

## DESCRIPTION

The AS1301 is a 1.5MHz constant frequency current mode PWM step-down converter. The device integrates a main switch and a synchronous rectifier for high efficiency without an external Schottky diode. It is ideal for powering portable equipment that runs from a single cell Lithium-Ion (Li+) battery. The AS1301 can supply 800mA of load current from a 2.5V to 6.5V input voltage. The output voltage for the AS1301-adj can be regulated as low as 0.6V, while the output voltage of the AS1301-1.8 is fixed at 1.8V. The AS1301 can also run at 100% duty cycle for low dropout applications.

The AS1301 is available in a low profile (1mm) 5-pin, TSOT23 package.

## ORDER INFORMATION

Part Number	Output Voltage
AS1301EHT-adj	Adjustable
AS1301EHT-1.8	1.8V

## EVALUATION BOARD

Board Number	Dimensions
EV1301EH-00A	50 <sup>mm</sup> X x 50 <sup>mm</sup> Y x 1.4 <sup>mm</sup> Z

## FEATURES

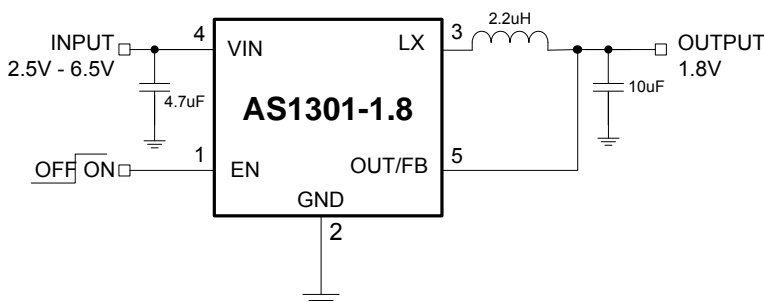
- High Efficiency: Up to 96%
- 1.5MHz Constant Switching Frequency
- 800mA Available Load Current
- 2.5V to 6.5V Input Voltage Range:
- Output Voltage as low as 0.6V
- 100% Duty Cycle In Dropout
- Current Mode Control
- Short Circuit Protection
- Thermal Fault Protection
- <1 $\mu$ A Shutdown Current
- Space Saving 5-pin TSOT23 Package

## APPLICATIONS

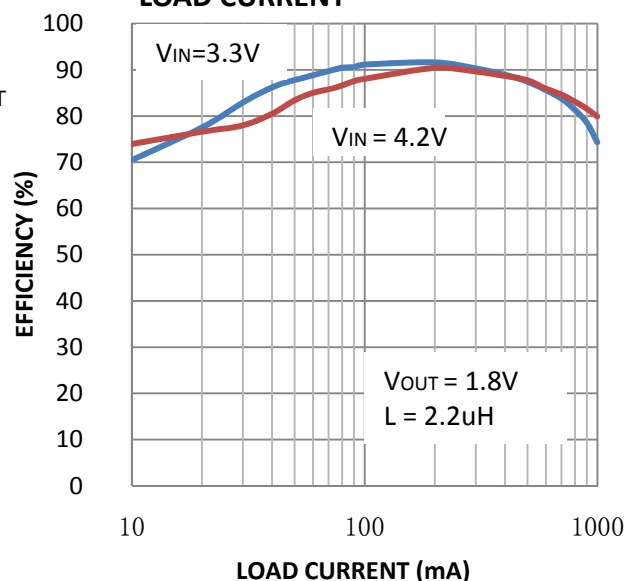
- Cellular & Smart Phones
- Microprocessors and DSP Core Supplies
- PDAs & MP3 Player
- Digital Still and Video Cameras
- Portable instruments

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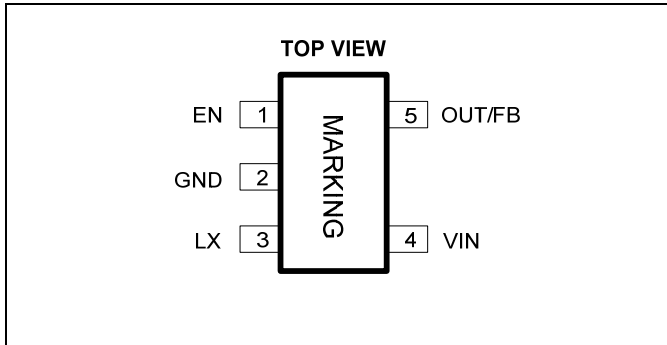
## TYPICAL APPLICATION



