February, 21st 2010

Automotive grade

AUIPS71411G

CURRENT SENSE HIGH SIDE SWITCH

Features
- Suitable 24V battery operation
- Over current shutdown
- Over temperature shutdown
- Current sensing
- Active clamp
- Low current
- ESD protection
- Optimized Turn On/Off for EMI

Applications
- Solenoid
- 24V loads for trucks

Description
The AUIPS71411G is a fully protected four terminal high side switch specifically designed for 24V battery application. It features current sensing, over-current, over-temperature, ESD protection and drain to source active clamp. When the input voltage Vcc - Vin is higher than the specified threshold, the output power Mosfet is turned on. When the Vcc - Vin is lower than the specified Vil threshold, the output Mosfet is turned off. The Ifb pin is used for current sensing.

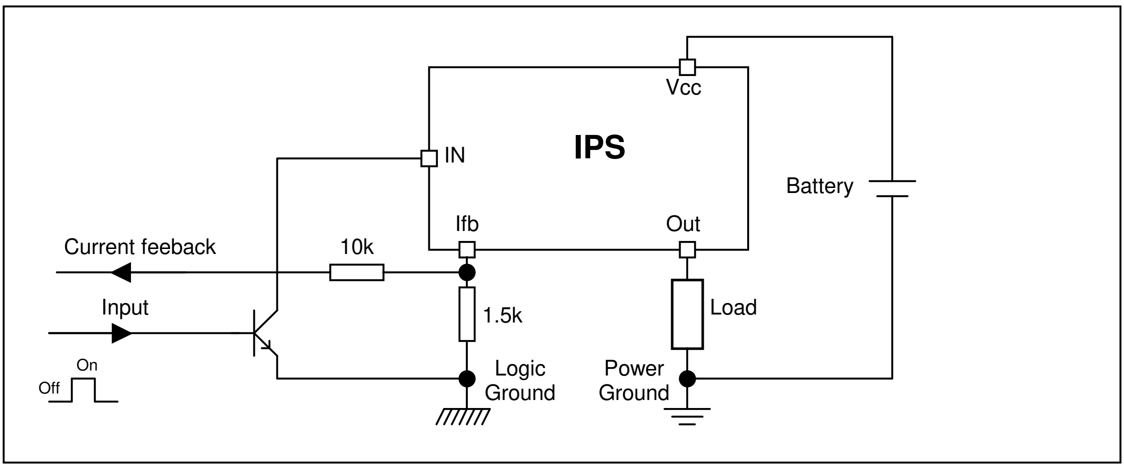
Product Summary

Rds(on)	100mΩ max.
Vclamp	65V
Current shutdown	5A min.

Packages

SO8

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		SOIC-8L	MSL2, 260°C (per IPC/JEDEC J-STD-020)
ESD	Machine Model	Class M2 (200 V) (per AEC-Q100-003)	
	Human Body Model	Class H1C (1500 V) (per AEC-Q100-002)	
	Charged Device Model	Class C5 (1000 V) (per AEC-Q100-011)	
IC Latch-Up Test		ClassII, Level A (per AEC-Q100-004)	
RoHS Compliant		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. All voltage parameters are referenced to the ground lead. (Tambient=25°C unless otherwise specified).

Symbol	Parameter	Min.	Max.	Units
Vout	Maximum output voltage	Vcc-60	Vcc+0.3	V
Vcc-Vin max.	Maximum Vcc voltage	-16	65	V
Iifb, max.	Maximum feedback current	-50	10	mA
Vcc sc.	Maximum Vcc voltage with short circuit protection see page 6	—	50	V
Pd	Maximum power dissipation (internally limited by thermal protection)			W
	Rth=100°C/W	—	1.25	
Tj max.	Max. storage & operating junction temperature	-40	150	°C

Thermal Characteristics

Symbol	Parameter	Typ.	Max.	Units
Rth1	Thermal resistance junction to ambient SO8	100	—	°C/W

