

# AUIPS1041(L)(R)/AUIPS1042G

## SINGLE/DUAL CHANNEL INTELLIGENT POWER LOW SIDE SWITCH

### Features

- Over temperature shutdown
- Over current shutdown
- Active clamp
- Low current & logic level input
- ESD protection
- Optimized Turn On/Off for EMI
- Diagnostic on the input current

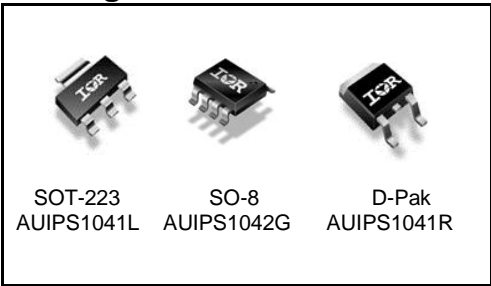
### Description

The AUIPS1041(L)(R) and AUIPS1042G are three terminal Intelligent Power Switches (IPS) featuring low side MOSFETs with over-current, over-temperature, ESD protection and drain to source active clamp. The AUIPS1042G is a dual channel device while the AUIPS1041 is a single channel. These devices offer protections and the high reliability required in harsh environments. Each switch provides efficient protection by turning OFF the power MOSFET when the temperature exceeds 165°C or when the drain current reaches 4.5A. The device restarts once the input is cycled. A serial resistance connected to the input provides the diagnostic. The avalanche capability is significantly enhanced by the active clamp and covers most inductive load demagnetizations.

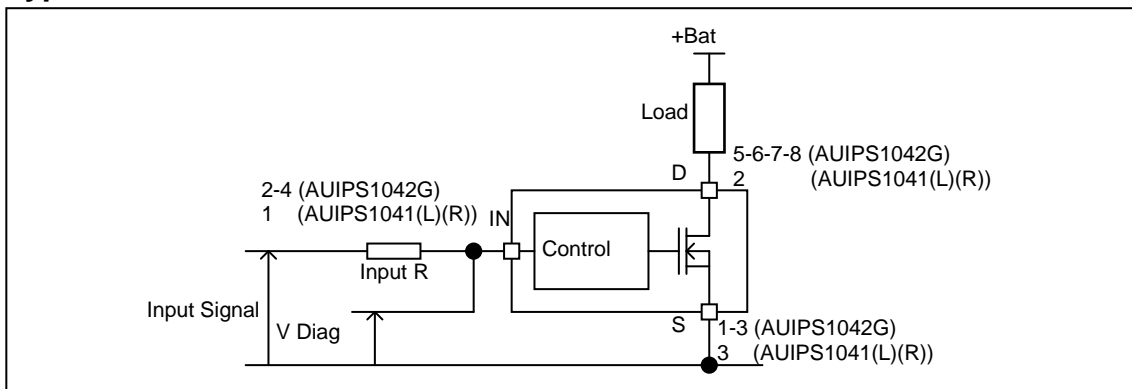
### Product Summary

|           |              |
|-----------|--------------|
| Rds(on)   | 100mΩ (max.) |
| Vclamp    | 39V          |
| Ishutdown | 4.5A (typ.)  |

### Packages



### Typical Connection



## Qualification Information†

|                                   |                      |   |  |
|-----------------------------------|----------------------|---|--|
| <b>Qualification Level</b>        |                      | Automotive<br>(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. |  |
| <b>Moisture Sensitivity Level</b> |                      | DPAK-3L   | MSL1, 260°C<br>(per IPC/JEDEC J-STD-020) |
|                                   |                      | SOT223-3L   | MSL2, 260°C<br>(per IPC/JEDEC J-STD-020) |
|                                   |                      | 8L-SOICN  | MSL2, 260°C<br>(per IPC/JEDEC J-STD-020) |
| <b>ESD</b>                        | Machine Model        | Class M4 (+/-450V)<br>(per AEC-Q100-003)  |  |
|                                   | Human Body Model     | Class H2 (+/-2500V)<br>(per AEC-Q100-002)   |  |
|                                   | Charged Device Model | Class C4 (+/-1000V)<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.

## Absolute Maximum Ratings

Absolute maximum ratings indicate sustained limits beyond which damage to the device may occur. (T<sub>j</sub>= -40°C..150°C, V<sub>cc</sub>=6..36V unless otherwise specified).

| Symbol                | Parameter  | Min. | Max.      | Units |
|-----------------------|--|------|-----------|-------|
| V <sub>ds</sub>       | Maximum drain to source voltage  | -0.3 | 36        | V     |
| V <sub>ds cont</sub>  | Maximum continuous drain to source voltage   | -    | 28        | V     |
| V <sub>in</sub>       | Maximum input voltage  | -0.3 | 6         | V     |
| I <sub>sd cont.</sub> | Max diode continuous current (limited by thermal dissipation)  | —    | 1.5       | A     |
| P <sub>d</sub>        | Maximum power dissipation (internally limited by thermal protection)                                       |      |           |       |
|                       | R <sub>th</sub> =60°C/W AUIPS1041L 1" sqr. Footprint<br>R <sub>th</sub> =100°C/W AUIPS1042G std. footprint |      | 2<br>1.25 | W     |
| T <sub>j max.</sub>   | Max. storage & operating temperature junction temperature  | -40  | 150       | °C    |

## Thermal Characteristics

| Symbol           | Parameter   | Typ. | Max. | Units |
|------------------|---|------|------|-------|
| R <sub>th1</sub> | Thermal resistance junction to ambient AUIPS1041L SOT-223 std. footprint              | 100  | —    | °C/W  |
| R <sub>th2</sub> | Thermal resistance junction to ambient AUIPS1041L SOT-223 1" sqr. Footprint           | 60   | —    |       |
| R <sub>th1</sub> | Thermal resistance junction to ambient AUIPS1041R D-Pak std. footprint                | 70   | —    |       |
| R <sub>th2</sub> | Thermal resistance junction to case AUIPS1041R D-Pak                                  | 6    | —    |       |
| R <sub>th1</sub> | Thermal resistance junction to ambient AUIPS1042G SO-8 std. Footprint<br>1 die active | 100  | —    |       |
| R <sub>th1</sub> | Thermal resistance junction to ambient AUIPS1042G SO-8 std. footprint<br>2 die active | 130  | —    |       |

