

### LOW EMI CURRENT SENSE HIGH SIDE SWITCH

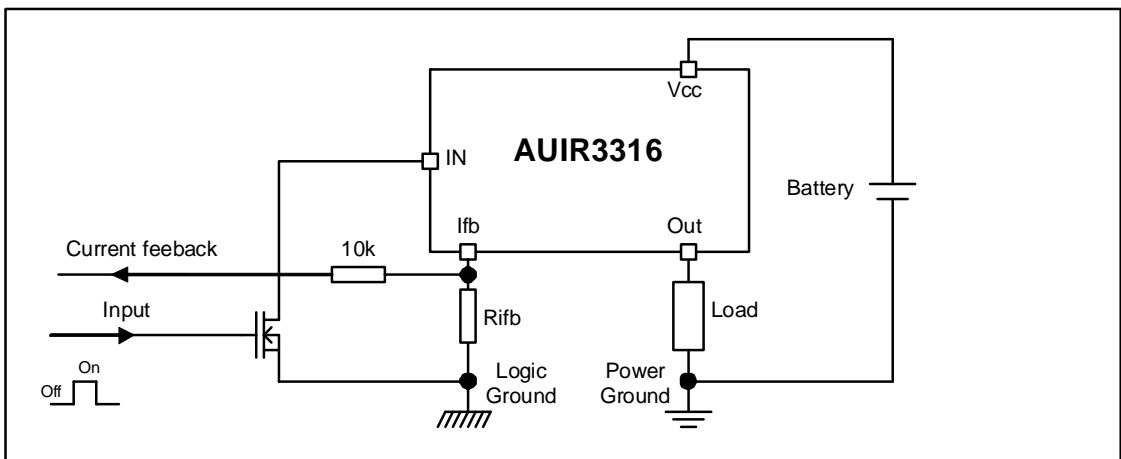
#### Features

- 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 AUIR3316(S) is a fully protected 4 terminals high side switch. The input signal is referenced to Vcc. When the input voltage  $V_{cc} - V_{in}$  is higher than the specified threshold, the output power Mosfet is turned on. When the  $V_{cc} - V_{in}$  is lower than the specified  $V_{il}$  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  $V_{ifb} - V_{in} > 4.7V$ . The current shutdown threshold is adjusted by selecting the proper R<sub>ifb</sub>. 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.

#### Typical Connection



#### Product Summary

R <sub>ds(on)</sub>	7 mΩ max.
V <sub>cc op.</sub>	6 to 26V
Current Ratio	8800
Prog. I <sub>shutdown</sub>	10 to 90A
V <sub>clamp</sub>	40V

#### Packages



TO-220  
AUIR3316



D<sup>2</sup>Pak  
Pin 4 and 5 fused  
AUIR3316S

**Qualification Information†**

<b>Qualification Level</b>		Automotive (per AEC-Q100††)	
		Comments: This family of ICs has passed an Automotive qualification. IR's Industrial and Consumer qualification level is granted by extension of the higher Automotive level.	
<b>Moisture Sensitivity Level</b>		D2PAK-5L	MSL1, 260°C (per IPC/JEDEC J-STD-020)
		TO220-5L	Not applicable
<b>ESD</b>	Machine Model	Class M4 (450V) (per AEC-Q100-003)	
	Human Body Model	Class H3A (4,500 V) (per AEC-Q100-002)	
	Charged Device Model	Class C4 (1000 V) (per AEC-Q100-011)	
<b>IC Latch-Up Test</b>		Class II, Level A (per AEC-Q100-004)	
<b>RoHS Compliant</b>		Yes	

† Qualification standards can be found at International Rectifier's web site <http://www.irf.com/>

†† Exceptions to AEC-Q100 requirements are noted in the qualification report.

## 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. (Tj=-40°..150°C, Vcc=6..26V 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 lfb voltage	-16	33	
Vcc-Vout	Maximum output voltage	-0.3	37	
I <sub>ds</sub> cont.	Maximum body diode continuous current R <sub>th</sub> =60°C/W (1) Tambient=25°C	—	2.8	A
I <sub>ds</sub> pulsed	Maximum body diode pulsed current (1)	—	100	
P <sub>d</sub>	Maximum power dissipation R <sub>th</sub> =60°C/W Tambient=25°C	—	2	W
T <sub>j</sub> max.	Max. storage & operating temperature junction temperature	-40	150	°C
Min Rfb	Minimum on the resistor on lfb pin	0.3	—	kΩ
I <sub>fb</sub> max.	Max. lfb current	-50	50	mA

