1.8V, 1A, 250kHz Step-Up Regulator in SOT23-5

General Description

The ASD5001 is a high efficiency, step up PWM regulator with an integrated 1A power transistor. It is designed to operate with an input Voltage range of 1.8 to 15V. Designed for optimum cost and ease of use, the device requires only three external components. The output voltage is set via two external resistors to as low as 1.25V.

The fixed 250kHz switching frequency with current mode architecture offers excellent transient response and output regulation. An independent Enable pin provides electrical On/Off of the regulator. When connected to logic low, the regulator shuts down and consumes very low current.

The step up regulator includes current limit and thermal shutdown to safe guard the device under fault conditions. An internal soft start circuit limits the inrush current for controlled output voltage regulation.

The ASD5001 is available in SOT23-5 package, and it is rated for -40 to +85°C temperature range.

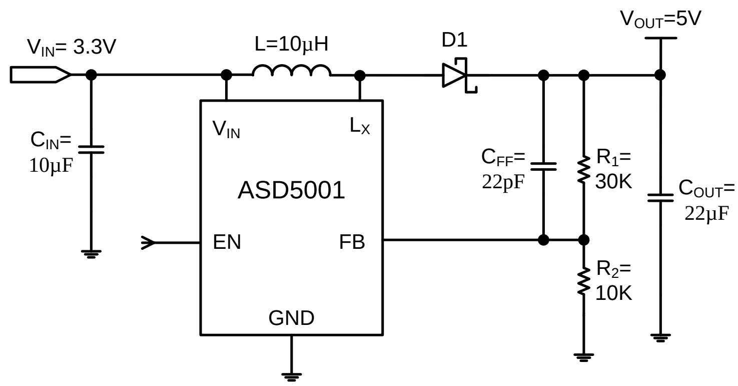
Features

- V_{IN} range: 1.8 – 10V
- Maximum output Voltage: 30V
- 1A maximum switch current
- Up to 95% efficiency
- Adjustable output voltage
- 250KHz switching frequency
- 2mA typical supply current
- 100µA typical shutdown current
- Independent enable pin
- Internal compensation
- Internal Soft-Start
- Cycle-cycle & current limit protection
- Thermal Shutdown protection
- -40 to +85°C temperature range
- Available in SOT23-5 package
- RoHS & WEEE compliant

Applications

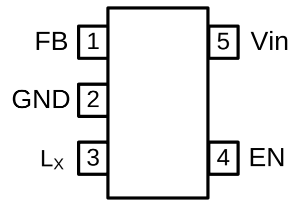
- Remote controls
- PCMCIA cards
- TFT-LCD display
- White LED driver
- LCD-TV
- 12V Supply for DSL application

Typical Application



Pin Configuration

SOT23-5 (Top View)



Pin Description

Pin #	Symbol	Description
1	FB	Feedback Voltage. This is the inverting input of the error amplifier. 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 FB pin.
2	GND	Ground connection.
3	L_X	Switching node - connect directly to the inductor. Due to the high speed switching and high voltage associated with this pin, the switch node should be routed away from high impedance nodes.
4	EN	Enable pin. Logic low shuts the device down. When connected to logic high, the device will resume normal operation. This pin should not be floating.
5	V_{IN}	Input supply voltage for the internal circuitry. Connect a 10µF capacitor between this pin and ground.

Absolute Maximum Ratings (1)

Maximum Input Supply Voltage .... -0.3V to 33V
Feedback Voltage (FB) .... -0.3V to 20V
Enable Voltage .... -0.3V to 33V
Switch Voltage .... -0.3V to 33V

Recommended Operating Conditions

Input Voltage .... 1.8 to 15V
Ambient Operating Temperature............ -40°C to +85°C

Thermal Information (2)

SOT23-5 θ_{JA} .... 140˚C/W
Storage Temperature Range .... -65 to 150˚C
Lead Temperature (soldering 10s)............ 300˚C
Junction Temperature .... -40°C to +125°C

Electrical Characteristics

UNLESS OTHERWISE NOTED:

