March, 26th 2012

**Automotive grade**

International
IOR Rectifier

# AUIPS7091(G)(S)PbF

## INTELLIGENT POWER HIGH SIDE SWITCH

### Features

- Over temperature shutdown (with auto-restart)
- Short circuit protection (current limit)
- Active clamp
- Open load detection
- Logic ground isolated from power ground
- ESD protection
- Ground loss protection
- Status feedback

### Product Summary

| | |
|---|---|
| Rds(on) | 120mΩ max. |
| Vclamp | 70V |
| I Limit | 5A (typ.) |
| Open load | 3V |

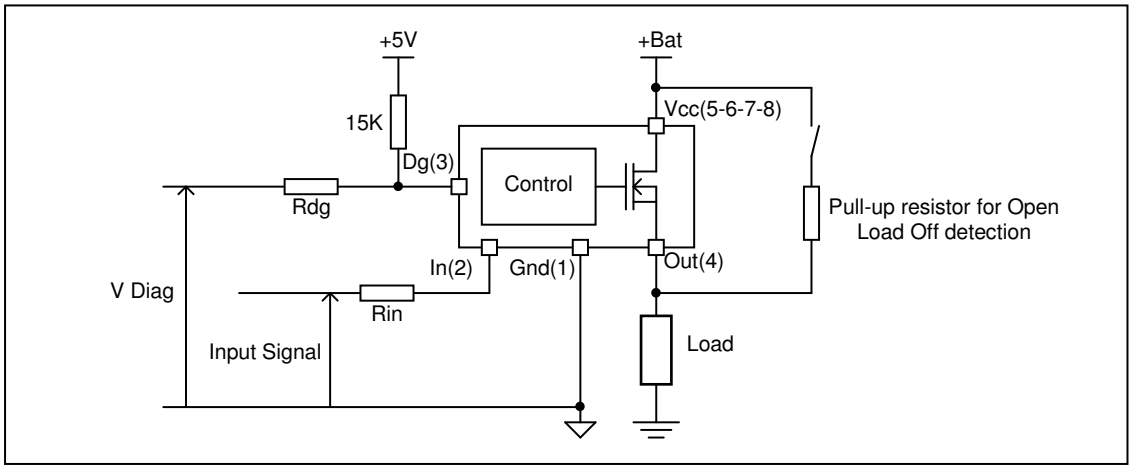
### Description

The AUIPS7091(G)(S)PbF is a five terminal Intelligent Power Switch (IPS) with built in short circuit, over-temperature, ESD protection, inductive load capability and diagnostic feedback. The output current is limited at Ilim value. Current limitation is activated until the thermal protection acts. The over-temperature protection turns off the device if the junction temperature exceeds Tshutdown. It will automatically restart after the junction has cooled 7℃ below Tshutdown. A diagnostic pin is provided for status feedback of short circuit, over-temperature and open load detection. The double level shifter circuitry allows large offsets between the logic ground and the load.

### Package

| TO220 | D2-Pak | SO-8 |
|---|---|---|
| AUIPS7091PbF | AUIPS7091SPbF | AUIPS7091GPbF |

### Typical Connection



## Qualification Information†

| | | | |
|---|---|---|---|
| **Qualification Level** | | 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. | |
| **Moisture Sensitivity Level** | | D2PAK-5L | MSL1, 260℃<br>(per IPC/JEDEC J-STD-020) |
| | | TO-220 | Not applicable<br>(non-surface mount package style) |
| | | SOIC-8 | MSL2, 260℃<br>(per IPC/JEDEC J-STD-020) |
| **ESD** | Machine Model | Class M2 (+/-200V)<br>(per AEC-Q100-003) | |
| | Human Body Model | Class H2 (+/-4000V)<br>(per AEC-Q100-002) | |
| | Charged Device Model | Class C4 (+/-1000V)<br>(per AEC-Q100-011) | |
| **IC Latch-Up Test** | | Class II, Level A<br>(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. All voltage parameters are referenced to Ground lead. Tj= -40℃..150℃, Vcc=6..35V (unless otherwise specified).

| Symbol | Parameter | Min. | Max. | Units |
|---|---|---|---|---|
| Vout | Maximum output voltage | Vcc-63 | Vcc+0.3 | V |
| Voffset | Maximum logic ground to load ground offset | Vcc-63 | Vcc+0.3 | |
| Vin | Maximum input voltage | -0.3 | 5.5 | |
| Vcc max. | Maximum Vcc voltage | — | 60 | |
| Vcc cont. | Maximum continuous Vcc voltage | — | 35 | |
| Vcc sc. | Maximum Vcc voltage with short circuit protection with Tj < -10℃ | — | 28 | |
| Iin max. | Maximum IN current | -1 | 10 | mA |
| Idg max. | Maximum diagnostic output current | -1 | 10 | |
| Vdg | Maximum diagnostic output voltage | -0.3 | 5.5 | V |
| Pd | Maximum power dissipation (internally limited by thermal protection) Rth=100℃/W | — | 1.25 | W |
| Isd cont. | Maximum continuous diode current (Rth=100℃/W) | — | 1.8 | A |
| ESD1 | Electrostatic discharge voltage (Human body) 100pF, 1500Ω | — | 4 | kV |
| ESD2 | Electrostatic discharge voltage (Machine Model) C=200pF,R=0Ω,L=10µH | — | 0.5 | |
| Tj op max. | Max. operating temperature junction temperature | -40 | +150 | ℃ |
| Tj Sto max. | Max. storage temperature junction temperature | -55 | +150 | ℃ |

