# High-Efficiency,2A,18V,600kHz Synchronous,Step-DownConverter

## GENERAL DESCRIPTION

The XC8112B is a high-frequency, synchronous, rectified, step-down, switch-mode converter with internal power MOSFETs. It offers a very compact solution to achieve a 2A continuous output current over a wide input supply range, with excellent load and line regulation. The XC8112B has synchronous-mode operation for higher efficiency over the output current-load range.

Current-mode operation provides fast transient response and eases loop stabilization. Protection features include over -current protection and thermal shutdown.

The XC8112B requires a minimal number of readily available, standard, external components and is available in a space-saving 6-pin SOT23 package.

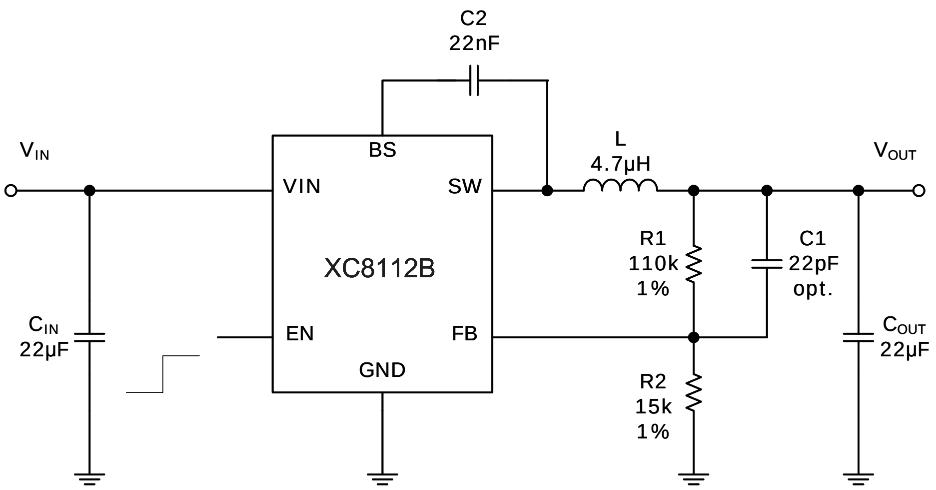
## FEATURES

- ●Wide 3.4V-to-18V Operating Input Range
- ●100mΩ/80mΩ Low-RDS(ON) Internal Power MOSFETs
- ●High-Efficiency Synchronous-Mode Operation
- ●Fixed 600kHz Switching Frequency
- ●PFM Mode for High Efficiency at Light Load
- ●Internal Soft-Start
- ●Input Voltage UVP&OVP
- ●Over-Current Protection and Hiccup
- ●Thermal Shut down
- ●Output Adjustable from0.6V
- ●Available in a 6-pin SOT-23 package

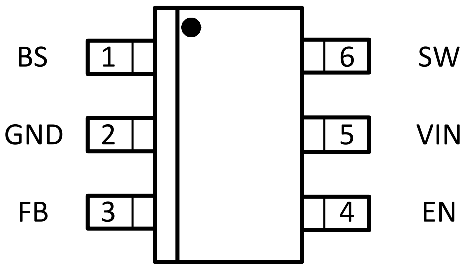
## APPLICATIONS

- ●Digital Set-top Box(STB)
- ●Tablet Personal Computer(Pad)
- ●Flat-Panel Television and Monitors
- ●Digital Video Recorder (DVR)
- ●Portable Media Player(PMP)
- ●General Purposes

