1.5MHz, 1A Synchronous Step-Down DC/DC Converter

FEATURES

- High Efficiency: Up to 96%(@3.3V)
- 1.5MHz Constant Frequency Operation
- 1.0A Output Current
- No Schottky Diode Required
- 2.5V to 5.5V Input Voltage Range
- Output Voltage as Low as 0.6V
- 100% Duty Cycle in Dropout
- Low Quiescent Current: 50µA
- Slope Compensated Current Mode Control for Excellent Line and Load Transient Response
- Short Circuit Protection
- Thermal Fault Protection
- Inrush Current Limit and Soft Start
- Input Over Voltage Protection(OVP)
- <1µA Shutdown Current
- SOT23-5 Package

DESCRIPTION

The AIC2354B is a 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 output voltage can be regulated as low as 0.6V. The AIC2354B can also run at 100% duty cycle for low dropout operation, extending battery life in portable system. This device offers two operation modes, PWM control and PFM Mode switching control, which allows a high efficiency over the wider range of the load.

APPLICATIONS

- Cellular and Smart Phones
- Wireless and DSL Modems
- PDA/MID/PAD
- Digital Still and Video Cameras

APPLICATIONS CIRCUIT

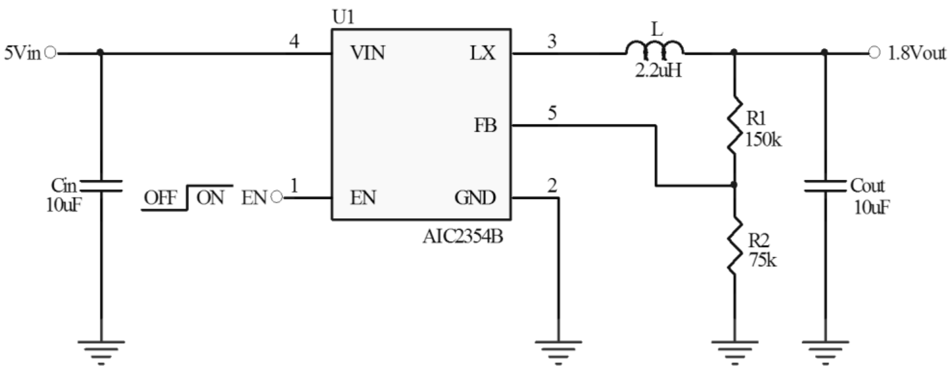


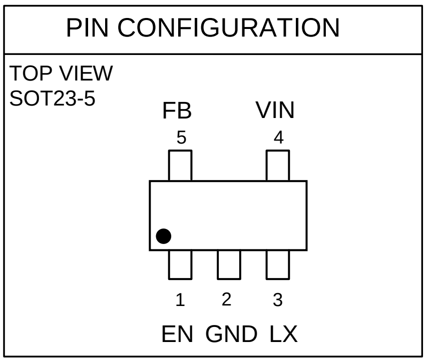
Fig. 1 Typical Application Circuit

ORDERING INFORMATION

AIC2354BXXXXX

- PACKING TYPE
  TR: TAPE & REEL
  BG: BAG
- PACKAGE TYPE
  U5: SOT23-5
- G: Green Package

Example: AIC2354BGU5TR
→ in SOT23-5 Green Package and Tape & Reel Packing Type



- **Marking**

Top Mark:T50XXX (T50:Device Code, XXX: Inside Code)

Part No.	**Marking**
AIC2354BGU5	T50XXX

ABSOLUTE MAXIMUM RATINGS

VIN Pin Voltage .... -0.3 V to 6.5V
LX Pin Voltage .... -0.3 V to 6.5V
EN Pin and FB Pin Voltage .... -0.3 V to 6.5V
Junction Temperature (Note2) T_J .... -40°C to 150°C
Storage Temperature Range T_{STG} .... -65°C to 150°C
Lead Temperature (Soldering 10 Sec.) .... 260°C
Operating Ambient Temperature Range T_A .... -40°C to 85°C
Power Dissipation 600mW
(Assume no Ambient Airflow, no Heat sink)

Absolute Maximum Ratings are those values beyond which the life of a device may be impaired.

