Low IQ High Light Load Efficiency Synchronous Boost Converter

FEATURES

- Deliver 3.3V at 60mA from a Single Alkaline/Ni-MH or 3.3V at 120mA from Two Cells
- Up to 94% Efficiency
- Low Shutdown Current: < 1μA
- Low Quiescent Current: 12μA.
- Low No-load Input Current (see Typical Performance Characteristics for detail)
- Output Disconnect by Shutdown Function
- Small SOT23-6 Package

APPLICATIONS

- Wireless Mice
- Medical Instruments
- Smart Phones
- Bluetooth Devices

DESCRIPTION

The AIC3412 is a synchronous step-up DC/DC converter. That is base on constant Off Time/PSM controller topology. The IC enters PSM mode automatically at light load, the goal is to improve efficiency and reduce quiescent current. The AIC3412 provide a complete power supply solution for products powered by one or two Alkaline, Ni-Cd, or Ni-MH battery cells. It stays in operation with supply voltages down to 0.7V. The implemented boost converter is based on a constant Off Time/PSM controller topology using an internal synchronous rectifier to obtain maximum efficiency. A low-EMI mode is implemented to reduce ringing and in effect lower radiated electromagnetic energy when the converter enters the discontinuous conduction mode.

TYPICAL APPLICATION CIRCUITS

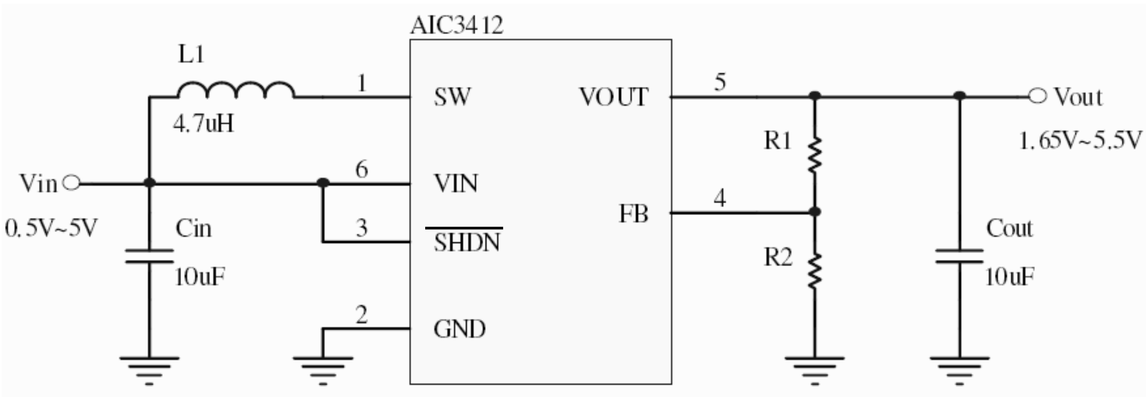


Fig. 1 One Cell Step-Up DC/DC Converter

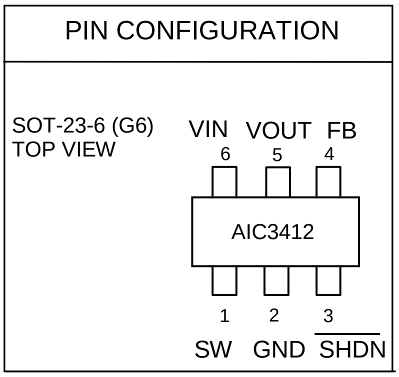
ORDERING INFORMATION

AIC3412X XX XX

- PACKING TYPE
  TR: TAPE & REEL
  BG: BAG
- PACKAGE TYPE
  G6: SOT-23-6
- G: GREEN PACKAGE

Example: AIC3412GG6TR

→ in SOT-23-6 Green Package & Taping & Reel Packing Type



Note: Pin1 is determined by orienting the package marking as shown.

