Synchnorous Step-Up DC/DC Converter

FEATURES

- Ultra Low Start-Up Voltage 0.75V(Typ.)
- High Efficiency
- Low Quiescent Current
- Low Ripple and Low Noise
- Fixed Output Voltage: 2.0V, 2.2V, 2.7V, 2.8V, 3.0V, 3.3V, 5.0V
- Space Saving Packages: SOT23-3, SOT23-5, SC70-3 and SC70-5

APPLICATIONS

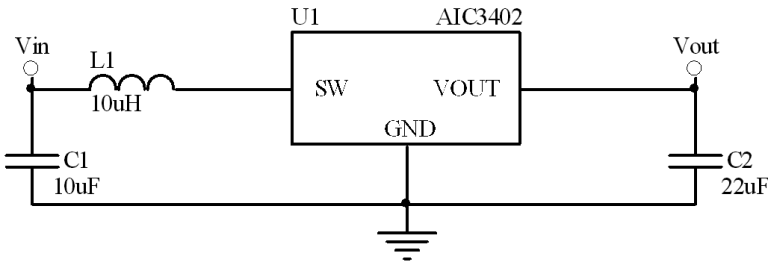
- Cameras
- Wireless Microphones
- Wireless mouse
- Hand held device
- Portable Instruments

DESCRIPTION

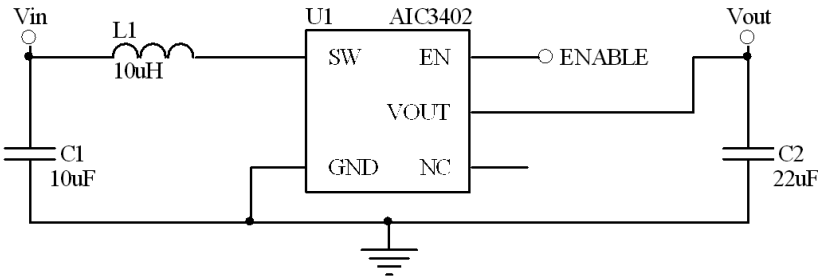
The AIC3402 is a high efficiency step-up DC/DC converter for applications using 1 to 2 NiMH battery cells. Only three external components are required to deliver a fixed output voltage of 2.0V, 2.2V, 2.7V, 2.8V, 3.0V, 3.3V, 5.0V. Fixed output voltage design can aid to reduce BOM cost and PCB area. The 3402 starts up from less than 0.75V(Typ.) input with 1mA resistive load which extends the battery operation time. Automatic PWM/PFM scheme brings optimized performance for applications with light output loading and low input voltages.

The space saving SOT23-3, SOT23-5, SC70-3 and SC70-5 packages make the AIC3402 an ideal choice of DC/DC converter for space conscious applications, like wireless mouse, wireless keyboard, electronic cameras, and wireless microphones.

TYPICAL APPLICATION CIRCUIT



One Cell Step-Up DC/DC Converter



One Cell Step-Up DC/DC Converter with Enable Control

ORDERING INFORMATION

AIC3402-XXXXXX

- PACKING TYPE
  - TR: TAPE & REEL
  - BG: BAG
- PACKAGE TYPE
  - U3: SOT23-3
  - V5: SOT23-5
  - J3 : SC70-3
  - J5 : SC70-5
- G: GREEN PACKAGE
- OUTPUT VOLTAGE
  - 20: 2.0V
  - 22: 2.2V
  - 27: 2.7V
  - 28: 2.8V
  - 30: 3.0V
  - 33: 3.3V
  - 50: 5.0V

(A unit of 0.1V within 1.7V~5.0V, additional voltage versions are available on demand)

Example: AIC3402-20GU3TR

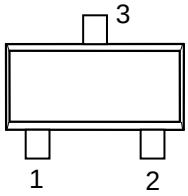
→ 2.0V Version, in Green SOT23-3 Package and Tape & Reel Packing Type

AIC3402-20GV5TR

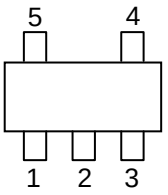
→ 2.0V Version, in Green SOT23-5 Package and Tape & Reel Packing Type

PIN CONFIGURATION

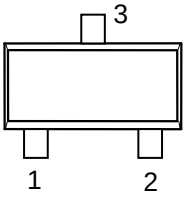
SOT23-3
TOP VIEW
1: GND
2: SW
3: VOUT



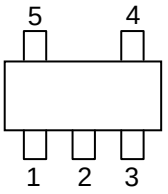
SOT23-5
TOP VIEW
1: EN
2: VOUT
3: NC
4: GND
5: SW



SC70-3
TOP VIEW
1: GND
2: SW
3: VOUT



SC70-5
TOP VIEW
1: EN
2: VOUT
3: NC
4: GND
5: SW



ORDERING INFORMATION (Continued)

- **SOT23-3 MARKING**

Part No.	Marking
AIC3402-20GU3	IJ20G
AIC3402-22GU3	IJ22G
AIC3402-27GU3	IJ27G
AIC3402-28GU3	IJ28G
AIC3402-30GU3	IJ30G
AIC3402-33GU3	IJ33G
AIC3402-50GU3	IJ50G

