AXP8020

2A, 6V, Synchronous Step-Down Converter

DESCRIPTION

The AXP8020 is a current mode monolithic buck switching regulator. Operating with an input range of 2.5V-6V, the AXP8020 delivers 2A of continuous output current with integrated P-Channel and N-Channel MOSFETs. The internal synchronous power switches provide high efficiency. At light loads, the regulator operates in low frequency to maintain high efficiency and low output ripples. Current mode control provides tight load transient response and cycle-by-cycle current limit.

The AXP8020 guarantees robustness with hiccup output short-circuit protection, FB and SW short-circuit protection, current run-away protection, input under voltage lockout and over voltage protection, and thermal protection.

The AXP8020 provides output power good indication which is only available in SOT23-6 package.

The AXP8020 is available in 5-pin SOT23-5 or6-pin SOT23-6 package, which provides acompact solution with minimal external components.

FEATURES

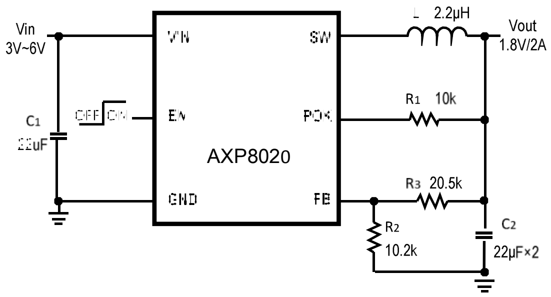
- 2.5V to 6V operating input range
- Up to 2A output current
- Up to 95% peak efficiency
- High efficiency (>85%) at light load
- Internal Soft-Start
- 1MHz switching frequency
- Input under voltage lockout and over voltage protection
- Short circuit protection
- Thermal protection
- Output POK indication (available in SOT23-6 package)
- Available in SOT23-5/SOT23-6 package

APPLICATIONS

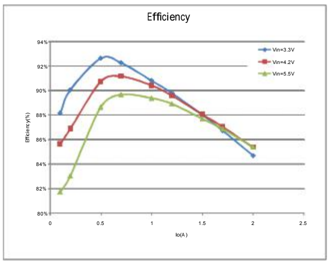
- 5V or 3.3V Point of Load Conversion
- Set Top Boxes
- Telecom/Networking Systems
- Storage Equipment
- GPU/DDR Power Supply

TYPICAL APPLICATION

1.8V/2A Step Down Regulator



Efficiency @ Vout=1.8V



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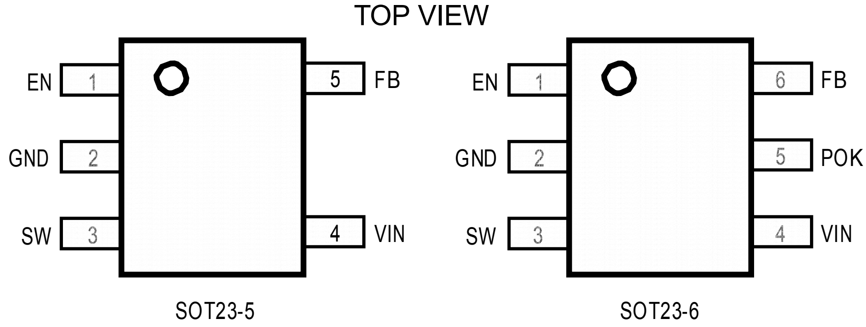
ORDER INFORMATION

LEAD FREE FINISH	TAPE AND REEL	PACKAGE	TOPMARKING
AXP8020DTA	AXP8020DTA	SOT23-5	
AXP8020DTB	AXP8020DTB	SOT23-6	

Note:
D:-40C~85C
T:SOT
A:SOT23-5
B:SOT23-6

PIN CONFIGURATION



ABSOLUTE MAXIMUM RATING1)

All Pins...-0.3V to 7.15V
JunctionTemperature2)3)..150º
Lead Temperature...260º
Storage Temperature.. -65ºC to +150ºC

RECOMMENDED OPERATING CONDITIONS

Input Voltage VIN ....2.5V to 6.5V
Output Voltage Vout.. 0.6V to VIN
Operating Junction Temperature...-40ºC to 125ºC

