

### DUAL CHANNELS CURRENT SENSE HIGH SIDE SWITCH

#### Features

- 24V battery system
- Over current shutdown
- Over temperature shutdown
- Current sensing
- Active clamp
- Low quiescent current
- ESD protection
- Optimized Turn On/Off for EMI
- Lead free and RoHS compliant

#### Applications

- 21W Filament lamp
- Solenoid
- 24V truck loads

#### Description

The AUIPS7142G is a fully protected dual high side switch specifically designed for driving lamp. It features current sensing, over-current, over-temperature, ESD protection and drain to source active clamp. The Ifb pin is used for current sensing. The over-current shutdown is higher than inrush current of the lamp.

#### Product Summary

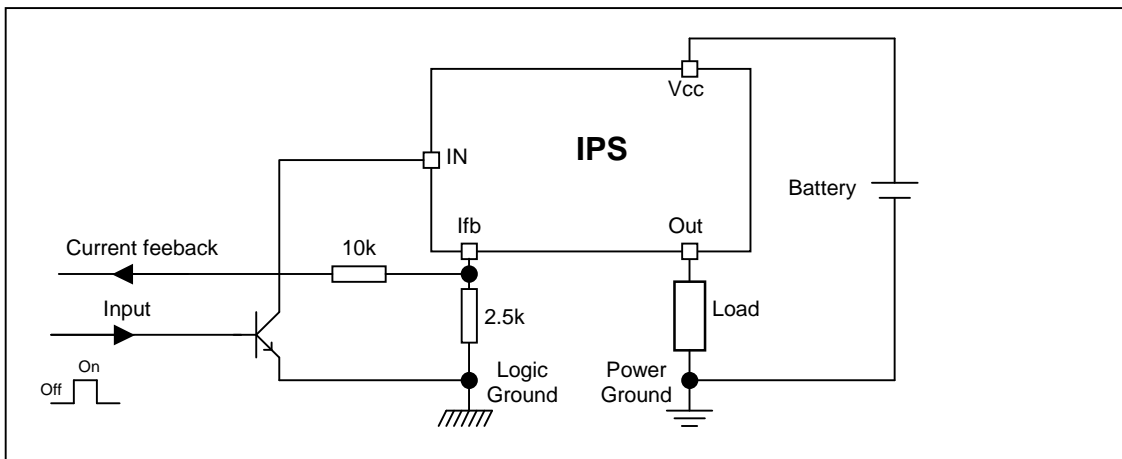
Rds(on)	100mΩ max.
Vclamp	65V
Current shutdown	20A min.

#### Package



SOIC16L-Wide Body

#### Typical Connection



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

<b>Qualification Level</b>		Automotive (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-16L WB	MSL2, 260°C (per IPC/JEDEC J-STD-020)
<b>ESD</b>	Machine Model	Class <b>M4</b> (+/-450V) (per AEC-Q100-003)	
	Human Body Model	Class <b>H2</b> (+/-4000V) (per AEC-Q100-002)	
	Charged Device Model	Class <b>C4</b> (+/-1000V) (per AEC-Q100-011)	
<b>IC Latch-Up Test</b>		Class <b>II</b> , Level <b>A</b> (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. ( $T_j = -40^{\circ}\text{C}..150^{\circ}\text{C}$ ,  $V_{cc}=6..50\text{V}$  unless otherwise specified).

Symbol	Parameter	Min.	Max.	Units
Vout	Maximum output voltage	$V_{cc}-60$	$V_{cc}+0.3$	V
I rev	Maximum reverse pulsed current ( $t=100\mu\text{s}$ ) see page 8	—	30	A
I <sub>sd</sub> cont.	Maximum diode continuous current $T_{\text{ambient}}=25^{\circ}\text{C}$ , $R_{\text{th}}=40^{\circ}\text{C/W}$ / per channel	—	1.7	
V <sub>cc</sub> -V <sub>in</sub> max.	Maximum V <sub>cc</sub> voltage	-16	60	V
I <sub>ifb</sub> , max.	Maximum feedback current	-50	10	mA
V <sub>cc</sub> sc.	Maximum V <sub>cc</sub> voltage with short circuit protection see page 8	—	50	V
P <sub>d</sub>	Maximum power dissipation (internally limited by thermal protection) $R_{\text{th}}=40^{\circ}\text{C/W}$	—	3	W
T <sub>j</sub> max.	Max. storage & operating junction temperature	-40	150	

## Thermal Characteristics

Symbol	Parameter	Typ.	Max.	Units
R <sub>th1</sub>	Thermal resistance junction to ambient 6cm <sup>2</sup> footprint one Mosfet on	45	—	$^{\circ}\text{C/W}$
R <sub>th2</sub>	Thermal resistance junction to ambient 6cm <sup>2</sup> footprint two Mosfet on	40	—	

note :  $T_j - T_{\text{ambient}} = \text{Power dissipated in the 2 channel} \times R_{\text{th}}$

## Recommended Operating Conditions

These values are given for a quick design.

