

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

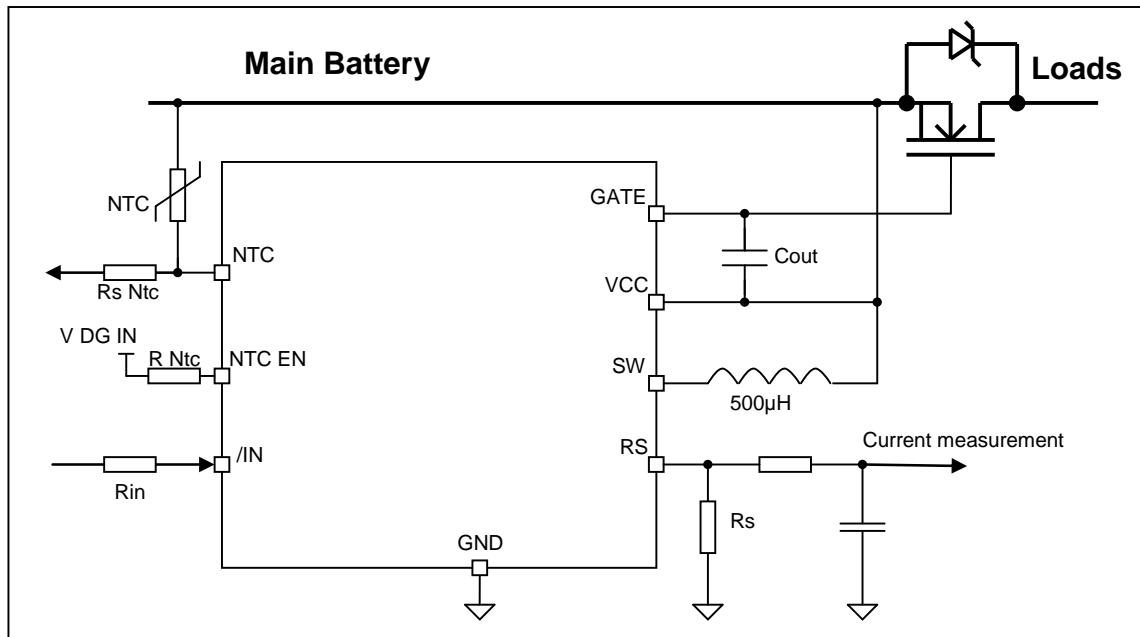
The AUIR3240S is a high side mosfet driver for battery switch application where a very low quiescent current is required when the driver is on. The AUIR3240S is a combination of a boost DC/DC converter using an external inductor and a gate driver. It drives standard level Mosfet even at low battery voltage.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

Typical Connection

Product Summary

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

Package



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. (T_{ambient}=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
T _j max.	Max. storage & operating temperature junction temperature	-40	150	°C

Thermal Characteristics

Symbol	Parameter	Typ.	Max.	Units
R _{th}	Thermal resistance junction to ambient	100	—	°C/W

Recommended Operating Conditions

Symbol	Parameter	Min.	Max.	Units
V _{IH}	High level input voltage	2.5	5.5	V
V _{IL}	Low level input voltage	0	0.9	
R _s NTC	Serial NTC resistor	4	10	kΩ
R _{in}	Input resistor	4	10	

Static Electrical Characteristics

$T_j=40..125^\circ\text{C}$, $V_{cc}=6..16\text{V}$ (unless otherwise specified), typical value are given for $V_{cc}=14\text{V}$ and $T_j=25^\circ\text{C}$.