THERMAL PERFORMANCE θ_{JA} θ_{JC}

SOT23-5 ....220...110ºC/W
SOT23-6 ....220...110ºC/W

Note

1) Exceeding these ratings may damage the device.
2) The AXP8010 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 AXP8010 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=5V, T_A=25 unless otherwise stated.						
Item	Symbol	Condition	Min.	Typ.	Max.	Units
V_{IN} Under Voltage Lockout Threshold	V_{IN_UVLO}	V_{IN} rising	2.45	2.5	2.55	V
V_{IN} Under Voltage Lockout Hysteresis	$V_{IN\_UVLO\_HYST}$	V_{IN} falling		200		mV
V_{IN} Over Voltage Protection Threshold	V_{IN_OVP}	VIN rising	5.95	6.07	6.19	V
V_{IN} Over Voltage Protection Hysteresis	$V_{IN\_OVP\_HYST}$	VIN falling		420		mV
Shutdown Current	I_{SHDN}	V_{EN}=0V		0.1	1	μA
Quiescent Current	I_Q	V_{EN}=5V, I_{OUT}=0A, V_{FB}=V_{REF}*105%		60		μA
Regulated Feedback Voltage	V_{FB}	2.5V<V_{IN}<5.5V	588	600	612	mV
PFET On Resistance	R_{DSON_P}	VIN=3.6V, I_{SW}=200mA		130		mΩ
NFET On Resistance	R_{DSON_N}	VIN=3.6V, I_{SW}=-200mA		130		mΩ
PFET Leakage Current	I_{LEAK_P}	V_{IN}=5.5V, V_{EN}=0V, V_{SW}=0V			0.5	uA
NFET Leakage Current	I_{LEAK_N}	V_{IN}=5.5V, V_{EN}=0V, V_{SW}=5.5V			0.5	uA
PFET Current Limit	I_{LIM_TOP}	Duty Cycle=100%		2.8		A
Switch Frequency	F_{SW}	I_{OUT}=1A		1		MHz
Minimum On Time	T_{ON_MIN}			60		ns
Maximum Duty Cycle	D_{MAX}			100		%
EN Rising Threshold	V_{EN_TH}	V_{EN} rising, FB=0V	1.2			V
EN Falling Threshold	V_{EN_HYST}	V_{EN} falling, FB=0V			400	mV
Thermal Shutdown Threshold	T_{SHDN}			150		℃

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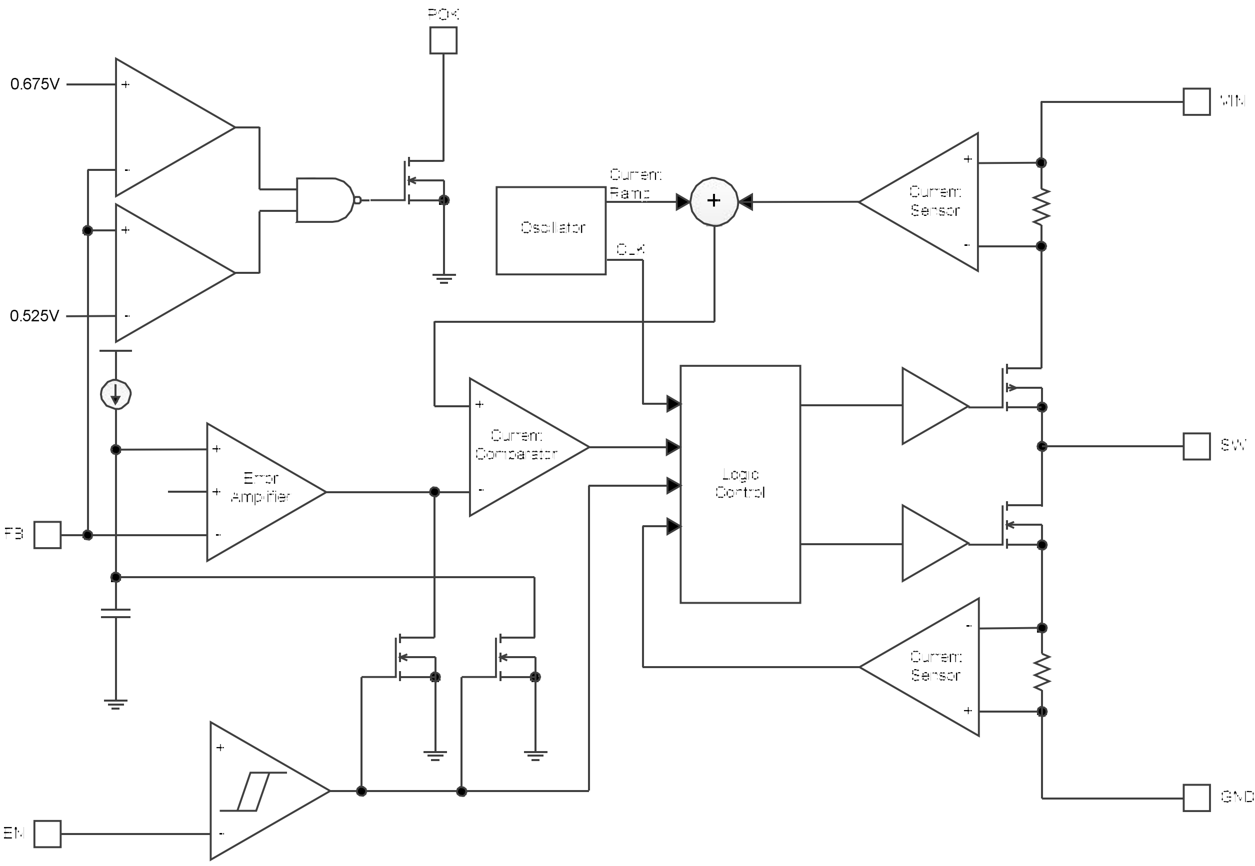
PIN DESCRIPTION