ABSOLUTE MAXIMUM RATINGS

Pin Voltage: FB, $\overline{\text{SHDN}}$, OUT, VIN .... -0.3 V to 6V

Pin Voltage: SW

DC .... -0.3 V to 6V

Pulsed < 100ns .... -0.3 V to 7V

Operating Ambient Temperature Range T_A .... -40°C to 85°C

Operating Maximum Junction Temperature T_J .... 150°C

Storage Temperature Range T_{STG} .... -65°C to 150°C

Lead Temperature (Soldering 10 Sec.) .... 260°C

Thermal Resistance Junction to Ambient .... 250°C/W

(Assume no Ambient Airflow, no Heatsink)

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

TEST CIRCUIT

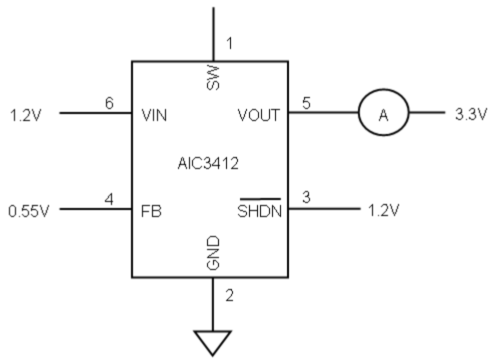


Fig. 2 Test Circuit

ELECTRICAL CHARACTERISTICS

(Typical application circuit, and the ambient temperature=25°C, V_{IN}=1.2V, V_{OUT}=3.3V, unless otherwise specified) (Note1)

PARAMETER	TEST CONDITION	SYMBOL	MIN	TYP	MAX	UNIT
Output Voltage Range		V_{OUT}	1.65		5.5	V
Minimum Start Up Voltage	RL= 3.3kOhm			0.75	0.9	V
Input Operation Voltage			0.7		5	V
UVLO of Vin	Vin decreasing			0.5	0.7	V
Quiescent Current (PSM)	V_{OUT}: V_{IN}=1.2V, V_{OUT}=3.3V, V_{FB}=0.55V **(Note 2)**	I_Q		12	25	μA
IC Shut Down Current	$\overline{SHDN}$ = 0V, V_{OUT} =1.1V	I_{SD}		0.01	1	μA
Feedback Voltage		V_{FB}	490	500	510	mV
FB Input Leakage Current	V_{FB}=1.3V	I_{FB}		1	50	nA
Inductor current ripple		I_{LH}		200		mA
Constant off time	V_{IN}=1.2V, V_{OUT}=3.3V	T_{OFF}		400		ns
Line Regulation	V_{IN}<V_{OUT} **(Note 3)**			0.5%		
Load Regulation	V_{IN}<V_{OUT} **(Note 3)**			0.5%		
NMOS Switch Leakage	V_{SW}=5V			0.1	5	μA
PMOS Switch Leakage	V_{SW}=5V, V_{OUT}=0V			0.1	10	μA
NMOS Switch On Resistance	V_{IN}=1.2V, V_{OUT}=3.3V			480		mΩ
PMOS Switch On Resistance	V_{IN}=1.2V, V_{OUT}=3.3V			800		mΩ
$\overline{SHDN}$ High Threshold Voltage	V_{IN}=1.2V		0.8			V
$\overline{SHDN}$ Low Threshold Voltage	V_{IN}=1.2V				0.2	V
$\overline{SHDN}$ Pin Input Current	$\overline{SHDN}$ = 5.5V	I_{SHDN}		0.01	1.0	μA
NMOS Current Limit	V_{IN}=1.2V, V_{OUT}=3.3V		0.28	0.48	0.68	A
Over Temperature Protection				150		°C
Over Temperature Hysteresis				30		°C

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: The test circuit shown in Fig. 2.

Note 3: Guarantee by Design.

