AS1310

Ultra Low Quiescent Current, Hysteretic DC-DC Step-Up Converter

1 General Description

The AS1310 is an ultra low I_Q hysteretic step-up DC-DC converter optimized for light loads (60mA), where it achieves efficiencies of up to 92%.

AS1310 operates from a 0.7V to 3.6V supply and supports output voltages between 1.8V and 3.3V. Besides the available AS1310 standard variants any variant with output voltages in 50mV steps are available. See Ordering Information on page 14 for more information.

If the input voltage exceeds the output voltage the device is in a feed-through mode and the input is directly connected to the output voltage.

In order to save power the AS1310 features a shutdown mode, where it draws less than 100nA. During shutdown mode the battery is disconnected from the output.

The AS1310 also offers adjustable low battery detection. If the battery voltage decreases below the threshold defined by two external resistors on pin LBI, the LBO output is pulled to logic low.

The AS1310 is available in a TDFN (2x2) 8-pin package.

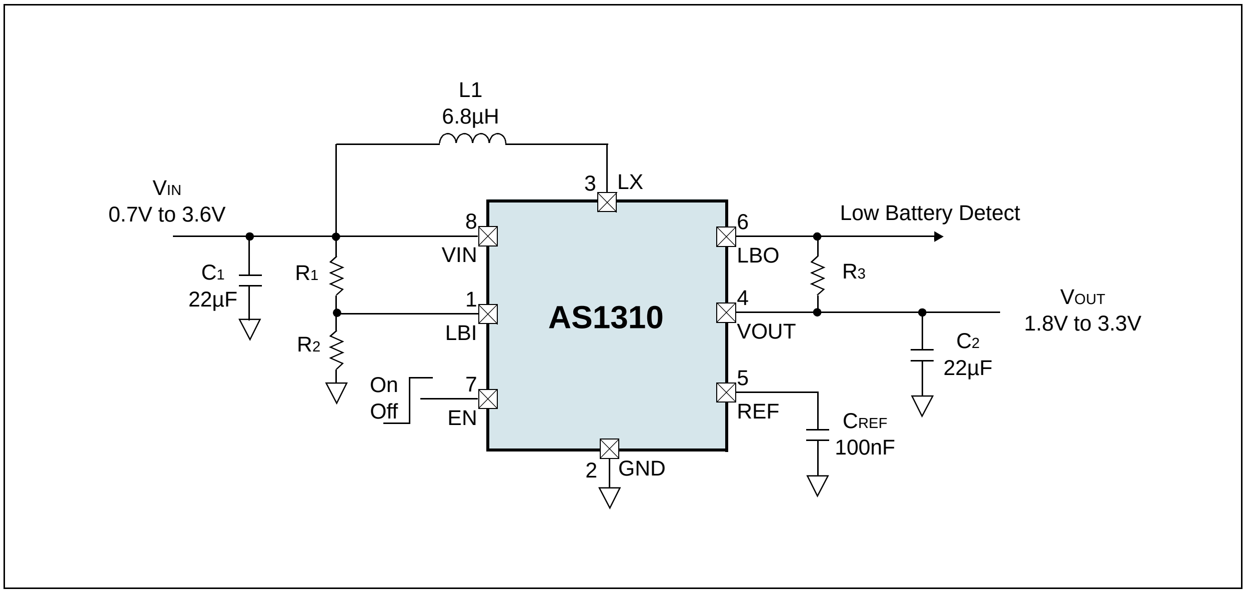
2 Key Features

- Input Voltage Range: 0.7V to 3.6V
- Fixed Output Voltage Range: 1.8V to 3.3V
- Output Current: 60mA @ V_{IN}=0.9V, V_{OUT}=1.8V
- Quiescent Current: 1µA (typ.)
- Shutdown Current: < 100nA
- Up to 92% efficiency
- Output Disconnect in Shutdown
- Feedthrough Mode when $V_{IN} > V_{OUT}$
- Adjustable Low Battery detection
- No external diode or transistor required
- Over Temperature Protection
- TDFN (2x2) 8-pin package

3 Applications

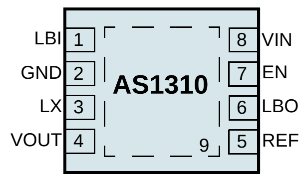
The AS1310 is an ideal solution for single and dual cell powered devices as blood glucose meters, remote controls, hearing aids, wireless mouse or any light-load application.

Figure 1. AS1310 - Typical Application Diagram



4 Pin Assignments

Figure 2. Pin Assignments (Top View)



Pin Descriptions

Table 1. Pin Descriptions

Pin Number	Pin Name	Description
1	LBI	Low Battery Comparator Input. 0.6V Threshold. May not be left floating. If connected to GND, LBO is working as Power Output OK.
2	GND	Ground
3	LX	External Inductor Connector.
4	VOUT	Output Voltage. Decouple VOUT with a 22µF ceramic capacitor as close as possible to VOUT and GND.
5	REF	Reference Pin. Connect a 100nF ceramic capacitor to this pin.
6	LBO	Low Battery Comparator Output. Open-drain output.
7	EN	Enable Pin. Logic controlled shutdown input. 1 = Normal operation; 0 = Shutdown; shutdown current <100nA.
8	VIN	Battery Voltage Input. Decouple VIN with a 22µF ceramic capacitor as close as possible to VIN and GND.
9	NC	Exposed Pad. This pad is not connected internally. Can be left floating or connect to GND to achieve an optimal thermal performance.