SOT23-6 Pin	Name	Description
1	EN	Drive EN pin high to turn on the regulator and low to turn off the regulator.
2	GND	Ground pin.
3	SW	SW is the switching node that supplies power to the output. Connect the output LC filter from SW to the output load.
4	VIN	Input voltage pin. VIN supplies power to the IC. Connect a 2.5V to 6V supply to VIN and bypass VIN to GND with a suitably large capacitor to eliminate noise on the input to the IC.
5	POK	Open drain output. Connect a 10KΩ resistor from POK to output. POK is high when V_{FB} is within +/-12.5% of V_{REF}.
6	FB	Output feedback pin. FB senses the output voltage and is regulated by the control loop to 0.6V. Connect a resistive divider at FB.

BLOCK DIAGRAM



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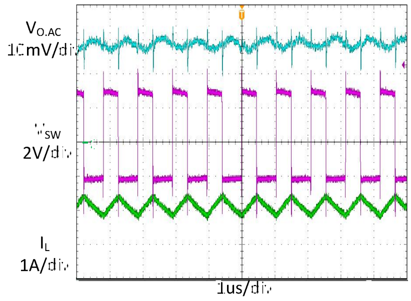
TYPICAL PERFORMANCE CHARACTERISTICS

Vin = 5V, Vout = 1.8V, L = 2.2μH, Cout = 22μFx2, TA = +25°C, unless otherwise noted

Steady State Test

VIN=5V, Vout=1.8V

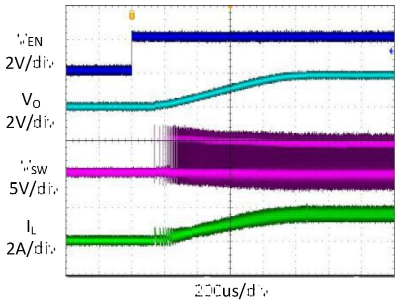
Iout=2A



Startup through Enable

VIN=5V, Vout=1.8V

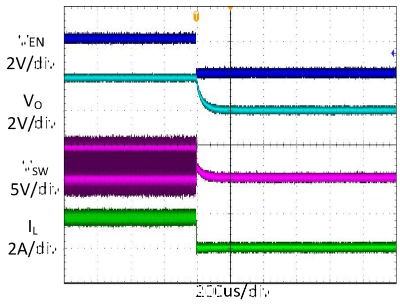
Iout=2A(Resistive load)



Shutdown through Enable

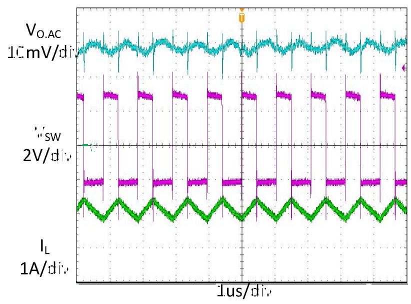
VIN=5V, Vout=1.8V

Iout=2A(Resistive load)



