LOW QUIESCENT CURRENT MOSFET DRIVER

Features

- Very low quiescent current on state
- Boost converter with integrated diode
- Standard level gate voltage
- Wide operating voltage 4-36V
- Temperature monitoring with NTC interface
- Lead-Free, Halogen Free, RoHS compliant

Applications

- Battery switch for Stop and Start system

Description

The AUIR3240S is a high side mosfet driver for battery switch application where a very low quiescent current is required when the driver is on. The AUIR3240S is a combination of a boost DC/DC converter using an external inductor and a gate driver. It drives standard level Mosfet even at low battery voltage. The input is active low to reduce current consumption.
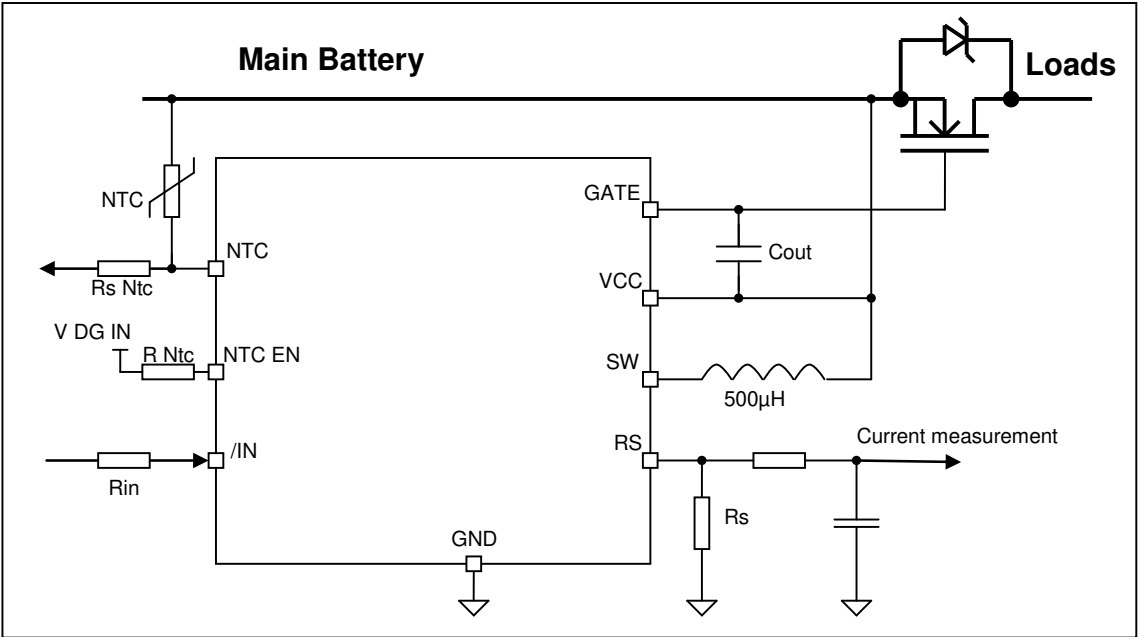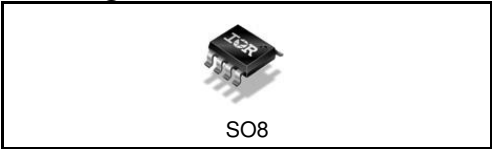
Product Summary

Operating voltage 4-36V
Vgate 11.5V min.
Iqcc On 50µA max.

Package

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 M0 (+/-50V) (per AEC-Q100-003)	
	Human Body Model	Class H0 (+/-50V) (per AEC-Q100-002)	
	Charged Device Model	Class C4 (+/-1000V) (per AEC-Q100-011)	
IC Latch-Up Test		Yes	
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. (Tambient=25°C unless otherwise specified).

Symbol	Parameter	Min.	Max.	Units
Vcc-gnd	Maximum Vcc voltage	-0.3	65	
Vgate-Vsw	Maximum Vgate-Vsw voltage	-1	65	
Vsw-gnd	Maximum Sw voltage	-0.3	65	
Vrs-gnd	Maximum Rs voltage	-0.3	6	V
Vntc	Maximum Ntc voltage	-0.3	65	
Vntc_en	Maximum NTC_EN voltage	-0.3	6	
Vin	Maximum IN pin voltage	-0.3	6	
Isw	Maximum continuous current in SW pin	—	200	mA
Tj max.	Max. storage & operating temperature junction temperature	-40	150	°C

