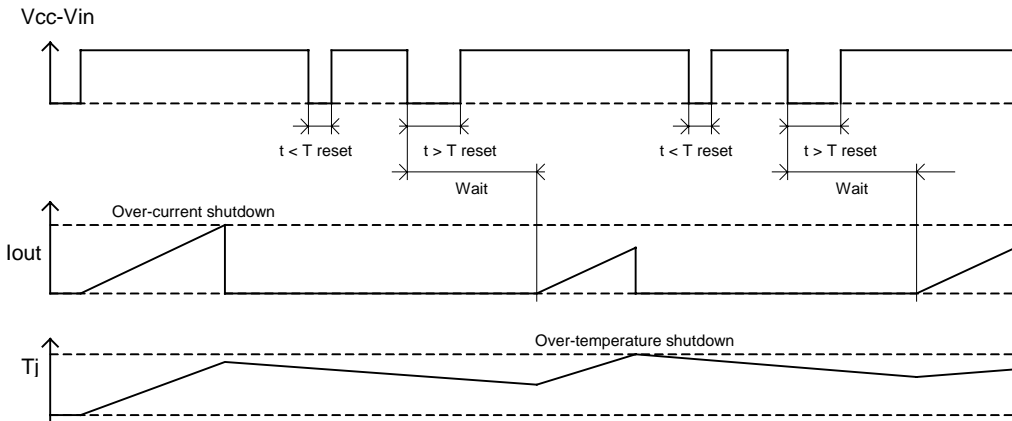
Figure 5 – Protection Timing Diagrams

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All curves are typical characteristics. Operation in hatched areas is not recommended. Tj=25°C, Rifb=500ohm, Vcc=14V (unless otherwise specified).
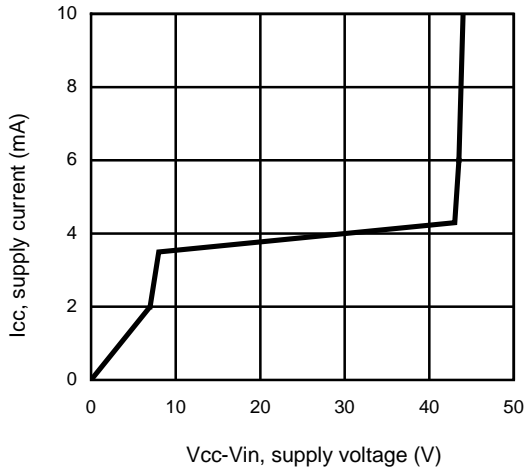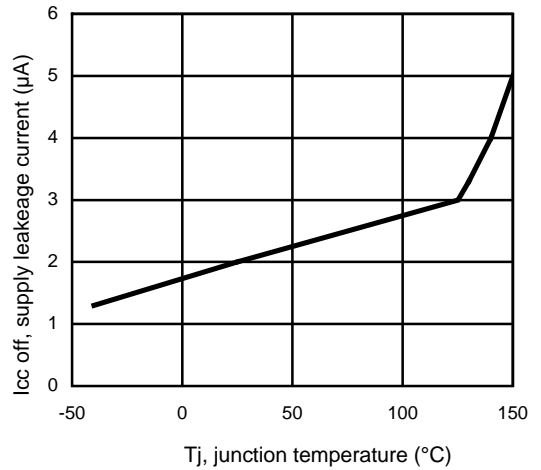

Figure 6 – Icc (mA) Vs Vcc-Vin (V)

Figure 7 – Icc off (µA) Vs Tj (°C)
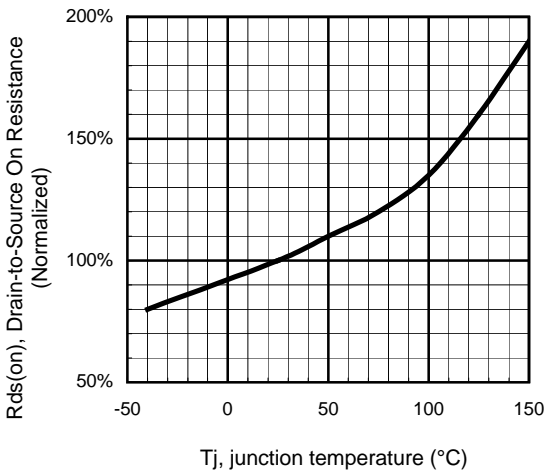
Figure 8 - Normalized Rds(on) (%) Vs Tj (°C)

