International
IOR Rectifier

June, 21st 2012
**Automotive grade**

# AUIPS1011(S)(R)

## 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

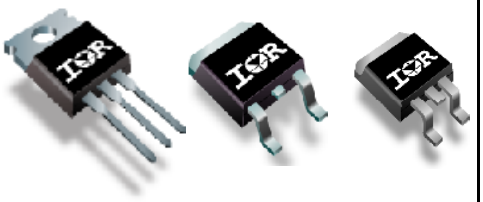
### Product Summary

| | |
|---|---|
| Rds(on) | 13mΩ (max.) |
| Vclamp | 39V |
| Ishutdown | 85A (typ.) |

### Description

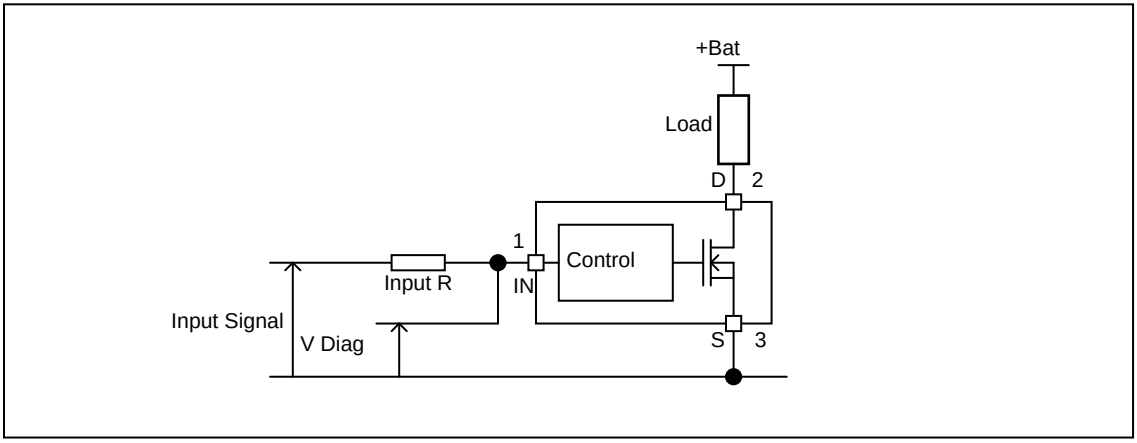
The AUIPS1011(S)(R) is a three terminal Intelligent Power Switch (IPS) that features a low side MOSFET with over-current, over-temperature, ESD protection and drain to source active clamp. This device offers protections and the high reliability required in harsh environments. The switch provides efficient protection by turning OFF the power MOSFET when the temperature exceeds 165°C or when the drain current reaches 85A. 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.

### Packages



| TO-220 | D²Pak | D-Pak |
|---|---|---|
| AUIPS1011 | AUIPS1011S | AUIPS1011R |

### 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** | | DPAK-3L | MSL1, 260°C (per IPC/JEDEC J-STD-020) |
| | | D2PAK-3L | MSL1, 260°C (per IPC/JEDEC J-STD-020) |
| | | TO220-5L | Not applicable |
| **ESD** | Machine Model | Class M4 (+/-450V) (per AEC-Q100-003) | |
| | Human Body Model | Class H2 (+/-2500V) (per AEC-Q100-002) | |
| | Charged Device Model | Class C4 (+/-1000V) (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/

## Absolute Maximum Ratings

Absolute maximum ratings indicate sustained limits beyond which damage to the device may occur. (Tj= -40°C..150°C, Vcc=6..36V unless otherwise specified).

| Symbol | Parameter | Min. | Max. | Units |
|---|---|---|---|---|
| Vds | Maximum drain to source voltage | -0.3 | 36 | V |
| Vds cont. | Maximum continuous drain to source voltage | - | 28 | V |
| Vin | Maximum input voltage | -0.3 | 6 | V |
| Isd cont. | Max diode continuous current (limited by thermal dissipation) | — | 5 | A |
| Pd | Maximum power dissipation (internally limited by thermal protection) | | | W |
| | Rth=5°C/W AUIPS1011 | — | 25 | |
| | Rth=40°C/W AUIPS1011S 1" sqr. footprint | — | 3.1 | |
| | Rth=50°C/W AUIPS1011R 1" sqr. footprint | — | 2.5 | |
| Tj max. | Maximum operating junction temperature | -40 | 150 | °C |
| | Maximum storage temperature | -55 | 150 | |

## Thermal Characteristics

| Symbol | Parameter | Typ. | Max. | Units |
|---|---|---|---|---|
| Rth1 | Thermal resistance junction to ambient AUIPS1011 TO-220 free air | 50 | — | °C/W |
| Rth2 | Thermal resistance junction to case AUIPS1011 TO-220 | 1.2 | — | |
| Rth1 | Thermal resistance junction to ambient AUIPS1011S D²Pak std. footprint | 60 | — | |
| Rth2 | Thermal resistance junction to ambient AUIPS1011S D²Pak 1" sqr. footprint | 40 | — | |
| Rth3 | Thermal resistance junction to case AUIPS1011S D²Pak | 1.2 | — | |
| Rth1 | Thermal resistance junction to ambient AUIPS1011R D-Pak std. footprint | 70 | — | |
| Rth2 | Thermal resistance junction to ambient AUIPS1011R D-Pak 1" sqr. footprint | 50 | — | |
| Rth3 | Thermal resistance junction to case AUIPS1011R D-Pak | 1.2 | — | |

