International
IOR Rectifier

December, 10th 2011
Automotive grade

# AUIPS6044G

# INTELLIGENT POWER HIGH SIDE SWITCH

## Features

- Over temperature shutdown (with auto-restart)
- Short circuit protection (current limit)
- Reverse battery protection (turns On the MOSFET)
- Full diagnostic capability (short circuit to battery)
- Active clamp
- Open load detection in On and Off state
- Ground loss protection
- Logic ground isolated from power ground
- ESD protection

## Product Summary

| | |
|---|---|
| Rds(on) | 130mΩ max. |
| Vclamp | 39V |
| I Limit | 7A |
| Open load | 3V / 0.22A |

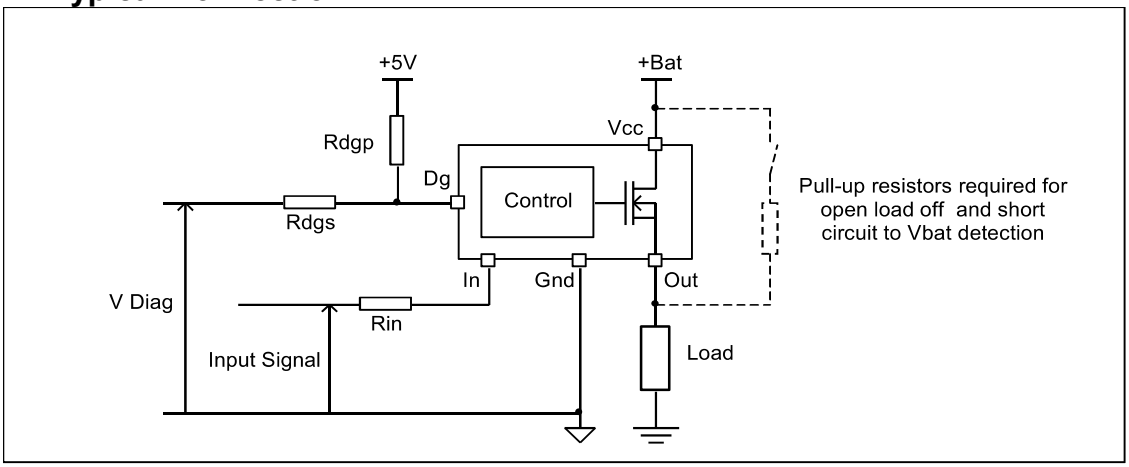
## Package

SOIC28 Wide body

## Description

The AUIPS6044G is quad output Intelligent Power Switch (IPS) for use in a high side configuration. It features short circuit, over-temperature, ESD protection, inductive load capability and diagnostic feedback. The output current is limited to the Ilim value. The current limitation is activated until the thermal protection acts. The over-temperature protection turns off the device if the junction temperature exceeds the Tshutdown value. It will automatically restart after the junction has cooled 7°C below the Tshutdown value. The reverse battery protection turns On the MOSFET. A diagnostic pin provides different voltage levels for each fault condition. The double level shifter circuitry will allow large offsets between the logic and load ground.

## Typical Connection



## 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** | | SOIC-28L | MSL2, 260°C (per IPC/JEDEC J-STD-020) |
| **ESD** | Machine Model | Class M2 (+/-150V)††† (per AEC-Q100-003) | |
| | Human Body Model | Class H1C (+/-1500V)††† (per AEC-Q100-002) | |
| | Charged Device Model | Class C4 (+/-900V)††† (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.
††† Passing voltage level

## Absolute Maximum Ratings

Absolute maximum ratings indicate sustained limits beyond which damage to the device may occur. All voltage parameters are referenced to Ground lead. Tj= -40°C..150°C, Vcc=6..35V (unless otherwise specified).