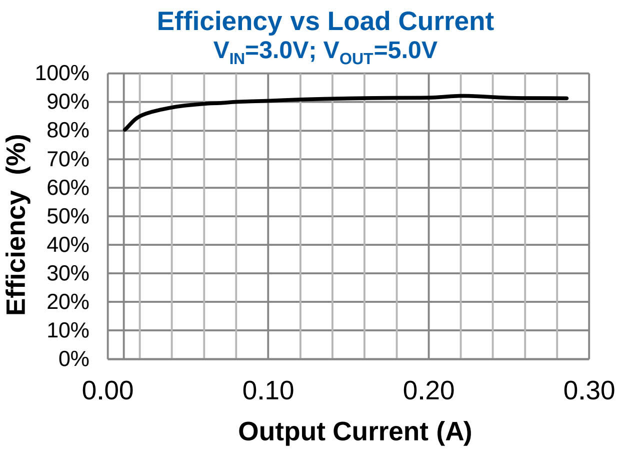
V_{IN}=3.0V;V_{OUT}=5V; C_{IN}=10µF; C_{OUT}=22µF; L=22 µH; -40˚C≤T_A=T_J≤85˚C; $T_{J(MAX.)}$= 125°C; TYPICAL VALUES ARE T_A= 25°C

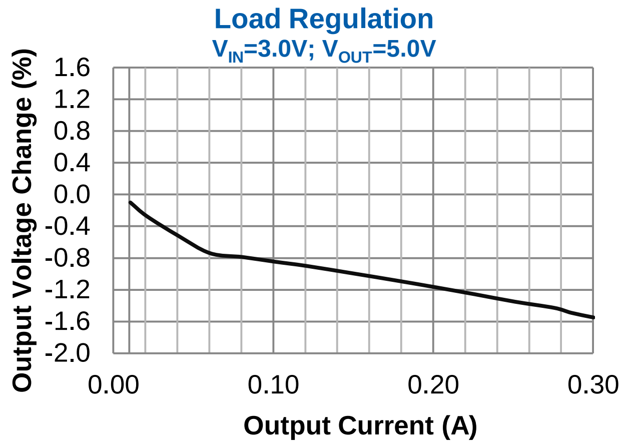
Parameter	Symbol	Conditions	Min.	Typ.	Max.	Units
Feedback Voltage	V_{FB}	Adjustable V_{OUT} only	1.2312	1.25	1.2687	V
Feedback bias current[3]	I_{FB_Bias}	Adjustable V_{OUT} only		10	100	nA
Maximum Switch Current	I_{SW_Max}		1.0			A
Load Regulation[3]		I_{OUT}= 150mA	-1.5	0.9	+1.5	%
Line Regulation[3]		V_{IN}=1.8 – 4.5V; I_{OUT}=2mA	-0.5	0.04	0.5	%
Oscillator Frequency	$F_{OSC.}$		200	250	300	KHz
Supply Current	I_{SUP}	V_{IN}=1.8 – 4.5V; No load		1.8	5.0	mA
Shutdown Current	I_{SHDN}	V_{EN}= 0V; V_{IN}=1.8 – 4.5V;		300	600	µA
Current Limit[2]	I_{LIM}			1.2		A
Soft start time[2]	T_{SS}	I_{OUT}=		700		µs
Maximum duty cycle[2]	D_{MAX}		70			%
Minimum duty cycle[2]	D_{MIN}				15	%
Enable Threshold Low	$V_{EN(L)}$				0.8	V
Enable Threshold High	$V_{EN(H)}$		2.0			V
Input Enable Low Current	$I_{EN(L)}$	V_{EN} = 0V			1.0	µA
Input Enable High Current	$I_{EN(H)}$	V_{IN} =V_{EN} =4.5V		22	50	µA
Thermal Shutdown[2]	T_{SD}			150		°C
Thermal Shutdown Hysteresis[2]	T_{SD_HYS}			25		°C

