

### INTELLIGENT POWER HIGH SIDE SWITCH

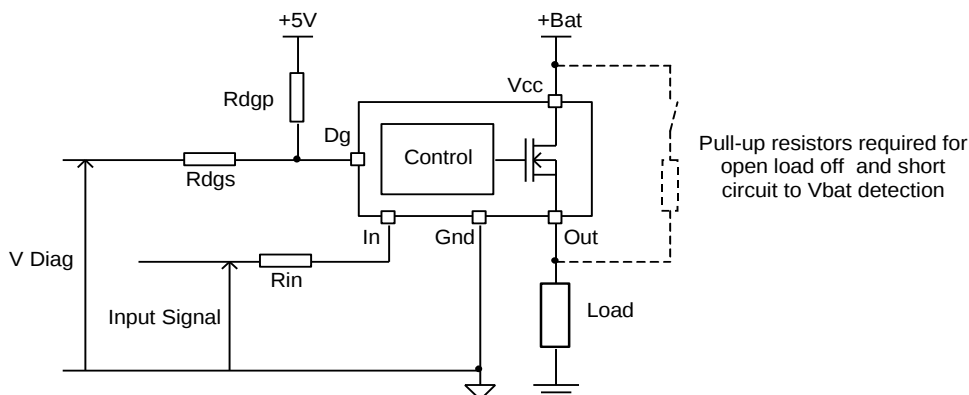
#### Features

- 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  $I_{lim}$  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  $T_{shutdown}$  value. It will automatically restart after the junction has cooled  $7^{\circ}\text{C}$  below the  $T_{shutdown}$  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

|              |                    |
|--------------|--------------------|
| $R_{ds(on)}$ | 130m $\Omega$ max. |
| $V_{clamp}$  | 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 (+/-150V)</b> <sup>†††</sup><br>(per AEC-Q100-003)                                                                                                                |                                          |
|                                   | Human Body Model     | Class <b>H1C (+/-1500V)</b> <sup>†††</sup><br>(per AEC-Q100-002)                                                                                                              |                                          |
|                                   | Charged Device Model | Class <b>C4 (+/-900V)</b> <sup>†††</sup><br>(per AEC-Q100-011)                                                                                                                |                                          |
| <b>IC Latch-Up Test</b>           |                      | Class II, Level A<br>(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.

††† 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    |
| I <sub>dg</sub> max. | Maximum diagnostic output current                                                               | -3     | 10      |       |
| V <sub>dg</sub>      | 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<br>Tambient=85°C / 1" sqrt. footprint<br>Tambient=105°C / 1" sqrt. footprint | —<br>— | 1.5<br>1.2 | A     |
| Rin    | Recommended resistor in series with IN pin                                                                                                  | 4      | 10         |       |
| Rdgs   | Recommended resistor in series with DG pin for reverse battery protection                                                                   | 4      | 20         | kΩ    |
| 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

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>      | Dg 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 |
|-------------------|------------------------------------------------------|------|------|------|-------|-----------------|
| T <sub>don</sub>  | Turn-on delay time                                   | —    | 5    | 15   | μs    | see Fig. 3      |
| Tr1               | Rise time to V <sub>out</sub> =V <sub>cc</sub> -5V   | —    | 3    | 10   |       |                 |
| Tr2               | Rise time to V <sub>out</sub> =0.9 x V <sub>cc</sub> | —    | 4    | 30   |       |                 |
| dV/dt (On)        | Turn On dV/dt                                        | —    | 2.5  | —    | V/μs  |                 |
| E <sub>On</sub>   | Turn On energy                                       | —    | 100  | —    | μJ    |                 |
| T <sub>doff</sub> | Turn-off delay time                                  | —    | 10   | 20   | μs    |                 |
| T <sub>f</sub>    | Fall time to V <sub>out</sub> =0.1 x V <sub>cc</sub> | —    | 3    | 10   | μs    |                 |
| dV/dt (Off)       | Turn Off dV/dt                                       | —    | 6.5  | —    | V/μs  |                 |
| E <sub>Off</sub>  | 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  | —    |       |                                              |
| 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  |       |                                              |
| UV-                | Under voltage protection V <sub>cc</sub> going down | —      | 4.5  | 5.8  |       |                                              |
| VOL Off            | Open load detection threshold                       | 2      | 3    | 4    |       |                                              |
| 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 |       | 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     |

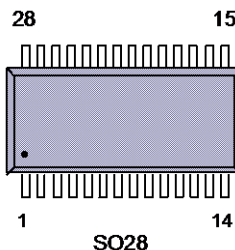
(3) With a pull-up resistor connected between the output and V<sub>cc</sub>.