5 Absolute Maximum Ratings

Stresses beyond those listed in Table 2 may cause permanent damage to the device. These are stress ratings only, and functional operation of the device at these or any other conditions beyond those indicated in Electrical Characteristics on page 4 is not implied. Exposure to absolute maximum rating conditions for extended periods may affect device reliability.

Table 2. Absolute Maximum Ratings

Parameter	Min	Max	Units	Comments
Electrical Parameters				
VIN, VOUT, EN, LBI, LBO to GND	-0.3	+5	V	
LX, REF to GND	-0.3	VOUT + 0.3	V	
Input Current (latch-up immunity)	-100	100	mA	Norm: JEDEC 78
Electrostatic Discharge				
Electrostatic Discharge HBM	+/- 2		kV	Norm: MIL 883 E method 3015
Temperature Ranges and Storage Conditions				
Thermal Resistance θ_{JA}	+33		ºC/W	
Junction Temperature		+150	ºC	
Storage Temperature Range	-55	+125	ºC	
Package Body Temperature		+260	ºC	The reflow peak soldering temperature (body temperature) specified is in accordance with *IPC/ JEDEC J-STD-020"Moisture/Reflow Sensitivity Classification for Non-Hermetic Solid State Surface Mount Devices".* The lead finish for Pb-free leaded packages is matte tin (100% Sn).
Humidity non-condensing	5	85	%	
Moisture Sensitive Level	1			Represents a max. floor life time of unlimited

6 Electrical Characteristics

V_{IN} = 1.5V, C1 = C2 = 22µF, C_{REF} = 100nF, T_{AMB} = -40°C to +85ºC. Typical values are at T_{AMB} = +25ºC. Unless otherwise specified.

Table 3. Electrical Characteristics

Symbol	Parameter	Conditions	Min	Typ	Max	Units
T_{AMB}	Operating Temperature Range		-40		85	°C
Input						
V_{IN}	Input Voltage Range		0.7		3.6	V
	Minimum Startup Voltage	I_{LOAD} = 1mA, T_{AMB} = +25°C		0.7	0.8	V
Regulation						
V_{OUT}	Output Voltage Range		1.8		3.3	V
	Output Voltage Tolerance	I_{LOAD} = 10 mA, T_{AMB} = +25°C	-2		+2	%
		I_{LOAD} = 10mA	-3		+3	%
	V_{OUT} Lockout Threshold[1]	Rising Edge	1.55	1.65	1.75	V
Operating Current						
I_Q	Quiescent Current V_{IN}	V_{OUT} = 1.02xV_{OUTNOM}, REF = 0.99xV_{OUTNOM}, T_{AMB} = +25°C			100	nA
	Quiescent Current V_{OUT}	V_{OUT} = 1.02xV_{ON}, REF = 0.99xV_{ON}, no load, T_{AMB} = +25°C	0.8	1	1.2	µA
I_{SHDN}	Shutdown Current	T_{AMB} = +25ºC			100	nA
Switches						
R_{ON}	NMOS	V_{OUT} = 3V		0.35		Ω
	PMOS	V_{OUT} = 3V		0.5		Ω
	NMOS maximum On-time		3.6	4.2	4.8	µs
I_{PEAK}	Peak Current Limit		320	400	480	mA
	Zero Crossing Current		5	20	35	mA
Enable, Reference						
V_{ENH}	EN Input Voltage High		0.7			V
V_{ENL}	EN Input Voltage Low				0.1	V
I_{EN}	EN Input BiasCurrent	EN = 3.6V, T_{AMB} = +25°C			100	nA
I_{REF}	REF Input BiasCurrent	REF = 0.99xV_{OUTNOM}, T_{AMB} = +25°C			100	nA
Low Battery & Power-OK						
V_{LBI}	LBI Threshold	Falling Edge	0.57	0.6	0.63	V
	LBI Hysteresis			25		mV
I_{LBI}	LBI Leakage Current	LBI = 3.6V, T_{AMB} = +25°C			100	nA
V_{LBO}	LBO Voltage Low[2]	I_{LBO} = 1mA		20	100	mV
I_{LBO}	LBO Leakage Current	LBO = 3.6V, T_{AMB} = +25°C			100	nA
	Power-OK Threshold	LBI = 0V, Falling Edge	90	92.5	95	%

Table 3. Electrical Characteristics

Symbol	Parameter	Conditions	Min	Typ	Max	Units
Thermal Protection						
	Thermal Shutdown	10°C Hysteresis		150		°C

1. The regulator is in startup mode until this voltage is reached. Caution: Do not apply full load current until the device output > 1.75V
2. LBO goes low in startup mode as well as during normal operation if:
   1) The voltage at the LBI pin is below LBI threshold.
   2) The voltage at the LBI pin is below 0.1V and V_{OUT} is below 92.5% of its nominal value.