## 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 | 5.5 | |
| VIL | Low level input voltage | 0 | 0.5 | |
| Ids | Continuous drain current, Tambient=85°C, Tj=125°C, Vin=5V | | | A |
| | Rth=5°C/W AUIPS1011 | — | 18 | |
| | Rth=40°C/W AUIPS1011S 1" sqr. Footprint | — | 6.5 | |
| | Rth=50°C/W AUIPS1011R 1" sqr. Footprint | — | 6 | |
| Rin | 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) | — | 5 | µH |
| Max F | Max frequency (switching losses = conduction losses) | — | 200 | 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

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

| Symbol | Parameter | Min. | Typ. | Max. | Units | Test Conditions |
|---|---|---|---|---|---|---|
| Rds(on) | ON state resistance Tj=25°C | — | 10 | 13 | mΩ | Vin=5V, Ids=30A |
| | ON state resistance Tj=150°C (2) | — | 19 | 25 | | |
| Idss1 | Drain to source leakage current | — | 0.1 | 2 | µA | Vcc=14V, Tj=25°C |
| Idss2 | Drain to source leakage current | — | 0.2 | 4 | | Vcc=28V, Tj=25°C |
| V clamp1 | Drain to source clamp voltage 1 | 36 | 39 | — | V | Id=20mA |
| V clamp2 | Drain to source clamp voltage 2 | — | 39 | 42 | | Id=5A |
| Vin clamp | IN to source pin clamp voltage | 5.5 | 6.5 | 7.5 | | Iin=1mA |
| Vth | Input threshold voltage | — | 1.7 | — | | Id=10mA |

## Switching Electrical Characteristics

Vcc=14V, Resistive load=0.5Ω, Rinput=50Ω, Vin=5V, Tj=25°C

| Symbol | Parameter | Min. | Typ. | Max. | Units | Test Conditions |
|---|---|---|---|---|---|---|
| Tdon | Turn-on delay time to 20% | 15 | 50 | 150 | µs | See figure 2 |
| Tr | Rise time 20% to 80% | 20 | 50 | 100 | | |
| Tdoff | Turn-off delay time to 80% | 100 | 330 | 700 | | |
| Tf | Fall time 80% to 20% | 30 | 70 | 150 | | |
| Eon + Eoff | Turn on and off energy | — | 5 | — | mJ | |

## Protection Characteristics

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

| Symbol | Parameter | Min. | Typ. | Max. | Units | Test Conditions |
|---|---|---|---|---|---|---|
| Tsd | Over temperature threshold | 150(2) | 165 | — | °C | See figure 1 |
| Isd | Over current threshold | 44 | 85 | 120 | A | See figure 1 |
| OV | Over voltage protection (not active when the device is ON ) | 34 | 37 | — | V | |
| Vreset | IN protection reset threshold | — | 1.7 | — | V | |
| Treset | Time to reset protection | 15(2) | 50 | 200 | µs | Vin=0V |

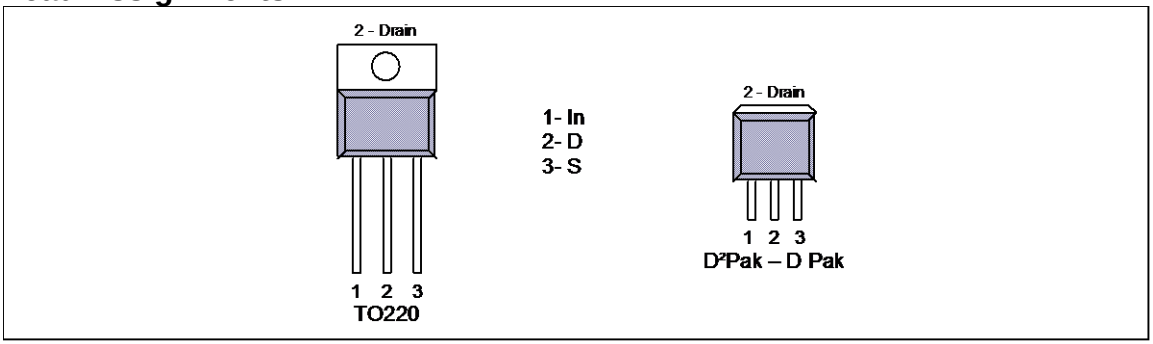
## Diagnostic

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

| Symbol | Parameter | Min. | Typ. | Max. | Units | Test Conditions |
|---|---|---|---|---|---|---|
| Iin, on | ON state IN positive current | 15 | 32 | 70 | µA | Vin=5V |
| Iin, off | OFF state IN positive current (after protection latched ) | 150 | 230 | 350 | | Vin=5V |