## Thermal Characteristics

| Symbol | Parameter | Typ. | Max. | Units |
|---|---|---|---|---|
| Rth1 | Thermal resistance junction to ambient SO8 std. footprint | 100 | — | ℃/W |
| Rth1 | Thermal resistance junction to ambient TO220 free air | 60 | — | |
| Rth1 | Thermal resistance junction to ambient D2Pak std. footprint | 60 | — | |
| Rth2 | Thermal resistance junction to ambient D2Pak 1” sqrt. footprint | 40 | — | |
| Rth3 | Thermal resistance junction to case D2pak/TO220 | 4 | — | |

## 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 | V |
| VIL | Low level input voltage | -0.3 | 0.9 | |
| Iout | Continuous drain current, Tamb=85℃, Tj=125℃, Vin=5V, Rth=100℃/W | — | 1.5 | A |
| Rin | Recommended resistor in series with IN pin | 10 | 20 | kΩ |
| Rdgs | Recommended resistor in series with DG pin | 10 | 20 | |
| Rol | Recommended pull-up resistor for open load detection | 5 | 100 | |

## Static Electrical Characteristics

Tj=-40..150℃, Vcc=6..35V (unless otherwise specified), typical values are given for Vcc=14V and Tj=25℃

| Symbol | Parameter | Min. | Typ. | Max. | Units | Test Conditions |
|---|---|---|---|---|---|---|
| Rds(on) | ON state resistance Tj=25℃ | — | 80 | 120 | mΩ | Vin=5V, Iout=2A |
| | ON state resistance Tj=150℃ | — | 150 | 230 | | Vin=5V, Iout=2A |
| | ON state resistance Tj=25℃, Vcc=6.5V | — | 90 | 130 | | Vin=5V, Iout=2A |
| Vcc op. | Operating voltage range | 6 | — | 35 | V | |
| V clamp | Vcc to Out clamp voltage | 63 | 70 | — | | Iout=30mA (see Fig. 1) |
| Vf | Body diode forward voltage | — | 1 | 1.4 | | Iout= 2.5A |
| Icc Off | Supply current when Off | — | 2.5 | 10 | µA | Vin=Vout=0V, Tj=25℃ |
| Icc On | Supply current when On | — | 2.5 | 4 | mA | Vin=5V, Vcc=14V |
| Iout@0V | Output leakage current | — | — | 10 | µA | Vout=0V |
| Iout@6V | Output leakage current | — | 20 | — | | Vout=6V |
| Idg leakage | Diagnostic output leakage current | — | — | 10 | | Vdg=5.5V |
| Vdgl | Low level diagnostic output voltage | — | 0.1 | 0.3 | V | Idg=1.6mA |
| Vih | Input high threshold voltage | — | 2.5 | 3.5 | | |
| Vil | Input low threshold voltage | 1 | 2 | — | | |
| In hys | Input hysteresis | 0.05 | 0.4 | 1 | | |
| UV high | Under voltage high threshold voltage | — | 5 | 6.2 | | |
| UV low | Under voltage low threshold voltage | 3 | 4.5 | 5.9 | | |
| UV hys | Under voltage hysteresis | 0.1 | 0.8 | 1.5 | | |
| Iin On | Input current when device is On | — | 40 | 80 | µA | Vin=5V |

## Switching Electrical Characteristics

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

| Symbol | Parameter | Min. | Typ. | Max. | Units | Test Conditions |
|---|---|---|---|---|---|---|
| Tdon | Turn-on delay time | — | 12 | 35 | µs | See Fig. 3 |
| Tr1 | Rise time to Vout=Vcc-5V | — | 7 | 40 | | |
| Tr2 | Rise time to Vout=0.9 x Vcc | — | 14 | 50 | | |
| dV/dt (On) | Turn On dV/dt | — | 0.95 | 5 | V/µs | |
| EOn | Turn On energy | — | 250 | — | µJ | |
| Tdoff | Turn-off delay time | — | 20 | 45 | µs | |
| Tf | Fall time to Vout=0.1 x Vcc | — | 6 | 25 | | |
| dV/dt (Off) | Turn Off dV/dt | — | 1.8 | 5 | V/µs | |
| EOff | Turn Off energy | — | 20 | — | µJ | |
| Tdiag | Vout to Vdiag propagation delay | — | 15 | — | µs | See Fig. 4 and Fig. 12 |

## Protection Characteristics

Tj=-40..150℃, Vcc=6..35V (unless otherwise specified), typical values are given for Vcc=14V and Tj=25℃

| Symbol | Parameter | Min. | Typ. | Max. | Units | Test Conditions |
|---|---|---|---|---|---|---|
| Ilim | Internal current limit | 2 | 5 | 8 | A | Vout=0V, Tj=25℃ |
| Tsd+ | Over temperature high threshold | 150[1] | 165 | — | ℃ | See Fig. 2 |
| Tsd- | Over temperature low threshold | — | 158 | — | | |
| Vsc | Short-circuit detection voltage [2] | 2 | 3 | 4 | V | |
| Vopen load | Open load detection threshold | 2 | 3 | 4 | | |

