

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

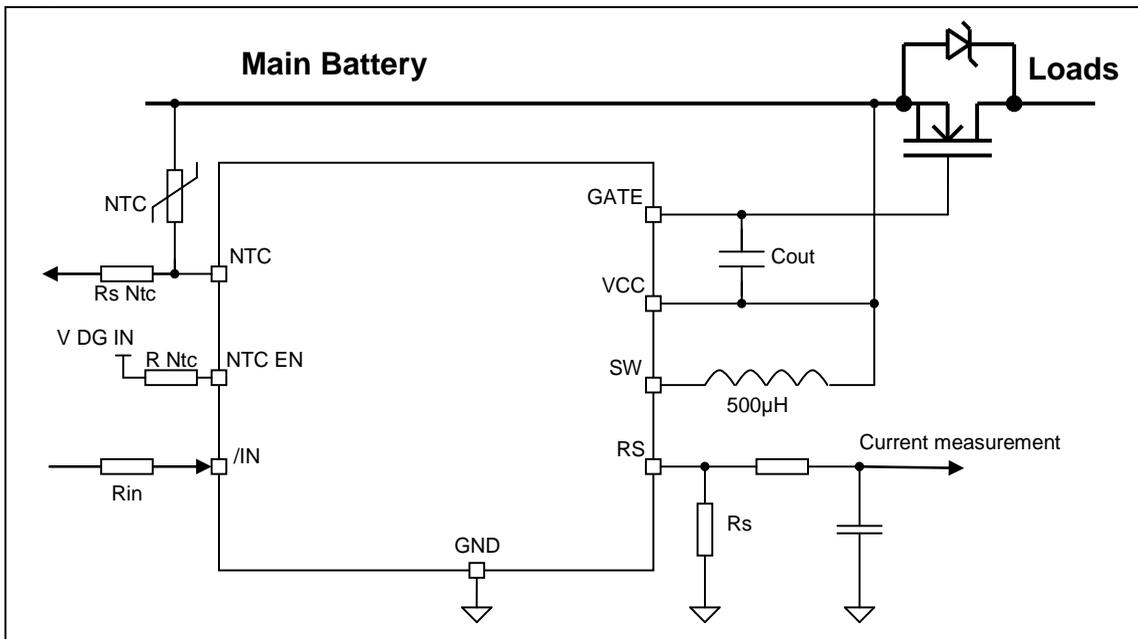
Applications

- 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.

Typical Connection



Product Summary

Operating voltage 4-36V
V_{gate} 11.5V min.
I_{qcc On} 50 μ A max.

Package



SO8

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/>

^{††} Exceptions to AEC-Q100 requirements, if any, 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 Ground lead. (Tambient=25°C unless otherwise specified).

Symbol	Parameter	Min.	Max.	Units
Vcc-gnd	Maximum Vcc voltage	-0.3	65	V
Vgate-Vsw	Maximum Vgate-Vsw voltage	-1	65	
Vsw-gnd	Maximum Sw voltage	-0.3	65	
Vrs-gnd	Maximum Rs voltage	-0.3	6	
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

T_j=-40..125°C, V_{cc}=6..16V (unless otherwise specified), typical value are given for V_{cc}=14V and T_j=25°C.

