Micro Power 150mA, Low Dropout Linear Regulator

General Description

The ASD2301 is a high performance linear regulator with very low dropout voltage and excellent transient response. It is designed to operate with wide input voltage range of 2.5 – 16 Volts making it ideal for two step conversion while maintaining high efficiency for many power sensitive applications. The device is capable of supplying 150mA of output current with a typical dropout Voltage of 165mV. The product is available in either fixed or adjustable output Voltage.

The linear regulator has been optimized for noise sensitive applications. Connecting a small capacitor from C_{BYP} to ground reduces output self noise and increase power supply ripple rejection. A typical value of 10nF achieves output voltage noise down to 26µV_{RMS}. The device includes an enable pin for electrical on/off of the regulator. Forcing the enable pin to logic low shuts down the LDO and reduces the supply current to 1µA.

The regulator offers complete short-circuit, reverse battery protection, and thermal protection. The combination of these internal protection circuits gives the device a comprehensive safety system to safe guard against extreme adverse operating conditions.

The ASD2301 is available in SOT23-5 package, and it is rated for -40°C to +125°C temperature range.

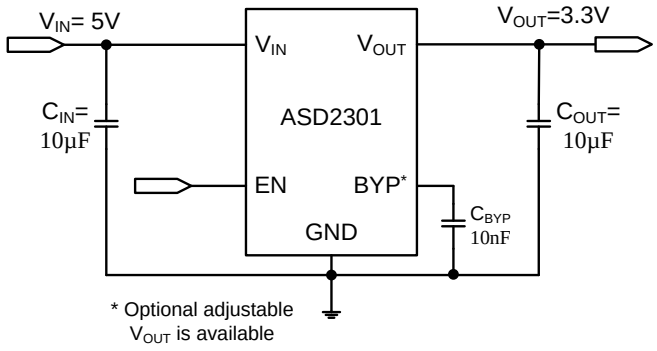
Features

- V_{IN} range: 2.5 – 16V
- Fixed and Adjustable output voltage as low as 2.0V
- 150mA maximum output current
- 165mV of typical dropout voltage @150mA
- Low self noise
- Bypass pin for low PSRR
- Enable pin for LDO on/off
- Reverse battery protection
- Ultra low noise output
- Low supply current
- High PSRR (58dB at 1KHz)
- Stable with Electrolytic, Tantalum or Ceramic capacitors
- Current Limit protection
- Over-Temperature Shutdown
- -40 to +125°C temperature range
- Available in SOT23-5 package
- RoHS & WEEE compliant

Applications

- Smart phones
- Wireless LAN
- Noise sensitive circuits such as VCO's
- Point of load regulation
- Medical devices
- Automatic meter reading (AMR)

Typical Application

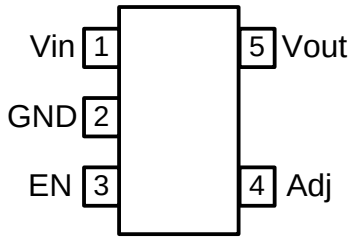


Pin Description

Pin #	Symbol	Description
1	V_{IN}	Input supply pin. Connect a 10µF capacitor between this pin and ground.
2	GND	Ground connection.
3	EN	Enable pin. It controls the electrical on/off of the device. When connected to logic low, the device shuts off and consumes 1µA of current. A logic high will resume normal operation
4	Adj	Feedback Voltage. A resistor network of two resistors is used to set-up the output voltage connected between V_{out} and GND. The center tap of the two resistors is connected to Adj pin.
	BYP	Bypass pin. Connect an external capacitor from BYP to ground to bypass the noise generated by the internal bandgap. This improves power supply rejection ratio and output noise.
5	V_{OUT}	Regulated output Voltage. Connect a 10µF capacitor from this pin to ground.