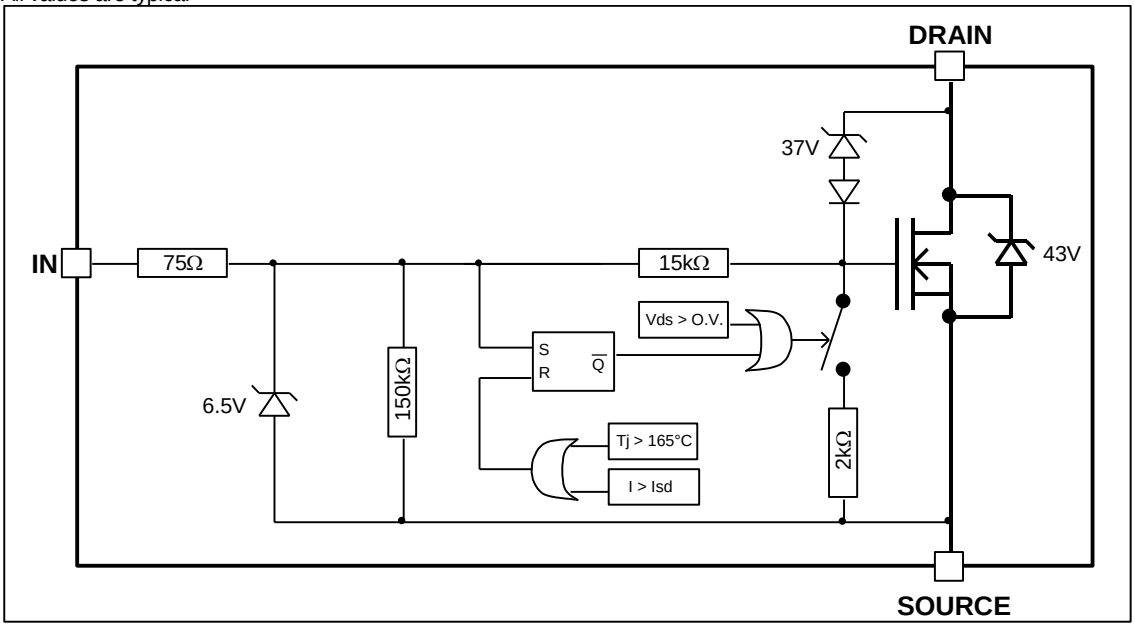
(2) Guaranteed by design

## Lead Assignments




## Functional Block Diagram

All values are typical



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

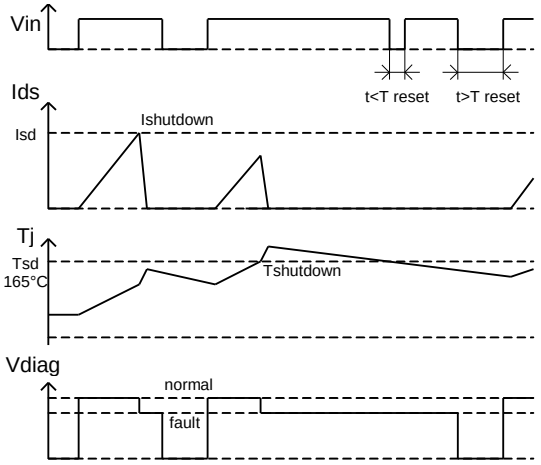



**Figure 1 – Timing diagram**

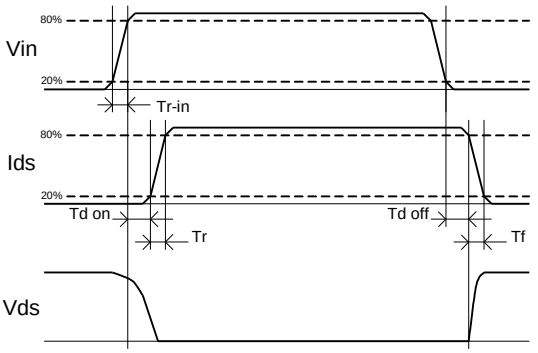



**Figure 2 – IN rise time & switching definitions**

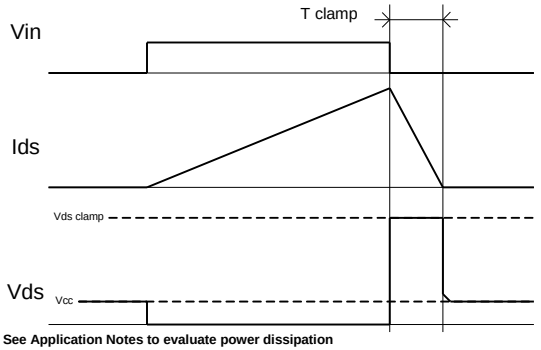



**Figure 3 – Active clamp waveforms**

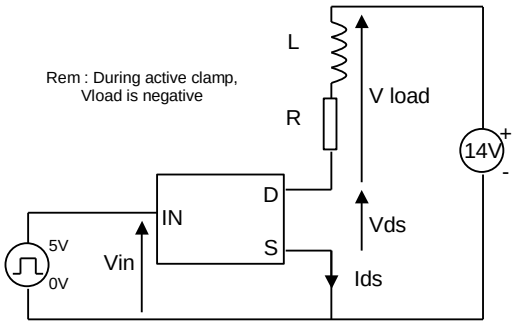



**Figure 4 – Active clamp test circuit**

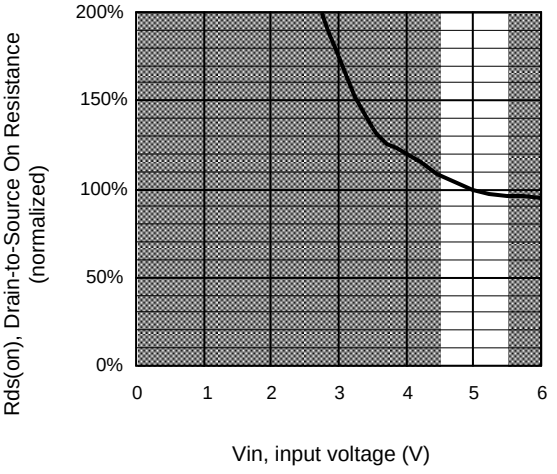