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

## Thermal Characteristics

Symbol	Parameter	Typ.	Max.	Units
R <sub>th1</sub>	Thermal resistance junction to ambient D <sup>2</sup> -Pak Std footprint	60	—	°C/W
R <sub>th2</sub>	Thermal resistance junction to case D <sup>2</sup> -Pak	0.7	—	
R <sub>th2</sub>	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
I <sub>out</sub>	Continuous output current	—	23 7	A
	T <sub>ambient</sub> =85°C, R <sub>th</sub> =5°C/W, T <sub>j</sub> =125°C			
	T <sub>ambient</sub> =85°C, R <sub>th</sub> =60°C/W, T <sub>j</sub> =125°C			
R <sub>lfb</sub>	Recommended lfb resistor (2)(3)	0.5	3.5	kΩ
Pulse min.	Minimum turn-on pulse width	1	—	ms
F <sub>max</sub>	Maximum operating frequency	—	200	Hz

(2) If R<sub>lfb</sub> is too low, the device can be damaged.

(3) If R<sub>lfb</sub> is too high, the device may not switch on.

## Protection Characteristics

T<sub>j</sub> = -40°..150°C, V<sub>cc</sub> = 6..26V, R<sub>ifb</sub> = 500 to 5kΩ

Symbol	Parameter	Min.	Typ.	Max.	Units	Test Conditions
V <sub>ifb-Vin@I<sub>sd</sub></sub>	Over-current shutdown threshold	3.8	4.7	5.9	V	
T <sub>sd</sub>	Over temperature threshold	—	165	—	°C	See fig. 5
OV	Over voltage protection (not latched)	26	29	33	V	
I <sub>sd</sub> f	Fixed over current shutdown	90	120	150	A	V <sub>ifb</sub> < V <sub>ifb-Vin@I<sub>sd</sub></sub>
I <sub>sd_1k</sub>	Programmable over current shutdown 1k	30	40	53		R <sub>ifb</sub> = 1kΩ
t <sub>reset</sub>	Time to reset protection	—	50	500	μs	See fig. 5
Min. pulse	Min. pulse width (no WAIT state)	—	900	2000		T <sub>j</sub> = 25°C
WAIT	WAIT function timer	0.4	1	2	ms	See fig. 4 and 5
R <sub>ds(on) rev.</sub>	Reverse battery On state resistance, T <sub>j</sub> = 25°C	4	6.7	10	mΩ	V <sub>cc-Vin</sub> = -14V, I <sub>out</sub> = 30A
	T <sub>j</sub> = 125°C	—	10	15		

## Static Electrical Characteristics

T<sub>j</sub> = -40°..150°C, V<sub>cc</sub> = 6..26V (unless otherwise specified)

Symbol	Parameter	Min.	Typ.	Max.	Units	Test Conditions
V <sub>cc op.</sub>	Operating Voltage range	6	—	26	V	
I <sub>cc off</sub>	Supply leakage current	—	1.5	5	μA	V <sub>in</sub> = V <sub>cc</sub> , V <sub>cc-Vout</sub> = 14V, V <sub>cc-Vifb</sub> = 14V, T <sub>j</sub> = 25°C
I <sub>in, on</sub>	On state I <sub>N</sub> positive current	1.5	3	6	mA	V <sub>cc-Vin</sub> = 14V, T <sub>j</sub> = 25°C
V <sub>ih</sub>	High level Input threshold voltage (4)	—	5.4	6.3	V	
V <sub>il</sub>	Low level Input threshold voltage (4)	4	4.9	5.8		
V <sub>hyst</sub>	Input hysteresis V <sub>ih</sub> -V <sub>il</sub>	0.2	0.4	1.5		
I <sub>out</sub>	Drain to source leakage current	—	1.2	5	μA	V <sub>in</sub> = V <sub>cc</sub> , V <sub>cc-Vifb</sub> = 0V, V <sub>cc-Vout</sub> = 14V, T <sub>j</sub> = 25°C
R <sub>ds(on)</sub>	On state resistance (5) T <sub>j</sub> = 25°C	4	5.5	7	mΩ	I <sub>out</sub> = 30A, V <sub>cc-Vin</sub> = 14V
	On state resistance (5) T <sub>j</sub> = 25°C	4	6	10		I <sub>out</sub> = 17A, V <sub>cc-Vin</sub> = 6V
	On state resistance (5)(6) T <sub>j</sub> = 150°C	7	10.5	13.5		I <sub>out</sub> = 30A, V <sub>cc-Vin</sub> = 14V
V <sub>clamp1</sub>	V <sub>cc</sub> to V <sub>out</sub> clamp voltage 1	36	39	—	V	I <sub>out</sub> = 50mA
V <sub>clamp2</sub>	V <sub>cc</sub> to V <sub>out</sub> clamp voltage 2	—	40	43		I <sub>out</sub> = 30A, T <sub>j</sub> = 25°C

(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) R<sub>ds(on)</sub> is measured between the tab and the Out pin, 5mm away from the package.

