

LOW EMI CURRENT SENSE HIGH SIDE SWITCH

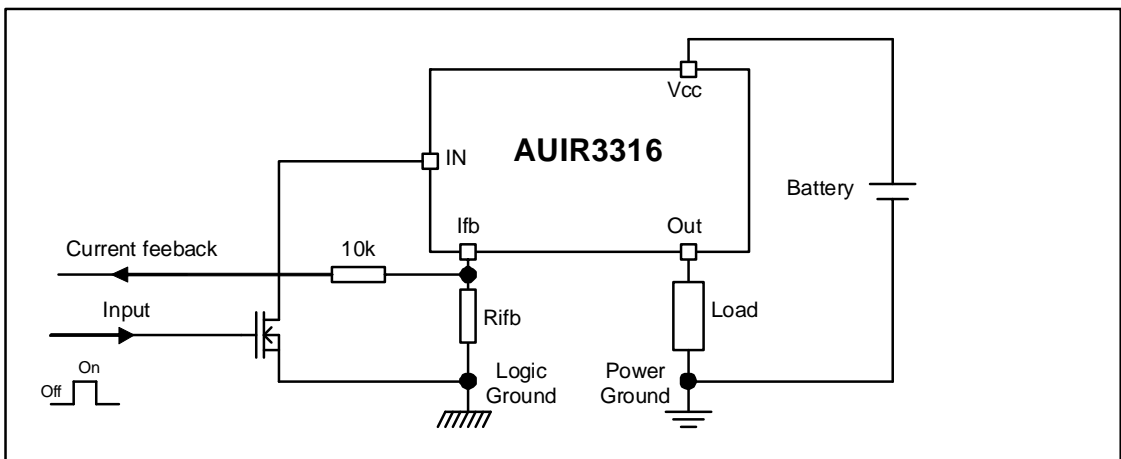
Features

- 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_{Ifb}. 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 _{ds(on)} | 7 mΩ max. |
| V _{cc op.} | 6 to 26V |
| Current Ratio | 8800 |
| Prog. I _{shutdown} | 10 to 90A |
| V _{clamp} | 40V |

Packages



TO-220
AUIR3316



D²Pak
Pin 4 and 5 fused
AUIR3316S

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. (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 _{ds} cont. | Maximum body diode continuous current R _{th} =60°C/W (1) Tambient=25°C | — | 2.8 | A |
| I _{ds} pulsed | Maximum body diode pulsed current (1) | — | 100 | |
| P _d | Maximum power dissipation R _{th} =60°C/W Tambient=25°C | — | 2 | W |
| T _j max. | Max. storage & operating temperature junction temperature | -40 | 150 | °C |
| Min Rfb | Minimum on the resistor on lfb pin | 0.3 | — | kΩ |
| I _{fb} 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 |
|--------|--|------|------|-------|
| Rth1 | Thermal resistance junction to ambient D ² -Pak Std footprint | 60 | — | °C/W |
| Rth2 | Thermal resistance junction to case D ² -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 |
|------------------|--|------|---------|-------|
| I _{out} | Continuous output current | — | 23 7 | A |
| | T _{ambient} =85°C, R _{th} =5°C/W, T _j =125°C | | | |
| | T _{ambient} =85°C, R _{th} =60°C/W, T _j =125°C | | | |
| R _{lfb} | Recommended lfb 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_{lfb} is too low, the device can be damaged.