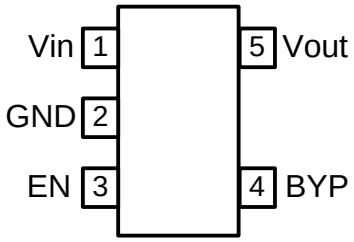
Pin Configuration (Adjustable Option)

SOT23-5 (Top View)



Pin Configuration (Bypass Option)

SOT23-5 (Top View)



Absolute Maximum Ratings (1)

Maximum Input Supply Voltage ..... -20V to 20V
Enable Voltage ..... -20V to 20V

Recommended Operating Conditions

Input Voltage ..... 2.5 to 16V
Enable Input Voltage ..... 0V to V_{IN}
Ambient Operating Temperature ..... -40°C to +125°C

Thermal Information (2)

SOT23-5 θ_{JA} ..... 220˚C/W
Storage Temperature Range ..... -65 to 150˚C
Lead Temperature (soldering 10s) ..... 260˚C
Junction Temperature ..... -40°C to +125°C

Electrical Characteristics

UNLESS OTHERWISE NOTED:

V_{IN}=6V; V_{OUT}=5V (FIXED VOUT); C_{IN}=10µF; C_{OUT}=10µF; -40˚C≤T_A=T_J≤85˚C; $T_{J(MAX.)}$= 125°C; TYPICAL VALUES ARE T_A= 25°C

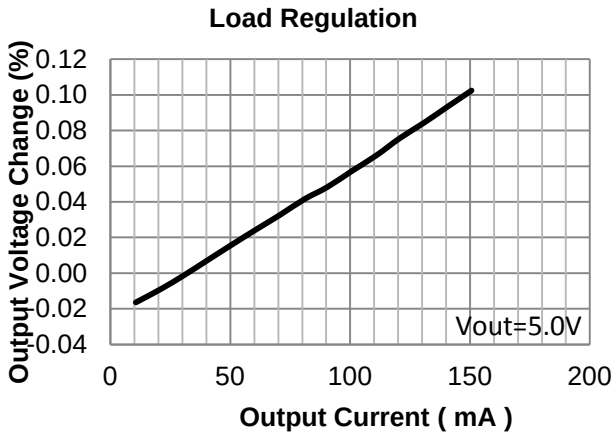
Parameter	Symbol	Conditions	Min.	Typ.	Max.	Units
Output Voltage Range	V_O	Adjustable only	2.0		V_{IN} - V_{DO}	V
Maximum Output Current	I_O		150			mA
Load Regulation[3]		I_{OUT}= 1mA – 150mA		0.1	0.2	%
Line Regulation		V_{IN} = 5.5 – 16V; I_{OUT}=1mA	-0.4	0.05	0.4	%/V
Supply Current	I_Q	I_{OUT}= 50mA		300	600	µA
		I_{OUT}= 100mA		600	1000	
		I_{OUT}= 150mA		1100	2000	
Shutdown current	I_{SHD}	V_{EN}=GND		56	100	µA
Current Limit [3]	I_{LIM}		0.45	0.70		A
Dropout Voltage[3]	V_{DO}	I_{OUT}=50mA		160	200	mV
		I_{OUT}=100mA		215	300	
		I_{OUT}=150mA		270	350	
Enable startup time	T_{SS}	C_{BYP}=Open; C_{OUT}=10µF;		1.1		ms
Feedback Voltage	V_{FB}	Adjustable only	1.229	1.242	1.254	V
Enable Threshold Low	$V_{EN(L)}$				0.4	V
Enable Threshold High	$V_{EN(H)}$		2.0			V
Input Enable Low Current	$I_{EN(L)}$	V_{EN} = 0V		0.1	1.0	µA
Input Enable High Current	$I_{EN(H)}$	V_{EN} =16		4.0	35	µA
Ripple Rejection Ratio	PSRR	F=100Hz, I_O=0.1A ; C_{BYP}= open		55		dB
Output Noise	e_n	BW= 20 – 100KHz ; Io=10mA ; C_{BYP}= Open		30		µVrms
Thermal Shutdown	T_{SD}			155		˚C

