AXP8120

2A, 20V Synchronous
Step-Down Converter

Parameters Subject to Change Without Notice

DESCRIPTION

The AXP8120 is a current mode monolithic buck voltage converter. Operating with an input range of 4.7V-20V, the AXP8120 delivers 2A of continuous output current with two integrated N-Channel MOSFETs. At light loads, regulators operate in low frequency to maintain high efficiency and low output ripple.

The AXP8120 guarantees robustness with over current protection, thermal protection, start-up current run-away protection, and input under voltage lockout.

The AXP8120 is available in a 6-pin TSOT23-6 package, which provides a compact solution with minimal external components.

FEATURES

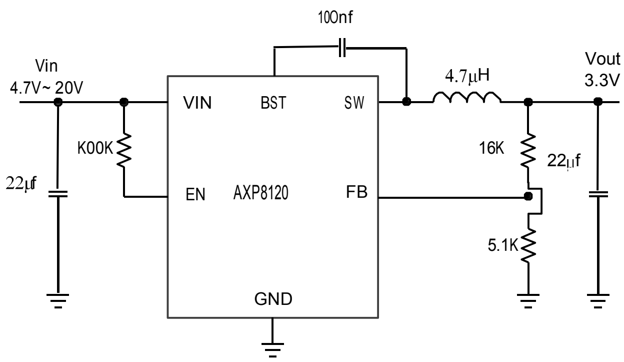
- 4.7V to 20V operating input range
  2A output current
- Up to 95% efficiency
- High efficiency (>80%) at light load
- Fixed 450kHz Switching frequency
- Input under voltage lockout
- Start-up current run-away protection
- Over current protection and Hiccup
- Thermal protection
- Available in TSOT23-6 package

APPLICATIOS

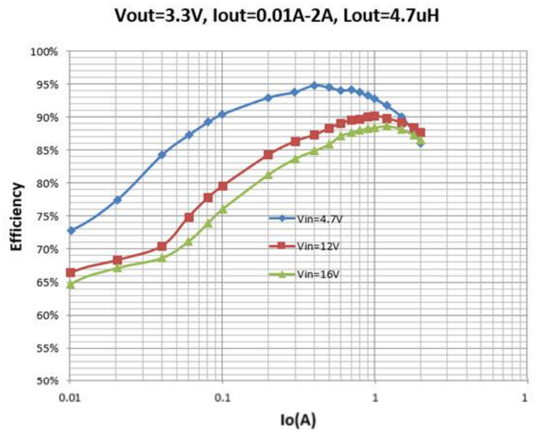
- Distributed Power Systems
- Networking Systems
- FPGA, DSP, ASIC Power Supplies
- Green Electronics/ Appliances
- Notebook Computers

TYPICAL APPLICATION

2A Buck Voltage Converter



Efficiency

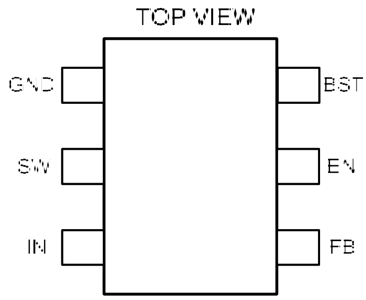


ORDER INFORMATION

LEAD FREE FINISH	TAPE AND REEL	PACKAGE	TOP MARKING
AXP8120DJ	AXP8120DJ	TSOT23-6	

Note:
D:-40C~85C
J:TSOT23

PIN CONFIGURATION



TSOT23-6

ABSOLUTE MAXIMUM RATING1)

VIN, EN, SW PIN ....-0.3V to 22V
BST PIN ....SW-0.3V to SW+5V
All other pins ....-0.3V to 6V
JunctionTemperature2)3)..150º
Storage Temperature.. -65ºC to +150ºC

RECOMMENDED OPERATING CONDITIONS

Input Voltage VIN..4.7V to 20V

Output voltage Vout ....0.8V to 18V

Junction Temperature (TJ)..-40ºC to 125ºC

THERMAL PERFORMANCE θ_{JA} θ_{JC}

TSOT23-6..10..55°C/W

Note:

1) Exceeding these ratings may damage the device.
2) The AXP8120 guarantees robust performance from -40°C to 150°C junction temperature. The junction temperature range specification is assured by design, characterization and correlation with statistical process controls.
3) The AXP8120 includes thermal protection that is intended to protect the device in overload conditions. Thermal protection is active when junction temperature exceeds the maximum operating junction temperature. Continuous operation over the specified absolute maximum operating junction temperature may damage the device.