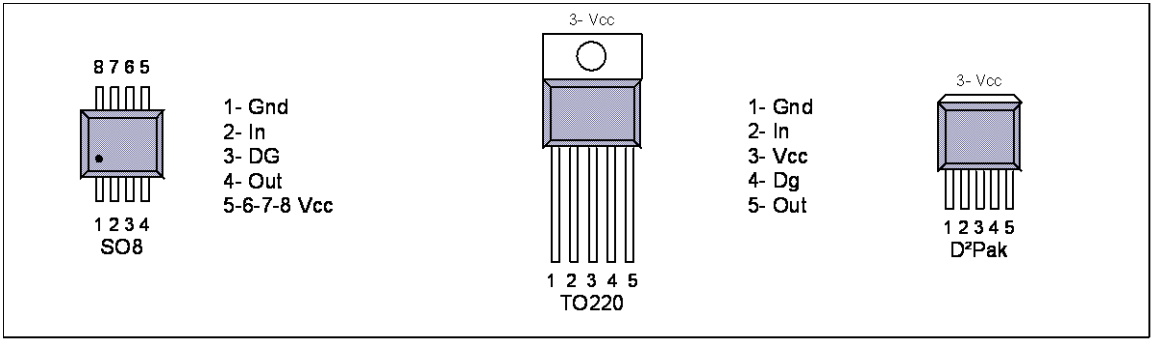
[1] Guaranteed by design
[2] Reference to Vcc

## Truth Table

| Operating Conditions | IN | OUT | DG pin |
|---|---|---|---|
| Normal | H | H | H |
| Normal | L | L | L |
| Open Load | H | H | H |
| Open Load [3] | L | H | H |
| Short circuit to Gnd | H | L (limiting) | L |
| Short circuit to Gnd | L | L | L |
| Over-temperature | H | L (cycling) | L |
| Over-temperature | L | L | L |

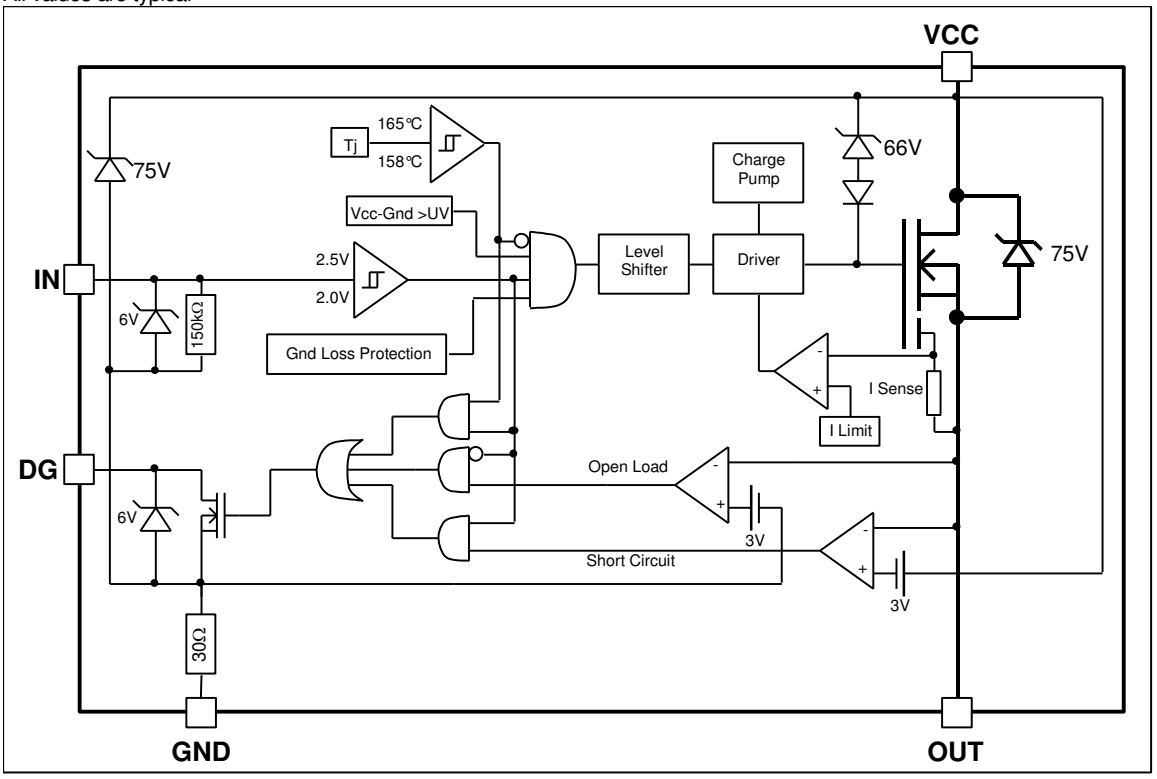
[3] With a pull-up resistor connected between the output and Vcc.