## 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 |
|-----------------|--|------|------|-------|
| V <sub>IH</sub> | High level input voltage   | 4.5  | 5.5  | V     |
| V <sub>IL</sub> | Low level input voltage  | 0    | 0.5  |       |
| I <sub>ds</sub> | Continuous drain current, T <sub>ambient</sub> =85°C, T <sub>j</sub> =125°C, V <sub>in</sub> =5V<br>R <sub>th</sub> =60°C/W AUIPS1041L 1" sqr. Footprint                 | —    | 1.95 | A     |
|                 | Continuous drain current, T <sub>ambient</sub> =85°C, T <sub>j</sub> =125°C, V <sub>in</sub> =5V<br>R <sub>th</sub> =50°C/W AUIPS1041R 1" sqr. Footprint                 | —    | 2.2  |       |
|                 | Continuous drain current, T <sub>ambient</sub> =85°C, T <sub>j</sub> =125°C, V <sub>in</sub> =5V<br>R <sub>th</sub> =100°C/W AUIPS1042G 1" sqr. Footprint - 1 die active | —    | 1.5  |       |
|                 | Continuous drain current, T <sub>ambient</sub> =85°C, T <sub>j</sub> =125°C, V <sub>in</sub> =5V<br>R <sub>th</sub> =130°C/W AUIPS1042G 1" sqr. Footprint - 2 die active | —    | 0.7  |       |
| R <sub>in</sub> | Recommended resistor in series with IN pin to generate a diagnostic  | 0.5  | 10   | kΩ    |
| Max L           | Max. recommended load inductance ( including line inductance ) (1)   | —    | 20   | μH    |
| Max. F          | Max. frequency   | —    | 2000 | Hz    |
| Max. t rise     | Max. input rising time   | —    | 1    | μs    |

(1) Higher inductance is possible if maximum load current is limited - see figure 11

## Static Electrical Characteristics

T<sub>J</sub> = -40..150°C, V<sub>CC</sub> = 6..28V (unless otherwise specified), typical value are given for 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  | —    | 80   | 100  | mΩ    | V <sub>in</sub> = 5V, I <sub>ds</sub> = 3A   |
|                       | ON state resistance T <sub>J</sub> = 150°C | —    | 135  | 175  |       |  |
| I <sub>dss1</sub>     | Drain to source leakage current            | —    | 0.1  | 2    | μA    | V <sub>CC</sub> = 14V, T <sub>J</sub> = 25°C |
| I <sub>dss2</sub>     | Drain to source leakage current            | —    | 0.2  | 4    |       | V <sub>CC</sub> = 28V, T <sub>J</sub> = 25°C |
| V <sub>clamp1</sub>   | Drain to source clamp voltage 1            | 36   | 38   | —    | V     | I <sub>d</sub> = 10mA                        |
| V <sub>clamp2</sub>   | Drain to source clamp voltage 2            | —    | 39   | 42   |       | I <sub>d</sub> = 1A                          |
| V <sub>in clamp</sub> | IN to source pin clamp voltage             | 5.5  | 6.5  | 7.5  |       | I <sub>in</sub> = 1mA                        |
| V <sub>th</sub>       | Input threshold voltage                    | —    | 1.7  | —    |       | I <sub>d</sub> = 10mA                        |

## Switching Electrical Characteristics

V<sub>CC</sub> = 14V, Resistive load = 5Ω, R<sub>input</sub> = 0Ω, V<sub>in</sub> = 5V, T<sub>J</sub> = 25°C

| Symbol                             | Parameter                  | Min. | Typ. | Max. | Units | Test Conditions |
|------------------------------------|----------------------------|------|------|------|-------|-----------------|
| T <sub>don</sub>                   | Turn-on delay time to 20%  | 2    | 7    | 15   | μs    | See figure 2    |
| T <sub>r</sub>                     | Rise time 20% to 80%       | 2    | 7    | 20   |       |                 |
| T <sub>doff</sub>                  | Turn-off delay time to 80% | 15   | 40   | 150  |       |                 |
| T <sub>f</sub>                     | Fall time 80% to 20%       | 4    | 10   | 20   |       |                 |
| E <sub>on</sub> + E <sub>off</sub> | Turn on and off energy     | —    | 0.2  | —    | mJ    |                 |

## Protection Characteristics

T<sub>J</sub> = -40..150°C, V<sub>CC</sub> = 6..28V (unless otherwise specified), typical value are given for T<sub>J</sub> = 25°C

| Symbol             | Parameter  | Min.   | Typ. | Max. | Units | Test Conditions                             |
|--------------------|--|--------|------|------|-------|---|
| T <sub>sd</sub>    | Over temperature threshold                                   | 150(2) | 165  | —    | °C    | See figure 1                                |
| I <sub>sd</sub>    | Over current threshold                                       | 2.7    | 4.5  | 6    | A     | See figure 1                                |
| OV                 | Over voltage protection ( not active when the device is ON ) | 34     | 37   | —    | V     |   |
| V <sub>reset</sub> | IN protection reset threshold                                | —      | 1.7  | —    | V     |   |
| T <sub>reset</sub> | Time to reset protection                                     | 15(2)  | 50   | 200  | μs    | V <sub>in</sub> = 0V, T <sub>J</sub> = 25°C |