Symbol	Parameter	Min.	Typ.	Max.	Units	Test Conditions
V _{cc op.}	Operating voltage range	4	—	36	V	See page 10
I _{q Vcc Off}	Supply current when Off, T _j =25°C	—	85	120	μA	V _{in} =5V, NTC_EN=0V K1 off, K2 on
	Supply current when Off, T _j =125°C	—	110	200		
I _{q Vcc On}	Supply current when On, T _j =25°C	—	2	10		
	Supply current when On, T _j =125°C	—	3	10		
I _{q gate On}	Quiescent current on Gate, T _j =25°C	—	6	20	V	V _{in} =0V, V _{gate} =14V K1 off, see page 8
	Quiescent current on Gate, T _j =125°C	—	12	40		
V _{br gate}	Breakdown voltage between and V _{cc}	15	17	20	V	I=10mA
OV	Over-voltage protection	50	55	60		
I _{in}	Input current	—	30	65	μA	V _{in} =5V
V _{in th}	IN threshold voltage	1	2	2.5		
V _{gs th}	Gate output threshold	11.5	12.5	13.5		I _{gate} =0μA
V _{rs th}	Rs threshold, T _j =-40°C	0.9	1.1	1.3	V	
	Rs threshold, T _j =25°C	0.85	1	1.2		
	Rs threshold, T _j =125°C	0.75	0.95	1.2		
R _{dson K1}	R _{dson} of K1, T _j =-40°C	—	8	13	Ω	I=100mA
	R _{dson} of K1, T _j =25°C	—	11	15		
	R _{dson} of K1, T _j =125°C	—	15	20		
R _{dson K2}	R _{dson} of K2, T _j =-40°C	—	20	30		
	R _{dson} of K2, T _j =25°C	—	25	35		
	R _{dson} of K2, T _j =125°C	—	40	55		
V _f	Forward voltage of rectifier diode	—	0.7	1	V	I=100mA
I _{q ntc}	Quiescent current in NTC	—	0.1	1	μA	V _{NTC} =16V, V _{ntc_en} =0V
I _{Ntc}	Out Ntc current R _{ntc} =7k, V _{dg in} =5V	—	1	—	mA	V _{ntc} >6V
V _{th_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		V _{ntc} >6V

Timing Converter Characteristics

T_j=-40..125°C, V_{cc}=6..16V (unless otherwise specified), typical value are given for V_{cc}=14V and T_j=25°C.

Symbol	Parameter	Min.	Typ.	Max.	Units	Test Conditions
T _{off}	Off time	5	7.5	10	μs	
T _{don K1}	Turn-on delay of K1	—	0.2	—		
T _{doff K1}	Turn-off delay of K1	—	10	—		

Switching Characteristics

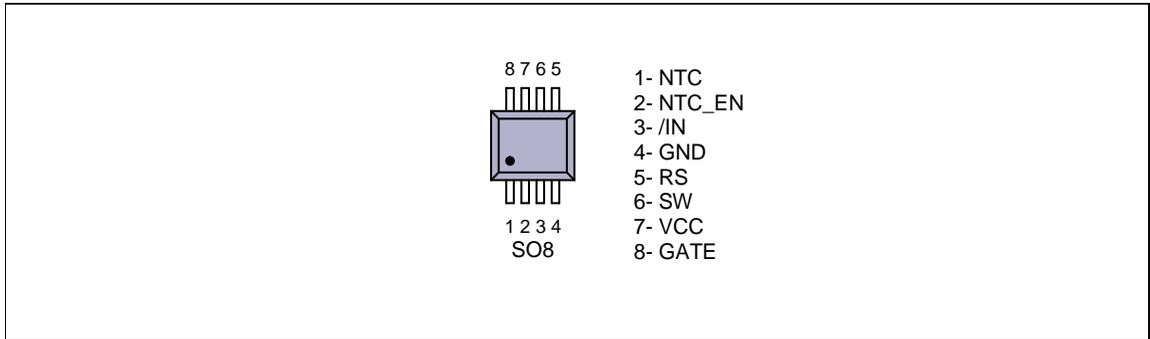
T_j=-40..125°C, V_{cc}=6..16V (unless otherwise specified), typical value are given for V_{cc}=14V and T_j=25°C.