(3) If R_{lfb} 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-Vin@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-Vin@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-Vin} = -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-Vout} = 14V, V _{cc-Vifb} = 14V, T _j = 25°C |
| I _{in, on} | On state I _N positive current | 1.5 | 3 | 6 | mA | V _{cc-Vin} = 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-Vifb} = 0V, V _{cc-Vout} = 14V, T _j = 25°C |
| R _{ds(on)} | On state resistance (5) T _j = 25°C | 4 | 5.5 | 7 | mΩ | I _{out} = 30A, V _{cc-Vin} = 14V |
| | On state resistance (5) T _j = 25°C | 4 | 6 | 10 | | I _{out} = 17A, V _{cc-Vin} = 6V |
| | On state resistance (5)(6) T _j = 150°C | 7 | 10.5 | 13.5 | | I _{out} = 30A, V _{cc-Vin} = 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_{ds(on)} 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-Vout} = 5V | 20 | 50 | 125 | | |
| t _{r2} | Rise time to V _{cc-Vout} = 0.1V _{cc} | 30 | 80 | 200 | | |
| E _{on} | Turn on energy | — | 14 | — | mJ | |
| t _{doff} | Turn off delay time | 30 | 140 | 350 | μs | |
| t _f | Fall time to V _{out} = 10% of V _{cc} | 35 | 100 | 250 | | |
| E _{off} | Turn off energy | — | 7 | — | | |