Thermal Characteristics

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

Recommended Operating Conditions

Symbol	Parameter	Min.	Max.	Units
VIH	High level input voltage	2.5	5.5	V
VIL	Low level input voltage	0	0.9	
Rs NTC	Serial NTC resistor	4	10	kΩ
Rin	Input resistor	4	10	

Static Electrical Characteristics

Tj=-40..125°C, Vcc=6..16V (unless otherwise specified), typical value are given for Vcc=14V and Tj=25°C.

| Symbol	Parameter	Min.	Typ.	Max.	Units	Test Conditions
Vcc op.	Operating voltage range	4	—	36	V	See page 10
Iq Vcc Off	Supply current when Off, Tj=25°C	—	85	120		Vin=5V, NTC_EN=0V
	Supply current when Off, Tj=125°C	—	110	200		K1 off, K2 on
Iq Vcc On	Supply current when On, Tj=25°C	—	2	10	µA	Vin=0V, NTC_EN=0V
	Supply current when On, Tj=125°C	—	3	10		K1 off, see page 8
Iq gate On	Quiescent current on Gate, Tj=25°C	—	6	20		Vin=0V, Vgate=14V
	Quiescent current on Gate, Tj=125°C	—	12	40		K1 off, see page 8
Vbr gate	Breakdown voltage between and Vcc	15	17	20		I=10mA
OV	Over-voltage protection between gate and gnd	50	55	60	V	
Iin	Input current	—	30	65	µA	Vin=5V
Vin th	IN threshold voltage	1	2	2.5		
Vgs th	Gate output threshold	11.5	12.5	13.5	V	Igate=0µA
Vrs th	Rs threshold, Tj=-40°C	0.9	1.1	1.3		
	Rs threshold, Tj=25°C	0.85	1	1.2		
	Rs threshold, Tj=125°C	0.75	0.95	1.2		
Rdson K1	Rdson of K1, Tj=-40°C	—	8	13		I=100mA
	Rdson of K1, Tj=25°C	—	11	15		
	Rdson of K1, Tj=125°C	—	15	20		
Rdson K2	Rdson of K2, Tj=-40°C	—	22	40	Ω	
	Rdson of K2, Tj=25°C	—	35	45		
	Rdson of K2, Tj=125°C	—	60	75		
Vf	Forward voltage of rectifier diode	—	0.7	1	V	I=100mA
Iq ntc	Quiescent current in NTC	—	0.1	1	µA	V NTC=16V, Vntc_en=0V
I Ntc	Out Ntc current R ntc=7k, Vdg in=5V	—	1	—	mA	Vntc>6V
Vth_ntc_en	NTC_EN threshold voltage	1.15	1.5	1.9	V	I=500µA
I ratio ntc	Current ratio between NTC_EN and NTC	1.9	2.05	2.2		Vntc>6V

Timing Converter Characteristics

Tj=-40..125°C, Vcc=6..16V (unless otherwise specified), typical value are given for Vcc=14V and Tj=25°C.

Symbol	Parameter	Min.	Typ.	Max.	Units	Test Conditions
Toff	Off time	5	7.5	10		
Tdon K1	Turn-on delay of K1	—	10	—	µs	
Tdoff K1	Turn-off delay of K1	—	0.2	—		

Switching Characteristics

Tj=-40..125°C, Vcc=6..16V (unless otherwise specified), typical value are given for Vcc=14V and Tj=25°C.

Symbol	Parameter	Min.	Typ.	Max.	Units	Test Conditions
Tdon K2	Turn-on delay of K2	1	2.5	4		C=100nF
Tf K2	Fall time of K2 90% to 10% of Vgate-Vcc	—	6	20	µs	
Iout- K2	Gate low short circuit pulsed current	100	350	—	mA	Vgate=14V

Lead Definitions

Pin number	Symbol	Description
1	NTC	An NTC resistor can be connected between this pin and the Vcc line close to the tab to sense the temperature of the Mosfet
2	NTC_EN	NTC_EN is the input of the NTC system.
3	/IN	Active low input pin to enable the boost converter or short the gate to Vcc
4	GND	Ground pin
5	RS	Current sense input pin
6	SW	Output of K1
7	VCC	Power supply
8	GATE	Output of the boost converter