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
Iout	Continuous output current, Tambient=85°C, Tj=125°C			A
	Rth=100°C/W	—	1.5	
RIfb	Ifb resistor	1.5	—	kΩ

Static Electrical Characteristics

Tj=25°C, Vcc=28V (unless otherwise specified)

Symbol	Parameter	Min.	Typ.	Max.	Units	Test Conditions
Vcc op.	Operating voltage	6	—	60	V	
Rds(on)	ON state resistance Tj=25°C	—	75	100	mΩ	Ids=2A
	ON state resistance Tj=150°C(2)	—	135	180		
Icc off	Supply leakage current	—	1	3	µA	Vin=Vcc / Vifb=Vgnd
Iout off	Output leakage current	—	1	3		Vout=Vgnd
I in on	Input current while on	0.6	1.6	3	mA	Vcc-Vin=28V
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	4.5		Id=10mA
Vil(1)	Low level Input threshold voltage	1.5	2.3	—		
	Forward body diode voltage Tj=25°C	—	0.8	0.9		If=1A
	Forward body diode voltage Tj=125°C	—	0.65	0.75		

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

Switching Electrical Characteristics

Vcc=28V, Resistive load=27Ω, Tj=25°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

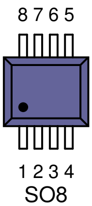
Symbol	Parameter	Min.	Typ.	Max.	Units	Test Conditions
Tsd	Over temperature threshold	150(2)	165	—	°C	See fig. 3 and fig. 11
Isd	Over-current shutdown	5	7	10	A	See fig. 3 and page 6
I fault	Ifb after an over-current or an over-temperature (latched)	2.7	3.3	4	mA	See fig. 3

Current Sensing Characteristics

Symbol	Parameter	Min.	Typ.	Max.	Units	Test Conditions
Ratio	I load / Ifb current ratio	2000	2400	2800		Iload=2A
Ratio_TC	I load / Ifb variation over temperature(2)	-5%	0	+5	%	Tj=-40°C to +150°C
I offset	Load current offset	-0.2	0	0.2	A	Iout<2A
Ifb leakage	Ifb leakage current	0	8	100	µA	Iout=0A