(6) Guaranteed by design

## Switching Electrical Characteristics

V<sub>cc</sub> = 14V, Resistive load = 0.5Ω, T<sub>j</sub> = 25°C

Symbol	Parameter	Min.	Typ.	Max.	Units	Test Conditions
t <sub>don</sub>	Turn on delay time to 10% V <sub>cc</sub>	30	120	300	μs	See figure 2
t <sub>r1</sub>	Rise time to V <sub>cc-Vout</sub> = 5V	20	50	125		
t <sub>r2</sub>	Rise time to V <sub>cc-Vout</sub> = 0.1V <sub>cc</sub>	30	80	200		
E <sub>on</sub>	Turn on energy	—	14	—	mJ	
t <sub>doff</sub>	Turn off delay time	30	140	350	μs	
t <sub>f</sub>	Fall time to V <sub>out</sub> = 10% of V <sub>cc</sub>	35	100	250		
E <sub>off</sub>	Turn off energy	—	7	—		

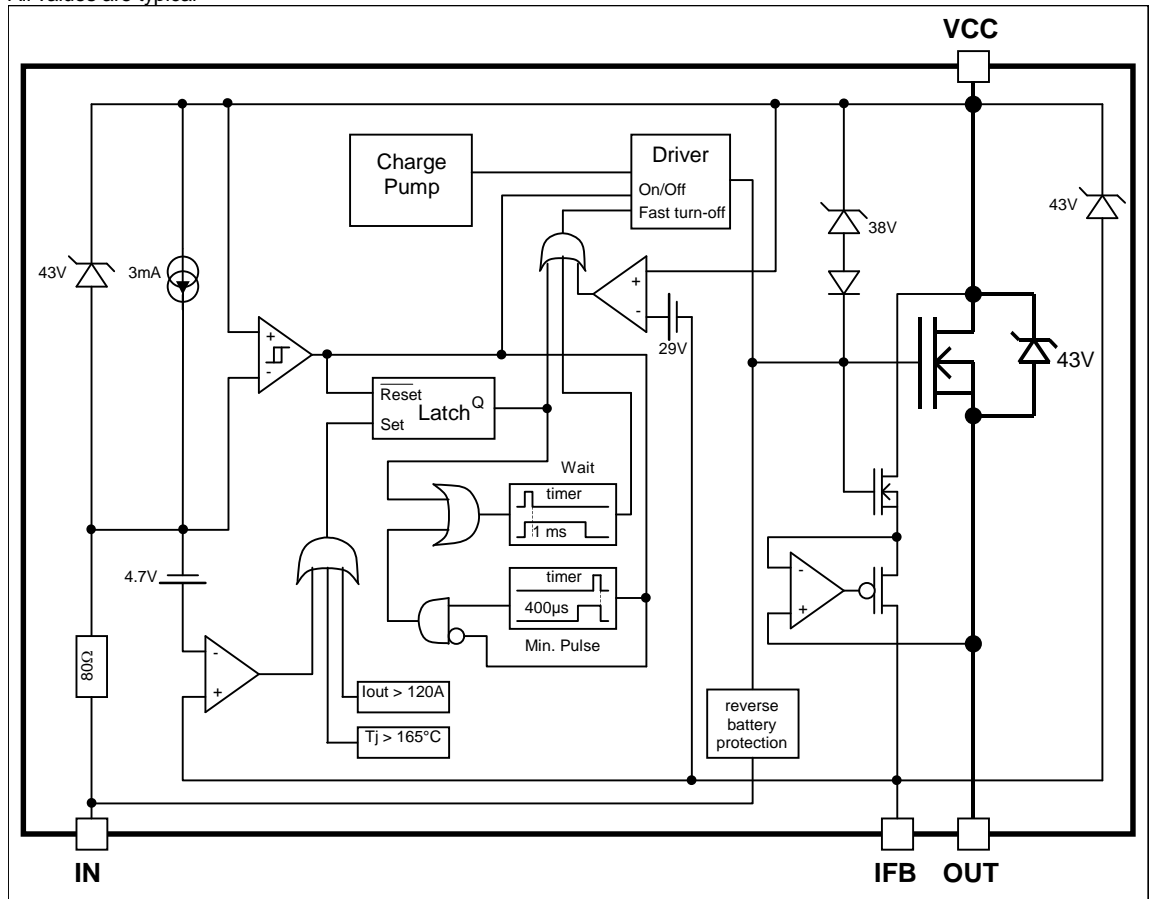
**Current Sense Characteristics**

$T_j = -40^{\circ}\text{C}..150^{\circ}\text{C}$ ,  $V_{cc} = 6..26\text{V}$  (unless otherwise specified)