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ELECTRICAL CHARACTERISTICS

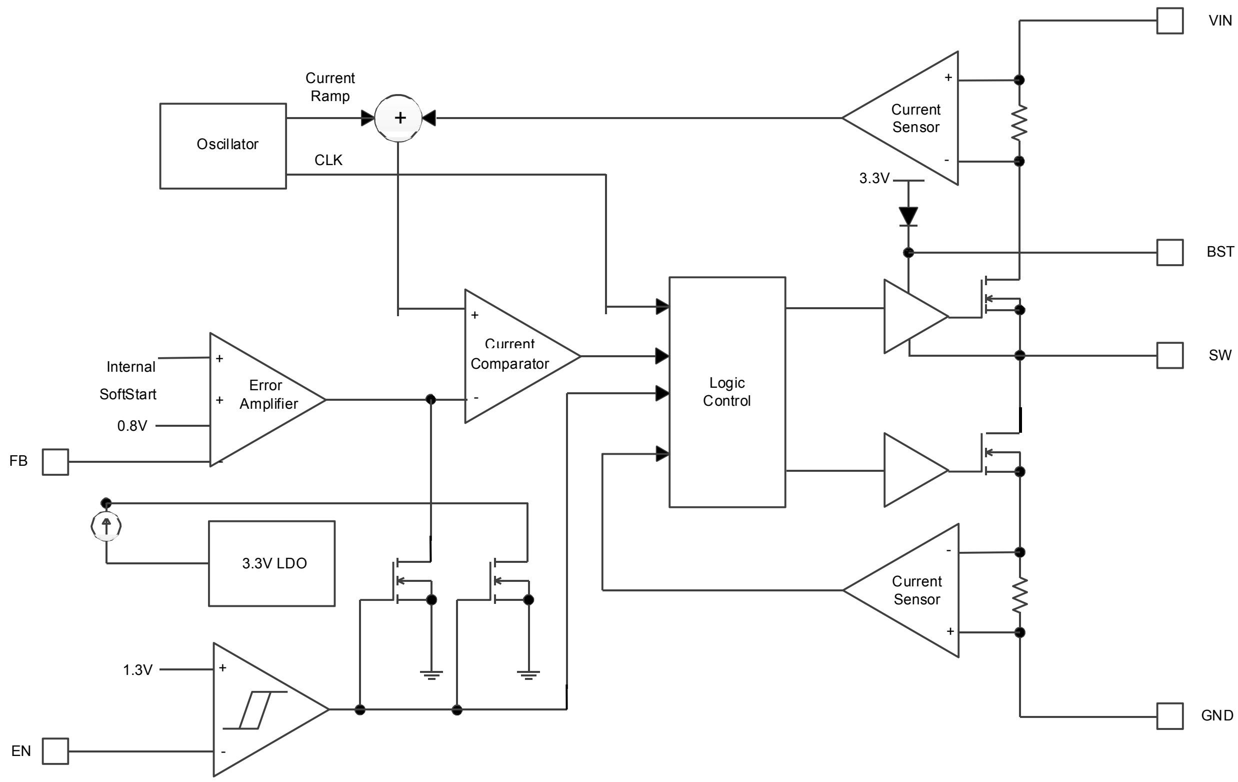
VIN=12V, T_A=25 unless otherwise stated.

