

LOW EMI CURRENT SENSE HIGH SIDE SWITCH

Features

- Load current feedback
- Programmable over current shutdown
- Active clamp
- ESD protection
- Input referenced to V_{CC}
- 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 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 $Vifb - Vin > 4.7V$. 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.

Typical Connection

Product Summary

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

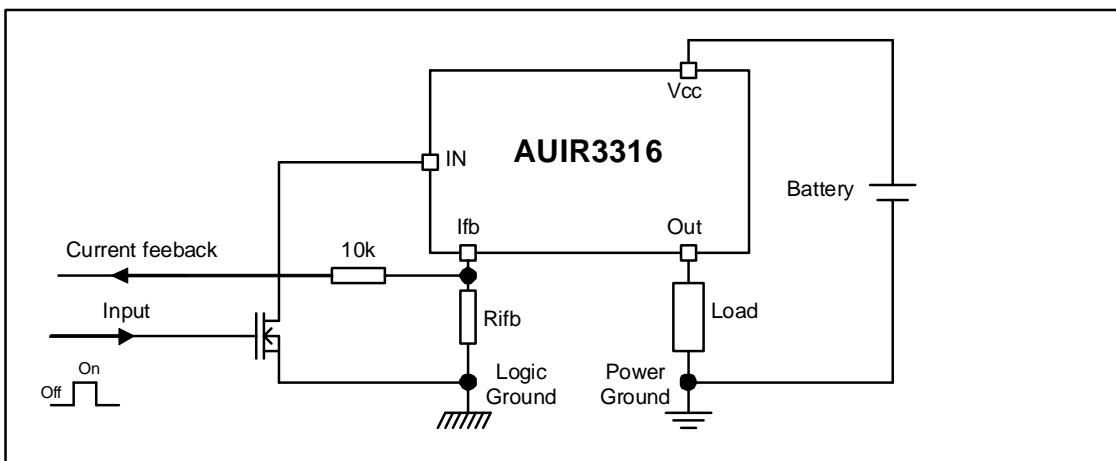
Packages



TO-220
AUIR3316



D²Pak
Pin 4 and 5 fused
AUJR3316S



Qualification Information[†]

Qualification Level		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.	
Moisture Sensitivity Level		D2PAK-5L	MSL1, 260°C (per IPC/JEDEC J-STD-020)
		TO220-5L	Not applicable
ESD	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)	
IC Latch-Up Test		Class II, Level A (per AEC-Q100-004)	
RoHS Compliant		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. (T_j =-40°..150°C, V_{cc} =6..26V $T_{ambient}$ =25°C unless otherwise specified).

Symbol	Parameter	Min.	Max.	Units
$V_{cc\text{-}Vin}$	Maximum V_{cc} voltage	-16	37	V
$V_{cc\text{-}Vin\ cont.}$	Maximum continuous V_{cc} voltage	-16	26	
$V_{cc\text{-}Vfb}$	Maximum I_{fb} voltage	-16	33	
$V_{cc\text{-}Vout}$	Maximum output voltage	-0.3	37	
$I_{ds\ cont.}$	Maximum body diode continuous current $R_{th}=60^\circ\text{C}/\text{W}$ (1) $T_{ambient}=25^\circ\text{C}$	—	2.8	A
$I_{ds\ pulsed}$	Maximum body diode pulsed current (1)	—	100	
P_d	Maximum power dissipation $R_{th}=60^\circ\text{C}/\text{W}$ $T_{ambient}=25^\circ\text{C}$	—	2	W
T_j max.	Max. storage & operating temperature junction temperature	-40	150	°C
Min R_{fb}	Minimum on the resistor on I_{fb} pin	0.3	—	kΩ
$I_{fb\ max.}$	Max. I_{fb} current	-50	50	mA

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

Thermal Characteristics

Symbol	Parameter	Typ.	Max.	Units
R_{th1}	Thermal resistance junction to ambient D ² -Pak Std footprint	60	—	°C/W
R_{th2}	Thermal resistance junction to case D ² -Pak	0.7	—	
R_{th2}	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_{out}	Continuous output current	—	23	A
	$T_{ambient}=85^\circ\text{C}$, $R_{th}=5^\circ\text{C}/\text{W}$, $T_j=125^\circ\text{C}$			
	$T_{ambient}=85^\circ\text{C}$, $R_{th}=60^\circ\text{C}/\text{W}$, $T_j=125^\circ\text{C}$			
R_{ifb}	Recommended I_{fb} resistor (2)(3)	0.5	3.5	kΩ
Pulse min.	Minimum turn-on pulse width	1	—	ms
$F_{max.}$	Maximum operating frequency	—	200	Hz

(2) If R_{ifb} is too low, the device can be damaged.