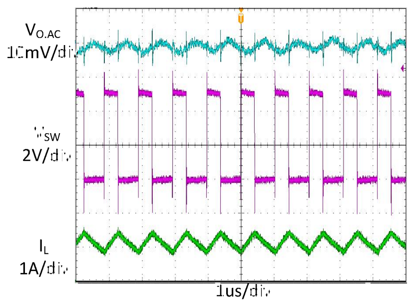
Heavy Load Operation

2A LOAD



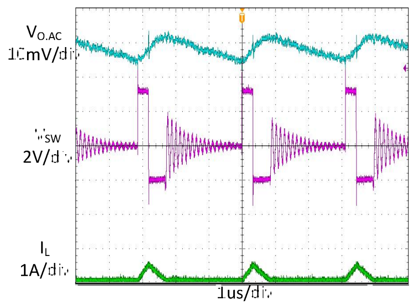
Medium Load Operation

1A LOAD



Light Load Operation

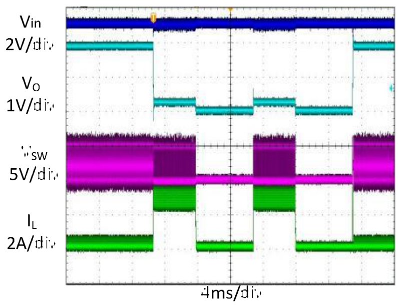
0 A LOAD



Short Circuit Protection

VIN=5V, Vout=1.8V

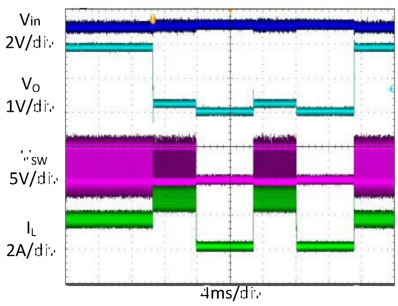
Iout=0A- Short



Short Circuit Protection

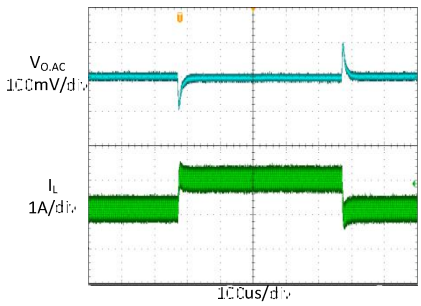
VIN=5V, Vout=1.8V

Iout= 2A- Short



Load Transient

1A LOAD 2A LOAD 1A LOAD



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TYPICAL PERFORMANCE CHARACTERISTICS (continued)

Vin = 5V, Vout = 1.8V, L = 2.2μH, Cout = 22μFx2, TA = +25°C, unless otherwise noted

Pin short test

Items	Phenomenon	Items	Phenomenon
GND short to EN	Normal	SW short to EN	Normal
GND short to FB	Normal	SW short to FB	Normal
GND short to SW	Normal	SW short to VIN	Normal
GND short to POK	Normal	SW short to POK	Normal
VIN short to FB	Normal	BST short to EN	Normal
VIN short to EN	Normal	BST short to FB	Normal
EN short to FB	Normal		

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FUNCTIONAL DESCRIPTION

The AXP8020 is a synchronous, current-mode, step-down regulator. It regulates input voltages from 2.5V~6V down to an output voltage as low as 0.6V, and is capable of supplying up to 2A of load current.

Current-Mode Control

The AXP8020 utilizes current-mode control to regulate the output voltage. The output voltage is measured at the FB pin through a resistive voltage divider and the error is amplified by the internal transconductance error amplifier.
Output of the internal error amplifier is compared with the switch current measured internally to control the output current.

PFM Mode

The AXP8020 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.

Shut-Down Mode

The AXP8020 shuts down when voltage at EN pin is driven below 0.4V. The entire regulator is off and the supply current consumed by the AXP8020 drops below 1uA.

Power Switches

P-channel and N-channel MOSFET switches are integrated on the AXP8020 to down convert the input voltage to the regulated output voltage.

Dropout Operation

The AXP8020 allows PFET to remain on for more than one switching cycle and increases the duty cycle while input voltage is dropping close to output voltage. When duty cycle reaches 100%, PFET is held on continuously to deliver current to output up to PFET current limit. The output voltage then is input voltage minus voltage drop across PFET and inductor.

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 AXP8020 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.

Short Circuit Protection

When output is shorted to ground, the switching frequency is reduced to prevent the inductor current from increasing beyond PFET current limit. If short circuit condition holds for more than 1024 cycles, both PFET and NFET are forced off and can be enabled again after 8mS. This procedure is repeated as long as short circuit condition is not removed.

SW Short Circuit Protection

When SW is shorted to ground, NFET will be turned off after inductor current drops to zero, and then both PFET and NFET are latched off. Only toggling EN or VIN UVLO/OVP can PFET and NFET be enabled again.