Item	Symbol	Condition	Min.	Typ.	Max.	Units
V_{IN} Under voltage Lockout Threshold	V_{IN_MIN}	V_{IN} falling		3.88		V
V_{IN} Under voltage Lockout Hysteresis	$V_{IN\_MIN\_HYST}$			360		mV
Shutdown Supply Current	I_{SD}	V_{EN}=0V		0.1	1	μA
Supply Current	I_Q	V_{EN}=5V, V_{FB}=2V		110		μA
Feedback Voltage	V_{FB}			800		mV
Top Switch Resistance	$R_{DS(ON)T}$			160		mΩ
Bottom Switch Resistance	$R_{DS(ON)B}$			80		mΩ
Top Switch Leakage Current	I_{LEAK_TOP}	V_{IN}=20V, V_{EN}=0V, V_{SW}=0V			0.5	uA
Bottom Switch Leakage Current	I_{LEAK_BOT}	V_{IN}=20V, V_{EN}=0V, V_{SW}=0V			0.5	uA
Top Switch Current Limit	I_{LIM_TOP}	Minimum Duty Cycle		3.8		A
Switch Frequency	F_{SW}			450		kHz
Minimum On Time	T_{ON_MIN}			100		ns
Minimum Off Time	T_{OFF_MIN}	V_{FB}=0.7V		100		ns
EN shut down threshold voltage	V_{EN_TH}	V_{EN} falling, FB=0V		1.2		V
EN shut down hysteresis	V_{EN_HYST}			100		mV
Thermal Shutdown	T_{TSD}			145		
Temperature Hysteresis	T_{HYS}			15		°C

PIN DESCRIPTION

Pin No.	Name	Description
1	GND	Power ground pin.
2	SW	SW is the switching node that supplies power to the output. Connect the output LC filter from SW to the output load.
3	VIN	Input voltage pin. VIN supplies power to the IC. Connect a 4.7V to 20V supply to VIN and bypass VIN to GND with a suitably large capacitor to eliminate noise on the input to the IC.
4	FB	Output feedback pin. FB senses the output voltage and is regulated by the control loop to 0.8V. Connect a resistive divider at FB.
5	EN	Drive EN pin high to turn on the regulator and low to turn off the regulator.
6	BST	Boostrap pin for top switch. A 0.1uF or larger capacitor should be connected between this pin and the SW pin to supply current to the top switch and top switch driver.

BLOCK DIAGRAM



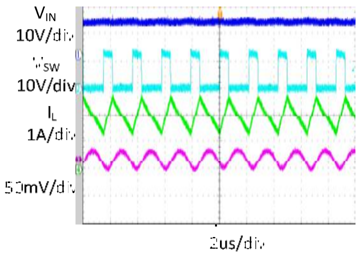
TYPICAL PERFORMANCE CHARACTERISTICS

Vin =12V, Vout = 3.3V, L = 4.7μH, Cout = 22μF, TA = +25°C, unless otherwise noted

Steady State Test

VIN=12V, Vout=3.3V

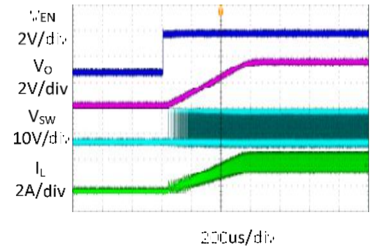
Iout=2A



Startup through Enable

VIN=12V, Vout=3.3V

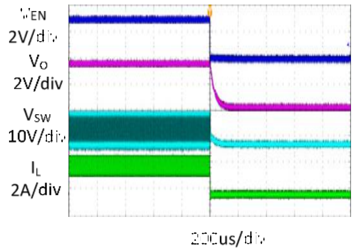
Iout=2A(Resistive load)



Shutdown through Enable

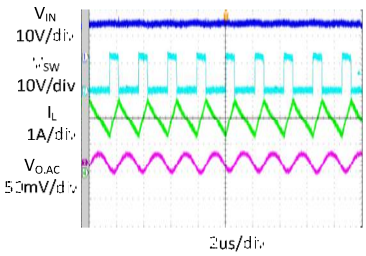
VIN=12V, Vout=3.3V

Iout=2A (Resistive load)