Symbol	Parameter	Min.	Typ.	Max.	Units	Test Conditions
Ratio	I Load/I <sub>fb</sub> current ratio	8,200	8,800	9,950	—	R <sub>fb</sub> =500Ω, I <sub>out</sub> =60A
Ratio_TC	I Load/I <sub>fb</sub> variation aver temperature(6)	-5	—	+5	%	T <sub>j</sub> =-40°C to 150°C
Offset	Load current diagnostic offset	-0.2	0	+0.25	A	I <sub>out</sub> =2A
trst	I <sub>fb</sub> response time (low signal)	—	1	—	μs	90% of the I <sub>out</sub> step

**Functional Block Diagram**

All values are typical



## Lead Assignments

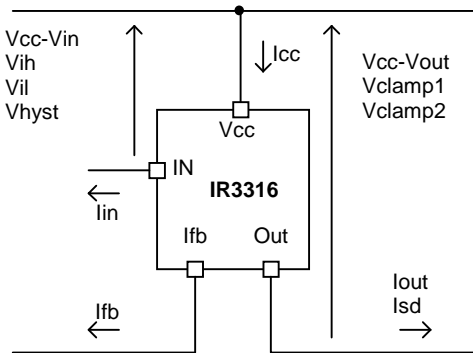
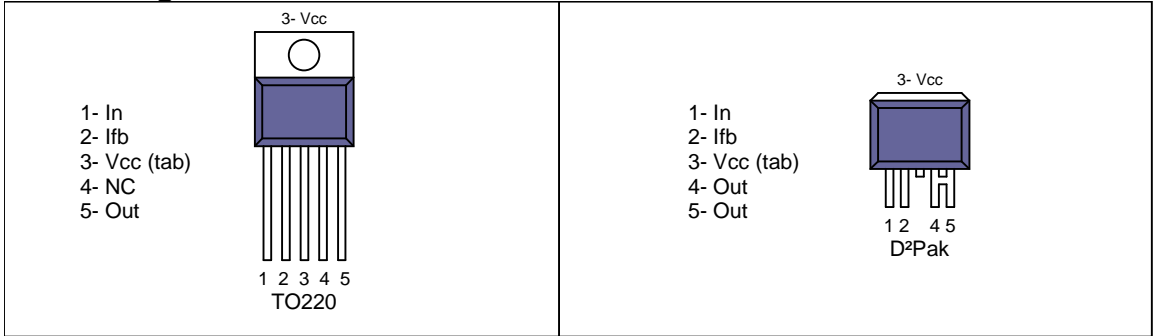


Figure 1 – Voltages and current definitions

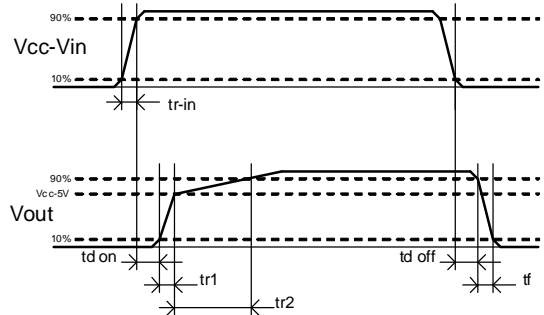
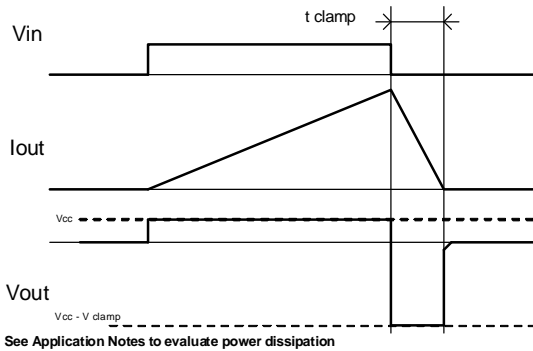
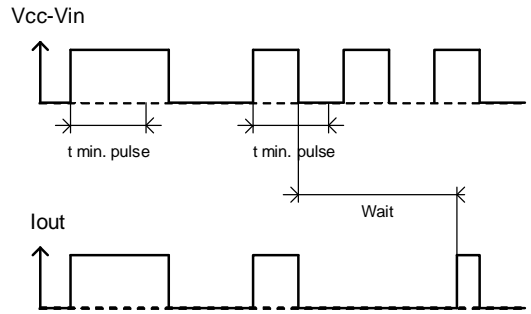