| Symbol | Parameter | Min. | Max. | Units |
|---|---|---|---|---|
| Vout | Maximum output voltage | Vcc-35 | Vcc+0.3 | V |
| Voffset | Maximum logic ground to load ground offset | Vcc-35 | Vcc+0.3 | |
| Vin | Maximum input voltage | -0.3 | 5.5 | |
| Vcc max. | Maximum Vcc voltage | — | 36 | |
| Vcc cont. | Maximum continuous Vcc voltage | — | 28 | |
| Iin max. | Maximum IN current | -3 | 10 | mA |
| Idg max. | Maximum diagnostic output current | -3 | 10 | |
| Vdg | Maximum diagnostic output voltage | -0.3 | 5.5 | V |
| Pd | Maximum power dissipation (internally limited by thermal protection)<br>Rth=130°C/W per channel | — | 3.8 | W |
| Tj max. | Max. storage & operating temperature junction temperature | -40 | 150 | °C |

## Thermal Characteristics

| Symbol | Parameter | Typ. | Max. | Units |
|---|---|---|---|---|
| Rth1 | Thermal resistance junction to ambient 1" sqrt. Footprint / 1 channel On | 50 | — | °C/W |
| Rth2 | Thermal resistance junction to ambient 1" sqrt. Footprint / 2 channels On | 100 | — | |
| Rth3 | Thermal resistance junction to ambient 1" sqrt. Footprint / 4 channels On | 130 | — | |

note : Tj=Power dissipated in one channel x Rth

## 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 |
|---|---|---|---|---|
| VIH | High level input voltage | 4 | 5.5 | |
| VIL | Low level input voltage | 0 | 0.9 | |
| Iout | Continuous drain current, Rth=130°C/W, Tj=150°C, 4 channels On | | | A |
| | Tambient=85°C / 1" sqrt. footprint | — | 1.5 | |
| | Tambient=105°C / 1" sqrt. footprint | — | 1.2 | |
| Rin | Recommended resistor in series with IN pin | 4 | 10 | kΩ |
| Rdgs | Recommended resistor in series with DG pin for reverse battery protection | 4 | 20 | |
| Rdgp | Recommended pull-up resistor for DG | 4 | 20 | |
| Rol | Recommended pull-up resistor for open load detection | 5 | 100 | |
| F max. | Max. switching frequency | — | 3.5 | kHz |

## Static Electrical Characteristics

Tj=-40°C..150°C, Vcc=6..28V (unless otherwise specified), typical values are given for Vcc=14V and Tj=25°C

| Symbol | Parameter | Min. | Typ. | Max. | Units | Test Conditions |
|---|---|---|---|---|---|---|
| Rds(on) | ON state resistance Tj=25°C | — | 110 | 130 | mΩ | Vin=5V, Iout=2.5A |
| | ON state resistance Tj=150°C(1) | — | 190 | 230 | | Vin=5V, Iout=2.5A |
| | ON state resistance Tj=25°C, Vcc=6V | — | 125 | 155 | | Vin=5V, Iout=1.5A |
| | ON state resistance during reverse battery Tj=25°C | — | 140 | 180 | | Vcc-Gnd=-14V |
| Vcc op. | Operating voltage range | 6 | — | 28 | V | |
| V clamp 1 | Vcc to Out clamp voltage 1 | 37 | 39 | — | | Iout=20mA |
| V clamp 2 | Vcc to Out clamp voltage 2 | — | 40 | — | | Iout=2.5A (see Fig. 1) |
| Icc Off | Supply current when Off and Vout connected to ground with R<4Ω | — | 4 | 9 | µA | Vin=0V, Vout=0V, Tj=25°C, Vcc=14V |
| Icc On | Supply current when On | — | 2.2 | 5 | mA | Vin=5V, Vcc=14V |
| Vih | Input high threshold voltage | — | 2.5 | 3 | V | |
| Vil | Input low threshold voltage | 1.5 | 2 | — | | |
| In hyst. | Input hysteresis | 0.2 | 0.5 | 1 | | |
| Iin On | Input current when device is On | — | 40 | 100 | µA | Vin=5V |
| Idg | Dg leakage current | — | 0.1 | 10 | | Vdg=5V |
| Vdg | Low level DG voltage | — | 0.25 | 0.4 | V | Idg=1.6mA |