(3) If R_{ifb} is too high, the device may not switch on.

Protection Characteristics

T_j=-40°..150°C, V_{cc}=6..26V, R_{ifb}=500 to 5kΩ

Symbol	Parameter	Min.	Typ.	Max.	Units	Test Conditions
V _{ifb} -V _{in} @I _{sd}	Over-current shutdown threshold	3.8	4.7	5.9	V	
T _{sd}	Over temperature threshold	—	165	—	°C	See fig. 5
OV	Over voltage protection (not latched)	26	29	33	V	
I _{sd} f	Fixed over current shutdown	90	120	150	A	V _{ifb} <V _{ifb} -V _{in} @I _{sd}
I _{sd} _1k	Programmable over current shutdown 1k	30	40	53		R _{ifb} =1kΩ
t _{reset}	Time to reset protection	—	50	500	μs	See fig. 5
Min. pulse	Min. pulse width (no WAIT state)	—	900	2000		T _j =25°C
WAIT	WAIT function timer	0.4	1	2	ms	See fig. 4 and 5
R _{ds(on)} rev.	Reverse battery On state resistance, T _j =25°C	4	6.7	10	mΩ	V _{cc} -V _{in} =-14V, I _{out} =30A
	T _j =125°C	—	10	15		

Static Electrical Characteristics

T_j=-40°..150°C, V_{cc}=6..26V (unless otherwise specified)

Symbol	Parameter	Min.	Typ.	Max.	Units	Test Conditions
V _{cc} op.	Operating Voltage range	6	—	26	V	
I _{cc} off	Supply leakage current	—	1.5	5	μA	V _{in} =V _{cc} , V _{cc} -V _{out} =14V, V _{cc} -V _{ifb} =14V, T _j =25°C
I _{in} , on	On state IN positive current	1.5	3	6	mA	V _{cc} -V _{in} =14V, T _j =25°C
V _{ih}	High level Input threshold voltage (4)	—	5.4	6.3	V	
V _{il}	Low level Input threshold voltage (4)	4	4.9	5.8		
V _{hyst}	Input hysteresis V _{ih} -V _{il}	0.2	0.4	1.5		
I _{out}	Drain to source leakage current	—	1.2	5	μA	V _{in} =V _{cc} , V _{cc} -V _{ifb} =0V, V _{cc} -V _{out} =14V, T _j =25°C
R _{ds(on)}	On state resistance (5) T _j =25°C	4	5.5	7		I _{out} =30A, V _{cc} -V _{in} =14V
	On state resistance (5) T _j =25°C	4	6	10	mΩ	I _{out} =17A, V _{cc} -V _{in} =6V
	On state resistance (5)(6) T _j =150°C	7	10.5	13.5		I _{out} =30A, V _{cc} -V _{in} =14V
V clamp1	V _{cc} to V _{out} clamp voltage 1	36	39	—	V	I _{out} =50mA
V clamp2	V _{cc} to V _{out} clamp voltage 2	—	40	43		I _{out} =30A, T _j =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_{dson} is measured between the tab and the Out pin, 5mm away from the package.