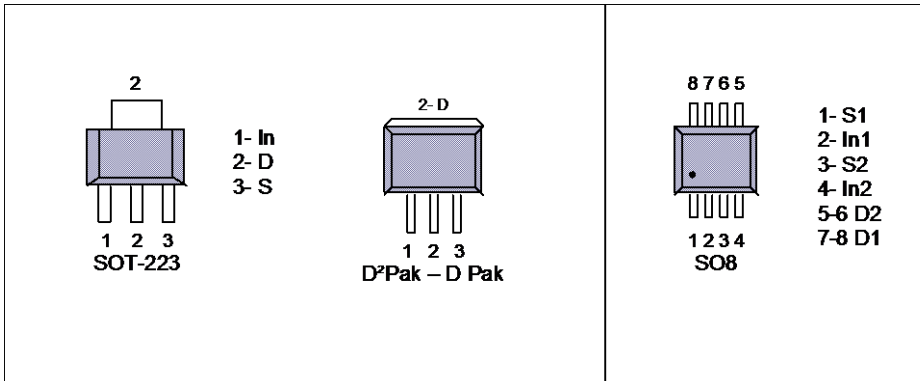
(2) Guaranteed by design

## Diagnostic

T<sub>J</sub> = -40..150°C, V<sub>CC</sub> = 6..28V (unless otherwise specified), typical value are given for T<sub>J</sub> = 25°C

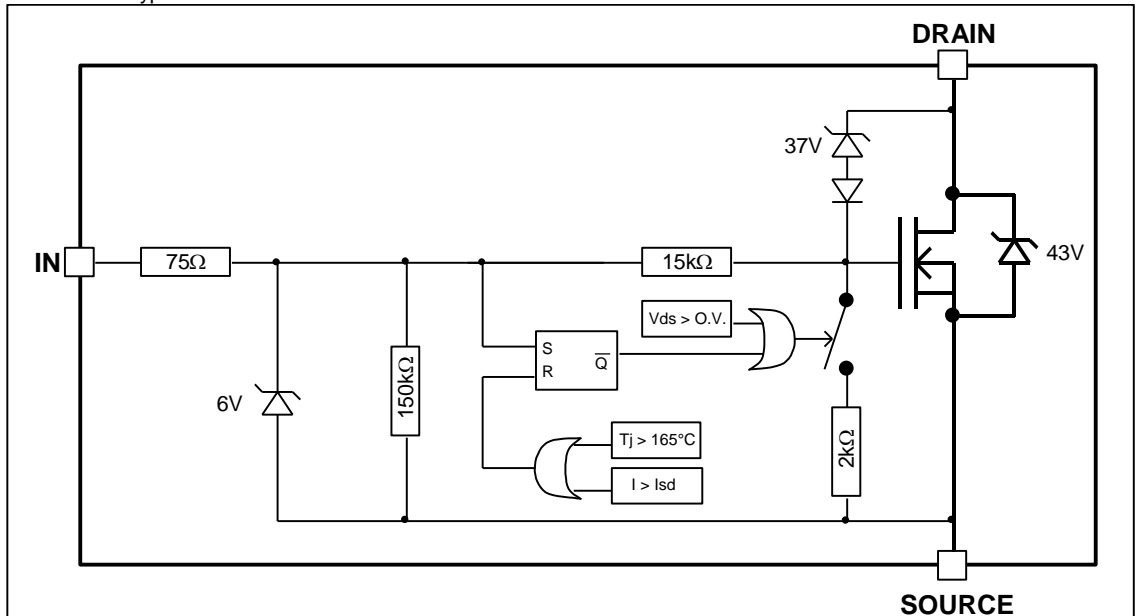
| Symbol               | Parameter   | Min. | Typ. | Max. | Units | Test Conditions      |
|----------------------|---|------|------|------|-------|----------------------|
| I <sub>in, on</sub>  | ON state IN positive current                                  | 10   | 32   | 80   | μA    | V <sub>in</sub> = 5V |
| I <sub>in, off</sub> | OFF state IN positive current<br>( after protection latched ) | 120  | 230  | 350  |       | V <sub>in</sub> = 5V |

## Lead Assignments



## Functional Block Diagram

All values are typical



All curves are typical values. Operating in the shaded area is not recommended.