TYPICAL PERFORMANCE CHARACTERISTICS

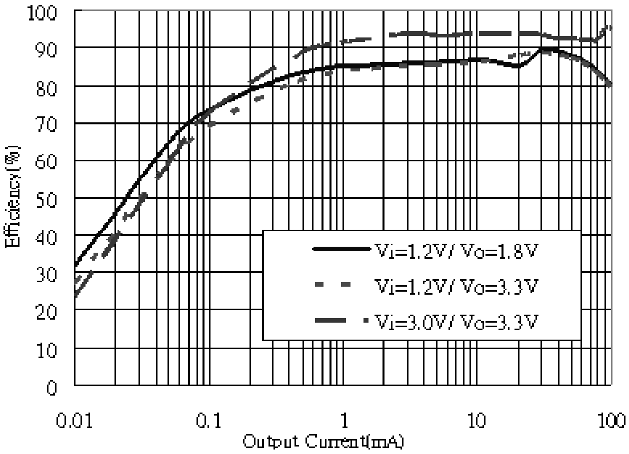


Fig. 3 Efficiency vs. Output Current

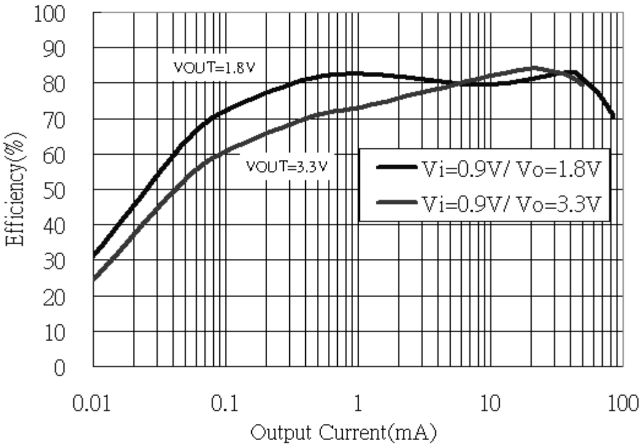


Fig. 4 Efficiency vs. Output Current

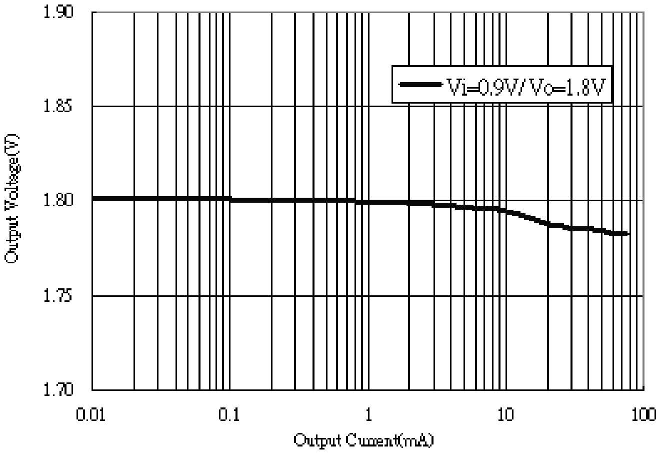


Fig. 5 Output Voltage vs. Output Current

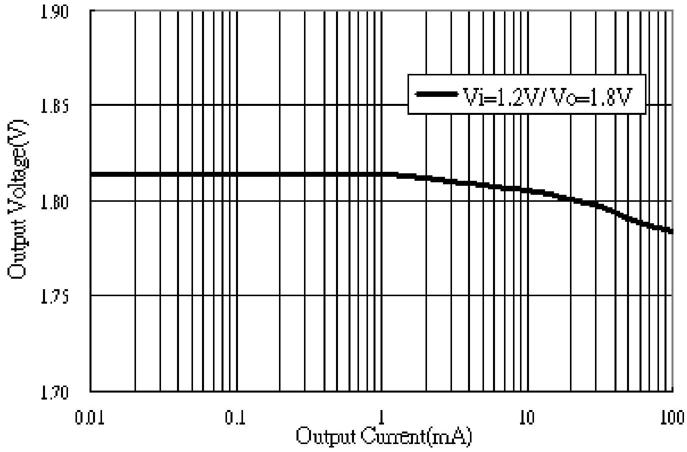


Fig. 6 Output Voltage vs. Output Current

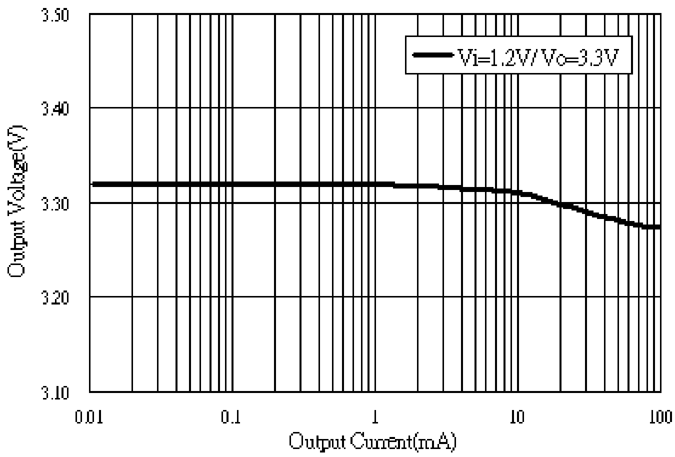


Fig. 7 Output Voltage vs. Output Current

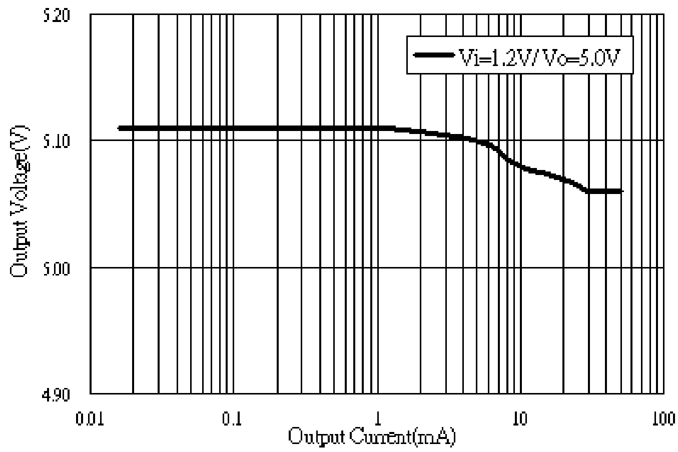


Fig. 8 Output Voltage vs. Output Current

TYPICAL PERFORMANCE CHARACTERISTICS(Continued)