## TYPICAL APPLICATIONS



## PACKAGE/ORDER INFORMATION

| | OrderPartNumber | Package |
|---|---|---|
|  | XC8112B | SOT23-6 |

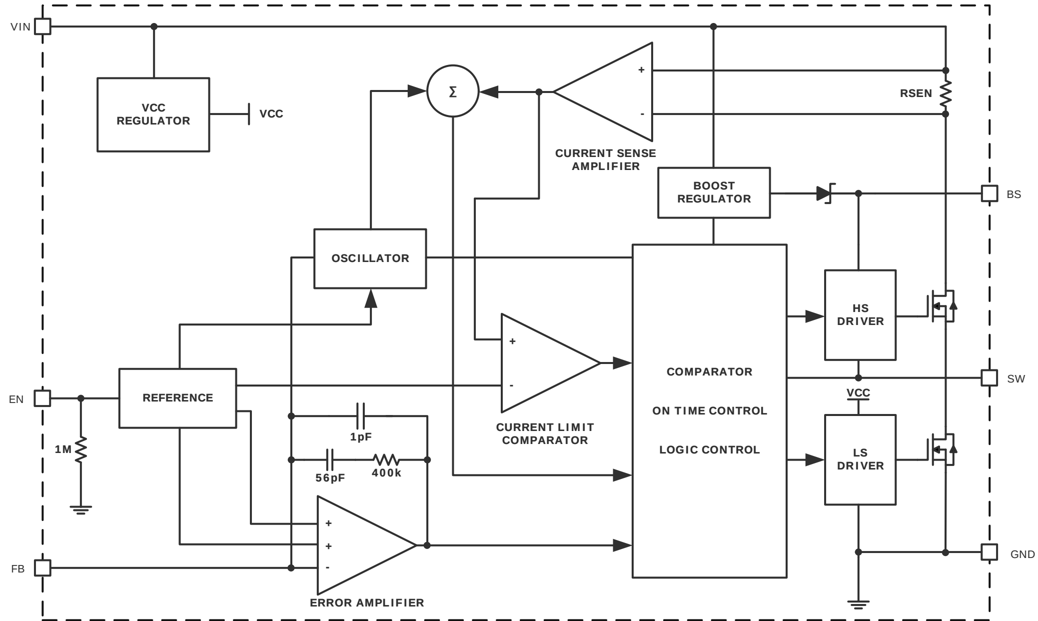


## FUNCTIONAL PIN DESCRIPTION

| PIN | NAME | TYPE | FUNCTION DESCRIPTIONS |
|---|---|---|---|
| 1 | BS | I/O | Boot-Strap Pin. Supply high side gate driver. Decouple this pin to SW pin with 22nF ceramic cap. |
| 2 | GND | G | System Ground. Reference ground of the regulated output voltage: requires extra care during PCB layout. Connect to GND with copper traces and vias. |
| 3 | FB | I | Output Feedback Pin. Connect this pin to the center point of the output resistor divider (as shown in Figure 1) to program the output voltage: $V_{OUT}$=0.6×(1+R1/R2) |
| 4 | EN | I | Pull High to enable the XC8112B. For automatic start-up, connect EN to VIN using a 100kΩ resistor. Do not float. |
| 5 | VIN | PI | Supply Voltage. The XC8112B operates from a 3.4V-to-18V input rail. Requires C1 to decouple the input rail. Connect using a wide PCB trace. |
| 6 | SW | I/O | Switch Output. Connect using a wide PCB trace. |

## FUNCTION BLOCK DIAGRAM

XC8112B




## ABSOLUTE MAXIMUM RATINGS

| PARAMETER | ABSOLUTE MAXIMUM RATINGS | UNIT |
|---|---|---|
| $V_{IN}$,$V_{EN}$ | -0.3 to 20 | V |
| $V_{SW}$ | -0.3 to 20 | V |
| $V_{BS}$ | $V_{SW}$+6 | V |
| All Other Pins | -0.3 to 6 | V |
| Continuous Power Dissipation($T_A$=+25℃) | 1.25 | W |
| Junction Temperature | 150 | °C |
| Lead Temperature | 260 | °C |
| Storage Temperature | -65 to150 | °C |
| Thermal Resistance $\theta_{JA}$ | 100 | °C/W |
| Thermal Resistance $\theta_{JC}$ | 55 | °C/W |