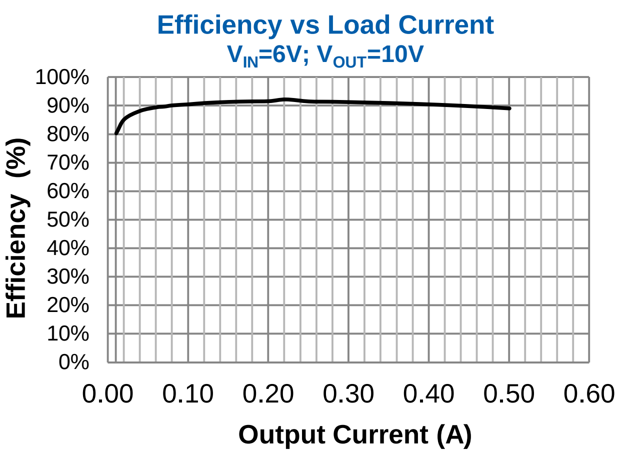
Notes:

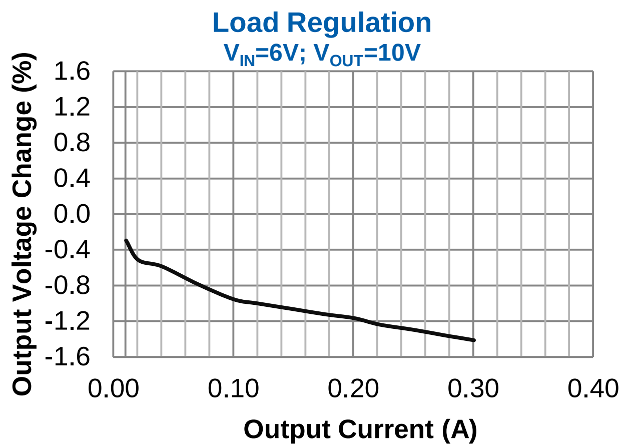
1. Stresses above those listed in Absolute Maximum Ratings may cause permanent damage to the device.
2. Measured on approximately 1" square of 1oz copper
3. The ASD5001 is guaranteed to meet performance specifications over the -40°C to +125°C operating temperature range and is assured by design, characterization, and correlation with statistical process control.
4. Low duty cycle pulse testing with Kelvin connection required.