Symbol	Parameter	Min.	Max.	Units
I <sub>out</sub>	Continuous output current, $T_{\text{ambient}}=85^{\circ}\text{C}$ , $T_j=125^{\circ}\text{C}$ $R_{\text{th}}=40^{\circ}\text{C/W}$ , 6cm <sup>2</sup> footprint	—	1.5	A
R <sub>I<sub>fb</sub></sub>	I <sub>fb</sub> resistor	1.5	—	

## Static Electrical Characteristics

 $T_j = -40^{\circ}\text{C}..150^{\circ}\text{C}$ ,  $V_{cc} = 6-50\text{V}$  (unless otherwise specified)

Symbol	Parameter	Min.	Typ.	Max.	Units	Test Conditions
Vcc op.	Operating voltage	6	—	60	V	
Rds(on)	ON state resistance $T_j = 25^{\circ}\text{C}$	—	75	100	m $\Omega$	Ids=2A
	ON state resistance $T_j = 150^{\circ}\text{C}(2)$	—	135	180		
Icc off	Supply leakage current	—	1	3	$\mu\text{A}$	Vin=Vcc / Vifb=Vgnd Vout=Vgnd, $T_j = 25^{\circ}\text{C}$
Iout off	Output leakage current	—	1	3		
I in on	Input current while on	0.6	2	4	mA	Vcc-Vin=28V, $T_j = 25^{\circ}\text{C}$
V clamp1	Vcc to Vout clamp voltage 1	60	64	—	V	Id=10mA
V clamp2	Vcc to Vout clamp voltage 2	60	65	72		Id=6A see fig. 2
Vih(1)	High level Input threshold voltage	—	3	5		Id=10mA
Vil(1)	Low level Input threshold voltage	1.5	2.3	—		
Vf	Forward body diode voltage $T_j = 25^{\circ}\text{C}$	—	0.8	0.9		If=1A
	Forward body diode voltage $T_j = 125^{\circ}\text{C}$	—	0.65	0.75		

(1) Input thresholds are measured directly between the input pin and Vcc.

## Switching Electrical Characteristics

 $V_{cc} = 28\text{V}$ , Resistive load=27 $\Omega$ ,  $T_j = -40^{\circ}\text{C}..150^{\circ}\text{C}$ 

Symbol	Parameter	Min.	Typ.	Max.	Units	Test Conditions
Tdon	Turn on delay time to 20%	4	10	20	μs	See fig. 1
Tr	Rise time from 20% to 80% of Vcc	2	5	10		
Tdoff	Turn off delay time	20	40	80	μs	
Tf	Fall time from 80% to 20% of Vcc	2.5	5	10		

## Protection Characteristics

 $T_j = -40^{\circ}\text{C}..150^{\circ}\text{C}$ ,  $V_{cc} = 6-50\text{V}$  (unless otherwise specified)

Symbol	Parameter	Min.	Typ.	Max.	Units	Test Conditions
Tsd	Over temperature threshold	150(2)	165	—	$^{\circ}\text{C}$	See fig. 3 and fig.11
I <sub>sd</sub>	Over-current shutdown	20	25	37	A	See fig. 3 and page 7
I fault	I <sub>fb</sub> after an over-current or an over-temperature (latched)	2.2	3	5	mA	See fig. 3

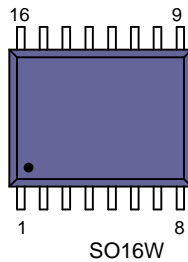
## Current Sensing Characteristics

 $T_j = -40^{\circ}\text{C}..150^{\circ}\text{C}$ ,  $V_{cc} = 6-50\text{V}$  (unless otherwise specified). Specified 500 $\mu\text{s}$  after the turn on.  $V_{cc}-V_{ifb} > 4\text{V}$ 