## RECOMMENDED OPERATING CONDITIONS

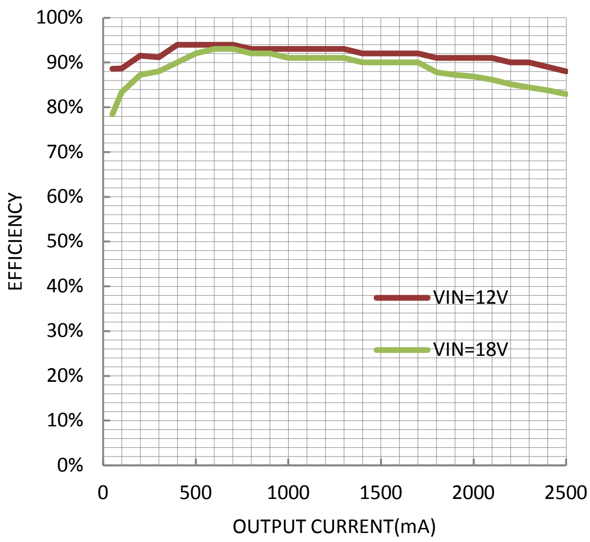
| PARAMETER | RECOMMENDED | UNIT |
|---|---|---|
| Supply Voltage $V_{IN}$ | 3.4 to 18 | V |
| Output Voltage $V_{OUT}$ | 0.6 to 0.9$V_{IN}$ | V |
| Operating Junction Temp.($T_J$) | -40 to 125 | °C |

## ELECTRICAL CHARACTERISTICS

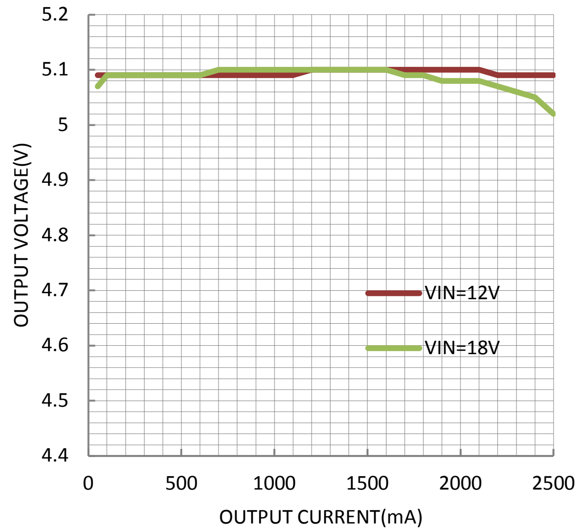
| PARAMETER | SYMBOL | TEST CONDITIONS | MIN | TYP | MAX | UNIT |
|---|---|---|---|---|---|---|
| Supply Current(Shutdown) | $I_{IN}$ | $V_{EN}$=0V | | | 1 | uA |
| Supply Current(Quiescent) | $I_q$ | $V_{EN}$=2V, $V_{FB}$=1V | | 0.8 | | mA |
| HSS witch-On Resistance | $HSR_{ds-on}$ | $V_{BST-SW}$=5V | | 100 | | mΩ |
| LSS witch-On Resistance | $LSR_{ds-on}$ | $V_{CC}$=5V | | 80 | | mΩ |
| Switch Leakage | $SW_{LKG}$ | $V_{EN}$=0V,$V_{SW}$=12V | | | 1 | uA |
| Current Limit | $I_{LIMIT}$ | | 3 | 3.1 | | A |
| Oscillator Frequency | $F_{sw}$ | $V_{FB}$=0.75V | | 600 | | kHz |
| Maximum Duty Cycle | $D_{MAX}$ | $V_{FB}$=700mV | 88 | 92 | | % |
| Feedback Voltage | $V_{FB}$ | | 588 | 600 | 612 | mV |
| EN Rising Threshold | $V_{EN\_RISING}$ | | | 1.5 | | V |
| EN Falling Threshold | $V_{EN\_FALLING}$ | | | 1.3 | | V |
| EN Input Current | $I_{EN}$ | $V_{EN}$=2V | | 1.6 | | uA |
| | | $V_{EN}$=0V | | 0 | | uA |
| $V_{IN}$ UVP Threshold—Falling | $V_{IN}UV_{FALL}$ | | 3.25 | 3.3 | 3.35 | V |
| $V_{IN}$ UVP Threshold Hysteresis | | | | 50 | | mV |
| $V_{IN}$ OVP Threshold—Rising | $V_{IN}OV_{RISE}$ | | | 19.5 | | V |
| $V_{IN}$ OVP Threshold Hysteresis | | | | 50 | | mV |
| Soft-Start Period | $T_{SS}$ | | | 1 | | mS |
| Thermal Shutdown | | | | 150 | | °C |
| Thermal Hysteresis | | | | 20 | | °C |