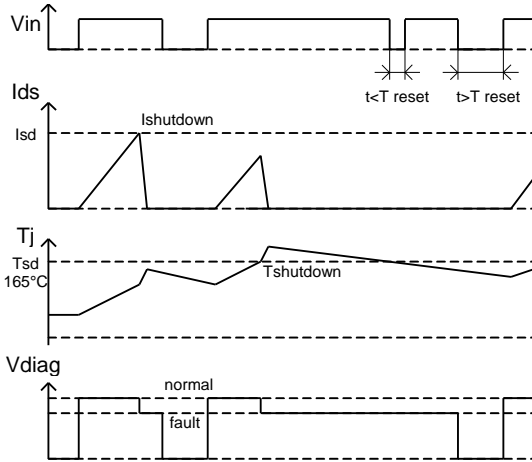


Figure 1 – Timing diagram

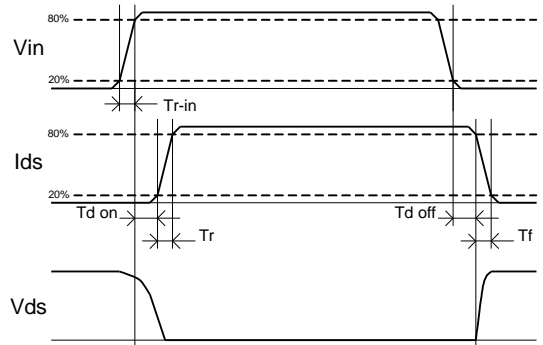


Figure 2 – IN rise time & switching definitions

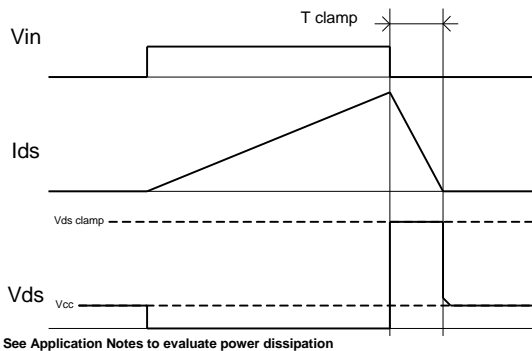


Figure 3 – Active clamp waveforms

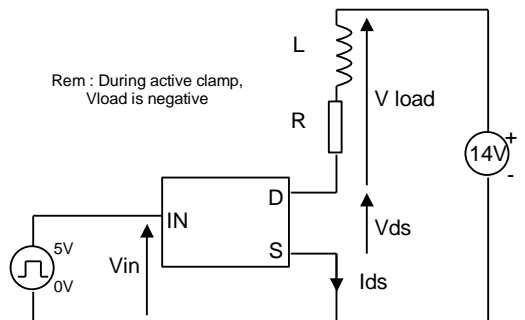
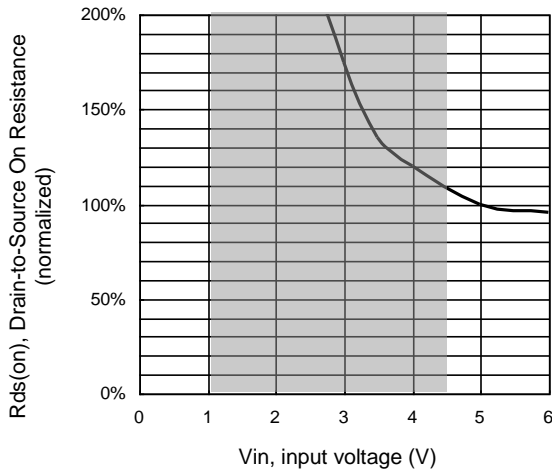
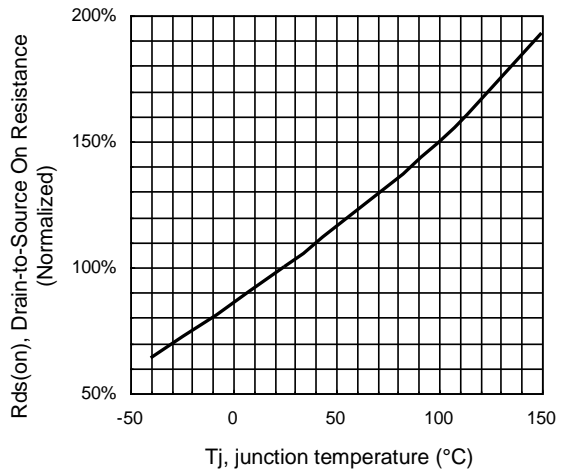


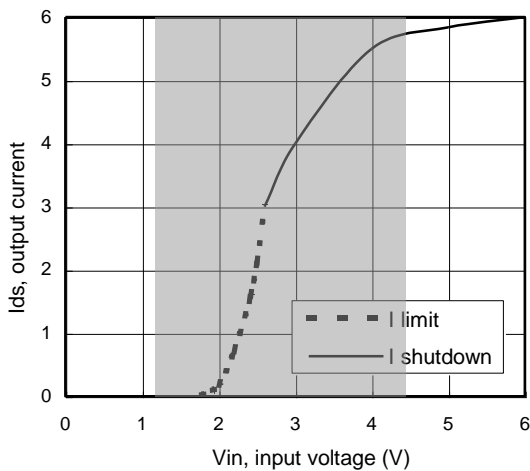
Figure 4 – Active clamp test circuit



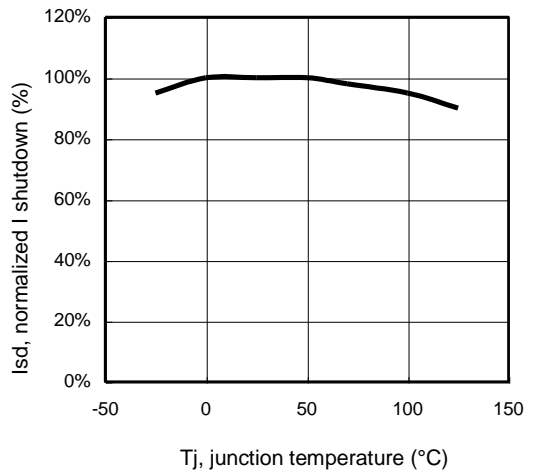
**Figure 5 – Normalized Rds(on) (%) Vs Input voltage (V)**



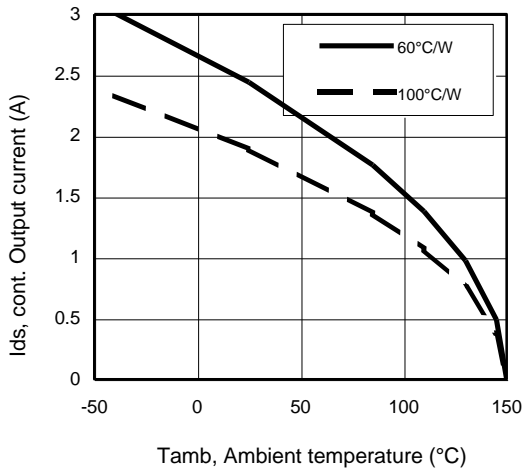
**Figure 6 - Normalized Rds(on) (%) Vs Tj (°C)**



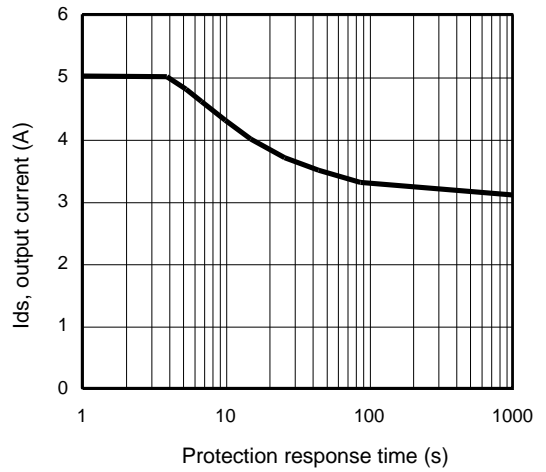
**Figure 7 – Current limitation and current shutdown Vs Input voltage (V)**