Figure 2 – Switching time definitions



**Figure 3 – Active clamp waveforms**



**Figure 4 – Min. pulse and Wait function**



**Figure 5 – Protection Timing Diagrams**

All curves are typical characteristics. Operation in hatched areas is not recommended.  $T_j=25^\circ\text{C}$ ,  $R_{\text{th}}=500\text{ohm}$ ,  $V_{\text{cc}}=14\text{V}$  (unless otherwise specified).

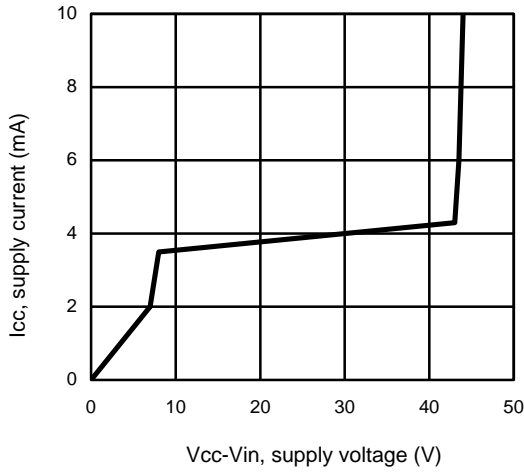


Figure 6 – Icc (mA) Vs Vcc-Vin (V)

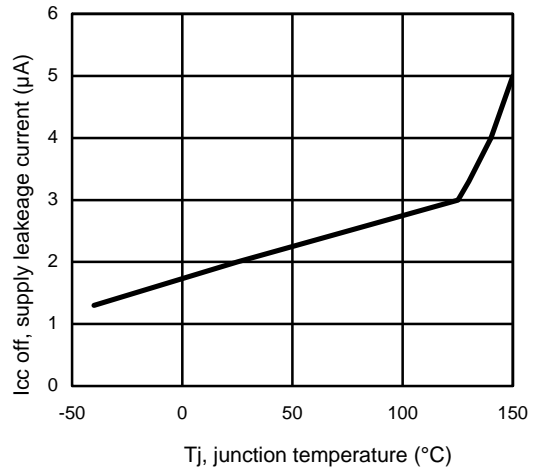


Figure 7 – Icc off ( $\mu\text{A}$ ) Vs  $T_j$  ( $^\circ\text{C}$ )

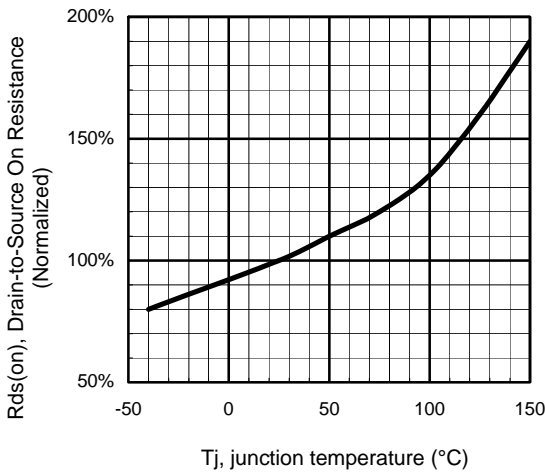


Figure 8 - Normalized  $R_{\text{ds(on)}}$  (%) Vs  $T_j$  ( $^\circ\text{C}$ )