- **SOT23-5 MARKING**

Part No.	Marking
AIC3402-20GV5	IK20G
AIC3402-22GV5	IK22G
AIC3402-27GV5	IK27G
AIC3402-28GV5	IK28G
AIC3402-30GV5	IK30G
AIC3402-33GV5	IK33G
AIC3402-50GV5	IK50G

- **SC70-3 MARKING**

Part No.	Marking
AIC3402-20GJ3	E20
AIC3402-22GJ3	E22
AIC3402-27GJ3	E27
AIC3402-28GJ3	E28
AIC3402-30GJ3	E30
AIC3402-33GJ3	E33
AIC3402-50GJ3	E50

- **SC70-5 MARKING**

Part No.	Marking
AIC3402-20GJ5	F20
AIC3402-22GJ5	F22
AIC3402-27GJ5	F27
AIC3402-28GJ5	F28
AIC3402-30GJ5	F30
AIC3402-33GJ5	F33
AIC3402-50GJ5	F50

ABSOLUATE MAXIMUM RATINGS

Supply Voltage (VOUT pin)		-0.3 V to 6V
SW pin Voltage		-0.3 V to 6V
EN pin Voltage		-0.3 V to 6V
Operating Temperature Range		-40°C to 85°C
Maximum Junction Temperature		125°C
Storage Temperature Range		-65°C to 150 °C
Lead Temperature (Soldering 10 Sec.)		260°C
Thermal Resistance Junction to Case	SOT23-3	115°C/W
	SOT23-5	115°C/W
Thermal Resistance Junction to Ambient	SOT23-3	250°C/W
	SOT23-5	250°C/W
	SC70-3	300°C /W
	SC70-5	300°C /W

(Assume no ambient airflow, no heatsink)

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

ELECTRICAL CHARACTERISTICS

(T_A=25°C, I_{OUT}=10mA, Unless otherwise specified) (Note1)

PARAMETER	TEST CONDITIONS	SYMBOL	MIN.	TYP.	MAX.	UNIT
Output Voltage		V_{OUT}	-2%		+2%	V
Start-Up Voltage	I_{OUT}=1mA, V_{IN}:0→2V	V_{START}		0.75	0.85	V
Min. Hold-on Voltage	I_{OUT}=1mA, V_{IN}:2→0V	V_{HOLD}			0.7	V
No-Load Input Current	V_{IN}=1.2V, V_{OUT}=3.3V, I_{OUT}=0mA	I_{IN}		11	15	μA
Supply Current	V_S=V_{OUT} + 0.5V Measurement of the IC input current (VOUT pin)	I_S		3		μA
Oscillation Frequency		f_{OSC}	680	800	920	kHz
Maximum Duty	V_S=V_{OUT} x 0.95	D_{MAX}	82	87	92	%
Main Switch-On Resistance	V_{OUT}=3.3V	$R_{DS(ON)\_N}$		0.5		Ω
Rectify Switch-On Resistance	V_{OUT}=3.3V	$R_{DS(ON)\_P}$		0.8		Ω
Main Switch Current Limit	Vout=3.3V	I_{SW}	0.3	0.45		A
Main Switch Leakage Current	V_{OUT}=3.3V				1	μA
Rectify Switch Leakage Current	V_{OUT}=3.3V				1	μA
Shut down Current	V_{EN} = 0, V_{IN} = 1.2V, I_{OUT} = 0mA	I_{SD}		0.1		μA
EN Pin Current	V_{EN} = V_{OUT}	I_{EN}		0.1	1	μA
EN Input Low Threshold	Chip Disable	V_{ENL}			0.3	V
EN Input High Threshold	Chip Enable	V_{ENH}	0.8			V

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).