**Figure 5 – Normalized Rds(on) (%) Vs Input voltage (V)**

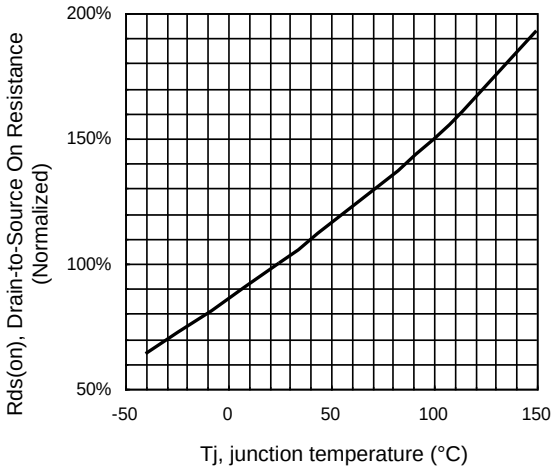



**Figure 6 - Normalized Rds(on) (%) Vs Tj (°C)**

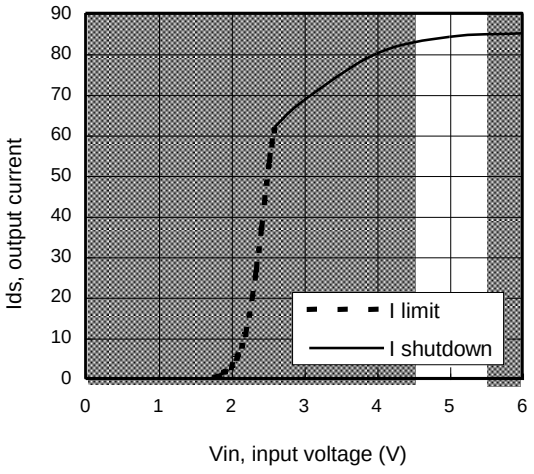



**Figure 7 – Current limitation and current shutdown Vs Input voltage (V)**

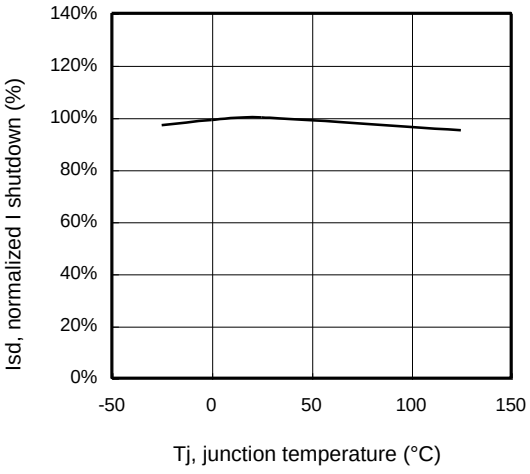



**Figure 8 – Normalized I shutdown (%) Vs junction temperature (°C)**

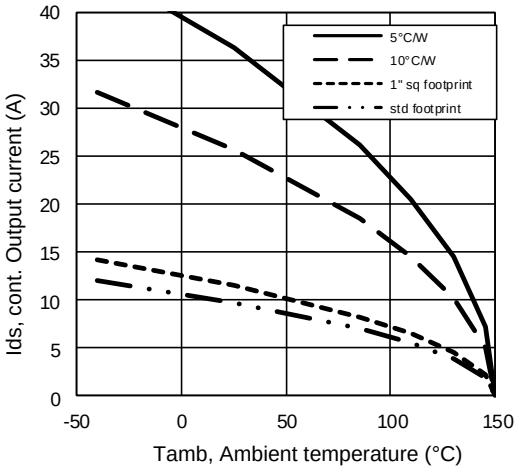



**Figure 9 – Max. continuous output current (A) Vs Ambient temperature (°C)**

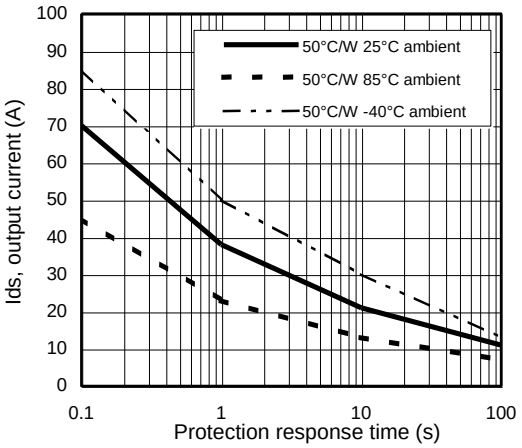