ELECTRICAL CHARACTERISTICS

(T_A=25°C, V_{IN}=V_{EN}=3.6V, V_{OUT}=1.8V unless otherwise specified.) (Note 1)

PARAMETER	CONDITIONS	SYMBOL	MIN	TYP	MAX	UNITS
Input Voltage Range		V_{IN}	2.5		5.5	V
OVP Threshold		V_{OVP}		6.0		V
UVLO Threshold		V_{UVLO}		2.1		V
Quiescent Current	V_{EN}=2.0V, I_{OUT}=0, V_{FB}=V_{REF}*105%	I_Q		50	65	μA
Shutdown Current	V_{EN} =0V	I_{SHDN}		0.1	1.0	μA
Regulated Feedback Voltage	T_A = 25°C	V_{FB}	0.588	0.600	0.612	V
Reference Voltage Line Regulation	V_{IN} = 2.5V to 6.0V			0.04	0.4	%/V
Output Voltage Line Regulation	V_{IN} = 2.5V to 6.0V			0.04	0.4	%
Output Voltage Load Regulation				0.5		%
Oscillation Frequency	V_{OUT}=100%	f_{OSC}		1.5		MHz
	V_{OUT}=0V			400		kHz
On Resistance of PMOS	I_{LX}=100mA	$P_{RDS(ON)}$		0.29		Ω
On Resistance of NMOS	I_{LX}=-100mA	$N_{RDS(ON)}$		0.18		Ω
Peak Current Limit	V_{IN}=5V,V_{OUT}=1.2V, L=4.7μH/2A	I_{PK}	1.5			A
EN Input Low Level					0.3	V
EN Input High Level			1.5			V
EN Leakage Current				±0.01	±1.0	μA
LX Leakage Current	V_{EN}=0V,V_{IN}=V_{LX}=5V			±0.01	±1.0	μA

Note 1: Specifications are production tested at T_A=25°C. Specifications over the -40°C to 85°C operating temperature range are assured by design, characterization and correlation with Statistical Quality Controls (SQC).

Note 2: T_J is calculated from the ambient temperature T_A and power dissipation P_D according to the following formula: $T_J = T_A + (P_D) \times (250°C/W)$.

Note 3: Dynamic supply current is higher due to the gate charge being delivered at the switching frequency.

■ TYPICAL PERFORMANCE CHARACTERISTICS

Test condition: V_{IN}=5V, V_{OUT}=1.2V, L=2.2μH, T_A=+25°C, unless other noted.