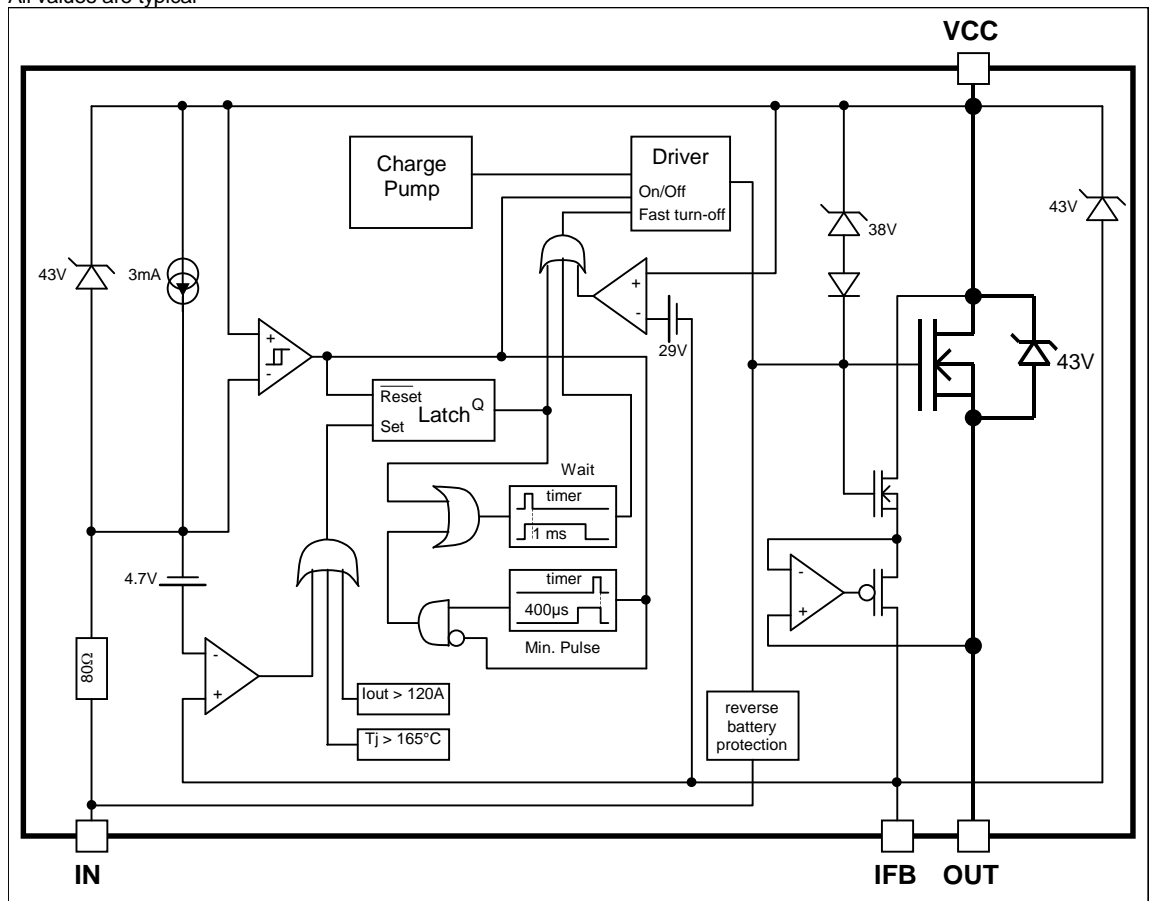
Current Sense Characteristics

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

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

Functional Block Diagram

All values are typical



Lead Assignments

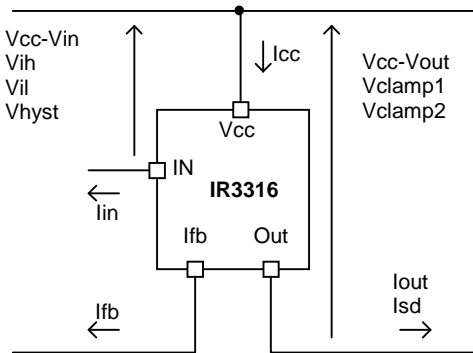
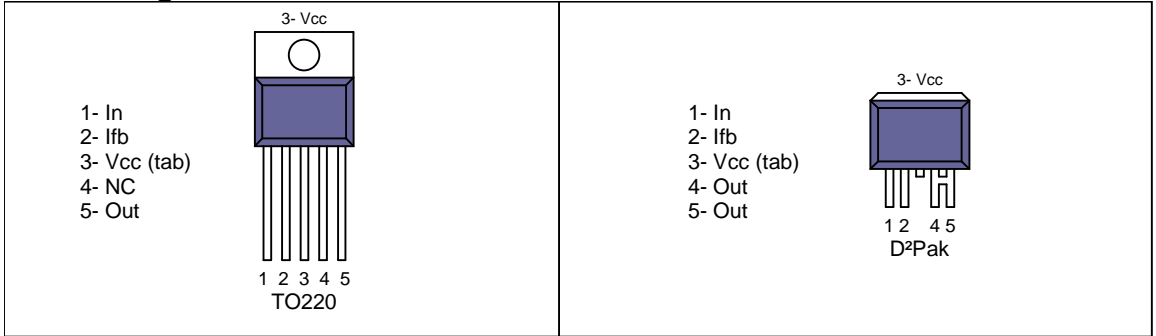