## Lead Assignments



## Functional Block Diagram

All values are typical



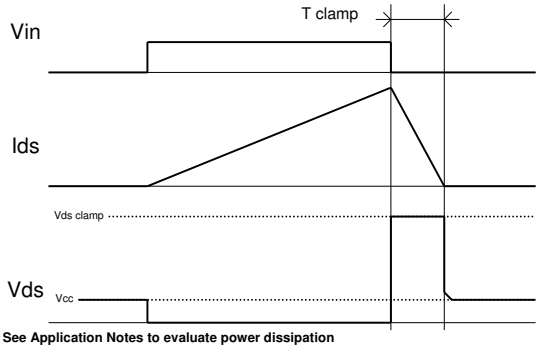



**Figure 1 – Active clamp waveforms**

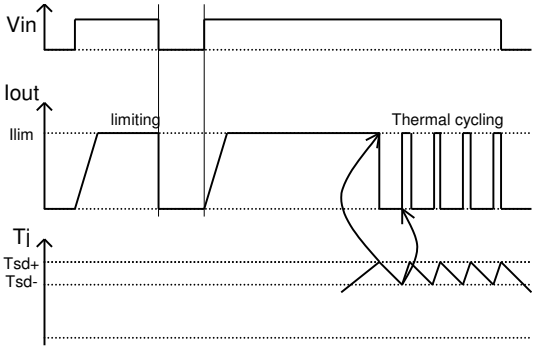



**Figure 2 – Protection timing diagram**

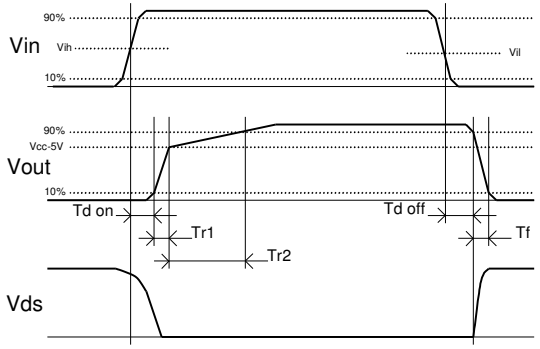



**Figure 3 – Switching times definition**

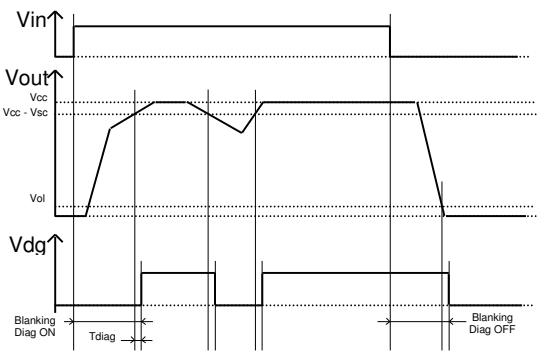



**Figure 4 – Diagnostic delay definition**

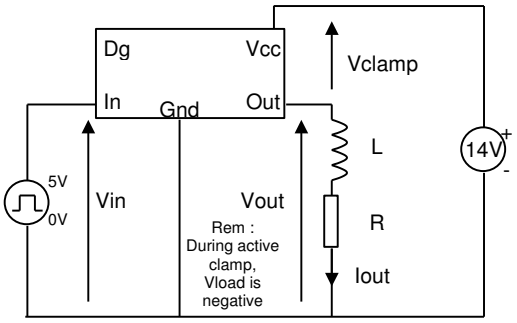



**Figure 5 – Active clamp test circuit**

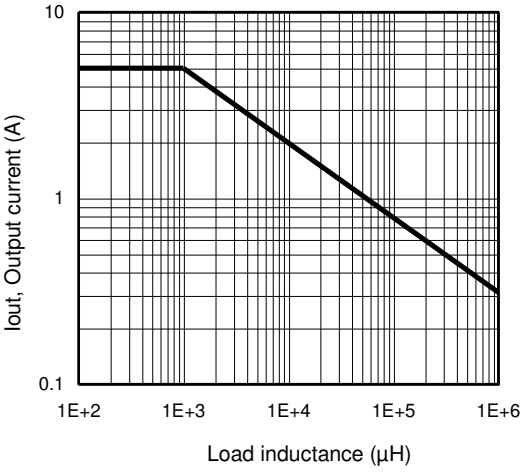



**Figure 6 – Max. Output current (A) Vs Load inductance (µH)**

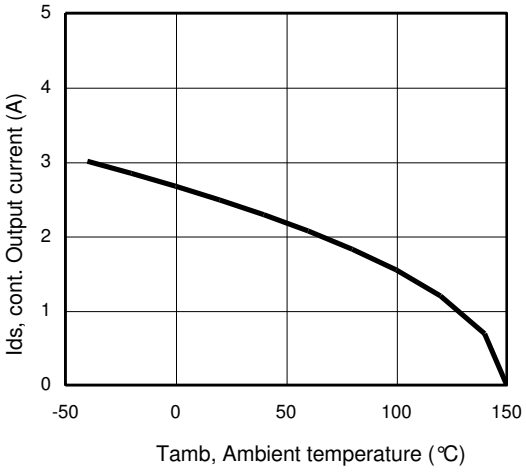



**Figure 7 – Max. ouput current (A) Vs Ambient temperature (°C) Rth=100°C/W**

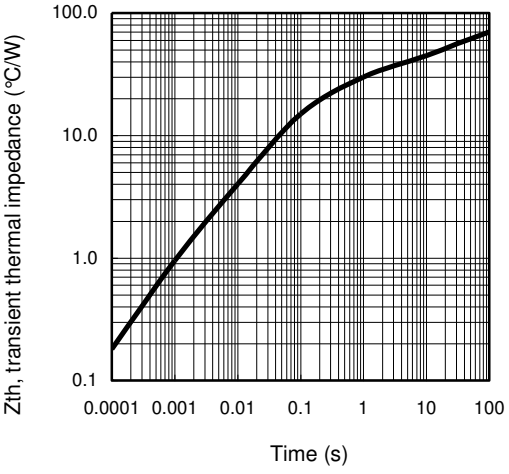



**Figure 8 – Transient thermal impedance (°C/W) Vs time (s)**

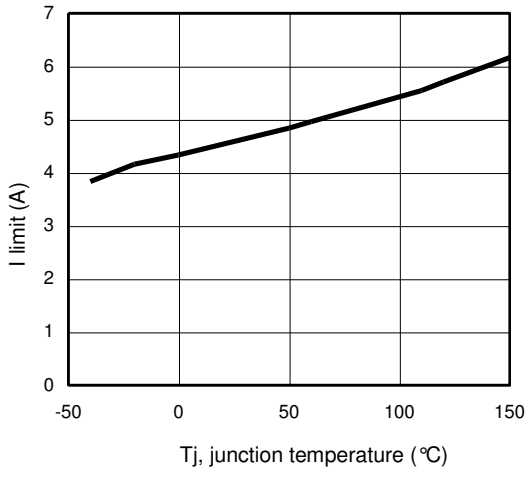



