

## INTELLIGENT POWER HIGH SIDE SWITCH

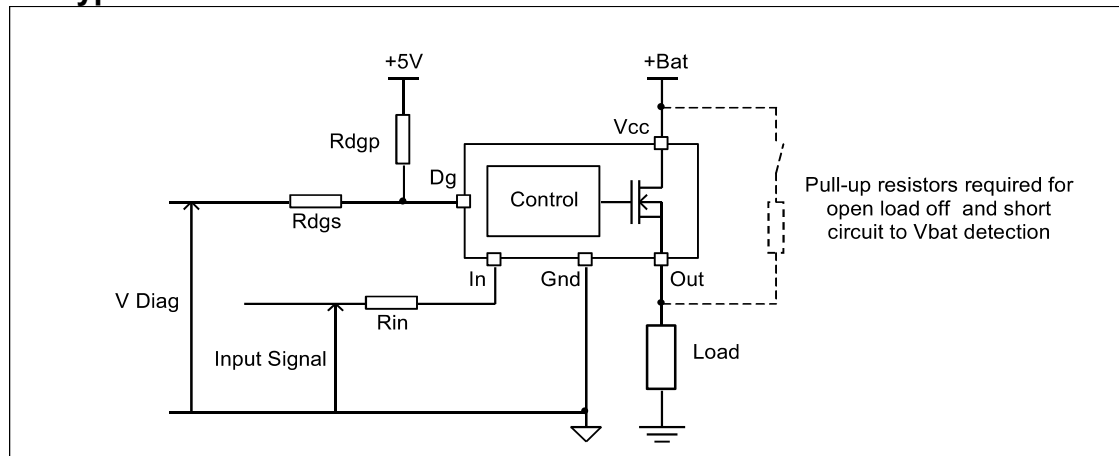
### Features

- 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

### 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



### Product Summary

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

### Package



SOIC28 Wide body

## Qualification Information<sup>†</sup>

|                                   |                      |                                                                                                                                                                               |                                          |
|-----------------------------------|----------------------|-------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|------------------------------------------|
| <b>Qualification Level</b>        |                      | Automotive<br>(per AEC-Q100 <sup>††</sup> )                                                                                                                                   |                                          |
|                                   |                      | 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> |                      | SOIC-28L                                                                                                                                                                      | MSL2, 260°C<br>(per IPC/JEDEC J-STD-020) |
| <b>ESD</b>                        | Machine Model        | Class <b>M2</b> (+/-150V) <sup>†††</sup><br>(per AEC-Q100-003)                                                                                                                |                                          |
|                                   | Human Body Model     | Class <b>H1C</b> (+/-1500V) <sup>†††</sup><br>(per AEC-Q100-002)                                                                                                              |                                          |
|                                   | Charged Device Model | Class <b>C4</b> (+/-900V) <sup>†††</sup><br>(per AEC-Q100-011)                                                                                                                |                                          |
| <b>IC Latch-Up Test</b>           |                      | Class <b>II</b> , Level <b>A</b><br>(per AEC-Q100-004)                                                                                                                        |                                          |
| <b>RoHS Compliant</b>             |                      | Yes                                                                                                                                                                           |                                          |

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

<sup>††</sup> Exceptions to AEC-Q100 requirements are noted in the qualification report.

<sup>†††</sup> 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    |
| Ildg 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        | A     |
| VIL    | Low level input voltage                                                                                                                     | 0    | 0.9        |       |
| Iout   | Continuous drain current, Rth=130°C/W, Tj=150°C, 4 channels On<br>Tambient=85°C / 1" sqrt. footprint<br>Tambient=105°C / 1" sqrt. footprint | —    | 1.5<br>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        | kHz   |
| F max. | Max. switching frequency                                                                                                                    | —    | 3.5        |       |