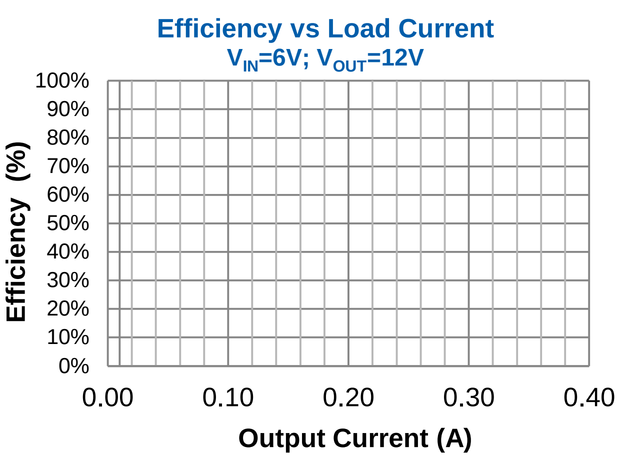
Typical Characteristics

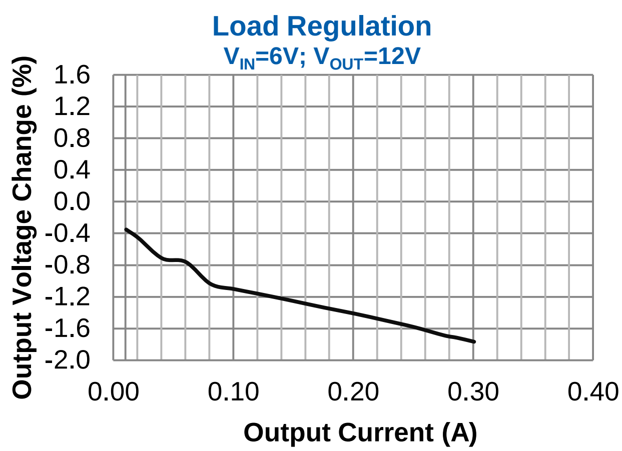






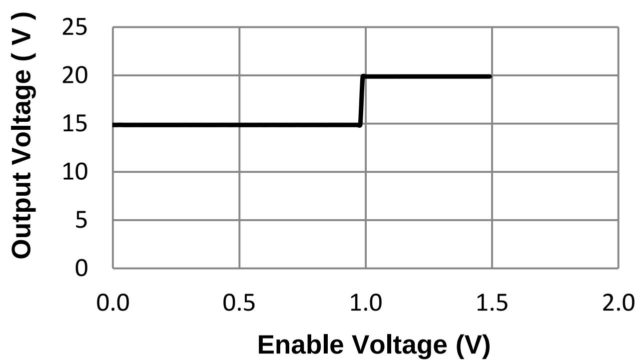




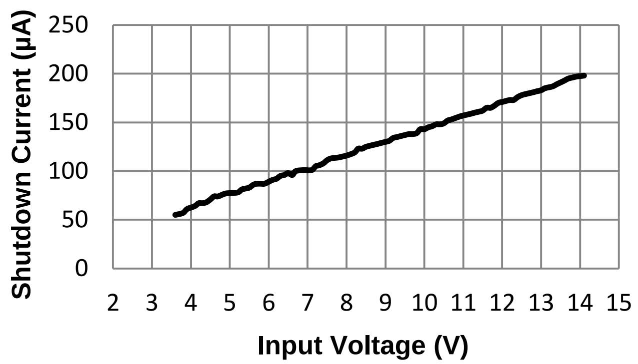


Typical Characteristics

Enable Voltage vs Output Voltage

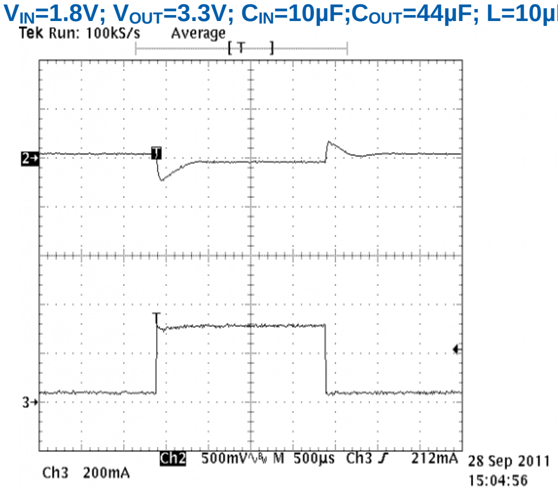


Shutdown Current vs Input Voltage

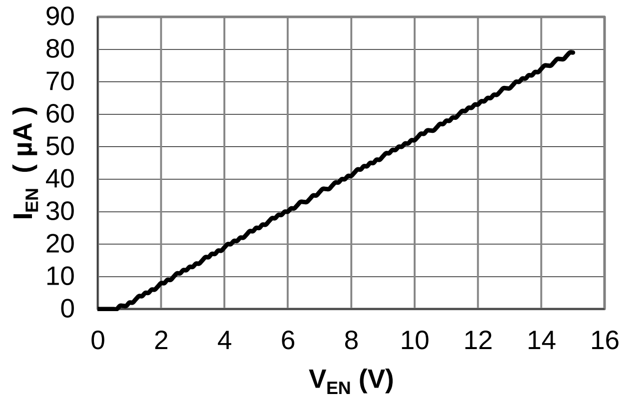


Transient Response

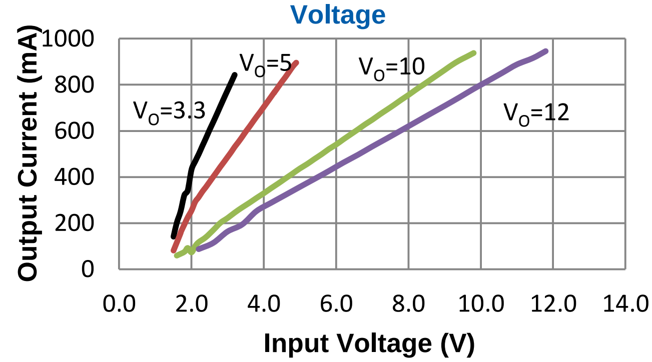
V_{IN}=1.8V; V_{OUT}=3.3V; C_{IN}=10µF;C_{OUT}=44µF; L=10µH