(6) Guaranteed by design

Switching Electrical Characteristics

V_{cc}=14V, Resistive load=0.5Ω, T_j=25°C

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

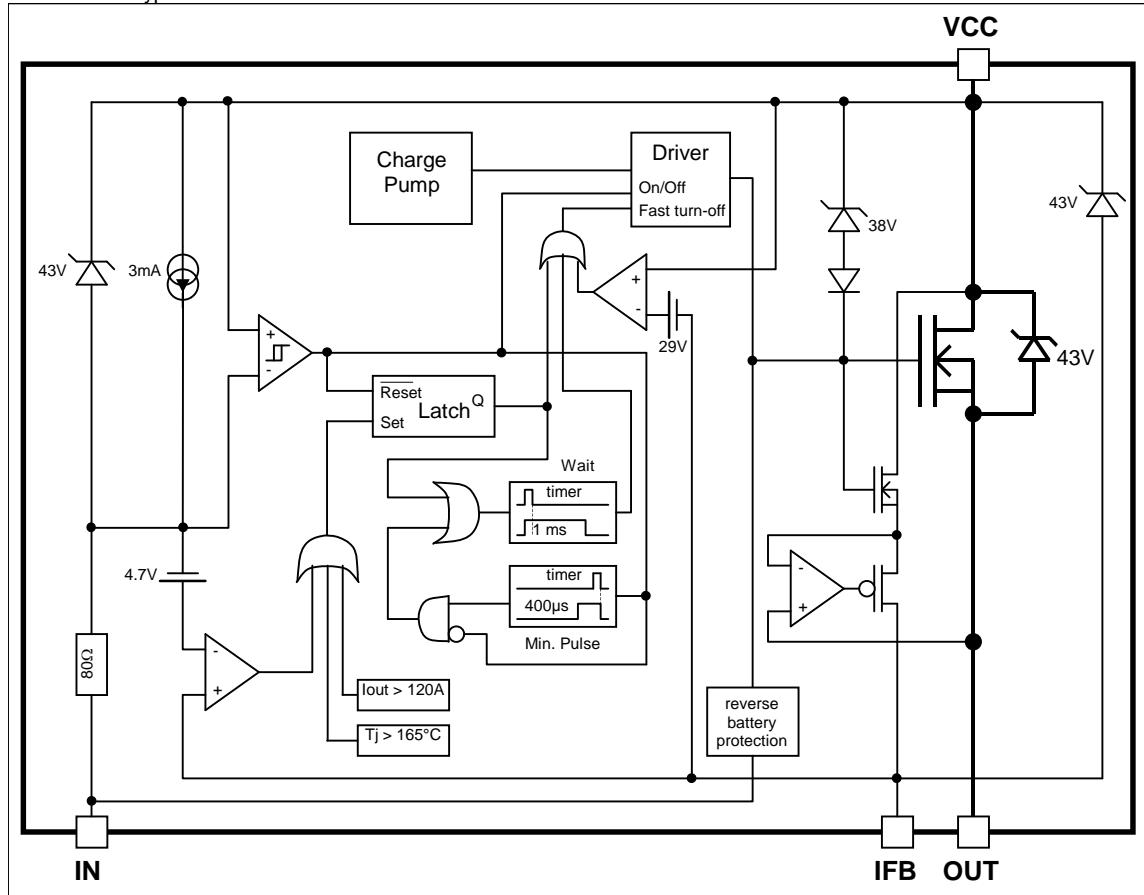
Current Sense Characteristics

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

Symbol	Parameter	Min.	Typ.	Max.	Units	Test Conditions
Ratio	I Load/lifb current ratio	8,200	8,800	9,950	—	$R_{fb} = 500\Omega$, $I_{out} = 60\text{A}$
Ratio_TC	I Load/lifb variation aver temperature(6)	-5	—	+5	%	$T_j = -40^\circ\text{C}$ to 150°C
Offset	Load current diagnostic offset	-0.2	0	+0.25	A	$I_{out} = 2\text{A}$
trst	lifb response time (low signal)	—	1	—	μs	90% of the I_{out} step

Functional Block Diagram

All values are typical



Lead Assignments

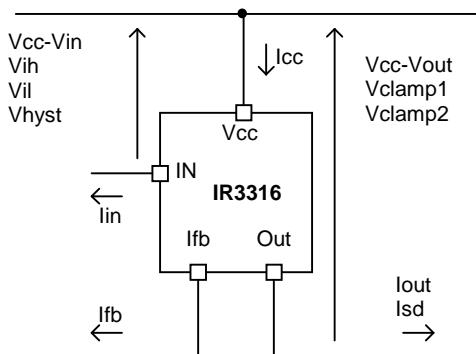
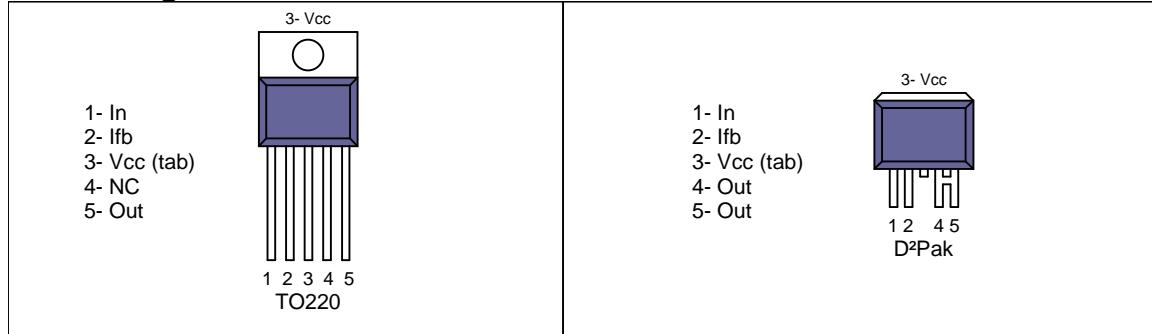