**Figure 10 – Ids (A) Vs over temperature protection response time (s)**

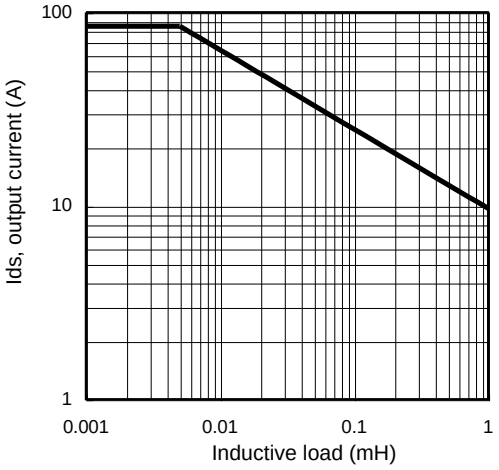



**Figure 11 – Max. ouput current (A) Vs Inductive load (mH)**

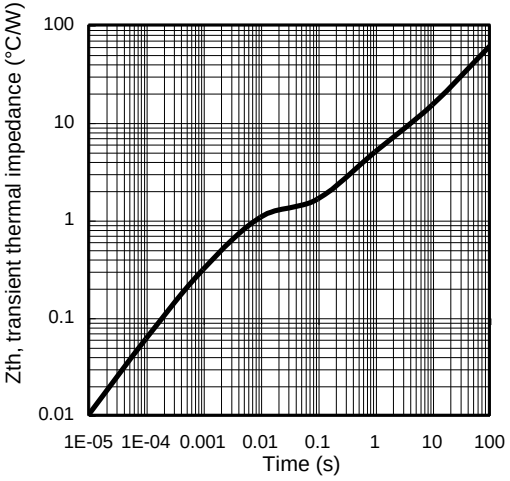



**Figure 12 – Transient thermal impedance (°C/W) Vs time (s)**

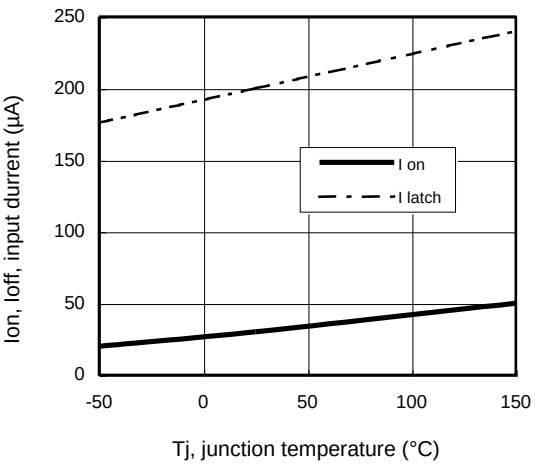



**Figure 13 – Input current (µA) On and Off Vs junction temperature (°C)**

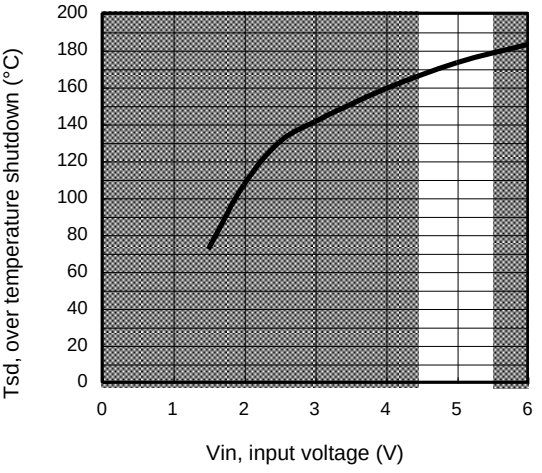
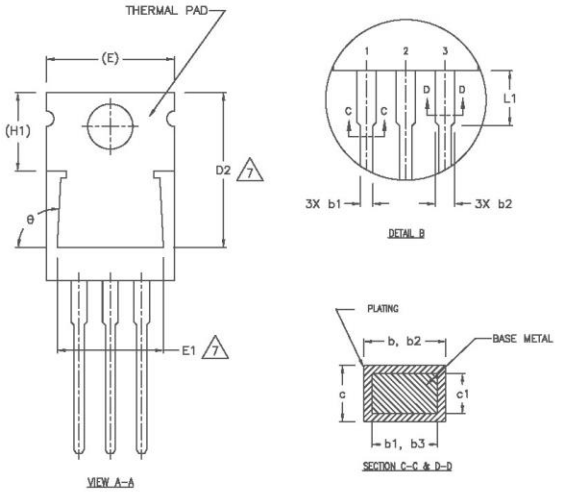
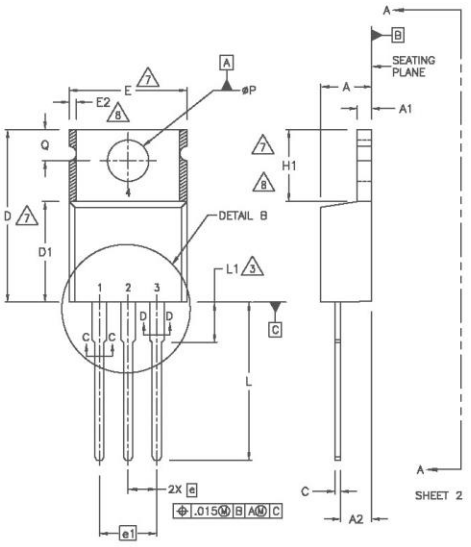