## Static Electrical Characteristics

T<sub>j</sub>=-40°C..150°C, V<sub>cc</sub>=6..28V (unless otherwise specified), typical values are given for V<sub>cc</sub>=14V and T<sub>j</sub>=25°C

| Symbol               | Parameter                                                                  | Min. | Typ. | Max. | Units | Test Conditions                                                                       |
|----------------------|----------------------------------------------------------------------------|------|------|------|-------|---------------------------------------------------------------------------------------|
| R <sub>ds(on)</sub>  | ON state resistance T <sub>j</sub> =25°C                                   | —    | 110  | 130  | mΩ    | V <sub>in</sub> =5V, I <sub>out</sub> =2.5A                                           |
|                      | ON state resistance T <sub>j</sub> =150°C(1)                               | —    | 190  | 230  |       | V <sub>in</sub> =5V, I <sub>out</sub> =2.5A                                           |
|                      | ON state resistance T <sub>j</sub> =25°C, V <sub>cc</sub> =6V              | —    | 125  | 155  |       | V <sub>in</sub> =5V, I <sub>out</sub> =1.5A                                           |
|                      | ON state resistance during reverse battery T <sub>j</sub> =25°C            | —    | 140  | 180  |       | V <sub>cc</sub> -Gnd=-14V                                                             |
| V <sub>cc op.</sub>  | Operating voltage range                                                    | 6    | —    | 28   | V     |                                                                                       |
| V clamp 1            | V <sub>cc</sub> to Out clamp voltage 1                                     | 37   | 39   | —    |       | I <sub>out</sub> =20mA                                                                |
| V clamp 2            | V <sub>cc</sub> to Out clamp voltage 2                                     | —    | 40   | —    |       | I <sub>out</sub> =2.5A (see Fig. 1)                                                   |
| I <sub>cc Off</sub>  | Supply current when Off and V <sub>out</sub> connected to ground with R<4Ω | —    | 4    | 9    | μA    | V <sub>in</sub> =0V, V <sub>out</sub> =0V, T <sub>j</sub> =25°C, V <sub>cc</sub> =14V |
| I <sub>cc On</sub>   | Supply current when On                                                     | —    | 2.2  | 5    | mA    | V <sub>in</sub> =5V, V <sub>cc</sub> =14V                                             |
| V <sub>ih</sub>      | Input high threshold voltage                                               | —    | 2.5  | 3    | V     |                                                                                       |
| V <sub>il</sub>      | Input low threshold voltage                                                | 1.5  | 2    | —    |       |                                                                                       |
| I <sub>n hyst.</sub> | Input hysteresis                                                           | 0.2  | 0.5  | 1    |       |                                                                                       |
| I <sub>in On</sub>   | Input current when device is On                                            | —    | 40   | 100  | μA    | V <sub>in</sub> =5V                                                                   |
| I <sub>dg</sub>      | D <sub>g</sub> leakage current                                             | —    | 0.1  | 10   |       | V <sub>dg</sub> =5V                                                                   |
| V <sub>dg</sub>      | Low level DG voltage                                                       | —    | 0.25 | 0.4  | V     | I <sub>dg</sub> =1.6mA                                                                |

## Switching Electrical Characteristics

V<sub>cc</sub>=14V, Resistive load=6Ω, V<sub>in</sub>=5V, T<sub>j</sub>=-40°C..150°C, typical values are given for T<sub>j</sub>=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

T<sub>j</sub>=-40°C..150°C, V<sub>cc</sub>=6..28V (unless otherwise specified), typical values are given for V<sub>cc</sub>=14V and T<sub>j</sub>=25°C

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

(1) Guaranteed by design

(2) Reference to V<sub>cc</sub>

## 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 V <sub>cc</sub>     | H  | H   | L (4) |
| Short circuit to V <sub>cc</sub> (5) | L  | H   | L     |
| Over-temperature                     | H  | L   | L     |
| Over-temperature                     | L  | L   | H     |

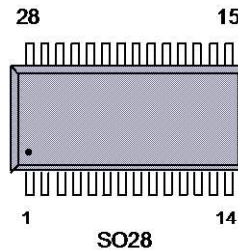
(3) With a pull-up resistor connected between the output and V<sub>cc</sub>.