## EFFICIENCY vs LOAD CURRENT



**PACKAGE REFERENCE**



Part Number*	Package	Marking
AS1301EHT-adj	TSOT23-5L	A1YW
AS1301EHT-1.8	TSOT23-5L	A3YW

\*For output voltage adjustable, add suffix -adj (eg. AS1301EHT-adj)  
For fixed 1.8V output voltage, add suffix -1.8 (eg. AS1301EHT-1.8)

**ABSOLUTE MAXIMUM RATINGS<sup>(1)</sup>**

V <sub>IN</sub> to GND	-0.3V to 7V
V <sub>LX</sub> to GND	-0.3V to V <sub>IN</sub> +0.3V
V <sub>EN</sub> , V <sub>FB</sub> Voltage	-0.3V to +6.5V
LX Peak Current	1.5A
Junction Temperature	125°C
Lead Temperature (Soldering, 10sec.)	+300°C
Storage Temperature Range	-65°C to 150°C

**Recommended Operating Conditions<sup>(2)</sup>**

Supply Voltage V <sub>IN</sub>	2.5V to 6.5V
Output Voltage V <sub>OUT</sub>	0.6V to 6.5V
Operating Temperature	-40°C to 85°C

**Thermal Resistance<sup>(3)</sup>**

	$\theta_{JA}$	$\theta_{JC}$
TSOT23-5L	220	110

NOTES:

- Exceeding these ratings may damage the device.
- The device is not guaranteed to function outside of its operating conditions.
- Measure on approximately 1"square of 1 oz copper.