Note: All limits are guaranteed. The parameters with min and max values are guaranteed with production tests or SQC (Statistical Quality Control) methods.

7 Typical Operating Characteristics

TAMB = +25°C, unless otherwise specified.

Figure 3. Efficiency vs. Output Current; VOUT = 1.8V

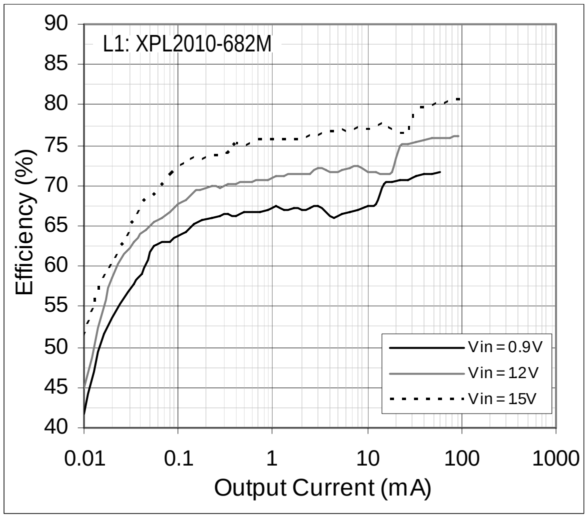


Figure 4. Efficiency vs. Output Current; VOUT = 1.8V

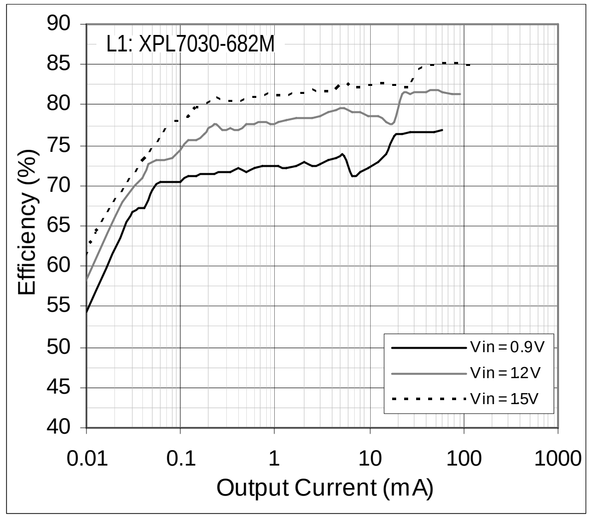


Figure 5. Efficiency vs. Output Current; VOUT = 3.0V

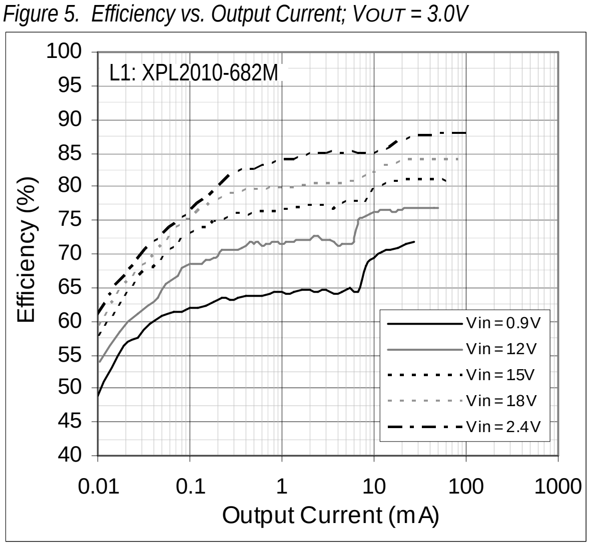