Enable Input Current vs Enable Voltage

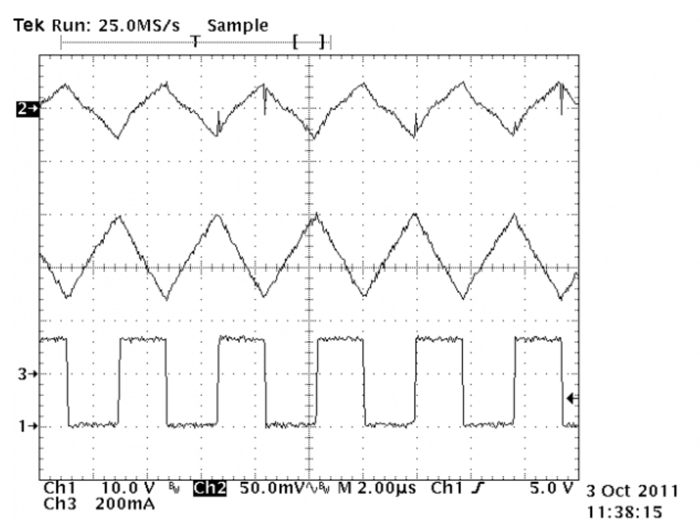


Maximum Output Current vs Input Voltage

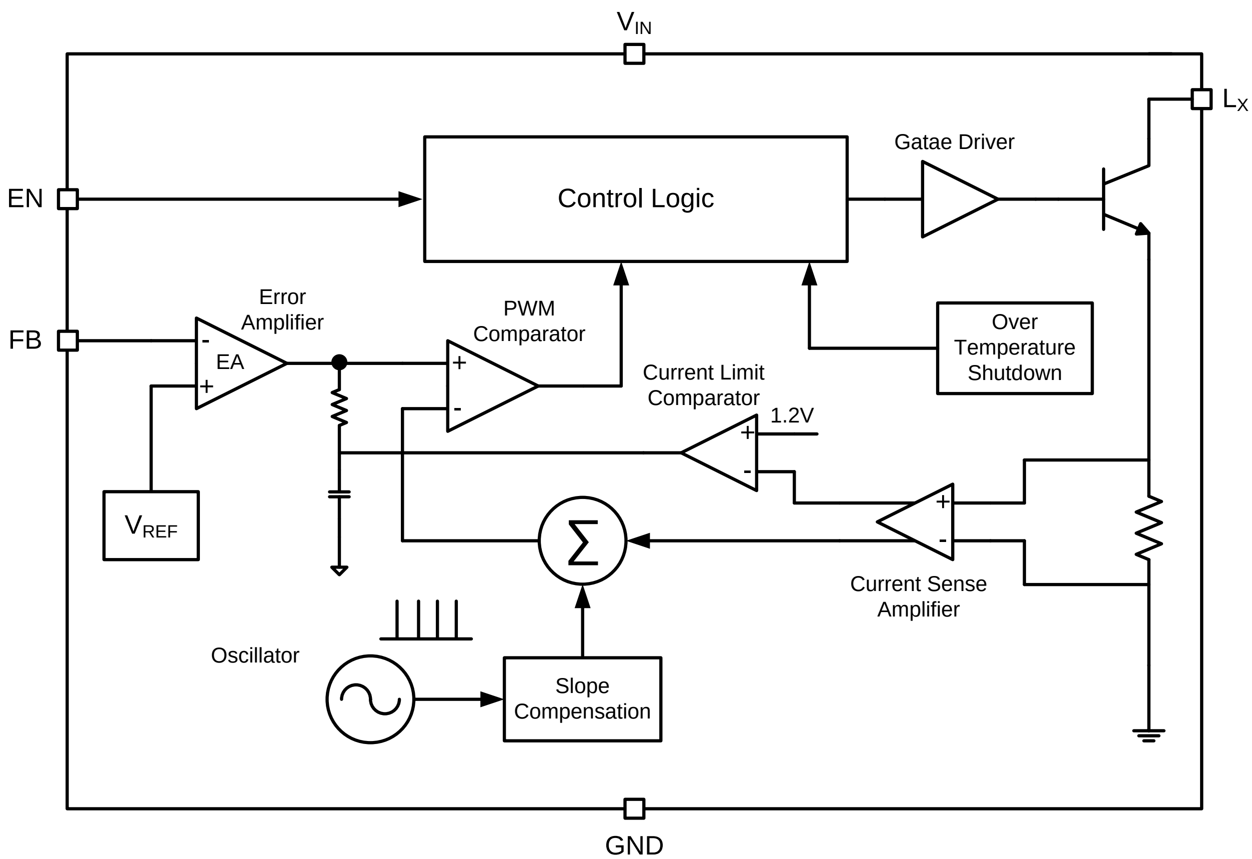


Steady State

V_{IN}=8V; V_{OUT}=16.5V; I_{OUT}= 250mA



Functional Block Diagram



Application Hints

Input Capacitor (C_{IN})

A minimum 10µF ceramic capacitor is recommended for designing with the ASD5001. For applications that run close to the maximum output current limit, input capacitor in the range of 22µF to 47µF is recommended. The higher input capacitance will improve performance and greater noise immunity on the source. The capacitor should be as close as possible to the inductor and ASD5001 with short traces for good noise performance.

Output Capacitor (C_{OUT})

The output capacitor in a boost converter provides all the output current when the switch is closed and the inductor is charging. The capacitor is selected based on the DC output voltage rating, output ripple voltage specification and ripple current rating.

The selected output capacitor must have a higher rated voltage specification than the maximum desired output voltage including ripple. De-rating needs to be considered for long term reliability.

Output ripple voltage specification is another important factor for selecting the output capacitor. In a boost converter circuit, output ripple voltage is determined by load current, input voltage, output voltage, switching frequency, output capacitor value and ESR.

A low ESR ceramic capacitor ranging from 10µF to 44µF is recommended.

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 the capacitor manufacturer's data curves before selecting a capacitor. High-quality ceramic capacitors can be obtained from Taiyo-Yuden, AVX, and Murata.

Inductor Selection

Inductor selection is a balance between efficiency, stability, cost, size, and rated current. The inductor parameters impacting ASD5001 performance are saturation current and DC resistance.