**ELECTRICAL CHARACTERISTICS**

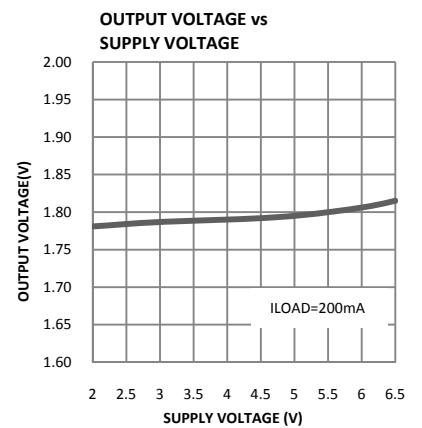
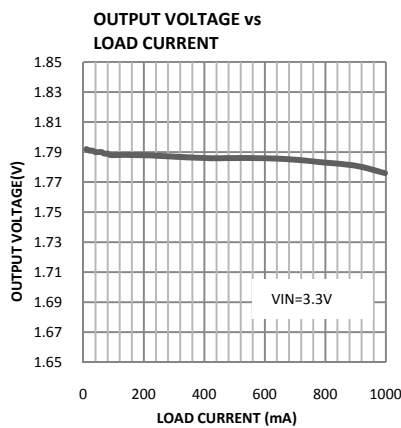
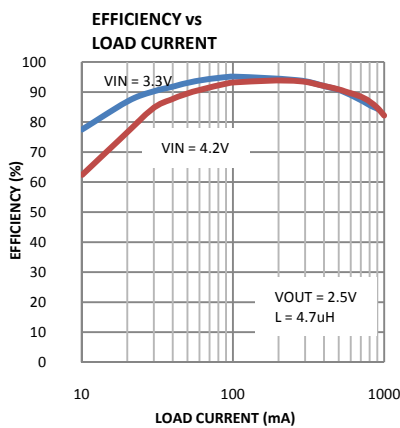
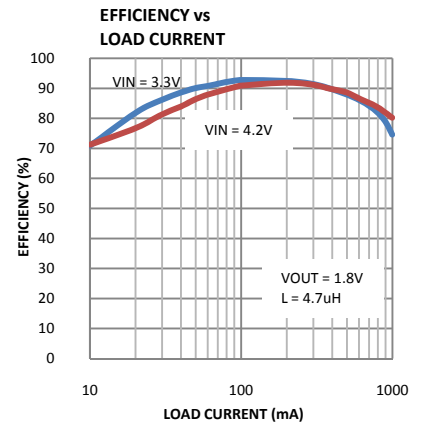
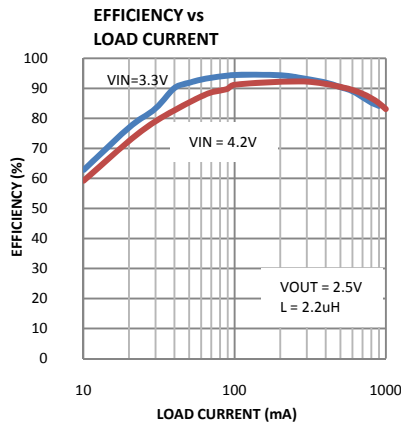
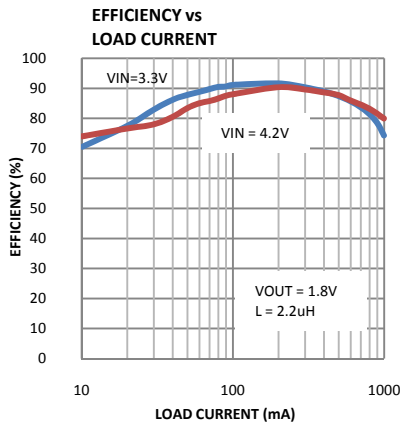
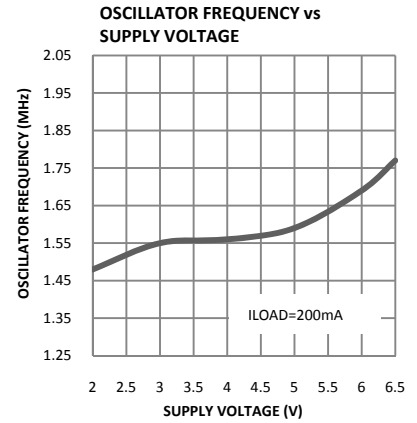
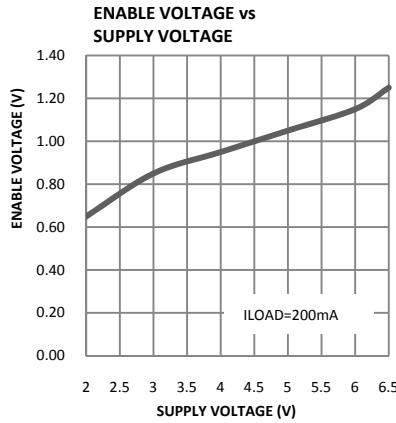
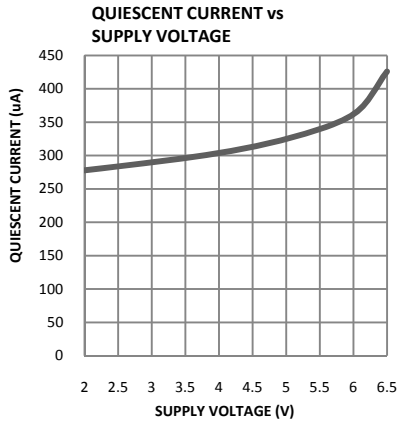
V<sub>IN</sub> = V<sub>EN</sub> = 3.6V, T<sub>A</sub> = 25°C Unless otherwise noted.