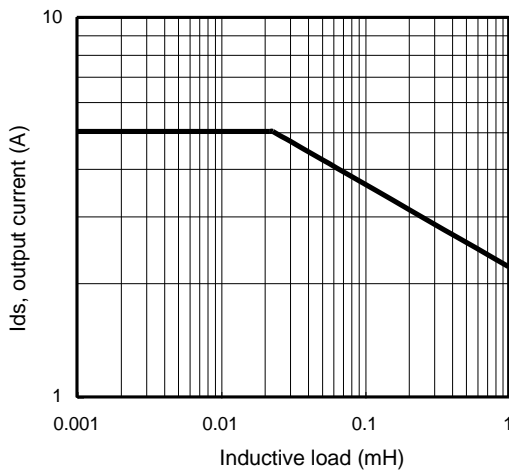
**Figure 8 – Normalized I shutdown (%) Vs junction temperature (°C)**



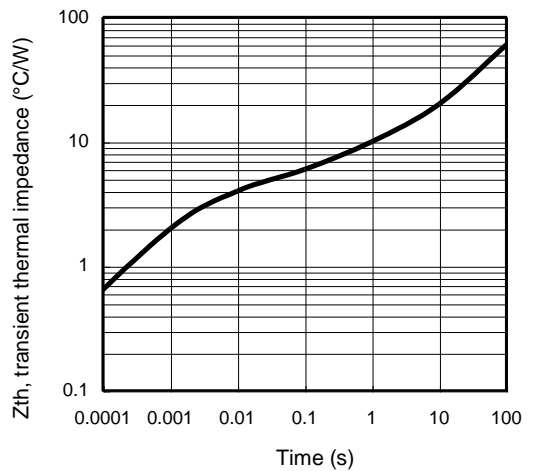
**Figure 9 – Max. continuous output current (A) Vs Ambient temperature (°C)**



**Figure 10 – Ids (A) Vs over temperature protection response time (s) / IPS1041L**

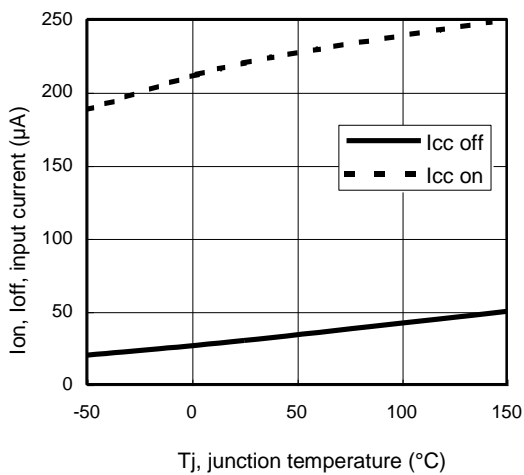


**Figure 11 – Max. output current (A) Vs Inductive load (mH)**

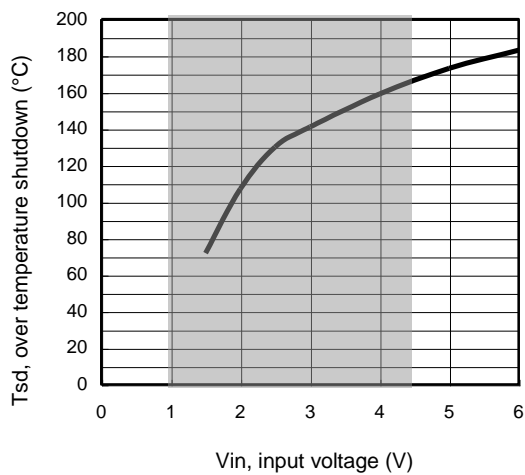


**Figure 12 – Transient thermal impedance (°C/W) Vs time (s)**



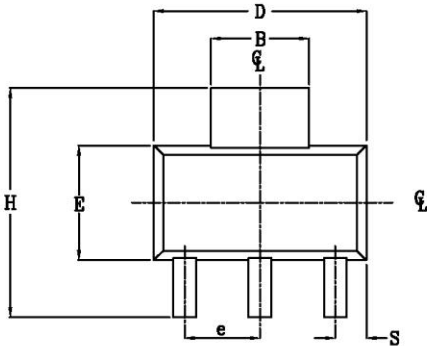


**Figure 13 – Input current ( $\mu\text{A}$ ) On and Off Vs junction temperature ( $^{\circ}\text{C}$ )**

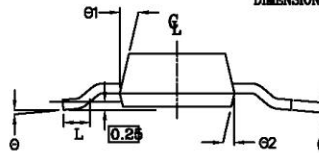
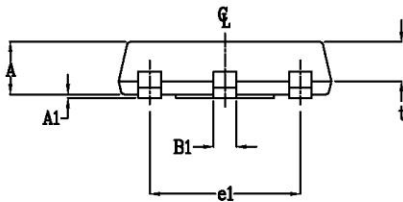


**Figure 14 – Over temperature shutdown ( $^{\circ}\text{C}$ ) Vs input voltage (V)**

## Case Outline - SOT-223 - Automotive Q100 PbF MSL2 qualified



| POS | MILLIMETERS |      | INCHES     |       |
|-----|-------------|------|------------|-------|
|     | MAX         | MIN  | MAX        | MIN   |
| A   | 1.70        | 1.50 | .067       | .060  |
| A1  | 0.10        | 0.02 | .004       | .0008 |
| B   | 3.15        | 2.95 | .124       | .116  |
| B1  | 0.85        | 0.65 | .033       | .028  |
| C   | 0.35        | 0.25 | .014       | .010  |
| D   | 6.70        | 6.30 | .264       | .248  |
| e   | 2.30 NOM    |      | .0905 NOM  |       |
| e1  | 4.60 NOM    |      | .181 NOM   |       |
| E   | 3.70        | 3.30 | .146       | .130  |
| H   | 7.30        | 6.70 | .287       | .264  |
| S   | 1.05        | 0.85 | .041       | .033  |
| t   | 1.30        | 1.10 | .051       | .043  |
| Ø   | 10° MAX     |      | 10° MAX    |       |
| Ø1  | 16°         | 10°  | 16°        | 10°   |
| Ø2  | 16°         | 10°  | 16°        | 10°   |
| L   | 0.75 MIN    |      | 0.0295 MIN |       |