**Figure 9 –I limit (A)**
**Vs junction temperature (°C)**

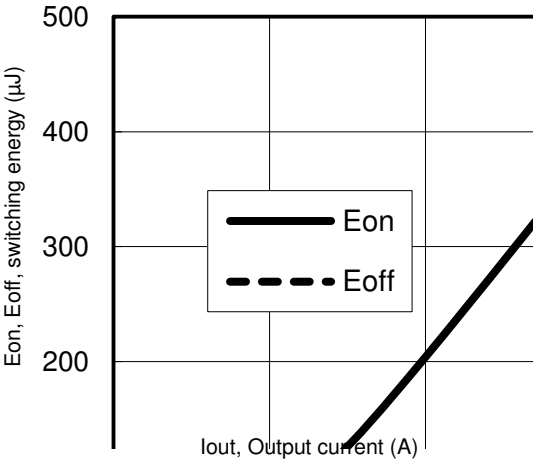



**Figure 10 – Switching energy (µJ)**
**Vs Output current (A)**

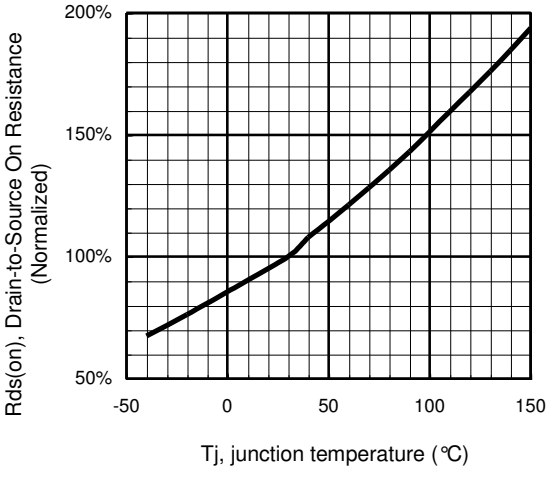



**Figure 11 - Normalized Rds(on) (%) Vs Tj (°C)**

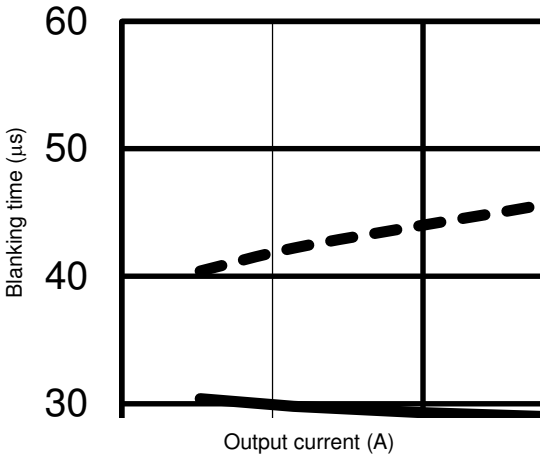



**Figure 12 – Diagnostic Blanking time (µs)**
**Vs Output current (A)**

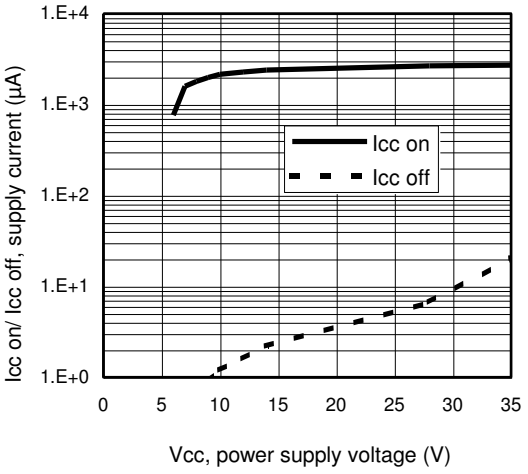



**Figure 13 – Icc on/ Icc off (µA) Vs Vcc (V)**

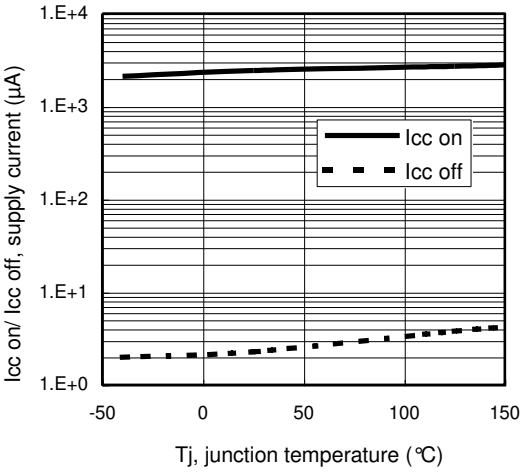
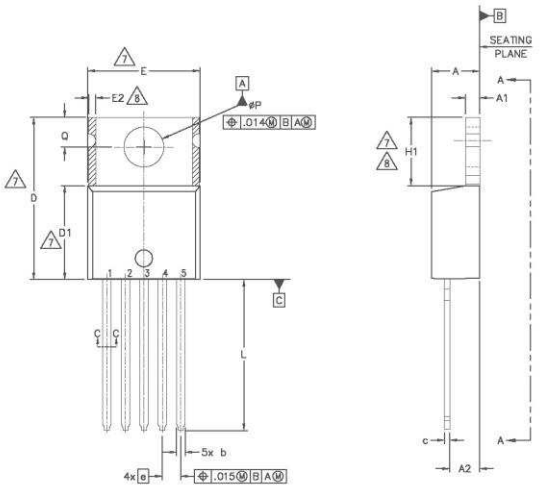
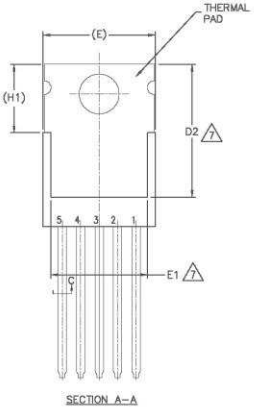
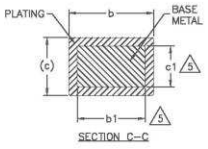



**Figure 14 – Icc on/ Icc off (µA) Vs Tj (°C)**

## Case outline - TO220



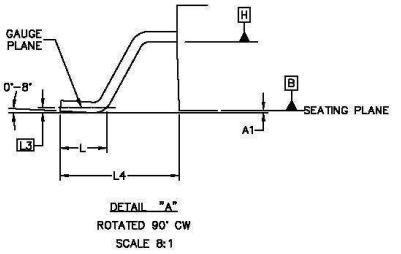




| SYMBOL | DIMENSIONS | | | | NOTES |
|---|---|---|---|---|---|
| | MILLIMETERS | | INCHES | | |
| | MIN. | MAX. | MIN. | MAX. | |
| A | 3.56 | 4.83 | .140 | .190 | |
| A1 | 0.51 | 1.40 | .020 | .055 | |
| A2 | 2.03 | 2.92 | .080 | .115 | |