PARAMETER	CONDITIONS	MIN	TYP	MAX	UNITS
Supply Voltage	-	2.5		6.5	V
Supply Current	Active Mode, V <sub>FB</sub> = 0.5V or V <sub>OUT</sub> =90%		300	400	µA
	Shutdown Mode, V <sub>FB</sub> = 0V, V <sub>IN</sub> = 4.2V		0.01	1	
Regulated Feedback Voltage	T <sub>A</sub> = 25°C	0.588	0.600	0.612	V
	T <sub>A</sub> = -40°C ≤ TA ≤ 85°C	0.582	0.600	0.618	
FB Input Bias Current	V <sub>FB</sub> = 0.65V			±30	nA
Output Voltage Line Regulation	V <sub>IN</sub> = 2.5V to 5.5V, I <sub>OUT</sub> = 10mA		0.04	0.40	%/V
Output Voltage Load Regulation			0.5		%
Peak Inductor Current	V <sub>IN</sub> =3V, V <sub>FB</sub> = 0.5V or V <sub>OUT</sub> = 90%; Duty Cycle <35%	0.75	1.00	1.25	A
Oscillator Frequency	V <sub>FB</sub> = 0.6V or V <sub>OUT</sub> = 100%	1.2	1.5	1.8	MHz
P-CH MOSFET R <sub>DS(ON)</sub>	I <sub>LX</sub> = 300mA		0.40	0.50	Ω
N-CH MOSFET R <sub>DS(ON)</sub>	I <sub>LX</sub> = -300mA		0.35	0.45	
LX Leakage	V <sub>EN</sub> =0V, V <sub>LX</sub> =0V or 5V, V <sub>IN</sub> =5V		±0.01	±1	µA
Enable Threshold	T <sub>A</sub> = -40°C ≤ TA ≤ 85°C	0.55	-	1.25	V
Enable Leakage Current	V <sub>EN</sub> =0V to 6.5V		±0.01	±1	µA

Note: 100% production test at +25°C; Specification over the temperature range are guaranteed by design.

**TYPICAL PERFORMANCE CHARACTERISTICS**

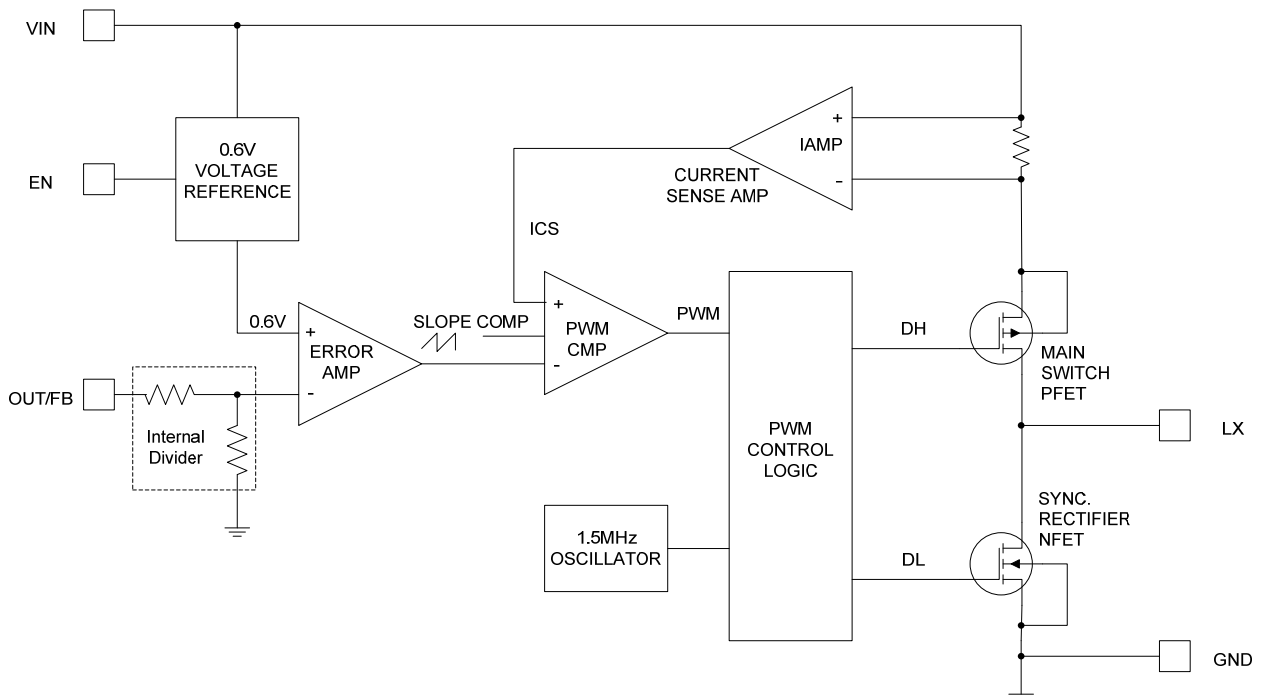
V<sub>in</sub>=3.3V, V<sub>out</sub>=1.8V, L=2.2uH, C<sub>in</sub>=10uF, C<sub>out</sub>=10uF; T<sub>A</sub> = +25°C; unless otherwise noted.