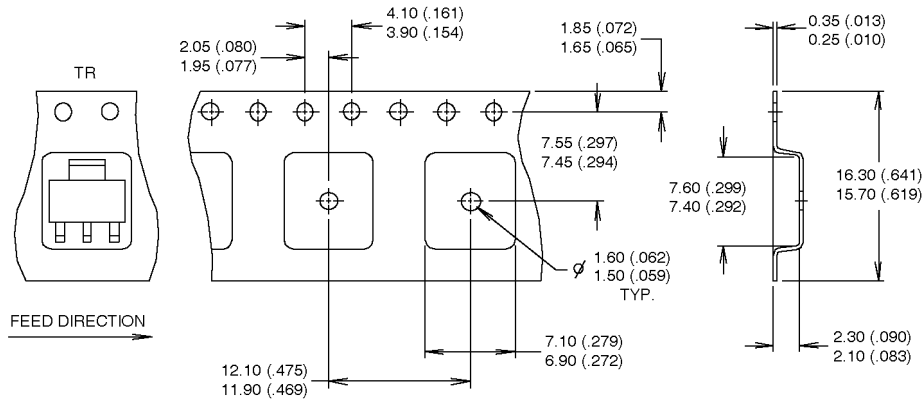


NOTE:  
 1. PACKAGE OUTLINE EXCLUSIVE OF ANY MOLD FLASHES DIMENSION.  
 2. PACKAGE OUTLINE EXCLUSIVE OF BURR DIMENSION.

Leads and drain are plated with 100% Sn

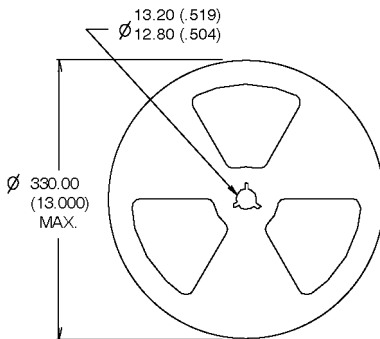
## Tape & Reel - SOT-223

Dimensions are shown in millimeters (inches)



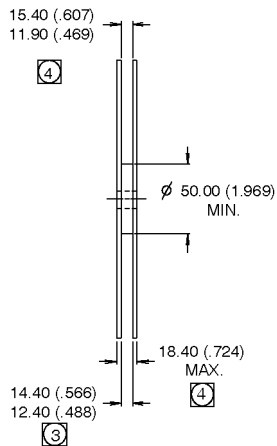
**NOTES :**

1. CONTROLLING DIMENSION: MILLIMETER.
2. OUTLINE CONFORMS TO EIA-481 & EIA-541.
3. EACH  $\varnothing 330.00$  (13.00) REEL CONTAINS 2,500 DEVICES.



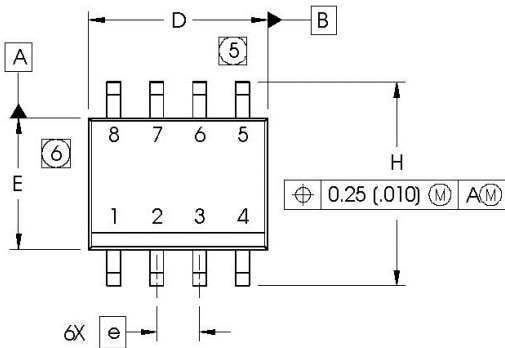
**NOTES :**

1. OUTLINE CONFORMS TO EIA-418-1.
2. CONTROLLING DIMENSION: MILLIMETER.
- ④ DIMENSION MEASURED @ HUB.
- ③ INCLUDES FLANGE DISTORTION @ OUTER EDGE.

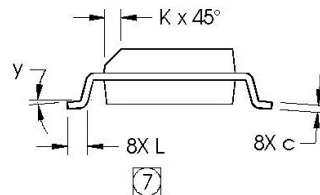
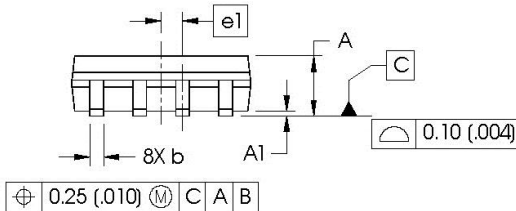


## Case Outline - SO-8 - Automotive Q100 PbF MSL2 qualified

Dimensions are shown in millimeters (inches)

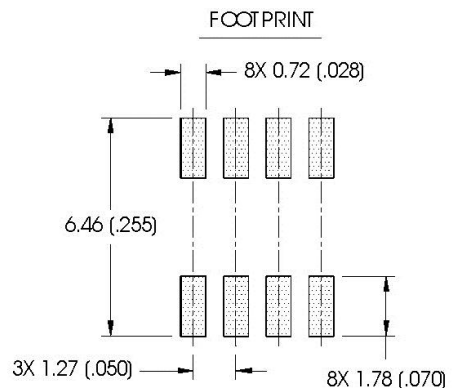


| DIM | INCHES     |       | MILLIMETERS |      |
|-----|------------|-------|-------------|------|
|     | MIN        | MAX   | MIN         | MAX  |
| A   | .0532      | .0688 | 1.35        | 1.75 |
| AI  | .0040      | .0098 | 0.10        | 0.25 |
| b   | .013       | .020  | 0.33        | 0.51 |
| c   | .0075      | .0098 | 0.19        | 0.25 |
| D   | .189       | .1968 | 4.80        | 5.00 |
| E   | .1497      | .1574 | 3.80        | 4.00 |
| e   | .050 BASIC |       | 1.27 BASIC  |      |
| e1  | .025 BASIC |       | 0.635 BASIC |      |
| H   | .2284      | .2440 | 5.80        | 6.20 |
| K   | .0099      | .0196 | 0.25        | 0.50 |
| L   | .016       | .050  | 0.40        | 1.27 |
| y   | 0°         | 8°    | 0°          | 8°   |