| b | 0.64 | 0.89 | .025 | .035 | |
| b1 | 0.64 | 0.84 | .025 | .033 | 5 |
| 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 | 11.68 | 12.88 | .460 | .507 | 7 |
| E | 9.65 | 10.67 | .380 | .420 | 4,7 |
| E1 | 6.86 | 8.89 | .270 | .350 | 7 |
| E2 | – | 0.76 | – | .030 | 8 |
| e | 1.70 BSC | | .067 BSC | | |
| H1 | 5.84 | 6.86 | .230 | .270 | 7,8 |
| L | 12.70 | 14.73 | .500 | .580 | |
| øP | 3.53 | 3.73 | .139 | .147 | |
| Q | 2.54 | 3.05 | .100 | .120 | |

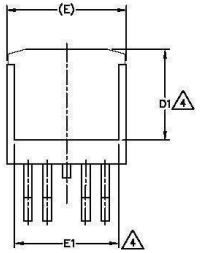
NOTES:

1.– DIMENSIONING AND TOLERANCING AS PER ASME Y14.5 M– 1994.
2.– DIMENSIONS ARE SHOWN IN INCHES [MILLIMETERS].
3.– LEAD DIMENSION AND FINISH UNCONTROLLED IN L1.
4.– DIMENSION D, D1 & 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.– OUTLINE CONFORMS TO JEDEC TO–220, EXCEPT A2 (max.) AND D2 (min.) WHERE DIMENSIONS ARE DERIVED FROM THE ACTUAL PACKAGE OUTLINE.
10.– LEADS AND DRAIN ARE PLATED WITH 100% Sn