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, $T_j=25^\circ\text{C}$	—	85	120	μA	Vin=5V, NTC_EN=0V K1 off, K2 on
	Supply current when Off, $T_j=125^\circ\text{C}$	—	110	200		
$I_{q\ Vcc\ On}$	Supply current when On, $T_j=25^\circ\text{C}$	—	2	10	μA	Vin=0V, NTC_EN=0V K1 off, see page 8
	Supply current when On, $T_j=125^\circ\text{C}$	—	3	10		
$I_{q\ gate\ On}$	Quiescent current on Gate, $T_j=25^\circ\text{C}$	—	6	20	μA	Vin=0V, V _{gate} =14V K1 off, see page 8
	Quiescent current on Gate, $T_j=125^\circ\text{C}$	—	12	40		
$V_{br\ gate}$	Breakdown voltage between and V_{cc}	15	17	20	V	$I=10\text{mA}$
OV	Over-voltage protection between gate and gnd	50	55	60		
I_{in}	Input current	—	30	65	μA	Vin=5V
$V_{in\ th}$	IN threshold voltage	1	2	2.5	V	$I_{gate}=0\mu\text{A}$
$V_{gs\ th}$	Gate output threshold	11.5	12.5	13.5		
$V_{rs\ th}$	Rs threshold, $T_j=-40^\circ\text{C}$	0.9	1.1	1.3		
	Rs threshold, $T_j=25^\circ\text{C}$	0.85	1	1.2		
	Rs threshold, $T_j=125^\circ\text{C}$	0.75	0.95	1.2		
$R_{dson\ K1}$	R_{dson} of K1, $T_j=-40^\circ\text{C}$	—	8	13	Ω	$I=100\text{mA}$
	R_{dson} of K1, $T_j=25^\circ\text{C}$	—	11	15		
	R_{dson} of K1, $T_j=125^\circ\text{C}$	—	15	20		
$R_{dson\ K2}$	R_{dson} of K2, $T_j=-40^\circ\text{C}$	—	22	40		
	R_{dson} of K2, $T_j=25^\circ\text{C}$	—	35	45		
	R_{dson} of K2, $T_j=125^\circ\text{C}$	—	60	75		
V_f	Forward voltage of rectifier diode	—	0.7	1	V	$I=100\text{mA}$
$I_{q\ ntc}$	Quiescent current in NTC	—	0.1	1	μA	$V_{NTC}=16\text{V}$, $V_{ntc_en}=0\text{V}$
I_{Ntc}	Out Ntc current $R_{ntc}=7\text{k}$, $V_{dg\ in}=5\text{V}$	—	1	—	mA	$V_{ntc}>6\text{V}$
$V_{th_ntc_en}$	NTC_EN threshold voltage	1.15	1.5	1.9	V	$I=500\mu\text{A}$
$I_{ratio\ ntc}$	Current ratio between NTC_EN and NTC	1.9	2.05	2.2		$V_{ntc}>6\text{V}$

Timing Converter Characteristics

$T_j=40..125^\circ\text{C}$, $V_{cc}=6..16\text{V}$ (unless otherwise specified), typical value are given for $V_{cc}=14\text{V}$ and $T_j=25^\circ\text{C}$.

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	—	10	—		
$T_{doff\ K1}$	Turn-off delay of K1	—	0.2	—		

Switching Characteristics

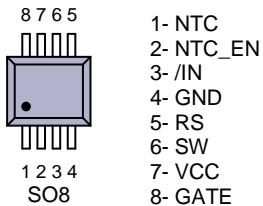
$T_j=40..125^\circ\text{C}$, $V_{cc}=6..16\text{V}$ (unless otherwise specified), typical value are given for $V_{cc}=14\text{V}$ and $T_j=25^\circ\text{C}$.

Symbol	Parameter	Min.	Typ.	Max.	Units	Test Conditions
$T_{don\ K2}$	Turn-on delay of K2	1	2.5	4	μs	$C=100\text{nF}$
	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	$V_{gate}=14\text{V}$