## TYPICAL PERFORMANCE CHARACTERISTICS

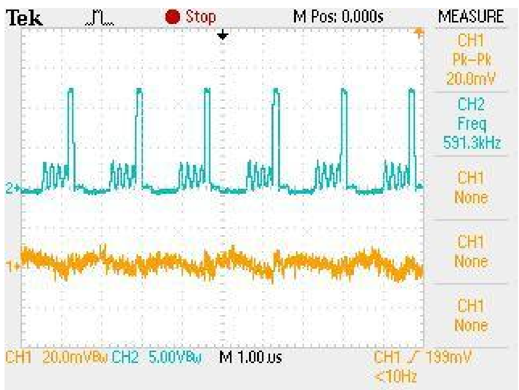
EFFICIENCY VS OUTPUT CURRENT (VOUT=5V)




OUTPUT VOLTAGE VS OUTPUT CURRENT (VOUT=5V)

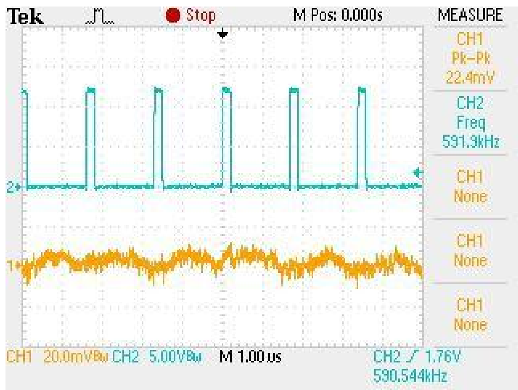



STEADY STATE OPERATION
(VIN=12V,VOUT=1.2V,IOUT=100mA)

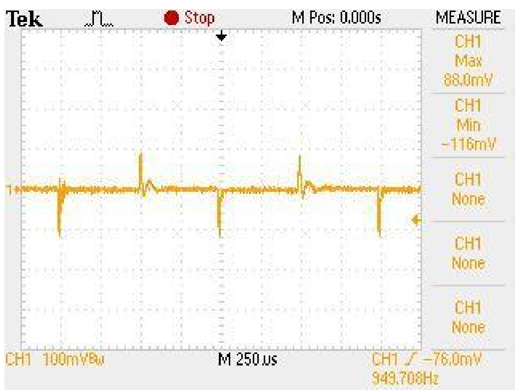



qw

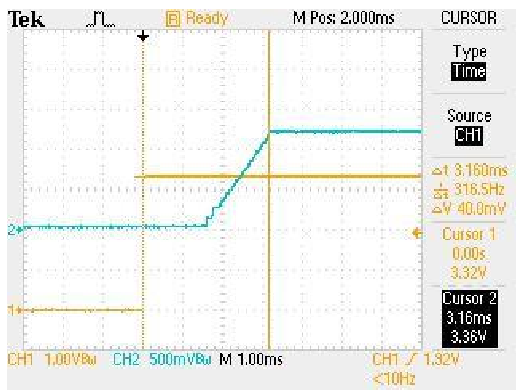
STEADY STATE OPERATION
(VIN=12V,VOUT=1.2V,IOUT=1000mA)




LOAD TRANSIENT RESPONSE
(VIN=12V,VOUT=1.2V,IOUT=100-1000mA,1A/uS)




STRAT UP
(VIN=12V,VOUT=1.2V)