Figure 9 – Vih, Vil and Vifb-Vin@Isd (V) Vs Tj (°C)
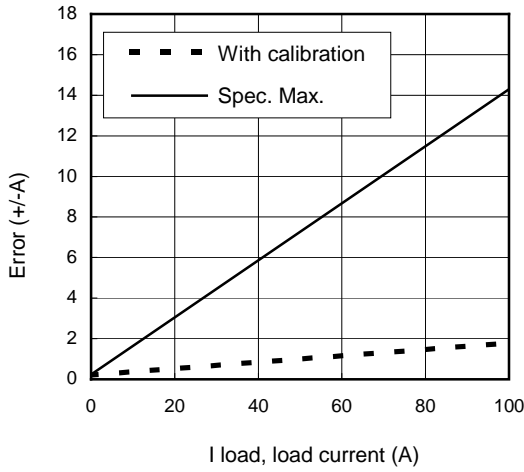
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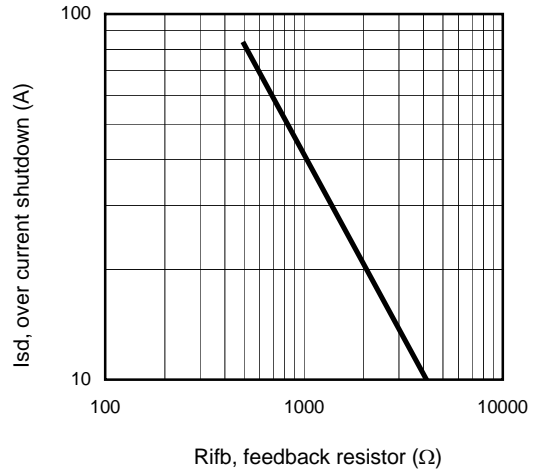# IR3316(S)PbF
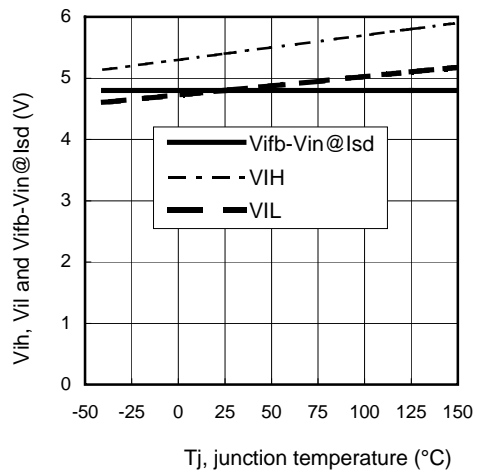
Figure 10 – Error (+/- A) Vs I load (A)
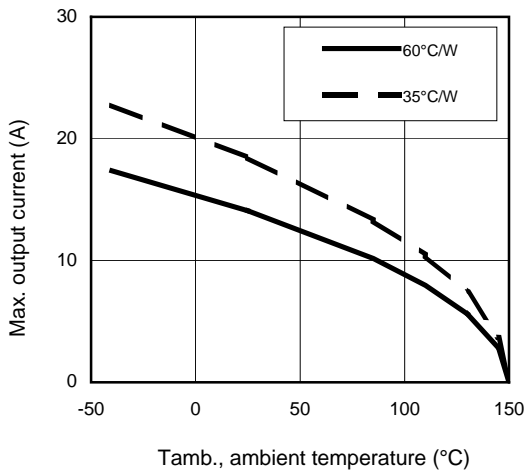