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

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

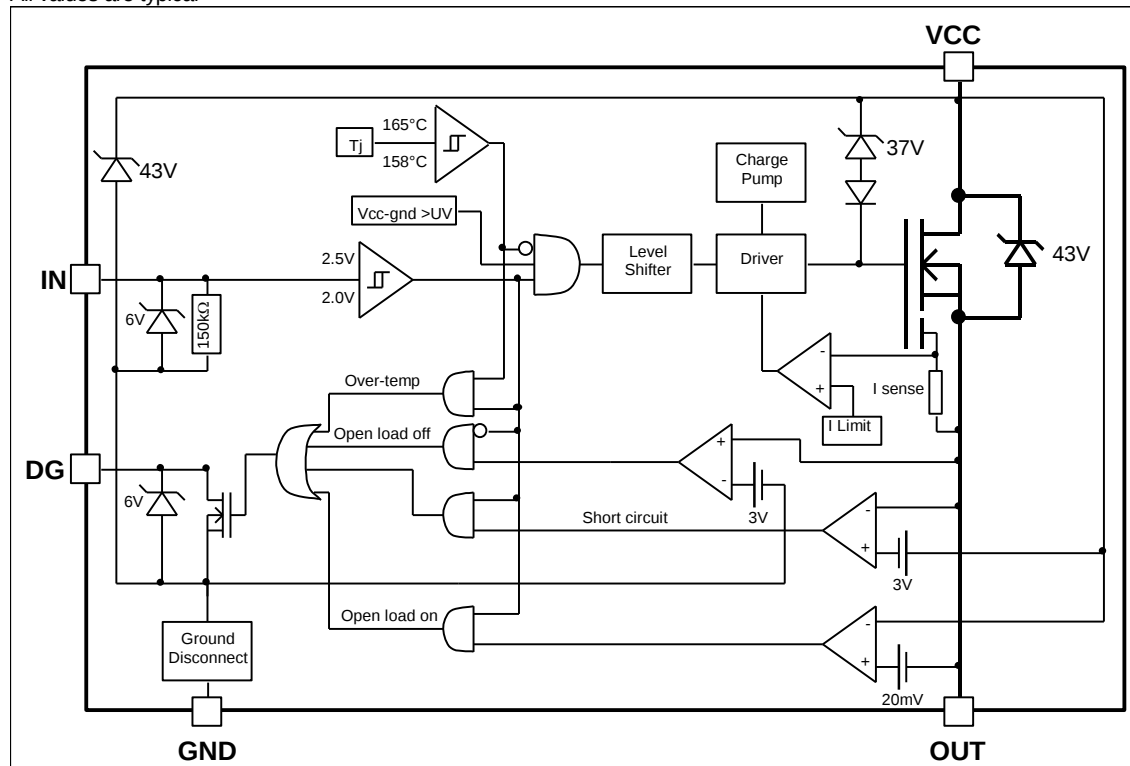
## Lead Assignments

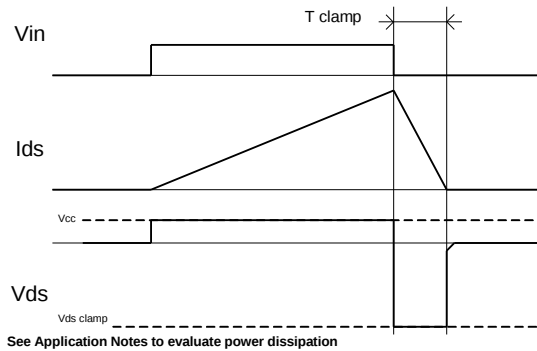
|          |          |
|----------|----------|
| 1- Vcc   | 15- Vcc  |
| 2- GND1  | 16- OUT4 |
| 3- IN1   | 17- OUT4 |
| 4- DG1   | 18- OUT4 |
| 5- DG2   | 19- OUT3 |
| 6- IN2   | 20- OUT3 |
| 7- GND2  | 21- OUT3 |
| 8- GND3  | 22- OUT2 |
| 9- IN3   | 23- OUT2 |
| 10- DG3  | 24- OUT2 |
| 11- DG4  |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