**NOTES:**

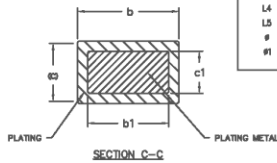
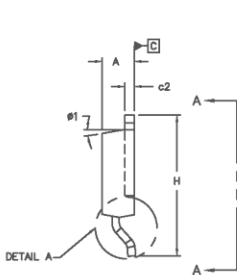
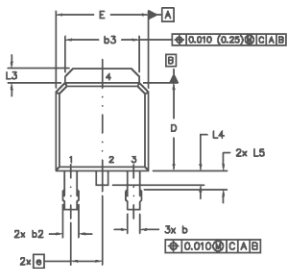
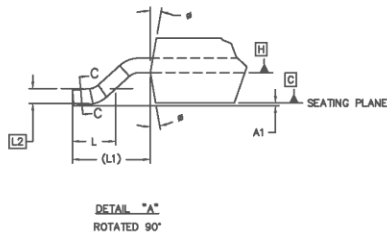
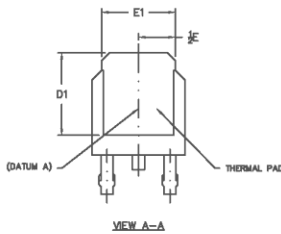
1. DIMENSIONING & TOLERANCING PER ASME Y14.5M-1994.
2. CONTROLLING DIMENSION: MILLIMETER
3. DIMENSIONS ARE SHOWN IN MILLIMETERS (INCHES).
4. OUTLINE CONFORMS TO JEDEC OUTLINE MS-012AA.
- ⑤ DIMENSION DOES NOT INCLUDE MOLD PROTRUSIONS. MOLD PROTRUSIONS NOT TO EXCEED 0.15 (.006).
- ⑥ DIMENSION DOES NOT INCLUDE MOLD PROTRUSIONS. MOLD PROTRUSIONS NOT TO EXCEED 0.25 (.010).
- ⑦ DIMENSION IS THE LENGTH OF LEAD FOR SOLDERING TO A SUBSTRATE.



Leads and drain are plated with 100% Sn



## Case Outline – D-Pak - Automotive Q100 PbF MSL1 qualified

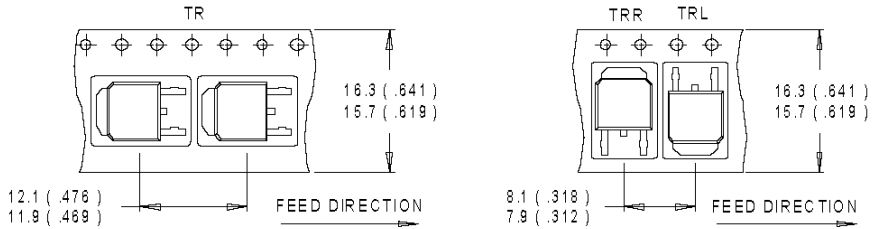


| SYMBOL | DIMENSIONS  |       |           |       | NOTES |
|--------|-------------|-------|-----------|-------|-------|
|        | MILLIMETERS |       | INCHES    |       |       |
|        | MIN.        | MAX.  | MIN.      | MAX.  |       |
| A      | 2.18        | 2.30  | .086      | .094  |       |
| A1     |             | 0.13  |           | .005  |       |
| b      | 0.64        | 0.69  | .025      | .035  | 5     |
| b1     | 0.64        | 0.70  | .025      | 0.031 | 5     |
| b2     | 0.76        | 1.14  | .030      | .045  |       |
| b3     | 4.95        | 5.48  | .195      | .215  |       |
| c      | 0.48        | 0.61  | .018      | .024  | 5     |
| c1     | 0.41        | 0.56  | .016      | .022  | 5     |
| c2     | .046        | 0.89  | .018      | .035  | 5     |
| D      | 5.97        | 6.22  | .235      | .245  | 6     |
| D1     | 5.21        | -     | .205      | -     | 4     |
| E      | 6.35        | 6.73  | .250      | .265  | 6     |
| E1     | 4.32        | -     | .170      | -     | 4     |
| e      | 3.28        |       | .090 BSC  |       |       |
| H      | 9.40        | 10.41 | .370      | .410  |       |
| L      | 1.40        | 1.78  | .055      | .070  |       |
| L1     | 2.74 REF.   |       | .108 REF. |       |       |
| L2     | 0.51 BSC    |       | .020 BSC  |       |       |
| L3     | 0.69        | 1.27  | .035      | .050  |       |
| L4     |             | 1.62  |           | .040  |       |
| L5     | 1.14        | 1.52  | .045      | .060  | 3     |
| #      | 0"          | 10"   | 0"        | 10"   |       |
| #1     | 0"          | 19"   | 0"        | 19"   |       |