Figure 1 – Voltages and current definitions

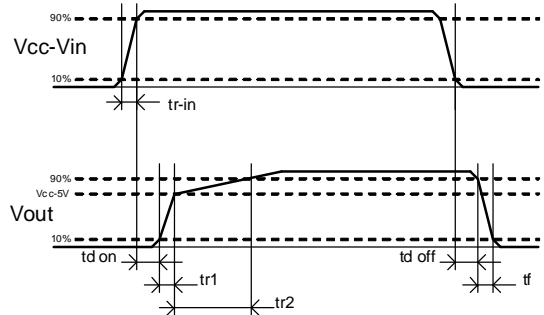


Figure 2 – Switching time definitions

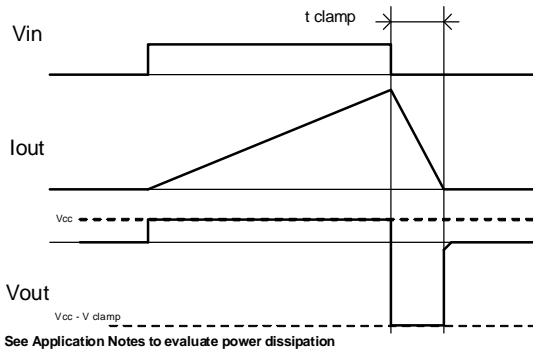


Figure 3 – Active clamp waveforms

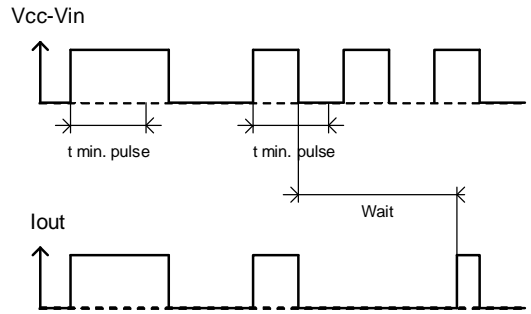


Figure 4 – Min. pulse and Wait function

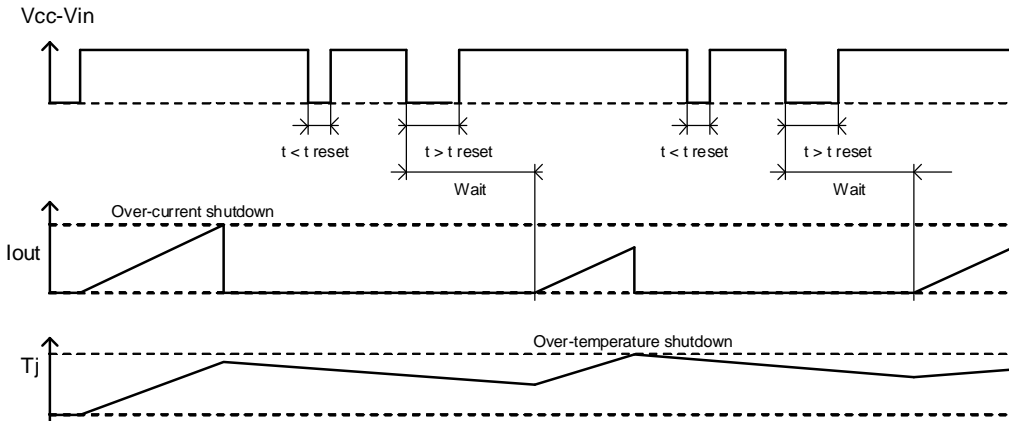


Figure 5 – Protection Timing Diagrams

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

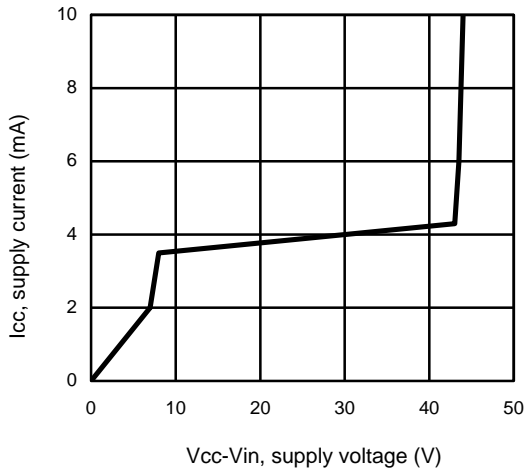


Figure 6 – I_{cc} (mA) Vs $V_{\text{cc}}-V_{\text{in}}$ (V)

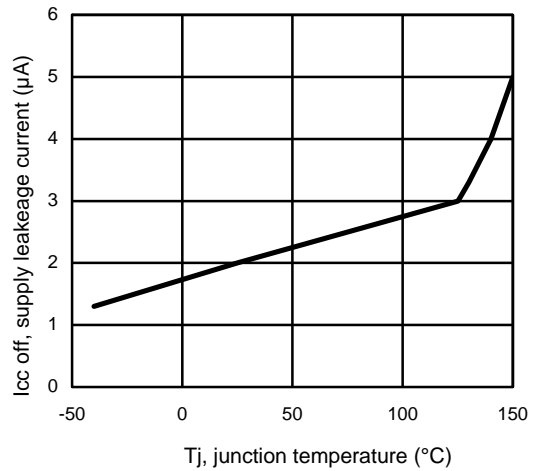


Figure 7 – $I_{\text{cc off}}$ (μA) Vs T_j ($^\circ\text{C}$)