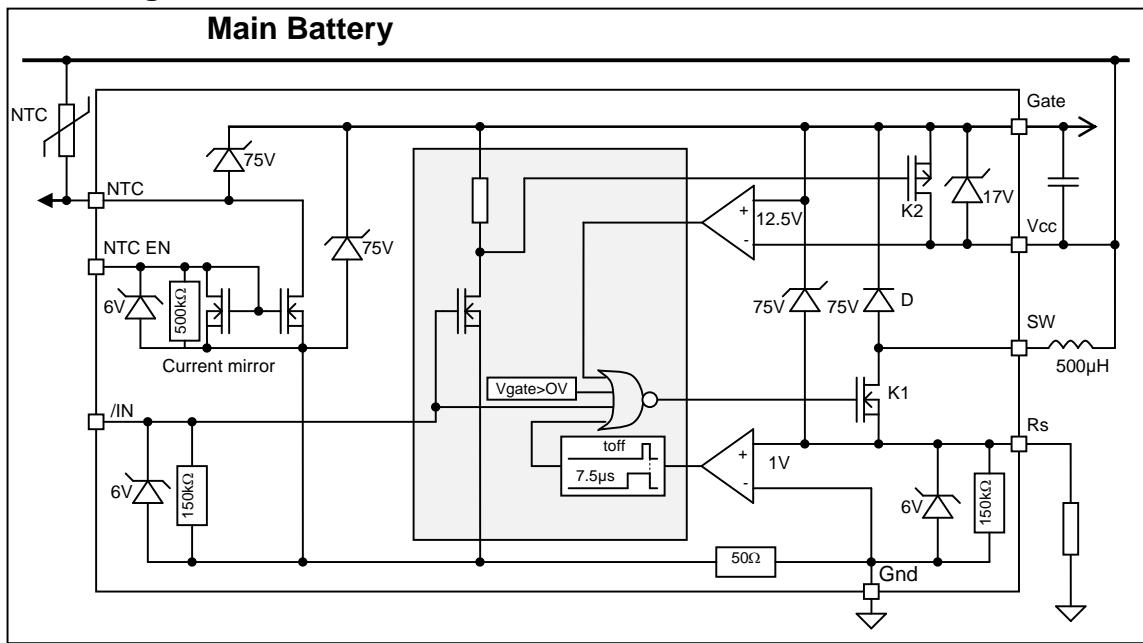
Lead Definitions

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



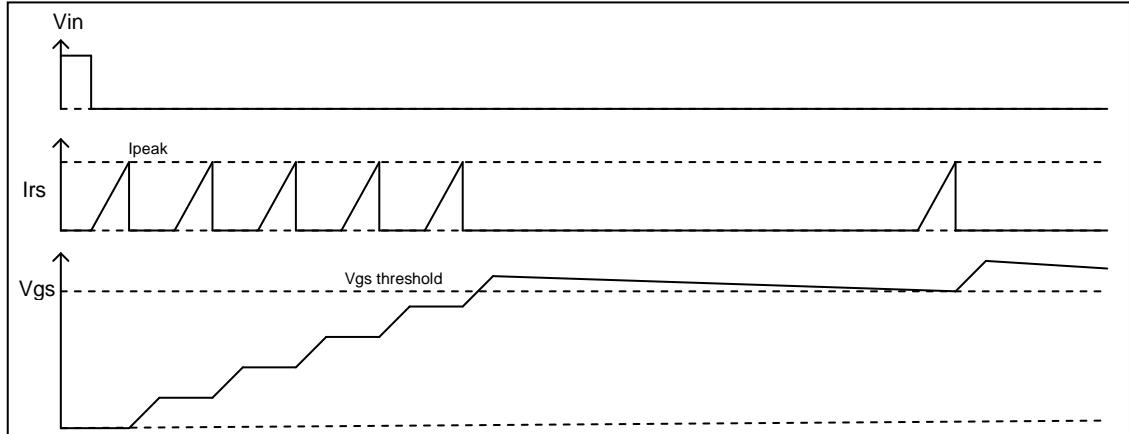
Block diagram



Description

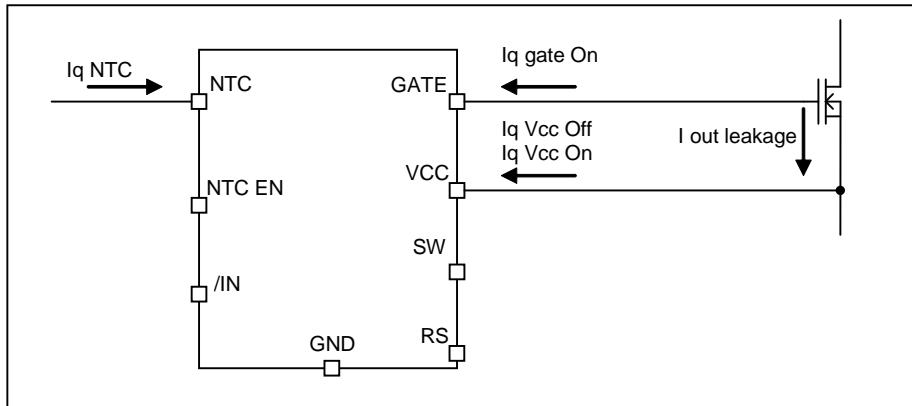
The topology of the AUIR3240S is a boost DC/DC converter working in current mode. K1 is switched on when the gate voltage is lower than V_{gs} threshold. When R_s pin reaches $V_{rs\ th}$, K1 is turned off and the inductor charge the gate capacitor through D. The system cannot restart during T_{off}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