## Switching Electrical Characteristics

Vcc=14V, Resistive load=6Ω, Vin=5V, Tj=-40°C..150°C, typical values are given for Tj=25°C

| Symbol | Parameter | Min. | Typ. | Max. | Units | Test Conditions |
|---|---|---|---|---|---|---|
| Tdon | Turn-on delay time | — | 5 | 15 | µs | see Fig. 3 |
| Tr1 | Rise time to Vout=Vcc-5V | — | 3 | 10 | | |
| Tr2 | Rise time to Vout=0.9 x Vcc | — | 4 | 30 | | |
| dV/dt (On) | Turn On dV/dt | — | 2.5 | — | V/µs | |
| EOn | Turn On energy | — | 100 | — | µJ | |
| Tdoff | Turn-off delay time | — | 10 | 20 | µs | |
| Tf | Fall time to Vout=0.1 x Vcc | — | 3 | 10 | | |
| dV/dt (Off) | Turn Off dV/dt | — | 6.5 | — | V/µs | |
| EOff | Turn Off energy | — | 50 | — | µJ | |

## Protection Characteristics

Tj=-40°C..150°C, Vcc=6..28V (unless otherwise specified), typical values are given for Vcc=14V and Tj=25°C

| Symbol | Parameter | Min. | Typ. | Max. | Units | Test Conditions |
|---|---|---|---|---|---|---|
| Ilim | Internal current limit | 4 | 7 | 10 | A | Vout=0V, Tj=25°C |
| Tsd+ | Over temperature high threshold | 150(1) | 165 | — | °C | See fig. 2 |
| Tsd- | Over temperature low threshold | — | 158 | — | | |
| Vsc | Short-circuit detection voltage(2) | 2 | 3 | 4 | V | |
| UV+ | Under voltage protection Vcc going up | — | 5 | 6.2 | | |
| UV- | Under voltage protection Vcc going down | — | 4.5 | 5.8 | | |
| VOL Off | Open load detection threshold | 2 | 3 | 4 | | |
| I OL On | Open load detection threshold | 0.05 | 0.17 | 0.27 | A | Tj=-40..25°C |
| | | 0.05 | 0.15 | 0.22 | | Tj=25..150°C |

(1) Guaranteed by design
(2) Reference to Vcc

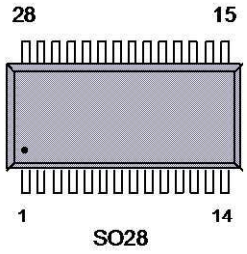
## True Table

| Operating Conditions | IN | OUT | DG |
|---|---|---|---|
| Normal | H | H | H |
| Normal | L | L | H |
| Open Load | H | H | L |
| Open Load (3) | L | H | L |
| Short circuit to Gnd | H | L | L |
| Short circuit to Gnd | L | L | H |
| Short circuit to Vcc | H | H | L (4) |
| Short circuit to Vcc (5) | L | H | L |
| Over-temperature | H | L | L |
| Over-temperature | L | L | H |

(3) With a pull-up resistor connected between the output and Vcc.
(4) Vds lower than 10mV.
(5) Without a pull-up resistor connected between the output and Vcc.