(4) V<sub>ds</sub> lower than 10mV.

(5) Without a pull-up resistor connected between the output and V<sub>cc</sub>.

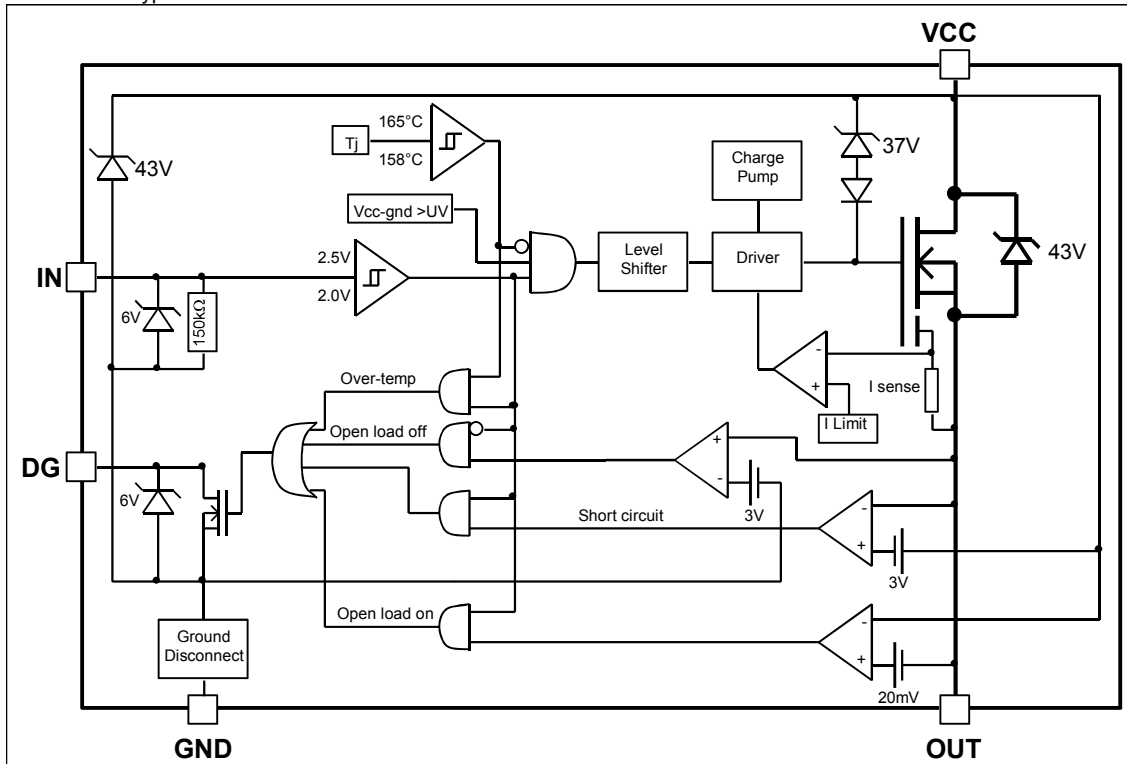
## Lead Assignments

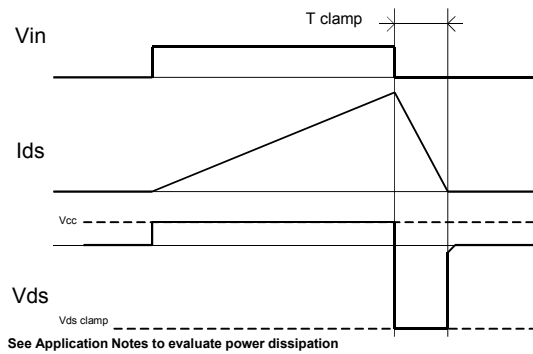
|          |          |
|----------|----------|
| 1- Vcc   | 15- Vcc  |
| 2- GND1  | 16- OUT4 |
| 3- IN1   | 17- OUT4 |
| 4- DG1   | 18- OUT4 |
| 5- DG2   | 19- OUT3 |
| 6- IN2   | 20- OUT3 |
| 7- GND2  | 21- OUT3 |
| 8- GND3  | 22- OUT2 |
| 9- IN3   | 23- OUT2 |
| 10- DG3  | 24- OUT2 |
| 11- DG4  |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