## PIN FUNCTIONS

PIN NUMBER	PIN NAME	FUNCTION
1	EN	<b>Regulator Enable Control Input.</b> Forcing EN above 1.25V turn on the AS1301. Forcing EN 0.55V to turn it off. Do not leave EN floating.
2	GND	<b>Ground .</b>
3	LX	<b>Power Switch Output.</b> Inductor connection to drains of the internal PFET and NFET switches.
4	VIN	<b>Supply Input.</b> Bypass to GND with a 4.7 $\mu$ F or greater ceramic capacitor.
5	OUT/FB	<b>Output Voltage Sense Input (AS1301-adj)</b> Connect FB to the center point of the external resistor divider. The feedback threshold voltage is 0.6V. <b>Feedback Input (AS1301-1.8).</b> An internal resistive divider divides is connected to this pin to set the proper output voltage.

## FUNCTION BLOCK DIAGRAM



## OPERATION

The AS1301 is a constant frequency current mode PWM step-down converter. The AS1301 is optimized for low voltage, Li-Ion battery powered applications where high efficiency and small size are critical. The AS1301 uses an external resistor divider to set the output voltage from 0.6V to 6.5V. The device integrates both a main switch and a synchronous rectifier, which provides high efficiency and eliminates an external Schottky diode. The AS1301 can achieve 100% duty cycle. The duty cycle D of a step-down converter is defined as:

$$D = T_{ON} \times f_{OSC} \times 100\% \approx \frac{V_{OUT}}{V_{IN}} \times 100\%$$

Where  $T_{ON}$  is the main switch on time,  $f_{OSC}$  is the oscillator frequency (1.5MHz),  $V_{OUT}$  is the output voltage and  $V_{IN}$  is the input voltage.

## CURRENT MODE PWM CONTROL

Slope compensated current mode PWM control provides stable switching and cycle-by-cycle current limit for excellent load and line response and protection of the internal main switch and synchronous rectifier. The AS1301 switches at a constant frequency (1.5MHz) and regulates the output voltage. During each cycle the PWM comparator modulates the power transferred to the load by changing the inductor peak current based on the feedback error voltage. During normal operation, the main switch is turned on for a certain time to ramp the inductor current at each rising edge of the internal oscillator, and switched off when the peak inductor current is above the error voltage. When the main switch is off, the synchronous rectifier will be turned on immediately and stay on until either the next cycle starts.

## DROPOUT OPERATION

When the input voltage decreases toward the value of the output voltage, the AS1301 allows the main switch to remain on for more than one switching cycle and increases the duty cycle until it reaches 100%. The output Voltage then is the input voltage minus the voltage drop across the main switch and the inductor.

## SHORT CIRCUIT PROTECTION

The AS1301 has short circuit protection. When the output is shorted to ground, the oscillator frequency is reduced to prevent the inductor current from increasing beyond the PFET current limit. The PFET current limit is also reduced to lower the short circuit current. The frequency and current limit will return to the normal values once the short circuit condition is removed and the feedback voltage reaches 0.6V.

## Maximum Load current

The AS1301 can operate down to 2.5V input voltage, however the maximum load current decreases at lower input due to large IR drop on the main switch and synchronous rectifier. The slope compensation signal reduces the peak inductor current as a function of the duty cycle to prevent sub-harmonic oscillations at duty cycles greater than 50%. Conversely the current limit increases as the duty cycle decreases.

**APPLICATION INFORMATION**

**OUTPUT VOLTAGE SETTING**

Figure 1 shows the basic application circuit with AS1301 fixed output versions.

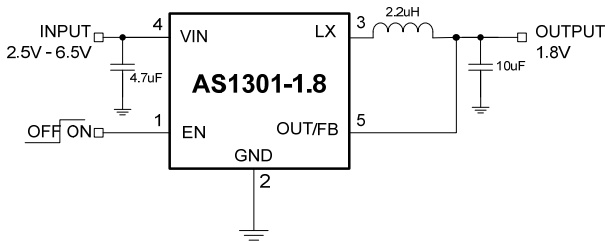


Figure 1 Fixed Output Application Circuit

Figure 2 shows the basic application circuit with AS1301 Adjustable output versions.