(2) Guaranteed by design

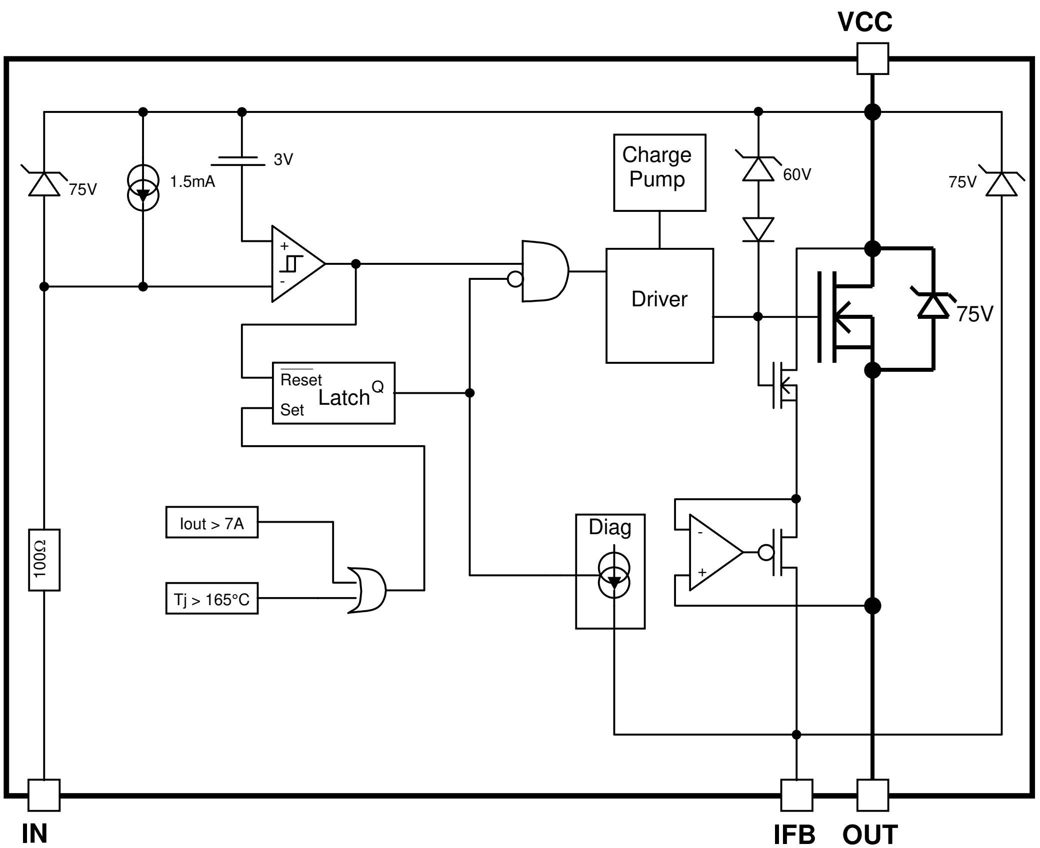
Lead Assignments



1- IN
2- IFB
3- Out
4- Out
5-6-7-8 Vcc

Functional Block Diagram

All values are typical



Truth Table

Op. Conditions	Input	Output	Ifb pin voltage
Normal mode	H	L	0V
Normal mode	L	H	I load x Rfb / 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 Vcc voltage : this is the maximum voltage before the breakdown of the IC process.
Operating voltage : This is the Vcc range in which the functionality of the part is guaranteed. The 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 * Vf
If the power dissipation is too high in Rifb, 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 Vcc-Vin 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:

$$\Delta_{Tj} = P_{CL} \cdot Z_{TH}(t_{CLAMP})$$

Where: $Z_{TH}(t_{CLAMP})$ is the thermal impedance at t_{CLAMP} 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_{CLAMP} value.

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

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

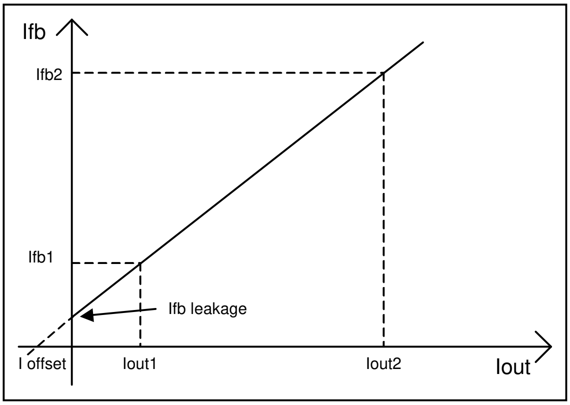
$\frac{di}{dt} = \frac{V_{Battery} - V_{CL}}{L}$: Demagnetization current

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 Isd. Nevertheless for high current and high temperature the device may switch off for a lower current due to the over-temperature protection (see Figure 11).

Current sensing accuracy

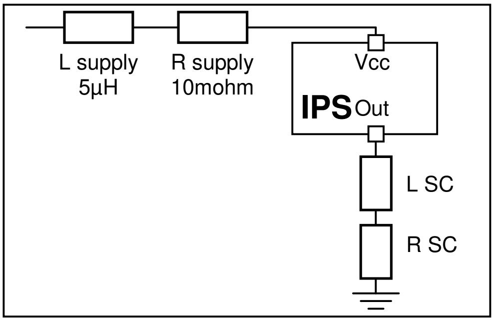


The current sensing is specified by measuring 3 points :
- Ifb1 for Iout1
- Ifb2 for Iout2
- Ifb leakage for Iout=0