Figure 1 – Voltages and current definitions

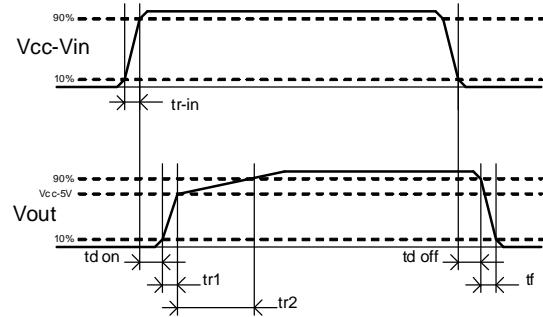


Figure 2 – Switching time definitions

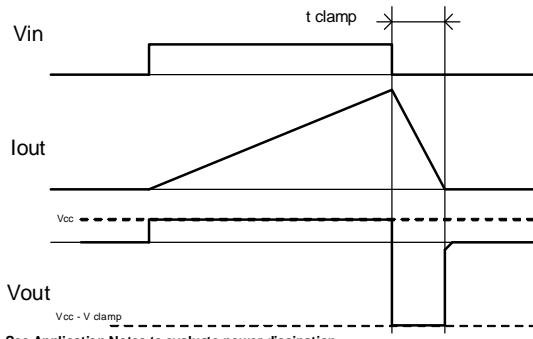


Figure 3 – Active clamp waveforms

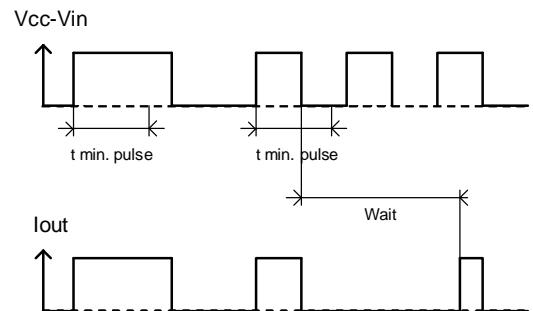


Figure 4 – Min. pulse and Wait function

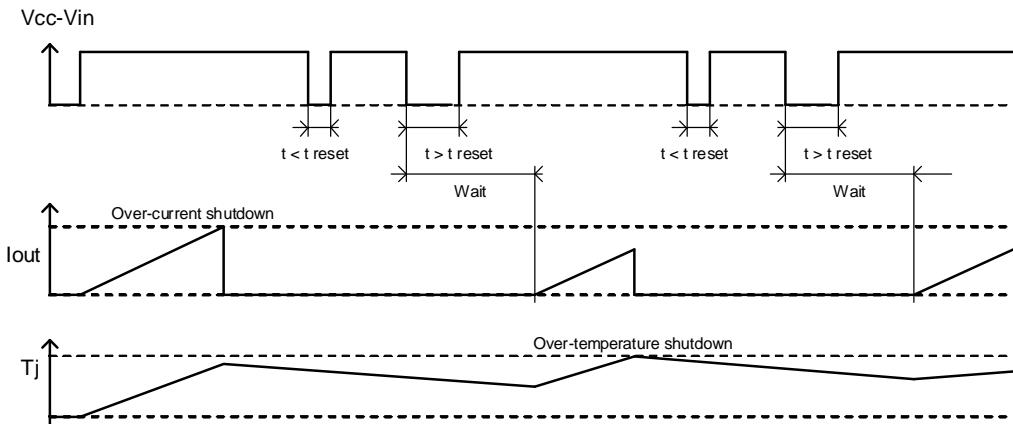


Figure 5 – Protection Timing Diagrams

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

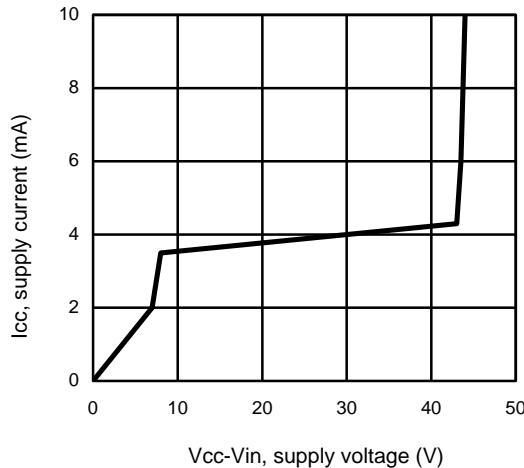


Figure 6 – Icc (mA) Vs Vcc-Vin (V)