## Lead Assignments

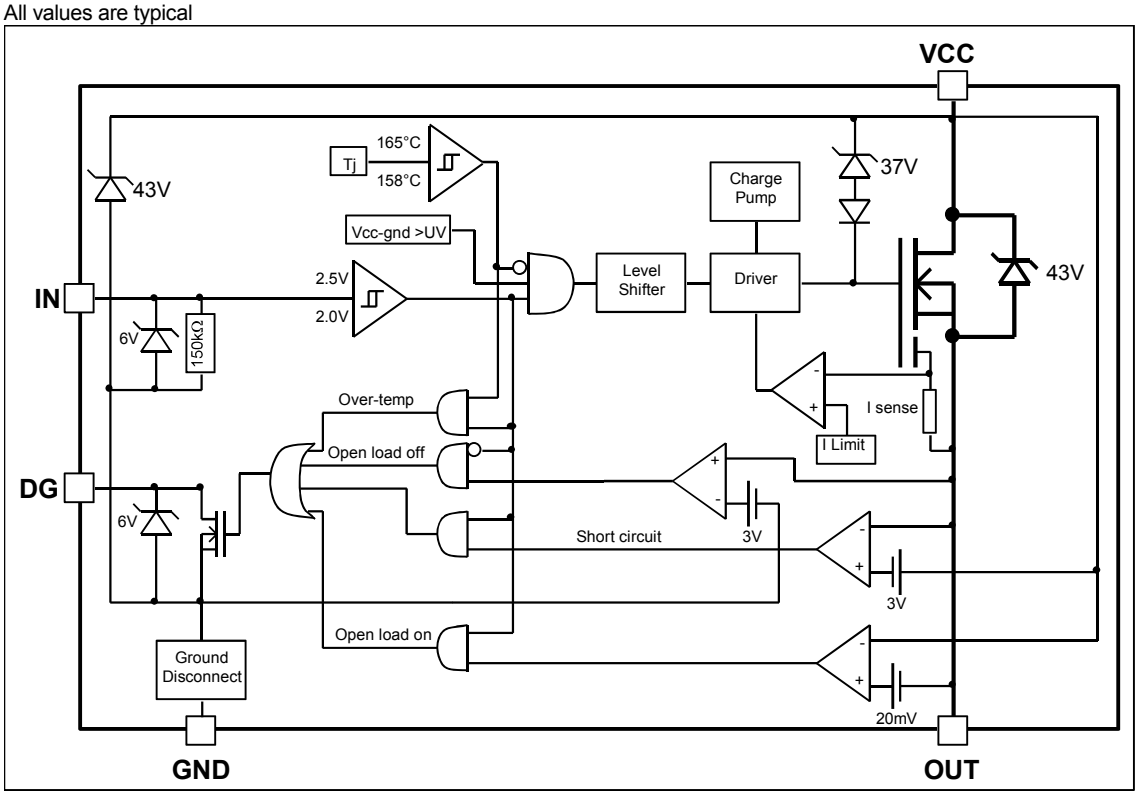
| | |
|---|---|
| 1- Vcc | 15- Vcc |
| 2- GND1 | 16- OUT4 |
| 3- IN1 | 17- OUT4 |
| 4- DG1 | 18- OUT4 |
| 5- DG2 | 19- OUT3 |
| 6- IN2 | 20- OUT3 |
| 7- GND2 | 21- OUT3 |
| 8- GND3 | 22- OUT2 |
| 9- IN3 | 23- OUT2 |
| 10- DG3 | 24- OUT2 |
| 11- DG4 | 25- OUT1 |
| 12- IN4 | 26- OUT1 |
| 13- GND4 | 27- OUT1 |
| 14- VCC | 28- Vcc |