Symbol	Parameter	Min.	Typ.	Max.	Units	Test Conditions
Ratio	I load / I <sub>fb</sub> current ratio	2000	2400	2800		Iload<4A
Ratio_TC	I load / I <sub>fb</sub> variation over temperature(2)	-5%	0	+5	%	$T_j = -40^{\circ}\text{C}$ to $+150^{\circ}\text{C}$
I offset	Load current offset	-0.02	0	0.02	A	Iout<4A
I <sub>fb</sub> leakage	I <sub>fb</sub> leakage current On in open load	0	1	10	$\mu\text{A}$	Iout=0A, Vcc-Vin=28V

(2) Guaranteed by design

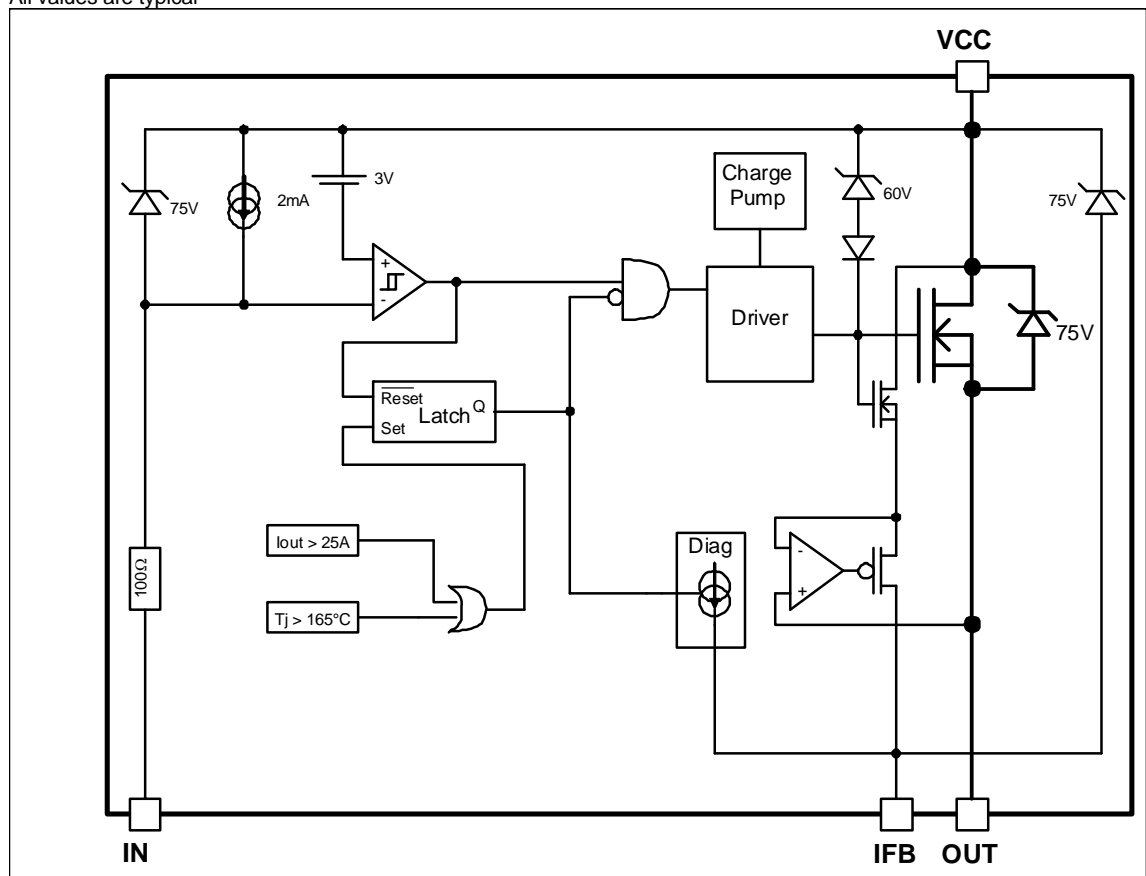
## Lead Assignments



- 1-2- Vcc
- 3- In1
- 4- Ifb1
- 5- In2
- 6- Ifb2
- 7-8-9-Vcc
- 10-11-12- Out2
- 13-14-15- Out1
- 16- Vcc

## Functional Block Diagram

All values are typical



## Truth Table

Op. Conditions	Input	Output	I <sub>fb</sub> pin voltage
Normal mode	H	L	0V
Normal mode	L	H	I <sub>load</sub> x R <sub>fb</sub> / Ratio
Open load	H	L	0V
Open load	L	H	0V
Short circuit to GND	H	L	0V
Short circuit to GND	L	L	V fault (latched)
Over temperature	H	L	0V
Over temperature	L	L	V fault (latched)

## Operating voltage

**Maximum V<sub>cc</sub> voltage** : this is the maximum voltage before the breakdown of the IC process.

**Operating voltage** : This is the V<sub>cc</sub> range in which the functionality of the part is guaranteed. The AEC-Q100 qualification is run at the maximum operating voltage specified in the datasheet.