Since the regulator is internally compensated, a 10µH inductor is a good selection for most input to output voltages.

The inductor selection determines the output ripple voltage, transient response, and efficiency. Its selection depends on the input voltage, output voltage, switching frequency, and maximum output current. For most applications, the inductance should be in the range of 10µH to 22µH. The inductor maximum DC current specification must be greater than the peak inductor current required by the regulator. The peak inductor current can be calculated using the following Equations:

$$I_{PK} = I_{L\_AVG} + \frac{\Delta I_L}{2}$$

$$I_{L\_AVG} = \frac{I_O}{1-D}$$

$$I_{L\_PK} = \frac{I_{OUT} * V_{OUT}}{V_{IN}} + \frac{1}{2} * \frac{V_{IN} * (V_{OUT} - V_{IN})}{L * V_{OUT} * Freq}$$

Refer to the maximum output current section for different input and output Voltage combinations.

A secondary effect of an inductor is its DC resistance (DCR). The DCR of an inductor will have a direct impact to efficiency of the device. The higher the inductances value the larger DCR of the inductor for the same package size. This is due to the longer windings required for an increase in inductance. Since the majority of input current (minus the ASD5001 supply current) is passed through the inductor, higher DCR inductors will reduce efficiency.

To maintain stability, increasing inductor value will have to be met with an increase in output capacitance. This is due to the unavoidable “right half plane zero” effect for the continuous current boost converter topology. Refer to the typical application section for different input to output voltage combinations.

Diode Selection

The ASD5001 requires an external diode for operation. A Schottky diode is recommended for most applications due to their lower forward voltage drop and reverse recovery time.

A barrier Schottky diode such as B340LB-13-F is recommended.