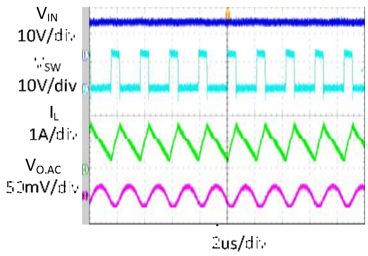
Heavy Load Operation

2A LOAD



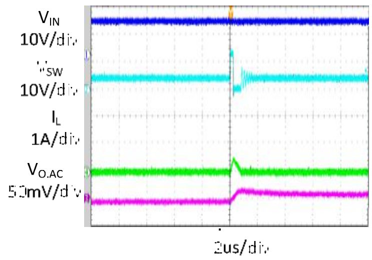
Medium Load Operation

1A LOAD



Light Load Operation

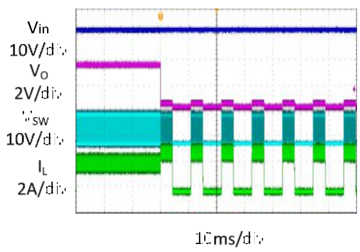
0 A LOAD



Short Circuit Protection

VIN=12V, Vout=3.3V

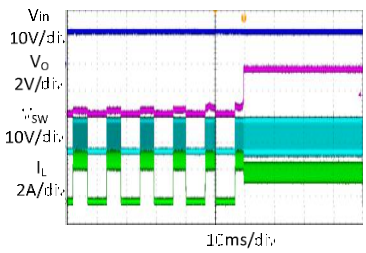
Iout=2A- Short



Short Circuit Recovery

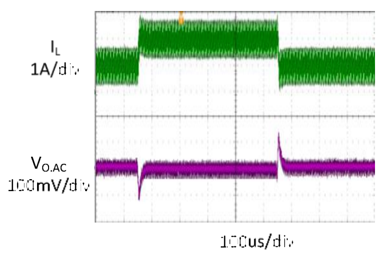
VIN=12V, Vout=3.3V

Iout= Short-2A



Load Transient

1A LOAD 2A LOAD 1A LOAD



FUNCTIONAL DESCRIPTION

The AXP8120 is a synchronous, buck voltage converter.

Current-Mode Control

The AXP8120 utilizes current-mode control to regulate the FB voltage. Voltage at the FB pin is regulated at 0.8V so that by connecting an appropriate resistive divider between VOUT and GND, designed output voltage can be achieved.

PFM Mode

The AXP8120 operates in PFM mode at light load. In PFM mode, switch frequency decreases when load current drops to boost power efficiency at light load by reducing switch-loss, while switch frequency increases when load current rises, minimizing output voltage ripples.

Internal Soft-Start.

Soft-Start makes output voltage rising smoothly follow an internal SS voltage until SS voltage is higher than the internal reference voltage. It can prevent overshoot of output voltage when startup.

Power Switch

N-Channel MOSFET switches are integrated on the AXP8120 to down convert the input voltage to the regulated output voltage. Since the top MOSFET needs a gate voltage greater than the input voltage, a boost capacitor connected between BST and SW pins is required to drive the gate of the top switch. The boost capacitor is charged by the internal 3.3V rail when SW is low.

Vin Under-Voltage Protection

A resistive divider can be connected between Vin and GND, with the central tap connected to EN, so that when Vin drops to the pre-set value, EN drops below 1.2V to trigger input under voltage lockout protection.

Output Current Run-Away Protection

At start-up, due to the high voltage at input and low voltage at output, current inertia of the output inductance can be easily built up, resulting in a large start-up output current. A valley current limit is designed in the AXP8120 so that only when output current drops below the valley current limit can the top power switch be turned on. By such control mechanism, the output current at start-up is well controlled.

Over Current Protection and Hiccup

AXP8120 has a cycle-by-cycle current limit. When the inductor current triggers current limit, AXP8120 enters hiccup mode and periodically restart the chip.

AXP8120 will exit hiccup mode while not triggering current limit.

Thermal Protection

When the temperature of the AXP8120 rises above 145°C, it is forced into thermal shut-down.

Only when core temperature drops below 130°C can the regulator becomes active again.

APPLICATION INFORMATION

Output Voltage Set

The output voltage is determined by the resistor divider connected at the FB pin, and the voltage ratio is:

$$V_{FB} = V_{OUT} \bullet \frac{R_2}{R_2 + R_1}$$

where V_{FB} is the feedback voltage and VOUT is the output voltage.
Choose R1 around 10kΩ, and then R2 can be calculated by:

$$R_1 = R_2 \bullet (\frac{V_{OUT}}{0.8V} - 1)$$

The following table lists the recommended Values.

VOUT(V)	R2(kΩ)	R1(kΩ)
2.5	7.5	16
3.3	5.1	16
5	3	16

Input Capacitor

The input capacitor is used to supply the AC input current to the step-down converter and maintaining the DC input voltage. The ripple current through the input capacitor can be calculated by:

$$I_{C1} = I_{LOAD} \bullet \sqrt{\frac{V_{OUT}}{V_{IN}} \bullet (1 - \frac{V_{OUT}}{V_{IN}})}$$

where ILOAD is the load current, V_{OUT} is the output voltage, V_{IN} is the input voltage.