Figure 6. Efficiency vs. Output Current; VOUT = 3.0V

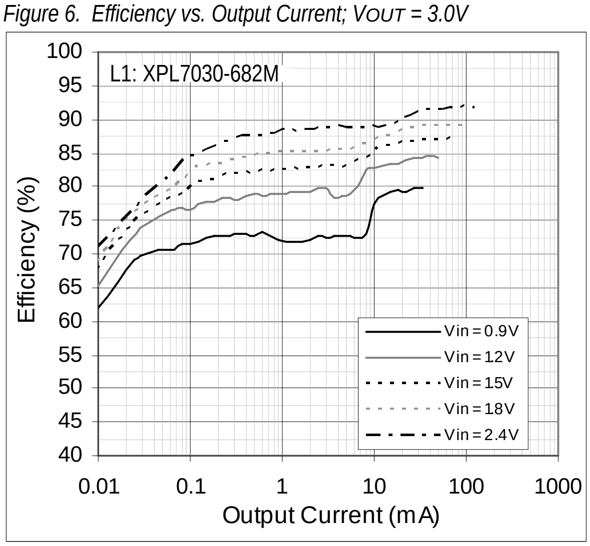


Figure 7. Efficiency vs. Input Voltage; VOUT = 1.8V

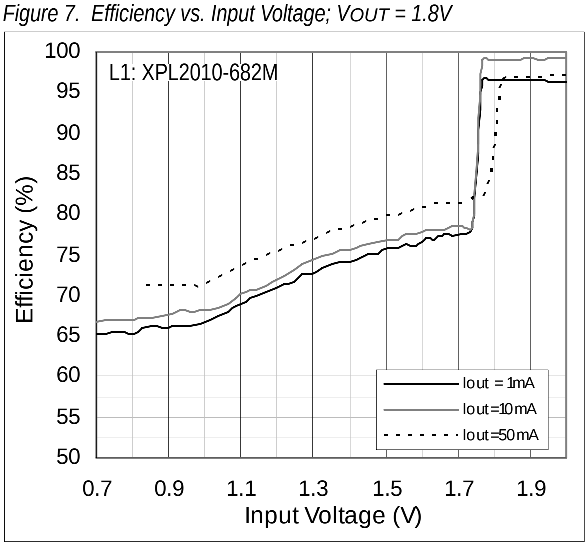


Figure 8. Maximum Output Current vs. Input Voltage

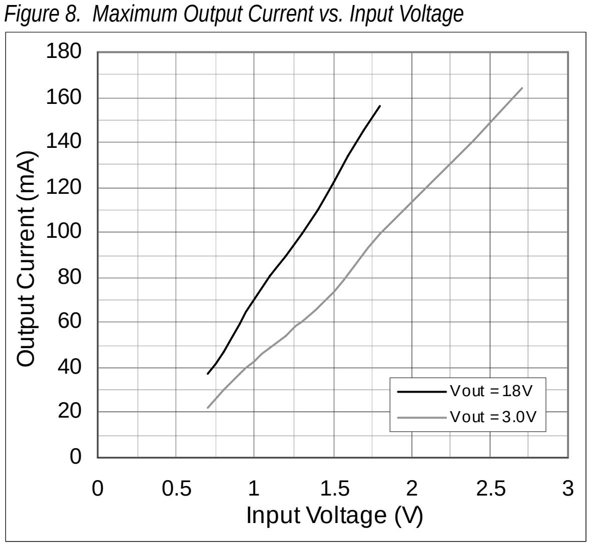


Figure 9. Start-up Voltage vs. Output Current

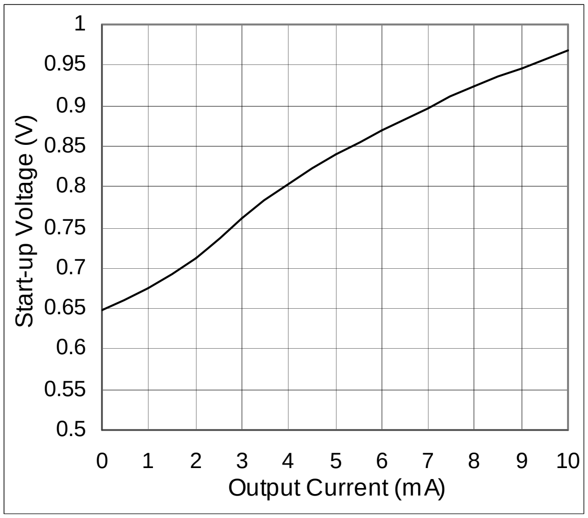


Figure 10. RON vs. Temperature

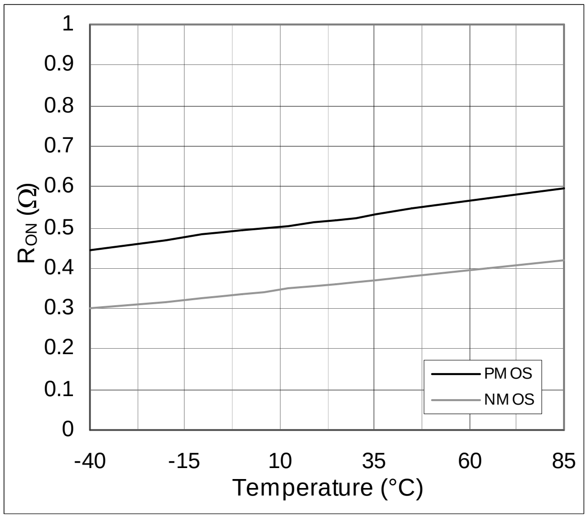
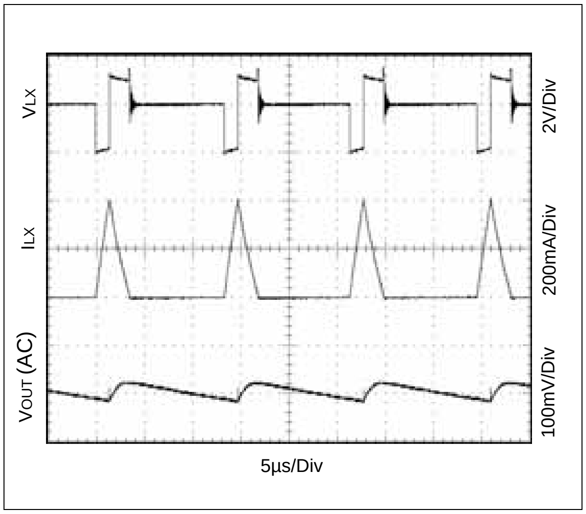