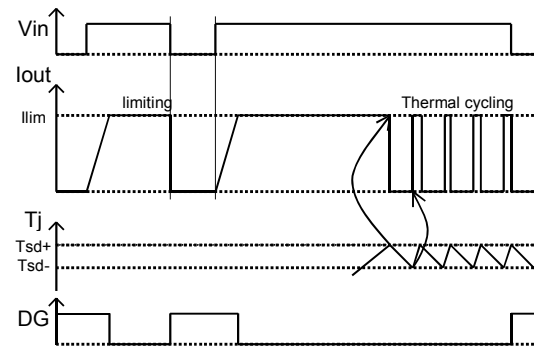
## Functional Block Diagram

All values are typical

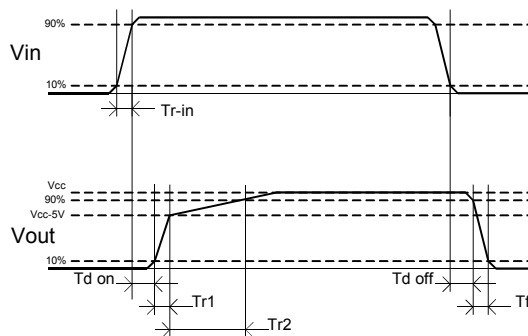




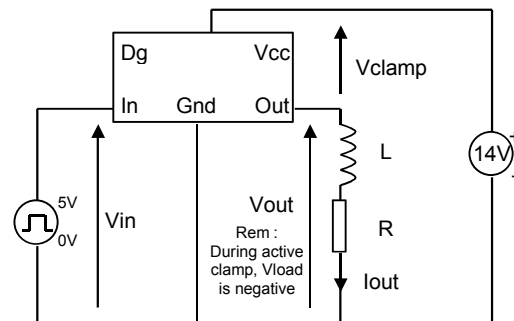
**Figure 1 – Active clamp waveforms**



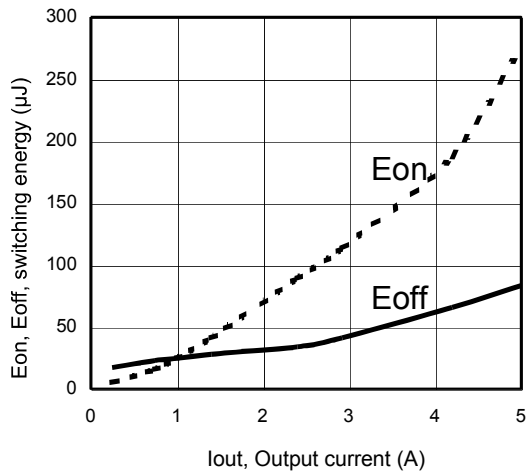
**Figure 2 – Protection timing diagram**



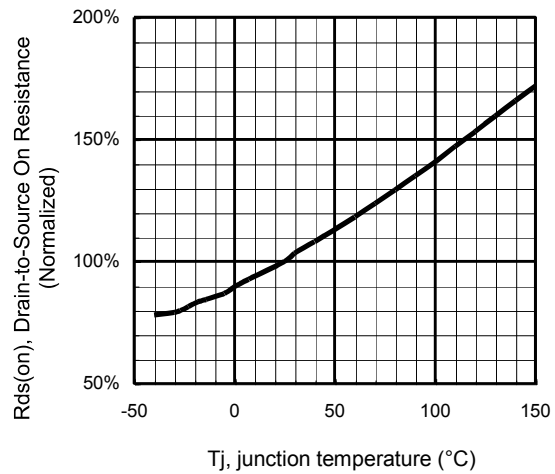
**Figure 3 – Switching times definitions**