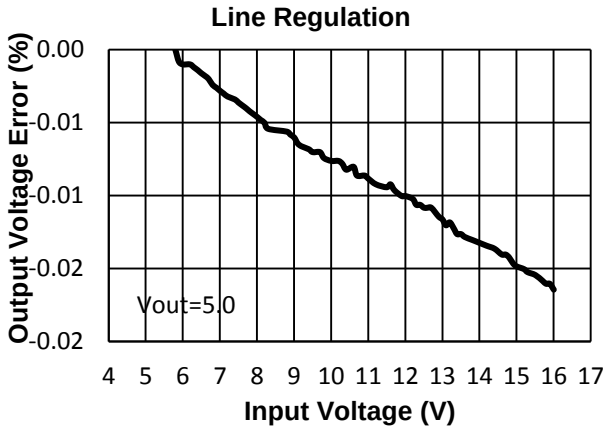
Parameter	Symbol	Conditions	Min.	Typ.	Max.	Units
Thermal Shutdown Hysteresis	T_{SD_HYS}			10		˚C

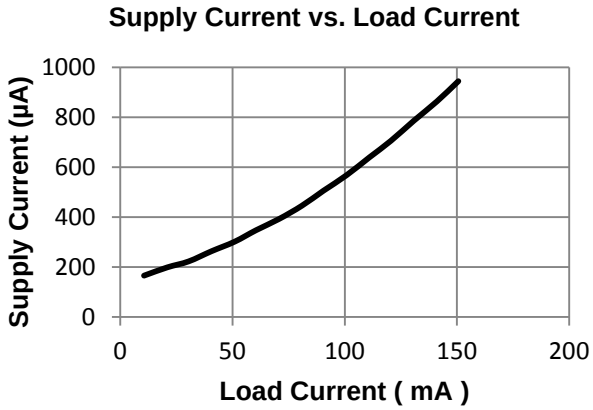
Notes:

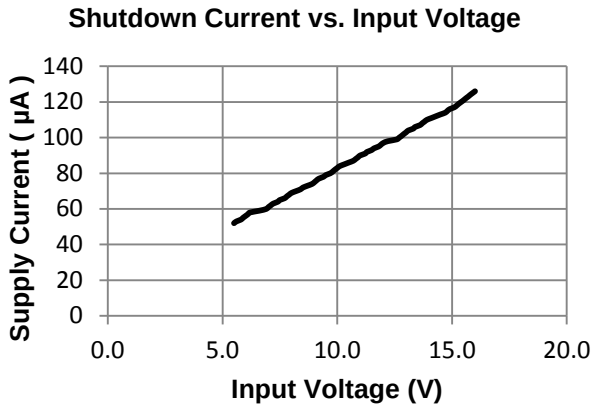
1. Stresses above those listed in Absolute Maximum Ratings may cause permanent damage to the device.
2. Measured on approximately 1" square of 1oz copper
3. The ASD2301 is guaranteed to meet performance specifications over the -40°C to +125°C operating temperature range and is assured by design, characterization, and correlation with statistical process control.
4. Load regulation is measured using pulse techniques with duty cycle <5%.