Lead Assignments

8 7 6 5

1 2 3 4
SO8

1- NTC
2- NTC_EN
3- /IN
4- GND
5- RS
6- SW
7- VCC
8- GATE
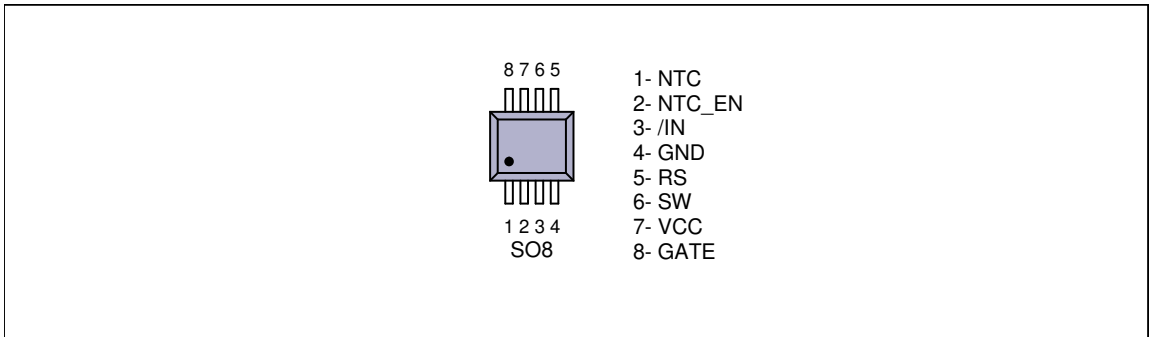
Block diagram
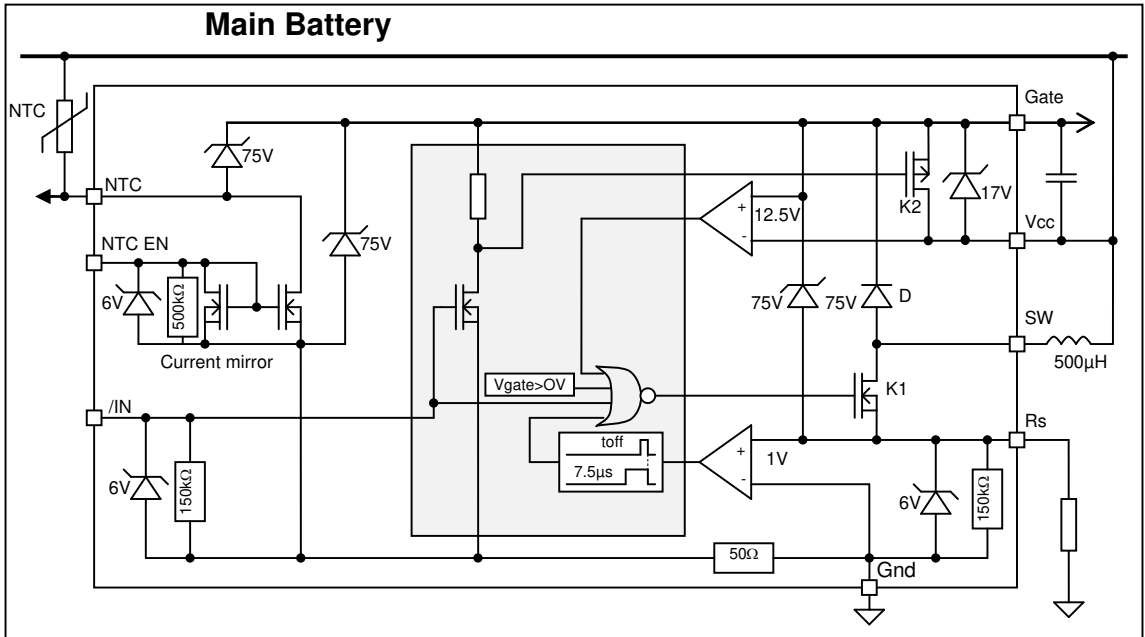
Description

The topology of the AUIR3240S is a boost DC/DC converter working in current mode. K1 is switched on when the gate voltage is lower than Vgs threshold. When Rs pin reaches Vrs th, K1 is turned off and the inductor charge the gate capacitor through D. The system cannot restart during Toff after Vrs th has been reached. The DC/DC restart only when the Gate and the Vcc voltage difference is lower than 12.5V in order to achieve low quiescent current on the power supply.