TYPICAL PERFORMANCE CHARACTERISTICS

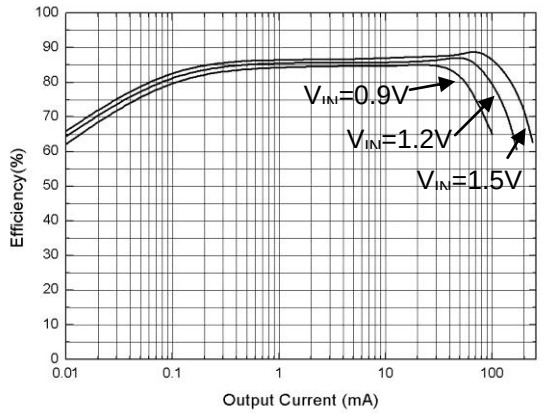


Fig. 1 Efficiency at V_{out}=1.7V

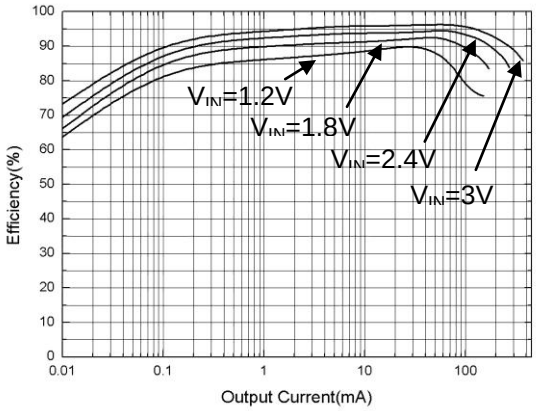


Fig. 2 Efficiency at V_{out}=3.3V

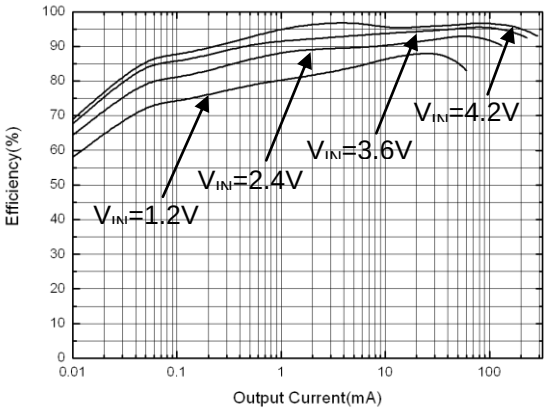


Fig. 3 Efficiency at V_{out}=5.0V

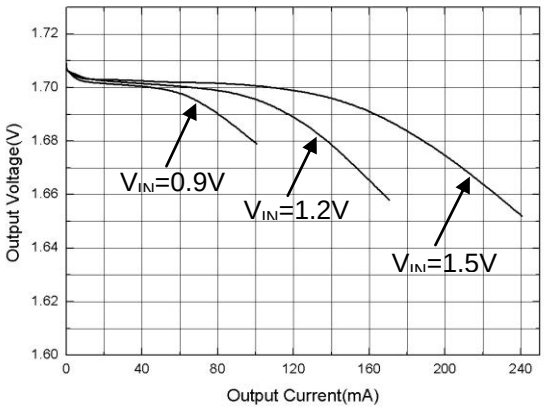


Fig. 4 Load Regulation at V_{out}=1.7V

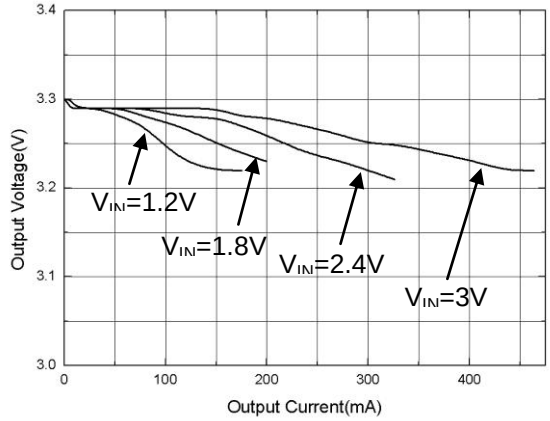


Fig. 5 Load Regulation at V_{out}=3.3V

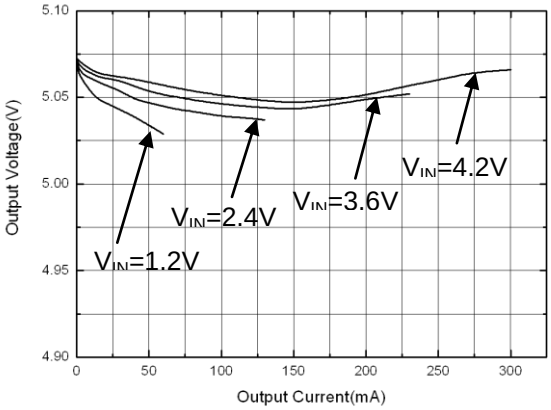


Fig. 6 Load Regulation at V_{out}=5.0V

■ TYPICAL PERFORMANCE CHARACTERISTICS(continue)