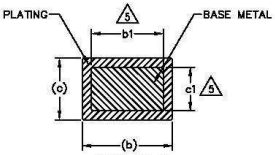
## Case outline – D²Pak



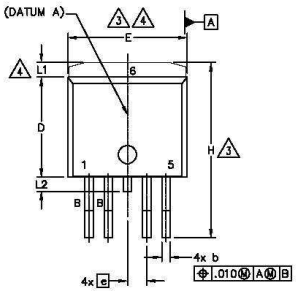

DETAIL "A"
ROTATED 90° CW
SCALE 8:1

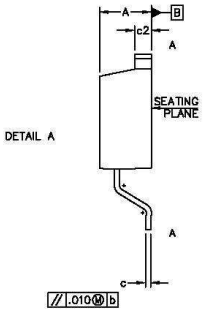



VIEW A–A




SECTION B–B
SCALE: NONE



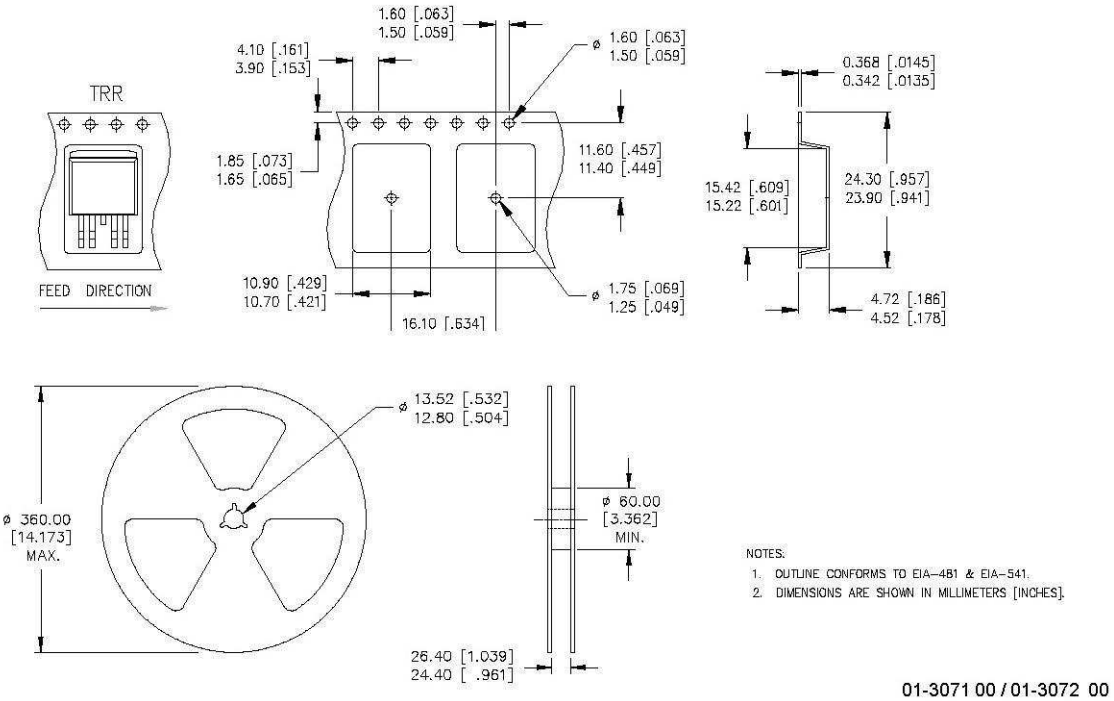




NOTES:

1. DIMENSIONING AND TOLERANCING AS 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 AT DATUM H.
4. THERMAL PAD CONTOUR OPTIONAL WITHIN DIMENSION E, L1, D1 & E1.
5. DIMENSION b1 AND c1 APPLY TO BASE METAL ONLY.
6. DATUM A & B TO BE DETERMINED AT DATUM PLANE H.
7. CONTROLLING DIMENSION: INCH.
8. OUTLINE CONFORMS TO JEDEC OUTLINE TO-263BA.
9. LEADS AND DRAIN ARE PLATED : 100% Sn

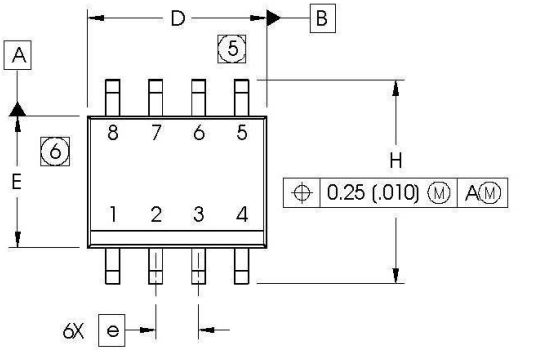
| SYMBOL | DIMENSIONS | | | | NOTES |
|---|---|---|---|---|---|
| | MILLIMETERS | | INCHES | | |
| | MIN. | MAX. | MIN. | MAX. | |
| A | 4.06 | 4.83 | .160 | .190 | |
| A1 | – | 0.254 | – | .010 | |
| b | 0.51 | 0.99 | .020 | .039 | 4 |
| b1 | 0.51 | 0.89 | .020 | .035 | |
| c | 0.38 | 0.74 | .015 | .029 | |
| c1 | 0.38 | 0.58 | .015 | .023 | 4 |
| c2 | 1.14 | 1.65 | .045 | .065 | |
| D | 8.38 | 9.65 | .330 | .380 | 3 |
| D1 | 6.86 | – | .270 | – | |
| E | 9.65 | 10.67 | .380 | .420 | 3 |
| E1 | 6.22 | – | .245 | – | |
| e | 1.70 BSC | | .067 BSC | | |
| H | 14.61 | 15.88 | .575 | .625 | |
| L | 1.78 | 2.79 | .070 | .110 | |
| L1 | – | 1.68 | – | .066 | |
| L2 | – | 1.78 | – | .070 | |
| L3 | 0.25 BSC | | .010 BSC | | |
| L4 | 4.78 | 5.28 | .188 | .208 | |

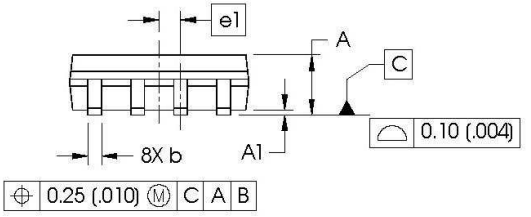
## Tape and reel – D²Pak

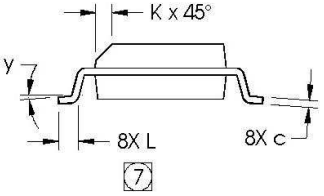


## Case Outline - SO-8

Dimensions are shown in millimeters (inches)