Figure 11 – Ids (A) Vs Rifb (Ω)
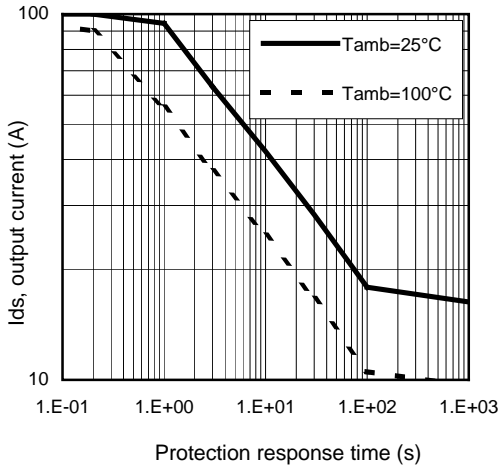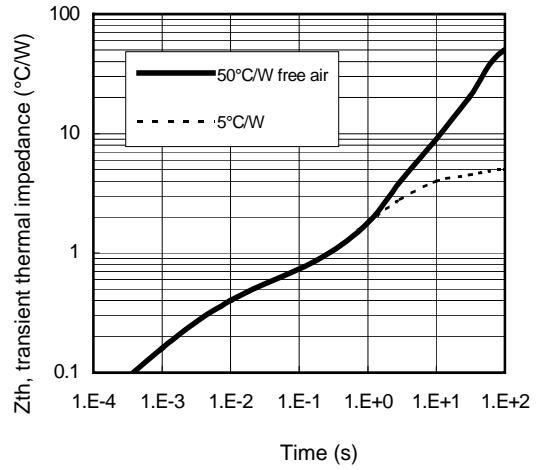

Figure 12 – Max. Iout (A) Vs Tamb. (°C)
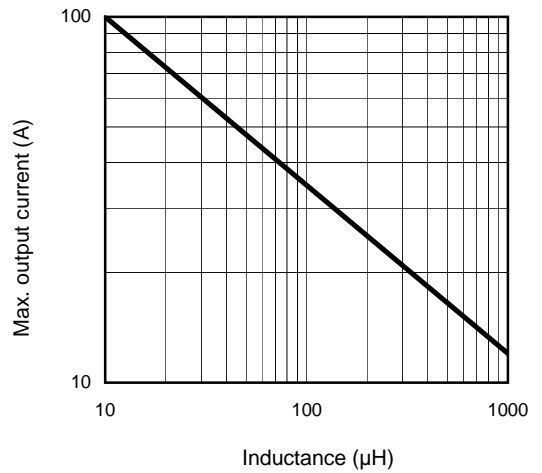
Figure 13 – Max. Iout (A) Vs inductance (µH)

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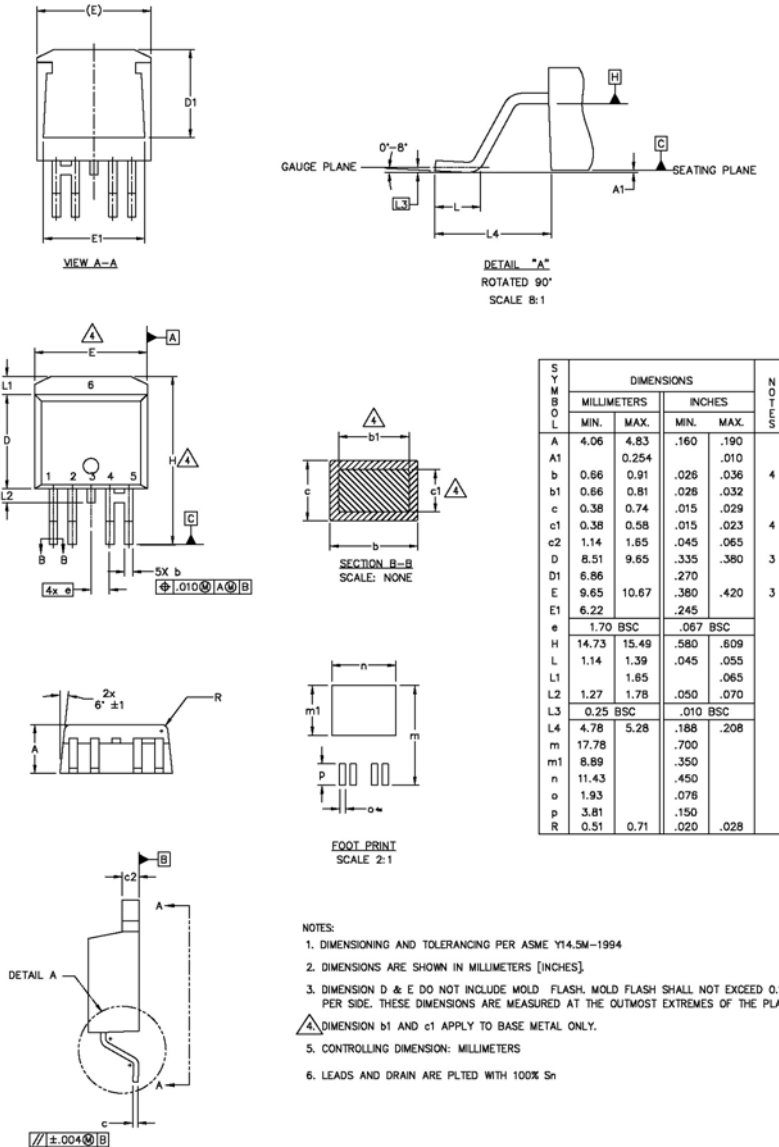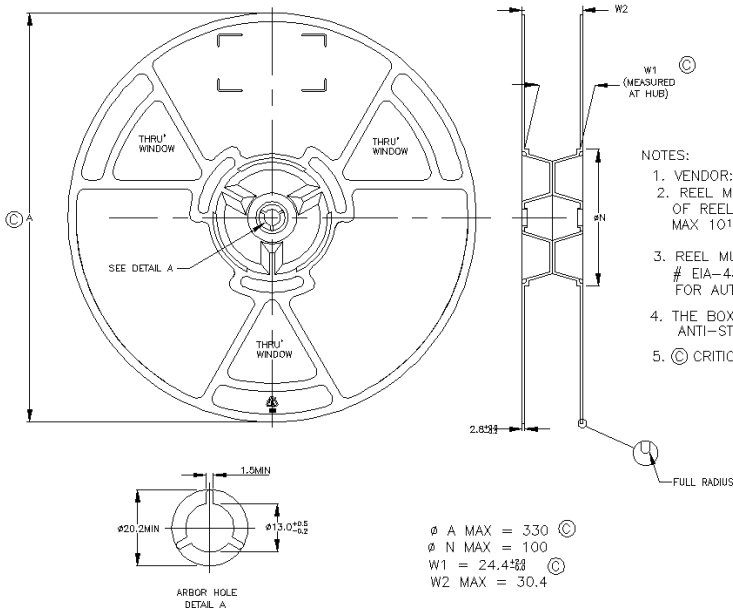