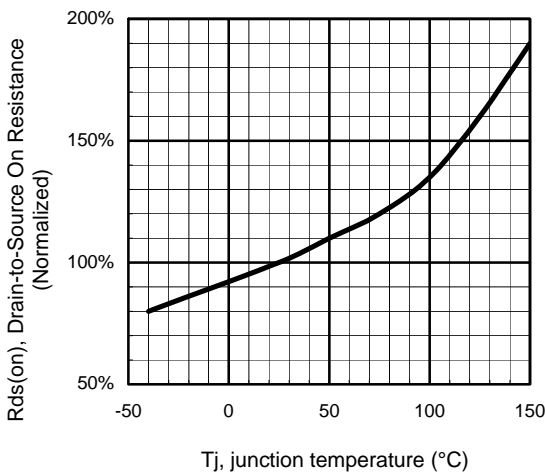


Figure 8 - Normalized $R_{\text{ds(on)}}$ (%) Vs T_j ($^\circ\text{C}$)

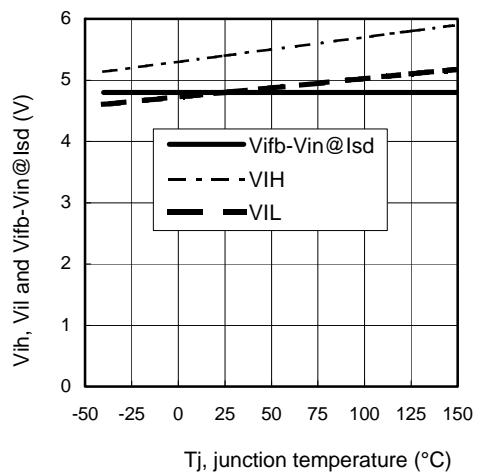


Figure 9 – V_{ih} , V_{il} and $V_{\text{fb}}-V_{\text{in}}@I_{\text{std}}$ (V) Vs T_j ($^\circ\text{C}$)

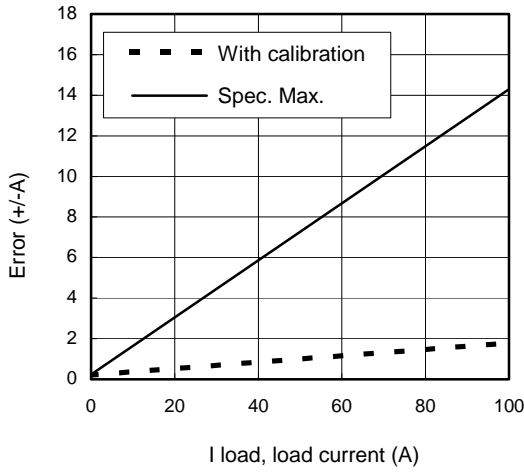


Figure 10 – Error (+/- A) Vs I load (A)

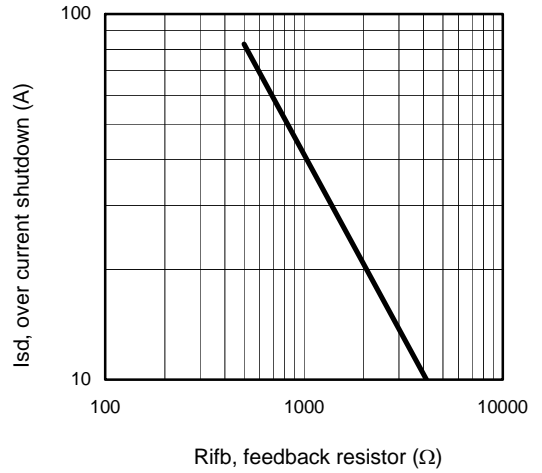


Figure 11 – Ids (A) Vs Rifb (Ω)