SO28

## Functional Block Diagram

All values are typical



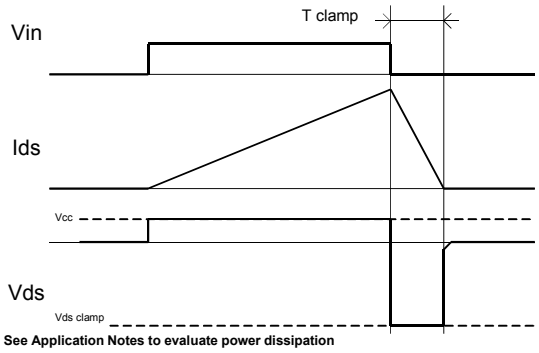



**Figure 1 – Active clamp waveforms**

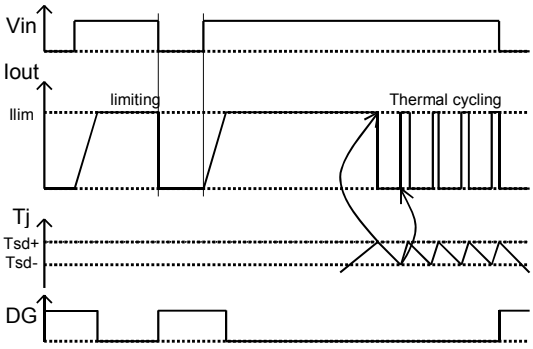



**Figure 2 – Protection timing diagram**

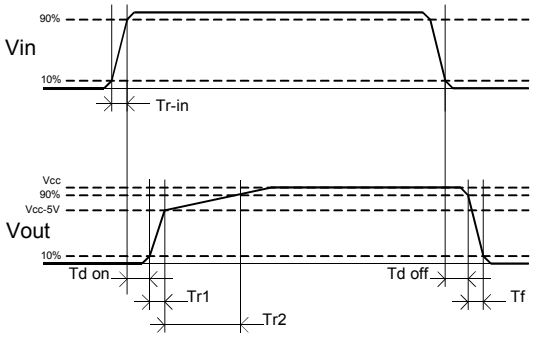



**Figure 3 – Switching times definitions**

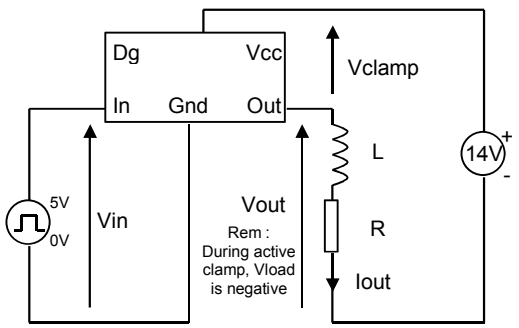