# OPERATION

## External Components Selection

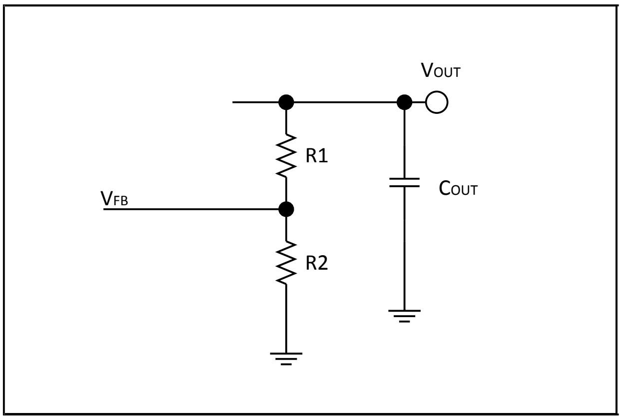
XC8112B require an input capacitor, an output capacitor and an inductor. These components are critical to the performance of the device. XC8112Bare internally compensated and do not require external components to achieve stable operation. The output voltage can be programmed by resistor divider.

$$V_{OUT} = V_{FB} \times \frac{R1+R2}{R2}$$

Select *R1* value around 50kΩ

$$R2 = R1 \times \frac{V_{FB}}{V_{OUT} - V_{FB}}$$

Where $V_{FB}$ as 0.6V




## Output Inductorsand Capacitors Selection

There are several design considerations related to the selection of output inductors and capacitors:

- Load transient response
- Stability
- Efficiency
- Output ripple voltage
- Over current ruggedness

The device has been optimized for use with nominal LC values as shown in the Application Diagram.

## BUCK Inductor Selection

The recommended inductor values are shown in the Application Diagram. It is important to guarantee the inductor core does not saturate during any foreseeable operational situation. The inductor should be rated to handle the peak load current plus the ripple current: Care should be taken when reviewing the different saturation current ratings that are specified by different manufacturers. Saturation current ratings are typically specified at 25°C, so ratings at maximum ambient temperature of the application should be requested from the manufacturer.

## BUCK PowerSupply Recommendations

XC8112B are designed to operate from input voltage supply range between 3.4V and 18 V. This input supply must be well regulated. If the input supply is located more than a few inches, additional bulk capacitance may be required in addition to the ceramic bypass capacitors. An electrolytic capacitor with a value of 47uF is a typical choice.VIN must be connected to input capacitors as close as possible.

$$I_{L(MAX)} = I_{LOAD(MAX)} + I_R$$

$$= I_{LOAD(MAX)} + \frac{D \times (V_{IN} - V_{OUT})}{2 \times L \times F_S}$$

$$D = \frac{V_{OUT}}{V_{IN}}, F_S = 1.5\ MHz, L = 2.2\ uH$$

where

- $I_{L(MAX)}$ ： Max inductor Current
- $I_{LOAD(MAX)}$ ： Max load current
- $I_R$ ： Peak-to-Peak inductor current
- $D$ ： Estimated duty factor
- $V_{IN}$ ： Input voltage
- $V_{OUT}$ ： Output voltage
- $F_S$ ： Switching frequency, Hertz

## Recommended Method for BUCK Inductor Selection

The best way to guarantee the inductor does not saturate is to choose an inductor that has saturation current rating greater than the maximum device current limit , as specified in the Electrical Characteristics . In this case the device will prevent inductor saturation by going into current limit before the saturation level is reached.

## Alternate Method for BUCK Inductor Selection

If the recommended approach cannot be used care must be taken to guarantee that the saturation current is greater than the peak inductor current:

$$I_{SAT} > IL_{PEAK}$$

$$IL_{PEAK} = I_{OUTMAX} + \frac{I_R}{2}$$

$$I_R = \frac{D \times (V_{IN} - V_{OUT})}{L \times F_S}$$

$$D = \frac{V_{OUT}}{V_{IN} \times EFF}$$

where

- $I_{SAT}$: Inductor saturation current at operating temperature
- $I_{LPEAK}$: Peak inductor current during worst case conditions
- $I_{OUTMAX}$: Maximum average inductor current
- $I_R$ : Peak-to-Peak inductor current
- $V_{OUT}$: Output voltage
- $V_{IN}$: Input voltage
- $L$ : Inductor value in Henries at $I_{OUTMAX}$
- $F_S$: Switching frequency, Hertz
- $D$ : Estimated duty factor
- $EFF$: Estimated power supply efficiency

$I_{SAT}$ may not be exceeded during any operation, including transients, startup, high temperature, worst case conditions, etc.