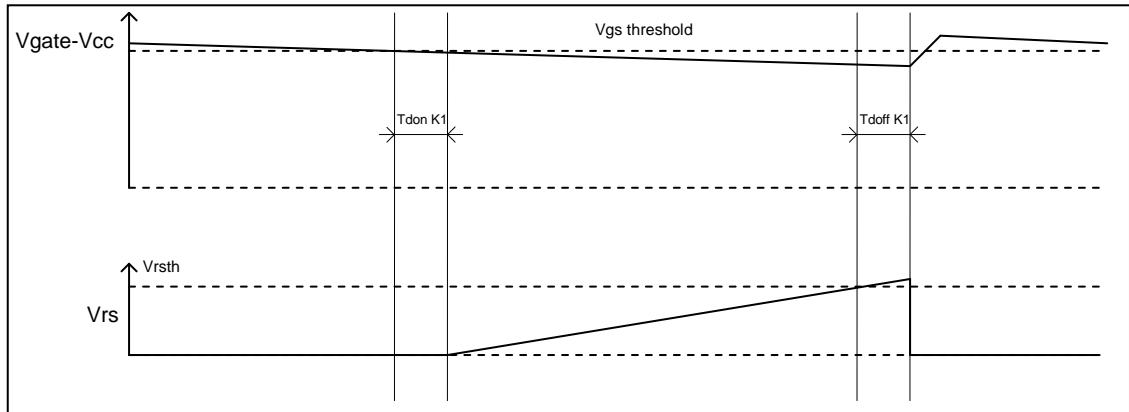
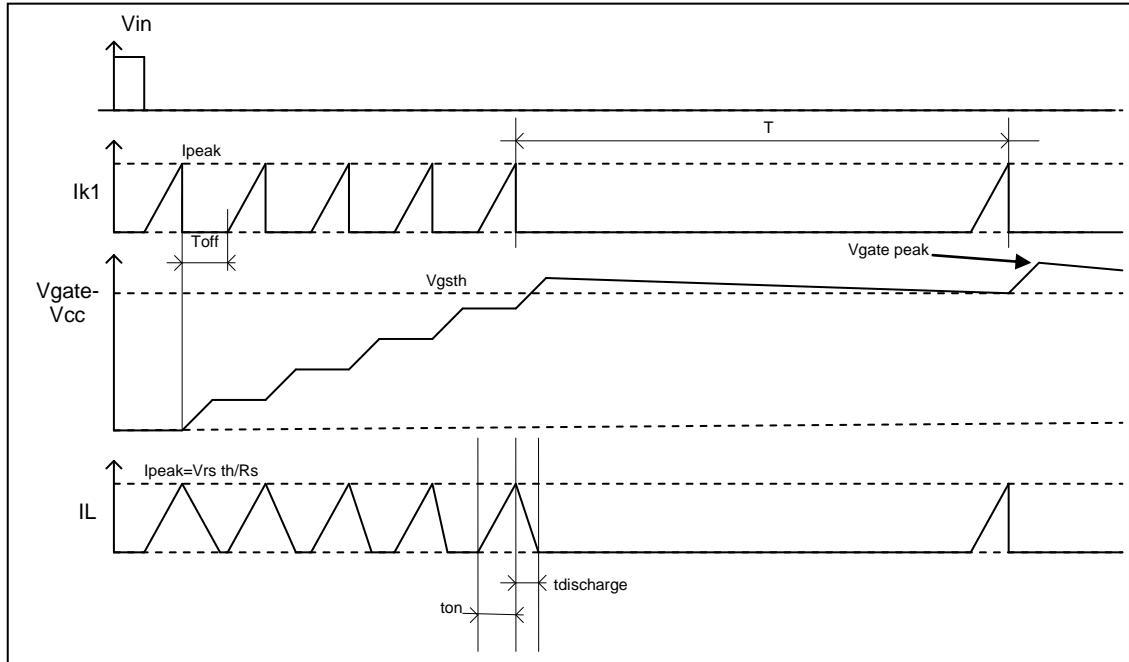
To turn off the power Mosfet, the input must be pull high. Then the DC/DC converter is turned and K2 shorts the gate to V_{cc} .