To turn off the power Mosfet, the input must be pull high. Then the DC/DC converter is turned and K2 shorts the gate to Vcc.
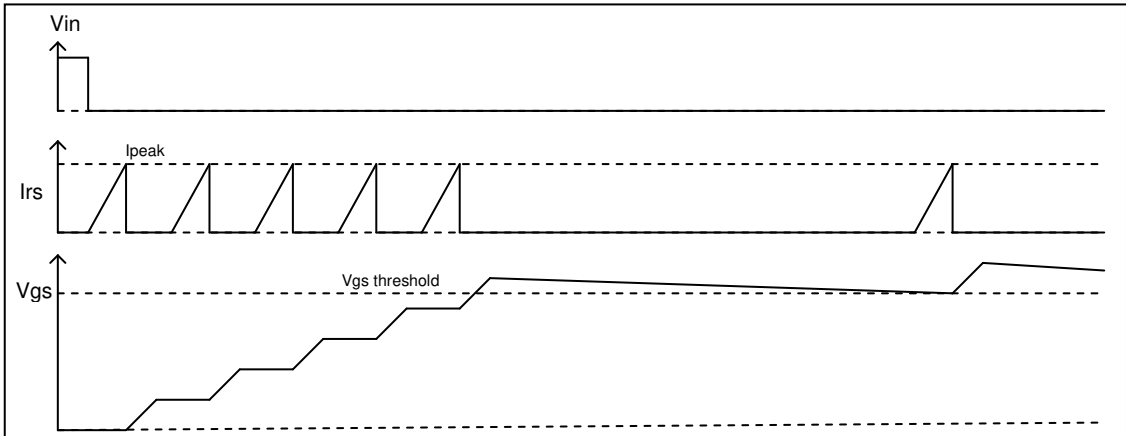
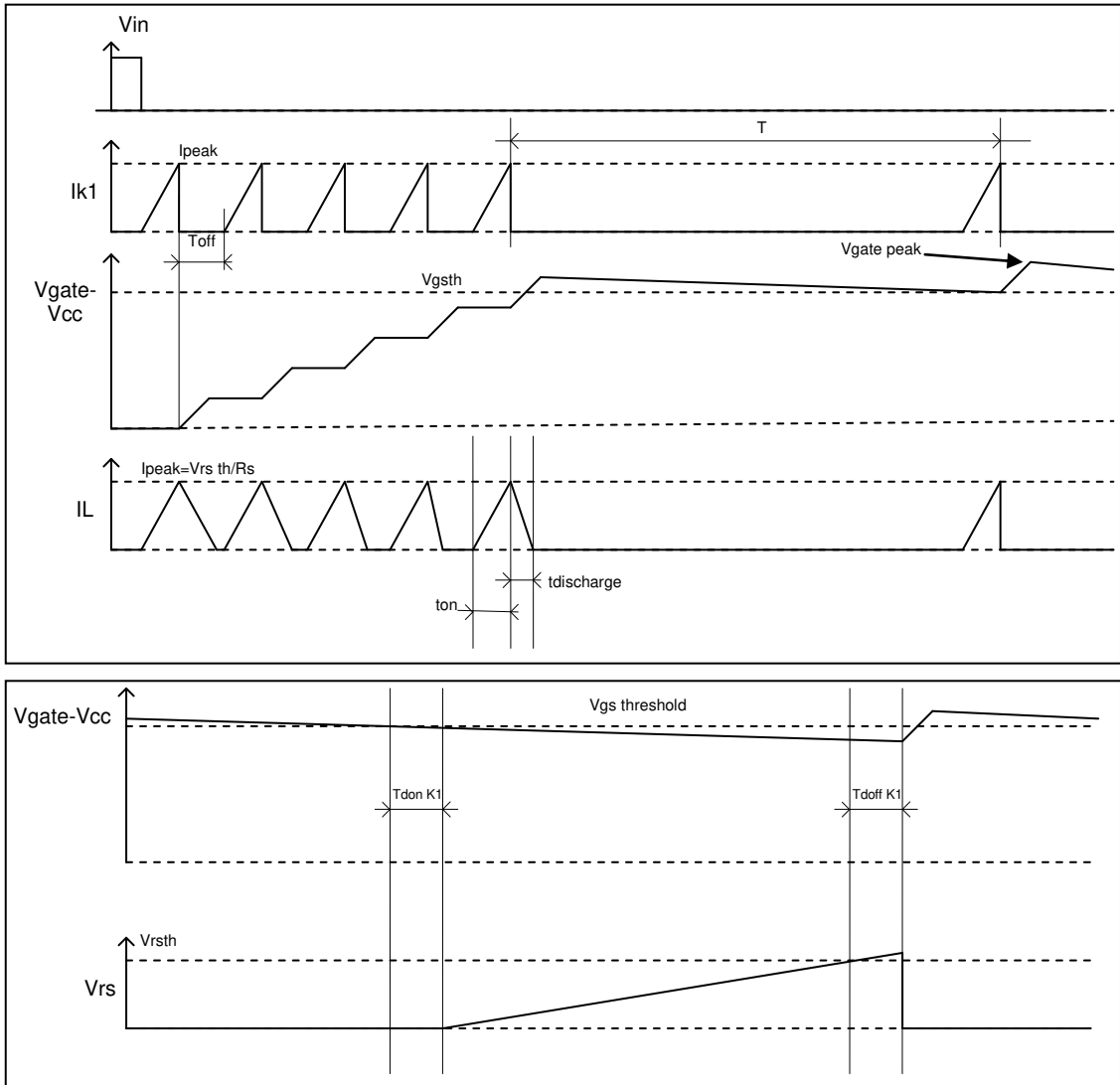## Parameters definition