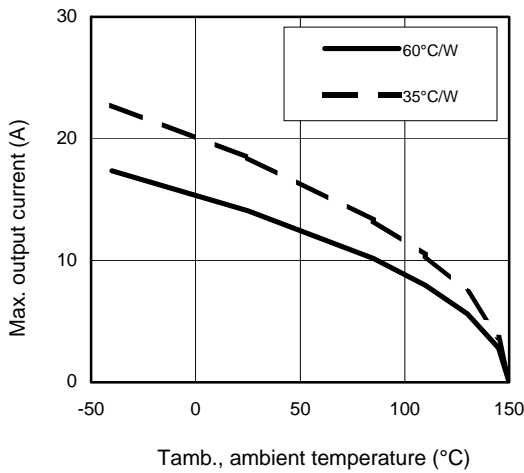


Figure 12 – Max. iout (A) Vs Tamb. (°C)

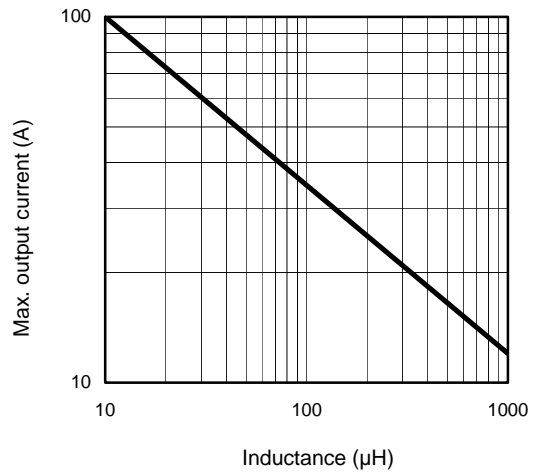


Figure 13 – Max. iout (A) Vs inductance (μH)

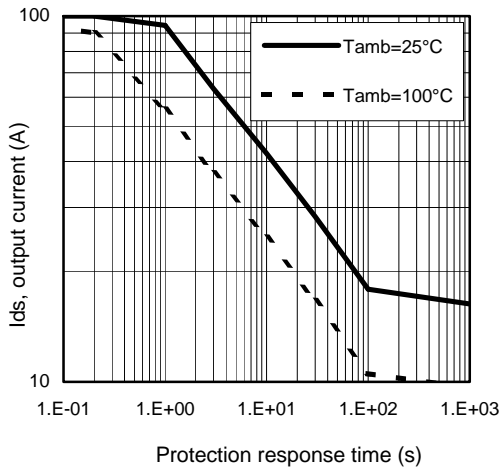


Figure 14 – I_{ds} (A) Vs over temperature protection response time (s)

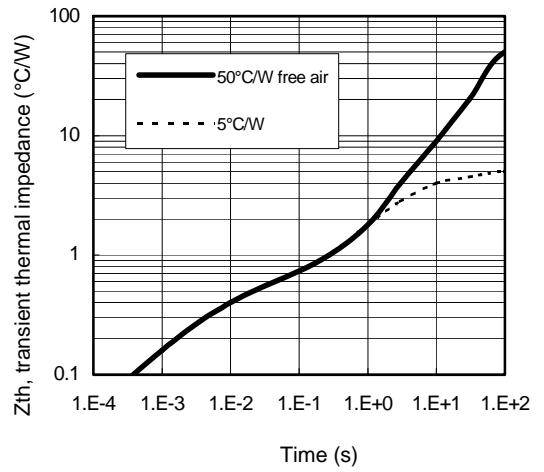
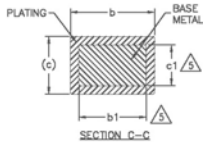
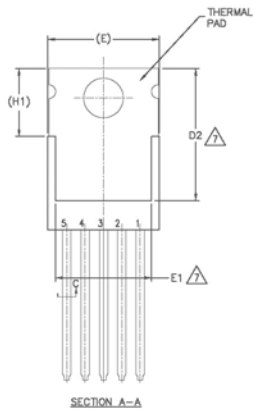
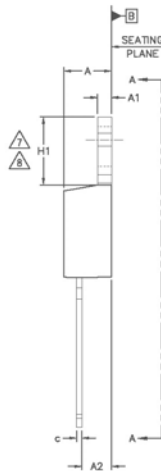
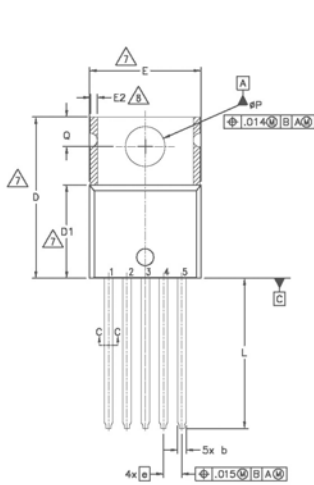