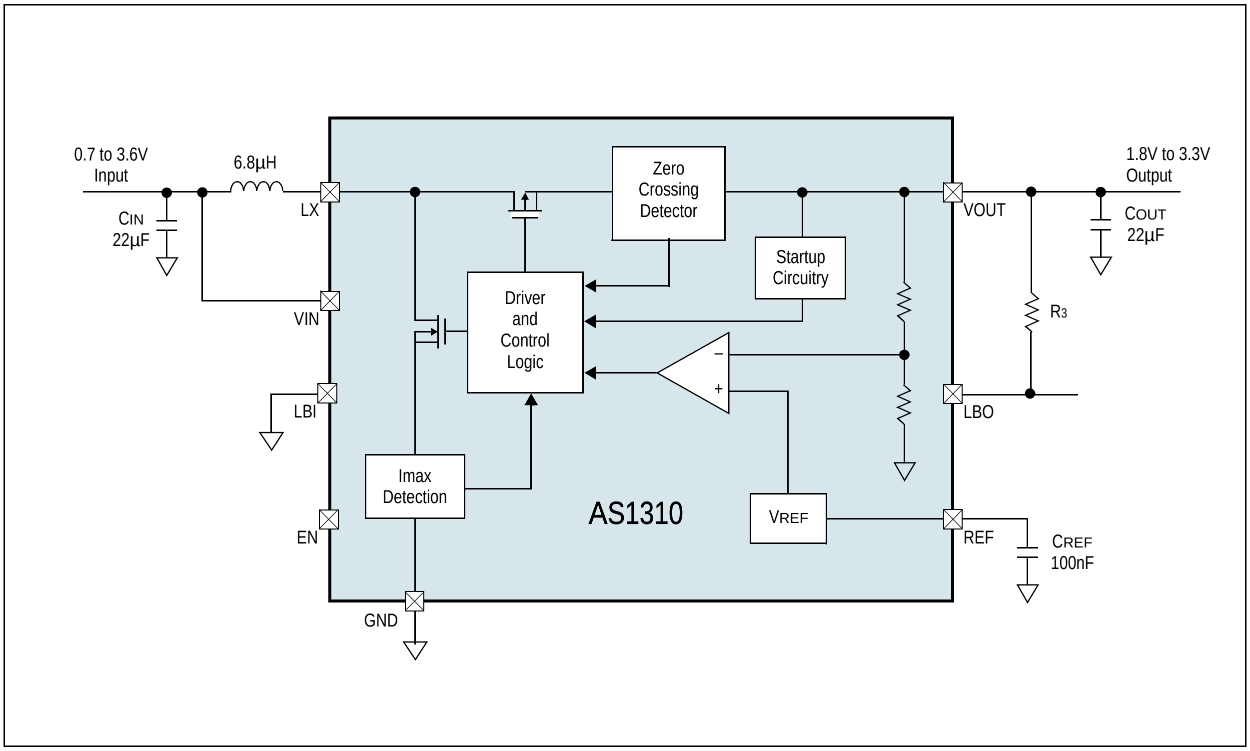
Figure 11. Output Voltage Ripple; VIN = 2V, VOUT = 3V, Rload = 100Ω



8 Detailed Description

The AS1310 is available with fixed output voltages from 1.8V to 3.3V in 50mV steps.

Figure 12. AS1310 - Block Diagram



AS1310 Features

Shutdown

The part is in shutdown mode while the voltage at pin EN is below 0.1V and is active when the voltage is higher than 0.7V.

Note: EN can be driven above VIN or VOUT, as long as it is limited to less than 3.6V.

Output Disconnect and Inrush Limiting

During shutdown VOUT is going to 0V and no current from the input source is running through the device. This is true as long as the input voltage is higher than the output voltage.

Feedthrough Mode

If the input voltage is higher than the output voltage the supply voltage is connected to the load through the device. To guarantee a proper function of the AS1310 it is not allowed that the supply exceeds the maximum allowed input voltage (3.6V).

In this feedtrough mode the quiescent current is 35µA (typ.). The device goes back into step-up mode when the oputput voltage is 4% (typ.) below VOUTNOM.

Power-OK and Low-Battery-Detect Functionality

LBO goes low in startup mode as well as during normal operation if:

- The voltage at the LBI pin is below LBI threshold (0.6V). This can be used to monitor the battery voltage.
- LBI pin is connected to GND and VOUT is below 92.5% of its nominal value. LBO works as a power-OK signal in this case.

The LBI pin can be connected to a resistive-divider to monitor a particular definable voltage and compare it with a 0.6V internal reference. If LBI is connected to GND an internal resistive-divider is activated and connected to the output. Therefore, the Power-OK functionality can be realised with no additional external components.

The Power-OK feature is not active during shutdown and provides a power-on-reset function that can operate down to VIN = 0.7V. A capacitor to GND may be added to generate a power-on-reset delay. To obtain a logic-level output, connect a pull-up resistor R3 from pin LBO to pin VOUT. Larger values for this resistor will help to minimize current consumption; a 100kΩ resistor is perfect for most applications (see Figure 14 on page 10).