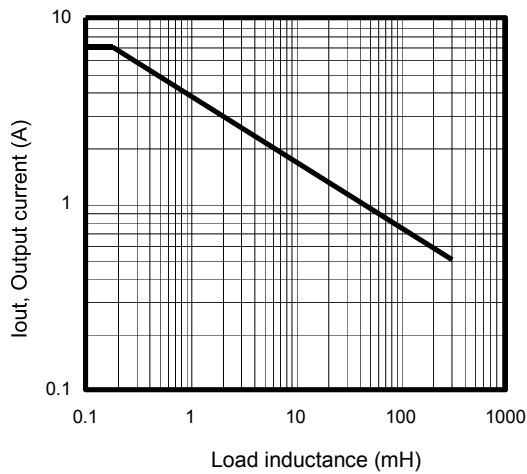
**Figure 4 – Active clamp test circuit**



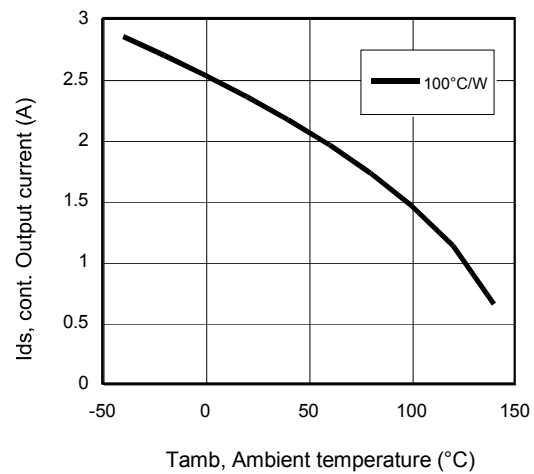
**Figure 5 – Switching energy (μJ) Vs Output current (A)**



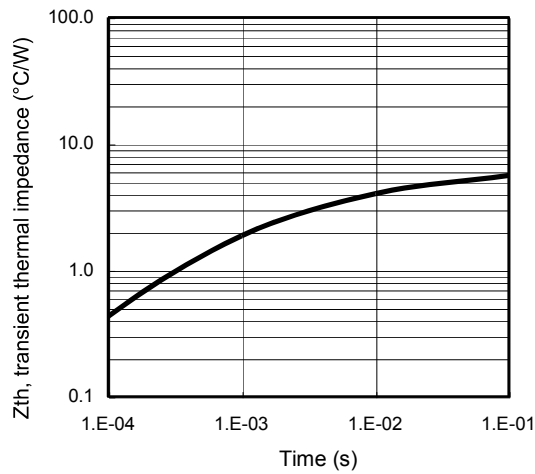
**Figure 6 - Normalized Rds(on) (%) Vs Tj (°C)**



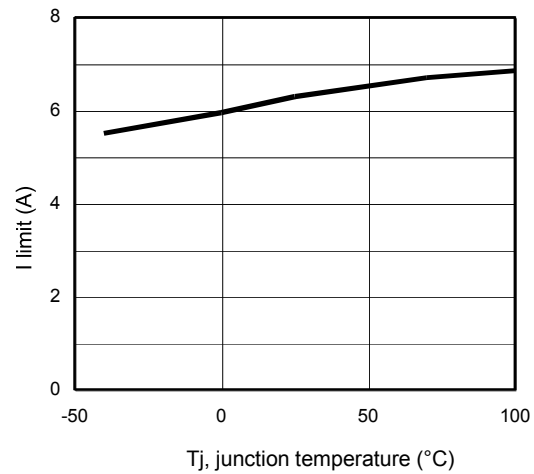
**Figure 7 – Max. Output current (A) Vs Load inductance (mH)**