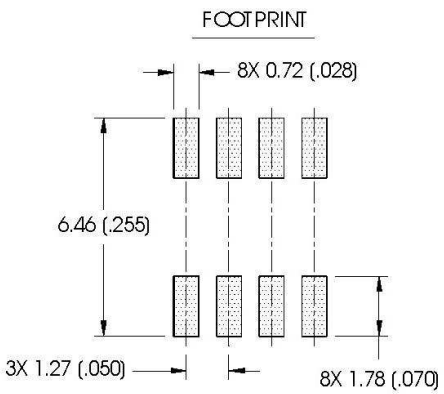



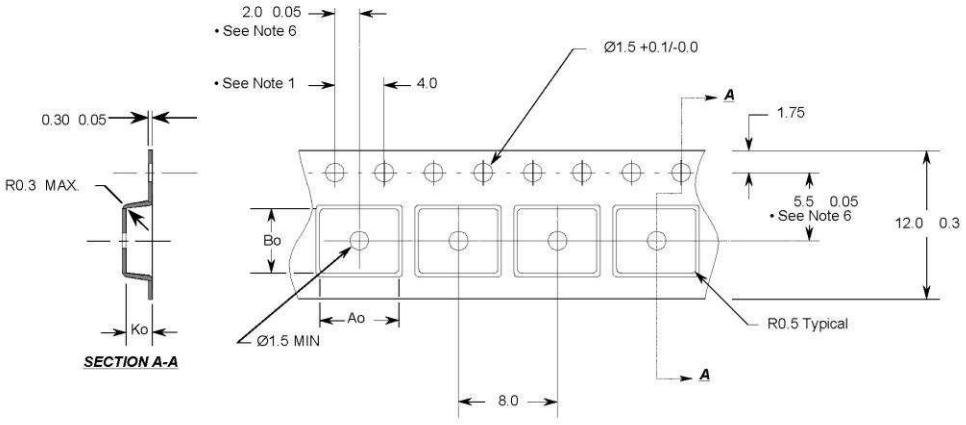

| DIM | INCHES | | MILLIMETERS | |
|---|---|---|---|---|
| | MIN | MAX | MIN | MAX |
| A | .0532 | .0688 | 1.35 | 1.75 |
| A1 | .0040 | .0098 | 0.10 | 0.25 |
| b | .013 | .020 | 0.33 | 0.51 |
| c | .0075 | .0098 | 0.19 | 0.25 |
| D | .189 | .1968 | 4.80 | 5.00 |
| E | .1497 | .1574 | 3.80 | 4.00 |
| 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.



## Tape & Reel - SO-8

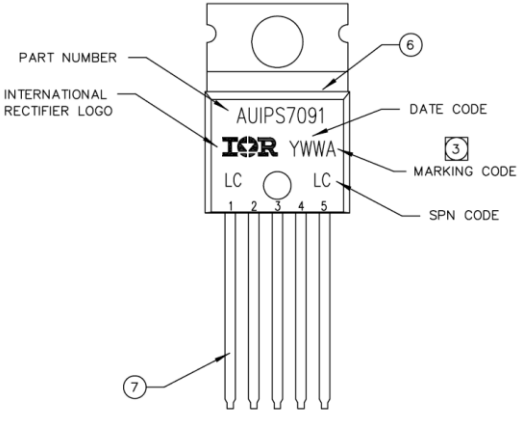


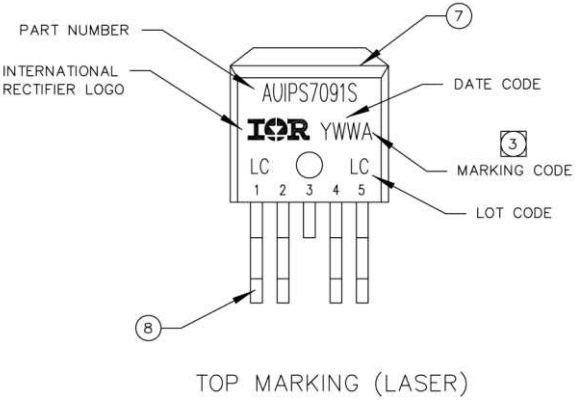

**Notes:**
1. 10 sprocket hole pitch cumulative tolerance 0.2
2. Camber not to exceed 1mm in 100mm
3. Material: Black Conductive Advantek Polystyrene
4. Ao and Bo measured on a plane 0.3mm above the bottom of the pocket
5. Ko measured from a plane on the inside bottom of the pocket to the top surface of the carrier.
6. Pocket position relative to sprocket hole measured as true position of pocket, not pocket hole.

Ao = 6.4 mm
Bo = 5.2 mm
Ko = 2.1 mm

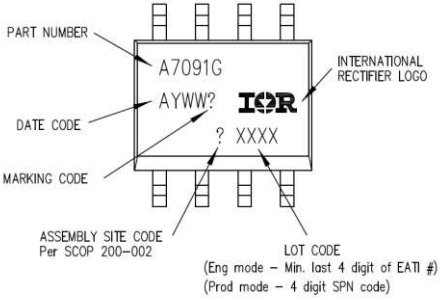
- All Dimensions in Millimeters -

## Part Marking Information




TOP MARKING (LASER)




TOP MARKING (LASER)

## Ordering Information

| Base Part Number | Package Type | Standard Pack | | Complete Part Number |
|---|---|---|---|---|
| | | Form | Quantity | |
| AUIPS7091 | TO220-5-Leads | Tube | 50 | AUIPS7091 |
| AUIPS7091S | D2-Pak-5-Leads | Tube | 50 | AUIPS7091S |
| | | Tape and reel left | 800 | AUIPS7091STRL |
| | | Tape and reel right | 800 | AUIPS7091STRR |
| AUIPS7091G | SOIC-8 | Tube | 95 | AUIPS7091G |
| | | Tape and reel | 2500 | AUIPS7091GTR |

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

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Tel: (310) 252-7105

## Revision History

| Revision | Date | Notes/Changes |
|---|---|---|
| A1 | October 2011 | First release |
| B | March 2012 | Remove the preliminary mention |
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