## Output and Input Capacitors Characteristics

Special attention should be paid when selecting these components. The DC bias of these capacitors can result in a capacitance value that falls below the minimum value given in the recommended capacitor specifications table.The ceramic capacitor’s actual capacitance can vary with temperature. The capacitor type X7R, which operates over a temperature range of −55°C to +125°C, will only vary the capacitance to within ±15%. The capacitor type X5R has a similar tolerance over a reduced temperature range of −55°C to +85°C. Many large value ceramic capacitors, larger than 1uF are manufactured with Z5U or Y5V temperature characteristics. Their capacitance can drop by more than 50% as the temperature varies from 25°C to 85°C. Therefore X5R or X7R is recommended over Z5U and Y5V in applications where the ambient temperature will change significantly above or below 25°C.Tantalum capacitors are less desirable than ceramic for use as output capacitors because they are more expensive when comparing equivalent capacitance and voltage ratings in the 0.47uF to 44uF range. Another important consideration is that tantalum capacitors have higher ESR values than equivalent size ceramics. This means that while it may be possible to find a tantalum capacitor with an ESR value within the stable range, it would have to be larger in capacitance (which means bigger and more costly) than a ceramic capacitor with the same ESR value. It should also be noted that the ESR of a typical tantalum will increase about 2:1 as the temperature goes from 25°C down to −40°C, so some guard band must be allowed .

## BUCK Output Capacitor Selection

The output capacitor of a switching converter absorbs the AC ripple current from the inductor and provides the initial response to a load transient. The ripple voltage at the output of the converter is the product of the ripple current flowing through the output capacitor and the impedance of the capacitor. The impedance of the capacitor can be dominated by capacitive, resistive, or inductive elements within the capacitor, depending on the frequency of the ripple current. Ceramic capacitors have very low ESR and remain capacitive up to high frequencies . Their inductive component can be usually neglected at the frequency ranges the switcher operates .The output-filter capacitor smoothes out the current flow from the inductor to the load and helps maintain a steady output voltage during transient load changes. It also reduces output voltage ripple. These capacitors must be selected with sufficient capacitance and low enough ESR to perform these functions. Note that the output voltage ripple increases with the inductor current ripple and the Equivalent Series Resistance of the output capacitor (ESRCOUT).Also note that the actual value of the capacitor’s ESRCOUT is frequency and temperature dependent, as specified by its manufacturer. The ESR should be calculated at the applicable switching frequency and ambient temperature.

## BUCK Output Capacitor Selection

$$V_{OUT-R-PP} = \frac{I_R}{8 \times F_S \times C_{OUT}}$$

where

$$I_R = \frac{D \times (V_{IN} - V_{OUT})}{2 \times L \times F_S}$$

$$D = \frac{V_{OUT}}{V_{IN}}$$

where

- $V_{OUT-R-PP}$: estimated output ripple,
- $I_R$ : estimated current ripple
- $D$: Estimated duty factor

Output ripple can be estimated from the vector sum of the reactive (capacitance ) voltage component and the real (ESR) voltage component of the output

$$V_{OUT-R-PP} = \sqrt{V_{ROUT}^2 + V_{COUT}^2}$$

where

$$V_{ROUT} = I_R \times ESR_{COUT}$$

$$V_{COUT} = \frac{I_R}{8 \times F_S \times C_{OUT}}$$

where

- $V_{OUT-R-PP}$: estimated output ripple,
- $V_{ROUT}$: estimated real output ripple,
- $V_{COUT}$: estimated reactive output ripple.

The device is designed to be used with ceramic capacitors on the outputs of the buck regulators. The recommended dielectric type of these capacitors is X5R, X7R, or of comparable material to maintain proper tolerances over voltage and temperature. The recommended value for the output capacitors is 22μF, 6.3V with an ESR of 2mΩ or less. The output capacitors need to mounted as close as possible to the output/ground terminals of the device.