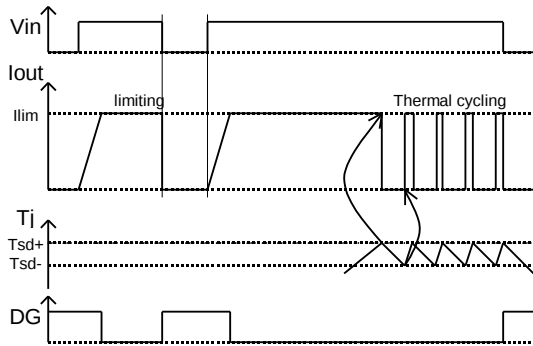
## Functional Block Diagram

All values are typical

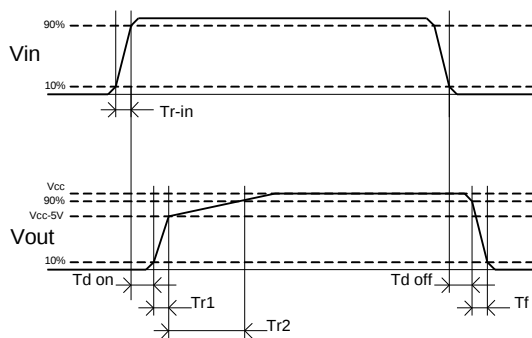




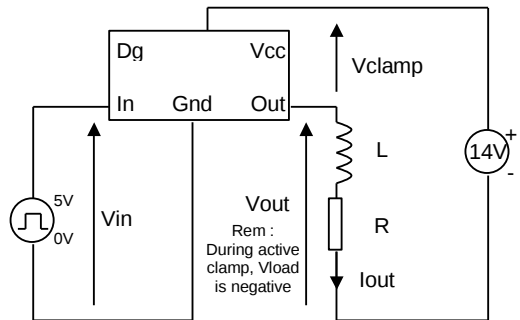
**Figure 1 – Active clamp waveforms**



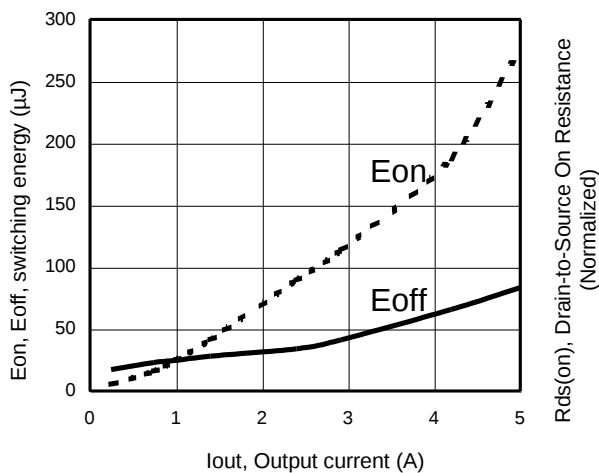
**Figure 2 – Protection timing diagram**



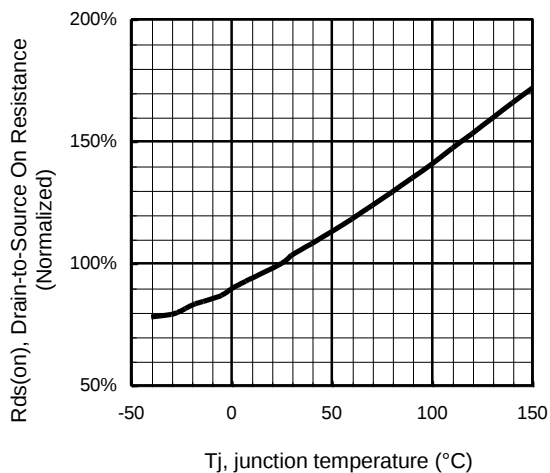
**Figure 3 – Switching times definitions**