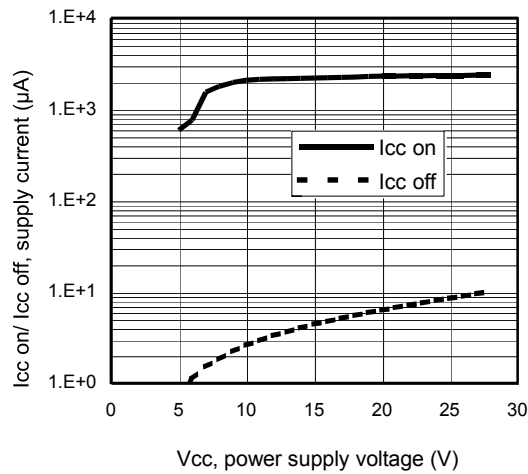
**Figure 8 – Max. output current (A) Vs Ambient temperature (°C)**



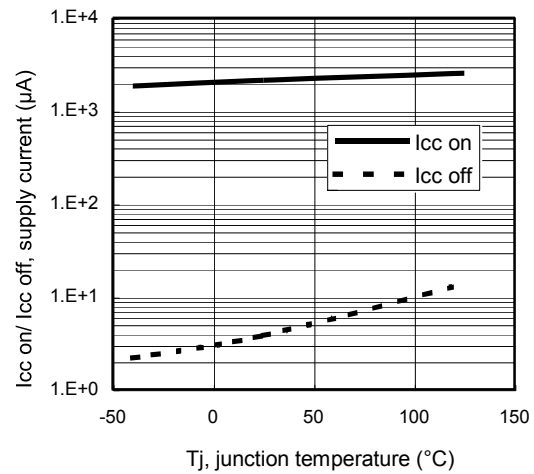
**Figure 9 – Transient thermal impedance (°C/W)  
Vs time (s)**



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



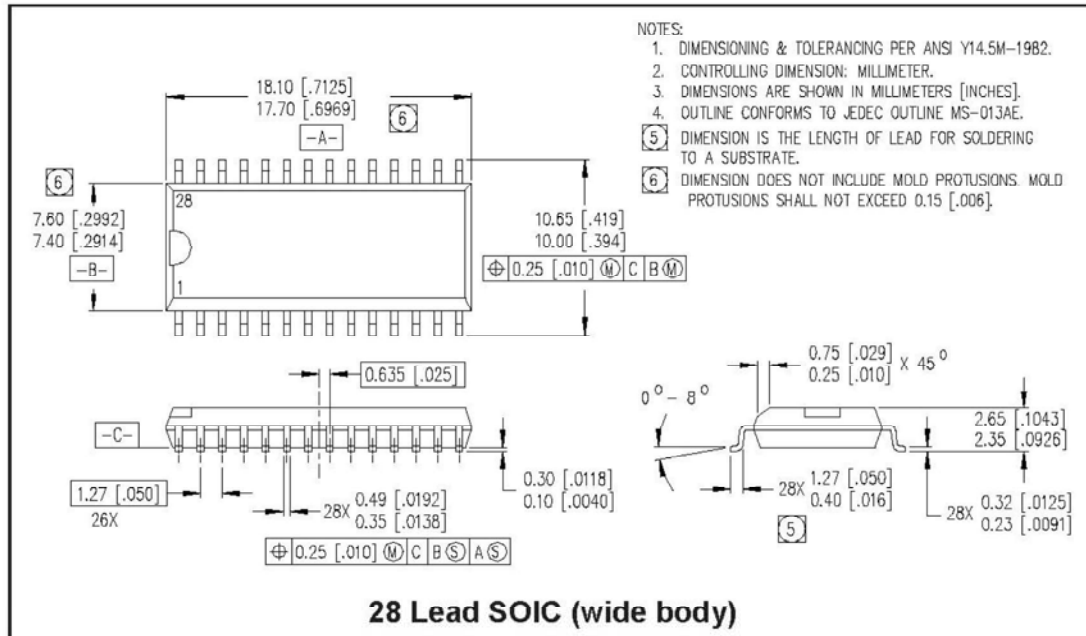
**Figure 11 – Icc on/ Icc off (µA) Vs Vcc (V)\***