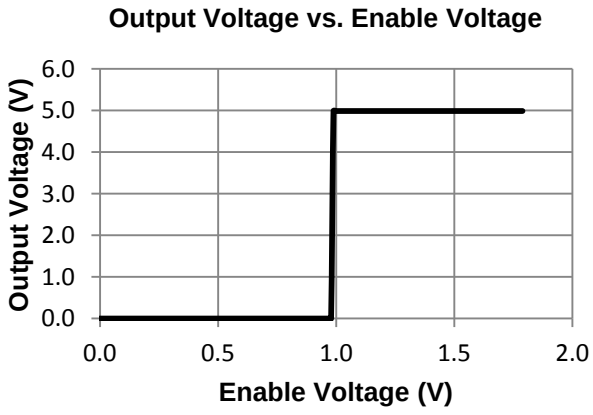
Typical Characteristics

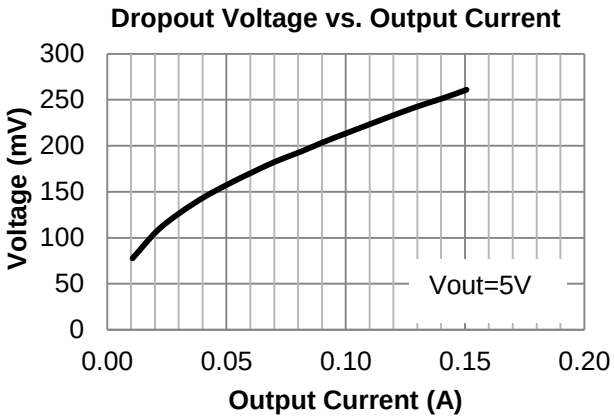








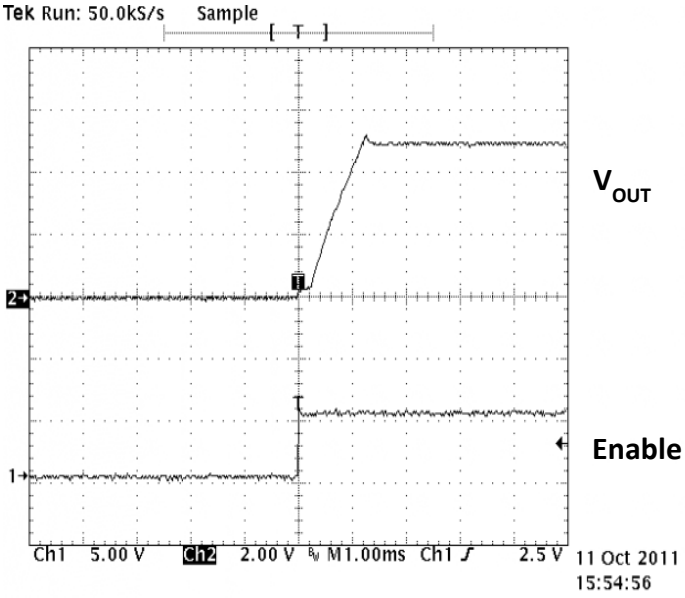




Typical Characteristics

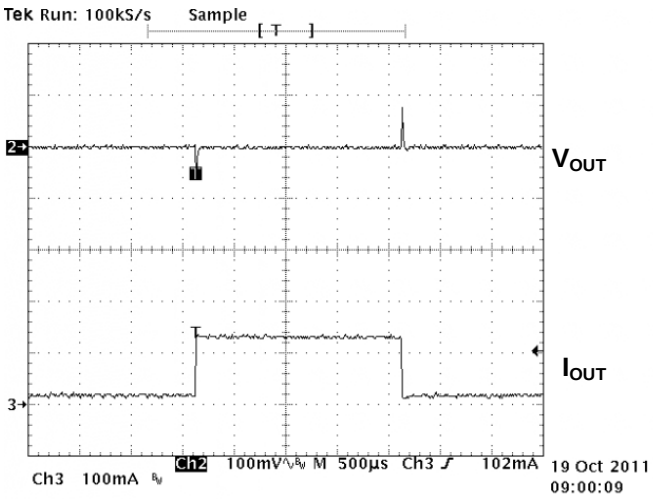
Enable Startup

V_{IN}=6V; V_{OUT}=5V; C_{IN}=10µF; C_{OUT}=10µF; C_{BYP}= Open

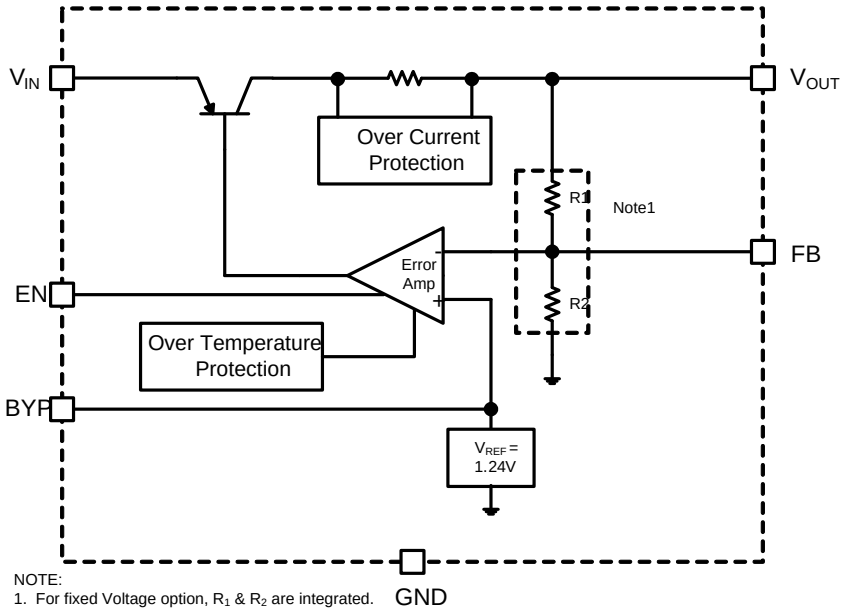


Transient Response

V_{IN}=5V; V_{OUT}=3.3V; Load Step= 0.11A; C_{IN}=10µF; C_{OUT}=20µF; C_{BYP}=Open



Functional Block Diagram



NOTE:
1. For fixed Voltage option, R_1 & R_2 are integrated.

Application Hints

Input Capacitor (C_{IN})

An Input capacitor may be required when the device is not near the source power supply or when supplied by a battery. This capacitor will reduce the circuit's sensitivity when powered from complex source impedance and significantly enhance the output transient response. The input bypass should be mounted with the short possible track directly across the regulator's input and ground terminals. A 10µF ceramic capacitor should be adequate for most applications.

Output Capacitor (C_{OUT})

The output capacitor provides not only stability to the regulator, but also, enhances the load transient response. A minimum capacitance of 10µF is required. When selecting a ceramic capacitor, only X5R and X7R dielectric types should be used. Other types such as Z5U and Y5F have such severe loss of capacitance due to effects of temperature variation and applied voltage, they may provide as little as 20% of rated capacitance in many typical applications.