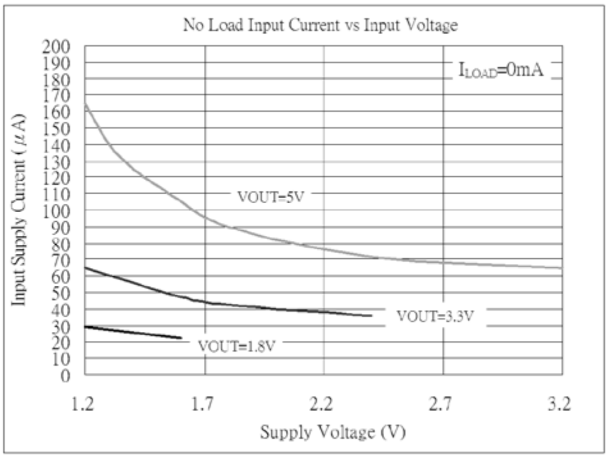


Fig. 9 Input Supply Current vs. Supply Voltage

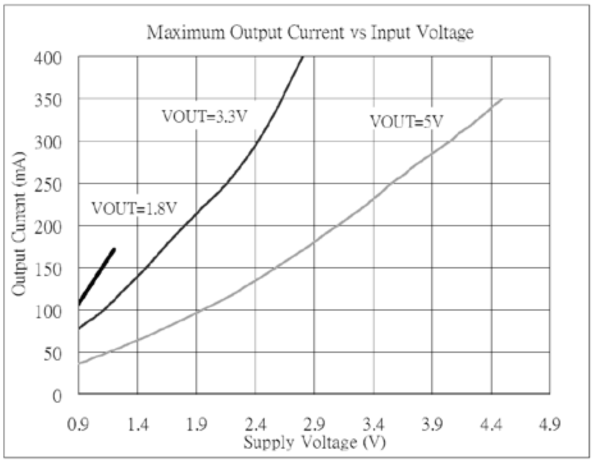


Fig. 10 Output Current vs. Supply Voltage

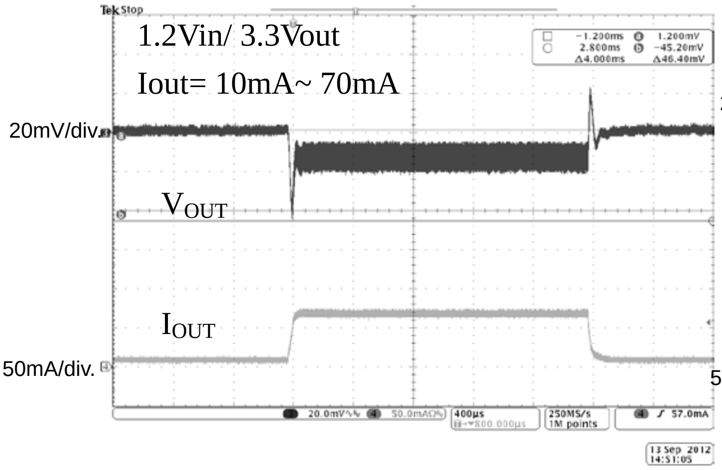