Current definition
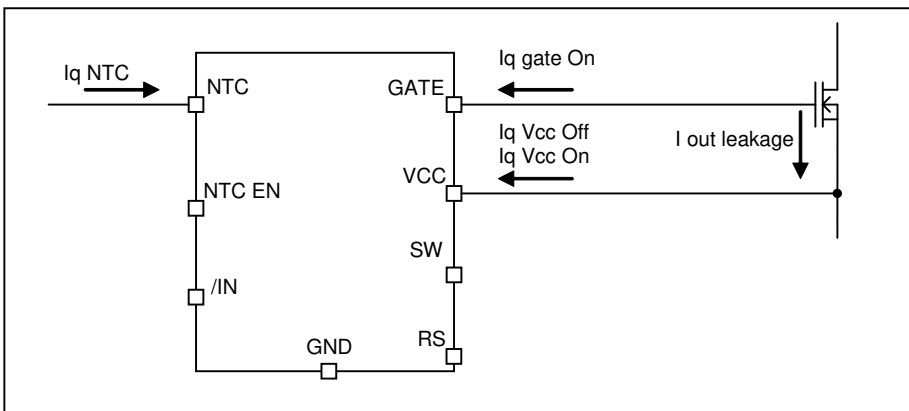
Timing definition

Low quiescent current operation when On.

The AUIR3240S is able to operate with a very low quiescent current on the Vcc pin. Nevertheless the supply current depends also on the leakage of the power mosfet named "I out leakage" on the diagram below.
The leakage current is given when K1 is off. When K1 is on, the current flowing in Vcc is the current charging the inductor. Therefore the average current on the Vcc is the combination of the current when K1 is ON and OFF. The average current on the Vcc pin can be calculated using:

$$Ivcc\ ave = (Iq\ gate + Iout\ leakage) * \frac{Vgate - Vcc + Vf}{Vcc} + Iq\ Vcc\ on + Iq\ gate\ on + Iq\ NTC$$

With Vgate: the average voltage on the output.
Vgate average = (Vgate peak + Vgsth)/2

Vgate peak can be calculated by:

$$Vgate\ peak = \sqrt{\frac{L}{Cout}.Ipeak^2 + Vgsth^2}$$

During On operation, the DC/DC works in pulse mode, meaning each time the Vgate-Vcc voltage comes below 12.5V, the AUIR3240S switches on K1 to recharge the gate voltage. When the Iout leakage is low enough to maintain the DC/DC in discontinuous mode, the frequency is calculate by:

$$T = \frac{Ipeak^2 * L}{2 * (Iq\ gate + Iout\ leakage) * (Vgate - Vcc + Vf)}$$

Peak current control

The current in the inductor is limited by the 1V comparator which monitors the voltage across Rs. Due to the delay in the loop (tdoff K1), the inductor current will exceed the threshold set by: $\frac{Vrsth}{Rs}$

At low voltage, the current waveform in the inductor is not anymore linear, but exponential because the sum of the resistor of K1, the inductor and RS are not any more negligible.
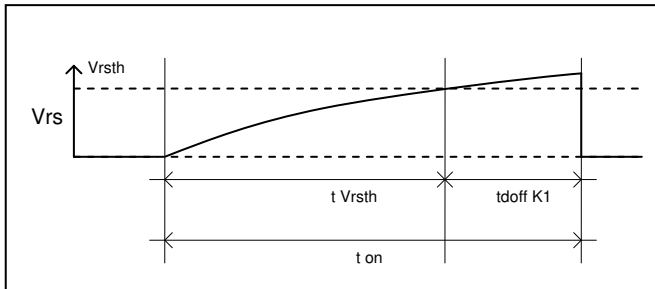
The peak current and ton can be calculated as follow:

$$t\ Vrsth = -\frac{L}{Rk1 + Rs + Rl} * \ln(1 - \frac{(Rs + Rk1 + Rl) * Vrsth}{Rs * Vcc})$$
Where Rl is the resistor of the inductor