Figure 15 – Transient thermal impedance ($^{\circ}\text{C}/\text{W}$) Vs time (s)

Case Outline - TO220 - 5 Leads

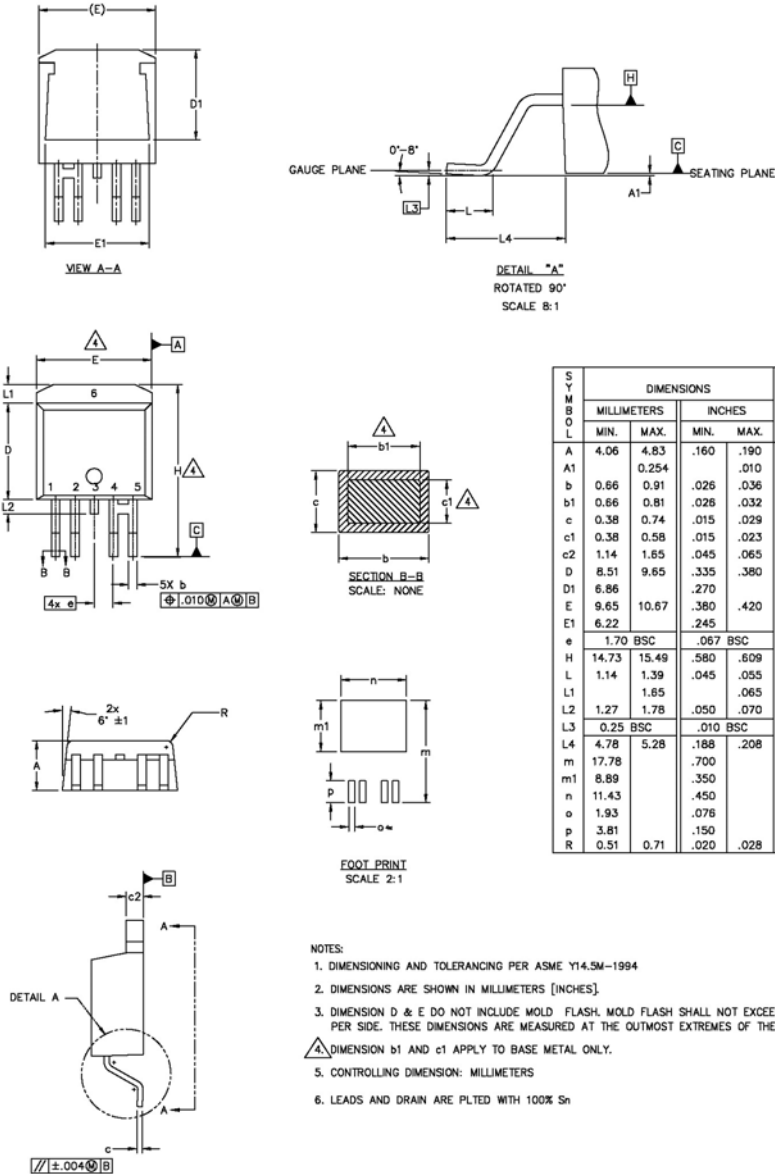


| SYMBOL | DIMENSIONS | | | | NOTES | |
|--------|-------------|-------|----------|------|-------|---|
| | MILLIMETERS | | INCHES | | | |
| | MIN. | MAX. | MIN. | MAX. | | |
| A | 3.56 | 4.83 | .140 | .190 | 5 | |
| A1 | 0.51 | 1.40 | .020 | .055 | | |
| A2 | 2.03 | 2.92 | .080 | .115 | | |
| b | 0.64 | 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 | | |