Fig. 11 Load Transient

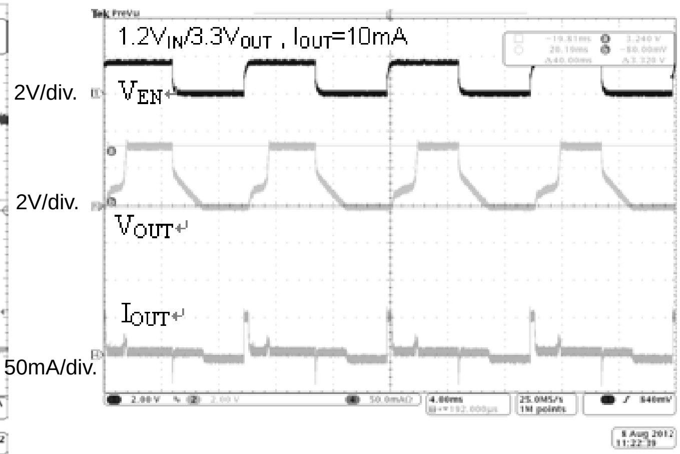


Fig. 12 Start up and Shutdown

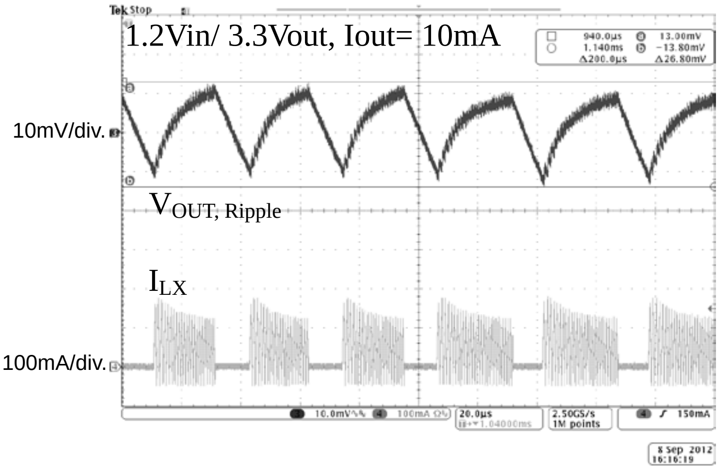
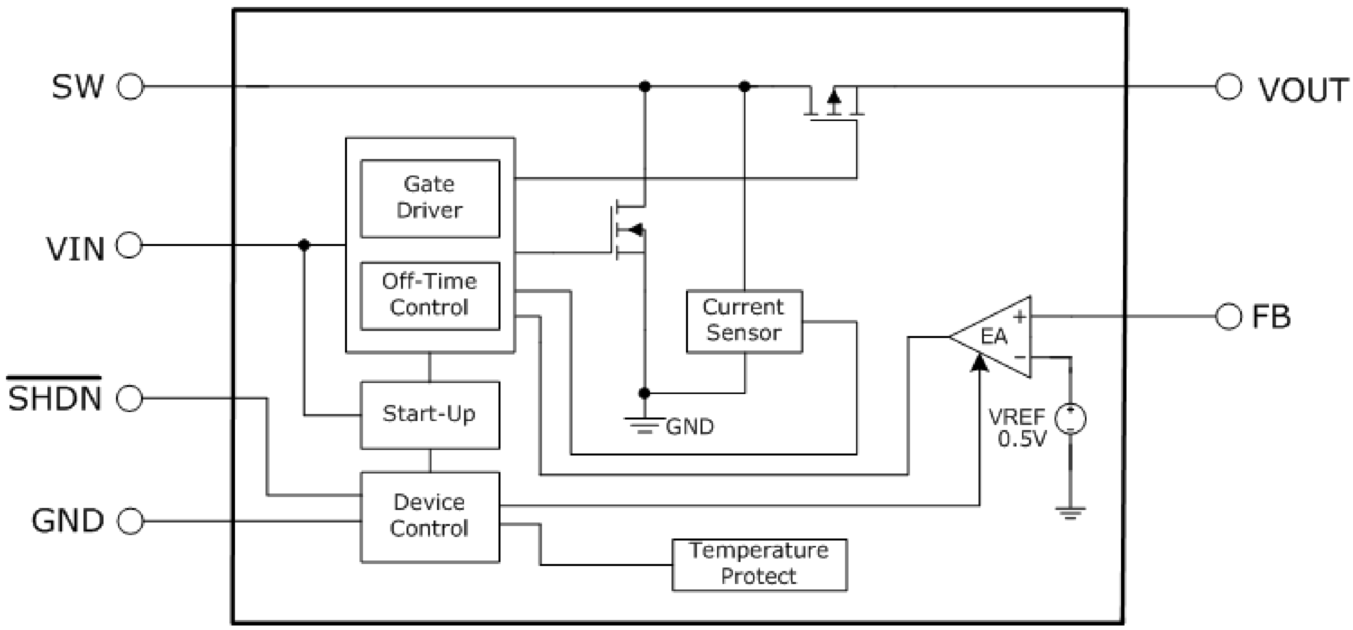