## Reverse battery

During the reverse battery the Mosfet is kept off and the load current is flowing into the body diode of the power Mosfet.

Power dissipation in the IPS :  $P = I_{load} \cdot V_f$

There is no protection, so T<sub>j</sub> must be lower than 150°C in the worst case condition of current and ambient temperature.

If the power dissipation is too high in R<sub>fb</sub>, a diode in serial can be added to block the current.

The transistor used to pull-down the input should be a bipolar in order to block the reverse current. The 100ohm input resistor can not sustain continuously 16V (see V<sub>cc</sub>-V<sub>in</sub> max. in the Absolute Maximum Ratings section)

## Active clamp

The purpose of the active clamp is to limit the voltage across the MOSFET to a value below the body diode break down voltage to reduce the amount of stress on the device during switching.

The temperature increase during active clamp can be estimated as follows:

$$\Delta T_j = P_{CL} \cdot Z_{TH}(t_{CLAMP})$$

Where:  $Z_{TH}(t_{CLAMP})$  is the thermal impedance at t<sub>CLAMP</sub> and can be read from the thermal impedance curves given in the data sheets.

$P_{CL} = V_{CL} \cdot I_{CLavg}$  : Power dissipation during active clamp

$V_{CL} = 65V$  : Typical V<sub>CLAMP</sub> value.

$$I_{CLavg} = \frac{I_{CL}}{2} : \text{Average current during active clamp}$$

$$t_{CL} = \frac{I_{CL}}{\left| \frac{di}{dt} \right|} : \text{Active clamp duration}$$

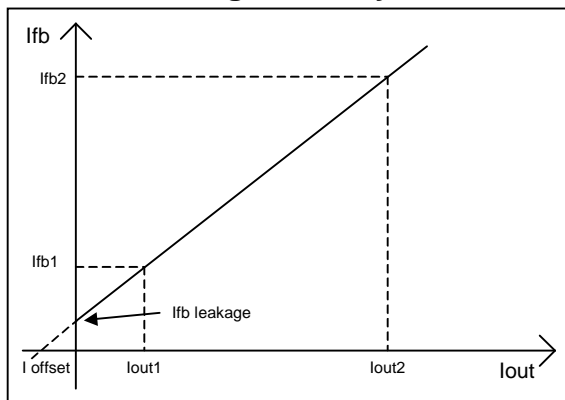
$$\frac{di}{dt} = \frac{V_{Battery} - V_{CL}}{L} : \text{Demagnetization current}$$

Figure 9 gives the maximum inductance versus the load current in the worst case : the part switch off after an over temperature detection. If the load inductance exceed the curve, a free wheeling diode is required.

## Over-current protection

The threshold of the over-current protection is set in order to guaranteed that the device is able to turn on a load with an inrush current lower than the minimum of  $I_{sd}$ . Nevertheless for high current and high temperature the device may switch off for a lower current due to the over-temperature protection. This behavior is shown in Figure 11.

## Current sensing accuracy



The current sensing is specified by measuring 3 points :

- Ifb1 for Iout1
- Ifb2 for Iout2
- Ifb leakage for Iout=0

The parameters in the datasheet are computed with the following formula :

$$\text{Ratio} = (I_{out2} - I_{out1}) / (I_{fb2} - I_{fb1})$$

$$I_{offset} = I_{fb1} \times \text{Ratio} - I_{out1}$$

This allows the designer to evaluate the Ifb for any Iout value using :

$$I_{fb} = (I_{out} + I_{offset}) / \text{Ratio} \text{ if } I_{fb} > I_{fb \text{ leakage}}$$

For some applications, a calibration is required. In that case, the accuracy of the system will depends on the variation of the  $I_{offset}$  and the ratio over the temperature range. The ratio variation is given by  $\text{Ratio}_{TC}$  specified in page 4.