For the circuit shown in the left of Figure 13, the input bias current into LBI is very low, permitting large-value resistor-divider networks while maintaining accuracy. Place the resistor-divider network as close to the device as possible. Use a defined resistor for R2 and then calculate R1 as:

$$R_1 = R_2 \cdot \left(\frac{V_{IN}}{V_{LBI}} - 1\right) \qquad \text{(EQ 1)}$$

Where:

V_{LBI} is 0.6V.

Figure 13. Typical Application with adjustable Battery Monitoring

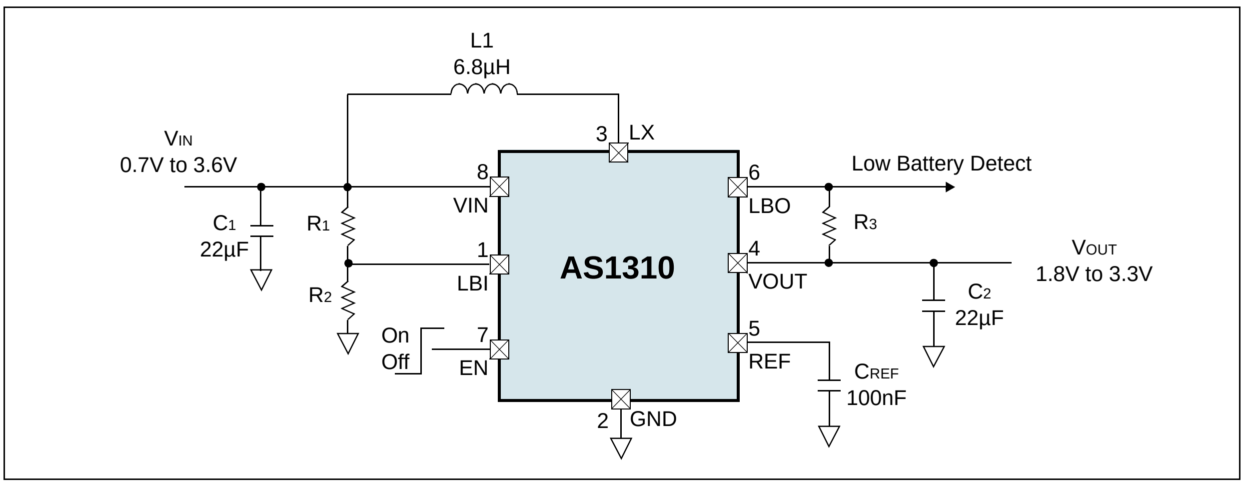
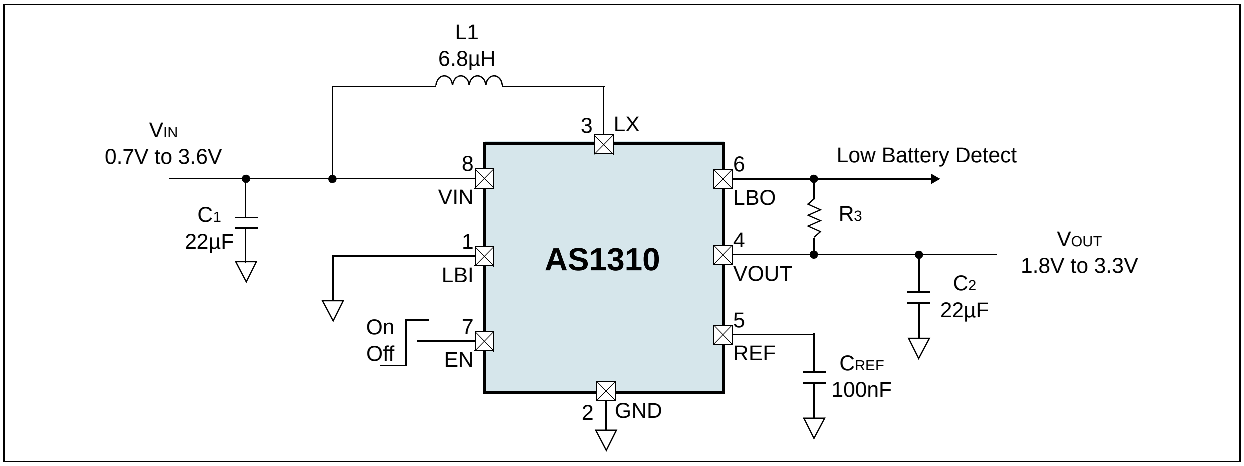


Figure 14. Typical Application with LBO working as Power-OK



Thermal Shutdown

To prevent the AS1310 from short-term misuse and overload conditions the chip includes a thermal overload protection. To block the normal operation mode all switches will be turned off. The device is in thermal shutdown when the junction temperature exceeds 150°C. To resume the normal operation the temperature has to drop below 140°C.