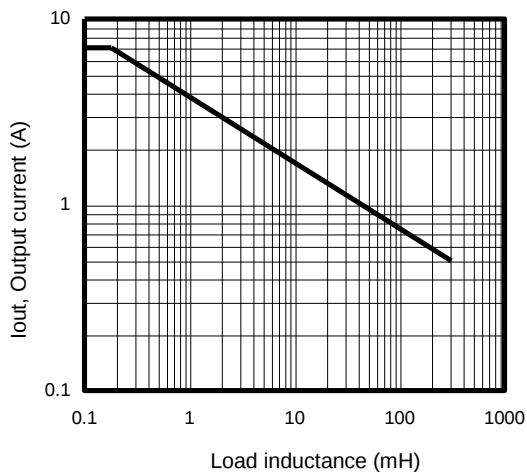
**Figure 4 – Active clamp test circuit**



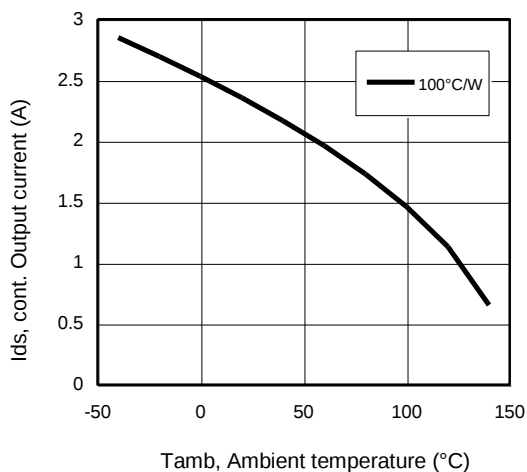
**Figure 5 – Switching energy (μJ) Vs Output current (A)**



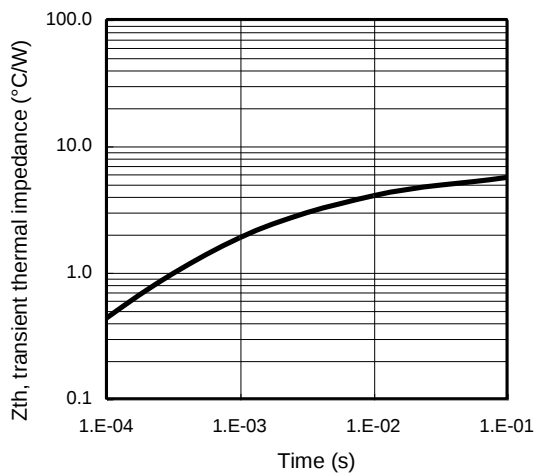
**Figure 6 - Normalized Rds(on) (%) Vs Tj (°C)**



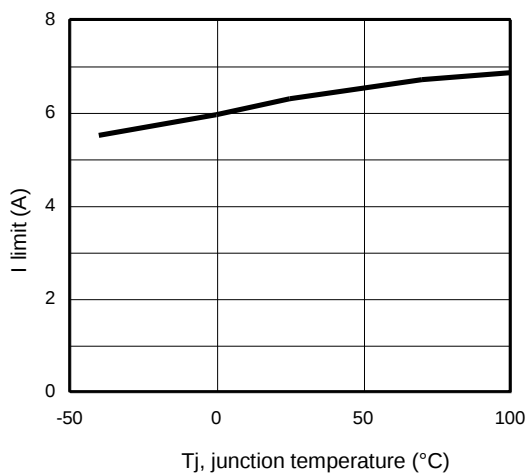
**Figure 7 – Max. Output current (A) Vs Load inductance (mH)**



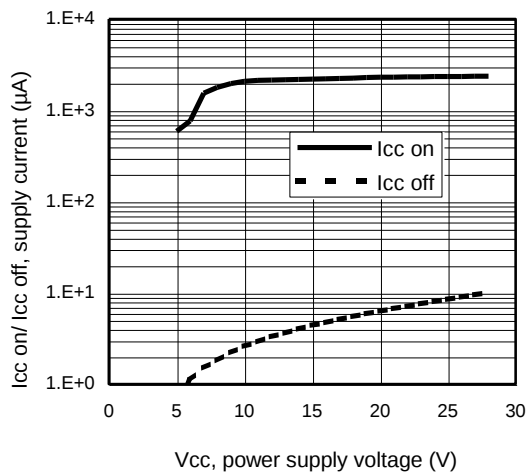
**Figure 8 – Max. output current (A) Vs Ambient temperature (°C)**