Symbol	Parameter	Min.	Typ.	Max.	Units	Test Conditions
T _{don K2}	Turn-on delay of K2	1	2.5	4	μs	C=100nF
T _{f K2}	Fall time of K2 90% to 10% of V _{gate} -V _{cc}	—	6	20		
I _{out- K2}	Gate low short circuit pulsed current	100	350	—	mA	V _{gate} =14V

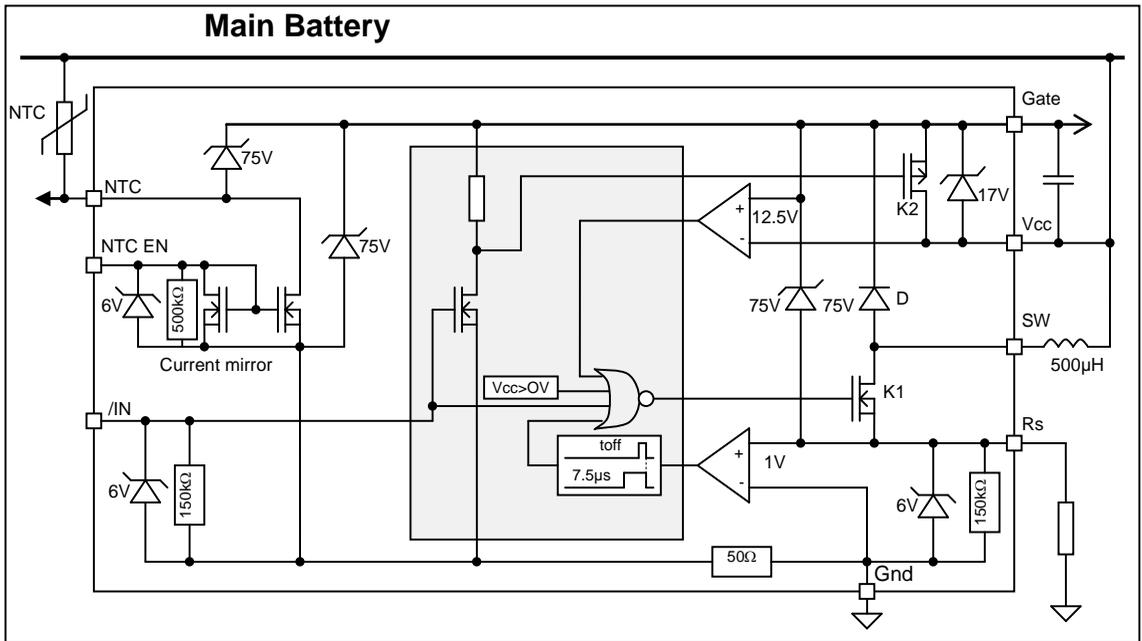
Lead Definitions

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



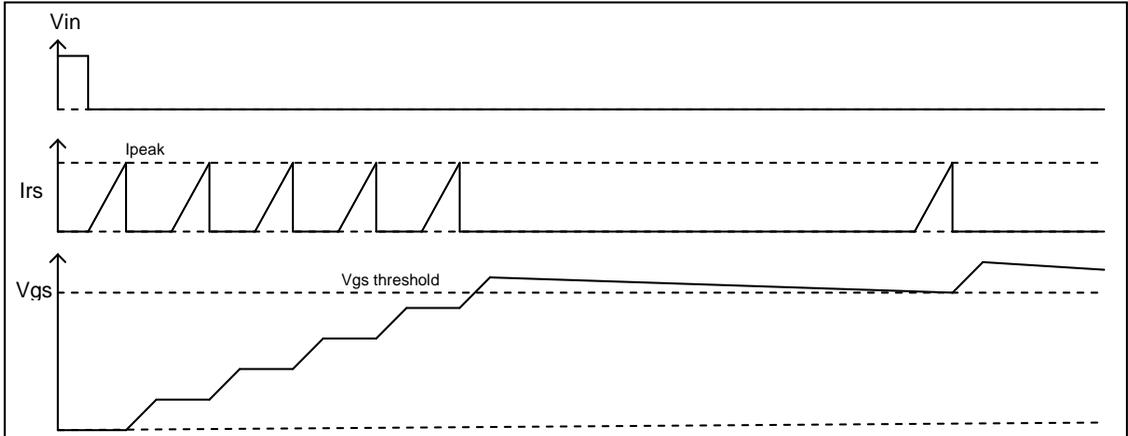
Block diagram



Description

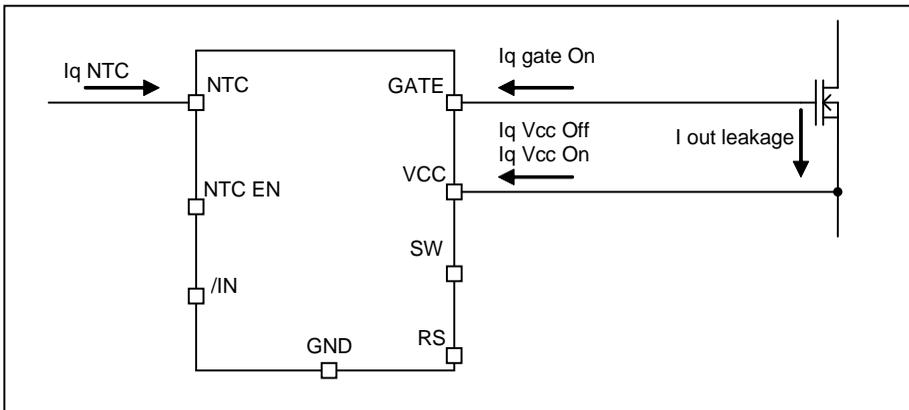
The topology of the AUIR3240S is a boost DC/DC converter working in current mode. K1 is switched on when the gate voltage is lower than V_{gs} threshold. When R_s pin reaches V_{rs} th, K1 is turned off and the inductor charge the gate capacitor through D. The system cannot restart during T_{off} after V_{rs} th has been reached. The DC/DC restart only when the Gate and the V_{cc} 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 V_{cc} .