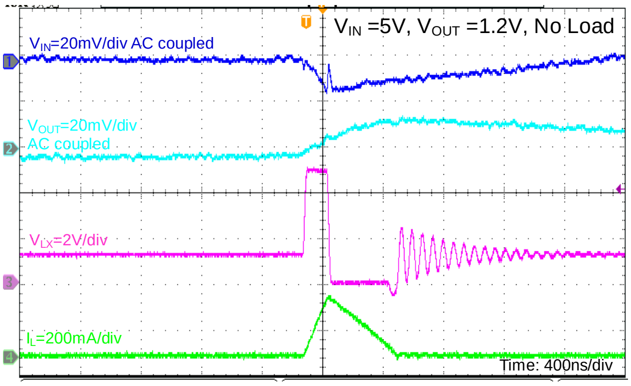


Fig. 2 Steady State Operation

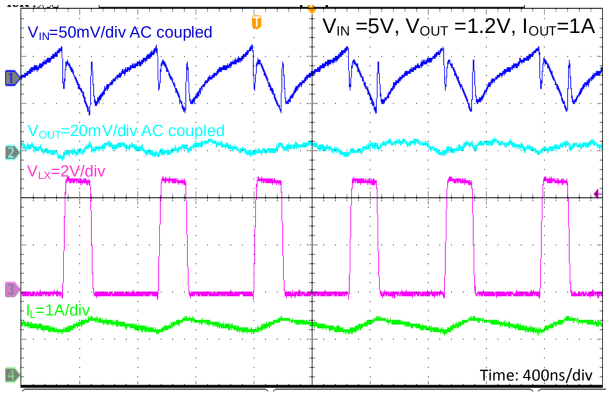


Fig. 3 Steady State Operation

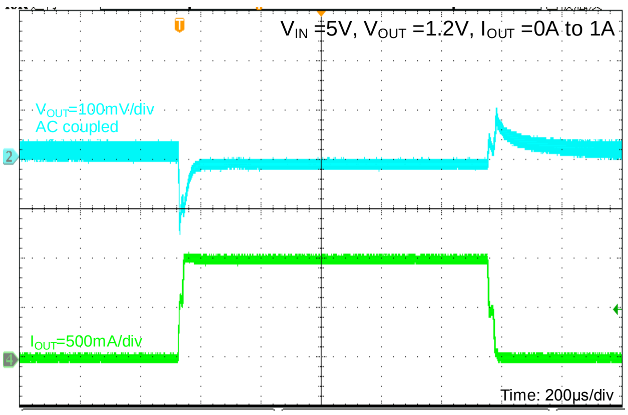


Fig. 4 Load Transient

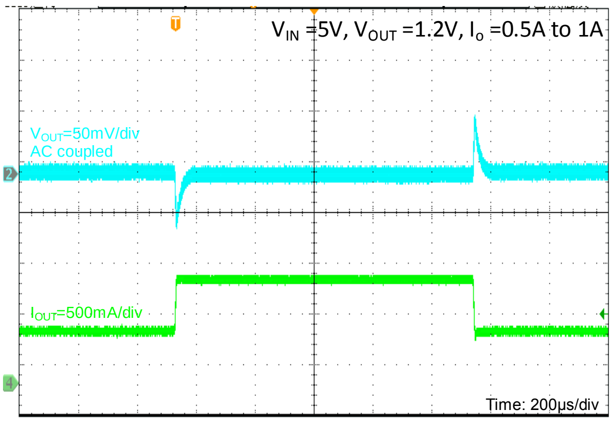


Fig. 5 Load Transient

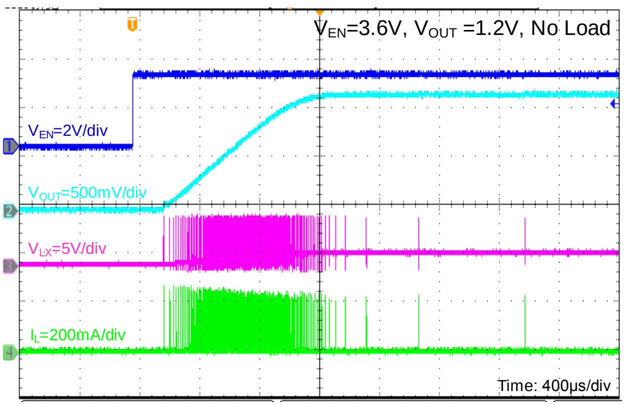


Fig. 6 EN Enable Power On

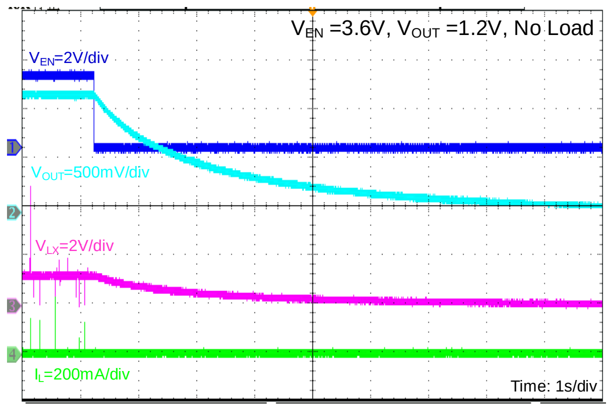


Fig. 7 EN Disable Power down

TYPICAL PERFORMANCE CHARACTERISTICS (Continued)

Test condition: V_{IN}=5V, V_{OUT}=1.2V, L=2.2µH, T_A=+25°C, unless other noted.