**Figure 4 – Active clamp test circuit**

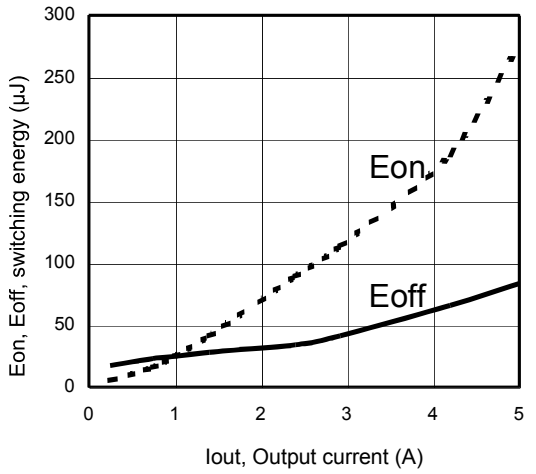



**Figure 5 – Switching energy (µJ) Vs Output current (A)**

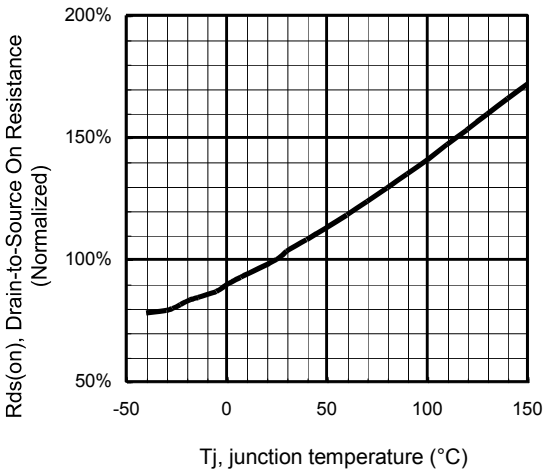



**Figure 6 - Normalized Rds(on) (%) Vs Tj (°C)**

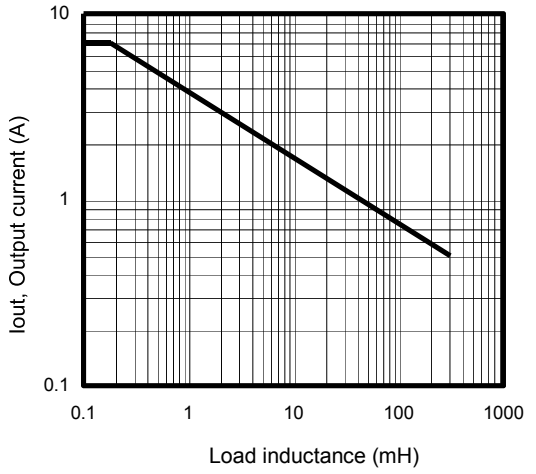



**Figure 7 – Max. Output current (A) Vs Load inductance (mH)**

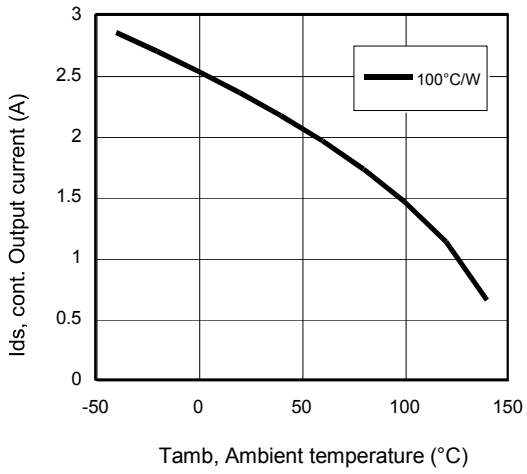