**Figure 14 – Over temperature shutdown (°C) Vs input voltage (V)**

## Case Outline – TO-220 AB – Automotive Q100 PbF qualified



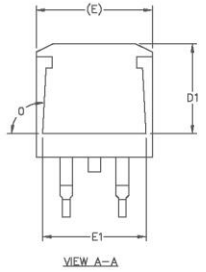




| SYMBOL | DIMENSIONS | | | | NOTES |
|---|---|---|---|---|---|
| | MILLIMETERS | | INCHES | | |
| | MIN. | MAX. | MIN. | MAX. | |
| A | 3.56 | 4.82 | .140 | .190 | |
| A1 | 0.51 | 1.40 | .020 | .055 | |
| A2 | 2.04 | 2.92 | .080 | .115 | |
| b | 0.38 | 1.01 | .015 | .040 | |
| b1 | 0.38 | 0.96 | .015 | .038 | 5 |
| b2 | 1.15 | 1.77 | .045 | .070 | |
| b3 | 1.15 | 1.73 | .045 | .068 | |
| c | 0.36 | 0.61 | .014 | .024 | |
| c1 | 0.36 | 0.56 | .014 | .022 | 5 |
| D | 14.22 | 16.51 | .560 | .650 | 4 |
| D1 | 8.38 | 9.02 | .330 | .355 | |
| D2 | 12.19 | 12.88 | .480 | .507 | 7 |
| E | 9.66 | 10.66 | .380 | .420 | 4,7 |
| E1 | 8.38 | 8.89 | .330 | .350 | 7 |
| e | 2.54 BSC | | .100 BSC | | |
| e1 | 5.08 | | .200 BSC | | |
| H1 | 5.85 | 6.55 | .230 | .270 | 7,8 |
| L | 12.70 | 14.73 | .500 | .580 | |
| L1 | – | 6.35 | – | .250 | 3 |
| øP | 3.54 | 4.08 | .139 | .161 | |
| Q | 2.54 | 3.42 | .100 | .135 | |
| ø | 90°–93° | | 90°–93° | | |

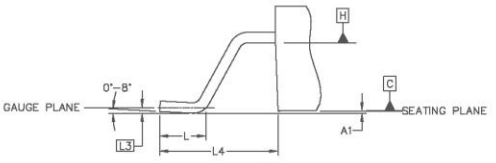
NOTES:

1 DIMENSIONING AND TOLERANCING PER ASME Y14.5 M– 1994.
2 DIMENSIONS ARE SHOWN IN INCHES [MILLIMETERS].
3 LEAD DIMENSION AND FINISH UNCONTROLLED IN L1.
4 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.
5 DIMENSION b1 & c1 APPLY TO BASE METAL ONLY.
6 CONTROLLING DIMENSION : INCHES.
7 THERMAL PAD CONTOUR OPTIONAL WITHIN DIMENSIONS E,H1,D2 & E1
8 DIMENSION E2 X H1 DEFINE A ZONE WHERE STAMPING AND SINGULATION IRREGULARITIES ARE ALLOWED.
9 LEADS AND DRAIN ARE PLATED WITH 100% Sn

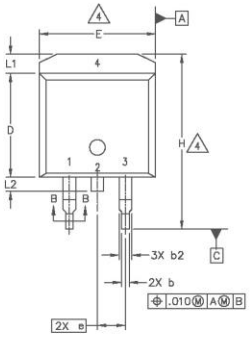
## Case Outline - D²Pak (SMD-220) - Automotive Q100 PbF MSL1 qualified

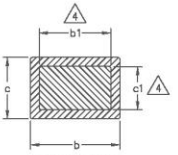



VIEW A–A



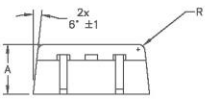

DETAIL "A"
ROTATED 90°
SCALE 8:1

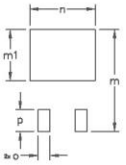


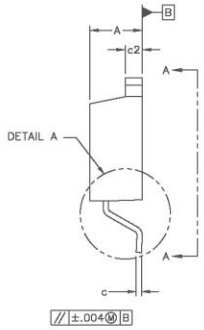

SECTION B–B
SCALE: NONE

| SYMBOL | DIMENSIONS | | | | NOTES |
|---|---|---|---|---|---|
| | MILLIMETERS | | INCHES | | |
| | MIN. | MAX. | MIN. | MAX. | |
| A | 4.06 | 4.83 | .160 | .190 | |
| A1 | 0.00 | 0.254 | .000 | .010 | |
| b | 0.51 | 0.99 | .020 | .039 | |
| b1 | 0.51 | 0.89 | .020 | .035 | 4 |
| b2 | 1.14 | 1.78 | .045 | .070 | |
| c | 0.38 | 0.74 | .015 | .029 | |
| c1 | 0.38 | 0.58 | .015 | .023 | 4 |
| c2 | 1.14 | 1.65 | .045 | .065 | |
| D | 8.51 | 9.65 | .335 | .380 | 3 |
| D1 | 6.86 | | .270 | | |
| E | 9.65 | 10.67 | .380 | .420 | 3 |
| E1 | 6.22 | | .245 | | |
| e | 2.54 BSC | | .100 BSC | | |
| H | 14.61 | 15.88 | .575 | .625 | |
| L | 1.78 | 2.79 | .070 | .110 | |
| L1 | | 1.65 | | .065 | |
| L2 | 1.27 | 1.78 | .050 | .070 | |
| L3 | 0.25 BSC | | .010 BSC | | |
| L4 | 4.78 | 5.28 | .188 | .208 | |
| m | 17.78 | | .700 | | |
| m1 | 8.89 | | .350 | | |
| n | 11.43 | | .450 | | |
| o | 2.08 | | .082 | | |
| p | 3.81 | | .150 | | |
| R | 0.51 | 0.71 | .020 | .028 | |
| θ | 90° | 93° | 90° | 93° | |