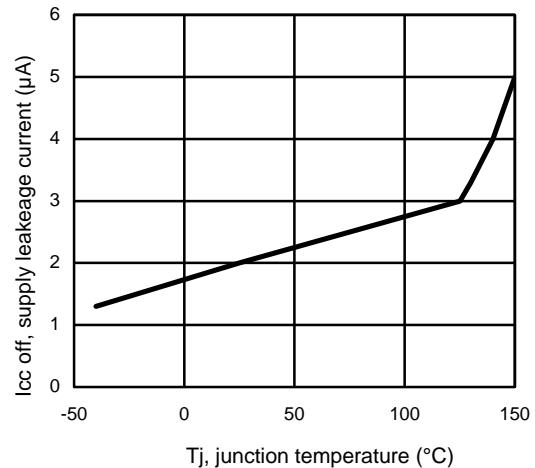


Figure 7 – Icc off (μA) Vs Tj (°C)

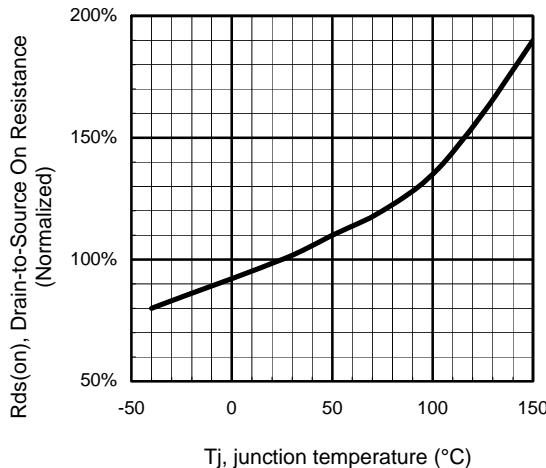


Figure 8 - Normalized Rds(on) (%) Vs Tj (°C)

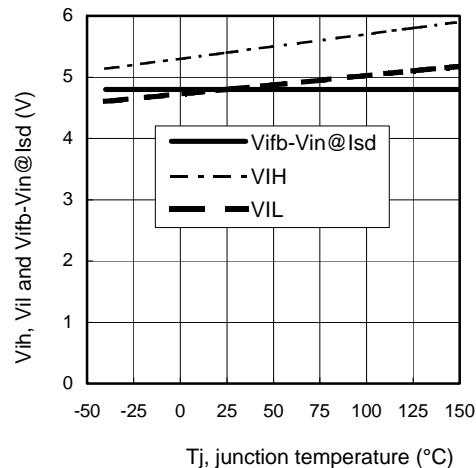


Figure 9 – Vih, Vil and Vifb-Vin@Isd (V) Vs Tj (°C)

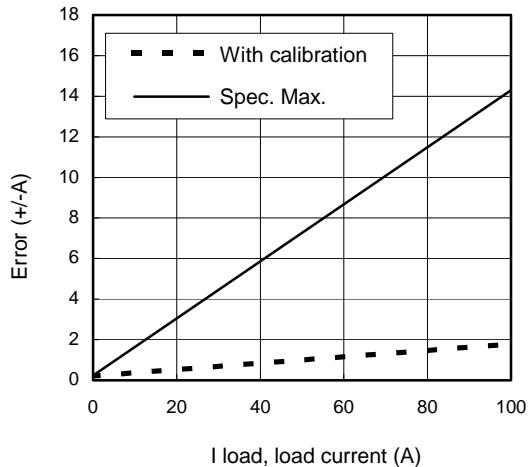


Figure 10 – Error (+/- A) Vs I load (A)

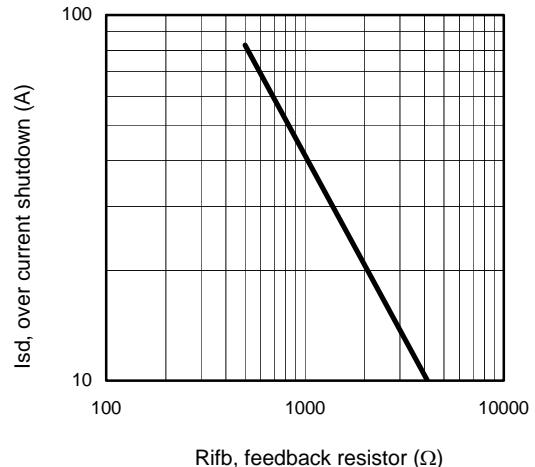


Figure 11 – Ids (A) Vs Rifb (Ω)