With : t on = t Vrsth + tdoff K1

The peak current can be solved by:
$$Ipeak = \frac{Vcc}{Rk1 + Rs + Rl} * (1 - e^{-ton * \frac{Rk1 + Rs + Rl}{L}})$$

Output voltage Characteristic

In most of case when the output of the AUIR3240S is able to recharge the capacitor higher than Vgsth, the output voltage will oscillate between Vgsth and Vgate peak. Vgate peak can be calculated by:

$$\text{Vgate peak} = \sqrt{\frac{L}{\text{Cout}} * \text{Ipeak}^2 + \text{Vgsth}^2}$$

Minimum operating voltage

While the AUIR3240S operating voltage is specified between 4V and 36V. The minimum voltage is limited by the fact that the Rs voltage must reach the Vrsth taking account all resistors which limit the inductor current.

$$\text{Vcc min} = \frac{\text{Rk1} + \text{Rs} + \text{Rl}}{\text{Rs}} * \text{Vrsth}$$

Over-Voltage protection

The AUIR3240S integrates an over-voltage protection in order to protect K1. When Vcc exceed the Over-voltage threshold, the DC/DC is stopped.

NTC interface

The NTC interface allows the system to have a temperature measurement of the mosfet using one resistor and one NTC. The NTC must be connected to Vcc and close to the tab of the power Mosfet to have a good temperature sensing. The system works as a current mirror between NTC_EN and NTC pins. The typical ratio is 2, with 500µA flowing into NTC_EN, 1mA will flow in the NTC. The current in the NTC is fixed by adjusting R_Ntc and V_Dg_In. With 7k and 5V, the current in the NTC will be 1mA. The NTC function activated only if NTC_EN is powered.
If the NTC feature function is not used, NTC EN and NTC must be remained floating. The low consumption is achieved only when the NTC interface is not activated.

Output current measurement

The average current into Rs can be measured by adding a low pass filter before the ADC of the micro controller. Then the average output current can be evaluated using :
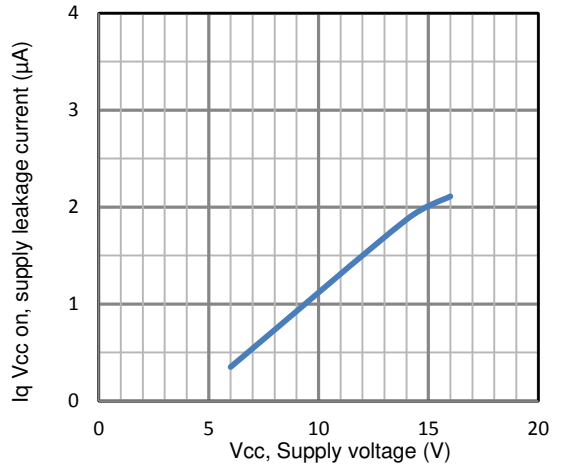I out av = I Rs av * Vcc / (Vgate - Vcc)
Knowing the output current can be useful to do a diagnostic on the power Mosfet. If the gate is short, the output current will be significantly higher than in normal operation.
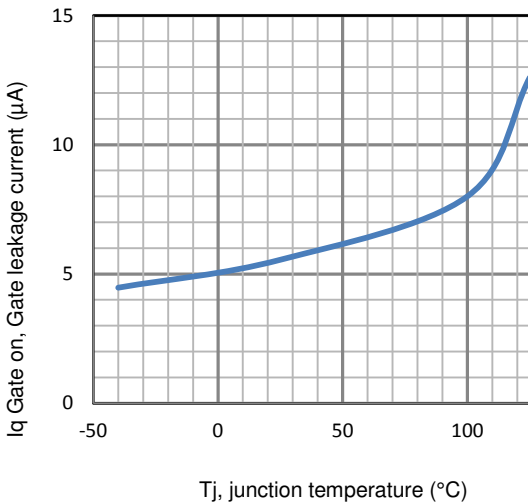
Figures are given for typical value, Vcc=14V and Tj=25°C otherwise specified
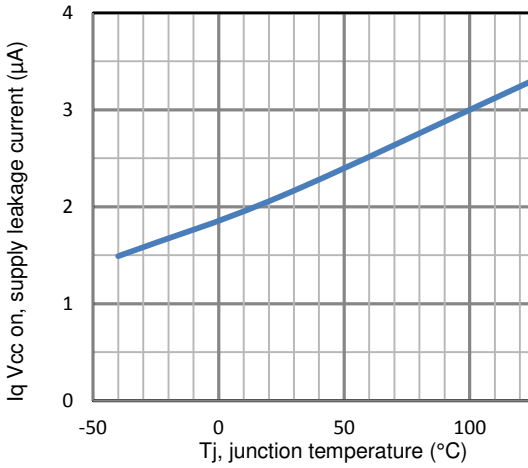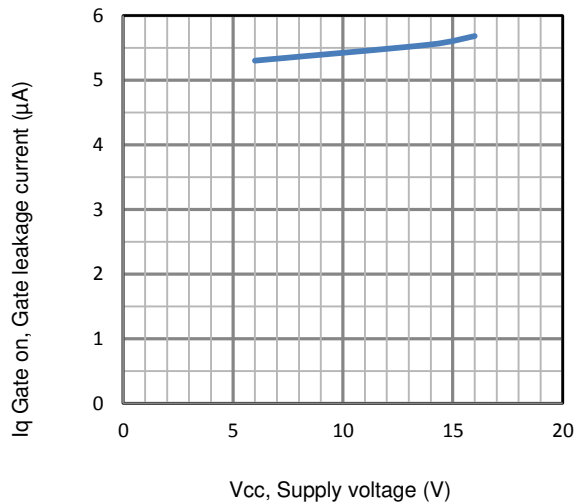