Then the parameters of the datasheet are computed by the following formula :
Ratio = (Iout2 – Iout1)/(Ifb2 – Ifb1)
I offset = Ifb1 x Ratio – Iout1
This allows the designer to evaluate the Ifb for any Iout value using :
Ifb = (Iout + I offset) / Ratio if Ifb > Ifb 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 Ratio_TC specified in page 3.
The Ioffset variation depends directly of the Rdson :
I offset@-40°C= I offset@25°C / 0.8
I offset@150°C= I offset@25°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 µH	10 mohm
Load SC	10 µH	100 mohm

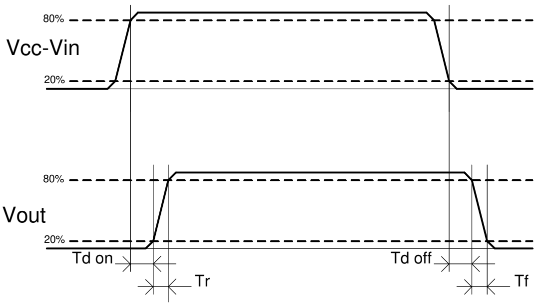


Figure 1 – IN rise time & switching definitions

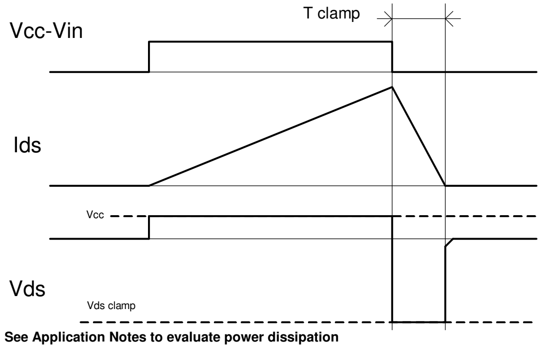


Figure 2 – Active clamp waveforms

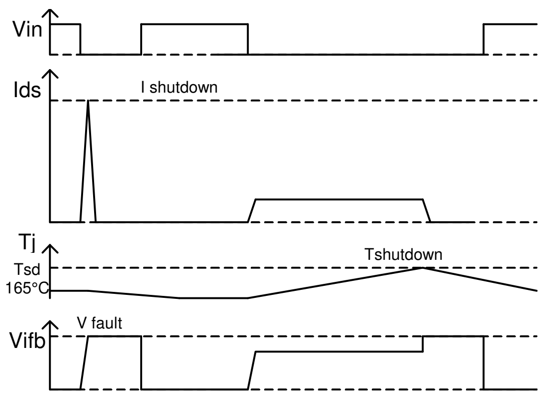


Figure 3 – Protection timing diagram

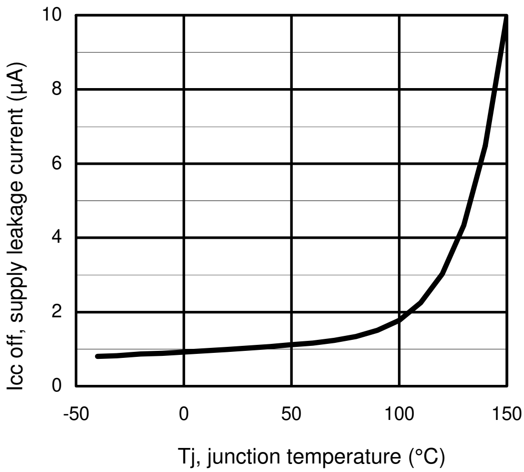


Figure 4 – Icc off (µA) Vs Tj (°C)