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 V_{cc} 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 V_{cc} is the current charging the inductor. Therefore the average current on the V_{cc} pin is the combination of the current when $K1$ is ON and OFF. The average current on the V_{cc} pin can be calculated using:

$$I_{VCC\ ave} = (I_{Q\ gate} + I_{out\ leakage}) * \frac{V_{gate} - V_{CC} + V_f}{V_{CC}} + I_{Q\ VCC\ on} + I_{Q\ gate\ on} + I_{Q\ NTC}$$

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

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

Vgate peak can be calculated by:

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

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:

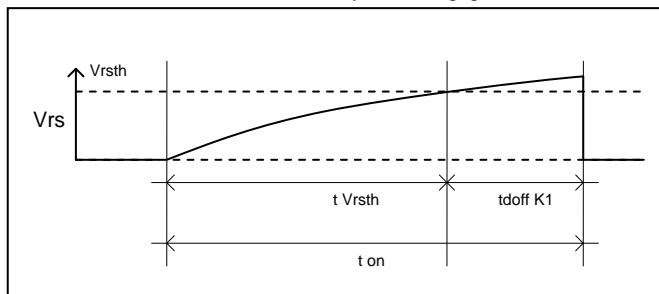
$$T = \frac{I_{peak}^2 \cdot L}{2 * (I_{Q\ gate} + I_{out\ leakage}) * (V_{gate} - V_{CC} + V_f)}$$

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:

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

Where R_l is the resistor of the inductor

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

The peak current can be solved by:

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

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:

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

Minimum operating voltage

While the AUIR3240S operating voltage is specified between 4V and 36V. The minimum voltage is limited by the fact that the Rs voltage must reach the Vrsth 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 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 500 μ A 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 :

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

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

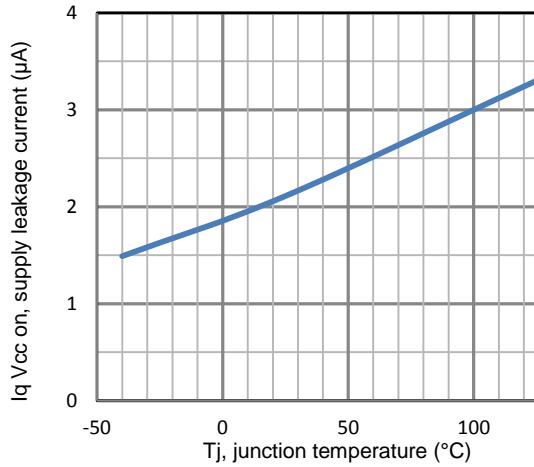


Figure 1 – I_q V_{cc} on (μ A) Vs T_j (°C)

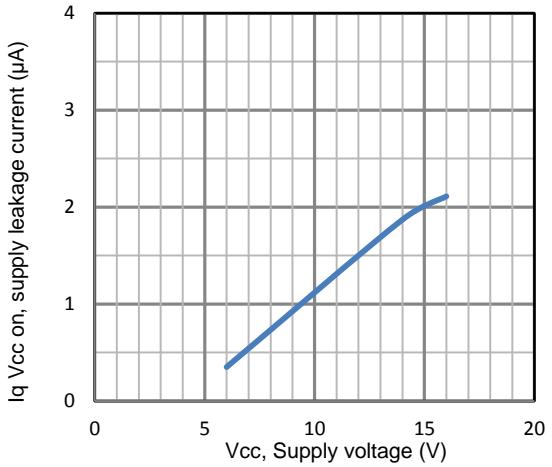


Figure 2 – I_q V_{cc} on (μ A) Vs V_{cc} (V)

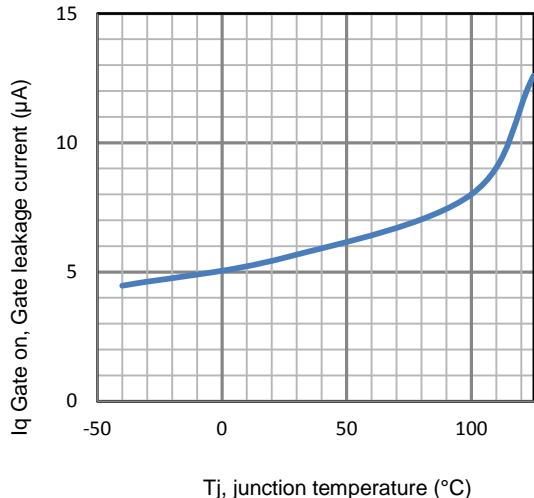


Figure 3 – I_q Gate on (μ A) Vs T_j (°C)