A good thermal path has to be provided to dissipate the heat generated within the package. Otherwise it's not possible to operate the AS1310 at its useable maximal power. To dissipate as much heat as possible from the package into a copper plane with as much area as possible, it's recommended to use multiple vias in the printed circuit board. It's also recommended to solder the Exposed Pad (pin 9) to the GND plane.

Note: Continuing operation in thermal overload conditions may damage the device and is considered bad practice.

9 Application Information

Component Selection

Only four components are required to complete the design of the step-up converter. The low peak currents of the AS1310 allow the use of low value, low profile inductors and tiny external ceramic capacitors.

Inductor Selection

For best efficiency, choose an inductor with high frequency core material, such as ferrite, to reduce core losses. The inductor should have low DCR (DC resistance) to reduce the I^2R losses, and must be able to handle the peak inductor current without saturating. A 6.8µH inductor with a >500mA current rating and <500mΩ DCR is recommended.

Table 4. Recommended Inductors

Part Number	L	DCR	Current Rating	Dimensions (L/W/T)	Manufacturer
XPL2010-682M	6.8µH	421mΩ	0.62A	2.0x1.9x1.0mm	Coilcraft www.coilcraft.com
EPL2014-682M	6.8µH	287mΩ	0.59A	2.0x2.0x1.4mm	
LPS3015-682M	6.8µH	300mΩ	0.86A	3.0x3.0x1.5mm	
LPS3314-682M	6.8µH	240mΩ	0.9A	3.3x3.3x1.3mm	
LPS4018-682M	6.8µH	150mΩ	1.3A	3.9x3.9x1.7mm	
XPL7030-682M	6.8µH	59mΩ	9.4A	7.0x7.0x3.0mm	
LQH32CN6R8M53L	6.8µH	250mΩ	0.54A	3.2x2.5x1.55mm	Murata www.murata.com
LQH3NPN6R8NJ0L	6.8µH	210mΩ	0.7A	3.0x3.0x1.1mm	
LQH44PN6R8MJ0L	6.8µH	143mΩ	0.72A	4.0x4.0x1.1mm	

Capacitor Selection

The convertor requires three capacitors. Ceramic X5R or X7R types will minimize ESL and ESR while maintaining capacitance at rated voltage over temperature. The VIN capacitor should be 22µF. The VOUT capacitor should be between 22µF and 47µF. A larger output capacitor should be used if lower peak to peak output voltage ripple is desired. A larger output capacitor will also improve load regulation on VOUT. See Table 5 for a list of capacitors for input and output capacitor selection.

Table 5. Recommended Input and Output Capacitors

Part Number	C	TC Code	Rated Voltage	Dimensions (L/W/T)	Manufacturer
GRM21BR60J226ME99	22µF	X5R	6.3V	0805, T=1.25mm	Murata www.murata.com
GRM31CR61C226KE15	22µF	X5R	16V	1206, T=1.6mm	
GRM31CR60J475KA01	47µF	X5R	6.3V	1206, T=1.6mm	

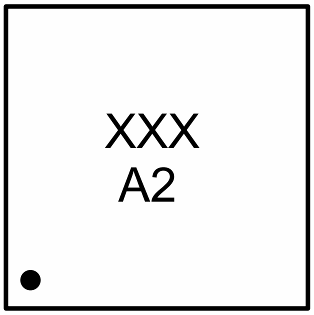
On the pin REF a 10nF capacitor with an Insulation resistance >1GΩ is recommended.

Table 6. Recommended Capacitors for REF

Part Number	C	TC Code	Insulation Resistance	Rated Voltage	Dimensions (L/W/T)	Manufacturer
GRM188R71C104KA01	100nF	X7R	>5GΩ	16V	0603, T=0.8mm	Murata www.murata.com
GRM31CR61C226KE15	100nF	X7R	>5GΩ	50V	0805, T=1.25mm	