Figure 14 – Ids (A) Vs over temperature protection
response time (s)

Figure 15 – Transient thermal impedance (°C/W)
Vs time (s)

Case Outline   5 Lead - D2PAK - Automotive Q100 PbF MSL1 qualified

S Y M B O L	DIMENSIONS				NOTES
	MILLIMETERS		INCHES		
	MIN.	MAX.	MIN.	MAX.	
A	4.06	4.83	.160	.190	
A1		0.254		.010	
b	0.66	0.91	.026	.036	4
b1	0.66	0.81	.026	.032	
c	0.38	0.74	.015	.029	
c1	0.38	0.58	.015	.023	4
c2	1.14	1.65	.045	.065	
D	8.51	9.65	.335	.380	3
D1	6.86		.270		
E	9.65	10.67	.380	.420	3
E1	6.22		.245		
e	1.70 BSC		.067 BSC		
H	14.73	15.49	.580	.609	
L	1.14	1.39	.045	.055	
L1		1.65		.065	
L2	1.27	1.78	.050	.070	
L3	0.25 BSC		.010 BSC		
L4	4.78	5.28	.188	.208	
m	17.78		.700		
m1	8.89		.350		
n	11.43		.450		
o	1.93		.076		
p	3.81		.150		
R	0.51	0.71	.020	.028	

NOTES:

1. DIMENSIONING AND TOLERANCING PER ASME Y14.5M−1994

2. DIMENSIONS ARE SHOWN IN MILLIMETERS [INCHES].

3. DIMENSION D & E DO NOT INCLUDE MOLD FLASH. MOLD FLASH SHALL NOT EXCEED 0.127 [.005"] PER SIDE. THESE DIMENSIONS ARE MEASURED AT THE OUTMOST EXTREMES OF THE PLASTIC BODY.