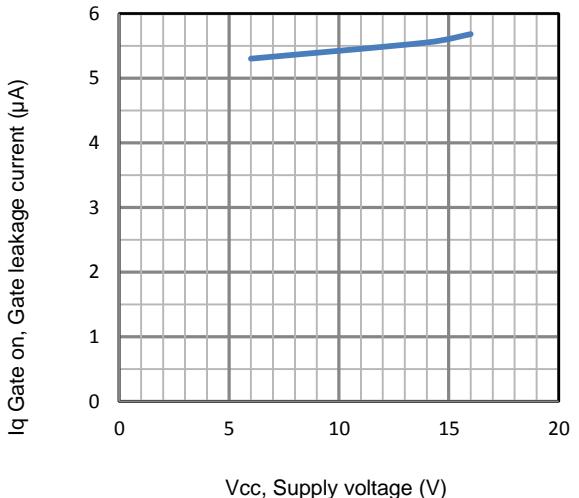


Figure 4 – I_q Gate on (μ A) Vs V_{cc} (V)

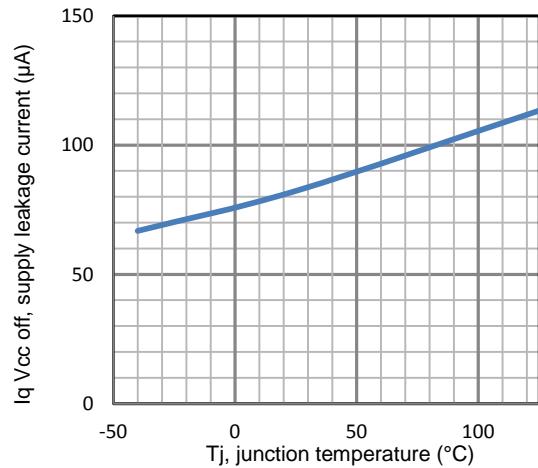


Figure 5 – I_q V_{CC} off (μA) Vs T_j (°C)

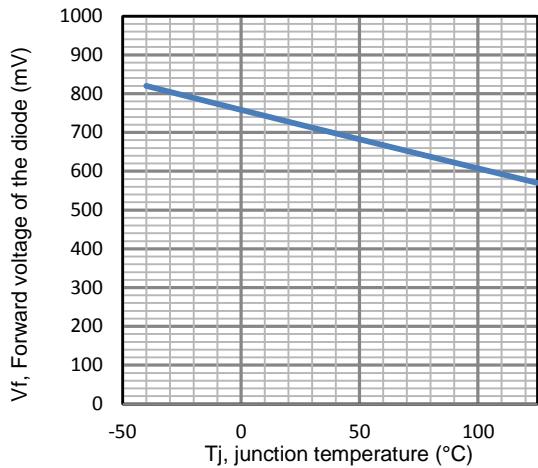
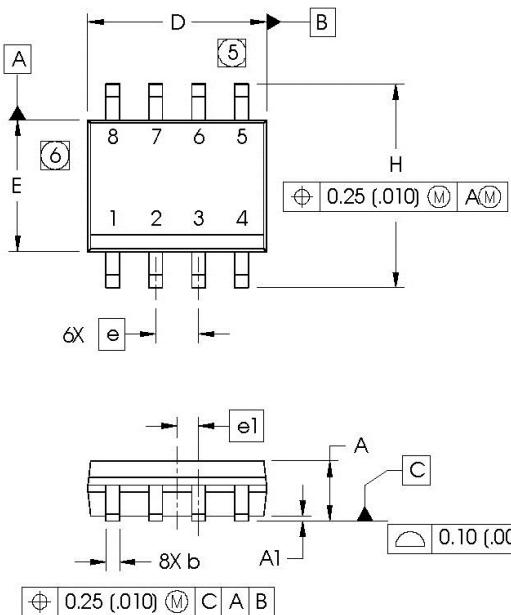