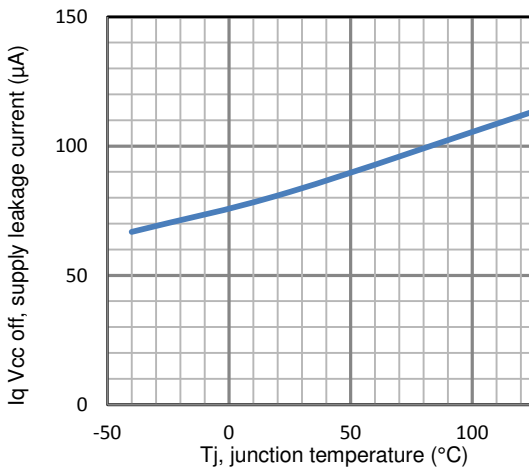**Figure 1 – Iq Vcc on (µA) Vs Tj (°C)**

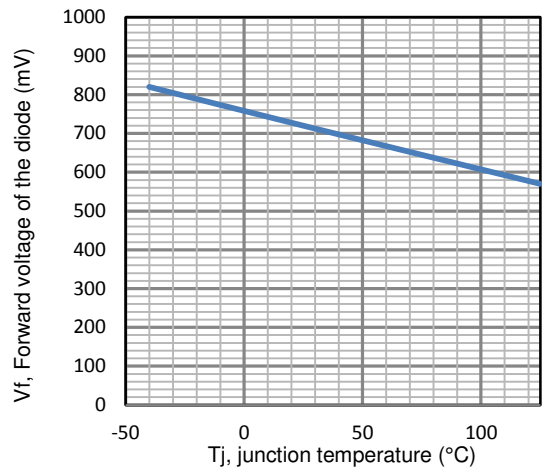**Figure 2 – Iq Vcc on (µA) Vs Vcc(V)**

Figure 3 – Iq Gate on (µA) Vs Tj (°C)
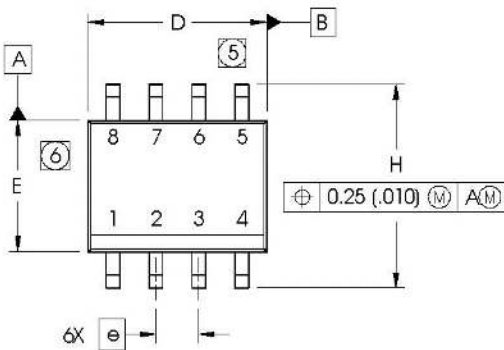

Figure 4 – Iq Gate on (µA) Vs Vcc(V)

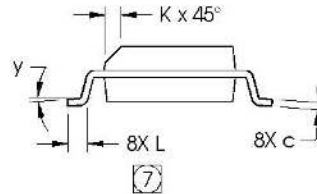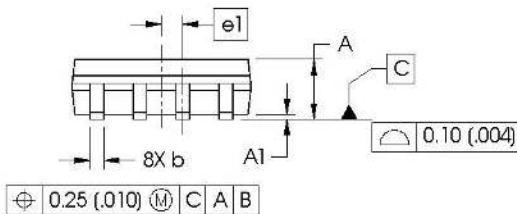**Figure 5 – Iq Vcc off (μA) Vs Tj (°C)**

Figure 6 – Vf (mV) Vs Tj (°C)

## Case Outline – SO8

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.