**Figure 8 – Max. ouput current (A) Vs Ambient temperature (°C)**

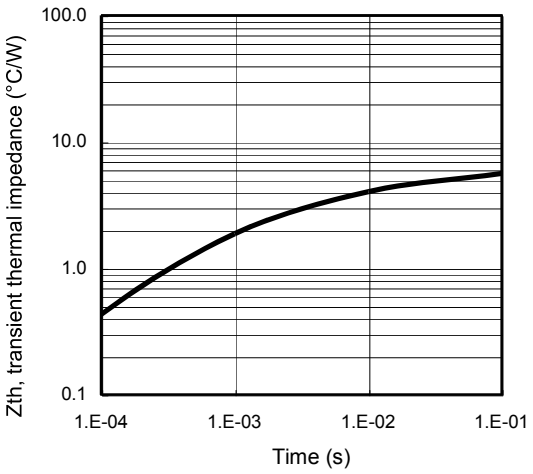



**Figure 9 – Transient thermal impedance (°C/W) Vs time (s)**

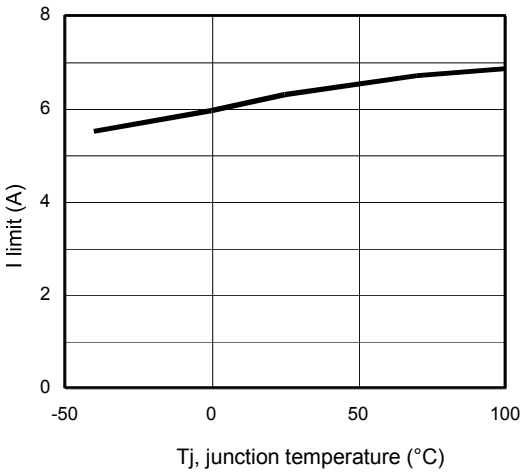



**Figure 10 –I limit (A) Vs junction temperature (°C)**

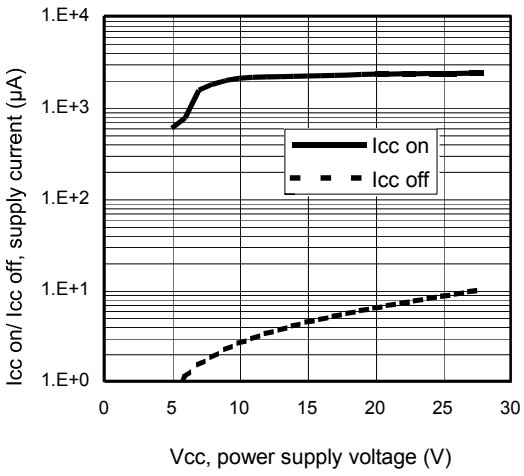



**Figure 11 – Icc on/ Icc off (µA) Vs Vcc (V)***

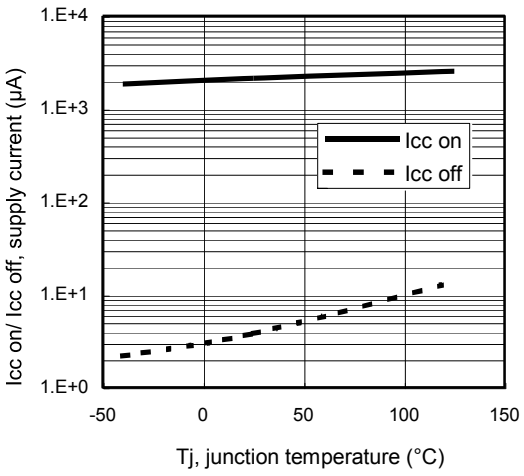
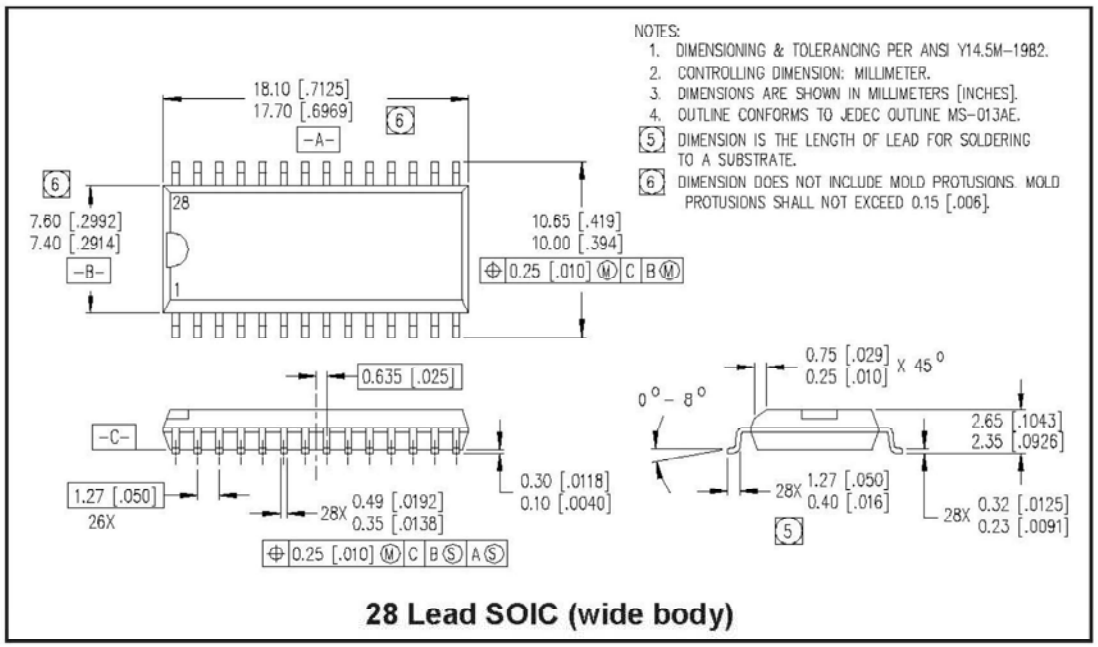