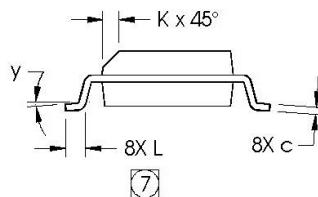
Figure 6 – V_f (mV) Vs T_j (°C)

Case Outline – S08

Dimensions are shown in millimeters (inches)

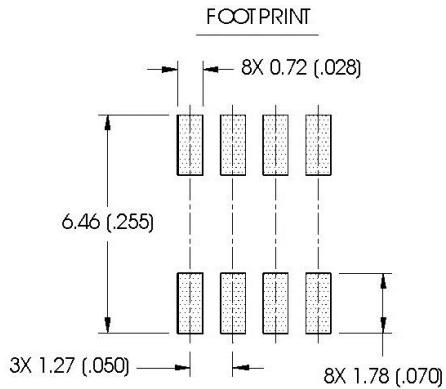


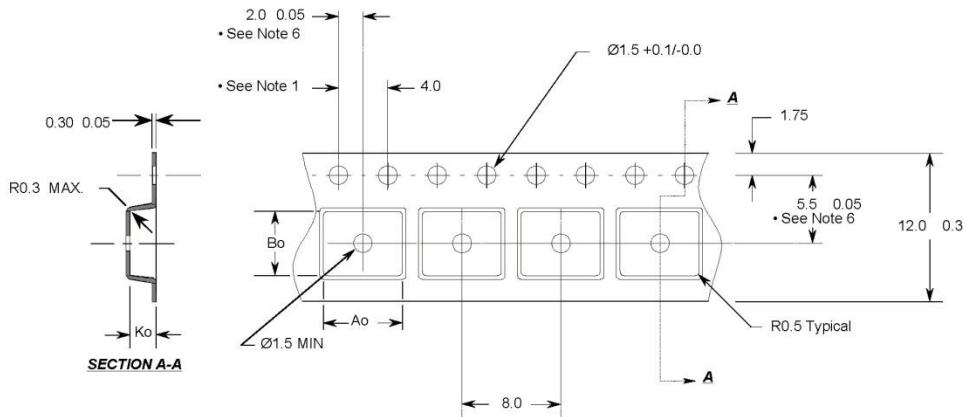
DIM	INCHES		MILLIMETERS	
	MIN	MAX	MIN	MAX
A	.0532	.0688	1.35	1.75
A1	.0040	.0098	0.10	0.25
b	.013	.020	0.33	0.51
c	.0075	.0098	0.19	0.25
D	.189	.1968	4.80	5.00
E	.1497	.1574	3.80	4.00
e	.050 BASIC		1.27	BASIC
e1	.025 BASIC		0.635	BASIC
H	.2284	.2440	5.80	6.20
K	.0099	.0196	0.25	0.50
L	.016	.050	0.40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



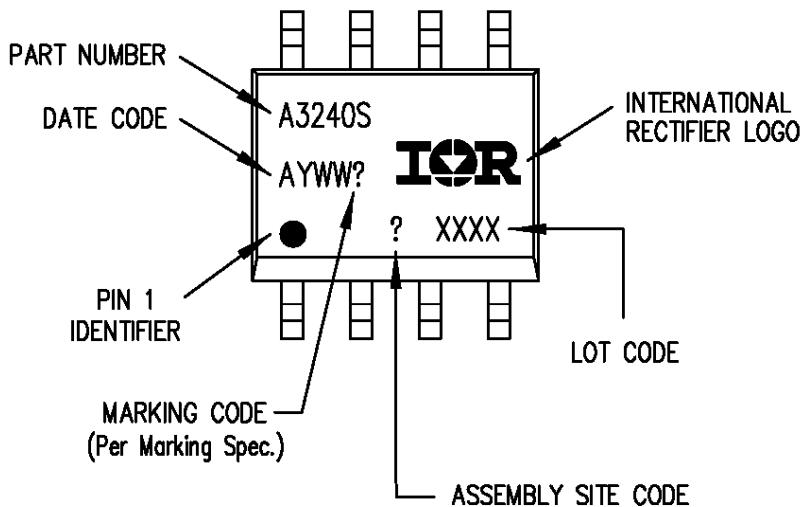
Tape & Reel SO8

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.

$Ao = 6.4 \text{ mm}$
 $Bo = 5.2 \text{ mm}$
 $Ko = 2.1 \text{ mm}$

- 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, 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
F	October, 17 th 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