FOOTPRINT
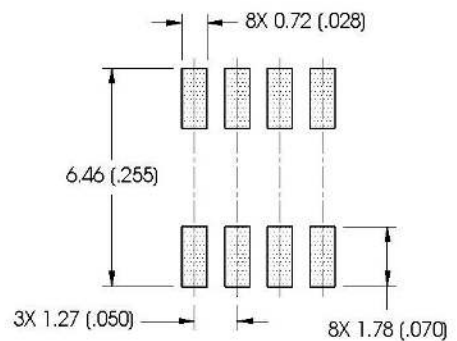
Tape & Reel   SO8
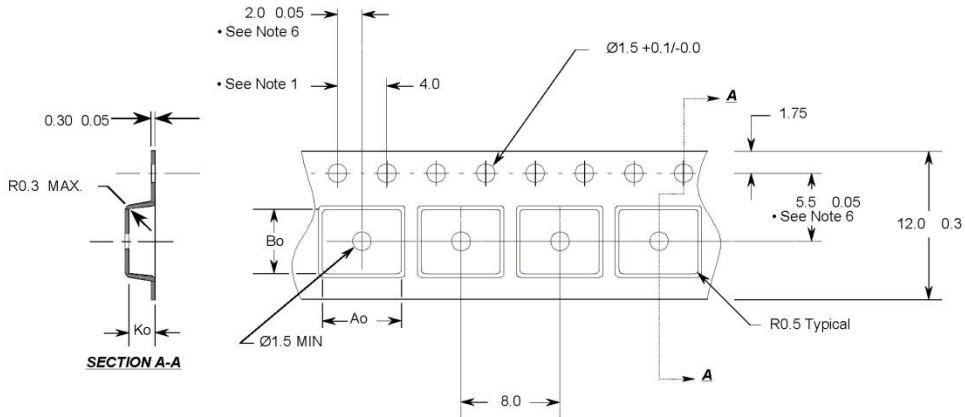
Notes:
1. 10 sprocket hole pitch cumulative tolerance   0.2
2. Camber not to exceed 1mm in 100mm
3. Material: Black Conductive Advantek Polystyrene
4. Ao and Bo measured on a plane 0.3mm above the bottom of the pocket
5. Ko measured from a plane on the inside bottom of the pocket to the top surface of 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
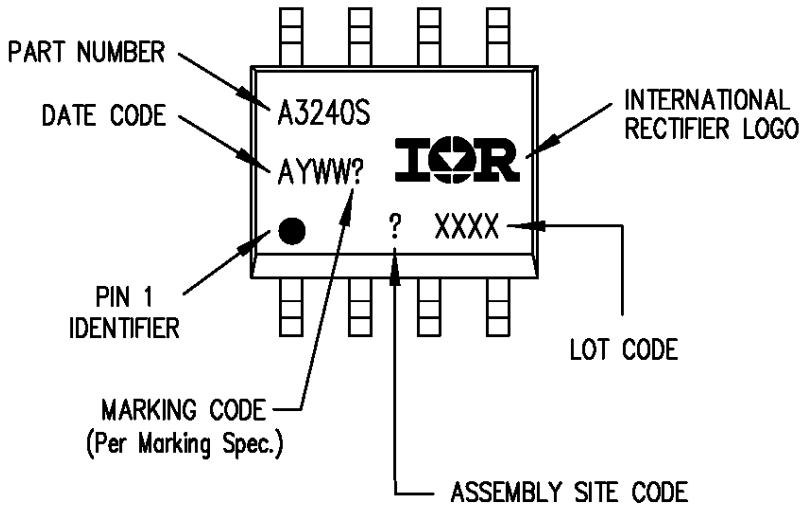
Ordering Information

Base Part Number	Package Type	Standard Pack		Complete Part Number
		Form	Quantity	
AUIR3240S	SOIC8	Tape and reel	2500	AUIR3240STR

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Revision History

Revision	Date	Notes/Changes
A	December 10th, 2011	Initial release
B	March, 28th 2012	Page4 correct temperature condition for Vrsth +125°C
C	April, 2nd 2012	Update maximum operating temperature
D	July, 17th 2012	Update page 4, Tdon K1 typ.
E	November, 19th 2012	Update formula page 9 tVrsth
F	October, 17th 2013	Update NTC interface current page10
G	October 31, 2014	Update limit max Rdson K2
H	October 10, 2015	Update the template Update OV definition Update ordering information
I	December 21, 216	Update Ivcc formula page 9
J	April 11, 2016	Update Tdon K1 and Tdoff K1
1.1	April 28, 2016	Update revision name