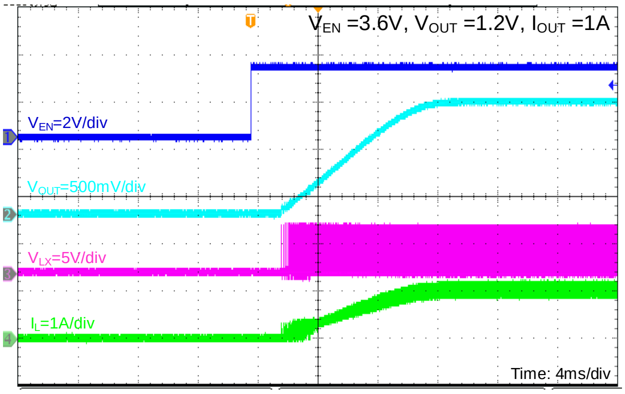


Fig. 8 EN Enable Power On

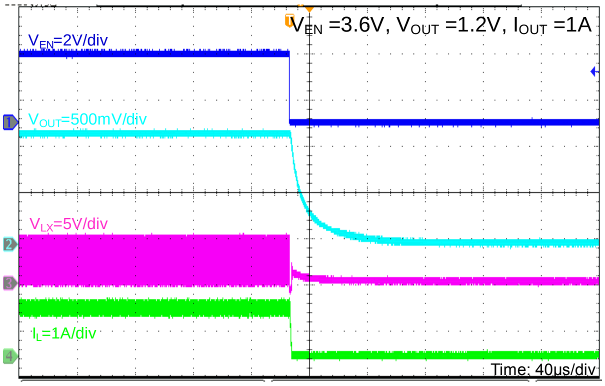


Fig. 9 EN Disable Power down

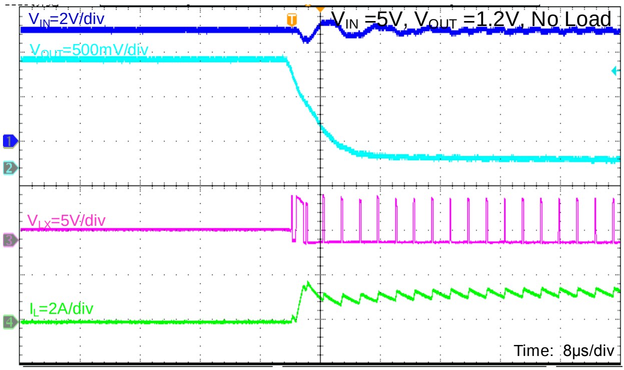


Fig. 10 Output Short Entry

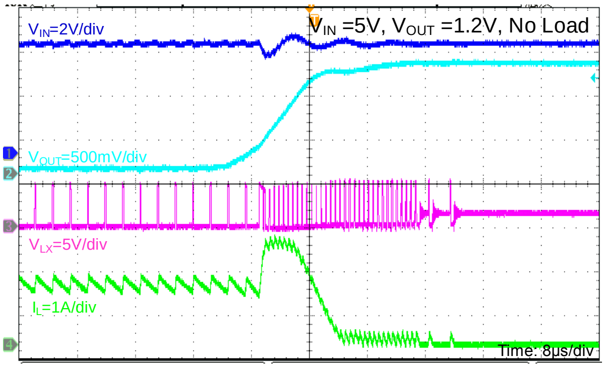


Fig. 11 Output Short Recovery

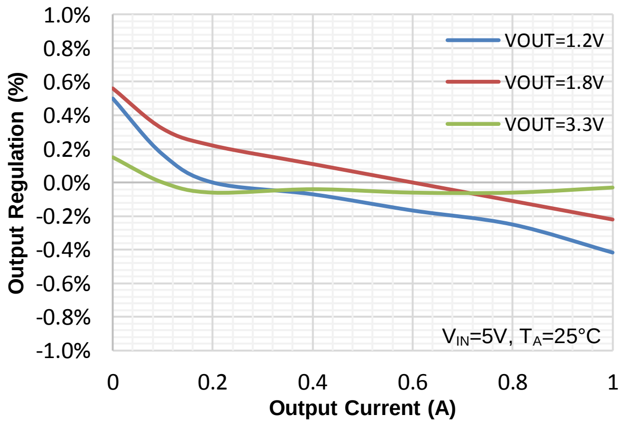


Fig. 12 Load Regulation at V_{IN} = 5V

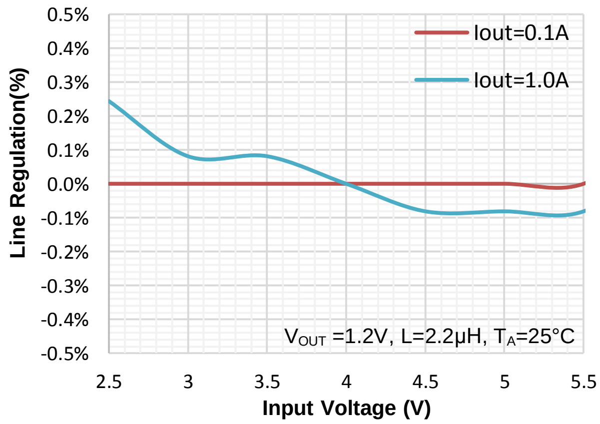