FB Short Circuit Protection

When FB is shorted to ground and holds for more 16 cycles, NFET will be turned off after inductor current drops to zero, and then both PFET and NFET are latched off. Only toggling EN or VIN UVLO/OVP can PFET and NFET be enabled again.

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Thermal Protection

When the temperature of the AXP8020 rises above 150°C, it is forced into thermal shut-down.

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

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APPLICATION INFORMATION

Output Voltage Set

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

$$V_{FB} = V_{OUT} \bullet \frac{R_2}{R_2 + R_3}$$

where V_{FB} is the feedback voltage and VOUT is the output voltage.
Choose R2 around 10kΩ, and then R3 can be calculated by:

$$R_3 = R_2 \bullet (\frac{V_{OUT}}{0.6V} - 1)$$

The following table lists the recommended Values.

VOUT(V)	R2(kΩ)	R3(kΩ)
1.2	10.2	10.2
1.8	10.2	20.5
3.3	10.2	46.2

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 10uF 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

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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.

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 AXP8010 (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.

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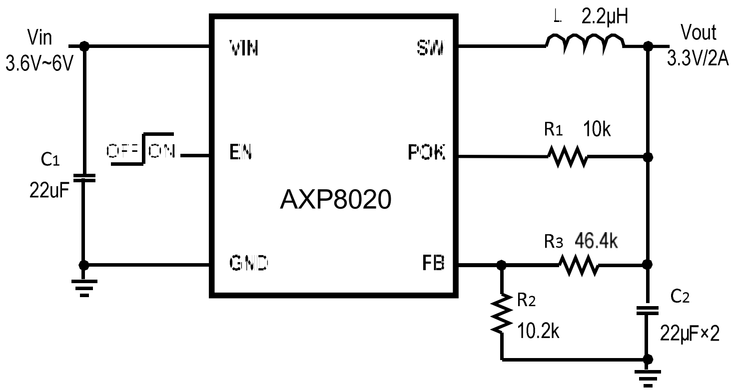
REFERENCE DESIGN

Reference 1:

V_{IN}: 3.6V ~ 6 V

V_{OUT}: 3.3V

I_{OUT}: 0~2A

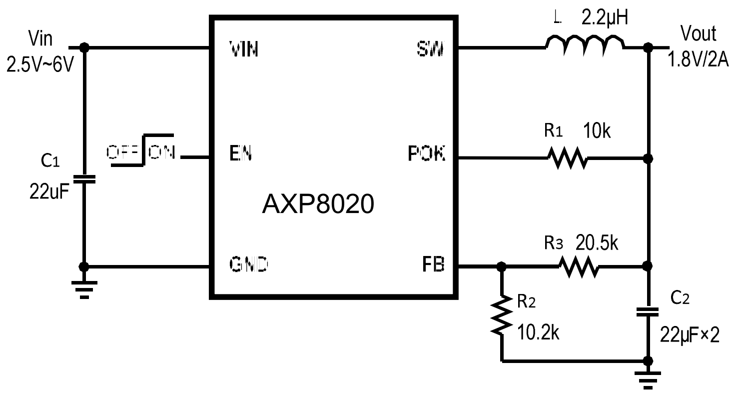


Reference 2:

V_{IN}: 2.5V ~ 6 V

V_{OUT}: 1.8V

I_{OUT}: 0~2A



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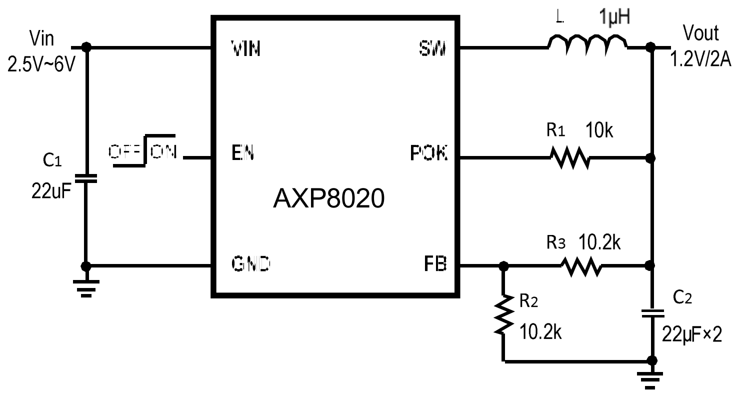
Reference 3：