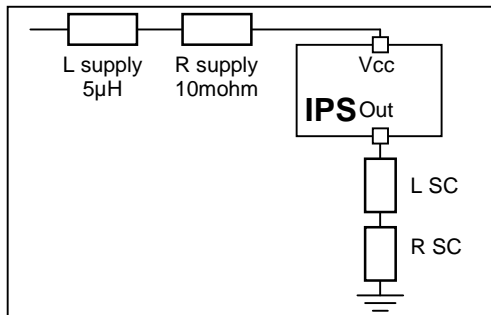
The  $I_{offset}$  variation depends directly on the  $R_{dson}$  :

$$I_{offset@-40^{\circ}C} = I_{offset@25^{\circ}C} / 0.8$$

$$I_{offset@150^{\circ}C} = I_{offset@25^{\circ}C} / 1.9$$

## Maximum Vcc voltage with short circuit protection

The maximum Vcc voltage with short circuit is the maximum voltage for which the part is able to protect itself under test conditions representative of the application. 2 kind of short circuits are considered : terminal and load short circuit.

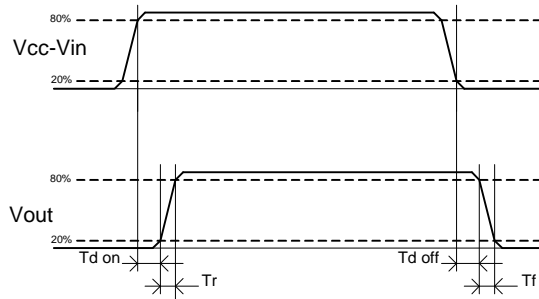


	L SC	R SC
Terminal SC	0.1 $\mu$ H	10 mohm
Load SC	10 $\mu$ H	100 mohm

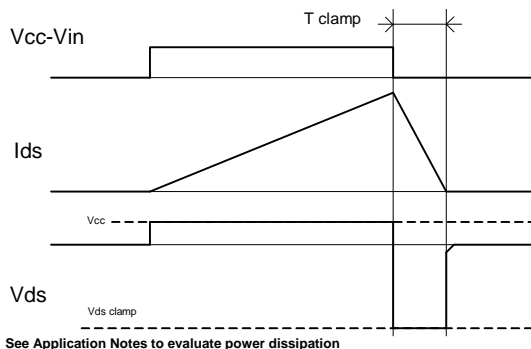
## Maximum current during reverse circulation

In case of short circuit to battery, a voltage drop of the Vcc may create a current which circulate in reverse mode. When the device is on, this reverse circulation current will not trigger the internal fault latch. This immunization is also true when the part turns on while a reverse current flows into the device. The maximum current ( $I_{rev}$ ) is specified in the maximum rating section.

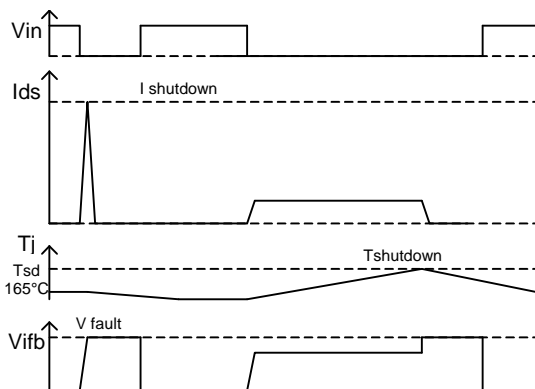




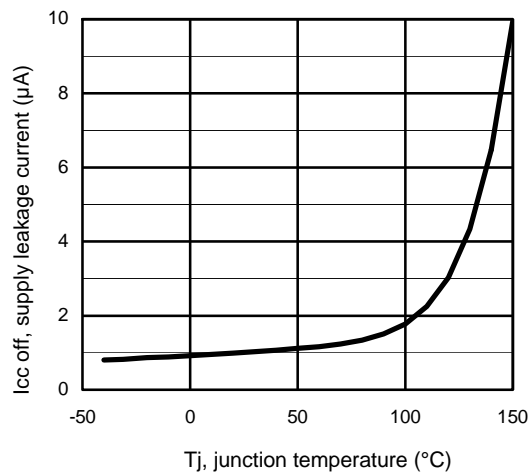
**Figure 1 – IN rise time & switching definitions**