Fig. 13 Line Regulation at V_{OUT} = 1.2V

■ TYPICAL PERFORMANCE CHARACTERISTICS (Continued)

Test condition: V_{IN}=5V, V_{OUT}=1.2V, L=2.2μH, T_A=+25°C, unless other noted.

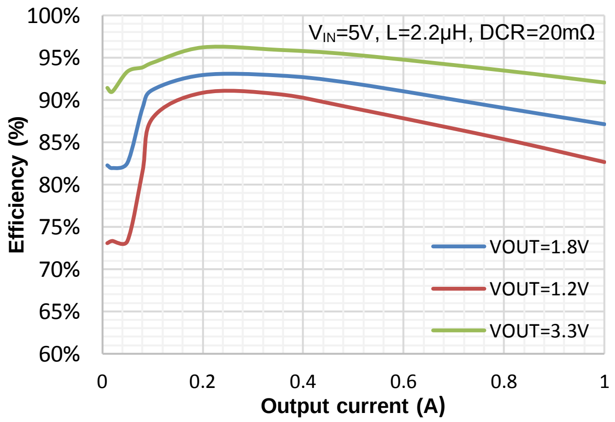


Fig. 14 Efficiency

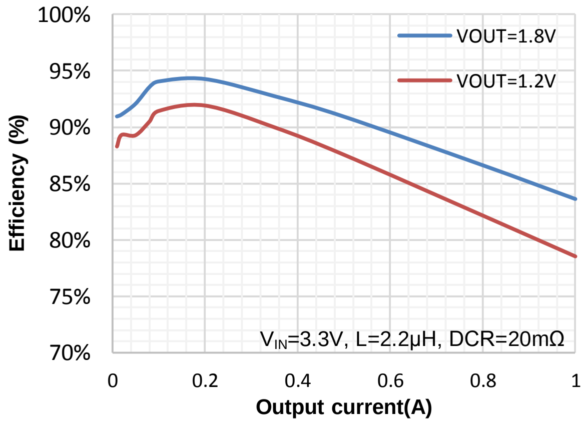


Fig. 15 Efficiency

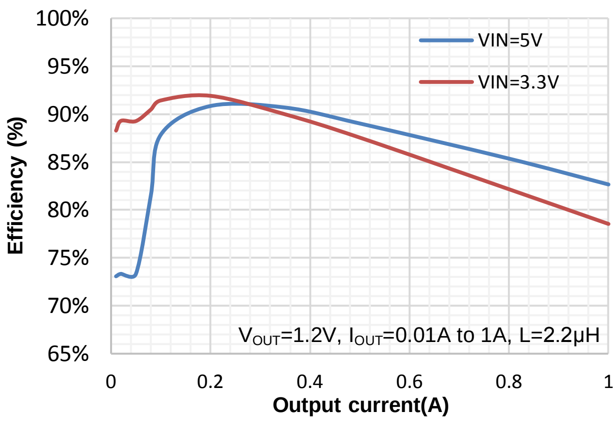
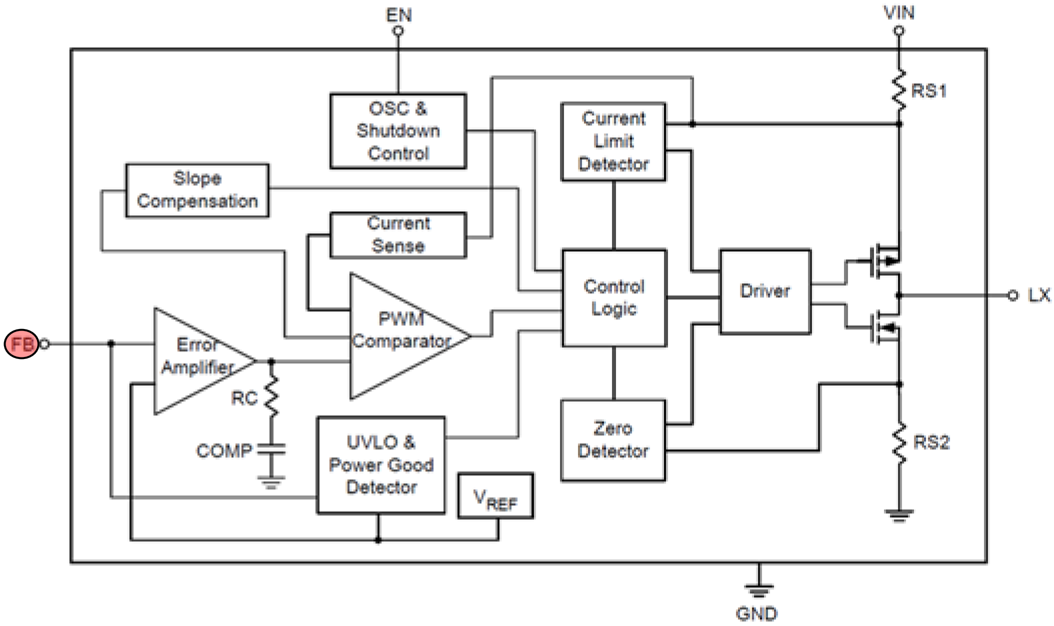