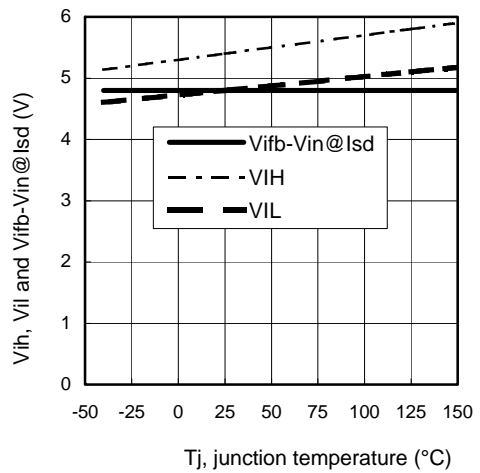
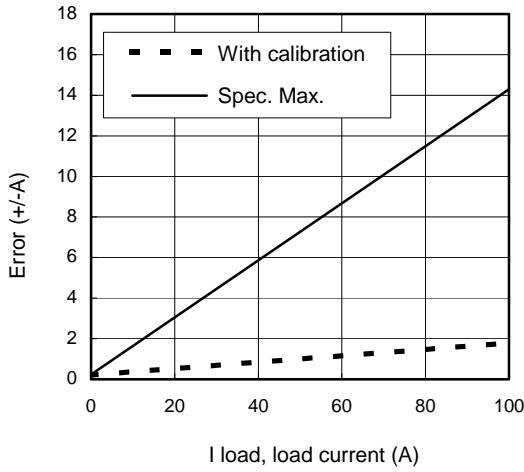
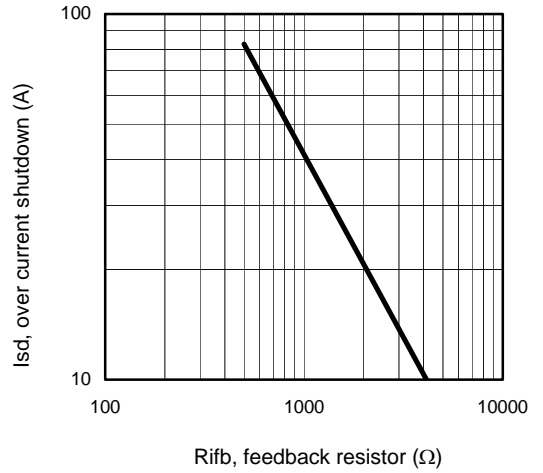


Figure 9 –  $V_{\text{IH}}$ ,  $V_{\text{IL}}$  and  $V_{\text{fb}} - V_{\text{in}}@I_{\text{std}}$  (V) Vs  $T_j$  ( $^\circ\text{C}$ )

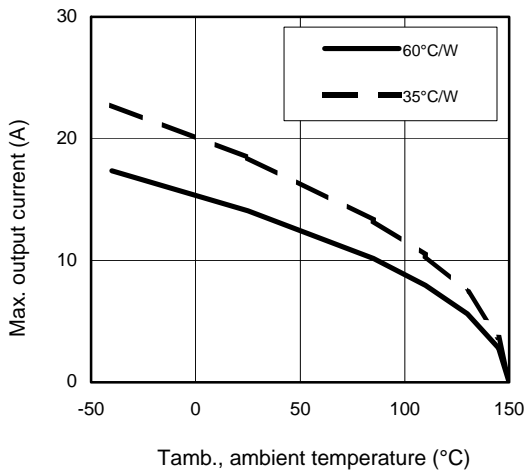




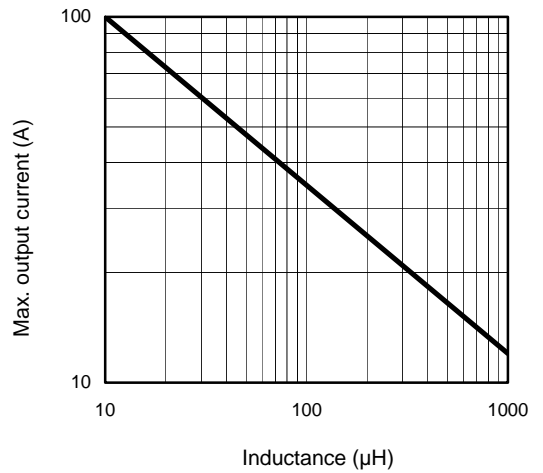
**Figure 10 – Error (+/- A) Vs I load (A)**