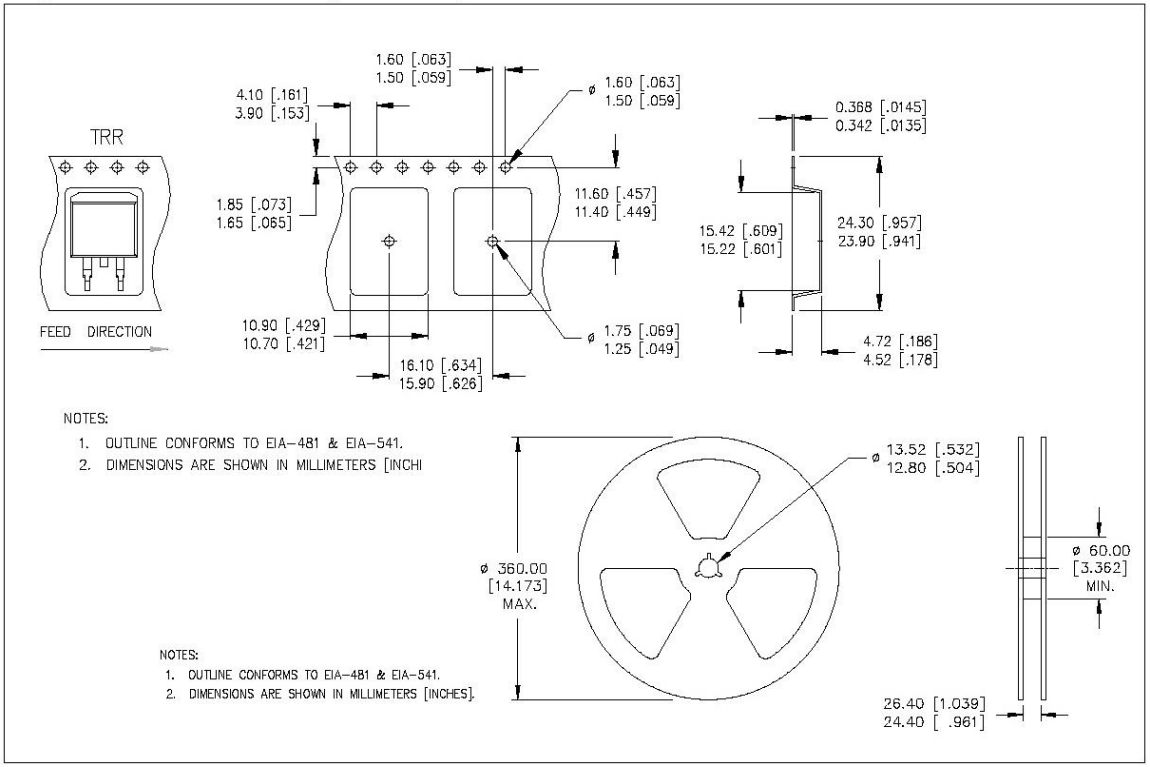

FOOT PRINT
SCALE 2:1



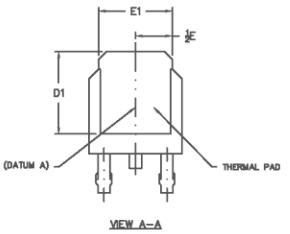

NOTES:

1. DIMENSIONING AND TOLERANCING PER ASME Y14.5M–1994
2. DIMENSIONS ARE SHOWN IN MILLIMETERS [INCHES].
3. DIMENSION D & E DO NOT INCLUDE MOLD FLASH. MOLD FLASH SHALL NOT EXCEED 0.127 [.005"] PER SIDE. THESE DIMENSIONS ARE MEASURED AT THE OUTMOST EXTREMES OF THE PLASTIC BODY.
4. DIMENSION b1 AND c1 APPLY TO BASE METAL ONLY.
5. CONTROLLING DIMENSION: INCH.
6. LEADS & DRAIN CONTACT ARE PLATED : 100% Sn

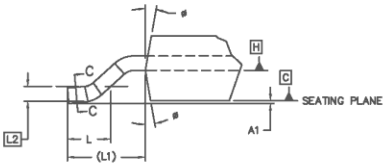
## Tape & Reel - D²Pak (SMD220)



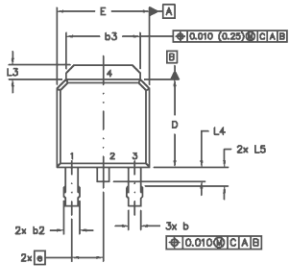
## Case Outline – D-Pak - Automotive Q100 PbF MSL1 qualified



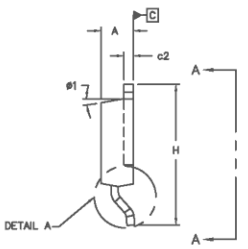

VIEW A–A

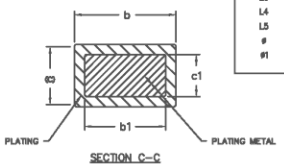



DETAIL "A"
ROTATED 90°




| SYMBOL | DIMENSIONS | | | | NOTES |
|---|---|---|---|---|---|
| | MILLIMETERS | | INCHES | | |
| | MIN. | MAX. | MIN. | MAX. | |
| A | 2.18 | 2.39 | .086 | .094 | |
| A1 | | 0.13 | | .005 | |
| b | 0.64 | 0.89 | .025 | .035 | 5 |
| b1 | 0.64 | 0.79 | .025 | 0.031 | 5 |
| b2 | 0.76 | 1.14 | .030 | .045 | |
| b3 | 4.95 | 5.46 | .195 | .215 | |
| c | 0.46 | 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 | 2.29 | | .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 | 0.89 | 1.27 | .035 | .050 | |
| L4 | | 1.02 | | .040 | |
| L5 | 1.14 | 1.52 | .045 | .060 | 3 |
| ø | 0° | 10° | 0° | 10° | |
| ø1 | 0° | 15° | 0° | 15° | |