Fig. 16 Efficiency

BLOCK DIAGRAM



Functional Block Diagram of AIC2354B

PIN DESCRIPTIONS

Pin No.	Pin Name	Pin Function
1	EN	Chip Enable Pin. Drive EN above 1.5V to turn on the part. Drive EN below 0.3V to turn it off. Do not leave EN floating.
2	GND	Ground pin.
3	LX	Power Switch Output. It is the switch node connection to Inductor.
4	VIN	Power Supply Input. Must be closely decoupled to GND with a 4.7µF or greater ceramic capacitor.
5	FB	Output Voltage Feedback Pin.

APPLICATION INFORMATION

FUNCTION DESCRIPTION

The AIC2354B is a high performance 1.0A 1.5MHz monolithic step-down converter. The AIC2354 requires only five external power components (C_{IN}, C_{OUT}, L, R_1 and R_2). The output voltage can be programmed with external feedback resistors to any voltage, ranging from 0.6V to the input voltage.

At dropout, the converter duty cycle increases to 100% and the output voltage tracks the input voltage minus the R_{DS_ON} drop of the high-side MOSFET.

The internal error amplifier and compensation provides excellent transient response, load, and line regulation. Soft start function prevents input inrush current and output overshoot during start up.

Setting the Output Voltage

Figure 1 shows the basic application circuit for the AIC2354B. The AIC2354B can be externally programmed. Resistors R_1 and R_2 in Figure 1 program the output to regulate at a voltage higher than 0.6V. To limit the bias current required for the external feedback resistor string while maintaining good noise immunity, the minimum suggested value for R_2 is 59kΩ. Although a larger value will further reduce quiescent current, it will also increase the impedance of the feedback node, making it more sensitive to external noise and interference.

The external resistor sets the output voltage according to the following equation:

$$V_{OUT} = 0.6 \times \left(1 + \frac{R_1}{R_2}\right)$$

$$R_1 = \left(\frac{V_{OUT}}{0.6} - 1\right) \times R_2$$

Inductor Selection

For most designs, the AIC2354B operates with inductors of 2.2µH to 10µH. Low inductance values are physically smaller but require faster switching, which results in some efficiency loss. The inductor 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 ΔI_L is inductor Ripple Current. Large value inductors result in lower ripple current and small value inductors result in high ripple current. For optimum voltage-positioning load transients, choose an inductor with DC series resistance in the 50mΩ to 150mΩ range.

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 should be less than input source impedance to prevent high frequency switching current passing to the input. A low ESR input capacitor sized for maximum RMS current must be used. Ceramic capacitors with X5R or X7R dielectrics are highly recommended because of their low ESR and small temperature coefficients. A 4.7µF ceramic capacitor for most applications is sufficient. A large value may be used for improved input voltage filtering.