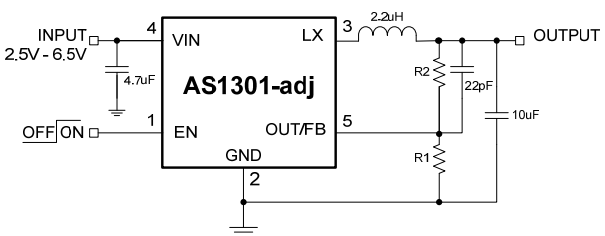


Figure2 Adjustable Output Application Circuit

In the adjustable version, the output voltage is set by a resistive divider according to the following formula:

$$V_{OUT} = 0.6 \times \left(1 + \frac{R2}{R1}\right)$$

Table1 Resistor Select for Output Voltage Setting

Vout	R1	R2
1.2V	316K	316K
1.5V	316K	470K
1.8V	316K	634K
2.5V	316K	1M

For best efficiency, the inductor DC resistance shall be <200mΩ. For most designs, the inductance value can be derived from the following equation:

$$L = \frac{V_{OUT} \times (V_{IN} - V_{OUT})}{V_{IN} \times \Delta I_L \times f_{OSC}}$$

Where ΔIL is the inductor ripple current. Choose inductor ripple current approximately 30% of the maximum load current, 800mA.

$$I_L(MAX) = I_{LOAD} + \frac{\Delta I_L}{2}$$

Under light load conditions below 100mA, larger inductance is recommended for improved efficiency.

**INPUT CAPACITOR SELECTION**

The input capacitor reduces the surge current drawn from the input and switching noise from the device. The input capacitor impedance at the switching frequency shall be less than input source impedance to prevent high frequency switching current passing to the input. Ceramic capacitors with X5R or X7R dielectrics are highly recommended because of their low ESR and small temperature coefficients. For most applications, a 10μF capacitor is sufficient.

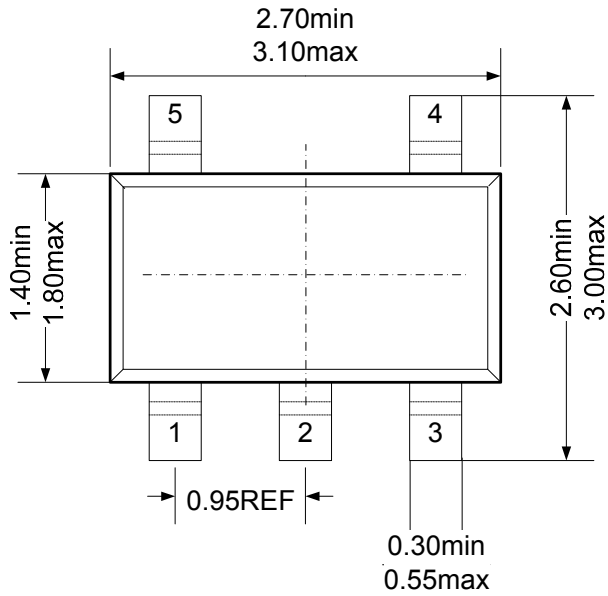
**OUTPUT CAPACITOR SELECTION**

The output capacitor keeps output voltage ripple small and ensures regulation loop stable. The output capacitor impedance shall be low at the switching frequency. Ceramic capacitors with X5R or X7R dielectrics are recommended. The output ripple ΔVOUT is approximately:

$$\Delta V_{OUT} \leq \frac{V_{OUT} \times (V_{IN} - V_{OUT})}{V_{IN} \times f_{OSC} \times L} \times \left( ESR + \frac{1}{8 \times f_{OSC} \times C3} \right)$$

**PACKAGE DESCRIPTION**

**Package  
5-Lead Plastic TSOT23-5L**



NOTE:

1. DIMENSIONS ARE IN MILLIMETERS
2. DRAWING NOT TO SCALE
3. DIMENSIONS ARE INCLUSIVE OF PLATING
4. DIMENSIONS ARE EXCLUSIVE OF MOLD FLASH AND METAL BURR
5. MOLD FLASH SHALL NOT EXCEED 0.254mm
6. JEDEC PACKAGE REFERENCE IS MO-193