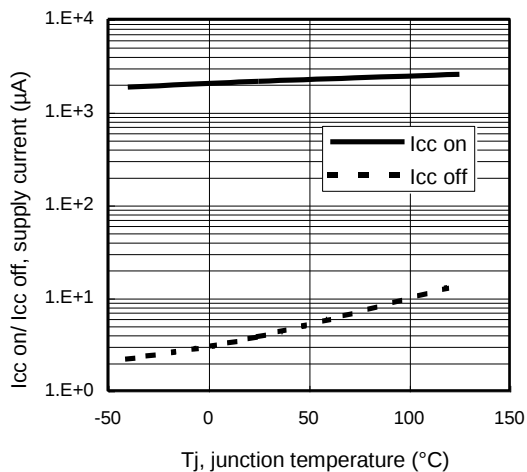
**Figure 9 – Transient thermal impedance (°C/W)  
Vs time (s)**



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



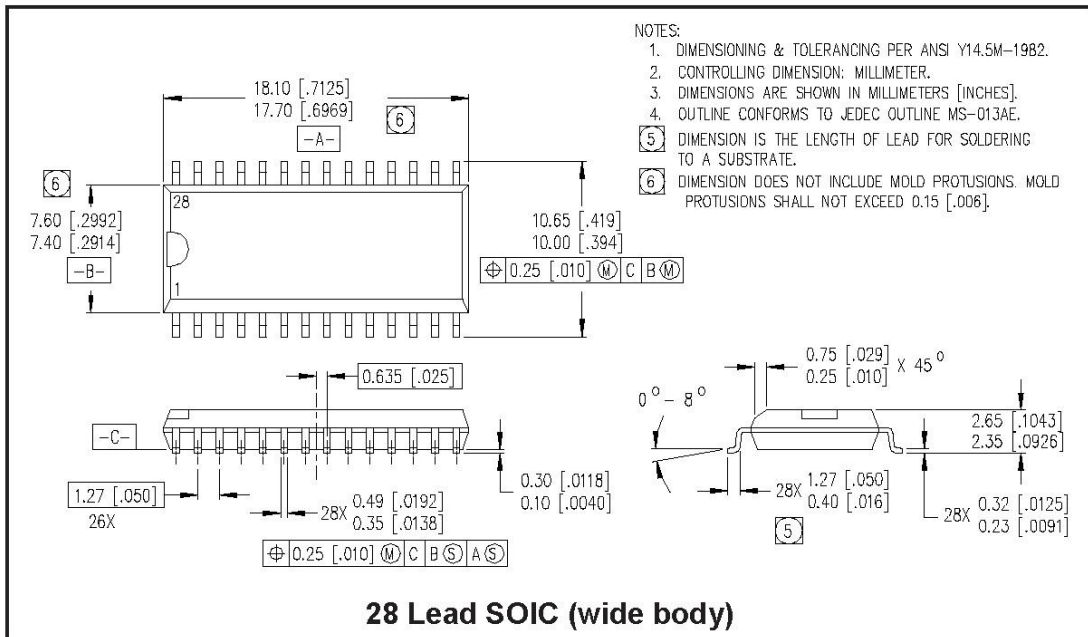
**Figure 11 – I<sub>cc on</sub>/ I<sub>cc off</sub> (µA) Vs V<sub>cc</sub> (V)\***



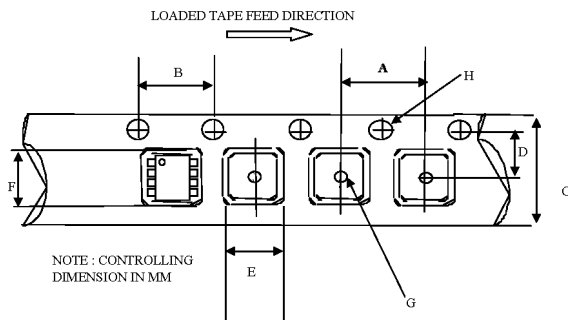
**Figure 12 – I<sub>cc on</sub>/ I<sub>cc off</sub> (µA) Vs T<sub>j</sub> (°C)\***