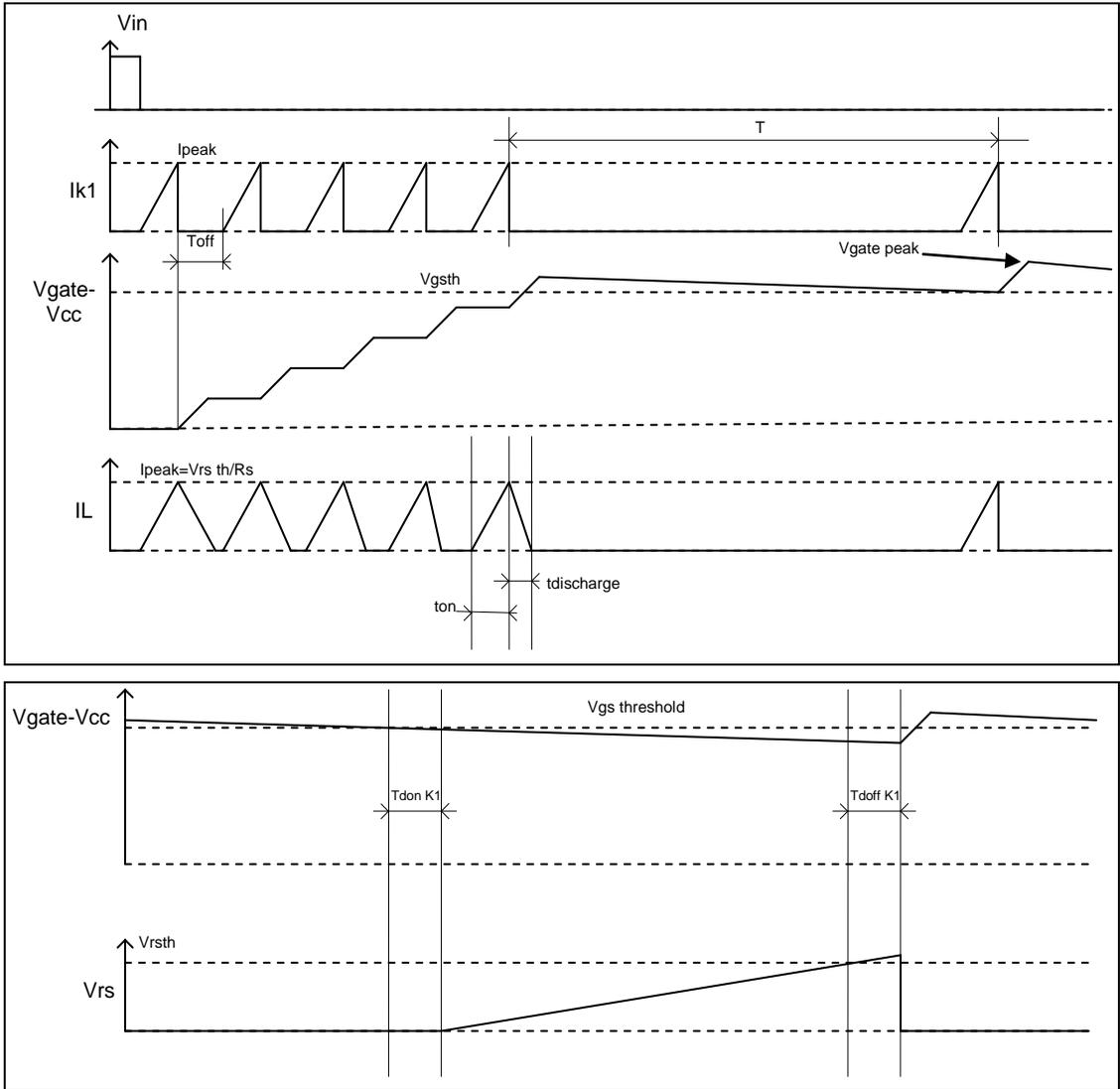


Parameters definition

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:

$$I_{Vcc\ average} = I_{Vcc\ average\ K1\ ON} + I_{Vcc\ average\ K1\ OFF} + I_q\ NTC$$

$$I_{vcc\ ave} = (I_{q\ gate} + I_{out\ leakage}) * \frac{V_{gate} - V_{cc} + V_f}{V_{cc}} + I_{q\ Vcc\ on} + I_{q\ NTC}$$

With V_{gate} : the average voltage on the output.

$$V_{gate\ average} = (V_{gate\ peak} + V_{gsth})/2$$

$V_{gate\ peak}$ can be calculated by:

$$V_{gate\ peak} = \sqrt{\frac{L}{C_{out}} * I_{peak}^2 + V_{gsth}^2}$$

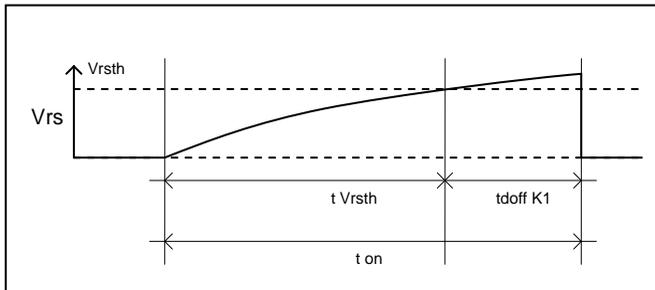
During On operation, the DC/DC works in pulse mode, meaning each time the $V_{gate}-V_{cc}$ voltage comes below 12.5V, the AUIR3240S switches on K1 to recharge the gate voltage. When the I_{out} leakage is low enough to maintain the DC/DC in discontinuous mode, the frequency is calculate by:

$$T = \frac{I_{peak}^2 * L}{2 * (I_{q\ gate} + I_{out\ leakage}) * (V_{gate} - V_{cc} + V_f)}$$

Peak current control

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

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 R_s are not any more negligible.