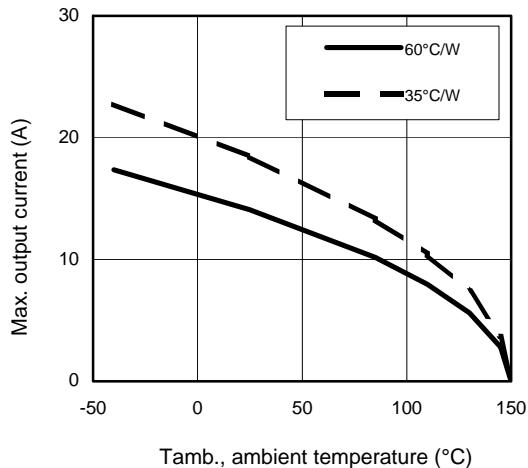


Figure 12 – Max. Iout (A) Vs Tamb. (°C)

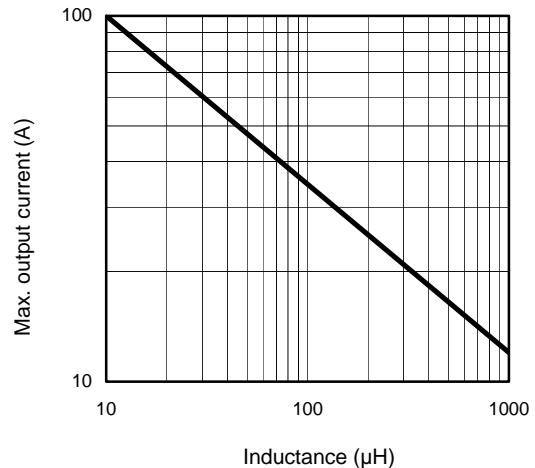


Figure 13 – Max. Iout (A) Vs inductance (μH)

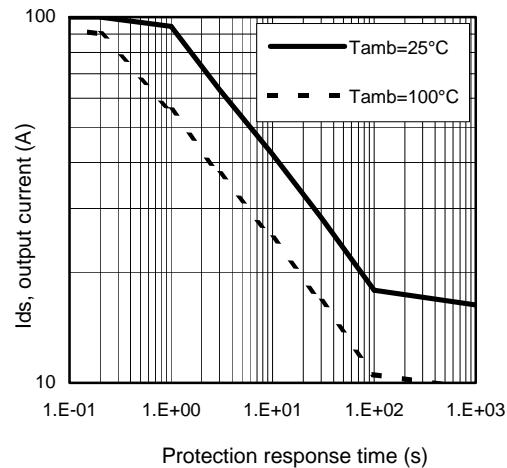


Figure 14 – I_{ds} (A) Vs over temperature protection response time (s)

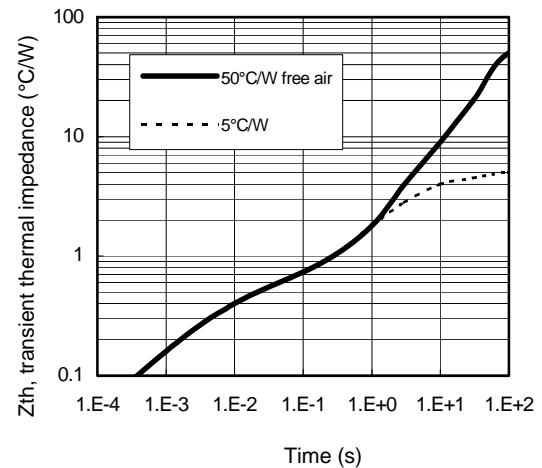
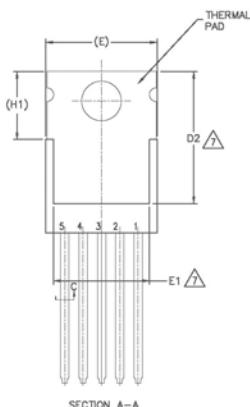
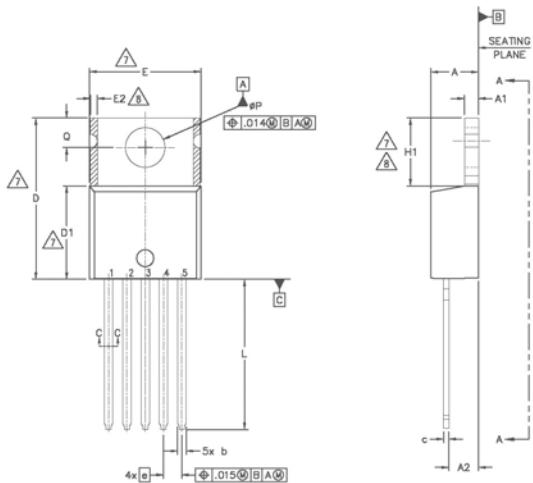