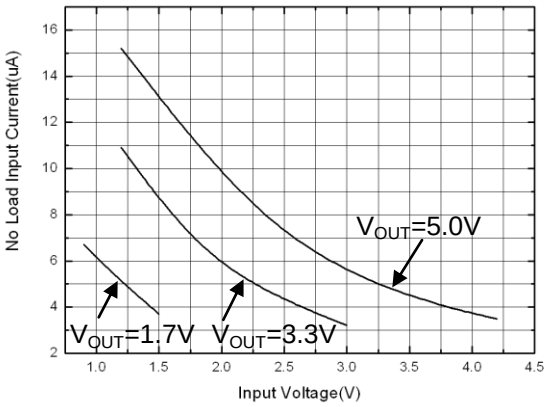


Fig. 7 No Load Input Current vs. Input Voltage

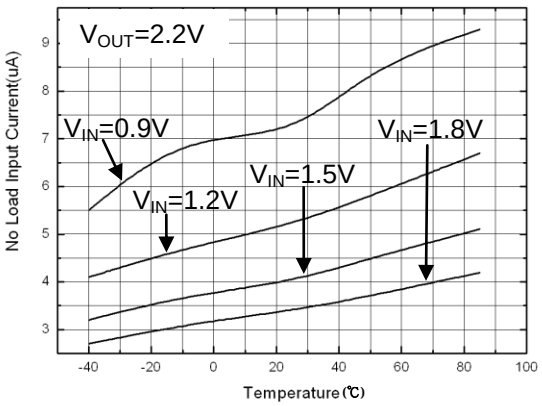


Fig. 8 No Load Input Current vs. Temperature

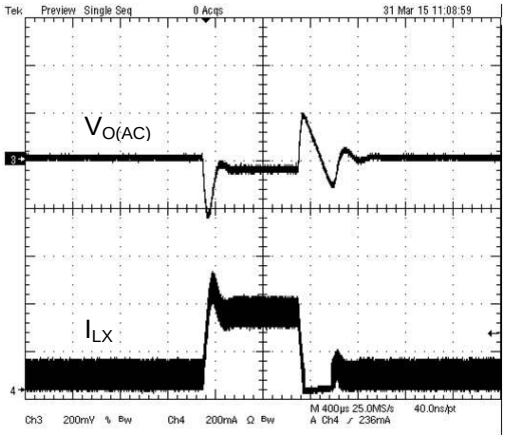


Fig. 9 Load-Transient Response at V_{IN}=2.4V , V_{OUT}=3.3V, I_{OUT}=20mA-200mA

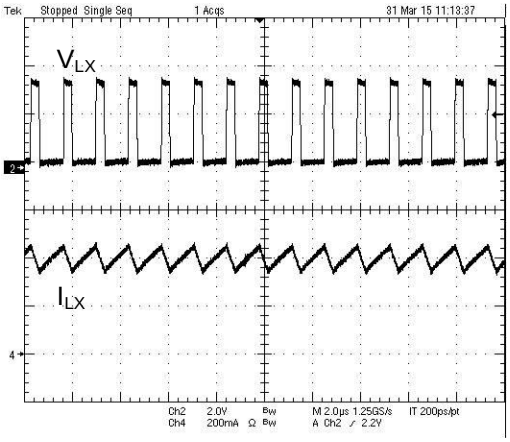


Fig. 10 CCM Waveform

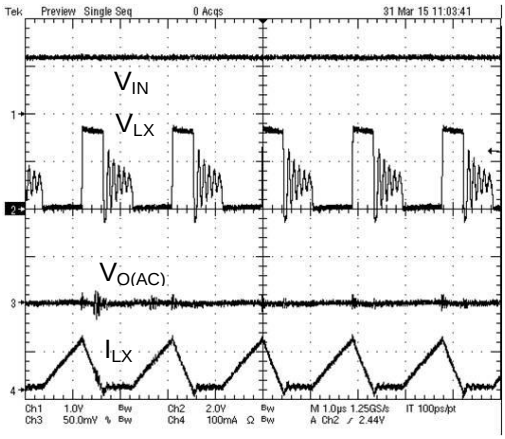


Fig. 11 DCM Waveform

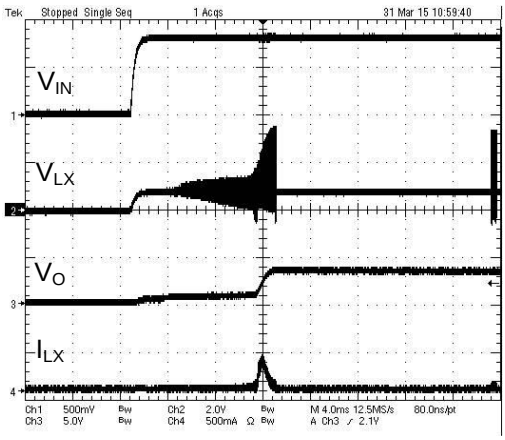


Fig. 12 Start_up at V_{IN}=0.8V, V_{OUT}=3.3V, I_{OUT}=0mA

■ TYPICAL PERFORMANCE CHARACTERISTICS (Continued)