The peak current and t_{on} can be calculated as follow:

$$t_{Vrsth} = -\frac{L}{R_{k1} + R_s + R_l} * \ln\left(1 - \frac{(R_s + R_{k1} + R_l) * V_{rsth}}{R_s * V_{cc}}\right)$$

Where R_l is the resistor of the inductor

$$\text{With : } t_{on} = t_{Vrsth} + t_{doff\ K1}$$

The peak current can be solved by:

$$I_{peak} = \frac{V_{cc}}{R_{k1} + R_s + R_l} * \left(1 - e^{-t_{on} * \frac{R_{k1} + R_s + R_l}{L}}\right)$$

Output voltage Characteristic

In most of case when the output of the AUIR3240S is able to recharge the capacitor higher than V_{gsth} , the output voltage will oscillate between V_{gsth} and $V_{gate\ peak}$. $V_{gate\ peak}$ can be calculated by:

$$V_{gate\ peak} = \sqrt{\frac{L}{C_{out}} * I_{peak}^2 + V_{gsth}^2}$$

Minimum operating voltage

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

$$V_{cc\ min} = \frac{R_{k1} + R_s + R_l}{R_s} * V_{rsth}$$

Over-Voltage protection

The AUIR3240S integrates an over-voltage protection in order to protect K1. When V_{cc} 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 V_{cc} 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 500mA 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 R_s 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 :

$$I_{out\ av} = I_{Rs\ av} * V_{cc} / (V_{gate} - V_{cc})$$

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, $V_{cc}=14V$ and $T_j=25^\circ C$ otherwise specified

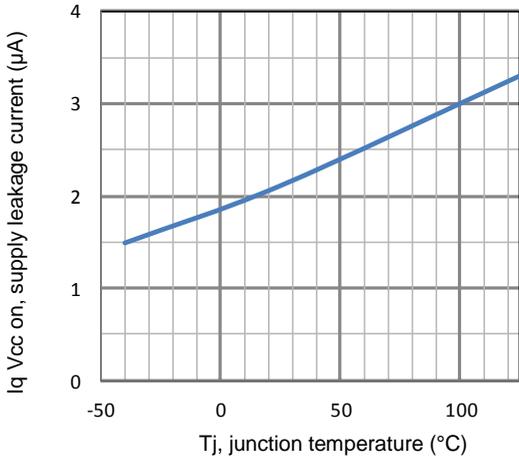


Figure 1 – Iq Vcc on (µA) Vs Tj (°C)

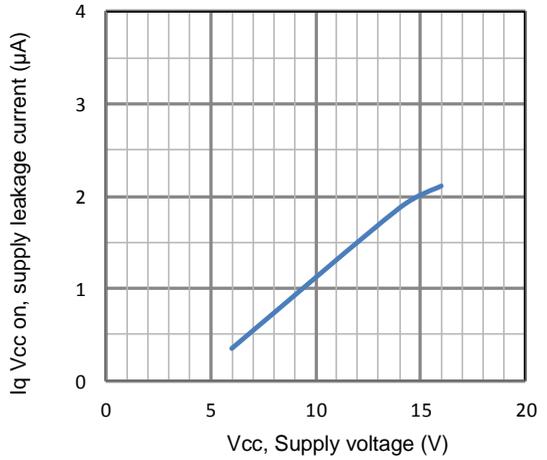


Figure 2 – Iq Vcc on (µA) Vs Vcc(V)

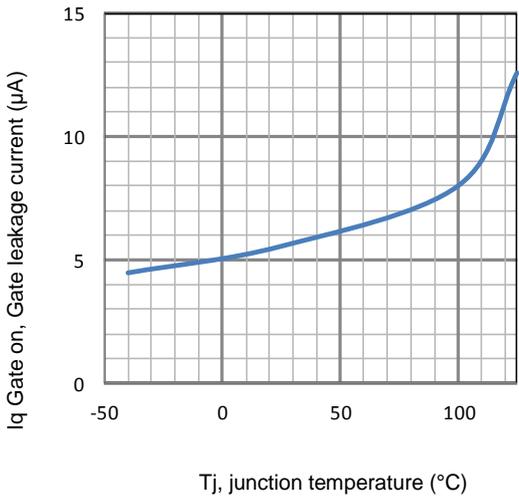


Figure 3 – Iq Gate on (µA) Vs Tj (°C)