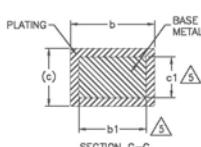
Figure 15 – Transient thermal impedance (°C/W) Vs time (s)

Case Outline - TO220 - 5 Leads



S Y M O L	DIMENSIONS		NOT ES	
	MM INCHES	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
c	0.36	0.61	.014	.024
c1	0.36	0.56	.014	.022
D	14.22	16.51	.560	.650
D1	8.38	9.02	.330	.355
D2	11.68	12.88	.460	.507
E	9.65	10.67	.380	.420
E1	6.86	8.89	.270	.350
E2	—	0.76	—	.030
e	1.70	BSC	—	.067 BSC
H1	5.84	6.86	.230	.270
L	12.70	14.73	.500	.580
P	3.53	3.73	.139	.147
Q	2.54	3.05	.100	.120

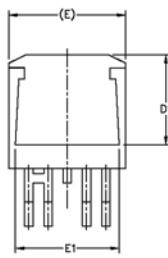
SECTION A-A



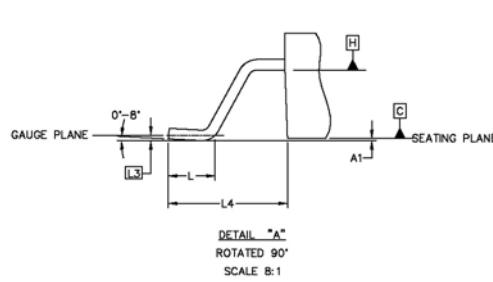
NOTES:

- 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 EXCLUDED EXCEPT .005 INCH (0.127 MM) PER SIDE. THESE DIMENSIONS ARE MEASURED AT THE OUTERMOST EXTREMES OF THE PLASTIC BODY.
- 5.- DIMENSION b1 & c1 APPLY TO BASE METAL ONLY.
- 6.- CONTROLLED DIMENSION : INCHES.
- 7.- THERMAL PAD CONTOUR OPTIONAL WITHIN DIMENSIONS E1,H1,D2 & E1
- 8.- DIMENSION E2 X H1 DEFINE A ZONE WHERE STAMPING AND SINGULATION IRRREGULARITIES 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

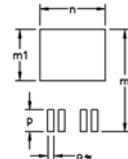
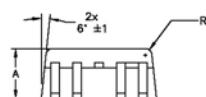
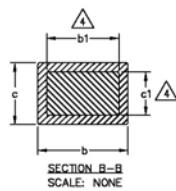
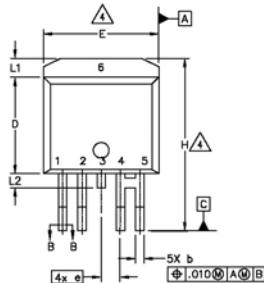
Case Outline - D2PAK - 5 Leads