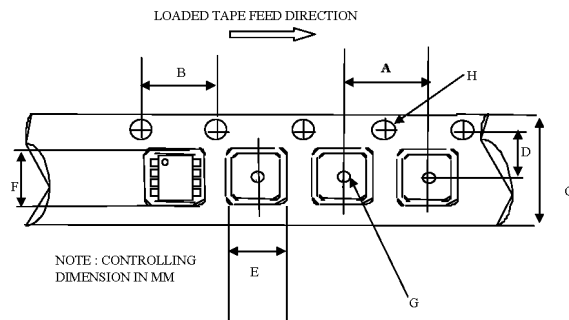
**Figure 12 – Icc on/ Icc off (µA) Vs Tj (°C)\***

\*Vout connected to ground with R<4Ω

**Case Outline – SO28**

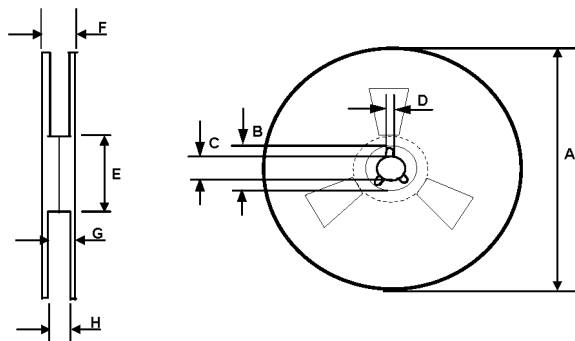


## Tape & Reel – SO28



CARRIER TAPE DIMENSION FOR 28SOICW

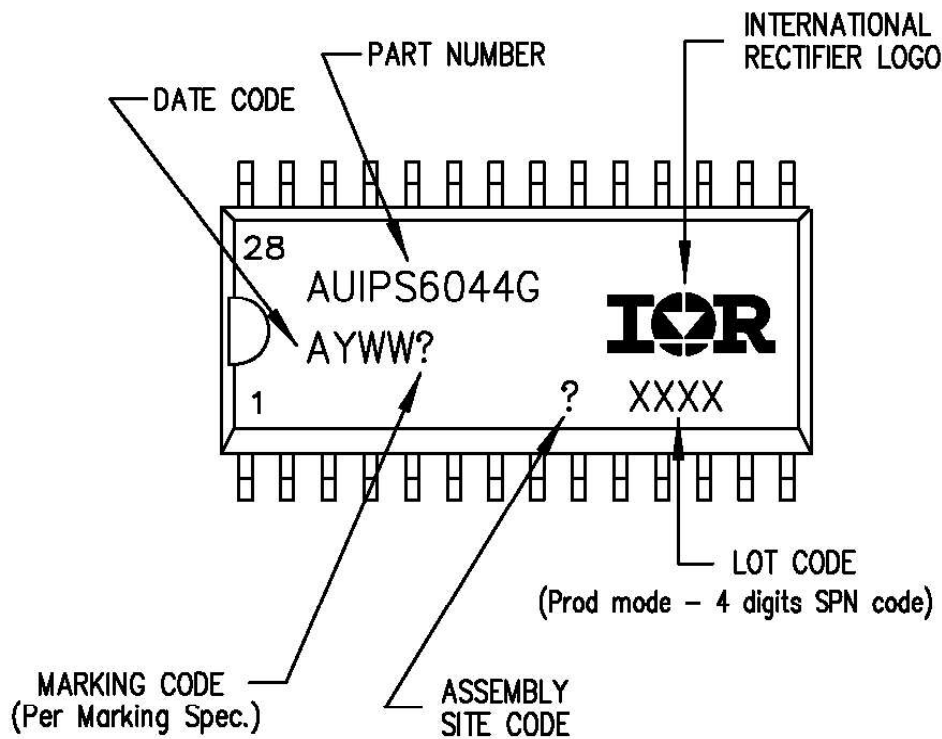
| Code | Metric |       | Imperial |       |
|------|--------|-------|----------|-------|
|      | Min    | Max   | Min      | Max   |
| A    | 11.90  | 12.10 | 0.468    | 0.476 |
| B    | 3.90   | 4.10  | 0.153    | 0.161 |
| C    | 23.70  | 24.30 | 0.933    | 0.956 |
| D    | 11.40  | 11.60 | 0.448    | 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         |