## BUCK Input Capacitor Selection

input capacitor should be located as close as possible to their corresponding VIN and GND terminals, tantalum capacitor can also be located in the proximity of the device.The input capacitor supplies the AC switching current drawn from the switching action of the internal power MOSFETs. The input current of a buck converter is discontinuous , so the ripple current supplied by the input capacitor is large. The input capacitor must be rated to hand le both the RMS current and the dissipated power. The input capacitor must be rated to handle this current:

$$V_{RMS\_CIN} = I_{OUT} \frac{\sqrt{V_{OUT} \times (V_{IN} - V_{OUT})}}{V_{OUT}}$$

The power dissipated in the input capacitor is given by:

$$P_{D\_CIN} = I_{RMS\_CIN}^2 \times R_{ESR\_CIN}$$

The device is designed to be used with ceramic capacitors on the inputs of the buck regulators. The recommended dielectric type of these capacitors is X5 R, X7R, or of comparable material to maintain proper tolerances over voltage and temperature. The minimum recommended value for the input capacitor is 10μF with a n ESR of 10mΩ or less. The input capacitors need to be mounted as close as possible to the power/ground input terminals of the device The input power source supplies the average current continuously. During the high side MOSFET switch on-time, however, the demanded di/dt is higher than can be typically supplied by the input power source. This delta is supplied by the input capacitor A simplified “worst case” assumption is that all of the high side MOSFET current is supplied by the input capacitor. This w ill Result in conservative estimates of input ripple voltage and capacitor RMS Current. Input ripple voltage is estimated as besides:

$$V_{PPIN} = \frac{I_{OUT} \times D}{C_{IN} \times F_S} + I_{OUT} \times ESR_{CIN}$$

where

- $V_{PPIN}$: Estimated peak-to-peak input ripple voltage
- $I_{OUT}$ : Output current
- $C_{IN}$: Input capacitor value
- $ESR_{CIN}$ : Input capacitor ESR

## BUCK Input Capacitor Selection

This capacitor is exposed to significant RMS current, so it is important to select a capacitor with an adequate RMS current rating. Capacitor RMS current estimated as besides:

$$I_{RMSCIN} = \sqrt{D \times (I_{OUT}^2 + \frac{I_{RIPPLE}^2}{12})}$$

Where

•$I_{RMSCIN}$ ： Estimated input capacitor RMS current

# PCBOARD LAYOUT

PC board layout is an important part of DC-DC converter design. Poor board layout can disrupt the performance of a DC- DC converter and surrounding circuitry by contributing to EMI, ground bounce, and resistive voltage loss in the traces. These can send erroneous signals to the DC-DC converter resulting in poor regulation or instability. Good layout can be implemented b y following a few simple design rules .

1. Minimize area of switched current loops. In a buck regulator there are two loops where currents are switched rapidly. The first loop starts from the CIN input capacitor, to the regulator VIN terminal, to the regulator SW terminal, to the inductor then out to the output capacitor COUT and load. The second loop starts from the output capacitor ground , to the regulator GND terminals, to the inductor and then out to COUT an d the load. To minimize both loop area s the input capacitor should be placed as close as possible to the VIN terminal. Grounding for both the input and output capacitors should consist of a small localized top side plane that connects to GND. The inductor should be placed as close as possible to the SW pin and output capacitor.

3. Have a single point ground for all device analog g rounds . The ground connections for the feedback components should be connected together then routed to the GND pin of the dev ice. This prevents any switched or load currents from flowing in the analog ground plane. If not properly handled, poor grounding can result in degraded load regulation or erratic switching behavior.