\*V<sub>out</sub> connected to ground with R<4Ω

## Case Outline – SO28

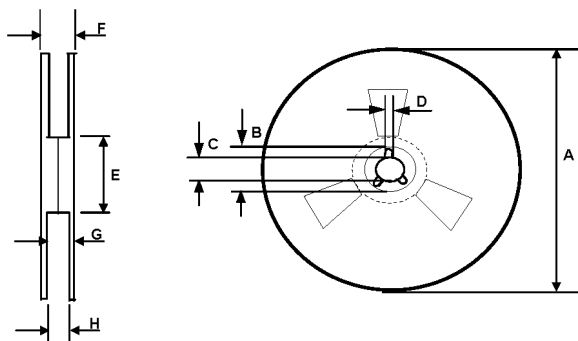


## Tape & Reel – SO28



CARRIER TAPE DIMENSION FOR 28SOICW

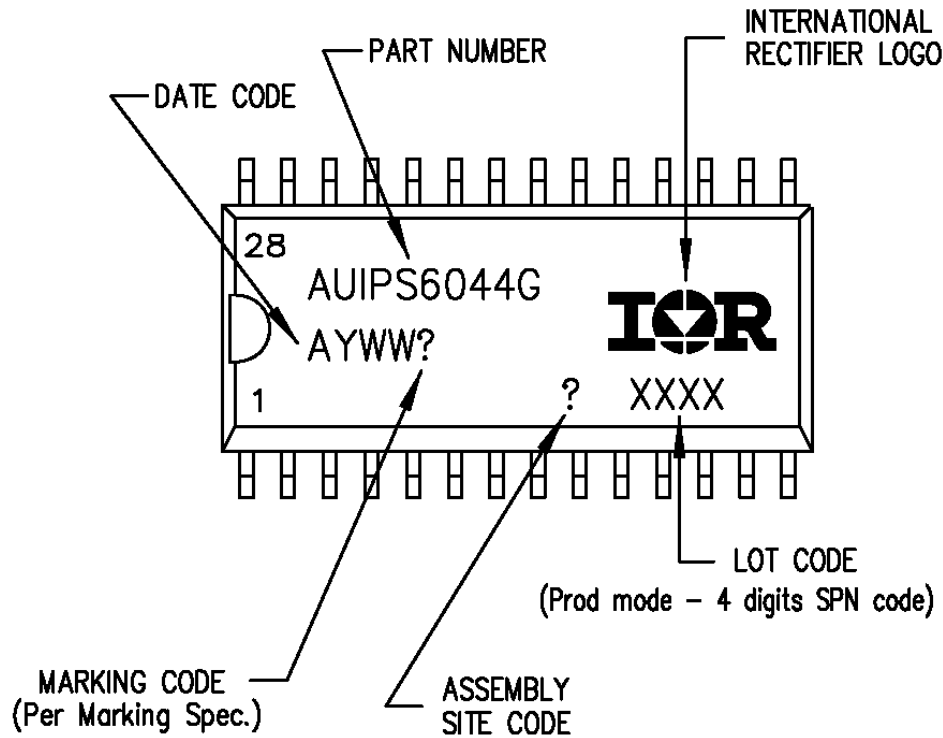
| Code | Metric |       | Imperial |       |
|------|--------|-------|----------|-------|
|      | Min    | Max   | Min      | Max   |
| A    | 11.90  | 12.10 | 0.468    | 0.476 |
| B    | 3.90   | 4.10  | 0.153    | 0.161 |
| C    | 23.70  | 24.30 | 0.933    | 0.956 |
| D    | 11.40  | 11.60 | 0.448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

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## Revision History

| Revision | Date                            | Notes/Changes                                       |
|----------|---------------------------------|-----------------------------------------------------|
| 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 |
|          |                                 |                                                     |
|          |                                 |                                                     |
|          |                                 |                                                     |
|          |                                 |                                                     |
|          |                                 |                                                     |
|          |                                 |                                                     |