V_{IN}: 2.5V ~ 6 V

V_{OUT}: 1.2V

I_{OUT}: 0~2A



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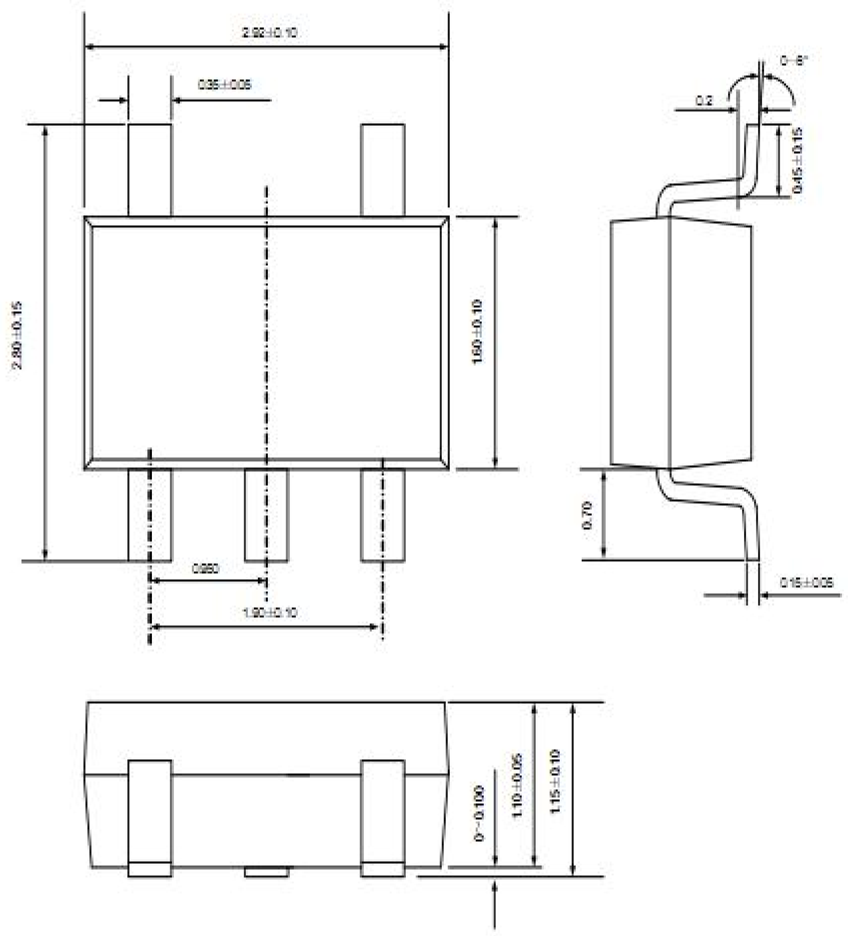
PACKAGE OUTLNE

SOT23-5 **UNIT: mm**



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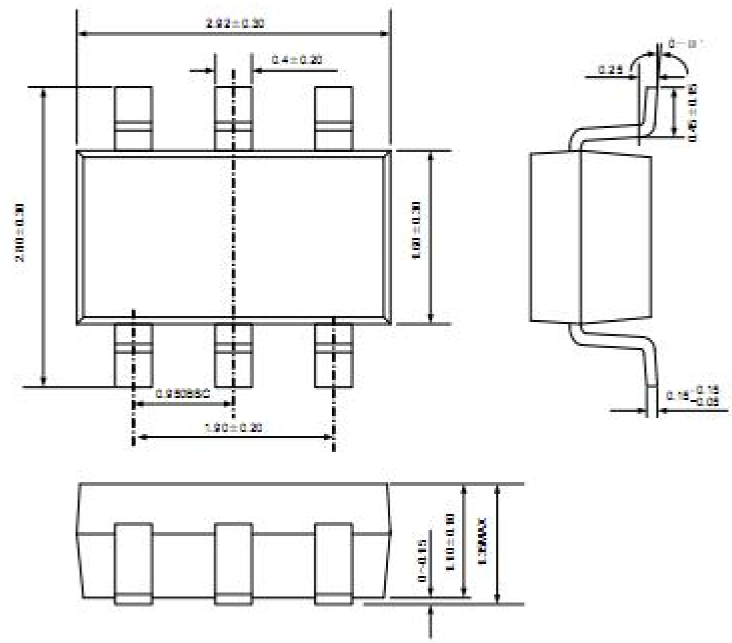
SOT23-6 **UNIT: mm**



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