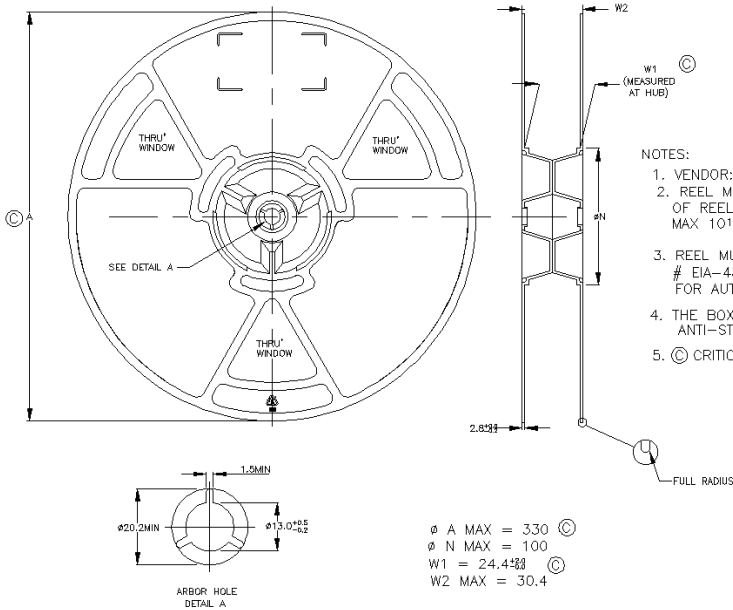
NOTES:

- 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

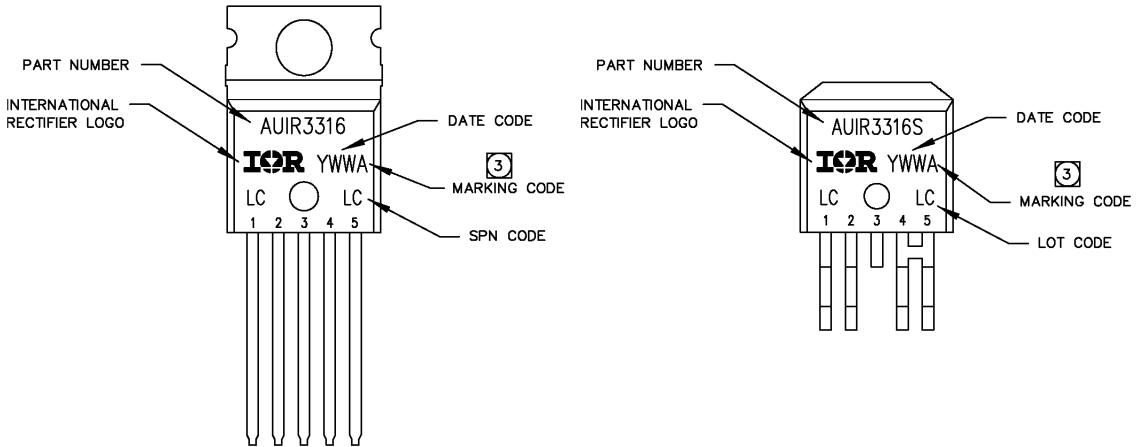
Case Outline - D2PAK - 5 Leads



Tape & Reel - D2PAK – 5 leads



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/>

WORLD HEADQUARTERS:

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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 |
| | | |
| | | |
| | | |
| | | |

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