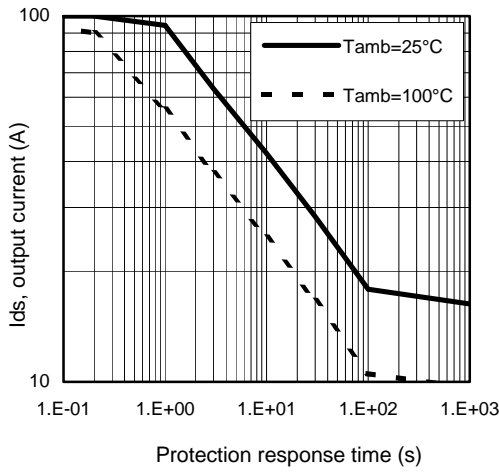
**Figure 11 – Ids (A) Vs Rifb (Ω)**



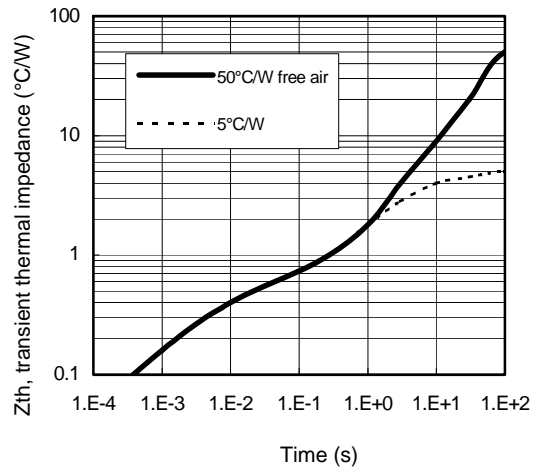
**Figure 12 – Max. iout (A) Vs Tamb. (°C)**



**Figure 13 – Max. iout (A) Vs inductance (μH)**

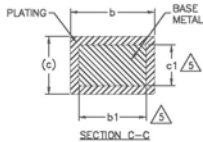
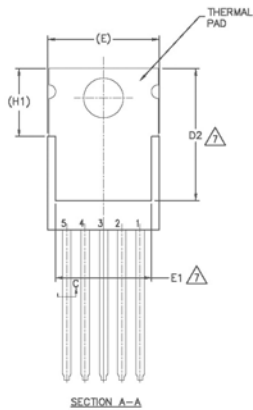
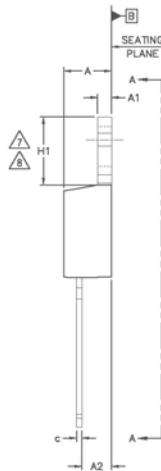
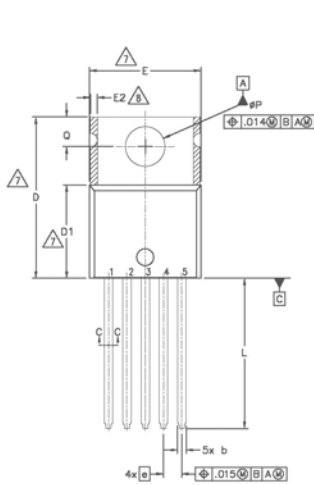