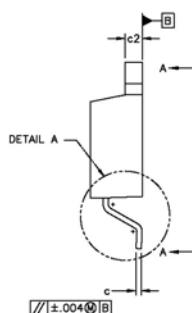
VIEW A-A



DETAIL "A"
ROTATED 90°
SCALE 8:1



FOOT PRINT
SCALE 2:1

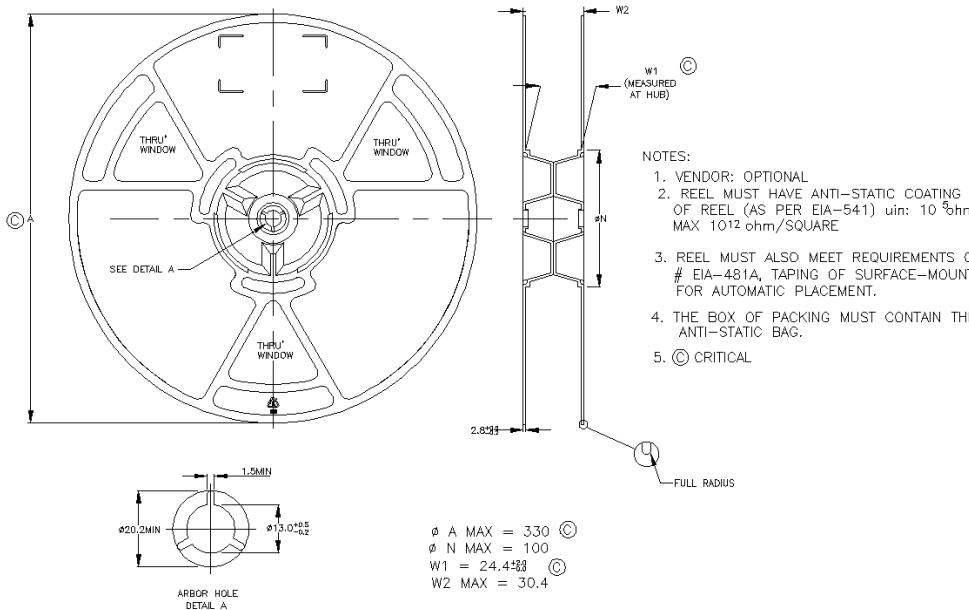


NOTES:

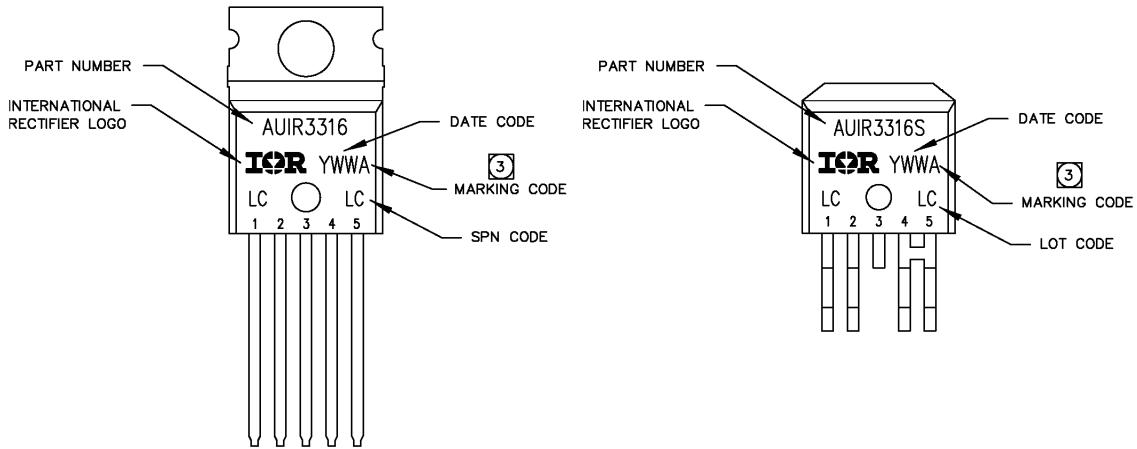
1. DIMENSIONING AND TOLERANCING PER ASME Y14.5M-1994
2. DIMENSIONS ARE SHOWN IN MILLIMETERS [INCHES]
3. DIMENSION D & E DO NOT INCLUDE MOLD FLASH. MOLD FLASH SHALL NOT EXCEED 0.127 [.005"] PER SIDE. THESE DIMENSIONS ARE MEASURED AT THE OUTMOST EXTREMES OF THE PLASTIC BODY.
4. DIMENSION b1 AND c1 APPLY TO BASE METAL ONLY.
5. CONTROLLING DIMENSION: MILLIMETERS
6. LEADS AND DRAIN ARE PLATED WITH 100% Sn

SYMBOL	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	.028	.032	
c	0.38	0.74	.015	.029	
c1	0.38	0.58	.015	.023	4
c2	1.14	1.85	.045	.065	
D	8.51	9.65	.335	.380	3
D1	6.86		.270		
E	9.65	10.67	.380	.420	
E1	6.22		.245		3
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	

Tape & Reel - D2PAK – 5 leads



Part Marking Information



Ordering Information

Base Part Number	Package Type	Standard Pack		Complete Part Number
		Form	Quantity	
AUIR3316	TO220 – 5Leads	Tube	50	AUIR3316
	D2-Pak-5-Leads	Tube	50	AUIR3316S
		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/>

WORLD HEADQUARTERS:

233 Kansas St., El Segundo, California 90245

Tel: (310) 252-7105

Revision History

Revision	Date	Notes/Changes
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