Always consult capacitor manufacturer's data curves before selecting a capacitor. High-quality ceramic capacitors can be obtained from Taiyo-Yuden, AVX, and Murata. Higher values of the output capacitance can be used to enhance loop stability and transient response.

The value of the output capacitor can be increased without limit. Higher capacitance values help to improve transient response and ripple rejection and reduce output noise.

Output Voltage

The adjustable output voltage option allows the user to select an output voltage by using an external resistor divider. See figure one.

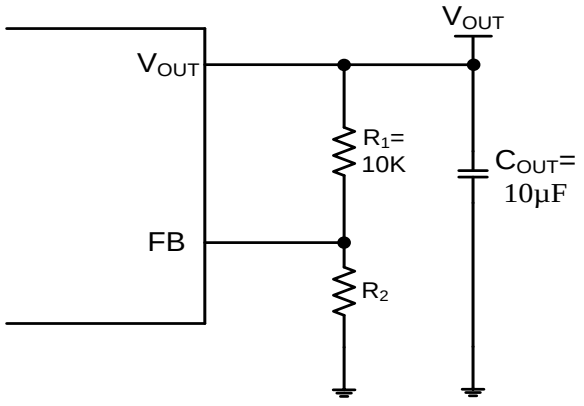


Figure 1: Adjustable Output Voltage Setting

ASD2301 uses a 1.25V reference voltage at the positive terminal of the error amplifier. To set the output voltage a programming resistor from the adjust pin (ADJ) to V_{OUT} must be selected. A 10kΩ resistor is a good selection for a programming resistor R1. A higher value may result in an excessively sensitive feedback node while a lower value will draw more current and degrade the light load efficiency. The equation for selecting the voltage specific resistor is:

$$V_O = \left(1 + \frac{R2}{R1}\right) * V_{FB}$$

The table below provides the resistor values for some common voltages.

R1	R2	V_{OUT}
10kΩ	10kΩ	2.5V
10kΩ	11.6kΩ	2.7V
10kΩ	12.4kΩ	2.8V
10kΩ	14 kΩ	3.0V
10kΩ	16.4kΩ	3.3V
10kΩ	30kΩ	5.0V

Table 1: Feedback Resistor Values

The minimum output Voltage for the device is 2.0V. For the fixed output devices, R1 and R2 are included within the device.