**Figure 12 – Icc on/ Icc off (µA) Vs Tj (°C)***

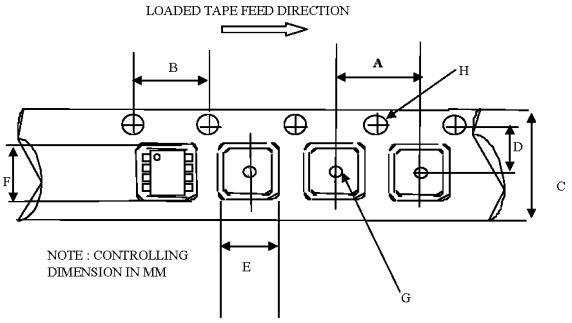
*Vout connected to ground with R<4Ω

## Case Outline – SO28



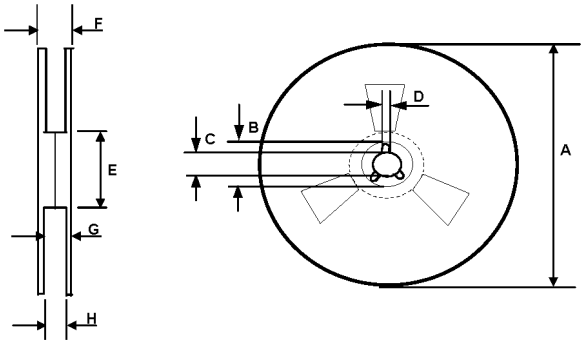

**28 Lead SOIC (wide body)**

## Tape & Reel – SO28




CARRIER TAPE DIMENSION FOR 28SOICW

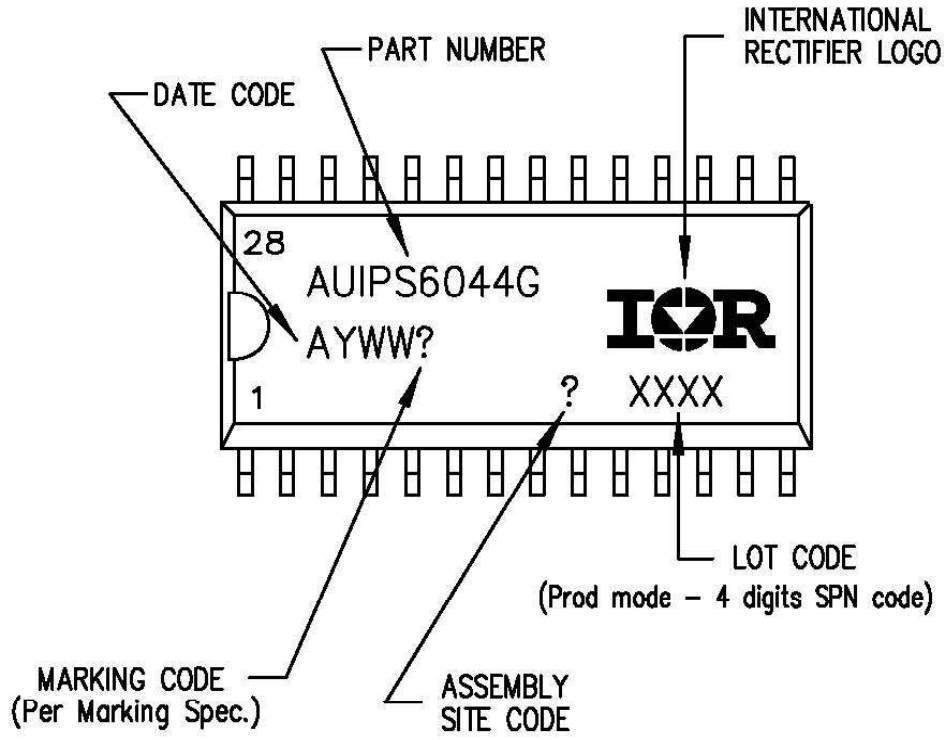
| Code | Metric | | Imperial | |
|---|---|---|---|---|
| | Min | Max | Min | Max |
| A | 11.90 | 12.10 | 0.468 | 0.476 |
| B | 3.90 | 4.10 | 0.153 | 0.161 |
| C | 23.70 | 24.30 | 0.933 | 0.956 |
| D | 11.40 | 11.60 | 0.448 | 0.456 |
| E | 10.80 | 11.00 | 0.425 | 0.433 |
| F | 18.20 | 18.40 | 0.716 | 0.724 |
| G | 1.50 | n/a | 0.059 | n/a |
| H | 1.50 | 1.60 | 0.059 | 0.062 |




REEL DIMENSIONS FOR 28SOICW

| Code | Metric | | Imperial | |
|---|---|---|---|---|
| | Min | Max | Min | Max |
| A | 329.60 | 330.25 | 12.976 | 13.001 |
| B | 20.95 | 21.45 | 0.824 | 0.844 |
| C | 12.80 | 13.20 | 0.503 | 0.519 |
| D | 1.95 | 2.45 | 0.767 | 0.096 |
| E | 98.00 | 102.00 | 3.858 | 4.015 |
| F | n/a | 30.40 | n/a | 1.196 |
| G | 26.50 | 29.10 | 1.04 | 1.145 |
| H | 24.40 | 26.40 | 0.96 | 1.039 |

## Part Marking Information




## Ordering Information

| Base Part Number | Package Type | Standard Pack | | Complete Part Number |
|---|---|---|---|---|
| | | Form | Quantity | |
| AUIPS6044G | SOIC-28 | Tube | 30 | AUIPS6044G |
| | | Tape and reel | 1000 | AUIPS6044GTR |

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

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Tel: (310) 252-7105

## Revision History

| Revision | Date | Notes/Changes |
|---|---|---|
| B2 | September, 12th 2011 | AU release |
| B3 | December, 10th 2011 | Update qualification page |
| C | May 15, 2012 | Add the test condition for the ICC (off) parameters |
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