**Figure 14 –  $I_{ds}$  (A) Vs over temperature protection response time (s)**



**Figure 15 – Transient thermal impedance ( $^{\circ}\text{C}/\text{W}$ ) Vs time (s)**

Case Outline - TO220 - 5 Leads

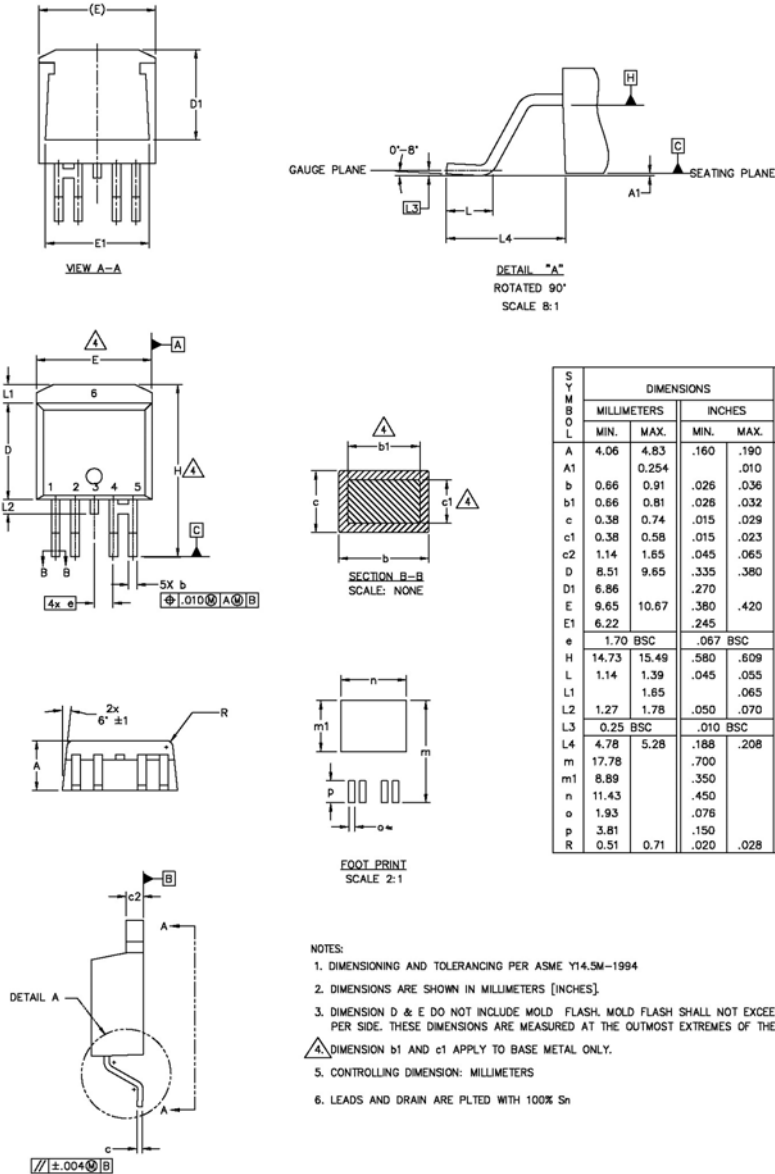


SYMBOL	DIMENSIONS				NOTES	
	MILLIMETERS		INCHES			
	MIN.	MAX.	MIN.	MAX.		
A	3.56	4.83	.140	.190	5	
A1	0.51	1.40	.020	.055		
A2	2.03	2.92	.080	.115		
b	0.64	0.89	.025	.035		
b1	0.64	0.84	.025	.033		
c	0.36	0.61	.014	.024		
c1	0.36	0.56	.014	.022		
D	14.22	16.51	.560	.650		4
D1	8.38	9.02	.330	.355		7
D2	11.68	12.88	.460	.507		
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		7,8	
H1	5.84	6.86	.230	.270		
L	12.70	14.73	.500	.580		
φP	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 100X Sn

## Case Outline - D2PAK - 5 Leads

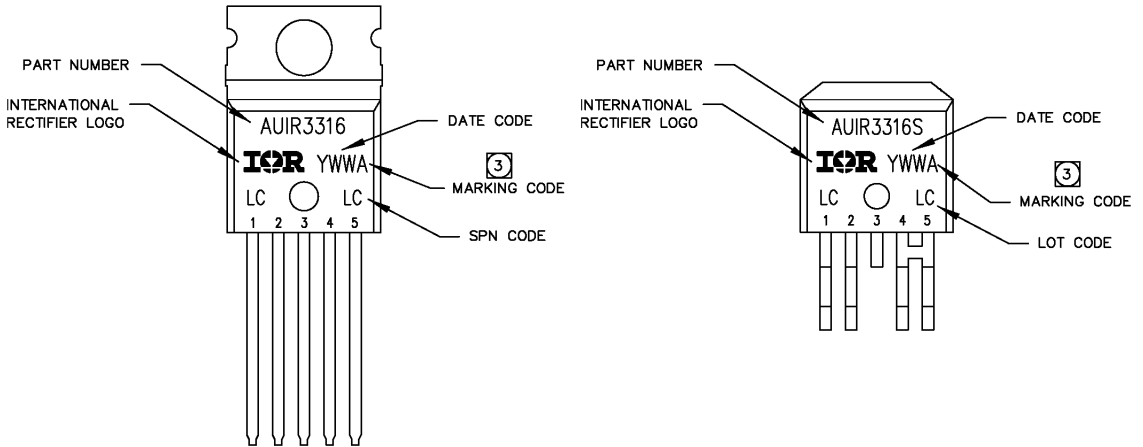


## Tape & Reel - D2PAK – 5 leads



- NOTES:
1. VENDOR: OPTIONAL
  2. REEL MUST HAVE ANTI-STATIC COATING SURFACE RESISTIVITY OF REEL (AS PER EIA-541)  $\mu\text{in}$ :  $10^9 \text{ ohm/SQUARE}$ ; MAX  $10^{12} \text{ ohm/SQUARE}$
  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.  $\text{\textcircled{C}}$  CRITICAL

## Part Marking Information



## Ordering Information

Base Part Number	Package Type	Standard Pack		Complete Part Number
		Form	Quantity	
AUIR3316	TO220 – 5Leads	Tube	50	AUIR3316
		Tube	50	AUIR3316S
	D2-Pak-5-Leads	Tape and reel left	800	AUIR3316STRL
		Tape and reel right	800	AUIR3316STRR

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For technical support, please contact IR's Technical Assistance Center

<http://www.irf.com/technical-info/>

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**Revision History**

<b>Revision</b>	<b>Date</b>	<b>Notes/Changes</b>
A	01/09/2006	First release
B	22/01/2007	Pbf release
C	16/04/2008	TO220 release
D	14/12/2009	AU release
E	14/11/2010	Change description