Thus the input capacitor can be calculated by the following equation when the input ripple voltage is determined.

$$C_1 = \frac{I_{LOAD}}{f_s \bullet \Delta V_{IN}} \bullet \frac{V_{OUT}}{V_{IN}} (1 - \frac{V_{OUT}}{V_{IN}})$$

where C_1 is the input capacitance value, fs is the switching frequency, ΔV_{IN} is the input ripple voltage.

The input capacitor can be electrolytic, tantalum or ceramic. To minimizing the potential noise, a small X5R or X7R ceramic capacitor, i.e. 0.1uF, should be placed as close to the IC as possible when using electrolytic capacitors.

A 22uF ceramic capacitor is recommended in typical application.

Output Capacitor

The output capacitor is required to maintain the DC output voltage, and the capacitance value determines the output ripple voltage. The output voltage ripple can be calculated by:

$$\Delta V_{OUT} = \frac{V_{OUT}}{f_s \bullet L} \bullet (1 - \frac{V_{OUT}}{V_{IN}}) \bullet (R_{ESR} + \frac{1}{8 \bullet f_s \bullet C_2})$$

where C_2 is the output capacitance value and RESR is the equivalent series resistance value of the output capacitor.

The output capacitor can be low ESR electrolytic, tantalum or ceramic, which lower ESR capacitors get lower output ripple voltage.
The output capacitors also affect the system stability and transient response, and a 22uF ceramic capacitor is recommended in typical.

Inductor

The inductor is used to supply constant current to the output load, and the value determines the ripple current which affect the efficiency and the output voltage ripple. The ripple current is typically allowed to be 30% of the maximum switch current limit, thus the inductance value can be calculated by:

$$L = \frac{V_{OUT}}{f_s \bullet \Delta I_L} \bullet (1 - \frac{V_{OUT}}{V_{IN}})$$

where V_{IN} is the input voltage, V_{OUT} is the output voltage, fs is the switching frequency and ΔIL is the peak-to-peak inductor ripple.

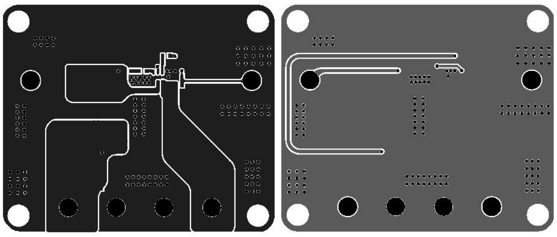
External Boostrap Capacitor

A boostrap capacitor is required to supply voltage to the top switch driver. A 0.1uF low ESR ceramic capacitor is recommended to connected to the BST pin and SW pin.

PCB Layout Note

For minimum noise problem and best operating performance, the PCB is preferred to following the guidelines as reference.

1. Place the input decoupling capacitor as close to AXP8120 (VIN pin and PGND) as possible to eliminate noise at the input pin. The loop area formed by input capacitor and GND must be minimized.
2. Put the feedback trace as far away from the inductor and noisy power traces as possible.
3. The ground plane on the PCB should be as large as possible for better heat dissipation.