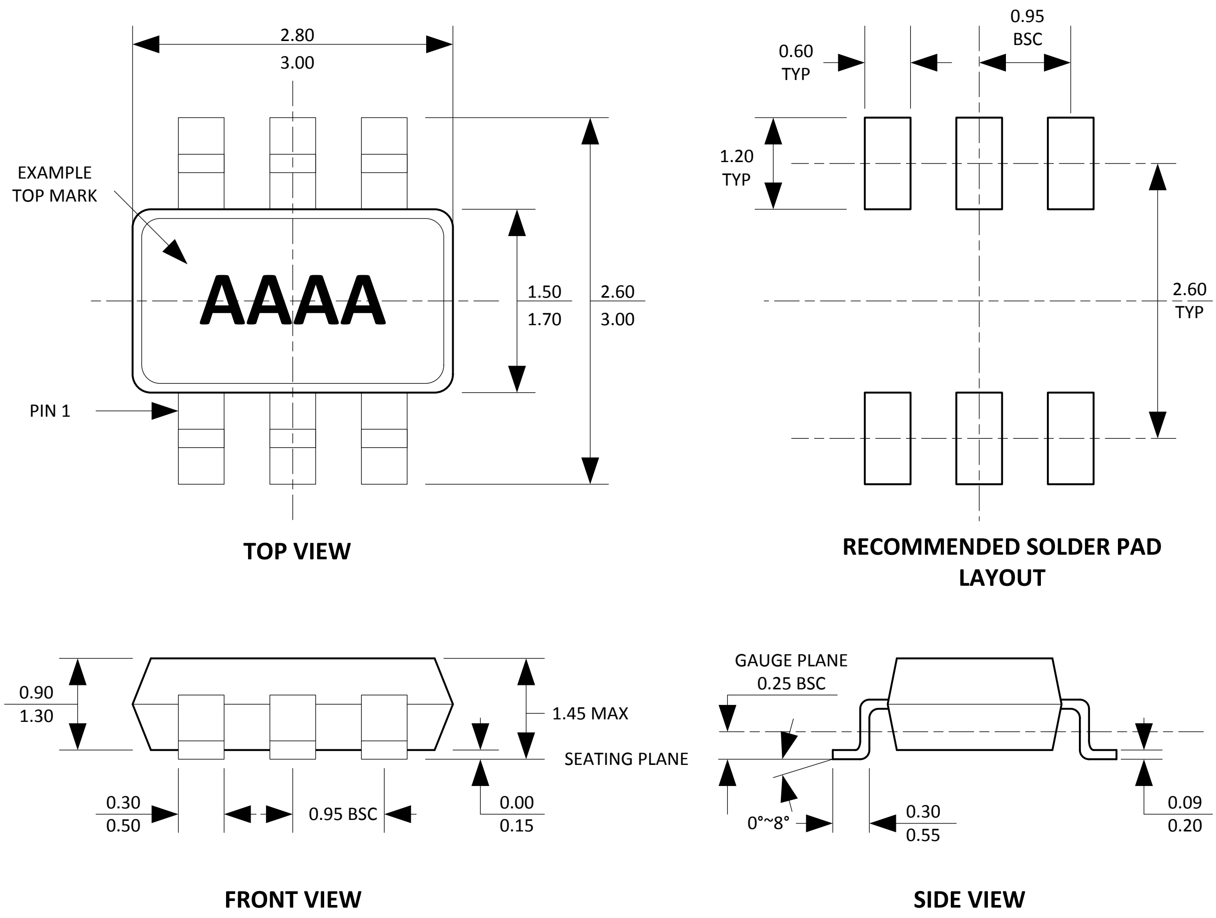
2. Minimize the copper area of the switch node. The SW terminals should be directly connected with a trace that runs on top side directly to the inductor. To minimize IR losses this trace should be as short as possible and with a sufficient width . However, a trace that is wider than 100 mils will increase the copper area and cause too much capacitive loading on the SW terminal. The inductors should be placed as close as possible to the SW terminals to further minimize the copper area of the switch node.

4. Minimize trace length to the FB terminal. The feedback trace should be routed away from the SW pin and inductor to avoid contaminating the feedback signal with switch noise.

5. Make input and output bus connections as wide as possible. This reduces any voltage drop s o n the input or output of the converter and can improve efficiency. If voltage accuracy at the load is important make sure feedback voltage sense is made at the load. Doing so will correct for voltage drop s at the load and provide the best output accuracy.

## PACKAGE

### SOT23-6




**NOTE:**
**1.DIMENSIONS ARE IN MILLIMETERS.**
**2.DRAWING NOT TO SCALE.**
**3.DIMENSIONS ARE INCLUSIVE OF PLATING.**
**4.DIMENSIONS ARE EXCLUSIVE OF MOLD FLASH AND METAL BURR.**