4. DIMENSION b1 AND c1 APPLY TO BASE METAL ONLY.

5. CONTROLLING DIMENSION: MILLIMETERS

6. LEADS AND DRAIN ARE PLTED WITH 100% Sn

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Tape & Reel   5 Lead - D2PAK

W2

W1
(MEASURED
AT HUB)

THRU'
WINDOW

THRU'
WINDOW

SEE DETAIL A

ØN

THRU'
WINDOW

NOTES:

1. VENDOR: OPTIONAL
2. REEL MUST HAVE ANTI−STATIC COATING SURFACE RESISTIVITY
   OF REEL (AS PER EIA−541) uin: 10^5 ohm/SQUARE;
   MAX 10^{12} ohm/SQUARE
3. REEL MUST ALSO MEET REQUIREMENTS OF EIA STANDARD
   # EIA−481A, TAPING OF SURFACE−MOUNT COMPONENTS
   FOR AUTOMATIC PLACEMENT.
4. THE BOX OF PACKING MUST CONTAIN THE REELS INSIDE AN
   ANTI−STATIC BAG.
5. Ⓒ CRITICAL

2.6

FULL RADIUS

1.5MIN

Ø20.2MIN

Ø13.0 +0.5 −0.2

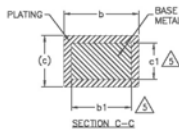ARBOR HOLE
DETAIL A

Ø A MAX = 330 Ⓒ
Ø N MAX = 100
W1 = 24.4 Ⓒ
W2 MAX = 30.4

Case Outline   5 Leads – TO220 – Automotive Q100 PbF qualified
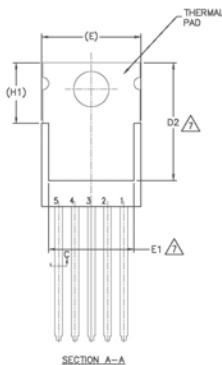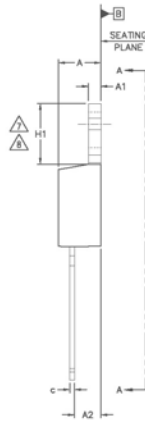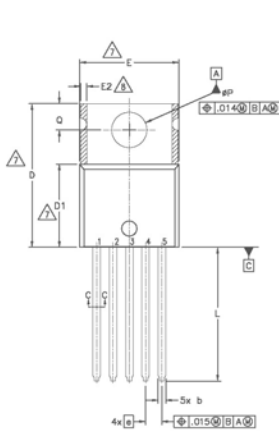
S Y M B O L	DIMENSIONS				N O T E S
	MILLIMETERS		INCHES		
	MIN.	MAX.	MIN.	MAX.	
A	3.56	4.83	.140	.190	
A1	0.51	1.40	.020	.055	
A2	2.03	2.92	.080	.115	
b	0.64	0.89	.025	.035	
b1	0.64	0.84	.025	.033	5
c	0.36	0.61	.014	.024	
c1	0.36	0.56	.014	.022	5
D	14.22	16.51	.560	.650	4
D1	8.38	9.02	.330	.355	
D2	11.68	12.88	.460	.507	7
E	9.65	10.67	.380	.420	4,7
E1	6.86	8.89	.270	.350	7
E2	--	0.76		.030	8
e	1.70 BSC		.067 BSC		
H1	5.84	6.86	.230	.270	7,8
L	12.70	14.73	.500	.580	
øP	3.53	3.73	.139	.147	
Q	2.54	3.05	.100	.120	

NOTES:
1.- DIMENSIONING AND TOLERANCING AS PER ASME Y14.5 M- 1994.
2.- DIMENSIONS ARE SHOWN IN INCHES [MILLIMETERS].
3.- LEAD DIMENSION AND FINISH UNCONTROLLED IN L1.
4.- DIMENSION D, D1 & E DO NOT INCLUDE MOLD FLASH. MOLD FLASH
   SHALL NOT EXCEED .005" (0.127) PER SIDE. THESE DIMENSIONS ARE
   MEASURED AT THE OUTERMOST EXTREMES OF THE PLASTIC BODY.
5.- DIMENSION b1 & c1 APPLY TO BASE METAL ONLY.
6.- CONTROLLING DIMENSION : INCHES.
7.- THERMAL PAD CONTOUR OPTIONAL WITHIN DIMENSIONS E,H1,D2 & E1
8.- DIMENSION E2 X H1 DEFINE A ZONE WHERE STAMPING
   AND SINGULATION IRREGULARITIES ARE ALLOWED.
9.- OUTLINE CONFORMS TO JEDEC TO-220, EXCEPT A2 (max.) AND D2 (min.)
   WHERE DIMENSIONS ARE DERIVED FROM THE ACTUAL PACKAGE OUTLINE.

10.- LEADS AND DRAIN ARE PLATED WITH 100% Sn