Setting the Output Voltage

The adjustable output voltage allows the user to program the output voltage by using an external resistor divider. ASD5001 uses a 1.25V reference voltage at the positive terminal of the error amplifier. To set the voltage, a programming resistor from the feedback pin (FB) to ground must be selected. A 10kΩ resistor is a good selection for a programming resistor R2 (see typical application). 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:

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

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

R2	R1	V_{OUT}
10kΩ	16.4kΩ	3.3V
10kΩ	30kΩ	5.0V
10kΩ	74kΩ	10.5V
10kΩ	86kΩ	12.0V
10kΩ	122kΩ	16.5V
10kΩ	150kΩ	20.0V

Table 1: Feedback Resistor Values

Soft-start

The ASD5001 has a fixed internal soft-start of 740µs (typ). This forces the regulator output to ramp in a controlled fashion, which helps reduce inrush current.

Enable

The enable pin provides electrical on/off of the regulator. To assure the regulators will switch on; the EN must be greater than 1.3 Volts. The device will shut down when the voltage on the EN pin falls below 0.8 Volts. In shutdown, the regulator will consume low current. If the enable function is not needed in a specific application, it may be tied to Vin to keep the device in a continuously on state.

PCB Layout

The inherently high peak currents and switching frequency of the power supplies requires careful PCB layout design. The following guidelines should be followed to insure proper layout.

1. Use wide traces for current paths and place the input capacitor, the inductor, and the output capacitor as close as possible to the integrated circuit terminals.

2. Keep the voltage feedback network very close to the regulator, within 0.2in (5mm) of the FB pins. Keep noisy traces such as LX pin, away from the voltage feedback network and guard from them using grounded copper.

3. For the external rectifier (Schottky diode), keep the traces short and use minimum copper area to avoid excess capacitance.

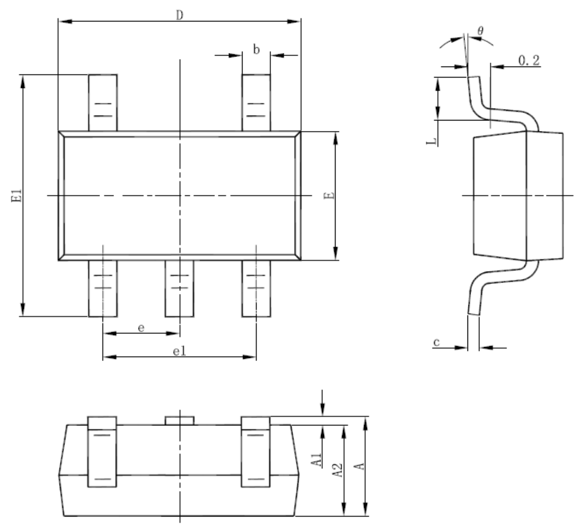
4. Keep the path between inductor, Schottky diode and output Capacitor extremely short. Parasitic trace inductance in series with the diode and C_{OUT} will increase noise and ringing.

5. A PCB with at least one ground plane connected to pin 2 of the IC is recommended. This ground plane acts as an electromagnetic shield to reduce EMI and parasitic coupling between components.

Ordering Information

Device	Package	Output Voltage	Packing Method & Quantity
ASD5001M5	SOT23-5	Adjustable	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°

Disclaimer:

The information furnished in this data sheet is believed to be accurate and reliable. However, no responsibility is assumed by Golden Gate Integrated Circuits (GGIC) for its use. GGIC reserves the right to change circuitry and specifications at any time without notification to the customer.

- Golden Gate Integrated Circuits reserves the right to make changes to the information herein for the improvement of the design and performance without further notice! Customers should obtain the latest relevant information before placing orders and should verify that such information is complete and current.
- All semiconductor products malfunction or fail with some probability under special conditions. When using Golden Gate Integrated Circuits products in system design or complete machine manufacturing, it is the responsibility of the buyer to comply with the safety standards strictly and take essential measures to avoid situations in which a malfunction or failure of such Golden Gate Integrated Circuits products could cause loss of body injury or damage to property.
- Golden Gate Integrated Circuits (GGIC) Products are not designed or authorized for use as components in life support appliances, devices or systems where malfunction of a product can reasonably be expected to result in personal injury. Life support devices or systems are devices or systems that (a) are intended for surgical implant into the body or (b) support or sustain life, and whose failure to perform can be reasonably expected to result in a significant injury to the user. A Purchaser's use or sale of GGIC Products for use in life support appliances, devices or systems is a Purchaser's own risk and Purchaser agrees to fully indemnify GGIC for any damages resulting from such use or sale.