Output Capacitor Selection

The output capacitor is required to keep the output voltage ripple small and to ensure regulation loop stability. The output capacitor must have low impedance at the switching frequency. Ceramic capacitors with X5R or X7R dielectrics are recommended due to their low ESR and high ripple current ratings. The output ripple ΔV_{OUT} is determined by:

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

A 10µF ceramic can satisfy most applications.

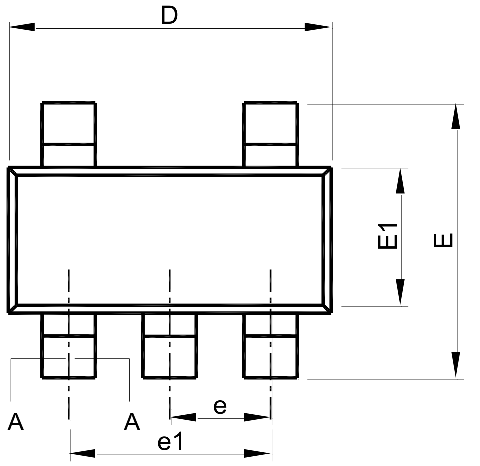
Layout Consideration

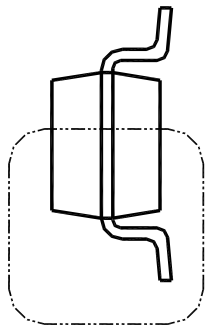
When laying out the printed circuit board, the following checking should be used to ensure proper operation of the AIC2354B. Check the following in your layout:

1. The power traces, consisting of the GND trace, the LX trace and the VIN trace should be kept short, direct and wide.
2. Does the (+) plates of C_{IN} connect to VIN piv as closely as possible. This capacitor provides the AC current to the internal power MOSFETs.
3. Keep the switching node, LX, away from the sensitive VOUT node.
4. Keep the (-) plates of C_{IN} and C_{OUT} as close as possible.

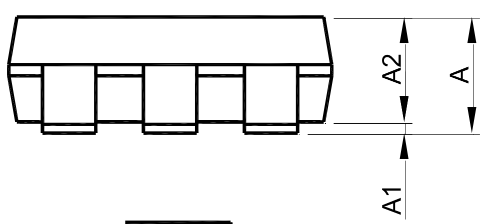
PHYSICAL DIMENSIONS

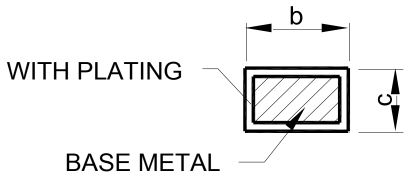
- **SOT23-5**



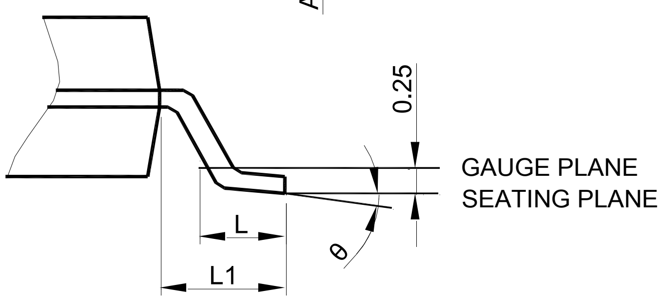


SEE VIEW B





SECTION A-A



VIEW B

SYMBOL	SOT23-5	
	MILLIMETERS	
	MIN.	MAX.
A	0.95	1.45
A1	0.00	0.15
A2	0.90	1.30
b	0.30	0.50
c	0.08	0.22
D	2.80	3.00
E	2.60	3.00
E1	1.50	1.70
e	0.95 BSC	
e1	1.90 BSC	
L	0.30	0.60
L1	0.60 REF	
θ	0°	8°

Note : 1. Refer to JEDEC MO-178AA.
2. Dimension "D" does not include mold flash, protrusions or gate burrs. Mold flash, protrusion or gate burrs shall not exceed 10 mil per side.
3. Dimension "E1" does not include inter-lead flash or protrusions.
4. Controlling dimension is millimeter, converted inch dimensions are not necessarily exact.

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