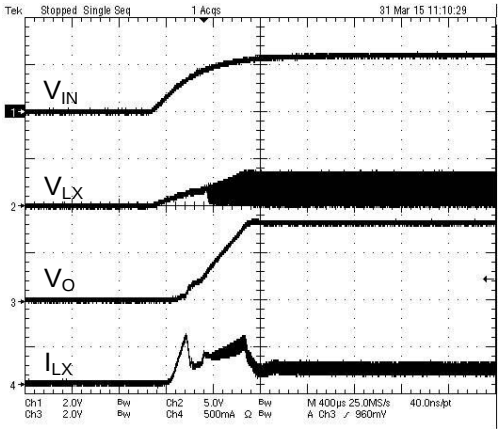
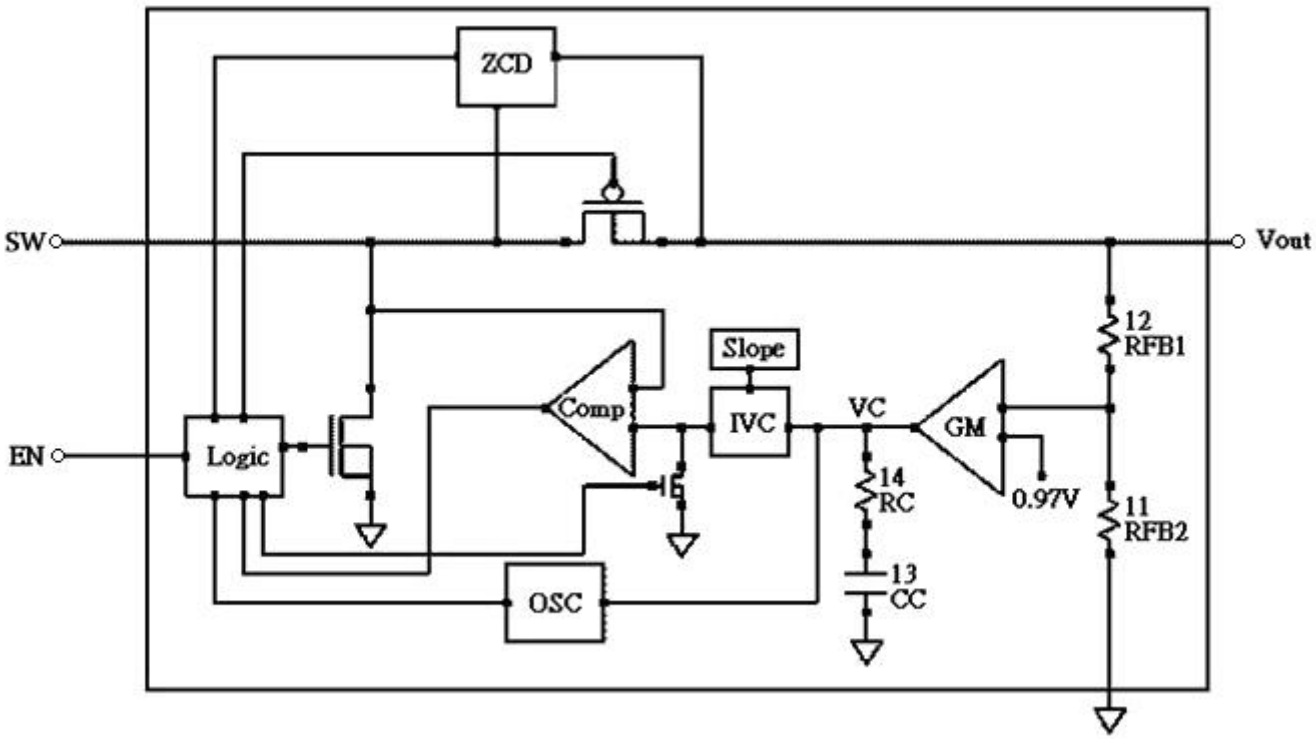


Fig. 13 Start_up at V_{IN}=2.4V, V_{OUT}=3.3V, I_{OUT}=100mA

■ BLOCK DIAGRAM



Functional Block Diagram of AIC3402

■ PIN DESCRIPTIONS

GND	–	Ground. Must be low impedance; connect directly to ground plane.	SW	–	Switch Pin. Connect Inductor between input supply and this pin.
VOUT	–	IC supply pin. Connect VOUT pin to the regulator output.	EN (5 Pin)	–	Chip Enable. This pin is not allowed to float.

APPLICATION INFORMATION

Operation

The AIC3402 is a high efficiency step-up DC/DC converter with current-mode PWM/PFM control architecture. It features an internal synchronous rectifier, which eliminates the external Schottky diode and increases efficiency. During normal operation, the AIC3402 can regulate its output voltage through internal feedback control circuit, which is composed of a resistive divider; an error amplifier; a current comparator and several control signal generators. While the main power switch (N-channel MOSFET) is turned on, the synchronous power switch (P-channel MOSFET) will be turned off. Similarly, when the main power switch is turned off, the synchronous power switch will be turned on until the inductor current starts to reverse or the beginning of the next switching cycle. In order to achieve better efficiency and prevent overcharging the output capacitor, AIC3402 will enter pulse-frequency-modulated mode (PFM) operation while working at light load conditions.

Enable Function

The AIC3402 has a dedicated enable pin. The device is enabled when pulling the EN pin above 0.8V. By connecting the EN pin to GND, the AIC3402 can be shut down to reduce the supply current. The EN pin is not allowed to float.

Current limit

The AIC3402 provides the current limit protection function by using an internal sensing circuit. When the current flowing through the internal main power switch reaches the current limit threshold, the current limitation function is activated. While the current limitation function is activated, the duty cycle will be reduced to limit the output power to protect the internal power switches. When the over current state is eliminated, the IC resumes its normal operation.

Component Selection

Inductor

The inductor selection depends on the current ripple of inductor, the input voltage and the output voltage.

$$L \geq \frac{V_{IN}}{f_{OSC} \cdot \Delta I_L}\left(1-\frac{V_{IN}}{V_{OUT}}\right)$$

Accepting a large current ripple of inductor allows the use of a smaller inductance. However, higher current ripple of inductor can cause higher output ripple voltage and large core loss. The current ripple is typically set for 20% to 40% of the maxium inductor current. The inductor should have low core losses at operation frequency and low DCR (copper wire resistance) to reduce the losses. In additional, it is important to ensure the inductor is able to handle the peak inductor current without saturating.

Typically, a 10μH inductor is recommanded for most AIC3402 applications.

Input Capacitor

To provide a low impedance loop for the edges of pulsed current drawn by the AIC3402, the use of low ESR ceramic capacitor for the maximum input voltage and maximum RMS current is recommended. For reliable operation, the input capacitor voltage rating should be at least 1.25 times greater than a maxium input voltage. Typically, 10μF or greater, X5R or X7R, ceramic capacitor is suggested for the input capacitor.