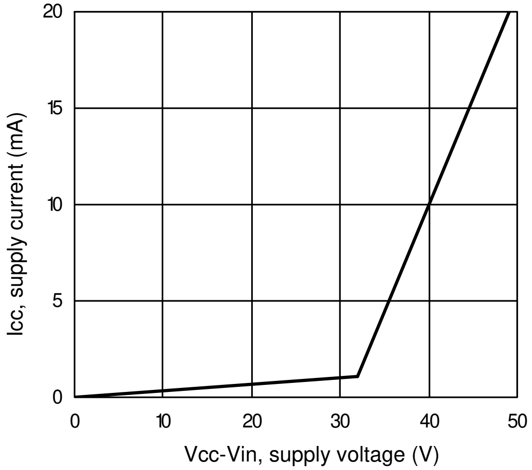


Figure 5 – Icc (mA) Vs Vcc-Vin (V)

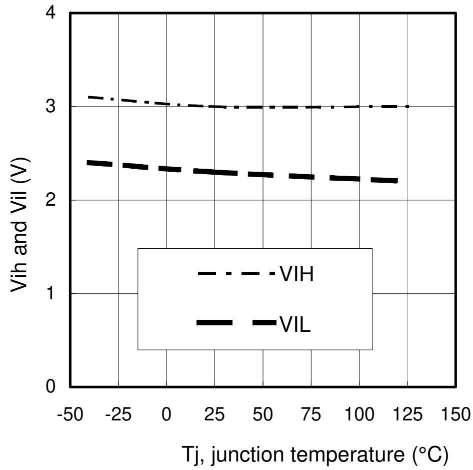


Figure 6 – Vih and Vil (V) Vs Tj (°C)

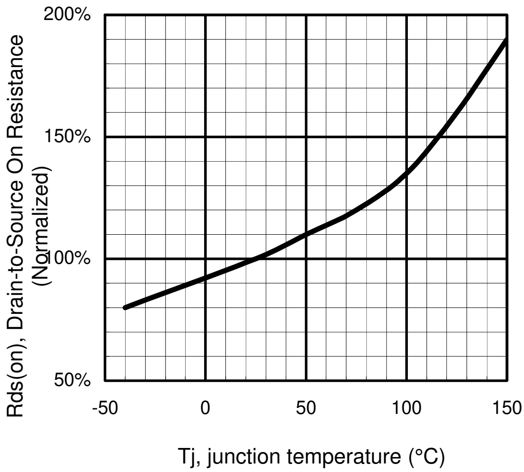


Figure 7 - Normalized Rds(on) (%) Vs Tj (°C)

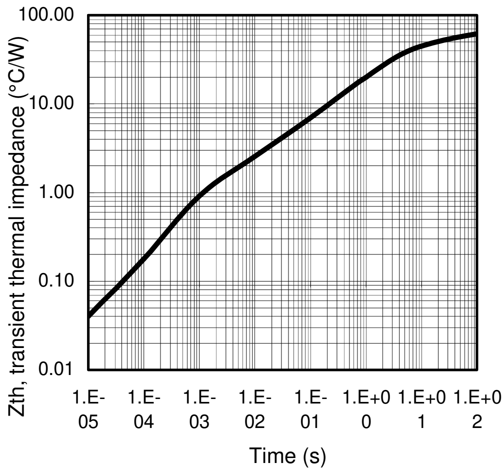


Figure 8 – Transient thermal impedance (°C/W) Vs time (s)

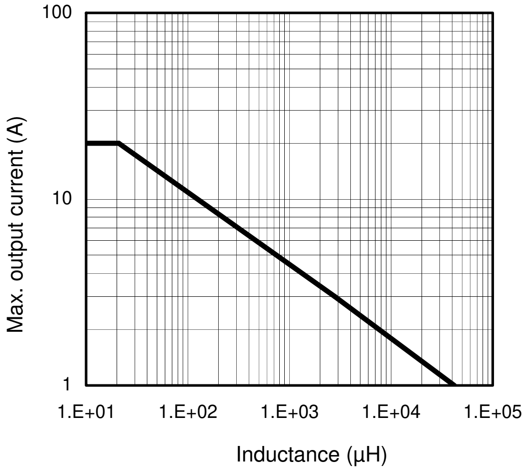


Figure 9 – Max. Iout (A) Vs inductance (µH)