Enable

The enable (EN) pin is active high and is compatible with standard digital signaling levels. When V_{EN} below 0.4V, it turns the regulator off while V_{EN} above 2.0V turns the regulator on.

If not used, EN can be connected to the input Voltage. If EN is connected to V_{IN}, it should be connected as close as possible to the largest capacitance on the input to prevent voltage droops on that line from triggering the enable circuit. This pin should be not be left floating.

Bypass

Connecting a capacitor between the BYP pin and ground can significantly reduce output noise. Depending on the sensitivity to output noise in the application, the values can range from 0pF to 10nF, The start up speed of the ASD2301 is inversely proportional to the size of the bypass capacitor. Applications requiring a slow ramp-up of output voltage should consider larger values of bypass capacitance. Likewise, if rapid turn on is necessary, consider omitting C_{BYP}.

Current Limit and Thermal Overload Protection

The ASD2301 is protected against damage due to excessive power dissipation by current and thermal overload protection circuits. The regulator is designed to limit current when the output load reaches 400 mA (typical). When the output load exceeds this limit, the output voltage is reduced to maintain a constant current limit.

Thermal overload protection is included, which limits the junction temperature to a maximum of 155°C (typical). Under extreme conditions (that is, high ambient temperature and power dissipation) when the junction temperature starts to rise above 155°C, the output is turned off, reducing the output current to zero. When the junction temperature drops below 125°C, the output is turned on again and the output current is restored to its nominal value.

Thermal Considerations

The ASD2301 is designed to provide 300mA of continuous current in a very small package. Maximum power dissipation can be calculated based on the output current and the voltage drop across the part. To determine the maximum power dissipation of the package, use the junction-to-ambient thermal resistance of the device and the following basic equation:

$$P_{D(\max)} = \left(\frac{T_{J(\max)} - T_A}{\theta_{JA}}\right)$$

Where TJ(max) is the maximum junction temperature of the die, TA is the ambient operating temperature, and θJA is layout dependent. The actual power dissipation of the regulator circuit can be determined using the equation:

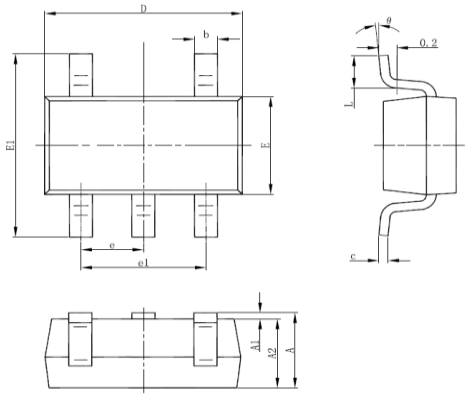
$$P_D = (V_{IN} - V_{OUT}) * I_{OUT} + V_{IN} * I_{SUP}$$

Substituting PD(max) for PD and solving for the operating conditions that are critical to the application will give the maximum operating conditions for the regulator circuit.

Ordering Information

Device	Package	Output Voltage	Packing Method & Quantity
ASD2301M5	SOT23-5L	Adjustable	2500 Tape & Reel
ASD2301M5-2.0V	SOT23-5L	2.0V	2500 Tape & Reel
ASD2301M5-2.5V	SOT23-5L	2.5V	2500 Tape & Reel
ASD2301M5-3.3V	SOT23-5L	3.3V	2500 Tape & Reel
ASD2301M5-5.0V	SOT23-5L	5.0V	2500 Tape & Reel

Outline Drawing and Landing Pattern – SOT23-5



Symbol	Dimensions In Millimeters		Dimensions In Inches	
	Min	Max	Min	Max
A	1.050	1.250	0.041	0.049
A1	0.000	0.100	0.000	0.004
A2	1.050	1.150	0.041	0.045
b	0.300	0.500	0.012	0.020
c	0.100	0.200	0.004	0.008
D	2.820	3.020	0.111	0.119
E	1.500	1.700	0.059	0.067
E1	2.650	2.950	0.104	0.116
e	0.950(BSC)		0.037(BSC)	
e1	1.800	2.000	0.071	0.079
L	0.300	0.600	0.012	0.024
θ	0°	8°	0°	8°

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