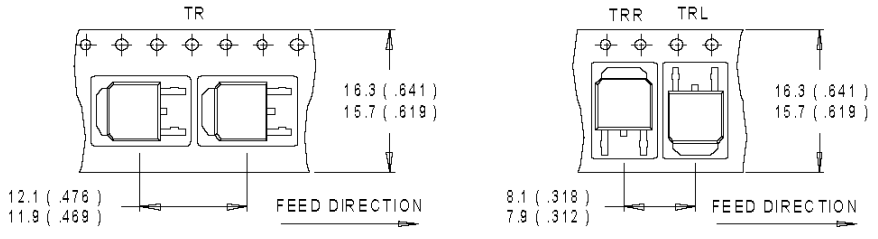

SECTION C–C

NOTES:

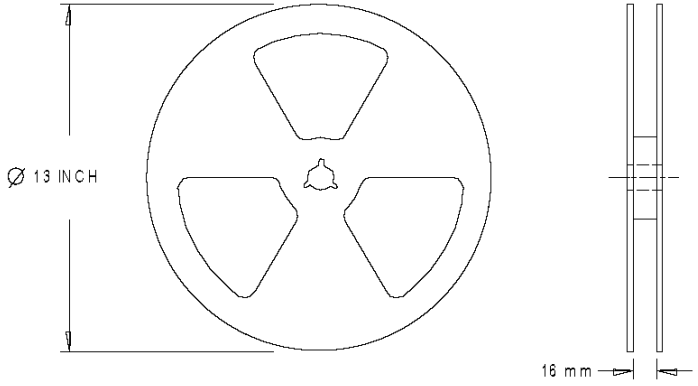
1.0 DIMENSIONING AND TOLERANCING PER ASME Y14.5 M– 1994.
2.0 DIMENSIONS ARE SHOWN IN INCHES [MILLIMETERS].
3.0 LEAD DIMENSION UNCONTROLLED IN L5
4.0 DIMENSION D1 AND E1 ESTABLISH A MINIMUM MOUNTING SURFACE FOR THERMAL PAD.
5.0 SECTION C–C DIMENSIONS APPLY TO THE FLAT SECTION OF THE LEAD BETWEEN .005 [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 PLTED WITH 100% Sn

## Tape & Reel - D-Pak



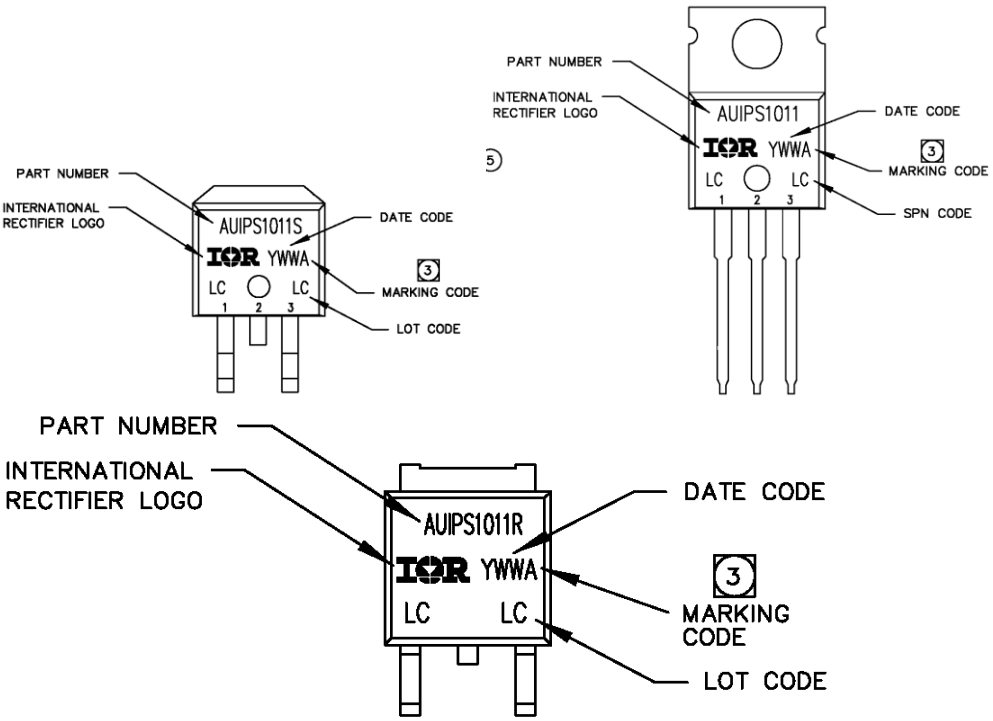

NOTES :
1. CONTROLLING DIMENSION : MILLIMETER.
2. ALL DIMENSIONS ARE SHOWN IN MILLIMETERS ( INCHES ).
3. OUTLINE CONFORMS TO EIA-481 & EIA-541.




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 | |
| AUIPS1011 | TO220 – 5Leads | Tube | 50 | AUIPS1011 |
| | D2-Pak-5-Leads | Tube | 50 | AUIPS1011S |
| | | Tape and reel left | 800 | AUIPS1011STRL |
| | | Tape and reel right | 800 | AUIPS1011STRR |
| | D-Pak-5-Lead | Tube | 75 | AUIPS1011R |
| | | Tape and reel | 2000 | AUIPS1011RTR |
| | | Tape and reel left | 3000 | AUIPS1011RTRL |
| | | Tape and reel right | 3000 | AUIPS1011RTRR |

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