Output Capacitor

An output capacitor is required to limit the output ripple and supply the load transient current. Therefore, a poor choice for an output capacitor can result in poor performance. A 22μF, X5R or X7R, ceramic capacitor is suggested for the output capacitor.

PCB Layout Guidance

PCB layout is important to guarantee satisfactory performance. For better performance, following the guidelines:

(1) The input capacitor should be placed as close as possible to inductor and GND pin to provide a low impedance loop.

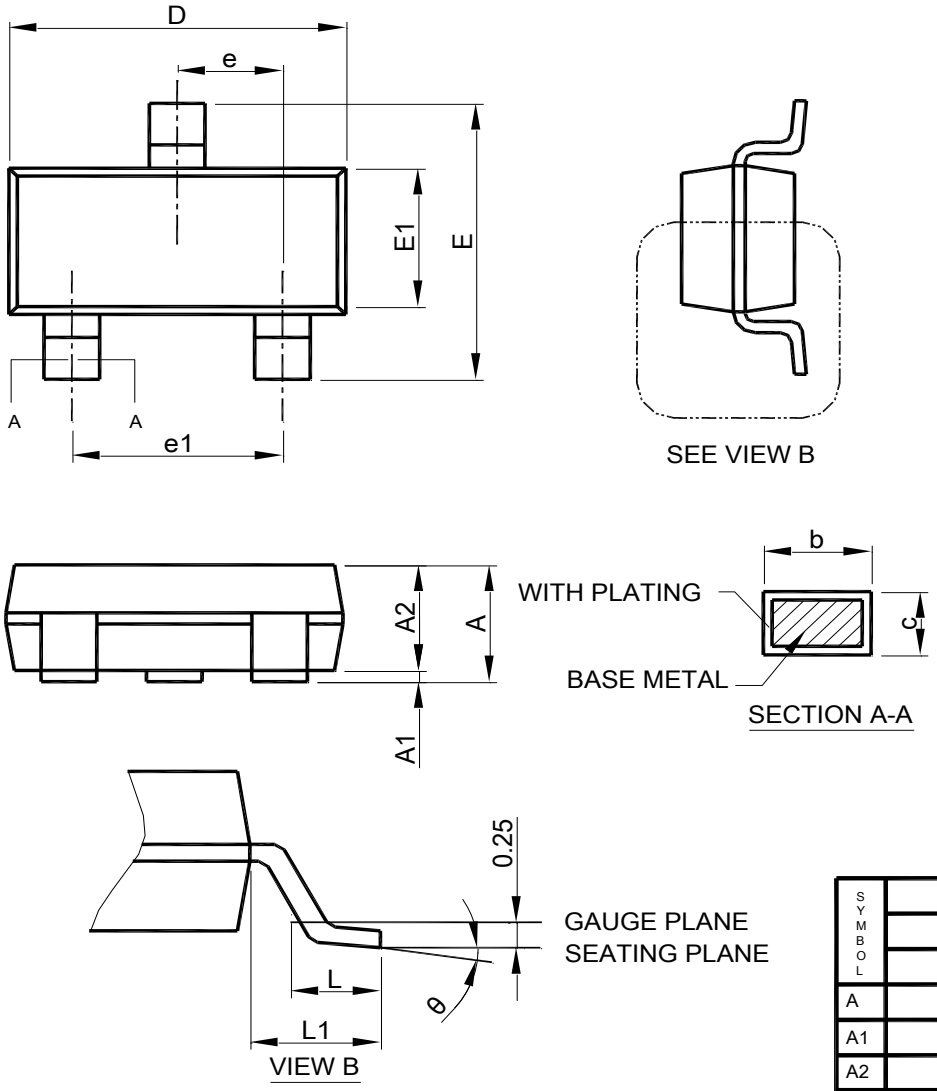
(2) The output capacitor should be placed as close as possible to VOUT and GND pins to reduce the output ripple noise.

(3) The loop, which is consisted of the input capacitor, the inductor, the internal power switchs and the output capacitor, should be kept as small as possible.

(4) The routes with large current should be kept short and wide.