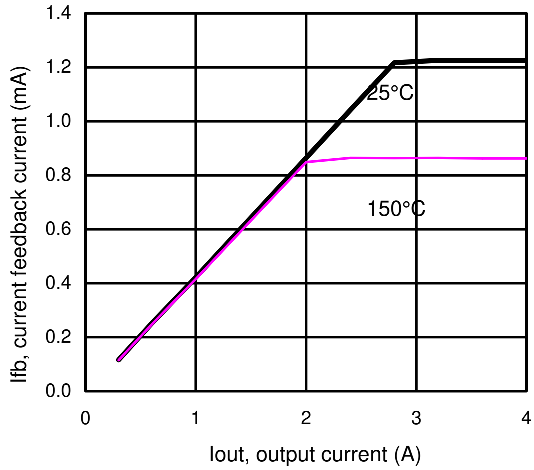
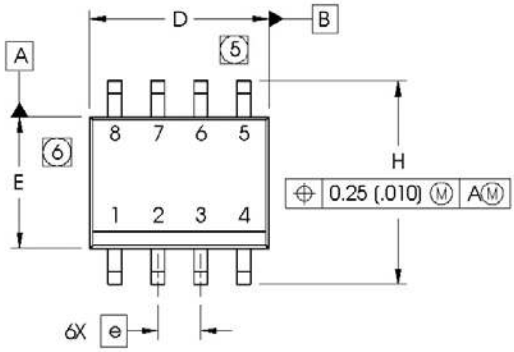


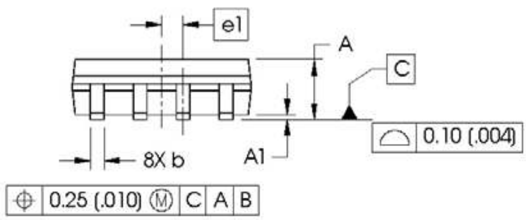
Figure 10 – Ifb (mA) Vs Iout (A)

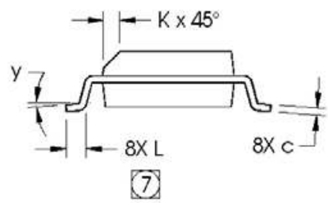
Case Outline - SO-8

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	
e 1	.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°



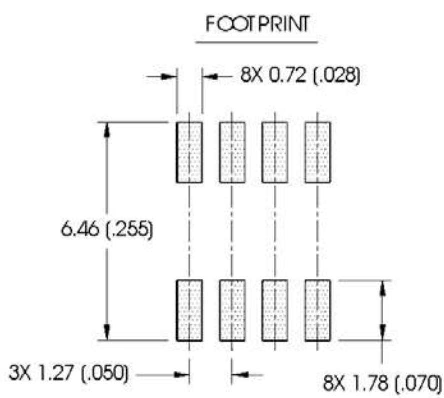


NOTES:
1. DIMENSIONING & TOLERANCING PER ASME Y14.5M-1994.
2. CONTROLLING DIMENSION: MILLIMETER
3. DIMENSIONS ARE SHOWN IN MILLIMETERS [INCHES].
4. OUTLINE CONFORMS TO JEDEC OUTLINE MS-012AA.