## **IMPORTANT NOTICE**

Unless specifically designated for the automotive market, International Rectifier Corporation and its subsidiaries (IR) reserve the right to make corrections, modifications, enhancements, improvements, and other changes to its products and services at any time and to discontinue any product or services without notice. Part numbers designated with the "AU" prefix follow automotive industry and / or customer specific requirements with regards to product discontinuance and process change notification. All products are sold subject to IR's terms and conditions of sale supplied at the time of order acknowledgment.

IR warrants performance of its hardware products to the specifications applicable at the time of sale in accordance with IR's standard warranty. Testing and other quality control techniques are used to the extent IR deems necessary to support this warranty. Except where mandated by government requirements, testing of all parameters of each product is not necessarily performed.

IR assumes no liability for applications assistance or customer product design. Customers are responsible for their products and applications using IR components. To minimize the risks with customer products and applications, customers should provide adequate design and operating safeguards.

Reproduction of IR information in IR data books or data sheets is permissible only if reproduction is without alteration and is accompanied by all associated warranties, conditions, limitations, and notices. Reproduction of this information with alterations is an unfair and deceptive business practice. IR is not responsible or liable for such altered documentation. Information of third parties may be subject to additional restrictions.

Resale of IR products or serviced with statements different from or beyond the parameters stated by IR for that product or service voids all express and any implied warranties for the associated IR product or service and is an unfair and deceptive business practice. IR is not responsible or liable for any such statements.

IR products are not designed, intended, or authorized for use as components in systems intended for surgical implant into the body, or in other applications intended to support or sustain life, or in any other application in which the failure of the IR product could create a situation where personal injury or death may occur. Should Buyer purchase or use IR products for any such unintended or unauthorized application, Buyer shall indemnify and hold International Rectifier and its officers, employees, subsidiaries, affiliates, and distributors harmless against all claims, costs, damages, and expenses, and reasonable attorney fees arising out of, directly or indirectly, any claim of personal injury or death associated with such unintended or unauthorized use, even if such claim alleges that IR was negligent regarding the design or manufacture of the product.

IR products are neither designed nor intended for use in military/aerospace applications or environments unless the IR products are specifically designated by IR as military-grade or "enhanced plastic." Only products designated by IR as military-grade meet military specifications. Buyers acknowledge and agree that any such use of IR products which IR has not designated as military-grade is solely at the Buyer's risk, and that they are solely responsible for compliance with all legal and regulatory requirements in connection with such use.

IR products are neither designed nor intended for use in automotive applications or environments unless the specific IR products are designated by IR as compliant with ISO/TS 16949 requirements and bear a part number including the designation "AU". Buyers acknowledge and agree that, if they use any non-designated products in automotive applications, IR will not be responsible for any failure to meet such requirements.

For technical support, please contact IR's Technical Assistance Center  
<http://www.irf.com/technical-info/>

**WORLD HEADQUARTERS:**

101 N Sepulbeda Blvd., El Segundo, California 90245  
Tel: (310) 252-7105

**Revision History**

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