**Figure 2 – Active clamp waveforms**



**Figure 3 – Protection timing diagram**



**Figure 4 – Icc off (µA) Vs Tj (°C)**

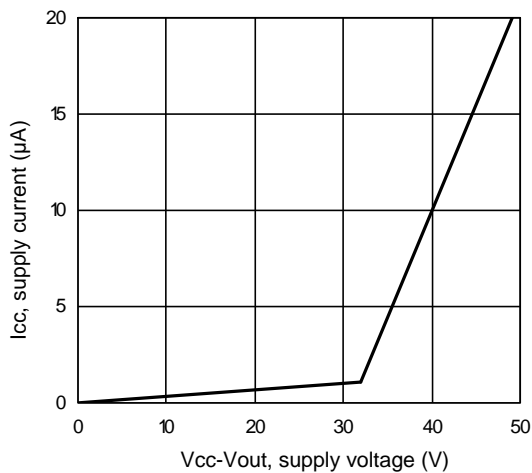


Figure 5 – Icc off (μA) Vs Vcc-Vout (V)

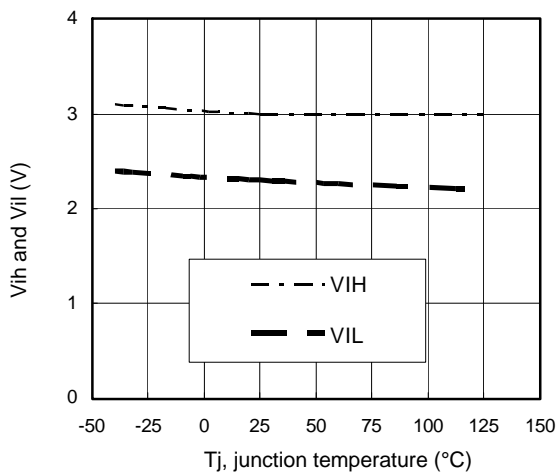


Figure 6 – Vih and Vil (V) Vs Tj (°C)

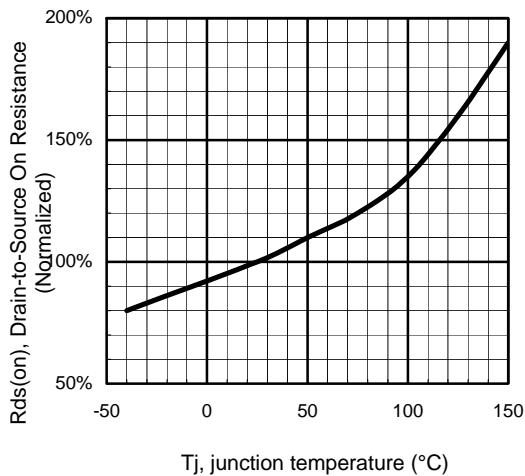


Figure 7 - Normalized Rds(on) (%) Vs Tj (°C)

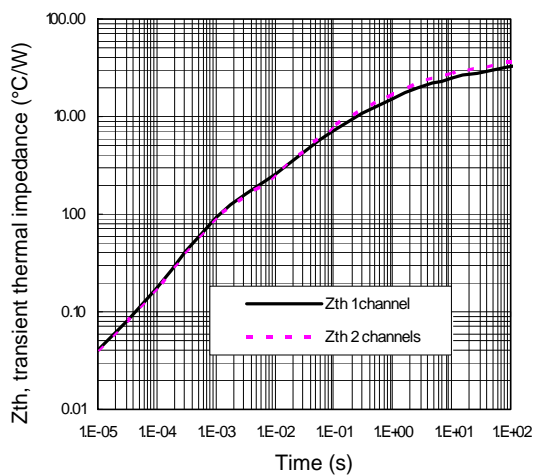
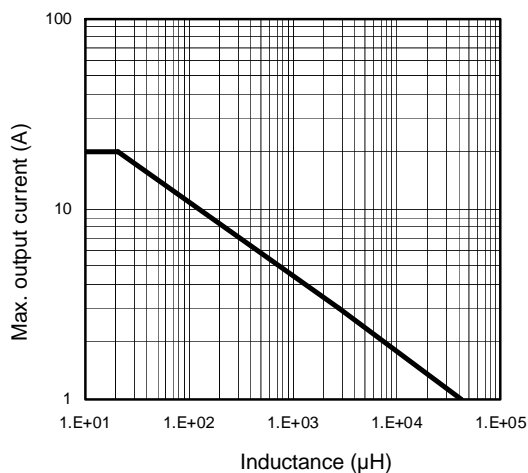
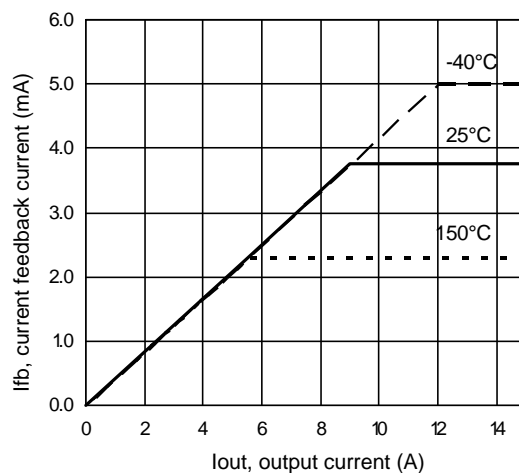