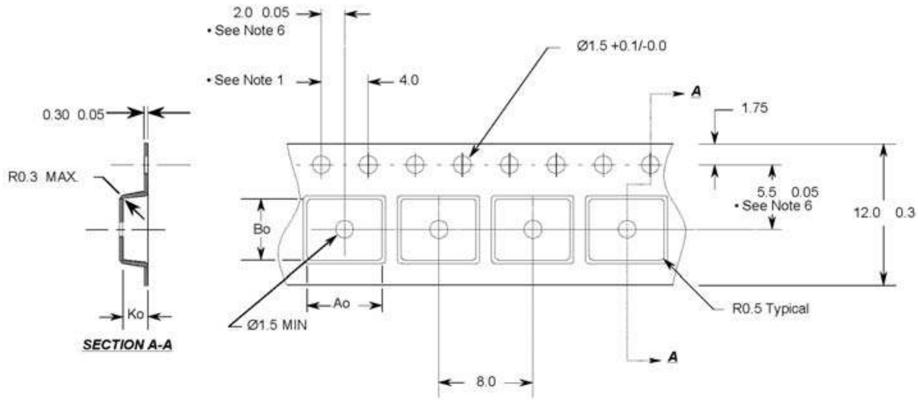
(5) DIMENSION DOES NOT INCLUDE MOLD PROTRUSIONS. MOLD PROTRUSIONS NOT TO EXCEED 0.15 [.006].

(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

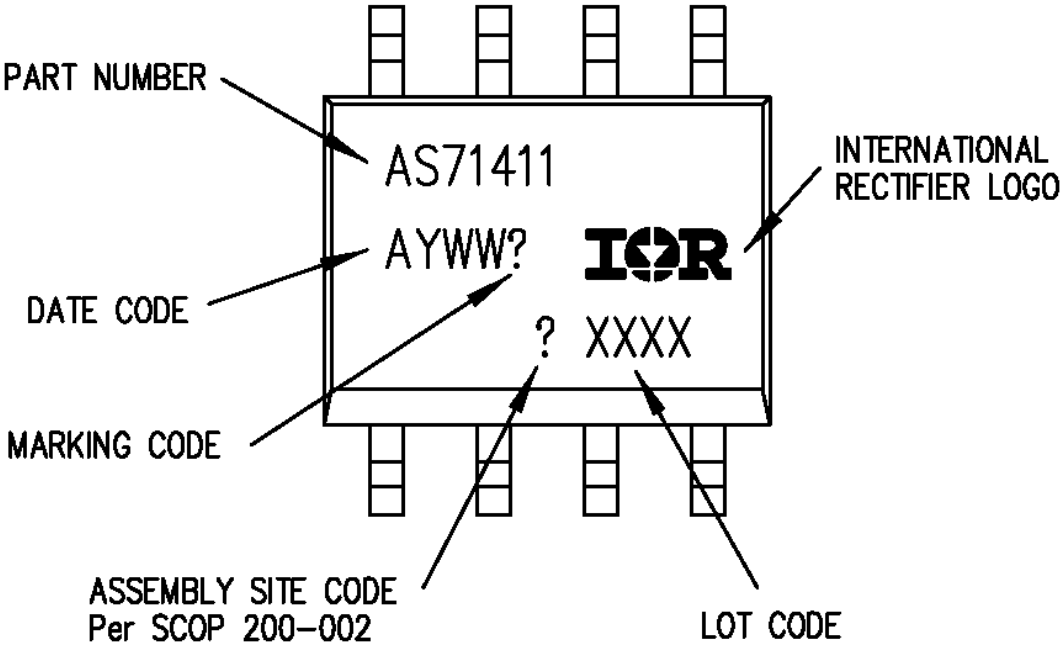


Notes:
1. 10 sprocket hole pitch cumulative tolerance 0.2
2. Camber not to exceed 1mm in 100mm
3. Material: Black Conductive Advantek Polystyrene
4. Ao and Bo measured on a plane 0.3mm above the bottom of the pocket
5. Ko measured from a plane on the inside bottom of the pocket to the top surface of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



Ordering Information

Base Part Number	Package Type	Standard Pack		Complete Part Number
		Form	Quantity	
AUIPS71411G	SO8	Tube	95	AUIPS71411G
		Tape and reel	2500	AUIPS71411GTR

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