PHYSICAL DIMENSIONS

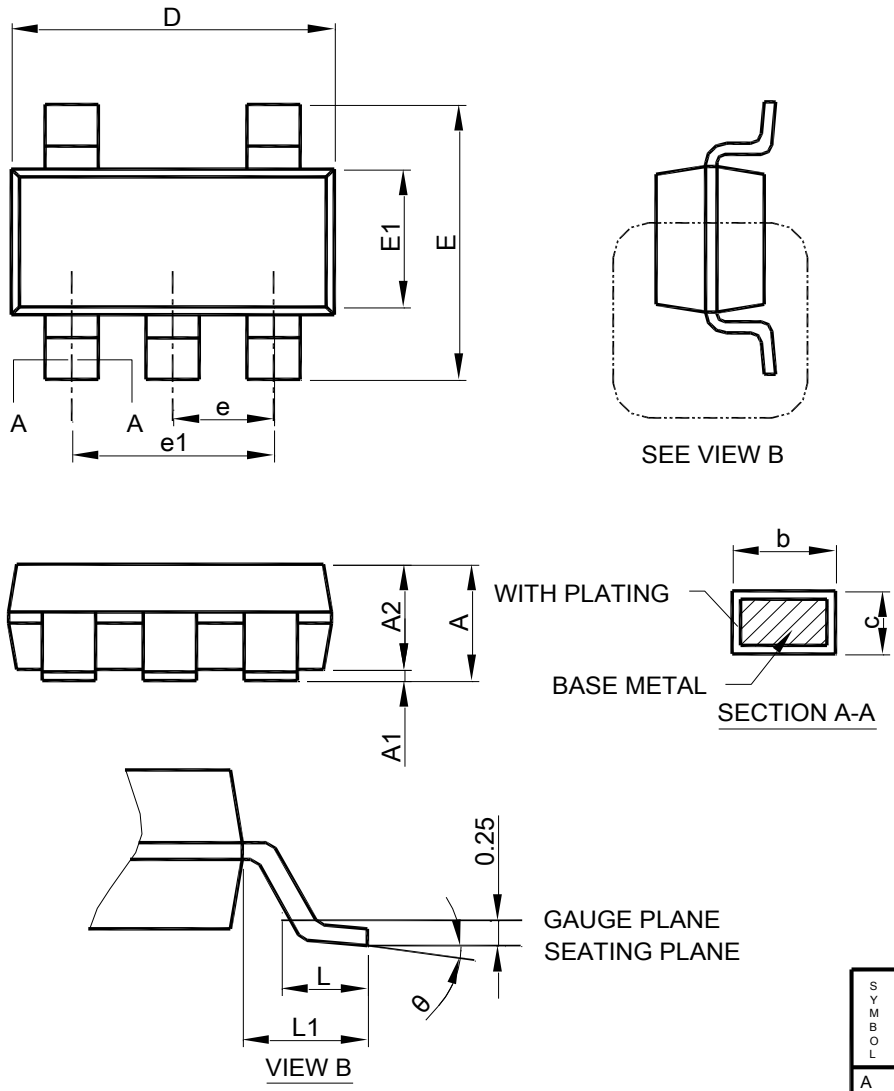
- **SOT23-3**



SYMBOL	SOT23-3	
	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-178.
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.

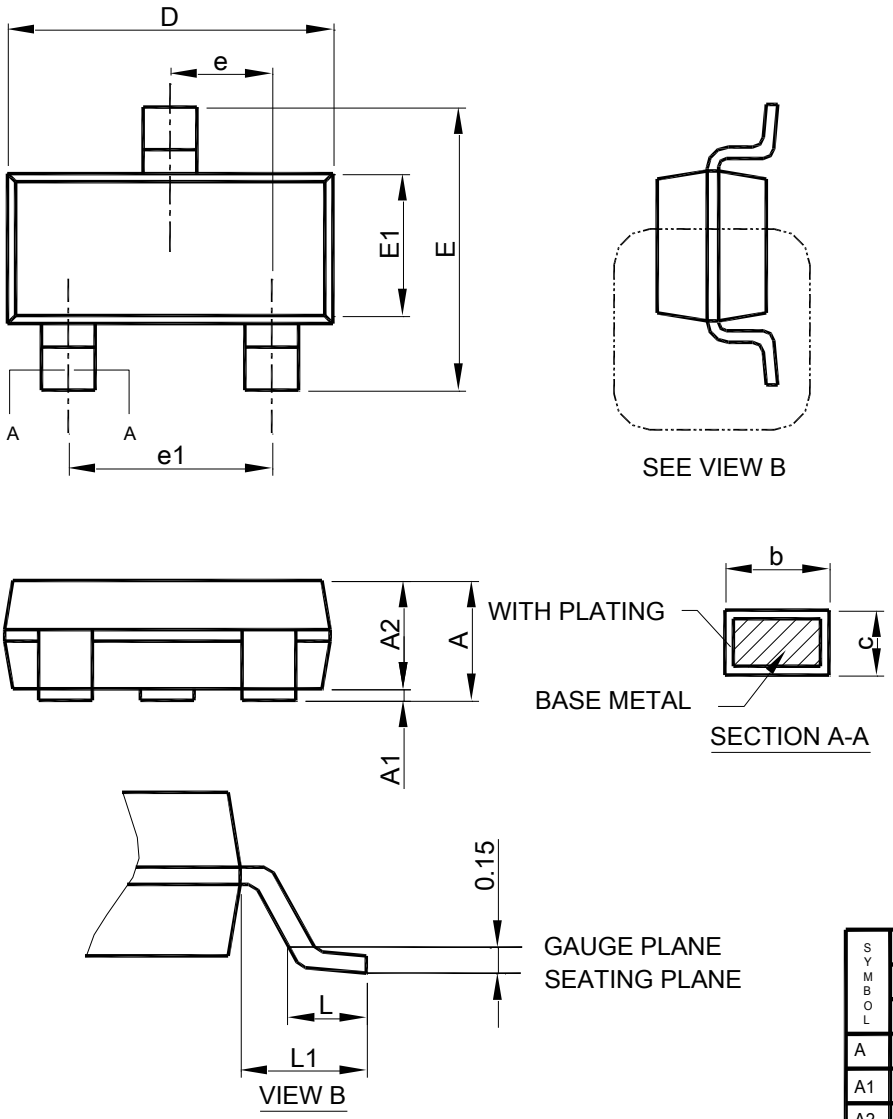
- **SOT23-5**



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.