Fig. 13 Output Voltage Ripple

FUNCTIONAL BLOCK DIAGRAM



PIN DESCRIPTIONS

1. SW - Switch Pin. Connect Inductor between VIN and this pin.

2. GND- Signal and Power Ground

3. $\overline{\text{SHDN}}$ - Logic Controlled Shutdown Input.
   $\overline{\text{SHDN}}$ = High: Normal Operation
   $\overline{\text{SHDN}}$ = Low: IC shutdown

4. FB - Feedback Input to Error Amplifier. Connect resistor divider tap to this pin.

5. VOUT- Output Voltage Sense and Drain of the Internal Synchronous Rectifier.

6. VIN - Input Supply Pin.

APPLICATION INFORMATION

The AIC3412 is a synchronous step-up DC-DC converter. It is based on constant Off Time/PSM controller topology. At the beginning of each clock cycle, the main switch (NMOS) is turned on and the inductor current starts to ramp. After the sense current signal equals the error amplifier (EA) output, the main switch is turned off and the synchronous switch (PMOS) is turned on. The device can operate with an input voltage below 1V; the typical start-up voltage is 0.75V.

Current Limit

The over current protection is to limit the switch current. The output Voltage will be dropped when over current is happened. The current limit amplifier will turn off switch once the current exceeds its threshold.

Zero Current Comparator

The zero current comparator monitors the inductor current to the output and shuts off the synchronous rectifier, This prevents the inductor current from reversing in polarity improving efficiency at light loads.

Device Shutdown

When $\overline{\text{SHDN}}$ is set logic high, the AIC3412 is put into active mode operation. If $\overline{\text{SHDN}}$ is set logic low, the device is put into shutdown mode and consumes less than 1μA of current. At the shutdown mode, the synchronous switch will turn off and the output voltage of AIC3412 step-up converter will reduce to 0V.After start-up, the internal circuitry is supplied by VOUT, however, if shutdown mode is enabled, the internal circuitry will be supplied by the input source again.

Adjustable Output Voltage

An external resistor divider is used to set the output voltage. The output voltage of the switching regulator (V_{OUT}) is determined by the following equation:

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

Where V_{FB} is 0.5V reference voltage.

Input Inductor Selection

A 2.2μH~6.8μH input inductor is commanded for most AIC3412 applications. The 4.7μH input inductor can get the good performance over the whole converter ratio cases. The inductor which is smaller than 2.2 μH is not recommended to use. It is important to ensure the inductor saturation current exceeding the peak inductor current in application to prevent core saturation.