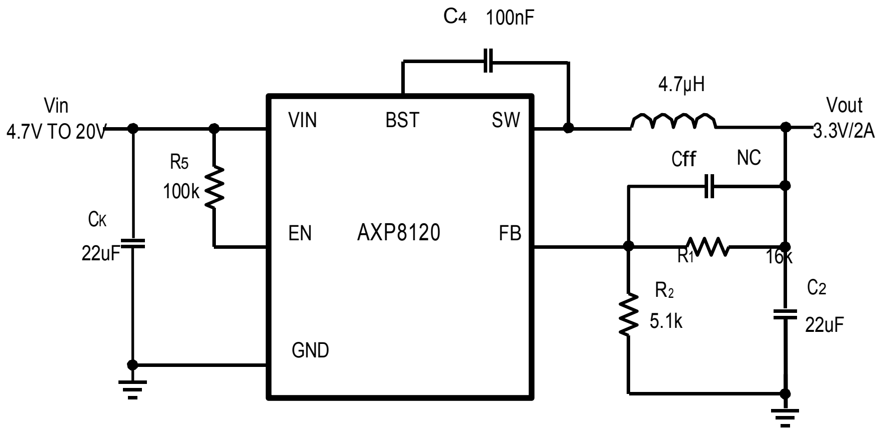
REFERENCE DESIGN

Reference 1：

V_{IN} : 4.7V ~ 20V

V_{OUT}: 3.3V

I_{OUT} : 0~2A

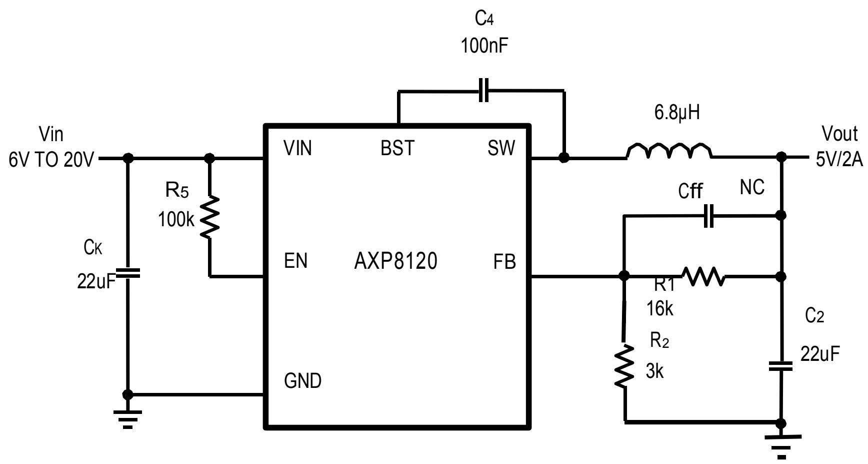


Reference 2：

V_{IN} : 6V ~ 20V

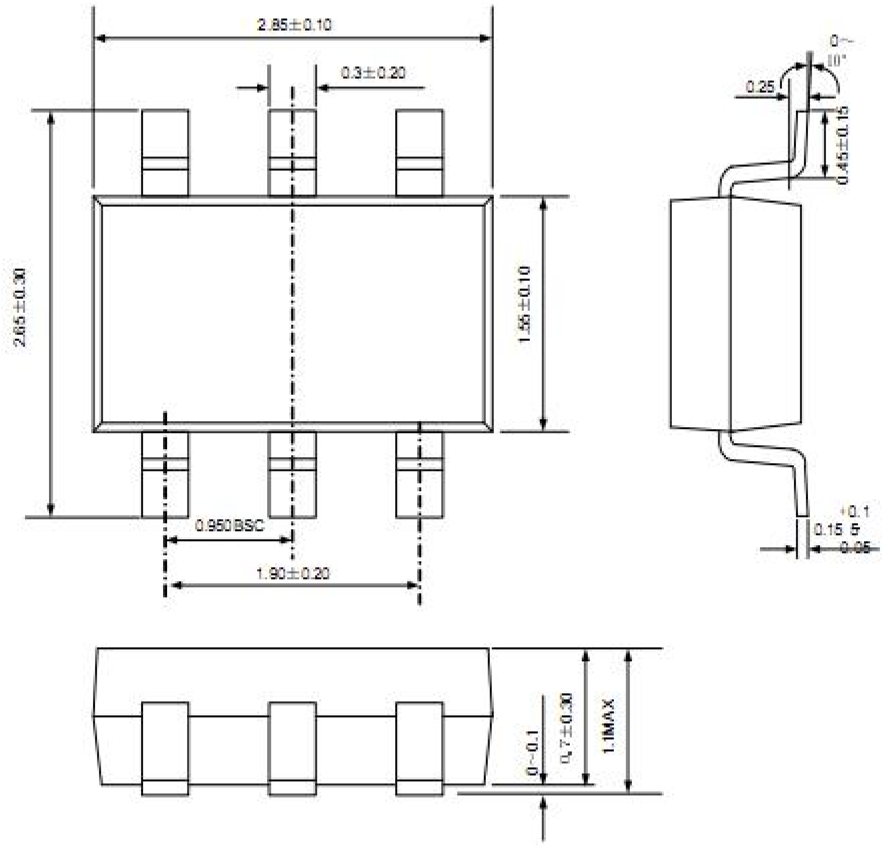
V_{OUT}: 5V

I_{OUT} : 0~2A



PACKAGE OUTLINE

TSOT23-6 UNIT: mm



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