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°

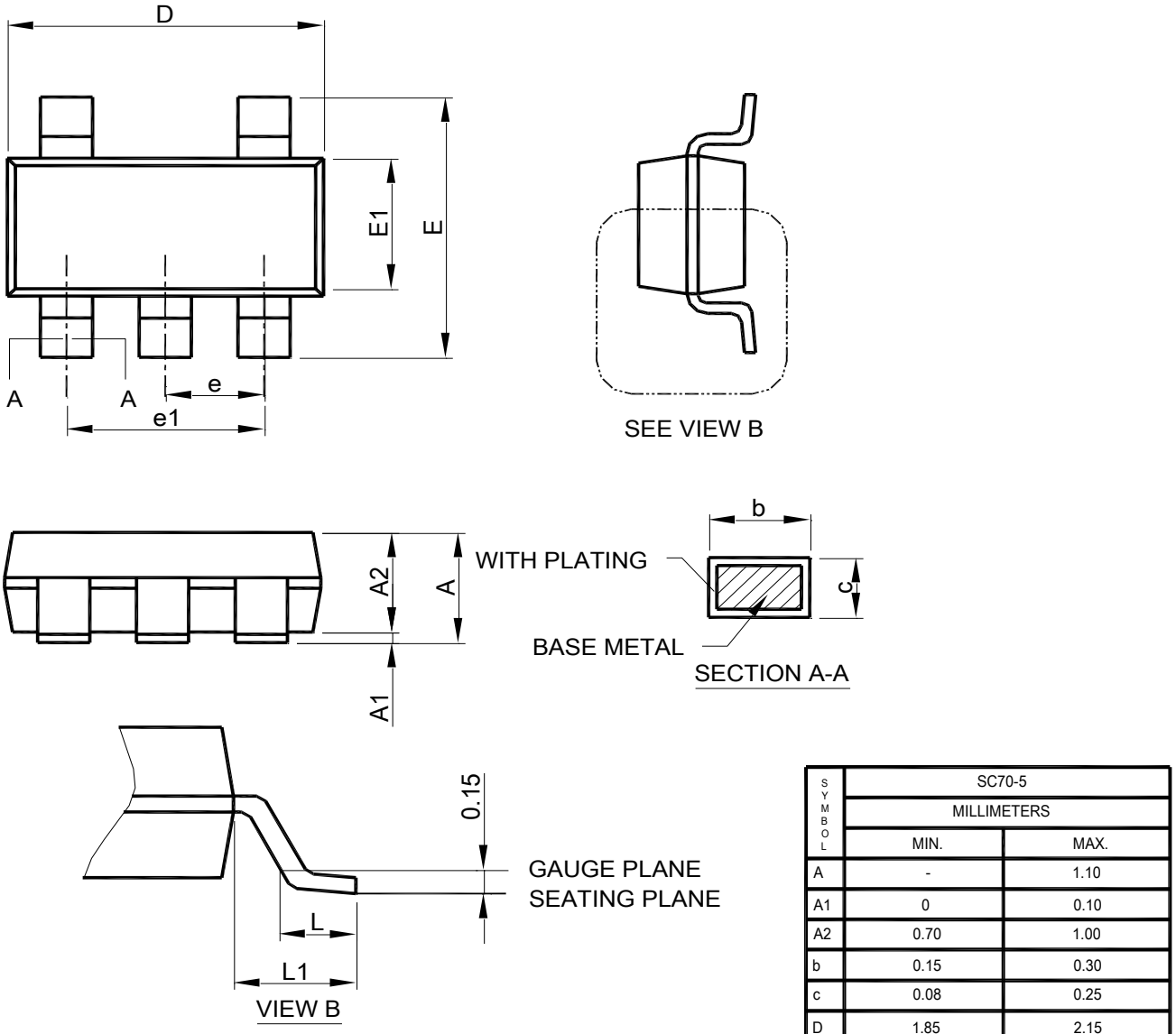
- **SC70-3**



SYMBOL	SC70-3	
	MILLIMETERS	
	MIN.	MAX.
A	-	1.10
A1	0	0.10
A2	0.70	1.00
b	0.15	0.40
c	0.08	0.25
D	1.85	2.15
E	1.80	2.40
E1	1.10	1.40
e	0.65 BSC	
e1	1.30 BSC	
L	0.26	0.46
L1	0.42 REF	

Note: 1. Refer to JEDEC MO-203.
2. Dimension "D" does not include mold flash, protrusions or gate burrs. Mold flash, protrusion or gate burrs shall not exceed 6 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.

- **SC70-5**



SYMBOL	SC70-5	
	MILLIMETERS	
	MIN.	MAX.
A	-	1.10
A1	0	0.10
A2	0.70	1.00
b	0.15	0.30
c	0.08	0.25
D	1.85	2.15
E	1.80	2.40
E1	1.10	1.40
e	0.65 BSC	
e1	1.30 BSC	
L	0.26	0.46
L1	0.42 REF	

Note: 1. Refer to JEDEC MO-203AA.
2. Dimension "D" does not include mold flash, protrusions or gate burrs. Mold flash, protrusion or gate burrs shall not exceed 6 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.