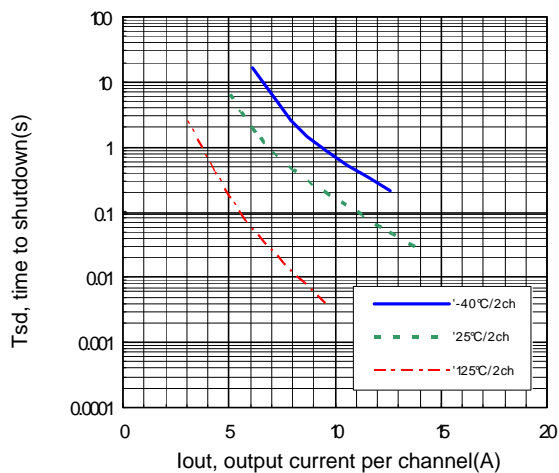
Figure 8 – Transient thermal impedance (°C/W) Vs time (s)



**Figure 9 – Max. I<sub>out</sub> (A) Vs inductance (μH)**

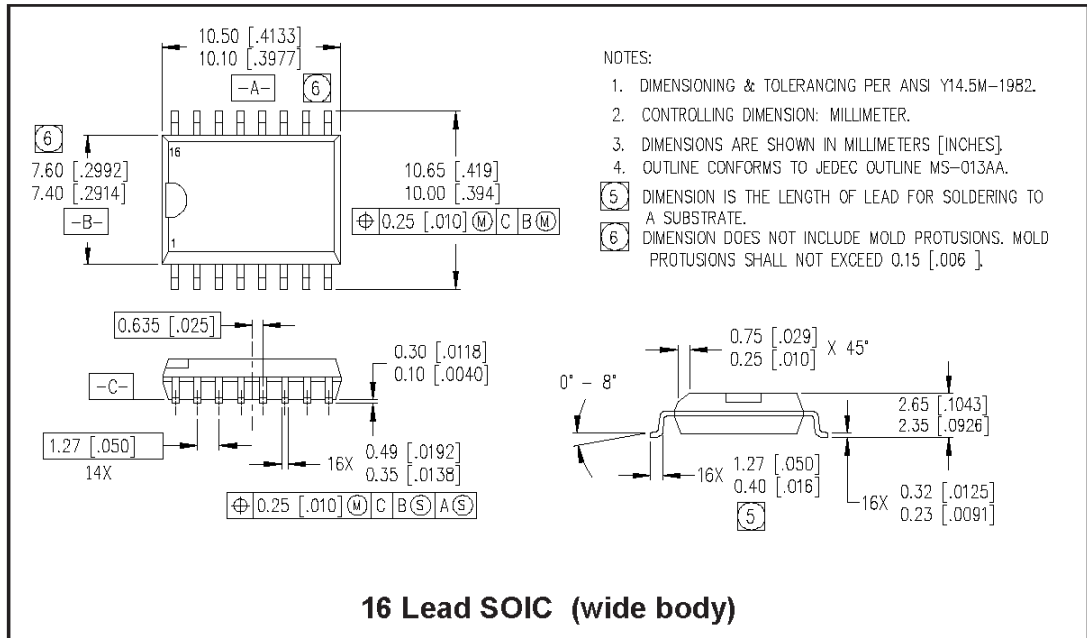


**Figure 10 – I<sub>fb</sub> (mA) Vs I<sub>out</sub> (A)**

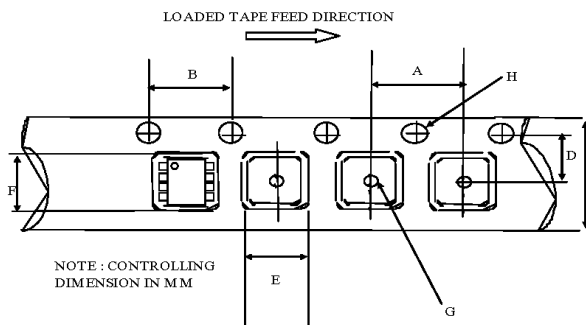


**Figure 11 – Tsd (s) Vs I<sub>out</sub> (A)  
2 channels on**

## Case Outline SOIC16W

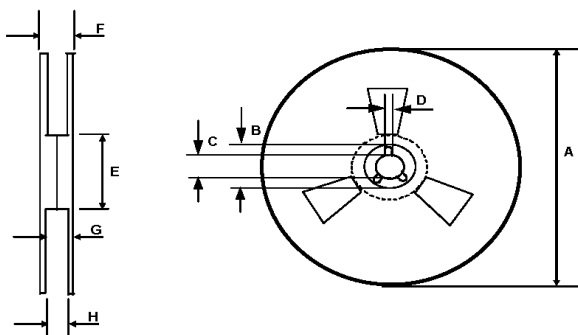


## Tape and Reel – SOIC16W



CARRIER TAPE DIMENSION FOR 16SOICW

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	15.70	16.30	0.618	0.641
D	7.40	7.60	0.291	0.299
E	10.80	11.00	0.425	0.433
F	10.60	10.80	0.417	0.425
G	1.50	n/a	0.059	n/a
H	1.50	1.60	0.059	0.062



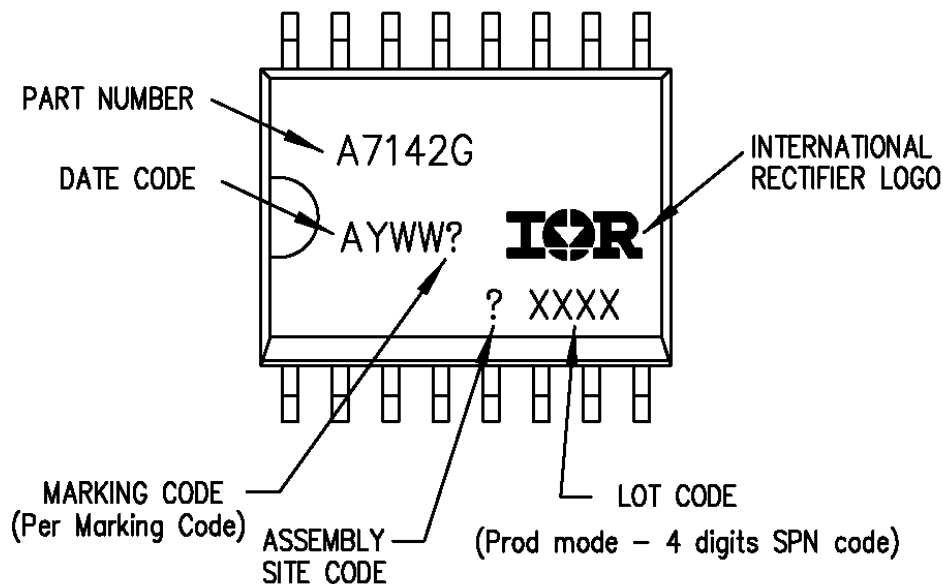
REEL DIMENSIONS FOR 16SOICW

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	22.40	n/a	0.881
G	18.50	21.10	0.728	0.830
H	16.40	18.40	0.645	0.724



## Part Marking Information

### TOP MARKING (LASER)



## Ordering Information

Base Part Number	Package Type	Standard Pack		Complete Part Number
		Form	Quantity	
AUIPS7142G	SO28W	Tube	45	AUIPS7142G
		Tape and reel	1500	AUIPS7142GTR

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## Revision History

Revision	Date	Notes/Changes
A3	April, 29 <sup>th</sup> 2010	Add tri-temp limits
A4	March, 17 <sup>th</sup> 2011	Au release
A5	March, 18 <sup>th</sup> 2011	Update lead free and RoHS 1 <sup>st</sup> page
A6	March, 24 <sup>th</sup> 2011	Add Tape and reel information

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