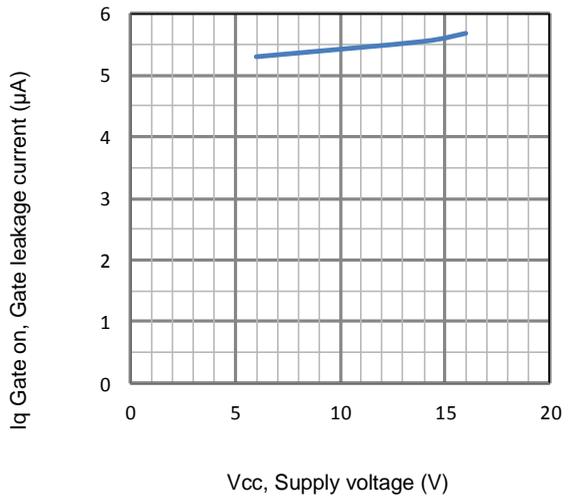


Figure 4 – Iq Gate on (µA) Vs Vcc(V)

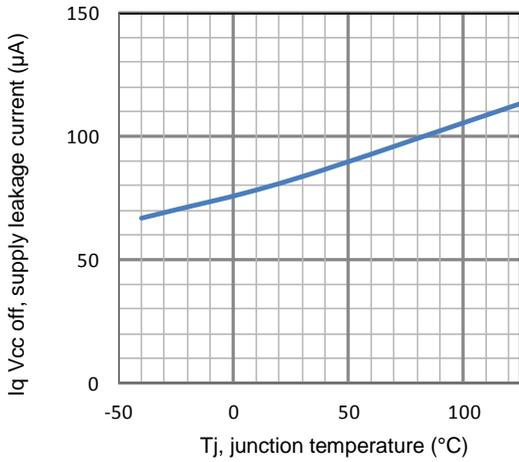


Figure 5 – Iq Vcc off (µA) Vs Tj (°C)

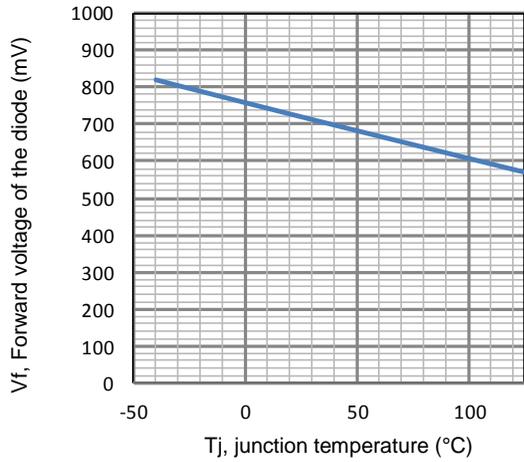
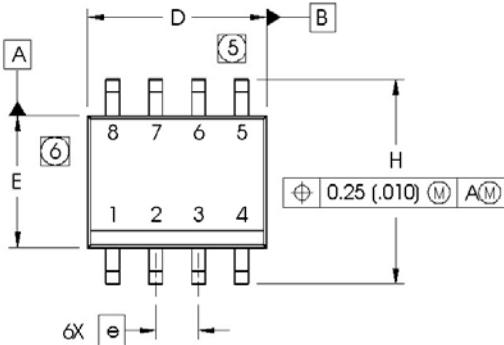