Input Capacitor Selection

Surfaces mount 4.7μF or greater, X5R or X7R, ceramic capacitor is suggested for the input capacitor. The input capacitor provides a low impedance loop for the edges of pulsed current drawn by the AIC3412. Low ESR/ESL X7R and X5R ceramic capacitors are ideal for this function. To minimize stray inductance, the capacitor should be placed as close as possible to the IC. This keeps the high frequency content of the input current localized, minimizing EMI and input voltage ripple. Always examine the ceramic capacitor DC voltage coefficient characteristics to get the proper value.

Output Capacitor Selection

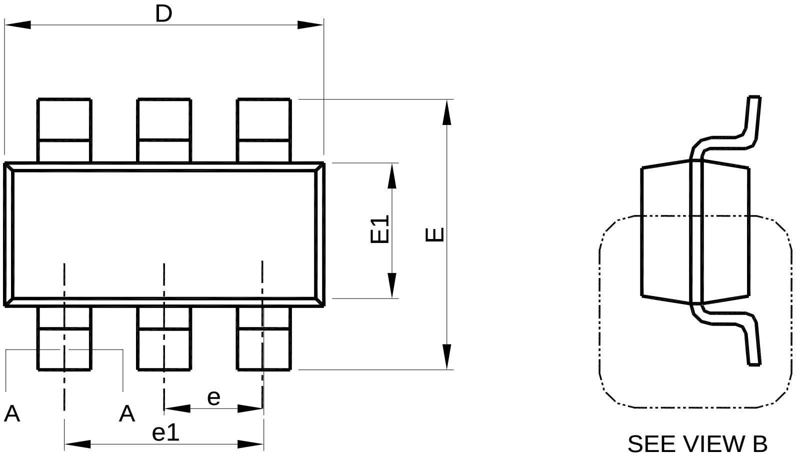
The output capacitor limits the output ripple and provides holdup during large load transitions. A 4.7μF to 10μF, X5R or X7R, ceramic capacitor is suggested for the output capacitor. Typically the recommended capacitor range provides sufficient bulk capacitance to stabilize the output voltage during large load transitions and has the low ESR and ESL characteristics necessary for low output voltage ripple.

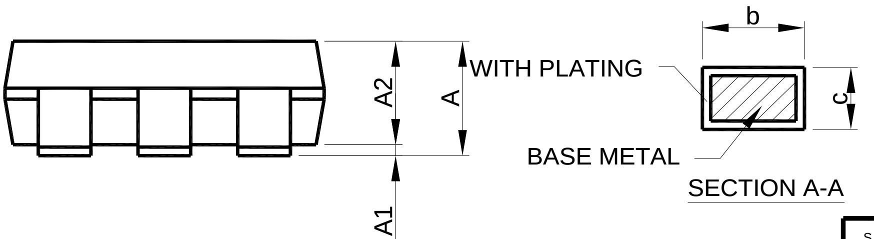
PCB Layout Guidance

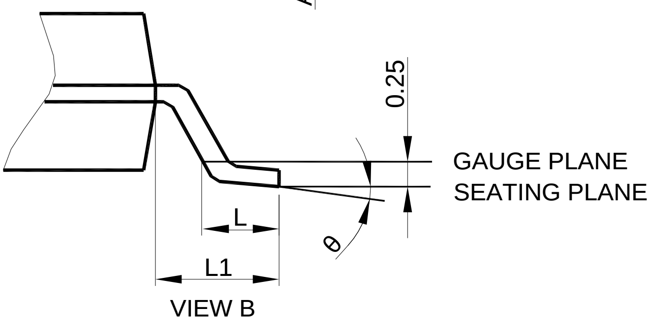
This is a considerably high frequency for DC-DC converters. PCB layout is important to guarantee satisfactory performance. It is recommended to make traces of the power loop, especially where the switching node is involved, as short and wide as possible. First of all, the inductor, input and output capacitor should be as close as possible to the device. Feedback and shutdown circuits should avoid the proximity of large AC signals involving the power inductor and switching node.

■ PHYSICAL DIMENSIONS

- **SOT-23-6**







SYMBOL	SOT-23-6	
	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-178AB.
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.