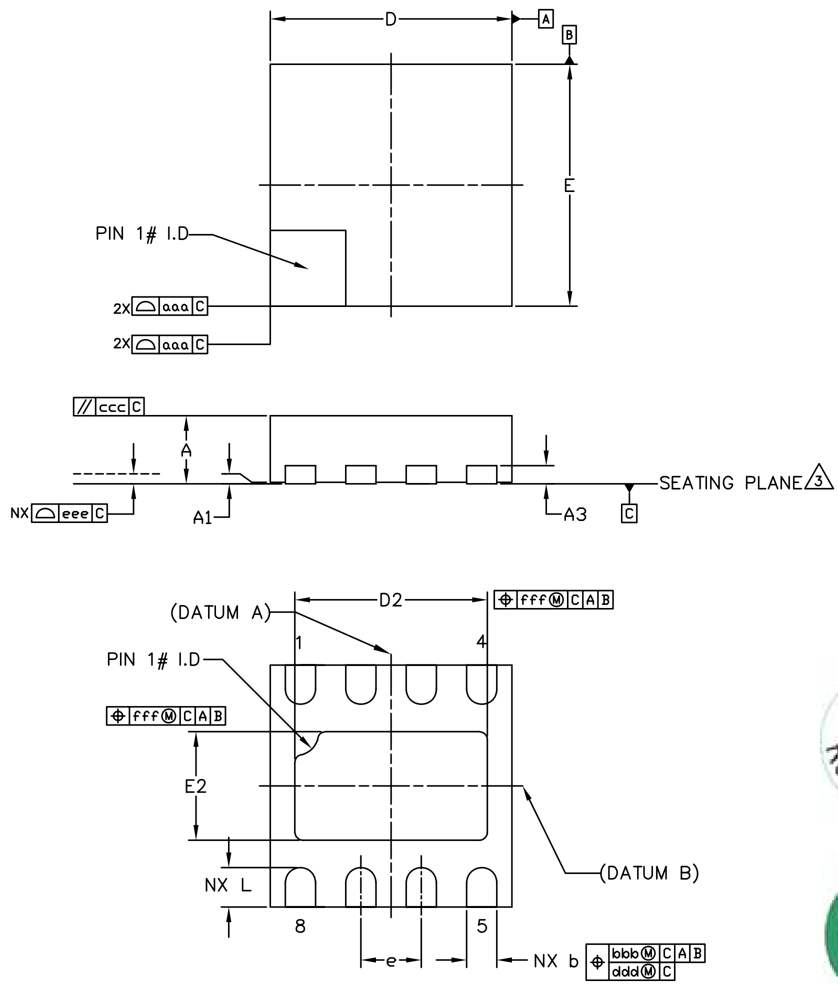
10 Package Drawings and Markings

Figure 15. TDFN (2x2) 8-pin Marking



Package Code:
XXX - encoded Datecode

Figure 16. TDFN (2x2) 8-pin package Diagram



REF.	MIN	NOM	MAX
A	0.51	0.55	0.60
A1	0.00	0.02	0.05
A3		0.15 REF	
L	0.225	0.325	0.425
b	0.18	0.25	0.30
D		2.00 BSC	
E		2.00 BSC	
e		0.50 BSC	
D2	1.45	1.60	1.70
E2	0.75	0.90	1.00
aaa	–	0.15	–
bbb	–	0.10	–
ccc		0.10	–
ddd	–	0.05	–
eee	–	0.08	–
fff	–	0.10	–
N		8	

NOTE:

1. DIMENSIONS & TOLERANCEING CONFIRM TO ASME Y14.5M–1994.
2. ALL DIMENSIONS ARE IN MILLIMETERS. ANGELS ARE IN DEGREES.
3. COPLANARITY APPLIES TO THE EXPOSED HEAT SLUG AS WELL AS THE TERMINAL.
4. RADIUS ON TERMINAL IS OPTIONAL.
5. N IS THE TOTAL NUMBER OF TERMINALS.

austriamicrosystems a leap ahead in analog			ASSEMBLY ENGINEERING	
			TITLE MLPD 2x2x0.55mm 8 LEAD, 1.60X0.90mm ePAD	REFERENCE DOCUMENT JEDEC MO – 248 LATEST REVISION
DRAWN RH8	DATE 2011.02.02	REV. N/C		
CHECKED GBO	DATE 2011.02.02		DRAWING NO. QFF	UNIT
APPROVED MKR	DATE 2011.02.02	SHEET 1 OF 1	DIMENSION AND TOLERANCE	SCALE NOT IN SCALE

11 Ordering Information

The device is available as the standard products shown in Table 7.

Table 7. Ordering Information

Ordering Code	Marking	Output	Description	Delivery Form	Package
AS1310-BTDT-18	A2	1.8V	Ultra Low Quiescent Current, Hysteretic DC-DC Step-Up Converter	Tape and Reel	TDFN (2x2) 8-pin
AS1310-BTDT-20	A8	2.0V	Ultra Low Quiescent Current, Hysteretic DC-DC Step-Up Converter	Tape and Reel	TDFN (2x2) 8-pin
AS1310-BTDT-25	A9	2.5V	Ultra Low Quiescent Current, Hysteretic DC-DC Step-Up Converter	Tape and Reel	TDFN (2x2) 8-pin
AS1310-BTDT-27	A7	2.7V	Ultra Low Quiescent Current, Hysteretic DC-DC Step-Up Converter	Tape and Reel	TDFN (2x2) 8-pin
AS1310-BTDT-30	A6	3.0V	Ultra Low Quiescent Current, Hysteretic DC-DC Step-Up Converter	Tape and Reel	TDFN (2x2) 8-pin
AS1310-BTDT-33[1]	tbd	3.3V	Ultra Low Quiescent Current, Hysteretic DC-DC Step-Up Converter	Tape and Reel	TDFN (2x2) 8-pin
AS1310-BTDT-xx[2]	tbd	tbd	Ultra Low Quiescent Current, Hysteretic DC-DC Step-Up Converter	Tape and Reel	TDFN (2x2) 8-pin

1. On request
2. Non-standard devices are available between 1.8V and 3.3V in 50mV steps.

Note: All products are RoHS compliant and austriamicrosystems green.
Buy our products or get free samples online at ICdirect: http://www.austriamicrosystems.com/ICdirect

Technical Support is found at http://www.austriamicrosystems.com/Technical-Support

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