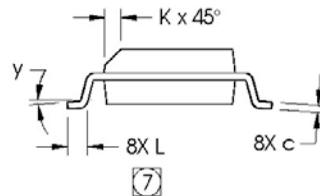
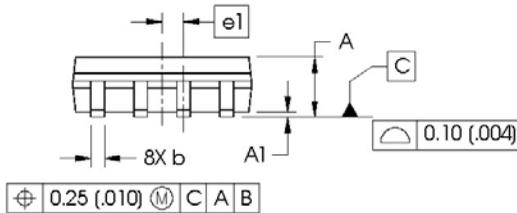
Figure 6 – Vf (mV) Vs Tj (°C)

Case Outline – SO8

Dimensions are shown in millimeters (inches)



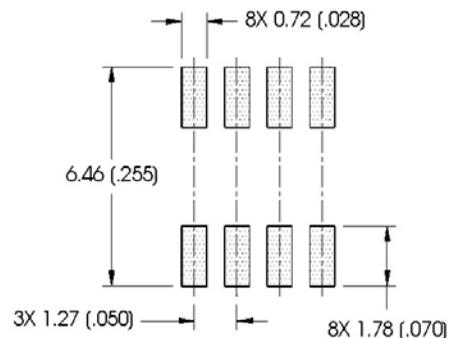
DIM	INCHES		MILLIMETERS	
	MIN	MAX	MIN	MAX
A	.0532	.0688	1.35	1.75
A1	.0040	.0098	0.10	0.25
b	.013	.020	0.33	0.51
c	.0075	.0098	0.19	0.25
D	.189	.1968	4.80	5.00
E	.1497	.1574	3.80	4.00
e	.050 BASIC		1.27 BASIC	
e1	.025 BASIC		0.635 BASIC	
H	.2284	.2440	5.80	6.20
K	.0099	.0196	0.25	0.50
L	.016	.050	0.40	1.27
y	0°	8°	0°	8°



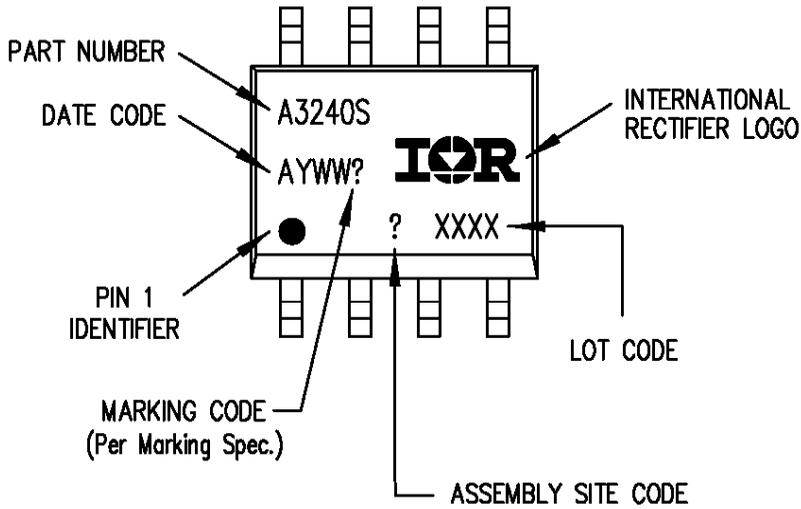
NOTES:

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



Part Marking Information



Ordering Information

Base Part Number	Package Type	Standard Pack		Complete Part Number
		Form	Quantity	
AUIR3240S	SOIC8	Tube	95	AUIR3240S
		Tape and reel	2500	AUIR3240STR

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

WORLD HEADQUARTERS:

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Tel: (310) 252-7105

Revision History

Revision	Date	Notes/Changes
A	December 10th, 2011	Initial release
B	March, 28 th 2012	Page4 correct temperature condition for Vrsth +125°C
C	April, 2 nd 2012	Update maximum operating temperature
D	July, 17 th 2012	Update page 4, Tdon K1 typ.
E	November, 19 th 2012	Update formula page 9 tVrsth