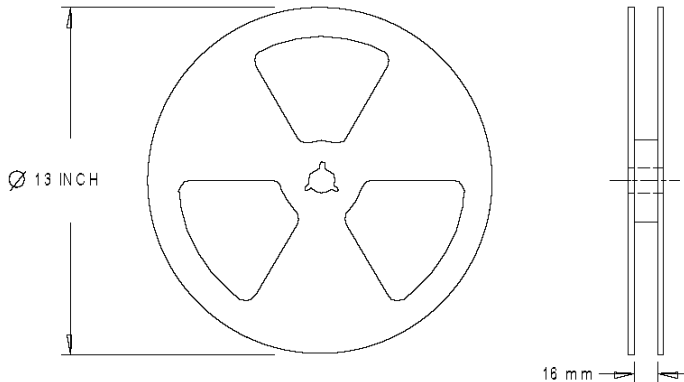
**NOTES:**

- 1.0 DIMENSIONING AND TOLERANCING PER ASME Y14.5 M- 1994.
- 2.0 DIMENSIONS ARE SHOWN IN INCHES [MILLIMETERS].
- 3.0 LEAD DIMENSION UNCONTROLLED IN L5.
- 4.0 DIMENSION D1 AND E1 ESTABLISH A MINIMUM MOUNTING SURFACE FOR THERMAL PAD.
- 5.0 SECTION C-C DIMENSIONS APPLY TO THE FLAT SECTION OF THE LEAD BETWEEN .005 [0.127] AND .010 [0.2540] FROM THE LEAD TIP.
- 6.0 DIMENSION D & 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.
- 7.0 OUTLINE CONFORMS TO JEDEC OUTLINE TO-252AA.
- 8.0 LEADS AND DRAIN ARE PLATED WITH 100% Sn

## Tape & Reel - D-Pak



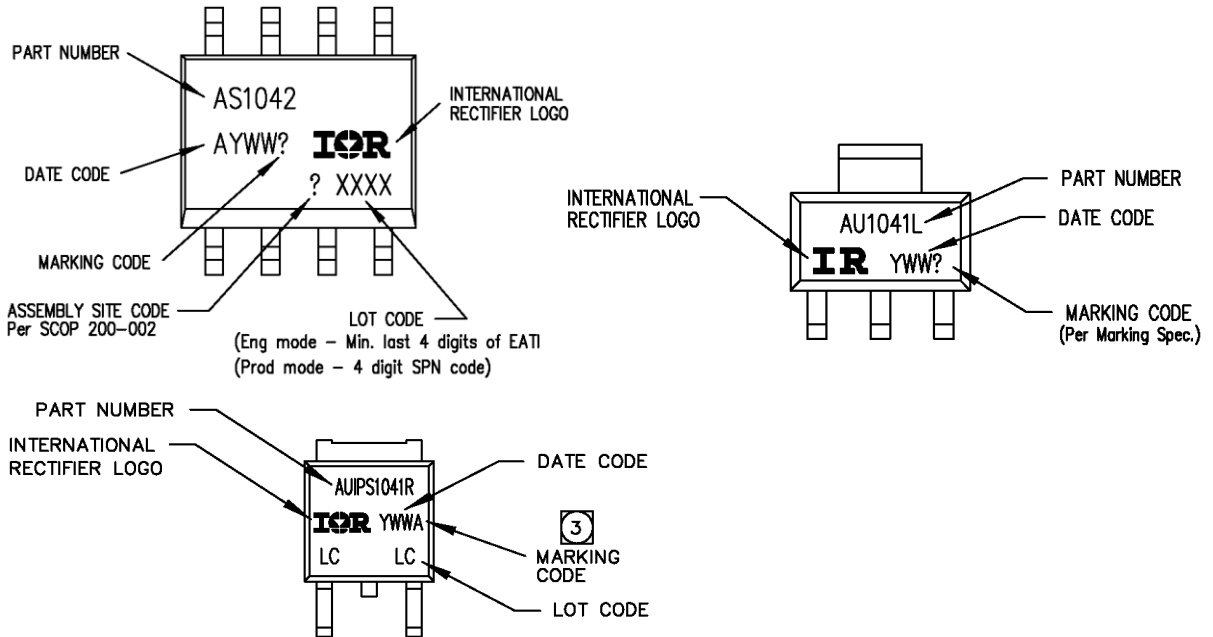
- NOTES :
1. CONTROLLING DIMENSION : MILLIMETER.
  2. ALL DIMENSIONS ARE SH OWN IN MILLIMETERS ( INCHES ).
  3. OUTLINE CONFORMS TO EIA-481 & EIA-541.



- NOTES :
1. OUTLINE CONFORMS TO EIA-481.

Dimensions are shown in millimeters (inches)

## Part Marking Information



## Ordering Information

| Base Part Number | Package Type | Standard Pack       |          | Complete Part Number |
|------------------|--------------|---------------------|----------|----------------------|
|                  |              | Form                | Quantity |                      |
| AUIPS1042        | SOIC-8       | Tube                | 95       | AUIPS1042G           |
|                  |              | Tape and reel       | 2500     | AUIPS1042GTR         |
| AUIPS1041        | SOT-223      | Tube                | 80       | AUIPS1041L           |
|                  |              | Tape and reel       | 2500     | AUIPS1041LTR         |
| AUIPS1041        | D-Pak-5-Lead | Tube                | 75       | AUIPS1041R           |
|                  |              | Tape and reel       | 2000     | AUIPS1041RTR         |
|                  |              | Tape and reel left  | 3000     | AUIPS1041RTRL        |
|                  |              | Tape and reel right | 3000     | AUIPS1041RTRR        |



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## Revision History

| <b>Revision</b> | <b>Date</b>                       | <b>Notes/Changes</b>                         |
|-----------------|-----------------------------------|--|
| C1              | November, 24 <sup>th</sup> , 2010 | AU release                                   |
| C2              | December, 7 <sup>th</sup> 2010    | Remove ESD section page 3                    |
| C3              | December, 9 <sup>th</sup> 2010    | Update qual page                             |
| C4              | December, 14 <sup>th</sup> 2010   | Update Tdon                                  |
| D               | February, 28 <sup>th</sup> 2011   | Update Max rating                            |
| E               | March, 14 <sup>th</sup> 2011      | Update part marking                          |
| F               | November, 14 <sup>th</sup> 2011   | Update T&R SOT223                            |
| G               | May 9th, 2012                     | Update component number for the SOT223 tube. |
|                 |                                   |  |

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